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Fungal alteration of organic coatings on sand grains

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We studied the fungal alteration of organically coated sand particles, sampled in Eocene sediments in the open cast mining Profen, near Leipzig (Germany). These organic coatings were formed on sand grains after their sedimentation owing to mobilization of organic matter from younger coal layers. The organic coatings formed non-continuous layers on quartz grains, measuring few micrometers up to 30 μm in thickness. It has been shown that organic coatings on sand grains retain efficiently dissolved metals by adsorption from groundwaters. They consequently might be used as adsorbent to purify low heavy metal contaminated water. However, their stability has not been assessed yet especially in the oxic environment and, more specifically, in the presence of microorganisms. This is important in order to evaluate whether coated sands could act as a reliable tool in remediation. In order to address this question we characterized the fungal alteration of organic coatings on sand grains using several techniques, including scanning electron microscopy (SEM), scanning transmission X-ray microscopy (STXM) and vertical scanning interferometry (VSI). Sand grains coated with organics were incubated on complex yeast medium with and without Schizophyllum commune to estimate changes in heavy metal retention. Formation of biominerals and etch pits is induced by fungal colonization as shown by SEM. Surface topography analysis was performed using VSI technique. Etch pit depth ranges from 0.5 to 1 μm. Pit formation is limited to the organic coating; dissolution of quartz grains was not detected. Using STXM we measured near-edge X-ray absorption fine structure (NEXAFS) spectra at the C K-edge, N-edge, and O K-edge to characterize the different organic compartments (fungi, genuine organic coatings, altered organic coatings) down to the 25-nm scale. We observed in the spectra measured at the C K-edge on the altered organic coatings a decrease in aromatic and phenolic groups as well as an enrichment in amide-rich molecules compared to the genuine organic coatings. Our results suggest heterogeneous biodegradation of organic coatings on sand grains by fungal exudation. An important implication might be the overall decrease in metal retention potential of organically coated sand grains owing to the alteration processes by S. commune.