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# Understanding soil organic matter formation and stabilization (Philippe Duchaufour Medal Lecture)

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During the biomass formation/decomposition cycle carbon dioxide ($CO_2$), the main gas driving global warming, is either released from or stabilized in the organic matter of soils. One of the most fundamental functions of soil organic matter is the provision of metabolic energy which drives soil biological processes. In essence, it is the transformation of carbon by plant, micro- and macro-biological processes that provides energy and results in the establishment of a cycle that connects above- and belowground energy transformations. The amount and type of organic matter accumulated in soils is controlled, among other factors by intrinsic soil properties, specifically soil texture and the associated aggregate structures. Soil development leads to the formation of aggregated structures composed of a highly complex mixture of different mineral and organic constituents. The resulting soil type specific carbon sequestration can strongly be affected by soil management, varying greatly with the type and intensity of land use. The processes of formation and stabilization of organic matter through organo-mineral interactions in aggregated soil structures are controlled at the sub-$\mu$m scale. Understanding the binding of organic matter in these fine soil structures is thus key to elucidate the biogeochemical soil processes that are part of the carbon cycle as well as to evaluate the effects of soil management on the carbon cycle. I will discuss open questions for understanding these processes and how we can approach them by combining state-of-the-art analytical techniques with innovative experiments.