

Generation mechanism of intraslab earthquakes -Verification of dehydration embrittlement hypothesis from seismic observations-

Junichi Nakajima[1]; Akira Hasegawa[1]

[1] RCPEV, Graduate School of Sci., Tohoku Univ.

Several models have been proposed to explain the occurrence of intraslab earthquakes in subducting slab where the lithostatic pressure appears to be too high for brittle fracture, and dehydration instability or dehydration embrittlement is considered to be one of the most plausible mechanism. Hydrous minerals in oceanic plates become unstable with increasing pressures and temperatures, and consequently dehydration reactions take place accompanied by the release of water to the surroundings. The water thus released is believed to trigger intraslab earthquakes by reducing effective pore pressure. This study summarizes recently-obtained detailed 3D seismic velocities in the subducting Pacific slab and discusses its relationship to intraslab earthquake activity.

Tsuji et al. (2008, GRL), and Nakajima et al. (2009, GRL) revealed that the depth extent of the low-velocity (hydrated) oceanic crust varies along the arc. The low-velocity oceanic crust is subducting to depths of 120-150 km beneath Kanto, which is 40-70 km deeper compared to NE Japan. Such a deeper preservation of the low-velocity oceanic crust can be explained by lower-temperature conditions in the Pacific slab as a result of the subduction of the Philippine Sea slab immediately above it. These observations suggest that phase change of crustal materials accompanied by large velocity changes are controlled principally by temperatures, not by pressures. We also find spatial correspondence between intensive seismicity in the oceanic crust and the disappearance depth of the low-velocity oceanic crust, showing a close relation between breakdown of hydrous minerals and seismicity in the crust.

Nakajima et al. (2009, Gondwana Research) provided a clue to understand the occurrence of earthquakes even in the lower plane of the double seismic zone. They found prominent low-velocity anomalies along the lower plane of the double seismic zone and above the aftershock area of the 1993 Kushiro-oki earthquake (M7.8). Since seismic velocities of unmetamorphosed peridotite are much higher than the observations, hydrous minerals are expected to exist in the lower plane as well as the hypocentral area of the 1993 earthquake. On the other hand, regions between the upper and lower planes, where seismic activity is not so high compared to the both planes, show relatively high velocities comparable to those of unmetamorphosed peridotite. These observations suggest that intermediate-depth earthquakes occur mainly in regions with a large volume of hydrous minerals, which can support dehydration embrittlement hypothesis as a cause of earthquake in the subducting slab.