Wildfire Impacts on the Biodegradability of Soil Organic Matter

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Global wildfire activity is increasing, causing ecosystems to be burned more frequently and at hotter temperatures. Wildfires can alter the presence and abundance of soil organic molecules such as amino acids, organic acids, and sugars. These molecules are important nutrient sources for microbes and vegetation; thus, changes in molecular abundance can influence the post-fire recovery of forested ecosystems. However, the specific organic molecules present in burned soil are often unknown owing to a lack of soil metabolomic analyses. Additionally, burned areas are often inaccessible, making it difficult to collect soil samples from burned ecosystems. Wildfires change the composition and biodegradability of soil organic matter (SOM) which contains nutrients that fuel microbial metabolism. Though persistent forms of SOM often increase postfire, the response of more biodegradable SOM remains unclear. Here, we simulated severe wildfires through a controlled “pyrocosm” approach to identify biodegradable sources of SOM and characterize the soil metabolome immediately postfire. Pyrocosms (steel containers filled with soil on which vegetation is ignited and burned to mimic wildfires) can be used to determine and compare the molecular content of burned soil across different locations. By burning soil and vegetation collected from different environments, pyrocosms can simulate various wildfire conditions across a diverse range of ecosystems.

Figure 1 shows negative-ion electrospray ionization 21 T Fourier transform ion cyclotron resonance mass spectrometry for burned and unburned pyrocosms after 28 days. Elemental compositions derived from mass spectral peaks showed that SOM in burned soil was lower in molecular weight and contained ~20-43% more nitrogen-containing compared to unburned soil. Nitrogen is often the limiting nutrient in soil systems; therefore, SOM enriched in nitrogen could serve as a nitrogen source for microbes in postfire environments, especially since nitrogen-containing species in burned soil likely contain amino sugars and peptides. We also measured higher water extractable organic carbon concentrations and higher CO_2 efflux in burned soils. The observed enrichment of biodegradable SOM and microbial heterotrophs demonstrates the resilience of these soils to severe burning, providing important implications for postfire soil microbial and plant recolonization and ecosystem recovery.

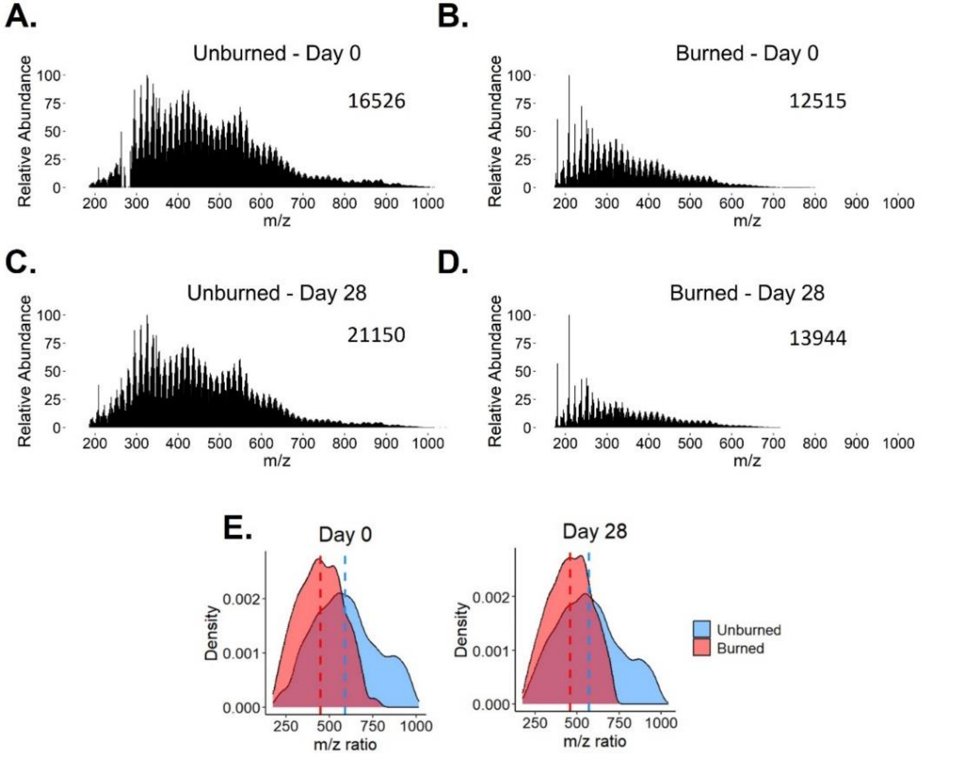

Figure 1. (A−D) FT ICR-MS mass spectra of unburned and burned soil from negative-mode electrospray ionization. The number in the upper-right corner of each spectrum is the total number of observed peaks that were assigned molecular formulas (including heavy isotopes).

(E) Density vs. *m*/*z* ratio plots for observed mass spectral peaks. The *y*-axis represents the relative probability of an ion featuring a given *m*/*z* ratio, i.e., higher density values for a given *m*/*z* ratio indicates that more ions were observed with that *m*/*z* ratio. Dashed lines are mean values.

Facilities and Instrumentation: Ion Cyclotron Resonance facility, 21T FT-ICR MS magnet

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