The rheology of talc at high P-T conditions with implications for subduction-zone dynamics

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Subduction-zone dynamics, kinematics, and seismicity are strongly affected by the rheology of hydrous phyllosilicates. Although there is growing evidence for hydrous minerals in the subducting plate, mantle wedge, and the interface between the plates, we are continuing to learn more about the rheological behavior of phyllosilicates at the relevant pressures. Talc is stable to depths of ~100 km and has been found in fault rocks and subduction-zones mélanges as the product of metasomatism and/or mineral breakdown (e.g., breakdown of antigorite). The frictional strength of talc under low to intermediate pressures (up to ~400 MPa) was studied and demonstrated some of the mineral's unique rheology; however, there is a lack of data for pressures of P > 0.5 GPa. Here we present the first rheological and microstructural analysis of experimentally deformed talc under pressure and temperature conditions relevant for the rheology of a subducted slab or mantle wedge.

We analyzed the mechanical and microstructural evolution of 15 samples of natural talc cylinders deformed using a high P-T deformation 'Griggs' type apparatus. We used natural samples comprise of >98 % talc and analyzed the post-mortem microstructure and chemistry of the samples using optical microscopy, scanning electron microscopy, and electron microprobe. The experiments were performed at confining pressures from 0.5 to 2 GPa and temperatures of 25 to 700°C; all within the talc stability field. Results show that the strength of talc at 25°C or 400°C is pressure-dependent up to the highest pressure tested (2 GPa). This behavior is attributed to brittle/semi-brittle mechanisms. At higher temperatures (500-700°C) and above a pressure threshold the strength becomes independent of pressure (e.g., when P > 1 GPa at T = 600 °C), indicating that dilatant cracking is suppressed at these pressures. However, microstructural analysis indicates that fracturing is evident in all samples at all conditions examined. Interestingly, samples deformed at higher temperatures (>600°C) show more localized deformation. A synthesis of results from this study and previously published studies demonstrate that the strength of talc only becomes temperature-dependent at higher pressures. It is suggested that an increasing P-T geotherm of a subducted slab is likely to induce weakening and localization of talc-rich layers with possible implications for the mechanism to induce/hinder regional seismicity and affect the plate-
coupling between the subducted and riding plates.