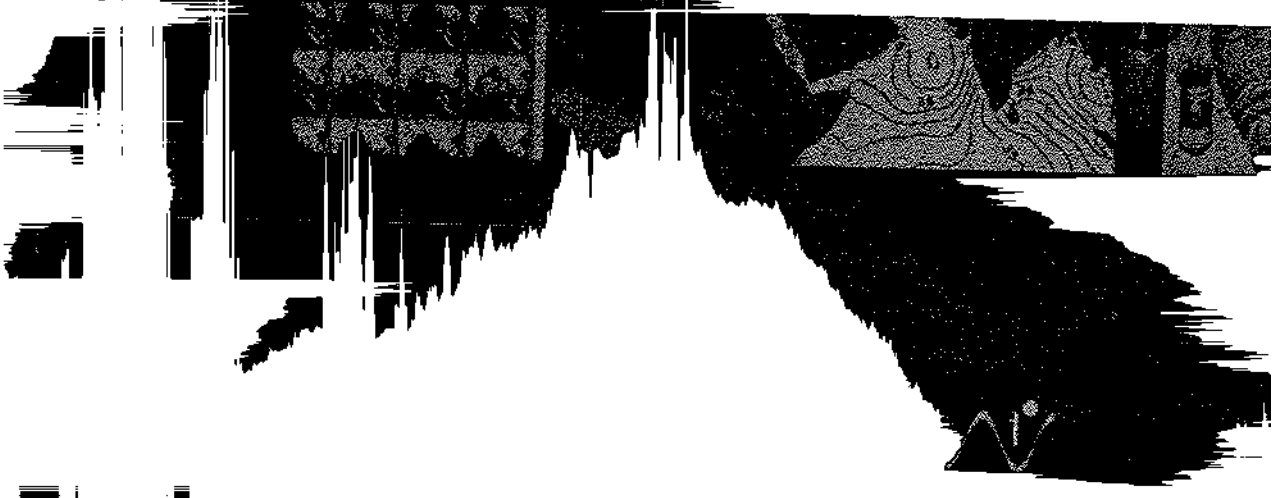
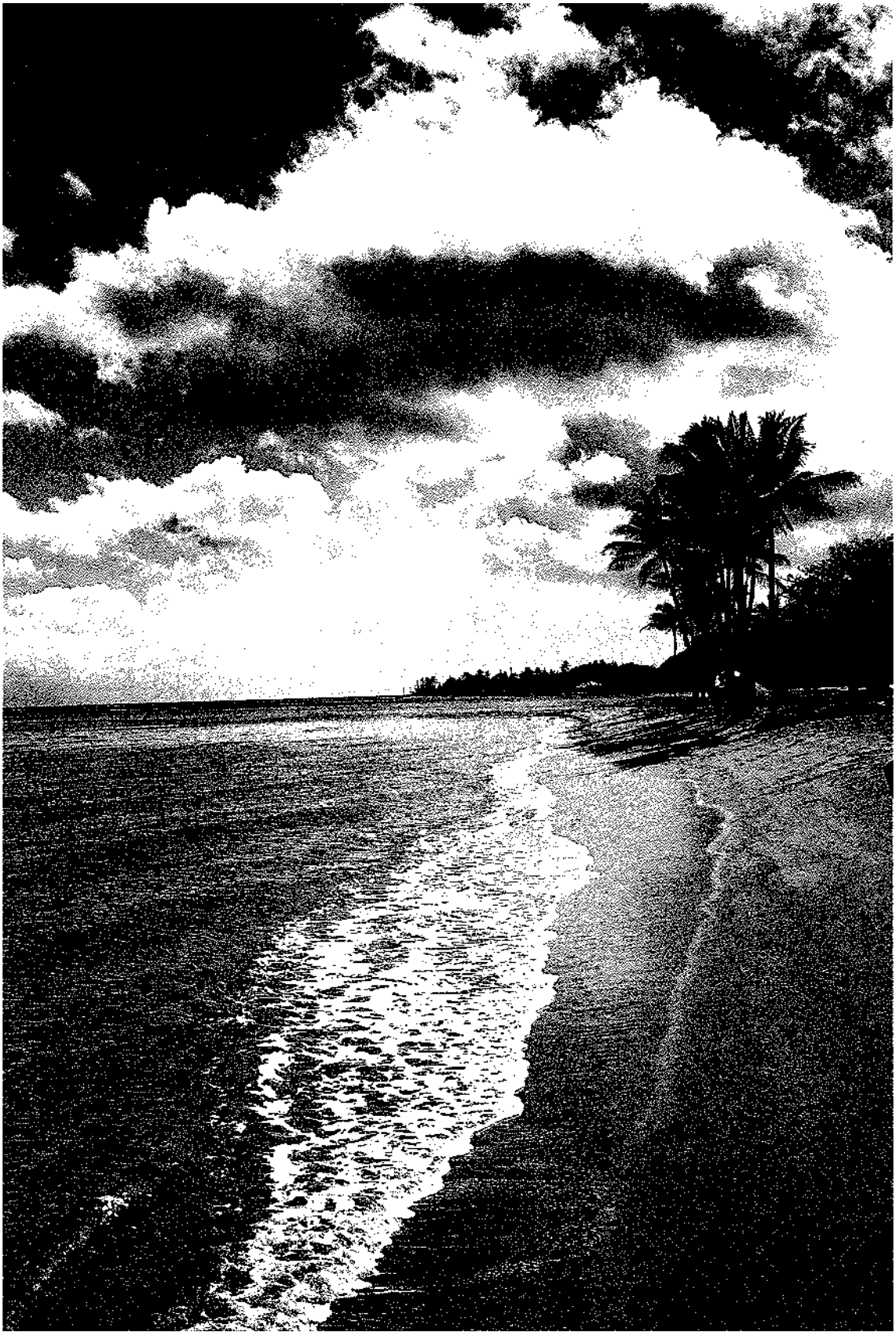
NIO

EXPLORING NEW FRONTIERS



ANNUAL REPORT
2001-2002



About NIO

The National Institute of Oceanography (NIO), one of the 38 laboratories of the Council of Scientific & Industrial Research (CS1R), was founded on 1 January, 1966. The Institute carries out research in different aspects of coastal and open ocean environment. Over the last three decades it has grown into the largest research organisation in the Indian Ocean Region.

The experiences and expertise of the institute are extensively utilised by its stakeholders. The institute provides consultancy and contract services in several aspects connected with the sea.

The institute with main laboratories in Goa has three regional centres at Mumbai, Kochi and Visakhapatnam. The staff strength during the year was 600 and the funds handled including ship costs exceeded Rs. 500 millions.

Our Mission

"to continuously improve our undersianding of the seas around us and to translate this knowledge to benefit all"

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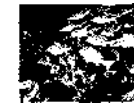

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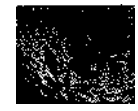

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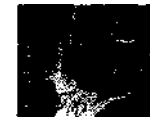

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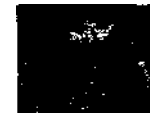

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निदेशक की रिपोर्ट 2001-2002

वर्ष 2001-2002 उपयुक्त विज्ञान, अवसंरचना निर्माण, पुरस्कारों द्वारा साथियों को मान्यता एवं अनुसंधान प्रणाली की गुणवत्ता प्रामाणिकता की उपलब्धियों के कारण एक और महत्वपूर्ण वर्ष रहा। कुछ कार्यक्रमों को समाप्त करने, अन्य की समीक्षा करने तथा रुचिपूर्ण कार्यक्रमों के प्रस्तावित करने के लिए यह पंचवर्षीय योजना का अंतिम वर्ष था तथा हमारे लिए अनुसंधान मार्ग की सम्पूर्ण समीक्षा करने का अच्छा अवसर था। वर्ष के दौरान संस्थान के अब तक के अनुसंधान कार्यक्रम के निष्पादन एवं प्रस्तुतीकरण तथा भविष्य की संकल्पना में संभवतः हम लगे रहे। समीपस्थ समुद्रों में सक्रिय प्रक्रियाओं के बारे में ज्ञान के महत्वपूर्ण स्रोत होने तथा दूसरे, सीएसआईआर के यथार्थवादी निष्पादन मापदंडों के आधार पर और प्रयोगशालाओं के मूल्यांकन के संदर्भ में हमारे संस्थान की स्थिति निष्पादन मूल्यांकन बोर्ड की निगाह में काफी अच्छी रही। आने वाले पाँच वर्ष के लिए निर्धारित लक्ष्य को प्राप्त करने के लिए हम विशेष उत्कंठित हैं।

योजना

पूर्व में प्रारम्भ किये गये कार्यक्रम तो जारी रहेंगे ही साथ में जैव-प्रौद्योगिकी, भूमंडलीय जैव-रासायनिकी एवं नवीन तथा स्वच्छ ऊर्जा स्रोत के लिये गैस हाइड्रेट संसाधन की खोज पर दसवीं योजना में विशेष महत्व दिया जायेगा। गैस हाइड्रेट कार्यक्रम पहले प्रारम्भ किया गया था, अब उचित सहयोगियों के साथ मिलकर आगामी वर्षों में गैस हाइड्रेट के भंडारों के आकलन करने की हमारी योजना है। स्वचालित अंतर्जलीय वाहन (आटोमेटिक अंडरवाटर वेहिकल) के विकास का नया कार्यक्रम शुरू किया गया है। हमारे वैज्ञानिकों तथा तकनीशियनों में इस वाहन के सूक्ष्म विवरणों को परिभाषित करने के लिये विशेष उत्साह है। हमारी निपुणता में पूर्णता के लिये जो सहयोगी उपलब्ध हैं उनका हम सहयोग लेंगे। यह वाहन वास्तव में सपुद्री रोबोट ऑकड़ा प्लेटफार्म के रूप में जलयान के लिये विशेष उपयोगी सिद्ध होगा क्योंकि उपग्रह एवं जलयान द्वारा नमूना प्राप्त करने की विधियों में रचनात्मक वृद्धि को रणनीति के लिये इसकी बहुत ही आवश्यकता है।

अवसंरचना

वैज्ञानिक अवसंरचना के निर्माण की जिम्मेदारी हमारे वैज्ञानिक एवं इंजीनियरों की होती है जो निस्वार्थ भाव से इसके लिये अपना समय लगाते हैं। कभी-कभी यह समय उन्हें अपनी रुचि के विज्ञान से निकालना होता है। हमारे नये तटीय जलयान *"सागर शुक्ति"* की तैयारी में उनका गत वर्ष का काफी समय लगा जिसके लिये हम उनके विशेष आभारी हैं। इस जलयान की कमीशनिंग राज्य की प्रथम महिला श्रीमती तस्नीम फजल एवं महामहिम श्री मोहम्मद फजल, गोवा के तत्कालीन राज्यपाल द्वारा की गई जिन्होंने सदैव प्रोत्साहन एवं प्रेरणा द्वारा हमारी गतिविधियों में रुचि दिखाई। उन्होंने तटीय जलों की गुणवत्ता तथा नीतियों के बारे में वास्तविक लगाव दिखाया जिनसे उपयोगकर्ताओं को संसाधन की उपलब्धि निरन्तर होती रहे। तटीय जलों से मात्स्यिकी आग्रहण जो कि तटवासियों के निर्वाह के लिये आवश्यक है, में उनकी विशेष रुचि रही। इस संदर्भ में सागर शुक्ति का योगदान तुरन्त देखने को मिला क्योंकि प्रथम तीन जलयात्राओं में हम निम्नलिखित काम कर सके -

भारत के पश्चिमी तट पर अल्प ऑक्सीजन की घटना में वृद्धि की जाँच की गई जिसके कारण हम मछलियों की मौसमीय मृत्यु देखते हैं। इन जलयात्राओं के दौरान आकस्मिक रूप से हमें गोवा के जल में हानिकारक शैवाल की उपस्थिति मिली। स्थानीय स्वादिष्ट हरी सीपी तथा शुक्तियों में इसके कारण विषाक्तता की संभावना के प्रति जन सामान्य में हम चेतना जगाने में समर्थ रहे।

