

**Committee for Co-ordination of Joint Prospecting for Mineral
Resources in South Pacific Offshore Areas (CCOP/SOPAC)**

Proceedings of the Ninth Session

Tarawa, Kiribati

20-28 October 1980

including

**Report of the Ninth Session of its Technical Advisory Group, the CCOP/SOPAC
Work Programme, Technical Documentation and the Summary Report of the
CCOP/SOPAC—IOC Second International Workshop on Geology, Mineral
Resources and Geophysics of the South Pacific**

Compiled by J. V. EADE

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COVER PHOTO

Deep water gorgonian corals being removed from a coral tangle-net dredge on m.v. *Komalialae*, Solomon Islands precious coral survey, October-November 1979.

(Photo: J. V. Eade, N.Z. Oceanographic Institute, Wellington, New Zealand)

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PREFACE

The Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) is an intergovernmental body established under the sponsorship of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP, formerly ECAFE) to develop and promote the investigation of the mineral potential, including petroleum, of the shelves, platforms, and ocean floor in the South Pacific Ocean. At the time of its Ninth Session the member Governments of CCOP/SOPAC were Cook Islands, Fiji, Kiribati, New Zealand, Papua New Guinea, Solomon Islands, The Kingdom of Tonga, Vanuatu, and Western Samoa.

The need for assistance to the developing countries of the South Pacific in this field was first brought to the attention of ECAFE by the representative of Fiji at the Joint (Eighth) Session of the ECAFE Working Party of Senior Geologists and Sub-Committee on Mineral Resources Development (Bandung, Indonesia, August 1970). Interest had been aroused in the petroleum potential of the submerged platform areas in the South Pacific after the discovery in 1968 of seepages of crude oil in Tonga. The attention being given to the possibilities of finding economic deposits of detrital heavy minerals in beaches and near-shore areas of some of the countries, and investigations of the feasibility of mining manganese nodules from the ocean floor for their metallic content, increased the need for a co-ordinated approach and for guidance to the South Pacific countries which had, as yet, little or no experience in these activities.

At the subsequent meetings of the ECAFE Committee on Industry and Natural Resources (Bangkok, January, February 1971) and the Commission Session (Manila, April 1971) further support was given by other countries in the South Pacific region to the proposal to form a co-ordinating committee for offshore prospecting in the South Pacific. As a result, the ECAFE Secretariat convened a Preparatory meeting at Manila in July 1971 to arrange the establishment of the new body. The Inaugural (first) Session of CCOP/SOPAC was held at Suva, Fiji, in 1972; its Second Session at Nuku'alofa, Tonga, in 1973; its Third Session at Apia, Western Samoa, in 1974; its Fourth Session at Honiara, Solomon Islands, in 1975; its Fifth Session at Rarotonga, Cook Islands, in 1976; its Sixth Session at Port Moresby, Papua New Guinea, in 1977; its Seventh Session at Wellington, New Zealand, 1978; its Eighth Session at Suva, Fiji, in 1979; and its Ninth Session at Tarawa, Kiribati, in 1980.

The sessions of CCOP/SOPAC have been attended by technical advisers provided by the following Governments, at their own expense, to give guidance to the Committee on the technical aspects of its activities: Australia, France, the Federal Republic of Germany, Japan, the Union of Soviet Socialist Republics, The United Kingdom, and the United States. Observers from the Federal Republic of Germany, Nauru, Norway, the Trust Territories of the Pacific Islands, the South Pacific Bureau for Economic Co-operation (SPEC), the United Nations Development

Programme (UNDP), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and its associated Intergovernmental Oceanographic Commission (IOC), the University of Papua New Guinea, the University of the South Pacific, and the University of Texas have attended the CCOP/SOPAC sessions.

Since the appointment of a UNDP Marine Geologist and establishment of a Technical Secretariat in late 1974 CCOP/SOPAC has been supported by many countries and international organisations.

The Technical Secretariat has its headquarters in Suva, where the Fiji Government has generously provided accommodation at the Mineral Resources Department. Member countries have supported the Secretariat, especially during the survey work, by providing personnel, facilities (including ships), equipment, and supplies.

Several countries have generously provided much support to the Committee's activities, including direct financial support (Australia, New Zealand, and USA); the services of non-reimbursable consultants (Australia, France, Japan, New Zealand, and USA); shipboard training (France, Japan, and USA); equipment gifts and loans (Japan, Australia, and USA); and publishing and printing costs (Australia and New Zealand).

The United Nations Development Programme (UNDP) has supported the Committee since the establishment of its Technical Secretariat in September 1974 by financing a preparatory assistance project. During this time two technical missions, financed by UNDP, visited member countries of CCOP/SOPAC and interested neighbouring countries. As a result of the recommendations of these missions, UNDP offered further support to CCOP/SOPAC by increasing its financial assistance to the region, especially to support investigations of mineral potential on the sea bed and in adjacent areas. In January 1979 the UNDP Project 'Investigation of Mineral Potential of the South Pacific' was established to carry out a large, but selected, portion of the CCOP/SOPAC work programme. The Project Office, along with the CCOP/SOPAC Technical Secretariat, is based in Fiji at the Mineral Resources Department, in Suva. It was agreed at the Eighth Session of CCOP/SOPAC, with UN concurrence, that the Project Manager would act as Technical Secretary to the Committee on an ad hoc and temporary basis pending a decision on the final legal status of CCOP/SOPAC.

The Intergovernmental Oceanographic Commission (IOC) has assisted the Committee by supporting the attendance of experts at meetings to develop long-range projects in the South Pacific, and by supporting trainees from member countries, allowing them to participate in training courses and survey cruises.

In recent sessions the attention of the Committee has been drawn to the results of survey work and data reassessment on prospects of petroleum, manganese nodules, submarine phosphate, precious coral, metalliferous sediments, detrital gold, submerged bauxite, aggregate

materials and clay deposits. Results have been published in *South Pacific Marine Geological Notes* and in the *CCOP/SOPAC Technical Bulletin* series. Survey work has been carried out using personnel, ships, equipment, and facilities provided by member countries through the Technical Secretariat and by UNDP through the Project Office. Training of member country personnel has been effected through participation in survey cruises in member country waters, on research vessels from supporting countries, and attendance at several training courses held in Suva. Programme planning for work of the Committee has been greatly assisted by the joint CCOP/SOPAC-IOC

IDOE International Workshop, the CCOP/SOPAC-University of Hawaii-IOC jointly sponsored Ad Hoc Meeting of Specialists on the Geodynamics of the Fiji Plateau, the CCOP/SOPAC Workshop on Precious Corals, the CCOP/SOPAC-UNDP Symposium on Petroleum Potential in Island Arcs, Small Ocean Basins, Submerged Margins, and Related Areas and the Joint IOC/WESTPAC-CCOP/SOPAC Second International Workshop on Geology, Mineral Resources and Geophysics in the South Pacific. To carry out work in the area the Committee now has a total of 75 country projects and 28 regional projects in its work programme.

Part 1: REPORT OF THE COMMITTEE, NINTH SESSION

(Document E/ESCAP/194, 5 January 1981, submitted to the thirty-seventh session of the United Nations Economic and Social Commission for Asia and the Pacific, 10-21 March 1981, Bangkok.)

Organisation of the session

1. The Ninth Session of the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (CCOP/SOPAC) and the Ninth Session of its Technical Advisory Group (TAG) were held at Tarawa, Kiribati, from 20 to 28 October 1980.

Attendance

2. Representatives of the following member countries attended: Cook Islands, Fiji, Kiribati, New Zealand, Samoa, Solomon Islands, Tonga, and Vanuatu. Papua New Guinea regretted that, owing to constraints on funding for overseas travel, it was unable to send a representative, but offered best wishes for a productive session.

3. Technical advisers provided by the following governments attended: Australia, France, Japan, Union of Soviet Socialist Republics, United Kingdom of Great Britain and Northern Ireland, and United States of America.

4. Representatives of the Economic and Social Commission for Asia and the Pacific (ESCAP), the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organisation (IOC/UNESCO) and the United Nations Development Programme (UNDP), and observers from Guam, the Trust Territory of the Pacific Islands, and the University of the South Pacific also attended.

Opening addresses

5. The Vice-President of the Republic of Kiribati, in his opening speech, emphasised that Kiribati with a land area of only 684 square kilometres had a water area totalling nearly 4.5 million square kilometres now that a 200-mile extended economic zone had been declared. He stressed that the exploitation of marine resources had therefore become critical. He was confident that appropriate technology would be devised for economic exploitation of marine mineral deposits.

6. In a message read on his behalf, the Executive Secretary of ESCAP noted the importance of the CCOP/SOPAC petroleum symposium, held at Suva, Fiji, in 1979, and emphasised the need to accelerate the exploration for and development of both conventional and non-conventional sources of energy. Results of CCOP/SOPAC offshore surveys for marine resources had indicated that an assessment could be made of some marine mineral potential and suggested that the work programme needed to be modified and new priorities established.

7. The UNDP Regional Programme Adviser commended the Committee for its important activities and

stated that UNDP was prepared to continue to provide funds, although possibly not for the full programme that would be proposed for 1982-86. He stressed that the future work programme should be based on known priorities, and all participants should be aware of the possible need for additional resources to meet the requirements of CCOP/SOPAC.

8. The outgoing Chairman of the Committee welcomed the presence of observers from Guam and the Trust Territory of the Pacific Islands and regretted that American Samoa and Nauru, which had also been invited, were not represented. He noted with pleasure the many important developments that had occurred during the past year.

Election of officers and adoption of the agenda

Election of officers

9. Mr T. Otang, Kiribati, was elected Chairman and Mr A. Macfarlane, Vanuatu, Vice-Chairman. The Committee appointed Mr M. J. Terman (United States of America) Rapporteur and Mr J. E. Wright (United Kingdom) Chairman of TAG.

Adoption of the agenda

10. The following agenda was adopted:

Plenary session

1. Opening of the session
2. Election of the Chairman and Vice-Chairman
3. Adoption of the agenda of the plenary
4. Admission of new members and designation of national representatives
5. Appointment of the Chairman of TAG

TAG session

6. Adoption of the agenda of TAG
7. Review of activities since the Eighth Session
 - (a) CCOP/SOPAC Technical Secretariat
 - (b) ESCAP Secretariat
8. Review of survey activities in the CCOP/SOPAC area since the Eighth Session
 - (a) Activities in the CCOP/SOPAC work programme
 - (b) Activities of the UNDP Project
 - (c) Other activities
9. Consideration of the report and recommendations of the CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific
10. Data and information management
11. CCOP/SOPAC publications
12. Training: programmes and requirements
13. Recent reports on the exploration, development and management of mineral, energy and other marine resources relevant to the activities of CCOP/SOPAC
14. Recent reports on the development and management of coastal area resources relevant to the activities of CCOP/SOPAC
15. Reports on developments in related areas of activity
 - (a) Law of the sea
 - (b) Marine pollution (caused by exploration and development of mineral resources)

- (c) Tsunami warning
- (d) Seismicity
- 16. Relations with other international organisations
- 17. Formulation of the work programme
 - (a) CCOP/SOPAC
 - (b) UNDP project
 - (c) Funding
- 18. Adoption of the report of TAG

Plenary session (continued)

- 19. Review of the terms of reference and legal status of CCOP/SOPAC
- 20. Tripartite review
- 21. Consideration of the report of TAG
- 22. Other matters
- 23. Arrangements for the Tenth Session
- 24. Adoption of the report
- 25. Closure of the session

Admission of new members and designation of national representatives

11. The Committee noted the designation of national representatives as follows:

Cook Islands—Mr S. G. Kingan (Scientific Research Officer, Premier's Department)

Fiji—Mr R. N. Richmond (Director, Mineral Resources Department)

Republic of Kiribati—Mr T. Otang (Secretary, Ministry of Natural Resources Development)

New Zealand—Dr D. Kear (Director-General designate, Department of Scientific and Industrial Research)

Papua New Guinea—Mr N. R. Agonia (Secretary, Department of Minerals and Energy)

Samoa—Mr P. D. Muller (Apia Observatory) (A new national representative is expected to be designated by early 1981)

Solomon Islands—Mr F. I. E. Coulson (Chief Geologist, Geological Division, Ministry of Natural Resources)

Kingdom of Tonga—Mr S. L. Tongilava (Superintendent of Lands, Survey and Natural Resources)

Vanuatu—Mr A. Macfarlane (Chief Geologist, Geological Survey Department)

Review of the terms of reference and legal status of CCOP/SOPAC

12. The Committee reviewed its terms of reference as set out on pages 44 to 46 of the *Proceedings* of the First Session of CCOP/SOPAC. It recognised that the functions of the Committee had necessarily expanded since its inception as the capabilities and requirements of the member countries had changed. Taking into consideration matters such as the proposed Pacific regional energy programme, the need to carry out onshore studies, especially those related to ongoing activities, and the recommendations of the UNDP natural resources sector review mission of 1980, the Committee decided to amend paragraph 8 of its terms of reference as follows:

Functions

8. The Committee shall promote, co-ordinate, plan and implement geological, geophysical, energy studies and other related natural resource prospecting projects and basic investigations in the onshore, coastal and adjoining offshore areas of the member countries as well as the oceanic areas of the region. It shall to this end:

(a) Review regularly the progress made with all projects included in the work programme of the Committee, as well as investigations carried out by other bodies relating to the onshore, coastal and offshore areas, together with training programmes pertaining to these and other activities of the Committee.

(b) Recommend to member Governments appropriate measures for implementing the Committee's geological, geophysical, energy studies and other natural resource prospecting projects and basic investigations, particularly through joint action and co-ordinated long-term projects.

(c) (Remains unchanged)

(d) Arrange for the preparation of requests for technical, financial and other assistance from international, scientific and research foundations concerned with natural resources.

(e) Advise member Governments on problems connected with onshore, coastal and offshore projects agreed upon between or among the Governments concerned, and on other related problems.

(f) Arrange means of advising member Governments, on request, concerning interpretation and evaluation of technical data relating to the natural resources potential, particularly minerals and energy, of their onshore, coastal and offshore areas for the information of the Governments concerned.

(g) (Remains unchanged)

(h) Prepare and promote plans for carrying out co-ordinated basic and applied research in the onshore, coastal and offshore areas of the member countries, as well as the oceanic areas of the region.

(i) Promote the establishment of programmes and facilities, both within and outside the region, for training personnel from the member countries in all fields relating to natural resources, especially minerals and energy.

(j) Promote the early publication of reports of the results of surveys and investigations conducted through the medium of CCOP/SOPAC and of other articles relating to the geology, mineral and energy potentials of the onshore, coastal and offshore areas of the region.

13. The Committee was reminded that the services of experts from the Regional Mineral Resources Development Centre (RMRDC) at Bandung were available on request to the Governments of member countries. It felt that, in view of the regular meetings of ESCAP Project Managers, there was little danger of duplication by CCOP/SOPAC of any onshore activities undertaken by RMRDC.

14. The Committee noted that ESCAP had provided to members samples and drafts of documents, and advice on matters concerning the legal status of CCOP/SOPAC.

15. However, the Committee held the view that, as significant issues were presented too late for serious study before this meeting, additional time would be needed for

the member countries to study the various alternatives before coming to a final decision on a legal framework for CCOP/SOPAC.

16. The Committee therefore agreed to maintain its present status while additional time be allowed for the completion of ongoing legal reviews by each of the Governments.

17. The UNDP representative agreed that the UNDP-financed Project Manager continue to act, on an ad hoc and temporary basis, as Technical Secretary to the Committee pending a decision by the member countries on the legal status of CCOP/SOPAC.

Tripartite review

18. At the tripartite review of the UNDP Project it was agreed that:

- (a) the present level of UNDP input was adequate for the work programme envisaged through the end of the current project assuming that funds underspent in 1980 would be carried forward to 1981;
- (b) participating countries would make an increased effort to identify candidates for training;
- (c) member countries' cash contributions should be used for training;
- (d) the services of an editor, on a non-reimbursable basis for 12 months, should be sought to expedite the processing of the publications backlog.

Consideration of the Report of TAG

19. The Committee adopted the report and recommendations of TAG, including the recommended work programme for 1980-81 (see annex I).

Other Matters

20. The Fiji representative expressed concern for the future of CCOP/SOPAC in view of the uncertainty of financial support from UNDP beyond 1984. He recommended that, subject to the agreement of the Governments involved, the offices of both the CCOP/SOPAC Technical Secretariat and the UNDP Project should be relocated as soon as possible in New Zealand. That country had always been the most responsive to requests for support in the past and it was considered that such a move would facilitate the obtaining of further support from that source in the future.

21. The Committee endorsed the recommendation, bearing in mind that the support services available in New Zealand would enhance the effectiveness of the Technical Secretariat in carrying out the CCOP/SOPAC work programme. The New Zealand representative promised to deliver the recommendation to his Government and suggested that a detailed written request be sent from the Technical Secretariat.

22. The Committee acknowledged the special contributions made to CCOP/SOPAC by Mr R. Richmond and Dr L. Kroenke and appointed them special advisers to the Technical Secretariat of CCOP/SOPAC to be effective 5 December 1980 and 1 July 1981 respectively—dates that each would leave the region.

23. The Committee strongly supported the proposed Pacific Geothermal Conference to be held at Auckland, New Zealand, from 2 to 6 November 1981, and requested that the Technical Secretariat transmit word of that support to the organisers of the conference. It further recommended that ESCAP be requested to seek funds necessary to permit the attendance of CCOP/SOPAC member country participants.

24. The Committee suggested that the Fiji Government be requested to issue a suitable licence to allow the Technical Secretariat to install and operate its own high frequency radio communication system so that good radio communications may be made between the CCOP/SOPAC Technical Secretariat and vessels undertaking its prospecting and research projects.

25. The Committee recommended that the Project Manager select a project expert to attend the meeting of the Consortium for Ocean Geosciences of the Australian Universities (COGS) in Australia in 1981 and to prepare a report on the results of the meeting for circulation to member countries and concerned parties.

26. The Committee recommended that the Technical Secretariat be responsible for preparing and editing the *Proceedings* of the sessions to facilitate their early production.

27. The Committee requested that ESCAP provide the Technical Secretariat with copies of the United Nations rules for conducting meetings similar to the CCOP/SOPAC sessions so that the Committee, at its next session, could promulgate its own rules and standing orders within the framework of United Nations rules.

Arrangements for the Tenth Session

28. The Committee accepted with gratitude the offer of the Government of Vanuatu to host the Tenth Session of CCOP/SOPAC. It was pleased to receive the offer from Tonga of an alternative site for the meeting should it not be possible for it to be held in Vanuatu. The actual dates of the meeting would be decided by the Executive Secretary of ESCAP in consultation with the host Government and the Technical Secretariat.

Adoption of the report

29. The Committee adopted its report on 28 October 1980.

Summary of conclusions and recommendations

30. The Committee:

1. decided to amend its terms of reference (para. 12);
2. agreed to maintain its present status pending the outcome of ongoing legal reviews by each of the member Governments (para. 16);
3. agreed, at the tripartite review of the UNDP Project, that (a) the present level of UNDP input was adequate, assuming that funds underspent in 1980 would be carried forward to 1981; (b) countries would make an increased effort to identify candidates for training; (c) member countries' cash contributions should be used for training; (d) the services of an editor on a non-reimbursable basis for 12 months should be sought (para. 18);
4. adopted the report and recommendations of TAG (para. 19);
5. endorsed the recommendation that the offices of both CCOP/SOPAC Technical Secretariat and the UNDP Project should be relocated as soon as possible (paras 20 and 21);
6. strongly supported the proposed Pacific Geothermal Conference (para. 23);
7. suggested that the Fiji Government be requested to issue a suitable licence to allow the Technical Secretariat to operate its own radio communications system (para. 24);
8. recommended that the Project Manager select a project expert to attend the COGS meeting (para. 25);
9. recommended that the Technical Secretariat should be responsible for preparing and editing the *Proceedings* (para. 26);
10. accepted with gratitude the offer of the Government of Vanuatu to host the Tenth Session of CCOP/SOPAC (para. 28).

ANNEX 1

REPORT OF THE TECHNICAL ADVISORY GROUP

The following abbreviations are used in this report:

AMSTAC	Australian Marine Science and Technology Advisory Committee
BMR	Bureau of Mineral Resources, Geology and Geophysics (Canberra, Australia)
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (Hanover, Federal Republic of Germany)
CCOP/SOPAC	Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas (Suva, Fiji)
CNEXO	Centre National pour l'Exploitation des Océans (Paris and Brest, France)
COGS	Consortium for Ocean Geosciences of the Australian Universities
DSIR	Department of Scientific and Industrial Research (Wellington, New Zealand)
HIG	Hawaii Institute of Geophysics (University of Hawaii, Honolulu)
IOC	Intergovernmental Oceanographic Commission (of UNESCO) (Paris)
IPOD	International Programme of Ocean Drilling
NZGS	New Zealand Geological Survey (DSIR, Lower Hutt, New Zealand)
NZOI	New Zealand Oceanographic Institute (DSIR, Wellington, New Zealand)
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer (Paris; regional centre in Noumea)
RMRDC	Regional Mineral Resources Development Centre (Bandung, Indonesia)
SPC	South Pacific Commission (Noumea, New Caledonia)
TAG	Technical Advisory Group (of CCOP/SOPAC)
TCDC	Technical co-operation among developing countries
UNDP	United Nations Development Programme (New York, USA)
UNESCO	United Nations Educational, Scientific and Cultural Organization (Paris)
UNEP	United Nations Environment Programme (Nairobi)
USGS	United States Geological Survey (Reston, Virginia, USA)
USP	University of the South Pacific (Suva, Fiji)
WESTPAC	IOC Programme Group for the Western Pacific
WWSSN	World Wide Seismic Station Network

Organisation of the Session

1. The Ninth Session of TAG was held from 20 to 28 October 1980.
2. The TAG agenda was adopted as presented in plenary session.

Review of activities since the Eighth Session

(a) CCOP/SOPAC Technical Secretariat

3. The Project Manager presented a summary of the major activities of the Technical Secretariat from 1 October 1979 to 30 September 1980. TAG commented favourably on the presentation and expressed its gratitude for the support CCOP/SOPAC had received from the United Nations and from supporting Governments and organisations.

(b) ESCAP Secretariat

4. The ESCAP secretariat presented a review of its activities since the eighth session.

Review of survey activities in the CCOP/SOPAC area since the Eighth Session

(a) Activities in the CCOP/SOPAC work programme

Hydrocarbons

5. In Tonga, single-channel seismic reflection profiles across the Tongan forearc north of Vavau revealed a basement reflector beneath at least 1.3 seconds of sediment. South of Tongatapu, across the Tonga Ridge, 1.3 seconds of acoustic penetration was recorded and refraction data, to be published by ORSTOM, showed sediments up to 5 km thick. TAG noted that the latter was one of the more attractive areas for petroleum exploration in Tongan waters.

6. In Vanuatu, a joint CCOP/SOPAC-ORSTOM cruise acquired single-channel seismic lines which have 1.5 to 2.0 seconds of acoustic penetration on some lines. The petroleum consultant proposed that seismic records from the same area held by Gulf and Western Geophysical should be acquired and that onshore geological studies be carried out on potential source rocks. A preliminary assessment of data from the central and northern basins of the Vanuatu group would be attempted by the consultant soon.

7. In the Solomon Islands, a review of available data by the petroleum consultant found that the main Solomon Basin possibly contained suitable reservoir and cap rocks and that structural traps occurred in some areas. More work, particularly refraction surveys, was recommended.

8. In Samoa, preliminary interpretation of single-channel seismic data was difficult because of the steep sea-bed slopes around the islands. The maximum sediment thickness was found to be about 560 m between the two

main islands. It was recommended that the CCOP/SOPAC petroleum geologist should carefully examine the data collected before a final conclusion was reached.

Manganese nodules

9. In Kiribati waters, nodules were found in moderate abundance at three stations south of the Equator and a few fragments at one station north of the Equator. More sampling was suggested on the south-western Line Islands, where CNEXO samples had indicated high Ni/Cu/Co values. In the Phoenix Island group, nodules were found at nine stations having densities as high as 31.6 kg/m² and sea-floor photographs showed coverage as high as 80 percent. Unfortunately, the Ni/Cu/Co content of the nodules was low at all stations, averaging only 0.64 percent.

10. In the Penrhyn Basin of the Cook Islands and Kiribati, nodules were found at 15 stations in generally low abundances, but locally up to 24 kg/m². Data on the nodules indicated that the highest grades (2 percent Ni/Cu/Co) were correlated with extremely low abundances. The deep sea floor around the Cook Islands had been reasonably well sampled and recommendations for further work would depend on the results of a comprehensive review of the Cook Islands nodule data that was presently under way.

11. In Samoa, 32 stations were sampled and no nodules found, but manganese crusts and coatings were obtained from three stations. The Ni/Cu/Co concentration in each was less than 1 percent.

12. A cruise by the West German research vessel *Sonne*, on which the New Zealand Oceanographic Institute participated, was carried out between Tahiti and Wellington in the Southwest Pacific Basin outside national economic zones. Many nodules were collected and fields of nodules have been described in preliminary reports.

13. TAG noted that world-wide studies of manganese crusts on the sea floor had found that crusts rarely, if ever, contained Ni/Cu/Co concentrations of economic value. Any future CCOP/SOPAC efforts to study such crusts would be of little but academic interest, and consequently it suggested that the Committee consider formally eliminating the study of crusts from its work programme.

14. TAG learned that on CCOP/SOPAC cruises spacing of nodule sampling stations was planned at 1° intervals and attempts were made to obtain one grab sample and one bottom photograph at each station and gravity cores at selected stations. Although the procedures were criticised for providing a somewhat inadequate determination of nodule abundance at individual stations, TAG considered that they were satisfactory for the CCOP/SOPAC regional reconnaissance programme.

15. TAG noted with interest that cruise reports supported the thesis that abundance tended to vary

inversely with metal concentration, i.e., where nodules were abundant, metal content was low and where metal concentrations were highest, abundance was low. It further noted that nodule concentrations had been described in reports in poorly defined qualitative terms, and differing quantitative terms e.g., some were based on grab samples (kg/m²) and others on bottom photographs (percentage of bottom covered). TAG noted the desirability of establishing quantitative criteria for these descriptive terms, and particularly of establishing some correlation between data from grab samples and bottom photographs.

Phosphates and phosphorites

16. Cruises on the Tongan Platform and the Samoan Platform and seamounts west and south of Upolu, Samoa, had not encountered sea-bed phosphorites of significant quality for further exploration.

17. A survey in Papua New Guinea waters found no phosphate north of New Ireland but additional studies were recommended in the vicinity of Mussau and Admiralty Islands. Off the western end of Bougainville Island, only low levels of P₂O₅ were found in two dredged samples and no further work was recommended in that particular area.

18. In Fiji waters, a cruise on the Lau Ridge between Ongea Ndriki and Vatoa found no further phosphate in the area, but more dredge sampling was recommended on targets identified from the echo-sounding survey.

19. In Kiribati waters, one dredge station on the side of Vostok Island showed no phosphate, and generally no areas were found that were sufficiently shallow to be currently prospective for phosphate. The shallow areas west of the Phoenix Islands were recommended for examination next.

20. In New Zealand, large samples of phosphorite from the Chatham Rise deposits had been tested with favourable results and a future joint Federal Republic of Germany/New Zealand cruise had been planned to continue the investigation.

21. A New Zealand Oceanographic Institute reconnaissance cruise on r.v. *Tangaroa* to the Tokelau Islands and northern Cook Islands found isolated occurrences of phosphate. The highest values were obtained from seamounts 200 km north-west of Atafu and 125 km north of Pukapuka. A project cruise on r.v. *Machias* in the northern Cook Islands found no unsurveyed seamounts within 200 m of sea level. At the one seamount dredged, south-east of Penrhyn Island, no sample adequate for testing was recovered. Onshore and lagoon samples were collected from Manihiki Island for analysis.

22. TAG was informed of a commercial company's interest in undertaking reconnaissance prospecting for phosphate in the lagoons of the northern Cook Islands, and its current prospecting activities in Fiji. It was

suggested that the Technical Secretariat should undertake reconnaissance drilling at similar localities within the region.

23. TAG noted that it was in the interest of CCOP/SOPAC to encourage carefully constrained commercial activity and cautioned against delaying such private exploration pending the doubtful development of any United Nations project-associated activities. The Australian adviser indicated that BMR would send plans for its light drilling rig to the Technical Secretariat and might consider assisting CCOP/SOPAC to develop a lagoon-drilling project.

Sand and gravel: coastal engineering

24. In Samoa, surveys of Asau and Salelologa harbours, Savaii, had been conducted to obtain up-to-date bathymetric information. In Fiji, a study of the Lami harbour for the relocation of a bulk-petroleum offloading facility had also been carried out.

25. Bulk carbonate sand samples obtained from Rarotonga and Samoa and tested in New Zealand for their suitability as an aggregate in concrete suggest that mix design and control of batching and curing need to be carefully monitored. The United States adviser would undertake to provide to CCOP/SOPAC data accumulated during the Second World War on the properties of concrete made from coral.

26. TAG noted with concern that if current beach mining continued in Tongatapu large sections of the south-eastern and south-western beaches would be depleted of sand. An area north-east of Nuku'alofa had been designated as prospective based on seismic reflection surveying and sediment sampling, and another area to the south of Pangaimotu as less prospective. Environmental studies would need to be undertaken before any mining operation could begin.

Precious coral

27. A comprehensive review of precious coral in the South Pacific revealed that *Corallium* was now known to occur in the northern Cook Islands, Samoa, Solomon Islands, Tonga, and Vanuatu, but not yet in Kiribati. The best commercial grade *Corallium* had been found in the western part of the region. Commercial-grade species were present in Solomon Islands but appeared to decline in size and quality to the east and south-east. Further reconnaissance work was recommended in the Cook Islands, Solomon Islands, and Vanuatu. In addition, detailed follow-up surveys were recommended for specific areas in the Cook Islands, Kiribati, Samoa, Solomon Islands, and Tonga.

28. In Papua New Guinea waters, the Project would continue as requested to dredge for precious coral while engaged in other activities.

Metalliferous sediments

29. Samples taken from six cores collected in Tongan waters in the Lau Basin had been analysed at Imperial College, London.

30. In Papua New Guinea and Solomon Islands waters, sampling of sediments close to possible spreading centres and active volcanic arcs had not found any significant metalliferous concentrations.

(b) Activities of the UNDP project

31. The Government of Tonga was giving serious consideration to the recommendations of a report on a reconnaissance survey into the energy potential and development prospects of wave energy reaching the blow-hole area along the south coast of Tongatapu.

32. With the exception of the cruises described in paragraphs 12 and part of 21, all the investigations and cruises previously described were undertaken, wholly or in part, as an activity of the UNDP-funded Project.

33. The economic potential of onshore clay deposits in the member countries was reviewed by a DSIR consultant provided by New Zealand. He concluded that Fiji and Papua New Guinea had already received detailed reports and had proven deposits, but that further field-work might be justified in Samoa, Solomon Islands, and Vanuatu. The Cook Islands, Kiribati, and Tonga had no clays that could be exploited for brick making or pottery.

(c) Other activities

34. TAG was informed of the USSR Ministry of Geology marine survey activities in the south-west Pacific in 1979-1980 and of further work in the central and south Pacific planned for the period 1981-1986. Results of the past cruises could best be obtained by direct application through official ESCAP channels. TAG recommended that the data obtained by those cruises in the CCOP/SOPAC region should be made available for the CCOP/SOPAC data repository as soon as possible.

35. TAG was pleased to learn of the marine investigations and other projects of the Geological Survey of Japan and of Japanese activities in the field of international co-operation.

36. TAG noted with interest the various Australian, United States, and French activities carried out in the CCOP/SOPAC area during the past year.

Data and information management

37. TAG was pleased to note that a bathymetric draftsman funded by the Australian contribution to ESCAP had been at the Project Office since June 1980 and had started preparing CCOP/SOPAC bathymetric maps.

38. Selected CCOP/SOPAC navigation and bathymetry data had been forwarded to HIG for computer processing.

39. Some of the maps being produced by the BMR Geophysical Marine Section extended into the CCOP/SOPAC area and would be available for purchase from the Australian Government Publishing Service (Production). BMR had provided the project office with a set of geophysical maps compiled from data collected from Papua New Guinea waters during extensive cruises carried out by the Bureau in 1970-1973.

40. TAG noted that the Project Office was in the process of obtaining, through HIG computer facilities, pertinent data taken by United States oceanographic institutions and already had on file about half of the HIG data on the south-west Pacific.

41. It noted with appreciation that NZOI had provided CCOP/SOPAC with all the geophysical track maps that it had compiled for the region; that the USSR adviser had provided CCOP/SOPAC with selected data in computerised form from the three Soviet cruises in the region; that ORSTOM had provided CCOP/SOPAC with the listings of its bathymetric and magnetic data in the region; that, with the approval of member countries, CCOP/SOPAC seismic reflection profiles were stored at the Project Office while microfilm copies were provided to the member countries; and that the Project was in the process of supplying each concerned member country with either a micro-film reader or a reader-printer.

42. TAG was pleased to note that CCOP/SOPAC had made considerable progress in developing a data management system and that CCOP/SOPAC data would be made available to member countries upon request, and to other countries on an exchange basis.

CCOP/SOPAC publications

43. CCOP/SOPAC reports completed since the last session included 19 cruise reports, three consultants' reports, and four technical reports which were, as yet, limited to internal distribution. Publications completed included three issues of the *Newsletter* and three issues of *South Pacific Marine Geological Notes* (with two more issues in preparation). One *Technical Bulletin* was at the proof stage.

44. TAG expressed appreciation and thanks to New Zealand for its efforts and funding which had made possible the publication of the *Proceedings*. The French adviser expressed his gratification that a summary was included and that it had been translated into French; the USSR adviser expressed interest in having the summary printed in Russian in the future.

45. TAG agreed that in future Part 3 of the *Proceedings* (Documentation) should include at least abstracts of all pertinent conference papers unless they were withdrawn by the author and suggested that the list of documents should be cross-indexed with Part 3.

46. TAG recommended that the papers from the joint CCOP/SOPAC-IOC/WESTPAC Second International Workshop on Geology, Mineral Resources and Geophysics in the South Pacific, held at Noumea, should be published. It agreed that certain papers might be omitted because:

- (a) they had been previously published elsewhere;
- (b) they were not appropriate for inclusion;
- (c) the authors wished to delay publication because the research described was not yet completed.

It further suggested that abstracts or, at the very least, titles of technical papers should be included in the *Technical Bulletin* if the entire paper was not available.

Training: programmes and requirements

47. National personnel, including two from Kiribati, two from Samoa, and one from Tonga, were given on-the-job training in nearshore positioning, satellite navigation, seabed sampling, sub-bottom profiling, and seismic profiling, aboard the UNDP Project charter vessel.

48. One trainee each from the Cook Islands and Samoa had participated in a cruise on the Japanese vessel r.v. *Hakurei Maru*.

49. A training course in bathymetric drafting techniques had been started at the Technical Secretariat headquarters at Suva and CCOP/SOPAC member countries had been invited to submit nominations. Two Fijian trainees had begun the course in September 1980 and others were expected to be trained through most of 1981; a tentative training schedule had been submitted to those member countries that had nominated candidates.

50. One Tongan trainee had spent six months at NZOI, participating in two cruises and a short course at Victoria University of Wellington. Tonga is planning to send a student to Victoria University for a full degree programme in geology.

51. A Cook Islands student was currently studying at the University of Otago for B.Sc. degree in geology and had spent three weeks at NZOI during the May vacation. TAG commended such arrangements for students during their vacations.

52. Solomon Islands would send two students to the University of Papua New Guinea to begin degree courses in early 1981.

53. Six nationals from Fiji, two from Samoa, three from Solomon Islands, and one from Vanuatu had attended the four-month "Basic Earth Science" course at Suva, Fiji, from November 1979 to February 1980. The course was sponsored by the Technical Secretariat with UNDP funds in co-operation with the University of the South Pacific (USP) and Victoria University of Wellington. Various member countries had already nominated trainees for the advanced basic earth science course to start in November 1980. The Government of New Zealand was providing funds for the course.

54. TAG noted that the basic course being offered by USP was of great importance and usefulness to the member countries and felt that a long-term programme of such courses should be developed. It recommended that ESCAP should request the Government of New Zealand to consider providing TCDC funds for this high-priority activity, at a level of \$40,000 for each of five years to start in 1981.

55. An advanced earth science course was being planned by USP for early 1981. Participation in the course would be limited to those persons who had successfully completed the basic earth science course.

56. USP had requested information about the projected future scheduling and funding of the earth science courses. It had advised the Technical Secretariat that it could not hold both the basic and the advanced courses concurrently in 1980. However, USP had agreed to hold two separate advanced earth science courses in 1981, with a basic course to be held the following year if required.

57. TAG strongly recommended that USP, in conjunction with Victoria University of Wellington, should be requested to continue to provide basic and advanced earth science courses for the next five years. It instructed the Technical Secretariat to negotiate with USP on the matter of the preparation for and implementation of the courses.

58. The IOC representative advised TAG that IOC would continue to fund trainees for participation in short courses whenever possible. Furthermore, should the advanced course at USP deal almost entirely with marine science, funding for that could be sought from IOC.

59. TAG endorsed the general recommendation of the Noumea Workshop that UNESCO and its IOC, CCOP/SOPAC, and ESCAP should provide immediate training in marine geology, geophysics, and mineral resources, as well as in data handling, to avoid delays in the implementation of the research programme.

60. TAG was pleased to be informed of an invitation by the United States Geological Survey for at least one, and possibly two, CCOP/SOPAC trainees to participate in a marine geological-geophysical cruise in early 1981. The participants should have advanced backgrounds in marine geology and member countries who wished to take advantage of the invitation were to communicate with USGS through the Technical Secretariat.

61. TAG suggested that the training cruise be combined with visits to oceanographic institutions and facilities in southern California and Hawaii, perhaps using a United States Government exchange-scientist position. It recommended that other sources of funding be sought to help to defray the travel expenses of the trainees.

62. TAG was pleased that the USSR had invited trainees to participate in a forthcoming Soviet cruise in the region

and took note of the kind continuing offer by the Geological Survey of Japan to provide training aboard r.v. *Hakurei Maru* and to arrange a group training programme in offshore prospecting. The Japanese adviser said that he would investigate whether it would be possible to waive the daily subsistence fee trainees were obliged to pay while aboard the vessel.

Recent reports on exploration, development and management of mineral, energy and other marine resources relevant to the activities of CCOP/SOPAC

63. In Fiji, two wells had been drilled for hydrocarbons, one in Bligh Water and the other on the Great Sea Reef, to total depths of more than 2700 m each. Although no hydrocarbons had been encountered, paleotemperatures were high enough to have generated hydrocarbons in the Bligh Water area. Additional exploration was anticipated. TAG was pleased to learn that all data acquired before 1978 was on open file at the Mineral Resources Department offices in Suva.

64. In New Zealand, developments in petroleum exploration indicated that the downtrend in exploration had been reversed recently because of more liberal tax conditions and other incentives. TAG noted with interest the plans for a Symposium/Workshop on Petroleum Geology and Geophysics and Exploration to be held at Wellington on 25 and 26 August 1981.

65. In Tonga, an agreement had been reached for the drilling of at least three offshore exploratory wells between Tongatapu and Eua to begin in late 1980 or early 1981.

66. TAG was pleased to learn of recent studies and other information relevant to the activities of CCOP/SOPAC as reported by the technical advisers from Australia, France, Japan, the USSR, and the United Kingdom.

67. The USSR adviser stated, concerning the availability of Soviet satellite imagery in the CCOP/SOPAC region, that satellite trajectories did not cover the south-west Pacific.

68. The United States adviser reported that an index of satellite imagery of the area had been sent to the CCOP/SOPAC Chairman in June 1980. It was suggested that member country representatives should choose images of interest from the index and forward a request to the adviser for black and white copies.

Recent reports on development and management of coastal area resources relevant to the activities of CCOP/SOPAC

69. The Solomon Islands adviser summarised developments affecting the coastal zone in his country that included pollution from sewage disposal in the waters off Honiara and the proposed development of a port and a fish cannery.

70. The Fiji adviser outlined the sedimentological regime of Laucala Bay, near Suva, where mining of carbonate sand from the lagoon area for cement manufacture was causing considerable concern, and he reviewed the environmental and other studies of the area being carried out.

71. The Cook Islands adviser reported on a study of the eastern coast of Rarotonga that had been carried out by an expert from the University of Canterbury, New Zealand.

72. The Workshop on Coastal Area Development and Management, held at Manila in December 1979, had proved most worthwhile. TAG strongly supported the recommendations of the Workshop and particularly urged that member country Governments should give attention to the enactment of coastal zone management legislation.

73. TAG was informed by the alternative United States adviser of a new technique for presenting coastal geologic and environmental elements on a map. It was emphasised that the maps could be rapidly and cheaply constructed from interpretation of air photography and coastal observations by the CCOP/SOPAC member countries and that training of national geologists to carry on such a mapping project could be done in a relatively short time.

Reports on other developments

(a) Law of the sea

74. Information on developments at the Ninth Session of the Third United Nations Conference on the Law of the Sea was presented.

(b) Marine pollution (caused by exploration and development of mineral resources)

75. The IOC programmes for global monitoring of pollution were reviewed.

76. TAG was informed that a Workshop at the East-West Center in Hawaii in July 1980 would prepare a general pamphlet and technical manual to illustrate and explain the potential impact of oil development in the coastal regions of Pacific countries.

77. Fiji's guidelines to control marine pollution were described. These are based largely on regulations recently issued in the United States and on environmental studies carried out by USP in the vicinity of the offshore oil drilling sites in the Bligh Water area.

78. Several members of TAG suggested that spills from tankers might pose a greater hazard than spills from oil-drilling operations, and further suggested that legislation should be passed by each member country to specify the liability for clean-up operations where pollution had resulted from international commerce.

79. Potential pollution problems resulting from near-shore mineral extraction operations were discussed.

80. TAG regretfully noted that the two man-months of consultancy services offered by UNEP at the Eighth Session had not materialised. It strongly recommended that UNEP be asked to support a study on marine pollution which might arise from the exploration and development of mineral resources, particularly construction materials, and possible ship spillage and tanker accidents.

