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Towards quantifying long-term erosion rates in the Campine Basin, NE Belgium

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The Campine Basin, NE Belgium, is situated between the uplifting Ardennes Massif and rapidly subsiding Roer Valley Graben. It contains a thick series of marine, estuarine and continental Neogene and Quaternary sediments, locally more than 300 m. As a result of relief inversion during the Quaternary, the Campine Plateau is nowadays a distinct morphological feature in this basin. Its surface elevation dips from 100 m in the south to 30 m in the north over a distance of about 60 km, which is the result of differential uplift. The Campine Plateau is covered by Early and Middle Pleistocene erosion-resistant fluvial sediments from the Rhine and Meuse and can thus be regarded as a fluvial terrace. The age of deposition and time of abandonment of the terrace have not yet been resolved by direct numerical dating.

In this study, we apply the cosmogenic radionuclide (CRN) profiling technique that, in ideal circumstances, allows one to constrain the exposure age, burial age and amount of post-depositional erosion of the landform. Samples were taken from a 3.5 m deep cross-section in coarse river sands that were deposited by the river Rhine, and now situated at an altitude of about 50 m (a.s.l.). Nine of them were prepared for CRN measurements according to state-of-the-art techniques. The in-situ 10Be concentration of the samples was determined using accelerator mass spectrometry (ETH, Zurich). The in-situ 10Be concentrations are 1.5x10e5 atoms/g for the uppermost sample (at 0.3 m depth) and 0.9x10e5 at/g for the lowermost sample (at 3.1 m depth), yielding an estimated 0.6x10e5 at/g of radionuclide accumulation following sediment deposition.

Using forward modelling, we solved for the exposure duration and erosion rate that best fit the measured in-situ 10Be depth profile data, nuclide inheritance and their associated analytical uncertainties. Model optimisation is here based on the sum of chi-squared between the measured and modelled 10Be concentrations. When taking previous geological age constraints of the sediments (between 0.6 and 1 Ma) into account, the model optimum occurs with a terrace erosion rate of 10 to 25 m/Ma. The uncertainty on the model fit calls for a dense sampling scheme to capture the full spectrum of internal variability in CRN concentrations, likely related to the highly polycyclic nature of the fluvial sedimentary environment. Furthermore, independent age control from OSL, ESR and/or paired Al-Be CRN dating would help to refine the erosional and depositional history of this landform.