OCEANOGRAPHY

# Indonesian Policies Stymie Global Circulation Experiment

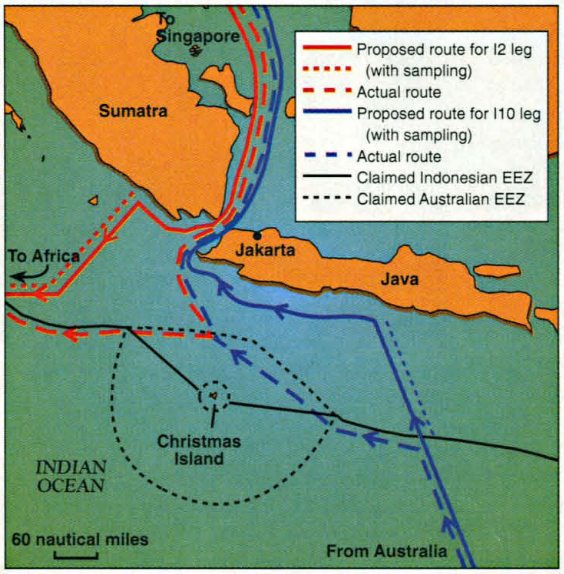
The ocean blithely ignores political boundaries, mixing and churning wherever the laws of physics take it. But oceanographers don't enjoy the same freedom. Four times in the last 9 months, Indonesian military officials have refused to grant requests from U.S. and Australian research vessels to take a close-up look at the South Java Current as part of the ongoing, 30-nation World Ocean Circulation Experiment (WOCE). The rejections have kept scientists on the U.S.-based *Knorr* and the Australian-based *Franklin* from exploring the interplay of the Indian and Pacific oceans and its effect on El Niño, the cyclical Pacific warming that can disrupt global weather, as well as leaving a gap in the project's coverage of the Indian Ocean.

They have also angered U.S. and Australian officials, who say that such refusals to allow research vessels to take water samples within the country's 200-nautical-mile Exclusive Economic Zone (EEZ) violate international law. What's more, Indonesia isn't the only country that is deeply suspicious of any foreign research vessel that wants to enter its waters. "There are a handful of countries that are problematic, [although] Indonesia is certainly near the top of the list," says Tom Cocke of the U.S. State Department, who coordinates the approval process for U.S.-based vessels.

Not all of these countries, which include some in Latin America and Africa as well as Asia, are as intractable as Indonesia. For example, Cocke says he was pleasantly surprised when India gave its approval last year for two other legs of WOCE's nine-part Indian Ocean survey that involved entering India's EEZ. "It was the first time in 12 years that they said yes to a U.S. vessel," he notes. And in the Western hemisphere, the *JOIDES Resolution*, the U.S.-based vessel used by the 19-nation Ocean Drilling Project, will be able to carry out its research plans this month—but only by following a route that's a logistical nightmare. To ease local concerns about drilling within the 200-mile limit, the ship will take on and drop off observers from each of five Caribbean countries.

In theory, oceanographic research shouldn't have to face such hurdles. The 1982 Law of the Sea Treaty, which has more than 80 signatories and went into force in 1994, commits nations, with few exceptions, to accommodate research vessels asking to enter a country's EEZ. But the treaty, which Indonesia has signed, hasn't reversed a mindset among some governments that foreign scientists are trying to acquire secret knowledge of their country's territorial waters, or that the data themselves are a valuable natural resource that should not be removed. "They feel that when you come into their waters, you're taking away something," says one veteran U.S. oceanographer.

In Indonesia, that feeling is strongest among the military. "The problem is with the military authorities," not civilian ones, says Bambung Herunadi, an Indonesian government oceanographer not involved in WOCE. By late last year, for example, the Indonesian Institute of Sciences (LIPI) and the Ministry




SOURCE: U.S. WOCE OFFICE

**No go.** The *Knorr* altered two legs of its Indian Ocean cruise after Indonesia failed to approve work within its 200-mile zone.

WOODS HOLE OCEANOGRAPHIC INSTITUTION

of Research and Technology had approved *Knorr*'s plans to study the fast-moving South Java Current as it falls away from the Javan coastal shelf, which would have required working as close as 30 nautical miles to land. WOCE scientists hoped that the data would help them characterize the flow of water—its volume, temperature, salinity, and speed—that passes from the Pacific into the Indian Ocean, as well as its seasonal and annual variations. That flow, the only one in which two oceans exchange vast amounts of warm water, is believed to play a major role in global ocean circulation and in turning El Niño on and off.

