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Carbonate landscapes evolution: Insights from ^{36}Cl

Vincent Godard (1), Franck Thomas (1), Vincent Ollivier (2), Olivier Bellier (1), Esmaeil Shabanian (1,3), Cécile Miramont (4), Jules Fleury (1), Lucilla Benedetti (1), Valéry Guillou (1), and Aster Team (1)

(1) Aix-Marseille Université, OSU-Pythéas, CEREGE, Aix-en-Provence, France (godard@cerege.fr), (2) Aix-Marseille Université, CNRS, LAMPEA, France, (3) Institute for Advanced Studies in Basic Sciences, Gava Zang - Zanjan, Iran, (4) Aix-Marseille Université, CNRS, IMBE, France

Carbonate landscapes cover a significant fraction of the Earth surface, but their long-term dynamics is still poorly understood. When comparing with the situation in areas underlain by quartz-rich lithologies, where the routine use of ^{10}Be-derived denudation rates has delivered fundamental insights on landscape evolution processes, this knowledge gap is particularly notable. Recent advances in the measurement of ^{36}Cl and better understanding of its production pathways has opened the way to the development of a similar physically-based and quantitative analysis of landscape evolution in carbonate settings. However, beyond these methodological considerations, we still face fundamental geomorphological open questions, as for example the assessment of the importance of congruent carbonate dissolution in long-wavelength topographic evolution. Such unresolved problems concerning the relative importance of physical and chemical weathering processes lead to question the applicability of standard slope-dependent Geomorphic Transport Laws in carbonate settings.
These issues have been addressed studying the geomorphological evolution of selected limestone ranges in Provence, SE France, where ^{36}Cl concentration measurements in bedrock and stream sediment samples allow constraining denudation over 10 ka time-scale. We first identify a significant denudation contrast between the summit surface and the flanks of the ranges, pointing to a substantial contribution of gravity-driven processes to the landscape evolution, in addition to dissolution. Furthermore, a detailed analysis of the relationships between hillslope morphology and hilltop denudation allow to identify a fundamental transition between two regimes: (1) a dynamics where hillslope evolution is controlled by linear diffusive downslope regolith transport; and, (2) a domain where denudation is limited by the rate at which physical and chemical weathering processes can produce clasts and lower the hilltop. Such an abrupt transition toward a weathering-limited dynamics may prevent hillslope denudation from balancing the rate of base level fall imposed by the river network and could potentially explain the development of high local relief observed in many Mediterranean carbonate landscapes.