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$CaSiO_3$-walstromite inclusions in super-deep diamonds

Chiara Anzolini (1), Fabrizio Nestola (1), Sula Milani (1), and Frank E. Brenker (2)

(1) Department of Geosciences, University of Padua, 35131 Padua, Italy (chiara.anzolini@studenti.unipd.it), (2) Geoscience Institute – Mineralogy, Goethe University, 60438 Frankfurt, Germany

Diamonds are considered the unique way to trap and convey real fragments of deep material to the surface of our planet. Over the last thirty years, great strides have been made in understanding of Earth's lower mantle, mainly thanks to technological and instrumental advances; nevertheless, it is only in the last two decades that a whole range of inclusion parageneses derived from the lower mantle was discovered in diamonds from São Luiz (Brazil) (Kaminsky, 2008 and references therein), thereby establishing a "window" into the lower mantle. These so-called super-deep diamonds form at depths greater than lithospheric diamonds, more precisely between 300 and 800 km depth, and contain mostly ferropericlase, enstatite (believed to be derived from MgSi-perovskite) and $CaSiO_3$-walstromite (believed to be derived from $CaSiO_3$-perovskite). Even though $CaSiO_3$ not only adopts the perovskite structure with increased pressure and temperature, but also it is considered the dominant Ca-bearing phase in the Earth's lower mantle (Tamai and Yagi, 1989), at the present day there are no reliable literature data on the pressure at which $CaSiO_3$ crystallizes within diamonds.

In order to obtain for the first time a pressure of formation value for $CaSiO_3$-walstromite, several inclusions still trapped in a diamond coming from Juina (Mato Grosso, Brazil) were investigated both by *in-situ* microRaman spectroscopy and *in-situ* single-crystal X-ray diffraction. First, we applied "single-inclusion elastic barometry" as improved by Angel et al. (2014) to determine the pressure of formation of the diamond-inclusion pairs. Starting from the maximum remnant pressure value ever reported (Joswig et al., 2003) and adopting the thermoelastic parameters already present in literature (Swamy and Dubrovinsky, 1997; Liu et al., 2012), we obtained an apparent entrapment pressure of $\sim$7.1 GPa, corresponding to $\sim$250 km, at 1500 K. The presence of fractures around the inclusions indicates this is a minimum estimate, and it is possible that the entrapment pressure falls at least into the stability field of Ca_2SiO_4-larnite + $CaSi_2O_5$-titanite. In support of this hypothesis we secondly compared our Raman spectra with reference spectra of the same phases obtained from an experimental product of Gasparik et al. (1994). Our preliminary results indicate in at least one inclusion the coexistence of $CaSiO_3$-walstromite + Ca_2SiO_4-larnite, suggesting that $CaSiO_3$-walstromite forms in sub-lithospheric conditions from the back transformation from $CaSiO_3$-perovskite. Further investigations are in progress in order to find evidence of $CaSi_2O_5$-titanite in these inclusions.

References

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