Intergovernmental Oceanographic Commission
Training Course Reports

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IOC-IOMAC
Advanced Training Course on Marine Geology and Geophysics off Pakistan

Organized with the support of the Government of Germany

National Institute of Oceanography
Karachi, Pakistan
12-26 November 1994

UNESCO

IOC Training Course Reports

No.	Title	Language versions
1.	IOC Indian Ocean Region Training Course in Petroleum Monitoring Perth, 18 February-1 March 1980	English
2.	IOC Regional Training Course for Marine Science, Technicians Cape Ferguson, Queensland, 1-28 June 1980	English
3.	ROPME-IOC-UNEP Training Workshop on Oceanographic Sampling Analysis, Data handling and Care of Equipment, Doha, Qatar, 3-15 December 1983	English
4.	Stage COI d'initiation à la gestion et au traitement de l'information scientifique et technique pour l'océanologie, Brest, France, 28 novembre - 9 décembre 1983	French
5.	Curso mixto COI-OMM de formación sobre el Sistema Global Integrado de Servicios Oceánicos (SGISO), Buenos Aires, Argentina, 15-26 de octubre de 1984	Spanish
6.	UNESCO-IOC-NBO Training Course on Tidal Observations and Data Processing Tianjin, China, 27 August - 22 September 1984	English
7.	Stage COI sur la connaissance et la gestion de la zone côtière et du proche plateau continental Talence, France, 18 septembre - 4 octobre 1984	French
8.	IOC Regional Training Course on Marine Living Resources in the Western Indian Ocean Mombasa, Kenya, 27 August - 22 September 1984	English
9.	IOC-UNESCO Summer School on Oceanographic Data, Collection and Management Erdemli, Icel, Turkey, 21 September - 3 October 1987	English
10.	IOC-UNESCO Regional Training Workshop on Ocean Engineering and its Interface with Ocean Sciences in the Indian Ocean Region, Madras, India, 17 March - 5 April 1986	English
11.	IOC-UNESCO Training Course on the Use of Microcomputers for Oceanographic Data Management Bangkok, Thailand, 165 January - 3 February 1989	English
12.	IOC Advanced Training Course on Continental Shelf Structures Sediments and Mineral Resources Quezon City, Philippines, 2-13 October 1989	English
13.	IOC/IODE Training Course on GF3 Data Formatting System Obninsk, USSR, 14-24 May 1990	English
14.	IOC Training Course on Microcomputers and Management of Marine Data in Oceanographic Data Centres of Spanish-speaking Countries, Bogotá, Colombia, 21-30 October 1991	English Spanish
15.	IOC Advanced Training Course on Nearshore Sedimentation and the Evolution of Coastal Environments, Kuala Lumpur, Malaysia, 17-29 February 1992	English
16.	First IOC Training Course on the Applications of Satellite Remote Sensing to Marine Studies Caracas, Venezuela, 24-28 September 1990	English
17.	IOC-KMFRI-RECOSCIX (WIO) Regional Training Course on Microcomputer-based Marine Library Information Management, Mombasa, Kenya, 10-21 August 1992	English
18.	ROPME-IOC Regional Training Course on Management of Marine Data and Information on Microcomputers for the ROPME Region, Kuwait, 18-28 October 1992	English
19.	IOC-SOA Training Workshop on Environmental Effects on Benthic Communities Xiamen, China, 19-23 October 1992	English
20.	IOC Training Course for the Global Sea Level Observing System (GLOSS) directed to the African and South American Portuguese and Spanish-Speaking Countries São Paulo, Brazil, 1-19 February 1993	English
21.	IOC-SSTC-SOA Training Course on Marine Information Management and ASFA Tianjin, China, 19-30 October 1992	English
22.	First IOC/IOCARIBE-UNEP Training Course on Monitoring and Control of Shoreline Changes in the Caribbean Region, Port-of-Spain, Trinidad and Tobago, 21-30 July 1993	English Spanish
23.	IOC/WESTPAC Training Course on Numerical Modelling of the Coastal Ocean Circulation Matsuyama, Japan, 27 September - 1 October 1993	English
24.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 28 September - 9 October 1992	English
25.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 27 September - 8 October 1993	English
26.	IOC Training Course on Ocean Flux Monitoring in the Indian Ocean. Organized with the support of the Government of Germany, Mombasa, Kenya, 15-27 November 1993	English
27.	IOC-UNEP-SPREP Training Course on Coral Reef Monitoring and Assessment Rarotonga, Cook Islands, 23 February - 13 March 1994	English
28.	IOC-JODC Training Course on Oceanographic Data Management Tokyo, Japan, 28 September - 9 October 1992	English
29.	IOC-UNEP-WHO-FAO Training Course on Qualitative and Quantitative Determination of Algal Toxins Jena, Germany, 18-28 October 1994	English
30.	IOC Training Course on Oceanographic Data Management for the Black Sea Countries Obninsk, Russian Federation, 1-12 August 1994	English
31.	COI-CEADO Curso Regional de Capacitación en Gestión de Datos e Información Oceanográficos Buenos Aires, Argentina, 17-28 de octubre de 1994	Spanish
32.	IOC-UNEP-FAO Training Course on Nutrient Analysis and Water Quality Monitoring Zanzibar, Tanzania, 21-26 November 1994	English
33.	IOC-IOMAC Advanced Training Course on Marine Geology and Geophysics off Pakistan. Organized with the support of the Government of Germany National Institute of Oceanography. Karachi, Pakistan, 12-26 November 1994	English