जलमान हेलीकोप्टर की पहचान में हमने तटीय कार्मिकों को सहयोग प्रदान किया।

गोवा के दूरस्थ जल में गैस प्रस्राव लाक्षणिकता की रिपोर्ट दी।

आईएसओ-9001 प्रामाणिकता प्राप्त करने के लिये वैज्ञानिकों का एक अन्य दल गुणवत्ता संलेख को लागू करने के लिये अनिवार्य जागरूकता जगाने में व्यस्त रहा। औपचारिक प्रामाणिकता समारोह पेट्रोलियम एवं प्राकृतिक गैस तथा संसदीय मामलों के केन्द्रीय राज्यमंत्री श्री संतोष गंगवार के द्वारा सम्पन्न हुआ।

एनआईओ से जुड़े जाने-माने व्यक्तियों की रुचि, समय तथा विज्ञान को संबल प्रदान करने के लिये हम उनके आभारी हैं।

विज्ञान एवं खोज

जब हम नये कार्यक्रम प्रारम्भ करते हैं तो समाप्त किये गये कार्यक्रमों से समीपस्थ समुद्रों के बारे में हमारी जानकारी में वृद्धि होती है -

1. बंगाल की खाड़ी तथा अरब सागर के मध्य समुद्र स्तर में 30 सेंटीमीटर का अन्तर क्यों है? समुद्र स्तर रिकॉर्ड के आधार पर हमारे भौतिकीय समुद्र वैज्ञानिकों के पास इसके लिये एक व्याख्या है। उत्तरी हिन्द महासागर के सांख्यिक मॉडल तथा उसके अनुकरण से ज्ञात हुआ कि इस जलस्तर अंतर के दो कारण हैं - महासागर के ऊपर मध्य वायु प्रवाह तथा लवणता में बदलाव। वायु प्रवाह उत्तरी हिन्द महासागर की सतह पर दक्षिण-पश्चिम से उत्तर-पूर्व की ओर अपनति के रूप में दबाव डालता है जो कि दक्षिण-पश्चिम मानसून की प्रमुख दिशा है। यह

समुद्र-स्तर के अन्तर को 60% तक प्रभावित करता है। दोनों बेसिनों में मृदुजल के आगम से तटीय लवणता में काफी अन्तर रहता है जिससे पूर्वी तट पर हल्का एवं कम लवणता वाला जल दोनों तटों के जलस्तरों में 40% अन्तर के लिये जिम्मेदार है।

2. हमारे भूभौतिकीय दल द्वारा मध्य हिन्द महासागर के प्रस्तरीय परिच्छेद के अध्ययन से ज्ञात हुआ कि भूतकाल में महाद्वीपीय प्लेटों के टकराने से उत्पन्न विकृति एवं दरारें विभिन्न कालों में घटित हुईं। विभिन्न कालों में मोड़ एवं भ्रंशों की वृद्धि क्रमशः 80, 40 एवं 8 लाख वर्ष पूर्व हुई जो प्रस्तर मंडल में घटित कालिक तथा विस्तार की प्रतीक हैं। यह अवधारणा विकृति काल तथा मॉडल की पूर्व धारणाओं को संशोधित करती है।

समुद्र हमें निरन्तर विस्मित करता रहता है जैसा कि अधोतलीय (15 मीटर की गहराई) जल में डायटम की बहुलता की खोज, जो कि साधारणतया उपग्रह प्रेक्षण से संभव नहीं है। इससे हमें ज्ञात हुआ कि उपग्रह आधारित प्राथमिक उत्पादन का आकलन करने का तरीका सदैव यथार्थ नहीं होता। जैवभार की बहुलता के अति शुद्धता से मापन हेतु हमें डायटम की प्रस्फुटन प्रक्रिया को समझने तथा वर्तमान उपग्रह अल्गोरिथ्म को निरन्तर परिशुद्ध करने की आवश्यकता है।

हिन्द महासागर बेसिन में 45 मीटर की गहराई पर तलछट के 15 सेंटीमीटर नीचे दबे अनपेक्षित बैक्टीरिया की प्राप्ति एक और आश्चर्य की बात है। इनसे संबंधित बैक्टीरियाओं द्वारा अमोनियम को नाइट्राइट तथा नाइट्राइट को नाइट्रेट में ऑक्सीकृत करने की क्षमता पाई गई। संबंधित बैक्टीरिया द्वारा नाइट्रीकरण के दोनों चरण पूरा करने की क्षमता मिलने का हमारे लिये पहला अवसर है।

प्रसार तथा जागरूकता निर्माण

संस्थान को हमारी दीर्घ तटरेखा की माँगों के लिये पश्चिम तट पर मुंबई, गोवा एवं कोची के केन्द्रों तथा पूर्वी तट पर सिर्फ विशाखापट्टनम के केन्द्र में सीमित जनशक्ति आधार का संतुलन करना था। भाग्यवश इस केन्द्र का विकास करने के लिये हमने आंध्र विश्वविद्यालय के प्रांगण में नवीन भवन के निर्माण हेतु व्यवस्था शुरू कर दी है। पूर्वी तट पर उड़ीसा, बंगाल तथा अंदमान में क्षेत्रीय केन्द्रों की स्थापना करना हमारी भावी योजना है जिसके लिये हम सक्रिय हैं।

प्रतिभाशाली युवा पीढ़ी को आकर्षित करने के लिये सीएसआईआर के कई कार्यक्रम हैं जिनके अंतर्गत इस वर्ष हाई स्कूल स्तर के लगभग 100 छात्रों तथा सूचना प्रौद्योगिकी के लगभग दो दर्जन छात्रों ने परियोजना प्रमुखों के निर्देशन में विभिन्न विज्ञान संबंधी निर्दिष्ट कार्यों को पूरा किया।

राष्ट्रीय दूरदर्शन चैनल के विज्ञान कार्यक्रम "टर्निंग पाइंट" के माध्यम से रा.स.वि.सं. के कार्य-कलापों से संबंधित सात लघु एपीसोडों का प्रसारण भी किया गया।

मानक श्रेणी के जर्नल्स में प्रकाशनों के साथ-साथ हमारी पेटेंट क्रियाशीलता चौथे वर्ष भी बढ़ी। अधिकतर पेटेंट अमेरिका, यूरोप संघ के देशों तथा पेटेंट सहयोगीय संधि में फाइल किये गये। आश्चर्यजनक रूप से हमारे अधिकांश वैज्ञानिक कार्यक्रमों से नवीन धारणायें प्रस्फुटित हो रही हैं जिनको हम बौद्धिक स्वामित्व व्यवस्था के अंतर्गत संरक्षण के लिये सक्रिय हैं।

हमारे सदाबहार गुरू - भूतपूर्व सहयोगी डॉ. राबिन सेन गुप्ता ने हमारे द्वारा उत्पन्न समस्त जानकारी तथा ज्ञान को एकत्रित करने का बीड़ा उठाया जिसके फलस्वरूप "द इंडियन ओशन - अ पर्सपेक्टिव" नामक पुस्तक का दो खंडों में प्रकाशन हुआ। प्रथम खंड में हिन्द महासागर के परिधीय देशों के अंतर्जलीय एवं अपतटीय जल के भौतिक एवं रासायनिक समुद्रविज्ञान तथा द्वितीय खंड में मुख्यतया जीवविज्ञान से संबंधित लेखों का समावेश हुआ है।

मुझे आशा है कि हिन्द महासागर के बारे में जानकारी तथा भारत में समुद्र विज्ञान के विभिन्न पहलुओं की विशेष जानकारी से छात्रगण एवं अनुसंधानकर्ता लाभान्वित होंगे।

हमारे स्टॉफ के सदस्यों को विभिन्न संस्थानों से लगातार प्राप्त हो रहे पुरस्कार संस्थान में जारी उत्कृष्ट विज्ञान के परिचायक हैं। इनमें से प्रमुख पुरस्कार एस.एस. भटनागर पुरस्कार है जो कि डॉ. के. श्रीकृष्ण को उनके मध्य हिन्द महासागर प्रस्तर मंडल की विकृति पर किये गये विशिष्ट कार्य के लिये प्राप्त हुआ है।

कुल मिलाकर सभी प्रकार से यह वर्ष उत्कृष्ट रहा जिसके लिये मैं अपने सभी साथियों को उनकी निष्ठा, कर्तव्य-परायणता एवं उत्कृष्ट विज्ञान के सृजन के लिये हार्दिक धन्यवाद देता हूँ।

हम सभी अपने लिये समृद्ध आगामी दसवीं योजना की कामना करते हैं।

जय हिन्द !

ऐ डेसा

ऐलिच डेसा

DIRECTOR'S REPORT 2001-02

Year 2001-2002 has been another important year of good science, infrastructure creation, recognition of colleagues through awards and quality accreditation for research methodologies. It was the last year of the IX Plan and the preparation of project documents to conclude some programmes, review others and propose new directions of interest which gave us the opportunity to thoroughly review our course. Probably the most important activity we engaged in during the year was preparing and presenting the performance of the institute to date, and its vision for the future. The Performance Appraisal Board was appreciative of the position of the institute both as an important source of knowledge of processes operating in the seas around us and within the larger context where CSIR rates its laboratories based on rigorous performance criteria. We should be in for exciting times if we are to reach the goals that we set ourselves for the coming 5 years.

Planning

While we will continue our research on the programmes initiated earlier, some areas such as biotechnology, global biogeochemistry and the search for the new and cleaner energy source - gas hydrate, will receive greater emphasis in the X Plan. The gas hydrates programme had been initiated earlier and with appropriate corporate partnering, we plan to assess probable hydrate horizons in the coming years. Development of an Autonomous Underwater Vehicle [AUV] is a new activity that we have initiated, and the enthusiasm of the team has gained momentum as they proceed to define the finer details of the AUV, and forge alliances in areas with partners who would compliment our skills. The AUV - a true marine robot data platform - will be an extended arm of the ship and will be important as a monitoring and measurement tool since satellite and ship-sampling methods need more creative augmentation strategies.

Infrastructure

The creation of scientific infrastructure rests with our scientists and engineers, who unselfishly devote their time to this activity, sometimes taking precious time from the science that they would be doing more joyfully. Our special thanks therefore goes to the group that devoted much of their time last year in readying our new coastal vessel *Sugar Shukti.* It was commissioned at the hands of the first lady of the State, Begum Tasneem Fazal, in the presence of His Excellency, Shri Mohammed Fazal, the then Governor of Goa who took great interest, encouragement and inspiration, whilst showing genuine concern for the health, of our coastal waters and the policies that would ensure their sustained use for the variety of stakeholders His special concern was the fishery potential of coastal waters which affects the livelihood of a large segment of our coastal population *Sagar Shukti* was immediately able to make a contribtion in this context as during her first three cruises we were able to

- monitor the development of hypoxia over the west coast of India that could be the underlying cause for the seasonal fish kill that we witness during the period During these cruises, we screen dipitously detected the first harmful algal bloom in Goan waters Thankfully we were able to flag the potential health hazards of local delicacies such as the green mussel and oysters.

- assist our coastal services in identifying a drowned helicopter

- report the first gas escape features in coastal watters off Goa

Creating an awareness of the essentiality of following quality protocols kept another group busy preparing and obtaining for us ISO 9001 accreditation The formal certification ceremony was kindly performed by the Union Minister of State for Petroleum and Natural Gas & Parliamentary Affairs, Shri Santosh Gangwar.

Our thanks for the concern, time and support to science given to us by all public figures associated with NIO.

Science and discovery

As we start new programmes, others are concluded leaving us with improved understanding of the seas around us.

1 Our physical oceanographers have a story to tell from mean sea level records as to why there is a 30 cm difference between the mean levels of the Bay of Bengal and the Arabian Sea A North Indian Ocean numerical model simulation, showed that this difference results from two factory- mean winds over the ocean and salinity variation. The

former sets up a tilt of the surface of the North Indian Ocean from the southwest to the north east, the predominant direction of southwest monsoon winds over the ocean. This factor accounts for about 60% of the sea level difference. Salinity variation along the coast arising from differences in freshwater influx into the two basins creates lighter, lower-salinity waters off/along tht east that account for about 40% of the sea level difference between the two Indian coasts.