(c) Tsunami warning

81. Although most Pacific countries already had adequate and rapid tsunami warning communication systems, warnings frequently did not arrive in time to notify outlying islands and rural areas. It was suggested that the installation of automated tide gauges in selected areas might provide earlier warnings. Maps of tsunami run-up areas might be useful, although only a limited capability for such work existed in the region, and advisers were asked for help in that matter.

82. TAG endorsed the IOC programme on the improvement of regional tsunami warning systems and requested that it be continued and improved as necessary, and that UNDP consider favourably the IOC request for funds for that purpose.

(d) Seismicity

83. A new telemetered earthquake recording station in Solomon Islands was described. That station and the WWSSN station were suffering to some extent from inadequate maintenance, owing to the absence of a qualified electronics technician.

84. Two seismic recording networks of seven telemetered stations each in Fiji were described, one that was set up through the United States Agency for International Development programme and the other to be established by Japan. It was noted that Fiji would need to hire a full-time electronics technician to maintain its programme.

85. TAG noted that Vanuatu had a joint ORSTOM/Cornell University network of 20 stations and that Samoa had WWSSN- and DSIR-supported instruments at Apia Observatory.

86. Electronics technicians were currently being provided to member countries periodically by supporting Governments. TAG requested the Technical Secretariat explore the possibility that the visits by such technicians be more fully co-ordinated and that their services be provided to other member countries on request during those visits. TAG also encouraged member countries to seek the services of technicians on a TCDC basis when necessary and for long term benefits to have their own nationals trained in electronics maintenance and repair.

87. TAG endorsed the following recommendations of the Noumea Workshop:

- (a) that a telemetered seismic network should be

installed in Tonga, and perhaps be tied into the existing Fiji network to permit more efficient data reduction and to allow regional early warning of potential tsunamis;

(b) that a study should be made of the shallow earthquakes in the Tonga area which had previously been recorded in the disbanded Cornell network, with a view to locating active shallow seismic zones;

(c) that Tongan nationals should be trained as seismograph station operators;

(d) that UNESCO should arrange for a meeting of operators of seismographic networks with interested representatives of island groups in order to discuss (i) the improvement of communication between existing networks and the establishment of a regular exchange of seismographic bulletins, (ii) the exchange of technical information of instrumentation, and (iii) the establishment of new networks in critical areas;

(e) that UNESCO and its IOC should examine and improve, as a matter of priority, the co-ordination and interpretation of the seismic information systems in Vanuatu, Fiji, Samoa, and Tonga, and the tsunami warning communication system in the region.

88. It was noted that, for more detailed hypocentre location by either regional or local networks, seismic velocity modelling was necessary from seismic refraction studies. However, it was pointed out that studies using explosives were limited or hampered by insufficient funds and by the lack of favourable legislation in the member countries.

Relations with other international organisations

89. TAG was informed that the Third Circum-Pacific Energy and Mineral Resources Conference, to be held at Honolulu, Hawaii, in August 1982, would emphasise progress made in the exploration and development of renewable energy resources of the Pacific region. It encouraged all participants of the Ninth Session of CCOP/SOPAC to attend and urged scientists working in the South Pacific region to submit papers to the Conference. CCOP/SOPAC had asked to be a co-sponsor of the Conference.

90. A south-west quadrant panel meeting of the circum-Pacific map project was held under the chairmanship of Mr H. F. Dutch on 17 October. It was anticipated that considerable beneficial co-operation could exist between the map project and CCOP/SOPAC.

91. RMRDC would send experts to visit CCOP/SOPAC next month to identify areas where assistance could be offered.

92. The USSR Academy of Sciences had established the Working Group on Geology, Geophysics and Geochemistry of the Southwestern Pacific within the frame of its Commission for World Ocean Problems. One of the main objectives of the Group was the co-ordination of relevant Academy investigations with CCOP/SOPAC programmes in the region.

93. TAG was advised that the Royal Society of New Zealand has offered to host a WESTPAC meeting, in association with the Pacific Science Congress to be held at Dunedin in February 1983, and, when appropriate, that New Zealand would be prepared to host small workshops on specific WESTPAC projects.

94. The Fiji adviser, who also represented UNESCO/IOC, read a letter from the Deputy Secretary of IOC that expressed IOC's continuing interest in marine geosciences through its Programme Group for the Western Pacific (WESTPAC) and of IOC efforts to obtain financial assistance from UNDP for certain WESTPAC activities.

Consideration of the report and recommendations of the CCOP/SOPAC-IOC Second International Workshop

95. TAG recommended that the summary report of the Noumea Workshop be approved and strongly endorsed its recommendations; it also recommended general endorsement of the proposed research programmes. Comments made on each project and the relevance of each project to the aims of CCOP/SOPAC are given in the following paragraphs 96 to 112. (Descriptions of each project can be found in the Noumea Workshop report, part 4 of these proceedings.)

96. Since part of project A-1 was of specific interest, TAG recommended that work on stratigraphic correlation and on-land shallow drilling might be carried out by member-country geological surveys and the Project Office, and that the remainder of the projects should be accomplished by the Project Office and outside agencies and institutions (e.g., BGR, HIG, LDGO, ORSTOM, USGS, USP, the USSR Academy of Sciences, and agencies of Japan).

97. TAG suggested, as project A-2 was considered to be of only general interest, that it should be brought to the attention of outside agencies, particularly the University of Sydney.

98. It agreed that project A-3 was of specific interest, in particular the seismic hazards aspect of the study, and recommended that it should be adopted as part of the Committee's work programme. However, considerable assistance from outside agencies and institutions would be required (e.g., from BMR, Cornell University, the University of Tokyo's Earthquake Research Institute, HIG, ORSTOM, the University of Texas, and the USSR Academy of Sciences). It suggested that ORSTOM should consider the possibility of establishing seismic stations on Wallis and Futuna islands.

99. TAG recognised that parts of project A-4 were of specific interest, in particular the onshore geological mapping of the New Georgia Islands and the heat-flow study of the Central Solomons Trough. It strongly endorsed those parts of the project and noted with interest that the study of that significant tectonic region entailed a

proposed co-operative work programme involving both the Solomon Islands Geological Survey and the Lamont-Doherty Geological Observatory. Other parts of the project would be of interest to other outside agencies and institutions (e.g., the Australian National University, Cornell University, and the University of Texas). It also suggested that the Royal Australian Air Force and Project Magnet of the United States Naval Oceanographic Office might be approached to carry out an aeromagnetic survey of the Woodlark Basin.

100. TAG agreed that parts of project A-5 were of specific interest, notably those dealing with seismic studies, hazards, and training. It recommended that those studies should be directed to outside agencies, institutions and intergovernmental bodies (e.g., Cornell University, DSIR of New Zealand, Japanese and United States aid agencies, ORSTOM, SPC, UNESCO/IOC, and UNDP). It also recognised other geological and geophysical investigations which related to hydrocarbons and basin genesis as being of specific interest. It recommended that those studies should also be directed to outside agencies (e.g., AMSTAC/COGS, Cornell University, NZOI, ORSTOM, University of Texas, University of Tokyo, and the USSR Academy of Sciences). It also suggested that the part concerned with the identification of changes in subaerial and submarine geomorphology of forearc regions should be brought to the attention of COGS as a priority project during its deliberation of IPOD drilling in the region.

101. It agreed that project B-1 was of general interest only as there was little relevance to offshore prospecting. It recommended that outside research agencies and institutions should be encouraged to participate.

102. TAG considered project B-2, with a few exceptions, to be of only general interest. It agreed that the few parts of specific interest were adequately provided for under other Workshop projects and that most should be directed to outside research agencies and institutions.

103. It considered most of project B-3 to be of only general interest. TAG recognised that the volcanicity and geothermal aspects, including hazards and back-arc sea-floor metallogenesis, were of specific interest.

104. TAG agreed that project C-1.1 was of general interest only and would be best directed to outside agencies, notably NZOI and those of Japan.

105. It recognised that project C-1.2 was of general interest only and should be directed to outside agencies such as BMR and the University of Auckland.

106. TAG agreed that project C-1.3 was of particular interest, especially in relation to the evaluation of hydrocarbon potential. It recommended that, although some work would be accomplished initially by the Project Office, most should be directed to outside agencies, including BMR, NZOI, the Universities of Auckland and Sydney, and the USSR Academy of Sciences.

107. TAG agreed that the carbonate sediments subproject of project C-1.4 was of immediate interest in relation to hydrocarbon exploration and investigations for coral sand and aggregate. It would best be directed to outside agencies, including NZOI, NZGS, and the universities of Auckland and Waikato in New Zealand and of Sydney and of other places in Australia. TAG agreed that both of the subprojects, volcanic sediments and abyssal sedimentation of project C-1.4, were of general interest only and that work should be directed to institutions such as NZGS, the University of Auckland, and NZOI.

108. TAG agreed that project C-2.1 was of direct interest despite the poor long-term prospects of working ocean-bed metalliferous sediments. While noting that some sampling would be carried out on CCOP/SOPAC cruises, the main thrust would need the capacity of outside agencies such as the Australian Hydrographic Department, the United States National Ocean Survey, the USSR Academy of Sciences, and Imperial College, London (for analytical work).

109. It noted that project C-2.2 was of immediate interest in view of the potential importance of manganese nodules to the region. Continued sampling by CCOP/SOPAC in selected areas would contribute to the project, but TAG agreed that research cruises to collect more sophisticated data would be needed from outside agencies such as NZOI, those of Japan and the USSR, and with analytical assistance, possibly from Imperial College.

110. TAG agreed that project C-2.3 was essentially a laboratory study and of less immediate interest. It recommended that that work should be directed to outside institutions such as HIG.

111. It agreed that project C-3.1 was of direct interest in relation to the search for phosphate deposits. TAG noted that part of that study would be accomplished through CCOP/SOPAC cruises and other work should be directed to outside agencies such as NZOI.

112. TAG agreed that project C-3.2 was not of immediate interest, although it was strongly supported as an essential basis for many of the geological studies taking place in the area. It recommended that the work should be directed to outside agencies, including particularly the USSR Academy of Sciences.

113. The adviser from France advised that he would try to stimulate interest by CNEXO, ORSTOM and the French universities in all the projects, especially those that TAG considered to be of high priority.

114. The advisers from New Zealand and the United States strongly endorsed the proposed sedimentary basins study, including source rock analysis, as it was likely to have considerable economic importance for member countries.

115. TAG noted that Soviet scientists' proposals for five-year studies in the south-western Pacific relevant to many projects recommended by the Workshop.

116. Concerning the Workshop recommendation to establish a South Pacific Information Centre in which all published and unpublished material could be centralised, with a specialised library, TAG recommended that the Technical Secretariat should hold discussions with ORSTOM and other organisations in the region to determine, by the time of the next WESTPAC meeting, the feasibility of and requirements for setting up such a Centre and its potential site.

117. TAG noted regretfully that the recommendation made at the Eighth Session concerning provision for participation of Soviet scientists in the Workshop was not followed up by the organising committee. In connection with national regulations and practices, it noted that it was essential to follow established governmental channels to facilitate approval when invitations were sent to scientists, particularly in the USSR and Japan, to attend meetings.

118. Being aware and concerned that budgetary constraints affecting the funding of scientific research in many of the TAG countries might hinder the implementation of the programme adopted at the Workshop, TAG urged that technical advisers from countries with institutions connected with programmes in the region should impress upon their Governments the need to maintain, and where appropriate enhance, their participation in scientific research under the aegis of CCOP/SOPAC.

Formulation of the work programme

(a) CCOP/SOPAC

119. In the Cook Islands, priority A was assigned to phosphate, precious coral, coastal engineering and bathymetry; and priority B to Mn nodules. Research work on clay deposits was requested. TAG was pleased to hear that the r.v. *Ravakai* could be used during 1981, on a cost-reimbursable basis, for work in the waters of the Cook Islands or adjacent nations.

120. The Fiji work programme was revised. Priority A was assigned to hydrocarbon assessment, nearshore terrigenous sedimentation, metalliferous minerals, and nearshore engineering studies. Long-term importance was attached to a reconnaissance survey programme for metalliferous sediments associated with spreading centres and other volcanic activity, and to reconnaissance survey for phosphate. A new programme of precious coral surveying was proposed. It was emphasised that, although Fiji had some offshore geological survey capacity which could be used in shallow water, it could not recruit the technical personnel to support a programme of reflection seismic survey. The lack of shallow water coring or drilling equipment was also identified as an operational problem.

121. TAG endorsed a new Fiji project on the extent and quality of deep-sea Mn nodules. Field studies were

dependent on the successful outcome of a compilation of existing data. Difficulties had been encountered in obtaining basic data and the United States adviser had offered to help to obtain data for that and related studies on nodules in the region.

122. TAG endorsed a lagoon survey project, CCSP/KI.4, for Kiribati, noting the serious erosion and pollution problems on Tarawa.

123. New Zealand proposed no new projects. TAG was informed of the two cruises planned for r.v. *Tangaroa* during 1981, one to the Lau Basin and Tonga-Kermadec Ridge and the other to the Cook Islands. TAG was pleased to hear that New Zealand would continue to lend assistance through the Project Office to CCOP/SOPAC at about the same level as in recent years.

124. TAG endorsed a new 1981-1986 work programme for Samoa that gave priority A to harbour sedimentation, dredging and wharf excavations, a site study for a sewer outfall and sand and coral surveys for construction materials; and priority B to environmental impact studies, wave-energy site studies, a bathymetric survey for placement of fish aggregation devices, precious coral surveys, and clay studies. Projects CCSP/WS.1, 2 and 6 were regarded as mostly complete; CCSP/WS.4 and 5 were continuing.

125. TAG endorsed three new projects, CCSP/SI.16-18, for Solomon Islands. Priority A was assigned to investigation of detrital heavy minerals in selected beach and offshore areas around Santa Isabel Island, inshore studies related to coastal development and the investigation of the suitability of local materials for the manufacture of ceramics.

126. It endorsed new and expanded projects within the Tongan work programme. Project CCSP/TG.6 was expanded to incorporate an inventory of beach sands on 'Eua, Ha'apai and Vavau, to complete the Nuku'alofa lagoon surveys and to carry out mining feasibility and preliminary environmental impact studies. One new project, CCSP/TG.7, deals with power generation from wave energy at the Nuku'alofa blow-holes.

127. TAG endorsed a new project for Vanuatu, CCSP/VA.5, to investigate the suitability of clay deposits for the manufacture of pottery, bricks, or tiles on Efate, Santo, Epi and other islands. The remainder of the work programme was unchanged.

128. TAG endorsed the new format listing of regional projects 1 through 23 with the understanding that previous regional projects might be closed or combined with new projects.

129. It also endorsed the new regional project 24, a tectonic analysis of the south-west Pacific, and regional project 25, the CCOP/SOPAC geophysical atlas of the south-west Pacific, although it was realised that the latter

was a very complex and ambitious undertaking. The USSR adviser suggested that Soviet scientists might be able to assist in the compilation of such an atlas and the United States adviser suggested that exchange of data with the Circum-Pacific Map Project might be of assistance.

130. The Solomon Islands representative was optimistic that the Solomon Islands Cartographic Department would be able to print the non-bathymetric maps prepared for the geophysical atlas, but could not commit the Department. In any case, the cost of materials could not be borne by Solomon Islands.

131. TAG noted with interest the increasing importance and number of projects either planned or proposed concerning studies of harbours, ocean energy, precious corals, and the marine environment, for which detailed bathymetric mapping was essential. Recognising the lack of expertise and facilities in individual member countries required for the compilation and preparation of bathymetric maps, it strongly recommended that those tasks should continue to be carried out by the Technical Secretariat and, if possible, expanded in the future.

132. TAG endorsed a statement by the Cook Islands adviser that stressed the critical nature of the energy problems of member countries and suggested an increased involvement of the project office in the field of energy, such as observations at sea of surface and deep water temperatures, temperature gradients, wave-energy studies, and solar radiation measurements.

133. It recommended that the terms of reference of CCOP/SOPAC should be expanded to encompass onshore geoscience activities that would be related to project objectives and marine and geoscientific aspects of the search for and development of alternative energy sources.

134. It also noted that several member countries had proposed new clay studies and recommended that a strong request should be forwarded to the New Zealand Government for continuation of the services of the DSIR clay consultant on a part-time and non-reimbursable basis. The involvement of other outside agencies was not precluded.

135. It noted that several proposed projects required, and would greatly benefit by, the availability of light drilling equipment. It recommended that a feasibility study should be carried out on existing light drilling equipment for use in shallow waters and that appropriate equipment should then be acquired and used by the Project Office.

136. TAG endorsed a proposal for a CCOP/SOPAC-sponsored Workshop on Inshore and Nearshore Resources to be held at Suva, Fiji, in mid 1981. The aim of the Workshop would be to focus attention of problems being confronted by project staff, particularly those concerning coastal area development, beach and nearshore processes, detrital mineral deposits, and precious corals.

137. Regarding the matter of studies of the petroleum source-rock potential of the region, TAG noted with appreciation:

- (a) that the Australian BMR might be willing to assess the significance of any source-rock analyses obtained from the region;
- (b) that USGS might be able to carry out hydrocarbon maturation studies which are of great importance to an understanding of the energy potential;
- (c) that the Geological Survey of Japan might be able to undertake laboratory studies of source-rock potential as a research project. TAG requested the Technical Secretariat to pursue actively all offers of assistance with source-rock studies.

138. The USSR adviser informed TAG of an offer for a two-month co-operative cruise with CCOP/SOPAC and the UNDP Project in the south-west Pacific in late 1981 as part of a five-year research effort in the region.

139. The member countries thanked the USSR adviser for the generous offer. CCOP/SOPAC was pleased to accept the proposal subject to the clear identification of the areas in which the co-operative scientific work was to be undertaken, and provided the permission of the Governments of those countries in whose waters the work was to be done was obtained before the commencement of the programme. The offer was particularly welcome since it not only would provide on-board training for nationals from the region, at no cost, but would also include participation of the Project scientists. Member countries requested that one of the Project scientists be joint Chief Scientist during the cruise in CCOP/SOPAC waters.

140. In relationship to this offer from the USSR adviser, the current areas of interest to CCOP/SOPAC identified, in order of priority, were:

- (a) the Melanesian Borderland;
- (b) the North Fiji Basin;
- (c) the South Fiji Basin.

The Melanesian Borderland had been assigned first priority, as it had been recommended as a high priority project, both in the 1975 Suva Workshop and in the 1980 Noumea Workshop.

141. TAG endorsed the statement of the member countries, welcomed the generous Soviet offer, and proposed that the Technical Secretariat should establish a working group to plan the cruise. It strongly recommended implementation of the cruise in the first priority area and hoped that the approval of the Governments concerned would be quickly forthcoming. It noted that an appropriate agreement between the USSR and ESCAP should be drawn up by March 1981 that would clearly define the work area, the conditions of work, and the duration of the co-operative cruise.

(b) UNDP Project

142. The representative of the UNDP South Pacific Regional Office reviewed the three major points affecting

future UNDP input to the project.

(a) Availability of UNDP funds. The UNDP/ESCAP review mission had concluded that further UNDP assistance was warranted for 1982-1984 and recommended a budget of \$US3.5 million. It also suggested that provision should be made for a review in 1984 to determine the need for, and the level of, any further UNDP assistance. However, the actual amount of funds eventually available to the Project would be determined by the countries themselves at an intergovernmental planning meeting to be held at Apia in November 1980.

(b) Legal status of CCOP/SOPAC. UNDP was concerned that CCOP/SOPAC, as currently constituted, was not in a position to implement its mandate fully, particularly as it pertained to the functioning of the Technical Secretariat. Accordingly, it urged Governments to take the necessary decisions concerning the legal status of the Committee as well as the funding of its Secretariat. In the meantime, UNDP would be agreeable to continuing the status quo.

(c) Short-term objectives of UNDP assistance. UNDP was concerned that the Project should focus on those activities which will have an impact, in the short term, on the development of recipient countries.

143. TAG endorsed the UNDP project work programme for 1980-1981, which was divided into offshore, nearshore, and onshore activities, and precious corals. It noted that the project was seeking from advisory countries the services of an electronics technician for one month, an editor for 12 months, and, if the terms of reference of CCOP/SOPAC were expanded, an energy expert for at least six months.

144. It endorsed the proposal for a second cruise on r.v. *Geovan* involving co-operation between CCOP/SOPAC, ORSTOM, and possibly a United States university in 1981. The cruise would be in Vanuatu and Solomon Islands waters and would support the Noumea Workshop project A-5.

145. TAG endorsed the UNDP Project work programme for the period 1982-1984 which was divided into offshore, nearshore, inshore, and training activities. Regarding the proposed six-month UNDP vessel charter in 1982, it suggested that the cruise include three months on hydrocarbons and three months on other work.

(c) Funding

146. TAG noted that the approximate cost of the CCOP/SOPAC total work programme (see Part 2 of these proceedings) for the period 1982-1986 was \$US22.6 million, of which \$11.4 million represented activities which would be carried out by other institutions. The activities of the CCOP/SOPAC work programme eligible for UNDP funding for 1982-1986 totalled about \$6.6 million, for which the UNDP review mission had recommended funding at a level of \$3.5 million for the period 1982-1984.

147. The representatives of UNDP and ESCAP provided information on the funding of other natural resource projects in the region as recommended by the sector reviews for the next UNDP cycle. The funding recommendations might be further modified by inter-country programming exercises. However, the final decision on funding would be made at intergovernmental meetings in each region and at the overall Asia/Pacific intergovernmental meeting scheduled for February 1981.

148. TAG endorsed the recommendation of the 1980 UNDP Review Mission report that funding of CCOP/SOPAC activities should be provided at the level of \$3.5 million for the period 1982-1984. It noted that the figure represented 15 percent of the input required for the CCOP/SOPAC work programme for the period 1982-1986. TAG regretted that the Review Mission had not recommended funding for the full five-year funding cycle. It further requested the Technical Secretariat to seek additional funding from international organisations, including UNDP or bilateral donors, as might be needed to implement the work programme and enter into agreements for the continuation of the offshore reconnaissance activities.

149. TAG recommended that the Technical Secretariat should be authorised to seek funding and enter into agreements for the establishment of a professional training programme leading to Bachelor's and/or Master's degrees for nationals from the region.

150. The technical advisers from Australia, France, Japan, the USSR, the United Kingdom, and the United States, having considered the CCOP/SOPAC work programme and taken into account the report of the UNDP natural resources sector review mission, submitted the following comments.

(a) They reiterated that one of the main functions of CCOP/SOPAC should continue to be the accomplishment of offshore surveys for minerals at a reconnaissance level throughout the region in order to attract the attention of industry for the benefit of the member countries. Such mineral surveys should be mostly directed to manganese nodules on the ocean bottom in the north and east of the region, to metalliferous sediments on marginal sea floors in the west of the region, and to hydro-carbons in the areas of the island arcs, mainly in the north-west of the region.

(b) They emphasised that the level of regional reconnaissance data was still far from complete for a preliminary inventory and that, by the end of 1982, there would still be some member countries who lacked adequate and definite indicators of the mineral resource potential of their exclusive economic zone.

(c) They pointed out that major economic benefits from offshore minerals would probably come only from the development of hydrocarbons or, in the longer term, of manganese nodule accumulations. While nearshore and inshore developments of minerals such as sand and gravel were of immediate local interest to some member countries, large-scale economic benefits would not accrue from such operations. The same might be said of the exploitation of precious coral beds.

(d) They agreed with the mission report that the results obtained so far on the commercial prospects for manganese nodules in the region were not optimistic. They emphasised, however, that for some areas, such as Kiribati, that this conclusion was based on very sparse survey data and more work was needed to cover those areas even at the first reconnaissance sample spacing of about 100 km (1° latitude). They strongly urged therefore that funds should be made available for the continuation of that work, in addition to the work on hydrocarbons recommended by the mission.

(e) They considered that there was a significant omission from the mission report relating to surveys from submerged phosphate (guano) accumulations in shallow lagoons and for nearshore detrital minerals. They should be included in the programme for nearshore and inshore studies as they could be of significant and immediate interest to some member countries.

(f) They recommended strongly that the level of support for the UNDP project in 1982-1984 should not fall below the recommended minimum level of \$3.5 million and that additional financial provision should be sought so that the emphasis on hydrocarbon studies should not be implemented to the serious detriment of continued reconnaissance surveys for manganese nodules and other mineral deposits where those were deemed to be necessary.

151. TAG expressed its appreciation for the support received from donor countries over the period since the Eighth Session, particularly from the governments of Fiji, Australia, New Zealand, France, and Japan and to UNDP and ESCAP for their contributions, and looked forward to a continued association with them in the future.

Summary of conclusions and recommendations

152. The Technical Advisory Group:

1. noted that it was in the interest of CCOP/SOPAC to encourage carefully constrained commercial activity (para. 23);
2. recommended that the data obtained by cruises in the CCOP/SOPAC region should be made available for the CCOP/SOPAC data repository as soon as possible (para. 34);
3. recommended that the papers from the joint Second International Workshop should be published (para. 46);
4. recommended that ESCAP should request the Government of New Zealand to consider providing TCDC funds for a long-term programme of basic earth science courses at a level of \$40,000 for each of five years to start in 1981 (para. 54);
5. strongly recommended that USP, in conjunction with Victoria University of Wellington, should be requested to continue to provide basic and advanced earth science courses for the next five years (para. 57);
6. endorsed the general recommendation of the Noumea Workshop related to training (para. 59);

7. recommended that other sources of funds should be sought to help to defray the travel expenses of trainees (para. 61);
8. strongly supported the recommendations of the Manila Workshop and particularly urged that member country Governments give attention to the enactment of coastal zone management legislation (para. 72);
9. strongly recommended that UNEP be asked for support for the study and report on marine pollution (para. 80);
10. endorsed the IOC programme on the improvement of regional tsunami warning systems (para. 82);
11. endorsed the recommendations of the Noumea Workshop related to seismicity studies (para. 87);
12. recommended that the summary report of the Noumea Workshop should be approved, strongly endorsed the recommendations, and recommended general endorsement of the proposed research programmes (paras. 95-112);
13. recommended that the Technical Secretariat should hold discussions with ORSTOM and other concerned organisations to determine the feasibility of and requirements for setting up a South Pacific Information Centre and its potential site (para. 116);
14. urged that technical advisers from countries with institutions connected with programmes in the region should impress upon their Governments the need to maintain, and where appropriate enhance, their participation in scientific research under the aegis of CCOP/SOPAC (para. 118);
15. strongly recommended that the tasks concerning compilation and preparation of bathymetric maps should continue to be carried out by the Technical Secretariat and, if possible, be expanded in the future (para. 131);
16. recommended that the terms of reference of CCOP/SOPAC should be expanded to encompass onshore geoscience activities (para. 133);
17. recommended that a strong request should be forwarded to the New Zealand Government for continuation of the services of the DSIR clay consultant, on a part-time and non-reimbursable basis (para. 134);
18. recommended that a feasibility study should be carried out on existing light drilling equipment for use in shallow waters (para. 135);
19. endorsed a proposal for a CCOP/SOPAC-sponsored Workshop on Inshore and Nearshore Resources, to be held at Suva, Fiji, in mid 1981 (para. 136);
20. strongly recommended implementation of the USSR cruise in the area established to have first priority and hoped that approval of the Governments concerned would be quickly forthcoming (para. 141);
21. endorsed the UNDP Project work programme for 1980/1981 (para. 143);
22. endorsed the proposal for a second cruise on r.v. *Geovan* involving co-operation between CCOP/SOPAC, ORSTOM, and possibly a United States university in 1981 (para. 144);
23. endorsed the UNDP project work programme for the period 1982-1984 (para. 145);
24. endorsed the recommendation of the report of the UNDP Review Mission that funding of CCOP/SOPAC activities should be provided at the level of \$US3.5 million for the period 1982-1984 and recommended that the Technical Secretariat seek additional funding (para. 148);
25. recommended that the Technical Secretariat should be authorised to seek funding and enter into agreements for the establishment of a professional training programme (para. 149);
26. the technical advisers from Australia, France, Japan, USSR, the United Kingdom and the United States, having considered the CCOP/SOPAC work programme, made a series of recommendations (see para. 150).

ANNEX II

LIST OF DOCUMENTS

Document No.	Title	Para. No. in Part I, Report of TAG	Section/ Paper No. in Part III Documentation
NR/CCOP/SOPAC(9)/1	Observations of the Commission at its Thirty-sixth session relevant to the programme of the Committee - ESCAP Secretariat	4	A.1
NR/CCOP/SOPAC(9)/CR.1	Report on the training activity on board the r.v. <i>Machias</i> - T. Kitekei'aho	47	C.6
NR/CCOP/SOPAC(9)/CR.2	Report on marine training and survey activities on board r.v. <i>Machias</i> November 1979 - January 1980 - F.G.H. Malele, S.C.B. Saifaleupolu	47	C.8
NR/CCOP/SOPAC(9)/CR.3	Report on training in marine geology on board r.v. <i>Hakarei Maru</i> - A.T. Utanga	48	C.10
NR/CCOP/SOPAC(9)/CR.4	Report on Basic Earth Science course from November 1979 - February 1980 - W. Harrison	53	C.-
NR/CCOP/SOPAC(9)/CR.5	The origin of channel-fill sands and gravels on an algal-dominated reef terrace, Rarotonga, Cook Islands - K.B. Lewis et al.	43	I.-
NR/CCOP/SOPAC(9)/CR.6	Areal distribution of marine sediment mercury in the region around Fiji - M.E. Cox	43	I.-
NR/CCOP/SOPAC(9)/CR.7	Cruise report. Tonga offshore survey, 14 January - 4 February 1980 - A.J. Halunen	5, 16, 29	G.32
NR/CCOP/SOPAC(9)/CR.8	Cruise report. Lami Harbour survey, 12 - 17 December 1979 - A.J. Halunen	24	G.15
NR/CCOP/SOPAC(9)/CR.9	Cruise KI-80(3). Addendum to Appendix I, results of nodule analysis - N.F. Exon	9	G.20
NR/CCOP/SOPAC(9)/CR.10	Excerpts from the report of the workshop on coastal area development and management, Manila, Philippines, 3 - 12 December 1979 - ESCAP Secretariat	72	B.4
NR/CCOP/SOPAC(9)/CR.11	Cruise CK-80(2). Addendum to Appendix I, results of nodule analysis - N.F. Exon	10	G.13

NR/CCOP/SOPAC (9)/CR.12	Cruise KI-80(2). Addendum to Appendix I, results of phosphate analysis - N.F. Exon	19	G.19
NR/CCOP/SOPAC (9)/CR.13	Report of activities of the Technical Secretariat of CCOP/SOPAC, 1 October 1979 through 30 September 1980 - CCOP/SOPAC Technical Secretariat	3	A.3
NR/CCOP/SOPAC (9)/CR.14	Report on training activity - cruises KI-80(1) and KI-80(2), CCOP/SOPAC project - B. Raobati	47	C.9
NR/CCOP/SOPAC (9)/CR.15	Cruise report. Kiribati Line Islands nodule survey, 1 - 20 May 1980 - K.B. Lewis	9	G.20
NR/CCOP/SOPAC (9)/CR.16	Cruise report. Vanuatu offshore geophysical survey, 25 July - 26 August 1980 - N.F. Exon	6	G.36
NR/CCOP/SOPAC (9)/CR.17	Cruise report. Samoa offshore survey, 6 - 24 December 1979 - G.A. Gauss	11, 16	G.25
NR/CCOP/SOPAC (9)/CR.18	Cruise report. Papua New Guinea offshore survey, 10 - 26 March 1979 - J.V. Eade	17, 30	G.22
NR/CCOP/SOPAC (9)/CR.19	Cruise report. Samoa offshore survey 24 - 28 November 1979 - G.A. Gauss	24	G.23
NR/CCOP/SOPAC (9)/CR.20	Cruise report. Fiji offshore survey, 28 October - 1 November 1978 - J.V. Eade	18	G.14
NR/CCOP/SOPAC (9)/CR.21	Cruise report. Cook Islands offshore survey, 21 March - 7 April 1980 - G.A. Gauss and D.L.E. Moreton	10	G.12
NR/CCOP/SOPAC (9)/CR.22	Training programme in Solomon Islands - F.I. Coulson	52, 53	C.5
NR/CCOP/SOPAC (9)/CR.23	Seismic monitoring in Solomon Islands - F.I. Coulson	83	G.29
NR/CCOP/SOPAC (9)/CR.24	Training activities at N.Z. Oceanographic Institute during 1979/80 - J.V. Eade and K.B. Lewis	50, 51	C.-
NR/CCOP/SOPAC (9)/CR.25	Review of activities since the Eighth Session of ESCAP Secretariat - ESCAP Secretariat	4	A.2
NR/CCOP/SOPAC (9)/CR.26	Status of petroleum exploration in Fiji - R.N. Richmond	63	G.17
NR/CCOP/SOPAC (9)/CR.27	Summary CCOP/SOPAC work programme for Samoa (1981 - 1986) - Samoa delegation	124	H.-

NR/CCOP/SOPAC (9)/CR.28	Preliminary information on the programme of geological-geophysical investigation in CCOP/SOPAC area by Soviet r.v. <i>Calisto</i> at the end of 1981 - USSR delegation	138-141	H.-
NR/CCOP/SOPAC (9)/CR.29	Some results of survey activities by the Ministry of Geology of the USSR in the Southwest Pacific in 1979/1980 - USSR delegation	34	G.41
NR/CCOP/SOPAC (9)/CR.30	Marine investigations of the Geological Survey of Japan, 1980 - Geological Survey of Japan	35	F.-
NR/CCOP/SOPAC (9)/CR.31	Phosphorite on seamounts and submarine ridges in the Southwest Pacific - D.J. Cullen	21	G.38
NR/CCOP/SOPAC (9)/CR.32	Evaluation of South Pacific aggregates for concrete making and other purposes - New Zealand delegation	25	G.40
NR/CCOP/SOPAC (9)/CR.33	New Zealand's activities in the CCOP/SOPAC work programme - J.V. Eade	12, 20	G.-
NR/CCOP/SOPAC (9)/CR.34	The New Zealand underway data file - K.B. Lewis	41	D.-
NR/CCOP/SOPAC (9)/CR.35	Proceedings of the Eighth Session of CCOP/SOPAC - J.V. Eade (comp.)	44, 45	I.-
NR/CCOP/SOPAC (9)/CR.36	Cruise report. Nuku'alofa lagoon survey, Tongatapu, Kingdom of Tonga, 1 - 20 September 1980 - G.A. Gauss	26	G.33
NR/CCOP/SOPAC (9)/CR.37	Newsletter, Project office, UNDP Offshore Mineral Prospecting in the South Pacific - CCOP/SOPAC Technical Secretariat	43	I.-
NR/CCOP/SOPAC (9)/CR.38	Report on short term consultancy for project petroleum assessment, New Hebrides - H.R. Katz	6	G.38
NR/CCOP/SOPAC (9)/CR.39	Cretaceous-Cenozoic sedimentary basins of New Zealand - H.R. Katz	-	I.-
NR/CCOP/SOPAC (9)/CR.40	Cruise report. Northern Cook Islands offshore survey, 16 - 28 April 1980 - K.B. Lewis	10	G.13
NR/CCOP/SOPAC (9)/CR.41	Cruise report. Solomon Islands offshore survey, 10 October - 25 November 1979 - J.V. Eade	27	G.28
NR/CCOP/SOPAC (9)/CR.42	Cruise report. Kiribati offshore survey, 9 - 25 February 1980 - G.A. Gauss	9	G.18

NR/CCOP/SOPAC(9)/CR.43	Cruise report. Samoa offshore survey, 8 - 13 January 1980 - A.J. Halunen	27	G.26
NR/CCOP/SOPAC(9)/CR.44	Cruise report. Tonga offshore survey, 1 - 17 November 1979 - G.A. Gauss	5	G.31
NR/CCOP/SOPAC(9)/CR.45	Petroleum developments in New Zealand - H.R. Katz	64	G.21
NR/CCOP/SOPAC(9)/CR.46	Cruise report. Southern Line Islands survey, 29 February - 17 March 1980 - A.J. Halunen	9	G.19
NR/CCOP/SOPAC(9)/CR.47	The results of a reconnaissance survey into the energy potential and develop- ment prospects of wave energy reaching the blow holes area along the south coast of Tongatapu, Kingdom of Tonga - CCOP/SOPAC Technical Secretariat	31	G.35
NR/CCOP/SOPAC(9)/CR.48	Economic potential of clay deposits in selected South Pacific countries - G.G.C. Claridge	33	G.37
NR/CCOP/SOPAC(9)/CR.49	Main principles of geological mapping of shelves zones in the USSR - USSR delegation	-	F.-
NR/CCOP/SOPAC(9)/CR.50	Soviet sample data submitted to the CCOP/SOPAC repository - USSR delegation	41	D.-
NR/CCOP/SOPAC(9)/CR.51	Basin development in the Solomon Islands and their petroleum potential - H.R. Katz	-	I.-
NR/CCOP/SOPAC(9)/CR.52	Soviet scientists proposals for main trends in geological-geophysical and geochemical research of the Southwest Pacific in 1981-1985 - USSR delegation	34	H.44
NR/CCOP/SOPAC(9)/CR.53	Review of precious coral in CCOP/SOPAC member countries - J.V. Eade	27, 28	G.39
NR/CCOP/SOPAC(9)/CR.54	Cruise report. Solomon Islands / Papua New Guinea offshore survey, 26 February - 8 March 1979 - J.V. Eade	30	G.27
NR/CCOP/SOPAC(9)/CR.55	Report on the Tonga sand inventory, 22 - 28 November 1979 - G.A. Gauss	26	G.30
NR/CCOP/SOPAC(9)/CR.56	Cruise report. Samoa offshore survey, 24 November, 3 - 6 December 1979 - G.A. Gauss	8	G.24
NR/CCOP/SOPAC(9)/CR.57	Oil exploration in the Kingdom of Tonga, 1980 - S.L. Tongilava	65	G.34

NR/CCOP/SOPAC(9)/CR.58	Training report, r.v. <i>Machias</i> 1980 - T.K. Tarau	47	C.-
NR/CCOP/SOPAC(9)/CR.59	Third United Nations conference on the Law of the Sea, Resumed Ninth Session, Geneva, 28 July - 29 August U.N. Information Service	74	B.-
NR/CCOP/SOPAC(9)/CR.60	Excerpts from the report on the seabed mineral resource development : recent activities of the international con- sortia - ESCAP Secretariat	66	E.11
NR/CCOP/SOPAC(9)/CR.61	Report on deep-sea mineral prospecting and oceanographical investigations in- service training, February - March 1980 - F.G.H. Malele	48	C.7
NR/CCOP/SOPAC(9)/CR.62	Excerpts of the UNDP Mineral Resources Sector Review Mission Report, July 1980 - ESCAP Secretariat	148, 150	A.-
NR/CCOP/SOPAC(9)/CR.63	Report of the Second International Work- shop on Geology, Mineral Resources and Geophysics of the South Pacific - CCOP/SOPAC Technical Secretariat	95-118	B.-
NR/CCOP/SOPAC(9)/CR.64	Coastal area development in Solomon Islands - F.I. Coulson	125	H.42
NR/CCOP/SOPAC(9)/CR.65	Proposed <i>Geovan II</i> cruise to Vanuatu and Solomon Islands (1981) - CCOP/SOPAC Technical Secretariat	144	H.-
NR/CCOP/SOPAC(9)/CR.66	Work programme. Fiji (new proposal) - Fiji delegation	121	H.-
NR/CCOP/SOPAC(9)/CR.67	Proposed agenda for the Tripartite Project Review - Project RAS/79/074 Investigation of Mineral Potential of the South Pacific - ESCAP Secretariat	(Report of Committee, para. 19)	A.-
NR/CCOP/SOPAC(9)/CR.68	Tonga work programme (new projects) 1980/1981 - Tonga delegation	126	H.-
NR/CCOP/SOPAC(9)/CR.69	Inshore and nearshore resources work- shop - New Zealand delegation	136	H.-
NR/CCOP/SOPAC(9)/CR.70	Petroleum source-rock potential - CCOP/SOPAC Technical Secretariat	137	H.43
NR/CCOP/SOPAC(9)/CR.71	Formulation of the work programme - regional projects - CCOP/SOPAC Technical Secretariat	128, 129	H.-
NR/CCOP/SOPAC(9)/CR.72	Nearshore zone survey in Tarawa lagoon for landfill/construction materials, sedimentation-erosion problems and pollution dispersal - Kiribati delegation	122	H.-

NR/CCOP/SOPAC(9)/CR.73	Diamond drilling results from a barrier reef adjacent to Suva - R. Holmes	70	G.16
NR/CCOP/SOPAC(9)/CR.74	Matters affecting future UNDP inputs to CCOP/SOPAC - UNDP Regional Programme Adviser	142	A.-

ANNEX III

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Part 2: WORK PROGRAMME

Summary for 1979-1980

The CCOP/SOPAC Work Programme consists of elements, each element identifying a particular target in one country. The work programme is defined on Element Data Sheets which are kept on file at the CCOP/SOPAC Technical Secretariat. Changes to this programme and advances made on individual elements are given below under the following headings.

- (a) *Proposal, Revision, Status:* identifying those TAG sessions at which these were made; details of element proposals and element revisions are given as follows -
- (i) Background Information
 - (ii) Element Objectives
 - (iii) Economic Target
 - (iv) Relationship of Element to Mineral Development Policy
 - (v) References

The current status of elements is given as follows -

Initiated
Deferred
Deleted
Completed

- (b) *Recommendations:* and suggestions for future work to be used as a basis for planning.
- (c) *Planning:* list of plans made for field work and other activities to be carried out in next 12 months.
- (d) *Work Completed:* field work and other activities being carried out or completed.
- (e) *Reports:* unpublished documents.
- (f) *Publications:* published papers.
- (g) *Final Recommendations:* recommendations made on completion of the element.
- (h) *Application of Results*

The categories of priorities used are: "A" - very important, early performance desirable; "B" - scientifically and economically important.

COOK ISLANDS

CCSP/CK.1: Sea-bed investigations for manganese nodules in oceanic areas adjoining Cook Islands (Priority B).

