Conditions combined for devastating tsunami

September 30 2009, By SETH BORENSTEIN , AP Science Writer

People search through the rubble following a powerful earthquake in Pago Pago village, on American Samoa Tuesday, Sept. 29, 2009. The quake in the South Pacific hurled massive tsunami waves at the shores of Samoa and American Samoa, flattening villages and sweeping cars and people back out to sea while leaving scores dead and dozens missing. (AP Photo/SamoaNews.com, Ausage Fausia)

(AP) -- Because of a lethal combination of geology and geography, the people of American Samoa didn't stand much of a chance. Almost every condition that triggers bad tsunamis was in place this time, generating waves that raced toward the island territory at speeds approaching 530 mph, or as fast as a 747 jumbo jet. And there was almost nothing to slow the water down.

It all started with a type of earthquake that tends to generate strong tsunamis because of the angle at which the ground breaks. Also, the quake was extremely powerful, with a magnitude of 8.0. It struck just below the ocean floor, which means very little lost energy. And it happened in deep water, which means bigger waves.

The deeper water also meant the tsunami sped along the ocean faster. American Samoa happened to be close to the epicenter, about 125 miles, and at just the right angle, with almost no shallow water to slow the speeding waves down.

Put that all together and there was less than 25 minutes, maybe as little as 13 minutes, between the ground shaking and the first tremendous waves swamping Samoa.

And it didn't help that an international computerized system, designed for relief agencies to figure out if they needed to respond, had a computer failure that caused it to pooh-pooh the tsunami's wrath initially.

"This is the kind of earthquake one would expect to be very destructive in the areas close to the epicenter, and unfortunately it was," said Stuart Weinstein, deputy director at the Pacific Tsunami Warning Center in Ewa Beach, Hawaii.

The shaking at the weather service office in Pago Pago, the capital of American Samoa, was so bad that one official immediately called the tsunami warning center in Hawaii, while the island's chief meteorologist phoned homeland security to activate the warning system. Just before 7 a.m. local time, bulletins were issued and alerts aired on TV and radio.

But there wasn't enough time. Four sets of waves 15 to 20 feet high hit. As of Wednesday afternoon, the death toll had climbed well over 100.

"It's one of those heart-wrenching situations where you have some time, but what can you do? It's not much time," said Eric Geist, a tsunami specialist and geophysicist at the U.S. Geological Survey in Menlo Park, Calif.

Tsunamis are towering waves triggered by earthquakes. They can top 100 feet, and can stick around for as much as an hour, recede violently, then come back hours later.

In some ways, the geological conditions were even worse for Tuesday's tsunami than they were during the devastating 9.0-magnitude quake and tsunami that killed more than 150,000 people in Asia in 2004. But this time, there were fewer people in harm's way in the middle of the Pacific Ocean.

The key factor this time was the type of earthquake. It was an "outer rise" quake - one that breaks the sea floor in a way that concentrates the energy and pushes up at the water to create a wave, said Bruce Jaffe, an oceanographer and tsunami specialist at USGS in Santa Cruz, Calif. Strong quakes are usually a different type, called a thrust event.

The area where it hit is no stranger to quakes, getting a few magnitude-6-to-7 ones per year, said Peggy Hellweg, a geophysicist at the Berkeley Seismological Laboratory. Because quakes are measured on a logarithmic scale, a magnitude-8 is 1,000 times stronger than a magnitude-6 in terms of energy released, Hellweg said.

Tuesday's quake was the fourth-strongest outer rise on record, Geist said.

This quake was also relatively shallow in the ground, only 11.2 miles under the sea floor. That's important because the closer the quake is to the surface of the ocean, the less energy dissipates as it travels through the ground.

It was also in deep water. Initial estimates are that there was well over 3 miles, maybe even 4 miles, of water above the shaking ground, Geist said. That means more water displaced, and thus bigger waves. If there had been only 1 mile of water above the quake, the waves would have

been about 11 feet smaller, Geist estimated.

That deep water also was responsible for the blinding speed of the tsunami. The deeper the water, the faster a tsunami travels.

This water was so deep that the tsunami could have been zipping along at 530 mph, Geist said. Usually, a tsunami slows down when it hits shallow water. Around the United States, for example, the shallow continental shelf slows downs waves dramatically.

Samoa didn't have that protection until just before the tsunami reached the shore. And by the time it hit, it was still coming at 30 mph.

And by the time you see a tsunami, "it's usually too late to outrun it," Geist said.

NOAA animation of the Sept. 29 tsunami:
http://nctr.pmel.noaa.gov/samoa20090929.html

NOAA tsunami safety information:
http://www.noaa.gov/features/protecting(underscore)0409/tsunami.html

U.S. Geological Survey Earthquake Information Center:
http://earthquake.usgs.gov/eqcenter/

2024 from https://phys.org/news/2009-09-conditions-combined-devastating-tsunami.html