Hydrothermal Origin of Smectite in Volcanic Ash

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Abstract: Smectite and fine-grained quartz were separated from 6 volcanic ash samples collected in Japan from Shinmoe-dake Volcano, southern Kyushu, and Mt. Usu Volcano, southern Hokkaido. Oxygen isotope ratios of smectite in the volcanic ash range from +6.9 to +12.9 per mill (‰), which are comparable to the values of smectite ($\delta^{18}O$ = +6.5 and +9.4‰) from currently active geothermal fields. Evaluation of the oxygen isotope data from smectite ($\delta^{18}O$ = +6.9 and +8.4‰) and quartz ($\delta^{18}O$ = +6.6 to +11.2‰) in volcanic ash erupted from Shinmoe-dake in 1959 indicates a hydrothermal origin at elevated temperatures (150 to 270 ° C from waters that have calculated $\delta^{18}O$ values ($\delta^{18}O$ = −3 to +5‰) that are enriched relative to local meteoric water ($\delta^{18}O$ = −7 to −8‰). This precludes an authigenic formation of the smectites under ambient temperatures in crater lakes and/or somma-atrios which had been previously proposed as a plausible mechanism. A peculiar clay flow was extruded on the sommaatrio of Mt. Usu Volcano. The isotopic composition of the clay (<0.5 μm, $\delta^{18}O$ = + 12.2‰) and evidence from geophysical exploration over volcanic vents of Shinmoe-dake support the concept that extensive hydrothermal alteration is taking place within volcanic vents.

Key Words: Hydrothermal Alteration • Oxygen Isotope Composition • Smectite • Volcanic Ash

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