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Temperature estimate of the Bt-Grt gneiss from Akarui Point, East Antarctica and biotite formation by local fluid infiltration

Aya Nakamura[1]; Masao Kitamura[2]; Tetsuo Kawakami[1]

[1] Kyoto Univ.; [2] Dept. Geology and Mineralogy, Kyoto Univ.

The Bt-Grt gneiss from the Akarui Point, Lutzow-Holm Complex, East Antarctica is mainly composed of coarse-grained Grt with 1cm diameter, Bt, Sil, alkali feldspar, quartz and plagioclase. The peak pressure-temperature condition of this rock was previously estimated to be 7.7-9.8 kbar, 770-790^{o}C using Grt-Bt geothermometers and GASP geobarometers (Kawakami et al., 2008). The alkali feldspar with perthitic texture is abundantly present in the rock matrix of the gneiss. In such alkali feldspars, domains with perthitic texture (Type I) adjoining anti-perthitic texture (Type II) are often found within single alkali feldspar crystal. Anti-perthitic texture is characteristically developed next to biotite grains. Lamella of the perthite texture varies from 3 um to 10 um in width, and both of them even coexist in single alkali feldspar grain. Thin lamellas, especially, are not perfectly straight although they tend to be uniform in width. They occasionally bifurcate, and their ends are pointed. Therefore, this perthite texture is a microperthite although it is formed through spinodal decomposition.

The formation temperature of the Type I alkali feldspar is estimated by recalculating the alkali feldspar composition before lamella formation utilizing the compositions of host K-feldspar and lamella plagioclase. As a result, the reintegrated composition is Ab43.8-49.0 An3.9-4.7 Or46.6-51.7, and the ternary feldspar thermometer (Fuhrman & Lindsley, 1988) gave above 825^{o}C. This temperature is nearly the same with the highest temperature estimate in the Akarui Point. Based on the phase diagram of Bowen & Tuttle (1950) and Morse (1970) on Ab-Or-H_2O system, this recalculated composition of alkali feldspar is not stable as single phase under high P(H_2O), but is stable under low P(H_2O). Therefore, Type I alkali feldspar would have been stable as a single phase at near peak-metamorphic temperature condition under low P(H_2O).

Type II alkali feldspar, on the other hand, was probably formed from Type I alkali feldspar forming biotite. When lamellas in the Type I alkali feldspar is in high angle with adjoining biotite, it is often observed that protuberances of biotite are developed against alkali feldspar every 3-5 um at the contact between them. Protuberances are selectively developed next to K-feldspar and the thickness of the K-feldspar gradually decreases towards biotite. Protuberances of biotite are not developed next to albitic lamellas. That is, Type II alkali feldspar is formed between Type I alkali feldspar and the protuberances of biotite. Based on this texture, we consider that protuberances of biotite were formed by consuming potash in Type I alkali feldspar. Because growth of biotite requires water, this reaction would have been driven by the infiltration of water. However, this kind of texture is not always developed at the grain boundary between biotite and alkali feldspar. Therefore, retrograde rehydration reaction only occurred where the aqueous fluid infiltrated, and consumed orthoclase component in Type I alkali feldspar to form Type II alkali feldspar and biotite. From the above discussion, it would be concluded that retrograde aqueous fluid did not infiltrate along every grain boundary but was localized at specific grain boundaries.

References

Bowen & Tuttle (1950) J Geol 58, 489-511.
Fuhrman & Lindsley (1988) Am Min 73, 201-215.
Kawakami et al. (2008) GSL Sp Pub 308. 351-375.
Morse (1970) J Pet 11, 221-251.