

**Intergovernmental Oceanographic Commission**  
Workshop report No. 13



# **Report of the IOCARIBE Workshop on environmental Geology of the Caribbean Coastal Area**

Port of Spain, Trinidad and Tobago  
16 - 18 January, 1978

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SUMMARY REPORT OF THE IOCARIBE WORKSHOP ON ENVIRONMENTAL  
GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago,  
16 - 18 January 1978

1. Opening of the workshop

The Workshop for Environmental Geology of the Caribbean Coastal Area was held at the Institute of Marine Affairs, Port of Spain, Trinidad and Tobago, from 16 to 18 January 1978, under the auspices of the IOC Association for the Caribbean and Adjacent Regions (IOCARIBE). The meeting was opened by Dr. John P. Scott, Chairman of the Workshop Steering Committee, after which Professor Max Richards, Chairman of the Marine Affairs Council, Institute of Marine Affairs, welcomed the participants to Trinidad. Professor Richards told the participants that this Workshop held special significance for the Institute of Marine Affairs which only a few days before had moved into its new building. He hoped that coming out of the meeting would be a programme to provide the region with the relevant information for management of coastal zones. This information, he stressed, was sadly lacking and any work towards remedying this position was most welcome.

1.1 Election of officers

Dr. John P. Scott (Trinidad and Tobago) was unanimously elected Chairman of the Workshop. Dr. Gabriel Dengo (Guatemala) was elected as Rapporteur. The List of Participants is attached as Annex VI.

1.2 Initial discussions and background review

Dr. Robert R. Lankford, Regional Secretary IOCARIBE, said that a number of invited key participants unfortunately had not been able to attend the Workshop for various reasons. He expressed the hope, however, that the goals of the Workshop could be accomplished despite this handicap.

Dr. Lankford briefly reviewed the history of IOCARIBE's interest in environmental geology studies, mentioning Recommendation 10, Environmental Geology of the Coastal Area, Annex IV of IOCARIBE ad hoc-I/3 (Puerto Rico, 1 - 4 March 1976), its high priority assessment and subsequent formulation as Recommendation IOCARIBE-I.3 at Caracas, in July 1976. It was this latter recommendation which called for the present meeting and gave its terms of reference.

Recommendation IOCARIBE-I.3 is attached as Annex II.

Dr. Lankford continued by explaining that environmental geology was the study of cause-effect relationships and as such was divisible into the study of both products and processes. It was in consideration of the fact that coastal

area processes are of importance to other disciplines that the Steering Committee had invited not only geologists to this Workshop but also had included experts in biology, marine pollution, coastal engineering, coastal area planners, etc. in an effort to ensure that the resulting environmental geology programmes would yield the greatest possible research benefits.

The participants briefly discussed the term "coastal area" and agreed that this term includes the marine and marginal marine areas from the seaward margin of the continental shelf to the water line and inland to include the coastal hinterlands which interact with the sea.

### 1.3 · Adoption of the agenda

The provisional agenda was presented by the Chairman. It was adopted without substantive modification. The agenda is attached as Annex I.

## 2. Definition of programme scope

The participants had been requested by the Steering Committee to consider, in addition to environmental geology per se the actual or potential relevance of the research programmes to other disciplines and information needs. They were also requested to bear in mind the need to incorporate training, education and mutual assistance within the programme structure and to consider the complementarity of research in view of other existing or planned coastal area programmes at national and international levels.

### 2.1 Environmental geological research

The participants noted that marine environmental geology departs from more classical geology by virtue of incorporating environmental processes as an integral part of the discipline. Environmental geology, consequently, seeks to relate the physical, chemical and biological processes to geological products. The scope of the proposed research programmes, hence, must also include research on specific environmental processes such as the mechanical and hydrodynamic systems, on biological systems which contribute to or otherwise influence the geological product, and on prevailing chemical conditions which result in solution, alteration or precipitation of solids.

The session stated that due to the absence of key participants it would not be possible to define the programme proposals with the desired precision at this time. It dedicated further definition and refinement to the eventually selected programme manager(s). The Regional Secretary stated that the programme manager might ideally be aided in this subsequent planning effort by a small committee of experts and said that he would investigate the funding situation to accomplish this goal. See Recommendation IOCARIBE/EGCCA.1 in Annex III.

