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The Si and Li isotope signatures of chemical weathering in tectonically quiescent, tropical areas

DAMIEN GUINOISEAU[1], JULIEN BOUCHEZ[2], JEAN-SÉBASTIEN MOQUET[3], DAMIEN CALMELS[1], JEAN-MICHEL MARTINEZ[4], KEILA ANICETO[5], NAZIANO FILIZOLA JR.[5] AND BRUNO LARTIGES[4]

[1]GEOPS, Université Paris Saclay (UMR 8148)
[2]Université Paris Cité, IPGP, CNRS
[3]Institut des Sciences de la Terre d'Orléans (ISTO), UMR7327
[4]GET, Université de Toulouse/CNRS/IRD (UMR5563)
[5]Universidade Federal do Amazonas

Presenting Author: damien.guinoiseau@universite-paris-saclay.fr

Tectonically quiescent areas are commonly considered to be low contributors to the global chemical weathering flux compared to mountain belts. However, the early Cenozoic land surface is thought to have been covered by deep and chemically leached soils, which typically develop under such conditions. The light Li isotope signatures recorded in oceanic planktonic foraminifera at the Paleocene-Eocene boundary (55Ma) has been explained by the congruent chemical weathering of continental rocks in environments typical of low-relief areas [1]. Nevertheless, these areas are characterized by a diversity of bedrock and soil cover, depending on topographic or climatological conditions. Therefore, a better assessment of the importance of these environments in the current weathering budget is essential to constrain their impacts on the carbon cycle at the geological timescale.

This study is focused on the tropical Rio Negro basin (Amazon River tributary), which offers various parent rock (cratonic shield vs. Cenozoic sediments) and overlying soil types (laterite, podzol, plinthosol). River waters were sampled in 2018 along the Rio Negro mainstream and its main tributaries. We measured the chemical compositions and the Li and Si isotope signatures, two excellent tracers of chemical weathering intensity. Across the basin, low chemical weathering fluxes are calculated (< 6 t/km^2/yr), except for rivers draining laterites developed on the Guyana shield (reaching 10 t/km^2/yr) . Elemental and isotope tracers of weathering can be interpreted as resulting from a mixture between two end members. Congruent weathering conditions are found in podzols and laterites developed on sediments, while the current formation of secondary clay minerals is shown from Li and Si isotope signatures in rivers draining laterites developed over the shield bedrocks and in unmatured plinthosols in the southern part of the basin. Therefore, soil-bedrock combination is the main control on weathering intensity, and isotope proxies measured in the corresponding rivers reveal current pedogenetic processes. These results challenge the hypothesis of a dominant congruent weathering at the Rio Negro basin scale. The hypothesis of an invariant, homogeneous geochemical signature released by tectonically quiescent, low-relief, tropical areas at geological timescale should thus be revisited.

[1] Misra, S., Froelich, P.N., 2012, Science 335, 818-823.