

New Stability Field of Jeffbenite (ex-“TAPP”): Possibility of Super-Deep Origin

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Jeffbenite is a new tetragonal phase with garnet-like stoichiometry (Nestola et al., 2016) previously referred to as TAPP (Tetragonal Almandine-Pyrope Phase), which is found exclusively in nature as inclusions in super-deep diamonds and may provide key information about their depth of formation. Nevertheless, whether jeffbenite forms as a primary phase in the transition zone (TZ) or in the lower mantle (LM), or is the product of retrogression from high-pressure mantle phases is still controversial. At present two possibilities are proposed for its formation: 1) entrapment as a primary mineral by diamond in the upper mantle at pressures up to 13 GPa (Armstrong & Walter, 2012); 2) retrograde formation from a bridgmanite or a majoritic garnet below 13 GPa (Armstrong & Walter, 2012; Brenker et al., 2002; Harte & Hudson, 2013). The only previously experimentally determined stability field for jeffbenite is that of Armstrong & Walter (2012), which provides a maximum pressure for jeffbenite stability of ~13 GPa (~390 km) at 1700 K. This suggested that jeffbenite is a sub-lithospheric mineral, but ruled out direct incorporation of jeffbenite into diamond at the TZ-LM boundary. These results were obtained on a Ti-rich jeffbenite, which is usually found as part of composite inclusions, and not on a Ti-free jeffbenite, which occurs as single-phase inclusions in diamonds. We therefore performed new laser heated diamond-anvil cell experiments from 5 to 30 GPa on a Ti-free jeffbenite, in order to determine the role that TiO₂ plays in its stability field and to determine if jeffbenite can be directly incorporated into diamond in the TZ or LM. Our preliminary results indicate that the absence of TiO₂ extends the stability field of jeffbenite to higher pressures than previously determined.

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