The participants then began their discussion on the scope of the environmental geology programme. It was agreed that the first requirement was to obtain the necessary topographic and bathymetric maps for the pilot study areas, noting that additional field surveying most likely would be required to fill in information deficiencies. It was stressed that any such surveys should endeavour to incorporate desired field sampling programmes whenever possible.

In regard to specific environmental geology programmes, the participants identified the following:

- (1) environmental identification and mapping in both the terrestrial and marine sectors of the coastal area (specific environments mentioned include: coastal and alluvial plains; river deltas; estuaries and lagoons; mangrove swamps; beach-dune complexes; marine substrates, including living and dead reefs and other biogenic accumulations; outcroppings of ancient consolidated rock, etc.).
- (2) sedimentology studies which will include: textural analyses; mineralogy/petrology; sedimentation (transport and rates); geotechnical properties.
- (3) coastal area dynamics and characteristics shall include investigations of: dominant and catastrophic waves (height, period, direction); tides (astronomical and meteorological); currents (wave-generated and permanent circulation); precipitation, evaporation and land runoff; water properties, including temperature, salinity and turbidity (and others, if desired).
- (4) climatology and meteorology data compilations for the purpose of supporting (c) above (e.g. dominant wind velocity and direction may be used for computing the wave regime for coastal sectors).

## 2.2 Relevance of research to other programmes

Following the suggestion of the Steering Committee, the participants considered potential applications of the environmental geology research results to other disciplines and information needs. Mr. Ken Snaggs (Trinidad and Tobago) speaking as a coastal area planner, said that it would be desirable to know what would be the predictable coastal environmental response to certain aspects of man's activities and what types of coast are sensitive or relatively insensitive in this regard. He said that coastal planning needs this information base in order to arrive at the first level of decision making. Dr. John Scott (Trinidad and Tobago) expressed the wish that the environmental geology studies should yield information pertinent to coastal engineering and protection and to such activities as port and harbour development. Tte. Steer (Colombia) stressed the need to include a strong research component in nearshore coastal dynamics and in the geotechnical properties of the coastal substrate. Dr. Barry Wade (Jamaica), reflecting his interests in biological oceanography and marine pollution, said that knowledge of the substrate characteristics (sediment types, rough or smooth topography, and geotechnical properties) was highly important in terms of exploration, exploitation and rational management of living resources. He also said that it would be highly desirable to include studies of the sedimentation history relative to man's activities, especially in view of the fact that accumulating sediment scavenges and traps pollutants which subsequently can be remobilized and resuspended in the water long after a particular pollutant source has disappeared. Dr. Gabriel Dengo (Guatemala) briefly described known non-renewable resources of the coastal area, principally deposits of detrital minerals such as magnetite (an ore of iron) and stated that mineralogical studies should be made with resource evaluation in mind. Dr. Lankford (Regional Secretary) pointed out that the proposed research on coastal hydrodynamics and

sediment mass transport also would provide an information base relative to coastal protection (erosion, sedimentation) and to pollutant transport. All the participants agreed that urbanization, whether at the coast or inland, would have drastic impact on coastal area environments and that in order to have intelligent planning and development, the environmental geology research results would necessarily provide an important part of the information base for urban planning.

### 2.3 Environmental geology relative to TEMA

The participants recognized that there was a scientific manpower deficiency within the developing countries of the IOCARIBE region, particularly in the fields of geological oceanography and environmental geology. The session went on record as mandating to future Project Managers and the IOCARIBE Secretariat that every effort be made to incorporate training, education and mutual assistance within the environmental geology research programmes. It was the sense of the meeting that by so doing, not only would the regional research manpower be increased but without TEMA, the research itself could not be accomplished. Along these lines, Mr. Trevor Boothe (UNEP/ECLA) mentioned several training programmes including the UNEP Tibilsí document and the UNEP training in environmental engineering available to qualified applicants in developing nations. He also called attention to the United Nations SIFCA training programme in environmental studies for Spanish-speaking students located in Spain.

