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Where do we go with in situ cosmogenic 14C?

Kristina Hippe (1) and Maarten Lupker (2)

(1) ETH Zürich, Laboratory of Ion Beam Physics, Zürich, Switzerland (hippe@phys.ethz.ch), (2) ETH Zürich, Geological Institute, Zürich, Switzerland

Quantifying the complex surface exposure histories of glacial landscapes has so far been the primary application for in situ 14C analysis. The relatively straightforward interpretation of in situ 14C data from glacially modified surfaces, the insensitivity of in situ 14C to surface pre-exposure and its high sensitivity to post-exposure surface shielding, has made the in situ 14C-10Be nuclide pair an excellent tool for unraveling complex glacier chronologies in different glacial environments worldwide [1]. However, beyond glacial settings combined in situ 14C-10Be analysis has the capacity for quantifying various geomorphic processes in Earth surface development and landscape change. These particularly relate to quantifying sediment storage and transfer times in fluvial catchments, changes of surface erosion rates or past surface erosion events, respectively, as well as dating of young sedimentary deposits.

Compared to the long-lived cosmogenic nuclides (e.g., 10Be, 26Al), the interpretation of the in situ 14C signal in sedimentary systems is less straightforward, particularly with regard to the integration of landscape-wide signals. For example, in slowly eroding landscapes the in situ 14C concentration measured in river sediments might not represent an integrated basin-wide erosion signal but be biased by nuclide decay occurring in the eroding source rocks. Moreover, changes in surface erosion rates or events of mass removal from the surface (in single events or by recurring mass-wasting processes) can equally cause a deviation of the 14C-10Be ratio from the erosion-controlled steady-state ratio [2,3]. Soil mixing processes can additionally decrease the in situ 14C concentration and modify the 14C-10Be ratio. While these factors might complicate the use of in situ 14C in sedimentary systems, they also open up new opportunities to unravel and quantify the processes affecting Earth surface evolution during Holocene timescales.

This contribution will discuss possible applications of the in situ 14C-10Be pair in sedimentary environments and evaluate the current analytical capabilities of in situ 14C analysis. In this context, we will also introduce the second generation in situ 14C extraction line built at ETH Zürich and present first data on its analytical performance.

[1] Hippe, 2017 – Quat Sci Rev 173 – pp. 1-19.
[2] Mudd et al., 2016 – Earth Surf Proc Land 42 – pp. 24-41.
[3] Lupker et al., 2017 – EGU2017-4925.