Genesis of tholeiitic and calcalcaline series of Zao volcano, NE Japan arc, employing trace element and isotopic compositions

Tomoyuki Shibata[1]; Atsushi Sakayori[2]; Qing Chang[3]; Yoshiyuki Tatsumi[3]

[1] BGRL, Kyoto Univ; [2] Dept. of Earth Sciences, Fac. of Education, Kanazawa Univ; [3] IFREE, JAMSTEC

Genesis of co-existing tholeiitic series (TH) and calcalkaline series (CA) in island arc and their relationship has been a focus of attention because it is critical to understanding magma genesis in island arc and continental crust formation. The Zao is Quaternary volcano situated on the Tohoku Backbone Ranges, Northeastern Japan arc, and both of TH and CA co-exist in continuous volcanic activity. In addition, geology and petrology of the Zao volcano is well understood by Sakayori (1991) so that Zao volcano is one of the suitable volcanos to elucidate the genetical relationship of TH and CA magma series. We already reported the preliminary results of Sr, Nd and Pb isotope and trace element compositions of Zao volcano, and shown that at least four components are necessary to explain the chemical characteristics of TH and CA of Zao volcano (Shibata et al, 2003). However, the sources and relationships of those components were still ambiguous. Therefore, we developed the discussions of the genesis of TH and CA from Zao volcano employing the Sr, Nd, Pb isotope and trace element compositions.

The volcanic activity of Zao volcano started about 1 Ma and continues to the present, and is divided into Stage 1 to Stage 4 (Sakayori, 1991). According to Sakayori (1991), the rocks of Stage 1 belong to TH (low-K), and all the other to CA (midium-K). And on the Harker Diagrams, volcanic rocks of Stage 1 and Stage 3 show obvious different trend and those of the other stage plotted in between those two trends. Thus, we selected the 5 samples from Stage 1 and 5 from Stage 3 as a representative of TH and CA, respectively. The trace element compositions of the studied samples show the typical characteristics of island arc magma in the diagram of MORB normalized pattern, such as enrichment of LILEs and negative Nb spike. Positive Pb and Sr spikes are also apparent. The LILEs enrichment and negative spikes of Nb are relatively larger in CA than TH. Although abundance ratios of Cs/Nb of TH are restricted to 0.09 - 0.20, those of CA can be divided into two ranges, such as 0.20 - 0.25 and 0.42 - 0.57.

The isotopic compositions of TH are more enriched compared to CA. In all the diagrams presenting the relationship of the isotope compositions, TH and CA make different liner trends, which indicate the mixing relation. Furthermore, Pb isotopic compositions suggest that two depleted endmember is necessary to explain the trend of TH and CA. The depleted endmenber of TH is relatively enriched than that of CA. On the other hand, tow enriched endmembers are required from the relationships between parent/daughter and the isotope ratios, because TH and CA show different linier trends in those relation and the liner trends are diverse in the direction of isotopically enriched side. The both of the enriched direction of TH and CA is differ from the mixing trend of mantle wedge and recycled materials form subducting slab observed from Northeastern Japan (Shibata and Nakamura, 1997). Therefore, slab component can not be a candidate of enriched endmember of TH and CA. Alternatively, it has to take account for the involvement of different crustal material. When we look at more in detail, isotopic trend of CA can be divided in to two trends on the bases of the low and high Cs/Nb ratios. The isotopic trends of CA with low Cs/Nb can have same isotopicaly enriched component. On the other hand, the isotopic trends of CA with high Cs/Nb differ from the direction of enriched extension of TH, and show a linier trends with pyroclastics occurred around the Zao volcano, which is considered as crust origin. From the observations in the above, it can be concluded that four components are necessary to explain the chemical characteristics of TH and CA from Zao volcano and the different two enriched components are derived from different crustal materials, although the sources of those are not obvious yet.