Geology and Hydrocarbon Potential of the South China Sea
Possibilities and Examples of Joint Research and Development*

Workshop Report
by
C. Y. Li, Coordinator
Mark J. Valencia, Rapporteur

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PART ONE

FOREWORD

The Environment and Policy Institute (EAPI) of the East-West Center was established in October 1977 to conduct research and education programs through multinational collaboration on environmental aspects of policy and decision-making in the East-West Center region. The program of the Institute emphasizes (1) analysis of various policies (e.g., economic development, maritime jurisdiction) to illuminate their dependence and impacts on natural systems and thus on the objectives of the policies, and (2) assessment of scientific and technical information about natural systems for more coherent policy formulation and implementation through planning and management. This systematic approach avoids the polarization of environmental values versus sectoral goals.

The marine environment represents a major resource for the countries of the world as they strive to meet a variety of needs on a sustained basis. Concerns such as environmental quality, viability of fish stocks, and orderly exploitation of hydrocarbons are important priorities as countries consider individual and collective strategies for effective utilization of the oceans. EAPI, with the cooperation of two other Center Institutes, Resource Systems (RSI) and Culture Learning (CLI), has undertaken a Project on Marine Environment and Extended Maritime Jurisdictions to study critical transnational resource and environment issues in Southeast Asian seas. A brief description of this project appears in Appendix 3.

In the early stages of this Project, it was determined that future oil exploration and development in the South China Sea could have significant implications for international relations and for environmental quality and the productivity of aquatic resources. Trying to assess these implications, it became clear that more had to be learned about the geology and hydrocarbon potential of the South China Sea in order to project activities that might occur in the coming years. EAPI was fortunate in attracting Dr. C. Y. Li to the Center as a Fellow to develop a workshop to address these questions.

Under Dr. Li's leadership, a group of researchers from EAPI, RSI, CLI, and the University of Hawaii organized the Workshop that was conducted at the East-West Center in Honolulu, Hawaii, August 5-12, 1980. This activity was co-sponsored by CCOP—the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas—an intergovernmental body supported by the United Nations Development Programme and based in Bangkok, Thailand. CCOP, which includes as members all countries bordering the South China Sea, is an active and effective institution in the region, and in this context
hoped that the Workshop would take significant steps in developing a program for future research.

The Workshop was attended by 50 leading authorities and experts drawn from governmental and intergovernmental organizations, multinational oil companies, and academic institutions in 12 countries. Persons attended and participated in the meetings in their individual capacities and did not represent or speak for their organizations or countries. This report of the Workshop’s findings, conclusions, and recommendations presents the spectrum of views expressed at the meeting. It should not be assumed that every participant subscribes to every statement, although a broad consensus was reached on most major points.

The blend of perspectives and expertise at this informal meeting resulted in an exchange of information not previously possible among such groups who rarely meet in a neutral exploratory setting. Indeed, it brought together in one place the separate pieces of the information jigsaw puzzle regarding the geology and hydrocarbon potential of the South China Sea and related transnational issues.

This report is the first step in communicating some of the results of this Workshop. In future publications and in follow-up meetings, we anticipate that the work begun will continue and reach a wider audience. In this way, we hope we are contributing to a creative resolution of issues that are vital to national and international interests of countries in the region.

William H. Matthews, Director
Environment and Policy Institute
East-West Center
INTRODUCTION

As the world faces an increasingly acute energy problem, and as the land area has been searched more intensely and extensively, countries and industries are turning their attention evermore to the sea. The tendency to search for and develop hydrocarbon resources under the sea is almost universal; indeed, some 80 countries have now begun offshore hydrocarbon exploration and/or production. It has been estimated that total recoverable subsea hydrocarbon resources may well exceed those of the continental areas.

The South China Sea has become one focus of industry and national attention in the search for hydrocarbon potential. This attention arises from the fact that some countries bordering the South China Sea already have offshore hydrocarbon production, e.g., Indonesia, Malaysia, and the Philippines. Other countries, such as Thailand, have areas where production is about to begin, and still others, such as China and Vietnam, have areas where offshore hydrocarbon potential is known to exist. Moreover, with rapid technological advances, particularly since the exploitation of North Sea deposits, the continental slope, the continental rise, and even some of the deeper oceanic basins with sufficient sediment thicknesses are fast becoming accessible for exploitation.

Development of hydrocarbon resources under the sea entails transnational marine environment and resource issues such as management of transboundary or shared resources, scientific research, or environmental quality. In the South China Sea, such issues and investigations are complicated by intricate and currently overlapping international offshore boundary claims of the bordering countries.

The South China Sea area is one of the most geologically complex in all the world, being the locus of the junction of three major plates—the Asian Continental Plate, the Pacific Oceanic Plate, and the Indo-Australian Plate. The South China Sea area thus provides an excellent setting for intensive research on the nature of continental-oceanic and oceanic-oceanic plate interactions and the associated geological processes that control the genesis of ore and hydrocarbons.

It was considered that cooperation among countries, industry, and academic institutions might be fostered through exchange of technical information leading to a better understanding of the geology and thus the hydrocarbon potential of the South China Sea. This by itself would be of scientific and potential economic importance. With that basis, researchers could consider other aspects of exploration and production of offshore hydrocarbon potential—such as the technological, economic, legal, and environmental perspectives.

Technologically, there are constraints on extending present technology—including exploration, drilling, and production—to "hostile" shelves and deeper waters. Economic and financial issues are of prime importance, and environmental problems will require greater attention. All these factors affect policy formulation regarding State participation in such ventures and the details of regulation, legislation, taxation, royalties, and basic contracts.

The exploration and exploitation of the hydrocarbon potential of the South China Sea presents a particular challenge because of the overlapping claims in the area. Yet if the South China Sea hydrocarbon potential is to be studied, explored, and developed in an orderly manner, close cooperation is a necessity among countries bordering the Sea. There are precedents for such cooperation among neighboring States, and it was considered that these precedents could be examined for possible future application in the area.
CONCLUSIONS AND RECOMMENDATIONS

Approximately 50 leading authorities and experts drawn from governmental and intergovernmental organizations, multinational oil companies, and academic institutions in 12 countries participated in this Workshop (see complete list in Appendix 1). After reviewing almost two dozen papers (summarized in Part Two), the participants divided into three working groups to formulate conclusions and recommendations (see Appendix 2 for the agenda and organization of the Workshop).

The following conclusions and recommendations, which reflect a broad but not necessarily complete consensus of the participants acting in their individual capacities, are divided into three sections:

I. Geology and Hydrocarbon Potential of the South China Sea
II. Technological, Economic, Legal, and Environmental Aspects of Exploration and Exploitation of Hydrocarbon Resources in Offshore and Adjacent Oceanic Areas
III. Precedents for Joint Development and Applicability of Precedents to Possible Areas for Joint Undertakings

In addition, there were recommendations on “Follow-up Meetings” to this initial Workshop activity.

I. Geology and Hydrocarbon Potential of the South China Sea

1. Significant data gaps exist, and assessment should be undertaken of the quantity and quality of basic geologic and geophysical data, such as the distribution of geophysical track lines. An entity should be appointed to be responsible for the compilation of maps showing such distributions of geological and geophysical data in the South China Sea area, and it was hoped that CCOP would assume the responsibility for undertaking this task.

2. Studies of the hydrocarbon potential of Tertiary sedimentary basins should be continued with emphasis on basic geometry and stratigraphy, and additional consideration should be given to geothermal gradient and heat flow studies.

3. Also, bathymetric highs within the intermediate shelf zone should be investigated for their hydrocarbon potential in Mesozoic and Paleogene sedimentary sections.

4. There is widespread interest in the hydrocarbon potential of the pre-Tertiary, and studies such as those carried out by the CCOP Project Office and member countries should be continued and expanded. Geological investigation in the form of case histories, cataloging of pre-Tertiary basin locations and characteristics, and collection of field data supplemented by geochemical analysis and geophysical studies should be carried out.

