Mode of occurrence of kyanite in sillimanite-biotite-garnet gneiss from Berckmanskampen, Sør Rondane Mountains, East Antarctica

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Gondwana supercontinent is widely believed to have formed through amalgamation of East and West Gondwana continents along an orogenic belt that extends from Arabian Peninsula in the north to East Antarctica in the south (e.g., Jacobs et al., 2003). In contrast, the collision between Northern and Southern Gondwana is proposed along another orogenic belt between Southern Africa and Antarctica (Meert, 2003; Grantham et al., 2008; 2013). Since the Sør Rondane Mountains (SRM), East Antarctica is located around the crossing point of these orogenic belts, it is a key area to reveal whether the latter collision occurred or not. The number of petrochronological studies in the SRM is increasing in the last dicade (e.g., Hokada et al., 2013; Kawakami et al., 2017; Adachi et al., 2023; Higashino et al., 2023), while such studies are not sufficient enough to construct the new tectonic model so far. Therefore, this study focuses on the Berckmanskampen in the central SRM where the metamorphic history has not been revealed, in order to constrain the metamorphic *P-T* conditions. Berckmanskampen is the mountain located between Menipa and Mefjell. The geological map of this area shows garnet-biotite and biotite-hornblende gneisses are mainly exposed (Shiraishi et al., 1997). The only previous study in Berckmanskampen is a description of retrograde kyanite (e.g., Osanai et al., 2013).

The studied sample is sillimanite-biotite-garnet gneisses, collected from northwestern part of Berckmanskampen. Main matrix mineral assemblage is Grt + Sil + Bt + Pl + Qz. Garnet porphyroblast is up to 20 mm in diameter, wrapped by the foliation defined by the arrangement of biotite and sillimanite. The garnet porphyroblast has P-rich inner core, P-poor outer core and P-rich rim defined by discontinuous zoning in P concentration. The inner core of the garnet is high in Y, Ca and Mn, and low in Mg. The gradual rimward decrease of Y, Ca and Mn and increase of Mg are observed in the outer core. Iron content is homogeneous from the inner core to the rim. Increase of Fe and Mn and decrease of Mg are also observed at the margin of garnet rim in contact with matrix biotite. Sudden increase of Y is observed at the garnet rim.

Garnet inner core includes kyanite, sillimanite, staurolite, plagioclase and quartz. Kyanite and sillimanite are included separately as a single phase at the margin of the garnet inner core. Staurolite inclusion often includes kyanite, plagioclase, K-feldspar, quartz and apatite. Plagioclase included in the staurolite inclusion shows various anorthite contents (~An45-84) that differ from those included in the inner core as a single phase (~An37-40). Garnet outer core includes biotite, quartz and tiny staurolite as a single phase. Plagioclase (~An30) is present as multiphase solid inclusions (MSI) composed of Pl + Bt + Kfs + Qz in the outer core. Garnet rim includes sillimanite and quartz as a single phase, and plagioclase (~An34) is present in MSI of Pl + Bt + Qz. Plagioclase in the matrix has homogeneous composition (~An30), and it is partly altered to albite at the margin. In addition to sillimanite porphyroblast, fibrous kyanite aggregate is partly present at grain boundary in the matrix.

The garnet-Al silicate-plagioclase (GASP) geobarometer (Holdaway, 2001) was applied to plagioclase included in the inner core as a single phase and garnet composition next to it. All pairs resulted in the sillimanite stability field, although temperature variation was taken into consideration. The reason why kyanite stability condition was not obtained is possibly due to the diffuse zoning in Ca in garnet. On the other hand, *P-T* conditions for retrograde reequilibrium between garnet and biotite were estimated using mineral assemblage of garnet rim, plagioclase and biotite in contact with the garnet rim. The garnet-biotite geothermometer (Holdaway, 2000) and the garnet-biotite-plagioclase-quartz (GBPQ) geobarometer (Wu et al., 2004) gave the *P-T* conditions of ~680 ºC and ~0.66 GPa. Although appropriate mineral assemblage for the usage of geothermobarometers is not observed in each garnet zone, the stable Al_2SiO_5 polymorph changes from kyanite to kyanite + sillimanite in the garnet inner core, sillimanite in the garnet rim and in the matrix, and to retrograde kyanite in the matrix.

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