Denudation rate meters in mountain belts: 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), 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 these rates. 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.

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, combined with weathering indices, and can be associated with distinct rates of bedrock stream lowering, valley incision, channel hillslope coupling, soil production, and sediment storage.

In situ Hf Isotope analyses within individual zircon growth zones

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We have developed a micro-analytical technique for precise and accurate *in situ* measurement of Hf isotopes of zircons within individual growth zones using a multiple-collector inductively-coupled-plasma mass spectrometer (MC-ICPMS) connected to a single excimer laser-ablation system. In order to improve the accuracy of the Hf isotope ratio analysis, previously reported correction methods for isobaric interferences on ^{176}Hf by ^{176}Yb and ^{176}Lu were evaluated, and we found that only the use of independent mass bias factors for Hf and Yb in the isobaric interference correction lead to more reliable Hf isotope ratios.

The precision and accuracy of this method was evaluated using six well-known and widely used zircon standards (91500, Temora-2, GJ-1, Mud Tank, BR266 and Monastery). Analyses were carried out using spot sizes of 40 and 60 µm. The resulting Hf isotopic ratios of these six zircons are in agreement with reported values. In order to test the isobaric correction of ^{176}Hf we added different Yb solution during the ablation procedure, based on the knowledge that the Yb/Hf ratios of many common zircon grains increased up to 0.15.

To test the reliability of the Hf isotopic data of small zircon growth zones we selected samples from the Cretaceous belt of the Balkan Peninsula (Serbia, Bulgaria). *In situ* LA-ICPMS U-Pb dating analyses remain important to define the time of geological processes. Based on Hf isotope measurements of zircons, including Pb-Sr-Nd isotope tracing, we can demonstrate different crust/mantle evolution within the Cretaceous belt. *In situ* Hf measurements can demonstrate that the Lu/Hf system remains closed during younger metamorphic events; no change of the εHf values between core and rim is observed.