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Rates and drivers of erosion in the Southern Pyrenees: a 10Be-supported model for the Valle de la Fueva catchments

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Intramontane basins are typical features of every mountain chain. These topographic depressions function as sediment traps during the syn- and postorogenic evolution of a range. Hence, studying their sedimentary archives and morphogenetic development may deliver important insights into the dynamics and magnitudes of erosion–sedimentation processes in mountain catchments and their susceptibility towards changing environmental conditions.

Aiming at quantifying Quaternary catchment erosion rates in the Southern Pyrenees and determining the timing and driving parameters of basin excavation stages, this research project focusses on a number of adjacent watersheds in the Valle de la Fueva in Aragon, Spain. Besides providing a comprehensive OSL and 10Be-supported catchment erosion model, potential relationships of intense late stage erosion phases with watershed capture, base level changes and climatic controls are addressed.

The Valle de la Fueva comprises a number of sub-catchments of the Ainsa depression – an Eocene sedimentary basin situated in the southern Pyrenean fold and thrust belt (SPFZ) which is recognized as a prime analogue for reservoir geometries and turbidite systems. The Valle de la Fueva is a highly erodible catchment, typical for the SPFZ with its shallow and deep marine strata, conglomerates and synorogenic debris. Preliminary observations revealed systems of "cut-in-fill" alluvial terraces and residual erosion surfaces – i.e. pediments and glacis that are strongly dissected by gullies and barrancos. Basin outlet canyons are deeply entrenched into the Los Molinos thrust front and represent dramatic landscape features that are relevant to the base level and opening history of the Valle de la Fueva catchments.

Combining digital terrain analysis with field surveys and exposure/burial dating, first results revealed differences in stream profile gradation and incision magnitudes among several sub-catchments. Since they share a common base level, the main river Cinca, non-uniform excavation across the five sub-catchments can be assumed. Whether river capture, lithological or structural controls caused unequal propagation of erosion across the catchments is currently under investigation. Preliminary terrace exposure ages point to extensive sediment aggradation during latest MIS 2, implying that profound landscape rejuvenation and severe erosion took place in (Early) Holocene times. Since it is established that, during Pleistocene, the Valle de la Fueva was a non-glaciated catchment, discharge of the local rivers and the (mainly seasonal) creeks should directly reflect precipitation levels across the structurally confined basin.

New TCN exposure and OSL burial data will enable a detailed chronology for glacis and terrace systems, hence, allowing to calculate erosion rates and sediment budgets, and to infer discharge (and precipitation) levels for the last major climate transition. This data will be most valuable for understanding the nature and rates of glacis and terrace formation in Europe, and in temperate mountain ranges elsewhere. New, field-derived precipitation estimates (MIS 2–MIS 1), in turn, can help to significantly improve the setup of numerical landscape evolution models (e.g., stream power models) which are of great importance to modern Earth system sciences, and the quantification of surface processes in particular.