Geophysical Research Abstracts
Vol. 20, EGU2018-14661-1, 2018
EGU General Assembly 2018

Where do ^{10}Be-derived denudation rates depend on grain size?

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In-situ cosmogenic ^{10}Be is a frequently used method to measure catchment average denudation rates from river sediment. Commonly, the sand fraction (<1 mm) is used to determine denudation rates. However, some studies suggest ^{10}Be concentrations may vary between different grain sizes. A typical explanation for such phenomenon invokes mass wasting processes that excavate coarser grains from greater depth where ^{10}Be concentrations are lower. Using the sand fraction (<1 mm), with higher ^{10}Be concentrations, could thus introduce a denudation rate bias in mass wasting dominated catchments. It is, therefore, important to investigate grain size dependent ^{10}Be concentrations and their potential climatic, tectonic and lithological causes.

This study consists of two parts: a controlled grain size study, in which we focus on the effect of precipitation only, and a global grain size compilation, in which we focus on the effects of precipitation, tectonics and lithology. In the controlled grain size study we measured ^{10}Be concentrations in 7 grain size fractions sampled in 4 catchments located on a precipitation gradient (∼13 to ∼1200 mm/yr) in the Coastal Cordillera of central Chile. The catchments share similar topographic and lithological conditions. Despite the large precipitation gradient, the variation in ^{10}Be concentrations in grain sizes was small and grain size trends were weak. The global compilation includes 95 sample sets covering different lithologies and a large gradient in climatic and tectonic conditions. Results revealed minor differences in ^{10}Be concentrations between grain sizes in shallow (<15˚) and slowly eroding catchments, whereas steep (>15˚) and fast eroding catchments show distinctly lower ^{10}Be concentrations in coarse grains. The effects of precipitation and lithology are less evident in the global compilation.

We conclude that the variation in denudation rates, as result of grain size dependent ^{10}Be concentrations, is small in shallow and slowly eroding catchments and large in steep and fast eroding catchments. The likelihood of introducing a bias, by sampling the sand fraction, is therefore higher in steep and fast eroding landscapes. We conclude that climate and lithology have a weak control on grain size dependent ^{10}Be concentrations. With the use of grain size distribution models we will further investigate the variation in denudation rates in different landscape settings. Additionally, we will evaluate the causes of grain size dependent ^{10}Be concentrations.