Intergovernmental Oceanographic Commission
Workshop report no. 20

Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources

Bandung, Indonesia, 17-21 october 1978

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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

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SECOND CCOP-IOC WORKSHOP ON IDOE STUDIES OF EAST ASIA TECTONICS AND RESOURCES

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SUMMARY REPORT AND RECOMMENDATIONS

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INTRODUCTION TO THE REVISED REPORT

by

THE PROJECT OFFICE

This revised report is a short summary of the recommendations arising out of the second CCOP-IOC/IDOE workshop on studies of East Asian Tectonics and Resources (SEATAR), which was held in Bandung, Indonesia from 17-21 October 1978. The purpose of this report is to briefly inform the sponsoring organizations, the participants of the workshop, and other interested scientists of the results of the workshop. The actual recommendations will be incorporated in a publication similar to the book entitled "Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia", which resulted from the first workshop held in Bangkok, Thailand in 1973. This publication will contain reviews of the work done in connection with the transects over the past five years, an outline of the reasons for the recommendations, and a comprehensive bibliography.

Before the conclusion of the second workshop, the participants were provided with a hand written summary of the recommendations and a final plenary session was held to give all participants the opportunity to amend the conclusions. The draft report was prepared immediately after the completion of the workshop and a copy was forwarded to each participant and other interested scientists for further comments and corrections. The comments received from the participants and interested scientists were chiefly concerned with minor additions and corrections to the wording of the recommendations. This revision of the draft report incorporates all their comments. The original draft report was also submitted to the fourth session of the Joint CCOP-IOC Working Group on IDOE/SEATAR studies held in Singapore on the 26 October 1978, and the conclusions of this meeting were taken into account during the preparation of this revision.

At that fourth session of the Joint CCOP-IOC Working Group, the Member States were invited to carefully study the recommendations and to make their comments and priorities available to the CCOP Secretariat for inclusion in a revised report. The Member States of the Joint CCOP-IOC Working Group present at the meeting included the CCOP Member Countries (Indonesia, Japan, Malaysia, Papua New Guinea, Philippines, Republic of Korea, Singapore, Thailand and the Socialist Republic of Viet Nam) and

/Member Countries

Member Countries of IOC (Australia, France, Federal Republic of Germany, Netherlands, Norway, Switzerland, United Kingdom and the United States of America). Comments received from the IOC Member Countries outside the SEATAR region concerned the SEATAR programme in general and the recommendations relating to organizational matters. The IOC Member Countries considered that the report of the Workshop highlighted the many areas and problems worthy of investigation, and that such investigations would result in significant progress in the understanding of the tectonics and mineral resources of the region. With regard to organizational matters it was pointed out by several of the IOC Member Countries that the first priority should be the appointment of a co-ordinator for each transect to encourage the progress of the work (see p. 18, Part 2, Recommendation (2)). In general these States felt that the resources oriented studies should be given first priority, and they pointed out that more specific priorities were a matter for the CCOP countries to decide on.

From the CCOP Member Countries more specific comments and priorities were received concerning the recommendations for studies along transects crossing their territories. These countries also stressed that the resources oriented studies received first priority, but pointed out that since a better understanding of regional tectonics is a pre-requisite to effective exploration, the execution of other transect studies was also desirable. Concerning the recommendations related to organizational matters (p. 18 and 19), most of the CCOP Member Countries recognized that there was a need for an overall co-ordinator, and also agreed that working groups headed by transect co-ordinators would greatly benefit the implementation of the transect studies. Several member countries stressed that the transect co-ordinators should come from one of the countries crossed by the transect. Publication of the results of transect studies, as soon as possible after the decade ends, was considered desirable and it was suggested that the overall co-ordinator should be responsible for this. One of the member countries expressed a desire to have the overall co-ordinator and the publication approved by the CCOP Member Countries.

With regard to the recommendations for transect studies it was pointed out that many of them were already in progress, some studies are being entirely undertaken by organizations within the CCOP Member Countries and others with the co-operation of organizations and individuals from

/outside the

outside the region. Many of the recommended studies could only be executed with international assistance, and several CCOP Member Countries identified the particular projects for which they welcomed outside participation. For Thailand these were most studies recommended for transects I and II with the exception of Transect I (a) (2) iv, v, viii, ix, (a) (3), (b) (4) (see pages 20 and 21) and Transect II (a) (4), (b) (5) and (8) (see pages 22 and 23). The Philippines hoped for co-operation to implement the short term studies along Transect V referred to in recommendations V (a) (1), (2), (9), (10), (11) and (12) (see pages 30 to 33) since these would be feasible only with assistance from developed countries. The Republic of Korea expressed its desire to implement the survey connected with Transect VI referred to in recommendation VI (a) (5) (see page 34) in collaboration with the supporting countries. The general recommendations (page 35-40) also mainly concerned studies for which the CCOP Member Countries considered that assistance from outside the region was required. The exception to this was recommendation IX (page 38) concerning tin granite studies, since these were to be undertaken by the Southeast Asian Tin Research and Development Centre located within the region.

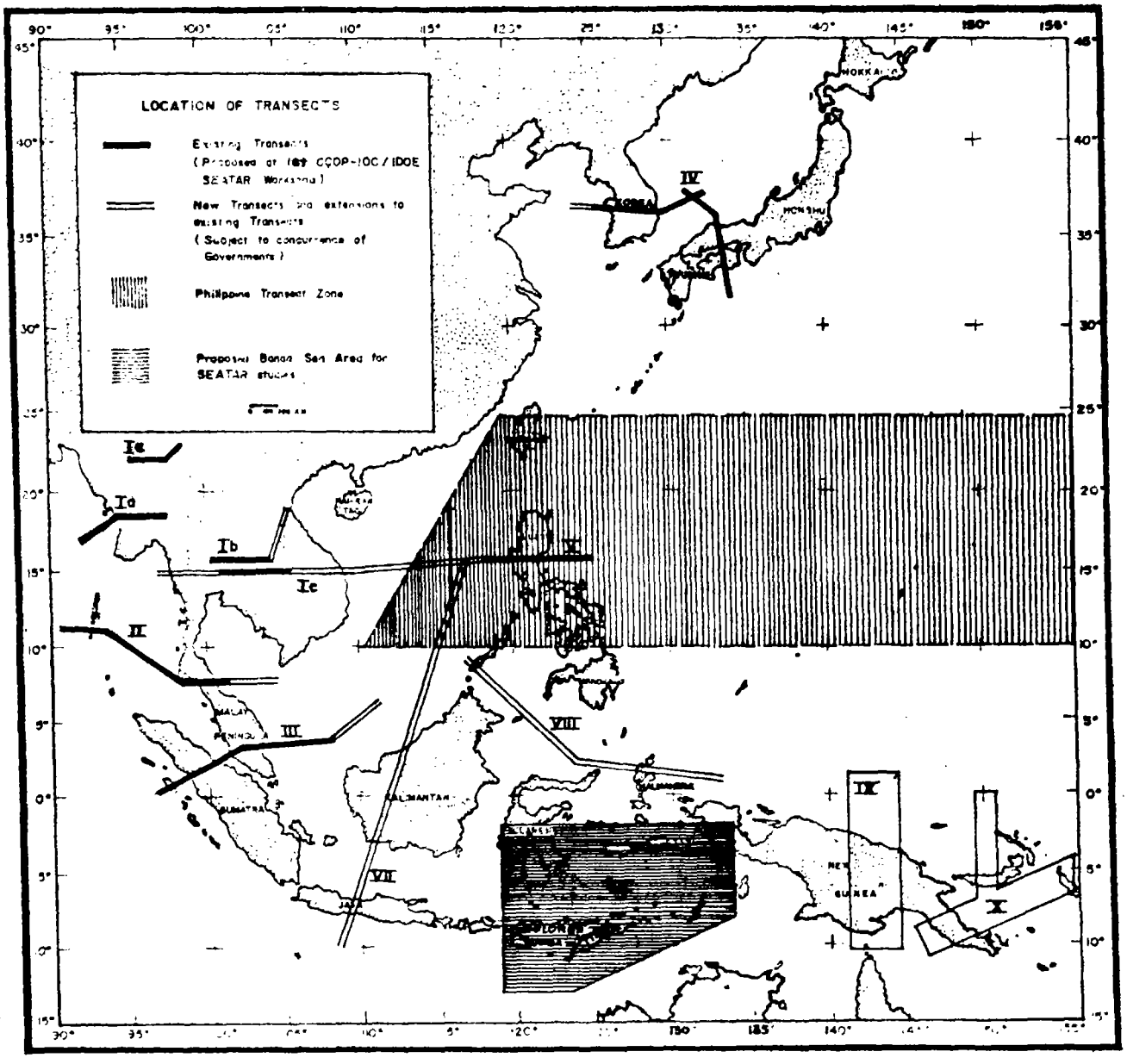
The Member States of the CCOP-IOC Joint Working Group were asked to state their priorities in order that individuals and organizations wanting to carry out studies recommended during the second SEATAR workshop would have a guide as to which particular study was considered most appropriate by the Governments. From the comments received from the Member States it is clear that resource oriented studies have overal priority. In Malaysia reassessment of geochronological data on the granite belts and dating of primary tin mineralization (Transect III (a) (9), page 24 and (b) (6), page 25) and the Malacca Strait studies (Transect III (b) (12), page 26) have the highest priority. Along Transect VI studies recommended under (b) (1) (see page 34) and (b) (8) (see page 35) are considered by the Republic of Korea to have the highest priority. With respect to the general recommendations (page 35-40) Korea wishes to conduct the studies on heat flow (Part 4, (2), page 35) and palaeomagnetics (Part 4, (3), page 35) prior to the other studies. The Philippines felt that in relation to the calc-alkaline studies (Part 4, (12), page 38 and 39), the petrological investigations and dating of related igneous rocks

/should be

should be given priority. Studies on fluid inclusions and stable isotopes could be undertaken after the end of the decade. In Viet Nam efforts are being directed to producing this country's geological map. SEATAR studies connected with the proposed extensions of transects 1b and 1c were therefore not expected to commence before 1980 (Part I, Transect I, (2), page 16 and Part 3, Transect I (b) (1) and (3) pages 20 and 21).

