Microstructure of aged tar-oil contaminated soil

PAVEL IVANOV[1], KARIN EUSTERHUES[1], THOMAS RITSCHEL[1], THILO EICKHORST[2], ANNA GEORGIADIS[3], THILO RENNERT[3], KAI UWE TOTSCHE[1]

[1] Institut für Geowissenschaften, Friedrich-Schiller-Universität Jena, Burgweg 11 Jena, Germany; pavel.ivanov@uni-jena.de

[2] Fachbereich Biologie/Chemie, Universität Bremen, Leobener Str. 2 Bremen, Germany; eickh@uni-bremen.de

[3] Institut für Bodenkunde und Standortslehre, Universität Hohenheim, Schloss Hohenheim 1, Stuttgart, Germany; t.rennert@uni-hohenheim.de

Tar oil hydrocarbons (HC), the waste product of coal carbonization at manufactured gas plants, are important contaminants in Germany and other countries. Aged tar oil due to its chemical composition is considered as toxic and hardly biodegradable. However, our investigation at one of the contaminated sites proved the presence of active microbial consortia with cell counts 2-3 times higher than those of the uncontaminated soil. We assume that the long-term-exposure at the site resulted in the adaptation of the specialized microbial community that utilize tar-oil borne HC as major carbon sources. To better understand and promote the ongoing remediation, we aimed at visualizing the spatial distribution of the contaminant and microbes within the soil structure.

We studied the microstructure of tar-oil contaminated soil on thin sections with a combination of light- and FTIR microscopy. This approach allowed to map soil microstructure to distinguish between mineral aggregates, pores, contaminant, plant tissue, and newly formed organic matter at a spatial resolution of 10 µm. The data showed that in the most contaminated layers, some aggregates were enriched in tar oil while others remained uncontaminated. At some spots, the oil-bearing aggregates were associated with newly-formed organic matter, which indicated bioremediation. In the layers below the contamination, root channels and macropores were coated with tar oil, suggesting that they acted as preferential pathways for contaminant transport.

Contaminated layers were found to be enriched in total Fe, as well as dithionite- and oxalate-extractable Fe. Several large siderite crystals were diagnosed by microscopy. We attribute this to the presence of oxic and anoxic microsites within the contaminated soil, where complementary biotic attenuation processes might occur.