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Source Mechanisms of Destructive Tsunamigenic Earthquakes occurred along the Major Subduction Zones

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Subduction zones, where an oceanic plate is subducted down into the mantle by tectonic forces, are potential tsunami locations. Many big, destructive and tsunamigenic earthquakes (Mw > 7.5) and high amplitude tsunami waves are observed along the major subduction zones particularly near Indonesia, Japan, Kuril and Aleutan Islands, Gulf of Alaska, Southern America. Not all earthquakes are tsunamigenic; in order to generate a tsunami, the earthquake must occur under or near the ocean, be large, and create significant vertical movements of the seafloor. It is also known that tsunamigenic earthquakes release their energy over a couple of minutes, have long source time functions and slow-smooth ruptures. In this study, we performed point-source inversions by using teleseismic long-period P- and SH- and broad-band P-waveforms recorded by the Federation of Digital Seismograph Networks (FDSN) and the Global Digital Seismograph Network (GDSN) stations. We obtained source mechanism parameters and finite-fault slip distributions of recent destructive ten earthquakes (Mw $\geq$ 7.5) by comparing the shapes and amplitudes of long period P- and SH-waveforms, recorded in the distance range of 30° - 90°, with synthetic waveforms. We further obtained finite-fault rupture histories of those earthquakes to determine the faulting area (fault length and width), maximum displacement, rupture duration and stress drop. We applied a new back-projection method that uses teleseismic P-waveforms to integrate the direct P-phase with reflected phases from structural discontinuities near the source, and customized it to estimate the spatio-temporal distribution of the seismic energy release of earthquakes. Inversion results exhibit that recent tsunamigenic earthquakes show dominantly thrust faulting mechanisms with small amount of strike-slip components. Their focal depths are also relatively shallow (h < 40 km). As an example, the September 16, 2015 Illapel (Chile) earthquake (Mw: 8.3; h: 26 km) reflects the major characteristics of the Peru-Chile subduction zone between the Nazca and South America Plates. The size, location, depth and focal mechanism of this earthquake are consistent with its occurrence on the megathrust interface in this region. This study is supported by the Scientific and Technological Research Council of Turkey (TUBITAK, Project No: CAYDAG - 114Y066).