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Exhumation Rates from Bedrock and Detrital Cooling-Age Elevation Signals: Effects of Post-Closure Deformation in the Marsiyandi Valley, Central Nepal

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A bedrock sample's cooling age is a function of elevation and denudation rate in a tectonic block with a simple thermal structure that undergoes uniform unroofing, As a consequence, age-elevation relationships can be used to estimate long-term unroofing rate. Detrital mineral cooling ages from modern rivers have also been used as a proxy for unroofing rates because they integrate bedrock cooling ages from the contributing basin. Both types of estimates are reliable only if deformation within the block ceased before closure, and only if all minerals used in the analysis grew before unroofing began. If the relationship between a basin's detrital mineral cooling-age signal and its hypsometric curve is to be used to infer denudation rates, the basin must have been at topographic and thermal steady state since the closure interval. Moreover, its detrital signal must represent a high-fidelity sampling of bedrock ages in proportion to area. These assumptions can be tested through statistical comparisons of cooling-age distributions and hypsometric curves.

Based on our interpretation of new bedrock and detrital muscovite ^{40}Ar/^{39}Ar dates from the Marsiyandi Valley of central Nepal in the context of recent detailed structural mapping, we suggest that, although the sedimentary signal reasonably represents bedrock cooling ages from the catchment and may be consistent with steady-state assumptions, the fundamental assumption that bedrock cooling ages vary simply as a function of sample elevation is compromised by activity of multiple post-closure thrust sheets.

Dates for bedrock muscovites collected over 3 km of topographic relief are not correlated with elevation in a straightforward way. Some summit ages are younger than ages observed in valleys. Some anomalously young ages might be explained by local hydrothermal muscovite growth. However, mapped Quaternary thrust faults which juxtapose units with different cooling histories are likely to be responsible for the complex pattern of bedrock dates. Given this, more sophisticated models that take into account post-closure deformation are needed to interpret both bedrock and detrital thermochronologic data in terms of unroofing rates.