Application of calcite-graphite carbon isotope thermometry in rehydrated high-grade metamorphic terrains: An example from Sør Rondane Mountains, East Antarctica

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Sør Rondane Mountains in East Antarctica is a high-grade metamorphic terrain where retrograde hydration has extensively erased the earlier granulite facies metamorphic imprints. During the 51st Japanese Antarctic Expedition, we have carried out regional geological field survey of the Sør Rondane Mountains and collected samples from various lithologic units to understand the metamorphic conditions and tectonic evolution of the region, which is a key area lying between East and West Gondwana. Here we present a preliminary report on the determination of peak metamorphic temperature condition using calcite-graphite carbon isotope thermometry in marble layers from Sør Rondane Mountains.

High-grade marbles are common lithological units in Sør Rondane Mountains, which occur as layers up to few tens of meters in thickness and extending several kilometers in strike length. They are associated with garnet-biotite and hornblende-biotite gneisses. The marbles are composed of alternating pure calcitic/dolomitic layers and impure forsterite + spinel + diopside + phlogopite ± clinohumite ± apatite-bearing marble layers. For this study, we have carefully selected nearly pure marbles which contain graphite. Furthermore, preliminary carbon and oxygen isotopic composition of calcite and dolomite were used for selecting marbles unaffected by rehydration process, because these isotopes will shift their values if external fluids had infiltrated the layers (e.g., Satish-Kumar *et al.*, 2010a). Some layers showed large carbon and oxygen isotope shifts relating to re-hydration process ($\delta^{18}O$ values decrease up to 13‰ from unaltered values of 24 ~ 25‰). Well-formed polygonal graphite crystals in calcite-rich and dolomite-rich marbles were selected for carbon isotope measurements because earlier studies have suggested that irregular and dull surfaced graphite preserve later stage overgrowth and considerably lower the $\delta^{13}C$ values of graphite (Satish-Kumar *et al.*, 2010b). Coexisting calcite/dolomite and graphite gave carbon isotope fractionation between 1.9 to 4.1‰, suggesting a wide range values for Sør Rondane marbles. These values, if in equilibrium, correspond to metamorphic temperatures between 1100 and 640 ˚C.

The highest temperature estimates were obtained from Perlebandet and Austhamaren area in the northern parth of the Sør Rondane Mountains, where the temperatures exceeded 1000ºC. It is possible that this region of Sør Rondane might have experienced ultrahigh temperature metamorphic condition. Earlier study by Asami *et al.* (2007) has reported high temperature metamorphism (>900˚C) from Balchen area. Marbles in the Balchen region gave estimates of around 850ºC. However, some of the marble samples gave lower temperature estimates. We suspect that either carbon isotope compositions of calcite were altered and/or new graphite overgrew in the preexisting ones in these samples during retrograde metamorphism of the terrain, which apparently increased the carbon isotope fractionation between calcite and graphite. We also compare our results with the recent estimates of peak metamorphic temperature condition using two pyroxene geothermometry and Ti-in quartz thermometry (Adachi *et al.*, 2010). It is possible that the some of the regions in the Sør Rondane Mountains have experienced high to ultra-high temperature metamorphism. Further detailed analyses of selected marble samples are underway to establish the regional peak metamorphic temperature conditions.

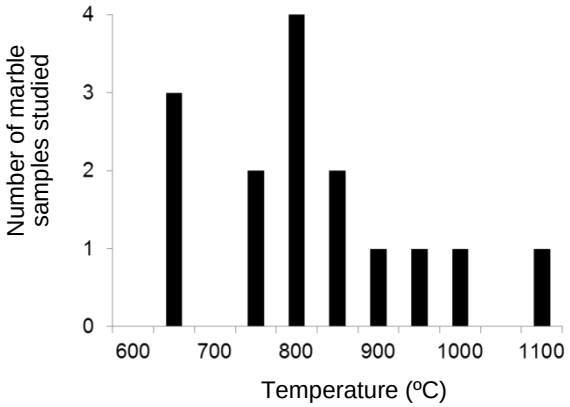

Figure 1. The distribution of metamorphic temperature estimates based on calcite-graphite carbon isotopes thermometry of marbles from Sør Rondane Mountains.

References

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