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Spatial gradient of chemical weathering and its coupling with physical erosion in the soils of the Betic Cordillera (SE Spain)

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The production and denudation of soil material are controlled by chemical weathering and physical erosion which influence one another. Better understanding and quantification of this relationship is critical to understand biogeochemical cycles in the critical zone. The intense silicate weathering that is taking place in young mountain ranges is often cited to be a negative feedback that involves a long-term reduction of the atmospheric CO_2 and the temperature cooling. However the possible (de)coupling between weathering and erosion is not fully understood for the moment and could reduce the effect of the feedback.

This study is conducted in the eastern Betic Cordillera located in southeast Spain. The Betic Cordillera is composed by several mountains ranges or so-called Sierras that are oriented E-W to SE-NW and rise to 2000m.a.s.l. The Sierras differ in topographic setting, tectonic activity, and slightly in climate and vegetation. The mountain ranges located in the northwest, such as the Sierra Estancias, have the lowest uplift rates ($\sim$20-30 mm/kyr); while those in the southeast, such as the Sierra Cabrera, have the highest uplift rates (>150mm/kyr). The sampling was realised into four small catchments located in three different Sierras. In each of them, two to three soil profiles were excavated on exposed ridgetops, and samples were taken by depth slices. The long-term denudation rate at the sites is inferred from in-situ 10Be CRN measurements. The chemical weathering intensity is constrained using a mass balance approach that is based on the concentration of immobile elements throughout the soil profile (CDF).

Our results show that the soil depth decreases with an increase of the denudation rates. Chemical weathering accounts for 5 to 35% of the total mass lost due to denudation. Higher chemical weathering intensities (CDFs) are observed in sites with lower denudation rates (and vice versa). The data suggest that chemical weathering intensities are strongly associated with long-term 10Be derived denudation rates. Several causative factors may contribute to this observation, amongst which variation in climate, topography, and vegetation that are all associated with the measured variation in denudation rates. Finally, our data do not support a positive relation between the weathering rate and the physical erosion rate in the soil.