Evidence of partial melting and melt extraction in mafic granulites

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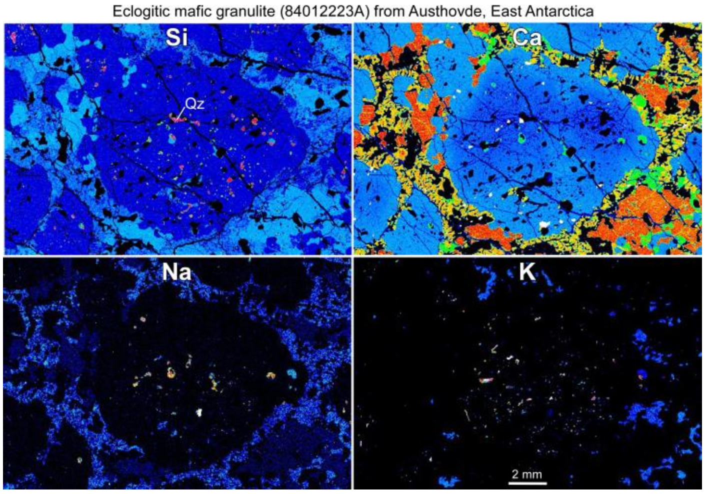

Figure 1. Elemental maps of zoned porphyroblastic garnet.

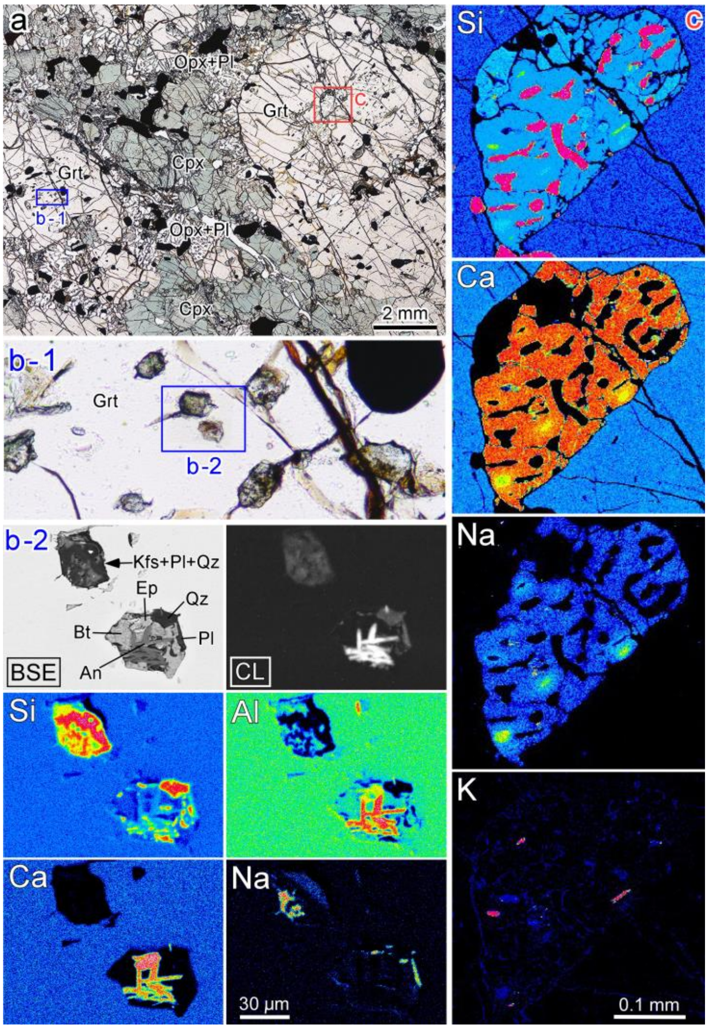

Figure 2. Two types of granitic inclusions in garnet in mafic granulite (84012223A) from Austhovde. One is felsite-nanogranite inclusions (b) and the other is plagioclase grains intergrown with K-feldspar and quartz (c). Anorthite and epidote rarely occur in felsite inclusions.

It is generally accepted that high-grade metamorphic rocks, especially those of pelitic and quartzo-feldspathic compositions, might have experienced partial melting under high-temperature conditions (i.e. > 700˚C). However, it is often difficult to confirm whether natural samples in hand have certainly undergone partial melting in the absence of reliable criteria for partial melting. Here we report several lines of evidence for partial melting of mafic and ultramafic granulites from Austhovde in the Late Proterozoic-Early Paleozoic Lützow-Holm Complex, East Antarctica (Takahashi & Tsunogae, 2017, and references therein). The granulites consist mainly of garnet and clinopyroxene with lesser amounts of orthopyroxene, hornblende, plagioclase, biotite and ilmenite (Figs. 1 and 2). Quartz is usually absent in the matrix, and occurs only as inclusions in garnet (Figs. 1 and 2). Garnet is partially replaced by symplectitic intergrowths of anorthite and orthopyroxene from outside. Garnet porphyroblasts sometimes show compositional zoning whith Ca-poorer cores and Ca-richer mantles (Fig. 1). Plagioclase inclusions in such garnet porphyroblasts show concomitant and systematic change in composition; those in the Ca-poorer cores are relatively Na-rich, while those in the Ca-richer mantles are more calcic. In addition, relatively Na-rich plagioclase inclusions are sometimes intergrown with K-feldspar and quartz (Fig. 2c), and therefore granitic mineral assemblage is present in garnet. It is consistent with the fact that garnet porphyroblasts also contain felsite-nanogranite inclusions which may be former melt inclusions (e.g. Hiroi et al., 2014) (Fig. 2b). These facts suggest the following continuous partial melting reaction under nearly the same P-T conditions:

Hbl + Bt + Qz + sodic Pl + Ca-poorer Grt ± K-feldspar
= granitic melts + more calcic Grt and Pl + Cpx + Opx.

Subsequently most melts may have been extracted and a small amount of melt was trapped by garnet. The rare occurrence of grandidierite only in felsite-nanogranite inclusions is explained by this model.

References

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Takahashi, K. and T. Tsunogae, Carbonic fluid inclusions in a garnet–pyroxene granulite from Austhovde in the Lützow–Holm Complex, East Antarctica: Implications for a decompressional P–T path. Journal of Mineralogical and Petrological Sciences, **112**, 132–137, 2017.