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A hundred million years in a long, hot orogen: zircon and monazite growth during tectono-thermal activity in the Lützow-Holm Complex of east Antarctica

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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, tectono-thermal 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.

In the Lützow-Holm Complex of East Antarctica, a Neoproterozoic to Cambrian high-grade gneiss terrane that is located in the Gondwanan supercontinent adjacent to Sri Lanka and the Indian peninsula, a sharp transition of the dominant orientation of major tectonic features and lithological types occurs along the Telen Glacier in Lützow-Holm Bay. Here, Mesoproterozoic charnockite-dominated lithologies to the north were warped into westward-verging recumbent folds and shear zones, whereas south of the glacier tectonic intercalations of Paleoproterozoic to Neoproterozoic supercrustal lithologies and Neoarchean charnockitic basement were reworked by steep to vertical E-W lateral shear zones. The absence of discrete structural features that might identify a tectonic suture along the Telen Glacier, suggests that this transition is instead the reworking of a pre-existing orogenic boundary, and that the steep ductile fabric in the south represents pervasive tectonic reworking that has largely obliterated pre-orogenic lithological relationships.

The sequence of orogenic development can only be revealed through multiple geochronometers. Zircon and monazite growth occurred at granulite-grade temperatures over a long period, from 610 to 510 Ma, with dominant modes around 590 and 540 Ma. Zircon production in UHT metasediments around Rundvåg peaks not only at ca 540 Ma, as it does elsewhere in the orogen, but also ca 590 Ma, similar to lower-grade granulites at Botnnuten, further south. Monazite ages vary from 590 Ma in the south to 540 Ma to the north. The timing of zircon and monazite growth is also dependant on the host assemblage; metapelitic host rocks yield zircon with spread age results, whereas metasomatic assemblages (skarns) and quartzites yield discrete populations of growth associated with fluid/thermal pulses. These differences reflect the metamorphic reactions that produce zircon and monazite, and help define the stages of tectono-thermal activity in this key component of the East-West Gondwana assembly. This

concept can be tested by the identification of prolonged or polystage orogenesis in other parts of the Pan-African orogen that assembled East and West Gondwana.