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Climate, tectonic and weathering : new insights from combined Hf and Nd isotopic composition of clays.

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On a multimillion year timescale, continental weathering that drawdown atmospheric CO_2 through silicate weathering reactions is a major driver of the carbon cycle, central in the evolution of climate. This process is also critical for the release of nutrients and chemical elements impacting primary productivity and organic carbon burial in the oceans. Yet our understanding of the links between continental weathering and climate is still impeded by the scarcity of existing records of silicate weathering intensity.

In the past few years, the potential of the combined Lu-Hf and Sm-Nd isotope systems to track silicate chemical weathering rate at the basinal scale has been highlighted (Bayon et al., 2016). The Sm-Nd and Lu-Hf isotope systems behave similarly during magmatic processes, but are decoupled by Earth surface processes, which leads to distinct ε_{Hf} signatures of alteration products. A large part of this decoupling arises from mineral sorting processes occurring during sediment transport and deposition. Yet it has been shown that ε_{Nd} and ε_{Hf} decoupling in the clay fraction isolated from modern river sediments ($\Delta\varepsilon_{Hf}$), reflects weathering conditions on continents.

Here we explore the potential of this new proxy to track variations in chemical weathering intensity over geological timescales in different tectonic and climatic contexts : during the climate cooling and anoxia development in the Sonoma Foreland Basin at the Smithian-Spathian boundary (Early Triassic), and during the intense uplift events of the western African margin and of the eastern South American margin in the late Cretaceous.

Our dataset highlights the major role of tectonic uplifts on the evolution of continental weathering, either through enhanced denudation of the continent or by favoring the establishment of more hydrolyzing conditions on the slope of the created relief. Enhanced silicate weathering over part of the African and South American continents may well have played a key role in initiating the long-term late Cretaceous cooling. By contrast, in the three studied settings only in the absence of major tectonic events did the evolution of global climate appears to drive chemical weathering intensity.

Bayon, G., et al. (2016). Earth and Planetary Science Letters, 438, 25-36.