



HAL
open science

Making the Seafloor. French Geologists, Marine Resources, and New Deep Territories (1945-1975)

Beatriz Martínez-Rius

► **To cite this version:**

Beatriz Martínez-Rius. Making the Seafloor. French Geologists, Marine Resources, and New Deep Territories (1945-1975). History, Philosophy and Sociology of Sciences. Sorbonne Université, 2022. English. NNT : 2022SORUS284 . tel-03888988

HAL Id: tel-03888988

<https://theses.hal.science/tel-03888988>

Submitted on 7 Dec 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Sorbonne Université

École Doctorale Géosciences Ressources Naturelles et Environnement (ED 398)

Institut des Sciences de la Terre de Paris

Making the Seafloor

French Geologists, Marine Resources, and New Deep Territories

(1945-1975)

Beatriz Martínez-Rius

Thèse de doctorat en Histoire des Sciences

Dirigée par Nestor Herran, Laurent Jolivet, et David Aubin

Présentée et soutenue publiquement le 14 Juin, 2022

Devant un jury composé de :

AUBIN, David (Professeur, Co-directeur)

CAMPRUBÍ, Lino (Chercheur)

GREVSMÜHL, Sebastian (Chercheur)

HERRAN, Nestor (Maître de Conférences, HDR, Co-directeur)

JOLIVET, Laurent (Professeur, Co-directeur)

PETIT, Carole (Professeur)

ROZWADOWSKI, Helen (Professeur, Rapporteur)

TURCHETTI, Simone (Lecturer, Rapporteur)

Para Javi, por tanto.

Acknowledgements

My first and most sincere acknowledgement goes to Nestor Herran, my supervisor, who has accompanied me in this adventure from start to finish. He has patiently taught me the historians' craft, has guided me with infinite advices, and has always had his office's door open for me. I would also like to express my gratefulness to Laurent Jolivet and David Aubin, who have co-supervised this thesis. Laurent Jolivet has counsel me on how to integrate geologists' perspective in my research, and has lectured me on the Mediterranean's geology. David Aubin has provided numerous insights to this research, during our meetings or in his reviews on previous drafts.

This research is framed in the European project SALTGIANT ETN, and has been funded by the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie grant agreement No. 765256. Being part of SALTGIANT has been a life experience, not only for enabling me to conduct this research but especially for widening my perspectives beyond history, for revealing me the marvels of field (or sea) work, and for introducing me wonderful people from the scientific community – with whom I hope to keep on collaborating in the future. I am especially grateful to Giovanni Aloisi and Angelo Camerlenghi for warmly welcoming a historian in their community, and for being always keen to chat about their past experiences, anecdotes, and perspectives; to Daniel García-Castellanos and Paul Meijer for enthusiastically engaging in historical discussions; and – last but not least – to my SALTGIANT PhD fellows: Francesca, Hanneke (who has made the bathymetrical maps here presented – I owe you one!), Fadl, Athina, Federico, Laetitia, Ronja, Simon, Maria, Simon, Jimmy, Michael, Gaia, and Mariam. Their support has been invaluable.

I would not be writing these words without the guidance of Lino Camprubí. He introduced me to the world of the history of science, and his work, his example as researcher and as person, have been a source of inspiration for my research. I can only express to him my biggest thanks. I would also like to thank Sam Robinson, for his kind advices and reviews, for being always available for a chat, and for introducing me to the community of historians of science and diplomacy, and to the experts in the history of the oceans. Likewise, I am grateful to the historians of the Commission on Science, Technology and Diplomacy (STAND) and of the International Commission of the History of Oceanography (ICHO), for making me feel part of their community, and for their support.

From January to March 2020 Peder Roberts and Sabine Höhler warmly welcomed me at the KTH. I am thankful to them, as well as to the researchers, PhDs, and postdocs at the Division of History of Science, Technology, and Environment for the stimulating months I could spend there. I am also grateful to the ISTeP, their researchers and PhD candidates, for hosting and accompanying me during these years. Christian Gorini and Sebastian Grevsmühl have followed the development of this research from its first year, I would like to thank them for their helpful insights.

Archivists always deserve a great deal of credit in historical research. I would like to thank to librarians at the Library of Geosciences and Environment (Sorbonne University) for moving heaven and earth to provide me with ancient PhD thesis, books, and journals. At the Special Collections of the University of California San Diego, Jennifer Donovan and Heather Smedberg became my eyes and hands. They patiently reviewed the documents contained in untapped boxes, reported me, and scanned for me more than two-hundred pages. Part of this research could not have been achieved without their work. I would also like to thank archivists at the Archives Historiques du Groupe TOTAL and at the Archivio Storico Eni for their careful and personalized attention; as well as to archivists at the Archives Historiques du CNRS, Archives Nationales de France, Archives Diplomatiques de France, Service Historique de la Défense, and special collections at the Muséum National d'Histoire Naturelle.

By being part of SALTGIANT and by working at the ISTeP I could to meet and interview retired geologists and geophysicists. I have received immense kindness from them, and I cannot be more grateful to (in the order I met them) Jean-Marie Rouchy, Lucien Montadert, Catherine Pierre, Jean Letouzey, Jean-Pierre Suc, Xavier le Pichon, Gian Battista Vai, Alain Mauffret, Rinaldo Nicolich, Bill Ryan, Pierre-Rene Bauquis, Gilbert Boillot, Jean Mascle, and Edith Vincent Lancelot; who opened to me their memories, homes, and offices. I hope this thesis does justice to part their past. All mistakes are mine.

To all my family, and especially my father, my grandma Carmen, and Eli – who has tirelessly been by my side, with her numerous visits to Paris and her daily calls. My deepest thanks to each of you for your unconditional support.

To my mother, who is not anymore among us. Her life example of fortitude and love survives, being a source of strength every day.

Words fail to express my gratitude to Javi.

Contents

Acknowledgements	3
List of figures	7
List of tables	8
Acronyms and abbreviations	9
Chapter 1. Introduction	11
1.1. Industrial money and marine geosciences	15
1.2. The quest for new deep territories	23
1.3. From fieldwork to archives: Sources and research methodology	28
1.4. From the shore to the deep ocean crust: structure of this dissertation	35
1.5. Explanatory note on stratigraphic periods	38
Chapter 2. From mainland to the offshore: Jacques Bourcart and military patronage	39
2.1. The history of the Mediterranean basin from mainland	41
2.2. Submarine warfare and the roots of marine geosciences	46
2.3. The onset of the offshore oil industry in the US	51
2.4. The French strategy in the oceans	57
2.5. The (short-lived) military-supported marine geology	66
Chapter 3. International science, fundamental research, marine geophysics	69
3.1. The oceans at the international spotlight	71
3.2. Marine sciences in the political agenda	78
3.3. A new research tool box: geology, physical methods, and oceanographic logistics	87
3.4. Seeing below the seabed	105
Chapter 4. From fundamental research to the valorization of the oceans: Towards an ocean policy soaked with oil	107
4.1. Turning to the oceans: the renewal of a national oil industry	109
4.2. Technologies, experts, and surveys: the take-off of offshore oil exploration	116
4.3. Shifting priorities: a new perception of the oceans and the inception of an oceanic policy	129
4.4. A new economic frontier	137
Chapter 5. Hybrid research across the continental shelf: the Centre National pour l'Exploitation des Océans	139
5.1. A new national center to exploit the oceans	140
5.2. Exploring natural resources in foreign and international seawaters	150

5.3. Controlling data flows in the continental shelf's mapping	164
5.4. The removal of boundaries between academic and industrial research	175
Chapter 6. Science diplomacy and the common heritage of mankind: Anticipating the exploitation of the high sea	177
6.1. Towards a new jurisdictional framework to exploit the high seas	179
6.2. Franco-American diplomatic relations through the CNEXO	187
6.3. Controlling distant oceans: the quest to exploit polymetallic nodules	197
6.4. Franco-Soviet relations in the exploitation of the oceans	209
6.5. Oceanic diplomacy to anticipate the exploitation of marine richness	218
Chapter 7. Drill ships and deep oil: commercial exploration through scientific cooperation	220
7.1. The discovery of the Messinian Salinity Crisis: A scientific account	222
7.2. Salt domes in deep waters	231
7.3. The deep Mediterranean, a new energy frontier	241
7.4. The aftermath of DSDP campaigns in the Mediterranean	253
7.5. The place of the oil industry in the seafloor's knowledge production	256
Coda. (Mis)understanding academic-industrial relations	259
Chapter 8. Conclusion	262
8.1. French geologists and marine resources	262
8.2. New deep territories	267
8.3. Limitations and avenues for future research	271
Bibliography	278
Annex	308
Detailed table of contents	312
Abstract	316
Résumé	317

List of Figures

Figure 1. Jacques Bourcart.....	40
Figure 2. Model by Shepard of submarine canyons found off New England coast.....	49
Figure 3. Chart on the continental shelf's topography of the French Mediterranean	62
Figures 4. Kullenberg's piston corer onboard the Swedish vessel <i>Albatross</i>	64
Figure 5. Two oceanographers operating a Kullenberg piston corer.....	64
Figure 6. Working schema of reflection seismics.	89
Figure 7. Olivier Leenhardt and Harold Edgerton testing the 'Boomer'.	93
Figure 8. Vignette in Le Figaro's newspaper.....	94
Figure 9. Seismic profile acquired by Leenhardt.	98
Figure 10. Cross-section view of a salt dome	102
Figure 11. Reflection seismic profile and its interpretation, acquired in the Ligurian sea onboard the <i>Calypso</i>	105
Figure 12. The North Sea's approximate territorial division after UNCLOS I.....	111
Figure 13. Schema of a <i>Flexotir</i>	120
Figure 14. A <i>Flexotir</i> , operated by IFP technicians.	122
Figure 15. The IFP's <i>électrocarottier</i> being lowered.....	122
Figure 16. The oceanographic vessel <i>Jean Charcot</i>	131
Figure 17. Yves la Prairie discussing with General Charles de Gaulle, circa 1965.....	146
Figure 18. Seismic profile acquired with <i>Flexotir</i> during the campaign GUINÉE I	155
Figure 19. The oceanographic vessel <i>Jean Charcot</i> , sailing across the Labrador Sea.	156
Figure 20. Map depicting the route of NORATLANTE I and NESTLANTE I	160
Figure 21. Cruise NESTLANTE II	163
Figure 22. Bathymetric map of the Bay of Biscay.....	166
Figure 23. Map depicting the regions surveyed by oil companies in the Bay of Biscay.	173
Figure 24. Deep-sea diving submersible <i>Cyana</i> during FAMOUS	195
Figure 25. Deep-sea diving submersible <i>Archimède</i> during FAMOUS.....	195
Figure 26. Yves la Prairie on his first official trip to Japan	200
Figure 27. Aerial view of the Centre Océanologique du Pacifique in 1975	208
Figure 28. The D/V <i>Glomar Challenger</i>	221
Figure 29. Leg 13's scientific crew	224
Figure 30. Gibraltar Millennium Stamp,.....	230
Figure 31. The <i>Glomar Challenger</i> 's drill sites in the Gulf of Mexico.	234
Figure 32. The <i>Glomar Challenger</i> 's drill sites across the Mediterranean, Leg 13.....	238

Figure 33. Seismic profiles Augusta, acquired with multichannel reflection seismics.....	245
Figure 34. Drill sites during the Glomar Challenger's leg 42, in 1975.....	250
Figure 35. International Chronostratigraphic Chart, 2022.	308
Figure 36. Regions of the Mediterranean basin.	309
Figure 37. Regions of the western Mediterranean basin.	309
Figure 38. Continental margins	310

List of Tables

Table 1. Budget allocation planned by the COMEXO in 1960, for a four year period.	84
Table 2. Contribution of different institutions to the national program to map the Atlantic continental shelf	168
Table 3. Presentations during the 1970 Symposium on the By of Biscay	172
Table 4. Public investment in ocean research (in 1970 million US dollars).....	186
Table 5. Exploratory activity in the Gulf of Mexico's continental shelf..	232
Table 6. Boreholes drilled by oil companies at more than 200m depth (October 1978).	254

Frequently used Acronyms and Abbreviations

AFERNOD	Association Française pour l'Étude et la Recherche des Nodules Polymétalliques
API	American Petroleum Institute
BRP	Bureau de Recherche de Pétrole
CCRST	Comité Consultatif de la Recherche Scientifique et Technique
CEA	Commissariat à l'Énergie Atomique
CEPM	Comité d'Études Pétroliers et Marines
CFP	Compagnie Française des Pétroles
CIESM	Commission Internationale pour l'Exploration Scientifique de la Méditerranée
CNES	Centre National d'Études Spatiales
CNRS	Centre National de la Recherche Scientifique
COB	Centre Océanologique de Brest
COEC	Comité d'Océanographie et des Études des Côtes
COMEXO	Comité d'Études Exploitation des Océans
CUSS	Continental Union Shell Superior (consortium)
DGRST	Délégation Générale de la Recherche Scientifique et Technique
DDP	Deep Sea Drilling Project
ERAP	Entreprise de Recherches et d'Activités Pétrolières
FAMOUS	French-American Mid-Ocean Undersea Study
IFP	Institut Français du Pétrole
IGY	International Geophysical Year
IODP	Integrated Ocean Drilling Program (2003-2013) / International Ocean Discovery Program (2013 -)
IPOD	International Program of Ocean Drilling
MNHN	Muséum National d'Histoire Naturelle
ODP	Ocean Drilling Program
OPEC	Organization of the Petroleum Exporting Countries
RAP	Régie Autonome des Pétroles
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organization

Abbreviations for Archives

ADF	Archives Diplomatiques de France
AHT	Archives Historiques du Groupe TOTAL
ANF	Archives Nationales de France
SHD	Service Historique de la Défense
UCSD	University of California San Diego Historical Collections

Chapter 1. Introduction

At the narrowest part of the Straits stand mountains on either side, enclosing the channel, Ximiera in Africa and Gibraltar in Europe; these were the limits of the labors of Hercules, and consequently the inhabitants call them the Pillars of that deity, and believe that he cut the channel through them and thereby let in the sea which had hitherto been shut out, so altering the face of nature.¹

Pliny the Elder, *Historia Naturalis*

Only fourteen kilometers separate Africa from Europe through the Strait of Gibraltar. To the west opens the vast Atlantic Ocean, whose boundaries were unknown to Mediterranean peoples until the fifteenth century. To the east, their sea expands: explored, sailed, and charted since the time of the Phoenicians.² Given its semi-enclosed shape and its well-known coastline, it is no wonder that the Ancients imagined that, if the Strait of Gibraltar were to collapse, the entire Mediterranean basin could become an arid desert – as Roman natural philosopher Pliny the Elder noted in his *Historia Naturalis* (77 C.E.).

I first heard about the Mediterranean becoming a desert not by means of classical literature, but through geologists, when I engaged in the project SALTGIANT at the start of this PhD research. There I dove into a community completely foreign to me: I met geologists, geophysicists, micropaleontologists and geochemists, senior scholars and PhD researchers, who recounted me with passion stories about events that happened millions of years ago, drove me across mounts that were remnants of ancient coral reefs, taught me how to “look” below the seabed’s surface without touching a single stone, and crafted on paper hypothetical landscapes of places and epochs that we will never experience. They explained to me that six million years ago, the seawater filling the Mediterranean basin could have evaporated, leaving at its place a wide desert-like landscape, patched with brackish lakes and salt marshes.

The narrative accompanying this account was what historian Adrian Wilson has called “scientists’ imagined past”: a scientific genealogy that traces back the development of

¹ Pliny the Elder, “Natural History;” Garcia-Castellanos and Vidal, “Alternative Mediterraneans Six Million Years Ago”.

² The history of the Mediterranean Sea as a surface to connect peoples and cultures from the Ancient times is recounted in: Abulafia, *The Great Sea*.

geologists' research lines, from the first evidences suggesting a desert-like Mediterranean up to their current knowledge, going through innumerable scientific debates and controversies.³ Geologists' narratives, heading the opening section of their academic publications, set August 1970 as the point of departure for research lines focused on the desert-like Mediterranean. The only scientific drillship in the world operated by the international scientific program Deep Sea Drilling Project, the *Glomar Challenger*, for the first time then recovered geological samples at thousands of meters' depth, offering material evidences that the Mediterranean basin could have become a deserts landscape in a distant past.

I grew captivated by the geological stories and historical discoveries they recounted to me. Yet, what fascinated me the most was the pervasive presence of the oil industry. Some of my colleagues had been previously employed by oil companies, while industrial experts participated in almost all of our meetings, shared data and samples recovered during oil exploration activities, or hosted us at their research laboratories. When oil experts were not present, academic geologists discussed how to obtain their samples or to strike fruitful collaborations with industrial institutions. Through my outsider's eyes, I began wondering what kind of sneaky relationship existed between geologists' community and the oil industry, a domain characterized by its secrecy, its deliberate construction of doubt and ignorance, and the relentless and potentially catastrophic environmental impact it promotes.⁴ Yet, I soon realized that these relationships offered a different outlook of *what is* the oil industry, drawing my cautionary attention to gaps in a fine-grained understanding of academic-industrial networks of patronage and cooperation. Slowly emerged in me the conviction that a more nuanced perspective on how oil industry secrecy works and, more generally, on its role in building (or hindering) the production of scientific knowledge were needed.

This research aims at illuminating relationships between extractive industries and the marine sciences in the construction of knowledge about the seafloor. From this perspective, the departure point of scientists' narratives can be reinterpreted as a climax in the story of how geologists had managed to put large and distinctive oil industry technologies at the service of their scientific interests. This research, therefore, looks at the prehistory of scientists' narratives: from the aftermath of World War 1 to the late 1970s, a time period in which growing

³ Wilson, "Science's Imagined Pasts." The term draws inspiration from Anderson, *Imagined Communities*.

⁴ Oreskes, *Merchants of Doubt*; Proctor and Schiebinger, *Agnology*; Bonneuil, Choquet, and Franta, "Early Warnings and Emerging Accountability."

international, economic, and political interests were projected onto the seafloor.⁵ I follow French academic scientists, petroleum geologists, and government officers, tracing their activities and movements to connect research laboratories, governmental structures, oil companies, and international forums. The term “marine geosciences,” central to this dissertation, encapsulates disciplines and techniques used in the study of phenomena and processes related to the seafloor, including theories and approaches from modern dynamics and sediment formation, marine geophysical techniques and tectonics, volcanology, geochemistry, microbiology, or paleontology. It is not a scientific discipline, but a heterogeneous set of experts, practices, and disciplines.⁶

This thesis is an inquiry into the ways in which some patrons’ motivations to explore the seafloor drove the production of knowledge about it. This question draws inspiration from the most recent work of historian Naomi Oreskes, *Science on a Mission*, a timely contribution that revitalizes the study on how military patronage and its secrecy regime shaped sciences.⁷ Focusing on American oceanographers and the ocean sciences from the aftermath of World War 1, Oreskes argues that military funding was both enabling and constricting: while it was instrumental in producing knowledge about the oceans and their seabed, it also created long-lasting and consequential domains of ignorance.⁸ The Navy’s pressing operational needs defined the research agenda of American oceanographic institutions either straightforwardly, by a selective allocation of funds to research lines of major national security interest, and by embedding research in secret programs; or through more ambiguous mechanisms, like choosing collaborators according to their suspected political biases, discouraging researchers from pursuing particular research lines due to a lack of access to relevant data, or simply by not making them know that the Navy possessed certain pieces of information. Beyond the singularities of military priorities, Oreskes’ work reveals that the motivations of one or another patron have epistemological consequences on scientific development, since patrons – being the military, big corporations, oil companies, or even public organisms – pursue their own non-scientific goals by means of producing scientific knowledge: commercial revenues, applied

⁵ To frame this time period in previous and later developments on the oceans’ history, see the outstanding work: Rozwadowski, *Vast Expanses*.

⁶ Thiede et al., “Marine Geosciences: A Short, Eclectic and Weighted Historic Account.” For an account on scientific disciplines, its definition, and multiple pathways of consolidation, see: Vinck, *The Sociology of Scientific Work*, 61-76.

⁷ Oreskes, *Science on a Mission*.

⁸ *Ibid.*, 14.

uses, or national prestige, obtaining key assets for negotiating diplomatic relations or influencing public opinion. These motivations are not necessarily at odds with researchers' interests, nor are necessarily detrimental to knowledge production, but certainly have influence: they shape the development of science and, I shall add, the environments they study.⁹

I approach this inquiry from two complementary perspectives: first, I focus on the institutional, political, and logistic settings through which the seafloor was explored, charted, and exploited, asking through which mechanisms the patron's motivations drove the production of knowledge; and, second, I look at the seafloor as territory, which is shaped by contemporary geopolitical concerns and, in turn, as knowledge about it accrues, has influence on such concerns. The goal of this thesis is thus twofold: to provide new insights on the impact of patronage relations in technoscientific production by offering a different perspective from previous accounts of ocean sciences in the Cold War (which are mostly focused on military patronage); and to integrate the oceans as territories in the context of decolonization. The history of the oceans and the marine sciences from the aftermath of World War 2 has been framed in the Cold War context, pervaded by its characteristic tensions and frictions. Incorporating the international dynamics, anxieties, and imaginaries emerging from the twilight of colonialism is essential to develop a comprehensive overview of the oceans' history, and has the potential to enhance our understanding of contemporary global issues and concerns.

The history of the seafloor exploration is therefore a story about anticipation in a still-unknown environment: preparing a future economic scenario reliant on the exploitation of submerged mineral and energy resources, long before it was technologically possible and economically feasible to extract them. My research suggests that, in their pursuit to access, tame, and control a new territory, the oil industry and the French administration directed funds at knowing, and eventually extracting, natural resources from the seafloor: this, ultimately, is what drove technological development and defined the regions to be surveyed and the topics to be explored.

In this introduction, I first explain why we need to focus on the oil industry's support of sciences. I then discuss how two key elements – patronage networks and secrecy – have been addressed in the literature and outline my own approach to both elements. The second section

⁹ Studies on how military patronage shaped scientific outcomes inaugurated in 1981 with Paul Forman's work, where he argued that the US military funding was deviating physicists priorities from producing fundamental knowledge to employ large, cutting-edge, and expensive technologies. This hypothesis, largely explored in the history of science, is known as the "distortionist hypothesis" (in: Forman, "Behind Quantum Electronics." Hounshell has characterized this and other debates in Cold War historiography in: Hounshell, "Rethinking the Cold War").

focuses on the seafloor's emergence as a new territory, by discussing how different bodies of literature have broached the topic and emphasizing the contributions this thesis aims to make to this subject. In a third section, I present the sources mobilized and the methodology used in the thesis. A final section details the chapters' structure throughout which the thesis' main arguments unfold.

1.1. Industrial money and the marine geosciences

In 2012, scholar David Edgerton encouraged historians to “follow the money,” paraphrasing informant Deep Throat, from the Watergate case, who advocated this method to identify situations in which funding agencies and recipients were not being frank.¹⁰ Edgerton's claim has become a maxim for historians of science keen on tracing military, commercial, or geopolitical motivations that supported scientific research, and analyzing their impact on knowledge produced. Naomi Oreskes has referred to this money as “tainted money”: funding that has the potential to subvert scientific research by promoting malpractices, creating controversy where there earlier was consensus, or by building ignorance.¹¹ Examples from the latest part of the twentieth century are ubiquitous: in the eighties, the tobacco lobby funded scientific research to discredit evidences linking tobacco with cancer; almost simultaneously, the American Petroleum Institute promoted misinformation about the connections between CO₂ emissions and global warming.¹² After Chernobyl's nuclear catastrophe, governmental standards to measure radiation invisibilized health hazards; while big pharmaceutical corporations have mechanisms to produce their own research, to smoothly integrate it in the medical sciences.¹³

Money from the oil industry falls into the category of tainted money, and there are reasons to consider that it has a subverting influence on science as more and more cases surface showing its detrimental impact on the production of scientific knowledge, on society, and on political decision-making. We have now historical evidences confirming that oil firms like TOTAL, Exxon-Mobile, or Royal Dutch-Shell have been downplaying the environmental impact of their

¹⁰ Edgerton, “Time, Money, and History.” See also: Andersen, Bek-Thomsen, and Kjærgaard, “The Money Trail.”

¹¹ In: Oreskes, *Science on a Mission*. This topic can also be addressed from the field of agnotology, the study of how ignorance is produced (see: Proctor and Schiebinger, *Agnotology*.)

¹² Oreskes, *Merchants of Doubt*; Bonneuil, Choquet, and Franta, “Early Warnings and Emerging Accountability;” Kuchinskaya, *The Politics of Invisibility*.

¹³ Sismondo, “Epistemic Corruption, the Pharmaceutical Industry, and the Body of Medical Science.”

activities and crafting doubts about climate change since the 1970s.¹⁴ Yet, wealthy patrons as the oil industry or the military are not monolithic structures but complex, intertwined working mechanisms that operate at different levels, where individuals – from oil geologists to corporate managers – navigate and establish relations outside the network. Their impact on the production of scientific knowledge is therefore also multidimensional.

Funding from the oil industry calls for the attention of historians of science precisely because of the overwhelming evidence of its detrimental impact on the production of scientific knowledge, and the scarcity of contributions pointing to different directions and connections. Over the last decades, historians have tried to deconstruct military patronage relations, showing their ambivalent impact on sciences and knowledge production. Likewise, we should also address the myriads of ways in which the oil industry's extractive motivations inform science. Historian Tai Kreidler dubbed the oil industry "the unknown kingdom" in his 1997 dissertation.¹⁵ Its records are difficult to access because confined to private archives and, as he asserts, increasingly so, as oil companies armor themselves against public criticism while marketing a benign public image.¹⁶ Some historical accounts of the oil industry have been subsidized by oil companies (and tend to neutralize controversies); meanwhile, historical research on technological innovation or offshore oil exploration tend to focus on the inner dynamics of oil companies, without tracing connections with academic science or public organisms.¹⁷

In this research I follow the money trail from public and private sources that were interested in exploiting seafloor resources, all the way down to its materialization in marine geological research.¹⁸ To start, it is necessary to outline the singularities of France's oil industry to understand its characteristics as a patron to the sciences. Instead of a collection of independent private firms, the French oil industry was composed of oil companies and oil-related institutions

¹⁴ Bonneuil, Choquet, and Franta, "Early Warnings and Emerging Accountability;" Kuchinskaya, *The Politics of Invisibility*; Supran and Oreskes, "Addendum to 'Assessing ExxonMobil's Climate Change,'" n.a. "A crack in the Shell."

¹⁵ Kreidler, *The Offshore Petroleum Industry*.

¹⁶ Ibid.

¹⁷ For example, Taylor Priest's study on Shell's technological innovation to explore the offshore (Priest, *The Offshore Imperative*), or on the oil-tech company Brown & Root (Pratt, Priest, and Castaneda, *Offshore Pioneers*). Burleson's book is based on archival documents from the oil-tech company Glomar Inc. (Burleson, *Deep Challenge!*). In other cases, oil companies produce their own historical accounts (for instance TOTAL: Gaston-Breton, *Total, Un Esprit Pionnier* or the Institut Français du Pétrole: Lacour, *Terre d'innovations*). A notable exception is Van Keuren, "Breaking New Ground," where the author traces the oil industrial origins of technologies for scientific deep-sea drilling.

¹⁸ Andersen, Bek-Thomsen, and Kjærgaard, "The Money Trail."

completely or partially subsidized by the French government: the state owned one third of the *Compagnie Française des Pétroles* (CFP), the main oil firm created in 1924; the *Société Nationale des Pétroles d'Aquitaine* (SNPA) was a national firm inaugurated in 1941; and the *Entreprise de Recherches et d'Activités Pétrolières* (ERAP) was born in 1965 after the merger of the *Bureau de Recherches de Pétrole* (BRP) and the *Régie Autonome des Pétroles* (RAP), which were both public institutions.¹⁹ Because of its dependence on government, its connection to state goals, and its funding system, the patronage structure of France's oil industry is closer to military patronage than to funding relations among private corporations: in short, the state was in France the main actor both in military domain and in the oil industry.²⁰ In this introduction, therefore, I anchor my analytical approaches in the solid body of scholarly literature about military patronage in the ocean sciences, drawing fruitful comparisons and tracing continuities and discontinuities.

This thesis suggests that, in France, funding from the oil industry directed at exploring natural resources from the seafloor gave birth to the research field of the marine geosciences, which was embedded in big science, political-led settings, reliant on industrial-academic networks in which trade secrecy dissolved. Through these mechanisms, a political elite related to the oil industry succeeded in driving the seafloor's exploration. The term "big science" was first proposed in 1961 by American physicist Alain Weinberg, director of the Oak Ridge National Laboratory (formerly involved in the Manhattan Project), to raise concern about the exorbitant national investment on mammoth fundamental research programs, based on large, complex, and expensive technologies (particle accelerators, space rocketry, or astronomic telescopes) and its ruinous effects on science and the economy.²¹ He compared big science projects to monuments of the modern era: a political hubris manifesting national power through large-scale, unpractical constructions. Historian Jeff Hughes later encapsulated the five defining features of big science: Money, manpower, machines, media, and the military – which provided funding or directed some goals – at large scale.²² In the following decades academic literature has enlarged this meaning, decentering it from big instruments to suggest that data-driven, cooperative projects (as the International Geophysical Year) can also be regarded as big

¹⁹ About France's oil industry, see: Nouschi, *La France et le Pétrole*; Vindt, "De la CFP à Total."

²⁰ It could be argued that private corporations can influence and even integrate in government stances through lobbies. Unlike these cases, in France oil companies were an integral part of the Ministry of Industry, not an external group exerting pressure or with decision-making power.

²¹ Weinberg, "Impact of Large-Scale Science on the United States."

²² Hughes, *The Manhattan Project*.

science.²³ The chronological framework has also been expanded beyond the twentieth century (the HSM *Challenger* oceanographic expedition, for instance, complies with the criteria to be considered as Victorian big science); and a number of works have moved away from military patronage and fundamental science, showing how nonmilitary programs such as the Human Genome Project can also be successfully approached as big science.²⁴ In this work, big science is evoked to emphasize the growing entanglement of the marine geosciences with new forms of institutional, political, social, and organizational settings aimed at achieving big state goals: secure energy supplies, gain in national prestige, and strengthen France's presence in international seaways.²⁵

The embedding of ocean research in structures of political power has been mainly approached from the perspective of the military-industrial complex. Observers point to the converging interests that led to the establishment of patronage relations: oceanographers needed a wealthy patron who could provide money, vessels, and research technologies to access the depths, while the US Navy wished to enhance its understanding of the marine environment primarily for the conduct of its own, secretive underwater operations.²⁶ Some classical questions addressed by the historical literature have brought nuance to the impact of military patronage on scientific production by inquiring about who hold agency in constructing patronage or cooperative relations, who exerted control over the scientists' intellectual agenda, or how oceanographers navigated between military and scientific governing bodies.

This literature shows that stable patronage relations do not simply consist of pouring money into action-oriented research, but of crafting a framework in which researchers still have some flexibility to pursue their desired research lines, while patrons maintain some control over the orientation of research towards the outcomes they want to achieve.²⁷ This middle-ground needs to be negotiated either through social mechanisms or by the organization of a funding

²³ Aronova, Baker, and Oreskes, "Big Science and Big Data in Biology."

²⁴ Solla, *Little Science, Big Science*; Burstyn, "'Big Science' in Victorian Britain;" Kelves, "Big science and big politics." Recent works on big science seek continuities and discontinuities between big science projects in the 20th and 21st century, pointing to its current orientation to achieve social and welfare goals (for a review on recent trends in the study of big science, see: Cramer, *A Political History of Big Science*).

²⁵ In: Helvy, "Reflections on Big Science and Big History," the author considers this institutional elements as definitory of big science.

²⁶ About the intrinsic dependency of ocean exploration to technologies that mediate between human senses and the depths, see: Camprubí and Lehmann, "The Scales of Experience;" Camprubí, "Experiencing Deep and Global Currents at a 'Prototypical Strait';" Rozwadowski et al., *The Machine in Neptune's Garden*; Höhler, "Depth Records and Ocean Volumes."

²⁷ A clear example is found in: Oreskes, "A Context of Motivation."

mechanism. Although not always explicitly articulated, these mechanisms have been specified in numerous historical accounts of military patronage and the ocean sciences, ranging from to the crucial role played by mediating actors to the creation of new institutional settings. For historian Gary E. Weir, mediating oceanographers were the key mechanism of success. Tracing the expanding relationships between US naval officers and oceanographers from World War I, Weir labeled military-academic relations as a convenient, but far from natural partnership that needed “translators” (frequently oceanographers) who could articulate priorities, value systems, and expectations between both communities to reach a mutual understanding.²⁸ Jacob Hamblin sided with Weir in pointing out the relevant role played by the heads of oceanographic institutions who, besides attending international congresses, participated in military meetings as advisors, thus hybridizing the motivations behind international cooperative projects. As Hamblin argues, oceanographers strongly supported building patronage relations with the US Navy, actively seeking to convert policy-makers into “disciples of the marine sciences” fully committed to the oceanographers’ causes.²⁹ Historian Ronald Rainger agreed with Hamblin, detailing how oceanographer Roger Revelle, director of the Scripps Institution of Oceanography, actively aligned the center’s research lines with the US Navy’s interests in order to gain its financial support.³⁰ These accounts describe oceanographers as active network-builders who successfully maintained definite control over their research agenda by negotiating with Naval officers and policy-makers.

Moving from individuals to institutions, the ocean sciences in the US were sharply marked by the founding of the Office of Naval Research (ONR), a federal agency created in 1946 to support fundamental research of potential military interest. The *Encyclopedia of the History of Science in the US* points to the ambiguous role the ONR played in constraining (or not) scientific research: it was administered by civil scientists and a Naval Research Advisory Committee (composed of prominent nonmilitary researchers), who supported academic research projects in a wide range of topics not necessarily of direct relevance to naval operations.³¹ For historian Harvey Sapolsky, who addressed the origins of the ONR in his book *Science and the Navy*, the institution was pivotal in enhancing the position of American universities after the war, in stimulating the blossoming of fundamental science, and in

²⁸ Weir, *An Ocean in Common*.

²⁹ Hamblin, *Oceanographers and the Cold War*.

³⁰ Rainger, “Patronage and Science.”

³¹ Wang, “Office of Naval Research, United States.”

designing the current structure of government-science relations.³² Yet the ONR also had its critics: according to Oreskes, the ONR funded fundamental science, but only as far as it “fitted the mission profile” – and marine biology, for instance, usually fell outside the ONR’s priorities.³³ Other historians debate whether the apparent abundance of means made available to US oceanographers had the paradoxical effect of enhancing a feeling of keeping control over intellectual agendas while tapering any qualms of declining research autonomy.³⁴ Building on this argument, sociologist Chandra Mukerji added that by supporting fundamental ocean research, the US government aimed at creating and maintaining an “elite reserve labor force” of oceanographers, to be mobilized whenever their advice or expertise was needed.³⁵ Sam Robinson’s work on British Cold War oceanography moves away from the apparently monolithic division between oceanographers, the military, and the administration by offering evidence of the way patronage relations thrived when these instances were headed by the same actors – in his case study, British oceanographer George Deacon, who was as instrumental in running research centers and defining the research agenda as he was in negotiating military support in the corridors of the British administration.³⁶

These accounts reveal that to fully understand how military or industrial patronage shapes scientific outcomes it is not only necessary to consider interests or motivations, but also to examine the material mechanisms through which these are articulated from the highest managerial levels to marine scientific surveys, the actors who are in control of designing these mechanisms, and the systems through which patrons negotiate (or impose) a middle-ground. In them resides the key to understand how the patron’s interests have the potential to drive research and to maintain scientists eagerly engaged in research agendas that are somehow constraining. In this thesis, I therefore approach patronage relations by focusing on the institutional and social mechanisms and strategies through which patronage networks operated. In using the term “networks,” instead of “relations,” I want to convey the multidirectional nature of patronage relations in this case study. The definition of “relation” entails a connection between two persons, groups, or elements – scientists and their patrons, for instance. Yet, in this case, the

³² Sapolsky, *Science and the Navy*.

³³ Oreskes, *Science on a Mission*.

³⁴ Naomi Oreskes has discussed different perspectives on Cold War military patronage to science and, in particular, to the kind of motivations behind the ONR’s funding in: Oreskes, “A Context of Motivation.” Also in: Wang, “Office of Naval Research, United States.”

³⁵ Mukerji, *A Fragile Power: Scientists and the State*.

³⁶ Robinson, *Ocean Science and the British Cold War State*.

dynamics of patronage unfolded in multiple directions, connecting different governmental institutions and actors from diverse backgrounds (academic and industrial geologists, oil industry managers and statespersons), whereas money moved across a number of connected institutions before reaching academic geologists. In this sense, the analogy of a network, in which experts are nodes connected by two-way flows of money, technologies, expertise, and geological knowledge, captures more precisely an expanding chain of relations.³⁷

The second central aspect I examine is secrecy. The study of patronage relations and networks is indissociable from secrecy, which is usually evoked as the chief mechanism that hinders scientific and technological development.³⁸ Historical accounts on how military secrecy shaped what we know, and do not know, about the oceans (as Naomi Oreskes has phrased it) offer again a rich basis to compare with oil industrial secrecy and knowledge production.³⁹ Because data and information from the oceans holding scientific interest was the same, and came in the same form, that the one that catered to the Navy's operational priorities, conflicts of interest were ubiquitous.⁴⁰ According to Oreskes, military secrecy had strong epistemological consequences on the ocean sciences: the Navy's secrecy stood in the way of plate tectonics theory, delaying its enunciation for three decades by maintaining magnetic data (which depicted parallel magnetic stripes expanding from mid-ocean ridges) secret.⁴¹ Difficulties to access classified information or the Navy's security protocols, which prevented data dissemination in academic forums, dissuaded oceanographers to pursue certain lines of research.⁴² The impact of military secrecy can directly be seen in published works: in 1958, American oceanographers Marie Tharp and Bruce Heezen published the first map of the seafloor's topography. It was a physiographic map, closer to a piece of art than a technical chart, because the US Navy prohibited the publication of bathymetrical data.⁴³ For Hamblin, the Navy even constrained international cooperation in ocean sciences: while naval officers considered strategically

³⁷ On the different academic uses of networks, see: Knox, Savage, and Harvey, "Social Networks and the Study of Relations." For a detailed account on the study of networks in ocean sciences, see: Robinson, *Between the Devil and the Deep Blue Sea*.

³⁸ Kapper, "The Role of Government;" Gusterson, "Secrecy, Authorship and Nuclear Weapons Scientists;" Galison, "Removing Knowledge."

³⁹ Oreskes, *Science on a Mission*.

⁴⁰ Hamblin, *Oceanographers and the Cold War*.

⁴¹ Oreskes, *The Rejection of Continental Drift*.

⁴² Oreskes, *Science on a Mission*; Hamblin, *Oceanographers and the Cold War*.

⁴³ Doel, Levin, and Marker, "Extending Modern Cartography;" Oreskes, *Science on a Mission*.

beneficial to disclose and share with some specific nations particular pieces of data, it did not easily accepted wider, indiscriminate dissemination.⁴⁴

Stepping back from what secrecy hinders enables us to see a wider picture, in which denying and allowing access to information are two components of an encompassing action addressed at controlling flows of information.⁴⁵ By looking at what the pair secrecy/disclosure enables, instead of what it hinders, secrecy becomes a key component of scientific and political strategies.⁴⁶ For instance, in the previous examples on military-supported ocean research, secrecy can be approached as part of a strategy to gain social capital in the academic community in the form of scientific prestige.⁴⁷ Those who could move in and out of the boundaries of military secrecy had more chances of improving their scientific careers by working with data that was inaccessible with the research resources universities could offer and, when the time arrived, disclosing it in published papers or scientific conferences.⁴⁸ Its potential to bestow scientific prestige can be interpreted as a motivation to engage in military, corporate, or oil industrial research.

In this framework, the crucial inquiry is how patrons craft a secrecy/disclosure strategy to further their goals, while researchers navigate or negotiate secrecy mechanisms to achieve their own objectives. I approach this question by focusing on the elements that leaked from the oil industry to the academic community – in other words, what was disclosed and why? This methodological approach is inspired by the work of historian John Krige, who has challenged the idea that knowledge can move through borders without friction (in his case, national borders). By problematizing circulation, Krige has emphasized the need to look at the social and material constraints that impede the movement of knowledge.⁴⁹ The approach I suggest looks toward the opposite direction: to focus on the social and material mechanism that enabled the transference of knowledge between communities that were, apparently, bounded by secrecy without assuming smooth, accidental, or unpremeditated exchanges. Results suggest that, in the

⁴⁴ Hamblin, *Oceanographers and the Cold War*.

⁴⁵ Denis, “Secrecy and Science revisited.”

⁴⁶ Shuldiner, “Learning to Keep Secrets;” Wright and Wallace, “Varieties of Secrets and Secret Varieties.”

⁴⁷ Bourdieu, “Le capital social;” Dennis, “Secrecy and Science Revisited.” Also in: Biagioli, “From Ciphers to Confidentiality.”

⁴⁸ Oreskes, *Science on a Mission*.

⁴⁹ Krige, *How Knowledge Moves*; Krige, “Building the Arsenal of Knowledge;” Secord, “Knowledge in Transit”. Historian Nestor Herran has characterized the circulation of knowledge as a politically loaded process, problematizing its transnational nature as a painful and demanding process (in: Herran, “John Krige (Editor). *How Knowledge Moves*”).

oil industry's patronage networks, secrecy was used as a political strategy: in shaping and reshaping the boundaries of secrecy, government officers linked to extractive industries could define who could have access to data produced at the oil industry depending on the industrial, economic, or geopolitical needs and priorities of each moment.

1.2. The quest for new deep territories

From the end of World War 2, geopolitical and economic concerns dominating global political priorities derived from Cold War dynamics, which produced an East-West fracture – that had also its reflection on the oceans.⁵⁰ Yet by the 1960s, new economic imaginaries flourished “with respect to and because of the sea in the decolonization era,” as political historian Surabhi Ranganathan has argued.⁵¹ In this section, I argue for the need to integrate the oceans in the history of decolonization by approaching to them as territories. I first offer a historical overview of the oceans' place in this historical framework, and I then delineate how the topic has been addressed by other scholars. I follow by outlining my two approaches – looking at the development of research technologies, and at the political and diplomatic uses of geophysical data that was produced.

Early in the 1960s, decolonization spurred the emergence of global anxieties about overpopulation, resource erosion, and environmental degeneration on land, which drove the attention of coastal governments and private industries to the oceans as territories to be “scouted, explored, mapped, colonized, and connected to land and its economies.”⁵² Innovations in marine technology, frequently deriving from underwater military devices, progressively opened new spaces of exploitation. As legal scholar Edward Miles underlined in 1969, until a decade earlier uses of the oceans were essentially restricted to its surface; while at the time of writing, new technologies were opening the threshold of “the third dimension” – depth.⁵³ The seafloor stood as a marine region of paramount interest since its potential, barely explored resources were deemed to be economic pillars for generations to come: minerals,

⁵⁰ Literature framing the history of ocean sciences in the Cold War period, specifying how military priorities and concerns shaped knowledge on the oceans: Campubí, “‘No Longer an American Lake’: Depth and Geopolitics in the Mediterranean;” Colby, “Conscripting Leviathan;” Hamblin, *Oceanographers and the Cold War*; Martínez-Rius, “For the Benefit of All Men;” Robinson, *Ocean Science and the British Cold War State*; Turchetti, “Sword, Shield and Buoys.”

⁵¹ Ranganathan, “Decolonization and International Law.”

⁵² Kaji-o’grady and Raisbeck, “Prototype Cities in the Sea.”

⁵³ Miles, “Technology, Ocean Management, and the Law of the Sea;” Barkenbus, “The Politics of Ocean Resource Exploitation”.

phosphorite, organic sediments, sands, and placers were to be industrially exploited from the continental shelf; silica, clay, and manganese nodules (portrayed as a cornucopia of strategic minerals) extracted from the deep seabed; and hydrocarbons secured from the seafloor's geological layers.⁵⁴ Global inequalities with respect to technological capabilities to explore and exploit marine resources prompted fears among emerging nations about the establishment of neocolonialist dynamics, in which power relations of the former colonial world order were replicated in the oceans.⁵⁵ In the framework of the Third United Nations Convention for the Law of the Sea (UNCLOS III, 1973), developing and emergent nations gathered under a unified position against the potential excesses of the world's maritime powers.⁵⁶ In the twilight of colonialism, two conflicting imaginaries about the oceans dominated political ambitions, which mirrored the ones previously projected on colonial lands: the oceans were conceived as a territorial frontier with scrambles to control its potential resources, and as testing grounds for new experiments in international relations.⁵⁷

This historical overview gives a glimpse of the oceans' geopolitical relevance in the postcolonial world order, which played a crucial role in reshaping international dynamics and diplomatic relations. Yet, the topic has received little attention from historians of science, environmental historians, and social scientists.⁵⁸ Ranganathan has recently made explicit this gap by using the UN's maps of decolonization as an illustrative example. While they depict changes in frontiers and power relations between 1945 and 2011, the oceans appear as blank spaces, as if they were detached from human activities, timeless and oblivious to events happening on mainland.⁵⁹ In her view, the oceans are conspicuously absent from the history of decolonization. Yet, I shall nuance her claim:⁶⁰ what is lacking are accounts approaching the

⁵⁴ Enumeration based on the reference book Mero, *The Mineral Resources of the Sea*. Also expressed during benchmark speeches (UN General Assembly, "First Committee Debate," November 1, 1967).

⁵⁵ Inequalities would be defined by different technological capabilities for offshore exploitation (Miles, "Technology, Ocean Management, and the Law of the Sea;" Barkenbus, "The politics of ocean resource exploitation"). In this sense, possessing advanced technological capabilities in strategic research fields (as nuclear or space research) was instrumental in shaping the postcolonial world order (Krige and Barth, "Introduction.")

⁵⁶ See for instance: Friedman and Williams, "The group of 77 at the United Nations;" Ranganathan, "Ocean Floor Grab."

⁵⁷ Ranganathan, "Decolonization and International Law;" Ranganathan, "Ocean Floor Grab." These conceptions explicitly manifested during the three United Nations Convention on the Law of the Sea (UNCLOS I in 1958, II in 1960, and III 1973-1982), backdrop of this thesis.

⁵⁸ Although there is a solid body of literature on legal history about the Law of the Sea (for instance: Miles, *Global Ocean Politics*; Hollick and Osgood, *New era of Ocean Politics*; Hollick, *U.S. Foreign Policy and the Law of the Sea*; Churchill and Lowe, *The Law of the Sea*).

⁵⁹ Ranganathan, "Decolonization and International Law."

⁶⁰ Ibid.

oceans as *territories* in the postcolonial period, understood as areas shaped by political-economic and strategic processes, completely reliant on technologies to be studied, measured, and controlled (legally and physically), and where appropriation and occupation are counterbalanced by the drawing of borders.⁶¹

Historians have not consistently approached the oceans as territories; instead, the interplay between the oceans and decolonization – articulated through the exploitation of marine resources – appears obliquely, while addressing the oceans’ history through varied approaches: metaphors, imaginaries, and technological activities.⁶² Historian Sam Robinson has traced the origin of the ocean’s imaginary as a limitless source of natural resources in the metaphor of the American frontier, evoked in 1893 by American historian Frederick J. Turner.⁶³ Paraphrasing oceanographer Athelstan Spilhaus, Robinson demonstrates that in the mid-sixties the oceans came to be conceived as equivalent to emergent frontiers in the 19th century US: territories to be explored, occupied, and conquered by humans.⁶⁴ Following up with imaginaries, Helen Rozwadowski has emphasized the cultural resonance of the ocean frontier metaphor, which shifted political priorities in the oceans from warfare to industrial exploitation of an “untapped treasure.”⁶⁵ Moving to diplomatic relations, Robinson has argued that anticipated technological capabilities to extract natural resources were at the core of international negotiations to legislate the uses of the oceans, driving discussions and creating frictions.⁶⁶ Other observers have

⁶¹ Based on the work of geographer Stuart Elden (in: Elden, “Land, Terrain, Territory”). Other geographers have enriched this approach, introducing the term “vertical geopolitics” to emphasize that, to understand geopolitical dynamics that unfold over a territory, it is essential to pay greater attention to its vertical axis, the one containing minerals, hydrocarbon deposits, aquifers, tunnels, and underground bunkers; as well as the airspace above and different layers of human infrastructures (Graham, “Vertical Geopolitics”). The “vertical turn” on geography – and more recently, on history of science – conveys that the territory should be approached as a volume, not as an area (Bridge, “Territory, Now in 3D!;” Elden, “Secure the Volume;” Hardenberg and Mahony, “Introduction. Up, down, Round and Round;” Bobbette and Donovan, *Political Geology*. For instance, Scott has emphasized the need to look at subterranean issues related to mineral extraction to better understand processes of European colonization (Scott, “Colonialism, Landscape and the Subterranean”).

⁶² Although historians have approached the oceans’ surface as sites of pivotal importance for the well-functioning of empires (Burnett, “Hydrographic Discipline;” Reidy and Rozwadowski, “The Spaces In Between: Science, Ocean, Empire;” Smith, *To Master the Boundless Sea*).

⁶³ Robinson, “Scientific Imaginaries and Science Diplomacy;” Turner, “The significance of the frontier in American History.” For a critical perspective on the American frontier, emphasizing its ideological and cultural role, see: White, Limerick, and Grossman, *The Frontier in American Culture*.

⁶⁴ Robinson, “Scientific Imaginaries and Science Diplomacy.”

⁶⁵ Rozwadowski, “Ocean’s Depths;” Rozwadowski, “Arthur C. Clarke and the Limitations of the Ocean as a Frontier;” Rozwadowski, *Vast Expanses*; Rozwadowski, “Engineering, Imagination, and Industry.”

⁶⁶ Robinson, “Scientific Imaginaries and Science Diplomacy.” Robinson arguments draw from the concept “sociotechnical imaginaries”, coined in: Jasanoff and Kim, “Containing the Atom.” Sociotechnical imaginaries, in which imagined futures constitute driving forces for technoscientific development and social construction. The term imaginaries has spread across STS studies, usually accompanied by a qualifier that may even be redundant (‘sociotechnical’, ‘technoscientific’, ‘social’, ‘political’, ‘genetic’, ‘public’... imaginaries). The concept has been

focused on practices, fostered by state actors, that were consistent with territorial expansion and control: Rachel Squire has shown how the SEALAB projects, launched by the US Navy to install underwater habitats, was pursued to reaffirm the US control of the seabed by means of its physical occupation.⁶⁷ Historian Stephan Huebner has described how in the sixties architects and engineers envisioned the growth of Tokyo beyond land, in pursuing a sort of amphibious city, while Asian political elites became the guiding force behind the establishment of oil rigs in the open sea to secure national hydrocarbon supplies.⁶⁸ Meanwhile, Rozwadowski has detailed the efforts of the Californian Scripps Institution of Oceanography to install an underwater laboratory, and the cultural origins and influence of *Homo aquaticus* – the dream that humanity could one day live under the sea.⁶⁹

These historical accounts are inexplicitly dealing with the emergence of the oceans as territories: metaphors and imagination preceded technological development, which was instrumental in exploring, charting, and controlling the seafloor.⁷⁰ Potential natural resources that could supply the metropole were at the core of international negotiations, which expanded throughout three decades for the inherent difficulties and frictions arising from drawing borders. Meanwhile, ingenious infrastructures were installed on the seafloor, attempting to physically occupy a hostile environment that resisted being tamed. In a postcolonial world, the enterprises that colonial powers had undertaken in colonized territories found their replicas in the oceans. I suggest that colonialist ambitions did not disappear, but were only transformed as they were projected onto a different environment. An enhanced historical understanding of the processes that led to global inequalities in controlling and using the oceans, and how they evolved, would illuminate the different shapes they may have adopted up to our days.⁷¹

This thesis aims at situating the seafloor as a territory in histories of decolonization, by showing how it was shaped, and in turn shaped, contemporary geopolitical anxieties and concerns.

applied to highlight clusters and communities investigated, research methods, or approach (McNeil et al., “Conceptualizing Imaginaries of Science, Technology, and Society;” Sismondo, “Sociotechnical Imaginaries.”)

⁶⁷ Squire, *Undersea Geopolitics*; Adler, “Deep Horizons.”

⁶⁸ Huebner, “Earth’s Amphibious Transformation.”

⁶⁹ Rozwadowski, “Engineering, Imagination, and Industry;” Rozwadowski, “Bringing Humanity Full Circle Back into the Sea.”

⁷⁰ In the words of Rozwadowski, “motive is the precursor of technology.” (in: Rozwadowski, “Ocean’s Depths”).

⁷¹ Indeed recent critical voices pointing to global inequalities on the oceans that derived from the Law of the Sea, that sets developed countries in a vantage position in, for instance, exploitation of deep mineral resources (Zalik, “Mining the seabed, enclosing the area;” Seas at Risk, *At a Crossroads: Europe’s Role in Deep-Sea Mining*). For a critical review on current ocean diplomacy see: Polejack, “The Importance of Ocean Science Diplomacy for Ocean Affairs.”

Approaching the seafloor as an emergent territory implies focusing on the technoscientific processes that “made” the territory – an approach rooted in environmental history, which focuses on the processes of co-construction between human labor and the environment.⁷² Therefore I pay detailed attention to the development of research technologies for the exploration of the seafloor: from the motivations, funding, and actors who built them to the mechanisms through which the French oil industry and state actors controlled their utilization. My second approach to the seafloor as a territory focuses on the data these geophysical technologies produced. I examine the different political and diplomatic uses the French government have for its knowledge about the seafloor, framing it in the history of science and diplomacy. Traditionally defined as the promotion of international scientific collaborations and exchanges as means of establishing or improving cordial relations between nations, science diplomacy is now the topic of a flourishing historiographical trend that is problematizing this definition by expanding its roles.⁷³ Behind easing tensions, forging cordial relations, or displaying a benign political agenda, recent literature is emphasizing the role of sciences in diplomatic relations as tools of *soft power*, as a political cover for less candid ambitions, or as a strategy to keep up with the Joneses.⁷⁴ This thesis ascribes to this trend by seeking the different roles that knowledge from the seafloor played in France’s international relations, and how these roles evolved as the seafloor emerged as a territory in the eyes of coastal nations and private companies.

In this regard, literature on the history of the earth sciences might offer some preliminary answers on the diplomatic uses of data from colonial territories. Historian Daniel Gamito-

⁷² The foundational publication on environmental history is: White, “American Environmental History”. Classical works: Co-determination between Columbia River and its surrounding societies: White, *The Organic Machine*. About the development of Chicago, while industrialization tamed the hinterlands where it sits, see: Cronon, *Nature’s Metropolis*. Helen Rozwadowski has pinpointed the potential of looking at the oceans from the perspective of environmental history (Rozwadowski, “Oceans;” Rozwadowski, “The Promise of Ocean History for Environmental History”). This approach has also been revalidated by the history of technology (Gärdebo, “Environing Technology;” Sörlin and Wormbs, “Environing Technologies”).

⁷³ About the field of science diplomacy, see: Ruffini, *Science and Diplomacy*. Recent works problematizing the wide-spread definition are: Turchetti et al., “Introduction. Just Needham to Nixon?;” Adamson and Lalli, “Global Perspectives on Science Diplomacy;” Rungius and Flink, “Romancing Science for Global Solutions.”

⁷⁴ The term “soft power” was coined by political scientist Joseph Nye to account for diplomatic mechanisms to influence over other nations through persuasion rather than coercion (Nye, “Soft Power”). A foundational work on this field is Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe*. Other examples of soft power as a diplomatic tool through transferences of technologies, fellowships or training programs: Rentetzi, “With Strings Attached;” Wittje, “Engineering Education in Cold War Diplomacy;” Creager, “Radioisotopes as Political Instruments, 1946-1953.” I wrote about the interplay between competition and cooperation in Franco-American diplomatic relations through oceanography in: Martínez-Rius, “For the Benefit of All Men.” See also: Robinson, “Early Twentieth-Century Ocean Science Diplomacy.”

Marques has pointed to the relevance of geographical information gathered by Portuguese naturalists to negotiate colonial borders in central Africa; while historians Simone Turchetti and Peder Roberts have emphasized the relevance of Cold War geophysical surveillance systems to monitor the earth *and* exert sovereign control over colonial territories, thus avoiding material occupation.⁷⁵ Stemming from this argument, a number of authors have analyzed the pivotal role geophysical data played in scrambles to control deposits of hydrocarbons, ores, and strategic minerals, at the same time as it became a valuable bargaining asset in diplomatic negotiations.⁷⁶

As for the seafloor, this thesis suggests a continuum in practices, infrastructures, and state actors (mainly public officers and industrial managers) from the decolonization of France's oil producing territories to the seafloor, in searching new productive grounds. In this context, geological knowledge from the seafloor increasingly became a crucial asset for the French government, who mobilized it in its negotiation of international relations and its fostering national prestige.

1.3. From fieldwork to archives: Sources and research methodology

As historian Dominique Pestre noted, historians never “follow” actors – instead we select some of them, while ignore many others. We “make actors move and speak in particular ways, we give meaning to their actions by putting them into scenarios.”⁷⁷ The same happens with events, institutions, and documents from archives: we select some while discarding many others, we connect them in particular ways in an attempt to create an intelligible narrative, and we fix chronological and spatial borders to events that expand in all directions. In so doing we define, more or less consciously, a pertinent pathway for our research – or, in Pestre's words, we “create particular ontologies.”⁷⁸

⁷⁵ Gamito-Marques, “Science for Competition among Powers;” Turchetti and Roberts, *The Surveillance Imperative*.

⁷⁶ Lino Camprubí has shown the critical value of geophysical technologies for phosphate prospection in geostrategic decisions and diplomatic negotiations to control potential deposits in the Western Sahara (Camprubí, “Resource Geopolitics”); while Matthew Adamson has addressed similar issues with uranium research in the French Protectorate of Morocco, showing how French and American eagerness to secure this resource promoted the establishment of secret collaborations, having diplomatic and postcolonial consequences (Adamson, “Les Liaisons Dangereuses”). Roberto Cantoni has explored how access to geophysical devices and its results on Algerian deposits of oil and gas shaped diplomatic relations between the US, France, and Italy (Cantoni, *Oil Exploration, Diplomacy, and Security*).

⁷⁷ Pestre, “Concluding Remarks Debates in Transnational and Science Studies.”

⁷⁸ *Ibid.*

By consciously choosing to look at patronage networks, academic-industrial relations, and the backdrop of decolonization in the oceans, and by selecting certain laboratories and actors, I have left aside many other stories that have crossed my path. In these four years I have met numerous geologists interested in their scientific genealogy who have encouraged me to follow their stories: retired experts who enthusiastically explained to me their past experiences; scientists interested in tracing back the origins of the concepts they daily mobilize, even going centuries back; and researchers knowledgeable of non-written events, like personal relations, disputes, or misunderstandings between geologists that marked alliances and antagonisms in their scientific community. I am deeply aware that numerous narratives have been left aside in this research that could have produced a completely different account of the scientists' past. For instance, instead of following with detail transferences of scientific knowledge, the development of ideas, and the materialization of new theories about the seafloor; I have chosen to focus on a different framework, in which political decisions and state actors have gained greater prominence, in many cases, than the activities conducted by academic geologists. Similarly, I have not attempted to map all the laboratories and marine stations in France where some kind of marine geology was being developed.⁷⁹ Instead, I have focused on the institutions and scientists who aligned their agenda with the national oceanographic policy, or who were relevant in industrial-academic relations.

Not only intentional choices have informed my research pathway, but also unexpected contingencies. I initially conceived this research as a transnational history, that would connect geologists from different backgrounds and countries through their will to explore the Mediterranean's seafloor history.⁸⁰ However, the global pandemic impacted my research plans. Unable to travel and to meet experts from other countries, I was incited to focus on France. Yet, this accident resulted in an excellent opportunity to analyze in depth the inner mechanisms of academic-industrial relations in the French community of geoscientists, as well as to find a unique case study in which political ambitions of economic expansion informed a research field. This focus has led me to realized that a national approach is rarely solely "national" – as

⁷⁹ Most part of university laboratories and marine stations received their funding from the CNRS. Geologists working in these institutions could undertake the research lines they wished with the budget available and the research means they could afford; at the same time they interacted in joint programs, conferences, or training with experts from other national or foreign institutions.

⁸⁰ A transnational approach de-centers the nation-state as unit of analysis, to illuminate relationships between disparate peoples and places that traverse national borders (see: Turchetti, Herran, and Boudia, "Have We Ever Been 'Transnational'?" Krige, *How Knowledge Moves*).

historian Mark Walker affirmed, “all science is national or transnational, and most is both.”⁸¹ Some French researchers, policy-makers, and civil servants central to this thesis were deeply connected to foreign political and scientific settings, which influenced and, to certain extent, shaped the pathways the development of the seafloor exploration followed. Therefore, a focus on France has not hindered me to trace connections that transcended national borders, quite on the contrary: to understand the development of the seafloor exploration, it is essential to understand France’s international relations and the evolving position of the oceans in international politics.

Conversely, my initial temptation to deliberately follow those actors I deemed suitable representatives of their institutional contexts or research fields proved unachievable. In many occasions I found myself “following” actors (academic or industrial geologists) simply because they were the only ones from whom I could collect enough information to trace their path. Others, as the CNEXO’s director Yves la Prairie, casually appeared when I was peeking at archival boxes I had not planned to examine, and their role became so prominent in this research that it was inconceivable to neglect them. The scarce information available from industrial experts has remarkably shaped – and limited – my study of industrial clusters. While academic scientists are relatively easy to track because they leave a written trace of publications, presentations, and participation in international programs; oil geologists barely leave personal traces. Even at a more pragmatic level, it is relatively easy to contact retired academic geologists because they frequently remain active, maintain virtual profiles in social networks, or keep relations with still active geologists. Conversely, oil geologists do not need to publish papers to advance their careers –they are therefore frequently absent from scientific databases. Their personal information is stored and inaccessible deep in oil industry archives that impose a moratorium of 120 years on documents containing personal information about their employees (therefore no contracts, no personal letters, and no first-hand reports). In the same vein, the activities of government officers who were not visible figures are diluted in coauthored reports and minutes of official meetings, thus making it challenging to distinguish their agency from other individuals’. During these four years I had the chance to meet and discuss with some of the central actors of this thesis, who have contributed by sharing with me their past experiences. For those who are already deceased, I have resorted to published and archival sources: for public officers I have relied on grey literature kept in public and private archives; while for scientists,

⁸¹ Walker, “The ‘National’ in International and Transnational Science.”

I have combined a variety of published scientific sources with archival documents. Yet, before following geologists I needed to understand the language of geology – and fieldwork helped me with that.

1.3.1. Fieldwork: Understanding geology (and geologists) from the inside

It is not a common historical practice to be directly involved in the scientific community of study, and SALTGIANT has offered me the opportunity to experience it. In joining my PhD colleagues in scientific training courses, I have conducted geological fieldwork across the south of Spain and Sicily, learned how to acquire, process, and interpret geophysical data, witnessed how scientific drilling is performed and core samples analyzed, and I have grown familiar with a large array of geological concepts, formations, processes, and events. In scientific congresses, I observed how colleagues discussed the latest advancements on their research, planned to undertake new joint investigations, or lamented economic, social, or time constraints to the pursuit of their works.

Looking at present social dynamics can inform our understanding on the past. Informal conversations with innumerable geoscientists have provided me fine-grained details regarding their experience, knowledge, and perceptions from their field of research and beyond, while by being part of the community I have experience how they interact, forge relations, organize joint missions, or coauthor papers. However, I have not developed this familiarity as the sociologist who keeps itself at the edge to study a research community, but by being an active part of the community.⁸² What I have learned beyond sciences, therefore, is the inherent result of being integrated in a social group, where nonwritten norms and social dynamics are unconsciously assimilated.

These experiences have enriched this thesis not only because I grew knowledgeable on *what geologists do* (their research techniques and methods, approaches, constraints...); but also because I have grown familiar with the inner needs and social dynamics of a scientific community – which I have attempted to reflect as faithfully as possible in this thesis.

⁸² See for instance: Latour and Woolgar, *Laboratory Life*.

1.3.2. Oral History

Being integrated in a community of geologists has facilitated me to meet and interview experts who, in the early years of their scientific career, witnessed the birth of the seafloor's exploration. Yet I soon realized that the first stories these experts recounted me were what historian Adrian Wilson has called "scientists' imagined past": a genealogical narrative of their research lines, known through past experiences and/or for its privileged position in the opening paragraph of scientific publications.⁸³ This narrative fulfils a sociological function: it is the cement that brings a community together. Memory is a reconstruction of the past, individually and collectively, that is shaped by the selective memories we reinforce.⁸⁴ What geologists tend to remember from their research experiences, forty or fifty years ago, is strongly related to the scientific narrative that appears on scientific papers, the one they have discussed about and contributed to throughout their career.

This has posed a daunting challenge for this research, since thirteen out of fourteen experts interviewed were geologists or geophysicists, from academia or oil-related institutions, who experienced the birth of marine geosciences mainly in exploring the Mediterranean.⁸⁵ This "collective past" is what they understand as history of science – something that historians should also bear in mind while conducting oral history. Scientists tend to consider an internalist narration, focused on the production of scientific knowledge, concepts, and hypothesis as the most relevant part of history of science.⁸⁶ Therefore, they frequently start wearing what historian Lillian Hoddeson has called "scientists' mask": acting as experts, they initially tend to neglect their personal experiences, anecdotes, or memories for detailed scientific accounts on discoveries or controversies.⁸⁷ This misconception risked to transform interviews in a reiterative and biased narrative. Avoiding it has primarily consisted on encouraging interviewees to move their focus of attention from their scientific activities and strongly-forged scientific narrative, to other events, relations, and contexts that surrounded them; for instance,

⁸³ Wilson, "Science's Imagined Pasts."

⁸⁴ Ibid., Hoddeson, "The Conflict of Memories and Documents;" De Charadevian, "Using Interviews to Write the History of Science."

⁸⁵ On oral history as a source of historical information, its usefulness and limitations, see: Perks and Thomson, *The Oral History Reader*; Thompson, *The Voice of the Past*.

⁸⁶ About internalist-externalist debate in the history of science, see: Shapin, "Discipline and Bounding;" Fuller, "Internalism versus Externalism."

⁸⁷ Hoddeson has used the metaphor of a mask to emphasize the bold line that scientists usually trace between his scientific activities, status, and beliefs; from their personal thinking or opinions. From my perspective, this not only applies to scientists, but to almost any profession. In: Hoddeson, "The Conflict of Memories and Documents."

by asking about their interactions with foreign experts (how they met them, and how their collaboration evolved), fine-grained details on how they engaged in industry-supported research, or their personal memories on how and why they got involved in a scientific career.

Bearing in mind that through this kind of exercise memory is co-constructed (this is, selective memories emerged when I pointed to certain events, people, or institutions) and would always be limited; first-hand reflections have illuminated a multifaceted narrative of the same scientific genealogy, manifesting the multiple perspectives that constitute what seems an straightforward sequence of events.⁸⁸ In this regard, oral history has been central to inform understanding on personal dynamics between academic and industrial scientists, to reveal decisions that constituted tipping points in the academic community but are not written in archival documents, to identify key spaces of exchange or events, and to drive me towards relevant documents or sources. But it also has its limits: it is not useful for delineating an accurate chronology or to directly relate political changes and ambitions with scientific research – for that purposes, it is necessary to rely on archival sources.

Interviewing entails forging a personal relationship with someone that has opened his or her past – and therefore his or her life – to you; especially because, beyond discussing about marine geosciences in the sixties and seventies, interviewees have welcomed me in their homes and offices, we have had lunch together in a number of occasions, some have introduced me to their partners and siblings, and afterwards I have maintained frequent correspondence with some of them. The warmth of this (unexpected) aspect of oral history has, in some occasions, problematized the use of information: it was tempting to flow with the enthusiasm of knowing someone and try to integrate in my narrative all the experiences interviewees evoked in order to preserve, in some way, their memories. In this research, I have carefully weighted which particular stories were relevant for each historical case; ending up mobilizing explicit content of the interviews only in punctual occasions, and utilizing them transversally to better interpret relations and events.

1.3.3. Archival research

Tracing back activities at the oil industry has proved more challenging than initially envisioned. The private historical archives of the oil firms TOTAL (Archives Historiques du Groupe Total, Paris) and Eni (Archivio Storico Eni, Castelgandolfo, Italy) hold large, well-classified,

⁸⁸ De Charadevian, “Using Interviews to Write the History of Science.”

collections.⁸⁹ Although I found useful documents to identify exploration and exploitation activities the oil industry was conducting on the seafloor, they failed in offering detailed accounts. Most part of the information relevant for my research is still classified: besides the moratoria on documents containing information on the employees, access to reports containing geological or geophysical information is restrained. Conversely, at the archival collections from the Ministry of Industry (stored at the Archives Nationales de France) I could find a way to sneak part of the limitations at the oil industry archives. These collections include documents by the Comité d'Études Pétroliers et Marines (CEPM), the oil industry's network created to explore the offshore (detailed in chapter 4) which preserves letters, contracts, and official documents on the oil industry's activities, ambitions, and investments in marine exploration. A particular collection has proved of central importance to this research: the personal papers of Fuels Director André Giraud, responsible of introducing the oil industry into scientific oceanographic activities (see chapter 4). This collection stores letters, hand-written notes, reports, and minutes of meetings from the period when Giraud was involved in defining France's oceanographic policy.

A second collection of central importance for this research has been the CNEXO's, stored at the Archives Nationales de France (Peyrefitte-sur-Seine, Paris). The collection is composed by almost fifty boxes containing the correspondence of its general director, Yves la Prairie; meeting reports from the Administrative Council and the Scientific and Technical Commission, contracts, and all kinds of documents from the Department of International Relations. Given the size of the collection, I have only examined those documents directly related to the study of the seafloor.⁹⁰ Conversely, the evolution of France's oceanic policy, from its inception to the mid-seventies, can be tracked through grey literature in the archival collections of the Ministry of Industry and the Ministry of Scientific Research, also stored at the Archives Nationales de France. To prevent getting lost in the massive maze of governmental documents, the boxes I examined fulfilled the criteria of being directly related to the transformations of scientific

⁸⁹ The Service Historique du Groupe TOTAL (former *Compagnie Française des Pétroles*, CFP) preserves more than 800 collections of French oil firms. Besides documents from the CFP, it also stores collections from the firms that would fuse in the *Groupe Elf Aquitaine*: the *Bureau de Recherches de Pétrole* (BRP), *Régie Autonome des Pétroles* (RAP), *Entreprise de Recherches et d'activités Pétrolières* (ERAP), and *Société Nationale des Pétroles d'Aquitaine* (SNPA); as well as collection from the refining company PetroFina.

⁹⁰ The CNEXO's archival collection has a great (and completely unexplored) research potential on international relations and science diplomacy, environmental questions as managing pollution, public representation of political aims in ocean sciences, management of national and international fisheries, technological innovation and development in submersibles or exploitation devices, studies on marine resources whose exploitation never materialized (as thermal energy from the oceans), etc.

policies between the 3rd and the 5th Plan of Economic Development (from 1958 to 1970) – the key moments when France’s ocean policy steadily took shape, moving from devoting an strategic budget to ocean research, to the materialization of a national, coordinating structure. As for international relations, I have supplemented the information from the collections of the CNEXO’s Department of International Relations with visits to the Archives Diplomatiques de France (La Courneuve), where reports and letters from the French Embassy in Washington manifest not only its close relation to the CNEXO, but also the central importance of oceanography in Franco-American relations during the seventies.

Finally, archivists at the historical collection of the Scripps Institution of Oceanography (La Jolla, US) have become my eyes and my hands. Due to travel restrictions derived from Covid-19 pandemic, I have not been able to visit in-person archival collections in the US, crucial to deepen into the study of the Deep Sea Drilling Project in the Mediterranean (chapter 7). Archivists at the Scripps’ historical collections selected and scanned for me more than two-hundred pages of documents and letters I had previously selected from their inventories. Although the documents have been of chief relevance for this part of the research, not being able to go through the entire collection might have resulted in some knowledge gaps.⁹¹

1.4. From the shore to the deep ocean crust: structure of this dissertation

The thesis’ structure follows chronologically the expansion of the seafloor exploration, in extent and in depth, along industrial patronage networks and France’s expansionist ambitions to discover the oceans’ richness enlarged. Geographically, I depart from the study of the Mediterranean basin, from its coastal and shallow regions, to progressively expand the focus of analysis to more distant and deeper areas, along technological innovation, larger sums of funding, new expertise and collaborations enabled French experts to deepen into the Atlantic and Pacific Oceans. In the last chapter I return to the Mediterranean, illustrating how the way of conducting research on the seafloor had changed in less than three decades.

Chapter 2 (1914-1957) traces the origins of marine geology in France and the modest role military patronage played on it. I follow Jacques Bourcart, French geologist pioneer in moving geological studies to the continental shelf, to show how military priorities defined the tools and techniques he utilized, the regions he explored, and the strategic knowledge he gathered – first

⁹¹ A detailed list of collections and archives visited can be found in the bibliography of this thesis.

on colonial territories and from 1945, at sea. Meanwhile, in the US an incipient offshore oil industry was flourishing, accompanied by the development of knowledge and research techniques to study the seafloor's composition. By comparing the evolution of marine geology in France and in the US up to 1957, I show how different political strategies about the regions where to secure oil supplies led to divergent pathways of development in exploring the seafloor. While in the US geologists enjoyed economic and logistic support from the oil industry and could start undertaking more complex research programs; in France the Navy's patronage to marine geology was not sufficient to trigger the flourishing of the discipline, nor to move research below the continental shelf's surface. This chapter has a notable scientific focus, utilizing Bourcart's interest to unravel past geological events in the Mediterranean basin to depict how scientific knowledge from the seafloor was produced, when techniques to explore its topography and composition were rudimentary and occasions to go at sea, scarce.

Chapter 3 (1958-1965) traces how marine geosciences gained a foothold in the French government's agenda, motivated by the prominent role the oceans were gaining in international politics. Initially, for the French government, exploiting hydrocarbon and mineral resources was not a priority – more important was to enhance France's presence in the high seas for fishing, and to grow involved in international cooperative programs. At the core of this oceanographic policy was the promotion of fundamental research, which pervaded scientific and political discourses. The national oceanographic agenda was left in the hands of an expert committee of scientists, the *Comité d'Études Exploitation des Océans* (COMEXO) who invested for the first time in incorporating marine geophysical techniques in geologists' toolbox to explore the Mediterranean seafloor.

Chapter 4 (1960-1967), partially overlapping with the previous, shifts the focus of attention from academic geologists to the oil industry. By following Fuels Director André Giraud, I show how the independence of North African colonial territories prompted the French oil industry's interest in edifying its future on the seafloor. With this aim, Giraud played a leading role in crafting an oil industry network to pool economic efforts and to coordinate a joint program of technological innovation and marine exploration. Innovative technologies and new data from the seafloor were shared among the network, but did not leak towards the academic community because, initially, Giraud did not envision the creation of institutionalized bridges through which data, experts, and technologies could flow. However, Giraud soon realized that counting with the advice of academic researchers would reduce costs and time. Profiting the renovation

of the COMEXO in 1966, Giraud introduced in the expert committee and embodied in him, commercial interests of rampant exploitation.

Chapter 5 (1967-1972) focuses on the creation of the Centre National pour l'Exploitation des Océans (CNEXO), responding to a national strategy to unify oceanographic research under a centralized, government-led structure. Its design exemplifies how the oceans' perception had changed among France's political circles: military interests and Naval representatives were displaced by economic motivations and industrial stake-holders, explicitly aiming to exploit marine resources. The CNEXO succeeded in entangling scientific with industrial research through its position as a centralizing national structure, in particular due to the secrecy regime it promoted. Rather than designing a strong secrecy policy, the CNEXO ensured its control on data flows, organized collaborations between academic geologists and oil industry experts, orchestrated the pooling of research resources designed by the oil industry, and sponsored "hybrid surveys", where the boundary between fundamental and applied research vanished.

Simultaneous in time, chapter 6 (1967-1975) addresses the second role the CNEXO was committed to: represent France in international relations for ocean exploration and exploitation. The "common heritage of mankind" became a political motto in international forums, that legitimized exploration in the high seas if conducted through international cooperation, without (manifestly) pursuing commercial goals. This framework shaped the CNEXO's science diplomacy agenda, which I exemplify with three cases: first, the bilateral relation France established with the US, launched with an ambitious deep-sea project in the Mid-Atlantic to display their colossal technological capabilities while offering direct and unprecedented evidences of seafloor spreading. Second, relations established with Japan and the French Polynesia to explore polymetallic nodules in the deep Pacific, while enhancing scientific knowledge on the genesis of these formations. And third, the ambivalent scientific relationship developed with the USSR, marked by its eminently diplomatic usefulness.

Chapter 7 (1968-1975) moves back to the Mediterranean basin, to show how oil exploration, marine geology, and international relations were intertwined in the Deep Sea Drilling Project (DSDP). The DSDP was above all a scientific program, designed to provide material evidences of plate tectonics and unravel the Earth's history by recovering deep core samples from around the globe. I show how France's oil industry involved in this big science international program through oil experts and the CNEXO, due to the potentially valuable information it could provide for identifying deep-sea oil deposits. However, instead of finding hidden richness, the most

relevant outcome of the oil industry's involvement was the forge of cooperative relations that have expanded up to today.

These seven chapters conclude with a Coda, where I resume the central subject of oil industry-academic relations and the consequences of current misconceptions about them. I illustrate it with a contemporary case, that of a failed academic marine geophysical campaign around the Balearic Islands.

1.5. Explanatory note on stratigraphic periods

Throughout this thesis, each mention to a specific geological period will be accompanied by its age in millions of years (Ma) only the first time it appears, to facilitate understanding to foreigners in geology. However, the reader should bear in mind that, through part of the period this thesis covers, geological dating was relative. Geologists knew, for instance, that the Miocene was previous to the Pliocene because of their distribution in the sedimentological record; but their absolute age (in millions of years) was unknown. Accurate, absolute chronology began only after the introduction of isotopic methods to analyze sample sediments, throughout the sixties.⁹²

When referring to the Mediterranean, my work mostly concerns the most recent periods (the Messinian, in the upper Miocene Epoch, and the early Pliocene).

The international chronostratigraphic chart can be consulted in the Annex.

⁹² See: O'Hara, *A brief history of geology*. The international chronostratigraphic chart, periodically updated and published by the International Commission on Stratigraphy, can be found here: <https://stratigraphy.org/chart>

Chapter 2. From mainland to the offshore:

Jacques Bourcart and military patronage

Au cours du XXe siècle, la Terre semble s'être rétrécie, comme la légendaire peau de chagrin. Les espaces blancs qui, dans ma jeunesse, occupaient encore une grande partie de la carte du monde, ne sont plus que de minuscules taches.

La conquête scientifique du monde est maintenant entièrement du passé. Le nom même d'« exploration » fait sourire... Pourtant, sous la nappe d'eau qui recouvre 72% du globe, il reste une immense étendue de terres à découvrir !⁹³

In April 1945, a secret report issued by the French Fighting Forces described geologist Jacques Bourcart as a man of “peculiar intelligence, a scientist of great value with unusual knowledge, a glorious military past, and a brilliant clandestine activity.”⁹⁴ At that time, Bourcart was the head of the Laboratory of Geography and Dynamic Geology at the University of Paris, and few of his colleagues knew of his military prestige – while his eagerness to unravel the Mediterranean’s geological history was known to all.

Bourcart’s relation with the Army had been built during wartime. At the outbreak of World War 1, Bourcart found in the French Army a generous patron to subsidize his geological studies across North African territories in exchange of strategic information; while after World War 2 the Navy backed him to move his geological investigations offshore, to the seafloor. After four decades of military patronage, Bourcart’s scientific conclusions relied on strategic knowledge, produced in the first place to satisfy military needs in mapping, first, North African territories and later, the French continental shelf. Resulting from these studies, he speculated that the

⁹³ “Throughout the twentieth century the Earth seems to have shrunk, as the legendary skin of Shagreen. The blank spaces that, in my youth, still occupied large portions of the world map are now nothing more than tiny spots. The scientific conquest of the world belongs to the past. The very name of “exploration” brings a smile... However, below the water surface covering 72% of the globe, there is still a vast expanse of lands to discover!” In: Bourcart, *Le Fond Des Océans*, 5. All quotations originally in French have been translated by the author. The skin of Shagreen refers to the novel *La peau du Chagrin*, written by Honoré de Balzac in 1831. The skin of Shagreen had magical properties: it fulfilled the desires of his owner, but each time it shrunk, taking with it part of his owners’ energy.

⁹⁴ The *Forces Françaises Combattantes* was a French military organization constituted in 1942 by the Resistant network, to fight against the German control of occupied France (from 1942-1945). In: *Forces Françaises Combattantes*, “Fiche Individuelle de l’Agent 20205” (SHD, GR 16P 81000).

Mediterranean Sea could have disappeared some million years ago, after a massive sea-level regression.



Figure 1. Jacques Bourcart around the 1950s. Image courtesy of Gilbert Boillot (Boillot, Comment l'idée vient au géologue).

Bourcart's academic pathway illustrates how studying the Mediterranean basin moved from mainland outcrops to the seafloor with military support; and how France's military priorities influenced and shaped the geological study of the Mediterranean by defining the tools, approaches, research areas, and features to be explored. Focusing on the onset of the seafloor's exploration, the French Navy started to modestly support Bourcart's marine geological studies in 1946, making him in a pioneer of the field in his country. However, whilst this support was important to launch the first topographical studies of the seabed, it was not sufficient to make the discipline flourish, as it was happening in the US. After World War 2, different geopolitical priorities led to divergent pathways through which marine geology developed: in the US, where the offshore became a promising region for oil exploration, the discipline began to thrive in public research centers. Conversely, in France, oil supplies were deemed to be secured in colonial territories. Therefore, the continental shelf had an eminently strategic value, where marine geological research was interesting as a means to chart the rugged seabed.

2.1. The history of the Mediterranean basin from mainland

2.1.1. Geologists at war: Training disciples for military cartography

Jacques Bourcart was born in a French bourgeoisie family in the small Alsatian village of Guebwiller, in 1891.⁹⁵ During his childhood, he grew fascinated by the sea when spending summers with his family on the French Atlantic shore. This interest drove him to graduate with a degree in the Natural Sciences at the University of Paris and, in 1909, to engage in marine biological research at the Parisian *Institut Océanographique*.⁹⁶ However, his training in ocean sciences was short-lived. In October 1912, Bourcart was called up to perform his military service in Morocco for two years.⁹⁷ When World War 1 erupted, in July 1914, he voluntarily offered his services to the French Army by remaining in a Moroccan cavalry brigade. His military activities led him to leave aside marine biology, to redirect his academic career to geography and geology on the mainland.

In the Army, naturalists were considered valuable experts for exploring and charting enemy territories. Bourcart was thus designated to conduct geological and geographical survey tasks at the Moroccan boundaries under the mentorship of geologist Louis Gentil, born in Algeria in 1868. Gentil, who perfectly fitted the stereotype of a classical explorer and adventurer, caused a deep impression in Bourcart and had a long-lasting influence on his scientific career. From a young age, Gentil had undertaken the geological study of the most remote regions of the Moroccan territory, even before it became a French Protectorate.⁹⁸ By disguising himself as an Egyptian monk, Gentil traveled across Morocco from corner to corner, drawing the first itinerary maps and designing the first charts of the Western Atlas and of the Saharan Anti-Atlas – documents that he later handed to the French Army.⁹⁹ While drawing maps, Gentil devoted those adventures to study geological formations and to sample rocks and sediments, with which he attempted to explain the geological evolution of North Africa.

⁹⁵ Alsace was then a disputed region between France and the German Empire: twenty years before Bourcart was born, during the Franco-Prussian War, the German Emperor William 1st had annexed the French regions of Alsace and Lorraine to his empire, whereas French-speaking communities remained there. Bourcart would argue that his French-Alsatian origins predisposed him to offer his support to the French Army at the outbreak of World War II (in: Forces Françaises Combattantes, “Fiche Individuelle de l’Agent 20205” (SHD, GR 16P 81000)).

⁹⁶ Gougenheim, “Funérailles de Jacques Bourcart.”

⁹⁷ Forces Françaises Combattantes, *Un-named document*, November 12, 1945 (SHD, GR 16P 81000).

⁹⁸ In 1912.

⁹⁹ Bourcart, “La Vie et l’œuvre de Louis Gentil (1880-1925).”

Based on his observations, Gentil suggested that the region currently occupied by Morocco, between Casablanca and Uchda going through Fez, could have been submerged under the sea until the Pliocene (5,33-2,58 Ma), constituting a wide marine corridor between the Atlantic Ocean and the Mediterranean Sea. This connection could have been suddenly interrupted towards the end of the Miocene (23,03-2,58 Ma), cutting off water exchanges between the ocean and the sea until the current Strait of Gibraltar was formed. This hypotheses implied that a Miocene sea, much vaster than the actual Mediterranean, covered regions currently emerged, breaking against cliffs in the mid-Atlas mountain chain. This hypothesis suggested that the Mediterranean coastline had not been stable throughout geological history, but it had been transformed due to tectonic forces (this is, because of the deformation of the crust).¹⁰⁰

By attempting to unravel North-African tectonics, Gentil was joining a generation of geologists who, from the late-19th century, discussed the mechanisms that could explain why and how continents move. Contemporary German geologist Alfred Wegener (1880-1930) was among the few arguing for horizontal movements – a dynamic he named continental drift. Wegener's theory was supported by some European researchers, as English physicist Arthur Holmes (1890-1965), who suggested that continents drifted due to a convective flow in the Earth's mantle. Meanwhile, explanations appealing to vertical movements were more common and widely accepted among the geological community.¹⁰¹ In France, the hypothesis of geosynclines, proposed by the French paleontologist Emile Haug (1861-1927), was the most popular. It conveyed that continental masses were fixed, but their boundaries were formed by large accumulations of sediments that moved vertically, becoming mountain chains when ascending, and triggering marine transgressions when descending.¹⁰² Gentil's hypothesis on North African tectonics were framed in this kind of vertical dynamics, and constituted the germ of Bourcart's interest in exploring how these tectonic movements could have triggered marine regressions and transgressions in the Mediterranean.

Bourcart's training with Gentil was suddenly interrupted in 1917, when he was called to the Albanian front. One year before, French regiments had occupied Korçe, declaring it an

¹⁰⁰ The term 'tectonics' was already used in early-20th century in the study of continental dynamics.

¹⁰¹ Wegener's theory of continental drift was rejected until the mid-1960s, when it was revisited by American geophysicists and, from then, became the accepted mechanism to explain plate tectonics.

¹⁰² In the first decades of the twentieth century, tectonic hypothesis flourished, and many geologists (notably European, like Irish John Joly or British Edward Suess, just to name two) grew involved in discussions on the dynamics of continents and their evolution. Naomi Oreskes has studied the history of tectonic theories in: Oreskes, *The Rejection of Continental Drift*. For an exhaustive scientific examination of the development of concepts and evidences, see: Frankel, *The Continental Drift Controversy*.

autonomous region under France's administrative control due to its strategic value. The area connected the Italian front in Albania with the French in Macedonia, isolating the Greek region under Austrian-German control.¹⁰³ The Geographical Service of the French Army had entrusted him to gather strategic information about Albania's geographical features, the condition of roads and paths, and the amount of local resources to supply the French troops; as well as to study the local population's character (an essential knowledge to minimize frictions between the French occupiers and Albanians): all of them, pieces of strategic knowledge to effectively deploy French troops.¹⁰⁴

There, Bourcart drew inspiration from Gentil's research style: he took advantage of military reconnaissance missions to undertake the geological study of the region, sampling rocks, drawing observations, and studying the fossil microfauna he found. Reconnaissance missions alternated with the duties and risks specific to the warfront context: although lacking medical training, Bourcart worked as auxiliary doctor when wounded soldiers returned from the battle, and at some point was severely intoxicated with mustard gas.¹⁰⁵ When studying the geology of Albania, a coastal region on the northern shore of the Mediterranean, opposed to the North African coastline, Bourcart found numerous evidences of marine regressions and transgressions probably contemporary to the events Gentil identified in Morocco.

In Albania, Miocene deposits corresponded to marine formations, whereas more recent sediments, from the Pliocene, suggested a phase of seawater retreat ("as in almost all the Mediterranean basin", Bourcart specified).¹⁰⁶ According to Bourcart, the Aegean Sea could have been connected with the Adriatic through Albania until the late-Pliocene by the same ancient and vast Miocene sea depicted by Gentil. Once in the boundary period between the Miocene and the Pliocene, the submerged region started to rise, separating the two seas. In concave areas of this new territory, the remaining water pounds become brackish, isolated lagoons.¹⁰⁷ On the later ascending phase, the territory that we now know as Albania emerged completely, acquiring its current coastal profile.

¹⁰³ Bourcart, *Les Confins Albanais Administrés Par La France*.

¹⁰⁴ Ibid. About the origins of the Service Géographique de l'Armée, see: Schiavon, *Itinéraires de la précision*.

¹⁰⁵ Forces Françaises Combattantes, "Fiche Individuelle de l'Agent 20205" (SHD, GR 16P 81000).

¹⁰⁶ Bourcart, *Les Confins Albanais Administrés Par La France*, 93. Among the French community of geologists, this period of retreat, that marked the limit between the Miocene and the Pliocene, had been named Pontien.

¹⁰⁷ Ibid., 100-119.

This in-depth and pioneering study of Albania's geology enabled Bourcart to start developing a conception of the Mediterranean basin as a structural unit, where geological events would have occurred simultaneously in the whole basin, shaping all coastal regions. However, in the early-1920s, Bourcart didn't dare to suggest such a unifying hypothesis, presenting instead his ideas on Albanian dynamics as local events.

2.1.2. Oil and colonial exploration in North African territories

In the aftermath of World War 1, major changes in the global geopolitical context influenced geological research in colonial territories – and thus, Bourcart's activities. At the war's end, it became evident that the way of conducting war had changed: the introduction of fast, highly mobile vehicles to substitute cavalry troops (like airplanes, tanks, large battleships, and submarines) not only modified military strategy, but also turned their fuel, oil, into the most valuable resource worldwide.

Between 1910 and 1918, global production of oil doubled, increasing from 40 million to 80 million tons per year.¹⁰⁸ During the war, France had suffered serious supply difficulties, since supply routes through which Russian and Romanian oil reached the country felt under Ottoman control. At that moment, France turned to American and British producers as its future suppliers. After the war ended, and witnessing the pivotal role an abundant oil supply had played in the Allied victory, the French Government established as its national priority to develop its own petroleum industry. Aiming at securing oil supplies for the country without relying on Anglo-American companies, the French Government created the national *Compagnie Française des Pétroles* (CFP) in 1924.¹⁰⁹ French colonial territories appeared then as promising regions for oil exploration. The French government ushered the *Service de la Carte Géologique*, a national institution to coordinate oil exploration and cartography through Algeria, Morocco, and Sub-Saharan Africa. Its economic and logistic support allowed geologists, like Bourcart, to develop their scientific researches in colonial Africa, at the same time their outcomes contributed to build a strong national oil industry.¹¹⁰

¹⁰⁸Gaston-Breton, *Total, Un Esprit Pionnier*, 31.

¹⁰⁹ About the creation of TOTAL (formerly CFP), see: Gaston-Breton, *Total, Un Esprit Pionnier*. More about the history of the French oil industry at: Nouschi, *La France et Le Pétrole*.

¹¹⁰ Historian Radouan Mounecif has exhaustively analyzed how the CFP recruited and trained its experts from geological institutions, a key asset for the growth of the national oil company, in: Mounecif, *Chercheurs d'Or Noir*.

In April 1920, with the end of France's protectorate in Albania, Bourcart returned to Paris.¹¹¹ During the interwar period, he combined a position as lecturer of geology at the University of Paris with scientific and military activities in Morocco. In 1925 he succeeded Louis Gentil at the head of the *Institut Scientifique Chérifien* (Rabat), where he resumed his mentor's studies about the Moroccan Pliocene and Quaternary.¹¹² Meanwhile, Bourcart began to collaborate with the *Service de la Carte Géologique du Maroc*, who financed his missions across North Africa to gather geological and geographic information that could be applied to military purposes – such as transportation, movement of troops and supplies, establishment of the front, and defense.¹¹³ He also worked occasionally for *Service des Mines*, but Bourcart did not appear to be neither too much involved, nor interested, in oil and mining exploration.¹¹⁴

The lack of references to oil and mineral exploration in Bourcart's works may seem striking, especially if we consider that, simultaneously, France was investing large economic efforts in exploring the potential natural resources of Morocco, Tunisia, Mauritania, Mali, and Niger, just to name a few regions.¹¹⁵ It should be borne in mind that the mining potential of those territories was completely unknown, hence military and industrial goals converged toward a single priority: establishing a detailed geological cartography of the upper sediments (corresponding to the Quaternary); which was one of Bourcart's permanent tasks.

Through those missions Bourcart resumed fieldwork in Morocco, where he re-focused on the study of marine regressions and transgressions. New sediment and fossil evidences reinforced the theory that an ancient water-corridor across Morocco had disappeared in the late-Miocene, as the sedimentological record displayed a sequence of a landscape of increasing aridity: marine deposits were followed by fossil beaches, and those by fossil, Pliocene dunes.¹¹⁶ How to explain

¹¹¹ With the information he had gathered during his times in Albania, Bourcart digested his PhD dissertation in geography and geology, although he also included large sections on anthropological studies (in: Bourcart, *Les Confins Albanais Administrés par la France*).

¹¹² Bourcart, "Premiers Résultats d'une Étude du Quaternaire du Maroc."

¹¹³ About the work of French geologists in Morocco, exploring for the Service de la Carte Géologique, see: Médioni, "L'œuvre des Géologues Français qu Maroc."

¹¹⁴ His only contribution to an official report on the mining potential of French overseas' territories is on the prospects of the Saharian region. With a rather harsh sentence, he concluded that "the mining resources in the Sahara are null" (in: Bourcart, "Le Sahara Algérien"). It's worth to note that Bourcart's report was published in 1933, almost two decades before oil was discovered in the French Sahara. About the work of French geologists and oil exploration in the Sahara, see: Combaz, "Les Premières Découvertes de Pétrole au Sahara").

¹¹⁵ For first-hand accounts of this exploratory period, see: Médioni, "L'œuvre des Géologues Français au Maroc;" Rocci, "L'œuvre des géologues français en AOF."

¹¹⁶ Bourcart, "Essai de Classement des Formations Continentales du Maroc Occidental;" Bourcart, "Premiers Résultats d'une Étude du Quaternaire du Maroc;" Bourcart, "Les Dépôts du Second Cycle Miocène."

these sudden changes of paleo-environments? According to Bourcart, the answer was to be found in vertical, tectonic movements, through which continental masses moved in the opposite direction than marine lands – a dynamic he called ‘continental flexure’. When continents rose, marine basins became deeper, thus generating a sea-level drop (a regression). Conversely, when continents sank, the seawater invaded emerged lands (a transgression). In these movements, the coastline was the hinging point.¹¹⁷

But despite this theory was inspired in those supported by renowned geologists like Edward Suess, Émile Haug, and John Joly, it did not find much acceptance among the French geological community. Scientific records do not hold strong criticism towards Bourcart’s hypothesis –it rather seems like his hypothesis were overlooked by the geological community, being only mobilized as a tectonic explanation by Bourcart himself.¹¹⁸ This lack of grip made Bourcart aware that he could not keep on informing his ideas simply with mainland evidences: studying the seafloor could enhance understanding on continental tectonics, on marine regressions and on transgressions. His determination was inspired by American geologists, who were already moving their geological ventures below the seawater.¹¹⁹

2.2. Submarine warfare and the roots of marine geosciences

Besides oil as a new source of energy, World War 1 brought new technologies to explore and control the oceans. Bourcart grew convinced that studying the seabed’s geology was a real possibility after witnessing how American researchers were successfully applying military-based technologies to explore the seabed’s topography around their territory.

2.2.1. Echo-sounders: New technologies to chart the seabed

The history of echo-sounders, devices to send and receive acoustic signals underwater, traces back from the early years of the 20th century. Initially designed in 1912 by a Boston-based engineering enterprise, the Submarine Signal Company, first prototypes were conceived to

¹¹⁷ More about the theory of the continental flexure in: Bourcart, “La Marge Continentale.”

¹¹⁸ I could not find evidences of harsh criticism to his theory, yet in private exchanges with Gilbert Boillot (one of his former students), he acknowledged that Bourcart was rather dismissed among the French geological community for his tendency to oppose to established concepts, his strong personality, and perhaps his eccentric ideas. However, this does not explain why scientifically his theory was neglected (in: Martínez-Rius, “Interview to G. Boillot”).

¹¹⁹ Bourcart, “La Marge Continentale.”

enable communication between vessels and mainland stations. By ringing underwater bells, sailors could send about twenty Morse-code words per minute, that were received by hydrophones up to eighty kilometers in distance. In 1914, the US Coast Guard with a team from the Submarine Signal Company tested the system's capabilities to detect icebergs. Besides successfully detecting those up to 20 kilometers away, the team noted a persistent echo that appeared after sending the outgoing signal: that of the signal bouncing back from the seabed, 1,5 kilometers below the hull. They had just discovered that echo-sounders could substitute lead-ropes and other rudimentary techniques to fathom the ocean's depths and chart the seabed.¹²⁰

The outbreak of World War 1 prompted the interest of contending nations on underwater acoustic systems, for their ability to detect enemy submarines as to enhance communication between allied vessels while at sea. The US equipped its warships with the *Sub Sig* system (as it was called) with little success; while the British Navy designed prototypes that worked in higher frequencies.¹²¹ In 1919, the French Navy started testing its own prototypes, designed by the hydrographic engineer Pierre Marti, consistent on exploding cartridges with submerged rifles. Although peculiar, the system proved to be successful, enabling the Hydrographic Service to sound the Bay of Biscay from shallow waters (less than 200 meters depth) to the open ocean, up to 4,000 meters depth.¹²²

When the war ended, echo-sonars were enhanced in private companies and Naval organizations, while their use spread among oceanographic laboratories. During the twenties and thirties, national governments, private institutions, and philanthropic individuals supported numerous oceanographic campaigns around the world, refitting military vessels with echo-sounders to explore the depths and unveil the topographical features of the seabed. Expeditions like the world-wide German *Meteor* campaign (1925-1927); the US *Carnegie's* Cruise VII across the North Atlantic and Pacific Oceans (1928-1929); the British Antarctic Expedition led by explorer Richard E. Byard (1928-1930) and the Discovery Investigations (1926-138) onboard the *William Scoresby*; and the around-the-globe Danish *DANA I* and *II* expeditions (1928-1929), demonstrated for the first time that mid-ocean ridges, mounts, plains, gorges, and

¹²⁰ Early history of echo-sounders can be found at: Lawrence, *Upheaval from the Abyss*; Bates, Gaskell, and Rice, *Geophysics in the Affairs of Man*

¹²¹ Ibid. More about the development of sonar systems in the US Navy during wartime in Weir, *An Ocean in Common*.