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SUMMARY REPORT Page

1. INTRODUCTION

The IOC-IOMAC-Germany Advanced Training Course on Marine Geology and Geophysics off Pakistan, was held at National Institute of Oceanography (NIO) Karachi, Pakistan, 12-26 November 1994. The aim of the course was to train scientists of the Indian Ocean States at an advanced level in the field of marine geology and geophysics.

The exploration and evaluation of the offshore non-living resource potential *inter alia* hydrocarbons, minerals, construction materials, are entirely dependent on the capabilities of a country in the field of marine geology and geophysics. The coastal states of the Indian Ocean have sizeable areas of Exclusive Economic Zone (EEZ) in their jurisdiction and these valuable resources need to be mapped and assessed properly for present and future economic needs of the coastal states.

Marine geological and geophysical mapping and exploration, though very expensive, is indispensable for this purpose and the nations with better facilities and competency in this field have better chances of finding these vital non-living resources. The coastal and shelf areas are very favourable and of immense priority in this respect. At present, the capabilities of IOMAC countries to conduct such investigations and surveys vary greatly. Some have equipment and personnel familiar with the relevant methods and techniques and some others have just started, while many countries have not yet undertaken any work in this field.

Responding to this situation and in pursuance to the Intergovernmental Oceanographic Commission (IOC) and Indian Ocean Marine Affairs Co-operation (IOMAC) policies and programmes, in accordance with their Memorandum of Understanding and particularly related to strengthening of regional co-operation and co-ordination, this advanced training course was conducted in Pakistan as it is one of those IOMAC nations which have sufficient basic capabilities and facilities for conducting this type of training course. The two-week long course was sponsored by IOC-IOMAC and was funded by the Federal Republic of Germany while the Government of Pakistan, through its Maritime Affairs Wing (MAW), of Ministry of Defence and NIO hosted the programme and provided all the local facilities, including survey vessel for this purpose. All local arrangements were made by NIO and the course was held at its premises. The actual training and technical session was jointly conducted by German, Dutch and NIO scientists. Thirteen foreign trainees from the Indian Ocean countries along with six Pakistani trainees and five NIO observers attended the training course.

Dr. Kitazawa co-ordinated the course on behalf of IOC-UNESCO; Dr. Giermann was the co-ordinator on behalf of the German Government and it was led by Dr. H.R. Kudrass also on behalf of the German Government. Commander S. Mazhar, Deputy Secretary of MAW, represented the Government of Pakistan. The local host and organizer, Mr. S.H. Niaz Rizvi, National Institute of Oceanography, supervised the conduction of the course programme. Mr. Muhammad Tahir, Senior Research Officer, of NIO, acted as the local co-ordinator.

