Geophysical Research Abstracts
Vol. 16, EGU2014-14047, 2014
EGU General Assembly 2014

The influence of production conditions, starting material and deposition environment on charcoal alteration in a tropical biome.

Philippa Ascough (1), Michael Bird (2), Will Meredith (3), David Large (3), Colin Snape (3), and Corinne Manion (4)

(1) Scottish Universities Environmental Research Centre, The University of Glasgow, East Kilbride, G75 0QF UK, (2) Centre for Tropical Environmental and Sustainability Science, School of Earth and Environmental Sciences James Cook University, Cairns, Australia, (3) Department of Chemical and Environmental Engineering, University of Nottingham, Nottingham NG7 2RD, UK, (4) School of GeoScience, University of Edinburgh, Edinburgh, EH8 9XP, UK

Natural and anthropogenic burning events are a key link in the global carbon cycle, substantially influencing atmospheric CO_2 levels, and consuming c.8700 teragrams yr-1 of dry biomass [1,2,3]. An important result of this process is charcoal, when lignocellulosic structures in biomass (e.g. wood) are converted to aromatic domains with high chemical stability. Charcoal is therefore not readily re-oxidized to CO_2, with estimates of 5-7 ky for the half-life of charcoal carbon in soils [3,4]. Charcoal's high carbon content coupled with high environmental resistance has led to the concept of biochar as a valuable means of global carbon sequestration, capable of carbon offsets comparable to annual anthropogenic fuel emissions [5,6,7]. Charcoal is not, however, an environmentally inert substance, and at least some components of charcoal are susceptible to alteration in depositional environments. Despite the importance of charcoal in global carbon cycling, the mechanisms by which charcoal is altered in the environment remain, as yet, poorly understood. This fact limits our ability to properly incorporate both natural environmental charcoal and biochar into global carbon budgets.

This study aimed to improve understanding of charcoal alteration in the environment by examining the influence of production conditions, starting material and deposition environment on the physical and chemical characteristics of charcoal at a field site in the Daintree rainforest. These factors have been identified as critical in determining the dynamics of charcoal in depositional environments [8,9] and climatic conditions at the field site (in Tropical Queensland, Australia) are likely to result in extensive alteration of charcoal. Charcoal from wood (Nothofagus spp.), algae (Enteromorpha spp.), and sugarcane (Saccharum spp.) biomass was produced at temperatures over 300-500°C and exposed to conditions of varying pH and vegetation cover. The effect of these variables on charcoal chemistry, molecular structure, resistant carbon content, microbial interactions and physical characteristics were investigated using a suite of techniques including 13C-MAS-NMR, scanning electron microscopy, stable isotope ratio mass spectrometery, elemental analysis, Raman spectroscopy and hydropyrolysis. The study results have important implications for: i.) the use of quantitative charcoal measurements within global carbon budgets and fire history reconstruction; ii.) understanding of the dynamic role of charcoal within soil and sedimentary systems.

References:

[1] Langenfelds RL, Francey RJ, Pak BC, Steele LP, Lloyd J, Trudinger CM, Allison CE. 2002. Global Biogeochem. Cycles, 16, doi:10.1029/2001GB001466.
[2] Schimel D, Baker D. 2002. Nature 420, 29–30.
[3] Levine JS, 1991. The MIT Press, Cambridge, Massachusetts.
[4] Preston CM, Schmidt MWI. 2006. Biogeoscience 3, 397-420.
[5] Lehmann J, Gaunt J, Rondon M. 2006. Mitigation and Adaptation Strategies for Global Change 11, 395-419.
[6] Sohi SP, Krull E, Lopez-Capel E, Bol R. 2010. Advances in Agronomy, Academic Press, 105, 47-82
[7] Woolf D, Amonette J.E, Street-Perrott F.A, Lehmann J, Joseph S. 2010. Nature Communications, 1, 56.
[8] Ascough PL, Bird M I, Francis SM, Thornton B, Midwood A, Scott AC, 10 Apperley D. 2011. Geochimica et Cosmochimica Acta. 75 (9), 2361-2378.
[9] Zimmermann M et al. 2012. Global Change Biology. doi: 10.1111/j.1365-2486.2012.02796.x