Zircon age dating for the timing of ultrahigh-temperature metamorphism in the Limpopo Belt, southern Africa

Kei Sato[1]; Toshiaki Tsunogae[2]; Yoshiaki Kon[1]; Takafumi Hirata[3]

[1] Earth and Planetary Sci., Tokyo Tech.; [2] Univ. Tsukuba; [3] Earth and Planetary Sci., TITech

The Limpopo Belt in southern Africa is a classic Archaean high-grade metamorphic province sandwiched between the Zimbabwe Craton and the Kaapvaal Craton [e.g. 1], and is subdivided into the Central Zone, the Southern Marginal Zone and the Northern Marginal Zone by the major shear zones and/or lithology. The Central Zone is composed of Archaean and Paleoproterozoic lithology such as widespread ages of about 2000 Ma to over 3000 Ma for geologic events [e.g. 2-4]. Although the timing of ultrahigh-temperature (UHT) metamorphism in the belt has not been solved, it is recognized commonly that the zone were affected by two major thermal events at about 2000 Ma and 2600-2700 Ma.

The Central Zone is characterized by the occurrences of pure metaquartzite, marble, calc-silicate rocks and extensive leucocratic gneisses, which underwent remarkable deformation. Clockwise decompression P-T trajectories with UHT metamorphism of the zone can be given by the rare inclusions of moderate-Mg staurolite [5 and 6] and sapphirine + quartz assembly [5 and 7] within poikiloblastic garnets, because the moderate-Mg staurolite with Mg# = 0.5 suggests the possibility for prograde high-pressure metamorphism [8] and the sapphirine + quartz assembly is a robust indicator for UHT metamorphism under thermal peak condition [9]. Previous works [10 and 11] proposed two high-grade metamorphic events with decompression-cooling to around 5 kbar and following relatively low-temperature isobaric re-heating.

In this study, we focused on the timing of UHT metamorphism of the Central Zone and we measured the U-Pb and Pb-Pb ages for in-situ zircons within orthopyroxene-sillimanite-quartz granulite by using laser ablation-ICP-mass spectrometry technique. As a result, the age of zircon inclusion within host orthopyroxene was given as 2787 plus minus 31 Ma. The orthopyroxene + sillimanite + quartz assembly is one of typical mineral assemblages that characterize UHT rocks, and the lower pressure limit of the assembly in the FeO-MgO-Al2O3-SiO2 system is situated at around 6 kbar [e.g. 12]. It is obvious that the orthopyroxene-bearing assembly formed during the first UHT event in the polymetamorphism of the Central Zone. Therefore, the result in our geochlonologic study implicates that the timing of this first thermal event occurred at the Late Archaean.

References: [1] van Reenen et al. (1987) Geology 15, 11-14; [2] Armstrong et al. (1991) Precamb. Res. 53, 243-266; [3] Boshoff et al. (2006) Jour. Geol. 114, 699-716; [4] van Reenen et al. (2008) Gondwana Res. 14, 644-662. [5] Schreyer et al. (1984) Contrib. Mineral. Petrol. 86, 200-207; [6] Tsunogae and van Reenen (2006) Lithos 92, 576-587; [7] Tsunogae and van Reenen (2007) Jour. Mineral. Petrol. Sci. 102, 57-60; [8] Sato et al. (in review); [9] Hensen and Green (1971) Contrib. Mineral. Petrol. 33, 309-330; [10] Perchuk et al. (2008) Lithos 103, 70-105; [11] Perchuk and van Reenen (2008) Lithos 106, 403-410; [12] Kelsey (2008) Gondwana Res. 13, 1-29.