Geophysical Research Abstracts
Vol. 14, EGU2012-12146, 2012
EGU General Assembly 2012
© Author(s) 2012

Quantifying sediment storage using combined cosmogenic in situ 14C-10Be-26Al analysis

K. Hippe (1), F. Kober (2), S. Ivy-Ochs (3), L. Wacker (3), P.W. Kubik (3), and R. Wieler (1)

(1) Institute for Geochemistry and Petrology, ETH Zürich, Switzerland (hippe@erdw.ethz.ch), (2) Geological Institute, ETH Zürich, Switzerland, (3) Laboratory for Ion Beam Physics, ETH Zürich, Switzerland

The transport of sediment through a drainage basin is often interrupted by repeated intervals of sediment storage and remobilization. These processes link hillslope sediment production and sediment delivery at the outlet of a basin and play an important role assessing the sediment budget of a drainage system. The spatial distribution of sediment storage can mostly be qualitatively recognized from field observations, but it is difficult to quantify storage times and budgets and thus to determine sediment transit times.

We present a new approach to determine sediment storage times by the combined analysis of cosmogenic in situ 14C with 10Be (and 26Al) in fluvial sediments. The long-lived 10Be and 26Al are used to obtain basin-averaged denudation rates that provide long-term estimates on sediment production. While these nuclides are insensitive to sediment storage of up to several 104 years the short-lived in situ 14C reacts rapidly to short-term interruptions of sediment exposure and can be used to identify sediment storage episodes as short as a few thousand years. Results obtained from two largely different landscapes – the arid Altiplano and the humid European Alps - will be presented. Both studies illustrate the importance of sediment storage even over comparatively short distances (several km) and demonstrate the potential of in situ 14C to provide fundamental information on the sediment flux and residence time.

(i) The high-elevation Bolivian Altiplano plateau is characterized by a flat topography and low geomorphic gradients. Denudation is dominated by hillslope processes; fluvial transportation occurs episodically and is dependent on the strongly seasonal rainfall. Concentrations of 10Be and 26Al imply consistently low catchment-wide denudation rates and indicate long-term geomorphic and isotopic steady-state conditions. In contrast, in situ 14C concentrations are comparatively low and suggest that 14C decayed during sediment storage over at least the past ~10-20 kyr. We discuss the influence of soil-mantled hillslopes and storage depth on the in situ 14C concentration.
(ii) The upper Aare catchment in the Swiss Alps is a steep, glacially modified system dominated by frequent mass wasting processes (rock fall, debris flow). Catchment-wide denudation rates determined from 10Be concentrations are about two orders of magnitude higher than on the Altiplano and are strongly perturbed by debris flows events. In situ 14C data suggest that sediment can be stored up to a few thousand years within low order catchments before being remobilized and incorporated in a debris flow.