

Source characterization of the 2014 Iquique, Chile, earthquake (M_w 8.1) based on an inversion of strong-motion waveforms

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For predicting ground motions during megathrust earthquakes ($M > 8$), it is important to investigate the source characteristics of the past earthquakes when seismograms are obtained close to the source regions. In this study, we perform an inversion of strong-motion waveforms at periods of 5–30 s to investigate the rupture process of the Iquique earthquake (M_w 8.1), which occurred along the Peru-Chile Trench on 1 April 2014. We discuss the source characteristics of this earthquake in terms of the source scaling relation and the reproduction of ground motions.

The inversion was performed using the multi-time-window linear waveform inversion method (Hartzell and Heaton, 1983). The source fault was defined depending on the 3-D geometry of the plate boundary (Hayes *et al.*, 2012). The Green's functions were computed by the discrete wavenumber method (Bouchon, 1981) and the reflection/transmission coefficient matrix method (Kennett and Kerry, 1979). For the calculations, an 1-D velocity structure model (Husen *et al.*, 1999) was adjusted using waveforms of an M_w 6.2 earthquake.

The estimated seismic moment and average slip were 1.65×10^{21} Nm (M_w 8.08) and 1.40 m, respectively. Applying the criterion of Murotani *et al.* (2008) to the inversion result, we identified a large slip area with 17% (4,000 km²) of the entire rupture area, which was roughly comparable to the area identified based on Somerville *et al.* (1999) (20%; 4,700 km²). The relations of the seismic moment to the entire rupture area, average slip, and large slip area were consistent with the empirical equations of Murotani *et al.* (2013) and Skarlatoudis *et al.* (2016). Because large slips were estimated to range from the trench axis to the downdip limit of the seismogenic zone (e.g., Oleskevich *et al.*, 1999), we suggest that this earthquake was a 2nd-stage event for the 2-stage scaling model (Tajima *et al.*, 2013).

Using an algorithm considering the estimation errors in slip velocity functions, we derived the durations of the slip velocity functions from the inversion result. The average durations of shallow large slips were 2–3 s longer than those of deep large slips, which reflected a depth dependence of the frequency of the seismic wave radiation (e.g., Lay *et al.*, 2012; Suzuki *et al.*, 2016). We also found that the rupture of the shallow large slips propagated primarily in the down-dip direction, not perpendicular to the circular rupture front from the hypocenter. This dip-direction rupture and the resulting directivity effect were important contributors to the observed pulses at periods of 10–11 s.

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Keywords: Megathrust earthquake, Source inversion, Source scaling relation, Rupture process, Characterized source model

