

Spatial and temporal variations of helium and carbon isotopes at Ontake volcano, Japan

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We report spatial and temporal variations of helium and carbon isotopes measured in CO₂-rich bubbling gases from natural springs associated with Ontake volcano (central Honshu, Japan) from November 1981 to September 2015. During the whole period, the ³He/⁴He and CO₂/³He ratios decreased with increasing distance of sampling site from the central cone. In contrast, δ¹³C values of the CO₂ increased with the distance. These spatial trends became more significant after the 27 September 2014 Ontake eruption, suggesting the reactivation of the volcano plumbing system with enhanced emission of magmatic volatiles. The ³He/⁴He ratios of the closest site to the central cone stayed constant until 2000 and increased apparently from June 2003 to October 2014 and became constant soon after the eruption until September 2015. The ten-year helium-3 enhancement may have been a precursor of the 2014 Ontake eruption. In contrast, δ¹³C values of CO₂ at the same site stayed constant all over the period. Lack of δ¹³C anomaly may be attributable to ; 1) either negligibly small amounts of magmatic CO₂ introduced into the source of hot spring compared with ambient CO₂ in the aquifer; 2) or that the carbon signature of magmatic CO₂ is very similar to that of ambient CO₂ and thus its addition cannot change the overall δ¹³C value of the sampled hot springs. At the distant sampling sites no valuable changes of helium and carbon isotopes were observed in relation to the 2014 Ontake eruption, suggesting that the impact of this eruption on the Ontake hydrothermal system was geographically localized.