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COMMITTEE FOR CO-ORDINATION OF JOINT PROSPECTING FOR MINERAL RESOURCES IN ASIAN OFFSHORE AREAS
(C C O P)

THE OFFSHORE HYDROCARBON POTENTIAL OF EAST ASIA
A Decade of Investigations (1966-1975)

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PREFACE

CCOP was established in 1966 with the principal objective of co-ordinating, sponsoring and facilitating the development of offshore hydrocarbon resources in east Asia. At the special session held in Tokyo in April 1973 of the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP), which serves as the governing body of the project for east Asian offshore prospecting assisted by the United Nations Development Programme (UNDP), it was unanimously agreed that there should be a review of results of investigations of hydrocarbon potential in east Asian offshore areas.

In deciding the above, the session considered the fact that CCOP, since its establishment in 1966, has played a leading role in attracting the world's interest in the search for petroleum and natural gas to offshore areas of east Asia. Before CCOP came into being, very little offshore exploration for hydrocarbons had been undertaken in the area. Since 1966, regional and subregional surveys sponsored by CCOP have been carried out, which have been followed by more detailed work by institutions and private industry. Considering the lack of knowledge prior to 1966, the progress has been spectacular, with drilling ventures completed, started, and/or contemplated at an early date in the offshore areas of the Gulf of Thailand, Sunda Shelf, South China Sea, East China Sea, and the Yellow Sea.

In pursuing the directives of the special session, reports on Asian offshore geology and petroleum exploration were prepared, with the help of a consulting firm, and were submitted to the CCOP regular session held in Bangkok during September 1973. Various papers and country statements given at that latter meeting have helped in revising the report, which was issued in 1974 as a dual supplement to the CCOP annual report.

The rapid developments in both knowledge and activity in the region, partially as a result of CCOP's efforts, have necessitated the revision of that document. It is also appropriate that this document revision coincides with the tenth anniversary of the founding of CCOP and thus includes all developments over the past decade (to mid-1975).

It is with the interests and aspirations of the member countries in mind in regards to offshore hydrocarbon resource development that the

Project Office takes great pleasure in presenting the present document. It is sincerely hoped that the member countries will find this a useful review upon which they may base their projected offshore hydrocarbon activities over the next decade.

It may be mentioned that due to the change of governments and consequently change of government policies on petroleum development, the information concerning Cambodia and Viet-Nam, as contained in Part II of this document, are for record only.

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INTRODUCTION

The discussed area includes the offshore region under the jurisdiction of the member countries of the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP) which comprises most countries of east Asia and western Pacific, but with reference to areas of Burma and Bangladesh to the west, Timor and Australia to the south, and the People's Republic of China to the north-east.

Prior to 1965 when the proposal to form CCOP was put before the Economic Commission for Asia and the Far East (ECAFE) (now ESCAP), little offshore prospecting had been done and only Japan and East Malaysia had proven offshore production.

Since the creation of CCOP in 1966, offshore activities have increased tremendously due in part to the catalytic action of CCOP in providing encouragement, and arranging co-operation between member countries for obtaining offshore data. Other factors conspired to boost the activity, much of it technological, including multicoverage digitally recorded marine seismic, positioned by satellite navigation and improved mobile offshore drilling equipment. Regulations were finalized by CCOP countries which provided a suitable investment climate for offshore exploration by petroleum companies.

Hydrocarbon exploration has been almost exclusively oriented to examination of the Tertiary sediments in which a number of very significant discoveries have been made. Drilling activities have increased each year since 1966 with a corresponding increase in number of discoveries.

Reconnaissance exploration has already covered nearly all of the continental shelf areas, but none of the areas could be considered fully explored and all are only partially evaluated. Except for reconnaissance seismic, most of the deep-water areas beyond the continental shelf in southeast Asia remain unexplored.

PART I

OFFSHORE GEOLOGY AND THE HYDROCARBON POTENTIAL

The purpose of Part II and the Appendices is to trace the history of offshore hydrocarbon exploration from 1966 when CCOP was established to the present time. Statistical summaries are to 31 December 1974 with comments on progress into mid-1975. Many sources of data have been used, including government statistics. Conflicts in the data are frequent and have had to be resolved according to best judgement.

Appended to the report are a number of tables which summarize the exploration activities in the various member countries of the region.

Hydrocarbon Geology of the Region

The region is East Asia from about 50° North to 15° South, flanking the east side of Asian continent; from Japan to Australia. The region is characterized by arcuate volcanic island chains which define ocean basins between themselves and the Asian mainland.

The small ocean basins from north to south are the Okhotsk Sea north of Japan, the Japan sea between Japan Islands and Korea-China, the Yellow/East China Sea between the Ryukyu chain and mainland China. and the South China Sea between Philippines and Indochina. Other Tertiary basins are: the Gulf of Thailand between Thailand and Indochina, the Andaman Sea between Andaman-Nicobar Islands and Thailand extending to the Malacca Straits, the Java Sea, the Sumatra Arc front basins which extend to south Java and the east Kalimantan foreland basins. In eastern Indonesia, a confused array of small deep ocean basins is found between the Philippines and Indonesian island arcs and between them and the Australian Sahul Shelf.

Research has determined these basins are the results of different geologic processes which can be partly explained in the context of plate tectonics. Two of the different types of basins that can be recognized are; one, which has been the scene of recent sea floor spreading and has oceanic crust as basement beneath the young sediments, and two, which is foundered continental crust which has older continental rocks as basement under the young sediments.

Three of the major crustal plates control the present geological configuration of this region. The Indo-Australian plate, the Asian continental plate and the Pacific Ocean plate. Here, for discussion, the Asian plate, which includes Sundaland extending southward to western Indonesia, is regarded as stationary. The Indo-Australian plate then is moving north-west with perhaps some clockwise rotational component. The Pacific plate moves essentially westward and may be underthrusting the other plates. The basins generally fit coherently into this three plate system except southern Philippines-eastern Indonesia, where the three major plates are chaotically interacting causing wildly confused island/ocean basin relationships. The three plates have been acting in this manner only recently;

they are each made up of several smaller plates which formerly were independant but apparently recently welded together.

The Japan Sea seems to be an example of a small ocean basin forming behind an island arc and expanding between it and a continent. One theory suggests that upwelling mantle behind the arc sets up a "convection cell" which tends to open the small ocean basin. This basin then has oceanic crust below the younger sediments. Fragments of ripped off continental crust may explain a few of the features noted on the sea floor.

The Okhotsk Sea north of Japan seems to be of similar origin, but perhaps in a younger stage of development. However, only its southern end with shelf attached to Japan is examined here. The sediments are thin in the deep part of this basin, but a fairly broad shelf is attached to Northwest Hokkaido Island which is shared with the Union of Soviet Socialist Republics.

South of Japan, the China Sea has opened behind the Ryukyu chain of volcanic islands. This basin, however, is more than half filled with sediments which have overflowed from the Gulf of Pohai and Yellow Sea. The Yangtse and Huang Ho Rivers contribute a tremendous sediment load into this basin.

The Yellow and China Seas contain sub-basins controlled by very prominent northeast trending ridges in the basement. The Shantung Peninsula is a manifestation of such a ridge that restricts the Gulf of Pohai. A second ridge at the mouth of the Yellow Sea is a part of the Fukien-Reinan massif that extends from China to southernmost Korea. These two ridges are composed of continental crust and probably are still an integral part of the Asian continent. Further seaward a basement ridge-like feature coincides approximately with the edge of the continental shelf and projects toward the north coast of southern Japan. This ridge may have island arc associations and the basement near it may be oceanic crust. Present data is sufficient only to suggest there are structural affinities between the China Sea and the Sea of Japan and the South China Sea.

The outermost ridge is the Ryukyu island arc, manifested by a chain of volcanic islands extending from Japan southwestward. The basement trough between the Ryukyus and the continental shelf is only partly filled with sediments. It appears that the Sea of Japan and the China Sea have a very similar genesis and may not be far apart in age. The difference is that sediment is available to fill the China Sea basin whereas the Japan Sea is relatively starved for sediment.

The genesis of the South China Sea is much more difficult to identify. It is much larger than the small ocean basins to the north and it does not have a clear bounding set of island arc systems. Northern Luzon to Ryukyus may be an island arc limiting a small part of the sea and the Philippines Islands themselves seem to be a coalescing of several arc systems, but no single arc system dominates.

The South China Sea has features which suggest that it once was actively spreading but is now dormant and a compressional regime prevails. The "Dangerous Ground" seems to be dormant volcanic seamounts which might be from early spreading. East-west magnetic lineations west of Luzon, apparently now dormant indicate another spreading area. Data suggests basement may be oceanic crust throughout most of the deep water part of the basin. To the southwest where the basin becomes filled with sediment, the 200 metre isobath line approximately delineates the thick sediment area.

Basement under the sediments is continental crust near Con Son and Natuna Islands. Basement in the deep water area is apparently oceanic crust. The limit of the continental crust is unclear with present data. However, the character of the seismic basement seems to change from that seen beneath the thick sediments to the deep ocean basin where basement is clearly oceanic crust. The change in character may possibly be related to a change from oceanic to continental basement. If so, the change from continental crust to oceanic crust roughly follows the edge of the shelf to 12^{o} S where it departs westward to 5^{o} S 108^{o} E and then turns due east to come close to the present coast of Sabah.

A triangular shaped wedge of thick sediment is lying on oceanic crust and has built the continental shelf northeastward. This is the area where the old Sunda River is thought to have terminated and the old Mekong River emptied here from the north. Wells drilled in this area have indeed found fluvial and deltaic type sediments which supports the view that this triangle is the site of the ancient deltas of the Mekong River and the ancient Sunda River.

The old continental Sunda Shelf and Gulf of Thailand is presently the area of greatest interest. Here a series of basins and sub-basins have formed on the edge of the continent or within the craton. These have been filled with Tertiary sediments which have proved to be hydrocarbon bearing in a number of localities.

Adjacent to the China Sea the Brunei-Saigon basin is a very thick seouence of marine fine clastic sediments lying on Mesozoic to early Tertiary basement. Offshore the basement has not been seen. Deltaic sands make up the younger part of the Tertiary and that part of the section contains presently known hydrocarbon reservoirs.

This basin is separated from the Mekong basin to the north by the Con Son Swell. The Mekong basin is filled with thick shallow water deposits. Neither of these basins has an expression on the present day ocean bottom bathymetric maps. The traces of the ancient river courses seem to disregard the estimated basin configuration.

The Sunda platform may be considered to extend from Natuna Islands to Borneo to Billiton/Bangka Islands to the Malay Peninsula. Ringing this great cratonic area are foreland basins which includes Brunei basin and the East Kalimantan Basins, the Java basins, the Sumatran basins and the Andaman Sea basins. Most of these basins presently have some emergent portion, but they are all similar in that they were formed at the edge of the craton and are filled with sediments derived mostly from the Sunda craton. Brunei basin and East Kalimantan sediments perhaps are derived more from the uplifted Mesozoic Borneo geosyncline. The East Java basin is farthest from the Sunda Shield and the Borneo geosyncline sediment source areas and so was starved for sediment fill material.

It consequently became a carbonate filled basin. These basins surrounding the Sunda craton contain almost all of the known hydrocarbons in Southeast Asia, both on and offshore.

Southwest of the Sunda craton, the Indian Ocean plate is moving in such a way that it is underthrusting the Sunda continental crust. This has created a line of volcanic mountains in front of which have formed arc front basins and an outer island arc. These deep basins are partially filled with typical eugeosynclinal sediments. The trend extends over 6,000 km from east Java to Burma.

The Gulf of Thailand basin is unique in the Sunda Area. It is a cratonic depression of major dimensions. The depression is a fault controlled graben with numerous internal horst-graben features. It is filled with sediments deposited in a restricted environment and exhibits a continental related facies as would be expected.

Eastern Indonesia and Philippines will not fit neatly into any ocean basin classification. The area consists of a number of island arcs, both volcanic and non-volcanic which have been and are being convoluted by the interaction of three major plates so that they have lost their orientation, shape and identifying character. Philippines and Celebes seem to be coalescing island arcs, others seem to be torn apart and transported. This description of the land areas is equally appropriate for the oceanic areas between. These are even more confusing because they are not easily mappable. Water depths exceeding 5,000 metres are measured between some of these islands.

Southeast of this chaotic area is the stable Sahul/Arafura Shelf which is a northern extension of the Australian craton beneath shallow seas. It lies under the southern part of Irian Jaya-Papua New Guinea from the Gulf of Papua to the Arafura Sea at the neck of the Vogelkop and southward to the northwest shelf of Australia. This shelf is Pre-cambrian basement overlain by Mesozoic clastics and Tertiary carbonates all very thin. The northern limit of this region is rugged mountains which are composed of some continental margin sediments and island arc rocks which have been plastered along the north edge of the continent. The

Vogelkop appears to be a block of Australia that was sundered and rotated clockwise to its present position.

North of the Vogelkop and the Irian Jaya-New Guinea mountains the coast rapidly drops off into very deep water of the Pacific Ocean.

It is interesting to note that all of the present important oil production is found in sediments laid on continental crust. This includes the circum-Sunda Basins in Sumatra, Java and Borneo. Promising discovery areas also overly continental crust in Gulf of Thailand and South China Sea. Reported significant production has been developed in the Gulf of Pohai in China. Even the carbonates of the Vogelkop appear to be deposited upon continental crust. Japan, Seram and some other areas probably have no continental crust but the production found there is not important.

Geological History of the Region

The map of Southeast Asia at the end of Mesozoic likely had little resemblance to the present map. Most of the Mesozoic sedimentary rocks now are highly contorted and altered by both igneous and tectonic causes. Only those Mesozoics on stable cratonic areas seem to have retained some of their original sedimentary characteristics, such as the Cretaceous clastics seen on parts of the Arafura Shelf.

Many parts of the region collecting the continental margin sedimentation of Mesozoic and older were later welded to the continental crust to increase the craton. In the process any characteristics which might have made them attractive for petroleum exploration were destroyed. The late Mesozoic/early Tertiary were periods of intense tectonic disturbance and these and older rocks are dominantly altered to some degree.

The Tertiary deposition eventually became widespread and in some areas very great thickness of sediments have accumulated. Characteristically the earliest sedimentation was of continental to near shore nature. These early rocks are unable to be dated by paleontological means. In most parts of the region good dating by paleontological means is not possible until Neogene.

Paleontologists now are suggesting that very little of the sedimentary section is of Paleogene age. If so, it means that there was a much longer period of exposure and erosion of the Mesozoic rocks. Thus it is even more difficult to visualize Mesozoics as a prospective group of rocks. Early work in the deep oceans recognized two facies, pre and post deformational which were thought to be Paleogene and Neogene. In some areas these have proved to be Miocene and Plio-Pleistocene.

At the beginning of the Tertiary-Neogene the general configuration of the region was as today, except probably eastern Indonesia. The foreland basins around Sundaland were depressed areas receiving sediment and the volcanic and outer arc were incipiently manifest, perhaps appearing much as the present Andaman Sea. The Gulf of Pohai and Yellow Sea probably formed then and started filling with sediment. Sediments were accumulating and building a continental shelf along the margins of Asia. What we see today is the logical development of that situation, and the sedimentary processes can be observed continuing now, as in the past.

The Neogene volcanoes indicate that the Indo-Australian plate was underthrusting Sundaland in Neogene time, however, most of the basins exhibit younger deposition features such as horst and graben that are indicative of tensional tectonics.

Most of these basins presently, and likely in the past, exhibit relatively high temperature gradients, another characteristic feature of tensional tectonics. The high temperatures have enhanced the hydrocarbon generation in the basins.

Those basins with significant production at this time have onshore and offshore portions and cannot be regarded purely offshore basins. Much of the production in Southeast Asia comes from fluvio-deltaic type sediments. However, it must be noted that the deltas of the major rivers draining the Asia mainland are as yet not major producing areas. Significant shows have been reported in exploration wells in these deltas which suggests they ultimately will be important. Map No. 1,

Index Map shows the various oceanic basins, physiographic and gross tectonic elements. The discussion will regard the ocean basins and consider their geology and that of the surrounding shelf and emergent areas. The area is that discussed north to south:

1. Okhotsk Sea
2. Sea of Japan
3. Yellow Sea
4. East China Sea
5. China basin of South China Sea
6. Sunda Shelf basins
7. Eastern Indonesia
8. Philippines archipelagic basins
9. Eastern continental shelf

Okhotsk Sea

The sea, north of Japan is bounded to the north by Siberia, east by the Kamchatka Peninsula and the Kuril Islands, the west by Sakholin Island and at the southern end by Hokkaido Island of Japan.

A deep trench on the Pacific side of the Kuril Islands becomes the Japan Trench southward. In the basin itself the sea is deepest on the southeast and shallows westward. Of interest here is the shallow water area attached to Hokkaido Island in the Soya Strait which is shared by the Soviet Sakhalin Island. The onshore of Hokkaido has a series of small fields on the coast facing the Japan Sea. No discoveries have been made, apparently, on the Sea of Okhotsk side. On Hokkaido, the emergent land facing the sea of Okhotsk consists of Paleozoic and Mesozoic sediments intruded and covered by Tertiary igneous rock. As yet there is no stratigraphic information from the offshore shelf other than seismic evidence for presence of sediments. The expected dominant lithology is volcanics and volcanic derived clastics in this shelf.

The entire shelf inside the Japanese border is under permit to Japanese companies. Leases have been taken beyond 200 metre water depth. Offshore seismic work suggests the presence of a sedimentary basin over 3,000 square kilometres and as much as 4,000 metres thick. This basin is described as having a steep eastern flank and a gentle western flank. Some folded structures are noted on the west flank. No drilling has yet been done on this side of the island to provide definitive subsurface information.

In view of the depositional environment of the area, good reservoirs may not be plentiful. No direct temperature gradient data is available, but the volcanic activity often is associated with a high temperature gradient environment and high temperatures favour gas. Lower grade reservoirs which would not be produceable for oil may be satisfactory for gas.

Sea of Japan

The continental shelf of the Sea of Japan is narrow and within a short distance from shore water depths quickly exceed 1,000 metres. Depths of more than 2,000 metres are common in the seafloor basins of the Sea of Japan. Geomorphologically, the Yamato trough and rise, and the Japan abyssal plain are recognized from east to west across the central part of the sea of Japan. The Japan abyssal plain has up to 1,500 metres of sediments. Other smaller basins are present with less sediment.

The depth of the water and present technology limits the hydrocarbon exploration and exploitation to a rather narrow strip along the coastal areas of Japan. The shelf facing the Japan Sea along the mainland is also very narrow.

(i) Japan (west Hokkaido, Honshu)

This narrow shelf has been explored since near the turn of the century as an extention of onshore oil and gas development at the shoreline. However, at no time has the amount of production been significant.

The productive section is from rocks of Miocene and Pliocene age. Late Miocene bituminous mudstones and Mio-Pliocene mudstones are regarded as the source rocks for the presently known production. These also provide effective seals between porosities in the vertical stratigraphic section.

Reservoirs are thin shaley sands with poor permeability and which have low productivity or are much thicker volcanic derived pyroclastic type reservoirs made up of rhyolites, andesites, agglomerates, breccias and tuffs whose fairly good fracture and intergranular porosity provide good productivity. Dolomite is a reservoir at Fukubezawa field.

Traps are described as anticlines on the down-thrown side of thrust faults, anticlines developed on a synchronous high, and rare stratigraphic traps. Characteristically structures are tightly folded and areally small, the reservoirs thin and the fields do not have significantly large reserves.

The main area of offshore production is in the Tsushima Basin whose shelf extends along the northwest coast of Honshu. All of the known production to date is confined to the area northeast of the Fossa Magna Fault.

Geophysical work and recent drilling results show that several onshore basins extend offshore under the continental shelf and even to the continental slope. Sediment thickness may be as much as 10,000 metres in the thickest basins, but this is thought to include a substantial thickness of Mesozoic age sediments. Structures according to seismic data tend to become more gentle offshore and cover a greater area. The largest structures are found near Shonai, but the Akita offshore area is characterized by complex structures which have been intruded by igneous rocks.

(ii) Korea (east coast)

Mesozoic sediments of the Kyongsan and Taedong systems are exposed in southeast Korea. Northwards, Precambrian granite gneisses and Paleozoic sediments are exposed. The Kyongsan and Taedong systems comprise 4,300 metres of mudstones, shales, siltstones, sandstone, conglomerates, and some effusive rocks of Lower Jurassic to Cretaceous age. The rocks of these systems are cited as having good hydrocarbon source rock potential, but the onshore

exposures are slightly metamorphosed and thus hardly prospective.

The Tertiary rocks of Korea are generally restricted to a maximum 2,200 metres of the Changi and Yonil series (Miocene). The Changi series comprises a basal conglomerate deposited upon eroded Cretaceous rocks, overlain by shales sandstone, coal seams, tuffs, breccias, and effusive rocks. The volcanic rocks account for approximately one half of the total thickness of 2,200 metres. The Yonil series (900 metres) consists of a basal conglomerate overlaid by mudstones, shales, sandstones, and some lignite beds; however, most of this sequence was deposited in a marine environment.

Tertiary rocks outcrop on the east coast of Korea, in a small basin centering on Pohang. Slimhole (CCOP.1/ROK.3) drilling at Pohang City has yielded small quantities of gas. These shows, and the nature of the onshore Tertiary sequence, has prompted the search for offshore extensions of the Pohang Tertiary basin.

