plosions even closer to uniformity, said Ken'ichi Nomoto, reporting on work he did with Izumi Hachisu at the University of Tokyo and Mariko Kato at Keio University in Japan. Their calculations suggest that a white dwarf can steal material from a companion star and blow up only if it has a specific composition. Material ripped from the companion, he explains, tends to form a huge gas cloud around the dwarf, which could disrupt the steady accretion. The accretion can proceed only if the white dwarf sweeps away the cloud with a strong wind.

Intense x-rays from the white dwarf drive material off the dwarf's surface and so create the wind. But the wind will be either too weak to disperse the cloud or so strong that it prevents all accretion unless the white dwarf is laced with just the right amount of x-ray–absorbing heavy elements—ensuring further uniformity. "If anything, it strengthens [the case] for a standard candle," says Livio.

The clinching evidence that the supernovae are telling the truth about cosmic expansion, however, could come from further observations. Both teams are reaching for more distant supernovae, which probe the expansion rate even earlier in cosmic history. In the young universe, when the same amount of matter was crammed into a smaller volume, gravity should have overwhelmed the unchanging boost of the cosmological constant, slowing the expansion. The earliest supernovae should appear relatively close and bright—an effect that no confounding factor suggested so far could create. Perlmutter's team took the lead last month, discovering what is probably the most distant supernova yet at the 10-meter Keck Telescope in Hawaii.

Named after the composer Tomaso Albinoni (Perlmutter's team now has so many supernovae to keep track of that they have taken to naming them after composers), this event is more than 8 billion light-years away. With many more like it, the team should be able to see the brightening. So far, the musical theme fits: As far off as the searchers can find them, the supernovae all keep playing the same tune. **–JAMES GLANZ**

MARINE GEOPHYSICS

Ocean Drilling Floats Ambitious Plans for Growth

A proposed major expansion of the world's ocean drilling research program is taking the community into uncharted waters

For 15 years, a vessel that looks like a cross between a freighter and an oil derrick has been roaming the oceans, boring holes in seafloor sediments and crust. Its team of roughnecks and scientists has sampled ancient muds beneath the ice-infested waters of Antarctica and rocky crust off the Galápagos Islands. However, some of the most tempting scientific targets on the ocean floor, including unstable sediments, oil- and gas-rich regions, and the deepest reaches of the crust, have been off limits to the *JOIDES Resolution* and the Ocean Drilling Program (ODP), the 22-nation scientific consortium that operates it. Next year, Japan hopes to begin building a $350 million drill ship that could open up these forbidden zones. But researchers don't know if their governments will be willing to spend the extra money needed to operate that country's generous gift to the ocean drilling community.

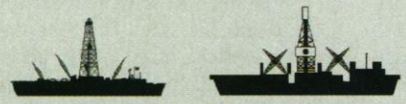
Japan's plans, expected to be approved early next year by the Diet, call for up to $40 million to start construction of a ship equipped with a riser—a pipe enclosing the drill pipe—that extends from the ship to the sea floor. Risers, which are standard on deep-sea oil platforms, allow drillers to flush heavy debris from deep holes and shore up unstable sediments. They also help provide a safeguard against blowouts when the bit penetrates oil or gas deposits. Japan intends to pick up the entire tab for building the ship, which should be completed by 2003, just when the ODP's lease on the *JOIDES Resolution* will end. The timing seems perfect, and many ocean drillers would welcome the riser ship's capabilities. "We've come up against these technological barriers. ... We need a riser drill ship," says ODP director Kathryn Moran.

The problem is that most people in the ocean drilling community believe the program also needs a second ship, to replace the *JOIDES Resolution*, that could drill less ambitious holes in rapid succession while the riser ship concentrated on more challenging projects. And they know that the annual cost of operating two ships—roughly $130 million, or nearly three times the current $44 million budget—is steep. "The [U.S.] National Science Foundation and we are aware there has to be new money if [a two-ship program is] going to fly," says Michael Arthur, a geochemist at Pennsylvania State University, University Park, and chair of the U.S. Science Advisory Committee to Joint Oceanographic Institutions Inc., which runs the ODP from Washington, D.C. Although no one can say how NSF and its counterparts in Europe will be able to find that new money, administrators and scientists have already set up the framework for a successor to the ODP, dubbed the Integrated Ocean Drilling Program (IODP), that assumes the use of two ships.

