**Intergovernmental Oceanographic Commission**

Workshop Report No. 134

# IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum)

Shanghai, China
27-29 May 1997

**UNESCO**

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## SUMMARY REPORT

The IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping on the Holocene Optimum was held in Shanghai on 27-29 May, 1997. Some 10 experts from the WESTPAC countries were present at the Workshop and the representatives from the secretariats of IOC/WESTPAC region and CCOP also attended the Workshop.

The aim of the Workshop was to commence the compilation of a paleogeographic and paleo-oceanographic map for the entire Western Pacific from pole to pole during the Holocene Optimum. The Holocene Optimum, around 6,000 ± 1,000 years ago, was a period of generally warmer and wetter climate and higher sea level than today, and as such is a good model for future study on global change. Apart from testing climatic models, the map is also useful in environmental and resource studies - in particular the impact of rising sea level on the coastal plains of Asia where most of the region's population live and most of the food is produced.

The Workshop decided that products similar to Last Glacial Maximum (LGM) map be published for the Holocene Optimum, but hard copy will be restricted only to the coloured paleogeographic map and the text. The data maps, detailed case studies, databases of control sites and dated samples will be made available in digital format on a CD-ROM. The participants agreed on the time slice to be mapped (6,000 ± 1,000 years ago), the scale (1:10,000,000), the legend and the format of the maps, as well as the structure of the data tables. A timetable for the compilation of the map was also agreed on, taking into account that several countries had already made good progress towards constructing maps under their responsibility. It was recommended the final compilation Workshop prior to the publication of the Holocene Optimum map be held in the second half of 1998 and publication of the map be scheduled in 1999 both in hard copy and on CD-ROM.

The meeting also decided to expand the scope of participation of countries in the paleogeographic mapping project by involving representatives from Cambodia, Vietnam, the Philippines, Papua New Guinea and New Zealand.

## 1. INTRODUCTION

The IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping was held in Shanghai, 27-29 May 1997. Experts from Australia, China, Indonesia, Japan, Korea, Malaysia and Russia, as well as the representatives from the secretariats of IOC Sub-Commission for the Western Pacific (WESTPAC) and the Co-ordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia (CCOP) attended the Workshop. The expert from Thailand was unable to be present, but sent his contribution to the Project Leader. The Workshop was very successful in the number of participants brought together, including the participation for the first time by representatives from the Republic of Korea and the Russian Far East, as well as from CCOP which co-sponsored the Workshop. A Programme of the Workshop is attached as Annex I. The List of Participants is attached as Annex II.

At the final compilation Workshop on the Last Glacial Maximum (LGM) map, in Bali, November 1994, it was decided that the next map to be produced would be for the Holocene Optimum. This period was chosen because of its relevance to global change studies and the availability of better data sets than older periods.

The Holocene Optimum paleogeographic map is a follow - up to the first phase of IOC/WESTPAC Project on Paleogeographic Map. Its main objectives are to produce maps of the WESTPAC region that could serve the need of resource and environmental studies, foster co-operation between member countries and establish and maintain a vital network of geoscience researchers. The paleogeographic map in itself is a unifying image, showing the entire WESTPAC Region at one time in the past.

As a result of the first phase of the Project, a map from pole to pole in the western Pacific region for the last Glacial Maximum (LGM), some 20,000 to 15,000 years ago was published in 1995. The LGM map includes a coloured paleogeographic map, data maps, a text and a database of control sites. It shows that the sea level during the LGM was more than 100 m lower than that of today and climate colder and drier.

The goal of the present Workshop is to compile preliminary data on paleogeography of the Holocene Optimum, roughly 6,000 years BP for the entire WESTPAC region. Prior to the Shanghai Workshop, Professor Wang Pinxian, Co- Project Leader, sent a data package (Annex III) to the participants listing the items that they were requested to bring to the Workshop.

## 2. OPENING

Dr. Marita Bradshaw, Co-Project Leader, opened the Workshop by welcoming all participants and thanking the host, Tongji University, for its hospitality. She also thanked the IOC/WESTPAC and CCOP for their financial and technical support to the Workshop. Professor Ma Zaitien, Member of the Chinese Academy of Sciences, Chairman of Scientific Committee, SEC Laboratory of Marine Geology, and Professor Zhou Zuyi, Vice-Chairman, Department of Marine Geology and Geophysics, Tongji University, also delivered welcoming speeches on behalf of the host. Tongji University was then celebrating its 90th anniversary since 1907. Being one of 35 key universities in China, it focuses on science and technology, including marine geosciences. The motto of Tongji University - "People in the Same Boat Help Each Other"- is very pertinent to the paleogeographic mapping project, including the Workshop in that the spirit of co-operation enshrined in the motto is well materialized in the Project which aims to promote cooperation among WESTPAC countries.

Mr.Jiang Yihang from the IOC/WESTPAC Secretariat in Bangkok, addressed the meeting on behalf of Dr. Gunnar Kullenberg, the Executive Secretary IOC. He complimented the publication of the Last Glacial Maximum map and supported the shift of focus of the Project on compilation and publication of the Holocene Optimum map, the result of which will be of particular relevance to climate change and sea- level rise studies. He expressed his appreciation to CCOP for its co-sponsorship of the Workshop and extended welcome to its representative.

Professor Hideo Kagami, the Co-ordinator of the IOC/WESTPAC Programme on Ocean Sciences in Relation to Non-Living Resources, of which the paleogeographic mapping project forms a part, briefed the meeting on the latest development of the programme. He also informed the Workshop that the 4th IOC/WESTPAC Scientific Symposium will be held in Okinawa, Japan, 2-7 February 1998, and encouraged the experts attending the Workshop to actively participate in the Symposium.

Dr. Bert Van der Valk , the representative of CCOP provided information on the structure, programmes and objectives of his organization. At present, CCOP's Member Countries include Cambodia, China, Indonesia, Japan, Republic of Korea, Papua New Guinea, the Philippines, Singapore, Thailand and Vietnam, with Australia, Belgium, Canada, Denmark, France, Germany, Japan, the Netherlands, Norway, the Russian Federation, Sweden, Switzerland, the United Kingdom and the United States of America as Co-operating Countries. "COASTPLAN" represents one of CCOP's core projects aiming at increasing the use of geoscience in integrated coastal zone management (ICZM). CCOP is also carrying out three case studies, respectively in Yellow River Delta in China, Jakarta Bay in Indonesia and Lae in Papua New Guinea. It also provides training workshops in geosciences. CCOP considers paleogeographic mapping as the culmination and integration of a great variety of geoscience information, and is therefore pleased to co-sponsor with the WESTPAC Sub-Commission the Holocene Optimum paleogeographic mapping project. It is also interested in the application of paleogeographic maps in the coastal zone research and management, and will help promote the participation of more countries in the Project.

## 3. PRESENTATION OF COUNTRY REPORTS

Following these opening remarks, Professor Wang, the Co-Project Leader, outlined the aims of the Workshop and the detailed scientific questions to be considered (Annex IV). Though there were some debates on the definition of the Holocene Optimum in terms of its exact temporal coverage, participants agreed that data compilation be focused on the period around 6,000 ± 1,000 years ago. Despite the experience gained in the compilation and publication of the Last Glacial Maximum (LGM) map, the preparation of Holocene Optimum map presents a new set of challenges. The change in shoreline between then and now is so minor (a few metres compared to over 100 m for the LGM) that smaller scale mapping will be required. Holocene provides much more data to be compiled with better resolution in terms of time and space. However, since the shoreline for the Holocene Optimum is already onshore and close to the present coastline, all countries in the WESTPAC region may potentially contribute useful data. The Holocene Optimum study has more direct impact on humanity in the densely populated coastal plains of the WESTPAC region. It is a good analogue of the warmer world with an elevated sea level predicted for the 21st century.

Experts attending the Workshop then presented their national reports, including the respective research work and data available in their countries. The national reports are presented in Annex V.

