Geophysical Research Abstracts
Vol. 19, EGU2017-13869, 2017
EGU General Assembly 2017

Constraining the Quaternary exhumation of the Siwaliks using very low temperature OSL-thermochronometry

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The Himalayan foreland fold-and-thrust belt is composed of Neogene synorogenic sediments of the Siwalik Group and accommodates ∼15-20% of the India-Eurasia convergence [1]. Along the strike of the 2500-km-long orogenic arc, despite homogenous lithology and erodibility, the fold-and-thrust belt narrows towards the east. This has been attributed to increasing annual rainfall and specific stream power, rather than to lateral changes in shortening rates [1]. However, exhumation/erosion rates of this unit remain unknown. Constraining these rates would allow estimation of the relative contributions of tectonic and climatic processes to the erosion of the youngest and frontal part of the Himalayan orogen as well as how shortening is distributed within the range. Here we present new OSL-thermochronometry data from western Nepal and eastern Bhutan.

Thermochronometry enables the cooling histories, and therefore exhumation/erosion histories of rocks to be determined. However the cooling histories of the Siwalik Group, which have experienced limited burial heating not exceeding ∼100-50 °C remain very difficult to constrain using traditional thermochronometers. Optically stimulated luminescence (OSL)-thermochronometry is a recently developed very low temperature thermochronometer sensitive to temperatures of 40-100 °C. Consequently, its application to the Siwalik deposits may provide insights into their cooling and exhumation histories.

K-feldspar extracts from 18 sandstones samples of the Siwalik Group were investigated using a multi-OSL-thermochronometry approach, whereby four different signals, with different thermal stabilities were measured for each sample. The sandstone samples were collected along two transects across the Himalayan fold-and-thrust belt in western Nepal, and eastern Bhutan. Using signals with different thermal sensitivities enables high precision Quaternary cooling histories to be derived. Inverting these data, results in erosion rates of ∼3 mm/yr, which are broadly consistent between samples from eastern Bhutan, indicating similar rates of cooling. In contrast, preliminary data for the transect from western Nepal indicate lower rates of erosion, supporting the empirical observations of Hirschmiller et al. [1] that higher rates of precipitation in the eastern part of the Himalayan fold and thrust belt are coincident with higher erosion rates. These preliminary data may explain the eastward narrowing of the fold and thrust belt, suggesting that surface processes play an important role in shaping the morphology of the frontal Himalaya. Further measurements from the western Nepal transect and other sites will confirm these results.

[1] Hirschmiller et al., 2014. What controls the growth of the Himalayan foreland fold-and-thrust belt? Geology, 42(3), pp.247-250.