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Plagioclase textures and variation of core-rim chemical profile as a tool for understanding the pre and syn-eruptive magma modifications within the feeding system. The case study of the 2002 eruptive event at Mt. Etna (Italy)

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In situ investigations on phenocrysts zoning patterns in volcanic rocks have been found to be a powerful tool for understanding differentiation processes within magma chambers. The growth history of crystals can be highly sensitive to gradual or sudden modifications in the volcanic system, and can record in their textural and compositional zoning patterns changes of the thermodynamic equilibria, such as recharging of fresh magma, volatile input/loss or ascent-related decompression. We observed plagioclase of 2002 eruption of Mt. Etna with SEM back scattered electrons, this allowed us to sort crystals in various textural types, related to crystallization conditions. Across major resorption surfaces, chemical profiles of major elements using EMP and trace element in-situ determination by LAM, has been made.

Mount Etna is one of the most active volcanoes on Earth, its activity is generally persistent, however there are many examples of articulated eruptions, often lateral, in which syn-eruptive interactions such as magma mixing or chemically modified magma recharge can occur. The 2002 eruption of Mt. Etna, which occurred on both the southern (S) and northeastern (NE) flanks of the volcano, was the last important lateral event. Distinct magmas (Low-K Oligophyric – LKO and High-K Oligophyric – HKO), have been emitted at different times by distinct fracture segments. On the southern flank and on the lowermost section of the NE-Rift were erupted High-K Porphyritic (HKP) lavas, which represent the largest volume among the emitted products of the entire event. HK and LK magmas cannot be related each other to simple crystal fractionation, thus indicating that these two batches evolved independently. The model previously proposed suggests that magma batches intruded along the NE-Rift during the pre-eruptive period. At the onset of the eruption, the fractures opening and migration that accompanied the seismic swarm, intersected these batches and triggered magma ascent and eruption along the NE Rift.

The compositional profiles of crystals revealed that plagioclases of S HKP lavas show resorbed cores or rims characterized by abrupt An increase after the resorption. Cores are often in equilibrium with the whole rock, becoming less anorthitic with time. Plagioclases of N HKP lavas exhibit high-An rounded cores, sometimes with alignments of melt inclusions at the rim, associated with An decrease. S and N HKP magmas show a common fractionation trend. S lavas are generally more primitive, although they differentiate with time, thus becoming similar to N lavas. However, lavas erupted on the S flank at the end of the event are more primitive indicating input of fresh magma.

The integration and comparison of petrochemical and mineralogical data strongly suggest a common origin of the HKP magma (volumetrically the most significant) on both NE and Southern flank. This conclusion is also supported by the occurrence of quartz-rich xenoliths embedded on HKP lavas erupted on both flanks. HKP magma rose through a NNW-SSE trending system at depth on the southern flank, whereas the NE-SW trending structures of the NE-Rift have been intersected only at shallow depth (< 6 km).