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# Magma differentiation induced by volatile migration in the shallow plumbing system of active volcanoes: evidence from the 2001 eruption at Mt. Etna (Italy)

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A stratigraphically controlled sampling of tephra layers was performed at the most active vents of the 2001 eruption at Mt. Etna, in particular at the 2100 m (CAL) and at the 2550 m (LAG) scoria cones. Detailed SEM-EDS analyses performed on glasses found in tephra and comparison with lava whole rock compositions have evidenced an anomalous increase of Ti, Fe, P and particularly of K and Cl, in the upper layers of the LAG sequence. Mass balance and thermodynamic calculations have shown that this enrichment cannot be accounted for by classical differentiation processes, such as crystal fractionation and magma mixing, already recognized as fundamental in determining the petrological evolution of these products. The analysis of petrological features of the magmas involved in the event, integrated with the volcanological dynamics, has evidenced the role played by volatiles in controlling the magmatic evolution within the crustal portion of the plumbing system. Volatiles, constituted of $H_2O$, $CO_2$ and Cl-complexes, came from a deeply seated magma body (DBM). Their upward migration occurred through a cataclastic network possibly developed by the seismic swarms during the months preceding the event. In the upper portion of the plumbing system, a shallower residing magma body (ABT) had chemical and physical conditions to receive migrating volatiles, which hence dissolved the mobilized elements inducing the observed selective enrichment. This volatile-induced differentiation involved exclusively the basal portion of the ABT magma, due to the low rate of volatiles diffusion within a crystallizing magma body and/or to the short time occurred between volatiles influx and the onset of the eruption. The increased amount of volatiles in this level of the chamber strongly affected also the eruptive behaviour. The emission of these products at the LAG vent, towards the end of the eruption, modified the eruptive

style from classical strombolian to strongly explosive. The mechanism has been here highlighted on the scale of the individual eruption, but further data and improvements of the model probably might help to extend the role of volatiles to much broader issues at Mt. Etna and to other alkali basaltic volcanoes. The same rigorous field-based approach may cast new light on petrological and volcanological anomalies, which could be then reconducted to processes controlled by volatile-induced differentiation.