## 4. DISCUSSION

Professor Wang chaired the general discussion following the country presentations and summarized the key points (Annex VI). It was agreed that existing data on the Holocene Optimum be compiled - recording key sites, dates and literature so that current status of knowledge be captured, rather than to carry out new research. It was recognised that the climatic optimum is not equal to the highest sea level which in turn, is not equal to the maximum transgression. There is a lag between climate change and the sea level change. The sea level and shoreline positions are influenced by isostatic, tectonic, oceanographic and sediment balance effects. It was decided that the period around 6,000 years BP ± 1,000 years as an approximation for the Holocene Optimum be used in compilation and mapping.

The meeting confirmed that the quality of the data available for the Holocene Optimum is variable throughout the WESTPAC region and that small scale mapping will be required to capture changes in the shoreline. GIS and CD-ROM technology were seen as means to overcome these problems and capture the data at the most suitable scales and also to store a much larger volume of data than was compiled for the LGM map. The meeting proposed to include case studies at selected sites as insets on the main map to be published as well as on CD-ROM.

One of the key points considered by the Workshop was the expansion of the scope of participation to involve more countries in the Project. The Project would benefit from the involvement of Vietnam, Cambodia, the Philippines, PNG, New Zealand and other Southwest Pacific countries. A Cambodian representative had been identified but was unable to attend the Workshop. It was noted that one participant of the Workshop, Dr. Shinji Tsukawaki, has worked extensively in Cambodia on the Tongle Sap and his experience would be useful for the Project. In addition, the networks established by CCOP and IOC/WESTPAC will be helpful in identifying representatives in other countries.

Other key studies of relevance to the Holocene Optimum mapping were identified, including the Atlas of paleoclimates and paleoenvironments of the northern hemisphere for Late Pleistocene - Holocene , the global pollen map for 6,000 years BP ± 500 years currently in preparation, and the FAO coastal plains soil map, in which edge of the Holocene transgression is given.

## 5. RECOMMENDATIONS

It was recommended that the final compilation Workshop will be held in the second half of 1998 and the map published in 1999. The format of the map will be a hard copy of the paleogeographic map with insets, coloured, at 1:10,000,000 scale using the circum-Pacific map based on Lambert Azimuthal Equal Area Projection as for the LGM supported by an explanatory text also in hard copy. The data maps, tables of sites, tables of dating and references will be stored on CD-ROM. Special efforts will be directed towards getting participants from other countries of the region in the Project. A list summarizing all recommendations of the meeting is provided in Annex VII.

ANNEX I

## PROGRAMME OF THE WORKSHOP

**Tuesday, 27 May**

| | |
|---|---|
| 8:30 - 9:30 | Opening session |
| 9:30 - 10:00 | Coffee break |
| 10:00 - 12:00 | Presentations by member countries |
| 12:00 - 13:30 | Lunch |
| 13:30 - 15:00 | Touring the Tongji University campus |
| 15:00 - 17:30 | Presentations by member countries |
| 18:30 | Welcome party |

**Wednesday, 28 May**

| | |
|---|---|
| 8:30 - 10:00 | Discussions |
| 10:00 - 10:30 | Coffee break |
| 10:30 - 12:00 | Discussions |
| 12:00 - 13:30 | Lunch |
| 13:30 - 15:00 | Discussions |
| 15:00 - 15:30 | Coffee break |
| 15:30 - 17:00 | Discussions |

**Thursday, 29 May**

| | |
|---|---|
| 8:30 - 16:30 | Field tour |
| 17:00 - 18:00 | Closing Session |

ANNEX II

# LIST OF PARTICIPANTS

## I. EXPERTS

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ANNEX III

## DATA PACKAGE SENT TO THE PARTICIPANTS PRIOR TO THE SHANGHAI WORKSHOP

WESTPAC Paleogeographic Maps —The Holocene Optimum

The IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum) will be held in Shanghai, May 27-29, 1997. The goal of the Workshop is to compile preliminary data for the paleogeography of the Holocene Optimum, roughly 6,000 years BP. Unlike at the last glacial maximum (LGM), the coastline at the Holocene Optimum is basically onshore at its present position, and the distance from the modern coast is, generally, not significant. Therefore, it would be very difficult to show the Holocene Optimum paleogeography on a big map, like the LGM one. We will probably produce an atlas with a unified legend rather than a big map. Moreover, with the experience of compilation of the LGM map, we can complete the second map within a shorter time interval.

To ensure the success and efficiency of the Workshop, we would like to ask representatives of all countries to prepare preliminary data and maps. Following is the request to each of the participant:

To bring the following data and maps to the workshop:

- Preliminary map of the Holocene Optimum coastline (or the coastline at the maximum transgression in the Holocene) with a suitable scale ( scale has not yet been defined at this stage, but may be 1: 10,000,000);

- Map and table of data sites with age determination and sedimentological, paleontological, geographical and environmental information when available (including both onshore and offshore sites; data map scale should be larger e.g. 1:5,000,000);

- Reference maps and papers, a list of publications for the country.

In addition, the participants are asked to think over the following questions to be discussed during the workshop:

- What items, aside from the coastline, should be shown on the paleogeographic map and what is the proper scale for mapping? For example, is it possible to show hydrological net and vegetation type on land, and sea surface temperature in the sea?

- What should be the format of the Holocene maps and the explanatory text ( legend, colour or white-black, etc.)?

- Can you provide a paper describing the Holocene Optimum paleogeography of your country (and its offshore area, if possible) to be included in the explanatory volume?

- What can we show for the Holocene Optimum paleoenvironment in the open western Pacific Ocean and its marginal seas?
- As the third map of this series, can we compile the WESTPAC paleogeographic map for the last interglacial (oxygen isotope stage 5e about 125 kaBP)?

The Workshop will last for three days including an excursion. It will start with presentations by a representative of each country, followed by discussions on scientific and technical aspects of the map. Any suggestions for the Workshop or the mapping will be appreciated.

**Information on the WESTPAC Paleogeographic Mapping Project**

The IOC/WESTPAC paleogeographic mapping activities started in 1988, with its project entitled "Late Quaternary Paleogeographic Maps of the WESTPAC Region". The project was proposed by Dr.Peter COOK (then with the Bureau of Mineral Resources, Australia ) at the Fourth Session of the IOC Regional Committee for WESTPAC (now renamed as the IOC Sub-Commission for the Western Pacific (WESTPAC)) in Bangkok, 1987. The Session adopted the proposal as one of two projects in WESTPAC Programme on OSNLR(Ocean Science in Relation to Non-Living Resources), the other being the Margin of Active Plates. The First Planning Meeting was held in Shanghai on the campus of the Tongji University, during the First International Conference on Asian Marine Geology in September 1988. Then, the Project was endorsed by the Third Session of IOC-UN/OSNLR in Bordeaux, 1989, and by the First Session of IOC/WESTPAC in Hangzhou, China, 1990.

The objective of the Project was defined as to produce a series of maps of the sea-floor and coastal zone for the WESTPAC region related to: ( i ) present sedimentology and geomorphology; ( ii ) paleogeography for 18 ka BP (15-20 ka BP timeslice); and ( iii ) paleogeography for 120-125 ka BP (100-140 ka BP timeslice). The project aims at compiling numerous available paleogeographic and geophysical data on the coastal zones in the region and mapping coastlines on high and low stand in the late Quaternary.

The Paleogeographic Mapping Working Group discussed in details the Project at the Second WESTPAC Scientific Symposium in Penang, Malaysia, 1991. It was decided that the compilation begins with the last glacial maximum (LGM) paleogeographic map (15-20 ka BP) at 1:20,000,000 scale, and data maps at 1 :1,000,000 scale. Along with geomorphological and sedimentological components, the maps will also include paleohydrological, paleo-oceanographic, as well as paleovegetation information when available. The project is expected to contribute to PAGES studies and exploitation of mineral resources in the region, and to improve paleomapping capability in the participating countries.

