

Morphological change of zircon under high temperature metamorphism: Example of the Kiso Ryoke metamorphic rocks

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Zircon is an important key mineral to obtain the age of rocks, however zircon newly grew at each metamorphic cycle and its timing of crystallization should have been recorded as U-Pb age. It is not always fully understood how zircon crystal grows at different metamorphic grade. Williams (2001) demonstrated that the behavior of zircon has been changed accompanying with metamorphic grade in Cooma complex, SE Australia. In low grade, there are detrital zircons but in high grade, overgrown or newly formed zircons are observed. Kawakami et al (2013) reported the behavior of zircon in the upper-amphibolite to granulite facies schist/migmatite transition, Aoyama area, Ryoke metamorphic belt. They concluded that the recrystallization of zircon has been controlled by partial melt. Thus, crystal morphology is quite important for understanding the U-Pb age of zircon.

This study reports morphological change of zircon crystal at different metamorphic grades in the Kiso area, Ryoke metamorphic belt in Central Japan, where metamorphic grade continuously increases from non-metamorphic (Mino belt) to migmatite facies, similar with Cooma complex. The district is located in northeastern part of Mt. Kisokomagatake and the study area is about 43km from north to south, and about 22km west to east. In this district, regional metamorphic rocks (metasediments, quartz schist, basic schist, and carbonate rocks, etc.) and non-metamorphic rocks widely occur. Morikiyo (1984) classified the district into nine mineral zones (I to VII) based on the mineral assemblages.

We have studied total 46 samples from all zones. Mineral assembles of the studied samples indicate the following characteristics features: biotite appears in zone II, albite disappears in zone IIIa, chlorite disappears in zone IIIb and sillimanite appears in zone VIa.

On the basis of the optical microscope and SEM observations, morphology of zircon is divided into 3 groups, such as zones I-II, zones IIIa-V and zones VIa-VII.

Zones I-II: Under the optical microscope, each zircon grain shows different color (purple, pale-pink and colourless). Zircon grains are essentially euhedral, and show variable range of grain size (40-220 μm). In SEM observation, the abrasion and cracks are notable in zircon crystal surface. The above observations are consistent that the zircons in these zones are detrital origin that were derived from a variety of different source rocks.

Zones IIIa-V: Surface of zircon in these zones are irregular and rough with small holes which are likely to reflect resorption during the metamorphism. In contrast with the zircons from zones I-II, zircon crystal surface is relatively rough and shows no abrasion and cracks. But, even in the same zircon grain, both resorption surface and non-resorption surface can also be observed. Non-resorption surface is considered to preserve detrital surface (same with zone I-II), and resorption surface possibly reflects metamorphic dissolution or recrystallization (similar to zone VIa-VII). According to BSE images, no obvious new growth zone can be observed in many of zircon grains, but a few grains show sign of new overgrowth zone. Grain size of newly growing zircon is relatively small about 30 μm .

Zones VIa-VII: Surface of zircon in these zones is relatively smooth, which differs from rough crystal surface in zones IIIa-V. It is assumed that the irregular surface of zone IIIa-V zircons are overgrown and filled by smooth surface as temperature increases to zones VIa-VII. In the highest-grade zone VII, the rough surface is disappeared, and smooth zircon grains are dominated.

Thus in the Ryoke metamorphic rocks from Kiso area, crystal morphology of zircons changes from the dominant detrital signature in the lowest-grade zone through irregular and rough resorption and recrystallization features in the middle-grade zone to the more smooth overgrowth recrystallization in the higher-grade. New zircon grain growth can be found in the middle to higher-grade zone.

Keywords: zircon morphology, regional metamorphism, Ryoke belt