¹²² Marti, "Rapport sur les expériences de sondage," November 12, 1919 (SHD, MV 9JJ 39).

trenches populated the ocean depths.¹²³ As importantly, during these missions the continental shelf – a shallow, submerged region bordering the continents – was recognized as a common feature of continental margins around the world.

2.2.2. Submarine canyons: American pioneering discoveries in the seabed

Meanwhile, in the US, a new model of oceanographic research was emerging supported by federal organizations. Military devices like echo-sounders, which enabled experts to *see* below the mass of water, prompted a sort of techno-optimism in which the seabed was, for the first time, accessible.¹²⁴ After the war, the US Coastal and Geodetic Survey, devoted to map the territory, grew interested in using acoustic devices to chart submarine regions annexed to the US. For these purposes, they contacted with geologist Francis P. Shepard (1897-1985), who had just completed his PhD at the University of Illinois. Shepard was among the first geologists who dove in the study of shallow-water sediments, supported by more enthusiasm than research means. For his PhD research, Shepard embarked on his father's yacht to sample the seafloor off New England shores, to study the role of sea-water level changes in the evolution of that continental shelf.

These investigations caught the attention of the US Coast and Geodetic Survey, whose experts did not possess the scientific expertise needed to interpret the sounding data that was being acquired. Especially problematic was data recovered off the New England coast, where the Survey had discovered numerous submarine canyons: steep gorges, excavated on the edges of the American continental shelf (fig.2). Captain Patton, from the Survey, contacted with Shepard and offered him to collaborate in future campaigns, a proposition he enthusiastically accepted.¹²⁵ That same year, Shepard embarked onboard the vessels of the US Coast and Geodetic Survey which, equipped with echo-sonars, produced large amounts of data from the Atlantic continental shelf, and were fully available for Shepard's researches. Those surveys demonstrated that, far from being anecdotic, submarine canyons populated the American continental shelf from Boston to southern North Carolina.

¹²³ The main goal of most of these expeditions was to study marine biology, yet they utilized echo-sonars to measure depths and draw the seabed's topographical features (Dolan, "An early example of international oceanography;" Sewell and Wiseman, "Le relief du fond de la mer").

¹²⁴ Weir, *An Ocean in Common*.

¹²⁵ Shepard, *Autobiography*.

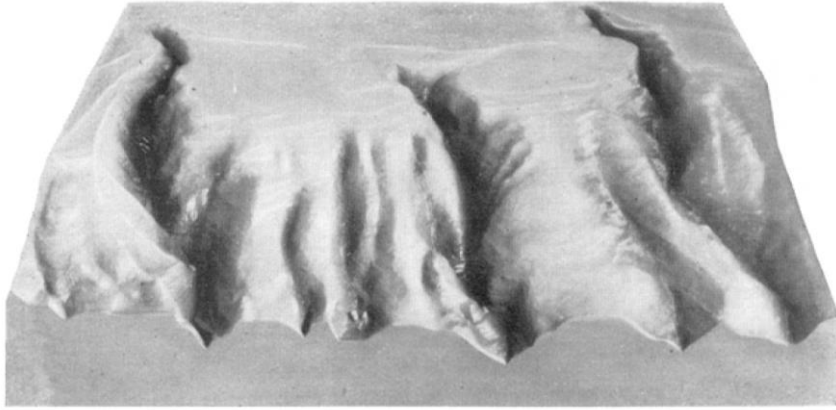


Figure 2. Model by Shepard of submarine canyons found off New England coast (Shepard, “American Submarine Canyons”).

The existence of submarine canyons greatly intrigued Shepard, a fascination that intensified when, in 1934, he moved his investigations to the Californian coastline and found equivalent formations cutting across the continental shelf.¹²⁶ He and his team had just settled at the Scripps Institution of Oceanography, at La Jolla, by then a humble marine station with barely a dozen permanent oceanographers, small boats, and unstable sources of funding.¹²⁷ From that spot, he would devote a large part of his career deepening the understanding of the genesis of submarine canyons: were they excavated by underwater currents? were they cracks, resulting from sudden catastrophic events, such as tsunamis? or had they been eroded by ancient, once emerged rivers?¹²⁸

Shepard’s studies on submarine canyons were widely disseminated in scientific articles and congresses, immediately arousing Bourcart’s interest. Those made him recall that, in the French Mediterranean, geologist Georges Pruvôt had already identified similar formations in the late 19th century, calling them “rechs”.¹²⁹ If those rechs were equivalent to Californian submarine canyons, and if they had been created by the course of ancient rivers, Bourcart would have a strong evidence supporting continental flexure theory in the Mediterranean. In that framework, submarine canyons could be the result of massive seawater regressions, when the continental

¹²⁶ Shepard, “American Submarine Canyons.”

¹²⁷ Oreskes, *Science on a Mission*.

¹²⁸ His team included the young geologists Robert S. Dietz and Kenneth O. Emery. Both of them would become, just some years later, renewed experts for their pioneering works in continental drift. Shepard, “Underlying causes of submarine canyons.”

¹²⁹ Bourcart, “Le ‘rech’ Lacaze-Duthiers.” By using sounds (lead weights attached to a long rope) to determine water-depths, Pruvôt had noticed the likely existence of deep submerged gorges in front of Roussillon coastline, which called “rechs” – a term borrowed from Catalan.

shelf was exposed out of water. Mainland rivers would have had to traverse it to reach the sea, thus eroding steep gorges (submarine canyons); being later refilled by sediments and seawater when the sea re-invaded the continental shelf.

In 1938, Bourcart began to exhort the French geological community to take a more serious look at the seafloor: evidences from mainland geomorphology needed to be complemented with data from the seabed to efficiently unveil the Mediterranean's geological history. According to him, the combination held a great explanatory potential both to study continental tectonics and to understand dynamics of marine regressions and transgressions.¹³⁰ The outbreak of World War 2 however forced Bourcart to postpone any plan to pursue the seabed's geological study; but, unexpectedly, far from being an obstacle, the war became a context of opportunity that enabled him to move his investigations to the sea.

2.2.3. An unexpected relation: Bourcart and the French Navy during World War 2

At the war's outbreak, Bourcart voluntarily enlisted in the French Army, being appointed geological and chemical engineer at the *Service d'Études de Génie*. He was first assigned to French chemical factories and, from November 1939, he was sent to the Libyan and Syrian frontline. There, he combined his military activities with geological investigations: during spare hours, he traveled around the French controlled regions, studying outcrops and comparing them with the Western Mediterranean formations.¹³¹ When, in June 1940, France was occupied by German army, Bourcart returned to the metropolitan territory.

Bourcart joined the Resistance in 1942, when two of his students requested him to use his laboratory to compile maps on the German coastline and suitable landing spots.¹³² Stimulated by the idea of contributing to his country's liberation, Bourcart engaged in cartographical tasks inside the Resistance, by transforming his laboratories at the University of Paris in meeting points for resistance agents. There he gathered strategic data, designed maps, and offered geographical training to recruited men.¹³³ In 1943, under the pretext of conducting geological

¹³⁰ Bourcart, "La Marge Continentale."

¹³¹ Bourcart, "Recherches sur la Stratigraphie du Pliocène." It is interesting to note that in this communication at the *Société Géologique de France*, Bourcart did not explain to the audience why he was in Libya and Syria.

¹³² Direction Générale des Services Spéciaux, "Fiche de déclarations P. 279758," October 23, 1944 (SHD, GR 28 P58 (80)). The *Résistance intérieure française* was constituted by the French networks and activities organized to fight against the Nazi German occupation of France and the collaborationist Vichy régime during World War 2.

¹³³ Some of these "resistance agents" who attended to Bourcart's meetings were indeed his own students. Villat, "Mémoire de proposition pour l'attribution de la Médaille de la Résistance" (SHD, GR 16 P 81000); Forces Françaises Combattantes, "Fiche Individuelle de l'Agent 20205" (SHD, GR 16P 81000).

fieldwork for his researches, Bourcart studied and designed a general plan of the Atlantic coastline defense of Brittany and the Mediterranean one of the Alpes-Maritimes department, a work through which he gained high prestige among the Navy's circles.¹³⁴

His secret military activities, ignored by his colleagues at the university, earned him the Résistance Medal after the war in recognition for his contributions. Most importantly, his studies of the French coastlines to assist potential Allied landings, and to defend France from incoming enemies, brought him renown among military circles. This unique position would grant him the opportunity to undertake marine geological studies after the war by offering expert assistance to the Navy.

2.3. The onset of the offshore oil industry in the US

Thirst for oil grew among contending nations during World War 2 and soared from 1945, with the urgency to reconstruct extraction infrastructures and to recover economy. Global oil production exploded from barely 5 million barrels per day in 1936, to more than 10 million in 1950.¹³⁵ Three weeks after the war officially ended, a key event related with the American craving for oil changed the perception on how coastal nations regarded the seafloor: On September 28, 1945, American President Harry S. Truman declared that natural resources from the continental shelf surrounding the US, belonged to the US.¹³⁶ The announcement, intended to exert control over *potential* oil deposits that could be found underwater, set the seafloor in the international spotlight. The need to establish a consensual, international legislation on still-unknown resources gave momentum to marine geosciences, since only through the improvement of marine geological knowledge and techniques, potential oil and mineral deposits could be identified and exploited.

However, different geopolitical contexts led to different understandings on the uses of this new territory. This is particularly evident if we compare how and why marine geosciences developed in the US and in France between 1945 and 1960: while in the former they thrived to explore the

¹³⁴ Villat, "Mémoire de Proposition" (SHD, GR 16 P 81000); Forces Françaises Combattantes, "Fiche Individuelle de l'Agent 20205" (SHD, GR 16P 81000); Forces Françaises Combattantes, "Questionnaire Signalétique. Jacques Bourcart" (SHD, GR 16 P 81000). In the Resistance, Bourcart developed a prestigious career: he led an operation to study enemy positions in the German border and, after being detained by the Gestapo, managed to escape liberating nine French prisoners with him (in: Villat, "Mémoire de Proposition" (SHD, GR 16P 81000); Forces Françaises Combattantes, "Questionnaire Signalétique", (SHD, GR 16 P 81000).

¹³⁵ Robelius, *Giant oil fields*.

¹³⁶ Scharf, "The Truman Proclamation on the continental shelf."

continental shelf's potential on natural resources; in the later it barely developed, as France expected to rely on North-African oil supplies.

2.3.1. Turning to the oceans: Truman Proclamation on the continental shelf

Truman's Proclamation was issued in a period when no international jurisdiction over marine territories existed; only customary laws and unilateral proclamations ruled on the extension of national seawaters.

The issue of the property of the seas and oceans, and its natural resources, was not new. The canons of the Roman law considered the oceans *res communis*: belonging to everyone, and therefore no-one could appropriate them.¹³⁷ Towards the sixteenth century, with the emergence of independent states, an opposite approach spread among the nascent empires: oceans were *res nullius*, belonging to no one, and therefore open to claim – as the Spanish and Portugal empire did, after reaching the American coastline. By signing the Tordesillas Treaty in 1494, they assigned the world oceans to each of them.¹³⁸ However, this division was to be contested in the following decades with the development of British and Dutch naval powers, who ambioned to sail freely across allegedly Spanish and Portuguese seawaters. In 1608, the Dutch Hugo Grotius published the pamphlet *Mare Liberum*, where he argued for the freedom of the seas and their liberation from any national control.¹³⁹ Grotius doctrine was internationally accepted for more than three hundred years; although from the 18th century coastal nations began to consider territorial seawaters “as far as a cannon fired from land can go” – around 3 miles.¹⁴⁰

Neither was Truman's pronouncement the first national declaration to control potential marine resources. Ceylon, for instance, had declared in 1811 national jurisdiction over pearl fisheries,

¹³⁷ Political scientists Robin R. Churchill and Alan V. Lowe have argued that the legislation on the oceans is inseparable from the development of international law; therefore, it grew up only with the emergence of independent States – this is, roughly from the sixteenth century onwards. The first laws drawn partly from the canons of the Roman law, together with scriptures of classical Greek and Roman writers (Churchill and Lowe, *The Law of the Sea*).

¹³⁸ Pope Alexandre VI also qualified America as *terra nullius*, legitimizing the colonization of the continent. Other countries followed the stream: Venice claimed the Adriatic Sea, and various states laid claims on the Baltic (Buzan, *Seabed politics*, 1).

¹³⁹ In line with contemporary struggles to control commercial routes, Grotius' pamphlet aimed at vindicating claims of its employer, the Dutch East India Company, to trade in the area claimed by the Portuguese (Churchill, *The Law of the Sea*).

¹⁴⁰ Scharf offers a great historical overview of the history on oceans' jurisdiction before, and after, the Law of the Sea (Scharf, “The Truman Proclamation on the Continental Shelf”).

specifying in 1925 that it covered up to a hundred fathoms depth. Panama had also declared control over fisheries up to 120 miles from his coastline; while Tunisia extended its national control up to 17 miles on the sea to control sponge fisheries. In the UK, the Cornwall Submarines Act of 1858 claimed the right to build tunnels into the seabed beyond the three-mile limit of the territorial sea; while Australia, Japan, Chile, and Canada undertook coal mining activities in shallow waters.¹⁴¹

So why did the new American policy constitute a turning point in the international legislation of the oceans? Unlike previous proclamations, the Truman Proclamation asserted that technological knowhows were already available to transform underwater mineral resources into potential key assets for the national economy. It was also a conceptual breakthrough, since the meaning of the continental shelf was changed from a geographical feature to an extension of a country's landmass and thus, "naturally appurtenant to it."¹⁴²

Truman's proclaim began to take shape in 1943, during the presidency of Franklin D. Roosevelt. It emerged from the confluence of the federal government's eagerness to speed up the country's economic recovery after the war, and a growing pressure from the American oil industry, who was craving to obtain exploration leases in submerged lands.¹⁴³ In the 1920s, the swamps and marshes in South Louisiana had become promising grounds for oil exploitation due to a mix of "geological good fortune and corrupt deals with Louisiana officials," as historian Taylor Priest phrased it.¹⁴⁴ The region was covered by easy-to-identify salt domes, geological structures prone to harbor hydrocarbon deposits; and through a corrupt state system oil companies obtained extremely cheap leases on public lands.¹⁴⁵ Profitable oil and gas fields found in shallow, inner waters prompted interest in the adjacent offshore region: the open waters of the Gulf of Mexico. Its excellent environmental conditions – a wide and shallow continental shelf, with mild weather and barely waves – transformed the area in an excellent

¹⁴¹ Suarez, *The Outer Limits of the Continental Shelf*.

¹⁴² Buzan, *Seabed Politics*.

¹⁴³ Hannigan, *The Geopolitics of Deep Oceans*. The first lease requested to exploit oil in the offshore came in 1918, when an American citizen who claimed to have found oil 40 miles off the coast in the Gulf of Mexico, requested the government an exploration permit. The government's answer was that it did not possess jurisdiction over the seafloor (Waldock, "Legal Basis of Claims to the Continental Shelf").

¹⁴⁴ Priest, "Extraction not creation".

¹⁴⁵ According to Priest, the poor seismic technology to indirectly explore oil deposits was compensated with drilling. Oil companies sought to obtain large and cheap leases to allow wide-ranging exploration programs (Priest, "Extraction not creation"). The first identification of a salt dome in a water-covered area, in Louisiana, was published in: Rosaire and Lester, "Seismological Discovery of Vermilion Salt Dome." More details about salt domes in pp. 99-100.

testing ground for the just-emerging offshore oil industry. In 1934, the oil firm Texaco began to test offshore drilling devices for coastal shallow waters and soft-bottoms; while one year later, Pure Oil and Superior Oil installed the first productive oil rig two kilometers off the coastline.¹⁴⁶ The shallow seafloor of the US continental shelf began then to be regarded as a new region where to exploit hydrocarbons and minerals, a safe supplier for being close to the national territory, and probably cheaper for its proximity to refining and consumption areas.¹⁴⁷ Truman proclamation, therefore, benefited American oil firms as well as the national government, since it ensured US operators that the government was backing their activities; while it moved the power to issue leases from the hands of state governments to the federal government.¹⁴⁸ Truman claims were not directly opposed by foreign countries. Quite on the contrary, in the following five years, around thirty countries proclaimed similar jurisdictions. Coastal nations understood that, by legitimizing the American movement, they could claim the same rights over their continental shelf – which, perhaps, might assure them a future source of wealth.¹⁴⁹

Now that the continental shelf was legally included as part of national territory, American oil companies launched intensive efforts to move their ventures from coastlines to deeper waters: from 1945 to 1950, forty oil companies invested a hundred million dollars in leases, and another hundred million for marine equipment and platforms.¹⁵⁰ The oil firm Shell “pushed aggressively offshore,” as its vice-president Bob Nanz asserted, by strategically focusing on technological innovation to minimize costs and risks.¹⁵¹ In 1946, Union Oil struck an alliance with Continental Oil Company to share costs in a joint project in order to conduct a systematic survey

¹⁴⁶ Priest, “Extraction not creation;” Pratt, Priest, and Castaneda, *Offshore Pioneers*.

¹⁴⁷ Scharf, “The Truman Proclamation.” On the freedom of foreign vessels to sail across American waters, see Suarez, *The Outer Limits of the Continental Shelf*.

¹⁴⁸ Following Truman Proclamation and to manifest their disagreement with his decision, the state government of Texas, Louisiana and California halted oil exploration activities in their waters. The conflict was solved in May 1953, when the US Congress passed two agreements: the Submerged Lands Act, that granted the power to issue oil and gas leases to the state government up to 4,8 kilometers off their coastline; and the Outer Continental Shelf Act, that situated all lands beyond 4,8 kilometers under federal jurisdiction (see: National Academies of Sciences, Engineering, and Medicine, “History of the Offshore Oil and Gas Industry”).

¹⁴⁹ Especially from Latin America (Mexico, Argentina, Panama, Chile, Peru, Costa Rica, Guatemala, Brazil, Nicaragua, Honduras and Ecuador); nine Persian Gulf Sheikdoms, and also Iceland, Saudi Arabia, Iran, the Philippines, Pakistan, and Yugoslavia. Many authors have attempted to explain this absence of public opposition. Some have argued that, after six years of war, nations were too weak economically, too concerned on a quick recovery or, directly, they were too reliant on the US to oppose its new doctrine (Suarez, *The Outer Limits of the Continental Shelf*.) Other historians have pointed out that the US dodged opposition by specifying that it would grant drilling rights to foreign governments to explore its seawaters (Buzan, *Seabed Politics*).

¹⁵⁰ Kreidler, *The Offshore Petroleum Industry*, 83.

¹⁵¹ Priest, *The Offshore Imperative*.

of the seabed, staffing geologists and engineers for that purpose. Shell and Superior Oil Company joined later the team, becoming the CUSS group.¹⁵² One year later, Brown & Root Marine, an American company devoted to develop offshore platforms and marine pipelines, built the first offshore platform beyond-sight in the Gulf of Mexico, almost 20 kilometers off Louisiana's coast.¹⁵³ By 1949, oil and gas companies crammed the Gulf of Mexico's continental shelf, having drilled forty-four oil wells and identified eleven hydrocarbon deposits in seawaters shallower than 10 meters depth.¹⁵⁴

However, the offshore presented a daunting challenge: the oil industry knew nothing about the marine environment, nor possessed any guaranteed methods to operate at sea. Before 1945, oil companies that ventured in shallow waters (lakes or marshes) had relied on coast shipyards and naval architects to obtain data and design infrastructures. But the ocean opened new questions and presented new dangers: what sort of waves would they find? and how high would they get in a severe storm? how piles of platforms could be safely fixed? under which meteorological conditions was it safe to drill? how similar was the seabed structure from mainland? were there the same chances of finding oil and gas? To venture into the oceans, the oil industry required new expertise that could only be obtained from scientific institutions, where the war had boosted the field of oceanography.

2.3.2. Shepard, the oil industry, and the Californian submarine canyons

In 1948, thirty-two American oil firms gathered under the Offshore Operators Committee, a group fostering cooperation to confront the complexities of offshore operations by sharing data and activities.¹⁵⁵ The group decided that the Gulf of Mexico would be the first area to be surveyed, relying on experts recruited from research institutions.¹⁵⁶ For its part, the American Petroleum Institute (API), an American trade association representing most of the oil industry,

¹⁵² CUSS accounts for the initial letters of these firms: Continental, Union, Shell, and Superior. Burlison, *Deep Challenge!*, 39.

¹⁵³ Pratt, Priest, and Castaneda, *Offshore Pioneers*.

¹⁵⁴ National Academies of Sciences, Engineering, and Medicine, "History of the Offshore Oil and Gas Industry."

¹⁵⁵ Kreidler argues that, although the offshore industry was competitive, "the complexity of marine operations required a cooperative effort" (in Kreidler, *The Offshore Oil Industry*). The Offshore Operators Committee has evolved into the oil and gas industry's principal representative regarding regulation of offshore exploration, development, and producing operations in the Gulf of Mexico.

¹⁵⁶ In the US, we can arguably say that marine geophysics developed following two different – yet complementary – pathways. This chapter recounts only part of the story, highlighting how oil companies subsidized individual geologists. Chapter 3 deepens into the origins of marine geophysics supported by the US Navy in oceanographic laboratories.

decided to fund a general, unclassified research program to be conducted at universities and research centers.¹⁵⁷

The Scripps Institution of Oceanography quickly caught the oil industry's attention. Before and during the war, its experts had conducted studies whose outcomes could be applied to offshore oil operations. Oceanographers Harald Svedrup (the Scripps' Director) and Walter H. Munk had developed studies on wave forces and prediction on surf conditions during World War 2. The data, commissioned and used by the US Navy, was also valuable to assess offshore oil operations. As for the seafloor, Francis P. Shepard was arguably the only American expert in marine geology. In wartime he had joined the University of California War Department, where he developed coastal studies related to sand dynamics, wave formation, and forecast to assess landing operations. Besides those, his pioneering works supporting the US Coastal and Geodetic Survey on the Mississippi delta had offered hints of the region's oil promises.¹⁵⁸ Shepard's just-published book *Submarine Geology* (1948) became a touchstone of offshore oil exploration, as he optimistically affirmed the "immense possibilities of finding oil" in the Gulf of Mexico.¹⁵⁹

In 1948, oil companies approached the Scripps Institution of Oceanography seeking expert advice and new recruits among PhD researchers, and started to subsidize studies. Seizing the opportunity to obtain large funds from API, Shepard proposed them a research project on sedimentation in the Gulf Coast continental shelf, covering an area of great interest to major oil companies.¹⁶⁰ From 1951 to 1957, Shepard and his team obtained from API a grant of 100,000 US dollars per year for their studies. Shepard was able to use a low-flying plane from Gulf Oil Company to get an eye-view of the gulf, access geophysical profiles of the Mississippi Delta acquired by oil companies, organize missions to sample sediments across the region, meet and collaborate with petroleum geologists, and train himself in sedimentation.¹⁶¹ Although he temporarily had to leave his studies on submarine canyons aside, the oil industry provided him with data and borehole samples – materials otherwise inaccessible at Scripps – which offered crucial information about the canyons' formation. Seismic profiles evidenced that more

¹⁵⁷ Rusnak, "Afoot and Afloat Along the Edge."

¹⁵⁸ Shepard, *Autobiography*. He recounts how he identify the top of a pinching salt dome using an echo-sonar when embarked in a campaign of the US Coast and Geodetic survey (being salt domes evidences of oil deposits – more in chapter 3).

¹⁵⁹ Shepard, *Submarine Geology*, 127-128.

¹⁶⁰ Shepard, *Autobiography*.

¹⁶¹ *Ibid.*

submarine canyons were buried below recent layers of sediment, meaning that, after fluvial erosion and a marine re-flooding, canyons were filled by the accumulation of recent sediments until its morphology disappeared under them.

Besides supporting Sheppard, the American oil industry contributed to the institutionalization of oceanography at universities. Oil companies were increasingly depended upon academic institutions, as the Scripps or Louisiana University, for their research expertise, but all of them were far away from the Gulf Coast. In 1949 Claude ZoBell, marine microbiologist at Scripps, recommended that Texas A&M University created an oceanographic department – a suggestion that became effective the next year. In 1951, the Department launched a major study of the Gulf of Mexico, institutionalized expert formation, and developed most of their projects stemming from commercial inquiries. In short, during the fifties, marine geology thrived in the US triggered by the oil industry's economic support, which led to the establishment of cooperative relationships, large funds to conduct marine geological studies, and the institutionalization of specialized departments.

2.4. The French strategy in the oceans

2.4.1. Oil in colonial territories and military surveillance in the oceans

After the war, France adopted a different approach than the US. Given its control of North African territories, the nation's future energetic security was considered to be found there, not in the oceans. Thus, oil and mineral exploration intensified in Tunisia, Morocco, and Algeria as well as in Sub-Saharan regions; whereas the continental shelf, far from projecting an economic attractive, became a region of strategic and military interest.¹⁶²

In August 1945 France's provisional government created the *Comité d'Océanographie et des Études des Côtes* (COEC), a national committee informed by military representatives under the *Service Hydrographique de la Marine*.¹⁶³ Initially conceived to expand collaborations between

¹⁶² On oil exploration in Algeria after World War 2, see: Cantoni, *Oil Exploration, Diplomacy, and Security*. For a first-hand account, see: Combaz, "Les Premières Découvertes de Pétrole au Sahara." For the history of the CFP after the war, and a detail on how it started its offshore adventure in the early 1960s, see: Gaston-Breton, *Un Sprit Pioneer*; Mounecif, *Chercheurs d'Or Noir*.

¹⁶³The Central Committee was presided by the French Navy's vice-admiral Jacques Missoffe and the Permanent Secretary André Gougenheim, an hydrographic engineer. Among its permanent members there was one representative from the military Secret Services, the Land Forces, the Air Forces, the Hydrographic Service and the *Service des Travaux Maritimes*; as well as a representative from the Ministry of Public Works, the Ministry of National Education (who was usually the CNR's Director), and the *Office National Météorologique*.

the French Navy and the Allied Beach Intelligence Committee beyond the war period, the COEC was responsible for promoting and coordinating hydrographic and oceanographic studies adapted to peacetime.¹⁶⁴ It was mainly devoted to gather hydrographical data on currents, tides, and surf around the world; to assess the Department of Public Works in building and maintaining coastal infrastructures (like ports), and to enrich the Navy's oceanographic knowledge by promoting the participation of its members in international congresses and research projects. Moreover, the COEC was used to strengthen the French control over colonial territories by establishing its bases in cities like Dakar, Casablanca, Tunis, Saigon, and Nouméa from where its members could conduct oceanographic research with military purposes.

After the launch of the COEC, Bourcart was appointed advisor in coastal geology for his remarkable military assistance during wartime. He would offer technical assistance in coastal issues, usually related to erosion problems and their impact on coastal infrastructures, studies on port sedimentation, and by facilitating reports on coastline morphology.¹⁶⁵ Bourcart actively participated in the COEC's quarterly meetings, held at the *Institut Océanographique de Paris*, where he met commanders and admirals from the French Navy, as well as other experts with a mixed scientific and military background.¹⁶⁶ Henri Lacombe (1913-2000), hydrographic engineer, became one of the leading oceanographers at the Parisian *Muséum National d'Histoire Naturelle* (MNHN). Lacombe had worked for the Hydrographic Service from 1935, where he developed his expertise in underwater acoustic techniques as well as an interest in ocean sciences, while commanding hydrographic surveys across French and Tunisian seaways. After the war, Lacombe inaugurated the first course on physical oceanography in France, initially restricted to naval hydrographers and, from 1956, also addressed to undergraduate students from the University of Paris. He would remain attached to the Navy until 1957, when he moved to the MNHN to occupy the first chair in physical oceanography.¹⁶⁷ The young – and still unknown – Commander Jacques-Yves Cousteau (1910-1997) was also a

¹⁶⁴ In archival sources, Jacquinet refers to the “Beach Intelligence Committee of the allied countries,” but there is no further evidence of the existence of this committee. Jacquinet might be referring to the American Beach Erosion Board, created in 1930, that contributed to identify conductive beaches for allied landings during World War 2; or to the British Beach Reconnaissance Committee (in: Bates, Gaskell, and Rice, *Geophysics in the Affairs of Man*, 99).

¹⁶⁵ For instance: Bourcart, “Étude de la plage de Graves;” Bourcart, “Le littoral Breton;” Bourcart and Auzel, “Sur l'érosion de la plage de Deauville.”

¹⁶⁶ During those meetings, attendants presented the last news in their field related to ocean sciences, discussed which projects should be organized, and selected who would conduct them (either among COEC members or external collaborators from academic circles). Jacquinet, Louis (Minister of the Navy). Letter to the Minister of National Education, August 4, 1945 (ANF, 19800284/205).

¹⁶⁷ Bourgoïn, “Henri Lacombe, 1913-2000.”

frequent participant in the COEC's meetings. Trained as second lieutenant in the Naval Academy, Cousteau had started his underwater diving experiments in 1943 while in the Navy, accompanied by Captain Philippe Tailliez. Their successful prototypes of diving technologies caught the attention of the Navy General Staff, Admiral André Lemonnier, who created the Groupe de Recherches Sous-Marines (GRS) so that Cousteau and his team could continue developing diving devices. The COEC was not only the organism that enabled Bourcart to move his geological researches from the mainland to the offshore; but it also marked the start of collaborations between Lacombe, Cousteau, and Bourcart in marine projects and national committees.

2.4.2. Bourcart's new patron and the exploration of submarine canyons

The COEC began to support the exploration of the French-Mediterranean continental shelf in summer 1946. Bourcart was offered to embark some weeks per year in military vessels moored in Toulon's Naval base equipped with echo-sonars, sampling instruments, and mariners.¹⁶⁸

The Navy's main interest on Bourcart's researches was military and strategic: they commissioned him to identify and exhaustively characterize the submarine canyons that crossed the French-Mediterranean continental shelf – which, in turn, were relevant for Bourcart's studies.¹⁶⁹ Submarine canyons were of an utmost military importance, as they could become secret corridors for enemy submarines to approach the French coast without being detected. The issue was particularly delicate in the French Mediterranean, as in the early-1930s secret bathymetric soundings had shown the existence of a deep canyon that led directly to the Toulon Bay, where a naval base was established.¹⁷⁰ Due to its high strategic value, that information remained top secret and classified throughout World War 2 and, under the aegis of the COEC, Bourcart was assigned to resume the task. From 1946, thus, Bourcart was granted an

¹⁶⁸ The COEC did not possess its own budget, but it relied upon the Service Hydrographique de la Marine's budget to support researches, acquiring materials and documents, publications, etc. (Ministre des Armées, "Arrêté - organisation et fonctionnement," (SHD, AA553 5I 283). Bourcart could publish his results from the very first mission supported by the COEC: Bourcart, "Sur les Rechs."

¹⁶⁹ Bourcart believed that the Truman Proclamation would urge the French Government to invest in exploring its continental shelf, and he explicitly referred to it during the COEC's meetings in several occasions. He emphasized that France not only must undertake research programs on the seafloor equivalent to the American ones, but that the French Navy should be the responsible of organizing and coordinating such a program as it was, according to him, the only institution that could "tackle the common interest of the nation". However, it seems that this claim had little or no repercussion on the COEC, as the economic prospect of the continental shelf is not mentioned at any point (Bourcart, "Compte Rendu des Missions de Géologie Sous-Marine 1949").

¹⁷⁰ Bourcart, "Géologie Sous-Marine de la Baie de Villefranche ;" Gougenheim, "Les Canyons Sous-Marins."

unprecedented access to the Navy's research facilities and resources, which could not have been obtained from the National Research Council (the *Centre National de la Recherche Scientifique*, CNRS).¹⁷¹

Each summer, Bourcart traveled with his family to Villefranche-sur-Mer, a small fishing village near Nice, where he installed a temporary laboratory at the Oceanographic Observatory – one of the oldest marine stations in France.¹⁷² Situated 150 kilometers away from the Toulon naval base, the spot was ideal to conduct marine geological experiments: Villefranche-sur-Mer sat at the foot of the rugged Maritime Alps, facing a close, calm, and deep harbor (its center easily reaching a depth of 100 meters). Facing south, with a narrow connection to the sea, the site was protected from strong winds and waves, and devoid from the turbulences of fresh water streams. A team of young geologists, recruited among Bourcart's collaborators at the University of Paris, joined him in the offshore missions, becoming the first team of marine geologists in France. The geochemist – and only woman in the group – Claude Lalou was responsible for studying the chemistry of sediments and of drawing bathymetrical charts,¹⁷³ while geologists Maurice Genesseeux, François Ottmann, and Eloi Klimek worked together on analyzing the recovered sediments.¹⁷⁴

To study submarine canyons, the team embarked on military vessels specifically adapted to hydrographic surveys like the *Ingénieur Elie-Monnier*, commanded by Commander Cousteau before he acquired his mythical *Calypso* in 1950.¹⁷⁵ The team sailed along the French coastline exploring the continental shelf of the Gulf of Lion, the Côte d'Azur, and even around Corsica. Identifying submarine canyons was not an easy task, as the team used the onboard echo-sonars which were not specifically suited to sound deep, irregular, regions. These devices performed well when sounding flat areas, since acoustic signals bounced over a single plane. But sounding canyons was another story: acoustic signals bounced in many planes (the canyon slopes, its

¹⁷¹ The CNRS was founded in 1939 (about its origins, see: Picard, "La Création du CNRS"), but it was not until 1948 that it subsidized ocean sciences, by contributing to refurbish the marine stations of Roscoff, Banyuls-sur-Mer, and Marseille (see: Laubier, "L'Émergence de l'Océanographie au CNRS").

¹⁷² The marine station at Villefranche-sur-Mer is one of the oldest in France. Zoologists Hermann Fol and Jules Barrois funded the first laboratory of marine zoology in 1882, encouraged by Charles Darwin to design a marine station in the French Mediterranean equivalent to the Anton Dohrn laboratory in Naples. The Marine Observatory of Villefranche-sur-Mer was shared by Russian and French zoologists from its ushering to the 1930s, as in 1885 the Kingdom of Sardinia allowed the Russian Imperial Navy to anchor its fleet in Villefranche's bay.

¹⁷³ Piccard, "Interview to Claude Lalou by Jean-François Piccard."

¹⁷⁴ Genesseeux and Mascle, "La Naissance de la Géologie Marine à Villefranche-sur-Mer."

¹⁷⁵ The *Aviso Ingénieur Elie-Monnier* was acquired in 1947 by the Groupement de Recherches Sous-Marines (GRS), led by Commander Cousteau.

bottom, the seabed...) and, after being processed, Bourcart had to disentangle the messy data to identify the canyons' topographical profile.¹⁷⁶ This information was complemented with samples acquired with dredges and corers; although sampling was almost impossible on the steep and rocky walls of the canyons. To these technological difficulties added the problem of the vessel's location. As vessels were not equipped with any radiolocation system, the team of geologists had to situate their position – and thus, that of the data gathered – with sextants, which decreased the accuracy of the submarine charts produced.

Being involved in the Navy's research projects enabled Bourcart to access privileged information: after he delivered his first results on the *rech Lacaze-Duthiers*, the Navy disclosed Marti's topographical map for him.¹⁷⁷ His task consisted in resuming Marti's work in collaboration with the *Service Hydrographique de la Marine*: while the later provided bathymetrical data between 200 and 2,000 meters depth, Bourcart and his team would draw with detail the continental shelf's morphology (indicating the location of underwater canyons, its depth, nature of sediment, point of origin and end, etc.). Beginning with the Côte d'Azur, between Marseille and Toulon, they planned to chart the entire French continental shelf between the Italian and Spanish borders, plus that of Corsica (fig.3).¹⁷⁸

¹⁷⁶ Gilbert Boillot, a former student of Bourcart, explained me that Bourcart “believed to possess a sort of special intuition to select the topographical data that could indicate him the canyon's profile” (Martínez-Rius, “Interview to G. Boillot”).

¹⁷⁷ According to Bourcart, the Ministry of Defense authorized him to consult the map after he published a first paper in 1948. In: Bourcart, “Morphologie du Précontinent.”

¹⁷⁸ Bourcart, “Topographie Sous-Marine et Sédimentation Actuelle.”



Figure 3. Chart on the continental shelf's topography of the French Mediterranean, elaborated by Bourcart and the Service Hydrographique de la Marine (Bourcart, "Topographie Sous-Marine").

These studies were pivotal for Bourcart's research on the Mediterranean regressions and transgressions, as they provided evidences indicating that the submarine canyons were probably excavated by ancient rivers – as American sedimentologist Francis Shepard had already speculated. The distinctive V-shape of the walls, as that of any other mainland river; the winding path of the canyon, feed by small gorges on its sides; and the walls' nature, constituted by hard rocks, drove him to argue that underwater canyons could only be formed by fluvial erosion. Moreover, Bourcart highlighted that their excavation had been a rapid process, generated by a torrential water-stream: indeed, at the canyons' feet, he had recovered gross fluvial pebbles up to 3 centimeters in diameter, that could only have traveled moved by a torrential river-stream.¹⁷⁹

By correlating these findings with stratigraphic evidences from the mainland, Bourcart dated the canyons' excavation in the late-Miocene, venturing that, by then, the connection between the Atlantic ocean and the Mediterranean sea had been cut off. This hypothesis fitted with the ancient water-corridor his master Louis Gentil found across Morocco. As no other water-source had poured into the Mediterranean to resupply water-losses by evaporation, the sea-level would have massively descended by about 2,000 meters from its initial level, therefore transforming the basin in a mosaic of brackish and isolated lagoons.¹⁸⁰ As a key evidence, Bourcart pointed to Toulon's submarine canyon foot: it ended 2,200 meters depth forming a river delta, which

¹⁷⁹ Bourcart, "Hypothèses sur la Genèse des Gorges Sous-Marines."

¹⁸⁰ Bourcart, *Géographie du Fond des Mers*.

indicated that in the late-Miocene, the river mouth was located there.¹⁸¹ Later, during the Pliocene, the connection between the Mediterranean and the Atlantic was reestablished through the region we now know as the Gibraltar Strait, which refilled the basin with seawater and transformed it in the current sea. This ground-breaking hypothesis was not well-received by the French geological community who, more conservative in their principles, refused the idea that the sea-level could ever drop more than 200 meters in a single event.

2.4.3. New spaces of research

The Navy's economic and logistic support enabled Bourcart to reach fascinating conclusions on submarine canyons, while the Mediterranean seabed began to take shape through his offshore cruises. However, these studies were not enough to move below the seabed's surface. To understand the seafloor's geological composition, as well as to study regions deeper than the continental shelf, Bourcart's team needed new research technologies that were being developed in countries like the US, the United Kingdom, or Sweden.

Besides the oil industry's support to American oceanographers, marine geosciences were thriving with the support of national organisms and philanthropic organizations. In the US and the UK, marine geophysical technologies began to develop relying on the Navy's funding; while in Sweden, oceanographer Börje Kullenberg designed and tested an inventive corer device with the support of the Naval Authorities in Gothenburg. Developed in 1946, the "piston core sampler" (also called Kullenberg corer) was an hydraulic coring instrument capable of recovering 20 meters-long cores from the seafloor – while Bourcart's corers barely sampled 2 meters-long cores (fig. 4 and 5).¹⁸² The device was successfully utilized during the Danish around-the-world expedition of the *Albatross* (1947-1949), led by oceanographer Hans Pettersson and fully subsidized by private donors from the Royal Society of Goteborg. The Danish team also tested a new device to register reflected signals in the seafloor, and an echosounder capable of obtaining continuous depth profiles in waters up to seven kilometers depth. With those, Pettersson and his team proved the thickness of soft sediments across the oceans, giving the basis of the later Ice Age's geochronology.¹⁸³

¹⁸¹ Bourcart, "Hypothèses sur la Genèse des Gorges Sous-Marines."

¹⁸² Kullenberg, "The Piston Core Sampler."

¹⁸³ In: Bourcart, "Géologie Sous-Marine de la Baie de Villefranche." About Pettersson's expedition, see: Pettersson, *Westward Ho with the Albatross*.



Figures 4 and 5: Kullenberg's piston corer onboard the Swedish vessel *Albatross*. The left image depicts the instrument in vertical, waiting to be descended. On the right, two oceanographers are hinging the samples (source: WHOI Online Repository, 1949).

Because of the scarcity in available funding, Bourcart and his team could not get involved in developing these kinds of devices, nor acquire them due to the ancillary gear needed. Kullenberg's corer, for instance, required a special vessel equipped with powerful winches that could hinge a more than a tone in weight (the 170 kilograms of the device plus the weight of the sediments recovered), coupled with a trained team of technicians to operate with it. Yet, Bourcart dreamed with pursuing equivalent investigations in the Mediterranean, which only seemed feasible through international collaboration.

With this aim in mind, Bourcart first contacted Francis Shepard in 1950, inviting him to the Laboratory of Dynamic Geology in Paris.¹⁸⁴ After a short meeting three years later, both maintained a frequent correspondence until Shepard traveled to France for a second time, in the spring of 1955. By then Bourcart had just been appointed Professor in Physical Geography and Dynamic Geology at the University of Paris, in recognition for his fruitful academic career. Bourcart invited Shepard onboard the *Ingénieur Elie-Monier* during a short cruise to study submarine canyons in Corsica's continental shelf. Both shared experience and knowledge,

¹⁸⁴Shepard, *Autobiography*; COEC, "Informations Avril 1953."

identifying similarities between Californian and French formations and pooling together ideas and hypothesis. Shepard's visit continued in Paris as special guest in the international "Colloquium of Submarine Geology," organized by Bourcart at Sorbonne University. Oceanographer Hans Pettersson was also invited, together with Philip Kuenen, director of the Geological Institute of Groningen. Besides creating a forum where the incipient community of French marine geologists could meet renowned international experts, the gathering was prepared to discuss about future collaborative missions. Indeed, the participants began to organize a large survey across the Mediterranean for the next summer which would bring together French, American, Swedish, and Danish experts.¹⁸⁵

Eventually, however, their intentions met with little success, and the envisioned joint campaign never materialized. There are no written traces on why it was not organized, but it might have been related to France's scarce research resources for academic investigation. Bourcart had been commissioned to provide a research ship but, besides the Navy's, the French oceanographic community could not count with a large oceanographic ship that could be equipped with devices like the piston corer, nor were they prepared host a large scientific party onboard. Lacking the main element to conduct an oceanographic mission handicapped the development of French international collaborations in the early stages of marine geology.

Yet, Bourcart's training of disciples gave its fruits. In 1956, the CNRS offered him funds to establish a permanent laboratory of marine geology at Villefranche-sur-Mer, where the Zoological Observatory agreed to donate an old, disused building for the team's settlement.¹⁸⁶ Not only it was an ideal spot to conduct marine geological studies, but also the laboratory sat only 10 kilometers away from Monaco, where Jacques Cousteau had moved in 1957 to head the *Musée Océanographique de Monaco*. This closeness stimulated collaborations between both teams, as the *Calypso* became Bourcart's main research ship for the seafloor's exploration beyond shore.

The first base for marine geological studies in the Mediterranean, the Villefranche laboratory, soon became a gathering point for all those young geologists who wished to introduce themselves to the field. After gaining a stable gateway to the Mediterranean, Bourcart recruited enthusiastic students from his undergraduate course "Oceanography: Introduction to Geology"

¹⁸⁵ Bourcart, "Colloque de Géologie Sous-Marine."

¹⁸⁶ About the laboratory's establishment, see: Boillot, "1956-2021. La Géologie Marine à l'Observatoire Océanologique de Villefranche-sur-Mer;" Gennesseaux and Mascle, "La Naissance et le Développement de la Géologie Marine à Villefranche-sur-Mer".

at the University of Paris.¹⁸⁷ Students like Gilbert Boillot and Wladimir Nesteroff, who later became renowned experts in their fields, were among the first French geologists who engaged in doctoral investigations in marine geology, studying surface sediments across the continental shelf recovered with dredges and corers.¹⁸⁸

When the team established its permanent settlement at Villefranche, Bourcart was about to retire. Looking back at and taking stock of his achievements, he was proud that his community could finally rely on some research resources (small ships, sampling technologies, and laboratories) to study the Mediterranean's marine geology.¹⁸⁹ However, he was afraid that those means would be insufficient to pursue studies on a scale comparable to those conducted by foreign researchers. In order to attract more funding to marine research, Bourcart began to forge a public discourse that became a mainstay in academic marine geosciences: a call to the "Public Powers" urging them invest in seafloor exploration, if they wanted to maintain the nation's international prestige and to benefit from the economic possibilities this new region could offer.¹⁹⁰ As next chapter details, other critical voices joined Bourcart in urging the national government, through public appearances and official reports, to invest in exploring the oceans equal efforts and sums than the ones invested by foreign countries, for the ocean's political, strategic, and future economic importance.

2.5. The (short-lived) military-supported marine geology

French military priorities shaped the geological study of the Mediterranean basin, both on mainland and at seas. The geographical exploration of France's colonial territories enabled Bourcart to acquire an overall perspective of the basin, conceptually becoming a geological unit. Topographical studies, essential to draw military maps, allowed Bourcart to know first-hand the geology of distant regions and to trace connections between them.¹⁹¹ Therefore,

¹⁸⁷ Boillot, *Fonds Rocheux, Dépôts Quaternaires*; Nesteroff, *Recherches sur les Sédiments Marins Actuels*.

¹⁸⁸ Boillot, *Comment l'Idée Vient au Géologue*; Bourcart, *Océanographie. Introduction à la Géologie*.

¹⁸⁹In his own words: "Malgré un manque de crédits qui es devenu traditionnel, l'océanographie française est aujourd'hui pourvue en bâtiments, outillage et en équipes dressées au travail en Méditerranée. Elle peut donc prendre la part qui lui revient normalement dans l'étude de cette mer. Il ne s'agit plus que de vouloir. Au moment où le période active de ma vie scientifique va bientôt s'achever, je suis heureux de penser que j'ai fait mon possible pour s'hâter ce renouveau" (in: Bourcart, "Géologie Sous-marine de la Baie de Villefranche").

¹⁹⁰ In his popular science books, Bourcart made explicit references to the exploitation of natural resources (like oil and minerals), as well as to the national prestige embodied in France's marine research capabilities (Bourcart, *Problèmes de Géologie Sous-Marine*; Bourcart, *Géographie du Fond des Mers*).

¹⁹¹ Notably Morocco, the French Sahara, Albania, Libya and Syria.

instead of tackling the study of marine regressions and transgressions as local events, Bourcart attempted to interlock local evidences into a unifying theory, which could explain how these massive events could have simultaneously affected the entire basin. The context of colonial France, which spread along the Mediterranean coastline, was particularly favorable to develop this overall perspective.

After World War 2, the French Navy's support prompted the beginning of marine geology. With it, Bourcart could move his investigations to the continental shelf, while military strategic priorities defined his research goals. As in mainland exploration, priority was to establish a detailed cartography of the seabed, delineating its topography and the nature of surface sediments. The exhaustive study of submarine canyons was particularly urgent for their interest on coastal defense; thus Bourcart undertook the task using the technologies available onboard military vessels: echo-sonars, complemented with samples recovered by dredging and coring. Yet, although naval priorities converged with Bourcart's scientific interests, the Navy's approach to the seafloor's exploration constrained research in other directions, as to study deep regions, to undertake cruises around the world, or to develop marine geophysical techniques to study deep sediments – activities that were already being conducted in other countries.

Focusing on a Franco-American comparison, I have argued that, in the fifties, marine geology strongly thrived in the US and not so much in France due to different political approaches to the seafloor and, most importantly, in their divergent strategies to secure oil supplies. From 1945, the American government began to consider the continental shelf as a new and promising territory for oil exploitation; while France relied on its colonial territories to secure its future oil supplies. For the French government, the marine environment was regarded as a theater of military operations, hence the Navy invested in oceanographic studies that contributed with valuable data for navigation, coastal protection, or to monitor oceans surrounding France's overseas territories.¹⁹² Mapping the continental shelf and studying its submarine canyons was among these valuable researches; but not the study of the seafloor's deep geology. Meanwhile, in the US, marine geosciences began to flourish as the essential tools to explore potential resources of the seafloor.

Without the search for oil as a driving force, marine geological studies were constrained to the seabed's surface; while the Navy's scarce support to Bourcart's activities was insufficient to

¹⁹² In the US the seafloor was *also* a theater for military operations, and the US Navy supported the development of marine geophysics in oceanographic research centers (more details in chapter 3).

organize larger, systematic studies, to acquire more advanced research technologies, or to coordinate a critical mass of disciples to move marine geological studies beyond the shoreline. However, the way of studying marine basins had definitely changed in a direction that pleased geologists: at Villefranche-sur-Mer, Bourcart and his modest research team could freely organize their marine surveys, sample sediments, and analyze them at the coastal laboratory since, as Bourcart's PhD student Wladimir Nesteroff proudly asserted, "research at sea requires two things: a boat and a winch. These two elements are essential, while the rest is of a secondary importance."¹⁹³

¹⁹³ Nesteroff, *Recherches sur les Sédiments Marins*.

Chapter 3. International science, fundamental research, and marine geophysics

A summer morning of 1958 the *Calypso*, Commander Jacques Cousteau's vessel, set sail from the port of Nice to explore a submarine valley that runs underwater from the city's coastline to the abyssal plain. On-board, geologists from the Oceanographic Observatory at Villefranche-sur-Mer – doctoral researchers Gilbert Boillot, Maurice Genesseeux, Éloi Klimek, and Claude Lalou – accompanied their supervisor Jacques Bourcart in recovering sediments from the deep valley.¹⁹⁴

The vessel's position was inferred based on bathymetrical and topographical maps, whose information was contrasted with signals coming from the echo-sonar, and by using sextants, which obliged the crew to keep the coastline always at sight. Bourcart had selected a dozen of spots throughout the underwater valley to sample utilizing geological techniques: a gravity corer to uplift cores up to one-meter in length and a dredge, to pull up superficial gravels, sands, and muds. Back in the laboratory, the team spent months analyzing recovered fine sands mixed with planktonic foraminifera and wood scraps, fluvial gravels, and mud from the deepest areas. By analyzing their composition, organic content, and type of microfossils, they reached conclusions far beyond Nice's underwater valley, that allowed them to keep on building and refining their knowledge of the marine regressions and transgressions that had shaped the Mediterranean basin for millions of years.

This research style, prevalent throughout the 1950s in French laboratories, relied on transferring traditional geological practices to coastal seawaters.¹⁹⁵ Although useful for charting and studying the seabed's surface composition, these practices were not enough to *see* what laid beyond, below the first meters of soft sediments: what geological formations constituted the seafloor? which layers of rocks and sediments accumulated? and what could they explain about past dynamics of the oceans and continents? These questions could only be answered by applying marine geophysical techniques, which provided numerical information about the

¹⁹⁴ Bourcart et al., “Les Sédiments Profonds au Large de la Côte Niçoise.”

¹⁹⁵ Here I employ the term “research style” as the set of intellectual preferences, techniques, instruments, and materials that characterized research in Bourcart's marine geological laboratory (Gayon, “On the Uses of the Category of Style”).

seafloor's deep composition and structure. Yet, operating them required specific technologies and well-equipped vessels, large amounts of funding to spend time at sea, and a different set of expertise stemming from physics.

To understand how marine geophysical techniques were incorporated in the practices of French geologists' community, it is necessary to first look at how marine sciences gained a foothold in the French government's agenda. In 1958, for Charles de Gaulle's just-inaugurated government, marine sciences began to appear as means to achieve political goals in the international sphere. The newly proclaimed Law of the Sea granted freedom of scientific research in the high seas, while international cooperative projects to explore the oceans multiplied. Oceanographic research could therefore be mobilized at sea to strengthen diplomatic relations, to develop geopolitical strategies of territorial control, or to reaffirm France's international position. At the core of this oceanic political strategy laid the promotion of *fundamental* research, the kind conducted at public laboratories and institutions (here called by the generic term of *academia*).¹⁹⁶ In the frame of coordinated, government-led scientific policy, a hand-picked committee of expert marine researchers was appointed to decide upon the future of France academic oceanography and to distribute a budget accordingly: the Comité d'Études Exploitation des Océans, or COMEXO. This expert committee, on which sat Bourcart and Cousteau, played a decisive role in the integration of marine geophysical techniques in the French geological community by acquiring technologies, funding a training program, and organizing cooperative surveys between geologists and geophysicists.

The relevance of this decision, and the main difference with contemporary leading countries in marine geophysics (namely, the US and UK), is that in France marine geophysics were initially promoted by geologists' initiatives, without a specific support nor relation to the offshore oil industry or military funding.¹⁹⁷ As I highlight in this chapter, studying the seafloor's deep structure held no political nor military value for French policy-makers or naval officers. Statespersons leading scientific policies were oblivious to the fine-grained mechanisms of

¹⁹⁶ The concepts "basic research" and "applied research" have played a central role in shaping the politics of science from the mid-twentieth century, while they became powerful tools to communicate national scientific policies. For a thorough analysis on the political utilization of this dichotomy, see: Kaldewey, Schauz, *Basic and Applied Research*.

¹⁹⁷ Historians Naomi Oreskes, Roland E. Doel, and James R. Flemming have emphasized the role of military patronage as driving force to enhance geophysical studies in the US, for their military applications in detecting, for instance, nuclear tests (Oreskes, Doel, "The physics and chemistry of the Earth;" Oreskes, Flemming "Why geophysics?"). The same argument is true for the development of geophysical studies in the UK (Bates, Gaskell, and Rice, *Geophysics in the Affairs of Man*).

science, their interests were rather focused on ensuring that the economic investment in marine sciences was reflected on the image French sciences projected on the international community. The COMEXO's leeway and capacity to shape the political strategy sharply contrasts with the situation I describe in the following chapters, when a growing eagerness to exploit offshore hydrocarbons drove the French government to prioritize applied science and to stimulate academic-industrial cooperation.

3.1. The oceans at the international spotlight

3.1.1. International cooperation in ocean exploration and the discourse of lagging behind

By the mid-1950s, international cooperation began to emerge as one essential component of the oceans' exploration. In the Cold War political setting, cooperative scientific research in the oceans appeared as a means to build alliances, as well as a mechanism through which national governments could obtain information and even access to the technoscientific capabilities of other nations.¹⁹⁸

International cooperation first proved its political and scientific value for exploring the oceans during the International Geophysical Year (IGY). Launched in July 1957 under the leadership of American and British scientists, the IGY became the first global-scale, cooperative project in earth sciences devoted to study the Earth's systems. For more than a year, research teams from sixty-seven countries undertook synoptic studies to acquire geological, hydrographic, and atmospheric data around the world, which resulted in unprecedented conclusions about global processes.¹⁹⁹ The IGY was conceived as an inter-scientists' program, where national governments should not be involved on its organization. In the organizers' discourse, the project aimed at being devoid of the Cold War politics, where *basic* scientific research was pursued for a common benefit. However, as historian Jacob Hamblin has emphasized, in spite of this rhetoric the IGY was politically-laden from its inception. Some countries feared that research in Antarctica would establish precedents for future territorial claims, the US government was reluctant to include Soviet scientists in a global data network, and one of the oceanographic

¹⁹⁸ Historian Jacob Hamblin has exhaustively studied the origins of international cooperation in oceanography, and the confluence of military, diplomatic, and scientific motivations that promoted it during the 50s and 60s (Hamblin, *Oceanographers and the Cold War*).

¹⁹⁹ About the IGY see, for instance: Collis and Dodds, "Assault on the Unknown;" and on its organization: Korsmo, "The Genesis of the International Geophysical Year."

programs consisted on identifying deep oceanic areas where water was relatively stagnant, so that radioactive waste could be deposited without harmful effects.²⁰⁰ Even though oceanography did not occupy a prominent role in the IGY's planning, the program provided opportunity for American oceanographers to expand collaborations beyond their traditional British and Scandinavian partners, aiming at including Western-European scientists. Robert E. Dietz, oceanographer at the Scripps Institution of Oceanography, invited French oceanographer Henri Lacombe to participate in the oceanographic research working group, an offer that he accepted.²⁰¹ In 1958 under the aegis of the IGY, Lacombe organized a Franco-Spanish survey to study seawater exchanges through the Strait of Gibraltar – a research topic that besides its scientific interest was of utmost geostrategic importance.²⁰²

After the IGY's success, international programs and committees to explore the oceans multiplied. The International Council for Science inaugurated the Special Committee on Oceanographic Research (SCOR), an international, non-governmental committee gathering scientific associations from around the world. The group was committed to assure the continuity of oceanographic programs after the IGY, which materialized in the organization of the Indian Ocean Exploration (IOE).²⁰³ In parallel, the International Advisory Committee on Marine Sciences (IACOMS), an advisory group for UNESCO on ocean activities, began to consider the creation of an intergovernmental mechanism devoted to education, training, and cooperation in ocean sciences.²⁰⁴ In September 1959 Lacombe was invited to their meetings, where he met renowned experts like Danish Anton Bruun (hitherto president of the IACOMS), British Georges Deacon, and American Roger Revelle. During July 1960's meeting in Copenhagen, UNESCO agreed on creating the Intergovernmental Oceanographic Commission (IOC), which

²⁰⁰ Hamblin, *Oceanographers and the Cold War*.

²⁰¹ About Lacombe's background and relation to the French Navy, see chapter 2, p.57. When the IGY was organized, Lacombe had just been appointed Professor in Physical Oceanography at the *Muséum national d'Histoire naturelle*. From there, he pioneered in the field by studying seawater exchanges through the Strait of Gibraltar, the dynamics of deep water currents in the Mediterranean, and the exchanges of energy between atmosphere and hydrosphere (Bourgoin, "Henri Lacombe, 1913-2000").

²⁰² Historians Lino Camprubí and Sam Robinson have discussed on Lacombe's role in studying the Strait of Gibraltar underwater currents at: Camprubí, Robinson, "A Gateway to Ocean Circulation." For the US, the Strait of Gibraltar was a benchmark to control the traffic of Soviet submarine fleets. An accurate knowledge on submarine currents and the exact location of the thermocline was essential to accurately operate sonar systems, in order to detect the movement of soviet submarines. About the Mediterranean's military strategic value, see: Camprubí, "No Longer an American Lake."

²⁰³ Kullenberg, *Ocean Science and International Cooperation*.

²⁰⁴ Roberts, "Intelligence and Internationalism." The IACOMS was founded in 1956.

would involve national governments in cooperative efforts within UNESCO.²⁰⁵ Lacombe was appointed representative of French ocean sciences at SCOR and IOC, where he was expected to contribute to international efforts with experts, vessels, technologies, and laboratories.

But not only international cooperative projects were increasingly orientated toward the exploration of the oceans. Growing frictions between the US and the USSR led NATO to strengthen its military surveillance in the North Atlantic and the Mediterranean sea, through which undetected soviet submarines reached the oceans. In late-1958, American anxieties grew stronger after a secret report issued by the British Navy showed how the Soviets were gaining ground over them in charting – and controlling – the oceans.²⁰⁶ To prevent Soviets catching up control, NATO commanders decided to invest in developing scientific knowledge on the Mediterranean and North Atlantic, essential to enhance military capabilities for underwater surveillance, operations for submarine warfare, weather prediction, marine transport, and prevention of the effects caused by radioactive fallout. Aiming at these goals, NATO's Scientific Committee created, in September 1959, the Subcommittee on Oceanographic Research (ORC), responsible for organizing a coordinated oceanographic program among NATO member states.²⁰⁷ France was expected to participate through the representation of Lacombe and Jean-Marc Eyrès, director of the Navy's Hydrographic Service, and to contribute with resources like vessels, experts, and research technologies.

These appointments concerned Lacombe, who knew first-hand the hitherto negligible importance of marine sciences in the French government's agenda. In France, the scarcity of public investment in university laboratories and marine stations had prevented the development of marine scientific research at a level comparable to that of countries like the US or the UK. The lack of well-equipped oceanographic vessels, suited to survey the high seas, impeded the development of physical oceanography. Until that date, Lacombe and his team could only pursue studies on underwater currents and tides with the occasional logistic support of the

²⁰⁵ Kullenberg, *Ocean Science and International Cooperation*; Brunn, "The International Advisory Committee on Marine Sciences of UNESCO."

²⁰⁶ The report was entitled "Oceanography and Defence in the USSR, 1956–1958." Robinson details how the report was drafted after "scientific intelligence gathering" through open-source intelligence: collecting data from unclassified sources, scientific publications, and international meetings. It evidenced that the Soviets were the only ones possessing a deep-water magnetic oceanographic vessel, while it revealed the size of the Soviet oceanographic fleet (Robinson, *Ocean Science and the British Cold War State*; Ramsay, Norman F. "Co-operative oceanographic research," April 4, 1959 (NATO, C-M(59)44).

²⁰⁷ Turchetti, Simone, "Sword, shield and buoys."

Navy's Hydrographical Service (through the COEC).²⁰⁸ Marine research was dispersed across dozens of small, ill-equipped laboratories and marine stations – which, in turn, were mainly used to train undergraduate students in zoology and algology; and the absence of an academic training plan prevented the formation of future generations of oceanographers.²⁰⁹

Lacombe began to voice his concerns in 1956, during his opening lecture for the first course of oceanography at the *Muséum National d'Histoire Naturelle* (MNHN):

N'est pas besoin d'aller très loin dans l'étude de l'océanographie pour constater que cette science a surtout progressé grâce à des travaux étrangers, récemment surtout. Il est humiliant de constater la part minime prise par notre pays dans la recherche marine.²¹⁰

With the advent of international cooperative programs and committees, discourses lamenting the poor situation of French marine research, and therefore the incapacity to efficiently represent the country, multiplied. After his participation in the IGY, Lacombe criticized the scarcity of the governmental support he received, which had affected the survey's development (France had only contributed with two vessels, although it was committed to bring three).²¹¹ In a report addressed to the Prime Minister's cabinet, Lacombe denounced that the French participation in the IGY had been only possible “thanks to the good will” of French researchers, who had mobilized all their available resources to support the project.²¹² However, he warned that France risked a loss of international prestige if the situation was repeated.

Lacombe could neither believe the apparent indifference of French authorities on the international Indian Ocean Exploration, organized by SCOR, in such an important region for France:

Il est impensable que la France qui a tant d'intérêts stratégiques, politiques et humaines dans cette région et qui, par des moyens de fortune, a été une des premières nations à en amorcer l'étude, ne soit pas associée à cette entreprise. Si les autorités gouvernementales, responsables de l'action scientifique sur le plan international, jugent que cette carence est inacceptable, il leur faut de toute

²⁰⁸ I have detailed the COEC's foundation and activities supporting oceanographic research in chapter 2, p.55-57. DGRST, “Rapport du Comité d'Études Exploitation des Océans”, March 12, 1960 (ADF, 236QO/35).

²⁰⁹ Ibid. More specifically, students from the “third cycle,” the last year of undergraduate training where courses are more specialized.

²¹⁰ “There is no need to look far in oceanography to see that this science has mainly progressed thanks to foreign contributions, especially in recent times. It is humiliating to see the minimal contribution of our country to marine research.” Lacombe, “L'Océanographie: Travail d'Équipe.”

²¹¹ Camprubí and Robinson, “A Gateway to Ocean Circulation.”

²¹² DGRST, “Rapport du Comité d'Études Exploitation des Océans,” March 12, 1960, 10 (ADF, 236QO/35).

urgence envisager les moyens d’y remédier, puisque nous n’avons actuellement ni le navire, ni les crédits, ni le matériel, ni le personnel qui nous permettraient de prendre une telle charge.²¹³

All these speeches shared allusions to national prestige. According to Lacombe, the poor oceanographic capabilities with which to contribute to international forums could lead to an embarrassing situation and an “humiliating position.”²¹⁴ Scientific capabilities displayed in international committees and programs should reflect the economic and political power that France ambitioned in the world order; yet, France’s oceanographic capabilities were far from reflecting any power. It was thus urgent, as his arguments followed, to invest in equipping laboratories, building vessels, designing new technological devices, and training a body of experts that could adequately represent its country in fundamental research.²¹⁵

Undoubtedly, these calls to governmental interests sought to enroll “disciples of marine sciences” in scientists’ causes, as historian Jacob Hamblin has named it: to attract the attention and financing of national institutions and organizations, like the Ministry of Research, the Ministry of Industry, or the Army, to promote their scientific agenda.²¹⁶ Proof of it is that Lacombe called for an investment in *fundamental* science (this is, research developed at public laboratories, without any direct goal or application), asserting that – in principle – it was the kind of research pursued in international oceanographic programs. Conversely, in France, applied research was indeed supported by the government: research devoted to enhance fisheries’ efficiency, for instance, had its own institution (the *Institut Scientifique des Pêches Maritimes*) and a large oceanographic vessel, equipped for long cruises in high-seas (the *Président Theodore Tissier*).²¹⁷

If efficiently participating in international programs was not a motivation strong enough to promote marine research in France, the same years witnessed the emergence of a new legal

²¹³ “It is unbelievable that France, who possesses strategic, political, and human interests in this region and who, by chance, has been one of the first nations to initiate its study, would not be involved in this venture. If the public authorities, responsible of the scientific involvement at international level, judge this deficiently unacceptable, they would need to urgently plan the means to remediate it, since currently we don’t possess neither the vessel, nor the budget, equipment or personnel, that would be necessary to undertake such ventures.”

Underlined emphasis in the original. DGRST, “Rapport du Comité d’Études Exploitation des Océans,” March 12, 1960, 10 (ADF, 236QO/35).

²¹⁴ *Ibid.*, 1.

²¹⁵ About the effect of declinist discourses in policy-making, see Edgerton, *The Rise and Fall of the British Nation*.

²¹⁶ Hamblin, *Oceanographers and the Cold War*.

²¹⁷ DGRST, “Rapport du Comité d’Études Exploitation des Océans,” March 12, 1960, 3 (ADF, 236QO/35).

framework about the oceans. This was the last straw that established ocean exploration as priority in the French government's agenda.

3.1.2. UNCLOS I: freedom of research and the blurred limits of the continental shelf

On February 24, 1958, the first United Nations Conference of the Law of the Sea (UNCLOS I) was opened in the Swiss city of Geneva. Attended by more than 700 delegates from 86 countries, the meeting aimed at reaching an international legal consensus on the rights of coastal nations over the oceans. The need for the Conference grew from the international turmoil caused by the Truman Proclamation, when numerous coastal nations around the world unilaterally proclaimed their rights over extended marine regions. In 1948, the United Nations constituted the International Law Commission, a body of thirty-four eminent lawyers from different countries responsible for drafting the conventions that were later discussed during the UNCLOS I.²¹⁸

Throughout the conference, debates were deeply configured by prevailing international relations. Disputes between the Eastern and the Western blocks suffused the agreements; and a growing North-South fracture began to appear, characterized by an anti-colonial sentiment among new nations who feared that the Law of the Sea could become a new mechanism to extend colonial power.²¹⁹ Main contentious issues were related to military security, commercial navigation, and fishing rights: while the US pushed for a narrow territorial sea (up to three miles), to be able to freely move its forces through strategic points like straits and narrow seas; the USSR claimed for a 12 miles limit – which, from the US perspective, risked to jeopardize global maritime commerce. National control on fisheries, both in the high seas and over the continental shelf, was also a divisive issue: developing nations pushed for extended rights, fearing that the new legal framework would limit their control over fishing grounds.

After two months of intense discussions, the Conference ended with mixed results. Four conventions were adopted concerning the territorial sea and its contiguous zone, the definition and freedoms on the high seas, coastal-state rights on fisheries, and on coastal-state jurisdiction

²¹⁸ Churchill and Lowe, *The Law of the Sea*. One lawyer at the International Law Commission, Georges Scelle, was French. However, experts at the International Law Commission were not supposed to voice the concerns and decisions, but to act independently.

²¹⁹ Vanderpool, "Marine science and the Law of the Sea;" Hollick, *US Foreign Policy and the Law of the Sea*.

over the seabed and its subsoil resources.²²⁰ These conventions acknowledged four freedoms on the high seas: navigation, fishing, laying submarine cables and pipelines, and overflight; plus what came to be considered the “fifth freedom”: marine research on the high seas. The high seas were recognized as “open to all nations, [where] no State may validly purport to subject any part of them to its sovereignty” and therefore, an ideal environment to ease diplomatic tensions by means of international cooperation.²²¹

However, the Conference failed to reach a consensus on the breadth of the territorial waters, and on a precise definition of natural resources and the continental shelf – the issue that had prompted the Conference’s organization in the first place. In fact, one of the delegates’ main challenges was to transform a geological concept, that of continental shelf, into a legal one and to precisely define the natural resources it harbored.²²² Agreement was reached on a flexible definition that left room to extending national control over further regions, along with the development of technological capabilities to exploit deeper resources:

The seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas.

In this definition, what was considered a natural resource? Among delegates, positions moved between two extremes: Sweden, Greece, and Germany proposed to limit them to mineral resources; while at the other extreme, newer nations wanted to include also living resources even if those only occasionally inhabited the seabed. Eventually, the definition accepted encompassed “mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species.”

New regulations on the continental shelf encompassed and profoundly affected scientific research.²²³ From the 1958 Convention, the explicit consent of the coastal-state was required

²²⁰ Enacted in the 1959 Convention on the High Seas, the 1958 Convention on the Territorial Sea and Contiguous Zone; the 1958 Convention on the Continental Shelf, and the 1958 Convention on Fishing and Conservation of the High Seas.

²²¹ United Nations, *Convention on the High Seas 1958*, Article 2. Although it’ has been called the “fifth freedom,” the 1958 Convention on the High Seas did not specify anything related to marine scientific research.

²²² There is no comprehensive historical study about when, how, and by whom the continental shelf around the world was delineated. Knowledge on the limits of the continental shelf, when the water depth sharply increases, was local: fishermen and navigators, for instance, knew it by fathoming the seawater depths. For the Mediterranean, the report of the Danish Oceanographic Expedition to the Mediterranean, published in 1912, already shows a bathymetrical map of the basin with the continental shelf well delimited (Schmidt, *Report of the Danish Oceanographic Expeditions 1908-1910*).

²²³ United Nations, *Convention on the High Seas 1958*, Article 5.

before undertaking “basic” scientific research on its continental shelf – yet, there was not a definition on what was considered “basic” or “applied” research, neither a clear limit of the continental shelf. Coastal nations had also the right to participate in foreign scientific campaigns conducted on its continental shelf. These decisions disappointed many marine researchers, who feared losing the freedom they enjoyed of carrying out surveys along continental shelves, where most part of their marine explorations were conducted.²²⁴ However, from the perspective of national governments, marine sciences came to be perceived as a means to support their territorial claims.

UNCLOS I manifested the geostrategic importance of the oceans not only in terms of military security, but also for its natural resources (mainly fisheries, since the exploitation of mineral resources and hydrocarbons was still in an early stage of development). As further UN conferences were to follow, from the perspective of coastal nations like France, it was crucial to stimulate knowledge on territorial waters and to identify sources of natural resources on their continental shelf, in order to properly define and defend their interests in future meetings. From that moment, the oceans came to occupy a relevant position in the French government’s agenda.

3.2. Marine sciences in the political agenda

3.2.1. Charles de Gaulle’s government: Sciences at the service of State

Peak interest in exploring the oceans coincided with the election of General Charles de Gaulle to the French presidency in December 1958. De Gaulle had led the exiled French government during German occupation and became the head of the Provisional Government of the French Republic in June 1944, after France’s liberation. However, his disagreements with the subsequently elected government drove him to retire from politics in 1946. On May 13, 1958, when the Algerian coup d’état (inspired by Gaullists activists) brought France to the brink of a civil war, the French National Assembly transferred power from president René Coty to Charles de Gaulle, who was then named President of the Council. From there, he prepared the Constitution that gave birth to France’s Fifth Republic in September 1958 and, two months later, was inaugurated as its first President.

²²⁴ Hallick, *US Foreign policy and the Law of the Sea*.

Once in office, de Gaulle undertook major political reforms to restore what he called France's *grandeur* – the nation's international prestige that had been lost during World War 2. His political agenda aimed at transforming France in a nation that would be non-dependent from the greatest powers, the US and the USSR, counter-balancing the influence of both in Europe.²²⁵ In this framework, scientific and technological development were considered as central pillars upon which the nation's economic independence would be built, as well as key assets to increase France's international prestige.²²⁶ At the same time, the promotion of coordinated, politically-driven, scientific policy was justified by the trope of "lagging behind" other countries like the US, the UK, or Germany.²²⁷ Explicit references downgrading scientific development in France, as well as the political fear of "France becoming an underdeveloped nation in scientific research," pervaded reports and minutes of ministerial meetings.²²⁸ Comparisons with the American budget devoted to scientific research were also common, as well as calls to articulate academic research with industrial production, following the American strategy designed to boost national economy through scientific and technological development.²²⁹ However, as historian Nicolas Simoncini has highlighted, this perception hardly corresponded to reality. Between 1954 and 1959, the French economy thrived: its GDP increased by 41% as exportations grew by 44%, and industrial production by 47%.²³⁰ This declinist discourse, thus, was not mobilized to faithfully reflect the state-of-affairs, but to play a performative role in political circles (similar to the goal of Lacombe's speeches).

With the start of the 5th Republic, scientific and technical development was set to serve state interests through the creation of new institutions. Louis Jacquinot, State Minister responsible

²²⁵ About France's international position and particularly Franco-American diplomacy during de Gaulle's tenure, see: Martin, *General De Gaulle's Cold War*; Reyn, *Atlantis Lost*.

²²⁶ About de Gaulle's re-organization of scientific policies, to transform technosciences in a pillar of the nation's development, see: Jacq, "The Emergence of French Research Policy;" Jacq, "Aux sources de la politique de la science;" Lelong, "Le général de Gaulle et la recherche en France;" Simoncini, *Histoire de la Recherche sur les Piles à Combustible*.

²²⁷ As shown by David Edgerton (*The Rise and Fall of the British Nation*), declinist discourses were common among left-wing intellectuals in the 1960s UK, who offered a biased image of the nation's past, exacerbating its economic and political failures in relation to other countries. These discourses became a powerful political tool to build up particular political ideologies and agendas.

²²⁸ DGRST, "Note sur un fonds de développement de la recherche scientifique et technique," April 13, 1959 (ANF, 19920548/09). The term "undeveloped" referred to France's scientific research also appears in: DGRST, "Note sur le Financement de la Recherche Scientifique," April 16, 1959 (ANF, 19920548/9).

²²⁹ Simoncini, *Histoire de la Recherche sur les Piles à Combustible*. The DGRST archival collection includes a number of reports summarizing the state of research policies and investment in the US, sometimes translated from American journals and official reports (i.e. n.a. "Des fondations et des organismes divers disposent de 95 millions de dollars," December 14, 1959 (ANF, 19920548/15)).

²³⁰ Simoncini, *Histoire de la Recherche sur les Piles à Combustible*.

for Scientific Research in the new office, promoted the creation of an inter-ministry structure devoted to coordinate efforts in scientific research (the *Comité Interministériel de la Recherche Scientifique et Technique*); a council of twelve high-rank scientists was appointed to advise the inter-ministerial council (the *Comité Consultatif de la Recherche Scientifique et Technique*, or CCRST);²³¹ and a special group was formed to implement the general directions decided – the *Délégation Générale de la Recherche Scientifique et Technique* (DGRST).²³² With this articulated structure, scientific research was going to be politically driven – yet, not every scientific field bore an equal importance. The CCRST advised to promote only those research domains judged important for its economic, political, military, or social relevance. Its applied usefulness was important, as well as its state of development in relation to other countries.²³³ Therefore, the CCRST selected the fields in which they perceived that France was “lagging behind,” beginning with marine sciences for its international, economic, and geopolitical relevance. Most of the selected fields related to medicine and human wellbeing (as cancer and leukemia, neurophysiology and pharmacology, human and animal nutrition, applications of genetics), only one dealt with technoscientific development (energies conversion), and some tackled problems in social sciences and economy (as the economic sciences and problems on development; and demographic, economic, and social analyses).²³⁴

3.2.2. The discourse of fundamental research and the Comité d’Études Exploitation des Océans

Marine sciences were selected under the label “Exploitation of the Oceans,” a name that made explicit the political goals of investing in the field. DGRST delegates justified its selection by the growing international importance of marine sciences, both to “scientifically explore an unknown environment that covers two thirds of the globe,” as for the “direct benefits” that could be obtained in weather forecast, navigation, enhancing fisheries, military defense

²³¹ The first CCRST was constituted by mathematician André Lichnerowicz, biologist Charles Sadron (expert in macromolecules), chemist Félix Trombe (specialist in solar energy), Pierre Taranger (responsible of the construction of the nuclear site in Marcoule), the scientific director of *Charbonnages de France* Maurice Letort; the co-director of the Radium Institute at the Curie Foundation Raymond Latarjet, mathematician Paul Germain; René Dumont (Institut National Agronomique), demographer Louis Chevalier; physician expert in leukemia Jean Bernard; Pierre Agrain (expert in electro-techniques), and Maurice Ponte, director of the *Compagnie Générale de la Télégraphie*.

²³² Details in Simoncini, *Histoire de la Recherche sur les Piles à Combustible*.

²³³ DGRST, “Note à l’attention de messieurs les secrétaires des Comités d’Études,” February 22, 1960 (ANF, 19920548/16).

²³⁴ DGRST, “Les actions concertées. Leur financement,” June 15, 1959 (ANF, 19920548/9); n.a. “Décret n.69-1397,” December 1959.

(specifically in collaboration with NATO), exploring new “oceanic industries” (like the exploitation of bromine, magnesium, seaweeds, or hydrocarbons), and managing coastal pollution. All of them were activities that other nations were already pursuing in the oceans, and that the 1958 convention on the Law of the Sea regulated in the new legal framework.²³⁵ Since developing these fields required “fundamental research,” the DGRST was going to invest a special budget to build the logistic, technological, and human resources aimed at fixing the “delay of France in these domains.”²³⁶

It is important to notice that exploiting offshore hydrocarbons was not among the French government priorities. The offshore oil industry was still in an early stage of development, and national oil companies had not yet directed their attention to the oceans. More important to develop scientific and technical capabilities to cooperate with NATO in military surveys, and to secure and enhance fishing activities in the high seas. In this regard, after World War 2 high seas fisheries had become tools to exert national control over disputed marine regions and, thus, a source of geopolitical frictions.²³⁷ By the late-1950s, a number of nations had succeeded at articulating fundamental research with their fishing industry, which enhanced their efficiency in exploiting the oceans. Japan counted three universities devoted to fisheries’ oceanography, the pearl industry employed more than 500 researchers, and marine biologists were appointed to lead Japan’s fishing fleets. In the Soviet Union, the fishing institute VNIRO gathered about 2,600 researchers, most of them experts in chemistry and marine biology; while the US censused more than 2,000 experts devoted to applied oceanography (including fisheries). More modest in its resources, the UK possessed a laboratory specialized in fisheries that employed 180 researchers.²³⁸

In France, a similar strategy could be read between lines in the inter-ministry wish to inscribe the exploitation of the oceans among high-priority research fields. Roger Pacque, secretary at the Prime Minister’s Cabinet, observed that investing in oceanography was needed for France to strengthen its presence in distant seas, where it hold political interests and influence. Those regions, euphemistically termed by Pacque as “particularly attached to the French culture,” included former or current French colonial territories: the Indian Ocean surrounding

²³⁵ DGRST, *Les actions concertées. Rapport d’activité 1961*, 30.

²³⁶ *Journal Officiel de la République Française*, August 29, 1962: 738.

²³⁷ This context and disputes have been exhaustively analyzed at: Finley, *All the Boats on the Ocean*.

²³⁸ *Journal Officiel de la République Française*, August 29, 1962: 737-747.

Madagascar, the South-Western Pacific, and the Antilles, plus Brazil and Argentina.²³⁹ In the framework of the new legislation on the high seas, which established freedom of fishing in international waters, scientific surveys in regions where French fishing fleets were already present (as the Moroccan Atlantic, English Channel, North Sea, and the Antilles), could enhance France's control over international waters where its fleets deployed their nets.²⁴⁰

Moreover, military interests were also at stake. André Marechal, General Delegate at the DGRST from 1961, kept close contact with the director of the Navy's Hydrographical Service, André Gougenheim, and with the Chief of the French Navy, Admiral Georges Cabanier, who voiced the Navy's needs in terms of scientific research, training, and logistic support.²⁴¹ At the Navy, fundamental research was increasingly considered the basis of the oceans' military control: Cabanier exposed that his institution needed to undertake acoustic and hydrographic studies useful for submarines and mines' detection, underwater communication, and for installing fixed detectors in regions where its fleets were deployed; gravimetric studies applied to navigation; and to ameliorate knowledge on the seabed for its importance to submarine navigation. It is important to stress that the Navy did not consider the seafloor in its three dimensions, but only on its surface (as noted in chapter 2). Cabanier clarified that the Navy was interested in surveying the seabed's topography, studying underwater currents, and charting magnetic anomalies for their potential to perturbate detection or to be used as benchmarks in submarine navigation.²⁴² In a joint meeting between the DGRST and representatives from the Navy, Gougenheim even suggested to ease military secrecy at the Hydrographical Service to build bridges between fundamental research at academia and the Navy (perhaps following the American model, where the US Navy was extensively supporting oceanographic institutions from the wake of World War 2).²⁴³ Mirroring foreign oceanographic institutions where military

²³⁹ Pacque, "Rapport relatif à un programme national d'océanographie," March 2, 1962 (ADF, 236QO/35).

²⁴⁰ DGRST, "Les actions concertées. Leur financement," June 15, 1959 (ANF, 19920548/9).

²⁴¹ Marechal, André. Letter to André Gougenheim, March 9, 1962 (SHD, MV 9JJ 584); Cabanier, Georges. Letter to André Marechal, April 02, 1962 (SHD, MV 9JJ 584).

²⁴² Ibid.

²⁴³ DGRST, "Note sur la réunion tenue le 9 novembre 1962," November 9, 1962 (SHD, MV 9JJ 584). About the establishment of collaborations between American oceanographers and the US Navy, see: Weir, *An Ocean in Common*.

research was developed, such as the British National Institute of Oceanography, the Navy and the DGRST began to envision the creation of a similar institution for France.²⁴⁴

To decide on the orientation of the program “exploitation of the oceans,” the DGRST appointed a committee of experts in marine sciences: the Committee *Exploitation des Océans*, or COMEXO. Its hand-picked members were among those experts who had played prominent roles in international oceanographic forums like physical oceanographer Henri Lacombe, the hydrographer and NATO-collaborator Marc-Marie Eyrès, commander Jacques Cousteau, and explorer Théodore Monod. Probably through his links with the French Navy, Jacques Bourcart was appointed the only representative of marine geology. Given the relevance of the fishing industry, three experts were going to voice its needs at the COMEXO: the director of the *Institut Technique des Pêches Maritimes*, Jean Furnestin; the vice-president of the *Office de la Recherche Scientifique et Technique d’Outre-Mer*, Paul Budker, and Ferdinand Sarraz-Bournet, president of the *Confédération des Armateurs des Pêches*. Three marine biologists experts in fundamental research completed the team: Louis Fage, expert in Mediterranean fisheries from the MNHN, Maurice Fontaine, director at the *Institut Océanographique de Paris*, and Jean-Marie Pérès, attached at the Faculty of Sciences at Marseille, where he had inaugurated the first undergraduate course in France on marine biology. The COMEXO was therefore dominated by the aim of enhancing fisheries through fundamental research in marine biology. Physical oceanography and marine geology had its representatives and would receive part of the budget, but the committee’s composition reflected its rather secondary importance.

The COMEXO was conceived as a temporary committee that, over four years (between 1961 and 1965) would be responsible for the identification of the most acute needs in marine sciences, the establishment of an annual program of cooperative researches among national laboratories, and the monitoring of its proper development.²⁴⁵ For that purposes, the DGRST devoted the equivalent of 8,65 million US dollars for the four-years period, the most well-funded program on their list.²⁴⁶ By the end of 1964, the “exploitation of the oceans” had consumed a 27% of the DGRST’s special budget, which had been divided among nine high-

²⁴⁴ DGRST, “Note sur la réunion tenue le 9 novembre 1962” (SHD, MV 9JJ 584). Explicit reference to the NIO in: Lacombe, “Avenir de l’Océanographie Nationale,” February 21, 1963 (SHD, MV 9JJ 584). About the NIO’s creation, see: Robinson, *Ocean Science and the British Cold War State*.

²⁴⁵ *Journal Officiel de la République Française*, December 1959.

²⁴⁶ Currency conversion in 1960 US dollars, which corresponded to 42,45 million francs. Followed by the program “energy conversion,” supported with the 45,9 million francs. DGRST, “Avant-projet de répartition des crédits en 1965,” August 11, 1964 (ANF, 19920548/16).

priority research fields.²⁴⁷ Under the COMEXO's choices, the budget was invested in solving the three weakest points of French marine sciences: to provide research institutions with adequate technologies and equipment, to organize joint missions to save efforts, and to design an official training plan in marine sciences for graduate researchers (table 1).²⁴⁸

Institution or disciplines	Budget to be invested (in thousand US dollars)
Applied oceanography (fisheries) Institut Scientifique et Technique des Pêches, Station Castiglione (Algeria), Office de la recherche scientifique et technique outre-mer	1,782
Physical oceanography	1,800
Marine biology and geology (university labs) (Non specified)	1,610
Marine biology (marine stations) Alger, Dakar, Banyuls, Villefranche, Luc-sur-Mer, MNHN	480
International cooperation	875
Oceanographic vessels and submersibles	6,520

Table 1. Budget allocation planned by the COMEXO in 1960, for a four year period (including investments and functioning costs). The laboratories in marine biology and geology are not specified (DGRST, "Rapport du Comité d'Études « Exploitation des Océans », March 12, 1960).

Because of the special relevance the DGRST attributed to fundamental research, the COMEXO was designed as a scientific committee with decision-making capacity. As the DGRST's delegate Louis Jacquinet affirmed, the delegation firmly believed that the future was "determined by fundamental and basic research."²⁴⁹ Thus, the committee's actions had to aim at promoting fundamental studies at universities and public research laboratories, which would constitute the pillars of future applications in navigation, exploitation of marine resources, or military surveillance.²⁵⁰ For their previous career and experience, the COMEXO experts were considered to know first-hand how to promote fundamental research in academic institutions,

²⁴⁷ Ibid. From the most to the less funded, these fields included: Molecular Biology, Energy Conversion, Cancer and Leukemia, Demographic Analysis, Nutrition, Psychopharmacology, Genetics, and Neurophysiology. Space research also received part of the DGRST special budget.

²⁴⁸ DGRST, *Rapport d'activité 1961*, 30.

²⁴⁹ DGRST, "Note sur le financement de la Recherche Scientifique," April 16, 1959, 2 (ANF, 19920548/9).

²⁵⁰ DGRST, *Rapport d'activité 1961*, 30.

how to enhance France's participation in international scientific programs, and how to articulate marine biology with the fishing industry.

Rhetoric about the government's unconditional support to fundamental research was made explicit during the first meeting of the COMEXO, on January 11, 1960. Roger Pacque, permanent representative of the DGRST at the COMEXO's meetings, stated that he would not impose the government's vision, but he would merely channel the government's priorities and vice-versa.²⁵¹ He reassured that far from pursuing a "narrow control" of research, the DGRST's policy aimed at providing them flexibility to decide on the organization of marine sciences, as well as to create – in Pacque's words – "the climate of freedom that conditions the effectiveness of fundamental research."²⁵² He encouraged participants to voice the needs of the "free sector of research," and to find common solutions where the special budget could be devoted. Perhaps because the discourse of promoting fundamental research explicitly avoiding the involvement of private companies clashed with the very name of the committee ("exploitation of the oceans"), Jacques Cousteau wondered about its meaning, to which Pacque responded that:

Tous les problèmes relatifs à l'océan peuvent être envisagés. Les buts pratiques sont acceptables, mais on ne doit pas mettre l'accent sur l'aspect rentabilité. Il s'agit d'un programme de "ressources" au sens américain.²⁵³

By emphasizing the "American sense," Pacque was revealing the government's anxieties and constant comparisons with the US scientific policy. The American "way of doing science," as noted above, was characterized by a close articulation between fundamental research and industrial production processes. The rationale behind was the so-called linear model of innovation, in which fundamental science led to useful knowledge, which in turn enabled the development of new technologies and the enhancement of industrial processes.²⁵⁴ On the other hand, as explained above, the emphasis on promoting fundamental research was a central part of the rhetoric displayed by numerous national governments (notably the US), who saw in

²⁵¹ Comité Consultatif de la Recherche Scientifique et Technique, "Procès-verbal analytique de la réunion 3 février 1960," February 3, 1960 (ANF, 20060160/1).

²⁵² Comité Consultatif de la Recherche Scientifique et Technique, "Rapport sur les structures de la recherche fondamentale," April 8, 1959, 2 (19920548/9).

²⁵³ "Every problem related to the ocean can be considered. Applied goals are acceptable, but we should not focus on profitability. This is a program about "resources" in the American sense." In: Pacque, "Comité d'Études Exploitation des Océans," January 11, 1960, 5 (ANF, 19920548/16).

²⁵⁴ Schauz and Kaldewey, "Why do concepts matter in science policy?."

academic research a tool to ease diplomatic tensions through international cooperation and a means to approach and learn about the techno-scientific capabilities of other nations.²⁵⁵

Despite the fact that the COMEXO's decisions had to be framed in the guidelines defined by the *Comité Interministériel de la Recherche Scientifique et Technique*, this group of marine experts was not a mere puppet committee. Quite on the contrary, it clearly demonstrated its capabilities to shape the political strategy on marine sciences, which was evident in the selection of regions to explore first. As detailed above, the French government was especially interested in the strengthening of France's presence in high seas for fishing and geopolitical issues; yet, COMEXO experts considered unfeasible to start a national strategy by moving research resources far from home. As they argued, France did not yet possess the human and material resources required to take advantage of long campaigns across the high seas.²⁵⁶ No matter how significant political interests were, to mobilize human and logistic resources to distant regions would be extremely costly in terms of time, money, and efforts; while reported benefits would be rather scarce. Moreover, the study of the distant seas could be pursued during international cooperative projects in which Lacombe, Eyrès, Pérès, or Fontaine were going to continue participating.²⁵⁷ Conversely, devoting the first years to exhaustively explore the coastal waters of metropolitan France would not only contribute to train experts in new research techniques and methodologies, but it would also bring detailed inventories of France's underwater territory – including about its potential natural resources. As the COMEXO argued, studies on the English Channel, the North Atlantic, and the Western Mediterranean could reconcile national with scientific interests, did not require an excessive investment of money, and available resources were enough to begin with.²⁵⁸ In this way, the Mediterranean exploration was prioritized, benefiting those research teams eager to study its seafloor.

Focus on fundamental research and the nearby regions' strategy boosted the exploration of the Mediterranean seafloor, giving impetus to the fusion of geological and marine geophysical practices to undertake it. For the first time, at the COMEXO's bosom, marine geology (a term

²⁵⁵ Praising for fundamental research has its origins in the wake of World War II when Vannevar Bush, director of the US Office of Scientific Research and Development during the war, published the booklet *Science, The Endless Frontier* (1945) calling for the government's responsibility to support fundamental science and its role on society. About the US rhetoric of promoting fundamental sciences as means to exert influence over Western nations, see: Krige, *American Hegemony*.

²⁵⁶ Pacque, "Rapport relatif à un programme national d'océanographie", March 2, 1962, 1 (ADF, 236QO/35).

²⁵⁷ Ibid.

²⁵⁸ Ibid.

embracing the seafloor exploration) was identified as a branch of marine sciences that deserved special attention, next to physical oceanography and marine biology.²⁵⁹

3.3. A new research tool box: geology, physical methods, and oceanographic logistics

3.3.1. Oil and American oceanographers: The onset of marine geophysics

From his chair at the COMEXO, Jacques Bourcart considered the DGRST's budget a unique opportunity to consolidate marine geosciences in France by bringing together small and dispersed research teams in cooperative efforts to survey the Mediterranean seafloor, to equip ships and laboratories with expensive research technologies and, most importantly, to promote the introduction of marine geophysical techniques in the methodological toolbox of French marine geologists.²⁶⁰ Marine geophysics can be defined as a set of seismic techniques to study the seafloor below its surface, and are remarkably different – yet complementary – from marine geological techniques. Their functioning required advanced equipment, initially developed at the US, and a set of expertise stemming from physics. To understand how the introduction of this set of techniques modified the seafloor's exploration and its connection to hydrocarbon prospection, it is important to look first at its functioning, and then at its American origins.

As detailed earlier in this chapter, Jacques Bourcart and his crew relied only on geological techniques, as dredging and coring superficial sediments, to study the continental shelf's seafloor. They *directly* recovered material samples and analyzed their composition, microfossils' content, and texture; yet, these techniques only enabled them to study the most superficial sediments. On the other hand, sounding techniques, like echo-sonars, provided topographical information but the signal could not penetrate below the surface. Conversely, marine geophysical technologies were *indirect*: its devices generated numerical data that, after being digitally processed and interpreted, allowed experts to deduce the seafloor's deep geological composition and structure without touching a single rock. However, operating with marine geophysical devices required a complex logistic setting, including equipped vessels, personnel, and a different set of expertise closer to physics than to geology.

²⁵⁹ DGRST, "Rapport du Comité d'Études Exploitation des Océans," March 12, 1960 (ADF, 236QO/35).

²⁶⁰ This will was reflected in Bourcart's opening speech at the 1961 national congress on Marine Geology and Geophysics (Bourcart, "Allocution d'Overture").

On-board logistics for conducting seismic surveys, a particular type of geophysical techniques, were very similar to echo-sounding.²⁶¹ A sounding source generates acoustic waves that, after bouncing and bending over the seafloor's deep layers, were registered with one or more hydrophones towed through the water (fig.).²⁶² As waves propagate at different velocity in each kind of sediment due to their different physical properties, waves can behave in two ways when reaching a new kind of sediment: they can bounce, traveling back to the surface; or they can be refracted, following its path deep into the Earth's crust but with a different angle of incidence. The difference between reflection and refraction seismic techniques was found in the kind of waves recorded by the hydrophones: in the 1960s the analysis of reflected, high-frequency waves (as in reflection seismics) gave geoscientists information on the uppermost layers, but failed in offering hints about the deepest structure.²⁶³ On the other hand, the analysis of refracted waves (sent with a lower frequency from the sounding source) was especially suited to study the deepest geological structure of the oceanic crust, although it provided less precise images.²⁶⁴ After processing the signals, information materialized in seismic profiles, depictions of a seafloor's vertical cut (as if laterally looking a layered piece of cake) where the layers' thickness corresponded to the velocity at which the acoustic wave traveled through each kind of sediment. Knowing this velocity allowed experts to deduce the composition and depth of each layer.

²⁶¹ Techniques to conduct marine geophysical studies can be classified into gravity, magnetic, heat flow, and seismic techniques, these later embracing reflection and refraction seismics. Here I will focus on seismic techniques, with particular attention to diverse devices to produce the acoustic signal.

²⁶² Hersey, "Continuous reflection profiling," 47-49.

²⁶³ Present-day seismic reflection techniques provide images up to the Mohorovicic discontinuity.

²⁶⁴ Refraction data gives precise information on the layers' velocity and true depths, but it has to be processed through multiple steps before obtaining a vertical profile. It also requires a more complex technological deployment. On the contrary, data obtained from reflection seismics needs lesser processing and gives a more precise image of the subsurface layers. For the logistical constraints, reflection seismics was (and is) more commonly used in offshore oil and gas exploration, complemented with refraction seismic data. A comprehensive book on the history of refraction seismics is Prodehl and Mooney, *Exploring the Earth's Crust*.

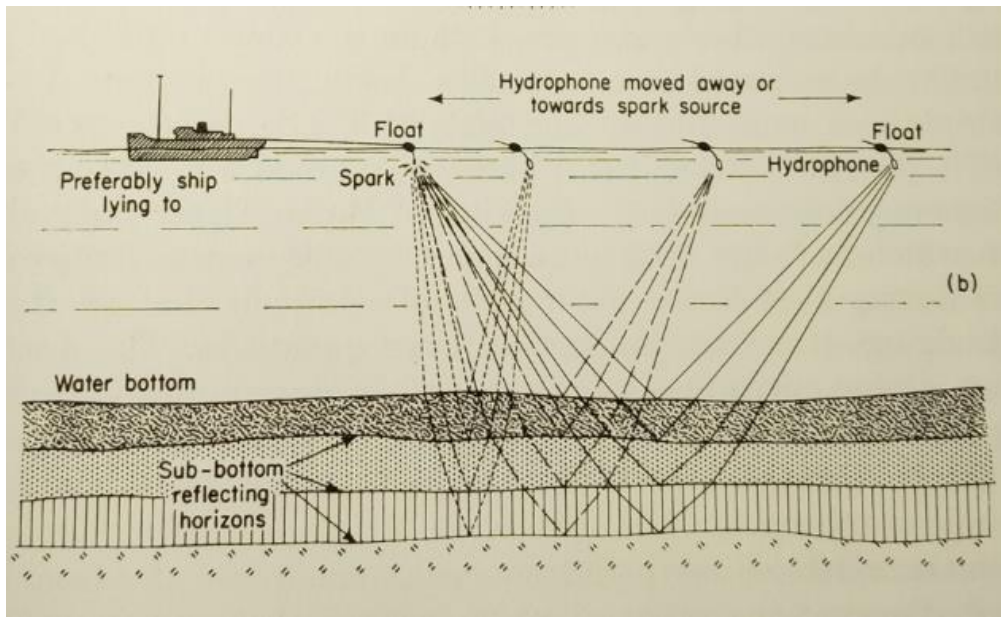


Figure 6. Working schema of reflection seismics (Hersey, “Continuous Reflection Profiling”).