Clear sailing. JAMSTEC's Kinoshita says Japan is committed to a riser ship.

There is no question that the limitations of the *Resolution* are hindering scientific progress. For example, Arthur notes that a recent attempt to drill into a fault in the Woodlark Basin in the western Pacific had to be stopped after a rising hydrocarbon content indicated that drillers might be approaching an oil or gas deposit. The *Resolution*'s attempts to drill more than about 2 kilometers into the crust beneath the sediments, even in the absence of oil and gas deposits, have been foiled by jammed drill bits and poor core recovery. Nor has the ship had much luck drilling through the loose sands along continental margins, which provide a record of changing sea level.

DRILL SHIPS—PRESENT AND FUTURE



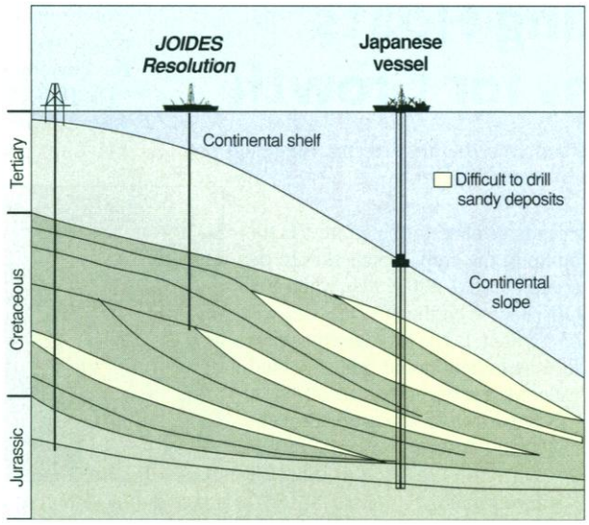
	JOIDES Resolution	Japanese vessel
Length	143 m	190 m
Annual cost	$44 million	$85 million, est.
Max. hole depth	2.1 km	5–7 km
Max. water depth	6 km	2.5 km, eventually to 4 km
Gross tonnage	9719 tons	~30,000 tons
Riser	none	2.5 km, eventually to 4 km

Outgunned. By any comparison, Japan's proposed drill ship is impressive, although the *JOIDES Resolution* can drill cheaper holes.

CREDITS: (TOP) D. NORMILE; (BOTTOM) SOURCE: NSF/JAMSTEC/ODP

A riser drilling system addresses all of these problems. Risers are typically used with blowout preventers, which can prevent oil or gas from leaking into the sea. And the enclosing pipe of a riser provides a channel for drilling mud—a viscous slurry of clay, water, and chemicals—which is pumped down through the drill pipe and circulates back up in the space between the drill pipe and the surrounding riser. The dense mud helps prevent the drill hole from collapsing, lubricates the drill bit, and flushes cuttings away, in principle allowing the rig to extend as much as 7000 meters beneath the sea floor.

Although the ocean drilling community identified the need for a riser in the early 1990s, Arthur says, the original idea was to lease such a ship from the oil industry as needed. But then the Japanese government, in particular its Science and Technology Agency (STA), stepped into the picture. STA's Marine Science and Technology Center (JAMSTEC), which is overseeing the design and construction of the vessel, saw a riser ship both as a key component of an increasing emphasis on basic research and as a project that might have technological spin-offs for Japan's shipbuilding industry (*Science*, 11 July 1997, p. 170). The combination was a winner politically. "The Japanese government and the [STA] are intent on completing this ship," says Hajimu Kinoshita, JAMSTEC's director of deep-sea research.



A deep reach. The proposed Japanese ship could reach deeper and, therefore, older sediments washed onto the continental slope.

Scientists are already thinking up missions for the riser ship. JAMSTEC, for example, has sponsored workshops on its scientific objectives, and a mission to study the ocean floor just east of Japan has received top priority. There drilling would approach its depth limits to penetrate a fault that generates large earthquakes off Japan. Kinoshita says this target will also allow officials to keep a close eye on the vessel during its shakedown cruises. Mark Zoback, a geophysicist at Stanford University, says such drilling is "very ambitious and it's going to be expensive. ... [But] we've been talking about these questions [in fault mechanics] for a long time, and they haven't been answered by indirect techniques."

