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Preservation of cosmogenic nuclide signals during floodplain - river interaction in the upper Amazon basin

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An important precondition for calculating catchment-wide denudation rates from cosmogenic nuclides is that all nuclides are produced during denudation in the sediment-producing areas, and none during transport in rivers or during post-erosional storage in floodplains. Therefore, the application of this method to catchments including large depositional basins seems unfeasible.

The tributaries to the Amazon basin are an ideal setting to test the behavior of this system. The sediment-generating areas within the Andes have high denudation rates, hence they deliver sediment with low cosmogenic nuclide concentrations, which is then stored in the floodplain basins of the upper Amazon over geologically significant periods. In the large pristine Beni catchment, which drains the northern Bolivian Andes, this nuclide signature has been characterized in great detail[1]. Mean denudation rates in the Andes are 0.4mm/yr and concentrations at the headwater river outlet are ca. 30000atoms ^{10}Be/g(Qtz). On its way to the Amazon the Beni traverses through $\sim$50000km^2 of floodplain, thereby depositing half of its sediment load ($\sim$100Mt) each year. Cosmogenic nuclide measurements on bedload from the active Beni channel (n=20; avg. concentration of 25000 to 45000ats/g) show that this signal is certainly

preserved along a river course of more than 800km length, and neither significant accumulation (by irradiation) nor decrease (by radioactive decay) of nuclides can be observed.

We have generated a numeric model that considers depth- and time- dependent nuclide production and decay in storage settings that are fed by sediment eroded from the source area which is then being mixed with sediment eroded from the river bank. Model results are mainly sensitive to initial nuclide concentration and magnitude of upstream discharge of the erosion products, channel migration velocity, and channel remobilization depth. The model indeed predicts no significant gain in nuclide concentration from floodplain sediment remobilization for conditions as those found in the Beni river. We have applied the model to a variety of other large rivers and cannot observe significant gain or decrease in nuclide concentration for typical storage times. The reason is that floodplain storage depth is usually so deep (e.g. 5-50m) that all but the uppermost meters of sediment are being shielded from irradiation. On the other hand, remobilization of sediment usually occurs before significant radioactive decay of ^{10}Be can occur.

This study is the first that applies cosmogenic nuclides to large depositional settings. Its suggests that a sample collected from any point along the river course of an active channel from within the floodplain will reveal the denudation rate of the source area, provided that the nuclide production rate used is that calculated only for the sediment-producing area.

[1] Safran et al., 2005, ESPL, Vol. 30, pp. 1007-1024.