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Melting, fluid migration and fluid-rock interactions in mafic garnet granulite xenoliths from the Bakony-Balaton Highland Volcanic Field (Hungary)

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We studied fluid-rock interactions in alkaline basalt hosted mafic lower-crustal garnet granulite xenoliths from the Bakony-Balaton Highland Volcanic Field, W-Hungary. For this, petrographic, microthermometric, electron microprobe, Raman and IR spectroscopic study have been performed on silicate melt ± fluid inclusions to constrain the composition and origin of the migrating melts and fluids and to assess their interaction with the granulitic lower crust.

The studied xenoliths have granoblastic texture and the main rock forming minerals are plagioclase, clinopyroxene, garnet ± orthopyroxene. The most common accessories are sphene and ilmenite. Some xenoliths contain hydrous minerals like amphibole and rarely biotite. This is the oldest mineral assemblage which could be detected. Texturally younger minerals occur in the some samples originating from such reactions as melting and subsequent crystallisation due to fluid-rock interaction.

Two generations of silicate melt inclusions (SMI) were observed in the xenoliths. There are primary silicate melt inclusions in the primary granulite facies rock forming minerals such as plagioclase, clinopyroxene and sphene. Furthermore, some minerals, formed later on during fluid-rock interactions (e.g., ilmenite, clinopyroxene, orthopyroxene, newly formed amphibole, plagioclase), also trapped SMI during their growth.

The SMI contain glass phase ± bubble. Microthermometric measurement was conducted on bubbles of the SMI. Melting temperatures of the bubble content ranged from -56.6 to -57.6 °C. It suggests that the bubbles contain CO_2-dominated fluid. The homogenization temperatures (+29.9 °C) show low-density liquid in the bubbles in the clinopyroxene hosted SMI. Raman spectroscopy shows other gas and liquid components associated with the CO_2 (81-100 mol%), such as CO (up to 26 mol%), N2 (up to 7 mol%), H2S and CH4 (under 1 mol%) and H_2O (up to 12 mol%). Raman spectroscope was also used on those inclusions where microthermometry was not possible due to the small size or dark appearance of the bubble.

We measured the composition of glass phase in SMI by electron microprobe and compared them with experimental data in geochemical characters. The composition of the glass of SMI trapped in clinopyroxene and plagioclase show similarities to the rhyolitic-dacitic glass derived by melting of biotite-quartz-plagioclase mineral assemblage (Patiño-Douce & Beard, 1995) or of metagraywacke (Montel & Vielzeuf, 1994, 1997) but also might have derived by melting of mafic granulites (Springer & Seck, 1997). The composition of the glass phase of SMI trapped in ilmenite is close to composition of a glass phase which derived by melting of alkaline basalt in presence of additional CO_2-H_2O fluid (Kaszuba & Wendlandt, 2000). The glass phase of granulitic sphene hosted SMI has the same compositions as the ilmenite hosted ones. The glass of SMI trapped in later sphene has dacitic to rhyolitic composition similarly to those derived by melting of quartz-amphibolite (Patiño-Douce & Beard, 1995) or mafic granulite.

These results suggest that the SMI originated from partial melting of different lower crustal rocks of mafic and metasedimentary origin with an occasionally presence of C-O-H-N fluids.

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