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Ar/Ar Single Crystal White Mica Ages for Himalayan Erosion, Exhumation and Provenance Studies

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Detrital white mica single-crystal Ar-Ar cooling ages from the Himalayan foreland sedimentary record are potentially a powerful tool in constraining source regions, tectonic evolution, and the timing and extent of exhumation (Copeland & Harrison 1990, Najman 1997). Here we present the results of detrital single grain ages in sediments from a modern Himalayan river and from Early to Middle Miocene fluvial sediments deposited in the Northern Indian foreland basin. From the modern river study we conclude that detrital micas from large rivers yield a representative 'cooling profile' of the source. We then use mica age distributions from sediments of known age to constrain rates and mechanisms of exhumation of the metamorphic hinterland.

Two samples of river sediment from the Ganges which drains the Garhwal Himalaya, Northern India were selected. 60 mica analysis range in age from 10 to 30 Ma with most grains 10 to 20 Ma are in good agreement with the published cooling data from the High Himalayan Crystallines (HHC) and MCT of the Garhwal Himalaya (Metcalfe 1993) and we interpret these grains as derived from these units. We conclude that, the river is effective at sampling the 'cooling profile' of the crust. A lack of ages older than 30 Ma which, despite 60% of the river catchment area draining the Lesser Himalayan Series (whole rock cooling ages range >60-500 Ma and mica cooling ~1000 Ma, Oliver et al 1995 & Frank et al 1995), may be attributed to low uplift rates compared to the HHC, smaller proportion of micaceous lithologies and the fine grain size of the micas.

The Dharamsala formation, deposited in the foreland basin from ~20 Ma -12 Ma, provide a syn-kinematic denudation history of the orogen following initial post-collisional regional metamorphism of the High Himalayan slab (40-30 Ma) and co-eval with crustal anatexis (24-18 Ma) and a period of rapid cooling in response to extensional movement on the South Tibetan Detachment System and thrusting beneath the main metamorphic belt along the Main Central Thrust (MCT).

The Lower Dharamsala sandstones (20-17 Ma) contain abundant low- to medium-grade metapelites to metafelsites, detrital micas (9% of framework grains) and garnet. Ar-Ar ages of detrital white mica are almost entirely 'Himalayan' in age (<~55 Ma), with the greatest abundance between ~30-20 Ma (peak 22-24 Ma). These ages indicate that the majority of the source rocks were exhumed and eroded within 10 Myr of cooling through ~350 ºC which followed the early burial metamorphism at 40-30 Ma. The difference between the youngest cooling ages and deposition in the basin is ~1-3 Ma. This rate of delivery alludes to rapid exhumation. Petrography and mica cooling ages show an abrupt shift in the provenance, between the Lower and Upper members of the Dharamsala formation. Higher-grade metamorphic source-rocks are replaced by sedimentary and very low-grade metasedimentary source-rocks, detrital micas are minor (1% of framework grains). Although Himalayan mica-cooling ages persist they are much less abundant and there are no grains younger than 20 Ma. Therefore the difference between cooling age and depositional age increases and apparent exhumation rates decrease. Pre-Himalayan ages become dominant in the Upper Dharamsalas, whole rock Sr & Nd suggest a source similar to the Outer Lesser Himalayas found in Garhwal (Ahmed et al 2000). The event responsible for the shift in provenance, with all likelihood, tectonic in nature, interrupted and reversed the unroofing trend as documented in the Dagshai-Kasauli sandstone suite of the Indian foreland basin (Najman & Garzanti 2000) and continued through the Lower Dharamsala.

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