"Spatial and temporal interplay between viscous and frictional deformational processes in the Himalayan megathrust"

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Abstract:

What processes cause and regulate the interplay between fast and slow strain behaviour on faults? To tackle this question, we investigate the internal deformational and thermal structure of an active continental megathrust exposing a full spectrum of active fault behaviours—from aseismic creep at depth to earthquakes creating surface ruptures. Himalayan thrusts have collectively operated over broad ranges of pressure, temperature, and strain rates. As all these structures merge into the Himalayan basal décollement, the Main Himalayan thrust, it can be safely assumed that the rocks now at the surface were within the MHT at the time of their deformation.

We investigate the Himalayan megathrust system across a range of observation scales and approaches, including field observations, microanalyses, thermochronology, and numerical modelling. We determined the metamorphic peak temperatures by Raman spectroscopy of carbonaceous material (RSCM) and established the deformation temperatures by Ti-in-quartz thermobarometry and quartz c-axis textures. These data were combined with thermochronology, including 40Ar/39Ar ages of muscovite, apatite fission-track ages, and apatite and zircon (U-Th)/He ages. To obtain accurate metamorphic, deformation and closure temperatures of thermochronological systems, pressures and cooling rates for the period of interest were derived by inverse modelling of multiple thermochronological datasets, and temperatures were determined by iterative calculations.

Microstructural and textural analyses of quartz mylonites from the Main Central thrust allow identification of switches of deformation mechanisms caused by reductions in pressure and temperature during exhumation, and they provide quantitative constraints on stress history. At

some localities there is an evolution of samples experiencing shifts to higher stress deformation that may be a result of interaction between end-member mechanisms where viscous flow cannot accommodate all the imposed displacement, which leads to "semi-brittle" deformation. Alternatively, the pulses of high stress associated with earthquakes might also be involved in generating bimodal populations of dynamically recrystallized grains. At other localities, however, there is an evolution of samples experiencing switches to lower stress deformation. The latter microstructures may be results coeval decrease of strain rate and temperature. These two contrasting deformation histories are the focus of our ongoing studies of megathrust systems.