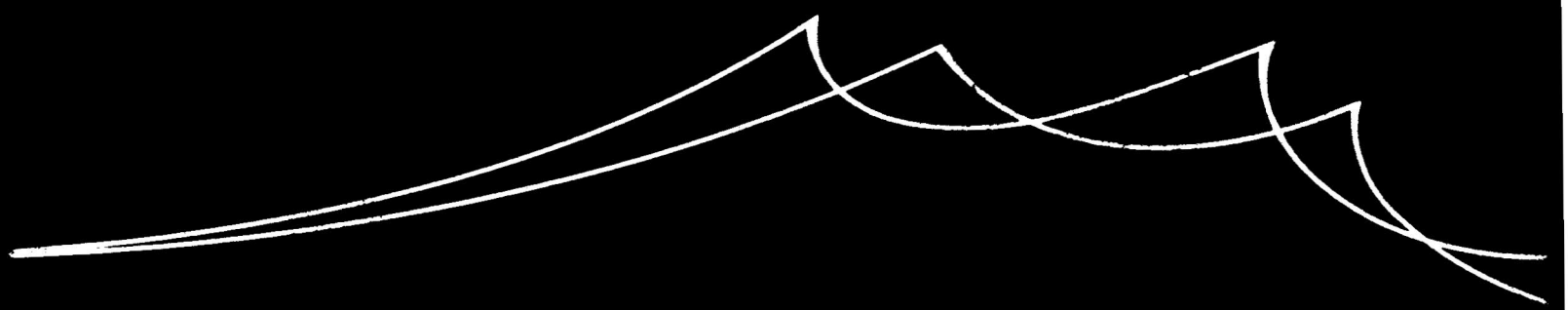
SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH



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INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

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INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

PROCEEDINGS
OF THE
SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

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PROCEEDINGS

of the

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

Report of the 16th Executive Committee Meeting
Copenhagen, 10 - 12 January 1972

The 16th Executive Committee Meeting was held at Charlottenlund Slot, headquarters of the International Council for the Exploration of the Sea, 10-12 January 1972, with the President, Professor Wooster, in the chair. Participants were greeted by the General Secretary of ICES, Mr. H. Tambs-Lyche who arranged for the facilities of the Council to be used by SCOR. During the afternoon of 11 January, participants visited the Marine Biological Laboratory of the University of Copenhagen, in Helsingør.

A list of those who attended the meeting is given in Annex I. The agenda of the meeting serves as an outline for the report which follows.

1.0 ORGANIZATION AND FINANCE

1.1 MEMBERSHIP

In order to meet the purposes of Invited Membership (see Proceedings, vol. 7, p. 1), SCOR Members and National Committees should provide suggestions of appropriate scientists for consideration by the Executive Committee. A full list of members in all categories should be published in Proceedings after the next General Meeting.

1.2 PUBLICATIONS

A proposal had been made that the reports of the Affiliated Organizations be published in Proceedings. It was agreed that those organizations could use the SCOR publication at their discretion; a report of CMG for 1971 is given in Annex II. The agenda for the next meeting should include an item for these organizations to introduce such reports or other items of concern to them.

The volume on the Symposium on Biology of the Indian Ocean (see Proceedings, vol. 7,p.2) was reported to be in press with publication expected during the first half of 1972. It was agreed that publications resulting from SCOR activities should be listed conspicuously in future issues of Proceedings. Proceedings of the Joint Oceanographic Assembly "The Ocean World", 13-25 September 1970, edited by Michitaka Uda, have been published by the Japan Society for the Promotion of Science.

As a consequence of a WG 31 recommendation concerning regional working meetings, SCOR joined other organizations in sponsoring a Symposium on Structural History of the Bay of Biscay, held in Rueil-Malmaison, France, on 14-16 December 1970. The papers of this symposium have been published and are available as follows:

Anon 1971. Histoire structurale du golfe de Gascogne. 2 vols, 944 p. Pub. de l'Institut Francais du Petrole. Available for 180 F from Editions Technip, 27 rue Ginoux, 75-Paris 15e.

1.3 BUDGET AND FINANCE

An estimate of SCOR finances for 1971 is given in Annex III. Reserve funds, which had fallen to a low level by the end of 1970, have been restored as a result of increased national contributions and support from UNESCO and ICSU. These reserves will be required to cover deferred meetings of working groups and new activities anticipated in the development of LEPOR/IDOE(with GIPME)and other international programs and are necessary to give SCOR the necessary flexibility to meet new scientific opportunities as they arise.

The representative of UNESCO reported that UNESCO support for SCOR in 1972 would remain as in 1971 except that the contract covering expenses of UNESCO nominees on joint working groups would be reduced.

In considering new activities during 1972, the possibility of obtaining additional staff support was discussed. At present, SCOR incurs no expense for personnel; a part-time secretary is supported by the University of California. With the growing level of SCOR activity, it will soon be necessary to provide some full-time staff. Alternative possibilities include (1) joining with another ICSU body, either Union or Committee, in the support of an executive secretary who could be located together with the ICSU Secretariat in Paris, (2) cooperative arrangements on a contractual basis with ICES, and (3) engage part-time assistance for the President or Secretary. Although it was recognized that SCOR could not continue to depend entirely on volunteer support for its administrative work, it was agreed to defer action until the forthcoming General Meeting.

2.0 WORKING GROUPS

2.1 FORMER GROUPS

The analysis of results of the ICES/SCOR intercalibration experiment on methods of nutrient analysis is underway, with some financial support from SCOR. An inquiry has been sent to those laboratories which have not yet submitted their data. A final report on the experiment is expected in time for the ICES meeting in the fall of 1972. This should be published jointly by ICES and SCOR in an appropriate ICES Series; Drs.Koroleff(ICES) and Gieskes(SCOR) will be the editors.

2.2 EXISTING GROUPS

WG 10 Oceanographic Tables and Standards (with ICES, IAPSO and UNESCO): A proposal to explore the feasibility of providing standard sea water at salinities of approximately 7°/oo and 38.4°/oo for work in the Baltic and Mediterranean Seas respectively, was endorsed. It was hoped that the IAPSO Standard Sea Water Service would take the lead in preparing samples of these approximate concentrations for an experimental intercalibration of salinometers, to establish the magnitude of errors resulting from the present use of a salinity standard greatly different from the unknowns. Necessary expenses of this work should be met by SCOR. The joint ICES/SCOR group concerned with the Baltic (see item 2.3) should be asked to organize the Baltic intercalibration, while the International Coordinator of the Cooperative Investigation of the Mediterranean should do the same for that region.

Dr. Kremling (Institut für Meereskunde, Kiel) is determining specific gravity in samples from various parts of the ocean to compare measured values with those computed from salinity-conductivity measurements as obtained from the cooperating institutions. SCOR has agreed to support this work by covering shipping costs of the samples.

The UNESCO representative reported that the International Oceanographic Tables are being reprinted and that the new tables for dissolved oxygen concentration, sigma-t and chlorosity, will soon be added.

The International Union of Geodesy and Geophysics at its XV General Assembly in Moscow, August 1971, adopted the following resolutions based on proposals of WG 10:

"Res. 18: IUGG endorses the recommendation n° 1 of the Joint Panel on Oceanographic Tables and Standards dealing with the determination of the absolute density of pure water at 4°C and at least two different temperatures, preferably 0 and 20°C, to obtain a sound basis for the determination of the absolute density of sea water, furthermore, the accurate determination of the thermal expansion of water with the necessary precision between 0 and 40°C."

"Res. 19: IUGG taking into account the increasing use of instruments for in situ measurements of thermal conductivity, strongly recommends that:

a) high precision measurements of conductivity of sea water are carried out in the temperature range 0°C to 14°C,
b) that high precision measurements are made of conductivity as a function of temperature and pressure,
c) that high precision measurements are made of sound velocity as a function of temperature, salinity and pressure."

Professor Lacombe reported that the International Bureau of Standards had agreed to encourage some of this work.

WG 15 Photosynthetic Radiant Energy (with IAPSO and UNESCO): To expedite completion of data analysis from the 1970 DISCOVERER experiment, SCOR had arranged for $1500 of UNESCO funds to support Dr. Andre Morel in Villefranche. Many of the working group members and participants in the experiment will be attending the IAPSO Symposium on Optical Aspects of Oceanography in Copenhagen, 19-23 June 1972, and it was agreed that the working group should meet on that occasion to prepare a report on their terms of reference and to discuss completion of the reporting on the experiment. This meeting could take place on 23-25 June 1972; SCOR and UNESCO should arrange for the participation of working group members, thus also supporting the IAPSO Symposium.

WG 21 Continuous Current Velocity Measurements (with IAPSO and UNESCO): The group met in Moscow during the XV General Assembly of IUGG; a report of the meeting is given in Annex IV. A further intercomparison experiment was recommended, using the Geodyne, Alekseev and LSK meters. Subsequently, the Woods Hole Oceanographic Institution has arranged that the work can be done from R/V ATLANTIS II, departing Woods Hole on 22 August and returning on 10 September, 1972. These dates have been accepted by the prospective participants. Regarding the publication of the results of the second experiment, on R/V AKADEMIK KURCHATOV, the matter is still being considered by the UNESCO publication authorities.

WG 23 Zooplankton Laboratory Methods (with UNESCO): Plans have been prepared by Dr. Hansen, Chairman of the Group, and Dr. Steedman for a workshop and final meeting to be held at the University of Bath in July 1972. It was agreed that SCOR and UNESCO should provide funds for the participation of working group members and that an additional amount of several thousand dollars should be made available for other invited participants. Since less money will be available than called for in the present plans, it may be necessary to reduce somewhat the scale of the meeting. A valuable draft chapter on the use of aldehydes had been prepared by Dr. Steedman, and it was agreed that after obtaining the necessary permission, SCOR should reproduce the material and give it wide distribution prior to the workshop.

WG 24 Estimation of Primary Production under Special Conditions (with IBP/PM): The final report of this group is scheduled to be published in the first half of 1972 in the UNESCO series "Monographs on Oceanographic Methodology".

WG 27 Tides of the Open Sea (with IAPSO and UNESCO): The group met in Venice on 18-19 October 1971; a report of the meeting is given in Annex V. Upon recommendation of the group, it was agreed to replace Professor Munk with Dr. D.E. Cartwright as Chairman, and to change the name of the group (formerly Deep-Sea Tides). A recent publication related to activities of the group is:

Cartwright, D.E. (1971) Tides and waves in the vicinity of Saint Helena. Phil.Trans.Roy.Soc.Lond.A. 270 (1210): 603-649.

WG 28 Air-Sea Interaction (with IAMAP and IAPSO): The group met in Moscow during the XV General Assembly of IUGG; a report of the meeting is given in Annex VI.

WG 29 Monitoring in Biological Oceanography (with ACMRR, UNESCO and IBP/PM): The group is scheduled to hold its final meeting at the Institute for Environmental Research in Plymouth for one to two weeks beginning on 6 March 1972. A proposal had been received from Professors Banse and Dugdale that the group should consider trends in available time series of biological information (for example, rate of photosynthesis, concentration and species composition of zooplankton) and the timing of changes in trends. Although the group cannot consider this question in full detail, it was agreed to invite them to review it and to recommend further action to SCOR. ICES will provide the group with information on the time series of plankton collections from North Atlantic weatherships.

WG 32 Biological Data Inventories (with ACMRR): Subsequent to the meeting of the IOC WG on oceanographic data exchange, at which SCOR was represented by Dr. Colebrook, it became apparent that there was need for further action of the SCOR/ACMRR group, with regard to perfection of the biological and pollution sections of the data inventory form being approved by IOC (ROSCOP) and to the development of a second level inventory system. Therefore, it was agreed that Dr. Colebrook should be authorized to convene another meeting, possibly in Edinburgh in the late spring of 1972. The participation of ICES should be invited.

WG 33 Phytoplankton Methods (with IBP/PM): A summary of the activities and findings of this group is given in Annex VII. The Executive Committee noted that this work was still in progress and agreed to consider its status at the forthcoming General Meeting.

WG 34 Oceanographic Basis of Ocean Monitoring and Prediction Systems: Members of the Theoretical Panel of this group met in Moscow on 9 August 1971; their recommendations are as follows:

"1. The study of the SYNOPTIC SCALE of mid-ocean motions (sometimes referred to as MESOSCALE or EDDY-SCALE) is of major importance for the understanding of the general circulation and its variability, and the development of predictive models.

2. New types of both experimental and theoretical investigations must be undertaken; POLYGON and MODE-1 (PREMODE) represent the preliminary steps in this direction.

3. We recommend the necessity of a DYNAMICAL EXPERIMENT - MODE - as the next step. Such an experiment must be:

a) highly desirably of two years or longer duration; not worth undertaking for less than a year,
b) of large enough horizontal extent to allow interactions on the eddy-scale (probably several degrees),
c) involve sufficiently dense sampling in the horizontal to allow the resolution of interactions on the eddy-scale.

Thus,

d) the scale and scope of the experiment will be of such a size as to necessitate International Cooperation.
e) At this time we think that a grid of moored buoys will be a basic element in the experiment.
f) If technical capabilities permit, the experiment should start in 1975.

4. We recognize the necessity of theoretical investigations and/or developments of:

a) NUMERICAL MODELS FOR diagnosis and PREDICTION WITHIN LIMITED open-sided REGIONS of the ocean, and associated studies of sensitivity and dependence upon various types of boundary and initial conditions.

b) NUMERICAL MODELS of the GENERAL CIRCULATION capable of RESOLVING the SYNOPTIC SCALE and associated studies of novel computing techniques and methods.
c) PHYSICAL PROCESSES which may serve as the ENERGY SOURCE of EDDY-MOTIONS, including: problems forced by meteorological transients; the transfer of energy between diverse scales of oceanic motion; non-linear interactions; scale-transfer effected by interactions involving bottom topography; baroclinic and barotropic instabilities of the open ocean, and of major currents and associated problems of propagating waves and the dynamics of isolated and interacting eddies.
d) The ROLE OF THE SYNOPTIC-SCALE IN THE GENERAL CIRCULATION. "

Subsequently, Professors Stommel and Robinson made further proposals to facilitate work of the group. The group should review the scientific progress of relevant new programs, such as CINECA, MODE and CUE, and should identify areas being neglected. The Theoretical Panel should expand its area of attention from MODE to the design of other large scale experiments that fall within the purview of WG 34. A new Panel on Monitoring Ocean Climate Fluctuations is required, to determine the type, quantity, variety, and accessibility of data necessary to monitor large scale, long period fluctuations of the ocean and their coupling with the atmosphere. This panel would have the responsibility for monitoring and long time scales while the Theoretical Panel would have the responsibility for mid-ocean dynamical experiments and predictions. A third Panel on Instrumental and Technical Capability would be needed to examine the required new techniques of measurement.

In a discussion of these suggestions, it was agreed to discuss with the present WG 21 the possibility of transforming it into the third panel. The proposed second panel was also approved, and names were proposed for its membership.

WG 35 Methods in Quantitative Ecology of Coral Reefs: The group has been working through correspondence and is planning to report its progress at the 11th General Meeting. It was agreed to ask the Soviet National Committee to nominate an appropriate specialist to join the group.

WG 36 Coastal Upwelling Processes (with ACMRR and ACOMR): Dr. K.N. Fedorov has accepted to chair the overall group with Professors Dugdale and Yoshida chairing the biological and physical panels respectively. ACOMR has recommended to WMO that it finance participation of one meteorological expert selected by the Chairman of ACOMR. Names of members of the two panels were proposed, and the President was asked to invite their participation, after discussion with the panel chairmen. It was noted that the terms of reference for this group linked its activities to the upwelling region off northwest Africa, so that close liaison with ICES, IOC and the CINECA coordination group would be required.

WG 37 Marine Plankton and Sediments: It was agreed to accept the proposal of the Marine Geoscience Workshop (see below) for a new working group on the paleo-oceanography project and to revise the terms of reference of WG 37 to clarify the division of responsibility between the two groups. The new terms are as follows:

To discuss new advances in the investigation of structure, biology, ecology, distribution, systematics of phyto- and zoo-plankton of micropaleontological importance, their occurrence throughout the water column and in the sediments, and related stratigraphic problems; to examine procedures for sampling and preparation, isotopic methods and statistical methods; to review progress in deep-sea drilling and related micropaleontology; to prepare a symposium on these topics.

The working group is planning to organize the symposium in Kiel in the autumn of 1974, and would like to publish a volume of review papers in advance. It was agreed that the group should meet in Montreal in August on the occasion of the International Geological Congress.

WG 38 Special Studies on Circumpolar Waters South of 40° S (with SCAR): Sir George Deacon reported that his initial exploration of the problem described in the terms of reference had shown that there were not so many simple scientific tasks that could be performed by relief ships as had at first been thought. Also, the success of any such program requires that someone is continually using the resulting data. Some of the goals may be achieved by means of remote sensing with satellites. The GARP representative, Dr. Ruttenberg, pointed out the need for additional data from the Antarctic waters during the 1st Global Experiment, now scheduled for 1976, 1977 (see Annex X). The WG Chairman was asked to explore the possibility of deploying suitable buoys from relief ships. Dr. Saetersdal pointed out the interest of ACMRR in a survey of living resources in the region, but it was agreed that this was a more appropriate topic for the IOC WG on the Southern Ocean. Some consideration of resources, especially krill, will be given by SCAR biologists meeting in August. It was agreed that progress on the terms of reference could be achieved if the Chairman, Sir George Deacon, were to participate in discussions of JOC GARP, were to visit appropriate scientists in the United States and the Soviet Union, at SCOR expense, and were to then report his conclusions to the 11th General Meeting.

WG 39 Scientific Investigation of Pollution in the Marine Environment (with GESAMP, ACMRR and ACOMR): The group met in San Marco di Castellabate and Rome on 11-18 October 1971; the report was printed by FAO (FAO Fish.Rep.No. 112) and was available for consideration by the IOC VII Session in Paris, 26 October - 5 November 1971. A summary of the report is given in Annex VIII. The IOC, in its Resolution VII-4, accepted the report, decided to establish the Global Investigation of Pollution in the Marine Environment (GIPME) as a major project of IDOE/LEPOR, and asked the various bodies concerned to start to implement the WG 39 recommendations. Relevant SCOR actions are discussed below (item 2.3).

The Executive Committee decided to request FAO to make available copies of the full WG report for distribution to SCOR. A decision on continuation of the group could be deferred to the 11th General Meeting, after discussions at the UN Conference on the Human Environment and at the IOC Executive Council.

Marine Geoscience Workshop: This workshop was held in Honolulu on 20-24 September 1971 with financial support from the State of Hawaii; it was attended by 26 scientists from 15 countries. A report of the meeting, given in Annex IX, was considered by the IOC at its VII Session; in its Resolution VII-24, the Commission requested SCOR to render its recommendations on implementation of the report to the IOC Executive Council.

In accordance with proposals of the workshop, the Executive Committee agreed to establish new working groups on paleo-oceanography and on morphological mapping of the ocean floor (see section 2.3). In its report to IOC, SCOR should inform about these groups, should note the present IDOE investigations of the east Atlantic continental margins and the need for these to be extended to the western side of the south Atlantic at a later date, should note the need to encourage an expansion of the preliminary work now underway in the southwest Pacific which is an area geologically very different from the south Atlantic, should stress the importance of reexamining the priorities for research in the Indian Ocean after the IIOE Geological and Geophysical Atlas becomes available, and should recommend that the proposed Mediterranean symposium be organized by the International Coordinator of CIM. It was also agreed to invite Mr.Brodie to present the proposal for work in the southwest Pacific to the International Symposium on Oceanography of the South Pacific, to be held in New Zealand in the near future.

