Residence time analysis of active volcanic systems: Rb-Sr isotope study of Ischia and Pantelleria

M. CASALINI[1]*, R. AVANZINELLI[1] AND S. TOMMASINI[1]

[1] Dipartimento di Scienze della Terra, Università di Firenze, Italy (*correspondence: martina.casalini@unifi.it)

Numerous active and potentially high-risk volcanoes do occur in the Italian peninsula and therefore understanding their dynamics is crucial for volcanic hazard assessment. Here we present a study on the active volcanic systems of Ischia and Pantelleria, representing two high-silica volcanoes emplaced in subduction related and within-plate geodynamic settings, respectively.

Ischia is characterised by a continuous transition from trachy-basalt to phonolite. The geochemical and radiogenic isotope data of its volcanic products demonstrate a two-steps evolutive process: the first step, controlled by fractional crystallization plus crustal assimilation (AFC), drives magma composition from trachy-basalt to moderately differentiated trachyte; the second step, controlled only by fractional crystallisation (FC), drives the magma composition to the more differentiated products (phonolite) determining very low Sr (a few ppm) and high Rb (>500 ppm) contents due to extreme plagioclase and K-feldspar fractionation.

Pantelleria island displays a bimodal magmatism made up by alkali-balsalt and differentiated products, which evolve from trachyte to peralkaline ryolite (i.e. Pantellerite) through FC processes. Pantelleritic rocks also show extremely low Sr and high Rb contents.

The active volcanic systems of Ischia and Pantelleria, despite belonging to different geodynamic settings, are characterized by the occurrence of strongly differentiated products with anomalously high Sr isotope compositions that cannot be justified by the assimilation of crustal material.

This characteristic could be explained by ^{87}Sr in-growth in long-lived magma chambers, due to the high Rb/Sr of the most evolved rocks. To explore this hypothesis we carefully screened and selected a number of evolved samples: from these we separated the rock-forming minerals (sanidine and clinopyroxene) and groundmass/glass in order to determine Rb and Sr content by isotope dilution, along with Sr isotope composition. The extremely low diffusion coefficients of Sr in feldspar and clinopyroxene makes them suitable candidates to estimate the timing of crystallisation and, by inference, the magma residence time. The calculated crystallization times for the two islands are here compared and discussed in terms of the chemical and physical characteristics of the magmas.

Crystals modulate non-explosive gas transfer at Stromboli volcano, Italy

K. CASHMAN[1], A. RUST, I. BELIEN[2], J. OPPENHEIMER[1] AND A. SOLDATI[1]

[1]School of Earth Sciences, University of Bristol, UK (glkvc@bristol.ac.uk)

[2]Exxon Mobil Upstream Research, Houston, TX

Stromboli is best known for its eponymous frequent and mildly explosive eruptions. Most of Stromboli's gas loss (~ 90%), however, occurs by non-explosive mechanisms, either passively or via periodic small gas bursts known as "puffing". Passive degassing probably occurs across the entire magma surface beneath the crater terrace; puffing, in contrast, is focused into one or a few central vents that are stable over the short term but migrate with time. What, then, controls the spatial and temporal patterns of non-explosive gas loss? One clue comes from volcanic clasts ejected during normal Strombolian activity, which show that the near-surface magma has ~ 50% crystals. To explore the effect of crystals on gas migration, we have run experiments using 50:50 mixtures of golden syrup and rice (an anisotropic particle that is neutrally buoyant and approximates plagioclase in shape) fluxed by air; this allows us to investigate the effect of varying gas flux through static 'magma' columns. A first order observation is that, at steady state, the amount of gas retained within the column (the gas holdup) increases with increasing gas flux from below. Gas holdup is achieved by trapping small bubbles within the particle-melt suspension. Importantly, these small bubbles are created by interaction of the gas with the suspension by bubble splitting either around particles or by expansion after passage between two particles into a particle-poor space. At the same time, larger parcels of gas migrate though the suspension by creating transient fractures. The pressure increase required to fracture the suspension causes quasi-periodic gas release to the surface; the fracture is transient because of healing by viscous flow. These observations suggest physical mechanisms to explain both passive degassing and puffing. Passive degassing is best explained by the slow rise of individual bubbles through the crystal-melt suspension, with bubble size modulated by the size and spacing of crystals. Puffing activity is more analogous to quasi-periodic fracturing and gas release; healing of fracture paths explains the migration of puffing vents around the central crater terrace. The location of puffing in the center of the crater terrace further suggests focusing of the steady gas supply from depth at the center of the elongated shallow magma storage region.

www.minersoc.org
DOI: 10.1180/minmag.2013.077.5.3