2. Our geophysics group in their studies of the lithospheric cross sections of the Central Indian Ocean found that the lithosphere responded to the continental collision b) buckling and cracking at different ages in the past The growth of folds and faults at different times about 8 Ma 4 Ma and 0 8 Ma - provide evidence of these events that are spaced both temporally and spatially over the lithosphere. This hypothesis corrects some earlier concepts of defrmation timings and models.

The sea continues to amaze us as in the discovery of subsurface [15 m] diatom blooms that are normally out of reach of satellite observation. We can now better understand why gross estimates of primary production by satellite based method are not always correct. We need to undurstand bloom processes in greater detail and contmuously refine satellite algorithms if we are to quantify biomass abundance with greater precision.

Another surprise was an unusual bacterium isolated from the Central Indian Ocean Basin at 4500 m depth, buried some 15 cm below sediments. The cultured forms were able to oxidize ammonium to ni trite and further to nitrate. This is our first instance of isolation of bacteria that are capable of carrying out both the stages of nitrification

Outreach and awareness building

The institute has had to balance the demands of our long coastline against its restricted manpower base distributed at centres at Mumbai, Goa, Kochi on the West coast, and a single regional center at Visakhapatnam on the east coast. Fortunately this centre will have a growth phase as we begin negotiations for construction of a new building on the campus of Andhra University. Our further plans on the east coast include active consideration of regional centres in Orissa, Bengal and the Andaman Islands.

The CSIR has several outreach programmes meant to attract young talent and under these programmes we placed around 100 high school & pre-university students and about 25 Information Technology graduates with our science project leaders who guided them on various assignments.

We also made it to the visual media through seven short episodes on oceanography which featured the institute activities and were telecast on the national TV channel in a popular weekly science programme *"Turning Point"*.

Along with publications in standard cited literature, our patent activity rose for the 4th straight year, with most filings being in the USA. European Union countries and under the Patent Cooperation Treaty. Wonderlully, many of our basic science programmes too are emerging with innovative ideas that we are able to write-up for protection under the intellectual property regime.

Our evergreen chemical "guru" - former colleague Dr. Rabin Sen Gupta, took up the task ol collating all the information and knowledge that we had generated about the Indian Ocean and bringing out a two-volume set titled "The Indian Ocean - a perspective". The first volume is devoted to physical and chemical oceanography of open and nearshore waters of India and countries bordering the Indian Ocean and the second volume is primarily devoted to biological oceanography. I am sure that both students and researchers will find these to be useful in understanding the Indian Ocean, and gaming an insight into various aspects of ocean research in India.

The excellence of science at the Institute continues to be reflected in the awards and recognitions the staff members receive from various organizations. The most notable of such awards this year was the S.S. Bhatnaar Puze given to Dr. K. Sree Krishna for his outstanding work on the deformation of the Central Indian Ocean lithosphere.

To sum up, the year has been excellent on all counts and for this I profusely thank all my colleagues for their sincerity, dedication and doing good science.

Wish us prospective Xth Plan ahead.

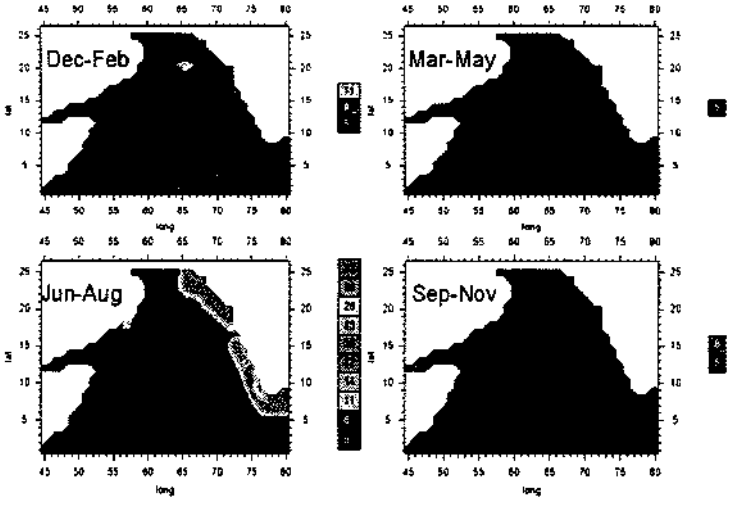
Jai Hind,

Ehrlich Desa

COASTAL ENVIRONMENT

Nitrogen cycling in the Arabian Sea

The oceanic combined nitrogen budget appears to be out of balance today with the loss from the oceans far exceeding inputs A very substantial fraction of this loss occurs through denitrification in the Arabian Sea not only as nitrogen, but also as radiatively-active and ozone-depleting nitrous oxide (N_2O).



Seasonal N_2O fields for the sea-surface based on data averaged for echo I° x 1° grid

Photosynthetic production b) phytoplankton is generally controlled by the availability of fixed nitrogen in the form of nitrate and ammonia The inventory ol fixed nitrogen is determined by the balance between the inputs mainly through nitrogen fixation, atmospheric deposition and river runoff, and the loss due to denitrification

An evaluation of all available data from the world oceans including the Arabian Sea suggests that about 450 million tonnes of nitrogen is lost annually through denitrification, while the total inputs amount to only about 200 million tonnes This means that the oceanic fixed nitrogen budget has deviated to a great extent from steady state.

The Arabian Sea, due to its extensive oxygen deficiency, not only acts as an important site for denitrification, but it is also an important source for atmospheric N_2O. A synthesis of all available data led to quantification of the total N_2O emission rate from this region as 0.33- 0.70 million tonnes annually. This estimate, how ever, does not include the intense season ally anoxic zone along the west coast of India, where our recent measurements have revealed huge accumulation of N_2O through denitrification. Inclusion of this seasonal flux would raise the total (lux estimate from the Arabian Sea to approximately 1 million tonnes When compared with the flux of N_2O from the ocean as a whole (around 5 million tonnes an nually) it would appear that as much as 20% of the global N_2O emission seems to come from merely 2% of the oceanic area. It is possible that the N_2O emissions from the Arabian Sea, and also from other coastal anoxic sites, have been enhanced recently as a result of coastal eutrophication. This calls for measures to check the growing over-fertilization of our coastal waters.

Phytoplankton blooms - observational surprises An underwater bloom of diatoms

Phytoplankton distributions are detected routinely from space By sea-viewing satellite based passive radiometers that monitor the total flux of light reaching the sensor at selected wavelengths. The phytoplankton component of the water leaving flux emanating from the ocean carries useful information on the phytoplankton biomass. These features are manifested in satellite imageries and belong to flux contributions from the surface layers of the ocean. Phyloplankton occurring at deeper water depths are not detected by the satellite.

In our nearshore coastal waters, towards the end of the monsoon upwelling season, warm fresh water from river runoff and monsoonal rain forms a thick layer that floats over more saline but cooler upwelled waters. This freshwater cap prevents the upwelied water from reaching the surface. Both water types arc rich in nutrients, resulting in conditions conducive to the formation of blooms at the interface between them. Underwater blooms of this type occur at a depth out of reach of satellite penetration depth and therefore, will not be observed in chlorophyll distributions processed from satellite data. On a recent cruise, we had the opportunity to observe and make measurements of an underwaterbloom of diatoms at a depth of 15 m, out ol reach of the satellite penetration depth of 9 m. Effects of this nature result in gross underestimates of primary production by satellite based methods and indicate, that our understanding of bloom processes

and a continuous refinement of existing satellite algorithms are needed to quantify biomass abundance with greater precision.

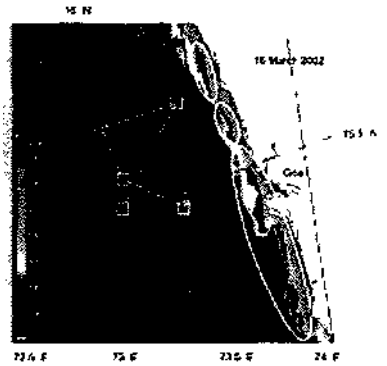
A nursery of Trichodesmium cells

It is common knowledge that the nitrogen fixing marine diazotrophic cyanobacterium known as *Trichodesmium* appears regularly in our coastal waters in the months of February March April each year. We were surprised when we found countless young cells of *Trichodesmium* being formed in a nursery far out at sea in the month of November when it was least expected.

This requires that we re-examine ideas on what constitutes th physical, chemical, or biological conditions that trigger the formation and growth of *Trichodesmium* to the point that it may not have coastal origin but is more likely formed in the open ocean and gradually driven to shore by increasing wind forces. Optical detection of young cells by satelite would be difficult as the amount of backscattered flux would be too small to be detected with any degree of confidence.

Trichodesmium blooms all along the west coast of India

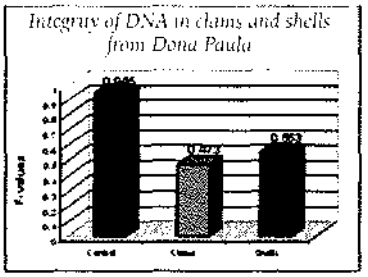
As expected we encountered massive kilometer wide and kilometer long swaths of Trichodesmium blooms in the month of March 2002. It was detected in the old fashioned way — ship rope bucket microscope and fluorometer to measure chlorophyll concentrations. This time we extended our detection of *Trichodesmium* using the Ocean Color Monitor on the Indian satellite IRS-P4. Much to our surprise we were able to capture chlorophyll patches of *Trichodesmium* origin for hundreds of kilometers stretching from Gujarat to the south in Kerala. A huge differencc from the old fashioned way of doing things but now with high technology space based tools to estimate *Trichodesmium* colonies without touching them.

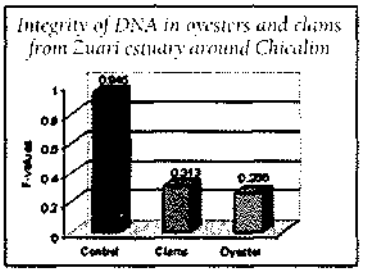


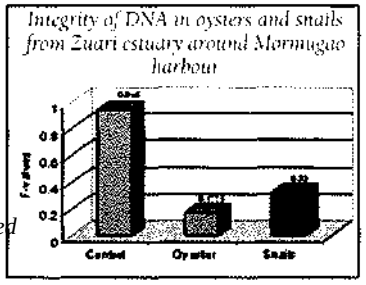
Patches of Trichodesmium bloom detected in the IRS-P4 OCM satellite image during the Sagar Shukti cruise

Application of DNA damage in marine pollution studies

Exposure of living organisms to environmental pollutants can lead to genetic damage to then body tissues. One such example is the damage to the integrity (strand break) of DNA, the core genetic material of all living tissues.







We have measured the integrity of DNA in different species of mollusks such as clams snails and ov sters collected from estuarine and coastal waters of Goa subject to different levels of environmental stresses (clean as well as polluted environments).

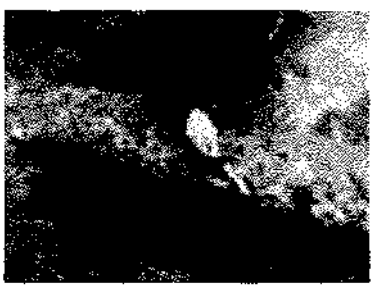
The study has shown a clear sign of damage (strand breaks) to DNA. Largest damage was observed in organisms from polluted areas while organisms from areas subject to relatively lower level of pollution (tourist spots) showed mod crate damage. Remote areas that are free from pollution showed minimum damage. Further studies are on to identify the pollutants and their specific effects on DNA.

This study could lead to the development of DNA damage as a biomarker in pollution monitoring and abatement.

Basking in the past glory

Marine archaeological studies at Bet Dwarka (north west India) got a fillip with thermo-luminescence dating of 9 potsherds which helped in establishing cultural sequence of Okha Mandal region, Gujarat. The TL date (3800±490 yrs BP) indicates continuous habitation on the island.

Our scientist divers also located this year a temple complex dating probably back to 1500-1200 BP, now lying undcrwater off Mahabalipuram (southeast coast of India. This is one of the finest discoveries in the reccnt times since, of the seven shore temples constructed during the rule of Pallava dynasty, only one remains onshore now.



