Equilibrium calculations of calc-silicate xenoliths by the Gibbs free energy minimization method

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The purpose of this study is to realize the behavior of fluid during metamorphism of calc-silicate xenoliths (NS1; 25 cm in diameter, IW10; 1 m in diameter). I determined the volumetric fluid/rock ratios and molar SiO_2/H_2O ratios of the xenoliths from equilibrium calculations of systems, which are chemically equivalent to protoliths of each xenoliths plus fluid, by using the gibbs free energy minimization algorithm of de Capitani and Brown (1987).

Description of calc-silicate xenoliths

The calc-silicate xenoliths croped out in granite quarries of Kasama, Ibaraki Prefecture, Japan. Protoliths of them were sedimentary carbonate rocks from the adjacent Yamizo Group. Calcite, dolomite and chondrodite ($Mg_5SiO_4(OH,F)_2$) are the main constituents of the central part of them.

Equilibrium calculations

It was assumed that the xenoliths were formed from calcite and dolomite, and H_2O fluid, which contained SiO_2 and HF. Molar ratio of them except for H_2O were calculated from modal and chemical composition of constituent minerals of the xenoliths. The stability field of mineral assemblages on P-T pseudosections varies with amount of H_2O. P-T conditions of the xenoliths (1.5~3 kbar and 620~670°) are obtained from metamorphic conditions of adjacent Tsukuba and Wagakunisan metamorphic rocks (Miyazaki et al., 1992; Miyazaki, 1999). The most suitable amounts of H_2O, which stabilize chondrodite + calcite + dolomite at the P-T conditions, were determined for each xenoliths. The calculated volumetric fluid/rock ratios of NS1 and IW10 at 650 °, 2 kbar are 1.18 and 0.41, and the molar SiO_2/H_2O ratios of them are 0.11 and 0.03, respectively.

Interpretation of Result

The fluid/rock ratios, which are higher than porosity of common rocks, are evidence for fluid infiltration during metamorphism. The SiO_2/H_2O ratios, which are considerably higher than solubility of SiO_2 in H_2O, suggest that SiO_2 was mainly transported within the fluid by diffusion. The higher ratios of smaller xenolith (NS1) suggest that the effects of fluid infiltration and diffusion depend on xenolith size.

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Geological settings and geochemical characteristics of the Mn-oxide deposits in NE Pontide, NE Turkey

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There are approximately one hundred Mn-oxides deposits in the NE Pontides (NE Turkey). These are placed in Senonian aged reddish biomicrites in the Upper Cretaceous aged volcano-sedimentary rocks (Yalcinalp, 1992). They show features of exhalative sedimentary settlement, and especially occur at Ardanuc-Borcka (Artvin) and Arakli-Macka (Trabzon) region. Generally they have been observed in the shape of lens, stockworked and dissemined structure. Dominantly ore minerals are braunite and bixybite. In addition, native gold (10 gr/ton) and electrum are observed at the some deposits near Macka (Trabzon).

Volcanogenic Mn-Oxides deposits are formed related to bimodal volcanism developed inner arc rift area of the Pontide which has volcanic characteristics being affected by extensional regime at the Upper Cretaceous. As a result of acidic and reductic hydrothermal solutions mixed with sea water, exhalative sedimentary Fe and Mn-oxides exist. Density of the braunite and bixybite indicates that these deposits are vein type hydrothermal in which increment condition and high temperature develop (Choı and Hariya, 1992; Roy, 1992). Mn-oxides samples have been major and trace element analysed. They have 14-30% SiO_2, 0,8-2,5% Al_2O_3, 52-72% MnO, 0,7-3% MgO, 0,5-2% Na_2O and 0,4-2,5% K_2O, and show low Al, Fe/Mn but high Ni, Zn, Ba contents. This geochemical variations and Si-Al diagram (Fig.1) indicate that hydrothermal activities factor in forming these deposits. Bedding structure, shapes, mineralogical and geochemical characteristic of the Mn-oxides deposits have suggested that this mineralization is hydrothermal origin.

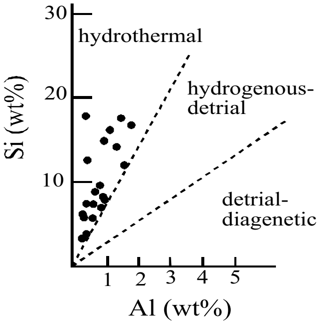

Fig.1. Geochemical origin diagram of the Mn-oxides deposits in the NE Turkey (after Crerar et al., 1982)

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