

He, CO₂ and heat fluxes in Aira caldera, Kyushu, Japan: Evidence for distinct degassing activity at Wakamiko and Sakurajima volcanoes

Emilie Roulleau¹, Yuji Sano², Naoto Takahata², Shinsuke Kawagucci³

¹Universidad de Chile, Departamento de Geología, CEGA, Santiago, Chile, ²The University of Tokyo, Atmosphere and Ocean Research Institute, Kashiwa, Japan, ³JAMSTEC, Yokosuka, Japan

E-mail: roulleau_emilie@yahoo.fr

Subduction zone volcanism is a key area to study volatile transfers from the upper mantle to the atmosphere and volatile recycling in the mantle. Aira caldera is a typical submarine caldera in subduction setting, composed of a subaerial volcano, the well known Sakurajima volcano, and a submarine crater, so-called Wakamiko. Sakurajima volcano presents many hot springs and bubbling gas spots in its flanks. Wakamiko crater shows large fumarolic bubbling gas emanation on its seafloor. To better understand the degassing activity related to the hydrothermal activity in Aira caldera, we calculate the volatile fluxes using two different methods. First, we determine for the first time, the helium and heat fluxes and also CO₂ flux based on the correlation between ³He/⁴He, temperature and water depth in Wakamiko crater, along with CO₂/³He ratios. Second, we calculate the helium flux at Sakurajima volcano from its estimated CO₂ flux and the global CO₂ flux.

The helium isotopic composition of Sakurajima hot springs ranges between 6.6 to 7.7Ra; it is 7.2Ra for Wakamiko seawater. This similarity of helium signature is strong evidence for a common magmatic reservoir for both Wakamiko and Sakurajima. He, CO₂ and heat fluxes calculated for Wakamiko are 900±211 mol/y (⁴He), 0.01±0.002 mol/y (³He), 184±43 t/d, and 195±22 MW, respectively. All these Wakamiko fluxes are at least one order of magnitude lower than those observed for Sakurajima (³He: 0.71 mol/y, CO₂: 1800 t/d, heat: 2100 MW; Kagiyama, 1981), implying that degassing at Sakurajima volcano is much stronger than that at Wakamiko crater. The variation of Sakurajima CO₂ flux (calculated from SO₂ flux (Kazahaya et al., 2012) and CO₂/SO₂ ratio) with time, source (Minamidake or Showa crater) and eruptive activity, appears not to significantly affect the CO₂ flux at Wakamiko crater, much more stable (132-307 t/d; Horibe et al., 1980; Dissanayake et al., 2012) during the last 30 years. This indicates that there is no link between Sakurajima and Wakamiko degassing activity, despite having the same magmatic source.