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## Experts' Fears of Big Quake Appear to Be Borne Out

By **ANDREW C. REVKIN**

**E**leven days ago, a team of earthquake experts published a scientific paper precisely describing how the titanic tsunami-generating earthquake off Sumatra on Dec. 26 greatly raised risks of a fresh offshore earthquake. The earthquake they described was almost exactly like the one that struck yesterday.

The paper's authors and other experts had calculated how the December shock increased stress on the adjacent section of the Sunda Trench, a seam in the earth's crust where one plate dives beneath another. The pressure greatly increased the chance that the seam would fail, they said. The new earthquake was generated when the plates suddenly moved, releasing pent-up energy.

Yet for hour after hour yesterday, no scientist could say with any certainty whether the new quake, a giant of magnitude 8.7 on a fault known to set off killer waves in the past, had in fact spawned destructive tsunamis like those that swept the Indian Ocean on Dec. 26. A tsunami is generated when the ocean floor moves up or down during the quake.

Particularly puzzling to ocean and quake experts was that there were clear signs that a tsunami radiated southwest from the epicenter, far from the crowded coasts of the Bay of Bengal that were struck so hard in December. For waves to propagate in that direction and not toward the Indonesian coast was highly unlikely, many experts said.

Dr. Bruce Jaffe, a United States Geological Survey oceanographer who is in charge of a federal project aimed at clarifying tsunami threats, said he and colleagues had been in touch with Sri Lankan and Maldivian officials who had evacuated some communities as a precaution.

Like other experts, he expressed concern about silence from Sumatra, where the earthquake hit in the middle of the night.

Dr. Jaffe said a tsunami that swept parts of Java in 1994 struck the same way. "Initially it was just reported as a big earthquake, but then the death toll kept rising and rising and rising," he said.

This time, he said, "we're all hoping that the lack of reports is because there wasn't a large tsunami, rather than the opposite."

The difficulty of predicting tsunami hazards from earthquake signs underscored how much remains to be done to create a truly effective warning system for tsunamis in the heavily populated but poorly studied region, experts said.

As a result, three months after the December tsunamis exacted a huge death toll, and three weeks after tsunami experts and government officials met in Paris under the auspices of the United Nations to design an Indian Ocean alert system, scientists expressed frustration yesterday with the vast gaps that must be plugged.

Dr. Costas Synolakis, a professor of civil engineering at the University of Southern California who attended the Paris meeting, said governments and scientific agencies appeared too focused on expanding networks of seismometers, sensitive gauges that detect ground motion. Knowing how the earth has moved is only the first step to determine if a wave has been spawned, he said.

Tide gauges, another priority in the new international tsunami-warning plan, also only give a narrow local view, he added, saying the most valuable tools are deep-ocean instruments called tsunameters that sense a passing wave and transmit an alert via buoys at the surface.

"What we really need is direct tsunami detection," Dr. Synolakis said. In the Pacific, the United States has already deployed half a dozen such devices and plans on expanding the network to 32. They provide a clear, direct signal that a high-energy wave is passing, he and other experts said.

It would take years before such an array of sensors and buoys could be deployed in the Indian Ocean, where funds and expertise are extremely limited. Until then, countries there will most likely have to rely on indirect measures, several tsunami experts said yesterday.

The limits of the system were evident yesterday. Two hours and 20 minutes after the earthquake, Australian officials said a tide gauge on Cocos Island, 650 miles south of Sumatra, registered passing tsunami waves 10 inches high. That is a significant height for a spot in the middle of the ocean, where a wave's energy is spread from the surface to the seabed, making it nearly imperceptible from above.

But data about that reading, the one clear signal that a tsunami had been generated, had still not circulated beyond Australian government agencies and a few other offices eight hours after the tremors.

Seismologists and oceanographers refused to express a sense of relief about the lack of tsunami reports from Sumatra well into last night.

Dr. Kerry Sieh, a Caltech seismologist who has spent more than a decade deciphering past patterns of quakes and waves etched in Sumatran reefs, said it would be nearly impossible not to have an earthquake on that fault line, of that magnitude, without swamping nearby shores. "I'm biting my fingernails," he said last night.