

## Organic matter accumulation in volcanic ash soil revealed by C-13 tracer experiments and density fractionation analysis

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Organic matter (OM) enters into soil system mainly as plant detritus, root exudates, and microbial metabolites and detritus. The OM experiences both microbial degradation and the interaction with soil mineral particles, leading to the formation of organo-mineral particles that have a wide range of size, density, and chemical reactivity. Physical fractionation studies have shown that the OM present in organo-mineral particles (e.g., microaggregate in high-density fraction) are more stable against microbial degradation compared to mineral-free OM (e.g., plant detritus in low-density fraction). Little is known, however, the rate at which the OM is stabilized in organo-mineral particles and the transfer of C among various types of particles present within a soil. We thus conducted a laboratory soil incubation experiment to quantify the rate at which easily-metabolizable C transfer among the organo-mineral particles of three different density classes.

We added <sup>13</sup>C-labelled glucose (99 <sup>13</sup>C atom%, 0.1915 mmol <sup>13</sup>C g<sup>-1</sup>soil as solution) to a typical volcanic-ash soil (2-mm sieved, 10 g moist) and incubated for 30 d at 35 oC and 50% water holding capacity. After the incubation, soil was separated according to particle density using sodium polytungstate into low (<1.8 g mL<sup>-1</sup>), middle (1.8-2.5 g mL<sup>-1</sup>), high (>2.5 g mL<sup>-1</sup>) density fraction. We measured the mass, isotopic ratio (<sup>13</sup>C/<sup>12</sup>C) and total C content of the density fractions as well as the amount of CO<sub>2</sub> respired during the incubation by alkali trap method. This experiment was conducted in triplicate.

The density separation showed that 85 percent of total soil C was recovered in the mid-density fraction, whereas 10 and 5% was recovered in the low- and high-density fractions, respectively. The highest concentration of short-range-order minerals (e.g., allophane/imogolite) was found in the mid-density fraction, which imply that high specific surface areas and sorption capacity of the short-range-order minerals contributed to the large OM accumulation in this fraction. Of the <sup>13</sup>C added to the soil, half was mineralized to CO<sub>2</sub> during the 30-day incubation. The other half of added <sup>13</sup>C was recovered from soil density fractions with greater partitioning into lower density (37, 13, 0.8% of the <sup>13</sup>C in the low-, mid- and high-density fractions, respectively). Highest <sup>13</sup>C recovery in the low-density fraction suggests rapid assimilation of added glucose by the active microbial communities in and subsequent turnover of the labeled C within the low-density fraction. Our results support the hypothesis that microbial degradation of newly-added OM is accompanied by the progressively intimate interaction with mineral particles.

Keywords: soil organic matter, C-13 glucose, density fractionation, soil microorganism, organo-mineral particles, short-range-order minerals