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Relationship between the source process of the 2013 Sea of Okhotsk deep earthquake and the thermal structure of the slab

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Deep earthquakes occur at depths where, due to the high normal pressures and the prominence of plastic behavior caused by high temperatures, the brittle fracture is difficult to explain. As a consequence, the mechanism of deep earthquakes has been long standing challenge in Earth Science since the early twentieth century. Some mechanisms of deep earthquakes have been suggested and these mechanisms are sensitive to the thermal structure of slabs. Accordingly, the purpose of this study is (1) to infer the source process of the Sea of Okhotsk deep earthquake (Mw 8.3, depth 608.9 km) on 24 May 2013 (UTC) by using the Hybrid Back?projection (HBP) method (Yagi et al., 2012) and waveform inversion (Yagi and Fukahata, 2011) and (2) to elucidate the relationship the source process and the thermal structure in the Kurile slab.

We found that the reactivation of the rupture occurred near the hypocenter. This means that a stress concentration near the hypocenter overcomes the fault strength and reactivates rupture at the hypocenter (Gabriel et al., 2012). We investigated the relationships between our results and the thermal structure of the Kurile slab and found that (1) the main shock started to rupture from the outer portion of the slab (2) the source region of the earthquake extended in a temperature range between 740 ℃ and 990 ℃. This study does not clearly support transformational faulting as a mechanism for occurrence of the Sea of Okhotsk deep earthquake suggested by Zhan et al. (2013) because it is unlikely that metastable olivine exists all over the slab at the depth of the main shock.

Keywords: deep earthquake, HBP method, rupture reactivation