New stability field of jeffbenite (ex-“TAPP”): possibility of super-deep origin

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 TiO_2 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 TiO_2 extends the stability field of jeffbenite to higher pressures than previously determined.

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