The recommendations arising out of the second SEATAR workshop are an indication of the kind of studies which the individual scientists who participated, thought desirable in order that knowledge concerning the tectonics and resources of the region can be advanced. The execution of these recommend studies is however entirely the responsibility of the existing bodies within the region. The release of confidential data from within the CCOP Member Countries and the involvement of organizations and individuals from outside the region to assist such studies would be subject to the request, concurrence and approval of the States concerned. There is no intention on the part of CCOP and IOC to direct any organization within CCOP Member Countries to undertake any of the recommended studies should they not wish to do so.

As a result of the workshop several new transects and extensions to existing transects have been proposed. The previous transect line crossing the Banda Sea has been broadened into an area study. Likewise the original Luzon Transect has been widened into a 15° transect zone and extended eastward as far as the Mariana Trench. The location of the present transects and areas for multidisciplinary SEATAR studies is shown in the figure on the next page. Studies along these extensions and new transects will only be carried out with the concurrence of the States involved.


LOCATION OF TRANSECTS
Existing Transects
(Proposed at 1987 CCOP-IOC/IDOE SEATAR Workshop)
New Transects and extensions to existing Transects
(Subject to concurrence of Governments)
Philippine Transect Zone
Proposed Banda Sea Area for SEATAR studies
Ia
Id
Ib
Ic
II
III
IV
V
VII
VIII
IX
X
HOKKAIDO
HONSHU
KOREA
MALAYSIA
SUMATRA
KALIMANTAN
SULAWESI
NEW GUINEA

I ORGANIZATION OF THE WORKSHOP

1. The second Workshop on IDOE (International Decade of Ocean Exploration) programme of Studies of East Asia Tectonics and Resources (SEATAR) was held at Bandung, Indonesia from 17-21 October 1978, under the joint sponsorship of the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP) and the Inter-Governmental Oceanographic Commission (IOC).

2. The Workshop was conducted under the joint chairmanship of Professor Dr. John A. Katili, CCOP's Principal Co-ordinator of the East Asia Programme of the International Decade of Ocean Exploration and Dr. Edward M. Davin, Programme Manager IDOE Section, National Science Foundation, Washington.

3. The Workshop was convened in accordance with the decision of the fourteenth session of CCOP, which endorsed the recommendation of the third session of the Joint CCOP-IOC Working Group on SEATAR, that "a workshop be held in 1978 to evaluate the projects which have been implemented under SEATAR so far, to point out the still existing gaps and to establish a list of projects which still needed implementation before the end of the decade (31 December 1980). The workshop is further requested to develop a draft programme for the decade to come....." (Document E/ESCAP/L.9).

4. The above recommendation was also approved by IOC in its resolution X-11.

5. The Workshop in Bandung marked the fifth anniversary of the inception of the SEATAR programme, the foundations for which were laid at an IDOE Workshop on Tectonic Patterns and Metallogenesis in East and Southeast Asia which was held in Bangkok, Thailand from 24-29 September 1973, under the sponsorship of CCOP and IOC.

Attendance

6. Scientists from the following CCOP member countries participated in the workshop; Indonesia, Japan, Republic of Korea, Malaysia, Papua New Guinea, the Philippines, Singapore, Thailand and the Socialist Republic of Viet Nam. Scientists from the following co-operating countries which had undertaken various co-operative projects in the region as part of the overall SEATAR programme also participated: Australia, France, Federal Republic of Germany, Netherlands, the United Kingdom and the United States of America.

7. The following international organizations concerned with the SEATAR programme were represented: The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the Inter-governmental Oceanographic Commission (IOC) of UNESCO and the Commission for the Geological Map of the World (CGMW).

Opening Addresses

8. Dr. Edward M. Davin - Programme Manager for Seabed Assessment of the IDOE office of the National Science Foundation of the USA, expressed thanks to the Government of Indonesia for providing the excellent facilities for the meeting and thus giving the opportunity for discussion of the accomplishments of the SEATAR programme and to plan the programme of studies to be undertaken to the end of the decade and beyond. He pointed out that the emphasis of the SEATAR programme was on obtaining a better understanding of the relationship between the tectonics and resources of the area as a guide for future exploration for both metalliferous and hydrocarbon deposits. The lessons learned through such studies in east Asia would be applicable in other parts of the world.

9. Professor Dr. John Katili, Chairman of the Joint CCOP-IOC Working Group on SEATAR and CCOP's Principal Co-ordinator for the SEATAR programme reminded participants that since the first workshop, which was held at Bangkok in September 1973, five years had passed. In those five years, the SEATAR programme had made impressive progress; over 15 million dollars had been spent and a large number of geoscientists from both within and outside the region had participated in the implementation of the programme. In 1976-1977, alone, no less than 10 research vessels had operated in East and Southeast Asia, directly or indirectly carrying out surveys for the programme.

10. All the above efforts had been made in order to obtain a better understanding of existing geological principles or to lead to new principles or theories which it was hoped would aid in discovering new metallogenic and hydrocarbon provinces. The main objectives of the SEATAR programme formulated in Bangkok in 1973 had been originally defined as; (i) to determine the location, characteristics and significance of the principal tectonic features of the continental margins and associated structural elements of east and southeast Asia, (ii) to relate metalliferous ore deposits to the major tectonic features and plate boundaries, particularly

/convergent and

convergent and shear boundaries, and (iii) to analyse the characteristics of various types of sedimentary basins and their hydrocarbon habitat in terms of their position relative to plate margins and to study the geological, geochemical and geothermal history factors governing the transformation of organic matter into hydrocarbons in small basins.

11. It had been decided to concentrate the investigations along a number of so called transects, sections of the earth's crust where the processes operating in the earth's interior manifest themselves in a number of geological and geophysical features; six transects had been defined in the region of East and Southeast Asia.

12. This ambitious programme had, firstly, been able to mobilize research funds and capabilities on a massive scale, concentrated on specific portions of the earth's crust and had resulted in a massive accumulation of primary data in a very short time; secondly, the programme had proved to be an excellent vehicle to promote international co-operation in earth sciences, bringing together scientists and research institutes of developed nations, like the USA, Japan, the Federal Republic of Germany, the United Kingdom and Australia with those of developing countries such as Thailand, Malaysia, the Philippines, Korea and Indonesia and thirdly, the programme was a major enterprise in a multi-disciplinary approach towards scientific problem-solving, combining the various disciplines of earth-sciences like seismic, gravity, paleomagnetism, tectonics, geochemistry, age-dating, paleontology etc.

13. Professor Katili felt that the SEATAR Programme had been successful for the above reasons as well as the following factors:

(a) A well-conceived programme. The programme had undergone modification and some changes along its course, which was perfectly normal for every scientific undertaking, as "trial and error" is standard scientific practice by which one becomes wiser, and because it was better to retract early and change course rather than to follow a predetermined course leading nowhere;

(b) An enthusiastic reception and an exemplary spirit of international co-operation between the participating countries, institutions and scientists and

/(c) The CCOP,

(c) The CCOP, the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas, whose prestige and credibility had left its positive imprint on SEATAR and had contributed in a fundamental way towards the success of the programme.

14. Since its start, CCOP had received enthusiastic support from its member-states, because it had been able to fulfill its role as a forum for international co-operation in the truest sense; it had succeeded in achieving the status so many international organization were aiming for, namely, to become the "property" of its member-states, an organization with which they could identify themselves and for which they felt responsible; this statement held true for the developing, as well as the developed member-states.

15. Being fortunate in having two out of the six transects located within its area, Indonesia had benefited a lot from the SEATAR Programme and a number of institutes from the USA, Japan, England, Federal Republic of Germany and Australia had carried out joint investigations with Indonesian counterparts like the Geological Survey, the National Institute of Geology and Mining, the National State Oil Company, the Indonesian Petroleum Institute and the Naval Hydrographic Office. The national programme was unique in that, besides Government agencies, state mining and petroleum companies and multi-national mining and petroleum companies had contributed towards the execution of the programme; this had been well demonstrated during the Workshop on the Sumatra Transect held at Parapat, Sumatra, early in 1978.

16. Professor Katili felt that an undertaking such as the SEATAR Programme could not have been carried out by one single country or institution, so this international co-operation in highly advanced technology could be considered very rewarding.

17. Turning to the workshop, Professor Katili reminded participants that its goal was to apply the knowledge of tectonic processes obtained during the last five years to both occurrences of minerals and hydrocarbons and also to a better understanding of the active plate margins. He reiterated that the SEATAR Programme had achieved a lot and should be considered a success.

/Nevertheless, there

Nevertheless, there were certain things that might be improved, including a better balance between scientific data gathering and finding new deposits and fully exploiting the opportunity to achieve transfer of knowledge and technology. It was therefore only appropriate that after five years of operation, there should be a review of the progress made, a consideration of work still to be carried out before the end of the present decade and the formulation of ideas on what should be done in the decade to come.

18. The workshop should not be satisfied merely to explain the known mineral and hydrocarbon occurrences based on plate tectonic theory, but should also aim at the discovery of new resources based on an understanding of this very elegant concept. The task before this workshop was therefore not only of scientific interest but also of economic significance. Professor Katili concluded by expressing satisfaction with the achievements of the Programme during the past five years, which had been made possible only through the joint efforts of many people and organizations; he felt sure that with the high level of expertise possessed by the participants, the workshop would be a success.

