Rare earth composition in groundwaters in the Aso caldera

*Hitomi Nakamura[1], Noritoshi Morikawa[1], Hikaru Iwamori[2], Shuhei Sakata[2], Qing Chang[3]

1. Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, 2. The University of Tokyo, 3. Japan Agency for Marine-Earth Science and Technology

Recently, a variety of groundwater geochemistry, including rare earth elements, has been reported in diverse tectonic settings such as island arcs and continental regions (e.g., Nakamura et al., 2016; 2021), which shows that rare earth elements are useful to discuss groundwater circulation and upwelling processes of deep fluid. Around the Aso volcano, central Kyushu, there are numerous spring waters with a large variety in rare earth element abundances and patterns (Annual report of the Secretariat of the Nuclear Regulation Authority, 2020; Nakamura et al., 2021, JPGU abstract). According to the classification of major solutes by statistical analysis (whitened data-based k-means analysis, Iwamori et al., 2021, JPGU abstract), the variations in rare earth element abundances and patterns can be understood as products of combined independent processes and/or sources. Here we present the compositional variations of groundwaters in the Aso caldera and suggest the corresponding mechanisms to produce the variations in rare earth elements.
The Aso volcano has a caldera structure formed with huge four eruptions and numerous small eruptions (e.g., Kaneko et al., 2007). After the caldera formation, a cone named as Naka-dake at the center of caldera has been and is active. At the depth range from 8 to 12 km, the northward-dipping structure that could represent a fluid/magma supply system toward Naka-dake has been detected by the electromagnetic study (Hata et al., 2018). At the shallower levels near the surface, the groundwater circulation, which is mostly related to meteoric water cycling, has been revealed by statistical analysis of geochemical data of groundwaters; the meteoric water sourced along the caldera rim flows down to the caldera floor, where it meets and mixes with the meteoric water with magmatic components sourced in the central cone to produce an overall concentric structure surrounding the cone (Iwamori et al., in prep). We have examined the chemical composition of rare earth elements, associated to the distribution of major solutes based on the result of statistical analysis. As a result, we found a clear difference among the fluids coming from the caldera rim and the central cone. Also, a relatively low REE content is found in the groundwater coming from the central cone, compared to the fluids from the caldera rim. This indicates that the two circulation systems of meteoric water are well established in the Aso caldera, producing the variations in rare earth element abundances and patterns observed in the groundwaters in this area.

This study was supported by the Secretariat of the Nuclear Regulation Authority, Japan.

Keywords: groundwater, hot spring, REE

