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Influence of management practices on C stabilization pathways in agricultural volcanic ash soils (Canary Islands, Spain)

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Although C stabilization mechanisms in agricultural soils are still controversial [1], a series of overlapped pathways has been suggested [2] such as: i) insolubilization of low molecular weight precursors of soil organic matter (SOM) with reactive minerals through physical and chemical bonding, ii) selective accumulation of biosynthetic substances which are recalcitrant because of its inherent chemical composition, and iii) preservation and furter diagenetic transformation of particulate SOM entrapped within resistant microaggregates, where diffusion of soil enzymes is largely hampered. In some environments where carbohydrate and N compounds are not readily biodegraded, e.g., with water saturated micropores, an ill-known C stabilization pathway may involve the formation of Maillard's reaction products [3]. In all cases, these pathways converge in the formation of recalcitrant macromolecular substances, sharing several properties with the humic acid (HA) fraction [4].

In template forests, the selective preservation and further microbial reworking of plant biomass has been identified as a prevailing mechanism in the accumulation of recalcitrant SOM forms [5]. However, in volcanic ash soils with intense organomineral interactions, condensation reactions of low molecular weight precursors with short-range minerals may be the main mechanism [6].

In order to shed some light about the effect of agricultural management on soil C stabilization processes on volcanic ash soils, the chemical composition of HA and some structural proxies of SOM informing on its origin and potential resistance to biodegradation, were examined in 30 soils from Canary Islands (Spain) by visible, infrared (IR) and ^{13}C nuclear magnetic resonance (NMR) spectroscopies, elementary analysis and pyrolytic techniques.

The results of multivariate treatments, suggested at least three simultaneous C stabilization biogeochemical trends: i) diagenetic alteration of plant biomacromolecules in soils receiving periodical inputs of manures. This includes accumulation of slightly transformed material in scenarios of high C mineralization rates, such are in vitrandic soils. ii) Accumulation of resilient organo-mineral complexes in non andic-soils with crystalline minerals and probable inputs of pyrogenic C in the past. Finally, iii) accumulation of aliphatic structures, such as carbohydrate- and N-rich macromolecules, leading to HAs with characteristics in common with those formed in aquatic environments. The formation of these HAs could be favoured by microbial activity in andic Anthrosols, and would define a specific type of soil C stabilization mechanism of aliphatic compounds encapsulated in nanoparticle-size soil pores, where persistent hydromorphic conditions were favoured by amorphous gels in volcanic ash soils.

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