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Tracing sedimentary processes with paired in-situ 14C and 10Be measurements in rapidly eroding settings: constraining landslide inputs and sediment transfer times.

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Cosmogenic nuclides, such as 10Be, measured in detrital river sediments are widely used to derive denudation rates and sediment fluxes at the scale of entire catchments. Pairing 10Be with another short-lived nuclide such as in-situ 14C (5700 years half-life) allows erosion and sediment processes occurring on Holocene time-scales to be traced at the Earth's surface [1].

In this contribution we evaluate the use of paired 10Be - in-situ 14C in detrital sediments eroded from the rapidly eroding Himalayan range to better quantify how sediments are produced and transferred from source to sink. 10Be and in-situ 14C data from trans-Himalayan rivers shows that the concentration of in-situ 14C relative to 10Be is lower than what would be expected if sediments were produced by steady-state superficial erosion of the landscape. Since long term storage and transfer over 10's of thousands of years of the sediment along the Himalayan valleys seem incompatible with present very active sediment export [2], such apparent offset between 10Be and 14C concentrations may be explained by the erosion and mobilisation of sediments from large, deep-seated, landslides. In that case, we show that it is possible to use paired 10Be and in-situ 14C measurement in detrital sediments to evaluate the average landslide depth and recurrence time at the scale of entire catchments. These data confirm other recent studies showing that landslides are the dominant mode of erosion in the Himalayan range [3]. Once the sediments are exported to the lowlands, the paired 10Be - in-situ 14C concentrations measured in sediments are mainly sensitive to sediment transfer processes in the floodplain [4]. Sediment storage in alluvial settings leads to the partial shielding of sediments from cosmic rays and results in the rapid decay of 14C in comparison to 10Be. Our preliminary data obtained from the sediments sampled at the mouth of the Ganges in Bangladesh has slightly higher 10Be/14C ratios compared to Himalayan rivers which may be used to constrain storage and residence time of sediments along the ca. 1000 km long floodplain separating the Himalayan range from the Bay of Bengal.

Overall, this contribution illustrates novel potential applications of paired cosmogenic nuclide 10Be and in-situ 14C as a sediment process tracer with the goal of exploring applications going beyond the more traditional use of cosmogenic nuclides in sediments as "simple erosion-rate meter".

[1] Hippe, 2017 – Quaternary Science Reviews, vol. 173, p. 1-19.
[2] Morin et al., 2018 – JGR-Earth Surface, vol. 267, p.482-494.
[3] Gabet et al., 2015 – EPSL, vol. 12, Q07023-36.
[4] Lauer & Willenbring, 2010 – JGR-Earth, vol. 115, F04018.