30-year secular variation in helium isotope ratios in Izu-Oshima volcano

*Hirochika Sumino[1], Kohei Yamane[2], Kaori Kawana[1], Toshiya Mori[3], Aya Shimizu[4], Kenji Notsu[5], Pedro Hernández[6]

1. Department of Basic Science, Graduate School of Arts and Sciences, The University of Tokyo, 2. Department of Integrated Science, College of Arts and Science, University of Tokyo, 3. Geochemical Research Center, Graduate School of Science, University of Tokyo, 4. Tokyo Metropolitan Industrial Technology Research Institute, 5. Center for Integrated Research and Education of Natural Hazards, Shizuoka University, 6. Instituto Volcanolo´gico de Canarias

Izu-Oshima is an active volcanic island located around 100 km SSW of Tokyo. The center of the island is occupied by a caldera complex with a diameter of 3 km. A large post-caldera cone known as Mt. Mihara is located at the south-western quadrant of the caldera. During the last 10,000 years, large-scale eruptive activities have occurred repeatedly once every 100-150 years. The historical activity of the present Izu-Oshima volcano, including Mt. Mihara was well documented since 7th century A.D. The last magmatic eruption occurred in 1986, followed by small eruptions emitting volcanic ash and steam until 1990. Secular variations in $^{3}He/^{4}He$ ratios of steam from an observation well located about 3 km north of Mt. Mihara have been intermittently collected and analyzed since October 1986, about a month before the beginning of the last magmatic eruption. The $^{3}He/^{4}He$ increased to 5.5 Ra, where Ra denotes the atmospheric $^{3}He/^{4}He$ ratio of $1.4x10^{-6}$, resulting from an increase in relative contribution of magmatic helium. After the $^{3}He/^{4}He$ peak in 1988, the $^{3}He/^{4}He$ ratios of the steam well gases decreased gradually due to depletion of magmatic gas emission and subsequent mixing with atmospheric helium entering the hydrothermal system (Sano *et al.*, 1991; 1995; Shimoike and Notsu, 2000; this study). The present $^{3}He/^{4}He$ value of the steam gas is around 1.4 Ra, which is close to the value observed before the 1986 eruption (1.7 Ra), indicating magmatic helium discharge has returned to the level before the last activity.
The corrected $^{3}He/^{4}He$ ratios for the atmospheric contamination based on $^{4}He/^{20}Ne$ ratio range from 5.9 to 6.5 Ra during the last activity between 1987 and 1990. The isotope ratios of helium dissolved in hot-spring water collected from a well 50 m east of the observation steam well in 2001 and 2016 were about 6.3 Ra after air-contamination. It is unlikely that mixing ratio of crustal helium (dominantly ^{4}He) and magmatic helium in the hydrothermal system has been constant for 30 years, thus the air-corrected $^{3}He/^{4}He$ ratio can be regarded as that of the magma. These indicate magmatic helium with $^{3}He/^{4}He$ ratio of ca. 6.3 Ra still has discharged without significant change in isotope ratio since the last eruption. The $^{3}He/^{4}He$ value of the magma is lower than the typical mantle value (8 ±1 Ra), suggesting crustal helium contamination to the magma chamber.

References: Sano *et al.* (1991) *Earth Planet. Sci. Lett.* 107, 95-100. Sano *et al.* (1995) *J. Volcanol. Geotherm. Res.* 64, 83-94. Shimoike & Notsu (2000) *J. Volcanol. Geotherm. Res.* 101, 211-221.

Keywords: helium, isotope, Izu-Oshima, volcanic gas, hot spring

