South Tibetan detachment system in Sikkim: stuck between a massif and a cross-structure.

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The Sikkim, India segment of the South Tibetan detachment system is cut by two major strike-perpendicular structures. To the west, the N-S-striking Nyönni Ri detachment has unroofed the Ama Drime metamorphic massif with top-east displacement (Jessup et al., 2008), and to the east, the Yadong cross-structure apparently offsets the South Tibetan detachment system by > 50 km (Edwards and Harrison, 1997; Wu et al., 1998). The South Tibetan detachment system itself comprises a brittle-ductile fault with Tethyan sedimentary sequence black shale in the hanging wall and garnet-biotite-sillimanite gneiss and leucogranite of the Greater Himalayan sequence in the footwall. The top ~500 m of the footwall has been deformed into a mylonite layer with top-to-the-north sense of shear.

Zircon from a weakly-deformed leucosome in footwall garnet-biotite-sillimanite gneiss yields SHRIMP U-Pb ages for rims ranging 28.5-15.5 Ma. Weakly-deformed leucogranite dykes which cross-cut the mylonitic foliation in host gneiss contain zircons with rims as young as 13.0 Ma. A cordierite-bearing granite, which may reflect crystallization at low pressure (~4 kbar, e.g. Streule et al., 2010) yields U-Pb ages for zircon rims as young as 13.4 Ma. The lack of mylonitisation the leucogranites indicates that little ductile shearing occurred following their crystallization. Zircon crystallization temperatures, determined by measurement of Ti-in-zircon, are 660-810 °C during 34-13 Ma. Muscovite from four of these samples yield $^{40}Ar/^{39}Ar$ cooling ages of c. 13.1 Ma, with an estimated closure temperature for Ar diffusion of 430-490 °C. Apatite fission track ages from the same granites indicate cooling below 120 °C at c. 8-6 Ma.

Monazite were analyzed *in situ* in three host garnet-biotite-sillimanite gneisses by LA-ICP-MS. Monazite included in garnet yield Th-Pb ages of 36-23 Ma. In general, monazite Th-Pb ages range from 36-14.5 Ma. Youngest monazite ages in the host gneiss are associated with ductile deformation and older than the youngest zircon ages in leucogranite, in agreement with structural observations that little ductile deformation proceeded leucogranite emplacement.

Taken together, these data provide constraints on long-lived partial melting in the uppermost Greater Himalayan sequence between 34-13 Ma, as well as the cooling history of rocks unroofed by this segment of the South Tibetan detachment system. Latest deformation in the footwall of the South Tibetan detachment system constrains initiation of both the Nyönni Ri detachment, and the Yadong cross-structure, to younger than 13 Ma. Activation of the Nyönni Ri detachment before 11 Ma (Kali et al., 2010; Leloup et al., 2010) marks a major transition in tectonic transport in the eastern Himalaya from N-S to E-W. However, the South Tibetan detachment system in the Bhutan Himalaya, east of the Yadong cross-structure, was active after 11 Ma (Kellett et al., 2010). Thus the transition from NS-directed to EW-directed deformation in the eastern Himalaya was not synchronous.

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