Geochemistry of volcanic fluids from the Norikura Volcanic Chain

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The crust beneath the Norikura Volcanic Chain (NVC), Hida Highland, central Japan, is tectonically active and characterized by frequent shallow microearthquakes. Recent seismic tomography studies of this area indicates zones of low seismic wave velocities (Vp and Vs) beneath the NVC at depths of 5-15 km, with relative reduction of the velocities being up to 20%. Fluid and gas light isotope geochemistry was used to clarify the relationships between hydrothermal activity and seismic activity of this area. Geochemistry of gases from fumaroles, boreholes and hot springs, abundantly found along the NVC volcanoes, reveals that (1) water vapor in the fumarolic gases is a mixture of the arc-type magmatic water and local meteoric water, (2) the hot spring waters are mostly of local meteoric origin, (3) some of the hot spring waters experienced water-rock interaction at max. 220C, (4) the 3He/4He ratios of 10.3-11.2 x 10E-6, the highest values ever measured for volcanic gases in the Japanese arc system, were found in fumarolic gases from Tateyama, Yakedake and Ontake volcanoes, suggesting a MORB source for the helium, (5) slightly lower 3He/4He ratios were also found in gases from the borehole and bubbling hot springs surrounding the above volcanoes, (6) the ultimate source of carbon is probably derived from decarbonation of the subducting sediments based on the d13C-C/3He relationship. Close coincidence of the distribution of the high 3He/4He sites with that of the zones of low seismic wave velocity at a depth of 5 km suggests that extensive development of hydrothermal systems driven by magmatic heat of the NVC volcanoes is responsible for the shallow low velocity zones, rather than emplacement of a felsic magma chamber at these depths that has previously been invoked to explain the nature of the low velocity zones. The shallow microeqrthquakes may be produced by hydro-fracturing of the rocks under compression when magmatic volatiles invade.