Stable isotope evidence for fluid flow during spurrite skarn formation at Fuka, Okayama.

Satish-Kumar Madhusoodhan[1], Yasuhito Yoshida[1], Hideki Wada[1], Isao Kusachi[2]

[1] Faculty of Science, Shizuoka Univ., [2] Faculty of Education, Okayama Univ.

Contact metamorphism is accompanied by fluid flow that results in formation of skarn deposits. Studies on skarn deposits are often carried out in the low to medium temperature conditions resulting from granitic intrusions. It is rare to find high temperature skarn (- 1000 C) accompanying large scale fluid flow in contact aureoles. Here we present the petrologic and stable isotope results of the spurrite-bearing skarn formation at Fuka, Okayama. The contact aureole here is famous for the peculiar occurrence of high temperature skarn. It is also notable for the finding of eight new calcium-boron-bearing minerals and tens of other rare minerals. The formation of skarn is considered to be resulting from the intrusion of Mesozoic quartz monzonite into Paleozoic marine carbonate rocks. The common high temperature minerals found in this skarn are spurrite [Ca5Si2O8(CO3)] and gehlenite [Ca2Al2SiO7]. Other associated minerals such as foshagite and hillebrandite form by hydration reactions in a later stage. Several earlier studies considered mineralogical aspects and geochemical mass transport.

The spurrite skarn examined in the present study is from Fuka mine, where the contact of igneous rock (several cm thick dike) and marble a reaction zone (a few meter) comprised of mainly spurrite was found in the quarry face. In order to find out the isotope alterations inside the marble from the contact zone, systematic sampling of marble was carried out (marble in contact with spurrite, marble 30cm away from contact, marble 60cm away from contact and marble 230cm away). Millimeter scale calcite samples were then carefully drilled out from slab samples perpendicular to the contact. Spurrite from the contact zone was reacted with phosphoric acid in vacuum to release CO2, which was measured for carbon and oxygen isotopes. The carbon isotope values at the contact of spurrite and marble show a smooth diffusion profile, whereas oxygen isotope shows more scattered values. The values become constant after a distance of 30mm.

The formation of spurrite skarns occurred at high-temperature contact metamorphism with considerable amounts of material transport from the intrusive quartz monzonite. Average aqueous silica concentration of the fluid is about 2.5 x 103 mol/liter. Temperature condition during the spurrite formation is between 980 C and 1080 C and the XCO2 was between 0.25 and 0.42. Earlier geochemical studies have also shown that there was extensive mass transport during the skarn formation. Carbon and oxygen isotope shifts in the spurrite zone is caused by the combined effect of decarbonation and fluid flow. The carbon and oxygen isotope profile within marble from spurrite-marble contact indicates that carbon has moved by lattice diffusion, whereas oxygen moves by both lattice and grain boundary diffusion. Also, it is found that during high temperature (greater than 1000 C) skarn formation the diffusion constants of carbon and oxygen species resembles, in contrast to the low temperature hydrothermal skarn forming fluids, where oxygen diffuses several times than carbon.