

# Pressure-temperature estimates of the Lützow-Holm Complex utilizing distributions of trace elements and inclusions in garnet porphyroblasts in pelitic gneisses

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The Lützow-Holm Complex (LHC) in East Antarctica is a late Neoproterozoic to early Cambrian orogenic belt, formed during the amalgamation of Gondwana and composed of various bulk compositions of high-grade metamorphic rocks. Based on matrix mineral assemblages of mafic to intermediate mafic rocks, the LHC has been divided into three metamorphic facies zones; upper-amphibolite facies zone, transitional zone and granulite facies zone [1]. Because of the continuous distribution of upper-amphibolite facies to granulite facies metamorphic rocks, the LHC has been considered as a good exposure of the cross section of lower crust during continental collision events.

However, recent studies have found that high-*T* conditions above 850 °C are common even in the transitional zone and such temperatures are attained under kyanite stability field [3, 6, 7]. The aim of this study is to re-examine the peak metamorphic *P-T* conditions and *P-T* paths of selected regions in the LHC (Rundvågshetta, Skallen, Skarvsnes and Akarui Point) utilizing distributions of trace elements and inclusions such as Al<sub>2</sub>SiO<sub>5</sub> minerals and rutile in garnet porphyroblasts in high-grade pelitic gneisses. The Zr content of rutile coexisting with zircon+quartz strongly depends on the temperature condition and has been calibrated as Zr-in-rutile geothermometers that is more robust than the traditional Fe-Mg exchange type geothermometers during high-*T* metamorphism. In this study, experimentally calibrated Zr-in-rutile geothermometer [8] was applied to rutile grains in garnet and matrix.

The polymorphs of Al<sub>2</sub>SiO<sub>5</sub> minerals are known as valuable indicators of the *P-T* conditions. In the course of this study, sillimanite with a characteristic Raman peak around 420 cm<sup>-1</sup> which is not listed as a sillimanite peak in the Lyon database (<http://www.geologie-lyon.fr/Raman/>) were found as inclusion minerals in garnet and as matrix minerals from all of the four studied regions. In order to examine whether such a peak is related to the phase transition from kyanite or mullite to sillimanite, we observed them in detail by TEM. However, no evidence for such transition was found. Therefore, sillimanite with 420 cm<sup>-1</sup> peak is dealt as normal sillimanite in this study.

Chemical zoning of garnet in high-*T* metamorphic rocks in terms of major elements (Fe, Mg, Ca and Mn) are commonly obscured by the diffusion under high-*T* conditions. On the other hand, chemical zoning of garnet in terms of trace elements, especially P, is less affected by the later diffusion, and commonly preserves sharp growth zoning [e.g., 2, 4]. Utilizing the sharp P zoning as a contemporaneous surface during garnet growth to define core and rim of garnet, and utilizing relic inclusions in garnet such as Al<sub>2</sub>SiO<sub>5</sub> minerals and rutile to constrain the *P-T* conditions of each metamorphic stage [e.g., 5], we estimated metamorphic *P-T* conditions recorded in pelitic gneisses from the four regions in the LHC. Although Akarui Point is located in the “transitional zone” and three other regions are in the “granulite facies zone”, all of the inferred *P-T* paths of high-grade pelitic gneisses from Skallen, Skarvsnes and Akarui Point indicate nearly isothermal decompression starting from kyanite stability field at temperature around 850 °C. From Rundvågshetta, although pressure condition could not be well constrained, extremely high peak metamorphic temperature (> 900 °C) was inferred.

Since the peak metamorphic grades inferred from inclusion minerals in garnet porphyroblasts from Skallen, Skarvsnes and Akarui Point are almost the same, the traditional metamorphic zone mapping

based on matrix mineral assemblages does not represent the highest metamorphic conditions attained, and needs re-evaluation utilizing petrochronological approach.

#### References

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