2.3 PROPOSED GROUPS

As noted above, WG 39 proposed establishment of a number of new working groups by SCOR in cooperation with other appropriate organizations. The following decisions were taken on these proposals:

Atmospheric transport of pollutants - the representative of WMO reported that Professor Münnich was preparing a review on this subject which would be available during the fall. The interest of OECD in this problem was also noted. It was agreed to defer action

until the September meeting when more information on actions by other bodies would be available.

Transfer across the pycnocline - there was general agreement on the scientific and practical importance of this problem. The Symposium being organized by ICES at Aarhus will touch on some aspects of the physical processes involved, but there does not seem to be any concerted interdisciplinary approach being taken. Suitable instruments and methods for studying the processes are not available. It would be appropriate for SCOR, possibly with ACMRR, to establish a working group structured like WG 36 with physical and biological panels meeting together as necessary. The President was asked to work out the details of such a group so that it could be established at the General Meeting in September.

Dynamics of ecosystems - it was noted that a resurgence of interest in modelling ecosystems had resulted in part from the activities of IBP/PM. It was important to gain better understanding of the dynamics of ecosystems for a number of reasons including the practical ones related to marine pollution and to improving the productivity of the oceans(refer WG 36). Accordingly, IABO was requested to take the responsibility for proposing terms of reference and membership for a new SCOR working group, possibly with ACMRR, to be acted upon in September.

Biological effects of pollutants - it was agreed to request ACMRR to look into the desirability of establishing a joint group to look at the feasibility of monitoring pollutants through their effects on organisms and to report their views to SCOR in September.

River inputs - proposals for studying the inputs of materials by rivers into the ocean were first made in the 1969 Ponza report; both the marine geoscience workshop and WG 39 have since proposed actions to stimulate research on this problem. Captain Capurro reported the difficulties he had encountered in attempting to obtain the information proposed by WG 39. Professor Postma was requested to help in this task in the hope that a report could be ready for consideration in September.

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The Marine Geoscience Workshop proposed the establishment by SCOR of three new working groups, on paleo-oceanography, on large river mouths, and on sea floor morphology. As noted above, action on river mouth exchanges was deferred until September. The following new working groups were approved:

WG 40 Paleo-oceanography: The following terms of reference were approved:

To prepare an inventory of available marine sediment core collections and to develop methods for their international use; to consider the development of a paleo-oceanograpy project, keeping in mind the activities of other working groups and the plans of the International Geological Correlation Program; to recommend further action to be taken by SCOR.

Members were proposed for the group, and it was agreed that the group should meet during the International Geological Congress in August and should report to the 11th General Meeting in September.

WG 41 Morphological Mapping of the Ocean Floor: The following terms of reference were approved:

To determine a rational scheme for reduction and presentation of sounding data that would constitute a framework in which the international geological mapping of the sea floor could proceed; to present recommendations to the International Cartographic Association meetings in Ottawa in September 1972; to recommend further action to be taken by SCOR.

Members were proposed for the group, and it was agreed to invite the cooperation of the International Hydrographic Bureau. It was further agreed that the Chairman of the group should be invited to represent SCOR at the forthcoming International Hydrographic Conference.

An ad hoc ICES/SCOR meeting to consider the possibilities for an international investigation of the pollution of the Baltic was held in Helsinki, 24 and 25 September 1971. The SCOR Executive Committee was represented by Professor Hempel who also served as co-chairman together with Professor Cieglewicz, President of ICES. The meeting approved a recommendation to ICES and SCOR that they continue to promote collaboration in the study of the pollution of the Baltic. At its Statutory Meeting, ICES then adopted the following resolution (C.Res.1971/3:1):

"It was decided, that:
the Council endorses the recommendations of the ICES/SCOR Meeting on the Pollution of the Baltic and agrees that ICES should collaborate with SCOR in the Study of Pollution and its Effects on the Living Resources of the Baltic Sea, by establishing a Joint Working Group with the following terms of reference:

a) to identify from the point of view of pollution the need for further basic hydrographical, biological, biochemical and biogeochemical studies,
b) to coordinate appropriate surveys of the open Baltic, making use of existing groups of experts whenever possible,
c) to coordinate and develop programmes for biological monitoring stations with such indicators of changes in the environment as,
   (i) benthic microorganisms,
   (ii) benthic macro-flora and fauna,
   (iii) plankton.
d) to develop plans for coordination of the studies of the level of toxic substances in food fish and the marine environment,
e) to cooperate with the corresponding North Sea Group in ship-board and laboratory intercalibration tests of sampling, storage and analysis methodology for toxic substances,
f) to develop a scheme for continuous collection and analyses of all pertinent information on input of pollutants into the Baltic Sea and on the changes in its degree of stagnation brought about by organic waste,
g) to report to the 60th Statutory Meeting of ICES and to the next General Meeting of SCOR, both in September 1972, on the progress of their work."

The Executive Committee discussed the need for such a group in order to ensure that all countries bordering the Baltic would be able to participate in the proposed cooperative investigation. It was agreed to accept the report and recommendations of the ad hoc meeting and to cooperate with ICES in establishing a joint working group devoted to studying the oceanic processes relevant to pollution in the Baltic. For SCOR purposes, this group would be designated WG 42 Baltic Pollution. It was decided to propose to ICES that Professor Hela be designated Chairman of the group. SCOR would nominate four members, three from countries bordering the Baltic and one with experience of similar activities in other parts of the world. The necessary expenses of these nominees would be met by SCOR. The first meeting of the group is to be held in Lund, Sweden on 2-4 May 1972.

3.0 RELATION WITH INTERGOVERNMENTAL ORGANIZATIONS

3.1 ADVISORY MATTERS CONCERNING UNESCO AND IOC

The representative of the Intergovernmental Oceanographic Commission reviewed the resolutions of the IOC VII Session (Paris, 26 October - 5 November 1971), noting particularly the following which were of direct concern to SCOR:

VII-4 Global investigation of pollution in the marine environment - actions taken with regard to this resolution are discussed in items 2.2 and 2.3.

VII-5 Mutual assistance, education and training - the Commission endorsed a proposal of the IOC WG on this subject, namely that the IOC Secretary should seek the assistance of the scientific advisory bodies in listing the areas of specialized training most required for implementation of LEPOR. This matter had not previously been referred to SCOR and the Executive Committee suggested that IOC direct to it a specific request for the required action.

VII-6 Oceanic data management - SCOR and ECOR, in consultation with FAGS, were requested to review the requirements for mean sea-level data as compiled and made available by the Permanent Service for Mean Sea Level and to transmit their findings to the IOC Executive Council for further review and appropriate action. In this connection, the President reported that he had since written to the IOC Secretariat reiterating a statement on this subject transmitted to IOC in May 1970. The UNESCO representative reported that UNESCO had agreed to support PSMSL in 1971 and 1972 and that the inclusion of mean sea-level data in IGOSS was under consideration.

VII-21 International institute of physical oceanography - SCOR had submitted this GELTSPAP proposal to members of several working groups and to other physical oceanographers for their comment, and had compiled their responses for consideration by IOC. The Commission, noting the results of this inquiry, instructed the IOC Secretary to look further into the matter. In the discussion of this matter by the SCOR Executive Committee, the consensus seemed to be that continuing support of existing laboratories and institutions was of first priority and that if such an international institute were to be established, it should be an extension of the activities of an existing laboratory.

VII-23 Joint oceanographic assemblies - this matter is discussed under item 5.2.

VII-24 International workshop on marine geosciences - this matter is discussed under items 2.2 and 2.3.

VII-32 Oceanographic participation in the GARP Atlantic Tropical Experiment (GATE) - the action of the IOC Bureau in requesting SCOR to identify the oceanographic processes that could be studied in conjunction with GATE (see Proceedings, vol. 7, p.8), was endorsed in this Resolution. The President reported that the following actions had been taken:

1. Members of WG's 21, 28 and 34 discussed the matter in Moscow and recommended that full information on design of the experiment and the associated facilities be made available promptly to oceanographers.

2. WG 39 had noted that GATE could provide an opportunity for multiship investigation of the atmospheric transport of pollutants.

3. The marine geoscience workshop suggested (see Annex IX) that GATE ships could be used to investigate in detail selected parts of the ocean floor from the continental margin of equatorial west Africa to the western side of the crest of the Mid-Atlantic Ridge.

4. A sub-committee of the U.S. National SCOR Committee was exploring the development of several compatible experiments in physical oceanography.

The current status of the design of GATE was described by the representative of the GARP Joint Planning Staff, Dr. S. Ruttenberg. It was noted that the U.S. SCOR Committee was planning further discussions of GATE oceanography, in Miami on 17-19 February 1972, and it was agreed that an attempt should be made to bring oceanographers from several countries participating in GATE to that meeting. The report of that meeting should then be made available to the SCOR Executive Committee so that further SCOR action could be determined. It was also noted that the proposed CINECA multi-ship survey planned for 1973 could provide useful background information on the GATE region, and it was suggested that the organizers of GATE should be in direct contact

with the International Coordinator of CINECA.

Other matters concerning IOC and UNESCO were as follows:

1. Deep reference stations - another proposal of GELTSPAP was that an international network of deep reference stations should be established, primarily for controlling the quality of chemical data. On this matter, the comments of Drs. Rochford and Wyrtki, who had analysed the data from such stations in IIOE, were obtained and transmitted to IOC. Subsequently, the IOC Secretariat had suggested that SCOR design a network of such stations and to suggest their observational programs. In a discussion of this proposal, it was noted that data from such stations were particularly useful in studies of long term changes in the ocean. From this point of view, an important criterion in selecting locations for such stations would be the availability of past data from the same position. It was therefore decided to ask NODC to locate places where deep observations of high quality had been made repeatedly during the past forty years; it was recognised that in most cases only temperature and salinity data would be usable from the earlier cruises. The President was also asked to ask the views of scientists studying deep ocean circulation for their views on the utility of further development of the deep reference station concept.

2. IIOE Atlas on Chemical Biology - a small editorial advisory group under the chairmanship of Professor Postma had met with the Chief Editor of the Atlas, Professor Krey, to determine how best to facilitate completion and publication of this volume. The Executive Committee after considering the report of this meeting decided to appoint Mr. Jitts, Professor Postma and Dr. Zeitschel as Assistant Editors for primary production and chlorophyll, chemistry and physics, and for general editorial matters, respectively.

3. Draft Manual on International Oceanographic Data Exchange - upon the recommendation of the IOC WG on International Oceanographic Data Exchange, the Directors of WDC-A/B had completed a draft revision of this manual. In order for the Manual to go into effect, it was then necessary to obtain the concurrence of SCOR and the ICSU Panel on World Data Centers. The Executive Committee therefore decided to have the draft reviewed by Professor Lacombe, Mr. Currie, Dr. Gaskell, and the Secretary of SCOR, with the comments to be compiled and forwarded to the appropriate parties by Professor Wooster.

3.2 RELATION WITH FAO/ACMRR

The representative of FAO reported on the need for updating of the "International Directory of Marine Scientists", a project in which SCOR had agreed to continue to participate. Corrections were being received from some of those listed, but an intensive effort would be required to identify others who had not been listed. It was agreed to designate the SCOR Secretary as the point of contact with the FAO Secretariat,and as the one to solicit updated listings from SCOR National Committees.

In connection with reviewing the coverage of "Marine Science Contents Tables", Professor Postma was designated as the SCOR nominee on the Editorial Board.

A plan for fishery development in the Indian Ocean has been elaborated by FAO, and the program leader for this activity, Dr. Marr, has suggested that SCOR look at the general question of the role of oceanography in such a program. Related recommendations had been made by GELTSPAP, some post-IIOE work including satellite observations was becoming available, the Oceanographic Atlas of IIOE was now available, and it may soon be appropriate to organize a symposium on the subject. It was agreed to recommend to FAO that a consultant be employed to assemble a summary of available information on the ocean environment of the region. SCOR should work closely with ACMRR in exploring the most appropriate further action to be taken.

3.3 RELATION WITH WMO/ACOMR

The representative of ACOMR, Dr. Kostjanoj, reported on the first meeting of ACOMR (Geneva, 6-10 September 1971), at which SCOR was represented by Professor Stewart. ACOMR

agreed to cosponsor WG 36, as noted under item 2.2, and is also prepared to cooperate in the Joint Oceanographic Assembly (see item 5.2). With regard to the forecasting of storm surges, an earlier SCOR proposal to cooperate (see Proceedings, vol. 7, p.9) was referred to the WMO Executive Committee Panel of Experts on Tropical Cyclones.

The representative of the GARP Joint Planning Staff introduced a paper concerning the need for observations from oceanic areas; this is reproduced in Annex X.

3.4 RELATION WITH ICES

The development of cooperative ICES/SCOR action regarding pollution in the Baltic is discussed in item 2.3. In this connection, reference was made to the ICES Symposium on the physical processes responsible for the dispersal of pollutants in the sea with special reference to the nearshore zone, to be held in Aarhus on 4-7 July 1972. It was agreed that SCOR should provide some financial support for this symposium.

4.0 RELATION WITH NONGOVERNMENTAL ORGANIZATIONS

4.1 RELATION WITH ICSU

As previously noted (Proceedings, vol. 7, p.10), the SCOR views on the role of the Scientific Committees within ICSU have been brought to the attention of the ICSU Officers. Although receipt of these comments has been acknowledged, there have been no indications that the SCOR proposals have been accepted. It is likely that decisions on ICSU structure will be reached at the ICSU General Assembly in September, and it was agreed that despite the conflict with the SCOR General Meeting, SCOR should be represented at that Assembly.

The 15th Executive Committee Meeting had requested the President to formulate an appropriate statement on the conditions for freedom of oceanic research. A draft of such a statement has been discussed with the ICSU Officers who noted a related ICSU action in 1958 and agreed that such a statement could be considered by the ICSU General Assembly. The SCOR Executive Committee decided that the statement should first be sent for approval to its members and then to National Committees who, it was hoped, would express concern to their governmental representatives dealing with Law of the Sea affairs at an early date before inflexible positions on restricting oceanic research had developed. In this connection, Professor Hela expressed the view that many of the issues to be considered by the Law of the Sea Conference had important scientific aspects. He cited not only the freedom of oceanic research but also the limits of the continental shelf, internationalization of the sea bed, and international management of deep seabed resources and of living resources occurring beyond the limits of national jurisdiction. In his opinion, SCOR should approach the UN Conference Secretariat offering to provide scientific advice on the scientific aspects of the forthcoming conference. Although there was considerable sympathy with this proposal, no decision was reached on the action to be taken.

4.2 RELATION WITH UNIONS AND COMMITTEES

Financial support was provided by SCOR to the IBP/PM Working Conference held in Rome, 4-8 October 1971. After the formal termination of IBP, foreseen in about two years, some programs will be carried on by organizations such as SCOPE and UNESCO's Man in the Biosphere program. The Executive Committee agreed that those programs that deal with ocean systems should involve SCOR and IABO on the non-governmental level and IOC and FAO on the intergovernmental level, as proposed in a resolution adopted by the Working Conference. Identification of the specific programs that might involve SCOR could be considered at the forthcoming General Meeting when it is hoped that the Convenor of IBP/PM would be present. It was agreed to invite IABO to consider this matter and report to that meeting. It was also agreed that SCOR representation in IBP should be arranged by IABO, and that Dr. Oren, who had been the SCOR representative, should be discharged with appreciation.

A request had been received from IBP/PM for SCOR to contribute toward paying the travel expenses for the IBP/PM Marine Mammal Working Group scheduled to meet in Seattle in September 1972. The Executive Committee decided not to approve this request, since SCOR had had no close association with this activity.

It was noted that Mr. S. Ruttenberg, Secretary of COSPAR Working Group 6 (Applications of Space Techniques to Meteorology and Earth Surveys) had been appointed interim liaison member to SCOR. Mr. Ruttenberg presented a report on satellite-related observing techniques under discussion in COSPAR which is given in Annex XI. SCOR would be invited to participate in arranging the program of a COSPAR Symposium on Applications of Space Techniques to Earth Survey Problems to be held during the 1973 COSPAR General Assembly.

Professor Wooster reported on the First General Assembly of SCOPE (Canberra, 1-3 September 1971) and the meetings of the SCOPE Bureau and the Institutional Arrangements Working Group (Amsterdam, 3-6 January 1972). For the working group, he had presented a paper entitled "SCOR and IOC: Interactions between intergovernmental and scientific organizations." In order to facilitate cooperation between SCOPE and SCOR in connection with the provision of scientific advice on environmental matters to various elements of the United Nations system, SCOR should continue to be represented in SCOPE activities, including the SCOPE meeting scheduled for 16-18 March 1972 in London.

Professor Lacombe reported that in addition to the IAPSO Symposium on Optical Aspects of Oceanography (see item 2.2, WG 15), IAPSO is sponsoring a Symposium on Physical Oceanography of the Red Sea in Paris, 4-7 October 1972. It was agreed that because of SCOR's continuing interest in the results of the International Indian Ocean Expedition, it would be appropriate to cosponsor this symposium and to provide $1000 to assist in meeting its expenses. IAPSO also plans to cosponsor (with CMG) a Symposium on the Contribution of Deep Sea Drilling to Geology (September 1972 in Montreal), and with IAMAP in organizing a symposium on the air and sea boundary layers to be held in Melbourne in 1974. There are indefinite plans to organize a symposium on the effects of engineering works on the oceanographic environment. During the IUGG General Assembly to be held in Paris in 1975, there will be a IAPSO General Assembly with a number of scientific symposia.

4.3 RELATION WITH ECOR

The ECOR First General Assembly will be held in London, 16-17 March 1972; SCOR will be represented by Dr. Gaskell.

5.0 FUTURE MEETINGS

5.1 ELEVENTH GENERAL MEETING

This meeting will take place at the Dunstaffnage Marine Research Laboratory in Oban, Scotland, on 21-23 September 1972, following the Second International Congress of the History of Oceanography and the Challenger Expedition Centenary Celebration in Edinburgh. The session will be a business meeting and will include election of officers.

5.2 JOINT OCEANOGRAPHIC ASSEMBLY 1976

In its Resolution VII-23, the IOC endorsed the holding of the next Joint Oceanographic Assembly in 1976, requested the scientific bodies concerned to proceed with organization of the program, and invited IOC Member States and non-Member States, UNESCO and the other organizations of the United Nations System, and other interested organizations and institutions, to support the Assembly, including the making of adequate budgetary provisions.

It was noted that ACOMR at its first session had expressed the view that it would be happy to collaborate in the organization of the Assembly, and had recommended to WMO that it

consider the possibility of financing the participation of two or three lecturers on air-sea interaction subjects and the participation of an ACOMR nominee in the organizing committee.

Participants in the Executive Committee Meeting unanimously agreed that the most desirable location for such an assembly would be in the United Kingdom; the possibilities there and in other countries in northern Europe should be explored. In addition, the SCOR President should take the initiative to meet with representatives of IAPSO, IABO and CMG to take the initial steps in organizing the Assembly.

5.3 OTHER MEETINGS

At its 15th Meeting, the Executive Committee had agreed to organize in 1973 a symposium on polar oceanography, the general theme being the relation between the special physical conditions, both past and present, in the polar oceans and their consequences for life. Other interested bodies include SCAR, ACMRR, ACOMR, the IOC Coordination Group on the Southern Ocean, ICES, and ICNAF. In addition, IOC is considering relevant proposals in the development of LEPOR. It was agreed to invite Professor Dunbar to chair an organizing committee for the symposium, the other members of which would be selected in consultation with him.

