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Linking wood source and charring temperature to the stability and biological reactivity of PyOM in a temperate forest soil.

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Fire is a major mediator of carbon (C) and nitrogen (N) cycling in forests, releasing significant quantities of greenhouse gases, soot, and aerosols while simultaneously depositing pyrogenic organic matter (PyOM) onto forest soil. The condensed aromatic structure of PyOM imparts a resistance to weathering and decay and potentially promotes soil C stabilization and sequestration. This resistance however, is largely dependent upon the physiochemical characteristics of source material and production temperature. Few studies have been able to determine the stability and reactivity of well-characterized PyOM in field or laboratory decay studies.

To address this, we added highly 13C-enriched red maple (RM) or jack pine (JP) pyrolyzed at 200, 300, 450 or 600°C to a low C, near-surface soil (0.5%; 0–20 cm-depth) at 60% water holding capacity and 11% of native soil C. We then incubated the samples in the dark at 25^0C for 6 months. The results of $13CO_2$ evolution measurements indicated that both pyrolysis temperature and wood species played a significant role in PyOM mineralization. PyOM mineralization rates decreased with increasing pyrolysis temperature for either species. RM mineralization rates were consistently greater (∼5 to ∼25%) than for JP <600°C during the first 17 days, but declined after this time point with the exception of RM PyOM 300°C and 450°C, which had higher mineralization rates than JP throughout the entire incubation period.

These observations of relative reactivity were consistent with our detailed spectroscopic, elemental, and stable isotope analysis of the PyOM samples across this pyrolysis gradient, which shows significant physico-chemical changes happening more readily for JP (∼300°C) than for RM (450°C). These results highlight how differences in PyOM physiochemical characteristics linked to wood species thermal transformation thresholds may be predictors in determining the relative stability of PyOM in soil.