After the Penang meeting, an "Information Package" of the Project was distributed from Shanghai to all members of the Working Group. General information, data compilation workshop announcement, legends for maps, and a paper contributed by the Working Group to the Symposium ("West Pacific marginal seas in last glaciation: paleogeography and its environmental impact", by WANG Pinxian, 1991) were included in the package. It turned out that the following seven WESTPAC countries participated in the Working Group: Australia, China, Indonesia, Japan, Malaysia, Russia and Thailand.

Each member was required to provide relevant data and compiled maps for his/her own country and neighbouring seas, and this was mainly done in 1993. Australia, for example, provided maps produced by the AGSO-APIRA projects, with the mapped area including the Australian plate - eastern

Indonesia, Papua-New Guinea, the south-west Pacific, Australia, New Zealand and Antarctica. The northernmost part of the WESTPAC maps was provided by a group of Russian colleagues from the Pacific Institute of Geography, and Dr. S. Ganzay visited Shanghai in 1994, to present the data and maps.

The data compilation workshop of the paleogeographic maps was held in Bali, Indonesia from 20-21 November 1994, immediately prior to the Third IOC/WESTPAC Scientific Symposium. Representatives from Australia, Belgium, China, Indonesia, Japan, Malaysia, the Netherlands and Thailand participated in the Workshop. Participants from the WESTPAC countries presented their own paleogeographic map of the LGM, together with a data-base map, list of sites and list of references. The coverage of the maps extended from Arctic to Antarctic. Discussion was held on how to compile data for the publication of the LGM maps. It was decided that the final maps will be compiled in Tongji University, Shanghai, and published as a UNESCO/IOC monograph in early 1996. The Workshop also decided that the next maps to be compiled by the Group will be Holocene Optimum map, the badly-needed map for the prediction of the consequences of the future sea-level rise. The originally planned two maps for 0 ka and 120-125 ka BP will be postponed.

The LGM map published in Shanghai was the first product of the Working Group consisting of Wang Pinxian (China), M. Bradshaw (Australia), S.S.Ganzay(Russia), S. Tsukawaki (Japan), K. Bin Hassan (Malaysia), W.S.Hantoro(Indonesia), S. Poobrasert (Thailand). Zhao Quanhong and Li Haiquan, Tongji University, China, compiled the final version of the map, and Wang Pinxian and Zhao Quanhong edited the volume. During the 30th International Geological Congress in Beijing, August 1996, the LGM paleogeographic map of WESTPAC was presented to the Western Pacific Marginal Seas Symposium and the paper will soon be published in the Proceedings of the 30th International Geological Congress, Volume 13, in the Netherlands.

The Third Session of IOC/WESTPAC in Tokyo, March 1996 decided to continue its support to the Working Group and to publish the WESTPAC Paleogeographic Map for the Holocene Optimum. In 1997, CCOP decided to co-operate with IOC on this project. Now the new Working Group comprising more countries is starting the compilation of its second set of maps.

ANNEX IV

## QUESTIONS FOR DISCUSSION DURING THE WORKSHOP

What items, aside from coastline, should be shown on the paleogeographic map ? e.g.

- hydrographic network,
- vegetation type,
- air temperature and precipitation,
- sea surface temperature ?

What scale and legend should be adopted for mapping?

Can you provide a paper describing the Holocene Optimum paleogeography of your country (and its offshore area, if possible) to be included in the explanatory volume?

What can we show for the open Western Pacific Ocean and its marginal seas?

How can we involve more countries into the project:-
Vietnam, Cambodia, Philippines, North Korea...

As the third map of this series, can we compile the map for the last interglacial (oxygen isotope stage 5e, about 125 kaBP)?

SCIENTIFIC QUESTIONS RELATED TO THE HOLOCENE OPTIMUM

Time and datings: when was the optimum ?

- around 6,000 yrs BP
- - 5,500 yrs BP
- ± 3,000 yrs BP
- datings: quality check;

Higher sea level than today at the Optimum ?

- Diversity of Holocene sea level curves
- Neotectonics
- Storm deposits or high sea level?
- Changes in tidal amplitude

Changes in sedimentation:

- Transgression: onshore marine sediments
- Apparent regression: Great Mangrove Swamps South Alligator River
- Changes in currents and sand movement, sediment budget

Climate and vegetation:

- COHMAP: climate modelling
- Atlas of Paleoclimates of the Northern Hemisphere (1992)
- Pollen mapping
- Air temperature ( + 1.5$^0$C ) and precipitation
- SST (sea surface temperature)

ANNEX V

# COUNTRY REPORTS

## Australia

### The Holocene Optimum in Australia

*Marita Bradshaw, Australian Geological Survey Organisation,*
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Preliminary paleogeographic and data maps were presented at the meeting for Australia during the Holocene Optimum, around 6,000 ± 1,000 years BP. At that time parts of Australia experienced a wetter and warmer climate than today's and sea level was higher in some locations. Information for these maps comes from the published literature, especially the proceedings of the CLIMANZ conferences which synthesise a great wealth of data. AGSO's QUATDB database, an ORACLE relational database of Quaternary climatic information, allowed easy searching of the literature. A simple search produced over 400 records for 74 sites with information about the Holocene Optimum.

Past climates and sea level history are reconstructed from coastal sediments, cave and lake deposits, geomorphic features and offshore sampling. A very high resolution record of past flood events is revealed in Sr/Ca, $\delta^{18}O$ and UV fluorescence measurements on core from *Porites* coral from the Great Barrier Reef. The results from a *Porites* micro-atoll from Orpheus Island (Gagan et al., in press) dated at 5,800 years BP, are interpreted as indicating a weaker El Nino - Southern Oscillation (ENSO), with droughts and floods being rare and the Monsoon being less variable than at present.

Any interpretation of Holocene climates in Australia needs to take into consideration the impact of Aboriginal burning of the vegetation. Plant communities have been altered over a period of at least 40,000 years, selecting against those species that are fire sensitive. However, against this background, the Holocene Optimum does seem to be a period when forest communities were expanded in comparison to today, as a response to wetter conditions.

The consensus is that eustatic sea level reached its present position in Australia around 6,500 years BP. However, relative sea level positions of up to 3.8 m above present level have been recorded for the Holocene at different locations around the continent depending on isostatic effects. The shoreline map of the Holocene Optimum looks little different to the current map of Australia at the 1:10 million scale, as there are few areas where there has been significant progradation. The Lake McLeod case study from the west coast was presented at the meeting, where a major marine embayment existed during the Holocene Optimum in an area which is now an enclosed coastal salt lake.

For the next meeting the draft maps will be updated and reviewed by other Quaternary workers, a database of Holocene Optimum sites constructed and a number of case studies from representative sites selected.

## China

### The Holocene Optimum in China

*Prof. Zhao Quanhong, Department of Marine Geology & Geophysics*
*Tongji University, Shanghai 200092, CHINA*

The Holocene transgression and the Mid Holocene Climate Optimum have been studied in China since the 1960s, particularly in the coastal areas. A special project on the Holocene Optimum was finished a few years ago (Shi et al., 1993). Large deltaic plains, such as the Yangtze River and Pearl River Deltas, have been extensively drilled for engineering, hydrological and scientific purposes. In the Hong Kong area alone, tens of thousands of boreholes have been drilled to the middle Holocene. Numerous archaeological discoveries have provided valuable data on paleoenvironments and human activities around 6,000 years ago. As a result of our first efforts, nearly two hundred related papers and data from 254 sites have been collected.

Preliminary map sets for two areas have been prepared for the meeting:- (A) the East China Sea with the Yellow Sea and Bohai Gulf; and (B) the northern and central parts of the South China Sea. The map sets consist of paleogeographic (1: 10,000,000) and data maps (1: 5,000,000). Several delta areas have been selected for preparation of enlarged maps including - the Liaohe Delta (Bohai Gulf), Heihe Delta (Bohai Gulf), Yellow River Delta (Bohai Gulf), Yangtze Delta (East China Sea) and the Pearl River Delta (South China Sea).

