Effect of bituminous coal on methanogenesis

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Methane with a biogenic stable isotope signature and associated with groundwater recharge has been found in numerous coal seams globally.[1] The spatial distribution of biogenic gas within basins is likely related to sterilisation and then re-innoculation of coal seams, as well as groundwater salinity. We conducted batch experiments with a microbial community sourced from a Bowen Basin (Queensland, Australia) underground coal mine[2] and pure cultures of methanogens to determine the effect of coal on growth with methanogenic substrates, either a headspace of H_2/CO_2 (80:20) or acetate (10 mM) in the medium.

With a complete microbial community, acetoclastic methanogenesis was stimulated by the presence of coal, suggesting a syntrophic methanogen-bacteria partnership was important. In the presence of a low concentration of coal (1 g into 25 ml medium), methane production by *Methanococcus* sp. was slightly inhibited at the start of growth whereas methane production by *Methanosarcina barkeri* was not affected. In contrast, at a 1:1 volumetric ratio of coal to medium, methane production in both pure cultures was completely inhibited. Using a scanning electron microscope, cells were observed to be associated with clay particles in the coal, particularly in the *Methanococcus* sp. culture. Bitumens adsorbed to the clay particles and the dissolution of hydrocarbons into the medium may be responsible for the inhibition of methanogenesis.

This experiment demonstrates that the laboratory conditions of coal-microbe batch experiments may be under estimating the inhibitory effect of coal. If inhibition of microbial growth is occurring in coal seams, the removal of inhibitory compounds by groundwater recharge may allow for increased biogenic methane production from coal.

[1] Golding, Boreham & Esterle (2013), *International Journal of Coal Geology* 120, 24-40.
[2] Raudsepp, Gagen, Evans, Tyson, Golding & Southam (2016), *Geobiology* 14, 163-175.