How reliable is your detrital geothermochronological data? Quantifying the influence of abrasion on detrital heavy minerals through numerical modelling

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Summary of the project

Detrital heavy minerals have been used to learn about the early evolution of the Earth and are often the only record we have of events that have affected rocks at the Earth's surface [1]. Recent studies have focused on the investigation of bias in detrital mineral analysis in order to enhance the technique's reliability [2]. However, in spite of the widely-known influence of physical abrasion [3], no attempts have been made to quantitatively assess how it could potentially biases abrasion-driven products such as the mineral assemblages on which geothermochronology relies.

In this work, we explore, through numerical modelling, how varying a series of parameters (rock erodibility, zircon concentration, sediment travel distance, source area lithology, and initial grain size distribution) yields different river loads and zircon signatures over the fluvial system. We assume that pebbles are abraded according to the commonly used Sternberg's law (1875), that fining due to selective sorting is negligible, and that all abrasion products that release zircon are in the sand size fraction.

Our results highlight that the spatial location of lithologies and variations in rock erodibility and zircon concentration are the main parameters influencing the release of zircon grains into sand. Even in a scenario where a catchment is made of two lithologies with identical properties, the one further from the outlet contributes relatively more zircon to the sand fraction. These results highlight that fluvial physical abrasion could be accounted as a natural bias in heavy minerals from fluvial sands.

The value of the BSG grant in our research

The support from the British Society for Geomorphology (BSG) grant was essential to my participation in the American Geophysical Union (AGU) fall meeting 2016 held in San Francisco (USA). Financially, it supported part of the costs for registration, flight tickets and subsistence during my attendance. With this support, I could get involved for the first time with several top-ranked researchers from my field and, at the same time, spread my results and get feedback from them (Fig. 1). The oral and poster sessions were very helpful to update me about other studies being carried out in Geomorphology. I could also be in touch for the first time with some new modelling approaches and new technologies on Earth surface processes research. During my poster presentation, discussions with professors and PhD students were very good and provided me new insights for researching. I have now a broader knowledge of my own research topic both scientifically and professionally speaking. As a consequence of such debates, I and my supervisors are highly motivated to refine the model by performing calibration tests in real watersheds. By doing this, we aim to provide a sensitivity analysis of the model and publish the results for the geomorphological community soon, preferentially in the Earth Surface Processes and Landforms (ESPL) journal edited by the BSG.

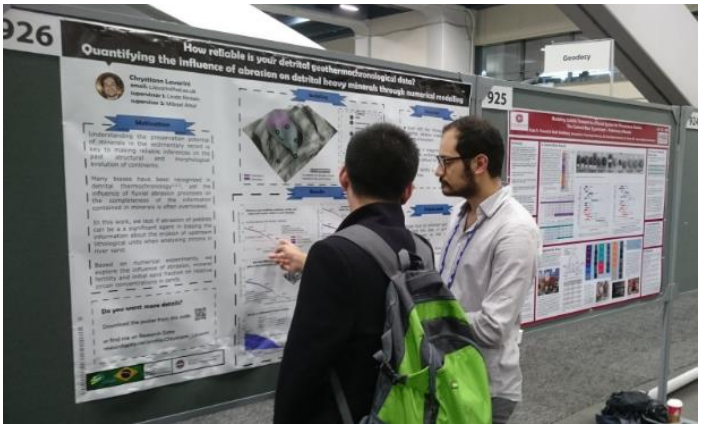

Figure 1: Chrystiann Lavarini (with white shirt) presenting the poster at the AGU 2016.

References

[1] Watson & Harrison (2005). Science.
[2] Moecher & Samsom (2006). EPSL.
[3] Attal & Lave (2006). GSA Special Papers.