Formation of Corona around Corundum from Akarui Point in the Lützow-Holm Complex, East Antarctica: Controlling factor and P-T slope of reaction

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Corona, a disequilibrium texture, is often found in metamorphic rocks. Its textural feature that preserves both reactant and product minerals gives us various information for metamorphc reactions including mass transfer, diffusion and pressure (P) –temperature (T) path. In this study, we dealt with a corona developing between corundum and hornblende in ultrabasic gneiss, and revealed controlling factor of zonal arrangement, reaction, volume change and P-T slope of corona formation.

The studied gneiss composed mainly amphibole and plagioclase was collected from Akarui Point in the Lützow-Holm Complex, East Antarctica. Corundum grains in the rock are surrounded by corona composed of green spinel, sapphirine and plagioclase that are regularly arranged from corundum to the matrix. In the matrix, hornblende, plagioclase and gedrite occur together with minor brownish-green spinel, biotite and opaque minerals. The brownish-green spinel also occurs as inclusion in corona plagioclase or at the outer border of corona sapphirine.

Chemical composition of corundum is almost pure Al_2O_3. Cr content in green spinel is as low as 0.00 –0.01 apfu (O = 4), while brownish-green spinel contains significant amount of Cr as 0.08 –0.26 apfu. Si content of corona sapphirine increases and Al content decreases outward. Anorthite content [=100*Ca/(Ca+Na)] of corona plagioclase decreases from inner to outer part (from 89 to 78). Hornblende and gedrite are classified with pargasite and sodicgedrite according to Leake et al. (1997), respectively. Ca/(Ca+Na) of hornblende ranges from 0.67 to 0.74.

Al contents of constituent minerals normalized by 40 oxygen decrease in the following order: corundum, spinel, sapphirine, plagioclase and hornblende. Corona sapphirine and plagioclase show a similar feature that Al decreases outward. Si content shows inverse trend to Al in sapphirine and plagioclase, so these features suggest that diffusion of Al and Si controlled corona formation.

Stoichiometric equation of the reaction is estimated by considering mass-balance in the Na_2O –CaO –MgO –Al_2O_3 –SiO_2 –H_2O system. The value of Ca/(Ca+Na) differs between hornblende and plagioclase, which requires to treat Na, Ca or both as mobile component. The resultant equations are inconsistent with the microstructure in the case of only one mobile component (Na or Ca). Calculation with treating both Na and Ca as mobile component provides following equations in which stoichiometric coefficient of plagioclase, x, is introduced as a variable.

Hbl + (8.24 –0.86x)Crn + (– 1.65 + 0.83x)Ca = (– 10.47 + 5.23x)Spl + (2.19 –0.76x)Spr + xPl + (0.68 –0.17x)Na + H_2O.

The microstructure constrained the range of x as 2.00 –2.87. This result suggests that inflow of Ca and outflow of Na occurred during corona formation.

We also estimated volume change and slope in P-T space of the reaction by using standard molar volume and entropy of Holland and Powell (1998). Total volume and entropy of products are always larger than those of reactant in the range of $2.00 < x < 2.87$. This result means that volume increased by the corona formation and the slope of the reaction is positive. Previous studies (e.g., Iwamura et al. 2013) have revealed that the complex experienced nearly isothermal decompression in a clockwise P-T path. It may be suggested that the corona-forming reaction took place during the decompression.

We conclude the history of the corona formation as bellow. Corundum contacts with hornblende before corona formation at high pressure. The corona-forming reaction that has positive P-T slope was triggered by decompression. The diffusion of Al and Si controlled the rate of mass transfer, during which Ca was supplied and Na was released.

Keywords: corona, reaction texture, the Lützow-Holm Complex