19. Mr. A. Johannas, Project Manager/Co-ordinator of the UNDP assisted project Technical Support for Regional Offshore Prospecting in East Asia, speaking on behalf of the Project and of CCOP, expressed highest appreciation to the Government of Indonesia for hosting the Workshop. He assured the meeting that the SEATAR Programme was considered to be one of the most important programmes of CCOP, from which the member countries had benefited greatly; young geoscientists from the member countries had had the opportunity of working together with geoscientists from the developed countries in using the most sophisticated equipment and techniques available at present for marine surveys and the increases in knowledge of the structure and tectonics of the region would be of great assistance in assessing its mineral and hydrocarbon potentials.

20. He expressed gratitude to Professor Dr. John A. Katili for his guidance and leadership in both the planning and execution of the programme; to the IOC for their co-operation; to all of the developed countries which had participated in the execution of the programme and to the National Science Foundation of the United States of America, IOC and UNDP for their financial support to enable such a large number of geoscientists from the member countries and developed countries to participate in the Workshop.

/21. Mr. Johannas was

21. Mr. Johannas was sure that under the chairmanship of Professor Dr. John A. Katili, the participants would have fruitful discussions and would formulate practical recommendations for programmes to be implemented during the remainder of the decade and in the decade to come.

22. Dr. Gunther K.F. Giermann, Deputy Secretary of the Intergovernmental Oceanographic Commission (IOC) of UNESCO, welcomed participants to the Workshop on behalf of UNESCO. He informed the meeting that the IOC considered the SEATAR Programme to be most valuable and important in providing a better knowledge of the tectonics and resources of the region and was therefore pleased to be a co-sponsor of the workshop. He wished the participants every success in their discussion to formulate plans for future work within the programme.

23. Mr. J.B.P. Maramis, Executive Secretary of the United Nations Economic and Social Commission for Asia and the Pacific welcomed participants to the Workshop. He expressed thanks to Mr. Subroto, Minister for Mines and Energy, Republic of Indonesia, for inaugurating the meeting; and also to the Government of the Republic of Indonesia for hosting the workshop.

24. Mr. Maramis stressed the important role which Professor Dr. John A. Katili, Director General of Mines of Indonesia, had played in the implementation of the SEATAR Programme. As CCOP's principal co-ordinator of the East Asia IDOE programme and as Chairman of the Joint CCOP-IOC Working Group since its inception he had made a most valuable contribution to the success of the Programme.

25. Due acknowledgement also had to be given to the National Science Foundation of the United States, IOC and the United Nations Development Programme (UNDP), for their financial support, which enabled the participation of the large number of distinguished geoscientists in this Workshop.

26. Mr. Maramis recalled that he had had the pleasure to address the First IDOE Workshop held at Bangkok, Thailand in September 1973, shortly after assuming duties as the Executive Secretary of ESCAP. During the last five years, he had watched, with satisfaction the progress made under the Programme, which from the United Nations' point of view truly represented and international co-operative effort between developing and developed countries, to promote the transfer of science and technology and to help in the future exploration of mineral resources. It was on the basis of these tangible factors that this programme had been accorded high priority by barious

United Nations bodies. It hardly needed emphasizing that the efforts of the expert participants could lead either to new geological principles or to the better understanding of existing ones which would aid the discovery of new metallogenic or hydrocarbon provinces not only in east and southeast Asia but elsewhere too, both in the oceans and on land.

27. In the implementation of the SEATAR Programme, the total expenditure involved had been millions of US dollars and large numbers of geoscientists, from both developing and developed nations, had participated; in the period of 1976-1977 alone, no less than ten research vessels had carried out investigations directly or indirectly related to the programme. That an undertaking of such a magnitude had been mobilized, was by itself a considerable achievement.

28. Mr. Maramis concluded that it was therefore most timely for this Second Workshop to evaluate the progress made so far, to point out the existing gaps, to establish a list of activities which still required implementation before the end of the decade, and to draft a programme for the decade to come. He felt confident that, with the expert knowledge of the participants, the workshop deliberations would be fruitful and wished the meeting all success.

29. Mr. Subroto, the Minister of Mines and Energy of the Republic of Indonesia extended a warm welcome to all participants, particularly to those who had travelled a long-way to get to Indonesia to participate in this important workshop. The fact that Indonesia had been chosen as the venue for the Workshop would give everyone in Indonesia concerned with such work an excellent opportunity to become acquainted with the activities of the CCOP-IOC/IDOE (International Decade of Ocean Exploration) programme of studies on East Asian Tectonics and Resources.

30. The Honourable Minister felt sure that the results of the SEATAR programme would not only be of regional importance but would be a valuable contribution to the great endeavour of mankind to obtain a better insight into the resources of this planet and its oceans and seas; they would serve as a good example of what could be achieved by international co-operation among developing and developed countries.

/31. Indonesia had

31. Indonesia had always participated actively in the project in the past, and would continue to do so; it had made available research ships in the past and the research vessel "Jalanidhi" would be made available for future activities of CCOP and for onboard training for research workers from CCOP member countries.

32. The Honourable Minister expressed gratitude to all those countries and international bodies who had made this undertaking possible through their financial and other contributions and the hope that such contributions would continue, to make this project a real success and a monument of genuine and truly productive international co-operation.

33. Being an archipelagic country, Indonesia's interest in this CCOP-IOC research programme was obvious. On the scientific side, it would certainly help in clarifying many still unsolved geological problems of this part of the earth's crust. On the practical side, a better understanding of the geology of Indonesia would certainly lead to better exploration concepts and more rapid and rational development of Indonesia's mineral wealth.

34. In regard to this practical aspect, the Honourable Minister outlined the Indonesian experience on tin and oil development. Tin dredging in offshore areas in Indonesia had started many years ago, long before the outbreak of the second world war. However, activities had been limited to near-shore areas, and at that time nothing was known about the potential for offshore minerals other than tin. Serious efforts to explore the continental shelf areas had started only in the late 1960's. Today some ten years later, the results of these efforts could best be demonstrated by Indonesia's oil and tin production figures as follows:

35. In 1971, for the first time in the history of its oil industry, Indonesia produced oil from its offshore area. This production, amounting to slightly over 4.5 million barrels, representing only 1.4 per cent of Indonesia's total production which amounted to 312.8 million barrels in that year. Since then, within a relatively short period of time, a number of offshore oil prospects had been discovered and delineated and in 1977, offshore oil production amounted to 220 million barrels, representing 35.8 per cent of Indonesia's total production of 615 million barrels.

36. In the case of tin, renewed interest in the potential of the offshore areas had rapidly developed after extensive investigations in the early 1970's.

/The discovery

The discovery of good tin prospects in some offshore areas surrounding the tin-islands beyond the minus 30 meter depth had led to decisions to introduce giant tin-dredgers to Indonesian waters. Today, offshore tin production amounted to some 35 per cent of the total Indonesian production of around 26,500 tons (anticipated for the year 1978). With the introduction of three giant dredgers, it was hoped that offshore tin production in the early 1980's would represent some 47.5 per cent of Indonesia's annual production of around 33,000 tons.

37. This brief summary gave an illustration of the importance of offshore mineral resources development for Indonesia and indicated its genuine interest in the continuation the intensification as well as the extension of offshore research activities throughout the Indonesian archipelago.

38. The Honourable Minister expressed the hope that by participating actively in this international programme, jointly undertaken by the CCOP and the IOC, Indonesian scientists could learn more about and gain more experience of the sophisticated methods applied during the investigations. He therefore looked forwarded to the fruitful results of this workshop and sincerely wished all the participants success in their deliberations.

Workshop Format

39. It was agreed by the participants that the workshop would devote the first two days to plenary sessions; these would be introduced by a summary of the pre-workshop review which had been prepared by the CCOP Project Office and would be followed by detailed reviews of work done along individual transects, which would be introduced by a number of discussion leaders for each transect. Those discussion leaders were to be; for Transect I- Dr. A. Mitchell, Dr. D. Workman and Dr. S. Suensilpong; for Transect II- Dr. A.J. Barber, Dr. P. Ashton; for Transect III- Dr. F. Hehuwat, Dr. G. Shor Jr., Dr. D. Karig, Dr. B. Page, Prof. N. Haile, Prof. C. Hutchison; for Transect IV - Dr. C. Bowin, Dr. G. Shor Jr., Prof. B. Isacks, Dr. P. Jezek, Mr. S. Tjokrosapoetro, Dr. A.J. Barber, Prof. N. Haile and Dr. H. Schlueter; for Transect V - Prof. S. Uyeda, Dr. G. Balce, Dr. D. Karig, Dr. D. Hussong and Dr. D. Hayes; for Transect VI - Prof. K. Kobayashi, Dr. R. Sillitoe, Prof. S. Aramaki, Prof. S. Uyeda, Dr. A.J. Barber.

/40. Following the

40. Following the plenary sessions the meeting would break up into a number of panels for the next two days to discuss the work programme for the future, first under the topics of Tectonics and Geophysics, Tectonics and Sedimentation, Tectonics and Hydrocarbons and Tectonics Petrology and Metallogenesis, then within the context of work along the six individual transects. Recommendations for future work were to be considered in two parts; firstly work which needed to be completed before the end of the IDOE decade on 31 December 1980 and secondly work recommended for the coming decade.

41. Plenary sessions would be held at the end of each day's discussions, so that all participants could be acquainted by the panel chairmen of the discussions and recommendations made to that stage, and would therefore be able to consider these in their future deliberations.

42. The final plenary session, to be held for half a day on the fifth day of the workshop, would present a summary of the various recommendations made; all participants would be able to then suggest additions, alterations or deletions.

43. The recommendations would then be incorporated in a report of the workshop which was to be prepared by the CCOP Project Office for presentation at the fourth session of the Joint CCOP-IOC Working Group on Studies of East Asia Tectonics and Resources (SEATAR) which was to be held in Singapore, on 26 October 1978, under the Chairmanship of Professor Dr. John Katili.

II REVIEW OF PREVIOUS WORK

Introduction

44. A review of research work which had been carried out on the transects proposed at the last CCOP workshop held at Bangkok in September 1973, had been prepared by Dr. A.J. Barber and Dr. D. Jongsma who had been engaged by the CCOP Project Office to do that work.