- (a) *Proposal:* see Proc. 2nd Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 3rd Session.
- (b) *Recommendations:* further work justified only in Penrhyn Basin.
- (d) *Work Completed:* *Machias* cruise CK-80(1): nodules from 15 stations in Penrhyn Basin; *Machias* cruise CK-80(2): nodules from 1 station in Penrhyn Basin.
- (e) *Reports:* GAUSS, G.A.; MORETON, D.L.E. Cruise Report 41, Cook Islands Offshore Survey, 21 March - 7 April 1980.
LEWIS, K.B. Cruise Report 42, Northern Cook Islands Offshore Survey, 16-28 April 1980.
- (f) *Publications:* EXON, N.F., 1981: Manganese nodules in the Cook Islands region, Southwest Pacific. *S. Pacif. mar. geol. Notes* 2(4) : 47-65.

CCSP/CK.2: Distribution and economic potential of submarine phosphate deposits in Cook Islands waters (Priority A).

- (a) *Proposal:* see Proc. 4th Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 5th Session.
- (b) *Recommendations:* further Tech. Sec. work awaits results of *Tangaroa* cruise NZOI-1113; initiation of lagoon drilling programme to be considered depending on availability of suitable equipment.
- (d) *Work Completed:* *Machias* cruise CK-80(1): no phosphate from one sampling station on a seamount SE of Penrhyn; *Machias* cruise CK-80(2): no seamounts found worth dredging for phosphate; *Tangaroa* cruise NZOI-1113: isolated phosphatic material found on seamounts in northern Cooks.
- (e) *Reports:* GAUSS, G.A.; MORETON, D.L.E. Cruise Report 41, Cook Islands Offshore Survey, 21 March - 7 April 1980.
LEWIS, K.B. Cruise Report 42, Northern Cook Islands Offshore Survey, 16-28 April 1980.
CULLEN, D.J. 1980: Phosphorite on seamounts and submarine ridges in the Southwest Pacific. *NR/CCOP/SOPAC* (9)/CR.31.

CCSP/CK.3: Investigation for precious coral in the near-shore waters surrounding the Cook Islands (Priority A).

(a) *Proposal*: see Proc. 5th Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 6th Session.

(b) *Recommendations*: further work is justified in northern Cook Islands.

(d) *Work Completed*: *Machias* cruise CK-80(1): dredging off Penrhyn, Manihiki, and Nassau, *Corallium* from Manihiki; *Machias* cruise CK-80(2): dredging off Pukapuka, Rakahanga, Manihiki, and Penrhyn, *Corallium* from Pukapuka and Penrhyn; review made of all precious coral data available to CCOP/SOPAC.

(e) *Reports*: GAUSS, G.A.; MORETON, D.L.E. Cruise Report 41, Cook Islands Offshore Survey, 21 March - 7 April 1980. LEWIS, K.B. Cruise Report 42, Northern Cook Islands Offshore Survey, 16-28 April 1980. EADE, J.V. 1980: Review of precious coral in CCOP/SOPAC member countries. CCOP/SOPAC Tech. Rep. 8.

CCSP/CK.4: Study of sediments and sedimentary processes of beach, lagoon, and adjacent offshore areas of Rarotonga and other islands to assist with coastal management programmes (Priority A).

(a) *Proposal*: see Proc. 6th Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.

(c) *Planning*: foundation and environmental studies to be carried out for sewage outfall planned for Avarua Harbour, Rarotonga.

(f) *Publications*: LEWIS, K.B.; UTANGA, A.T.; HILL, P.J.; KINGAN, S.G. 1980: The origin of channel-fill sands and gravels on an algal-dominated reef terrace, Rarotonga, Cook Islands. *S. Pacif. mar. geol. Notes* 2(1) : 1-23.

CCSP/CK.5: Bathymetric mapping of the Cook Islands (Priority A).

(a) *Proposal*: see Proc. 7th Session.

Status: initiated, see this report.

(d) *Work Completed*: bathymetric map of Rarotonga.

(f) *Publications*: UTANGA, A.T.; LEWIS, K.B. 1981: Rarotonga Nearshore Bathymetry, 1:20,000. *N.Z. oceanogr. Inst. Chart, Misc. Ser. 56* (being also CCOP/SOPAC Misc. Ser. Chart 1:20,000).

CCSP/CK.6: Investigation of suitability of clay deposits for the manufacture of pottery, bricks, or tiles (Priority A).

(a) *Proposal*: see Proc. 8th Session.

Status: initiated, see this report.

(b) *Recommendations*: search for pottery clay justified, although there are no large ceramic clay deposits.

(d) *Work Completed*: desk study of clay deposits in CCOP/SOPAC countries.

(e) *Reports*: CLARIDGE, G.G.C. 1980: Economic potential of clay deposits in selected South Pacific countries. CCOP/SOPAC Tech. Rep. 9.

FJI

CCSP/FJ.1: Assessment of hydrocarbon potential in northwest Fiji about Bligh Water (Priority A).

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.

CCSP/FJ.2: Review of shallow penetration seismic data in relinquished offshore concessions for detrital heavy minerals (Completed, see Proc. 8th Session).

CCSP/FJ.3: Re-evaluation of seismic and other data available on relinquished petroleum concessions west of the Yasawa Group (Deleted, and transferred to FJ.1, see Proc. 7th Session).

CCSP/FJ.4: Offshore geological mapping of the shallow shelves surrounding Bligh Water (Priority B).

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 6th Session.

(d) *Work Completed*: sediment sampling and echo sounding surveys in Bligh Water, around Yasawa Islands, and along the NW coast of Viti Levu completed during January - March 1979.

CCSP/FJ.5: Sea-bed sampling for phosphorites in the Lau Group (Priority B).

- (a) *Proposal*: see Proc. 1st Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 6th Session.

(b) *Recommendations*: further work justified by *Tangaroa* cruise NZOI-1113 and CCOP/SOPAC FJ-78(1) cruise results.

(c) *Planning*: *Machias* cruise FJ-80(1) to Lau Ridge is planned for November 1980.

(e) *Reports*: EADE, J.V. 1980: Cruise Report 39, Fiji Offshore Survey, 28 October - 1 November 1978.

CCSP/FJ.6: Nearshore surveys of coastal areas, beach to reef (Priority A).

- (a) *Proposal*: see Proc. 2nd Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 4th Session.

CCSP/FJ.7: Bathymetric gravity and magnetic surveys in selected areas (Completed, see Proc. 8th Session).

CCSP/FJ.8: Interpretation of regional aeromagnetic data (Completed, see Proc. 8th Session).

CCSP/FJ.9: Seismic refraction survey, Viti Levu and Vanua Levu (Priority B).

- (a) *Proposal*: see Proc. 2nd Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 7th Session.

CCSP/FJ.10: Bathymetry and bottom sampling Kandavu Passage, south and south-west of Suva (Completed, see Proc. 8th Session).

CCSP/FJ.11: Marine geological and geophysical investigation of the northern margin of the Fiji Platform (Priority A).

- (a) *Proposal*: see Proc. 3rd Session
Revision: see Proc. 7th Session
Status: initiated, see Proc. 5th Session.

CCSP/FJ.12: Marine geological and geophysical investigations southwards of Suva,

between 175°E and 179°W longitude and parallels 18°S and 20°S (Priority A).

- (a) *Proposal*: see Proc. 3rd Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 5th Session.

CCSP/FJ.13: Marine geological and geophysical surveys south and south-west of Viti Levu (Deleted, and transferred to FJ.12, see Proc. 7th Session).

CCSP/FJ.14: Interpretation of detailed aeromagnetic data (Priority B).

- (a) *Proposal*: see Proc. 6th Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 7th Session.

CCSP/FJ.15: Relocation of selected points throughout the Fiji Group by multiple pass satellite fixes (Priority A).

- (a) *Proposal*: see Proc. 6th Session
Revision: see Proc. 7th Session
Status: initiated, see Proc. 7th Session.

CCSP/FJ.16: Geochemical and associated geological investigations of the seafloor spreading axes of the Fiji Plateau west and north of Fiji (Priority A).

- (a) *Proposal*: see Proc. 6th Session.
Revision: see Proc. 7th Session.
Status: initiated, see below.
- (f) *Publications*: COX, M.E. 1980: Areal distribution of marine sediment mercury in the region around Fiji. *S. Pacif. mar. geol. Notes* 1(10) : 111-22.

CCSP/FJ.17: Characterisation of the extent and quality of deep-sea manganese nodules (Priority B).

- (a) *Proposal*: (new element)
- (i) BACKGROUND INFORMATION. Deep-water polymetallic nodules are reported from the sea floor near Fiji (Rawson and Ryan, 1978). The prospects of finding economic fields of nodules in Fiji waters are very remote. However, some nodules may occur in the Pacific Basin north of Rotuma and in the northern part of the South Fiji Basin where more sampling is required to establish details of nodule distribution and mineral content.

(ii) PROJECT OBJECTIVES. To find the extent, quantity, and grade of manganese nodules in the Fiji economic zone deep water basins.

(iii) ECONOMIC TARGET. To establish nodule density and quality (metal content, especially Cu, Co, and Ni).

(v) REFERENCES.

RAWSON, M.D.; RYAN, O.B.F. 1978: Ocean floor sediment and polymetallic nodules; map at 1:23,230,300 scale. Lamont-Doherty Geological Observatory, Columbia University, Palisades, New York.

- (b) *Recommendations*: compilation of existing nodule data, especially that shown on the Rawson and Ryan map.
- (c) *Planning*: existing data to be examined during 1981.

KIRIBATI

CCSP/KI.1: Assessment of possibilities for occurrence of offshore phosphate deposits in the Kiribati region (Priority A).

- (a) *Proposal*: see Proc. 4th Session.
Revision: see Proc. 7th Session.
Status: initiated, see below.
- (b) *Recommendations*: cruise to sample banks west of Phoenix Island; assessment of commercial exploration results.
- (d) *Work Completed*: *Machias* cruise KI-80(1): no areas suitable for phosphate found in Phoenix Group; *Machias* cruise KI-80(2): non-phosphatic coralline fragments dredged from Vostock Island.
- (e) *Reports*: GAUSS, G.A. Cruise Report 37, Kiribati Offshore Survey, 9-25 February 1980.
HALUNEN, A.J. Cruise Report 36, Southern Line Islands Survey, 29 February - 17 March 1980.

CCSP/KI.2: Investigation of the occurrence of manganese nodules/crusts in the Kiribati region (Priority B).

- (a) *Proposal*: see Proc. 4th Session.
Revision: see Proc. 7th Session.
Status: initiated, see below.
- (b) *Recommendations*: further work in Gilbert Islands and Phoenix Group, also in Line Islands where several high grade samples have been collected.

(c) *Planning*: nodule sampling in 1981 on *Machias* field programme 1980-81 leg 10 in southern Gilberts; nodule sampling in 1981 on *Machias* leg 12 in western Phoenix Group.

- (d) *Work Completed*: *Machias* cruise KI-80(1): nodules from 9 of 16 stations in Phoenix Islands - high densities but very low grades; *Machias* cruise KI-80(2): no nodules from 10 stations in southern Line Islands; *Machias* cruise KI-80(3): nodules from 4 of 9 stations east of Line Islands.
- (e) *Reports*: GAUSS, G.A. Cruise Report 37, Kiribati Offshore Survey, 9-25 February 1980.
HALUNEN, A.J. Cruise Report 36, Southern Line Islands Survey, 29 February - 17 March 1980.
LEWIS, K.B. Cruise Report 43, Kiribati Line Islands Nodule Survey, 1-20 May 1980.

CCSP/KI.3: Investigation for precious coral in the nearshore waters surrounding the Kiribati Islands (Priority A).

- (a) *Proposal*: see Proc. 5th Session.
Revision: see Proc. 7th Session.
Status: initiated, see below.
- (b) *Recommendations*: future work to concentrate in Gilbert Islands.
- (d) *Work Completed*: *Machias* cruise KI-80(1): no precious corals from four stations at Phoenix and Sydney Islands; *Machias* cruise KI-80(2): no potential precious coral sites found in S. Line Islands; review of precious coral potential of CCOP/SOPAC region recommended more work in Gilbert Islands.
- (e) *Reports*: GAUSS, G.A. Cruise Report 37, Kiribati Offshore Survey, 9-25 February 1980.
HALUNEN, A.J. Cruise Report 36, Southern Line Islands Survey, 29 February - 17 March 1980.
EADE, J.V. 1980: Review of precious coral in CCOP/SOPAC member countries. CCOP/SOPAC Tech. Rep. 8.

CCSP/KI.4: Nearshore zone surveys in Tarawa and elsewhere in Kiribati for landfill/construction materials, sedimentation-erosion problems, and pollution dispersal (Priority A)

- (a) *Proposal*: (new element)
- (i) BACKGROUND INFORMATION. The high population density on Tarawa has led to

several problems in the nearshore lagoon region. Causeways have been built, and are continuing to be built, for economic reasons, to link islets together. These causeways block flow in and out of the lagoon, diminish the lagoon flushing rate, and alter the sediment transport regime. The recent cholera epidemic with numerous fatalities emphasised the importance of lagoon circulation for dispersal of human waste. Certain fish species may use specific channels during part of their life cycles, and their ability to adapt to channel blockage is not known. Construction materials are continually required for building the causeways, as well as for other construction jobs.

(ii) PROJECT OBJECTIVES. To determine the pattern of coastal sediment movement, nearshore currents, wave and tide action, lagoon circulation, water quality studies, and budget of sand and other marine construction materials.

(iii) ECONOMIC TARGET. Controlled development and proper management of the nearshore zone in the islands of Kiribati, especially near centres of population.

(v) REFERENCES. Reports on: Drilling survey in Tarawa lagoon for Betio/Bairiki causeway construction material; Impact of human activity on Tarawa lagoon.

(b) Recommendations: initial studies of: Tarawa lagoon for fill/construction material; water circulation in relation to pollution problems and beach areas where erosion is apparent.

(c) Planning: initial studies in Tarawa to commence in 1981.

NEW ZEALAND

CCSP/NZ.1: Morphologic, sedimentary, and structural features of the New Zealand shelf and slope (Priority A).

(a) Proposal: see Proc. 2nd Session.

(b) Planning: cruises are planned for Hauraki Gulf in November 1980 and Bay of Plenty October - November 1980.

(d) Work Completed: studies on the following continue: morphology of North Cape - Three Kings area (at NZOI); sediments and sub-bottom structure of Hauraki Gulf (at University of Auckland); sediments of Cook Strait (at NZOI); morphology and sediments at Otago shelf and slope (NZOI and University of Otago).

(f) Publications:

CARTER, L. 1980: New Zealand Region Bathymetry, 1:6,000,000 (2nd edition). *N.Z. oceanogr. Inst. Chart, Misc. Ser.* 15.

CARTER, L.; EADE, J.V. 1980: New Zealand Region Physiography, 1:4,000,000. *N.Z. oceanogr. Inst. Chart, Misc. Ser.* 51.

HERZER, R.H. 1979: Submarine slides and submarine canyons on the continental slope off Canterbury, New Zealand. *N.Z. Jl Geol. Geophys.* 22(3) : 391-406.

CCSP/NZ.2. Studies of the southern termination of the Tonga - Kermadec Trench (Priority A).

(a) Proposal: see Proc. 2nd Session.

(c) Planning: early 1980, two cruises on r.v. *Tangaroa* are planned to collect more sub-bottom profiling data and outcrop samples off the East Coast, North Island.

(d) Work Completed: work has continued on areas off East Coast, North Island (at NZOI and NZGS) and Conway Trough off East Coast, South Island (at NZOI).

(f) Publications:

CARTER, L.; CARTER, R.M.; GRIGGS, G.B. (in prep.): Conway Trough: a deep marine basin at the junction of the Alpine transform and Hikurangi subduction plate boundary, New Zealand.

COLE, J.W.; LEWIS, K.B. 1981: Evolution of the Taupo - Hikurangi subduction system. *Tectonophysics* 72 : 1-21.

KATZ, H.R.; WOOD, R.A. 1980: Submerged margin east of the North Island, New Zealand, and its petroleum potential. *CCOP/SOPAC Tech. Bull.* 3 : 221-35.

KATZ, H.R. (in press): Plate margin transition from oceanic arc-trench to continental system. *Tectonophysics*.

CCSP/NZ.3. Tectonic history and structure of sedimentary basins offshore from New Zealand (Priority A).

(a) Proposal: see Proc. 3rd Session.

(c) Planning: work on all basin areas in the South Island except Clutha will be completed by the Basin Studies Group and reports be in manuscript form by the end of 1981.

- (d) *Work Completed:* the Basin Studies Group, N.Z. Geological Survey, has continued to synthesise data on open file from the following areas: West Coast (work completed, report in preparation); Great South Basin (work continuing, on land field work two-thirds complete); Chatham Rise (work continuing, two stratigraphic wells completed at western end of land); Western Southland (work started).

Work is continuing at NZOI on morphology and structure of Northland Plateau and associated basins Whangaroa, Knights, and Barrier, and at Geophysics Division and University of Auckland a study of Raukumara Plain and other basin areas off the Bay of Plenty.

CCSP/NZ.4: Study of mafic sands on the western shelf (Priority B).

- (a) *Proposal:* see Proc. 6th Session.

- (f) *Publications:*

CARTER, L. 1980: Ironsand in continental shelf sediments off western New Zealand - a synopsis. *N.Z. Jl Geol. Geophys.* 23 : 455-68.

CCSP/NZ.5: Survey of nearshore detrital sands and gravels (Priority B).

- (a) *Proposal:* see Proc. 6th Session.

- (d) *Work Completed:* bulk sand samples from Solosolo Beach, Apia Harbour, and off Mulinu have been collected and are being tested for their suitability as an aggregate in concrete by the N.Z. Concrete Research Association.

CCSP/NZ.6: Investigation of phosphorite and glauconite deposits on the Chatham Rise (Priority A).

- (a) *Proposal:* see Proc. 6th Session.

- (c) *Planning:* a two-month cruise by r.v. *Sonne* is planned for early 1981. This joint FRG/NZ cruise will carry out bulk sampling, sub-bottom profiling, underwater photography, and possibly vibrator operations.

- (d) *Work Completed:* large samples were collected by r.v. *Valdivia* at the end of 1978. Analyses of these samples are complete and a report is in preparation; direct application to pasture tests are

continuing at Massey University and large sample testing has been initiated by the Ministry of Agriculture and Fisheries; commercial interest in the Chatham Rise phosphorite has led to an application for a prospecting licence.

CCSP/NZ.7: Distribution of gold in shelf sediments (Priority B).

- (a) *Proposal:* see Proc. 6th Session.

- (c) *Planning:* the possibility of exploring for gold and other precious metals off the West Coast, South Island, is being investigated by a private company.

PAPUA NEW GUINEA

CCSP/PN.1: Regional reconnaissance geological mapping, particularly of the outlying islands (Priority B).

- (a) *Proposal:* see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.

CCSP/PN.2: Preliminary appraisal of detrital heavy minerals in coastal and nearshore areas, and reconnaissance sampling of potentially favourable areas (Priority B).

- (a) *Proposal:* see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.

CCSP/PN.3: Crustal study of eastern Papua New Guinea (Priority A).

- (a) *Proposal:* see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 3rd Session.

CCSP/PN.4: Inshore and nearshore surveys related to harbour development and coastal management (Priority A).

- (a) *Proposal:* see Proc. 4th Session.

Revision: see Proc. 7th Session.

CCSP/PN.5: An evaluation of the hydrocarbon potential of offshore areas in Papua New Guinea from existing data (Priority A).

- (a) *Proposal:* see Proc. 7th Session.

Status: initiated, see below.

- (c) *Planning*: petroleum geologist to spend two months during 1981 to examine and catalogue data with the aid of Geological Survey staff and to make an initial assessment of the areas which appear most prospective.

CCSP/PN.6: An investigation into the hydrocarbon potential of offshore areas of the Cape Vogel Basin (Priority A).

- (a) *Proposal*: see Proc. 7th Session.

CCSP/PN.7: An investigation into the hydrocarbon potential of the New Ireland Basin (Priority A).

- (a) *Proposal*: see Proc. 7th Session.

Status: initiated, see below.

- (b) *Recommendations*: CCOP/SOPAC single-channel seismic survey to be combined with existing data in petroleum assessment.

- (c) *Planning*: *Machias* field programme 1980-81 legs 7, 8, and 9 will cover basin from SW of Bougainville to Manus Island, and record about 2500 nautical miles of seismic and magnetic data.

CCSP/PN.8: To explore for and evaluate the potential of possible metalliferous sediments in basins where there is known high heat flow or nearby volcanic activity (Priority B).

- (a) *Proposal*: see Proc. 7th Session.

Status: initiated, see Proc. 8th Session.

- (d) *Work Completed*: *Machias* cruise PN-79(1): samples from Manus and south New Ireland Basin have no significant metalliferous enrichment.

- (e) *Reports*: EADE, J.V. Cruise Report 25, Papua New Guinea Offshore Survey, 10-26 March 1979.

CCSP/PN.9: An evaluation of the potential for submarine phosphate deposits in northern Papua New Guinea (Priority B).

- (a) *Proposal*: see Proc. 7th Session.

Status: initiated, see Proc. 8th Session.

- (b) *Recommendations*: further sampling recommended especially near the Admiralty Islands.

- (c) *Planning*: *Machias* field programme 1980-81 leg 8 will sample for phosphate south of Manus Island.

- (d) *Work Completed*: *Machias* cruise PN-79(1): no phosphate accumulations found north of New Ireland.

- (e) *Reports*: EADE, J.V. Cruise Report 25, Papua New Guinea Offshore Survey, 10-26 March 1979.

CCSP/PN.10: An evaluation of manganese nodule deposits north of the West Melanesian Trench (Priority B).

- (a) *Proposal*: see Proc. 7th Session.

- (b) *Recommendations*: work to be done only on an "as the opportunity arises" basis.

CCSP/PN.11: Bathymetric mapping of the sea floor of Papua New Guinea (Priority A).

- (a) *Proposal*: see Proc. 7th Session.

CCSP/PN.12: An assessment of the potential of deep-water precious corals (especially *Corallium*) in Papua New Guinea (Priority B).

- (a) *Proposal*: see Proc. 7th Session.

Status: initiated, see Proc. 8th Session.

- (d) *Work Completed*: *Machias* cruise SI-79(2): phosphate dredging recovered deepwater corals off Bougainville but no *Corallium*; review of precious coral potential of CCOP/SOPAC region.

- (e) *Reports*: EADE, J.V. Cruise Report 24, Solomon Islands/Papua New Guinea Offshore Survey, 26 February - 8 March 1979. EADE, J.V. Review of precious coral in CCOP/SOPAC member countries. CCOP/SOPAC Tech. Rep. 8.

SAMOA

CCSP/WS.1: Assessment of possibilities of sea-bed phosphorites on the slopes of the Samoa Platform and seamounts northwest of Savai'i and south of Upolu (Priority B).

- (a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 5th Session.

- (b) *Recommendations*: further planning to await results of *Tangaroa* cruise NZOI-1113.

(d) *Work Completed:* *Machias* cruise WS-79(1): three dredge hauls of carbonate rocks were non-phosphatic; *Tangaroa* cruise NZOI-1113: seamounts were dredged for phosphate with negative results.

(e) *Reports:* GAUSS, G.A. Cruise Report 35, Samoa Offshore Survey, 6-24 December 1979.
CULLEN, D.J. 1980: Phosphorite on seamounts and submarine ridges in the Southwest Pacific. *NR/CCOP/SOPAC* (9)/CR.31.

CCSP/WS.2: Sea-bed investigation for manganese deposits on the Samoa Platform and in Samoan oceanic areas (Priority B).

(a) *Proposal:* see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 5th Session.

(b) *Recommendations:* future work should be done only on an "as the opportunity arises" basis.

(d) *Work Completed:* *Machias* cruise WS-79(1): thirty-two deep-water stations south of Samoa yielded no Mn nodules. All field work considered completed.

(e) *Reports:* GAUSS, G.A. Cruise Report 35, Samoa Offshore Survey, 6-24 December 1979.

CCSP/WS.3: Reconnaissance survey for possible manganese deposits on the western Samoa Platform and offshore areas (Deleted and transferred to WS.2, see Proc. 8th Session).

CCSP/WS.4: Investigation of the deeper flanks of the island slope for precious coral (Priority B).

(a) *Proposal:* see Proc. 5th Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 6th Session.

(b) *Recommendations:* further sampling of promising areas NW of Savai'i and SE of Upolu.

(c) *Planning:* plans are being made to survey promising precious coral areas off the western side of Savai'i, off Falealupo, off the eastern side of Upolu, near Aleipata.

(d) *Work Completed:* *Machias* cruise WS-79(1): at two stations south and east of Upolu

no *Corallium* was recovered; *Machias* cruise WS-80(1): *Corallium* recovered from NW of Savai'i and SE of Upolu; review of precious coral potential in CCOP/SOPAC region includes an assessment for Samoa.

(e) *Reports:* GAUSS, G.A. Cruise Report 35, Samoa Offshore Survey, 6-24 December 1979.

HALUNEN, A.J. Cruise Report 40, Samoa Offshore Survey, 8-13 January 1980.

EADE, J.V. 1980: Review of precious coral in CCOP/SOPAC member countries. *CCOP/SOPAC Tech. Rep. 8*.

CCSP/WS.5: Coastal zone management surveys for landfill, construction materials, and harbour construction (Priority A).

(a) *Proposal:* see Proc. 6th Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.

(c) *Planning:* plans to survey undesirable siltation in Apia Harbour for an excavation site adjacent to Aleipata wharf are being given first priority. Second priority programmes include a sand, coral, and environmental survey in the Asau channel area; the evaluation of construction sands in Vaiusu Bay; a Vaiusu Bay pre-construction environmental survey; and a sewage outfall route and environmental survey at Apia Harbour. Other planned projects include an offshore survey of the non-carbonate sands in the Solosolo area; offshore survey of coral sands in the Mulinuu area; surveys of wave energy sites on Upolu and Savai'i; assistance with the emplacement and monitoring of fisheries aggregation devices.

CCSP/WS.6: Crustal seismic survey of sediment thickness and basement structure of Samoan Platform, to determine the hydrocarbon potential (Priority B).

(a) *Proposal:* see Proc. 7th Session.

Status: initiated, see below.

(c) *Planning:* data collected in 1979 to be examined late 1980.

(d) *Work Completed:* 470 nautical miles of single-channel seismic reflection data collected around Upolu and Savai'i.

(e) *Reports:* GAUSS, G.A. Cruise Report 34, Samoa Offshore Survey, 24 November, 3-6 December 1979.

SOLOMON ISLANDS

CCSP/SI.1: Coastal survey, Choiseul to Santa Isabel Islands (Priority B).

- (a) *Proposal*: see Proc. 1st Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see Proc. 2nd Session.

CCSP/SI.2: Transverse seismic profiling of the Solomon Basin (the 'Slot' area) (Priority A).

- (a) *Proposal*: see Proc. 1st Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see Proc. 8th Session.

- (b) *Recommendations*: no more single-channel seismic reflection profiling required; planning proceed with refraction studies.

(f) *Publications*:

KATZ, H.R. 1980: Basin development in the Solomon Islands, their petroleum potential and prospects for exploration. Pp 59-76 in Symposium on "Petroleum Potential in Island Arcs, Small Ocean Basins, Submerged Margins and Related Areas". CCOP/SOPAC Tech. Bull. 3.

CCSP/SI.3: Bathymetry, geophysical profiling and bottom sampling in the Solomon Sea (Deleted, and transferred to REG.1, see Proc. 4th Session, then to REG.2, see Proc. 8th Session).

CCSP/SI.4: Investigation of shallow submerged plateaus in Manning Strait and south-west of Choiseul Island for bauxite deposits (Priority B).

- (a) *Proposal*: see Proc. 3rd Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see Proc. 5th Session.

- (b) *Recommendations*: high resolution boomer survey of plateau areas, followed by air-lift sampling if results of boomer survey are favourable.

CCSP/SI.5: Investigations of detrital gold in beach and nearshore areas of central north Guadalcanal (Priority B).

- (a) *Proposal*: see Proc. 4th Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see Proc. 5th Session.

- (b) *Recommendations*: high resolution boomer profiling, bulk sampling of surface samples, and possibly drilling for gold, in Tetere Bay.

CCSP/SI.6: Investigation of the phosphate potential of submerged seamounts and current swept ridges (Priority B).

- (a) *Proposal*: see Proc. 4th Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see below.

- (c) *Planning*: survey planned for January 1981 on *Machias* field programme 1980-81, leg 5.

CCSP/SI.7: Investigation into the discharges from submarine volcanoes in the Solomon Islands (Priority B).

- (a) *Proposal*: see Proc. 4th Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see below.
- (c) *Planning*: survey planned for January 1981 on *Machias* field programme 1980-81, leg 5.

CCSP/SI.8: Investigation into metal dispersion in marine sediments around Vella Lavella and in other nearby areas (Priority B).

- (a) *Proposal*: see Proc. 4th Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see Proc. 8th Session.
- (c) *Planning*: survey planned for January 1981 on *Machias* field programme 1980-81, leg 5.
- (d) *Work Completed*: *Machias* cruise SI-79(2): 22 sediment samples from New Georgia region revealed no metal concentrations.
- (e) *Reports*: EADE, J.V. Cruise Report 24, Solomon Islands / Papua New Guinea Off-shore Survey, 29 February - 8 March 1979.

CCSP/SI.9: Search for bauxite sediments inside Indispensable Reefs and in Lake Te Nggano, Rennell Island (Priority B).

- (a) *Proposal*: see Proc. 5th Session.
- Revision*: see Proc. 7th Session.
- Status*: initiated, see Proc. 6th Session.

- (b) *Recommendations*: no further field work is required.

CCSP/SI.10: Evaluation of hydrocarbon potential in Solomon Islands offshore areas (Priority A).

- (a) *Proposal*: see Proc. 6th Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 7th Session.

- (b) *Recommendations*: study of existing data to recommend priority areas for further survey work; geophysical surveys of Manning Strait, Rennell Arc, and Santa Cruz Groups; sampling programme for source rock studies.

- (c) *Planning*: petroleum geologist to study existing data in early 1981; *Machias* field programme 1980-81, leg 6 is a geophysical cruise over Rennell Arc; USGS may support source rock drilling and analytical programme in 1981; Japan may support analytical programme of source rock study; ORSTOM and SOPAC may jointly carry out reflection profiling in Santa Cruz Group and refraction survey in Slot in 1981.

CCSP/SI.11: Bathymetry and geophysical profiling and bottom sampling in Manning Strait (Priority A).

- (a) *Proposal*: see Proc. 6th Session.
Revision: see Proc. 7th Session.
Status: deleted, and transferred to SI.10.

CCSP/SI.12: Surveys of deep-sea areas south of the Solomon Islands to investigate the possible occurrence of manganese nodules (Priority B).

- (a) *Proposal*: see Proc. 6th Session.
Revision: see Proc. 7th Session, see below.
Status: initiated, see below.

(i) **BACKGROUND INFORMATION**. The title is changed above to reflect more accurately the objectives of this element and the area to be studied.

- (c) *Planning*: survey southwest of Santa Cruz Islands, planned for January 1981 on *Machias* field programme 1980-81, leg 4.

CCSP/SI.13: Survey of the Rennell Arc to establish hydrocarbon potential (Priority B).

- (a) *Proposal*: see Proc. 6th Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 8th Session. Deleted, and transferred to SI.10.

CCSP/SI.14: The potential of precious corals, especially *Corallium* species, in the Solomon Islands (Priority A).

- (a) *Proposal*: see Proc. 7th Session.
Status: initiated, see Proc. 8th Session.

- (c) *Planning*: survey of Santa Cruz Islands planned for January 1981 on *Machias* field programme 1980-81, leg 4; a six-week follow-up survey of Indispensable Strait planned for late 1981.

- (d) *Work Completed*: survey on m.v. *Komalialae* examined 28 sites between Vella Lavella and Makiri islands discovering *Corallium* at 8 sites. Most promising area is Indispensable Strait where *Corallium* was found in 11 dredge hauls at 6 sites; review of precious coral potential in CCOP/SOPAC region includes an assessment for Solomon Islands.

- (e) *Reports*: EADE, J.V. Cruise Report 38, Solomon Islands Offshore Survey, 10 October - 25 November 1970.
EADE, J.V. 1980: Review of precious coral in CCOP/SOPAC member countries.
CCOP/SOPAC Tech. Rep. 8.

CCSP/SI.15: Bathymetric mapping of Solomon Islands (Priority A).

- (a) *Proposal*: see Proc. 7th Session.
Status: initiated, see below.
(d) *Work Completed*: compilation of Hydra data has started and two maps at scale 1:100,000 are completed.

CCSP/SI.16: Investigation of detrital heavy minerals in selected beach and near-shore areas around Santa Isabel Island (Priority A).

- (a) *Proposal*: (new element)
(i) **BACKGROUND INFORMATION**. Although no systematic mapping programme has yet

been made of Santa Isabel Island, preliminary information suggests that detrital minerals may be concentrated in beaches or immediately offshore, especially where beaches near major rivers are not protected from wave action by reefs.

(ii) ELEMENT OBJECTIVES. To identify beaches and nearshore areas around Santa Isabel Island where detrital heavy minerals have been concentrated; to survey, sample, and analyse sediments from these areas and so establish size, content, and grade of deposits found; to evaluate the economic potential of these deposits.

(iii) ECONOMIC TARGET. Assessment of the economic potential of detrital heavy minerals such as magnetite, titanomagnetite, chromite, gold, and platinum.

CCSP/SI.17: Inshore studies related to coastal development (Priority A).

(a) *Proposal*: (new element)

(i) BACKGROUND INFORMATION. Major developments are taking place in the immediate coastal zone of many of the islands in Solomon Islands. Port developments at Honiara on Guadalcanal and at Noro in the Western Solomons include expansion of wharf facilities and increased waste disposal from urban sewerage and industry, especially fish processing plants. Other major coastal developments in Solomon Islands include agricultural projects on Guadalcanal, a possible geothermal energy field on Vella Lavella, fish processing plants at Tulagi and Noro, forestry expansion on New Georgia Group, Guadalcanal, and Shortland Islands, and a possible gold field on Guadalcanal.

(ii) ELEMENT OBJECTIVES. To provide baseline data on the marine environment in coastal areas where developments which may affect this environment are planned or taking place.

(iii) ECONOMIC TARGET. To assist with the proper management of coastal development programmes.

CCSP/SI.18: Investigation of the suitability of local materials for the manufacture of ceramics (Priority A).

(a) *Proposal*: (new element)

(i) BACKGROUND INFORMATION. From the limited information on the mineralogy of soils of the Solomon Islands it appears

that some may be suitable sources of ceramic clays. The most likely sources of brickmaking clays appear to be either soils on steep slopes, on the most acid rocks present (andesites), or alluvium derived from the erosion of such soils, in which the unweathered minerals may have accumulated as the finer textured clays have been washed out. Suitable materials may also be found on soils derived from alluvium. Such materials may be found on the northern sides of Guadalcanal, San Cristobal, and Choiseul.

(ii) ELEMENT OBJECTIVES. To study clays of the Solomon Islands to identify those which may be suitable for the manufacture of pottery, bricks or tiles; to establish the quantity and quality of any suitable clays found.

(iii) ECONOMIC TARGET. To assist with establishing an industry which would use clay as a primary raw material.

(v) REFERENCES.

CLARIDGE, G.G.C. 1980: Economic potential of clay deposits in selected South Pacific countries. *CCOP/SOPAC Tech. Rep.* 9.

(b) *Recommendations*: field investigations be carried out on Guadalcanal, especially around Mt Popori at the western end of the island and on the northern plains.

TONGA

CCSP/TG.1: Sea-bed investigations for manganese nodules on the deep submarine shelf on the east side of Tonga Platform (Priority B).

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 5th Session. Completed, see below.

(b) *Recommendations*: as no nodules were found during survey work, no further work is recommended and this element is considered completed.

CCSP/TG.2: Assessment of possibilities for occurrence of sea-bed phosphorites on and in the vicinity of the Tonga Platform (Priority B).

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 5th Session.

- (b) *Recommendations*: dredge Tonga Ridge south of Tongatapu and Lau Ridge in the vicinity of Minerva Reef.

CCSP/TG.3: Survey of nearshore areas for precious coral occurrence (Priority A).

- (a) *Proposal*: see Proc. 5th Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 6th Session.

- (b) *Recommendations*: further work be carried out south of Va'vau, east of Ha'apai and between Tongatapu and Va'vau.

- (c) *Planning*: a two weeks survey is planned for June 1981.

- (d) *Work Completed*: twenty-seven localities have been dredged on the Tofua Ridge north of Va'vau and the Tonga Ridge between Va'vau and Tongatapu on *Machias* cruise TG-80(1). Small specimens of *Corallium* were found at three localities - south of Va'vau and east of Ha'apai.

- (e) *Reports*: HALUNEN, A.J. Cruise Report 32, Tonga Offshore Survey, 14 January - 4 February 1980.
 EADE, J.V. 1980: Review of precious coral in CCOP/SOPAC member countries. CCOP/SOPAC Tech. Rep. 8.

CCSP/TG.4: Survey for zones of metalliferous enrichment in active volcanic areas in Tonga (e.g., Tofua Ridge, Lau Basin) (Priority B).

- (a) *Proposal*: see Proc. 5th Session.
Revision: see Proc. 7th Session.
Status: initiated, see Proc. 6th Session.

- (b) *Recommendations*: further work to await results of *Tangaroa* cruise NZOI-1122 in mid 1981 to Lau Basin.

- (d) *Work Completed*: *Machias* cruise TG-80(1): anomalous metal values were found in six gravity cores from Lau Basin.

- (e) *Reports*: HALUNEN, A.J. Cruise Report 32, Tonga Offshore Survey, 14 January - 4 February 1980.

CCSP/TG.5: Seismic reflection survey of the Tonga Platform to determine sediment thickness and basement structure, with particular reference to oil production potential (Priority A).

- (a) *Proposal*: see Proc. 6th Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.

- (b) *Recommendations*: analyse existing data, then decide whether further seismic profiling and what type of survey is required.

- (c) *Planning*: UNDP petroleum geologist will analyse existing CCOP/SOPAC and other data on southern and northern Tonga Platform in late 1980 and early 1981.

- (d) *Work Completed*: *Machias* cruise TG-79(1): 1155 nautical miles of single-channel seismic data from southern Tonga Platform; *Machias* cruise TG-80(1): 300 nautical miles of seismic data from northern Tonga Platform.

- (e) *Reports*: GAUSS, G.A. Cruise Report 33, Tonga Offshore Survey, 1-17 November 1979.
 HALUNEN, A.J. Cruise Report 34, Tonga Offshore Survey, 14 January - 4 February 1980.

CCSP/TG.6: Reconnaissance inventory of beach and nearshore sand for landfill, construction, and roading, and determination of beach-sand resources and renewal rates (Priority A).

- (a) *Proposal*: see Proc. 6th Session.

Revision: see Proc. 7th Session.

Status: initiated, see Proc. 7th Session.
 Revised, see below.

(i) BACKGROUND INFORMATION. A study of beaches on Tongatapu has shown that mining is depleting and probably damaging permanently most of the beaches. Alternative sources of sand and coral aggregate for construction and roading purposes need to be found and assessed for mining.

(ii) ELEMENT OBJECTIVES (expanded). To locate and establish quantity and quality of sand and coral aggregate deposits required for building and roading purposes throughout the Kingdom; to carry out an environmental study of any site where mining may occur.

- (b) *Recommendations*: await analysis of sand samples sent to CRA in N.Z. before carrying out further site work; assess suitability of Apia dredge method to Tongatapu situation.

- (c) *Planning*: a technical/economic dredging consultant may visit Tonga in mid

1981 to advise on recovery of sand from lagoon areas.

- (d) *Work Completed*: profiling of beaches on Tongatapu is continuing; sand deposit in lagoon off Nuku'alofa has been identified as potential source of sand and surveyed.
- (e) *Reports*: GAUSS, G.A. Cruise Report 45, Nuku'alofa Lagoon Survey, Tongatapu, Kingdom of Tonga, 1-20 September 1980. GAUSS, G.A. Cruise Report 30, Report on Tongatapu Sand Inventory, 22-28 November 1979.

CCSP/TG.7: Investigation of oceanographic conditions at Tongatapu blowholes for assessment studies of power generation from wave energy (Priority A).

(a) *Proposal*: (new element)

(i) *BACKGROUND INFORMATION*. A preliminary study of the southern coast of Tongatapu has shown that there are various favourable factors in the blowholes area for a power generation scheme to be developed using wave energy. Further investigations have been recommended and these should include baseline data surveys.

(ii) *ELEMENT OBJECTIVES*. To produce baseline data of the inshore waters of the southern coast of Tongatapu to assist investigations into the use of wave energy at the blowholes as a source of power.

(v) *REFERENCES*.

ANON. 1980: The results of a reconnaissance survey into the energy potential and development prospects of wave energy reaching the blowholes area along the south coast of Tongatapu, Kingdom of Tonga. Internal report to CCOP/SOPAC by Development Services, Crown Agents for Overseas Government and Administration, London.

VANUATU
(Previously NEW HEBRIDES - NH)

CCSP/VA.1: To investigate the metalliferous mud potential in the active volcanic arc and the back-arc basins of Vanuatu (Priority A).

(a) *Proposal*: see Proc. 7th Session.

Status: initiated, see below.

- (c) *Planning*: sampling planned during *Machias* field programme 1980-81, legs 3 and 4.

(f) *Publications*:

COX, M.E. 1980: Areal distribution of marine sediment mercury in the region around Fiji. *S. Pacif. mar. geol. Notes* 1(10) : 111-22 (includes results from samples from the Fiji Plateau in Vanuatu waters).

CCSP/VA.2: To collate all data relevant to hydrocarbon potential in Vanuatu and to recommend (or not) active exploration (Priority A).

(a) *Proposal*: see Proc. 7th Session.

Status: initiated, see Proc. 8th Session.

- (b) *Recommendations*: after assessment of existing data in late 1980, establish further refraction and reflection work to be done during cruise *Geovan II*.

- (c) *Planning*: joint ORSTOM-CCOP/SOPAC geophysical cruise *Geovan II* to be carried out in late 1981. Includes both refraction and reflection studies.

- (d) *Work Completed*: joint ORSTOM-CCOP/SOPAC cruise *Geovan I* (VA-80(1)): recorded 2300 nautical miles of single-channel seismic data in Vanuatu. A review of this and existing data by UNDP petroleum consultant started in October 1980.

- (e) *Reports*: EXON, N.F. Cruise Report 44, Vanuatu Offshore Geophysical Survey, 25 July - 26 August 1980.

CCSP/VA.3: To determine the potential for precious coral occurrences in Vanuatu offshore areas (Priority A).

