



STATE MINING AND GEOLOGY BOARD

EXECUTIVE OFFICER'S REPORT

For Meeting Date: June 9, 2011

Agenda Item No. 12: Information Report from the California Geological Survey on the March 11, 2011 M 9.0 Tohoku Earthquake, and the Resultant Tsunami on California.

INTRODUCTION: The magnitude (M) 9.0 Tōhoku Earthquake of March 11, 2011, and associated tsunami was the fourth most powerful earthquake measured by modern instruments (since about the year 1900), and it occurred at the interface of the Pacific and North America plates. Two days prior to the earthquake, a M 7.2 earthquake occurred near what would be the epicenter of the Tohoku Earthquake. It was followed by three aftershocks in the M 6 range later that day. These earthquakes were reported to the SMGB at its regular business meeting on March 10th, with the indication that these could be precursors of further action along the Japan Trench. In retrospect, these earthquakes were foreshocks to the M 9.0 event that followed. An overview of this historic event and its impact on California is being presented by the California Geological Survey (CGS).

The Tohoku Earthquake: The hypocenter of the Tohoku Earthquake was located 81 miles off the east coast of the Oshika Peninsula, part of the Tohoku region of the island of Honshu, near the city of Sendai, at a depth of 20 miles below the seafloor. Over the next several days, hundreds of aftershocks, the largest of M 6.8, outlined the area of the plate boundary that ruptured. Aftershocks extend to depths of about 340 miles, although most are above a depth of 125 miles. Two weeks after the earthquake, some 726 aftershocks had been recorded, 26 of them magnitude 6.0 or greater. These aftershocks are expected to continue, at a decreasing frequency, for the next several years.

The Tohoku Earthquake is what is termed a “*megathrust earthquake*,” a major subduction zone earthquake whereby built-up pressure bending the leading edge of the North American Crustal Plate suddenly is released allowing that plate edge to spring upward and the Pacific Crustal Plate to lurch beneath the North America Plate. The affected portion of the North America Plate is a westward and southward extension of the plate from the Alaska region that underlies eastern Siberia and the northern Sea of Japan. Some geologists divide this geologically complex region into a number of microplates.

The area of the plate boundary that ruptured during this earthquake was about 210 miles long and 120 miles wide, which is larger than the areas of San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties combined. At the location of the earthquake, oceanic crust of the Pacific Plate is being thrust under oceanic crust of the North



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America Plate at an angle of about 15 degrees, creating the Japan Trench, a bathymetric trough expressed along the seafloor. The average rate of this movement is approximately 83 mm/yr, one of the higher rates of plate convergence in the world. Much of this movement occurs episodically in earthquakes such as the Tohoku Earthquake.

The earthquake brought enormous crustal deformation on eastern Japan. Taking a fixed point at Misumi, Hamada City in Shimane Prefecture, the Pacific side of eastern Japan moved several meters in an ESE direction. Surface displacement of 4.4m was observed at Shizugawa, Minami-Sanriku Town in Miyagi Prefecture, and the largest displacement of 5.3m was detected at Oshika, Ishinomaki City, while displacement on the Japan Sea side was around 1m causing a large extensional field in western Japan.

Tsunami Hazards: The tsunami generated by the devastating earthquake caused millions of dollars in damages to harbors along the California coastline. CGS sent field teams to investigate the impact and collect valuable information on the tsunami's effects that can be used to improve model forecasts and identify ways to reduce risks to harbor facilities. For purposes of coordination and sharing of observations, a virtual clearinghouse has been established on the California Earthquake Clearinghouse website: <http://www.eqclearinghouse.org/CA/>

An estimate of loss as a result of the tsunami has not been developed. The lack of tools in developing this estimate has generated discussion of a module being developed for HAZUS, FEMA's software for loss estimation, but is in its infancy. In summary, there have been 17 deaths in California attributable to tsunamis since 1946. Damages to California ports from the recent Tohoku-Oki Earthquake tsunami are estimated at about \$50 million. There are about 370,000 people that reside in the current California tsunami evacuation zone maps, and on hot summer days California beaches can draw millions of people into the zones.

EXECUTIVE OFFICER'S RECOMMENDATION: The information being presented by CGS is for the SMGB's information. No recommendations are offered at this time.

Respectfully submitted:

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Executive Officer

