Petrological study of clinopyroxene-bearing garnet amphibolite in the Barberton granite-greenstone belt, South Africa

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The approximately 3.5-3.2 Ga Barberton granite-greenstone belt (BGGB) is one of the oldest and best-preserved examples of Archean geology in the world. Cpx-bearing Grt amphibolites were reported from the Inyoni Shear zone in south of this belt (Moyen et al., 2006). These rocks record the highest-grade metamorphism compered with other rocks in this belt, and are considered to form under geothermal gradients of ca. 12-20˚C/km, which is similar to those found in recent subduction zone. However, the specific metamorphic P-T trajectory from subduction to exhumation has not yet been clarified. In this study, petrological study for the Grt-amphibolite has been examined for mineral assemblages and compositions in detail to discuss the metamorphic history of the BGGB.
Microscopic observation has indicated that the studied samples contain quartz (Qz), garnet (Grt), amphibolite (Amp), clinopyroxene (Cpx), plagioclase (Pl) and epidote (Ep) with minor opaque mineral. Chemical compositions obtained from each mineral by EPMA analyses are as follows; Grt, Cpx and Pl compositions were homogeneous and no chemical zoning was confirmed. Amps were defined as Ca-amphibole. There was a little deference of Al contents between core-mantle (Amp1) and rim (Amp2) part. Amp2 growth was confirmed along fracture part in Grt and the circumference of Cpx. Epidote occurred as matrix grains (Ep1) and component of symplectite (Ep2 + Qz) which is originally Grt. Mn content of Ep1 was slightly higher that that of Ep2. The petrography and mineral compositions indicated that the studied samples record the change of mineral assemblage from Grt + Amp1 + Cpx + Pl + Qz +Ep1 (AS1) to Grt + Amp2 + Cpx + Pl + Qz + Ep2 (AS2).
The metamorphic P–T conditions have been estimated by garnet-clinopyroxene geothermometer (Ai,1994; Nakamura,2009) and the average P-T calculations of THERMOCALC ver. 3.3.3 with the computer program AX (Holland and Powell, 1998 and its update). P-T pseudosection and isopleth calculations were performed by a computer program PERPLEX ver. 6.7.4 (Connolly, 2005 and its update). These results showed that the stability P-T field of AS1 and AS2 are at P= ca. 9.8–11.3 kbar and T = ca. 625–675 ˚C.
The estimated P conditions are lower than that of previous work in the same area (Moyen et al., 2006). Our samples probably record the later stage metamorphism. Integration of our new results with published data suggest that the geothermal gradients at the prograde metamorphism associated with 3.23 Ga subduction-collisional event was not at least exceeding ca. 20˚C/km and the initial retrograde P-T trajectory was isothermal decompression or decompression with increasing temperature like a clockwise path.