The course consisted of three main components: (i) lectures/seminars and laboratory exercises; (ii)) a geological field trip and (iii) survey cruises. Three day-long cruises were made on board the government of Pakistan's **S.V. BEHR PAIMA.** The training course was successfully concluded with a certificate awarding ceremony and an excursion trip to the historical city of Thatta near Karachi.

2. BACKGROUND

The Indian Ocean is the smallest amongst the world oceans, covering about 60 million Sq. Km. of the surface of the earth. However, for several reasons it is a very important ocean for the world community. About one third of the world population lives in the countries surrounding the Indian Ocean including some of the least developed. Their population represents the largest single concentration of world population, and is heavily dependent on their marine resources. It has been recognized that the Indian Ocean has vast mineral and hydrocarbon potential but very little is known about the extent and location of these resources. Inadequate national capabilities in marine science and technology and financial constraints of most of the Indian Ocean countries have hampered the development of these resources.

There are a number of international agencies under the umbrella of the United Nations in the pursuit of cooperative effort for the collective well being of maritime nations. The IOMAC is a regional body with broad based interest and of activities encompassing all the aspects related to the marine sector economy. In order to develop the resources it was felt necessary for the IOMAC member states to cooperate actively with each other. Accordingly, a Technical Group has been formed by IOMAC for combining forces to investigate the offshore potential of mineral and hydrocarbon resources. Pakistan hosted the first meeting of this Technical Group at Karachi in 1988 where the essential organizational and administrative arrangements were formulated. The standing committee and the sub committees were formed to further increase the scale of functions of IOMAC in carrying on their tasks actively. A symposium on Prospecting for Mineral Resources in the Indian Ocean, was organized at Karachi from 11 to 14 July 1988, sponsored by IOMAC. During this symposium, the first meeting of the IOMAC Technical Group on Offshore Prospecting for Mineral Resources in the Indian Ocean took place, and Pakistan was selected to organize and conduct an advanced training course in this respect. The need for training courses in marine geology and geophysics was further emphasized during the IOMAC International Scientific Workshop on Marine Scientific Cooperation in the Indian Ocean held at Colombo, Sri Lanka, from 18 to 25 October 1992 where the working group on non-living resources recommended this aspect among one of its priorities.

Pakistan is an active and significant member of IOMAC and therefore had its full support for this training course and conducted it in pursuance of the above mentioned facts and the Government of Pakistan's commitments for international and regional cooperation in the field of scientific research.

The IOC Regional Committee for the Central Indian Ocean (IOCINDIO) at its First Session, 3-7 July 1988, in Islamabad, Pakistan, in considering the regional component of the IOC Ocean Science in Relation to Non-Living Resources (OSNLR), adopted two related projects, aiming at a geological survey of the continental shelf in the Central Indian Ocean, and a study of riverine sediment impacts to the Indus Cone. The Regional Committee also decided that a state-of-the-art report on the scientific basis of mineral exploration and exploitation in the central Indian Ocean was desirable, reflecting the state of affairs in each of its Member States. It furthermore stressed, that hydrocarbons are the object of both economic and scientific interest. The present advanced study course is also an element of this regional OSNLR programme of IOCINDIO.

The co-operation between IOC and IOMAC manifests the importance of the subject area. The human capacity building is a pre-requisite for advancement and satisfactory development of this important subject in the region,

3. OBJECTIVES

The main objective of the course was to provide advance training to the participating scientists of the region about modern techniques and future trends of exploration surveys and mapping in marine geology and geophysics, as well as familiarizing them with the operation of modern survey equipment, field procedures, data and sample acquisition, analysis and interpretation with special emphasis on high-resolution seismic and shallow sediment sampling surveys.

The course also aimed at providing up-to-date scientific knowledge about the sedimentary processes, features and deposits in the coastal and shelf regions, including deltaic areas.

4. PARTICIPANTS

The trainees for this training course were selected by IOC, on preset criteria and in consultation with Dr. Giermann and Dr. Kudrass. This included nineteen candidates both from nine Indian Ocean coastal states and Pakistan as follows:

Indonesia (l); Iran (l); Kenya (3); Malaysia (1); Mauritius (l); Mozambique (2); Oman (l); Pakistan (4) Sri Lanka (l); Thailand (l).

