Timing and duration of continental collision during Gondwana assembly – a case study from Antarctica

H R MARSCHALL[1], J PAULY[2], H P MEYER[3], N CHATTERJEE[4] AND B D MONTELEONE[1]

[1]WHOI, USA, hmarschall@whoi.edu; [2]Univ. Bern, CH; [3]Univ. Heidelberg, Germany; [4]EAPS, MIT, USA

The formation of large continents and supercontinents throughout the Proterozoic and Phanerozoic is marked by large collisional orogenic belts. One of the largest of these belts was formed during the Pan-African orogeny during the assembly of the Gondwana supercontinent. Detailed dating and unraveling of the *P-T* histories of individual parts of collisional belts aid in the reconstruction of the paleogeography, the collision history and the geodynamic modeling of the events. One of the most difficult elements of the metamorphic history to be reconstructed is the duration of high-grade metamorphism. Decompression and cooling histories of metamorphic rocks have been dated in various studies over the past decade or two. Yet, there is still little information on the rate of burial and heating, and on the duration of peak metamorphic conditions.

In this study, we combine Zr-in-rutile and Ti-in-zircon thermometry with zircon U-Pb dating, monazite chemical dating and petrological modeling to reconstruct the *P-T-t* history of ultra-high temperature metamorphic rocks from Dronning-Maud Land (East Antarctica). Heating is recorded in prograde Ti zonation in zircon, while younger rims on zircon show again lower Ti temperatures. The highest *T* are recorded in rutile, but not in zircon, showing that the high solubility of Zr in rutile leads to the dissolution rather than growth of zircon in UHT rocks at peak *T*. Zircon growth ceased appr. 50 ºC below the peak *T* and resumed after cooling to appr. the same *T*. This record is also a function of respective solubility levels of Zr in Rt and Ti in Zrn at UHT and of the grossly different diffusivities of the two elements in the two minerals.

The total recorded metamorphic history in a single sample spans ~150 million years, but the records of prograde heating and ≥40 km of exhumation are separated by less than 10 million years, putting tight constraints on the duration of peak metamorphic conditions (2.1 GPa, 930 ºC). The *P-T-t* record shows a long-lasting metamorphic history that generated thickened crust and high geothermal gradients over a time-span of ~40 million years, a short-lived peak at UHT conditions for <10 million years, rapidly followed by fast orogenic collapse, exhumation and an extended period of cooling and relaxation (~100 million years).