Marine reflection seismics was born – as most of the tools in marine geosciences – from American oil companies’ eagerness to find oil and gas deposits buried below shallow waters and from military patronage. In 1927, the Geophysical Research Exploration company conducted the first successful marine seismic survey in Louisiana’s coastline, which indicated the likely existence of oil deposits.²⁶⁵ Private oil and geophysical companies embarked upon developing seismic devices and new techniques for exploring the economic possibilities of the offshore, but it was not until the 1930s that marine geophysical techniques were acquired by and improved at academic institutions.²⁶⁶ Maurice Ewing (1906-1974), physicist at the Lamont Geological Observatory, pioneered in using seismic reflection techniques to study the deep seafloor’s structure. Ewing was introduced to marine geophysics while studying physics at Rice University, when he spent his summertime working with an oil prospecting crew at the shallow lakes of Louisiana. The group was acquiring seismic and gravimetric measurements to reveal buried salt domes in the Gulf coast, and Ewing’s growing interest on the subject led him to write a PhD thesis on theoretical physics of seismic reflection techniques.²⁶⁷ In 1935, established as assistant professor at Lehigh University, Ewing began to apply the principles of

²⁶⁵Rosaire and Lester, “Seismological Discovery of Vermilion Bay Salt Dome;” Bates, Gaskell, and Rice, *Geophysics in the Affairs of Man*.

²⁶⁶ In: Sternlicht, “Looking Back: Seismic Exploration” it is explained that marine geophysics moved to academia thanks to military technological advancements (notably in hydrophones). However, Maurice Ewing began some years before testing seismic devices at sea.

²⁶⁷ Bullard, “William Maurice Ewing.”

shallow water oil prospection to the exploration of the oceanic crust. With funding from the Geological Society of America and logistic support from the US Coastal and Geodetic Survey, Ewing demonstrated that seismic techniques could be applied to identify formations and specific geological horizons up to 200 meters depth. Accompanied by a young team of physicists, Ewing progressively moved his surveys from the continental shelf to deeper waters, while testing the use of TNT explosives and other methods to create more powerful sound signals. His innovative results and techniques led him to win the support of the US during World War 2 and, afterwards, to secure generous funding from the Office of Naval Research. British geophysicist Edward Bullard began to collaborate with Ewing in 1937, leading seismic surveys on the eastern side of the Atlantic and creating a research team at Cambridge University. Other American research teams followed Ewing: at the Scripps Institution of Oceanography, physicist Russell W. Raitt began in 1947 to study how sound waves are reflected from within the seafloor, using for that purposes large charges of dynamite to create acoustic signals.²⁶⁸ It is important to highlight that in these early years, marine geophysics were frequently separated from marine geology in terms of researchers, expertise, departments, and expeditions. At the Scripps, for instance, sedimentologist Francis P. Shepard was not involved in Raitt's investigations, developed at the Marine Physical Laboratory of the Scripps (Shepard's institution).

In the US, collaborations between geologists and geophysicists (a term which embraces a wide range of scientific backgrounds, as physicists, mainland geophysicists, or oceanographers) began to take shape during the 1950s, when seismic devices were reliable enough to produce seismic profiles that needed to be interpreted. Dynamite – dangerous to embark on-board, extremely harmful for the marine environment, and expensive without the Navy's support – was substituted by innovative and more affordable means.²⁶⁹ John B. Hersey (1913-1992), at the Woods Hole Oceanographic Institution, tested in 1952 a sounding source that generated acoustic waves from a high-voltage electric spark discharged underwater, the *Sparker*.²⁷⁰ At the MIT, American engineer Harold Edgerton designed the *Boomer*, an electromagnetically-driven sounding source. Simultaneously, Maurice Ewing became the first director of the just-founded

²⁶⁸ The story of marine geophysics at Scripps is detailed in: Noble Shor, *Scripps Institution of Oceanography*. According to Raitt, after the war TNT was “readily available” through the US Navy without cost, thus he and his colleagues could utilize up to twenty kilograms of dynamite per shot without any cost.

²⁶⁹ Hersey, “Sedimentary basins of the Mediterranean Sea.” Dynamite explosions posed another problem: they made impossible to send sound pulses at regular and rapid intervals as the vessel sailed forward, which was an essential feature to acquire continuous profiles (instead of acquiring data from a single location).

²⁷⁰ To understand the *Sparker* functioning, see Caulfield, “Predicting Sonic Pulse Shapes;” Hersey, “Continuous Reflection Profiling,” 49; Knott and Hersey, “Interpretation of high-resolution echo-sounding.”

Lamont-Doherty Observatory, where he developed a sounding source that generated sound pulses by discharging high-pressured air, the *Air gun*.²⁷¹

Equipped with enhanced geophysical techniques and a generous economic support granted by the US Navy, Ewing and his team began to undertake large geophysical surveys around the world, which led to unprecedented discoveries about the ocean floor. In 1955 Ewing demonstrated through seismic surveys that oceanic crust was thinner than the continental crust, while the thickness of accumulated sediments was also thinner in the deep oceans.²⁷² These evidences suggested that the ocean floor was much younger than the continents, thus offering hints that the key to understand the earth's dynamics was to be found at the bottom of the oceans. This hypothesis was reinforced with parallel scientific discoveries backed by military data and sounding devices. At the Lamont, assistant Marie Tharp had been analyzing echo-sounding profiles from around the globe, finding that underwater ridges similar to the Mid-Atlantic Rift (discovered during the *Challenger* expedition in 1872-76), were found around the globe; whereas his collaborator Bruce C. Heezen identified that the epicenter of earthquakes coincided with the ridges.²⁷³ Suspecting that the mid-ocean ridges could correspond to extensional regions (areas where the ocean crust is pulled apart), Ewing undertook in 1959 an around-the-world cruise to study ocean ridges with geophysical techniques.²⁷⁴ These and other geophysical and magnetic evidences pointed to the existence of continental drift, giving impetus to American oceanographers to mobilize their vessels and seismic techniques to explore the seafloor around the globe.

Scientific and technical capabilities of American geologists sharply contrasted with resources available at French academia. When the COMEXO was established, in 1958, marine geophysics were completely absent from marine geologists' methodologies, nor collaborations existed between French geologists and geophysicists to explore the seafloor. Similarly to the

²⁷¹ Edgerton, "The 'Boomer' Sonar Source;" Knott and Ewing "Interpretation of high-resolution echo-sounding techniques."

²⁷² Ewing and Press, "Geophysical contrasts between continents and ocean basins." On average, oceanic crust is four times thinner than continental crust.

²⁷³ They first published their evidences in: Heezen, Tharp, and Ewing, "The Floors of the Oceans." This story has been recounted from different perspectives, as it constitutes a central part of the history of the discovery of plate tectonics. For an approach focused on how Tharp and Heezen dodged military secrecy see: Oreskes, "The Iron Curtain of Classification." For a focus on military patronage: Doel, Levin, and Marker, "Extending Modern Cartography." For details on the controversy and the production of scientific knowledge: Frankel, *The Continental Drift Controversy*.

²⁷⁴ Le Pichon, "Fifty years of plate tectonics." Naomi Oreskes explains that Ewing was primarily interested in expanding ridges for its ventured connection to the formation of underwater canyons, and not that much on the still unproved continental drift (Oreskes, "The iron curtain of classification").

development of marine geology, marine geophysics was not a consolidated discipline in France. Yet, some small research groups and enthusiastic physicists had begun to develop their own seismic prototypes to study the oceanic crust. At the laboratory of Applied Physics at the University of Montpellier, physicist Pierre Muraour was designing refraction seismic devices to study the composition of the Gulf of Lion's continental shelf.²⁷⁵ Muraour, who had gained experience in mainland geophysics while working for the *Service de Mines* in North Africa, began to develop and test his own prototypes of seismic devices across the Bay of Algiers in 1956.²⁷⁶ When he moved to the University of Montpellier, he brought with him his techniques and expertise in marine geophysics – together with the eagerness to keep on essaying them in the Western Mediterranean.

Another incipient team was being consolidated at the *Musée Océanographique de Monaco* due to Cousteau's constant relationship with American experts, like engineer Harold Edgerton and oceanographer John Hersey. Edgerton became Cousteau's main collaborator in developing underwater cameras and ingenious apparatus to shoot his films, while profiting from his stays at Monaco to test sounding sources like his *Boomer*. Hersey furthermore used to stop-by in Monaco while undertaking marine geophysical campaigns across the Mediterranean basin, which had enabled young experts based in Monaco to learn from the American techniques and even to embark on their cruises.²⁷⁷ Olivier Leenhardt stood among those. Trained as a physicist at the University of Paris, Leenhardt grew captivated by marine geophysics from the first time he embarked onboard the *Calypso*, in the spring of 1956, during a short course taught by Bourcart. Cousteau later remembered the first time he saw this young physicist onboard, “cluttered with tampered grenades and shell bombs,” with which Leenhardt aimed to obtain seismic profiles from the deep seafloor.²⁷⁸ Some years later and once installed at the Musée, Leenhardt became a frequent collaborator of Edgerton, with whom he tested marine geophysical devices in the calm waters facing Monaco (fig. 7).²⁷⁹

²⁷⁵ Martínez-Rius, “Interview to G. Boillot.”

²⁷⁶ Muraour, “Études de Séismicité Artificielle Sous-Marine.”

²⁷⁷ Jacques Cousteau expressed it during the 1961 national conference on Marine Geology and Geophysics (Muraour and Leenhardt, “Éléments pour un Programme de Recherches Séismiques”).

²⁷⁸ Cousteau, “Préface.”

²⁷⁹ Edgerton and Leenhardt, “Expériences de Sondage Élastique du Fond de la Mer.” It is very likely that Leenhardt's team collaborated with the NATO's ASW Research Center in La Spezia (Italy) for its proximity, which could have also granted him access to resources to conduct marine geophysical tests, and to establish further contacts with American oceanographers.



Figure 7. Olivier Leenhardt (right) and Harold Edgerton (left) onboard, testing the 'Boomer' sounding source in Monaco, 1961 (Edgerton Digital Collections, MIT).

The introduction of marine geophysical techniques in the community of French geologists offers evidence on the unprecedented freedom the COMEXO possessed to shape the political agenda on marine sciences, precisely because of the flexibility the DGRST had granted it to manage the budget. Marine geophysics were not among the DGRST's guidelines, neither inscribed in the scientific requirements of the French Navy, nor in need for enhancing fisheries. However, COMEXO experts were aware that developing marine geophysics in France was essential to stay competitive in the international arena, where the exploration of the ocean floor was gaining importance in foreign and cooperative expeditions.

Geologists could express their concerns regarding lack of access to marine geophysical techniques in April 1961.²⁸⁰ Bourcart had gathered twenty-five French geologists and enthusiasts of the Mediterranean seafloor's exploration at Villefranche-sur-Mer in order to discuss how to invest the COMEXO's budget devoted to marine geology. Perhaps because the meeting stemmed from new scientific policies, *Le Figaro* announced the event under the heading "Action plan of scientists who attempt to snatch the secrets of the Mediterranean's

²⁸⁰ Colloques Nationaux du CNRS, *Océanographie Géologique et Géophysique*.

formation” (fig.8).²⁸¹ Attendants, including Jacques Cousteau, Muraour, and Leenhardt, informed about the expansion of marine geophysical surveys around the world: American, British, and Soviet research teams were embarked on exploring deep regions across the Atlantic, Pacific, and Indian oceans; their outcomes were published in scientific journals and presented during international conferences. More disturbing for French geologists, these foreign research teams were moving their investigations towards the Mediterranean.



Figure 8. Vignette in Le Figaro's news on the Conference (Rousseau, "Plan d'action des savants").

John B. Hersey, American oceanographer at the Woods Hole Oceanographic Institution, had begun to explore the Mediterranean's seafloor in 1957, stimulated by the geological potential of the region to advance knowledge on crustal tectonics. He utilized echo-sonars to define the bathymetry and morphology of the deepest regions, refraction seismics to understand crustal features, and reflection seismics to study sedimentary sequences accumulated over the basement. Maurice Ewing, from the Lamont Geological Observatory, had also explored the Mediterranean basin onboard the *Vema* in summer 1956 and returned the next year equipped

²⁸¹ Rousseau, "Villefranche-sur-Mer: Plan d'action des savants qui tentent d'arracher à la Méditerranée les secrets de sa formation."

with new seismic refraction devices;²⁸² while English researchers at the University of Cambridge and at the National Institute of Oceanography had ventured in the Western Mediterranean to acquire seismic profiles.²⁸³

From the French researchers' perspective, launching geophysical studies across the Western Mediterranean was not anymore a matter of simple scientific curiosity, but also an issue of priority: Bourcart and his collaborators feared losing the scientific prestige associated with being first in reaching new conclusions on regions they had been traditionally studying.²⁸⁴ Minutes of the discussions held during the meeting point to geologists' scientific interest in undertaking investigations similar to the ones developed by American research teams, and the regrettable consequences of being "replaced by foreigners" after having invested so much efforts in studying the Mediterranean dynamics.²⁸⁵ Hence, attendants reached a consensus on investing the COMEXO's budget in a cooperative program to survey the Western Mediterranean seafloor with geophysical tools, pooling together vessels, experts, and laboratories.

Reasons to promote such a program subtly changed when Bourcart transmitted the meeting's decisions to the DGRST. In a report transmitted to Roger Pacque, Bourcart resumed the discourse of promoting sciences to increase national prestige and the fear of lagging behind other countries in the seafloor's exploration. He alleged that investing in a cooperative, large program of marine geophysical surveys was essential to keep pace with American, German, and Soviet research teams, who were already surveying the Western Mediterranean with their large oceanographic vessels and well-prepared research teams.²⁸⁶ The arguments deployed by Bourcart to convince his patrons of the direction marine geosciences should follow are illustrative of the French government's priorities. As in that moment offshore oil exploration was not yet conceived as an applied use of marine geophysical surveys, Bourcart highlighted the main reason why exploring the seafloor should be a matter of political attention: because France risked to lag behind in fundamental marine geological research.

²⁸² Discussed during a 1958 congress organized by Bourcart in Nice: Colloques Internationaux du CNRS, *La Topographie et la Géologie des Profondeurs Océaniques*; also reflected in American publications: Fahlquist, *Seismic Refraction Measurements*.

²⁸³ Gaskell and Swallow, "Seismic Refraction Experiments."

²⁸⁴ Colloques Nationaux du CNRS, *Océanographie Géologique et Géophysique*, 100.

²⁸⁵ Glangeaud's intervention appears in: Muraour and Leenhardt, "Eléments pour un programme de recherches séismiques."

²⁸⁶ Bourcart, "Projets de Développement des Études de Géologie et Géophysique Marines," May 9, 1961 (ADF, 236QO/35).

The conference's main outcome was a joint plan to promote the development of marine geophysics at French academic institutions by acquiring research technologies to equip oceanographic vessels, developing a training program for graduate students, and bringing together geologists and geophysicists in cooperative oceanographic surveys. New equipment, bought with the COMEXO's support, included American geophysical devices to conduct refraction and reflection seismic surveys,²⁸⁷ a unique German instrument to conduct gravimetric studies from the surface,²⁸⁸ and an hydraulic piston corer that could recover samples up to 10 meters-long.²⁸⁹ These devices were installed in a new 23-meters oceanographic vessel, the *Catherine Laurence*, exclusively devoted to marine geology and physical oceanography in the Mediterranean.²⁹⁰ Laboratories in marine geology also got the COMEXO's attention. At Villefranche-sur-Mer, Bourcart's laboratory received 300,000 US dollars to upgrade its installations and buy new equipment, like devices to perform physical and chemical measures or to study minerals and sediments.²⁹¹ The *Musée Océanographique de Monaco* received a budget to refurbish five floors of the center and to equip their laboratories with new material and devices.²⁹²

Part of the COMEXO's budget was invested in research resources that would benefit the entire community of marine researchers. Most importantly, the committee decided to acquire a brand-new oceanographic vessel designed to undertake long, multidisciplinary cruises across the high seas: the *Jean Charcot*, christened in 1965, which became the most tangible inheritance of the COMEXO for French marine sciences.²⁹³ Equally important, the COMEXO promoted the establishment of a radio-frequency positioning system in the Western Mediterranean that covered a 200-kilometers radius at sea. Until then, marine researchers relied on sextants to define the vessel's position, which required keeping the coastline at sight. The radio-navigation chain RANA, installed to cover the northern region of the Western Mediterranean in early-

²⁸⁷ Not specified which instruments, or where they were stored. DGRST, *Rapport d'Activité 1961*, 32-33.

²⁸⁸ An *Askania GS2*. Until the date, gravimetric instruments needed to be lowered near the ocean floor, thus they were frequently embarked in submarines and submersibles. The *Askania*'s novelty relied in that it could be used from a vessel, freeing researchers from the military's support to conduct gravimetric research. DGRST, *Rapport d'Activité 1961*, 33. About the origins of gravimetric surveys, and their use on US Navy's submarines, see: Oreskes, "Weighting the Earth from a submarine."

²⁸⁹ DGRST, *Rapport d'Activité 1961*, 33.

²⁹⁰ DGRST, *Rapport d'Activité 1962*, 47.

²⁹¹ DGRST, "Rapport du Comité d'Études Exploitation des Océans," March 12, 1960 (ADF, 236QO/35).

²⁹² Even though the Musée was settled in Monaco, not in France, the center entered inside the French government's budget for being dependent on the Foundation Albert I, which was legally based in France. DGRST, *Les actions concertées. Rapport d'activité 1962*, 45-46.

²⁹³ DGRST, *Rapport d'activité 1961*, 31.

1961, constituted a milestone in the Mediterranean's exploration.²⁹⁴ The system consisted on two mainland transmitters whose signals were registered by a receiver located on the research vessel; thus, any ship equipped with a compatible receiver could determine with great precision its exact location. This apparently simple technology enabled, for the first time, to chart the region's topographical features, sediment distribution, and depths with unprecedented precision.

3.3.2. Mixing research approaches at French academia

French marine geophysical surveys were launched in January 1962. Pierre Muraour, onboard the Musée de Monaco's vessels *Espadon* and *Winaretta Singer*, led a pilot survey utilizing refraction seismic techniques across the Gulf of Lion. He detonated 500 kilograms of dynamite in 36 shots and data acquired was coupled with geological samples, recovered using dredges.²⁹⁵ The deep seabed began to take shape as seismic profiles depicted all its horizons (although with coarse resolution), from the solid granite basement to the upper soft and unconsolidated sediments.²⁹⁶ In parallel, the COMEXO granted Leenhardt with the equivalent of 165,000 US dollars to undertake a three-year program to survey and chart the Western Mediterranean with reflection seismic techniques.²⁹⁷ Soon after launching his pioneering campaigns, Leenhardt and his team found that the Gulf of Lion's continental shelf was excavated by a number of underwater canyons undetected in topographical soundings, since they were silted up by recent sediments (fig. 9). Linking with Bourcart's interpretations, Leenhardt suggested that the canyons could have formed during the Pliocene, when the continental shelf emerged due to a massive marine regression.²⁹⁸ Meanwhile, researchers at the laboratory of Villefranche-sur-Mer were devoted to chart exhaustively the distribution, composition, and age of superficial sediments to enrich Leenhardt's maps.²⁹⁹

²⁹⁴ DGRST, *Rapport d'activité 1961*, 32.

²⁹⁵ Muraour, Merle and Ducrot, "Observations sur le plateau continental;" DGRST, *Rapport d'activité 1962*, 48-49; COMEXO, "Commission Méditerranée," November 7, 1962 (ADF, 236QO/35).

²⁹⁶ Muraour, Merle, and Ducrot, "Observations sur le plateau continental;" DGRST, *Rapport d'activité 1961*, 34.

²⁹⁷ COMEXO, "Marche de Convention Protocole. Institut Océanographique Monaco," n.d. (ANF, 201103801/01). Muraour, Leenhardt, and Merle, "Éléments pour un Programme de Recherches Séismiques."

²⁹⁸ Leenhardt, "Un Sondage Sismique Continu sur le Plateau Continental."

²⁹⁹ Bourcart, "Projets de développement des études de géologie et géophysique marines," 1 (ADF, 236QO/35); Genesseeux and Bourcart, "Écoulements Profonds de Sables et de Galets;" Bourcart and Ros, "Sur le Remplissage Sédimentaire".

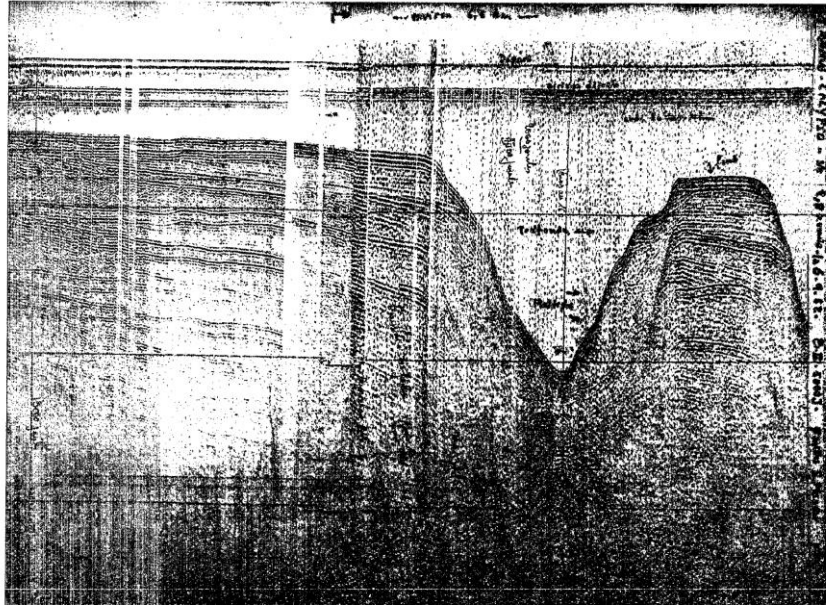


Figure 9. Seismic profile acquired by Leenhardt, depicting a submarine canyon (Leenhardt, “Un sondage séismique continu”).

First results from marine geophysical surveys enthused French academic geologists. Louis Glangeaud, geologist contemporary to Bourcart, claimed at the *Académie des Sciences de Paris* that “Geophysical and geodynamic facts could be more important, from the viewpoint of the Earth’s History, than the discovery of a microfossil in a calcareous rock.”³⁰⁰ After having devoted his entire career to study the geodynamics of the Mediterranean basin applying geological methods, he was thrilled about the explanatory power of marine geophysics: according to him, those techniques would be pivotal to reveal dynamics and structures that neither seismology, nor traditional geology, could tackle. The “physical method,” Glangeaud concluded, should “be a model for all sciences that aimed to become exact sciences.”³⁰¹

Glangeaud’s assertion points to the epistemological change that was taking place in the geologists’ community, not only in France but around the world, from qualitative to quantitative methods. Geology had traditionally been considered as a qualitative science, where results relied on the researcher’s direct experience and interpretation. On land, geologists observed outcrops and geological formations, selected sampling locations, and manipulated samples in the laboratory before stating their conclusions. Because outcomes comprised a certain degree of subjectivity and geological processes could not be replicated in a laboratory, geology was (and still is) a discipline prone to scientific controversies. Conversely, geophysical techniques

³⁰⁰ Glangeaud, “Application des Méthodes Géophysiques à la Tectonique Profonde”.

³⁰¹ Ibid.

(both on the main land and on the offshore) provided technology-mediated results, deemed as more “objective” because instruments freed results from scientists’ manipulations.³⁰²

Historians Naomi Oreskes and Ronald E. Doel have pointed out that scientific preference for quantitative methodologies became a common trend in earth sciences by the mid-1950s both as a result of “an abstract epistemological belief in the primacy of physics and chemistry” and, in the case of the US, of a strong military backing to geophysics, who found in those techniques concrete applications related to national security needs.³⁰³ However, France’s case seems to differ: the military was not directly supporting the development of marine geophysics, but it had been a venture undertaken by academic researchers after witnessing recent foreign advancements. Geologists themselves grew convinced of the great explanatory power of geophysical methodologies, and foresaw the chance to engage in marine geophysical surveys with the now bountiful budget coming from the DGRST. It would also be misleading to assert that geophysical techniques were preferred to geological methodologies. Rather, geophysical research methods (like seismics) were integrated in the geologists’ methodological toolbox and considered as essential complementary techniques to explore the seafloor’s structure.

This fusion of research approaches was particularly well reflected by the COMEXO’s training program, designed to train a new generation of scientists whose expertise mixed geology with notions of physics. The COMEXO offered training grants for undergraduates in their last-year to pursue specific courses in marine sciences and to fulfil a traineeship in a French or foreign laboratory.³⁰⁴ In the program of marine geology, geophysics occupied a prominent position: only candidates in the Natural Sciences with a certified training in physics or geophysics were accepted; and trainees coming from engineering schools, educated in applied geology or mining, were also welcomed.³⁰⁵ Between four and six trainees were funded each year to enroll in a laboratory of their choice: Bourcart’s at the University of Paris, the laboratory of Geology and Paleontology at the University of Caen, or Muraour’s laboratory in Applied Physics at the

³⁰² This point is paradoxical, as quantitative data needs to be processed to become a seismic profile, and seismic profiles had to be interpreted by an skilled researcher.

³⁰³ Oreskes and Doel, “The Physics and Chemistry of the Earth.” About epistemic considerations about scientific objectivity, instrument-mediated, see: Daston and Galison, *Objectivity*.

³⁰⁴ COMEXO, “Note sur la Formation de Chercheurs,” May 25, 1966 (ANF, 20110381/01).

³⁰⁵ COMEXO, “L’Accès aux Carrières des Sciences de la Mer,” December 17, 1962 (ADF, 236QQ/35).

University of Montpellier. Afterwards, trainees were expected to go on with their doctoral research.³⁰⁶

After equipping research ships with marine geophysical devices and proving their capabilities, collaborative missions began to take shape. From 1963, young geologists at Villefranche-sur-Mer frequently accompanied Muraour on his seismic reflection surveys across Nice's continental slope;³⁰⁷ while inter-institutional missions were organized under the auspices of the COMEXO to combine geological, seismic, and magnetic data from the seafloor's depths between Marseille and Monaco.³⁰⁸ However, French geoscientists were not alone in exploring the Mediterranean seafloor with geophysical techniques. As Bourcart and his colleagues had noted in 1961 during their meeting at Villefranche-sur-Mer, American research vessels were also exploring French nearby international waters, equipped with more advanced geophysical devices and large research teams.

3.3.3. The discovery of deep-Mediterranean salt domes

In April 1965, during the 17th Symposium of the Colston Research Society at Bristol, American oceanographers John B. Hersey and Henry W. Menard, from the Woods Hole Oceanographic Institution and the Scripps Institution of Oceanography, presented some of their results coming after seven years of geophysical surveys across the Mediterranean basin.³⁰⁹ Their investigations were framed in the growing interest on crustal tectonics, intensified after US oceanographer Henry H. Hess proposed in 1962 the theory of seafloor spreading to account for the structure of ocean basins and as the driving force of continental drift.³¹⁰

The Mediterranean appeared as an excellent ground to test and explore crustal tectonics: it lay along an earthquake belt, which is related to the folding mountains that cover its Northern shore – as the Apennines and the Alps.³¹¹ Hersey started leading geophysical surveys across the

³⁰⁶ Ibid. The COMEXO supported 20 trainees per year, out of those, 4-6 were in marine geology and the others divided among physical oceanography and marine biology (COMEXO, "Réunion du 19 septembre 1962," September 19, 1962 (ADF, 236QO/35).

³⁰⁷ Muraour and Genesseeux, "Quelques Remarques à la Suite d'une Étude par Séismique Réfraction."

³⁰⁸ Organized by Louis Glangeaud (University of Paris), Christian Agarate (Institute Phisique du Globe), and Pierre Muraour (Montpellier). In : Glangeaud et al. "Morphotectonique de la Terminaison Sous-Marine."

³⁰⁹ Most of the participants were oceanographers (mainly British and American, followed by Dutch, German and French), but it was also attended by experts from oil companies (American Overseas Petroleum Ltd., British Petroleum Co., Shell Petroleum Co., Royal Dutch Shell, and the French SNPA), and representatives of the British Royal Navy (in: Whittard and Bradshaw, *Submarine Geology and Geophysics*).

³¹⁰ Oreskes, "Stymied by Secrecy."

³¹¹ Hersey, "Sedimentary Basins of the Mediterranean Sea."

Mediterranean in 1958 with the aim of studying the processes at work “that form and reform the crust of the Earth.” Yet selecting the Mediterranean could have also been defined by the just inaugurated SACLANT Antisubmarine Warfare Research Center that NATO had settled at the Italian village of La Spezia, which offered to Hersey a logistical base and research resources.³¹² Menard’s surveys followed similar motivations, sometimes in direct collaboration with Hersey’s team at Woods Hole.

In his presentation, Hersey summarized the results he and his team had acquired in the last decade by studying the Mediterranean. After characterizing the structure of its deep seafloor, detailing its stratigraphic sequence, drawing correlations between the western and eastern basins, and mapping its morphology; Hersey mentioned that, in geophysical profiles acquired with reflection seismics in the Balearic basin, his team had identified “dome-like structures.” Most likely, he added, those were salt domes, since in the coastline of Italy evaporites could be easily found.³¹³ He was unaware of the great impact this secondary discovery would have on the European geological community and on the oil industry for the next decade.

Salt layers and domes are structures constituted by evaporitic sediments (this is to say, salts that accumulate after massive evaporation of saltwater, as it happens in natural saline flats). At the scale of geological history, salt accumulations tend to originate when ancient oceans open or disappear. Salty minerals, which accumulate at the basins’ bottom in horizontal layers, are covered during the following millennia by more recent sediments. But since salt is a very plastic material, less dense than the sediments covering it, it tends to ascend to the surface deforming overlaying layers. This process creates salt domes, elongated structures made out of evaporitic materials. Studying when the thick evaporitic layer had deposited, through which processes, and how the Mediterranean basin looked like by then, could shed new light on the region’s geological evolution. If salt domes were as ancient as the basin it would imply that evaporites had accumulated from the closing of the former, wider Tethys ocean, at the time when the Mediterranean adopted its current shape; but if they were more recent, it could indicate massive

³¹² Ibid., Hersey acknowledged NATO’s support in surveying the region. However I could not find direct evidences that support the hypothesis that Hersey was conducting military research while undertaking his marine geophysical surveys. More about NATO’s ASW Research Center at La Spezia in: Ross, “Twenty Years of Research at the SACLANT ASW Research Center.”

³¹³ Hersey, “Sedimentary Basins of the Mediterranean Sea.” Interestingly, Hersey did not published the seismic profiles that led him to announce this hypothesis. The reason might relate to military secrecy: as his cruises around the Mediterranean were often supported by the US Navy, it is likely that he did not obtained clearance to publish raw data.

events of seawater regression – a theory that converged with Bourcart’s hypothesis.³¹⁴ Besides its geological interest, domes and layers of evaporites were also at the spotlight of oil companies. Due to its high impermeability, evaporites constitute good seals for hydrocarbons, which tend to accumulate below (fig. 10). This relation had been first proved in the late-19th century in Louisiana’s mainland oil fields, and from then salt domes constituted benchmarks for oil exploration.³¹⁵

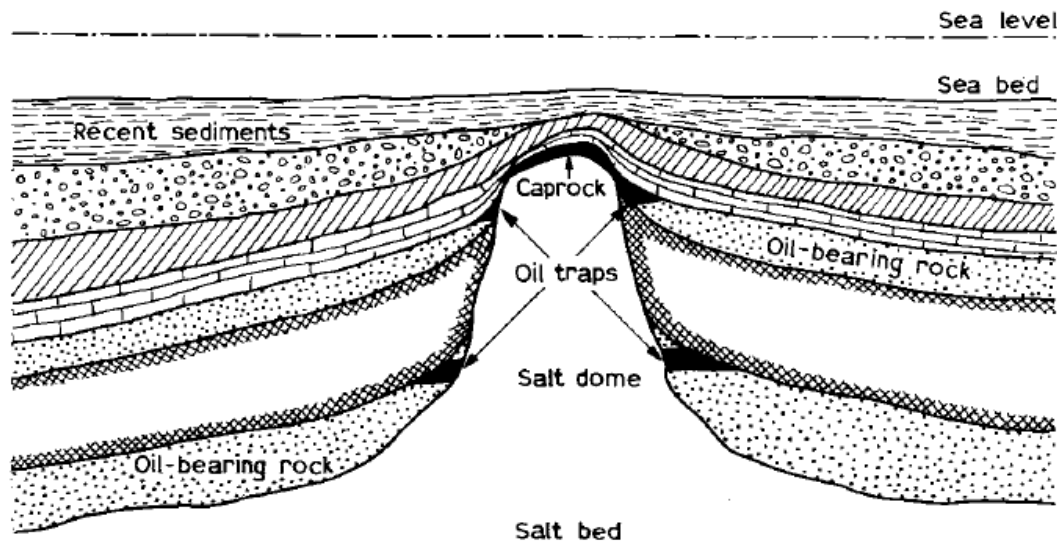


Figure 10. Cross-section view of a salt dome. By pinching off the sediments through which it passes and dragging these sediment layers upward, salt domes form oil traps around them (from: Mero, *The Mineral Resources of the Sea*, 91).

Henry Menard had simultaneously found equivalent evidences while studying a different topic by using different research techniques: sedimentation and underwater currents around the Rhône’s deep-sea fan, in the Balearic basin’s abyssal plain.³¹⁶ While sounding with echo-sonars the sedimentary fan’s morphology, Menard and his team had encountered a dozen of knolls protruding between 20 and 150 meters over the seabed. Their study revealed that they looked exactly like the small mounts found at Sigsbee Knolls (in the Gulf of Mexico) by American geophysicist Maurice Ewing, which he had identified as underwater salt domes.³¹⁷ Menard, presenting these results as discoveries of minor importance, agreed with Hersey by emphasizing

³¹⁴ Seen in chapter 2.

³¹⁵ Hydrocarbons were first found around salt domes in Texas and Louisiana Gulf Coast (Cook and Harrison, “Geology and Development of Jennings Salt Dome”).

³¹⁶ Menard, Smith, and Pratt, “The Rhône Deep-Sea Fan.”

³¹⁷ Ewing and Antoine, “New Seismic Data Concerning Sediments and Diapiric Structures.”

that those formations could only be salt domes.³¹⁸ Jacques Cousteau and his team at Monaco quickly backed Hersey's hypothesis, claiming that while surveying the Ligurian Sea with echosounders they had identified intriguing "*accidents de terrain*" protruding from the seabed, which could well correspond to the upper section of those salt domes.³¹⁹

Hersey and Menard's presentations have become milestones in the scientific literature about the Messinian Salinity Crisis (the geological event through which the Mediterranean may have become a desert), being identified as the first authors who mentioned the existence of deep-sea evaporites through seismic profiles. Yet, albeit being pioneers in this discovery, a careful reading of their papers suggests that these American researchers did not acknowledge their discovery as a revolutionary one – as ensuing literature would. More important for them was to answer major geological questions related to crust dynamics and the deep ocean floor.

Menard and Hersey's investigations across the Mediterranean evidenced, first, how involved Americans were in the region; and second, how large was the research gap between American and French geoscientists. Results presented from the deepest seafloor had been acquired during long offshore cruises for years, by combining geological and geophysical techniques using cutting-edge technologies. Conversely and regardless of the French enthusiasm for marine geophysics, the COMEXO had just begun to coordinate efforts between geologists and geophysicists, surveys had only been conducted across the shallow continental shelf, and the only oceanographic vessel in France, the *Jean Charcot*, had just been launched from its shipowner.

Evidences of deep salt domes shook the community of French geologists, who rushed to organize a joint geophysical and geological campaign across the deep Balearic basin: GÉOMÈDE I.³²⁰ Led by geologist Louis Glangeaud, director of the Laboratory of Dynamic Geology following Bourcart's retirement, the mission aimed at deepening the study of salt domes by reflection seismics and gravimetric studies; trying to identify their exact location and

³¹⁸ Menard suggested a number of other hypothesis: those formations could be buried underwater volcanoes, small volcanoes or laccoliths, mud-lumps, or anticlines. However, he proved that none of these formations could have formed in an enclosed-basin such as the Mediterranean, for its particular geology and history. In: Menard, Smith, Pratt, "The Rhône Deep Sea Fan."

³¹⁹ In fact, it seems that Cousteau had the opportunity to pool together and discuss with Hersey and Menard their results before the Colston meeting (in: Alinat, Giermann, and Leenhardt, "Reconnaissance Sismique des Accidents de Terrain en Mer Ligure"), presumably during joint surveys or meetings at NATO's center in La Spezia, or through Cousteau's collaboration with the National Geographic Society, his main patron to film underwater movies (Cousteau and Schiefelbein, *The human, the orchid and the octopus*).

³²⁰ Alinat, Giermann, Leenhardt "Reconnaissance Sismique des Accidents de Terrain en Mer Ligure."

to date its formation – an essential piece of information to entangle the salt deposition with coeval mainland formations. The mission even got a headline in *Le Monde*, which labeled its goals as to “auscultate the subsoil of the Western Mediterranean” with the support of the DGRST.³²¹ Between March and April 1966, the brand-new *Jean Charcot* sailed across the Balearic Basin acquiring geophysical data with the seismic reflection source *Air gun*, designed by a team at the *Institute Physique du Globe de Paris*.³²² At the same time, Monaco’s research vessel *Winaretta-Singer* utilized the marine geophysical sources *Boomer* and *Mud-Penetrator*, both conceived by MIT engineer Harold Edgerton. With this set of technologies, academic researchers could obtain data of a quality “equivalent to that of the best American laboratories,” as a report from the team of the *Musée Océanographique de Monaco* affirmed.³²³ Indeed, results allowed French researchers to identify the location of salt domes and its surrounding sedimentary structures, and to ground some speculations about the salt domes’ age (fig.11). Glangeaud, for instance, suggested that evaporites had accumulated in an ancient period, when the Mediterranean Sea did not yet exist and its seafloor belonged, instead, to the Tethys ocean.³²⁴ Yet, data acquired was insufficient to move knowledge further from speculations.

Geologists were not the only ones chasing salt domes in the deep seabed. For their capacity to harbor hydrocarbon deposits, the possibility that those formations were salt domes arose the interest of French oil companies, who rushed to acquire permits to explore the western Mediterranean’s oil potential across its continental shelf. Next chapter explains how the French oil industry turned to the sea, and how economic interests derived from the exploitation of offshore hydrocarbons began to permeate the COMEXO.

³²¹ Rebeyrol, “La Campagne de Recherches Géomède 1 va Ausculter le Sous-sol de la Méditerranée Occidentale.”

³²² COMEXO “Contrat 660031 – Sondages Topographiques,” December 25, 1966 (ANF, 201103801/01). That the *air-gun* was manufactured by the geophysicist C. Agarte is specified in: Glangeaud, “Les grands ensembles structuraux de la Méditerranée occidentale”.

³²³ Ibid.

³²⁴ He hypothesized that salt had accumulated during a slow but steadily subsidence of the Earth’s crust between 250 and 50 million years ago, in the Triassic. Glangeaud, “Les grands Ensembles Structuraux de la Méditerranée Occidentale.”

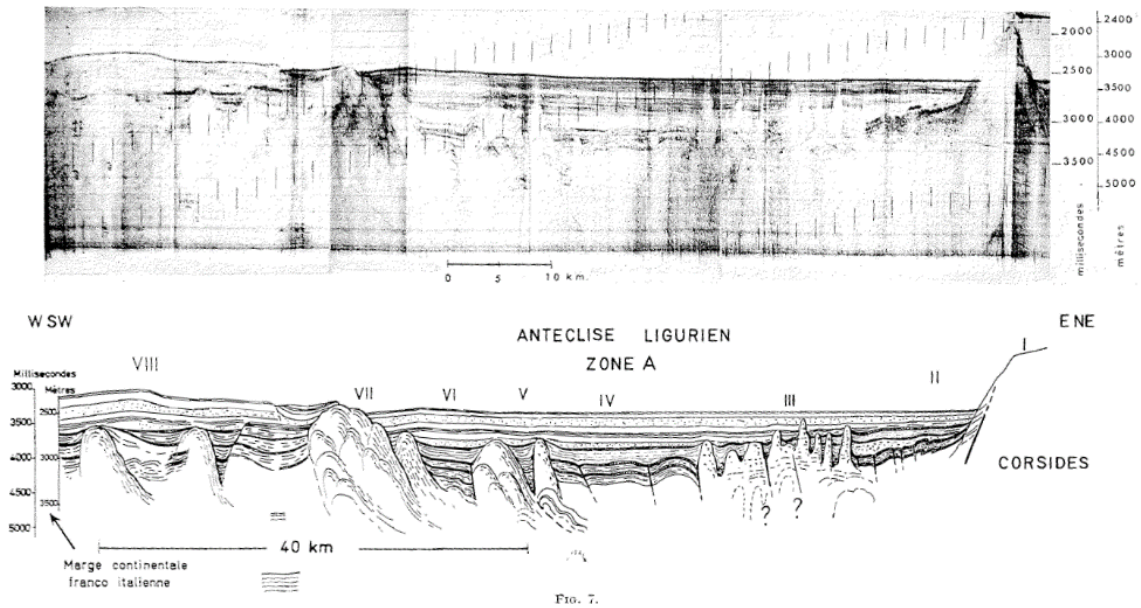


Figure 11. Reflection seismic profile and its interpretation, acquired in the Ligurian sea onboard the *Calypso* (Glangeaud et al., “Les grands ensembles structuraux de la Méditerranée”).

3.4. Seeing below the seabed

By the mid-1960, research methods to explore the seafloor began to crystallize. Geologists’ research portfolio was enriched with marine geophysical techniques, while logistics to conduct work at sea were shared with oceanography. Studying the seafloor in its three dimensions, thus, required a re-organization of research practices in which geological expertise was necessary but not anymore sufficient: geologists needed to collaborate with physicists and geophysicists; depend on a large budget to acquire research technologies and learn to operate them; and share resources and spaces with marine scientists (like the oceanographic vessel *Jean Charcot* or expert forums like the COMEXO).

In France, marine geophysical techniques were promoted by academic geologists and experts who were scientifically interested in integrating those practices to marine geological research. And indeed, once incorporated, they enabled French researchers to establish new conversations with the international community. As illustrated with the case of the salt domes’ discovery, French experts like Leenhardt or Glangeaud could enrich evidences presented by American researchers by utilizing their recently-acquired research capabilities (the *Jean Charcot*, three different geophysical devices, and an economic support that enabled them to spend weeks at sea). It is important to emphasize that the geologists’ interest in the undertaking of marine geophysical surveys was scientific; because when researchers, like Bourcart or Lacombe, addressed to policy-makers, the rhetoric they mobilized to attract attention always appealed to

national prestige and the risk of lagging behind other nations in international scientific development.

French policy-makers were unsatisfied with the image France projected in the international community, after defeat in World War 2 and the rapid process of decolonization that was taking place in their African and Asian territories. General de Gaulle's office considered the promotion of the fundamental sciences as a means to regain international prominence; meanwhile, the oceans began to emerge as new theaters to build international relations and to display the nation's strength. Yet, the fundamental research the DGRST promoted was not aimed at developing "knowledge for its own sake" (as we conceive basic or fundamental research), but to develop specific fields of knowledge for its applied uses. In other words, the DGRST funding was part of a strategy to enhance academic research, which was to be later articulated with oceanic industries (as other countries were already doing).

The COMEXO had a privileged capacity to take bottom-up decisions on the direction marine geosciences should take: its experts decided to acquire marine geophysical technologies, to renovate geological laboratories, or to design their own training program. Yet, if the DGRST support to fundamental research was supposedly government-driven, why the COMEXO had such freedom? I suggest the answer is found in the political perception of the seafloor. Unlike marine biology or physical oceanography, where applied goals were evident (enhancing fisheries or controlling the marine environment for military operations); when the COMEXO was established delegates at the DGRST did not yet possess a clear idea regarding the applied uses of marine geosciences.³²⁵ Official reports of the DGRST barely mention the exploitation of mineral resources as a driving force to promote marine sciences, nor a primary result of its investment. Therefore, investing in developing research capabilities to explore the seafloor was deemed important for its *potential* uses: to be ready to mobilize France's research force when needed.³²⁶

³²⁵ Sociologist Chandra Mukerji has put forward a similar argument to explain the ethos behind the US Navy's support to marine sciences (Mukerji, *A Fragile Power*).

³²⁶ Ibid., Mukerji has called oceanographers supported by US Navy's funding as an elite reserve labor force, to be mobilized as advisors whenever needed

Chapter 4. From fundamental research to the valorization of the oceans: Towards an ocean policy soaked with oil

Après avoir fait rendre à la terre la plus grande partie des richesses qu'elle contenait, les hommes se lancent à présent à la conquête des immenses trésors que recèle le fond des mers, afin de pouvoir répondre aux exigences d'une consommation en rapide accroissement.³²⁷

On May 20, 1965, the General Secretary of Cultural Affairs in Monaco, René Nouvella, delivered the opening speech of the 1st International Congress *Le Pétrole et la Mer* in front of an audience of eight hundred people: managers and engineers from oil and gas companies, technicians and experts in underwater technologies, and oceanographers. The meeting, organized under the auspices of Prince Rainier III of Monaco, gathered for the first time experts from forty-two countries to pool and discuss the latest advancements on offshore hydrocarbon activities: underwater technologies for exploration and production, means of maritime transportation, and juridical issues related to offshore oil and gas exploitation. Monaco, the country that at the turn of the century had become a benchmark in marine scientific research after the creation of the *Musée Océanographique de Monaco*, where Jacques Cousteau had filmed the first colored underwater movies, was now praising the oceans as new grounds to exploit mineral resources.³²⁸ What had happened?

Monaco's International Congress signaled a change of perception of the marine environment: in the mid-1960s the oceans came to be regarded as new sources of wealth for oil industry managers, policy-makers, and even the wider public. In France, the driving force behind that shift was found in the growing instability of its hydrocarbon suppliers, the Middle-East and colonial territories that had just gained independence. At that moment, the French oil industry turned to the seafloor as "the only virgin territory where France's oil industry could develop."³²⁹

³²⁷ "After having returned to the Earth a great part of the riches it contained, men are embarking on the conquest of the immense treasures hidden below the seabed, in order to fulfill demands of a consumption in steady increase." Nouvella, "Discourse d'Aperture du 1^{er} Congrès Le Pétrole et la Mer."

³²⁸ The Musée was remarkably known for its studies in marine biology. About marine stations and the creation of the Musée Océanographique de Monaco, see: Adler, "Marine Science for the Nation or for the World?."

³²⁹ Piketty, "Texte pour l'Audiovisuelle XX^{ème} Anniversaire CEPM," n.d. (ANF, 19980125/36).

This refurbished, marine-oriented, oil industry was built upon a network that connected all French public institutions and national firms devoted to hydrocarbon exploration and production, being the key actor who moved the threads for its creation the civil servant André Giraud (1925-1997).³³⁰ Fervent French nationalist, Giraud, who was trained at the *École Polytechnique* and assigned to the *Corps des Mines* in 1944, aimed at helping the nation acquire its long-awaited energy self-sufficiency.³³¹ In 1958 he was appointed Joint Director of the *Institut Français du Pétrole* (IFP), a public institution devoted to offer technical, scientific, and economic assistance to French oil companies. From that position, Giraud witnessed with dismay how the national oil industry collapsed in North Africa, while strategies to achieve an energetic independence by relying on these regions vanished. Committed to oil exploration at the seas, Giraud undertook the establishment of the main pillars upon which an efficient offshore oil industry would be built: technological innovation, the training of offshore oil experts, and cooperative surveys. These were connected through a network of oil companies and oil-related institutions designed to gather research efforts.³³² Innovative technologies and new data from the seafloor were shared among the network, but did not leak towards the academic community because, initially, Giraud did not envision the creation of institutionalized bridges through which data, experts, and technologies could flow. However, expecting that the advice of academic researchers would reduce costs and time, Giraud later committed himself to link academic and industrial research.

Giraud's presence in different forums left a (metaphoric) oil trail: Channeled by him, oil interests spilled from strictly industrial forums towards scientific spheres – namely, the COMEXO.³³³ The shifting perception of the oceans and the prominent role economic interests

³³⁰ Giraud was formally a mining engineer for his training at the *École des Mines*, yet he never worked as an engineer, but always as a high-level civil servant at the *Institut Français du Pétrole*, the *Commissariat de l'Énergie Atomique*, and at *Électricité de France*.

³³¹ n.a. “Andé Louis Yves Giraud.” France was struggling to achieve energy independence from the aftermath of World War 1, when oil became a key asset in warfare and in international politics (Salut, “Politique Nationale du Pétrole”).

³³² From archival sources and published documents, it looks like if Giraud took the initiative of building a strong offshore oil industry (see, for instance: Piketty, “Texte pour l’audiovisuelle, XXème Anniversaire CEPM,” n.d. (ANF, 19980125/36)).

³³³ As mentioned in chapter 1, following a high-rank government official has proved trickier than following a scientist (like Jacques Bourcart). Whereas for the former numerous documents and publications reflect his ideas, motivations, and interests; for Giraud it has been much more difficult to find equivalent documents: his ideas and arguments usually dissipate in official co-authored reports and minutes of official meetings. I could barely find letters, and no personal record in the archives. Most of the information about his role in ocean sciences comes from a dossier, stored at the Ministry of Industry's archives, entitled “André Giraud. Dossier Océanographie” (ANF, 20060160/1).

were gaining, were reflected in the new orientation of the COMEXO: from 1966 its patron, the *Délégation Générale de la Recherche Scientifique et Technique* (DGRST), moved from emphasizing its support to fundamental research to prioritizing what they called “the valorization of the oceans” – research geared towards the exploitation of natural resources.

4.1. Turning to the oceans: the renewal of a national oil industry

4.1.1. The seed of an oceanic neocolonialism: France’s urgency to secure oil supplies

By 1956, France’s supply of hydrocarbons was in tension. From the aftermath of World War 1, the country had secured its supplies in the Near and Middle East, which by then represented 90% of its imports.³³⁴ However these suppliers proved unstable during the Suez Crisis, started in July 1956, when Egyptian president Gamal Abdel Nasser nationalized the British and French-owned Suez Canal Company. The subsequent Arab-Israeli war – with the involvement of France and the UK – prompted Nasser to close the Suez Canal from October 1956 to March 1957, affecting global commerce and interrupting the flow of oil and gas from the Middle East to European countries.

New discoveries in French Algeria sparked hopes to secure supply of hydrocarbons closer to the metropole: in 1956, the national firm *Compagnie Française des Pétroles* (CFP) identified the oil reservoir of Hassi Messaoud and the gas field of Hassi R’Mel. These discoveries spawn a new political strategy, in which France would base its energy policy on the *pétrole franc* – the Algerian reserves.³³⁵ Yet, at the turn of the decade, the process of decolonization incited experts at the Fuels Directorate³³⁶ to rethink their strategy. In July 1958, a coup d’état in Iraq led to the nationalization of its Iraq National Oil Company, which expropriated foreign oil firms (among which the CFP) of 90% of their exploration and exploitation leases.³³⁷ By 1960, fourteen sub-Saharan territories had gained independence, including oil-producing countries such as Nigeria and Congo-Brazzaville. Initially, the CFP went on with normal operations in

³³⁴ At the same time global oil consumption skyrocketed: from 469 million tons in 1949, to 763 in 1955, and 1,051 million tons by 1960 (Nouschi, *Pétrole et relations internationales*, 35).

³³⁵ In: Salut, “Politique Nationale du Pétrole,” the author details the history of the *pétrole franc* in Algeria, focusing on the negotiations between the French and Algerian government to set the new conditions for French oil companies in the country.

³³⁶ The Direction des Carburants, or DICA, a branch of the Ministry of Industry. Here I will use the name translated to English.

³³⁷ Gaston Breton. *Total, un Esprit Pionnier*.

these regions, as local institutions required training and expertise from French engineers. However, managers at the CFP realized that it was a matter of time before these regions followed Iraq in nationalizing their oil industry.³³⁸

The creation of the Organization of the Petroleum Exporting Countries (OPEC) in 1960 strengthened these anxieties. Maurice Leblond, director of the Fuels Directorate, feared that the organization became a cartel in control of the oil market at a moment when imports from Algeria were not enough to supply the metropole: in 1957, France imported a mere 1% the hydrocarbons it consumed from North Africa, in 1960 this share had increased to 15%.³³⁹ When Algeria obtained its independence in 1962, future prospects were dismal: although the Evian Agreements ensured that the CFP could still operate in the territory under the same conditions, disagreements between the Algerian and French governments over oil exploration, exploitation, refining, and transportation multiplied.³⁴⁰ Fearing to jeopardize its future energy supplies, the Ministry of Industry and French oil companies decided, in the words of the high-officer Gérard Piketty,

Chercher une aire de jeu ouverte aux deux opérateurs Français pour s'« approprier » des réserves sur lesquelles le pays puisse compter pour assurer sa sécurité d'approvisionnement et sa non-dépendance par rapport au cartel des majors.³⁴¹

The oceans then began to emerge as such a “playground,” as Piketty had called them. An early orientation towards the seas seemed as promising: the new legislation on the continental shelf ensured sovereignty rights to the national government for the exploration and exploitation of hydrocarbons as far as their technological capabilities allowed.³⁴² In the US, offshore oil production across its continental shelf had increased from 133 barrels a day in 1954, to 444 in 1960, and now constituted a 6% of the country's oil production.³⁴³ In Europe, offshore oil exploration took-off in 1959, when Shell and Standard Oil found the biggest natural gas

³³⁸ Ibid.

³³⁹ Nyaberg, “A Few Strategic Considerations Concerning French Imports of Oil Products.”

³⁴⁰ Salut, “Politique Nationale du Pétrole.”

³⁴¹ “To find a new playground for the two French operators to “appropriate” supplies, on which the country can rely, avoiding to depend on the Majors.” In: Piketty, “Allocution de Gérard Piketty à la Journée CEPM-COPREP.”

³⁴² Seen in chapter 3, pp.74-76.

³⁴³ Data from the US Energy Information Administration, consulted in:

<https://www.eia.gov/totalenergy/data/annual/showtext.php?t=ptb0502>

The history of offshore oil exploration in the US appears in: Burlinson, *Deep Challenge!*. Other authors have tackled the development of particular companies in the offshore, like in: Pratt, Priest, Castaneda, *Offshore Pioneers*; and Priest, *The Offshore Imperative*.

reservoir ever discovered in the continent in front of Netherland's coast.³⁴⁴ In the Law of the Sea's framework, the North Sea's continental shelf was divided among its seven bordering countries, and the allocation of exploration leases was regulated. This facilitated the acquisition of leases by foreign oil companies for offshore exploration (fig. 12).



Figure 12. The North Sea's approximate territorial division after UNCLOS I. Note that almost all the region is characterized by shallow waters, rarely surpassing 100 meters depth.

In 1962, French oil companies started to consider potential developments at sea.³⁴⁵ The *Bureau de Recherche de Pétrole* (BRP) and the oil firm *Régie Autonome des Pétroles* (RAP) undertook

³⁴⁴ Burleson, *Deep Challenge!*. Oil exploration in the North Sea has received notable scholarly attention, for instance: Kemp, *The Official History of North Sea Oil and Gas*; Harvie, *Fool's Gold*.

³⁴⁵ In fact, the CFP had already conducted one attempt of offshore oil exploration in shallow waters in the Persian Gulf, in consortium with British Petroleum (BP) as operator. Managers at the CFP outsourced Jacques Cousteau to conduct preliminary surveys in the region onboard the *Calypso* and, in 1957, CFP and BP installed a mobile drilling platform (in: Gaston Breton. *Total, un Esprit Pionnier*, 147-149).

their first seismic surveys across the German, Norwegian, Danish, and Dutch continental shelves; whereas the CFP joined them one year later to explore the British underwater region.³⁴⁶

Growing international interest in offshore oil provided a glimpse of the new geopolitical theater that, in years to come, the submerged territory could become. Each nation's technological capabilities would decide the level of control they exerted over new sources of hydrocarbons and minerals. At the *Institut Français du Pétrole* (IFP), André Giraud was well aware of how crucial it was to define, as soon as possible, a national strategy in order to develop an efficient offshore oil industry, regardless of the investment and effort needed. Giraud advocated for designing an "exploitation of the oceans" policy – an expression infused with imperialist undertones, connoting territorial control and expansion – as a means to secure France's energetic supplies. He clearly expressed his ideology in a persuasive letter to the Prime Minister's Cabinet some years later:

La formation des empires grecs, carthaginois et romains; le développement de Venise, de l'Espagne, du Portugal; la constitution de l'Empire britannique, et sa survie sous la forme du Commonwealth ; les suprématies américaine et soviétique, le développement colonial français, ont été fondés – entre autres exemples – sur l'acquisition et ou la mise en exploitation de territoires nouveaux.

Aujourd'hui, la prise de contrôle de ressources naturelles ou humaines prend des formes plus subtiles et les nations attachent une importance croissante au développement de l'industrie humaine, à la mise en valeur des cerveaux [...] Ce phénomène illustre l'importance croissante pour les Etats de la recherche scientifique et technique.

Mais il reste un domaine naturel immense dont les ressources sont encore quasiment vierges : la masse, le sol et le sous-sol des océans – les 4/5 de la surface globale. Tout indique que, moyennement des connaissances et des moyens appropriés, il peut constituer une source de richesse et de puissance. La chance veut en outre que les grands Etats préoccupés plutôt par leur effort spatial ne s'en soient avisés que tout récemment.

Tout comme en leur temps la mise en exploitation de l'Amérique, des Indes Occidentales, de l'Afrique, la mise en exploitation des océans demandera ses explorateurs, ses zoologistes, ses géologues, ses botanistes, puis ses pionniers et ses ingénieurs. Elle demandera la mise au point de moyens originaux

³⁴⁶ Chapelle, "Le Pétrole et la Mer." The *Bureau de Recherche de Pétrole* was a public institution created in 1945 to coordinate and organize oil exploration in France's colonial territories. The *Régie Autonome des Pétroles* was a national oil company created in 1939 to assess the oil potential of continental France.

d'investigation et de pénétration. Elle suscitera – elle suscite déjà – des entreprises industrielles (pêche – mines – pétrole – chimie).

La France se doit de ne pas prendre de retard dans ce domaine. Elle dispose déjà d'un noyau d'océanographes de valeur indiscutable, et d'industriels dont l'intérêt s'éveille aux choses de mer.³⁴⁷

Giraud's letter provides a first hint of the oceanic neocolonialism that was going to diffuse among industrial and political circles in the years to come. In this mindset, the oceans would replace colonial territories as regions devoted to supply the metropole with minerals and hydrocarbons after a process of exploration, occupation, and conquest. This process of "conquest" could only be achieved through technological innovation, essential to reach those deep, unknown, and invisible regions. Thus, from Giraud's perspective, the three pillars upon which the future national offshore oil industry would rely were technological development, the training of new experts, and their coordination under a state administration to reap the result of their efforts.

Giraud's remarks were shared by other experts of the energy sector. Civil servant Maurice André Leblond, director of the Fuels Directorate, had pursued his career between the Ministry of Industry (in the *Service des Mines*) and the Ministry of Finances, where he was technical adviser to Félix Gaillard between 1957 and 1958. From 1959, he became head of the Fuels Directorate, from where he could rethink the national strategy to secure France's hydrocarbon supplies. Jean Blancard, civil servant also trained as mining engineer at the *École Polytechnique*, had been involved in advisory positions at the Fuels Directorate from 1942. In

³⁴⁷ "The formation of the Greek, Carthaginian, and Roman empires; the development of Venice, Spain, and Portugal; the constitution of the British Empire and its survival under the Commonwealth; the American and Soviet supremacy, the colonial development of France, have been founded – among other examples – over the acquisition or the exploitation of new territories.

Today, taking control over natural or human resources adopts a more subtle form, and the nations grant a growing importance to the development of the human industry, the valorization of brains (...) This phenomenon illustrates the growing importance of scientific and technical research for states.

But there is still an immense natural domain whose resources are still almost virgin: the mass, bed, and sub-floor of the oceans – 4/5 of the global surface. All indications are that, through the appropriate knowledge and means, it could constitute a source of richness and power. It is also fortunate that the large states are more concerned about their space effort, and only recently have become aware of this.

As in the past the exploitation of America, the Western Indies, or Africa, the exploitation of the oceans would require its explorers, its zoologists, its geologists, its botanists, and also its pioneers and engineers. It would require the development of original means of exploration and penetration. It would arise – as already does – industrial ventures (fishing, mining, oil exploration, chemistry).

France must not be delayed in this domain. It already counts with a nucleus of valuable oceanographers, and of industrialists who are growing interested on the things of the sea."

In: Giraud, "Note sur la Création d'un Établissement Public pour le Développement de l'Océanographie et la Mise en Valeur de la Mer," February 28, 1966 (ANF, 20060160/1).

1952 he became president of the *Bureau de Recherches de Pétrole*, the national institution responsible of defining a national program of oil exploration and of ensuring its proper development.

Giraud, Leblond, and Blancard envisioned the future of the French oil industry as being built upon the ocean floor.³⁴⁸ In 1963, the three men agreed to build, as soon as possible, a powerful and internationally competitive organization designed to advance a national strategy efficiently directing oil industry's interests towards the oceans. In front of the Council of Ministers, they pushed for the creation of a new organization, the *Comité d'Études Pétroliers et Marines* (CEPM).

4.1.2. An oil network: The Comité d'Études Pétroliers et Marines

On March 26, 1963, the Ministry of Industry and the Ministry of Economic Affairs instituted the *Comité d'Études Pétroliers et Marines* (CEPM), which gathered representatives from the main national oil institutions: the CFP, the *Régie Autonome des Pétroles* under Blanchard's presidency, the *Bureau de Recherches Pétrolières*, and the *Institut Française du Pétrole*, represented by Giraud.³⁴⁹ The CEPM was designed to create the favorable conditions through which a national offshore oil industry could flourish by defining high-priority actions and organizing their execution, coordinating exploration and exploitation activities, promoting technological and logistic innovation, and by stimulating collaborations between national institutions, thus preventing the unnecessary replication of studies. These actions would reduce the time and money invested.³⁵⁰ Although the CEPM was initially presided by Leblond, André Giraud replaced him in 1964, when he was appointed Director of the Fuels Directorate.

The CEPM's uniqueness relied in that, unlike aggregations of oil firms in other countries, its shape was closer to a national network than to a consortium of oil firms. Inside the oil industry, the creation of consortia was a classic strategy to explore the oil potential of new regions: a number of oil companies associate to share the economic burden of exploration and exploitation, while they also share the outcomes of their efforts. Consortia were particularly

³⁴⁸ Piketty, "Texte pour l'Audiovisuelle, XXème Anniversaire CEPM," n.d. (ANF, 19980125/36).

³⁴⁹ First named *Comité d'Études Marines*. Leblond, "Décision du Directeur des Carburants," May 7, 1963 (ANF, 20150386/156).

³⁵⁰ Combaz, "Le Comité d'Études Pétrolières Marines." The CEPM's structure and goals was not unprecedented in France. As Roberto Cantoni has detailed (Cantoni, *Oil Exploration, Diplomacy, and Security in the Early Cold War*, 85-88), the *Bureau de Recherches de Pétrole* was created in 1945 to coordinate and fund oil exploration abroad.

suited for exploring the offshore, as searching for oil was three times more costly at sea than across mainland territories, and the chances of finding a reservoir that could return up the investments were completely unknown.³⁵¹ Not many companies were prepared to risk their capital in developing exploration technologies, drilling new wells, or in undertaking exhaustive surveys without sharing the research burden with other firms. In the US, for instance, the main private oil firms devoted to offshore exploration (Continental, Union, Shell, and Superior Oil) had joined force in 1946 under the CUSS Group to explore oil off the Californian coast.

Conversely, the CEPM was a structure tightly linked to the Ministry of Industry due to the public nature of its member institutions: the French government owned a third of the CFP, while the *Régie Autonome des Pétroles* was a national firm created in 1939 to explore oil deposits in the national territory. Both the *Bureau de Recherches de Pétrole* and the *Institut Française du Pétrole* (IFP) were public institutions directly dependent on the Fuels Directorate: whereas the first was devoted to draft the national energetic strategy, the IFP trained engineers and technicians, and developed knowledge and new techniques, to supply the national oil industry. The CEPM's model, thus, ensured a smooth articulation between political priorities and oil exploration activities, avoiding frictions derived from the confrontation of private and public interests.

In this network, industrial secrets were shared among its member institutions along with technologies, experts, and budget. According to the Committee's rules, its members had to communicate all activities internally pursued that related, in one way or another, to the scientific and technological projects discussed, planned, or conducted under the CEPM's auspices; while only the President and the Permanent Delegate could keep information secret "in accordance to their position," as long as knowledge of it was not relevant to the Committee's functioning.³⁵² Geological information regarding the seafloor was thus shared inside the network, but not outside: from its inception, the CEPM did not envision any collaboration or connection with the academic community of geologists, probably because they had neither been envisioned in previous industrial cooperative ventures.

This type of networking structure was not new at the Ministry of Industry, as similar networks had been successfully implemented during the 1950s to coordinate exploration efforts in

³⁵¹ Chapelle "Le Pétrole et la Mer".

³⁵² Comité d'Études Marines, "Règlement du Comité d'Études Marines", April 28, 1966 (ANF, 20150386/77).

colonial territories.³⁵³ Conversely the CFP, the main company operating in North Africa, had not required a supply of external expertise, as it had implemented an ambitious training program from the hiring of mining engineers from the *École Polytechnique* and the *École de Mines*. With the support of other public institutions devoted to technological development, like the *Compagnie Générale de Géophysique*, the CFP trained its experts in new exploration techniques (specially to conduct mainland geophysics).³⁵⁴ For the exploration of the offshore, managers of French oil companies aimed at following the same pathway of development as the one followed in North Africa.

4.2. Technologies, experts, and surveys: the take-off of offshore oil exploration

4.2.1. The *Flexotir* or how to conduct seismic surveys without damaging the marine environment

The first obstacle oil managers were confronted with at the CEPM was the absolute lack of technologies and infrastructures for exploration and exploitation activities at sea. Given that foreign oil companies were already manufacturing their own devices and infrastructures, the CEPM had two options: either acquiring those, together with the technical expertise required to operate them in the short-term; or designing its own devices, which implied a higher investment of time and money but would free the French oil industry from reliance on foreign companies.³⁵⁵

³⁵³ The *Bureau de Recherches de Pétrole*, for instance, was born with the same aim: a structure designed to coordinate oil exploration by specifying the nature of permits and concessions, to fund prospecting activities through its own budget, and to devise a national program of oil exploration; working together with the Fuels Directorate and the RAP (Cantoni, *Oil Exploration, Diplomacy and Security*).

³⁵⁴ Historian Radouan Mounecif has offered a detailed account on the training program of the “chercheurs d’or noir” at the CFP, together with the implementation of geophysics as main research technique (Mounecif, *Chercheurs d’Or Noir*).

³⁵⁵ From the reading of archival sources, it appears like petroleum engineers had to learn how to conduct research at sea from scratch. In 1964 the CEPM forged a collaboration with the Navy’s Hydrographic Service to exchange relevant information (i.e. bathymetrical charts, meteorology, corrosion of materials...), radio-location systems, and gravimetry research methods – although the CEPM soon revealed its scarce interest in the Navy’s gravimetry data, because they needed data with much higher resolution and detail (in: Cabanier, Georges. “Compte-Rendu. Collaboration entre la Marine et les organismes pétroliers. Réunion du 28 juin 1966,” September 28, 1966 (SHD, MV 9 JJ 567)). Even an engineer from the RAP was invited to embark onboard the Navy’s ship *Amiral Mouchez* to learn about techniques in gravimetry research (in: n.a. “Note pour Mr. Amiral Chef d’Etat-Major de la Marine. Autorisation d’embarquement sur un bâtiment hydrographique,” July 2, 1963 (SHD, MV 9 JJ 567)).

Giraud supported the second option: investing in technologies developed by the French oil industry, specifically designed to fulfill its own needs. According to some experts involved in the CEPM activities, framing this new offshore venture at a strictly national level stemmed from pragmatic reasoning: in a period when prototypes for offshore oil technologies were being developed around the world, it appeared more profitable, for the Ministry of Industry, to invest in designing devices adapted to its own needs instead of purchasing them to American or British firms.³⁵⁶ However, this decision could have also derived from recent misfortunes in the Sahara. As historian Roberto Cantoni has detailed, when Saharan regions were still to be prospected and its oil potential assessed, French oil companies decided to share the research burden with Anglo-American enterprises to benefit from their technological knowledge. At that moment, Giraud justified the decision by arguing that priority was not so much on employing national technology, but using the best available regardless of its origins – and that meant American technologies. However, yielding territorial control to Anglo-American companies proved fatal, since it contributed to a decrease in French control over the area, culminating in France's loss of the Algerian oil-producing territories.³⁵⁷

Programs for technological development were coordinated by the IFP. To this end, Giraud appointed two men knowledgeable in marine technologies: Pierre Willm, dubbed “the man of bathyscaphes,” in charge of exploration technologies; and the IFP engineer Jacques Delacour, who would lead the development of exploitation devices (oil rigs, wellhead equipment, and seabed infrastructures).³⁵⁸ The CEPM ensured a bountiful financing for the IFP programs that freed them from the ups and downs experienced by scientific research at public institutions: research at the IFP would rely on a special budget allocated by the Ministry of Industry, the *Fonds de Soutien aux Hydrocarbures*, coming from a special tax on oil products and therefore in constant increase, independent from the academic system based on bureaucracy and grants-award. Oil companies under the CEPM would also contribute financially to support projects of greater interest, which granted them certain capacity to shape research according to their priorities. From 1963, large sums of money began to flow from the Ministry of Industry to the “Marine Project” at the IFP: 9 million US dollars in 1963, 10,3 million for 1964, and 13,3

³⁵⁶ Martínez-Rius, “Interview to P.F. Bauquis.”

³⁵⁷ In: Cantoni, *Oil Exploration, Diplomacy, and Security in the Early Cold War*.

³⁵⁸ Jarry, *L'aventure Des Bathyscaphes*. Pierre Willm was a Naval engineer, responsible for designing of the submersibles FNRS 3 and (later on) the Archimède. He had worked shoulder to shoulder with August Piccard and the ubiquitous Jacques Cousteau. In: Guillou, “Éloge de l'Ingénieur Général de l'Armement Pierre Willm,” the author affirms that Willm and Giraud were schoolmates and friends from the *École Polytechnique* (which might justify Willm's appointment to lead the IFP' marine program).

million in 1965.³⁵⁹ To compare, the COMEXO – that was simultaneously investing its own budget in promoting marine research at academia – received a budget of 8,65 million US dollars for a four-years period, to be shared by all disciplines.³⁶⁰

For oil managers involved at the CEPM, priority laid in developing advanced exploration technologies. Almost nothing was known about the origin and geological structure of the French continental shelf: the Atlantic and Mediterranean seafloor were unexplored grounds, whose economic promises were “completely unknown and unpredictable.”³⁶¹ It was thus essential to undertake seismic surveys that would offer an overview of the seafloor’s sedimentary composition, and would help identifying oil-harboring structures below the seabed. At the IFP, engineers Jean-Pierre Fail and Jacques Cholet undertook the task of designing a high-penetration seismic device – that is, a geophysical technology capable of acquiring data from hundreds of meters below the seabed – that did not depend on exploiting large dynamite charges. In fact, until the mid-1960s large explosions (of about 10 kg of TNT per shot) were a *sine qua non* condition to obtain seismic profiles from the deepest layers of the seabed, as it was the only known method to overcome the “bubble pulse”: an air bubble, generated when operating the sounding source, that distorted acoustic signals.³⁶² Besides problems related to the unfeasibility of depending upon large supplies of dynamite (not always available, and dangerous to embark on board), seismic surveys with explosives had already prompted anger among fishermen in the Mediterranean coastline.³⁶³ Each underwater detonation massacred all kinds of fauna, from fishes to plankton, and a single survey was composed by dozens of explosions. Official documents from the oil company ERAP reported complaints of fishermen in the Gulf of Lion after they had run a seismic survey; while the newspapers *Le Monde* also reflected this concern in an article devoted to marine exploration.³⁶⁴ Second problem to solve was to generate continuous detonations, each few seconds, to acquire seismic profiles across a continuous section of the seafloor (and not only information from an isolated location).³⁶⁵

³⁵⁹ Leblond, Maurice. Letter to the IFP General Director, June 17, 1963 (ANF, 20150386/108); and Giraud, André. Letters to the IFP General Director, February 8, 1964 and February 20, 1965 (ANF, 20150386/108).

³⁶⁰ Equivalent to 42,45 million francs.

³⁶¹ *Journal Officiel de la République Française*, August 29, 1962, 742.

³⁶² McQuillin, *An introduction to seismic interpretation*, 40.

³⁶³ About the environmental controversy between fishermen and the oil industry, see: Locher, “Lutter contre l'Empire du Pétrole.”

³⁶⁴ ERAP, *Programme d'Études Marines 1966* (AHT, 07AH119/76); Rebeyrol, “Le Flexotir ou comment Chercher du Pétrole en Mer sans Tuer les Poissons.”

³⁶⁵ Hersey, “Continuous Reflection Profiling.”

Without a continuous sounding source, the vessel could not keep on sailing while data was being acquired, thus time at sea increased and with it, the cost of the survey.

Between 1963 and 1965, the CEPM invested more than 300,000 US dollars in the development of seismic reflection devices at the IFP.³⁶⁶ Fail and Cholet acquired a small tuna boat, the *Petite Marie-Françoise*, and equipped it with radar, sonar, and a radio. From there, their team would be able to conduct as many tests as they wished without having to rely on external institutions and companies.³⁶⁷ Next, they tested different systems of sound-wave generation at sea, like electromagnetic vibrations and compressed-gas explosions. After several trials, Fail and Cholet realized that to overcome the bubble pulse problem they could use small explosive charges detonated in a structure that would amplify the signal. Based on this premise, Fail and Cholet designed a brand-new device, patented in 1965: the *Flexotir* (fig.13).³⁶⁸

Unlike other seismic sources relying on explosions, the *Flexotir* only required 50 grams of dynamite per shot, which was detonated inside an iron-perforated sphere a dozen of meters below the seawater surface. The innovation was announced in the newspaper *Le Monde*, which emphasized its environmental-friendly approach to offshore oil exploration by heading the article as “The Flexotir or how to look for oil without killing fishes.”³⁶⁹ It was designed for what the oil industry called “*océanographie de grande reconnaissance*”: it could generate sound waves every 18 seconds, enabling a continuous acquisition of data for kilometers while the vessel kept on sailing.³⁷⁰

With the *Flexotir*, French oil companies now had access to information about the seafloor unattainable by academic research teams. As explained in the previous chapter, geophysicists Pierre Muraour and Olivier Leenhardt were leading the exploration of the Mediterranean seafloor using self-made or American-manufactured seismic sources: the *Sparker*, which generated acoustic waves by releasing electric sparks, and the *Boomer*, an electromagnetically-driven seismic source. Both of these devices produced high-frequency waves, which offered high-resolution data but low penetration rate. This meant that academic geologists could only study with accuracy the first dozen of meters below the seabed, but they could not obtain any

³⁶⁶ Equivalent to 1,5 million francs. In: Giraud, André. Letter to the IFP General Director, February 8, 1964 (ANF, 20150386/108).

³⁶⁷ IFP, *Rapport Annuel 1963*.

³⁶⁸ Cholet and Fail, “Dispositif émetteur d’ondes sonores;” Cholet and Fail, “Patent Specification 1.097.227.”

³⁶⁹ Rebeyrol, “Le Flexotir ou comment Chercher du Pétrole en Mer sans Tuer les Poissons.”

³⁷⁰ Cassand, Fail, and Montadert, “Sismique Réflexion en Eau Profonde (Flexotir).”

clue about the deeper layers.³⁷¹ Unlike these technologies, dynamite explosions in the *Flexotir* generated a low-frequency signal that could travel much deeper below the seabed and offer high-resolution data from deep sedimentary structures. Yet, the *Flexotir* was out of reach for academic researchers: if techniques of light seismics (as *Sparker* and *Boomer*) could be easily transported and installed from one vessel to another, the *Flexotir* weighted 800 kilograms and required a specific ancillary gear (including expert technicians) to operate it.

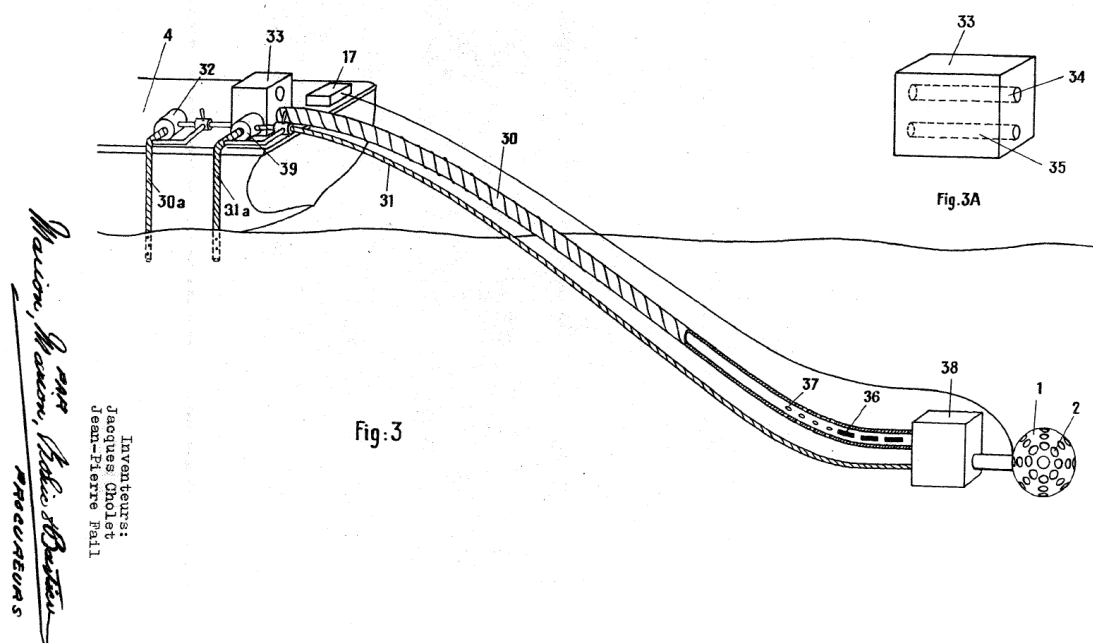


Figure 13. Schema of a *Flexotir* (Cholet and Fail, “Patent Specification 1,097,227”).

Oil companies applauded the *Flexotir*’s design and outsourced the IFP team, through the CEPM network, to conduct geophysical surveys (fig.14). In June 1964, the *Flexotir* was first tested in a campaign that toured the North Sea’s continental shelf, since the CFP and the *Bureau de Recherches Pétrolières* were interested in the region’s oil potential.³⁷² In 1966, the *Entreprise de Recherches et Activités Pétrolières* (ERAP) joined the CEPM to use the *Flexotir* in its offshore campaigns and to count with the IFP’s support.³⁷³ That same year, the oil-services

³⁷¹ McQuillin, *An introduction to seismic interpretation*.

³⁷² The public institution ERAP was created in 1965 from the fusion of the *Bureau de Recherches Pétrolières* and the company *Régie Autonome des Pétroles* (in: Lacour, *Terre d’Innovations*).

³⁷³ ERAP, *Programme d’Études Marines 1966* (AHT, 07AH119/76).

company *Compagnie Générale de Géophysique* bought four *Flexotir* devices to equip its vessels, acquiring more than 5,000 kilometers of seismic profiles just to test its capabilities.³⁷⁴

Other technological advances set the IFP at the forefront of the seafloor exploration in France, not only in marine geophysics but also in marine geological methods. A new coring system, called *électrocarottier*, could drill and obtain one-meter long cores up to 50 meters below the seabed, immersed under 500 meters of water (fig.15). Yet, its burdensome infrastructure and dependence on an electric source prevented its use by other than the oil industry.³⁷⁵ The IFP's Division of Exploitation had also made progresses patenting the *Flexoforage* in July 1965, a new drilling system that, unlike other existing methods, utilized a flexible drill pipe and an electric source of energy, thus speeding up drilling operations.³⁷⁶

These technological advances manifested how successful the cooperative network built by the CEPM was: experts at the commission could drive the development of research technologies and stimulate the establishment of cooperative ventures. Every year, at the Committee, Giraud discussed the proposals and budget requirements presented by IFP engineers and, according to the interest expressed by representatives of oil companies, suggested fruitful collaborations among companies, offered without reservation large sums of money to the most relevant projects, or directly rejected some studies. In the case of the *Flexotir*, Giraud suggested that Fail and Cholet asked for economic contributions from companies interested in using it, like the *Compagnie Générale de Géophysique* – which soon after began to collaborate in the testing of the device.³⁷⁷ On another occasion, Giraud denied support for the development of an instrument for refraction seismics, at least “until ERAP specifies its interest on such a device.”³⁷⁸ Conversely, Giraud readily supported any project related to the enhancement of lateral sonar systems and the numerical processing of data, pressing the IFP team to provide some results “as soon as possible.”³⁷⁹ In this way, Giraud and oil industry managers at the

³⁷⁴ IFP, *Rapport Annuel 1966*. A Yugoslavian company also acquired a *Flexotir* to equip its fleet. Evidences of these joint surveys appear in the IFP's annual reports (IFP, *Rapport Annuel 1967, 1968, 1969, 1970*) and at reports from oil companies (ERAP, “Programme d'Études Marines. Rapport Annuel 1966” (AHT, 07AH119/76); ERAP, “Programme d'Études Marines. Rapport Annuel 1968” (AHT, 07AH119/76)). Yet, it is difficult to better characterize these campaigns due to the scarce information available. There are barely disclosed documents that detail the results obtained, which experts were involved, and how did they interact during joint projects.

³⁷⁵ Delacour, Parola, and Grolet. “Dispositif pour le carottage sous-marine.”

³⁷⁶ Delacour and Castela. “Appareillage de forage sous-marin.”

³⁷⁷ Giraud, André. Letter to the IFP General Director, February 20, 1965 (ANF, 20150386/108).

³⁷⁸ Giraud, André. Letter to the IFP General Director, February 7, 1966 (ANF, 20150386/108).

³⁷⁹ Giraud, André. Letter to the IFP General Director, January 24, 1967 (ANF, 20150386/108).

CEPM were defining which research techniques were suitable – or not – for oil prospecting, hence orienting the knowledge to be produced at the oil industry.

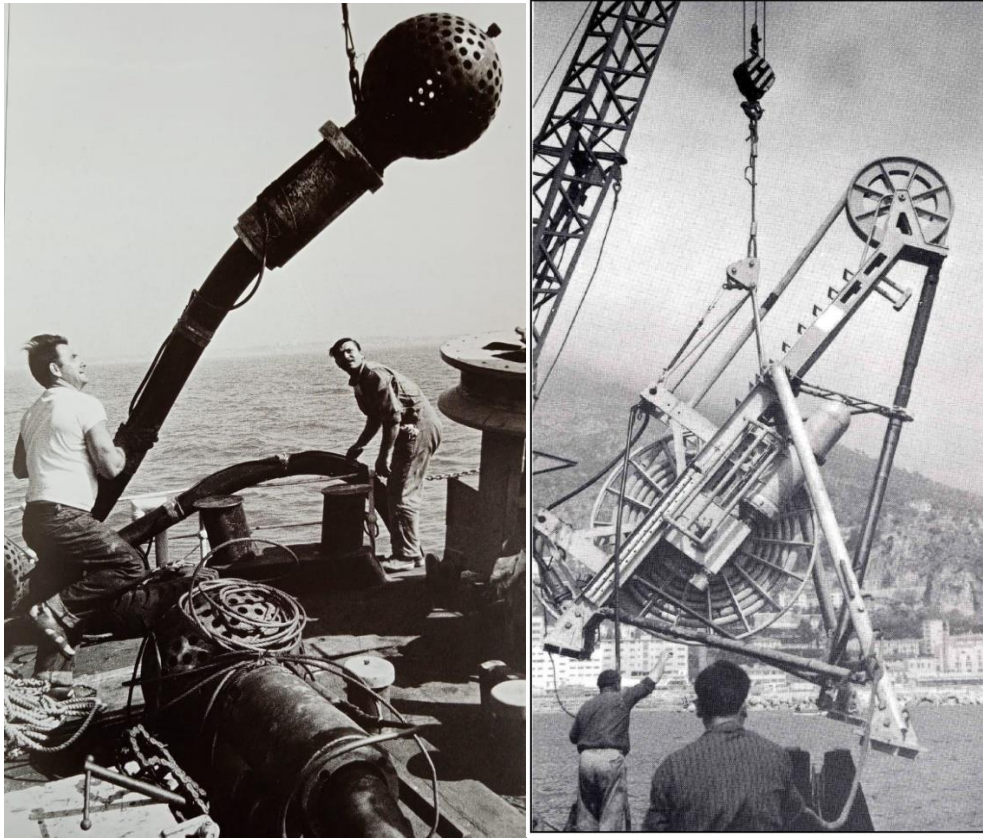


Figure 14 (left). A *Flexotir*, operated by IFP technicians (Lacour, *Terre d'innovations*).

Figure 15 (right). The IFP's *électrocarottier* being lowered (IFREMER, *Inventaire de ressources*).

4.2.2. A new community of petroleum geologists

Once technologies for the exploration of the seafloor were available, they were made to work. From 1965, oil companies and the IFP's technical team traveled across the continental shelf of the North Sea, the Bay of Biscay, the Mediterranean, and the Red Sea gathering geophysical data to draw the main geological features of these sedimentary basins. Thousands of kilometers of seismic profiles began to flow into the IFP's Division of Geology, where geologists processed and interpreted that data. For these purposes, as it happened in academia, geological expertise from learned experts was essential.

Besides being committed to designing new research and exploitation technologies, the IFP was a training center for oil experts.³⁸⁰ The *École Nationale Supérieure du Pétrole et des Moteurs*

³⁸⁰ The history of the IFP can be found at: Lacour, *Terre d'Innovations*.

was the IFP's own school where recent graduates could specialize for any kind of positions, from oil economists to engineers or technicians, to be employed at the national oil industry. By the mid-1960s, the offshore was emerging as the new promising labor niche for recently graduated geologists, at a time when decolonization had transformed geology into a "discipline in crisis."³⁸¹ Because of the loss of colonial territories and, with them, the disappearance of overseas Geological Services, numerous geologists, engineers, technicians, and oil consultants were forced to move back to continental France. The *Bureau de Recherches Géologiques et Minières* was compelled to dismiss part of its permanent staff, and the CFP faced the daunting challenge of relocating hundreds of its engineers and technicians previously employed in Algeria.³⁸² Since a similar Geological Service did not exist on the continent, these relocated experts occupied vacant positions at universities, public research centers, or even quitted from research.³⁸³ This situation was particularly problematic at universities, where laboratories suffered from a chronic shortage of credits.³⁸⁴ For recent graduates in geology, the emergent offshore oil industry became the most promising option: besides offering permanent positions with a fixed salary, it granted access to the most advanced research resources, large budgets to travel around the world, frequent missions at sea, and the opportunity to work with exceptional data.³⁸⁵

Lucien Montadert (1934-), a young geologist trained at the University of Paris, saw the field of industrial research rife with opportunities. After completing his degree in geology, Montadert pursued his training at the IFP's school and, from there, he was directly employed at the IFP's Division of Geology. In a later interview, Montadert recalled the moment he got involved in offshore oil exploration, one day when someone in the Division asked for a geologist to interpret a seismic profile acquired in the Bay of Biscay. According to him, virtually nothing was known about its geological structure.³⁸⁶

At the IFP, geologists were trained to conduct geological and geophysical research at sea by using the new available technological means, as the *Flexotir* or the *électro-carottier*. They

³⁸¹ Based on interviews, notably with L. Montadert, J.P. Bauquis, and J.M. Rouchy.

³⁸² Historian Radouan Mounecif has detailed the CFP's plan to repatriate engineers and technicians from autumn 1961, which created a turmoil among employees for the job instability generated (Mounecif, *Chercheurs d'Or Noir*).

³⁸³ CNRS, *Rapport National de Conjoncture* 1963/1964, 211.

³⁸⁴ CNRS, *Rapport National de Conjoncture* 1959; 1962/1963 and 1963/1964.

³⁸⁵ Martínez-Rius, interviews to L. Montadert, J.P. Bauquis, and J.M. Rouchy.

³⁸⁶ Martínez-Rius, "Interview to L. Montadert."

devoted themselves to the task of providing scientific and technical advice to oil exploration industrialists while working shoulder to shoulder with oil engineers. Yet, this labor did not impede them to conduct geological research in an academic sense – quite on the contrary, geologists at the IFP enjoyed a sort of freedom that academic geologists did not possess. Montadert’s research was orientated by the fluctuating goals and needs of the oil industry, which tended to move fast from one region to the other, aiming at sketching as fast as possible the geological composition of the seabed in order to identify suitable areas for hydrocarbon occurrences. However, and unlike what happened in academia, at the IFP young geologists enjoyed a permanent position and salary, independent from unstable sources of funding, exhausting bureaucratic duties, the publication of scientific papers to enhance their careers, or never-ending writing tasks to apply for grants.³⁸⁷ They could freely access to cutting-edge research resources, and found plenty of opportunities to embark on offshore missions. In the years to come, Montadert and his colleagues would play a central role in disseminating data produced at the oil industry into academic forums through published papers, presentations in congresses, and cooperative surveys. Yet, by the mid-sixties, formalized pathways of exchange between the oil industry (IFP included) and academic geologists were inexistent. This disconnection is well-illustrated by their simultaneous exploration of the Mediterranean salt domes and the divergent scientific conclusions reached by academic geologists and oil experts.

4.2.3. Academic-industrial disconnection: the case of the Mediterranean salt domes’ dating

As detailed in chapter 3, when in 1965 American geophysicists John B. Hersey and Henri Menard identified dome-like structures across the Western Mediterranean basin, French academic researchers rushed to undertake a cooperative geophysical survey with the aim of characterizing these formations across the Balearic Basin, named GÉOMÈDE I. Yet, not only academic geologists were interested in salt domes: for their ability to harbor oil deposits, the western Mediterranean began to appear as a promising basin for oil exploration, too – which aroused the French oil industry’s interest in surveying the region.³⁸⁸

³⁸⁷ Martínez-Rius, “Interview to J. Letouzey.”

³⁸⁸ The CFP obtained the first exploration lease on the Gulf of Lion’s continental shelf in 1966 (Cabinet du Premier Ministre, “Decret du 15 mars 1966 ” (AHT, 85ZW456/2).

From 1966, France's oil companies and the IFP began to survey the Gulf of Lion's continental shelf, employing the same research techniques (seismic and gravimetry studies) that academic geologists were utilizing in GÉOMÈDE I although with higher resolution devices; while aiming at the same goal: to identify and survey the "massive salt structures" found in the region, as a CFP's report phrased it.³⁸⁹ The CFP devoted two years to spot suitable sites to drill exploratory wells; while the oil firm ERAP requested the IFP's help to acquire geophysical data from the Mediterranean's French continental shelf.³⁹⁰ Data recovered during these missions was not disseminated: it did not appear in scientific papers, nor it was presented during geological conferences. Anecdotal leaks of oil industrial data only happened during informal, face to face conversations between oil and academic geologists who knew each other in advance – most frequently because they had been classmates during their graduate training.³⁹¹ I suspect that this disconnection was not due to a strong secrecy regime because, as chapter 5 describes, in the following years confidential policies at the oil industry did not change, whereas leaks from the oil industry became common. Rather, it may have been due to the fact that formalized pathways of collaboration and exchange between academic geologists and industrial experts have not been yet created.

The absence of forums where both communities could pool and discuss their results led to divergent conclusions about the age of the evaporitic structures, an essential knowledge to estimate the region's oil potential and to disentangle the Mediterranean's past. At the University of Paris, geologist Louis Glangeaud (leader of the campaign GÉOMÈDE I) defended that salt domes had been created during the ancient Triassic period, more than 200 million years ago. Conversely, oil geologists at the IFP and at the CFP concluded that the salts' origin was much

³⁸⁹ These geophysical methods were central of the portfolio for hydrocarbon exploration in mainland regions. During the first phase of exploration, reflection seismics provided information on sedimentary basins, helping to delineate its sedimentary sequence, and was key to identify potential source rocks. French oil companies could utilize the *Flexotir* for that purposes, which generated high-quality data from deep sedimentary layers. Gravimetric methods were then utilized to find structures within those basins that hold promises of being oil or gas traps. Gravimetric methods measure anomalies in the Earth's gravitational attraction. Put it simply, gravity changes according to the density of materials around the measuring point; and variations in density came from different rock types (due to characteristics as porosity, grain density, etc.), the existence of fault zones, or the thickness of overlying materials. For the Western Mediterranean seafloor, gravimetric measurements were especially suited to identify salt domes and hydrocarbon deposits based the gravitational anomalies they produced (McQuillin, *An introduction to seismic interpretation*; Bates, Gaskell, and Rice, *Geophysics in the Affairs of Man*; Assaad, "Surface geophysical petroleum exploration methods").

³⁹⁰ Compagnie Française des Pétroles, "Sondage d'exploration 'Mistral 1'. Rapport implantation," October 1968 (AHT, 85ZW456/2); Cabinet du Premier Ministre, "Decret du 15 mars 1966" (AHT, 85ZW456/2); ERAP, "Programme d'Études Marines. Rapport Annuel 1966" (AHT, 07AH119/76).

³⁹¹ There are a number of examples of informal exchanges between the oil industry and the academic community (Martínez-Rius, "Interview to A. Mauffret;" Martínez-Rius, "Interview to J.M. Rouchy").

more recent, from the Oligocene (around 30 million years ago).³⁹² From a geological perspective, a Triassic age would imply that evaporites had been deposited before the Mediterranean basin was formed (being coetaneous to most of the salt deposits found in Europe); while an Oligocene age would mean that its deposition was coeval to the basin's formation. But besides its geological relevance, one or another age drastically affected the prospects of hydrocarbon exploration and exploitation. If salt structures were cap rocks of hydrocarbon deposits, a Triassic deposition would imply that now salt structures were located at the deepest part of the sedimentary section; while if sedimented during the Oligocene, they would be located closer to the surface. This difference not only affected drilling activities, but was also essential to infer the quality and maturation stage of potential hydrocarbons (which depends on the environmental conditions of sedimentation, pressure, and temperature). It was becoming evident that oil industry required geologists' knowledge, and academic geologists needed data produced at the oil industry.

4.2.4. The oil industry's need for geological expertise

During its first years of existence, the CEPM's funding and direction had greatly contributed to the development of new technologies for the seafloor's exploration: the seismic source *Flexotir*, which enabled the acquisition of thousands of kilometers of seismic profiles across the North Sea, the Bay of Biscay, and the Western Mediterranean's continental shelf; and the pioneering drilling system of *Flexoforage*, which could penetrate 70 meters below the seabed.³⁹³ Thanks to generous economic support, the IFP's vessels, the *Petite Marie-Françoise* and the drilling vessel *Térebél*, could spend almost all year-round working at sea, acquiring a massive amount of new data with its own devices.³⁹⁴ At the IFP, the Division of Geology was responsible for processing and interpreting the data, drawing the first geological maps of the continental shelf.³⁹⁵

However, this scientific expertise was not enough. Since virtually nothing was known about the seafloor's structure, dynamics, or composition, the oil industry's first concern was to get a sense

³⁹² CFP, "Sondage d'exploration Mistral 1. Rapport d'implantation," October 1968 (AHT, 85ZW456/2); Corgnet, J.L. "Généralités sur le Programme de forage Golfe du Lion," June 21, 1968 (85ZW456/2); Montadert, personal communication.

³⁹³ IFP, *Rapport Annuel 1963*; IFP, *Rapport Annuel 1964*.

³⁹⁴ In 1964, the IFP's Division of Geophysics worked at sea 121 days out of 200 days (IFP, *Rapport Annuel 1964*). This exceeded the days at sea spent by academic geologists and geophysicists, who could not undertake a complex mission until 1966, when the *Jean Charcot* was set in operation.

³⁹⁵ IFP, *Rapport Annuel 1965*.

of what was in there, rather than directly identify hydrocarbon deposits. By exhaustively exploring entire sedimentary basins, oil geologists and engineers tried to sketch their main sedimentological features, correlate them with mainland formations, and date their deposition; to spot cracks, faults, and fracture zones that could jeopardize future oil-exploitation activities, and to draw geological synthesis from the incoming data. This information would then be mobilized to identify regions where hydrocarbon deposits were likely to occur.

Not only achieving such an understanding was beyond the geological expertise available at exploration divisions of oil companies, but it would also consume an excessive amount of funds and time.³⁹⁶ Conversely, academic geologists were considered as excellent advisors for these tasks due to their particular research approach. While oil exploration tended to move fast from one region to another, academic geologists specialized in particular regions, chronological periods, and research lines: at the University of Paris, Glangeaud and his team at the Department of Geodynamics were experts in Mediterranean tectonics; Leenhardt and the team at Monaco were proficient in conducting seismic reflection surveys across the Mediterranean continental shelf; and at the University of Brest and Rennes some geologists were starting to study the sedimentological composition of the Atlantic continental shelf. Because of their limited research budget, French geologists tended to develop exhaustive knowledge of their nearby regions and to squeeze any piece of data (from sediments to seismic profiles) to the latest conclusions. At universities, young researchers tended to inherit the research lines of their masters, generating a pool of knowledge that stretched across generations. Scientific forums, where information was exchanged and discussed, enriched geologists' interpretations of the seafloor's geology, dynamics, and history.

From the perspective of oil industry managers, the academic community of geologists was a pool of geological knowledge and expertise on which the industry could rely. Gradually, petroleum geologists established informal and mutually-beneficial relations with academic researchers. In 1964, geologist Gilbert Boillot concluded at the University of Rennes the first sedimentological study of the Breton continental shelf, during which he had sampled and charted the upper sediments of the area by using modest research resources. His experience attracted the attention of Étienne Winnock, petroleum geologist at the oil company *Société*

³⁹⁶ Even though the French oil industry counted with numerous proficient geologists and geophysicists, who produced groundbreaking scientific knowledge. When they published, their works obtained large scholarly attention. Crucial papers, co-authored by petroleum geologists, are for instance: Montadert, et al., "De l'Âge Tertiaire de la Série Salifère;" and Cravatte, et al., "Les Forages du Golfe du Lion."