### 3. Complementarity to other programmes

The Chairman requested that participants identify existing or planned programmes within the region which were complementary to the proposals of this Workshop. Mr. Trevor Boothe (UNEP/ECLA) briefly described the contents of the proposed Action Plan for Sound Environmental Management of the Greater Caribbean Area, mentioning those aspects which particularly pertained to marine and coastal environments (e.g. pollution contingency planning, coastal zone management, identification and conservation of critical habitats, natural resources and ecosystems, etc.). Mr. Boothe further stated that there was a critical need to educate the general public regarding the desirability of sound environmental management. Mr. Snaggs (Trinidad and Tobago) reported that Sierra Club International has proposed a mangrove study programme for immediate implementation in Trinidad and Tobago, Venezuela and Puerto Rico. He said that the programme interest was compatible to the environmental geology programme scope, that there was planned field studies but that there appeared to be no training and education component. Dr. Lawrence Neuman (UN) said that the UN Ocean Economics and Technology Office had identified a coastal management programme which encompassed environment identification, coastal engineering and protection and rational exploitation of resources. He said that Costa Rica has made a request to the UN that its Caribbean coast be considered for the OETO coastal mapping programme. He also said that OETO was developing a guide to marine activities within the UN system as well as technology manuals for developing countries. Dr. Neuman concluded by saying that OETO desired cooperation with the IOCARIBE environmental geology programme, specifically mentioning the desirability to arrive at a consensus regarding map scales, projections and symbols. In reference to the IOC/International Oceanographic Data Exchange programme, Dr. Lankford said that IOCARIBE was already committed to send data to the IOCARIBE Regional Data Centre but added that a variety of data and documentation services were also available to IOCARIBE programmes through its RDC.

The participants then enumerated various national programmes within the region. Particular interest was expressed in special problem areas in which environmental clean-up and management were focal points. It was noted that separate efforts were underway or were being planned for Havana Bay (Cuba), Biscayne Bay (USA), Kingston Bay (Jamaica) and Cartagena Bay (Colombia), and that there appeared to be a need for coordination of efforts in terms of methods, calibration and technology transfer. Dr. Wade (Jamaica) and Tte. Steer (Colombia) concurred that IOCARIBE might well function as a co-ordinating agency for these separate bay-harbour management efforts and that a meeting of concerned scientists and managers would be desirable. Dr. Scott asked Dr. Wade and Tte. Steer to join him as a drafting group to write a specific recommendation to this effect. See Recommendation IOCARIBE/EGCCA 2 in Annex III.

#### 4. Definition of methods and techniques

The participants, in accepting that the environmental geology programmes developed for pilot areas ultimately will be extended to the entire region, recognized the need for standardized methods and techniques to ensure comparative results in different areas and at different times. It was the opinion of the meeting, however, that it was not possible at this time to establish standard procedures in all aspects of the programme. The participants preferred to designate certain standardization responsibility, particularly in the areas of field sampling and laboratory analyses, to the future Project Managers in consultation with a small panel of experts. The participants, however, decided to consider certain other procedural matters which were considered within present capabilities.

##### 4.1 Field and laboratory

Dr. A.P. Colvocoresses (USA) gave an in-depth presentation of remote imagery as an investigation and field tool. He said that present satellite imagery techniques permitted gross environmental mapping and commented that such maps would furnish the first level information for subsequent field studies and correlation. Dr. Colvocoresses illustrated various aspects of remote sensing application which presently exist or are planned for future launches. He called particular attention to the Landsat and Seasat systems, pointing out both advantages and limitations. He also indicated that a large portion of the Caribbean was not now covered by near-real-time remote sensing reception. Dr. Colvocoresses concluded, however, that he considered remote sensing to be an invaluable tool for many of the environmental geology programmes being considered.

The Chairman asked Dr. Colvocoresses to prepare a series of recommendations pertaining to the potential use and application of remote sensing and to suggested map scales and projections. The participants subsequently reviewed his presentation and requested that it be included in the Summary Report as a guide for future Project Managers. Dr. Colvocoresses' recommendations are attached as Annex IV.

##### 4.2 Report format

Recalling that an important aspect of the environmental geology programme would be its potential use to other disciplines and to the general field of coastal zone management and development, the participants agreed that the reports include large maps depicting (a) the topography and bathymetry, (b) sedimentary environments and submarine substrates, (c) sediment texture, (d) sediment mineralogy, (e) coastal area dynamics. The participants further agreed that relatively short

explanatory texts would accompany each map and that the whole would constitute a folio report format. Map sizes and map symbols were not considered.

The workshop having considered the desirability of including training, education and mutual assistance as integral components of the programmes, agreed that reporting to scientific journals and writing of student thesis was desirable. The Regional Secretary suggested that project managers should report periodically to IOCARIBE on programme progress; this was accepted.

#### 5. Identification of two pilot areas

The discussion began by considering the kinds and distribution of known geological investigations within the coastal area of the IOCARIBE region. The participants noted that such information would not be complete and, further, that such investigation results may be of questionable value to the proposed environmental geology programmes. It was stressed, however, that the eventual Programme Manager and his investigators would make a thorough literature and data search prior to detailed field planning.