Kim (1967), commenting on the results of a seismic survey by Huntec Ltd. for the Geological Survey of Korea, considers the offshore Pohang area to consist of Miocene sediments, resting on Upper Cretaceous or Paleogene volcanics, thickening eastwards, and being partly overlain by sedimentary basin to the north, centering on Ulchin. This last basin is separated from the Pohang basin by a structural uplift, possibly representing an extension of the Fukian-Reinan swell or massif. Both Cenozoic and Tertiary sediments are present, with the Tertiary sediments increasing in thickness southwards. The thickness of the Miocene-Pliocene-Pleistocene sediments have been estimated at between 600 to 1,400 metres, while in the Pohang area a maximum 1,800 metres of sediments are present. These sedimentary basins appear to be limited to the east by intrustive igneous rocks, or fault uplifted basement. An aeromagnetic survey (CCOP.1/ROK.2) southeast of Pohang has suggested the presence of a basin with depths of 300 or 600 metres. Four possible hydrocarbon trap conditions were indicated in the survey areas: anticlinal folds, faults, and pinch-outs along the igneous basement flanks, and lateral facies changes. From results of these surveys, it appears that sufficient

conditions for hydrocarbon entrapment did exist, in spite of the thin sedimentary layers.

(iii) Southwestern Japan-Korea Strait (Tsushima basin)

The Tsushima basin extends into the southern part of the Sea of Japan. The northern portions of this basin, under the Japan Sea, apparently are deep, with a maximum of 3,000 metres of Tertiary sediments. The continental shelf off southwest Japan is wide and shallow.

The results of an aeromagnetic survey (CCOP.1/ROK.2), conducted off the south coast of Korea, show depths to magnetic basement of 1,600 to 3,300 metres.. This basement is considered to be dykes and younger volcanics of early Tertiary age. Possibly the overlying sediments represent an extension of the adjacent onshore Mesozoic Kyongsan basin, but a younger age is more likely.

Seven wildcats have been drilled on the Japanese side of the straits and one on the Korea side. The stratigraphy encountered in these wells is not available but they are thought to have stopped drilling in volcanics or igneous rocks. The deepest wells were just over 4,000 metres and the average total depth is about 3,000 metres.

Japan and the Republic of Korea have reached agreement on exploration and development in the boundary area so intensified exploration is expected in this rather promising region. Shell in its well just east of Cheju is reported to have had "strong oil shows" although the shows have since been suggested to be not good enough for exploitation.

(iv) Summary

The shallow water around the Sea of Japan does have interesting Tertiary rocks. These rocks have obviously come to rest in a marine environment. Onshore granites and other rocks from which quartz can be derived are present on both flanks of the basin, so clastic reservoirs can be reasonably expected offshore. The basins are small and tend to be isolated one from the other.

Except in the Strait of Korea the shelf is very narrow, and the widespread igneous activity which has been manifest throughout Tertiary is discouraging. Certainly all of the fields found so far have been very small. However, in this particular environment

a small field can still be an economic unit, and this region of Korea and Japan is expected to see an increase of exploration activity over the next few years with attendant increase in reserves.

Yellow Sea

The Yellow Sea covers an area of approximately 0.5 million square kilometres with water depths of 55 to 125 metres. The morphology of the area is dominated by huge loads of sediment delivered by the Hwang Ho and Yangtze Kiang rivers from the west. Sediments from these rivers are deposited over the western two-thirds of the Yellow Sea. The remaining eastern third is covered by recent sediments partly derived from the Korean Peninsula.

To the north, the Yellow Sea basin is bounded by the Shantung Laoyehling massif. To the south, the Yellow Sea is separated from the East China Sea by the submerged Fukian-Reinan swell, which has acted as a dam to earliest sediments entering the East China Sea. The swell was probably emergent in the Mesozoic, but breached in upper Cretaceous or lower Tertiary times.

Onshore north of the Gulf of Pohai, a small field was found at Tungt-An in the small Fou Hsin basin. The reservoir is apparently Mesozoic lacustrine facies.

South of the Gulf of Pohai the Sheng-li or Victory oilfield is one of the more important fields of China. This field produces from the deltaic facies found at the mouth of the Hwang Ho river. Apparently, multiple producing sands range in age from Cretaceous to Tertiary. The field reserves have been estimated up to two billion barrels of oil.

Offshore in the south part of the Gulf, the Takang Field has become important. This field is reported to produce from Tertiary reef carbonate and is variously reported as having up to over one billion barrels reserves.

Emery, et al (1969), on the basis of geophysical surveys (CCOP, 1/IZ.4), report the existence of two broad, interconnected basins in the Yellow Sea, filled

with Neogene sediments, including shale, with high organic content and hence good source rock characteristics. Neogene and Pleistocene sediments are considered to reach a maximum thickness of 1,400 metres, underlain by probably older Tertiary sediments. Emery and Niino (1967) have recovered, by dredging, samples dated as Paleogene, which occur in faulted, graben-like basins. Dredging has also recovered silt and clay (reworked loesses), and sands from the western and eastern parts of the sea respectively, indicating that up to Tertiary time this basin may have been isolated from marine influence. No outcrop from the central parts of the sea is known. One bore hole in the Hwang Ho delta encountered 960 metres of Pleistocene deltaic sediments without reaching older sediments or basement.

The geology of the west coast of the Republic of Korea is basically igneous, with Precambrian crystalline schists and granite gneisses occurring north of Konsan, and post-Tertiary igneous rocks to the south. Small areas of sedimentary Kyongsan system (Mesozoic) rocks occur. The west coast is considered to be subsiding but sedimentary thicknesses are not enough to be of interest for at least 50 km offshore.

Geophysical surveys, in the offshore areas of the Republic of Korea, suggest shallow basement with not more than 100 metres of recent sediments in the zones near shore. The seismic surface of basement in these studies showed a shallow dip to the west so that further offshore sediment thicknesses increase. Recent surveys (1971) (CCOP, 1/ROK.9b) in the northern part of the Yellow Sea by seismic and magnetic methods, have indicated a minimum of 300 metres of Tertiary sediments. There is also some seismic and magnetic evidence suggesting the Tertiary sequence is pierced by volcanic rocks or diapirs.

The deltaic nature of the sediments is promising and the tendency towards a reducing and restricted marine environment, imposed by the Fukian-Reinan swell, would favour oil and gas preservation. The nature of the pre-Neogene sequence is largely unknown but is thought to be of continental environment, and possibly prospective, if not too deeply buried. Coupled with the already discovered large

(possibly giant) oilfields at the head of the Gulf, the Yellow Sea still appears to have tremendous potential.

Subsurface data is limited to two holes drilled by Gulf. The wells drilled to almost 4,000 metres, presumably all sediments. This next couple of years may see increased exploration activity and probably some discoveries will be found in the Yellow Sea.

East China Sea

The continental shelf here is wide, extending 450 kilometres east of Shanghai, to the 120-metre bathymetric contour. Most of the East China Sea has water depths of less than 200 metres. Surficial silts and clays predominate in the western parts of the continental shelf, with sands developing in the outer areas.

Emery, et al (1969), recognized a structural framework involving a succession of northeast-southwest elements. Those elements are listed from northeast to southwest: (i) Fukian-Reinan swell; (ii) East China Sea basin; (iii) Sinzi folded zone; (iv) Okinawa trough; (v) Ryukyu folded zone; and, (vi) the Ryukyu trench.

The East China Sea basin contains a continental shelf with an area exceeding 300,000 square kilometres, of which the thickest portions occur south of latitude 30°. The width of the zone varies between 80 and 320 kilometres, and is connected in the north to the Tsuchima basin by a narrow channel. Dredged samples (Emery, et al , 1967) suggest Neogene strata beneath Pleistocene and recent sediments. The thickness of the sediments varies from less than 1,000 metres in the northeast to more than 2,000 metres southward. However, similar sequences which developed elsewhere have attained thicknesses from 5,000 to 9,000 metres. The geosyncline undoubtedly extends both north and west. Two sedimentary facies are recognized: (i) post-deformational of possibly Pliocene and Pleistocene age; and (ii) pre-deformational of probable Miocene age. The precise definition of these facies and their ages must await drilling.

The onshore geology of the south coast of Korea is Precambrian granite gneisses in the west, with Mesozoic sediments in the east, probably extending to offshore areas. Bosum, et al (1970), based on the results of an aeromagnetic survey (CCOP. 1/ROK.2), regarded the western shelf areas as seaward extensions of onshore geologic provinces. Shallow magnetic source bodies were noted being either basement, younger volcanics, or Mesozoic intrusives. There is a marked change in character to the west and south of Cheju Island, indicating basement descends to depths of 2,000 to 5,000 metres.

The general picture emerging from those studies cited, and others, indicates that the rocks of the Sino-Korean shield extend into offshore water to the south and west, with Tertiary sediment thicknesses beyond, not exceeding 1,000 metres. From Cheju Island southwest along the axis of the East China Sea basin, an increase in thickness of Tertiary sediments occurs over a distance of 1,500 kilometres.

The continental shelf, including the East China Sea basin, is apparently limited on the seaward side by the Sinzi folded zone. This comprises a belt of folded, thick Neogene strata (Emery, et al, 1969). The folded zone itself is a possible structural environment for oil and gas accumulations.

Bordering the continental shelf slope is the Okinawa trough. The trough is an area of deposition dammed by the Ryukyu ridge. Tertiary sediment layers are present, estimated between 1,000 - 3,000 metres thick, but water depths exceed 1,000 metres. The ridge is an island arc system, with an inner arc composed of volcanics and an outer arc with outcrops of Tertiary, Mesozoic (intensely folded), and some Paleozoic sediments (Ryukyu folded zone) extending southward from Japan.

In summary, the East China Sea basin, especially its seaward edge and the Sinzi folded zone, appear to offer some petroleum potential. The promising factors are:

(1) shallow water depths;

(2) large thicknesses of Tertiary sediments over extended areas, especially in the southwest;

(3) similarities of Sinzi folded zone to certain onshore producing areas;

(4) availability of source rocks suggested by hydrocarbon in some areas, Naha (Okinawa), and near Shanghai; and also, by the nature of the Cenozoic coal sequences of southern Japan, and the Mesozoic sediments of Korea;

(5) deltaic environments, both ancient and modern, developed by the major mainland rivers, and the large sediment load delivered to the area by those rivers.

Discouraging factors include:

(1) thin sequences, with relatively shallow basins prevalent in the northeastern parts of the area, notably the offshore areas of the Republic of Korea and Japan;

(2) the distal end of clastic deposition in very deep water building on oceanic crust means the China Sea must be regarded less favourably than the Yellow Sea;

(3) recent igneous activity in the northeast near Japan and Korea does nothing to enhance the prospects.

South China Sea (China Basin)

This area discussed excludes Sunda Shelf, Saigon-Brunei basin and western Kalimantan.

Most of this area is covered by water from 1,000 to 4,000 metres deep. A continental shelf about 200 kilometres wide parallels the coast of Asia on the northwest flank of the basin. As the Saigon-Brunei basin is excluded here, the rest of the basin margins are marked by a very narrow continental shelf.

With the exception of certain limited areas little information is available on the western continental shelf off mainland Asia. Dredges (Emery and Niino 1967) have recovered Neogene fossils in the Gulf of Tonkin. Aero-magnetic data (Mainguy 1970) suggests a thin sedimentary basin pierced by intrusives between Hainan Island and

Hue extending offshore to the Paracel Islands and the Macclesfield bank. Tertiary sediment thicknesses up to 3,000 metres have been estimated for limited parts of western continental shelf. Another such basin, containing Neogene sediments may occur as an extension of the Red River basin, offshore from the Hue Paleozoic basin in the Republic of Viet-Nam.

The bulk of information concerning the China basin is derived from seismic and magnetic studies, reported by Emery, et al (1972), and by Parke, et al (1971), concerning seismic and geomagnetic traverses (CCOP.1/IZ.4).

As a result of the surveys, a series of northeast trending ridges, in the basin and basin slopes, have been recognized as providing sediment dams. The recent tectonic framework of sedimentation is therefore similar to that of the East China and Yellow Seas. Some of these basement ridges are manifested topographically as banks or islands. The eastern limit of the South China Sea is marked by the Palawan trough, Manila trench, west Luzon trough and associated ridge systems. The studies of the area recognize stratigraphic similarities between the East China Sea and the South China Sea. The older sediments are a pre-deformational facies which exhibits some conformity with the irregular surface of the acoustic basement. That deposition was gently folded and succeeded by deposits of post-deformational sediments. Probably most of the sediments in the South China Sea are Neogene.

The irregular nature of the acoustic basement is suggestive of volcanic features with some coral atolls and fault blocks. The basement appears to have been relatively smooth in early Tertiary on which pre-deformational sediments were deposited (0 to 1,500 metres thick) and post-deformational sediments (0 to 2,000 metres thick). Both series show variations in thickness, with the pre-deformational sediments thickest in the northeast, and the post-deformational sediments thickest in the southwest.

The stratigraphy as indicated by seismic would encourage exploration for hydrocarbons except the sediments lie beneath water much deeper than current technology can cope with.

The occasional banks and islands are mostly associated with anomalous basement and so cannot be used as drilling islands.

Almost no data is available about the continental shelf parallel to mainland Asia. Some scattered data indicates an interesting thickness of sedimentary deposits, so this area is of great interest. However, serious exploration of this shelf has not yet started.

Along the east flank of the basin the shelf along Palawan Island is currently being intensively explored. At least one rig has been active there through most of 1975. Good drillable structures are not plentiful, and a distinct lack of reservoir is discouraging.

The South China Sea basin has not yet proven to have commercially exploitable hydrocarbon deposits.

Sunda Shelf and Environs

(i) General

The area includes the Gulf of Thailand, Java Sea, Straits of Malacca, and parts of the Andaman and South China Seas. Virtually the entire sea-floor of the area lies above the 200-metre bathymetric contour, and large areas have water depths of less than 100 metres. The continental shelf claimed by Indonesia is estimated at nearly two million square kilometres of which about 60 percent contains potentially prospective sedimentary deposits.

The major physiographic features of interest in the oil search are the Sunda shelf part of the Asian plate in the west and the Sahul shelf part of the Indo-Australian plate in the east, separated by a confused array of deepsea basins and island festoons. In terms of plate tectonics, this is a complex area where the Asian, Indo-Australian and Pacific blocks interact.

The Sunda Shelf is a stable continental plate which probably finally became welded into a coherent plate in Cretaceous time. The youngest major structural events which caused widespread metamorphism seems to have been about that age. Younger tectonics

seem to be related to volcanism around the southwest margin or to tensional tectonics manifested by normal faults and some horst-graben features.

Two major structural systems predominate, one being folding and faulting which seems related to and parallel to the major mountain axis of Java and Sumatra and peninsular Malaysia. A second major faulting systemtrends very nearly due north. This system is manifest from Gulf of Thailand to East Java. These structural trends control local structure in which the hydrocarbon accumulations of the region are found. Many of these structure features are still active and exhibit a record of growth throughout Tertiary and it is in these fault controlled structures that the larger, more important fields are found.

The extreme stability of the Sunda Shelf is a concept which must be considered when studying the Tertiary basins that have developed upon it. The foreland basins of Java and Sumatra developed around the perifery of the Sunda Shelf and at various times have acted as if they are continental margin b asins.

The manifestation of the Barisan and Java mountains as they are today is a recent occurrence. There is evidence in Sumatra and Java that the foreland basins were completely open to the Indian Ocean during much of their depositional history. The fore-arc basins were, however, forming at the same time.

The two basin systems differ in sediment source. The foreland basins received most of their sediment from the erosion of the Sunda Shelf. Thus the granites so common or the shield provided the quartz for the basal clastics which have proved so important as reservoirs in Sumatra and Java, and periodically floods of sand have created reservoirs in the younger section.

The fore-arc basins, however, have a large portion of their sediment fill derived from the volcanics and volcanic associated material which was being emplaced periodically during the Tertiary. During periods of quiet, the open ocean encouraged the growth of reefs so that in the north part of the Mentawi basin the section became dominantly carbonate.

Eastward in what is now the East Java basin the sediment source area was at a distance. The water over the shield was shallow and clean with the result that the age equivalent to the sand-shale sequence in Java and Sumatra is carbonate bank sequence in east Java.

A major structural feature which is presently expressed as the mountain spine of Borneo is composed of geosynclinal deposits which have been uplifted. These sediments have provided an abundant sediment source for the filling of the East Kalimantan basins which are filled with clastics of a generally finer grained character. Excepting the areas of present or ancient deltas good thick sand reservoirs are not as plentiful, as in Java and Sumatra.

Northward in the Brunei-Saigon basin the main sediment fill is also fine grained clastic overlain by a coarser series. This younger series has proved to be a particularly prolific hydrocarbon bearing section in the near offshore.

The Gulf of Thailand seems to be a relatively young feature, probably first developed within the Miocene. The sediments here,however, are either continental or restricted marine. There was apparently a hiatus at the end of Miocene and then sediments recommenced after some structural adjustment but the depositional environment still remained restricted. The opening of the Gulf of Thailand to the ocean is apparently only a very recent feature of the topography.

(ii) Western Indonesia

The petroleum basins of western Indonesia are developed in a belt between the Sunda shelf and the inner volcanic arc extending from Sumatra to Kalimantan. This is only a partially continuous basin and is split up into a number of smaller basins and sub-basins by basement highs. The belt is composed of predominantly emergent Tertiary basins, noted in counter-clockwise order: the north central and southern Sumatra basins, the west Java basin and its extension, the east Java and Madura basins. Followed by a change in trend to east Kalimantan, the Barito, Kutei and Tarakan basins are developed both emergent and offshore, and are the most prolific hydrocarbon producers in Southeast Asia. Crude oil production for this region was 495,631,663 barrels in 1974 with reserves estimated at about

17 billion barrels as of 1 January 1974.

The onshore geology of the area may be briefly summarized as follows:

A variety of facies are present, ranging from continental deposits to abyssal sediments. Rapid fluctuations of facies occur in the vertical section, but the facies change is more subdued in the horizontal section. The sediments of the Tertiary geosynclines attain thicknesses over 15,000 metres. In the area of the volcanic arcs, igneous intrusions have penetrated into these sediments, changing their texture and composition occasionally so that the exogenous origin of the deposits becomes practically unrecognizable. The crystalline schists of the basement complex are often poly-metamorphic rocks, having been subjected to more than one cycle of metamorphism. In the Borneo geosyncline some Tertiary rocks have already attained a phyllitic appearance.

Based on some detailed studies mostly in the Malay peninsula, the following can be said about basement:

Crystalline schists which occur in the circum-Sunda mountain system, form part of overthrust complexes that are partly pre-late Paleozoic, late Paleozoic, Mesozoic, and even Eocene. Remnants of Silurian, Devonian and Permo-Carboniferous sediments have been identified. During the upper Paleozoic, the area was apparently submerged by seas, stretching between the islands and land masses. The crust at that time was formed of old cycles of mountain-building whose signatures have all but been obliterated. In the upper Paleozoic, a new cycle of mountain-building began, which continued as successive cycles throughout the Mesozoic, Tertiary and Quaternary. The Mesozoic of the archipelago is characterized by parallel belts containing sediments of widely different facies, indicating that the processes of mountain-building were fully active at that time.

Geologically, the present archipelago is a "young structure": about three-fourths of the surface of the islands consists of sediments and volcanic deposits of Cenozoic age. Tertiary strata are distributed on all the larger, and most of the smaller, islands. The Tertiary is mostly marine, but on the larger islands limited areas of continental and coal-bearing strata, with some sediments of a brackish-water facies

are found. Deposits of the neritic (partly littoral) zone include coral, foraminiferal, and algal limestones, sandy and clayey strata, breccias, and conglomerates. The sediments are often mixed with, or intercalated with tuffs, breccias, and lava flows to such an extent that the volcanic components often locally predominate in the arc-front basins.

The Tertiary basins of Java and Sumatra consist of a very long narrow trough separated but not entirely isolated by basement positive areas that arbitrarily divide this trough into basins. The sediments in each basin are similar to and actually grade into those of the adjacent basins. This situation is reflected in the use of the nomenclature which is often carried between basins. There is not always sufficient difference in equivalent beds as found in basins to justify separate nomenclature.

Western Indonesia is one of the oldest producing areas in the world, and commercial production was established in North Sumatra already at the turn of the century. The Telaga Said Field was discovered in 1892 and has produced some 24 million barrels. Exploration for oil was actively undertaken in North and South Sumatra and Java prior to First World War. Production was first established on Tarakan island in 1906.

Due to these early discoveries the amount of subsurface data acquired was quite extensive and the Tertiary geology of Western Indonesia is quite well known. The onshore geology prevails to the offshore and the Java Sea is probably the best documented offshore area in Southeast Asia. The Java Sea has generously rewarded the exploration effort. Details of these production areas are found in Table III, part II.

Emery, et al (1972) (CCOP.1/INS.1) reports on 7,500 kilometres of geophysical traverses in the Java Sea and adjacent continental shelf. The survey noted the existence of two main types of seismic reflectors: (i) an irregular, presumably pre-Tertiary, basement of igneous and metamorphic rocks, and (ii) a smooth surface presumed to be the top of the Miocene limestones. Basement is considered to form a series of north and northeast trending major ridges from Sumatra to Java to Kalimantan, with the intervening troughs filled by sediments, up to 3,000 metres thick. Emery (1972) also notes the presence of numerous folds, faults and pinchouts

in the sedimentary sequences. Parke, et al (1971) (CCOP.1/IZ.4) suggests the existence of a ridge representing a submerged continuation of the Malay Peninsula, extending to Kalimantan. Parallelling this ridge successively to the east is the Khorat-Semitau swell, which separates the Gulf of Thailand basin from the Brunei-Saigon basin, and a possible ridge bordering the Brunei-Saigon basin to the east. The study also suggests the main volcanic arc and non-volcanic arcs of western Indonesia as the western bordering ridges. The Java Sea and the Gulf of Thailand basin are segmented by a series of smaller basement highs between the main ridges. Thus the Sunda craton is made up of many of north and northeast trending ridges and troughs, of varying magnitudes which controlled the sedimentation and thus the hydrocarbon accumulations. Most of these structures show evidence of continuous development during Tertiary time.

