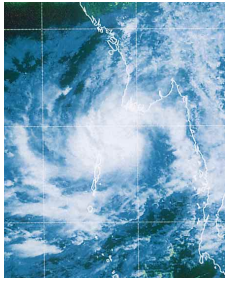


CHAPTER XXXV

# DEPARTMENT OF OCEAN DEVELOPMENT

India is endowed with a well-established maritime tradition. Long coastline and the adventurous nature of our ancestors took us to far off places. As far as ocean sciences are concerned, early nineteen eighties mark the beginning of a new era. The adoption of the Convention of the UN Conference on the Law of the Seas in 1982 established a new international order for the oceans. This extended the economic jurisdiction of coastal states to an area ranging from 200 to 350 miles from the coastline. According to this regime, nearly 2.02 million square kilometres of area, or nearly two-third of the land mass came under India's jurisdiction. In this area, the exclusive right to utilize living and non-living resources vests with the nation.

> FROM MARCH 1982, THE DOD HAS BEEN FUNCTIONING AS A SEPARATE NODAL DEPARTMENT IN LINE WITH THE OCEAN POLICY STATEMENT OF 1982.

The Department of Ocean Development (DOD) was created in Jul, 1981. In 1982, the Government of India issued the Ocean Policy Statement in which control, management and utilization of the internal resources available in the sea and development of appropriate technologies to harness these resources have been emphasized. From March 1982, the DOD has been functioning as a separate nodal department in line with the Ocean Policy Statement of 1982. The programmes pursued by the Department over the years have also kept pace with developments world over and addressed national needs and issues.

In addition to basic knowledge to determine the potentialities inherent in the Indian sea-space we had to develop appropriate technologies to harness these resources. A supporting infrastructure had to be built. Effective systems of management and control of the entire set-up were also necessary. Keeping this in view, various institutional mechanisms were set up, viz. National Institute of Ocean Technology (NIOT) at Chennai, National Centre for Antarctic and Ocean Research (NCAOR) at Goa, and Indian National Centre for Ocean Information Service at Hyderabad. Additionally, the existing institutes and science departments have significantly contributed to DOD's endeavour. A special mention must be made of the National Institute of Oceanography (NIO), Goa, one of the CSIR institutes which has very significantly added information on several disciplines.

The Department's programmes can be broadly classified in the following groups.

- Multi-institutional and multi-disciplinary Polar

Science Programme and Antarctic Expeditions with scientific and geopolitical significance;

- Marine Non-Living Resources Programme – Minerals and Energy;
- Marine Living Resources Programme;
- Marine Environment and Coastal Zone;
- Ocean Atmosphere and Climatology;
- Capacity Building Programme Towards Self-Reliance and Creation of Public Awareness of Ocean, its Potential and Usage.

The scientific research and technology development programmes mentioned above are formulated, coordinated and executed through autonomous institutions attached offices supported by the Department . These multi-disciplinary and multi-institutional programmes are also assisted by national research laboratories, academic institutions and industries. The Department is the nodal agency for international programmes in the ocean sector and represents the country in Inter-Governmental Oceanographic Commission (IOC) of UNESCO, Regional Committee of IOC in Coastal Indian Ocean (IOCINDIO), International Sea-Bed Authority (ISBA) and the State Parties of the United Nations Convention on the Law of the Seas (UNCLOS), the Antarctic Treaty System (ATS) and its scientific and managerial organs – Commission on Conservation of Antarctic Marine Living Resources (CCAMLR), Council of Managers of National Antarctic Programme (COMNAP), andScientific Committee on Antarctic Research (SCAR). These activities have scientific, economic and geopolitical impacts. Further, marine research and capacity building is one of the key areas of the Department to promote basic research in marine science and establish centres of excellence in academic institutions.

## SIGNIFICANT ACHIEVEMENTS

During the last two decades the Department has made significant additions to our knowledge of Ocean Science and Technology. Some of these are given below.

**Antarctic Programme:** Realizing the scientific importance of Antarctica, in addition to strategic, geopolitic, and economic significance in terms of conservation, management and exploitation of living resources in the southern ocean and long-term conservation and management of mineral resources, India entered into the realm of polar science in 1981 with the launch of the first scientific expedition. Since then, India has achieved maturity in launching the expeditions and conducting front rank polar research in various disciplines. The first Indian permanent station *Dakshin Gangotri* was

***Top: Work being carried out in Antarctica during summer months in field camps.***
***Bottom: India's permanent base station Maitri, in SCHIRMARCHER OASIS.***

*Development of Current Meter Mooring on the equator at 93° east from ORV Sagar Kanya.*

established in 1983. Through demonstration of sustained interest and capabilities in polar science and its logistics, India was admitted to the Antarctic Treaty System in 1983 and granted a consultative status in the same year. Later, India established an indigenously built modern station *Maitri* in 1988-89.

