Geophysical Research Abstracts
Vol. 18, EGU2016-6438-1, 2016
EGU General Assembly 2016

Watching dehydration: transient vein-shaped porosity in the oceanic mantle of the subducting Nazca slab

Wasja Bloch (1), Timm John (1), Jörn Kummerow (1), Peter Wigger (1), Pablo Salazar (2,3), and Serge Shapiro (1)

(1) Freie Universität Berlin, Fakultät für Geowissenschaften, Institut für Geologische Wissenschaften, Berlin, Germany, (2) Departamento de Ciencias Geológicas, Universidad Catlóica del Norte, Antofagasta, Chile, (3) National Research Center for Integrated Natural Disasters Management (CIGIDEN), Chile

Subduction zones around the world show the common pattern of a Double Seismicity Zone, where seismicity is organized in the form of two sub-parallel planes, one at the plate contact and the other one, 10 to 30 km below, in the mantle of the oceanic lithosphere (Lower Seismicity Zone, LSZ). A commonly held hypothesis states that dehydration processes and the associated mineral reactions promote the earthquakes of the LSZ.

Fluids filling a porespace strongly alter the petropyhsical properties of a rock. Especially the seismic P- to S-wave velocity ratio (Vp/Vs) has been shown to be sensitive to the presence of fluid-filled porosity. It transforms uniquely to Poisson's ratio. To test the mineral–dehydration-hypothesis, we use local earthquake data to measure Vp/Vs in the oceanic mantle of the subducting Nazca slab at 21°S. We determine it as the slope of the de-meaned differential P- vs. S-wave arrivaltimes of a dense seismicity cluster in the LSZ. This measurement yields a value for Vp/Vs of 2.10 $\pm$ 0.09, i.e. a Poisson's ratio of $\sim$0.35. This value clearly exceeds the range of Vp/Vs values expected for oceanic mantle rocks in their purely solid form at $\sim$50km depth.

We follow a poroelastic approach to model the rock's elastic properties, including Vp/Vs, as a function of porosity and porespace-geometry. This results in a porespace model for the target volume having a vein-like porosity occupying only a minor volume fraction. Porosity is in the order of 0.1%. These findings are in very good agreement with field surveys and laboratory experiments of mantle dehydration. The pore-geometry is close to the geometrical percolation threshold, where long-ranged interconnectivity statistically emerges, suggesting good draining capabilities. Indeed, porosity is soft so that the amount of porosity and, consequently, permeability is very sensitive to local fluid pressure.

We conclude that in the oceanic mantle of the subducting Nazca slab, mineral dehydration reactions are continuously releasing water into a transient, dynamically evolving vein-system. Permeability is most probably high enough to drain the rock at the rate of metamorphic fluid production.