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Major element geochemistry of cumulates from the Bjerkreim-Sokndal layered intrusion (Norway)

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Whole-rock major element compositions of 98 cumulates from the Proterozoic Bjerkreim-Sokndal layered intrusion (Rogaland Anorthosite Province, SW Norway) are investigated in order to bring new constraints on crystallisation processes of cumulates, to calculate cotectic assemblages and better to define the liquid line of descent of the jotunite parental magma in the magma chamber. The scattering of cumulate composition covers three types of cumulates: ilmenite-leuconorite with plagioclase, ilmenite and Ca-poor pyroxene as cumulus minerals, magnetite-leuconorite cumulate with the same minerals plus magnetite, and gabbronorite made up of plagioclase, Ca-poor and Ca-rich pyroxenes, ilmenite, Ti-magnetite and apatite. Each type of cumulate displays a linear trend in variation diagrams. The first pole of the linear trends is represented by plagioclase, and the second, by a mixture in constant proportion of the mafic minerals. This suggests that crystal settling was not operating during the cumulate formation, and that in situ crystallisation with variable nucleation rate of plagioclase is the dominant formation mechanism. The trapped liquid fraction of the cumulate plays a negligible role in the major element cumulate composition. Each linear trend is a locus for the cotectic composition of both types of cumulates.

This property permits to reconstruct by graphical mass balance calculation the first two stages of the liquid line of descent, starting from the Tjörn jotunitic parental magma. A third type of cumulate, called jotunite cumulate and defined by the mineral association from the transition zone of the intrusion, has to be subtracted to simulate the most evolved part of the liquid line of descent.

The proposed model does not account for the K_2O evolution, suggesting that the system was open to contamination by roof melts. The liquid line of descent corresponding to the Bjerkreim-Sokndal cumulates slightly differs from that obtained with jotunitic dykes in that the most Ti-, P- and Fe-rich melts (evolved jotunite) are lacking. The model fails to explain the anorthosite of the first megacyclic unit of the intrusion, which needs further investigation. The constant composition of the mafic poles during interval of crystallisation in which cryptic layering is conspicuous is explained by a compositional balance of the Fe-Ti oxide minerals and the ferromagnesian minerals evolution.

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Magma chamber processes recorded in gabbro xenoliths from Midfell (SW Iceland)

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Introduction

The Iceland hotspot is a region where crust-magma interaction is widespread. A very common process affecting magma composition is assimilation of crustal rocks triggered by melt migration [1]. Partially melted and well quenched gabbro xenoliths in tholeiitic pillow lavas from Midfell [2] were studied by EPMA and SIMS in order to asses crustal melting quantitatively. Dynamic of magma chamber processes inferred from element distribution in clinopyroxene and plagioclase composing gabbro nodules, as well as the processes of gabbro xenoliths partial melting based on trace elements abundances in coexisting glass and crystals are discussed.

Experimental Details

Samples were analyzed using the Jeol JXA 8200 and Cameca ims 3f instruments, both located at MPI for Chemistry in Mainz (Germany).

Results and discussion

The xenoliths are cumulates of earlier crystallized magmas. They consist of reversely zoned, slightly resorbed, subhedral plagioclase (Pl; An_{81-90}, 50–60%) and unhedral, strongly resorbed clinopyroxene (Cpx; mg# = 83–90, 25–32%), interstitial glass (9–22%); trace amounts (<5%) of small (up to 500 μm) euhedral olivine (Ol, Fo_{85-89}) and spinel (Sp, mg# = 66–73, cr# = 29–51) crystals are also observed. Complex preeruptive history of gabbro xenoliths follows, while considering the character of mineral zoning, major and trace element concentrations in surrounding host matrix glass, different types of glasses inside gabbro xenoliths, as well as the results of xenoliths partial melting modeling. Essential is that the melt resulted from 15-25% of partial melting of gabbro nodules ([La/Sm]n = 0.5–0.7, [Sr/Ce]n = 1.4–2.6) and calculated in an attempt to reproduce the composition of interstitial glass and glass embayments in Cpx ([La/Sm]n = 0.4–0.7, [Sr/Ce]n = 2.2–3.5) does not match that with respect to [Ba/Nb]n ratios (2.5–3.8 and 0.6–1.0, respectively). We conclude therefore that the geochemical signature of gabbro partial melts, if present at all, appeared to be strongly attenuated by continuously percolating tholeiitic magmas erupted within the rift zone of Iceland.

References

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