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Strain-induced partial serpentinization of germanate olivine with a small amount of water

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Abstract

Antigorite, a high-pressure polymorph of serpentine, is considered to be the most abundant hydrous mineral in subduction zones. Although antigorite dehydration is presumed as one of the origins of intermediate-depth earthquakes in the subduction zone, the amount of antigorite is uncertain because the amount of water infiltrated into the oceanic lithosphere is still debated. To investigate whether antigorite can be formed even with limited water availability, we conducted the axial deformation experiments of magnesium germanate at 1.2 GPa and $T = 500–800$ °C using a Griggs-type deformation apparatus. Magnesium germanate is an analog material of magnesium silicate, and the starting material was dried prior to experimentation. Nevertheless, the samples had initially high porosity, and hence a small amount of water (about 200 ppm wt H_2O) was retained in the samples. In the samples deformed at 600 °C, stable slip occurred, and TEM analysis revealed that fine-grained platelets of germanate antigorite existed along the faults. A sharp absorption band assigned to the OH-stretching vibration of antigorite in Fourier transform infrared spectroscopic (FTIR) analysis also implies that antigorite was formed in the samples deformed at a temperature lower than 600 °C. Our results indicate that strain-induced hydration of germanate olivine results in antigorite formation even with only a small amount of water present. Thus, partial serpentinization in the oceanic lithosphere can occur under slight water infiltration due to the high strain accumulated by subduction.

Keywords: Antigorite, serpentinization, subduction zone, TEM, Griggs-type deformation apparatus