Constraining aggradation mode of fluvial deposits using a 10Be/26Al depth profile and modelling

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Résumé

Cosmogenic radionuclide depth profiles have proven to be useful to constrain the absolute age, erosion and paleo-denudation rate of fluvial deposits. A main assumption of simple depth models is that the period of aggradation of deposits is short compared to their post depositional history.
In this paper, we present a model simulating CRN depth profiles for complex aggradation modes, including hiatuses in the sedimentary record. This model calculates the accumulation of 10Be and 26Al in fluvial deposits, and dynamically adjusts the CRN concentrations as a function of time-variable aggradation and erosion, and accounts for inherited CRN concentrations and the total exposure duration.

The model is applied to a Quaternary fluvial deposit of the Meuse River Campine Plateau, Belgium). Age constrain is poor, and situated between 0.5 and 1 Ma. Besides a characterization of the granulometry and geochemistry of the 8m-thick gravel sheet, a detailed CRN profile was established containing 15 10Be and 3 26Al measurements.
We provided the model with realistic scenarios constrained from granulometry and geochemistry i.e. a series of distinct units in the 7 upper-most meters. Diagnostic scenarios for the measured CRN depth profile were determined from optimization of the Nash-Sutcliffe efficiency index (NSE). We compared the fitting quality of these scenarios against scenarios from simple depth models, and analyzed the parameters determining the aggradation mode and the post depositional evolution of the deposit. Values of NSE $>$ 0.65 were observed for complex aggradation modes, and systematically below 0.1 for simple depth models. The best scenarios indicate an age of the oldest deposits around 630ka, separated from the deposition of the youngest sediments by an aggradation duration of 60-105 kyrs comprising 2 well identified hiatuses. We can thus conclude that complex aggradation mode can detected a quantified to more accurately describe the geomorphic history of fluvial deposits.

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