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The role of volatiles during magma storage, decompression and eruption at Stromboli Volcano

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Open system volcanoes are natural laboratories to investigate how volatiles migrate and concentrate under dynamic conditions. Among them Stromboli plays a key role due to its persistent activity. Fluid phases are involved in magma decompression and pressurization, modulate Strombolian activity and rule magma rise and fragmentation processes.

Thermobarometric estimates indicate that the deeper detected part of the plumbing system is located in the upper mantle, at approximately 34-24 km. During their ascent basaltic magmas will interact with lower crust materials represented by cumulates of earlier Stromboli-type basalts at 13-10 km depth. This zone is also the sector of the plumbing system where the feeder dike is entering the chamber. Current primitive Stromboli basalts equilibrate at about 0.3-0.13 GPa for temperatures approaching 1150-1200 ℃, and progressively crystallise, cool and degas before being erupted. Crystal Size Distributions on lavas and juvenile tephra recently erupted give variable residence times. Although further refinements are needed to identify the time-related variations in fluid diffusion coefficients, the estimated times for the exsolution of the gaseous phases, based on average bubble distances, range from 44-126 minutes for the lavas and scorias, down to about 12 minutes for the pumices ejected during paroxysmal explosions.

Pure extensional regimes and geophysical data indicate the existence of a prolate ellipsoidal magma chamber below Stromboli. To assess its volume we calculated the magma volumes associated with SO_2 degassing (during the 2007 major eruption) by applying a refined petrological model to estimate the magma flux entering the degassing zone. The trend of this magma flux follows an exponential decay, typical of pressurised magmatic systems. This trend has been interpreted as due to the release of elastic strain accumulated either by pressurisation of the rocks surrounding the magma reservoir, or by pressurisation of the magma itself, or both. The reservoir elastic response during magma decompression suggests that Stromboli magma chamber volume may be constrained to 1-2 km^3.

Keywords: magma, volatiles, magma storage, decompression, eruption