



## **Millennial size-dependent velocity of coarse river sediment determined using $^{10}\text{Be}$ in cobbles of the Aroma canyon (Atacama, Chile).**

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We focus on coarse sediment routing velocity in fluvial systems. The millennial mean velocity at which coarse sediment move along the fluvial system lies at the heart of many source-to-sink issues. For example, this velocity determines if a climatic or tectonic pulse of sediment generated in the mountain is advected or diluted towards the basin, and thus if the basin stratigraphy is able to record such variations. Whether this millennial velocity depends on pebble size or not is still unclear. Yet, quantifying this possible size dependence is fundamental to interpret the observed transitions between coarse and fine sediment in basin architecture. These uncertainties result from the difficulty to measure coarse sediment velocities and flux that integrate a wide range of floods over periods longer than several years. Here we show that the  $^{10}\text{Be}$  concentrations in distinct river pebbles can bridge this gap. We selected cobbles and pebbles ([0.01-0.3] m) along a  $\sim 50$  km Andean arid canyon in the Atacama. These samples come from a unique lithological source at catchment head. We obtained the mean  $^{10}\text{Be}$  concentrations of  $\sim 20$  to 100 samples at 7 river stations downstream. In addition, the  $^{10}\text{Be}$  concentration of individual pebbles was measured for 3 of these 7 locations. They show a downstream increase of both the mean and scattering of  $^{10}\text{Be}$  concentrations. Using a simple stochastic model of grain transport and  $^{10}\text{Be}$  evolution, we show that: 1- the millennial maximum mean velocity of  $\sim 10$  cm pebbles is on the order of several meters by year, and 2- that the velocity is inversely related to pebble size, despite a large variability for a given size. This size-dependence is consistent with the observed downstream fining in this river. Such velocities imply a wide range of residence times ([0.1-100] ka) of pebbles ([0.01-0.3] m) in this arid canyon.