In situ crystallisation processes in the Miocene PX1 pyroxenite intrusion (Fuerteventura)

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The PX1 gabbro-pyroxenite intrusion of Fuerteventura (Canary Islands) displays a remarkable NNE-SSW trending vertical magmatic layering. This layering is strongly dependant on the regional tectonic regime and is expressed by alternating horizons of gabbros and pyroxenites, generated by successive magma injections into a progressively widening dyke system. Multi-scaled compositional variations span from olivine-rich pyroxenite, pure clinopyroxenite and plagioclase bearing pyroxenite to non-cumulative gabbro.

Whole-rock incompatible trace-element contents show large variations and poorly correlate with monotonous major element compositions, these features are typical of *in situ* crystallisation (Langmuir 1989) with variable amounts of interstitial liquid (L). La-ICPMS analyses of minerals and quantitative modelling based on Langmuir's equation using REE concentrations in mineral phases show that these underwent re-equilibration with interstitial melts (Hermann *et al*. 2001).

Calculated REE patterns of mineral phases in samples are adjusted to fit the measured REE plots by playing with the degree of differentiation (F) and the proportion of interstitial liquid (L). L has a stronger influence than F on LREE for low Dmin/melt minerals such as Cpx, high L values (20 to 30%) correspond to high modal proportions of amphibole.

Dcpx were estimated using a predictive model (Wood & Blundy, 1997) on a sample selected for low whole-rock Zr, Nb and ΣREE (24,33 ppm), and displaying a Eu/Eu* close to unity (0,96). The bulk rock partition coefficients have been estimated using modal contents of an olivine-gabbro sample.

The calculated amounts of L are 15 to 30% for plagio-pyroxenites and gabbros and correlate well with the proportion of interstitial amphibole in studied samples. The calculated amounts of fractionation (F) relative to a primary magma varies from 5 to 20%, which confirms periodicity in the replenishment of the underlying magma chamber.

The initial magma composition (Lo) has been be estimated by taking into account the fractionation of olivine and orthopyroxene (rare and resorbed crystals); it fits well with the alcaline ocean island magmatism documented in the Canary Islands.

References

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The effect of minor H_2O content on crystallization in MORB: Experiments, model, applications

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The role of H_2O on mineral cotectics and petrochemical trends in MORB systems has been thoroughly discussed in the literature (*e.g.* [1]). However, the quantitative knowledge on the effects of small amounts of H_2O on the liquidus of olivine (Ol), plagioclase (Plag) and clinopyroxene (Cpx) is still limited by the lack of experimental data with well-constrained values of water activity. This, probably, results in considerable inconsistency between the available models [1-3] predicting the mineral liquidus depression as a function of the water dissolved in the melt.

To address the problem we conducted a set of crystallization experiments at 200 and 500 MPa. All experiments have been performed in an internally heated pressure vessel at intrinsic oxygen conditions using pure argon as a pressure medium. Three starting basaltic compositions have been chosen so that Ol, Plag or Cpx are crystallizing as a liquidus phase. The H_2O concentrations in the glasses were obtained by infrared spectroscopy and Karl-Fischer-Titration. As a result of the study we parameterized our experimental data in the form of simple equations describing the liquidus of Ol, Plag and Cpx as a function of dissolved H_2O content. Finally, these simple equations have been incorporated into the algorithm of the COMAGMAT program [3].

Application of the refined COMAGMAT model is presented for basaltic lavas from the Mid-Atlantic Ridge (MAR) east of Ascension Island (7-11°S). To determine crystallization conditions of the given MORB suite two sets of equilibrium and fractional crystallization calculations have been performed. The results indicate that MORB-magmas beneath different segments of the MAR have crystallized over a wide range of pressures (100 to 900 MPa). Nearly isobaric crystallization conditions (100-300 MPa) were obtained for the geochemically enriched MORB, whereas N-MORB magmas are characterized by polybaric crystallization conditions (200-900 MPa). Our results demonstrate close to anhydrous crystallization conditions of N-MORBs, whereas geochemically enriched MORBs were successfully modeled in the presence of 0.4 to 1 wt % H_2O in parental melts. Our results are in agreement within ±200 MPa with previous approaches used to evaluate pressure estimates in MORB. In addition, our data illustrate that the effect of H_2O on pressure estimates is within this uncertainty.

Reference

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