India's no-first-use principle, is not safe.

For example, if India firms up the change to its no-first-use policy, Pakistan might take this as a signal that India could pre-emptively strike at Pakistani nuclear installations, says Narang. And that might, in turn, prompt Pakistan to use all its nuclear weapons first. "And so, you get this destabilizing dynamic where as soon as the crisis becomes nuclearized, there is an incentive for both sides to go first," Narang says.

How likely are these scenarios?

Ramamurti Rajaraman, a physicist and emeritus professor at the Jawaharlal Nehru University in Delhi, calls the escalating rhetoric a "war of words" that will not on its own lead to military action.

However, the increasing tensions, combined with references to nuclear conflict from both sides, mean that the two countries are now likely to have changed the status of their nuclear-weapons readiness from "peacetime" to "crisis", says Feroz Hassan Khan, who teaches security studies at the Naval Postgraduate School in Monterey, California.

In practice, this means moving the three main physical components of a weapon — the warhead, missile-delivery system and fissile-material core — either to be assembled or to get them closer to where they need to be, ready for launch. In peacetime, each component is kept at a different location, for safety and security.

According to Feroz Hassan Khan, who worked on Pakistan's nuclear-weapons planning team in the early 2000s, such a state of readiness for a strike heightens the risk of a nuclear accident, but is not in itself a sign that war will happen.

But if there is another attack in India similar to that seen in February, India's armed forces might again respond with force. That would precipitate a reaction from Pakistan's military, prompting a retaliation from India. Unless one side voluntarily holds back, the prospect of such military escalation concerns analysts because it could eventually lead to strikes against nuclear targets. ■

GEOLOGY

Ocean drillers chart an ambitious new course

Geologists begin laying out a vision for the next phase of sea-floor studies.

BY ALEXANDRA WITZE

This month, off the coast of Ecuador, scientists are hunting for hot, teeming masses of microbes living in two long, skinny holes drilled into the bottom of the sea.

This cruise, aboard the legendary research ship *JOIDES Resolution*, is the latest in the five-decade history of scientific ocean drilling. The practice of boring holes in the sea floor has revolutionized Earth science, helping researchers to confirm the theory of plate tectonics, discover microbes deep in the ocean crust and probe the hidden risks of earthquakes and tsunamis. But to keep the field alive for years to come, scientists must now convince international funding agencies that there are discoveries waiting to be made.

The international agreement that governs scientific ocean drilling expires in 2023. Researchers from the 26 nations that participate in that framework, known as the International Ocean Discovery Program (IODP), will gather in Osaka, Japan, on 11 September to discuss how they might replace it. The scientists will hammer out a new list of scientific goals for the next phase of ocean drilling, from 2023 to 2050 — if they can convince funding agencies to pay for it.

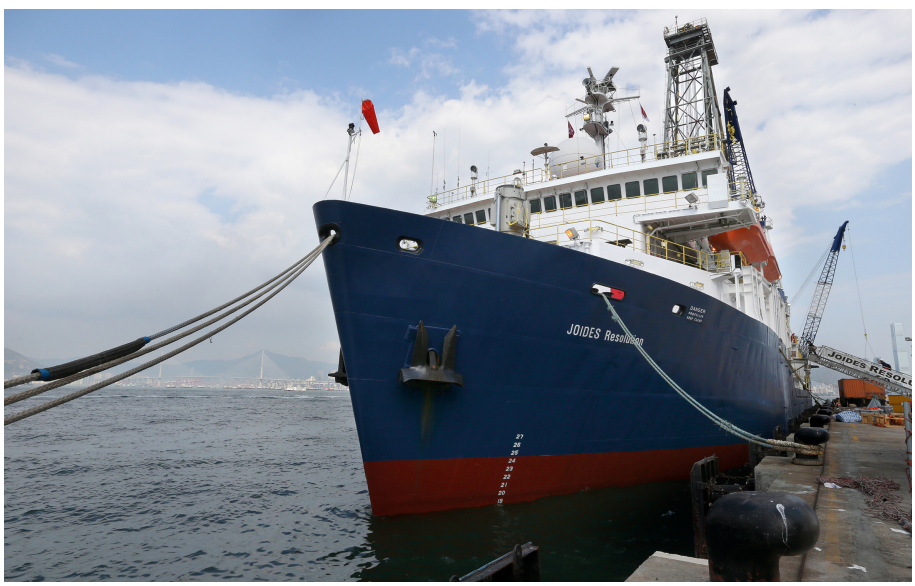
IODP member nations collectively spend around US$150 million a year to send researchers on drilling expeditions. "The stakes are really high if we want to continue scientific ocean drilling beyond 2023," says Anthony Koppers, a marine geologist at Oregon State University in Corvallis.

