

Organic compounds on mineral surfaces – let's turn up the heat

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Soils form at the interface between lithosphere and atmosphere where weathering and decomposition disassemble rocks and dead plant materials into their basic components. The weathering products feed into a cascade of constructive processes which lead to the formation of novel mineral phases and support growth processes in organisms. Newly formed minerals and thriving biota associate to create a highly structured, porous natural body that serves as an efficient bioreactor for transformations of matter and energy. The temperature dependence of processes within the soil has lately received much attention, mainly because there is reason to expect a global feedback between rising atmospheric temperatures and the enhanced emission of radiatively active trace gases from the soil bioreactor.

While the fundamental temperature dependence of chemical reactions is well known, we find that research into the temperature dependence of organic matter decomposition has been skewed towards the biological reactions involved.

But does the temperature of the mineral phase matter for reaction rates? Very likely so, but little is known about the exact mechanisms that would operate or the potential quantitative relevance for the overall performance of the soil bioreactor. Here we present some results from a desorption experiment aimed at painting a very initial picture of thermal effects on mineral-organic associations. To this end, we examined the desorption behavior of 5 organic compounds (glucose, deoxyribose, peptide [PGG], lauryl sulfate and coniferyl alcohol) from a variety of mineral surface types, including a polished silica wafer, montmorillonite, kaolinite, birnessite, hematite and goethite. Laser Desorption Post Ionisation Mass Spectroscopy (LDPI-MS) was used to quantify the extent of desorption at 4°, 20°, 40° and 60°C and to determine variations in fragmentation patterns as a function of the mineralogy of the sorbent surface.

Our data confirm a variable temperature dependence of desorption rates for specific sorbate and sorbent combinations. We interpret our observations as an indication that the ability of the abiotic, "matrix" part of the soil bioreactor to release protected carbon may be affected by variations in temperature.