Quantification and geochemical characterization of total mass fluxes in river catchments of the Rhenish Massif and the Black Forest, Germany

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We aim to constrain long-term erosion rates from the concentration of cosmogenic ^{10}Be in stream sediments in order to quantify the Late Quaternary denudation history of mountain ranges in central Europe. Four different catchments in Germany, ranging in size from 8 to 379 km² are being investigated. Two of them, the Aabach and Möhne catchments in the Rhenish Massif, drain predominantly low-grade Paleozoic metasediments. The other two, the Gutach and Acher catchments in the Black Forest are situated in late Paleozoic granites. Initial samples from river catchments in the Rhenish Massif yield preliminary erosion rates between 30 and 50 mm/ka. These spatially-averaged erosion rates integrate over the past 10 to 20 ka. Central to our investigation are questions concerning the relative importance of lithology and catchment relief on long-term erosion rates.

Short-term erosion rates for all catchments will be quantified by combining the amounts of suspended and dissolved loads in water samples with water discharge data and basin area. By analyzing the stable isotopic signatures $\delta^{34}S$ and $\delta^{18}O$ of sulfate and $\delta^{13}C$ of dissolved anorganic carbon we aim to correct the suspended and dissolved load for organic, atmospheric and anthropogenic inputs. These results will be complemented by erosion rates derived from the volume of sediment stored behind reservoirs of known age. Preliminary erosion rates, based on accumulated suspended matter from both reservoirs in the Rhenish Massif vary between 4 and 24 mm/ka over a period of 13 to 28 a.

Carbon, nitrogen, and sulfur cycling in a euxinic end-Permian ocean

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Abundant isotopic, geochemical, and biomarker evidence suggests the end-Permian mass extinction coincided with widespread anoxia and possible euxinia (anoxic and sulphidic waters). Anoxia might have resulted from a coincidence of warm surface ocean temperatures, low atmospheric oxygen content, and high O_2 demand in the deep ocean. Subsequent organic matter remineralization by bacterial sulphate reduction would produce euxinic conditions. Phosphate release from shallow sediments under a sulphidic water column would further enhance oceanic euxinia through positive feedbacks to primary productivity. Here we use earth system modelling to investigate the physical and biogeochemical conditions necessary for the development of intense euxinia during the end-Permian. We hypothesize that reasonable variations in oceanic nutrient content will induce deep ocean euxinia.

We use the end-Permian configuration of GENIE (www.genie.ac.uk), an energy-moisture-balance atmospheric model coupled to a 3-D, non-eddy-resolving, frictional geostrophic model to evaluate this hypothesis. The model includes marine carbon, nitrogen, and sulfur cycles and accounts for metabolisms critical for the transition to ocean euxinia. We performed model simulations over a range of oceanic phosphate concentrations to relate nutrient content to the buildup of widespread euxinia and subsequent chemocline (oxygen-sulphide interface) destabilization. Deep-water H_2S appears with a doubling of oceanic phosphate, and we observe the greatest deep-water sulphide concentrations in the Paleo-Tethys Ocean. The metabolic activities of sulfide-oxidizing phototrophs and denitrifying organisms delay, but do not prevent H_2S buildup. Additionally, H_2S in equatorial and high latitude upwelling zones is released to the atmosphere when the upwelling flux of sulphide exceeds the downward oxygen flux from the atmosphere. Under modern atmospheric oxygen levels, significant air-sea H_2S fluxes result from 6- to 10-fold increases in oceanic phosphate. This destabilization of the chemocline causes sulphide poisoning in both marine and terrestrial environments, imposing environmental stress that may promote extinction. These simulations support the hypothesis that extreme euxinia and episodic H_2S eruptions can result from modest changes in the ocean's nutrient content. Comparing these spatially resolved predictions to the rock record will help constrain the geochemical environment in which the end-Permian mass extinction appears.