5. An understanding of the regional tectonic setting and its evolutionary aspects is important and in this regard:

   a. further magnetic profiling should be undertaken to update previously recorded linear anomalies;
   b. further seismic profiling should be undertaken to delineate the basin;
c. an additional transect should be made parallel to SEATAR Line 1-C*;
d. studies should be undertaken on the recognition, significance and age of tectonic melanges, such as the Danau Formation;
e. an undertaking of ophiolites and other mafic and ultramafic rock bodies should be developed;
f. work on determination of ages of igneous and metamorphic rocks should be carried forward, as well as investigations of Pliocene-Pleistocene volcanics in western Sarawak and Sabah to determine if these rocks can be related to continuing subduction of the South China Sea crust; and
g. deep sea drilling sites in the South China Sea should be recommended to the JOIDES Planning Committee.

II. Technological, Economic, Legal, and Environmental Aspects of Exploration and Exploitation of Hydrocarbon Resources in Offshore and Adjacent Oceanic Areas

1. There are overlapping national jurisdictional claims to certain parts of the South China Sea.

2. Although policies for development of hydrocarbon resources must be dominated by national objectives, petroleum is also of regional and international importance. The various “stake holders” (e.g., those groups involved in and/or owning potential hydrocarbon areas in the South China Sea) should communicate on a regular basis and whenever possible, in order to promote orderly development and avoid conflicts and unnecessary delays in the exploration and exploitation of potential hydrocarbon resources.

3. “Host” government policies, legislation, and attitudes are the basis for an active, rational, and orderly petroleum development program. “Home” governments of the various oil exploration companies also play a major role in assuring orderly programs in many areas of the South China Sea. Consultations, studies, and reviews should be made to identify common problems and to determine how cooperation could be enhanced, assured, or arranged between “host” governments (including State oil companies of countries bordering the South China Sea), operating oil companies, and home governments of those companies. Hope was expressed by experts from industry that governments of host countries would see fit to consult with affected operators before making fundamental changes in contracts.

4. The expected increased exploration efforts in the South China Sea will contribute greatly to the knowledge and data base for the area. Every effort should be made by relevant entities and countries to cooperate in future joint conferences and workshops and to share appropriate information and data for the benefit of all those interested or involved in South China Sea activities and programs.

5. Efforts should be made to study and review, within the context of each nation’s own environmental guidelines, various possible areas of cooperation including the development of joint contingency plans and the sharing of equipment, material, and supplies for meeting and dealing with significant oil pollution problems. This cooperation might begin by joint discussions between such organizations as CCOP, UNEP, EAPI, and others.

6. New technological developments and methods, deep water completions, and in-
creased work in harsher environments can be expected to contribute to or cause increasing offshore oil-related problems and accidents in the 1980s. It should be brought to the attention of those “host” countries and companies involved in South China Sea programs and development activities that every effort should be made to train personnel to make use of adequate planning and sound operational procedures for avoiding and coping with potential offshore accidents.

7. There are several efforts underway by external organizations such as EAPI and UNEP/CCOP to compile basic environmental data and to identify critical and/or valuable natural environmental resources. These efforts should be continued and where absent, initiated. This information might be used by countries to identify areas of priority in marine and coastal environmental resources, in terms of protection in the event of threat by spilled oil, and in the siting of protection equipment.

8. At the end of an offshore field’s life the decommissioning of installations and structures might be necessary and is normally included in leasing/production agreements. Consideration should be given to the criteria to be used in deciding what to do with such structures—whether to remove or destroy them, or keep them because of the benefits or other potential uses they might have.

III. Precedents for Joint Development and Applicability of Precedents to Possible Areas for Joint Undertakings

1. The geology of the seabed of the South China Sea is complex. When compounded with the intricate and currently overlapping international offshore boundary lines of the countries involved, it does not allow pre-exploration activities to be accomplished efficiently unless such activities are undertaken jointly by the bordering countries. CCOP, as a neutral agency, might play a useful role in this regard.

2. Joint arrangements for exploration and for production may have to be considered as separate operations for economic and political reasons.

3. The majority of the participants considered that the existence of defined and agreed international offshore boundary lines might not be a prerequisite for a joint development operation, although it would simplify planning of operations.

4. Joint development for production is feasible for any area if planning and operation are properly adapted to suit existing situations and conditions. Factors involved are political, economic, legal, and cultural, all of which require careful attention and consideration.

5. Historical neighborly ties or a traditional spirit of cooperation, friendly political relationship, or understanding of mutual economic and security interests are major factors in the viability of a joint development operation.

6. The institution and application of one composite regime of law in a joint development area would be the ideal. Alternatively, there should at least be an agreement that embodies principles to regulate all aspects of exploration and production operations. The underlying assumptions upon which these agreements are based include recognized principles of customary international law.

a. The Anglo-Norwegian joint development agreements are suitable examples of procedures to follow where deposits straddle an international boundary but are extracted as a single unit by one nominated oil company, as operator, which has executed a joint development agreement with all the other participants.

b. The Thailand-Malaysia Memorandum of Understanding appears also to qualify as an exercise in the strengthening of traditional friendship and the implementation of national policies stipulating control and management to be in the hands of a government-appointed authority rather than a company.
c. Other examples of such a procedure, as is described in (b.) above, may be noted in the Arabian/Persian Gulf.

d. Regarding the Japan-Republic of Korea agreement, it is noted that the area in question is claimed by China, which does not acknowledge the claims of either Japan or the Republic of Korea. In this joint agreement, both Japan and the Republic of Korea have decided that each party should appoint its own operating company and legislate its own laws and regulations to be applied in the area. The agreement also includes provisions relating to all aspects of the laws considered necessary for the control and administration of exploration and production operations.

7. Joint exploration may be undertaken by the countries involved through the services of petroleum exploration companies that have at their disposal a very high quality of technology. Opportunities for gaining appropriate experience and facilities for training should be made available to the participating countries by these companies. Agreement by oil companies to transfer sufficient technical expertise to the participating governments to reduce the gap between and among the parties would ensure a better basis for cooperation.

8. A factor of major importance in such joint arrangements is the acceptance and understanding on the part of the operating oil companies that control and management require consideration of the politics, security, and culture of the participating countries. Consideration of economic reward alone is not sufficient.

9. The necessity for oil companies involved in joint development operations to respect the political integrity of the region cannot be over-emphasized. A major factor, therefore, is the full understanding by these companies of the political implications of such operations, and their acceptance of the implied responsibilities created thereby. Arbitration is, of necessity, a legal consideration with attendant political and social factors as well.

IV. Follow-up Meetings

The Workshop attempted to cover all subjects relating to exploration and exploitation of South China Sea hydrocarbon potential. As a first undertaking of its kind, the Workshop was considered to be highly successful. Although the emphasis of this Workshop was on the geology and hydrocarbon potential of the South China Sea, the Workshop also explored technological, economic, legal, and environmental aspects of offshore exploitation and production and considered cases both within and outside the region where joint undertakings are already in place.

Due to time constraints, and the breadth of interest of the participants, the Workshop was not in a position to delve into each subject in depth, although it was considered that each subject area was sufficiently important to do so. Thus, the Workshop agreed that there should be follow-up meetings such as those listed below.

1. A meeting on the geology and hydrocarbon potential in and adjacent to the South China Sea.

This meeting would review the progress made in the implementation of the five Workshop recommendations on the subject and identify work to be done to obtain a clearer picture of the geologic structure and evolution of the South China Sea and of the hydrocarbon potential of the region.

Offshore East Asia, including Southeast Asia, has been considered as a "frontier" region in the search for hydrocarbon resources. Governments, industries, and oceanographic institutes have been undertaking a vast amount of work in this area, and new information has been coming out in recent years. A continuing mutual exchange of such information would be of benefit to all concerned. The meeting may be held in a country bordering the South China Sea.

For determination of the hydrocarbon potential of this frontier region, its geological struc-
ture, thermal development, and tectonic evolution must be established. The structure of the deeper oceanic basins controls that of prospective basins marginal to the continental regions. The manner in which the initial rupture occurred prior to opening of an oceanic area determines the extent, shape, thermal history, and sedimentary content of the marginal basins, and hence the likelihood of hydrocarbon formation, the type of hydrocarbons, and the probability of the formation of an economic deposit. Transform faulting during development of the oceanic area may distort marginal basins.

The age, manner, and rate of growth of various parts of the oceanic basin may determine the age and thermal and subsidence history of the marginal basins, as well as the presence of evaporites that may be important in later entrapment of hydrocarbons. Even development of shelf basins is now thought to be linked directly to the tectonic evolution of adjacent oceanic areas. These subjects provide ample scope for cooperation through joint study, research, and ship-borne surveys.

