Magmatic andalusite in the migmatite from the Aoyama area, Ryoke metamorphic belt, and its importance in constructing the P-T path

Tetsuo Kawakami[1]

[1] Dept.of Geology and Mineralogy, Kyoto Univ

http://www.kueps.kyoto-u.ac.jp/~kawakami/index.html

Magmatic andalusite is found form the metatexite that distributes in the Grt-Crd zone of the Aoyama area, Ryoke metamorphic belt, SW Japan. Andalusite crystals in the Sil-Kfs zone and low temperature part of the Grt-Crd zone are always partly transformed into sillimanite. On the other hand, magmatic andalusite crystals found from the low temperature part of the Grt-Crd zone are euhedral, and are not transformed into sillimanite. They are characteristically found from the leucosome. The finding of the magmatic andalusite from the low-temperature part of the Grt-Crd zone suggests that the P-T path of this zone may pass through the overlapping region of water-saturated solidus and andalusite stability field, and have experienced almost isothermal decompression.

Magmatic andalusite is found form the metatexite that distributes in the Grt-Crd zone of the Aoyama area, Ryoke metamorphic belt, SW Japan.

In the Aoyama area, pelitic-psammitic schists are distributed in the north, but metatexite to inhomogeneous diatexite are dominant in the south. Andalusite crystals in the Sil-Kfs zone and low temperature part of the Grt-Crd zone are generally partly transformed into sillimanite, suggesting that the peak P-T conditions of the Aoyama area have reached to the sillimanite grade.

On the other hand, magmatic andalusite crystals found from the low temperature part of the Grt-Crd zone are euhedral, and are not transformed into sillimanite. They are characteristically found from the leucosome. The rim part of the magmatic andalusite is replaced by a thin layer of fine-grained aggregates of muscovite. Magmatic andalusite is considered to be the retrograde product because they are not transformed into sillimanite, which implies that these crystals did not experience the prograde andalusite-sillimanite transition, and because they are found from leucosome parts and are euhedral.

Following two modes of occurrence are found from two different localities:

1) Magmatic andalusite from the leucosome that is filling the interboudin partitions, which occurs near the schist-migmatite transition. Leucosome consists of Qtz+Pl+Kfs+Tur+Ms+Bt+Ap and magmatic andalusite. Magmatic andalusite, Pl, Tur and Ap show euhedral shape.

2) Magmatic andalusite from the metatexite leucosome which consists of Qtz+Pl+Kfs+Ms+Bt +Crd.

Euhedral andalusite is also found from the high-temperature part of the Grt-Crd zone. This andalusite crystal coexists with Qtz+Ms+Bt and euhedral to subhedral cordierite pseudomorph now observed as a fine aggregate of muscovite. Because andalusite and cordierite show euhedral shape, the origin of these crystals can be magmatic. However, this rock does not contain plagioclase and K-feldspar, implying that the origin of it can be different from that of 1) and 2).

In order to crystallize such magmatic andalusite, water saturated solidus must have an overlapping region with andalusite stability field. The presence of this overlap is often ascribed to the solidus-lowering effect of fluorine and/or boron in the melt. However, tourmaline-bearing leucosome containing magmatic andalusite is limited to one locality and, therefore, it is difficult to explain the solidus lowering only by means of the effect of fluorine and/or boron in this study. Rather, addition of the Al2O3 to the subaluminous Qtz-Ab-Or system, which may result in the lowering of solidus temperature, may played an important role in the crystallization of the magmatic andalusite (e.g. Johannes and Holtz, 1996).

The finding of the magmatic andalusite from the low-temperature part of the Grt-Crd zone may suggest that the P-T path of this zone may pass through the overlapping region of water-saturated solidus and andalusite stability field. If we adopt the aluminosilicate phase diagram of Holdaway (1971) and assume that the peak P-T conditions of the Grt-Crd zone to be 650-800C, 4.0-6.0kbar (Kawakami, 2001) and that water-saturated solidus is lowered for 20 degrees by saturating in muscovite and aluminosilicate (Johannes and Holtz, 1996), it follows that the low-temperature part of the Grt-Crd zone have experienced almost isothermal decompression. The peak P-T conditions of the Grt-Crd zone can be much higher, because it was estimated using the Grt-Bt geothermometers. Even if this possibility is considered, the existence of the magmatic andalusite may suggests that the P-T path of the Grt-Crd zone is not a hair-pin shaped one.