45. That review had highlighted the effectiveness of the transect method in integrating data from all branches of geology and geophysics; deep sea marine, shallow marine and land geology, using a variety of techniques and involving a great many organizations and institutions and concentrating the

/studies on

studies on cross-sections of the island arc systems crossing all of the different structural units and sometimes crossing the territories of several different countries.

46. The review had clearly shown that some of the transect studies had been outstandingly successful both as examples of the effectiveness of concentrating scientific effort and of international and inter-organizational co-operation to achieve the aims of the programme. In some areas, work during the past five years had produced an order of magnitude increase in the knowledge and understanding of the tectonics and resources of the region.

47. The pre-workshop review of work done along the six transects was intended as a preliminary report which would form a framework around which more complete reviews could be built, incorporating all the additional material which was to be presented at the workshop. Corrections and additions suggested by the participants would also be included, as well as any additional published results. In some cases it was known that work along some transects had been completed but the results had not yet been published; it was hoped that that material would be made available to the Project Office for inclusion in the revised report.

(a) Burma - Thailand Transect

48. Results of geological investigations carried out in Burma had not been available for incorporation in the review; however, it was hoped that an informal presentation of some of the results, which were relevant to the SEATAR programme could be made by participants who had some knowledge of them.

49. In Thailand, the Department of Mineral Resources had completed basic mapping in the area of the transects at a scale of 1:250,000, and preliminary geological cross-sections had been prepared along the lines of the transects. Some geophysical work had been carried out as part of local surveys for mineral deposits such as coal and oil shale, as well as some heat flow measurements. Palaeomagnetic studies of Mesozoic rocks had been made by the Universities of Chieng Mai and Malaya. There had, however, been no studies of the deep crustal structure. Some gravity and magnetic surveys had been carried out over the Khorat Plateau in northeastern Thailand, but the information had not been available for the review. It was felt that a comprehensive synthesis of all available information along the transects crossing northern Thailand is needed.

/(b) Andaman Sea

(b) Andaman Sea - Gulf of Thailand Transect

50. Although a considerable amount of work had been carried out along this transect by different groups. This work had not yet been completed and therefore a comprehensive synthesis of the data had not yet been carried out.

51. The Andaman and Nicobar Islands had been mapped by the Indian Geological Survey and it was hoped that these results could be obtained for inclusion in the revised report.

52. The Andaman Sea had been studied since 1968 by the Scripps Institution of Oceanography; a synthesis of this work was in the press and a copy of the paper had been distributed for the information of participants.

53. Details of work on the Mergui shelf had not been available for the review, but it was hoped that they would become available before the end of the decade so that a more complete account of the structure and geological history of this important area could be included in future reports of this transect. It had, however, been assumed that the Mergui Shelf was similar to the North Sumatra Basin, for which data were available.

54. In peninsular Thailand geological mapping and geochemical surveying had been carried out by the Department of Mineral Resources. Parts of the work were carried out jointly with the Institute of Geological Sciences of the United Kingdom and a report had been published outlining the results. A general review had also been published of the results of investigations in the Gulf of Thailand but more information was needed for a complete account of the geology and tectonics of this part of the transect, especially of the deep crustal structure.

(c) Sumatra - Malay Peninsula Transect

55. This had been one of the more successful of the transects, largely because it had had a co-ordinator for the Sumatran part of the transect. No less than 18 organizations from 10 different countries had been involved in the work on this transect. The Indian Ocean floor, the Sunda Trench, the trench-slope break and the arc-trench gap had been studied in a combined land and sea survey by the National Institute of Geology and Mining, Indonesian Institute of Science (LIPI), Scripps Institution of Oceanography and Cornell University and the work had been very well integrated. On Sumatra the Geological Survey of Indonesia and the Institute of Geological Sciences,

/London, mapping

London, mapping team were preparing geological and geochemical anomaly maps and accounts of the sedimentary deposits in the back-arc basins which were being exploited for oil and gas had been published. Palaeomagnetic studies had been made by the Universities of Malaya and Kyoto. There was, however, a need for deep seismic studies in these zones.

56. On land in peninsular Malaysia, a review of the geology had been published at about the time of the previous workshop held at Bangkok in 1973; this had subsequently been revised in the light of the plate tectonics hypothesis, including the results of age dating of granites in the peninsula. A gravity traverse had been completed across the peninsula and some heat flow measurements had been made. Palaeomagnetic and petrological studies, and detailed mapping of part of the "Bentong Line" on the transect had been made by the University of Malaya. All of the data from the Malay Basin, to the east of the Peninsula had not yet been incorporated in the transect studies.

(d) Banda Sea Transect

57. This had been a very successful transect with 12 different organizations from six different countries participating in the work programme. All of the data obtained on the north Australian continental shelf had been published. Geological mapping of many of the islands in East Indonesia, including Timor and Seram had been completed by the Geological Survey of Indonesia. The Banda Sea programme which had involved work by Woods Hole Oceanographic Institution; Scripps Institution of Oceanography, University of Malaya and the Geological Survey of Indonesia, in 1976, had provided a great deal of information on the marine section of the transect; some of the results still had not been published. Research groups from the University of London and Flinders University, South Australia, had made contributions to the land studies; in the volcanic arc there had been studies of the petrology, geochemistry and the petrogenesis of the volcanic rocks by the Smithsonian Institution, the University of Malaya the Carnegie Institution and Flinders University.

(e) Philippine - Marianas Transect

58. This transect had been defined in 1973 along latitude 16° North, passing through central Luzon and extending several hundred kilometres on either side of the island. Since 1973, much of the work had been concentrated along latitude 18° North and had been extended eastwards as far as the Marianas Trench. There

/had been

had been a considerable increase in knowledge concerning this transect as it had been the site of deep sea drilling, magnetic anomaly and earthquake focal mechanism studies. Those studies had helped to solve many of the problems of the tectonics of the region; however, the results of much of the work had not yet been published.

59. On the western side of Luzon, the Manila Trench and Luzon Trough had been surveyed by Lamont-Doherty Geological Observatory of Columbia University, New York, in the late 1960's.

60. A deep sea drillhole on the Benham Plateau, to the west of Luzon, had provided evidence of its age and structure although its origin still remained obscure.

61. Along the land segment of the transect, two sedimentary basins on Luzon had already been explored in 1973; there had been some additional exploration in the Cagayan Valley basin. The results of work carried out by Hawkins, Divis, Balce and Batiza on the Zambales ophiolite and porphyry copper deposits in Luzon had been published in abstract form.

62. Heat flow measurements, gravity and aeromagnetic work had been carried out by the Philippine Bureau of Mines, with the assistance of the Scripps Institution of Oceanography and the Japan Earthquake Research Institute; it was expected that the results would be published in the near future.

(f) Japan - Korea Transect

63. A vast amount of data had been collected along this transect and it had been very well synthesised. The age and origin of the Shikoku Basin had been determined from a study of the magnetic pattern; a DSDP drillhole through the imbricate wedge of the Nankai Trough had provided a great deal of information on the mechanism of accretion in such wedges; the first geological maps of the sea floor in the neighbourhood of a subduction zone had been prepared by the Geological Survey of Japan and were exhibited at the workshop.

64. On land, the recently published "Geology and Mineral Resources of Japan" gave a comprehensive account of the geology of the Japanese Islands. Geological cross-sections had been prepared to show geology, crustal structure, the magnetic field, heat flow, gravity and earthquake data, along the line of the Japanese part of the transect. However, problems concerning the age and origin of the Sea of Japan still remained. /65. In Korea

65. In Korea, much of the area along the transect had been mapped at a scale of 1:50,000 by the Korea Institute of Geoscience and Mineral Resources (KIGAM); a review of the geology of Korea had been published, but it was clear that there were still some outstanding stratigraphic problems, particularly in the Proterozoic.

66. The pre-workshop review had covered only those transects proposed at the 1973 workshop. Since that workshop, work along what could be considered two new transects, Java and North Japan, had been carried out; the results of this work were not included in the review.

III RECOMMENDATIONS

67. The main objective of the SEATAR programme, as originally proposed, was to relate geodynamic processes to metallogenesis and hydrocarbon occurrence and maturation processes. CCOP attaches great importance to such resources oriented studies, to provide a basic framework for the systematic exploration for mineral resources in the region, thereby assisting in the economic development of the member countries.

68. In compiling the reviews of work along the transects and in the discussions at the workshop, special emphasis was therefore given to the "economically" oriented research studies, and the recommended work plans for the rest of the decade and beyond which are summarised below, reflect this emphasis.

69. All of the recommendations related to resources oriented studies have been brought together in Part one. Part two summarises general recommendations and Part three summarises all of the recommended work along the transects, (a0 for the rest of the decade and (b) for the coming decade, respectively. Part four lists general recommendations relating to specific techniques and problems concerning all transects and Part five summarises proposals for new transects.

/Part I: Recommendations

Part 1: Recommendations for Resources Oriented Studies

Transect I

(1) Determine geological, geochemical and mineralogical controls of ore deposits.

(2) Extend transect Ib(former Ib*) to northeast to cover tin deposits in eastern Laos and Chromite deposits in north-central Viet Nam.

(3) Extend work along transect Ic westward to include stratabound lead and zinc deposits and tin/tungsten deposits.

Transect II

(1) Search for hot brines metalliferous muds and hydrothermal systems in Andaman Sea Basin.

(2) Detailed study of stratigraphy and sedimentation of the potential and proven Tertiary hydrocarbon bearing basins of Mergui Shelf and Gulf of Thailand and comparison with exposed Tertiary strata in the onshore Krabi Basin.

(3) Compilation of data offshore peninsular Thailand and use of geophysical methods and drilling combined with onshore Quaternary studies to aid in the location of detrital tin deposits.

(4) Support on land programme of research into mineralization of granite bodies.

(5) Investigate the basins of the Gulf of Thailand with respect to the occurrence of possible Mesozoic sections which may be hydrocarbon bearing.

