Fukushima Earthquake Moved Seafloor Half a Football Field

The massive shift, laterally and upward, caused the epic March 2011 tsunami

Mark Fischetti, Scientific American, 12-2-11

The March 2011 Tohoku-Oki earthquake that decimated Japan and its Fukushima nuclear reactors with a monster tsunami altered the seafloor off the country's eastern coast much more than scientists had thought. Analysis released today in the journal *Science* indicates the ocean bed moved as much as 50 meters laterally and 16 meters vertically. The magnitude 9.0 quake occurred close to the nearby Japan Trench that runs north to south in the Pacific Ocean (dark blue line on the map below).

The trench exists because the oceanic Pacific Plate (dark blue on map below) is moving westward, hitting and bending down under the continental Okhotsk Plate (light blue) from which Japan rises (green, brown). This "subduction" action creates tension within the tectonic plates, which is occasionally released in the form of earthquakes.

Although measurements from satellites and seismic ground sensors had indicated the Okhotsk Plate moved after the 9.0 temblor on March 11, the extent of the movement was not clear. Researchers at the Japan Agency for Marine-Earth Science and Technology compared new seafloor maps made of the region this year with maps made in 1999 and were surprised by the extent of motion. For example, data along one transect (yellow marker, below) near the quake's epicenter (black "x" on the map) indicated that the Okhotsk plate moved 50 meters east-southeast toward the trench.

Comparison of depth data showed that the earthquake itself lifted the Okhotsk plate 10 meters where the plate dives deep toward the trench (yellow to purple color, at center, below). The plate's lateral shift also caused it to tip up another four to six meters there. "We think that the additional uplift contributed to the generation of the pulsating pattern of tsunami waves," Toshiya Fujiwara, one of the lead researchers, wrote in an email.

So if the Okhotsk plate shifted 50 meters at the trench, what happened at Japan's eastern shore? According to Fujiwara, data from various Japanese agencies and universities shows that the seafloor at the Tohoku shore moved 5 meters seaward. Offshore, the plate shifted from 15 to 31 meters in the same east-southeast direction, and close to the trench it moved 50 meters. The gradually increasing displacement suggests that the plate was actually stretched from the shore toward the trench, changing local stress patterns along the way. The many large aftershocks that occurred (red circles, below; yellow is the quake epicenter) are evidence of the stretching, Fujiwara noted.