Exhumation history of the western Himamaya: the Rupshu-Lahul-Kullu geochronological transect (NW India)

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This thesis presents new geochronological data about the exhumation history of the western Himalaya in NW India. It was accomplished through a north-south oriented transect across the entire Himalayan range from the Rupshu area in eastern Ladakh to the Kullu valley in Himachal Pradesh. The transect extends from the Trans-Himalayan Plutonic Belt, through the Indus-Tsangpo Suture Zone and the Indian Margin, to the internal parts of the Indian crust. We used fission track and 40Ar/39Ar dating methods as they permit us to reconstruct upper crustal cooling history through the temperature range of approximately 500-60 °C. Consequently, the fission track ages and mica 40Ar/39Ar ages from sixty samples place new time constraints on the exhumation of several structural domains with contrasting tectono-metamorphic evolutions.

The ages from this thesis combined with data from previous studies, suggest that the internal parts of the SW-directed North Himalayan nappe stack in the Rupshu area (comprising the Mata, Tetraogal and Tso Morari nappes) were emplaced and metamorphosed at ca. 50-45 Ma, and exhumed to moderately shallow depths (~10 km) at ca. 45-40 Ma. From the middle Eocene to the present, exhumation in the internal parts of the North Himalayan nappes continued at a steady and slow rate, except for the root zone of the Tso Morari nappe, which cooled faster than the rest of the nappe stack. Rapid cooling occurred at ca. 20 Ma and is linked to brittle deformation along the normal Ribil-Zildat fault.

The front of the North Himalayan nappes was emplaced and metamorphosed slightly later than the internal parts at ca. 45-40 Ma. The rocks that were buried at deep depth (~30 km) were subsequently exhumed to a moderately shallow upper crustal depth (~10 km) at only 19-14 Ma. From the middle Eocene to the present, exhumation continued at slow rates except for the zone lying in the footwall of the high-angle normal Sarchu Fault. The footwall of the Sarchu Fault cooled faster than the rest of the nappe front during the activity of the fault under a brittle regime between ca. 20 and 16 Ma. High-angle normal faulting in the Sarchu area, followed therefore the activity of the low-angle normal Tapachan faults that are the brittle equivalent of the ductile Zanskar Shear Zone dated at 22-19 Ma.

In the High Himalayan Crystalline Zone, late extrusion of the Crystalline nappe along the Main Central Thrust to the south-west was concomitant with ductile shearing along the Zanskar Shear Zone. In the Kullu valley, after cessation of activity on the Main Central Thrust at ca. 18 Ma, erosive denudation was the principal control on exhumation of the Crystalline nappe until the present, except for the zone located on top of the Larji-Kullu-Rampur dome. This zone cooled faster than the rest of the Crystalline nappe from ca. 7 Ma until the present. Here, rapid cooling is related to upwarping of the Larji-Kullu-Rampur dome. The formation of this structure is concomitant with extrusion of the Lower Crystalline nappe along the Munsiari Thrust and of the Lesser Himalaya along the Main Boundary Thrust.

Another part of this thesis presents additional petrographic and thermobarometric data from mafic rocks of the units composing the Rupshu area. These data show that the barrovian metamorphic conditions gradually decrease from the core to the frontal part of the North Himalayan nappes; no metamorphic jump occurs on the nappe boundaries. Lower amphibolite facies conditions at 600 ± 50 °C / 8.5 ± 2 kbar are restricted to the core of the Tso Morari nappe, while the Tetraogal and the core of the Mata nappes underwent epidote-amphibolite facies conditions at 520 ± 50 °C / 9 ± 2 kbar.