(a) *Proposal*: see Proc. 7th Session.

Status: initiated, see Proc. 8th Session.

- (c) *Planning*: sampling planned during *Machias* field programme 1980-81, legs 3 and 4.

- (e) *Reports*: EADE, J.V. 1980: Review of precious coral in CCOP/SOPAC member countries. *CCOP/SOPAC Tech. Rep. 8*.

CCSP/VA.4: Bathymetric mapping of Vanuatu Island arc and the adjacent deep sea-floor (Priority A).

(a) *Proposal*: see Proc. 7th Session.

CCSP/VA.5: Investigation of suitability of clay deposits for the manufacture of pottery, bricks, or tiles (Priority A).

(a) *Proposal*: (new element)

(i) BACKGROUND INFORMATION. A tradition of pottery making has persisted in some of the islands of Vanuatu for several thousand years and pottery has been made until very recent times on the west coast of Espiritu Santo. Soils on the southeastern slopes of the islands are very clayey and rich in halloysite or kaolinitic materials. They have, however, frequently been rejuvenated by additions of more recent ash and sometimes have appreciable contents of silt-sized material. On Efate such soils are formed on old alluvial terraces and they may be suitable for brick-making or pottery. On Epi, on the plateau of Valesdir-Leman, soils formed on basaltic and andesitic tuffs have also been rejuvenated by recent falls of andesitic ash and may be a source of ceramic clay. On Espiritu Santo similar soils are formed, especially on the slopes of the western range.

(ii) ELEMENT OBJECTIVES. To find clays in the soils of Vanuatu suitable for making pottery, bricks, or tiles; to assess the quantity and quality of the clays.

REGIONAL ELEMENTS

CCSP/REG.1: Geological and geophysical investigations in the Coral Sea.

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 8th Session.

(d) *Work Completed*: joint Federal Republic of Germany / Australian cruise on r.v. *Sonne* November 1980.

(e) *Reports*: HINZ, K. et al. Report on *Sonne* cruise 80-7B in the Coral Sea. BGR internal Report.

(iii) ECONOMIC TARGET. The establishing of small-scale industry producing pottery, brick, or tiles.

(v) REFERENCES.

CLARIDGE, G.G.C. 1980: Economic potential of clay deposits in selected South Pacific countries. *CCOP/SOPAC Tech. Rep.* 9.

(f) *Publications*:

CAMERON, P.S.; FRITSCH, J.; HINZ, K.; KARNER, G.; MOAINA, R.B.; PROESER, H.A.; SCHLUETER, H.U.; BALFE, P.A. 1979: Papuan and Queensland Plateau margins, Coral Sea: geophysical results of *Sonne* cruise 80-7. Abstract in: IGC Symposium 5, Canberra, "Tectonics of the S.W. Pacific Margin", 17th IUGG Congress, Canberra, 3-15 December 1979.
 DRUMMOND, B.J.; COLLINS, C.D.N.; GIBSON, G. 1979: Crustal structure of the Gulf of Papua and the NW Coral Sea. Abstract in: IGC Symposium 5, "Tectonics of the SW Pacific Margin", 17th IUGG Congress, Canberra, 3-15 December 1979.

CCSP/REG.2: Study of the Bismarck, Solomon, and Woodlark Basins.

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 8th Session.

(b) *Recommendations*: see Project A-4, Tectonic evolution of arcs and back-arc basins, 1980 Noumea Workshop Report - Part 4, this volume.

(f) *Publications*:

WEISSEL, J.K.; TAYLOR, B.; KARNER, G.D. (in press): The opening of the Woodlark Basin, subduction of the Woodlark spreading system, and the evolution of north-western Melanesia since mid-Pliocene time. *Tectonophysics*.

CCSP/REG.3: Melanesian borderland study.

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 8th Session.

(f) *Publications*:

FALVEY, D. 1980: Southwest Pacific tectonics from palaeomagnetic analyses. Presented at the 1980 CCOP/SOPAC - IOC. Noumea Workshop (abstract only).
 JOHNSON, R.W. 1980: New Britain - typical island arc?. Presented at the 1980 CCOP/SOPAC - IOC Noumea Workshop (abstract only).
 HUGHES, G.W.; RIDGWAY, J. 1980: New evidence bearing on the tectonic evolution of the Solomon Islands region. Presented at the 1980 CCOP/SOPAC - IOC Noumea Workshop (abstract only).
 KATZ, H.R. 1980: Basin development in the Solomon Islands and their petroleum potential. *CCOP/SOPAC Tech. Bull.* 3 : 59-75.

CCSP/REG.4: Geological and geophysical investigations of the Fiji Plateau.

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 8th Session.

(b) *Recommendations*: see Project A-3, Tectonic evolution of arcs and back-arc basins, 1980 Noumea Workshop Report - Part 4, this volume.

(d) *Work Completed*: Lamont-Doherty Geological Observatory cruises Vema 3601, 3602 and 3603 in 1979; joint ORSTOM-CCOP/SOPAC cruise Geovan I in 1980.

(f) *Publications*:

CHERKIS, N.Z. 1980: Aeromagnetic investigations and sea-floor spreading history in the Lau Basin and Northern Fiji Plateau. *CCOP/SOPAC Tech. Bull.* 3: 37-47.

HALUNEN, A.J. 1979: Tectonic history of the Fiji Plateau. Ph.D. thesis, University of Hawaii, Honolulu, May 1979. 127 p.

JOUANNIC, C.; TAYLOR, F.W.; BLOOM, A.L.; BERNAT, M. 1980: Late Quaternary uplift history from emerged reef terraces on Santo and Malekula Islands, central New Hebrides Island arc. *CCOP/SOPAC Tech. Bull.* 3: 91-108.

MALAHOFF, A.; FEDEN, R.; FLEMING, H. (in press): Magnetic anomalies and tectonic fabric of marginal basins north of New Zealand. *J. geophys. Res.*

CCSP/REG.5: Geological and geophysical investigations of the Lau Basin.

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 8th Session.

(b) *Recommendations*: see Project A-3, Tectonic evolution of arcs and back-arc basins, 1980 Noumea Workshop Report - Part 4, this volume.

(d) *Work Completed*: Lamont-Doherty Geological Observatory cruises Vema 3601 and 3602 in 1979.

(f) *Publications*:

CHERKIS, N.Z. 1980: Aeromagnetic investigations and sea-floor spreading history in the Lau Basin and Northern Fiji Plateau. *CCOP/SOPAC Tech. Bull.* 3: 37-47.

PONTOISE, B.; LATHAM, G.V.; DANIEL, J.; DUPONT, J.; IBRAHIM, A.B. 1980: Seismic refraction studies in the New Hebrides

and Tonga area. *CCOP/SOPAC Tech. Bull.* 3: 47-58.

CCSP/REG.6: Regional geologic evaluation to determine additional drilling sites in the South Pacific region.

(a) *Proposal*: see Proc. 1st Session.

Revision: see Proc. 8th Session.

CCSP/REG.7: Surveys of abyssal sediment cover north and east of New Zealand.

(a) *Proposal*: see Proc. 2nd Session.

(b) *Recommendations*: see Project C-2.2. Environments of deposition of manganese nodules in the South Pacific, 1980 Noumea Workshop Report - Part 4, this volume.

(c) *Planning*: a cruise is planned for December 1980 on r.v. *Tangaroa* by NZOI to study the Western Boundary Undercurrent at the base of the Subantarctic Slope, southwest of New Zealand.

(f) *Publications*:

CARTER, L. 1980: The seafloor along selected routes between Australia, New Zealand and Hawaii. *NZOI oceanogr. Summ.* 16.

CCSP/REG.8: Distribution of shelled plankton in water column and sediments of South Fiji Basin.

(a) *Proposal*: see Proc. 2nd Session.

CCSP/REG.9: Seismic profiling and bottom sampling between northern New Caledonia and Ontong Java Plateau.

(a) *Proposal*: see Proc. 3rd Session.

Revision: see Proc. 8th Session.

(f) *Publications*:

MAILLET, P.; MONZIER, M.; SELO, M.; STORZER, D. (in press): La zone d'Entrecasteaux (Sudouest Pacifique): nouvelle approche petrologique et geochronologique. In: Contribution a l'Etude Geodynamique du Sudouest Pacifique. *Mem. ORSTOM.*

CCSP/REG.10: Search for metalliferous muds and hot brines in enclosed oceanic basins.

(a) *Proposal*: see Proc. 3rd Session.

Revision: see Proc. 8th Session.

(b) **Recommendations:** see Project C-2.1. Nature, origin, and development of metal-liferous sediments along active rifts in the SOPAC region, 1980 Noumea Workshop Report - Part 4, this volume.

(c) **Planning:** a cruise on r.v. *Tangaroa* is planned for 1981 to collect metal-liferous sediments from the Lau Basin and Tonga - Kermadec Ridge (combined NZOI and Imperial College, London, cruise).

(f) **Publications:**

CRONAN, D.S. 1979: Metalliferous sediments formed by basalt sea water interaction in the Southwestern Pacific. IAPSO Symposium 110, IUGG, Canberra, December 1979 (abstract only).
CRONAN, D.S. 1980: Metalliferous sediments of the Southwestern Pacific: an update. Presented at the 1980 Noumea Workshop (abstract only).

CCSP/REG.11: Search for phosphate on seamount surfaces in equatorial areas of the South Pacific.

(a) **Proposal:** see Proc. 3rd Session.

(b) **Recommendations:** see Project C-3.1. Phosphorites, phosphatic sediments and associated ferromanganese crusts, 1980 Noumea Workshop Report - Part 4, this volume.

(d) **Work Completed:** sampling in Northern Cook Islands on r.v. *Tangaroa* in 1980 on cruise NZOI-1113.

(f) **Publications:**

CULLEN, D.J. 1980: Recent investigations of submarine phosphorite deposits in the SW Pacific. Presented at the 1980 Noumea Workshop (abstract only).

CCSP/REG.12: Search for manganese nodules in the Ontong Java - Ellice Basin area.

(a) **Proposal:** see Proc. 4th Session.

Revision: see Proc. 8th Session.

CCSP/REG.13: Search for manganese nodules along a Cook Islands - Tuamotu transect.

(a) **Proposal:** see Proc. 4th Session.

Revision: see Proc. 8th Session.

(b) **Recommendations:** see Project C-2.2. Environments of deposition of manganese nodules in the South Pacific, 1980

Noumea Workshop Report - Part 4, this volume.

(d) **Work Completed:** samples were collected south of the Tuamotu and Cook Islands during a Tahiti to Wellington cruise of r.v. *Sonne* in August and September 1980.

CCSP/REG.14: Compilation of chemical analyses of sediments in the South Pacific.

(a) **Proposal:** see Proc. 4th Session.

Revision: see Proc. 8th Session.

(f) **Publications**

CRONAN, D.S. 1979: Regional geochemistry of sediments in the SW Pacific. Presented at the 3rd SW Pacific Symposium on IGCP 110 "Evolution of the India - Pacific plate boundaries", Sydney, 17-19 December 1979 (abstract only).
CRONAN, D.S.; GLASBY, G.P.; HALUNEN, A.J.; COLLEN, J.D.; COOPER, J.; JOHNSTON, J.H.; KNEDLER, K.E.; LANDMESSER, C.W.; WINGFIELD, R. 1981: Sediments from the Braemar Ridge and Yasawa Trough, northwest of Fiji. *S. Pacif. mar. geol. Notes* 2(2): 25-35.
GLASBY, G.P.; HUNT, J.L.; RANKIN, P.C.; DARWIN, J.H. 1979: Major element analyses of marine sediments from the S.W. Pacific. *N.Z. Soil Bur. scient. Rep.* 36.

CCSP/REG.15: Compilation of manganese nodule data.

(a) **Proposal:** see Proc. 4th Session.

Revision: see Proc. 8th Session.

(b) **Recommendations:** that this element be incorporated into the IGCP Project 3, Genesis of manganese ores.

(f) **Publications:**

EXON, N.F. 1981: Manganese nodules in the Cook Islands region, Southwest Pacific. *S. Pacif. mar. geol. Notes* 2(4): 47-65.
GLASBY, G.P. (in press): Manganese nodules from the South Pacific: an evaluation. *Mar. Mining*.
GLASBY, G.P.; MEYLAN, M.A.; MARGOLIS, S.V.; BACKER, H. (in press): Manganese deposits of the Southwestern Pacific Basin. 25th I.G.C. Manganese Monograph.
GLASBY, G.P. 1981: Manganese nodule studies in the Southwest Pacific 1975-1980: a review. *S. Pacif. mar. geol. Notes* 2(3): 37-46.
GLASBY, G.P.; LAWRENCE, P. 1980: Manganese deposits in the South Pacific Ocean: Relation to sediment type, 1:25,000,000. *N.Z. oceanogr. Inst. Chart, Misc. Ser.* 40.

CCSP/REG.16: The study of energy release and seismicity in the Southwest Pacific.

(a) *Proposal*: see Proc. 4th Session.

Revision: see Proc. 8th Session.

(b) *Recommendations*: see final recommendations 3 and 4, 1980 Noumea Workshop Report - Part 4, this volume.

(f) *Publications*:

CARDWELL, R.; ISACKS, B.L.; CHATELAIN, J.L. 1980: A detailed study of a sequence of magnitude 6 earthquakes in the central New Hebrides islands. *EOS Trans. A.G.U.* 61(17) : 370.

COX, M.E. 1980: Geothermal occurrences in the Southwest Pacific. *CCOP/SOPAC Tech. Bull.* 3 : 197-219.

COX, M.E. 1980: Preliminary geothermal investigations in the Savusavu area, Vanua Levu. *Geotherm. Rep. Mines Resour. Div. Fiji*, 1.

COX, M.E. 1980: Preliminary geothermal investigations in the Lambasa area, Vanua Levu. *Geotherm. Rep. Mines Resour. Div. Fiji*, 2.

COUDERT, E. 1980: Etude de la seismicite du sud de l'arc insulaire des Nouvelles Hebrides, energistree par un reseau temporaire de stations locales et sous-marines. These 3° cycle, Univ. Paris Sud-Orsay.

ISACKS, B.L.; BEVIS, M.; CARDWELL, R.; CHATELAIN, J.L.; LOUAT, R.; MARTHELOT, J.R. 1980: Monitoring seismicity and surface deformation in the New Hebrides island arc. Ewing Symposium on Earthquake Prediction, May 12-16, 1980.

LATTER, J.H. 1976: Variations in stress release preceding and accompanying a submarine eruption in northern Tonga. Pp. 355-73 in : Johnson, R.W. (ed.) "Volcanism in Australasia". Elsevier, Amsterdam.

LOUAT, R.; DUBOIS, J.; ISACKS, B.L. 1979: Anomalous propagation of seismic waves through the zone of shearing contact between converging plates of the New Hebrides arc. *Nature* 281 : 293-95.

RODDA, P. 1979: Hot springs of Vanua Levu. *Rep. Mines Resour. Div. Fiji*, 10.

CCSP/REG.17: Regional data and synthesis.

(a) *Proposal*: see Proc. 4th Session.

Revision: see Proc. 8th Session.

(d) *Work Completed*: Sheets 5.06 (north-western equatorial Pacific) and 5.11 (Cook Islands and Line Islands area) of 5th edition of the General Bathymetric chart

of the Ocean (GEBCO) have been completed; SW quadrant bathymetric map of the Circum-Pacific Map Project also completed, other maps for SW quadrant nearing completion.

CCSP/REG.18: Ocean thermal data collection

(a) *Proposal*: see Proc. 4th Session.

Revision: see Proc. 8th Session.

CCSP/REG.19: Study of the tectonics of the Fiji Plateau using OBS and other marine geophysical survey techniques (Deleted, and transferred to REG.4).

CCSP/REG.20: An investigation of lithospheric properties by teleseismic studies in the Samoa - Tonga - Cook Islands region.

(a) *Proposal*: see Proc. 5th Session.

Revision: see below.

(i) BACKGROUND INFORMATION. This element is defined by special project 2-2, Energy release and seismicity, 1975 Suva Workshop - see Suva Workshop Report, Proc. 4th Session; the title revised at the 9th Session.

(ii) ELEMENT OBJECTIVES. To collect data on earthquakes for upper mantle studies by setting up a temporary seismic recording station initially on Rarotonga and later at other sites.

CCSP/REG.21: Origin and evolution of the Line Islands.

(a) *Proposal*: see Proc. 8th Session.

(d) *Work Completed*: 2nd and 3rd legs, in late 1979 and early 1980, of HIG cruise to the area included piston coring, dredging, bathymetry, magnetometry, gravimetry, and seismic reflection.

CCSP/REG.22: Search for manganese nodules in the central equatorial Pacific (from east of Wake Island to Northern Cook Islands).

(a) *Proposal*: see Proc. 8th Session.

(b) *Recommendations*: see Project C-2.2, Environments of deposition of manganese nodules in the South Pacific, 1980 Noumea Workshop Report - Part 4, this volume.

(d) *Work Completed*: Geological Survey of Japan cruise GH-80-1 completed - con-

sisting of two parallel survey lines about 4500 km long with stationary observations including sediment sampling, bottom photography and heat flow measurements, and continuous geological observations.

(f) *Publications:*

MORITANI, T. (ed.) 1979: Deep-sea mineral resources investigation in the central-western part of Central Pacific Basin, Jan-March, GH 77-1 cruise. *Geol. Surv. Japan cruise Rep.* 12.
 MORITANI, T. (ed.) (in press): Deep-sea mineral resources investigation in the western part of the Central Pacific Basin, Jan-March 1978, GH 78-1 cruise. *Geol. Surv. Japan cruise Rep.*
 MORITANI, T. (ed.) (in press): Deep-sea mineral resources investigation in the northern part of the Central Pacific Basin, Jan-March 1979, GH 79-1 cruise. *Geol. Surv. Japan cruise Rep.*

CCSP/REG.23: Search for manganese nodules in the neighbourhood of the Marquesas fracture zone.

(a) *Proposal:* see Proc. 8th Session.

(b) *Recommendations:* see project C-2.2, Environments of deposition of manganese nodules in the South Pacific, 1980 Noumea Workshop Report - Part 4, this volume.

(f) *Publications:*

PAUTOT, G.; MELGUEN, M. 1979: Influence of deep-water circulation and sea-floor morphology on the abundance and grade of central South Pacific manganese nodules. Pp 621-49 in: Bischoff, J.L. and Piper, D.Z. (eds) *Marine geology and geography of the Pacific manganese nodule province*. Plenum Press, New York.

CCSP/REG.24: A tectonic analysis of the Southwest Pacific.

(a) *Proposal:* (new element)

(i) **BACKGROUND INFORMATION.** At the 8th Session of CCOP/SOPAC held in Suva, Fiji, 24 September - 1 October 1979, it was recommended that a structural geologist undertake a study of the regional geology and tectonics of the Southwest Pacific, in particular identifying areas of interest for further investigation.

(ii) **ELEMENT OBJECTIVES.** To make a systematic tectonic analysis of the

CCOP/SOPAC region, area by area, describing the structural geology in the context of geological evolution and tectonic development of the Southwest Pacific; review all pertinent geological literature; incorporate results of recent geological/geophysical investigations utilising and re-interpreting, where necessary, key geophysical data; revise regional geological interpretations in the light of new global tectonic theory and in view of recent advances in the field; produce a regional synthesis describing the geological evolution and tectonic development of the Southwest Pacific.

CCSP/REG.25: The CCOP/SOPAC geophysical atlas of the Southwest Pacific.

(a) *Proposal:* (new element)

(i) **BACKGROUND INFORMATION.** In 1972 Mamerickx and others first published the Bathymetric Chart of the South Pacific containing all available data obtained to 1970. Since that time a considerable amount of new information has been obtained. This new data is mostly positioned by highly accurate satellite navigation and can be used to reposition older, less well positioned data sets. Furthermore, much of the older data was contoured and contours extrapolated without understanding the origin of many of the features being illustrated. Using the new global tectonics theory, we can now more accurately portray the morphology of submarine features, particularly in areas of low data density where these predictive capabilities are most useful.

A sufficiently large body of data has now been accumulated to enable accurate identification and location of most of the major tectonic elements in the Southwest Pacific. A chart of this type would be particularly useful in promoting and guiding further exploration and prospecting in the CCOP/SOPAC region.

An awareness of regional patterns of sediment accumulation is often a prerequisite to offshore exploration and prospecting, particularly for hydrocarbons. Ewing and others first published a highly generalised chart of South Pacific sediment distribution patterns. Since that time a considerable amount of new information has been obtained, particularly in South Pacific marginal seas.

Both seismicity and convergence rates are cited as indicators of the geodynamic state of active convergent margins. The

shape and inclination of the Benioff Zone is commonly given as the reason for the presence of differing metallogenic provinces, as in the South American example. Variation in crustal thickness, a measure of potential rheological response, is often called on to explain subduction zone anomalies. Departures from the normal inverse relationship of crustal thickness to bathymetry (with the exception of convergent and divergent plate margins) conceivably could signal the presence of thermal diapirs which might indicate sites of potential metallogenic enrichment.

Mapping the gravity field is a frequently employed technique in geophysical prospecting. Bouguer anomalies have been commonly used in petroleum exploration to locate potential reservoir structures and in mining exploration to locate prospective sites for ore body emplacement.

The temperature and pressure dependence of petrogenesis is well known. The role of hydrothermal fluids in emplacement of ore bodies is critical. The importance of the thermal history in the maturation of hydrocarbons is also of critical importance. The importance of the earth's thermal regime is thus clearly recognised and the ultimate earth model will, in all probability, be a thermal one.

(ii) ELEMENT OBJECTIVES. To assemble in appropriate format all available, relevant geophysical data for the CCOP/SOPAC region between latitudes 5°N and 40°S and between longitudes 140°E and 155°W; to construct a series of charts on Mercator Projection at an approximate scale of 1:6,500,000 at the Equator, covering the above area. The series would contain 6 charts incorporating: bathymetry, geomorphologic and tectonic elements, magnetic lineations, sediment thickness, crustal structure, seismicity, regional crustal thickness, gravity anomalies (F.A.A.) and/or regional heat flow; to publish, in colour, an atlas containing the above series of charts; to update and prepare timely revisions of segments of these charts as new information becomes available.

- (c) *Planning*: the first task to start late 1980, is to synthesise latest bathymetric interpretation and produce a bathymetric map of the SW Pacific.

CCSP/REG.26: Delineation of sediment bodies in time and space.

- (a) *Proposal*: (new element)

(i) BACKGROUND INFORMATION. Proposed at the 1980 Noumea Workshop as projects A-1, Study of island arc sedimentary basins; correlation of reference sections and seismic stratigraphy, and C-1.3, Delineation of sediment bodies in time and space - see Part 4, this volume.

(ii) ELEMENT OBJECTIVES. To delineate distribution of sediment bodies of different ages and produce stratigraphic and isopach maps of the region; to establish from detailed stratigraphic analysis of the bodies:

- basin genesis and tectonic setting
- depositional history
- facies relationships and paleoenvironments
- sediment provenance
- resource potential;

to establish the stratigraphic relationship between sedimentary sequences of basins, ridges, and shelves and thus provide basic data to assist in the preliminary assessment of hydrocarbon potential and seismic hazards.

CCSP/REG.27: Carbonate sediment studies in the CCOP/SOPAC region.

- (a) *Proposal*: (new element)

(i) BACKGROUND INFORMATION. Proposed at the 1980 Noumea Workshop as part of project C-1.4, Sedimentological studies in the SOPAC region - see Part 4, this volume.

(ii) ELEMENT OBJECTIVES. To improve understanding of carbonate sedimentation and diagenesis under different environmental and climatic conditions; to relate these studies to hydrocarbon exploration, and coral sand and aggregates investigations.

CCSP/REG.28: Effects of subduction of aseismic ridges and small plateaux in the Southwest Pacific.

- (a) *Proposal*: (new element)

(i) BACKGROUND INFORMATION. Proposed at the 1980 Noumea Workshop as project A-5, Effects of subduction of aseismic ridges and small plateaux in the SW Pacific - see Part 4, this volume.

(ii) ELEMENT OBJECTIVES. To study the effects of subduction of an aseismic ridge (the Louisville Ridge) and of a small plateau (the d'Entrecasteaux Ridge and the North d'Entrecasteaux Plateau) on hydrocarbons and basins genesis, and on the regional seismicity.

Part 3: DOCUMENTATION

A. CCOP/SOPAC Agencies' Reports for 1979-80

1. OBSERVATIONS OF THE ESCAP COMMISSION AT ITS THIRTY-SIXTH SESSION RELEVANT TO THE PROGRAMME OF THE COMMITTEE

Submitted by the ESCAP Secretariat

(Document NR/CCOP/SOPAC (9)/1)

The ESCAP Commission:

I. On its activities in the Pacific

(1) Welcomed Kiribati as a newly independent country in its membership.

(2) Was pleased to note the establishment of a permanent post at the D-1 level for the appointment of an ESCAP liaison officer in the Pacific and urged that that appointment be accorded the highest priority. The appointment of the liaison officer should result in avoiding duplication in the work to be undertaken and ensuring that the Pacific island Governments could make their views adequately known to ESCAP through a recognised channel.

(3) Attached great importance to co-operation between ESCAP and the subregional organisations such as SPC and SPEC and to a regular expansion of participation by individual Pacific island Governments in the full range of ESCAP activities. Because of the special disadvantages faced by the developing island countries in meeting the high cost of attending ESCAP meetings, it urged that ways and means be sought to ease that burden in order that the Pacific subregion be given the opportunity to make an impact on important ESCAP deliberations.

(4) Noted that arrangements had been made for flexible in-service training in the ESCAP Secretariat for officials of Pacific island Governments for a period of three to six months and that the Secretariat was prepared to receive four government officers from the subregion for such training during 1980. It was informed that one officer from Fiji had already completed such a training course.

(5) Welcomed the various technical and advisory services rendered by the Secretariat to the Pacific island countries in the fields of agricultural information, data processing, industry and technology, population, environment, international trade, shipping and ports,

social development, statistics, involvement of women in the development process, and transnational corporations.

II. On the Committee for Co-ordination of Joint Prospecting for Mineral Resources in the South Pacific Offshore Areas

(1) Endorsed the report and recommendations of the CCOP/SOPAC at its Eighth Session.

(2) Commended the ambitious but realistic work programme of CCOP/SOPAC, which had resulted in a number of positive accomplishments.

(3) Noted with interest the statement by the representative of the USSR that his Government would be ready to consider a marine geological/geophysical survey programme to be carried out by its research vessels for a three-month period annually, in co-operation and co-ordination with the CCOP/SOPAC programme.

(4) Recognising the importance of interdisciplinary regional projects for oceanic areas, urged UNDP and donor countries to give favourable consideration to extending their support to the Committees' activities to be carried out during the next UNDP programming cycle, 1982-1986.

III. On natural resources

(1) Noted that the proper development and conservation of natural resources, particularly energy, mineral, and water resources, were essential to the achievement of the growth rate targets of the regional development strategy for 1980s. It therefore endorsed the report of the Committee on Natural Resources on its Sixth Session and its recommendations. It also endorsed the proposed changes in the 1980-1981 programme of work in that sector.

(2) Noted with interest the bilateral and multilateral co-operation of member countries in the field of natural resources and was pleased to note that such joint efforts had resulted in regional projects like the Mekong Committee, CCOP, CCOP/SOPAC, the Typhoon Committee, and others.

(3) Supported the UNDP-financed regional energy programme being finalised by ESCAP and UNDP and the energy package programme for the South Pacific. It stressed that the exploration and development of non-conventional

sources of energy should be priority areas in the 1980s and pointed out that ESCAP activities in those fields were useful and timely.

(4) Stressed the need for priority to be given during 1980-1981 to studies on the mineral potential of the region, improvement in legal/institutional arrangements for mineral exploration and development, environmental management of mineral exploration and development activities, and the promotion of the application of modern technologies for the exploration and development of minerals, including coal and petroleum.

(5) Welcomed the expanded coverage of the third edition of the Mineral Distribution Map to include the Pacific areas as well as Asia and urged member countries to provide the services of a co-ordinator for compiling the map.

(6) Noted the progress made by the project on stratigraphic correlation between sedimentary basins and the generous support provided by the Government of Australia to that project. It was hoped that specialist services would continue to be provided by that Government.

(7) Was pleased to note the progress made by the WMO/ESCAP Panel on Tropical Cyclones. It noted that at its Seventh Session the Panel had established a timetable for the phased takeover of the responsibilities of the international staff in the Technical Support Unit and agreed to rotate the location of the Unit among the Panel members.

IV. On the environment

(1) Expressed its appreciation of the assistance provided to ESCAP by the Swedish Environmental Protection Service in connection with the regional project on the protection of the marine environment and related ecosystems in Asia and the Pacific. It suggested that sustained and continuous efforts should be made to develop action-oriented programme in the field of protection of the marine environment, as a follow-up of the recommendations of national seminars. In that regard, the proposal for the establishment of a regional training centre for protection of the marine environment was welcomed. It recommended that efforts be made to develop appropriate mechanisms for exchange of information related to the marine environment, including the establishment of a clearing-house within the Secretariat for dissemination of information.

(2) Noted with appreciation the progress made so far on the South Pacific regional environmental programme under the auspices of the Regional Co-ordinating Group, consisting of SPC, SPEC, ESCAP, and UNEP. It

further noted that the programme had the potential for engendering subregional co-operation in a number of environmental activities of importance for the survival of the fragile ecosystems of the Pacific island countries.

(3) Called for increased attention to the legislative and institutional aspects of environmental protection, at both the national and the international levels. At the national level, the development and enforcement of marine pollution legislation, the strengthening of environmental impact assessment procedures and the development and application of environmental quality standards were emphasised. The Commission also drew the attention of the member Governments to the international conventions for the protection of the environment and stressed the need for ratification of those conventions, particularly the Convention on International Trade of Endangered Species of Wild Fauna and Flora.

2. REVIEW OF ACTIVITIES SINCE THE EIGHTH SESSION OF THE ESCAP SECRETARIAT

Submitted by the ESCAP Secretariat

(Document NR/CCOP/SOPAC(9)/CR.25)

The activities of ESCAP Secretariat since the Eighth Session have included arrangements for recruitment of staff, ship charter and purchase of equipment, improving and expediting administrative and financial matters, preparing a draft legal base for CCOP/SOPAC, obtaining support for approved CCOP/SOPAC activities, and strengthening ESCAP's position in the South Pacific.

You will recall at the Eighth Session that the Committee had found two candidates to be accepted for the post of Petroleum Geologist. However, it requested ESCAP to postpone recruitment until the end of October to allow the technical advisers time to submit the names of other candidates. Information on one candidate was received from TAG in early November. Unfortunately, advice that he was medically unfit was received later in the year. Thereafter, in spite of concerted efforts by ESCAP and TARS, each of the two original candidates for the post were found to be not available.

As a result of vigorous continuing endeavours, all of the posts except one were filled by the third quarter of 1980 and the one vacant marine geologist post will be filled in early 1981. In addition to the long-term

osts a number of specialist consultants were recruited and appointed to the project on short-term assignments.

The arrangements for the UNDP ship charter for 1979/1980 and 1980/1981, for joint charter in 1980, and for the purchase of equipment items during 1980 were completed as requested.

With the arrival of the project manager at Suva in mid January for the first time increased delegation of financial and administrative authority, including a higher level of imprest account to the project, was accomplished. Further streamlining of administrative and financial matters between ESCAP and the project are continuing within the constraints of existing United Nations rules and regulations. Concurrently attempts by ESCAP are continuing to obtain maximum control of financial and administrative matters from United Nations headquarters.

Support to member governments has included arranging for nationals to participate in meetings such as the Seminar on Modern Methods of Mineral Exploration at Tashkent, USSR, August 1980, and the Workshop on Coastal Area Management and Development at Manila, Philippines, December 1979.

The more important contributions received from supporting Governments were as follows: Australia, A\$70,000; New Zealand, NZ\$20,000; France, provision of the services of Mr C. Jouannic for one year and its vessel c.v. Vauban on a joint survey cruise in Vanuatu waters; Japan, provision of the services of a marine geophysicist on the survey cruises during 1981 and training for member country nationals aboard R.V. *Hakurei Maru* and ashore in 1980; the United States of America, equipment on long-term loan.

UNDP, as evidence of their strong interest in, and support of, natural resource activities, fielded a Natural Resources Sector Review Mission in June. The task of the Mission was to review ongoing projects and to make recommendations for UNDP inputs to this sector for the next five year programming cycle from 1982 to 1986. The Mission, whose report has been only recently sent to the member governments, we are happy to advise, has recommended continuation of the UNDP project for the period 1982-1984.

It will be important, therefore, that a draft project document be formulated and approved at this session for submission to UNDP. As regards the time frame we suggest that the draft project document be designed to cover the period 1982-1986 so that it would coincide with the full UNDP funding cycle rather than the three-year period recommended by the UNDP Review Mission.

Although member countries have had only a short time to examine the new information on the Committee's legal status forwarded to them by ESCAP recently, we hope that this important matter could be discussed in a preliminary manner at this session. This would allow the participants to become acquainted with, and for the respective governments to review, the draft alternatives with a view to selecting the legal base of the Committee they might wish to adopt prior to the CCOP/SOPAC Tenth Session.

It is hoped that the amendments to Committee's terms of reference could be discussed and approved and that the names of member country candidates to be considered for training and/or fellowships for the coming year could be submitted at this session.

3. REPORT OF ACTIVITIES OF THE TECHNICAL SECRETARIAT OF CCOP/SOPAC

Submitted by the CCOP/SOPAC Technical Secretariat

(from Document NR/CCOP/SOPAC (9)/CR.13)

ADMINISTRATION

With the arrival of the UNDP Project Manager, ESCAP has granted greater autonomy to the UNDP project at the operational level. As a result, many of the administrative problems previously encountered have now been eliminated.

In late 1979 the Technical Secretariat moved into new quarters constructed for the Secretariat by the Government of Fiji on the premises of the Mineral Resources Department. The Technical Secretariat now occupies a total of approximately 2000 square feet of space.

The project office is now fully staffed as follows:

Cruz A. Matos	Project manager
Donald Tiffin	Marine geophysicist
Loren Kroenke	Structural geologist
Garry Gauss	Engineering geologist
Neville Exon	Marine geologist
Wendell Gayman	Marine scientist
Tun U. Maung	Petroleum geologist
Christian Jouannic	Marine geologist
Edward Saphore	Electronics technician
Phillip Woodward	Bathymetric draftsman
Patresio Fuata	Marine technician
Tina Israel	Administrative assistant
Molly Lee Joe	Publication clerk
Elizabeth Morris	Secretary
Ram Rattan	Storeman/driver
Sekove Motutwaca	Geological technician
Chandra Singh	Draftsperson

OFFSHORE ACTIVITIES

WORK PROGRAMME

The UNDP chartered vessel, r.v. *Machias* undertook survey activities in the waters of Cook Islands, Kiribati, Samoa, and the Kingdom of Tonga. The cruise commenced in October 1979 and ended in May 1980. The principal minerals reconnoitered during the survey cruise were manganese, phosphates, precious coral, hydrocarbons, and metal-liferous sediments. The status of the investigations of the principal minerals in these countries is as follows.

Cook Islands

Following the 1979/80 cruise approximately 80% of the waters of the Cooks have been sampled for manganese at a reconnaissance scale. Results indicate that there is an inverse relationship between nodule grade and abundance in this region, and no samples have combined grades and abundances above the cut-off economic level generally quoted for first generation mining sites. A full review and report on all the existing data is now in preparation.

Offshore sampling for phosphates in the Cooks has been minimal, although some onshore and lagoonal samples have been collected from the northern Cooks, principally by the New Zealand Oceanographic Institute (NZOI). One high phosphate value of 28% is reported from Manihiki Lagoon. It is considered that the offshore area of the Manihiki Plateau is prospective. Initiation of a programme of lagoonal surveys in the northern Cooks is under consideration.

Final results of the 1979/80 cruise precious coral sampling in the northern Cooks are still awaited. However a preliminary assessment indicates that further work will be desirable both in the northern and southern Cooks.

Kiribati

Following the 1979/80 cruise, reconnaissance sampling for manganese nodules has now been carried out in parts of all three Kiribati groups - the western, central (Phoenix), and eastern (Line). Results so far have not been encouraging in that, although high abundances are proven in the eastern and central groups, grades are well below economic cut-off. In the Line Islands abundances are generally very low, although a few high grades have been reported by other workers. However, only 20%, 29%, and 13% (respectively west to east) of the three areas have been sampled on the reconnaissance scale and further work is required. During the 1980/81 cruise further investi-

gation for manganese nodules is planned in the western group.

Sampling for phosphate in Kiribati waters by the Project has scarcely been started. One sampling station was undertaken in the southern Line Islands during the 1979/80 cruise. Further work is required in all groups. Some will be undertaken in the western group during the 1980/81 cruise programme.

A very small amount of precious coral sampling was undertaken in the Phoenix group during the 1979/80 cruise. Further work is required, especially in the western group. This is planned as part of the 1980/81 cruise.

Samoa

Following the 1979/80 cruise about 80% of Samoan waters has been sampled for manganese at the reconnaissance level. Results are discouraging and no further work is planned by the Project in this field unless undertaken by a "vessel of opportunity".

Approximately 60% of the phosphate prospective banks and ridges around the Samoan islands had been sampled by the end of the 1979/80 cruise. No encouraging phosphate values have been encountered but some of the remaining sites have potential. It is possible that most of these will be sampled by NZOI during their 1980 cruise programme.

Almost all of the prospective area of the Samoan platform was covered by the airgun reconnaissance survey for hydrocarbons carried out during the 1979/80 cruise. No further work is at present planned in this field.

With the work done during the 1979/80 cruise, reconnaissance sampling for precious coral around Upolu and Savali was nearly completed. Detailed surveys are now required off the western end of Upolu island and the eastern end of Savali island.

Kingdom of Tonga

The programme of investigation of manganese nodules on the eastern shelf of the Tongan Platform was considered completed (with negative results) prior to the 1979/80 cruise and no work was undertaken on this during this cruise. However, there are other large uninvestigated areas in Tongan waters which have some potential for manganese and which would warrant a reconnaissance survey.

No phosphate sampling was undertaken in Tongan waters in 1979/80. During previous cruises about 40% of the Tongan Ridge area has been sampled for phosphate on the reconnaissance scale, with negative results. However, no sampling has been undertaken on the

prospective Lau Ridge, nor on isolated off-ridge reefs and seamounts.

Following the 1979/80 cruise programme, approximately 50% of the prospective sites in Tongan waters have been sampled for precious coral at the reconnaissance scale. Sub-commercial size samples of *Corallium* have been obtained from the Vavau and Ha'apai groups. Further sampling work is recommended in these areas and also off Eua island.

With the 1979/80 work it is considered that the reconnaissance programme of sampling for metalliferous sediments in Tongan waters is completed. Analytical results of the latest samples are awaited.

During the 1979/80 cruise reconnaissance airgun seismic reflection surveys for hydrocarbon potential were carried out over the Tongan Platform south of Tongatapu and north of Vavau. These data have yet to be fully analysed and reported. Preliminary results suggest that further airgun work in Tongan waters will probably be desirable at some future time.

A joint survey cruise with the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) in the waters of Vanuatu was undertaken during the reporting period on the research vessel *Vauban*. This survey was done as part of the hydrocarbon programme for Vanuatu. The success of this cruise has encouraged future joint undertakings of a similar nature.

The 1980/81 survey cruise of the UNDP chartered vessel has been programmed as follows.

Fiji waters - Seabed sampling for phosphorites

X Vanuatu waters - Investigation of the metalliferous mud potential
- Investigation of precious coral occurrences

Solomon Islands waters - Investigation for manganese nodules
- Investigation for precious coral occurrences
- Investigation of the phosphate potential
- Investigation into discharges from submarine volcanoes
- Investigation into metal dispersion in marine sediments
- Evaluation of hydrocarbon potential

Papua New Guinea waters - Evaluation of hydrocarbon potential
- Investigation of the phosphate potential

Kiribati waters - Investigation for manganese nodules

- Investigation of precious coral occurrences

NEARSHORE ACTIVITIES

The heavy involvement of available sea-going personnel in offshore activities during 1979/80 resulted in only a limited amount of field work being carried out on nearshore activities.

The principal nearshore activities undertaken during this period were as follows.

Fiji

A bathymetric and seismic profiling survey in Lami Harbour in connection with a proposed oil loading pipeline facility. The work was conducted jointly with the Mineral Resources Department and the Fiji Marine Department.

Samoa

Surveys in connection with port developments were carried out at Salelologa and Asau harbours. Bathymetric charts were produced showing soundings reduced to chart datum.

Kingdom of Tonga

The beach profiling programme, initiated in 1978, was revived and extended; a photographic study of beaches being mined for sand was continued and a sediment transport study in one back reef area was initiated.

A nearshore survey to locate new sand deposits in the lagoonal areas off Nuku'alofa was started.

Nearshore activities planned for 1980/81 include the following.

Cook Islands - A sea bed survey and oceanographic study in connection with a WHO sewage outfall project in Rarotonga.
- Seismic profiling and sea bed sampling for construction materials as a follow-up to the 1978 Rarotonga Nearshore Survey carried out by the New Zealand Oceanographic Institute.

Samoa - Sea bed and oceanographic surveys in connection with harbour developments and a sewage outfall scheme.

Tonga - Continuation of the Tongatapu sand inventory with beach profiling and sediment transport studies.

ONSHORE ACTIVITIES

The only onshore activity undertaken during the reporting period was related to clay soils. A report on the clay potential of the CCOP/SOPAC member countries was prepared by a consultant, and a definitive clay

programme based on the report and country priorities will be prepared and implemented during the forthcoming year.

PRECIOUS CORAL ACTIVITIES

The precious coral programme continued to gather momentum during the reporting period. Precious coral surveys were carried out in the waters of the Cook Islands, Kiribati, Samoa, Solomon Islands, and the Kingdom of Tonga.

A report summarising the precious coral work made off the Cook Islands, Kiribati, Papua New Guinea, Samoa, Solomon Islands, the Kingdom of Tonga, and Vanuatu has been prepared. The report indicates that *Coralium* is now known to occur in the Cook Islands, Samoa, Solomon Islands, the Kingdom of Tonga, and Vanuatu and recommends that further precious coral work be carried out in these countries and in Kiribati and Papua New Guinea.

