Quantitative elemental mapping of pyroxenes and plagioclase by line scanning femtosecond LA-ICPMS

Q. CHANG[1] AND J.-I. KIMURA[1]

[1]Dept. Solid Earth Gochemistry, JAMSTEC, Yokosuka, Japan (*correspondence: qchang@jamstec.go.jp)

Compositional images of silicate minerals in a volcanic rock provide valuable information on the genesis of magma. By taking advantages of the high sensitivity and reduced matrix effect provided by the femtosecond laser ablation system connected to a sector-field ICPMS (fsLA-SF-ICPMS), we present rapid and quantitative multi-elemental mapping analyses of pyroxenes and plagioclase studied previously for igneous rock geochemistry[1,2]. Quantification of elements in the crystals and their adjacent ground mass was achieved via external calibration against basalt reference material BHVO-2G, together with correction of ablation efficiency by normalizing the sum of measured major elements composition to 100%. This approach dose not require prior determination of internal standard element by another method (e.g., electron micropobe), and is applicable to all anhydrous silicate minerals ubiquitous in volcanic rocks [3]. 2D maps of elemental abundance and ratios of interest were constructed from equally spaced line scans on the samples. The lateral resolution was estimated to be ~40 μm with a laser beam diameter of 16 μm, scanning velocity of 2 μm/s for the fsLA system and fast scan data acquisition mode for the SF-ICPMS. Quantitative imaging of 43 elements including trace, minor and major elements for an area 500 × 500 μm can be acquired in 3 hours. Both laboratory bias and repeatability of the line scan analysis were estimated by mapping the BCR-2G basalt glass standard and found to be better than 5% for most of the elements except for Er, Lu, and Ta which were 9–10%. Limits of detection were sub-ppm for the trace and minor elements, and sub-percent level for the major elements. The method was used to generate quantitative multi-element maps of a plagioclase crystal within a dacite lava from Daisen volcano, SW Japan, and revealed significant zoning. The anorthite composition (Ca/(Ca+Na) molar ratios) of the plagioclase co-varied with Sr and rare earth element compositions. The results show that both compositional and temperature variations occurred in the host melt during crystallization of the plagioclase. Thus quantitative multi-element mapping of phenocryst phases has the potential to be a useful tool in studies of magma genesis.

[1] Kimura et al., 2005, *The Island Arc*. [2] Takahashi et al., 2013, *J. Petrol*. [3] Kimura & Chang 2012, *J. Anal. At. Spectrom*.