

Mechanisms of ultra-deep earthquakes ($h > 660\text{km}$) in a slab penetrating the 660-km discontinuity

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Recent mantle tomography has begun to reveal the characteristic differences between the deep hypocentral distributions associated with stagnant slabs and those associated with penetrating slabs (e.g., Fukao and Obayashi, 2014). We here show that there are differences in focal mechanism as well. Mechanisms of deep shocks within tomographically imaged stagnant slabs (typically in Bonin and Tonga) are characterized by horizontal compression (e.g., Bonnardot et al., 2009). Those within tomographically imaged penetrating slabs (typically in Java and Tonga) are characterized by very steeply dipping compressional axes (e.g., Alpert et al., 2010).

The deepest seismicity is especially active in Tonga, where many shocks occur at depths greater than 660km. Such ultra-deep shocks show in general very unusual mechanisms, typified by nearly vertical tensional axes with a large amount of CLVD component, as demonstrated in Figure 1 (Mechanisms viewed from the side). This figure also shows a remarkable contrast of mechanisms of deepest shocks just above and below the 660km depth. The source region of the ultra-deep shocks ($h > 660\text{km}$) is underlain by the greatly deepened post-spinel phase boundary (Niu and Kawakatsu, 1995) so that the source region is at the pre-spinel state while the underlying portion is at the post-spinel state. This situation along with contortion of the slab associated with its interaction with the post-spinel phase boundary (e.g., Cizkova and Bina, 2013) may explain the mechanism change across the 660km depth as observed in Figure 1. We explore the finer velocity structure and hypocentral distribution in the source region by a technique of differential travel time tomography.

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