CERAMAH TEKNIK **TECHNICAL TALK**

Trace element analysis by laser ablation ICP-MS and its application to tephrochronology

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Abstract — Tephra deposits are widely used in correlation and provenance studies, which often rely on accurate chemical analyses of material from the deposit. Many large magnitude eruptions are broadly rhyolitic, and major element analyses of glass shards by EPMA may not identify these unequivocally. Trace element analyses of the juvenile glass component can help to distinguish or correlate individual deposits, although preparation of sufficient material for bulk analysis from distal deposits may be difficult. ICP-MS, a highly sensitive trace element analytical technique which requires only small amounts of sample, offers possibilities for the analysis of distal tephra deposits by either solution digestion methods (around 25mg of sample) or by laser ablation analysis of individual (around 40 microns) grains of material.

Solution ICP-MS analysis of glass separates weighing as little as 0.025g, and digested in $HF/HClO_4$ are accurate (typically better than +/-5%) with precisions (1 s.d.) of about +/- 3% for most trace elements, although this deteriorates to about +/-20% for rare elements in small samples (e.g. HREE in a 25 mg sample). Some examples of solution ICP-MS analyses of glass will be presented to illustrate both the application and some of the problems of bulk analysis.

Laser ablation (LA) ICP-MS has been used to determine the trace element composition of very small volumes of bulk glass, and also of individual glass shards from tephra deposits. Here a powerful UV laser vapourises the sample, and use of an internal standard (usually 29Si) accounts for variations in the volume of ablated material and calibrates the analyses. For single shard analyses, the EPMA mount is used and the same grains are analysed for their trace element content. Despite spatial resolutions around 5µm, at present reliable trace element data can be produced from shards about 40 microns across, with 30 elements determined in a 45 s analysis. Laser ablation methods are less accurate (around +/-5-10%) than solution ICP-MS analyses, and precision decreases from around +/- 3% at a few hundred ppm (e.g. Zr, Rb, Sr) to about +/-10% at 1 ppm, and about +/-30% at 0.05 ppm (e.g. HREE). Detection limits vary with tuning and operating conditions, but are typically around 0.5-0.05 ppm. Recent improvements in both ICP-MS and laser instrumentation enable smaller shards to be analysed, and the potential for this will be discussed. Whilst unlikely ever to challenge ion probes for spatial resolution, material from cryptotephras and ice cores is coming into the size range possible for analysis using newer ICP-MS and laser instrumentation, although issues such as the quality of the mounting resin become very important. A series of examples of the application of both LA-ICP-MS data to tephra studies from North America, Santorini and New Zealand will be presented to illustrate the potential of this powerful analytical technique.

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