Are chemical fractionation methods able to isolate stable organic matter pools?

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1. Introduction and objectives

An analytically defined stable soil organic matter (SOM) pool can help estimating soil organic carbon (SOC) stabilization potentials and support the acceptance of models that are currently based on non-measurable pools.

The aim of this study was to assess the suitability of five chemical fractionation methods for extracting stable SOM pools by

1. analysis of OC contents before and after chemical fractionation,
2. comparison of C contents after chemical fractionation with the inert organic matter (IOM) pool as calculated using the Rothamsted Carbon Model and isotope data as well as with the black carbon (BC) content of the soil, and
3. determination of the stability of the C-residue of a maize soil using 14C natural abundance and radiocarbon dating.

2. Material and Methods

Soils: Stagnic Luvisol derived from loess (silty loam)
Located in Rotthalmünster, Germany (N 48° 21' E 13° 11')
Land use: Maize, wheat (AP & E); grassland (AH); forest (Ah)
Density fractionation (SPT, density 1.8 g cm-3) for removal of particulate organic matter before chemical fractionation
Chemical fractionations:
1. Wet oxidation using Na2S2O5 (80°C) for 2 days
2. Wet oxidation using H2O2 (55°C) for 7 days
3. Wet oxidation using NaOCl (room temp.)
4. Demineralisation of the residual fraction after oxidation with NaOCl using HF (NaOCl/HF)
5. Stepwise hydrolysis (100°C) using TFA and HCl with increasing concentrations (2-6N) and reaction times (2-24 h).

3. Results and discussion

C contents after treatment with Na2S2O5 and H2O2 were mostly independent of land use. The other chemical fractionation methods resulted in residual C contents that were significantly higher in the grassland and forest soil than in the maize soil (Figure 1).

C contents after treatment with H2O2 and Na2S2O5 gave a good approximation to the calculated IOM pool as well as the BC content, while treatment with NaOCl+HF approximated these fractions only in the maize Ap horizon (Figure 1).

All methods removed significantly more of the younger, C1 derived C than of the older, C2 derived C (Figure 2).

The highest amounts of C1 derived C were removed by treatment with H2O2, Na2S2O5 and NaOCl+HF (Figures 2-3).

The portion of C1-derived C in the residual fractions indicates an increasing stability in the order: hydrolysis < NaOCl < NaOCl+HF < H2O2 = Na2S2O5 (Figure 3).

14C data proved the mean 14C ages of the residual fractions. The mean 14C ages increased in the order NaOCl < NaOCl+HF < hydrolysis < H2O2 = Na2S2O5 (Figure 4).

4. Conclusions

All chemical fractionation methods removed preferentially younger organic carbon, leaving behind an older C fraction, but oxidation using H2O2 and Na2S2O5 were the most effective in obtaining stable C pools, because they left residual C fractions that...

- were independent of current land use,
- had the highest stability according to 13C and 14C data,
- approximately matched the BC contents and the IOM pool as calculated using the Rothamsted Carbon Model and isotope data.

Literature

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