OCEANOGRAPHY

Deep-Trench Research Waits on Balky Japanese Submersible

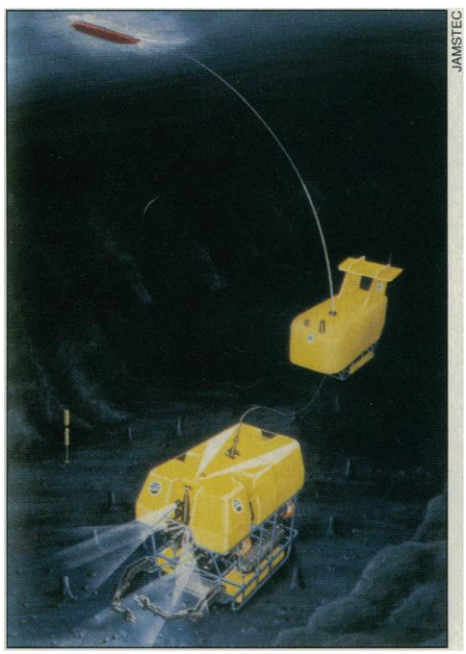
TOKYO—Early last month, Japanese engineers peering at video screens watched the slow but steady progress of Kaiko, the world's deepest-diving submersible, as it closed in on a 34-year-old record. The 3-meter-long robotic submersible was descending into the Challenger Deep of the Mariana Trench off Guam on what seemed to be a flawless test dive. But just as it approached the ocean floor, the video screens suddenly went blank. The crew aborted the dive at 10,911 meters—about 1 meter short of the world record depth set by the U.S. bathyscaph Trieste in 1960—and hauled Kaiko back to the surface.

Now, the best hope for researchers to explore the deepest parts of the world's oceans is sitting in a repair shop as engineers scramble to find out what went wrong. The problem seems to be in the communications system linking the submersible to the support ship, with cables carrying video and sensor data to the base ship and control signals to the remote vessel. And it will be months, if not more than a year, before Kaiko reenters the water. Although the company that is building the submersible, Mitsui Engineering & Shipbuilding Co., hopes to find and fix the problem as quickly as possible, the support ship needed for further testing has other missions and won't be available until next winter. Last month's mishap was the second setback for Kaiko in less than a year—last July, a cable problem cut short a demonstration dive in shallow water off the coast of Japan—and delivery of the Kaiko now looks to be at least 18 months behind schedule.

The delay is causing frustration among researchers eager to begin using Kaiko to explore a range of scientific topics at the bottom of the ocean. The only submersible capable of working below 6,500 meters, Kaiko is equipped with five TV cameras, still cameras, a side-scan sonar, sub-bottom profiler, a pair of manipulators, and a battery of sensors. Researchers are planning to use these instruments to map in considerable detail the surface manifestations of currently active faults. Another research target is the sediment atop subducting plates; video images and side-scan radar mapping may indicate if it gets scraped off and piled up on the ocean floor, or drawn down into the mantle and metamorphosed. Current methods of dredging and trolling from the surface give only severely limited data on the physical and chemical processes at work in the deep trenches, explains Yoshiyuki Nozaki, professor of marine geochemistry at the University of Tokyo's Ocean Research Institute. "From the top, you can't tell what you're sampling," he says.

Marine biologists are hoping Kaiko also will provide a window for observing what life forms may exist at extreme depths. There is indirect evidence—from dredging and trolling—that such creatures as sea anemones, bivalves, and mollusks are living at the bottom of even the deepest trenches, says Suguru Ohta, professor of marine ecology at the Ocean Research Institute. But there have been no observations. "We hope the Kaiko will reveal spectacular biota, and allow real-time observations," he says.

The impact of Kaiko's mechanical problems extend beyond Japanese science. This summer, Japan's Marine Science and Technology Center (JAMSTEC), which will take charge of Kaiko once it has completed its testing, was planning to send the submersible on an exploratory mission in the middle of the Atlantic Ocean with researchers from the Woods Hole (Massachusetts) Oceanographic Institution (WHOI). WHOI scientists had planned to use Kaiko and the Shinkai 6500, a manned submersible that can dive to 6,500 meters, to explore a hole in the Kane Fracture Zone along latitude 24° N in the mid-Atlantic Ridge that is beyond the reach of WHOI's own Alvin submersible, which can operate down to 4500 meters. The main objective is geologic sampling and observation, using the faults in the region to access deep portions of the crust.



Two-part harmony: Kaiko's launcher dives to within 100 meters of the seafloor before releasing a tethered roving vehicle.

Kaiko was meant to play the role of scout for the operation. "A remote-operated vehicle can go in and map in considerable detail with video and side-scan sonar," explains Mike Purdy, chairman of the Department of Geology and Geophysics at WHOI. "This allows [researchers] to see where the sediment-free scarps are and target the manned submersible dives much more accurately. That makes Kaiko a very valuable vessel for research." Last month's failure means that Kaiko will not be available. "Our planned Shinkai 6500 dives will, without doubt, provide significant new insights into fundamental Earth processes," says Purdy. "But with Kaiko we could have done more, it is that simple."

Researchers are not the only ones eager for Kaiko to get over its teething troubles. Engineers at Mitsui must demonstrate Kaiko can function down to the ocean's deepest spot before the company turns it over to JAMSTEC and collects its $50-million fee. What's more, Mitsui and its partners must absorb any additional costs involved in repairing and modifying the craft.

JAMSTEC, which is part of the Science and Technology Agency, is equally anxious to accept delivery. The Kaiko, when ready, will complete its fleet of two manned and two robotic submersibles and contribute to one of the major missions of the $186-million agency: to increase understanding of seismic activity in ways that may eventually lead to an ability to predict earthquakes.

Although disappointed, some researchers say they were not completely surprised by the mechanical problems. "I half expected it," says Suguru Ohta, professor of marine ecology at the Ocean Research Institute. He says that, given the technical challenges involved in sending such a bundle of equipment 10,000 meters down, getting it right the first time would have been "really extraordinary."

Despite its travails, Kaiko has lost none of its luster in the eyes of those who hope to use it. "It's not fully appreciated that ocean science remains an exploratory field," says Purdy. "It is rare to make a descent and not make discoveries." And it doesn't bother Hiroshi Hotta, director of deep-sea research at JAMSTEC, that the crew monitoring Kaiko's progress reported that the water at the bottom of the trench was too turbid for anything to be detected. He's confident that something quite interesting will turn up once Kaiko is ready to provide him and other scientists with their first good, long look at the deepest spots on Earth.

–Dennis Normile

Dennis Normile is a science writer based in Tokyo.