Diver examining underwater structure at Mahabalipuram

ENGINEERING & TECHNOLOGY

Technology - new and trusted *Maya* - a technology start

Marine Instrumentation Division has embarked on a journey of change - towards the development of small, intelligent and safe Autonomous Underwater Vehicles [AUVs]. Several innovations are being incorporated in this development including distributed intelligence, software procedures that mimic human diver logic, low-weight smart battery packs, and a simple launch and recovery system. A family of small AUVs constitutes the vision lor the division.

Christened *Maya*, the vehicle is conceptualized for use by oceanographers in coastal waters, with the first prototype targeted for Year 2004. The Division has initiated collaboration with the Institute of Systems and Robotics [ISR], Portugal, which comes in the wake of a recent bilateral cooperation in Science and Technology between India and Portugal.

Spreading know-how - tide gauges and weather stations

Marine Instrumentation engineers have been engaged in successive refinements of Tide Gauges and Weather Stations over the last two decades. A new chapter in this area has been the transfer of know-how to two industries. In an important initial step in the technology transfer, we assisted industries to fabricate and test 18 tide gauges lor use in the extreme conditions of the Gulf of Kutchch. Apart from pilferage of three units, the gauges demonstrated their robustness and reliability in extreme conditions.

The institute's Autonomous Weather Stations have been installed on the fleet of research vessels of the Department of Ocean Development, and most recently on our own coastal research vessel CRV *Sagar Sukthi*. Six stations were fabricated for use in the Gulf of Kutchch, performing successfully in those extreme conditions.

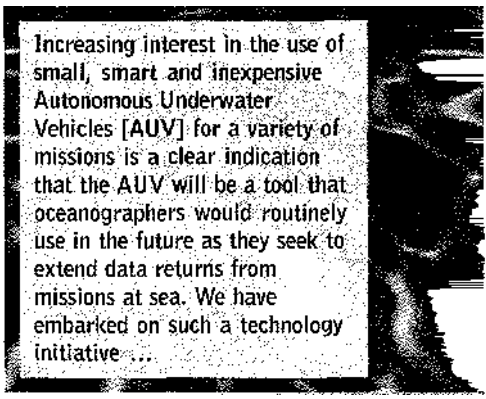
A high speed Linux based data acquisition and logging system was developed at the Division to record ship board data from a single beam echo sounder. The system has been tested with success in research cruises. The requirement of this system fulfilled the need of geophysicists at the Institute to analyze the backscattering strengths of acoustic signals from the water column and the seabed and to test algorithms that will be used to characterize micro-relief structure and classify seabed sediment properties, and determine zooplankton biomass in the water column.

Biotechnology patenting prospers

This year we have added 4 more patents to our inventory; preparation of an extract with multiple properties from a deep sea bacterium for use in food and cosmetics, a process for biological deinking of office waste paper, a process for degradation of polycyclic aromatic hydrocarbons and a method for enhancing levels of polyunsaturated fatty acids in thraustochytrid fungi.

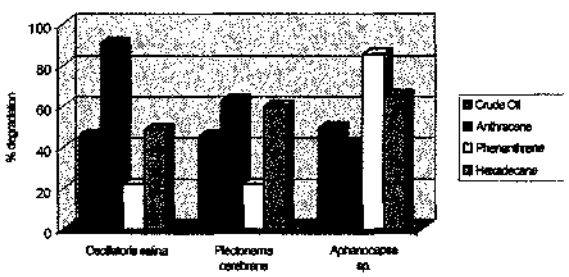
Two patents filed in 1996 were published. These publications deal with degradation of crude oil by marine cyanobacteria (Figure; Applied Microbiology and Biotechnology, 2001, Vol. 57) and tar balls by marine protists, the thraustochytrids (Indian J. Marine Sciences, 2001, Vol. 30).

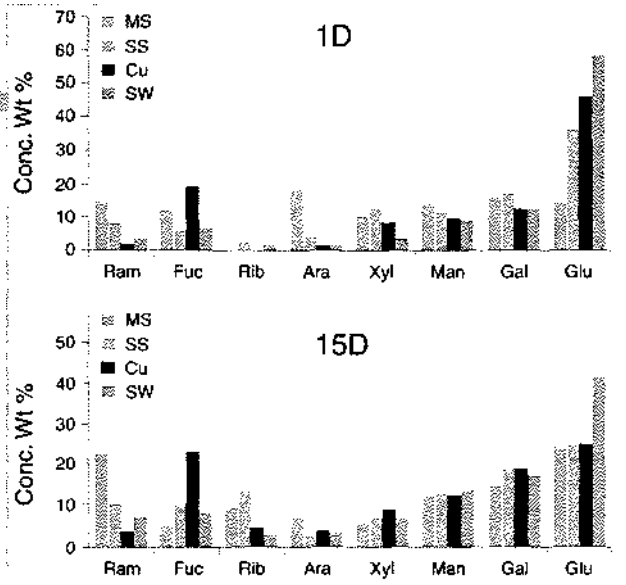
Unique properties of deep sea bacterial isolates capable of participating in both the phases of ammonia oxidation was demonstrated under laboratory simulated conditions of 400 bars and 5°C (Current Science, 2001, Vol. 80).



The middleman in play...

The organisms that foul marine structures need some sort of preconditioning of the surface. This is usually in the form of a





Average monosaccharide composition of the suspended particulate material (▨) and biofilm products developed on mild steel (▨), stainless steel (▨) and copper (■) panels over the 15 d period of immersion in Dona Paula Bay.

microfilm, composed of extracellular polymeric substances (EPS).

Chemical characterization of the EPS provides dues to what makes the biofilm attractive to big foulers. We used a range of indicators (concentrations of arabinose, xylose, glucose and ribose and ratios of carbon to nitrogen and carbon to chlorophyll) to characterize the biofilm on materials immersed in seawaier (copper, mild steel and stainless steel).

Our results show that organic matter of terrestrial origin or of microalgal origin was abundant on the surfaces in the early days of immersion of the metals in seawaier. It was only by the 15th day of immersion that bacteria began to make an impact.

What does this mean for control of fouling?

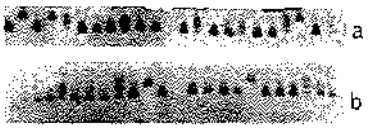
An understanding of the composition of EPS and its role in initial stages of fouling can aid in developing strategies to retard fouling by larger organisms. Additional support for this could come from chemoreception and olfaction cues, as shown by our experiments with the barnacle *(Balanus amphirite).*

An ecological control of fouling by barnacles in tropical waters could be the transient phytoplankton blooms during monsoon. These blooms can induce impulsive release of barnacle larvae but do not last long enough to be nutritionally adequate lor a successlul recruitment to the sessile population.

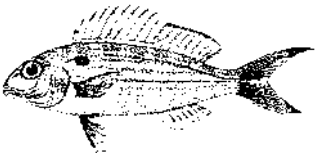
Looks can be deceptive...

The thumb rule in conventional taxonomy is the external appearance, but recent advances in genetic science have provided tools that are turning conventional wisdom on its head and can explore beyond the outer lookol an organism. Functional differences stem from the genetic makeup and is of important consideration in biodiversity and fisheries. Studies with nemipterid fish have shown that *Nemipterus japonicus* and *Nemipterus peronii* are closer to *Parascolopsis aspinosa* than the other species of their own genus.

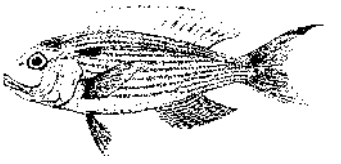
It is also lound that the *Nemipterus japonkus horn* the east and west coasts oflndia are significantly different in their genetic composition.



Polymorphism at ADH locus in Nemiptcrus iapomcus from (a) Vizagand <b)Goa.*



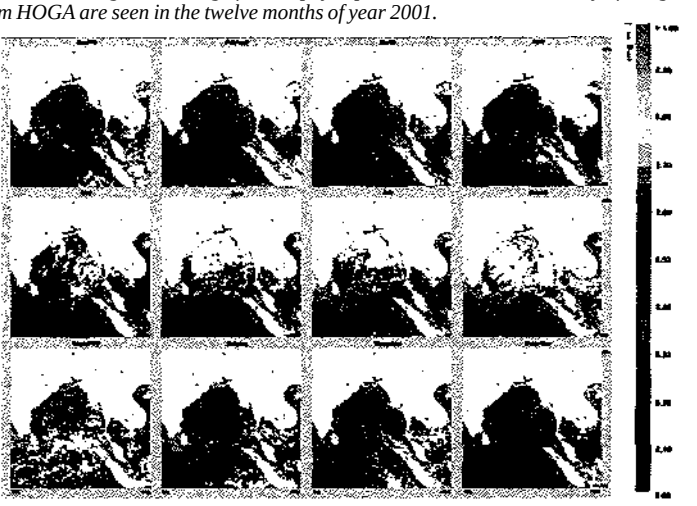
Kernipterus japoiv.tus



N. *Pcivnii*

ParaSi. lopsis aspinosa

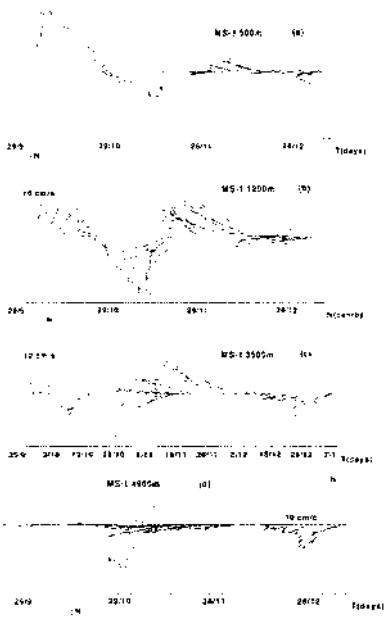
HOGA - the SeaWiF's station at the Institute celebrated its third annivary in August 2001. The waxing and waning of chlorophyll spatial distributions in the Bay of Bengal from HOGA are seen in the twelve months of year 2001.



OCEAN PROCESSES & RESOURCES

Probing the deep to understand its ecology

Oceans are on average four kilometers deep. A question that has intrigued oceanographers is: how do currents at a location differ with depth? Of particular importance are currents at strategic locations. Central Indian Ocean basin is one such location. India might some day mine polymetallic nodules from the ocean floor here and data on deep currents may provide clues on how the pollutants due to the mining might disperse to influence ecology of the region.



Time variation of daily averaged current vectors at (a) 500 m, (b)1200 m, (c) 3500 m and (d) 4900 m *at MS-1 during southern spring-summer season of 1*996.

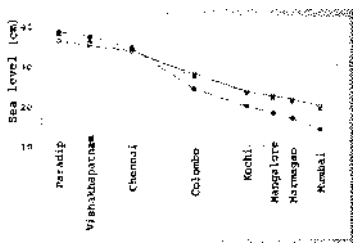
With this in mind, NIO scientists have deployed instruments at 10°S, 74°54'E; 14°46'S, 71°54'E and 14°58'S, 76°58'E to determine variability of currents at different depths (VSN Murty et al., 2001). The data collected during 1995-97 provide valuable insights into hydrodynamics of the region. The surface current here are dominated by the great South Equatorial Current that flows from east to west (*figure*) throughout the year, but its axis moves in the north-south direction from season to season. Signatures of this movement can be seen in the upper one kilometer. Below this depth the data showed prescence of a clockwise-turning gyre. Also observed are other oscillations with a period of about two weeks, in addition to tides.

It is expected that all these complicated array of currents will have a strong impact on how pollutants (for example, line suspended sediments) move in the ocean abyss here and hence have an impact on the ecology of the region. The current meter data provide clues on how the ecology might evolve if mining actually takes places in the future.

