



## **Secular variations of helium and nitrogen isotopes related to the 2015 volcanic unrest of Mt Hakone, central Japan**

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Mt Hakone in central Japan erupted on 29th June 2015, ejecting small amounts of volcanic ash and gas. It was a tiny hydro-volcanic eruption although historically first one. We have conducted long-term and short-term survey of helium isotopes in the Owakudani geothermal area close to Mt Komagatake, central cone of Hakone Volcano. Long-term data of Black-egg site show generally constant  $3\text{He}/4\text{He}$  ratios with  $6.37 \pm 0.06 R_a$ , from July 1976 to October 2016 with a small peak in 1990-91. Short-term data of two fumarole sites indicate rapid increase from May to August 2015 and gradual decrease until January 2017, while seismic activity started to enhance in March 2015, arrived at the maximum in May and decreased faster than helium isotopes. The time sequence is summarized as; inflation of volcanic edifice > maximum swarm activity > phreatic eruption > maximum helium anomaly. We also measured elemental and isotopic compositions of nitrogen and argon in recent fumarole samples. They are well explained by a mixing of three components; mantle, sediment and atmospheric nitrogen in a  $\delta^{15}\text{N} - \text{N}_2/36\text{Ar}$  diagram. Short-term variation of air corrected  $\delta^{15}\text{N}$  value shows fast decrease and then slow increase, consistent with corrected  $3\text{He}/4\text{He}$  variation, suggesting a common driving source.