Sufficient data is now becoming available that some serious attempts to upgrade the stratigraphy are being published because the nomenclature of 1970 is becoming obsolete. The changes are mostly in detail and the overall concept of the depositional history has remained essentially valid since the previous cycle of exploration.

Western Indonesia is a proven area and is moving to a more mature development stage. Structure and stratigraphy are sufficiently well known in some local areas that exploration for purely stratigraphic traps can be seriously considered. The region has developed rapidly and will continue to be very active because of the high ratio of exploratory success.

(iii) Gulf of Thailand

The sedimentary record in Thailand begins in early Paleozoic times, and contains marine clastic deposition with some carbonate phases (e.g., Thung Song and Ratchaburi limestones). Following the Ratchaburi limestone deposition, most of the country was elevated, with associated regional metamorphism and diastrophic movements. Isoclinal folding on north-south trends is most common in the Paleozoic rocks. Emergent conditions during the Mesozoic led to the deposition of the predominately continental Khorat series. Extensive granite intrusions date from the early Mesozoic and continue until the early Tertiary.

The structural basins of northern and peninsular Thailand developed by faulting and folding movements in the middle to late Tertiary. To the north, fluviatile and lacustrine sediments accumulated, and in the south, strata with marine influences were deposited. In late Tertiary times, local intrusions and volcanic activity occurred in scattered localities followed by regional uplift.

Two Tertiary series are recognized in Thailand:

(a) Kai Sot Series, which rests unconformably on the Khorat series of Triassic and Jurassic age. This series is lacustrine or fluviatile deposits of clays, shale, sands, muds, freshwater limestone, conglomerates, clacareous sandstone and gypsum beds.

(b) Krabi Series, which is probably partly contemporaneous with the Kai Sot Series, but contains some marine fossils. Lithologies include coal, lignite, shales, bituminous shales, gypsum, and marine limestones. The Krabi Series appears to have accumulated in active structural troughs or grabens, and has later been tilted and folded.

In West Malaysia, Tertiary sediments are rare, with only five small areas known. These are probably of Miocene age and consist of sandstones, conglomerates, shales, and thin coal seams, of estuarine or lacustrine origin. However, there is some interfingering of marine sediments. As in Thailand, the Cretaceous period in the Malay Peninsula appears to be one of non-deposition. Quaternary sediments are also thin. Tectonically, the Malay Peninsula forms a continuation of the late Mesozoic-early Tertiary folded mountain system, extending southwest from east Burma.

Onshore geology on the eastern side of the Gulf of Thailand may be summarized briefly by three main physiographic provinces:

(a) the Vietnamese Cordillera consists of granitic and metamorphic rocks, indurated sediments, and basalts, with some continental sediments of Triassic age extending from central Laos to Da Nang;

(b) the Highlands which are mostly indurated continental sediments, granite, metamorphic rocks and effusives;

(c) Mekong river delta, a recent alluvial plain lying upon some Permian limestone, Mesozoic sandstones, and granite intrusives.

The onshore geology of surroundings to the Gulf of Thailand is not of interest for hydrocarbon exploration. Exploration has not extended the Mae Soon and Boh Ton fields in northern Thailand. The onshore of Thailand probably will have an ultimate cumulative production of less than a million barrels. One wildcat was drilled in Khorat but the section drilled consisted of mostly continental sandstones and did not offer much encouragement. Four wells were drilled on the delta plain near Bangkok where they drilled a section of mostly coarse continental clastics.

However, offshore, the Gulf has attracted partially marine sediments and is filled with a locally up to 4000 metre thick series of sediments. The sediments predominantly are characteristic of a restricted marine environment, with some entirely terrestrial elements.

Extending from the head of the Gulf to the north flank of the Anambas and Natuna Islands, the Gulf of Thailand basin is bounded to the west by the Malay Peninsula, and to the northeast by the Con Son swell and Khorat-Semitau swell (M.L. Parke 1971) (CCOP.1/IZ.4) The relationship to the Sunda Shelf southward is obviously more complex than the above description would imply. The existence of folds, unconformities, faults, and diapiric structures is also evident from published surveys.

Seismic investigations (Dash, et al, 1970 - CCOP/ROV.2 and 5), in the region of Poulo-Panjang, offshore from southwest Viet-Nam, indicate possibly 3,000 to 3,500 metres of Mesozoic sediments which do not appear too badly disturbed and 3,200 to 4,500 metres of Paleozoic sediments. No Tertiary is present and the area may be an extension of the Mesozoic basin of the Cardamom region. The survey located a fault, which seems to be the eastern limit of the Tertiary Gulf of Thailand basin. It seems likely that a Mesozoic basin does exist around Poulo-Panjang, possibly extending to the south and southeast. In this area a play for possible pre-Tertiary hydrocarbons may someday be tried. However, certain non technical factors will delay exploration in this area, and it will be sometime before serious exploration will be possible, especially as there are other exploration plays which have more attractive prospects.

The Tertiary basin part of the Gulf of Thailand has been the arena for some rather intensive exploration. Already 28 exploration wells have been drilled in the Thai portion of the Gulf and almost half of these have had encouraging shows of hydrocarbons. The wel ls have drilled sediments of a rather more continental character than was at first expected, and have also found that a rather higher than normal temperature gradient prevails.

Structurally, the Gulf is a mega graben trending slightly west of north with a series of sub parallel horsts and grabens. Superimposed on this structural grain is a ridge and basin regime which trends slightly east of north.

Sedimentation on this structural framework is of a fluviatile nature and the sands or reservoir rocks are discontinous. Predominance of gas has made many of the discoveries less than obviously economic. To 1975 none of the discoveries have been large enough to be clearly economic, although feasibility studies have been done to examine the economic viability of exploiting some of the Union wells in blocks 12 and 13.

(iv) Brunei-Saigon basin

The basin is between the Khorat-Semitau and Con Son swells to the southwest, and the edge of the China basin to the northeast, and includes the offshore areas of the Mekong delta and the northwestern coast of Kalimantan.

The southwestern part of the island of Kalimantan, with the Malay Peninsula and submerged Sunda shelf, is part of the old continental craton called Sundaland. Van Bemmelen (1949) describes a triangular core in Kalimantan, its base on the west coast between Cape Datu and Cape Sarbar, and its apex at the Muller Mountains plunging under the Tertiary cover west of the Mahakam River. Haile (1955), puts the northern limit along the Lupan River in Sarawak. This is a sharp break in the regional geology, and it marks the northern limit of the upper Tertiary igneous intrusions of western Kalimantan.

The "Sundaland core" in Kalimantan consists mainly of Paleozoic crystalline schists, as well as large acid and intermediate batholitic intrusions of granite, granodiorite, quartz porphry, diorite, and syenite of Paleozoic and Mesozoic age. In addition, intermediate and basic pre-Tertiary volcanic rocks, and large extrusions of Neogene and Quaternary andesites and basalts, are present.

On the north, it is flanked by the northwest Borneo geosyncline, and to the south, by the geosynclines of southern and eastern Kalimantan (the Barito/Kutei basins and the Tarakan basin, etc.). The northwest Borneo geosyncline extends from the vicinity of the Lupan valley in Sarawak to Mount Kinabalu in Sabah, and comprises much of onshore Sarawak, Brunei and the adjoining parts of Kalimantan. Tertiary formations occupy northeast and central Sarawak, Brunei and the western part of Sabah, but in many places are covered by Quaternary deposits and volcanic rocks.

The geosyncline has been uplifted and it now is mountains and high ground forming the spine of Borneo. This tectonic activity occurred mostly in Tertiary as some lower Miocene rocks are included in the uplifted part. These geosynclinal deposits are the source of the sediments for much of the younger basin fill in the Brunei-Saigon basin.

The rocks that form the first deposition in the Brunei-Saigon basin are essentially unknown in the offshore. The basin filled with a tremendous thickness of a shale named Setap Shale after an anticline where it is well exposed. It lies on older Tertiary near shore and seems also to gradationally become sandy toward the mountains. Offshore, however, it is so thick that its base is not seen. The shale is characteristically geopressured, and in many wells drillers have been unable to maintain their borehole beyond the first few hundred feet of Setap shale. The shale is plastic and does form diapirs and diapir controlled structures have been documented at the Setap anticline and Miri Field. Many if not all of the offshore structures that have contained hydrocarbons are associated with diapirs formed by the Setap Shale. The Setap Shale is considered economic basement by explorers as the few wells that penetrated significant thickness of Setap found almost no reservoir type rock. Drilling problems have discouraged exploration in the Setap Shale.

Older rocks than Setap Shale are exposed onshore where they are mostly in flysch facies since Cretaceous. They have little merit as a hydrocarbon exploration objective where they have been mapped. The facies under Setap Shale offshore is unknown.

The Brunei-Saigon basin and the Mekong basin are partially separated by the Con Son swell. Bosom, et al (1970) (Project Magnet), suggest depths to magnetic basement of 5,000 to 8,000 metres in the lower part of the Mekong delta. Sedimentary thicknesses of up to 4,000 metres are suggested for that basin. M.L. Parke (1971) considers that the Brunei-Saigon basin dates from late Cretaceous, and that the pre-middle Miocene sediments were highly deformed.

The hydrocarbon potential of northwestern Kalimantan (Sarawak-Brunei-Sabah) is well-established, especially the offshore portions of the north-west Borneo geosyncline.

Northward in waters controlled by Viet-Nam drilling has already shown this part of the basin also probably will be an important hydrocarbon area. However, some of the shows are a very long way from shore. When certain non technical problems are resolved, active exploration of these waters will resume.

Eastern Indonesia (Sulawesi-Moluccas-Irian Jaya)

The physiography and geology of the eastern Indonesian islands are spectacular, characterized as sharp topographic relief, active volcanoes and faulting, high elevations and deep troughs.

The western portion of the area (Sulawesi-Moluccas) is a complex of deepsea basins and coalescing island arcs, a result of the interaction of the three plates. The shallow water areas surrounding these islands are narrow, or non-existent. The northern Moluccas consist of a series of submarine ridges and island groups separated by relatively shallow seas. The southern Moluccas islands consist of the Banda arcs, with Seram as the largest island. The Lesser Sunda Islands are situated on two anticlinal belts which form the westward extension of the Banda arcs.

They consist of a volcanic inner arc and a non-volcanic outer arc and form a physiographic continuation of the western Indonesian circum-Sunda system from East Java.

A wide range of igneous rocks occurs in these islands. Mesozoic ultrabasic and basic intrusions and extrusions are followed by granitic batholiths intruded into the cores of rising geanticlines. The Tertiary was a period of sedimentation, intensive mountain-building and volcanic activity. The present crystalline character of the schists is due to the metamorphism resulting from intense folding and igneous intrusions.

The world-wide rise in sea level at the end of the Pleistocene time caused inundation of most of the Sunda and Sahul shelf areas. However, tectonic uplift at the same time has lifted many islands so that reefs of Pleistocene age are now found in terrace-like formations as much as 200 metres above present sea level.

The largest island in the Lesser Sunda Islands is Timor. The island contains crystalline schists as well as a great number of intrusive and extrusive igneous rocks of different ages from Permian to Paleogene. Sedimentary facies are dominantly flysch and limestones and from littoral to abyssal depositional environments are represented. Structure is dominated by thrust faulting from north to south and includes some detached olistostromes manifested by the Bobonato Formation. The post-paleogene and post-orogenic sediments are confined to only small basins in the interior and some narrow coastal basins. In these basins, a typical sedimentary sequence consists of a porous carbonate near the base covered by marls. Clastic reservoirs are rare.

Hydrocarbon manifestations are common in the eastern Indonesian islands, varying from slight intermittent gas seeps reported almost everywhere, through oil seeps which have been locally exploited to major seeps which are used commercially such as the bituminous limestones of Buton Island and the commercial oilfield currently producing at Bula Seram.

Irian Jaya, with its neighbouring islands to the east, forms part of the circum-Australia system, a series of intersecting island arc systems which appear to be accreting to the north Australian craton. To the south, the Sahul shelf is a major sector of this craton which extends eastwards from Irian Jaya through Papua. The Vogelkop which may be a fragment of the northwest corner of the craton has attracted most of the petroleum exploration interest in the region. The principal targets in the area are Miocene reefs of the Kais Formation now proven commercially productive at several locations. Several onshore producing fields have been established, whose production averaged over 30,000 BOPD in 1974.

Prospecting in the area has been active in the offshore Vogelkop area and the offshore Sahul shelf area of southern Irian Jaya. By 1975 seismic and other surveys had been carried out by oil companies covering all of the shallow water offshore and some reconnaissance in the deep water. Subsequent to these surveys, many exploratory wells have been drilled. Three of these exploration test wells in the immediate coastal area of the Vogelkop were declared discoveries. The explorers are most optomistic about oil and gas potential of offshore Irian Jaya. However, in contrast with other areas, the targets are essentially stratigraphic reef type limestone. Such targets are no less promising than other types, but they require a specific exploration approach. Offshore production from Irian Jaya is expected to start in 1975.

Philippines Archipelago

The Philippines archipelago might be regarded by some as an extension of the circum-Sunda system. The archipelago is bounded on the west by the Manila-Palawan-North Luzon trench and ridge systems, and to the east by the Mindanao Deep and the Pacific Ocean. The Palawan and Sulu archipelago ridges with the intervening Sulu Sea, extend southwestward toward Kalimantan.

The Paleozoic-Mesozoic history of the Philippines involved geosynclinal sedimentation with volcanic and intrusive activity. Pre-Tertiary rocks are mostly metamorphosed and must everywhere be basement. The Philippines archipelago appears to be a coalescing of several island arcs between some of which a number of onshore Tertiary basins have developed, many with offshore extensions. The Sulu Sea and West Palawan are offshore basins. The Tertiary geological history of the Philippines may be generally divided into two provinces since early Tertiary after the orogenesis which terminated the Cretaceous geosynclinal cycle.

(a) "Aseismic zone". This relatively stable area in the southwestern part of the archipelago is characterized by marine clastic deposition, minor igneous activity, and reduction of land areas by subsidence.

(b) "Mobile Zone". In this zone, sedimentary basins continued to develop until late Pliocene, and up to 7,000 metres of flysch type sediments accumulated. The area is characterised by seismic instability, vulcanicity, intrusive activity and localised rapid subsidence. Marked lateral and vertical facies changes occur in all sediments, with dirty and poorly sorted clastics characteristic in all basins. Tectonics in the late Tertiary has produced numerous anticlinal folds many of which have been drilled in the search for petroleum. Explorers have concluded that older Miocene reefs and possibly some younger Pliocene reefs must be regarded as the most probable reservoirs both onshore and offshore.

The physiography and geology of the Philippines archipelago are complex. Areas with substantial width of continental shelf in shallow water are limited to four:

(a) Southern Luzon offshore areas. An aeromagnetic survey (CCOP.1/PH.2) has delineated four small offshore basins: three basins on the western continental shelves and one on the eastern. This survey also defined the boundary between the Mobile and Aseismic zones.

(b) Visayan Sea. An aeromagnetic survey and marine seismic survey in 1962 delineated three small basins containing some promising petroleum structures, including major converging anticlinal belts, reefal limestones, structural closure, and beds thinning over structures. In the adjacent onshore non-commercial petroleum shows have been recorded.

(c) Sulu Archipelago offshore areas. The environs of the Sulu archipelago include a continental shelf of approximately 120 kilometres width. Sediments are very thick - over 5000 meters in some places. The area has attracted interest and over 10 wells have been drilled with more planned. Shows of hydrocarbon have been few and the stratigraphy characterized by lack of reservoir.

(d) Palawan archipelago offshore areas. The continental shelf down to the 200 metre bathymetric contour is narrow, but widens at the southern and northern ends. The southern portion of the Palawan continental shelf is continuous physiographically with the Sabah continental shelf, but the two shelves are geologically quite different. Some drilling already done on the Palawan shelf has shown this area of the Philippines also lacks reservoir rocks. Good drillable closed structures are not abundant.

Geophysical surveys by private oil companies suggest a thick sedimentary sequence of 3,000 to 13,000 metres. W. Bosom et al (CCOP.1/PH.1 1972) have reported on 21,000 line kilometres of aeromagnetic survey, stating that the topography of magnetic basement is characterised by swells and depressions.

In summary, offshore Tertiary basins in the Philippines do exist. The nature of the sedimentary sequence suggests that source rocks are present. Some structure appears to be conducive to oil and gas entrapment. Given the prevalence of dirty clastic and poorly porous stratigraphic sequences, the problem would appear to be the location of suitable reservoir rocks. Most current drilling is directed toward possible Miocene reef reservoirs.

Eastern Continental Shelf

The eastern continental shelf encompasses the offshore areas facing the Pacific Ocean, from Irian Jaya to Japan.

Mainguy (1970) has noted that the following features of the area inhibit petroleum prospects:

(1) narrow continental shelves;

(2) many adjacent deepsea troughs (Japan, Ryukyu and Philippines trench, among others) which drain off the little sediment that is available.

(3) volcanic nature of the bordering sediment source area whose decomposition products are unsuitable for the formation of reservoir beds;

(4) small, isolated nuclear basins only.

It is interesting to note that in the Pacific bordering area the only hydrocarbon occurences known are gas. In Japan the Iwaki structure off the east coast about 37^{o}N has the potential to be an important gas field. Farther south at Tokyo a large number of very small fields contain gas only. Further south, the only show so far in Philippines was at Ipil in northern Luzon. This gas show is considered by some to be part of the eastern shelf. In northern Irian Jaya the R-1 well reported a show consisting of a good flow of gas.

Onshore hydrocarbon occurrences are restricted to the Tokyo-Chibu area and northern Luzon.

Tono (1973) has investigated the Pacific coast offshore areas of Japan and notes that the young sediments of eastern Japan consist largely of marginal orogenic facies. Any large offshore basins would probably be located at some distance and would be in very deep water.

In the Philippines, the eastern continental shelf is narrow, the widest being areas off south Luzon. An aeromagnetic survey (CCOP.1/PH.2) indicates a sedimentary basin in Lemon Bay with approximately 3,500 metres of sediments. Two offshore wells were drilled in this area with very discouraging results.

Offshore north of Irian Jaya a large basin is developed. It is the only large basin facing the Pacific in Southeast Asia. The gas show reported in the R-1 well does enhance the area. However, the sediments seem to be all greywacke. In certain areas carbonates are developed so there is potential for reefs. One oil company is currently prospecting in the area.

The eastern Pacific shelf is considered to have low potential, but remains largely uninvestigated. Detailed programmes are necessary to delineate the small basins, but they would rate a low priority, compared to other areas with wider continental shelves, thicker Tertiary sequences containing more attractive stratigraphy.

Summary and Conclusions

The continental shelves off mainland Asia and the Southeast Asian archipelagos possess numerous and deep Tertiary basins, filled with predominantly clastic sediments. Carbonate reservoirs are becoming important (e.g. Irian Jaya, Java Sea). In general, the nature of the Cenozoic and Mesozoic onshore sequence provides evidence, both in their marine and continental facies, that they contain potential source rocks. These Tertiary basins embrace a wide variety of structural styles. Tilting, compressional folding, gravity sliding and diapir structures, amongst others have already proven commercially productive in different areas of the region. The dominant ridge-trench-basin systems of most of the offshore areas also provides an extremely attractive structural framework for hydrocarbon entrapment. Deltaic environments developed off the mainland coasts and the larger islands, as well as the provenance and deposition of large quantities of detritus by the major rivers of the area have been extremely successful in some areas, but other similar areas are as yet untested.

The oil and gas search has hereto concentrated on Tertiary basins with their favourable lithologic and structural characteristics. Pre-Tertiary sections have received little attention in the first phase of commercial offshore exploration, as the volume and nature of Tertiary sediments are large and attractive and numerous enough to be the prime focus. The exploratory methods required to investigate subsea sequences of older formations, which may be buried beneath thick Tertiary sequences,

does pose technical problems.

The total lack of success of the few wells which have examined any significant thickness of Mesozoics in Southeast Asia has done nothing to encourage their prospects. Certain areas can be pretty well eliminated and include the areas near present or former mountain building where pre-Tertiary is always severely distorted and usually metamorphosed.

Pre-Tertiary production is known in Pakistan, Mainland China and Australia. South and East Asia is therefore surrounded. The Mesozoic producing areas are characterized by an environment where sediments preserved over a great length of time by the stability of a craton. By this reasoning the areas of stable in Southeast Asia may be the Yellow Sea which seems a depressed area on a stable continent, and perhaps the shelf along Southeast China.

The Sunda shelf including the Gulf of Thailand and the South China Sea seems most likely to have exploitable pre-Tertiary hydrocarbons. It will be necessary to have thin Tertiary cover so that the Mesozoic can be reached. However, a large part of the Sunda Craton is not made up of sedimentary rocks and this means that there will be very few and limited localities where pre-Tertiary exploration can be seriously considered.

To the Southeast Irian Jaya may have Mesozoic hydrocarbons. The Northwest Shelf of Australia is part of the same cratonic environment. Thus the situation found there may extend northeast into Indonesia. Another area may be the Cretaceous of the north. It is described as a predominantly sand facies in Southern West Irian where it was examined in several wells. If the old continental margin can be found beneath the overthrusts of the foothills of the southern flank of the Central Ranges then they may find a more marine facies which would have claystones interfingering with the sandstones. Thus cap, source and reservoir may be found all together. This is the most probable area where Mesozoic production will be found in Indonesia.

