Why the Tongan volcanic eruption triggered a tsunami 8,000 km away in Japan

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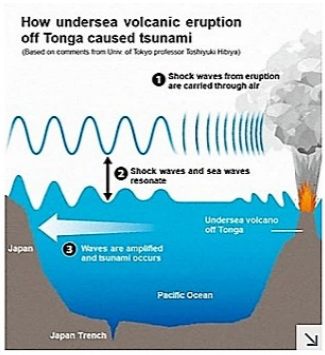
Japanese version



(Mainichi)

TOKYO -- The tsunami that accompanied the massive eruption of an undersea volcano off Tonga had two mysterious characteristics: The tsunami waves hit Japan's shores earlier than the weather agency expected, and those waves were bigger than the ones that struck Pacific island nations closer to Tonga.

Experts say one reason for this was likely that airborne shockwaves from the eruption matched the speed of sea waves to create resonance, and that the waves were amplified as they approached the Japanese archipelago some 8,000 kilometers away.

According to the Japan Meteorological Agency (JMA), tide level changes near Chichijima -- one of the Ogasawara Islands some 1,000 kilometers south of Tokyo -- were first observed at around 8 p.m. on Jan. 15, around 2 1/2 hours earlier than expected. But there were no major changes at observation points near the U.S. commonwealth island of Saipan or the Micronesian island of Pohnpei, which lie between the undersea volcano and Japan.

Fumihiko Imamura, director of the International Research Institute of Disaster Science at Tohoku University in Sendai, thinks that airborne shockwaves triggered the tsunami. He believes that shockwaves caused air vibrations which traveled across the water and brought waves to Japan's shores. In fact, there was a temporary increase in air pressure of about 2 hectopascals around the time the first change in sea levels was observed in Japan. This was the shockwaves compressing the air.

Kenji Tanaka, a professor in meteorology and coastal engineering at the Hiroshima Institute of Technology in western Japan, says the shockwaves spread concentrically from the eruption point at a speed of about 300 meters per second. These shockwaves travel faster than the tsunami created directly by the eruption, and resonated with the waves near the Japan Trench. He thinks that the waves were accordingly amplified, and reached the Pacific coast of Japan.

In parts of the ocean as deep as the Japan Trench (around 8,000 meters), the estimated speed of waves on the surface reached 280 meters per second, which is believed to have created conditions for resonance to occur in specific areas. This also explains why no great changes in tide levels were observed near Saipan and other islands closer to the eruption than the Japan Trench.

Tanaka speculates that there were two types of tsunami that reached Japan. The tide level rise observed from around 8 p.m. on Jan. 15 was from the shockwaves, while the tsunami that was observed about three hours later is thought to have been mainly caused by a huge amount of sediment flowing from the eruption into the sea.

Professor Toshiyuki Hibiya of the University of Tokyo, whose research field is ocean dynamics, also says that the speed of shockwaves likely matched that of the sea waves and resonated. He says that the mechanism of the latest tsunami is similar to that of a seiche, or "abiki" in Japanese, where large changes are seen in tide levels in Nagasaki Bay and other places facing the East China Sea, due to low atmospheric pressure and other factors. The abiki phenomenon is known as a kind of "meteotsunami" or meteorological tsunami, as distinguished from regular tsunami which is directly caused by crustal movements as a result of events like earthquakes and volcanic eruptions.

"It's thought that the latest tsunami occurred based on the same principles as a meteotsunami. I guess we could call it an open ocean version of 'abiki,'" Hibiya said.

(Japanese original by Shinpei Torii and Yurika Tarumi, Science & Environment News Department)

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How undersea volcanic eruption off Tonga caused tsunami

(Based on comments from Univ. of Tokyo professor Toshiyuki Hibiya)