ASTRONOMY

Mega-scope's permit revoked

Court decision throws Thirty Meter Telescope into limbo.

BY ALEXANDRA WITZE

Hawaii's supreme court has ruled that the construction permit for the Thirty Meter Telescope (TMT) on top of the mountain Mauna Kea is invalid. The decision on 2 December is a major blow to the international consortium backing the US$1.5-billion telescope, and a win for the Native Hawaiians who have protested against its construction on what they regard as a sacred summit.

Hawaii's Board of Land and Natural Resources should not have approved the permit in 2011, the court said, because it did so before protestors could air their side in a contested case hearing. "Quite simply, the Board put the cart before the horse when it issued the permit," the court decision reads. "Accordingly, the permit cannot stand."

"TMT will follow the process set forth by the state, as we always have," TMT board chair Henry Yang said in a statement. "We are assessing our next steps on the way forward."

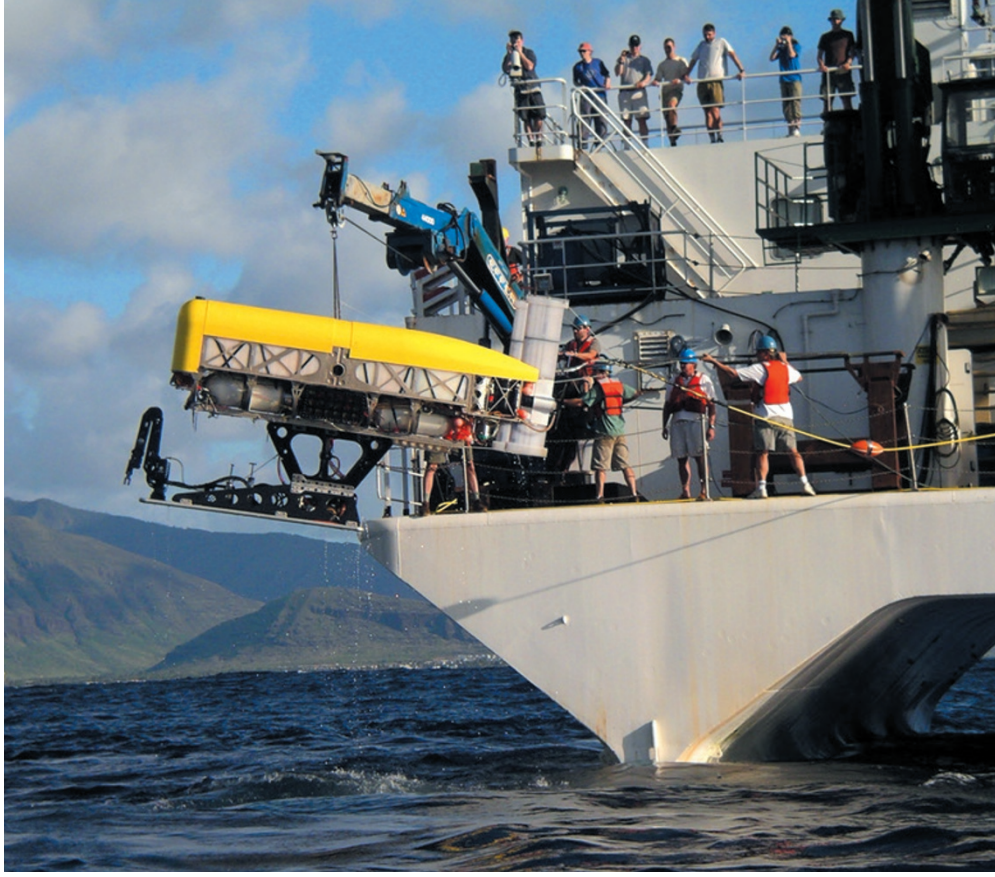
It is unclear whether and how the TMT will proceed given the new ruling. Work on the telescope's components has continued at sites outside Hawaii, but the court's decision to block the construction permit is a significant setback. To restart work on Mauna Kea, the project would have to acquire another permit from the board.

Part of the planned TMT site has been cleared, and construction was to have begun last April. But protestors have blocked the roads to the site and pursued legal means to halt the project.

Thirteen observatories — one with multiple telescopes — currently sit on Mauna Kea in a science reserve operated by the University of Hawaii. One existing telescope is being dismantled and two others are slated for decommissioning, after the fight over the TMT accelerated plans to limit development on the mountain top.

The skies above Mauna Kea are among the clearest in the world. Some Native Hawaiians say that the benefits to astronomy do not outweigh the need to respect and protect the natural and cultural environment. Many took to social media to praise the court's decision.

The TMT's partners are the University of California and the California Institute of Technology, along with research entities from the governments of Canada, China, India and Japan. ■



Nereus (yellow) was the only vehicle in the world capable of reaching the deepest parts of the ocean.