The following national coastal areas were identified as having known studies pertinent to environmental geology:

<u>Nation</u>	<u>Coastal sector(s)</u>
USA	Gulf of Mexico and Atlantic; also in the Caribbean (Puerto Rico, US Virgin Islands).
Mexico	Gulf of Mexico; some in the Caribbean.
Cuba	Atlantic and especially the Caribbean.
Bahamas	Atlantic, extensive carbonate studies.
Jamaica	Caribbean, mainly in Kingston area; scattered studies elsewhere.
Belize	Caribbean, mainly reef-lagoon studies.
Colombia	Caribbean, scattered studies, mainly in Cartagena Bay
Venezuela	Caribbean, scattered studies, mainly in Lake of Maracaibo and Gulf of Cariaco; extensive studies on Orinoco shelf.
Trinidad and Tobago	Atlantic, Orinoco Shelf and in Gulf of Paria
Lesser Antilles	Caribbean and Atlantic, mainly thesis.
Central America (including Guatemala, Honduras, Nicaragua, Costa Rica, Panama)	Caribbean, isolated studies, essentially nil.
Haiti, Dominican Republic, Guyana, French Guyana, Surinam, French Antilles, Netherland Antilles	Caribbean and Atlantic, a few isolated studies; some areas nil.

In addition to pre-existing information as a criterion for identifying pilot areas, the participants considered the potential need for environmental geology studies in view of actual or planned development, other programmes and any expressions of interest on the part of Member States. Dr. Neuman (UN/OETO) reminded the participants of Costa Rica's request for assistance in coastal development planning. This was substantiated by Dr. Lankford and Dr. Dengo. The latter said that although other Central American nations had coastal development plans, there are both manpower



and funding problems. Mr. Snaggs (Trinidad and Tobago) said that the Gulf of Paria, bordered by Venezuela and Trinidad, was under heavy development pressure and said that such information as would be provided by environmental geology studies would be highly beneficial. Dr. Cruz Matos, Acting Director of the Institute of Marine Affairs (Trinidad and Tobago) briefly described the in-house data acquisition programme stating that geological studies would be a welcome supplement.

Several other areas were discussed in detail but the participants decided to recommend the following pilot areas for the environmental geology studies:

- (a) Costa Rica: the Caribbean coastal area between the respective international boundaries with Nicaragua on the north and Panama on the east.
- (b) Trinidad and Tobago and Venezuela: the Gulf of Paria, including the adjacent coastal lands and those pertinent portions of the adjacent Caribbean and Atlantic which are in direct communication with the Gulf of Paria.

The Chairman pointed out that although the two pilot areas were ideally selected, the IOCARIBE Secretariat must secure the permission of the respective governments before studies could be initiated. He suggested that alternate pilot areas be identified as a **safeguard**. After a brief discussion, the following alternate pilot areas were selected in the order given:

- (c) Dominican Republic: the Caribbean (southern) coastal area, extending from the international border with Haiti on the west, to the eastern extremity of the coast at Isla Saona.
- (d) St. Lucia, British West Indies: the entire island coastal area.

The Chairman asked Mr. Snaggs, Dr. Dengo and Dr. Lankford to write brief descriptions of the two pilot areas and the two alternate areas as general information for the Summary Report. These descriptions are attached as Annex V.

## 6. Identification of project managers

The discussion began by considering the general qualifications of project managers. It was agreed that he should be a senior man with ample field and laboratory experience in the field of environmental geology (or geological oceanography) and that he should have both practical and theoretical capabilities. Dr. Lankford suggested that in view of the two pilot programmes to be initiated it would be wise to identify an overall coordinator whose work probably would be part-time and two full-time pilot area programme directors. As had been suggested previously, they would have responsibility for standardizing many of the field and laboratory techniques and methods and could, if need be assisted in this by a small group of experts. It was requested that the IOCARIBE Secretariat initiate the search for appropriate programme directors. See Recommendation IOCARIBE/EGCCA.1

## 7. Project funding and support

The participants agreed that the costs of the environmental geology programmes undoubtedly would be very high but, in their opinion, well justified in terms of information gained. Dr. Lankford pointed out that much of the costs would be dedicated to ship support, laboratory facilities, equipment purchases, etc.

