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Denudation of carbonate landscapes: Insights from the Luberon Mountains, Provence, France

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Understanding landscape evolution, under the combined influence of denudation and tectonic uplift, requires the descriptions of the processes at work and derivation of quantitative models. The use of cosmogenic nuclides as quantization means of surface processes has fostered tremendous advances in terms of validation and calibration of denudation laws for different types of settings. However, most of these studies have focused on soil mantled landscapes underlain by silicate-rich bedrock, due to (1) the very dense conceptual background for the evolution of such landscapes, that goes back to the origins of quantitative geomorphology and, (2) the possibility to use 10Be concentration in quartz to constrain the rates of surface processes.

Carbonate landscapes, even though dominant in numerous areas such as the Mediterranean region, have received significantly less attention from that perspective, and the processes regulating their evolution over 10-100 ka timescales are far less constrained. One marked difference between the two types of contexts, which might hinder the direct transposition of concepts and formalisms from silicate-dominated to carbonate landscapes, is the prevalence of congruent dissolution for the latter, whose global geomorphological significance still needs to be physically and quantitatively evaluated.

Here, we present a new dataset of 36Cl measurements in bedrock and amalgamated clasts sampled along the main summital crest of the Luberon Mountains, Southeastern France, which is essentially made of lower Cretaceous (Urgonian) limestones. The deduced denudation rates spread from 30 to 80 mm/ka, which is in the range of carbonate denudation rates reported from elsewhere in Provence or other peri-Mediterranean regions. At a same site, the 36Cl concentrations of the bedrock and amalgamated clasts samples, and thus the derived denudation rates, are identical. The lowest rates correspond to background dissolution of flat surfaces along the main crest, whereas higher rates are observed on convex hilltops belonging to the secondary crest network. We also acquired high resolution DEM from SFM photogrammetry, in order to derive the main topographic metrics associated with each sampling site. We observe a clear linear relationship between denudation rates and hilltop curvature. This observation suggests that slope-dependent regolith flux acts to control hillslope evolution in a way similar to diffusion occurring across soil-mantled landscapes, in addition to carbonate dissolution.