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Role of long-term/continuous erosion events versus extreme and rare events on long-term landscape evolution

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Erosion is a key parameter involved in the evolution of the Earth's surface, and regulates the coupling between climatic and tectonic processes. The quantification of erosion at different spatial and temporal scales is a major challenge in earth sciences to better understand the nature and importance of these interactions. In addition, erosion processes are associated with significant natural hazards like landslides and debris flow. These relatively low-frequency but high-intensity events seem to play an important role in erosion budgets and in the long-term landscape evolution. It has been shown that rare and catastrophic erosion events can even dominate the long-term erosion rates. The aim of this study is to understand the respective role of long-term/continuous erosion dynamics versus extreme and rare events on long-term landscape evolution.

We focused on the ideal case of the western Peruvian Andes between Lima and Pisco (12°S and 13°S), where the hyper arid environment allows unequaled preservation of Pleistocene alluvial archives. This area presents several alluvial deposits including at least three mega-alluvial fans resulting from the upstream erosion of the western Andes and located at the outlet of the Rio Rimac in Lima, Rio Omas and Rio Cañete. These alluvial mega-deposits are mainly made up of rounded pebbles with a sandy matrix intercalated by sand lenses and levels of debris-flow deposits. To obtain the paleo-erosion rates from these deposits, we used *in-situ* produced cosmogenic ^{10}Be concentrations in quartz and feldspar in deposits previously dated by Optically-Stimulated Luminescence (OSL) with ages ranging from 10 to 90 ka.

Our results show that the measured paleo-erosion rates differ depending on the type of deposits. In the fine grain debris-flow deposits, the paleo-erosion rates are of the same order of magnitude as the erosion rates measured in the current rivers, ranging from 10 to 100 mm/ka. But, paleo-erosion rates measured in conglomeratic deposits are ranging from 200 to 600 mm/ka and are therefore higher than erosion rates measured in both modern river sands and any debris-flow deposits. This shows that in order to precisely understand the governing erosional processes for a given context, it is necessary to constrain both the erosion rates responding to continuous and non-exceptional forcing (recorded in conglomerate deposits), and erosion rates related to extreme events recorded by low-frequency and high-intensity debris-flow deposits.