As a result, precious coral work has been programmed for 1980/81 in the waters of Kiribati, the Solomon Islands, and Vanuatu using the UNDP charter vessel and in the waters of the Cook Islands, Samoa, and the Solomon Islands using government vessels.

NEW ACTIVITIES

With the arrival of additional professional staff, new programme activities have been identified as follows.

Structural geology - A systematic tectonic analysis of the CCOP/SOPAC region.

Petroleum geology - Surveys for potential hydrocarbon resources in the nearshore and coastal areas.

- Assistance to CCOP/SOPAC member countries in evaluating and interpreting data related to their hydrocarbon resource potential.

Marine science - Baseline data surveys in the inshore waters related to existing or proposed industrial, harbour and other coastal zone developments.

- Assistance to the CCOP/SOPAC member countries in the development of coastal engineering design criteria and environmental criteria.

The staff members responsible for these new activities will visit the CCOP/SOPAC member countries to ensure that the programmes developed reflect the priorities of the countries concerned.

FUTURE PROGRAMMES AND RECOMMENDATIONS

The present UNDP programme support of CCOP/SOPAC activities will end in December 1981, a date which coincides with the end of the

second UNDP 5-year funding cycle. As a result, a UNDP Sectorial Review Mission visited the Technical Secretariat for one week in mid 1980. The purpose of the visit was to review the existing project and make recommendations with respect to UNDP inputs during the third UNDP 5-year funding cycle.

Based on a review of the past and current programme, the Review Mission agreed to recommend that the UNDP inputs to CCOP/SOPAC be continued beyond December 1981. The recommendation is for approximately US\$3.5 million over a three year period commencing in January 1982.

The work programme envisaged for 1982 through 1984 is as follows.

Offshore - One six month cruise in 1981/82.

- Bathymetric data.
- Analysis and publication of all offshore data.

Nearshore - The location and quantification of mineral deposits, including hydrocarbons.

- The location and quantification of precious coral beds.
- Bathymetric data.
- Analysis and publication of data collected.

Inshore - The location and quantification of construction materials, including sediment transport studies.

- Baseline environmental studies where shore line development is planned.
- Bathymetric data.
- Analysis and publication of data collected.

Training - On-the-job activities.

- Basic and advanced earth science courses at the University of the South Pacific.
- Seminars/workshops/symposia on relevant topics.
- Technician training at the Secretariat Headquarters in Suva, Fiji.

Not all the offshore reconnaissance work will be completed by the end of 1982. There are some member countries who will still lack definite indicators of the mineral resources potential of their Extended Economic Zone (EEZ). Accordingly the Technical Secretariat RECOMMENDS that it be authorised to seek additional funding from international organisations (including UNDP) or bilateral donors and enter into agreements for the continuation of the offshore reconnaissance activities beyond 1982. The funding required is in the order of US\$1.5 million.

At present, CCOP/SOPAC is the only inter-governmental organisation in the region involved with the technical and scientific aspects of natural resources. To date, the

focus of CCOP/SOPAC activities has been in the marine area as prescribed by its terms of reference.

In view of the high priority assigned by member governments to the development of alternative sources of energy and because the potential alternative sources of energy have a natural resource base (e.g., ocean thermal energy, geothermal energy, wave energy), the Technical Secretariat RECOMMENDS that the terms of reference of CCOP/SOPAC be expanded to include activities in the technological aspects of the search for, and development of, alternative energy sources in the region.

One of the primary objectives of the United Nations assistance to CCOP/SOPAC is the development of CCOP/SOPAC as an inter-governmental organisation with technological and scientific capabilities for regional and national activities in the natural resources sector. Additionally their assistance is focussed primarily on supporting programme activities as opposed to the Secretariat function.

In considering the long-term viability of CCOP/SOPAC it becomes apparent that nationals from the region should be trained at the professional level with the view of assuming responsibility for the Secretariat functions as UN assistance is phased out. Accordingly, the Technical Secretariat RECOMMENDS that it be authorised to seek funding and enter into agreements for the establishment of a professional training programme leading to Bachelor's and/or Master's degrees for nationals from the region.

TRAINING

The Technical Secretariat sponsored, with UNDP funds, a four month Basic Earth Science Course in Suva, Fiji, in co-operation with the University of the South Pacific and Victoria University of Wellington. Attendance at the course was as follows.

Fiji, 6 participants; New Hebrides, 1; Samoa, 2; and Solomon Islands 3.

Staff gave lectures and seminars in marine geological and geophysical techniques and organised and participated in shipboard field courses lasting 3 to 4 days at the end of the Basic Earth Science Course.

On-the-job training activities were performed by inviting member countries to provide trainees for all UNDP project activities conducted in the country's jurisdiction. As a result, national personnel were trained in nearshore positioning, sea bed sampling, sub-bottom profiling, satellite navigation, seismic profiling, and bathymetric techniques.

At the kind invitation of the Geological Survey of Japan, arrangements were made for the participation of one trainee each from the Cook Islands and Samoa on the research vessel *Hakurei Maru*. Funds for this activity were provided by the UNDP.

Arrangements have now been finalised for an Advanced Earth Science Course to be held in Suva, Fiji, in early 1981. Participation in this course will be limited to those persons who have successfully completed the Basic Earth Science Courses. Funds for this activity are being provided by New Zealand.

CCOP/SOPAC member countries have been invited to submit nominations for a training course in bathymetric drafting techniques. The course will be held at the Technical Secretariat headquarters in Suva. Funding for this course is being provided by the UNDP and the governments of Australia and France.

NOTE : Also presented were documents:

NR/CCOP/SOPAC (9)/CR.62 - Excerpts of the UNDP Mineral Resources Sector Review Mission Report, July 1980 - submitted by the ESCAP Secretariat (see Part 1, report of TAG, para. 148, 150).

NR/CCOP/SOPAC (9)/CR.67 - Proposed agenda for the tripartite project review - (see Part 1, report of the Ninth Session, para. 19).

NR/CCOP/SOPAC (9)/CR.74 - Matters affecting future UNDP inputs to CCOP/SOPAC - submitted by the representative for UNDP (see Part 1, report of TAG, para. 142).

B. International Meetings

4. EXCERPTS FROM THE REPORT OF THE WORKSHOP ON COASTAL AREA DEVELOPMENT AND MANAGEMENT, MANILA, PHILIPPINES, 3-12 DECEMBER 1979

Submitted by the ESCAP Secretariat

(Document NR/CCOP/SOPAC (9)/CR.10)

The workshop, which was the first of its kind to be held in the South-east Asia and Pacific Region, noted that the techniques and methodologies which had been discussed and examined would have direct and immediate application to the activities of the countries of the region being undertaken or planned in coastal management.

Papua New Guinea's extensive potential offshore and onshore resources coupled with a small population were favourable to development. The Port Authority was the responsible agency controlling the development of Port Moresby, but no agency was responsible for the overall development of the country's coastal areas.

Fiji islands were subjected from time to time to destructive natural events such as hurricanes, earthquakes, and tsunamis and to the persistent demands of increasing population and tourism. Alternative energy sources were being sought, and the urgent need for a unified approach to development of coastal areas was recognised.

Samoa considered the development and management of its coastal areas to be very important. Improper siting without adequate studies beforehand had resulted in serious wave reflectance problems in established harbours and uncontrolled mining of sand beach deposits had facilitated erosion. Development of coastal areas might be hindered by complex local ownership and appropriate legislation was under consideration.

Solomon Islands land ownership was complicated and contributed to hindering development of resources. There was no specific agency controlling offshore areas and it was expected that offshore petroleum legislation would be enacted in 1980.

The workshop *strongly recommended* that:

1. Coastal Area Development and Management (CAD & M) be included as an agenda item on all future meetings of relevant regional, inter-governmental organisations including ASEAN, CCOP, CCOP/SOPAC, ESCAP, SEAFDEC, SPC, SPEC, UNEP, OETB, IOC/WESTPAC, and other U.N. bodies;
2. the agenda item on current and projected activities of CAD & M include consideration of the following:
 - major projects, data requirements and collection, research, legislation, policy and regulations, training, workshops, and public education;
3. one of the existing regional bodies be responsible for the collection, documentation and dissemination of information pertinent to CAD & M;
4. to facilitate communications one individual be designated in each national government and regional organisation to be responsible for all matters dealing with CAD & M;
5. in order to optimise the development of their coastal areas, close communications, co-operation, and co-ordination be established among all organisations within

each country involved directly or indirectly with CAD & M;

6. a team of experts be made available to visit each member country, upon request, to identify the CAD & M problems and to organise inter-organisational seminars, workshops, and research and to develop and/or review in-country and regional programmes as appropriate;
7. based on the specific CAD & M problems in member countries, further regional workshops be organised to apply the concepts of CAD & M to topics such as, but not limited to:
 - ports and harbours, water resources, mineral resources, coral and mangrove ecology, fisheries, animal husbandry, agriculture, mariculture and aquaculture, recreation and tourism, marine transport, ocean energy activities, standardisation of data, mapping, environmental control, and coastal area protection;
8. a directory of specialists, agencies, and institutions, listing their areas of competence in CAD & M, be compiled by OETB and the information disseminated to the countries;

The Workshop further *recommended* that:

9. present national legislation of the member countries pertinent to CAD & M be reviewed to insure that it incorporates principles of good resources management. Where legislation is found to be deficient immediate steps be taken to formulate adequate rules and regulations, appropriate institutional arrangements and a review process of coastal area development activities;
10. an inter-governmental personnel exchange programme be established or continued among member countries to improve CAD & M methods and the transfer of appropriate technology.

NOTE : Also presented were documents:

NR/CCOP/SOPAC(9)/CR.59 - Third United Nations Conference on the Law of the Sea. Resumed Ninth Session, Geneva, 28 July - 29 August 1980 - submitted by the ESCAP Secretariat (see Part I, report of TAG, para. 74);

NR/CCOP/SOPAC(9)/CR.63 - Report of the Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific - reproduced in full in this volume (see Part 4).

C. Training Reports

5. TRAINING PROGRAMME IN THE SOLOMON ISLANDS

Frank I. Coulson
Ministry of Natural Resources, Honiara,
Solomon Islands

(from Document NR/CCOP/SOPAC (9)/CR.22)

In common with many countries of the South-west Pacific, the provision of trained manpower is one of the most crucial needs in the Solomon Islands.

At this stage of educational development, the Solomon Islands finds great difficulty in identifying candidates suitably qualified to take advantage of advanced and specialised courses of education, and there is an understandable reluctance on the part of Government to commit the few graduates now in service to long periods of post-graduate education when they are so urgently needed for the immediate development programmes. However, two students will commence geology degree courses next year at the University of Papua New Guinea.

At the non-graduate level, there is an equal, if not greater, need for training. At this level the Solomon Islands has benefited and will continue to benefit from the following activities : Basic Earth Science Courses held at the University of the South Pacific; instruction in bathymetric map compilation and construction at the CCOP/SOPAC Technical Secretariat; shipboard training on CCOP/SOPAC and U.S.A. agencies' cruises in Solomon Islands waters.

6. REPORT ON THE TRAINING ACTIVITY ON BOARD R.V. MACHIAS

T. Kitekei'aho
Department of Lands, Survey and Natural
Resources, Nuku'alofa, Tonga

(from Document NR/CCOP/SOPAC (9)/CR.1)

During January/February 1980 I was invited to participate as a trainee on board r.v. *Machias* on project CCSP-1/TG-3 (Survey of nearshore areas for precious coral occurrence).

The survey was under the leadership of Dr John Halunen of the Project Office in Suva. I joined the survey party in Vava'u for the first leg of the survey and from Tongatapu to Pagopago for the second leg.

The survey was aimed at locating sites with precious coral types and to determine their quantity together with their related quality.

The first place of interest as we moved southward to Tongatapu was the eastern side of the platform; the shallow water of the western side was being reserved for the second half of the survey. The areas of research were mainly the channel mouths and adjacent areas that satisfied the conditions for jewel coral types.

We encountered many favourable sites on both legs of the survey, and collected many samples which were to be sent to Dr Grigg of the University of Hawaii for identification. Some of the samples collected, especially during the second half of the survey, looked promising but until comments on the samples are received from either the Project Office or from Dr Grigg, we cannot be positive that precious corals do occur in Tonga.

7. REPORT ON DEEP-SEA MINERAL PROSPECTING AND OCEANOGRAPHIC INVESTIGATIONS, IN-SERVICE TRAINING, FEBRUARY - MARCH 1980 ON R.V. HAKUREI MARU

F.G.H. Malele
Apia Observatory, Apia, Samoa

(from Document NR/CCOP/SOPAC (9)/CR.61)

This report of cruise GH.80-1 (2nd leg) includes reference mainly to on-board observations, survey methods, investigations, and daily work on the r.v. *Hakurei Maru*.

The Marine Geology Department of the Geological Survey of Japan has been engaged in marine geological and geophysical investigations in the Central Pacific region under the project *Basic Study on the Exploration of Deep-sea Mineral Resources* from 1974 to 1978. The wider area study was the northern part of the Central Pacific Basin, where manganese nodule distribution relative to topography, sedimentology, and other geologic factors was examined.

The programme has been re-organised into a new project *Geological Study of Deep-sea Mineral Resources* which will span the next five years. The area under surveillance lies between Wake Island in the north and Tahiti in the south.

The second part of the first reconnaissance cruise, in which I participated, GH.80-1 from Papeete to Funabashi, took place during January to March 1980. It consisted of two parallel survey lines,

(about 4500 km each) from the east of Wake to the west of Tahiti.

During the cruise I assisted with many operations and learned how to collect and process a wide variety of data. Underway geophysical observations included 12 kHz and 3.5 kHz echo sounding, seismic reflection profiling using two 150 cu. inch Bolt airguns, proton magnetometer surveys, and shipboard gravimetry measurements. Stationary operations included the use of free-fall photo-grabs and box and piston cores. Heat flow measurements were also made. On-board processing of samples included photography, visual description, smear slide examination, and X-ray photography. Geotechnical properties including vane-shear, water content, and cohesiveness measurements were also made. Manganese nodules collected were measured, weighed, and photographed on board the ship. All samples were subsampled for further study ashore including chemical analysis and dating.

During the cruise I also received basic training in use of the ship's satellite navigation system.

8, REPORT ON MARINE TRAINING AND SURVEY ACTIVITIES ON BOARD R.V. MACHIAS, NOVEMBER 1979 - JANUARY 1980

F.G.H. Malele & S.C.B. Saifaleupolu
Apia Observatory, Apia, Western Samoa

(from Document NR/CCOP/SOPAC(9)/CR.2)

The r.v. *Machias*, under charter to the U.N., visited Western Samoa for marine geological and geophysical investigations. The survey was scheduled into three cruises, each with a new cruise leader and concentrating within the Samoan waters.

As originally planned, the first leg was to carry out seismic sub-bottom profiling, completely enclosing the Western Samoan area. We were forced to abandon the plan because of an electrical fault with the graphic recorder. The rest of the scheduled time was spent in bathymetric survey of Salelologa and Asau harbours. This was done by the line-tape sounding method.

The second leg was devoted to bottom sampling using free-fall grabs and free-fall cameras. The recovery rate was slightly disappointing, probably due to rough sea conditions.

The last leg was to complete some of the work we could not fully or partly finish on the previous cruises. Most of the time was spent in precious coral investigations. We

were slightly successful on the east side of Upolu. Elsewhere there was little or no precious coral.

9, REPORT ON TRAINING ACTIVITY - CRUISES KI-80(1) AND KI-80(2)

B. Raobati
Fisheries Department, Tarawa, Kiribati

(from Document NR/CCOP/SOPAC(9)/CR.14)

Mr Tebeko and the author joined the CCOP/SOPAC charter vessel r.v. *Machias* in Pago Pago to take part in cruises KI-80(1) in the Phoenix Group and KI-80(2) in the Southern Line Islands.

Activities for trainees included working with the satellite navigator, handling sampling equipment, e.g., camera, grab, corer, and coral net and taking 4-hour watches on the depth recorder. We learned to operate the equipment and log satellite fix information and seafloor depth at regular intervals. When on station, the trainee on watch helped with the fitting, lowering and retrieving of the camera and grabs.

Activities were the same for the two cruises.

10, REPORT ON TRAINING IN MARINE GEOLOGY ON BOARD R.V. HAKUREI MARU

A.T. Utanga
Department of Survey and Physical Planning
Rarotonga, Cook Islands

(from Document NR/CCOP/SOPAC(9)/CR.3)

I was fortunate to be able to take part in the Geological Survey of Japan first leg cruise of their GH80-1 survey of the central and south Pacific from 12 January to 6 February 1980.

The research programme of GH80-1 was carried out under the Japanese special research programme of Geological Study of Deep Sea Mineral Resources and Study of the Exploitation Technique of Submarine Mineral Resources, sponsored by the Agency of Industrial Science and Technology, Ministry of International Trade and Industry.

The area surveyed on the first leg followed a straight line from 17°00'N, 177°30'E to 15°00'S, 158°30'W, the latter point being 435 km NE of Aitutaki in the Cook Islands. The second leg followed a parallel line from 15°00'S, 156°00'W to 17°00'N, 180°00'.

The survey was under the control of Dr A. Mizuno, Chief, Marine Resources Section of Marine Geology Department, Geological Survey of Japan, as chief scientist on board r.v. *Hakurei Maru*.

The r.v. *Hakurei Maru* sailed from Funa-bashi, Tokyo, on Saturday, 12 January 1980. My training programme on board the ship commenced on 13 January and for the next four days I was in No.5 laboratory reading the gravity meter records and observing the satellite navigation system.

From 17 to 20 January I was in No.1 laboratory reading and observing the 12 kHz PDR and the 3.5 kHz sub-bottom profiler and the seismic reflection profiling survey records and the sea gravity meter records.

The deep-sea sampling programme commenced on 21 January. I was attached to No.3 laboratory and the duties included preparation of the various samplers and assisting in their launchings. These samplers include single spade box corers, double spade box corers, piston corers, free-fall grabs with single shot deep-sea 10 mm cameras (boom-erang-preussag model). This free-fall photo grab sampler also incorporated a small sediment cylinder to obtain surface sediment. My training was concentrated on manganese nodules and their on-board treatment and sediments and their treatment.

I was transferred to No.3 laboratory from 24 to 27 January to work on manganese nodules. This included assisting with the handling of sampling gear (box corers, piston corers, and free-fall grabs with camera).

Nodules obtained were described and observed for occurrence and morphology (against a standard sample chart developed on earlier cruises, e.g., GH76-1), size classification, measurement of weight and abundance (kg per m²). Chemical analyses were to be carried out in their shore laboratory after the cruise.

I was transferred to No.1 laboratory from 28 to 31 January and worked mainly on seismic records and with the twin air-guns and compressor. From 1 to 4 February I was transferred to No.5 laboratory and worked mainly on the computation of corrected positioning by NNSS using the shipboard programmed computer.

Obviously the intensive training offered by the Geological Survey of Japan on board r.v. *Hakurei Maru* was very useful and beneficial and on a senior level. Therefore the trainee needs to be sufficiently trained in geology (marine) to be able to reap the full benefits of the training offered. The language problem was real but I was able to get help from English speakers on the staff and the crew.

NOTE : Also presented were documents:

NR/CCOP/SOPAC(9)/CR.4 - Report on Basic Earth Science Course, November 1979 - February 1980 - by W. Harrison, Vanuatu trainee (see Part 1, report of TAG, para. 53);

NR/CCOP/SOPAC(9)/CR.24 - Training activities at N.Z. Oceanographic Institute during 1979/80 - (see Part 1, report of TAG, para. 50, 51);

NR/CCOP/SOPAC(9)/CR.58 - Training report : R.V. *Machias* 1980 - by T.K. Tarau, Kiribati trainee (see Part 1, report of TAG, para. 47).

D. Data Management

NOTE : Documents presented were:

NR/CCOP/SOPAC(9)/CR.34 - The New Zealand underway data file - (see Part 1, report of TAG, para. 41);

NR/CCOP/SOPAC(9)/CR.50 - Soviet sample data submitted to the CCOP/SOPAC Data Repository - (see Part 1, report of TAG, para. 41).

E. Technology Related to Offshore Exploration, Mining, and Production

11. THE OUTLOOK FOR DEEP-SEA MINING INDUSTRY

Submitted by the ESCAP Secretariat

(from Document NR/CCOP/SOPAC(9)/CR.60)

Extensive exploration activities of the deep-sea mining industry consortia have resulted in the identification of potential nodule deposits which could be exploited as first generation mine sites in the North Pacific Ocean. Metallurgical problems of recovering metals from nodules have been essentially solved. Concern is now focussed on economic and operational feasibility rather than on the technical capability. A series of tests of small-scale plants have narrowed the number of possible processing routes, most of which are based on the hydrometallurgical technique.

Some of the consortia have already tested their mining systems (the collector, lifting system, and the mining vessel) at sea and have succeeded in raising nodules from a depth of around 5000 metres. The capability of each component of the mining system has been more or less proven, although the capacity of the collector has to be scaled up five times or more in commercial operation. The reliability and maintainability of the co-ordinated mining system appear to be the important unknowns to be resolved in the future. More detailed exploration work, including mapping, will be required on the potential mine sites. All these activities will demand substantially larger capital expenditure than the preliminary research and development work has up to now required. However, a substantial slow-down of the research and development work was recently announced by the major consortia.

None of the consortia have discontinued their joint activities completely. Since their decisions to slow down current work, no participant has withdrawn from any of the major consortia. It is therefore, clear that re-activation or disintegration of joint activities by the deep-sea mining consortia will largely depend on the future development of international and/or national legal regimes and on the future outlook in the world metal markets.

F. Summary of Activities in Areas Outside CCOP/SOPAC Region

NOTE : Documents presented were:

NR/CCOP/SOPAC (9)/CR.30 - Marine investigations of the Geological Survey of Japan, 1980 (see Part 1, report of TAG, para. 35);

NR/CCOP/SOPAC (9)/CR.49 - Main principles of geological mapping of shelf zones in the USSR.

G. Results of Work Completed in the CCOP/SOPAC Region

COOK ISLANDS

12. CRUISE REPORT : COOK ISLANDS OFF-SHORE SURVEY, CK-80(1), 21 MARCH TO 7 APRIL 1980

G.A. Gauss
Project Office, Suva, Fiji
and

D.L.E. Moreton
Monash University, Melbourne, Australia

(from Document NR/CCOP/SOPAC (9)/CR.21)

The first of two cruise legs planned in Cook Islands waters during the 1979/80 cruise programme of the U.N. chartered vessel r.v. *Machias* was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/CK.1 (Sea bed investigation for manganese nodules and crusts in oceanic areas adjoining the Cook Islands), CCSP-1/CK.2 (Distribution and economic potential of submarine phosphate deposits in Cook Islands waters), and CCSP-1/CK.3 (Investigation for precious coral in the nearshore waters surrounding the Cook Islands).

Altogether, 21 sampling stations were occupied during this cruise leg, of which 17 were for manganese nodules (Stns 1-5, 7, 9-19), three were for precious coral (Stns 8, 20, 21) and one was for phosphate (Stn 6). Stns 1, 2, and 3 are outside Cook Islands waters and were undertaken to balance some stations made in the Cook Islands zone during the previous cruise which was to Line Islands (Kiribati) waters (see Project Report No.36).

Manganese nodules

Sediment recovered at the manganese nodule stations indicates that the deep-sea floor in the Penrhyn Basin is composed of dark red-brown mud at its surface. Coarse detrital material is uncommon although some small pumice fragments were recovered. These were usually stained with brown oxides.

Manganese nodules or nodule fragments were recovered at Stns 2-5, 7, 9-12, and 14-18. Nodule concentrations varied from insignificant to dense, with the largest concentration of 23.7 kg/m² at Stn 3 to the south-east of Penrhyn Island, just outside the Cook Islands economic zone. The second and third highest nodule concentrations also occurred to the southeast of Penrhyn Island, at Stns 4 and 5 respectively, and within the Cook Islands economic zone.

Precious coral

Dredging for precious coral was carried out at the islands of Penrhyn (Stn 8), Manihiki (Stn 20), and Nassau (Stn 21). A preliminary identification of the material recovered indicates that some of the coral recovered at Manihiki is of precious *Corallium* type. Corals recovered at the other stations all appear to be of non-precious type.

Phosphate

At the only station sampled for phosphate - the seamount lying to the southeast of Penrhyn (Stn 6) - two small pieces of dead coral were recovered.

13. CRUISE REPORT : NORTHERN COOK ISLANDS OFFSHORE SURVEY, CK-80(2), 16-28 APRIL 1980

K.B. Lewis
N.Z. Oceanographic Institute, Wellington,
New Zealand

(from Document NR/CCOP/SOPAC(9)/CR.40)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/CK.1 (Sea bed investigation for manganese nodules in oceanic areas adjoining Cook Islands), CCSP-1/CK.2 (Distribution and economic potential of submarine phosphate deposits in Cook Islands waters), CCSP-1/CK.3 (Investigation for precious coral in the nearshore waters surrounding the Cook Islands), and CCSP-1/CK.4 (Study of sediments and sedimentary processes of beach, lagoon, and adjacent offshore areas of Rarotonga and other islands to assist with coastal management programmes).

Seventeen tangle net stations and one camera station were occupied off Pukapuka, Tema Reef, Rakahanga, Manihiki, and Penrhyn islands in the search for precious coral. No suitable 200-600 m deep plateaus or channels were found so all were on relatively steep slopes within about 1 km of coral reefs.

Fragments of precious coral of the genus *Corallium* were dredged from two stations, one off Pukapuka and one off Penrhyn in the northern Cook Islands. Non-commercial species of gold coral were found at four stations, two off Pukapuka, one off Rakahanga, and one off Penrhyn. Most of the stations yielded specimens of the family Dendrophyllidae. This group commonly occurs associated with, but deeper than, precious coral in the North Pacific. It prefers the same hard substrates and moderately strong currents. Future surveys

should concentrate on a search for channels and ridges at depths of 150-300 m (somewhat shallower than in the North Pacific). However, large areas at such depths, where deposits could be extensive enough to be commercial, appear to be rare because of reef growth on a generally subsiding substrate. Surveys around rising "makatea" islands might offer the best prospects for success.

No seamounts within 200 m of sea level were discovered so no dredging for submarine phosphate was attempted.

A small phosphate deposit on Manihiki was resampled and a search was made for similar depositional environments on Manihiki, Rakahanga, and Penrhyn. One soil sample from Te Puka Island at the southwest corner of Manihiki Atoll contained 9.38% P_2O_5 and three sediment samples from an adjacent partly enclosed brackish pond contained 1.41-4.63% P_2O_5 . All other samples contained less than 0.51% P_2O_5 .

One station was occupied in the western Penrhyn Basin to complete a survey for manganese nodules begun on earlier cruises. It yielded abundant nodules (32 kg/m²). In all three samples analysed the combined value of nickel, cobalt, and copper did not exceed 1%. These values are the same as others previously found in nodules from the same basin and are substantially lower than values from North Pacific nodules.

Sufficient bathymetric information was collected around Manihiki, Rakahanga, and Penrhyn that, with the body of pre-existing data, environments for precious coral and phosphate accumulations can be defined.

The position of the centre of Tema Reef was estimated to be at 11°07.1'S, 165°36.1'W. This is between its charted position and its last reported position and about 4 km from each. The reef is about 200 m in diameter. It is closest to sea level in the southwest and deepens to the north and west. There appears to be a more deeply submerged ridge out to the north.

NOTE : Also presented was document:

NR/CCOP/SOPAC(9)/CR.11 - Cruise CK-80(2), Addendum to Cruise Report No.42 - these results are incorporated into paper 13, this report (CR.40).

FIJI

14, CRUISE REPORT : FIJI OFFSHORE
SURVEY, FJ-78(1), 28 OCTOBER -
1 NOVEMBER 1978

J.V. Eade
N.Z. Oceanographic Institute, Wellington,
New Zealand

(from Document NR/CCOP/SOPAC (9)/CR.20)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP/FJ-5 (Sea bed sampling for phosphorites in the Lau Group). It was the first cruise of the 1978/1979 CCOP/SOPAC field programme and continued investigations into recent mineral discoveries on the Lau Ridge near the islands Ongea Ndriki and Vatoa in Fiji.

Echo soundings were collected north of Vatoa (2 ridge crossings) and south of Vatoa (1 ridge crossing). These tracks were designed to supplement existing data collected by r.v. *Tangaroa*, r.v. *Kana Keoki* and HMFSS *Ruve*. They confirmed the very irregular nature of the sea floor in this area.

One station was successfully completed on the ridge crest north of Vatoa Island. Several small boulders of soft foraminiferal limestone, light brown in colour, were dredged from about 500 m. This rock is probably recent in origin, being formed partly by iron oxide from sea water and partly by remobilisation of carbonate within the sediment.

A bathymetric map of the Lau Ridge near Ongea Ndriki and Vatoa has been constructed from all existing echo sounding data available. The ridge is an irregular feature about 65 km (35 n.m.) wide. The eastern side is clearly defined by a very steep slope, increasing from 400 to 600 m on the ridge to depths over 2400 m in the Lau Basin over horizontal distances of less than 19 km (10 n.m.). The western side of the ridge is characterised by gentler slopes, increasing from about 600 m to 1200-2000 m over horizontal distances of about 28 km (15 n.m.). The crest of the ridge consists of several peaks and narrow, steep-sided ridges. Shallowest areas, less than 400 m, lie along the western edge of the Lau Ridge, north and south of Vatoa Island, where the ridge is continuous at depths less than 800 m. Further shallow areas, less than 400 m, lie to the west of Vatoa where there are several isolated peaks rather than a distinct ridge feature.

Seismic reflection profiles were collected by r.v. *Kana Keoki* in two crossings of the Lau Ridge in the area under study. Moderate-

ly thick sedimentary sequences in the basin west of the ridge, the northernmost part of the South Fiji Basin, thin on to the ridge. The ridge consists of a highly irregular basement with pockets of sediment lying between basement outcrops. Basement, especially where it outcrops, appears to be volcanic. Older sediments, which can be recognised as sub-bottom reflectors in deep water, outcrop on the higher parts of the ridge.

Three dredgings have produced samples from higher parts of the ridge near Vatoa. Two of these, both collected by r.v. *Tangaroa*, samples 1306 and 1308 have been analysed. Rocks dredged consist of foraminiferal limestone and various volcanoclastic rocks with various amounts of calcium carbonate. Most rocks are encased in an Fe/Mn crust and some Fe/Mn nodules are also present.

One limestone sample has been analysed for phosphate and contains 10% P_2O_5 . This sample is a foraminiferal limestone which appears to have been phosphatised in situ. Further sampling and analysis are required to evaluate the distribution and quality of this phosphatised limestone and its relationship, if any, with the phosphatic soils on nearby islands.

The Fe/Mn crusts and nodules have also been analysed. Formation of these deposits appears to have been in two stages. Some Fe/Mn material and rock samples are enriched in manganese (<20%) and molybdenum (<0.03%) and are noticeably low in iron (>5%), copper (>0.01%), nickel (>0.05%), cobalt (0.05%). Other samples (crust samples only) are high in iron (<20%), manganese (<15%), copper (0.04), nickel (0.4), cobalt (0.5) and lead (0.25%). Molybdenum is also high (0.05%).

15, CRUISE REPORT : LAMI HARBOUR
SURVEY, 12-17 DECEMBER 1979

A. John Halunen, Jr
Project Office, Suva, Fiji
and

Shwe Kyaw
Mineral Resources Department, Suva, Fiji

(from Document NR/CCOP/SOPAC (9)/CR.8)

The Mineral Resources Department, Fiji, Off-shore Section assisted by the Project Office, conducted a shallow seismic reflection survey of an area in Suva Harbour to help determine the sub-bottom foundation properties necessary for the relocation of a bulk petroleum offloading facility. An E.G. & G. Uniboom seismic reflection profiling system was used for the survey.

The main objective of the survey was to determine the strike and dip of the upper surface of the Lami Limestone (soapstone) which lies submerged beneath the survey area. This information is necessary first to locate drill sites and later pilings to be used to support a pipeline for off-loading petroleum.

The survey was made spanning the low tide period on the day of the survey (17 December 1979). On each profile the vessel proceeded into the shallowest water possible before terminating the survey line.

The series of lines seen directly below bottom represent relatively thin layers of sediment roughly parallel to the bottom. The thickness of these layers assumes a sediment velocity of 1500 m/s. Below these stratified sediment layers is a rough apparently bumpy surface. Each high lump in this dispersed layer is thought to be a small patch reef which, when numerous, cause significant dispersion of acoustic energy. Often on the profiles these features absorb or disperse nearly all of the energy, hence, occasionally, layers which are below these features are not seen. In areas where this layer is non-existent or minimal sedimentary layers can be seen well down into the column.

The particular layer of interest here, inferred to be the top of the Lami Limestone, is always dipping to the south or southeast toward the deeper part of Suva Harbour. On several profiles the layer does not appear, probably being masked by the overlying opaque (dispersing) layer. During test runs through the area at high tide, the top of the Lami Limestone is much better defined on the records.

Comparisons of depth to reflectors with borehole data strongly suggest that the seismic velocity of the sediment overlying the Lami Limestone is very near that of water.

16. DIAMOND DRILLING RESULTS FROM A BARRIER REEF ADJACENT TO SUVA

R. Holmes
Mineral Resources Department, Suva, Fiji

(from Document NR/CCOP/SOPAC (9)/CR.73)

Laucala Bay is a lagoon adjacent to Suva which is 6 km long from west to east between Suva Point and the Rewa Delta and 9 km wide from north to south between the barrier reef inner margin and the furthest land shore to the north. The barrier reef enclosing Laucala Bay varies in width from 0.8 to 2 km and runs from east to west across the mouth

of the bay. All coarse sediments from the Rewa Delta distributaries which run into Laucala Bay are contained within the bay. Laucala Bay also receives coarse sediments in the form of coral sand which is brought in to the reef margin of the lagoon from the southeast, south or southwest by waves and by the tidal ebb current which drains off the reef towards the north. The coral sand accumulates on the inner margin of the barrier reef enclosing the bay but the sand is stable and accumulates slowly so that sea grass grows on top of the deposit.

The coral sand accumulating on the inner margin of the barrier reef is dredged in one concession area by Fiji Industries Ltd at rates of 800 000 to 100 000 tonnes per year and is used for cement manufacture. The cement produced meets all Fiji's needs and is also exported to other countries. At present rates of dredging Fiji Industries Ltd estimates that the concession area has sufficient reserves to last another 15 years. After this there may be a problem locating new dredge concession areas in the Suva region which do not interfere with fishing, important tourist amenities, and ships' navigation into Suva and which are close enough to Fiji Industries Ltd processing plant to be an economic proposition.

The reefs and lagoons adjacent to Suva are being studied in relation to pollution and the environmental impact of coral sand dredging - past, present, and future. The study is being conducted at the University of the South Pacific by Mr N. Penn. As part of the study a drilling programme was carried out to help determine rate of growth and origin of the inner barrier reef platform.

Results

1. The corer would not recover a loosely cemented stick work of coral, coral sand, or loose coral fragments. Massive corals or strongly cemented corals were recovered by the corer.
2. Two sites were drilled on a 1.20 km wide section of the barrier reef enclosing Laucala Bay and adjacent to the concession area presently being exploited by Fiji Industries Ltd for coral sand. Both sites were on the consolidated reef platform which was largely drained of water at low tide.

It was found that:

1. the soft ground under the hard pavement adjacent to the lagoon may yield resources of coral sand to last several years beyond the presently estimated life of the concession;
2. the barrier reef on its inner and central portions is very porous and perme-

able. This suggests that:

- (a) there has been relatively rapid build up of reef structure in the late Quaternary on parts of the south coast of Viti Levu; and
- (b) that any feasibility studies for wave energy or engineering projects in similar environments should include a reconnaissance drilling programme for data on the strength and the permeability of the reef.

17. STATUS OF PETROLEUM EXPLORATION IN FIJI (1980)

R.N. Richmond
Mineral Resources Department, Suva, Fiji

(from Document NR/CCOP/SOPAC (9)/CR.26)

The four areas under licence at the beginning of 1980 were.

1. Lomai Viti - Bau Waters area : Dakota and Pacific Energy; option to Mapco;
2. Bligh Waters : Mapco and Pacific Energy; Chevron option;
3. Yasawas Area : Pacific Energy; Chevron option;
4. Great Sea Reef area : Pacific Energy; Chevron option.

All these licences had been granted in 1978 with a requirement that a well be drilled in each area within three years. Although a number of applications for licences were received during the year, no new licences were granted pending the results of drilling operations later in the year.

Exploration

As all the licensees had carried out extensive marine seismic, gravity, and magnetics surveys during the previous two years, no new exploration was conducted in 1980 while the previously collected data were being processed and interpreted to select drilling targets.

Site Surveys

Chevron Fiji Inc., which had contracted the drillship *Diamond Ice* to drill in Fiji, carried out site surveys on possible drill locations as required by the Directions issued under the Petroleum (Exploration and Exploitation) Act, 1978. These site surveys were carried out at four locations in the Bligh Water area and three locations in the Great Sea Reef area. The site surveys showed that there should be no danger of shallow gas blowouts.

Drilling

On 16 May, the drillship *Diamond Ice* arrived in Fiji to drill one hole (with an option for a second) for Chevron while en route from Chile to Singapore. Bligh Water No.1 was spudded-in on 23 April, about 10 km north of Mba town in water about 47 m deep. It was plugged and abandoned as a dry hole on 24 June after encountering drilling difficulties at a depth of 2743 m. The rig then moved to the Great Sea Reef licence area where Great Sea Reef No.1 was spudded-in on 30 June at a water depth of 54 m, about 50 km west of Yandua Island. On 6 August this hole was also plugged and abandoned as a dry hole. The *Diamond Ice* then left for Singapore.

Results

Although the detailed results of the drilling are still confidential, certain general information is now common knowledge. Among this is that the sedimentary column drilled is much thicker than the acoustic basement delineated from seismics. Temperatures appeared to be favourable and the hole in Bligh Water ended in a Lower Tertiary sequence without reaching basement. Several lost-circulation zones were encountered during the drilling operations. No hydrocarbon traces were found.

Prognosis

The data gathered in the Bligh Water and Great Sea Reef drill holes are currently being analysed to determine future exploration programmes in the area. While these two wildcat holes, the first ever drilled in Fiji, were dry, they have confirmed an interesting sequence and thickness of sedimentary rocks. They should also help continue to keep Fiji and other southwest Pacific islands a worthwhile target area for petroleum exploration.

KIRIBATI

18. CRUISE REPORT : KIRIBATI OFF-SHORE SURVEY, KI-80(1), 9-25 FEBRUARY 1980

G.A. Gauss
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC (9)/CR.42)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/KI.1 (Assessment of possibilities for occurrence of offshore phosphate deposits in the Kiribati Islands region); CCSP-1/KI.2 (Investigation of the occurrence of manganese nodules/

crusts in the Kiribati Islands region), and CCSP-1/KI.3 (Investigation for precious coral in the nearshore waters surrounding the Kiribati Islands).

During this cruise the south-eastern quadrant of the Phoenix Islands Group off-shore area was sampled. Manganese nodules exist in the deep-water eastern basin of the Phoenix Group in sufficient quantities to have potential as an economic deposit, provided that a sufficient metal content grade also exists. Analyses of the samples collected during the present cruise indicate, however, that grades of the principal economic minerals - copper, nickel, and cobalt - are well below those generally quoted as being the cut-off limit for economic exploitation.

No indications of precious coral were found at Phoenix or Sydney Islands where dredgings were conducted.

No areas sufficiently shallow to be of potential interest for investigation for phosphate deposits were encountered along the lines of the ship's track in the cruise area.

19. CRUISE REPORT : SOUTHERN LINE
ISLANDS SURVEY, KI-80(2),
29 FEBRUARY - 17 MARCH 1980

A. John Halunen, Jr
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.46)

This cruise of r.v. *Machias* was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/KI.1 (Assessment of possibilities for occurrence of offshore phosphate deposits in the Kiribati offshore region), CCSP-1/KI.2 (Investigation of the occurrence of manganese nodules/crusts in the Kiribati region), and CCSP-1/KI.3 (Investigation for precious coral in the nearshore waters surrounding Kiribati).

The deep ocean samples collected during this cruise suggest there are no manganese nodule deposits in the immediate vicinity of the Southern Line Islands, or to the south between the Southern Line Islands and Tahiti. A total of ten stations were occupied in this area.

A brief bathymetric survey was made of the flanks of Vostok Island, but slopes proved to be too steep for anything more to occur other than the occasional specimen of precious coral.

20. CRUISE REPORT : KIRIBATI LINE
ISLANDS NODULE SURVEY, KI-80(3)
1-20 MAY 1980

K.B. Lewis
N.Z. Oceanographic Institute, Wellington,
New Zealand

(from Document NR/CCOP/SOPAC(9)/CR.15)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/KI.2 (Investigation of the occurrence of manganese nodules and crusts in the Kiribati region). The nine stations occupied were between 7°S and 7°N and ranged in depth from 4610 to 5355 m.

Only four stations yielded nodules. In three samples south of the Equator, nodules were moderately abundant and in one sample north of the Equator, there were a few small fragments. The southernmost sample, which was in the north-west corner of the Tapu Basin, consisted of fragments of several large (9 cm) discoidal nodules, whereas the other nodule samples were generally small and irregular.

Small sediment samples were obtained at eight stations. At two deeper than 5000 m the sediment was residual brown clay. At five stations the sediment consisted of various light brown mixtures of residual brown clay and foram/nanno ooze, indicating that the samples were collected just above a carbonate compensation depth at about 4800 to 5000 m depth.

Bottom photographs were attempted at seven stations, but successful results were obtained only at Stn 1.

NOTE : Documents also presented were:

NR/CCOP/SOPAC(9)/CR.9 - Cruise KI-80(3),
Addendum of Cruise Report No.43 - these results are incorporated into paper 20, this report (CR.15).

NR/CCOP/SOPAC(9)/CR.12 - Cruise KI-80(2),
Addendum to Cruise Report No.36 - these results are incorporated into paper 19, this report (CR.46);

21. PETROLEUM DEVELOPMENT IN NEW
ZEALAND

H.R. Katz
N.Z. Geological Survey, Lower Hutt,
New Zealand

(from Document NR/CCOP/SOPAC(9)/CR.45)

EXPLORATION

Offshore - No exploration activities were

carried out during 1979 and most of 1980. A seismic vessel arrived in New Zealand in mid September 1980, and surveys lasting about 8 weeks are planned. Drilling is soon to be resumed, too, with the SEDCO 445 drillship due for about November 1980, to drill a first well in the North Taranaki Bight.