The offshore methods of hydrocarbon exploration are mainly geophysical. Knowledge about the continental shelves has advanced rapidly in recent years, through the increasing sophistication of the various geophysical techniques. In regional and subregional studies, geophysics provides an effective tool. Extrapolation of onshore geology to offshore areas is a valid technique, if used with caution. The framework of the petroliferous offshore basins of western Indonesia and East Malaysia are, in part, extensions of the onshore basins, where data derived onshore can be used to aid offshore exploration. In contrast, the mainland geology of Thailand, Peninsular Malaysia and the Republic of Viet-Nam offers no direct evidence for the existence of the Gulf of Thailand Tertiary basin. Similarly, a consideration of the geology of Korea would not be of much assistance in the detection of the Yellow Sea or Tsushima basins nor of the stratigraphy of the rocks in the basins.

Paleontological studies have been used in bottom sediment sampling and other testing methods. The research into and use of planktonic foraminifers, diatoms, radiolaria, and palynological techniques has advanced their usefullness. These procedures, along with conventional geological lithofacies, and other studies have proven valuable in the exploration programmes to date. This type of work will be increasingly emphasised as drilling programmes progress to provide a more detailed pattern, and as the search for hydrocarbons extends more and more toward stratigraphic-type traps.

The East Asian Offshore regions include large areas of continental shelf, with water depths that are technically prospective for hydrocarbons. As the oil and gas search expands and drilling technology advances more offshore areas will become prospective. Water depths fall off sharply at the edge of the continental shelf, with relatively small areas lying between the 200 to1000 metre bathymetric contours. Hence, before more large areas can become open to commercial exploration and exploitation, drilling technology must be capable of reaching depths over 1,000 metres and production technology must be invested to make discoveries practically produceable.

In this respect, offshore exploratory wells in water depths from over 750 metres have been drilled and exploratory drilling in depths of 1,000 metres will become possible by 1976. Although the present capability of commercial production still lags behind the capability of drilling, installation of bottom-supported production platforms has been achieved in 150 metres of water in the North Sea, and in more than 120 metres in the Santa Barbara Channel and should be possible in depths of 300 metres of water and it is in these methods that very deep water production is dependant because the techniques adopted are theoretically independant of water depth.

There are certain technological problems that have yet to be solved. The link from sea bottom to surface is the heart of the problem, and has a breakover at somewhere around 300 metres deep. To go much beyond that depth a totally new concept must be adopted. There are many ideas and designs but there is not yet a working model which solves the problem of the link from surface to seabottom in very deep water.

In spite of technical limitations at present, exploration is now going on in Southeast Asia in areas where water depths are greater than present technology will allow production. The west coast of Thailand and the east coast of Kalimantan are two areas of great promise. The deep water around the Japanese islands is also receiving some attention.

Reference has been made to the significant roles played by the United Nations and CCOP, the various national Governments, and the private oil companies. In particular, CCOP has been a "prime mover", giving considerable impetus to the offshore search for hydrocarbons. This super-regional framework for expediting continental shelf exploration and exploitation has in a relatively short span of time, considerably advanced both knowledge and commercial development.

Recommendations

The following list of recommendations should be considered according to the particular requirements of member countries. Countries with long and well-established petroleum industries have different needs than those where exploration or exploitation is at an early stage of development. The recommendations compose a general framework for future studies.

1. Establishment of data acquisition and storage centres.

The increasingly detailed nature of exploration work makes the establishment of data centres essential. A twin system is recommended, with a central, international CCOP repository for certain types of non-proprietary data, which would be linked to national data centres. Both the international and national centres should be standardised (perhaps under CCOP guidance), to facilitate the transmission and storage of information. The system should combine manual data processing and storage methods with computer applications.

2. Geological studies

The following types of programmes appear advisable, given the changing nature of the oil and gas search.

(i) Geological mapping.

Preparation of sub-oceanic geological trend maps, based on offshore and adjacent onshore wells, geophysics, and geology, which should be revised as new information becomes available. Up-to-date maps would be essential in planning the location and type of new seismic or other geophysical work. The maps would cut across international borders and, therefore, would be a natural concern for CCOP.

(ii) Regional and sub-regional surveys.

Broad surveys are required for a framework for the operations of companies. Thus, a continuation of the traditional and successful CCOP programmes, providing "broad-scale surveys of a pre-investment nature", would be necessary, and could be aimed at regions where the petroleum industry has not yet explored.

(iii) Pre-Tertiary basin investigations.

Investigation of potential pre-Tertiary petroliferous provinces is recommended. Some of the Mesozoic foreland basins could have subsided and been preserved beneath Tertiary sedimentary sequences or behind island arcs, and may have been preserved in a favourable environment for petroleum and natural gas reservoirs.

This project would require a pre-expenditure study to discover those areas where pre-Tertiary production is a possibility. Then field projects would be planned to acquire new data to evaluate the possibilities.

(iv) Standardisation of nomenclature.

The standardisation of stratigraphic and paleontological terminology, would be a project of great value which could be co-ordinated by CCOP.

(v) Sedimentary basin studies.

Systematic sedimentary basin analyses could be done by individual countries, using their specific knowledge of their offshore areas, and their access to restricted data. Certain basins cross international boundaries and the CCOP may play a role in the cooperation of study by two or more countries.

(vi) Heat flow investigations.

Moderately high heat flow appears to enhance the early generation, maturation, and migration of petroleum. Heat flow investigations should therefore be an important research target, again could be a suitable project for co-ordination by CCOP.

(vii) Geochemical and palynological investigations.

Studies on the geochemical characteristics of kerogen, including preserved pollen, in relation to petroleum source rocks in offshore Tertiary sediments of Southeast Asia, would be valuable. Also, systematic geo-chemical studies should be undertaken in the established petroliferous basins to ascertain the regional variations in composition of crude oils and gases, formation brines, and reservoir pressures. The origin of petroleum in these basins needs to be clearly understood. Funds could be provided to support studies of this nature

by member countries and CCOP can co-ordinate results.

(viii) Investigations of the nature and age of crystalline basement, and the age of various events which cause metamorphism.

Determination the age of igneous and metamorphic events is to be significant to the understanding of the basement and its influence on sediments lying upon it. Hard data is rarely acquired and CCOP could do well to co-ordinate regional data inventories and studies in these fields.

(ix) Hydrocarbon migration investigations.

As the mechanisms and circumstances of hydrocarbon migration are still poorly understood, the petroliferous basins of the CCOP regions should be investigated.

(x) Paleomagnetic investigations.

More paleomagnetic investigations in the Southeast Asian region will contribute to efforts to unravel the history of plate tectonics, and its relationships to metallogenesis and hydrocarbon genesis. CCOP should provide assistance for cooperation with these studies.

(xi) Combination of onshore mineral and offshore petroleum investigations.

In some areas, such as the Philippines, mineralisation occurs along transverse faults which are related to the plate tectonics of the region. A combination hydrocarbon/minerals programme would enhance understanding of both the geology and plate tectonics of the region.

(xii) Continental and marine facies studies.

The characterization of some basin facies as continental is questionable, and the hydrocarbon potential of such basins should be re-investigated. In addition, recent studies indicate that some non-marine sedimentary facies, with abundant terrigenous organic matter, are potentially good petroleum source rocks. According to literature China has more reserves in continental rocks than all the rest of the world. Is their geology unique, or is there similar potential elsewhere.

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PART II

THE HISTORY OF OFFSHORE HYDROCARBON EXPLORATION

Introduction

The prime factor in stimulating the offshore search for hydrocarbon in the continental shelf areas of the CCOP countries has been the enact of a legislative framework within which exploration by national and international bodies can work in co-operation with private investors. In the climate created by the legislation the exploration for, discovery of and development and production of hydrocarbons becomes the mutual objective of all parties concerned.

Successful legislative formulae have several forms which serve to satisfy national aspirations and still provide a mechanism for a fair return to the investor. Little doubt exists that the technology and expertise of private oil companies, together with their capital resources can most quickly and efficiently develop offshore petroleum deposits for the greatest benefit for all concerned.

In this discussion, statistical summaries are given to mid-1975. The summaries have been compiled from various publications, journals, government statistics, and the proceedings of CCOP meetings. Data from different sources may conflict. Symbols in the tables denote the reliability of the various statistics.

The number and magnitude of geophysical surveys by oil companies are difficult to accurately enumerate and precise information on wells is often incomplete. Other difficulties are the frequent lack of distinction in the literature between onshore and offshore data. The term "wildcat" or "exploration" wells is generally used to denote the first well drilled on a new structure. Subsequent wells on the same structure are designated as "confirmatory" or "development" wells, or other terms as the case may be.

Except in the case of the well-established petroleum regions of East Malaysia and Japan, offshore exploration before 1966 was meager. In 1965, the U.N. Economic Commission for Asia and the Far East (ECAFE) proposed co-operative efforts for prospecting offshore in Asia, leading to the formation of CCOP in 1965. From 1966 onward the pace of offshore exploration has accelerated each year.

In western Indonesia, exploration proceeded from virtually zero in 1966 to offshore fields in several areas capable of producing over million barrels per day. The existence of adjacent onshore production in Sumatra, Java and Kalimantan, and the projection of these basins into offshore areas facilitated the development. Most other areas where neither onshore nor offshore geology was so well-known, exploration began with a smaller fund of basic information. Regional and sub-regional geologic surveys were sponsored by CCOP and other agencies, followed by more detailed work by private oil companies. Considering the lack of knowledge prior to 1966, progress in the oil search in the southeast Asian offshore areas has been spectacular, with exploration drilling already underway in the Gulf of Thailand, Sunda Shelf, South China Sea, Mekong Delta, East China and Yellow Seas, and in the shelf areas of eastern Indonesia, Philippines and Japan.

Table I summarizes the offshore activities in the CCOP countries prior to 1966 and Table II parts A through H describes the offshore activities in each CCOP member country from 1966 to mid-1975.

Table III parts A through H lists under company alphabetical order the contract areas and concessions in the offshore areas of the member countries. In most cases the interest division, area, identification, and work commitment is shown. Some inaccuracies are inevitable due to boundary overlap, imprecise measure, negotiated adjustments in relinquishment obligations, and changes of inter relationships in the contract holders.

In summary, this table shows that companies are operating on exploration blocks, occupying a maximum total area of more than 3,168,000 square kilometres.

Table IV A through H lists the declared discoveries by country and by basin. Some details are included when available such as production or test rate, age or formation name and gravity of oil. Most discoveries have been made after 1966.

Table V is a summary of offshore and coastal surveys for petroleum related data acquisition conducted in co-operation with CCOP since 1966. Several are currently in progress.

Table VI is a summary of the annual oil production in CCOP countries from 1955 to 1974. This shows a fairly regular increase in production from CCOP countries over the last 20 years. The production almost doubled from 1955 to 1966 after which the rate of increase accelerated.

Table VII is a summary of production during the year 1974 for CCOP countries. The production figures reflect a drop in world demand as a result of the sharp price increase in 1973. Also affecting production figures was the sale of crude from the People's Republic of China to Japan which displaced crude normally supplied from Indonesia.

The following is a brief history of hydrocarbon exploration in each CCOP country.

CAMBODIA (now known as Democratic Kampuchea)

Exploration history, 1966-1975.

A summary of the offshore exploration activities has been compiled into Table I. There is no record of offshore exploration prior to 1966 in the Khmer Republic.

The first exploration took place in 1969, when the Government granted rights to the entire shelf area to ELF du Cambodge (Table IIIG) with a clause for 50 percent relinquishment after 18 months. A refinery and state marketing company ensured a market for any discoveries, and 2,880 line kilometres of seismic work had been completed by 1970. In 1972 ELF drilled its H-I wildcat which was abandoned at 2,437 metres. 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 17,000 square kilometre concession on part of the area relinquished by ELF. Canadian Reserve earned an interest in the block by performing some seismic work.

Regarding CCOP activities in Cambodia there have been three surveys, current and planned, two of which are related to petroleum, CCOP.1/KHR.2 (seismic and sonic) and CCOP.1/KHR.3 (aeromagnetic). In addition, other surveys by Thailand and Viet-Nam, CCOP, and private companies are related to the investigation of the general framework of the Khmer Republic's portion of the Gulf of Thailand. Hence, project CCOP.1/IZ.4 (1969) included approximately 200 line kilometres of seismic and magnetic surveys in Cambodian waters in the Gulf of Thailand.

Review of Government legislation.

Cambodia was one of the first ECAFE countries to claim continental shelf jurisdiction, both internally and at the international level, when it passed domestic legislation in 1957, and ratified the Continental Shelf Convention in 1960.

The then Government of Cambodia signed an agreement on the 6th February, 1970 with the oil exploration company, ELF du Cambodge (a subsidiary of the ELF/ERAP group), granting sole exploration rights for Cambodian territorial areas in Gulf of Thailand. The agreement included the following provisions:

(a) 20 percent Government participation in the event of a commercial discovery;

(b) 50 percent profits tax;

(c) five-year exploration period granted, with one option for renewal;

(d) drilling to commence within two years.

On 11 June 1972 a similar agreement was signed with Marine Associates on Elf relinquished areas.

INDONESIA

Exploration history prior to 1966.

Onshore drilling for oil began in 1872. By 1940, annual production of oil had reached 59 million barrels, but later declined to a low of 1.8 million barrels in 1946. No offshore exploratory wells were drilled until early 1960's. Offshore geophysical work carried out in this period was approximately 400 line kilometres of shipborne magnetics by the Tokyo University of Fisheries in 1964, in conjunction with their Indian Ocean Expedition.

Exploration, 1966-1975.

Table IIB summarizes offshore hydrocarbon exploration activities in Indonesia from 1966-1975. In 1966 the only offshore exploratory work was an aeromagnetic survey off north Sumatra. After 1967, exploration activity rapidly increased.

Wildcat and confirmation drilling increased from 8 wells in 1968 to a maximum 85 wells in 1971, and then declined to 76 in 1974. Other offshore wells, mostly development and production wells, demanded facilities from the exploration effort. Generally, exploration drilling increased annually between 1966-1971, declined in 1972, and 1973 and increased again in 1974. Exploration drilled metres have been reduced in the last three years due to rigs being occupied in evaluation drilling and shifting to other countries.

Offshore seismic surveys in Indonesian waters averaged about 56,000 line kilometres for the last three years. The geophysical activity is shown in Table IIB. CCOP, in conjunction with other organizations, has been involved in six surveys in Indonesian waters since 1968. Another two surveys are planned. These projects are listed in Table V, and include 12,560 line kilometres of geophysics, and two sediment sampling programmes.

In the 1.17 million square kilometres of the offshore area under production sharing contract, 21 companies are operating 32 leases and have drilled over 600 wells altogether; approximately half are wildcats and confirmation wells. Table IIIB lists the names, block sizes, and members of the companies' groups.

Since 1967 there has been an ever increasing level of petroleum activity in Indonesia which has resulted in increasing annual production from 170.5 million barrels in 1966 to 506.5 million barrels in 1974. In 1975 Indonesia is capable of considerably more production, but market demand is holding production rates down. The softening of market demand became quite evident in August 1974 according to Table VII.

The intense level of exploration activity has resulted in a large number of discoveries and a rather satisfactory success ratio. The discoveries offshore since 1966 are tabulated in Table IVB. Sumatra has had only three marginal gas discoveries but West Java has 19 discoveries of which a majority are probably commercial. East Java has six discoveries, but it appears so far that only one will be commercial. The Kutei Basin has 12 discoveries of which nine are apparently being developed. The Tarakan Basin has one non-commercial gas show. The Salawati offshore basin has three discoveries, one of which is being developed, and the northern West Irian area has one gas show. In the Indonesian portion of the Gulf of Thailand Basin there are three discoveries of which two may ultimately be developed, and one gas blow-out in the South China Sea.

In all, there have been 49 offshore discoveries in Indonesia of which at least 22 are surely commercially exploitable and possibly more.

Review of Government Legislation pertaining to offshore hydrocarbon exploration:

The Indonesian constitution vests the natural resources irrevocably in the people and these resources can be entrusted only to a state enterprise. Law 44 of 1960 contemplated that a state enterprise would collaborate with foreign companies in conducting petroleum operations. The Law 44 left the terms of contract to the discretion of the government according to conditions prevailing at the time of contract. The first production sharing contract was signed with Ilapco on 18 August 1966. The terms of that contract formed the basic framework for subsequent production sharing contracts.

JAPAN

Exploration history prior to 1966.

Table I summarizes offshore exploration carried out in Japan prior to 1966. In 1780 in the vicinity of Niigata City, some gas was drawn from shallow water wells and collected for domestic use. In the late 19th century, wells were drilled offshore on man-made islands to develop production from a seaward extension of the Almazo structure, off the coast of Niigata Prefecture. The earliest offshore exploration surveys were begun in 1948 by geologists diving from fishing boats to map the underwater geology. Up to 1956, four wells had been drilled on the basis of this type of mapping, but all were unsuccessful.

Seismic work was carried out in relation to coal fields and engineering projects, but not for hydrocarbons. In 1956, the Japan Petroleum Exploration Co., Ltd. (JAPEX) was established to promote and develop petroleum and natural gas resources, under the Government's 5-year plan. A second plan ran from 1962-1966. Since 1956, offshore exploration in Japan has been carried out by government and scientific organizations, as well as private oil companies.

Geophysical exploration commenced in 1957, followed by drilling in 1958, leading to a discovery off the Japan Sea coast of Honshu. This was the Tsuchizki-Oki field (off Akita), which produced 260,809 barrels of oil and 160.6 mmcf of gas in 1962. Also, JAPEX in 1959 had a gas flow of 8 mmcf per day near Kubiki in Niigata Prefecture, an area characterized by pyroclastic reservoir rocks. However, until 1968 geophysical exploration was restricted to shallow areas of the continental shelf. Similarly, until 1970 drilling activity was limited to water depths of less than 25 metres.

Exploration history, 1966-1975.

Table IIC summarizes offshore hydrocarbon exploration in Japan during the period 1966-1975.

Geophysical exploration continued during the period. A CCOP seismic and magnetic survey in the Yellow Sea and East China Sea (CCOP.1/IZ.3) covered a portion of Japanese waters west of the island of Kyushu. Innovations in geophysical methods occurred during the mid-1960's: aeromagnetic surveys began in 1965, followed by sparker surveys in 1967. A Decca Hifix positioning system was first used in 1966, and an air-gun system in 1968 all of which contributed to a spectacular improvement in seismic data quality.

Drilling activity is tabulated in Table IIC. Exploratory drilling in relatively deep waters commenced in 1970, and to date, 45 wells have been drilled in addition to the wells drilled in shallow waters as extensions of onshore production.

A new cycle of exploration began in 1967, with the establishment of the Japan Petroleum Development Corporation. From 1969 to 1975 about 50,000 line kilometres of seismic geophysics was completed. Wildcat drilling was renewed, with 7 wells in 1971 and 33 wells in the next three years. The 1972 drilling resulted in an oil discovery off Niigata, which tested 1,446 bopd. Table IV summarizes Japanese offshore fields and discoveries.

Presently, 13 major companies and some smaller companies are exploring over 943,000 square kilometres of Japanese shelf and continental slope in the search for hydrocarbons. Details of these permits are summarized in Table IIIC.

In summary, offshore exploration in Japan has been carried on continuously, using latest sophisticated geophysical exploration tools. Although a member of CCOP, Japan's role in the organization is different from other members, in that it contributes professional expertise, and training programmes as well as funds to the other member countries.

Review of the Government role in offshore exploration.

The petroleum industry in Japan has been controlled since 1952 by the Mining and Petroleum Industry Law which provides that all permits be held by 50 percent Japanese companies. In spite of the advent of applications for offshore prospecting rights in 1966, there is apparently still no specific legislation either defining the continental shelf nor covering development of its wealth.

The Government of Japan has actively promoted the development of offshore petroleum. Since 1970, geophysical surveys of the continental shelf have been carried out by the Ministry of International Trade and Industry as part of the fourth five-year plan, in addition to and in collaboration with the work programmes of various private oil companies.

REPUBLIC OF KOREA

Exploration history, 1966-1975.

Table IIID summarizes offshore hydrocarbon exploration programmes carried out between 1966-1975.

There are no reports of offshore petroleum prospecting in the Republic of Korea prior to 1966. Nine CCOP co-operation projects were undertaken between 1967 and 1975. These included CCOP-1/ROK Numbers 2, 3, 4, 6, 9a, 9b, 9c, 10 and 11.

In addition two regional projects; CCOP-1/IZ.1 and /IZ.3 have contributed to the knowledge of offshore Korea.

In 1969, Gulf Oil was awarded two blocks, and by late 1970 four companies occupied seven blocks, covering an area of 341,600 square kilometres. Relinquishments in 1974 have reduced the area under concession to 299,700 square kilometres. Over 11,000 kilometres of seismic has been run by these companies.

Wildcat drilling began in 1972, and to date five exploration wells have been drilled, two by Gulf, one by Caltex and two by Shell. Shell's second well drilled in 1975 may be a discovery although it apparently falls short of being commercial.

Government legislation.

A proclamation was issued on the 18th January 1952 claiming that the continental shelf of Korea belonged to the Republic of Korea. Twenty years later, in 1972, this shelf area had been delineated into seven blocks. Four companies have been granted rights for petroleum exploration therein, and are carrying out seismic, magnetic and gravity prospecting during an eight-year survey period. Exploratory drilling was commenced in 1972.