2. A meeting on technological, environmental, economic, and legal aspects of exploration and exploitation of hydrocarbon resources in offshore and adjacent ocean areas.

Present knowledge indicates that hydrocarbon potential in and adjacent to the South China Sea does exist. Such knowledge will be increased through the deliberations of the meeting on geology and hydrocarbon potential. Attention therefore should be given to technological, environmental, economic, financial, and policy aspects of exploration and development.

This meeting would review developments in offshore exploration and production technologies and assess likely advances in the years ahead, particularly as prospecting and development move towards deeper waters. Also, as the search for and production of hydrocarbons extends into hostile shelves and into deeper waters, the present approaches to prevention and control of marine environmental problems may not be sufficient from institutional, legislative, methodological, and financial perspectives.

Given the existence of hydrocarbon potential, it is clear that economic and financial issues are important, especially in dealing with a region such as the South China Sea. Economics of both offshore and deepwater petroleum exploration and production, as well as financial provisions in petroleum arrangements, will be examined. All of these factors affect the formation of policies for safe and economically efficient development of hydrocarbon resources in the South China Sea. In this connection, the role of industry vis-a-vis governments also needs to be reviewed.

3. A meeting on possibilities of joint development.

Having obtained through the above two meetings a better knowledge of hydrocarbon potential of the South China Sea and technological and other factors involved in its exploration and development, it may be of interest to explore the ways and means and extent to which countries bordering the Sea may be prepared to cooperate in exploration and development of hydrocarbons in overlapping claim areas.

Given the present circumstances where various claims exist to the islands in the South China Sea and where a number of areas are in dispute, this meeting would be a difficult one. With the friendly relations now prevailing among most of the countries bordering the Sea, however, and taking into consideration the precedents for joint development that already exist where the claimants may proceed with development of much needed hydrocarbon resources without compromising the basic principles behind the claims, such a meeting could serve a useful purpose.

These three meetings may culminate in a conference at which scientists, engineers, economists, legal experts, marine environment specialists, and administrators would all be invited to participate to expedite practical action in the exploration and development of the South China Sea hydrocarbon potential.
PART TWO

SUMMARY OF PRESENTATIONS AND DISCUSSIONS

The Workshop was divided into three substantive sections following the organization in Appendix 2. The titles of these sections and the papers presented within each section are listed below and then summarized. The full contributed papers will be published later in a separate Proceedings of the Workshop.

List of Contributed Papers

Offshore Hydrocarbon Production and Potential of Countries Bordering the South China Sea

1. Hydrocarbon Potential of Philippine Basins
   by Emmanuel V. Tamesis

2. Petroleum Possibilities of the Paleogene in the Philippines
   by A. Saldivar-Sali,
   N. L. Caagusan, and R. S. Rieza

3. Offshore Hydrocarbon Potential of Indonesia
   by G. A. S. Nayoan

4. Offshore Hydrocarbon Production and Potential of Thailand
   by Charan Achalabhuti

5. Geology and Hydrocarbon Potential of the Gulf of Thailand
   by Charan Achalabhuti

6. China's Offshore Potential
   by Jan-Olaf Willums

Geology and Hydrocarbon Potential of the South China Sea

7. Geology of Southeast Asia with Particular Reference to the South China Sea
   by J. A. Katili

8. The Tectonic Evolution of the South China Basin
   by Brian Taylor and Dennis E. Hayes

9. Tectonics and Deposits of the Cenozoic Era in the South China Sea
   by Luo Zhetan, Zhang Ruixiang, and He Liansheng
10. Review of Principal Hydrocarbon-bearing Basins of the South China Sea Area by Ernest P. Du Bois


12. Pre-Tertiary Hydrocarbon Potential of the South China Sea by Maurice Mainguy and Henri Fontaine

13. Textural Characteristics and Nannofossil Distribution in South China Sea Sediments by Min-Pen Chen

14. Basic Prerequisites for Petroleum Exploration and Development Programs by Allen G. Hatley


16. Considerations in Establishing an Effective Production Sharing Type Tax Regime for Petroleum by Charles J. Johnson

17. Evolution in Petroleum Legislation of Thailand by Charu-Udom Ruangsuvan

18. Environmental Planning and Management of Offshore Hydrocarbon Operations: The Development of Environmental Guidelines by J. T. E. Gilbert and P. Harrison

**Precedents for Joint Development**


21. Thailand-Malaysia Memorandum of Understanding by Prakong Polahan

22. Joint Development of Mineral Resources in Disputed Waters: The Case of Japan and South Korea in the East China Sea by Choon-ho Park
Offshore hydrocarbon potential does exist in all countries bordering the Sea, with the exception of Singapore. The high offshore exploration activity in the area, especially in China, will lead to significantly increased proven reserves. The offshore production for the region as a whole will increase and the region is likely to become a major world oil producer. Production in offshore areas will play an increasingly important role as compared with production from land, and in some countries it will be the sole source of production.

**China**

China has emerged as the leading producer of petroleum in East Asia, with 1979 production passing 2 million barrels per day. All production has come from land. However, Chinese geologists and geophysicists have been undertaking a large amount of survey work on the continental shelf, as revealed by the marine geological map of China displayed at the Workshop with permission of Chinese participants.

Chinese experts, working together with foreign oil companies, have recently carried out intensive surveying in the Mainland Shelf. The most prospective areas appeared to be at the outer shelf margin, near the 200 m water depth line, and at the innermost part of the shelf, close to the present shoreline (Paper 6., Willums). A number of fields situated at the onshore edge of the basin were discovered in the Guanchow (Canton) area as early as 1962, and more recently and notably in the Zhunjang (Pearl River) estuary in Guangdong Province. Also, discoveries off the coast of Hainan in 70 m of water, and on the Luichow peninsula, just to the north of Hainan, strengthen the belief that the continental shelf of the southern part of China may be the most promising area for production in the 1980s.

**Indonesia**

Indonesia is the leading petroleum producer in Southeast Asia, with current production exceeding 1.6 million barrels per day. Offshore Tertiary sedimentary basins in Indonesia account for 34 percent of total daily production, and the offshore reserves (including both shallow and deep waters) are estimated to exceed those on land. The producing basins offshore are basically the geological continuation of onshore producing basins. Offshore exploration has taken place mainly in the shallower part of the shelf regions, although regional reconnaissance seismic reflection data exist for deeper waters.

The hydrocarbon potential offshore Indonesia is governed by regional geological setting, water depth, and development of clastic reservoirs, with limestone plays and volcanic reservoirs becoming increasingly important. Regionally, the South China Sea area does not conform to the typical Indonesian offshore basin setting, although geologically, the Natuna basins form an undivided part of the Indonesian geological system.

**Malaysia**

The search for petroleum resources in Peninsula Malaysia began in the late 1960s. The main area of present interest is the continental shelf in the South China Sea adjacent to the east coast of Peninsula Malaysia.

The first marine seismic and gravity survey was undertaken on the continental shelf off west Sabah in 1955. Oil production began there in 1974, after almost 20 years of offshore search. Oil exploration activities have since been intensified resulting in major discoveries. In Sarawak, intense exploration activities have been carried out during the last 15 years, and have resulted in the discoveries of offshore fields. Malaysia's oil production is expected to reach 300,000 barrels per day in 1980.

**The Philippines**

The first commercial oil field in the Philippines was brought into production in early 1979 offshore northwest Palawan, about three years after the first significant wildcat discovery there. All the Philippine sedimentary basins are located within a complexly deformed zone between the Philippine Sea plate and the Asian continental plate. The basins can be classified genetically as archipelagic basins, continental margin basins, and marginal sea basins. Archi-
pelagic basins may in turn have either a volcanic arc or intervolcanic setting. The stratigraphy of most of these basins reflects the cyclicity of geologic events recognized on a regional scale in Southeast Asia, and gives further evidence of the interconnected nature of the basins from late Paleogene to Neogene time.

