The coarse-grained, high-Mg basaltic enclaves of Capo Marargiu (Sardinia, Italy): constrains on the differentiation of arc magmas

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We present results from a textural and geochemical study conducted on calc-alkaline volcanic and hypoabyssal rocks from the Oligo-Miocene Capo Marargiu Volcanic District (CMVD; Sardinia, Italy).

Stratigraphic units of CMVD consist of lava domes, a pyroclastic breccia interbedded with lava flows, and dikes. The pyroclastic breccia is in lateral contact with a low crystallinity (~15 vol.% phenocrysts), massive hypoabyssal body hosting decimetre-sized, coarse-grained enclaves with porphyritic textures (~50 vol.% phenocrysts).

The crystal-rich enclaves and the host rock exhibit phase assemblages of clinopyroxene + plagioclase + amphibole + olivine + magnetite + low-Ca pyroxene, and plagioclase + clinopyroxene + magnetite + low-Ca pyroxene, respectively. The bulk-rocks of crystal-rich enclaves are high-Mg basalts (i.e., 10 wt.% MgO), whereas the host rock is a more differentiated basaltic andesite (i.e., 5 wt.% MgO). Major oxides and compatible trace element modelling suggest that the basaltic andesitic magma originates by crystal fractionation of olivine + clinopyroxene from the high-Mg basalt. In turn, compatible trace elements of the high-Mg basalt are lower (330 ppm Cr, 130 ppm Ni) that those of a picritic arc magma, suggesting crystal fractionation of olivine ± Cr-spinel from a primary magma at depth.

Thermobarometric calculations reveal that the crystal-rich enclaves underwent a decompression path started at high crustal depths (~500 MPa) and concluded at hypoabyssal conditions (<200 MPa) in a temperature range of 1200-950 °C. In this view, the high-Mg basalt and the basaltic andesite represent two different regions of a chemically zoned magma chamber formed by crystal fractionation of a primary magma ponding at ~500 MPa. Subsequently, buoyancy forces associated with density gradients caused upward migration of the basaltic andesite carrying portions of the adjacent high-Mg basalt to shallower crustal levels.