

Steaming ahead

India's new Ministry of Earth Sciences is at the helm of ambitious plans to advance deep-sea and polar research. **K. S. Jayaraman** reports.

India, despite being the only country with an ocean named after it, has not always been a global driving force in the field of oceanography, with most of its research focused on the seas close to its shores. Now Indian researchers are pushing beyond this traditional base, with a \$100-million-a-year drive deeper into their own waters and farther afield to the poles (see 'Push for the poles').

For instance, the Indian government is planning a new deep-sea research vessel to complement the *Sagar Kanya*, the flagship of the Indian research fleet. In collaboration with Russia, India is also building a robotic underwater vehicle that can dive up to 6 kilometres deep. And on the drawing board are dreams for a manned underwater submersible that Indian scientists believe would put the country on a par with more developed nations.

"I am really excited about the idea of India becoming a major blue-water research institution," says Henry Dick, a senior scientist at the Woods Hole Oceanographic Institution in Massachusetts, who is on the editorial board of the *Indian Journal of Marine Sciences*. "Indians have a tremendous contribution to make, and I see that as a great asset to the international community."

India is, after all, in an excellent geographical location — a suitable launching point for expeditions to the relatively little-explored Indian and Southern Oceans. Both play important roles in the formation of the Indian monsoon, and both contain underwater geological features of interest — such as the Southwest Indian Ridge, where oceanic plates are pulling apart at one of the slowest rates in the world. "This portion of the global plate-boundary system is the most poorly explored region on the globe," says Dick. "Basically, this is where the frontier of oceanographic research is, and India is located next to it." In addition, nearly 40% of the Southern Ocean can be reached only from the launching-off points of India and Australia, adds Maruthadu Sudhakar, senior scientist at the National Centre for



Floating labs: research vessels, such as *Sagar Kanya*, will assist deep-sea mineral extraction.

Antarctic and Ocean Research (NCAOR), which together with India's other government-funded laboratory of oceanography — the National Institute of Oceanography (NIO) — is located in the state of Goa.

Out of disaster

Still, Indian oceanography is a relatively new field. "Systematic oceanography in India really started with the International Indian Ocean Expedition in the 1960s," says Satish Ramnath Shetye, director of the NIO. That expedition produced the first oceanographic atlas of the Indian Ocean, and the core group of scientists set up the NIO in 1966. Today, with more than 200 researchers, the NIO is "the largest institution dedicated to ocean sciences in this part of the world," says Shetye.

The entire field got an unexpected boost after the official monsoon forecast failed to predict the driest season for decades in 2002 (see *Nature* **418**, 713; 2002). The Indian government asked

atmospheric physicist Roddam Narasimha to suggest ways to revamp the country's meteorology department, and his report concluded that India needed an agency more along the lines of the US National Oceanic and Atmospheric Administration. The recommendation might have remained just that but for C. N. R. Rao, chair of the science advisory council to the prime minister, who pushed hard to implement it — and whose group met for the first time to discuss it just after the devastating tsunami of 26 December 2004.

That disaster apparently convinced the government that oceans and atmosphere should be brought under the same umbrella. India's space and nuclear scientists have left their marks on global science, says seismologist Harsh Gupta, former secretary of the government's Department of Ocean Development and a driving force behind the new initiatives. "It is now the turn of oceanographers," he says. In July 2006, the new Ministry of Earth Sciences was born, bringing

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together national programmes in ocean science, meteorology, climate, environment, seismology and polar research. In its first year, the ministry has been allocated US\$240 million and is staffed by some 8,000 scientists.

India's interest in the ocean that surrounds it is economic as well as scientific. The country's exclusive economic zone, or EEZ, extends by almost two-thirds of the land area, and India has long set its sights on deep-sea mining. In October, the state-funded National Institute of Ocean Technology (NIOT) in Chennai anticipates getting a new \$70-million research vessel, which is being built in Italy. It will be the mother ship for a \$5-million unmanned submersible, expected to be ready in two years with Russian help, whose main goal is to recover manganese-rich nodules of rock and sediment from the sea floor. A prototype dived to 205 metres last October, says Subramaniam Kathirolu, director of NIOT. A manned exploration vehicle remains something of a dream, with a token allocation of \$1.25 million in this year's budget for 'development'.