Much of this he termed "in-kind support" indicating that this was not a hard money budget item and that hopefully such support could come through national contributions. He mentioned other potential funding and support sources including direct assistance from UN agencies, the IOC/Voluntary Assistance Programme and the IOC Trust Fund and possibly from various national and international foreign assistance programmes. The participants stated that they did not feel they should work out detailed budgets at this time and requested that the IOCARIBE Secretariat take on this responsibility.

8. Other matters

There were no other matters discussed.

9. Adoption of the report and closing of the meeting

The Chairman requested that the IOCARIBE Secretariat prepare a Draft Summary Report to be adopted by correspondence.

The Chairman expressed his appreciation to all the participants for their attendance and asked that the Summary Report note, with thanks, the excellent **accommodation** provided by the Institute of Marine Affairs, for the services and hospitality of the Trinidad and Tobago Coast Guard and to the IOCARIBE Secretariat for its organizational efforts. The participants, in turn, asked that their appreciation to the Government and people of Trinidad and Tobago be recorded.

The meeting was closed at 18:00, 18 January 1978.

ANNEX I

WORKSHOP ON ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago, 16 - 18 January 1978

A G E N D A

1. Opening of the workshop
  - 1.1 Election of officers
  - 1.2 Initial discussions and background review
  - 1.3 Adoption of the genda
2. Definition of programme scope
  - 2.1 Environmental geological research
  - 2.2 Relevance of research to other programmes
  - 2.3 Environmental geology relative to TEMA
3. Complementarity to other programmes
4. Definition of methods and techniques
  - 4.1 Field and laboratory
  - 4.2 Report format
5. Identification of two pilot areas
6. Identification of project managers
7. Project funding and support
8. Other matters
9. Adoption of the report and closing of the meeting

ANNEX II

RECOMMENDATION IOCARIBE-I.3

ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

The IOC Association for the Caribbean and adjacent regions,

Recognizing that the coastal area of islands and mainlands is most strongly affected by man's activities and is therefore the immediate concern of coastal zone management,

Proposes a systematic and time-progressive and geological programme of investigation collectively referred to as "Environmental Geology of the coastal area" within the IOCARIBE area - the term "coastal area" being defined as those contiguous marine and land areas characterized by direct interaction (typically the coastal plains and submerged continental and insular shelves) - and being guided in the formulation of this programme by information contained in Programme 10 of the ad hoc Group of Experts (Puerto Rico, March 1976) and in the draft programme "Morpho- and Litho-genesis of the Mexican-Caribbean Coastal Shelf Zones", presented by the delegation of the Soviet Union;

Recommends that one of the products of this investigation will be a series of folios (quadrangular maps) of these coastal areas.

Recognizing further that various countries do not have the capability to produce such folios,

Decides that two pilot programmes should be developed,

Suggests that areas which might be considered for these pilot studies include all the coastal areas of the region but in particular, the Lesser Antilles, Central America and portions of the Greater Antilles,

Recommends that a workshop be convened to:

- i) define the content of the above folios
- ii) identify investigative procedures and methods
- iii) develop a co-ordinative scheme for existing national programmes which could produce such folios
- iv) identify areas for the two IOCARIBE pilot studies mentioned above
- v) select Project Managers and Assistant Project Managers as needed;

Appoints Dr. John P. Scott of Trinidad and Tobago as Chairman of a Steering Committee to convene this Workshop and empowers him, in consultation with the Chairman of IOCARIBE, to select the remaining members of the Steering Committee.

ANNEX III

WORKSHOP ON ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago, 16 - 18 January 1978

RECOMMENDATION IOCARIBE/EGCCA.1

PROJECT MANAGERS AND FUNDING

The IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area.

Recognizing that the proposed environmental geology programmes will require on-going individual responsibility in terms of detailed planning and execution, as well as programme funding and support,

Considering that the participants of this Workshop concur that detailed planning and identification of responsible Project Manager(s) is not possible at this time,

Requests the Regional Secretary of IOCARIBE to begin immediately the identification of appropriate and technically competent Project Manager(s) as well as any expert assistance required, and

Further requests the Regional Secretary of IOCARIBE to initiate the identification of funds for the Project Manager(s) and programme implementation.

