

Variation in delta N-15 among the soil organo-mineral particles of various sizes in two volcanic-ash soils

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Stabilization and destabilization of soil organic matter (SOM), representing the largest carbon pool of terrestrial ecosystem, exert strong control on the biogeochemical cycling of biogenic elements. Growing evidence suggest that SOM stabilization is largely controlled by the interaction of organic matter (OM) and soil minerals. Volcanic-ash soils are characterized by a high contents of OM, short-range-order (SRO) minerals (e.g., allophane/imogolite), and organo-metal complexes. Previously, we showed that SOM is mainly stabilized in the soil particles of <2 micro-m size class where SRO minerals and organo-metal complexes were enriched relative to larger-size particles. Furthermore, we found that the decline of C:N ratio and 5 permil enrichment of N-15 towards finer particle size fraction. These results suggest that the OM in finer-sized particles appears to be more strongly altered by microbial metabolism. How the microbial transformation of SOM is linked to soil mineralogical property remains poorly understood, however. Here we hypothesized that N-rich OM is stabilized by interacting with metal ions (Al and Fe) and the organo-metal interaction, in turn, controls the variation in delta N-15 among the soil particles of various sizes. To test this, we chose two types of volcanic-ash soils - one is rich in SRO minerals and the other rich in layer-silicate minerals and organo-metal complex. We used particle-size fractionation to separate organo-mineral particles and characterized each by selective-dissolution, solid-state C-13 NMR, isotopic (N-15, C-13, C-14), and microscopic techniques. Our results showed that: (i) OM was mainly stabilized in <2 micro-m size fractions in both mineral type soils, (ii) OM content showed strong positive correlation with the content of organically-complexed metals, (iii) C:N ratio, N-15, and C-14 values were correlated with one another among the size fractions of both soils. Based on these results, we will discuss the possible factors and processes controlling the variation in N-15 among the organo-mineral particles and its relation to SOM stabilization in the studied soils.

Keywords: soil organic matter, organo-mineral associate, particle-size fractionation, short-range-order minerals, organo-metal complexes, carbon stabilization