The 63rd GRC & The 8th MEXT Shin-Gakujutsu "Core-Mantle Coevolution"

International Frontier Seminar

Experimental reproduction of mantle earthquakes analogues by antigorite dehydration & comparison with natural pseudotachylytes

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Venue: Meeting Room #486, Science Research Bldg 1, Ehime Univ.

Intermediate-depth earthquakes (30-300 km) have been extensively documented within subducting oceanic slabs but their mechanism remains enigmatic. Earthquakes occur both in the upper and lower Wadati-Benioff planes. The latter is located in the mantle of the subducted oceanic lithosphere, 15-40 km below the plate interface, and is thought to fit the thermal breakdown of antigorite, the high-temperature serpentine, around 600 ° C. To test this hypothesis and understand which mechanism is at play in the lower plane, both experiments (Griggs and D-DIA) and field work (Balmuccia, Italy) have been performed. Artificial peridotites were dehydrated during deformation at upper mantle conditions. Between 1 and 3.5 GPa, acoustic emissions are recorded in samples with only 5 vol.% antigorite. Associated microfaults are sealed by fluid-bearing pseudotachylytes, showing that antigorite destabilization triggered dynamic shear failure and frictional melting of olivine. These results lead to a model in which dehydration-induced stress transfer is the trigger of mantle rocks embrittlement. Simultaneously, a pseudotachylyte from the Balmuccia peridotite reveals the recorded sliding history of an ancient Mw > 6 earthquake. The co-seismic fault lubrication is complete and transient, as melt could rapidly flow into tensile fractures generated by the rupture front. Melt suction within the fractures led to rapid cooling and may have promoted strength recovery and sliding arrest. This natural pseudotachylyte, one million times larger than the experimental ones, has formed at the same pressure and temperature. The high similarity between those experimental and natural faults indicates a similar mechanism at both scales, and thus that the experiments show a rupture mechanism representative of what happens in nature. Furthermore, water, found fossilized in the pseudotachylyte, was somehow present during the seismic rupture. This work reconciles decades of apparently contradictory studies on the possible link between mantle earthquakes and serpentine dehydration. At a certain scale, an antigorite fraction as low as 5 vol.% is sufficient to trigger seismicity, which could therefore ultimately be seen as an indicator for the degree of hydration in the lithospheric mantle.

CoreMantle Evolution

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