Geophysical Research Abstracts
Vol. 16, EGU2014-10158-2, 2014
EGU General Assembly 2014

Melt segregation in the Muroto Gabbroic Intrusion, Cape Muroto - Japan

David Floess (1), Luca Caricchi (1), and Simon Wallis (2)
(1) University of Geneva, Switzerland (david.floess@unige.ch), (2) Nagoya University, Japan

Melt segregation is a crucial process in igneous petrology and is commonly used to explain characteristic geochemical trends of magmatic rocks (e.g. Brophy 1991), as well as the accumulation of large amounts of eruptible magma (e.g. Bachmann & Bergantz, 2008). In order to gain further insight into the physical processes behind melt segregation we investigated a small-scale, natural setting. The Miocene Muroto Gabbroic Intrusion (MGI) is a 230m thick, layered sill located at Cape Muroto (Shikoku Island – Japan; Yoshizawa, 1953). It was rotated into a near-vertical ($\sim$70°) orientation after horizontal emplacement, allowing for easy sampling of the entire sill from bottom to top. We collected $\sim$70 oriented samples for petrographic and geochemical analysis, as well as for structural analysis using Anisotropy of Magnetic Susceptibility (AMS).

A well-defined horizon (zone I) between 50 and 125m from the bottom shows spectacular evidence for the segregation of felsic melts from the mafic mush (Hoshide et al. 2006). Individual, cm- to m-sized, anorthositic melt lenses mainly consist of plagioclase laths with minor cpx. Small diapirs emanate from the melt lenses and clearly indicate the paleo-upward direction of the sill. Zone I is overlaid by a coarse-grained gabbro (zone II) with cm-sized crystals of plag+cpx and no anorthositic segregations can be found. The MGI grades into fine-grained dolerite towards the top and bottom margins of the sill.

We modeled the phase relations of a representative MGI gabbro composition (chilled margin) upon cooling using MELTS (Gualda et al. 2012). Extracted physical parameters (i.e. melt and solid densities, melt viscosity) were used as a proxy for melt mobility (Sakamaki et al. 2013). The temporal and spatial evolution of melt mobility within the sill was investigated using the temperature-time curve obtained through a thermal model for the MGI. We observed several peaks for the melt mobility, implying zones of melt drainage (when mobility increases) and pondage (when mobility decreases). This is especially pronounced at a characteristic distance from the bottom, corresponding to zone I of the MGI. The structural analysis of zone I using AMS yields results in agreement with the above-mentioned process. The AMS ellipsoid is predominantly prolate at the bottom and changes to predominantly oblate towards the top of zone I. Further, the major axis of the ellipsoid (lineation) initially strongly varies at the bottom and steadily converges to a subhorizontal orientation towards the top of zone I. There, the minimum axis (pole to the foliation) becomes subvertical.

These findings suggest that the spatial and temporal evolution of intrinsic parameters of the magma, i.e. the liquid and solid densities and melt viscosity, control the melt segregation observed in the MGI.

Bachmann & Bergantz, 2008, Elements, v. 4, 17-21.
Brophy, 1991, CMP, v. 109, p. 173–182.
Gualda et al., 2012, J.Pet, v. 53, p. 875-890.
Hoshide et al., 2006, J.Min.Pet.Sci., v. 101, p. 223-239.
Sakamaki et al., 2013, Nat.Geo., v. 6, 1041-1044.
Yoshizawa, 1953, Mem.Col.Sci.Univ.Kyoto, v. 20, p. 271–284.