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Imprint of landscape dynamics in the luminescence signal of fluvial sediments (Rangitikei River, NZ)

Anne Guyez[1], Stephane Bonnet[1], Tony Reimann[2], Sébastien Carretier[1], and Jakob Wallinga[3]
[1]Geosciences Environment Toulouse (GET), Université de Toulouse, CNRS, IRD, UPS, Toulouse, France
[2]Institute of Geography, University of Cologne, Cologne, Germany
[3]Soil Geography and Landscape group & Netherlands Center for Luminescence Dating, Wageningen University, Wageningen, The Netherlands

Enlightenment of sediments pathways and storage patterns within river systems is critical to apprehend sediment transfer at the Earth's surface and landscape response to tectonics and climate. Because direct tracing methods (painted, fluorescent or magnetic sediments) are of limited use in terms of their analytical resolution in time and space, alternative physico-chemical methods suitable for larger spatial-temporal scales have been developed (e.g. cosmogenic isotope, detrital thermochronology, isotopic geochemistry, etc). The study of the natural luminescence of sediment particles is emerging for this purpose and seems promising for providing new information complementary to existing methods. This method is based on the quartz/feldspar grains ability to store energy while buried below the Earth's surface and to emit lumen with light exposure. Some recent studies have used this property to solve geomorphological questions regarding particle fluxes in soil or fluvial systems (Reimann et al., 2017; Sawakuchi et al., 2018) and to quantify rock exhumation (e.g. Herman et al., 2010). Here, we present an experimental testing of an innovative single-grain luminescence-based approach on feldspars. Focusing alongstream the Rangitikei River (RR), New Zealand, we carried out analysis on both modern sediment and Holocene terraces deposits.

We based our analysis on two complementarians proxies, the paleodose estimated using the bootstrapped minimum age model (Cunningham and Wallinga, 2012) and the percentage of grains eroded from bedrock and re-deposited in the river without signal resetting, i.e. saturated grains. We document changes in the luminescence signature of fluvial sediments while the RR evolves in response to uplift and climate change; from a late Pleistocene-early Holocene braided system to a Holocene incising canyon that subsequently widen. This allows us to appraise temporal changes in the alongstream contribution of canyon flanks landsides to sediment supply to the river. Overall, we show that distinct landscape dynamics gives distinct luminescence signatures.