There has been notable recent progress in paleo-oceanographic studies of the Holocene in the China Seas. High-resolution analyses of the Holocene sections in the South China Sea and the Okinawa Trough have discovered Holocene monsoon cyclicity (L. Wang et al., in press) and the *Pulleniatina* events indicative of mid-Holocene warming and late Holocene (4,000 years BP) cooling (Jian et al., 1996; Li et al., in press). These new data will be compiled and mapped for the offshore areas.

## Indonesia

### HOLOCENE RELATIVE HIGH STAND SEA LEVEL IN INDONESIA DEDUCED FROM EMERGED CORAL REEF LIMESTONE.

*Wahyoe Soepri Hantoro, Research and Development Centre for Geotechnology,*
*Indonesian Institute of Sciences*

Emerged Holocene coral reef and carbonate beach sediments are found in several places in Indonesia. The height of this carbonate unit varies from some centimetres to up to 6 metres above present mean low water spring sea level (mlws). The emerged coral reef is commonly measured at about 2.5 m above mlws and its platform is 5 to 25 m wide. In some cases the reef platform is covered by beach sediments, and in other locations it gradually slopes seaward to merge with the modern platform. The emerged reef consists of clean and fresh massive and branching corals at the reef crest, while the lagoonal facies consists of reefal debris and molluscan shells. This more landward tract was probably not well developed or has been covered by vegetation or other coastal deposits.

Radiometric dating of some clean and *insitu* massive coral samples shows that the emerged coral reef is evidence of a relative high stand of sea level during the Holocene. Ages vary from 6,800 to 700 years BP and the highest emerged reef of the maximum high Holocene sea level has the age of about

6,000 years BP. The height of the Holocene sea level high in Indonesia is established at 2.5 m above mlws from dated emerged reefs along the relatively stable North East Java coast. Differences in the height of this unit in other locations may be due to local vertical tectonic deformation (uplift and subsidence) or differential hydro-isostatic response, or local oceanographic effects (wave and tide variations).

Based on data from several different areas the Holocene sea level curve for the Indonesian region can be established. The trend shows a rapid rise of sea level (6 - 7 mm/yr) with a peak of about 2.5 m above mlws attained by 5,500 years BP. Then followed a slow sea level drop to the zero present position with the hydro-isostatic rebound of the continent due to water loading. Under the initial rapid rise of sea level (about 6 mm/yr) and the mean coral growth rate of about 3 mm/yr, the Holocene reef should start to develop probably around 8,500 years BP at about -12.5 m deep. The modern reef develops by covering the dead Holocene reef substratum or by continuing to grow in the upper part of the submerged reef.

**Japan**

### Paleogeographic Map of Japan at the Holocene Optimum (c.a. 6 Ka)

*Shinji Tsukawaki, Department of Civil Engineering, Faculty of Engineering Kanazawa University, Kanazawa, 920-11, Japan*

Different eustatic curves during the Holocene period have been reported from several regions of the Japanese Islands due to differential tectonic activity. However, it can be considered that the sea level at the Holocene Optimum (c.a. 6,000 years BP) stood about 2.5 to 3 metres higher than the present sea level, then it fell to the present level with small fluctuations. The estimated rate of sea level rise from 11,000 years BP to the Holocene Optimum is about 10m/1,000 years. Thus, submergenced shorelines at the Optimum were the result of this rapid rise of sea level. Coral reefs were developed mainly around the Ryukyu Islands. No glaciers were developed, but some seasonal periglacial phenomena and geomorphic features are recognized in limited areas of Hokkaido and the central mountains in Honshu.

Volcanic activity at the Holocene Optimum was relatively quiet, in comparison to before and after the period, thus a only a limited number of widespread tephras such as the Kikai-Akahoya (K-Ah) ash are known. The K-Ah ash erupted from the Kikai Volcano situated south of Kyushu about 6,300 years BP. It is a markedly traceable tephra all over the southwestern and central parts of Japan, both onshore and offshore.

In the Pacific Ocean, it is known that the Kuroshio Front moved northwards gradually from about 10,500 years BP. It reached to off-Nakaminato (KH79-3-C1) at about 7,500 years BP through off-Boso (KH79-3-C6) at about 10,000 years BP, then it returned back southwards across off-Nakaminato at about 5,500 years BP. Accordingly, it can be considered that the Kuroshio Current flowed to the north of its present position at the Holocene Optimum. On the other hand, in the Japan Sea the present oceanographic situation has been existent since about 8,000 years BP. No major difference is recognized in the surface sediment distribution around Japan between the present and the Holocene Optimum.

Archaeological sites at the Holocene Optimum (Middle Jomon Age) are distributed mainly in the central and northeastern parts of Honshu, and they are particularly concentrated (5 to 20 sites per 20 $km^2$) in and around the present Kanto Plain. Mammalian fauna in this period was same as it in the present. Some domesticated mammals such as dogs were distributed closely with these archaeological sites. On the other hand, wild mammals such as black bears, wild boars, Japanese deers, etc. were distributed mainly in the mountainous and hilly areas.

**Korea**

## The Holocene Optimum in Korea

*Dr Yi Hi-Il, Marine Geology and Geophysics Division,*
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*Ansan P.O. Box 29, Seoul 425-600, KOREA*

Work is still in progress in Korea in compiling data concerning the Holocene Optimum. There is doubt as to whether there was a higher Holocene sea level and interpretation of data from the west coast are complicated by the large tidal range, of up to 8 m. Marine deposits at higher levels are variously interpreted as the result of storms, tsunamis, middens or tectonic movements. But there is evidence of elevated marine deposits dating at around 4,500 years BP. Data from a well studied tidal flat sequence was presented which has sediments dating back to 7,000 years BP. There is also evidence of a warmer period, from molluscan faunas at sometime after the LGM, but the age of this period is not well constrained.

**Malaysia**

## The Holocene Optimum in Malaysia

*Kamaludin bin Hassan, Geological Survey of Malaysia,*
*P.O. Box 1015, 30820 Ipoh, Malaysia.*

A list of radiometric dating from the coastal areas of Malaysia that record high sea levels during the Holocene was presented at the meeting. The data indicate that for peninsular Malaysia, the Holocene Optimum coincides with the peak of the Holocene Transgression. In the interval ca. 6,500 to 4,000 years BP sea levels of more than 2.0 m above present are known from many localities on the peninsular.

A paleogeographic map of Malaysia for the Holocene Optimum was also presented. The map is based on data collected in earlier studies and from currently ongoing projects of the Quaternary Geology Mapping Programme of the Geological Survey of Malaysia. For Sarawak and Sabah, the paleogeographic map for the Holocene Optimum is based on the extent of Holocene coastal sediments. However, for Sabah this is problematic as Holocene tectonic uplift has been reported from some coastal locations.

A case study from the northwest of Peninsular Malaysia, in the Seberang Prai area, was presented. The study showed that a high sea level of at least 2.1 m above present mean seal level occurred around 6,470 ± 120 years BP. The date is from the top of a peat layer overlying the most inland beach sand deposit.

For the next meeting of the group (proposed for the early second half of 1998) the tasks that need to be attended to include:-

1) update the currently compiled radiometric dating data
2) update the existing references
3) update the prepared (1:10 m) Holocene Optimum paleogeographic map
4) prepare the data map (1: 5 m)
5) add another case study site (proposed the Baram Delta).

All the above tasks are to be ready before the next meeting.

**Russia**

**Holocene Optimum of the Sea of Japan and Okhotsk Sea Regions**

*Dr. Nadezhda Razjigaeva and Dr. Vladimir Pushkar, Laboratory of Paleogeography, Pacific Institute of Geography, Far East Branch, Russian Academy of Science, Vladivostok 690041 Russia*

Six maps have been compiled for the Holocene Optimum of the Sea of Japan and the Okhotsk Sea: - two data maps showing site localities and special analyses, two paleogeographic maps showing lithological information and two paleogeographic maps showing paleoclimate/paleo-oceanographic information. The database includes four tables with information about the studied sites and radiocarbon dating for Holocene Optimum deposits from the two seas. A sea level curve for the Sea of Japan was also presented, which showed that there were at least two transgressive peaks during the Holocene Optimum. The maximum rise was around 6,300 to 6,000 years BP followed by a small regression between 5,700 to 5,600 years BP and then another rise.

