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The grain size of fluvial and hillslope sediments across an erosion gradient in the Feather River Basin, California

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Grain size in hillslope sediments is conditioned by erosion rates and processes, and these sediments are then delivered to channels. How the channels respond to and modify these characteristics dictate whether rivers aggrade or erode their substrate. We investigate how the grain size of hillslope and fluvial sediments respond to an erosion gradient within the Feather River basin in northern California. Studied basins are underlain exclusively by tonalite lithology. Erosion rates vary over an order of magnitude, from >250 mm ka^{-1} in the Feather River canyon to <15 mm ka^{-1} on an adjacent low-relief plateau. Hillslope particle size increases with increasing steepness, a proxy for erosion rate. We hypothesise that, in our soil samples, the measured 10-fold increase in D50 and doubling of the amount of fragments larger than 1 mm when slope increases from 0.38 to 0.83 m m^{-1} is due to a decrease in the residence time of rock fragments, causing particles to be exposed for shorter periods of time to processes that can reduce grain size. For slopes in excess of 0.7 m m^{-1}, landslides and scree cones supply much coarser sediment to rivers, with D50 and D84 more than one order of magnitude larger than in soils. In the tributary basins of the Feather River, a prominent knickpoint separates the rapidly eroding canyon from the slowly eroding plateau. Downstream of the break in slope, fluvial sediment grain size increases, due to an increase in flow competence (mostly driven by channel steepening) as well as a change in sediment source and in sediment dynamics: on the plateau, rivers transport easily mobilized fine-grained sediment derived exclusively from soils. In the Feather River Canyon, mass wasting processes supply a wide range of grain sizes that rivers entrain selectively, depending on the competence of their flow.