In addition, five NIO scientists participated as observers. The trainees belonged to various disciplines of marine geosciences such as oceanography, hydrography, sedimentology, geochemistry, geohydrology, marine geology and geophysics and were associated with government organizations in their respective countries. There were two female trainees, one from Kenya and one from Pakistan amongst the course participants. The course was conducted by four foreign instructors, three from Germany and one from the Netherlands along with two instructors from NIO. Two guest speakers, one from SUPARCO, Pakistan and another one from USGS, USA, were also invited to deliver lectures on special topics. Dr. Kudrass from BGR, Germany was the Chief instructor with Mr. Muhammad Tahir from NIO Pakistan as the host coordinator of the training course. The details about the participants are given in Annex II.

5. COURSE LEVEL

The level of the course was of an advanced nature, but it was formulated in such a way that all the trainees technically benefitted to a maximum possible extent. The language of the course was English and the lectures were quite well perceived by the trainees and well supported by audio-visual aids such as slides, transparencies.

6. COURSE OUTLINE

The training course basically consisted of three main components: (i) lectures and laboratory exercises; (ii) field work and (iii) survey cruises and data acquisition and interpretation. The first week was devoted to lectures and laboratory exercises and analysis work in the morning and afternoon sessions respectively. The Seminar presentations by the trainees were the last item each day during the first week.

The lectures covered major topics related to coastal and shelf sedimentary processes, deposits and exploration survey methods. Special emphasis was given to high-resolution seismics including bathymetry, sub-bottom seismic profiling and side scan sonar surveying techniques and their applications. Similarly, the exercises on bathymetric and sub-bottom profiling data as well as sedimentological and geochemical sediment laboratory analysis were performed as hands on illustrations of the concepts and knowledge gained through lectures. At the end of the first week of lectures and laboratory work a field trip to a beach site was made so that the trainees could observe beach sedimentary processes and features *in situ* and had an opportunity of systematic sediment sampling and description in the field by themselves.

The survey cruises on board **S.V. BEHR PAIMA** were the most vital part of the training course. It was planned to provide maximum possible practical knowledge and experience to trainees by demonstrating to and involving them in cruise planning, equipment operation, on board data acquisition, sample collection preservation and preliminary analysis and evaluation. Further time was reserved for analysis and interpretation of the acquired data and samples in the laboratory.

7. PRE-COURSE ACTIVITIES

In the early stages, after the announcement of the training course, matters of local arrangements were discussed at meetings of MAW and NIO. MAW was to obtain the required government clearances and permission in this respect and to arrange the survey vessel from Pakistan Navy. NIO was to make all technical and administrative arrangement to conduct the training course at NIO. Meetings with Mr. Tahir of NIO and the Chief Instructor, Dr. H. R. Kudrass, were held in Hannover, Germany, during July-September 1994, to discuss the technical matters of the course. A meeting between Mr. Tahir, Dr. Kudrass, Dr. Giermann and Dr. h-ion was also held in August 1994, at Bremen, Germany, where all the major aspects of the training course programme were finalized. Communication between NIO, IOC and the German scientists continued in this regard until the start of course. The trainees were also contacted about the course programme. Mr. Scheer, the Consul General of Germany, also visited NIO and discussed matters relating to the training course.

The Director General, NIO, appointed Mr. Tahir, Senior Research Officer, Co-ordinator for this training course programme. To accomplish this programme NIO constituted committees for the necessary arrangements as follows;

(i) secretariat services;
(ii) equipment preparation, installation, operation, and maintenance for the survey cruises as well as for the lab and field work;
(iii) transport and board/lodging/catering for participants;
(iv) inauguration and closing ceremonies;
(v) excursion and field trips;
(vi) publicity and press.

Besides the above mentioned committees, all NIO scientists and staff were also involved in the arrangement of the course.

A suitable hotel (Embassy Hotel) was arranged for the non-Karachi participants at the nearest possible distance from NIO. Transport was also arranged to collect and drop off the participants. All the necessary arrangements were completed before the commencement of course.