At the Osaka meeting, scientists will debate whether to accept an ambitious draft research plan that draws on discussions at regional meetings held in IODP nations over the past year. "We have to dream, to really go for it," says Dick Kroon, a geoscientist at the University of Edinburgh, UK, who will chair the Osaka conference.

The plan calls for ships to drill regularly spaced holes across the world's oceans in an unprecedented effort to reconstruct the past climate — and improve researchers' understanding of how Earth might operate during future climate change. Other goals include probing how life might have arisen and evolved in ocean crust.

The idea excites Anais Pages, a marine scientist at the Commonwealth Scientific and Industrial Research Organisation in Bentley, Australia. She says that setting ambitious interdisciplinary goals "will be crucial to achieve major scientific discoveries".

What's not clear is which of the IODP's ▶



DAVID WONG/GETTY

The *JOIDES Resolution* is the workhorse of the world's fleet of ocean-drilling research vessels.

DRILLING DOWN
A fleet of ships has drilled cores deep into the sea floor over the past half-century — enabling major discoveries in Earth science.

Ship	Run by	Operational	Known for
JOIDES Resolution	United States	1985	Gathering records of climate change over the past 100 million years.
Chikyu	Japan	2007	Drilling a world-record 3,252 metres beneath the sea floor in an attempt to reach the boundary between two tectonic plates.
Fugro Synergy	Europe*	2017	Exploring the underwater geology of the seismically active Corinth Rift in Greece.
Liftboat Myrtle	Europe*	2016	Probing the Chicxulub impact crater, the scar left by the meteorite impact 66 million years ago that led to the extinction of the dinosaurs.

*European Consortium for Ocean Research Drilling

26 member nations will buy into these scientific goals. Once researchers approve a final plan, government funding agencies will have to decide how much they are willing to invest in the future of ocean drilling.

Chief among those is the US National Science Foundation (NSF), which supplies the bulk of the *JOIDES Resolution*'s $65-million funding each year. The ship began extracting geological cores in 1985 and is the workhorse of the IODP fleet (see 'Drilling down'). It travels around the world, staffed by a rotating, international crew of scientists who explore topics ranging from the history of Indian monsoons to the risk of earthquakes in Indonesia.

The vessel has funds to keep sailing until the end of September 2024, but it is old and outdated, and might be retired after that. The Norwegian shipping company Siems Offshore has offered to build a replacement vessel for free — in exchange for a ten-year commitment for Siems to operate it.

Brad Clement, director of science services for the US portion of the IODP, says that because the new ship would be faster than the *JOIDES Resolution*, scientists could spend more time each year drilling and exploring the sea floor. The NSF would pay about 12% more per year to operate this ship than it does for the *JOIDES Resolution*, says Clement, who is based at Texas A&M University in College Station.

Japan is expected to keep sending scientists out on its drill ship, the Chikyu, which has been operational since 2007. The Chikyu can drill much deeper into the sea floor than can the *JOIDES Resolution*, but it operates almost exclusively in Japanese waters, limiting its value to scientists around the world.

A group of European countries, the European Consortium for Ocean Research Drilling, is also likely to continue occasionally hiring industry ships for one-off scientific-drilling projects. But the consortium has struggled to find the money for all the cruises it would like to do, and has had to postpone expeditions such as one to explore the Arctic sea floor.

And China could have a new drill ship ready to sail by the early 2020s. Its geological survey is building a vessel that is supposed to focus on searching for gas hydrates close to the Chinese coast, but could also be sent on international research expeditions. Representatives of the Chinese ocean-drilling community are expected to discuss this at the Osaka meeting.

No matter what happens, Rosalind Coggon, a marine geologist at the National Oceanography Centre at the University of Southampton, UK, sees plenty of room for fresh findings in the coming decades. "I really hope in 25 years we've discovered something that we totally didn't know about," she says. ■