Insights of Spatiotemporal evolution of Yamuna Valley, Garhwal Himalaya: Derived from Fission track dating and Morphotectonic analysis

Prerna Gahlaut[1], R.C. Patel[2]

1 HNBGU, Uttarakhand, India; 2 Banaras Hindu University

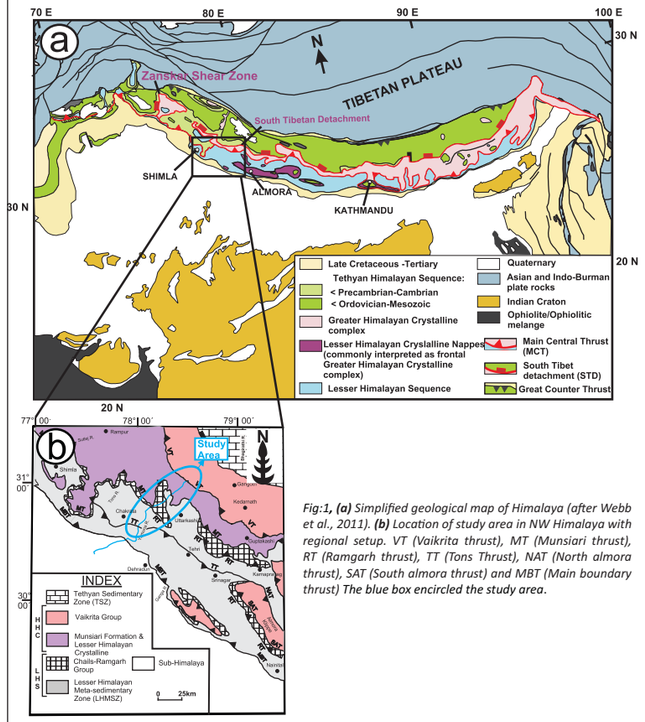

*Fig:1, **(a)** Simplified geological map of Himalaya (after Webb et al., 2011). **(b)** Location of study area in NW Himalaya with regional setup. VT (Vaikrita thrust), MT (Munsiari thrust), RT (Ramgarh thrust), TT (Tons Thrust), NAT (North almora thrust), SAT (South almora thrust) and MBT (Main boundary thrust) The blue box encircled the study area.*

Introduction

1- Himalaya originated as the product of continuous tectonic compression and structural deformation in convergent settings of continent- continent collision which take place between Eurasian plate and northward moving Indian subcontinent estimated 50-55 my ago (Jain et al., 2000; Guillot et al., 2003).

2- Low temperature thermochronology provides insights to enumerate nature and timing of tectonic course from extracted thermal records of vertical moving rock block over geological past.

3- Apatite Fission track ages are used with morpho-tectonic analysis to evaluate land-scape evolution of Yamuna valley. Erosion rates derived from previous study, are also compared with our AFT based exhumation rates.

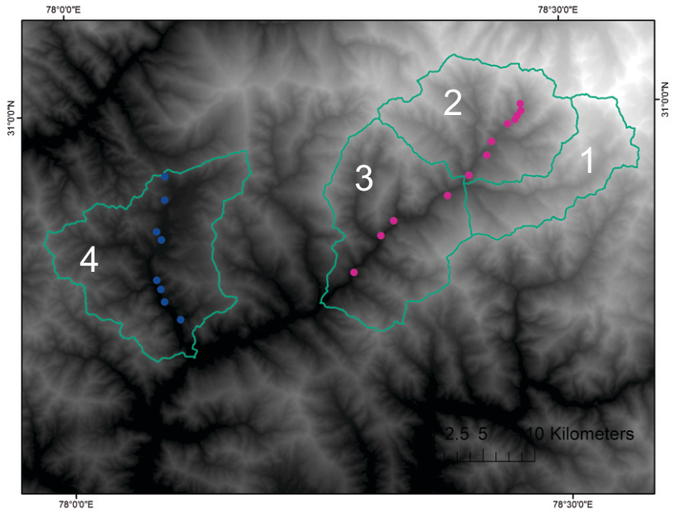

Fig: 2, Three basins (1-3) in Yamunotri region and basin No- 4 from Purola region is selected for AFT sample collection and morphotectonic analysis.

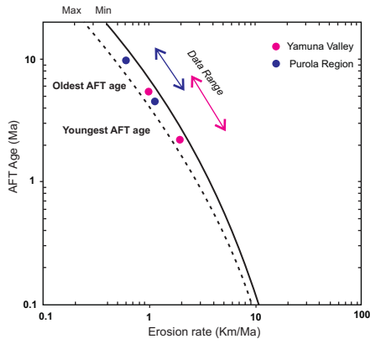

Fig: 3, Growth curve of AFT ages and erosion rate plotted using AGE2DOT (Ehlers et al.,2005) along the Yamuna and Purola traverse. The upper and lower curves represent the maximum and minimum values related to the range of thermal parameters suited to the Himalaya.

