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Amorphous Mn_2SiO_4: A potential manganese phase in the stagnant slab

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Abstract

Tephroite (Mn_2SiO_4), together with some manganese (Mn)-rich mineral inclusions, has been found in ophiolite-hosted diamonds, possibly originating from Mn-nodules and sediments that were once deposited on the oceanic floor and later subducted into the deep mantle, which provides evidence for oceanic crustal recycling. However, the state and behavior of tephroite under high-pressure and high-temperature conditions remain poorly understood. In this study, we conducted in situ synchrotron single-crystal X-ray diffraction (XRD) and Raman spectroscopy of synthetic tephroite up to ~30 GPa and ~900 K. The XRD and Raman spectroscopy experiments in this study first show that tephroite undergoes a pressure-induced, irreversible, amorphous transformation above ~20 GPa. Temperature (<900 K) is found to be an insignificant factor governing the process of amorphous transformation. Amorphous tephroite may be a potential phase in a rapidly cooling oceanic lithospheric subduction slab stagnating at the bottom of the mantle transition zone.

Keywords: Tephroite, amorphization, single-crystal X-ray diffraction, high-pressure Raman spectra, stagnant slab