RECOMMENDATION IOCARIBE/EGCCA.2

IOCARIBE INFORMATION SEMINAR

The IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area,

Considering that there are a number of bays and harbours in the IOCARIBE area which have critical problems related to development (urban, industrial, tourism, etc.) and to pollution,

Recognizing that all of these cases have a local characteristic and small space scale, but that they are present through the whole IOCARIBE area,

Considering that in Biscayne Bay (USA), Havana Bay (Cuba), Kingston Bay (Jamaica) and Cartagena Bay (Colombia) relevant research projects have been initiated or are being planned,

Further recognizing the convenience of unifying the methodology, techniques and procedures being used in each one of these research projects as well as mutual interaction and transfer of technology,

Considering that the terms of reference of the IOCARIBE Secretariat include keeping close contact with the programmes being developed in the region to avoid duplication and achieve optimal effect,

Requests the Regional Secretary IOCARIBE to convene an information seminar late in 1978, or as soon as possible thereafter, with the participation of the scientists involved in the above mentioned projects and working in their main scientific disciplines;

Recommends that the Regional Secretary IOCARIBE identify and contact the above mentioned scientists, through the pertinent IOCARIBE National Associates;

Further recommends that the Regional Secretary IOCARIBE promote the distribution of the bibliography, projects methodology and achievements among the mentioned scientists prior to the seminar.

ANNEX IV

WORKSHOP ON ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago, 16 - 18 January 1978

MAPPING/REMOTE SENSING RECOMMENDATIONS

by A.P. Colvocoresses  
(U.S. Geological Survey)

A. Mapping

1. Coastal mapping of the area be conducted with the aim of covering all pertinent coastlines at 1:250,000 scale and selected areas at larger scales.
2. That such coastal mapping involve a continuous topographic-bathymetric portrayal with tidal lines (low, mean, high) shown where appropriate.
3. That such mapping be conducted on the Universal Transverse Mercator (UTM) projection and based on shut lines as currently developed for land (topo) mapping.
4. That accuracy standards as currently accepted for land mapping be met insofar as is possible and economically feasible.
5. That coastal (topo-bathy) mapping, insofar as possible, be integrated with or made a part of the established mapping programmes of the various countries concerned.

B. Remote Sensing

6. That Landsat satellite data be recognized as a major data source and be applied to the environmental geology programmes to the extent possible.
7. That steps be taken to increase Landsat coverage of the Caribbean as follows:
  - (i) Representation to the USA (NASA) to complete cloud-free Landsat coverage of the Caribbean and to cover selected areas on a continuing basis of at least twice per year and to conclude the thermal channel.
  - (ii) Support the installation of a Landsat receiver that will provide real-time reception for the Caribbean.

- (iii) Support the development of an operational Landsat that will provide coverage of the Caribbean for the foreseeable future.
- 8. That new satellites other than Landsat, such as ITOS, TIROS-N, NIMBUS-G, DMSP, HCMM, and Seasat be evaluated and considered as basic data sources.
- 9. That aerial photographic and aerial basic depth determination methods be evaluated and considered as data sources, particularly for mapping at the larger scales.



ANNEX V

WORKSHOP ON ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago, 16 - 18 January 1978

DESCRIPTION OF PROPOSED ENVIRONMENTAL GEOLOGY PILOT AREAS

First Priority Pilot Areas

I. Pilot Area: Gulf of Paria, Trinidad and Tobago and Venezuela

Definition of the Area

The Gulf of Paria is a marine but nearly landlocked body of water approximately 125 km (east-west) by 60 km (north-south). The Gulf communicates with the Atlantic on the south by the 12 km wide Serpent's Mouth and with the Caribbean on the north by the 15 km wide Dragon's Mouth. An international water boundary separates Trinidad and Tobago (on the east and north) and Venezuela (on the west and south). The central Gulf water depths range from 20 to 35 metres; nearshore waters typically are very shallow. Gulf water characteristics are influenced by the "flow-through" oceanic circulation and the discharge of rivers, mainly discharging from the Venezuela mainland; the effect of the Rio Orinoco is especially pronounced.

Importance, Trinidad and Tobago

The Gulf of Paria watershed comprises about 50% of the Trinidad land area. Within this coastal area, the significant proportion of the national hydrocarbons are produced, refined, processed and shipped. The majority of the agriculture including sugar-cane and sugar refining is located here as is almost all of the major commercial and industrial developments. Petroleum-fueled electric power stations, which supply all the national electrical requirements, are also located in the Gulf coast.

Paralleling the concentration of economic activity in the Gulf coast is the concentration of approximately 90% of the population of the republic, principally in greater Port of Spain, the western peninsula and the urban centres of San Fernando and Point Fortin.

