An unusual partial retrograde phase transition of majoritic garnet from Snap Lake diamond

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Majoritic garnets, containing pyroxene solid solution initially discovered in Monastery mine, South Africa (Moore, Gurney, 1985) are very rare both in limited number of kimberlite pipes and alluvial sources (e.g. Stachel, 2005). Most of them are eclogitic, but some peridotitic (U-type) and websteritic (W-type) are also found (e.g. Sobolev et al., 1977; 2004). Significant percentage (40%) of majoritic garnets among subcalcic Cr-pyrope inclusions in diamonds was discovered in Snap Lake kimberlites (Pokhilenko et al., 2004). Garnet with highest majorite content (up to 17 mol. %) was additionally investigated by TEM techniques using FIB prepared foils (Wirth, 2004). Fine-grained symplectite consisting of low Ca orthopyroxene, clinopyroxene, spinel and coesite was detected with TEM in the inner part of the garnet grain forming a sharp interface with the garnet. EPMA showed an identical chemical composition of the nanometer-sized symplectite and garnet. X-ray diffraction patterns confirmed the presence of the phases detected by TEM. Further polishing of garnet grain removed the symplectite, which possibly was present as thin lense within garnet. The detected symplectite testified partial retrograde phase transition of the examined garnet, which probably was caused by plastic deformation of diamond at high temperatures of the Earth's mantle (Stachel, 2005). In this particular sample such a plastic deformation and retrograde reaction occurred within coesite stability field at depths no less than 100 km. Earlier only pyroxene exsolutions from majorite garnet was documented (Wilding, 1990). Because previous studies of rare majoritic garnets were performed by EPMA only it might be possible that the presence of partial phase transitions or even complete ones could have been missed without additional XRD and/or TEM/AEM studies and identical results of chemical analyses of garnets and possible nanometer sized retrograde symplectite.

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