Cooling History of the MCT-Process in the NW-Himalayas in the Light of Geochronology, Thermal Modelling and Palaeogeography

TALK

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GEOCHRONOLOGY: In the Crystalline nappe of the NW-Himalayas amphibolite facies temperatures ceased from 25-23Ma onwards. $^{40}Ar/^{39}Ar$ plateau ages of white micas from the Higher Himalayan Crystalline (HHC) along the Chenab river S of Kishtwar typically yield cooling ages around 22-21Ma. Biotites frequently yield ages (appr. 300°C) about 16Ma, locally also younger ones. A rapid cooling phase is only indicated for higher temperatures, but was obviously not active for the whole 500°C-300°C interval. From this cooling pattern it can be inferred that the Main Central Thrust (MCT) process started not later than 23Ma.

Up to now reliable cooling ages from the metamorphosed Lesser Himalayan unit (LH) are nearly missing. From several reasons it is difficult to obtain reliable ages from these units. The Proterozoic granitic rocks usually have not reached total equilibrium in alpine times. Slates and schists without major Ca-bearing mineral phase are unsuitable for Rb/Sr-dating. Excess ^{40}Ar (up to $1x10^{-4}cm^3$ STP/g) is ubiquitous in these units. Therefor the few reliable data from these units have an important significance. The youngest ages in the Larji-Kulu-Rampur window indicate formation ages for the very low metamorphic zones of about 12Ma.; biotites from this area may have passed their blocking temperature later than 10Ma. Locally the HHC W of Kishtwar window suffered a reheating from below, an interpretation based on Ar/Ar data on biotites around 7-8Ma.

Youngest ages in the LH are derived from 1860Ma granite gneisses in Garwahl along the Bhagirathi river below the Vaikrita thrust (main MCT). $^{40}Ar/^{39}Ar$-plateau ages of 4.5Ma were measured on phengites from these rocks. Several other results on micas from this region with different methods support a cooling history from 10Ma onwards.

THERMAL MODELLING: Two-dimensional finite-difference thermal modelling of the overthrusting of the HHC over the LH establishes that the shape of cooling curves for samples from the footwall and hanging wall are very sensitive to the actual displacement history. The cooling curves deduced from mineral ages in the hanging wall are steeper between 25-15Ma and become shallower in more recent time. Samples form the footwall show a temperature rise between 25-10Ma followed by rapid cooling. These patterns can be numerically modeled assuming an initial displacement of about 10mm/a and crustal thickening of 10km, which produces an elevated geothermal gradient and warming of the footwall. From appr. 15Ma onwards the hanging wall was exhumed at a rate of about 1mm/a. The rapid cooling of the samples in the footwall at around 10Ma can be explained by an exhumation rate of about 1.5mm/a or higher, which was caused by rapid uplift near extensional faults.

PALAEOGEOGRAPHY: The thermal history of the HHC is closely connected with the detailed palaeogeographic position of the different units at the former border zone between the LH and HHC units. It has important consequences if the present southern front of the HHC was near to the leading edges of the overthrust along the MCT or far behind it.

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From our geochronological data of the Proterozoic sequences, from field work in the Lahul/Chamba region and the similarities between the Simla Slates and the Haimantas we reject the widely accepted interpretation that the Simla Slate - Krol sequence was deposited on the Early to Middle Riphean Shali - Deoban carbonate platform. We propose an alternative model in which the Simla - Krol sequence was deposited in the southern continuation of the vast clastic Haimanta sedimentary pile, which often exhibit a flyschtype character and got their clastic material from a northern region.

We assume that the northern Chail series (without carbonates) or the Jutoghs and their equivalents (Lower Crystalline nappe in the sense of G. FUCHS) may have been the former basement of the Simla Slates.

In a first phase of the MCT process the Simla/Krol sequence together with the main HHC began to move along a nearly horizontal thrust plane with ramps. In a second phase the thin leading edge of the overthrust unit (i.e. the Simla/Krol unit) was overridden by the main mass of the HHC and parts of the Chail units, forming now some kind of a giant duplex structure.

This interpretation has several consequences apart from palaeogeographic and lithostratigraphic aspects: the thrust distance between the HHC and LH should be extended by the order of 100km. This special setting and the geometry of the initial MCT-process greatly facilitates the evolution of the reversed metamorphic sections. The present stacking: Chail units / Lower Crystalline nappe / HHC may have developed for some Ma in the first stage by thrusting hot material on already warm substrate and the reversed metamorphism developed in the associated shear regime of considerable thickness. The geochronological results of the cooling pattern are in better correspondence with this new model than with a very rapid thrusting of hot on cool elements.