Trinidad and Tobago's economy makes it heavily dependent on the sea. With one exception, all shipping uses the Gulf of Paria. Port of Spain is the only general cargo port. There are five other specialist ports which handle crude oil, refined petroleum products, asphalt, fertilizers, sugar and cement; there are two bauxite trans-shipment ports.

The total Gulf of Paria coastline in Trinidad is 130 km in length. Of this about 25% is occupied by human settlement, industry and recreation and there is a significant portion composed of swamps and wet lands. In consideration of population and economic distribution, the human environmental impact on the Gulf coast can be described as intense.

#### Complementary Programmes, Trinidad and Tobago

The Institute of Marine Affairs has initiated plans and staff acquisition for the following programmes which will complement the IOCARIBE Environmental Geology Programmes:

- 1) Data Acquisition Programme: designed to obtain data which will form the information base for planning and action in coastal zone management and development.
- 2) Coastal Zone Management Programme: to enhance the development of the coastal region by providing criteria and policies as governmental guidelines for regulating further development of Gulf Coastal Zone.

#### Importance, Venezuela

The Gulf coastal region is peripheral to industrial and economic centers. There are few towns which exist mainly as rural centres, fishing villages and for shipment of fish, oil and mineral ores. Settlement is very scattered and population densities are approximately on the order of one per square mile.

It is significant that three Venezuelan rivers are navigable with depths great enough for ocean-going vessels. They are the Rio Grande, Rio San Juan and Rio Orinoco which provide access to the inland ports of Ciudad Bolivar, Caripito and Puerto Ordaz. This maritime traffic is important both internationally and intra-nationally providing links between raw materials and processing centres.

There is developed hydro-electric power inland on the Rio Caroni, a tributary of the Orinoco, which is the major electrical supply for the region. **Oil-fuelled electrical generation is a future potential asset.**

Of the approximately 250 km of Venezuelan Gulf shore, relatively little is occupied by human settlement and consequently there is at present essentially very low environmental impact, a situation in striking contrast to the Trinidad side of the Gulf of Paria.

#### Complementary Programme, Venezuela

No specific programmes in the Venezuelan part of the Gulf coastal area are presently known. There has been and probably will continue to be oil exploration activity which usually includes bathymetry in conjunction with geophysical surveys at sea.

## II. Pilot Area: Caribbean Coast, Costa Rica

### Definition of the Area

The area proposed includes the entire coastal zone of the Limon Province, between the Costa Rican boundaries with Nicaragua and Panama, which is approximately 150 km long. This zone includes the mouths of several important rivers such as the Rio San Juan (Nicaraguan border), Rio Reventazon, Rio Banano, Rio Estrella, and Rio Sixaola (Panama border). From Port Limon, in the central part of the coast and to the north, the coastline is fairly straight. Parallel to the coast, there are a series of inland lagoons (e.g. Laguna de Tartugurro) now interconnected by a navigation canal for small boat traffic. The adjacent land is low and, in places, swampy. The southern portion of the coast, beginning at Port Limon, is characterized by a series of small points (Limon, Cahuita, Sixaola) surrounded by coral reefs. The land topography in this sector is abrupt, with the exception of some wide valleys (Rio Bananito, Estrella, Sixaola).

The rainfall is very high, particularly in the north, where it exceeds 6,000 mm annually.

### Importance

The area, with the exception of Port Limon, is sparsely populated. The major economic activity is agricultural with large banana plantations and smaller cocoa and coconut farms. Port Limon is the only port on the Caribbean coast of Costa Rica, and therefore, it is an important economic point. Industrial development is small; there is one small oil refinery and some smaller industrial plants, particularly for lumber and fisheries. There are several new industrial installations being considered, particularly a new and larger oil refinery and food processing plants.

In recent years several tourism projects have been underway, particularly for sport fishing and hunting. There has been some intensive exploration for petroleum, inland and offshore, without positive results thus far. The beaches have a large concentration of iron and titanium minerals (magnetite-ilmenite), the most important being at Puerto Viejo, in the southern part. One part of the beach, to the north of Port Limon, is a wild life reservation for the purposes of protecting the Caribbean green turtle.

The entire area is developing relatively rapidly and there is an obvious need of basic information in order to plan and orient its development.

