Geophysical Research Abstracts, Vol. 7, 09910, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09910

Depths of partial crystallization and H2O contents of MORB inferred from glass composition: phase equilibria simulations of basalts at the Mid-Atlantic Ridge near Ascension island (6˚-10˚S)

R. Almeev (1), F. Holtz (1), J. Koepke (1) and K. Haase (2)

(1) Institut fuer Mineralogy, Universitaet Hannover, Germany, (2) Institut fuer Geowissenschaften, Universitaet Kiel, Germany (r.almeev@mineralogie.uni-hannover.de / Fax: +49 511 762-3045)

A pronounced dependence of clinopyroxene saturation temperature on pressure (dT/dP) results in earlier development of trend of decreasing CaO and CaO/Al2O3 with decreasing MgO in the melts, evolving along the Ol+Plag+Aug cotectics at higher pressures. A series of semi-empirical methods have been developed utilizing this observation to estimate partial crystallization pressures for MORB-like magmas (e.g. Weaver and Langmuir, 1990; Grove, 1992; Danyushevsky, 1996; Yang et al., 1996, Herzberg, 2004). Application of these models to the lavas erupted along MAR (6˚-10˚S) leads to (1) consistent estimates of crystallization pressure for “mildly” evolved basalts (5-8 wt.% MgO), which vary from 3 to 7 kbar in segments A1, A2 and A4 , and (2) some deviations between models and inconsistencies for the more evolved lavas (4-6wt.% MgO) of segment A3. In particular, negative pressures are predicted for the crystallization of such compositions, mostly due to high $\pm$ 2kbar calculation error.

A set of fractional crystallization (FC) calculations have been carried out utilizing the COMAGMAT phase equilibria model (Ariskin, 1999) to constrain the crystallization pressures and to evaluate the effect of small amounts of water dissolved in the melts. The most magnesian samples of each segment (A1 to A4) were used as a starting composition. For all four compositions we conducted a subsets of FC-simulations in the pressure interval of 1 atm – 8 kbar (with steps of 0.1 kbar), along three oxygen buffers (QFM, QFM-1 and QFM-2) and with different amounts of initial H2O contents (from

dry to 0.2, 0.5, 0.7 and 1 H_2O wt.%). The results were systematically compared to the natural MORB glasses to constrain the conditions prevailing during fractionation. The modeled melt compositions were considered to be successful only if they were identical (within analytical precision of EPMA) to the given natural MORB glass. The advantage of our approach is that fractionation history, hidden in major element chemistry of a magmatic suite, can be traced. For example, polybaric fractionation paths may be simulated.

Our calculations are in a good agreement with the above mentioned models for the less evolved MORBs, being crystallizing at elevated pressures (segments A1, A2 and A4). The results obtained for the evolved MORBs from segment A3 demonstrate a profound effect of small amounts of H_2O and liquid lines of descent can reproduce natural compositions only in the presence of water (0.8-1.2 wt.%) and at pressures below 2 kbar. We were not able to reproduce natural MORB glasses of segment A5 in dry conditions.

The discrepancies between the models and the difficulty to reproduce the effect of water on liquid lines of descent of MORBs arise from the poor experimental datasets at strongly water-undersaturated conditions (less than 1wt%H_2O). In addition, the results of most “nominally dry” high pressure experiments are included in the calibration databases as representative for “dry” conditions, although they are not devoid of water. Thus, rigorous experimental studies on the effect of small amounts of water on liquidus temperatures are needed. Our preliminary experimental results on MORB composition with known melt water contents in the range 0.2 to 1.5 wt% H_2O (2 kbar) are presented and highlight the crucial effect of small amounts of water on the crystallization of olivine and plagioclase at the liquidus.