U-Pb Zircon Ages as a Sediment-Mixing Tracer in the Nepal Himalaya

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Overview

Steeper hillslopes and channel gradients across the Greater Himalayan Series (GHS) of central Nepal suggest higher rates of rock uplift throughout this region. Suggested causes include 1) reactivation of the Main Central Thrust (MCT), 2) uplift along a crustal scale ramp and 3) uplift along a previously unmapped thrust 20-30 km south of the MCT. If rock uplift exerts the primary control on modern erosion rates, a break in erosion rate should exist across the break in rock uplift. We use mixing of U-Pb zircon ages in modern river sediment to measure relative erosion rates in adjoining drainages above and below the MCT. Preliminary results do not show a significant break in erosion rate across the MCT, suggesting the break in uplift may be focused elsewhere. Basin-scale mixing of U-Pb zircon ages will also be assessed in the Marsyandi drainage to better understand the construction of the foreland zircon population.

How can we use mixing of U-Pb zircon ages to derive relative erosion rates between two drainages?

Step 1: Define the U-Pb zircon age distribution in each drainage and assume they are mixing in a 1:1 ratio to form a downstream sample "C".

Step 2: Predict the U-Pb zircon age distribution in the downstream mix based on the difference in drainage area

Area correction: ~0.5A:1B
Zircon mixing ratio: ~4A:1B
Relative erosion rate: 0.3A:1B
Conc. correction: ~1A:1B

Step 3: Predict the U-Pb zircon age distribution in the downstream mix based on the difference in zircon concentrations

Step 4: After accounting for drainage area and concentrations the mixing ratio reflects relative erosion rates between the source regions

A. Greater Himalayan Drainage
Area = 1.9 G
Zr Conc. = 283 ppm
n=99
B. Lesser Himalayan Drainage
Area = 10 G
Zr Conc. = 226 ppm
n=101
C. Mixed Downstream Sample
Area = 42 G
Zr Conc. = 190 ppm
n=132

Preliminary Results

How can modern mixing of U-Pb zircon ages on a basin scale improve our interpretation of the foreland zircon population?

- Does the proportion of zircon in the foreland derived from a specific source region with:
1) Drainage area within the source region?
2) Erosion rate of the source region?
3) Concentration of zircon in the source rocks?

Approach

- Sampling strategy combines:
1) Samples defining the contribution from distinct source regions
2) Downstream samples reflecting the importance of each source
- U-Pb ages mixing data will be supported by:
1) Heavy mineral point counting
2) Analysis of zircon size, color and morphology

Potential Implications

- Similar erosion rates across the MCT suggest that either:
1) Erosion rates are not technically controlled
2) The break in uplift rates is focused south of the MCT
3) Uplift is broadly distributed across a crustal scale ramp

- Better understanding of how the foreland zircon population is constructed will:
1) Test assumptions commonly made when using foreland zircon fission-track ages to interpret the exhumational history of mountain belts
2) Address issues of transport survivability and source-sink biasing, fundamental to any bedrock detrital zircon study