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Conference Abstract

Differences in the Physicochemical Properties of Wildfire Generated Pyrogenic Carbon and Biochar

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Abstract

Pyrogenic carbon (PyC) results from the pyrolysis of organic materials through thermal decomposition at high temperatures in low oxygen environments (I.B.I. 2012). The broad term includes many forms of thermochemically altered carbon, including charcoal, black carbon, soot, and biochar (Scott et al. 2014), and consists of a pyrolyzed carbon fraction as well as an inorganic ash or mineral fraction. PyC is produced naturally during forest fires, where it forms at potentially high temperatures (up to 1200 °C) for very short periods of time (seconds to minutes for temperatures >300 °C; Santin et al. 2016a). Wildfire derived PyC has been shown to be a significant component of the carbon cycle, with an estimated 32 Tg of PyC cycled through aquatic environments annually (Santin et al. 2016b). Man-made biochar is generated under controlled conditions via pyrolysis in furnaces at controlled temperatures and under anoxic conditions (Ahmad et al. 2014), typically up to 700 °C, for longer periods of time (up to ~6 hours). Several studies have investigated the surface chemistry of biochar and its ability to remove metals from aqueous solution (e.g., Alam et al. (2018a), Alam et al. (2018b)). However, PyC produced during natural pyrogenic activity such as wild fires, is produced under highly variable temperatures and atmospheric conditions, in the presence of numerous and variable microenvironments which are

challenging to measure (Scott et al. 2014), and its surface chemistry and reactivity is not well understood. To fill this gap, we investigate the physicochemical properties including the proton and metal adsorption potential of wildfire generated PyC (WF-PyC) collected from 4 locations within a recent forest fire along the Western slope of Mount Hunter, near Golden, British Columbia. We explored the binding capacity of a model cation (species of Cd^{2+}) under a range of environmentally relavent pH conditions (3-9) and then compared the findings to the adsorption potential of synthetically generated biochar produced from the same biomass. Fourier transform infrared (FTIR) and Raman spectroscopy was used to constrain the number and types of surface functional groups, and the coordination environment of Cd^{2+} ions bound to WF-PyC and biochar. Potentiometric titrations were performed and modelled to calculate the acidity constants associated with each site and the total reactive surface area of both biochar and WF-PyC. Our results demonstrate greater reactivity to Cd^{2+} associated with WF-PyC, not replicated in synthetic biochar of an equivalent biomass (Fig. 1). This both provides insight to the potential of WF-PyC to play a critical role as a vector for elemental transport in natural systems and also makes apparent the need to understand the pyrolysis conditions during forest fires to improve our understanding of its role in global metals transport and cycling.

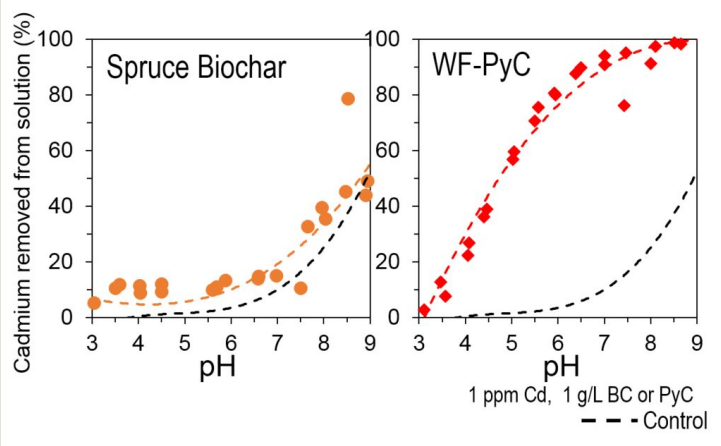

Figure 1. doi

Cd adsorption potential of Spuce biochar produced at 700°C for 6 hr (left) and wildfire produced pyrogenic carbon (right), illustrating greater adsorption potential over a wider range of pH conditions.

Keywords

Pyrogenic Carbon, Hydrology, Geochemistry

Presenting author

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Presented at

I would prefer an oral presentation, but would take a poster if that is all that is available. I believe my work would best be suited for the Natural Settings Theme, under the freshwaster, groundwater, and rivers category.

Conflicts of interest

The authors have declared that no competing interests exist.

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