Characterization of indigenous oil field microorganisms for microbially enhanced oil recovery (MEOR)

J.SITTE[1], E. BIEGEL[2], A. HEROLD[2], H. ALKAN[3] AND M. KRÜGER[1]

[1] BGR, Geomicrobiologie, D-30655 Hannover
[2] BASF SE, GVF/H, D-67056 Ludwigshafen
[3] Wintershall Holding GmbH, R&D, D-34119 Kassel

Microbial activities and their resulting metabolites became a focus of attention for enhanced oil recovery (MEOR, microbial enhanced oil recovery) in the recent years. In order to develop a strategy for a MEOR application in a German oil field operated by Wintershall experiments were performed to investigate different sampling strategies and the microbial communities found in these samples. The objectives of this study were (1) to characterize the indigenous microbial communities, (2) to investigate the dependency of microbial activity/diversity on the different sampling strategies, and (3) to study the influence of the *in situ* pressure on bacterial growth and metabolite production. Fluids were sampled at the well head (surface) and *in situ* in approx. 785 m depth to collect uncontaminated production water directly from the reservoir horizon and under the *in situ* pressure of 31 bar (subsurface). In the lab the pressure was either released quickly or slowly to assess the sensitivity of microorganisms to rapid pressure changes. Quantitative PCR resulted in higher microbial cell numbers in the subsurface than in the surface sample. Biogenic CO_2 and CH_4 formation rates were determined under atmospheric and high pressure conditions in the original fluids, with highest rates found in the surface fluid. Interestingly, no methane was formed in the native fluid samples. While nitrate reduction was exclusively detected in the surface samples, sulfide formation also occurred in the subsurface fluids. Increased CO_2 formation was measured after addition of a variety of substrates in the surface fluids, while only fructose and glucose showed a stimulating effect on CO_2 production for the subsurface sample. Stable enrichment cultures were obtained in complex medium inoculated with the subsurface fluid, both under atmospheric and *in situ* pressure. Growth experiments with constant or changing pressure, and subsequent DGGE analysis of bacterial 16S rRNA genes, revealed that the pressure treatment did not affect the bacterial community composition. Our results show that bacteria in the enrichment culture can tolerate pressure changes between atmospheric and *in situ* reservoir pressure, which makes them promising candidates for further MEOR tests. Since substantial differences in microbial activities were observed between the surface and subsurface fluids, the selection of the sampling strategy should also be considered for MEOR research and industrial application.

Uranium accumulation by plants covering piles and dumps in uranium post-mining area in SW Poland

A. SKLODOWSKA[1]*, D. LECH[2] AND D. RUSZKOWSKI [1]

[1]Faculty of Biology, University of Warsaw, Miecznikowa 1, 02-096 Warsaw, Poland; (*correspondence: asklodowska@biol.uw.edu.pl)
[2]Polish Geological Institute, 4, Rakowiecka Street, 00-975 Warsaw, Poland (dariusz.lech@pgi.gov.pl)

The uranium exploration and exploitation in the South-West Poland (Lower Silesia District) had been carried out since 1925 when the first 9 Mg of uranium ore were mined from which 690 mg of radium was extracted and the mining ceased in 1962 (total amount of 704 Mg of U was derived). Nevertheless the old subsurface mines, piles and dumps are still involved in the geochemical cycle of the area. Leaching of uranium and radionuclides may be a serious environmental problem in many countries.

Investigations of the influence of mining activity on the natural environment revealed the local-scale radioactive contamination limited to the dumps and their nearest vicinity at four localities: Kowary-Podgorze, Radoniow, Kopaniec/Kromnow and Grzmiaca. Standard ecological test "MARA" performed on 54 samples of wastes and water taken in 15 localities showed moderate toxicity in 5 waste samples and 1 water sample. Another standard test MicroTox showed minor toxicity in 2 waste samples and did not show ecotoxicity of any water sample.

Accumulation of uranium by plants covering the surface of 5 piles containing the most radioactive wastes (dose 1.94-97μSv/h) was examined. Grasses were found as hyper-accumulator of uranium in all examined places. Maximum uranium concentration 817.15mg/kg d.w. was noted in the roots of fescue (*Festuca* sp.) growing in Kopaniec pile and 178.85 mg/kg d.w. in the roots of meadow grass (*Poa* sp.) growing in Grzmiaca. Aerial parts of these plants contained 10-20 lower concentration of uranium. Dicotyledonous plants accumulate uranium in the roots up to 196.22 mg/kg d.w. and in leaf up to 138.56 mg/kg d.w. (hawkweed in Kopaniec). Hyper accumulation of uranium was noted in mosses (mainly in *Hypnum cupressiforme*) occurring in streams in the nearest vicinity of piles (up to 700mg/kg d.w. in Kowary).

These results clearly show that plants actively participate in uranium geochemical cycling what is important factor in environmental risk assessment and may be valuable indication for planning remediation processes.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.19