Soil iron reduction and carbon mineralization in reconstructed aggregates during redox fluctiations

DIEGO BARCELLOS[1] , WHENDEE SILVER[2], JENNIFER PETT-RIDGE[3], AARON THOMPSON[1]

[1]3111 Miller Plant Sciences, University of Georgia. Athens, GA, USA, 30602. (barcello@uga.edu ; aaront@uga.edu)

[2]Univ. of Californa Berkeley, Berkeley, CA, USA, 94720

[3]LLNL, Livermore, CA, USA, 94550

Iron minerals have the capacity of changing oxidation state between Fe^{III} to Fe^{II} in response to changing soil oxygen status. However, oxygen content is extremely heterogeneous because of microsites within the soil. In fluctuating redox environments, we hypothesized heterogeneity would shift the amplitude of the redox fluctuations toward more anoxic conditions. We tested this by exposing slurried (representing homogeneous conditions) and reconstructed mini-aggregates (representing heterogeneous conditions) to redox fluctuations of specific frequency variations. For the mini-aggregate soil experiment, we constructed a 50 ± 10 mg soil aggregate within a 2-mL-microtube. For the slurried experiment, we used 5 g of soil in 50 mL buffered solution at pH 5.5. In both experiments, we used soils from Luquillo CZO (Puerto Rico), 2-mm-sieved and homogenized anaerobically, 24-h after collection. To explore the effects of different redox conditions, we pre-conditioned all soils in three cycles of 1 d oxic : 6 d anoxic before imposing to five treatments containing three cycles each. Three long-period treatments had τ_{anoxic} fixed at 6 d and τ_{oxic} at either 72, 24, and 8 h (tt1, tt2, and tt3, respectively). Two short-period treatments had τ_{anoxic} fixed at 2 d and τ_{oxic} at 24 or 8 h (tt4 and tt5). We measured 0.5 M HCl-extractable Fe^{II}, CO_2 and CH_4 fluxes, and solid-phase-carbon. In the paired experiments, Fe^{II} increased substantially in the pre-conditioning phase. During the treatment phase we found: for non-slurried soils, a gradual increase of Fe^{II} in tt1, but unvarying for tt2 and tt3; for slurried soils, we found higher increase of Fe^{II} in tt3, followed by tt2 and tt1. However, no significant changes in iron reduction occurred for the short-period treatments in either experiment. The initial carbon content in solid phase (38 mg C g^{-1} of soil) decreased on average by 6 ± 2 % for all treatments. CO_2 and CH_4 fluxes differed between the slurried and mini-aggregate treatments, with results from the full dataset increased for all treatments. Therefore, the dynamics of redox fluctuations and aggregate structure affects iron reduction and carbon mineralization in soils.