Abstract

Sometimes, but not often.

Introduction

Many labs employ density fractionation as a proxy for determination of carbon (C) recalcitrance and lability. However, it is unknown if the resulting fractions correspond to chemically stable, and hence recalcitrant, C. It is generally assumed that phenolic compounds are more recalcitrant than O-alkyl-C and carboxylic-C moieties (Kleber et al., 2011). The objective was to determine if density-based fractionation of SOM represents chemically different C species.

Methods

- Soil samples were taken at 0-5 and 5-10 cm from two sites in Bolivia and two sites in Ecuador (Table 1) in 2010 before implementation of conservation agriculture (CA) treatments.
- The experiments were RCB designs with three replications at each site.
- After sequential density fractionation at <1.8, 1.8-2.0, and >2.0 g cm⁻³, samples were analyzed for total C&N (dry combustion).
- C k-edge near-edge X-ray absorption fine structure spectroscopy (NEXAFS, Fig. 2) was used to determine the relative proportions of organic functional groups.
- SAS Proc GLIMMIX was used to determine differences among fixed effects at the 95% confidence level unless otherwise stated.

Results & Discussion

More than 90% of Bolivian whole soil mass was partitioned into the heavy fraction; in Ecuador, the figure was 260%. As particle density increased, C concentration decreased (Fig. 1), a result corroborated elsewhere (Sollins et al., 2009). Generally, SOC species did not differ by depth, nor was a depth x fraction interaction significant. Only in Alumbre was there a significant difference by depth for carboxylic-C and aromatic-C. At all sites, total C&N were significantly different by fraction, as were C:N ratios.

More often than not, fractions did not represent different proportions of C species (Fig. 3). The data are preliminary evidence that density fractionation sometimes, but not often, represents chemically different SOC species. If density fractionation is a measure of C recalcitrance, this may imply that chemical recalcitrance is less important for C sequestration than physical protection. Future work should include determination of C mean residence times and microbial or plant derivation.

References


Table 1. Select characteristics from Bolivia & Ecuador sites

<table>
<thead>
<tr>
<th>Country</th>
<th>Site</th>
<th>Coordinates</th>
<th>Mean annual ppm (mm)</th>
<th>Mean annual temp (°C)</th>
<th>Elev (m)</th>
<th>Dom. soil type(s)</th>
<th>Soil texture</th>
<th>Cropping history</th>
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</thead>
<tbody>
<tr>
<td>Bolivia</td>
<td>Wayllala Puru</td>
<td>W65°39'57.1&quot; S 510</td>
<td>9.9</td>
<td>3648</td>
<td>Udic Ustochrepts</td>
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<td>Potato-bean-cereal-fallow, full tillage</td>
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<td>Bolivia</td>
<td>W78°16'14.4&quot; S 570</td>
<td>11.2-22.2</td>
<td>2600</td>
<td>Andic Haplustolls &amp; Entic Dystrandepts</td>
<td>Loam</td>
<td>Potato-bean-cereal-fallow, full tillage</td>
<td></td>
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</tbody>
</table>

Figure 1. Total SOC concentration of whole soil and density fractions in Bolivia and Ecuador soils. Error bars represent standard errors of the means.

Figure 2. Schematic of NEXAFS beamline. (Adapted from Lehmann et al., 2009.)

Figure 3. Proportions of C species present in whole soil and density fractions in Bolivia and Ecuador soils. Error bars represent standard errors of the means. Within a site, different letters signify significantly different fractions at p<0.10. All other fraction comparisons within a site are not different.

Figure 4. Proportion of C (%)

Hermon 33 beamline at the SRC

NEXAFS sample preparation