Development of any petroleum or natural gas resources is controlled by the 38 articles of the Submarine Mineral Resources Development Law passed in January 1970. A presidential decree to enforce the law was promulgated on 30th May 1970, together with enforcement regulations which stipulated 16 articles and 20 types of application and acknowledgement forms relating to the above law and decree.

According to Article 4 of the law, submarine mining rights shall be vested in the Government only. Grants and registration of submarine mining rights, either exploration rights or exploitation rights, shall be declared by presidential decree.

MALAYSIA (with notes on BRUNEI)

Exploration history prior to 1966.

The history of exploration for hydrocarbons in Malaysia and Brunei before 1966 is dominated by the Shell group of companies. The first offshore field, discovered in the early 1950's, is an extension of the Seria field, an old onshore field discovered in 1928 which has led production in Brunei for many years. Sabah's first offshore well was drilled in 1958. Table I summarizes drilling in Malaysia and Brunei prior to 1967.

Shell has undertaken seismic and gravity surveys offshore since 1954, in East Malaysia and Brunei. The year 1964 was unusual, for Shell did no geophysics, and the Tokyo University of Fisheries ran a 400-kilometre magnetic survey in East Malaysia. Twelve dry offshore wildcats had been drilled by 1961, when Shell terminated onshore exploration. Their onshore exploration led to the discovery in 1955 of the small Jerudong field, after drilling 49 wildcats.

Offshore drilling has continued since 1961, with eight wildcats in 1962 (of which five indicated hydrocarbons), three wildcats in 1963 (with one potential producer), and four dry wildcats in 1964. No wildcats were drilled in 1965. Increasing emphasis has been placed on development wells; for example, two potential offshore producing fields are being developed from 17 onshore and offshore development wells drilled in 1963. From 1964 to 1966, 41 development wells were sunk in the south-west Ampa field (Brunei). In 1965 Aquitaine acquired acreage in Sabah, and became the fourth operator, alongside the three Shell companies, in Malaysia and Brunei.

Exploration history, 1966-1975.

In 1966, Teiseki and ESSO acquired acreage and began exploration in offshore East Malaysia. Nine wildcats were drilled in Malaysia and Brunei in 1966, as noted in Tables IIE.

The two new companies continued principally with seismic exploration. Table IIE, summarizes offshore exploration completed during the period 1966 to 1975. In 1962 and 1963, 644 and 1,600 line kilometres completed during 5 and 11.9 months of seismic were completed. Subsequently, there was an increase in geophysical exploration, particularly by CCOP in 1969 (see below). In 1970, 5,000 line kilometres, and in 1971 nearly 10,000 line kilometres of seismic and magnetics were completed. Seismic activity has increased to much higher levels in recent years.

CCOP and related organizations have completed five projects in Malaysian waters; a magnetic survey (CCOP.1A/UNEC.3) in 1968, a seismic and magnetic survey in 1969 (CCOP.1/IZ.4) and two bottom-sampling programmes (CCOP.1/IZ.7 and 1A/UNEC.4), and a diverse geophysical project on the West Malaysian shelf (CCOP.1/MAL.3), a project to obtain basic geological data by sparker, sonic, sonar, and seismic methods. Two aeromagnetic surveys (CCOP.1/IZ.5 and 1A/UNEC.2) are presently in the planning stage.

An active drilling programme has sunk over 260 exploration wells in Malaysian waters according to Table IIE. The most active period of exploration drilling was 1969 to 1971, when nearly 100 exploration wells were drilled.

From 1970, there were eight operators in Malaysian waters and three in Brunei, working an area of 202,800 square kilometres (10 blocks) and 8,655 square kilometres (three blocks), respectively. Table 15 lists details of the concessions, and Table 8 lists the oil and gas fields, and discoveries, according to area.

Sarawak.

There are seven fields in Sarawak: Bakau, 1967 (1,900 bopd), Baram, 1964 (54,000 bopd), Baronia North, 1970 (2,500 bopd) Lutong West, 1966 (54,000 bopd), Miri, 1910 (Depleted), Temana, 1962 (Facilities ready 1975) and Tukau, 1973 (Facilities planned) production rates in mid-1974. However, Sarawak production averaged 95,000 barrels of oil per day for all 1974.

Sabah.

There are five discoveries on record. In the Sulu Sea the Aquitaine's Nymphe Nord, 1972 is probably non-commercial. Shell drilled West in 1972, Furious South in 1974, Samarang in 1973 and ESSO discovered Tembungo in 1971. Samarang and Tembungo are under development and production has now started.

Peninsular Malaysia.

Ten discoveries have been made in the Malaysian portion of the Gulf of Thailand. Conoco discovered Anding 1973, Duyong 1970 and Sotong in 1973. ESSO discovered Bekok in 1971, Bintang in 1970, Jerneh in 1969, Pilong in 1971, Pulai in 1973, Seligi in 1971 and Tapis in 1969.

None of these fields have been officially declared commercial, although ESSO was at one time planning a platform for one or more of its discoveries.

Brunei.

An offshore extension of the Seria field was discovered in the 1950's which still produces 40,000 barrels of oil per day. In 1963 the south-west Ampa field was discovered. This field now produces 112,000 barrels of oil and 770 million cubic feet of gas daily, with estimated reserves of over a billion equivalent barrels of oil. The gas is supplied to a new liquid natural gas plant near the old Seria field area, for liquification and shipment in liquid natural gas tankers.

Apart from these two producing areas, two other fields are on production. The Champion field, discovered in 1970, is producing 36,000 barrels of oil per day. The Fairley field was discovered in 1969, is producing about 36,000 barrels of oil per day. With the exception of the Champion field, all of Brunei's offshore fields are close to the Sarawak border and apparently the Fairley/Baram fields are one and will straddle the boundary. This will be the first international unitization in CCOP countries.

Review of Government legislation.

The Continental Shelf Act of Peninsula Malaysia was passed in 1966, and extended to cover East Malaysia in 1970. The act lays claim to the seabed and subsoil of the sea, beyond the three-mile limit, as far as the 200 metre isobath. The act provides for federal jurisdiction over areas beyond the three-mile territorial limit, and for state jurisdiction over areas within the three-mile limit.

A State Oil enterprise, Petronas, was created in 1974. The Petronas charter provides that it shall administer all affairs with regard to hydrocarbons in Malaysia.

PHILIPPINES

Work prior to 1966.

Onshore drilling for petroleum in the Philippines started in 1896, and has continued intermittently to the present time. Considerable petroleum exploration offshore was completed in the Philippines before 1966. Offshore exploration began in the 1950's, following the passage of the 1949 Petroleum Law and grants of leases. No drilling, however, was undertaken in offshore areas until 1971.

In the period 1950 to 1966, approximately 40,000 line kilometres of geophysics were completed, beginning in 1957 with a single airborne aerial magnetometer traverse from Corregidor to Lebrun in northern Kalimantan. In the period 1958-1966 a consortium of Mobil, Esso, Amoseas, Visayan Exploration, White Eagle Overseas Oil Corporation, AAOC and San Jose Oil had completed the geophysical surveys as follows:

Aeromagnetic (30,152 kilometres), marine seismic gas exploder (3,874 kilometres), conventional marine seismic (4,616.5 kilometres), sparker (3,900 kilometres), and marine gravity (300 kilometres).

The work included airborne magnetometer surveys in the Sulu Sea (Aero Services Corp.) and along the west coast of Palawan (Hunting Surveys), as well as an aeromagnetic and marine seismic survey of the Visayan basin (Sulu Sea) by Mobil. Table I summarizes this activity.

The results of these geophysical surveys apparently indicated areas with thick sedimentary sequences with favourable structures. Nine wells were drilled on small islands in the Visayan Sea during 1963 and 1964. However, due to lack of onshore discoveries or even much encouragement, offshore exploration virtually ceased in 1966, and onshore exploration also ceased in 1967.

Exploration history, 1966-1975.

Table IIF summarizes offshore hydrocarbon exploration activities in the Philippines during the period 1966-1975.

Offshore geophysical exploration, after a period of inactivity from 1966 to 1969, commenced again in late 1969. An aeromagnetic survey (CCOP. 1/PH.1 and 1/PH.2) in the Palawan-Sulu offshore areas was completed in 1969, and another was completed in 1970 in the southern Luzon, Marinduque, and Mindoro Islands and offshore areas. A total of 25,200 line kilometres were flown by these two surveys, and involved CCOP, the office of Project Magnet, the Geological Survey of the Federal Republic of Germany, and the Government of Japan. Also, Project CCOP. 1/IZ.4 included approximately 1,500 line kilometres of seismic and magnetic surveys in waters off the Philippines. Another seven surveys are either planned or in progress, involving seismic refraction, sonic reflection, conventional marine seismic, aeromagnetic and gas exploder surveys. Geophysical work in 1970 carried out by private companies surpassed 786 line kilometres, and has continued at a high level to the present.

Drilling activity commenced in 1971 with two unsuccessful wildcats off Palawan. None were drilled in 1972 but three were abandoned in each of 1973 and 1974, and about 10 wells are expected to be drilled in 1975. These data

are listed in Table IIF.

At a recent count there were 42 companies with 301 blocks in Philippines offshore areas. The total area of these concessions, including a minor portion of land in islands, was 168,391 square kilometres. However, the current offshore drilling is taking place under terms of service contracts of which there are now 11 covering 63,788 square kilometres.

Review of Government legislation.

The Philippines Petroleum Act was promulgated in 1949 for petroleum exploration and exploitation, both on land and offshore. In 1968, measures were taken to claim the Philippines continental shelf.

In September 1972, a law regulating "service contracts" was introduced by Presidential Decrees 8 and 87, allowing foreign investors to join the search for oil and gas. The Petroleum Board of the Bureau of Mines was established to administer the laws.

Immediately following the introduction of the new legislation, the two companies Standard Oil of California and Texaco signed the first service contract with the Government. By 1975, a total of nine companies have agreed to 11 contracts on 63,788 square kilometres. See Table IIIF. Another development was the creation of the Philippine National Oil Company in 1974 which is taking an active part in the exploration of the archipelago.

THAILAND

Exploration prior to 1966.

There are no records of offshore petroleum exploration being carried out before 1966 in Thailand. Onshore interest centred around the Khorat plateau area, where Union Oil commenced a five-year exploration programme in 1962.

Exploration history, 1966-1975.

Table IIG summarizes offshore hydrocarbon exploration. Most offshore exploration by private oil companies commenced after June 1967 when the Government of Thailand offered 19 blocks, comprising 189,007 square kilometres in the Gulf of Thailand.

CCOP, with the U.S. Naval oceanographic office, completed approximately 2,500 line kilometres of seismic and geomagnetic traverses in Thai waters as part of the 1969 project CCOP.1/IZ.4. An aeromagnetic survey (CCOP.1/IZ.5) is being planned. Also, Project CCOP.1/ROV.2(a), a seismic refraction survey off southwest Viet-Nam, has contributed some geological knowledge of the Gulf of Thailand.

By early 1968 six of the oil companies who had been provisionally awarded 17 of the 19 available blocks all signed agreements with the Thai Government. No drilling occurred, however, until 1971 when Surat-1 was drilled and abandoned by Conoco. Final ratification of the Thai petroleum legislation by its government and final signature on the petroleum agreement was not accomplished until 1972 after which the exploration campaign accelerated.

Since late 1972 until mid-1975, 25 wells have been drilled in the Thai portion of the Gulf. Of these, eight wells reported tests at a rate that can potentially be commercial. Gas, however, is the predominant hydrocarbon and shows tend to be in discontinuous reservoirs and development of these shows will be difficult.

The last two blocks in the Gulf were awarded to Triton in October 1972. In addition, six blocks have been awarded on the Indian Ocean side to six groups or companies. Two small blocks remain open adjacent to the Malay offshore border.

Prior to the 1975 round of relinquishments 308,064 square kilometres were under lease. In early 1975 some 49,000 square kilometres were relinquished in the Gulf leaving some 259,000 square kilometres under concession. Operations on the Indian Ocean side to date have been confined to geophysical survey, but drilling will be underway in very deep water by early 1976.

Review of Government legislation.

In June 1967 the Thai Government received bids for 19 offshore blocks in the Gulf of Thailand. Seventeen of the blocks were awarded to companies in 1968. The contracts signed were exclusive and for combined hydrocarbon exploration and exploitation, with a preferential option for exclusive exploitation

rights. Also in 1968, the Government made official claims to the Thai shelf area by ratifying the continental shelf convention (July) and passing domestic legislation (September). The Petroleum Law and Income Tax Act were passed in April 1971, following which new concession agreements were negotiated with the private oil companies.

The agreements with the oil companies are for a concession type contract, subject to 12½ percent royalty and a sliding scale profits tax from 50 percent to 60 percent.

VIET-NAM (now known as the Socialist Republic of Viet-Nam)

Work prior to 1966.

The only recorded prospecting activity off the shores of Viet-Nam was conducted at the Bay of Qui-Nhon, near the central part of the east coast in the 1940's. A small accumulation of possible crude oil on the waters of the bay led to drilling an unspecified number of wells. These wells penetrated thick, recent muds and bottomed in granite basement at a shallow depth.

Exploration history, 1966-1975.

Table IIH summarizes all offshore exploration work between 1966-1975 in Viet-Nam.

Four projects sponsored by CCOP have been carried out, and three more are being planned. The first project (CCOP.1/ROV.4) involved interpretation of an aeromagnetic survey by Project Magnet over the Mekong Delta area. Project CCOP.1/IZ.4 covered approximately 4,000 line kilometres of seismic and geomagnetic surveys in Vietnamese waters. The other two projects, both in 1968, (CCOP.1/ROV.2 (a) and ROV.5) involved seismic refraction surveys and shallow penetration sparker profiles off the southwest coast

A consortium of eleven private oil companies participated in an 8,406-line kilometre seismic survey conducted by Ray Geophysical in 1969-70.

In 1973 after the operating framework for offshore exploration had been established bids were called for concessions. In August 1973 eight concessions were awarded to four operators. A year later an additional five concessions were awarded and the number of operators increased to eight. See Table IIIH.

Review of Government legislation.

Law No. 011/70 on petroleum was promulgated on 1 December 1970 by the President of the then Republic of Viet-Nam, and covers provisions relating to exploration, exploitation, and related taxation and exchange regulations. The National Petroleum Board was formed in 1971 by Decree No. 003-SL/KT. The Petroleum Board issued Decree No. 249 on 9th June 1971, related to grants of petroleum exploration and exploitation concessions. Seven new decrees had been issued to supplement the basic legislation, which bear the numbers 062 to 065/SL/KT and 170 to 172/BKT/UP/UBQGD/ND, inclusive.

These laws and regulations were the prevailing legislation dealing with hydrocarbons up to early 1975.

CCOP

The formation of CCOP followed a proposal, subsequently approved by ECAFE, at the seventh session of ECAFE Committee on industry and natural resources, held in Bangkok in February 1965. The Governments of Japan, Republic of Korea and the Philippines later confirmed their readiness to join in establishing CCOP in March/April 1966, at the twenty-second session of ECAFE held in New Delhi. The first session of CCOP was held at Quezon City, Philippines from 27th May to 2nd June 1966. As of June 1967 CCOP membership had grown with the addition of Indonesia, Cambodia, Malaysia, Viet-Nam and Thailand.

Table V lists projects undertaken and planned by CCOP since 1966 which includes only those related to offshore hydrocarbon exploration. Other programmes in the fields of offshore mineral exploration have also been undertaken, but are not listed.

The original charter of CCOP was to co-ordinate, sponsor and facilitate the development of offshore hydrocarbon resources in east Asia. Given the large amounts of capital, sophisticated equipment and expertise required to develop offshore petroleum resources, it was felt that an international organization would facilitate co-operation in this sphere between the developing countries. Such an organization could, and indeed has, enlisted the support of other organizations in the search for oil and natural gas.

CCOP has engaged in a variety of projects. In addition to the field projects listed in Table IV, the Committee has been involved in research, data accumulation and processing, and legislative recommendations to the various member countries concerning offshore concessions. Basically, however, the Committee aims to promote and co-ordinate the development of offshore petroleum and mineral resources of the member countries. In this respect the Committee has been extremely successful, judging from the spectacular advance in petroleum exploration and exploitation in the area since 1966.

CCOP's first undertaking with UNDP support was a continuous marine seismic profiling survey, supplemented by magnetic recording, along the southeast coast of the Republic of Korea in 1966. While the results of that survey were not encouraging, the interest of the Government was stimulated in the search for hydrocarbons in its offshore areas. Thereafter a geophysical survey in the East China Sea and the Yellow Sea aboard R/V F.V. Hunt yielded valuable information, and was followed by an aeromagnetic survey over areas offshore from the southeastern, southern and western parts of the Korean Peninsula in 1969. These initial surveys promoted the interest of private oil companies, who subsequently entered the area.

In the Philippines, a number of projects have been undertaken, the first an aeromagnetic survey carried out in 1969.

Indonesia, Cambodia, Thailand, Viet-Nam, and Malaysia were not initially members of CCOP, so the first surveys concentrated on north Asian offshore areas. Projects were implemented in southeast Asian waters from 1968. Refraction and continuous seismic profiling were carried out by CCOP along the west coast of Viet-Nam. Since then,

considerable interest has been shown by oil companies in the area.

Of great significance are the regional studies of the marine shelves of east Asia. Real advances have been made towards understanding the tectonic and sedimentary framework of the subsea areas. Mention has already been made of these studies in the text, notably the CCOP-Project MAGNET Series of Surveys.

A vast upsurge of offshore hydrocarbon exploration has occurred after CCOP began promoting prospecting in all member countries, although Japan previously had an active offshore programme underway.

The basic objectives of CCOP have been achieved.

Part II

EXPLORATION STATISTICS

APPENDICES

Table I

OFFSHORE HYDROCARBON EXPLORATION PRIOR TO 1965

	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
INDONESIA										
Drilling	-	-	-	-	-	-	-	-	-	-
Geophysics (km)	-	-	-	-	-	-	-	-	400	-
Contract areas	-	-	-	-	-	-	-	-	-	-
Companies	-	-	-	-	-	-	-	-	-	-
JAPAN										
Drilling	-	-	-	3	1	-	-	-	-	-
Companies	1	2	2	2	2	2	2	2	2	2
MALAYSIA-BRUNEI										
Drilling	-	-	1	-	5	6	8	3	4	-
Discoveries	-	-	-	-	-	-	-	1 gas	-	-
Metres drilled	-	-	2133	-	10972	14152	20073	7953	9458	-
Companies	3	3	3	3	3	3	3	3	3	4
PHILIPPINES										
Drilling	-	-	-	-	-	-	-	*	*	-
Seismic(km)	-	-	-	?	?	?	4264	785	?	2871
Magnetic(km)	-	-	-	-	-	-	-	6720	-	23
Gravity(km)	-	-	-	-	-	-	300	-	-	-
CAMBODIA	-	-	-	-	-	-	-	-	-	-
KOREA	-	-	-	-	-	-	-	-	-	-
VIET-NAM	-	-	-	-	-	-	-	-	-	-
THAILAND	-	-	-	-	-	-	-	-	-	-

* 9 offshore island wells in Visayan Sea

EXPLORATION STATISTICS

Table II

Table IIA

OFFSHORE HYDROCARBON EXPLORATION 1966-1975

CAMBODIA

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Wildcats	-	-	-	-	-	-	1	-	2	0
GEOPHYSICS										
Seismic (km)	-	-	-	-	2880	-	-	2159	1794	0
CCOP combine (km)	-	-	-	2000	-	-	-	-	-	0
Concessions Km^2 x 1000	-	-	-	40	40	40	20	37	37	37
Total leases	-	-	-	1	1	1	1	2	2	2
Operators	-	-	-	1	1	1	1	2	2	2

Table IIB

INDONESIA

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Exploration wells	-	-	8	24	58	85	67	82	102	27
Declared discovery	-	-	-	3	5	5	8	11	15	0
Metres drilled	-	-	15209	33556	11520	157025	131575	163547	207314	44193
GEOPHYSICS										
Seismic (km)	-	-	51799	97237	62492	63592	35687	45213	38999	12242**
Magnetic (km)	96643	-	2500	150	10131	27050	1170	10611	2536	
Gravity (km)	-	-	-	-	10169	20200	-	1791	715	
Total Production										
Sharing contracts	-	7	18	25	32	35	36	34	31	35
Area sq km x 10^6	-	.39	1.68	2.04	2.08	2.86	2.23	1.74	1.23	1.22
Total Operators	-	5	13	18	20	20	20	20	21	22

** To May 1975

Table IIC

JAPAN

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Exploration total	4	5	3	Na	-	7	10	8	5	3
Discoveries	2gas	-	-	-	-	1 oil	1 oil 1 gas	1 oil	1 gas	-
GEOPHYSICS										
Seismic (km)	6.2*	1.7*	-	9879	6554	6140	10247	8282	35.5*	6+*
Magnetic (km)	1.7*	-	-	-	19738	400	550	11585	6.6*	-
Gravity (km)	1.8*	-	-	-	7760	3070	550	5856	7*	-
PERMITS										
Area Km^2 x 1000	Na	61	73	213	261	309	600	943	943	943
Companies	2	3	4	6	8	10	9	12	14	14

Table IID

KOREA, REPUBLIC OF

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Exploration total	-	-	-	-	-	-	0	4	0	1
Discoveries	-	-	-	-	-	-	0	0	0	1
Metres drilled										
GEOPHYSICS										
Seismic (km)	-	-	6000	-	-	-	5290	5650	588	0
Magnetic (km)	-	-	6000	40000	1300	-	-	5299	-	0
Gravity (km)	-	-	-	-	1300	-	-	4574	-	0
CONCESSIONS										
Area km^2 x 1000	-	-	-	81.7	341.6	341.6	341.6	341.6	299.7	299.
Number	-	-	-	2	7	7	7	7	7	7
Operators	-	-	-	1	4	4	4	4	4	4

