Chemical compound classes supporting microbial methanogenesis in coal

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Microbial generation of coalbed methane (CBM) occurs in numerous basins worldwide. This study aims to identify specific classes of chemical compounds in coals from the Illinois Basin in southwestern Indiana that are degraded during methanogenesis. Springfield (SPR) coal is rich in vitrinite and Lower Block Coal (LBC) coal has greater liptinite and inertinite contributions. Anaerobic bioreactors contained a mineral-salts medium, operationally-defined coal extracts and a microbial inoculum obtained anoxically via filtration of formation water from a CBM-producing well. Our experiments investigated methanogenesis and concurrent degradation of organic matter (OM) using H2O-, CH3OH-, and CH2Cl2-soluble fractions of extractable OM from coal as the sole carbon source. This approach allowed us to trace specific molecular changes in the OM during methanogenesis. GC/MS and FTIR techniques were employed to compare the molecular composition of the initial organic extracts with their biodegraded residues.

Periodic GC-FID methane measurements over several months revealed greater CH₄ generation in reactors containing extracts from SPR coal, and slightly more CH₄ produced from CH₃OH-extracts than from CH₂Cl₂ (DCM) extracts. Inoculated controls containing H2:CO2 or acetate instead of coal extracts showed significant methanogenesis indicating that a viable inoculum was used in all reactors. GC/MS characterization of organic extracts enabled assessment of the occurrence and distribution of constituent n-alkanes, acyclic isoprenoid alkanes, hopanes in higher abundance than steranes, methylphenanthrenes, phenanthrene, anthracene, fluoranthene, and pyrene in the non-polar fraction, as well as carboxylic acids in the polar fraction. FTIR results showed higher aromaticity and presence of longer aliphatic chains in DCM extracts than in methanol extracts. The expected greater biodegradability of lower-MW compounds with lesser aromaticity might explain greater CH₄ production in the reactors containing methanol extracts. Continued analysis through June 2011 is expected to result in diagnostic changes in molecular composition, most likely affecting n-alkanes and possibly some aromatics.

Different types of Precambrian ophiolites

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Phanerozoic ophiolites are classified into subductionrelated and unrelated types based on their tectonic and geochemical association with palaeo-subduction zones [1]. These two main types are further subdivided into several subtypes that exhibit different crustal architecture and igneous stratigraphy, with or without a sheeted dike complex. The geochemistry of the lavas and/or dikes of the two main types show pronounced differences in the concentration of elements that are sensitive to subduction processes (Cs. Pb. Rb. K. Ba. Th, U and LREE), and thus define contrasting patterns with respect to element-element -, element ratio -, and multielement diagrams. We apply this new ophiolite classification to some of the well-preserved Precambrian greenstone belts, ranging in age from ca. 2.0 - 3.8 Ga. The metabasalts of the Isua (Greenland) and Barberton (South Africa) greenstone belts, 3.8 and 3.5 Ga, respectively, show geochemical signatures comparable with those of the best-documented Phanerozoic suprasubduction-zone ophiolites. The 2.7 Ga Wawa greenstone belt (Superior Province, Canada) and the 1.95 Ga Jormua Complex (Finland), on the other hand, display subduction-unrelated geochemical patterns, and are classified as plume- and continental margin type ophiolites, respectively. This approach to identifying Precambrian ophiolites with their distinct geochemical and tectonic fingerprints can be used effectively to decipher the geodynamic setting of the formation of ancient oceanic crust during the geological evolution of the greenstone belts.

[1] Dilek & Furnes (2011) GSA Bull 123, 387-411.

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