6.0 OTHER MATTERS

The SCOR Secretary reported on the status of completion of the studies resulting from the International Baltic Year. It is now planned that unpublished data will be submitted to ICES for publication; several reports are now in the scientific literature. It was agreed that this project should be of great interest to the new joint group with ICES, WG 42 on Baltic Pollution.

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A list of future meetings of SCOR and associated organizations is given in Annex XII.

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ANNEX I

16th SCOR EXECUTIVE MEETING
Charlottenlund Slot, 10-12 January 1972

List of Participants

MEMBERS OF THE EXECUTIVE COMMITTEE

Professor Warren S. Wooster	(U.S.A.)	President
Captain Luis R.A. Capurro	(Argentina)	Past President*
Professor A.S. Monin	(U.S.S.R.)	Vice President
Professor Dr. H. Postma	(Netherlands)	Vice President
Dr. Klaus Voigt	(GDR)	Secretary
Dr. T.F. Gaskell	(IUGS/CMG)	Ex Officio
Professor Dr. G. Hempel	(IUBS/IABO)	Ex Officio
Professor H. Lacombe	(IUGG/IAPSO)	Ex Officio

OTHER PARTICIPANTS

Dr. E. Bertelsen (SCOR member from Denmark)
Mr. R.I. Currie (IUBS)
Professor E. Dahl (SCOR member from Sweden)
Sir George Deacon (SCOR member from UK)
Professor I. Hela (SCOR member from Finland)
Mr. G.E. Hemmen (SCAR/UK)
Dr. N. Jerlov (SCOR member from Denmark)
Dr. G. Kostjanoj (WMO/ACOMR)
Mr. H. van der Merwe (South Africa)
Dr. S. Ruttenberg (COSPAR/JPS GARP)
Professor Dr.E.Seibold(SCOR member from FRG)
Professor E.S.W. Simpson (SCOR member from South Africa, Secretary CMG)
Dr. G. Saetersdal (Chairman, ACMRR)
Mr.H.Tambs-Lyche (Secretary-General, ICES)
Dr. O. Tandberg (SCOR member from Sweden)
Professor R.Vaissiere(SCOR member from Monaco)
Dr. T. Wolff (Secretary, IABO)

* also represented IOC and UNESCO

ANNEX II

REPORT OF COMMISSION FOR MARINE GEOLOGY, 1971

1. Meetings

An informal meeting of CMG was held in Madrid on 18 May 1971, and further informal discussions were held during the meetings of the International Workshop on Marine Geoscience in Hawaii, 20-24 September 1971.

2. Membership

The names and addresses of CMG members are as follows:

Dr. T.F. Gaskell (Chairman), British Petroleum, Britannic House, Moor Lane, London, E.C.2,UK
Professor E.S.W. Simpson (Secretary), Department of Geology, University of Cape Town, Rondebosch, South Africa
Professor P.L. Bezrukov, Institute of Oceanology, USSR Academy of Sciences, I Letnyaya, Lublino, Moscow, J-387, USSR
Dr. J.M. Harrison (Associate Member), Assistant Deputy Minister, Energy, Mines & Resources, Ottawa 4, Ontario, Canada
Professor B.C. Heezen, Lamont-Doherty Geological Observatory, Palisades, N.Y., 10964, USA
* Dr. A.S. Laughton, National Institute of Oceanography, Wormley, Godalming, Surrey, UK
* Dr. X. le Pichon, Centre Oceanologique de Bretagne, CNEXO, 29N-Plouzane, France
* Dr. A.E. Maxwell, Provost, Woods Hole Oceanographic Institution, Woods Hole, Mass., 02543, USA
* Dr. N. Nasu, Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano-ku, Tokyo 164, Japan
Professor E. Seibold, Geologisch Institut der Universitat, Olshausenstrasse 40/60, 23 Kiel, Germany, FRG
* Dr. G.B. Udintsev, Institute of Oceanology, USSR Academy of Sciences, I Letnyaya, Lublino, Moscow, J-387, USSR
* Dr. S. Uyeda, Earthquake Institute, The University of Tokyo, Bunkyo-ku, Tokyo 113, Japan

* An asterisk denotes those whose membership of the Commission has been approved by the Executive Committee of IUGS, but not yet finally confirmed by Council.

3. Relationship with other bodies

(a) SCOR. Both the Chairman and Secretary of CMG attended the XV meeting of the SCOR Executive Committee in Madrid, 17-19 May 1971.

A new SCOR Working Group 37 on Marine Plankton and Sediments was set up with the following membership:

Seibold (FRG, Chairman), Be (USA), Bolli (Switzerland), Funnel (UK), Riedel (USA), Takayanagi (Japan), Zhuse (USSR), plus an IABO nominee. The WG is to be responsible for discussion of the principles of systematics, stratigraphy and environmental interpretation of planktonic remains in marine sediments, and for providing a basis for comparison of submarine and land stratigraphy, culminating in the organization of a symposium embodying also the results obtained from deep-sea drilling cores.

It was agreed that the next Joint Oceanographic Assembly be held in 1976. The initial long-term planning and arrangements will be considered by an international steering committee consisting of the Presidents and Secretaries of SCOR, CMG, IABO and IAPSO.

(b) IAPSO/IUGG. The Secretary of CMG attended meetings as a member of the IAPSO Executive Committee in Moscow during the XV General Assembly of IUGG in Moscow, 1-14 August 1971. On the subject of the relationship between IAPSO and CMG, the IAPSO Executive noted with approval that membership of CMG had been enlarged to include five marine geophysicists whose affiliation lies mainly with IUGG. At the same time the Secretary of CMG was elected to the Executive Committee of IAPSO. All three core members of the IAPSO Commission for Marine Geophysics are now members of the reconstituted CMG, thus providing an informal liaison between the marine geoscience activities of IUGG and IUGS.

(c) ICG. Dr. X. le Pichon has been appointed Secretary-General of the Inter-Union Commission on Geodynamics, whose membership includes the Secretary of CMG (Professor E.S.W. Simpson) as Chairman of Working Group 8. Meetings were held in Moscow during the XV General Assembly of IUGG, August 1971

4. Coordination of Marine Geoscience Activity

CMG recognizes the importance of its involvement with each of the following programmes and activities which cover considerable areas of overlap and duplication:

(a) International Geological Correlation Programme (IGCP)
(b) Inter-Union Commission on Geodynamics (ICG)
(c) The IOC Long-Term and Expanded Programme of Oceanic Exploration and Research (LEPOR), and the report of the IOC Group of Experts on Long-Term Scientific Policy and Planning (GELTSPAP)
(d) The International Decade of Ocean Exploration (IDOE).

The following CMG representatives have been appointed with the request that they advise on specific action to be taken by CMG with regard to implementation and coordination of the programmes:

IGCP Group	- E. Seibold, H. Bolli, X. le Pichon
ICG Group	- X. le Pichon, E.S.W. Simpson
LEPOR Group	- E. Seibold, X. le Pichon, J.M. Harrison

On the initiative of SCOR, and with funds provided by the State of Hawaii, an International Workshop on Marine Geoscience was organized in cooperation with CMG and ICG for the purpose of (a) considering the GELTSPAP proposals in relation to the marine aspects of ICG and IGCP, and (b) preparing specific proposals for implementation of further cooperative investigations, for consideration by the IOC and by National Committees of ICG. The International Workshop comprised a meeting of some 25 marine and other appropriate geoscientists under the chairmanship of Dr. T.F. Gaskell, during the period 20-24 September 1971 in the University of Hawaii. Each of the GELTSPAP proposals was carefully reviewed and in most cases considerably modified or expanded. The final detailed and general recommendations of the Hawaii Workshop have been submitted to SCOR for inclusion in the SCOR report and recommendations which will be considered by the VII Session of the Intergovernmental Oceanographic Commission in Paris, 26 October to 5 November 1971.

5. CMG Special Projects

(a) Handbook on National Programmes. The CMG Handbook listing national programmes, facilities and activities in marine geology has been completed by Professor B.C. Heezen under the title of "Geological Investigation of the Sea Bed: National Programs". An edition of 600 has been printed and copies are available from Professor Heezen or the Secretary-General of IUGS. Many gaps are evident due to lack of response from National Committees of IUGS, and arrangements are being made for the compilation of a second and hopefully more complete edition.

(b) Marine Geological/Geophysical Inventories. In terms of an IUGS/UNESCO contract for the development and compilation of an international inventory of marine geological/geophysical coverage, CMG has accepted a double responsibility:

(i) To develop, print and distribute as widely as possible, formats for the reporting of post-1970 marine geological/geophysical coverage to World Data Centre A (Oceanography). This responsibility has been substantially discharged, and CMG will continue to encourage the cooperation of appropriate institutes and individual scientists.

(ii) To compile, in chart form at a scale of 1:5 000 000, an inventory of all pre-1970 marine geological/geophysical coverage by traverse and station procedures. The reasons for the initial poor response have been evaluated and discussed with many of the scientists concerned,

and renewed efforts will now be made to obtain the information required for plotting. If this project can be successfully completed it is the intention of UNESCO to publish the information in atlas form.

6. Status of CMG Symposia

(a) East Atlantic Continental Margins. The SCOR/IUGS Symposium in Cambridge, March 1970, has stimulated the following publications and activities:

(i) Publication in four volumes of the SCOR/IUGS Symposium, by the Institute of Geological Sciences, London (IGS Reports 70/13-16, 1971)
(ii) SCOR Symposium on "The Structural History of the Bay of Biscay", Paris, December 1970 (to be published by l'Institut Francais du Petrole)
(iii) Symposium on "Geologie de Bassin Parisienne et de la Manche", Paris, January 1971
(iv) West African continental margin cruise WALDA by R/V JEAN CHARCOT (CNEXO, France), May-August 1971.
(v) West African continental margin cruise 25 by R/V METEOR (Deutsche Forschungsgemeinschaft), October - December 1971
(vi) West African continental margin cruises by R/V ATLANTIS II (Woods Hole Oceanographic Institution), 1972/73.

(b) A Discussion on the Petrology of Igneous and Metamorphic Rocks from the Ocean Floor (SCOR/IUGS/IUGG/UMC), London, November 1969. Published in Phil.Trans.Roy. Soc.Lond., A 268, 381-745 (1971).

(c) Sedimentation of Marine Organisms (CMG/IABO), Tokyo, September 1970. Papers in press.

(d) Global Tectonics and Sea-Floor Spreading (CMG/UMC), Tokyo, September 1970. Papers in press (Tectonophysics).

(e) Marginal Seas of the Western Pacific (CMG/UMC), Tokyo, September 1970. Papers in press (Japanese Journal of Marine Geology).

(f) XXIV International Geological Congress, 1972. Arrangements by the CMG Convenors for the following symposia are in hand:

(i) "Geology of the Indian Ocean". To be included in Report of ICG Section 8. Convenor, E.S.W. Simpson
(ii) "The Contribution of Deep-Sea Drilling to Geology". (IUGS/IUGG). Arrangements completed by Convenors, B.C. Heezen and M.N.A. Peterson.
(iii) "East African Sedimentary Basins" (ASGA/CMG). Manuscripts in hands of Convenor, J. Lombard.

7. CMG Representatives

(a) Permanent

SCOR Executive: Dr. T.F. Gaskell (Chairman, CMG, ex officio).
SCOR:Professor E.S.W. Simpson (Secretary, CMG, ex officio)
SCOR Working Group 37 on Marine Plankton and Sediments: Professor E. Seibold (Chr.)
IOC/GELTSPAP:Dr. J.M. Harrison, Professor E. Seibold, Dr. X. le Pichon
IAPSO Executive:Professor E.S.W. Simpson
IAPSO Commission on Marine Geophysics and GEBCO Committee: Dr. G.B. Udintsev, Professor B.C. Heezen, Dr. A.S. Laughton
UNESCO/Indian Ocean Geological/Geophysical Atlas Editorial Board: Dr.G.B.Udintsev (Chr.), Dr. A.S. Laughton, Professor E.S.W. Simpson
CGMW:Professor B.C. Heezen, Professor E.S.W. Simpson
ICG:Dr. X. le Pichon (Secretary-General), Professor E.S.W. Simpson (Chr. WG 8)

(b) Ad Hoc

IOC VII Session, Paris 1971: Dr. T.F. Gaskell, Dr. L. Montadert

IUGG XV General Assembly, Moscow 1971: Professor P.L. Bezrukov, Professor B.C. Heezen, Professor E.S.W. Simpson

12th Pacific Science Congress, Canberra 1971: Dr. J.M. Harrison, Professor B.C. Heezen

SCOR/CMG/ICG Workshop on Marine Geosciences, Hawaii 1971: Dr. T.F. Gaskell (Chr.), Dr. S. Uyeda, Professor E. Seibold, Professor E.S.W. Simpson

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ANNEX III

ESTIMATE OF SCOR FINANCES

(1 January thru 31 December 1971)

BALANCE AS OF 1 January 1971			
In Rome			$ 2,219.23*
In La Jolla			7,707.03
* $219.23 in Indian Rupees			$ 9,926.26
INCOME			
IBP/PM Support for Kiel Symposium		2,500.00	
IUBS/IABO Support for Kiel Symposium		998.50	
Hawaiian Support for IDOE Meeting		20,000.00	
Grants from UNESCO Subvention to ICSU		2,500.00	
Grants from ICSU Fund		2,500.00	
UNESCO Contracts		28,012.85	
National Contributions		25,358.00	
Refund, 1970		141.80	
Interest on Savings Account		454.29	82,465.44
			$ 92,391.70
EXPENSES			
Office		3,663.61	
Publications		1,106.40	
Working Groups			
WG 15	1,728.00		
WG 21	1,203.50		
WG 23	1,106.50		
WG 25	830.00		
WG 27	4,110.36		
WG 32	387.00		
WG 33	806.17		
WG 34	3,204.52		
WG 39	3,175.17	16,551.22	
Executive Expenses		6,198.63	
"Ocean World" - 1970		641.00	
Kiel Symposium		6,417.13	
IDOE Meeting, Marine Geoscience		21,182.35	
IABO Support, Proceedings		500.00	
IBP/PM Working Conference		1,925.00	
Representatives, Other Meetings		3,423.79	
Support, New Zealand "South Pacific Symposium"		1,000.00	
TOTAL EXPENSES		$ 62,609.13	
BALANCE AS OF 31 December 1971			
In Rome			$ 2,819.23*
In La Jolla			26,963.34
* $219.23 in Indian Rupees			$ 29,782.57

ANNEX IV

REPORT ON SCOR WORKING GROUP 21
CONTINUOUS CURRENT VELOCITY MEASUREMENTS
MEETING IN MOSCOW, 5, 7 and 9 AUGUST 1971

Working Group 21 met three times during the XV Assembly of the IUGG in Moscow. All members of the group were present for the first two days, and were joined by Dr. E. Francke from Warnemunde. Discussions were based on the following recommendation of the SCOR Executive Committee:

"... the group should consider how to complete and publish the results of the 1970 intercomparison experiment and should examine the need for further intercomparison of the Alexeev and Geodyne meters. The views of the group were also desired on the problem of undertaking intercomparisons of current meters in shallow water, of evaluating new types of current meters as they became available, and of interrelating WG 21 activities with those of WG 34."

The following conclusions were reached:

1. Completion of the report on the 1970 intercomparison experiment. Amendments to a draft version circulated by Dr. Webster in July 1971 were agreed, and, although some work on coherences remains to be done, no difficulties are foreseen in producing a final version in the near future.

2. The need for a further intercomparison. Two discrepancies revealed by the 1970 intercomparison remain unexplained. These are in the incremental responses to speed changes (that of the Alexeev being relatively high) and in the spectral energy levels at high frequency (that of the LSK being relatively low). The group agreed that there is an urgent need to clarify these discrepancies and unanimously supported Dr. Fofonoff's proposal that Alexeev, Geodyne and LSK meters should be compared on surface and subsurface moorings during a cruise from Woods Hole in May-June 1972. (Further support for this experiment is given in the appendix.)

3. Intercomparison of current meters in shallow water. It was recognized that the intercomparisons made and proposed by WG 21 were limited to deep water, and that further problems might arise in continental shelf depths and close to coasts. But the members of the group had little relevant experience, and thought that users of current meters in shallow water could better judge for themselves what was needed.

4. Evaluation of new types of current meters. The group's view was that users should in their own interests evaluate new instruments themselves. WG 21 had not attempted to evaluate all kinds of current meters and considered that its terms of reference will have been met by the completion of the proposed third intercomparison.

5. Interrelation of WG 21 activities with those of WG 34. Members of WG 21 expressed interest in problems of planning large array experiments, and any or all of the members would be willing to serve on a SCOR working group for that purpose, if required. It was recognized, however, that the range of experience within WG 21 was limited and that other specialists would doubtless be needed.

Appendix to WG 21 Report

Further support for the proposed intercomparison experiment is given in the following paragraphs from the draft report on the 1970 experiment:

"Conclusion 3. The agreement in estimates of mean velocities (noted in conclusion 2) is, however, largely fortuitous. The plots of speeds of paired instruments show that the incremental response in, for example, AK14 (Geodyne) was approximately half that of AK15 (Alexeev). A discrepancy in the same sense between other instruments and the Alexeev is less clearly indicated, due to lack of low speeds. Observed differences in vector variance and in spectral

distribution of kinetic energy are partly due to this unexplained discrepancy in speed response.

Conclusion 5. The relatively low estimates of energy density at high frequencies given by the LSK records seem unlikely to be wholly due to the response characteristics of the instrument or to smoothing during processing. The energy level corresponding to the speed digitizing interval in the curve follower used for reading the LSK records is at least an order of magnitude below the observed minimum values. One might speculate that the LSK was exposed to a lower amplitude of high frequency fluctuations due to its manner of mounting directly on the mooring line instead of being offset on a bracket, but we have no positive evidence of this and the effect remains unexplained.

Recommendation 1. Another intercomparison should be designed to resolve the discrepancies mentioned in conclusions 3 and 5 above. Comparison should be made on both surface and subsurface moorings and instruments should preferably be mounted in the manner in which they are most commonly used. Not all the types of instrument used in the 1970 experiment need be involved; it would be sufficient if Alexeev, LSK and Geodyne were used."

ANNEX V

REPORT ON SCOR WORKING GROUP 27
TIDES OF THE OPEN SEA
MEETING IN VENICE, 18-19 OCTOBER 1971

All members were present except Capurro, Eyries and Horn; Drs. J.L. Hyacinthe and F. Schott attended as observers. Dr. Cartwright served as secretary for the meeting.

1. Review of recent documents

The Chairman read out the following items, and recommended that they be reproduced in the minutes.

1.1 From SCOR Proceedings, Volume 7 (September 1971), p. 21, re WG 27

Terms of Reference: To encourage and assist with the design of instruments for measuring tides on the continental shelf and in the deep sea; to establish criteria concerning precision, sampling times and related considerations; to coordinate the observational programs and ultimately to bring about some uniform analyses of the deep sea data.

Members: Nominated by IAPSO: W.H. Munk, USA (Chairman); L.R.A. Capurro, Argentina; G.C. Dohler, Canada.

Nominated by SCOR: D.E. Cartwright, UK; J.R. Radok, Australia; T. Teramoto, Japan.

