‘Okunen’ in a long, hot orogen: a timeline of tectonometamorphic activity in southern Lützow-Holm Bay

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In large, hot orogens produced by the collisions of multiple continental terranes to form supercontinents, the links between the timing of plate collision and assembly, tectonothermal processes, and the timing of metamorphic parageneses are obscured by the extended duration of elevated geotherms and the pervasiveness and complexity of multistage deformation. In such an environment, geochronometers that date specific processes of mineral growth and ionic diffusion should be expected to show a variety of ages that reflect the prolonged development of the orogen. Different minerals will record the timing of different metamorphic reactions, and if those reactions are progressive, responding to changes in conditions that can occur repeatedly during periods of elevated temperature, then dates obtained from single geochronometers will reflect the prolonged period during which such processes occur.

The highest-grade part of the Lützow-Holm Complex (LHC) of East Antarctica lies in the southern Lützow-Holm Bay, where granulite to UHT-grade metamorphism and high-strain deformation obscures crustal elements and stages of orogenesis. The sequence of orogenic development can be extracted only through the multiple geochronometers. Zircon and monazite growth occurred at granulite-grade temperatures over an extended period, from 610 to 510Ma, with dominant modes around 590 and 540Ma, and additional growth around ca 565 and 515Ma. Elevated temperatures were maintained well after the thermal peaks, in a crustal block that experienced exhumation and scant late-orogenic magmatism, then slow cooling to Ar-Ar closure temperatures in K-feldspar as late as 420Ma (Fraser *et al.*, 2000).

Zircon production in UHT metasediments around Rundvåg Bay peaks not only at ca 540Ma, as it does elsewhere in the orogen, but also at ca 590Ma, synchronous with granulite-grade metamorphism further south at Botnnuten. Monazite ages from both localities concentrate around 590Ma. The disparity in ages reflects the metamorphic history, with an Ediacaran stage of anatexis and melt extraction at high pressure, and a Cambrian stage of melting in already dehydrated granulites in which UHT conditions were attained in a small region. The structural contrast between Botnnuten and Rundvåg Bay reflects the complexity in accessory mineral growth; recumbent gneisses to the south are reworked into E-W trending macrofolds in low-strain domains and steep ductile shear zones in high-strain domains, probably around ca 540Ma. The lack of clearly defined crustal terranes in the western LHC, or metamorphic indicators of terrane suturing during East-West Gondwana assembly, is a result of the extended period of orogenesis.

References

Fraser, G., Mcdougall, I., Ellis, D. J. and Williams, I. S., Timing and rate of isothermal decompression in Pan-African granulites from Rundvågshetta, East Antarctica. J. Metamorphic Geol. 18, 441–454, 2000.