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# Characterization of extractable soil organic matter pools from African Dark Earths (AfDE): A case study in historical biochar and organic waste amendments

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Anthropogenic Dark Earths are soils generated through long-term human inputs of organic and pyrogenic materials. These soils were originally discovered in the Amazon, and have since been found in Australia and in this case in Africa. African Dark Earths (AfDE) are black, highly fertile and carbon-rich soils that were formed from the original highly-weathered infertile yellowish to red Oxisols and Ultisols through an extant but hitherto overlooked climate-smart sustainable soil management system that has long been an important feature of the indigenous West African agricultural repertoire. Studies have demonstrated that ADE soils in general have significantly different organic matter properties compared to adjacent non-DE soils, largely attributable to the presence of high concentrations of ash-derived carbon. Quantification and characterization of bulk soil organic matter of several (n=11) AfDE and non-AfDE pairs of surface (0-15 cm) soils using thermal analysis techniques (TG-DSC-EGA) confirmed substantial differences in SOM composition and the presence of pyrogenic C. Such pyrogenic organic matter is generally considered recalcitrant or relatively stable, but the goal of the current study was to characterize the presumably labile, more rapidly cycling, pools of C in AfDEs through the characterization of hot water- and pyrophosphate-extractable fractions, referred to as HWEOC and PyroC respectively. Extracts were analyzed for carbon content, as well as composition using fluorescence (EEM/PARAFAC) and high resolution mass spectrometry (FTICR-MS). The amount of extractable C as a proportion of total soil C was relatively low: less than $\sim$0.8% for HWEOC and 2.8% for PyroC. The proportion of HWEOC did not differ ($P = 0.18$, paired t-test) between the AfDE and the non-AfDE soils, while the proportions of PyroC were significantly larger ($P = 0.001$) in the AfDE soils compared to the non-AfDE soils. Preliminary analysis of the EEM/PARAFAC data suggests that AfDE samples had a greater fraction of their DOM that was more humic-like than the paired non-AfDE samples, though differences were small. Similarly, FTICR-MS analysis of hot water extracts suggests that differences among the three sites analyzed were larger than between the paired AfDE and non-AfDE extracts. Overall, in spite of substantial differences in the composition of bulk SOM, the extractable fractions appear to be relatively similar between the AfDE and non-AfDE soils.