The Holocene Optimum event is coincident with the Atlantic Period associated with the maximum of the global Flandrian Transgression. Around the Sea of Japan, Holocene marine and lagoon terrace deposits are at elevations of up to 6 m above present mean sea level. From the relatively tectonically stable coast of south-east Primorye a sea level position of about 2.5 to 3 m was established for the Holocene transgression. The geographical position of the Sea of Japan situated between the tropical and boreal zones allows decisions to be made on some important paleogeographical problems, because Quaternary paleoclimatic changes were of most contrast in this region. Also, paleogeographic data from the Sea of Japan are very useful for event correlation between the low and high latitudes. Diatom data indicate that there was very little sea-ice in the Sea of Japan during the Holocene Optimum and pollen information from the surrounding land areas indicates that vegetation zones shifted northwards and upwards in elevation in mountainous areas.

The Okhotsk Sea is of interest because of its high sedimentation rates in the Holocene which permit high resolution paleoclimatic and paleo-oceanographic studies. As with the Sea of Japan, the Okhotsk Sea is characterised by contrasting current systems. The migration of warm and cold currents strongly influenced marine environments and coastal systems during the general global warming following the last glaciation. Today, the Okhotsk Sea is mostly covered by seasonal sea ice, but during the Holocene Optimum sea-ice was restricted to the north-western and north-eastern margins of the Sea and in Aniva Bay, bordering Sakhalin. There was intense volcanic activity within the Kurile-Kamchatka region during the Holocene, between 7,800 and 5,500 years BP.

The maps presented were compiled from published sources and from our own original material. The Holocene Optimum of the Sea of Japan has been studied in detail, while there are few works devoted to the Holocene of the Okhotsk Sea. More than 15 deep-sea sites, 20 shelf sites and numerous coastal outcrops were the database for the Sea of Japan paleogeographical maps; and 15 deep-sea sites, 20 shelf sites and 50 coastal outcrops were compiled for the Okhotsk Sea maps. Investigations of the material from the sites has included sedimentology, pollen, diatoms, forams, molluscs, $C^{14}$ and oxygen isotope analyses, and palaeomagnetism.

**Thailand**

The representative for Thailand, Dr Thanawat Jarupongsakul, was unable to attend the meeting. Professor Wang gave a short report on Thailand during the Holocene Optimum from material previously supplied by Dr Suparb Poorrasert, during the compilation of the LGM map. The maximum Holocene sea level was at around 6,000 years BP at an elevation of around 5.5 m above present level. The shoreline was far to the north of Bangkok, and since the Holocene Optimum an extensive coastal plain has prograded into the Gulf of Thailand.

**CCOP**

After the country reports were presented, Dr van der Valk, from CCOP gave a presentation on the pioneering work done in the Netherlands on Holocene sea level change and coastal defence. Much of the experience gained here is of value to the WESTPAC region and the coastal zone management problems it faces, which will become more pressing with increasing populations and climate and sea level change. During a ten year research programme detailed sea level curves for sectors of the Netherlands coast were derived, maps were produced of the paleogeography at 7,000 and 5,500 years ago and the coastal system and sediment budget analysed. The conclusions of the study were that during the Holocene coastal progradation had declined and the shoreline was now under regression. To hold the shoreline at the 1990 position beach nourishment is required, dredging sand from below -20 m.

ANNEX VI

## IOC/WESTPAC - CCOP Paleogeographic Mapping Project (Holocene Optimum)

### POINTS FOR DISCUSSION

Recognising:

- Unequal quality of data (particularly datings) in the region;
- Climate optimum ≠ highest sea level ≠ maximal transgression

Goal:

- Compilation of existing data: sites, datings, literature
- Showing the current status, not to carry our new researches

Time slice:

- Broadly covering 6 + 1 kyrs and around it

Content:

| | |
|---|---|
| Large coastal plain: | paleo-coastline with datings (maximal transgression) |
| Steep coast: | sea-level curve with datings (highest sea-level) |
| Land: | vegetation types |
| Sea: | oxygen-isotope |

Maps:

Paleogeographic map: 10,000,000 for two Hemispheres (colored) . with numerous insets

Data map:

5,000,000 (black-white)
with numerous insets

Text volume:

General
Reports from individual country (including colored and black-white maps)
Table of sites, datings
Literature

ANNEX VII

## IOC/WESTPAC-CCOP Paleogeographic Mapping Project (Holocene Optimum)

## RECOMMENDATIONS

Time table:

| | |
|---|---|
| Early second half of 1998 | Final data compilation workshop |
| Early in 1999 | Publication of the map |

Format:

Hard copy: Paleogeographic map with insets

( colored; 1: 10,000,000; using the Circum-pacific geographic maps on Lambert Azimuthal Equal Area Projection as basis)

Explanatory text volume

- General part
- Report from member-countries including maps (colored and black-white)

CD-ROM:

- Data maps
- Table of sites
- Table of datings
- Literature

Content of the paleogeographic map:

Land
- Vegetation types (using the PEP-II legend)
- Rivers and lances ( freshwater vs. saline)
- Known active volcano

Sea
- Oxygen isotope ( shallow-dwelling planktonic foraminifer)
- Sea currents and upwelling
- Coral reefs
- Sea ice

Insets
1) Major coastal plains; coastline at maximal transgression
2) Steep coast: sea-level curve
3) Deep sea: oxygen isotope curve

Request from each country:

Paleogeographic map ( onshore and offshore; 1:10,000,000)
with several insets (appropriate scale)
Data map ( 5,000,000, with different scale for insets )
Explanatory text with maps ( colored or black-white)
Table of sites
Table of datings
Literature

Participation:

Since the Holocene optimum map is mostly based on onshore data, involvement of more countries is required such as Vietnam, Cambodia, Philippines, and North Korea. ( For literature, legend and site table, use the same format as the LGM map )

*EXAMPLES OF FORMATS*

*TABLE OF RADIOCARBON DATINGS*

| Lab. | Lab. No | Site | Position | Height or depth | Material | Method | C-14 age | Reference | Note |
|---|---|---|---|---|---|---|---|---|---|
| Arizona | xxx | Tongji Shanghai | 31020'N 121030'E | 3.5m | *Gl. ruber* | AMS | 6500 + 70 | Li, 1995 | highq. |

LIST OF REFERENCES

Zhu Yongqi, Li, C., Zeng, C. and Li, B., 1979. On the lowest sea-level in the continent of the East china Sea during the late Pleistocene. Chinese Sci. Bull. 7:317-320. (in Chinese)
Zhu yongqi, Zeng ,C. and Jin, C., 1979. Sea-level changes of the shelf of the East China Sea since the late Pleistocene. Haiyangshijian. 3: 21-27 (in Chinese}
Zeng Cllengkai, Zllu, Y. and Jin, C., 1984. A preliminary analysis of the form environment of the shell beaches on the outer-continental shelf of the East china-Sea Studies oa the East China Sea. China Ocean Press, Beijing, 27-41 (in Chinese)
Zeng Cheng5kai, Jin, C. and Wang X, 1986. The contact relation between the sea-level changes and stratum on the continental shelf of East China Sea In: China Sea Level Changes. China Ocean Press, 149-155 (in Chinese)
Zong Yongqiang, lDB7. Depositional cycles of the Quaternary in the Hanjiang Delta. Tropic Geogr., 7(2): 117-127 (in Chinese).

