A systematic investigation of rupture directivity, stress drop, fault geometry, and radiation efficiency of small inland earthquakes in Japan

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Stress drops of small earthquakes have been estimated under the priori assumption that the rupture propagates symmetrically within a circular fault. However, recent studies have observed directivity effects on seismic waves even for small earthquakes. In this study, the rupture directivity was investigated systematically for small to moderate-sized earthquakes (M 3.5-5.5) beneath inland Japan from 2004 to April 2019. The apparent moment rate functions were determined, and their corner frequencies were inverted using the rupture parameters of 1,463 earthquakes. The results indicate that most of the analyzed earthquakes (1,335 of 1,463) are characterized by a significantly asymmetrical rupture propagation. The rupture tends to propagate to the direction along the fault-strike both for dip-slip and strike-slip earthquakes. The stress drop for the earthquakes were estimated by considering the asymmetrical rupture propagation. The average value of the stress drop is 16.8 MPa, which is almost two times larger than that based on the commonly used symmetrical rupture model. Spatial distribution of stress drop correlates well with the maximum shear strain rate in central and eastern Japan where strain rate probably contributed to the accumulation in the background stress field. Estimated stress drop increases with depth. These observations are consistent with the hypothesis that stress drop reflects the absolute values of shear stress and fault strength.

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