* party months

Table IIE

MALAYSIA

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
							+Shell	+Shell		
Exploration total	9	12	17	24	47	23	20	25	32	7+
Discoveries	3 oil	1 oil	Na	Na	-	3 oil 1 gas	3	3 oil	2	-
					+Shell	+Shell	+Shell	+Shell	+Brunei	
Metres drilled	27566	31308	Na	76513	24433	29390	40403	28249	78777	
GEOPHYSICS										
Seismic (km)		644	1600	4680	4996	9975	12798	9968	14685	
	6*	11.9*	5*	39*	5*			+Shell		
Magnetic (km)	-	-	1300	4500	-	3300	0	12872	0	-
Gravity (km)	-	-	-	1*	-	0	0	0	0	-
CONCESSIONS										
Area km^2 x 1000	190.1	197.9	347.2	347.2	340.0	258.0	258.0	204.7	202.8	202.8
Number	5	6	9	9	9	10	10	10	10	10
Operators	5	5	7	7	7	8	8	8	8	8

Table IIF

PHILIPPINES

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Exploration	-	-	-	-	-	2	-	3	3	4+
Metres drilled	-	-	-	-	-	4395	-	7129	9992	-
GEOPHYSICS										
Seismic (km)	960	-	-	1500	786	11803	5000	6*	2100+	
Magnetic (km)	-	-	-	22500	4200	10000	-	-	-	-
Gravity (km)	-	-	-	-	-	-	-	-	-	-
SERVICE CONTRACTS										
Area	-	-	-	-	-	-	12962	49403	62598	63788
Number	-	-	-	-	-	-	1	7	10	11
Operators	-	-	-	-	-	-	1	7	9	9

*Party months

Table IIG

THAILAND

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Exploration total	-	-	-	-	-	1	3	5	12	4
Discoveries	-	-	-	-	-	0	1	2	4	1
Metres drilled	-	-	-	-	-	2935	5355	15688	35596	
GEOPHYSICS										
Seismic (km)	-	-	11686	11552	6310	1670	11473	12615	25472	
Magnetic (km)	-	-	-	2413	59533	-	4124	1228	-	-
Gravity (km)	-	-	-	-	-	-	4124	1228	-	-
CONCESSIONS										
Area x1000 km^2	-	-	-	Awaiting		265.3	218.2	218.2	308.2	308.
Number	-	-	-	Legislation		12	11	11	14	1
Operators	-	-	-	-	-	9	9	9	11	1

Table IIH

VIET-NAM

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
DRILLING										
Exploration total	-	-	-	-	-	-	-	-	2	4
Discoveries	-	-	-	-	-	-	-	-	1	1
Metres drilled	-	-	-	-	-	-	-	-	5689	4000
GEOPHYSICS										
Seismic (km)	-	-	657	4000	8406	-	-	4800	22032	Na
Magnetic (km)	-	140	-	4000	-	-	-	-	-	-
Gravity (km)	-	-	-	-	-	-	-	-	-	-
CONCESSIONS										
Area x 1000 km^2	-	-	-	-	-	-	-	58.3	84.2	84
Number	-	-	-	-	-	-	-	8	13	1
Operators	-	-	-	-	-	-	-	4	8	

Table III

SOUTHEAST ASIA CONCESSION AND CONTRACT AREAS,

STATUS AT MID-1975

OFFSHORE

HEADING EXPLANATION

COMPANY ACTING AS OPERATOR DATE CONTRACT AWARDED	GENERAL GEOGRAPHIC PLACEMENT	PARTNERS IN CONTRACT WITH PERCENT INTEREST OF EACH SHOWN	ORIGINAL AREA AWARDED IN SQUARE KILOMETRES (EQUIVALENT ACRES) PRESENT AREA AFTER R.	SIGNATURE BONUS PRODUCTION BONUS $\$ \times 10^6$ AND BOPD X 10^3	WORK COMMITMENT $\$ \times 10^6$ OVER YEARS	NUMBER OF WELLS DRILL UNDER TERMS OF CONTRACT DIVISION OF PROFIT OIL

TABLE IIIA.

CAMBODIAN CONCESSIONS
Status Mid 1975

ELF 21/2/69	Gulf of Thailand	ELF 50% ESSO 50%	81,800 (20.2×10^6) 20,000	- o -	2 years to drill	(3) 12½% royalt 50% profit tax
Marine Asscs. 11/6/72	Gulf of Thailand	Cdn.Res. 75% Sunlight 25% Marine has carried interest	17,000 (4.2×10^6) 17,000	- o -	\$3.0 in 3 years	(0) 12½% royalt 50% profit tax

TABLE IIIB

INDONESIAN PRODUCTION SHARING CONTRACTS

STATUS MID 1975

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM² ORIGINAL (ACRES X 10^6) PRESENT	BONUS ȣ X 10^6 000 b/d	COMMITMENTS ȣ X 10^6 000 b/d	(NO WELLS DRILLED) PROFIT SPLIT
AGIP 19/12/68	S. China Sea Block A	*AGIP Phillips	33.1/3% 33.1/3%	104,470 (25.81 58.871)	Sig ȣ1.5m ȣ0.5 @ 50 ȣ1.0 @ 75	ȣ 21 in 10 years	(15) 65/35 67½/32½ @ 75
AGIP 1/11/68	S. China Sea Block C	*AGIP Phillips Tenneco Frontier Koch Texas Crude Grt.No.Oil	29.167% 29.167% 29.167% 5.00% 2.500% 2.500% 2.500%	112,695 (27.84) -o-	Sig ȣ1.55m ȣ2 @ 50 ȣ5 @ 200	ȣ15.45 in 6 years	(4) 65/35
AMINOIL 9/8/69	Indian Ocean W. Sumatra	*Aminoil White Shield Tri-Cont' Oil	48.30% 47.04% 4.66%	72,500 (17.91) 47,125	Sig. ȣ2.5m ȣ1 @ 50 ȣ1 @ 200	ȣ17.5 in 8 years	(4) 65/35 67½/32½ @ 75
ASHLAND 19/1/67	East Java Sea	*Ashland Kyushu Deminex Zapex ?	33.1/3% 33.1/3% 33.1/3%	127,073 (31.40) 31,700±	Sig -o- ȣ5 @ 50 ȣ10 @ 100	ȣ25.7 in 8 years	(11) 65/35
ASHLAND 19/1/67	Makassar Strait	*Ashland Kyushu BP	25% 50%	70,800 (17.49) 35,400	-o-	ȣ7.5 in 6 years	(5) 65/35
ARCO 18/8/66	N.W. Java Offshore	*ARCO IIAPCO Carver Dodge Warrior	46% 36.85% 12.25% 4.9%	54,000 (13.34) 27,000	-o-	ȣ7.5 in 6 years	(147) 65/35
ARCO 5/8/70	Malacca Strait Kondor Block	*ARCO Pan Ocean Houston	56.67% 39.00% 4.33%	40,000 (9.88) 32,000	Sig ȣ0.4 ȣ1 @ 50 ȣ2 @ 100	ȣ11 in 8 years	(4) 65/35 67½/32½ @ 75

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST	AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $\$ \times 10^6$ 000 b/d	COMMITMENTS $\$ \times 10^6$ 000 b/d	(NO WELLS DRILLED) PROFIT SPLIT
BP 2/3/70	N.E. Kalimantan Makassar St.	*BP 50% Pan Cdn. 50%	27,725 (68.51) 20,790	Sig $ 1.0 $ 1 @ 50 $ 2 @ 100	$ 9.8 in 8 years	(1) 65/35 67½/32½ @ 75
Caltex Amoseas 9/2/70	Lombok Straits	Calasiatic 50% Topco 50%	56,810 (14.04) 42,600	Sig $ 2.0 $ 1.5 @ 50 $ 2.0 @ 100	$ 9.8 in 8 years	(4) 65/35 67½/32½ @ 65
Champlin 3/3/72	Arafura Sea, South W. Irian	*Champlin 53.875% Pexamin 7.250% White Sh. 8.875% L.V.O. 12.5% Patrick 5.0% ODECO 12.5%	74,360 (18.37) 63,200	Sig $ 0.5 $ 1 @ 50	$ 13.25 in 8 years	(3) 65/35 67½/.5 @ 65 70/30 @ 75
Cities Service 21/10/67	East Java Sea	*Cities S. 1/3 Ashland 1/3 Robina 1/6 Monoil 1/6	147,000 (36.32) 73,500	-o- $1 @ 40 $4 @ 100	$ 7.5 in 6 years	(29) 65/35
Conoco 16/10/75	S.China Sea Block B	*Conoco 40% Getty 25% Ameco 35%	106,707	Sig $ 7.0 $ 3 @ 50 $ 3 @ 100	$ 14.2 in 6 years	(23) 65/35 67½/37½ @ 75
Conoco 16/1/75	Makassar Strait	*Conoco 50% Ultramar 50%	3,835 (0.95) 3,835	Sig $ 2	$ 17.1 in 8 years	(0) 70/30
Gulf 17/6/68	Sunda Shelf	*Gulf 100%	140,000 (34.79)	Sig 1.15	$ 11.3 in 8 years	(4) 65/35 67.5/32.5 @ 7
Gulf 14/6/69	Sulawesi	*Gulf 100% (Shell 50%)	100,000 (24.71) 50,000	Sig. 0.25 $ 1 @ 75 $ 1 @ 100	$ 8.0 in 8 years	(3) 65/35 67½/32½ @ 75

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL ($ACRES \times 10^6$) PRESENT	BONUS $\$ \times 10^6$ 000 b/d	COMMITMENTS $\$ \times 10^6$ 000 b/d	(NO WELLS DRILLED) PROFIT SPLIT
Gulf 18/1/63	N.E. Sumatra Malacca Straits	*Gulf Japex	50% 50%	23,000 (5.68) 23,000	-o- SEE	-0- NOTE	(14) 65/35
G.+W. 1/11/69	Seram Buru	A.A.R. G+W	100% 0%	130,000 (32.12) 78,000	Sig $ 3.0 $ 1.5 @ 25 $ 3 @ 50 $ 5 @ 100	$ 14.5 in 8 years	(40) 65/35 67½/32½ @ 55
IIAPCO 6/9/68	Java Sea West	*IIAPCO Carver-D Indomar Warrior R&B	56.64 18.83 13.00 7.53 4.00	132,600 (32.77) 61,300	Sig $ 1.25 $ 3.50 @ 75	22.5 in 10 years	(100) 65/35 67½/32½ @ 75
INCA 20/3/75	S.China Sea	INCA Group	100%	20,030 (4.94) 20,030	Sig $ .75 Spud $ .50 Disc $ 1.50 $ 1 @ 50 $ 1.5 @ 75 $ 2 @ 100	$ 10.25 in 8 years	(0) 72.5/27.5 Steps up to 90/10 @ 500
INTERNATIONAL 3/4/68	Timor & Timor Sea	INT. BOC.	35% 65%	26,000 (6.42) 13,000	-o- $ 1 @ 50	$ 2.45 in 6 years	(0) 65/35 67½/27½ @75
JENNEY 3/8/69	S.W. Sumatra Mentawi	*Jenney Bow Valley States	12.5% 12.5%	75,200 (18.58)	Sig $ 0.81	$ 2.45 in 6 years	(2) 65/35 67½/32½ @ 65
JENNEY 3/8/69	S. China Sea Karimata	Marine Santa Fe	37.5% 37.5%	47,000 (11.61) -0-	Sig $ 3.0 $1.25 @ 25 $3 @ 50 $5 @ 100	11.9 in 8 years	(3) 65/35 67½/32½ @ 60

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS Ø X 10^6 000 b/d	COMMITMENTS Ø X 10^6 000 b/d	(NO WELLS DRILLED) PROFIT SPLIT
MOBIL 16/10/68	E. Sumatra Malacca St. N. & Central	Mobil	100%	32,300 (7.98) 22,600	Sig Ø 0.5 Ø 5 @ 50, 100, 200, 300	Ø 5.5 in 6 years	(11) 65/35
MOBIL 14/3/73	E. Kalimantan Deep Water	Mobil	100%	20,800 (5.14) 20,800	Sig Ø 1.375 Ø 2 @ 100 Ø 3 @ 150	Ø 9 in 10 years	(0) 65/35 67½/3½ @ 10 70/30 @ 150
MONCRIEF 20/11/74	E. Java Sea Ex Cities	Moncrief Pexamin	50% 50%	20,390 (4.94) 20,390	Sig Ø 0.95 Ø 1.5 @ 50 Ø 1.75 @ 75 Ø 2 @ 100	Ø 11.85 in 8 years	(0) 70/30 75/25 @ 50 80/20 @ 125
NORTH SUMATRA OIL	Malacca Strait (See Gulf)	N.S.O. Refican	100%	23,000 (5.68) 23,000	-o-	-o-	(3) 65/35
Phillips 1/1/68	Arafura Sea	*Phillips Superior Agip	36% 50% 14%	325,325 (80.38) 162,662	Sig Ø 0.5 Ø 2 @ 100	Ø 17 in 8 years	(5) 65/35 67½/32½ @ 100
Phillips 10/10/68	West Irian Teluk Baru	*Phillips Agip Conoco	35% 40% 25%	100,000 (24.71) 50,000	Sig Ø 1.5 Ø 0.5 @ 75 Ø 1.5 @ 100 Ø 2 @ 200	Ø 16 in 8 years	(17) 65/35 67½/32½ @ 75
Shell 15/1/71	South Java Sea	Shell	100%	9,000 (2.22) -o-	Sig Ø 4.0 Ø 1 @ 50 Ø 1 @ 75	Ø 18.0 in 8 years	(2) 65/35 67½/37½ @ 75

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $ X 10^6 000 b/d	COMMITMENTS $ X 10^6 000 b/d	(NO WELLS DRILLED) PROFIT SPLIT
TENNECO 22/11/74	S. China Sea	*Phillips Tenneco Marathon Huffco	25% 25% 25% 25%	5,165 (1.28) 5,165	Sig $ 6.0 $ 2 @ 50 $ 2.5 @ 100 $ 3 @ 200	$ 20.5 in 8 years	(0) 72.5/27.5 77.5/22.5 @ 50 80/20 @ 150
TESORO 4/2/70	North W. Irian	Tesoro W. Phil Arco	75% 25%	40,070 (9.90) 30,052	Sig $ 0.5 $ 1 @ 50 $ 1 @ 75 $ 2 @ 100		(5) 65/35 67½/32½ @ 75
Total 31/3/67	Kalimantan Mahakam	*Total Japex	50% 50%	16,370 (4.05) 8,185	-o-	$ 7.5 in 6 years	(35) 65/35
Total 6/10/66	N.E. Kalimantan Bunyu	*Total Japex	50% 50%	17,150 (4.24) 8,575	-o-	$ 7.5 in 6 years	(4) 65/35
Total 6/11/68	Java Sea	Total	100%	8,800 (2.17) 8,800	-o-	$ 0.625 in 4 years	(1) 65/35
UNION 26/1/68	N. Sumatra W. Coast NIAS	Union	100%	122,500 (36.27) 61,250	Sig $ 0.5 $ 1.5 @ 75	$ 4.6 in 6 years	(15) 65/35 67½/32½ @ 50
UNION 25/10/68	E. Kalimantan Mahakam	Union	100%	12,700 (3.14) 12,700	Total Bonus $ 1.125 $ 1.5 @ 75 $ 1.5 @ 175	6.5 in 6 years	(81) 65/35
UNION 17/4/70	Attaka Unit	Union Japex	50% 50%	285 (0.07) 285	Part above contract Part Japex/Total contract		65/35

TABLE IIIC

J A P A N

STATUS EARLY 1975

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $ X 10^6	COMMITMENT $ X 10^6	NO WELLS DRILLED
Alaska	Japan Sea Hokkaido Honshu 1 permit	Alaska	100%	5,653 (1.40) 5,653	-o-		0
Idemitsu	Japan Sea Tokyo 3 permits	Idemitsu	100%	24,000 (5.93) 24,000	-o-		6 wells
Japex	7 permits	Japex	100%	83,900 (20.73)	-o-		0
Japex/ Offshore	10 permits	Amoco Idemitsu Japex	25% 25% 50%	2,967 (0.73) 2,967	-o-		3 wells Explor.
Mitsubishi	S.E. Hokkaido 1 permit	Mitsubishi	100%	196 (0.05) 196	-o-		0
Mitsui	Hokkaido 6 permits	Mitsui	100%	29,467 (7.28) 29,467	-o-		0
Nippon	Tosa Bay Yellow Sea 2 permits	Nippon Socal Texaco	50% 25% 25%	85,846 (21.21) 85,846	-o-		0
North Japan	1 Permit	N.Japan	100%	120 (0.03)	-o-		0
Teikoku	S.W.Japan Ryukus 2 permits	Teikuku *Gulf	100%	195,000 (48.19) 195,000	-o-	*Gulf took 50% interest 1975	0

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $ X 10^6	COMMITMENT $ X 10^6	NO WELLS DRILLED
Teikoku/ Esso	East Coast 1 permit	Teikoku Esso E. Japan	50% 35%* 15%	70,000 (17.30) 70,000	-o-	Esso withdrew in 1975. Taken up by Gulf Lwaki Gas Area Excluded	6
Teikoku/ Gulf	E. China Sea 1 permit	Teikoku Gulf	50% 50%	75,000 (18.53) 75,000	-o-		0
Uruma	Kyuku 1 permit	Uruma Res	100%	40,000 (9.88) 40,000	-o-		0
West Japan	Korea Strait West, North, East Deep Water 7 permits	Mitsubishi Shell	50% 50%	332,000 (82.04) 332,000	-o-	6 permits in deep water	7

TABLE III D

KOREA, REPUBLIC OF

STATUS TO MID 1975

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL ($ACRES \times 10^6$) PRESENT	BONUS $\$ \times 10^6$	COMMITMENT $\$ \times 10^6$	NO WELLS DRILLED
Caltex 17/2/70	Blk I Seoul Blk V Cheju-do 2 permits	Socal Texaco Lucky	40% 40% 20%	80,000 (19.77) 33,6C)	Sig $ 0.8 12½ royalty 50% tax		1
Gulf 15/4/69	Blk II Kunsan Blk IV Cheju-do 2 permits	Gulf Koco 2 permits	80% 20%	97,000 (23.97) 40,740	Sig $ 0.8 12½ royalty 50% tax		2
Shell 28/1/70	Blk III Mokpo Blk VI Pusan 2 permits	Shell	100%	70,000 (17.30) 29,400	Sig $ 0.8 12½% royalty 50% tax		2
Korean American 24/9/70	Blk VII Ryuku	Universal Hamilton Weeks W.Phillips Norse 1 permit	40% 25% 22.5% 10% 2.5%	60,701 (15.0) 60.701	Sig $ 0.5 Disc $ 1.0 12½ royalty 50% tax	$ 7 in 7 years $5 @ 100	0

TABLE III E

MALAYSIA

STATUS AT MID 1975

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS	INTEREST	AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS \$ X 10^6	COST PER ACRE	(NO WELLS DRILLED) PROFIT SPLIT
Aquitaine 1965	East Coast Sabah	Aquitaine Sabah Marine	50% 50%	6,858 (1.69) 3.727	-o-	Royalty 12½% Tax 50%	(7)
Conoco 16/4/68	W. Malaysia S. China Sea	*Conoco BHP El Paso	50% 25% 25%	62,159 (16.26) 19,165	-o-	Royalty 12½% Tax 50%	(12) 65% / 35%
Esso 1968	Sabah China Sea Blk 8, 9, 10	Esso	100%	30,510 (7.54) 9,958	-o-	Royalty 12½% 10% 8% Tax 50%	(16)
Esso 16/4/68	W. Malaysia S. China Sea	Esso	100%	72,519 (17.92) 36,250	-o-	Royalty 12½% Tax 50%	(28)
Mobil 25/1/72	W. Malaysia Malacca Str.	*Mobil Teijin	60% 40%	31,468 (7.78) 15,730	-o- M\$ 5 @ 50 M\$ 7 @ 100 M\$ 9 @ 200	Royalty 12½% Tax 55%	(2) 60% 40% 67½/32½ @ 75
Oceanic 1969	Sabah China Sea	Oceanic Fluor	87½% 12½%	1,437 (0.34) 727	\$ 3 @ 50 \$ 3 @ 100	Royalty 12½% 8% 5% Tax 50%	(1) 65/35%
Shell 1934	Sabah	Shell Shell	50% 50%	23,309 (5.76) 11,654		Royalty 12½% Tax 50%	(25) 65/35

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST	AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $ X 10^6	COST PER ACRE	(NO WELLS DRILLED) PROFIT SPLIT
Shell 1957	Sarawak	Shell 100%	77,700 (19.20) 38,800	-o-	Royalty 12½% Tax 50%	(106 expl.)
Teiseki 16/7/64	S.E. Sabah Blks 5, 6	Teikoku 50% Sekiyu 50%	19,380 (4.79) 9,700	-o-	Royalty 12½% Tax 50%	(4)

TABLE III Ea

BRUNEI

STATUS AT MID 1975

OPERATING COMPANY	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $ X 10^6	COST PER ACRE	NO WELLS DRILLED
Shell Pre War	Brunei Offshore	Shell	100%	20,124 (4.97) 20,124	-o-	Royalty 12½% Tax 50%	50+

TABLE III F (1)

