^{238}U-^{234}U-^{230}Th-^{226}Ra radioactive disequilibria in an Amazon lateritic profile (Manaus, Brazil)

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A powerful tool to understand processes and timescales of chemical weathering controlling geochemical dynamics and mineralogical evolution of weathering profiles is to combine study of tracers recording processes under different timescales [a]. Here we propose to apply this approach to an old lateritic profile in Manaus (Brazil), developed on quartzo-kaolinitic sediments, using major elements, trace elements and ^{238}U-^{234}U-^{230}Th-^{226}Ra disequilibria.

Variation of major and trace elements within the profile highlights the occurrence of two main geochemical fractionation processes: (1) strong chemical weathering in the sediment and nodular horizons, inducing quartz dissolution and transformation of kaolinite into gibbsite; (2) biogeochemical cycling by vegetation in the latosol, this processe retaining Si and stabilize kaolinite in this surface horizon [b].

Both the variations and the intensity of the ^{238}U-^{234}U-^{230}Th-^{226}Ra disequilibria remain quite limited within this profile – This is certainly ascribed to the specific location of U in strongly refractory minerals such as zircon or Ti-oxides [c]. Nevertheless, the variations of ^{238}U-^{234}U-^{230}Th-^{226}Ra disequilibria along the profile point out the following informations:

- Variations with depth of ($^{230}Th/^{232}Th$) and ($^{238}U/^{232}Th$) activity ratio suggest that U-Th fractionation is quite old (older than 400-600 ka), whereas the occurrence of radioactive disequilibria among U-series nuclides – especially between ^{226}Ra and ^{230}Th – indicates that these fractionation processes are still active.
- In the latosol, ^{238}U-^{234}U-^{230}Th disequilibria - ($^{230}Th/^{234}U$)~1, ($^{230}Th/^{238}U$)<1 and ($^{234}U/^{238}U$)<1 - imply that U enrichment by biological cycling and U depletion by chemical weathering would be close to a steady state.
- In the intermediate and deepest horizons, the (^{226}Ra-^{230}Th) disequilibria - Ra loss in the nodular zone, and Ra gain in the sediments - could be ascribed to a recent downward flux of Ra (<8ka) related to the evolution of oxide nodules in the profile.

References

[a] Dequincey et al. (2002), GCA, 1197-1210. ; Chabaux et al. (2003), C. R. Acad. Sci., 1219-1231 ; [b] Lucas et al. (1993), Science, 521-523 ; [c] Balan et al. (2005), GCA, 2193-2204.