Geophysical Research Abstracts
Vol. 20, EGU2018-11138, 2018
EGU General Assembly 2018

Influence of the chemical composition of organic matter on the structural stability and carbon storage of soils under xeric environment (Cape Verde, Africa)

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Volcanic ash soils under dry climate conditions are very susceptible to soil loss due to their poor structural stability and low bulk density. Although it appears paradoxical, these soils may have a high amount of organic matter (OM). However, this high content of OM does not seem to improve the soil physical properties in all cases. When intense rainfalls occur in short wet periods, bare soils are quickly eroded and, in consequence, a great volume of sediments are lost ex situ.

This study is carried out on the Fogo Island (Cape Verde archipelago, near to African continent), where the strong relief of volcanic islands magnifies the problem of soil loss, leading to very pronounced erosive processes spread all over the landscape. This research aims to analyze the role of OM on soil aggregation and stability. Samples collected at different soil depths were analyzed in the laboratory by routine methods, and the chemical composition of the OM from whole soil samples was determined by analytical pyrolysis. The compounds released by pyrolysis were separated by gas chromatography and identified by mass spectrometry and retention times. The main pyrolysis compounds were quantified and classified in terms of their origin (lignins, polysaccharides, N-compounds, aromatic rings, aliphatics and, finally compounds with unspecific origin).

Exploratory physical analyses suggested that the weak soil structural stability observed in the field coincided with the lack of macro-aggregates. Although soils have neutral pH and high content of OM and nutrients, a high erosion rate (estimated in 100 Mg/ha/yr) is characteristic of the studied area. Poor vegetation cover, highly erodible soils, very steep slopes and intense rainfalls in a short wet season, help explaining this dramatic soil loss.

The above results are interpreted in terms of the molecular composition of the soil OM. In fact, the amount of OM (> 40 g/kg) showed a good correlation with the amorphous oxides (measured as Alo + $\frac{1}{2}$ Feo). Pyrolysis results showed the practical lack of products derived from higher plants (i.e. lignin) with a major contribution of microbial compounds (carbohydrate and N-derived compounds).

In consequence, the levels of soil organic C in these volcanic soils under xeric conditions, seem to be due to intense microbial activity into the soil microporous structure, rather than to a direct effect of the OM on soil macroaggregation, reflected in the soil structural stability. This high susceptibility to erosive processes is postulated to be due to the lack of specific aggregating agents from the biomass of vascular plants.