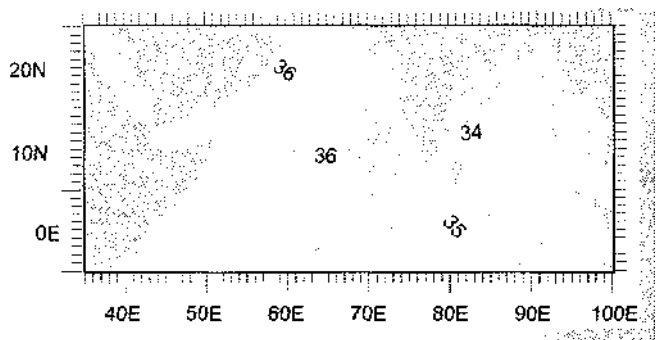
Why is the mean sea level along the Indian coast higher in the Bay of Bengal than the Arabian Sea?

The Great Trigonometrical Survey carried out during 1858-1909 by the Survey of India was a landmark effort to map the Indian subcontinent. This effort, together with other studies, showed that mean sea level along the east coast is higher than on the west coast. While concluding the survey, Colonel S.G. Burard. head of the Survey of India, left it for future generations to determine validity of this result and if true determine the reasons for it.

Subsequent studies did confirm that sea level along the east coast is indeed higher by about 30 cm. NIO scientists (Shankar and Shetye, 2001) have now identified the reasons why. Using simulations with a numerical model of the North Indian Ocean they have argued that the difference in sea level is the result of iwo factors: mean winds over the ocean and salinity variation along the coast ol India. The former sets up a till of the suriace of



Three model simulations of annual mean sea level (centimeters) along the coast of India: the effect of purely wind-forced circulation (solid line, open circles), of both wind-forced circulation and salinity (dashed line, filled circles), and of increasing wind stress unifbrmly over the basin (dotted line, triangles). The difference between the *dashed and solid lines is a measure of the influence of temperature being negligible, and the difference between the dotted and solid lines is a measure of the effect of a 10% increase* in *the strength of monsoon winds.*



Annual mean salinity, averaged over the top 100 m, in the north Indian Ocean. Contour interval in 0.2 PSU.

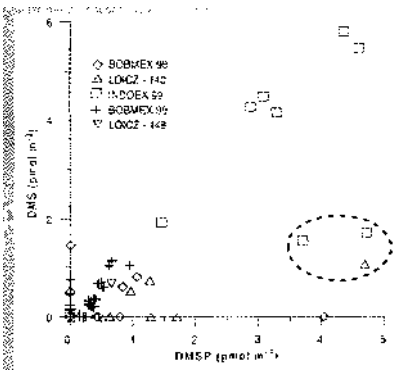
the North Indian Ocean from southwest to the northeast, the predominant direction, of southwest monsoon and mean winds over the ocean. This factor accounts for about 60% of the sea level difference. Salinity variation along the coast is due to differences in freshwater influx into the two basins, the Bay of Bengal on the east and the Arabian Sea on the west. The lighter, lower salinity waters on the east contribute to about 40% of the sea level difference between the coasts of India.

Sea level is a sensitive indicator of the ocean climate. India holds a wealth of information on how the sea level along the coast of India has varied during the last century. The study by NIO scientists indicates yet again how sea level information can be used to gain insights into working of the ocean.

Dimethyl sulphide in the waters and atmosphere of the North Indian Ocean

Dimelhylsulphoniopropionatc (DMSP), the precursor of dimethyl sulphide (DMS). a climatically important constituent of the atmosphere, has been found in marine aerosols for the first time.

DMS is a naturally-occurring gas formed through the decomposition of DMSP, produced by marine phytoplankton. In the atmosphere, DMS forms sulphate aerosols and cloud condensation nuclei leading to a decrease in solar insolation at the Earth's surface. Thus, it serves as an anti-greenhouse agent that can to some extent counter global warming.



We have carried out extensive measurements of DMS and DMSP in the waters and atmosphere of the North Indian Ocean. The data have been used to compute the extent of DMS emission to the atmosphere from this region. The average diffusive fluxes of DMS from the Arabian Sea and Bay ol Bengal are 217 mg m^{-2} d^{-1} and 663 mg m^{-2} d^{-1}, while the average flux from the enure Indian Ocean is 340 mg m^{-2} d^{-1}. This indicates that the Bay of Bengal is an important source of atmospheric DMS.

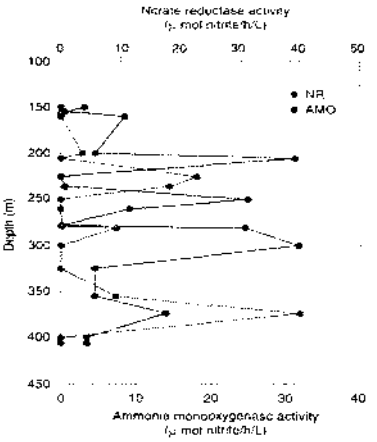
The diffusive flux was considered to be the most important mode of DMS emission from the oceans so far. Our work has shown lor the first time that marine aerosols commonly contain significant amounts of DMSP, facilitating substantial production of DMS in the atmosphere itself.

Activities of respiratory enzymes in suboxic waters

Enzymatic measurements reveal a hitherto unrecognized fine structure in redox environment with occurrence of both nitrification and denitrification activities in several closely-spaced layers within the Arabian Sea oxygen minimum zone.

Chemical transformations in the oceans are predominantly biologically-mediated. These reactions are facilitated by specific enzymes. Knowledge of the activities of these enzymes provides important insights into the mechanisms and rales ol biogcochemical transformations.

The Arabian Sea experiences acute oxygen depletion within a large volume of water at mid-depths (~150-1000 m). Due to the non-availability of oxygen within this depth range the heterotrophic bacteria, which derive their energy by degrading organic matter, switch over to nitrate as an oxidant. This process, known as denitrification, leads to the production of chemically inert elemental nitrogen (N_2) at the expense of bio-assimilable nitrate. The reduction of nitrate to nitrogen occurs in several steps. The first two steps (conversion of nitrate to nitrite, and of nitrite to nitric oxide) arc mediated by the enzymes nitrate reductase and nitrite reductase.



Representative profile of distribution of activities of enzymes of denitrification (nitrate reductase, NR) and nitrification (ammonia monooxygenase, AMO) in the Arabian Sea oxygen minimum zone.

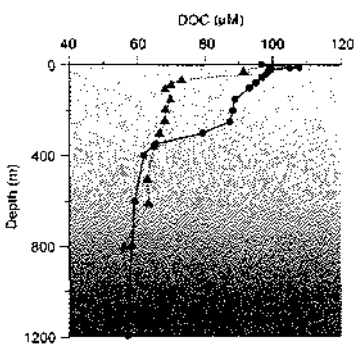
We have investigated the inter-relationships between the activities oi these enzymes and the respiratory electron-transport system, the enzyme system that facilitates the electron transfer to oxygen or other oxidams such as nitrate, in the Arabian Sea oxygen minimum zone (OMZ). The results revealed occurrence of both nitrification and denitrification activities in several closely-spaced layers within the OMZ. Such a fine scale variability, not recognized previously, has important implication on aspects of nitrogen cycling such as the production and consumption of nitrous oxide (N_2O). which has been found to accumulate in very high concentrations under certain circumstances. As the observed structure

seem to reflect a fine structure in the watermass composition, the results underscore the sensitivity of the OMZ processes to any shifts in physical forcing.

Modulation of primary and export production by Saips

Silicate deficiency in surface waters of the northern Arabian Sea during winter modifies the food web structure leading to moderate primary production and greater retention of organic matter in the surface layer.

Biological productivity of the oceans is dependent on the availability of nutrients, the most important of which are the salts of nitrogen, phosphorus and silicon. Uptake by phytoplankton, the microscopic plants, usually keeps the concentrations of these nutrients at very low levels in surface waters, while the regeneration from the decaying organic debris sinking from the surface leads to their accumulation in subsurface layers. The quantity of particulate organic matter exported from the surface layer is determined by the food web structure which, in turn, is regulated by the concentrations of various nutrients and their ratios, while the nutrient supply to the surface waters is maintained by upwelling and vertical mixing. Winter cooling and mixing bring nutrients to the surface waters over large parts of the northern Arabian Sea. However, due to the differences in vertical distributions of various nutrients, and the shallow reach (maximum 120 metres) of convective overturning, the supply of phosphate and nitrate, which constitute the soft tissue of organisms, is more than that of silicate, which forms the skeletal part of some important phyloplankton (diatoms). The larger-sized diatoms are the workhorses of the biological pump since they can be easily grazed upon by zooplankton such as copepods that produce particles large enough to sink out of the surface layer while the smaller phytoplankton such as cyanobacteria and eukaryotic algae make small contributions to particle exports. High concentrations of nitrate and phosphate and low concentration of silicate in surface waters ol the northern Arabian Sea during winter lend to support growth of smaller phytoplankton and limit diatom productivity. This creates an ecological niche for large filler feeders such as salps, pelagic tunicates that are capable ol utilizing phytoplankton in the small (few mu m) size range.



Vertical profiles of DOC at the beginning (12 Feb 1997, ▲) and at the end of salp swarms (19 Feb 1997, ●)

We observed widespread swarms of salps during a time-series study conducted in the northern Arabian Sea during the period of winter convection. Indiscriminate feeding by these suspension feeders led to marked removal of chlorophyll from surface waters. Surprisingly, even though salps are known to produce dense, rapidly-sinking fecal pallets, floating sediment traps deployed at 130 and 300 meters to intercept the sinking material did not collect much organic matter. Instead, a very substantial increase in the dissolved organic carbon (DOC) was recorded following the salp swarms. Thus, the presence of salps in large numbers not only moderated the primary productivity through removal of chlorophyll, it also led to enhanced retention of organic matter in the surface layer. The DOC accumulated during winter most probably supports bacterial growth during the following less productive spring intermonsoon period. The bacteria are grazed upon by micro-zooplankton (2-20 mu m) that, in turn, are utilized by mesozooptankton (20-200 mu m). Such a microbial loop may explain the high mesozooplankton biomass throughout the year in the Arabian Sea, a puzzling feature of Arabian Sea biology.

These observations imply that selective fertilization of surface waters with nutrients may not always lead to sequestration of carbon to the deep sea, a possible measure being considered to counter the rising atmospheric carbon dioxide levels.

An unusual bacterium from deep-sea sediments

Buried 15-20 cm below the scafloor, at depths beyond 4500 m in the Central Indian Ocean Basin, we recovered and cultured (under high pressure) bacteria that oxidize ammonium to nitrite and further to nitrate. This is the first time such a bacterium, with the unusual property of being able to carry out both the phases of nitrification, has been isolated.

Putting the jigsaw pieces together...

The frequent changes in magnetic field that our planet experiences, arc preserved us magnetic signatures in the earth's crust, and used as a tool by marine geophysicists to place major events such as the history of the split and drifts of continental land masses, in an accurate time frame. Field data has allowed us to use this technique to establish the conjugate nature and time of separation of the Indian continent, from Antarctica.

The institute has spent many years studying the Bay of Bengal for its magnetic and gravity fields. Magnetic anomalies are preserved in the crust, and we have identified anomalies M11 to M0 imprinted during times from 132 to 118 million years ago (Ma). It is commonly believed that the eastern Gondwanaland split and drifted about 140 million years ago, and that the Eastern Antarctica and Eastern India were adjoined.

Magnetic data sets from Enderby Basin, East Antarctica (given to us by the Scripps institute of Oceanography) were analysed in conjunction with data sets from the Bay of Bengal for similarity in anomaly sequences. Magnetic (and satellite-derived gravity) data sets of both regions were comparable in the anomalies M11-M0.

When a continent or plate fractures and the components drift apart, their drift away from a quasi-stable feature - in this case the mid-oceanic ridge - is imprinted on the spatial separation of successive

anomalies. This "half spreading rate" and the anomalies in the Enderby Basin have a striking coincidence with those of the Bay of Bengal, further strengthening the conclusion that these two basins were conjugate and contemporary.

The clinching evidence was the occurrences of the oldest magnetic anomaly M11 close to the coasts of both these two offshore basins, further strengthening the conclusion that the split between India and Antarctica took place about 132 Ma.

Rewriting the birth certificates of faults and mountains in the central Indian Ocean...

