Noble gases: A tool to track the degassing of active volcanic systems

Conference or Workshop Item

NOBLE GASES: A TOOL TO TRACK THE DEGASSING OF ACTIVE VOLCANIC SYSTEMS

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He, Ne and Ar are widely used to characterize magmatic reservoirs and to study volcanic processes. Their isotopic signature and fractionation (e.g. $^{4}He/^{40}Ar$ ratio) provide information on magma source, differentiation, contamination and degassing. Several studies have investigated sources, reservoirs and chemical controls of noble gases, but few efforts have been made to study which factors control noble gas incorporation, partition and release during degassing episodes.
The aim of this research is to identify these factors and to test how they influence noble gas behaviour in volcanic rocks with different degassing histories. This will help improve our understanding of how noble gases are recycled into the atmosphere during volcanism. Particular attention will be given to the behaviour of Ar because of its use in $^{40}Ar/^{39}Ar$ dating. A better knowledge of how Ar is trapped and released from volcanic rocks will help find a solution to the '*excess argon problem*': the presence of an excess portion of ^{40}Ar inside rocks that is not related to atmospheric Ar nor to the radiogenic decay of ^{40}K, which complicates $^{40}Ar/^{39}Ar$ age dating. Younger volcanic rocks are more affected by this problem due to their lower concentrations of radiogenic ^{40}Ar with respect to non-radiogenic Ar.
Samples from 0 to 1 Ma are used to study rocks with different proportion of radiogenic and excess ^{40}Ar. A variety of materials (pumice, ash, non-vesicular glass, crystals) and deposit types (pyroclastic fall, ignimbrites, lavas, and Pele's hairs) from Tenerife (Spain), Etna (Italy) and Masaya (Nicaragua), will be used to test how noble gases vary in response of cooling rate (Pele's hairs vs. lavas vs. mode of pyroclastic emplacement) and physical characteristics of the deposit (crystals vs. bubbles, rock porosity).
Noble gas mass spectrometry results from Pele's hairs/tears collected in 2015-2016 at Masaya Volcano, a persistent degassing system, show an inverse degassing trend with 2016 samples less degassed (low $^{4}He/^{40}Ar$ ratio) than 2015 samples (high $^{4}He/^{40}Ar$ ratio).
Causes and factors controlling this trend have been investigated. Mineral assemblages and sample textures have been characterised by petrographic analysis; samples chemistry have been determined by electron-probe and NANO-SIMS analysis; further studies on the internal structure of the considered material will help to understand the role of bubbles in noble gas distribution and release during degassing episodes.