8. COURSE ACTIVITIES

8.1 ARRIVAL OF PARTICIPANTS

NIO staff received the course participants at airport and took them to their hotel. The organizing group, comprising of the Director-General of NIO, instructors and senior NIO scientists, held a meeting at NIO on the morning of 12 November 1994 to review the arrangements and facilities for the course and to finalize the programme.

On the same evening an informal reception party was held at the Hotel Embassy, where the participants and organizers had a get-together with light refreshment. The participants were provided with the programme and miscellaneous information about the course.

8.2 OPENING CEREMONY.

The course was officially opened in the name of Allah and recitation from the Holy Quran at 10:00 hours on 13 November 1994 at the Avari Towers Hotel in Karachi. Mr. S.H. Niaz Rizvi, Director-General NIO, delivered his welcome address in which he emphasized the need and importance of such training courses for the IOMAC countries. After this, Dr. H.R. Kudrass, the Scientific Course Leader, explained the objectives and technical structure of the course. It was followed by the addresses of Dr. G. Giermann and Dr. K. Kitazawa, representing the German Government and IOC respectively, in which they expressed their greetings and views about the purpose and benefits of the course. Mr. Naimatullah Khan, Additional Secretary, MAW, Ministry of Defence, spoke on behalf of the Government of Pakistan. Mr. Syed Murad Ali Shah, Provincial Minister for Agriculture of the Government of Sindh was the chief guest of this opening ceremony. In his inaugural address he commended IOC-IOMAC and German Government for organizing this course in Pakistan. The Consul General of Germany, Mr. Scheer, was also present. The inaugural session was also attended by the scientists, hydrographers, engineers, technicians and officials belonging to various departments of Government of Pakistan. All the instructors, trainees, and NIO scientists also attended the opening ceremony, after which they proceeded to NIO where the technical session commenced with an introductory lecture by Dr. Kudrass.

8.3 SUMMARY OF TECHNICAL PROCEEDINGS

The first week of the course was devoted to lectures, exercises and laboratory work and the second week was devoted to field-work, survey cruises and data evaluation with some further lectures and exercises. The Timetable of the course programme is given in Annex I. A brief account of the three components of the training course is presented below.

8.3.1 Lectures and Laboratory Exercises

Pakistan offshore region in the east is formed mainly by the sediments brought by the Indus River. Therefore the initial lectures were about the river inputs, general sediment sampling and coring techniques. A presentation about the geological frame-work of Pakistan was also given to provide the basic information about the past and present geological conditions, salient morphological features and non-living resource potential of the offshore region It was followed by lectures on the introduction of survey methods such as position-fixing end navigation, a very critical and vital aspect of any marine survey, bathymetry, high resolution seismic profiling and seismic data interpretation. Sediment sampling strategy and methods were also described.

During the next stage, presentations focussed on the mapping of the coastal and shelf areas and on the sedimentary processes operative there, elaborated by selected case histories. Sea level changes and their impact on the sedimentation, geochemistry, paleoclimate, age determination, identification of coastal land forms by remote sensing, coastal geology and management were other important topics addressed during these lectures. Further lectures on research vessel operations and management, side scan sonar, magnetics and seismic equipment on board S.V. **BEHR PAIMA** were delivered during the latter part of the course after field and cruise work. A special invited lecture on “Manganese Nodules” was delivered by Dr. J.R. Hein of USGS.

During the first week the last lecture hour of each day was designated for a seminar where trainee scientists made presentations related to their own research work, or some relevant case history of their country. Laboratory exercises were conducted in afternoon sessions. These exercises were prepared to provide the trainees with more detailed understanding of the lectures and working practice for data evaluation, sediment sample preparation and analysis etc. Bathymetry and seismic data interpretation, as well as sedimentological and geochemical sediment analyses were given more time and attention. At the end of the course a compiled set of all reproducible teaching and exercise material was presented to each trainee.

8.3.2 Field Work

In order to elaborate and understand the coastal marine processes and deposits a day-long geological field trip was made in the Sonmiani area of Makran Coast. The entire day was spent in studying the beach sedimentary processes and features, as well as observing the beach profiles and collecting sediment samples. Heavy mineral deposits in the area were of specific interest and a few possibly favourable sites were identified. Nearby rock outcrops were also visited. The collected samples were described in the field and were later analyzed in detail in the laboratory during the following days.