Table: 1, Values of morpo-tectonic parameters and IRAT classes.

Basin no	SL index	HI	V_f	A_f	BS	IRAT
1	1	1	1	1	1	***1***
2	1	1	1	2	3	***1***
3	1	2	1	2	2	***1***
4	2	3	3	2	2	***3***

Fission Track Dating and Morphotectonic analysis

1- AFT ages in Yamuna Valley vary between 5.6 ± 0.6 my to 2.3 ± 0.5 my. The resultant exhumation rate in this region range from fast as 2.3 km/my to slow as 1.2 km/my.

2- While AFT ages from Purola region vary between 9.5 ± 0.6 my to 4.0 ± 0.8 my. Exhumation rate from these ages range from 1.6 km/my - 0.8 km/my.

3- Index of relative active tectonics (IRAT) values from morpho-tectonic analysis are high in Basin no 1,2 and 3 which fall in class 1 of IRAT, on the other hand Basin no 4 has lowest class of IRAT.

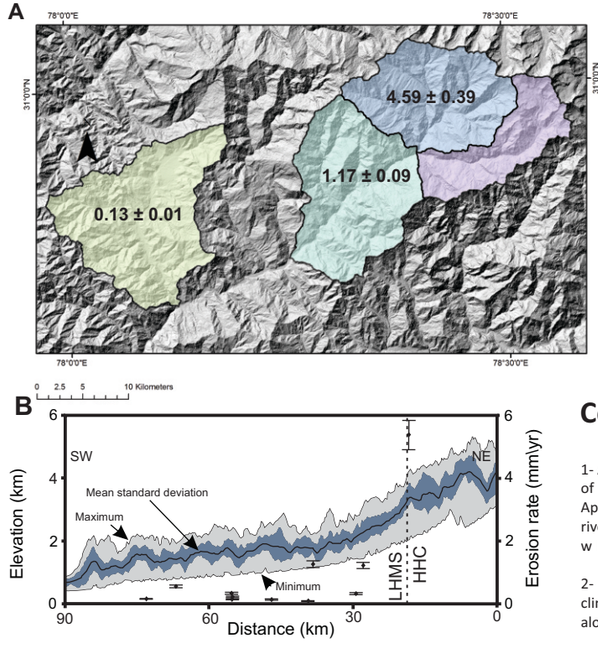

Fig: 4, Be-derived erosion rate Scherler et al., 2014. The erosion rate is in mm/yr. 40 km wide swath profile, presenting distribution of elevation in Yamuna valley, Garhwal Himalaya from NE to SW. Plots of erosion rates with vertical error bars. High erosion rate is observed at transition of HHC and LHMS .

Previous Study

1- Erosion rates derived from 10Be nuclides (Scherler et al 2014) show very slow erosion rate in Purola region (~ 0.13±0.01 mm/yr) while for Yamunotri region higher erosion rate (>4.9 mm/yr) is recorded. These erosion rates are attributed to subsurface geometry of MCT.

2- The erosion rates from previous study are higher than the erosion rates of AFT thermochronology.

Conclusion

1- All three approaches together construct an evolution record of study area over geological past. Exhumation history of Apatite and erosion rates from early studies conclude Yamuna river valley, specifically upper region of valley is very active while Purola region is less active.

2- These combined study point toward relegate control of climate and dominance of ongoing sub-surficial deformation along MCT in Yamuna valley on geological time scale.

Acknowledgment

We are thankful to Science and Engineering Research Board, Department of Science and Technology, Gov of India's reserach project (No: IP/S4/ESF-15/2009) awarded to R.C. Patel, Department of geophysics, Kurukshetra University.

Reference

Webb, A. A. G., A. K. Schmitt, D. He, and E. L. Weigand (2011b), Structural and geochronological evidence for the leading edge of the Greater Himalayan Crystalline complex in the central Nepal Himalaya, Earth Planet. Sci. Lett., 304, 483–495, doi:10.1016/j.epsl.2011.02.024.

Scherler, D., Bookhagen, B., Strecker, M.R., 2014a. Tectonic control on 10Be-derived erosion rates in the Garhwal Himalaya, India. J. Geophys. Res. 118, 1–24. http://dx.doi.org/10.1002/2013JF002955

Ehlers, T.A., et al., 2005. Computational tools for low-temperature thermochronometer interpretation. Reviews in Mineralogy and Geochemistry 58, 589–622.