Paleoarchean felsic magmatism: A melt inclusion study of 3.45 Ga volcanic rocks from the Barberton Greenstone Belt

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Archean felsic magmatism spatially and temporally associated with the Barberton Greenstone Belt (BGB) of Southern Africa can be broadly subdivided in an early (≥3.2 Ga), Na-rich series that formed the tonalite-trondhjemite-granodiorite (TTG) series, and a generally later (~3.1 Ga), K-rich series akin to modern granites [1].

Felsic volcanic rocks in the BGB are less abundant than their intrusive counterparts, and are mostly strongly deformed. The 3.45 Ga old Buck Ridge Volcanic Complex (BRVC; [2]) contains the least deformed felsic volcanic rocks in the BGB. However, widespread alteration (silicification, K-metasomatism) of these rocks involved strong mobilisation of major and some trace elements [3].

Quartz-hosted melt inclusions have been used to obtain infomation on the unaltered melt composition. Whole-rock compositions of the least altered samples bear strong resemblance with coeval TTG intrusions, and can be modeled as a mixture of modal phenocrysts (Na-plagioclase, quartz, Fe-Ti oxide, apatite) and melt as indicated by melt inclusion analyses, thus suggesting a cogenetic relationship between the BRVC and TTG intrusions. This is also confirmed by whole-rock concentrations of fluid-immobile trace elements. Further, melt inclusions have moderate Cl contents (≤0.7 wt.%), low F and low S (≤0.12 and <0.02 wt.%, respectively). The moderate Cl and low F/Cl suggest a sea water contribution to the melting protolith [4]. These characteristics are interpreted as due to melting of source rocks that have undergone sea floor metamorphism, although in an Archean context this does not have immediate tectonic implications.

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Magmatic and hydrothermal history of felsic rocks within oceanic core complex (MAR, 13º31'-13º35' N)

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Felsic plutonics and dykes – oceanic plagiogranites (OPG) – spatially associate with inactive hydrothermal fields and are regarded as the products of gabbro/dolerite hydrous melting within the oceanic core complex at 13º31'-13º35' N, Mid-Atlantic Ridge. We used cathodoluminescence (CL) and SIMS analytics to reveal mineralogical and geochemical features, and distinguish main stages of the OPG formation.

The OPG lithology includes: metadolerite - amphibolite veined by hornblende plagiogranite; coarse-grained gabbro with biotite-bearing plagiogranite veins; massive hornblende and amphibole-free OPG. The CL image (Fig. 1) demonstrates relationships between mineral assemblages, corresponding to three successive stages: mafic igneous (Pl_1, Cpx_1), felsitic igneous (Qtz, Bt, Pl_2, Cpx_2, Zrn) and hydrothermal (Qtz, Pl_3, Chl ± Cpx_3).

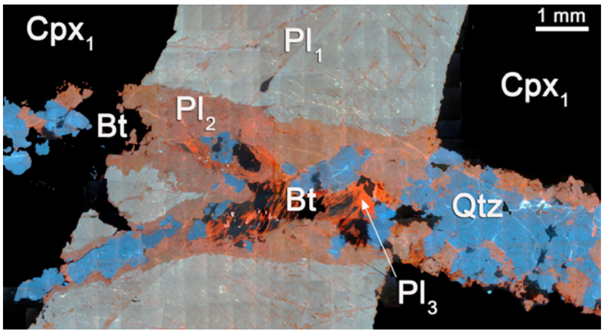

Figure 1: The OPG- vein in gabbro (CL image).

The trace-element data allow distinguishing: (1) mafic (gabbroic) fractionation; (2) felsic (OPG) fractionation; and (3) hydrothermal processing. Pl_1 (An65-60) and Cpx_1 show core-to-rim REE enrichment being appreciably depleted as compared to Pl_2 and Cpx_2 respectively. Felsic stage associates with subsequent REE enrichment of Pl_2 (An47-27) and Cpx_2. The hydrothermal stage exhibits Pl_3 (An17-5) and Cpx_3 that are significantly depleted in REE.

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