Nationale des Pétroles d'Aquitaine (SNPA) and responsible for drafting a preliminary report on the oil potential of the Manche. To speed up his work and rely on external expertise, Winnock contacted Boillot in 1965, requesting his contribution to the inventory.³⁹⁷ This was the origin of a mutual-beneficial relationship that extended over many years: when Boillot lamented his lack of a sampling instrument for accurately studying the region's rocky structure, Winnock bought for him a Stettson-Hill piston corer with the SNPA's budget. This English-manufactured device, inexistent in any other French laboratory, allowed Boillot to acquire core samples from the rugged and hard seafloor. As Boillot himself acknowledged, the economic and technological contributions of the oil industry to his modest laboratory transformed him into a "full-time marine geologist," who could study the geological history hidden under the seafloor beyond its sedimentary cover.³⁹⁸ For the Mediterranean seafloor, engineers from ERAP contacted with Pierre Muraour, at the University of Montpellier, to conduct some tests on refraction seismics. They funded a marine survey using Muraour's self-designed sounding-buoys, trying to apply the outcomes to identify oil deposits.³⁹⁹ One year later, managers from ERAP requested Olivier Leenhardt to draft for them a bibliographical report on the existing instruments to conduct reflection seismic surveys and their particularities.⁴⁰⁰

The need to rely on external experts was not only felt by oil geologists working in exploration divisions, but also in other departments. One illustration is the attitude towards fundamental research expressed by the Department of Technical Innovation of the *Société Française de Recherches et d'Exploitation de Pétrole* (SOFREP), a subsidiary company of ERAP devoted to innovation in exploration and exploitation activities.⁴⁰¹ In its 1966 annual report, the Department's chief engineer Jean-Pierre Verrien praised the usefulness of academic research to speed up oil-related activities and technological innovation. Among metaphors of conquests and struggles, so recurrent in the oil industry's mindset, he stated that:

La compétition industrielle, forme moderne de transfert de la lutte pour la vie, exige pour son accomplissement efficace l' « idée », fécondant des ressources et des moyens. C'est la Recherche Scientifique qui par son esprit créateur fournira les « idées fécondantes », source de progrès des nations. (...)

³⁹⁷ Martínez-Rius, "Interview to G. Boillot." Also in: Boillot, *Comment l'Idée Vient au Géologue*.

³⁹⁸ Ibid.

³⁹⁹ ERAP, *Programme d'Études Marines. Rapport Annuel 1966* (AHT, 07AH119/76).

⁴⁰⁰ ERAP, *Rapport Annuel 1968* (AHT, 07AH119/76).

⁴⁰¹ The *Société Française de Recherches et d'Exploitation de Pétrole* was short-lived: one year after its creation, it became ELF.

Ainsi, il n'est pas outrecuidant d'affirmer que l'ensemble de la production rationnelle des hydrocarbures naturels tant recherche qu'exploitation est fondée sur une construction intellectuelle scientifique sans cesse.⁴⁰²

Central in his discourse was the need to stimulate and build formal pathways to attract academic experts to activities related to the oil industry. To justify this claim, Verrien pointed to the large quantity of money and time his department had consumed in the last year in the pursuit of scientific research, and the scarce number of engineers trained or skilled enough to carry out these studies. The policy to be followed, thus, should rely on outsourcing external institutions, which would “guarantee an opening towards new scientific and technical domains”: faculties of sciences, the CNRS, and even specialized public institutions or private companies.⁴⁰³ The situation described at the SOFREP department was not necessarily shared by other research laboratories in the oil industry. That same year, the oil firm ERAP for instance reported a successful effort at gathering engineers and technicians proficient in a wide range of geological methodologies in its exploration laboratory, which could therefore aim at developing scientific capabilities to look for oil in any kind of sedimentary basin around the world.⁴⁰⁴ The landscape described by Verrien however hints the way in which the idea of articulating fundamental research and industry, already prevalent among ministerial circles (chapter 3), had now pervaded the oil industry and was supposed to be an essential condition for its progress.

4.3. Shifting priorities: a new perception of the oceans and the inception of an oceanic policy

Verrien's concern was shared by André Giraud, who considered that fundamental research had to pursue certain economically relevant goal. But unlike Verrien, who suggested that a mechanism to establish bilateral collaborations between oil companies and academic experts needed to be formalized, Giraud aimed higher: he supported the establishment of a state-led structure that would push oceanographic research towards economic profit.⁴⁰⁵ The moment was

⁴⁰² “Industrial competition, modern form of the struggle for life, requires for its efficient accomplishment “the idea”, fertile in resources and means. It is the Scientific Research which, for its creative spirit would provide the “fertile ideas”, source of progress for nations. (...) Thus, it is not dared to affirm that the whole rational production of hydrocarbons, either in exploration than in exploitation, is founded over a continuous intellectual scientific construction.”

In: SOFREP, “Direction d’Exploration. Rapport Annuel, 1966” (AHT, 07AH119/76).

⁴⁰³ Ibid.

⁴⁰⁴ ERAP, Laboratoire Exploration. *Compte-Rendu d’Activité pour la Période 1966-1967* (AHT, 07AH119/76).

⁴⁰⁵ Giraud, André, “Pour une Politique Française d’Exploitation des Océans,” n.d. (ANF, 20060160/1).

particularly propitious to promote such an organization since the Council of Ministers was drafting the 5th Plan for Economic and Social Development, having selected “the articulation between fundamental research and its industrial applications” as one of the main topics.⁴⁰⁶

Ministers partaking in the *Commissariat Général du Plan*, presided by François Ortoli, were particularly concerned by the poor articulation between national industries and scientific research. Domains like electronics, agriculture, automotive, and energy production suffered a notable delay in their development if compared with those at “the main industrialized countries” (i.e. the US) and the reason, according to them, was to be found in the scarce support they received from fundamental research.⁴⁰⁷ Pursuing the goal of building an internationally competitive industry for the 5th Plan, the Commissariat would encourage the implementation of policies and structures bolstering scientific research. Giraud’s goals, therefore, were aligned with the national plan for scientific and industrial development, and he would devote the remaining of his mandate as Fuels Director to boldly enter into the COMEXO and to orient its policy towards the oil industry’s benefit.

4.3.1. The “valorization of the oceans” and international competition

The 5th Plan of Economic Development gave a new orientation to ocean sciences not only because of its commitment to articulate fundamental research with industrial activities, but also because the *Délégation Générale à la Recherche Scientifique et Technique* (DGRST) would continue funding the COMEXO. Yet priorities had changed, induced by the economic efforts the Ministry of Industry was investing in developing offshore capabilities.

In 1965, the COMEXO activities came to an end. The committee’s biggest achievement had been the construction of the *Jean Charcot*, the first oceanographic vessel in France able to conduct interdisciplinary surveys on the high seas (fig.16). COMEXO’s oceanographers, biologists, and geologists had contributed to foreshadow a future organization for oceanography; however, they also acknowledged their incapacity to establish an efficient training plan and research remained dispersed across more than a hundred laboratories.⁴⁰⁸

⁴⁰⁶ Comité Consultatif de la Recherche Scientifique et Technique, *Rapport au Comité Interministériel de la Recherche Scientifique et Technique*, March 29, 1966 (ANF, 20060160/1).

⁴⁰⁷ Commissariat Général du Plan, *Cinquième Plan de Développement Économique et Social*.

⁴⁰⁸ Giraud, André, “Note sur la création d’un établissement public pour le développement de l’océanographie,” February 28, 1966 (ANF, 20060160/1); DGRST, “Projet d’exposé des motifs instituant un Centre National d’Études Océanographiques,” February 10, 1964 (ANF, 19920548/19).



Figure 16. The oceanographic vessel *Jean Charcot* (CNEXO, *Plan Naval Horizon 80*).

At the DGRST, general delegate André Maréchal approved the renewal of the COMEXO's funding. Yet, the arguments put forward in favor of keeping up support had changed: in addition to praising ocean sciences as a means to enhance France's international prestige, the exploitation of natural resources now appeared as a major driving force. As the DGRST reflected in a report justifying its decision in front of the Inter-Ministry Council:

La France d'aujourd'hui ne peut ignorer l'espace océanique qui l'entoure et que d'autres nations modernes cherchent à connaître et s'appêtent à exploiter. Que son effort sur les mers, comme celui qu'elle fait en recherche spatiale, ne puisse rivaliser avec ceux que font les deux plus grands états du monde ne constitue pas un motif de renoncement. Les mers ont cessé d'être uniquement un moyen commode de communication dont il fallait s'assurer la maîtrise en surface. Elles offrent un milieu où l'aventure scientifique précédera une exploitation rationnelle des richesses contenues dans la masse des eaux ou dans les fonds marins. Un monde angoissé par les problèmes de la faim, une nation préoccupée de trouver le libre accès à des matières premières indispensables à son économie, une défense convaincue que les techniques modernes imposent un renouvellement des connaissances, créent un devoir nouveau et impérieux. Qu'elle le veuille ou non, la France est entrée dans une grande compétition internationale. Il s'agit de lui donner la place raisonnable que l'intérêt commande.⁴⁰⁹

⁴⁰⁹ "Today, France cannot ignore the oceanic space that surrounds it, and which other modern nations seek to explore and are get ready to exploit. That [France's] efforts on the seas, like its efforts in space research, cannot compete with those of the world's two largest states, is not a reason to give up. The seas are not anymore simply

Delegates at the DGRST now poetically acknowledged the ocean's potential beyond its surface, a new perception of the seafloor's increased importance for its hidden resources. Scientific research was not anymore presented as an activity pursued for the sake of knowing the marine environment, but was portrayed as an "adventure" devoted to supply the nation's needs in terms of alimentary and economic resources while keeping pace with other nations.

What had prompted this change of priority? For one thing, the new orientation of the oil industry towards the oceans, its needs and concerns, were channeled from the CEPM to the Inter-Ministry Council through Giraud. Giraud was appointed vice-president of the advisory committee that would define the goals of oceanographic sciences in the 5th Plan, sharing the board with representatives from different ministries, ocean industries, and some COMEXO scientists.⁴¹⁰ The new oceanographic policy materialized during discussions where these representatives expressed their needs, concerns, and priorities in ocean exploration: the "valorization of the oceans," for the seas' scientific interest as much as their large economic potential.⁴¹¹

Recent oceanographic developments in the US, which representatives at the Inter-Ministry Council and André Giraud were constantly comparing with France's oceanographic advancements, also contributed to policy changes.⁴¹² President Lyndon B. Johnson, in office from 1963 to 1969, was excited about the future possibilities of marine resources for his country

means of communication, for which to ensure the control of its surface. They offer an environment where scientific adventures will precede a rational exploitation of the wealth contained in the water mass or in the seafloor. A world distressed by problems of hunger, a nation concerned to find free access to raw materials essential to its economy, a Defense convinced that modern techniques impose a renewal of knowledge, create a new and compelling duty. Whether is liked or not, France has entered into a great international competition. It is important to situate it in the reasonable place that its interest requires."

In: DGRST, "Projet d'exposé des motifs instituant un Centre National d'Études Océanographiques," February 10, 1964 (ANF, 19920548/19).

⁴¹⁰ DGRST, "Rapport du Groupe 'Océanographie' de la Commission de la Recherche Scientifique du 5^{ème} Plan," March 24, 1965 (MNHN, ARCH PC 46 (7)).

⁴¹¹ Ibid., Comité Consultatif de la Recherche Scientifique et Technique, *Rapport au Comité Interministériel de la Recherche Scientifique et Technique*, 29 March, 1966 (ANF, 20060160/1). Also, the Director of Economic Forecast Jean Saint-Geours distributed among the Inter-Ministry Council a report entitled *L'Allocation des Ressources Consacrées à la Recherche Intéressant l'Industrie*, where he claimed for the need to valorize the oceans for its economic prospects. Mentioned in: DGRST, "Note sur l'Organisation de l'Océanographie," November 29, 1965 (ANF, 19920548/19); and in Marechal, André. Letter to Maurice Fontaine, January 20, 1966 (ANF, 20060160/1).

⁴¹² Giraud, André. Letter to Raymond Toussaint, February 28, 1966 (ANF, 20060160/1).

and pushed for huge national efforts to promote oceanography.⁴¹³ In a single year (1963), the US spent for oceanography ten times more than France had invested over the five-year period 1961-1966. In 1965, the US Congress designed a national plan to drive oceanographic research towards the fulfillment of national needs, which crystallized in the creation of the Commission on Marine Science, Engineering and Resources. This Commission would set the basis to what was expected to become a “NASA of the Oceans”: an institution that would implement and coordinate a national oceanographic program.⁴¹⁴ Meanwhile, in France, research was spread among more than a hundred ill-equipped laboratories.⁴¹⁵ Giraud was especially concerned by the growing importance of exploitation activities undertaken by the US, sending newspaper clippings to the Minister of Scientific Research Alain Peyrefitte on which, as it was written, the US was “preparing to launch an offensive to discover all the richness of the seas.”⁴¹⁶ A national policy addressed at “exploiting the oceans” thus was needed, aiming at putting France at the international forefront by interweaving scientific research and its applied uses.

4.3.2. André Giraud and the new oceanographic policy

In January 1966, the COMEXO’s activities were extended for two years in the shape of a transition structure, responsible for continuing the committee’s activities while the Inter-Ministry Council defined the shape of a stable, politically-led, structure through which the new oceanic policy would be implemented. Unlike the previous committee, this one possessed larger financial means, smaller scientific representation, and aimed at different goals.⁴¹⁷

To ensure a proper articulation between fundamental research and the Ministry of Industry, André Giraud was appointed as its vice-president, a strategic move into a domain that had until then been highly scientific. From that position, Giraud could try to direct the COMEXO’s

⁴¹³ About the interest of President Johnson in promoting oceanography see: Doel and Harper, “Prometheus unleashed;” Adler, “Cold War Science on the Seafloor.” A detailed history of oceanography under Johnson’s Presidency can be found in Hamblin, *Oceanographers and the Cold War*.

⁴¹⁴ For a first-hand account of the creation of the Commission, see Merrell, Katsouros, and Bienski “The Stratton Commission” and Wenk, *The Politics of the Ocean*.

⁴¹⁵ DGRST, “Rapport du Groupe ‘Océanographie’ de la Commission de la Recherche Scientifique du 5^{ème} Plan,” March 24, 1965, 3 (MNHN, ARCH PC 46 (7)).

⁴¹⁶ n.a. “Un Milliard de Francs pour l’Océanographie Américain” (ANF, 20060160/1); Giraud, André. Letter to Raymond Toussaint, February 28, 1966 (ANF, 20060160/1).

⁴¹⁷ For the three-year period 1967-1969, the DGRST granted a budget of almost 47 million dollars (230 million francs), almost six times more than the budget devoted for the period 1960-1964 (in: DGRST, “Projet de Loi Portant à l’Organisation de Certains Efforts de Recherche,” May 26, 1966 (ANF, 20060160/1)).

activities towards the new, more politically-driven oceanographic policy.⁴¹⁸ Presided over by marine biologist Maurice Fontaine, the refurbished COMEXO was composed of one representative of each scientific discipline: Jean-Marie Pérès for biology, Henri Lacombe for physical oceanography, and Jean Vigneaux for geology (replacing Jacques Bourcart). The fishing industry was represented by Jean Furnestin, director of the *Institute Technique des Pêches Maritimes*, while hydrographer Jean-Marc Eyrès and Commander Villat mediated with the French Navy. Jacques Cousteau was also present, together with five representatives from the DGRST.

On February 1966, André Giraud sketched the principles of the new oceanographic policy and presented them at the second COMEXO meeting. After an opening speech pervaded by a neocolonial overtone of expansion, occupation, and conquest, Giraud described the measures decided on the 5th Plan to promote oceanography: decisions would be taken at an inter-ministry level, specific research equipment and laboratories would be renovated, and links between “basic” research and the valorization of the oceans would be strengthened. Only research lines aimed at achieving particular economic goals and that could quickly display “visible results” on how the funding was being invested were to be supported.⁴¹⁹ These actions would be coordinated under a centralizing structure (whether it would be a brand-new national oceanographic center or another kind of government structure was still under discussion).

This approach to the near-future research was neither criticized nor contested by researchers sitting at the committee (at least, not on official documents), probably because scientific interests were aligned with industrial ambitions.⁴²⁰ The measures Giraud presented were in principle beneficial for academic researchers and their institutions: increased funding for marine research, some freedom to continue allocating the funds, and the creation of an

⁴¹⁸ Even though previously representatives from the DGRST had participated by virtue of the funding organism, their role in driving discussions and in defining research priorities was minimal.

⁴¹⁹ Marechal, André. Letter to Maurice Fontaine, André Giraud and Jean-Marie Pérès, “À propos du COMEXO II,” January 20, 1966 (ANF, 20060160/1).

⁴²⁰ COMEXO, “Procès-Verbal de la 2^{ème} réunion du COMEXO,” February 21, 1966 (ANF, 20060160/1). After the meeting, Giraud’s proposal was enriched and transcribed in subsequent reports, being eventually approved by the Council of Ministers. I have been able to track how it moved from a hand-written note by Giraud (Giraud, “Pour une politique française d’exploitation des océans,” n.d. (ANF, 20060160/1)), to a typed note (February 22, 1966 (ANF, 20060160/1)), to the second meeting of the COMEXO. Then it was enriched and transcribed in an official document issued by the DGRST (DGRST, “Note sur la création d’un établissement public pour le développement de l’océanographie” (ANF, 20060160/1)), to end up in an official report issued by the Council of Ministers.

institution to bolster France's position in the international competition.⁴²¹ Fundamental research was not (apparently) at risk, since almost any research line could provide knowledge useful for fundamental research as much as to the exploitation of natural resources. In marine geosciences, for instance, better knowledge on sedimentation processes could help identify areas where hydrocarbons, minerals, and other "useful materials" could be gathered. Designing topographic and geological maps of the seafloor was as useful for scientific research as it was for exploiting deposits of minerals and hydrocarbons.⁴²² Moreover, the new policy would contribute to institutionalize exchanges between academic researchers and the offshore oil industry.

Meanwhile, at the corridors of power, discussions lingered on the particular shape the permanent oceanographic structure should take. From minutes and reports by the Inter-Ministry Council and André Giraud's documents, it appears clear that building an oceanographic center was out of discussion. However, it was not so evident that a research center should centralize the power of the national ocean policy coordinating all oceanographic activities in French waters and abroad, ensuring a proper articulation between academic and industrial research, and pursuing to equal American oceanographic capabilities – Giraud, for instance, disagreed with this approach.⁴²³ For those purposes, more suitable was a governmental structure, a sort of program's agency that could efficiently articulate political and economic priorities with scientific research.⁴²⁴

In November 1965, representatives from different ministries met at the DGRST to weigh whether the most suitable strategy was to create an organization inside the Public Administration or to design a National Oceanographic Center (not a *research* center), similar in shape to the *Centre National d'Études Spatiales* (CNES, inaugurated in 1961).⁴²⁵ The first option consisted on a sort of council, presided by a minister or a state secretary, which would

⁴²¹ The new research center was expected to become a key element in organizing European oceanography, to transform it in a counter-balance force between the US and the USSR (DGRST, "Note sur le Projet de Création d'un Centre National d'Études Océanographiques," (ANF, 20060160/1)).

⁴²² Comité Consultatif de la Recherche Scientifique et Technique, *Rapport au Comité Interministériel de la Recherche Scientifique et Technique*, January 29, 1966, 57-59 (ANF, 20060160/1).

⁴²³ Cousteau, *Français, on t'a volé la mer*.

⁴²⁴ DGRST, "Projet d'Exposé des Motifs Instituant un Centre National d'Études Océanographiques," February 20, 1964 (ANF, 19920548/19).

⁴²⁵ More detail on this institutions, and the similarities with the forthcoming CNEXO, in chapter 5. In: DGRST, "Note sur l'Organisation de l'Océanographie," November 29, 1965 (ANF, 19920548/19). Present at the meeting were the Director of the Minister's Cabinet, two representatives from the Commissariat Général au Plan, the Director of Economic Forecast at the Ministry of Finances, two representatives from the *Comité Consultatif de la Recherche Scientifique et Technique*, and four representatives from the DGRST.

attempt to coordinate research among different ministries and institutions. It was soon discarded: coordination would be impossible if ministries were not willing to cooperate. Conversely, the CNES constituted a successful example on coordination conducted under the auspices of the Ministry of Defense, the National Education, and the Prime Minister's Cabinet.⁴²⁶ Decisions pointed to the creation of a national center where experts from different industries were involved at managerial levels to express their needs, with capacity to manage its own budget, and responsible for organize the use of national resources like vessels, submersibles, and researchers.⁴²⁷ However disagreements remained open regarding to the limits of the center's responsibilities (for instance, whether or not it should include military research or oil exploitation), what ministries and priorities should be involved, who would possess decision-making power, or how it would be articulated with the Inter-Ministry Council.⁴²⁸ Giraud had its own position on the matter. He supported the creation of a double mechanism: an oceanographic research center, where fundamental research articulated with applied research, and a Committee that would control the center's activities and would mediate with the Inter-Ministry Council. He pushed at the *Comité Consultatif de la Recherche Scientifique et Technique* (spokesperson to the Inter-Ministry Council) for creating the "Inter-Ministry Committee for the Exploitation of the Oceans," arguing that it would be an essential component to efficiently channel economic priorities and the oceanographic policy towards the center's activities.⁴²⁹

However, Giraud's proposal was rejected, presumably for the complexity and cost of creating such a council *and* an oceanographic center. The final decision came on April 22, 1966, when the Inter-Ministry Council issued an official report announcing the creation of a new institution addressed at coordinating oceanographic research.⁴³⁰ Yet, Giraud would not lose power of influence. As next chapter details, he became the representative of France's oil industry at the

⁴²⁶ DGRST, "Note sur l'organisation de l'océanographie", November 29, 1965 (ANF, 19920548/19).

⁴²⁷ Ibid.

⁴²⁸ Giraud, André. Letter to the President of the *Comité Consultatif de la Recherche Scientifique et Technique*, April 12, 1966 (ANF, 20060160/1); Giraud, André. Letter to Yves la Prairie, September 26, 1966 (ANF, 20060160/1). Giraud criticized la Prairie's ambition to gather all kinds of oceanographic activities under the COMEXO, pointing out his doubt that the institution could "manage the budged devoted to prepare nuclear explosions in the Pacific or oil exploration at sea."

⁴²⁹ Giraud, André. Letter to the President of the *Comité Consultatif de la Recherche Scientifique et Technique*, April 12, 1966 (ANF, 20060160/1).

⁴³⁰ DGRST, "Création d'un Organisme de Coordination de la Recherche Océanographique," June 1966 (ANF, 20060160/1).

Centre National pour l'Exploitation des Océans (CNEXO), the new institution designed to control national ocean exploration and future exploitation.

4.4. A new economic frontier

Early in the 1960s, the instability of France's hydrocarbon suppliers gave rise to a new perception of the oceans among the oil industry. Now regarded as promising areas to secure oil, gas, and minerals supplies, the oceans became an extension of France's colonial territories, where the same kind of activities, strategies, and economic prospects were projected by the same actors and institutions. These were the seeds of an oceanic neocolonialism that would spread in the following years, in which geopolitical interests and the exploitation of offshore resources would drive marine research.

André Giraud led the creation of a network that connected national institutions devoted to oil exploration, addressed at building a powerful and internationally competitive offshore oil industry by investing in developing essential research resources: cutting-edge technologies, a trained pool of experts, and coordinated surveys. Yet, although the oil industry network quickly developed its research capabilities, the need for scientific expertise became evident from their first surveys: counting with academic geologists would reduce the cost and time invested in sketching the geology of vast underwater regions. However, during the first years of offshore oil exploration, leaks between industrial experts and academic geologists were anecdotal. The discovery and study of salt domes in the deep western Mediterranean basin illustrates this point: although academic geologists and oil companies launched parallel surveys aiming at similar goals by using equivalent research methodologies, both communities were completely disconnected. I have suggested that this disconnection was not due to a strong confidentiality inside the oil industry, but rather because institutional pathways through which information could circulate had not yet been created. Proof of it was the new oceanographic policy, detailed in the following chapter: for the next decade, secrecy policies inside the oil industry did not change, what did change was the construction of institutionalized pathways between both domains.

The independence of France's colonial territories was linked to the establishment of a new oceanographic policy through a key actor, André Giraud. From his position as representative of the national oil industry, he pushed in political circles for the reorientation of ocean sciences from fundamental research to the valorization of natural resources. The political context was

favorable to this shift: a political strategy articulating scientific research with industrial production converged with the offshore oil industry's most pressing need; while the international context was especially conducive for investing in exploring the seafloor's economic potential (the US was steadily expanding across the oceans in the quest to control new sources of natural resources).

Thus, the future direction of oceanography was defined by two political and economic needs: an international ambition to keep pace with the US, and a national interest in putting *fundamental* science at the service of the industry. By virtue of the interconnection between the State and the oil industry, the support to marine geological research in a national centralizing institution would reduce costs associated to offshore exploration, while it would set the pool of expertise available at academic laboratories at the service of oil exploration. André Giraud's involvement on issues related to renewing oceanographic policies contributed to define this direction: one that would prioritize the exploitation of natural resources, where the oil industry would have a say in driving the goals of fundamental research. Discretely, between 1963 and 1966, Giraud contributed to weave a network that connected all French organisms involved in the seafloor's exploration: oil companies, the IFP, and academic research centers; a network where the oil industry's secrecy would be much more prone to exchanges and collaborations. As the next chapter shows, the new national oceanographic research center would constitute the materialization of that network, and the birth of academic-industrial collaborations.

Chapter 5. Hybrid research across the continental shelf: the Centre National pour l'Exploitation des Océans

La mer a été de tout temps, et avant tout, un élément de communication et, à travers les communications, un élément de domination. Maintenant la mer est également un élément de subsistance, aussi bien par ses réserves d'eau que par ses possibilités de production animale et végétale ; par la mise en valeur de ce qu'elle contient, et de ce qu'elle recouvre comme le pétrole et les minerais ; et par ce qu'elle recèle comme source d'énergie dans les courants et marées.

Plus que jamais la mer est l'objet de la compétition internationale. L'activité des hommes se tournera de plus en plus vers la recherche de l'exploitation de la mer. Et naturellement les ambitions des États chercheront à dominer la mer pour en contrôler les ressources.⁴³¹

General Charles de Gaulle, 1969

On January 25, 1969, President Charles de Gaulle used these words to underscore the central national importance of the oceans during a speech at the Military School in Quimper. A new perception of the oceans as economic frontiers of limitless natural resources had taken hold, while military interests were relegated to a secondary role: most relevant now was to dominate the oceans “to control its natural resources.” This domination required – and would be achieved by means of – the development of scientific knowledge.

France's oceanographic policy entailed that the exploration phase (acquiring geological, biological, and physical knowledge about the oceans while developing research technologies and a human force) preceded the commercial and industrial exploitation of natural resources.⁴³²

⁴³¹ “The sea has always been, above all, an element for communication and, through communications, an element for domination. Now the sea is also an element for survival, for its water supply as for its vast possibilities of animal and plant production; for the exploitation of what it contains and is covered by, like hydrocarbons and minerals; and for which it hides, as energy embedded in its currents and tides. More than ever the sea is at the core of international competition. Men's activities will increasingly turn towards the exploration and exploitation of the seas. Therefore states' ambitions will seek to dominate the seas to control its resources.” Quotation of General de Gaulle during a speech at the École Militaire in Quimper (January 1969). Although I could not find the original transcript of Charles de Gaulle's speech, it appears transcribed with the same words in: La Prairie, *Ce siècle avait de Gaulle*, 365; Hoffert, *Les nodules polymétalliques*, 135.

⁴³² This mindset can be related to a linear model (as I have pointed out in p.83), where fundamental research precedes its applications. Historians and political scientists have utilized the concept of “linear model” to account for the post-World War style of research that spread across Western countries. However, as historian David

This mindset, where science fell under the state's interests, crystallized in 1967 in the *Centre National pour l'Exploitation des Océans* (CNEXO): a public institution responsible for managing oceanographic programs, resources, and politics at a national level. Its main goal was to increase the efficiency of offshore exploration by articulating fundamental research with all kinds of marine industries. The CNEXO was instrumental in dissolving the limits that separated academic geologists from oil industry experts, and actively promoted their collaboration. It carefully waded a cooperative network between extractive industries – already brought together under the CEPM – and academic research teams, where trade secrecy faded as technologies, data, and experts flowed from one domain to the other. Through this network the CNEXO aimed at developing oceanographic programs pursuing a double agenda: enhance geological knowledge on the ocean crust's dynamics, while providing valuable information about hydrocarbon exploration.

But why was the maintenance of industrial secrecy not the CNEXO's priority? I suggest that it was due to a cost-efficiency balance. Maintaining strong secrecy policies in cooperative programs would have increased their cost and would have probably dissuaded collaboration among academic geologists.⁴³³ Conversely, the CNEXO was focused on controlling the flows of information: it orchestrated the pooling of research resources, sponsored joint oceanographic surveys (or 'hybrid surveys'), and designed spaces of exchange and mutual understanding; all of them, activities in which the CNEXO had a leading or managerial role. As a result, the oil industry contributed with budget, technologies, and experts to the development of geological knowledge on the North Atlantic tectonic dynamics, a scientific field of burgeoning international interest.

5.1. A new national center to exploit the oceans: the Centre National pour l'Exploitation des Océans (CNEXO)

5.1.1. From military research to resource exploration

On April 22, 1966, France's Inter-ministry Council approved the creation of a national center that was to become the cornerstone of a new oceanographic policy: the *Centre National pour*

Edgerton has argued, the concept misleads the kind of research that was being supported by national governments. Part of the budget was devoted to universities, whose results would then be applied to R&D; yet the bulk of public budget did not go to that kind of research. See: Edgerton, "'The Linear Model' Did Not Exist."

⁴³³ As Oreskes, *Science on a Mission* points out.

l'Exploitation des Océans, or CNEXO. The CNEXO was not a scientific research center, but a political-laden institution devoted to implement a national oceanographic policy, supervise its development, drive marine sciences towards industrial-oriented goals, and ensure a proper international representation.

To fully grasp how priorities about ocean exploration had changed in less than a decade and how they were reflected in the CNEXO, it is necessary to go back to 1962, when the French Navy started parallel negotiations with the DGRST to establish a research center on ocean sciences.⁴³⁴ Soon after the COMEXO was inaugurated, delegates at the DGRST began to plan, in close relation with naval representatives Georges Cabanier (Chief of the Navy Staff), Jean Philippon (Navy's General Secretary), and André Gougenheim (director of the Hydrographic Service), a permanent structure for the coordination of marine research. Built on an association between the Hydrographic Service and academic research centers, this institute would organize systematic research surveys on the high seas, create bridges between the French Navy and oceanographers, and play a diplomatic role in "European oceanography," as it was called.⁴³⁵ Its nature was well-captured by its tentative name, the *Institute National des Sciences de la Mer* – where the term "marine sciences" was chosen for its widespread use in international congresses and for embracing all scientific disciplines.⁴³⁶ Only non-military scientists would be employed, and only fundamental research with no direct military applications would be supported. Yet, naval experts would use the outcomes – hydrographic, geological, and biological data – to increase their knowledge about the marine environment.⁴³⁷ As first envisioned, the research center would also aim at easing secrecy about the Navy's marine activities since, as Admiral Philippon argued, military secrecy should not be an obstacle for the development of marine research. He was keen to organize cooperative projects and to promote the exchange of information between the Hydrographic Service and academic researchers.⁴³⁸

However, as the oceans loomed as new spaces for the exploitation of natural resources and France's economic interests tilted towards the seas, the nature of the envisioned center changed:

⁴³⁴ Described in chapter 3, p.80.

⁴³⁵ DGRST, "Note sur le projet de création d'un Centre National d'Etudes Océanographiques," October 5, 1964 (ANF, 19920548/19).

⁴³⁶ Pacque, Roger. "Note à l'attention de Monsieur le Délégué Général: Action concerté en océanographie," November 21, 1962 (SHD, 9JJ 584); Gougenheim, "Fiche: quelques remarques au sujet du projet d'Institut national des Sciences de la Mer," December 6, 1962 (SHD, 9JJ 0584).

⁴³⁷ DGRST, "Groupe de travail mixte DGRST – Armées," November 28, 1963 (ANF, 19920548/19).

⁴³⁸ The issue of military secrecy appears discussed in: DGRST, Océanographie, "Compte rendu de la réunion du 29 juin 1963," September 27, 1963 (SHD, 9JJ 0584).

the institution geared towards fundamental research in cooperation with the Navy gave way to a research center devoted to the implementation of the “exploitation of the oceans” policy. First hints of this shift appeared in a report the DGRST commissioned to André Giraud in January 1964, where he drafted the motivations, goals, and structure of a tentative future oceanographic center. The document, transmitted to all the ministries involved in marine exploration, irritated naval experts. Admiral Cabanier complained that the planned center did not take the needs of the Navy into account anymore: the integration of the Hydrographic Service was not even mentioned and the number of naval experts in the directive board had been reduced to the benefit of representatives from fishing institutions, now more numerous.⁴³⁹ Some months later, when the 5th Plan of Economic Development was published, the new orientation became crystal-clear: the seas were described as centers of economic interest. France’s hydrocarbon policy was “resolutely oriented towards the search for marine deposits,” while the exploitation of fisheries was called to intensify. New sources of energy and minerals appeared as promising supplies, while economic problems related to marine pollution and coastal infrastructures needed to be solved.⁴⁴⁰

When, in April 1966, the Inter-Ministry Council approved the CNEXO’s creation for “the vast possibilities of economic development” the oceans offered, the Navy stepped back from the project.⁴⁴¹ Not only the institution was not a research center, but also the Navy’s representation had notably weakened at the expense of experts in fisheries, representatives from the Ministry of Finances, and from private offshore technological companies. Cabanier, on behalf of the Navy, agreed on organizing ad-hoc collaborations with the new institution, but the bulk of military oceanographic activities would remain at the Hydrographic Service.⁴⁴²

Displacing a military orientation in favor of economic priorities reflected the gain in momentum the perception of the oceans as unlimited sources of natural resources underwent in political circles. Military and industrial agendas were not opposed, and certainly were complementary – especially in a public center driven by national, inter-ministerial interests, where secrecy would not be an obstacle. However, in a peacetime period when the seafloor was emerging as a portion

⁴³⁹ From 13 representatives, the Navy had initially 2 seats; while in Giraud’s proposal they only had one. Cabanier, Georges. Letter to Jean Philippon (sous-chef d’Etat major de la Marine), May 13, 1964 (AHD, 9JJ 584).

⁴⁴⁰ DGRST, “Rapport du groupe océanographie de la commission de la recherche scientifique du 5^{ème} plan,” April 1, 1965 (ANF, 19920548/19).

⁴⁴¹ Comité Consultatif de la Recherche Scientifique et Technique, “Rapport au Comité Interministériel de la Recherche Scientifique et Technique”, March 29, 1966 (ANF, 19920548/19).

⁴⁴² As can be seen in: Grousson, Roger (Director of the Service Hydrographique de la Marine). Letter to Yves la Prairie, November 25, 1967 (SHD, MV 9JJ 585).

of the national territory, economic motivations were stronger than enhancing military surveillance at sea. Control over submerged territories was no longer to be achieved by deploying military fleets. A nation's power in the oceans would be measured by its technoscientific capabilities to reach hitherto unattainable regions, to identify new sources of natural resources, and to exploit them efficiently. The CNEXO was born from that commitment.

5.1.2. Mechanisms to drive marine research: official status, structure, and public dissemination

After the CNEXO's creation, the ocean sciences came to stand close to nuclear and space research – the technoscientific fields driving international relations in the Cold War. The nature, goals, and structure of the oceanographic center drew inspiration from the *Commissariat à l'Énergie Atomique* (CEA), established in 1945, and the *Centre National d'Études Spatiales* (CNES), inaugurated in 1961.⁴⁴³ Like them, the CNEXO hold the legal status of an industrial and commercial establishment under the Prime Minister's administration, which granted CNEXO managers an absolute autonomy in managing its budget while freeing them from dependence on other ministries. The center's features were characteristic of big science settings, which were growing in popularity as international displays of the nation's technoscientific power (although in this case, by investing in applied rather than in fundamental research).⁴⁴⁴ At the CNEXO, research was oriented towards the fulfilment of economic motivations through its politically-laden structure, where selected representatives from public institutions and private companies occupied decision-making positions. They would define a research agenda geared towards applied research, at the same time as they crafted a media-dissemination strategy to obtain the population's support to their activities.

Jean Cahen-Salvador, State Councilor and former head of the French Aerospace Industries Association, became the first president of the CNEXO's Administrative Council. Under his presidency, a group of twelve experts articulated political priorities to the CNEXO's research

⁴⁴³ Indeed, official documents frequently compared ocean research with space exploration: studying the oceans implied exploring vast spaces, of international nature, by using the most advanced technological means. Oceans were considered to have less political interest than the outer space; yet, their economic value was recognized to be higher (fishing, mining, hydrocarbon exploitation, energy...). DGRST, "Note sur le projet de création d'un Centre National d'Études Océanographiques," October 5, 1964 (ANF, 19920548/19). However it is important to note that they were similar in their internal structure and administrative nature, but not in goals, since the CEA was much more oriented towards military research. About France's nuclear policy and the CEA's creation and evolution, see: Hecht, *The Radiance of France*; Belot, *L'Atome et La France*.

⁴⁴⁴ Weinberg, "Impact of Large-Scale Science on the United States;" Hughes, *The Manhattan Project*.

agenda by voicing the needs and wills of public ministries and organizations (the DGRST, Army, Foreign Relations, Finances, CNRS and Higher Education, Fisheries, Transportation, and Industry) and private companies (the *Compagnie Générale d'Electricité*, *Société AIR LIQUIDE*, *Compagnie PECHINEY-SAINT-GOBAIN*). André Giraud, participating as head of the Fuels Direction, ensured the articulation between the French oil industry (the CEPM network) and the CNEXO's activities.

Oceanographers were relegated to the role of technical advisors at the Scientific and Technical Committee. Most of its members had been part of the former COMEXO: marine biologist Jean Furnestin, hydrographer Jean-Marc Eyrès, physical oceanographer Henri Lacombe, marine biologist Jean-Marie Pérès, geologist Michel Vigneaux, and – new onboard – the IFP engineer Pierre Willm, responsible for developing exploration technologies at the IFP's Marine Project (chapter 4). Unlike in the previous committee, the decision-making capacity of this group was demoted under the CNEXO's General Director, who would play a mediating role between oceanographers and policy-makers at the Administrative Council.

The CNEXO's roots in the CEA model were particularly evident in the hand-picked selection of its General Director. On May 1966, the Minister of Scientific Research Alain Peyrefitte committed to the CEA's technical advisor Yves la Prairie to the task of drafting the bylaws of the CNEXO and, some months later, appointed him General Director.⁴⁴⁵ Trained as a naval officer in Toulon, Yves la Prairie (1924-2015) had developed the first half of his career in the French Navy, sailing across North Africa and the Middle-East. During that period his nationalist, pro-Gaullist ideology reinforced. He wished to see France's prestige restored and was concerned about the consequences of the nation's loss of control over colonial territories.⁴⁴⁶ In 1954, la Prairie set his military career aside to settle with his family in Paris and – thanks to his military contacts – obtained a position at the CEA as secretary of Jacques Yvon, director of the department of atomic piles. In the following years, he rose to technical counselor to Gaston Palewski, Minister of Scientific Research and Atomic and Space Affairs.⁴⁴⁷ By occupying these positions, la Prairie learned how decision-making was implemented at the highest political levels.⁴⁴⁸ He developed first-hand knowledge about the workings of big science institutions;

⁴⁴⁵ Peyrefitte, Alain. Letter to Bernard Pache (Minister of Industry), July 11, 1966 (ANF, 20060160/1). La Prairie's first duties included defining the new center's priorities, contacting with suitable representatives from each Ministry, and establishing contact with public research centers to assess the needs of academic marine research.

⁴⁴⁶ La Prairie, *Ce siècle avait de Gaulle*.

⁴⁴⁷ In that position until 1965.

⁴⁴⁸ La Prairie, *Ce Siècle Avait de Gaulle*, 326.

became skilled in interacting with high-officers, scientists, and policy-makers; and was familiar with the political apparatus through which scientific policies materialized in scientific projects.⁴⁴⁹ For Minister Alain Peyrefitte, la Prairie's ideology was as important as his skills. La Prairie considered himself a sincere Gaullist, something well-known among his fellows at the Ministries (fig.17).⁴⁵⁰ That loyalty was fundamental during the Cold War's most tense period, when in some cases Western governments had distrusted or even dismissed the heads of research centers for being close to communism.⁴⁵¹ In France, the paradigmatic case was Frédéric Joliot-Curie's. After forging a brilliant scientific career, obtaining a Nobel Prize in chemistry (1935) and being the CNRS Director (1944-1946), Joliot-Curie became in 1945 the first High Commissioner of the CEA, which he had contributed to establish. However, due to his allegedly sympathy to the French Communist Party, he was dismissed five years later.⁴⁵²

La Prairie's background fitted with Peyrefitte's expectations for who would fill the position of the CNEXO's General Director: "not an admiral, nor a Naval engineer, but someone younger and external to the Military ... Neither university scientists, given the CNEXO's orientation towards applied and economic goals ... Nor experts from the private industry, at least at the beginning".⁴⁵³ La Prairie's complete lack of oceanographic training was irrelevant: a committee of experts would stand at his side, providing him the scientific and technical advice he would need.⁴⁵⁴ More important was his civil service background, mixed enough to mediate in political, military, scientific, and international grounds. In the eyes of skeptics, he was no more a military officer, neither an expert from the oil industry. He was a policy-maker, someone that would be capable of channeling the ideas and priorities from the ministries, putting state interests ahead of scientific ones.

⁴⁴⁹ Historian Jacob Hamblin has discussed one more reason to justify why an expert outside the discipline could be selected to drive oceanography. At the US, the harsh rivalry between oceanographic institutions forced the National Academy of Sciences to choose a geochemist, Harrison Brown, to implement a national oceanographic program, rather than one of the directors of the main institutions (in: Hamblin, *Oceanographers and the Cold War*, 141-143).

⁴⁵⁰ His admiration for the General was such that he entitled his memoirs *This Century had de Gaulle*, where he narrates his career in parallel to that of the General. In it, he details his relationships with policy-makers related to the Gaullist government.

⁴⁵¹ Some of these cases have been presented in Wang, "Science, Security and the Cold War"; Oreskes and Rainger, "Science and Security Before the Atomic Bomb."

⁴⁵² Hecht, *The Radiance of France*, 55-60.

⁴⁵³ This event is also described by la Prairie in his Memoirs. Peyrefitte crossed off the name of Giraud, while Jacques Cousteau, also candidate for the position, rejected the proposal by claiming that he'd rather be a "free wolf" than a "pet dog serving the state" (in la Prairie, *Ce siècle avait de Gaulle*, 349).

⁴⁵⁴ About the role of scientists as political advisors, see: Mukerji, *A Fragile Power: Scientists and the State*.



Figure 17. Yves la Prairie (left) discussing with General Charles de Gaulle, circa 1965 (la Prairie, *Ce siècle avait de Gaulle*).

In April 1967, the CNEXO became operational as an administrative institution. In the absence of a building for its own, the center temporarily established its headquarters at the CEA, in Paris.⁴⁵⁵ La Prairie recruited a team of experts, hand-picked to guarantee their loyalty, from among his fellows in the CEA and the military.⁴⁵⁶ Marine technologies under COMEXO's control were transferred to the CNEXO's authority: Three oceanographic vessels (the *Jean Charcot* among those) and three more under construction; diving technologies (the submersible *SP-3000*, the deep-sea submersible *Argyronète*, and the bathyscaph *Archimède*), the fixed

⁴⁵⁵ La Prairie requested the CEA its help for launching the CNEXO, and they offered some of their offices (in: la Prairie, Yves. Letter to the General Administrator of the CEA, December 29, 1967 (ANF, 20160129/327).

⁴⁵⁶ La Prairie first hired his close colleague at the Navy, Jacques Perrot, and appointed him his right-hand. Later he recruited some more experts from the Military: Navy's Captain Philippe Villat, employed at the DGRST, and Frigate Captain Alain Sciard, both dear friends from their youth (la Prairie, Yves. Letter to Alain Sciard, June 29, 1967 (ANF, 20160129/328)). The first would be responsible of underwater technologies; while the second would manage international relations. Also engineer at the Army Daniel Coulmy was appointed responsible for coordinating industrial activities (la Prairie, Yves. Letter to Mr. General de l'Armée Aérienne, July 18, 1967 (ANF, 20160129/328)). By December 1967, the CNEXO was composed by nine former experts from the CEA, three from the DGRST, and four from private industries (la Prairie, Yves. Letter to Mr. Grandin (Sérvice Médicale CEA), December 11, 1967 (ANF, 20160129/328)).

offshore platform for scientific research *BOHRA I*, and the research contracts previously granted to scientific laboratories by the COMEXO.⁴⁵⁷

Yves la Prairie, together with his right-hand and former colleague from the Résistance Jacques Perrot, sketched guidelines for the CNEXO's research agenda and presented them during the first meeting of the Administrative Council, in July 1967. The institution would only support research geared toward exploring and exploiting natural resources, through a strategic allocation of funds to research teams whose investigations aligned with the CNEXO's goals.⁴⁵⁸ Unlike the former COMEXO, which distributed its budget among scientific disciplines, the CNEXO's research agenda was innovative insofar as it was divided into five interdisciplinary topics, each one addressing a common problem: exploitation of living resources, exploitation of mineral and fossil resources (which included the seafloor's exploration), coastline management, control of pollution (oil spills, urban discharges, etc.), and the ocean's interaction with meteorology and climate conditions.⁴⁵⁹

Support to fundamental research was deemed unproductive as it was, in the words of Perrot, "an ancient conception of research that did not consider broader interests."⁴⁶⁰ The Administrative Council dismissed the idea of funding fundamental research since its place was believed to be at universities, where researchers could keep on pursuing the investigations they wanted with the economic support offered by the CNRS. This stand arose immediate criticism from oceanographers at the Scientific and Technical Council like Henri Lacombe, Jean-Marie Pérès, and Maurice Fontaine, who were concerned about the damaging consequences of this policy on the production of scientific knowledge and freedom of research.⁴⁶¹ To avoid growing frictions with his advisory committee, la Prairie let them integrate their research lines in those guiding topics, as far as their results were productive with respect to the "applied" problems

⁴⁵⁷ A detailed history of French submersibles can be found in Jarry, *L'aventure des bathyscaphes*.

⁴⁵⁸ Conseil d'Administration CNEXO, "Procès-verbal de la 1^{ère} réunion," July 20, 1967 (ANF, 19980125/01).

⁴⁵⁹ Conseil d'Administration CNEXO, "Procès-verbal de la 2^{ème} réunion," October 5, 1967 (ANF, 19980125/01). This structure of scientific research, based on approaching common problems from different scientific disciplines, was not new. The idea came from the US, where research in Earth Sciences was being developed in that shape (see for instance: Doel, "Constituting the Postwar Earth Sciences").

⁴⁶⁰ n.a. "Interview to Jacques Perrot," June 13, 1968 (SHD, 9JJ 584).

⁴⁶¹ Conseil Administration CNEXO, "Procès-verbal de la 5^{ème} réunion," December 18, 1967 (ANF, 19980125/01); Conseil Administration CNEXO "Procès-verbal de la 6^{ème} réunion," January 29, 1968 (ANF, 19980125/01).

selected. Now, their freedom of research under the CNEXO's auspices was subordinated to the general program.⁴⁶²

The launch of the CNEXO created tensions within the CNRS, mainly among physical oceanographers and marine biologists who feared losing economic support and seeing their access to research vessels and campaigns restricted. Oceanographer Lucien Laubier, who later on directed the CNEXO's research institute the *Centre Océanologique de Brest* (inaugurated in 1971), described in an historical account why these tensions emerged and how they evolved.⁴⁶³ According to him, after the CNEXO's inauguration only the research contracts signed with the institutions who had representatives at the CNEXO's Scientific and Technical Committee survived. The management of the oceanographic fleet was in the hands of CNEXO officers, and initially decision-making on the campaigns' schedule was not transparent – mainly benefiting research programs aligned with the CNEXO's plan.⁴⁶⁴ Tensions strengthened in 1971, when the CNRS created a Committee on Oceanography whose responsibilities overlapped with the CNEXO's ambitions (managing oceanographic training plans and research resources, for instance) and its goals were completely opposed, since the CNRS committee was addressed at promoting fundamental research.⁴⁶⁵ Frictions persisted throughout the seventies, until in 1979 the CNEXO convened renowned experts from universities and the CNRS to draft a research plan for the period 1980-1983. Then, according to Laubier, both communities began to come nearer to one another. From Laubier's narration, it transpires that tensions happened at managerial levels and revolved around the question of who had the power to control France's ocean sciences. At the level of researchers, during interviews I have found different stances towards the CNEXO. Some experts from university laboratories acknowledged having a close and friendly relation with CNEXO geoscientists, and collaborating with them was seen as an opportunity to embark in large-scale scientific campaigns.⁴⁶⁶ Others criticized the almost-imperialistic approach of Yves la Prairie, who aimed at controlling national research and elevate its international position – at the cost, perhaps, of the quality of scientific production.⁴⁶⁷ On the

⁴⁶²Conseil Administration CNEXO, "Procès-verbal de la 5ème réunion," December 18, 1967 (ANF, 19980125/01).

⁴⁶³ More details about the creation of the *Centre Océanologique de Brest* in chapter 6, p. 188.

⁴⁶⁴ Laubier, "L'émergence de l'océanographie au Cnrs."

⁴⁶⁵ Ibid.

⁴⁶⁶ For instance in Martínez-Rius, "Interview to A. Mauffret."

⁴⁶⁷ Martínez-Rius, "Interview to G. Boillot." Boillot, marine geologist at the University of Rennes, pointed out during our interview that the CNEXO's approach of gathering large amounts of data from different areas, in short periods of time, jeopardized the subsequent analysis of results. According to him, many relevant information was

other hand, many just-graduated geologists saw in the CNEXO an opportunity to engage in a successful career in marine geosciences, and eagerly enrolled in the institution.⁴⁶⁸

Moving back to the CNEXO's setting, to justify its industrial and politically-oriented goals in the oceans, the policies implemented needed to obtain the population's support. This point was especially relevant at a moment when, coming from the United States, an environmental consciousness was spreading among the general public and the first oil spills had devastated marine regions, stirring deep concerns among coastal populations.⁴⁶⁹ To influence public opinion, experts at the Administrative Council agreed from their first meeting on implementing a dissemination strategy that would, according to André Giraud, "create the spirit 'exploitation of the oceans' from government spheres to the wider public."⁴⁷⁰ La Prairie began then to move threads to draw public attention towards the CNEXO and its goals: just after its inauguration, the newspaper *Le Monde* announced that the CNEXO constituted a "renewal of French oceanography," while *Le Figaro* appraised that, after the CNEXO's establishment, "there won't be shortage of work for French oceanographers," and *Les Échos* pointed out that the institution would pursue "realist goals in collaboration with the industry."⁴⁷¹ In February 1968, *Le Monde Diplomatique* printed a special dossier entitled "The richness of the 21st century would be grabbed from the seas' depths," whose edition had been coordinated by la Prairie. He had selected the experts and the topics they wrote about: mining exploration at sea, offshore oil, the CNEXO's logistical and technological means, the state-of-the-art of marine research in France and, written by la Prairie himself, a plea for ocean exploitation as a "national need" for France.⁴⁷²

overlooked or treated superficially because CNEXO experts did not devote enough time to post-cruise analysis. This, as he ventured, could have delayed the production of scientific knowledge.

⁴⁶⁸ According to some interviewees, almost the entire generation of PhD candidates at the University of Paris who graduated in marine geology or geophysics between 1967 and the early 1970s, was recruited (Martínez-Rius, "Interview to J. Mascle;" Martínez-Rius, "Interview to G. Boillot").

⁴⁶⁹ Especially the *Torrey Canyon* oil spill, on March 1967 – weeks before the CNEXO's inauguration.

⁴⁷⁰ Conseil d'Administration CNEXO, "Procès-verbal de la 1^{ère} réunion," July 20, 1967 (ANF, 19980125/01).

⁴⁷¹ Rebeyrol, "Le CNEXO: vers un renouveau de l'océanographie française;" CNEXO, "Synthèse des principales activités océanologiques, du 1 juin au 1 octobre 1968" (ANF, 19980125/01).

⁴⁷² *Le Monde Diplomatique*, "Dossier: Les richesses du XXI^e siècle sont à prendre au fond des mers;" la Prairie, Yves. Letter to Pierre Willm, January 15, 1968 (ANF, 2016129/327) and la Prairie, Yves. Letter to Maurice Fontaine, January 15, 1968 (ANF, 2016129/327).

5.2. Exploring natural resources in foreign and international seaways

5.2.1. The pillars of hybrid surveys: the Law of the Sea's framework and the emergent theory of plate tectonics

The 1958 Convention on the Continental Shelf, approved during Geneva's UNCLOS I and enacted in 1965, stimulated the definition of a strategy to assess the seafloor's economic potential by coastal governments and oil companies. This new legal framework not only defined the boundaries of the submerged national territory (200 meters depth *or* as far as exploitation technologies could operate), but it also regulated hydrocarbon and mineral exploration in foreign continental shelves. Public and private companies aiming at industrial goals needed to obtain an exploration lease from the coastal government, who would define the conditions under which the company could operate (as it normally happened for mainland hydrocarbon exploration).⁴⁷³ Conversely, regulation on scientific research was more flexible: although it was necessary to ask permission to the coastal government before undertaking a campaign, the Convention on the Continental Shelf stipulated that the coastal state "shall not normally withhold its consent if the request is submitted by a qualified institution with a view to purely scientific research into the physical or biological characteristics of the continental shelf."⁴⁷⁴

Under these circumstances, the CNEXO became a key asset for France's oil industry in its eagerness to explore foreign seaways. Promoting scientific campaigns to undertake oil reconnaissance surveys around the world would reduce costs, time, and bureaucratic procedures related to the obtention of exploration leases. Although not openly admitted, marine geophysical campaigns under the CNEXO's sponsorship became the tip of the spear for French oil companies, which benefited from the data acquired to identify promising oil-harboring regions. This was achieved through a carefully waded network that connected the oil industry with academic institutions, which resulted in hybrid campaigns: marine surveys of a blurred academic-industrial nature, where research resources from both communities (experts, vessels, money, and technologies) were mobilized and pooled together. Their goals were allegedly

⁴⁷³ International Law Commission, *Convention on the Continental Shelf*. In France, conditions drafted in: CNEXO, "Projet de loi et projet de décret relatifs à l'exploration et l'exploitation du plateau continental," June 17, 1968 (20060160/1).

⁴⁷⁴ International Law Commission, *Convention on the Continental Shelf*, article 5.8.

scientific, and their outcomes were published in scientific journals; yet, oil companies utilized that same data to assess the region's oil potential.

Yves la Prairie and André Giraud began to build this oil-academic network from the CNEXO's inauguration, in April 1967. From his seat at the Administrative Council, Giraud transmitted to la Prairie the needs of the French oil industry, suggested desirable guidelines in marine geosciences, and discussed how to formalize industry-academia relationships.⁴⁷⁵ To organize joint surveys by cutting down investments, Giraud offered the research means available at the oil industry: research technologies as the *Flexotir* and the coring system *électro-carottier*, the research vessel *Petit Marie Françoise*, and the drilling vessel *Térebel*.⁴⁷⁶ This would save the CNEXO time and money in designing, building, or acquiring new devices; while it would enable academic researchers to work with industrial-quality data. For his side, la Prairie set the oceanographic vessel *Jean Charcot* at the service of hybrid campaigns, as the CNEXO was now its operator.

In April 1968, the CNEXO orchestrated its first industrial-academic campaign, GUINÉE I, across the coastlines of Ivory Coast and Guinea. The mission appeared announced in the newspaper *Le Monde* under the headline “A research-industrial attempt of cooperation: the next campaign of the *Jean Charcot*” – an article clearly stemming from the CNEXO's media dissemination strategy.⁴⁷⁷ Initially conceived by marine biologists at the *Office de Recherche Scientifique et Technique d'Outre-Mer* (ORSTOM), the *Jean Charcot*'s campaign across the Gulf of Guinea was in principle addressed at identifying fisheries of yellow fin tuna. However, as the region arose the interest of oil firms, the goals of the mission changed. In February 1968 the IFP and the oil company ERAP requested the CNEXO, on its quality as mediating institution, to embark their geologists and oil engineers to study the geological structure of the region.⁴⁷⁸ In exchange, the CEPM provided 611,000 US dollars and the cutting-edge

⁴⁷⁵ La Prairie, Yves. Letter to André Giraud, May 22, 1968 (ANF, 20160129/327). Giraud also aimed at transferring some of the coordination from the CEPM to the CNEXO, especially the projects related with “penetration of men underwater,” “seawater corrosion,” and “action of natural elements on materials” (la Prairie, Yves. Letter to André Giraud, March 21, 1968 (ANF, 20160129/327).

⁴⁷⁶ Giraud, André. Letter to Yves la Prairie, January 15, 1969 (ANF, 20060160/1).

⁴⁷⁷ Rebeyrol, “Un essai de coopération recherche-industrie.” The author of this article had probably been appointed responsible of media communication of ocean exploration in *Le Monde* as, from 1966, she signed almost all papers related to national advancements in ocean research, international cooperation, and about oil in the depths.

⁴⁷⁸ La Prairie, “Fiche - campagne du navire océanographique « Jean Charcot » dans le Golfe de Guinée en 1968,” May 22, 1968 (ANF, 20160129/327).

positioning system TORAN 3G, which would benefit everyone onboard.⁴⁷⁹ To undertake seismic surveys, the IFP installed the *Flexotir* onboard the *Jean Charcot*, accompanied by two IFP technicians that would make the instrument work. This action was clad with symbolism: it implied equipping the only large oceanographic vessel in France, designed to conduct scientific missions, with a device built for offshore oil prospection.⁴⁸⁰

On May 20, 1968, at the port of Abidjan, the team of geoscientists embarked onboard the *Jean Charcot*: Philippe Patriat and Roland Schlich, geophysicists at the *Institut de Physique du Globe*, the IFP geologists Lucien Montadert and Jean-Pierre Fail, and oil geologists from the Exploration Department of ELF-ERAP Jean Raymond Delteil and Pierre Valéry.⁴⁸¹ Through marine geophysics, the team studied fracture zones and regions with thick accumulation of sediments across the Gulf of Guinea, from the continental shelf to the abyssal plain.⁴⁸² Scientific and industrial interests converged: results would help to identify sedimentary regions suitable to hydrocarbon accumulations while it would foster the study of transform faults, introducing France into the blooming research field of seafloor spreading.⁴⁸³

The concept of transform faults had been recently coined by Canadian geologist J. Tuzo Wilson to account for the apparently abrupt disruption of seismic activity across mid-ocean ridges, something that had struck him when exploring island arcs in the Pacific Ocean.⁴⁸⁴ According to him, the Earth's surface was divided into rigid plates separated by a belt of weak spots that took the shape of mid-ocean ridges, chains of mountains, or major faults with large horizontal movements. Transform faults constituted the junction that connected one feature with another, where plates slipped in opposite directions.⁴⁸⁵ This concept was key in strengthening the

⁴⁷⁹ Rebeyrol, "Un Essai de Coopération Recherche-Industrie." According to the CNEXO's annual report, the campaign costed 2,581,972 Francs, but it does not specify how much from this amount was contributed to by each institution.

⁴⁸⁰ First negotiations on installing the *Flexotir* onboard the *Jean Charcot* are found in a letter from la Prairie to Pierre Willm (February 7, 1968 (ANF, 20160129/327). It seems like Giraud was who first suggested it, from the way in which la Prairie answered him in a letter (la Prairie, Yves. Letter to André Giraud, June 22, 1968 (ANF, 20160129/327).

⁴⁸¹ Fail et al. "Prolongation des zones de fractures de l'Océan Atlantique dans le Golfe de Guinée."

⁴⁸² For detail on this and later campaigns see: Schlich, "BENIN 1971 cruise, RV Jean Charcot." It is likely that the CNEXO focused on that region after the American campaign onboard the *Discovery* collected large amounts of data from there, supported by the US Geodetic Survey (Vanney, "Les campagnes du Discovery au large de l'Afrique tropical").

⁴⁸³ Although the team did not mention the term "plate tectonics," as the theory had just been proposed (Fail et al., "Prolongation des zones de fractures de l'océan Atlantique dans le Golfe de Guinée").

⁴⁸⁴ As seen in pp. 46 and 89, mid-ocean ridges had been identified by the late 1950s. Wilson, "A New Class of Faults and Their Bearing on Continental Drift;" Oreskes and LeGrand, *Plate Tectonics*.

⁴⁸⁵ Wilson, "A New Class of Faults and Their Bearing on Continental Drift."

hypothesis of seafloor spreading, put forward by American oceanographers Harry H. Hess and Bob Dietz in 1962, since transform faults could only exist if there was crustal displacement.⁴⁸⁶ In 1967, American seismologist Lynn Sykes, from the Lamont Geological Observatory, demonstrated the consistency of Wilson's hypothesis by studying seismological data gathered in mid-ocean ridges around the world.⁴⁸⁷ All these evidences removed doubts that the oceans were splitting apart. In the following year, plate tectonics theory emerged as a synthetic, quantitative integration of different evidences and theories coming from American and British institutions. Working independently, geologists Daniel P. McKenzie and Robert L. Parker at Scripps Institution of Oceanography, and Jason Morgan at Princeton University, established the model of plate tectonics; while French geophysicist Xavier le Pichon, working at Lamont, depicted this data in a world map and calculated their movement based on paleomagnetic information.⁴⁸⁸ Plate tectonics, the unifying theory of earth sciences, had just born.⁴⁸⁹

The French community of geoscientists was slow in learning and embracing plate tectonics, which only happened after the theory was widely spread through scientific publications, international congresses, and exchanges of experts.⁴⁹⁰ For that reason the scientific goals of GUINÉE are so remarkable: it is one of the first evidences of French geoscientists aiming at contributing to contemporary scientific debates, which could only be achieved by acquiring ground-breaking data from the deep seafloor with the *Flexotir*.

At return from the mission, data acquired across the Guinean Gulf was distributed: Montadert and Fail, at the IFP, processed the *Flexotir* seismic profiles; while at the Parisian *Institut de Physique du Globe* physicists worked with magnetic data. Both teams shared their results, discussed possible interpretations, and reached consensual conclusions.⁴⁹¹ Because the geophysical data had been acquired during a scientific campaign, oil companies involved in the mission (Elf-Re, CFP, and SNPA) agreed on disclosing it in scientific publications: in 1970, results of GUINÉE I were published in the international journal *Earth and Planetary Science*, together with hitherto unpublished geological data from the African continental margin

⁴⁸⁶ As noted in chapter 3 p.98, seafloor spreading implied that that new crust is formed by magmatic intrusions along the crests of mid-ocean ridges, and then drifts steadily away from those crests.

⁴⁸⁷ He relied on data acquired by the World-Wide Standardized Seismograph Network of the US Coast and Geodetic Survey, installed with military purposes. Sykes, "Mechanism of Earthquakes."

⁴⁸⁸ Le Pichon, "Sea-Floor Spreading and Continental Drift."

⁴⁸⁹ Oreskes and LeGrand, *Plate Tectonics*; Le Pichon, "Fifty Years of Plate Tectonics."

⁴⁹⁰ About the acceptance of continental drift and plate tectonics in France's geological community, see: Gaudant, "Enquête Sur La Dérive Des Continents."

⁴⁹¹ ERAP, "Programme d'Études Marines. Rapport Annuel 1968" (AHT, 07AH119/76).

acquired during oil surveys (fig.18).⁴⁹² The paper constituted one of the first reevaluations of the seafloor's geological structure in the light of continental drift, which had been achieved by relying on industrial-quality data.⁴⁹³ Through *Flexotir* seismic profiles, the team of geophysicists had identified deep fracture zones between the Equatorial Atlantic and the Gulf of Guinea: hints of the ocean's expansion, resulted from the movement of transform faults. Yet the authors were cautious when announcing their conclusions, mentioning that their evidences "could be interpreted" as transform faults, and suggesting the need of further symmetrical studies on South American and South-Western African continental margins in order to understand the evolution of the Atlantic oceanic basin. Besides its successful geological results, GUINÉE I demonstrated that a close collaboration between the oil industry and academic researchers was not only possible, but also conducive for both parts. The oil industry could benefit from the label "scientific research" to develop preliminary explorations of industrial interest, in regions beyond the French government's control. In exchange, geophysical technologies and seismic profiles of industrial quality could be disseminated through scientific publications, becoming a crucial contribution for the development of the Earth's knowledge.

⁴⁹² Fail et al., "Prolongation des zones de fractures de l'océan Atlantique dans le Golfe de Guinée." As expressed by la Prairie, the campaign GUINÉE I was organized from the perspective of an overall study of the region, which justified its "scientific" nature (la Prairie, Yves. Letter to André Giraud, May 22, 1968 (ANF, 20160129/327)).

⁴⁹³ Because sediments accumulated in transform faults were so thick, it was essential to utilize high-penetration geophysical devices, that could only be found at the oil industry.

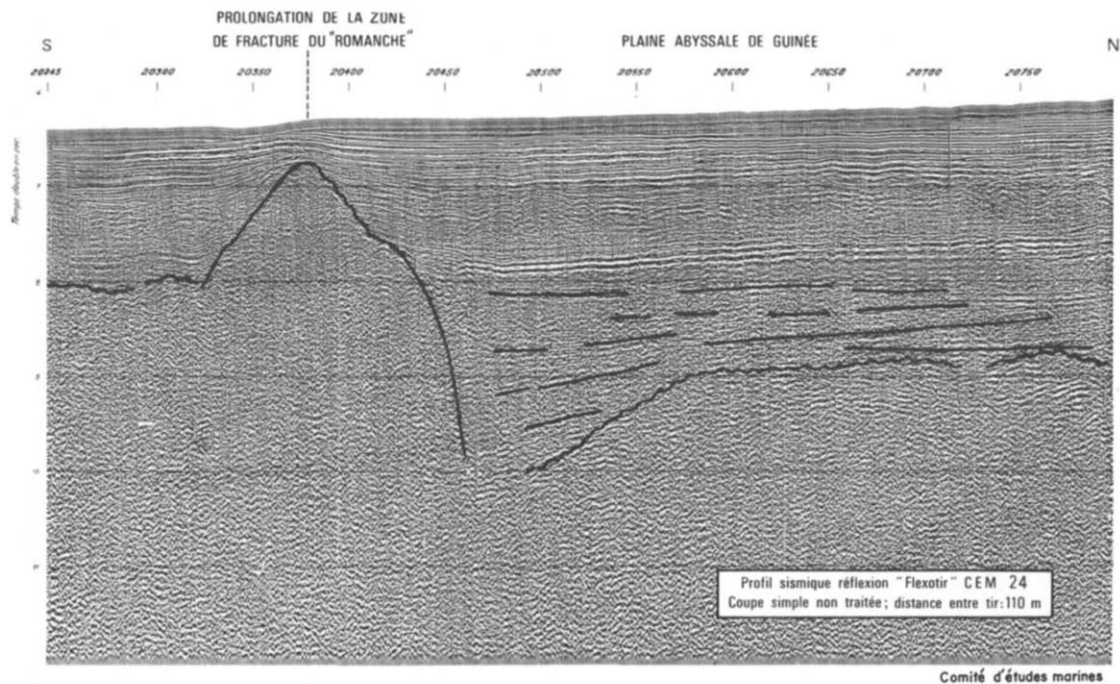


Figure 18. Seismic profile acquired with Flexotir during the campaign GUINÉE I. Bottom right the profile is signed by the Comité d'Études Marines (the CEPM) (Fail et al. "Prolongation des zones de fractures").

The campaign's success led la Prairie to initiate negotiations with Jean-Claude Balanceanu, General Director of the IFP, to install a permanent *Flexotir* onboard the *Jean Charcot*. The issue was difficult to solve for its unprecedented nature. La Prairie and Balanceanu had to set clear limits between fundamental and industrial research, as both kinds of research could not overlap to avoid misusing the data acquired.⁴⁹⁴ Besides establishing an operating regime for each case, both general directors had to design a secrecy regime loose enough to enable geologists and geophysicists using and publishing data acquired with *Flexotir*, while ensuring that the oil industry would keep control over acquired data. The final contract, signed by la Prairie and Balanceanu in July 1969, stipulated the *Flexotir*'s operating regime for scientific research: The IFP committed to provide the technical knowledge, savoir-faire, and expertise to install and operate the device; while the CNEXO agreed on sharing with the IFP all geophysical data acquired, and imposed an 18 months' moratorium to publish it after each campaign.⁴⁹⁵ This

⁴⁹⁴ La Prairie, Yves. Letter to André Giraud, May 22, 1968 (ANF, 20160129/327).

⁴⁹⁵ CNEXO, Contrat 08/163, "Procédé FLEXOTIR," June 28, 1969 (ANF, 20110381/10). If the CNEXO did not comply with these conditions, the contract specified that it must pay to the IFP 25 cents per kilometer of seismic profile acquired.

clause gifted oil companies a precious time window during which they had exclusive rights to use geophysical data for its own goals, before it was disseminated across academic domains.

5.2.2. Scientific surveys with industrial by-products, or industrial surveys of scientific interest?

After the agreement's signature, the CNEXO began to organize geophysical surveys utilizing the *Flexotir* onboard the *Jean Charcot*. Some of those campaigns were genuine international displays of France's just-acquired oceanographic capabilities in which the *Jean Charcot*, research technologies, and numerous researchers from different backgrounds were mobilized to undertake large-scale oceanographic missions, backed by a generous economic support. Campaign NORATLANTE I, conducted between August and November 1969, clearly illustrates this point (fig.19).



Figure 19. The oceanographic vessel *Jean Charcot*, sailing across the Labrador Sea during NORATLANTE I (CNEXO, *Résultats de la Campagne Noratlante*).

More than forty experts – marine geologists, geophysicists and biologists, engineers, and technicians – participated. Part of them belonged to the just-recruited scientific team of the CNEXO, selected among young academic researchers to become the institution’s human force; whereas the other half of the scientific party was constituted by invited researchers from academic institutions, from France and abroad. Two engineers from the IFP ensured the proper functioning of the *Flexotir* during three months onboard.⁴⁹⁶ This interdisciplinary campaign on the high seas made headlines in *Le Monde*, where – following with the CNEXO’s public dissemination policy – it was presented as the most ambitious, largest campaign ever undertaken by the *Jean Charcot*.⁴⁹⁷

NORATLANTE’s goals aimed specifically at contributing to plate tectonics theory by studying the North Atlantic mid-ocean ridge. Its organization was given by Xavier le Pichon, one of the main contributors to plate tectonics’ theory, who was now ascribed to the CNEXO and ambitioned to bring France’s marine geosciences to the international level. Le Pichon, born in 1937 in the Vietnamese region of French Indochina, had developed most of his career in marine geophysics at the American Lamont Geological Observatory.⁴⁹⁸ Renowned geophysicist Maurice Ewing became his mentor on seafloor exploration while surveying the mid-Atlantic and Pacific ocean ridges. As mentioned above, in 1968 le Pichon gained international prestige among geologists’ community after publishing a quantitative model of plate tectonics theory – a fame that immediately arose la Prairie’s attention.⁴⁹⁹ He wanted le Pichon leading France’s marine geosciences, for his vast experience in the American research system and his just-acquired international reputation, which would contribute to build up the CNEXO’s international prestige.⁵⁰⁰ In January 1968, la Prairie wrote a letter to Xavier le Pichon offering him a permanent senior position at the newly-created CNEXO, which he gladly accepted.⁵⁰¹ One month later, le Pichon entered onboard as Scientific Advisor to the General Director and

⁴⁹⁶ Groupe Scientifique du COB, *Résultats de la Campagne Noratlante*.

⁴⁹⁷ Rebeyrol, “L’Opération Noratlante.”

⁴⁹⁸ In 1962, le Pichon graduated in Physics at the University of Caen, in France. He then obtained a Fulbright fellowship that led him to the US, where he first engaged as assistant professor in Geophysics at Columbia University. There, he was introduced to marine geophysics under Maurice Ewing’s team.

⁴⁹⁹ Le Pichon, “Sea-Floor Spreading and Continental Drift.”

⁵⁰⁰ La Prairie specified how interest he was in le Pichon’s American experience in, for instance, a letter to M. Parker (Technical Advisor at the Ministry of Scientific Research), June 26, 1968 (ANF, 20160129/327); and in a letter to the Associate Director of the Lamont Earth Observatory, J.L. Worzel, March 28, 1968 (ANF, 20160129/327). More about le Pichon’s role in bringing to the CNEXO the American model of doing research in chapter 6, p.186.

⁵⁰¹ La Prairie, Yves. Letters to Xavier le Pichon, January 11, 1968 and February 7, 1968 (both in ANF, 20160129/327).

as responsible for creating a team of marine geoscientists. Geologists Jean-Marie Auzende, Guy Pautot, and Jean-Louis Olivet, all of them trained at the University of Paris, engaged in the group under the leadership of le Pichon.⁵⁰²

NORATLANTE I, therefore, studied rifting processes and transform faults across the North Atlantic continental margins by employing seismic, magnetic, and gravimetric techniques (fig.20). For many French geoscientists, being embarked three months with Xavier le Pichon constituted their gateway to learn about plate tectonics, which illustrates the key role played by the CNEXO in the transference of scientific knowledge from foreign institutions to France.⁵⁰³ Results were published in prestigious academic journals like *Nature*, where the CNEXO's team engaged in plate tectonics' research by presenting a model of the North Atlantic's evolution from the Cretaceous (140 to 180 Ma), when the North American and African plates began to drift away.⁵⁰⁴ As key evidence, the team had identified a continuous salt layer off Labrador and Newfoundland, which correlated in age with salt deposits off Morocco, Portugal, and the Bay of Biscay. According to them, its formation dated from the initial stage of the North Atlantic's rifting process.⁵⁰⁵

In principle, the campaign had not received the oil industry's support. The CNEXO financed the mission with its own budget, and the only hint of the oil industry's involvement – or contribution – was the *Flexotir*. But despite its scientific nature, NORATLANTE I was as useful for understanding the Earth's dynamics as for the oil industry's strategy to explore continental margins around the world.⁵⁰⁶ Continental margins, a term that embraces the continental shelf, rise, and slope, are chiefly oil-harboring regions. Even though their exploitation was not yet feasible for lacking suitable technologies and for belonging to international seawaters, France's oil companies were interested in enhancing their geological understanding on the formation, dynamics, and age of continental margins, to assess its mid-term economic potential.⁵⁰⁷ French

⁵⁰² The creation of this research team is linked to the construction of the CNEXO's research center in Brest, which would be described at length in chapter 6, 188-190.

⁵⁰³ Martínez-Rius, "Interview to G. Boillot."

⁵⁰⁴ Pautot, "La dorsale Médio-atlantique et le Renouveau des Fonds Océaniques;"; Olivet et al., "La Faille Transformante Gibbs entre le Rift et la Marge du Labrador."

⁵⁰⁵ Pautot, Auzende, and Le Pichon, "Continuous Deep Sea Salt Layer along North Atlantic Margins Related to Early Phase of Rifting;" Le Pichon, Hyndman, and Pautot, "Geophysical Study of the Opening of the Labrador Sea."

⁵⁰⁶ Oil interest expressed in: n.a. "Rapport pour l'Assemblée Nationale – Questionnaire pour la préparation de la loi de finances pour 1972," n.d. (ANF, 20160259/21).

⁵⁰⁷ Strategy stated in numerous documents, for instance: le Pichon, "Mission Nestlante I. Rapport du chef de mission."

oil companies could benefit from the campaign NORATLANTE I through the *Flexotir*'s working regime in scientific missions. As agreed between la Prairie and Balanceanu, geophysical profiles acquired during the campaign were readily available to the IFP and, by virtue of its relation, to national oil companies. The 18-months' moratorium for publishing the data was also respected – a detailed volume including geophysical profiles, magnetic, and bathymetric data was published in February 1971, exactly eighteen months after the survey ended.⁵⁰⁸

Conversely, other campaigns under the CNEXO's auspices overtly constituted preliminary surveys for oil exploration utilizing the *Jean Charcot* and the human resources from the CNEXO. The series of campaigns NESTLANTE were organized to complete outlining the North Atlantic's structural framework with the oil industry's collaboration, in terms of expertise or funding. NESTLANTE I, carried out during January 1970, was framed in the CNEXO-CEPM's program to cooperate in exploring continental margins: it aimed at deepening understanding in potentially productive areas already surveyed during NORATLANTE I, like the continental margins off Morocco and southern Portugal, and the Bay of Biscay's northern region (fig.20).⁵⁰⁹ On-board, a team of geoscientists from the IFP, the CNEXO, and the University of Rennes (including petroleum geologist Lucien Montadert, academic geologist Gilbert Boillot, and Xavier le Pichon) acquired magnetic and geophysical data from the Bay of Biscay to the southern tip of Portugal, which could be later applied to understand compressive tectonic dynamics occurring in the boundary between the African and European plates.⁵¹⁰

⁵⁰⁸ La Prairie promoted a policy of data-sharing, following the example of other advanced oceanographic countries (US) and their international projects.

⁵⁰⁹le Pichon, "Mission Nestlante I. Rapport du chef de mission." It seems that NESTLANTE I was a failure from the perspective of CNEXO researchers, as the oil companies retired its financial participation at the last moment, and the IFP experts who were going to embark had to postpone its participation because of a simultaneous survey in the Mediterranean supported by the oil company SNPA.

⁵¹⁰ CNEXO, *Rapport Annuel 1970*.

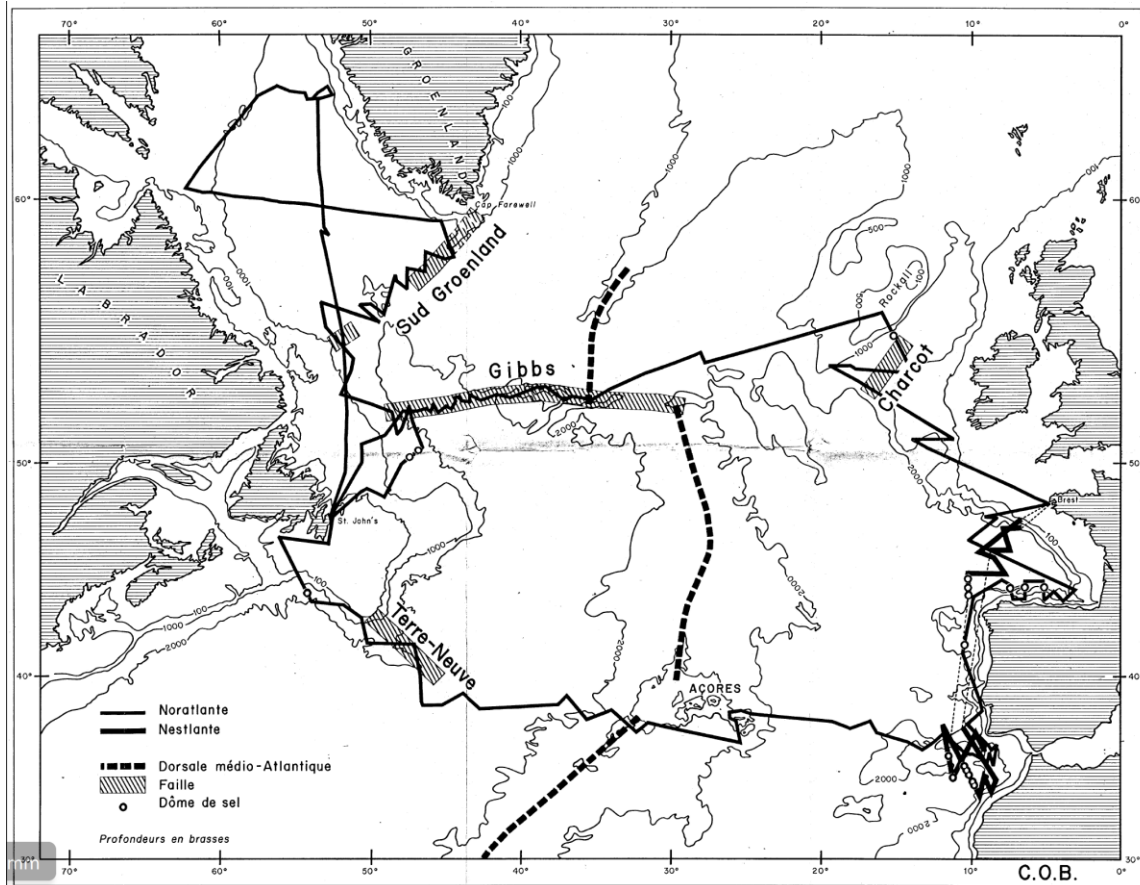


Figure 20. Map depicting the route of NORATLANTE I and NESTLANTE I (Groupe scientifique du COB, *Résultats des campagnes du N.O. Jean CHARCOT*).

Even more involved was France's oil industry in its successor, NESTLANTE II, undertaken in August 1970 across Norwegian seawaters. Throughout the sixties, the North Sea had progressively become a key exploration ground for the companies CFP and Elf-ERAP. In 1965, both firms joined under the subsidiary Elf Norge, in a consortium where they shared surveys, data, and logistic resources to operate across Norwegian seawaters.⁵¹¹ For these companies, organizing pré-reconnaissance missions through the CNEXO constituted a convenient opportunity to reduce costs, to avoid mobilizing its own research resources and human force (or outsource private companies), and freed them from going through the burdensome administrative process of obtaining an oil exploration leases from Norwegian authorities.

NESTLANTE II, also onboard the *Jean Charcot*, pursued to study the opening of the Atlantic rift from the north of Iceland, the formation of the Barents Sea, and the contact zone between oceanic and continental crust throughout the North East Atlantic, from Spitsbergen to Faroe

⁵¹¹ Gaston-Breton, *Total, un esprit pionnier*; Mounecif, *Chercheurs d'or noir*.

Islands (fig. 21).⁵¹² Yet it was funded with almost 30,000 US dollars from the oil companies ERAP, CFP and SNPA, which requested the CNEXO's team of geologists to acquire seismic reflection data with a *Flexotir* (to glimpse the structure of deep sedimentary layers) and with an *Air gun* (to obtain high-quality data on surface sediments), and seismic refraction profiles by deploying fifty sounding-buoys.⁵¹³ Although the region was further north than the North Sea's oil-producing area, learning about the formation and sedimentary structure of the Northern Atlantic continental margin would enhance understanding on the commercial possibilities of deeper regions, potentially productive in the mid-term.⁵¹⁴

Labeling the mission as scientific campaign – undertaken by a scientific institution, with a team of non-industrial experts onboard – reduced the costs of an industrial pré-reconnaissance survey, because the international legislation that applied was the one that regulated scientific research, not industrial prospection. As detailed above, the recently enacted Law of the Sea compelled nations to acquire exploration leases from foreign authorities if aiming at conducting industrial exploration; whereas if the mission's goals were scientific, only the prior consent of foreign authorities – which should not normally be withheld – was required. I am not suggesting that Norwegian authorities were oblivious to the oil industry's contribution to NESTLANTE II; quite on the contrary, it seems like they granted permission to the mission because Norwegian institutions (scientific or industrial) could also benefit from the results.⁵¹⁵ La Prairie invited a Norwegian observer onboard, while committed himself to share any piece of data under request.⁵¹⁶

The mission's geophysical results contributed to frame the Norwegian continental margin in plate tectonics. They shed light on the opening processes of the Norwegian Sea, characterized the formation of fracture zones in the Spitsbergen area, and demonstrated the sedimentary origin of the Vøring Plateau, a tongue-like structure that elongated from the continental shelf into the

⁵¹² Beuzart, *Nestlante II*.

⁵¹³ CNEXO, "Protocole de subvention pour la réalisation de la campagne océanographique NESTLANTE II," June 18, 1970 (ANF, 20110381/12).

⁵¹⁴ CNEXO, "Commission de Finances. Développement industriel et Scientifique de la recherche océanographique" (ANF, 20160129/323).

⁵¹⁵ There are no archival documents showing the exchanges between La Prairie and Norwegian authorities, but it seems unlikely that Norway was unaware of the oil industry's contribution in the campaign given that the CNEXO needed to provide all kinds of details on the scientific campaign to obtain permission.

⁵¹⁶ CNEXO, "Protocole de subvention pour la réalisation de la campagne océanographique NESTLANTE II," June 18, 1970 (ANF, 20110381/12).

deep oceanic domain.⁵¹⁷ Yet the data did not only belong to the CNEXO, but also to the three funding oil companies. If data was of direct oil interest, they reserved the right to prevent its publication.⁵¹⁸

These campaigns are illustrative of CNEXO's success in creating pathways for industrial-academic collaboration. The only large oceanographic vessel in France, the *Jean Charcot*, became the common ground where industrial interests to survey continental margins merged with scientific motivations to study the dynamics of the ocean crust. Although the campaigns pursued industrial goals, they could be labeled as "scientific" because of the absence of a fine international legislation, fixing well-defined criteria to sharply differentiate scientific from industrial surveys. CNEXO managers did not aim at keeping data secret, bounded to the walls of a single laboratory or institution, but rather to promote their publication as a way of displaying its *scientific* character. Most important was to control the flows of data, which was particularly well-reflected in the CNEXO's program to explore France's portion of continental shelf.

⁵¹⁷ CNEXO, *Rapport Annuel 1970*; Malod and Mascle, "Structures géologiques de la marge continentale à l'ouest du Spitzberg"; Briseid and Mascle, "Structure de la marge continentale norvégienne au débouché de la Mer de Barentz."

⁵¹⁸ Although I don't have evidences that oil companies hindered the publication of any piece of data. CNEXO, "Protocole de subvention pour la réalisation de la campagne océanographique NESTLANTE II," June 18, 1970 (ANF, 20110381/12).

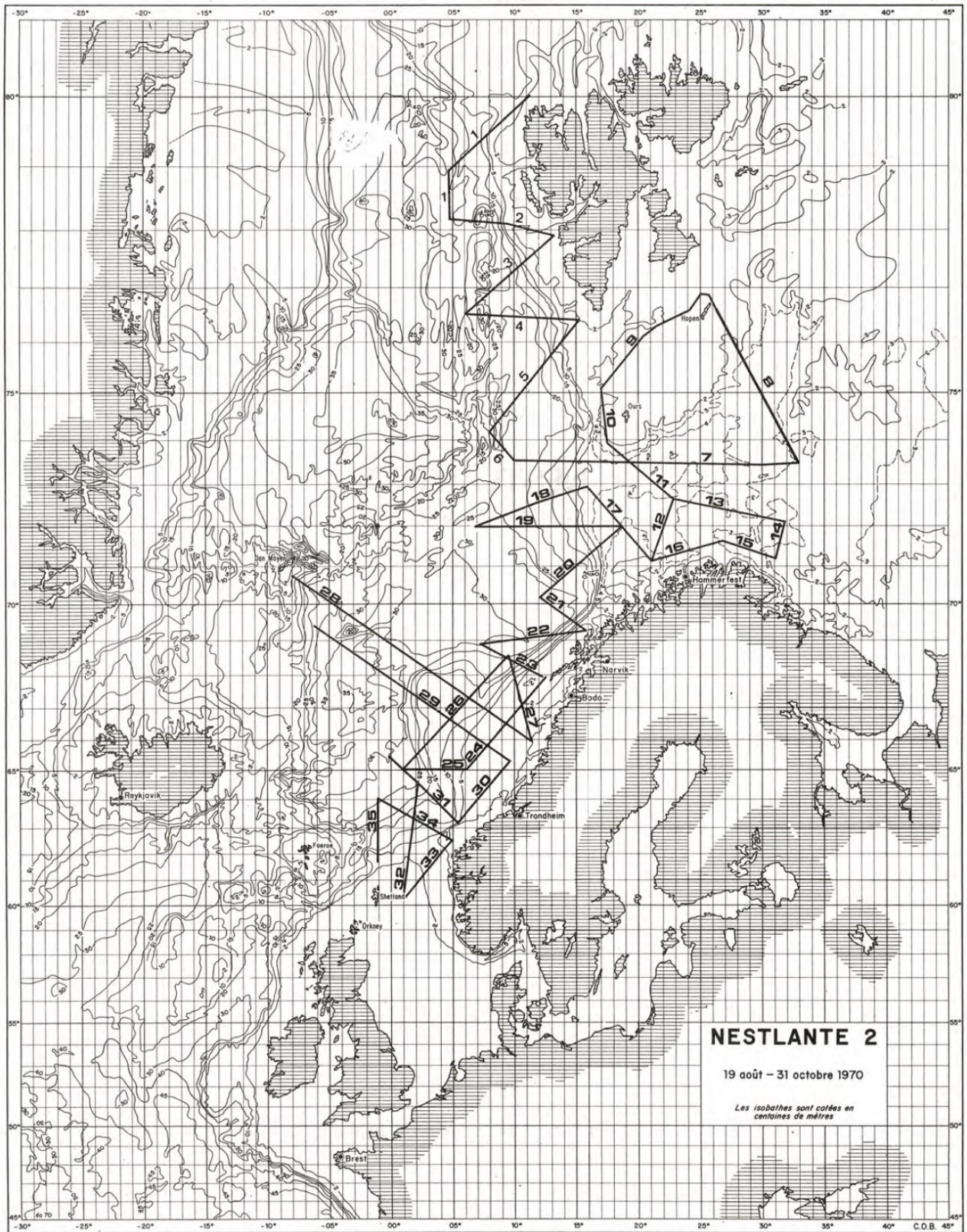


Figure 21. Cruise NESTLANTE II (Beuzart, *Nestlante II*)

5.3. Controlling data flows in the continental shelf's mapping

5.3.1. A coordinated national program to survey the Atlantic continental margin

Since the CNEXO had been designed to found the pillars of an ocean economy, priority was to identify suitable areas for hydrocarbon and mineral occurrences in the national (submerged) territory. Experts at the Administrative Council identified the Atlantic continental shelf as the most promising research ground: during previous oil surveys, IFP experts had identified thick layers of sediments indicating likely hydrocarbon occurrences; while its wide and shallow continental shelf (up to 200 meters depth, reaching 150 kilometers width) facilitated industrial activities like testing exploration technologies, conducting systematic surveys, and eventually installing infrastructures for oil and gas exploitation (fig. 22). Besides hydrocarbons, the region was covered by surface deposits of sands and gravels, potentially exploitable for commercial purposes in the short-term.⁵¹⁹ Conversely, the Mediterranean continental shelf received lesser attention: it was narrower (up to 60 kilometers in its widest point), so it would require lesser efforts, and preliminary surveys had demonstrated that potential hydrocarbon deposits would be found at greater depths, around the salt domes' region in the Balearic Basin. Unlike the Atlantic continental shelf, the Mediterranean was not as economically promising in the short-term; thus, during the first years of CNEXO activities, its exploration was mainly left in the hands of academic researchers.

Early in 1968, the CNEXO's Administrative Council began to organize a coordinated and systematic effort to survey the French Atlantic continental shelf by bringing together scientific laboratories and industrial institutions.⁵²⁰ Possessing an exhaustive cartography of the continental shelf was particularly relevant to define France's position in the upcoming UN Convention on the Law of the Sea, where the limits of national waters were to be re-discussed. Only by relying on detailed knowledge, which could indicate the seabed's potential in natural resources, the French delegation would be able to properly define and defend its position.⁵²¹ However, it was soon evident that France lacked a comprehensive geological, sedimentological,

⁵¹⁹ CNEXO, "Rapport du groupe exploitation des matières minérales et fossiles," n.d. (ANF, 19980125/01); Conseil d'Administration CNEXO, "Procès-verbal de la séance du jeudi 4 avril 1968," April 4, 1968 (ANF, 19980125/01).

⁵²⁰ Ibid., CNEXO, "Note préparatoire à l'établissement d'un programme CNEXO concernant l'exploitation minière des océans" (ANF, 19980125/01).

⁵²¹ La Prairie, Yves. Letter to the Minister of Foreign Affairs, March 5, 1968 (20160129/326).

and bathymetrical map of the continental shelf, the basis to identify conductive regions for the accumulation of building materials, minerals, and hydrocarbons. Until then, mapping activities had been undertaken by multiple institutions and laboratories, who draw local, non-standardized, charts, while vast submerged regions remained unknown.

Designing such a cartography of France's submerged territory was also a task aligned with the CNEXO's new role as the government's advisor in granting exploration and exploitation mining leases. The international Law of the Sea enacted in 1965 compelled coastal countries to issue their mining law on the continental shelf's exploration and exploitation activities. Subsequently the French National Assembly created a working group inside the General Secretariat of the Government to draft the new legislation, who had almost finished the law enforcement texts when the CNEXO was inaugurated.⁵²² But Yves la Prairie interceded, as he ambioned that his institution possessed some control on the leases granted to oil, mining, and fishing industries. In a persuasive letter to the Prime Minister, la Prairie exposed that, consistent with the coordinating position the CNEXO was called to play, it should possess some role in granting mining leases – either directly or through the Ministry or Research.⁵²³ According to his arguments, the CNEXO would be in a privileged position to decide which regions or kind of resources should be (or not) exploited, thanks to the exhaustive scientific knowledge it would gather. He suggested, thus, to add a short article subordinating the allocation of exploration and exploitation leases to the CNEXO's prior advice.⁵²⁴ Eventually, the enacted Law on the Exploration of the Continental Shelf and the Exploitation of its Natural Resources did not literally include la Prairie's suggestion, but it did integrate the CNEXO's advisory role.⁵²⁵ As stated in Article 34, the CNEXO would have access to geological, hydrological, and biological data collected during exploration and exploitation activities (while the employees accessing to that information would be subjected to the industrial secrecy conditions specified in the

⁵²²La Prairie, "Instructions du Directeur Général du CNEXO pour M. le Fauchaux," July 24, 1967 (ANF, 20160129/327); La Prairie, letter to Prime Minister, November 21, 1967 (ANF, 20160129/327).

⁵²³ La Prairie, letter to Prime Minister, November 21, 1967 (ANF, 20160129/327).

⁵²⁴ Literally: "Toutes les demandes d'autorisation – sont après une instruction préliminaire, soumises pour avis au CNEXO qui les examine sous l'angle de leur opportunité et de leur cohérence avec les autres activités en cours ou en projet". In a private note to his Technical Advisor, Olivier le Fauchaux, la Prairie declared his ambitions to receive an income from the taxes obtained through mining leases in the continental shelf. However, he didn't mention it in his subsequent letter to the Prime Minister, nor it materialized in the final Law (in: La Prairie, "Instructions du Directeur Général du CNEXO pour M. le Fauchaux," July 24, 1967 (ANF, 20160129/327).

⁵²⁵ "Loi n° 68-1181 du 30 décembre 1968 relative à l'exploitation du plateau continental et à l'exploitation de ses ressources naturelles".

lease).⁵²⁶ From May 1971, the Minister of Industrial and Scientific Development reported la Prairie about the oil leases requested (normally from French oil companies), while la Prairie replied by offering his advice on the CNEXO's behalf. He always emphasized the need to carefully define a strategy to prevent oil spills and seawater pollution; and reminded that all geological, hydrological, meteorological, and biological information had to be addressed to the CNEXO.⁵²⁷ In this way, he ensured an absolute control over any activity happening on the continental shelf and over the outcoming information, which could possess strategic value.

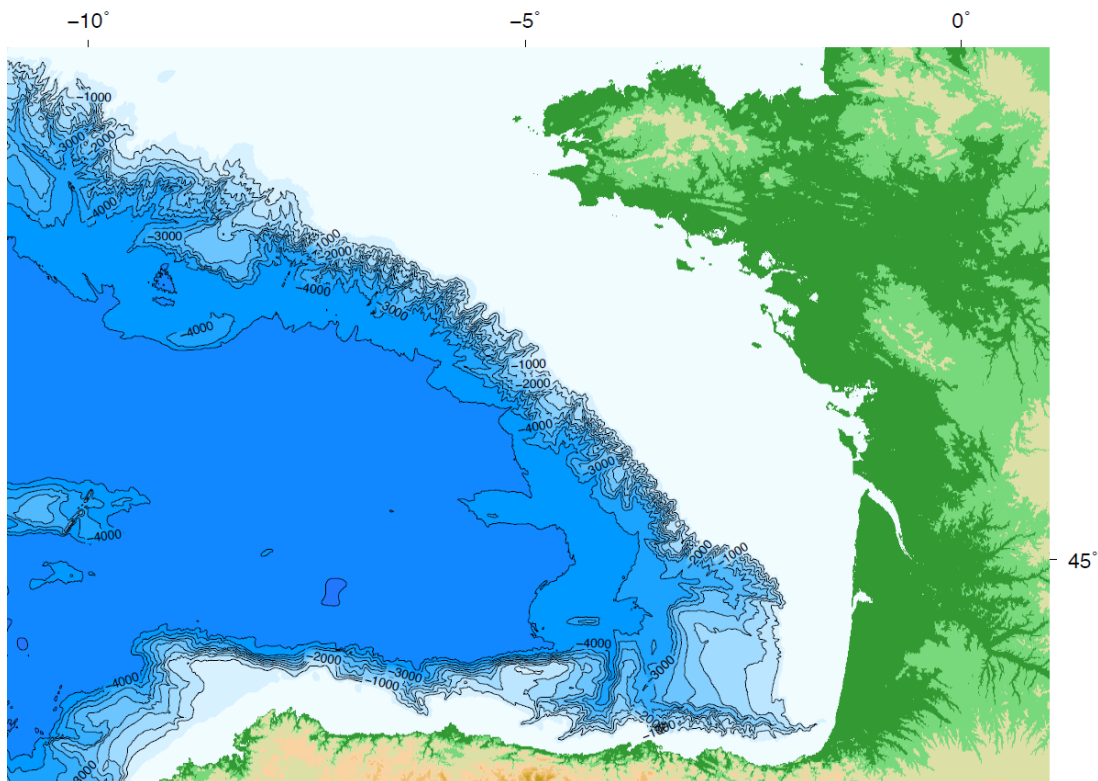


Figure 22. Bathymetric map of the Bay of Biscay.

The national program to chart the Atlantic continental shelf was the first large-scale, coordinated research project undertaken in France's marine geosciences.⁵²⁸ The CNEXO occupied the core of a network-shaped structure that connected academic research teams, public

⁵²⁶ Ibid. I have not found archival evidences about CNEXO marine geoscientists utilizing information coming from exploration and exploitation leases.

