

## Organic matter stabilization in Andisol and Ultisol revealed by isotopic tracer experiment and density fractionation

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For predicting C cycling in terrestrial ecosystem, dynamics of organic matter (OM) in soil can be a large component that increases uncertainty. Once OM is supplied into soil system mainly as plant detritus and root exudates, OM is decomposed by microorganisms and a proportion of OM is stabilized through association with soil mineral particles. The OM in soils has a wide range of size, density, and chemical reactivity. Organo-mineral particles of heavy-density fraction are highly resistant against microbial degradation compared to mineral-free OM (i.e., plant detritus and low-density fraction). The high C sequestration capacities of soils (e.g., Andisol) are hypothesized to be regulated by incorporation rates of microbial-processed OM into heavier fraction. To test this hypothesis, we conducted incubation experiment using tracer to quantify the pool sizes, influx and efflux rates, and mean residence times (MRTs) of different density classes.

Different types of soils were sampled from two agricultural lands; a volcanic-ash soil (Andisol) from Japan and a highly-weathered tropical soil (Ultisol) from Indonesia. The incubation experiments were carried out after addition of <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) or <sup>13</sup>C, <sup>15</sup>N-labeled glutamic acid to the soils (2-mm sieved, 5 g dry weight). The soils were incubated for 276 d at 30°C and 50% water holding capacity. After the incubation, soil was separated into three fractions according to its density using sodium polytungstate as heavy liquid: low (<1.8 g cm<sup>-3</sup>), middle (1.8-2.25 g cm<sup>-3</sup> for Andisol, 1.8-2.5 g cm<sup>-3</sup> for Ultisol), high (>2.25 g cm<sup>-3</sup> for Andisol, >2.5 g cm<sup>-3</sup> for Ultisol) density fractions. We measured the mass, isotopic ratios (<sup>13</sup>C/<sup>12</sup>C, <sup>15</sup>N/<sup>14</sup>N) and total C and N concentrations of the density fractions as well as the amount of CO<sub>2</sub> respired during the incubation by alkali trap method. We also measured the specific surface areas (SSA) of soil minerals and the concentrations of Al, Fe oxides/hydroxides.

For both soils, ca. 70 to 80 % of added <sup>13</sup>C were mineralized to CO<sub>2</sub> within 1 month after substrate addition. The density fractionation showed that <sup>13</sup>C recovery in the low-density fraction was low (0.5 - 3.8%) throughout the incubation period. The <sup>13</sup>C recovery within the mid- and high-density fractions was greater than 20%. This indicates that labile substrates were immediately incorporated into the mid- and high-density fractions through microbial processing in the both soils. The highest <sup>13</sup>C recovery was observed in the mid-density fraction of Andisol and in the high-density fraction of Ultisol, respectively. MRTs of <sup>13</sup>C in the density fractions positively correlated with SSAs for respective soil types. This can be explained by differences in mineralogy which contribute to OM stabilization through sorption; short-range-order minerals (e.g., allophane and imogolite) in Andisol and iron oxides in Ultisol, respectively. Our results support the hypothesis that newly-added OM is stabilized through association of microbial metabolites with mineral particles. However, dominant density class and turnover of stabilized OM could be variable depending on soil types and clay mineralogy with high specific surface areas.

Keywords: <sup>13</sup>C-glucose, <sup>13</sup>C, <sup>15</sup>N-glutamic acid, Andisol, Ultisol, organo-mineral particle