Ocean secrets

Although some researchers now see deep-sea mining as economically unfeasible (see *Nature* 447, 246–247; 2007), India continues to pursue it. A pilot plant in Udaipur that extracts copper, nickel and cobalt from manganese nodules dredged from the sea floor, has been operating for several years at a rate of 500 kilograms of nodules processed per day. India has also been looking at underwater volcanic mountains — seamounts — as potential sources for mining cobalt. The cobalt-rich crusts capping the seamounts are available at shallower depths than the manganese nodules, which are up to 4 kilometres deep. The cobalt content of the crusts is three to six times greater than that of nodules. Virupaxa Banakar, a senior researcher at the NIO, says there are promising results from the Afanasy-Nikitin seamount in the

Push for the poles

Even as India puts more resources into exploring its surrounding ocean, the research focus pushes farther afield towards the poles.

India already has two polar research bases in Antarctica, and a third, a US\$10-million base to be built at Larsemann Hills in Princess Elizabeth Land, was approved this spring (see *Nature* 447, 9; 2007). It also maintains a \$25-million ice-core laboratory run by Thamban Meloth at the National Centre for Antarctic and Ocean Research (NCAOR), which

holds samples gathered from Antarctic expeditions.

Forays were made into the Arctic as early as 1991, to study how Indian soldiers fighting at high altitude in the conflict with Pakistan might cope with the cold.

Now Indian scientists are embarking on their first fully fledged expedition into the Arctic, in collaboration with the Norwegian Polar Research Institute, which has a research facility on the island of Spitsbergen. "Our scientists are keen to give India's polar science programme a bipolar

perspective," says Rasik Ravindra, director of the NCAOR.

The first expedition will be split into two groups. The first left for Spitsbergen last week, and the second will go in February next year. The project, costing \$250,000 this year, is expected to run for several years.

India is also pursuing the possibility of building an Arctic-class research vessel. The design has been selected and it will be built in the next four or five years, says Ravindra. **K. S. J.**

equatorial Indian Ocean — which is in international waters and cannot be mined without additional permits — and at several sites within India's EEZ.

Yet the secrecy with which India treats the oceanographic data from its EEZ is not going down well with the international community. "That is a great way to retard progress," says Dick. Indian researchers say they are bound by the guidelines of a 1975 parliamentary committee report that calls for "strict scrutiny" of foreign participation "in all aspects of oceanographic research related to ocean resources and coastal areas". For instance, India's forthcoming petition to claim an additional 1.5 million square kilometres of seabed will not contain magnetic or seismic data on the region, says Sivaramakrishnan Rajan, a senior scientist at the NCAOR.

Indian collaboration with foreign scientists might be helped, though, by the fact that India is on the verge of joining the Integrated Ocean Drilling Programme (IODP). The United States,

Japan and a coalition of 17 European countries are the primary members of this deep-sea drilling programme; India is looking to join as an associate member, as China is already. As part of the IODP, the Indian government plans to explore its energy and mineral resources beneath the sea and also investigate the geology of the Indian plate. Of particular interest are three potential drill sites: one each in the Arabian Sea, the western Andamans, and the Bay of Bengal, whose floor is carpeted by the world's thickest sediments, at 22 kilometres thick. The drilling, however, has to take place far offshore. "We cannot allow drilling by foreign ships within our EEZ unless there is a policy change," says Rasik Ravindra, director of the NCAOR.

But interacting with the scientific community of the IODP could be valuable for young Indian scientists. And India desperately needs to alleviate a creeping manpower shortage in this field. Last year, Mangalore University, one of four universities in India that teaches oceanography, closed its marine-geology programme because it had only two students.

"We need 20 fresh scientists a year," says Shetye, "but it is hard to find them." Many of the marine geophysicists trained at the NIO are poached by offshore oil companies, he adds. The NIO gives 12-week courses to 300 university students each year in the hope that some will opt for a career in this area, and the new ministry has created nine ocean science and technology cells in universities.

But the results are yet to be seen. "We will not survive," says Shetye, "if we don't produce enough manpower to do research." ■

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See Editorial, page 623.

S. R. SHETYE/NIO



Marine ambition: the National Institute of Oceanography, based in Goa, has led ocean research in India since 1966.