Hidden lignin in soils

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The relative importance of lignin toward stabilized soil organic matter has been a subject of much debate, with early paradigms based on presumed recalcitrance replaced by more recent studies in surface soils that suggest turnover times similar to bulk organic matter. A primary tool in these studies has been alkaline CuO oxidation in which soils are subjected to high temperatures and 2N basic conditions, which is assumed to extract all lignin from mineral soils. However, we conducted an experiment using plant litter leachates sorbed to various minerals to demonstrate that even the hot alkaline conditions of CuO oxidation are insufficient to extract all lignin. This irreversible lignin (determined by difference) is almost certainly more stable than the measured lignin in previous turnover studies, and compositionally quite distinct from either the parent litter leachates or what can be measured on the sorbed systems. Further, our optical characterizations of the leachate (carbon-specific absorbance in the UV range as a proxy for aromaticity) indicate that lignin may be more broadly representative of aromatic compounds in general, and perhaps all surface active compounds. This has clear implications for deep-soil organic carbon as sorption of dissolved organic matter leached from upper layers is a primary mechanism for building up and stabilizing deep-soil carbon stores, namely that lignin and other aromatics may become increasingly important toward soil organic matter stabilization with depth, even if we cannot directly measure them.