# Giant earthquakes studied from tsunami data

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Giant earthquakes in subduction zones generate tsunamis. The generation and propagation of tsunami can be numerically computed to forecast the coastal heights. We can also estimate the tsunami source of giant earthquakes from the tsunami data. For the recent earthquakes since 20th century, the slip distributions on fault have been estimated by inversion of tsunami waveforms recorded on tide gauges. For old earthquakes, tsunami inundation area can be estimated from distribution of tsunami deposits, and the comparison with simulated tsunami makes it possible to estimate the source parameters.

Giant earthquakes with M˜9 have faults longer than several hundred km and slip larger than 10 m, that are larger than those from great earthquakes with M˜8. At some subduction zones, great and giant earthquakes have occurred and the latter produced larger amount of crustal deformation and tsunamis.

For the 2004 Sumatra-Andaman earthquake, the fault length was at least 900 km and the largest slip was 13 to 25 m off Sumatra Island and up to 7 m near Nicobar Island [1].

In the 20th century, four giant earthquake with M˜9 occurred in the world. For the 1952 Kamchatka earthquake (Mw 9.0), the source length was ˜600 km and there were two asperities with more than 10 m slip, according to inversion of tsunami waveforms [2]. The aftershock length of the 1957 Aleutian earthquake (Mw 8.4-8.6) was 1200 km, similar to the 2004 Sumatra-Andaman earthquake and the longest in the world. Most slips were located in the western 500-km-long part and the maximum slip was 7 m [3]. This area was reruptured in 1986 by Andreanof earthquake (Mw 8.0) and in 1996 by Delanof earthquake (Mw 7.9) [4]. The 1960 Chilean earthquake (Mw 9.5) was the largest in the world in the 20th century. From geodetic data, the fault length was estimated to be 800 km, Mw = 9.3 and the maximum slip of 40 m [5]. The tsunami from this earthquake caused ˜150 casualties in Japan. For the 1964 Alaskan earthquake (Mw 9.2), joint inversion of geodetic and tsunami data indicate two asperities, the largest slip of 22 m around the epicenter, and the other with ˜10 m [6].

Recent paleoseismological surveys indicate the recurrence of older giant earthquakes. In the source area of the 1960 Chilean earthquake, historical data indicate the recurrence of great earthquake with an average interval of ˜100 years. Geological surveys revealed that the crustal deformation and the tsunami from the 1737 and 1837 earthquakes were smaller than those from the 1960 and 1575 earthquakes [7]. Along the Pacific coast of eastern Hokkaido, where great earthquakes repeat with intervals of several decades since 1800s, tsunami deposits have been found much further inland than the inundation limits of these earthquakes. Geological surveys indicate that such unusual earthquakes recurred at an average of 500 years in the last 7000 years. The most recent one was in the 17th century with the maximum coastal height of more than 10 m and the maximum inundation of 4 km from coast [8, 9]. Comparison of simulated tsunami shows that the source of such unusual tsunami was a multi-segment earthquake in Tokachi-oki and Numero-oki, with the maximum slip of 10 m and Mw of 8.5 [9,10].

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