

Contrastive geochemical and petrological features of island-arc tholeiitic and calc-alkaline magmas at Adataro volcano

Akihiko Fujinawa[1], Eizo Nakamura[2]

[1] Environmental Sci., Ibaraki Univ., [2] ISEI(Misasa), Okayama Univ.

Adataro volcano is located at the volcanic front of the northeastern Japan arc (NEJ), having been active for recent 600000 years. The calc-alkaline magmatism has been dominant thorough the eruption history, whereas the tholeiitic magmatism occurred episodically around 0.35 Ma.

The tholeiitic and calc alkaline series at Adataro volcano show contrastive petrological and geochemical features which are mostly compatible with the general features recognized between the two series at the frontal zone of NEJ. Basaltic to basic andesitic members are dominant in the tholeiitic series, showing increase of FeO^*/MgO and maxima of FeO^* and TiO_2 around 56 wt% SiO_2 in the silica variation diagrams, and classified consistently into the low-K series. The calc-alkaline series is dominantly andesitic, showing no FeO^* and TiO_2 enrichment with increasing SiO_2 , and all the members are plotted within the medium-K series region. When compared at similar SiO_2 contents, the calc-alkaline series consistently shows high concentrations of not only incompatible elements such as Rb, Cs, Ba, Zr, but also compatible elements (Ni, Cr, Co, V) relative to the tholeiitic series. Further, LILE/HFSE, LREE/HREE, Rb/Ba, and Zr/Nb are also distinctive between the two, all of which are high in the calc-alkaline series. These ratios are kept constant with displaying flat REE pattern in the tholeiitic series. Also in the calc-alkaline series, LILE/HFSE, Rb/Ba, and Zr/Nb are virtually constant, whereas LREE/HREE slightly increases (dip from LREE to MREE becomes steeper) with increasing incompatible element contents.

The contrastive trends of major- and trace-element compositions between the two series likely reflect differences in the mechanisms operating during magmatic evolution. Geochemistry and petrology of the tholeiitic series concur with a model that the members of the tholeiitic series are able to be related through fractional crystallization of phenocrystic minerals. Geochemical and petrological data of the calc-alkaline series may be reconcilable by supposing composite mechanisms of evolution; crystal fractionation under low temperature and high $f\text{O}_2$ conditions (more magnetite crystallizes in the magma chamber) relative to the tholeiitic series is predominant, but internal mixing of co-genetic magma may operate concurrently.

Systematics of isotopic compositions is examined by adding newly analyzed Nd and Pb isotopic data to the already published $^{87}\text{Sr}/^{86}\text{Sr}$. All the isotopic ratios examined here are kept practically constant in each suites. Systematics of $^{87}\text{Sr}/^{86}\text{Sr}$ - $^{143}\text{Nd}/^{144}\text{Nd}$, $^{206}\text{Pb}/^{204}\text{Pb}$ - $^{143}\text{Nd}/^{144}\text{Nd}$, $^{208}\text{Pb}/^{204}\text{Pb}$ - $^{206}\text{Pb}/^{204}\text{Pb}$, and $^{207}\text{Pb}/^{204}\text{Pb}$ - $^{206}\text{Pb}/^{204}\text{Pb}$ for the tholeiitic series indicate that the source of the tholeiitic magma is enriched in components derived from oceanic sediment relative to the averaged magma source of basalts at frontal zone of NEJ. The isotopic systematics for the calc-alkaline series strongly suggests that incorporation of lower crustal materials is crucial in generating the primitive calc-alkaline magma. This view is compatible with the fact that the calc-alkaline series shows consistently higher LREE/HREE, Rb/Ba, and Zr/Nb ratios than the tholeiitic series.