# TABLE OF SITES

A list of all sites applied in the base maps for the WESTPAC Paleogeographic Map, showing their original name, location, analysed items and data resources. The following abbreviations are employed in the column of analysed items:

C 14 = Radiocarbon dating, Ca = Carbonate content, D = Diatom, Di = Dinoflagellate, F = Foraminfera, IVf=Inveinebratefossil, Mf=Microfossil, Mg=Paleomagnetic, Mo=Mollusc, MS - Magnelic susceptibility, N = Nannofossil, O = Oxwgen isotope, Os = Ostracoda, P = Pollen R=Radiolarian, Si=Silicollagellate, T=Tephra, V~=Vertebratefossil.

| Code Core | Original Site | Location | Analysed Items | References |
|---|---|---|---|---|
| 12 | DSDP264 | 34°5S S.112°03'E | Mf | Hayesetal., 1975 |
| 13 | DSDP 265 | 54° S. 110°30'E | Mf | as above |
| 14 | DSDP 266 | 56°30 S.111°..E | Mf | as above |
| 15 | DSDP 267 | 59°..S.1044..E | | as above |

ANNEX VIII

## LIST OF ACRONYMS

| | |
|---|---|
| AGSO | Australian Geological Survey Organization |
| BP | Before Present |
| CCOP | Co-ordinating Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia |
| CD-ROM | Compact Disc with a Read-Only Memory |
| COASTPLAN | CCOP's Programme |
| ENSO | El Nino-Southern Oscillation |
| FAO | Food and Agriculture Organization of the United Nations |
| GIS | Geographic Information System |
| IOC | Intergovernmental Oceanographic Commission |
| LGM | Last Glacial Maximum |
| MLWS | mean low water spring |
| OSNLR | Ocean Science in Relation to Non-Living Resources |
| SST | Sea Surface Temperature |
| UN | United Nations |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| WESTPAC | IOC Sub-Commission for the Western Pacific |

# IOC Workshop Reports

The Scientific Workshops of the Intergovernmental Oceanographic Commission are sometimes jointly sponsored with other intergovermental or non-governmental bodies. In most cases, IOC assumes responsibility for printing, and copies may be requested from:

Intergovernmental Oceanographic Commission - UNESCO
1, rue Miollis, 75732 Paris Cedex 15, France

| No. | Title | Languages |
|---|---|---|
| 1 | CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand, 24-29 September 1973 UNDP (CCOP), 138 pp. | E (out of stock) |
| 2 | CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (UNESCO Technical Paper in Marine Sciences, No. 20). | E (out of stock)<br>S (out of stock) |
| 3 | Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean; Monte Carlo, 9-14 September 1974. | E, F<br>E (out of stock) |
| 4 | Report of the Workshop on the Phenomenon known as 'El Niño'; Guayaquil, Ecuador, 4-12 December 1974. | E (out of stock)<br>S (out of stock) |
| 5 | IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources; Kingston, Jamaica, 17-22 February 1975. | E (out of stock)<br>S |
| 6 | Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Suva, Fiji, 1-6 September 1975. | E |
| 7 | Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/UNESCO/EAC; Nairobi, Kenya, 25 March-2 April 1976. | E, F, S, R |
| 8 | Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters; Penang, 7-13 April 1976. | E (out of stock) |
| 9 | IOC/CMG/SCOR Second International Workshop on Marine Geoscience; Mauritius, 9-13 August 1976. | E, F, S, R |
| 10 | IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring; Monaco, 14-18 June 1976. | E, F<br>E (out of stock)<br>R |
| 11 | Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976. | E, S (out of stock) |
| 11 Suppl. | Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions; Port of Spain, Trinidad, 13-17 December 1976. | E (out of stock), S |
| 12 | Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects; Fort-de-France, Martinique, 28 November-2 December 1977. | E, F, S |
| 13 | Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area; Port of Spain, Trinidad, 16-18 January 1978. | E, S |
| 14 | IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas; Abidjan, Côte d'Ivoire, 2-9 May 1978. | E, F |
| 15 | CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific; Santiago de Chile, 6-10 November 1978. | E (out of stock) |
| 16 | Workshop on the Western Pacific, Tokyo, 19-20 February 1979. | E, F, R |
| 17 | Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS); Moscow, 9-11 April 1979. | E |
| 17 Suppl. | Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOSS Data Processing and Services System; Moscow, 2-6 April 1979. | E |
| 18 | IOC/UNESCO Workshop on Syllabus for Training Marine Technicians; Miami, U.S.A., 22-26 May 1978 (UNESCO reports in marine sciences, No. 4 published by the Division of Marine Sciences, UNESCO). | E (out of stock), F, S (out of stock), R |
| 19 | IOC Workshop on Marine Science Syllabus for Secondary Schools; Llantwit Major, Wales, U.K., 5-9 June 1978 (UNESCO reports in marine sciences, No. 5, published by the Division of Marine Sciences, UNESCO). | E (out of stock), E, S, R, Ar |
| 20 | Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources; Bandung, Indonesia, 17-21 October 1978. | E |
| 21 | Second IDOE Symposium on Turbulence in the Ocean; Liège, Belgium, 7-18 May 1979. | E, F, S, R |
| 22 | Third IOC/WMO Workshop on Marine Pollution Monitoring; New Delhi, 11-15 February 1980. | E, F, S, R |
| 23 | WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific; Tokyo, 27-31 March 1980. | E, R |
| 24 | WESTPAC Workshop on Coastal Transport of Pollutants; Tokyo, Japan, 27-31 March 1980. | E (out of stock) |
| 25 | Workshop on the Intercalibration of Sampling Procedures of the IOC/ WMO UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters; Bermuda, 11-26 January 1980. | E (superseded by IOC Technical Series No. 22) |
| 26 | IOC Workshop on Coastal Area Management in the Caribbean Region; Mexico City, 24 September-5 October 1979. | E, S |
| 27 | CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific; Nouméa, New Caledonia, 9-15 October 1980. | E |
| 28 | FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes. Lima, 20 April-5 May 1980. | E |
| 29 | WESTPAC Workshop on Marine Biological Methodology; Tokyo, 9-14 February 1981. | E |
| 30 | International Workshop on Marine Pollution in the South-West Atlantic; Montevideo, 10-14 November 1980. | E (out of stock)<br>S |
| 31 | Third International Workshop on Marine Geoscience; Heidelberg, 19-24 July 1982. | E, F, S |
| 32 | UNU/IOC/UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the context of the New Ocean Regime; Paris, France, 27 September-1 October 1982. | E, F, S |
| 32 Suppl. | Papers submitted to the UNU/IOC/UNESCO Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the Context of the New Ocean Regime; Paris, France, 27 September-1 October 1982. | E |
| 33 | Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR); Halifax, 26-30 September 1963. | E |
| 34 | IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa); Tenerife, 12-17 December 1963. | E, F, S |
| 35 | CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific; Suva, Fiji, 3-7 October 1983. | E |
| 36 | IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, Portugal, 28 May-2 June 1984. | E |
| 36 Suppl. | Papers submitted to the IOC/FAO Workshop on the Improved Uses of Research Vessels; Lisbon, Portugal, 28 May-2 June 1984. | E |
| 37 | IOC/UNESCO Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs; Colombo, 8-13 July 1985. | E |
| 38 | IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region; Basrah, Iraq, 8-12 January 1984. | E |
| 39 | CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific; Suva, Fiji, 24-29 September 1985. | E |
| 40 | IOC Workshop on the Technical Aspects of Tsunami Analysis, Prediction and Communications; Sidney, B.C., Canada, 29-31 July 1985. | E |
| 40 Suppl. | First International Tsunami Workshop on Tsunami Analysis, Prediction and Communications, *Submitted Papers;* Sidney, B.C., Canada, 29 July - 1 August 1985. | E |
| 41 | First Workshop of Participants in the Joint FAO/IOC/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2); Dakar, Senegal, 28 October-1 November 1985. | E |
| 43 | IOC Workshop on the Results of MEDALPEX and Future Oceanographic Programmes in the Western Mediterranean; Venice, Italy, 23-25 October 1985. | E |
| 44 | IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities; Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986. | E (out of stock)<br>S |
| 44 Suppl. | IOC-FAO Workshop on Recruitment in Tropical Coastal Demersal Communities, *Submitted Papers;* Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986. | E |
| 45 | IOCARIBE Workshop on Physical Oceanography and Climate; Cartagena, Colombia, 19-22 August 1986. | E |
| 46 | Reunión de Trabajo para Desarrollo del Programa "Ciencia Oceánica en Relación a los Recursos No Vivos en la Región del Atlántico Sud-occidental"; Porto Alegre, Brazil, 7-11 de abril de 1986. | S |
| 47 | IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence; Townsville, 1-6 December 1966. | E |
| 48 | IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on 'Ocean Science in Relation to Non-Living Resources (OSNLR)'; Havana, Cuba, 4-7 December 1986. | E, S |
| 49 | AGU-IOC-WMO-CPPS Chapman Conference: An International Symposium on 'El Niño'; Guayaquil, Ecuador, 27-31 October 1986. | E |
| 50 | CCALR-IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR); Paris, France, 2-6 June 1987. | E |
| 51 | CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations; Lae, Papua-New Guinea, 1-8 October 1987. | E |

