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In April, the *Chikyu* will set out to drill through the fault that caused the Tohoku earthquake.

SEISMOLOGY

Drilling ship to probe Japanese quake zone

Fast-tracked expedition will measure fault's residual heat.

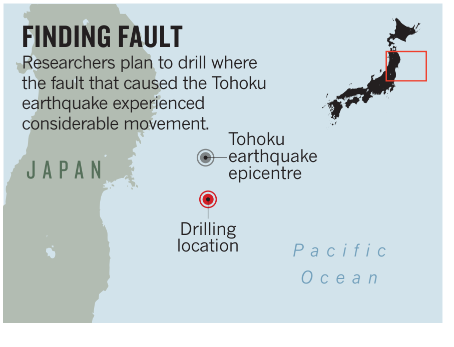
BY NICOLA JONES

After being tossed about and damaged by the tsunami that devastated northeastern Japan on 11 March, Japan's drilling ship the *Chikyu* has been given an especially fitting assignment: to drill into the fault zone and take temperature measurements near the epicentre of the magnitude-9.0 Tohoku earthquake that caused the tsunami. It will be the first time that researchers have drilled into an underwater fault soon after a quake. The aim of the exercise is to solve a decades-old mystery about the part that friction plays in such an event. This should help scientists to understand why some faults are more likely than others to cause tsunamis — in this case, one that ultimately claimed more than 23,000 lives.

"It would be a great disservice to society if we did not learn as much as possible from the fault zone heated by this huge earthquake," says Kiyoshi Suyehiro, president and chief executive of the management group of the Integrated Ocean Drilling Program (IODP). Following its initial approval of the proposal in September, the IODP has now confirmed that funding is available for the *Chikyu* to set sail in April and drill at a site south of the quake's epicentre (see map).

The scientific rationale for the expedition, officially called the Japan Trench Fast Drilling Project, is detailed in a 2009 report promoting rapid-response drilling through fault lines as soon as possible after an earthquake in which the ground slips by more than one metre. The Tohoku event set a new record for the greatest amount of slippage ever observed — a whopping 50 metres — making it an ideal target.

"It's a fundamental issue in seismology right now: how do you get rock to slip tens of metres?" says James Mori, a seismologist at the Disaster Prevention Research Institute of Kyoto University in Japan, a co-author of the rapid-response report and joint chief of the upcoming drilling expedition. Researchers think that an important part of the answer is that resistance between the plates of rock, sand and water in a fault line drops significantly during a quake — because of rock melting or increased water pressure, for example — but no one has been able to measure this effect properly. Because friction is dissipated as heat, precise temperature data should fill a crucial knowledge gap.



"We did a lot of planning, not knowing what kind of quake we'd have to do it with," says Emily Brodsky of the University of California, Santa Cruz, who is also involved in the mission.

Researchers have attempted to monitor the underground temperature after an on-land earthquake on three previous occasions — after the 1995 Kobe earthquake in Japan, the 1999 Chi Chi quake in Taiwan and the 2008 Wenchuan quake in Sichuan Province, China. But these projects produced only a few temperature readings between them, and found only tiny temperature increases, or nothing at all — perhaps because the temperature rise was too small to see, or because of imperfect monitoring techniques. "The recurring theme is that the faults tend to be colder than they should be," says Brodsky. A larger slip event provides a better chance of tracking the expected temperature increase of up to 0.5 °C, she says. "We need to do this now, and do it fast, and do it correctly."

The *Chikyu* will drill down 1 kilometre through the fault, and drop a string of temperature sensors down the hole. By tracking temperatures for one to three years — much longer than has been attempted before — researchers should be able to calculate the total amount of heat that was generated by the quake. That will provide them with the resistance forces felt in the fault during the slip, filling in a blank in models of earthquake dynamics. "This is a key missing ingredient," says Jean-Philippe Avouac, a geologist at the California Institute of Technology in Pasadena, who is not involved in the project.

Completing the drilling won't be easy. At the proposed site, the Tohoku fault lies under 7 kilometres of water and some 700 metres of Earth's crust, so a huge drill string will be needed. Previously, only a tiny 15-metre core has ever been extracted from beneath water of that depth, says Brodsky; most cores are taken from beneath 6 kilometres of water or less.

In addition to temperature measurements, the project will also examine the sediments pulled up in the core. Certain sediment textures, such as ball-bearing-like particles of clay, might be associated with large-slip earthquakes. Identifying such features should help scientists to forecast the slip potential of other faults.

The chance to collect precious information from the Tohoku event represents "an opportunity, maybe even a responsibility", says Mori. Almost all of the damage caused by the quake was done by the tsunami, he points out. "What we really want to understand is what caused that." ■

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