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Rheology of Talc: Consequences for Subduction Processes and the Localization of Deformation

J. Escartín 1, G. Hirth 2, B. Evans 3

[1] Geosciences Marines - CNRS/IPGP, 4 Pl. Jussieu (Case 89), Paris, 75252, France
[2] Geology and Geophysics - WHOI, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA
[3] EAPS - MIT, 54-718 77 Massachusetts Avenue, Cambridge, MA 02139-4307, USA

Subduction of altered oceanic lithosphere results in the dehydration of serpentinite and formation of talc. Talc also forms on oceanic shear zones that have a long history of localized deformation and fluid flow (i.e., oceanic detachments and transform faults). Being an extremely weak material, the presence of even small amounts of talc can substantially weaken the subducted lithosphere, and affect its behavior and evolution. Despite its potential importance for ocean tectonics, many aspcts of the mechanical behavior of this mineral are poorly characterized. Consequently, we are conducting conventional triaxial mechanical tests on intact cores of talc at P<400 MPa and T<600°C, and a strain rate of $\sim 10^{-5}$ s^{-1}. At that strain rate, with confining pressure of 100 MPa and at room temperature, the peak strength is only ~50 MPa. Unlike crystalline silicate rocks that fail by Mohr-Coulomb criterion under similar conditions, the strength of the talc rocks is modestly dependant on pressure. Even so, deformation localizes on sets of parallel and cross cutting shear zones oriented ~45° from the shortening direction. Within the errors of the strain gauge systems used to measure volumetric strain, little or no dilation occurs during deformation. Suprisingly, this style of localized deformation was also observed for an experiment conducted at T~600°C and P=300 MPa. The extremely weak nature of talc (<10% of the maximum strength of pure peridotite, and ~20% of that of lizardite serpentinite) may play a major role on the dynamics of subduction zones and on the rheology of altered mantle. For example, hydration of the overlying mantle wedge by fluids arising from the dehydratation of the subducting slab could result in the formation of talc along grain boundaries, enhancing plastic deformation at very low degrees of alteration.