Exhumation of the Higher and Lesser Himalayan Crystallines of the Western Arunachal Himalaya, NE-India: Constraints from Fission-Track Studies

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The active topography and extrusion of the ductilely deformed and highly metamorphosed rocks of the high peaks of the Himalaya have attracted many geoscientists from different parts of the world to study the growth mechanism of the Himalaya. Despite many studies from the NW- and Nepal Himalayas, the growth mechanism is still not completely understood in the absence of geological and geochronological data from the eastern segment of the Himalaya. Current debate has focused on the role of dynamic interaction between tectonics and climate. To address this issue, we conducted detailed field studies and apatite and zircon fission-track (AFT and ZFT) thermochronology of the Higher Himalayan Crystallines (HHC) and the Lesser Himalayan Sequence (LHS) along the Bhalukpong-BomdiLa-Tawang-BumLa/LumLa traverse in western Arunachal Himalaya, NE-India (Figure 1)

AFT and ZFT data collected from western Arunachal Himalaya across the HHC and LHS has been used to understand the exhumation of the region. AFT results from both the HHC and LHS show no change in ages in each tectonic zone with respect to distance from the Main Central Thrust (MCT), whereas ZFT ages show a well-developed correlation with respect to their distance from the HHC to the LHS through the MCT. Ages within the HHC gradually increase from the location close to the Jimithang Thrust to the LHS with a break along the MCT (Figure 2). AFT ages range between 1.4±0.2 to 2.6±0.4 Ma with ages clustering around 2.1 Ma whereas ZFT ages range between 4.5±0.5 and 8.9±1.3 Ma with clustering around 7 Ma. No AFT ages > 5 Ma have been found from this part of the HHC, despite being reported by Grujic and others (2006) from the adjacent eastern Bhutan Himalaya (separated by only ~50 km) (3.0± 0.7 to 8.6±0.8 Ma with weighted mean 5.08±0.09 Ma) although both the regions share similar ectonic structures, rock types and rainfall. It reflects rapid exhumation of the HHC in the western Arunachal Himalaya as compared to the eastern Bhutan Himalaya in spite of their similar location in the shadow zone of the Shillong plateau, a topographic high in front of the Himalaya.

The FT data of the LHS are significantly older than the HHC. The AFT ages in the LHS range between 5.6±0.6 and 12.4±1.3 Ma with ages clustering around 7.9 Ma and ZFT ages range between 10.9±0.6 and 14.1±1.1 Ma with ages clustering around 12.5 Ma. This indicates slow exhumation of the LHS in comparison to the HHC.

Analysis of FT data from both the HHC and LHS indicates that: 1. the MCT is not only a structural boundary separating the HHC and the LHS but also a break in exhumation pattern i.e. a rapidly exhuming zone in the hanging-wall HHC rocks but a slowly exhuming zone in the footwall LHS rocks. Reactivation of the MCT might be mainly responsible for accelerating the exhumation rate in the hanging wall i.e the HHC zone. 2. Ages are poorly correlated with the present-day rainfall. There is a major difference in exhumation of the HHC and LHS zone despite their similar rainfall pattern. 3. Despite the location of the western Arunachal Himalaya adjacent to the eastern Bhutan Himalaya and in the same rain-shadow zone of the Shillong plateau in the Himalayan foreland, there is significant difference in AFT age data sets between the eastern Bhutan and western Arunachal Himalayas. This neither supports any spatial correlation between long-term erosion and precipitation rates nor a climatically driven erosion rate change on the scale of the eastern Himalaya as described by Grujic and others (2006) in the Bhutan Himalaya. It is likely that the tectonic structures such as large-scale folding and thrusting along the MCT in the eastern Himalaya are responsible for the change in erosion rate.