Nominated by UNESCO: W. Hansen, FRG; M. Eyries, France; S.S. Voit, USSR; W. Horn, FRG.

1.2 From SCOR Proceedings, Volume 6.2 (December 1970), pp. 72-73, Report on WG 27

There have been no formal meetings for the last two years, but the time may be ripe for a new review.

Theoretical efforts to compute the global tides by Pekeris in Israel, Hendershott in the United States, and Zahel in Germany have made considerable progress. I have not learned of the recent results in the Soviet Union where similar work is underway. It is my impression that a meaningful comparison between deep-sea calculations and deep-sea measurements is only a short time away. The boundary dissipation problem has not been solved, but it now looks as if the total energy in the oceans is rather larger than had been estimated; so the relative dissipation

is not quite so dramatic. Some connection between the age-old problem of the age of the tides and tidal dissipation has been established by Christopher Garrett.

The ESSA (Miami) group is getting set for employing Filloux tide gauges during September to study the M_2 node in the Gulf of Mexico and the tide in Yucatan Channel. Current meters will be deployed in the latter location. One principal goal is to study the $M_2 - S_2$ difference in this location.

The ESSA (Seattle) group under the leadership of Captain Barbee has been making measurements of internal tides off the continental shelf. Apparently, such internal tides are generated at the break of the shelf by mode coupling and propagating seaward along predictable "rays".

At the Scripps Institution we have occupied stations offshore from California, and these form the basis of the paper by Munk, Snodgrass and Wimbush: Tides Off-Shore: Transition from California Coastal to Deep-Sea Waters, Geophysical Fluid Dynamics, Vol. 1, 161-235, 1970. I think the work has served to clarify the cotidal structure in this part of the world. We now plan for a special cruise this October to occupy stations surrounding the alleged M_2 amphidrome.

Frank Snodgrass made a successful drop and recovery of three capsules at 40°, 50° and 60°S between Australia and Antarctica. The duration was approximately a month. Most of the equipment worked, and the tides show a sensible continuity between the Antarctic and Australian continents.

Our main emphasis for the next year will be the design and construction of a capsule which is to remain on the sea floor unattended for one year.

Walter H. Munk, Chairman

1.3 Report on progress of WG 27 presented to IAPSO at IUGG General Assembly, Moscow, August 1971

The subject has progressed, but too slowly and in too few quarters to justify planned international programs or any general meeting since that of Berne in 1967. The Committee will next meet in Venice in October 1971, when the state of the science will be reviewed. The present brief survey is therefore not comprehensive.

The global computations published by Pekeris and Accad in 1969 probably carry the direct solution of Laplace's unmodified equations to its practical limit. As with recent cotidal maps by other authors, agreement with observations, where they exist, is only partial. The importance of better understanding and representation of the energy dissipation at and near the shelf boundaries and of the distortion of the sea floor is now apparent; appropriate computer models are being developed by Pekeris and by Hendershott. An interesting new result from Hendershott's global computations is that the total oceanic tidal energy is about an order of magnitude greater than was previously thought. This effectively reduces our estimate of the Q factor of dissipation. Garrett and Munk have re-examined the problem of tidal 'age' in terms of Q factors and modal structure.

As a result of a small working session at La Jolla in 1969, Cartwright, Munk and Zetler laid down a suggested procedure for analysis of short pelagic tidal records. Such records have been obtained at several deep stations off the Californian coast, principally by Snodgrass, but also by Filloux and by the Lamont group, using their own instrumentation. Munk, Snodgrass and Wimbush have used these data to analyse the local tidal regime in terms of Kelvin and Poincare modes. Their latest results 'box in' the amphidrome between California and Hawaii. Snodgrass has also obtained records between Australia and Antarctica, in collaboration with the Flinders University of South Australia.

Cartwright has identified an unusual shelf-wave mode in the diurnal tide west of Scotland, and with other workers from NIO is building up a chain of tidal pressure and current

stations around the N.W. European shelf edge. He has also obtained and analysed new data from islands in the South Atlantic, and applied them to a beta-plane Poincaré mode synthesis of the central area. The resulting local cotidal map supports the controversial M_2 amphidrome of Pekeris and Accad (and of Zahel), but suggests it is further south, closer to one postulated by Bogdanov and Magarik.

The NOAA(Miami) group is using Filloux gauges to study the M_2 node in the Gulf of Mexico. NOAA (Seattle) is measuring internal tides off the shelf edge; conversion from surface to internal modes is thought to be a significant factor in tidal dissipation.

The use of altimeters in GEOS satellites to survey the ocean tides has been seriously discussed. In principle, this technique could revolutionise the tidal measurement problem, but current estimates of precision, of order 1 to 5 m, makes one pessimistic about early success.

We are far from our ultimate goal, a realistic definition of the tides in all the oceans. But computing and measurement techniques, with solution of some intermediate problems, are slowly reaching out towards some sort of link-up. With continued effort, hopefully on a wider international scale, one might see a solution within the next decade.

David E. Cartwright
p.p. Walter H. Munk (Chairman)

1.4 Extract from letter from B.D. Zetler (ESSA, Miami) to W.H.Munk, dated 15-3-71

Although I am not a member of the Group, I would like to suggest that the agenda for the next meeting include a discussion of whether an incompatibility exists between the agreed-on program to obtain 29-day series and an objective to zero-in on amphidromic points.

As you may recall from an earlier letter, Bob Cummings of NOS and I have been experimenting with this problem, using a year of hourly heights at Magueyes Island, reasonably near the semidiurnal node in the eastern Caribbean. The enclosed tabulation shows the results of individual analyses of the first 29 days in each month, compared with results from a least square analysis of the complete year. Although the station is believed to be some distance from the M_2 node, a significant amount of variation is found in individual 29-day analyses.

Cummings and I have been thinking about an optimum set of two one-month series of observations, based on the fact that the principal amount of interference from nearby frequencies deals with separations of 2 cpy.

However, looking at the enclosed data makes me believe that in any case it is necessary to lower the energy level of the continuum in the vicinity of the lines and this can be achieved only by longer series of observations. I am glad you have designed a one-year gauge.

(The table referred to shows semidiurnal and diurnal constants derived from a year's succession of 29-day records. M_2 (H = .023 ft, K = 279°) shows Standard Deviations = 0.32H, 38°, while K_1 (H = .260 ft, K = 166°) shows S.D. = 0.09H, 6°).

The main points arising from the discussion were that (a) amphidromes are no longer considered the best objectives (see 1.5), and (b) most people were finding the logistics of one-month pelagic records difficult enough, but that as techniques improved, two one-month records separated by a 2 month gap would be considered a worthy higher objective.

1.5 Three contemporary notes on deep sea tide problems by M. Hendershott (Scripps Institution of Oceanography)

(i) A number of numerical models of the global M_2 tide now exist (see Hendershott and Munk 1971 for bibliography). They are rather different in their construction and their parameterization of

dissipation but there is nevertheless an encouraging qualitative agreement between the various model results and island observations regarding the gross features of the global elevation field as well as between the computed global rates of dissipation (when they have been evaluated). The most salient features of computed cotidal charts are the amphidromes but the regions of large tidal range and slowly varying phase separating the amphidromes are of greater interest because they are the locations at which tidal potential energy is concentrated. Deep sea tide measurements at these locations would permit substantial improvement in the calibration of existing numerical models. The cotidal chart of Hendershott (Hendershott and Munk, 1971) suggests that the most important of these regions are centered at approximately 0°N, 15°W; 15°S, 75°E; 5°N, 135°W; 10°S, 115°W. There are other similar regions of smaller amplitude. Other numerical cotidal charts yield somewhat different locations. These regions, as determined by careful consideration of all existing numerical predictions, are the natural sites for the initial open ocean measurements in a systematic international program of deep sea tide measurements.

(ii) Two problems of importance and difficulty in existing numerical global tidal models are (a) the transition from coastal to deep sea tides over a shelf, and (b) incorporation of marginal seas into global models.

(a) Munk, Snodgrass and Wimbush (1971) have shown that California coastal tides may successfully be extrapolated seaward of the shelf, by fitting them to a sum of dissipationless free and forced motions over the shelf. This procedure could probably be applied almost without alteration to a number of other coasts (i.e., the western coast of South America). However, there are a number of shelf regions where the assumption of no dissipation is a poor one (Irish, 1971); further theoretical and observational study of the tidal transition across such regions is essential.

(b) Hendershott and Speranza (1971) have shown how measurements of tides in a rectangular marginal sea may be utilized to derive a deep sea boundary condition for semidiurnal global models. Measurements to confirm the validity of this procedure are now underway in the Gulf of California. A number of marginal seas may be treated in a similar manner but the irregular geometry of several other important dissipative regions requires more elaborate theoretical and observational treatment.

(iii) The customary parameterization of bottom friction is probably adequate in models which compute the velocity field with sufficient precision. No corresponding parameterization exists for the conversion of barotropic tidal energy into internal modes although this scattering may be the most important interaction between the barotropic tide and the general circulation of the oceans. This is a difficult theoretical problem whose resolution is of great importance for a definitive model of the global tide.

(These remarks were noted with great interest, particularly the importance of points of high potential rather than amphidromes. Hansen has a concept, 'wirkungspunkt', which appears to be similar in principle; he was asked to propose further sets of positions from his and Zahel's experience. Voit proposed to make a similar study with Kagan. It was regretted that Hendershott's four positions were so distant from the few countries equipped with open sea tide gauges.)

2. Progress reports from individual members

2.1 Hansen reported the application by Zahel of time-stepping techniques (the 'H-N method') to the world oceans, specified by a 4° mesh. A 1/2° mesh with better extension to shallow water areas was being considered. He recommended some measurements near the Gulf Stream, whose interaction with ocean tides may be important.

In discussion, Munk suggested that even a 1/2° mesh would ignore much coastal detail responsible for dissipation, which might be better represented by Hendershott's empirical boundary conditions than by the usual $\underline{u}.\underline{n} = 0$ condition. Also, the power loss by conversion to baroclinic tides at the shelf edge could hardly be accounted for other than empirically. In reply, Hansen said that extension of H-N methods to layered models was in progress. In connection

with the incorporation of marginal seas into global models, being necessary to consider details of the shelf regions in respect to dissipation effects for example, it should be mentioned that H-N methods which are taken as a basis for Zahel's global tidal investigations, have been successfully applied to tidal problems even non-linear in adjacent and marginal seas by Hansen and his cooperators within recent time. In principle, according to recent investigations, it is possible to operate an H-N model including different grid-sizes. In such a model the ocean, adjacent seas and even tidal estuaries are included.

Germany had no deep-sea tide gauge at present, but in the absence of Horn, Schott reported on work at I.F.M. (Kiel), and D.H.I. (Hamburg) using arrays of current meters to identify baroclinic tidal modes in the North Sea, in the Norwegian Sea and over the Meteor Seamount, and with shallow water (Graafen) pressure sensors on the West African shelf and off Southeast Iceland. Two more big experiments with current meters and tide gauges are planned off NW Africa (1972) and in the Shetland-Iceland ("overflow") area (1973). A new deep-sea tide gauge is now under development with an industrial firm. The means were provided by the Ministry of Science. The measuring principle will be either the N. and P. quartz pressure sensor or the Texas instrument quartz Bourdon tube. Both sensors are now under test.

2.2 Hyacinthe reported that his group CNEXO (Brest) had taken over the Eyries deep sea capsule in 1970, and had nearly completed a miniaturised version. This would be capable of 0.5 m and 10^{-3}°C precision at depths up to 6000 m, with more than six months' readings at 5 minute intervals. Low power consumption was achieved by COSMOS electronics. Recovery may be by line, after acoustic recall of a sub-surface float. Estimated price is about $15,000.

Four records each of a few days' duration, had been taken with the Eyries gauge in the Bay of Biscay, and used by Hyacinthe for an analysis of the M_2 tide regime there. The programme for 1972 is to cover other parts of the North Atlantic, with special study of the deformation of the tidal wave at the shelf edge. Development of a static current meter for use with the pressure capsule was probable.

2.3 Voit. The USSR had no plans for a deep pressure sensor, but were concentrating on theoretical tidal work. Bogdanov is considering new computations of ocean tides with smaller mesh sizes and is comparing the two usual types of boundary conditions (elevation, and zero normal velocity specified). Kagan is working with an oceanic tidal model involving varying turbulent friction coefficients and stratification. A method of determining the friction coefficients has recently been published. Voit is himself investigating a transformation of the tidal equations to integral equations of Fredholm type. Theoretical solutions of these equations have been found, and they have the great advantage that they involve only integration around the boundary. A fuller report will be ready for the next meeting.

Voit promised to supply a recent bibliography of Russian work on tides, for circulation to WG members.

2.4 Radok summarised five years of progress of his group (Horace Lamb Centre, University of South Australia). In the absence of an ocean going ship, they have concentrated on shelf-tide measurements down to 200 m. Capsules employing differential and absolute pressure gauges, sampling every 4 minutes using Kennedy tape decks and their own logger, have given several records up to 30 days' duration, from nearshore to 100 miles out, at various parts of the south and west Australian shelves. This capsule also records at 4 second intervals swell waves every 7-1/2 hours. They now intend to equip one capsule with a Siemens strain gauge, a Schlumberger piezo gauge, and one of their own sensors to run a comparison test.

Radok also showed the WG a novel flowmeter designed by R.K. Steedman of his group. Derived from the Pitot tube principle, the meter operates on the temperature differential between two diffused silicon transistor sensors subjected to different velocity fields, and uses the linear dependence on temperature of their base emitter voltages. The response of each tube is proportional to the square of the velocity (threshold about 1 mm/s), with cosine directional dependence. Three tubes in a cross give complete direction information. They are small, light,

inexpensive, and have low power consumption.

The group's prospects for 1972 include several pressure/current records in the Great Australian Bight, 200 miles apart. Radok hopes to continue with industrial support further extensive surveys up to 100 miles offshore around Australia. He also plans an experimental tidal programme in Lake Baikal (Siberia).

2.5 Dohler reported on offshore tide recording in the St. Lawrence and Bay of Fundy area, and projected work in the arctic. His Tides and Water Levels Section (Department of the Environment, Ottawa) have developed and used a self-contained system involving a differential pressure transducer (up to 200 m) temperature sensor, and paper tape punch, housed with batteries in a stainless steel capsule, total displacement 210 lbs. It can record 1/2 hour samples for 3 months. Release is by acoustics or skin divers. Accuracy is of order 20 mm, which, being as good as or better than most surface tide gauge installations is considered adequate. Cost is about $11,000. Further details are in report by W. Zubrycky. Results of comparative tests between various instruments were shown, confirming the stated accuracy.

Dohler also showed a new 'Data Inventory Retrieval System' listing details of all tidal measurements available in computer applicable media from Canadian waters. This raised the question of an international inventory, noted more fully in 3.2.

2.6 Teramoto reported that efforts in Japan had largely concentrated on the accurate recording of currents, although a simple shallow water sea bed (up to 150 m) pressure device had been in use for several years before the World War II and had recently been improved at the Hydrographic Office. The improved device was successfully used in the Straits of Malacca. The acoustic current meter (10^7 Hz) had given good results in the Bay of Sagami, but its limitation was its 50 m watt power consumption. A project denominated as OSPER has started this year to develop a system for long simultaneous recording of (u, v, t, p) in the open sea. Teramoto, who participated in the project, promised to make the system applicable to a study of the open sea tides.

2.7 Cartwright described his own tidal work at NIO (Wormley) and reported on that of ICOT (Bidston). At NIO, Collar and Spencer have developed a shelf-tide capsule, consisting of a capacitance-plate pressure sensor (60kHz) whose F/M output is recorded digitally to 10^{-5} precision at 15 minute intervals. Bell and Howell strain gauges have recently been used successfully as pressure sensors. The data logger, which also records two temperatures, is a moderately priced device available in the UK, housed with all electronics and batteries in a 56 cm Aluminum sphere. Acoustic recall system is based on many years' experience at NIO, and has been 100% successful in the last three recording arrays. They are being used to define the tides around the shelf edge surrounding the UK, and so far 11 records, about 100 km apart, of up to 30 days' duration, each accompanied by corresponding current records from Aanderaa meters in adjacent moorings, have been retrieved between Ireland and the Shetlands and at the approaches to the English Channel. The chain should be extended to reach Norway in 1972. Sea bed pressure records have also been obtained from isolated islands in the shelf area, where no previous data was available. The diurnal tides show a strong continental-shelf-wave mode, among other features.

Cartwright has also obtained and re-analyzed all available data from the South Atlantic islands Ascension, Tristan and Trinidade, and made new recordings at St. Helena. The results, to be published shortly, confirm the positive M_2 amphidrome postulated by the computations of Pekeris and of Zahel, and Dietrich's negative K_1 amphidrome.

ICOT have placed a contract with Marconi Company for a 20-channel tide recorder with computer-compatible magnetic tape, and 5/million resolution . By mid 1972 they hope to have three such devices fitted with Vibrotron pressure sensors and Hewlett-Packard temperature sensors, and have plans for H-P pressure crystals also. Numerical models have been used to determine optimum siting for offshore instruments (chiefly re storm surges). ICOT are participating in the UK/Germany/Holland/Belgium study of the North Sea, principally by providing coastal and offshore-tower tide gauges. The main object of this exercise is to obtain a long term buoy network of current meters and other sensors within the North Sea. ICOT are also making an intensive

numerical study with measurements of the Irish Sea.

2.8 Munk summarised his group's (IGPP, La Jolla) deep sea tide work of the last 3 years. The three successful drops between Australia and Antarctica (plus island stations) proved on analysis to be rather 'unexciting'. The tidal constants merely showed a steady trend between Australia and Antarctic values. The results are to be published shortly by J. Irish (Ph.D. Thesis). The six or so deep records off California formed the basis of an interesting study in modal structure along a straight shelf in a semi-infinite ocean, (Munk, Snodgrass and Wimbush, 1970). The system was resolved into a tide locally forced by the yielding Earth, a Kelvin-type mode, and an optimised Poincaré mode. This probably defined the M_2 amphidrome better than any present co-tidal map. A later expedition to fix this amphidrome with an array of three sensors resulted in the loss of two of them, but the sensor retrieved showed the appropriate large phase difference, which confirms the expected position.

Snodgrass is now working on a new instrument, involving Hewlett-Packard crystals, COSMOS logic, and magnetic core storage. It is to give a year's record at 2h intervals, but will switch to 2-minute recording whenever a high frequency band (internally computed) exceeds a certain energy level. Every day at noon, it will transmit some of its core acoustically to a surface buoy then via satellite to land. Without such a monitoring system, a year's recording on the ocean floor would be psychologically intolerable.

Currents are still recorded by a hot-wire (also crystal) system with a vane, but the system is far from ideal.

A study of baroclinic tides (see 3.4) by Garrett and Munk showed a very complex modal structure, (in contrast to Schott's work, which uses a 2-mode synthesis).

Regarding other tidal work in the USA, Munk mentioned a study of the Gulf of California by Hendershott and Cox, the continuing work by NOAA(Seattle-baroclinic tides; Miami-Gulf of Mexico), and some new deep pressure capsules developed by Miller at Hawaii.

3. Important decisions and points of discussion

3.1 Existence and identity

The WG voted unanimously that it should continue to exist. However, the name "Deep Sea Tides" suggested that only the few who possessed deep sea pressure capsules could contribute to the work, whereas it was clear that many members were doing useful work with shelf-tide recorders, and the shelf edges were also very relevant boundary areas. It was therefore proposed that the name should be altered to - "Working Group on Tides of the Open Sea".

