CPO induced seismic velocity anisotropy in subduction zones: Anitigorite vs. olivine

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Antigorite, the high P/T polytype of serpentine, is considered to be an important component in mantle wedge and subducting slab of subduction zones. Its crystallographic preferred orientation (CPO) may play an important role in trench parallel anisotropy. However, there is a significant discrepancy in antigorite CPO among natural serpentinites and experimental samples. We have conducted systematic shear experiments on a hot-pressed serpentinite at 350–600 °C and 1.0-2.0 GPa, using a 5GPa Griggs-type deformation apparatus. Antigorite develops a [hk0](001) fabric in responding to shear deformation. The [010] axes tend to concentrate toward the slip direction with increasing temperature, indicating a change of the dominant slip system from (001)[hk0] to (001)[010] with increasing temperature from 350 °C to 600 °C. These results are different from previous experimental fabrics of antigorite at low temperatures (300-400 °C), but similar to many antigorite fabrics observed in natural samples. Antigorite accommodates most plastic strain while olivine acts mostly like rigid bodies during the deformation of serpentinite. The observation of weak CPOs in coexisting olivine is consistent with the much greater strength of olivine comparing to that of antigorite. The deformation of serpentinite can explain both trench-parallel seismic wave polarization and shear wave delay time in subduction zone. We proposed that the observed strong seismic anisotropy in subduction zones is caused by antigorite CPO rather than by B-type olivine CPO.