But military clearance for the *Knorr*'s two cruises, in November and December, never came through. In the meantime, the ship was asked to jump through a series of impossible hoops on its first leg as it headed toward Indonesian waters. "It was a Catch-22," says Cocke. "They imposed conditions but didn't allow us to fulfill them."

One such requirement for work inside the EEZ was the presence of two military observers on the ship, which already had one Indonesian scientist and two students on board. But when the Knorr agreed to pick them up, Indonesia cited a rule that says no foreign ship is allowed in Indonesia's territorial waters—up to 12 nautical miles offshore—without observers on board. Using a helicopter to ferry the observers to the ship would have cost $15,000, and even then there was no guarantee that the effort would succeed, so the *Knorr* scrapped its plans.

The *Knorr* wasn't the first vessel in the WOCE project to sail into this bureaucratic limbo. An April effort by the *Franklin* to sample the South Java Current was stymied when officials were told that the ship had not provided sufficient detail about its activities. So for the next cruise, in September, "we bent over backwards to make sure that they had everything—information on the crew, the vessel, the purpose of the research, and so on," says one Australian government official, who requested anonymity.

However, after getting diplomatic clearance, the *Franklin* arrived at Christmas Island, on the edge of Indonesia's EEZ, only to learn that there were problems with its security clearance. To resolve the problem, the *Franklin* agreed to take on a team of military observers. But after waiting several days for the team to show up, the ship ran low on fuel and was forced to head back to port. "You are rarely given a firm answer," says the official. "So silence really means no."

The failure to obtain data on the South Java Current leaves a gap in WOCE, which has conducted more than 60 cruises in the past 5 years, including nine in the Indian Ocean in the last 15 months. "It presents us with a fairly large uncertainty in the transport profile across this latitude," says Piers Chapman, director of the U.S. WOCE program, which is located at Texas A & M University. For example, the *Knorr* had planned to take water samples along the sea floor, starting well offshore at a depth of some 6000 meters and then moving toward the Javan coast, taking additional samples at depth intervals of 500 meters. Its measurements were to be part of a 15-month cycle of data collection in the region. Without that information, says Chapman, it will be harder for scientists to determine upper limits for the amount of water flowing through the Indonesian archipelago.

The gaps in WOCE would be larger if one hard-to-please nation, India, had not changed its mind about allowing the *Knorr* into its EEZ last February. For that visit, to the waters off the southern tip of India, "it took over a year from the time we put in the request," says Paul Maxwell, science counselor at the U.S. Embassy in New Delhi. He admits to having been "pleasantly surprised when the answer came back yes," and he suspects that the cruise benefited from a successful meeting last year between Indian Prime Minister P. V. Rao and U.S. President Clinton that included discussions on continued scientific cooperation.

Last spring India also granted permission for a second cruise, but only after protracted negotiations, Maxwell says. And last summer India turned down a third request to work off the Indian coast, from another U.S. research vessel, insisting on conditions that would have subverted its intended mission.

Although there is no indication that Indonesia's stance is likely to change any time soon, U.S. and Australian officials haven't given up the fight. Both countries filed a diplomatic protest after the *Knorr* cruise, says science counselor Gary DeVight of the U.S. embassy in Jakarta, and on 14 December the LIPI-led committee that reviews requests to conduct marine research in Indonesia agreed to draw up and disseminate a written description of the procedures that foreign research vessels must follow to receive clearance.

DeVight is hoping for the best—and expecting something short of that. "I'd give it a 25% chance of success," he says about the prospects for change. "But you have to start somewhere."