The Paleogene section has gained increasing importance as a possible producer based on recent information from recent deep offshore drilling and detailed onshore geological studies. The geochemistry of source rocks, hydrocarbon shows, and production tests from this section indicate that oil and gas have been generated. Isotopic analysis reveals no correlation between the oil now being produced in lower Miocene reservoirs and the contemporaneous shale that is a potential source rock, further supporting the possibility of the derivation of hydrocarbons from deeper, older sections. Exploration in the past has been focused on Neogene reservoirs. The present inclination of explorationists to test the Paleogene section will lead to more definite data and possibly to economic discoveries.

**Thailand (4., 5., Achalabhuti)**

Four commercial gas/condensate deposits have been delineated in the Gulf of Thailand with gas reserves of at least 7 trillion cubic feet. Efforts are being made to bring up 200 to 250 MMCFD from September 1981, and 500 to 700 MMCFD of gas is expected ashore by 1983-84.

Hydrocarbon accumulations in Tertiary sedimentary basins in the Gulf developed in deep sea basins where mature source beds were closely associated with reservoir deltaic sands at depths ranging from 1100 m to 2600 m within the growth-fault structures. Other prospective productive anomalies in the Gulf appear to have a large potential.

In the Thai portion of the Andaman Sea, deep-water drilling for hydrocarbons revealed that the Tertiary source beds are mainly immature. Pre-Tertiary sedimentary basins beneath the Gulf and the offshore areas of the Andaman Sea, however, may have geological conditions favorable for hydrocarbon potential. Study of source beds and reconstruction of the paleogeography of pre-Tertiary horizons, with a focus on the carbonate facies along the coastal plains of Thailand should provide important evidence in this regard.

**Vietnam**

The first offshore oil strike was made in February 1975 by Mobil with a flow rate of 2400 barrels a day. By May 1975, Shell was due to finish its scheduled drilling. The last official review of oil progress issued by the South Vietnamese regime was one of optimism. Since the reunification of Vietnam, intensive efforts have been made in the search for offshore hydrocarbon resources through PETROVIETNAM, and several foreign companies have expressed interest.

**Kampuchea**

In Kampuchea, the first offshore exploration took place in 1969, when the government at the time granted rights to the entire shelf area to ELF du Cambodge with a clause for 50 percent relinquishment after 18 months. In 1972, ELF drilled its H-1 wildcat, which was abandoned at 2,437 m. In the same year, ESSO agreed to earn a 35 percent interest in the concession by committing to a work obligation. In 1972, Marine Associates was awarded a 17,000 km² concession on part of the area relinquished by ELF. Canadian Reserve earned interest in the block by performing some seismic work. ELF continued its activities until the Government changed in 1975.

Under the present conditions in the country, no further search for hydrocarbons in the offshore areas of Kampuchea has been undertaken. It is presumed that work will be resumed when political stability is reestablished.
The South China Sea is the part of the Pacific Ocean that lies west of the Philippines and Kalimantan (Borneo) covering an area of approximately 2000 km by 1000 km. The South China Sea consists of a basin surrounded by broad shallow continental crust to the north, west, and southwest, and limited to the southeast by the northwest Borneo/Palawan trench. The eastern boundary is well defined by the Manila trench.

Geology

There is insufficient understanding of the geology, geophysics, and hydrocarbon potential of the South China Sea Basin. According to plate tectonic theory, the South China Basin is the westernmost of the Pacific marginal basins, bordered to the north and west by the passive continental margin of mainland Asia, and to the east by the active subduction zone west of Luzon. To the south, shoal areas separate the basin from an extinct subduction zone along the Sunda Shelf, Borneo, and Palawan. In tectonic setting, the South China Sea Basin is considered somewhat analogous to the Japan Sea, and its apparent genesis might closely parallel that of the Tasman and Coral Sea Basins.

Because the western third of the South China Sea Basin has not been adequately surveyed, and in any case very limited data are available, the papers and discussion concentrated on the southwest, south, and northwest portions of the South China Sea (7, Katili).

The Sumatra, Java, and Meratus arcs (Paleozoic to present), and the Tertiary Banda arc were generated by spreading centers situated in the Indian Ocean, whereas the Tertiary spreading center for the Sulawesi arc was located in the Pacific Ocean, and the spreading center for the Natuna and Palawan arcs was located in the South China Sea.

The South China Sea Basin is characterized by a central northeast-southwest oriented bathymetric deep below 2000 m, a broad intermediate shelf area between 2000 m and 200 m, and a continental shelf less than 200 m deep. Shoal areas on the intermediate shelf such as the Spratly Islands, Paracel Islands, Macclesfield Bank, and others are fragmented continental crust.

The Paleogene uplift of the China margin is evidenced by the absence of early Tertiary sediments over most of the South China shelf and coastal region. Stratigraphic and seismic data from the shoal area west of Palawan indicate that seafloor spreading in the South China Sea Basin originated in Middle Oligocene time, and the rifting of the China margin began in Middle Eocene time, resulting in a series of Middle Miocene graben-type basins under the China shelf.

New and previously existing magnetic data indicate north-south seafloor spreading in the South China Sea Basin during Middle Oligocene to Early Miocene time (32–17 m.y.B.P.) (8, Taylor and Hayes). Reconstruction by closure of this basin would place the northeastern Palawan-Mindanao microcontinent against the China shelf adjacent to the eastern Macclesfield Bank. Recent exploratory drilling on the shoal area to the west of Palawan and in the Paracel Islands supports the conjecture that these areas are underlain by continental crust. The crust beneath Macclesfield Bank may also be continental. The microcontinental blocks extending from Luconia shoals to southwest Mindoro were apparently rifted from the Chinese margin and moved southward. Marine seismic data indicate that a block-faulted continental basement connects the shoal area to the west of Palawan with northeast Palawan. The northeastern extension of the Cretaceous and Paleogene subduction zone northwest of Borneo and southern Palawan extends only to the vicinity of the Ulugan fault and thus terminates south of the Calamian block.

According to another view, (9, Lou Zhetan, Zhang Ruixiang, and He Liansheng), the South China Sea consists of a faulted continental craton. Four units originated during the Mesozoic Era, namely, the South China fault block on the north, the Indo-China block on the west, the Nansha-Borneo faulted blocks on the south, and Island arc fragments on the east. Subsequent development of Cenozoic sedimentary basins (Figure 1) on the faulted blocks are presumed to be closely related to tensional rifting accompanying divergence of the continental blocks.

Their basic model for sedimentation in these
Figure 1. Isopach map of Cenozoic deposits of the South China Sea. (From Luo Zhetan, Zhang Ruixiang, and He Liansheng, Tectonics and Deposits of the Cenozoic Era in the South China Sea.)
basins follows the classical concept of sedimentary sequences in tension-rifted and diverging continental margins in which the initial stage of riftting is followed by sedimentation of terrestrial and transitional sediments, and subsequently by deposition of littoral and neritic sediments accompanying regional depression and transgression.

To have a complete picture regarding the tectonic evolution of the South China Basin and its relationship to hydrocarbon potential, additional geological and geophysical information will be required, particularly from the China plate margin.

Tertiary Hydrocarbon Potential

The South China Sea is ringed by recent hydrocarbon finds, such as northwest Palawan in the Philippines, the Gulf of Tonkin, offshore Guantang, China, and the known fields in offshore Sabah and Sarawak. Potential oil reserves were assessed for a total of 11 genetic basin types identified in Southeast Asia. The dominant basin types are oceanic margin, wrench, rift, and continental margin. Those basins bordering the South China Sea contain some 56 percent, or 20 billion barrels of the remaining undiscovered reserves in Southeast Asia.

The known hydrocarbon-bearing basins of the South China Sea area were reviewed, namely, the Thai Basin, the Malay Basin, the West Natuna, and Penyu Basins; the Saigon (Ho Chi Minh) and Mekong (Vung Tau) Basins; the East Natuna area; the Greater Sarawak Basin including Central Luconia and Balingian depositional provinces; the Baram Delta/Brunei-Sabah Basin; and the Northwest Palawan Shelf (Figures 2-7; 10., Du Bois). Where hydrocarbons have been encountered, the deposits are commonly associated with rocks of Middle and Late Miocene age. Oligocene and Pliocene occurrences are locally important. With some exceptions, most sedimentary fill was deposited within a continental to coastal environment. Such sediments are commonly gas prone; where oil prone, there are suggestions that the oil has been generated under greater thermal maturity.