| No. | Title | Languages |
|---|---|---|
| 52 | SCOR-IOC-UNESCO Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere; Paris, France, 6-10 May 1985. | E |
| 53 | IOC Workshop on the Biological Effects of Pollutants; Oslo, 11-29 August 1986. | E |
| 54 | Workshop on Sea-Level Measurements in Hostile Conditions; Bidston, UK, 28-31 March 1988 | E |
| 55 | IBCCA Workshop on Data Sources and Compilation, Boulder, Colorado, 18-19 July 1988. | E |
| 56 | IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Cleveland, Australia, 24-30 July 1988. | E |
| 57 | IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms; Takamatsu, Japan, 16-17 November 1987. | E |
| 58 | International Workshop on the Technical Aspects of the Tsunami Warning System; Novosibirsk, USSR, 4-5 August 1989. | E |
| 58 Suppl. | Second International Workshop on the Technical Aspects of Tsunami Warning Systems, Tsunami Analysis, Preparedness, Observation and Instrumentation. *Submitted Papers*; Novosibirsk, USSR, 4-5 August 1989. | E |
| 59 | IOC-UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring Research, Control and Abatement in the Wider Caribbean; San José, Costa Rica, 24-30 August 1989. | E, F, S |
| 60 | IOC Workshop to Define IOCARIBE-TRODERP proposals; Caracas, Venezuela, 12-16 September 1989. | E |
| 61 | Second IOC Workshop on the Biological Effects of Pollutants; Bermuda, 10 September-2 October 1988. | E |
| 62 | Second Workshop of Participants in the Joint FAO-IOC-WHO-IAEA-UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region; Accra, Ghana, 13-17 June 1988. | E |
| 63 | IOC/WESTPAC Workshop on Co-operative Study of the Continental Shelf Circulation in the Western Pacific; Bangkok, Thailand, 31 October-3 November 1989. | E |
| 64 | Second IOC-FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP); Phuket, Thailand, 25-31 September 1989. | E |
| 65 | Second IOC Workshop on Sardine/Anchovy Recruitment Project (SARP) int he Southwest Atlantic; Montevideo, Uruguay, 21-23 August 1989. | E |
| 66 | IOC *ad hoc* Expert Consultation on Sardine/Anchovy Recruitment Programme; La Jolla, California, U.S.A., 1989. | E |
| 67 | Interdisciplinary Seminar on Research Problems in the IOCARIBE Region; Caracas, Venezuela, 28 November-1 December 1989. | E (out of stock) |
| 68 | International Workshop on Marine Acoustics; Beijing, China, 26-30 March 1990. | E |
| 69 | IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; Leningrad, USSR, 28-31 May 1990. | E |
| 69 Suppl. | IOC-SCAR Workshop on Sea-Level Measurements in the Antarctica; *Submitted Papers*; Leningrad, USSR, 28-31 May 1990. | E |
| 70 | IOC-SAREC-UNEP-FAO-IAEA-WHO Workshop on Regional Aspects of Marine Pollution; Mauritius, 29 October - 9 November 1990. | E |
| 71 | IOC-FAO Workshop on the Identification of Penaeid Prawn Larvae and Postlarvae; Cleveland, Australia, 23-28 September 1990. | E |
| 72 | IOC/WESTPAC Scientific Steering Group Meeting on Co-Operative Study of the Continental Shelf Circulation in the Western Pacific; Kuala Lumpur; Malaysia, 9-11 October 1990. | E |
| 73 | Expert Consultation for the IOC Programme on Coastal Ocean Advanced Science and Technology Study; Liège, Belgium, 11-13 May 1991. | E |
| 74 | IOC-UNEP Review Meeting on Oceanographic Processes of Transport and Distribution of Pollutants in the Sea; Zagreb, Yugoslavia, 15-18 May 1989. | E |
| 75 | IOC-SCOR Workshop on Global Ocean Ecosystem Dynamics; Solomons, Maryland, U.S.A., 29 April-2 May 1991. | E |
| 76 | IOC/WESTPAC Scientific Symposium on Marine Science and Management of Marine Areas of the Western Pacific; Penang, Malaysia, 2-6 December 1991. | E |
| 77 | IOC-SAREC-KMFRI Regional Workshop on Causes and Consequences of Sea-Level Changes on the Western Indian Ocean Coasts and Islands; Mombasa, Kenya, 24-28 June 1991. | E |
| 78 | IOC-CEC-ICES-WMO-ICSU Ocean Climate Data Workshop Goddard Space Flight Center; Greenbelt, Maryland, U.S.A., 18-21 February 1992. | E |
| 79 | IOC/WESTPAC Workshop on River Inputs of Nutrients to the Marine Environment in the WESTPAC Region; Penang, Malaysia, 26-29 November 1991. | E |
| 80 | IOC-SCOR Workshop on Programme Development for Harmful Algae Blooms; Newport, U.S.A., 2-3 November 1991. | E |
| 81 | Joint IAPSO-IOC Workshop on Sea Level Measurements and Quality Control; Paris, France, 12-13 October 1992. | E |
| 82 | BORDOMER 92: International Convention on Rational Use of Coastal Zones. A Preparatory Meeting for the Organization of an International Conference on Coastal Change; Bordeaux, France, 30 September-2 October 1992. | E |
| 83 | IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 12-13 October 1992. | E |
| 84 | Workshop on Atlantic Ocean Climate Variability; Moscow, Russian Federation, 13-17 July 1992. | E |
| 85 | IOC Workshop on Coastal Oceanography in Relation to Integrated Coastal Zone Management; Kona, Hawaii, 1-5 June 1992. | E |
| 86 | International Workshop on the Black Sea; Varna, Bulgaria 30 September - 4 October 1991. | E |
| 87 | Taller de trabajo sobre efectos biológicos del fenómeno «El Niño» en ecosistemas costeros del Pacífico Sudeste; Santa Cruz, Galápagos, Ecuador, 5-14 de octubre de 1989. | S only (Summary in E, F, S) |
| 88 | IOC-CEC-ICSU-ICES Regional Workshop for Member States of Eastern and Northern Europe (GODAR Project); Obninsk, Russia, 17-20 May 1993. | E |
| 89 | IOC-ICSEM Workshop on Ocean Sciences in Non-Living Resources; Perpignan, France, 15-20 October 1990. | E |
| 90 | IOC Seminar on Integrated Coastal Management; New Orleans, U.S.A., 17-18 July 1993. | E |
| 91 | Hydroblack'91 CTD Intercalibration Workshop; Woods Hole, U.S.A., 1-10 December 1991. | E |
| 92 | Réunion de travail IOCEA-OSNLR sur le Projet « Budgets sédimentaires le long de la côte occidentale d'Afrique » Abidjan, Côte d'Ivoire, 26-28 juin 1991. | F |
| 93 | IOC-UNEP Workshop on Impacts of Sea-Level Rise due to Global Warming. Dhaka, Bangladesh, 16-19 November 1992. | E |
| 94 | BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Field of Eutrophication in Semi-Enclosed Seas and Harmful Algal Blooms, Bremerhaven, Germany, 29 September - 3 October 1992. | E |
| 95 | SAREC-IOC Workshop on Donor Collaboration in the Development of Marine Scientific Research Capabilities in the Western Indian Ocean Region; Brussels, Belgium, 23-25 November 1993. | E |
| 96 | IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; Zanzibar, United Republic of Tanzania, 17-21 January 1994. | E |
| 96 Suppl. 1 | IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; *Submitted Papers* 1. Coastal Erosion; Zanzibar, United Republic of Tanzania 17-21 January 1994. | E |
| 96 Suppl. 2 | IOC-UNEP-WMO-SAREC Planning Workshop on an Integrated Approach to Coastal Erosion, Sea Level Changes and their Impacts; *Submitted Papers* 2. Sea Level; Zanzibar, United Republic of Tanzania 17-21 January 1994. | E |
| 97 | IOC Workshop on Small Island Oceanography in Relation to Sustainable Economic Development and Coastal Area Management of Small Island Development States; Fort-de-France, Martinique, 8-10 November, 1993. | E |
| 98 | CoMSBlack '92A Physical and Chemical Intercalibration Workshop; Erdemli, Turkey, 15-29 January 1993. | E |
| 99 | IOC-SAREC Field Study Exercise on Nutrients in Tropical Marine Waters; Mombasa, Kenya, 5-15 April 1994. | E |
| 100 | IOC-SOA-NOAA Regional Workshop for Member States of the Western Pacific - GODAR-II (Global Oceanographic Data Archeology and Rescue Project); Tianjin, China, 8-11 March 1994. | E |
| 101 | IOC Regional Science Planning Workshop on Harmful Algal Blooms; Montevideo, Uruguay, 15-17 June 1994. | E |
| 102 | First IOC Workshop on Coastal Ocean Advanced Science and Technology Study (COASTS); Liège, Belgium, 5-9 May 1994. | E |
| 103 | IOC Workshop on GIS Applications in the Coastal Zone Management of Small Island Developing States; Barbados, 20-22 April 1994. | E |
| 104 | Workshop on Integrated Coastal Management; Dartmouth, Canada, 19-20 September 1994. | E |
| 105 | BORDOMER 95: Conference on Coastal Change; Bordeaux, France, 6-10 February 1995. | E |
| 105 Suppl. | Conference on Coastal Change: Proceedings; Bordeaux, France, 6-10 February 1995 | E |
| 106 | IOC/WESTPAC Workshop on the Paleographic Map; Bali, Indonesia, 20-21 October 1994. | E |
| 107 | IOC-ICSU-NIO-NOAA Regional Workshop for Member States of the Indian Ocean - GODAR-III; Dona Paula, Goa, India, 6-9 December 1994. | E |
| 108 | UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; Paris, France, 9-12 May 1995. | E |
| 108 Suppl. | UNESCO-IHP-IOC-IAEA Workshop on Sea-Level Rise and the Multidisciplinary Studies of Environmental Processes in the Caspian Sea Region; *Submitted Papers*; Paris, France, 9-12 May 1995. | E |
| 109 | First IOC-UNEP CEPPOL Symposium; San José, Costa Rica, 14-15 April 1993. | E |
| 110 | IOC-ICSU-CEC Regional Workshop for Member States of the Mediterranean - GODAR-IV (Global Oceanographic Data Archeology and Rescue Project) Foundation for International Studies, University of Malta, Valletta, Malta, 25-28 April 1995. | E |

