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Angaben zur Veröffentlichung / Publication details:

Reichenbach, Mario, Peter Fiener, Florian Wilken, Johan Six, Laurent Kidinda, Basile Mujinya, and Sebastian Doetterl. 2020. "Soil organic carbon stocks in tropical soil systems under rainforests controlled by geochemistry." In *EGU General Assembly 2020, 4–8 May 2020*. Augsburg: Universität Augsburg. https://doi.org/10.5194/egusphere-egu2020-12993.

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EGU2020-12993, updated on 10 Jun 2021
https://doi.org/10.5194/egusphere-egu2020-12993
EGU General Assembly 2020
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Soil organic carbon stocks in tropical soil systems under rainforests controlled by geochemistry

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Soil mineralogy plays an important role in stabilizing soil organic carbon (SOC) against decomposition by forming organo-mineral complexes with reactive mineral surfaces. However, few studies take the influence of parent material geochemistry on the development of C stabilization mechanisms into account. In addition, studies evaluating C stabilization in soil are often limited to temperate climate zones with young to intermediate aged soils. This is not representative for older, deeply weathered and leached tropical systems and limits our understanding of the relationship between geology, soil formation and their effect on C stabilization.

Here, we study the relationship between soil carbon stabilization and the geochemical properties of soils developed on different parent material along geomorphic transects in pristine tropical forest systems under comparable climate. Our study is located in the eastern part of the Congo basin along the East African Rift Mountain System where we sampled 36 one meter soil cores along nine geomorphic transects on geologies ranging from mafic to felsic geochemistry.

Carbon stocks ranged between 2.67 tC ha^{-1} to 85.75 tC ha^{-1} and were on average composed of 4.5% (±5.3% SD) coarse particulate organic matter, 46.0% (±10.3% SD) (micro)aggregates associated C and 49.6% (±11.2% SD) free silt and clay associated C. Our analysis shows that the topographic position of the investigated soils had no effect on SOC stocks and the distribution of soil C fractions. Regression models and partial correlation analysis reveal that strong correlations of SOC stocks exists to geochemical properties of the solid phase of soil but not to the distribution of soil C fractions. SOC decreased strongly with soil depth on soils developed on felsic parent material, but less so on mafic or intermediate parent material. In addition, mafic geochemistry shows significantly higher SOC stocks compared to their felsic counterparts.

We conclude that despite long-lasting weathering, the contrasting geochemistry of the underlying parent material leaves a footprint in soil geochemistry that affects C stocks but less so on stabilization mechanisms. We hypothesis that carbon dynamics in these undisturbed tropical forest systems are more driven by C input and nutrient recycling than by variation in C

stabilization potential.