Stratigraphic correlation depends largely on recognition of stages in cyclic transgressive-regressive sequences by means of integration of information derived from seismic stratigraphy, paleontology, and environmental analysis. The structures in the basins are commonly anticlinal and fault-associated; and the anticlines are commonly suspected to have diapiric cores. Major transcurrent faults of regional extent may have been instrumental in the formation of depositional provinces and anticlinal trends.

An examination of eight Tertiary basins (Figure 8) revealed a relationship of hydrocarbons to both clastic and carbonate facies in Tertiary sedimentary cycles (Figure 9; 11., Beddoes). These Tertiary sedimentary cycles can be correlated in a general way throughout East Asia. Each basin, however, has its unique structural, stratigraphic, and temperature-gradient characteristics, reflecting its unique setting in relation to plate interactions. This relationship forms a basis for improved exploration and predictability in other Tertiary basin areas in the region (Figure 10).

Pre-Tertiary Hydrocarbon Potential

(12., Mainguy and Fontaine)

Investigations undertaken so far in the search for hydrocarbon resources in Southeast Asia have been confined mainly to Tertiary formations, and it is from these formations that oil and gas are produced. Very little prospecting has been conducted in older strata. However, petroleum potential in pre-Tertiary sedimentary sequences should not be neglected.

There are two different types of hydrocarbon accumulations in the pre-Tertiary sediments. In the first type, hydrocarbons are generated in Tertiary source beds and have subsequently migrated into older rocks. The other type is where the source bed can be attributed with certainty to pre-Tertiary rocks. A great part of the pre-Tertiary sections of countries bordering the South China Sea consists of rather fresh rocks, unaltered by metamorphism, and containing significant amounts of organic matter.

The two factors that have deterred prospecting in pre-Tertiary formations are (1) the great depth of possible objectives, and (2) high heat flows. The latter probably have been the most important deterrent vis-a-vis deep prospecting in this part of the world, as it appears that only gas can be found in these sections.
Figure 2. Thai Basin structure in seconds TWT; Panjang Basin sediment thickness in kilometers. (From Ernest P. Du Bois, Review of Principal Hydrocarbon-Bearing Basins of the South China Sea Area.)
Figure 3. Malay, West Natuna, and Penyu Basins: sediment thickness. (From Ernest P. Du Bois, Review of Principal Hydrocarbon-Bearing Basins of the South China Sea Area.)
Figure 4. Mekong and Saigon Basins: sediment thickness. (From Ernest P. Du Bois, Review of Principal Hydrocarbon-Bearing Basins of the South China Sea Area.)
Figure 5. East Natuna and offshore Sarawak: sediment thickness. (From Ernest P. Du Bois, Review of Principal Hydrocarbon-Bearing Basins of the South China Sea Area.)
Figure 6. Baram Delta and offshore Sabah: sediment thickness. (From Ernest P. Du Bois, Review of Principal Hydrocarbon-Bearing Basins of the South China Sea Area.)
Figure 7. Northwest Palawan: sediment thickness. (From Ernest P. Du Bois, Review of Principal Hydrocarbon-Bearing Basins of the South China Sea Area.)
Figure 8. Tectonic elements of Southeast Asia. (From Leslie R. Beddoes, Jr., Relationship of Hydrocarbons to Tertiary Sedimentary Cycles.)
<table>
<thead>
<tr>
<th>TERTIARY DEPOSITIONAL CYCLE</th>
<th>PLAY-TYPE</th>
<th>CUMULATIVE OIL PRODUCTION* (to mid-79) (MILLION BBLS.)</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEOGENE REGRESSION</td>
<td>E CARBONATES</td>
<td>200 ± (plus major gas production)</td>
<td>1.9 %</td>
</tr>
<tr>
<td>(LATE MIocene TO EARLY PLIOcene)</td>
<td>D CLASTICS</td>
<td>4200 ± (plus major gas production)</td>
<td>39.3 %</td>
</tr>
<tr>
<td>NEOGENE TRANSGRESSION</td>
<td>C CARBONATES</td>
<td>210 ± (plus major gas production)</td>
<td>2.0 %</td>
</tr>
<tr>
<td>(LATE OLIGOcene TO MIDDLE MIocene)</td>
<td>B CLASTICS</td>
<td>5800 ±</td>
<td>54.3 %</td>
</tr>
<tr>
<td>PALEogene TRANSGRESSION</td>
<td>A CLASTICS</td>
<td>270 ±</td>
<td>2.5 %</td>
</tr>
<tr>
<td>(EOcene TO EARLY OLIGOcene)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>10,680 ±</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

*CUMULATIVE PRODUCTION IN: BURMA, BRUNEI, MALAYSIA, INDONESIA AND PHILIPPINES (after Auldrige, 1979)

Figure 9. Cycles of sedimentation during the Tertiary in Southeast Asia. (From Leslie R. Beddoes, Jr., Relationship of Hydrocarbons to Tertiary Sedimentary Cycles.)
Figure 10. Play-type distribution of cumulative oil production, Southeast Asia. (From Leslie R. Beddoes, Jr., Relationship of Hydrocarbons to Tertiary Sedimentary Cycles.)
Technological, Economic, Legal, and Environmental Aspects of Exploration and Exploitation of Hydrocarbon Resources in Offshore and Adjacent Ocean Areas (Papers 14–18)

The Workshop considered a wide range of subjects, including the basic prerequisites for hydrocarbon exploration and development programs, resource and development policies and legislation, and the need for environmental planning and management of offshore petroleum operation.

Basic Prerequisites for Petroleum Exploration and Development Programs (14., Hatley)

It is important to gain more geological and geophysical knowledge to determine favorable or unfavorable areas for hydrocarbon deposition in the South China Sea. If the indications are that there are possibilities for hydrocarbon discovery, as is the case of the South China Sea region as a whole, then certain basic prerequisites are necessary for initiating and maintaining rational and orderly oil and gas exploration and development programs.

These prerequisites include: (1) realistic government policies augmented by effective petroleum legislation to initiate and promote adequate exploration and development programs, (2) a “reasonable expectation” for success in attaining the goals of all participating parties, (3) available “risk capital” to invest in these programs, and (4) “sound exploration judgment” and adequate technology possessed by those responsible for conducting programs. There is considerable scope for clarification of “realistic policies,” “reasonable expectation,” “risk capital” and “sound exploration judgment.”

A nation’s “right of sovereignty” over its own natural resources is indisputable, and this right has to be exercised in the interest of each country’s economic development, taking into consideration that country’s choice of priorities, methods, objectives, and goals. Consequently, the “best” government policy or legislative approach for one country is not necessarily applicable to others.

Most, if not all, countries bordering the South China Sea have sought and obtained, to varying degrees, outside involvement for exploration and development, risk capital, expertise, equipment, technology, and markets. Thus, foreign companies have been engaged in exploration within a host nation’s sovereign territory and the goals of the state and foreign industry operations in that country must be in sufficient harmony for such arrangements to proceed. To achieve this harmony, dialogue has to be maintained and certain compromises may be necessary and desirable by each party.

“Risk capital” is perhaps one of the most misunderstood terms in relation to the petroleum industry. “Risk capital,” in the petroleum industry, is composed of funds taken almost exclusively from profits and invested by a company in exploration programs that historically have no better than about a 2 percent chance for discovery of recoverable reserves in excess of 1 million barrels of oil or gas equivalent. From an industry perspective, in order to attract “risk capital” to an area or to a nation that has either not been explored or where more exploration is desired by the host nation, it is vital that the work contract or concession agreement, along with the economic and geologic evaluations of the prospects, allows a rate of return on investment appropriate to the estimated risks involved.

Geological conditions provide an essential element in a “reasonable expectation for success.” Such expectations also have economic and technological connotations. Evaluations and expectations are subject to change with time, technology, and the knowledge of explorationists. Sound judgment depends on technical expertise, based on years of experience in research. Without past and present public and privately-sponsored, costly, petroleum-oriented research and development projects, along with the practical experimentation and application in field operations, many of today’s producing oilfields would not have been discovered or produced.

Considerations in Establishing an Effective Production Sharing Type Tax Regime for Petroleum (16., Johnson)

The primary reason for developing a nation’s petroleum resources for export is to generate government revenues. The goal of most govern-
ments is to maximize the net present value of their petroleum revenues subject to efficient exploration and production practices and depletion considerations.

