Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SMP055-P24 Room: Convention Hall Time: May 23 17:15-18:45

U-Th-Pb age and accessory phase behavior of Mather UHT Gneisses at Rauer Islands, Prydz Bay, Antarctica

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The Rauer Islands in Prydz Bay, East Antarctica, includes both Archaean and Mesoproterozoic crustal components last metamorphosed and deformed at ~500 Ma. A distinct suite of supracrustal rocks, the Mather Paragneiss, within the Rauer Islands preserves evidence for ultrahigh-temperature (UHT) metamorphism at 990-1030 degree C and 1.0-1.2 GPa followed by isothermal decompression (ITD) at >850-950 degree C (e.g., Harley, 1998).

Recent monazite data indicate that the peak UHT metamorphism of the Mather Paragneisses occurred prior to c.590-580 Ma (Harley et al., 2009; Hokada et al., 2003) which is significantly older than the 540-525 Ma ages suggested by Kelsey et al. (2007). We have dated zircons in the Mather UHT gneisses and the surrounding host gneisses using SHRIMP II at the National Institute of Polar Research. All four analyzed samples, two from the Mather UHT unit and two from the host orthogneiss unit yield the c.530-510 Ma concordant ages with older inheritence/ protolith ages of c.2800-2400 with minor 1000-800 Ma and c.3200 Ma without any Proterozoic isotopic disturbance.

In contrast to the well-defined 530-510 Ma ages obtained from the zircons in the UHT rocks, monazite grains measured by electron microprobe show a distinct internal zonation, from 580-560 Ma dark-BEI cores to 550-520 Ma mid-BEI mantles and 510-500 Ma bright-BEI rims (Hokada et al., 2003). Mg-Al-rich Mather UHT gneiss preserve UHT mineral assemblages including garnet, orthopyroxene and/or sillimanite that are locally replaced by fine-grained symplectite composed of sapphirine, cordierite, orthopyroxene, spinel or plagioclase, consistent with decompressional P-T path. These gneisses have also experienced extensive hydration, manifested in the formation of biotite-bearing reaction coronas and localized biotite-rich zones and reaction selvedges. Almost all monazite grains are distributed in the symplectitic reaction zones. From the chemical and textural evidence we infer that the M-HREE-rich 580-560 Ma monazite cores may have formed through the decomposition of garnet during decompression just after the UHT event, whereas the M-HREE-depleted 550-500 Ma monazite grains/rims formed or recrystallized in reactions associated with the subsequent extensive hydration, which also caused the marked recrystallization of zircon. This interpretation is consistent with the observation that all of the older (e.g. Archaean) concordant and discordant zircons have HREE-enriched chondrite-normalized REE patterns. As these zircons have not equilibrated with the flat-HREE garnet present in the UHT gneiss, none of the zircon ages obtained in our study provide an age of the peak UHT event in which garnet was stable. The above data strongly support the interpretation proposed by Harley et al. (2009) that the UHT metamorphism occurred prior to 590-580 Ma and that such UHT rocks occur only locally at tectonic boundaries between Archaean and Proteroaoic units that do not record this 590 Ma event.

Keywords: Antarctica, Prydz Bay, Ultra high temperature / UHT, U-Th-Pb age, Accessory phase