3.2 Information problems

Hansen stressed the need for some mode of dissemination of the results of recent tidal analyses, particularly from the open sea, which was made more acute by IHO having ceased to publish their sheets of tidal constants. He also mentioned the difficulty of obtaining up-to-date bathymetric figures for use in numerical ocean tide models.

The WG accepted a proposal by Dohler that he would incorporate all information on open sea tidal data sent to him in the uniform modern format of his group's new 'Data Inventory Retrieval System'. He was asked to provide precise details of what information should be supplied to him.

It was further agreed that Dohler and Cartwright (as Secretary) would draft a statement for presentation to the IHO, informing them of the special needs of the WG. (Such a statement has now been sent to the directors of IHO, 15 December 1971).

Dohler also promised to press this matter at meetings of IHO which he plans to attend as representative, and also to suggest to IHO that they should ultimately take over his proposed inventory system or establish a new one, and should consider the general need for a world bank of tidal data in modern format.

In any case, there should be a free exchange of data between members of the WG and their associates, once the originator has had time to assimilate the data himself.

3.3 Satellite altimetry

Cartwright had made enquiries about the state of this art, and had been assured from reliable sources that accuracy was unlikely to be better than an order of 2 metres in the near future, despite more optimistic figures quoted in some literature. Some improvement might be possible using, say, the Red Sea as a local reference level, but the prospects of useful tidal analysis were too doubtful to warrant active participation in this field by the WG. (Note added after the meeting: Zetler and Maul, J. Geoph.Res. 76, 27, (1971) have recently suggested that useful analysis is in fact possible with a noise background of order 1 metre amplitude.)

3.4 Baroclinic tides

In view of the progress made recently in this field by Schott, Garrett and Munk, Wunsch, Cox and others, and the possible importance of baroclinic tides as an energy sink, the question was raised whether the WG should form a sub-group for their study. The Chairman advised against this, since it would distract unduly from the WG's prime occupation with the barotropic tides. The only point relevant to the group, he said, was the energy loss at the shelf edges and similar places, and this may soon be amenable to rough calculation.

3.5 Current measurements

The WG recommended that all open sea pressure measurements should be accompanied by measurements of current and temperature, with due attention to the effects of stratification.

It was recognised that no conventional current meter could give an adequate account of the barotropic component, and the WG recommended research into depth-integrating methods such as electrode arrays.

3.6 Analysis of open sea tidal records

While recognising the need for a uniform method of analysis of all open sea data, the WG were unable to agree on what that method should be. They recommend that each authority should analyse its own data in a reasonable way, and retain at least the following characteristics of the Cartwright-Munk-Zetler (EOS, 1969) procedure:

(a) The inference of a simple relationship to a nearby 'reference' station whose tidal characteristics are thoroughly known.

(b) Extraction of harmonic constants (H,G) for the constituents Q_1, O_1, P_1, K_1; N_2, M_2, K_2, S_2.

See 3.2 re dissemination of data and results.

3.7 Areas for concentrated study

Immediate progress in measurements would perforce be made in sea areas within easy reach of those groups capable of making them, (e.g., Australia, and north west Europe), but opportunity should be sought to reach Hendershott's four points of maximum potential, and also any 'wirkungspunkte' which Hansen's group may recommend.

Cartwright suggested (with approval of Hansen and others) that a fair-sized area of the North Atlantic could be surrounded by boundary measurements in the not too distant future. The work in UK and France was a starting point, and could be continued via Iceland and Greenland to Canada, while lines defined by Madeira - St. Johns or Dakar - Natal were also conceivable. Such an area could provide a useful testing ground for numerical models, theories of dissipation etc., besides being invaluable for world-ocean studies.

Munk mentioned the pressure records his group would be making in an open North Atlantic area as part of the MODE project; also probable deep sea tidal work by Miller in the Pacific.

Radok mentioned investigations under the ice of Ross Sea, planned for 1975-76, in which his group may participate with the Scott Polar Research Institute.

3.8 Coordinated testing program

All members with working instruments agreed to a joint open sea comparison test to be planned for mid 1973 (after MODE and not August). The location had to be easily accessible, and a steep shelf or island, where deep and shallow meters could be tested in close proximity, was recommended. The site and other logistics will be decided at a future meeting. Meanwhile, the primary logistic of 'booking' a suitably sized ship will be pursued by (i) Hyacinthe, (ii) Cartwright. If these two fail, Voit offered to find a Russian ship. Members will be informed of progress, and of the date of the preliminary meeting.

3.9 Change of officers

Walter Munk announced his wish to be relieved as Chairman, while continuing of course to serve as a member of the Working Group. He proposed David Cartwright as his successor, and that the post of Chairman should in any case be rotated at about 5 year intervals. This motion was seconded by Dohler and approved unanimously. Members expressed their appreciation of Walter Munk's service as the first Chairman of WG 27.

ANNEX VI

REPORT ON SCOR WORKING GROUP 28
AIR-SEA INTERACTION
MEETING IN MOSCOW, 1 and 7 AUGUST 1971

The following members, or representatives thereof, participated: H. Charnock (Chairman), S.A. Kitaigorodskii (rep. A.S. Monin), J. Namias, C.H.B. Priestley, R.W. Stewart, S.S. Zilitinkevich, K. Bryan and P. Welander were unable to attend. The following observers were present: Brocks, Burt, Busch, Coantic, Dobryshman (WMO), Foster, Kraus, Lacombe, Malone, Mitsuta, Miyake, Munn, Pond, Roth, Taylor, Zwang.

1. Matters arising from previous meeting

It was reported that an Air-Sea interaction symposium was in progress at the XV General Assembly of IUGG. It was noted that many of the papers were concerned with small-scale motion in the air over the sea; for future symposia an effort would be made to attract papers on a broader spread of topics, including more work on the upper layers of the ocean.

It was reported that further instrument inter-comparison trials had taken place at Tsimlyansk, USSR, between Australian, Canadian, Soviet and United States scientists. These had again proved valuable but further work was desirable especially on humidity instruments. There also appeared to be a growing need for comparison of instruments used in aircraft.

It was agreed that on future occasions it was desirable that information was exchanged and that others involved were consulted before results were presented or published.

It was suggested that a land-based instrument comparison trial be held in Australia in June, July and August, perhaps in 1974. This would involve the estimation of heat flux and evaporation as well as stress; the need for analysis on site was recognized.

A comparison of aircraft turbulence sensing instruments was proposed for 1973. This could take place in Canada and be restricted to the lowest 1000 m of the atmosphere. A small group (Munn(Convener), Miyake, Warner and Zwang) were asked to consider this possibility and make suggestions for implementing it.

(NOTE: the following resolution was subsequently passed by IUGG - The IUGG recognizing the great value of the international comparisons made of turbulence instruments at Vancouver and Tsimlyansk and appreciating the need for further development in preparation for GARP and related programmes, recommends that further comparisons be arranged, emphasizing the importance of humidity sensors and of airborne instruments.)

2. Membership

It was reported that the membership of Messrs Bryan and Zilitinkevich, who had been coopted at the request of the JOC for GARP, would be ratified by IAMAP and IAPSO at their plenary session.

H. Charnock was re-elected as Chairman but gave notice that he would resign this office at the next meeting. The offices of Secretary and Treasurer were not filled.

(NOTE: at the subsequent meeting of IAMAP and IAPSO the membership of the Joint Committee was agreed as: K. Brocks, C.H.B. Priestley, J. Namias, S.S. Zilitinkevich (IAMAP); K. Bryan, H. Charnock, R.W. Stewart, L.R. Zwang (IAPSO).

3. The transfer of gases between the ocean and the atmosphere, especially H_20 and $C0_2$

At the 10th SCOR General Meeting the following recommendation was made to the Joint Committee (which also joins SCOR WG 28):

"It was recommended that the working group give special attention to the question of direct eddy flux measurements of the water vapor transport. The adequacy and intercomparability of existing instrumentation should be evaluated, as should the distribution of measurements needed to establish reliable estimates of evaporation for any place on the surface of the world ocean."

The need for instrumental comparisons was readily agreed; the necessary action has already been agreed (see 3 above).

It was, however, unlikely that the necessary equipment would ever be useable routinely from merchant vessels. It would probably be used to establish relations between more easily observed elements which could then be used to make the estimates of evaporation needed.

This raised two general needs; for the improvement of ships' routine meteorological observations and for more work on the complicated processes which occur at the interfacial layer between the atmosphere and the ocean.

Various means for filling these general needs were discussed. The WMO and its CMM were continually trying to improve the quality of observations from merchant vessels. But ships were becoming more automated and some new development was becoming necessary. Even this would not produce observations outside shipping lanes. The possibility of satellite observations

depended on an increased knowledge of the interfacial layer as well as of suitable sensors.

It was recognised that water vapour was not the only gas whose exchange between sea and air was important, carbon dioxide, lead tetraethyl and others were of concern. They would be considered by SCOPE and other international bodies.

It was agreed that work on these problems would be stimulated wherever possible and that at a joint meeting of IAMAP and IAPSO (now fixed for 14th - 25th January 1974 in Melbourne) one session should be devoted to discussing the mechanisms involved in the exchange of gases between the atmosphere and the ocean.

4. Air Sea interaction in relation to ocean circulation projects

This was discussed briefly but it was agreed to defer detailed consideration to the next meeting when it was hoped Dr. Byran would report on recent developments. The question of monitoring the results was important and there was a brief discussion of the MODE and Polygon projects.

5. Air Sea interaction in relation to GATE, GARP and other Meteorological projects

The detailed plans for GATE would not be available until the end of 1971, and it was agreed that Dr. B.J. Mason, Chairman of the Tropical Experiment Board, should be invited to present an account of its present status.

(NOTE: Dr. Mason presented his account at a subsequent meeting, attended also by SCOR WG 21 and 34. It became clear that a coordinated oceanographic project, using all the ships, would probably prejudice the meteorological objective. There would be an opportunity to do some oceanographic work but detailed planning could not be done until the GATE plans became firmer. The collaboration of oceanographers would be sought by publication of a general account of the proposed GATE project in oceanographic journals. The air sea interaction aspects were important: it was thought they should deal with interactions which affected synoptic developments rather than with small-scale near-surface motions. Much depended on decisions about the station keeping required of ships, the navigational aids available for windfishing, etc.)

As regards GARP, little progress had been made since the last meeting in specifying the need for buoys. Various prototypes were being constructed in several countries. Professor Stewart reported that the University of British Columbia was collaborating with the French EOLE Project in studying the satellite location of drifting buoys. Concern was expressed that the IRIS system was being abandoned but no definite information was available. The general view was that satellite interrogation of buoys would prove desirable but that to transmit only the sea surface temperature would not be adequate.

Professor Zilitinkevich reported that he has accepted an invitation from the Joint Organizing Committee for GARP to provide a review on air sea interaction in connection with GARP.

Dr. Mitsuta spoke briefly about the 1974 AMTEX project to study air sea interaction when cold air flows south over Japanese waters. The importance of this and other area studies was recognised and it was agreed that they should be fully supported.

(NOTE: the following resolution was subsequently passed by IUGG - The IUGG recognizing the great importance of boundary layer phenomena to the development of the GARP project and to ocean circulation projects and being aware of the value of international studies of regions of particular significance, recommends that such studies be supported, especially those concerned with

1) air mass modification in the Sea of Japan
2) wind/wave interaction in the North Sea and
3) boundary layer interaction in the Atlantic Ocean)

6. Air-land interaction in relation to GATE, GARP and other meteorological projects

This was discussed only briefly. Dr. Priestley reported on Australian work on this aspect. The views of the JOC for GARP were not yet clear. Nothing had been done about a network to monitor the radiation surplus or to assess surface wetness.

7. Air-surface interaction in relation to seasonal and long term development

This was acknowledged to be related to questions, discussed earlier, of the increased density and improved accuracy of observations, especially over the ocean. There seemed little hope of explicit modelling but the reality of the so-called tele-connection was now in little doubt. Dr. Dobryshman reported that the WMO Historical Sea Surface Temperature Project was still active.

8. Survey of relevant research activity

It did not seem necessary, or desirable, to produce a comprehensive survey of relevant research activity. Air-sea interaction was not a well-defined subject but had ramifications into most aspects of meteorology and oceanography. It was thought that the Joint Committee could most usefully concern itself with the interaction of the atmospheric and oceanic boundary layers.

9. Status report on WWW and IGOSS

Dr. Dobryshman, though not an official WMO representative, spoke briefly about WWW, which was progressing satisfactorily and referred to various reports of progress which were available from WMO. The development of IGOSS had apparently been temporarily halted pending a more realistic specification of a practicable system.

10. Date of next meeting

It was agreed that the next meeting should be held in January 1974 during the joint meeting of IAMAP and IAPSO which it is hoped will take place in Melbourne, Australia, in January 1974.

Recommended subjects for symposia at that meeting are:

The determination and prediction of sea surface temperature
Exchange of gases between atmosphere and ocean
Meso-scale structure of the atmospheric and oceanic boundary layer
The role of air sea interaction in synoptic and climatic development

The Joint Committee expressed its thanks to their Soviet hosts for allowing the meeting in Moscow University.

ANNEX VII

REPORT ON SCOR WORKING GROUP 33
PHYTOPLANKTON METHODS

The Working Group was established at the SCOR Executive Meeting in Mexico City (29 - 31 January 1969) and is concerned with quantitative phytoplankton methods exclusive of chemical determinations. After considerable preparatory correspondence, the group met on 1 - 3 December 1970, at the University of Rhode Island, Kingston, Rhode Island, USA, where members primarily reviewed the methods now used for quantitative phytoplankton studies, and discussed the desirability of a manual on phytoplankton methods (Items 1 and 4 of the Terms of Reference). There was unanimity on many procedural points, as well as agreement that several questions cannot be answered without extended work.

On the basis of the meeting, a draft of the review of methods was prepared and circulated among the members. Before selecting the most satisfactory methods (Item 3 of the Terms of Reference), however, the working group wants to compare some commonly used methods. Presently, plankton samples of known composition (made up from algal cultures) are being mailed from Seattle. They are to be counted by members with the methods the members themselves use regularly. The result may permit ranking of methods. Drafts for a few standard procedures (Item 3 of the Terms of Reference) have also been prepared.

The need for a manual on methods for phytoplankton research that emphasizes the distribution of phytoplankton in space and time, i.e., the measurement of concentrations rather than rates, is endorsed. In the opinion of WG members, the manual should contain chapters on: goals of investigating the distribution of phytoplankton; sampling design; instrumentation and methods for the field and the laboratory; evaluation of observations; and an annotated bibliography to serve as a guide to the literature on identification. A biological oceanographer (ecologist) would seem preferable to a taxonomist for the position of managing editor responsible for cohesiveness among chapters in this manual. The working group has not yet agreed on names of possible contributors.

Discussion continues about the advisability of reprinting ten to twenty classical papers on methods in a bound volume as an interim measure to facilitate access to these publications.

During the meeting in Kingston, considerable discussion was devoted to fixing and preserving of nanoplankton. Buffered formalin is still believed to be the most satisfactory chemical, but there is remarkably wide disagreement on the most suitable concentrations; the experts' opinions range from 0.5 to 10% formalin (0.2 to 5% of aldehyde). Two recommendations formulated during the meeting ask for work by an interested biochemist or histologist on satisfactory fixatives and/or preservatives, and for studies on the best buffering agent for formalin. A third recommendation suggests work on long-term storage of diatoms in aqueous solutions (i.e., of preserved original samples of nanoplankton); a fourth urges studies on permanent mounts that maintain the quantitative character of the original samples. Beyond the concern with the conventional aims of plankton work, monitoring of the oceans was on the mind of WG members in this context.

Other recommendations include phytoplankton courses for experienced participants, catalogues of computer programs, and deposition of raw data in national data centers, all of which will require some funds for implementation. The full recommendations and reasoning will be presented in the final report. A further meeting is not planned at present.

K. Banse (Chairman)
10 March 1972

REPORT ON SCOR WORKING GROUP 39
SCIENTIFIC INVESTIGATION OF POLLUTION IN THE MARINE ENVIRONMENT
SUMMARY OF RECOMMENDATIONS

The following extracts are from the "Report of the ACMRR/SCOR/ACOMR Joint Working Party on Global Investigation of Pollution in the Marine Environment (GIPME)", published as FAO Fish.Rep.No. 112 (1971).

PREFACE

The Group of Experts on Long-Term Scientific Policy and Planning established by the Intergovernmental Oceanographic Commission proposed in November 1970 that the Commission should establish a Global Investigation of Pollution in the Marine Environment (GIPME) as a major project in its Long-Term and Expanded Programme of Oceanic Exploration and Research (LEPOR). Subsequently the Bureau of the Commission at its meeting with the Consultative Council in Bordeaux in March 1971 requested the Commission's scientific advisory bodies (SCOR, ACMRR and ACOMR), together with GESAMP, to cooperate in developing the programme elements of this global investigation and to prepare a working paper for consideration at the Seventh Session of the Commission to be held in November 1971.

In response to this request, the advisory bodies and GESAMP agreed to establish a Joint Working Party on the Global Investigation of Pollution in the Marine Environment with the following terms of reference:

1. To review relevant documents concerning programmes of scientific investigation of pollution in the marine environment.

2. To identify the lines of research that appear to be the most effective in such investigations.

3. To develop an outline for GIPME, including estimates of priorities and timing and of the facilities and manpower required, and to suggest institutional arrangements for the planning and coordination of the work and the allocation of responsibilities for parts of the programme among the various interested organizations.

4. To note the regional approach to the development of GIPME suggested by GESAMP and to (a) consider areas, additional to those named by GESAMP, in which investigations might be commenced at an early date, (b) bear in mind the need to enable the developing nations to take an active part in GIPME.

This group met at San Marco di Castellabate, Italy, from 11 to 16 October and in Rome on 18 October 1971. A list of the participants is given. Mr. A.J. Lee was appointed Chairman and Professor W.S. Wooster acted as Rapporteur. Excellent arrangements were provided by FAO and enabled the group to conduct its work expeditiously.

SUMMARY OF RECOMMENDATIONS

In considering the great variety of research efforts that will ultimately be required to answer the questions raised by man's increasing pollution of the ocean, the Working Group decided to identify a number of projects that should be initiated now. Some of these required elaboration by appropriate specialists, while others are ready for action by international organizations. Implementation of the proposals below, with the coordination of IOC, would compose the initial phase of GIPME.

The following recommendations were agreed:

1. That SCOR and ACOMR, in collaboration with the Commission on Atmospheric Chemistry and Radioactivity (of IAMAP) evaluate the problems involved in studying the transport of pollutants through the atmosphere and their transfer to the ocean, including the development of suitable sampling methods, and consider means for promoting their investigation, with the goal of achieving the capability of conducting a multiship observational programme by 1974.

2. That IOC consider the desirability and method of organizing an international multidisciplinary study of River Inputs to Ocean Systems (RIOS) and that as an initial step the IOC Secretariat compile an inventory of present national and international programmes of river discharge study and measurement, including the monitoring of river-borne pollutants.

3. That SCOR, in cooperation with other interested scientific groups, examine the possibility of designing critical experiments to evaluate the rate and extent of vertical transfer of materials across the pycnocline by phsyical and biological processes.

4. That SCOR and ACMRR, in cooperation with other interested scientific groups, evaluate further the concept and design of a comprehensive investigation into the dynamics of ecosystems in relation to pollution, identify the methodological problems, and propose programmes for its implementation.

