Geophysical Research Abstracts
Vol. 18, EGU2016-8144, 2016
EGU General Assembly 2016

Revealing the magmas degassing below closed-conduit active volcanoes: noble gases in volcanic rocks versus fumarolic fluids at Vulcano (Aeolian Islands, Italy)

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With the aim to constrain the nature of magma currently feeding the fumarolic field of Vulcano, we measured the elemental and isotopic compositions of noble gases (He, Ne, and Ar) in olivine- and clinopyroxene-hosted fluid inclusions in high-K calcalcaline-shoshonitic and shoshonitic-potassic series so as to cover the entire volcanological history of Vulcano Island (Italy). The major and trace-element concentrations and the Sr- and Pb-isotope compositions for whole rocks were integrated with data obtained from the fluid inclusions. $^{3}He/^{4}He$ in fluid inclusions is within the range of 3.30 and 5.94 R/Ra, being lower than the value for the deep magmatic source expected for Vulcano Island (6.0-6.2 R/Ra). $^{3}He/^{4}He$ of the magmatic source is almost constant throughout the volcanic record of Vulcano. Integration of the He- and Sr-isotope systematics leads to the conclusion that a decrease in the He-isotope ratio of the rocks is mainly due to the assimilation of 10-25% of a crustal component similar to the Calabrian basement. $^{3}He/^{4}He$ shows a negative correlation with Sr isotopes except for the last-emitted Vulcanello latites (Punta del Roveto), which have high He- and Sr-isotope ratios. This anomaly has been attributed to a flushing process by fluids coming from the deepest reservoirs. Indeed, an input of deep magmatic volatiles with high $^{3}He/^{4}He$ values increases the He-isotope ratio without changing $^{87}Sr/^{86}Sr$. A comparison of the He isotope ratios between fluid inclusions and fumarolic gases showed that only the basalts of La Sommata and the latites of Vulcanello have comparable values. Taking into account that the latites of Vulcanello relate to one of the most-recent eruptions at Vulcano (in the 17^{th} century), we infer that that the most probable magma which actually feeds the fumarolic emissions is a latitic body ponding at about 3-3.5 km of depth and flushed by fluids coming from a deeper and basic magma.