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Syn-eruptive magma mingling during paroxysmal eruptions of Stromboli volcano (Italy)

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The explosivity of Stromboli volcano, usually very mild, is periodically increased by the occurrence of high energy (VEI=3), short explosions sequences called paroxysms. Paroxysms are sudden explosions related to fast ascent from depth of poorly crystallized, volatile-rich magma batches, rising through the partly degassed and crystal-rich shallow magma reservoir (Rosi et al., 2006). The two magmas have the same bulk composition (HKCA basalt) and are called 'low porphiricity' (LP) and 'high porphyricity' (HP) magmas, respectively (Bertagnini et al., 2003; Corsaro et al., 2004; Metrich et al., 2001). Occurrence of the two last paroxysmal explosions (5 April 2003, 15 March 2007) during effusive crises of the volcano underlined the existence of complex interaction and feedback processes between the two feeding systems.

Constraining timescale, extent and effect of the interaction between the two magmas during paroxysmal events is a key point to understand the mechanisms controlling the explosivity of these eruptions. To address this topic, we performed a detailed study of physical, compositional and textural features of two populations of clasts erupted during the climactic phases of the 2003 and 2007 events. The populations consisted of 100-150 clasts each, randomly chosen in the field at 1-1.5 km W-SW of the summit vents. Shape, density, glass composition, crystal, matrix and vesicle textures were analyzed to obtain information on the relative proportions of the two magmas both in single clasts and whole population, and on the extent of their interaction. LP magma portions are marked by the occurrence of smaller, more abundant vesicles with respect to the HP magma portions. These features, associated to distinct glass matrix composition and color, allowed clear identification of the two different components (LP pumice and HP scoria) both at macro and microscales, and suggest the use of vesicularity as a proxy for relative proportions of the two magma types in a single clast. The majority of the clasts are composite, ranging from dominantly LP pumices embedding mm- size patches of HP scoria, to clasts constituted by the two end members in same proportions, to pure HP scorias. Contacts between the two glasses are always sharp at the macroscale, but display a remarkable microtextural variability ranging from wavy or convoluted surfaces, and can be sharp to banded.

Our results indicate that the magmas likely interacted shortly before the eruption resulting into intimate mingling phenomena. Limited viscosity differences between the two fluids and high shearing stress allowed for formation of mm size enclaves and of micron-scale mingling structures, but short residence time of LP magma in the shallow reservoir prevented effective chemical mixing. The lack of pure LP pumices, very limited occurrence of pure HP scoria also suggest that the deep magma batch fully interacted with the magma residing in the shallow reservoir, that was only partially involved into the explosions.