Onshore - The Government-owned company Petrocorp has remained the only operator. After abandoning Toko-1 in Taranaki, it drilled McKee-1 on a neighbouring structure later in 1979, then shifted the rig to the west coast of the South Island where Kokiri-1 was drilled early in 1980. This was followed by a return of the rig to Taranaki, where a step-out well, McKee-2, was spudded-in on 14 August 1980. It is currently drilling.

DEVELOPMENT AND PRODUCTION

Platform A of the large offshore Maui field was commissioned and started production in June 1979. In spite of this, total production of the Maui and Kapuni fields combined amounted to less, for the year 1979, than Kapuni had produced alone in previous years. The total daily average of gas and condensate production further declined during the first seven months of 1980, but a pronounced increase of Maui's production is noted. In Kapuni, a considerable proportion of the gas is now being re-injected to maintain pressure, and to gain the maximum in condensate production.

CONCESSION CHANGES

During 1979/1980, all previously held offshore exploration concessions expired, but new ones were granted in partial replacement to Hunt International Petroleum Company (2 blocks south of the South Island, a total of 79 254 km²), to New Zealand Petroleum Co. Ltd (west of the South Island, 6143 km²), and to Shell BP and Todd Oil Services Ltd (offshore Taranaki, 2 licences totalling 11 441 km²). Thus 96 838 km² of offshore areas are currently under licence. Several more applications, however, have recently been received for further offshore licences, and are currently under discussion by the relevant government departments.

On land, Petrocorp relinquished its Wanganui licence and is now holding four blocks to a total of 11 436 km².

NOTE : Another document presented was:

NR/CCOP/SOPAC (9)/CR.33 - New Zealand's activities in the CCOP/SOPAC Work Programme - the contents of this document are presented in Part 2, CCOP/SOPAC Work Programme.

PAPUA NEW GUINEA

22. CRUISE REPORT : PAPUA NEW GUINEA OFFSHORE SURVEY, PN-79(1), 10-26 MARCH 1979

J.V. Eade
N.Z. Oceanographic Institute, Wellington,
New Zealand

(from Document NR/CCOP/SOPAC (9)/CR.18)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP/PN.8 (To explore for and evaluate the potential of possible metalliferous sediments in basins where there is known high heat flow or near-by volcanic activity) and CCSP/PN.9 (An evaluation of the potential for submarine phosphate deposits in northern Papua New Guinea).

Project PE/PN.8: Five samples (1-5) were collected from the Manus Basin and two (26, 27) from the south New Ireland Basin. Surface sediment in the Manus Basin is soft to sloppy brown mud. In cores from Stns 1 and 2, this mud is underlain by stiff grey mud and silt with some plant debris. The mud is thought to be primarily derived from air- and water-borne volcanic material and deposited slowly. The underlying grey mud and silt are turbidite layers which apparently occur throughout the eastern end of the basin. Active or recently active volcanic centres lie to the south of the area sampled, especially near Manus Island, Witu Islands, and along the northern coast of New Britain. Volcanism is also thought to be taking place on the Manus-Willaumez Rise which bisects the Manus Basin. Metalliferous enrichment of sediments may be associated with this volcanism. All five samples collected have been tested (by AMDEL, Australia) for the following: Cu and Zn (for sulphide concentration); Mn and Fe (for ore body halo); Al (for terrigenous detrital dilution); Ca (for organic CaCO₃ dilution); and Pb and Zn.

The one sample collected from south New Ireland Basin has also been tested for metalliferous enrichment.

Results have been compared with mean values calculated by Cronan & Thompson (1978) from 230 samples representing most basins in the South-west Pacific where fine sediments are accumulating. Most metal values from the Manus Basin and south New Ireland Basin samples are less than the regional mean values. Manganese values at Stns 4 and 5 from Manus Basin are higher than the average but not to any significant extent.

Project PE/PN.9: Eleven bathythermograph stations were occupied in the area north of New Hanover and northern New Ireland. Temperature profiles at all stations were very similar and temperatures were the same, or nearly so, at the same depth throughout the area indicating no active upwelling at this time. Seismic reflections were collected along about 300 km in two lines across the New Ireland Basin and bounding ridges.

New Ireland and adjacent islands are part of a Cenozoic island arc. Volcanism occurred in pre-middle Miocene and Quaternary times building up the New Hanover - New Ireland ridge and the Mussau - Tabar - Green Island ridge (also called the North-east Ridge). Miocene and Pliocene limestone and volcanoclastics lie draped across these volcanic centres and are up to 4000 m thick in the intervening basin, the New Ireland Basin. These limestones and volcanoclastics outcrop on most islands and were dredged from the seafloor off the west end of New Hanover and from several localities on the Mussau - Tabar - Green Island ridge. Limestone and calcareous sediment samples collected have been tested (by AMDEL, Australia) for phosphate content.

All phosphate values are low and do not represent any significant past or present concentration of phosphate in this area.

SAMOA

23. CRUISE REPORT : SAMOA OFFSHORE SURVEY, WS-79(1A), 24-28 NOVEMBER 1979

Garry A. Gauss
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.19)

This work was undertaken as part of the CCOP/SOPAC Work Programme CCSP/WS.5 (Coastal zone management surveys for landfill, construction materials and harbour construction).

Salelologa Harbour

A soundings chart was prepared at a scale of 0.25 inches equals 0.01 nautical mile (scale of the field plot) showing spot depths in metres below Chart Datum along the 15 lines measured and hand-sounded across the final approach channel between the outer leading light and the dock. The position of the channel marker piles, leading lights, and dock face, all of which were fixed by radar as described above, are also shown on this plan. An inset plan, at a larger scale, of the dock face showing spot water depths along the face is also on the chart. This was made by tape measure and hand-sounding

line. All soundings on the chart were reduced to Chart Datum by applying a correction for the tidal levels predicted for Apia Harbour as published in the Admiralty Tide Tables, Volume 3 (Pacific Ocean). No time or height difference data between Apia and Salelologa are available and these are almost certainly negligible.

Asau Harbour

A soundings chart was prepared at a scale of 1 cm equals 0.01 nautical mile (scale of the field plot) showing spot depths in metres below Chart Datum along the lines measured and hand-sounded across the channel entrance to the Harbour. In all, 13 lines were sounded between the outer reef point and the inner, north side, channel marker pile. Soundings have been reduced to Chart Datum by applying a correction for the tidal levels calculated for Asau Harbour from the predictions and corrections for Apia published in the Admiralty Tide Tables.

24. CRUISE REPORT : SAMOA OFFSHORE SURVEY, WS-79(1B), 24 NOVEMBER, 3-6 DECEMBER 1979

G.A. Gauss
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.56)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/WS.6 (Crustal seismic survey of sediment thickness and basement structure of the Samoan Platform to determine the hydrocarbon potential).

A total of 470 nautical miles of airgun reflection profiling was carried out around Upolu and Savaii, with lines extending up to a maximum distance of about 25 miles from shore. Water depths encountered along the airgun lines ranged from about 100 m in the nearshore platform areas to about 4500 m at the base of the slope offshore.

Although over the greater proportion of the lines run with the airgun around Upolu and Savaii acoustic basement lies at or near the sea bed, sediments of sufficient thickness and areal extent to be resolved on the records do exist in places. The maximum thickness observed, possibly up to about 560 m (at water velocity), occurs about 6 miles east of Salelologa on the shallow water platform in the Apolima Strait. Elsewhere, sediments appear to be thin on the shallow water platform areas. Thicknesses may reach about 225 m on the steep slopes surrounding the islands and 300 m further offshore in abyssal depths. The sediment thicknesses indicated by this preliminary

interpretation of the airgun work are not normally considered sufficient for significant hydrocarbon generation and entrapment.

25. CRUISE REPORT : SAMOA OFFSHORE
SURVEY, WS-79(2), 6-24 DECEMBER
1979

G.A. Gauss
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.17)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/WS.1 (Assessment of possibilities of sea bed phosphorites on the slopes of the Samoa Platform and seamounts northwest of Savaii and south of Upolu); CCSP-1/WS.2 (Sea bed investigations for manganese deposits on the Samoa Platform and in Samoan oceanic areas), and CCSP-1/WS.4 (Investigation of the deeper flanks of the island slope for precious coral).

Altogether 39 sampling stations were occupied during this cruise period. Of these, 32 were deep-water stations (Stns 1-2, 5-11, 15-22, 24-31, 33-39); 5 were relatively shallow-water stations sampled for phosphorite (Stns 3, 4, 14, 23, 32), and 2 were coral dredge stations (Stns 12 and 13).

Manganese deposits

At most of the deep-water sampling stations the grab samplers came up empty except for traces of red-brown mud adhering to the metal jaws, or for a few small fragments of volcanic material, probably pumice. This indicates that the deep-sea bed in the survey area is generally composed of red-brown mud without significant amounts of coarse material. However, at Stns 22, 24, and 29 to the north-west of Savaii, several handfuls of volcanic pebbles were recovered at each station. Most of these were stained with ferro-manganese oxides although they would not normally be described as manganese nodules. It is possible that the greater abundance of volcanic pebbles from these stations is due to the prevailing southeasterly winds and currents carrying pumice material from the recently active island of Savaii.

At Stns 3, 4, and 23, which were rock dredge stations on seamounts, ferro-manganese oxide stained or coated carbonate rock fragments, some very large, were recovered, and at Stn 23 oxide-coated material of probable volcanic origin also occurred. Some

pebbles from the last station are completely coated with a thin oxide layer and can be termed manganese nodules. Analysis of a sample of these nodules by the Australian Mineral Development Laboratories (AMDEL) gave a combined Cu / Ni / Co content of 0.45%.

At Stn 10, situated to the east of Upolu where the sea bed forms a saddle between Upolu and Tutuila (American Samoa), the rock dredge recovered a small sample of basalt with a thick ferro-manganese oxide coating. Analysis of a sample of this material by AMDEL gave a combined Cu / Ni / Co content of 0.32%.

Phosphorites

At Stns 3, 4, and 23 quite large amounts of carbonate rock were dredged up. Identifiable materials included massive and single dead corals and cemented calcarenite and calcirudite material, much of which is clearly of shallow water origin. At Stn 32 the dredge recovered a small amount of biogenic, skeletal, non-carbonate material, possibly from siliceous sponges. Analyses of samples of material from Stns 3 and 4 by AMDEL gave P_2O_5 contents of 0.85 and 0.05% respectively. $CaCO_3$ contents were 86.9 and 94.8% respectively.

Precious corals

At Stn 12 the coral tangle net dredge was snagged on the sea bed and lost. At Stn 13 a small sample of dead, white, non-precious coral was recovered.

26. CRUISE REPORT : SAMOA OFFSHORE
SURVEY, WS-80(1), 8-13 JANUARY
1980

A. John Halunen, Jr
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.43)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme for CCSP-1/WS.4 (Investigation of the deeper flanks of the island slope for precious coral).

Living and dead *Corallium* specimens were recovered from 300-350 m water depth off the north-west end of Savaii (Falealupo).

No interesting coralline material was found along the south coast of Savaii and this area may be eliminated as a prospective area.

SOLOMON ISLANDS

27. CRUISE REPORT : SOLOMON ISLANDS/ PAPUA NEW GUINEA OFFSHORE SURVEY SI-79(2), 26 FEBRUARY - 8 MARCH 1979

J.V. Eade
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.54)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP/SI.8 (Investigations into metal dispersion in marine sediments around Vella Lavella and in other nearby areas), CCSP/PN.9 (An evaluation of the potential for submarine phosphate deposits in northern Papua New Guinea), and CCSP/PN.12 (An assessment of the potential of deep water precious corals, especially *Corallium*, Papua New Guinea).

Twenty-two sediment samples were collected from four areas within the New Georgia volcanic province. No concentrations of either "indicator" metals (Mn or Al) nor metal sulphides (Cu, Pb, Zn, Ni) were found in any of the four areas - in Paraso Bay, Vella Gulf, Blanche Channel, and south of Vangunu Island.

Results of dredgings off north-western Bougainville are not encouraging for phosphate occurrence. No phosphate concentrations were found in limestone samples from a ridge which lies approximately 75 km west of northern Bougainville.

No *Corallium* was collected in the dredges used for phosphate sampling. However, as the environment (depth and nature of the sea floor) is favourable for *Corallium* to occur, and as *Keroeides* and *Dendrophyllia* were collected, further dredgings should be made on the shallower parts of this ridge.

28. CRUISE REPORT : SOLOMON ISLANDS OFFSHORE SURVEY, SI-79(3), 10 OCTOBER - 25 NOVEMBER 1979

J.V. Eade
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.41)

In late 1975 - early 1976, fragments of gem coral were reported from several localities in the Solomon Islands by the Japanese company Takuho Eresi Ltd. The 2½ month survey was carried out with Solomon Island Government permission and was monitored by the Fisheries Division of the Natural Resources Department. The company did not present a report on the survey, but Fisheries Division officers

participating in the survey kept notes on the work done. The results were apparently considered unfavourable as the company showed no interest in continuing after working in Solomon Islands for 2½ months.

This cruise (SI-79(3)) was undertaken as part of the CCOP/SOPAC Work Programme CCSP/SI.14 (The potential of precious corals, especially *Corallium* species, in the Solomon Islands).

Hard bottom (attached) corals were collected at 48 stations; about 18 species were collected. They ranged from the soft chitinous corals, to chitinous corals with a calcareous outer layer, to purely calcareous species.

The most common forms collected that indicate a favourable environment for *Corallium* occurrence include calcareous hydrocorals (*Stylaster* sp., *Stenohelia* sp., and *Cryptothelia* sp.), the dendrophyllid coral *Enallopsammia* sp., and non-commercial gorgonian corals *Calyptrophora* sp., *Callogorgia* sp., *Keroeides mosaica*, and *Narella* sp.

Corallium was recovered at 14 stations and hard bottom found at another 34 stations. Four species of *Corallium* were found at localities throughout the area studied from Shortland Islands in the north-west to Makira in the south-east. However, *Corallium* appears to be more common in the area from Ndai Island, through Indispensable Strait, to Marau Sound. The potential for the occurrence of commercial quantities of precious coral is greatest in the Indispensable Strait area between Ndai Island and Marau. The following were collected from this area. One specimen of *C. konojoi*, collected living, is of commercial grade, but being white is of relatively low value. Another specimen, probably *C. elatius*, is of commercial grade (size and colour), but as it was dead when collected it is not commercial. *Corallium* sp. d. has excellent colour but none of the three specimens collected are large enough to be commercial.

The existence of these specimens, the presence of several gorgonians and one dendrophyllid frequently found in association with *Corallium*, and the favourable nature of many sites as seen from echo soundings and underwater photographs indicate that the precious coral potential of the Solomon Islands is very promising.

29. SEISMIC MONITORING IN SOLOMON ISLANDS

Frank I. Coulson
Ministry of Natural Resources, Honiara,
Solomon Islands

(from Document NR/CCOP/SOPAC (9)/CR.23)

For several years, the Geological Survey has monitored the island of Savo, a quiescent volcano of the Pelean type, situated some 22 miles north-west of Honiara.

In order to increase the effectiveness of this monitoring, a project to install a teleseismic link is now underway. This project is being undertaken with the close co-operation of the Institute of Geological Sciences Global Seismology Unit at Edinburgh, U.K. This co-operation has included a 9-month training period at the Global Seismology Unit (GSU) for the (Solomon Islander) Seismological Observer and the temporary loan of a single-channel teleseismic link system which is now installed at Savo. A three-channel teleseismic link system, being purchased under a U.K.-aid project, is now being assembled and tested at GSU before being despatched to Solomon Islands.

Maintenance of this and other electronic equipment is becoming increasingly difficult due to a lack of suitably qualified technicians.

KINGDOM OF TONGA

30. REPORT ON TONGATAPU SAND INVENTORY

G.A. Gauss
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(from Document NR/CCOP/SOPAC (9)/CR.55)

On Tongatapu, Tonga, sand is mined from beaches along the south-eastern and western coasts.

If the current practice of beach mining continues, then large sections of the south-eastern and western beaches will become depleted in sand and will be formed of beach rock (fossil coral or cemented sand) between the low and high tide levels. Mining of sand above the high tide level is not the solution since this leads to unsightly excavations, and eventually, probably to shoreline erosion on the coasts facing the prevailing winds. It should be recognised that any offshore deposits found, whether on islands and spits or in deeper lagoon waters, would initially cost more to extract than the present deposits

which are mined in the cheapest possible way. However, the costs of mining have to be set against the environmental value of the Tongatapu beaches and their related value as an asset of the tourist industry in Tonga.

Of the beaches presently mined, it would appear that the central part of Laulea Beach would sustain mining for longest before depletion of the sand becomes severe. Local longshore sand transport appears to be towards this section from either side and this has built up a wide beach berm and back-beach dune system.

31. CRUISE REPORT : TONGA OFFSHORE SURVEY, TG-79 (1), 1-17 NOVEMBER 1979

G.A. Gauss
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC (9)/CR.44)

The objective of this cruise was to increase the density of seismic reflection profiling data in the unlicensed area to the south of Tongatapu along the Tongan Ridge. The survey was part of the CCOP/SOPAC Work Programme CCSP-1/TG.5 (Seismic reflection survey of the Tonga Platform to determine sediment thickness and basement structure, with particular reference to oil production potential).

Thirteen airgun lines were run across the Tonga Ridge between Tongatapu and a position 24°10'S. The average spacing of these lines across the Ridge was about 14 miles. A single line was run with the airgun from 24°10'S back to Tongatapu along the length of the Ridge. The total length of the airgun tracks was 1155 nautical miles (2140 km).

A preliminary analysis of the airgun results indicates that along most of the survey lines crossing the Ridge, where water depths are 1000 m or less, a significant thickness of sediments underlies the sea bed. Because of the presence of strong sea bed multiple reflections, interpretation of the records is effectively limited at any place to a sub-bottom depth equal to the water depth there. In addition, the moderate airgun discharge capacity and the analogue recording methods used give an effective maximum sub-bottom penetration of seismic energy of about 1.3 seconds in the sediments present here. These factors resulted in a situation where only *minimum* estimates of sediment thicknesses can generally be made from these airgun results; actual thicknesses may be considerably greater than these minima. However, the results do indi-

cate that the sedimentary section present beneath the Tonga Ridge south-west of Tongatapu is of sufficient thickness and extent to have hydrocarbon potential. Minimum thicknesses of around 1 second (two-way time - about 750 m at water velocity) are quite commonly seen on the records and thicknesses of up to 1.3 seconds were seen at the southern end of the survey area.

**32. CRUISE REPORT : TONGA OFFSHORE
SURVEY, TG-80(1), 14 JANUARY -
4 FEBRUARY 1980**

A. John Halunen, Jr
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.7)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme for Element CCSP/TG.2 (Assessment of possibilities for occurrence of seabed phosphorites on and in the vicinity of the Tonga Platform), Element CCSP/TG.3 (Survey of nearshore areas for precious coral occurrence), Element CCSP/TG.4 (Survey for zones of metalliferous enrichment in active volcanic areas), and Element CCSP/TG.5 (Seismic reflection survey of the Tonga Platform to determine sediment thickness and basement structure, with particular reference to oil production potential).

The seismic reflection profiles collected across the Tongan forearc north of Vavau are exciting and should be interpreted in detail as soon as possible.

In spite of the equipment difficulties, very good single-channel reflection profiles were collected during this survey in northern Tonga. Acoustic penetration exceeds 1.3 seconds in some of the basins. Major structures are evident including folding, horst and graben structures, and faulting.

Most of the bottom samples collected with the tangle nets are of little interest. On two stations on the volcanic ridge between Fonualei and Niuaotupapu Islands samples of a hard white coral were collected from water depths between 500 and 800 m (Stns TG-32 and 33). This material is of substantial size (1-2 cm diameter stalks) and if of sufficient hardness and colour may be of commercial interest. On several other stations small pieces of hard material were recovered. This material should also be identified, particularly that from Stns TG-1, 8, 10, 13, 14, 26, 27, 32, and 33.

Six good gravity cores were collected in the Lau Basin for metalliferous sediment analysis. Subsamples of the top and bottom

of each core have been sent to Dr David Cronan, Imperial College, London, for analysis.

A brief survey was completed in the area north of Tafahi in the vicinity of the plotted position of Curacao Shoal. Curacao Shoal was first discovered in the last century but the position was incorrectly given. During this survey the shoal was relocated about 4.5 nautical miles north-west of its charted position. One dredge sample recovered from the top of this 20 m deep shoal recovered shallow-water coralline material or little economic potential. This shoal may be very important to the Kingdom of Tonga for its fishery potential.

**33. CRUISE REPORT : NUKU'ALOFA LAGOON
SURVEY, TONGATAPU, KINGDOM OF
TONGA, TG-80(2)**

G.A. Gauss
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC(9)/CR.36)

A sea bed survey in the lagoonal area north of Nuku'alofa was undertaken by UNDP staff assisted by personnel from the Ministry of Lands, Surveys and Natural Resources during September 1980. The survey was in partial fulfillment of CCOP/SOPAC Work Programme CCSP-1/TG.6 (Tongatapu Sand Inventory, Kingdom of Tonga).

During the last year the Tongatapu Beach Profile Study, undertaken under Task 1 of PE/TG.6, has indicated that some of the beaches currently being mined on Tongatapu have receded significantly since the study was initiated in 1978. This conclusion is supported by visual observations, notably at Laulea beach where the beach berm receded by up to 10 m during a period of intensive mining between November 1979 and July 1980. It was also observed that on other beaches where it is reported that heavy mining several years ago resulted in the exposure of beach rock between low and high water that replenishment since mining ceased has not to date been sufficient to rebuild the beach in this zone. On the other hand, demand for fine aggregate for fill and construction on Tongatapu is very heavy in relation to the existing beach resources and this demand is increasing. In the short term some relief of pressure on the beaches may be found by mining the raised dunes that occur in places landwards of the present beaches, but it is evident that new sources of supply of fine aggregate will have to be quickly found and exploited if considerable beach denudation is to be avoided.* Studies of the available

sea bed data, maps, charts, and aerial photographs of Tongatapu indicate that the lagoonal areas north of Nuku'alofa have potential for the discovery of sand deposits. Accordingly, the present survey was undertaken in those areas of the lagoon considered the most promising from a study of the existing data.

Approximately 4 million cubic metres of fine to medium, shelly carbonate sand occurs in water depths between 30 m and 6 m immediately to the south of Fafa and Velitua Islands, about 6 km to the north of Nuku'alofa. The suitability of this deposit for construction purposes on Tongatapu has yet to be determined and samples collected during the present survey have been sent to New Zealand for analysis.

Considerable volumes of uncemented sediment also occur beneath the lagoon floor off the eastern part of the Nuku'alofa waterfront and beneath the steep slope up to the shallow water area lying to the south-east of Pangaimotu Island. A preliminary appraisal of the sediment samples obtained from these areas suggests, however, that much of this material is too fine for construction purposes. Coarser sand deposits occur in the shallow water area to the south-east of Pangaimotu Island and, although no accurate estimate of the volume of material present can be made from the present work, this volume may be considerable.

34. OIL EXPLORATION IN THE KINGDOM OF TONGA 1980-1981

S.L. Tongilava
Ministry of Lands, Surveys and Natural Resources, Nuku'alofa, Tonga

(Document NR/CCOP/SOPAC (9)/CR.57)

In November 1979 a U.S. oil company completed an offshore seismic survey between Tongatapu and 'Eua and along part of the eastern side of the Tonga Ridge.

Agreement has been reached between Samual Gary Oil Producers Inc. of Denver and the Tonga Government for the drilling of the minimum of three offshore exploratory wells between Tongatapu and 'Eua.

It is planned that the drilling operations will start as soon as preparations for setting up of oil rigs is completed towards the end of 1980 or during 1981.

35. THE RESULTS OF A RECONNAISSANCE SURVEY INTO THE ENERGY POTENTIAL AND DEVELOPMENT PROSPECTS OF WAVE ENERGY REACHING THE BLOW-HOLES AREA ALONG THE SOUTH COAST OF TONGATAPU, KINGDOM OF TONGA

Submitted by the CCOP/SOPAC Technical Secretariat

(from Document NR/CCOP/SOPAC (9)/CR.47)

There is a super-abundance of wave energy reaching the southern coasts of Tongatapu, especially along the blow-hole sector. The essential feature is how best to develop this potential source of power, having in mind the engineering economics and other factors concerned. In particular, the engineering aspect presents the major challenge and would undoubtedly be the controlling factor.

Any coastal or frontal approach appears to be out of the question, but there is at least one credible alternative, that of attacking the problem from the landward site and thereby reaping valuable benefits such as easier and cheaper construction of a modular nature.

The project could offer certain peripheral advantages including (a) the possibility of commercial fish farming in the Fanga'atu Lagoon; (b) the concentration of all generating plant (apart from the existing diesel station) at a single point; and (c) central location of the wave power station with respect to the high voltage network.

It is concluded that (a) a further investigation and research on the development of the blow-hole would appear to be well justified; (b) it would appear logical to conduct a similar and parallel exercise with respect to the Mauritius passive system to establish a merit order; and (c) in view of the various favourable factors concerning Tongatapu, it would seem a suitable location at which to establish a research group with the task of establishing inter alia the best design of energy-converter and with a view to constructing a commercial pilot project.

VANUATU

36. CRUISE REPORT : VANUATU OFFSHORE GEOPHYSICAL SURVEY, VA-80(1), 25 JULY - 26 AUGUST 1980

N.F. Exon
Project Office, Suva, Fiji

(from Document NR/CCOP/SOPAC (9)/CR.16)

This cruise was undertaken as part of the CCOP/SOPAC Work Programme CCSP-1/VA.2 (To collate all data relevant to hydrocarbon potential in Vanuatu, and to recommend, or not, active exploration).

The objectives were to collect continuous seismic reflection and magnetic data from the central and northern basins, the northern New Hebrides Trench, and the back-arc basins east of the Banks Islands. These data are required for a preliminary evaluation of the hydrocarbon potential of offshore Vanuatu.

Adequate regional line spacing now exists in the central basin. Seismic penetration in this area was generally less than 1.5 seconds and the base of the basinal sequence was only recognisable near the basin margins. A single line south of Aoba had penetration of 2 seconds, and revealed the base of the basinal sequence away from the margins.

Adequate regional line spacing is now available in the northern basin. Seismic penetration was generally less than 1.5 seconds, but in many areas basement is fairly shallow.

The seismic records from four crossings of the northern New Hebrides Trench were of fair to poor quality. The trench axis shallowed from 7800 m on the northernmost crossing to 5850 m on the southernmost. The eastern slope contained marked slope breaks and there was generally little sediment cover. The western slope showed some normal faulting and up to 0.5 seconds of sediment was visible on the upper slope.

The four seismic profiles across the region east of Banks Islands show a well-developed back-arc basin in the south, with up to 0.6 seconds of sediment, little sediment near the Hazel Holme Fracture Zone, and a complex of small troughs west-south-west of Tikopia.

NOTE : Also presented was document:

NR/CCOP/SOPAC (9)/CR.38 - Report on short term consultancy for Project petroleum assessment, New Hebrides - by H.R. Katz; a preliminary review of data available in Vila and at ORSTOM, Noumea in preparation for a future, thorough study (see Part 1, report of TAG, para. 6).

REGIONAL SURVEYS

37. ECONOMIC POTENTIAL OF CLAY DEPOSITS IN SELECTED SOUTH PACIFIC COUNTRIES

G.G.C. Claridge
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(from Document NR/CCOP/SOPAC (9)/CR.48)

Ceramic materials are those that can be prepared from naturally occurring inorganic materials by shaping in a moist condition, followed by drying and permanent hardening by heat. Materials used for the manufacture of ceramic products are commonly called clays, although the bulk of the material may not be of clay size, and must consist of the so-called clay minerals.

The principal properties required for a ceramic clay are that (a) it should be sufficiently plastic to mould easily into shape, (b) it should be able to retain that shape in both the wet and dry shape, and (c) it fire together to form a strong, stable article without excessive shrinkage or deformation when heated to a temperature between 900 and 1100°C. The essential components that give rise to these properties are (a) a clay mineral to give the required plasticity, (b) an inert filler which controls shrinkage and working of the structure and which gives the final product much of its strength, and (c) a fluxing material which, on firing, melts and bonds the other components together into a solid mass. Ideally, therefore, a ceramic clay should consist of kaolin, quartz, and feldspar, although other minerals may also be present.

To identify suitable clay deposits, the best method is to subject likely materials to laboratory versions of the processes of drying and firing that would be used in practice. It is possible to predict ceramic properties from a knowledge of the mineralogy of the clays, if this is known. However, such predictions need to be confirmed by firing trials. In the absence of mineralogical data, the mineralogy of a soil may often be predicted from a knowledge of the parent rock from which it has been formed and the degree of weathering to which it has been subjected.

Using these criteria, together with records of the past or present-day manufacture of pottery throughout the south-west Pacific, it was possible to predict the probability or otherwise of the occurrence of ceramic clays in project member countries.

Kiribati

Kiribati consists of coral islands and the soils contain no clay minerals or any other component that could be used for the manufacture of ceramic products.

Cook Islands

The soils of Rarotonga consist largely of kaolin, smectite, and iron oxide, and those of the outer volcanic islands contain kaolin

and oxides of iron and aluminium. They do not contain any quartz and only small amounts of unweathered primary minerals derived from the basalt of which the islands are formed.

On the basis of their mineralogies the soils were considered to be relatively unpromising as raw materials for ceramic production, but some of them were subjected to further trials. These, however, showed that although bricks could be formed from these materials, they had high drying and firing shrinkage and consequent cracking and low strength of the finished product. Consequently it was concluded that there were no resources of ceramic clays in the Cook Islands.

Tonga

The principal islands of Tonga are varied coral platforms mantled with layers of strongly weathered andesite ash. This ash has weathered to a clay, consisting largely of tubular halloysite. Only traces of the most resistant primary minerals are found in the soil.

The composition of these soils is such that they would not be expected to be sources of ceramic raw materials. The results of firing trials on a few selected samples confirmed this; fired bricks had high shrinkage cracking and low strength.

Western Samoa

The main islands of Western Samoa consist of an accumulation of successive basaltic flows and pyroclastic eruptions. Some of the older rocks are basic andesites and the more recent flows are olivine basalt. Because of wide variations in climate, topography, and age of the rock the soil pattern is complex. The soils formed from basalt consist largely of gibbsite and iron oxide with little kaolin, although at high altitudes the proportion of kaolin increases markedly. Some of the soils from basic andesite in the north-western end of Upolu are more plastic than the other soils of Samoa and consist largely of kaolin. Although these soils on their own would not be expected to be suitable as ceramic raw material because of their high clay content, it is possible that some of the deeper soils, or alluvial deposits derived from them, would repay further investigation.

Vanuatu

The islands of Vanuatu are of eruptive origin and essentially volcanic. They are essentially basic in composition, ranging from gabbros to andesites, interbedded with thick calcareous sediments. The whole of the surface of the older islands has been covered with a mantle of recent basaltic ash.

The soil pattern is complex, but in general all but the most recent soils are strongly weathered soils from volcanic ash containing much allophane, and those formed from basic rocks contain iron-rich smectites. Neither would be suitable as ceramic clays. Soils formed on old weathered ash contain much halloysite or kaolinite, but many of them also have been rejuvenated by the addition of younger ashes and contain appreciable amounts of glass and other primary minerals which may act as fluxes or fillers. Such soils may provide suitable materials for the manufacture of ceramics. Other soils formed on basaltic and andesitic tuffs on Epi and Espiritu Santo contain halloysite and goethite, but also contain considerable quantities of sand- and silt-sized materials. These soils also have possibilities as ceramic raw materials.

Further investigations of selected materials from the islands of Efate, Epi, and Espiritu Santo is recommended.

Solomon Islands

The central chain of the Solomon Islands consists largely of andesitic and basaltic rocks and sediments derived from these rocks. Some of these rocks have been metamorphosed and ultra-basic rocks have also been intruded. The islands are tectonically active and the rainfall is high; consequently the topography is steep and broken.

There is little information available on the mineralogy of the soils, although they are mainly strongly weathered and of fine texture. The dominant clay minerals are expected to be kaolin and iron oxide. The most likely sources for ceramic clays appear to be alluvial sediments derived from the erosion of andesitic rocks, or from the erosion of older sediments derived from these rocks.

It is recommended that further investigations be carried out on the edge of the Northern Plains of Guadalcanal, both to the west and to the east of Honiara, where the available geological and soil data indicate that conditions are favourable.

Papua New Guinea

Papua New Guinea is a large land mass with a complicated geological and tectonic structure. With the strongly continental nature of the geology of Papua New Guinea and the abundance of sediments of an acidic nature, suitable materials for ceramic manufacture should abound. Pottery has been made by the inhabitants of Papua New Guinea for many thousands of years, and for some years bricks were made at Goroka in the Central Highlands. The suitability of many materials from Papua New Guinea as sources for ceramic clays has

already been investigated and no further investigations are recommended.

Fiji

The Fiji archipelago rises from a shallow platform which is thought to be a fragment of continental crust; consequently, in many places, acidic rocks or sediments derived from the erosion of these soils are found. Soil from quartz-rich parent materials are found along the north coast of Vanua Levu, in the interior of Viti Levu, particularly in the headwaters of the Rewa, Navua, and Sigatoka Rivers, and in the uplands behind Nadi. These soils contain considerable quantities of kaolin and some quartz sand. These materials can be and have been used for the manufacture of pottery, especially with the addition of further quartz sand from river alluvium. Moulding and firing tests, carried out by the Mineral Resources Department (Fiji Geological Survey), showed that most materials tested failed because of high shrinkage, cracking, and consequent low fired strength. There appeared to be an absence of suitable fluxes and this is consistent with the mineralogy of the soils. As basic studies have been completed by the Minerals Resources Department no further work is recommended at this time.

38. PHOSPHORITE ON SEAMOUNTS AND SUBMARINE RIDGES IN THE SOUTH-WEST PACIFIC

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(from Document NR/CCOP/SOPAC (9)/CR.31)

In August-September 1980 the N.Z. Oceanographic Institute, in collaboration with Florida State University, carried out a reconnaissance cruise searching for phosphorite occurrences on submarine ridges and seamounts between 7° and 20°S in the exclusive economic zones of Niue, Western Samoa, the Tokelau, and the Cook Islands.

Seamount and submarine ridge phosphorites

Phosphate was found in small quantities at a number of localities in this general area, almost invariably in association with ferromanganese crusts. Usually the phosphate occurs as a discrete, pale core or nucleus encrusted with dark oxides of manganese or iron.

Pale coloured (possibly "decayed" coral) cores within ferromanganese concentrations from depths of about 1350 m on a seamount 200 km north-west of Atafu in the Tokelau

Islands contain some 6% P_2O_5 , and similar material from 1780 m depth on a seamount 130 km north of Pukapuka in the Northern Cooks contains up to 20% P_2O_5 . In some of these samples the ferromanganese coating is compact and up to 45 mm thick.

Phosphate also occurs in more diffuse form in manganiferous nodules and micro-nodules from seamounts west of Samoa, from Eclipse Seamount (east of Aitutaki), and from a seamount 200 km west-south-west of Rarotonga. At the last locality, micro-nodules from depths of 1000-1250 m contain 3.2% P_2O_5 , possibly in a fine brownish substance disseminated throughout the nodules.

In contrast, a sample of Miocene limestone from 950 m depth on Capricorn Seamount, on the eastern margin of Tonga Trench at latitude 18 40'S, has a P_2O_5 content of only 0.25% (W. Kitt, pers. comm.), and a manganiferous coating a fraction of a millimetre thick.

39. REVIEW OF PRECIOUS CORAL IN CCOP/SOPAC MEMBER COUNTRIES

J.V. Eade
N.Z. Oceanographic Institute, Wellington,
New Zealand

(from Document NR/CCOP/SOPAC (9)/CR.53)

During the 1977 CCOP/SOPAC cruises in Western Samoa, Cook Islands, and Tonga a few dredge hauls were made for deep water precious corals. The results of these cruises were negative, but from the experience gained it was obvious that we, at the Technical Secretariat, needed to know much more about precious corals, especially their distribution and the way they are collected. At the Sixth Session of the CCOP/SOPAC in Port Moresby during October 1977, the Technical Secretariat was requested to seek the services of an expert consultant to advise member countries on the economic potential of precious coral. Early in 1978 the services of Dr Richard Grigg, Hawaii Institute of Marine Biology, were sought. While preparations were being made for a meeting with Dr Grigg, information exchange sessions were organised using the PEACESAT (Pan Pacific Educational and Communication Experiments by Satellite) network. Three sessions were held in the first six months of 1978. At these sessions, which were chaired by the CCOP/SOPAC Technical Secretariat in Suva, Dr Richard Grigg provided much useful information on the biology, distribution, harvesting, and use of precious coral in the Pacific.

In April 1978 a three-day workshop was held in Nuku'alofa to cover all aspects of precious corals and to evaluate their potential as an

economic resource in the South Pacific. Representatives from Western Samoa, Cook Islands, Tonga, and the CCOP/SOPAC Technical Secretariat met Dr Grigg, who had brought with him material to illustrate all aspects of the industry in Hawaii. Underwater photographs and samples of both raw coral and coral jewellery were presented at the workshop. Following the discussions, which were generated by the presentation of this material, charts of Western Samoa, Cook Islands, and Tonga were examined for possible sites where precious corals might occur.

Since the Precious Coral Workshop, dredgings have been made by Project staff off Papua New Guinea, Solomon Islands, New Hebrides, Kiribati, Western Samoa, Tonga, and Cook Islands. Earlier problems with gear design have been overcome with expert advice from Dr Grigg and by modifications made through practical experience.

As a result of this field work *Corallium* is now known to occur in the Solomon Islands, New Hebrides, Western Samoa, Tonga, and Cook Islands. Details of the occurrence and distribution follows.

DEFINITIONS

Precious coral (= Gem Coral, Jewel Coral) classically refers to the red corals of commerce. In this report the term is used to describe those corals whose skeleton is the raw material of the coral jewellery industry. As well as the red corals, these include the white and pink varieties and the non-calcareous black and gold species. All these corals have one factor in common - they are hard and dense enough to take and hold a good polish. Hardness ranges from 2.5 to 4.0 on the Mohs scale.

Deepwater precious corals are primarily *Corallium* species (white, pink, and red) but also gold and bamboo corals. Depths at which these species are found are beyond free-diving and scuba-diving depths and are found and collected by shipborne operations (echo sounding, dredging, underwater photography) and by the use of submersibles.

Shallow water precious corals - refer to the black corals (*Antipathes* species). Although black corals live over a wide depth range, the precious species are found at scuba-diving depths (30-70 m). Some black corals and stoney corals from much shallower water are used to produce items for sale in many countries. The quality of this material is considerably poorer than black coral from 30-70 m and is not considered a precious resource in this report.

PRECIOUS CORAL (*Corallium*) DISTRIBUTION IN THE SOUTH PACIFIC

Cook Islands

Twenty-eight dredgings have been made on four cruises (CK-77(1), 78(2), 80(1), and 80(2)) and the slopes of eight islands dredged for deeper water corals. The slopes of Rarotonga have also been briefly examined for black coral.

Corallium occurs at Penrhyn, Manihiki, and Pukapuka. No *Corallium* has been found off Rarotonga, Manuae, Rakahanga, Nassau, and Tema Reef. As all island slopes are steep and terrace areas are either small or non-existent the chances of finding large beds of *Corallium* are small.

Kiribati

Seven dredgings have been made in the Phoenix Group and bathymetric surveys made around Vostok Island. However, island slopes around Phoenix, Sydney, and Vostok Islands are too steep for substantial beds of coral to exist. From available data other islands in the Phoenix Group and Line Islands appear to be all too steep for other than small quantities of *Corallium* to occur, if at all. However, the potential for Western Kiribati (Gilbert Islands) where several favourable sites exist, is much better.

Papua New Guinea

In early 1979 dredgings were made on a ridge feature which lies 75 km off the west coast of north Bougainville. Two dredgings were made. Hard bottom corals *Dendrophyllia* and *Keroeides mosaica* were collected, but no *Corallium* was found.

Samoa

Thirty-six dredgings have been made off Samoa including Pasco and Tupuola banks as well as the main islands - Savaii and Upolu.

All prospective sites that can be identified from existing bathymetry have been surveyed at a reconnaissance level. *Corallium* has been found in three areas: off eastern Upolu, off Falealupo, and at Tupuola Bank. Living *Corallium* has been collected from these localities but all specimens found so far are too small to be commercial. Prospects for areas where no *Corallium* has been found are poor.

Solomon Islands

More than 30 sites have been surveyed representing the most prospective localities from Makira to Vella Lavella islands. *Corallium* has been found at 12 of these sites. From 138 dredgings made, 27 have recovered precious coral. This represents a 20% success rate. Three species of *Corallium* have been found, two of which are used commercially elsewhere in the Pacific. Although small, all specimens collected were living. Most

promising specimens are from an area spanning the Indispensable Strait from north Malaita to Marua off eastern Guadalcanal.

The Santa Cruz islands and the Rennell area have not yet been surveyed.

Tonga

Fifty-five dredgings have been made along the Tonga Ridge and adjacent volcanic ridge in Tongan offshore areas from Niuatoputapu in the north to Eua in the south.

Hard bottom corals - *Dendrophyllia*, *Keroneides*, hydrocorals, and others - have been collected at most localities where hard bottom was found. A few small specimens of *Corallium* have been found east of Ha'apai and in southern Vavau. Conditions for deep water coral growth are excellent off Eua but strong currents and rough seas have made sampling here difficult.

Vanuatu

Eighteen dredgings have been made between Ambrim and Efate islands and *Corallium* has been collected at one locality off northern Epi. Although the specimen collected is dead and worn-looking, it is of commercial size and pinkish in colour. This site and others which are as yet unsurveyed look promising from available bathymetric data.

40. EVALUATION OF SOUTH PACIFIC AGGREGATES FOR CONCRETE MAKING AND OTHER PURPOSES

Submitted by the New Zealand delegation

(from Document NR/CCOP/SOPAC (9)/CR.32)

Enquiries made to the New Zealand Concrete Research Association on the use and properties of coral aggregate indicate that there is a need for guides in the use of coral as a concrete material. Since little work has been done on the subject, the physical properties of coral aggregates need investigating with particular emphasis on the salt content. Trial mixes using the various types of coral need to be manufactured to obtain a full range of test results on all types of coral aggregate currently to be used in the South Pacific islands.