So far India has successfully launched twenty multi-disciplinary and multi-institutional expeditions to Antarctica. During the 19th expedition, Dr. (Mrs.) Kanwal Vilku became the first Indian woman to spend 15 months in the icy continent. Besides the annual expeditions to Antarctica, one expedition to the Weddell Sea and one for krill exploration in the Antarctic waters have also been sent. Through these expeditions, a carefully balanced and contemporary scientific research programme has been pursued in the frontier domains of polar science. So far more than 45 national institutions have participated as scientific and logistic components of the expedition thereby putting about 1300 Indians to the icy continent. Among the major contributions in Antarctic sciences are, setting up of a three Component Seismic Observatory at India's permanent Station *Maitri*. This seismic observatory is mainly helpful in monitoring the earthquake activity in Antarctica. A few excellent records of breaking of the ice shelf have been also made by this observatory. A state of art DGPs has been also set up in Antarctica which is helpful in estimating the rate of movement of the Indian plate with respect to the Antarctic plate. The sediments of *Priyadarshini* Lake have been estimated to date back to 10,000 years. Very detailed meteorological and upper atmospheric studies have been undertaken in Antarctica which constitute the necessary baseline to provide inputs to forecast and predict Indian monsoons and weather. On the medical side, detailed investigations carried out on human physiology and psychology under extreme cold conditions have been useful. Valuable experience has been also gained in waste disposal in extreme cold conditions. This knowledge would be helpful in waste disposal at very high mountain terrains of our country. It may be mentioned that by conducting multi-disciplinary scientific experiments and observations in Antarctica, India is making the necessary basis for detailed future investigations. This has also helped the nation to play an active, authoritative and influential role in the affairs of Antarctica through the Antarctic Treaty System and its associated bodies mentioned earlier.

INDIA ENTERED INTO THE REALM OF POLAR SCIENCE IN 1981 WITH THE LAUNCH OF THE FIRST SCIENTIFIC EXPEDITION.

To catalyse and consolidate the gains achieved through the expeditions launched so far and in order to effectively comply with the various international obligations arising out of our consultative status in the Antarctic Treaty, the DOD established a dedicated polar research institute, namely, the NCAOR at Goa.


***OTEC barge Sagar Shakti constructed by NIOT with all installations for IMW OTEC power generation.***

**National Data Buoy Programme:** Collection of time series observations of oceanographic and surface meteorological parameters over Indian seas are necessary to improve oceanographic services and predictive capability of short-term and long -term weather / climatic changes as well as to improve the understanding of ocean dynamics. Keeping this in view the National Data Buoy Programme was started in 1997. This forms an important component of the programme on Ocean Observation and Information Services. Till date twelve buoys have been deployed in Indian waters in the depth range of 20 to 4,500 metres.

These data buoys carry sensors to measure wind speed, wind direction, air pressure, air temperature, conductivity, sea surface temperature, current speed, current direction, and wave parameters. The buoys are equipped with global positioning system, beacon lights and satellite transceivers. A few buoys are provided with additional sensors to measure parameters, like radioactivity, light attenuation in three wavelengths, chlorophyll- A and dissolved oxygen. Power to the buoys is provided by solar panels and chargeable battery packs.

A few applications of this programme are:

- *Environment Impact Assessment:* The data collected from the buoys is useful for continuous monitoring of coastal and marine environment.
- *Meteorology:* The real time surface meteorological data obtained by these buoys are vital for a reliable operational weather forecasting model and to alert the coastal population about imminent natural disasters such as depressions and cyclones.
- *Oceanography:* The long term oceanographic data collected from the buoys are useful in enhancing our knowledge of Indian ocean circulation.
- *Fisheries:* The sea surface temperature and water quality parameters obtained from the buoys have been found useful in identifying potential fishing zones.
- *Validation of Satellite Data:* The satellite data can be easily validated with the help of *in-situ* data collected from the boys.
- *Offshore Installations, Ports and Coastal Structures:* The data provided by buoys on waves, wind and current are useful in designing various coastal and offshore structures.
- *Shipping:* The data on sea state, particularly wind, wave and currents, is very useful for navigation.

The data from the buoys is transmitted through two-way INMARSAT-C communication system to


*A view of components of OTEC plant assembled on board Sagar Shakthi.*

the shore station. Daily data are being disseminated to various user agencies like Indian Meteorological Department, Coast Guard and Navy and various R&D organizations including NIO, Space Applications Centre and Centre for Atmospheric and Oceanic Sciences to meet their specific requirements.

