SCIENCES SORBONNE UNIVERSITÉ

Internship proposal
Master 2
2023-2024

Institut de minéralogie de physique des matériaux et de cosmochimie

Influence of soil mineralogy on organic carbon dynamics : contribution of a fine characterisation of the clay mineralogy in temperate soils

Keywords : carbon cycle, soil, organic matter, clay, mineralogy, X-ray diffraction

Context : Soils are a key player in the terrestrial carbon cycle. Due to the importance of organic carbon stocks and associated fluxes, soils are at the hearts of the ongoing environmental changes. Studying the evolution of the stocks and the processes that control carbon fluxes to and from the soils is essential to better forecast the future evolutions of the carbon cycle by the end of the century in the context of changing soil management practices and occupation and more broadly of global change.

Research problem : Carbon inputs in the soil result from primary productivity. Organic matter arrives in varied forms and is later transformed and redistributed within the soil profile due to fauna, microorganisms and water activity. The rate of decomposition, and thus carbon persistence in soil mostly depends on (i) the chemical quality of the organic matter, (ii) the environmental conditions more or less favourable to microorganisms activity and (iii) the mineral matrix (*ca.* 90 wt% of dry soil). In the finest fraction (clay, < 2 µm), organic matter sorption onto the surface of mineral particles can make organic molecules inaccessible to microorganism. Coprecipitation between organic and mineral matter could play the same role, at least in certain soils rich in amorphous or poorly cristalline phases. By aggregation, mineral particles can also trap organic matter into pores and physically isolate it from the action of microorganisms. The precise description and quantification of the role of these phenomena as a function of pedoclimatic parameters and soil management and occupation is a key challenge to better constrain soil organic carbon dynamics.

Internship objectives and tasks : This internship aims at finely studying the nature of the mineral phases in selected soils from which organic matter has been characterised. A hundred of temperate soils exhibiting a vast range of quantities of soil organic carbon of varied persistence has been selected and analysed using X-ray diffraction. In the first phase of the internship, we will characterise quantitatively the mineralogy of the bulk soil, in particular the nature and proportion of phyllosilicates. An experimental part of the internship will consist in separating the clay fraction (< 2 µm) and the sub-fractions ($< 0{,}05$ µm/0,05-0,2 µm/0,2-2 µm) by centrifugation on a sub-selection of these samples. A detailed analysis using X-ray diffraction on oriented specimen and data analysis using modelling techniques will give a precise quantification of clay phases in the fine fractions. Linking these results with those obtained on organic carbon and with the pedoclimatic data will help precise the role played by the nature of the phases and their cristallinity in soil organic carbon persistence. It will then be possible to clarify the mechanisms at stake and better describe the pedoclimatic conditions most suitable to soil organic carbon preservation.

Candidate profile : the candidate will be in second year of a master related to geosciences or environmental sciences. An experience in X-ray diffraction or on another technique of material analysis, in material physics or chemistry and/or in data analysis will be appreciated.

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