

Geochemistry for metamorphosed ultramafic rocks and associated rocks from Howard Hills in Enderby Land, East Antarctica

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Large blocks of metamorphic rocks with mafic to ultramafic compositions were found in felsic gneiss at the central part of northern Howard Hills of the Napier Complex. They are regarded as ultrahigh temperature (UHT) metamorphic rocks from their mineral assemblages and compositions (e.g., paragenesis of sapphirine+quartz coexistence, geothermometry for restored compositions of mesoperthite). Mineral assemblages at the early stage of the metamorphism, which are remained in grain boundary between granoblastic orthopyroxene in granulite, show sufficient possibility of incongruent melting at the P-T conditions of the UHT metamorphism.

To understand the crustal evolution of the Napier Complex, Rb-Sr, Sm-Nd and U-Pb analyses were done for the metamorphic rocks and mineral fractions separated from them. Conventional isotope dilution methods were applied to determined Rb, Sr, Sm, Nd, U and Pb compositions in the samples. Carefully separated phlogopite fractions from a pyroxene granulite have Rb-Sr compositions with 1.85 Ga model age. Samarium and neodymium isotope compositions of orthopyroxene, feldspar, and bulk rock of the same granulite are regressed to a line which has a slope with an age of 1.85 +/- 0.15 Ga on the isochron diagram. Rutile fractions from the granulite have almost concordant composition with 1.5-1.6 Ga. Zircon grains from a felsic gneiss bordered to the granulite yield reliably concordant ages around 2.45 Ga on the concordia diagram.

Occurrences of the zircon fractions with 2.45 Ga U-Pb age in the felsic gneiss imply that metamorphic rocks from Howard Hills suffered UHT metamorphism under melt related condition at the Latest Archean. Since recent SHRIMP dating of zircon and CHIME ages of monazite and zircon grains in the metamorphic rocks from the Napier Complex also indicate 2.4-2.5 Ga, the most metamorphic rocks probably suffered simultaneous UHT metamorphism at the Latest Archean. Rutile shows the youngest age in this study. Lead in rutile is easy to remove from its crystal under low-temperature condition. Though the concept of closure temperatures has to be applied with utmost care, the 1.5-1.6 Ga of rutile indicates the last stage of thermal conditions at the Napier Complex except igneous activity of Amundsen dyke.

Some of the metamorphic rocks with mafic to ultramafic compositions make us calculate improbable Nd model age (T-CHUR), because of an increase of Sm/Nd ratio at the compositional modification of their protolith. Felsic gneiss with the 2.45 Ga zircon grains has high Sr isotope ratio at that time. The metamorphic rocks with mafic to ultramafic compositions are enriched in incompatible elements in spite of their compositions, and have higher Sr isotope ratios after restoring at 2.45 b.y. before. This evidence leads an event of enrichment of compatible elements and/or depletion of incompatible elements at the Latest Archean. We conclude that these metamorphic rocks experienced partial melting at the UHT metamorphism.