Geophysical Research Abstracts
Vol. 18, EGU2016-1027-1, 2016
EGU General Assembly 2016

Timing of magma storage at the Vulcano Island during the last 1000 years

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Understanding the nature and timescales of magmatic processes is one of the primary goals of modern volcanology, and chemical zoning is an efficient tool to achieve this aim. In basic volcanic rocks, plagioclase is a common phase used for documenting magmatic processes and their timescales. This is chiefly due to its stability over a wide range of physical-chemical conditions and its sensitivity to changes in thermodynamic parameters during its growth in magma storage and transport zones. We present here textural analysis and major (SEM-EDS/WDS) and trace (LA-ICP-MS) element zoning data on plagioclase crystals from selected volcanic products of Vulcano (Aeolian Islands), emitted during the last 1000 years. The collected samples belong to the La Fossa cone (Palizzi latitic lava flow, latitic enclaves within Commenda and Pietre Cotte rhyolitic lava flows, 1888-90 spatter bombs) and Vulcanello peninsula (shoshonitic and shoshonitic-latitic lava flows at the end of Vulcanello I and Vulcanello 3 phases, respectively).

Textural observations through polarizing optical microscope, high-contrast BSE images and SEM-EDS/WDS core-to-rim profiles, allowed to discriminate four different plagioclase textures, namely: 1) oscillatory-zoned crystals; 2) sieve-textured rims; 3) dissolved/resorbed cores; 4) cores with coarse sieve-textures. Plagioclase with sieve-textured rims and coarsely-sieved cores (Types 2 and 4) are the most abundant in the analyzed products. The estimates of maximum magma residence time have been obtained on crystals with exclusive oscillatory-zoned patterns (Type 1) or portions of crystals not severely affected by μm-sized glass inclusions caused by disequilibrium. We used one-step modeling of Sr diffusion considering the highest An content of each crystal and magma temperature ranging between 1075 and 1175°C.

Textural observations and core-to-rim profiles on plagioclases show that dynamics of magma ascent and storage are markedly different at La Fossa and Vulcanello systems. Transfer mechanisms are however almost unchanged in each system during the considered timespan. Diffusion modelling gives residence times between 2 and 22 years. The most striking feature is that residence times are relatively low for the most evolved products (latites or latitic enclaves), especially at La Fossa eruptive system (2-19 years), with respect to the less evolved products of Vulcanello (19-21 years). It is worth to note that these timescales cannot account for the total amount of residence time of La Fossa magmas within the crust, but they can reflect the storage time of the most evolved products into the shallowest feeding system. Residence times for Vulcanello magmas could be related to longer magma storage at intermediate levels of the plumbing system followed by rapid transfer at the surface prior to the eruption.