Recently the New Zealand Concrete Research Association received ten coral sediment samples from Cook Islands (Rarotonga) and Samoa (Apia), collected during a visit to the islands by the r.v. *Tangaroa*. Initial test results show monograde, clean reef, beach, and lagoon sand with absorption figures ranging from 7 to 11%. The test results indicate that the performance of the coral concrete

will differ from the conventional aggregate concrete to such an extent that mix design, control of batching, and curing should be carefully monitored. Further laboratory analysis will assist in identifying the parameters that effect coral concrete distress.

41. SOME RESULTS OF SURVEY ACTIVITIES BY THE MINISTRY OF GEOLOGY OF THE USSR IN THE SOUTHWEST PACIFIC IN 1979-1980

Submitted by the USSR delegation

(Document NR/CCOP/SOPAC (9)/CR.29)

Investigations by the Ministry of Geology of the USSR in the CCOP/SOPAC area since 1979 have been reconnaissance studies with a main goal of understanding major structural features of the oceanic floor. With this purpose r.v. *Dmitrii Laptev* has provided magnetic and bathymetry (echo-sounding) surveys along the regional profiles. Some of these profiles were accompanied by continuous seismic reflection surveys (sparker type) and bottom sediment sampling by grab, piston corer, and dredge.

Hydromagnetic surveys were carried out by proton magnetometer reading the total vector of magnetic anomaly with apparatus accuracy of 3 n T, and cycle of measurements of 10 s. The interpretation of data has not been completed yet.

One of the profiles passes across Lau Ridge, Lau Basin, Tonga Ridge, and Tonga Trench. Qualitative analysis of magnetic anomaly data shows an essential difference in amplitude of the anomalies and its spectral composition over Lau Ridge and Tonga Ridge, which is evidently due to different structure and rock composition of these two ridges.

Magnetic anomaly data in the Central Pacific Basin, according to several profiles, indicate complex block tectonic structure. The area south of 03°S is characterised by magnetic anomalies of 200-300 nT with wave length 10-20 km. Over the area between 03°S and the Equator magnetic anomalies are broad (up to 30-40 km) and range in amplitude from "plus" to "minus" 400-400 n T. Between these two areas there is a broad zone of low intensity magnetics. Topography of the oceanic floor is also different. To the south of 03°S it is very rugged, seamounts being marked by distinct negative anomalies. North of the Equator, broad high intensive anomalies (up to 800-1000 n T) are measured.

According to the magnetic anomaly data and topography there are several major blocks of

the crust different in tectonic structure and magmatic activity in the area of the Central Pacific Basin studied.

Seismic reflection single-channel profiling at the ship's speed of 12 knots was carried out to determine thickness and structure of a sedimentary cover of the area under consideration. There are grounds to suggest that profiling speed can be increased up to 15 knots without affecting the quality of records.

On the seismic records one can distinctly see an upper transparent layer which corresponds to ooze, as was proved by bottom sampling. The estimated thickness of the transparent layer, using the average sound velocity of 1500 m/s, ranges from 0 to 20 m (seamount slopes), up to 200 m for the foot of seamounts, and an average value of 120-130 m for abyssal plains. The seafloor carries erosional cavities sometimes as deep as 100 m and 4-6 km in width, probably due to bottom current activity.

The first distinct sub-bottom reflector probably corresponds to consolidated sedimentary or volcanic rocks. The thickness of this layer is obscure because of absence of continuous deeper reflectors.

The Ministry of Geology of the USSR plans to continue regional reconnaissance research of the Central Pacific and South Pacific Bains during the period 1981-86 with one or two vessels in a year, aiming to study major structural features, thickness and composition of bottom sediments, and seafloor topography. Areas have been chosen primarily for the study of manganese nodule deposits. It is intended to conduct investigations mainly across structural lineaments along profiles by total length of 20-25 thousand km. Data collection will include magnetic surveys, continuous seismic reflection profiling, echo sounding, bottom sampling by grab, piston corer, dredge, and deep-sea camera.

H. Preparations for Future Work in the CCOP/SOPAC Work Programme

42. PROPOSED COASTAL AREA DEVELOPMENTS IN SOLOMON ISLANDS

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Solomon Islands

(from Document NR/CCOP/SOPAC (9)/CR.64)

Solomon Islands is a recently independent (1978) developing nation of six major and numerous smaller islands. Because of the

relatively small size of even the major islands, the whole of the Solomons can be regarded as "coastal area". Most major development is taking place in the immediate coastal zones, but inland projects inevitably have some impact at the coast, if only on shipping which is the chief form of transport between the islands.

Current and prospective developments can be summarised under the following headings.

Agriculture

The main agricultural developments are on the coastal plains of north Guadalcanal, where extensive areas are given over to palm oil, rice, copra, and cocoa production.

Energy

The island of Vella Lavella in the New Georgia Group of the Western Solomons has a geothermal field which has potential as an energy source. Investigation of the field is under way, and if the geothermal power potential is sufficient industrial development could take place in the area. Pulp or paper making, fish processing, cement manufacture, and alumina smelting have been suggested as possible uses of the power.

Fisheries

On 1 January 1978, Solomon Islands declared a 200 mile fishing limit for the territorial waters. Within this limit there is a large and not yet fully exploited fish resource.

Solomon Taiyo, a joint venture company between the Solomon Islands Government and Taiyo Fishing Company of Japan is currently engaged in fishing and run two fish processing plants, a cannery at Tulagi, and a freezer at Noro. A second canning factory is planned at Noro.

Minerals

Panning for gold on Guadalcanal is the only mining operation taking place at the moment. There are, however, a number of prospects which are attracting interest and a programme of reconnaissance geological mapping and geochemical exploration aimed at completing a preliminary geological survey of the Solomons is being supported by British Aid funds.

Gold panning is restricted to the rivers draining the Gold Ridge area of Guadalcanal. The increase in the price of gold during 1979 has led to renewed interest in the Gold Ridge prospect and also in the Suta gold-field 8 miles further inland. An offshore gold prospect has been found where the rivers draining Gold Ridge enter the sea on the north coast of Guadalcanal. The chief interest here is a submerged buried river channel, the early investigations being carried out under a CCOP/SOPAC project.

Forestry

Forests cover the major part of the land surface of Solomon Islands. Logging operations are carried out exclusively by the private sector, the main areas worked being in the New Georgia Group, Guadalcanal, and the Shortland Islands. Logs are exported, in preference to sawn timber, most of which is sold locally.

Urban, Industrial and Port Development

Honiara, the capital of Solomon Islands on Guadalcanal, is the only centre with a population of over 5000, the latest figure being just under 15 000. New housing and light industrial development are taking place, but the proliferation of large hotels, which is associated with the tourist industry, has been resisted. Proposed extensions to the wharf are at the tender stage.

At Noro, in the Western Solomons, a new port is being developed. The previous main port for the west, at Gizo, had difficult access and the larger international shipping lines, which carry copra for export, have refused to call there. It is possible that the new port will become the administrative centre for the Western Solomons and its population may eventually rise to the level of that of Honiara.

Management Problems

(a) Honiara: Recent tests have shown that Honiara coastal waters are polluted with sewage from the main outfall. Redesign or extension of the outfall would probably solve the problem, but coastal marine studies should form the basis for any modifications to the present system.

(b) Noro Port: The design and construction of Noro Port, particularly as it relates to the disposal of wastes from the proposed fish-cannery and wastes from urban sewage, are immediate and urgent problems which require assistance from CCOP/SOPAC.

43. PETROLEUM SOURCE-ROCK POTENTIAL

Submitted by CCOP/SOPAC Technical Secretariat

(from Document NR/CCOP/SOPAC (9)/CR.70)

The aim of source-rock studies is to determine whether or not sedimentary sequences are capable of producing hydrocarbons, what sort of hydrocarbons they might produce, and whether their thermal history is such that they have in fact produced hydrocarbons. This is done by a series of analyses on unweathered rocks.

When sediments are laid down they contain few hydrocarbons, apart from biogenic methane. With increasing burial hydrocarbons form, and as the depth of burial increases so does the range of hydrocarbon types. The hydrocarbons are produced from organic debris via intermediaries, the most important of which is insoluble organic matter known as "kerogen".

The abundance of hydrocarbons (if produced) depends essentially on the "richness" in total organic carbon of the source-rock. The type of hydrocarbon depends on the type of organic matter originally trapped in the sediment and on the temperatures to which the source-rock has been subjected as it was buried (organic matter is altered to hydrocarbons by thermal "cracking").

It is generally believed that plant debris tends to produce gas and marine algae tend to produce oil. Woody plant material does produce mainly gas, but if there is a great deal of waxy leaf cuticle in the sediment, oil may be produced (as in Bass Strait). The temperature to which the source-rock has been subjected determines the "maturity" of the source-rocks, and this is a major controlling factor in what hydrocarbons can be generated. Thus gas can be produced in "immature" rocks which have never been heated to 65°C, gas and oil can be produced in "mature" rocks which have been heated to temperatures of between 65°C and 180°C, and gas and condensate can be produced in "super-mature" rocks which have been heated to more than 180°C. The thermal gradient in an average sedimentary basin means that the top of the "mature" zone lies beneath about 2000 m of sediment but, in areas of high heat flow (such as island-arcs), the "mature" zone may be much higher in the sedimentary column.

To be capable of producing hydrocarbons, rocks have to be fine-grained (to prevent oxidation of organic matter soon after burial) and must contain adequate quantities of organic carbon. The best source-rocks are shales and siltstones with more than 1% of organic carbon - 0.4% organic carbon is the minimum. Some carbonates and clayey carbonates are also potential source-rocks.

As a first step in evaluating the source-rock potential of a sediment one must thus first analyse for total organic carbon. Information about the types of hydrocarbons which might be, or have been, generated comes from further analyses. These include analysis of the amount of organic matter which can be dissolved by organic solvents, and the composition of the extractable organic matter, in particular the proportions of the main hydrocarbon groups; asphaltenes, saturates, aromatics, and

from further analyses. These include analysis of the amount of organic matter which can be dissolved by organic solvents, and the composition of the extractable organic matter, in particular the proportions of the main hydrocarbon groups; asphaltenes, saturates, aromatics, and resins. Spectroscopic analysis of the group of saturates enables them to be fully characterised. Microscopic analysis of the coaly layers is also important as different coal types yield different hydrocarbon types.

The maximum temperature to which a suspected source-rock has been subjected, which controls its maturity, is normally judged by the alteration of the organic material within it.

A chemical method of measuring this temperature (the "maximum palaeotemperature") depends on the fact that thermal cracking gives rise to unpaired electrons in the kerogen. The higher the temperature attained, the more abundant are the unpaired electrons. The abundance of unpaired electrons per unit of kerogen is measured with a spectrometer and compared to abundances in standard samples whose maturity is known.

Microscopic examination of plant spores in a suspected source-rock can give similar information; the spores change colour from yellow through brown to black with increasing maturity. Another method is to measure the reflectivity of vitrinite (coaly) grains under a microscope; the higher the reflectivity, the more mature the rock. In both methods the results are compared with results from rocks of known maturity.

44. SOVIET SCIENTISTS' PROPOSALS FOR MAIN TRENDS IN GEOLOGICAL, GEOPHYSICAL AND GEOCHEMICAL RESEARCH OF THE SOUTHWEST PACIFIC IN 1981-1985

Submitted by the USSR delegation

(from Document NR/CCOP/SOPAC (9)/CR.52)

The part of the Southwest Pacific located within the CCOP/SOPAC region is a key area for solving a wide range of fundamental geological problems as well as applied geological, geophysical, and geochemical studies.

Soviet scientists consider that the main goals of geological, geophysical, and geochemical investigations in the Southwest Pacific for 1981-1985 be formulated as follows.

1. Elucidation of the basic morphologic characteristics of major structural elements of the region, including a study of their principal structural relationships from the surface to subcrustal layers.

2. Study of spatial and temporal inter-relations between tectonic structures, the probability of their causative interconnections and character of co-influence in evolutionary processes, the nature of their boundaries, and the degree of development of plicative and disjunctive dislocations.

3. Study of the place and role of magmatic and metamorphic processes in the geodynamic evolution of the South-west Pacific.

4. Study of the character of contemporary displays of tectonic activity and their specifics within the basic types of structural forms in the region and along their boundaries. Study of the nature of tsunami-genic earthquakes, intensity of thermal, gravitational, and magnetic fields typical for different region of structures.

5. Reconstruction of the geological evolution of principal structures of the region to identify regularities in the times and conditions of formation of magmatic, metamorphic, and sedimentary complexes, study of their petrological composition, possible sedimentational hiatuses, and the location, character, and age of volcanism.

6. Study of the main characteristic features of the distribution of mineral resources. Study of the magmatic and metamorphic rock formations of the main regional structures and the endogenic mineralisation related to them. Survey of modern geosynclinal sedimentation and ore formation in the light of comparisons with Phanerozoic geosynclinal development. Investigation of sediment composition, stratification types, ore content in different structural zones at different distances from volcanoes and other active centres, detailed mineralogical and geochemical alterations in hydrogenous and hydrothermal study of ore formations.

7. Study of the main features of regional deep structure including heterogeneity of upper mantle physical properties such as density, velocity of propagation of seismic waves, seismic wave energy absorption, for the whole region as well as for its parts, and their geological interpretation. Development of paleogeodynamic reconstructions.

8. Development of a general geodynamic model of the region. It could be supposed that achieving the above mentioned goals will allow development of a spatial-temporal model of the region.

NOTE : also presented were documents:

NR/CCOP/SOPAC (9)/CR.27 - Summary of CCOP/SOPAC work programme for Samoa (1981-86) - (see Part 2, work programme, Samoa);

NR/CCOP/SOPAC (9)/CR.28 - Preliminary information on the programme of geological-geophysical investigation in CCOP/SOPAC area by Soviet r.v. *Callisto* at the end of 1981 - (see Part 1, report of TAG, para. 138-141);

NR/CCOP/SOPAC (9)/CR.65 - Proposed *Geovan II* Cruise to Vanuatu and Solomon Islands (1981) - (see Part 1, report of TAG, para. 144);

NR/CCOP/SOPAC (9)/CR.66 - Work programme - Fiji (new proposal) - (see Part 2, work programme, Fiji);

NR/CCOP/SOPAC (9)/CR.68 - Tonga work programme (new project) 1980-1981 - (see Part 2, work programme, Tonga);

NR/CCOP/SOPAC (9)/CR.69 - Inshore and near-shore resources workshop - (see Part 1, report of TAG, para. 136);

NR/CCOP/SOPAC (9)/CR.71 - Formulation of the Work Programme - Regional Projects - (see Part 2, work programme, regional projects);

NR/CCOP/SOPAC (9)/CR.72 - Nearshore zone survey in Tarawa Lagoon - (see Part 2, work programme, Kiribati).

KATZ, H.R. 1980: Cretaceous-Cenozoic sedimentary basins of New Zealand (map). Enclosure for "Prospectus for Petroleum Exploration in New Zealand". Ministry of Energy, Wellington, N.Z. Document NR/CCOP/SOPAC (9)/CR.39.

KATZ, H.R. 1980: Basin development in the Solomon Islands and their petroleum potential (Abstract only). Pp 59-75 in ANON: Petroleum potential in island arcs, small ocean basins, submerged margins and related areas. CCOP/SOPAC *Tech. Bull.* 3. Document NR/CCOP/SOPAC (9)/CR.51.

LEWIS, K.B.; UTANGA, A.T.; HILL, P.J.; KINGAN, S.G. 1980: The origin of channel-fill sands and gravels on an algal-dominated reef terrace, Rarotonga, Cook Islands. *S. Pacif. mar. Geol. Notes* 2(1) : 1-23.

I. Publications

NOTE : The following publications relevant to the CCOP/SOPAC work programme were presented:

ANON. 1980: Newsletter. Project Office, UNDP Offshore Mineral Prospecting in the South Pacific (UNDP and CCOP/SOPAC). *NewsL. 1*(3) : 1-4. Document NR/CCOP/SOPAC (9)/CR.37.

COX, M.E. 1980: Areal distribution of marine sediment mercury in the region around Fiji. *S. Pacif. mar. Geol. Notes* 1(10) : 111-22. Document NR/CCOP/SOPAC (9)/CR.6.

EADE, J.V. (comp.) 1980: Proceedings of the Eighth Session of the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Off-shore Areas (CCOP/SOPAC). Wellington : DSIR Science Information Division for CCOP/SOPAC. 99 p. Document NR/CCOP/SOPAC (9)/CR.35.

Part 4: SUMMARY REPORT OF THE CCOP/SOPAC— IOC SECOND INTERNATIONAL WORKSHOP ON GEOLOGY, MINERAL RESOURCES, AND GEOPHYSICS OF THE SOUTH PACIFIC

Noumea, New Caledonia, 9-15 October 1980

(Previously published as Intergovernmental
Oceanographic Commission (IOC) Workshop
Report No. 27)

Preface

The Workshop is jointly sponsored by the Intergovernmental Oceanographic Commission (of UNESCO) and the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas, and will review and update the CCOP/SOPAC - IOC IDOE programme which was developed at the 1975 Workshop on the same subject (see IOC Workshop Report No.6). The terms of reference of this Workshop in accordance to decision WESTPAC 1-9, are to:

1. summarise present knowledge and ongoing research projects on marine geosciences in the South-west Pacific;
2. identify major unsolved problems in the field of geology, geophysics, and mineral resources, and further research work needed to solve these problems;
3. define new scientific research and training programmes for execution in the region.

Summary report

1. OPENING OF THE WORKSHOP AND ADOPTION OF THE AGENDA

The meeting was opened by His Excellency the High Commissioner of the Republic in the Pacific Ocean, Chief of the Territory of New Caledonia and Dependencies, Mr C. Charbonniaud. His opening address is attached as Annex III. The representative of IOC, Dr G. Giermann, Deputy Secretary of IOC, then welcomed the Workshop on behalf of the Director-General of UNESCO and the Secretary IOC and thanked the French Government for its kind offer to host the Workshop in Noumea. The representative of ESCAP, Mr L. Machesky, addressed the Workshop on behalf of the Executive Secretary of ESCAP. In his message, the Executive Secretary stressed the importance of close co-operation between the United Nations agencies and Member States for the benefit of the region. Additional greetings were made by the Chairman of CCOP/SOPAC, Mr R. Richmond, who also served as Chairman of the opening ceremony and by the Director of the ORSTOM Centre, Mr de Boissezon, being the host of the Workshop. The opening ceremony

was attended by representatives of the Government Council and the Territorial Assembly as well as by the Lord Mayor of Noumea. Scientists from the following 18 countries participated: Australia, Cook Islands, Fiji, France, Indonesia, Japan, Kiribati, Nauru, New Zealand, Papua New Guinea, Philippines, Solomon Islands, Tonga, United Kingdom, United States of America, Union of Soviet Socialist Republics, Vanuatu, Western Samoa.

2. ELECTION OF CHAIRMAN AND VICE-CHAIRMAN AND NOMINATION OF RAPPORTEURS

The Workshop elected Dr S. Uyeda as Chairman of the Workshop and Mr R. Richmond as Vice-Chairman. Mr A. Macfarlane and Mr J. Dubois were appointed rapporteurs.

3. GENERAL REVIEW AND BACKGROUND PRESENTATIONS

On behalf of the two sponsoring organisations, the IOC representative introduced the IOC resolution under which the Workshop was established (decision WESTPAC 1-9) and read out the Terms of Reference (as quoted in the Preface). The Chairman then explained how the Workshop would be conducted. He stated that after a two-day review session (symposium) a two-and-a-half day Workshop would follow in which three Subcommittees would meet separately in order to update and reformulate programmes and projects. The last morning of the session would then be reserved for adoption of the Summary Report, the Subcommittee programmes and projects, and the general recommendations. The three Subcommittees were established as follows:

- A. Tectonic evolution of arcs and back-arc basins / Evolution tectonique des arcs et bassins arriere-arc

(Chairman - P. Coleman)

- B. Deep crustal structure, petrogenesis and thermal regime - evolution of the lithosphere / Structure profonde de la croute, petrogenese et regime thermique - evolution de la lithosphere

(Chairman - C.J. Allegre)

C. Stratigraphy, sedimentary provenance and metallogenesis / Stratigraphie, origine des sediments et metallogenese

(Chairman - J. Wright)

A list of participants in the Subcommittees is attached as Annex VII. In the symposium held under this agenda item, 32 speakers presented overview papers and specific papers which collectively summarised the state of present knowledge and drew attention to problems that remain to be solved. A list of presentations is attached as Annex VI.

The setting up of a volcanological institute has been proposed to serve the Australo-Asian or Western Pacific region. This institute could provide a formal course in the basic principles of applied and theoretical volcanology; assist in joint research projects on the geology and geophysics of active and dormant volcanoes, strengthen communication between volcanically active countries so that volcanologists could move quickly to critical areas during times of volcanic emergency, and provide a data bank for information on the volcanoes of the region. A resolution proposing such an institute was presented by the Australian National Commission for UNESCO to the twenty-first session of the General Conference of UNESCO, held in Belgrade (October 1980).

The prospects for further ocean floor drilling in the area were mentioned by Dr Keith Crook, Secretary of the Consortium for Ocean Geosciences of the Australian universities (COGS). He reported that COGS had recently received funds from the Australian Marine Science & Technology Advisory Committee (AMSTAC) to support a workshop which would consider Australian participation in the last year (1983) of the International Programme of Ocean Drilling (IPOD) and the subsequent Ocean Margins Drilling programme (OMD). The workshop, which will involve representatives of industry, government institutions, and universities, will be held in Canberra, in March. The OMD organisation is contemplating group membership, with several countries forming a group which would have a single vote. A group comprising Australian and SOPAC countries could be appropriate, and COGS therefore extends an invitation to CCOP/SOPAC to send an observer to the workshop. If Australia were to join IPOD, reinstatement of the recently abandoned programme of hydraulic piston coring in the South-west Pacific is likely.

4. DEVELOPMENT OF FUTURE PROGRAMMES AND PROJECTS

The three Subcommittees met and formulated the programmes and projects outlined in Annex V. In doing so, the Subcommittees took into account the Report of the CCOP/SOPAC -

IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, held in Suva, Fiji, 1-6 September 1975 (IOC Workshop Report No.6), the Report of the WESTPAC Workshop on the Marine Geology and Geophysics of the North-west Pacific, held in Tokyo, 27-31 March 1980 (IOC Workshop Report No.23), and the Report of the Second International Workshop on Marine Geoscience, held under the sponsorship of IOC, SCOR, and CMG (of IUGS), in Mauritius, 1-3 August 1976 (IOC Workshop Report No.9).

The Subcommittees agreed that rather than updating the programme contained in the Suva Report of 1975, they would concentrate on a small number of new projects which could be implemented at an early date with the assistance of the countries in the region.

The Workshop was informed of a five-year proposal for Soviet research in the South Pacific, including the following.

A study of recent tectonic activities, in particular seismicity, including microseisms, tectonic strain indices, and tsunamigenic earthquakes;

a study of the main features of regional depth structure including the anisotropy of the upper mantle and the study of place and role of magmatic and metamorphic processes in the geodynamic evolution of the South-west Pacific;

a study of the main characteristic features of mineral resources distribution. A comprehensive study of magmatic and metamorphic rock associations of main regional structures and related endogenous mineralisation. A survey of modern geosyncline sedimentation and ore formation in comparison with Phanerozoic geosyncline development. Investigations of sediment composition, their stratification types, ore content in different structural zones, at different distances from volcanoes and other active centres, a detailed study of hydrogenous and hydrothermal mineralisation.

The future programmes and projects of research which were developed under this agenda item are attached to this report as Annex V; special recommendations are contained in Annex IV.

5. ADOPTION OF THE SUMMARY REPORT INCLUDING RECOMMENDATIONS AND NEW PROGRAMMES

The Workshop adopted the Summary Report and the Annexes IV (Recommendations) and V (Programmes of research) contained therein.

6. CLOSURE OF THE WORKSHOP

The meeting closed on Wednesday, 15 October,

at noon. The participants expressed their appreciation to the organisers of the Workshop for their excellent arrangements and their generous hospitality.

ANNEX I

AGENDA

1. Opening of the Workshop and adoption of the agenda
2. Election of Chairman and Vice-Chairman and nomination of rapporteurs
3. General review and background presentations
4. Development of future programmes and projects
5. Adoption of the Summary Report including recommendations and new programmes
6. Closure of the Workshop

ANNEX II

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ANNEX III

ADDRESS BY

Mr C. CHARBONNIAUD

On behalf of the Government of the French Republic, I am particularly happy to welcome the officials in charge of the technical departments of various countries and territories in the Pacific, and eminent scientists who in some cases have come a much greater distance, to this second Workshop organised jointly by the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas and the Intergovernmental Oceanographic Commission. As Chief of the Territory, I am glad that it has been possible to hold this meeting in New Caledonia at the ORSTOM Centre in Noumea, whose teams of geologists and geophysicists have contributed to a greater knowledge of the South Pacific.

The peoples of the South Pacific have realised that the energy resources and raw materials of the land masses are limited or will rapidly be exhausted. They have turned their attention to the vast ocean around

them. They have great hopes of it - perhaps unduly great! But the scientists taking part in the exploration of the South Pacific are not yet in possession of enough reliable knowledge to encourage their hopes or to dispel their dreams.

I might mention that the South Pacific has been left relatively untouched in recent years by major scientific programmes, and, in particular, no IPOD drilling has been carried out there for some time. Oceanographic expeditions organised by bodies outside the South Pacific seem to have been less numerous than previously. I do not think that this is due either to lack of scientific interest in the region or to lack of interest in its potential; but our maritime zones are far from the large countries which can afford to promote such research, and the economic crisis has, without a doubt, caused them to revise their priorities. Furthermore, the size of the maritime zones to be explored is out of all proportion to the funds at the disposal of the countries and territories of the South Pacific.

It is therefore particularly important that, acting through international organisations such as the Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas and the Intergovernmental Oceanographic Commission of UNESCO, we should be able to pool our efforts and even our funds in order to extract maximum benefit from national programmes or to co-operate in carrying out exploration programmes. In this connection, I am able to state on behalf of the government that France intends to continue to offer the services of its scientists and, as far as possible, its nautical facilities, as it has already done both in the past and very recently off the coast of Vanuatu.

You have met, then, to assess what has been learned and to devise research programmes which, in the years to come, will help us to advance our knowledge of submarine resources in the South Pacific and subsequently to make use of those resources. I hope that these programmes may further the advance of science, but, above all, I hope that any mineral resources that you may be able to detect will contribute to development and to a better quality of life for all the inhabitants of this region.

Ladies and gentlemen, in welcoming you to the Territory of New Caledonia, I should like to express my sincere hope that your proceedings and discussions may be fruitful and that your present and future research may provide the peoples of the South Pacific

with reliable knowledge of the mineral resources of their vast ocean domain.

ANNEX IV

RECOMMENDATIONS

The Second CCOP/SOPAC - IOC International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific,

1. Recommends that the Chairman of the Workshop transmit for approval the adopted Summary Report of the Workshop (including recommendations and programmes of research) to the next session of CCOP/SOPAC, to be held in Tarawa, Kiribati, 20-28 October 1980, and to the Secretary of IOC for submission to the next session of the IOC Executive Council, to be held in May or June 1981 in Spain, as well as to the next session of the Programme Group for the Western Pacific (WESTPAC), to be held in Jakarta, September 1981.
2. Recommends that UNESCO and its IOC, CCOP/SOPAC, and ESCAP provide immediate training in marine geology, geophysics, and mineral resources as well as in data handling, so as to avoid delays in the implementation of the programmes of research.
3. Recommends that UNESCO arrange for a meeting of operators of seismographic networks with interested representatives of island groups, in order to discuss: (1) the improvement of communication between existing networks and the establishment of a regular exchange of seismographic bulletins; (2) the exchange of technical information on instrumentation; and (3) the establishment of new networks in critical areas.
4. Recommends that UNESCO and its IOC examine and improve, as a matter of priority, the co-ordination and interpretation of the seismic information system in Vanuatu, Fiji, Samoa, and Tonga, and tsunami warning communication system in the region.

ANNEX V

PROGRAMMES OF RESEARCH

1. REPORT OF SUBCOMMITTEE A ON TECTONIC EVOLUTION OF ARCS AND BACK-ARC BASINS

INTRODUCTION

The CCOP/SOPAC region is a key area for studying a wide range of fundamental problems, many of which are closely connected

with assessments of hydrocarbon and mineral resources potential, and geological hazards.

Elucidation of the crustal history of the region, which among other things will require integration of marine and land-derived stratigraphic and geophysical data, is an essential component in the assessment of the mineral and hydrocarbon resource potential of the region. Consequently the research projects treated below have been examined from a conjoint perspective in which relevance to fundamental scientific problems and relevance to resource assessments are integrated.

The region affords excellent examples of many important tectonic, geomorphic, and sedimentary features associated with the active margins of oceanic plates. These include: the active volcanic island arcs and their associated trenches which characterise the zones of plate convergence along the Melanesian Borderland and Tonga-Kermadec chain; fossil convergence zones such as the Fiji Platform; actively extending and inactive marginal basins with passive, oblique-slip, and active trench margins; active and inactive inter-arc basins diverse in size and sedimentary fill; and regions where the polarity of subduction may have been reversed following the collision of an oceanic plateau with a trench.

Each of these features displays considerable internal variation. For example, the active trenches vary in depth along their lengths. In three instances this variation is due to the presence of ridges on the oceanic crust which is being consumed at the trench. The Woodlark Rise, an active spreading centre is being consumed at a high angle beneath New Georgia, interrupting the Solomons Trench. An inactive ridge, the d'Entrecasteaux Fracture Zone, is being consumed orthogonally beneath Espiritu Santo, interrupting the New Hebrides Trench. The inactive Louisville Ridge, which is being consumed obliquely at the Tonga-Kermadec Trench, has swept southwards along the trench during the past few million years thereby contributing to morphological contrasts between the fore-arc regions in the Tonga and Kermadec segments of the Tonga-Kermadec arc.

Convergent margins in the region vary greatly in their vectors of motion relative to the earth's mantle. This feature of the region's lithosphere dynamics may account for the tectonic and geomorphic diversity within the region, and related variations in seismicity, volcanicity, and heat flow.

Geological and geophysical data attest to the dynamic nature of the region throughout the Cenozoic. The history of crustal evolution in the region is complex. Work under-

(Field Project 2-6) have been made by ORSTOM. Compilation of this project depends upon future work in the region under the aegis of IPOD or the Ocean Margin Drilling Programme (OMD). Other projects, such as the study of the Solomon and Woodlark Basins (Field Project 1-3), remain virtually untouched.

The present status of each of the previously proposed projects is tabulated in an appendix to this report. The CCOP/SOPAC meeting in Kiribati may wish to comment on this summary, and the WESTPAC recommendations, in the light of scientific, technological, and economic developments which have occurred since the projects were originally proposed.

PROJECT A-1 - Study of island arc sedimentary basins; correlation of reference sections and seismic stratigraphy

The geological history of island sedimentary basins is of fundamental importance to the study of island arc tectonics, their resource evaluation and geological hazards assessment. Detailed age, lithological and thickness data from sedimentary reference sections on the islands are vital to the recognition and understanding of offshore seismic reflection and refraction profiles. In particular, thickness and lithology observed in outcrops are the data to be used for comparison with velocity parameters obtained from refraction work offshore, as well as, where possible, on land (e.g., Guadalcanal Plains). These velocity parameters will also define total sedimentary thickness and basement. taken since the first CCOP/SOPAC Workshop in 1975 shows that this history involves large lateral rotations of crustal blocks, such as Vanuatu and Fiji which rotated in opposite senses, and substantial vertical movements, with late Quaternary rates as high as 5 m/1000 years in parts of Vanuatu and New Zealand.

The thermal, deformational, and geomorphic consequences of this dynamic history are particularly relevant to sedimentary basins in the region, such as the Central Solomons Trough, which are prospective for hydrocarbons.

The 1975 CCOP/SOPAC Workshop proposed a number of research projects that fall within the purview of Committee A. Other projects were commended to this Workshop by the WESTPAC Workshop held in Tokyo in March 1980. Substantial progress has been made on some of these projects, for example, Field Project 1-2: Study of the North Fiji Basin. Essential preliminary studies have been completed on other projects, for example, the site surveys of the Tonga-Lau Transect

The purpose of this project is to provide basic stratigraphic and structural data to assist in the preliminary assessment of hydrocarbon potential and seismic hazards. This can be accomplished by detailed marine geophysical surveys including the collection of single and multi-channel seismic reflection, gravity and magnetic data, along with the land studies.

Such investigations are recommended in the island arcs of Manus - New Ireland, Bougainville, the Solomons, Vanuatu, Fiji, and Tonga, where detailed stratigraphic sections can be evaluated.

(1) In the Manus - New Ireland region, the Miocene Laus formation and the Mio-Pliocene Rambutoyo Beds may occur in offshore wrench fault basins.

(2) The mid-Tertiary sequence of Western Bougainville should be correlated with the Ettoile-1 Well section.

(3) In the Solomon Islands, the detailed data available from the Shortland Group, Choiseul, and New Georgia Islands would usefully serve as a control for the Oligocene to Pleistocene stratigraphy in the north-western Central Solomons Trough. Likewise, the detailed data of the Late Cretaceous to Pleistocene sequence in southern Malaita, Nggela, and Guadalcanal would assist interpretation in the south-eastern part of the same basin.

Lithological data from Rennell Island Miocene and Pleistocene limestones may assist in the interpretation of future seismic surveys in that region.

The Middle Miocene to Pleistocene sequence of Nendo Island in the Santa Cruz Group may usefully be correlated with sequences in nearby offshore basins, such as the North Fiji Basin and the northern New Hebrides Basin.

(4) In Vanuatu, detailed data on the Miocene and Pliocene sediments of Espiritu Santo and Malekula Islands, together with the Mio-Pliocene sediments on Maewo and Pentecost Islands, will assist the interpretation of seismic profiles in the adjacent Central Basin.

(5) In the Fiji region, detailed work on the Miocene-Pliocene sedimentary basins of western Viti Levu, especially stratigraphic, and thickness relationships between the Wainimala and younger formations would assist correlation of offshore seismic studies with land data.

(6) In Tonga, the Eocene-Oligocene and Miocene sequence of 'Eua, the Miocene sections exposed on various islands of the Nomuka Group, and the probable Pliocene

limestones of Vava'u should be studied and presented in detail, to assist offshore seismic interpretation.

Recommendations

(1) For the success of Project A-1, the geological surveys of the respective island countries should produce bio- and litho-stratigraphic columns and correlations between adjacent islands. This study should be combined with shallow drilling (50-100 m) on land for stratigraphic section compilation, heat flow measurements, determination of physical properties, and to obtain samples for source rock analyses.

(2) Detailed, high quality, marine geophysical data (single-channel seismic, seismic refraction, gravity, magnetics, and bathymetry) should be collected in the key prospective areas of the Melanesian Borderlands. In addition, high frequency, true amplitude multi-channel seismic data should be collected to elucidate basin seismic stratigraphy, subsidence history, structure and tectonics, initially in the Central Solomons Trough and the Central Basin of Vanuatu.

(3) The presence of broad wrench fault zones such as those suspected between Manus and New Ireland, along the eastern and possibly south-western limits of the Central Solomons Trough and also the Central Basin of Vanuatu should be investigated in detail. The results of this investigation should be related to the ESCAP Sedimentary Basins Correlations Project (IGCP Project No.32).

PROJECT A-2 - Solomon Islands palaeomagnetic project

Palaeomagnetic studies have been carried out in Tonga, Fiji, Vanuatu, and Papua New Guinea over the last four years following the recommendations of the previous Workshop. Arc rotations demonstrated by these data, together with the sea-floor magnetics, provide an essential basis for Tertiary palaeotectonic and palaeogeographic reconstructions. The understanding of the geotectonic history of a region is a necessary prerequisite for hydrocarbon exploration and a desirable adjunct to mineral exploration.

Whether or not the polarity of the northern side of the Melanesian arc reversed in the Miocene is one of the more important unresolved problems of the tectonics of the arc complex. It has been suggested that the island of Malaita is part of a flake of the Ontong Java Plateau, thrust across the blocked subduction zone. The motion of the Pacific plate with respect to the asthenosphere in the northern Melanesian region is approximately westwards, and that of the Indian plate northwards. Because of these

contrasting motions, palaeomagnetic studies on well-dated rocks on Malaita and other islands of the group should indicate their plate associations and the timing of any relocations of plate boundaries.

The Solomon Islands arc may have originated on the Indian/Australian plate, or alternatively on the Pacific plate remote from the present plate boundary region. Palaeomagnetic studies of Palaeogene and Late Cretaceous rocks may resolve this question.

Another fundamental problem concerns the degree of integrity of an island arc during a back-arc or marginal basin sea-floor spreading episode. Miocene and Pliocene palaeomagnetic data from Vanuatu have strongly suggested integral arc rotation from six million years ago. Miocene and Pliocene rocks also occur in the Santa Cruz Islands. Since these are part of the New Hebrides island arc palaeomagnetic sampling on Santa Cruz Islands should resolve the style of arc rotation. Confirmation of the presumed tectonics of the remnant arc ("Vityaz Arc") should be gained by palaeomagnetic sampling of Fatutaka (Mitra) Anuta and adjacent eastern Solomon Islands.

Recommendations

(1) A detailed palaeomagnetic survey including magnetostratigraphic studies should be carried out on the islands of Malaita and Guadalcanal in the Solomon Islands. Some sampling may also be necessary on Ngela, San Cristobal, and Santa Isabel.

(2) A palaeomagnetic survey should be carried out on the eastern Solomon Islands.

PROJECT A-3 - Definition of Indian Pacific plate boundary north of Fiji

Most of the tectonic lineations along the South-west Pacific reflect the present and former plate boundaries between the Indian and Pacific plates. It is important to delineate the position of the present plate boundaries between the Pacific and Indian plates and between the plates and the marginal basins, both for scientific reasons and for the assessment of earthquake hazards.

The plate boundary between the North Fiji Basin, the Lau Basin, and the Pacific plate is poorly defined, especially in the region north of Fiji where there appears to be a complex zone between the two marginal basins and the Pacific plate.

It is recommended that the data collected since 1970 on earthquake activity in the North Fiji - Lau Basins area be re-examined. First motion determinations should be made together with relocation of foci using lithospheric seismic velocities obtained

from recent refraction studies.

Accuracy of locations should also be improved by the installation of seismic stations on islands of the region such as Wallis, Futuna, Rotuma, and Nia'foou. Towards this end the Committee also strongly recommends that the complementary telemetered seismic network in Fiji be improved by the provision through aid sources of an on-line computer for interpretation of data (cf. Recommendation in Annex IV).

Target areas for plate boundaries studies should be selected from analysis of the seismic data and from the examination of magnetic anomalies located over the North Fiji and Lau Basins. These areas would be best located along active ridge sections and fracture zones and their intersections. Seismic and microseismic activity of the target areas should then be examined through the ship-board deployment of ocean bottom seismic arrays across and along these active tectonic features.

These studies should provide a precise definition of the marginal basin/Pacific plate boundary and a better assessment of the earthquake hazards and kinematic history of this region.

PROJECT A-4 - The geophysical and geochemical consequences of subduction of the Woodlark spreading system at the Solomon Island arc-trench system

The subduction of an active spreading system at an oceanic island arc-trench system is a significant tectonic occurrence. In the South-western Pacific this situation is occurring today, where the Woodlark spreading system (of post-Miocene age) is being subducted beneath the New Georgia Islands section of the Solomon Island arc. The Woodlark Basin - Solomon Islands region thus provides: (a) a unique opportunity to study the geophysical and geochemical effects of oblique subduction of an active oceanic spreading system at an intra-oceanic island arc; and (b) a natural laboratory in which the roles of sediment and altered oceanic crust in island arc magma genesis can be determined. We therefore propose an integrated study of this region with the following objectives.

(1) To ascertain the geochemistry of both the incoming (Woodlark Basin) crust and sediments and the voluminous Plio-Pleistocene subaerial and submarine lavas erupted in and around the New Georgia Islands.

(2) To determine the present heat flow regime in that part of the Solomon Island arc where the Woodlark spreading system is being subducted.

(3) To determine the ages of the main rock associations of the New Georgia group.

(4) To undertake a comparative study of the post-Pliocene vertical tectonics of the New Georgia group and the adjacent islands of the Solomons arc and hence to investigate possible links between subduction of buoyant Woodlark Basin crust and such vertical movements.

To implement this project approximately one month of shiptime would be required in the Woodlark Basin - Solomon Islands region. A shipboard dredging and coring programme would be necessary to collect a suite of oceanic crust and sediment samples representative of the materials being delivered to the Solomon Trench, and to sample the two recently active submarine volcanoes 20-40 km landward of the trench axis. The month of shiptime would also allow the mapping of the poorly known tectonic fabric of the eastern part of the Woodlark Basin (near the trench) and make possible the necessary measurements of the thermal regime at the trench and in the fore-arc and back-arc areas around the New Georgia Islands (including the Slot).

The New Georgia Islands are currently the subject of a 1:50 000 scale geological mapping programme being conducted by the Solomon Islands Geological Survey. This work will include petrographic studies and major element geochemistry of the main rock associations.

Samples of both subducted and erupted materials should be analysed for phase chemistry, major, minor, and trace elements and Nd, Sr, and Pb isotopic ratios.

An aeromagnetic survey over the Woodlark Basin before the shipboard programme would determine the magnetic lineation fabric in more detail. This would allow more precise location of the dredge sites.

Knowledge of the geothermal regime over the Solomon Island arc, and particularly over the thickly sedimented Central Solomons Trough (the Slot), will have important implications for the hydrocarbon potential of sedimentary basins in the Solomon Islands.

Both the geochemical data and geothermal measurements acquired under this project would provide the important chemical (mass balance) constraints and physical boundary conditions required for the understanding of how oblique subduction of an active spreading system influences or determines island arc magma genesis.

PROJECT A-5 - Effects of subduction of aseismic ridges and small plateaus in the South-west Pacific

The entry of large oceanic plateaus, such as Ontong Java, into subduction zones is known

to have profound geologic consequences. The collision and subsequent incorporation of small seamounts with island arcs have been documented in both the Tonga and Marianas regions. The interaction of features of intermediate size, such as elongate aseismic ridges and small plateaus, has not been as well studied, however, and is not fully understood.