Transect III

(1) Studies of sedimentary processes on the lower trench slope to explore processes of hydrocarbon generation and possible accumulation.

/(2) Study the

(2) Study the occurrence of detrital tin in Malacca Strait and east coast of Peninsular Malaysia, by investigation of Quaternary and late Tertiary stratigraphy and by compiling available data.

(3) Investigate mineralization in the Barisan Ranges associated with the arc volcanics such as the copper prospects at Tangse and the lead zinc zonation indicated by geochemical mapping:

(4) Studies of granite intrusions of the west coastal area of Sumatra and their mineralization.

(5) Date the primary mineralization of the tin belts.

(6) Study the organic geochemistry of deep sea sediments to gain an understanding of hydrocarbon accumulation.

Transect IV

(1) Study possible evidence for submarine calderas in the lesser Sunda Arc and the southern Banda Sea which may be sites for Kuroko-type base metal deposits.

(2) Study of the ophiolite complexes of eastern Indonesia with a view to possible platinum, chromium and gold deposits.

(3) Co-ordinate data on the region from oil company records.

(4) Review hydrocarbon occurrences with respect to regional tectonics with a view to determining the origin of oil and gas in the Banda Arcs.

Transect V

Major nickel chromium, platinum and copper deposits occur along the land part of this transect (Luzon), and hence studies here are of prime importance to help locate similar types of ore bodies elsewhere in the region.

(1) Studies of Zambales ophiolites in relation to their time of emplacement and mineralization and comparison with other bodies in the region.

/(2) Porphyry

(2) Porphyry copper bodies should be investigated by geological and isotopic studies. Host rock composition, alteration, age of intrusion and mineralization, initial Sr isotope ratios and other characteristics of mineralization should be determined. An integration and comparison of these studies would form the basis for an initial attemp to correlate on land mineralization processes with ocean floor data.

(3) The Mariana Trough needs to be sampled for metallogenic sediments and hot brines.

(4) Comparative study of metallogenesis in Marianas and Philippine systems.

Transect VI

(1) Studies of mode of generation of Kuroko-type and porphyry copper type mineralization as a basis for understanding similar problems along other transects.

(2) Study hydrocarbon generation and accumulation in the shelf sediments on either side of the Sea of Japan and on the possible extension of the transect to the west of Korea subject to the concurrence of all coastal states involved.

Part 2: Recommendations Related to Organizational Matters

(1) There is a need for an overall co-ordinator of transect studies, or alternately 2 co-ordinators, one for the Petroleum and one for the Non-Petroleum aspects of the SEATAR programme.

(2) There should also be a co-ordinator for each individual transect who would head a working group concerned with that transect.

(3) The results of the transect studies should be incorporated in a publication (perhaps in several volumes) to be produced as soon as possible after the decade ends.

/(4) The Petroleum

(4) The Petroleum Geologist of the CCOP Project Office should oversee compilation of data and publication of a review of known hydrocarbon occurrences in the region, with respect to tectonic settings. He should also serve as a liaison man between CCOP and other agencies, associations and societies and resources development companies.

(5) Emphasis should be placed on capability development in CCOP member countries. All SEATAR projects should include a training element for geologists/technicians from the region. There is a need for a careful selection of trainees to be trained in a particular speciality. They should remain in that speciality to maintain the facility and to participate in the training of their associates.

(6) A data base should be established for all geochemical data of suitable reliability from the whole region. The data should be compiled on standard data cards.

(7) There is a need for steering/advisory groups for projects in metallogenesis, petrology and geochemistry to review recommended projects and to assist in finding experts to participate in particular programmes, review training arrangements and to act as an information centre. An ad hoc expert group should meet informally at convenient times to review the progress of the SEATAR programme, perhaps concurrently with other international meetings.

(8) The SEATAR workshop requests IOC and CCOP to support a meeting of SEATAR ad hoc group of experts on Eastern Indonesian tectonics and related resources (transect IV, Banda Sea) to be held in Bandung, Indonesia, mid 1979, the liaison officers for which will be Dr. H.M.S. Hartono, Director, Geological Research and Development Center, Ministry of Mines of Energy, and Dr. Peter A. Jezek, Mineral Sciences, Smithsonian Institution.

/Part 3:

Part 3: Transect Recommendations

Transect I - Burma, Thailand

(a) Short Term Studies

(1) Drop transect Ib and consider Ib* as Ib in future

(2) Attempt to complete work along alternative transects recommended in 1973, including:-

i) aeromagnetic surveys;
ii) seismic, gravity and magnetic profiles;
iii) study of ERTS imagery;
iv) study of petrology, mineralogy geochemistry, isotopic composition and geological setting of mineralised igneous rocks to determine the geological, geochemical and mineralogical controls of ore deposits;
v) determine significance of serpentinites and other basic rocks along transect Ib (former Ib*);
vi) determine structural significance of folded Mesozoic rocks of central Thailand compared with the flatlying Mesozoic rocks of the Khorat Plateau;
vii) compile data on the salt beds of the Khorat Plateau;
viii) make a special study of Quaternary basalts;
ix) carry out palaeomagnetic studies of all suitable rocks on the transect lines;
x) continue heat flow measurements.

(3) Co-operate with Malaysia and Indonesia on studies of tin granites.

(b) Long Term Studies

(1) Subject to concurrence of the Governments of Laos, Viet Nam and the other coastal states, extend studies along Transect Ic to the South China Sea coast and across the South China Sea Basin to connect this transect with the

/Philippine-Marianas

Philippine-Marianas transect. This would cover areas underlain by granites associated with occurrences of tin, tungsten and molybdenum in southeastern Viet Nam.

(2) Studies along Transect Ia as specified in CCOP-IOC (1974) review.

(3) Continue work on eastern extension, through Viet Nam and Laos of Transects Ib (former Ib*) and Ic. Extension of Transect Ib to east or northeast would cover some tin deposits in eastern Laos and chromite deposits in north-central Viet Nam.

(4) Continue co-operation with Malaysia and Indonesia on studies of tin granites.

(5) Extend work along Transect Ic westwards to the Burma border and if possible beyond to the Andaman Sea. In Thailand this transect will cover the Quaternary Chao Phaya Basin, stratabound lead and zinc deposits and tin tungsten deposits, and should include an attempt to elucidate the tectonics of the central part of Thailand.

Transect II - Andaman - Gulf of Thailand

(a) Short Term Studies

(1) Seismic reflection and refraction data of the imbricate wedge west of the Andaman Nicobar Ridge is required, to determine what proportion of sediments in the Bengal Fan are subducted or accreted. Basic data are possibly available at Scripps Institute.

(2) More information is required on the distribution of heat flow in the Andaman Sea basin. This study should be combined with sediment sampling, a search for hot brines, metalliferous muds and hydrothermal systems.

(3) The continuation of the major structures recognised in North Sumatra, such as the Sumatra Fault Zone, should be traced into the Andaman Sea area using multi-channel seismic reflection profiling. Some data are possibly already available from Scripps.

/(4) A detailed

(4) A detailed study should be made of the stratigraphy and sedimentation of the Tertiary basins on the Mergui shelf and Gulf of Thailand, using available (and future available) data; and to compare these studies with the exposed Tertiary strata onshore peninsular Thailand (eg. Krabi Basin).

(b) Long Term Studies

(1) Study of organic geochemistry of deep sea sediments from both Bengal Fan and Andaman Sea side. All IPOD drilling should include these studies in future. These studies of organic geochemistry should also include the land areas of the Sumatra basins.

(2) It is necessary to obtain data on the Andaman-Nicobar Islands from the Indian Geological Survey. These might include Bengal Fan sediments which will throw light on the history of uplift of the Himalayas. A study of the organic geochemistry of these sediments would indicate the effects of the passage through the imbricate wedge.

(3) The volcanic arc has not yet been studied. The geochemistry of these rocks should be compared with the rest of the Sunda arc to determine variations along strike with relation to the variations in the geochemistry of the segment of the Indian plate which is being subducted.

(4) The Mergui Shelf should be studied as an Atlantic type margin by additional seismic refraction to determine deep crustal structure. The history of the shelf in terms of the relationship between structure and sedimentation needs to be evaluated.

(5) Offshore peninsular Thailand the programme for the location of granites and the study of overlying sediments commenced by DMR should be extended to both sides

/of the

of the peninsula by compilation of existing data and by geophysical methods and drilling to establish type sections. A study should be made onshore of Quaternary sediments to establish type sections and a generalised stratigraphy which can be extended offshore. These should be combined with facies studies to obtain a better understanding of the location of detrital tin deposits.

(6) On land the programme of research into the granitic bodies and their associated mineralisation commenced by DMR, with isotopic studies, should be strongly supported.

(7) An attempt should be made to establish the palaeogeographic relationships of the Palaeozoic rocks in peninsular Thailand.

(8) Investigations of sequences below the Tertiary basins of the Gulf of Thailand, in particular, with respect to the occurrence of a prospective Mesozoic section.

(9) Gravity surveys along the transect in conjunction with transects I and III.

Transect III - Sumatra - Malay Peninsula - Sunda Shelf

(a) Short Term Studies

(1) Studies of magnetic anomalies, morphology and sediment distribution on the Indian plate west of the Sunda Trench. North-south oriented lines are necessary to delineate the age of east-west anomalies and to determine the history of the spreading ridge that formerly existing in this region.

(2) Studies of sedimentary processes on the lower trench slope. Coring in the detailed survey area will allow correlation of facies with morphologic and structural setting and will explore the processes of downslope transport hydrocarbon generation and possible accumulation of hydrocarbons.

/(3) Seismic

(3) Seismic stratigraphy of the forearc region. The complex history of this basin may be clarified by a study of reflection profiles calibrated by the wells drilled in the area.

(4) Magnetic survey of the continental shelf off Western Sumatra. These measurements will aid in determining the location and shape of the edge of continental crust beneath the forearc basin.