5. That GESAMP consider how best to promote the international exchange of information on research into the survival and fate of pathogenic bacteria and viruses in the marine environment.

6. That SCOPE, in cooperation with SCOR and ACMRR, be invited to arrange for consultation, coordination and information exchange on studies of pollutant concentrations in natural deposits and in marine and other organisms held in museum and other collections, paying particular attention to possible contamination and changes in composition with preservation and storage.

7. That ACMRR elicit, evaluate and disseminate information on biological accumulators of pollutants and encourage their use in monitoring programmes.

8. That a joint SCOR-ACMRR working group be established to review the various aspects of design and methodology in monitoring the biological effects of pollutants, to evaluate the research required to perfect methods for application in monitoring programmes, and to recommend ways whereby this research can be expedited through international cooperation.

9. That IOC encourage and coordinate national and regional programmes for marine pollution present state (base line) studies, giving due attention to the improvement and intercalibration of analytical methods and training in their use, and the exchange and evaluation of data and other results and information.

10. That IOC arrange now for scientists engaged in national and regional studies on present levels and/or effects of marine pollution to combine their findings in a preliminary report on the "health of the ocean".

11. That GESAMP (1) propose initial criteria to be met from the point of view of the marine environment in establishing test programmes for evaluation of product toxicity, and (2) in consultation with ICES and other appropriate bodies, prepare an initial list of biological criteria to be satisfied before approvals for ocean dumping should be issued.

12. That IOC promote the organization of networks of cooperating laboratories concerned with marine problems, on regional and subject bases, for the exchange of information, improvement and intercalibration of methods, provision of analytical services and coordination of scientific effort, training and education. Regional networks should be developed within the context of regional cooperative investigations and regional organizations where these exist. In the

case of subject networks, high priority should be given to (a) laboratories concerned with determining the effects of pollutants on marine organisms, and (b) laboratories concerned with development and application of methods for determining chemical pollutants in sea water, marine organisms and sediments.

13. That IOC in the first place explore the possibility of developing in a suitable location an International Institute of Tropical Oceanography whose functions would include education and training, and marine research. The research effort should include present-state baseline studies of marine pollutants and related problems. It could also include the study of structure and process characteristic of coral reefs and lagoons, and of mangrove associations. Eventually, several laboratories of this character may be required.

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(1) member; (2) ex officio; (3) observer

ANNEX IX

REPORT OF MARINE GEOSCIENCE WORKSHOP HONOLULU 20-24 SEPTEMBER 1971

Introduction

At the SCOR Executive Meeting in Madrid in May 1971, it was decided that an international meeting should be held, before the convening of the 7th Session of the Intergovernmental Oceanographic Commission, of a group of experts who should exchange information on present knowledge and activities relating to the geoscience exercises proposed by GELTSPAP and the marine aspects of the Geodynamics Project and the IGCP, and who should prepare specific proposals for implementation of further cooperative investigations for consideration by the IOC and by National Committees of ICG.

Because of the Hawaiian Government's interest in oceanography, Hawaii being in a central position of the world's largest ocean, a kind invitation was issued by Dr. Craven, Dean of Ocean Science in Honolulu, for the small international group to meet in Hawaii in September. It was possible to collect a representative set of scientists from many countries and diverse earth science interests, although it is a pity that some invited members could not attend.

Although the meeting took place in the Pacific, its scope of activity was not confined to this single area of the world, and the comments on the GELTSPAP report which follow, together with the recommendations for specific international action during the International Decade of Oceanic Exploration (or in a shorter time as performed in GELTSPAP) set out in the main text and summarized in the conclusions, are of a world-wide nature, and should fulfill the desires of those people who wish to see active participation by countries of all sizes in the new style exploration of the sea-space of the earth.

Marine Geoscience is organized in the IUGS by their appointed Commission for Marine Geology which meets closely with the Commission for Marine Geophysics of IAPSO/IUGG. However, two other bodies are concerned with many fundamental aspects of the subject. They are the ICSU inter-union (IUGG/IUGS) Geodynamics Commission and the joint UNESCO/IUGS International Geological Correlation Programme. The workshop meeting in Hawaii, therefore, was designed to include the views of these activities so that SCOR could be usefully advised with a single voice which would include the scientific plans representative of those interested in the problems associated with the geology of the sea-covered portion of the world.

Much data collected by marine geoscientists is vitally important to the projects of the Commission for the Geological Map of the World (CGMW). Geological maps of the continents should show the geology of the adjacent sea-covered areas. Such widely differing techniques as deep-sea drilling and interpretation of magnetic anomaly patterns provide data essential for the ocean sheets of the Geologic World Atlas of CGMW.

The GELTSPAP report and its main proposals were taken as the basis of this set of comments and recommendations and we have used the same item numbers because most members of IOC will have used the GELTSPAP report for their present advice since the GELTSPAP report was a distillation of opinion set forth by previous meetings of experts whose reports have been commented on by IOC members. Specific schemes are presented for implementation gradually over the succeeding years. It was well understood by the workshop group that planning oceanographic expeditions cannot be done overnight and that long-term views were necessary. It was also a constant consideration that projects should be of a nature which would encourage cooperation between countries of all sizes and possessing facilities and skills of varying orders.

Where similar aims of the Geodynamics Commission and the IGCP have been considered, they have been welded into the GELTSPAP proposals so that individual countries will not be confused by similar proposals from different scientific bodies.

It has been made abundantly clear during the course of the meeting of international experts in the field of marine geoscience that, although short-term projects with foreseen specific results are of importance and are tempting to those who have limited resources, mankind will be best served in the long run by a continuation of the fundamental studies of the working of the earth. Our successors on this earth may have to take action to avoid world catastrophes, and they will not thank this generation if gathering of basic data about natural processes is neglected in favor of immediate gains.

The following report contains items which have been designed to encourage collaboration between peoples who have limited facilities and wide-ranging countries who account for most of the deep-water oceanographic studies, and although it is not the business of this group to comment on such matters as exchange of scientists and equipment and joint publications of results and exchange of collected data, these subjects have been considered in discussion.

Opportunity should be taken by geoscientists where possible to use ships whose primary function may not be geological or geophysical investigations. As an example, one project commended to SCOR for reconsideration is participation by geoscientists in the Global Atmospheric Tropical Experiment. This may provide opportunity to investigate in detail selected parts of the ocean floor from the continental margin of equatorial western Africa to the western side of the crest of the Mid-Atlantic Ridge. As an example there could be unparalleled opportunity for detailed

seismic reflection and refraction experiments. Investigations of such areas fall under exercises 4.2, 4.6, 4.7, 4.8 and 4.11. It could be an excellent opportunity for international cooperation. It could be considered as an opportunity for a substantial extension of the survey of the western continental margin of Africa already under way, so that geoscientists may take part and use expensive resources more profitably.

The text which follows contains many recommendations for establishment of working groups both for SCOR and IOC, and also many projects which will call for international cooperation. Following the main text is a short conclusion which stresses the few most important projects in the respect that they should be started as soon as possible; the other projects should logically follow in due course.

Exercise 4.1 International Morphologic Mapping of the Ocean Floor

Morphologic mapping of the sea floor as a whole is of the utmost importance in view of the immediate necessity for the results for application to scientific and practical problems. Among these are the detection, evaluation and exploitation of minerals and biological resources; tsunami studies and the emplacement and operation of marine engineering structures including cables; waste disposal; oil production, storage and delivery systems.

Among the parameters (morphology, various sediment and rock properties, upper sediment stratigraphy, for example) that of most widespread immediate interest is morphology.

The need for morphologic information, the consequent need for a rational system of accumulating the data and for using agreed units scales, projections and sheet boundaries and standard presentation of interpretations, makes international cooperation essential.

There are two important general aspects to be kept in mind. The first is that all interpretations of bathymetry made for marine science purposes need to be made by marine geoscientists. A critical presentation is only possible if comprehensive geological and geophysical data are used to aid interpretation. Secondly, the very substantial contribution that can be made to the acquisition of properly positioned data and to the cartographic process by hydrographic establishments, should be noted. Collaboration between both scientific and hydrographic groups is essential to progress in the production of useful results.

Any sounding data deliverately acquired to improve our knowledge of the sea floor will either be fall-out from a specific geologic study or should be planned with sounding lines spaced and oriented by marine geoscientists so as to obtain optimum information. The unselected simple filling of chart areas by NS or EW lines of soundings is not the desirable way to spend the very considerable sums of marine science money involved. The first priority for expenditure of such money must be an examination of very specific problems. One example of an area whose morphology would well repay intensive critical examination is the junction of the Pacific - Antarctic Indian - Antarctic and Macquarie - Balleny ridges.

We should note the very considerable value nevertheless of hydrographic surveys for navigational purposes already made and of random soundings, and welcome the continued input of such data. There is an urgent need to encourage marine geoscientists to make use of the data presently available.

One of the first priorities is to arrive at the projection; range of standard uniform scales; and delineation of sheet boundaries; so that individual efforts by scientists or scientific institutions, involved first in the world reconnaissance bathymetry and later in the interpretation of more adequately planned and positioned data, will be clearly contributions to an International Project. We urge that the present system be progressively replaced by the accumulation of digital data in standard format.

Bearing in mind the existence of a world sounding collection system on scales of $1:10^6$ operated through the International Hydrographic Bureau; the hope of producing the GEBCO series

of charts on a scale of $1:10^7$ and the existence of an IAPSO Commission concerned with this; the evident interest and collaboration of hydrographers in this problem as evidenced by the intended discussions to be held in August 1972 at Ottawa; we recommend (1) that SCOR set up a Working Group of marine geoscientists on which hydrographers are represented, to determine a rational scheme for reduction and presentation of sounding data that would constitute a framework in which the international geologic mapping of the sea floor could proceed; (2) that SCOR inform the International Cartography Association of the International Ocean Floor Morphology Working Group and take steps to ensure that the recommendations of this Working Group are taken into account at the ICA conference in Ottawa; (3) that SCOR transmit this present report to ICA and IHB; and (4) that marine geoscientists adopt one of the standard formats for presentation of their morphologic studies whenever these are appropriate to the problem they are studying.

Exercise 4.2 Geophysical and Geological Studies of Continental Margins

It is convenient to separate continental margins into those which are seismically active, including island arcs, and those which are at present inactive, since the methods which can be used to study these two types are often quite different. Nevertheless, there exists many scientific problems related to both types of continental margins: The dispersal of dissolved and suspended matter from the coast to the shelf and to the continental slope by wave and current action or by mass transport and the different rates of sedimentation need investigations together with physical and chemical oceanographers. The contributions of planktonic and benthonic organisms to bottom sediments must be investigated in association with marine biologists. A better knowledge of all these processes will help to explain not only depth and latitudinal zonation of sediments and organisms but will also give models for the formation and distribution of many contemporary and ancient syngenetic mineral deposits and for the environmental interpretation of many ancient sediments.

Only with this knowledge can we improve the stratigraphy of these regions and, together with investigations of the geology of adjoining land areas, elucidate the evolution of continental margins in the geologic time scale.

The economic importance of both types is well known from offshore mining as well as production of oil and gas, exploitation of construction materials, placers and phosphates. Shelf and upper slope morphology and sediment character, furthermore, has relations to bottom fisheries. Certainly new scientific results should improve economic benefits in all these regions.

Active Margins

Advances in our basic knowledge during the last decade have led to a working model which pictures the Earth's surface as being made up of a small number of very large lithospheric plates moving relative to each other. Along the active continental margins, these plates are considered to be converging and one of the most fundamental problems in the earth sciences is to establish the current movement patterns and to determine whether and how they are related to past movements during Cenozoic and Mesozoic time and to the geological features produced by these movements.

The forces which express themselves as movements and deformations, earthquakes and active volcanism may create major problems for the populations of these areas while in the past such activity has yielded extensive mineralization of significant economic interest. A deeper understanding of these forces and of the crustal materials on which they operate is of critical importance, not only for our understanding of the dynamics of the earth as a whole, but also for significant social and economic reasons. Solution of the problems of the active continental margins will require detailed multidisciplinary studies carried out both on land and at sea. These margins are located around the Pacific and along the Alpine - Himalayan mountain chain, and the ultimate goal of understanding the deformational history of the earth, particularly for the last 100 million years, will require full understanding of all of these areas. Initially, the basic character of the entire system should be established on a reconnaissance basis while detailed work is carried out

in special areas. Different parts of the system lend themselves particularly well to be extended to other parts. For example, the relation of volcanism to tectonics might be best studied initially in Central America, Kamchatka or Indonesia where active volcanism is common: studies of deep earthquakes in the Tonga-Fiji-Kermadec region or Japan where deep focus earthquakes are frequent and well located; the Nasca plate presents interesting possibilities since it is sufficiently small that all aspects of a single plate could be studied in a relatively short period of time; the Gulf of California area is a special case because of the intersection of the East Pacific rise with the continent and so forth. In regions where particular phenomena can be most easily examined, special efforts should be made.

Attention is called to the report of the Buenos Aires meeting on the Andean Geophysical Program and related geological and geophysical problems, since this meeting, attended by representatives of 12 Latin American countries and 9 other states, prepared many detailed presentations which are pertinent to the program under discussion.

The Interunion Commission on Geodynamics has organized working groups on the Western Pacific, the Eastern Pacific and the Alpine-Himalayan region who will prepare programs designed to improve our understanding of the active continental margins. Furthermore, many of the programs suggested by IGCP are relevant to the aims of this program and should be taken into consideration.

Recommendations

1. The overlapping interests of SCOR, IGC and other international or regional groups with regard to continental margins are such that close coordination will be required. We recommend that IOC request SCOR to keep in close communication with ICG so that maximum cooperation and minimum duplication can be achieved.

2. A particularly rewarding program could be developed in the southwest Pacific-Indonesian area in coordination with the program of small ocean basin studies recommended under Exercise 4.3 (Geological and Geophysical Studies of Mediterranean and Marginal Seas) and relevant ECAFE Projects. We recommend consideration by IOC, through SCOR and working group 1 of ICG, of a multidisciplinary coordinated program in this area.

Inactive Continental Margins

In the working model the continents are presumed to have been once joined into land masses which separated, creating along their rifted and subsequently submerged borders stable continental margins, characterized by the absence of volcanic and seismic activity. The major scientific problems associated with such continental margins are to establish the nature of the activity during the break-up of the continents, and the subsequent development of the submerged margins. This includes the relationships between the oceanic and continental crusts within the transition zone, the mechanism of crustal subsidence, and the development of sedimentary basins and thick deposits. These problems should be investigated on all stable continental margins, for example, the opposed continental margins bordering the Atlantic and the continental margins surrounding the Indian Ocean. Because of the size of the international cooperation effort required to study these problems, it is recommended that a particular area be chosen for an extensive multi-national program involving both reconnaissance and comprehensive investigations within such a region. The initial region recommended for such a cooperative study is the area of the Atlantic between Africa and South America (South Atlantic) which seems to offer the most favorable and least complex geological setting for solving the basic problems involved.

In addition, at the Conference on Solid Earth Problems, held in Buenos Aires in November 1970, a detailed report was prepared on planning coordinated geological and geophysical programs in South America and the adjacent offshore regions, which the group considers a significant contribution to regional investigation in the South Atlantic.

Intensive surveys are currently being carried out by several countries or groups of countries in certain parts of this area. The ICG in WG 8 recommends the South Atlantic as an area of

particular interest for studying the problems of structures common to oceans and continents (Walvis Ridge, Cameroon Fernando-Po volcanic chain, etc.). Also, the IGCP in Division 2, "Major geological events in time and space and their implications in environmental processes" recommends as a general problem: South Atlantic Ocean Margin correlations to perform collaboration between the different countries and the different programs. The investigations of these continental margins would best be pursued by wide international cooperation and with particular emphasis on participation by both developing and developed countries.

Recommendation

In view of the above, we recommend that the study of the South Atlantic Continental Margins be one of the major components of an international cooperative exercise on the South Atlantic and that there be created under IOC an international coordination group for this program.

Exercise 4.3 Geological and Geophysical Studies of Mediterranean and Marginal Seas

The group draws attention to the existing programs in the Mediterranean (CIM) and in the Caribbean (CICAR) Seas; also to the interest of the ICG in the Mediterranean (WG 3; Alpine - Mediterranean Study Group) and of IGCP in both the Mediterranean and Caribbean Seas.

The problems associated with the origin and development of marginal seas, particularly in the area of the Western Pacific, and their intimate relation to active island-arc systems, are among the foremost in understanding the dynamics of the earth. Also, because of the very significant social and economic consequences attached to geological phenomena within this region (see Geoscience Exercise 4.2), these problems warrant urgent and particular attention.

The geographical area of the southwestern Pacific (including Australia, New Guinea, New Zealand, Melanesia, part of Indonesia and the Philippines) offers a unique opportunity for the study of these problems, and lends itself to a multi-national program in the best interests of international cooperation.

Recommendations

1. We support the recommendation in 4.2 for an international cooperative study of the highly active island-arc systems of the southwestern Pacific under the sponsorship of the IOC and ICG. We point out that the study of the active island-arc systems in this area must include the marginal seas with which they are closely related, both geographically and geodynamically.

2. We recommend consideration by IOC (CIM), through SCOR, and in coordination with ICG and IGCP, of the organization of a symposium on the Mediterranean Sea during 1973, to report progress in the study of this area.

Exercise 4.4 Studies of the Fluvial Supply of Sedimentary Matter to the Sea and of its Longshore and Offshore Dispersal

Quantitative measurements of the transport of bottom load, suspended load and dissolved substances through river mouths, and of their sedimentation in nearshore waters, together with analyses of the composition of these materials are of great scientific importance, not only to marine geoscience, but also to chemical and biological oceanography. These investigations will be especially useful if they are carried out in many different parts of the world so that comparisons can be made between the situations in areas that differ in climate (artic to tropical, humid to arid), in hinterland morphology, in coastal and nearshore bottom topography, and in varying regimes of waves, currents and tidal range.

Such studies have also a great economic significance, for example, with respect to problems of pollution, and of coastal engineering (navigability, land reclamation, etc.).

Although work on river mouth monitoring is being done already by many countries, partly in the framework of the International Hydrological Decade and partly by coastal engineers, much more information can be gathered by applying also specific sedimentological methods and by extending the research to other countries.

International Cooperation

This is essential for the following reasons:

1. A world-wide scale of the investigations is desirable

2. Many of the largest river mouths are located in countries that so far have contributed little to studies of this kind

3. Several rivers supply sedimentary matter and dissolved substances, that come from different countries in the hinterland

4. Sedimentary material is transported, in numerous cases, along the coast from one country to the next

5. Several river mouths lie on the borders between different nations

6. The results of the research gain much in value if the methods used are standardized by international agreement

7. Because it is relatively cheap, this research can also be carried out by countries that can afford no great financial outlay. In this way these countries will be able to benefit from scientific contacts and technical help offered by other countries.

As a first step towards realizing this exercise we recommend the formation of a SCOR working group, in collaboration with UNESCO in the International Hydrological Decade and with the Commission for Marine Geology and other bodies, together covering the disciplines of sedimentology, coastal engineering, hydrology, physical oceanography, geochemistry and biology. Their task should comprise coordination of the investigations, standardization of the methods of research and organization, where necessary, of technical and scientific assistance.

