東南極セールロンダーネ山地パーレバンデおよびバルヒェン山に産する泥質変成岩類

河上哲生 [1]、サティシュ・クマール [2]、土屋範芳 [3]、石川正弘 [4]、東野文子 [1]、ジェフ・グランサム [5]、吉田健太 [1]
[1] ***京都大学***、 [2] ***静岡大学***、 [3] ***東北大学***、 [4] ***横浜国立大学***、 [5] ***南アフリカ地球科学委員会***

Pelitic metamorphic rocks from Perlebandet and Balchenfjella, Sør Rondane Mountains, East Antarctica

Tetsuo Kawakami[1], M. Satish-Kumar[2], Noriyoshi Tsuchiya[3], Masahiro Ishikawa[4], Fumiko Higashino[1], Geoff Grantham[5] and Kenta Yoshida[1]
[1]*Kyoto University,* [2]*Shizuoka University,* [3]*Tohoku University,* [4]*Yokohama National University,*
[5]*Council for Geoscience, South Africa*

In order to understand the fluid activity in the continental collision zone, it is important to observe the microtextures that are related to the fluid activity. The metamorphic rocks in Sør Rondane Mountains, East Antarctica are apparently strongly affected by the fluid activity postdating peak metamorphism, which is observed, for example, as a replacement of garnet porphyroblast by biotite. Our goal is to understand the fluid activity in the framework of pressure-temperature-time-fluid composition path (*P-T-t*-fluid path) and unfold when and where the fluid activity took place during continental collision event and constrain the volume and composition of the fluid and whether it was generated locally or from external sources. Our results on carbon and oxygen isotopes show that significant fluid activity took place throughout Sør Rondane Mountains, and it is clearly recorded in marbles (Tsuchiya et al., 2010). In this study, we try to find out the trace of fluid activity from the pelitic metamorphic rocks that are often found adjacent to the marbles and calcsilicates in Sør Rondane Mountains.

Before constraining the fluid activity it is essential to understand the P-T evolution of the region in detail. We have identified new localities of retrograde andalusite from Perlebandet and prograde kyanite from Balchenfjella, Sør Rondane Mountains, as described in detail below.

Retrograde andalusite from Perlebandet is found in the migmatitic garnet-sillimanite-biotite gneiss. The gneiss contains large porphyroblast of subgrained sillimanite that is partly overgrown by garnet. The rim of the sillimanite includes spinel (ZnO = 4-6 wt%, XMg = 0.18-0.22) grains. In the matrix, fine-grained garnets are replaced by andalusite + biotite assemblage (Fig. A). Therefore, the reaction

Grt + Kfs + fluid → And + Bt + Qtz (1)

is likely to have occurred. Garnet porphyroblast is also present in the same sample, and are irregularly-shaped. The garnet (Grt1) includes sillimanite and spinel (Spl1; ZnO = 4-5 wt%, XMg = 0.28), and is partly replaced by the aggregate of Bt+And+Crn+/-Ms at the rim (Fig. B). This aggregate is rimmed by garnet (Grt2). Grt2 and the aggregate includes spinel (Spl2; ZnO= 11-13 wt%, XMg = 0.18). Elemental mapping shows that Grt1 has higher pyrope and phosphorus contents and Grt2 is lower in them. This suggests that Grt1 and Grt2 represent different stages of formation. Tiny phosphate grains are distributed around Grt1 where the Bt+And+Crn+/-Ms aggregate and Grt2 are developed. Grt1 does not include phosphate at all. These observations imply that breakdown of phosphorus-bearing garnet (Grt1) caused the formation of the Bt+And+Crn+/-Ms aggregate, Grt2 and phosphate(s). The zinc-rich nature of the Spl2 relative to Spl1 may imply that Spl2 was formed through recrystallization of Spl1. This reaction is basically the same as the reaction (1) proposed above, and may be written as follows:

Grt1 + Spl1 + Kfs + fluid → Grt2 + Spl2 + phosphate(s) + Bt + And + Crn +/- Ms. (2)

In the aggregate part, kyanite is locally found included in andalusite. Because only one kyanite grain is found so far, whether this kyanite is retrograde in origin or originally included in garnet as a prograde product is still not clear.

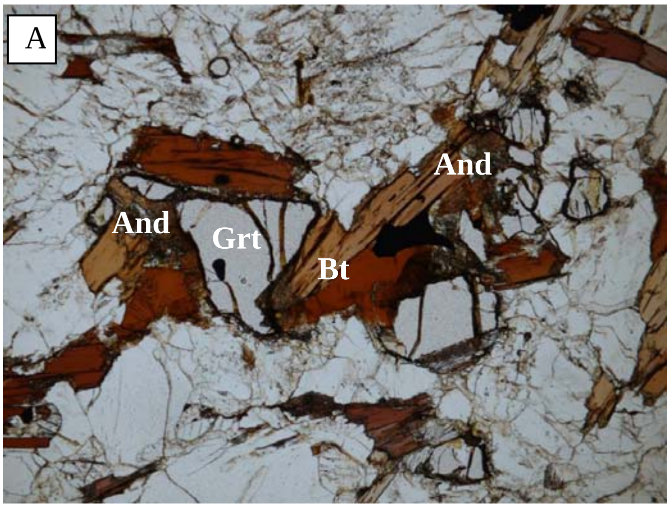
New finding of retrograde andalusite (+retrograde biotite) from Perlebandet and previous reports of retrograde andalusite from the northern part of the central Sør Rondane Mountains (Shiraishi et al., 1997) shows that significant fluid infiltration occurred in the northwestern Sør Rondane Mountains under the andalusite stability field.

