Thermal stability of soil organic matter pools under elevated CO_2 and their turnover times calculated by $\delta^{13}C$ and $\delta^{15}N$ values

MAXIM DORODNIKOV[1,3], ANDREAS FANGMEIER[2] AND YAKOV KUZYAKOV[1]

[1]Department of agroecosystem research, University of Bayreuth, Germany, 95440 Bayreuth; (maxim.dorodnikov@uni-bayreuth.de; kuzyakov@uni-bayreuth.de).

[2]Institute of Landscape and Plant Ecology (320), University of Hohenheim, Germany, August-v.-Hartmann-Str. 3, 70599, Stuttgart; (afangm@uni-hohenheim.de)

[3]Institute of Physico-chemical and Biological Problems in Soil Science, RAS, Puschino, Russia, Institutskaya 2, 142290

Various SOM fractionation approaches (density, particle size, chemical extractability etc.) have been applied to estimate C and N turnover rates in SOM pools. The thermal stability of SOM coupled with C and N isotopic analyses has never been studied in experiments with FACE. We tested the hypothesis that the mean residence time (MRT) of SOM pools is inversely proportional to their thermal stability. Soil samples from FACE plots under ambient (380 ppm) and elevated CO_2 (540 ppm; for 3 years) treatments were analyzed by thermogravimetry (TG) coupled with differential scanning calorimetry (DSC). Based on TG, five SOM pools were distinguished. Soil samples were heated up to the respective temperatures and the remaining soil was analyzed for $\delta^{13}C$ and $\delta^{15}N$ by IRMS. Energy consumption and mass losses in the temperature range 20-200°C were mainly connected with water volatilization. The maximum weight losses occurred from 200-310°C. $\delta^{13}C$ values of SOM pools under elevated CO_2 treatment showed an increase from -34.3‰ (20-200°C) to -18.1‰ (>480°C). The incorporation of new C and N into SOM pools was not inversely proportional to their thermal stability. SOM pools decomposed at 20-200 and 200-310°C had 2 and 3% of new C, with a MRT of 149 and 92 years. The pool decomposed between 310-400°C had 22% of new C, with a MRT of 12 years. The amount of fertilizer-derived N after 2 years of application in ambient and elevated CO_2 treatments was similar in SOM pools decomposed up to 480 °C (3.4%), with MRT of about 60 years. In contrast, the pool decomposed above 480°C had only 0.5% of new N, with a MRT of more than 400 years in soils under both treatments. Thus, the separation of SOM based on their thermal stability was not sufficient to reveal pools with contrast turnover rates of C and N.

The timescale of sediment transport in a small tropical watershed

ANTHONY DOSSETO[1], SIMON P. TURNER[1], HEATHER L. BUSS[2] AND FRANÇOIS CHABAUX[3]

[1]GEMOC, Department of Earth and Planetary Sciences, Macquarie University, Sydney, Australia. (adosseto@els.mq.edu.au; sturner@els.mq.edu.au)

[2]USGS, Menlo Park, CA, USA. (hlbuss@usgs.gov)

[3]CGS-EOST, Université de Strasbourg, Strasbourg, France. (fchabaux@illite.u-strasbg.fr)

How fast are sediments produced, stored and transported in a watershed? This question has important implications for understanding the transfer of carbon, nutrients and pollutants from their continental sources to the oceans. Sediment transport times can be inferred indirectly through the measurement of erosion rates, however uranium-series isotopes have the great advantage of providing a direct measurement of the residence time of sediments in a catchment. Most previous studies have focused on large basins (e.g. Amazon [1,2], Mackenzie [3]), yielding important insights on timescales of sediment transport and chemical weathering. However, the provenance and path of sampled sediments are not well-constrained. In this study, we chosed to focus on small catchments (less than a few km^2) to quantify how much time sediments reside in a tropcial watershed where landslides are the dominant agent of physical denudation.

The study area is located in the rainforest of the Luquillo Mountains, Puerto Rico. River suspended and bedload sediments have been analyzed for ^{238}U-^{234}U-^{230}Th and ^{226}Ra isotopes. Assuming that sediments have followed a single, continuous weathering evolution since their production from the bedrock, we inferred that the time elapsed between the onset of bedrock weathering and export of sediments out of the catchment is 100 – 200 years. This constrats with previous estimates for rivers around the world (1,000 – 500,000 years [1-4]) and is best explained by the landslide-dominated nature of erosion in this region, which delivers to the river weakly weathered soil particles.

Soil profiles will also be studied in order to understand the rate of development of the weathering profile in this region and how physical erosion and sediment transport relate to weathering profile evolution.

References

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