A basis was provided for the determination of an effective tax regime that would achieve this goal. The analysis focused on 12 standard production-sharing contract options applied to four hypothetical exploration environments. A relatively recently proposed Resources Rent Tax Option was also examined as an add-on to production-sharing contracts or other tax regimes. The results highlighted the need for governments to understand and to use appropriate profit criteria, an understanding of multinational petroleum corporation behavior, and *a priori* geological information, in establishing effective tax regimes for petroleum.

Among the issues discussed were (1) the significance of the rate of depreciation, (2) determination of the appropriate rate of discount, and (3) whether a fixed internal rate of return to a company would work. The rate of depreciation is quite important. Because governments tend to use a lower discount rate than private companies, a relatively high rate of depreciation provides a rather unique opportunity to gain for both investor and government. The investor recovers its investment more rapidly, thus reducing perceived risks and increasing its internal rate of return on investment. Government induces more investment and can increase its net present value of revenues by taking a higher share of profits after the depreciation period than would otherwise be possible.

Actual calculation of a government’s discount rate is quite difficult. A discount rate of 10 to 15 percent in current terms was used in the analysis. A fixed internal rate of return is not practical because (1) most companies would not knowingly invest unless the rate of return was set at a relatively high level and (2) it would remove the incentive for financial rewards resulting from innovation and increased efficiency in mining and processing operations.

**Implications of the Southeast Asian Contractual Framework (15., Siddayao)**

The property rights arrangements covering petroleum resource development in Southeast Asia imply certain economic responses on the part of the firms contracting to develop such resources. The data indicate that the supply of such petroleum reserves are in fact sensitive to such arrangements. The structure of the industry also suggests that decisions to supply such reserves are generally made within a context that extends beyond the boundaries of the region.

Analyses of the specific contractual terms governing cost recovery and production bonuses suggest, however, that, where the goal of the host country is accelerated development of its petroleum resources, there may in fact be underinvestment in the exploration and development of such resources, especially in high risk areas. These contract provisions have serious implications for the supply of petroleum reserves in Southeast Asia.

They suggest that a better understanding of firm behavior may be required to allow a host government to develop strategies that will optimize its supply of reserves as well as the benefits it wants to capture from the development of its resource endowments. The profit-maximizing motive of the investor, however this is defined, remains a paramount factor in assessing the response of an investor to a policy variable. The effectiveness of a host government’s strategies depends significantly on the means it chooses to develop its petroleum resources, keeping in mind the economic objective of the investor.

**Environmental Planning and Management of Offshore Hydrocarbon Operations (18., Gilbert and Harrison)**

The results of a meeting on this subject organized by EAPI were summarized, including a general approach to the planning and management of environmental aspects related to offshore oil and gas prospecting, drilling, development, and production. Preparation of environmental guidelines are part of a conscious effort to move from the present focus on oil spills and clean up operations to an approach that can identify environmental concerns and plan to minimize adverse impacts from the very early stages of a project.

In this regard, the following relevant environmental management principles were presented to the Workshop:

1. the ocean, marine life, seafloor, and adjoining coastal zone should be seen as an existing environmental resource;
2. effective early environmental planning is based on cooperation, communication and effective information dissemination to all parties;
3. early determination of the environmental parameters the industry will be required to work within are necessary requirements for both industry and the country involved; and
4. in order for the exploration, development, and production phases to proceed, sound and uncomplicated environmental-institutional relationships are required.

On this basis, point-by-point guidelines were presented regarding action to be taken in constructing a management plan and in negotiating environmental aspects with operators and other marine area users.

**Precedents for Joint Development (Papers 19–22)**

Four precedents of joint development of hydrocarbons in areas of overlapping boundary claims were reviewed and each situation was considered to be basically different.

**North Sea Example (19., Onorato)**
In the case of the North Sea example, there was no dispute over sea boundaries between the parties concerned at the time of negotiations for joint development. Arrangements between Britain and Norway over the Murchison and Sforfjord oilfields and the Frigg gasfield stipulated the terms of joint development of unitized deposits. The Anglo-Norwegian precedents are, therefore, an excellent example of one way to avoid an endless legal squabble.

**The Saudi Arabian/Persian Gulf Example (20., Fesharaki)**
There were three primary reasons for the success of approaches to joint development in the Saudi Arabian/Persian Gulf: (1) political and territorial disagreements were set aside where oil was concerned on the basis of an “unwritten agreement” to keep oil out of differences, (2) production from the joint offshore fields made up only a small portion of the total production of the oil-producing States concerned, and (3) the Gulf States had a practical understanding that the key to offshore joint development was how to get the oil fields quickly developed. Thus, the situation in the Gulf has to be seen in the perspective of the special political relations among the coastal states.

**The Thailand-Malaysia Example (21., Polahan)**
This is an example of a practical approach to jointly develop oil from an area of overlapping claims on the continental shelf while continuing to seek settlement of the sea boundary issues. The fact that the joint development area in this case represents only a small portion of each party’s claims to the continental shelf made it easier for the parties to agree on the arrangements.

**The Japan–Republic of Korea Example (22., Park)**
This case is the most complicated of the four examples presented at the Workshop and differs from the others in many ways. The joint development area is believed by both claimants to be the most promising part of the East China Sea. Each party singularly insists on the tenability of its own claims in disregard of the other coastal state(s’) claims; besides the two parties, the area is also claimed by China; and the two-party agreement is silent on how the boundary issues will be resolved in the future.

**Summary (Miyoshi)**
Agreement was reached in one way or another on the delimitation of continental shelf boundaries in the Anglo-Norwegian and Saudi Arabian/Persian Gulf precedents, whereas no delimitation agreement was arrived at in the Japanese–Republic of Korea and Thai-Malaysian joint development precedents. This difference is due to the fact that the first two precedents of joint development were arranged subsequent to delimitation agreements that carried a clause on “future discoveries of common deposits,” whereas the latter agreements were concluded solely for joint development purposes.

The Japan–Republic of Korea joint develop-
ment agreement and the Thailand-Malaysia memorandum of understanding were both concluded to set aside or bypass the conflicting boundary claims, but only the latter arrangement provides for continuing efforts to resolve the boundary dispute. In view of these differences, caution is advised in applying these precedents to other candidate areas.

Since joint development involves politically sensitive issues, especially in the case of the East China Sea example, it appeared advisable not to elaborate on claims in dispute, as it was not necessary to do so in discussions in which the technicalities of arranging joint development were the major interest. The very idea of a "joint" development or undertaking, however, implies the necessity of cooperation between the parties, although the concept of State sovereignty must not be disregarded. Joint development would seem to lead to the need for the development of a law of cooperation, coordination, and good neighborliness. In a sense such law has been emerging.

Traditionally, the territory of a State has been one of the essential constituents of the modern State system (the others being the population and the political power of the government.) The continental shelf, since the Truman Proclamation of 1945, has been regarded mutatis mutandis as an important part of the territory of the State. It is in this sense that the delimitation of continental shelf boundaries is a very sensitive issue, nearly as sensitive as the delimitation of land boundaries. This is so much so that it could be thought of as extraordinary to put aside some area of the continental shelf for the purpose of joint work in it, when otherwise it would be jealously controlled under the adjacent State's sovereignty. Consequently, there must be some extraordinary rationale for a State to assent to such an idea.

Perhaps the strongest case for a State's action for joint undertaking would be its sense of urgency or obligation to protect its interests in potential oil or gas deposits. Thus, States adjacent to the continental shelf area in question may come to terms for "functional" purposes of joint development. The States can designate licensees or concessionaires for actual exploration for, or exploitation of, the mineral resources in question. Yet the States retain sovereign control over the seabed and its subsoil. In short, States may choose to concede part of their sovereignty for the sake of "functional" joint development or undertaking, but do not abandon their sovereign control over such work.

The crucial question here is whether the "functional" concession on the part of States has much State practice and can reasonably be interpreted to have contributed to the formation of customary rules of international law in the field of joint development. There are relevant trends pointing towards customary rules in the field of joint work. One is the "common heritage of mankind" principle for the resources of the deep seabed. Another is the concept of "only one earth" or "Spaceship Earth" as the common recognition of the shared environment of the globe.

