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How fast does kaolinite transform in lateritic soils?

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Fine-grained minerals, such as kaolinites, occurring in the loose clayey horizons of lateritic soils generally display a progressive vertical change of their chemical, isotopic and crystallographic properties. Depending on the assumptions made on the rate of mineral transformation, various interpretations about the dynamics of the lateritization process can be inferred from these progressive changes. In a model assuming rapid dissolution-crystallization cycles ("dynamical equilibrium" model) and a high water/rock ratio, the crystal chemistry and isotopic composition of kaolinite are assumed to be representative of the present-day physico-chemical conditions. Alternatively, in a model assuming slower dissolution-crystallization processes, the vertical changes may reflect the progressive transformation of an older kaolinite population by a more recent one. A slow rate of transformation would support the use of the isotopic composition of lateritic kaolinite as a paleoclimatic indicator. The rate of kaolinite transformation in lateritic soils is thus a key parameter to understand the dynamics of tropical environments.

In the middle part of the Amazon basin, thick lateritic soils are developed in situ on kaolin deposits of sedimentary origin. From bottom to top, kaolinites progressively suffer a decreasing crystallographic order, which may support a "dynamical equilibrium" model. These profiles are thus ideally suited for the investigation of the rate and mechanisms of kaolinite transformation under lateritic weathering conditions. From a detailed spectroscopic study, we will show here that a model based on only two kaolinite populations with differing structural order fully accounts for the experimental observations. In addition, we have developed a direct assessment of the age of kaolinites, based on the accumulation of radiation induced defects (RID) over the course of time.

The underlying sedimentary kaolin provides apparent ages older than 20 Ma, whereas kaolinites from the lateritic soils provide apparent ages ranging from 10 to 6 Ma. The high RID content of these lateritic kaolinites implies that they cannot be representative of present day weathering conditions. Models assuming the "dynamical equilibrium" of kaolinites with local physical-chemical conditions prevailing in lateritic soils are thus questionable.