A natural analogue in Southwest Wyoming for geologic co-sequestration of carbon & sulfur

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Geologic sequestration of CO_2 generated by coal-fired power plants is a critical component of carbon capture and storage. Emissions from coal-fired power plants contain sulfur as well as CO_2, thus successful capture and storage of anthropogenic CO_2 may require an understanding of geologic carbon-sulfur co-sequestration. The Mississippian Madison Limestone on the Moxa Arch, a major north-south trending anticline located in southwest Wyoming, USA, contains large amounts of supercritical CO_2 that it has stored naturally for millions of years, supercritical H_2S, aqueous sulfur complexes (SO_4^{2-} and HS^-), and sulfur-bearing minerals (anhydrite, pyrite, and native sulfur). A simple equilibrium geochemical model of the Madison Limestone was constructed using mineralogic data obtained from well core and published aqueous analyses to simulate reactions among supercritical CO_2, sulfur-bearing and accessory aluminosilicate minerals, and resident brine. The model accurately predicts crystallization of analcime, feldspar, and illite whereas dawsonite ($NaAlCO_3$ $(OH)_2$), an important carbon sink in numerous sequestration modeling studies, does not occur in the Madison Limestone and was not predicted by the model. CO_2-brine-rock reactions in the model Madison Limestone-fluid system decrease pH, from 6.4 to 4.0, as expected from dissolution of supercritical CO_2 and dissociation of carbonic acid. Redox potential increased from -0.26 to -0.06 volts due to equilibrium among CO_2, anhydrite, and pyrite. Final Eh-pH conditions correctly predict the coexisting H_2S, aqueous SO_4^{2-}, anhydrite, pyrite, and native sulfur observed in produced waters and well core. The Madison Limestone serves as a natural example of the thermodynamic end point that similar fluid-rock systems will develop following emplacement of a supercritical CO_2-sulfur mixture and is a natural analogue for geologic carbon-sulfur co-sequestration.

Coalbed Natural Gas (CBNG) produced water: Geochemistry and water quality

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The CBNG extraction is facilitated by pumping water from the aquifer. The majority of CBNG produced water is discharged into disposal ponds. Water samples from outfalls and corresponding disposal ponds in Cheyenne River (CHR), Belle Fourche River (BFR), Little Powder River (LPR), Powder River (PR), and Tongue River (TR) within the Powder River Basin (PRB) were collected over a period of 10 years. CBNG produced samples were monitored pH, electrical conductivity (EC), major elements [e.g. calcium (Ca), magnesium (Mg), sodium (Na), alkalinity], trace elements [e.g. iron (Fe), aluminium (Al), barium (Ba), arsenic (As), selenium (Se)]. From Na, Ca, and Mg measurements, sodium adsorption ratios (SAR) were calculated. Results suggest that Na, alkalinity, and pH all tend to increase, possibly due to environmental factors such as evaporation, while Ca decreased from outfalls to corresponding disposal ponds due to calcite precipitation. Trace elements concentrations in both outfalls and disposal ponds were low, however an increasing trend was observed in disposal ponds (see fig. 1). Overall, these results are useful to develop management approaches for CBNG produced water and reclamation of disposal ponds [1].

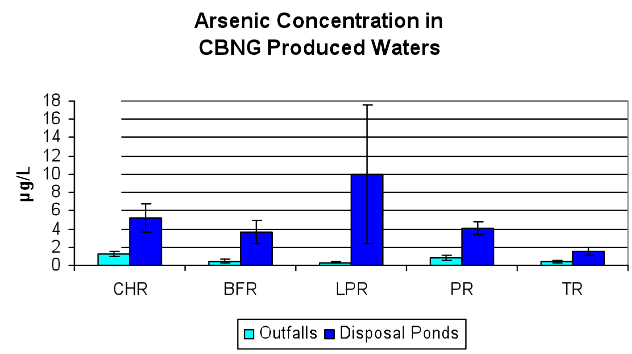

Figure 1. Dissolved arsenic concentration in CBNG outfalls and disposal ponds.

[1] Reddy, K.J (ed.) (2010) *Coalbed Natural Gas: Energy & Environment,* Nova Science Publishers, Inc. Hauppauge, NY **11788**, ~pp200.