### Complementary Programs

There are several studies that cover part of the area in other aspects. The most important are:

- 1) Study of the Rio San Juan basin, undertaken by the Permanent Secretariat for Central America Economic Integration (SIECA).
- 2) Ecological study of the Limon Province, undertaken by Cornell University, U.S.A.
- 3) Study for development of the Costa Rica - Panama border zone undertaken by the Planning Ministries of both countries.
- 4) Study of the Port Limon area, proposed by the UN Ocean Economics and Technology Office.

#### Alternate Pilot Areas

### III. Definition of Area

The area selected covers the entire southern coastal sector of the Dominican Republic which is approximately 350 km long. The capital city, Santo Domingo, is located in its centre at the mouth of the Masama River. To the west of Santo Domingo, the coastline is irregular, with a large peninsula (Barabona), and one bay (Bahia Oesa). To the east it is fairly straight between Santo Domingo and La Romana. The coast is characterized by reef terraces and modern reefal growths; sand beaches are mostly in the eastern part.

#### Importance

Near the city of Santo Domingo the area is developing very fast, with several new industrial and housing projects underway. To the west of Santo Domingo, at Haina, there is a large oil refinery, and at Cabo Rejo, near the Haiti border, there is a bauxite loading port. The eastern part has important tourism resorts at Boca Chica and La Romana. There has been some oil exploration in the past; at present, offshore geophysical surveys are being conducted in part of the area. However, no commercial oil or gas has been found.

#### Complementary Programmes

- 1) The Instituto Dominicano de Tecnologia Industrial (INDOTEC), with the assistance of the Interamerican Development Bank, will start a study for small-scale fisheries.
- 2) INDOTEC contracted in 1977 the Marine Sciences Institute of the University of Texas to undertake a bathymetric, seismic and magnetometric study of the southern continental shelf. The interpretation of this information will be ready in 1978.

### IV. Second Alternate Pilot Area, St. Lucia, BWI

#### Definition of the Area

St. Lucia is located in the southern half of the Lesser Antilles Island Arc, between Martinique and St. Vincent. The island is approximately

20 km wide and 45 km long, with the long axis oriented north-south. The topography is dominated by the occasionally eruptive volcano, Soufriere; the higher elevations range from 400 to more than 600 metres. Annual rainfall exceeds 3,000 mm in the mountains. The bordering continental shelf typically is less than 5 km wide on the east and west and wider to the north and south. The windward east coast is irregular with many rocky headlands and pocket beaches; more extensive sand beaches occur on the leeward west coast.

#### Importance

The principal economic bases are agriculture (mainly bananas, sugar, cocoa, and copra for export) and tourism. A new oil terminal and refinery is now under construction on the island's west coast and will soon go into operation. Small scale fishing ("trap" fisheries) also is significant in terms of a local protein source and is important economically to the coastal villages.

The population is concentrated along the coast, principally at Castries, the principal port and capital, and in the Choiseul-Laborie region in the southwest. The interior, constituting more than 75% of the island area, has a population density of less than 20 per square mile.

#### Complementary Programme

IOCARIBE Fisheries Oceanography Programme; the St. Lucia area was previously selected as one of the two pilot areas for oceanographic investigations. Certain aspects of this programme, principally the proposed study of oceanic-circulation and nearshore hydrodynamics, would directly complement the Environmental Geology Programme.

ANNEX VI

WORKSHOP ON ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago, 16 - 18 January 1978

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ANNEX VII

WORKSHOP OF ENVIRONMENTAL GEOLOGY OF THE CARIBBEAN COASTAL AREA

Port of Spain, Trinidad and Tobago, 16 - 18 January, 1978

LIST OF ACRONYMS

ECLA	Economic Commission for Latin America
EGCCA	Environmental Geology of the Caribbean coastal area
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	Intergovernmental Oceanographic Commission Association for the Caribbean and adjacent regions
NASA (USA)	National Aeronautics and Space Administration
OETO (UN)	Ocean Economics and Technology Office
RDC	Regional Data Centre
TEMA	Working Committee on Training, Education and Mutual Assistance in the marine science
UN	United Nations
UNEP	United Nations Environment Programme

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

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

<u>No.</u>	<u>Title</u>	<u>Publishing body</u>	<u>Languages</u>
8	Joint IOC/FAO(IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
12	Report of the IOCARIBE Interdisciplinary Workshop on scientific programmes in support of fisheries projects, Fort-de-France, Martinique, 28 November-2 December 1977	IOC, Unesco, Place de Fontenoy 75700 Paris, France	English Spanish
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area, 16-18 January 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish