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Geochemical characterization of zircon grains for U–Pb age determination in Fyfe Hills of the Napier Complex, East Antarctica

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Ultra-high temperature (UHT) metamorphism is critical to understanding the large-scale tectonic processes affecting the deep crust and lithosphere throughout Earth's history. The Napier Complex in East Antarctica is experienced extremely high temperatures (>1100 °C) based on the mineral assemblage of sapphirine + quartz. The thermal history is essential for unraveling the Earth's crustal evolution, including deep crust; however, geochronological constraints, such as the timing and duration of the metamorphic events, are still debated. Two hypotheses for the timing are proposed in previous studies: (i) the UHT metamorphism occurred no earlier than 2840 Ma and possibly from 2590 to 2550 Ma (e.g., [1]), (ii) it occurred from around 2500 to 2450 Ma (e.g., [2]).

In this study, U–Pb zircon geochronology integrated with rare earth element (REE) and oxygen isotope was applied to a garnet-bearing quartzo-feldspathic gneiss to confirm the timing of UHT metamorphism in Fyfe Hills in the western part of the Napier Complex. The zircons collected from the quartzo-feldspathic gneiss were analyzed using a sensitive high-resolution ion microprobe (SHRIMP) at National Institute of Polar Research. Cathodoluminescence (CL) observation and U–Pb ages allowed us to classify the analytical domains into three types: inherited domains, metamorphic domains, and U–Pb system disturbed domains. The REE patterns of metamorphic domains are characterized by a weak fractionation between the middle REE and heavy REE, which reinforces the classification based on the CL observation and the U–Pb ages. The $^{207}Pb/^{206}Pb$ ages of metamorphic domains have an age peak at 2501 Ma, therefore, the gneiss experienced high-temperature metamorphism at 2501 Ma. The $\delta^{18}O$ of zircons are homogeneous among the three groups (5.53 ± 0.11‰, 5.51 ± 0.14‰, and 5.53 ± 0.23‰), which suggests the oxygen isotope compositions in zircon were re-equilibrated after the metamorphism at ca. 2501Ma under dry UHT conditions.

[1] Harley (2001) In Proceedings of 4th IAS Extended Abstract Volume.

[2] Carson et al. (2002) Precambrian Res. 116, 237–263.