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Crystallisation/dissolution experiments on lavas from Etna and Stromboli, Italy: an invaluable approach to interpret crystal size distribution data

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Kinetics data and thermodynamic models are both essential to better understand silicate magma systems. The former can be obtained through experiments on significant starting materials at different P-T-fO_2 conditions. In this study, two distinct volcanic systems, Etna and Stromboli (Southern Italy) in which volcanic hazard is significant, are taken into account.

Recent products erupted by Etna and Stromboli have variable porphricity and volatile contents. They are likely to arrive at the surface following different crystallisation (and degassing) sequences from magma reservoirs sited at different depths. In particular, the dynamic of eruption of Stromboli system, occurring in a steady state, open conduit conditions, produces complex textures and compositional zoning in plagioclase crystals linked to mixing between volatile-poor, crystal-rich magma with volatile-rich melts from the deeper portion of the "plumbing" system. Thus the magmatic differentiation processes occurring in the volcanoes may be evaluated by the complementary information from crystal size distribution (CSD) and from laboratory experiments on natural lavas. In particular, an estimate of kinetics factors (e.g. growth and dissolution rate of crystals) helpful to interpret the data obtained from CSD can be obtained by experimental studies. In order to establish phase relationships and to assess growth and dissolution rate of plagioclases (Pl) and clinopyroxenes (Cpx), experiments were

performed (in air) at P=0.01 MPa under anhydrous conditions using a representative hawaiite as starting material composition for Etna and a shoshonitic basaltic golden-pumice sample or a Fe-free synthetic starting material representing a golden-pumice composition for Stromboli.

Experimental charges were performed using a Cpx or Pl seed embedded in a glass obtained by melting the starting material. This technique allowed to visualise overgrowth rims and dissolution on minerals (Pl or Cpx) and to estimate the crystal growth and dissolution rates.

As regards Etna's starting material, several experiments were performed between 1160 and 1240˚C; their duration varied between 15 and 20 hours. The determined crystallisation sequence on the Etna's starting material is: spinel (at T$>$1240˚C), Pl (1230˚C$<$T$<$1240˚C), Cpx (1180˚C$<$T$<$1190˚C). Pl and Cpx growth rates have been estimated to be up to 10^{-8}cm/sec in a range of values in agreement with results obtained by CSD in natural samples.

Experiments on Stromboli compositions were performed between 1200 and 1240˚C. Growth experiments (T$<$1210˚C) on the natural and synthetic compositions from Stromboli, give estimated growth rate for plagioclase in the order of 10^{-8}cm/s. Dissolution experiments (T$>$1210˚C) showed that the reabsorbing rates of Pl is in the order of 10^{-6}cm/s in the natural composition and one order of magnitude lower (10^{-7}cm/s) in the synthetic material.

Further experiments performed at different undercooling are necessary to get more accurate Pl and Cpx growth and dissolution rates which are mandatory to interpret CSD data.