

Melting experiments of an UHT orthopyroxene felsic gneiss from Napier Complex, East Antarctica

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The possibility of partial melting, which accompanied ultrahigh-temperature (UHT) metamorphism, was locally implied by field evidence and petrological observations in the Napier Complex, East Antarctica [e.g., 1-5]. To investigate on the partial melting, high-pressure and high-temperature experiments were carried out under UHT and dry conditions using the orthopyroxene felsic gneiss (sample no. TM981229-03Ef, [5]) from the Napier Complex. The gneiss is composed of orthopyroxene, plagioclase, K-feldspar, quartz and small amounts of rutile and zircon, and is almost H₂O-free as: H₂O (+) = 0.20 wt% and H₂O (-) = 0.12 wt%.

We prepared a mixture of 90 wt% glass and 10 wt% seed mineral aggregate of the pulverized gneiss sample, as a starting material. Glass was obtained by fusing the gneiss at 10 kbar and 1600 degree-C for 2 minutes in a graphite capsule using a 16 mm piston-cylinder apparatus at Ehime University. Starting material was put into an inner molybdenum-foil capsule within an outer platinum tube. Two edges of platinum tube were welded using a carbon arc.

Present experiments were planned as pressures of 9 kbar and 4 kbar. At 9 kbar and temperatures of 1050 degree-C, 1100 degree-C and 1150 degree-C, melting experiments were carried out using the piston-cylinder apparatus at Ehime University. On the other hand, at 4 kbar and temperatures of 1050 degree-C and 1100 degree-C, experiments were conducted using an internally-heated gas pressure apparatus at Tokyo Institute of Technology. After maintaining the pressure and temperatures for the desired duration, the samples were quenched.

As experimental results, the assemblage of orthopyroxene + plagioclase + quartz was found within dry melt at 9 kbar and 1150 degree-C. The same assemblages were also found at 4 kbar and temperatures of 1050 degree-C and 1100 degree-C. Chemical features of the melt were similar to those of granitic gneisses, which were reported from few localities at the Napier Complex and Lutzow-Holm Complex, East Antarctica. This also agreed with Hokada and Arima's [6] experimental result. At 9 kbar and temperatures of 1050 degree-C and 1100 degree-C, melt disappeared from run products, and the produced phase was orthopyroxene + plagioclase + quartz. Any K-feldspar and rutile were not found in run products.

At 9 kbar, the dry solidus of the gneiss lies between 1100 degree-C and 1150 degree-C, where this temperature is close to the peak condition of UHT metamorphism in the Napier Complex [e.g., 7 and 8]. This implies the possibility of partial melting that accompanied the UHT metamorphism. Although the melt ought to have been segregated from the system during the metamorphism, the gneiss system preserves its quartzo-feldspathic composition. It is possible that the partial melt, which was generated in the gneiss, was not completely squeezed from the system under UHT condition in excess in 1100 degree-C. This means that the residual dry melt is essential for formation of UHT metamorphic rocks in the Napier Complex.

References: [1] Sheraton et al., Australian Bureau of Mineral Resources, Bulletin, 223 (1987) 51 pp; [2] Osanai et al., Polar Geosci., 12 (1999) 1-28; [3] Hokada et al., Polar Geosci., 12 (1999) 49-70; [4] Yoshimura et al., Polar Geosci., 13 (2000) 60-85; [5] Miyamoto et al., Polar Geosci., 17 (2004) 88-111; [6] Hokada and Arima, Polar Geosci., 14 (2001) 39-52; [7] Harley and Motoyoshi, Contrib. Mineral. Petrol., 138 (2000) 293-307; [8] Sato et al., J. Mineral. Petrol. Sci., 99 (2004) 191-201.