Interactions between organic matter and soil structure and their impact on organic matter preservation in soils

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A significant fraction of soil organic matter (SOM) would be physically protected from biodegradation by virtue its location within the soil mineral matrix. As organic matter contributes to the formation and stability of soil aggregates, strong feedback effects are expected between soil structure dynamics and soil organic matter dynamics. The aims of this study were to get insigths into these relationships through an analysis of the spatial distribution of SOM within soil aggregate fractions.

Surface horizons of silty soils, cultivated or under forest vegetation, were studied. Continuous maize cultivation since several years allowed to distinguish this recently incorporated carbon from older one using ^{13}C natural abundance. In the same field experiments we traced organic nitrogen using ^{15}N labelling. Organic matter (C and N) with different locations in the soil structure were separated, quantified and their $\delta^{13}C$ and $\delta^{15}N$ were measured. We separated organic fractions (i) associated with different particle size fractions[2] and located (ii) in dry-sieved aggregates of different sizes [1,5] (iii) in wet-sieved aggregates of different sizes and stabilities[5] or (iv) located inside vs outside of stable aggregates[3,4].

Organic matter with different locations in the soil structure were found to have different apparent turnover rates. C and N were found to turnover more rapidly in macroaggregates than in microaggregates[1,6] and outside of aggregates than inside aggregates[3,6]. These results support the idea of a physical protection of SOM within soil microaggregates.

Stable aggregates were enriched in carbon and in young carbon as compared to unstable ones[5]. This suggested that young organic carbon is involved in the stability of the aggregates. A model is proposed in which the aggregate stability is driven by the incorporation and biodegradation of organic residues in the aggregates.

Organic matter thus contribute to the physical stability of the structures that occlude them and protect them against biodegradation. The consequences of the strong interactions between soil structure and organic matter dynamics on SOM preservation under different land uses is discussed.

References

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