LA-ICP-MS Imaging of Heterogeneous Volcanic Glass: Method and Applications

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Trace element compositions of volcanic glass shards are widely use for tephrostratigraphic and volcanic studies. However, traditional LA-ICP-MS spot analyses can be complicated by the presence of microscale heterogeneities, including microlites, inclusions, and compositonal banding. For example, the accidental ablation of unidentified, subsurface microlites results in inaccurate glass compositons. We present a method in which these heterogeneities can be identified and used to better correlate volcanic units and understand magmatic processes.

Firstly, BSE and EDS images of glass shards in polished epoxy mounts are collected and used to identify hetrogeneities and guide point placement for EPMA analyses. Then, trace element data are collected by rastering the sample stage at 5 μm/second under a 10 μm laser spot with 10 Hz repition rate and 4.5 J/cm^2 fluence, resulting in a ~1 μm deep ablation area. Finally, the raw data are processed into quantitative maps using the built-in fuctions of the Iolite software package [1,2,3], and trace element compositions from regions of interest are extracted using the Monocle plug-in for Iolite [4].

Trace element concentrations of homogenous reference glasses measured using this mapping technique have similar or better precision (≤5% RSD) and accuracy (±10% of accepted values) than measurements made by spot analyses for most elements. Unidentified, subsurface heterogeneities are avoided due the shallow depth of ablation, and the mapped heterogeneities can either be integrated into or excluded from the calculated glass compositons. Furthermore, the trace element compositions of microlites and inclusions can be quantified, providing additional information from a single glass particle. This technique provides an improved way to quantify the trace element concentrations of volcanic glass shards and visualize and exploit the heterogeneities of tephra particles.

[1] Paton et al. (2011), *JAAS* 26, 2508-2418. [2] Paul et al. (2012), *JAAS* 27, 700-706. [3] Paul et al. (2014), *GGR* 38, 253-263. [4] Petrus et al. (2017), *Chem Geol* 463, 76-93.