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Mineral-scale Sr isotopic variations as recorders of magmatic processes in the Fish Canyon system, U.S.A.

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The use of crystal isotope 'microstratigraphy', through microanalysis for Sr isotopes, shows that inter- and intra-crystalline isotopic and compositional heterogeneities exist within many volcanic rocks. Here we report Sr isotope data for sanidine, plagioclase, sphene, apatite, glass, biotite and hornblende crystals separated from representative samples of the 5000km^3, 28 Ma Fish Canyon Tuff and the pre-caldera Pagosa Peak Dacite, from the La Garita Caldera, San Juan Volcanic Field, U.S.A.

Age-corrected bulk-rock $^{87}Sr/^{86}Sr$ values define a small range (0.70632 to 0.70652), whereas inter- and intra-grain variations among plagioclase, sanidine and apatite crystals exhibit a much larger range (0.706070 to 70672). These ranges in $^{87}Sr/^{86}Sr$ cannot be solely attributed to radiogenic ingrowth during residence in the Fish Canyon magma reservoir, since measured $^{87}Rb/^{86}Sr$ are too low to significantly affect $^{87}Sr/^{86}Sr$ over ~30Myrs. In contrast, biotite, glass and hornblende exhibit much higher age-corrected Sr isotope ratios (0.70692 to 0.70738), a wider range of $^{87}Rb/^{86}Sr$ ratios and can be used to construct a Rb-Sr isochron which yields an eruption age of 28.18±0.86 Ma and an $^{87}Sr/^{86}Sr_i$ of 0.707255.

The $^{87}Sr/^{86}Sr_i$ of the isochron is much higher than any of the $^{87}Sr/^{86}Sr_i$ ratios recorded by the plagioclase, sanidine, apatite and sphene crystals, and is taken as evidence - consistent with - textural observations, that these crystals were remobilised from an older igneous protolith shortly prior to eruption. The biotite and hornblende crystals which appear to be in isotopic equilibrium with the glass (by virtue of defining the isochron) appear to have grown from a liquid generated at ~28Ma from partial melting of this protolith. Thus, we interpret the isotopic variations to represent open system processes in the generation of the Fish Canyon magma by the direct incorporation of xenocrystic phases from earlier periods of magmatism to produce an isotopically heterogeneous magma (and rock) at the mineral scale.

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Textural and Strontium isotopic analysis of plagioclase phenocrysts of the Vancori Series, Stromboli volcano (Aeolian Islands)

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As part of the ongoing ERUPT (European Research on Understanding Processes and Timescales in magma systems) project, we report the results of a detailed Sr isotopic study of individual plagioclase crystals from stratigraphically constrained samples taken from the Vancori eruptive period (26-13 ka) of Stromboli volcano, Aeolian Arc, southern Tyrrhenian Sea. Previous studies at Stromboli volcano have revealed that whole-rock $^{87}Sr/^{86}Sr$ for the Vancori series range from 0.70595-0.70659 [1]. Initial microsampling of $^{87}Sr/^{86}Sr$ profiles for individual plagioclase phenocrysts from the Vancori series reveals the presence of distinct compositional zones within these phenocrysts with an even greater range in $^{87}Sr/^{86}Sr$ (0.70583-0.70684). Preliminary petrographic observations suggest the presence of at least three types of plagioclase phenocrysts including the following: 1) larger (~2-3mm) plagioclases with five or more compositionally distinct zones, 2) intermediate sized (~1-2mm) plagioclases with three distinct (core, inner rim, and outer rim) zones, and 3) even smaller sized (≤1mm) plagioclases with only two separate (core and rim) zones. These observations suggest that multiple crystal populations have evolved in environments isolated from each other and were mechanically mixed just prior to eruption. Further more detailed textural-CSD investigations in conjunction with additional isotopic "fingerprinting" of individual plagioclase crystals should: a) reveal whether shifts in the Sr isotopic composition of individual plagioclases coincide with sudden textural changes, b) allow for more defined characterization of individual plagioclase crystals of different sizes and hence different residence times, and c) permit us to determine whether the occurrence and abundance of such plagioclase phenocrysts varies with stratigraphic position in the Vancori Series.

References

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