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Priming of native soil organic matter by pyrogenic organic matter

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Priming, in relation to pyrogenic organic matter (PyOM), describes the change in mineralization rate of non-pyrogenic ("native") soil organic matter (nSOM) due to the addition of PyOM. Priming may be 'positive', in that the addition of pyC increases the mineralization rate of native SOM, or 'negative', in that the mineralization rate of nSOM is decreased. Reasons for increased mineralization may include: (i) co-metabolism: microbial decomposition of labile C-additions increases microbial activity, and facilitates additional decomposition of npSOC by active enzymes; (ii) stimulation: substrate additions result in lifted pH, nutrient, oxygen, or water constraints resulting in increased microbial activity. Decreased mineralization may be a result of: (i) inhibition: the opposite of stimulation whereby constraints are aggravated by substrate addition. Substrate addition may also cause inhibition by interfering with enzymes or signaling compounds; (ii) preferential substrate utilization: labile fraction of PyOM additions are preferentially used up by microbes thus causing a decrease in nSOC decomposition; (iii) sorption: organic compounds are adsorbed onto PyOM surfaces, decreasing their rate of mineralization; (iv) stabilization: formation of organo-mineral associations forms stable SOC pools.
We have conducted a suite of experiments to investigate these potential interactions. In a seven year long incubation study, PyOM additions increased total OM mineralization for the first 2.5 years, was equal to control after 6.2 years, and was 3% lower after 7.1 years. Cumulative nSOM mineralization was 23% less with the PyOM additions than without, and over 60% of the added PyOM was present in the labile soil fraction after the 7.1 year incubation. Two additional incubation studies, one with and without plants, showed greater nSOM mineralization in the short term and lower nSOM mineralization over the long term. Increased nSOC mineralization due to the presence of plants was counteracted by PyOM additions. However, repeated additions of crop residues over seven years did not result in lower mineralization of the residue and nSOM. We have also determined that, although there is no optimal duration for pre-incubation of soil before SOC studies, the type of carbon available is crucial in determining the effects of PyOM additions. We will continue to examine the contribution of the different mechanisms by isolating variables such as nutrient addition, soil texture, and mineral availability. We anticipate that sorption on PyOM surfaces are important in nSOM stabilization and will continue to study these effects using highly labeled substrates and nano secondary ion mass spectrometry (nano-SIMS).