P H I L I P P I N E S

SERVICE CONTRACTS

STATUS AT MID 1975

OPERATING COMPANY	LOCATION OFFSHORE	PARTICIPANTS	INTEREST	AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS \$ X 10^6	COMMITMENT \$ X 10^6	NO WELLS DRILLED PROFIT SPLIT
Amoco 1/9/73	9 Blocks N.Palawan 2 blocks Sulu Sea	*Amoco Mosbacher Husky Transasia) Philodrill) Baguio) Sabena) Philex) Martin)	50% 16.6% 16.6% 16.6%	12,975 (3.21) 12,975	-o-	\$ 15.5 in 5 years Drill 40,000 feet	1
Champlin 11/8/73	2 Blocks West Palawan	*Champlin Pexamin Astro) Lepanto) Baguio) Oriental)	70% 50% 25%	5,765 (1.42) 5,765	Sig \$ .75 \$ 1 @ 25 \$ 2 @ 75 \$ 3 @ 150	\$ 7 in 5 years Drill 35,000 feet	0
Chevron 30/12/72	3 Blocks Sulu Sea 3 Blocks Palawan	Chevron Texaco Astro Japtract	42.5% 42.5% 7.5% 7.5%	12,962 (3.20) 12,962	-o-	\$ 8 in 5 years	1
Cities Service 12/11/73	1 Block S. Palawan	Cities Husky Phil Aust	60% 20% 20%	2,773 (0.69) 2,773	Sig \$.050 \$ 1 @ 50 \$ 2 @ 75 \$ 3 @ 150	\$ 8.5 in 7 years	0
Filon 30/10/74	1 Block Pacific Side Luzon	Filon	100%	4,813 (1.19) 4,813	-o-		3
Phillips 25/5/73	1 Block West Palawan	Phillips	100%	5,933 (1.47) 5,933	-o-	\$4.2 in 5 years Drill 35,000 feet	

OPERATING COMPANY	LOCATION OFFSHORE	PARTICIPANTS INTEREST	AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS Ø X 10^6	COMMITMENT Ø X 10^6	NO WELLS DRILLED
Sun 23/1/74	1 Block S. Sulu Sea	Sun 59.5% Westrans 19.8% Basic 18.3% Landoil 1.4% Liberty 1.0%	2,072 (0.51) 2,072	-o-		1
Superior 14/7/73	4 Blocks Sulu Sea	Superior 45.0% CDN Super 12.5% Endeavor 10.0% Pacific 10.0% Filam 5.0% Dixilyn 12.5% Philex) Sabena) Baguio) 5.0% Philodrl)	7,737 (1.91) 7,737	-o-	Ø 8.0 in 5 years 35,000 feet	1
Superior 5/10/73	One Block S. Sulu Sea	Superior 70% Endeavor 10% Filam 10% Pacifica 10%	2,558 (6.32) 2,558	Sig Ø .050 Ø 1 @ 25 Ø 2 @ 75 Ø 3 @ 150	Ø 7.5 in 5 years 35,000 feet	1
Texas Pacific 24/7/74	One Block Luzon Lamon Bay	Texas Pacific 80% Pal Basins 20% Pac	4.95 (1.22) 4.95			
Tricentrol 1975	N.W. Palawan	Champlin Tricentrol 10 Westrans Basic Landoil Oriental	1,250 (0.31) 1,250		Drill by 4/76 Rec Cost from 55%	65/35 70/30 @ 75

Table IIIF (2)

PHILIPPINES

OFFSHORE PETROLEUM EXPLORATION CONCESSIONS

Operating Company	Offshore Permits	Location	Area km^2	Participants Interest
AAOC	218	Leyte	204	AAOC 100%
American	247, 248	Visayan Sea)		
Asiatic	252, 253, 258	")		
Oil	259, 260, 261	")	5025	
Company	262, 263, 264	")		
	275, 276	")		
	418, 419	Palawan	1935	
	402	Cebu	233	
ACOJE Oil	249	Davao	127	ACOJE 50%
Expl Drilling				ANGLO 50%
Company				
ANGLO	174	Cebu	140	ANGLO 100%
Philippines	214	Negros	68	
Oil Corp	250	Palawan	576	
BAGUIO	449, 450, 451	Nasbate	2157	Baguio 100%
Gold Fields				
BASIC	366, 367, 368	Palawan	4357	Basic 100%
PETROLEUM	369, 370, 371	"		
and	372, 373, 374	"		
MINERALS	375, 376, 414	"		
	440	"		
BUENDIA	391, 393	Zamb del Sur.	1292	Buendia 100%
Natural	394, 395	Sulu Sea	1851	
Resources				
C.P.C.	201,	Cebu	209	CPC 33.75%
Chinese	213, 246, 277	Visayan Sea	700	AAOC 32.5%
Petroleum				Pionee 33.75%
Company				
FIL-AM	353, 354, 355	Sulu Sea	4366	Fil Am 100%
Resources	428, 429			
FORTUNA	377, 378, 379	Sulu Sea	2743	Fortuna 100%
Offshore	380			
Mining Corp				
IMPERIAL	410, 411, 412	Sulu Sea	4185	Imperial 100%
Resources Inc	413, 425			

Operating Company	Offshore permits	Location	Area Km^2	Participants Interest
ISLAND Oil Co. Inc.	443	Palawan	573	Island 100%
JAPTRACT Mining & Industrial Corp	358, 359, 441 360, 442	Palawan Sulu Sea	1371 904	Japtract 100%
ORIENTAL Petroleum & Mining Corp	301, 302, 303 304, 305, 306 322, 323, 324 325, 326, 327 328, 329, 330 331, 332	Palawan " " " " "	13191	Oriental 60% Westrans 40%
PACIFICA Inc	406, 407	Sulu Sea	1889	Pacifica 100%
PHIL-AUSTRALIAN Pkl & Mineral Corp.	363	Sulu Sea	388	Phil-Aust 100%
PHILEX Mining Co.	220 445, 446, 447 448	Albay Sulu Sea	70 2891	Philex 100%
PHILODRILL Philippine Overseas Drilling & Dev Corp.	444	Palawan	357	Philodrill 100%
PHILODRILL Endeavor	299	Palawan	649	Philodrill 25% Endeavor 75%
PIONEER Natural Resources Exploration Co.	383, 384, 385 386, 387	Sulu Sea	2276	Pioneer 100%
REPUBLIC Resources Dev. Co. Inc.	748 224	Palawan Bohol	170 266	Redeco 100%
REDECO	75	Manila	426	Redeco 50% San Jose 50%
SABENA Mining Corp.	316, 317 454 455 452, 453	Palawan Nasbate Zamb. Sur. Mindoro	1517 753 753 782	Sabena 100%
SAMAR Mining Co.	92	Palawan	245	Samar 100%

Operating Company	Offshore permits	Location	Area Km^2	Participants	Interest
SEAFRONT	430, 431, 432	West Palawan	9999	Seafront	80%
Petroleum &	433, 434, 435,	"		Salem rederuna)	
Mineral Res.	436, 437, 438	"		Swedesh-Match)	20%
Inc.	439	"		Kemalloid)	
SESMAR	339,	Palawan	240	Sesmar	100%
Southeastern	342, 345	Davao	510		
Sierra Madre	343, 344	Ticao Pass	850		
Res. Inc.	346, 352, 400	Sulu Sea			
	401, 402, 403	"	3688		
	404	"			
TRANSASIA Oil & Mineral Dev. Corp.	348, 351	Cebu	333	Transasia	100%
TRITON Phil	381, 382	Sulu Sea	1675	Triton	33.3%
Oil & Gas Co.				Pioneer	33.3%
				Podco	33.3%
WHITE EAGLE	181	Leyte	200	White Eagle	75%
Overseas Oil Co.				Manila	25%

TABLE III G

T H A I L A N D

STATUS MID 1975

OPERATING <u>COMPANY</u> DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $\$ \times 10^6$	COMMITMENT $\$ \times 10^6$	(NO WELLS DRILLED) PROFIT SPLIT
AMOCO 10/71	Gulf Blk 5, 6	*Amoco Idemitsu	50% 50%	24,319 (6.01) 12,100 ±	-o-	$\$300/\text{km}^2$ Rental	(2) Royalty 12½% Tax 50-60%
AMOCO 23/12/72	Indian Ocean W-2	Amoco	100%	5,100 (1.26) 5,100	Sig $\$$ 0.5	$\$300/\text{km}^2$ Rental	(0) Royalty 12½% Tax 50-60%
BP 3/7/68	Gulf Blks 3, 4, 1/3 16, 17	BP	100%	41,712 (10.31) 41,712	-o-	$\$300/\text{km}^2$ Rental	(3) Royalty 12½% Tax 50-60%
Conoco July 1969	Gulf Blks 10, 11	*Conoco Mitsu	80% 20%	21,358 (5.28) 10,600	-o-		(3) Royalty 12½% Tax 50-60%
ESSO 4/74	Indian Ocean W-9	Esso	100%	29,888 (7.39) 29,888	Sig $\$$44.0		(0)
Gulf 4/72	Gulf Blk 7, 8, 9	Gulf *Sun I.O.L.	33.1/3% 50% 16.2/3%	29,180 (7.21) 29,180	Sig $\$$3.8	$\$300/\text{km}^2$ Rental	(5) Royalty 12½% Tax 50-60%
OCEANIC 4/74	Indian Ocean W-7	*Oceanic Suwanamas	73% 27%	28,192 (6.97) 28,192	Sig $\$$ 7.0 $\$$ .050 @ 100 $\$$ .1 @ 200 $\$$ .2 @ 300 $\$$ .4 @ 400		(0) Royalty 12½% Tax 50%
OCEAN 12/71	Indian Ocean W-3 & 4	Pan Ocean	100%	16,000 (3.95) 16,000			(0) Royalty 12½% Tax 50%

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS	INTEREST	AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $\$ \times 10^6$	COMMITMENT $\$ \times 10^6$	(NO WELLS DRILLED) PROFIT SPLIT
TENNECO 2/12/68	Gulf Blocks 1, 2 14, 15	*Tenneco Marathon Phillips Agip	33.1/3% 33.1/3% 23.1/3% 10%	37,466 (9.26) 20,374	-o-	$\$300/km^2$ Rental	(4) Royalty 12½% Tax 50-60%
TRITON 12/10/72	Gulf Blks 18, 19	*Triton Crown Anshutz The George Co. Inlet Pet.	50% 12½% 12½% 12½% 12½%	15,897 (3.93) 15,897	-o-	$\$300/km^2$ Rental	(0) Royalty 12½% Tax 50-60%
UNION 16/6/68	Gulf Blks 12, 13	*Union Seapec Maruzen) Nippon) Daikyo)	80% 20%	19,075 (4.71) 9,530	-o-	$\$300/km^2$ Rental	(7) Royalty 12½% Tax 50-60%
UNION 4/74	Indian Ocean W-8	Union Amoco BP Hamilton Seams	23.3/4% 23.3/4% 23.3/4% 23.3/4% 5%	31,874 (7.88) 31,874	Sig $\$8.5$		(0) 12½% Royalty 8% Deep Water 50% Tax
Weeks 14/7/72	Indian Ocean W-1	Weeks Associates	100%	8,003 (1.98) 8,003	Sig $\$ .16$	$\$300/km^2$ Rental	(0) Royalty 12½% Tax 50-60%

TABLE III H

VIET-NAM

STATUS MID 1975

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS \$ X 10^6 Prod X 10^3/d	COMMITMENT \$ X 10^6	(NO WELLS DRILLED) PROFIT SPLIT
Esso July 73	Block 10 China Sea	Esso	100%	6,250 (1.54) 6,250	-o- \$ 1 @ 100 \$ 3 @ 150 \$ 5 @ 200	\$ 12 in 5 years	(0) Royalty 12½% Tax 50%
Mobil July 73	Block 8 Mekong Block 4 China Sea	*Mobil Kaiyo	70% 30%	13,000 (3.21) 13,000	Sig \$ 5.5. Prod. \$ 35.0	\$ 15 in 5 years	(2) Royalty 12½% Tax 50%
Mobil 22/6/74	Block 3 China Sea	Mobil Kaiyo	70% 30%	5,000 (1.23) 5,000	Sig. \$ 5.25	\$ 8 in 5 years	(0) Royalty 12½% 14½% @ 55 16% @ 75
Mobil 22/6/74	Block 9 Mekong	Mobil Kaiyo	70% 30%	5,000 (1.23)	Sig. \$ 5.75	\$ 8 in 5 years	Tax 55%
Shell July 73	3 Blocks 3, 7,11 Mekong 11 S.China Sea 3, 7	Shell Cities	50% 50%	20,000 (4.94) 20,000	Sig. \$9.0	\$ 20.25 in 5 years	(4) Royalty 12½% Tax 55%
Shell 22/6/74	Block 4 S.China Sea	Shell BHP	50% 50%	5,000 (1.24) 5,000	Sig. \$ 4.0	\$ 8 in 5 years	(0) Royalty 12½% 14½% @ 50 16% @ 75 Tax 55%
Sun 22/6/74	Block 11	Sun Marathon Amerada	33.1/3% 33.1/3% 33.1/3%	5,000 (1.24) 5,000	Sig. \$ 6.1	\$ 8.5 in 5 years	(0) Royalty as above

OPERATING COMPANY DATE	LOCATION OFFSHORE	PARTICIPANTS INTEREST		AREA KM^2 ORIGINAL (ACRES X 10^6) PRESENT	BONUS $\$$ X 10^6 Prof x 10^3/d	COMMITMENT $\$$ X 10^6	(NO WELLS DRILLED) PROFIT SPLIT
Sunningdale July 73	Block 21 South China Sea	Sunningdale Bow Valley Santa Fe Siebens Elf. earn	25% 25% 25% 25% 50%	6,252 (1.54) 6,252	Sig. $\$$ .05	Drill inside 2 years	(0) Royalty 12½% Tax 55%
Sunningdale July 73	Block 22 South China Sea	Sunningdale Bow Valley Santa Fe Siebens	25% 25% 25% 25%	6,256 (1.55) 6,256	Sig. $\$$ .05	Drill inside 2 years	(0) Royalty 12½% Tax 55%
Union Texas 22/6/74	Block 7 South China Sea	Union Texas I.O.L. Skelly Cigol	25% 25% 25% 25%	4,560 (1.13)	Sig. $\$$ 8.0	$\$$ 12 in 5 years	(0) Royalty 12½% 14½ @ 50 16 @ 75

TABLE IV

OFFSHORE DISCOVERIES AND FIELDS

TABLE IV.A Cambodia

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in feet
		No significant shows have been reported in Cambodia			

TABLE IV.B Indonesia

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in feet
MENTAWI BASIN					
Meulaboh	1970	Test 7.0 MMCFGPD	Miocene Ls	Gas	Non Commercial
NORTH SUMATRA					
Idi	1968	Gas Blowout Test Rate 5000 B/D	Idi Sandstone	O&G	Non Commercial
NSO-IS	1974	3.91 MMCFGPD 214 BCPD Test	Basal Sand	63°	To be evaluated
WEST JAVA BASIN					
Arjuna	1969	Prod 90541 B/D Mid 1974	Air Benakat Cibulakan Batu Raja	37°	G,S,K, & E pools 4000
Banuwati	1970	Test 684 B/D 5 MMCFGPD	Talang Akar	42°	Non Commercial 9700
Cinta	1970	Prod 41803 B/D Dec. 1974	Batu Raja Talang Akar	34°	330-4500 Cum 38 x 10^6 bbls
Gita	1972	Up to 5000 B/D on test	Talang Akar	33°	Non Commercial 5000
Janti	1970	Test 1152 B/D	Talang Akar		Non Commercial 5600
Kitty	1971	Prod 3692 B/D 12/74	Batu Raja	30°	2900 Cum 1.5 x 10^6 bbls
Nora	1973	Test 4370 B/D	Batu Raja	27°	Under Develop 2000
PSI-AA	1969	Test 9000 B/D 5 zones	Batu Raja		4300
PSI-AV	1974	Test 5500 B/D	Talang Akar	35°	7300
PSI-E	1969	864 B/D best test	Air Benakat Talang Akar	32° 41°	Non Commercial 3000
PSI-FF	1974	Test 4300 B/D	Batu Raja	37°	3800
PSI-HH	1973	Test 1488 B/D	Talang Akar	-	Non Commercial 7500
PSI-L	1972	Test 1900 B/D + 7 MMCF	Parigi Talang Akar	59° 35°	L-3 Blew out. 6500'

BASIN Discovery or Field	Year Disc.	Prod. of Test Rate	Formation	API°	Remarks/Depth in feet
PSI-LL	1973	Test 24 MMCFGPD 240 BCPD	Batu Raja	Gas	Non Commercial 6600'
PSI-P	1971	Test 600 B/D + Gas	Batu Raja	Gas	Non Commercial 3000'
PSI-U	1971	Test 5664 B/D + Gas	Air Benakat Talang Akar	41° 31°	Under Develop 6500'
PSI-X	1973	Test 2420 B/D	Batu Raja	33°	3500'
Rama	1974	Test 10,502 B/D 21.3 MMCFGPD	Batu Raja Talang Akar	36°	Under Develop 4000'
Zelda	1971	Prod 4570 B/D Dec 74	Talang Akar	32°	Under Develop 6000'
EAST JAVA BASIN					
JS-1	1970	Test 2246 B/D Total	Berai Ls	39°	Non Commercial 4360'
JS-2	1971	Test 6.8 MMCFGPD	Berai Ls	Gas	Non Commercial 3600'
JS-5	1971	Test 2 MMCFGPD	Basal Clastic	32%N	Non Commercial 5850'
JS-8	1970	Test 850 B/D	Berai Ls		Not Commercial 4350'
JS-15	1971	Test 3.3 MMCFGPD	Basal Clastic		Not Commercial 4800'
JS-20	1972	Test 823 B/D 18 MMCFGPD	Berai Ls	43°	Under Develop 5800'
BARITO BASIN					
Tanjung	1938	Prod 7609 B/D (1974)	Tanjung Sand	41°	7300' Cum 92.6×10^6 bbls
Warukin	1965	Prod 1000 B/D (1974)	Warukin Beds	27°	4300' Cum 6.9×10^6 bbls
KUTEI BASIN					
Attaka	1970	Prod 100,616 B/D(1974)	Balikpapan Beds	43°	Cum 46.0×10^6 bbls 7800'
Bekapai	1972	Prod 4993 B/D(1974)	Balikpapan Beds	40°	7000'

BASIN Discovery or Field	Year Disc.	Prod or Test rate	Formation	API°	Remarks/Depth in feet
Handil	1974	Test 10,440 B/D	Balikpapan beds	36°	Under develop 9500'
Kerindingan	1972	Test 2800 B/D 2.9 MMCFGPD	Balikpapan beds	31°	Under develop 5500'
Melahin	1972	Test 1090 B/D 17.0 MMCFGPD	Kampung Baru	26°	Under develop 4430'
Panyilatan	1972	Test 468 BCPD 10.6 MMCFGPD	Balikpapan beds	57°	Part of Badak Field 9100'
Santan	1971	Test 38.6 MMCFGPD 1696 BCPD	Balikpapan beds	58°	To be developed 6900'
Sepinggan	1973	Test 1483 B/D 27.5 MMCFGPD	Balikpapan beds	32°	Under develop 10,500'
Serang	1973	Test 1483 B/D 8.2 MMCFGPD	Balikpapan beds	47°	To be developed 6500'
Tambora	1974	Test 21 MMCFGPD	Balikpapan beds	Gas	8900'
Tanjung Bayor	1973	Test 1025 BCPD 15.2 MMCFGPD	Balikpapan beds	56.5°	Non commercial 8900'
Tengah	1974	Test 7758 B/D 21.3 MMCFGPD	Balikpapan beds	Gas	7500'
TARAKAN BASIN					
OBN-1	1970	Test 7.0 MMCFGPD	Tarakan Fm.	Gas	Not commercial 9500'
SALAWATI BASIN					
TBA	1974	Test 4305 B/D 8.54 MMCFGPD	Kais Fm.	Gas	6900'
TBC	1974	Test 135 MMCFGPD	Kais Fm.	Gas	6300'
TBN	1974	Test 12,186 B/D	Kais Fm.	24°	5900'
MAMBERAMO BASIN					
R-1	1973	Test 21.6 MMCFGPD	Mamberamo Fm.	Gas	Not commercial 5800'

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in Feet
GULF OF THAILAND BASIN					
AI-X	1972	9.2 MMCFGPD	Arang Fm.	Gas	Not commercial 5800'
Terubuk	1973	Test 4320 BOPD 24 MMCFGPD	Mio Pliocene	61°	3095'
Udang	1974	Test 4727 BOPD 265 MMCFGPD	Mio Pliocene	42°	5700'
BRUNEI BASIN					
Paus, NE	1970	Gas Blow out	Mio Pliocene	CO_2	2850' Not commercial

Table IV C. JAPAN

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in Metres
AKITA AREA					
Isuchizki-Oki	1959	Test 1800 B/D 0.37 MMCFGPD	580 m. Zone		600 metres Under development
NIIGATA AREA					
Katamachi	1959	Test 1250 B/D 0.035 MMCFGPD	Tertiary		Ext. from onshore
Teikoku		Test 12 B/D 2.8 MMCFGPD	Tertiary	Gas	
North IA-1	1972	Test 1446 B/D	Tertiary		Thin Sand 2000 metres
Aga-Oki	1972	Prod Est. 60 MMCFGPD 2000 BCPD	Tertiary	Gas	Platform installed 2200 metres
EAST COAST					
Iwaki (Joban)	1973	Test 26 MMCFGPD	Tertiary C Tertiary F	Gas	Under development 2700 metres
PARTLY OFFSHORE NEAR NIIGATA					
Kubiki	1959	Producing	Tertiary	Oil	
Kubiki Near	1959	Test 8 MMCFGPD	Tertiary	Gas	
Almazo	1800's	Producing	Tertiary	Oil	