| No. | Title | Languages |
|---|---|---|
| 111 | Chapman Conference on the Circulation of the Intra-Americas Sea; La Parguera, Puerto Rico, 22-26 January 1995. | E |
| 112 | IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials (GESREM) Workshop; Miami, U.S.A., 7-8 December 1993. | E |
| 113 | IOC Regional Workshop on Marine Debris and Waste Management in the Gulf of Guinea; Lagos, Nigeria, 14-16 December 1994. | E |
| 114 | International Workshop on Integrated Coastal Zone Management (ICZM) Karachi, Pakistan; 10-14 October 1994. | E |
| 115 | IOC/GLOSS-IAPSO Workshop on Sea Level Variability and Southern Ocean Dynamics; Bordeaux, France, 31 January 1995. | E |
| 116 | IOC/WESTPAC International Scientific Symposium on Sustainability of Marine Environment: Review of the WESTPAC Programme, with Particular Reference to ICAM Bali, Indonesia, 22-26 November 1996. | E |
| 117 | Joint IOC-CIDA-Sida (SAREC) Workshop on the Benefits of Improved Relationships between International Development Agencies, the IOC and other Multilateral Intergovernmental Organizations in the Delivery of Ocean, Marine Affairs and Fisheries Programmes; Sidney B.C., Canada, 26-28 September 1995. | E |
| 118 | IOC-UNEP-NOAA-Sea Grant Fourth Caribbean Marine Debris Workshop; La Romana, Santo Domingo, 21-24 August 1995. | E |
| 119 | IOC Workshop on Ocean Colour Data Requirements and Utilization; Sydney B.C., Canada, 21-22 September 1995. | E |
| 120 | International Training Workshop on Integrated Coastal Management; Tampa, Florida, U.S.A., 15-17 July 1995. | E |
| 121 | Atelier régional sur la gestion intégrée des zones littorales (ICAM); Conakry, Guinée, 12-22 décembre 1995. | F |
| 122 | IOC-UNEP-PERSGA-ACOPS-IUCN Workshop on Oceanographic Input to Integrated Coastal Zone Management in the Red Sea and Gulf of Aden Jeddah, Saudi Arabia, 8 October 1995. | E |
| 123 | Second IOC Regional Science Planning Workshop on Harmful Algal Blooms in South America; Mar del Plata, Argentina, 30 October - 1 November 1995. | E, S |
| 124 | GLOBEC-IOC-SAHFOS-MBA Workshop on the Analysis of Time Series with Particular Reference to the Continuous Plankton Recorder Survey; Plymouth, U.K., 4-7 May 1993. | E |
| 125 | Atelier sous-régional de la COI sur les ressources marines vivantes du Golfe de Guinée ; Cotonou, Bénin, 1-4 juillet 1996. | F |
| 126 | IOC-UNEP-PERSGA-ACOPS-IUCN Workshop on Oceanographic Input to Integrated Coastal Zone. | E |
| 127 | IOC Regional Workshop for Member States of the Caribbean and South America GODAR-V (Global Oceanographic Data Archeology and Rescue Project); Cartagena de Indias, Colombia, 8-11 October 1996. | E, S |
| 128 | Atelier IOC-Banque Mondiale-Sida/SAREC-ONE sur la Gestion Intégrée des Zones Côtières ; Nosy Bé, Madagascar, 14-18 octobre 1996. | E, F |
| 129 | Gas and Fluids in Marine Sediments, Amsterdam, the Netherlands; 27-29 January 1997. | E |
| 130 | Atelier régional de la COI sur l'océanographie côtière et la gestion de la zone côtière ; Moroni, RFI des Comores, 16-19 décembre 1996. | F |
| 131 | GOOS Coastal Module Planning Workshop; Miami, USA, 24-28 February 1997. | E |
| 132 | Third IOC-FANSA Workshop, Punta-Arenas, Chile, 28-30 July 1997 | S/E |
| 133 | Joint IOC-CIESM Training Workshop on Sea-level Observations and Analysis for the Countries of the Mediterranean and Black Seas, Birkenhead, U.K., 16-27 June 1997 | E |
| 134 | IOC/WESTPAC-CCOP Workshop on Paleogeographic Mapping (Holocene Optimum), Shanghai, China, 27-29 May 1997 | E |