Exercise 4.5 Deep Drilling at Key Sites in the Oceans

This project is of major importance for the understanding of the characteristics, history, and tectonic development of the floors of the deep oceans, mediterranean and marginal seas, and of continental margins. It will contribute enormously to the development of the concepts of sea floor spreading and plate tectonics and thereby significantly improve our understanding of continental, as well as oceanic, geology. It supplies the geological input to the interpretation of seismic and other geophysical data and furnishes samples for biostratigraphic, petrologic, sedimentological and geochemical research.

Practical Aspects

This project supplies direct information about mineral resources of the sea bed and may supply indirect information about continental resources through a better understanding of global tectonics. Benefits will also be derived from improvement of drilling technology in deep water.

Developing Countries

Participation by scientists from developing countries, in the field and in data interpretation, should be encouraged, both as support to the project and as a means of improving the scientific and technological capacities of the participating countries.

Relations to Other Projects

There is close relationship between this and the IGCP, and Geodynamics, 4.2, 4.3, 4.6, 4.7, 4.8 and 4.9.

Recommendations

We recommend that this project receive strong support from the Commission and that to the greatest extent possible, participation by other countries be encouraged to make this a multilateral project. Participation could be envisaged in two areas: (1) planning and execution of the drilling program itself, and (2) research on cores and synthesis of results. (1) The Commission might investigate ways by which other countries could join the U.S. in financing and directing the project, in selecting general areas, as well as specific sites for drilling, and in technological and scientific support of the operation. (2) In view of the importance of the drilling results to all aspects of marine geosciences, we recommend that UNESCO, SCOR, IUGG, IUGS assist in the organization of further symposia to allow rapid dissemination of the results and by assisting scientists from all countries to receive support for participation and in the study of the data.

Exercise 4.6 Studies of Active Ridge Crests and Active Fracture Zones

Studies of these regions of the earth are of fundamental importance because it is here that oceanic crust is generated. The crestal regions tell us what mechanisms operate now.

There are several fields for study which are likely to prove to be of basic importance. These include: petrology and mineralogy, together with associated studies of ore genesis, sulphides in the igneous rocks of ridge crests, and minerals in sediments of the Red Sea; anisotropy of seismic velocity in the mantle in relation to spreading directions; and variability of seismic velocity in the crust in different parts of the ridge crest.

Methods used in the past will continue to be important; precision sounding, gravity, magnetics, heat flow, seismics and seismology, and dredging. However, particular attention should be paid to methods used so far relatively little: for example, electrical conductivity measure - ments; ocean bottom seismometers; near bottom measurements; and drilling, to obtain precise petrological information.

Regional studies should focus upon ridges with different characteristics: slowly spreading, such as the Mid-Atlantic Ridge; fast spreading, such as the East Pacific Rise; and regions where the ridges connect with what is now land, such as Iceland and the Afar Triangle.

We recommend that a symposium with international participation on "the state of the art" be held in 1973 under the auspices of ICG.

Exercise 4.7 Paleo-Oceanography and Depositional History of Ocean Sediments

Scientific Aspects

Relations, on a geologic time scale, between the evolution of climate and ocean circulation and the sedimentological, micro-paleontological and geochemical properties of the sediments; determination of the rates and directions of fluctuations of oceanic and climatic phenomena on several time scales; a short time scale by means of varved sediments, and intermediate time scale through detailed study of the late Quaternary, and very long trends through studies of the Cenozoic evolution of oceanic circulation of the basis of deep-sea drilling cores; studies of input-output rates, and residence times of dissolved and suspended materials over long, medium and short time scales by similar but more geochemically oriented techniques; studies of the evolution of oceanic life in response to long term environmental changes of natural origin.

Practical Aspects

Establishment of the interrelation between ocean circulation and climate on long-term scales; determination of the period and nature of natural fluctuations of the ocean circulation and dependent climatic phenomena; establishment of the natural long-term response of the ocean to the input of suspended and dissolved materials; evaluation of the response of oceanic life communities to long-term environmental changes, as baselines for the evaluation of modifications induced by man and for very long-term forecasts.

Methods

Utilization of existing core collections and collection of long cores and deep-sea drill cores for sedimentological, micro-paleontological and geochemical studies with initial emphasis on the correlation between multiple environmental and sediment parameters and eventual construction of paleo-oceanographic maps for suitable time planes in relevant parts of the ocean basins; studies of stagnant basins and marginal seas should be included, and seismic reflection studies are important means for extending conclusions based on core data.

Recommendations

In view of (1) our conviction that this problem area represents a unique opportunity for a major advance of our knowledge of the evolution of the oceans; (2) the availability of large existing core collections including those of the Deep Sea Drilling Project; (3) the modest requirements for facilities, which permits participation from many countries, and (4) the close relationship with existing programs such as SCOR Working Group 37 on Marine Plankton and Sediments, and elements of the U.S. IDOE Program, and to the plans of the IGCP:

We recommend that a SCOR - CMG Working Group with appropriate participation by IGCP be established to develop a program for a Paleo-Oceanography Project by the following or other means:

(a) Organization of symposia in locations suitable to advance communications between scientists from already active countries with countries interested in participation

(b) Preparation of an inventory of available core collections and development of curatorial support necessary to facilitate their utilization

(c) Evaluation of requirements for additional core material

(d) Development of programs for exchange and training of scientists and for interaction with climatologists and physical and biological oceanographers

(e) Development of a master program to serve as a guide for the design of specific projects in participating countries.

This Working Group should remain active for a sufficient time past the planning stage to insure coordination and efficient utilization of core resources.

Exercise 4.8 Continuation of Magnetic Studies of the World Ocean

The hypotheses of seafloor spreading and plate tectonics have shown the great scientific importance of the magnetic anomalies of the world ocean. They are the basis for understanding the evolution of the sea floor and they relate to the tectonics of continents. We have to continue the investigation of magnetic anomalies. In order to accomplish the scientific goals of magnetic studies we recommend that special attention should be directed to the following points:

(1) Magnetic surveys should be planned according to the specific problems. Spacing of tracks, for example, need not be uniform.

(2) Patterns of magnetic anomalies in areas corresponding to pre-Cenozoic periods are of special scientific interest. Most of the western Pacific Ocean and parts of the Indian, Atlantic and Arctic Oceans are such areas and clues to their origin and history may be obtained by magnetic studies. These studies should be supplemented by age determination of basement by deep sea drilling (4.5).

(3) The magnetic quiet zones in continental margins are important because their origins are so far unknown. We note that in addition to the major examples from the Atlantic, other areas, e.g., the continental rise off South Australia and west of Norway, merit study.

(4) Anomalies of continental shelves and slopes especially of seismic margins also are important. The problem of their origin is not yet resolved.

(5) Detailed studies in areas of special interest related to magnetic properties of ocean floors. Areas such as seamounts with or without notable magnetic anomalies are of special interest for such studies.

(6) Magnetic stratigraphy of deep sea sediment cores and paleo-magnetic studies using oriented rocks from and below the sea floor. Development of techniques to orient deep sea drilling samples (4.5) is of great importance.

Marine magnetic investigations will be greatly advanced by cooperative surveys conducted in association with nations' hydrographic surveys.

Time correlation of magnetic anomaly patterns associated with sea floor spreading has provided a powerful input to the International Geological Correlation Program. Every effort should be made to extend the range of absolute age determination of these anomalies which at present have been dated for only the past four million years. Systematic mapping of spreading anomaly patterns essentially constitutes geologic mapping of sea floor basement age and tectonic events.

The studies described here are relevant to the Geodynamics Project and to Geosciences 4.1 and 4.2. International cooperation through exchange of data is vital. At present exchange of marine geophysical data through Data Centres is minimal. To avoid duplication and to make interpretative studies, data exchange must be made more efficient and rapid (see Appendix #1).

Exercise 4.9 Deep Sea Mineral Resources

Scientific Aspects

This problem area requires the cooperation of many disciplines in order to deal with the following aspects:

(a) the origin, composition and distribution of manganese nodules and crusts are related to physical and chemical interactions between sea water, interstitial water, sediments and sea floor rocks. The processes involved range from volcanic to microbiological;

(b) tectonic, sedimentologic, volcanic and morphologic relations are fundamental to achieve understanding of hot brine ores of the Red Sea type and the iron and trace element-rich oozes immediately overlying the basement in some oceanic rift and ridge flank localities;

(c) the role and origin of heavy metal ores, such as nickel, chromium, and copper that may be associated with the igneous activities of the rift areas requires further petrologic and tectonic examination.

Practical Aspects

A better understanding of the origin and better data of the distribution, and economic characteristics of these deep-sea mineral resources are necessary to obtain a more realistic evaluation

of their economic value and the conditions that may favor exploitation. Furthermore, technological advances in deep-sea dredging and other means of recovery must be developed.

Developing Countries

In certain areas, such as the Red Sea and Gulf of California, direct cooperation is essential; in general, cooperative efforts are desirable to achieve world-wide expertise regarding this international resource.

Relation to Other Programs

This project is closely related to items in the Geodynamics Program and to Exercises 4.6 and 4.5 (Ridge-Rift Studies and Deep Sea Drilling) of the GELTSPAP report.

Recommendations

We recommend that SCOR be requested to organize a symposium in 1973-4 to exchange ideas and data in this area. This Working Group should be composed of geochemists, mineralogists and geologists both from scientific institutions and industries and should include appropriate geophysical, physical, chemical and microbiological oceanographers.

Exercise 4.10 Investigations of Anomalous Oceanic Areas

Large portions of the ocean basins appear to be relatively uniform geologically and geophysically. The characteristics of these regions can be determined in a general way through reconnaissance cruises or by detailed examination of parts of broadly uniform areas. On the other hand, there are anomalous areas which require special attention. Foremost among these are the continental margins, island arcs and mid-ocean ridges which have been covered separately. The marginal seas are also anomalous but because of their significance have been treated in another section.

Anomalies may be manifested in the character of the crust, the age of the crustal rocks that may be inconsistent with surrounding age relationships and areas of topographic or structural prominence.

In the western Indian Ocean granitic rocks,characteristic of continents, have been found on small islands in the deep ocean, such as the Seychelles, leading to the interpretation that fragments of continental blocks have been isolated in our oceanic crustal regime after Gondwanaland broke up. These islands are commonly referred to as microcontinents. They are relatively rare in the oceans and should be studied in great detail in order to understand the cause and mechanism of formation and present relationships. Similar crustal blocks have been identified in the eastern Indian Ocean adjacent to the Australian continent.

The western Pacific north and east of New Guinea, including the Philippine Sea, appears to be an anomalously young area bordered by regions of significantly older crust. Although seismic investigations have revealed that the Philippine Sea is underlain by what is commonly termed "normal" oceanic crust, the Ontong-Java Plateau north and east of New Guinea is underlain by a thickened crust with what appears to be atypical seismic velocities. Further investigation of these areas would be of prime importance to the understanding of the major tectonic forces and crustal generation in the ocean basins.

Within the ocean basins are prominent ridges or lines of islands, submerged and subaereal, that may have formed as the lithosphere moved over a relatively stationary magma source referred to as a "hot spot". The investigation of these ridges may be important to the understanding of crustal motions in terms of direction and velocity and geochemical variations as a function of crustal velocity, thickness and depth to magma source. Some ridges are believed to be dormant or inactive spreading centers that may provide valuable data complementary to the above mentioned objectives.

Recommendations

Each of the examples of anomalous oceanic areas noted above may be investigated under other Geoscience Exercises listed in the GELTSPAP report. For example, the Indian Ocean micro-continent studies may be included in Exercises 4.2 and 4.5; the Philippine Sea and the area north and east of New Guinea in Exercises 4.2 and 4.3; the "hot spot" areas may effectively be studied under Exercise 4.5.

We recommend that careful consideration be given to the problems of these anomalous areas by those working groups of ICG, SCOR or other international bodies when planning programs.

Exercise 4.11 Geotraverses across Major Crustal Features and Land-Sea Geologic Traverses in Critical Areas

Geotraverses were strongly encouraged by the Upper Mantle Project supported by IOC and several integrated geological and geophysical studies were made along continental strips during UMP. The Upper Mantle Committee recommended to the Inter-Union Commission on Geodynamics that geotraverses be encouraged and ICG, in its initial recommendations noted that:

"Major effort should be devoted to systematic integrated surveys in selected areas, using geophysical, geochemical and geological techniques. They should be oriented toward those areas where specific problems need to be solved; and it may often be desirable not to restrict these surveys to uniform linear bands."

Very little has yet been done to carry out geotraverses at sea or to extend those carried out on land across the continental margins. In addition, little has been done to study in a detailed way structures which extend from the deep ocean onto the continental shelf or further onto the continent proper.

Systematic integrated surveys can greatly increase our understanding of the nature of continental margins and their relations to continents and oceans, to structures which appear to transect this margin, to specific portions of the mid-ocean ridges and to anomalous oceanic areas. Since these studies are complex and costly, it is of utmost importance that they be designed and justified on sound scientific, technical and economic grounds.

Recommendations

We support the concept of integrated, systematic geological and geophysical studies in critical areas and recommend:

(1) That these be designed to provide maximum benefit to other research efforts, such as discussed in Geoscience Exercises 4.2, 4.3, 4.6 or 4.10.

(2) That close attention be given to priorities so that those data which are most needed to carry out other programs are available at the earliest opportunity.

CONCLUSIONS

The group after having carefully considered the various recommendations on the 11 cooperative exercises in marine geoscience outlined in the GELTSPAP report concludes in recommending to the different organizations involved, to take immediate action on the following proposals:

1. The IOC is requested to set up two IOC International Coordination Groups for coopérative geoscientific investigations -- one in the South Atlantic (between Africa and South America); the other in the southwestern Pacific.

2. The IOC is further requested to continue at a later date the IIOE on specific geoscientific topics in special areas.

3. SCOR is requested to set up the following three working groups: (a) on paleo-oceanography (4.7); (b) on large river mouths (4.4); (c) on sea floor morphology (4.1). The working group on sea floor morphology should meet in June 1972 in order to enable it to report to ICA in Ottawa, August 1972. The working group on paleo-oceanography should not meet later than 1972 in order to get this important work started.

4. SCOR is further requested to organize, in collaboration with other organizations, three symposia: one on deep-sea drilling (4.5); one on mineral resources (4.9); and one on the Mediterranean (4.3). The second one should not meet before 1974; the Mediterranean should meet in 1973-74.

5. ICG is requested to organize a symposium on active ridge crests (4.6).

The group further states that a discussion on the priorities outlined in the GELTSPAP report did not take place, but the group feels that it expressed its feeling for the right order of priorities through its above recommendations.

The group further calls the attention of the IOC to the resolutions of the ICSU Panel on World Data Centers that a revised "Guide to International Data Exchange through the World Data Centers" should be issued by the Panel early in 1972. In view of the importance of profile data to geoscience and the short time available to prepare recommendations, it is recommended that the opinions outlined in Appendix #1 be drawn to the attention of the ICSU Panel.

APPENDIX 1
Exchange of Profile Data through a Data Centre

Exchange of continuous observations taken from ships and airplanes has been fundamental to our present understanding of the evolution of the oceans. Further progress will depend on interpretation of new observations in terms of data previously collected, and therefore, on an efficient procedure for exchange of such data. The problem of data exchange was discussed by the working group in Hawaii, and the statement below represents the views of the majority of the participants at this meeting. Much of the data is already in digital form, and can easily be exchanged. For various reasons it is unlikely that the data will be, in general, available unless the institutions who obtained the measurements have worked up and published the results, and unless the form in which they are asked to provide the data is convenient to them. Data which have been reduced for publication will be more reliable than data which has not been treated in this way, and institutions which obtained it are more likely to be prepared to part with it when they have published their interpretation. Furthermore, there will be an incentive to the institutions which took the observations to send the data to a centre after the paper has been published since they will at this time receive requests for the observations and can more easily satisfy such requests by sending one copy to the data centre rather than to each worker who individually asked. If unpublished data are supplied this should certainly be accepted, but the existence of a data centre should not be used to attempt to extract data which an institution is unwilling to provide; it should exist only to help those who wish to provide such data.

What forms of data are suitable and how should it be provided? Most observations at sea are taken while a ship is under way, and are recorded as time series. Such data are easy to exchange and we believe that at the beginning at least no effort should be made to attempt to include station data. This restriction means that only bathymetry, magnetics, gravity and reflection seismic records should be provided, together with the navigation as a time series of turning points. The data should preferably consist of total magnetic field, total gravity field, depth and navigation turning points, all measured with respect to time and provided in digital form. Reflection seismic records should be provided by photographic means together with the navigation turning points in digital form. The centre should be able to accept and supply data in several formats and forms to suit individual users, though it should provide a guide for suppliers and users. It should not attempt to impose sophisticated ideas of data handling and storage on marine geophysicists, to whom such sophistication is unnecessary at present.

The data would be available to any individual or institution who wished to apply for it, but since the initial problem would be to persuade the institutions which at present possess this data to part with it, it is essential that people closely concerned with data reduction at these places be involved in any proposed scheme.

A data centre which exists only to exchange data which is to be collected in the future, and will not deal with data which has already been collected will be useless for our purposes.

Identification of the sources of past data will be greatly facilitated by implementation of the CMG/UNESCO proposal for an inventory of data coverage.

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ANNEX X

THE FIRST GARP GLOBAL EXPERIMENT (FGGE): REQUIREMENTS FOR OBSERVATIONS FROM OCEANIC AREAS

The FGGE is currently being proposed for the period 1976/77, a time in which maximum satellite support is expected (according to the plans of the nations) that will help fulfill the data requirements. The emphasis in FGGE is on the larger-scale features (1000 km and larger) of the global circulation that may have a deterministic predictability of some tens of days.

One of the basic data requirements is for surface pressure at extra-tropical latitudes. These observations are available in the Northern Hemisphere from ships of opportunity. The merchant shipping in the Southern Hemisphere is too sparse, however, to fill more than a nominal part of this need. Hence, an alternate data source had to be developed. It was thought impractical to use buoys as the basic data source for the Southern Hemisphere, and a system has been developed to obtain nearly equivalent observations from constant-level balloons equipped with accurate radio altimeters ($\pm$ 10 meters at 12 km flight level) and pressure sensors. These observations, combined with satellite derived temperature profiles, will permit the derivation of surface pressure through the hydrostatic relationship. However, two factors make it highly desirable to supplement the balloon system with surface measurements (buoys). First, satellite observations will be frustrated in regions of persistant cloudiness; second, the pressure reference level at the surface contains more useful information than that derived from the balloons because in some dynamical conditions the latter will not accurately represent the mass structure. Moreover, the buoys will also supply the sea surface temperature which will not be obtained by the satellite in cloudy conditions.

In addition to these direct needs, it is recognized that realistic models of the atmospheric circulation must eventually account for the thermal structure of the upper oceanic layers as forecasting is extended beyond five or so days. Thus, a limited buoy network during FGGE will provide valuable experience in using oceanic data, especially if the temperature structure can be measured down to the seasonal thermocline.

Studies of cloud cover as seen by satellites are under way to provide a basis for proposing buoy distribution. It is not expected, however, that these studies will provide definitive results until about the end of 1973 at the earliest. It will be better to postpone actual decisions on buoy locations until 1974 when two years of data can be analysed, starting from the launch of the U.S. operational satellite ITOS-D in mid-1972.

The buoys that are being tested to serve as platforms for FGGE include discus hulls of diameters of about 2.0 m and weights of 230 kg and spar buoys (polypropylene pipe) of about 30-50 cm diameter, 5-7 m length and 100-200 kg. They will probably be used in a drifting mode, with a drogue so that they will measure subsurface currents. Their positions will be determined by satellite radio techniques and their observations collected and stored by the satellite for relay to a processing center. Their lifetime is expected to be about one year.

