

Spatial heterogeneity of the frictional property on the Pacific plate off south-east of Hokkaido, Japan

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The stress drop is an indicator of the difference of the shear strength and the dynamic frictional stress. We analyzed 330 middle-size earthquakes to investigate the spatial heterogeneity of the frictional property on the Pacific plate off south-east of Hokkaido.

Large earthquakes have been occurring repeatedly off south-east of Hokkaido, Japan, where the Pacific Plate subducts beneath the Okhotsk Plate in the north-west direction. For example, the 2003 Tokachi-oki earthquake (Mw8.0) recently took place in the region in 2003. Yamanaka and Kikuchi (2003) analyzed the slip distribution of the earthquake and concluded that the area with a large slip during the 2003 earthquake was mostly overlapped with the area of the 1952 Tokachi-oki earthquake. Miyazaki *et al.* (2004) reported that a notable afterslip was observed at adjacent areas to the coseismic rupture zone of the 2003 earthquake, which suggests that there would be significant heterogeneities of strength, stress and frictional properties on the surface of the Pacific Plate in the region. In addition, some previous studies suggest that the region with a large slip in large earthquakes permanently have large difference of strength and the dynamic frictional stress level and that it would be able to predict large slip areas by analyzing the stress drop of small earthquakes (e.g. Allmann and Shearer, 2007 and Yamada *et al.*, 2010).

We estimated stress drops of 330 earthquakes ($4.2 \leq M \leq 5.0$), using S-coda waves of Hi-net data. The 330 earthquakes were the ones that occurred from June, 2002 to December, 2012 off south-east of Hokkaido, Japan, with the latitude from 40.5N to 43.5N and the longitude from 141.0E to 146.5E. First we selected the closest earthquakes with magnitudes between 3.0 and 3.2 to individual 330 earthquakes as empirical Green's functions. We then calculated source spectral ratio of the 330 pairs of interested earthquakes and EGFs by deconvolving the spectra of S-coda waves. We finally estimated corner frequencies of earthquakes from the source spectral ratios by assuming the omega-squared model of Boatwright (1978) and calculated stress drops of the earthquakes by using the model of Madariaga (1976). The estimated values of stress drop range from $3.0 \times 10^{(-1)}$ MPa to $2.0 \times 10^{(2)}$ MPa independent of the seismic moment. Figure shows the spatial distribution of estimated stress drops.

We found spatial difference of estimated values. The average value of stress drop in the afterslip area at the 2003 Tokachi-oki earthquake, where the small displacement was observed, was 1.2 MPa. On the other hand, the value in the source area of the 2004 Kushiro-oki earthquake was 2.0 MPa. In addition, the average values of stress drops in the deeper and shallower parts of the source area of the 1973 Nemuro-oki earthquake were 1.0 MPa and 2.1 MPa, respectively, and the difference was statistically significant. These differences would reflect the spatial heterogeneity of the frictional property on the Pacific plate.

Acknowledgments: We used Hi-net waveform data (<http://www.hinet.bosai.go.jp/>) and the slip distribution of large earthquakes (EIC seismic note; http://www.eri.u-tokyo.ac.jp/sanchu/Seismo_Note/index.html)

Keywords: Pacific plate, Friction, Spatial heterogeneity, Stress drop

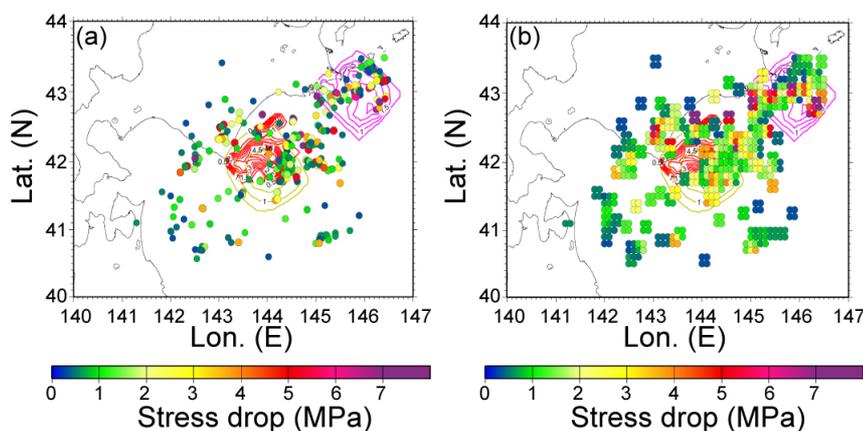


Fig. (a) Estimated stress drops of analyzed 330 middle-size earthquakes ($4.2 \leq M \leq 5.0$). Each circle shows the stress drop for each earthquake. Contours indicate slip distributions of past four large earthquakes off south-east of Hokkaido (EIC seismic note, http://www.eri.u-tokyo.ac.jp/sanchu/Seismo_Note/index.html). (b) Spatial pattern of the averaged stress drop. Individual circles indicate averaged values of stress drop for every 0.1 degree, which were calculated from the values of earthquakes in areas with 0.2×0.2 degrees.