**Ocean Thermal Energy Conversion:** In tropical oceans, within about 25 degrees north and south latitudes, a temperature difference of about 20° C exists between the waters at the surface of the ocean and at a depth of 1,000 m or so. The process of harnessing the energy due to this temperature difference is called Ocean Thermal Energy Conversion (OTEC). OTEC is an untapped, non-polluting, renewable energy source, which is appropriate for an energy starved nation like India. This method is capital intensive but the unit cost comes down drastically with higher rating plants and improvement in technology.

NIOT, Chennai, is in the process of commissioning a 1 MW OTEC plant off Tuticorin. The plant would generate electricity using the Rankine cycle with ammonia as the working fluid. Design, manufacture and assembly of almost all the components has been completed. The OTEC plant consists of special titanium plate heat exchangers (largest of this kind ever manufactured in the world), special four stage axial ammonia turbine of 1 MW rating, cold seawater and warm water pumps and necessary control and instrumentation. The OTEC plant barge which was constructed at the Dempo Shipyard, Goa is 69 m long, 16 m wide and 4 m high, approximately weighing 500 tonnes and houses all the components of the OTEC plant mentioned above. This plant barge has been named *Sagar Shakthi*. The 1,000 m long, 1 m dia HDPE pipe which will bring cold sea water of 7° C to the plant barge is already assembled and deployed at the OTEC site, approximately 60 km south east of Tuticorin harbour, and upended on reaching the site. It will be integrated with OTEC plant barge, when it reaches the OTEC site.

There are many technology firsts for this plant, like large plate heat exchangers, deep single-point mooring with intake pipe acting as the mooring, large retractable sump for cold water and a specially designed 1 MW ammonia turbine.

This technology demonstration project of 1 MW rating would be the first of its kind in the world and based on the results of the plant, larger plants with 25 MW capacity and above could be built to provide pollution-free renewable energy at a cost compared to other fossil fuelled plants.

*Red algae having anti-fungal properties.*

**Development of Potential Drugs from Ocean:** India is endowed with a rich marine biota all along its 8,000 km coastline. The coral reefs that occur in her tropical water demonstrate the highest level of known diversity among marine species. The marine diversity is largely unexplored and, therefore, offers a great challenge and opportunity for new discoveries. A national project on 'Drugs from Sea' was taken up by DOD during 1990-91. This project is being implemented by involving ten institutions with the Central Drug Research Institute (CDRI), Lucknow, as the nodal agency for implementation.

Over 800 different species of marine flora and fauna collected from Indian coasts including island groups were subjected to investigations to identify bioactive compounds. During the last few years, about 4,000 samples were extracted/fractionated and subjected to a wide spectrum of screening for biological activities such as antidiabetic, anti-hyperlipidaemic, antidiarrhoeal, antimicrobial/antiviral, antimalarial, and so on. 597 samples exhibited various types of biological activities and out of these 16 samples were identified for follow up studies in different areas.