The major question concerning such buoys is deployment in the Southern Ocean (say, south of 40°S); they need not be recovered. It is hoped that use can be made of ships that resupply the Antarctic research stations and any research ships operating in the Southern Ocean to deploy the buoys on their regular journeys. It is thought that it may be feasible to supply about 100 buoys of this kind for deployment.

In the tropics, it has been determined from numerical simulation experiments of the proposed observing system for FGGE that direct wind observations are essential in the equatorial zone 10°N - 10°S at least during the two special observing periods of FGGE, lasting four to six weeks (or eight weeks, if possible), and separated by about six months. One possible way of obtaining these observations would be from ship stations. It is possible now to measure winds readily by using the Omega navigation VLF signals to track radiosonde balloons as they ascend. Omegasonde systems are now in pilot operation and should be in routine operation by 1974. The equipment can be put on any kind of ship large enough to maintain an open sea station for four to six weeks. It is estimated that to meet FGGE requirements a minimum of about 30 ships will be needed to fill part of the data requirements in the equatorial zone. There are alternate methods to obtain the needed observations but the ship station concept has one important advantage in the spirit of GARP: almost any marine nation can offer a ship on which the omegasonde equipment can be installed for the duration of the experiment.

S. Ruttenberg, JPS GARP, 11 Jan. 72

ANNEX XI

SATELLITE-RELATED OBSERVING TECHNIQUES UNDER DISCUSSION IN COSPAR

COSPAR WG 6, "Application of Space Techniques to Meteorology and Earth Surveys" has been studying the feasibility of various remote-sensing and data relay possibilities to meet the observational requirements for the Global Atmospheric Research Programme (GARP), in particular the First GARP Global Experiment. This work has recently been extended to a broader area of geophysical and biological applications under the name of "earth surveys". Investigations are also underway with regard to establishing the technical potential and limitations for space-based techniques to the detection and monitoring of pollutants, both atmospheric and oceanic.

The relationship between COSPAR WG 6 and the planning of the GARP experiments has been fruitful in large part owing to the fact that the GARP experiments have specific observational requirements (parameters needed and the spatial, temporal and accuracy characteristics), against which technology could be measured in terms of ability to provide these observations in a feasible manner. In some cases, requirements were stated that could not be met by existing techniques or even by those under development and such a situation stimulated the creation of new appropriate techniques. In other cases, alternate means of obtaining data or even alternate parameters were suggested for consideration by the users. In this way a useful dialogue was established between suppliers and users of observations and after several iterations there came into focus a feasible observing system for FGGE, consisting of many components each tailored to meet specific needs and which in the aggregate will provide information required for the experiment. Perhaps it may be said that this effective collaboration between suppliers and users of meteorological information was particularly successful because those working on the development of new technology were in the main also scientists and users of data, and therefore, much interested in the solution of meteorological problems.

Nevertheless, COSPAR WG 6 believes that the nature of the dialogue in the GARP planning efforts may be useful in other geophysical areas and is now exploring with other appropriate discipline groups, such as SCOR, how space techniques may be used or be developed for use in connection with various research problems. As a means of starting this dialogue, a very brief summary is given here of techniques that may have application to some problems in oceanographic research.

1. Observations from Polar Orbiting Satellites

For technical reasons, US "Polar orbiting" satellites are generally placed in a retrograde orbit (inclination about 100°) such that they pass over a given point on the earth at the same local time day and night. Their altitude is generally in the range of 1000 km. Detector technology has improved to the point where acceptable signal-to-noise ratio is obtained for even rather small

fields of view and spectral bandwidth. Almost any portion of the electromagnetic spectrum can be observed with almost any range of bandwidth, field of view, and scanning capability. The main problem in designing systems for remote-sensing is one of choosing the appropriate spectral intervals; a major problem in utilizing the measured radiances (which have accuracies of the order of 1% or better) is constructing a physical interpretation model.

Current research and operational satellites have been limited to cloud and surface imaging and spectroradiometers with rather coarse resolution. In addition, use of vidicon imaging systems and analogue recording of images and radiances has resulted in a serious degradation of signal-to-noise ratio. A new family of operational satellites will be implemented in 1972 in which all the imaging will be accomplished by improved radiometric detectors and in which some improvements will be made in the on-board storage.

A further improvement in systems is expected in the mid-1970's, when even more advanced detectors will be used and probably full-digital recording will reduce the system noise to a minimum. At that time it may be expected to have the following types of observations:

(i) Cloud cover, snow and ice cover where appropriate, with a lineal resolution of about 1 km in the visible and window region of the near infrared. Full lineal resolution will be available only for limited portions of each orbit owing to limitations of on-board storage, but the high resolution observations will be broadcasted continually via the APT mode and thus be readily available locally.

(ii) Temperature and moisture soundings in regions of clear sky or part cloudiness. These in themselves are probably not of direct oceanographic interest, but are needed to process the high-resolution IR data for the determination of sea surface temperature. Such observations will make it possible, for example, to derive surface temperatures to about 1°C absolute. The system noise and the sensitivity of the various corrections to variability will be such that relative accuracies of about 0.5°C may be expected. In some particularly favourable cases, sensitivity to variations may be a factor of two higher. High resolution mapping of sea surface temperature should be possible with the observing systems of the mid-1970's.

The Polar orbiting satellites by the mid-1970's are also expected to include a radio location and data relay system capable of accommodating some 1000 remote platforms. Location of drifting buoys should be possible to within 1-2 km, two to four times a day at low latitudes and every two hours at mid and high latitudes. About ten channels of data can be relayed; however, it may turn out to be feasible to commutate channels on the buoy and provide twice that number of data channels. Each data channel can accommodate about 100 bits of information. The design of the platform electronics calls for a power of several watts at UHF, and the cost of the package (less sensors) is estimated to be about $1000. A large-scale test of this system will take place in 1974 in conjunction with the Nimbus-F satellite; the experiment is planned to test the large-scale use of constant-level balloons but it is hoped that at least 10 and perhaps many more simple buoys will also be used.

Currently, a similar test is underway by French scientists, using the EOLE satellite. Some 10 buoys will be emplaced in January in the mid-north Pacific and tracked from the satellite. They will have a drogue set at one hundred meters or so, so that sub-surface currents will be measured, along with water temperatures from the surface down to the drogue. An additional set of 10 buoys will be deployed in the Atlantic in February.

2. Observations from Geostationary Satellites

The first operational geostationary satellites will be launched in 1972. There appears to be good expectation that by 1976/77 there will be four such satellites, approximately equally spaced around the Equator, so as to give full zonal coverage. The capability of such satellites of direct interest to oceanography will be data relay. Provision is being made for the U.S. and Japanese satellites to have considerable relay capability on UHF (about 10,000 interrogated

communications per day per satellite). The proposed European satellite will have more limited capability, on S-band.

The basic observing capability of the geostationary satellites will be high resolution imaging in the visible (linear resolution of the order of 2-3 km) and infrared (resolution 5-10 km). The satellites will provide one complete picture of the earth's disc, every 20 minutes (30 minutes for the European satellite). The images will be synchronized and accurately gridded (or rectified) at specialized processing centres and made available in the high resolution form (about 1×10^9 bits) only to a few locations where data processing and further image manipulation will take place. Lower resolution forms of the images will be available more widely. Two kinds of information will be available from these efforts of possible interest here:

(i) Winds at a low level (about 1500 m). Well defined wind fields in the zone $\pm$ 30° about the Equator are expected to be derived on a routine basis, twice a day. Since the wind field at a low level (the fair weather cumulus zone) may be related to some behavior of the ocean surface layer, these observations may be of importance for some oceanographic studies.

(ii) Observation of the sunglint. Work at the University of Wisconsin shows that with intensive analysis, the sunglint information can be used to derive information on the wind stress (magnitude and direction) at the sea surface.

In addition, the nearly continuous observation of the cloud patterns show up dynamic atmospheric features that may have strong effects on the upper layers of the oceans. Hurricanes and typhoons come to mind but there are other manifestations of strong atmospheric circulations that may either arise from oceanographic influence or that may couple enough momentum or energy in the oceanic surface layers to be of significance.

3. Earth Survey Satellites

The U.S. Earth Resources Technology Satellite (ERTS) program will be initiated circa 1973/74. These satellites will have imaging capability in a number of spectral intervals and will provide an opportunity for exploring the possible use of such information in a variety of disciplines. Plans are indefinite at this time as to the exact nature of the continuing series of US geophysical research satellites but it is expected that opportunities will continue to be available for experiments and observing systems designed to meet specific objectives. The USSR Cosmos research satellite series is expected to continue and provide opportunities for special observations, and the Federal Republic of Germany is planning a satellite circa 1976 for geophysical observations.

4. COSPAR Symposium on the Application of Space Techniques to Problems in Earth Surveys, 1973

COSPAR WG 6 is beginning to organise an interdiscipline symposium for the 1973 general assembly (probably to be held in Europe). Appropriate unions and committees of ICSU and other international scientific groups are being invited to collaborate by nominating one or two speakers to give a brief review of work in their respective disciplines using space-related techniques, and to discuss some problem areas of current interest to which as yet untested or even undeveloped space-related techniques may possible be applied. COSPAR on its side will nominate several speakers to review the current status of space technology that may be of interest to the disciplines and make some projections giving an idea of planned and possible future developments.

COSPAR sincerely hopes that SCOR will be interested to collaborate in participating in such a symposium.

S. Ruttenberg, COSPAR, 10 Jan. 72

FUTURE MEETINGS OF SCOR AND ASSOCIATED ORGANIZATIONS, 1972

28 February - 3 March	London	IMCO, 12th Ses. Sub-Comm. Marine Pollution
28 February - 31 March	New York	UN Comm.Peaceful Uses Sea Bed etc.
6 - 10 March	Geneva	GESAMP, 4th Ses.
6 - 10 March	Manila	IOC Int. Coord. Grp. CSK, 8th Ses.
6 - 17 March	New York	UN Conf. Human Environ. Prep. Comm.
6 - 17 March	Plymouth	SCOR WG 29 Monitoring in Biological Oceanography
13 - 17 March	Geneva	IOC/WMO Grp. Exp. IGOSS, Technical Systems Design and Development and Service Requirements
14 - 16 March	London	SCIBP Bureau and Section Conveners
16 - 17 March	London	ECOR 1st Gen.Assem.
16 - 18 March	London	SCOPE Bureau and 4th Meet.
6 - 13 April	Rome	FAO Committee on Fisheries, 7th Ses.
11 - 22 April	Monaco	International Hydrographic Conf., 10th
17 - 21 April	London	IUTAM/ITTC Symp. Directional Stability and Control of Bodies Moving in Water
2 - 4 May	Lund	ICES/SCOR Joint WG Baltic Pollution
8 - 12 May	Tokyo	IOC Int. Coord.Grp. Tsunami Warning System in Pacific, 3rd Ses.
15 - 24 May	Madrid	COSPAR XV Meet. and Symp.
22 - 26 May	Pallanza	SCIBP Meet. on Detritus and its Role in Aquatic Ecosystems
5 - 16 June	Stockholm	UN Conf. on Human Environment
12 - 16 June	London	IMCO, 13th Ses. Sub-Comm. Marine Pollution
19 - 23 June	Copenhagen	IAPSO Symp. Optics of the Sea
20 - 23 June	Paris	IOC Grp. Exp. Oceanogr. Res. rel.IGOSS, 3rd Ses.
23 - 25 June	Copenhagen	SCOR WG 15 Photosynthetic Radiant Energy
26 - 30 June	Paris	IOC/WMO Planning Grp.for IGOSS, 1st Ses.
27 June - 3 July	Malta	Pacem in Maribus III
3 - 8 July	Hamburg	IOC Exec. Council, 1st Ses.

4 - 7 July	Aarhus	ICES Symp. Phys.Proc. responsible for Dispersal Pollutants with special reference Nearshore Zone
10 - 14 July	Seattle	IAEA Symp. Interaction Radioactive Contaminants with Constituents Marine Environment
13 - 18 July	Bath	SCOR WG 23 Zooplankton Lab. Meth., Workshop
17 July - 18 August	Geneva	UN Comm. Peaceful Uses Sea Bed etc.
7 - 9 August	Canberra	SCAR, XII Meet. and WG's
10 - 17 August	Montreal	IGU, 22nd Internat.Geogr.Congr., 13th Gen.Assy.
21 August - 1 September	Montreal	IUGS, 24th Internat.Geol.Congr., 13th Gen.Assy.
22 August - 10 September	Woods Hole	SCOR WG 21 Continuous Current Velocity Measurements, sea trials
12 - 20 September	Edinburgh	Internat.Congr.Hist.Oceanogr., 2nd; Challenger Exped. Centenary Celebr.
14 - 20 September	Helsinki	ICSU, Exec.,Extraord. Gen.Assy.,14th Gen.Assy.
21 - 23 September	Oban	SCOR, 11th Gen.Meet.
25 September - 4 October	Copenhagen	ICES 60th Statutory Meet.
25 September - 4 October	Copenhagen	IOC Joint Coord.Grp. Systematic Studies North Atlantic
30 September - 7 October	Seattle	SCIBP, 5th Gen.Assy. and Symp.
? September	Monaco	SCIBP Symp.Biol.Effects Inter-Ocean Canals
3 - 9 October	Tokyo	WMO Tech.Conf.Acquisition Ocean Data
4 - 7 October	Paris	CNRS/CNEXO Colloq. Processes of Formation of Oceanic Deep Water, in Particular in the western Mediterranean
9 - 10 October	Paris	IAPSO Symp. Phys.Oceanogr. Red Sea
3 - 11 November	Athens	ICSEM 23rd Congr., Plenary Assy.
4 - 8 December	London	IMCO, 14th Ses. Sub-Comm. Marine Pollution

PUBLICATIONS IN 1971 FROM SCOR ACTIVITIES

1. Funnell, B.M. and W.R. Riedel (Editors). 1971. The Micropaleontology of Oceans. Cambridge University Press. (Proceedings of the SCOR Symposium on Micropaleontology of Marine Sediments held in Cambridge in September 1967).

2. Report of the Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment, Rome, 4 - 10 December 1970. FAO Fish. Rep., No. 99, Suppl. 1, Pub. August 1971. (SCOR was a sponsor of this seminar).

3. A discussion on the petrology of igneous and metamorphic rocks from the ocean floor. Phil. Trans. Royal Society London, vol. 268, no. 1192, pages 381 - 750, 1971. (SCOR was a sponsor of this discussion).

4. Delany, F.M. (Editor) 1971. The Geology of the East Atlantic Continental Margin. 1. General and Economic Papers (Rep. 70/13). 2. Europe (Rep. 70/14). 3. Europe (Rep. 70/15). 4. Africa (Rep. 70/16). (Papers presented at the SCOR WG 31 Symposium held in Cambridge in March 1970).

5. Anon. 1971. Histoire structurale du golfe de Gascogne. Pub. de l'Institut Francais du Petrole. 2 vols. (Papers of a Symposium on Structural History of the Bay of Biscay held in Rueil-Malmaison, France, in December 1970; SCOR was a sponsor of the symposium).

6. Report of the ACMRR/SCOR/ACOMR/GESAMP Joint Working Party on Global Investigation of Pollution in the Marine Environment, San Marco di Castellabate and Rome, Italy, 11 - 18 October 1971. FAO Fisheries Reports, No. 112. (SCOR WG 39).

7. Wyrtki, K. (Editor). 1971. Oceanographic Atlas of the International Indian Ocean Expedition. National Science Foundation, Washington. (Report of an expedition organized and coordinated by SCOR).

ABBREVIATIONS

ACMRR	Advisory Committee on Marine Resources Research (of FAO)
ACOMR	Advisory Committee on Oceanic Meteorological Research (of WMO)
AMTEX	Air Mass Transformation Experiment (of GARP)
APT	Automatic Picture Transmission
CGMW	Commission for the Geological Map of the World
CICAR	Cooperative Investigation of the Caribbean and Adjacent Regions
CIM	Cooperative Investigation of the Mediterranean
CINECA	Cooperative Investigation of the Northern Part of the Eastern Central Atlantic
CMG	Commission on Marine Geology (of IUGS)
CMM	Commission for Maritime Meteorology (of WMO)
CNEXO	Centre National pour l'Exploitation des Oceans (France)
CNRS	Centre National de la Recherche Scientifique (France)
COSPAR	Committee on Space Research (of ICSU)
CSK	Cooperative Study of the Kuroshio and Adjacent Regions
CUE	Coastal Upwelling Experiment
DHI	Deutsches Hydrographisches Institut (Hamburg)
ECAFE	Economic Commission for Africa and the Far East
ECOR	Engineering Committee on Oceanic Resources
ERTS	Earth Resources Technology Satellite
ESSA	Environmental Science Services Administration (USA)
GARP	Global Atmospheric Research Program (of WMO/ICSU)
GATE	GARP Atlantic Tropical Experiment
GEBCO	General Bathymetric Chart of the Oceans
GELTSPAP	Group of Experts on Long Term Scientific Policy and Planning
GESAMP	Group of Experts on Scientific Aspects of Marine Pollution
GIPME	Global Investigation of Pollution in the Marine Environment
IABO	International Association for Biological Oceanography (of IUBS)
IAMAP	International Association of Meteorology and Atmospheric Physics (of IUGG)
IAPSO	International Association for the Physical Sciences of the Ocean (of IUGG)
IBP/PM	International Biological Programme/Productivity Marine
ICA	International Cartographic Association (of IGU)
ICES	International Council for the Exploration of the Sea
ICG	Inter-Union Commission on Geodynamics (of IUGG/IUGS)
ICNAF	International Commission for the Northwestern Atlantic Fisheries
ICSEM	International Commission for the Scientific Exploration of the Mediterranean
IDOE	International Decade of Ocean Exploration
IGCP	International Geological Correlation Program
IGOSS	Integrated Global Ocean Station System
IGPP	Institute of Geophysics and Planetary Physics (La Jolla)
IGS	Institute of Geological Sciences (UK)
IGU	International Geographical Union (of ICSU)
IHB/IHO	International Hydrographic Bureau/International Hydrographic Organization
IIOE	International Indian Ocean Expedition
IOC	Intergovernmental Oceanographic Commission
IPGH	Instituto Panamericano de Geografia Historia
IUBS	International Union of Biological Sciences (of ICSU)
IUGG	International Union of Geodesy and Geophysics (of ICSU)
IUGS	International Union of Geological Sciences (of ICSU)
IUTAM	International Union of Theoretical and Applied Mechanics (of ICSU)
JOC/JPS	Joint Organizing Committee/Joint Planning Staff (of GARP)
LEPOR	Long-Term and Expanded Program of Oceanic Research
MODE	Mid-Ocean Dynamics Experiment
NIO	National Institute of Oceanography (UK)
NOAA	National Oceanic and Atmospheric Administration (USA)
NODC	National Oceanographic Data Center (USA)
NOS	National Ocean Survey (of NOAA)
OECD	Organization for Economic Cooperation and Development
ROSCOP	Report of Observation/Samples Collected by Oceanographic Programs
SCAR	Scientific Committee on Antarctic Research (of ICSU)
SCIBP	Special Committee for International Biological Programme
SCOPE	Scientific Committee on Problems of the Environment (of ICSU)
UMC/UMP	Upper Mantle Committee/Upper Mantle Project
WDC	World Data Center
WWW	World Weather Watch (of WMO)