Interaction of organic matter with different minerals in an artificial soil incubation experiment

GEERTJE JOHANNA PRONK[1,2], KATJA HEISTER[1] AND INGRID-KÖGEL-KNABNER[1,2]

[1]Lehrstuhl für Bodenkunde, Technische Universität München, 85350 Freising-Weihenstephan, Germany
[2]Institute for Advance Study, Technische Universität München, Lichtenbergstrasse 2a, 85748 Garching, Germany

The interaction between minerals, organic matter (OM) and microbes leads to the formation of complex biogeochemical interfaces in soil. It is challenging to characterize these interactions in natural soils, where environmental conditions are highly variable. Therefore, we performed an incubation experiment with so-called 'artificial soils' composed of mixtures of clean model materials, where the development of organic matter (OM) was followed in a simplified system. The artificial soils were composed of 8 different mixtures of quartz, illite, montmorillonite, ferrihydrite, boehmite and charcoal, manure as OM source, and a microbial inoculant extracted from a natural arable soil. They were incubated up to 18 months. Development of OM during incubation was determined from CO_2 respiration, C and N content, and particle size and density fractionation. The OM composition was determined by e.g. solid-state ^{13}C nuclear magnetic resonance (NMR) spectroscopy and acid hydrolysis.

The artificial soil mixtures developed quickly into aggregated materials, and nitrogen-rich, proteinaceous material, originating from microbial debris, acumulated in the <20 μm size fraction. Furthermore, density fractionation showed an increasing association of OM with minerals. There was no effect of mineral composition on the respiration rate. However, the presence of a clay mineral led to a higher content of non-hydrolysable N, indicating that interactions took place between N-containing OM and clay mineral surfaces. Contrary to expectations, the presence of ferrhydrite had no effect on OM. We conclude that OM preferentially interacted with the clay minerals in this system.

Overall, the artificial soil incubation experiment provided a system, where the turnover of the original manure substrate could be studied in a simplified system. Due to the well-defined composition of the artificial soils, this experiment gives us new insight into the dynamics of interactions between specific minerals and charcoal, OM and a microbial community during the turnover of organic matter in a soil-like system.

Carbon isotope analysis in conglomerates of the Cambro-Ordovician Cow Head Group, western Newfoundland as a proxy for the origin of carbonate cements

SARA B. PRUSS[1], DAVID A. FIKE[2] AND KATIE A. CASTAGNO[3]

[1]Department of Geosciences, Smith College, Northampton, MA USA, spruss@smith.edu
[2]Department of Earth and Planetary Sciences, Washington University, St. Louis, MO USA 63130, dfike@levee.wustl.edu
[3]Department of Marine Affairs, University of Rhode Island, Kingston, RI USA 02881, katie@castagno.com

The radiation of complex skeletal organisms in the Upper Cambrian to Middle Ordovician interval is preserved in the Cow Head Group at Cow Head, western Newfoundland, in approximately 255 m of deep-water slope deposits. Conglomerate beds are a ubiquitous feature of the Cow Head Group and span Upper Cambrian through Middle Ordovician stratigraphy. To determine the source of carbonate cements and the relationship between clast and matrix in individual samples, conglomeratic samples were microdrilled in several places for carbon isotope analysis. Generally, clasts showed the most consistent isotopic variability within a single sample, but individual matrix values could vary by as much as 3.5. The large variability of carbon isotope values in individual samples, particularly in the matrix, suggests some role for local organic matter remineralization, perhaps in the presence of low oxygen which may enhance precipitation, and that these samples may not be recording DIC. Additionally, the low variability in some beds and the overlapping values of both clast and matrix carbonate indicates that clasts were occasionally sourced locally and that these values might best be approximating DIC. This study, along with complementary trace element analyses, provide important constraints on the possible sources of carbon in cements for allodapic conglomerate deposits that straddle this Cambro-Ordovician interval.

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