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Dating Amazonian laterites through the novel geochronometers kaolinite and iron oxides

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Soils on Earth's surface are in constant interaction with climate. As a matter of fact, soils cannot only produce greenhouse effect gases, such as NO_2 and CH4, but also behave as sinks for CO_2, especially by silicate weathering. Major processes of silicate weathering are known and exhibit climatic zonation at the global scale. Laterites are particularly relevant because they are ancient and deeply weathered soils of major significance. They occupy 30 % of the continental surface and can keep records of past climates and landscape modifications (paleosurface) through specific mineral markers. These formations reach several tens of meters and are mainly composed of kaolinite, iron and aluminium oxides as well as relicts of parent minerals such as quartz and ancillary minerals. Once the major processes of laterite formation are known, their age will allow a growth of researches, owing to the implementation of various chronometers. Moreover, it is fundamental to date laterites in order to improve our understanding of soil formation related to paleoclimates, and to build predictive models of their evolution. In this study, we focus on comparing kaolinite ages with the still unknown ages of lateritic duricrusts from the central Amazon region (Brazil), where strong weathering processes were developed from the early Tertiary, after the Andean uplift. The central Amazon region displays flat areas and dissected plateaus (100-180 m a.s.l.) sustained by weathered clastic sedimentary rocks and latosols. The region contains horizons of duricrusts, relatively continuous layers of Fe-cuirasses, stratified lateritic profiles, and kaolin deposits. Here we employed two methods to date ubiquitous secondary minerals of laterite, which are consistent with geological time-scale. The corresponding geochronometers are the following: (i) radiation-induced defects in kaolinite (trapped in duricrusts) analysed by electron paramagnetic resonance spectroscopy (EPR) (Balan et al., 2005), and (ii) (U-Th)/He on millimetric-sized pisolites of iron oxides. Goethite (U-Th)/He ages range from Late Pliocene to Pleistocene. Taking advantage of the crystallographic characterization of samples and the use of a new He production/diffusion code for iron oxides, we interpret that the results correspond to the ages of Fe oxides crystallization. In addition, these ages are younger than those assessed by kaolinite, which yielded Oligocene-Miocene ages for the weathered sediments of Alter do Chão Formation (Cretaceous-Paleogene unit) and Miocene-Pliocene ages for the topsoil. As a result of the Andean uplift and drainage reversal of the Amazon River, Miocene sediments were deposited in the western Amazon. Dated Fe-cuirasses suggest a minimum age of Early Pliocene for the Solimões formation A probability density plot of Goethite ages suggests an intensification and/or preservation of weathering processes during the Late Pliocene, revealing warm and humid conditions for that period. Both geochronometers are providing an opportunity to constrain the geodynamics and climatic history for the central Amazon region.

Balan, E., Allard, T., Fritsch, E., Sélo, M., Falguères, C., Chabaux, F., Pierret, M.C. and Calas, G. (2005) Formation and evolution of lateritic profiles in the middle Amazon basin: insights from radiation-induced defects in kaolinite. Geochimi. Cosmochimi. Acta. 69, 2193-2204.