⁵²⁷ As in: Minister of Industrial and Scientific Development, letter to Yves la Prairie, May 11, 1971 (ANF, 20160259/321); and la Prairie, Yves. Letter to the Minister of Industrial and Scientific Development, June 18, 1971 (ANF, 20160259/321) about the CFP's request to extend its exploration lease at the Gulf of Lion's continental shelf. Also: la Prairie, Yves. Letter to Minister of Industrial and Scientific Development, March 21, 1972 (ANF, 20160259/320) about SNPA's request of the exploration lease "Gironde-Maritime;" or letter by la Prairie to Minister of Industrial and Scientific Development, February 4, 1972 (ANF, 20160259/320), about the SNPA's and CFP's request of the lease "Permis d'Irose" to explore the Atlantic continental shelf off Finisterre.

⁵²⁸ Boillot, "Des marges continentales atlantiques."

institutions, and private companies, through which data acquired and jointly interpreted flowed towards the CNEXO. The program was particularly attractive for those academic geologists willing to align their research lines with the national agenda: the CNEXO granted them economic support, facilitated inter-institutional collaborations and – as relevant – enabled them to access industrial-quality data (table 2). The case of geologist Michel Vigneaux, from the University of Bordeaux and member of the CNEXO’s Scientific and Technical Committee, is illuminating. Vigneaux obtained 120,000 US dollars to collaborate in the cartographic program by studying, through marine geological techniques, upper sediments in the Bay of Biscay.⁵²⁹ Before undertaking this research, geologists from the IFP transferred him their seismic profiles, which enabled Vigneaux to select sampling regions.⁵³⁰ By using dredges and sediment corers, Vigneaux’s team at Bordeaux produced sedimentological and geochemical data that was transferred to research groups working with marine geophysical profiles: Pierre Muraour, at the University of Montpellier, and cartographers at the *Bureau de Recherches Géologiques et Minières*. As well as Vigneaux needed geophysical data to organize his campaigns, geophysicists required geological information to precisely interpret the sedimentary formations displayed in their seismic profiles.⁵³¹ Similar partnerships were established among other French institutions: at the University of Rennes, geologist Gilbert Boillot and his team worked shoulder to shoulder with the offshore-tech company *Société GEOTECHNIP*, with whom they exchanged geological data for reflection seismic profiles of the English Channel’s eastern region.⁵³² Geologists at the IFP contributed with their *Flexotir* data, acquired during oil prospection missions, and the vessel *Petit Marie François*, equipped to undertake seismic surveys.⁵³³ Results and data flowed to the CNEXO embodied in final reports, which were then

⁵²⁹ This is, 587,000 francs. In: CNEXO, “Reconnaissance géologique du plateau continental atlantique dans le Golfe de Gascogne,” Contract 69/141, December 12, 1969 (ANF, 20110381/10).

⁵³⁰ The IFP facilitated Vigneaux geophysical data acquired on-board the *Florence* during July 1969, framed in the activities supported by the CEPM (Vigneaux, Maurice. “Rapport préliminaire concernant les activités du Laboratoire de Géophysique Appliquée,” convention n.69/141, n.d. (ANF, 20110381/10).

⁵³¹ CNEXO, “Études sismiques de la marge continentale Atlantique,” contract n.68/33, 1968 (ANF, 20110381/07); CNEXO, “Étude sismique de la marge continentale Atlantique,” contract 6700534, 1967 (ANF, 20110381/05).

⁵³² CNEXO, “Reconnaissance Géologique en Manche Orientale,” contract 70/181 with Geotechnip, April 8, 1970 (ANF, 20110381/12); Boillot, Gilbert, “Étude stratigraphique de carottes de roche prélevées en Manche Orientale,” November 5, 1970 (ANF, 20110381/09); CNEXO, “Reconnaissance par carottages de surface du substratum de la Manche centrale et orientale,” contract 69/79 (ANF, 20110381/09).

⁵³³ CNEXO, “Synthèse des principales activités océanologiques du 1 février au 15 avril 1969”, n.d. (ANF, 19980125/01). Also in CNEXO, “Synthèse des principales activités océanologiques du 15 avril au 15 juin 1969”, n.d. (ANF, 19980125/01). They also offered the *Petite Marie Françoise*, their research vessel adapted to conduct marine geophysical surveys.

transferred to experts at the *Bureau de Recherches Géologiques et Minières*, responsible for drawing the geological map at 1/1,000,000 scale.

Institution	Contribution (in % of data)	
	Core samples	Seismic data
Universities		
Bordeaux	2,3	11,3
Caen	16,9	2,3
Nantes	8,7	12
Paris + Rennes	50,9	22,9
Perpignan	1,1	0
Rouen	3,8	0
Total universities	83,7	48,5
Other institutions		
IFP (through BECIP lab)	10,7	10,9
BRGM	5,6	24,3
CNEXO	0	16,3
Total other institutions	16,3	51,5

Table 2. Contribution of different institutions to the national program to map the Atlantic continental shelf (modified after Boillot, “Des Marges Continentales Atlantiques”).

This intermediate, apparently redundant step of transferring all pieces of data to the CNEXO was the central element of the institution’s strategy to control the flows of data from the seafloor. As the CNEXO was the funding and coordinating institution of the mapping project, la Prairie was responsible for drafting and signing the contracts of collaboration with all involved institutions, from academic researchers to private companies. This granted the CNEXO power to design the secrecy clauses and the conditions under which information could be disseminated. According to their contracts, academic geologists like Vigneaux or Boillot were not allowed to directly publish the data acquired (by their technological means, with the CNEXO’s economic support) for the national mapping project without the prior, explicit agreement of the CNEXO.⁵³⁴ However, as Boillot and other geologists admitted, la Prairie always granted them clearance to publish. Therefore, the CNEXO did not use confidentiality clauses to keep geological data secret, but rather to ensure control over its use and dissemination

⁵³⁴ For example, Boillot requested la Prairie in a letter if he could publish the results obtained during the sedimentological study of the Western Manche (Boillot, Gilbert. Letter to Yves la Prairie, November 20, 1970 (ANF, 20110381/12).

– a strategy rooted in the peculiarities of geological knowledge.⁵³⁵ Individual pieces of geological and geophysical data, pooled to sketch the continental shelf’s map, did not possess an intrinsic, straightforward value for oil exploration. Seismic profiles did not depict oil deposits, neither retrieved sediments from the upper seabed were impregnated with oil. It was the bulk of entangled data from different nature, exhaustively recovered from vast regions (in extent and depth) which was of industrial interest.⁵³⁶

For academic geologists, tracing the limit between knowledge (not data) acquired during surveys devoted to the mapping program, and that developed during their own research, was an impossible task. To further complicate the matter, geologists like Gilbert Boillot not only accessed industrial data through transferences, but also during face to face conversations. La Prairie organized monthly meetings at the CNEXO’s headquarters to monitor the program’s development, where representatives from the involved institutions participated.⁵³⁷ These meetings constituted arenas of exchange between academic and industrial experts, where knowledge and expertise circulated between them: they discussed their findings and techniques used; suggested further collaborations, and established personal relationships that would facilitate future exchanges of information.⁵³⁸ While the CNEXO could easily control the flows of reports, seismic profiles, or scientific papers; how could a geologist avoid integrating some element he had learned during the mapping project, either from looking at seismic profiles or while discussing with oil geologists, in the analysis of his own data?

From geologists’ perspective, this trade-secrecy mechanism did not jeopardize their research, as they always received approval to publish. Nevertheless, I suggest that confidentiality clauses impacted on academic research inasmuch as they indicate who controlled the production of scientific knowledge. Fundamental research was now pinned to secrecy mechanisms specific to the industry, which hindered free circulation of scientific information – as in needing la Prairie’s agreement before publishing any piece of data. Unlike surveys conducted under the auspices of the former COMEXO, where academic researchers did not require permission to

⁵³⁵ In the words of historian Peter Galison, “scientific knowledge is diffused in nature; and blocking its transmission, an extraordinary difficult and costly task. It is much easier to control the movement of materials (documents, technologies), than knowledge embodied in scientists” (Galison, “Removing knowledge”). About controlling flows of knowledge, see also: Krige, *How knowledge moves*.

⁵³⁶ Galison, “Removing Knowledge” about a similar argument in relation to military secrecy.

⁵³⁷ Called “groupe de travail mixte exploitation de matières minérales et fossiles,” constituted by geologist Michel Vigneaux, the IFP engineer Pierre Willm (IFP), and a representative of the BRGM.

⁵³⁸ Boillot mentioned this during our interview (Martínez-Rius, “Interview to G. Boillot”), as well as Montadert did during our conversations.

publish acquired data; now it was a politically-led institution, driven by industrial ambitions, who controlled knowledge produced during the most well-supplied oceanographic projects.

Beyond industrial exploitation of mineral resources, mapping the Atlantic continental shelf's geology served other national purposes: it became a diplomatic tool, utilized to prevent diplomatic frictions; and a pilot program to undertake industrial activities over foreign continental shelves. For the first case, shortly after launching the mapping program, la Prairie met Mr. Fenning, from the British Natural Environment Research Council (NERC), to discuss about a cooperative project to explore the central and western English Channel. Similar to the CNEXO, the NERC was a research council, funded in 1965, to coordinate research and training in environmental sciences. France and the United Kingdom shared their national border on the English Channel's continental shelf and, to prevent misunderstandings and political tensions derived from the discovery of natural resources in middle-grounds, la Prairie and Fenning agreed on harmonizing their national mapping programs. As they argued, it would prevent the unnecessary duplication of efforts, while the conditions included sharing "the most relevant discoveries" (in natural resources, it was implied), and to establish a standardized, common geological chart of the region.⁵³⁹ This agreement became the seed of a wider, bi-lateral collaboration in marine sciences between France and the UK.⁵⁴⁰

The exploration of minerals well-represents the undertaking of industrial activities in foreign regions. The mapping program of the Atlantic continental shelf included the deployment of exploration techniques to identify mineral deposits, like metals or placers. However, experts at the CNEXO's Administrative Council were well-aware that in France's continental shelf those resources were scarce or absent.⁵⁴¹ Why, then, investing in training experts and developing research methodologies for a resource that would not be economically profitable? The answer lays in the neocolonial mindset of the CNEXO leaders. Mineral prospecting activities would serve as pilot studies to develop the skills and technologies needed to undertake the exploitation of continental shelves in overseas and foreign territories. As the CNEXO's Administrative Council phrased it, those activities would serve to strength relations with "friendly nations,

⁵³⁹La Prairie, Yves. Letter to M. Fenning, January 21, 1969 (ANF, 20160129/326).

⁵⁴⁰ La Prairie, Yves. Letter to M. Parker, January 29, 1969 (ANF, 20160129/326).

⁵⁴¹ Asserted by the Scientific and Technical Committee and, later, mentioned at the Administrative Council (Comité Scientifique et Technique, "Procès-Verbal de la 5^{ème} reunion," December 18, 1968 (ANF, 20110381/05). Perrot and la Prairie suggested that it would be better to start to "acquire [oil] concessions over foreign continental shelves," notably in francophone countries.

notably francophone African countries and Madagascar.”⁵⁴² What is not mentioned, but appears as evident, is that besides friendly relations France would benefit from the natural resources to be extracted. These ambitions began to crystalize early in 1971, after numerous tests conducted over the Atlantic continental shelf, when the CNEXO undertook in collaboration with the *Bureau des Recherches Géologiques et Minières* a global-scale synthesis to define coastal regions favorable to the accumulation of placers like zircon, rutile, ilmenite, gold, or diamonds; aiming at facilitating France’s mining industry the exploitation of seabed minerals around the world.⁵⁴³

5.3.2. Scientific-industrial conferences to build knowledge on the Atlantic basin's formation

Seismic profiles, bathymetric data, and sedimentary information collected to draw the Bay of Biscay’s cartography led to the first comprehensive overview of the region’s history, dynamics, and economic prospects, since knowing the evolution of marine sedimentary basins was essential to estimate its oil potential. Basins recently formed would be poor in hydrocarbons; while an ancient basin, in subsidence for millions of years for the high weight of accumulated sediments, offered favorable prospects.⁵⁴⁴ The international scientific community learned from the Bay of Biscay’s geological overview during a conference organized under the joint auspices of the IFP and the CNEXO.

In December 1970, more than two hundred experts from oil companies, national geological services, and universities from around Europe and the United States gathered at the IFP’s headquarters, in Rueil-Malmaison, to participate in a three-days Symposium about the Structural History of the Bay of Biscay.⁵⁴⁵ The meeting manifested how the boundaries between academic and industrial research had blurred: Organized by Lucien Montadert and Jacques Debysier, experts at the IFP’s exploration division, and Xavier le Pichon, geophysicist at the CNEXO, the meeting included forty-three communications that alternated academic investigations with results obtained during oil exploration (table 3). Renowned managers from France’s oil

⁵⁴² CNEXO, “Programme National d’Océanographie – Les choix du CNEXO,” April 4, 1968 (ANF, 19980125/01).

⁵⁴³ CNEXO, “Synthèse des principales activités océanologiques du 15 mars 1971 au 1er juin 1971” (ANF, 19980125/02).

⁵⁴⁴ Vigneaux, Maurice. “Rapport préliminaire concernant les activités du Laboratoire de Géophysique Appliquée à l’Océanographie,” 1969 (ANF, 20110381/10).

⁵⁴⁵ Where the symposium was going to take place created frictions between the CNEXO and the IFP: according to la Prairie, organizing such a pivotal meeting at Rueil-Malmaison meant a waiver in favor of the IFP, who should thus return the favor in a future occasion.

industry, like the CEPM's president Maurice Leblond, the IFP's general director André Navarre, and even Yves la Prairie delivered the conference's opening speeches; while petroleum geologists and foreign geoscientists chaired the sessions.⁵⁴⁶

Speakers from French institutions	Universities	26
	Industrial institutions	24
	CNEXO	7
Speakers from foreign institutions	Universities	22
	Industrial institutions	4

Table 3. Presentations during the 1970 Symposium, divided by the nature of the speaker's institution (based on Debyser, Montadert, le Pichon, *Histoire Structurale du Gulf Gascogne*).

As stated by the organizers, the symposium “demonstrated, if proof is still necessary, that in the field of geology no progress is possible except through close cooperation between fundamental and applied research.”⁵⁴⁷ French oil companies disclosed information hitherto confidential about the geology and structure of the Atlantic margin, while experts involved in the mapping project had the opportunity to present their results to the international academic community.⁵⁴⁸ Montadert, on behalf of the oil companies ELF and SNPA, presented a modern chronology of tectonic movements based on geophysical data gathered at oil companies;⁵⁴⁹ followed by Pierre Valéry, petroleum geologist at ELF, who offered a geological synthesis of the Aquitanian margin developed at the bosom of the CEPM's consortium, where he described the region's dynamics since the Mesozoic (252-66 Ma).⁵⁵⁰ Academic geologists Maurice Vigneaux and Gilbert Boillot described the geological results their teams had developed while gathering data for mapping the continental shelf. These conclusions were articulated in the presentation of Xavier le Pichon with results obtained during the CNEXO campaigns NORATLANTE and NESTLANTE, in a paper where he framed for the first time the Bay of Biscay in plate tectonics theory.⁵⁵¹ In this new framework, the region was conceived as a passive continental margin: a transition area between the continental and the oceanic crust,

⁵⁴⁶ Chairs of the sessions: Burollet (CFP), Drake (Darmouth College, USA); Goguel (BGM), Levy (ELF-ERAP), Matthews (Uni. Cambridge), Radier (SNPA).

⁵⁴⁷ Debyser, Montadert and le Pichon, *Histoire structurale du Golfe de Gascogne*.

⁵⁴⁸ Martínez-Rius, “Interview to G. Boillot.”

⁵⁴⁹ Montadert et al., “Structure géologique de la marge continentale septentrionale du Golfe de Gascogne. ”

⁵⁵⁰ Valéry et al., “La marge continentale d'Aquitaine.”

⁵⁵¹ Le Pichon, Bonin, Francheteau, Sibuet, “Une hypothèse d'évolution tectonique du golfe de Gascogne.”

characterized by thick sedimentary layers and geological inactivity.⁵⁵² The Bay of Biscay, thus, did not correspond to a boundary of tectonic plates, but it appeared after the opening of an ancient rift due to the rotation of the Iberian peninsula (axed in the Pyrenees) during the Mesozoic (about 110 Ma).⁵⁵³ The symposium's volume was published one year later, containing unpublished data gathered at oil companies like seismic profiles, schemas of interpretation, and maps depicting where the data had been acquired (fig. 23). Publishing this information could have fostered future academic-industrial collaborations: since the regions where the oil industry had been acquiring data were not a secret, academic experts interested in those areas or research lines could contact with exploration divisions at oil companies, offering their scientific expertise for analyzing the oil company's data.

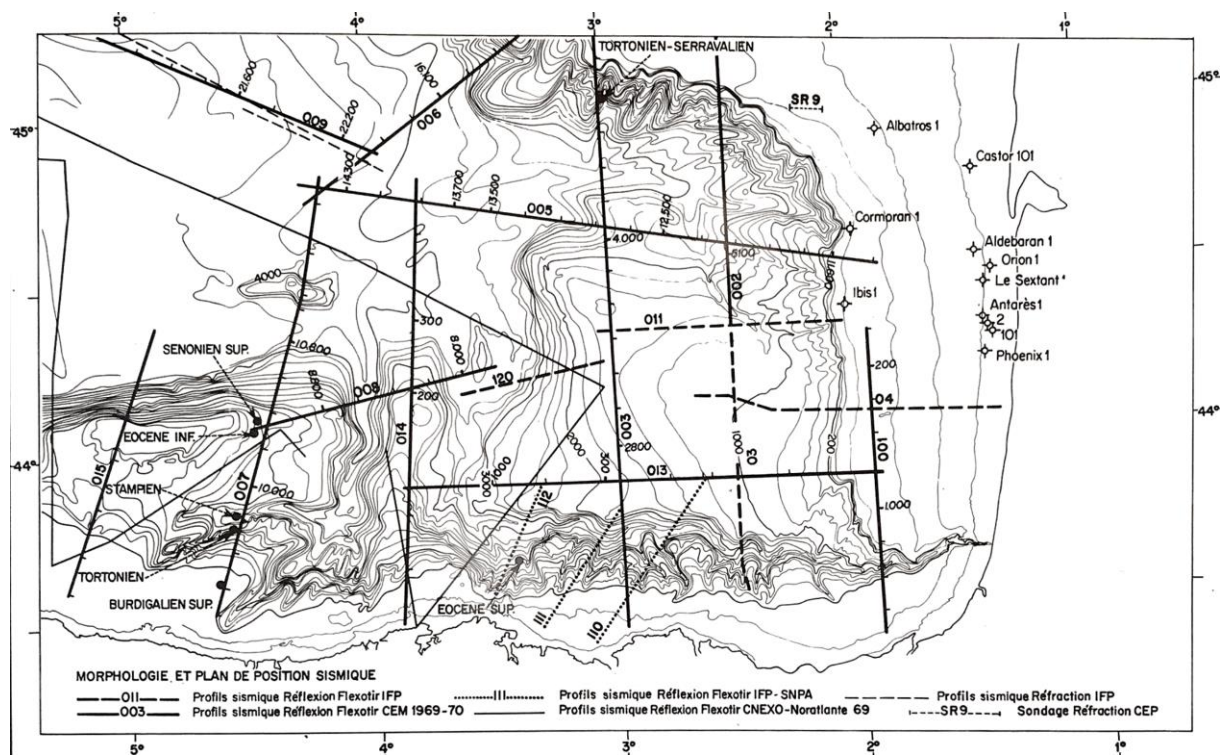


Figure 23. Map published in the Symposium's volume, depicting the regions surveyed by oil companies and the location of exploration boreholes. Seismic profiles were also published (Valéry et al. "La Marge continentale d'Aquitaine").

From geologists' perspective, the 1970 Symposium constituted the founding act of marine geosciences in France, a milestone event in the geological understanding on continental margins

⁵⁵² In the framework of plate tectonics, there are two types of continental margins: passive and active. Active continental margins correspond to the boundaries of tectonic plates, where geological activity is high (earthquakes, vulcanism...) and are related to subduction processes or convergent plates.

⁵⁵³ Boillot, "Des Marges Continentales."

and on the Earth's evolution in the light of plate tectonics.⁵⁵⁴ Yet, it could also be regarded as a turning point in academic-industrial relations in France's marine geosciences for constituting a trading zone, a spatial and symbolic area where two communities, each one with its own "culture," meet to exchange some good – in this case, geological knowledge.⁵⁵⁵ But should we consider academic geologists and industrial experts as constituting two different research cultures?⁵⁵⁶

Although both groups differed in their sources of funding, which defined their research goals and approach to their object of study; there was a clear convergence of scientific interests in building knowledge on, for instance, the tectonic dynamics of the Atlantic ocean. Their research methodologies (geophysical data combined with geological samples) also grew convergent with the CNEXO's mediation, that created spaces of cooperation.⁵⁵⁷ Before 1967, the wall that separated the community of academic from industrial researchers was not epistemological or methodological, but a metaphorical one: there were no institutionalized bridges through which they could communicate their findings, exchange their experts, or pool research resources. During the 1970 Symposium, both communities could combine their expertise, align their research goals, and homogenize the outcoming scientific knowledge: the concept of passive continental margins to frame the Bay of Biscay's geology, the events that shaped the region during the Mesozoic, or the geological features of particular areas.

Remarkably this trading zone did not emerge naturally from a convergence of academic and industrial research interests, but it was an outcome of the research system designed by the CNEXO. On their eagerness to explore and exploit natural resources from the seafloor, CNEXO managers not only created the conditions under which information and knowledge could flow (embedded, for instance, in bi-lateral contracts), but also enabled the emergence of physical

⁵⁵⁴ Martínez-Rius, Interview to G. Boillot.”

⁵⁵⁵ Galison, “Trading zone: coordinating action and belief.”

⁵⁵⁶ Research cultures have been usually analyzed from the perspective of laboratory studies, and are characterized by local rules and knowledge, in turn defined by the resources that scientists draw upon for their work (Pickering, *Science as Practice and Culture*; Knorr-Cetina, *Epistemic Cultures*). Steven Shapin has argued that industrial scientists constitute a different culture inasmuch as their different sources of funding defined their working values and ambitions, research goals, and approach to their object of investigation (Shapin, *The Scientific Life*).

⁵⁵⁷ Some historians have considered geologists and geophysicists as belonging to different research cultures or “epistemic traditions,” although here this distinction arguably does not apply because geology and geophysics mingled in individual expertise (Oreskes and Fleming, “Why Geophysics?;” Oreskes and Doel, “The Physics and Chemistry of the Earth”).

locations where both communities could meet and reach mutual understanding – which, in turn, would translate in future collaborations.

5.4. The removal of boundaries between academic and industrial research

The CNEXO's creation epitomized which public interests would drive the oceans' exploration: commercial and economic ambitions that even replaced former military interests. National security was not discarded, but it certainly lost relevance in the new ocean policy. This turn of the events defined the kind of secrecy that affected marine geosciences, while shaped the cooperative relations between industrial and academic researchers that were going to flourish.

In 1971, after four years of existence, the CNEXO had managed to forge a solid cooperative network between national oil companies, public organisms, and academic geologists by driving research lines towards shared goals. The CNEXO's success relied on its strategy to control the flows of information, while it formalized corridors of exchange between industrial and academic research teams in which industrial secrecy dissolved. This system to deal with sensitive information was possible because of the nature of geological data: seismic profiles or pieces of geological information did not possess a straightforward value to identify hydrocarbon deposits, but it was the bulk of pieces of data which enabled to assess the oil potential of a region. Under these circumstances, stimulating information exchanges led to situations where geological knowledge from the seafloor was co-produced between oil experts and academic geologists.

Oceanographic surveys sponsored by the CNEXO played with the blurred boundaries of the category “scientific research” as defined in the 1958 Convention on the Continental Shelf. The CNEXO used scientific geophysical surveys to provide valuable data to France's oil industry by pursuing a double agenda: building knowledge on tectonic processes of the oceans' crust, while gathering structural and geological data to prepare future oil exploration ventures. This proved to be a suitable strategy to explore the oil potential of faraway regions without needing to acquire leases for oil exploration and exploitation, while generating unprecedented knowledge about the earth's dynamics.

But beyond its industrial and scientific interests, these missions on the high seas were also sending a clear message to the international community: France now possessed technological, human, and logistic capabilities to organize large-scale oceanographic campaigns and to engage in the latest research lines. It was a genuine display of how the French government was

supporting the growth of ocean sciences embedded in big science settings, and of its ambitions to expand France's presence across the oceans. The CNEXO had been called to play a key role in international ocean diplomacy.

Chapter 6. Science diplomacy and the common heritage of mankind: Anticipating the exploitation of the high seas

The known resources of the sea-bed and of the ocean floor are far greater than the resources known to exist on dry land. The sea-bed and the ocean floor are also of vital and increasing strategic importance. Present and clearly foreseeable technology also permits their effective exploitation for military or economic purposes. Some countries may therefore be tempted to use their technical competence to achieve near-unbreakable world dominance through predominant control over the sea-bed and the ocean floor. (...) The process has already started and will lead to a competitive scramble for sovereign right over the land underlying the world's seas and oceans, surpassing in magnitude and in its implication last century's colonial scramble for territory in Asia and Africa.⁵⁵⁸

On November 1, 1967, diplomat Arvid Pardo, Maltese delegate at the United Nations (UN), pronounced these words to the UN General Assembly. Pardo's discourse combined an alluring description of boundless seabed richness, opened up via future technological innovation, with a concerned warning against the seabed's grab and enclosure by the most powerful nations in ocean research.⁵⁵⁹ While seabed resources could solve global anxieties of overpopulation and resource scarcity, its exploitation could perpetuate colonial power relations in the new post-colonial world order. In his vision, the seabed was equivalent to land: a territory to be explored, mapped, colonized, and connected to mainland economies through national claims and technological occupation.⁵⁶⁰

Drawing inspiration from previous international treaties taking "the benefit of the humankind" as legal concept, Pardo proposed to consider natural resources on the high seas as "the Common Heritage of Mankind": belonging to present and future generations, not subject to national

⁵⁵⁸Speech at the 1st UN General Assembly by Ambassador Arvid Pardo, Malta's delegate (UN General Assembly, First Committee Debate, November 1, 1967).

⁵⁵⁹ Ranganathan has argued for a "grab of the seabed" at: Ranganathan, "Ocean floor grab."

⁵⁶⁰UN General Assembly, First Committee Debate, November 1, 1967; also analyzed in: Ranganathan, "Decolonization and international law."

appropriation, and reserved exclusively for peaceful purposes.⁵⁶¹ Pardo's suggestion fostered the re-opening of the UN Conferences on the Law of the Sea, becoming a landmark throughout the decade in UN negotiations. The "common heritage of mankind" dominated legal discourses on governing global commons, where tensions between sharing and preserving natural resources in the high seas had to be accommodated into an internationally-regulated exploitation regime.

From a science diplomacy perspective, the common heritage (or benefit) of mankind became a political motto, utilized by policy-makers to display their good-will in exploring the oceans through scientific cooperation while forging cordial diplomatic relations. However, diplomatic motivations achieved through scientific cooperation should be analyzed beyond a benign and hagiographic approach.⁵⁶² In this chapter I analyze further roles science diplomacy relations were playing beyond this rhetoric. In France, the "common heritage of mankind" became the framework that shaped the ocean's political strategy to prepare a future exploitation of the high seas, informing a science diplomacy agenda through the CNEXO. This agenda pursued to integrate activities of territorial expansion through sciences and deep-sea technological testing into the international approach of cooperatively explore the global commons. Three cases – the relationships France established with the US, Japan and the Pacific region, and the USSR – depict how beyond the benevolent rhetoric to explore the oceans for the benefit of humankind laid a geopolitical strategy designed to situate France in an internationally vantage position for a future exploitation of deep-sea natural resources, and to re-shape its power relations with the two world-dominating nations.

In this framework, the CNEXO became the national structure to design, display, and control the development of a national strategy in ocean diplomacy. Its managers, as la Prairie, acted as diplomats; its geologists and geophysicists, as Xavier le Pichon and Guy Pautot, mediated with foreign communities and channeled scientific information to the CNEXO; and the network established around France's extractive industries became instrumental in informing the position of the French delegation in UN forums. The CNEXO acted as a science-diplomacy nexus, a

⁵⁶¹ UN General Assembly, First Committee Debate, November 1, 1967. In: Gorove, "The concept of Common Heritage of Mankind," the author mentions the Antarctic Treaty (1959), the Non-proliferation Treaty (1968), and the international regulation of the outer space at the UN General Assembly (1959).

⁵⁶² Particularly emphasized as one of the weak spots of contemporary analysis on science diplomacy in: Adamson and Lalli, "Global perspectives on science diplomacy."

mechanism by which issues of science intermingled with those of diplomacy, and where decision-making on political and diplomatic issues was co-constructed.⁵⁶³

6.1. Towards a new jurisdictional framework to exploit the high seas

6.1.1. Arvid Pardo and the common heritage of mankind

By the late-1960s, international anxieties for overpopulation, resource erosion, and environmental degeneration on land began to permeate the public sphere.⁵⁶⁴ The rampant process of decolonization impelled to re-define national borders, and hostile international relations between East and West, developed and developing states, jeopardized international political stability.⁵⁶⁵ The “tragedy of the commons,” a concept introduced by biologist Garrett Hardin in 1968, epitomized this feeling, becoming an ominous warning on the catastrophic consequences of a growing population driven by a consumerist, *laissez-faire* ideology.⁵⁶⁶

At the UN General Assembly, Pardo’s advocacy to legislate the still-to-be discovered resources of the high seas as belonging “to the common heritage of mankind” emerged from that context. Arvid Pardo, born in Italy in 1914, graduated in international law and engaged in the UN after the end of World War 2. He first worked for the Department of Trusteeship and Non-Self Governing Territories and for the Secretariat of the Technical Assistance Board, before being appointed Malta’s chief diplomat – the first permanent representative of the just-independent country.⁵⁶⁷ His 1967 discourse was framed in Malta’s request to bring to the fore, in the UN General Assembly’s discussions, the threats posed by new offshore mining technologies on national appropriation and militarization of the seabed.⁵⁶⁸ The Maltese government feared that

⁵⁶³ Pierre-Bruno Ruffini, “The intergovernmental panel on climate change.”

⁵⁶⁴ Global trends experienced an exponential growth between 1900 and 1960: global population duplicated from 1,65 billion to 3,04 billion; global energy consumption increased from 12,128 terawatts/hour to 41,7 terawatts/hour, and to feed the growing population, agricultural land doubled from 2,51 billion ha to 4,38 billion ha (source: www.ourworldindata.org). This exponential growth and its consequences as part of the Anthropocene is detailed in: Bonneuil and Fressoz, *The shock of the Anthropocene*.

⁵⁶⁵ Thirty-two African countries acquired its independence between 1960 and 1968 (Ranganathan, “Global commons”).

⁵⁶⁶ Hardin, “The tragedy of the commons.” First introduced in a speech for the Pacific Division of the American Association for the Advancement of Science (an audience constituted by scientists), reached wider dissemination thanks to its later publication in the journal *Science*. Historian Fabien Locher has traced the ideological, intellectual and political currents that informed the concept in: Locher, “Les pâturages de la Guerre froide.”

⁵⁶⁷ Ranganathan has compared the opposite backgrounds and ideology of Pardo and Hardin, and how those informed their claims on the “commons”, in: Ranganathan, “Global Commons.”

⁵⁶⁸ UN General Assembly, “Note verbal from the Permanent Mission of Malta,” August 18, 1967.

the most technologically capable nations appropriated marine regions beyond national jurisdiction – something that was already happening around its national seawaters regarding halieutic resources.⁵⁶⁹ Illegal fishing was becoming common across the Mediterranean Sea, while oil companies were moving prospecting activities each time further from the continental shelf. Pardo, voicing Malta’s concerns, denounced that those were the initial steps towards a sort of oceanic neocolonialism, where developing nations would fall again under the control of those more technologically developed.⁵⁷⁰

In Pardo’s speech, the seafloor was openly conceived as a territory to be occupied and governed, the battleground to define a new world order.⁵⁷¹ Three competing visions, depicted in Pardo’s discourse, informed international understanding of this new piece of land: the oceans as “the womb of life,” to be safeguarded; as a new economic frontier, with boundless richness susceptible to national appropriation; and as the great and still remaining common of mankind, whose resources should equally benefit all nations – preserving, exploiting, and sharing. Pardo’s advocacy for the still-to be discovered resources as belonging to the common heritage of mankind implied a peaceful (and arguably, utopian) approach to the oceans’ exploitation. As he suggested, an international mechanism defined by the UN would ensure the sharing of economic revenues from offshore mining activities. This source of funding offered a potential solution to world hunger and poverty – and, therefore, directly tackled global anxieties that pervaded the international landscape. Developing nations immediately sympathized with Pardo’s proposal, gathering for the first time around a unified position against the excesses of (technologically) developed nations.⁵⁷² At the same time, his thorough description of seabed’s “boundless treasures,” hidden in un-governed regions, drew the attention of the most developed nations to the deep seafloor while sparked fears of jeopardizing national access to them.⁵⁷³

⁵⁶⁹ UN General Assembly, First Committee Debate, November 1, 1967.

⁵⁷⁰ Argued by Hannigan, *The Geopolitics of Deep Oceans*. Historian Maria Gavouneli has highlighted how Pardo’s ideas fit on the ideological economic framework of his times. After World War 2, former colonial systems in African and Asian territories collapsed, being replaced by a neoliberal system that increased socioeconomic differences between countries with different technological and economic capabilities (Gavouneli, “From uniformity to fragmentation”).

⁵⁷¹ Hannigan, *The Geopolitics of Deep Oceans*.

⁵⁷² Barkenbus, “The politics of ocean resource exploration.” The North-South battle has been pointed out as one of the characteristic features of UNCLOS III, that sharply contrasted with the classical East-West clash that pervaded UNCLOS I and II (to expand about the topic see, for instance, Miles, *Global Ocean Politics*).

⁵⁷³ Hollick and Osgood, *New era of Ocean Politics*.

Pardo's speech triggered international interest to regulate the global commons, fostering to re-open negotiations in the UN to legislate the high seas (described as "the sea-bed and ocean floor underlying the seas beyond the limits of present national jurisdiction"). That same year, the UN created the ad hoc Committee on the Peaceful Uses of the Seabed and the Ocean Floor Beyond the Limits of National Jurisdiction, popularly known as "the Seabed Committee," composed by representatives from thirty-five nations including France.⁵⁷⁴ Gathered between 1968 and 1973, the Seabed Committee was responsible for studying Pardo's arguments, define an international regulatory system for the high-seas, and establish a legal framework for the exploration and exploitation of underwater resources under the regulation of a new international agency.⁵⁷⁵

6.1.2. Networks of power: France's international strategy through the CNEXO

Debates around an international ocean legislation coincided with the CNEXO's creation, fostering the integration of diplomatic affairs as one of the institution's main advisory roles. While the academic-industrial network was being developed to gather scientific data from the seafloor, la Prairie began to build further connections to transform the CNEXO into an information center on foreign oceanographic capabilities. The institution became what political scientist Pierre-Bruno Ruffini has called "the science-diplomacy nexus": an integrated organism where scientific and diplomatic affairs mingled to inform political decisions, which were in turn intrinsically scientifically-laden.⁵⁷⁶

La Prairie established a department of International Relations directed by his colleague and Naval commander Alain Sciard, who mediated with different government offices (like the Ministry of Foreign Affairs) and France's embassies in countries like the US, the UK, Japan, or Germany.⁵⁷⁷ In those, scientific attachés periodically reported Sciard about foreign oceanographic advancements, missions and results, annual budget for oceanography, and even

⁵⁷⁴ Composed by seven African states (Kenya, Liberia, Libya, Senegal, Somalia, Tanzania and the UAR), five from Asia (Ceylon, India, Japan, Pakistan, and Thailand), six from Latin America (Argentina, Brazil, Chile, Ecuador, El Salvador and Peru), eleven Western countries (Australia, Austria, Belgium, Canada, France, Iceland, Italy, Malta, Norway, UL and the USA), and six communist countries (Bulgaria, Czechoslovakia, Poland, Romania, USSR and Yugoslavia). In: Winthrop Haight, "United Nations Affairs. Ad Hoc Committee on Sea-Bed and Ocean Floor."

⁵⁷⁵ Barkenbus, "The The politics of ocean resource exploration." As Barkenbus notes, the UN was "tacking local seabed issues in a manner similar to its approach regarding outer space nearly a decade earlier." Buttigieg, "Arvid Pardo – a diplomat with a mission."

⁵⁷⁶ Bruno-Ruffini, "The intergovernmental panel on climate change."

⁵⁷⁷ La Prairie, Yves. Letter to Alain Sciard, June 29, 1967 (ANF, 20160129/328).

news on activities undertaken by private companies.⁵⁷⁸ Reports climbed from Sciard to la Prairie, and from him to different Ministries involved, constituting the basis to discuss strategies of bilateral and international cooperation.⁵⁷⁹ To represent the CNEXO at the UN meetings, la Prairie appointed lawyer Georgette Mariani, deputy head to the International Relations Department.⁵⁸⁰ Mariani, trained in international law at the universities of Harvard, Urbino, and Paris, was familiar with international diplomacy for her ten-year position as administrator at the Commission of European Community in Brussels.⁵⁸¹ Mariani participated at the UN Seabed Committee from its first meeting, reporting la Prairie about discussions and negotiations that had taken place – who, in turn, reported Minister of Foreign Affairs Maurice Schumann.⁵⁸²

The CNEXO also offered a space where extractive industries had a word in defining France's position at international, highly influential, committees. From 1967, la Prairie established a small working group to inform France's position in the Seabed Committee, constituted by representatives from the main oil firms and mining companies, experts in marine geosciences, and policy-makers from different ministries.⁵⁸³ This setting was not unprecedented, but probably drew inspiration from the US' Commission on Marine Science, Engineering, and

⁵⁷⁸ Just to mention some: Ambassade de France à Bonn, "Rapport Océanologie," June 1970 (ANF, 20080658/23); Mission Scientifique - Ambassade de France en Washington, "Les nouvelles structures de l'océanographie américaine," September 14, 1971 (20080658/22) and "L'enseignement des disciplines océanographiques aux États-Unis," July 1, 1970 (20080658/22); n.a. "L'océanographie en Italie", n.d. (ANF, 20080658/23).

⁵⁷⁹ Some examples of reports digested by the CNEXO's International Relations department are: Service Relations Internationales CNEXO, "L'année scientifique en Grande-Bretagne, 1970" (ANF, 20080658/23); Service Relations Internationales CNEXO, "Budgets océanographiques de quelques pays," January 15, 1970 (20080658/24); Service Relations Internationales CNEXO, "Contacts avec le Mexique en ce qui concerne l'océanographie," November 21, 1969 (ANF, 20080658/24).

La Prairie sent frequent letters to different Ministries reporting about the state-of-the-art of international collaborations (la Prairie, Yves. Letter to Minister of Scientific Research, "Bilan et perspectives de coopération internationale en matière d'océanographie," October 17, 1969 (20160129/328)), asking for their guidelines about Franco-German cooperation (la Prairie, letter to Minister of Scientific Research, April 21, 1967 (20160129/328)), or Franco-British cooperation (la Prairie, letter to Minister of Scientific Research, 29 Jan. 1969 (ANF, 20160129/326)); presenting the US budget to ocean sciences (la Prairie, note to M. Bally du Bois (Technical Advisor at the President's Cabinet), February 6, 1968 (ANF, 20160129/327)); or informing about new diplomatic contacts established (la Prairie, letter to Minister of Scientific Research, "Visite du Ministre de la République Arabe Unie," April 30, 1969 (ANF, 20160129/326)).

⁵⁸⁰ Schumann Maurice. Letter to Yves la Prairie, July 31, 1968 (ANF, 20160129/327); la Prairie, Yves. Letter to the Minister of Foreign Affairs, June 13, 1968 (ANF 20160129/327).

⁵⁸¹ Lacharrière, "Georgette Mariani à la III Conférence des Nations Unies sur le Droit de la Mer."

⁵⁸² Mariani, Georgette. "Schéma de discussion à propos de l'étude du Secrétariat Général des Nations Unies sur un mécanisme International", June 13, 1969 (20160129/325); la Prairie, Yves. Letter to the Minister of Foreign Affairs, November 24, 1969 (20160129/325).

⁵⁸³ Mariani, Georgette. "Problèmes juridiques posés par l'exploration et exploitation du sol et sous-sol marin", n.d. (ANF, 19980125/02). The presence of oil companies in the ad hoc working group was also emphasized during a meeting of the Administrative Council (in: CNEXO, "Procès-verbal de la séance du Comité d'Administration," November 26, 1970 (ANF, 19980125/02)). However, it is not mentioned who was involved, and from which companies.

Resources, ushered in May 1966 to assess and advise the American government on oceanographic issues and recommend an overall national oceanographic program. The Stratton commission, as it was known after its president Dr. Julius A. Stratton (chairman of Ford Foundation and recently-retired president of the MIT), was constituted by fifteen eminent American delegates from industry, universities, and the state and federal governments, plus four congressional advisors. The group gathered and pooled the advice, needs, and concerns from different stake-holders in the uses of the oceans, including the hard-mining industry, the American Petroleum Institute, and the US Navy, in order to define the American position during UN discussions.⁵⁸⁴ According to its members, the Commission had an “unparalleled and unprecedented influence” on driving American marine policies and priorities for thirty years.⁵⁸⁵ In a similar vein, the CNEXO constituted a node where public and private stake-holders, representatives of new and traditional uses of the oceans, could voice their interests and concerns. Because it was a point of convergence for scientific oceanographic data and foreign policy information, experts at the working group possessed enough information to confront different interests at play, to assess France’s technological and economic capabilities in regard to other nations, and to define a unified national position that articulated scientific, economic, and political interests.⁵⁸⁶

At the Seabed Committee, which began to meet in 1967, France perceived itself as being among the most advanced nations in ocean capabilities by means of the CNEXO. This manifested in the stance the French delegation adopted: just next to the US delegation, who boldly affirmed to be “a major maritime power and the leader in ocean technology.”⁵⁸⁷ The “common heritage of mankind” was the indisputable principle upon which a mechanism to regulate resource exploitation on the high seas should be built. Establishing an international administrative body, which would distribute the benefits of seabed resources and have the power to license seabed uses, became a popular idea among the thirty-five participant nations. However, tensions arose when defining the boundaries of international seawaters: developing nations tended to claim for extending national jurisdiction over large underwater areas and the establishment of a strict

⁵⁸⁴ Hollick, *US Foreign Policy and the Law of the Sea*.

⁵⁸⁵ Merrell, Katsouros, Bienski, “The Stratton Commission.”

⁵⁸⁶ Mariani, Georgette. “Problèmes juridiques posés par l’exploitation du sol et du sous-sol marin. Le rôle du CNEXO” (ANF, 19980125/02); also Mariani, “Schéma de discussions à propos de l’étude du Secrétariat Général des Nations Unies sur un Mécanisme International,” July 31, 1969 (20160129/325).

⁵⁸⁷ French position specified at: Mariani, “Schéma de discussions à propos de l’étude du Secrétariat Général,” July 31, 1969 (20160129/325). American power stated by Nixon, in: Nixon, “Statement About United States Oceans Policy.”

legal regime on the high seas; while developed nations – led by the US – leaned towards a narrow strip of national seawaters.⁵⁸⁸ The US hard mining industry’s lobby and the Navy’s security concerns had informed this position: restricting the extent of national seawaters would enable the US Navy to freely move its fleets around the world’s ocean without interfering with foreign authorities; and, to govern the high seas, the US delegation argued for a loose international authority on seabed mining – “less likely to be troublesome” than most autonomous national regimes.⁵⁸⁹ This position was based on anticipation: a legal international regime was essential to avoid an open confrontation on resource exploration and exploitation, or to prevent that some nations monopolized the most potentially rich regions. Yet, it should be loose enough to enable taking positions in the seafloor before the effective exploitation began.⁵⁹⁰

The Seabed Committee succeeded in bringing to the UN General Assembly a first proposal to regulate economic exploitation in the high seas, enacted on December 15, 1970. The “Declaration of Principles governing the sea-bed and the ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction” specified the general guidelines of an international regime to govern these regions: only peaceful activities could be undertaken, the exploration and exploitation of natural resources for the benefit of all mankind was to be developed under an international regime, and there would not be neither appropriation, nor claims of sovereignty, over resources or territory; while benefits would be shared among coastal nations.⁵⁹¹ However, the Committee failed in a defining a fine-grained regulatory mechanism and in precisely drawing the boundaries between national and international seawaters.⁵⁹² Moreover, as international excitement on the economic promises of the ocean floor rose, more nations joined the Committee: if in 1967 it was challenging to find its thirty-five constituting members, next year nine countries joined and, by 1971, ninety-one had representatives at the Seabed Committee to define the high seas’ legal framework.⁵⁹³ The Third Convention of the Law of

⁵⁸⁸ Nixon, “Statement About United States Oceans Policy”; Mariani, “Schéma de discussions à propos de l’étude du Secrétariat Général,” July 31, 1969 (20160129/325).

⁵⁸⁹ Described in Hollick, *US Foreign Policy and the Law of the Sea*. In the US, the oil industry disagreed with the hard mining industry: while the firsts were benefited by extended continental shelves, mining companies would benefit from narrow ones. Finally, the position adopted was selected for being more beneficial to military interests. Hollick and Osgood, *New era of ocean politics*.

⁵⁹⁰ Expressed by Nixon, Richard “Statement About United States Oceans Policy,” May 23, 1970. About the role of anticipation in informing decisions at UNCLOS, see: Robinson, “Scientific imaginaries and ocean diplomacy.”

⁵⁹¹ UN General Assembly, Resolution 2749 (XXV) of December 17, 1970.

⁵⁹² Winthrop Haight, “United Nations Affairs. Ad Hoc Committee on Sea-Bed and Ocean Floor.”

⁵⁹³ Miles, “The structure and effects of the decision process in the Seabed Committee.”

the Sea, initiated in Caracas in 1974, was aimed at reaching an international agreement on how to regulate the high seas.

Against this backdrop, characterized by a benign rhetoric and collaborative approaches to the high seas' legal issues, France's nationalistic mindset spilled in public discourses delivered by CNEXO managers (but not from its scientists). Jacques Perrot, vice-director and right-hand of la Prairie, exemplified France's international strategy in the oceans during a conference to the National Association of Reserve Officers, by asserting that:

Les concurrents sont de plus en plus nombreux à se joindre à la course, mais l'aventure océanographique n'est pas un 100m où chaque sprinter dispose de son couloir, c'est une course de fonds où la tactique compte presque autant que le souffle. Or, dans une telle course, il s'agit de ne pas se laisser enfermer ; dès le départ, il faut prendre la corde en tête ; un fois la course lancée, les efforts à faire pour sortir du peloton et retrouver éventuellement une place que l'on a laissée échapper au départ, sont démesurés par rapport à la pointe du démarrage.⁵⁹⁴

The race metaphor translated into a quest to establish convenient relations with those nations that, in one way or another, would render France access to the deepest ocean floor, with whom they could develop scientific expeditions "for the benefit of mankind" (this is, avoiding explicit military or commercial implications), and as means to strengthen France's international power.⁵⁹⁵ European nations were regarded as delayed in ocean matters, since none had established a centralizing structure like the CNEXO with whom to mediate.⁵⁹⁶ The Inner Six (Belgium, France, Italy, Luxemburg, Netherlands, and West Germany) started meeting in January 1968 to delineate a cooperative program in ocean sciences, but la Prairie criticized that the proposed goals were not aligned with the CNEXO's ambitions: representatives from

⁵⁹⁴ "Each time more competitors are joining the race, but the oceanographic adventure is not a 100-meters where each one runs in its own corridor, it's a long-distance race, where tactics are as important as breath. From the very beginning, we need to take the leadership, since once the race has begun, the efforts to leave behind the bulk of racers and find a new place [at the forefront] will be excessive if compared with the efforts required at the beginning." Perrot, Jacques, Conference "Aspects Économiques De L'Exploitation Des Océans," April, 1970 (ANF, 20160259/323). About how competition was articulated with cooperation, see: Robinson, "Early Twentieth-Century Ocean Science Diplomacy"; Martínez-Rius, "For the Benefit of All Men."

⁵⁹⁵ Explicitly stated in: Programme National d'Océanographie - Chapitre 3. Les choix du CNEXO, n.d. (ANF, 19980125/1). On avoiding military or commercial implications in international cooperation: La Prairie, Yves. Confidential letter to the Minister of Scientific Research, November 29, 1967 (ANF, 20160129/328).

⁵⁹⁶ DGRST, "Note sur le projet de création d'un Centre National d'Etudes Océanographiques," October 5, 1964 (ANF, 19920548/19).

universities, who dominated the meetings, pushed for cooperation in “fundamental oceanography” instead than “on preparing the future exploitation of the oceans.”⁵⁹⁷

Conversely, the US, the USSR, Japan, the UK, and Canada were deemed as conducive partners: the first two were the only nations that had built a centralizing ocean policy, while Japan and Canada were investing large budgets to prepare the oceans’ exploitation (table 4).⁵⁹⁸ Indeed, the unit to measure the nation’s advancements in ocean exploitation was not the economic revenue coming from a *de facto* exploitation, but the investment in *exploring* the oceans. For CNEXO managers, public expenditures in oceanographic research were deemed the rule to estimate the nation’s potential to extract marine resources in a nearby future.⁵⁹⁹

	1969	1970	1971
US	565,7*	-	332,7
Japan	8	18	27
France (CNEXO)	8,8	12,8	16,2
UK	32,3	-	33,2
West Germany	-	32,3	33
Canada	32,3	28,7	-

Table 4. Public investment in ocean research (in 1970 million US dollars), based on the information gathered at the CNEXO’s department of International Relations (* 3/5 funded through military contracts). 1960 and 1970 data from la Prairie, “Fiche sur l’effort français en océanologie,” January 12, 1970 (ANF, 20160129/325). 1971 data from: CNEXO, “Effort financier public poursuivi en matière océanologique par les principales puissances industrielles,” September 19, 1972 (20160259/318).

Implementing its diplomatic strategy, by 1971 France had established solid bi-lateral collaborations with the US, Japan, and the USSR under the rhetoric of cooperating for a common good.⁶⁰⁰ At the other side of the coin were France’s ambitions to re-shape power relations with the US by standing next to its side in ocean exploration; set a foot in the deep

⁵⁹⁷ Perrot, Jacques. Letter to the Minister of Scientific Research, February 13, 1968 (ANF, 20160129/327); la Prairie. Yves, confidential note to the Minister of Scientific Research, January 31, 1969 (ANF, 20160129/326). Also discussed in: Conseil Administration CNEXO, “Procès-verbal de la 2^{ème} réunion,” October 5, 1967 (ANF, 19980125/1).

⁵⁹⁸ DGRST, “Note sur le projet de création d’un Centre National d’Etudes Océanographiques,” October 5, 1964 (ANF, 19920548/19). The budget invested by these countries appears detailed in: la Prairie, “Fiche sur l’effort français en océanologie,” January 12, 1970 (ANF, 20160129/325).

⁵⁹⁹ As described above, when the French government began funding fundamental ocean sciences in 1958-1965 it followed the rationale of a “linear model of innovation,” in which fundamental science leads to useful knowledge, which translates in the enhancement of industrial processes and commercial activities. La Prairie’s mindset seem to follow a similar way of thinking: effort in exploration would directly translate in exploitation capabilities and that, into commercial revenues.

⁶⁰⁰ About bi-lateral collaborations in 1971: Conseil Administration CNEXO, “Procès-Verbal de la séance du Conseil d’Administration,” November 26, 1970 (ANF, 19980125/2).

Pacific to explore polymetallic nodules by approaching Japan; and learn about the USSR oceanographic capabilities while maintaining cordial diplomatic relations.

6.2. Franco-American diplomatic relations through the CNEXO

6.2.1. Emulating US oceanography: Research centers, training, and the American way of doing marine sciences

From the CNEXO's inauguration, in April 1967, la Prairie undertook a persistent policy to approach the US. For two decades, the Americans had been at the forefront of the oceans' exploration, so if he aimed at situating the CNEXO in a similar position, he deemed crucial to establish friendly contacts with American oceanographic structures and import to the CNEXO the key elements of the US success.⁶⁰¹

La Prairie was quick in opening a conversation with Edward Wenk Jr., Executive Secretary of the National Commission on Marine Science, Engineering and Resources – the CNEXO's counterpart in the US.⁶⁰² Wenk, trained as civil engineer at Johns Hopkins University, had worked as engineering specialist in submarines for the US Navy before turning to policy-making. In 1959 he was appointed the first science policy advisor to the US Congress, playing diverse advisory roles at the White House in the administrations of Presidents Kennedy and Johnson, where he had led the establishment of the National Commission on Marine Science.⁶⁰³ On their correspondence, Wenk and la Prairie convened that the concerns and interests of the Commission and the CNEXO were very similar, which led la Prairie to anticipate in a private letter to the Minister Maurice Schumann, by then France's Minister of Scientific Research and Atomic and Space Matters, a likely future cooperation with the US.⁶⁰⁴

⁶⁰¹ I have analyzed Franco-American ambiguous relations between cooperation and competition in marine sciences in: Martínez-Rius, "For the benefit of all men." This section is partially based on this publication.

⁶⁰² According to la Prairie (*Ce siècle avait de Gaulle*, 353), he first contacted with Wenk on April 7, 1967, but there is no written evidence in la Prairie's correspondence until December 20, 1967 where he answers a previous letter from Wenk (la Prairie, Yves. Letter to Edward Wenk, December 20, 1967 (ANF, 20160129/328)). La Prairie highlights Wenk's interest on the CNEXO in both sources. About the American ocean policy, see: Wenk, *The Politics of the Ocean*. About how Johnson's administration sought to use environmental sciences as a tool for foreign policy (notably oceanography and meteorology), see: Doel and Harper, "Prometheus Unleashed."

⁶⁰³ The Seattle Times, "Edward Wenk Jr. Obituary." Seen in p.130-131.

⁶⁰⁴ La Prairie, Yves. Letter to Edward Wenk, December 20, 1967 (ANF, 20160129/328); la Prairie, Yves. Letter to M. Jean-Louis Chaussende (deputy chef to Maurice Schumann, Ministry of Scientific Research), October 17, 1967 (ANF, 20160129/328). The correspondence at the Archives Nationales de France seems to be incomplete, and does not include most of the incoming letters by Wenk.

La Prairie ambitioned to identify which were the keys of the American success in oceanography, those elements that had kept them as world leaders in exploring the oceans. For that, the reports Daniel Frèrejacque, scientific attaché at France's Embassy in the US, sent to the CNEXO's International Relations department offered a first glimpse. Frèrejacque periodically reported la Prairie about the latest American advancements in ocean sciences, summarized discussions held at the US Congress, collected information on the public annual budget devoted to ocean sciences, and described the US higher education system.⁶⁰⁵ One of his reports, for instance, offered fine detail on the oceanic domains where federal budget was to be allocated in 1968: national defense headed the list with 200 million dollars, followed by fisheries (50 million dollars), transportation, leisure activities, control of pollution, international cooperation, medicine, and coastal protection (with an investment of barely 1,6 million dollars). Oceanographic research had received 75 million dollars, followed by hydrographic studies (40 million dollars), forecast (21 million dollars), equipment (10,5 million dollars), and training (5,5 million dollars).⁶⁰⁶ The American budget devoted to ocean sciences was estimated in seventeen times the budget France was investing – even though the US population was four times bigger, and its GDP, 7,5 times France's GDP.⁶⁰⁷ Besides the higher economic investment in knowing the oceans, these reports distilled that the US success in ocean exploration could rely on the training system, interdisciplinary and tightly articulated with industrial needs; the government's large support to fundamental research in academic laboratories, and the structure of oceanographic centers, which stimulated inter-disciplinary exchanges.⁶⁰⁸

Informers in US governmental bodies offered valuable information, yet la Prairie aimed at appointing a direct advisor knowledgeable about the American way of doing ocean sciences, familiar with the international scientific community, who could help him in molding the CNEXO in the shape of US research institutions. For his vast experience in the American research system, he recruited Xavier le Pichon, appointing him Scientific Adviser to the General Director.⁶⁰⁹ For la Prairie, as important was le Pichon's research experience in using cutting-

⁶⁰⁵ La Prairie, Yves. Letter to Daniel Frèrejacque (Scientific Attaché at the French Embassy in the US), September 12, 1967 (ANF, 20160129/328).

⁶⁰⁶ Frèrejacque, Daniel. "L'océanographie aux États-Unis," July 17, 1967 (ANF, 20160129/328).

⁶⁰⁷ n.d. "Note d'information – budget Océan des USA," n.d. (ANF, 20160129/328).

⁶⁰⁸ Frèrejacque, Daniel. "Eléments d'information pour M. le Président du CNEXO. L'océanographie aux États-Unis," July 17, 1967 (ANF, 20160129/328); Frèrejacque, "Nouveau plan d'action en faveur de l'océanologie aux États-Unis," January 21, 1969 (ANF, 20080658/22). In this case, they were referring to non-military research, like industries devoted to exploitation of natural resources and technological development.

⁶⁰⁹ As detailed in chapter 5, p.155-56, la Prairie specified how interest he was in le Pichon's American experience in a letter to M. Parker (Technical Advisor at the Ministry of Scientific Research), June 26, 1968 (ANF,

edge theories and technologies in marine geosciences as the eight years he spent working inside the American scientific community. Le Pichon had first-hand experience on how research was organized and supported, the mechanisms of exchange and collaboration with other teams and marine industries, and the governmental programs aiming at the oceans' exploitation. Le Pichon entered on-board the CNEXO in February 1968. Following his advices, la Prairie would hasten in shaping a new oceanographic center in the mold of US institutions, to send French researchers to the US, and to import the American way of doing science to the CNEXO.⁶¹⁰

In March 1968, la Prairie traveled to the US in an official trip to participate in the second meeting of UN experts in Marine Science and Technology, held in New York. La Prairie used his trip to meet prominent experts – both scientists and policy-makers – of American oceanography. Wenk conducted private tours for him around the Lamont Earth Observatory, the Woods Hole Oceanographic Institution, the University of Miami, and the Scripps Institution of Oceanography, and organized la Prairie's visit to the White House to meet the American vice-president Hubert H. Humphrey, who was overseeing American ocean policy under Johnson's administration.⁶¹¹ Despite diplomatic tensions between both countries, Humphrey warmly welcomed la Prairie, exclaiming that he was and would always be “deeply Francophile.”⁶¹² They discussed how their ambitions in ocean exploration aligned, envisioning a Franco-American cooperation.⁶¹³

This trip reinforced previously held opinions by le Pichon on the American oceanographic supremacy: the high-quality of the US research centers, which were well-founded, supported by heavy research equipment (as submersibles and large vessels), and a structure that facilitated cross-disciplinary studies, were among the keys to American oceanography's success. From la Prairie' visit to the US, reports facilitated by France's Embassy, and le Pichon's advices, the CNEXO held large amounts of information about American research institutions, from detailed maps of their organization to statistics about the centers' capacity and space devoted to each

20160129/327), and in a letter to the Associate Director of the Lamont Earth Observatory, J.L. Worzel, March 28, 1968 (ANF, 20160129/327).

⁶¹⁰ Le Pichon, Xavier, “Réflexions sur l'Etat de l'Océanographie Française,” October 10, 1968 (ANF, 20160129/327).

⁶¹¹La Prairie, Yves. Letter to Edward Wenk, December 20, 1967 (ANF, 20160129/328).

⁶¹² La Prairie, Yves. Letter to the Minister of Scientific Research, March 20, 1968 (ANF, 20160129/327).

⁶¹³ Collaboration would be established between the CNEXO and the NOAA, a research institution that was established in October 1970 after the recommendations issued by the National Commission on Marine Science, Engineering and Resources.

activity.⁶¹⁴ Based on that information, the CNEXO bluntly drew inspiration to build their own research center, the *Centre Océanologique de Brest* (COB).⁶¹⁵

Situated on the Atlantic shore, the COB would contribute to advance the exploration of the French Atlantic continental shelf, equal to one third of France's emerged lands and promising in hydrocarbons (as seen in chapter 5).⁶¹⁶ International cooperation to explore the high seas would also be benefited, as Brest constituted an open door to the North Atlantic Ocean; while cooperation with the Navy's Hydrographical Service and fishing industries would be fostered thanks to the proximity of their headquarters to Brest. The COB gathered and managed the utilization of France's research resources, from vessels to submersibles, constituting the CNEXO's arm to implement its oceanographic agenda. As stated in an article published in the journal *Science*, the COB was "both a symbol and the first fruits of a new concentrated national attack on oceanographic problems," concluding that "[France] seems to feel that in oceanography an investment of this size will keep them in a competitive position with regard to other nations."⁶¹⁷

The COB became the ground to implement a new training program shaped by the CNEXO, different from the academic training learned at universities. Le Pichon advised La Prairie that, if goal was to train a pool of proficient experts, capable of working in international, cooperative, and multidisciplinary projects, the CNEXO needed to recruit the best young researchers in France and encourage them to travel abroad.⁶¹⁸ Besides meaningful for their scientific training, these exchanges would be pivotal to import information, expertise, and the American research model as tools to boost French oceanography. By training abroad, these experts would develop the capacity to effectively represent France, to report upon return about foreign developments, and to evaluate how France's potential was considered in the international community – all of them essential elements to the CNEXO's diplomatic strategy.

La Prairie profited his just-established contact with American oceanographers to start sending French young researchers to US research centers. The case of marine geophysicist Jean Bonnin,

⁶¹⁴ Folder "Centres de Recherche 1969" (ANF, 20080658/22).

⁶¹⁵ The COB was built between 1968 and 1971, devoting a 2-million-dollar budget (CNEXO, "Fiche sur le futur Centre d'Océanologie de Brest," n.d. (ANF, 20160129/328).

⁶¹⁶ Hardy, "Exploring the Shelf."

⁶¹⁷ Ibid.

⁶¹⁸ La Prairie, Yves. Letter to the Minister of Scientific Research, November 29, 1967 (ANF, 20160129/328); le Pichon, Xavier. "Rapport confidentiel: réflexions sur l'état de l'océanographie française et ses possibilités de développement en géologie, géophysique et physique," October 10, 1968 (ANF, 20160129/327).

hosted at the Lamont Geological Observatory for one year under the CNEXO's sponsorship, is illuminating. Bonin, graduated at the *École Normale Supérieure* in geology, orientated his career towards the study of global tectonics during his stay at the Lamont, from 1968 to 1969. There he learned to conduct paleomagnetic studies in the deep North Atlantic and to analyze outcoming data, while getting involved in current and cutting-edge discussions on plate tectonics. The economic support he obtained from the CNEXO was enough to acquire and bring back with him the device utilized by Lamont experts to conduct paleomagnetic surveys (a measuring chain).⁶¹⁹ Upon return, Bonnin exhaustively reported la Prairie about the skills they had learned and the technologies he had used, the scientific projects the American government was supporting, and the scientists he had met. For the next four years, Bonnin was engaged at the COB, where his just-acquired American expertise was well-profited.⁶²⁰

At Brest's center, le Pichon was responsible for gathering a research team in marine geology and geophysics by hiring young and "promising" – as la Prairie phrased it – researchers from universities around the country.⁶²¹ Guy Pautot, recruited from the University of Paris, was among the first who engaged in the new center. Pautot had just obtained his *Thèse d'Etat* in geology and geodynamics by studying the Mediterranean continental margin off Cannes.⁶²² Being at the CNEXO, Pautot would have privileged access throughout his career to research opportunities unattainable at academia: he embarked numerous times on deep-sea submersibles, led 65 surveys in the Mediterranean and 95 across the Pacific Ocean, and was among the first French researchers who participated in the Deep Sea Drilling Project (see chapter 7). Other colleagues joined him from the University of Paris, like Jean Mascle and Jean-Marie Auzende, attracted by the bountiful research opportunities the new research center offered.

Le Pichon's elite team would develop a new approach the seafloor's study, where disciplinary fragmentation of research (characteristic of academic laboratories) was substituted by international and inter-industrial cooperation, while their playing ground moved from local Mediterranean regions to expand across the high seas. According to le Pichon, the American

⁶¹⁹ CNEXO, "Contrat 68/43 géothermique et magnétisme marines. Responsables: J. Bonnin et B. Leclerc du Sablon," 1968, n.d. (ANF, 20110381/07).

⁶²⁰ Ibid., CNEXO, "Intégration Jean Bonnin," April 29, 1970 (ANF, 20160129/324).

⁶²¹ La Prairie, Yves. Letter to Xavier le Pichon, January 11, 1968 (ANF, 20160129/327); CNEXO, "Fiche sur le futur centre d'océanologie de Brest," n.d. (ANF, 20160129/328). By 1967 half of French oceanographers worked in Parisian universities, whereas there were twice as many Mediterranean research centers as on the Atlantic coast (in: la Prairie, Yves. Letter to the Minister of Scientific Research, November 29, 1967 (ANF, 20160129/328).

⁶²² Pautot, Guy, *Étude géodynamique de la marge continentale au large de l'Estérel*; CNEXO, "intégration Guy Pautot," October 20, 1969 (ANF, 20160129/325).

model of “doing science” relied on the massive acquisition of data during long and far-away campaigns.⁶²³ In his view, such methodology constituted the basis of the international credibility of an oceanographic center – and the CNEXO enjoyed a budget large enough to implement it.⁶²⁴ Therefore, oceanographic surveys sponsored by the CNEXO were characterized by mobilizing numerous technological and human resources to acquire large amounts of data. The first example, as presented in the previous chapter, was the campaign NORATLANTE I. This research style, completely opposite to traditional academic research (marked by squeezing up the most the limited sets of data available), was characteristic of big science projects.⁶²⁵ In this sense, the CNEXO marked an inflecting point in France’s ocean sciences, epitomizing the transition towards a big science setting.

6.2.2. Collaboration in the high seas: the project FAMOUS

As French structures resembled American oceanography by leaps and bounds, relationships between the CNEXO and its American counterparts intensified. In April 1968, la Prairie and the American vice-president Hubert H. Humphrey initiated talks to establish a cooperative treaty that materialized in February 1970 in a Bilateral Agreement in exploration of the oceans, signed between la Prairie and Wenk.⁶²⁶

The Agreement’s principles reflected the interest of both nations to explore the great depths, framed in the discussions that were simultaneously taking place at the United Nations. In the first Article was stated that any cooperative project should, above all, “advance study and effective utilization of the sea for the benefit of all men.”⁶²⁷ This exhibition of good will was phrased in a rhetoric inspired in the “common heritage of mankind” concept; yet, the Franco-

⁶²³ Notably characteristic of the Lamont, under the leadership of Maurice Ewing.

⁶²⁴ Le Pichon, “Mission NESTLANTE I.”

⁶²⁵ Some academic geologists have criticized the CNEXO’s research style, arguing that more data does not necessarily led to produce better science. Quite on the contrary, in some occasions their excess of data made CNEXO geophysicists lose key elements for studying particular processes and events (Martínez-Rius, “Interview to G. Boillot”).

⁶²⁶ La Prairie, Yves. Letter to the Minister of Scientific Research, March 20, 1968 (ANF, 20160129/327); Mission Scientifique de l’Ambassade de France en Washington, “Evolution de la coopération scientifique et technique Franco-Américain,” n.d. (ANF, 20080658/22).

⁶²⁷ Wenk Jr., “Terms of Reference for Marine Science Cooperation between the National Center for the Exploration of the Oceans of France and the National Council on Marine Resources and Engineering Development of the United States of America,” in: Wenk, Edward J. Letter to Yves la Prairie, January 20, 1970 (ANF, 20080658/22). The discourse of “the benefit of all men” was rather common in that period. Given the public refusal to the Vietnam War and the East-West tensions, the American administration was reluctant to frame any other venture in a heated competition against other nations (Hamblin, *Oceanographers and the Cold War*, 244).

American Agreement also reflected the position adopted by both countries at the forefront of ocean exploration, recognizing themselves as its leaders.⁶²⁸ Because its spokesmen (la Prairie at the CNEXO, Wenk and Humphrey at the NOAA) recognized their institutions as being situated in an equivalent position, an equitable partnership in carefully selected projects could bring mutual benefits in exploring new territories and in exchanging technologies, expertise, and scientific knowledge.⁶²⁹ Therefore, from the Agreement's signature, the CNEXO began to work on building an environment of mutual trust, where both communities could exchange information and design joint programs to access the great depths side by side.

Their joint technological capabilities to reach the deep ocean floor were first displayed in the ambitious project FAMOUS (French-American Mid-Ocean Undersea Study), a five-year oceanographic program to study phenomena occurring at the edge of tectonic plates, in the mid-Atlantic ridge. From 1967, the identification of continental drift and the first publications proving plate tectonics theory spurred global interest to study the dynamics of the oceanic crust. Rifts, deep-sea regions where new ocean crust creates, were at the spotlight of engineers and geophysicists around the world, who competed to develop ingenious technologies to study these areas in situ.⁶³⁰ Depth was the challenging factor, as it was almost impossible to conduct studies from on-board and geophysical techniques did not possess a resolution high enough to understand the processes occurring in the mid-ocean ridges. It was necessary to go and see, to recover samples and to take pictures – something that could only be achieved by using manned submersibles, capable of diving up to 3,000 meters depth.⁶³¹

France and the US were the only countries who possessed technologies capable of reaching such depths: the French Navy counted with the *Archimède*, a submersible christened in 1961 and utilized in more than a hundred deep divers; and the *Scoupe Plongante 3000* (renamed *Cyana*), that belonged to Jacques Cousteau's group (fig. 24 and 25). In the US, the American Navy had just refurbished their submersible *Alvin* to perform scientific missions.⁶³² The just-signed treaty of bilateral cooperation constituted an excellent opportunity to demonstrate

⁶²⁸ In Robinson, "Scientific imaginaries and ocean diplomacy" analyzes the same will but from the American perspective, where policy-makers and oceanographers interested in marine exploitation were eager to be the ones who would "conquer the oceans" first.

⁶²⁹ Sciard, "Réflexions et suggestions sur la politique de coopération internationale du CNEXO," September 16, 1971 (20160129/321).

⁶³⁰ Riffaud and le Pichon, *Expédition FAMOUS*.

⁶³¹ Ibid., for a first-hand account of FAMOUS expedition.

⁶³² Oreskes, "A Context of Motivation."

mutual confidence by pooling their submersibles and budget to organize a large-scale project.⁶³³ The organization of FAMOUS revolved around the use of manned submersibles instead than on the scientific goals, which points to the international relevance of such a display of technological prowess. In the words of Alain Sciard, at the CNEXO's International Relations Department, the mission was above all addressed at "striking the opinion of the scientific community and of the general public, which can only be profitable for us."⁶³⁴ *National Geographic* ensured a massive media coverage throughout the scientific program from its inception to its end. In other words, FAMOUS was addressed at contributing to marine geosciences while strengthening France's position in the high seas.

FAMOUS stimulated the exchange of researchers between France and the US and, with them, the transfer of expertise, technologies, and scientific knowledge.⁶³⁵ Xavier le Pichon led the French team, who took active part in organizing the mission, toured around American research centers, and visited numerous times the facilities housing the *Alvin*.⁶³⁶ Beyond learning from the American institutions, le Pichon and his colleagues benefited from an exclusive training: from conducting fieldwork in Iceland in order to become familiar with a landscape similar to the environment they would confront 3,000 meters below seawater; to dive onboard the *Archimède* in the Mediterranean to simulate the diving conditions at which they would be exposed in the deep Atlantic.

⁶³³ Ibid., where Naomi Oreskes has presented the project FAMOUS from the American's perspective. The project's organization from the US has been described in Ballard, "The History of Woods Hole's Deep Submergence Program" and, from the French perspective, in Jarry, *L'aventure des Bathyscaphes*.

⁶³⁴ Sciard, "Réflexions et suggestions sur la politique de coopération internationale du CNEXO," September 16, 1971 (20160129/321).

⁶³⁵ La Prairie, Yves. "Note pour Monsieur le Contrôleur d'Etat," July 30, 1970 (ANF, 20160129/324).

⁶³⁶ Constituted by the COB geophysicist Jean Francheteau, Gilbert Bellaiche (sedimentologist from Villefranche-sur-Mer), Jean-Louis Cheminée (volcanologist at the CNRS) and Pierre Choukroune (geologist at the University of Rennes).

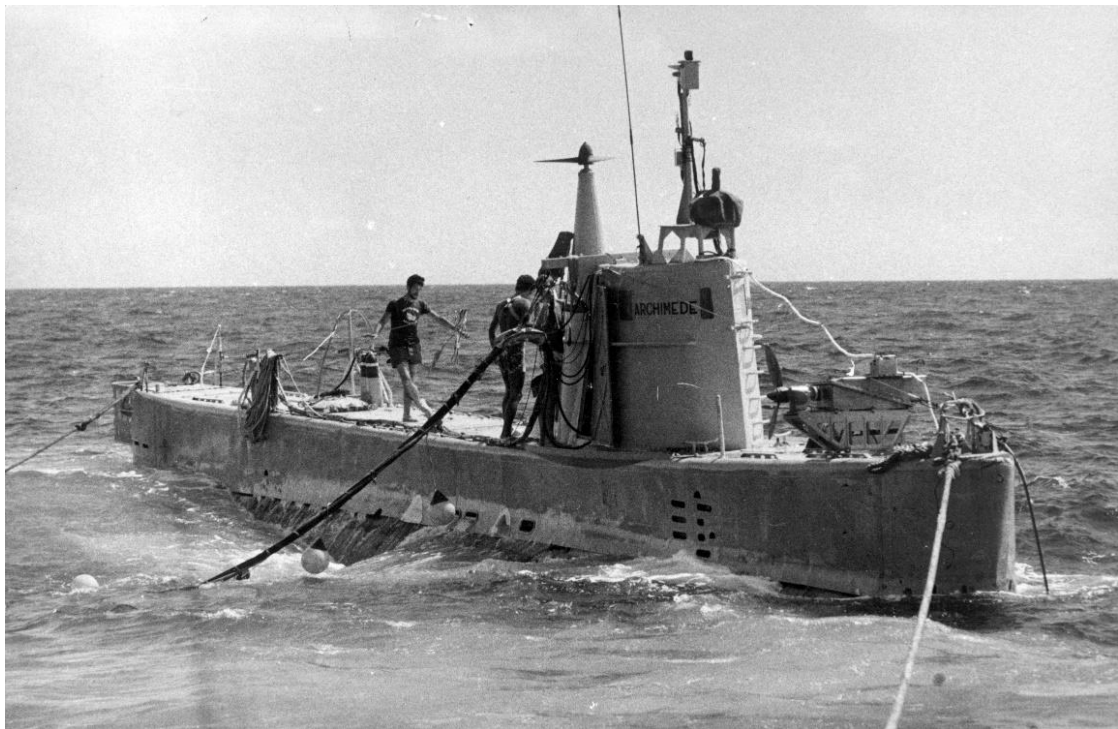
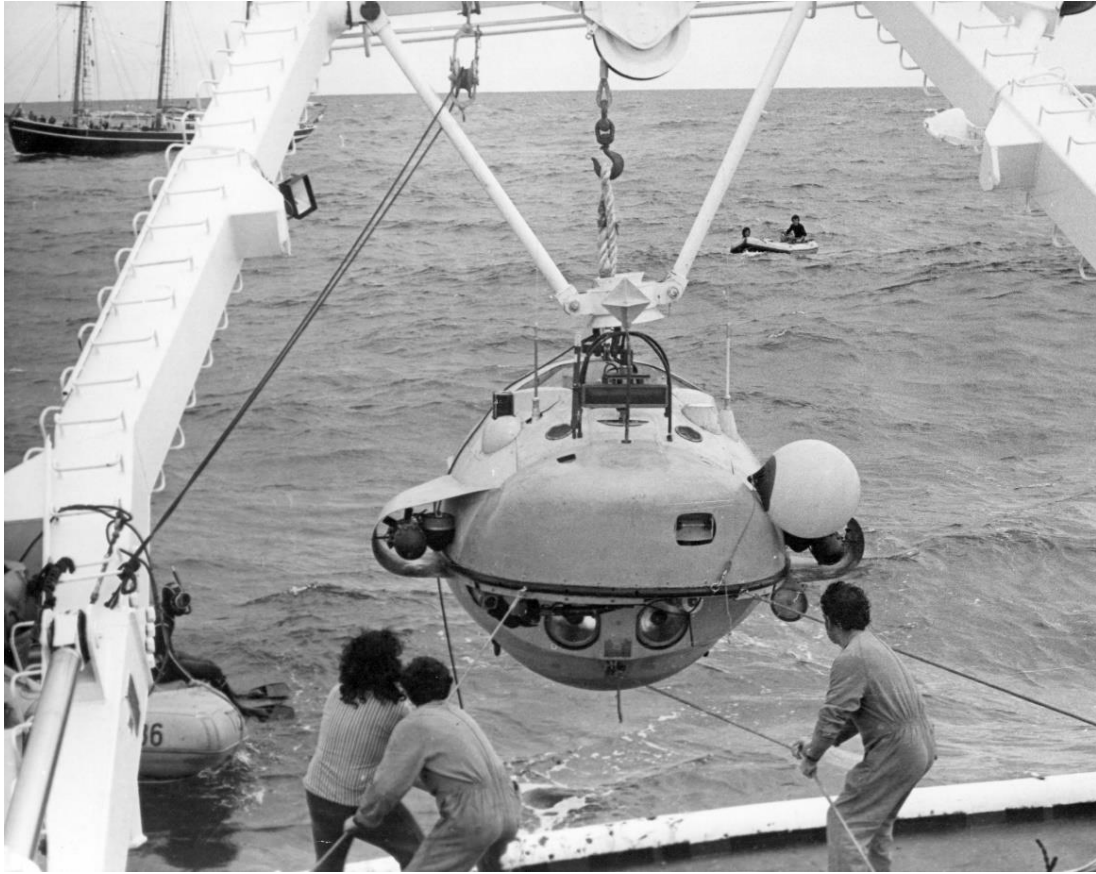


Figure 24 (above) and 25 (below). Deep-sea diving submersibles *Cyana* and *Archimède* during FAMOUS campaign (source: WHOI virtual collection).

On August 2, 1973, the first phase of project FAMOUS began.⁶³⁷ The *Archimède*, with le Pichon on-board, dove more than 2,700 meters depth in the mid-Atlantic ridge, capturing for the first time images of oceanic crust in formation. There was no precedent that humans have captured images of such depths, in the middle of the ocean. After the success of the first diving, the Franco-American team organized the second stage of the program, starting the following summer, where the three submersibles were simultaneously mobilized to explore different regions: the *Cyana* explored the rough territory of the transforming fault, while the *Archimède* studied the transition zone between the fault and the rift, and the US *Alvin* would dove into the rift itself. Each submersible conducted more than a dozen immersions, which resulted in 167 sample operations that brought to the surface two tons of volcanic rock; besides the 23,000 underwater pictures took by astonished geologists during the two hundred hours they had spent under the ocean.

During the following years, American and French experts kept on meeting to analyze, interpret, and publish the results, which contributed to strengthen collaboration between both countries. Scientific results provided solid evidence that oceanic crust forms in mid-ocean ridges during processes of active vulcanism. Some samples, rich in manganese, showed that the origin of this and other strategic minerals could be found in hydrothermal vents, that should appear in underwater regions experiencing active vulcanism (yet hydrothermal vents were not discovered until 1978, during an *Alvin* mission across the Pacific).⁶³⁸ Besides the value of its scientific results, FAMOUS illustrates how the study of the ocean floor was gaining momentum in the international community, standing from the first time next to physical oceanography and marine biology in large, ambitious cooperative projects.⁶³⁹

The enthusiasm to publicly display a technological hubris benefited the greatest depths rather than the continental shelf or coastal regions. Choosing international waters as playing grounds for scientific cooperation responded to a geopolitical strategy, and avoiding explicit goals aimed at the exploitation of underwater resources, to a diplomatic decision.⁶⁴⁰ By moving away from national waters, the French and American delegations avoided any kind of friction related to

⁶³⁷ CNEXO, "Coopération franco-américaine dans le domaine de l'océanographie, Programme 1973-74," May 29, 1973 (ANF, 20160129/317). Overview based in Jarry, *L'aventure des bathyscaphes* and on Riffaud and le Pichon, *Expedition FAMOUS*.

⁶³⁸ Oreskes, "A Context of Motivation."

⁶³⁹ About big science projects in biology during and after the IGY, see: Aronova, Baker, and Oreskes, "Big Science and Big Data in Biology."

⁶⁴⁰ La Prairie, Yves. Confidential note to Maurice Schumann (Minister of Scientific Research), November 29, 1967 (ANF, 20160129/328).

the economic exploitation of regions under national jurisdiction, attributing to their joint ventures the prestigious label of supporting *fundamental* research for a common benefit or heritage. Yet, France was not oblivious to American industrial activities. Far from it, the CNEXO's intelligence network was following with interest American innovations by its oil industry, as well as the hard mining industry's new ventures to test mining technologies at great depths. The quest to efficiently exploit polymetallic nodules in the high-seas was amongst the US main economic interests – and therefore, also a significant matter for France.

6.3. Controlling distant oceans: the quest to exploit polymetallic nodules

6.3.1. A newborn mining industry

Polymetallic nodules, spherical mineral concretions formed by concentric layers of manganese and iron hydroxides, came to be perceived as the most economically valuable sediment of the deep ocean floor by the mid-sixties.⁶⁴¹ Yet, the quest for deep-sea nodules became a story about anticipating new and imminent economic ventures that, eventually, never arrived.

In a period of rampant techno-optimism about the promises of the ocean, the mining industry spotted these spheres as the supply of mankind needs in metals for a million years.⁶⁴² This perception spread from Ambassador Pardo's 1967 discourse to the UN General Assembly, where he offered a panegyric account of the nodules' potential to fulfill global consumption for hundreds of thousands of years: only in the Pacific Ocean floor, nodules contained reserves of manganese and cobalt enough to cover two-hundred thousand years of consumption, nickel for hundred-fifty thousand years, and aluminum for twenty thousand years; among reserves of copper, zirconium, iron, titanium, magnesium, lead, vanadium... that could also feed future generations.⁶⁴³

Pardo's estimates relied on the 1965 book by American mining engineer John L. Mero *The Mineral Resources of the Sea*, which had become a reference for the mining industry.⁶⁴⁴ That

⁶⁴¹ Mero, *The Mineral Resources of the Sea*, 127.

⁶⁴² Stated by the President of Deepsea Venture Inc., John R. Flipse (in: n.a. "German firm joins Deepsea Ventures' exploratory program").

⁶⁴³ UN General Assembly, First Committee Debate, November 1, 1967.

⁶⁴⁴ For his book and experience, Mero has been dubbed "the father of ocean mining" (in: Cruickshank, "John L. Mero. In memoriam"). His book included economic and commercial estimates of exploiting sands from beaches, gravels and minerals from the continental shelf, minerals dissolved in the seawater, surface sediments (as oozes) from the deep ocean floor, hydrocarbons, and polymetallic nodules (Mero, *The Mineral Resources of the Sea*).

polymetallic nodules existed in the Pacific ocean floor was not new, as they had been discovered in 1872 during the *Challenger's* scientific expedition.⁶⁴⁵ Yet, Mero was the first who affirmed that those concretions were potential mines of manganese, nickel, and copper, projecting that about 20% of the Pacific deep ocean floor (between 1,500 and 6,000 meters depth) was covered by nodules in concentrations up to 50 kilogram per square meter.⁶⁴⁶ More alluring were his economic estimates: Mero affirmed that, via technological innovation, by 1980 polymetallic nodules could be mined, transported to port, and processed at about 28,5 US dollars per ton, whereas its gross commercial value ranged from 40 to 100 US dollars per ton.⁶⁴⁷

Mero's projections triggered stir among mining industries, since his work offered evidences that exploiting the deep ocean floor at industrial scale would be feasible in the short-term. In 1968, American company Tenneco openly expressed its intention to exploit nodules by creating a specialized firm, Deepsea Venture Inc. Two years later, the American company Glomar Marine Inc., specialized in developing offshore-oil drilling technologies, joined to the exploration of the deep Pacific; while the German firm Metal Gesellschaft A.G. associated in consortium with Deepsea Venture Inc. to start the first prospection survey across the North Pacific.⁶⁴⁸ At the opposite shore, the Japanese government launched a three-year program to explore mineral resources, from its territorial seawaters to 4,000 meters depth in the South Pacific, going through the Izu and Bonin archipelagoes.⁶⁴⁹

At the CNEXO, the Administrative Council was following with interest the progress of foreign companies and mining initiatives, as well as the simultaneous discussions having place at the UN Seabed Committee.⁶⁵⁰ Without neglecting the importance of the nodules' economic potential, la Prairie had serious doubts on whether the American ventures were an excuse of the

⁶⁴⁵ Ibid. 127-241, for a detailed account on manganese nodules' composition, process of formation, and location.

⁶⁴⁶ Mero started studying seafloor mineral resources at the Institute of Marine Resources at Scripps Institution of Oceanography, where he launched the economic study of California offshore phosphorites and manganese (in: Cruickshank, "John L. Mero. In memoriam").

⁶⁴⁷ As Pardo affirmed in his speech at the UN General Assembly. However Mero gives this estimates only for the cost of processing nodules, not including its exploitation and transportation: 25 US dollars per ton of raw nodules, versus 40 to 100 US dollars of gross commercial value. However it is not mentioned on which grounds Mero estimated these costs (Mero, *The Mineral Resources of the Sea*, 272).

⁶⁴⁸ CNEXO, "Synthèse des Principales Activités Océanologiques, du 15 Avril 1970 au 1 Septembre 1970" (ANF, 19980125/2).

⁶⁴⁹ Ibid.

⁶⁵⁰ For example, they reported the analysis conducted by researchers at the University of Ottawa and at the Imperial College of London, that studied the quantity of valuable metals in nodules recovered from different regions (North and South America) and from different depths – from 1,000 to 6,000 meters (in: CNEXO, "Synthèse des Principales Activités Océanologiques, du 15 Novembre 1969 au 15 Janvier 1970" 19980125/01.).

US government to take a strategically advantageous place in the Pacific before the new international legislation was enacted.⁶⁵¹ Yet, either for their economic or strategic potential, France's over-seas territories in the South Pacific Ocean – French Polynesia, the island of Wallis-et-Futuna, and New Caledonia – offered an opportunity to launch equivalent surveys across the deep oceans. Georgette Mariani, representative at the UN Seabed Committee, and Alain Sciard, head of the CNEXO's International Relations, issued an internal report arguing for the need to devote more efforts in exploring the economic potential of these regions, which in the near future could fall under international jurisdiction. Although exploitation was not envisioned in the short-term, it was essential to position as soon as possible among those nations that had already launched studies or developed exploitation technologies to be at the forefront “when the first fruits could be picked up,” as they phrased it.⁶⁵²

Because of the dominant discourses in the international context, scientific exploration needed to be the spearhead of future commercial exploration. To avoid raising suspicions by undertaking industrial surveys unilaterally, CNEXO managers decided to approach to foreign counterparts with whom establish suitable relationships to explore deep regions potentially rich in nodules, to test mining technologies, and to learn from their expertise. Japan appeared then as a suitable partner: for the last few years, the nation was becoming the most engaged in exploring the mineral possibilities of the ocean floor, besides being located at the Pacific's core. In April 1970, la Prairie visited Japan during a first official trip, accompanied by his most trusted men forming the French delegation (fig. 26).⁶⁵³ The mission's goals were to establish contact with renowned experts from Japanese oceanography, study the structure of the Japanese oceanographic policy (by comparing their programs and goals), visit scientific and industrial facilities, and to lay the groundwork of a future cooperation.⁶⁵⁴ Internationally, Japan stood out for its proficiency in fishing and aquiculture; yet, the CNEXO delegation was more interested in their programs of mineral and hydrocarbon exploitation. Japan had traditionally exploited

⁶⁵¹ la Prairie, Yves, “Compte-Rendu de la mission au Japon, 9-22 Avril 1970,” n.d. (ANF, 19980125/02).

⁶⁵² Mariani, Georgette. “Problèmes juridiques poses par l'exploitation du sol et du sous-sol marin. Le rôle du CNEXO,” n.d. (ANF, 19980125/02).

⁶⁵³ Alain Sciard (director of International Relations), Jean Coulmy (Division of Programs), Riffaud (Division Technologies), Lucien Laubier (Groupe Scientifique du COB), and Delauxe, president of the offshore tech-company COMEX. In: la Prairie, Yves. “Compte-Rendu de la mission au Japon, 9-22 Avril 1970,” n.d. (ANF, 19980125/02).

⁶⁵⁴ They Visited the Fishing University of Tokyo and Todai University (the most prestigious of the country); the offshore oil exploitation company Kubiki and the building company Taisei Construction Co. Also Mitsubishi Heavy Industries, who were developing jack-up rigs for offshore oil exploitation, and Sumitomo, the most important mining company in Japan, who were starting with nodules' ventures.

surface minerals from shallow waters (like coal and magnetite-rich sands, locally extracted from the mid-19th century), but now the country was rapidly moving towards large mining settings in the high seas, devoting large public and private investments to commercially exploit placers and minerals in the near future. The Japanese Geological Service had already charted about 200,000 square kilometers of its continental shelf (out of 280,000 km²); while private firms as Sumitomo had undertaken the exploration of nodule deposits thousands of meters deep in the central and western Pacific.



Figure 26. Yves la Prairie on his first official trip to Japan (CNEXO, Rapport Annuel, 1970).

On its Japanese trip, the CNEXO delegation toured around the Sumitomo headquarters, guided by Japanese engineers who bid them farewell by offering some nodules as souvenir.⁶⁵⁵ This visit, coupled with the internal reports Sumitomo handed to la Prairie, made the French delegation aware that the nodule-mining industry was a serious bet for the near future. As la Prairie affirmed in an internal report, the trip to Japan had opened his eyes: he was now convinced that the American enterprises undertaken by, for instance, American Deepsea Venture Inc., were not a geopolitical pretext but a serious investment for a new source of

⁶⁵⁵ CNEXO, “Synthèse des Principales Activités Océanologiques, du 15 Avril 1970 au 1 Septembre 1970,” (ANF, 19980125/2).

income.⁶⁵⁶ Japanese studies showed that polymetallic nodules could cover industrial needs in nickel, cobalt, and manganese during at least two decades. If shredded, nodules could be used in filters to prevent atmospheric pollution with sulfurous gases, and first estimates demonstrated that the costs of exploitation could be easily covered in a few years of extraction.⁶⁵⁷

For the CNEXO, Japan became a suitable partner to formalize bi-lateral collaborations. La Prairie admitted in a report his surprise after discovering how aligned the priorities of both countries were.⁶⁵⁸ Japanese experts knew well the CNEXO's "Blue Book" – the CNEXO's scientific agenda, that had been translated to Japanese and could be found in all their oceanographic institutions; and the Japanese government aimed at drawing inspiration from the COB to build a similar institution in Okinawa (when the Americans returned them the archipelago). The overall impression, according to La Prairie, was that "among all countries, Japan is the most conscious on the importance of marine resources to its economy, and the most committed to exploit them as soon as possible."⁶⁵⁹ Franco-Japanese relations in ocean sciences intensified after that trip. As a token of confidence, Japanese embarked the CNEXO engineer Michel Gauthier onboard the *Chyoda Maru 2* in a mission organized by the Japan Resources Association.⁶⁶⁰ The mission, whose goal was to assess the effectiveness of new dredging procedures to exploit nodules, offered the CNEXO the opportunity to observe and learn from the Japanese mining techniques, and from the set-up of their vessels and laboratories.⁶⁶¹ Successful exchanges led to a signature of an agreement of bilateral collaboration on July 2, 1974, where both countries agreed to exchange information relevant to the exploitation of the oceans, with special focus on the exploitation of polymetallic nodules and fisheries.⁶⁶²

Meanwhile, in Europe, the Federal Republic of Germany was also growing interested in the exploration of deep mineral resources, which immediately attracted La Prairie's attention. In January 1970, the German Government had created an "oceanology" industrial association in Düsseldorf addressed at coordinating national exploration and exploitation activities, whose

⁶⁵⁶ La Prairie, Yves. "Compte-Rendu de la mission au Japon, 9-22 Avril 1970," n.d. (ANF, 19980125/02).

⁶⁵⁷ Ibid.

⁶⁵⁸ Ibid.

⁶⁵⁹ Ibid.

⁶⁶⁰ An industrial group whose 90% of the budget came from mining and private companies and a 10% from the Japanese Government.

⁶⁶¹ CNEXO, "Synthèse des principales activités océanologiques, du 1 Septembre 1970 au 01 Novembre 1970" (ANF, 19980125/02).

⁶⁶² CNEXO, *Rapport Annuel 1974*.

twelve funding members were among the most advanced companies in marine technologies.⁶⁶³ This event, together with the above mentioned consortium between Metal Gesellschaft A.G. and Deepsea Venture Inc., led la Prairie to undertake conversations with the German oceanographic industry, aiming at organizing an industrial bilateral collaboration. From a political perspective, la Prairie considered a Franco-German tandem as promising, since it could become a benchmark for other European countries and even a counterweight to the American and Soviet exploitation techniques.⁶⁶⁴ In April 1974, after a number of mutual visits and exchanges, the CNEXO signed a technical agreement with the German Federal Ministry of Research and Technology addressed at collaborating in exploring, recovering, and processing polymetallic nodules. The envisioned collaboration would include organizing joint campaigns across the Pacific, the exchange of researchers and technical information, and a regular comparison of techniques used. Scientific cooperation would be the first step towards an industrial and commercial collaboration, established between private companies from France and western Germany.⁶⁶⁵

After the CNEXO grew interested on the South Pacific ocean floor, the neocolonial tinges of its oceanographic policy became evident. In a private note probably addressed to some Minister, la Prairie displayed his admiration for the Japanese, who – according to his interpretations – “ambitioned to conquer the world not military, but economically” by means of exploiting marine resources. More meaningful of his ideology, la Prairie speculated that “the conquest of the Pacific” would be headed by three nations: the US with the Scripps, Japan with its forthcoming center in Okinawa, and France with the CNEXO.⁶⁶⁶ But, to achieve it, the CNEXO needed a stable position in the Pacific – thus, they began to pull strings to create an Oceanographic Base in the French Polynesia.

⁶⁶³ Including: August Thyssen Hütte, Demag, Deutsche Barbock und Wilcox, Drägerwerk, Mannesmann, Klein, Schanzlin und Becker, Krupp, Messerschmidt Bolkow-Blohm, Metallgesellschaft, Preussag, Siemens, and J.M Voith (in: CNEXO, “Synthèse des Principales Activités Océanologiques, du 15 Novembre 1969 au 15 Janvier 1970” (ANF, 19980125/02).

⁶⁶⁴ La Prairie, Yves. Letter to the Minister of Industrial and Scientific Development, August 25, 1969 (ANF, 20160129/326).

⁶⁶⁵ CNEXO, *Rapport Annuel 1974*.

⁶⁶⁶ la Prairie, Yves. “Note sur l’océanologie au Japon,” April 10, 1970 (ANF, 20160129/324).

6.3.2. A doorway to Pacific richness: the Base Océanologique du Pacifique

In January 1965, few years before the CNEXO's ushering, the Minister of Research Gaston Palewski had already evoked the idea of establishing an oceanographic center in the French Polynesia; soon after, during an official visit to the capital city of Tahiti, Papeete, President Charles de Gaulle proudly announced this plan appealing to the maritime vocation of Polynesian people – a cliché that the French government frequently used to engage the public opinion on its ocean policy.⁶⁶⁷ Political reasons to establish an oceanographic base precisely there were beyond the industrial juncture, being related to the French nuclear tests.

France started conducting nuclear tests in February 1960 by detonating nuclear bombs in the Algerian Sahara. Yet in 1964, after Algeria's independence and the need to find suitable grounds to conduct mega-explosions (hundred times stronger than the Hiroshima nuclear bomb), French authorities moved their testing grounds to the Pacific Ocean (following the US and the UK, who had established their nuclear test bases in the Marshall and Kiribati archipelagoes). In 1964, the French government founded the *Centre d'Expérimentation du Pacifique* in Papeete, which became the core of a massive infrastructure across archipelagoes and atolls, expanding up to 1,600 kilometers from Tahiti.⁶⁶⁸ More than 90,000 experts moved to French Polynesia to work on the nuclear test apparatus: military troops, meteorologists, oceanographers, divers, engineers, electricians, workers, administrative personnel... increasing twenty per cent the region's population. The industry around nuclear testing triggered an economic boom: ports were refurbished and airstrips build, routes between the metropole and the Pacific grew more frequent, and new economies emerged to feed the growing population. By the onset of the seventies the GDP had tripled, and the region's economy was sustained upon the *Centre d'Expérimentation*.⁶⁶⁹ Nuclear tests began in 1966 and lasted for thirty years. Initially, detonations were atmospheric: forty-one nuclear bombs exploited in open-air whipping up atolls, destroying coral reefs, and exposing the local population to high levels of

⁶⁶⁷ CNEXO, "Projet de Création d'une base pour l'exploitation des océans en Polynésie," n.d. (ANF, 19980125/02).

⁶⁶⁸ A recently-published comprehensive work on the untold consequences of these nuclear tests, based on just-disclosed archival documents: Philippe and Status, *Toxique*.

⁶⁶⁹ CNEXO, "Projet de Création d'une base pour l'exploitation des océans en Polynésie," n.d. (ANF, 19980125/02). More details about the center in: Chesneaux, "Le Centre d'Expérimentation du Pacifique et son impact."

radiation.⁶⁷⁰ From 1974, tests moved to the underground, where explosions happened inside wells a hundred of meters below the surface – leading to the subsidence of the Moruroa atoll, the destruction of surface lagoons, and polluting seawaters due to accidental leaks.

The French Government grew concerned that, if nuclear tests came to an end, the region would suffer a brutal regression in their lifestyle. French Polynesia had two options for its future: either turning to tourism or investing in mining underwater minerals. Foreign companies were already involved in both domains, and French authorities feared losing such a strategic position in oceanographic terms.⁶⁷¹ The UN Seabed Committee had recently suggested a legal regime where coastal states were responsible for the trusteeship of its surrounding waters and for evaluating exploitation projects presented by foreign nations and companies.⁶⁷² Therefore, setting a stable oceanographic base in Tahiti would ensure keeping control of exploration and exploitation permits granted to foreign bodies.

