# Petrogenesis of mafic inclusions of the Shirataka volcano, NE Japan

# Shiho Hirotani[1]; Masao Ban[2]

[1] Division and Interactive Symbioshere Sci., Yamagata Univ.; [2] Earth and Environmental Sci., Yamagata Univ.

The mafic inclusions, which are a minor but ubiquitous component of the so-called calc-alkaline andesite, are thought to be quenched products of the co-genetic mafic magma. As basalts are scarcely observed in most of the volcanoes in the back arc of NE Japan, mafic inclusions are helpful in providing the information of mafic end-members. We systematically collected mafic inclusions from the Shirataka volcano, and examined them in detail to clarify the petrologic characteristics of the mafic end-members.

Mafic inclusions are petrographically classified into two types. The hbl-bearing type (type 1, 48.3-54.1 wt% in $SiO_2$), with hbl occurring in groundmass, is gray to dark gray colored basalt to basaltic andesite. The dark gray colored inclusion was rarely contained inner part of the gray colored type. The dark gray ones (up to ca. 3 cm) show spherical in shape and sharp margin. Whereas the hbl-free type (type 2, 53.0-57.5 wt% in $SiO_2$) is light gray colored basaltic andesite to andesite. Both types of inclusions (up to ca. 30 cm) are subspherical in shape, and moderately vesicular. These are porphyritic, however, the amount of total phenocrysts is lower (ca. 5-10 vol.%) than in their host rocks (ca. 23-40 vol.%). The phenocrysts are ol, opx, cpx, and pl in type 1, whereas they are opx, cpx, pl, and qtz in type 2. Considering whole rock compositions, although some scatter can be seen, these compositions plot on the extension of the trend lines defined by the corresponding host rocks in most of the variation diagrams, except for the Cr and Ni diagrams. In the Cr and Ni diagrams, the data of mafic inclusions show two trends. High Cr-Ni type inclusions are embraced in high Cr-Ni type host rocks, and vice versa, indicating that high and low Cr-Ni types rocks originated from distinct eruptions. The dark gray colored inclusions correspond to the high Cr-Ni type, while the gray and light gray colored inclusions belong to the low Cr-Ni type. However, these features cannot be found in the incompatible elements vs. $SiO_2$ variation diagrams, e.g., $K_2O$, Rb, Zr, suggest that high and low Cr-Ni types mafic end-members are consanguineous. Moreover, estimated high Cr-Ni type end-members are poorer in Si content than low Cr-Ni type ones. Thus, considering these end-members are observed in $Al_2O_3$, CaO, FeO, and MgO diagrams, the differentiation of ol +Cr-sp (+pl) from the high Cr-Ni type magma may have caused the low Cr-Ni type magma.

In the magma feeding system of the Shirataka volcano, it is reasonable that these types inclusions have been produced by following processes. The silicic magma, which was produced by partial re-melting of the solidified mafic magma leaving a gabbroic residue, buoyantly ascended and settled to form a chamber in the shallow part of the crust. In the case of petrologic groups, which have only high Cr-Ni type of type 1 inclusions in the corresponding host rocks, the high Cr-Ni type magma ascended and injected into the silicic magma chamber to be inclusions. With respect to the other groups, most of observed mafic inclusions are low Cr-Ni type of type 1 and 2 ones, and type 1 inclusions rarely have dark colored high Cr-Ni type ones. At first, high Cr-Ni type mafic magmas injected into the silicic chambers of low Cr-Ni type, and formed zoned magma chambers. In the lower part of the zoned chambers, the low Cr-Ni type mafic magmas to form low Cr-Ni type of type 1 inclusions, have been likely produced by the differentiation. In addition, in the periphery of the boundary of the zoned magma chamber, the differentiated magma diffuse volatile components toward silicic magmas, and also promoted even more differentiation of the magma, which would be type 2 inclusions. Afterwards, high Cr-Ni type mafic magmas newly injected into the lower part of the zoned silicic magma chamber though the different vent from ascended silicic magmas. As a result, peculiar type 1 inclusions, which comprise dark colored high Cr-Ni type ones, are formed.