Geophysical Research Abstracts
Vol. 14, EGU2012-6097, 2012
EGU General Assembly 2012

Geophysical imaging of water from the slab to the mantle wedge

B. Reynard

CNRS ENS Lyon, Laboratoire de Géologie de Lyon, CNRS, Lyon, France (bruno.reynard@ens-lyon.fr)

Water is recycled to the Earth's interior at subduction zones, and a large portion of the subducting fluid is mobilised at depths shallower than 150 km. Seimological and magneto-telluric methods are potential tools for imaging fluid circulation when combined with petrophysical models. Recent measurements of the physical properties of serpentine are presented, and allow refining hydration of the mantle and fluid circulation in the mantle wedge from geophysical data.

In the slab lithospheric mantle, serpentinisation caused by bending at the trench is limited to a few kilometers below the oceanic crust (<5 km). Double Wadati-Benioff zones, 20-30 km below the crust, are explained by deformation of dry peridotites, not by serpentinisation. It reduces the required amount of water stored in solid phases in the slab (Reynard et al., GRL, 2010).

In the cold (<700°C) fore-arc mantle wedge above the subducting slab, serpentinisation is caused by the release of large amounts of hydrous fluids in the cold mantle above the dehydrating subducted plate. Low seismic velocities in the wedge give a time-integrated estimate of hydration and serpentinisation. Serpentinisation reaches 50-100% in hot subductions, while it is below 10% in cold subduction (Bezacier et al., EPSL 2010).

Electromagnetic profiles of the mantle wedge reveal high electrical-conductivity bodies. In hot areas of the mantle wedge (> 700°C), water released by dehydration of the slab induces melting of the mantle under volcanic arcs, explaining the observed high conductivities. In the cold melt-free wedge (< 700°C), high conductivities in electromagnetic profiles provide "instantaneous" images of fluid circulation because the measured electrical conductivity of serpentine is below 0.1 mS/m (Reynard et al., Earth Planet Sci Letters, 2011).

A small fraction (ca. 1% in volume) of connective high-salinity fluids accounts for the highest observed conductivities. Low-salinity fluids ($\leq$ 0.1 m) released by slab dehydration evolve towards high-salinity ($\geq$ 1 m) fluids during progressive serpentinisation in the wedge. These fluids can mix with arc magmas at depths and account for high-chlorine melt inclusions in arc lavas.

High electrical conductivities up to 1 S/m in the hydrated wedge of the hot subductions (Ryukyu, Kyushu, Cascadia) reflect high fluid concentration, while low to moderate (<0.01 S/m) conductivities in the cold subductions (N-E Japan, Bolivia) reflect low fluid flow. This is consistent with the seismic observations of extensive shallow serpentinisation in hot subduction zones, while serpentinisation is sluggish in cold subduction zones.