Tracing He, N, Ar and C isotopes in the hydrothermal system of Tatun Volcanic Group, Taiwan

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Tatun Volcanic Group (TVG) is a part of the northern Taiwanese volcanic zone produced by the subduction of the Philippine Sea Plate under the East Asian continent. TVG is composed of more than 20 Quaternary volcanoes distributed along the NE-SW Chinshan older than 0.2 Ma. Fumaroles and hot springs located along Chinshan fault indicate that 1) TVG is still active and 2) there is a link between the major fault and the TVG volcanic hydrothermal activity. In this study, we present preliminary results of He, N, Ar and C isotopic compositions from hot springs and bubbling gases of Tatun Volcanic Group. This gives important constrains on the origin and formation of this volcano-hydrothermal system, and may help in forecasting volcanic eruptions or large seismic events.

The $^{3}He/^{4}He$ ratios show two distinct groups ranging between (A) 5.32Ra and 5.57Ra, and (B) between 2.80Ra and 4.94Ra, with group B affected by assimilation of crustal helium compared to group A. Importantly, this variation of helium isotopic compositions is largely correlated with Vp/Vs anomalies observed under TVG (Wen et al., 2012). The samples of group A are located where the Vp/Vs anomalies are low, which is evidence for a mantle-derived He (from the TVG fluids) connected to the magmatic-hydrothermal activity. This has important implications on the potential hazards.The $\delta^{15}N$ data are also divided in two groups, ranging from -1.8±0.8‰to 2.2±0.7‰for group A and from 0.4±0.7‰to -0.4±0.7‰for group B. The ratios $^{40}Ar/^{36}Ar$ and $N_2/^{36}Ar$ of our TVG samples vary from 279±11 to 331±14 and from $3.2x10^4$ to $5.3x10^4$, respectively. The low $^{40}Ar/^{36}Ar$ values clearly indicate the importance of atmospheric-derived nitrogen. The corrected δ ^{15}N (from the atmospheric component) data show the implication of sediment-derived nitrogen for group A, but only little contribution for group B. The $\delta^{13}C\text{-}CO_2$ values (-9.62±0.8‰to -4.66±0.19‰) are negatively correlated with $CO_2/^{3}He$ ($2.77x10^9$ to $2.59x10^{10}$), which is explained by fractionation and crustal assimilation. If we exclude these fractionation and crustal effects, the high $\delta^{13}C\text{-}CO_2$ values (ca. -5.5‰) from TVG bubbling gases seem to represent the original magmatic signature, which is described here in terms of a mixture of three components: limestones, MORB and organic sediments.