In June 1971, the French Government published the decision to establish an oceanographic center in Tahiti which, with the CNEXO's management, would be devoted to studies with industrial goals in fisheries, aquiculture, and exploitation of mineral resources. It was openly envisioned as a logistic base to explore and assess the abundance of nodule deposits in the South Pacific, while becoming a major actor in the CNEXO's science diplomacy agenda.⁶⁷³ Because of Tahiti's isolation in the middle of the Pacific, the CNEXO expected that numerous foreign research vessels would make their supplying stops there, enabling the French to keep track of foreign progress in ocean sciences and technologies, and to facilitate scientific and technical exchanges.⁶⁷⁴ Although the center would require eight years of works before becoming fully operative due to budget shortages, since the laying of its first stone the CNEXO obtained an open door to the Pacific and a mooring spot for its high sea expeditions.

Until the construction of the Polynesian base was made public, the CNEXO had been discreet on announcing its campaigns to probe the region's potential in nodule deposits. Instead of

⁶⁷⁰ Recently, a number of articles have been published in newspapers going back to the neglected effects of nuclear radiation during France's nuclear tests in the Pacific, as in: Henley, "France has underestimated impact of nuclear tests."

⁶⁷¹ CNEXO, "Projet de Création d'une base pour l'exploitation des océans en Polynésie," n.d. (ANF, 19980125/02).

⁶⁷² Suggested by the American delegation, it came to be known as "the Nixon Amendment." Mentioned in: CNEXO, "Projet de Création d'une base pour l'exploitation des océans en Polynésie," n.d. (ANF, 19980125/02).

⁶⁷³ CNEXO, *Rapport Annuel 1971*.

⁶⁷⁴ CNEXO, "Projet de Création d'une base pour l'exploitation des océans en Polynésie," n.d. (ANF, 19980125/02).

organizing its own missions, la Prairie had embarked experts from the COB in French Navy's activities across the South Pacific addressed at recovering polymetallic nodules.⁶⁷⁵ In December 1970, la Prairie entrusted COB's geologist Jean-Marie Auzende the direction of the mission TAHINO 1, onboard the Navy's vessel *La Coquille*. Auzende traveled in a military aircraft to Papeete and, once onboard the vessel, was responsible for supervising technical operations: dredging nodules and taking underwater images of the deposits, near the islands Tuamotu.⁶⁷⁶ That the mission was to some extent confidential emanates from la Prairie's guidelines: instead of asking Auzende a written report, as he usually requested; la Prairie specified that he wanted to be informed orally about the results and difficulties faced during the mission.⁶⁷⁷ The campaign was success: 550 kilograms of nodules were analyzed by the French firm *Le Nickel*, showing that the sediments were much richer in cobalt than the nodules described by John Mero in his 1965 book; but poorer in nickel and copper. These results encouraged la Prairie to launch a large-scale program on nodule exploration for their potential strategic interest. Neither the US, nor Europe, possessed manganese reserves, yet it was a key asset in the steel industry. Only in 1968 France had spent 21,5 million US dollars in importing 890,000 tons of manganese. Identifying nodule deposits rich in manganese, therefore, was a potential source of an strategic resource.⁶⁷⁸

Conversely, after establishing the logistic base in Tahiti, the French chase after polymetallic nodules was widely announced. From 1971, the CNEXO launched an ambitious industrial program to explore inch by inch the nodules' potential of the South Pacific: first around Tahiti's seawaters, expanding later to the high seas. This was pursued in collaboration with experts from the company *Le Nickel* and the *Commissariat de l'Énergie Atomique* (CEA), who joined the CNEXO in March 1972 to implement deep-sea mining technologies.⁶⁷⁹ France's nodule consortia crystallized in 1974 under the name *Association Française d'Étude et de Recherche des Nodules Océaniques* (AFERNOD), constituted by *Le Nickel*, the CEA, and the *Chantiers de France-Dunkerque*, which would be responsible of prospection, exploration, technological

⁶⁷⁵ It is challenging to assess military interests on polymetallic nodules based on archival information, but it was probably related to define France's geopolitical strategy in the region, and to secure potentially rich areas around French Polynesia.

⁶⁷⁶ Hoffert, *Les nodules polymétalliques dans les grands fonds océaniques*.

⁶⁷⁷ La Prairie, Yves. Letter to Jean-Marie Auzende, "Opération nodule," n.d. (ANF, 20160129/323).

⁶⁷⁸ In Hoffert, *Les nodules polymétalliques dans les grands fonds océaniques*, 135, quoting Yves la Prairie.

⁶⁷⁹ About the association with the New-Caledonian mining company *Société Métallurgique Le Nickel – SLN* see: CNEXO, *Rapport Annuel du groupe de travail CEA-CNEXO. Economie du Traitement des Nodules Polymétalliques* (Mars-May 1973), May 1973 (ANF, 20080658/40). Half of the company had been acquired in 1974 by the French oil company SNPA, becoming one of its filial.

development, international negotiations, and relations with fundamental research related to polymetallic nodules.⁶⁸⁰ They soon launched exploration campaigns aiming at surveying the abyssal plain of the South Pacific and testing mining technologies. Unlike private consortiums in foreign countries (like Japan and Germany), AFERNOD was a mixed public and private organization, responsible for centralizing the works developed and the results obtained at a national level, both of scientific and industrial nature. Between 1970 and 1992, the French Government contributed with a 95% of the AFERNOD's budget – this is, more than 130 million US dollars – on its quest for economically profitable deposits of polymetallic nodules, either by direct investments or through the budget of the public organizations CEA and CNEXO. This setting evidences once again the particular strategy behind France's ocean policy: strengthening relations between academic research and industrial production, and waving networks that gathered private and public firms under a state-led structure (as had been achieved with the offshore oil industry).

The team of geoscientists at COB – particularly Xavier le Pichon and Guy Pautot – were not satisfied with this industrial enthusiasm. For them, priority was to keep on exploring continental margins and entangling knowledge acquired with the new framework of plate tectonics (as seen in chapter 5). A compromise was reached when la Prairie agreed on utilizing industrial campaigns across the Pacific to obtain geological data.⁶⁸¹ In October 1972 Pautot led the campaign TRANSPAC I, the first French oceanographic mission across the South Pacific from Panama to Tahiti; which was followed by TRANSPAC II, from Moruroa to Lima.⁶⁸² Both campaigns embarked French academic researchers together with the CNEXO's team of geoscientists. Besides studying regions suitable for the accumulation of nodules, the team acquired continuous bathymetrical, seismic, and magnetic profiles across the Pacific; contributing to the study of the ocean floor with relevant and unique conclusions. They found that the fracture zone of Marqueses extended throughout thousands of kilometers underwater, while Pautot proposed a geological model to predict the formation of polymetallic nodules under different geological conditions.⁶⁸³

⁶⁸⁰ See the dedicated page at the IFREMER website: Henriot, "The polymetallic nodules."

⁶⁸¹ Explained by Michel Hoffert, who was employed in the CNEXO's program of nodule exploration (Hoffert, *Les nodules polymétalliques dans les grands fonds océaniques*).

⁶⁸² Pautot, "TRANSPAC Rapport de mission."

⁶⁸³ Le Suavé et al., "Cadre géologique de concrétions polymétalliques cobaltifères sous-marines;" Hoffert, *Les nodules polymétalliques dans les grands fonds océaniques*.

From 1970 to 1975, the CNEXO led a dozen of scientific-industrial campaigns across the South Pacific, while the *Centre Océanologique du Pacifique* became their base of departure and arrival. However, regardless of the large investment allocated in nodule prospection, the Pacific Oceanographic Base barely grew. Geologists and geophysicists traveled from Brest to Tahiti, gathered large amounts of data with underwater cameras, dredging techniques, and sampling instruments, and brought them back to Brest, where they analyzed them with microscopes, X-Ray mineralogical techniques, and specific instruments to conduct chemical analysis. Conversely, the Pacific base barely employed ten permanent researchers (eight biologists and two technicians), devoted to aquiculture and biology of tropical fishes and seafood.⁶⁸⁴ As the seventies went by, the CNEXO's Annual Reports progressively ceased to mention the industrial exploration of polymetallic nodules as one of the Base's main activities, while aquiculture of crabs and shrimps, or the biology of tuna fisheries, monopolized the center's exercises. Rather than building a large oceanographic nucleus for international research, the construction of the *Centre Océanologique du Pacifique* seems more like a pretext to establish a logistic base for vessels and researchers that were to embark on industrial campaigns (fig.27). Aligned with the neocolonial mindset that pervaded France's extractive industries, the exploration of polymetallic nodules overseas mostly benefited, in scientific and economic terms, experts and institutions settled in continental France.

Besides being an open door to the Pacific, I suggest that behind the establishment of the Pacific's base there were further strategic and economic goals. When the center was inaugurated, la Prairie affirmed that "unlike it has happened with Algeria, France would not lose control of the French Polynesia and its potential natural resources."⁶⁸⁵ Therefore, under the cover of the Government's investment in marine research facilities in overseas territories, France was attempting to gain control on the region in the case that economically profitable mineral resources existed around French Polynesia's seawaters.

⁶⁸⁴ CNEXO, *Rapport Annuel 1974*.

⁶⁸⁵ CNEXO, "Projet de Création d'une base pour l'exploitation des océans en Polynésie," n.d. (ANF, 19980125/02).



Figure 27. Aerial view of the Centre Océanologique du Pacifique in 1975 (CNEXO, Rapport Annuel, 1975).

Meanwhile, information acquired during campaigns across the high seas enabled AFERNOD to estimate the economic prospects of the South Pacific. By 1975, data was sufficient to conclude that the region would not be economically profitable for mining nodules, whereas the North Pacific, already controlled by American and Japanese mining consortiums, appeared as much more promising. As geologist Michel Hoffert has highlighted in his exhaustive book on France's quest for polymetallic nodules, moving AFERNOD's ventures to the North Pacific entailed long diplomatic negotiations – in some occasions, confidential – with Japanese and American representatives, even signing secret contracts to divide the North Pacific's international seawaters among them, anticipating the moment when exploiting nodules would be economically profitable and legally possible. At the same time, representatives from these

countries were negotiating at UNCLOS meetings the establishment of an international regime to regulate and share the economic outcomes of mining as the common heritage of mankind.⁶⁸⁶ The story of ocean diplomacy anticipating the exploitation of polymetallic nodules is still to be written, yet this case manifests how France managed to stand next to the world oceanic powers by developing an industrial, politic, and academic set up to explore mineral resources in international seawaters; at the same time it forged collaborations with countries whose collaboration could be conducive for deep-sea mining (in technoscientific or in diplomatic terms).

After 1982, international interest in mining deep-sea nodules decreased. The unparalleled scientific and technological development around this industry evidenced that its exploitation would not be feasible at least for a decade. The deep ocean floor was not anymore seen as a vast expanse covered by easily-recoverable nodules; but a complex geographical region, where nodules were scattered in small patches. Globally, industrial growing stagnated and the value of minerals like manganese, copper, or cobalt decreased. AFERNOD continued supporting nodule exploration until it dissolved in 1998, yet with varying approaches and strategies depending on the value of minerals and the prevailing international legislation.⁶⁸⁷ Commercial mining of polymetallic nodules never materialized, and arguably the most remarkable outcome of the CNEXO's activities in the Pacific was an unprecedented geological understanding on the deep ocean floor composition and on the formation of polymetallic nodules.

6.4. Franco-Soviet relations in the exploitation of the oceans

As well as the CNEXO had successfully established cooperative relations with the US and Japan to explore the deep ocean floor in a display of allegedly benign aims; it also attempted to reproach the USSR by means of ocean exploration. Yet, the outcomes were not as successful as it was expected.

Franco-Soviet cooperation in seafloor exploration can be regarded either as a scientific failure or as an excellent example of successful science diplomacy performance. First conceived in 1966 by Charles de Gaulle's Office to approach both countries in sciences and economy, CNEXO managers expected to use this cooperation to learn from Soviet programs and

⁶⁸⁶ Hoffert, *Les nodules polymétalliques dans les grands fonds océaniques*.

⁶⁸⁷ Currently, pushed by a rampant scarcity of strategic minerals, the enthusiasm to exploit deep-sea nodules has revived around the globe. In the last few years, numerous articles have been published in newspapers about the promises and dangers of that new mining industry, for example: Watts, "Race to the Bottom."

technologies of offshore mineral exploitation. However, after repeated frictions due to a lack of consensus, grievances on the Soviet side, administrative shortcomings, and military suspicions, it became apparent that the usefulness of the Franco-Soviet collaboration was to be purely political: maintaining the cooperation in “exploitation of the oceans,” even if it was only on paper, symbolized a will to cultivate cordial diplomatic relations between both countries, without aspiring to materialize them in joint scientific projects.⁶⁸⁸

6.4.1. The tug-of-war of underwater technologies in the Franco-Soviet bilateral cooperation

Cooperative initiatives between Soviet and French researchers were common from the fifties, yet they only acquired a diplomatic projection after the arrival of Charles de Gaulle in office.⁶⁸⁹ In an attempt to reproach the USSR, from 1965 France signed a number of bilateral treaties to collaborate in relevant scientific fields: the nuclear, the space, and the exploitation of the oceans, displaying a political will to leave aside differences and prejudices.⁶⁹⁰

Since the CNEXO was not yet inaugurated, experts at the COMEXO acted as spokespersons of France’s oceanographic interests, negotiating the terms and elements of common interest with their Soviet counterparts.⁶⁹¹ In January 1967, marine biologist Jean-Marie Pérès signed the Cooperative Agreement with Soviet physical oceanographer Konstantin Nikolayevich Fedorov, internationally well-known for his position at the UN’s International Oceanographic Commission (IOC).⁶⁹² The envisioned cooperative program, organized around topics related to the exploitation of marine resources, had to rely on “reciprocity” – an element that, as the French delegation would later recall and lament, was conspicuously absent.⁶⁹³

⁶⁸⁸ Marie-Pierre Rey, in his study about Franco-Soviet relations, has examined the treaties of scientific and technical cooperation (Rey, “Les Échanges Scientifiques et Techniques”). Although he focus extensively on nuclear and space cooperation, nothing is detailed about cooperation in “exploitation of the oceans” (or oceanography).

⁶⁸⁹ Rey, “Les Échanges Scientifiques et Techniques.”

⁶⁹⁰ Ibid. About de Gaulle’s diplomatic relations with the USSR, see: Lipkin, “Charles de Gaulle’s Visit to the Soviet Union;” Martin, *General de Gaulle’s Cold War*; Rey, *La Tentation Du Rapprochement*.

⁶⁹¹ About the COMEXO, see chapter 3.

⁶⁹² First meeting in Moscow. CNEXO, “Rapport de situation: Coopération franco-soviétique dans le domaine de l’océanographie,” June 29, 1967 (ANF, 20160129/328). Fedorov acquired a leading role in international oceanography through his position at the UN’s Intergovernmental Oceanographic Commission (from 1960) and his presidency of the Scientific Committee on Oceanic Research.

⁶⁹³ Topics selected included marine geology and geophysics, marine biology and fishing techniques, physical oceanography and its instrumentation.

One month after the Agreement's signature and as first symbol to build a relationship of mutual confidence, the French government welcomed a Soviet delegation of experts, organizing for them a tour around French facilities pioneering in underwater technologies. The *Office Française de Recherches Sous-Marines*, settled at the *Musée Océanographique de Monaco*, was where Cousteau and his team designed, built, and stored submersibles and underwater habitats; while the *Compagnie Maritime d'Expertise* (COMEX), in Marseille, was a private company devoted to design underwater manned technologies. The Soviet delegation could embark on the *Archimède* in Toulon, the *Cyana* in Monaco, and Cousteau's third prototype of underwater habitat, the *Précontinent III*.⁶⁹⁴ This visit awakened the interest of Soviet experts in acquiring these underwater technologies. During the following years, the Soviet party would try to access them by different means – either by suggesting cooperative projects, or buying them to owner companies.

In April 1967, after being appointed the CNEXO's General Director, la Prairie proceeded to assess what could Soviet oceanography provide to France and weighed up how much the CNEXO was willing to offer. By that time only the US and the USSR counted with a national structure to coordinate marine research equivalent to the CNEXO. As he was doing with American oceanography, la Prairie aimed at understanding how this counterpart worked in order to identify and implement at the CNEXO some interesting elements of the Soviet oceanographic structure. The USSR ocean program employed an estimate of four to five thousand people, but its structure, organization and annual budget were a mystery for foreign observers. Perhaps more relevant to the CNEXO's ambitions was the scant information available about Soviet exploitation of seabed resources. The CNEXO's Department of International Relations had informed that the Soviets were much more advanced than France in fisheries, while the exploitation of minerals and hydrocarbons on the Baltic continental shelf had already begun.⁶⁹⁵ Little information leaked about technologies, research methodologies, and progress in those fields – the CNEXO suspected that the Soviets counted with a heavy-load mining vessel, but no-one had been able to provide more details.⁶⁹⁶ Hence, for the French side, interest laid in

⁶⁹⁴ CNEXO, "Rapport de situation: Coopération franco-soviétique dans le domaine de l'océanographie," June 29, 1967 (ANF, 20160129/328).

⁶⁹⁵ n.a. "Éléments d'information pour M. le Président du CNEXO," July 17, 1967 (ANF, 20160129/328); CNEXO, "Synthèse des principales activités océanologiques du 15 Avril 1969 au 15 Juin 1969" (ANF, 19980125/01).

⁶⁹⁶ As it can be glimpsed in: la Prairie, Yves. Letter to the Minister of Foreign Affairs, January 10, 1972 (ANF, 20160129/320).

establishing cooperative projects and fostering exchanges in exploitation of offshore minerals and high sea fisheries.

However, Soviet interests moved in another direction. Dazzled by the French submersibles, they craved for accessing them during their planned bilateral cooperative projects. The Soviet scientific delegation's first proposal was a two-years joint oceanographic campaign where the CNEXO would contribute with the laboratory-buoy, Cousteau's underwater habitat *Précontinent III*, the bathyscaphe *Cyana*, and the vessel *Jean Charcot*. In exchange, the Soviets would bring their oceanographic vessel *Akademik Kurtchatov* and some measuring instruments. This proposal was clearly disadvantageous for France: the cost of mobilizing and operating research technologies was excessive for the expected scientific outcomes.⁶⁹⁷ French experts who mediated with the Soviet delegation were the first in sounding the alarm. Jean Emery, financial adviser of Cousteau's Team in Monaco, wrote a letter to la Prairie emphasizing how unprofitable would be for France to give in to the Soviet demands. As he explained:

La hâte des soviétiques tient visiblement à leur désir de rattraper les USA, eux-mêmes en retard sur la France pour un petit nombre d'années encore. Du fait de leur retard, les soviétiques ne peuvent évidemment fournir au groupe Cousteau qu'un apport scientifique qui, sans être négligeable, est cependant secondaire.⁶⁹⁸

The cost of such a program was estimated in more than three hundred thousand dollars – an amount that was not justified by having access to “Soviet instruments of measurement.” However, as Emery's argument followed, the issue of whether to support or not the Franco-Soviet cooperation had to be a political decision, not a scientific one:

Le Groupe Cousteau n'a d'autre désir que de mener une action s'inscrivant dans le cadre de la politique de son pays. Il serait donc techniquement prêt à démarrer la collaboration franco-soviétique océanographique dans les plus brefs délais si des directives en ce sens lui étaient données.⁶⁹⁹

⁶⁹⁷CNEXO, “Rapport de situation: Coopération franco-soviétique dans le domaine de l'océanographie,” June 29, 1967 (ANF, 20160129/328).

⁶⁹⁸ “The Soviets' haste clearly responds to their eagerness to catch up the US, being even behind France for a few years. Because of their delay, the Soviets cannot provide to the Group Cousteau more than a scientific contribution than, although not negligible, is currently secondary in importance.” In: Emery, Jean. “Note d'Information sur les activités scientifiques et techniques du Commandant Cousteau et sur la collaboration franco-soviétique,” June 21, 1967 (ANF, 20160129/328).

⁶⁹⁹ “The Group Cousteau wishes to carry out an program within the framework of the national policy. Thus it would be technically ready to launch a Franco-Soviet collaboration in oceanography in the shortest term if it receives guidelines pointing to that direction.” In : Emery, “Note d'Information sur les activités scientifiques et techniques du Commandant Cousteau et sur la collaboration franco-soviétique,” June 21, 1967 (ANF, 20160129/328).

Emery's report was transferred to the Minister of Scientific Research Maurice Schumann, who in turn handed it to the State Minister. Even though the answer to Emery's letter has not been preserved, facts demonstrate that the policy to follow with the USSR could be phrased as giving the least the CNEXO could offer while maintaining a certain level of scientific cooperation, in an attempt to sustain a technological advantage over the Soviets. Regarding underwater technologies, this strategy translated in setting limits to the devices the Soviets could have access to – even though submersibles and underwater habitats were not in the export control lists issued by the Coordinating Committee for Multilateral Export Controls (CoCom) and therefore, could in principle be commercialized with the USSR.⁷⁰⁰

In February 1969 came to la Prairie's ears that Soviet authorities had contacted the private company COMEX to acquire a number of submersibles. After asking the French Navy and the Ministry of Industry how to proceed, la Prairie defined the details of the commercial policy to follow with the Soviets: France would only sell them underwater technologies that had been in use for a number of years (like the laboratory-buoy and the manned submergible *Scoupe Plongante 350*); but under no circumstances the submersibles *Scoupe Plongante 3,000* (this is, the *Cyana*) or the *Argyronète* (which would be mobilized some years later during the FAMOUS campaigns).⁷⁰¹ Moreover, French private companies had to report the CNEXO about any transaction closed with the Soviets.⁷⁰² This political and economic strategy facilitated that France maintained a technological advantage over the USSR that could be used to show friendly gestures with them. And indeed, the opportunity was not long in coming.

In 1971, a dialogue opened between the Western and the Eastern blocs. The Secretary of the Soviet Communist Party Léonid Brezhnev traveled to the US in June to meet President Nixon, to initiate negotiations on the nuclear disarmament program. On his way back to Russia, Brezhnev stopped for some days in Paris, where he met President Georges Pompidou. Successor of Charles de Gaulle from 1969, Pompidou wished to maintain cordial relations with

⁷⁰⁰ The CoCom was created in 1949 by the US and its allies to coordinate national controls over goods exported to the Soviet bloc, and operated until 1994. About its history and functioning see, for instance: Cupitt, Grillo. "COCOM Is Dead, Long Live COCOM." The CoCom list consulted was issued by the British Government in 1969 in its Board of Trade Journal ("Consolidated list of goods subject to security export control", October 8, 1969).

⁷⁰¹ La Prairie, Yves. Letter to Admiral Joybert (General Chief of the Navy), February 07, 1969 (ANF, 20160129/326).

⁷⁰² Letter from Yves la Prairie, "Instruction concernant la vente de matériels océanologiques en USSR par des industriels français," April 23, 1969 (ANF, 20160129/326).

the Soviet Union, thus becoming an active interlocutor with the Soviets.⁷⁰³ Brezhnev visit to France included a tour around the *Centre de Recherches Hyperbares* at the COMEX organized by the CNEXO. Accompanied by the Minister of Industrial and Scientific Development François Ortolé and Yves la Prairie, Brezhnev visited with fanfare the new hyperbaric hydrosphere belonging to the CNEXO, an underwater habitat that enabled weeks-long stays at more than 3,000 meters depth.⁷⁰⁴ The prominent international status ocean exploration was gaining transformed this gesture into a symbol of diplomatic rapprochement: France displayed its capabilities of underwater exploration, while declaring that it was willing to maintain close relationships through which the USSR could benefit from France's technological advancements.

6.4.2. A never-coming cooperation in marine geosciences

Franco-Soviet cooperation using the most advanced underwater technologies never materialized – unlike it happened in the Franco-American scientific cooperation, where FAMOUS constituted a display of technological prowess at great depths. Yet, the French scientific party attempted to organize cooperative projects in marine geosciences and physical oceanography sharing vessels, standardizing research methods, and co-producing oceanographic data.

Exchanges in marine geosciences began in July 1967, when geologist Maurice Vigneaux, geophysicist Pierre Muraour, and the director of the Geological Survey (BRGM) Claude Beaumont met in Moscow their Soviet counterparts to discuss a joint scientific program. The agenda established was much more optimistic than the activities that would be accomplished, and included studies sensitive for their oil exploration potential: the region selected comprised the eastern part of the Western Mediterranean (the Ligurian and Tyrrhenian seas), where the Franco-Soviet team would study sediments recovered by coring and deep-drilling technologies.⁷⁰⁵ That France would contribute with the IFP's drilling technologies (described in chapter 4) was taken for granted, as in the reports and discussions there is no hint that the

⁷⁰³ Pompidou and Brezhnev would meet five times, two of them in the URSS. In: Allain, et al., *Histoire de la Diplomatie française*.

⁷⁰⁴ CNEXO, *Rapport Annuel 1971*.

⁷⁰⁵ Vigneaux, Maurice, "Aide-mémoire sur les pourparlers entre experts soviétiques et français," August 8, 1967 (ANF, 20160129/328). The CEPM was interested in the region, as can be seen in the (later published) paper: Biju-Duval, Borsetti, and Colantoni, "Géologie des fossés du détroit Siculo-Tunisien."

USSR possessed, or was keen to contribute with, equivalent devices.⁷⁰⁶ Frictions appeared soon after the scientific program was decided between the CNEXO and its counterparts at the Soviet Academy of Sciences. La Prairie complained about informalities from the Soviet administration, who did not send the visas on due time, frequently forgot to reply to CNEXO's letters, offered "conflicting information," changed "suddenly and unilaterally" the agenda, and lacked smooth communication with the French embassy.⁷⁰⁷ Administrative conflicts led to cancel the Mediterranean geological survey.

The following year, Xavier le Pichon, Guy Pautot, and Jean-Claude Sibouet, marine geoscientists from the CNEXO's *Centre Océanologique de Brest*, substituted academic geologists as spokespersons of the French delegation. The new cooperative program they outlined was to be conducted over the most valuable region for the CNEXO's immediate ambitions: the French Atlantic continental margin. In October 1969, Xavier le Pichon and Soviet geophysicist Gleb Udinstev co-directed a Franco-Soviet campaign across the Bay of Biscay's continental margin. Soviet experts embarked onboard the *Jean Charcot* while French geoscientists sailed on the Soviet oceanographic vessel *Akademik Kurtchatov*, simultaneously acquiring refraction and reflection seismic profiles.⁷⁰⁸ Because this data could be interpreted to identify hydrocarbon deposits, the mission constituted a symbol of mutual trust; while, apparently, the scientific value of the campaign was of a secondary importance (at least, among the CNEXO's leading circles): neither at the CNEXO's annual reports, nor in internal correspondence, the goal of this mission or its scientific outcomes are specified – as it did happen with Franco-American joint campaigns.⁷⁰⁹ The matter of fanfare was rather that both parties were cooperating *de facto*, carrying out some work at sea.

After the campaign, la Prairie organized a tour around the BRGM's laboratories to the Soviet team, where they could learn in detail about the CNEXO's ambitious cartographic project of

⁷⁰⁶ Ibid. Years later, la Prairie specified that the USSR sought to develop an offshore oil industry based on foreign technologies – mainly French, but also German and Dutch. In: la Prairie, Yves. Letter to the Minister of Scientific and Industrial Development, June 6, 1973 (ANF, 20160129/317).

⁷⁰⁷ CNEXO, "Synthèse des principales Activités océanologiques, 1ère Juin au 1ère Octobre 1968" (ANF, 19980125/1). The elements here mentioned are complains of la Prairie to the Minister of Foreign Affairs (in: la Prairie, Yves. Letter to the Minister of Foreign Affairs, June 27, 1968 (ANF, 20160129/327)).

⁷⁰⁸ La Prairie, Yves. Letter to Keldysh (Soviet Academy of Sciences) and Vingradov (vice-president of the Soviet Academy of Sciences), December 27, 1969 (ANF, 20160129/325).

⁷⁰⁹ It seems that le Pichon, Pautot, and Sibouet were planning to travel to the USSR to analyze the data acquired, but besides a letter from Jacques Perrot to the vice-president Soviet Academy of Sciences on April 19, 1970 (ANF, 20160259/324) there is no more information, thus it is probable that this trip never materialized.

the continental shelf.⁷¹⁰ After opening up the French seawaters and laboratories to the Soviets, la Prairie expected an equivalent gesture from his counterpart, to whom he probed in numerous occasions to establish a joint program in mineral exploration on the continental shelf.⁷¹¹ Neither letters, nor in-person discussions, convinced the Soviets to open their offshore mining capabilities to the French. La Prairie complained to the Minister of Foreign Affairs that the Soviets dodged the question, and avoided offering any hint about the kind of vessels and exploitation technologies they possessed. Desperate by this “lack of reciprocity,” la Prairie even warned that he would refuse to give green light to any Soviet petition unless they responded in a clear way to each one of the CNEXO’s requests and interests.⁷¹²

This “lack of reciprocity” was not only the main source of problems, but also the consequence of a cooperative agreement based more on political considerations rather than in a mutual scientific benefit.⁷¹³ The reluctance of the French Navy to see their ports full of moored Soviet vessels did not contribute to alleviate tensions, and set a bold limit to Soviet collaborations in the Mediterranean.⁷¹⁴ In September 1971, the CNEXO received orders from the Minister of Foreign Affairs to be “less open to cooperate” with the Soviets, while clearly prioritizing more beneficial relations as those with the Americans.⁷¹⁵ This decision did not entail a complete break up of their relations, since la Prairie kept on testing the good-will to cooperate of the Soviet delegation – while they responded positively, following the Law of the Sea’s etiquette on allowing scientific missions over territorial seawaters. In June 1973, for instance, la Prairie requested Soviet authorities to explore the Romanian and Bulgarian continental shelf during one of the CNEXO’s hybrid missions, ODYSÉE IV.⁷¹⁶ A mixed team of marine geophysicists from the IFP and the COB would study the region’s deep geological structure by utilizing

⁷¹⁰ Cartographic program detailed in chapter 5. The first visit of the Soviet delegation to the BRGM was organized in late 1967 (la Prairie, Yves. Letter to the General Director of the BRGM, September 12, 1967 (ANF, 20160129/328)).

⁷¹¹ La Prairie, Yves. Letter to Federov (general director of de Hydro-Meteorological Service in the USSR), April 11, 1968 (ANF, 20160129/327); also during an in-person meeting in Moscow (in: la Prairie, “Compte-rendu de mission en URSS, 12-14 octobre 1970”, October 21, 1970 (ANF, 20160129/323)). He transmitted his numerous complaints to the Minister of Foreign Affairs (la Prairie, Yves. Letter to the Minister of Foreign Affairs, January 10, 1972 (ANF, 20160259/320)).

⁷¹² Ibid.

⁷¹³ Sciard, Alain, “Réflexions et suggestions sur la politique de coopération internationale du CNEXO,” September 16, 1971 (ANF, 20160129/321).

⁷¹⁴ Conseil d’Administration CNEXO, “Procès-Verbal de la Séance du 26 juin 1969,” (ANF, 19980125/01).

⁷¹⁵ Sciard, Alain, “Réflexions et suggestions sur la politique de coopération internationale du CNEXO,” September 16, 1971 (ANF, 20160129/321).

⁷¹⁶ La Prairie, Yves. Letter to the Minister of Industrial and Scientific Development, June 6, 1973 (ANF, (20160129/317)).

marine geophysical techniques. The Soviets authorized the campaign probably because, in the Law of the Sea's framework, refusing scientific surveys in the national territory could be regarded as an animus gesture; whereas embarking three geologists from the Institute of Geophysical Research at Krasnodar onboard would enable them gathering first-hand knowledge on the French knowhow and research techniques.⁷¹⁷

In 1977, after one decade of Franco-Soviet cooperation in marine sciences, the French Minister of Foreign Affairs unambiguously expressed the state of these relations: if the French government maintained a bilateral scientific cooperation with the USSR was “for a purely political imperative (...) even tough scientific results had been unsatisfactory.”⁷¹⁸ In ten years, joint Franco-Soviet missions could be counted on one hand. Besides the 1969 joint mission across the Atlantic margin, two campaigns in physical oceanography had taken place: COFRASOV I and II, in 1969 and 1972, marked by how unprofitable (in scientific and economic terms) they were for France. Initially envisioned to compare methods of measurement and interpretation of data, the second mission was redundant. According to oceanographer Henri Lacombe, who led both missions, the French scientific delegation had never asked for that joint project.⁷¹⁹ Moreover, there is no evidence that the points included in the agreement of bilateral cooperation “Exploitation of the Oceans” ever materialized: each two years, the French and Soviet delegations went through the topics to cooperate on, including exploitation of halieutic resources, geological and geophysical surveys, and physical oceanography.⁷²⁰ Yet, cooperation was usually limited to visits of Soviet experts to France, and scarce visits in the opposite sense. Why the moments of doing science were so rare?

Ocean sciences had just-acquired diplomatic relevance, being at the core of discussions held at the UN General Assembly under a particular rhetorical framework. The mere gesture of exchanging experts or inviting high-officers to visit cutting-edge technological facilities was on itself a symbol of good-will in international relations. Nevertheless, the French government

⁷¹⁷ Ibid.

⁷¹⁸ Ministère d’Affaires Étrangères, “Réunion interministérielle sur les activités de coopération en océanologie,” February 10, 1977 (ADF, 243BGS/60).

⁷¹⁹ La Prairie, Yves. Letter to the Minister of Industry and Research, November 29, 1976 (ANF, 20160259/308). What is interesting of those missions is that French and Soviet experts were taking measurements on salinity, temperature, currents, and exchanges between the atmosphere and the hydrosphere – data that could be considered strategically sensitive in war-fare times. But paradoxically, now that data was unproblematically shared, whereas seismic profiles from the seafloor were considered much more sensible in strategic terms.

⁷²⁰ CNEXO, *Rapport Annuel 1974*.

had lesser confidence on the USSR than what it publicly showed.⁷²¹ Scant works on marine geosciences, and the refusal to share underwater technologies, evidence how the seafloor was a new, and strategically important, territory.⁷²² The scientific value of cooperative activities was of a secondary importance; more relevant was to show, not only to the USSR but to the entire international community, that France maintained close diplomatic relations with the Soviets.⁷²³ And that was perfectly expressed in such a bilateral cooperation in oceanography – although, behind the scenes, frictions and disagreements exceeded the moments of making science.

6.5. Oceanic diplomacy to anticipate the exploitation of marine richness

In February 1972 Minister of Foreign Affairs Maurice Schumann wrote a personal letter to Yves la Prairie, congratulating him for the international success the CNEXO had rapidly achieved:

C'est une grande satisfaction pour un Ministre des Affaires Etrangères, qui fut en quelque sorte en 1967 le « lanceur » du CNEXO, d'entendre dire dans la plupart des capitales du monde où je me suis rendu depuis deux ans, que la France grâce au CNEXO occupe en océanologie une des toutes premières places, quand ce n'est pas la première. (...) Tout récemment, c'est l'Empereur du Japon lui-même qui m'a parlé spontanément des activités du CNEXO et des liens franco-japonais (...) Je pourrais aussi vous parler de Washington, de Londres, de Stockholm, et de Madrid.⁷²⁴

Reaching this international position was the result of the intense and well-planned diplomatic strategy the CNEXO undertook from its foundation, orchestrated through a network that articulated different governmental bodies, French embassies around the world, the hydrocarbon

⁷²¹ The French Navy displayed its reticence to have soviet vessels touring French seawaters, especially close to military bases.

⁷²² We could find an equivalent with the mass of water during the two world wars. The oceans were then a theater of military operations, and any piece of information about currents, temperature, or salinity were strategically valuable.

⁷²³ Mentioned in a report from a meeting of ministers at the Ministry of Foreign Affairs: “Des impératifs purement politiques peuvent également militer en faveur du maintien d'une coopération avec certains pays – URSS ou Etats d'Afrique francophone – même si ses résultats scientifiques sont peu satisfaisants” (in: Ministère d'Affaires Étrangères, “Réunion interministérielle sur les activités de coopération en océanologie,” February 10, 1977 (ADF, 243BGS/60)).

⁷²⁴ “It is a great satisfaction for a Minister of Foreign Affairs, who was to some extent in 1967 the “trigger” of the CNEXO, to hear in most of the world capitals I have visited in the last two years, that France thanks to the CNEXO occupies in oceanology a forefront position, if not the leading one (...) Recently, the Emperor of Japan has spontaneously talked to me about the CNEXO's activities and about the Franco-Japanese relations (...) I could also talk about Washington, London, Stockholm, and Madrid.”

In: La Prairie, Yves. “Note pour M. le Chef de Service des Relations Internationales”, February 8, 1972 (ANF, 20160129/320).

and mining industries and, as mediator and spokesperson, the CNEXO. Its goal: establishing the most fruitful international collaborations to anticipate the exploitation of the high seas.

By the late-1960s international collaboration appeared as an imperative condition to prepare the future exploitation of the oceans, since developing and emergent countries denounced the menace of a perpetuated colonial world order in the ocean floor – perceived as a new global economic frontier. At the UN, the “common heritage of mankind” concept was taken as a pillar upon which an international legal regime for the high seas should be built; yet, it also became a façade behind which nations like France displayed its national geopolitical agenda. From this perspective, the CNEXO’s science diplomacy strategy pursued to integrate activities of territorial expansion and deep-sea technological testing with the international approach to cooperatively govern global commons. By means of establishing bi-lateral cooperation agreements with the US, the USSR, Japan, and the French Polynesia, France managed to set a foot in the deep Atlantic and Pacific oceans, to re-shape power relations with the US (by standing at its side in oceanographic research) and with the USSR (by deliberately maintaining a vantage position in deep-sea technologies and exploration), and to be internationally regarded as a world power in ocean research.

But not only the deep Atlantic and Pacific oceans were theaters to display diplomatic strategies and to anticipate future sources of richness. In the seventies, technological hubris to reach deep oceanic regions were embedded in international cooperative projects, which became as valuable for hydrocarbon exploration as to unveil the ocean crust’s past. Like the great oceans, the Mediterranean Sea would also become the backdrop of an interplay between academic research and resources’ exploration.

Chapter 7. Drill ships and deep oil: commercial exploration through scientific cooperation

Compte-tenu de la position prééminente que détient le pétrole dans la satisfaction des besoins énergétiques (...) et de la nécessité de diversifier toujours davantage les sources d’approvisionnement pour être à l’abri des crises politiques, il apparaît vital pour l’off-shore pétrolier, qui va devoir représenter un pourcentage sans cesse croissant d’une production aussi croissante, de reculer ses frontières en opérant sur des puits, de plus en plus profonds, à des distances sans cesse croissantes de la côte. Il reste donc énormément à faire dans ce domaine technologique.⁷²⁵

Scientists have their own “imagined past,” a historical narrative that draws an academic genealogy from the first proponents of a theory or the pioneers of a ground-breaking discovery, up to current investigations around that subject.⁷²⁶ These narrations however tend to leave aside the economic, political, and social contexts that led to those advancements; or the multiple connections established beyond the scientific community. The narrative around the desert-like Mediterranean is an illustrative case. According to scientific accounts, the 1970 and 1975 deep-sea drilling campaigns across the Mediterranean of the *Glomar Challenger* (fig.28), the only scientific drillship, resulted in unprecedented evidences of a catastrophic event that could have transformed the face of the basin six million years ago. Yet, beyond the scientific relevance of these discoveries, the quotation above reflects the trend simultaneously followed by the offshore oil industry: stimulated by technological advancements and growing oil prices, oil firms were moving their ventures beyond the continental shelf, towards deep sea waters – the regions drilled during the Deep Sea Drilling Project (DSDP).

⁷²⁵ “Given the critical position oil occupies in fulfilling our energy needs (...) and the urgency to diversify our supplies to be able to face political crisis, it appears as vital for the offshore oil industry, which will represent a growing percentage of production, to extend its frontiers in drilling wells each time deeper, at increasing distance from shore. Much remains to be done in the technological domain.” In: Perrot, “Aspects Économiques De L’Exploitation Des Océans,” April 1970 (ANF, 20160259/323).

⁷²⁶ Wilson, “Science’s Imagined Past.”



Figure 28. The D/V Glomar Challenger (Special Collections & Archives, UCSD).

As shown in previous chapters, in the early seventies the imaginary of the oceans as limitless sources of natural resources was at its peak, prompting the enthusiasm of national governments and private oil firms about the promises of the seafloor's hydrocarbon supplies.⁷²⁷ By 1968, more than sixty countries were engaged in offshore oil exploration, while 18% of the world's production came from the seafloor: in the Gulf of Mexico and off Californian coastlines, around the Persian Gulf and the Gulf of Guinea, off Gabon and Indonesia, and across the promising North Sea.⁷²⁸ Although the seabed beyond 50 meters depth was not yet feasible to exploit for technological and economic limitations, oil firms had set future interests beyond that limit, pushing to explore and develop production infrastructures in deep waters.⁷²⁹

⁷²⁷ From 1900 to 1966, global energy consumption moved from 748 tons to 5,000 million tones and from those, oil moved from a 3,7% to a 34%. The oceans appeared as promising future suppliers to fulfill the even-growing consumption (Chapelle, "La France et la Recherche du Pétrole en Mer").

⁷²⁸ Morvan, *Les Océans*.

⁷²⁹ Pratt, Priest, and Castaneda, *Offshore Pioneers*; Burleson, *Deep Challenge!*

The DSDP is commonly identified by first-hand participants and scientific literature with a big science program in fundamental research, only driven by interests revolving around knowing the Earth's formation and dynamics.⁷³⁰ Yet if we look at the parallel trend the offshore oil industry was following, it is inevitable to ask whether there were points of convergence. Our knowledge on how the oil industry influenced on the DSDP and on its successors (the International Program for Ocean Drilling, the Ocean Drilling Program, or the International Ocean Drilling Program) is still poor, and thus far there are no studies that have assessed whether commercial interests were more conspicuous in some cruises, regions, and periods than in others. As detailed in chapter 3 and 4, France's oil industry had grown interested in the Mediterranean's oil potential after American geoscientists Henry B. Hersey and John Menard glimpsed structures in the deep Balearic Basin that could correspond to salt domes. Given the oil industry's interest on ocean drilling and on learning about evaporitic structures as hydrocarbon traps, the intersection between the *Glomar Challenger's* campaigns across the Mediterranean and France's oil industry seems ineluctable.

In this chapter I offer an alternative account to the scientific narrative about the discovery of the desert-like Mediterranean; one that entangles economic ambitions and defines the role played by the offshore oil industry in producing knowledge from the Mediterranean basin. But first I shall introduce the narrative as it is commonly recounted in academic publications and mass media.⁷³¹

7.1. The discovery of the Messinian Salinity Crisis: A scientific account

The scientific account on the discovery of the Messinian Salinity Crisis – the geological event that transformed the Mediterranean into a desert – was built over the narratives of the first proponents of the hypothesis, which were presented in scientific publications, disseminated through newspapers, and published in science dissemination journals.⁷³² The complete story

⁷³⁰ Assertion based mostly in personal communications and interviews to involved experts (as in: Martínez-Rius, “Interview to L. Montadert”, Martínez-Rius, “Interview to X. le Pichon”), as well as in literature of scientific dissemination (Hsü, *The Mediterranean Was a Desert*). There are also hints of this conception in historical literature: John Hannigan, in his book about the geopolitics of the deep sea and the quest to exploit natural resources, frames the DSDP in exploration for the sake of scientific curiosity (Hannigan, *The Geopolitics of Deep Oceans*). Only a few historians have traced an explicit connection between the *Glomar Challenger* and its oil-industry origins: Van Keuren, “Breaking New Ground;” Burluson, *Deep Challenge!*.

⁷³¹ Notably in Hsü, *The Mediterranean was a desert*.

⁷³² For example, the first publication it appears: Ryan, Hsu, and Maria B. Cita, “The Origin of the Mediterranean Evaporite.” and subsequent reports in mass media: Hsü, “When the Mediterranean Dried Up,” Rebeyrol, “Le fond de la Méditerranée est tapissé d’une épaisse couche de sel.” First-hand accounts include: Ryan, “Decoding the

crystallized in the autobiographical book geologist Kenneth J. Hsü, one of the first supporters of this hypothesis, wrote, where he recounted the first *Glomar Challenger*'s cruise across the Mediterranean almost in the shape of an epic adventure.⁷³³ For the following fifty years, scientific publications presenting new results on the Messinian Salinity Crisis have included in the opening section a brief summary of this story, thus reinforcing the same narration.⁷³⁴ What follows is a reconstruction of these accounts.

At daybreak of August 18, 1970, the drilling vessel *Glomar Challenger* crossed the Strait of Gibraltar to venture for the first time into the Mediterranean. This cutting-edge vessel had been built from scratch for the American scientific program Deep Sea Drilling Project (DSDP), the first big science program in marine geology. By acquiring core samples at thousands of meters depth from around the world, the DSDP aimed at providing material evidences of seafloor spreading and to study the Earth's past and dynamics.⁷³⁵

The National Science Foundation funded it from 1968, while the Scripps Institution of Oceanography was its operator.⁷³⁶ Although decision-making was in the hands of American marine geoscientists, foreign researchers were invited to participate from the organization phase to the post-cruise core analysis, going through an onboard party always constituted by geologists from all over the world.⁷³⁷ For the 1970 Mediterranean cruise, nine experts from European and American scientific institutions embarked onboard (fig.29).

Mediterranean Salinity Crisis," and scientific historical accounts: Suc, "Quarante Ans de Débats Autour Des Évaporites Messiniennes", Vai, "Over half a century of Messinian salinity crisis."

⁷³³ Hsü, *The Mediterranean Was a Desert*.

⁷³⁴ Just to name a few examples: Krijgsman et al., "Chronology, Causes and Progression of the Messinian Salinity Crisis"; Roveri et al., "The Messinian Salinity Crisis"; Krijgsman et al., "The Gibraltar Corridor"; Suc, "Quarante Ans de Débats Autour Des Évaporites Messiniennes."

⁷³⁵ About the origins of the DSDP and the JOIDES, see: Van Keuren, "Breaking New Ground"; Bascom, *A Hole in the Bottom of the Sea*; Bascom, "The First Deep Ocean Drilling."

⁷³⁶ Although the Scripps was its operator, the program had been ushered by the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), an association of American researchers from oceanographic institutions. In 1966, the NSF provided 7,4 million US dollars to support the first eighteen months of the DSDP (in: Winterer, "Scientific Ocean Drilling, from AMSOC to COMPOST").

⁷³⁷ At the DSDP, decision-making was distributed among fifteen specialized committees constituted by American geoscientists, engineers, and petroleum experts (as the Executive Committee, the Planning Committee; the regional-setting Advisory Panels on Atlantic, Pacific, and Gulf; and the technical advisory panels on Core Description, Paleontology and Biostratigraphy, Sedimentary Petrology and Geochemistry, Igneous and Metamorphic Petrography, Paleomagnetism, Heat Flow Program and X-Ray Mineralogy. The number and goal of advisory Panels changed throughout the years, appearing more on diverse regional settings (the Mediterranean, Indic Ocean, or Atlantic continental margins), or on emerging issues (as the Advisory Panel on Polluting Prevention).



Figure 29. Leg 13's scientific crew. Upper row, from left to right: William B.F. Ryan, Guy Pautot, Paul Dumitrica (Romanian Academy of Sciences, Romania), Forese C. Wezel (University of Catania, Italy), Herbert Stradner (Geologisch Bindedanstalt, Austria), Kenneth J. Hsü. lower row, from left to right: Wladimir Nesteroff, Jennifer Lort (University of Cambridge, UK), Maria Bianca Cita (Hsü, *The Mediterranean was a Desert*).

The campaign, called Leg 13, pursued to study the birth and dynamics of the Mediterranean basin to frame it in plate tectonics' theory; while deepening into the origin and formation of the salt dome-like structures, first identified in 1965 by American geoscientists John B. Hersey and Henry Menard.⁷³⁸ The idea of organizing such a mission came from Kenneth J. Hsü (1929-), a Chinese sedimentologist who had developed his scientific career in American research institutions.⁷³⁹ Even though he had never studied the Mediterranean region, with the burst in of

⁷³⁸ Seen in chapter 3, p.98-102. All details of the Mediterranean cruise can be found at: Ryan, Hsü, and et al., *Initial Reports of the Deep Sea Drilling Project, 13*.

⁷³⁹ Of Chinese origin, Hsü moved in 1948 to the US to undertake studies in geology. After obtaining his PhD at the University of California, he joined Shell Oil as research geologist for almost a decade. In 1964 he shifted to academic geology, teaching at the State University of New York and at the University of California while

plate tectonics Hsü grew intrigued by the origins of the basin. Until the date, geologists had considered the basin a depression of the Earth crust remnant of the ancient Tethys Ocean. However, from the new perspective of plate tectonics, the Mediterranean became a sort of seam between the African and Eurasian plate.⁷⁴⁰ Only deep-sea cores, recovered with the *Glomar Challenger*, could throw light on its age, origin, and dynamics.⁷⁴¹

Accompanying Hsü as co-chief scientist of the mission was William B.F. Ryan (1939-), a young marine geophysicist from the Lamont Geological Observatory. Although not yet in his thirty, Ryan was arguably the most knowledgeable expert in the Western Mediterranean seafloor in the US. He had engaged in marine geophysics in 1961 under the mentorship of Maurice Ewing and Bruce Heezen – both of them pioneers in marine geophysics and in the study of continental drift (seen in chapters 3 and 5). In his PhD research, based on data acquired during Ewing’s cruises across the Mediterranean, Ryan had offered the first comprehensive tectonic outlook of the basin and a detailed review of the dome-like formations.⁷⁴² Two French experts embarked as part of the scientific party: Guy Pautot, geophysicist at the CNEXO (seen in chapter 6), and Franco-Russian sedimentologist Wladimir Nesteroff (1925-2008), from the University of Paris, who had had a lengthy career in marine sedimentology.⁷⁴³ After being trained by Jacques Bourcart at Villefranche-sur-Mer, Nesteroff participated in the first survey of Jacques Cousteau onboard the *Calypso* across the Red Sea; while during the sixties collaborated frequently with American researchers from the Lamont and the Scripps Institution of Oceanography.⁷⁴⁴ Leg 13 was his second cruise onboard the *Glomar Challenger*, since ten months before he had embarked on Leg 8 across the Pacific Ocean.⁷⁴⁵

After drilling its first successful borehole in the Alboran Sea, the *Glomar Challenger* headed towards the salt domes’ region in the Balearic basin. There, the team recovered the first deep-

conducting research on sedimentology and tectonics. In 1967 he moved to the Swiss Federal Institution of Technology in Zurich, where he continued his academic career keeping links with American researchers.

⁷⁴⁰ Hsü, *The Mediterranean Was a Desert*, 33.

⁷⁴¹ Hsü doesn’t mention the study of deep-sea salt domes as a reason that impelled him to suggest the Mediterranean campaign. Moreover, his career before embarking on the *Glomar Challenger* is almost impossible to trace – there are no publications, nor hints of his research at Shell or academia.

⁷⁴² Ryan, *The Floor of the Mediterranean Sea*. About Ryan’s biography, see Tanya Levin’s oral history interview (Levin, “Interview of William Ryan by Tanya Levin”).

⁷⁴³ About Guy Pautot’s recruitment and activities at the CNEXO, see p.189. About the laboratory of Villefranche-sur-Mer, see p.63.

⁷⁴⁴ Nesteroff, Cousteau, Tazieff, “Coupes transversales de la Mer Rouge;” Nesteroff, Sabatier, Heezen, “Les minéraux argileux dans les sédiments du bassin occidental de la Méditerranée;” Nesteroff, “Quelques résultats sédimentologiques des premiers forages du précontinent américain.”

⁷⁴⁵ Tracey, et al. *Initial Reports of the Deep Sea Drilling Project*, 8.

sea core that displayed a complete sequence of evaporitic materials: gypsum, halite, and anhydrite, minerals that only accumulate after a massive evaporation of seawater. They have just obtained the first physical evidence that a thick salt layer covered the Mediterranean seafloor, from where salt domes grew. In the on-board laboratory, Italian micropaleontologist Maria Bianca Cita examined the cores to date the salt's deposition.⁷⁴⁶ Cita (1924-), Italian geologist from the University of Milan, belonged to the first generation of micropaleontologists in Italy and was expert in studying Italian stratigraphic sections. She had been the first woman who embarked onboard the *Glomar Challenger* during its second campaign, in 1968, and from then onwards she had turned to marine geology.⁷⁴⁷ Salt deposits are known to be formed after the opening or demise of ancient oceans, when the flux of incoming seawater decreases until the sea completely evaporates, leaving as proof of its existence a thick layer of marine salt. Cita realized that the Mediterranean evaporites had not accumulated during the formation of the Mediterranean basin but in an extremely recent period, when the basin already existed with its current shape (from 5 to 9 million years ago, she suggested). More extraordinary were the sediments and nannofossils that covered the evaporitic sequence, characteristic from deep oceanic regions. How the Mediterranean could have moved from being a lacustrine, brackish region, into an open water environment in a handful of years?

Hsü put forward the revolutionary hypothesis that the Mediterranean could have become a desert, after a sudden disruption of the inflow from the Atlantic Ocean that prompted a massive evaporation of seawater. The sea-level dropped thousands of meters, thus salt accumulated even in the deepest regions of the basin. Cita quickly backed Hsü, pointing out that in the Sicilian coastline Italian geologists had identified salt deposits of that same period, named Messinian.⁷⁴⁸ Yet not all embarked geologists embraced with the same enthusiasm such a catastrophic hypothesis. Nesteroff and Pautot doubted that the sea-level could drop thousands of meters, suggesting as an alternative that, during the Messinian, the depth of the Mediterranean basin was much lower than nowadays. Others like Bill Ryan were more moderated in their hypothesis,

⁷⁴⁶ As evaporites are accumulated in hyper-saline environments, where life is almost impossible, do not contain microfossils or other elements that enable to date them. Its age can be defined by analyzing the type and species of microfossils that are embedded in underlying and over-laying sediments.

⁷⁴⁷ In an interview conducted when she was in her eighties, Cita recalled that mariners did not want a woman onboard, as they believed it would jinx the cruise. Another problem was logistic: cabins were shared in partners, and she should be with another woman. Therefore, the cruise organizers (Americans Melvin Peterson and Terence Edgar) invited a second woman, Catherine Nigrini (Simon, "Interview to M.B. Cita").

⁷⁴⁸ According to Cita, Messinian formations were hitherto considered the result of a local marine regression in the area, but no-one had ever ventured to suggest such a massive drawdown. Selli, "Il Bacino Del Metauro;" Selli, "An Outline of the Italian Messinian."

reminding that evaporites could crystalize before reaching a complete evaporation of the water mass.⁷⁴⁹ Discussions continued throughout the eight weeks the cruise lasted, while new cores brought onboard further evidences to support (or to disagree with) Hsü's and Cita's hypothesis.

The *Glomar Challenger* moored back in Lisbon on October 7, 1970, and two days later the CNEXO organized a press conference in Paris where journalists, researchers, and oil industry experts from all over the world, as well as the American leaders of the DSDP, attended to hear about the cruise's preliminary results.⁷⁵⁰ Hsü, Cita, and Ryan offered detailed accounts of their findings: it seemed that a massive layer of salt, up to two kilometers in thickness, covered the Mediterranean seabed. Unlike other saline giants scattered around the globe, originated when continents were not yet in their actual setting, the Mediterranean deposits were surprisingly recent, from a time when the basin had already its current shape. Although the team was cautious in announcing the hypothesis of a desert-like Mediterranean, the compelling image of a landscape so different in a region so familiar triggered astonishment amongst the audience. For academic geologists, explaining such an accumulation of salt presented a new scientific challenge; whereas for journalists, the imaginary of a desertic basin would compose compelling headlines. The newspaper *Le Monde* announced that "The Mediterranean seabed is covered by a thick layer of salt" (which was misleading, as the evaporitic layer was buried below hundreds of meters of more recent sediments), while the journal *Scientific American* published a paper by Hsü entitled "When the Mediterranean dried up."⁷⁵¹ Bill Ryan, in a later interview, lamented that the results about the Mediterranean's desiccation arouse such an amazement that veiled the relevant tectonic results acquired during the cruise.⁷⁵²

The image of a desert-like Mediterranean spread like oil through mass media and around the European geological community. Science dissemination journals published articles evoking the image of a dry Mediterranean, which were written by members of the onboard party as means to raise public awareness on their research lines.⁷⁵³ Maria Bianca Cita first presented the scientific results acquired to the geological community during the 5th Stratigraphic Congress of

⁷⁴⁹ Ryan, Hsü, and Cita, "The Origin of the Mediterranean Evaporite."

⁷⁵⁰ Peterson, Melvin N.A. (chief scientist DSDP). Letter to Yves la Prairie, September 21, 1970 (UCSD, b.99 f.8); Wiley, Tom (public information office DSDP). Letter to K.E. Brunot (Project Manager DSDP), July 8, 1970 (UCSD, b.99 f.08).

⁷⁵¹ Rebeyrol, "Le fond de la Méditerranée est tapissé d'une épaisse couche de sel;" Hsü, "When the Mediterranean Dried Up."

⁷⁵² Martínez-Rius, "Interview to W. B.F. Ryan."

⁷⁵³ n.a. "Mediterranean evaporites;" Hsü, Ryan, Cita, "Late Miocene desiccation of the Mediterranean"; Rebeyrol, "Le fond de la Méditerranée est tapissé d'une épaisse couche de sel" ; Hsü, "When the Mediterranean Dried Up."

the Mediterranean Neogene, held in September 1971 in Lyon, offering evidences of a massive sea-level drop during the Messinian period. Her talk triggered a heated scientific debate in which positions moved around three poles. Some experts, as Cita, agreed on a deep-Mediterranean basin that had completely desiccated. Others were more inclined to think that the basin was much shallowed than nowadays and that it had completely dried, later subsiding into its current position. Third group bet for a deep basin that had not completely desiccated (which nowadays is the most accepted hypothesis). According to the memories of some in-site participants, experts from the oil industry harshly criticized Cita's hypothesis, completely opposing to a deep, desiccated basin. French geologist Georges Clauzon stood up to support Cita by arguing that he had found deep-sea canyons eroded at the Rhône's mouth coeval to the Messinian seawater drop-down – an almost univocal evidence of a massive marine regression.⁷⁵⁴ Besides the inquiry on whether the Mediterranean had become a desert or not, numerous questions remained opened like how, when, and why the sea-level could have dropped down, if it had happened during a gradual or a catastrophic event, and how the basin was refilled with seawater.⁷⁵⁵ Some experts, for instance, dared to suggest that the Strait of Gibraltar could have become a colossal waterfall, pouring water from the Atlantic ocean during a hundred years.⁷⁵⁶

Determined to solve the controversy, Hsü organized a second deep-sea drilling cruise across the Mediterranean. In January 1971, Hsü gathered in Zürich thirty experts from ten countries interested in studying the salt giant, with whom he drafted a proposal that was approved by the DSDP's organizers on September 29, 1973.⁷⁵⁷ Leg 42, as it was called, aimed at coring samples from stratigraphic layers below the salt layer, drilling less boreholes but reaching deeper structures. Drill sites were selected based on high-resolution seismic profiles, in regions were

⁷⁵⁴ Based on the memories of geologist Georges Clauzon, collected by his colleague, Jean-Pierre Suc (in: Suc, "Notes sur Georges Clauzon", personal communication).

⁷⁵⁵ Compiled volumes on conferences well-reflect the different perspectives, and the heated controversy, around the Messinian Salinity Crisis: Drooger, *Messinian Events in the Mediterranean*; Catalano, Ruggeri, and Saproveri, *Messinian Evaporites in the Mediterranean*.

⁷⁵⁶ The controversy around the Messinian Salinity Crisis still continues nowadays. It has been detailed by involved experts in: Ryan, "Decoding the Mediterranean Salinity Crisis;" Roveri et al., "The Messinian Salinity Crisis;" Suc, "Quarante Ans de Débats Autour des Évaporites Messiniennes;" Vai, "Over Half a Century of Messinian Salinity Crisis,"

⁷⁵⁷ Apparently, the American organizers of the DSDP were initially against organizing a second campaign in the same region, especially because the DSDP pursued to obtain scientific results of global relevance, instead of solving local geological problems (in: Hsü, Montadert, and et al., *Initial Reports of the Deep Sea Drilling Project, 42 Pt. 1*).

the salt layer was very thin or had been completely removed by erosion (since thick and hard evaporites are almost impossible to drill across).

Leg 42 started on April 4, 1975, with a fresh international scientific party onboard.⁷⁵⁸ Hsü repeated as co-chief scientist, but this time he shared the leadership with French geophysicist Lucien Montadert, from the *Institut Français du Pétrole* (IFP). During five weeks at sea, the *Glomar Challenger* recovered almost 700 meters of sediment from eleven boreholes, at water depths overpassing 4,000 meters. Once on land, samples were distributed among dozens of European and American laboratories. The cruise volume, published two years later, gathered the scientific conclusions and presented the onboard party's consensus on some geological events that occurred during the Messinian: Due to tectonic movements that altered the Atlantic water inflow, the Mediterranean basin dried up and refilled numerous times during some thousands of years, which could explain such an enormous amount of accumulated salt.⁷⁵⁹

Yet many questions remained opened, and the topic had already gathered strong impetus among the scientific community. European cooperative research projects around the Messinian Salinity Crisis lingered by the initiative of individuals – even though the *Glomar Challenger* and its successor, the *JOIDES Resolution*, did not return to the Mediterranean until 1995.⁷⁶⁰ These new investigations mostly relied on fieldwork across the Mediterranean coastline, but also on the development of punctual marine geophysical campaigns. From 1975, Maria Bianca Cita co-organized the “Messinian Seminars,” a series of annual meetings under the sponsorship of UNESCO's International Geoscience Programme to bring together academic geoscientists from around Europe where they discussed recent results and organized joint investigations.⁷⁶¹ Scientific efforts continued, and research lines around particular details of the Messinian

⁷⁵⁸ Hsü and Montadert were the co-chief scientists of a team constituted by Maria Bianca Cita (only expert who repeated), Carla Müller and Germaine Bizon (both ascribed to the IFP by then), three American geologists, one Swiss, one British, one German, and a French sedimentologist.

⁷⁵⁹ According to the interpretation of the cores, the Mediterranean basin, similar in depth as it is today, was dried up and refilled numerous times during some thousands of years, which explained such an enormous amount of accumulated salt. This unique event was caused by tectonic movements between the African and Eurasian plate, that had been going on for fifteen million years before the salinity crisis triggered. By the end of the Messinian period, the Balearic basin was reflooded with seawater from the Atlantic Ocean, but it took some thousands of years before the Mediterranean basin was completely refilled, becoming once again a deep, open-water marine basin. Hsü, Montadert, and et al., “History of the Mediterranean Salinity Crisis.”

⁷⁶⁰ The reason why it did not returned relates to the international interest of exploring again the Mediterranean. The American organizers prioritized less explored areas or more geologically interesting from a global tectonic perspective. The *JOIDES Resolution* did come to the Mediterranean in 1987, but only to study the Tyrrhenian Sea (during the Ocean Drilling Program (ODP) leg 107). The entire basin was surveyed in 1995 during ODP legs 160 and 161, pursuing similar goals as the 1970s drilling cruises.

⁷⁶¹ Cita, “The Messinian Salinity Crisis in the Mediterranean: A review.”

Salinity Crisis were inherited from senior researchers to their PhD students, creating a research genealogy.

Meanwhile, the imaginary of a desert-like Mediterranean gained traction among the wider public. For the last four decades, journals and daily press have published reports about the desert-like Mediterranean: In 1999, *Nature* published about “When the Mediterranean was a desert” and one year later, the Royal Gibraltar Post Office issued a special collection of stamps illustrating key moments in the regions’ history – being the “Messinian flooding” was among them (fig.30).⁷⁶² In 2008, a short report on the Messinian Salinity Crisis appeared in France’s televised news in *France 2*; even as recent as in 2020, *National Geographic* published a report entitled “The Mediterranean nearly dried up. A cataclysmic flood revived it.”⁷⁶³



Figure 30. Gibraltar Millennium Stamp, depicting the waterfall that re-filled the Mediterranean.

Almost fifty years after the *Glomar Challenger* offered evidences that a thick layer of salt covered the deep Mediterranean basin, the European project SALTGIANT ETN inaugurated aiming at bringing together again an enthusiastic community of Italian, French, Spanish, Dutch, German, Israeli, and British geoscientists into the study of the Messinian Salinity Crisis.

In the scientific narrative summarized above, the oil industry’s contribution or presence is barely mentioned, but it appears in certain moments behind the scenes. But what was exactly the involvement of oil industry experts in these cruises? How oil experts interacted or cooperated with academic geologists? And how they contributed to enhance knowledge on the Mediterranean basin and the Messinian Salinity Crisis? In what follows I offer an alternative account of this scientific narrative, illuminating the involvement of economic interests and the active role of oil industry experts. But first, it is essential to understand why the oil industry

⁷⁶² Ball, “When the Mediterranean was a desert.”

⁷⁶³ Wei-Haas, “The Mediterranean nearly dried up.”

grew interested in exploring deep-sea salt domes and for that, we should move slightly before Leg 13, up to the christening and first cruise of the *Glomar Challenger*.

7.2. Salt domes in deep waters

7.2.1. The oil industry and first survey of the *Glomar Challenger*

The *Glomar Challenger* was born at the oil industry, designed and built by the American oil-tech company Glomar Marine Inc., specialized in designing floating rigs for offshore oil firms.⁷⁶⁴ In 1967, the Scripps Institution of Oceanography awarded them the construction of the first scientific drillship in the world, which would operate for the Deep Sea Drilling Program (DSDP).⁷⁶⁵

The *Glomar Challenger* possessed an unprecedented design based on incremental innovations developed at the oil industry.⁷⁶⁶ Its hull drew from Glomar Marine's latest and most advanced drill ship, the D/V *Grand Isle*, modified to operate in unprecedented deep waters. The firm's engineers designed for the *Glomar Challenger* a revolutionary system to hold the drillship in position while drilling at high seas without requiring anchors, chains, or other mooring systems. The dynamical positioning system consisted on four computer-controlled propellers installed in the hull, in constant communication through sound signals with four transponder beacons lowered to the seafloor. Moreover, it was the first commercial vessel that relied on the Navy's satellite navigation and communication system.⁷⁶⁷ Other innovations were already common in Glomar Marine drill ships: a re-entry system that enabled finding back the bore hole if the drill pipe had to be pulled out, a derrick that towered 43 meters above the drilling platform to weight almost 500 tons, and a drill pipe that could extend up to seven kilometers across the seawater and the seafloor.⁷⁶⁸

⁷⁶⁴ At that time, Glomar Marine Inc. was also turning to the exploration of polymetallic nodules (as mentioned in p. 196). Burleson has written the history of Glomar Marine's floating rigs in Burleson, *Deep Challenge!*.

⁷⁶⁵ There is no evidence on the drillship's cost, or about when the contract between Scripps and Glomar Marine was signed. More details about how and why Glomar Marine was chosen, in: Burleson, *Deep Challenge!*, 124-125. Glomar Marine Inc. became the drillship operator at the DSDP.

⁷⁶⁶ Van Keuren, "Breaking New Ground."

⁷⁶⁷ In 1958, the US military had implemented its first global satellite navigation system, *Transit*, that was enhanced in the following decades. In 1967 the US Navy launched a more advanced satellite, *Timation*, that offered more precise information on location. About the history of navigation systems, from the 19th century to the GPS, see: Ceruzzi, *GPS*.

⁷⁶⁸ All the technical details of the *Glomar Challenger*'s design appear at: Burleson, *Deep Challenge!*

Glomar Marine handed the vessel to the Scripps Institution of Oceanography in March 1968 and five months later, its first deep sea oceanographic survey began. The Gulf of Mexico became the testing ground for the just-christened *Glomar Challenger* for its scientific interest and for being the most explored, drilled, and developed offshore oil province in the world.⁷⁶⁹ From 1947, American oil firms had drilled almost 3,000 exploratory wells at an average water-depth of 36 meters (table 5),⁷⁷⁰ which had enabled engineers, technicians, and oil geologists to develop vast technical expertise in studying marine sediments and to prevent the risks associated to underwater drilling. Each drill site needed careful evaluation before being selected, since accidentally piercing into an hydrocarbon deposit could originate a massive explosion or an oil spill impossible to stop – as it had happened in June 1964, when the floating platform C.P. Baker blew up after drilling into a gas deposit, off New Orleans.⁷⁷¹ Expertise was also necessary while drilling to identify oil from retrieved cores if the drill bit hit a hydrocarbon trap.

	Exploratory wells	Proved fields	Average water depth
1947-1959	442	70	16
1960-1969	2,377	119	36
1970-1979	3,356	265	59

Table 5. Exploratory activity in the Gulf of Mexico’s continental shelf. Modified after Lore, “An exploration and discovery model”.

Besides being a significant site for oil prospection, the Gulf of Mexico had been object of numerous geophysical campaigns during the 1950s and the 1960s, most of them led by American geophysicist Maurice Ewing, from the Lamont Doherty Earth Observatory. Ewing was intrigued by the dome-like structures that appeared depicted in seismic profiles acquired from the Gulf’s abyssal plain. If those were salt domes and not geophysical artifacts, their likely existence below 3,000 meters of water challenged the assumed knowledge of salt dome formations.⁷⁷² As salt deposits accumulate after the retreat and evaporation of seawater, geologists considered that, in the marine domain, they could only be found in shallow areas

⁷⁶⁹ Historian Taylor Priest has put forward the compelling argument that policies triggered technological innovation for deep-water exploration, rather than the hitherto assumed opposite relation (where technological innovation precedes deep-water exploration). In: Priest, “Extraction not creation.”

⁷⁷⁰ Lore, “An exploration and discovery model.”

⁷⁷¹ Of the 43 crew on board, twenty-one died (out of which thirteen were never found), and the rest were injured.

⁷⁷² As in: Ewing, Antoine, “New seismic data concerning sediments and diapiric structures.”

resulting from past marine regressions over the continental shelf.⁷⁷³ The DSDP offered a unique opportunity to probe Ewing's hypothesis by drilling in the Gulf's abyssal plain, in the region called Sigsbee Knolls (fig.31).

Led by Ewing himself, the *Glomar Challenger* started its journey across the oceans in August 1968, in a cruise from Texas to New Jersey. The crew drilled and recovered continuous sections of sediment from the Gulf's deepest region, around the Sigsbee Knolls' salt domes – up to 5,354 meters of water, deeper than any oil company had ever ventured.⁷⁷⁴ The cruise's double goal aimed at testing the drillship's drilling gear, while advancing knowledge on the Gulf's geological history and its dome-like formations. Due to the Gulf's propensity to harbor hydrocarbon deposits, Ewing recruited for the scientific party oil geologists Arthur O. Beall and Creighton A. Burk, from Continental Oil and Mobile Oil, who could quickly evaluate the oil content of retrieved sediments. Soon their presence onboard proved useful: on August 19, while drilling at 3,500 meters depth in the Sigsbee Knolls' region, a retrieved core came out spilling oil. The drill pipe had hit a cap rock, a geological structure that covers and seals hydrocarbon deposits. The drilling was immediately stopped and the borehole, filled and abandoned to prevent an oil spill. However the scientific party could not stop the word to spread: the interpretation of the core demonstrated that the deep abyssal plain of the Gulf hid oil-rich salt domes.⁷⁷⁵

⁷⁷³ As mentioned in p.100, salt domes constitute oil traps, thus oil companies exploring the continental shelf chased salt domes and layers of evaporites as key sites to find hydrocarbon deposits.

⁷⁷⁴ Ewing, Worzel, and Burk, "Introduction to Leg 1." Recovering a continuous section means keeping the drilled hole open while bringing a core onboard; and later introduce the drill pipe again in the same hole to recover a second core. The challenge lays in the difficulty of keeping the hole open during the operation, and finding it again once the drill pipe goes in for coring for the second time.

⁷⁷⁵ Ewing, Worzel, and Burk, "Introduction to Leg 1;" Burlison, *Deep Challenge!*

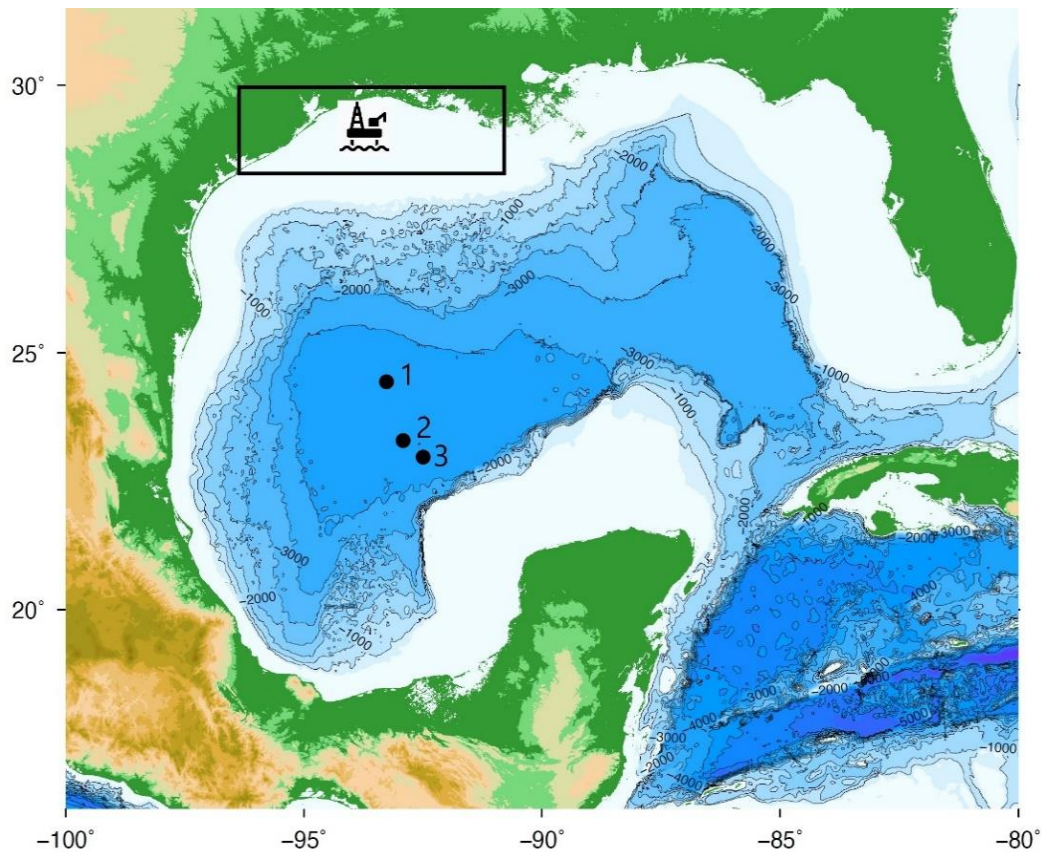


Figure 31. The *Glomar Challenger*'s drill sites in the Gulf of Mexico.

7.2.2. Fears of American expansion across the deep Mediterranean

The news of Ewing's findings reached mainland before the drillship. On September 4, 1968, the French newspaper *Le Monde* announced with fanfare that oil had been found for the first time in deep waters.⁷⁷⁶ As the report detailed, finding oil around salt domes was commonplace, but finding it in such depths altered all principles on where hydrocarbons could be found. More relevant, this scientific discovery proved that the technological capabilities to explore and access potential deep sea deposits already existed, paving the way for the oil industry to venture into this new frontier.

The finding had a major impact on the CNEXO's leading circles.⁷⁷⁷ On December 1968, during a meeting of the CNEXO's Administrative Council, André Giraud expressed his fear of finding themselves "highly distanced from the Americans" in the domain of deep-sea drilling, especially in the field of oil exploration. He was concerned that the US could use the *Glomar*

⁷⁷⁶ Rebeyrol, "Pour la première fois du pétrole est découvert en mer profonde."

⁷⁷⁷ Mentioned in numerous official reports, for instance in: CNEXO, "Synthèse des principales activités océanologiques, du 1^{er} décembre 1968 au 1^{er} février 1969", February 1, 1969 (ANF, 19980125/1).

Challenger for oil exploration disguised under the label of “scientific exploration,” especially if the drillship was going to sail near the French submerged territory.⁷⁷⁸ The DSDP has been launched as a scientific program, but what if American oil companies were behind the organization of its cruises? And what would happen if it progressively transformed into a support for oil exploration in deep waters?

One of the regions Giraud was most concerned about was the Western Mediterranean, in the case the DSDP’s Executive Panel decided to organize a drilling mission there – especially because the structures Ewing had found in the deep Gulf were overtly similar to the structures glimpsed in the deep Western Mediterranean through seismic profiles.⁷⁷⁹ In the case of being also salt domes, the region would become a promising oil field, close to mainland France and open to be grabbed. However, French oil companies did not yet possess the technological capabilities to explore or drill into the abyssal plain. The oil firm CFP had just drilled its first borehole in the Gulf of Lion’s continental shelf, in waters shallower than 100 meters, by outsourcing the *D/V Drillship* from the American firm Drillship Associates.⁷⁸⁰

Following with the CNEXO’s mindset, it would be regrettable if the *Glomar Challenger* was sent into the Mediterranean – here understood as the playground of French oil companies – before French academic or industrial experts possessed detailed information about its economic potential or its geological value, as that would grant advantage to the Americans in exploiting its potential richness.⁷⁸¹

7.2.3. Where to drill and whom to embark: the CNEXO’s involvement in Leg 13

Giraud’s fear to find the Americans drilling across the deep Mediterranean before French oil companies did was not unfounded. Simultaneously to conversations held at the CNEXO’s headquarters, Kenneth Hsü had begun to organize the DSDP Mediterranean cruise. He and Ryan were contacting European experts who could assess them in defining the cruise’s goals and drill sites, which led them to reach Xavier le Pichon. Le Pichon had met Ryan during his

⁷⁷⁸ Conseil d’Administration CNEXO, “Procès-verbal de la séance du Conseil d’Administration du CNEXO du 5 décembre 1968”, December 5, 1968 (ANF, 19980125/1).

⁷⁷⁹ Described in pp. 98-101.

⁷⁸⁰ CFP, “Sondage d’exploration MISTRAL 1” (AHT, 50ZZ604/32). The next year the well was abandoned for being dry, and the company continued exploring the area with geophysical techniques, to select further sites to drill (in: CFP, “Documents sur l’exercice 1968;” CFP, “Documents sur l’exercice 1969”).

⁷⁸¹ Expressed in: Le Pichon, Xavier. “Note à l’attention de DG. Objet: Forages profondes,” May 19, 1969 (ANF, 20160129/326).

stay at Lamont (from 1963 to 1968), before moving to the CNEXO as Scientific Advisor to the General Director.⁷⁸² When Ryan told him about their plans to conduct a deep-sea drilling survey across the Mediterranean, le Pichon caught fast the chance to move French marine geology into an international level, and sent a letter to Yves la Prairie urging him to get the CNEXO involved in the campaign's organization as soon as possible.⁷⁸³ Le Pichon was probably oblivious to the conversations that had taken place during the Administrative Council's meeting, five months before, because his letter aimed at persuading la Prairie of the DSDP's scientific and economic importance – something that la Prairie was well-aware of.⁷⁸⁴

Le Pichon became the mediator between the CNEXO at the DSDP's organization committee. From that position, he suggested to la Prairie two strategies through which the CNEXO could benefit from the data (and knowledge) obtained during the deep-sea drilling campaign: by disclosing geophysical information to select drill sites, before Leg 13 was conducted; and by embarking a CNEXO expert onboard the *Glomar Challenger* during the Mediterranean cruise.⁷⁸⁵

To ensure a safe and effective drilling, the selection of drill sites needed to rely on numerous seismic profiles and geological information, which demonstrated that the drilling would avoid cracks and faults (as they can create geological instability), and that the stratigraphic sequence expected to be recovered would respond to the mission's scientific goals. Although geophysicists at the Lamont and at the Woods Hole Oceanographic Institution possessed numerous geophysical profiles from the Mediterranean seafloor, acquired during their previous around-the-world campaigns, those were not sufficiently detailed to organize a drilling cruise across the basin.⁷⁸⁶ Hence they frequently resorted to foreign institutions as providers of detailed information.

From the CNEXO's perspective, having the ability to offer high-quality data to the DSDP's organizers would translate in a vantage position in the program's organization, as well as the capacity to suggest drill sites that could fulfill their economic and scientific interests. For that reason, in March 1970 the CNEXO undertook a series of campaigns aimed at recovering

⁷⁸² Martínez-Rius, "Interview to W. B.F. Ryan". Le Pichon invited Ryan to the CNEXO when he got his permanent position as scientific advisor to the General Director, showing him the facilities, vessels, and national program.

⁷⁸³ Le Pichon, "Note à l'attention de DG. Objet: Forages profondes", May 19, 1969 (ANF, 20160129/326).

⁷⁸⁴ Ibid.

⁷⁸⁵ Ibid.

⁷⁸⁶ Some of these surveys have been detailed in chapter 3 (pp.92-93 and 130-131).

geophysical and sedimentological information that could be used to suggest drill sites for Leg 13.⁷⁸⁷ The surveys were conducted by CNEXO geoscientists and IFP experts (a partnership that was already proving fruitful to explore the Atlantic continental margin), and employed a prototype of a light deep-sea drilling system just designed by engineers at the IFP.⁷⁸⁸ The *flexo-électro-carottage* had been specifically designed to undertake quick reconnaissance campaigns by recovering short cores from up to two thousand meters depth without requiring a dynamic positioning system.⁷⁸⁹ CNEXO geoscientist Guy Pautot, who was employed at the *Centre Océanologique de Brest*, was appointed chief scientists of these hybrid surveys. Pautot was standing out as a proficient geoscientist, expert in studying the Western Mediterranean's continental margin through marine geophysics and by analyzing cored sediments.⁷⁹⁰ But besides his scientific expertise, he was committed to lead these surveys because la Prairie and le Pichon aimed at embarking him onboard the *Glomar Challenger*.⁷⁹¹ By leading the CNEXO-IFP drilling surveys, Pautot was rapidly trained in using deep-sea drilling techniques, grew familiar with the oil industry's offshore activities, and learned more about the geological formations expected to be found during Leg 13. In addition to these drilling campaigns, in May 1970 Pautot was also called to lead the mission POLYMÈDE I, specifically addressed at recovering geophysical data from the Western Mediterranean's abyssal plain to suggest drill sites to the Leg 13's organizers, while fostering knowledge on the geological structure of the

⁷⁸⁷ Pautot, "Résultats de la campagne de Flexo-électro-carottage;" CNEXO, "Contrat IFP - CNEXO: Reconnaissance de structures géologiques en Méditerranée profonde par flexo-électro-carottage," April 16, 1970 (ANF, 20110381/12); CNEXO, "Synthèse des principales activités océanologiques du 15/01/1970 au 15/04/1970", April 26, 1970 (ANF, 19980125/2). Although these campaigns were first evoked during the Administrative Council's meeting of December 1968, they were oriented towards supporting the organization of Leg 13 when Xavier le Pichon got involved (Conseil d'Administration CNEXO, "Procès-verbal de la séance du Conseil d'Administration du CNEXO du 5 décembre 1968," December 5, 1968 (ANF, 19980125/1)).

⁷⁸⁸ Pautot, "Résultats de la campagne de Flexo-électro-carottage en Méditerranée Nord-occidentale;" Conseil d'Administration CNEXO, "Procès-verbal de la séance du Conseil d'Administration du CNEXO du 5 décembre 1968," December 5, 1968 (ANF, 19980125/1).

⁷⁸⁹ The drilling capabilities of this system were far from those of the *Glomar Challenger*, among other things because it did not enable to maintain the borehole open while retrieving a core. Therefore, it only allowed to obtain a single core sample from a particular depth. The design of this drilling system, as well as the joint campaigns undertook to test it, were announced in the French press, emphasizing (misleadingly) that France already owned oil exploration capabilities equivalent to the American ones. In: *Le Monde*, "L'Institut Français du Pétrole expérimente une nouvelle méthode de forage par grands fonds."

⁷⁹⁰ Pautot began to develop this experience from early 1960s, when he initiated his academic career at the University of Paris under the supervision of geologist Louis Glangeaud. As presented in chapter 6, Guy Pautot was recruited at the CNEXO in 1969, just after obtaining his PhD in marine geology, to become part of le Pichon's team at Brest's Oceanographic Center.

⁷⁹¹ Le Pichon, Xavier. "Note à l'attention de DG. Objet: Forages profondes," May 19, 1969 (ANF, 20160129/326).

salt domes' region. Under the CNEXO's auspices, the *Jean Charcot* sailed from Marseille to Alger, recovering continuous seismic profiles with *Flexotir*.⁷⁹²

The seismic profiles acquired during POLYMÈDE, together with sedimentological information gathered during the CNEXO-IFP campaigns, enabled Xavier le Pichon to suggest several drill sites to Hsü and Ryan, the cruise's organizers.⁷⁹³ Based on the seismic profiles the CNEXO provided, Hsü and Ryan selected three drill sites: in the salt domes' region of the Balearic Basin (site 124), in the Sardinian Channel (site 133), and over the Western Sardinia continental slope (site 134) (fig.32).⁷⁹⁴

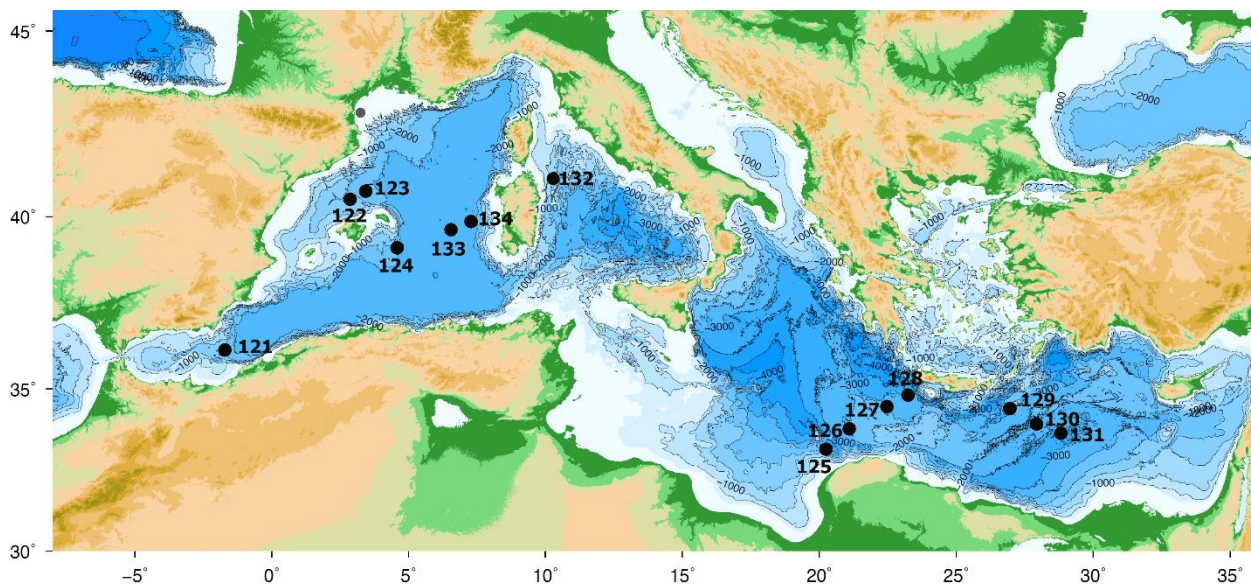


Figure 32. The *Glomar Challenger*'s drill sites across the Mediterranean, Leg 13. In grey, the approximate location where the CFP drilled four boreholes in the Gulf of Lion.

The planned boreholes were not going to drill across cap rocks (structures that trap hydrocarbon deposits), like Ewing's mission had accidentally done. Not only because Hsü and Ryan refused transforming the mission into an oil exploration survey, but especially because of the

⁷⁹² POLYMÈDE was meant to be a multidisciplinary campaign in marine biology and geology. However geologists and geophysicists conducted their research during the first leg (Marseille-Alger-Marseille), and afterwards were replaced by the team of biologists, who conducted their investigations in a leg from Marseille to Brest (COB. *N.O. Jean CHARCOT. Campagne Polymède I*).

⁷⁹³ Mentioned in DSDP, "Scientific Prospectus for Leg XIII Mediterranean Sea," n.d. (UCSD, b.99 f.7). The usefulness of POLYMÈDE for later interpreting the sediments recovered in site 124 is specified in a drafted paper, clipped in a letter from C. Benoit (CNEXO's International Relations Department) to Tom Willey, November 18, 1970 (UCSD, b.88 f.08).

⁷⁹⁴ DSDP, "Scientific Prospectus for Leg XIII Mediterranean Sea," n.d. (UCSD, b.99 f.7). In his biographical account, Hsü affirmed that 7 out of 15 drill sites were selected based on CNEXO's and IFP's seismic profiles, but I could not contrast it with archival sources (Hsü, *The Mediterranean Was a Desert*).

environmental risks associated.⁷⁹⁵ Two recent accidents derived from oil activities, the sinking of the *SS Torrey Canyon* in March 1967 and the blow up of a Union Oil platform in Santa Barbara (January 1969), had set the environmental damages of offshore drilling and oil transportation at the public spotlight.⁷⁹⁶ Early in 1970, the DSDP Executive Committee created an Advisory Panel on Pollution Prevention and Safety, responsible for evaluating the safety of each deep-sea drilling proposal. Constituted by a dozen of experts from US universities and private companies, the board scrutinized the polluting risks of each proposed drilling, specifically banning any site close to a potential hydrocarbon deposit – which meant near or over salt domes.⁷⁹⁷ So if Leg 13 was not aiming at directly identifying oil deposits, how these drill sites would benefit French oil companies? As highlighted in chapter 4, knowing the age of salt domes and their surrounding formations was key to inform understanding about their hydrocarbon potential, maturation stage, and quality. Therefore, any piece of data informative about the salt domes' age and the paleoenvironment in which evaporites deposited was valuable.

On the other hand, to be part of the *Glomar Challenger's* onboard party, scientific proficiency was as important as to maintain a diplomatic *status quo*. For each leg, American organizers invited geologists, sedimentologists, and micropaleontologist from around the world to embark onboard, to study core samples, and to coauthor the campaign's final report. Scientific reasons to do so were weighty: the local expertise of foreign researchers was fundamental to analyze and interpret samples, while the huge amount of data produced during each campaign required a combined effort that was beyond the capabilities of American researchers. But also by the late-sixties delegates from emergent nations expressed their concerns at UNCLOS meetings about research activities conducted across the high seas, especially those that had obvious commercial connotations and were carried out by nations leading oceanographical research – and the DSDP fell into this category. Therefore, although the program was totally subsidized by the American National Science Foundation, it was important to transform it into an

⁷⁹⁵ In his autobiographical account, Hsü explains that petroleum geologists from oil companies pressed him to select drill sites traversing cap rocks, but he (backed by Xavier le Pichon) discarded them. However I could not find more evidences or details of this incident (Hsü, *The Mediterranean Was a Desert*).

⁷⁹⁶ The *Torrey Canyon* accident polluted the coastlines around the English Channel (France and the UK), and Spain. About its disastrous consequences, see: Crochet, *Marées Noires*. Santa Barbara oil spill, in the southern California coastline, had major repercussions in US policy-making, speeding up and informing the legislation to regulate water pollution; and triggering a strong public opposition to offshore oil platforms (for a detailed account, see: Sabol Spezio, *Slick Policy*).

⁷⁹⁷ Hsü, *The Mediterranean Was a Desert*.

international project. The presence of foreign researchers onboard prevented suspicions among coastal nations' authorities about possible commercial goals, hidden behind the Americans' pursuit to drill in international waters around the world.

For the Mediterranean, as Hsü synthesized, "it would be discourteous to European colleagues if Americans were to poke holes in their backyard without their active participation."⁷⁹⁸ For their contribution in organizing the cruise as well as for their experience in studying the Mediterranean seafloor, Hsü and Ryan reserved two sites onboard for French experts. To embark onboard was a unique opportunity for foreign researchers to grow involved in the world's most advanced marine geological project, as well as to perform a satisfactory representation of France's research capabilities abroad.

As mentioned above, sedimentologist Wladimir Nesteroff, from the University of Paris, had been the first and only French scientist who, until Leg 13, had embarked onboard the *Glomar Challenger*.⁷⁹⁹ He participated in Leg 8, conducted between October and December 1969 across the distant Pacific Ocean, not for his scientific experience in the region but due to diplomatic reasons. The drillship departed from Honolulu and moored in Papeete, French Polynesia. Utilizing Hsü's phrase, it would have been "discourteous" to reach a French overseas port while not inviting a French representative onboard. Nesteroff was well-known at the Scripps Institution of Oceanography for his previous collaborations with American oceanographers, therefore he was suggested by the DSDP Executive Panel to embark on Leg 8. Diplomatic formalisms were well-encapsulated in a letter la Prairie wrote to the Governor on French Polynesia before the *Glomar Challenger* reached port, describing the scientific and political importance of the DSDP, and cordially inducing him to receive the *Glomar Challenger* "with the best traditions of your legendary hospitality."⁸⁰⁰

Regarding Leg 13 participants, the CNEXO had the last word in deciding who would embark, since the institution was responsible for surveilling France's representation in international

⁷⁹⁸ Hsü, *The Mediterranean Was a Desert*, 36.

⁷⁹⁹ Even Soviet researchers were invited onboard before French geologists. During Leg 6, which crossed the Pacific from Hawaii to Guam in summer 1969, Dr. Valery Krasheninnikov and Dr. Alexander P. Lisitzin (both from the Academy of Sciences USSR) participated on-board (in: Tracey, *Initial Reports of the DSDP*). This diplomatic aspect of the DSDP is still to be studied, and deserves attention inasmuch as it could illuminate how diplomatic dynamics were reflected, or shaped by, international participation in cooperative oceanographic programs.

⁸⁰⁰ Maintaining friendly relations was especially important at that moment because la Prairie had just begun his conversations with Edward Wenk Jr. to establish a Franco-American collaboration in ocean sciences (see p.185-187). La Prairie, Yves. Letter to the Governor of French Polynesia, March 12, 1969 (ANF, 20160129/326).

oceanographic forums. Guy Pautot, recently trained during the CNEXO-IFP surveys and POLYMÈDE, was selected; as well as Wladimir Nesteroff, for his past participation onboard Leg 8, his experience in studying the Mediterranean basin, and his role as representative of France's academic community.

As mentioned in the scientific account, during Leg 13 the first material evidences of a thick salt layer covering the deep Mediterranean basin, from which salt domes grew, were retrieved. Onboard the *Glomar Challenger*, enthusiasm about the finding mixed with the first scientific disagreements among the onboard party: not all embarked scientists embraced the hypothesis of a complete desiccation of the basin as justification of such an accumulation of evaporites. The three different positions around the Messinian Salinity Crisis controversy began to crystallize, as embarked geologists tried to correlate their scientific knowledge and the most fundamental geological principles with the sediments recovered.

After mooring back in Lisbon, the team enthusiastically headed towards Paris to communicate their findings in the press conference. Hsü, Cita, and Ryan were unsure about how to communicate their results and how attendants would receive an hypothesis that implied a catastrophic event, which might not have had an equivalent throughout the Earth's geological history, affecting the Mediterranean basin. Yet, not only French geologists were impatient to know about the secrets that the team had uncovered from the deep Mediterranean. Representatives from oil companies were as eager as them to hear the news brought by the scientific party.

7.3. The deep Mediterranean, a new energy frontier

On October 9, 1970, Yves la Prairie organized an international press conference sponsored by the CNEXO. Journalists, researchers, and oil industry experts from all over the world, as well as the American leaders of the DSDP, attended to hear about the cruise's preliminary results.⁸⁰¹ Maria Bianca Cita's presentation, describing the existence of a thick layer of evaporites covering the Mediterranean, sparked the enthusiasm of French oil companies: they thought the region could become the Gulf of Mexico's equivalent near European coastlines.

⁸⁰¹ Letter from Peterson, Melvin N.A. (chief scientist DSDP) to Yves la Prairie, September 21, 1970 (UCSD, b.99 f.8).

After the press conference, oil activities and scientific exploration skyrocketed across the Mediterranean basin. Between January 1971 and January 1973, French and foreign oil companies requested twenty exploration permits across the Western Mediterranean, eighty per cent of them beyond the continental shelf and, from those, half at more than 2,000 meters depth.⁸⁰² At the same time, investigations around the Messinian salt giant, its geological origins, and the quantity of hydrocarbons it could harbor transformed the exploration of the deep Mediterranean in a fashionable research subject – together with coeval debates on plate tectonics, in which the Mediterranean received great geological attention.⁸⁰³

Plate tectonics offered a new geological framework through which oil occurrences could be predicted in the offshore domain. Oil matures in sedimentary basins, convex regions favorable to the accumulation of sediments, usually formed near continental margins. Since the kinematics of tectonic plates could explain how, where, and when continental margins and sedimentary basins were formed and destroyed, it could offer a powerful approach to oil prospecting, suggesting guidelines for identifying promising regions to explore and even to predict oil and gas occurrences.⁸⁰⁴ For the Mediterranean this was a problematic change of perspective: as mentioned above, the region had been traditionally considered a depressed region in permanent subduction where sediments tended to accumulate.⁸⁰⁵ If the Mediterranean was not a depressed and stable basin, but the seam between the Eurasian and African plate, all existing data needed to be reinterpreted.

⁸⁰² Until the date, there were only two exploration and exploration leases in the Western Mediterranean, all of them in the continental shelf: CFP's "Permis du Golfe du Lion" and "Permise Corse Maritime". Data based on the map: Direction des Carburants, "Périmètres des titres miniers d'hydrocarbures," January 1, 1973 (19980125/49). Because of access restrictions in oil industry archives, I could not confirm a direct relation between data produced during DSDP Leg 13, and these exploration leases.

⁸⁰³ This increasing interest on plate tectonics and the Messinian Salinity Crisis is well-reflected in the bi-annual volumes of the CIESM (for instance: CIESM, *Rapports et Procès-Verbaux Des Réunions*, 22). I have analyzed how the discovery of deep salt domes and the new framework of plate tectonics prompted collaboration and exchanges between the oil industry and academic geologists in: Martínez-Rius, "An open secret."

⁸⁰⁴ Thompson, "Plate Tectonics in Oil and Gas Exploration of Continental Margins;" Bullard, "Overview of Plate Tectonics;" Fischer, "Epilogue." About the impact of the theory on the US oil industry: Maud, Edmundson, "Tectonic Shocks in the Oil Industry". Plate tectonics' theory found the reticence of senior scholars and petroleum geologists. In the French CFP, for instance, petroleum geologists Rustum Byramjee and Pierre-Félix Burolet, showed some doubts on the global validity of this theory. According to them, plate tectonics could not explain some geological processes observed in the north-African margins of the Mediterranean basin, hence it had its limits as a unifying geological framework (Byramjee and Burolet, "Réflexions Sur La Tectonique Globale").