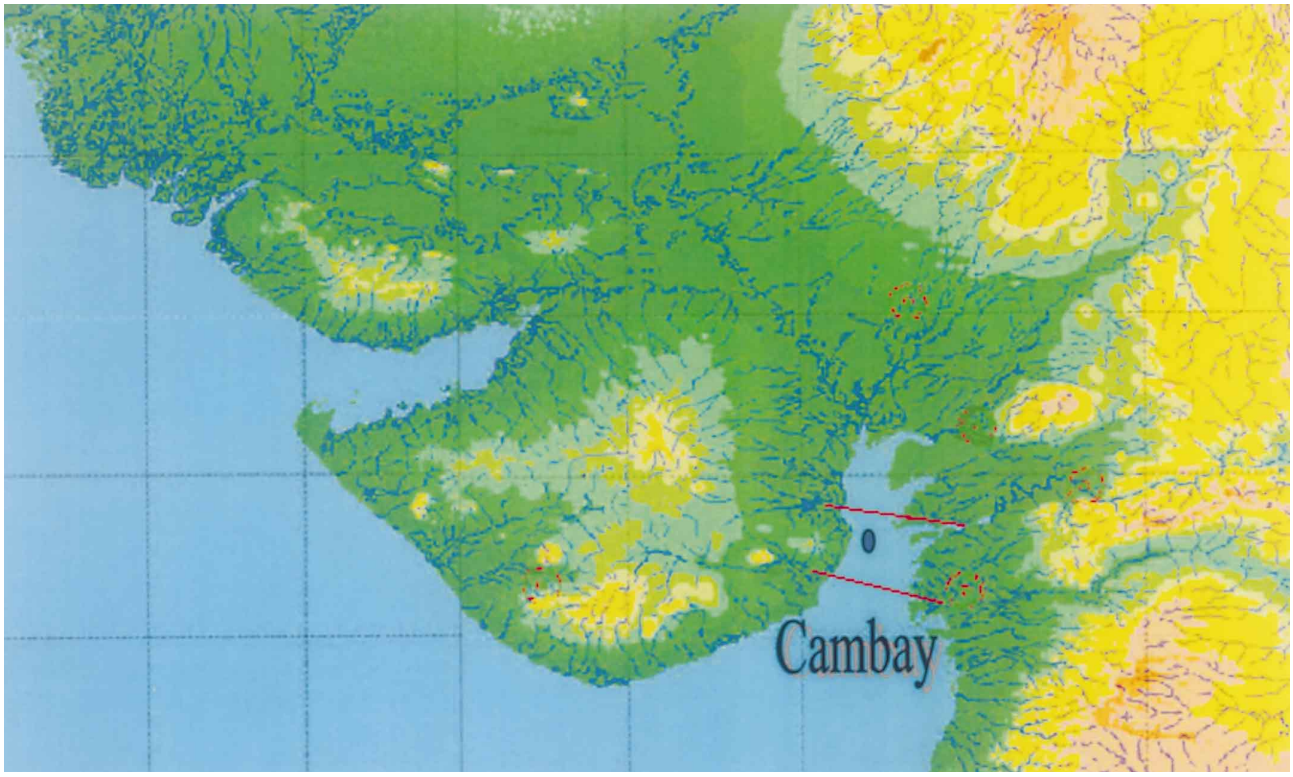
The following organisms mentioned in code numbers have been taken up for product development.

| | | |
|---|---|---|
| 1. | CDR | Antidiabetic/Antidiarrhoeal |
| 2. | CU1/002/004 | Antihyperlipidaemic |
| 3. | NIO - 450 | Antianxiety |
| 4. | AU-2-106 | Antioxidant/ Antihyperlipidaemic/ Antihyperglycaemic |
| 5. | CBM-089 | Antibacterial/Antifungal/ Larvicidal |
| 6. | 11C - 276 | Larvicidal |

Over the years, 319 pure compounds have also been isolated. Some of these possessed interesting biological activities while some others, though inactive, had novel chemical structures, like alkaloids, glycosides, aminoacids; fatty alcohol esters and so on. Ocean organisms have been widely used in the *Ayurvedic* system of medicine. The DOD is trying to use these organisms and the results available till date are encouraging.

**Polymetallic Nodules Programme:** In August 1987, India became the first country in the world to be allotted 150,000 sq. km. of area in the central Indian Ocean for exploration and exploitation of polymetallic nodules under certain obligations and was given the status of a Pioneer Investor under the law of the Sea Convention. This status given was based on the pioneering work of exploration done by India in the central Indian Ocean with the help of exploration technologies developed at the NIO, Goa. As a part of the obligation, India has to relinquish 50% of the allotted area in phases. India has already relinquished 30% of the allotted area to the International Seabed Authority. The balance 20% of the area is proposed to be surrendered by 2001-02.

DOD is currently establishing a 500 kg/ day processing plant to treat ocean nodules. The plant is mainly based on the process developed by the Regional Research Laboratory, Bhubaneswar, and Bhabha Atomic Research Centre, Mumbai. While the plant is being erected, the research activities are continuing to improve process parameters, and to establish the use of secondaries and byproducts




***Location of new marine archeological sites discovered earlier this year by NIOT in Cambay shown by blue dot; red lines show the possible sunken river courses.***

generated by the process. The plant is expected to be commissioned by the end of 2001.