The theory of plate tectonics was a major step in understanding many features of the solid earth. Plate deformation and earthquakes were assumed to occur only at plate boundaries. A recent study, in collaboration with the Southampton Oceanography Centre and Edinburgh University, has found that the ocean floor in the middle of the Indo-Australian Plate is also subjected to such forces, experiencing high seismicity and crustal deformation at diferent times in the past.

The central Indian Ocean seafloor responses to the collision of India with Asia are seen as buckles and cracks at different geological times. Analysis of cross-sections of this area of the Indian Ocean lithosphere (the outer rigid layer of the earth) shows that these parts of the ocean floor have been substantially transformed. The two dominant features are faults that rise to 800 m, and folded mountains as high as 3000 m and as long as 300 km. These features were formed - about 8 million years ago (Miocene), 4 millions years ago (Pliocene), and most recently about 800,000 years ago (Pleistocene). The events are not only spaced in time (about 4 millions years), but also spatially across the ocean floor. The spatial extent of the Pleistocene folding event overlaps the two earlier folding events, and is the area of most active faulting and greatest seismic activity.

Dr KS Krishna who has been analyzing these events has found that these cracking faults occurred simultaneously when the crust was buckling. The two earliest faulting events have since been overlain with sediments, whereas the faults from the Pleistocene event (which straddles portions of both earlier regions) are not only manifested up to the present sea-floor, but also have longer fault throws.

These new findings are in contradiction to earlier concepts (derived from models of plate reconstruction), which proposed a single event that started about 18 million years ago - almost 10 million years earlier than what is now proposed. The study has also brought about an understanding of multiphase folding and faulting that we expect will improve global plate reconstructions and models of how the lithosphere deforms in the central Indian Ocean.

The oxygen isotope weatherman says...

The oxygen has two major isotopes: ^{16}O and ^{18}O. The isotopic ratio is measured as delta^{18}O and is different for different forms of water: delta^{18}O of the seawater is 0 ‰, water vapour is -16 to - 7‰ and freshwater - 7‰ , and that of ice is - 25‰. The ^{18}O content of the seawater increases relatively when there is intense evaporation, similarly, the ^{18}O content of the waters decreases when there is glacial discharge or freshwater influx by precipitation. This natural difference in isotopic ratios is effectively used as a paleo-thermometric tool. Microorganisms such as the foraminifers that live in the surficial waters imprint the signature of the oxygen isotope ratio (delta) in the calcium carbonate contents of their shells. When these organisms die and sink to the seafloor, they retain in their shells the isotopic signature of the sea water when they were alive.

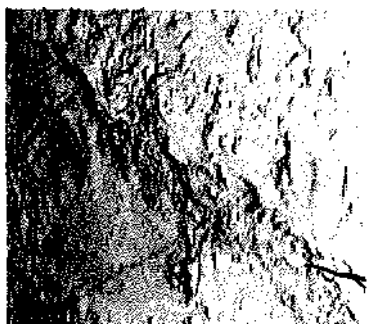
We measured oxygen isotope ratios of the foraminifer *G. Ruber* and *G. Sacculifer* from sediment cores collected from the southwestern Arabian Sea and Bay of Bengal. The Arabian Sea data shows there was reactivation of the monsoons leading to high precipitation (leading to lowering of seawater temperature) between 13000 and 6000 years BP, with a maximum after 9000-8000 years BP.

Similar records from the Bay of Bengal cores indicate two arid events undetected so far, at approximately 4800 and 2300-2200 years before present.

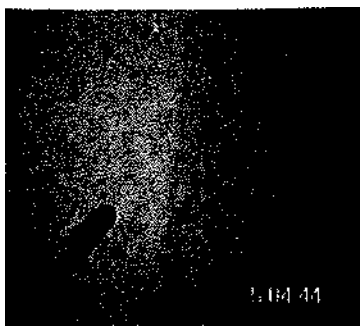
Deep seabed mining hazardous ? Not qyite

To evaluate the potential impact of deep seabed mining, a benthic disturbance experiment was conducted in the Central Indian Ocean (at depths 5200 m) by suspending 6000 cubic metres of sediment. The observations of a group of geologists, biologists, chemical oceanographers and physical oceanographers show that the benthic environment is getting restored and the recolonisation has started.

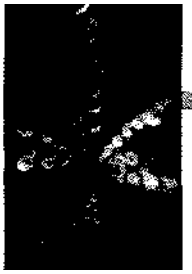
The initial results of these studies were published as a special volume of the journal - Deep Sea Research.



Tracks made on the seafloor by the disturber



Recolonisation seen in the disturbed *area 44 months after the disturbance*



COMMUNICATIVE EVENTS

NIO acquired Coastal Vessel

A new Coastal Research Vessel *Sagar Shukti*, equipped with the state-of-the-art equipment was commissioned by the first lady of the State of Goa, Ms. Tasneem Fazal in the presence of His Excellency Shri Md. Fazal, Governor of Goa at a function organized by NIO on 5 October 2001.

Addressing the gathering the Governor, wished that the new-vessel would help NIO to be in forefront of ocean research. He hoped that the vessel would enhance institute's research activities and facilitate in bringing out better and effective means to improve quality of life. He was happy to learn that NIO generates its own resources (Lab Reserves) and uses for purchase of vessel such as *Sagar Shukti* and in enhancing infrastructure.

The Governor, also flagged off first maiden research cruise, with Dr. Desa, Director NIO as leader on board. Shri Srinivas Dempo, Chairman Dempo Group of Companies, and other dignitaries were present at the function.

The various facilities and equipment onboard include Differential Global Positioning System for accurate positioning and communication channels, digital side scan sonar, digital sparker system, current-temperature-depth profiler to 600 meters, towed magnetometer, spectrophotometer and spectrofluorometer.

Since the decommissioning of Research Vessel *Gaveshani* in August 1994, NIO has been using the vessels of the Department of Ocean Development (DOD) for sea explorations. Commissioning of CRV *Sagar Shukti* has opened up new avenues for the Institute in carrying out ocean studies particularly in coastal areas.

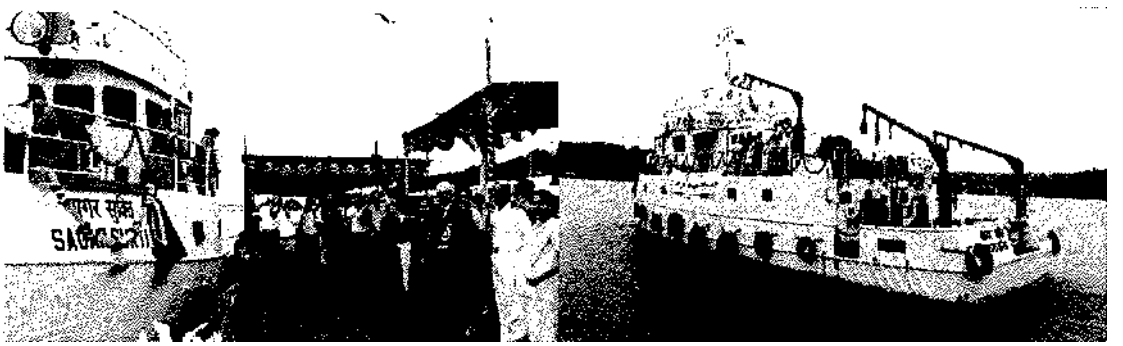
NIO awarded ISO-9001

At a formal function held at it's headquarters on 5 November, NIO received ISO 9001 certificate, at the hands of Union Minister of State for Petroleum and Natural Gas & Parliamentary Affairs, Shri Santosh Gangwar. NIO thus joined the select group of CSIR laboratories, in providing quality assurance to its stakeholders.

While commending their work, the Hon'ble Minister urged the scientists to accept greater challenges. He appreciated their hard work under tedious and uncertain conditions, searching wealth from ocean bottom. To save foreign exchange spent on crude oil import, the minister saw a vast scope for cooperation

H.E. Shri Md. Fazal addressing *the audience. Sitting (L-R): Dr. E. Desa, Ms. Tasneem Fazal and Shri Srinivas Dempo.*

Union Minister Shri Santosh Gangwar presenting ISO 9001 certificate to Dr. E. Desa, Director, NIO.



Governor flagging off Sagar Shukti on maiden cruise.

between his ministry and NIO to venture upon gas hydrate search.

Dr. P.S. Rao, NIO's Management Representative for ISO implementation provided an account of various tasks involved and performance of his team in getting the certification. Dr. D. Chandramohan, who guided the process, said that it is just the beginning and one need to carry out continuous improvement to achieve performance excellence. Both Drs. Rao and Chandramohan acknowledged Dr. Desa's initiatives and drive in achieving ISO accreditation.

On this occasion Dr. K. Sree Krishna, recipient of Shanti Swarup Bhatnagar Prize for the year 2001 and recipients of this Award in earlier years Drs. S.R. Shetye and S.W.A. Naqvi, were felicitated by Shri Gangwar.

MoU with Portugal signed

An eight-member delegation of the Republic of Portugal visited the Institute on 29 November following the MoU that was signed earlier by governments of Republics of Portugal and India for Cooperation in Ocean Science & Technology. Of several areas of mutual interests identified, NIO and organizations in Portugal will jointly work on Remotely Operable and Autonomous Vehicle Systems and explore underwater for archaeological studies in the first instance. Scientific presentations were made by both sides on this occasion to identify further areas of cooperation.

Eng. Armando Trigo de Abreu, President, Institute of International Scientific & Technological Cooperation, Ministry of Science & Technology led the delegation.

International Ship Observations Team Meet

A team of 50 S&T experts from 20 countries was at NIO on 25 February, for a weeklong participation in the first meeting of an International Ship Observations Team. The team was a major international component of the Joint Technical Commission for Oceanography and Marine Meteorology, sponsored jointly by the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). The meeting was followed by a scientific and technical workshop next day.

The team was concerned with the international coordination of programmes, which use volunteer merchant vessels and oceanographic research vessels as platforms for observation of meteorological and oceanographic parameters. These observations, which are globally distributed through Global Telecommunications System of WMO, are used for a number of important applications, such as operational weather forecasting, maritime safety services, global climate studies and oceanographic research. A new programme, related to use volunteer ships to monitor the amounts of carbon dioxide in the oceans was reviewed.

Annual Convention of IGU

The 38th Annual Convention of Indian Geophysical Union (IGU) with over 250 participants was held at Visakhapatnam regional centre of NIO. The focal theme of the convention was "Natural

Hazards and Disaster Management: Role of Earth System Scientists". Over 150 research papers were presented both on the focal theme and related aspects as solid earth geophysics, electromagnetic imaging of the crust, oceanic basins, ridge processes and atmospheric, space and planetary sciences.

During the convention H.N. Siddiquie Memorial Lecture series was introduced and the the first Lecture on "How long triggered earthquakes will continue in Koyna, Maharashtra, India?" was delivered by Dr. Harsh K. Gupta, Secretary, Govt. of India, Department of Ocean Development, New Delhi. On this occasion the website http://www.iguonline.org designed at the Regional Center, NIO was hosted by B.M. Reddy, Vice-President, IGU.

Foundation Stone laid for permanent building of Regional Centre

Dr. Harsh K. Gupta, Secretary, DOD, New Delhi, laid foundation stone for permanent building of NIO Regional Centre on 18 December. The function was presided over by Prof. J.M. Naidu, Registrar, Andhra University, Visakhapatnam.

Speaking on the occasion, Prof. J.M. Naidu assured further help and co-operation from Andhra University. He appreciated the closer links between NIO and the University. Dr. K.S.R. Murthy, Scientist-in-Charge of the NIO Regional Centre expressed gratitude to the University for allotting the site.

Book on Indian Ocean released

"The Indian Ocean - a perspective", two volume publication was released at NIO by Dr. Harsh K. Gupta, Secretary, DOD. The volumes edited by Drs. Rabin Sen Gupta and Ehrlich Desa and published by Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, contain comprehensive information on many oceanographic regimes. The first volume is devoted to physical and chemical oceanography of open and inshore waters of both India and countries bordering the Indian Ocean and the second volume deals primarily with biological oceanography. These volumes provide not only useful references to ocean students and researchers but also an insight into the ongoing mainstream ocean research in India.

