Magmatic gas scavenging through ashes: Mt. Etna July-August 2001 eruption

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The July-August 2001 lateral eruption of Etna has been characterised by strong explosive activity produced by a vent located in the S flank at 2550 m a.s.l.. This explosive activity has showed three phases: a phreatomagmatic opening phase (20-24 July), a magmatic phase (25-30 July) and a final phreatomagmatic phase (31 July-5 August). In both the first and final phases, tephra fallout were produced from impulsive ash jets superimposed on a continuos ash emission that formed a stable eruptive column up to 2 km high. It produced a widespread lapilli and ash fallout on the E-SE flank that caused many civil defence and health problems.

25 ash samples not exposed to rain were collected at the end of the first phase. Grain size analyses of tephra collected along the dispersal axes have been performed at one-phi interval. An aliquot of 1 g of each granulometric class was reacted with 25 ml of αQ grade Millipore water for 4 hours with constant agitation. Subsequently water was filtered and analysed for major and minor element contents by IC and ICP-OES techniques.

F, Cl and SO_4 display values in the range 15 - 476, 47 - 1280 and 96 - 6320 µg/g respectively. Quantities of these elements increase with decreasing granulometry, the finest portions (Φ=5) showing values over an order of magnitude higher than the coarser ones (Φ=-2). Total F, Cl and SO_4 deposition is in the range 0.024 – 0.917, 0.038 – 2.51 and 0.19 – 6.44 g/m^2 with the highest values measured in proximal sampling sites.

SO_2/HCl ratios of leachates are in the range 0.6 – 1.8 significantly lower than those measured in the plume with FTIR techniques (2.7 – 3.2; Allard et al., 2002) indicating a more efficient scavenging of HCl with respect to SO_2.

The estimated amounts of gas scavenged by the ash in the period 20 – 25 July are 7.9, 17 and 35.3 T/d for HF, HCl and SO_2 respectively. These are minimum values taking in account only ashes deposited on an area of about 220 km^2 disregarding peripheral areas and deposition on the Ionian sea, which probably account for amounts in the same order of magnitude. SO_2 deposited on ashes is therefore about two order of magnitude lower than that emitted through all the open vents in the same period (7000 T/d, - Allard et al., 2002).

References

Allard P., Bruno N., Burton M., Caltabiano T., Condorelli D., Longo V. and Murè F. (2002) *Proc. of the Annual Assembly of GNV, Rome 9-11 Oct. 2001*, 230-231.

U-series dating of archaeological bone material by Laser Ablation Multiple-Ion-Counter ICP-MS

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Accurate U/Th dating of bones and teeth would be a powerful tool for archaeologists and palaeontologists. It would extend the dating of these key materials beyond ^{14}C, and into the time period which covers the emergence of Modern Humans, the extinction of both Neanderthals and *H. erectus*, and four glacial-interglacial climate cycles. Such dating has generally proved unreliable because most U in bones is incorporated gradually after death. But the use of a diffusion-adsorption model, coupled to U-series data from several depths within each bone, has enabled this uptake to be assessed and an age to be calculated for those samples with suitable uptake histories (Millard & Hedges 1996; Pike *et al.* this conference). Unfortunately, collecting such U-series data by physical subsampling is time consuming, destructive and only applicable to large samples.

Spatially resolved *in situ* analysis may reduce both the time of analysis and the required sample size. We have tested the measurement of U-series isotopes on bone samples by laser ablation (LA) multiple-collector ICP-MS. Bone samples, and finely-ground pressed bone standards, are ablated using a 193 nm excimer laser and swept into a Nu instrument in an Ar-He mixture (Young et al. 2002). Three channels of ion-counting allow for synchronous collection of ^{230}Th, ^{232}Th, and ^{234}U, while ^{235}U and ^{238}U are also collected in Faraday collectors. A second analysis step also allows for collection of ^{231}Pa and ^{235}U on ion-counters if required, while ^{238}U is used to correct plasma instability.

Resulting U beam sizes are proportional to U contents, and LA ^{234}U/^{238}U ratios are identical to those measured by TIMS on the same samples. U/Th elemental ratios are dependant on laser-cell sweep-gas composition and flow-rate (Stirling et al. 2000) but reproducible values with a constant relationship to the true U/Th ratio can be measured. These results indicate that U-series dating of bones by LA-ICP-MS is possible - a development which will have widespread application in the archaeological sciences.

References

A.R. Millard & R. Hedges, GCA 60(12) p2139-2152, 1996
A.W.G. Pike, R.E.M. Hedges & P. van Calsteren. Providing reliable chronologies: Direct dating of bone by U-series disequilibrium. Goldschmidt 2002
C.H. Stirling et al., GCA 64(21) p3737-3750, 2000
E.D. Young et al. GCA 66(4) p683-698, 2002