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Miocene (∼12 Ma) transition from E-W to N-S syn-convergence normal faulting in the central Himalayas (Ama Drime range).

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In the high Himalayan range, near the transition to the Tibetan plateau, at least two generations of syn-convergence normal faults have been described. The oldest one corresponds to a major orogen parallel (∼E-W) normal fault termed the South Tibet Detachment (STD) while the younger one corresponds to orogen perpendicular (∼N-S) active normal faults similar to those observed thorough South and Central Tibet. The timing of activation and end of each of these fault systems has major bearings on the mechanical models of geodynamic evolution of the India-Asia convergence zone.

Just North of the highest stretch of the Himalayan range, comprised between the Chomolongma and KanchenJunga summits, rocks of the Himalayan crystalline slab are exhumed in the 6500 m high Ama Drime range. This range is a horst bounded on both sides by preeminent N-S active faults: the Kartha fault to the west and the Dinggye fault to the east. Both of these faults show steep (dip ∼35-65°) brittle fault planes and quartzitic cataclasites. In the footwall of both faults outcrop shallower (dip ∼30-45°) ductile mylonites showing evidences for normal shear sense. These N-S faults clearly offset the STD. In the core of the range outcrop orthogneiss and migmatites embedding amphibolite layers that belong to the Lower Himalayan Crystalline series and that have been buried to a depth of ∼60 km (1.7 GPa). Our study that combines structural and petrographic analysis of the mylonites with U-Pb, Ar/Ar and U/He geochronology, indicates that the Dinggye shear zone has been activated prior to 11 Ma ago and that rocks rapidly cooled below ∼300°C at ∼10Ma. Data from the Kharta shear zone are more dispersed but are also compatible with exhumation starting ∼12 Ma ago. The lower temperature thermo-chronometers [(U-Th)/He apatite] confirm apparent exhumation rates of about 1 mm/yr in the last 5 Myr for the whole range (Jessup et al., 2008). Total exhumation linked with the Kharta and Dinggye Faults and shear zones is on the order of 2 to 4 kbar (7 to 15 km), and could have taken place in two separate phases, the youngest one starting ∼5 Ma ago.

East of the Ama Drime, in the hanging wall of the Dinggye fault, the STD separates Paleozoic Tethyan series at the top from High Himalayan Crystalline (HHC) micaschists and leucogranites at the bottom. The STD dips ∼5-15° to the North. Immediately below the STD, the HHC is highly deformed in the STD shear zone, lineations trend NE and the shear senses indicate top to the N motion. P-T paths constrained by garnet isopleths in the HHC micashists show decompression and cooling from ∼5 kbar (∼18 km) and ∼650°C, after an initial heating phase. U/Pb dating of Monazite and zircons in both deformed and undeformed leucogranites suggest that ductile deformation lasted until at least ∼16 Ma but ended prior to ∼15Ma in the STD shear zone a few meters below the detachment. Ar/Ar micas ages span between ∼15 and 13 Ma indicating rapid cooling down to below ∼300°C at that time. These data are interpreted as reflecting ∼4 kbar (∼15km) of exhumation along the STD and STD shear zone prior to ∼13 Ma.

Such timing for the end of motion along the STD system fits particularly well with the ∼12Ma timing of initiation of the crosscutting Kharta and Dinggye faults. We thus propose that the local direction of extension switched from N-S to E-W at ∼12.5 Ma in the Ama Drime area. It is not yet clear if such switch occurred synchronously at the scale of the orogen (i.e. from the Thakkhola to the Yadong grabbens). Such switch should be taken into account in mechanical models of the Himalaya – Tibet orogeny.