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Organo-mineral interactions in soil system: examining the mechanisms behind the formation of largest carbon pool on land

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Soil organic matter (SOM) is the largest carbon (C) pool on the earth's surface and plays a fundamental role in biogeochemical cycling and ecosystem functioning. Yet long-term responses of SOM to environmental perturbation remain uncertain. Current predictions on the changes in soil C pool upon warming differ widely among global C models. This uncertainty is largely due to complex feedbacks among soil, biota, climate, and parent material at landscape scale and equally complex interactions between diverse organic compounds and mineral phases at microscopic scale. Here I focus on the latter scale and present some results from an on-going, collaborative study which examines the nature of organo-mineral associations using density fractionation coupled with multiple analytical tools including isotope technique. Using heavy liquid (sodium polytungstate) adjusted at 1.6 up to 2.5 g/cc, we isolated the soil particles differing in the degrees and types of mineral associations. Among dramatically-different soils (e.g., tropical soils developed on ultrabasic rock, temperate soils developed on silicious rock, volcanic-ash derived soil), we found following consistent patterns: (i) decline in C and N concentration due to higher mineral abundance for heavier particles, (ii) progressive decline in C:N ratio from 25-60 to 8-20, (iii) increase in delta N-15 by 2-6 per mil and, to a less extent, delta C-13, and (iv) general increase in the mean residence time of C based on C-14. By focusing on a volcanic-ash soil, we also measured the specific surface area of and the enthalpy of N2 gas sorption onto the soil particles of each density fraction to assess geometric aspects of the organo-mineral associations. Based on these results, we will discuss the physicochemical nature of organo-mineral associations and its biogeochemical implication.

Keywords: soil organic matter, carbon cycle, aggregate, C and N isotopes, organic coating on mineral