

Clay minerals, metallic oxides and oxy-hydroxides and soil organic carbon distribution within soil aggregates in temperate forest soils

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Soil mineralogy is of primary importance for key environmental services provided by soils like carbon sequestration. However, current knowledge on the effects of clay mineralogy on soil organic carbon (SOC) stabilization is based on limited and conflicting data. In this study, we investigated the relationship between clay minerals, metallic oxides and oxy-hydroxides and SOC distribution within soil aggregates in mature *Pinus radiata* D. Don forest plantations. Nine forest stands located in the same geographical area of the Basque Country (North of Spain) were selected. These stands were planted on different parent material (3 on each of the following: sandstone, basalt and trachyte). There were no significant differences in climate and forest management among them. Moreover, soils under these plantations presented similar content of clay particles. We determined bulk SOC storage, clay mineralogy, the content of Fe-Si-Al-oxides and oxyhydroxides and the distribution of organic C in different soil aggregate sizes at different soil depths (0-5 cm and 5-20 cm). The relationship between SOC and abiotic factors was investigated using a factor analysis (PCA) followed by stepwise regression analysis. Soils developed on sandstone showed significantly lower concentration of SOC (29 g C kg⁻¹) than soils developed on basalts (97 g C kg⁻¹) and trachytes (119 g C kg⁻¹). The soils on sandstone presented a mixed clay mineralogy dominated by illite, with lesser amounts of hydroxivermiculite, hydrobiotite and kaolinite, and a total absence of interstratified chlorite/vermiculite. In contrast, the major crystalline clay mineral identified in the soils developed on volcanic rocks was interstratified chlorite/vermiculite. Nevertheless, no major differences were observed between basaltic and trachytic soils in the clay mineralogy. The selective extraction of Fe showed that the oxalate extractable iron was significantly lower in soils on sandstone (3.7%) than on basalts (11.2%) and trachytes (8.2%) with no significant differences between the last two. On the other hand, ditionite extractable iron was significantly different among all soils with the following content: sandstone (13%) < trachytes (23%) < basalts (27%). Short-range order inorganic phases of Al and Fe were significantly higher in soils developed on volcanic parent materials. The distribution of organic C in soil aggregates revealed that as much as 50% of the organic C was concentrated in mega (20-10 mm and 10-5 mm) and large-(5-2 mm) aggregates in soils developed in sandstones, while 25% and 36% of the total organic C was found in these aggregates in basaltic and trachytic soils respectively. Basaltic soils showed significantly higher proportion of organic C (>20%) in microaggregates (0.25-0.053 mm) and silt+clay size aggregates (< 0.053 mm) than the other two soils (<10%). The regression analysis revealed that short-range order minerals influence the amount of SOC via microaggregation and that chlorite-vermiculite mixed layer minerals had a significant influence on the amount of SOC relating this stabilization mechanism to macroaggregation. This study highlights that dynamic models of SOC turnover in acid soils from temperate forest should include proxies for clay mineralogy and for the content of Fe and Al oxides and oxy-hydro-oxides.