Retrograde phases of former bridgmanite inclusions in superdeep diamonds?

Dmitry Zedgenizov[1,4], *Hiroyuki Kagi[2], Eiji Ohtani[3], Tatsuki Tsujimori[4], Kazuki Komatsu[2], Seiji Kamada[5]

1. V.S.Sobolev Institute of Geology and Mineralogy, Siberian Branch of the Russian Academy of Sciences, 2. Graduate School of Science, The University of Tokyo, 3. Graduate School of Science, Tohoku University, 4. Center for Northeast Asian Studies, Tohoku University, 5. Frontier Research Institute for Interdisciplinary Sciences, Tohoku University

Bridgmanite $(Mg,Fe)SiO_3$, a high pressure silicate with a perovskite structure, is dominant material in the lower mantle at the depths from 660 to 2700 km and therefore is probably the most abundant mineral in the Earth. Although synthetic analogues of this mineral have been well studied, no naturally occurring samples had ever been found in a rock on the planet's surface except in some shocked meteorites. Due to its unstable nature under ambient conditions, this phase undergoes retrograde transformation to a pyroxene-type structure. The identification of the retrograde phase as 'bridgmanite' in so-called superdeep diamonds was based on the association with ferropericlase (Mg,Fe)O and other high-pressure (supposedly lower-mantle) minerals predicted from theoretical models and HP-HT experiments.
In this study pyroxene inclusions in diamond grains from Juina (Brazil), one single-phase (Sample SL-14) and two composite inclusions of $(Mg,Fe)SiO_3$ coexisting with $(Mg,Fe)_3Al_2Si_3O_{12}$ (Sample SL-13), and with $(Mg,Fe)_3Al_2Si_3O_{12}$ and $(Mg,Fe)_2SiO_4$ (Sample SL-80) have been analyzed to identify retrograde phases of former bridgmanite. XRD and Raman spectroscopy have revealed that these are orthopyroxene (Opx). $(Mg,Fe)_2SiO_4$ and $(Mg,Fe)_3Al_2Si_3O_{12}$ in these inclusions are identified as olivine and jeffbenite (TAPP). These inclusions are associated with inclusions of (Mg,Fe)O (SL-14), $CaSiO_3$ (SL-80) and composite inclusion of $CaSiO_3$+$CaTiO_3$ (SL-13). XRD patterns of $(Mg,Fe)SiO_3$ inclusions indicate that they consist of polycrystals. This polycrystalline textures together with high lattice strain of host diamond around these inclusions observed from EBSD may be an evidence for the retrograde phase transition of former bridgmanite.
Single-phase inclusions of $(Mg,Fe)SiO_3$ in superdeep diamonds are suggested to represent a retrograde phase of bridgmanite and fully inherit its initial chemical composition, including a high Al and low Ni contents [Harte, Hudson, 2013; Kaminsky, 2017]. The composite inclusions of $(Mg,Fe)SiO_3$ with jeffbenite and other silicate and oxide phases may be interpreted as exolusion products from originally homogeneous bridgmanite [Walter et al., 2011]. The bulk compositions of these composite inclusions are rich in Al, Ti, and Fe which are similar to Al-rich bridgmanite produced in experiments on the MORB composition. However, the retrograde origin of composite inclusions due to decomposition of Al-rich bridgmanite may be doubtful because each of observed phases may represent single-phase inclusions, i.e. bridgmanite and high pressure garnet (majoritic garnet), with similar compositional features.

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References

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