TABLE IV D. KOREA, REPUBLIC OF

To Mid 1975 No significant shows have been reported in Korea

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in Feet
Table IV E. Malaysia					
GULF OF THAILAND BASIN					
Anding	1973	Test 1586 BOPD 5 MMCFGPD	Mio Pliocene	Gas	9000'
Bekok	1971	Test 2228 BOPD 10.0 MMCFGPD	Mio Pliocene	Cdst.	8000'
Bintang	1970	Test 600 BOPD 28.3 MMCFGPD	Mio Pliocene	Cdst.	6500'
Duyong	1970	Test 12.7 MMCFGPD	Mio Pliocene	Gas	6000'
Jerneh	1969	Test 0.1 & Gas	Mio Pliocene	Gas	Non commercial
Pilong	1971	Test 29 MMCFGPD 124 BOPD	Mio Pliocene	Gas	9000'
Pulai	1973	Test 2500 BOPD	Mio Pliocene	Oil	7000'
Seligi	1971	Test 1170 BOPD	Mio Pliocene	41°	9000' non commercial
Sotong	1973	Test 6000 BOPD 11 MMCFGPD	Mio Pliocene	46°	8400 ' delineation
Tapis	1969	Blow out	Mio Pliocene	Gas	8000'
BRUNEI BASIN					
Ampa, S.W.	1963	Prod. 111,399 BOPD	Seria Beds	41°	8100'
Bakau	1967	Prod. 1865 B/D 1974	Bakau Fm.	39°	11000'
Baram	1964	Prod. 53440 B/D	Seria Beds	41°	9500'
Baronia N.	1970	Prod. 2500 B/D	Seria Beds	42°	1100 '
Champion	1970	Prod. 35,853 B/D	Seria Beds	23°	4300'
Fairley	1969	Prod. 28,599 B/D	Seria Beds	42°	10,740'
Lutong West	1966	Prod. 53,440 B/D	Miri SS	39°	6800'
Temana	1962	Tested Oil & Gas	Seria Beds	Gas	Under development
Tukau	1973	Tested 2750 B/D	Seria Beds	Oil	7500'

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in Feet
SABAH BASIN					
Erb West	1972	Test 1800 B/D	Seria Beds	Oil	Production 1975
Furious S.	1974	Test 1400 B/D 43 MMCFGPD	Seria Beds	34°	6500' delineation
Samarang	1972	Test 1800 B/D	Seria Beds	Oil	Production 1975
Tembungo	1971	Test 12000 BOPD 4.2 MMCFGPD	Seria Beds	39°	Developing 7000'
SULU SHELF					
Nymphe Nord	1972	Test 503 BOPD 3.9 MMCFGPD	Mio Pliocene	42°	Not commercial 5400'

Table IV F. PHILIPPINES

To mid 1975 no significant shows have been reported in offshore Philippines

Table IV G. THAILAND

BASIN Discovery or Field	Year Disc.	Prod. or Test Rate	Formation	API°	Remarks/Depth in Feet
Surat	1971	Many shows	Mio Pliocene	Gas	Not commercial
6-2	1974	Test 800 B/D	Mio Pliocene	Oil	Non commercial 4000'
9-466	1973	Good Tests	Mio Pliocene	Gas	Non commercial
12-1	1973	Test 2000 B/D + Gas	Mio Pliocene	54°	7300'
13-1	1974	Test 1026 BOPD 35 MMCFGPD	Mio Pliocene	54°	7800'
15-B	1973	Tested 500 B/D	Mio Pliocene	Gas	9500' No. 2 & 3 Wells P & A
16-B	1974	Oil & Condensate	Mio Pliocene	Gas	Non commercial

Table IV H. VIET-NAM

Dua	1974	Test 2230 B/D 16 MMCFGPD	Mio Pliocene	52°	12000'
Hong	1974	Good shows	Mio Pliocene	Oil	4500' not commercial

Table V

CCOP OFFSHORE HYDROCARBON EXPLORATION PROJECTS COMPLETED, CURRENT AND PROPOSED 1966-1975 BY COUNTRY

Country	Project	Year	Participating with CCOP
Cambodia	CCOP-1/KHR.2 Seismic, refraction, and sonic surveys offshore, complementing work of oil companies and others.	Planned	
	CCOP-1/KHR.3 Aeromagnetic surveys offshore, 5,000 line-km within 40,000 sq km area.	Planned	
Indonesia	CCOP-1/INS.1 About 7,400 line-km of geographical traverses, incl. 6,000 line-km of seismic profiles, and magnetic and gravity profiling, in the Java Sea and adjacent continental shelf.	1971	Woods Hole Oceanographic Institution, U.S.A.; Institute of Geological Sciences, U.K.; Indonesia
	CCOP-1/INS.4 Geophysical studies on the Sunda Shelf; a basin study programme complementing work of oil companies.	Planned	Indonesia
	CCOP-1/INS.5 Geophysical research and training, Banda Arc; incl. refraction shooting, seismic reflection, magnetic profiling, bottom sampling on the continental shelf and oceanic crust.	Planned	Imperial College, London, and others, U.K.; U.S.A.; Indonesia
Malaysia	CCOP-1/MAL.3 Geochemical studies (537 samples from 400 sq mi) and geophysical surveys (1,000 line-km of reflection, 180 line-km refraction) for basic data on shelf areas of Peninsular Malaysia.	1969, 1971	Imperial College, London; University of Malaya
	CCOP-1/MAL.4 Surveys offshore east coast of Peninsular Malaysia, using seismic profiler, side-scan sonar, magnetometer, with sediment sampling (see CCOP-1/IZ.5).	Planned	Netherlands; Geol. Survey of Malaysia

Country	Project	Year	Participating with CCOP
Philippines	CCOP-1/PHI.1 21,000-line km of aeromagnetic traverses over 136,000 sq km area offshore Palawan-Sulu Sea region.	1969	U.S. Naval Oceanographic Office; Bundesanstalt fur Boden-forschung, Fed. Rep. of Germany; Bur. of Mines, Philippines.
	CCOP-1/PHI.2 4,000 line-km of aeromagnetic flight lines over 18,500 sq km area, Region II (incl. Luzon, Mindoro).	1968-70	Geol. Survey of Japan; Bur. of Mines, Philippines.
	CCOP-1/PHI.3 520 line-km of seismic refraction profiles off eastern Palawan, a part of which is already completed.	Planned	Philippines
	CCOP-1/PHI.4(a) Magnetometer survey over 4,400 line-km, for iron sand deposits in 3 area of Luzon and Panay.	Planned	Philippines
	CCOP-1/PHI.4(b) Sonic reflection profiling to survey extent of offshore coal field, western Mindanao.	Planned	Philippines
	CCOP-1/PHI.4(c) Seismic reflection profiling with air-gun, in 6 areas, Luzon.	Planned	Philippines
	CCOP-1/PHI.4(d) Gas exploder (or similar) surveys over 30,050 sq km, in 3 areas of Luzon and Palawan shelves.	Planned	Philippines
	CCOP-1/PHI.5 Aeromagnetic surveys over 4 areas.	Planned	Philippines; Fed. Rep. of Germany

Country	Project	Year	Participating with CCOP
Republic of Korea	CCOP-1/ROK.2 Over 40,000 line-km of aero-magnetic survey, over 200,000 sq km area, in Yellow Sea, East China Sea, Korea Strait.	1968-69	U.S. Naval Oceanographic Office; Bundesanstalt fur Boden-forschung, Fed. Rep. of Germany; Geol. Survey of Korea
	CCOP-1/ROK.3 Pohang area (east coast) drilling programme; 3 holes (2,300 m total sampling depths).	1967-68	Geol. Survey of Korea
	CCOP-1/ROK.4 Sea-bottom sampling, 191 stations in Yellow Sea, Korea Strait, near Cheju-do.	1967-71	Geol. Survey of Korea
	CCOP-1/ROK.6 Sonic survey of Mukho area, east coast; about 1,000 line-km over 2,500 sq km area.	1971-73	Fed. Rep. of Germany; Geol. Survey of Korea
	CCOP-1/ROK.9(b) 1,300 line-km of magnetometric and sonic measurements, over 18,000 sq km area of Yellow Sea.	1970	Fed. Rep. of Germany; Geol. Survey of Korea
	CCOP-1/ROK.9(c) 1,800 line-km of air-gun and magnetometer surveys, over a 145,000 sq km area between Kunsan-Mokpo, west coast	1971	Geol. Survey of Korea
	CCOP-1/ROK.10 2,550 line-km of deep seismic refraction across an area of 10,300 sq km continental margins, east coast.	1972	Fed. Rep. of Germany; Geol. Survey of Korea
	CCOP-1/ROK.11 Geological and geophysical surveys offshore Sosan, west coast, with bottom and water sampling.	1972	Geol. Survey of Korea

Country	Project	Year	Participating with CCOP
Republic of Viet-Nam	CCOP-1/ROV.1 Est. 28,940 line-km of aero-magnetic surveys over 160,000 sq km offshore Mekong Delta.	Planned	Project MAGNET; Directorate of Natural Resources, Rep. of Viet-Nam
	CCOP-1/ROV.2(a) 305 line-km of seismic refraction measurements (4 profiles) offshore Poulu Panjang, south-western coast.	1968-69	Imperial College, London; Dr. Nat. Res., Rep. of Viet-Nam
	CCOP-1/ROV.2(b) About 540 line-km of seismic refraction and continuous seismic reflection profiling, around Con Son, South China Sea.	Planned	U.K.; Rep. of Viet-Nam
	CCOP-1/ROV.4 Interpretation of aeromagnetic surveys, offshore and onland, for 30,675 sq km of a total 157,913 sq km surveyed; Mekong delta area.	1967-70	Project MAGNET; Fed. Rep. of Germany; Rep. of Viet-Nam
	CCOP-1/ROV.5 370 line-km of shallow penetration sparker profiles, and 4 seismic refraction lines around Poulo Panjang, off southwest coast.	1968	Imperial College, London; Rep. of Viet-Nam.
	CCOP-1/ROV.6(a) and (b) Continuous seismic profiling and refraction surveys, from Plan Thiet to Hue area, and Hue to Qui Nhon, eastern coast.	Planned	Rep. of Viet-Nam

Country	Project	Year	Participating with CCOP
Thailand	CCOP-1/THA.1 An aeromagnetic survey of 2,500 line-km over an area 25,000 sq km of the Andaman Sea (west coast)	Planned	Dept. of Mineral Resources, Thailand
Intermediate Zone	CCOP-1/IZ.1 15,000 line-km of aeromagnetic surveys over the East China Sea.	1968	Fed. Rep. of Germany; Geol. Survey of Korea; U.S.A.
	CCOP-1/IZ.2 Aeromagnetic survey over the East China Sea, partly completed already.	Planned	Project MAGNET
	CCOP-1/IZ.3 20,000 line-km series of seismic and geomagnetic traverses in Gulf of Thailand, northern Sunda Shelf, and adjacent sea floors, over national waters of Indonesia, Malaysia, Philippines, Rep. of Viet-Nam, and Thailand.	1968	U.S. Naval Oceanographic Office, Woods Hole Oceanographic Institution, U.S.A.; Japan Petroleum Development Corp.; Geol. Survey of Korea.
	CCOP-1/IZ.5 An aeromagnetic survey of 40,000 line-km over 300,000 sq km in the Malacca Strait.	Planned	Japn; Indonesia; Malaysia
	CCOP-1/IZ.7 Collation of previous research on bottom sediments of the Malacca Strait.	1970	Woods Hole Oceanographic Institution, U.S.A.
	CCOP-1A/UNEC.1 Geologic and sparker surveys in the Natuna Island area; 315 line-km over a 7,300 sq km area of the central Sunda Shelf.	1969-71	Imperial College, London; Naval Hydrographic Office, Indonesia; University of Malaya; UNESCO

Country	Project	Year	Participating with CCOP
	CCOP-1A/UNEC.2 Aeromagnetic profiling across Sunda Shelf.	Planned	Project MAGNET; Fed. Rep. of Germany; UNESCO.
	CCOP-1A/UNEC.3; CCOP-1A/UNEC.4 1,600 line-km of magnetic profiling and 19 bottom samples over the Sunda Shelf, between Borneo and Peninsular Malaysia.	1968	Tokyo University of Fisheries; UNESCO
	CCOP-1A/UNEC.5 1,700 line-km of sparker profiling and 420 line-km of seismic refraction, over 25,000 sq km between peninsular Malaysia and Natuna Island, with bottom sampling over 1,000 sq km offshore peninsular Malaysia.	1971	Imperial College, London; Indonesia; Malaysia; UNESCO
Regional	CCOP-1/REG.1 Eastern Asian IDOE survey of shelf margins and under deep waters, to study tectonic development in relation to metalliferous ores and hydrocarbon genesis.	1975-80	U.S.A.; Japan; CCOP member countries

TABLE VI

HYDROCARBON PRODUCTION CCOP COUNTRIES 1955-1975

	1955	1956	1957	1958	1959
Brunei	39,405,597	42,657,423	42,242,296	32,990,001	33,958,630
Indonesia	73,779,354	80,069,154	97,290,626	101,328,670	114,773,400
Japan	2,320,936	2,289,487	2,270,618	2,578,818	2,855,569
Malaysia	471,735	549,747	471,735	408,837	408,837
Total	115,505,887	125,565,811	142,175,175	137,306,326	151,996,436

	1960	1961	1962	1963	1964	1965
Brunei	34,191,352	30,725,673	28,480,214	25,939,135	26,549,245	31,449,000[e]
Indonesia	114,237,690	134,102,734	169,528,970	166,880,970	170,112,600	176,428,890
Japan	3,729,851	4,635,583	5,409,228	5,648,240	4,817,987	4,723,640
Sarawak	433,996	433,996	415,127	371,098	271,098	371,098
Total	152,592,889	169,897,986	203,833,539	198,839,443	201,750,930	212,972,628

	1966	1967	1968	1969	1970	1971
Brunei	35,159,346[e]	38,513,666	44,541,680	44,895,000	51,841,251	49,874,000
Indonesia	170,524,000	186,236,660	219,912,420	270,951,236	311,551,834	325,672,500*
Japan	5,463,000	5,511,000	5,466,015	5,537,701	5,688,225	5,529,020
Sarawak	345,654	328,334	1,521,423	3,387,418	6,558,749	25,070,892
Total	211,492,000	230,589,660	271,441,538	324,771,355	375,640,059	406,146,412

	1972	1973	1974
Brunei	67,007,900	83,700,000	70,338,420
Indonesia	395,552,322	484,968,000	506,708,751
Japan	5,264,000	5,220,000	4,955,796
Malaysia	33,866,949	33,534,000	29,323,735
Total	501,691,171	607,422,000	611,326,702

* First Offshore production commenced September 1971.

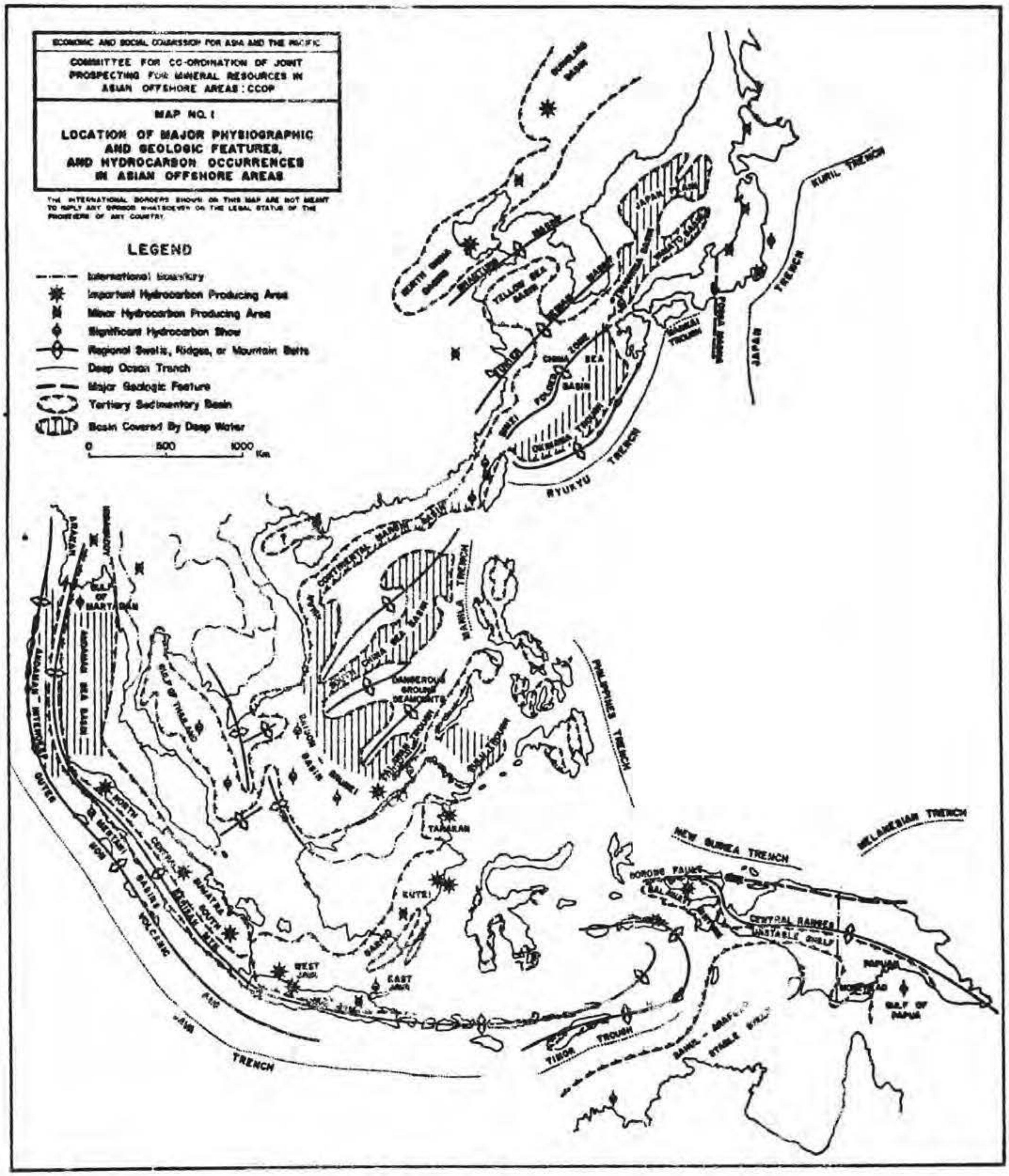
TABLE VII

1974/1975 Monthly Production of Crude Oil from CCOP Countries

	Brunei	Indonesia	Japan	Sarawak
January	7,106,037	43,705,317	461,900	2,718,900
February	6,418,356	41,052,515	420,000	2,537,640
March	5,974,000	45,707,560	461,838	2,528,577
April	5,781,240	43,728,355	424,530	2,410,170
May	5,973,948	45,931,851	434,000	2,490,509
June	5,781,240	43,938,759	404,580	2,410,170
July	5,973,948	44,715,919	401,233	2,490,509
August	5,973,948	41,584,597	369,396	2,490,509
September	5,781,240	39,397,967	367,080	2,410,170
October	5,973,948	42,167,426	406,255	2,490,509
November	5,781,240	37,086,485	393,180	2,410,170
December	5,973,948	37,692,000	411,804	2,490,509
1974 Total	70,338,420 1/	506,708,751	4,955,796	29,323,237 1/
1975 Approximate				
January	5,890,000 e	40,235,318	400,000 e	2,404,138
February	5,370,000 e	36,119,627	400,000 e	2,117,889
March	5,850,000 e	37,346,495	400,000 e	2,307,514
March Offshore Portion	5,850,000 e	6,839,665		2,307,514
				2,653,050 (April

1/ Total figure for year supplied-monthly rates estimated.

e Estimate only.


ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
COMMITTEE FOR CO-ORDINATION OF JOINT PROSPECTING FOR MINERAL RESOURCES IN ASIAN OFFSHORE AREAS: CCOP
MAP NO. 1
LOCATION OF MAJOR PHYSIOGRAPHIC AND GEOLOGIC FEATURES, AND HYDROCARBON OCCURRENCES IN ASIAN OFFSHORE AREAS
THE INTERNATIONAL BORDERS SHOWN ON THIS MAP ARE NOT MEANT TO IMPLY ANY OPINION WHATSOEVER ON THE LEGAL STATUS OF THE FRONTIERS OF ANY COUNTRY.
LEGEND
International Boundary
Important Hydrocarbon Producing Area
Minor Hydrocarbon Producing Area
Significant Hydrocarbon Show
Regional Swells, Ridges, or Mountain Belts
Deep Ocean Trench
Major Geologic Feature
Tertiary Sedimentary Basin
Basin Covered By Deep Water
0
500
1000
Km
KURIL TRENCH
JAPAN TRENCH
RYUKYU TRENCH
MANILA TRENCH
PHILIPPINES TRENCH
NEW GUINEA TRENCH
MELANESIAN TRENCH
JAVA TRENCH
TIMOR TROUGH
DANGEROUS GROUND SEAMOUNTS
GULF OF THAILAND
ANDAMAN SEA BASIN
TARAKAN
KUTEI
WEST JAVA
EAST JAVA
CENTRAL RANGES
UNSTABLE SHELF
GULF OF PAPUA
TRENCH