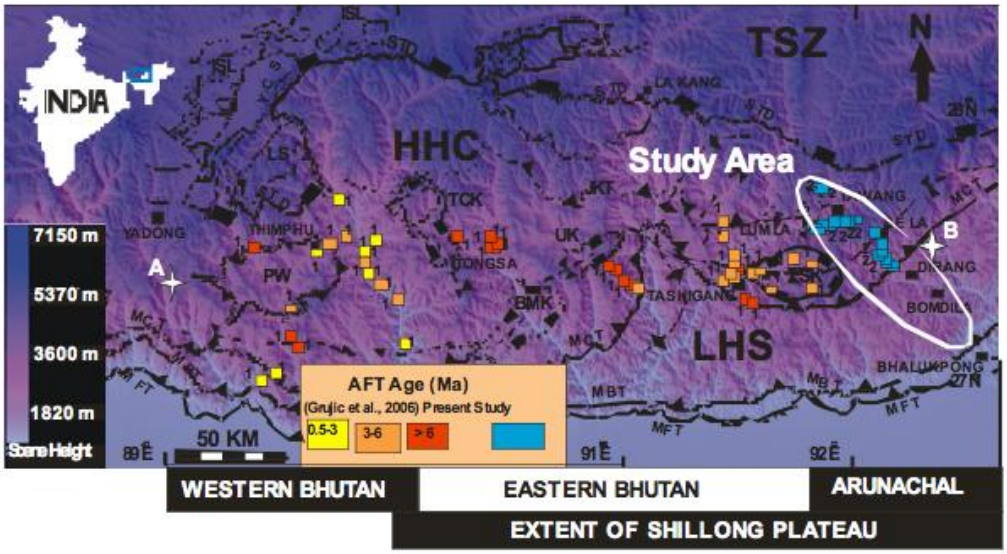

Figure 1. Digital elevation model of Bhutan and western Arunachal Himalaya. MFT: Main Frontal Thrust, MBT: Main Boundary Thrust, MCT: Main Central thrust, JKT: Jimithang-Kakhtang Thrust, STD: South Tibet Detachment, PW: Parro Window, SK: Skteng Klippen, UK: Ura Klippen, BMK: Black Mountain Klippen, TCK: TangChu Klippen.

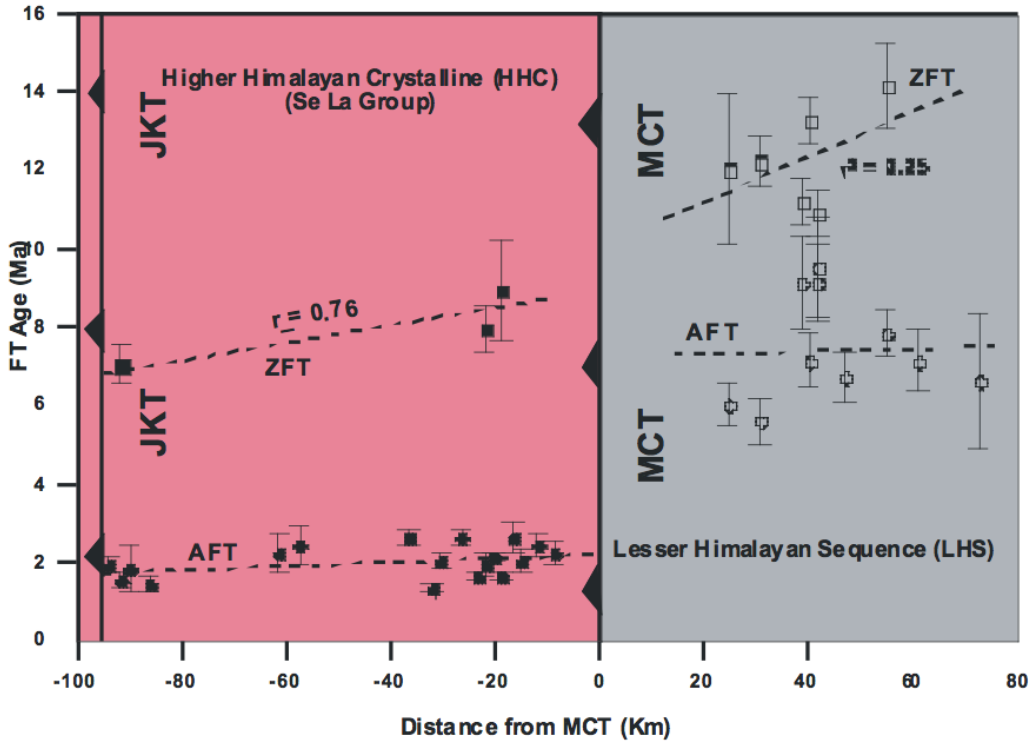

Figure 2: FT age plotted against distance from MCT to test for thrusting along the MCT. Solid and open circles represent AFT ages, and solid and empty squares represent ZFT ages.

Reference

Grujic, D., and others, 2006, Climatic forcing of erosion, landscape, and tectonics in the Bhutan Himalayas, Geol. Soc. Am. Bull., 34, 801-804.

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