SPONSORED PROJECTS

Title	Sponsoring Agency	Project Leader
Environmental Impact Assessment (EIA)		
Monitoring of Bhavnagar in the Gulf of Khambhat	Nirma Ltd., Bhavnagar	Jiyalal Ram Jaiswar
EIA study for IPCL's proposed MGCC expansion at Nagothane in Maharashtra.	Indian Petrochemicals Corporation Ltd. (IPCL), Nagothane.	K. Govindan
Monitoring of Amba Estuary (May-June 2001) and for conducting post monsoon survey (Nov-Dec 2001)	-do-	M.D. Zingde
Monitoring of Amba Estuary	-do-	-do-
Rapid EIA (RMEIA) inclusive of environmental management plan, emergency response plan and contingency plan for exploratory drilling operations in fourteen offshore blocks off the coast of India	Reliance Industries Ltd., Mumbai	-do-
RMEIA for 3 additional blocks	-do-	-do-
EIA for enhanced crude handling at Vadinar	Indian Oil Corporation Limited, Vadinar	-do-
Marine release of effluent from TCL in Mithapur	Tata Chemicals Ltd. (TCL), Mumbai	-do-
Rapid EIA for development of fish-landing facilities around Maharashtra coast.	Dept. of Fisheries, Govt. of Maharashtra	-do-
Risk assessment studies, development of emergency plan, emergency response plan and contingency plan for oil and gas exploratory drilling operations	-do-	V. Sanil Kumar
Marine impact assessment studies for minor fishery harbour at Dholai in Valsal District	Engineers India Ltd., New Delhi	S.N. Gajbhiye
EIA for fish landing platform at Navabandar	-do-	-do-
Offshore environment monitoring of western offshore oil fields during Nov./Dec. 2001 as a post-monsoon study	Institute of Petroleum Safety & Environment Management (IPSEM), ONGC, Betul, Goa	G. Parthiban
Offshore environment monitoring of western offshore oil fields during March 2002 as a pre-monsoon study	-do-	-do-
PPN combined cycle power project -offshore works approval for GA post project environmental monitoring	PPN Power Generating Company Ltd., Chennai	X.N.Verlenkar

Title	Sponsoring Agency	Project Leader
Monitoring strategy for biodiversity, coastal and marine environmental component of the EIA of Gujarat	Ecological Society, Gujarat Enterprise, Thane	
EIA for marine outfall for the proposed bulk drug unit. - U at Chippada village area Bhimunipatnam Mandal, Vizak Dist. - Regd.	Divis Laboratories Ltd., Hyderabad	K.H.Vora
Marine environmental monitoring along the west. coast of India.	Indomer Coastal Hydraulics (P) Ltd., Chennai	
Geological and Geophysical Surveys		
Shallow seismic survey off Gangavaram	Indomer Coastal Hydraulics Pvt. Ltd.. Goa	K. Mohan Rao
Laying of underwater HDPE pipeline across Zuari River	Public Works Department, Goa	N.M. Anand
Postlay survey of pipeline routing across Zuari river to confirm the burial 2 meters below the river bed	-do-	M.C. Pathak, K.S.R. Murthy, T. Suresh
Nearshore sediment transport estimation off PPN power plant	Marubeni Corporation Ltd.. Chennai	S. Jayakumar
Investigation of the seabed at Poompuhur and Mahabalipuram, South India	The Scientific Exploration Society, England	K.H.Vora
Engineering		
Wave and wind measurement off Kakinada	Cocanada Port Co. Ltd., Kakinada	K. Ashok Kumar
Calibration of sensors	Elcome Marine Services Pvt. Ltd., Vasco, Goa	G. Nampoothiri
Directional wave measurement off Minicoy island of Lakshadweep	Lakshadweep Harbour Works, Kavaratti.	P. Pednekar
Coastal Zone Management		
Marking of high tide line for proposed Dry Dock project	Terra Firma Env. Consultant Pvt. Ltd. Mumbai	K.L. Kotnala & M.C. Pathak
Delineation of high tide and low tide line and CRZ boundaries for property bearing CTS No, 2/1 to 2/12 of village Mahul at Mumbai	Eversmile Constructions Co. Pvt. Ltd.. Mumbai	M.C. Pathak
Delineation of HTL, LTL and CRZ boundaries near Dolphin's Nose Hill at Visakhapatnam outer harbour	South Asia LPG Co. Pvt. Ltd.	K.S.R. Murthy
Seabed surveys for inspection of 24 HDPE submarine outfall pipeline off Mangalore	Mangalore Refinery and Petro- chemicals Ltd., Mumbai	M.V. Ramana
Wave and current measurements at 4 locations in the Bay of Bengal.	Reliance Industries Limited, Mumbai	K. Ashok Kumar & S. Mandal

Title	Sponsoring Agency	Project Leader
Others		
Study of mangrove afforestation at Gorai, Mumbai	Pan India Paryatan Ltd., Mumbai	T.G.Jagtap
Analysis of total PCB content in 20 oil samples received from MPCB	Indian Institute of Petroleum, Mumbai	A.Sarkar
Testing of oil samples drawn from import consignments said to be furnace oil	Commissioner of Customs, Raigad	-do-
Testing of off-specification furnace oil/waste oil for presence of polychlorinated biphenyls - regarding	Central Intelligence Unit, Mumbai	-do-
Bombay sewerage disposal project -Stage-II Master Plan - selection of options	PHE Consultants, Mumbai	M.D. Zingde
Training NTPC Officers on Netscape	STG International, Hyderabad	S. Lakshminarayana
CRZ delineation in Goa for the Goa - Hyderabad Pipeline Project	Reliance Petroleum Limited, Mumbai	M.C. Pathak
Inspection of oifshore pipeline	BASF, Mangalore	K.H.Vora
The quality analysis of Co-Mn based synthetic catalyte compounds	M/s. Gamma Manganese Chemicals, Vasco	V.K. Banakar
Marine emergency management plan for crude oil and POL jetty of CPCL at Nagapattinam	Chennai Petroleum Corporation Ltd, Chennai	P. Vethamony
Analysis and input of published literature as per ASFA Standards	ICLARM, Malaysia	G.H. Sainekar
Quality analysis of Mn Acetate compound	METASAL Speciality Chemicals P. Ltd., Mumbai	B.R. Rao
Confirmation of dtffuser design and estimation of secondary dilution for M/s GACL, Dahej	Hydroair Tectonics (SPD) Pvt. Ltd., Navi Mumbai	M.T. Babu
Vulnerability assessment of various sectors due to climate change.	Ministry of Environment and Forests, New Delhi	O.S. Chauhan
Testing of oil spill dispersant Corexit 9500	Oil & Gas India Ltd.. Mumbai	Classy D'silva
Gold Crew - Water based dispersing agent for oil spill cleanup and fire fighting control agent etc.	Centreprise, Thane	-do-
Setting up of the Environmental Monitoring Laboratory at Kandla Port Trust	Kandla Port Trust, Kutch	P.V. Shirodkar
Development of Tadri Port: (i) Rapid EIA & Comprehensive EIA (ii) Demarcation of HTL, LTL & CRZ Boundaries (iii) Seabed surveys	Zoom Developers P. Ltd., Mumbai	X.N. Verlenkar K.L. Kotnala & M.C. Pathak -do-

Grant-in-Aid

Title	Sponsoring Agency	Project Leader
Diversity and enzymes of deep-sea fungi: life under an extreme environment	Department of Biotechnology (DBT), New Delhi	C. Raghukumar
Immunostimulatory activity of marine yeast polysaccharides on fishes against their pathogens	Indian Council of Agricultural Research (ICAR), New Delhi	Ranu Gupta
Mumbai Port baseline survey under Global Ballast Water Management programme.	UNDP	A.C. Anil
Atmosphere-land-ocean interaction during intense rainfall events along the west coast of India	Department of Science & Technology (DST), New Delhi	S.C. Shenoi
Comparative study of deformation and dynamics response to the inplane compressive forces in the Central Indian basin and Wharton basin, under ILTP Programme	-do-	D. Gopala Rao
Reconstruction of past sea surface temperatures in the eastern Arabian Sea/ Lakshadweep using coral records	Department of Ocean Development (DOD), New Delhi	S.W.A. Naqvi
Marine geology and gas hydrate potential of the western continental margin of India	-do-	M. Veerayya
Geochemical studies to decipher paleoclimatc in the Bay of Bengal (Sub-project: Palaeoceanographic studies in the Bay of Bengal Fan)	-do-	V. Ramaswamy
Benthic foraminiferal studies in the sub-surface sample of BOB to reconstruct palaeoceanographic changes (Sub-project: Palaeoceanographic studies in the Bay of Bengal Fan)	-do-	R. Nigam
Response of planktonic foraminifera and carbonate to palacoceanographic changes in Bengal Fan (Sub-project Palaeoceanographic studies in the Bay of Bengal fan)	-do-	D.P. Naidu
Collection of data on hydrodynamics, water quality, ecology, mining, socio-economics etc. for preparation of model Integrated Coastal and Marine Area Management (ICMAM) plan for Goa	-do-	S.N. De Souza
Collection of data on hydrodynamics, water quality, modelling and for ecology, socio-economics etc. for preparation of ICMAM plan for Gulf of Kachchh	-do-	P. Vethamony
Geoscientific investigations of shallow sediments in KG offshore, East Coast	KDMIPE. ONGC, New Delhi	M.V. Ramana
India-Myanmar joint oceanographic studies in the Andaman Seas	Ministry of External Affairs, New Delhi	P.S. Rao

AWARDS & HONOURS

S.S. Bhatnagar Award

Dr. Kolluru Sree Krishna was selected for the most coveted Shanti Swarup Bhatnagar award for excellence in earth, atmosphere, ocean and planetary sciences.

Dr. K.S. Krishna discovered an important phenomenon - periodicity in deformation o! the central Indian Ocean lithosphere in response to the continuing collision of India with Asia. The discovery led him to find the growth of the folded mountains and reverse faults. These features have been formed at different times in the past - about 8.0 Ma (Miocene), 4.0 Ma (Pliocene) and 0.8 Ma (Pleistocene). The events are not only spaced in time (about 4.0 Ma) but also spatially on the ocean floor. He who has been closely analyzing these events came with new findings that have superseded the earlier concepts of deformation of the lithosphere. The new hypothesis will now allow improving the plate kinematic and deformation models in the central Indian Ocean.

Election as Fellow of Indian Academy of Sciences, Bangalore added yet another feather to his cap this year.

Raman Research Fellowship

Dr. Y.K. Banakar was awarded Raman Research Fellowship by CSIR for 3 months (June-August, 2001) for carrying out stable isotopic study in the Hokkaido University, Japan, for paleoclimate reconstruction for the Eastern Arabian Sea.

D.Sc.

Dr. Rajiv Nigam was awarded the Doctor of Science degree in Geology by the Aligarh Muslim University. The award came to him in recognition of his significant contributions to the understanding of paleoclimate and sea level changes using foraminifera as a geological tool. He is now using it for pollution studies.

Dr. Sree Krishna receiving the S.S. Bhatnagar award at the hands of Prime Minister Shri Atal Bihari Vajpayee and Dr. M.M. Joshi, Union Minister for HRD and Science & Technology.

