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Characterisation of DOC and its relation to the deep terrestrial biosphere

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The deep subsurface is populated by a large number of microorganisms playing a pivotal role in the carbon cycling. The question arises as to the origin of the potential carbon sources that support deep microbial communities and their possible interactions within the deep subsurface. As the carbon sources need to be dissolved in formation fluids to become available to microorganisms, the dissolved organic carbon (DOC) needs further characterisation as regards concentration, structural as well as molecular composition and origin.

The Malm carbonates in the Molasse basin of southern Germany are of large economic potential as they are targets for both hydrocarbon and geothermal exploration (ANDREWS et al., 1987). Five locations that differ in their depth of the Malm aquifer between 220 m and 3445 m below surface have been selected for fluid sampling. The concentration and the isotopic composition of the DOC have been determined. To get a better insight into the structural composition of the DOC, we also applied size exclusion chromatography and quantified the amount of low molecular weight organic acids (LMWOA) by ion chromatography. With increasing depth of the aquifer the formation fluids show increasing salinity as chloride concentrations increase from 2 to 300 mg/l and also the composition of the DOC changes. Water samples from greater depth (>3000 m) showed that the DOC mainly consists of LMWOA (max. 83 %) and low percentages of neutral compounds (alcohols, aldehyde, ketones, amino acids) as well as "building blocks". Building blocks have been described to be the oxidation intermediates from humic substances to LMWOA. With decreasing depth of the aquifer, the DOC of the fluid becomes increasingly dominated by neutral compounds and the percentage of building blocks increases to around 27%. The fluid sample from 220 m depth still contains a small amount of humic substances.

The DOC of formation fluids in some terrestrial sediments may originate from organic-rich layers like coals and source rocks which may provide carbon sources for the deep biosphere by leaching water soluble organic compounds. We investigated the potential of a series of Eocene-Pleistocene coals, mudstones and sandstones from New Zealand with different maturities (Ro between 0.29 and 0.39) and total organic carbon content (TOC) regarding their potential to release such compounds. The water extraction of these New Zealand coals using Soxhlet apparatus resulted in yields of LMWOA that may feed the local deep terrestrial biosphere over geological periods of time (VIETH et al., 2008). However, the DOC of the water extracts mainly consisted of humic substances. To investigate the effect of thermal maturity of the organic matter as well as the effect of the organic matter type on the extraction yields, we examined additional coal samples (Ro between 0.29 and 0.80) and source rock samples from low to medium maturity (Ro between 0.3 to 1.1).

Within our presentation we would like to show the compositional diversity and variability of dissolved organic compounds in natural formation fluids as well as in water extracts from a series of very different lithologies and discuss their effects on the carbon cycling in the deep terrestrial subsurface.

References:

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