Dehydration-driven stress transfer evidenced beneath Tohoku and Hokkiado, NE Japan

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Both seismologists and experimental geophysicists use the b-value to study earthquakes populations because it gives us an important information on the spatial distribution of brittle deformation. Here we present b-values of intermediate-depth intraslab earthquakes in the Pacific slab beneath Tohoku and Hokkaido, northeastern Japan, and show a significant difference in the b-values of the lower Wadati-Benioff plane of the double seismic zone. Lower-plane events reveal a much larger b-value beneath Tohoku than beneath Hokkaido, which implies that the brittle deformation beneath Hokkaido is more localized and leads to larger earthquakes in the lower-plane than beneath Tohoku. Acoustic emissions (AE), i.e. experimental earthquakes, suggest that lower-plane b-values increase with increasing outer-rise hydration. Based on both experimental and natural earthquakes, the lower-plane peridotite would be more hydrated beneath Tohoku, which is consistent with the oceanic-plate velocity structure by the OBS studies beneath Tohoku-Oki and Hokkaido-Oki. We argue that, whilst interplane events are fluid-related, lower-plane events affect fresh peridotite in the vicinity of dehydrating faults, without fluid overpressure. Our b-value study confirms the “Dehydration-Driven Stress Transfer” (DDST) model proposed by Ferrand et al. [2017, Nature communiations] as the most accurate to explain the presence of the lower Wadati-Benioff plane.

Keywords: lower Wadati-Benioff zone, slab mantle, Dehydration-driven stress transfer, b-values, peridotite, intermediate-depth