The riser ship could also enable marine geophysicists to reach a long-sought goal: the Mohorovičić discontinuity, or Moho, the presumed boundary between the crust and the mantle. Although seismic waves bounce off the Moho, geophysicists aren't sure whether it's the boundary between the crust and the underlying mantle, an intrusion of rock into either layer, or something else. "There's no alternative to drilling" to settle such issues, says geologist Henry Dick of the Woods Hole Oceanographic Institution in Massachusetts.

In the mid-1960s, an NSF-funded project to reach the Moho, begun in 1958, became the first basic research project to be terminated by Congress after cost estimates ballooned from $5 million to $75 million. And 20 years ago NSF had equally ambitious, but ultimately frustrated, plans to convert the Central Intelligence Agency spy ship *Glomar Explorer* into a riser drill ship that would have cost twice as much to operate as Japan's new vessel (*Science*, 25 February 1983, p. 942). But in some parts of the ocean, Kinoshita says, the Moho might be within striking distance of the new ship after a planned upgrade in which the riser system is enhanced to work in water up to 4000 meters deep.

Although the initial funds for the riser driller are included in next year's JAMSTEC budget, completion of the ship will depend on continuing appropriations over the next 5 years. Kinoshita says the government has never pulled the plug on a project that has reached this stage. But he notes that these are unprecedented times for Japan's economy, in the doldrums since the early 1990s.

The bigger problem will be finding money to keep it at sea. At an estimated $85 million a year, the riser ship would be expensive to operate on its own, and many in the ocean drilling program are adamant that it not be the only vessel in the drilling fleet. Many paleoceanographers, for example, don't need its specialized capabilities; for their research on climate and past ocean circulation, collecting a lot of shallow sediment cores is more important. The Japanese proposal "scared everybody," says Nicklas Pisias, a paleoceanographer at Oregon State University in Corvallis, explaining that paleoceanographers worry that a riser ship would suck up funds while drilling just a few deep holes in difficult locations.

"To get the community behind [a riser ship], we need two ships of different design," says Arthur—the riser and a vessel resembling the current *JOIDES Resolution*. Last month Pisias pointed out another motivation for the two-ship approach at the annual meeting of the Geological Society of America. "The Japanese have said they have to move forward with a riser ship," he said. "The question is: Does the United States want to become a Third World nation" in ocean drilling by not coming up with a second ship?

The challenge, then, is finding the money to operate both ships. Kinoshita says the current thinking is to split the operating costs evenly among Japan, the United States, and Europe plus other participating countries. He is confident that Japan will find its share of the money, although he's troubled by a government decision last year that effectively cut the operating budgets of major facilities affiliated with the Ministry of Education, Science, Sports, and Culture (*Science*, 1 May, p. 669) as part of a countrywide belt-tightening measure.

However, other drilling administrators are less sure that their countries will be able to expand support. John Ludden of CRPG-CNRS in Vandoeuvre-les-Nancy, who heads the French ODP scientific committee, says that "the only way Europe can go ahead as part of an international ODP is by paying a European membership plus additional funds, say from the European Commission or from private sources" such as oil companies. Both the European Commission and oil companies would be new funding sources for ocean drilling.

U.S. officials are taking a wait-and-see attitude. "There's a good possibility that a strong justification could be made for a multiplatform program," says Michael Purdy, who heads NSF's division of ocean sciences and is co-chair of the international working group of the IODP. "How that would be [financially] supported is unclear."

Through all the uncertainty, the Japanese reiterate their commitment. Kinoshita hints that Japan might pay a bit more than one-third if that's what it takes to float the two-ship program. And Masakazu Murakami, director of STA's Ocean and Earth Division, says that a worst-case scenario would have Japan operating the ship on its own at whatever level it could afford. "But I don't like to think about that," he says. "We will really make our best efforts to convince other countries that it is worthwhile to pay" for a two-ship program.

–RICHARD A. KERR AND DENNIS NORMILE

SOURCE: JAMSTEC/ODP