8.3.3 Survey Cruises

Offshore research cruises on board **S.V BEHR PAIMA** were carried out on 20, 21 and 22 November 1994 to carry out geophysical and geological surveys in Karachi offshore areas. Each day the participants embarked on board **S.V BEHR PAIMA** from Karachi harbour and in the evening they returned back to their hotel. The first of these day-long cruises was made off the Cape Monze area close to the Churna Island where echosounding, 3.5 KHz sub- bottom profiling and surficial sediment sampling were carried out. NIO installed its GeoAcoustic’s (previously ORE) 3.5 KHz and Sonar Enhancement System (SES) on board **S.V BEHR PAIMA.** In addition to this, NIO also took on board its Side Scan Sonar System, large and small piston corers, grap samplers etc. The early part of the day when the ship was underway to the survey area was used in briefings about the ship and its equipment by ship’s organization and lectures about survey planning and management by the instructors. The time was also availed to time up the profiling system. After some initial problems and adjustments the 3.5 KHz profiling system started properly working and the data was continuously recorded both in the analogue and in the digital forms on Thermal Graphic Recorder and SES (Exabyte tapes) respectively. Echosounding and seismic profiling records revealed quite interesting bottom and sub-bottom features. Generally, there appeared the rugged bottom with occasional rock/reef outcrops and varying sediment veneer. A number of seabed sediment samples were also collected at selected sites using the grab sampler.

On the second day the survey was conducted in the Indus Shelf area. In contrast to the Off Cape Monze area, this part of the shelf generally had the featureless smooth bottom with spectacular subsurface acoustic features like small and wide buried charnels, channel cut and fill system, transparent to semi-transparent layers, erosional surfaces etc. Apart from these features the upper subsurface reflectors were horizontal, parallel and continuous for long distances except where interrupted by channels. Good seismic wave penetration, down to several tens of meters was commonly obtained in this area. Sediment grab samples were also collected at different selected locations.

On the third and last cruise the survey was first carried out in the SW of Karachi i.e., towards the Indus shelf side up to 60 m water depths. This time the ship's Boomer system was also operated for some time and further deeper acoustic penetration was obtained. However, the same subsurface strata and features prevailed as they appeared on 3.5 KHz profiling record in this area. In addition to grab sediment sampling the piston corer was also operated. Due to the unfavorable sediment nature a small length of about 40 cm of sediment core could be recovered. Further coring attempts were not successful due to the same reason. After spending considerable time in this area the ship proceeded once again to the Churna Island area where very interesting and useful bathymetric and seismic profiling data was collected. The Side Scan Sonar system was also deployed there but, after a short recording duration, the operation had to be abandoned due to some technical fault. Further surficial sediment sampling was also done.

These survey cruises gave an invaluable opportunity and practical experience to the trainees as they observed and participated in all the shipboard activities from survey planning to data and sample collection and preliminary analysis and evaluation. The S.V. BEHR PAIMA is a very well-equipped survey vessel with all modern equipment and facilities for hydrographic, high-resolution seismic, gravity and magnetic, as well as shallow sediment sampling surveys. The trainees were showed round the ship and were explained about these systems. The collected data and samples were further analyzed and interpreted in detail at NIO laboratory after the survey were completed.

8.4 Closing Ceremony

After the successful completion of the training part, the course was formally concluded with a simple but memorable ceremony on the evening of 24 November 1994 at the pool side of the Marriott Hotel, Karachi. About 150 guests attended this ceremony. After the recitation from Holy Quran the proceedings commenced with an open lecture by the Chief Instructor Dr. H.R. Kudrass on "Marine Mineral Resources". This informative talk was accompanied by a very nice and absorbing slide and video presentation which everyone enjoyed. This was followed by the distribution of a certificate chaired by Mr. S.H. Niaz Rizvi, Director-General, NIO, with Dr. G. Giermann and Dr. H. R. Kudrass accompanying him to distribute the certificate to the trainees.

