Source characterization of the 13 June 2005 Tarapaca, Chile, intermediate-depth earthquake (Ms7.8) from regional accelerograms

Keiko Kuge[1]; Jaime Campos[2]; Marcel Thielmann[2]; Adriana Perez[2]

[1] Dept. of Geophysics, Kyoto Univ.; [2] Departmento de Geofisica, Universidad de Chile

We have examined source characteristics of the 2005 Tarapaca, Chile, earthquake using waveform data from the strong-motion network of Universidad de Chile. The large earthquake occurred at a depth around 115 km (NEIC) in the Wadati-Benioff zone of the northern Chile. Five strong-motion stations successfully recorded acceleration ground motions from the mainshock within 300 km of epicentral distance. Aftershocks, which were located by Universidad de Chile deploying temporal seismic stations after the mainshock, are well concentrated along a nearly horizontal, flat region, implying that the Tarapaca earthquake could resemble the 1993 Kushiro-oki, Japan, earthquake. In the present study, we determined a point-source moment tensor solution, changing the centroid location in the 3-D space, and moment-release distribution on a finite fault. We used displacement waveforms by time-integrating and bandpass-filtering the accelerograms. For a velocity model, we used ak135 as well as local 1-D velocity models. The analysis method follows Kuge (2003). The moment tensor solution (Mwˇ7.7) we obtained has horizontal and vertical nodal planes, strongly dominated by a dip-slip component. The moment tensor solution is similar to the Harvard CMT solution, also in agreement with initial polarities of P waves recorded at teleseismic stations. Good match between observed and synthetic waveforms is attained when the centroid location is assumed in the west of the NEIC hypocenter. The centroid depth is estimated around 110 km, depending on used velocity models. Spatiotemporal propagation of moment release was examined on a finite fault which is characterized by a nodal plane of the moment tensor solution. Slips on the horizontal nodal plane can model observed waveforms better than those on the vertical plane, which suggests that the fault plane is likely to be nearly horizontal. A region of high moment release is found around the hypocenter. The size is estimated in a range from 40 x 40 to 20 x 20 kmˆ2, corresponding to the static stress drop from 10 to 90 MPa. Most of the moment was released within 20 sec. Since the values of static stress drop and source duration are consistent with those for deep and intraplate earthquakes reported in previous studies, the source characteristics of the Tarapaca earthquake can be attributed to the nature of deep and intraplate earthquakes. To determine moment-release distribution on the finite fault, we needed to relocate the hypocenter using our data because the arrival times of P and S waves are deviated from those predicted from the NEIC hypocenter and used velocity model. The relocated hypocenter is moved to the west of the NEIC hypocenter, and the origin time becomes early. Attempts to update the used 1-D velocity model have failed to match the data. Relocating the hypocenter can much more efficiently reduce the discrepancies in the arrival times. This might also be a helpful process in other regions when a sufficiently accurate velocity model and their Green's functions cannot be available.