Erosion, weathering and climate in Middle Earth

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The role of erosion and weathering on global climate is a central question in Earth sciences. In particular, whether the increase in erosion during the late Cenozoic has been responsible for global cooling [1-3]. To address this question, it is critical to understand the links between erosion, weathering and climate. For instance, the focus has recently been brought on the role of floodplains on weathering fluxes, yielding contrasting conclusions [4, 5].

In this study, we use the mineralogy and geochemistry of river sediments from the Southern Alps of New Zealand as these rivers are an ideal natural laboratory to investigate the role of floodplains on chemical weathering: while West Coast rivers drain directly into the Tasman Sea, East Coast rivers are characterised by extensive alluvial plains. In addition, the strong gradients in rainfall and uplift rate across the island allow us to investigate the relative role of climate and tectonics on weathering rates.

Our results show that physical weathering and mineral sorting are significant during transit through alluvial plains. U-series isotopes suggests that sediment transport through Eastern alluvial plains occurs over 10's of thousand years, while sediments are much more rapidly exported on the West Coast (<10 ka). Little chemical weathering takes place during sediment transport, even where transit occurs through an extensive alluvial plain. Most silicate chemical weathering occurs on hillslopes in the upland regions, where the dominant reaction is albite dissolution. Thus, in the case of New Zealand, an increase in erosion (whether climatically or tectonically driven) would result in stripping and rapid export of upland soils. This could result in a decrease in chemical weathering rate, because the residence time of sediments in upland regions would decrease. These results differ from observations in other regions (e.g. Ganga) and demonstrate the importance of investigating sediment dynamics and weathering at the basin scale in order to further our understanding of the links between landscape evolution and global climate.

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