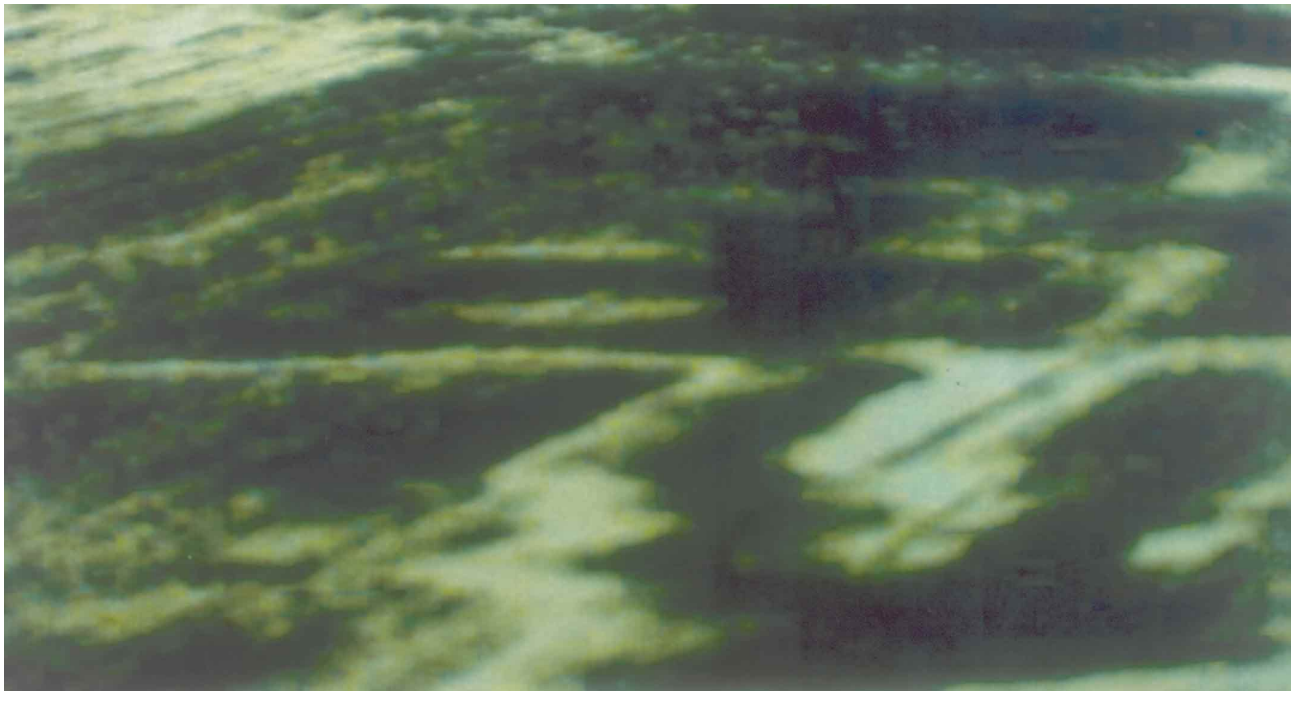
## Discovery of a Major Marine Archeology Site in the Gulf of Cambay

The NIOT, has been carrying out multi-disciplinary marine surveys in various parts of the country deploying state-of-the-art sophisticated underwater equipment.

During a recent survey in the Gulf of Cambay, a stretch of formations typical of the riverine regime in the middle of the sea was noted. The materials collected at site included well rounded pebbles, cobbles and alluvium. The Side Scan Sonar has picked images of several excellent geometric objects which are normally manmade. Further research revealed that for almost a stretch 9 km west of Hazira in Gujarat, the area is lined with very well laid house basement-like features, partially covered by the sand waves and sand ripples at depths of 30 to 40 m. The dwellings approximately measure 6 x 8 $m^2$ to 12 x 16 $m^2$. The basements are well laid in straight lines with a well-laid drainage system.

The acoustic images obtained point out to the existence of Harappan-like ruins below the seabed. Characterized by tanks 40 x 40 $m^2$ with steps and acropolis 45 x 20 $m^2$ like (100 m x 30 $m^2$ ) structure of the Harappan culture civilization. These archeological findings have been corroborated by sub-bottom profiler findings wherein the basement reliefs of the foundations have been clearly brought out.

A detailed examination of the geology and tectonics of the area has revealed that a couple of major rivers have been flowing approximately in the east-west direction, coinciding with the course of the present day Tapti and Narmada rivers. Due to geological processes and tectonic events, the entire Cambay area might have sunk taking down with it the then existing part of the river sections and the metropolis.



***Side-scan images of ruins discovered in the Gulf of Cambay. The estimated size is 40 m x 25 m***

NIOT is planning to revisit the site after the present monsoon is over with additional survey equipment for underwater videography and possible sampling. NIOT is coordinating with the NIO, Goa and the Archeological Survey of India in this work.

## Concluding Remarks

In this short article, a brief outline of the Department of Ocean Development and a few of its salient achievements have been provided. In the 21st century, Indians will have to depend a lot on sustainable use of ocean resources. Thirty per cent of our population lives in coastal areas. For a better India, we have to make a judicious use of our vast ocean wealth. For this to happen, we have to learn more about our oceans. We have to devise ways to collect meteorological parameters in real time. We need to map and estimate the utilizable potential of our living and non-living resources. The DOD is in the process of developing a vision document for the next 20 years as well as establishing an Ocean Commission on lines with the Space Commission and the Atomic Energy Commission for enhancing our ocean related activities.