Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 1058

Late Pleistocene to Holocene Erosion Rate Variations from Cosmogenic Nuclides in River Terrace Sediments

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We report a first attempt to quantify catchment-wide rates of "paleo erosion" using cosmogenic nuclides in sand from dated river terraces.

The approach is based on the finding that cosmogenic ^{10}Be in recent river-borne quartz records a time-integrated, large-scale erosion rate representative of an entire river catchment (Schaller et al., this volume). If this is the case then cosmogenic nuclides, extracted from quartz in sediment deposited by the river in past intervals in terraces, can be extracted to measure erosion rates integrating in the catchment at the time of terrace deposition.

An ideal test case is presented by the terraces deposited in the Late Pleistocene and Holocene in the Northern Massiv Central (Allier and Dore River). The terrace system has been extensively studied, dated by ^{14}C and U-series, and modelled (Veldkamp & Kroonenberg 1993). A rich framework exists in erosion-rate estimates integrating over various time scales: 1) modern river load gauging (10-30 yrs); 2) physical Late-Pleistocene erosion time series as measured by sediment accumulation in the Basin of Lac Chambon (12600 yrs, Macaire et al. 1997); 3) cosmogenically-derived erosion rates of recent Allier, Dore, and Loire sediment (10000 yrs, Schaller et al. this volume). Measured ^{10}Be nuclide concentrations in quartz were corrected for post-depositional irradiation using the known terrace age. The remaining nuclide inventory is attributed to irradiation in the source area of the terrace sediments. Erosion rates can then be calculated using the steady-state assumption of Lal (1991), and making use of neutron and muon production rates (Heisinger 1998) scaled for the mean altitude and latitude of the terraces upstream area.

Erosion rates based on ^{10}Be are all between 50 and 70 mm/kyrs for the Late Pleistocene to Holocene terrace samples (Fig. 1). These rates are very similar to those measured cosmogenically in recent Allier and Dore river sediment (40-80 mm/kyrs). They are also in excellent agreement with the long-term estimates based on sediment accumulation in the Chambon Basin. We have modelled the nuclide abundances expected in past river sediments by numerical integration of cosmic rays impinging in the catchment during the erosion history as represented by Chambon data. Although real erosion rates vary between 50 and 160 mm/kyrs, the variations expected from cosmogenic nuclides are strongly damped by the considerable lag time required (ca. 10000ys) for a new steady state to be achieved after a change in erosion rate.

These results present a plausible explanation for the 3- to 5-fold increase of cosmogenic erosion rates measured in recent river sediment over that measured by river load gauging in the same streams (Fig. 1): recent sand carries a memory of the Late Pleistocene erosion history, and possibly of the medieval erosion events caused by deforestation. Most importantly, however, the approach yields, for the first time, time-integrated erosion rates from a previous climate cycle.

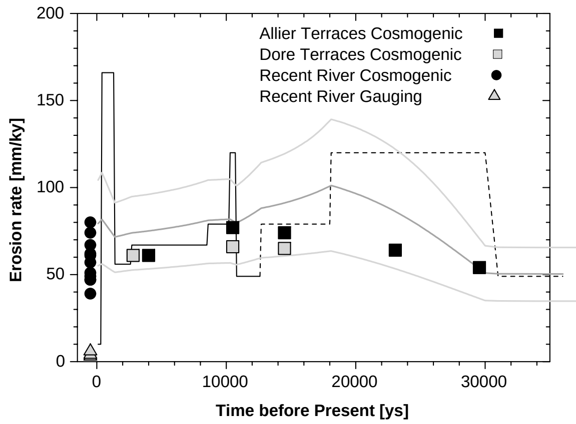

Figure 1. Erosion rates calculated from cosmogenic ^{10}Be concentration in Allier and Dore terraces at known ages (squares), in recent Allier and Dore river sediment (circles) and modern erosion rates from river load gauging (triangles). The thin solid line represents erosion rates measured by sediment accumulation in the Chambon basin back to 12600 yrs (Macaire et al. 1997), the dashed line represents our extrapolation of the data back through the Last Glacial Maximum, assuming an erosion history similar to that of the younger Dryas. The thick dark grey line is a model representing the cosmogenic erosion rates expected from river sediment at any point back through time based on integration through time of the Chambon Basin erosion curve, the light grey lines represent model results based on the Chambon Basin erosion error estimates (Macaire et al. 1997).

Heisinger BP, *Ph. D Thesis TU München*, 151, (1998).
Lal D, *Earth Planet. Sci. Lett*, **104**, 424-439, (1991).
Maccaire JJ et al, *Earth Surface Processes and Landforms*, **22**, 473-489, (1997).