Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08795, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08795
EGU General Assembly 2008

Denudation rate meters in mountain belts: is the future big brush or fine tip?

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Of the three meters that are in our hands for measuring the erosion and weathering (=denudation) of mountain belts, the newest addition to our toolbox, basin-wide rates determined from cosmogenic ^{10}Be in river sediment have in the past years perhaps provided the most fundamental insights into the patterns at which mountains erode. The global picture is constantly changing by high-quality data that is now being produced from active belts with high erosion rates. The rates are very consistent within an individual range, and good correlations with basin characteristics such as altitude emerge from global compilations of some 500 rates (Willenbring and McElroy). These rates also usually agree within a factor of two with those derived from thermochronology, hinting at some long-term stability or even geomorphic steady state. Unlike river loads with all their sometimes unpredictable short-term stochastic climate and land use forcing, cosmogenic nuclide-derived rates seem to record processes taking place over geologic time scales.

However, cosmogenic nuclide-derived rates have also produced their fair share of surprises, even contradicting previous geomorphic expectations. Some serious deviations from the global trends between denudation rates and basin characteristics emerge as ever closer looks are being made. For example basin studies in the Sierra Nevada and in the tropical Highlands of Sri Lanka have shown that it is active faults, not steep hillslopes per se that result in the fastest landscape denudation while the absence of active landscape rejuvenation results in slow denudation despite high rates of precipitation. In the European Central Alps denudation rates are high ($>$ 1 mm/yr), and correlate stunningly well with rock uplift rates from leveling measurements, a real tectonic eye

opener given that this part of the Alps is not even experiencing active convergence. Yet exceptions to this rule are already beginning to emerge from small basin studies. Norton (this meeting) shows that valley faults have the capability to trap sediment, and reduce denudation rates on steep slopes and at 3 km altitude almost ten-fold.

So it is the exceptions, based on individual basin-wide denudation rates, rather than the rules, that are telling us the real stories about the distinct tectonic, lithologic, or climatic processes that operate. If true, then the next steps are in identifying those small-scale settings where these driving forces can be singled out, and can be associated with distinct rates of bedrock stream lowering, valley incision, channel hillslope coupling, soil production, and sediment storage. This work needs to be done before denudation rates can be used to calibrate mountain-range size numerical tectono-gemorphic models.