After this the souvenirs were presented by the Director-General, NIO to the instructors. He also thanked all the participants, especially the guest trainees and instructors and other national organizations which helped during the course. Dr. H. R. Kudrass, on behalf of instructors, and Dr. G. Giermann, on behalf of IOC and IOMAC, as well as the German Government, expressed their thanks to the organizers. On behalf of the trainees, Mrs. Abuadha of Kenya also thanked the course organizers and sponsors. A farewell dinner hosted by NIO was the last event of this ceremony.

The next day a cultural trip to the historical city of Thatta near Karachi was made. This also enabled the participants to have a view of the deltaic land area. On 26 November 1994 an informal assessment of the course was made by the organizers and instructors.

9. FINANCIAL ASSISTANCE

The course was financially assisted by the German Government through a voluntary contribution to the IOC for TEMA activities. Further assistance was provided by the Government of Pakistan and the IOC Secretariat. Part of the funds were provided to NIO through IOC, UNESCO for local expenditures.

10. CONCLUSION

The training course was an overall success since it achieved all its major objectives, in spite of the variety of topics, hectic lecturing, laboratory sessions and extensive field and survey activities within a short period of just two weeks. This training course brought various important and major aspects of marine geology and geophysics together to the trainees from various disciplines of earth sciences and made them acquainted with the principal applications current state of development and future developments of the major and widely used survey techniques. The emphasis given to the practical aspects such as field data /sample collection, analysis and interpretation during the course has certainly provided improved confidence of the trainees in conducting these type of surveys by themselves. The cruises provided them with vital on-the-job training.

The individual presentations of the trainees during the seminars gave a good opportunity to the participant to familiarize and discuss the various mutual and regional marine geological aspects and problems. Scientific discussions among the scientists, both trainees and instructors, were a source of learning and increasing the knowledge in the field of marine geology and geophysics. This training course has certainly enhanced the capabilities of the trainees of the region in the field of Marine Geology and Geophysics.

Apart from the scientific and technical achievement the event was an unforgettable occasion of harmony, understanding, warmth and affection among the participants belonging to different regions and cultures.

11. RECOMMENDATIONS

In the light of experience gained during this training course, the following recommendations are being made for future training programmes of this kind:

(i) IOC-IOMAC should continue supporting and funding this type of course on a regular basis, on a two- to three-year periodic basis. This will enable the participating countries to update, develop and enhance their capabilities in marine geology and geophysics, especially in conducting the surveys for non-living resource exploration in their EEZ.

(ii) The duration of the course needs to be extended to at least three to four weeks, so that more time for lectures, cruises, field work and data and interpretation analysis is available.

(iii) A simple objective type tests of the trainees should also be held at the mid-term, after lecturing part, and at the end of the training course to evaluate the performance of trainees and to help the instructors to adopt a more effective line of action. This will also build up the interest of trainees.

12. ACKNOWLEDGEMENT

The success of the course is due to all those who contributed in its accomplishment, no matter at what level. NIO is extremely grateful for the assistance of all the Organizations and individuals in this respect. IOC enabled this course to be materialized and Dr. Kitazawa's efforts expedited the process making the on-time conduct of the course possible. In addition, during his brief stay at the start of the course, Dr. Kitazawa also provided his valuable guidance in the smooth running of the course. Dr. G. Giermam admirably used his vast administrative experience to co-ordinate the course activities wisely but discreetly. The lively personality of Dr. H.R. Kudrass provided the real spirit to the course with his deep scientific and technical knowledge, experience and leadership. The painstaking efforts of Dr. Schuttenhelm and Dr. Irion to educate and train the trainees were the main elements for the success of the course.

At the national level the course was patronized by MAW under the Ministry of Defence, which made possible the vital arrangements such as the facilities of S.V. BEHR PAIMA, all government clearances, personnel security etc. The Deputy Secretary, Cdr. Mazhar Hussain Shah of MAW, not only played the key role in this respect, but also wisely advised in these matters.

The Pakistan Navy made the most significant local contribution by providing its survey vessel S.V. BEHR PAIMA for training research cruises during the course. The Maritime Security Agency (MSA) is highly appreciated for making the security arrangement, and for the provision of additional transport facilities when required.

