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Mechanisms of biochar stability and functionality

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The objectives of this study were to assess the levels of oxidation in biomass derived black carbon (BC) and their effect on soil function using a chronosequence methodology spanning a total of ten years. Charcoal fragments recovered from historical charcoal production sites in the Wenchi district, Ghana were characterised for both their surface and bulk properties and charge characteristics. Samples of increasing age showed a decrease in pH as well as an increase in cation exchange capacity (CEC). X-ray photoelectron Spectropscopy (XPS) was used to reveal elemental ratios of carbon and oxygen as an indicator of oxidative weathering in BC. Surface oxygen to carbon ratios in fresh samples were around 0.3, increasing to 0.7 for the 10 year old samples. The analysis of whole ground fragments as well as a 'depth profile' of oxidative penetration, revealed the extent of BC weathering within individual fragments. Boehm titration and Fourier-transform infrared (FT-IR) spectroscopy suggested that formation of carboxylic functional groups was responsible for the increase in CEC over the ten year period. Decadal oxidation of BC in tropical soils has significance for its stability as well as for its effects on soil nutrient interactions and biogeochemistry.