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Thermochronological analysis of Siwalik sediments from the Karnali River section (western Nepal): Constraints on the kinematics of the frontal Himalayan prism.

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We study the dynamics of the Miocene-Recent Siwalik accretionary prism of the Himalayan orogen with the specific goal of quantifying the onset of activity as well as the deformation history recorded by the Main Frontal Thrust (MFT), the active frontal thrust of the system. We report new detrital apatite fission-track data from Miocene to Pliocene Siwalik Group sediments along the magneto-stratigraphically controlled Karnali River section in western Nepal. We also measure confined fission track lengths to constrain the thermal history, as well as etch-pit width measurements to provide a kinetic proxy (e.g., Carlson et al., 1999; Barbarand et al., 2003). The upper part of the section yielded samples with AFT ages older than the stratigraphic age and increasing downsection (unreset samples). Deeper samples have an increasing proportion of single-grain AFT ages younger than the stratigraphic age and ages decrease downsection (partly annealed samples). The top of the pre-exhumation Partial Annealing Zone occurs at ˜2500 m depth, indicating a pre-exhumational geothermal gradient of 15-20°C, in accord with vitrinite reflectance data and heat flow measurements in Ganges basin wells. The annealed AFT samples from the lower part of the section have a consistent minimum age peak of 2 Ma, suggesting that onset of exhumation along the MFT took place at this time.

Mean confined track lengths decreased with depth. Inversions of track-length data show initial heating of the sediments related to burial, followed by a phase of constant temperatures during a period of up to 5 My and extremely rapid cooling of the sediments since $<$1 Ma, which we interpret as being due to exhumation along the

MFT. Predicted peak temperatures are between 80-110°C for all samples, suggesting a strongly non-linear geothermal gradient. The results also clearly show that the mean and minimum thermochronological ages of partially annealed samples are not simply related to a specific tectonic event.

Finally, from a reconstructed initial basin geometry and a tectonic scenario, we calculate, using the Thrustpack Package, thermal histories for the rocks along the Karnali River section and thus predict the corresponding apatite fission track ages and length distributions. Our best-fit models suggest that initiation of the MFT took place after 2 Ma with an important recent shortening around 20 mm/yr from 0.3-0.1 Ma to today. The activity of MFT cannot have been homogenous through time; it has either accelerated recently or activity has been discontinuous through the last 2 My.