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Combining (U-Th-Sm)/He dating and geochemical budget to understand laterite formation

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Laterite formations are deep regoliths, up to one hundred of meters thick, that represent about 80% of the global soil volume. Formed under tropical conditions, laterites result from successive chemical weathering reactions over long periods up to tens of millions of years. Laterites can thus be seen as both an actor of the long-term carbon cycle, through CO_2 consumption by silicate weathering and witness of the long-term climate evolution. Indeed, secondary minerals found nowadays in lateritic profiles may have recorded past environmental conditions that prevailed at the time of their formation. Despite the large distribution of lateritic formations around the world, their timing and processes of formations as well as their preservation over long period of time remain unclear.

Here, we investigate an entire weathering profile developed on the Guiana Shield, in Brownsberg mountains, Suriname. The sampling region has remained in equatorial position for the last 100 Myr and has seen lateritic development since early Tertiary [1]. Such latitudinal stability offers the possibility to look at links between long-term climate evolution or climatic events and long-term chemical weathering processes.

The lateritic profile shows a strong loss in both alkali and alkaline-earth elements as well as a desilication, and an enrichment in Fe, particularly in the duricrust. The study of trace elements and rare earth elements highlights various geochemical processes behind the development of a lateritic – bauxitic profile.

(U-Th-Sm)/He ages of iron oxides from the duricrust show the presence of multiple generations of Fe oxides, demonstrating that the Brownsberg profile underwent multiple dissolution and recrystallization phases since its formation, at least 19.9 ± 1.8 Ma ago. These successive weathering processes may have led to the particular enrichment in the profile such as the one observed for Fe and V in the duricrust. Measurement of d18O – dD on secondary minerals, i.e. kaolinite and Fe-oxides s.l., will help to connect mineralogical and geochemical variations with the environmental conditions that prevailed at the time of their formation [2].

[1] Theveniaut and Freyssinet, 2002. Pal. Pal. Pal., 178, 91-117

[2] Girard et al., 2000. GCA, 64 n°3, 409 – 426