Geophysical Research Abstracts
Vol. 12, EGU2010-15314-1, 2010
EGU General Assembly 2010

Experimental Deformation of Dehydrating Antigorite: Challenging Models of Dehydration Embrittlement

Greg Hirth and Linda Chernak
Brown University, Providence, RI 02912, USA, linda_chernak@brown.edu

To test the hypothesis that intermediate depth earthquakes in subduction zones are caused by the dehydration of hydrous phases, we conducted temperature-ramping experiments on antigorite serpentinite. Cold-pressed powdered samples of antigorite were deformed to a high differential stress at 400°C and 1.0 GPa, within the antigorite stability field, where we have shown that deformation localizes. Temperature was then increased at different rates, 1800°C/hr and 180°C/hr, to cross the reaction boundary while the sample continued to deform; samples were deformed at strain rates of 10^{-4} s^{-1}, 10^{-5} s^{-1} and 10^{-6} s^{-1}. Two additional experiments were conducted in a similar manner at 300°C, 1.5 GPa and 10^{-5} s^{-1} but samples remained “statically” at high stress during the temperature increase.

Our results show that although the decrease in stress during temperature ramping is large, stress relaxes stably, even after dehydration. We find that the slopes of the unloading curves are approximately the same for constant values of the ratio (strain rate/ramp rate) and that the unloading slope is greater for higher values of this ratio. In addition, we find that the unloading curves with the greatest slopes are similar to the apparatus compliance, suggesting that we are generating “slow earthquakes” in our experiments over the course 5 to 10s of minutes. A strain rate stepping experiment indicates that antigorite has velocity strengthening behavior at 700°C and 1.5 GPa suggesting that as soon as an instability develops in the antigorite, the material strengthens sufficiently to not go unstable. Our results thus suggest that antigorite dehydration does not result in “dehydration embrittlement” but that it may promote slow earthquakes.

We have also conducted a preliminary experiment to study the role of effective pressure on deformation behavior after dehydration. A cold-pressed powdered sample of antigorite with a small core of coarse-grained olivine at one end was deformed at 700°C, 1.5 GPa and a strain rate of 10^{-5} s^{-1}. This sample had a strength of 300 MPa, which is significantly higher than samples deformed at the same conditions without olivine present; strengths were approximately 100 MPa for these samples. We hypothesize that the highly porous and permeable olivine layer provided a reservoir for the water released by the dehydration reaction and suggests that the presence of water causes the strength of antigorite to decrease.