In conclusion, cooperation between States in the exploitation of common deposits may not yet be customary law, but it might be considered customary international law to consult and reach agreement with the other States concerned before unilaterally exploring or exploiting a common deposit. The four examples thus indicated not only the desirability of joint development in areas of overlapping claims but also the difficulties in the process of negotiation for such arrangements.
APPENDIX 1
LIST OF PARTICIPANTS

Y. B. DATUK HARUN ARIFFIN
Chairman of Malaysia Joint
Authority for the Exploitation of the Hydrocarbons Resources in the Joint Development Area of Malaysia-Thailand
Petroleum Development Divison
(Implementation Co-ordination Unit)
Prime Minister's Department
Wisma Damansara
Jln. Semantan
Kuala Lumpur
MALAYSIA

MR. PAUL S. BASILE
International Energy Development Corporation
18, rue Le Corbusier
CH-1208 Geneva
SWITZERLAND

MR. LESLIE R. BEDDOES, JR.
General Manager
Cities Service East Asia, Inc.
Suite 606 Cathay Building
Mount Sophia Rd.
SINGAPORE 0922

DR. CHARAN ACHALABHUTI
Advisor, Office of Natural Gas Project
Petroleum Authority of Thailand
A. S. Building, 1 Soi Yasoob 1
Vibhavadi Rangsit Road
Bangkok 9
THAILAND

DR. CHEN MIN-PEN
Associate Professor
Institute of Oceanography
National Taiwan University
Roosevelt Road, Section IV
Taipei, Taiwan
CHINA

DR. CHOU JUI-TUN
Office of the Chief Geologist
Chinese Petroleum Corporation
7th Floor, China Gulf Plastics Building
3 Tun-Hwa S, Road
Taipei, Taiwan
CHINA
DR. FAN POW FOONG  
Associate Professor  
Department of Geology and Geophysics  
University of Hawaii  
Honolulu, Hawaii 96822  
U.S.A.

DR. WILLIAM K. GEALEY  
Geologic Consultant (Plate Tectonics)  
Chevron Overseas Petroleum, Inc.  
575 Market Street  
San Francisco, California 94105  
U.S.A.

MR. MICHAEL T. HALBOUTY  
The Halbouty Center  
5100 Westheimer Road  
Houston, Texas 77027  
U.S.A.

DR. WARREN B. HAMILTON  
United States Geological Survey  
Denver, Colorado  
U.S.A.

IR. EFFIRE HANTORO  
Director for Development  
Directorate General of Oil and Gas  
Jakarta  
INDONESIA

IR. NOTOWIJOYO HARIADI  
Senior Staff, Geological Research and Development  
PERTAMINA  
Pertamina Building, 16th Floor 1, Jalan Merdeka Timur  
Jakarta  
INDONESIA

GENERAL PIET HARYONO  
President-Director  
PERTAMINA  
Jalan Perwira 6  
Jakarta  
INDONESIA

MR. ALLEN G. HATLEY  
Vice-President, Eastern International Area  
Cities Service Company  
P. O. Box 642  
Houston, Texas 77001  
U.S.A.

DR. DENNIS E. HAYES  
Professor of Geological Sciences and Associate Director  
Lamont-Doherty Geological Observatory  
Columbia University  
Palisades, New York 10964  
U.S.A.

MR. HE LIANSHENG  
Petroleum Geologist  
South China Sea Geological Investigation Headquarters  
Guangzhou  
CHINA

DR. JOHN A. KATILI  
Director-General of Mines  
Ministry of Mines and Energy  
Jakarta  
INDONESIA

MR. PHILIP L. LAWRENCE  
Mobil Exploration and Producing Services, Inc.  
P. O. Box 900  
Dallas, Texas 75200  
U.S.A.

PROFESSOR LUO ZHETAN  
Director, Department of Petroleum Geology  
Chengdu College of Geology  
Chengdu  
CHINA

MR. MAURICE MAINGUY  
30 avenue du Marechal Joffre 78400 Chatou  
FRANCE

DR. MASAHIRO MIYOSHI  
Professor, Faculty of Law  
Aichi University  
Machihata Toyohashi  
Aichi (440)  
JAPAN

MR. G. A. S. NAYOAN  
Co-ordinator for Exploration  
PERTAMINA  
P. O. Box 12  
Jakarta  
INDONESIA
MR. CHUNG GONG SOO, Grantee
Environment and Policy Institute, and Korea Research Institute of Geoscience and Mineral Resources

DR. FEREIDUN FESHARAKI, Fellow
Resource Systems Institute

MR. JOHN GILBERT, Fellow
Environment and Policy Institute, and Senior Investigating Officer, New Zealand Commission for the Environment

DR. PETER HARRISON, Fellow
Environment and Policy Institute, and Associate Professor, Department of Geography University of Ottawa, CANADA

DR. CHARLES JOHNSON, Research Associate, and Project Leader
Resource Systems Institute

DR. C. Y. LI, Fellow
Environment and Policy Institute, and Honorary Advisor and Senior Consultant, CCOP

DR. WILLIAM H. MATTHEWS, Director
Environment and Policy Institute

DR. CHOO-N-HO PARK, Research Associate
Environment and Policy Institute and Culture Learning Institute

DR. CORAZON SIDDAYAO, Fellow
Resource Systems Institute

DR. TOUFIQ SIDDIQI, Research Associate and Project Coordinator
Environment and Policy Institute

DR. MARK J. VALENCIA, Research Associate and Project Coordinator
Environment and Policy Institute
APPENDIX 2
AGENDA AND ORGANIZATION OF THE MEETING

The Workshop was chaired by Dr. C. Y. Li, Fellow, EAPI, and former Coordinator of CCOP and at present its Senior Consultant. Dr. Mark J. Valencia, EAPI Research Associate and Coordinator of the EAPI Project “Marine Environment and Extended Maritime Jurisdic-tions,” served as General Rapporteur. The Workshop, after considering the scope of the meeting as outlined in the INTRODUCTION and taking into account the papers submitted to it, adopted the following agenda:

A. Introduction—Scope of the Workshop and Consideration and Adoption of the Agenda

B. Geology of Southeast Asia, with Particular Reference to the South China Sea

C. Offshore Hydrocarbon Production and Potential of Countries Bordering the South China Sea
   1. Hydrocarbon Potential of Philippine Basins
   2. Petroleum Possibilities of the Paleogene in the Philippines
   3. Offshore Hydrocarbon Potential in Indonesia
   4. Offshore Hydrocarbon Production and Potential of Thailand
   5. Geology and Hydrocarbon Potential of the Gulf of Thailand
   6. China’s Offshore Potential

D. Geology and Hydrocarbon Potential of the South China Sea
   1. Tectonic Evolution of the South China Basin
   2. Review of the Principle Hydrocarbon-Bearing Basins of the South China Sea
   3. Relationship of Hydrocarbons to Tertiary Sedimentary Cycles, Southeast Asia
   4. Pre-Tertiary Hydrocarbon Potential of the South China Sea
   5. Textural Characteristics and Nannofossil Distribution in South China Sea Sediments

E. Technological, Economic, Legal, and Environmental Aspects of Exploration and Exploitation of Hydrocarbon Resources in Offshore and Adjacent Ocean Areas
   1. Basic Prerequisites for Petroleum Exploration and Development Programs
   2. Petroleum Resource Development Policies and Implications of the Southeast Asian Contractual Framework
   3. Considerations in Establishing an Effective Production Sharing Type Tax Regime for Petroleum
   4. Evolution in Petroleum Legislation of Thailand
   5. Environmental Considerations in Hydrocarbon Exploration and Production

F. Precedents for Joint Development
   1. The North Sea
   3. The Case of Japan and the Republic of Korea in the East China Sea
   4. Thailand-Malaysia Memorandum of Understanding (on the Establishment of a Joint Authority for the Exploitation of the Hydrocarbon Resources)

G. Applicability of Precedents to Possible Areas for Joint Undertaking

H. Suggestions for Follow-up Research and Other Activities
The Workshop was organized into sessions dealing with four principle subjects of discussion:

**Session No. 1: Offshore Hydrocarbon Production and Potential of Countries Bordering the South China Sea**  
Chairman: A. Saldivar-Sali  
Rapporteur: Rene Daniel S. Rieza