MARINE SCIENCE

Ocean-diving robot will not be replaced

Woods Hole Oceanographic Institution will spend insurance money for Nereus vehicle on lower-risk projects.

BY DANIEL CRESSEY

When the underwater robot Nereus imploded at sea more than a year ago, oceanographers were left without a vehicle that can reach the deepest parts of the ocean. Now Nereus's operator has told *Nature* that it will not replace the submersible.

The Woods Hole Oceanographic Institution (WHOI) in Massachusetts says that it will instead spread the insurance money for Nereus across multiple, lower-risk projects.

Some oceanographers say that they will miss Nereus's unique exploration capabilities, but other efforts to build similar robots that can reach the very bottom of the sea are afoot in the United States and China.

WHOI originally built Nereus at a cost of around US$8 million — which includes its design, development and testing — with funding from the US National Science Foundation, the Office of Naval Research and the National Oceanic and Atmospheric Administration. Among other things, the institute hoped to use the robot, which was a 'hybrid' capable of being controlled remotely and operating autonomously, to investigate the ocean's hadal zone.

This area, in deep-sea trenches between 6,000 and 11,000 metres down, is one of the least explored regions on Earth. Exactly which organisms live down there, how they survive and how they might be altered by pressures such as climate change and pollution are still only poorly understood. Any research vehicles operating at such depths must withstand intense pressure from the weight of the water above, so they are expensive to make and prone to accidents.

WHOI lost contact with Nereus during a dive in the Pacific Ocean in May 2014 — probably because a failure in one of its sealed buoyancy spheres, or in the housing around a piece of equipment, set off a catastrophic implosion at a depth of some 10,000 metres (see *Nature* **509,** 408–409; 2014).

ROBERT ELDER/WHOI

At first, researchers hoped that the institute would build a replacement vehicle. But Andy Bowen, an engineer and director of WHOI's National Deep Submergence Facility, told *Nature* that after weighing up the risks and benefits, the institute decided that the money would be better spent on less risky projects.

The $3 million insurance payout will go towards a Nereus legacy fund to support activities "in keeping with the spirit of Nereus", he says.

This includes developing technology to improve WHOI's undersea vehicles that do not go as deep as Nereus — as well as deep-sea 'landers', which go to full depth but are unable to move around. They simply sink to the bottom with various pieces of equipment on board, and are later recovered.

Such landers are the only tools currently available to explore the hadal zone — and they are no substitute for submersibles, says Jeffrey Drazen, a deep-sea researcher at the University of Hawaii at Manoa. "You put a lander down and hope for the best," he says. By contrast, Nereus could travel around under water, relaying a real-time video feed, and be moved in response to observations. "We need both," says Drazen.

Only having landers restricts exploration opportunities, agrees Alan Jamieson, a hadal-zone researcher at the University of Aberdeen, UK. Last year, his team used landers to collect hundreds of hours of footage from the Mariana Trench, the ocean's deepest point, but could not take transects, a common fieldwork technique in which data is collected at multiple points along a set path. Neither could the team pick up samples, although some landers can do this.

However, Jamieson understands the choice not to recreate Nereus, describing the construction of a single, expensive robot as "a very good example of putting all your eggs in one basket". "We need to get clever in how we access the hadal zone," he says.

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A more conservative approach has delayed — but not stopped — an effort to build a full-depth vehicle at the Schmidt Ocean Institute, a private foundation in Palo Alto, California. Rather than having this vehicle completely ready by 2016 as originally planned, the institute now aims to create a series of deep-sea submersibles. One will be delivered each year starting in 2016, with gradually increasing depth capabilities, says the institute's director of research, Victor Zykov. This could lead to a full-ocean-depth vehicle by 2019, if all the precursors prove successful.

"When I have discussed our plans with the deep-ocean scientists, most of them understand and appreciate this approach," says Zykov. "They appreciate how difficult it is to operate in the ocean's deepest trenches."

The plans in China are even bigger. In a paper published in 2014, Weicheng Cui of the Hadal Science and Technology Research Center at the Shanghai Ocean University, described a rough plan to build and deploy three landers, one robotic submersible and one human-occupied vehicle that can all operate in the hadal zone (W. Cui *et al. Meth. Oceanogr.* **10,** 178–193; 2014).

Cui told *Nature* that the first lander and the robotic submersible are currently undergoing sea trials, and that a mother ship that would control them is under construction. Around August or September 2016, he hopes to do trials in the Mariana Trench, sending the landers and the submersible to 11,000 metres. He plans eventually to use the robot to scout areas, then deploy the landers and the crewed submersible to conduct more detailed research. The project is backed by a mixture of government funding and private investment.

As to working out exactly what destroyed Nereus, says Bowen, "we'll never know — short of going and recovering the debris, which isn't financially viable. And of course there's nothing that can get there at the moment." ■