Coal: gas sorption, swelling and small angle neutron scattering

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One option for storing carbon dioxide away from the atmosphere that has recently been proposed is to inject it into unmineable coal seams, because of coal's high affinity for carbon dioxide. This option has led to a flurry of investigation into the high-pressure sorption behaviour of coals. Yet several issues remain to be resolved. Coal swells when exposed to gases such as CO_2, CH_4 and even nitrogen; this will reduce the permeability of the coal seam and hence limit injection rates by an amount difficult to predict. Moisture, prevalent in coal seams, influences both gas sorption and swelling of coals, but quantitation of its effect is not straightforward.

Even fundamental issues as to the nature of supercritical gas sorption are not resolved: which pores are the most effective in sorbing the gas, is sorption mono- or multi-layer or more accurately described by porefilling models, and by what extent is CO_2 densified at the coal surface? Small angle scattering studies using X-rays and neutrons are well situated to answer these questions about the nature of sorption, especially because SANS and SAXS of coals exposed to high (60 MPa) pressures of gases is experimentally feasible, has been performed and can measure any sorption by pores of less than 0.5nm diameter.

In this presentation I will draw together the results of recent studies of high pressure gas sorption on coals and how small angle neutron scattering (SANS) of materials exposed to high pressures of gases can help determine the nature of sorption in coals (and sorption onto surfaces generally).

Quantitative studies on the relationship between surface roughness and bacterial adhesion

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Bacterial adhesion, the formation of biofilms and the release of metabolic byproducts can all lead to the mobilization of elements that alter the chemistry of the surrounding fluid, and in turn impact mineral dissolution rates [1,2]. A great deal of attention has been given to understanding genesis and growth of biofilms on both organic and inorganic substrates [3,4]. However, while the focus has remained on the biological characteristics of bacterial colonization, less attention has been given to the physical properties of the host substrate [5]. Although some qualitative work has been done identifying features such as surface roughness as physical properties important to bacterial adhesion [6], there is little quantitative understanding concerning the physical properties of a surface that influence bacterial adhesion and biofilm formation, and how these activities alter the dissolution kinetics of minerals. This lack of understanding handicaps the evaluation of the general effect of microbial populations on natural and synthetic surfaces, as well as specific attempts to control bacteria in some strategic manner, e.g., recovery enhancement for hydrocarbon reservoirs and infectious disease pathogenesis. Here we present data about the adsorption density of bacteria as a function of fluid flow velocity (Peclet number) as well as well-defined roughness range variations.

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