**Session No. 2: Geology and Hydrocarbon Potential of the South China Sea**  
Chairman: John A. Katili  
Rapporteur: Glenn L. Shepherd

**Session No. 3: Technological, Economic, Legal, and Environmental Aspects of Exploration and Exploitation of Hydrocarbon Resources in Offshore and Adjacent Ocean Areas**  
Chairman: Allen G. Hatley  
Rapporteur: Charles Johnson

**Session No. 4: Precedents for Joint Development**  
Chairman: Datuk Harun Ariffin  
Rapporteur: Choon-ho Park

Towards the conclusion of the Workshop, three working groups were established to formulate conclusions and recommendations for consideration and adoption by the Workshop:

**Working Group No. 1: Geology and Hydrocarbon Potential of the South China Sea**  
Chairman: Emmanuel V. Tamesis  
Rapporteurs: Glenn L. Shepherd, Rene Daniel Rieza

**Working Group No. 2: Technological, Economic, Legal, and Environmental Aspects**  
Chairman: Allen Hatley  
Rapporteur: Mark J. Valencia

**Working Group No. 3: Precedents for Joint Development**  
Chairman: Datuk Harun Ariffin  
Rapporteur: Choon-ho Park
Overview

Many countries are extending their national jurisdictions to 200 nautical miles from their shores. Yet many of the resources of the ocean are transnational in distribution, and the ocean, as a continuous fluid system, transmits environmental pollutants from one jurisdiction to another. Also, maritime activities such as transportation have relied on free access to areas now falling within national jurisdictions. As nations develop policies for managing their new jurisdictional areas, they need a sufficient scientific and technical understanding of the transnational character of the ocean environment. Without this knowledge, such policies may increase international tensions and misunderstandings and lead to conflicts concerning management of marine activities, resources, and environmental quality. This project focuses on issues that will arise in Southeast Asian seas during the decade of the 1980s.

Central Research Questions

1. What is to be managed? Resources and resource-related activities, or use patterns, are to be managed. Important resource activities include oil and gas exploration and exploitation, fishing, transportation and navigation, and scientific research.

2. How are these resources and resource-related activities to be managed? The types of jurisdictional regimes and their specific content will determine how these are to be managed.

3. Who will manage these resources and resource-related activities in these jurisdictional areas, and who will be affected? Extended jurisdiction, boundary delimitation, and resolution of boundary disputes will determine this.
Major Research Areas

Research is being conducted in four substantive areas: transnational efforts on transboundary fish stocks, regional marine environmental management issues, energy material transportation and environmental policies, and transnational oil and gas resource management issues. Each of these areas is examined with respect to three fundamental components of transnational ocean management issues: the natural environment, political-socioeconomic factors, and juridical regimes. Results of much of this research will be synthesized in a marine policy atlas.

Transnational Efforts on Transboundary Stocks
Access of distant-water fishing fleets to stocks within many of the extended jurisdictional zones is undergoing an abrupt or phased reduction, or an alteration of operational terms. As a result, distant-water fishing efforts are being concentrated in jurisdictional zones of nations permitting favorable concessionary access. These changes have significant implications for sustainable fishing practices and for international relations as fish migrate among national zones.

At EAPI, researchers are comparing the advantages and disadvantages—for the resource owner, resource exploiter, and the resource—of various cooperative arrangements for distant-water fishing for tuna. This substantive area has received the focused effort of a multidisciplinary, multicultural team of researchers from Indonesia, the Philippines, Japan, New Zealand, Australia, Canada, and the United States.

Although the efforts in this area are nearly complete for project purposes, there is a possibility that related activities may be organized in the future. Several journal papers and monographs are being prepared for publication as a result of the work in this area.

Regional Marine Environment Management Issues
Many aspects of environmental management will always remain the responsibility of nation states, while others may best be approached on a coordinated regional basis. Scientific, legal, and policy approaches to regional environmental protection have been or are being formulated or contemplated by the states bordering semi-enclosed seas such as the Baltic, the North Sea, the Mediterranean, the Caribbean, and the Iranian-Saudi Arabian Gulf. In this research area, these approaches will be compared to the natural and political circumstances pertaining in the South China Sea region, with a view to delineating possible useful precedents. As part of this work, EAPI co-sponsored with several United Nations and regional organizations a workshop on Coastal Area Development and Management in Southeast Asia in late 1979. It is anticipated that three monographs will be prepared reporting on research in this area.

Energy Material Transportation and Environmental Policies in Extended Jurisdictional Zones
Environmental policies in extended jurisdictional zones may influence transportation routes of energy sources or byproducts such as oil, uranium, spent nuclear fuel, and eventually, hydrogen. Altered routing of energy materials may have an impact on energy policies themselves. Also, energy needs and policies will determine energy material transport needs and policies and thus influence environmental policies regarding transport of energy material in extended jurisdictional zones. This is leading to the prospect of a dynamic interaction between national energy policies and environmental policies in extended jurisdictional zones, with transportation requirements, routes, and standards of transport as the link. This project works closely with the EAPI project on Environmental Dimensions of Energy Policies to examine these areas.

An EAPI workshop on the subject, to be co-sponsored by the Dalhousie Ocean Studies Programme of Dalhousie University in Canada, is scheduled for late 1980, and the proceedings will be published. In addition, a monograph will be completed in 1981.

Transnational Oil and Gas Resource Management Issues
Management regimes for oil and gas exploration and exploitation in disputed areas, transboundary deposits and research, and trans-
boundary environmental quality in relation to oil spills emanating from oil exploration are important components of transnational ocean policy issues.

The objectives of this research area are to identify and characterize transnational issues involving offshore hydrocarbons and to analyze the transnational implications of alternative approaches to their resolution. For example, it is possible that cooperative joint ventures could be established by the disputants with multinational companies for the development of hydrocarbon resources in the disputed areas by drawing on precedents of agreements such as those between the Republic of Korea and Japan and between Thailand and Malaysia. Disputes involving accumulations divided by extended national resource ownership could possibly be dealt with in similar fashion.

A major workshop on the subject, co-sponsored with the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP), was held in mid-1980 with participants from ten countries and five multinational oil companies. The proceedings will be published.


In addition to specific results of research in the four areas, which will be published as they develop, a major objective of this project for the next two years is the preparation of an atlas of marine policy parameters and issues in the Southeast Asian seas. Its purpose will be to set forth research findings from the Project in graphic and cartographic formats that may be useful as background material in cooperative, common, and national policy decisions.

The atlas is intended to be more than a mere storehouse for information; it will also be an analytical and heuristic device for broadening understanding of national attitudes and behavior toward the oceans in a regional setting to assist in policy making.

Included in the atlas will be displays of several topics: the natural environment and its use by humans, national indices directly relevant to patterns of marine use, patterns of use and trends, present and projected marine jurisdictional boundaries and content in the South China Sea, and projections and scenarios of international relationships. A companion volume of policy analysis may be prepared, drawing heavily on the work of individual project members.
THE EAST-WEST CENTER—officially known as the Center for Cultural and Technical Interchange Between East and West—is a national educational institution established in Hawaii by the U.S. Congress in 1960 to promote better relations and understanding between the United States and the nations of Asia and the Pacific through cooperative study, training, and research. The Center is administered by a public, nonprofit corporation whose international Board of Governors consists of distinguished scholars, business leaders, and public servants.

Each year more than 1,500 men and women from many nations and cultures participate in Center programs that seek cooperative solutions to problems of mutual consequence to East and West. Working with the Center's multidisciplinary and multicultural staff, participants include visiting scholars and researchers; leaders and professionals from the academic, government, and business communities; and graduate degree students, most of whom are enrolled at the University of Hawaii. For each Center participant from the United States, two participants are sought from the Asian and Pacific area.

Center programs are conducted by institutes addressing problems of communication, culture learning, environment and policy, population, and resource systems. A limited number of “open” grants are available to degree scholars and research fellows whose academic interests are not encompassed by institute programs.

The U.S. Congress provides basic funding for Center programs and a variety of awards to participants. Because of the cooperative nature of Center programs, financial support and cost-sharing also are provided by Asian and Pacific governments, regional agencies, private enterprise and foundations. The Center is on land adjacent to and provided by the University of Hawaii.

East-West Environment and Policy Institute
East-West Center
1777 East-West Road
Honolulu, Hawaii 96848