High-Mg Andesites generated by magma mixing: a case study of Ebisumori, Hachimanntai volcanoes

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High-magnesian andesites, containing much MgO up to 8wt% for andesitic silica contents (54.6-56.0wt%), occurred at Ebisumori , Hachimantai volcanic field , northeastern Japan. These rocks contain phenocrysts of plagioclase, augite, orthopyroxene , olivine , titanomagnetite , picotite , ilmenite , and rare quartz. These phenocryst minerals exhibit many disequilibrium aspects. Plagioclase phenocrysts involve reverse zoning, dusty zones , and sieved textures , and their compositions are bimodal (An60~67 , An81~95). Pyroxene phenocrysts are chemically zoned reversely. Iron-magnesium partitioning is not in equilibrium between olivine and pyroxenes. Small picotite phenocrysts involve chemical zoning and their rims are titanomagnetite except for those included in olivine. Olivine commonly involves normal zoning, but reversely zoned olivine was rarely found.

Groundmass compositions exhibit a parallel trend to whole rock compositions. Linear chemical variation of whole rock is not due to variation in proportions of crystals to an identical liquid, e.g. accumulation of phenocrysts or xenocryst , since groundmass compositions are not invariant. Therefore, these high-magnesian andesites from Ebisumori were generated by magma mixing.

Based on paragenesis of phenocrysts in terms of crystal connection and inclusion, phenocryst minerals can be divided into two assemblages: one including low-Ca plagioclase (An60~67), augite , orthopyroxene , titanomagnetite , and ilmenite , and the other including olivine , high-Ca plagioclase (An81~95) , and picotite. One assemblage is not in equilibrium with the other compositionally. Modal abundance of olivine decreases with increasing those of plagioclase, pyroxenes, and total phenocrysts. These imply that one endmember contained olivine, picotite, and rare high-Ca plagioclase, and the other contained pyroxenes , Fe-Ti oxides , much low-Ca plagioclase. As a matter of fact, the mafic endmember magma occurred as a glass inclusion in a picotite phenocryst , and its composition is similar to a primitive basalt (SiO_2=49~52wt% , MgO=10~12wt%). The glass composition is consistent with the chemical variation in whole rock chemistry of these mixed andesites. The felsic endmember magma is estimated as an andesite magma (SiO_2=57~58wt%) with the relation between modal olivine abundances and bulk compositions. Applied pyroxene geothermometer (Lindsley, 1983) , temperature of the felsic endmember was estimated as 900-1000C.