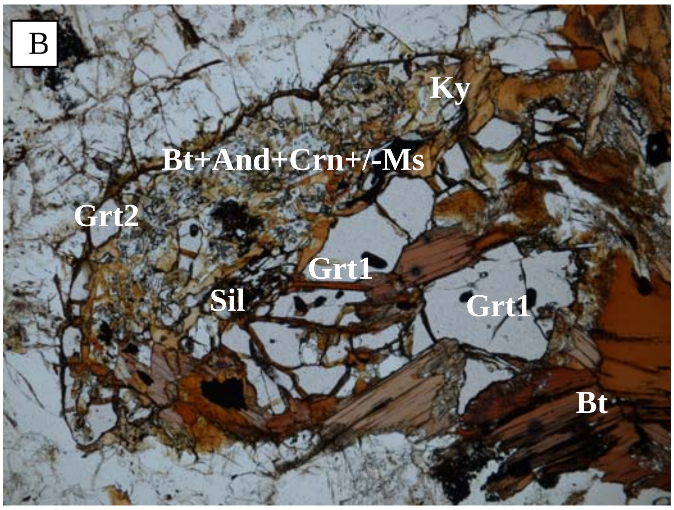
Prograde kyanite is found from the new outcrop at northern Balchenfjella. Kyanite grains occur as matrix phase or surrounded by garnet overgrowth. When not completely overgrown by garnet, sillimanite is found with kyanite. Finding of this new outcrop strengthens the tendency that prograde kyanite is found in the northeastern part of Sør Rondane Mountains.

Higashino et al. (2010, this volume) reports the ideal sample to constrain the timing of fluid infiltration in northern Balchenfjella. This pelitic gneiss sample contains garnet that includes Cl-rich biotite and large zircon grains. Interestingly, garnet is zoned in terms of phosphorus and the zoning profile implies that the garnet was once resorbed and recrystallized. The Cl-rich biotite and large zircon grains are both included exclusively in the recrystallized rim, implying their genetic correlation.

The Cl-rich biotite is not found in the rock matrix, possibly because such a biotite re-equilibrated with the matrix phases (including fluid) and changed its composition during retrograde metamorphism. Large zircon grains and the Cl-rich biotite are locally found together in the rock matrix of other sample as well (Fig. C).

Because Cl-rich biotite formation is related to the Cl-bearing fluid and Cl-content in biotite reflects the activity of HCl in the fluid (e.g. Sission, 1987), zircon formation and Cl-rich biotite formation could be genetically correlated to the Cl-rich fluid infiltration. Recent experimental study shows that Cl-rich Ca-bearing fluid can dissolve zircon (Dunkley et al., 2010). Therefore, it is possible that Cl-rich fluid can transport zirconium under the coexistence of other cations. Zircon-bearing vein cross-cutting the marble layer from northern Balchenfjella is a supporting evidence that zirconium was mobile during the metamorphism in Sør Rondane Mountains. By constraining the field distribution pattern of the Cl-rich biotite and by dating the zircon grains that is found together with the Cl-rich biotite, we could evaluate the scale and timing of fluid activity in Sør Rondane Mountains. Carbon and sulfur isotopic studies may also help to constrain the origin of the Cl-rich fluid.





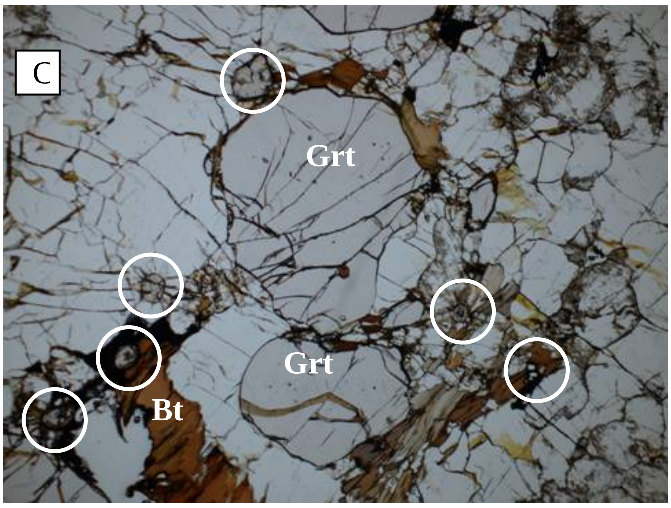


Fig. A Garnet grains partly replaced by the Bt + And assemblage.Width of photo is 3 mm (sample TK2009113001G2, Parlebandet)

Fig. B A garnet grain partly replaced by the Bt+And+Crn+/-Ms aggregate. Sillimanite and kyanite are also found in this texture. Width of photo is 3 mm (sample TK2009113001G2, Parlebandet).

Fig. C Large zircon grains associated with garnet and biotite. Biotite adjecient to zircon grains are relatively rich in Cl. Zircons are shown by circles. Width of photo is 6 mm (sample TK2010011404B, northern Balchenfjella).

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