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Understanding the fate of black (pyrogenic) carbon in soil: Preliminary results from a long term field trial

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Black carbon (BC, also known as pyrogenic carbon) is an 'inert' form of carbon and has been proposed as a means of long-term carbon sequestration, particularly by amending soils and sediments with BC known as biochar. While there is abundant anecdotal evidence of biochar stability over extended timescales it is essential to gain a greater understanding of the degree and mechanisms of biochar degradation in the environment. This study aims to quantitatively assess the stability of biochar by investigating samples from field degradation trials first buried during 2009 in a tropical soil, and recovered after 12 and 36 month intervals.

Catalytic hydropyrolysis (HyPy) is a novel analytical tool for the isolation of BC [1] in which high hydrogen pressure (150 bar) and a sulphided Mo catalyst reductively remove the non-BC fraction of the chars, and so isolate the most stable portion of the biochar, defined as BC(HyPy). This method also allows for the non-BC(HyPy) fraction of a sample, which from charcoal is known to include small ring PAHs (<7 rings) of pyrogenic origin to be recovered for molecular characterisation by GC-MS [2].

Biochars made from algae, sugarcane bagasse, and beech wood at 305, 414 and 512°C were emplaced under a variety of conditions allowing variables such as leaf cover, soil depth and pH to be investigated. Char stability (as measured by BC(HyPy) content) is dependent on both the feedstock and temperature of formation. HyPy is known to discriminate (in terms of BC isolation) against low temperature chars, composed of relatively small aromatic clusters [1], resulting in the low BC(HyPy) contents reported for the 305°C chars.

Fresh charcoals, and those not subject to environmental degradation have display a similar distribution of aromatic clusters in the non-BC(HyPy) fraction, with 2 to 7 ring PAHs abundant [2]. However, environmentally degraded charcoals such as that from a Chinese river sediment, and an Australian river estuary [3] show a more restricted distribution with markedly fewer 2- and 3- ring PAH structures apparent. This may be evidence for the partial solubilisation of the charcoal as observed for a forest soil [4] and suggested as a mechanism for the transport of BC to the oceans [5], implying that BC cycling could be faster than previously thought [6]. Longer term field trials will be required (analysis of the 36 month samples) to observe systematic changes in the PAH distribution of the non-BCC(HyPy) fractions isolated form aged chars, although natural analogues with a better constrained environmental history may also be useful.

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