The Consul General of Germany at Karachi, the Director General MSA and the Hydrographer, Pakistan Navy, deserve special thanks for hosting receptions and dinners in the honour of course participants.

ANNEX **I**

TIMETABLE

Saturday, 12 November	a.m.	Organizing group meeting
	p.m.	Reception party
Sunday, 13 November	a.m.	**Opening ceremony**
	p.m.	Lectures:
		River inputs (Irion)
		Sampling and coring techniques (Schuttenhelm)
		Geological framework of Pakistan (Tahir)
Monday, 14 November	a.m.	**Lectures:**
		Positioning and bathymetry (Kudrass)
		Principles of seismics (Tahir)
		High-resolution seismic interpretation (Schuttenhelm)
		Sampling strategy and methods (Irion)
	p.m.	Exercises:
		Bathymetry, grain size, and facies of shelf sediments (Brazil) (Kudrass, Schuttenhelm, Irion)
		Seminar by Aboudha/Unyao
Tuesday, 15 November	a.m.	**Lectures:**
		Sedimentation on tidal flats (Irion)
		Bathymetry (Kudrass)
		Coastal processes (Schuttenhelm)
		International organizations (Giermann)
		Case study on coastal change on Rarotonga (Giermann)
	p.m.	**Exercises:**
		Seismic interpretation (Schuttenhelm)
		Seminar by Al-Busaidi, Nazir, Chooramun
		Reception on board R.V. Behr Paima

Wednesday, 16 November	a.m.	Lectures:
		Shelf and coastal mapping (Schuttenhelm) Anthropogenic heavy metal record (Irion) Invited lecture on identification of coastal landforms (Javed) Sea-level changes (Kudrass)
	p.m.	Exercises:
		Construction of sea-level curve, and shelf mapping (Kudrass) Seminar by Masjedi
Thursday, 17 November	a.m.	**Lectures:**
		Shelf sedimentation (Irion) Gee-chemistry and paleo-climate (Athar) Age determination (Kudrass) Coastal geology and management (Schuttenhelm)
	p.m.	Exercises:
		Construction of surficial map (Schuttenhelm) Carbonate and organic carbon determination (Athar) Deep sea sediments (Kudrass) Seminar by: Chemane/Achimo, Udaya, Boonlue, Ranatunga
Friday, 18 November	a.m.	Geological excursion along the coast in the southern part of Sonmiani Bay, north of Karachi
Saturday, 19 November	a.m.	Evaluation of field data (Kudrass, Irion, Schuttenhelm) Case study on offshore gravel exploitation outside Nukualofa, Tonga Islands (Giermann) Seminar by: Boonlue, Ranatunga
	p.m.	F r e e
		Dinner by Maritime Security Agency on board MSS Barkat and Rehmat
Sunday, 20 November		**Cruise** onboard S.V. Behr Paima to Cape Monze offshore area near Churna Island.
Monday, 21 November		Cruise onboard S.V. Behr Paima to Indus Delta and shelf area.
Tuesday, 22 November		**Cruise** onboard S.V. Behr Paima to 60 meter depth SW of Karachi and Cape Monze offshore.

Wednesday, 23 November	a.m.	**Evaluation** of cruise data/samples Irion, Schuttenhelm)
		Lectures:
		Research Vessel operation and management (Kudrass) Side scan sonar (Kudrass) Magnetics (Tahir)
	p.m.	**Exercises:**
		Relict sands on the shelf of Pakistan (Kudrass) Reception by German Consul-General, Herr Scheer
Thursday, 24 November	a.m.	**Exercises:**
		Sambezi shelf sedimentary processes (Kudrass) Special Lecture by USGS Dr. J.R. Hein on Manganese nodules Seismic equipment of S.V. Behr Paima (Tahir)
	p.m.	F“ r e e
		Closing ceremony for the distribution of Certificates.
		Open Lecture on Marine mineral resources with video presentation (Kudrass).
		Farewell dinner.
Friday, 25 November	a.m.	**Cultural trip** to Thatta in Indus deltaic area.
Saturday, 26 November	a.m.	**Final assessment** of the course by instructors/organizers.

ANNEX II

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