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A seismic cluster at 155 km depth beneath Niigata: Implications for phase transformation from gabbro to eclogite

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Intermediate-depth earthquakes occur at depths of 60-300 km, forming the double Wadati-Benioff zone in subduction zones as a global prevalence (Brudzinski et al., 2007). Because of high pressures that prohibit brittle failure at such depths, the genesis of intermediate-depth earthquakes has been discussed in terms of dehydration embrittlement (Seno and Yamanaka, 1996; Peacock, 2001; Jung et al., 2004) or periodic shear heating (Kelemen and Hirth, 2007).

We find a tiny seismic cluster in the lower crust of the Pacific plate at a depth of 155 km and analyze it based on waveform similarity. The cluster consists of sub-clusters with similar waveforms, and earthquakes in each cluster lie on single fault plane with complementary rupture areas. This result suggests that earthquake occur as a reactivation of pre-existing hydrated faults. We also reveal that in the cluster, tensional faulting occurs closer to the top of the slab and compressional faulting is dominant away from the slab surface. Since regional stress around the cluster is compression, we interpret that shallow tensional faulting occurs as a result of a stretching deformation in the transformed crust underlain by untransformed crust. Our observations may reflect ongoing gabbro-eclogite transformation at a pressure of ˜5 GPa.

Keywords: intermediate-depth earthquake, dehydration, weak fault