(5) Studies in the Barisan Range of arc volcanics and associated mineralization such as the copper prospect of Tangse and the lead zinc zonation indicated by geochemical mapping. Both recent and past volcanic chains should be studied in relationship to evolution of subduction. This includes magnetostratigraphy of the Toba Tuffs.

(6) Studies of Quaternary and Late Tertiary (?) stratigraphy in Malacca Strait and on the east coast of Peninsular Malaysia in relation to sea level fluctuations, epeirogenic movements and the occurrence of detrital tin. This should be preceded by a compilation of data from both private companies as well as institutions.

(7) Palaeomagnetic studies. Further measurements should be directed toward sampling new sites over a wide range of ages and structural units across the transect.

(8) Gravity surveys along the transect. These measurements in conjunction with other geophysical data, may answer questions of local structure, coastal structure and coastal geodynamics and should be carried out in collaboration with transects I and II.

(9) Reassessment of geochronological results to identify problems and remedy data gaps.

/(10) Studies

(9) Studies including dating of younger basalts of Kuantan and Segamat (Malaysia), Pulau Midai (Indonesia) and other older gabbros of the Malay Peninsula.

b) Long Term Studies

(1) Study and correlation of lower Tertiary strata of Sumatra. These strata require studies of age, paleoenvironment and tectonic setting, both onshore and in the offshore areas.

(2) Structural style of the flanks of the Barisan Range. The geometry and age of deformation of the Barisan block is a necessary step in understanding the Neogene evolution of Sumatra.

(3) Studies of faulting on Sumatra. Amount and duration of displacements and effects of the faulting on the position of geologic units is required.

(4) Studies of the granite intrusions of the west coastal area of Sumatra. Work is required on those granitic intrusions that outcrop on the west flank of Sumatra to find their extent, ages, mineralization, genesis and their geological setting in a continental margin situation.

(5) Isotopic, geochronological studies of basement rocks in relation to the origin of granites in the transect area. These studies in conjunction with paleomagnetic and regional mapping studies are required for the delineation of major tectonic boundaries within the continental crust of Sumatra and Malaysia

(6) Dating of the primary mineralization of the tin belts.

(7) Additional mapping along the Malaysian leg of the transect especially along the new road section with reference to the problem of granites.

(8) Vertical tectonics along the western edge of Sumatra. Quaternary and long term vertical motions should be coupled with other data from the subduction zone to understand vertical tectonism along convergent plate margins.

/(9) Geothermal

(9) Geothermal studies in Sumatra. In view of the high heat flow in Sumatra Basin, it is recommended that similar measurements be made in the Malay Basin, Sunda Shelf and West Sumatra area.

(10) Studies of organic geochemistry of deep sea sediments

(11) IPOD drilling on the trench slope along the Sumatran transect. A series of cased holes in the accretion prism may outline the deeper structures associated with subduction.

(12) Malacca Strait studies:

(a) Studies of the late Cenozoic paleodrainage could result in delineation of older detrital tin deposits. This work should also include studies of the broad ages of the sediments, using all available techniques.

(b) Deep structure of the Malacca Straits and eastern Sumatra. The crustal structure of the area must be delineated before the possible collision or other modes of inter-reaction between Sumatra and Malaysia can be understood.

(13) Marine geophysical and detailed bathymetric studies from Natuna Island northeastwards into the deeper water over the shelf edge. Subject to the agreement of the coastal states.

(14) Drill a fully cored reference stratigraphic hole in a selected locality on the Sunda Shelf to obtain a section of the Quaternary-Late Tertiary Shelf sequence down to bedrock. Carry out the following studies:

(a) Age dating
(b) Sedimentation rates
(c) Depositional environment
(d) Mineralogy - organic content and maturation of the sediment
(e) Biota
(f) Magnetostratigraphy

/The above

The above recommendations a - f are designed to increase understanding of Quaternary placers.

Transect IV - Banda Arc

This transect should now be considered broadened into an area study.

(a) Short Term Studies

(1) Existing seismic stations in Eastern Indonesia need to be improved, so all supply data on an accurate timebase to International organizations.

(2) More information is required on existing stations.

(3) The Timor station should be encouraged to operate as well as possible, in view of its key locality for checking possible continental crust subduction.

(4) Temporary seismic networks to be set up in Western Indonesia.

(5) Additional marine geophysical measurements (bathymetry, single-channel seismic profiling, gravity, magnetic, heat-flow and seismic refraction) be conducted in the area north and northeast of the northern Banda Arc.

(6) The seismic refraction programme proposed in CCOP/IOC (1974) review, to determine crustal structure beneath Timor, should be implemented. A similar programme should be carried out on Seram.

(7) Additional marine geophysical studies of the fore-arc basin north of Timor should be carried out. Similar studies should be made in the Savu Sea, Wetar Strait and Weber Deep.

(8) Collect and collate available data on Quaternary terraces and beach ridges, particularly raised coral reefs, in order to determine uplift history of various tectonic units.

/(9) Carry out

(9) Carr out seismic stratigraphic studies in Aru Trough and Weber Deep, relating sequences to Quaternary/Late Tertiary sealevel curve. Map bedrock channels across Sahul and Arafura shelves using seismic profiling.

(10) Study and confirm the existence of three submarine volcanoes (Emperor of China, Niewerkerk and Yersey). Whether they are real active volcanoes or not.

(11) Carry out detailed seismic reflection profiling and bathymetric surveys on Timor and Seram Trough inner slopes.

(12) Implement a sediment-coring programme tied into (11), in order to document sedimentary processes and tectonics in the accretionary prism of a continent-arc collison zone.

(13) Detailed stratigraphic analysis of suitable units of key outer arc islands of Banda Sea, particularly Timor and Seram, is required to better understand the tectonic development models. Paleomagnetic studies of suitable units should be carried out, particularly the Maubisse formation (Permian) of Timor, and sediments and igneous rocks from Misool, Seram, Buru, Ambon and Sulawesi.

(14) Additional marine geophysical surveys should be carried out in the vicinity of Sumba and further west, in order to compare the oceanic subduction processes occurring to the west of Sumba with those of the continent-arc collision zone to the east.

(15) IPOD drilling programme to be recommended for inner slope of Timor Trough, the fore-arc basin north of Timor and the Banda Sea. This programme to outline tectonic and sedimentary processes in a continent-arc collision zone and to determine the age and origin of the Banda Sea.

(16) Detailed studies of Ambon:

(a) Mapping and geochemical sampling

(b) Gravity

(c) Geochronology

(d) Paleomagnetics

/(17) Study

(17) Study possible evidence for submarine calderas in the Lesser Sunda Arc and the southern Banda Sea which may be sites for Kuroko-type base metal deposits.

(18) Co-ordinate data from oil industry sources.

(19) Review known hydrocarbon occurrences with respect to regional tectonics.

(20) Study the geochemistry of oils observed in Banda Arc area to determine their origin.

(21) A study of organic geochemistry of deep sea sediments in terms of hydrocarbon generation and accumulation should be conducted, including samples obtained from IPOD drilling programme.

(b) Long Term Studies

(1) Comparisons to be made between stratigraphic units of Sulawesi and Banda Arc Islands to advance our understanding of the relationship between Sulawesi, the Banda Arcs and the Australian continental margin.

(2) Collect and collate data from dated raised coral terraces in various tectonic settings around the Banda Arc; use variations in elevation of last interglacial (-120,000 years) terrace to provide a contour map of current uplift rates throughout the spectrum of tectonic settings.

(3) Explore for submarine calderas in east Indonesia, with Japanese assistance, attempting to identify Kuroko-type base metal deposits. It may be possible to use seawater geochemistry to locate base metal dispersion haloes.

(4) Study distribution and ages of ophiolite and metamorphic complexes exposed on land in Banda Sea rea. This study would contribute to an understanding of the distribution of continental and past oceanic crust and of subduction and obduction processes in areas of continent-arc collision.

/(5) Regional

(5) Regional geochemistry and petrology of igneous rocks in east Indonesian arcs:

(a) detailed geochemistry of selected Quaternary and older volcanic complexes.

(b) detailed mapping, geophysics and geochemical exploration.

Compare this area with Philippines and Papua New Guinea (eg. geochemical characteristics of andesites associated with copper deposits in the Philippines compared with those of east Indonesia).

(6) Implement studies to date Quaternary/Late Tertiary sediment sequences and included unconformities on shelf areas using all available techniques. If possible, correlate unconformities with deep-sea sequences.

(7) Stratigraphic studies to be extended into Irian Jaya and Papua New Guinea, in order to determine the structural relationship between the collision belt of New Guinea (the New Guinea fold-belt) and the Banda Arc.

Transect V - Philippines - Marianas

(a) Short Term Studies

(1) Geophysical and geological studies of the South China Sea, subject to the concurrence of all coastal states involved. Magnetic profiling, to date previously recorded linear anomalies in central portion of the basin and to extend present coverage.

Seismic profiling to delineate possible areas of subsided continental fragments and the flanks of the basin.

(2) Offshore geophysical surveying. West coast of Luzon - Gravity magnetic and seismic profiling and sampling of "basement" outcrops in order that Zambales ophiolite can be placed in the overall tectonic framework, and to bridge the gap between land and offshore data.

/(3) Studies of

(3) Studies of Zambales ophiolites in relation to their time of emplacement and mineralization and comparison with other bodies in the region - Petrologic and geochemical studies with palaeomagnetic and geochronological studies to shed light on the origin and original position of the China Basin.

(4) Studies of Philippine Fault Zone

The duration of displacement, amount of displacement and effect of this on the distribution of geologic units needs to be known. Local geology geochronology and structural work combined with stratigraphic studies can help here. Vertical movements and deformed land surfaces in the transect region and their relation to tectonics should also be studied.

