JEFFBENITE (EX-"TAPP"): A HIGH-PRESSURE MARKER IN DIAMONDS

Anzolini C.*[1], Drewitt J.W.E.[2], Lord O.T.[2], Walter M.J.[2] & Nestola F.[1]

[1] Department of Geosciences, University of Padova, Italy
[2] School of Earth Sciences, University of Bristol, UK
* Corresponding author: Chiara Anzolini (chiara.anzolini@studenti.unipd.it)

Session P1, oral

Jeffbenite, sub-lithospheric diamonds, inclusions

Super-deep diamonds are thought to crystallize between about 300 and 800 km (Harte, 2010) on the basis of the inclusions trapped within them. Many of the inclusions are composites of multiple minerals and show evidence of retrograde transformation from lower-mantle (LM) or transition-zone (TZ) precursors, and their depth of origin is inferred. However, due to the lack of experimental evidence relating composite inclusions directly to high-pressure precursors, their actual depth of origin has never been proven. Jeffbenite is a new official mineral (Nestola et al., 2016), previously referred to as TAPP (Tetragonal Almandine-Pyrope Phase), which occurs both in composite inclusions and as homogeneous inclusions, and may provide key information about the depth of formation of super-deep diamonds. Jeffbenite is a tetragonal phase with garnet-like stoichiometry discovered in Brazilian diamonds (Harris et al., 1997) and found exclusively in nature as inclusions in super-deep diamonds. The main argument in favour of a super-deep origin for jeffbenite is its coexistence in the same diamond with minerals, which are interpreted to have crystallized in the TZ or LM (Harris et al., 1997; Harte et al., 1999; Hutchison et al., 2001; Brenker et al., 2002; Hayman et al., 2005; Kaminsky, 2012). An origin for jeffbenite in the LM is also supported by its capacity to hold ferric iron, as it was demonstrated that in deep mantle silicates Fe^{3+} is significantly abundant (McCammon et al., 1997; Harte, 2010). By contrast, the absence of octahedral silicon in the crystal structure, which is typical of high-pressure silicates below 200 km depth, makes a LM origin difficult to explain if the jeffbenite structure is primary (Harris et al., 1997; Finger & Conrad, 2000). Thus, whether jeffbenite forms as a primary phase in the LM or is the product of retrogression from high-pressure mantle phases has been a matter of debate and is still controversial.

The only 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 confirms that jeffbenite is a sub-lithospheric mineral, but rules out direct incorporation of jeffbenite in diamond at the TZ-LM boundary. However, 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 (Nestola et al., 2016). We therefore report here 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 the stability field of jeffbenite and to figure out if the latter can be directly incorporated into diamond in the TZ or LM. Our preliminary results show that the absence of TiO_2 extends the stability field of jeffbenite to higher pressures than previously determined.

This work was supported by Fondazione Cassa di Risparmio di Padova e Rovigo, NERC Grant NE/M000419/1 to MJW, NERC Fellowship Grant NE/J018945/1 to OTL and ERC-2012-StG 307322 to FN.

Armstrong, L.S. & Walter, M.J. (2012): Tetragonal almandine pyrope phase (TAPP): retrograde Mg-perovskite from subducted oceanic crust?. *Eur. J. Mineral.*, **24**, 587-597.

Brenker, F.E., Stachel, T., Harris, J.W. (2002): Exhumation of lower mantle inclusions in diamond: ATEM investigation of retrograde phase transitions, reactions and exsolution. *Earth Planet. Sci. Lett.*, **198**, 1-9.

Finger, L.W. & Conrad, P.G. (2000): The crystal structure of "tetragonal almandine-pyrope phase" (TAPP): A reexamination. *Am. Mineral.*, **85**, 1804-1807.

Harris, J., Hutchison, M., Hursthouse, M., Light, M., Harte, B. (1997): A new tetragonal silicate mineral occurring as inclusions in lower-mantle diamonds. *Nature*, **387**, 486-488.

Harte, B. (2010): Diamond formation in the deep mantle: the record of mineral inclusions and their distribution in relation to mantle dehydration zones. *Mineral. Mag.*, **74**, 189-215.

Harte, B., Harris, J., Hutchison, M., Watt, G., Wilding, M. (1999): Lower mantle mineral associations in diamonds from Sao Luiz, Brazil. *Mantle Petrology: Field Observations and High-Pressure Experimentation: A Tribute to Francis R. (Joe) Boyd*, **6**, 125-153.

Hayman, P.C., Kopylova, M.G., Kaminsky, F.V. (2005): Lower mantle diamonds from Rio Soriso (Juina area, Mato Grosso, Brazil). *Contrib. Mineral. Petr.*, **149**, 430-445.

Hutchison, M.T., Hursthouse, M., Light, M. (2001): Mineral inclusions in diamonds: associations and chemical distinctions around the 670-km discontinuity. *Contrib. Mineral. Petr.*, **142**, 119-126.

Kaminsky, F. (2012): Mineralogy of the lower mantle: A review of 'super-deep' mineral inclusions in diamond. *Earth-Sci. Rev.*, **110**, 127-147.

McCammon, C., Hutchison, M., Harris, J. (1997): Ferric iron content of mineral inclusions in diamonds from Sao Luiz: a view into the lower mantle. *Science*, **278**, 434-436.

Nestola, F., Burnham, A.D., Peruzzo, L., Tauro, L., Alvaro, M., Walter, M.J., Gunter, M., Kohn, S.C. (2016): PREPUBLICATION: Tetragonal Almandine-Pyrope Phase, TAPP: finally a name for it, the new mineral jeffbenite. *Mineral. Mag.*