⁸⁰⁵ Aubouin, *Geosynclines*.

7.3.1. Flows of data and experts to explore the deep Mediterranean

The converging interests of the oil industry and academic geologists stimulated exchanges between both communities, prompting that the oil industry became more prone to share its data. But why were this kind of relationships stimulated? One reason can be found in the particular setting the CNEXO was encouraging from its inauguration, in 1967, based on gathering national efforts in marine scientific research to speed up and facilitate industrial exploitation of marine resources. Hence, when French oil companies manifested their interest in exploring the Mediterranean's depths, the CNEXO launched research projects that connected, in different ways, three communities: the CEPM, network of national oil companies under the leadership of the Ministry of Industry; the IFP, public institution devoted to offer scientific and technical support to the CEPM; and research centers, including geologists attached to the CNEXO and to public laboratories.⁸⁰⁶

For oil companies, counting with the support of academic geologists was beneficial for scientific and economic reasons. Studies in fundamental geology were essential to develop theoretical models on the chances to find oil deposits in different conditions and structures, while regional studies were useful to assess the oil potential of particular areas.⁸⁰⁷ Conversely, geological exploration at the bosom of oil companies was ten times more expensive than subsidizing academic research: to rent a foreign drillship, to outsource private companies for preliminary geophysical surveys, or to mobilize petroleum geologists was more expensive than supporting scientific missions, outsourcing academic geologists, or to coordinate cooperative studies through the CNEXO.⁸⁰⁸ According to French oil companies, the Mediterranean could become, "for political and technical reasons," one of the first regions in the world where exploiting deep hydrocarbon deposits was feasible.⁸⁰⁹ In close collaboration with the CNEXO and the IFP, France's oil industry undertook a number of research projects addressed at

⁸⁰⁶ Oil companies expressed their interest in exploring the Mediterranean and its salt layer in internal reports, for example in: CFP, "Programme Forage Profond," June 30, 1971 (ANF 19980125/25); or in CEPM, "L'exploration des hydrocarbures en France: Résultats récents et nouvelles approches," n.d. (ANF, 1998125/25); CNEXO, "Contrat IFP-CNEXO n.71/326," November 04, 1971 (ANF 20110381/14).

⁸⁰⁷ CNEXO, "Procès-verbal de la séance du Comité Scientifique et Technique du 28 novembre 1973," November 28, 1973 (ANF, 19980125/4).

⁸⁰⁸ CNEXO, "Procès-verbal de la séance du Comité Scientifique et Technique du 28 novembre 1973", November 28, 1973 (ANF, 19980125/4).

⁸⁰⁹ CNEXO, "Contrat IFP-CNEXO n.71/326," November 04, 1971 (ANF 20110381/14).

producing geological knowledge of the Mediterranean basin, aiming at identifying favorable regions to launch oil prospecting campaigns.

An illustrative example is the *Projet Méditerranée*, launched early in 1971 under the CNEXO's sponsorship. By bringing together petroleum and academic geologists, the project aimed at compiling the first geological synthesis of the Mediterranean basin, to be distributed among the three national oil firms. Their interest in moving oil exploration beyond the continental shelf shaped the resulting report: information contained would facilitate the identification of promising regions in deep waters, the first step before acquiring exploration leases. The IFP headquarters became a forum of collaboration and exchange where academic geologists worked shoulder to shoulder with petroleum geologists from the IFP and the CFP.⁸¹⁰ Alain Mauffret, geophysicist at the University of Paris, was outsourced for his past experience in working with seismic profiles from the Balearic Basin, and PhD researcher Geneviève Alla, attached to the *Musée Océanographique de Monaco*, was called to collaborate for her geophysical investigations about the Gulf of Lion. The quantity of collected, compared, and interpreted information was unprecedented, as well as its multiple origins.⁸¹¹ Oil companies and the IFP shared seismic profiles and core samples acquired in previous oil surveys, which were intertwined with scientific data brought by academic participants.⁸¹² The CNEXO's involvement in the *Glomar Challenger's* expedition was crucial to transfer knowledge and information from the deep-sea cores to the Mediterranean Project.⁸¹³

The outcome was a hundred-pages report where the last sixty million years of history of the Mediterranean basin were detailed, specifying the characteristics of all its regions, unifying local terms to name geological periods, and including more than forty unpublished charts. Perhaps more relevant, it was the first attempt to frame the basin in plate tectonics' dynamics.⁸¹⁴

⁸¹⁰ CNEXO, "Contrat no. 71/326," November 04, 1971 (ANF 20110381/14); CNEXO "Convention no. 1708," December 30, 1971 (ANF, 20110381/16); CNEXO, "Contrat no. 71/399," December 30, 1971 (ANF, 20110381/16).

⁸¹¹ Apostolescu et al. "Données actuelles sur l'Histoire Tertiaire et la Structure de la Méditerranée," April 1972 (ANF, 20080658/40).

⁸¹² Olivier Leenhardt acknowledged to have collaborated in the IFP's Mediterranean synthesis by contributing with data acquired by his team at the Musée Océanographique de Monaco (in: Leenhardt, "Résumé du Rapport sur la Synthèse des Recherches géophysiques," 1971 (ANF, 20110381/14).

⁸¹³ CNEXO, "Questionnaire pour la préparation de la Loi des Finances pour 1972," n.d. (20160129/321). Besides Pautot's onboard participation, the team of geologists at the CNEXO's *Centre Océanologique de Brest* – Xavier le Pichon, Jean-Marie Auzende, and Jean-Louis Olivet – analyzed data from the DSDP and entangle it with their results, publishing three papers in the final report of the DSDP's mission (Ryan et al. *Initial Reports of the Deep Sea Drilling Project*, 13).

⁸¹⁴ Apostolescu et al. "Données actuelles sur l'Histoire Tertiaire et la Structure de la Méditerranée."

Direct references to oil exploitation were scarce; yet, information displayed was enough to identify promising regions and to organize preliminary campaigns. From 1972, the report was applied to assess the deep Mediterranean's oil potential on-site, from west to east. The series of hybrid surveys ODYSÉE epitomized the strength of France's scientific-industrial network: the CEPM subsidized them and the IFP provided experts and research resources (the vessel and on-board techniques), who collaborated onboard with CNEXO geoscientists.⁸¹⁵

At the same time, France's oil industry began to apply innovative systems to improve the quality of seismic data, aiming at recognizing more clearly the Mediterranean evaporitic layer. Multichannel reflection seismics consisted on adding multiple hydrophones to the streamer towed to the vessel, so the sound signal was registered by multiple receivers. Although the post-cruise processing was more burdensome, resulting profiles offered higher penetration rate and quality. Lucien Montadert, at the IFP, pioneered in utilizing this technique in collaboration with technicians from the oil firm SNPA, publishing in 1971 the first seismic profile depicting the sedimentary sequence below thin sections of the salt giant (fig.33).⁸¹⁶

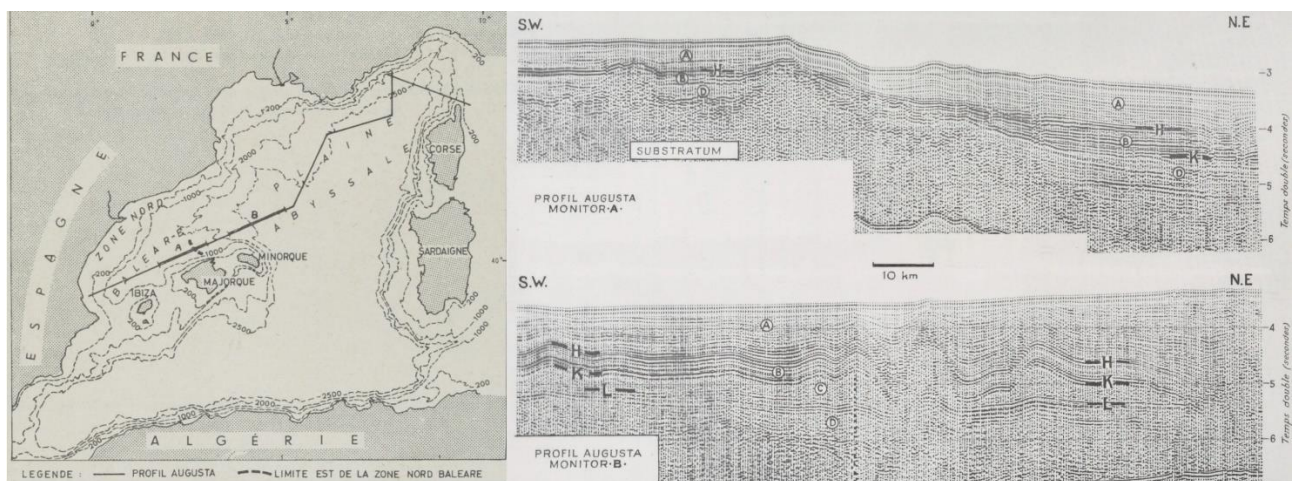


Figure 33. Seismic profiles Augusta, acquired with multichannel reflection seismics (right) and its location (left). The salt layer expands between horizons H-K, and K-L (Montadert et al., “De l’âge tertiaire de la série salifère”).

⁸¹⁵ Probably for its commercial orientation, there is barely information on those campaigns. The CNEXO archival collections do not contain information about these surveys, neither reports on their results (which, on the other hand, is common place in CNEXO scientific campaigns). IFP, *Rapport Annuel 1972*; CNEXO Equipe de Géologie, “Compte-rendu annuel d’activité octobre 1971- octobre 1972,” October 1972 (ANF, 20080658/41). As detailed in previous chapter, ODYSÉE IV was devoted to explore seawaters under Soviet jurisdiction in 1973 (p. 214).

⁸¹⁶ The IFP was the first in obtaining multichannel seismic profiles from the deep Mediterranean in 1970. Then French oil companies followed (through the CEPM), together with the CNEXO and foreign research institutions (as the Italian OGS, in Trieste). In: Biju-Duval, Letouzey, and Montadert, “Structure and evolution of the Mediterranean basins.”

Information from oil activities was also disclosed during international conferences, which became forums of exchange where petroleum geologists shared and discussed some of their results within the academic community. In 1972, experts from oil companies began attending the biannual congresses of the International Commission for the Scientific Exploration of the Mediterranean (CIESM) in notable numbers.⁸¹⁷ Lucien Montadert presented some of the results included in the Mediterranean's geological synthesis; while Mauffret and Alla shared their conclusions based on geophysical and borehole data coming from Elf and the CFP.⁸¹⁸ These presentations alternated with scientific talks, like those exposing preliminary results after analyzing the cores retrieved during the DSDP's Mediterranean cruise, that were as informative for petroleum experts as for the academic attendants.⁸¹⁹ In these meetings, new hypothesis and results were presented and debated while building knowledge on the Mediterranean's evolution, structure, and history. For petroleum geologists, being actively involved in the academic community helped them to better interpret their results, keep up with the last advancements and debates, and meet experts with whom establish future collaborations.

Beyond scientific conferences, where geological knowledge was transferred from academia to the oil industry; expertise began to flow in the opposite sense, from oil companies to academic experts. Geologists at the CNEXO, like Marthe Melguen, began to spent time in the laboratories of French oil companies. Melguen had completed a PhD in marine geology at the German University of Kiel, under the supervision of renowned geologist Eugene Seibold. Xavier le Pichon, who met her during an international congress in Germany, offered her a permanent position in his just-created team of marine geoscientists at Brest, where she engaged in 1971. By visiting the SNPA's laboratory of micropaleontology, ELF's laboratory of sedimentology, and the IFP's headquarters, Melguen learned about micropaleontological and geochemical

⁸¹⁷ Twenty-five geologists, engineers and technicians from European and American companies attended (like Agip, Apex, Auximi Petroleos, BP Italiana, British Petroleum, CFP France and Italy, CFP, Coparex Española, Deutsche Texaco, ELF Italiana Mineraria, Gulf Oil Italia, IFP, Shell, SFP, SNPA and Techneco). In: CIESM, *Rapports et Procès-Verbaux Des Réunions*, 22.

⁸¹⁸ Delteil et al., "Structure géologique de la marge continentale à l'ouest du Golfe de Bonifacio;" Alla et al. "Structure géologique de la marge continentale du Golfe du Lion;" Apostolescu et al., "Evolution sédimentologique et structurale du domaine Méditerranéen occidental;" Apostolescu et al., "Evolution sédimentologique et structurale du domaine Méditerranéen oriental."

⁸¹⁹ Hsü and Ryan, "Report on deep sea drilling project in the Mediterranean;" Nesteroff, "La crise de salinité Méssinienne en Méditerranée"; Edgar, Ryan and Hsü, "Plans for future drilling in the Mediterranean and Black Sea." It is no secret that experts from oil companies analyze carefully the results of DSDP drill sites, even decades after the campaign happened, to identify promising productive grounds. In a personal communication, geophysicist from the OGS Trieste Angelo Camerlenghi explained to me that he once met a petroleum geologist who knew at heart the location and results from all the DSDP and ODP drill sites across the Mediterranean region; better than any other geologist he had ever met.

techniques to analyze core samples.⁸²⁰ She applied her expertise to analyze deep Mediterranean cores, either acquired by the *Glomar Challenger* or by oil companies; even bringing that expertise onboard the *Glomar Challenger* when she embarked on its 1976 cruise across the central Atlantic Ocean.

During the first years of the seventies, a growing petroleum interest in the deep Mediterranean converged with a scientific fascination around the Messinian Salinity Crisis and the novel framework of plate tectonics, which prompted unprecedented collaborations and exchanges between academic and industrial spheres. But this context grew even more fertile after the 1973's oil shock, when oil companies around the world invested in moving their expeditions beyond the continental shelf.

7.3.2. Moving to deeper waters: the first oil shock and Leg 42

The first oil embargo shook the world from October 1973, prompting the oil industry's urgency to secure alternative sources of hydrocarbons. The deep seafloor then became an alluring future ground for commercial production. Almost at the same time, on September 29, 1973, the second DSDP campaign across the Mediterranean was approved to retrieve again cores from the deep basin. From the oil industry's perspective, the *Glomar Challenger*'s cruise could be now even more cost-effective than before.⁸²¹

In October 1973, the Organization of Petroleum Exporting Countries (OPEC) proclaimed an oil embargo over those nations that were supporting Israel during the Yom Kippur War, banning oil exports and cutting oil production.⁸²² In six months the price per barrel quadrupled, rising from 3 US dollars to 12 US dollars per barrel. The inflated oil price had a dramatic impact around western countries, as it weighted on every level of national economies. For the US, which imported 12% of its national oil consumption from OPEC countries, the oil crisis triggered a frenetic search to secure alternative energy sources safer than the Middle-East

⁸²⁰ CNEXO Equipe de Géologie, "Compte-rendu annuel d'activité octobre 1971- octobre 1972," October 1972 (ANF, 20080658/41); Apostolescu et al. "Données actuelles sur l'Histoire Tertiaire et la Structure de la Méditerranée", April 1972 (ANF, 20080658/40).

⁸²¹ Apparently the American organizers of the DSDP were initially against organizing a second campaign in the same region, especially because the DSDP pursued to obtain scientific results of global relevance, instead of solving local geological problems (in: Hsü, Montadert, and et al., *Initial Reports of the Deep Sea Drilling Project, 42 Pt. 1*).

⁸²² Initially, targeted nations were the US, Canada, the UK, Japan and the Netherlands; but it later extended to Portugal, Rhodesia, and South Africa.

supplies.⁸²³ As for France, the oil shock marked the end of the “*Trente Glorieuses*,” the post-war period characterized by a steady economic growth – now, national economy stagnated while unemployment escalated.

High oil prices stimulated oil companies to move exploration ventures beyond the continental shelf. At 12 dollars per barrel, investing in technological innovation to install oil rigs and drilling platforms beyond 300 meters depth became economically feasible. Oil deposits that were hitherto not commercial became productive after the 1973’s rising prices.⁸²⁴ The North Sea witnessed an oil exploration boom; while in the Gulf of Mexico the federal government opened for the first time leases in the continental slope, beyond 200 meters depth.⁸²⁵

Yet, that oil exploration towards the abyssal plain became commercially feasible did not imply that it was technologically effortless. To identify oil deposits in the abyssal plain, seismic profiles were as important as developing a detailed stratigraphic knowledge, which was only possible through the retrieval of deep-sea cores. By 1973, oil-tech companies were christening their first dynamically-positioned drill ships and oil companies were acquiring them. In France, the CFP had just acquired the D/V *Pélican*, a dynamically-positioned drillship capable of drilling up to 320 meters depth.⁸²⁶ However its high cost of operation hindered its utilization as a reconnaissance vessel and limited its activities to acquire deep-sea cores. To speed up drilling operations and retail their cost, drill ships did not (and do not) recover continuous sediment cores, but only “cuttings” – broken bits of rocks and sediments recovered from the borehole – at the most relevant depths. After the *Pélican*’s ushering, the CFP prioritized drilling operations in verified promising areas, as in the Gulf of Lion’s continental shelf or in the shallow North Sea.⁸²⁷ The *Glomar Challenger*’s campaigns were thus at the spotlight of oil companies: from the perspective of France’s oil industry, a high involvement in Leg 42 would offer large

⁸²³ In 1973, the US consumed 17 million barrels of oil per day. 2,095 of those came from OPEC countries. Data From EIA (<https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRIMXX2&f=A>).

⁸²⁴ Like Forties deposit, at 110 meters depth, discovered by BP in 1970 off the UK coastline.

⁸²⁵ Pratt and Priest, *Offshore Pioneers*; see also: Yergin, *The Prize*.

⁸²⁶ Designed by the Dutch firm GustoMSC and built in the shipyards of IHC, Rotterdam. CFP, “Programme de forage profond,” June 30, 1971 (ANF, 19980125/25).

⁸²⁷ Although I could not find the operating cost of the DV *Pélican*, drilling a single deep-sea borehole costed about 10 million US dollars. An entire exploration venture, including preliminary geophysical campaigns, post-analysis of data, and the acquisition of exploration leases costed about 5,000 million US dollars (in: Direction des Hydrocarbures, “Offshore Profond,” March 3, 1980 (ANF, 19980125/49).

The CFP considered to share the research burden of “non-industrial” campaigns with the CNEXO and the CEPM, as they had been doing with seismic surveys in hybrid campaigns (in: Harbonn, “Projet: Forages sous grande immersion CFP,” June 24, 1971 (ANF, 19980125/25). In 1972, the CFP drilled the borehole AUTAN in the Gulf of Lion (CFP, *Rapport Annual 1972*).

beneficial returns, in particular complete sedimentary sequences from deep-sea regions in areas that were not prioritized by the CFP in its oil-exploration drilling cruises.⁸²⁸

Therefore, Leg 42 received larger involvement of France's oil industry for a convergence of interests: while for the oil industry's network sharing seismic data costed them little in exchange of the instructive returns expected; for Kenneth Hsü, the mission's organizer, counting with the most knowledgeable experts and with multi-channel seismic profiles was crucial to plan the expedition. In fact, concurrent to the oil embargo, Hsü requested to embark IFP geophysicist Lucien Montadert as co-chief scientist of the mission, and her IFP colleague Germaine Bizon (expert in analyzing Mediterranean microfossils) as part of the scientific party.⁸²⁹ The reasons to select Montadert for such a crucial position were arguably scientific: Montadert was emerging as one of the best-trained experts in exploring the Mediterranean basin, for the numerous hybrid campaigns he had participated on as for his advisory role to oil companies. He was also well-aware of the scientific debates taking place in academic circles, where he had been deeply involved by participating in scientific congresses (as in the CIESM).⁸³⁰ Montadert accepted the invitation, participating in the DSDP's organization meetings from January 1974 – which, as he would later recall, were “events of precious scientific value for a young geologist.”⁸³¹

The numerous preparatory activities France's oil industry network had undertaken from 1971 like the geological synthesis, exploratory surveys, and core samples' analysis, had resulted in new information to select drill sites located in regions as valuable for oil exploration as for geological research. Montadert provided to Leg 42's organizers unique multichannel seismic profiles acquired by the CEPM and the IFP – since, by then, only the French oil industry counted with such information from the deep Mediterranean basin.⁸³² Handing in this information enabled Montadert to suggest a number of drill sites that complied with the

⁸²⁸ The CFP was closely following technological innovations introduced in the *Glomar Challenger* and comparing them with the *Pélican* drilling capabilities, as in: CFP, “Forage sus grande immersion,” May 16, 1972 (ANF, 19980125/49).

⁸²⁹ Edgar, Terence. Letter to Bettye, “Leg 39 Mediterranean,” October 03, 1973 (UCSD, b.104 f.15).

⁸³⁰ For instance: Montadert et al., “De l'âge Tertiaire de La Série Salifère.” It is possible that Hsü also wished to have Montadert involved in organizing the campaign for his privileged access to geophysical data produced at the oil industry, or as a sign of gratitude for contributing with that data; but there are no written evidences to prove it.

⁸³¹ Martínez-Rius, “Interview to L. Montadert.”

⁸³² The IFP was the first in obtaining multichannel seismic profiles from the deep Mediterranean in 1970. Then French oil companies followed (through the CEPM), together with the CNEXO and foreign research institutions (as the Italian OGS, in Trieste). In: Biju-Duval, Letouzey, Montadert, “Structure and evolution of the Mediterranean basins.”

scientific party's goals. To reassure the DSDP's Safety Panel that his proposed sites fulfilled security requirements, the IFP supported a preliminary campaign along the regions expected to be drilled.⁸³³ Eventually, four out of seven drill sites approved were based on that data, half in the Balearic basin and half in the Levantine basin (fig. 34).⁸³⁴

The *Glomar Challenger* returned to the Mediterranean on April 4, 1975, touring the basin for seven weeks, drilling holes in the continental slope and abyssal plain, and recovering hundreds of meters of rock and mud. Back on land, core samples were distributed to develop post-cruise studies across American, French, Italian, German, Soviet, and Swiss academic laboratories, as well as among the industrial laboratories of the IFP, the CFP, and Elf.

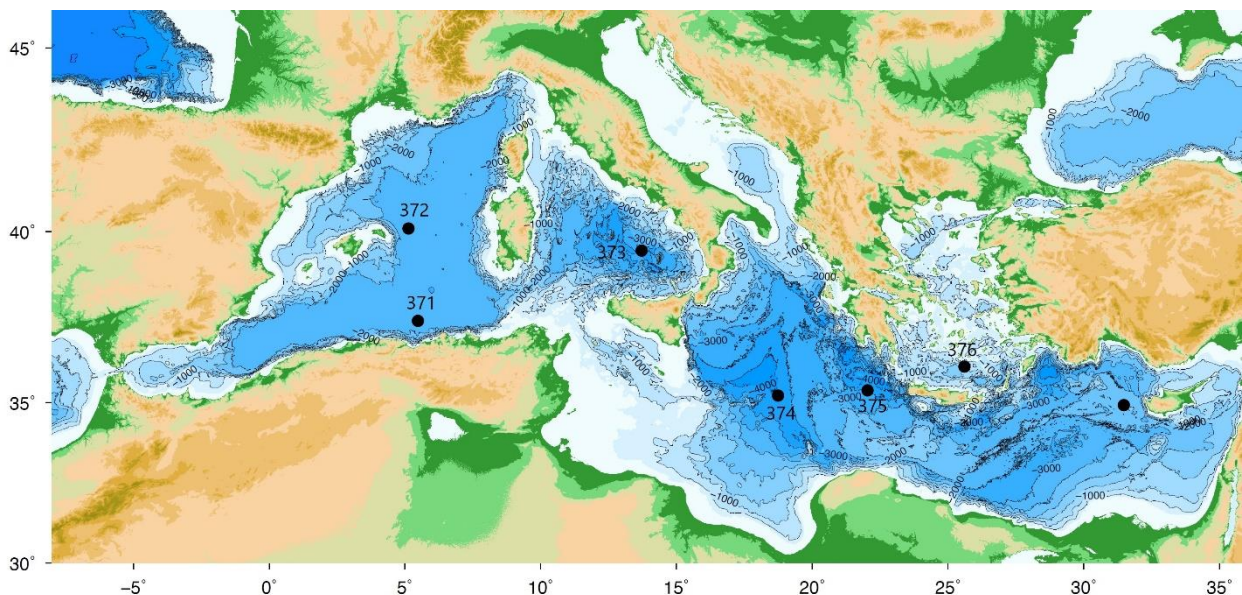


Figure 34. Drill sites during the *Glomar Challenger*'s leg 42, in 1975. It would drill less boreholes than the first survey but in deeper regions.

A dozen French petroleum geologists were involved in analyzing the cores: at the IFP headquarters, geologists and geophysicists conducted micropaleontological studies and geochemical analysis on organic matter, while at research laboratories of Elf and CFP,

⁸³³ DSDP, "Minutes of the Mediterranean Panel Meeting", January 17, 1974 (UCSD b.8 f.13); Hsü and Montadert, "DSDP Scientific Prospectus for leg 42, part A - Mediterranean Sea," March 5, 1975 (UCSD b.104 f.14); Hsü, Montadert et al., "Introduction and explanatory notes."

⁸³⁴ Hsü and Montadert, "DSDP Scientific Prospectus for leg 42, part A - Mediterranean Sea," March 5, 1975 (UCSD b.104 f.14). The others were retained based on data from the Italian OGS, the German campaign with the Meteor, and British cruises.

technicians provided inputs from X-ray mineralogy analysis.⁸³⁵ Results from Leg 42 were enriched with unpublished data from oil exploration: the IFP brought in seismic data from previous marine geophysical surveys and geological information from mainland outcrops; while Pierre-Félix Buroillet, petroleum geologist at CFP, offered unpublished information about two boreholes drilled on the Algerian continental shelf.⁸³⁶ These participations echoed the mutual benefit of academic-industrial collaborations: for academic researchers, petroleum geologists could contribute to solve the Messinian Salinity Crisis' riddle by bringing their expertise, research techniques (not always available at university laboratories), and unique data; whereas for oil companies, contributing to the DSDP's core analysis granted them a valuable time advantage. Results from each DSDP mission were published three years after the cruise; thus, offering themselves to study core samples enabled oil companies to know first-hand about the deep seafloor before the results were open to the international community.⁸³⁷

At this point, it is worth re-evaluating if those regions were of direct interest for oil companies. Was the French oil industry instrumentalizing a scientific program through some of its experts, to accomplish its commercial goals? Not necessarily – and this answer derives from comparing the oil industry's influence during the Mediterranean cruises with its probable influence on the campaigns conducted three years later across the Atlantic continental margin. For the Mediterranean cruises, it seems like the oil industry's capabilities (or better saying, wills) to influence on the *Glomar Challenger's* pathway were limited. The sites drilled fell outside the French oil industry's leases on the deep Mediterranean (like the SNPA's leases "Golfe du Lion Grands Fonds" and "Mer Hesperienne Grands Fonds," both of them granted in 1972).⁸³⁸ Conversely, the analysis conducted at the IFP, Elf, and CFP's headquarters on micropaleontology, geochemistry, and mineralogy might have been directly applied to assess the oil potential of the Western Mediterranean, as an internal report issued in 1979 indicate. Under the CEPM's sponsorship, Montadert and a team of petroleum experts from the CFP, the

⁸³⁵ Mélières et al., "X-Ray mineralogy studies;" Bizon and Glaçon, "Morphological investigations on the genus *Globorotalia* from site 372;" Deroo et al., "Organic geochemistry of some Neogene cores."

⁸³⁶ Mauffret et al., "Geological and geophysical setting of DSDP leg 372", Biju-Duval et al., "Structure and evolution of the Mediterranean basins;" Montadert et al., "Messinian event: seismic evidence;" Buroillet et al., "Slim holes drilled on the Algerian shelf" (drilled in 1974 and 1975, both were dry).

⁸³⁷ French petroleum geologists, including Montadert, continued being involved in the academic community after Leg 42. In 1976, Montadert co-edited with Bernard Biju-Duval, colleague at the IFP, a special volume gathering the papers presented during the CIESM conference in Split (Montadert, Biju-Duval. *Structural History of the Mediterranean Basins*).

⁸³⁸ Direction des Carburants, "Périmètres des titres miniers d'hydrocarbures," January 1, 1973 (ANF, 19980125/49).

IFP, and Elf-Aquitaine⁸³⁹ drafted a report on the “Petroleum possibilities of marine regions in the Western Mediterranean” to be distributed among the oil industry’s network.⁸⁴⁰ According to the authors, none of the *Glomar Challenger*’s drill sites during Leg 13 and Leg 42 had showed hints of hydrocarbon deposits, although geochemical analysis (developed by the IFP team) had demonstrated that the Mediterranean basin’s conditions favored the maturation of organic matter. Besides the deep Gulf of Lion, the Western Mediterranean abyssal plain was still a poorly understood region, that would require large economic investments and works before being able to properly define its oil potential.⁸⁴¹ Therefore, for the Mediterranean, data from scientific deep-drilling was useful to develop an overview of regions that were hitherto outside of the oil industry’s technological reach.

This situation sharply contrasts with the role of France’s oil industry during *Glomar Challenger*’s campaigns across the Atlantic continental margin, starting in 1978. Some archival evidences point to a deliberate involvement of France’s oil industry in selecting the drill sites according to their commercial priorities; probably because from 1975 the CEPM was financially involved in the International Program for Ocean Drilling (IPOD, the DSDP’s successor) and therefore, aimed at making profit from the sites drilled.⁸⁴² In a letter to the American organizer Maurice Ewing, la Prairie acknowledged the interest of France’s oil companies to be as involved as possible in the cruise, as they had done great progress in exploring the region.⁸⁴³ Montadert and other experts from the IFP participated onboard and in the post-cruise studies, later acknowledging the usefulness of that data to elaborate “realistic estimations of the petroleum possibilities of these regions,” and to make “reasonable choices of

⁸³⁹ Found at the archives as SNEA (P), accounting for *Société Nationale Elf-Aquitaine*.

⁸⁴⁰ CEPM, “Possibilités pétrolières des zones marines profondes de la Méditerranée occidentale,” 1979 (ANF, 19980125/36).

⁸⁴¹ Ibid.

⁸⁴² In the IPOD, selected foreign nations (France, the USSR, the Federal Republic of Germany, Canada, and Japan) contributed to the program’s budget with one million dollars per year. In exchange, they could sit representatives in decision-making positions at the Advisory Panels, suggest campaigns and drill sites, and have a fixed quota of embarked researchers per year.

Direct references to the oil industry’s involvement in France’s participation at IPOD include a hand-written note by the General Director of the CNRS, Hubert Curien, mentioning that the oil companies are interested in contributing with 300,000 US dollars to the French financial contribution (Curien, “RDV avec Debyser (CNEXO)”, February 7, 1974 (ANF, 19810244/449); and another hand-written letter (probably also by Curient) mentioning that the CEPM was only interested in drilling across continental margins, not in the deep oceans; and would be interested in “intervening in selecting drill sites” (n.d., (ANF, 19810244/449)). Finally, the permanent committee to organize France’s representation in IPOD host a permanent seat for a CEPM representative, that could channel the oil industry’s interests (n.a. “Projet d’organisation de la participation française à l’IPOD,” n.d. (ANF, 19810244/449)).

⁸⁴³ La Prairie, Yves. Letter to Maurice Ewing, July 11, 1975 (ANF, 20160129/311).

areas of maximum interest to acquire exploration and exploitation leases.”⁸⁴⁴ The history of IPOD and on how the oil industry’s financial involvement influenced on its deep-sea drilling campaigns is still to be written. Yet, these scattered evidences manifest that the oil industry’s presence in deep sea drilling programs should not be neglected, and that its presence during the Mediterranean cruises might have only constitute the commencing of an expanding involvement.

7.4. The aftermath of DSDP campaigns in the Mediterranean

After the 1979 report, concluding that potential hydrocarbon deposits in the deep Mediterranean would still require large economic and technological efforts to be identified and exploited, the Western Mediterranean began to lose the oil industry’s interest. Deposits had only been found off the Spanish continental shelf, in leases operated by American and Spanish oil firms (like Chevron, Shell, or ENI-EPSA).⁸⁴⁵ It was still believed that massive hydrocarbon deposits were trapped under the salt giant, yet French oil companies grew conscious that they would not possess, in the short-term, technological capabilities to operate beyond 150 meters depth.⁸⁴⁶

The second oil crisis, beginning in 1979, pushed France’s oil industry to re-define its exploration and production strategy in the offshore. The shock started in the aftermath of the Iranian revolution, caused by strikes of workers in oil producing facilities and the subsequent Iraq-Iran war. This provoked a drop down of oil production that deeply affected western countries, since Iran was the second largest exporter of oil.⁸⁴⁷ In less than one year the price per barrel rocketed from 12 US dollars to almost 40 US dollars, stimulating oil companies to set commercial aspirations in offshore regions of difficult access.⁸⁴⁸ The Gulf of Mexico was lagging as a productive area (despite soaring oil prices, offshore leases were becoming

⁸⁴⁴ IFP, “Programme de Recherches marines – fiches de projet 1976,” n.d. (ANF, 19980125/25).

⁸⁴⁵ Seven productive boreholes were drilled in front of the Ebro’s delta: Amposta (1970), Castellón C (1971), Dorada and Casablanca (1975), Tarraco (1976) and Montanazo C y D (1977-1978). In the lease called Castellón E they found two oil productive boreholes between 1971 and 1976; and in the Alboran Sea, three gas deposits in the Gulf of Cadix (1978). All these discoveries happened in waters no deeper than 150 meters depth (except for Montanazo C and D, at 675 and 470 meters depth). In: CFP, “Bilan des activités Pétrolières marines en Espagne et en Italie,” n.d. (ANF, 19980125/25).

⁸⁴⁶ CEPM, “L’exploration des hydrocarbures en France: Résultats récents et nouvelles approches,” n.d., (ANF, 1998125/25).

⁸⁴⁷ After Saudi Arabia. Out from 5,5 million barrels per day produced, about 4,5 million were exported. By November 1978, exports were reduced to less than a million barrels per day and in December, exports had ceased altogether. Yergin, *The Prize*.

⁸⁴⁸ Gaston-Breton, *Total, Un Esprit Pionnier*.

prohibitively expensive and discoveries, too rare), while international interest turned to the North Sea as a new Eldorado.⁸⁴⁹ France’s oil companies focused their efforts in promising, already productive regions: besides the North Sea, where CFP and ELF participated in exploiting the fields Ekofisk, Frigg, and Alwin-Nord; Indonesia, the Gulf of Guinea, off Tierra de Fuego (Argentina), and the Iroise sea were at the spotlight of their technological efforts. At the same time, they prioritized investments in technological innovation to equal the American capabilities rather than in developing geological knowledge. By the late 1970s, American oil firms were at the forefront of deep sea exploratory drilling, which prompted renewed anxieties among France’s industrial circles about lagging behind the US in technological development (table 6). The CFP created the department *Techniques Marines* where, in association with engineers and technicians from the IFP and oil-services companies, the French oil industry aimed at innovating in floating platforms, drill rigs, and pipelines.⁸⁵⁰

Country (No. oil firms)	200-300m	300-600m	>600m
US (13)	52	61	21
Italy (1)	1	0	1
France (2)	5	4	2
West Germany (1)	0	3	0
Spain (2)	1	0	1
Brazil (1)	0	1	0
Belgium (1)	0	4	0
Netherlands (1)	16	17	2
Japan (1)	1	0	0
Australia (2)	1	3	0
UK (2)	4	4	0

Table 6. Boreholes drilled by oil companies at more than 200m depth by 1st October 1978 (from Delacour, “O.T.C. 1979: Signal d’alerte pour l’industrie Française spécialisée”).

⁸⁴⁹ In the Gulf of Mexico, a deep-water lease could cost more than two billion US dollars; while a subsequent decrease of oil prices forced US companies to retail in production and exploration, and the region. The Gulf of Mexico experienced a second deep-water boom in the 90s and 2000s. About the 1980s decadence of the Gulf of Mexico, see Priest, “Extraction not creation”. About the North Sea boom of the 80s, see: Pratt and Priest, *Offshore pioneers*.

⁸⁵⁰ These two concerns are explicit in a report digested by the IFP engineer Jean Delacour, addressed to the CEPM, after attending to the 1979 Offshore Technology Conference in Houston (Delacour, “O.T.C. 1979: Signal d’alerte pour l’industrie Française spécialisée,” May 14, 1979 (ANF, 19980125/49)). About the French government’s and the CFP’s investments in technological innovation, see: Gaston-Breton, *Total, Un Esprit Pionnier*.

To which extent this shift of commercial priorities caused that the *Glomar Challenger* did not return to the Mediterranean is a still unanswered question, but the vessel would not cross again the Strait of Gibraltar to survey the entire basin until 1995, during the Ocean Drilling Program's Leg 161. Yet, despite deep-sea drilling activities were not performed to fulfil academic interests for twenty years, the two DSDP campaigns across the Mediterranean left an important legacy for academic geology.

Collaborations between academic and petroleum geologists did not require anymore the mediation of large-scale international projects or national research programs to function. Congresses, meetings, and joint activities had contributed to forge one-to-one relationships between academic geologists and oil experts (from managers at Exploration Divisions, to geologists and engineers). Alain Mauffret, for instance, who had collaborated in the 1971 Mediterranean Project with Montadert and petroleum geologists from the CFP, maintained throughout his career an external source of funding from French oil companies, which outsourced him to conduct particular studies or to analyze their geophysical data.⁸⁵¹

At the same time, industrial experts continued participating in the academic community. Lucien Montadert has been deeply involved in geological debates around the Messinian Salinity Crisis, the Mediterranean dynamics, and the Atlantic continental margin throughout all his career – even today. In 1984, he coedited a volume on France's continental margins and one year later, contributed to co-organize an international meeting about the Mediterranean's geological evolution.⁸⁵² He has been active in publishing scientific papers, frequently coauthored with academic geologists, where he mobilizes his knowledge and expertise to enhance scientific understanding on the Earth. These relationships, where the boundary that separated two apparently different research communities faded, is perhaps the most relevant legacy of the decade where the deep Mediterranean sea came to be perceived as a promising energy frontier.

⁸⁵¹ Personal communication. According to interviewed geologists, they never had problems in obtaining the agreement of oil companies to publish their results, which suggests that the oil industry's secrecy regime did change towards a more restrictive one.

⁸⁵² Boillot et al., *Les marges continentales actuelles et fossiles autour de la France*; Stanley, Wezel, *Geological Evolution of the Mediterranean basin*.

7.5. The place of the oil industry in the seafloor's knowledge production

The DSDP was undeniably a scientific program, pursuing the study of the Earth's crust through ground-breaking deep-sea drilling techniques. Yet, we should not overlook how commercial interests were involved in a number of *Glomar Challenger's* cruises, neither the program's influence on informing relationships between petroleum geologists and academic experts. This alternative account has located oil industry experts and commercial interests in preparing the surveys and in analyzing the cores, framing them in the wider context of the oil industry's pursuit to settle beyond the continental shelf.

But in the first place, why the French oil industry grew interested in the DSDP campaigns across the Mediterranean? I have suggested that its participation was framed in the oil industry's need-to-know basis and the cost-benefit balance of deep-water prospection. While for exploring the continental shelf the CFP, the IFP, or Elf already counted with technological resources and geological data; the deep seafloor presented a daunting – and costly – challenge. Deep-sea cores were prohibitively expensive to obtain by utilizing a private drillship, while by relying on the *Glomar Challenger's* results they could obtain geological information by reducing the time and cost invested. For petroleum geologists and oil industry managers, being involved in the DSDP – either by offering data to organize surveys, by suggesting safe and compelling drill sites, by embarking onboard, or by offering their expertise and techniques in post-cruise analyses – granted them first-hand access to the outcomes without needing to wait years until the results were published.

By contributing to organize and conduct the DSDP cruises, oil experts expected to gather knowledge and to develop geological models, which contributed to predict hydrocarbon occurrences in the Mediterranean as in other sedimentary basins. There was not an explicit aim to harshly project commercial interests in their contributions, as they did not expect to directly identify regions prone to hydrocarbon accumulation in the retrieved cores. Therefore, the oil industry's involvement during the Mediterranean DSDP should be framed as a contribution that enhanced the program's quality, rather than a sharp intrusion to impose commercial interests. However, it would be misleading to assume that oil firms do not directly benefit from the core samples retrieved and the geological knowledge produced during the DSDP and its successors, the IPOD, ODP, and IODP. A recent example illustrates this point. In 1995, the Italian oil firm Eni identified the giant gas field Zohar in the Eastern Mediterranean because its exploration geologists grew interested in the region's potential after reading the scientific results of ODP

Leg 160. During the cruise, the *JOIDES Resolution* (successor of the *Glomar Challenger*) had retrieved cores south of Cyprus across the Eratosthenes seamount. Although the region did not harbor oil, Eni geologists glimpsed the possibility that the carbonate geological structures found there could constitute oil traps in the surrounding regions. Indeed, after conducting geophysical surveys, they found the Zohar gas field some kilometers south Leg 106's drill site.⁸⁵³

I have detailed how Xavier le Pichon (CNEXO) and Lucien Montadert (IFP) offered to the cruises' organizers seismic profiles produced by the oil industry to select drill sites, and how geologists from oil companies disseminated sedimentary and geophysical data during international conferences and academic publications. But to which extent was this sensitive information for oil exploration? Some pieces of data disclosed during the seventies are surprising for their uniqueness, which stems from the exclusive technologies used to obtain them. As I have presented, in 1971 Montadert published the first multichannel seismic profile depicting sedimentary layers below the salt giant. Meanwhile, petroleum geologists from the CFP published stratigraphic and sedimentary information about offshore boreholes on the Gulf of Lion's continental shelf (Mistral 1, Sirocco 1, Tramontane 1, and Autan 1), and on the Algerian continental shelf (Alger 1 and Arzew 1).⁸⁵⁴ But despite the exclusivity of that data, a single geophysical profile was not relevant for oil exploration; and all those boreholes resulted to be dry, without proved commercial value. Therefore it could well be true that oil companies were only sharing information that was not commercially relevant, but I could not verify this hypothesis. For the Western Mediterranean, French oil companies did not find any productive well, and petroleum geologists in foreign companies – as those working in gas fields off Spain – seem to have avoided publishing any kind of information (neither from productive, nor from dry, boreholes). Documents in archival collections are neither illuminating: there is barely information to track what was disclosed and what remained secret; the only informative hints come from testimonies who worked for oil companies and, as they acknowledged, they never had any problem to obtain clearance to publish the data *they were working with*.

Besides uncertainties about the oil industry's secrecy mechanisms, this case shows the pivotal – and hitherto ignored – contribution of the offshore oil industry to the development of geological knowledge from the offshore. Once again, anticipation to prepare the future exploitation of the deep Mediterranean seafloor, still beyond technological capabilities,

⁸⁵³ Angelo Camerlanghi (personal communication). Also published by Eni geologists in: Esestime, Hewitt, and Hodgson, "Zohr – A Newborn Carbonate Play in the Levantine Basin, East-Mediterranean."

⁸⁵⁴ Cravatte et al., "Les Forages du Golfe du Lion;" Buroillet et al., "Slim Holes Drilled on the Algerian Shelf."

prompted an alignment of industrial and scientific interests, leading to the establishment of new collaborations.

Coda. (Mis)understanding academic-industrial relations

On August 18, 2016, the Spanish press dawned with news claiming to have uncovered an oil industry's complot to undertake hydrocarbon exploration activities in the Mediterranean under a disguise of scientific research. Under headings like "A scientific cover to search for oil" and "Scientific project, or the oil industry's outpost?," the daily press argued that the international geological project MEDSALT aimed at conducting a marine geophysical surveys around the Balearic Islands (in Spanish seawaters) as a "Trojan Horse for oil companies."⁸⁵⁵

Funded in October 2015 by the European Union's program COST Actions, MEDSALT was organized by European institutions aiming at deepening into the study of the Messinian Salinity Crisis and the evaporites accumulated in the deep Mediterranean.⁸⁵⁶ Resuming the research lines inaugurated five decades ago by the *Glomar Challenger*'s discoveries, geologists and geophysicists pursued to acquire geophysical data from the deep basin with the ultimate goal of attracting the drillship *JOIDES Resolution* (successor of the *Glomar Challenger*) to the region.⁸⁵⁷ However, the report outlining MEDSALT's research proposal, openly accessible on the COST Action web page, was spotted by Greenpeace Spain, who misinterpreted part of the information contained – in particular, a section where it was mentioned that some hydrocarbon exploration companies expressed interest in the future outcomes of MEDSALT research.

Environmentalist groups like Greenpeace and the regional association *Aliança Mar Blava* were growing sensitive about offshore oil and gas activities undertaken around the Balearic Islands for their harmful consequences on marine fauna, their potential polluting effects on the seawater, and the potential risk of triggering an environmental catastrophe. Greenpeace grew suspicious of MEDSALT's connection to the oil industry because the region to be surveyed partially overlapped with an exploration lease requested – and rejected – two years before by the private firm SPECTRUM, specialized in offering marine geophysical services to oil companies. MEDSALT sounded the alarm of environmentalist groups, which grew convinced

⁸⁵⁵ N.a., "Una tapadera científica para buscar petróleo;" Sevillano, "¿Proyecto científico o avanzadilla de las petroleras?;" Carlos, "Un caballo de Troya de la industria petrolera."

⁸⁵⁶ Acronym accounting for European Cooperation in Science and Technology. The entire project, from 2016 to 2020 was supported with 60 million euros for pursuing different activities (joint research programs, conferences, offshore surveys...). In: COST, "Memorandum of understanding."

⁸⁵⁷ From 2013 international deep sea drilling programs operate under the International Ocean Discovery Program (IODP), where European countries are represented through the European Consortium for Ocean Research Drilling (ECORD). The Mediterranean's drilling proposal was led by geophysicist Johanna Lofi, from the University of Montpellier.

that it was a cover project for oil exploration. Accusations against the scientific team included potential damages to cetaceans for utilizing air guns, seismic sources that create acoustic waves by discharging compressed air – misleadingly described in the Spanish press as “shelling” the seafloor with “canyons.”⁸⁵⁸

Greenpeace’s denouncement comprised all the elements needed to prompt public opposition: an allegedly uncovered complot of the oil industry, who hid behind “fundamental” research, and potential damages to cetaceans. The case snowballed through a massive media coverage until it reached the Parliament of the Balearic Islands, who prohibited MEDSALT scientific surveys.⁸⁵⁹ Meanwhile, geologists received harsh attacks from the press while their justifications were systematically ignored. Besides repeatedly calling MEDSALT a cover-up for oil exploration, journalists questioned researchers’ integrity by setting the term “scientific” between quotation marks each time the geophysical survey was mentioned, labeled the research program as “illegal,” and strongly asserted that it was “evident” that geologists were looking for oil – painful arguments for a group of geologists who, indeed, were oblivious to the repulse their research project would spur.⁸⁶⁰ MEDSALT leaders, geophysicists Angelo Camerlenghi (OGS Trieste) and Daniel García-Castellanos (CSIC Barcelona), tried to raise their voice over the press accusations, denying any direct relation between oil companies and their investigations. They provided evidences showing that the project met the highest world-class standards of marine geoscientific surveys and complied with the Spanish legislation to protect marine life. The irony of banning the project for its suspected connection to commercial interests was that the survey pursued to demonstrate the absence of oil and gas deposits in the region, because their presence jeopardizes the expensive deep-sea drilling technology onboard the *JOIDES Resolution*. Meanwhile, potential interests of oil companies in their project (if any) were rather addressed at keeping touch with the world of academic sciences as a pool of future employees or collaborators.⁸⁶¹

⁸⁵⁸ Redacción El Periódico, “Greenpeace y Alianza Mar Blava denuncian la ilegalidad del proyecto de prospecciones MEDSALT-2.”

⁸⁵⁹ *Bulletí Oficial del Parlament de les Illes Balears*.

⁸⁶⁰ For instance in: Redacción El Periódico, “Greenpeace y Alianza Mar Blava denuncian la ilegalidad del proyecto de prospecciones MEDSALT-2;” Colmenero, “Siete petroleras se interesan por el proyecto ‘científico’ MEDSALT-2”.

⁸⁶¹ Redacción la Vanguardia, “Representante de MEDSALT-2: “No buscamos petróleo, investigamos la mayor crisis medioambiental desde los dinosaurios””. A complete statement, signed by researchers and supporters of MEDSALT, has been published in their website: <https://MEDSALT.wordpress.com/1173-2/>

After almost a decade devoted to organize the project and obtain the EU's support by gathering a network of fifty experts from all around Europe, the MEDSALT geophysical survey was prohibited, and the *JOIDES Resolution* would not be back in the Western Mediterranean in a foreseeable future (although it will cross the Strait of Gibraltar to explore the Aegean Sea by the end of 2022).

This controversy emerged from a lack of understanding from both sides. Environmentalists and the wider public misjudged industrial-academic relations and were oblivious to the strategies commonly displayed by marine researchers to obtain economic support. For the side of researchers, they were barely aware of the nefarious considerations of popular clusters around scientific research supported by so-considered "tainted money." Praising in their initial research report the potential economic interest of their results might have been a suited strategy to attract the EU's funding, but a miscalculation to obtain the public's approval. This case points to the emergence of a strong environmental consciousness that was barely present in the seventies (which opens future avenues of research). Yet, it also traces some continuities with the past: underlining the potential commercial interests of fundamental research appears to be a suitable strategy to obtain funding to explore the seafloor in the present as it was in the past, since political elites are consistently eager to secure future energy supplies from new – and unexplored – potentially productive territories.

Chapter 8. Conclusion

Knowing the seafloor. A story about potential richness, economic ambitions, and new territories

He had long ago decided, since he was a serious scholar, that the caves of ocean bear no gems, but only soggy glub and great gobs of muchy gump.

James Thurber, *The Shore and the Sea*

The aim of this thesis has been two-fold. First, to study how commercial motivations to explore the seafloor influenced on the knowledge produced about it; and second, to analyze how the seafloor emerged as a territory shaped by concerns and priorities deriving from decolonization. Focusing on France, I have followed the correlated expansion of four elements – the institutional, the technological, the territorial, and the geopolitical: formal networks of academic geologists, public officers, and oil experts to explore the seafloor; research technologies and techniques in marine geosciences, from simple sampling systems to deep-sea drilling rigs; the seafloor's exploration, from mainland to the deepest layers of the oceanic crust; and France's presence in the oceans as a display of national power.

8.1. French geologists and marine resources

The first question posed draws from historiography on Cold War ocean sciences, where there is a solid body of literature on military patronage and its influence, at difference levels, in shaping our current understanding of the oceans. One of the main premises of this thesis is that the patron's motivations to explore the oceans did matter – but the question is, *how* did they matter? As this research suggests, the key element was the type of institutional organization through which these motivations articulated from higher managerial levels to scientific surveys. By tracing the evolution of material and social mechanisms through which oil companies, government officers, and researchers aligned their priorities, I have shown that more relevant than allocating money in marine geoscientific research was to promote interplays of academic and industrial geologists.

A political elite constituted by public officers, like André Giraud and Yves la Prairie, possessed power to drive technoscientific development towards preparing a future economic scenario reliant on the boundless exploitation of marine resources. The central mechanism implemented, the CNEXO, was an hybrid institution that articulated scientific production with commercial exploitation and national goals, formalized pathways of industrial-academic collaboration, and established carefully-selected diplomatic alliances to explore the oceans. Yet, this setting was also facilitated by the idiosyncrasies of France's oil industry which, instead of being a composite of private firms, was composed by institutions intrinsically attached to governmental structures. This setting not only enabled a smooth articulation of priorities and needs from political cabinets to extractive-related activities; but also to design a national, coordinated strategy that integrated academic research with industrial activities.⁸⁶²

In France, the evolving perception of the oceans among political spheres and their deemed uses to achieve national goals were central to promote one or another research agenda. Therefore the national, coordinated organization to explore the seafloor was not developed through a straightforward, meticulously crafted plan; but through a series of non-predefined steps that responded to the geopolitical needs and contingencies of each moment: first, allocating funds in a scientific committee that would invest in fundamental research (chapter 3); soon after, creating a consortium-like structure at the Ministry of Industry to speed up technological innovation for offshore oil production (chapter 4); and finally, centralizing all national oceanographic ambitions in a political-laden institution, the CNEXO (chapter 5). These oscillations evidence a drastic change on the political priorities and expectations projected on the seafloor: whereas in the aftermath of World War 2 its topography was mainly a subject of military interest (chapter 2), two decades later its depths were at the core of frantic efforts to explore and exploit potential natural resources.

This perspective sharply contrasts with hitherto historiographical accounts on how knowledge about the seafloor developed from the aftermath of World War 2, hand in hand with military funding and priorities for naval operations. My research suggests that, in France, military priorities and funding had almost no role in the development of marine geosciences; probably because, in contrast with the US, both countries held different geopolitical concerns and military strategies, occupied distinct positions in the world order, and designed disparate

⁸⁶² As I point out in section 8.3, further historical research is needed before being able to compare the influence on marine geosciences of France's oil industry patronage, with that of private companies or other kind of national structures in different countries.

structures to support military research. In France, military research to back naval operations was conducted at the *Service Hydrographique de la Marine*, which worked almost independently from academic researchers (except from punctual collaborations) and was primarily interested on physical oceanography. As I have noted, marine geosciences were conspicuously absent from their research agenda; while the largest patron to marine geosciences was the oil industry. However, the similarities of France's oil industry as a patron for sciences and US military structures (namely, that both instances were equivalent branches dependent from their national governments), might raise the question on how different industrial patronage was from military patronage to the ocean sciences.

The central difference is found in the organization both instances promoted to maintain (or ease) secrecy, which I have analyzed by focusing on the development of mechanisms that facilitated knowledge to move across the oil industry's secrecy boundaries. The years roughly comprised between 1967 and 1975 were characterized by an increasing exchange of information and numerous moments of collaboration between academic and petroleum geologists, and I suggest two reasons to account for this: one, organizational and the second, strategic.

The shape patronage networks adopted to support marine geosciences facilitated, consciously or not, the easing of secrecy. Unlike most part of military patronage to sciences, France's oil industry patronage rarely consisted on direct funding from oil firms to academic researchers. Instead, funding was managed by governmental structures like the CEPM, the DGRST, or both before it reached the CNEXO, who distributed the budget after decisions made by the Administrative Council – composed by experts of multiple backgrounds, whose fine interests were not necessarily aligned. Vice-versa, data produced during marine surveys moved from researchers to the CNEXO, who distributed it amongst the oil industry. If we compare this organization with Oreskes' accounts about the relations between the US military and oceanographers, two differences protrude: first, data was produced inside the Navy, and therefore remained bounded to its secrecy regime – whereas oceanographers who knew about its existence, perhaps for having collaborated in acquiring it during wartime, struggled for its declassification.⁸⁶³ And second, relations between oceanographers and the US Navy were

⁸⁶³ As in the case of Harry H. Hess and bathymetry data (Oreskes, “Stymied by secrecy”) or in the case of the Heezen-Tharp physiographic map of the world's oceans, which was based on echo-sounding data from the military (although the project was supported by the ONR and the Bureau of Ships, military policies of classification applied to the data), and some profiles from the Woods Hole, the Hydrographic Office, Bell Laboratories, and the British Admiralty (in: Oreskes, “The iron curtain of classification;” Doel, Levin, Marker, “Extending modern cartography”).

frequently one-to-one relationships: oceanographers maintained close contact with Naval officers, but were not part of a unified structure. The alignment of their goals was a contingency or came after negotiations, but it does not appear to be something crafted by higher managerial levels. The hierarchical, network-shaped organization of France's offshore industrial policy might partially explain why its secrecy regime was more prone to leaks than other regimes: secrecy dissolved across the network, because when shared, secrets lose part of their value as secrets.

Regarding to the economic strategy, from the perspective of the political elite interested in building an ocean economy, maintaining data or oil exploration activities strictly secret was not seen as efficient in a cost-benefit equation. First, for its cost: keeping data secret was massively expensive. As specified by historian Peter Galison, it required defining protocols to tag and store information, controlling the movement of experts involved in each research, designing mechanisms to prevent the circulation of knowledge, expertise or technologies, and ensure its proper functioning.⁸⁶⁴ Second, for the particularities of the geological knowledge needed, and the new international legislation implemented on the oceans. During the initial decade of seafloor exploration, the geology of entire marine basins (the Mediterranean, the Gulf of Guinea, or the Atlantic continental margin) was to be delineated before outlining its potential commercial interest. Industrial surveys on foreign seawaters required investing in acquiring exploration leases from foreign or national administrations; whereas scientific surveys only required an explicit permission that shall not be refused. And third, because of the time-related dynamics of secrecy. Keeping commercial (or military-produced) data secret granted advantage while no other institution or enterprise owned the technological capabilities or geographical access to produce it.⁸⁶⁵ Conversely, when private firms and academic institutions were undertaking geophysical surveys around the world, it was likely that other survey replicated efforts and published the data. The 1960s and 1970s witnessed a complete transformation of the scientific and industrial understanding about marine basins: the framework of plate tectonics is the paradigmatic example, but also the discovery of the Messinian Salinity Crisis and its thick evaporitic layers. The effervescence of scientific activities over the seafloor, coupled with the oil industry's need to reframe or integrate new geological knowledge in their basic principles

⁸⁶⁴ Galison, "Removing Knowledge."

⁸⁶⁵ This argument has been put forward by Naomi Oreskes to justify why the US Navy decided to maintain bathymetrical data secret from its production, in the thirties, until the sixties, when Henry Hess was granted clearance (Oreskes, "Stymied by secrecy").

for oil exploration, contributed to the easing of secrecy. Therefore, on the basis of these three reasons outlined, more profitable was to stimulate the pooling of efforts from the oil industry and the academic community (budget, research technologies, and experts) in order to speed up the reconnaissance phase of marine basins. Enabling the spread of information was regarded as a minor side-effect; more important than keeping a strict secrecy regime was to control the flows of information: who utilized it, when, and for what purposes. The master piece was, once again, the CNEXO, responsible for centralizing data and coordinating a national research program.

In short, economic futures anticipated by a political elite constituted a window of opportunity for marine geoscientists in their pursuit to explore the seafloor: a limited time-period when a series of political, economic, and industrial anxieties and interests converged in the need to know an unknown region, prompting an unprecedented period of public and private investment in developing marine geophysical techniques and geological knowledge. Although the anticipated future oceanic economy never arrived, it had long-lasting consequences for the seafloor's exploration: it enabled the birth of marine geosciences, led to new understandings about the seafloor, and stimulated the establishment of cooperative relations between academic geologists and oil experts that have persisted up to our days.

By revisiting the multidimensional influence of “tainted money” to sciences, this thesis has shown that extractive motivations stimulated the emergence of marine geosciences and the development of a vast scientific understanding on the seafloor. But how constraining was (or was not) the oil industry's patronage to marine geoscientists? This research has offered insights about the institutional mechanisms that enabled industrial managers and government officers to drive research, but the kind of sources I could – and could not – have access to have hindered me to develop a detailed understanding at the level of personal dynamics. Interviews were neither useful for this purpose, because geologists hardly acknowledge to what extent oil industrial priorities influenced or shaped their research lines. Indeed, rather than driving research in a linear way, funding from the oil industry created (as Oreskes has called it) a context of motivation, where it was pertinent to ask and answer particular research questions – related, for instance, to the Mediterranean basin or the Atlantic continental margin. Geological data produced was as useful for academic researchers to publish papers and fostering knowledge on their desired research lines, as for petroleum geologists to be applied in their own commercially-oriented investigations. Therefore, academic geologists tend to downplay the influence of their patrons in their research. From their perspective, the oil industry offered them

bountiful research resources while enabling them to maintain autonomy in their research agenda (which can also be seen, for instance, during the DSDP).

This conclusion does not aim at being pejorative to sciences, and arguably applies also to historians' work. Going back to the words of Dominique Pestre presented in chapter 1, we produce certain narratives because of the choices we consciously or unconsciously make; and these choices are, to some extent, delimited by our "patron," funding mechanism, or home institution. In this case, being part of SALTGIANT has facilitated me a framework where some research approaches shined above others: the imbrication of economic and scientific interests, for instance, was a natural interplay for my geology colleagues – whereas from my perspective it required a historical explanation and therefore, I selected it as my main research inquiry. However this thesis would have definitely been different if my funding organism was oriented towards other research areas (for example, prevention of marine pollution or sociological approaches to sociotechnical controversies), if I could not directly meet geologists nor interview them, or if my home institution was settled in a different country, where the advent of the seafloor's exploration had taken a different shape, not triggered or driven by commercial interests.

Research is never free from constraints. What granted geologists a sense of research freedom was that their interests and those of their patrons aligned – and, as this research has aimed at showing, that does not happen serendipitously but requires effort, negotiations, and a well-planned strategy that becomes invisible while driving scientific research.

8.2. New deep territories

The second inquiry of this research pursued to throw light on how the seafloor was shaped by concerns and anxieties related to the postcolonial context. This thesis has shown that the making of the seafloor through technoscientific practices was interlinked to colonialism from its inception: in the early sixties, France's loss of its oil-producing colonial territories prompted oil companies to look at the seafloor as "the replacement of the Sahara;"⁸⁶⁶ and indeed there was an explicit continuum of practices and organizational structures from overseas territories to the seafloor exploration. In France, the same industrial managers and public officers who had been leading oil companies in the Sahara projected over the seafloor equivalent economic

⁸⁶⁶ Lacour, *Terre d'innovations*.

ambitions, edified similar exploitation mechanisms, and covertly displayed identical objectives of rampant occupation.

The seafloor took shape as a territory at the same time its perception as a new economic frontier expanded. Against the backdrop of international negotiations at the UNCLOS, the exploration of the seafloor gained prominence in France's political agenda: if in 1958 exploring the seafloor was seen as one more component of ocean sciences, embedded in a rhetoric of promoting "fundamental research" to increase the nation's prestige (chapter 3); one decade later it became a central asset in the country's industrial strategy (chapter 5), and on its international relations through science diplomacy (chapters 6 and 7). Yet the seafloor's territory was not only a rhetoric component of political discourses, but a material reality opened up via technological innovation, which expanded the national frontiers to each time deeper areas. For geologist Jacques Bourcart, "deep" meant surface sediments from near the shore; while for the incipient offshore oil industry in the fifties, "deep" was considered any region beyond a dozen meters of water. In 1970, "deep" became the drilling limit of the *Glomar Challenger*, which could recover rock samples thousands of meters below water and seabed, triggering the oil industry's interest in those regions; while for the mining industry, "deep" were polymetallic nodules in the abyssal plain. By employing the phrase "new deep territories" in the title of this thesis without explicit reference to the marine environment, I pursued to evoke the notion that the seafloor came to be conceived as an intrinsic part of the national territory, a piece of land as conducive for human activities as the mainland – despite the essential technological mediation. From the perspective of policy-makers and industrial managers, the seafloor was as *terra* as the former colonial territories, where occupation and extraction were legitimized by a still ill-defined international legislation,⁸⁶⁷ and in occasions through concealed negotiations between the most capable nations to divide up the oceans. In other words, the race to expand across the seafloor alarmingly resembled to previous scrambles at colonial territories. Information about the seafloor, therefore, was as relevant to shape diplomatic negotiations and design geopolitical strategies as geological data had previously been for the mainland.

This brings me to the second approach, in which I have traced the evolving roles data from the seafloor played in political and diplomatic strategies. The dual nature of geological and

⁸⁶⁷ In p.75 I have described how, after the 1958 UNCLOS, the limit of national seawaters was determined by the limit of technological capabilities, since the breath of the territorial waters were defined as encompassing "the seabed and subsoil of the submarine areas adjacent to the coast (...) to a depth of 200 meters or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas."

geophysical data enabled French geologists to participate in relevant scientific debates (i.e. plate tectonics theory or the Messinian Salinity Crisis), while fulfilling political ambitions in the international theater. From the mid-1960s, knowledge from the seafloor was utilized by the political elite to identify regions promising in hydrocarbons and polymetallic nodules far from France's territorial waters disguised under cover of scientific surveys; as well as to foster international cooperation with the US while displaying France's technological prowess to reach the deepest oceans. In this regard, the seafloor's exploration became a strong tool to display national prestige, equivalent to coeval advancements in nuclear and space research. Possessing oceanographic capabilities guaranteed international recognition, and was a bargaining chip to negotiate the limits of maritime sovereignty.⁸⁶⁸ The evolving roles of scientific data can also be traced through political discourses: from being part of fundamental research in the oceans, to become crucial to discover "the last economic frontier" (chapter 5), a "common heritage of mankind" (chapter 6), and instrumental to drive international unique scientific projects (chapter 7).

The ambition to exploit marine resources was national, but its undertaking needed to be international.⁸⁶⁹ Therefore the CNEXO, designed to advance the commercial utilization of marine resources, was also meant to re-formulate France's position in the world order through its position in the oceans. The institution became a device for diplomacy inasmuch as its experts – not only scientists, but especially public officers – were the official representatives of France in international forums and possessed decision-making capabilities to establish bilateral cooperative relations in ocean exploration. Chapter 6 has shown how through the CNEXO France signed bilateral agreements of scientific collaboration with the US, Japan, and the USSR in pursuing ambitions beyond easing political tensions or jointly exploring the oceans "for a common benefit": gaining international prestige, exploring the economic potential of faraway territories, or maintaining a technological advantage that could be utilized as a bargaining asset in diplomatic negotiations. But France also established further diplomatic relations through the CNEXO that have not been central to this research, like those with Germany, Brazil, Sweden, the UK, or Egypt. Each one was shaped according to the oceanic advantages France could obtain from these countries, like accessing to foreign seawaters in the Eastern Mediterranean,

⁸⁶⁸ As historian Sam Robinson has argued in: Robinson, "Scientific Imaginaries and Science Diplomacy."

⁸⁶⁹ At a practical level, exploring the global oceans was an endeavor unfeasible for a single nation; while from a strategic perspective, as I have described throughout this thesis, the concerns of developing nations to see former colonial powers replicating power relations in the high seas prompted the establishment of cooperative ventures and bilateral agreements to jointly explore the oceans.

keeping control of marine research in South America by offering scientific and technical advice, or acquiring a leading position in European oceanographic research. These examples open up potential research lines that should be analyzed if we aim at integrating the oceans in our understanding of international dynamics from the 1950s up to the present.

Economic imaginaries projected onto unexplored territories are not something solely from the past, neither scrambles to control untapped treasures. With this research I have aimed at raising awareness on the political and economic anxieties that prompted the seafloor's exploration in the sixties, because they are being replicated in contemporary debates. In October 2021, France's President Emmanuel Macron announced the plan "France 2030," where 30 thousand million euros are to be invested in exploring the industrial possibilities of the seafloor – although now the depth frontier is set between 4,000 and 6,000 meters, where polymetallic nodules hide. The discourse Macron displayed is overly similar to the rhetoric utilized by his predecessors six decades earlier: future marine resources are the key to fulfill growing consumption on strategic minerals, and the basis to achieve the goals of energy transition the government has committed to. As Macron expressed it:

La France est la deuxième puissance maritime du monde. Il y a aujourd'hui, pour connaître les grands fonds marins, des innovations de rupture à conduire pour mener ces explorations et pour permettre le travail scientifique... Et j'entends déjà le débat à venir. Je ne parle pas d'exploitation à ce moment-là, je parle d'exploration. Mais qui peut accepter que nous laissions en quelque sorte dans l'inconnu le plus complet une part si importante du globe ?⁸⁷⁰

France's (re)turn to the seafloor reflects a growing trend among developed nations, which are integrating marine resources in their geopolitical strategies to secure mineral supplies in an attempt to lowering their dependence from potentially unstable suppliers like China. Yet, unlike six decades ago, we are now more informed about the fragility of deep-water environments and our limited understanding about them. We are aware of the massive and unfruitful economic investments previously devoted to extract mineral resources that, eventually, remained being utopias; and on the multiple conflicting public and private interests that arise when the "common benefit of mankind" is meant to be distributed evenly among developed and

⁸⁷⁰ "France is the second world maritime power. Nowadays, there are cutting-edge innovations to know the great ocean depths, to develop explorations and enable scientific activities... I can already hear the upcoming debate. I am not talking about exploitation, I talk about exploration. But who could accept that we leave, in some way, in an absolute unknown such an important part of the globe?."

The video of Macron's discourse has been uploaded in his Twitter account (@EmmanuelMacron, tweet from October 12, 2021).

developing nations. Meanwhile, new scholar research is raising awareness on the strategic value of oceanographic data, as useful to shed new light on marine environments as to push for national interests in international arenas.⁸⁷¹

8.3. Limitations and avenues for future research

By setting in 1975 the chronological limit of this thesis, I have realized that this research was only scratching the surface of a wider story. How industrial-academic relations survived and evolved from the seventies up to our days? How involved has been the oil industry in national and international marine geosciences, when its technological frontier has moved to hundreds of meters depth? How inequalities in the oceans' governance, crafted in that period, have persisted up to today? And why the imaginary of the oceans as limitless sources of strategic minerals has strongly revived in the last years?

Focusing on France, the CNEXO's history did conclude soon after the ending point of this thesis: in 1978, Yves la Prairie stepped down from the CNEXO's direction board and was substituted by Gérard Piketty, Director of Carburants at the Ministry of Industry. Soon after, in 1984, the CNEXO was transformed in the IFREMER (accounting for *Institut Français de Recherche pour l'Exploitation de la Mer*), a new institution that fused the CNEXO with the national institute devoted to commercial fisheries (the *Institut Scientifique et Technique des Pêches Maritimes*, or *ISTMP*). Still today, the IFREMER is responsible for coordinating the use of the French oceanographic fleet and research resources, while its headquarters sit at the Oceanographic Center of Brest.

Some evidences indicate that, by the early-eighties, the “lyrical illusion” for the oceans' exploration was being substituted by “realism,” as *Le Monde's* journalist Yvonne Rebeyrol reported. Quoting a discourse delivered by Rober Lesgards (joint director at the Ministry of Scientific Research) at the *Association Scientifique et Technique pour l'Exploitation des Océans*,⁸⁷² Rebeyrol opened her report stating that:

Au cours des quinze dernières années, le thème de “l'Océan, clé de l'avenir du monde” a fait l'objet d'un discours abusif. Ce discours contraste avec une certaine déception que suscite la pauvreté des résultats économiques obtenus

⁸⁷¹ Polejack, “The Importance of Ocean Science Diplomacy for Ocean Affairs;” Zalik, “Mining the seabed, enclosing the Area;” Seas at Risk, *At a Crossroads: Europe's Role in Deep-Sea Mining*.

⁸⁷² The ASTEO, a technical association devoted to develop commercial underwater technologies.

jusqu'ici par la France : aucune découverte pétrolière dans notre zone économique ; un déficit commercial des produits de la pêche qui ne cesse d'augmenter ; une pollution mal maîtrisée.⁸⁷³

Jacques Cousteau thought in the same vein, but he was extremely critic towards the CNEXO as the cause of these high hopes and greater failure. In his view, the ambitions of a political elite, driven by delusions of grandeur and unmeasurable richness, had provoked unjustifiable massive expenditures in ocean sciences (almost 400 million US dollars from its foundation⁸⁷⁴) that paradoxically had barely impacted positively on France's marine research, nor on the country's economy – indeed, albeit its “commercial and industrial nature,” the CNEXO's dependency from the public budget had never decreased from an 85%.⁸⁷⁵ His considerations are captured in a book Cousteau published in 1982 entitled *Français, on a volé ta mer* (“French, we have stolen your sea”), that reached my hands when I was writing these lines.⁸⁷⁶

The cause of this failure, according to Cousteau, was found in the frantic (political) quest of an economic imaginary in the oceans, which he acidly described as:

Les espaces marins ouvrent l'imagination des journalistes en même temps que les appétits des comptables. L'unité de référence est le million de tonnes: des millions de tonnes du pétrole, de protéines animales et de métaux sont à prendre qui vont apaiser notre triple faim d'énergie, de nourriture et de matières premières. La mer nourricière devient un grand magasin, une caverne d'Ali Baba dont le prodigieux inventaire défile sous nos yeux émerveillés: chaque goutte d'océan contient de l'or, de l'uranium, des métaux rares en solution (...) les clichés utilisés complètent l'impression de féerie. Ces richesses "dorment" sous la mer. Le baiser d'un prince charmant souffrira à les réveiller. L'État qui aime les déguisements se laisse tenter par le rôle.⁸⁷⁷

⁸⁷³ “Throughout the last fifteen years, the topic “the Oceans, key of the World's Future” has been subjected to an abusive speech. This discourse contrasts with certain disappointment, result of the rather poor economic outcomes France has obtained: no oil discoveries in our economic zone; an ever-increasing trade deficit in fisheries; and an ill-managed pollution.” In: Rebeyrol, “Au colloque de l'ASTEO le réalisme remplace l'illusion lyrique.”

⁸⁷⁴ 1,500 million francs from 1980.

⁸⁷⁵ Cousteau, *Français, on a volé ta mer*, 35. The title “commercial and industrial nature” implies that the institution is committed to *produce* something, to generate some kind of economic revenues that would enable it to be self-sufficient or at least, to provide an extra budget to be invested in further national institutions or needs.

⁸⁷⁶ Ibid.

⁸⁷⁷ Ibid, 19. “Marine spaces triggered the imagination of journalists as well as the appetites of accountants. The unit of reference was the million tons: million tons of oil, animal protein, and metals were to fulfill our triple hunger for energy, food, and raw materials. The nourishing sea became a large department store, the cave of Ali Baba where a prodigious inventory paraded before our amazed eyes (...) The images evoked create a sensation of fairy tale. These richness “sleep” under the sea. Only the kiss of a charming prince would awake them. The State, who loves to be disguised, was tempted by the role.”

Oceanography became too important to leave in the hands of oceanographers, as his claim followed, whereas policy-makers and public officers were deemed as the most capable of “judging the supreme interests of the oceans for the nation.”

Second nefarious decision was to combine research with industrial exploitation – two antagonistic activities, in Cousteau’s eyes, but not for an idealist conception of sciences but due to practicalities: aquiculture, exploitation of mineral resources, prevention of marine pollution, and energy production have barely anything in common except for its relation to the sea. Experts involved (policy-makers, engineers, lawyers, technicians...) are different; so are the skills, approaches, and methodologies required. Scientific research was only a fraction of the expertise needed to solve these complex problems – which Cousteau illustrated with a suited example for this thesis: in the quest for oil across the Sahara, geologists were not responsible for selecting to invest in drill sites, although their expertise was required to study the geology around drill sites. Why, then, the CNEXO was shaped in this uncoherent manner? According to Cousteau, because its designers were not seeking to fulfill needs, but *ambitions*.⁸⁷⁸ His most scathing criticism, illustrative of this claim, was addressed to the (utopian) exploitation polymetallic nodules: a venture driven by the French government’s eagerness to enhance national prestige, designed to display the superiority of French technologies above the American ones, that ended in resounding failure. After acknowledging the scarcity of economically-profitable deposits in French seawaters, the quest for nodules became a pretext to indefinitely maintain public funding, to avoid recognizing the failure for a matter of national pride. The hopes of “budget-eating technocrats,” as Cousteau satirically phrased it, became then to “maneuver so that their nodular speculations would sustain them until the age of retirement.”⁸⁷⁹ Cousteau traced parallelisms with the folktale *The King’s New Clothes*, by Hans Christian Andersen: nobody dared to point to the failure, fearing to be labeled as unpatriotic – “but France is still waiting for a child that screams: the King is naked!,” as he concludes.

In short, the mediatic naturalist and commander bitterly lamented that “France, its oceanographic future, and its taxpayers have been victims of a skillful sleigh of hands.”⁸⁸⁰ The French were attracted by siren voices inviting them to look at the hidden face of the planet, the new frontier, the sixth continent and then – as Cousteau literally phrased it – “the ocean took

⁸⁷⁸ Ibid., 158.

⁸⁷⁹ Ibid., 109.

⁸⁸⁰ Ibid., 192.

over from the great colonial empires and the conquest of the Wild West.” Once the population was marveled by the hidden promises of the oceans, it was easy to convince them on the need to invest in a great national oceanographic policy.⁸⁸¹

Beyond Cousteau’s merciless – and perhaps biased – criticism, his account prompts a question about France’s recent historiography. During this research I was surprised by the scarcity (if not complete lack) of historical literature about France’s oceanographic policy; whereas space and nuclear research, the other two big research pillars during the Cold War, had received vast scholarly attention.⁸⁸² Could it be that the CNEXO fell into an induced oblivion, together with other failed institutions, research programs, and policies in which large sums of money and expectations were invested, but which did not meet political expectations?

Conversely, Cousteau’s account misses one element: the CNEXO’s international impact. It might be true that the national oceanographic program was not economically profitable, nor relevant to foster national scientific research, but I do consider that its influence on the international context should not be neglected. Regardless of its scientific results, the CNEXO was instrumental to establish diplomatic relations with foreign nations by means of marine research, as well as to define France’s stance in UN conferences. In the international arena, the “scientific monument” to marine sciences (re-taking Weinberg’s naming of public investments in big science) was more important than the science in-the-making, because it embodied a political commitment to exert national power in (and through) the oceans.

The historical collections of the CNEXO at the Archives Nationales de France might respond to these and multiple other questions, addressed from numerous research approaches: designs of underwater and diving technologies are ubiquitous, like the frustrated plan to build a submersible designed for the oil industry’s needs. The control of pollution was a topic of growing concern in the CNEXO’s leading circles, who attempted to harmonize scientific investigation, resources’ exploitation, and a benign public image. La Prairie and his colleagues frequently participated in TV shows, organized international festivals of “oceanology” (like the 1971 Ocean Expo in Bordeaux), and published in mass media about the promises of the oceans. The French Navy had a secondary position in the institution, but it did collaborate in some researches on physical oceanography (for these purposes, the Navy’s collections at the *Service*

⁸⁸¹ Ibid., 192.

⁸⁸² Specially for its relation to France’s ambitions of *Grandeur* and the re-shaping of its national identity (the best example is Hecht, *The radiance of France*).

Historique de la Defense might be of great help). Because the CNEXO's nature was strongly shaped by its ambition to control distant waters, to exert control over developing nations, and to inform France's stance in international forums, these collections constitute an interesting site for studies on science diplomacy, as they include reports, letters, and exchanges with countries from around the world.

Deriving from this thesis emerges the question of whether France's organization of industrial patronage represents a unique case study, or if it was a common setting in other countries to explore the offshore. The scope of this research has impeded me to trace comparisons between countries; yet, I have found indications that, in Italy, the oil firm ENI might have had established patronage relations with academic geologists from the University of Bologna and geophysicists from the *Istituto Nazionale di Oceanografia e di Geofisica Sperimentale* (OGS) in Trieste – but probably not under the umbrella of a national institution. Indeed, before Covid-19 pandemic, I visited the historical archives of ENI at Castelgandolfo (Italy) and interviewed experts from the University of Bologna and at the OGS Trieste.⁸⁸³ Information gathered was not sufficient to develop an exhaustive research, but it pointed to the relevant role of the oil industry's patronage to study the Italian seafloor. Beyond the Mediterranean Sea, the question should be also posed for countries whose national economy grew partially linked to offshore oil production, for instance Norway, the UK, or the US. In short, to fully grasp how the seafloor came to be known it is essential to integrate nations that held different military priorities, economic needs, and geopolitical settings further than the US or France, and to include other patrons beyond the military.

Finally, the seafloor appears as a genuine site to explore the interplays between technoscientific practices and international relations for its singularities. Its exploration is an inherently cooperative venture that has been built upon exchanges of data sets, international investigations, and negotiations on its uses. Unlike the field of nuclear energy, the seafloor's exploration involved a territory whose control needed to be negotiated; and in addition to the motivations that drove diplomatic relations in exploring other territories, as the poles or the space, in these new deep territories serious economic interests were at stake – they were, indeed, being exploited while its depths were under exploration. Present power relations at stake could only be glimpsed through careful examination of the past.

⁸⁸³Martínez-Rius, "Interview to G.B. Vai;" Martínez-Rius, "Interview to R. Nicolich."

As historian Helen Rozwadowski has emphasized, the ocean requires its own history, one that accounts for its environmental characteristics and the diverse human activities that have informed our understanding on it.⁸⁸⁴ The seafloor also calls for its own history, one that considers its hybrid nature as a piece of marine environment and as a territory. Because only by fathoming how we came to know marine environments, and how our perception of them has changed over time, we could better understand the ambitions, hopes, and imaginaries, national or international, currently projected on them.

⁸⁸⁴ Rozwadowski, "Oceans;" Rozwadowski, "Focus: Knowing the Ocean: A Role for the History of Science."

Bibliography

Archives

Archives Nationales de France (ANF), Pierrefitte-sur-Seine

19800284 Centre national de la recherche scientifique

19800284/205 Comité directeur d'océanographie et biologie maritime, 1944-1945.

19810244 Enseignement; recherche et technologie (1958-1980)

19810244/449 International Program of Ocean Drilling (1973-76). Documents D.G.R.S.T., Rapports du CNEXO.

19920548 Recherche; recherche et technologie. Fonds Poignant

19920548/09 Création fonds pour le développement de la recherche scientifique et technique.

19920548/15 Le fonds de développement de la recherche, 1959-1971: mise en place.

19920548/16 Actions concertés.

19920548/19 Groupe de travail DGRT-Armée pour la création d'un centre national d'études océanographiques.

19980125 Industrie ; Direction générale de l'énergie et des matières premières ; Direction des hydrocarbures ; Service prospection, production (1961-1989)

19980125/1 CNEXO – Conseils d'Administration 1967, 68,69.

19980125/2 CNEXO – Conseils d'Administration 1970, 71.

19980125/3 CNEXO – Conseils d'Administration 1971, 72.

19980125/4 CNEXO – Conseils d'Administration 1973, 74.

19980125/25 CEPM – Récapitulatifs des avis formules par le CEPM et transmis à la DHYCA (1972-1977).

19980125/36 CEPM – Possibilités pétrolières des zones marines profondes de la méditerranée occidentale.

19980125/49 Études et Rapports 1963-1983.

19980125/50/51 Total – Exploitation, campagne de forage en méditerranée profonde, 1981.

20060160 Marine marchande, Centre national pour l'exploitation des océans

20060160/1 Dossier Océanographie d'André Giraud – Activités du comité Scientifique d'action concerté Comexo et création du CNEXO. 1965-1967.

20080658 Fonds du Centre national pour l'exploitation des océans (CNEXO) (1961-1984)

20080658/21 Relations Internationales – Asie.

20080658/22 Relations Internationales – États-Unis.

20080658/23-24 Relations Internationales – Europe, Afrique et Amérique (hors États-Unis).

20080658/40 COB. Département Géologie-Géophysique-Géochimie.
Droit de la mer; sédimentologie; géotechnique; géophysique.

20080658/41 COB. Département Géologie-Géophysique-Géochimie.
Dossiers; Comptes-rendus.

20110381 Institut français de recherche pour l'exploitation de la mer (IFREMER)

20110381/1 Contrats du COMEXO (1961-1966).

20110381/5 Contrats du CNEXO (1967).

20110381/7 Contrats du CNEXO (1968).

20110381/9 Contrats du CNEXO (1969).

20110381/10 Contrats du CNEXO (1969).

20110381/12 Contrats du CNEXO (1970).

20110381/14 Contrats du CNEXO (1971).

20110381/16 Contrats du CNEXO (1971).

20150386 Suivi des Industrie pétrolières et des nouveaux produits énergétiques

20150386/77 Fonds de Soutien aux Hydrocarbures. Fonctionnement et organisation.

20150386/156 CEPM - Textes constitutifs du Comité d'études pétrolières et marines
(CEPM), du Comité de programme exploration-production (COPREP).

20160129 Fonds de la présidence de l'IFREMER et du CNEXO (1967-2013)

20160129/328 Courrier Direction Générale (DG) départ 27/04/1967 au 29/12/1967.

20160129/327 Courrier DG départ 29/12/1967 au 31/12/1968.

20160129/326 Courrier DG départ 03/01/1969 au 30/06/1969.

20160129/325 Courrier DG départ 30/06/1969 au 29/12/1969.

20160129/324 Courrier DG départ 02/01/1970 au 13/08/1970.

20160129/323 Courrier DG départ 13/08/1970 au 24/12/1970.

20160129/322 Courrier DG départ 01/01/1971 au 14/05/1971.

20160259/321 Courrier DG départ 17/05/1971 au 04/10/1971.

20160129/320 Courrier DG départ 06/10/1971 au 31/12/1971.

20160129/317 Courrier DG départ 02/01/1973 au 08/06/1973.

20160129/311 Courrier DG départ 15/04/1975 au 25/08/1975.

20160129/308 Courrier DG départ 25/10/1976 au 31/12/1976.

Archives Diplomatiques de France (ADF), La Courneuve

236QO Relations culturelles, scientifiques et techniques. Directeurs (1948-1973)

236QO/35 Océanographie. COMEXO.

243BGS Direction de la Coopération Scientifique et technique (1956-1994). Sciences de la Terre

243BGS/60 Réunions Coopération CNEXO-Affaires Étrangères (1975-1976).

Archives du Muséum National d'Histoire Naturelle (MNHN), Paris

Archives des laboratoires du Muséum national d'Histoire Naturelle

ARCH PC 46(7) DGRST / Comité "Exploitation des Océans."

Archives Historiques du Groupe TOTAL (AHT), Paris

Fonds de la Compagnie Française des Pétroles

85ZW456/2 Permis d'Exploration en France (1967-1984).

50ZZ604/32 Compagnie Française Des Pétroles (Métropole) (1956-1982).

50ZZ496 CFP Documents de société (1924-1990).

Fonds Groupe Elf-Aquitaine

07AH119/76 Entreprise de Recherches et d'Activités Pétrolières (ERAP) (1947-1984).

Service Historique de la Défense (SHD), Vincennes

MV Fonds de la Marine Nationale

MV 9JJ Archives du Service hydrographique et océanographique de la Marine (1830-1990)

MV 9JJ 0567 Coopération SHOM et organismes pétroliers.

MV 9JJ 39 Marti; étude sondeurs acoustiques, études avec sources de sondage.

MV 9JJ 584 Centre National d'Exploitation des Océans. Situation et besoins de la recherche scientifique et technique en hydrographie, participation de la Marine à la création d'organismes civils en recherche (1962-1968).

MV9JJ 585 CNEXO – constitution groupes de travail pour la préparation de programme d'activités océanographiques, représentation SHOM, correspondances.

GR Fonds de Guerre et Armé de Terre

GR 16 P Deuxième Guerre Mondiale

GR 16 P 81000 Dossiers individuels du bureau de Résistance.

GR 28 P58 (80) Dossiers individuels des agents des réseaux et des mouvements.

Service Historique de la Défense (SHD), Châllerault

AA I Fonds Armement Navale

AA553 5I 283 Dossiers Techniques concernant la Marine (1917-1982).

NATO Archives (virtual)

NAC C The North Atlantic Council; sub-collection: C-North Atlantic Council

C(59)M Memoranda, 1959.

**University of California San Diego, Special Collections & Archives (UCSD),
La Jolla (CA, USA)**

**Coll.: Scripps Institution of Oceanography (SIO) Deep Sea Drilling Project Records,
1961-1987**

JOIDES Series

Box 8, folder 13 Mediterranean Advisory Subpanel (1970-1974).

Leg Files Series

Box 99, folder 8 Leg 13 (1969-1972) (2).

Box 99, folder 7 Leg 13 (1969-1972).

Box 104 folder 15 Leg 42 (1975).

Box 104, folder 14 Leg 42 (1975).

Oral History Interviews

Levin, Tanya. "Interview of William Ryan by Tanya Levin." July 1, 1998. Niels Bohr Library & Archives, American Institute of Physics. Accessed in March 3, 2022. www.aip.org/history-programs/niels-bohr-library/oral-histories/22894

Martínez-Rius, Beatriz. "Interview to Alain Mauffret." Paris, June 13, 2019 (unpublished).

———. "Interview to Gian-Battista Vai." Bologna, June 14, 2019 (unpublished).

———. "Interview to Gilbert Boillot." Nice, May 31, 2021 (unpublished).

———. "Interview to Jean Marie Rouchy." Paris, March 6, 2019 (unpublished).

———. "Interview to Lucien Montadert." Rueil-Malmaison, 13/03/2019 (unpublished).

———. "Interview to Pierre-René Bauquis." Paris, October 20, 2020 (unpublished).

———. "Interview to Rinaldo Nicolich." Trieste, June 21, 2019 (unpublished).

———. "Interview to William B.F. Ryan." Paris-Columbia, November 15, 2019 (unpublished).

———. "Interview to Xavier le Pichon." Paris, June 7, 2019 (unpublished).

Piccard, Jean-François. "Interview to Claude Lalou by Jean-François Piccard." July 19, 1986. Archives Orales du CNRS.

Simon, Dirk. "Interview to Maria Bianca Cita." Brisighella, Sicily, 2012 (unpublished).

Published sources

- Abulafia, David. *The Great Sea: A Human History of the Mediterranean*. New York: Oxford University Press, 2011.
- Adamson, Matthew, and Roberto Lalli. “Global Perspectives on Science Diplomacy: Exploring the Diplomacy-Knowledge Nexus in Contemporary Histories of Science.” *Centaurus* 63, no. 1 (2021): 1–16.
- Adamson, Matthew. “Les Liaisons Dangereuses: Resource Surveillance, Uranium Diplomacy and Secret French–American Collaboration in 1950s Morocco.” *The British Journal for the History of Science* 49, no. 1 (March 2016): 79–105.
- Adler, Antony. “Cold War Science on the Seafloor.” In *Neptune’s Laboratory: Fantasy, Fear, and Science at Sea*, 101–34. Cambridge, Massachusetts: Harvard University Press, 2019.
- . “Deep Horizons: Canada’s Underwater Habitat Program and Vertical Dimensions of Marine Sovereignty.” *Centaurus* 62, no. 4 (2020): 763–782.
- . “Marine Science for the Nation or for the World?.” In *Neptune’s Laboratory, Fantasy, Fear, and Science at Sea*, 46–73. Cambridge, Massachusetts: Harvard University Press, 2019.
- Alinat, Jean, Günter Giermann, and Oliver Leenhardt. “Reconnaissance Sismique des Accidents de Terrain en Mer Ligure.” *C.R. Académie Des Sciences de Paris B* 262 (1966): 1311–1314.
- Alla, Gèneviève, and Rustum Byramjee. “Structure Géologique de la Marge Continentale du Golfe du Lion.” In: *Rapports et Procès-Verbaux Des Réunions* 22, edited by CIESM, 38–40. Monaco: CIESM, 1973.
- Allain, Jean-Claude (ed.). *Histoire de la Diplomatie Française Vol. II. De 1815 à nos Jours*. Paris: Ed. Perrin, 2005.
- Andersen, Casper, Jakob Bek-Thomsen, and Peter C. Kjærgaard. “The Money Trail: A New Historiography for Networks, Patronage, and Scientific Careers.” *Isis* 103, no. 2 (June 2012): 310–315.
- Andersen, Casper, Jakob Bek-Thomsen, and Peter C. Kjærgaard. “The Money Trail: A New Historiography for Networks, Patronage, and Scientific Careers.” *Isis* 103, no. 2 (June 2012): 310–315.
- Anderson, Benedict R. *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. London: Verso, 1983.
- Apostolescu, Vespasian, Bernard Biju-Duval, Philippe Courier, and Jean Letouzey. “Evolution Sédimentologique et Structurale du Domaine Méditerranéen Occidental au Cours du Tertiaire.” In: *Rapports et Procès-Verbaux des Réunions* 22, edited by CIESM, 25–26. Monaco: CIESM, 1973.
- . “Evolution Sédimentologique et Structurale du Domaine Méditerranéen Oriental au Cours du Tertiaire.” In: *Rapports et Procès-Verbaux des Réunions* 22, edited by CIESM, 27–28. Monaco: CIESM, 1973.
- Aronova, Elena, Karen S. Baker, and Naomi Oreskes. “Big Science and Big Data in Biology: From the International Geophysical Year Through the International Biological Program

- to the Long Term Ecological Research (LTER) Network, 1957-Present.” *Historical Studies in the Natural Sciences* 40, no. 2 (n.d.): 183–224.
- Assaad, Fakhry A. “Surface Geophysical Petroleum Exploration Methods.” In: *Field Methods for Petroleum Geologists: A Guide to Computerized Lithostratigraphic Correlation Charts Case Study: Northern Africa*, ed. Assaad, Fakhry A., 21–23. Berlin, Heidelberg: Springer, 2009.
- Aubouin, Jean. *Geosynclines*. Amsterdam, London, NY: Elsevier Pub. Co., 1965.
- Ball, Philip. “When the Mediterranean Was a Desert.” *Nature* 12 (August 12, 1999).
- Ballard, Robert D. “The History of Woods Hole’s Deep Submergence Program.” In: *50 Years of Ocean Discovery: National Science Foundation 1950–2000*, ed. Ocean Studies Board and National Research Council, 67-84. Washington, D.C.: National Academies Press, 2000.
- Barkenbus, Jack N. “The Politics of Ocean Resource Exploitation.” *International Studies Quarterly* 21, no. 4 (Special Issue on International Politics of Scarcity) (December, 1977): 675-700.
- Bascom, Willard. “The First Deep Ocean Drilling.” In: *Oceanography: The Past*, edited by Mary Sears and Daniel Merriman, 316–24. New York: Springer-Verlag, 1980.
- . *A Hole in the Bottom of the Sea: The Story of the Mohole Project*. Weidenfeld (UK): Doubleday, 1961.
- Bates, Charles C., Thomas F. Gaskell, and Robert B. Rice. *Geophysics in the Affairs of Man*. Oxford, New York: Pergamon Press, 1982.
- Belot, Robert. *L’atome et La France: Aux Origines de La Technoscience Française*. Paris: Odile Jacob, 2015.
- Beuzart, Paul. *Nestlante II*. Paris: Centre National pour l’Exploitation des Océans, 1981.
- Biagioli, Mario. “From Ciphers to Confidentiality: Secrecy, Openness and Priority in Science.” *The British Journal for the History of Science* 45, no. 2 (June 2012): 213–233.
- Biju-Duval, Bernard, Ana Maria Borsetti, and Paolo Colantoni. “Géologie des Fossés du Détroit Siculo-Tunisien (mer Pélagienne).” *Revue de l’Institut Français du Pétrole* 40, no. 6 (November 1, 1985): 691–722.
- Biju-Duval, Bernard, Jean Letouzey, and Lucien Montadert. “Structure and Evolution of the Mediterranean Basins.” In: *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al., 951-984. Washington: US Government Printing Office, 1978.
- Bizon, Germaine and Georgette Glaçon. “Morphological Investigations on the Genus *Globorotalia* from Site 372”. In: *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al. 687-707. Washington: US Government Printing Office, 1978.
- Bobbette, Adam, and Amy Donovan, eds. *Political Geology*. New York, NY: Springer, 2018.
- Boillot, Gilbert, Lucien Montadert, Marcel Lemoine, and Bernard Biju-Duval. *Les Marges Continentales Actuelles et Fossiles Autour de la France*. Paris, NY, Barcelone: Masson, 1984.
- Boillot, Gilbert. “Fonds Rocheux, Dépôts Quaternaires, Sédiments Actuels.” Thèse de 3ème Cycle, Université de Paris, 1954.

- . *Comment l'Idée Vient au Géologue*. Paris: Orizons, 2021.
- . “1956-2012. La Géologie Marine à l'Observatoire Océanologique de Villefranche-Sur-Mer.” *Travaux du Comité Français d'Histoire de la Géologie*, 33 (2019).
- . “Des Marges Continentales Atlantiques aux Chaînes Plissées: Les Recherches Françaises entre 1967 et 2000.” *Travaux du Comité Français d'Histoire de la Géologie*, III, 26-1 (2012): 1-24.
- Bonneuil, Christophe, and Jean-Baptiste Frescoz. *The Shock of the Anthropocene: The Earth, History, and Us*. London; Brooklyn, NY: Verso, 2016.
- Bonneuil, Christophe, Pierre-Louis Choquet, and Benjamin Franta. “Early Warnings and Emerging Accountability: Total's Responses to Global Warming, 1971–2021.” *Global Environmental Change* 71 (November 1, 2021).
- Bourcart, Jacques, and Joaquin Ros. “Sur le Remplissage Sédimentaire de la Partie Centrale de la Méditerranée Occidentale.” *Comptes Rendus Académie des Sciences de Paris*, 254 (3) (April 16, 1962): 2897-2901.
- Bourcart, Jacques, and M. Auzel. “Sur l'Érosion de la Plage de Deauville Pendant le Printemps de 1950.” *Comité Central d'Océanographie et d'Étude des Côtes. Bulletin d'Information* 2, no. 10 (1950).
- Bourcart, Jacques, Gilbert Boillot, Jacques-Yves Cousteau, Maurice Genesseeux, Éloi Klimer, and Claude Lalou. “Les Sédiments Profonds au Large de la Côte Niçoise.” *Comptes Rendus Académie des Sciences* 247 (July 7, 1958): 116-118.
- Bourcart, Jacques. “Compte Rendu des Missions de Géologie Sous-Marine Accomplies en 1949.” *Comité Central d'Océanographie et d'Étude des Côtes. Bulletin d'Information* 8 (September 1949): 6-9.
- . “Essai de Classement des Formations Continentales Quaternaires du Maroc Occidental.” *Comptes Rendus Séances Société Géologique de France* (1931), 256–59.
- . “Géologie Sous-Marine de la Baie de Villefranche.” *Annales de l'Institut Océanographique* 3, 33 (1957): 137–200.
- . “Morphologie du Précontinent des Pyrénées à la Sardaigne.” In: *La Topographie et la Géologie des Profondeurs Océaniques*, LXXXIII: 33–52. Colloques Internationaux du CNRS. Paris: CNRS, 1959.
- . *Les Confins Albanais Administrés par la France, 1916-1920: Contribution à la Géographie et à la Géologie de l'Albanie Moyenne*. Paris: Librairie Delagrave, 1922.
- . “Allocution d'Ouverture.” In: *Océanographie Géologique et Géophysique de la Méditerranée Occidentale. Villefranche Sur Mer, 4 au 8 Avril 1961*, ed. by Colloques Nationaux du CNRS. Paris: Éditions du Centre National de la Recherche Scientifique, 1962.
- . “Colloque de Géologie Sous-Marine.” *Comité Central d'Océanographie et d'Étude des Côtes. Bulletin d'Information* 8, 7 (October 1955): 331-370.
- . “Étude de la Plage de Graves.” *COEC Bulletin d'Information* 5 (May 1949): 9–11.
- . “Hypothèses sur la Genèse des Gorges Sous-Marines.” *Comité Central d'Océanographie et d'Étude des Côtes. Bulletin d'Information* 2, 9 (November 1950): 21–39.

