

Petrogenesis of plagioclase phyric basalt from the Arctic ridges

B. HELLEVANG AND R.B. PEDERSEN

Geol. Inst., UiB, Allegaten 41, 5007 BERGEN,
bjarte.hellevang@geol.uib.no

Introduction

Neovolcanic, en échelon ridges and marginal highs of the ultraslow and oblique spreading Mohns and Knipovich ridges were sampled during the SUBMAR-2000 cruise. Samples comprise aphyric, sparsely phyric and highly plagioclase phyric basalts. Glass of 54 samples were analysed for major elements, and selected samples for trace elements and Sr- and Nd-isotopes. Plagioclase, olivine and clinopyroxene phenocrysts have been analysed for major elements.

Description of phenocrysts

The highly plagioclasephyric basalts (PUBs) show up to 65 % plagioclase phenocrysts ranging in size up to 40 mm. Primitive olivine and augite ($86 < \text{Mg\#} < 90.5$) occur as minor phenocryst phases. The PUBs show different plagioclase morphologies including skeletal, tabular, glomero and acicular crystals, and they comprise both highly resorbed and euhedral crystals. The presence of melt inclusions in distinct zones, and skeletal crystals that show more sodic compositions than tabular crystals, indicate rapid crystallisation due to strong undercooling. The anorthite content range from $\text{An}_{90.5}$ to $\text{An}_{77.5}$ and normal, reverse and more complex zoning patterns are observed. Growth relationships between phenocrysts indicate that the crystallisation order was plagioclase and olivine followed by augite.

Glass composition

Glass compositions vary between Mg# 66 and 53 with 75 % between 66 and 60. PUBs show a general depletion in incompatible elements relative to aphyric rocks. Isotope compositions of PUBs and aphyric rocks show no apparent differences for the Mohns Ridge rocks, although Knipovich PUBs show higher $^{143}\text{Nd}/^{144}\text{Nd}$ and lower $^{87}\text{Sr}/^{86}\text{Sr}$ ratios than aphyric rocks.

Conclusions

Morphologies and compositions of plagioclase phenocrysts in the PUBs suggest that these crystals formed in periodically replenished magma reservoirs where the magma became strongly under-cooled. These PUBs demonstrate the presence of relatively long-lived magma reservoirs at ultra-slow spreading ridges. The evidence for rapid crystal growth suggests that repeated magma replenishment was critical to avoid fast freeze-up of the reservoirs. The PUBs seem to have formed by higher degree of melting than the aphyric basalts. This may suggest that the PUBs formed where the melt volumes were just sufficient to sustain more long-lived magma reservoirs.

Solution-reprecipitation responsible for altered near-surface zones during feldspar dissolution: Do leached layers really exist?

R. HELLMANN¹, J.-M. PENISSON², R. HERVIG³,
J H. THOMASSIN⁴, M.-F. ABRIOUX⁴

¹LGIT, University of Grenoble, France (hellmann@obs.ujf-grenoble.fr)

²DRFMC, CEA Grenoble, France (jpenisson@cea.fr)

³Dept. Solid State Science, ASU, Tempe, USA
(hervig@asu.edu)

⁴LMGE-ESIP, Univ. de Poitiers, France
(thomassin@esip.univ-poitiers.fr)

In this experimental study labradorite feldspar was dissolved at pH 1 in a flow through reactor at 22°C for 500 h. Based on TEM images of an ultramicrotome-prepared thin-section, the thickness of the altered layer is variable, ranging from 500 to 1500 nm. The altered/non-altered interface is locally linear and extremely sharp (0.5-4 nm), based on HRTEM images of the interfacial region.

The interfacial region between the altered zone and non-altered labradorite was also examined by energy filtered TEM (EFTEM). This method provides a 2-D chemical map of a chosen area with nm-spatial resolution. The concentrations of Ca and Al are severely depleted in the altered zone; O and Si are enriched in the altered zone. Most importantly, the interfacial region is characterized by step-like concentration changes in these 4 elements that correspond perfectly with the structural interface that marks the interface between the amorphous, altered layer and the crystalline, non-altered matrix.

Based on the extreme sharpness and spatial correspondence of the observed structural and chemical interfaces, the formation of near-surface altered zones in feldspars is not compatible with a diffusion-controlled process associated with leached layer formation, but rather with a solution-reprecipitation process. We suggest that the intrinsic dissolution process (i.e., release of elements) is stoichiometric process (i.e., release of elements) is stoichiometric process at all pH conditions, thus calling into question prevailing dissolution models for alumino-silicate minerals.