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

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The stable soil organic matter (SOM) pool(s) are considered to account for the majority of SOM. Due to their slow carbon turnover, they are important for long-term sequestration of soil organic carbon (SOC). We aim to assess the suitability of four chemical fractionation methods to recover stable SOM pools. The mineral soil of a silty loam under wheat (0 – 30 cm and 30 - 45 cm), maize (0 – 30 cm and 30 - 45 cm), grassland (0-10 cm) and forest (0 -7 cm) was investigated. After density fractionation for removal of fresh plant debris, the mineral soil was exposed to 1) stepwise hydrolysis with TFA and HCl (100 ˚C), and to chemical oxidation with 2) $H_2O_2$ (50 ˚C), 3) $Na_2S_2O_8$ (80 ˚C), and 4) NaOCl (room temperature). The latter was followed by demineralisation with HF. We determined (i) the initial and residual SOC contents, (ii) the proportion of young, maize-derived C before and after chemical fractionation in the maize soil, (iii) the radiocarbon ages of SOC before and after chemical fractionation, and (iv) we compared the SOC contents after chemical fractionation with the inert organic matter (IOM) pool of the investigated site as calculated using the Rothamsted Carbon Model and isotope data. All chemical treatments induced high SOC losses, leaving residual C pools of 10 – 17 % of SOC in the topsoil and 18 – 25 % of SOC in the subsoil. Residual C contents were not dependent on land use in the case of oxidation with $H_2O_2$ and $Na_2S_2O_8$, but differed significantly between land uses after stepwise hydrolysis and oxidation with NaOCl. All chemical treatments led to a preferential loss of maize-derived SOC, but chemical oxidation with $Na_2S_2O_8$ and $H_2O_2$ were the most efficient in removing young, maize-derived C. Radiocarbon ages of SOC were higher after all chemical fractionations (1000 – 12 500 yrs) than before

(modern – 200 yrs), and increased in the order: oxidation with NaOCl $<$ oxidation with NaOCl plus demineralisation with HF $\leq$ stepwise hydrolysis $<$ oxidation with $H_2O_2$ $\leq$ oxidation with $Na_2S_2O_8$. None of the chemical fractionation methods was able to fit the inert organic carbon content calculated for this site using the Rothamsted carbon model and isotope data (0.6 g kg$^1$ compared to residual C contents of 0.9 – 4.2 g kg$^{-1}$). The results suggest that oxidation with $H_2O_2$ and $Na_2S_2O_8$ are capable of preserving a stable SOM pool, but none of the chemical fractionation methods was able to fit the IOM pool as calculated by using the Rothamsted Carbon Model and isotope data.