Seismic constraints on fluid-related embrittemenet in subducting plates

JUNICHI NAKAJIMA[1]

[1]Tokyo Institute of Technology, Tokyo 152–8551, Japan; nakajima@geo.titech.ac.jp

Dehydration of lawsonite plays a role in triggering earthquakes in a subducting crust [1], while the genesis of mantle earthquakes is enigma because unstable fault slip does not occur during dehydration reaction in antigorite [2]. Instead of dehydration embrittlement, thermal runaway is proposed as alternative model for the genesis of mantle earthquakes. However, source processes of earthquakes in the crust and mantle do not show substantial differences at least at intermediate depths. Here I show waveform analyses of two small seismic clusters in the subducting crust and mantle, providing lines of evidence for fluid-related embrittlement in both the subducting crust and mantle [3,4]. For the cluster in the crust, we reveal that tensional earthquakes are located ~1 km above compressional earthquakes, suggesting that the shear strength of faults is too weak to response to different stress regime over a short distance. Earthquakes with highly similar waveforms lie on well-defined planes with complementary rupture areas, suggestive of progressive ruptures along pre-existing fossil faults. For a seismic sequence in the mantle that started 8 month after the 2011 Tohoku-oki earthquake, we observe an upward migration of seismicity by 6 km for 6 month. Successive upward migration of overpressurized fluids reduces effective normal stress and weakens the strength of the faults sufficiently to bring the system into the brittle regime under the deviatoric stress. The permeability of the mantle is estimated to be 10^{-15}–10^{-19} m^2.

1] Okazaki & Hirth (2016) *Nature* **530**, 81-84.
[2] Chernak & Hirth (2010) *EPSL* **296**, 23–33.
[3] Nakajima et al. (2013) *Geology* **41**, 659–662.
[4] Nakajima et al. (2013) *JGR* **118**, 3492–3505.