(5) Porphyry Copper Studies

Both geological and isotopic studies to enable host rock composition, alteration and age dating, initial Sr isotope ratios and other characteristics of the mineralisation to be determined. Integration of these two types of study would form the basis for an initial attempt to correlate on land data on mineralisation processes with sea floor data on mineralisation particularly the timing, rates, and angles of subduction during the late Cenozoic.

(6) Temporary seismic network in East Luzon and gravity studies. A network should be established along the coast and offshore islands to surround the intense seismicity associated with early stages of subduction. Gravity work to study relationship between high seismicity and high gravity and vice versa.

(7) Geological studies of Sierra Madre Range

Early history of subduction is recorded in the complex of ophiolites and melange. Present stage of reactivation may be responsible for possible recent uplift of the range.

/(8) Palaeomagnetism

(8) Palaeomagnetism of Luzon

This study is needed to establish the history of movement of the Philippine and Pacific Plates. These plates are known to have moved northward 30° since the early Eocene but there is no data on possible rotation.

(9) Sampling and marine geophysics off north and northeast Luzon

It is necessary to sample the slope east of the Sierra Madre Range and to collect samples together with seismic reflection profiling, of the Cagua Ridge to decide if this feature was a spreading ridge or a convergent margin.

Additional data is needed in Batanes to establish subduction polarity reversal.

(10) Deep electromagnetic sounding in different geologic units

To delineate first order differences of the lithosphere and the thermal regime between the various parts of the subduction - volcanic arc system.

(11) Detailed studies of Mariana Trench - Arc - Backarc system

Sample in trough for metallogenic sediments and brines. Refraction, OBS, seismicity geophysical methods in trench to determine:

(a) stress/strain relationship for upper lithosphere and strength of inner trench wall (eg. understand subduction of seamounts).

(b) structure of apparent volcanic highs on the trench - slope break - also sample for petrological studies.

(c) nature of boundary between crust under ridge and volcanic arc flanking the Mariana Trough.

(12) Deep crustal structure of Mariana Trench - Arc - Backarc system

Long refraction lines using some 40 OBS, to provide fundamental model of island arc subduction zone region, necessary for any model of metallogenesis during the formation of an island arc system.

/(b) Long Term

(b) Long Term Studies

(1) Comparative studies of ophiolites (and related deposits).

(2) Geology, petrochemistry and radiometric dating of the northern Luzon volcano-plutonic arcs.

(3) Studies of Quaternary volcanic rocks from Basshi channel to southern Luzon.

(4) Comparative study of metallogenesis in Marianas and Philippine system.

(5) Detailed studies of ore deposits of calc-alkaline affinity (fluid inclusion, stable isotopes, dating of hydrothermal minerals, major and minor element geochemistry).

(6) Detailed seismic profiling (off Luzon).

(7) Accurate dating of Quaternary-Tertiary sequences and unconformities (Luzon).

(8) Deep crustal studies along strike of remnant and active arcs.

(9) Evolution of West Philippine Basin and surrounding ridges.

(10) Deep-tow and submersible observations in detailed survey areas.

Transect VI - Japan - Korea

(a) Short Term Studies

(1) Compile and synthesise existing data in both south-western Japan and Korea, including LANDSAT data.

(2) Studies of island - arc type magmatism using geo-chemical techniques.

(3) Studies of mode of generation of Kuroko-type and porphyry copper type mineralisation as a basis for understanding similar problems along other transects.

/(4) Use

(4) Use available data to construct type sections showing generalised stratigraphy of the unconsolidated Quaternary and Late Tertiary sediment sequences and relate these to documented sea level fluctuations. The sections should be carried onshore.

(5) Survey a specific area in the sea of Japan along the east coast of Korea as well as the oceanic area between Korean peninsula and Tsushima Island, with special attention to the buried fracture zone(s) which may have been formed by opening of the sea of Japan with associated southward drift of the Japanese Islands.

(6) Continue studies along an extension of the transect to the west of Korea, subject to the concurrence of all coastal states involved.

(7) Re-analysis of magnetic lineations in the sea of Japan along well-positioned tracks and acquisition of new data, to determine time of opening of Sea of Japan.

(b) Long Term Studies

(1) Study hydrocarbon generation and accumulation in the shelf sediments on either side of the Sea of Japan and on the possible extension of the transect to the West of Korea.

(2) Ocean bottom magneto - telluric studies in the sea of Japan Shikoku Basin and Nankai Trough in relation to extraordinarily high heat flow in the Nankai trough subduction zone - study of the deep thermal structure.

(3) Real-time monitoring of convergence in the Nankai Trough using sonar transponders or similar devices.

(4) Deep sea drilling in the Sea of Japan.

(5) Seismic reflection profiling in off-shore regions and sedimentary studies on land to determine sea level fluctuations and vertical movements of the continental and island - arc masses along the transect.

/(6) Continue

(6) Continue study of the age and mechanism of creation of Sea of Japan, the age of the pull-apart marine shelf sediments and palaeomagnetic determinations.

(7) Analysis of exact fit of SW Honshu against Asia using geologic, geophysical and remote sensing data.

(8) Study occurrence and origin of the Cretaceous sediments of SE Korea.

(9) Study the age and mechanism of the creation of the continental Tertiary grabens along the extension of the transect to the west of Korea. Such studies would be carried out only with the concurrence of all coastal states involved.

Part 4: General Recommendations

(1) Seismicity

Improvements to data base from

(a) Effective operation of existing stations and prompt reporting of accurate arrival time data.

(b) Development of temporary seismograph networks utilizing rapidly advancing technology of seismic instrumentation.

(2) Heat Flow

Gap in data base of shallow areas needs to be filled by:

(a) Use of existing data - co-operation with oil companies

(b) use of new device presently being tested.

(3) Palaeomagnetics

(a) Data gathering should be continued on opportunity basis and from selected areas of special importance.

(b) Preliminary survey and report should be made of favourable targets.

(c) Possibility of obtaining orientated samples from side wall cores should be investigated.

/(4) Crustal

(4) Crustal structure

Investigation of crustal structure of land areas and shallow sedimentary hydrocarbon bearing basins by seismic refraction and gravity measurement is needed.

(5) Geochronology

Continuation and expansion of geochronological studies in the region.

(6) Organic Geochemistry

Seafloor sediments, where sampled, should be analysed for organic geochemistry. Objectives should include:

(a) Total organic content
(b) Hydrocarbon source typing
(c) Red-Ox environment
(d) Relationships between above (a-c) and sedimentological data.

This overall project should include both shallow shelf areas and deepwater basins. In addition, industry sea-bed cores and IPOD cores should be included.

(7) Satellite Imagery.

In the context of the SEATAR Program, full use should be made of existing and forthcoming series of Landsat imagery, during the continuation of the SEATAR Programme. It is necessary to obtain new cloud-free imagery over the Southeast Asian land areas.

(8) Geobotanical studies of tropical rain forest areas in relation to mineral exploration.

(9) The study of causal relationships between plate tectonics and basin formation, with particular reference to hydrocarbons.

(10) Tin Granite Studies

Tin granites occur in Thailand, Malaysia and Indonesia. The study of the distribution, age and origin of the granites and their associated mineral deposits, which also include tungsten and antimony is of great importance to all three

/countries. The

countries. The following methods of study should be followed:

(a) All previous work on granites and their ores in the region should be compiled in standardised form and re-assessed. A working group of all interested researchers should be established for this purpose.

(b) The age of emplacement of the granites and their mineral deposits should be determined by field studies and by careful determination of Rb/Sr isochrons. The dating of mineralisation should be regarded as a separate problem from the dating of the granites. Fission track-dating may be of assistance here.

(c) The isotopic constitution of the granites should be determined including Pb, Nb and O ratios to determine their origin.

(d) The petrology and mineralogy of the granites should be carefully studied.

(e) Trace element composition of the granites should also be determined.

(f) The composition of the crystalline basement exposed in northern Thailand and in Sumatra, as possible sources of the granites and the mineralisation, should be determined.

(11) Studies of Quaternary/Late Tertiary Unconsolidated Sediment Sequences of East Asian Shelf Areas.

Among the major objectives of the CCOP Project are the following:

(i) To assess coastal and offshore non-hydrocarbon resources in east Asia.

(ii) To obtain a better understanding of the Quaternary geology of the broad shelf region in east Asia, in order to contribute to the search for offshore surficial mineral deposits and provide a fundamental framework for future offshore engineering geological investigations.

/The following

The following work programme is recommended to help achieve these objectives and increase understanding of the processes controlling the location of economic deposits of detrital tin and other minerals such as magnetite, platinum, etc.

(a) Collect and collate all available data relating to studies of Quaternary/Late Tertiary unconsolidated sediment sequences of the broad shelf regions of East Asia, including bathymetric, seismic, magnetic, side-scan sonar profiles and drilling. Geological, geophysical and drilling data from the adjacent coastal areas should also be incorporated so that the relationship between the offshore and onshore sediment sequences can be clearly established.

(b) Use all of the above data to construct type sections for different parts of the region, showing the generalised stratigraphy and the position within the sequences of economically interesting concentrations of detrital heavy minerals and construction materials, as a guide for future exploration.

(c) The various units recognised on the sections should be related to the published sea level curve and a high priority should be given to determining the ages of the units. Mapping of palaeodrainage channels should be continued as a further guide to sea level fluctuations and epeirogenic movements, and their relationship to the occurrence of economic concentration of minerals.

(d) A long term aim should be to drill a number of fully cored holes through representative sections of the Quaternary/ Late Tertiary unconsolidated sequences in various parts of the region, to provide a key reference for future detailed studies in all parts of the region, and for regional correlation studies. Samples, from the boreholes should be subjected to age dating, palaeontological, mineralogical, magnetostratigraphic, palaeoenvironmental and other studies.

(12) Calc-alkaline Studies

Calc-alkaline basalts, andesites and related plutonic rocks

/are frequently

are frequently associated with major porphyry copper deposits in some parts of the region (eg. Philippines, New Guinea) while in others (eg. Banda Sea, Sunda Arc) similar rocks appear to be devoid of mineralisation. A programme should be developed to determine the age and origin of these rocks and the reason why some occurrences are mineralised while others are not.

