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A laser ablation ICP-SFMS study of glassy juvenile fraction of ash of the 1995 summit activity of Mt. Etna

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Petrological monitoring of volcanic activity based on major/trace elements and isotope ratios is generally carried out using the bulk rock composition of lava samples. However, during eruptions the availability of fresh material, suitable for routine petrological analyses, is often limited to ejecta produced during mild explosive activity. When ash emission is the only volcanic activity, no compositional information is available. To overcome this limitation we applied in-situ microanalytical methods to characterise the juvenile glass fraction of ash.

The case studied is the 1995 summit activity of Mt. Etna. This was firstly dominated by ash emission (May-Oct) and only later (Oct-Dec) by lava flows output. Selected samples of juvenile ash fraction of have been characterised for the major and trace element signature using electron microprobe (EMP) and laser ablation (LA)-ICP-MS.

In-situ LA ICP-MS analyses revealed that mean absolute concentrations of the incompatible trace elements (REE, HFSE, Actinides, LILE, LLE) are almost constant between May and October; after this date they significantly decrease, coupled with a concomitant increase in Sr concentration, a geochemical feature that is consistent with the arrival of a new, less differentiated and gas-rich magma batch in the shallow plumbing system. Conversely, the regular decrease in time of some geochemically relevant ratios (e.g. Nb/Rb, Zr/Nb and Nb/B) indicates that more complex processes

(e.g. selective contamination) are superimposed to crystal fractionation and refilling of feeder conduit. Inferences based on trace elements composition are confirmed by preliminary in-situ measurements of δ^{11}B of ash by LA-multicollector (MC)-ICP-MS (Tiepolo et al., 2004, this meeting, VPG20 session).

Noticeably, the large variability in trace element concentrations observed within all ash samples is well above the analytical uncertainty. Probability density plots have been drawn for different trace elements on each ash sample to explain the origin of this compositional variability. They show that the ashes erupted between May and October are characterized, with the exception of boron, by the presence of at least two statistically distinguishable peaks representative of two compositionally different components. For most of trace elements, the peak at low concentration approaches the bulk-rock composition of products erupted after October from the same crater. Starting from October only one peak is evident and ash emission on 12 October represents the most enriched term. After this date the concentrations decrease towards the bulk rock composition of subsequently erupted volcanics (winter 1995/96). This suggests that ash compositions are representative of distinct magma portions which underwent different crystallization degrees, probably due to a different thermal history or degassing efficiency of magma standing in the conduit. The observed trace element composition and variability can be associated with the progressive arrival in the shallow plumbing system of a fresh, more primitive, hotter and gas-rich magma batch. In-situ chemical information thus reveals suitable for both tracking magma dynamics and processes and forecasting paroxysmal events.