Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.7309

Tropical weathering history recorded in the silicon isotopes of lateritic soils

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Lateritic soils are deep weathering profiles, developed in tectonically quiescent areas under tropical conditions and over long timescales. Laterites are key components in the regulation of element cycle in the Earth's history but, the timing between climatic changes and lateritic formation remains poorly constrained. In laterites, mineral assemblages, such as clays, offer precious records of past weathering conditions. In this study, we show that the combination of chronometric and weathering proxies supported by numerical models is one way to build a comprehensive story of laterite formation.

Our studied lateritic profile, located in the outer part of the Guyana Shield in the Amazon Basin, is developed over the Cretaceous sedimentary Alter do Chao formation. Silicon isotope signatures ($\delta^{30}Si$), known as an excellent weathering proxy [1], are measured in clay fractions that were previously dated using EPR technique [2]. The combination of these two techniques suggests that this soil and the surrounding region underwent two main weathering episodes, distinct in intensity.

The first episode (ca. 20-35 Ma) of moderate intensity produced well-crystallized kaolinites from the parent sediment with limited Si isotope fractionation. A more recent (6-8 Ma) and shorter phase caused the replacement, from top to bottom of the profile, of the first kaolinite generation by a new population through dissolution-precipitation and is characterized by higher crystallographic disorder and stronger Si isotope fractionation. This fractionation is associated with the partial conservation of the initial kinetic isotope fractionation occurring during kaolinite formation, which in turn implies a chemical weathering under conditions of rapid water percolation. An isotope-enabled reactive transport model [3] supports these observations and shows the distribution of Si isotopes in clays depends on the rapidity of rain water percolation in the soil.

Our results are consistent with paleoclimatic and paleogeographic evidences recorded over the Amazon Basin and shows that cutting-edge isotope analyses of laterite can reveal the past paleo-environmental conditions on the continents.

[1] Poitrasson (2017) RM&G, 82(1), 289-344

[2] Balan et al. (2005), GCA, 69(9),2193-2204

[3] Steefel et al. (2015) Comp. Geosciences, 19(3), 445-478