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Major and trace element maps of zoned clinopyroxenes at Stromboli: New clues on complex magma dynamics during 2003-2017 eruptions

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Stromboli volcano (Aeolian Islands, Southern Italy) is a typical steady-state volcanic system where the “normal” present-day activity (<1.2 ka) progresses by mild to moderate eruptions with occasional more violent explosions divided into “major explosions” and “paroxysms”. These latter are marked by strong mixing/mingling phenomena evidenced by the occurrence of black scoriae, representing a high porphyritic, volatile-poor magma (hp-magma) and generally a small volume of light pumice (<10 vol%), representing a low porphyritic, volatile-rich magma (lp-magma). The lp-magma is also more mafic in composition with incompatible trace element concentrations lower than the hp-magma. In this study, we present a comparatively approach based on new textural and compositional data on clinopyroxene phenocrysts from normal, major and paroxysm products sampled in a time span between 2003 and 2017. Through the integration of microprobe and laser ablation compositional maps, clinopyroxene phenocrysts have been categorized in 1) subeuhedral augites with homogeneous compositions and no evident zoning, 2) alternating intra-crystal augitic-diopsidic bands, possibly forming oscillatory zoned crystals, 3) diopsidic patchy and/or resorbed cores with augitic overgrowths and 4) a marked hourglass sector zoning that, sometimes, is overprinted on other crystal populations with {-111} sectors more magnesian than the aluminium-rich {100} sectors. Overall, the diopsidic bands and the resorbed cores show more mafic compositions (Mg#84-91, Di65-79, Hd8-14, Jd0-3 and CaTs+CaFeTs0-10) than the augitic portions (Mg#72-81, Di51-65, Hd15-22, Jd0-5 and CaTs+CaFeTs0-9). The different clinopyroxene components translate to a decoupling between major and trace element cations, where the diopsidic portions are enriched in MgO, CaO, and Cr, and depleted in $Al2O_3$, Sc, REE+Y and HFSE with respect the augitic portions. These new textural and compositional data illustrate that clinopyroxene phenocrysts have recorded a complex history of mixing (oscillatory zoned crystals and resorbed cores) and undercooling (hourglass sector zoning) regimes produced by repeated injections of a deep-seated lp-magma in the shallow hp-magma reservoir. Through the application of clinopyroxene-based thermobarometric models specifically designed for Stromboli magmas, we are now going to retrieve robust constrains on the crystallization pressure and temperature of the system, as well as more accurate estimates of the crystal residence times by using diffusion chronometry.