The igneous rocks should be mapped in detail and their petrology, mineralogy and petrochemistry studied in various parts of the region. Geochemical studies should include major and minor element composition, including Pb, Sr and O isotopes, rare earth content and isotopic age.

The associated ores should also be studied by determination of the major and minor element geochemistry, stable isotopes and dating of the hydrothermal minerals. Fluid inclusion studies of ore and gangue minerals should also be included. Since the calc-alkaline rocks are considered to originate from partial melting of oceanic lithosphere this study should be linked with a marine programme to study the composition of the basaltic rocks forming the ocean floor. The region offers a unique opportunity to compare ages and origins of subducted oceanic crust, with their presumed products extruded from the volcanoes of the magmatic arcs.

(13) Ophiolite Studies

Further study of all ophiolite complexes in the region is strongly recommended, with the following major objectives:

(a) To develop a systematic classification of ophiolite
(b) To determine the age of crystallization of each complex
(c) To accelerate mineral exploration including:
    (i) the need for specially-adapted exploration techniques
    (ii) the special problems of Pt-group exploration
    (iii) the potential for hydrocarbon accumulations below ophiolite thrust sheets
    (iv) to study the link, if any, between ophiolite complexes and porphyry copper mineralization
    (v) to study the variation in Cu content of sea-floor and ophiolite basalts.

/These studies

These studies should be related to marine programmes in the marginal basins of East Asia in order to:

(a) Search for mineralization in active rift zones
(b) Search for best sites for IPOD holes to sample marginal basin crust.

Part 5: Proposed New Transects

Transect VII - Java Transect

A new transect is proposed extending from the Indian Ocean through Java, Kalimantan and into the South China Sea. Work along this transect would only be carried out with the consent of all coastal states involved.

Transect VIII - Sulu Sea Transect

A proposal for a short transect from the South China Sea to the Celebes Sea crossing two inactive trenches and two volcanic arcs (Cagayan and Sulu Archipelagoes) resulted from recommendations of the Ophiolite subgroup of the Panel on Tectonics, Petrology and Metallogenesis. This transect could usefully be extended to cross the whole of the Celebes Sea and the Molucca Sea. The transect presents an opportunity to correlate oceanographic studies with exposed rocks on land in Sabah and to study ophiolite, and volcanic arc mineralization and oil deposits in a condensed setting. If extended to cross the Molucca Sea and Halmahera, two volcanic arcs, complete with opposite dipping subduction zones which are colliding, can be investigated further.

As a recently joined member of CCOP Papua New Guinea was not included in the transect proposals put forward in the 1973 workshop. At the 1978 SEATAR workshop the representative of Papua New Guinea formulated proposals for two new transects across Papua New Guinea for the second phase of the SEATAR Programme.

/Transect IX

Transect IX - New Guinea Transect

This transect extends north-south from a poorly known part of the Pacific Ocean Basin across the New Guinea Trench and Papua New Guinea in the region of the Papua New Guinea - Irian Jaya border, to the North Australian Shelf. This transect crosses a major porphyry copper province in the Victor Emmanuel Range and there are good petroleum prospects in the North New Guinea Basin and Gulf of Papua, adjacent to the transect.

Transect X - Bismarck Sea - Solomon Sea Transect

This transect has two branches; one originates in the Pacific Ocean Basin and extends southwards across the little known West Melanesian Trench, the Bismarck Sea and New Britain into the Solomon Sea; the second branch also originates in the Pacific Ocean Basin further to the south, and extends WSW across the island of Bouganville to meet the first branch in the Solomon Sea. Both branches cross major porphyry copper provinces in New Britain and Bouganville and a prospective petroleum province north of the Papuan Peninsula into the Coral Sea. Manganese and copper ores have been mined on the south side of the Papuan Peninsula, sulphide and lateritic nickel prospects and chromite beach sands also occur along this transect.

Annex 1

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LIST OF DOCUMENTS ISSUED FOR THE WORKSHOP

Document No. CCOP-IOC/SEATAR	Title and Author	Source	Date
(W II)/1	Review of Studies Along the SEATAR Transects PARTS I and II	CCOP Project Office	16 Oct
(W II)/2	Thrust Tectonics in Timor by A.J. Barber, M.G. Audley-Charles and D.J. Carter	Reprint from Jour.Geol.Soc. Australia	28 Sep
(W II)/3	The Tectonic Development of Timor. A new Model and its Implications for Petroleum Exploration by F.H. Chamalaun and A.E. Grady	Reprint from APEA Journal, 1978	28 Sep
(W II)/4	Tectonics of the Andaman Sea and Burma by J.R. Curray, D.G. Moore, L.A. Lawver, F.J. Emmel, R.W. Raitt, M. Henry and R. Kieckhefer	Reprint of paper to be published in AAPG memoir	29 Sep
(W II)/5 *	Sedimentology, Structural Geology and Tectonics of the Shikoku Subduction Zone, Southwest Japan by J.C. Moore and D.E. Karig	Reprint from Geol.Soc. of America Bulletin Vol. 87	30 Sep
(W II)/6	Patterns of Mineralization in Southeast Asia, Their Relationship to Broad-scale Geological Features and Relevance of Plate-Tectonic Concept to their Understanding by D. Taylor and C.S. Hutchison	Reprint of paper presented at 11th Commonwealth Mining and Metallurgical Congress	1 Oct
(W II)/7	Some Shallow Tectonic Consequences of Subduction and their Meaning to the Hydrocarbon Explorationist by P.A. Montecchi	Reprint from Am.Assoc.Petrol. Geol.Mem 25	3 Oct
(W II)/8	Plate Tectonic in Petroleum Exploration of Convergent Continental Margin's by T.L. Thompson	Reprint from Am.Assoc.Petrol. Geol.Mem 25	3 Oct
(W II)/9	Review of SEATAR-Related Activities in the Philippines	by the Philippines. Delegation	16 Oct
(W II)/10	The Molucca Sea Collision Zone Indonesia by E.A. Silver and J.C. Moore	Reprint from J.G.R. Vol. 83	16 Oct
(W II)/11	Quaternary Geology of Shelf Regions Southeast Asia	H.D. Tjia	16 Oct

/(W II)/12

Document No. CCOP-IOC/SEATAR	Title and Author	Source	Date
(W II)/12	A Geophysical Atlas of East and Southeast Asian Seas General Explanatory Notes	D.E. Hayes and Others	17 Oct
(W II)/13	Origin of Late Cenozoic Lavas from the Banda Arc, Indonesia, Trace Element and Sr Isotope Evidence by D.J. Whitford and P.A. Jezek	Reprint of paper to be published in Contribs to Mineral and Petrol.	18 Oct
(W II)/14	Plate Convergence in the Taiwan-Luzon Region by C. Bowin, R.S. Lu, Chao-Shing Lee and H. Schouten	Reprint from paper to be published in AAPG memoir	18 Oct
(W II)/15	Banda Arc of Eastern Indonesia. Petrology and Geochemistry of the Volcanic Rocks by P.A. Jezek and C.S. Hutchison	Reprint from Bull.Volcan.	18 Oct

The Scientific Workshops of the Intergovernmental Oceanographic Commission are usually jointly sponsored with other intergovernmental or non-governmental bodies. In each case, by mutual agreement, one of the sponsoring bodies assumes responsibility for publication of the final report. Copies may be requested from the publishing bodies as listed below or from the Secretary IOC, Unesco, Place de Fontenoy, 75700 Paris, France.

No.	Title	Publishing Body	Languages
1.	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia /Report of the IDOE Workshop on/; Bangkok, Thailand, 24-29 September 1973. UNDP (CCOP), 138 p.	Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok 2, Thailand	English
2.	CICAR Ichthyplankton Workshop, Mexico City, 16-27 July 1974. (Unesco Technical Paper in Marine Science, No. 20)	Division of Marine Sciences, Unesco, Place de Fontenoy, 75700 Paris, France	English Spanish
3.	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
4.	Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador 4-12 December 1974	FAO Via delle Terme di Caracalla, 00100 Rome, Italy	English Spanish
5.	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
6.	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
7.	Report of the Scientific Workshop to initiate planning for a co-operative investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/EAC, Nairobi, Kenya, 25 March- 2 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	Full text (English only) Extract and Recommendations: French Spanish Russian

No.	Title	Publishing Body	Languages
8.	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
9.	IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
10.	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
11.	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
11. Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
12.	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects, Fort-de-France, Martinique, 28 November-2 December 1977	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
13.	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area, 16-18 January 1978	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
14.	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas, Abidjan, Ivory Coast, 2-9 May 1978.	UNEP Palais des Nations 1211 Geneva 20 Switzerland	English French
15.	CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-east Pacific Santiago de Chile 6-10 November 1978	IOC, Unesco Place de Fontenoy 75700 Paris, France CPPS Dir. de Soberania Maritima Ministerio de Relaciones Exteriores Lima Peru	English Spanish

No.	Title	Publishing Body	Languages
16	Workshop on the Western Pacific Tokyo, 19-20 February 1979	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Russian
17.	Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS) Moscow, 9-11 April 1979	IOC, Unesco	English
17. Suppl.	Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOSS Data Processing and Services System Moscow, 2-6 April 1979	IOC, Unesco	English
18.	IOC/Unesco Workshop on Syllabus for Training Marine Technicians Miami, 22-26 May 1978	Division of Marine Sciences, Unesco	English French Spanish Russian
19.	IOC Workshop on Marine Science Syllabus for Secondary Schools Llantwit Major, South Wales	Division of Marine Sciences, Unesco	English French Spanish Russian
20.	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources Bandung, Indonesia, 17-21 October 1978	**IOC, Unesco**	English
21.	Second IDOE Symposium on Turbulence in the Ocean Liège, Belgium, 7-18 May 1979	IOC, Unesco	English French Spanish Russian