- . “La Marge Continentale. Essai sur les Régressions et les Transgressions Marines.” *Bulletin de la Société Géologique de France* 8, no. 4 (1938): 393–474.
- . “La Vie et L’œuvre de Louis Gentil (1880-1925).” *Bulletin de la Société Géologique de France* 7, 3 (June 5, 1961).
- . “Le ‘Rech’ Lacaze-Duthiers, Cañon Sous-Marin du Plateau Continental du Roussillon.” *Comptes Rendus de l’Académie des Sciences* 226 (n.d.): 1632–33.
- . “Le Littoral Breton, du Mont Saint-Michel au Finistère.” *Comité Central d’Océanographie et d’Étude des Côtes. Bulletin d’Information* 2, 1 (January 1950): 21–39.
- . “Le Sahara Algérien.” In *La Géologie et les Mines de la France d’Outremer*, by Bureau d’Études Géologiques et Minières Coloniales, 181–205. Paris: Société d’Éditions Géographiques, Maritimes et Coloniales, 1933.
- . “Les Dépôts du Second Cycle Miocène du Maroc Occidental.” *Comptes Rendus Hebdomadaires des Séances de l’Académie des Sciences* 195 (October 24, 1932): 736.
- . “Premiers Résultats d’une Étude du Quaternaire du Maroc.” *Bulletin de la Société Géologique de France* 27, no. 4 (1927): 3–33.
- . “Recherches sur la Stratigraphie du Pliocène et du Quaternaire du Levant.” *Bulletin de la Société Géologique de France* 5, 10 (1940): 207–30.
- . “Sur les Rechs, Sillons Sous-Marins du Plateau Continental des Albères (Pyrénées-Orientales).” *Comptes Rendus Hebdomadaires des Séances de l’Académie des Sciences de Paris* 224 (1947): 1175–77.
- . “Topographie Sous-Marine et Sédimentation Actuelle.” In *Comptes Rendus de la Dix-Neuvième Session Alger 1952*, by Congrès Géologique International, Vol. IV. Alger: Imprimerie Protat, 1953.
- . *Géographie du Fond des Mers*. Paris: Éditions Payot, 1949.
- . *Le Fond des Océans*. Paris: Presses Universitaires de France, 1954.
- . *Océanographie. Introduction à la Géologie*. Paris: Centre de Documentation Universitaire, 1952.
- . *Problèmes de Géologie Sous-Marine. Le Précontinent - Le Littoral et sa Protection - La Stratigraphie Sous-Marine*. Paris: Masson et Cie editers, 1958.
- Bourdieu, Pierre. “Le Capital Social.” *Actes de la Recherche en Sciences Sociales* 31 (January, 1980): 2-3.
- Bourgoin, Jean. “Henri Lacombe (33) 1913-2000.” *La Jaune et la Rouge* (February, 2001): 51-52.
- Bravo, Carlos. “Un caballo de Troya de la industria petrolera.” *20 Minutos*, May 24, 2018.
- Bridge, Gavin. “Territory, Now in 3D!” *Political Geography* 34 (May 1, 2013): 55–57.
- Briseid, E., and Jean Mascle, “Structure de la Marge Continentale Norvégienne au Débouché de la Mer de Barentz”. *Marine Geophysical Researches* 2 (1975): 231-241.
- Brunn, Anton F. “The International Advisory Committee on Marine Sciences of UNESCO.” *AIBS Bulletin* 8, no. 1 (January 1958): 12–14.
- Bullard, Edward. “Overview of Plate Tectonics.” In *Petroleum and Global Tectonics*, edited by Alfred G. Fischer, 1–22. Princeton: Princeton University Press, 1975.

- . “William Maurice Ewing.” *Biographical Memoires of Fellows of the Royal Society* 21 (November 1975).
- Bulletí Oficial del Parlament de les Illes Balears*, n.49 (33/28) June 3, 2016.
- Burleson, Clyde W. *Deep Challenge!: The True Epic Story of Our Quest for Energy beneath the Sea*. Houston: Gulf, 1999.
- Burnett, D. Graham. “Hydrographic Discipline among the Navigators: Charting an ‘Empire of Commerce and Science’ in the Nineteenth-Century Pacific.” In *The Imperial Map: Cartography and the Mastery of Empire*, edited by James R. Akerman, 185–259. Chicago: University of Chicago Press, 2009.
- Burollet, Pierre-Félix, and Rustum S. Byramjee. “Réflexions sur la Tectonique Globale.” *Compagnie Française des Pétroles Notes & Mémoires* 11 (1974): 71-120.
- Burollet, Pierre-Felix, Aymen Said, and Philippe Trouve. “Slim Holes Drilled on the Algerian Shelf”. In: *Initial Reports of the Deep Sea Drilling Project* 42 pt.1, edited by Kenneth J. Hsü, Lucien Montadert et al., 1181-1183. Washington: US Government Printing Office, 1978.
- Burstyn, Harold L. “‘Big Science’ in Victorian Britain: The Challenger Expedition (1872-6) and its Report (1881-95).” In: *Understanding the Oceans: A Century of Ocean Exploration*, 49-55. London: University College London Press, 2001.
- Bush, Vannevar. *Science, the Endless Frontier*. Washington: United States Government Printing Office, 1945.
- Buttigieg, Jean. “Arvid Pardo – A Diplomat with a Mission.” *Symposia Melitensia* 12 (2016): 13-28.
- Buzan, Barry. *Seabed Politics*. London: Praeger, 1976.
- Camprubí, Lino, and Sam Robinson. “A Gateway to Ocean Circulation: Surveillance and Sovereignty at Gibraltar.” *Historical Studies in the Natural Sciences* 46, no. 4 (2016): 429-459.
- Camprubí, Lino, and Philipp Lehmann. “The Scales of Experience: Introduction to the Special Issue Experiencing the Global Environment.” *Studies in History and Philosophy of Science* 70 (August 2018): 1–5.
- Camprubí, Lino. “‘No Longer an American Lake’: Depth and Geopolitics in the Mediterranean.” *Diplomatic History* 44, no. 3 (June 2020): 428–446.
- . “Experiencing Deep and Global Currents at a ‘Prototypical Strait’, 1870s and 1980s.” *Studies in History and Philosophy of Science* 70 (August 2018): 6–17.
- . “Resource Geopolitics: Cold War Technologies, Global Fertilizers, and the Fate of Western Sahara.” *Technology and Culture* 56, no. 3 (2015): 676–703.
- Cantoni, Roberto. *Oil Exploration, Diplomacy, and Security in the Early Cold War: The Enemy Underground*. New York: Routledge, 2017.
- Cassand, Jean, Jean-Pierre Fail, and Lucien Montadert. “Sismique Réflexion en Eau Profonde (Flexotir).” *Geophysical Prospecting* 18, no. 4 (December 1970): 600–614.
- Catalano, Raimondo, Giuliano Ruggeri, and Rodolfo Saproveri, eds. *Messinian Evaporites in the Mediterranean. Erice Seminar, October 1975*. Vol. XVI. *Memories della Società Geologica Italiana*. Roma: Società Geologica Italiana, 1978.

- Caulfield, David D. "Predicting Sonic Pulse Shapes of Underwater Spark Discharges." *Deep-Sea Research*, no. 9 (1962): 339-348.
- Centre Océanologique de Brest. *N.O. Jean CHARCOT. Campagne Polymede 1. 10 Mai - 3 Juillet 1970*. Publications du Centre National pour l'Exploitation des Océans (CNEXO), Série Résultats des Campagnes à la Mer, no. 5. Paris: 1972.
- Ceruzzi, Paul E. *GPS*. Cambridge, London: The MIT Press, 2018.
- Chapelle, Jean. "La France et la Recherche du Pétrole en Mer." *Sondages. Bulletin interieur de l'IFP* no. 42
- Chesneaux, Jean "Le Centre d'Expérimentation du Pacifique et son Impact." In: *Tahiti Après la Bombe. Quel Avenir pour la Polynésie?*, edited by Jean Chesneaux, 53-74. France: L'Harmattan.
- Cholet, Jaques, and Jean-Pierre Fail. "Patent Specification 1,097,227." The Patent Office London, January 22, 1965.
- . "Dispositif Émetteur d'Ondes Sonores." Office de la Propriété Intellectuelle du Canada, CA 723001-A (07/12/1965).
- Churchill, Robin R., and Alan Vaughan Lowe. *The Law of the Sea*, 2nd Edition. Manchester: Manchester University Press, 1988.
- CIESM. *Rapports et Procès-Verbaux des Réunions*, 22. CIESM: Monaco, 1973.
- Cita, Maria Bianca. "The Messinian Salinity Crisis in the Mediterranean: A Review." In: *Alpine-Mediterranean Geodynamics*, edited by Kenneth J. Hsü, 113-140. Washinton D.C.: American Geophysical Union, 1982.
- CNEXO. *Rapport Annuel 1970*. Paris: Centre National pour l'Exploitation des Océans, 1971.
- . *Rapport Annuel 1971*. Paris: Centre National pour l'Exploitation des Océans, 1972.
- . *Rapport Annuel 1972*. Paris: Centre National pour l'Exploitation des Océans, 1973.
- . *Rapport Annuel 1974*. Paris: Centre National pour l'Exploitation des Océans, 1975.
- CNRS. *Rapport National de Conjoncture 1959*. Paris: CNRS, 1960.
- . *Rapport National de Conjoncture 1962/1963*. Paris: CNRS, 1964.
- . *Rapport National de Conjoncture 1963/1964*, t.1. Paris: CNRS, 1965.
- Colby, Jason M. "Conscripting Leviathan: Science, Cetaceans, and the Cold War." *Diplomatic History* 44, no. 3 (June 1, 2020): 466–78.
- Collis, Christy, and Klaus Dodds, "Assault on the Unknown: The Historical and Political Geographies of the International Geophysical Year (1957–8)," *Journal of Historical Geography* 34, no. 4 (2008): 555–573.
- Colloques Internationaux du CNRS. *La Topographie et la Géologie des Profondeurs Océaniques. Nice, 5-12 Mai 1959*. Paris: CNRS, 1959.
- . *Océanographie Géologique et Géophysique de la Méditerranée Occidentale. Villefranche Sur Mer, 4 au 8 Avril 1961*. Paris: Éditions du Centre National de la Recherche Scientifique, 1962.
- Colmenero, Ricardo F. "Siete petroleras se interesan por el proyecto 'científico' MEDSALT-2." *El Mundo*, April 27, 2018.

- Combaz, André. "Le Comité d'Études Pétrolières Marines." *Annales de Géographie* 88, no. 486 (1979): 145-49.
- . "Les Premières Découvertes de Pétrole au Sahara dans les Années 1950: Le Témoignage d'un Acteur." *Travaux du Comité Français d'Histoire de la Géologie* 3, 16 (June 19, 2002).
- Comité d'Océanographie et d'Étude des Côtes. "Informations Avril 1953." *COEC Bulletin d'Information* 4, 4 (April 1953).
- Commissariat Général du Plan. *Cinquième Plan de Développement Économique et Social (1966-1970)*. Paris: Journaux Officiels, 1965.
- Cook J. Carlton, and Frank W. Harrison Jr. "Geology and Development History of Jennings Salt Dome 1901-1985: Clue to Future of Gulf Coast Salt Domes." *American Association of Petroleum Geologists* 70, no. 5 (May 1, 1986).
- COST Action. "Memorandum of understanding for the implementation of the COST Action "Uncovering the Mediterranean salt giant" (MEDSALT) CA15103." October 30, 2015.
- Cousteau, Jacques, and Susan Schiefelbein. *The Human, the Orchid, and the Octopus: Exploring and Conserving Our Natural World*. New York: Bloomsbury USA; Distributed to the trade by Holtzbrinck Publishers, 2007.
- Cousteau, Jacques-Yves. *Français, on t'a volé la Mer*. Paris: Robert Lafont, 1982.
- . "Préface." In: *Le Sondage Sismique Continu. Techniques, Méthodes et Interprétations*, by Olivier Leenhardt, V-VI. Paris: Masson et Cie. Éditeurs, 1972.
- Cramer, Katharina C. *A Political History of Big Science: The Other Europe*. Cham, Switzerland: Palgrave Macmillan, 2020.
- Cravatte, Jacques, Philippe Dufaure, Maurice Prim, and Serge Rouaix. "Les Forages du Golfe du Lion. Stratigraphie, Sédimentologie." *Compagnie Française des Pétroles. Notes et Mémoires* 11 (1974): 209-274.
- Creager, Angela N. H. "Radioisotopes as Political Instruments, 1946-1953." *Dynamis* 29 (2009): 219-39.
- Crochet, Bernard. *Marées Noires. 50 Ans de Catastrophes Écologiques*. Ouest France: 2018.
- Cronon, William. *Nature's Metropolis: Chicago and the Great West*. New York: Norton, 1992.
- Cruikshank, Michael J. "John L. Mero. In Memoriam." *Marine Georesources and Geotechnology*, 20 (2002): 85-86.
- Cupitt, Richard T., and Suzette R. Grillot. "COCOM Is Dead, Long Live COCOM: Persistence and Change in Multilateral Security Institutions." *British Journal of Political Science* 27, no. 3 (1997): 361-89.
- Daston, Lorraine, and Peter Galison. *Objectivity*. New York: Zone Books, 2010.
- De Charadevian, Soraya. "Using Interviews to Write the History of Science." In: *The Historiography of Contemporary Science and Technology*, edited by Thomas Söderqvist, 51-70. Amsterdam: Harwood, 1997.
- Debyser, Jacques, Xavier le Pichon, and Lucien Montadert, eds. *Histoire Structurale du Golfe de Gascogne*. Paris: Éditions Technip, 1971.

- Delacour, Jacques, and André Castela. "Appareillage de Forage Sous-Marin." Brevet d'Invention no. 1.482.823. Ministère de l'Industrie, Service de la Propriété Industrielle, July 2, 1965.
- Delacour, Jacques, Jean Parola, and Pierre Grolet. "Dispositif pour le Carottage Sous-Marine". Office de la Propriété Intellectuelle du Canada, Patent CA 726977A. February 1, 1966.
- Délégation Général de la Recherche Scientifique et Technique. *Les Actions Concertées. Rapport d'Activité 1961*. Paris, 1962.
- . *Les Actions Concertées. Rapport d'Activité 1962*. Paris, 1963.
- Delteil Jean R., J. Durand, P. Semichon, Lucien Montadert, Jean Letouzey, and Jean-Pierre Faye. "Structure Géologique de la Marge Continentale à l'Ouest du Golfe de Bonifacio". In: *Rapports et Procès-Verbaux des Réunions 22*, edited by CIESM, 46-49 . CIESM: Monaco, 1973.
- Dennis, Michael Aaron. "Secrecy and Science Revisited. From Politics to Historical Practice and Back." In: *The Historiography of Contemporary Science, Technology and Medicine*, by Ronald E. Doel and Thomas Söderqvist, 172-184. London; New York: Routledge, 2006.
- Deroo, Gerard, Jean-Paul Herbin, and J. Roucaché. "Organic Geochemistry of Some Neogene Cores." In: *Initial Reports of the Deep Sea Drilling Project 42* pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al., 465-172. Washington: US Government Printing Office, 1978.
- Doel, Ronald E. "Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA after 1945." *Social Studies of Science* 33, no. 5 (October 2003): 635–66.
- Doel, Ronald E., and Kristine C. Harper. "Prometheus Unleashed: Science as a Diplomatic Weapon in the Lyndon B. Johnson Administration." *Osiris* 21, no. 1 (January 2006): 66–85.
- Doel, Ronald E., Tanya J. Levin, and Mason K. Marker. "Extending Modern Cartography to the Ocean Depths: Military Patronage, Cold War Priorities, and the Heezen–Tharp Mapping Project, 1952–1959." *Journal of Historical Geography* 32, no. 3 (2006): 605–26.
- Dolan, John R. "An Early Example of International Oceanography: The Last Voyage of the *Carnegie* (1928-1929). *Bulletin of Limnology and Oceanography* 30 no. 3 (2001): 92-96.
- Drooger, C.W., ed. *Messinian Events in the Mediterranean*. Amsterdam, London: North-Holland Publishing Company, 1973.
- Edgar, Terence, William B.F. Ryan, and Kenneth J. Hsü. "Plans for Future Drilling in the Mediterranean and Black Sea". In: *Rapports et Procès-Verbaux des Réunions 22*, edited by CIESM, 23-25. CIESM: Monaco, 1973.
- Edgerton, David. "'The Linear Model' Did Not Exist: Reflections on the History and Historiography of Science and Research in Industry in the Twentieth Century." *The Science-Industry Nexus: History, Policy, Implications*, edited by Karl Grandin, Nina Wormbs, and Sven Widmalm, 31-57. Sagamore Beach: Science History Publications, 2004.
- . "Time, Money, and History." *Isis* 103, no. 2 (June 2012): 316–27.

- . *The Rise and Fall of the British Nation: A Twentieth-Century History*. London: Penguin Books, 2018.
- Edgerton, Harold E. “The ‘Boomer’ Sonar Source for Seismic Profiling.” *Journal of Geophysical Research* 69 no. 14 (July 15, 1964): 3033-3042.
- Edgerton, Harold E., and Olivier Leenhardt. “Expériences de Sondage Élastique du Fond de la Mer”. In: *Rapports et Procès-Verbaux des Réunions* 17, edited by CIESM, 975-984. Monaco: CIESM, 1963.
- Edmundson, Mark. “Tectonic Shocks in the Oil Industry.” *AAPG EXPLORER*, January 11, 2016.
- El Periódico Redacción. “Greenpeace y Alianza Mar Brava denuncian la ilegalidad del proyecto de prospecciones MEDSALT-2 en Baleares.” *El Periódico*, May 15, 2018.
- Elden, Stuart. “Land, Terrain, Territory.” *Progress in Human Geography* 34, no. 6 (December, 2010): 799-817.
- . “Secure the Volume: Vertical Geopolitics and the Depth of Power.” *Political Geography* 34 (May, 2013): 35–51.
- Esestime, Paolo, Ashleigh Hewitt, and Neil Hodgson. “Zohr – A Newborn Carbonate Play in the Levantine Basin, East-Mediterranean.” *First Break* 34, no. 2 (February 1, 2016).
- Ewing, Maurice, and John Antoine. “New Seismic Data Concerning Sediments and Diapiric Structures in Sigsbee Deep and Upper Continental Slope, Gulf of Mexico,” *AAPG Bulletin* 50, no. 3 (March, 1966): 479-504.
- Ewing, Maurice, and Frank Press. “Geophysical Contrasts between Continents and Ocean Basins.” *Geological Society of America Special Papers* 62 (January 1, 1955).
- Ewing, Maurice, J. Lamar Worzel, and Creighton A. Burk, “Introduction to Leg 1.” In: *Initial Reports of the Deep Sea Drilling Project* 1, edited by Maurice Ewing and J. Lamar Worzel, 3-9. Washington: U.S. Government Printing Office, 1969.
- Fabien Locher, chapter "Lutter contre l'Empire du Pétrole." In : *Une Histoire Environnementale de la Mer en France et dans l'Empire Français au XXe Siècle*, Mémoire d'Habilitation à Diriger les Recherches en Histoire, Science-Po Paris, 2022 (unpublished).
- Fahlquist, Davis Armstrong. *Seismic Refraction Measurements in the Western Mediterranean Sea*. PhD diss., Massachusetts Institute of Technology, 1963.
- Fail, Jean Pierre, Lucien Montadert, Jean Raymond Delteil, Pierre Valéry, Philippe Patriat, and Roland Schlich. “Prolongation des Zones de Fractures de l’Océan Atlantique dans le Golfe de Guinée.” *Earth and Planetary Science Letters*, 7 (1970): 413-419.
- Finley, Carmel. *All the Boats on the Ocean*. Chicago, London: University of Chicago Press, 2017.
- Fischer, Alfred G., ed. “Epilogue.” In *Petroleum and Global Tectonics*, 321–23. Princeton: Princeton University Press, 1975.
- Forman, Paul. “Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940-1960.” *Historical Studies in the Physical and Biological Sciences* 18, no. 1 (1987): 149–229.
- Frankel, Henry R. *The Continental Drift Controversy*. Cambridge: Cambridge University Press, 2012.

- Friedman, Alan G., and Cynthia A. Williams. "The Group of 77 at the United Nations: An Emergent Force in the Law of the Sea." *San Diego Law Review* 16 (1979): 555-574.
- Fuller, Steve. "Internalism Versus Externalism." In *Reader's Guide to the History of Science*, edited by Arne Hessenbruch, 380. London, Chicago: Fitzroy Dearbon Publisher, 2000.
- Galison, Peter. "Removing Knowledge." *Critical Inquiry* 31, no. 1 (September 2004): 229-43.
- . "Trading Zone: Coordinating Action and Belief (1998 Abridgment)." In: *The Science Studies Reader*, edited by Mario Biagioli, 137-60. Routledge, 1999.
- Gamito-Marques, Daniel. "Science for Competition among Powers: Geographical Knowledge, Colonial-Diplomatic Networks, and the Scramble for Africa." *Berichte Zur Wissenschaftsgeschichte* 43, no. 4 (2020): 473-92.
- Garcia-Castellanos, Daniel, and Ricarda Vidal. "Alternative Mediterraneans Six Million Years Ago: A Model for the Future?" In: *Alternative Worlds*, edited by Ricarda Vidal and Ingo Cornils, 53-71. London: Peter Lang, 2015.
- Gärdebo, Johan. *Environing Technology: Swedish Satellite Remote Sensing in the Making of Environment 1969-2001*. PhD diss., Royal Institute of Technology, 2019.
- Gaskell, Thomas F., and John C. Swallow. "Seismic Refraction Experiments in the Indian Ocean and in the Mediterranean Sea." *Nature* 172 (September 19, 1953): 535-37.
- Gaston-Breton, Tristan. *Total, un Esprit Pionnier*. Pollina (France): Éditions Textuel, 2019.
- Gaudant, Jean. "Principaux Résultats de l'Enquête sur la Dérive des Continents." *Travaux du Comité Français d'Histoire de la Géologie (COFRHIGÉO)*, no. 3 (1989): 21-36.
- Gavouneli, Maria. "From Uniformity to Fragmentation: The Ability of the UN Convention on the Law of the Sea to Accommodate New Uses and Challenges". In: *Unresolved Issues and New Challenges to the Law of the Sea*, edited by Anastasia Strati, Maria Gavouneli, and Nikos Skourtos, 205-234. Leiden: Martinus Nijhoff Publishers, 2006.
- Gayon, Jean. "On the Uses of the Category of Style in the History of Science." *Philosophy & Rhetoric* 32, no. 3 (1999): 233-246.
- Genesseeux, Maurice and Jacques Bourcart. "Écoulements Profonds de Sables et de Galets dans la Grand Vallée Sous-Marine de Nice." *Comptes Rendus Académie des Sciences de Paris*, 250 (June 8, 1960): 3761-3765.
- Genesseeux, Maurice, and Jean Mascle. "La Naissance et le Développement de la Géologie Marine à Villefranche-Sur-Mer: Des Années 1950 au Milieu des Années 1980." *Travaux du Comité Français d'Histoire de la Géologie (COFRHIGÉO)* 26, s. 3, no. 10 (2012).
- Glangeaud, Louis, Christian Agarate, Gilbert Bellaiche, and Guy Pautot. "Morphotectonique de la Terminaison Sous-Marine Orientale des Maures et de l'Esterel." *Comptes Rendus Académie des Sciences de Paris* 261 no. 22 (1965): 4795-4799.
- Glangeaud, Louis. "Application des Méthodes Géophysiques à la Tectonique Profonde du NO de la Méditerranée (Mer Hespérienne)-" *Bulletin Société Géologique de France* 7, s.7-IV (1962): 884-887.
- . "Les Grands Ensembles Structuraux de la Méditerranée Occidentale d'Après les Données de Géomède 1". *Comptes Rendus Académie des Sciences de Paris* 262, serie D (1966): 2405-2408.

- Gorove, Stephen. "The Concept of 'Common Heritage of Mankind': A Political Moral or Legal Innovation." *San Diego Law Review* 9, no. 3 (May 1, 1972): 390.
- Gougenheim, André. "Funérailles de Jacques Bourcart." *Académie des Sciences. Notices et Discours* 5 (June 28, 1965): 246–51.
- . "Les Canyons Sous-Marins de la Côte Sud de France." *Comité Central d'Océanographie et d'Étude des Côtes. Bulletin d'Information* 2, no. 3 (March 1950): 93-95.
- Graham, Stephen. "Vertical Geopolitics: Baghdad and After." *Antipode* 36, no. 1 (2004): 12–23.
- Groupe Scientifique du COB. *Résultats de la Campagne Noratlante du N.O. Jean Charcot (3 Août – 2 Novembre 1969)*. Série: Résultats des Campagnes à la Mer, no. 1. Paris: Publications du Centre National pour l'Exploitation des Océans (CNEXO), 1971.
- Guillou, Hervé. "Éloge de l'Ingénieur Général de l'Armement Pierre Willm (1926-2018)". Académie de la Marine, Session March 13, 2010.
- Gusterson, Hugh. "Secrecy, Authorship, and Nuclear Weapons Scientists." In: *Secrecy and Knowledge Production*, by Judith Reppy. Ithaca, NY: Cornell University Occasional Papers, 1999.
- Hamblin, Jacob Darwin. *Oceanographers and the Cold War Disciples of Marine Science*. Seattle: University of Washington Press, 2005.
- Hannigan, John A. *The Geopolitics of Deep Oceans*. Cambridge, UK; Malden, MA: Polity, 2015.
- Hardenberg, Wilko Graf von, and Martin Mahony. "Introduction. Up, Down, Round and Round: Verticalities in the History of Science." *Centaurus* 62, no. 4 (2020): 595–611.
- Hardin, Garrett. "The Tragedy of the Commons." *Science* 162, no. 3859 (1968): 1243–48.
- Hardy, Noah. "Exploring the Shelf." *Science*, April 12, 1969.
- Harvie, Christopher. *Fool's Gold: The Story of North Sea Oil*. London: Penguin, 1995.
- Hecht, Gabrielle. *The Radiance of France: Nuclear Power and National Identity After World War II*. Cambridge, Mass: MIT Press, 1998.
- Heezen, Bruce C., Marie Tharp, and Maurice Ewing. "The Floors of the Oceans; 1. The North Atlantic." *The Geological Society of America Special Paper*, 1959.
- Helvy, Bruce. "Reflections on Big Science and Big History." In: *Big Science. The Growth of Large Scale Research*, edited by Peter Galison and Bruce Helvy, 355-363. Stanford: Stanford University Press, 1992.
- Henley, Jon. "France Has Underestimated Impact of Nuclear Tests in French Polynesia, Research Finds". *The Guardian*, March 9, 2021. Accessed February 25, 2022. www.theguardian.com/world/2021/mar/09/france-has-underestimated-impact-of-nuclear-tests-in-french-polynesia-research-finds
- Henriet, Jean-Pierre. "The Polymetallic Nodules." April 19, 2016. Accessed February 25, 2022. https://wwz.ifremer.fr/gm_eng/Understanding/Public-Authority-support/Deep-Sea-Mineral-Resources/Polymetallic-nodules/Preface
- Herran, Néstor. "John Krige (editor). How Knowledge Moves: Writing the Transnational History of Science and Technology." *Isis* 111, no. 2 (2020): 430-433.

- Hersey, John Brackett. "Continuous Reflection Profiling." In: *The Sea. Ideas and Observations on Progress in the Study of the Seas* vol. 3, edited by Maurice Neville Hill. New York, London, Sydney: John Wiley & Sons, 1963.
- . "Sedimentary Basins of the Mediterranean Sea." *Woods Hole Oceanographic Institution Contributions* 1628 (1965): 75–91.
- Hoddeson, Lillian. "The Conflict of Memories and Documents. Dilemmas and Pragmatics of Oral History." In: *The Historiography of Contemporary Science, Technology, and Medicine: Writing Recent Science*, by Ronald E. Doel, and Thomas Söderqvist, 187–200. London, New York: Routledge, 2006.
- Hoffert, Michel. *Les Nodules Polymétalliques Dans Les Grands Fonds Océaniques: Une Extraordinaire Aventure Minière et Scientifique Sous-Marine*. Paris: Société Géologique de France Vuibert, 2008.
- Höhler, Sabine. "Depth Records and Ocean Volumes: Ocean Profiling by Sounding Technology, 1850-1930." *History and Technology* 18, no. 2 (2002): 119–54.
- Hollick, Ann L., and Robert E. Osgood. *New Era of Ocean Politics*. Baltimore, London: Johns Hopkins University Press, 1975.
- Hollick, Ann L. *U.S. Foreign Policy and the Law of the Sea*. Princeton: Princeton University Press, 1981.
- Hounshell, David A. "Epilogue: Rethinking the Cold War; Rethinking Science and Technology in the Cold War; Rethinking the Social Study of Science and Technology." *Social Studies of Science* 31, no. 2 (2001): 289–97
- Hsü, Kenneth J. "When the Mediterranean Dried Up." *Scientific American*, 227/6 (1972): 26–36.
- . *The Mediterranean Was a Desert: A Voyage of the Glomar Challenger*. Princeton: Princeton University Press, 1987.
- Hsü, Kenneth J., and William B.F. Ryan, "Report on Deep Sea Drilling Project in the Mediterranean." In: *Rapports et Procès-Verbaux des Réunions* 22, edited by CIESM, 19-20. CIESM: Monaco, 1973.
- Hsü, Kenneth J., Lucien Montadert, Daniel Bernoulli, Maria Bianca Cita, Albert Erickson, Robert E. Garrison, Robert B. Kidd, Frederic Mélières, Carla Müller, and Ramil Wright. "History of the Mediterranean Salinity Crisis." In: *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al., 1053-1078. Washington: US Government Printing Office, 1978.
- Hsü, Kenneth J., Lucien Montadert, et al. *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1. Washington D.C.: Government Printing Office, 1978.
- Hsü, Kenneth J., William B.F. Ryan, and Maria Bianca Cita. "Late Miocene Desiccation of the Mediterranean." *Nature* 242 (March 23, 1973): 240-244.
- Huebner, Stefan. "Earth's Amphibious Transformation: Tange Kenzo, Buckminster Fuller, and Marine Urbanization in Global Environmental Thought (1950s–Present)." *Modern Asian Studies* (2021): 1–30.
- Hughes, Jeff. *The Manhattan Project: Big Science and the Atom Bomb*. Revolutions in Science. New York: Columbia University Press, 2002. Institut Français du Pétrole. *Rapport Annuel de l'Institut Français du Pétrole*, 1968. Rueil-Malmaison: IFP, 1969.

- IFREMER. *Inventaire des Ressources en Matériaux Marins sur les Façades « Manche-Est » et « Loire-Gironde »*. Convention IFREMER-Ministère de l'Industrie no. 2006-0058-00-07, 2006.
- Institut Français du Pétrole. *Rapport Annuel de l'Institut Français du Pétrole 1963*. Rueil-Malmaison: IFP, 1964.
- . *Rapport Annuel de l'Institut Français du Pétrole 1964*. Rueil-Malmaison: IFP, 1965.
- . *Rapport Annuel de l'Institut Français du Pétrole 1965*. Rueil-Malmaison: IFP, 1966.
- . *Rapport Annuel de l'Institut Français du Pétrole 1967*. Rueil-Malmaison: IFP, 1968.
- . *Rapport Annuel de l'Institut Français du Pétrole 1968*. Rueil-Malmaison: IFP, 1969.
- . *Rapport Annuel de l'Institut Français du Pétrole 1969*. Rueil-Malmaison: IFP, 1970.
- . *Rapport Annuel de l'Institut Français du Pétrole 1970*. Rueil-Malmaison: IFP, 1971.
- . *Rapport Annuel de l'Institut Français du Pétrole 1972*. Rueil-Malmaison: IFP, 1973.
- International Law Commission, *Convention on the Continental Shelf*. United Nations, Treaty Series, vol. 499 (April 29, 1958).
- Jacq, François. “Aux Sources de la Politique de la Science: Mythe ou Réalités? (1945–1970).” *La Revue pour l'Histoire du CNRS* 6 (2002).
- . “The Emergence of French Research Policy: Methodological and Historiographical Problems (1945–1970).” *History and Technology: An International Journal* 12, no. 4 (1995): 285-308.
- Jarry, Jean. *L'Aventure des Bathyscaphes: Marins, Ingénieurs et Savants au Plus Profond des Mers*. Paris: Gerfaut, 2003.
- Jasanoff, Sheila, and Sang-Hyun Kim. “Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea.” *Minerva* 47, no. 2 (June 2009): 119–46.
- Kaji O'Grady, Sandra, and Peter Raisbeck. “Prototype Cities in the Sea.” *The Journal of Architecture* 10, no. 4 (September 2005): 443–61.
- Kaldewey, David, and Désirée Schauz, eds. “Why Do Concepts Matter in Science Policy?.” In: *Basic and Applied Research: The Language of Science Policy in the Twentieth Century*, edited by David Kaldewey, and Désirée Schauz, 1-32. Berghahn Books: 2018.
- Kapper, Francis B. “The Role of Government in the Production and Control of Scientific and Technical Knowledge.” In *Secrecy and Knowledge Production*, by Judith Reppy. Ithaca, NY: Cornell University Occasional Papers, 1999.
- Kemp, Alexander G. *The Official History of North Sea Oil and Gas*. London, New York: Routledge, Taylor & Francis, 2012.
- Kevles Daniel J. “Big Science and Big Politics in the United States: Reflections on the Death of the SSC and the Life of the Human Genome Project.” *Historical Studies in the Physical and Biological Sciences* 27, no. 2 (January 1997): 269–297.
- Knorr-Cetina, Karin. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, Mass.: Harvard University Press, 2003.

- Knott, S.T., and John B. Hersey. “Interpretation of High-Resolution Echo-Sounding Techniques and Their Use in Bathymetry, Marine Geophysics, and Biology.” *Deep Sea Research* 4, (1957): 36-44.
- Knox, Hannah, Mike Savage, and Penny Harvey. “Social Networks and the Study of Relations: Networks as Method, Metaphor and Form.” *Economy and Society* 35, no. 1 (February 2006): 113–40.
- Korsmo, Fae L. “The Genesis of the International Geophysical Year.” *Physics Today* 60, 7 (38) (2007): 38-43.
- Kreidler, Tai Deckner. *The Offshore Petroleum Industry: The Formative Years, 1945-1962*. PhD diss., Texas Tech University, 1997.
- Krige, John, and Kai-Henrik Barth. “Introduction: Science, Technology, and International Affairs.” *Osiris* 21, no. 1 (January 2006): 1–21.
- Krige, John, ed. *How Knowledge Moves. Writing the Transnational History of Science and Technology*. Chicago, London: University of Chicago Press, 2019.
- Krige, John. “Building the Arsenal of Knowledge.” *Centaurus* 52, no. 4 (2010): 280–96.
- . *American Hegemony and the Postwar Reconstruction of Science in Europe*. Cambridge, Mass.: MIT Press, 2008.
- Krijgsman, Wout, Frits J. Hilgen, Isabella Raffi, Francisco J. Sierro, and D. S. Wilson. “Chronology, Causes and Progression of the Messinian Salinity Crisis.” *Nature* 400, no. 6745 (August 1999): 652–55.
- Krijgsman, Wout, Walter Capella, Dirk Simon, Frits J. Hilgen, Tanja J. Kouwenhoven, Paul Th. Meijer, Francisco J. Sierro, et al. “The Gibraltar Corridor: Watergate of the Messinian Salinity Crisis.” *Marine Geology* 403 (September 2018): 238–46.
- Kuchinskaya, Olga. *The Politics of Invisibility: Public Knowledge about Radiation Health Effects After Chernobyl*. Cambridge, Mass.: MIT Press, 2014.
- Kullenberg, Börje. “The Piston Core Sampler.” Svenska Hydrografisk-Biologiska Kommissionens Skrifter 1, s. 3. Gotteborg, 1947.
- Kullenberg, Gunnar. *Ocean Science and International Cooperation. Historical and Personal Recollections*. Paris: UNESCO, 2021.
- La Prairie, Yves. “Ce Siècle Avait de Gaulle...”. *Un Homme de Mer Témoigne*. Rennes: Editions Ouest-France, 1990.
- La Vanguardia Redacción. “Representante de MEDSALT-2: “No buscamos petróleo, investigamos la mayor crisis medioambiental desde los dinosaurios”.” *La Vanguardia*, May 2, 2018.
- Lacombe, Henri. “L’Océanographie: Travail d’Équipe. Leçon Inaugurale du Cours d’Océanographie Physique Prononcée le 7 Novembre 1955.” *Bulletin du Muséum National d’Histoire Naturelle* (2e série) 28, no. 1 (1956): 69–83.
- Lacour, Jean-Jacques. *Terre d’Innovations 1944-2000: Histoire de l’IFP des Origines... À Nos Jours*. RUEIL-MALMAISON: Institut Français du Pétrole, 2001.
- Latour, Bruno, and Steve Woolgar. *Laboratory Life: The Construction of Scientific Facts*. Princeton, New Jersey: Princeton University Press, 1986.

- Laubier, Lucien. “L’Émergence de l’Océanographie au Cnrs: les Conditions de la Pluridisciplinarité.” *La Revue pour l’Histoire du CNRS*, no. 6 (May 5, 2002).
- Lawrence, David M. *Upheaval from the Abyss: Ocean Floor Mapping and the Earth Science Revolution*. New Brunswick: Rutgers University Press, 2002.
- Le Pichon, Xavier, Jean Bonin, Jean Francheteau, and Claude Sibuet. “Une Hypothèse d’Évolution Tectonique du Golfe de Gascogne.” In: *Histoire Structurale du Golfe de Gascogne*, edited by Jacques Debyser, Xavier le Pichon, and Lucien Montadert, VI.11-1 – VI.11-22. Paris: Ed. Technip, 1971.
- Le Pichon, Xavier, Roy D. Hyndman, and Guy Pautot. “Geophysical Study of the Opening of the Labrador Sea.” *Journal of Geophysical Research* 76 (July 1, 1971): 4724–43.
- Le Pichon, Xavier. “Fifty Years of Plate Tectonics: Afterthoughts of a Witness.” *Tectonics* 38, no. 8 (August 2019): 2919–33.
- . “Mission NESTLANTE I. 6-23 Janvier 1970 - Rapport du Chef du Mission” (1970). *Archimer, Archive Institutionnelle de l’Ifremer*.
- . “Sea-Floor Spreading and Continental Drift.” *Journal of Geophysical Research* 73, no. 12 (June 15, 1968): 3661–97.
- Le Suavé, Raymond, Guy Pautot, Michel Hoffert, Serge Monti, Yann Morel, and Claude Pichocki. “Cadre Géologique de Concrétions Polymétalliques Cobaltifères Sous-Marines dans l’Archipel des Tuamotu (Polynésie Française)”. *Comptes Rendus Académie des Sciences de Paris* 11, t.303 s.II (1986): 1013-1018.
- Leenhardt, Olivier. “Un Sondage Sismique Continu sur le Plateau Continental Près du Planier (Marseille).” *Académie des Sciences de Paris* 257, no. 18 (August 19, 1963): 1541-1544.
- Lelong, Pierre. “Le Général de Gaulle et la Recherche en France.” *La Revue pour l’Histoire du CNRS* 1 (1999). Accessed in April 30, 2019. <http://journals.openedition.org/histoire-cnrs/481>
- Lipkin, Mikhail. “Charles de Gaulle’s Visit to the Soviet Union and Moscow’s International Policy Strategy between 1966 and 1969.” *QUAESTIO ROSSICA*, no. 4 (2016): 261–74.
- Locher, Fabien. “Les Pâturages de la Guerre Froide: Garrett Hardin et la «Tragédie des Communs».” *Revue d’Histoire Moderne Contemporaine* 601, no. 1 (August 19, 2013): 7–36.
- Lore, G.L. “An Exploration and Discovery Model: A Historic Perspective – Gulf of Mexico Outer Continental Shelf.” Bureau of Ocean Energy Management.
- Malod, Jacques-André, and Jean Mascle. “Structures Géologiques de la Marge Continentale à l’Ouest du Spitzberg”, *Marine Geophysical Researches* 2 (1974): 215-229.
- Martin, Garret Joseph. *General de Gaulle’s Cold War: Challenging American Hegemony, 1963–68*. New York: Berghahn Books, 2013.
- Martínez-Rius, Beatriz. “For the Benefit of All Men: Oceanography and Franco-American Scientific Diplomacy in the Cold War, 1958–1970.” *Berichte Zur Wissenschaftsgeschichte* 43, no. 4 (November, 2020): 581-605.
- Mauffret, Alain, Lucien Montadert, and Pierre Willm. “Geological and Geophysical Setting of Site 372”. In: *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al., 889-897. Washington: US Government Printing Office, 1978.

- McNeil, Maureen, Michael Arribas-Ayllon, Joan Haran, Adrian Mackenzie, and Richard Tutton. "Conceptualizing Imaginaries of Science, Technology, and Society." In: *The Handbook of Science and Technology Studies*, edited by Ulrike Felt, Fourth edition., 435–63. Cambridge, Massachusetts: The MIT Press, 2017.
- Médioni, René. "L'Oeuvre des Géologues Français au Maroc." *Travaux du Comité Français d'Histoire de la Géologie* 3, 25, no. 1 (2011).
- Mélières, Frederic, Hervé Chameley, Francis Coumes, and Pierre Rouge. "X-Ray Mineralogy Studies". In: *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al., 361-383. Washington: US Government Printing Office, 1978.
- Menard, William H., Stuart M. Smith, and Richard M. Pratt. "The Rhone Deep-Sea Fan." In *Submarine Geology and Geophysics*, edited by Whittard and Bradshaw, 271–285 (Colston Papers, 17), 1965.
- Mero, John. *The Mineral Resources of the Sea*. Amsterdam, London, NY: Elsevier Publishing Company, 1965.
- Merrell, William J., Mary Hope Katsouros, and Jacqueline Bienski. "The Stratton Commission: The Model for a Sea Change in National Marine Policy." *Oceanography* 14, no. 2 (2/2001): 11-16.
- Miles, Edward L. "The Structure and Effects of the Decision Process in the Seabed Committee." *International Organization* 31 no. 2 (Spring 1977): 159-234.
- . "Technology, Ocean Management, and the Law of the Sea." *Denver Law Journal*, 46 (1969): 240-260.
- . *Global Ocean Politics: The Decision Process at the Third United Nations Conference on the Law of the Sea 1973 - 1982*. The Hague: Nijhoff, 1998.
- Montadert, Lucien, and Bernard Biju-Duval. *Structural History of the Mediterranean Basins*. Paris: Éditions Technip, 1976.
- Montadert, Lucien, Jean Letouzey, and Alain Mauffret. "Messinian Event: Seismic Evidence." In: *Initial Reports of the Deep Sea Drilling Project* 42 pt. 1, edited by Kenneth J. Hsü, Lucien Montadert et al., 1037-1050. Washington: US Government Printing Office, 1978.
- Montadert, Lucien, Jean Sancho, Jean-Pierre Fail, and Jacques Debysser. "De l'Âge Tertiaire de la Série Salifère Responsable des Structures Diapiriques en Méditerranée Occidentale (Nord-Est des Baléares)." *Comptes Rendus de l'Académie des Sciences* 271 (1970): 812–815.
- Montadert, Lucien, Renée Delmotte, Jean-Pierre Delteil, Pierre Valéry, and Étienne Winnock. "Structure Géologique de la Marge Continentale Septentrionale du Golfe de Gascogne (Bretagne et Entrées de la Manche)." In: *Histoire Structurale du Golfe de Gascogne*, edited by Jacques Debyser, Xavier le Pichon, and Lucien Montadert, III-2-1 – III-2-22. Paris: Ed. Technip, 1971.
- Morvan, R.G., ed. *Les Océans*. Morvan Humanisme, Série Les Grands Enquêtes no. 24-25 (1971).
- Mounecef, Radouan Andrea. *Chercheurs d'Or Noir: les pétroliers français entre le Sahara et le monde (1924-2003)*. PhD diss., Sorbonne Université, 2021.

- Mukerji, Chandra. *A Fragile Power: Scientists and the State*. Princeton: Princeton University Press, 1989.
- Muraour, Pierre, and Maurice Genesseeux. “Quelques Remarques à la Suite d’une Étude Par Séismique Réfraction sur la Pente Continentale Niçoise.” *Comptes Rendus Académie des Sciences de Paris* 240 no. 4 (1965): 227-229.
- Muraour, Pierre, Jacques Merle, and Jean Ducrot. “Observations sur le Plateau Continental à la Suite d’une Étude Séismique par Réfraction dans le Golfe du Lion.” *Académie des Sciences de Paris* 254, no. 15 (April 9, 1962): 2801-2803.
- Muraour, Pierre, Olivier Leenhardt, and Jacques Merle. “Eléments pour un Programme de Recherches Séismiques en Méditerranée.” In: *Océanographie Géologique et Géophysique de la Méditerranée Occidentale. Villefranche Sur Mer, 4 au 8 Avril 1961*, edited by Colloques Nationaux du CNRS, 103-110. Paris: Éditions du Centre National de la Recherche Scientifique, 1962.
- Muraour, Pierre. “Études de Séismicité Artificielle Sous-Marine (Méthode de Réflexion) dans la Baie d’Alger.” *Bulletin de la Société Géologique de France*, s. 6-IV (1956): 669-678.
- National Academies of Sciences, Engineering, and Medicine. “History of the Offshore Oil and Gas Industry and the Development of Safety Efforts.” In: *Strengthening the Safety Culture of the Offshore Oil and Gas Industry*. Washington D.C.: The National Academies Press, 2016.
- Nesteroff, Wladimir, Germain Sabatier, and Bruce C. Heezen. “Les Minéraux Argileux dans les Sédiments du Bassin Occidental de la Méditerranée.” In: *Rapports et Procès-Verbaux des Réunions 17*, edited by CIESM, 1005-1008. Monaco: CIESM, 1963.
- Nesteroff, Wladimir, Jacques Cousteau, and Haroun Tazieff. “Coupes Transversales de la Mer Rouge.” In: *Topographie Sous-Marine et Sédimentation Actuelle*, Comptes Rendus 19ème Session. Alger, 1952.
- Nesteroff, Wladimir. “La Crise de Salinité Méssinienne en Méditerranée: Enseignements des Forages JOIDES et du Bassin de Sicile.” In: *Rapports et Procès-Verbaux des Réunions 22*, edited by CIESM, 29-31. Monaco, 1973: 29-31.
- . “Quelques Résultats Sédimentologiques des Premiers Forages du Précontinent Américain (JOIDES).” *Bulletin Société Géologique de France* 7, VIII (1966): 773-385.
- . “Recherches sur les Sédiments Marins Actuels de la Région d’Antibes.” Thèse de 3ème Cycle, Université de Paris, 1958.
- Nixon, Richard. “Statement about United States Oceans Policy.” May 23, 1970. Online by Gerhard Peters and John T. Woollet, The American Presidency Project. Accessed in November 24, 2021. <https://www.presidency.ucsb.edu/node/239769>
- Noble Shor, Elizabeth. *Scripps Institution of Oceanography: Probing the Oceans, 1936 to 1976*. San Diego: Tofua Press, 1978.
- Nouschi, André. *La France et le Pétrole: De 1924 à Nos Jours*. Picard, 2001.
- . *Pétrole et Relations Internationales Depuis 1945*. Paris: Armand Collin, 1999.
- Nouvella, René. “Discourse d’Aperture du 1ère Congrès ‘Le Pétrole et la Mer’.” *Journal de Monaco* 5619, (June 4, 1965): 426.
- Nyaberg, Roberto. “A Few Strategic Considerations Concerning French Imports of Oil Products between 1946 and 2005.” In: *Oil Producing Countries and Oil Companies*,

- edited by Alain Beltran. Brussels, Bern, Berlin, Frankfurt, New York, Oxford: Peter Lang, 2011.
- Nye, Joseph S. *Soft Power: The Means to Success in World Politics*. New York: Public Affairs, 2009.
- O'Hara, Kieran. *A Brief History of Geology*. Cambridge: Cambridge University Press, 2018.
- Olivet, Jean-Louis, Bertrand Sichler, Pierre Thonon, Xavier Le Pichon, Guy Martinais, and Guy Pautot. "La Faille Transformante Gibbs entre le Rift et la Marge du Labrador." *Comptes Rendus Académie des Sciences de Paris* 271 (September 1, 1970): 949–52.
- Oreskes, Naomi, and Erik M. Conway. *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming*. New York: Bloomsbury Press, 2012.
- Oreskes, Naomi, and H. E. LeGrand, eds. *Plate Tectonics: An Insider's History of the Modern Theory of the Earth*. Boulder, Colo: Westview Press, 2003.
- Oreskes, Naomi, and James R. Fleming. "Why Geophysics?." *Studies in History and Philosophy of Modern Physics*, 31, 3 (2000): 253-257.
- Oreskes, Naomi, and Ronald E. Doel. "The Physics and Chemistry of the Earth." In: *The Cambridge History of Science*, vol. 5. edited by Mary Jo Nye, 538-360. Cambridge: Cambridge University Press, 2008.
- Oreskes, Naomi, and Ronald Rainger. "Science and Security before the Atomic Bomb: The Loyalty Case of Harald U. Sverdrup." *Studies in History and Philosophy of Science* 31, no. 3 (September 2000): 309–69.
- Oreskes, Naomi. "The Iron Curtain of Classification: What Difference Did It Make?" In *Science on a Mission: How Military Funding Shaped What We Do and Don't Know about the Ocean*, 194-255. Chicago: University of Chicago Press, 2021.
- . "A Context of Motivation: US Navy Oceanographic Research and the Discovery of Sea-Floor Hydrothermal Vents." *Social Studies of Science* 33, no. 5 (October 2003): 697–742.
- . "Stymied by Secrecy: Harry Hess and Seafloor Spreading." In *Science on a Mission: How Military Funding Shaped What We Do and Don't Know about the Ocean*, 138–193. Chicago: University of Chicago Press, 2021.
- . "Weighing the Earth from a Submarine: The S-21 Expedition." In: *The Earth, the Heavens, and the Carnegie Institution of Washington: Historical Perspectives after Ninety Years*, edited by Gregory Good, 53-67. Washington, DC: American Geophysical Union, 1994.
- . *Science on a Mission: How Military Funding Shaped What We Do and Don't Know about the Ocean*. Chicago: University of Chicago Press, 2021.
- . *The Rejection of Continental Drift: Theory and Method in American Earth Science*. New York: Oxford University Press, 1999.
- Pautot, Guy, Jean-Marie Auzende, and Xavier le Pichon. "Continuous Deep Sea Salt Layer along North Atlantic Margins Related to Early Phase of Rifting." *Nature* 227, no. 5256 (July 1970): 351–54.

- Pautot, Guy, ed. *Résultats de la Campagne de Flexo-Électro-Carottage en Méditerranée Nord-Occidentale*. Publications du Centre National pour l'Exploitation des Océans, January 1972.
- . “La Dorsale Medio-Atlantique et le Renouveau des Fonds Océaniques.” *Revue de Géographie Physique et de Géologie Dynamique* 2, vol. 6 (1970, 5): 379-402.
- Pautot, Guy. *Étude Géodynamique de la Marge Continentale au Large de l'Estérel*. PhD diss., Faculté des Sciences de Paris, 1959.
- Perks, Robert, and Alistair Thomson, eds. *The Oral History Reader*. Third edition. London, New York: Routledge, 2016.
- Pestre, Dominique. “Concluding Remarks Debates in Transnational and Science Studies: A Defence and Illustration of the Virtues of Intellectual Tolerance.” *The British Journal for the History of Science* 45, no. 3 (2012): 425–42.
- Pettersson, Hans. *Westward Ho with the Albatross*, New York: E.P. Dutton, 1953.
- Philippe, Sébastien, and Tomas Stadius, *Toxique. Enquête sur les Essais Nucléaires Français en Polynésie*. Paris: Presses Universitaires de France / Humensis, 2021.
- Picard, Jean-François. “La Création du CNRS.” *La Revue pour l'Histoire du CNRS* 1 (1999).
- Pickering, Andrew, ed. *Science as Practice and Culture*. Chicago London: University of Chicago Press, 1994.
- Piketty, Gérard. “Allocution de Gérard Piketty, Président du CEP&M, à la Journée CEP&M-COPREP du 10 Octobre 2000, Marquant par Ailleurs le 50ème Anniversaire du FSH.” *Journées du Pétrole*, Palais des Congrès. Paris, 2000.
- Polejack, Andrei. “The Importance of Ocean Science Diplomacy for Ocean Affairs, Global Sustainability, and the UN Decade of Ocean Science.” *Frontiers in Marine Science* 8 (March 19, 2021): 1-16.
- Pratt, Joseph A., Tyler Priest, and Christopher James Castaneda. *Offshore Pioneers: Brown & Root and the History of Offshore Oil and Gas*. Houston, Texas: Gulf Pub. Co, 1997.
- Priest, Tyler. *The Offshore Imperative: Shell Oil's Search for Petroleum in Postwar America*. College Station: Texas A&M University Press, 2010.
- Proctor, Robert N., and Londa Schiebinger, eds. *Agnology: The Making and Unmaking of Ignorance*. Stanford, Calif: Stanford Univ. Press, 2008.
- Prodehl, Claus, and Walter D. Mooney. *Exploring the Earth's Crust: History and Results of Controlled-Source Seismology*. Boulder: Geological Society of America, 2012.
- Rainger, Ronald. “Patronage and Science: Roger Revelle, the U.S. Navy, and Oceanography at the Scripps Institution.” *Earth Sciences History* 19, no. 1 (January 2000): 58–89.
- Ranganathan, Surabhi. “Decolonization and International Law: Putting the Ocean on the Map.” *Journal of the History of International Law / Revue d'Histoire du Droit International* 23, no. 1 (December 10, 2020): 161–83.
- Ranganathan, Surabhi. “Ocean Floor Grab: International Law and the Making of an Extractive Imaginary.” *European Journal of International Law* 30, no. 2 (July 22, 2019): 573–600.
- Rebeyrol, Yvonne. “La Campagne de Recherches Géomède 1 Va Ausculter le Sous-Sol de la Méditerranée Occidentale.” *Le Monde*, March 24, 1966.

- . “Au colloque de l’ASTEO le réalisme remplace l’ « illusion lyrique » dans les discours officiels sur l’océanologie.” *Le Monde*, January 25, 1982.
- . “L’Opération Noratlante.” *Le Monde*, August 5, 1969.
- . “Le CNEXO: Vers un Renouveau de l’Océanographie Française.” *Le Monde*, November 30, 1966.
- . “Le Flexotir Ou Comment Chercher du Pétrole en Mer sans Tuer les Poissons.” *Le Monde*, October 17, 1966.
- . “Le Fond de la Méditerranée Est Tapissé d’une Épaisse Couche de Sel.” *Le Monde*, October 12, 1970.
- . “Pour la Première Fois du Pétrole est Découvert en Mer Profonde.” *Le Monde*, September 4, 1968.
- . “Un Essai de Coopération Recherche-Industrie: La Prochaine Campagne du ‘Jean-Charcot’.” *Le Monde*, April 17, 1968.
- Reidy, Michael S., and Helen M. Rozwadowski. “The Spaces in Between: Science, Ocean, Empire.” *Isis* 105, no. 2 (2014): 338–51.
- Rentetzi, Maria. “With Strings Attached: Gift-Giving to the International Atomic Energy Agency and US Foreign Policy.” *Endeavour* 45, no. 1 (March 1, 2021): 100754.
- Rey, Marie-Pierre. *La Tentation du Rapprochement: France et URSS à l’Heure de la Détente, 1964-1974*, Internationale. Paris: Éditions de la Sorbonne, 2020.
- . “Les Échanges Scientifiques et Techniques.” In: *La Tentation du Rapprochement: France et URSS à l’Heure de la Détente, 1964-1974*. Paris: Éditions de la Sorbonne, 2020.
- Reyn, Sebastian. *Atlantis Lost: The American Experience with de Gaulle, 1958–1969*. Amsterdam: Amsterdam University Press, 2010.
- Riffaud, Claude, and Xavier le Pichon. *Expédition FAMOUS. À 3000 Mètres sous l’Atlantique*. Paris: Albin Michel, 1976.
- Robelius, Fredrik. *Giant Oil Fields - The Highway to Oil. Giant Oil Fields and their Importance for Future Oil Production*. PhD diss., Faculty of Science and Technology of Uppsala University, 2007.
- Roberts, Peder. “Intelligence and Internationalism: The Cold War Career of Anton Bruun.” *Centaurus* 55, no. 3 (August 2013): 243–63.
- Robinson, Sam. “Early Twentieth-Century Ocean Science Diplomacy: Competition and Cooperation among North Sea Nations.” *Historical Studies in the Natural Sciences* 50, no. 4 (September 23, 2020): 384–410.
- . “Scientific Imaginaries and Science Diplomacy: The Case of Ocean Exploitation.” *Centaurus* 63, no. 1 (2021): 150–70.
- . *Between the Devil and the Deep Blue Sea*. PhD diss., University of Manchester, 2015.
- . *Ocean Science and the British Cold War State*. Cham, Switzerland: Palgrave Macmillan, 2018.
- Rocci, Georges. “L’Oeuvre des Géologues Français en AOF.” *Travaux du Comité Français d’Histoire de la Géologie (COFRHIGÉO)*, 26, no. 2 (March 14, 2012): 30.

- Rosaire, Eugene E., and Oliver C. Lester. "Seismological Discovery and Partial Detail of Vermilion Bay Salt Dome, Louisiana." *AAPG Bulletin* 16 (1932): 1221-1229.
- Ross, Donald. "Twenty Years of Research at the SAACLANT ASW Research Center, 1959-1979." San Bartolomeo: NATO (1 January, 1980).
- Rousseau, René. "Villefranche-Sur-Mer : Plan d'Action des Savants Qui Tentent d'Arracher à la Méditerranée les Secrets de sa Formation." *Le Figaro*, April 10, 1961.
- Roveri, Marco, Rachel Flecker, Wout Krijgsman, Johanna Lofi, Stefano Lugli, Vinicio Manzi, Francisco J. Sierro, Adele Bertini, Angelo Camerlenghi, Gert de Lange, Rob Govers, Frits J. Hilgen, Christian Hübscher, Paul Th. Meijer, and Marius Stoica. "The Messinian Salinity Crisis: Past and Future of a Great Challenge for Marine Sciences." *Marine Geology* 352 (June 2014): 25–58.
- Rozwadowski, Helen M. "Bringing Humanity Full Circle Back into the Sea." *Environmental Humanities* 14, no. 1 (March 1, 2022): 1–28.
- . "Engineering, Imagination, and Industry. Scripps Island and Dreams for Ocean Science in 1960." In: *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, edited by Helen M. Rozwadowski and David K. Van Keuren. Sagamore Beach, Mass: Science History Publications, 2004.
- . "Ocean's Depths." *Environmental History* 15, no. 3 (July 1, 2010): 520–25.
- . "Oceans: Fusing the History of Science and Technology with Environmental History." In: *A Companion to American Environmental History*, edited by Douglas Cazaux Sackman, 442–61. Oxford, UK: Wiley-Blackwell, 2010.
- . "The Promise of Ocean History for Environmental History." *Journal of American History* 100, no. 1 (June 1, 2013): 136–39.
- . *Vast Expanses: A History of the Oceans*. Reaktion Books, Limited, 2019.
- Ruffini, Pierre-Bruno. "The Intergovernmental Panel on Climate Change and the Science-Diplomacy Nexus." *Global Policy* 9 (November 2018): 73–77.
- . *Science and Diplomacy*. Cham: Springer International Publishing, 2017.
- Rungius, Charlotte, and Tim Flink. "Romancing Science for Global Solutions: On Narratives and Interpretative Schemas of Science Diplomacy." *Humanities and Social Sciences Communications* 7, no. 1 (December 2020): 102.
- Rusnak, Gene A. "Afoot and Afloat Along the Edge: Adventures of an Ingenious Beachcomber - A Tribute to Francis Parker Shepard (1897-1985)". In: *From Shore to Abyss: Contributions in Marine Geology in Honor of Francis Parker Shepard*, edited by Robert H. Osborne. Society for Sedimentary Geology, 1991.
- Ryan, William B.F. "Decoding the Mediterranean Salinity Crisis." *Sedimentology* 56, no. 1 (January 2009): 95–136.
- . *The Floor of the Mediterranean Sea*. PhD diss., Columbia University, 1969.
- Ryan, William B.F., Kenneth J. Hsü, and Maria B. Cita. "The Origin of the Mediterranean Evaporite." In: *Initial Reports of the Deep Sea Drilling Project* 13, edited by Kenneth J. Hsü, William B.F. Ryan, et al., 1203-1231. Washington D.C.: U.S. Government Printing Office, 1973.
- Ryan, William B.F., Kenneth J. Hsü, et al. *Initial Reports of the Deep Sea Drilling Project* 13. Vol. 13. Washington D.C.: U.S. Government Printing Office, 1973.

- Sabol Spezio, Teresa. *Slick Policy. Environment and Science Policy in the Aftermath of the Santa Barbara Oil Spill*. Pittsburgh: University of Pittsburgh Press, 2018.
- Salut, Samir. “Politique Nationale du Pétrole, Sociétés Nationales et «Pétrole Franc».” *Revue Historique* 2, n. 638 (2006) 355-388.
- Sapolsky, Harvey M. *Science and the Navy: The History of the Office of Naval Research*. Princeton: Princeton University Press, 2014.
- Scharf, Michael P. “The Truman Proclamation on the Continental Shelf.” In: *Customary International Law in Times of Fundamental Change: Recognizing Grotian Moments*, 107–22. Cambridge: Cambridge University Press, 2013.
- Schiavon, Martina. *Itinéraires de la Précision. Géodésiens, Artilleurs, Savants et Fabricants d’Instruments de Précision en France, 1870-1930*. Nancy: Presses Universitaires de Lorraine, 2014.
- Schlich, Roland. *BENIN 1971 Cruise, RV Jean Charcot*. Archimer, archive institutionnelle de l’Ifremer.
- Schmidt, Johannes. *Report of the Danish Oceanographic Expeditions 1908-1910 to the Mediterranean and Adjacent Seas*. Copenhagen: A.F. Høst & Søn, 1912.
- Scott, Heidi V. “Colonialism, Landscape and the Subterranean.” *Geography Compass* 2, no. 6 (2008): 1853–69.
- Seas at Risk. *At a Crossroads: Europe’s Role in Deep-Sea Mining*. Brussels: Seas at Risk, 2021.
- Secord, James A. “Knowledge in Transit.” *Isis* 95, no. 4 (2004): 654–672.
- Selli, Raimondo. “An Outline of the Italian Messinian.” In *Messinian Events in the Mediterranean*, edited by C.M. Drooger, 150–71. Amsterdam, London: North-Holland Publishing Company, 1973.
- . “Il Bacino del Metauro. Descrizione Geologica, Risorse Minerale, Idrogeologia.” *Giornale di Geologia* 2, 24 (1952): 1–80.
- Sevillano, Elena G. “¿Proyecto científico o avanzadilla de las petroleras?.” *El País*, August 17, 2016.
- Sewell, Seymour R.B. and John D. H. Wiseman. “Le Relief du Fond de la Mer, Particulièrement dans l’Hémisphère Méridional”. In: *Comptes Rendus Du Congrès International de Géographie*, edited by the International Geographic Congress, 73-80. Amsterdam, 1938.
- Shapin, Steven. “Discipline and Bounding: The History and Sociology of Science as Seen Through the Externalism-Internalism Debate.” *History of Science* 30, no. 4 (December 1, 1992): 333–69.
- . *The Scientific Life: A Moral History of a Late Modern Vocation*. Chicago: University of Chicago Press, 2010.
- Shepard, Francis P. “American Submarine Canyons.” *Scottish Geographical Magazine* 50, no. 4 (July 1, 1934): 212–18.
- . “The Underlying Causes of Submarine Canyons.” *Proceedings of the National Academy of Sciences of the United States of America* 22, no. 8 (August 1936): 496–502.
- . *Autobiography*. August 1980.

- Shuldiner, Alec. “Learning to Keep Secrets: The Military and a High-Tech Company.” In: *Secrecy and Knowledge Production*, by Judith Reppy. Ithaca, NY: Cornell University Occasional Papers, 1999.
- Simoncini, Nicolas. *Histoire de la Recherche sur les Piles à Combustible en France des Années Soixante aux Années Quatre-Vingt*. PhD diss., Université de Technologie de Belfort-Montbéliard, 2018.
- Sismondo, Sergio. “Epistemic Corruption, the Pharmaceutical Industry, and the Body of Medical Science.” *Frontiers in Research Metrics and Analytics* 6 (March 8, 2021).
- . “Sociotechnical Imaginaries: An Accidental Themed Issue.” *Social Studies of Science* 50, no. 4 (August 1, 2020): 505–7.
- Smith, Jason W. *To Master the Boundless Sea: The U.S. Navy, the Marine Environment, and the Cartography of Empire*. Chapel Hill: University of North Carolina Press, 2018.
- Solla, Derek John de. *Little Science, Big Science... And Beyond*. New York: Columbia University Press, 1986.
- Sörlin, Sverker, and Nina Wormbs. “Environing Technologies: A Theory of Making Environment.” *History and Technology* 34, no. 2 (April 3, 2018): 101–25.
- Squire, Rachael. *Undersea Geopolitics: Sealab, Science, and the Cold War*. Lanham, Maryland: Rowman & Littlefield, 2021.
- Stanley, Daniel Jean, and Forese-Carlo Wezel. *Geological Evolution of the Mediterranean Basin*. New York, Berlin, Heidelberg, Tokyo: Springer, 1985.
- Sternlicht, Daniel D. “Looking Back: Seismic Exploration.” *IEEE Potentials*, 18, 1 (February-March 1999): 36-38.
- Suarez, Suzette V. *The Outer Limits of the Continental Shelf: Legal Aspects of Their Establishment*. Berlin Heidelberg: Springer-Verlag, 2008.
- Suc, Jean Pierre. “Quarante Ans de Débats Autour des Évaporites Messiniennes de Méditerranée et de la Crise Qui Leur Est Associée. Un Défi Scientifique Passionnant, Mais Singulier et Déroutant.” *Travaux du Comité Français d’Histoire de la Géologie (COFRHIGÉO)*, Troisième Série, XXX (2016).
- Supran, Geoffrey, and Naomi Oreskes. “Addendum to ‘Assessing ExxonMobil’s Climate Change Communications (1977–2014)’.” *Environmental Research Letters* 15, no. 11 (October 30, 2020).
- Sykes, Lynn R. “Mechanism of Earthquakes and Nature of Faulting on the Mid-Oceanic Ridges.” *Journal of Geophysical Research (1896-1977)* 72, no. 8 (1967): 2131–2153.
- Thiede, Jörn, Jan Harff, Wolfgang H. Berger, and Eugen Seibold. “Marine Geosciences: A Short, Ecclectic and Weighted Historic Account.” In: *Encyclopedia of Marine Geosciences*, edited by Jan Harff, Martin Meschede, Sven Petersen, and Jörn Thiede, 437–48. Dordrecht: Springer Netherlands, 2016.
- Thompson, Paul. *The Voice of the Past: Oral History*. Oxford: Oxford University Press, 2000.
- Thompson, Thomas L. “Plate Tectonics in Oil and Gas Exploration of Continental Margins.” *AAPG Bulletin* 60, no. 9 (September 1, 1976): 1463–1501.
- Tracey Jr., Joshua I., George H. Sutton, and Wladimir D. Nesteroff. *Initial Reports of the Deep Sea Drilling Project 8*. Washington D.C.: US Government Printing Office, 1971.

- Turchetti, Simone, and Peder Roberts, eds. *The Surveillance Imperative*. New York: Palgrave Macmillan US, 2014.
- Turchetti, Simone, Matthew Adamson, Giulia Rispoli, Doubravka Olsakova, and Sam Robinson. "Introduction. Just Needham to Nixon? On Writing the History of 'Science Diplomacy.'" *Historical Studies in the Natural Sciences* 50, no. 4 (September 24, 2020): 323–339.
- Turchetti, Simone, Néstor Herran, and Soraya Boudia. "Have We Ever Been 'Transnational'? Towards a History of Science Across and Beyond Borders." *The British Journal for the History of Science* 45, no. 3 (September 2012): 319–336.
- Turchetti, Simone. "Sword, Shield and Buoys: A History of the NATO Sub-Committee on Oceanographic Research, 1959–1973." *Centaurus* 54, no. 3 (2012): 205–231.
- Turner, Frederik Jackson. *The Significance of the Frontier in American History*. 1893.
- UN General Assembly. "Note Verbale from the Permanent Mission of Malta to the United Nations Addressed to the Secretary-General", UN Doc. A/6695, 18 August 1967. UN Virtual Library.
- . First Committee Debate, UN Doc. A/PV.1515 para. 91. 01 Nov, 1967. UN Virtual Library.
- . Resolution 2749 (XXV) of 17/12/1970, 25th Session. UN Virtual Library.
- United Nations. *Convention on the High Seas 1958*. Geneva, 29 April 1958.
- Vai, Gian Battista. "Over Half a Century of Messinian Salinity Crisis". *Boletín Geológico y Minero* 127 (2016): 615-632.
- Valéry, Pierre, Jean Raymond Delteil, A. Cottengon, Lucien Montadert, Renée Damotte, and Jean-Pierre Fail. "La Marge Continentale d'Aquitaine," In: *Histoire Structurale du Golfe de Gascogne*, edited by Jacques Debyser, Xavier le Pichon, and Lucien Montadert, IV.8-1 – IV.8-24. Paris: Ed. Technip, 1971.
- Van Keuren, David K. "Breaking New Ground: The Origins of Scientific Ocean Drilling." In: *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, edited by Helen M. Rozwadowski and David K. Van Keuren. Sagamore Beach, Mass: Science History Publications, 2004.
- Vanderpool, Christopher K. "Marine Science and the Law of the Sea." *Social Studies of Science* 13, no. 1 (February 1983): 107–29.
- Vanne, Jean-René, and Jean-Pierre Pinot. "La Campagne du Discoverer au Large de l'Afrique Tropical." *Bulletin de l'Association de Géographes Français*, année 1969: 368-369.
- Vindt, Gérard. "De la CFP à Total, une Entreprise sous Contrôle de l'Etat." *Alternatives Economiques* 295, no. 10 (October 28, 2010): 111–111.
- Vinck, Dominique, ed. *The Sociology of Scientific Work: The Fundamental Relationship between Science and Society*. Cheltenham: Elgar, 2010.
- Waldock, C. H. M. "The Legal Basis of Claims to the Continental Shelf." *Transactions of the Grotius Society* 36 (1950): 115–48.
- Walker, Mark. "The 'National' in International and Transnational Science." *The British Journal for the History of Science* 45, no. 3 (September 2012): 359–76.

- Wang, Zouyue. "Office of Naval Research, United States." In: *The History of Science in the United States. An Encyclopedia*, edited by Marc Rothemberg, 411-412. New York, London: Garland Publishing, 2001.
- Watts, Jonathan. "Race to the Bottom: The Disastrous, Blindfolded Rush to Mine the Deep Sea." *The Guardian*, September 27, 2021.
- Wei-Haas, Maya. "The Mediterranean Nearly Dried Up. A Cataclysmic Flood Revived It." *National Geographic*, March 6, 2020.
- Weinberg, Alvin M. "Impact of Large-Scale Science on the United States: Big Science Is Here to Stay, but We Have Yet to Make the Hard Financial and Educational Choices It Imposes." *Science* 134, no. 3473 (July 21, 1961): 161–64.
- Weir, Gary E. *An Ocean in Common: American Naval Officers, Scientists, and the Ocean Environment*. College Station: Texas A&M University Press, 2001.
- Wenk, Edward. *The Politics of the Ocean*. Seattle: University of Washington Press, 1972.
- White, Richard, Patricia Nelson Limerick, and James R. Grossman. *The Frontier in American Culture: An Exhibition at the Newberry Library, August 26, 1994 - January 7, 1995*. Chicago, Berkeley: University of California Press, 1994.
- White, Richard. *The Organic Machine: The Remaking of the Columbia River*. New York: Hill and Wang, 2001.
- Whittard, Walter Frederick, and R. Bradshaw, eds. *Submarine Geology and Geophysics. Colston Papers No. 17*. London: Butterworths, 1965.
- Wilson, Adrian. "Science's Imagined Pasts." *Isis* 108, no. 4 (December 2, 2017): 814–26.
- Wilson, J. Tuzo. "A New Class of Faults and Their Bearing on Continental Drift." *Nature* 207, no. 4995 (July 1965): 343–47.
- Winterer, Edward L. "Scientific Ocean Drilling, from AMSOC to COMPOST." In *50 Years of Ocean Discovery: National Science Foundation, 1950-2000*, 117–33. Washington, D.C.: National Academies Press, 2000.
- Winthrop Haight, George. "United Nations Affairs. Ad Hoc Committee on Sea-Bed and Ocean Floor." *International Lawyer* 3, no. 1 (1969): 22-30.
- Wittje, Roland. "Engineering Education in Cold War Diplomacy: India, Germany, and the Establishment of IIT Madras." *Berichte Zur Wissenschaftsgeschichte* 43, no. 4 (2020): 560–580.
- Wright, Susan, and David A. Wallace. "Varieties of Secrets and Secret Varieties: The Case of Biotechnology." In *Secrecy and Knowledge Production*, edited by Judith Reppy. Ithaca, NY: Cornell University Occasional Papers, 1999.
- Yergin, Daniel. *The Prize: The Epic Quest for Oil, Money & Power*. New York: Free Press, 2009.
- Zalik, Anna. "Mining the Seabed, Enclosing the Area: Ocean Grabbing, Proprietary Knowledge and the Geopolitics of the Extractive Frontier Beyond National Jurisdiction." *International Social Science Journal*, 68 (2018): 343-359.

Anonymous sources

- n.a. "A Crack in the Shell. New Documents Expose a Hidden Climate History." *Center for International Environmental Law* (2018).
- . "L'Institut Français du Pétrole Expérimente une Nouvelle Méthode de Forage par Grands Fonds." *Le Monde*, March 30, 1970.
- . "Loi n° 68-1181 du 30 décembre 1968 relative à l'exploitation du plateau continental et à l'exploitation de ses ressources naturelles." *Journal Officiel de la République Française*, n.307 (December, 1968).
- . "Décret n.69-1397." *Journal Officiel de la République Française* n.290, 14-15 (December, 1959).
- . "Consolidated list of goods subject to security export control." *Board of Trade Journal* (October 8, 1969).
- . *Journal Officiel de la République Française*, n.18 (August 29, 1962): 737-747.
- . "André Louis Yves GIRAUD (1925-1997)." *La Jaune et la Rouge*, n.79 (10 September, 1997).
- . "Edward Wenk Jr. Obituary." *The Seattle Times* (July 22, 2012).
- . "Mediterranean Evaporites," *Nature* 242 (March 23, 1973): 226-227.
- . "Les Richesses du XXI^e siècle sont à Prendre au Fond des Mers." *Le Monde Diplomatique*, (February, 1968).
- . "German firm joins Deepsea Ventures' exploratory program." *Circle 66 on Reader Service Card*, n.d.
- . "Una tapadera científica para buscar petróleo." *El Mundo* (August 18, 2016).

Annex

1. International Chronostratigraphic Chart, by the International Commission on Stratigraphy (version 2022/02)

The period concerning the Mediterranean partial desiccation, the Messinian, coincides with the Miocene-Pliocene boundary. Note that most of this thesis addresses the most recent periods on the Earth's history.

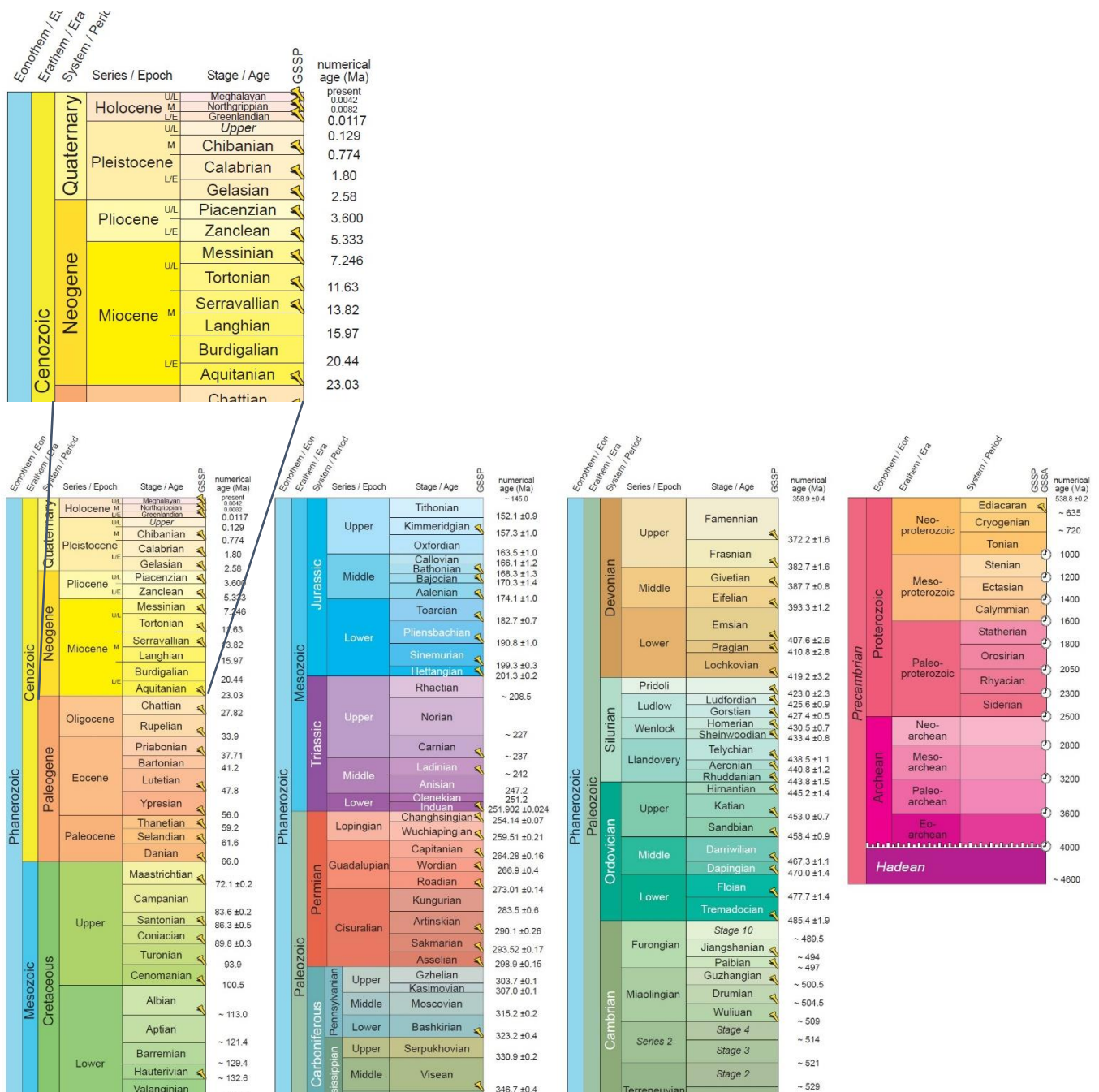


Figure 35. International Chronostratigraphic Chart, 2022.

2. Regions of the seafloor

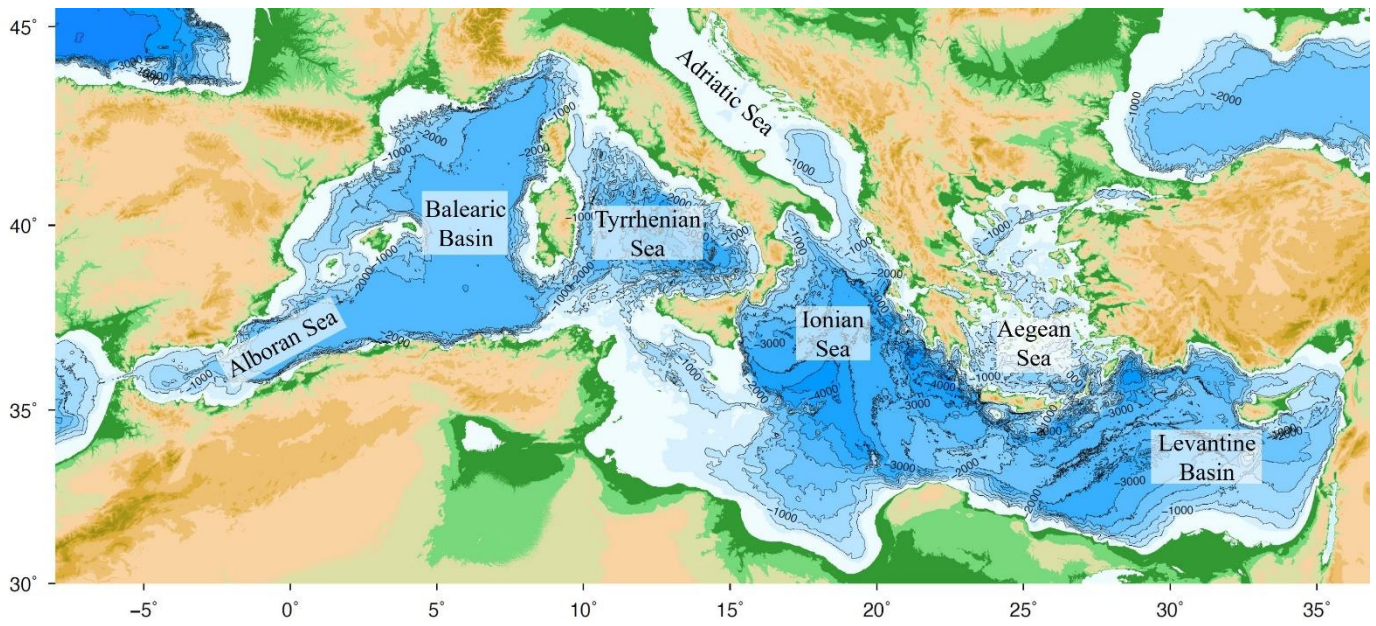


Figure 36. Bathymetric map of the Mediterranean basin.

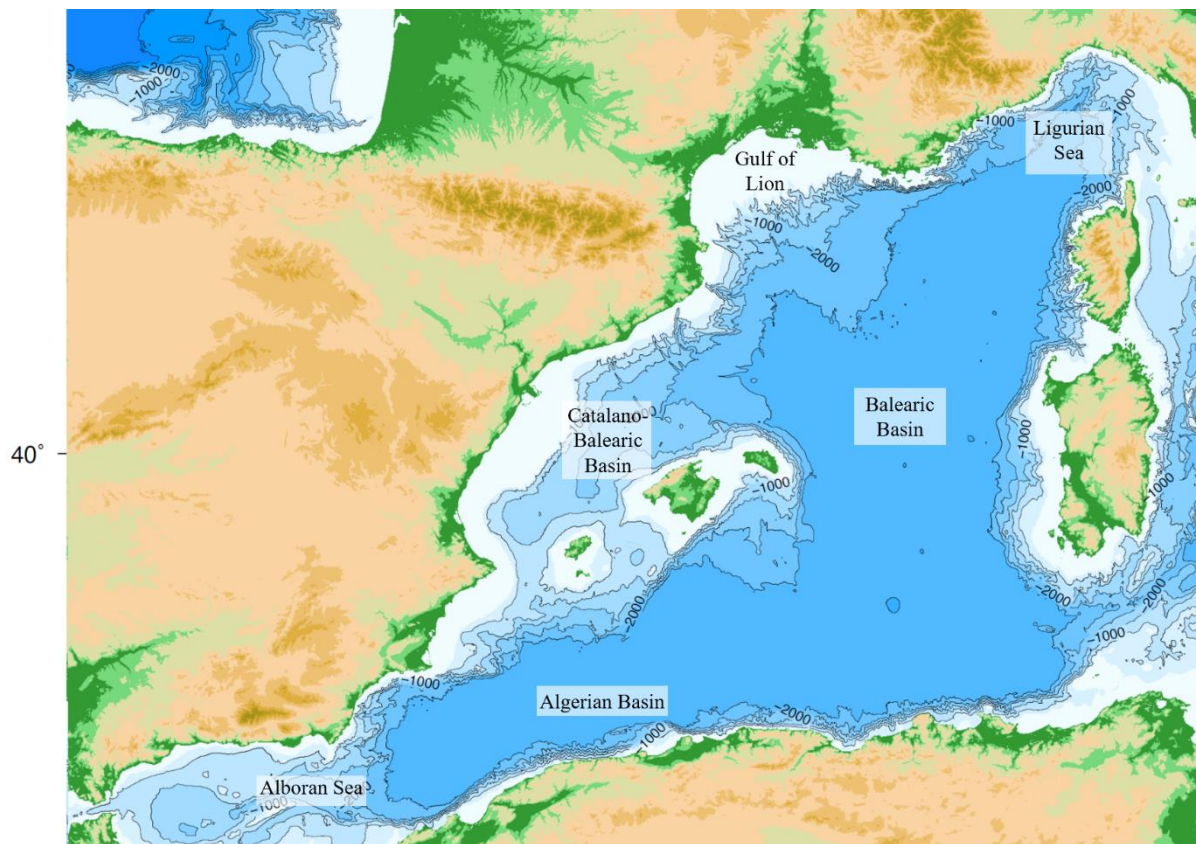


Figure 37. Bathymetric map of the western Mediterranean basin.

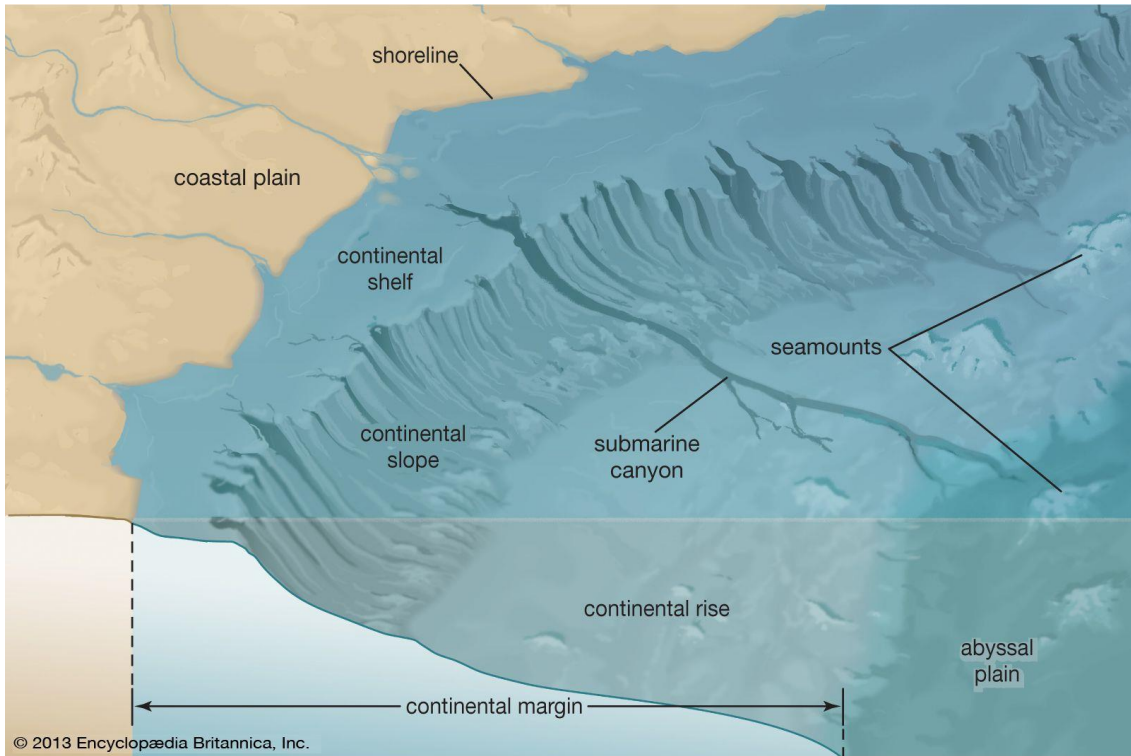


Figure 38. Regions comprised in continental margins (Encyclopædia Britannica, <https://www.britannica.com/science/continental-margin#/media/1/135007/147308>)

Detailed table of contents

Acknowledgements	3
List of Figures	7
List of Tables.....	8
Frequently used Acronyms and Abbreviations	9
Chapter 1. Introduction	11
1.1. Industrial money and the marine geosciences.....	15
1.2. The quest for new deep territories.....	23
1.3. From fieldwork to archives: Sources and research methodology	28
1.3.1. Fieldwork: Understanding geology (and geologists) from the inside.....	31
1.3.2. Oral History	32
1.3.3. Archival research	33
1.4. From the shore to the deep ocean crust: structure of this dissertation	35
1.5. Explanatory note on stratigraphic periods	38
Chapter 2. From mainland to the offshore: Jacques Bourcart and military patronage.....	39
2.1. The history of the Mediterranean basin from mainland.....	41
2.1.1. Geologists at war: Training disciples for military cartography	41
2.1.2. Oil and colonial exploration in North African territories	44
2.2. Submarine warfare and the roots of marine geosciences	46
2.2.1. Echo-sounders: New technologies to chart the seabed	46
2.2.2. Submarine canyons: American pioneering discoveries in the seabed	48
2.2.3. An unexpected relation: Bourcart and the French Navy during World War 2.....	50
2.3. The onset of the offshore oil industry in the US	51
2.3.1. Turning to the oceans: Truman Proclamation on the continental shelf	52
2.3.2. Shepard, the oil industry, and the Californian submarine canyons.....	55
2.4. The French strategy in the oceans.....	57
2.4.1. Oil in colonial territories and military surveillance in the oceans	57
2.4.2. Bourcart's new patron and the exploration of submarine canyons.....	59
2.4.3. New spaces of research	63
2.5. The (short-lived) military-supported marine geology.....	66
Chapter 3. International science, fundamental research, and marine geophysics	69
3.1. The oceans at the international spotlight.....	71

3.1.1. International cooperation in ocean exploration and the discourse of lagging behind.....	71
3.1.2. UNCLOS I: freedom of research and the blurred limits of the continental shelf.....	76
3.2. Marine sciences in the political agenda	78
3.2.1. Charles de Gaulle’s government: Sciences at the service of State	78
3.2.2. The discourse of fundamental research and the Comité d’Études Exploitation des Océans.....	80
3.3. A new research tool box: geology, physical methods, and oceanographic logistics	87
3.3.1. Oil and American oceanographers: The onset of marine geophysics.....	87
3.3.2. Mixing research approaches at French academia	97
3.3.3. The discovery of deep-Mediterranean salt domes	100
3.4. Seeing below the seabed	105
Chapter 4. From fundamental research to the valorization of the oceans: Towards an ocean policy soaked with oil.....	107
4.1. Turning to the oceans: the renewal of a national oil industry.....	109
4.1.1. The seed of an oceanic neocolonialism: France’s urgency to secure oil supplies	109
4.1.2. An oil network: The Comité d’Études Pétroliers et Marines.....	114
4.2. Technologies, experts, and surveys: the take-off of offshore oil exploration... ..	116
4.2.1. The <i>Flexotir</i> or how to conduct seismic surveys without damaging the marine environment	116
4.2.2. A new community of petroleum geologists	122
4.2.3. Academic-industrial disconnection: the case of the Mediterranean salt domes’ dating.....	124
4.2.4. The oil industry’s need for geological expertise.....	126
4.3. Shifting priorities: a new perception of the oceans and the inception of an oceanic policy	129
4.3.1. The “valorization of the oceans” and international competition	130
4.3.2. André Giraud and the new oceanographic policy.....	133
4.4. A new economic frontier.....	137
Chapter 5. Hybrid research across the continental shelf: the Centre National pour l’Exploitation des Océans.....	139
5.1. A new national center to exploit the oceans: the Centre National pour l’Exploitation des Océans	140
5.1.1. From military research to resource exploration	140
5.1.2. Mechanisms to drive marine research: official status, structure, and public dissemination	143

5.2. Exploring natural resources in foreign and international seawaters	150
5.2.1. The pillars of hybrid surveys: the Law of the Sea’s framework and the emergent theory of plate tectonics	150
5.2.2. Scientific surveys with industrial by-products, or industrial surveys of scientific interest?	156
5.3. Controlling data flows in the continental shelf’s mapping	164
5.3.1. A coordinated national program to survey the Atlantic continental margin	164
5.3.2. Scientific-industrial conferences to build knowledge on the Atlantic basin's formation	171
5.4. The removal of boundaries between academic and industrial research	175
Chapter 6. Science diplomacy and the common heritage of mankind: Anticipating the exploitation of the high seas	177
6.1. Towards a new jurisdictional framework to exploit the high seas	179
6.1.1. Arvid Pardo and the common heritage of mankind	179
6.1.2. Networks of power: France’s international strategy through the CNEXO	181
6.2. Franco-American diplomatic relations through the CNEXO	187
6.2.1. Emulating US oceanography: Research centers, training, and the American way of doing marine sciences	187
6.2.2. Collaboration in the high seas: the project FAMOUS	192
6.3. Controlling distant oceans: the quest to exploit polymetallic nodules	197
6.3.1. A newborn mining industry	197
6.3.2. A doorway to Pacific richness: the Base Océanologique du Pacifique ..	203
6.4. Franco-Soviet relations in the exploitation of the oceans	209
6.4.1. The tug-of-war of underwater technologies in the Franco-Soviet bilateral cooperation	210
6.4.2. A never-coming cooperation in marine geosciences	214
6.5. Oceanic diplomacy to anticipate the exploitation of marine richness	218
Chapter 7. Drill ships and deep oil: commercial exploration through scientific cooperation	220
7.1. The discovery of the Messinian Salinity Crisis: A scientific account	222
7.2. Salt domes in deep waters	231
7.2.1. The oil industry and first survey of the <i>Glomar Challenger</i>	231
7.2.2. Fears of American expansion across the deep Mediterranean	234
7.2.3. Where to drill and whom to embark: the CNEXO’s involvement in Leg 13	235
7.3. The deep Mediterranean, a new energy frontier	241
7.3.1. Flows of data and experts to explore the deep Mediterranean	243

7.3.2. Moving to deeper waters: the first oil shock and Leg 42.....	247
7.4. The aftermath of DSDP campaigns in the Mediterranean	253
7.5. The place of the oil industry in the seafloor's knowledge production.....	256
Coda. (Mis)understanding academic-industrial relations.....	259
Chapter 8. Conclusion	262
8.1. French geologists and marine resources	262
8.2. New deep territories	267
8.3. Limitations and avenues for future research	271
Bibliography.....	278
Archives	278
Oral History Interviews.....	281
Published sources	282
Annex	308
Detailed table of contents.....	312

Making the Seafloor. French Geologists, Marine Resources, and New Deep Territories (1945-1975)

Abstract

Early in the 1960s, the seafloor began to emerge as a new territory, over which imaginaries of limitless natural resources, to be explored and exploited, were projected. The oil industry became a patron for marine geosciences, whereas coastal governments hastened to ground in geophysical data their sovereign claims over underwater regions. This thesis inquiries through which mechanisms the patrons' motivations to explore the seafloor drove the production of knowledge about it; while it explores how the seafloor emerged as a territory, shaped by concerns and priorities deriving from decolonization. Focusing on France's oil industry and political stances interested in exploiting marine resources, I analyze the institutional and social mechanisms through which commercial motivations were articulated with marine geosciences. The key element that guaranteed a smooth imbrication was a singular network, weaved by a political elite, that grew connecting government instances, extractive industries, and scientific laboratories, creating academic-industrial interplays to explore the seafloor in which trade secrecy dissolved. By looking at the technoscientific practices that produced geological data, and the evolving political and diplomatic uses given to that information, this research suggests a continuum in practices, infrastructures, and state actors from the decolonization of France's oil-producing territories to the seafloor, in the quest for new productive grounds. In this context, geological knowledge from the seafloor increasingly became a crucial asset for the French government, which could mobilize it to negotiate international relations and foster national prestige. This research conveys that economic motivations to explore the seafloor and the oil industry's patronage shall not be overlooked in our understanding of the oceans' history.

Keywords: oceans, seafloor, geosciences, patronage, oil industry

Le Sous-Sol Marin. La Géologie Française et la Recherche de Ressources Marines dans des Nouveaux Territoires (1945-1975)

Résumé

Au début des années 1960, le sous-sol océanique est devenu un nouveau territoire dont l'image a été façonnée par des imaginaires sur l'abondance de ressources naturelles, prêts à découvrir et à exploiter. L'industrie pétrolière est devenue un mécène pour la géologie marine, tandis que les gouvernements se sont empressés de réclamer la souveraineté sur les régions sous-marines à partir de leurs données géophysiques. Cette thèse étudie le rapport entre le patronage étatique et la production de connaissances sur le sous-sol marin, en s'interrogeant sur la construction du sous-sol marin en tant que territoire en relation aux inquiétudes et priorités découlant du contexte de la décolonisation. La thèse met le focus sur l'industrie pétrolière française et les politiques qui ont promu l'exploitation des ressources marines, en étudiant l'articulation entre les géosciences marines, les mécanismes institutionnels et motivations commerciales qui les ont promus. La thèse indique que ces connections ont été tissées par un réseau d'acteurs connectant des élites politiques, industries extractives et laboratoires scientifiques, créant des interactions académiques-industrielles pour explorer le sous-sol marin dans lesquelles le secret commercial s'est dissous. La thèse montre l'existence d'un continuum de pratiques, infrastructures et acteurs impliqués initialement dans l'exploitation pétrolière dans les colonies françaises et qui considéraient les fonds marins dans leur quête de nouveaux terrains de production. Dans ce contexte, les connaissances géologiques du sous-sol marin sont devenues un atout crucial pour le gouvernement français, qui pouvait les mobiliser pour négocier des relations internationales et renforcer son prestige national. Cette recherche montre que les motivations économiques pour explorer le sous-sol marin et le mécénat de l'industrie pétrolière ne doivent pas être négligés dans notre compréhension de l'histoire des océans.

Mots clés : océans, sous-sol marin, géosciences, industrie pétrolière