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Quantifying basin-average denudation rates over the past 20 ka from landslide-damned lake sediments in the South Western Peruvian Andes

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The 4000m-high Western Cordillera of the Peruvian Andes is a typical example of relief construction caused by an oceanic and continental plate convergence. Both tectonic and erosion processes are at work in such settings. There is a current debate about the main factor controlling erosion processes in the western Andes: McPhillips et al., 2014 proposed that erosion depends strongly on the occurrence of earthquakes while others studies (Abbuhl et al., 2011; Carretier et al., 2014; Reber et al., 2017) reported positive correlations between 10Be-based catchment-averaged and latitudinal climate variations.

Here we use the opportunity a well-preserved landslide damn (volume=$\sim$1.5 km3) located in the Aricota valley (17°S) to derive a pilot study of a real sediment budget in Peru. This work has four objectives: (1) to constrain the age of the Aricota landslide failure using cosmogenic nuclides (10Be), (2) to determine the volume of sediments trapped behind the damn since the Pleistocene, (3) to explore its significance at the catchment scale in terms of average-denudation rates, and (4) to compare the denudation rate obtained from sediment-volume with denudation rate derived from the classic 10Be stream-sediment approach.

Using more than twenty samples collected either from scarps and landslide boulders, we show that two main gravitational failures occurred. The most massive failure that produced the damn took place at 19$\pm$6 ka contemporaneously to the Tauca humid phase. Then a debris avalanche affecting the scarp area occurred at 13$\pm$3 ka. This age of damn is consistent with previous time constraints obtained in this area from extensive diatoms dating (Placezk et al., 2001).

The volume of sediments stored behind the damn was determined by combing interpolations of the topography surrounding the lake with high-resolution bathymetry of the lake (2 m) and seismic refraction profiles performed to characterize the sediment thickness and volumes ($\sim$km3). After density correction, this volume was converted to a basin average denudation rate at work since 19 $\pm$ 6 ka. We base our discussion on four additional 10Be measurements of sand sampled from the stream feeding the Aricota lake. The denudation rates inferred from their 10Be concentrations are compared to the one obtained from the real sediment budget. The differences between those two independent rates highlight the possible effect of glacial sediment storage/release from the upper part of the catchment, sediment inputs from volcanic activities (several Holocene volcanos exist in this catchment) and from transient processes.