Within the South-west Pacific, two key examples exist of such ridge-trench interactions, clearly differing in tectonic style. One is representative of orthogonal subduction of a small elongate plateau and fracture zone. The other is representative of the oblique subduction of an extensive aseismic ridge, effectively sweeping the island arc longitudinally. In the former example, the d'Entrecasteaux Ridge and the adjacent North d'Entrecasteaux Plateau are impinging on the New Hebrides Trench. In the latter example the Louisville Ridge is sweeping down the Tonga frontal arc.

Consequences of the apparent subduction of these aseismic ridges include:

- (1) modification of the subduction geometry and patterns of seismicity;
- (2) uplift and deformation of the fore-arc regions;
- (3) changes in morphology of fore-arc and inter-arc basins which may include development of environments of restricted circulation;
- (4) shifts in sedimentary provenance resulting in the introduction of land-derived sediment;
- (5) in the case of obliquely subducted features, progressive changes in morphology and seismicity as the site of ridge subduction moves laterally.

Very little is known about the effects of aseismic ridge subduction on: (1) arc volcanism; (2) geochemistry of arc volcanics; (3) perturbation of the geothermal regime; and (4) tectonic erosion of the inner trench wall versus formation of accretionary prisms.

Particular note should be taken of the inadequate seismological coverage in the Kingdom of Tonga. Since Cornell University disbanded their deep earthquake seismological network in Tonga in 1975, no further seismic studies have been carried out in the area. It is important to note that Tonga has been the site of two great earthquakes (> 8, Richter scale) early in this century. Another major earthquake, measuring 7.8 on the Richter scale, occurred in 1977. Other major earthquakes may well continue to affect the area periodically. It is important, therefore, to monitor this activity with a view

to devising safety measures and long-term prediction of major events.

Recommendations

- (1) Investigate possible perturbations in the geothermal regime due to subduction of aseismic ridges in Tonga and Vanuatu.
- (2) Identify changes in subaerial and submarine geomorphology of the fore-arc region and outer and inner slopes of the trench, due to island arc-aseismic ridge interaction, including detailed bathymetric mapping, dredging, coring, and ocean-floor drilling along the fore-arcs in both Vanuatu and Tonga.
- (3) Identify structural elements in Vanuatu and Tonga resulting from trans-current fault and horizontal displacements.
- (4) Undertake comparative studies on the crustal structure of the d'Entrecasteaux Ridge, North d'Entrecasteaux Plateau, and Louisville Ridge using seismic reflection and refraction techniques, together with co-ordinated studies on the crustal structure of the affected regions of the adjacent arcs to assess the effects of differences in subduction geometry.
- (5) Compare the timing of sedimentary, magmatic, and deformational events in the Tonga arc with the timing of subduction events.
- (6) Install a telemetered seismic network in Tonga, perhaps tied into the existing Fiji network to permit more efficient data reduction and to allow regional early warning of potential tsunamis.
- (7) Study the shallow earthquakes in Tonga previously recorded in the disbanded Cornell network with a view to locating active shallow seismic zones.
- (8) Train Tongan nationals as seismograph station operators.
- (9) UNESCO and its IOC should examine and improve, as a matter of priority, the co-ordination and integration of the seismic information system in Vanuatu, Fiji, Samoa, and Tonga and the tsunami warning communication system in the region. (This Recommendation is repeated as Recommendation 4 of Annex IV.)

II. REPORT OF SUBCOMMITTEE B ON DEEP CRUSTAL STRUCTURE, PETROGENESIS AND THE THERMAL REGIME - EVOLUTION OF THE LITHOSPHERE

INTRODUCTION

Understanding the behaviour of lithospheric

plates in subduction zones is a crucial element of global tectonics. Subduction zones are major plate boundaries and may be the locations for generation and/or destruction of continental crust. Subduction zones are also the loci of earthquakes and volcanic activity. Better knowledge of these phenomena, as they relate to the subduction processes, will contribute to more accurate forecasting of these potentially devastating events.

Convergent margins are associated with many important mineral deposits. These include massive chromite deposits within ophiolite complexes and the porphyry copper deposits associated with acidic and andesitic volcanism. Thermal anomalies are recognised throughout the subduction zone. The development of this geothermal energy may be an important energy supply for the countries within this area.

The South Pacific offers a nearly unique opportunity to study lithospheric plate behaviour without the interfering effects of continental lithosphere because the subduction zones and island arcs are completely detached from the Indian-Australian plate by intervening ocean basins. The region contains a variety of geodynamic features including the trenches, arcs, and back-arc basins typical of convergent plate margins. It should be noted that as a result of extensive previous studies in the region the basic tectonic and geodynamic framework is better understood. It is proposed that the next decade be devoted to more detailed studies dealing with processes rather than to reconnaissance surveys. The key areas needing detailed geophysical and geologic study may be identified and major problems needing study may be proposed.

Field and laboratory research projects done with the funding support of governments or research institutions should be continued and given encouragement on the international level. This is necessary to achieve the major scientific objective of understanding the evolution of the earth's lithospheric plates.

The studies which can and should be made on these fundamental problems are numerous and varied.

Many of these projects may be done without the need for international co-operation, but it is important that the results of these be co-ordinated with other programmes, and that the data be synthesised periodically.

Such co-ordination of research, data compilation, and synthesis should continue in three fundamental areas:

- (a) cataloguing of active volcanoes and volcanic events;
- (b) cataloguing and mapping of seismicity;
- (c) systematic compilation of geological, geophysical, and bathymetric surveys. This should include satellite imagery and geophysical survey results.

A South Pacific information centre should be encouraged by appropriate funding to collect all documents relevant to these programmes. The information should be available to anyone who wishes to undertake research in this region.

Three specific projects are suggested for concentrated international co-operation during the next two years.

Project B-1 - Ophiolites; emplacement mechanisms variations; mineral resources.

Project B-2 - Mechanical properties of the oceanic lithosphere studied through bending processes.

Project B-3 - The thermal regime of the descending oceanic lithosphere.

All projects have specific importance to the South Pacific area. All have importance to the local populations in respect to mineral resources and to geological hazards.

PROJECT B-1 - Ophiolites; emplacement mechanisms variations; mineral resources

Ophiolite complexes have been recognised as a piece of oceanic crust "transplanted" on to the continent by some processes linked with plate convergence.

In recent years extensive exploration has been done on ophiolite complexes around the world, and these studies have given support to some early suggestions that the ophiolite complexes are not a unique petrologic association but contain several different kinds of associations reflecting varieties of oceanic crust. Some ophiolite complexes may have been formed in back-arc basins; others may be associated with island arc magmatism. Some may be generated in large ocean basins either at mid-ocean ridges, fracture zones, or as ocean islands.

The mode of transplantation on to the continent may not be unique. Some scientists support the obduction mechanism, others favour the back-subduction transplantation (BST), a third group emphasises the collision tectonic process, and recently a process of transduction has also been invoked.

Such variety is also apparent with respect to mineral deposits associated with ophiolites. Some complexes contain important chromite deposits associated with perido-

titic harzburgites or with cumulative dunites; other have quite minor chromite deposits. Pillow lavas may contain important Cu, Zn, Fe sulphide associations, while others contain only minor Mn, Fe oxide crusts. Some ophiolite belts are expected to contain nickel sulphide enriched in platinum group metals.

Therefore, the present day scientific question is not only to understand ophiolite genesis, but also to classify and explain their diversities. Such compilation may give a clue to understanding oceanic lithosphere genesis and evolution, tectonic processes in subduction zones related to the development of mountain chains, and a systematic guide for the exploration of mineral deposits.

In this respect the western Pacific offers unique opportunities to develop such a project.

(1) The ophiolite complexes are numerous, well exposed, and seem to display large variations. Huge complexes are known in the Philippines, Papua New Guinea, and New Caledonia. Small complexes have been reported in the Solomon Islands, Vanuatu (former New Hebrides), and New Zealand.

(2) The geodynamic situation in those areas excludes a tectonic emplacement by continent-continent collision (as in the Alps or in the Himalayas) and their evolution can be understood in terms of the plate tectonic history of the area.

(3) The western Pacific ophiolites are situated within the ocean-continent or ocean-ocean transition and therefore it is possible to study their character on land as well as offshore. Such studies have been conducted so far in Papua New Guinea and New Caledonia.

(4) Various ophiolites in the western Pacific are known to contain important mineral deposits; much economic hope can be attached to such a project.

(5) Such comparative projects can be best conducted by a co-operative effort involving scientists from the countries where these complexes are located.

Considering our present state of knowledge of ophiolites we suggest the following programmes for the next four years.

1. Mapping of the ophiolite complexes

Special emphasis should be given to

- (a) evaluation of the thickness of the pillow basalts, dolerite dike-sill complexes, gabbros, ultramafics;
- (b) study of the nature of sediments in contact with the upper pillow lavas;

- (c) systematic use of the structure cross-sections.

2. Dating of the ophiolite formation and tectonic emplacements

- (a) Dating of the ophiolite formation can be achieved routinely by two methods: Sm-Nd method applied to the gabbroic rocks using Plag Pyr combined with micropalaeontological dating applied to the sediments in contact with pillow lavas.
- (b) Dating of the age of tectonic emplacements is more difficult to achieve because some ophiolites have been involved in polytectonic episodes; the dating can be made only by careful geological studies combined with stratigraphic and dating techniques. However, a systematic use of the ^{39}Ar - ^{40}Ar radio-metric dating technique using the multi-plateau concept may be a way to solve such a problem. Another way may be the direct dating of metamorphic minerals (amphiboles).
- (c) Dating of the calcalkaline porphyries or granitoids which cut the ophiolites (such as in Papua New Guinea or New Caledonia).

3. Characterisation of the ophiolite complexes by chemical methods

- (a) Defining the petrological suites by the use of classical petrological concepts and by major element chemistry.
- (b) Studying a selected number of typical suites by mineral analysis using electron probe.
- (c) Studying different suites by trace elements with special emphasis on immobile incompatible elements; REE, Ta, Th, Hf, Zr, Ti.
- (d) Studying the isotopic composition of the different complexes by $^{143}\text{Nd}/^{144}\text{Nd}$, $^{87}\text{Sr}/^{86}\text{Sr}$, $^{206}\text{Pb}/^{204}\text{Pb}$, $^{207}\text{Pb}/^{204}\text{Pb}$, $^{208}\text{Pb}/^{204}\text{Pb}$.

The data should be compared with analyses obtained on dredged samples from the same region. A systematic local comparison with island arc volcanism should be done to decipher the possible relationships between these two fundamental aspects of island arc petrology.

4. Studies on metamorphism and hydrothermal alteration

- (a) Definition by petrological methods of the geothermal gradient associated with primary genesis (spreading centre) as opposed to the geothermal gradient

associated with tectonic processes (low T high P gradient).

- (b) Distinguishing by mineralogy and oxygen isotopes the alteration associated with spreading centres (sea water) from the continental alteration. Such distinction is specially important for serpentinisation which may be used as guide for mineral prospecting.

5. Studies on mineral resources and metallogenesis

- (a) Making a systematic study of the sulphides and oxides associated with pillows and sedimentary sulphide blankets.
- (b) Making a comparative study of chromite deposits considering chromite chemistry, host rock petrology, and deformation of the host rock.
- (c) Making systematic studies of the nickel sulphide within the lower part of the gabbro sequence.
- (d) Studying the concentration of nickel as alteration products of the peridotites in conjunction with the geomorphological evolution. A comparative historical geomorphology will be welcome.

6. Studies on palaeomagnetism and magnetism

The studies of rock magnetism of the ophiolites complexes of the western Pacific islands should be encouraged.

- (a) The location of the western Pacific relative to the geomagnetic pole position in the Tertiary time may help in the search for magnetic reversals in the ophiolite complexes.
- (b) Conventional palaeomagnetic reconstruction may give important constraints on the tectonic "trajectories" of the ophiolite complexes.
- (c) The study of the magnetic orientation in relation to the tectonic history may constrain models of tectonic formation.
- (d) The measurement of NRM and magnetic susceptibility of the different components of the ophiolite suites may become a fundamental guide in interpreting exploration magnetic surveys.

7. Geophysical surveys inland

- (a) Gravimetric survey: the high densities of peridotites and the sharp contrast of density between altered and fresh peridotites and within the country rocks (limestones and schists) permit construction of a deep structure model.

- (b) Seismic reflection and refraction profiles: a systematic determination of V_p , V_s , V_p/V_s *in situ* in conjunction with laboratory measurements by ultrasonics on rock samples may help in reconstructing the shape of the bodies. Three dimensional modelling techniques should be used in some selected bodies.

8. Offshore survey

A systematic geophysical and geological survey of the offshore continuation of these ophiolites should be made. Such a survey should include seismic profiling, gravimetric, and magnetic data.

In connection with the IPOD programme, a coring programme in the offshore continuation of ophiolites in Papua New Guinea or New Caledonia should be encouraged.

9. Seafloor sampling

A comprehensive dredging programme is recommended to obtain samples of oceanic crust/upper mantle for comparison with the ophiolite masses. Two areas deserve special attention: (1) back-arc basins; and (2) the walls of trenches closest to the arcs.

PROJECT B-2 - Mechanical properties of the oceanic lithosphere studied through bending processes

Since the original rheological definition of lithospheric plates (which distinguished between an elastic plate and plastic or visco-elastic asthenosphere), much progress has been made in the study of lithospheric rheology. Studies of both oceanic and continental areas suggest that the mechanical properties of the lithosphere should be examined in a more detailed and careful way.

Recently the structure of the oceanic lithosphere has attracted much scientific activity. Several types of oceanic lithospheric plates can be distinguished; among others, oceanic plateau or seamount types are clearly distinct from the "normal" oceanic type.

Near a subduction zone, a plate of oceanic lithosphere frequently exhibits a characteristic bulge before plunging into the trench at a subduction zone. The western Pacific subduction zones are characterised by being of the ocean-ocean type. Their geometry is unique, since the angle at which the plate is subducted into the mantle is extremely large. We propose to use such a phenomenon to study the structure and mechanical properties of oceanic lithosphere.

1. Geometrical observations of bending

Good observations of the shape of the oceanic

lithosphere are necessary, including detailed topography of the bulge and a good estimate of the depth of the trench. Therefore, accurate bathymetric maps are crucial for these projects as are seismic definitions of the dip angle and its possible variation with depth of the subduction zone.

In addition good observations are needed on the shape of the subducted lithosphere. These observations can be obtained by mapping the spatial distribution of earthquakes. These observations should be made at different places in order to obtain relationships with various geodynamical parameters including age of lithospheric plates, thickness of the plate.

2. Detailed seismicity studies including the use of ocean bottom seismometers

Seismicity studies should be continued in the South-west Pacific to determine the geometry of mantle seismic (Benioff) zones, earthquake focal mechanism solutions, spatial distribution of shallow earthquakes, and the seismic zonation of the region. For some regions, such as Tonga, for which there is no adequate distribution of seismograph stations, establishment of new networks should be encouraged. In regions where land is unavailable, ocean bottom seismometers should be deployed.

3. Gravimetry and geodesy

A systematic study of geodetic observations combining spacecraft radar altimetry with the marine gravimetric surveys will permit a better definition of the lithospheric characteristics.

Special attention should be given to the study of oceanic plateaus and the deflections caused by seamount loading and by subduction. Observations of instantaneous plate motions and deformations, using both spatial and terrestrial methods, should be encouraged.

4. Neotectonic observations

The neotectonics of the different islands give important information about the nature of deformation at convergent margins. This information can be obtained by mapping uplifted terraces and recent movements on faults.

5. Magnetics and experimental rock deformation

The bending of the lithospheric plate seems to be characterised by the disappearance of magnetic anomalies. Such phenomenon should be systematically studied by marine surveys, and by laboratory experiments to determine the stress regime at

which the magnetisation disappears on ocean basalts.

6. Theoretical modelling of the behaviour of bending plates

Computer studies should include both rheological and thermal models.

PROJECT B-3 - The thermal regime of the descending oceanic lithosphere

Three approaches to this problem are suggested:

- (1) ocean heat-flow studies;
- (2) volcanological studies;
- (3) studies of surface geothermal manifestations.

The integration of results from these three approaches should lead to a better understanding of the thermal regime of the descending lithosphere. It should also lead to a better appreciation of the possibilities for economic exploitation of resources and to an increasing awareness of geological hazards for the people of the South Pacific.

1. Ocean heat flow

A considerable data-set of ocean heat-flow measurements already exists and the broad pattern of behaviour is known. However, there is a need for heat-flow measurements to be made in a systematic way, with close spacing, to give adequate coverage of the various important regions associated with the descending lithospheric plate, viz; the "bulge"; the trench; the fore-arc region; the island arc; and the back-arc region.

Suitable study areas should be selected for these measurements across the Tonga and New Hebrides subduction zones.

2. Volcanology

(a) Constraints of thermal models

Obtaining constraints on the thermal behaviour of underthrust oceanic lithosphere may be made possible by petrological and geochemical studies of arc-trench-type rocks aimed at detecting the nature of the melting source regions. Origins within the wedge of upper mantle peridotite above downgoing slabs appear to be favoured at present, but the extent (if any) to which the wedge is modified by melts derived from downgoing ocean crust or from underthrust sediments (or both) should be determined. Whether or not melting takes place at the slab/wedge interface is critical in constraining the nature of the thermal regimes in downgoing slabs, and in understanding where metaliferous materials originate.

Volcano spacing may be a function of the depth and thickness of partial melting layers beneath the arcs. If so, volcano spacing may provide an additional constraint on where partial melting takes place - in the slab, or in the mantle wedge. Furthermore, because the distribution patterns of volcanoes in arc-trench systems are diverse (apparently reflecting particular deep-seated tectonic features), examination of volcano distribution - and separation distances - should be undertaken as a means of mapping deep-seated processes related to the nature of underthrust lithosphere.

(b) Eruption periodicity and tectonic activity

Studies of eruption periodicity of arc-trench-type volcanoes should be undertaken to determine if eruption frequency is related to: (1) similar frequencies of tectonic-earthquake activity; (2) changing rates of subduction; (3) earth tides; or (4) other phenomena.

(c) Volcanic hazard

Most countries represented in CCOP/SOPAC have active explosive volcanoes that pose a threat to life, property, and agriculture. Prediction studies, intraregional collaboration between volcanologists, and consideration of an IUGG proposal to set up a volcanological institute (whose primary function would be teaching of the basic principles of applied and theoretical volcanology) are therefore critically important recommendations for the well-being of SOPAC countries.

(d) Seafloor volcanic centres

The mapping of seafloor volcanic centres in the South-west Pacific should be undertaken, bearing in mind two points: (1) the tsunami-generating capacity of active submarine volcanoes; (2) the possible metallogenic capabilities of seafloor volcanic centres, particularly those in back-arc rift zones.

3. Surface geothermal manifestations

Surface and near-surface geothermal effects associated with the subducting lithosphere may have important consequences for island countries in the South Pacific region. These include the maturation of hydrocarbons in suitable oceanic sediments, mineralisation associated with geothermal activity, e.g., porphyry coppers and the practical exploitation of geothermal energy for power generation.

Reconnaissance geothermal surveys should be made in favourably located countries, such as Samoa, Tonga, Vanuatu, Solomon Islands, Papua New Guinea, and Fiji. Techniques should include geochemical investigation of thermal, spring waters, thermal infra-red

imagery, soil mercury surveys, and temperature gradient and heat-flow measurements in existing boreholes. Areas of high potential should be further investigated by detailed geological mapping, resistivity surveys, and microseismic studies. Offshore areas should not be neglected and may be studied by Curie isotherm mapping from aeromagnetism and from ocean heat-flow measurements.

Advantage should be taken of the considerable expertise in the fields of geothermal exploration and exploitation which already exists within the South Pacific region. Facilities for the training of personnel in the necessary techniques also exist in the region.

Summary of General Recommendations

Subcommittee B recommends:

- (1) to form a Western Pacific Ophiolite Group to promote the exchange of ideas and data, to conduct field trips, and to hold symposia (cf. Project B-1);
- (2) to expand the dredging programme of back-arc basins and trench walls, and to compare the chemical, isotopic, and petrological properties of these rocks with those of the ophiolite series;
- (3) to co-ordinate regional seismograph networks in the South Pacific by holding regular meetings to establish exchange of data and technical information. (This recommendation is repeated as Recommendation 3 in Annex IV.);
- (4) to use ocean bottom seismometers in addition to land stations for the study of geodynamical problems which cannot be studied by classical seismic land networks. This should improve hypocentre locations and focal mechanism solutions;
- (5) to make a systematic study of the thermal regime of the descending lithosphere by means of closely spaced ocean heat-flow measurements and by the study of the distribution and petrology of volcanoes;
- (6) to make a surface geothermal reconnaissance of island countries near subduction zones and more detailed follow-up studies where appropriate, with the objective of locating related economic mineral and energy resources;
- (7) to establish a South Pacific Information Centre in which all published and unpublished material can be centralised, with a specialised library.

III. REPORT OF SUBCOMMITTEE C ON STRATIGRAPHY, SEDIMENTARY PROVENANCE AND METALLOGENESIS

PROJECT C-1 - Stratigraphy

Discussion and background

Research programmes established at the 1975 CCOP/SOPAC-IOC IDOE International Workshop and results from these programmes reported at this Workshop have been especially concerned with tectonic, volcanic, geophysical, and geochemical studies. Sedimentary units and processes have received much less attention, despite both their scientific importance and their economic relevance to the region. A detailed understanding of stratigraphic relationships and sedimentary history, as recorded in sediment accumulations on the seafloor, is important in unravelling regional and local tectonic events. Detailed stratigraphic studies are also of primary importance in assessing resource potential, particularly in identifying potential sources and reservoirs for hydrocarbons. The Committee made the proposals outlined in order to stimulate specific attention on several major areas of stratigraphic and sedimentologic research.

Outlined below are four projects which identify major areas of current concern or topics whose prosecution would be of major significance to the South-west Pacific and the entire Western Pacific. The topics fall into two groups.

- (a) Those concerned with the distribution of bodies of sedimentary rock and the discontinuities within them, their origin, nature, and significance. Three major stratigraphic projects are identified as being of particular relevance to problem-solving in the South-west Pacific. These are hiatuses and their significance, an identification of periods of change, i.e., major stratigraphic events and a delineation of sediment bodies. Apart from the interpretation of data collected by the Deep Sea Drilling Project in the South-west Pacific, little work has been done to correlate results from basins to ridges and between basins, and to establish an understanding of regional seafloor stratigraphy. Initially, primary data for these studies will be drill hole information from the Deep Sea Drilling Project. Sixteen holes have been drilled and cores collected from the Tasman Basin, Queensland Plateau, Coral Sea Basin, New Hebrides Basin, Lord Howe Rise, New Caledonia Basin, South Fiji Basin, Lau Basin, South-west Pacific Basin east of Tonga, and the Ontong Java Plateau. However, as the region has a diverse and complex geologic history many more holes will be

needed to map the region effectively. Until this happens considerable progress can be made in these stratigraphic studies using seismo-stratigraphic techniques.

(b) Those concerned with sedimentation and sedimentary diagenetic processes. There is at present a growing interest in the sedimentation, lithification, and diagenesis of carbonates and in the mineralogical changes taking place in volcanoclastic sediments under different conditions. Too little is known about the movement and diagenesis of sediments along deep ocean basin margins. Such studies help us understand the relationships between sedimentation and diagenesis of different materials under different conditions and therefore help us understand resource genesis and distribution.

Both groups of studies embrace a number of topics which are currently the subject of attention over a much wider area than the South-west Pacific alone. Many of the topics presented highlight problems common to the whole of the Western Pacific and therefore it is appropriate that they should be part of a WESTPAC programme.

It is realised that many aspects of the projects and the scientific objectives presented below impinge upon or overlap with the interests of other international geological bodies, e.g., the IGCP and subcommissions of the IUGS Commission of Stratigraphy. Such overlap is both inevitable and beneficial in topics of wide current interest, and co-operative efforts should be encouraged by WESTPAC.

PROJECT C-1.1 - Sedimentary hiatuses in ocean bottom sequences

1. Areas of interest

Queensland Plateau and adjacent shelf, East Australian shelf - Lord Howe Rise - Norfolk Ridge system, North Fiji Basin, South Fiji Basin, Western New Zealand shelf and slope, Hikurangi margin, and the Campbell Plateau.

2. Scientific objectives

- (a) Mapping of regional hiatuses for various time periods and identification of their causes.
- (b) Estimating volumes of sediment lost or bypassed at hiatuses and identifying sites of redeposition.
- (c) Defining oceanic palaeo-current systems and their relationship to inter- and intra-plate movements, volcanic episodes, build-up of ice caps, sea level and biotic changes.
- (d) Extrapolation of knowledge of on-land geology to better understand hiatuses

offshore, especially with respect to glacio-eustatic movements of sea level.

- (e) Studying breakup hiatuses in detail for the major episodes of continental fragmentation.

3. Methods of investigation

- (a) Seismic reflection, especially high resolution and multichannel profiling.
- (b) High resolution seismic refraction.
- (c) Ocean floor drilling.
- (d) Seafloor sampling, e.g., vibro-coring, piston coring, and dredging.
- (e) Standard palaeontologic, sedimentologic, petrologic, and geochemical techniques on collected samples.
- (f) Magnetostratigraphic techniques.

PROJECT C-1.2 - Study of major stratigraphic events in the SOPAC region

1. Areas of interest

Pliocene-Pleistocene boundary, Upper Miocene in the Outer Volcanic Arc region from Papua New Guinea to New Zealand, Cretaceous - Tertiary boundary, Cretaceous orogeny in the Lord Howe Rise - Norfolk Ridge region, evidence for possible Jurassic opening of the Pacific Basin.

2. Scientific objectives

- (a) Identifying levels of major changes in the stratigraphic record.
- (b) Tracing the areal extent and influence of these changes.
- (c) Identifying their causes and relating them to the geologic record.

3. Methods of investigation

- (a) Collation of stratigraphic data from ocean drilling and relevant onland data.
- (b) Ocean drilling, vibro-coring, piston coring, and dredging.
- (c) Seismic reflection profiling.
- (d) Seismic refraction.
- (e) Standard palaeontologic, sedimentologic, petrologic, and geochemical techniques on collected cores.

PROJECT C-1.3 - Delineation of sediment bodies in time and space

1. Areas of interest

Continental margin between New Zealand and South Fiji Basin, east of New Zealand, Lord Howe Rise - South Fiji Basin ridge and

trough system, New Ireland Basin, Central Solomons Trough.

2. Scientific objectives

- (a) Delineating distribution of sediment bodies of different ages, and producing stratigraphic and isopach maps of the region.
- (b) To establish, from detailed stratigraphic analysis of the bodies:
 - (i) basin genesis and tectonic setting;
 - (ii) depositional history;
 - (iii) facies relationships and palaeo-environments;
 - (iv) sediment provenance;
 - (v) resource potential.
- (c) To establish the stratigraphic relationship between sedimentary sequences of basins, ridges, and shelves.

3. Methods of investigation

- (a) Seismostratigraphic and magnetostratigraphic techniques.
- (b) Ocean drilling.
- (c) Piston coring and dredging.
- (d) Standard palaeontologic, sedimentologic, petrologic, and isotopic analysis of samples.
- (e) Correlation of on-land geologic information.

Note

Where appropriate, the reporting of results of stratigraphic investigations should be in the format recommended for the ESCAP Sedimentary Basins Correlation Project (IGCP Project No.32) for which standards and specifications have been published and are available from ESCAP, Bangkok.

PROJECT C-1.4 - Sedimentologic studies in the SOPAC region

1. Areas of interest

Areas of carbonate sedimentation, Fiji area, the New Zealand margin of the South-west Pacific Basin, Samoa - Cook Islands region.

2. Scientific objectives

- (a) Improving understanding of carbonate sedimentation and diagenesis under different environmental and climatic conditions.
- (b) Improving understanding of diagenetic processes and products in volcanic sediments.

- (c) Studying transport, deposition, erosion, redeposition and diagenesis along the margins of deep ocean basins and around seamounts, especially in the area of the Western Boundary Undercurrent.

3. Methods of investigation

- (a) Ocean drilling.
- (b) Piston coring, vibro-coring, and dredging.
- (c) Sediment traps.
- (d) Underwater photography and television.
- (e) Long-term multiparameter observations at and near the sediment-water interface.
- (f) Observation and sampling by submersible.
- (g) High resolution seismic profiling.
- (h) Side scan sonar.
- (i) Standard palaeontologic, sedimentologic, petrologic, and geochemical analysis of samples collected.

PROJECT C-2 - Metallogenesis (including manganese nodules)

Discussion and background

The 1975 Suva Workshop recommended six projects, including field survey in the South Pacific for manganese nodules. The limited amount of marine survey which has been carried out between 1975 and 1980 has yielded economically disappointing results for the SOPAC area. It should not be assumed, however, that the possibilities for economically valuable deposits have been exhausted.

In the same period, however, very important new evidence has been found in the eastern Pacific on the accumulation of metalliferous deposits in close association with active rifts. These consist of iron, copper and zinc sulphides together with associated oxides and silicates.

The scientific emphasis of the programme proposed below is therefore placed firstly on a study (Project C-2.1) to find possible metalliferous deposits in association with active rifts in the South-west Pacific area, taking advantage of the recent studies in the Eastern Pacific. The importance of manganese nodule studies to the SOPAC area should not be neglected, however, and the Committee has made a proposal of second priority (Project C-2.2) to study further the environment of deposition of manganese nodules in the South Pacific. This project is intended to define the conditions under which nodules of ore grade may occur in the region and will relate conditions of formation in the southwestern area to those in

economically richer locations such as the northeastern equatorial Pacific and Central Indian Ocean. Surveys made as part of the project will provide further evidence on manganese nodule accumulations in South Pacific areas not already examined. The project should refine the criteria needed for ore-grade accumulations and is intended to focus future attention on the more profitable areas for survey. The Committee also considered that from a scientific point of view it was desirable to study (Project C-2.3) metal accumulation rates and growth rates in manganese nodules. This is proposed as a laboratory study on material already collected.

PROJECT C-2.1 - Nature, origin, and development of metalliferous sediments along active rifts, in the SOPAC region

1. Areas of interest

Tectonically active rift and volcanic areas within the arcs and marginal basins of the South-west Pacific, starting with the North Fiji Basin, the Lau Basin, and the Havre Trough.

2. Scientific objectives

To locate and study submarine hydrothermal metalliferous sediments in basins containing active rifts. Comparison should be made with rift-related deposits on mid-ocean ridges.

3. Methods of investigation

- (a) Compilation of existing seafloor data on magnetics, seismic activity, seismic structure, submarine volcanic activity, rifting and faulting, with a view to delineating active rifts where hydrothermal activity might occur.
- (b) High resolution bathymetry, magnetics, gravimetry, and seismic reflection profiling in areas of interest outlined by (a) above, using multiple beam and deep-tow devices if possible.
- (c) Heat-flow measurements.
- (d) Measurements of the thermal and chemical properties of the bottom waters.
- (e) Precisely located (using bottom transponders) sampling with corers and dredges.
- (f) Submersible observations along selected areas of the rifts, in order to collect samples and study the tectonics, morphology, physical properties, and extent of any hydrothermal deposits.
- (g) Geochemistry and sedimentology of recovered materials.

PROJECT C-2.2 - Environments of deposition of manganese nodules in the South Pacific

1. Areas of interest

The South-west Pacific Basin, the Samoa Basin, the Penrhyn Basin, and the basins of the equatorial Western and Central Pacific.

2. Scientific objectives

To determine the topographic, tectonic, stratigraphic, sedimentological, geochemical, and bottom-water characteristics of basins containing manganese nodules, in order to define the conditions under which ore-grade nodules might be found within the region.

3. Methods of investigation

- (a) High resolution bathymetric and seismic reflection profiling including 3.5 kHz profiling.
- (b) Precisely located bottom sampling using grabs and corers including box corers.
- (c) Measurements of bottom-water properties including temperature, salinity, and chemical composition.
- (d) Measurement of bottom-water movements.
- (e) Bottom photography and television.

PROJECT C-2.3 - Metal accumulation rate and growth rate studies on existing manganese nodule collections from the South Pacific

1. Area of interest

Areas of maximal concentration within basins in the South Pacific, particularly the South-west Pacific, Samoan, and Penrhyn Basins.

2. Scientific objectives

To determine the origin and sources of metals in nodules in the South-west Pacific; to compare the rates of metal accumulation with those of economically attractive nodules from the north-east equatorial Pacific; and to delineate past patterns of metal accumulation enrichment and, if possible, to correlate these observations on a regional basis.

3. Methods of investigation

- (a) Alpha particle track autoradiography and/or spectrometry to obtain accumulation rates by the excess ^{230}Th method.
- (b) Electron microprobe analysis for detailed microlayer chemical composition.
- (c) Physical property determinations: dry bulk density and X-ray radiography.
- (d) Mineralogy of selected layers by X-ray diffraction.

PROJECT C-3 - Sedimentary provenance

Discussion and background

Few studies have been carried out on sediment provenance within the South Pacific, but they can provide important information on the sources from which sediments have been transported to their present location. The Committee considered that it should propose two projects under this general heading, one (Project C-3.2) on the sources of sediment accumulation throughout the region, and a more specific study (Project C-3.1) of phosphorites. The latter is proposed because of the potential economic importance of phosphatic deposits to the SOPAC region. Recent work on phosphorites has indicated that the economic potential is greater north of the Tropic of Capricorn, in regions where the surface productivity is highest.

PROJECT C-3.1 - Phosphorites, phosphatic sediments and associated ferromanganese crusts

1. Area of interest

South Pacific north of latitude 23°S and between longitudes 160°E and 155°W.

2. Scientific objectives

Determination of the distribution of phosphatic and associated ferromanganese deposits in the designated area; radiometric dating of such deposits; geochemical analysis with a view to discovering the provenance, mode and rate of deposition, and geological association (e.g., phosphate-ferromanganese associations); and interpretation of relationships, if any, between phosphorites on seamounts and those exposed on Pacific islands. Location of commercially exploitable deposits.

3. Methods of investigation

- (a) High resolution profiling.
- (b) Pipe and mesh dredging.
- (c) Piston and box coring, wherever possible, for information on associated sediments.
- (d) Underwater photography.
- (e) Submersible observations and sampling.
- (f) Shipboard spectrophotometry to allow preliminary identification and estimation of phosphorus.
- (g) Particle-track autoradiography and/or alpha spectrometry.
- (h) Geochemical analysis.

PROJECT C-3.2 - The role of oceanic and arc evolution, and other processes, in determining sediment composition and provenance within the South Pacific

1. Area of interest

The island arcs and marginal basins of the South-west Pacific.

2. Scientific objectives

Studying the distribution of rock forming and minor elements, and the isotopic composition of sulphur, oxygen, and carbon, and on this basis to assess the contribution of oceanic and arc volcanism and other processes to the formation of seafloor sediments. Studying also the composition of sediments and volcanic rocks on the islands in order to evaluate further the relationships between volcanism and sediment composition.

3. Methods of investigation

- (a) Bottom sediment sampling, and on-land geological sampling.
- (b) Geochemical analysis of recovered materials.

ANNEX VI

LIST OF SCIENTIFIC PRESENTATIONS

OVERVIEW PAPERS

Tectonic Evolution and Kinematics of the South-west Pacific - *G.H. Packham* and *D.H. Falvey*, University of Sydney, Sydney.

Structural Evolution of the South-west Pacific Island Arcs by EVA Team (ORSTOM NOAA/NOS, Cornell University, University of Texas) presented by *J. Recy*, ORSTOM, Noumea.

Microchemistry and Mineralogy of Ferromanganese Nodules in the South Pacific - *S.V. Margolis* and *M.A. Meylan*, University of Hawaii, U.S.A., presented by *G. McMurtry*.

Metalliferous Sediments in the South-west Pacific; and Update - *D.S. Cronan*, Imperial College, London.

Plate Tectonic Evolution of the South-west Pacific - *R.G. Littlefield*, Phillips Petroleum Company, Oklahoma.

Tectonic Development of Oceanic Plateaux - *L.W. Kroenke*, University of Hawaii, Honolulu.

A Geophysical Discussion of the Oceanic Geoid for the South-west Pacific - *K. Lambeck*, Australian National University, Canberra.

The Geochemistry and Mode of Formation of Ophiolites in the South-west Pacific - C.J. Allegre, Institut de Physique du Globe, Paris.

SUBCOMMITTEE PAPERS

A. Tectonic evolution of arcs and back-arc basins

Geological Evidence Bearing on the Miocene to Recent Structural Evolution of the New Hebrides (Vanuatu) Arc - J.N. Carney and A. Macfarlane, Geological Survey Department, Vila.

South-west Pacific Tectonic Analysis from Palaeomagnetic Data - D. Falvey, J. Terrill, R. Cassie, B. Rumph, R. Musgrave, A. James, A. Chivas, University of Sydney, B. Emberton, CSIRO Mineral Physics, and M. McElhinny, Australian National University, Canberra.

Geologic History of the Marianas Arc - Trench - Back-arc System - J.W. Hawkins, C. Evans, S. Bloomer, J. Melchior, Scripps Institution of Oceanography, La Jolla, California.

New Evidence Bearing on the Tectonic Evolution of the Solomon Islands Region - G.W. Hughes and J. Ridgway, Geology Division, Honiara.

New Britain - A Typical Island Arc - R.W. Johnson, Bureau of Mineral Resources, Canberra.

North Fiji Basin : New Data by EVA Team (ORSTOM, NOAA/NOS, Cornell University, University of Texas) presented by B.M. Larue, ORSTOM, Noumea.

Development of Marginal Basins in the South-west Pacific - A. Malahoff, NOAA/NOS.

The Geology and Basement Configuration of the Lamon Bay - Bicol Shel Basin, Luzon, Philippines - R.D.S. Rieza, Bureau of Energy Development, Manila.

Tectonic Stress in the Arcs - S. Uyeda, University of Tokyo, Tokyo.

Submarine Active Faults Along the Nankai Trough, South-west Japan - N. Yonekura, University of Tokyo, Japan.

B. Deep crustal structure, petrogenesis and the thermal regime, evolution of the lithosphere

Obduction of the Lithosphere : the New Caledonian Example - J.Y. Collop, F. Missege, G. Bitoun, J. Recy, ORSTOM, Noumea, G. Lat- ham, University of Texas, and A. Malahoff, NOAA/NOS.

Study of the Deflection of Oceanic Lithosphere at Subduction Zone by a Definite Element Method - J. Dubois, University of Paris-Sud, Orsay.

Deep Crustal Structure of Oceanic Plateaux - J.F. Gettrust, Hawaii Institute of Geophysics, Honolulu, presented by N. Frazer, Hawaii Institute of Geophysics, Honolulu.

Volcanology in Australasia : Hazards and the Future - R.W. Johnson, Bureau of Mineral Resources, Canberra.

Geochemistry and Mineralogy of Potassic Volcanics from Fiji - B. Rao, University of Queensland, Brisbane.

Heat Flow Measurements in Fiji - N.J. Skinner, University of the South Pacific, Suva.

C. Stratigraphy, sedimentary provenance and metallogenesis

Nickel Ore and Mining Diversification in New Caledonia - M. Benezit, Service des Mines et de la Geologie, Noumea.

Recent Investigations of Submarine Phosphorite Deposits in the South-west Pacific - D.J. Cullen, New Zealand Oceanographic Institute, Wellington.

Origin of Ophiolite and Chromite, Zambales Range Luzon - C. Evans, J. Hawkins and G. Bacuta, Scripps Institution of Oceanography, La Jolla, California.

Reference Sections, Biostratigraphy and Correlation of the New Caledonian Triassic and Jurassic - H.J. Campbell, J.D. Campbell and J.A. Grant-Mackie, University of Auckland, Auckland.

Continental Margin Accretion or Tectonic Erosion : Implications for Hydrocarbon Potential in New Zealand - H.R. Katz, New Zealand Geological Survey, Lower Hutt.

Visual Observations of the Tectonics and Mineralisation of Active Submarine Rift-Fracture Zone Systems - A. Malahoff, NOAA/NOS.

Lithostratigraphy and Deformation of the New Caledonia Ophiolitic Complex, Application to the Chromite Prospection by the French Team from Chromite Study, presented by P. Podvin and J.P. Paris, B.R.G.M., Noumea.

Structure, Seismic Stratigraphy, and Petroleum Potential of the Lord Howe Rise Area - J.B. Willcos and P.A. Symonds, Bureau of Mineral Resources, Canberra.

ANNEX VII
SUBCOMMITTEE PARTICIPANTS

**A. TECTONIC EVOLUTION OF ARCS AND BACK-
ARC BASINS**

Branson, J.C.	Malahoff, A.
Coleman, P.J. (Chairman)	Nion, S.T.S.
Collot, J.Y.	Packham, G.H.
Coulson, F.I.	Recy, J.
Crook, K.A.W.	Richmond, R.N.
Falvey, D.A.	Saos, J.L.
Greene, G.	Terman, M.J.
Hughes, G.N.	Tongilava, S.L.
Jouannic, C.	Uyeda, S.
Katz, H.R.	Weissel, J.K.
Kroenke, L.W.	Willcox, J.R.
Larue, M.B.	Yonekura, N.
Littlefield, R.G.	Zdorovenin, V.V.
Macfarlane, A.	

**B. DEEP CRUSTAL STRUCTURE, PETROGENESIS AND
THERMAL REGIME - EVOLUTION OF THE LITHO-
SPHERE**

Allegre, C.J. (Chairman)	Hawkins, J.
Cardwell, R.	Lambeck, K.
Chatelain, J.L.	Pontoise, B.
Collot, J.Y.	Rao, B.
Dubois, J.	Skinner, N.
Evans, C.	Talandier, J.
Frazer, N.	Zhang, B.X.
Johnson, W.R.	

**C. STRATIGRAPHY, SEDIMENTARY PROVENANCE AND
METALLOGENESIS**

Cronan, D.S.	Machesky, L.
Cullen, D.J.	McMurtry, G.
Daniel, J.	Malahoff, A.
Doutch, F.H.	Michel, R.D.
Eade, J.V.	Utanga, T.A.
Exon, N.	Winterstein, E.
Grant-Mackie, J.A.	Wright, J.
Lopatin, B.	(Chairman)