**–Jeffrey Mervis**

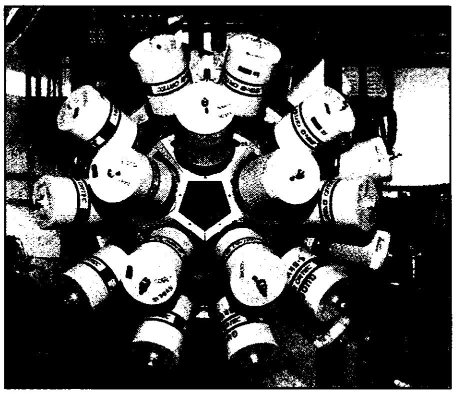
NUCLEAR STRUCTURE

# Broken Belt Sets Back New Accelerator

Even the largest, most high-tech scientific projects can sometimes grind to a halt because of the failure of the most mundane mechanical components—a loose nut, an unspooled tape recorder, a broken seal. Take the case of the Vivitron, an 18-month-old electrostatic accelerator that is one of Europe's top facilities for nuclear structure research. A rapidly disintegrating rubber belt brought research on the machine to a standstill last March, and engineers at its home, the Center for Nuclear Research (CRN) in Strasbourg, France, have spent the past 9 months trying to solve the problem. Now, with fingers crossed, they hope that a new belt installed last month will get things moving again. "The new belt ... is functioning correctly. The beam is now stable, and the precision of the beam is according to the specifications. We are now ready to do physics runs," says Jean-Pierre Vivien, CRN's deputy director for research.

The Vivitron is a Van de Graaff electrostatic accelerator, designed to boost heavy ions with fields of up to 35 million volts. Unlike particle physicists, who smash particles together and look at the debris, users of the Vivitron aim to fuse colliding nuclei and study the resulting large nucleus. If the collision is off-axis, the fused nucleus will spin at up to $10^{20}$ rotations per second and become flattened out by centrifugal forces—what nuclear physicists call a "superdeformed" nucleus. "These nuclei are very rigid structures," says Vivien, "and their deformation allows us to study the structure of the nucleus, because its layered structure becomes changed during the deformation."

At the heart of the Vivitron is a fabric belt coated with rubber that runs at 10 meters per second, picking up electric charge at one end of the machine and depositing it at a central electrode, building up the required positive voltage over a few hours. This apparatus is sealed inside a 50-meter-long enclosure, shaped like two ice cream cones joined together at their open ends and filled with sulfur tetrafluoride gas to prevent sparks. Researchers inject beams of negative ions in one end of the enclosure, and the electric field of the central electrode pulls them toward it. At the center, the negative ions pass through a carbon sheet that strips off several electrons. The resulting positive ions pass through the electrode, and the field pushes them toward the other end of the machine, where they collide with a target material.


CRN

**Revivified?** Work with the Eurogam gamma-ray spectrometer should resume soon.

Construction of the Vivitron began in 1986, and it opened for business in June 1994 (*Science*, 21 October 1994, p. 362). It operated almost continuously until March of this year, when its original rubber belt was worn out. The Vivitron team had two spares made by the same manufacturer, but to their surprise "these belts were catastrophic to the machine," says Vivien. "We found that we had to increase continuously the voltage to deposit the same amount of charge on the belt, and after a while, because there was too much energy dissipation in the belt, it started to disintegrate." Engineers traced the problem to new coatings the manufacturer had applied on the spare belts—polyurethane instead of nitrile rubber. "The manufacturer had changed the production method without informing us," adds Vivien.

The original manufacturer was not willing to supply belts produced by the older nitrile rubber method, but in the end the Vivitron engineers were able to find an Italian belt manufacturer who could help out. "They were prepared to return to an old method of manufacturing, especially for us," says Vivien. "The only belt problem left was a problem of gluing its components together. We asked a company to do this, and it has been done properly."

The hiatus has significantly delayed some research projects, however. The major victim was Eurogam, an Anglo-French gamma-ray spectrometer for studying superdeformed nuclei. This spherical detector array was first used at Britain's Daresbury Laboratory before its accelerator was shut down in 1993. Before its debut with the Vivitron, researchers increased the number of individual detectors in the array from 45 to 54. "From September 1994 we had about 3 months of running. [Then] we managed to do experiments in laboratories in other parts of the world to lessen the effect [of the stoppage]," says Paul Nolan of Britain's Liverpool University, a principal investigator with Eurogam. "We are 9 months behind because of the delays in Strasbourg."

As soon as the Vivitron is running again, Eurogam will return to center stage. "The next phase of the operation is to spectroscopically check that [superdeformed] states decay the way they are predicted to, and to measure their lifetime," says Nolan. "We will also look for more exotic deformed shapes, the so-called 'hyperdeformed' shapes, which have a 3-to-1 axis ratio." Nolan and his colleagues are eager to put the revivified Vivitron through its paces.

**–Alexander Hellemans**

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