CRUISES LED

Cruise No.	Dates Chief Scientist	Area Port: From - To	Objectives
ORV Sagar Kanya			
162	4-24 Apr. 01 L.V. Subba Raju	Laxmi Basin Mormugao-Mormugao	For surveys in Laxmi Basin and its surroundings
164	8-25 May 01 M.V.S. Guptha	Arabian Sea Mormugao-Mormugao	To carry out time series sediment trap mooring operations under the Indo-German bilateral programme and LOICZ Programme
165	28 May-2 Jul. 01 Sridhar D. Iyer	Central Indian Ridge Mormugao-Kochi	To study tectonics and petrological implications of fracture zones on crustal generation
166	2 Jul.-2 Aug. 01 Prasanna Kumar	Bay of Bengal Tuticorin-Chennai	To study seasonal variability of the upper ocean in response to atmospheric forcing and its implication to overall basin scale CO_2 air-sea exchange balance
168	29 Aug.- 4 Oct. 01 K.A. Kamesh Raju	NE Indian Ocean Chennai-Chennai	To acquire multibeam swath bathymetry (Hydrosweep) geophysical data and to carry out CTD observations, collect water, sediment and rock samples for oceanographic studies
169	7-14 Oct. 01 M.V.S. Guptha	Bay of Bengal Chennai-Chennai	To carry out sediment trap mooring operations under the Indo-German bilateral programme
171	2-18 Nov. 01	Mormugao-Mormugao	For validation of MOS (IRS P3)
172	21-30 Nov. 01 A.L. Paropkari	Arabian Sea Mormugao-Mormugao	To retrieve and re-deploy two time series sediment traps
173	8-12 Mar. 02 A.L. Paropkari	Arabian Sea Mormugao-Mormugao	-do-
RV A. A. Sidorenko			
34	20 Mar.-25 Apr. 01 B. Nagender Nath	Central Indian Basin Mangalore-Mormugao	To study the possible effects of nodule mining on the benthic environment under INDEX programme
38	16 May-19 Jun. 01 M. Shyam Prasad	Central Indian Basin Tuticorin-Port Luis (Mauritius)	Identification of marginal blocks for the final 20% relinquishment of the Pioneer Area to the International Seabed Authority
40	9 Dec. 01 - 9 Jan. 02 J.N. Pattan	Central Indian Basin Mormugao-Mormugao	For PMN survey and exploration

CRUISES LED

Cruise No.	Dates Chief Scientist	Area Port: From - To	Objectives
RV A. A. Sidorenko-continued			
41	14 Jan.-10 Feb. 02 A.L. Paropkari	Arabian Sea Mormugao-Mormugao	To investigate the proxies to decipher the possibility of gas hydrate concent tion.
42	13 Feb.- 8 Mar. 02 M.D. George	Arabian Sea Mormugao-Mormugao	To study biogeochemical cycling, carry out time-series observations in the area close to the boundary of denitrification zone and understanding paleoclimatic changes during the late quaternary
CRV Sagar Shukti			
1	5-11 Sep. 01 E. Desa	Inner & mid-shelf between Goa & Ratnagiri	To monitor the development of hypoxia over the west coast of India, assess its inter-annual variability, and characterize the nitrate reductase gene and bacterial diversity in shallow oxygen-deficient zone.
PI-1	12-14 Sep. 01 S.W.A. Naqvi	Cross-shelf section off Goa	To monitor the development of hypoxia over the west coast of India and assess its inter-annual variability.
PI-2	17-23 Sep. 01 S.W.A. Naqvi	Cross-shelf section off Goa, Honavar & Mangalore	To monitor the development of hypoxia over the west coast of India and assess its inter-annual variability
PI-3	24 Sep.-2 Oct. 01 S.M. Karisiddaiah	Between Mormugoa & Karwar	To identify the extent and presence of gas escape features along the west coast of India and its implications to the probable gas hydrate horizons.
4A	12 Oct. 01 L.V. Subba Raju	Off Baga (Goa)	To find out the sunken object (helicopter) of Goa Naval Area.
5	13-14 Oct. 01 Dilip Kumar	Off Goa (Condolim coast)	To monitor hypoxia along the Goa coast following upwelling.
6	15-23 Oct. 01 Lata Raghukumar	Goa to Kavaratti	To survey coral health in Kavaratti island of the Lakshadweep group of islands, to assess chlorophyll values and to isolate fungi and thraustochytrids from zooplankton and sediment. To record underwater life in the island for population genetics studies.
6A	26 Nov. 01 E. Desa	Inner shelf off Goa	To investigate the occurrence of "red tide" off Goa, identify the organism, determine its toxicity, if any, and understand the physico-chemical environmental forcing functions.
7	27 Oct.-2 Nov. 01 C.G. Naik	Lakshadweep	Exploration of marine macro biota of a group of Lakshadweep Islands.
8	8-15 Nov. 01 S. Raghukumar	West Coast of India	Collection of samples for identification and electronic documentation of marine

Cruise No.	Dates Chief Scientist	Area Port: From - To	Objectives
			biodiversity and monitoring of seasonal and annual changes with relation to environmental parameters.
9	8-11 Dec. 01 M.V. Ramana	Goa to Mangalore	Mapping of physiographic and subsurface geomorphic features in relation to suspected shallow gas pockets off Goa to Mangalore, collection of surface sediments samples at selected locations of gas escaping features to infer some geological proxies using foraminifer species.
10	12 Dec. 01 B.R. Rao	Off Goa	Long-H course for Naval Officers.
11	15-18 Dec. 01 L.V. Subba Raju	Redi to Vengurla rocks	To trace the palaeo-channels, to infer the faulting pattern in the nearshores of the shelf, to identify the rock outcrops, geological formations etc., to collect samples in a few selected places, to determine the gas charged and gas free sediment zones.
12	19-22 Dec. 01 S.W.A. Naqvi	Along one transect and few stations off Ratnagiri	To monitor the evaluation and understand causative factors for the development of anoxic conditions in the inner and mid-shelf region off central west coast of India, to investigate the distribution of primary productivity, chlorophyll and phytoplankton composition in relation to oxygen levels.
13	26-28 Dec. 01 S.N. Harkantra	Off Goa	To study benthic bio-diversity in relation to sediment characteristics.
14	1-10 Mar. 02 N.B. Bhosle	Goa to Cochin	To monitor tributyltin compounds and related parameters in and around Cochin harbour and at a few coastal stations along the west coast of India, to assess the biodiversity of phytoplankton and benthos along the coastal water of the west coast of India.
15	11-14 Mar. 02 B.R. Rao	Redi to Vengurla	To trace the palaeo-channels, to infer the faulting pattern in the nearshores of the shelf, to identify the rock outcrops, geological formations to collect samples in a few selected places, to determine the gas charged and gas free sediment zones.
16	18-23 Mar. 02 S.G.P. Matondkar	Off Goa	Ocean colour and *Trichodesmium* studies.
17	25-29 Mar. 02 D. Sundar	Off Goa	To study the seasonal variations in physical properties of coastal areas.

PATENTS & PUBLICATIONS

Patent filed	Inventors	Country
A novel fluorescent natural dye from a marine invertebrate	U. Goswami, A. Ganguly	Australia, Japan
Method for determining seafloor roughness using multibeam echosounder	B. Chakraborty, V. Kodagali	Germany
Preparation of an aqueous leaf extract having prophylactic and therapeutic properties for viral disease management of animals in aquaculture practices	Ulhas M. Desai, C.T. Achuthankuuy, R.A. Sreepada	WO, Thailand, Taiwan, Philippines, Chile
An extract from the Indian green mussel *(Perna viridis)* inhibits osteoclast formation and bone resorption	M.R. Wani, P.B. Parab, A. Chatterji	USA, WTO, India
Composition comprising *Zoanthus* sp. extract with antifouling activity and a use thereof	C.O.L. Gonsalves, C.T. Achuthankutty, P.S. Parameswaran, C.G. Naik	USA, WO
A novel pressure housing for in-water pressure based systems	Ehrlich Desa et al. (8 inventors)	USA, WO
An improved system for calibration of pressure transducers	A. Joseph, Vijay Kumar, S. Prabhudesai, P. Mehra, Ehrlich Desa, S.M. Nagvekar	USA, WO
A novel system for seafloor classilication using artificial neural network (ANN) hybrid layout with the use of unprocessed multi-beam backscatter data [Revised (PCT): A system for classifying seafloor roughness]	B. Chakraborty, V. Kodagali, J. Baracho, A. Joseph	USA, WO
A process for isolation of 2-deoxyecdysterone from *Zoanthus* sp.	C.O.L. Gonsalves, P.S. Parameswaran, C.G. Naik, C.T. Achuthankutty	USA
A novel compound and multiple fluorescent natural dye from a marine organism (Provisional)	U. Goswami, A. Ganguly	USA
A process for the preparation of an extract with multiple properties from deep sea bacterium for use in food and cosmetics	PA. Loka Bharathi, S. Achuthankutty, D. Chandramohan	USA
A controlled thruster-driven profiler for coastal waters	Elgar Desa, A. Pascol, P. Mehra, G.P. Naik, Ehrlich Desa, R. Madhan	USA
A new medium for the production of Indian horseshoe crab *(Tachypleus gigas)* amoebocytes in vitro	R.R. Bhonde, A. Chatterji	USA
Process for the cure and control of diabetes mellitus using natural products from *Perna viridis*	R.R. Bhonde, A. Chatterji	USA
A natural nontoxic fluorescent protein dye from a marine invertebrate, composition containing the said dye and its uses	U. Goswami, A. Ganguly	USA
A natural nonpolar fluorescent dye from a non-luminescent marine invertebrate, compositions containing the said dye and its uses	U Goswami, A Ganguly	USA

Patent filed	Inventors	Country
An extract from the Indian green mussel *(Perna viridis*) inducing differentialion and maturation of the dendritic cells (Provisional)	Kanury Rao & group (ICGEB), A. Chatterji, Z.A. Ansari	USA
Process for the identification of insulin producing *b*-cells proliferating factor from the peri-viialline fluid of fertilized eggs of horseshoe crab	EB. Parab, A. Chatterji	USA
Indian green mussel *(Perna viridis)* as a source of anti-HIV activity	D. Mitra, A. Chatterji	USA
A process for removal of polyaromatic hydrocarbons in waste waters and contaminated sites	C. Raghukumar, M.S. Shailaja, Shilpa Kamat	USA
A process for biological deinking of office waste paper	C. Raghukumar, C. Mohandass, T. Oliviera, S. Raghukumar, P.A. Loka Bharathi, S. Nair, D. Chandramohan	USA
A method for enhancing levels of the polyunsaturated fatty acids in Thraustochyirid protists (Provisional)	S. Raghukumar, Ruchi Jain	USA
A process for the isolation of pharmaceutical compound Cyclosporin A from the fungus *Fusarium nivale* (Fres.) Ces.	S. Bhosale, C.G. Naik, P.S. Parameswaran	USA
Upward closing grab sediment sampler	D. Ilangovan	India

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Kochi

Shoreline stability studies for 500 MWe PFBR Project at Kalpakkam.

Carrying capacity based developmental planning for Greater Kochi Region - coastal waters (third phase).

Determination of designated uses of coastal waters of Kerala and Karnataka (second phase)

Marine EIA for the site selection for the intake and outfall points for Naptha fired power station. Sponsor - M/s. Tracetebel Electricity & Gas International and M/s. Sujana Power Limited Tuticorin.

Environmental impact assessment on Vallarpadam container terminal - sponsored by Cochin Port Trust.

Determination of the designated use of coastal water (ICMAM) - DOD.

Marine EIA studies for the proposed port of Shell India at Hazira - sponsored by Shell India, Mumbai (Benthos only).

Rapid EIA, Risk Analysis and Disaster Management Plan for the backwater and river crossing portion of the IOCL Dock lines carrying petroleum products - sponsored by FACT Engineering and Design Organisation (FEDO), Udyogamandal, Eloor, Kochi.

Visakhapatnam

EIA studies for marine outfall for the proposed bulk unit for DIVI labs at Chippada Village, Bhimilipatnam Mandal (SSP-1300) - interim report

Rapid marine environment impact assessment studies ior treated effluents in the coastal environment oil Pydibhimavaram, Srikakulum Dist., Andhra Pradesh (MO/SP-14/2001).

Softwares developed

* Estimation of sand transport on natural beaches along given reach positions on the beach.
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* Diffraction model to coastal waters, useful to functional design of breakwaters.
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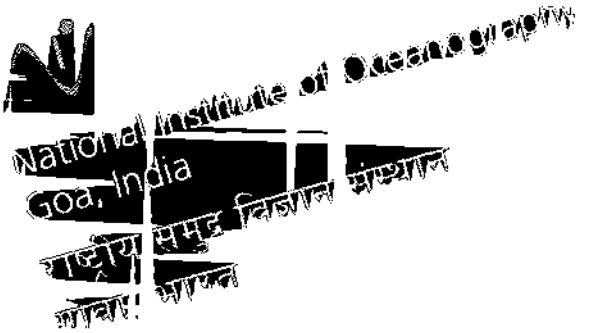
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