

In situ Sr isotope ratio of plagioclase phenocrysts of tholeiitic and calc-alkaline volcanic rocks from Zao volcano, NE Japan

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Sr isotope ratio is basic and important geochemical tracer for studying magma generation and evolution processes. And, chemical compositions and texture of phenocrystic minerals can provide important constraints on magmatic processes, such as fractional crystallization, magma mixing and assimilation.

The Quaternary Zao volcano is located at the central part of the volcanic front of northeastern Japan arc. The Zao volcano has been active since 1Ma, and is divided into Stage 1 to Stage 4 (Sakayori, 1991). According to Sakayori (1991), the rocks of Stage 1 belong to tholeiitic series (TH), and all the other stages to calc-alkaline series (CA). Shibata et al. (2003) determined bulk Sr, Nd and Pb isotopic and rare earth element compositions for stage 1 and stage 3, and argued that four components are necessary to explain the chemical and isotopic characteristics of TH and CA from the Zao volcano. Thus, we selected the one sample from stage 1 and two from stage 3, and performed the In-situ Sr isotope analysis on plagioclase phenocrysts of TH and CA samples.

The experimental procedure is described as the following. The rock samples are cut to thin plates. Then, the thin plate is bonded on a slide glass, and polished. The In situ Sr isotope analysis was performed by combined method of microdrilling and Thermal Ionization Mass Spectrometer (TIMS). The microdrilling is the sampling technique of drilling a sample mechanically with a small drill and collecting the sample powder milled. The diameter at the tip of the drills used for sampling is 0.1 and 0.27mm. The collected sample powder was dissolved with acid, and Sr was separated using columns cation-exchange resin. Sr isotope measurement was carried out on the TIMS. Before the In situ Sr isotope analysis, major elements measurement of plagioclase was carried out on the electron probe microanalyzer.

The plagioclase phenocrysts contained in all samples of the Zao volcano show various textures, which can be divided into 6 types. We selected clear, dusty and Xenocryst like types of plagioclase. Clear type is typical in both TH and CA, and is lacks inclusions. Dusty and Xenocryst like types are observed to be characteristic in CA. Dusty type is characterized by a core mantled by dusty zone composed of plagioclase and fine melts inclusions. Xenocryst like type is most rare in all plagioclase types, and is characterized by sharp outline though allotriomorphic form.

Clear type in TH has a homogeneous core (An90-95) with rim showing continuous normal zoning. The core and rim $87\text{Sr}/86\text{Sr}$ ratios of this crystal (0.70426-0.70427) are lower than the bulk $87\text{Sr}/86\text{Sr}$ ratio (0.70435).

Clear type in CA shows homogeneous or slightly normal zoning (An50-75). The core and rim $87\text{Sr}/86\text{Sr}$ ratios of these crystals (0.70405-0.70410) are higher than the bulk $87\text{Sr}/86\text{Sr}$ ratios (0.70357 and 0.70388). Dusty type has reversely zoned core (An50-55) and a rim (An70), which were separated by a dusty zone. Furthermore, one dusty type grain has high An content internal core (An90) and outer core (An50-60) displayed discontinuous normal zoning. The An50 core $87\text{Sr}/86\text{Sr}$ ratios are 0.70415-0.70418, but high An internal core $87\text{Sr}/86\text{Sr}$ ratio is 0.70396. Xenocryst like type show homogeneous and high An content (An90), and the lowest $87\text{Sr}/86\text{Sr}$ ratio (0.70339).

The TH samples data suggest that plagioclase phenocrysts first grew in magma with stable chemical composition and Sr isotope ratios, and then, the magma was mixed with high Sr isotope ratio material. On the other hand, plagioclase phenocryst in CA has widely compositional range and Sr isotope ratios. Furthermore, dusty type was recording a change of Sr isotope ratio. Therefore, it is thought that two or more components participated in the magma evolution process of CA magma.