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Do n-alkane biomarkers in soils reflect the D/H isotopic composition of precipitation? A case study from Mt. Kilimanjaro and implications for paleoclimate and paleoaltimetry research

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During the last decade compound-specific D/H analysis of plant leafwax-derived n-alkanes has become a promising and popular tool in paleoclimate research. This is based amongst other factors mainly on the finding that sedimentary n-alkanes primarily reflect the D/H isotopic composition of precipitation or lake water. Recently, several authors also suggested that D/H of n-alkanes can be used as proxy in paleoaltimetry studies, because they found soil n-alkanes reflecting the 'altitude effect' of D/H in precipitation.
Here we present results from a D/H transect study (1700 to 4000 m a.s.l.) carried out on the humid south-western slopes of Mt. Kilimanjaro. While D/H of precipitation shows the expected altitude effect, i.e. more negative deltaD values with increasing altitude, deltaD of nC29 and nC31 do not confirm this trend or even become more positive both in the O-layers (organic layers) and the Ah-horizons (mineral topsoils). Furthermore, deltaD of nC29 and nC31 are similar, but not identical (R2 = 0.22 and 0.34 for the O-layers and the Ah-horizons, respectively).
Although overall our D/H n-alkane results are in agreement with the results of Peterse et al., (2009, Biogeosciences) reported for the south-eastern slopes of Mt. Kilimanjaro, we suggest a re-interpretation. We explain the lacking correlation of D/H(alkanes) with D/H(precipitation) with other factors influencing D/H(alkanes) of plants and soils. First, large interspecies offsets in net fractionation are reported. Indeed, plant communities along the slopes of Mt. Kilimanjaro as well as along most altitude transects change dramatically. Second, D-enrichment by evapotranspiration (soil water and plant leaf-water), depending mainly on relative air humidity (RH) is neither constant along altitude transects nor over time. And third, soil n-alkanes do not only derive from plant litter but also from soil microorganisms (Zech et al., 2011, GCA), potentially adulterating the original plant D/H signal.
Given that our results highlight that n-alkanes in soils do not necessarily reflect the D/H isotopic composition of precipitation, we conclude that care has to be taken not to over-interpret D/H records from soils and sediments when reconstruction D/H of paleoprecipitation. Concerning paleoaltimetry studies, they additionally would require that D/H of paleoprecipitation did not change significantly. Recalling the temperature-, the amount- and the source-effect, we doubt this is case.