Potential dissolution of sandstone in the presence of supercritical CO_2-H_2S-H_2O: An experimental and geochemical modelling approach

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Introduction

The high monetary and energy costs associated with the production of pure CO_2, for storage has necessitated the need for consideration of waste stream with some impurities (e.g. H_2S, SO_x, NO_x). However, little knowledge exists on the geochemical impact of these gas mixtures when injected into geological formations for the long term geological storage of CO_2. We report results from initial experiments that have been conducted with pure CO_2 as base cases with which to compare subsequent experiments involving impurities. The experiments investigated the reaction of Permo-Triassic sandstones (the on-shore equivalent of a North Sea reservoir rock) with brine in the presence of supercritical CO_2. Experiments were conducted over 3-6 months using 0.5 M NaCl solution at 70°C and 200 bar pressure, conditions typical of many potential CO_2 geologic storage sites. Modelling of the experimental systems was also carried out using PHREEQC. Figure 1 below shows the schematic content of pressure vessel used for laboratory batch experiments.

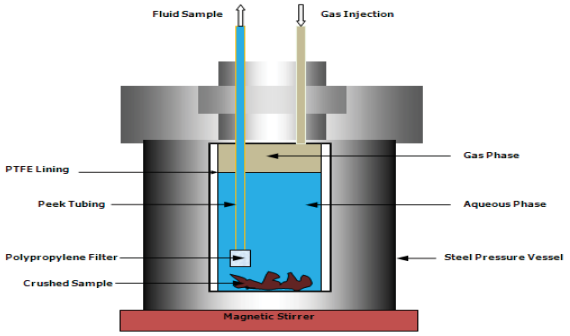

Figure 1: Schematic of pressure vessel

Results and Conclusions

Increasing concentrations of Mg, Ca and K were observed in the experiments over time. Mineralogical analyses and mass balance calculations for reacted and un-reacted rock samples, indicate that increases of Mg and Ca may be explained by dissolution of carbonate minerals such as calcite and dolomite, possibly followed by slight dissolution or ion-exchange with clay minerals. K concentrations are possibly governed by dissolution of trace halide minerals. In non-reactive 'control' experiments representing only the fluid-rock system equilibration using N_2 gas as the pressurising fluid, concentrations of the same elements were much lower.

PHREEQC modelling utilised rates of mineral dissolution and precipitation from the literature. Longer-term trends in observed solution chemistry could be modelled, if some assumptions about reactive surface areas were made. However, the model could not account for observed decreases in concentration of dissolved elements such as Al and Fe. Work is in progress to account for these changes and will be presented at the conference. Preliminary results from on-going experiments involving fluid-rock-CO_2 reaction in the presence of impurities (particularly H_2S) will also be presented.

Use of vegetation, soil, and radiometric survey to locate areas of concealed uranium mineralization at the Jacques Lake area, Labrador.

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Abstract

We applied biogeochemical analysis of black spruce twigs, bark, and Labrador tea shoots with soil geochemistry, and an air-borne magnetic and radiometric survey to delineate areas of uranium enrichment at the Jacques Lake prospect of the Central Mineral Belt, Labrador, Canada. This area is overlain by thick layers of glacial till and peat which effectively obscure the direct observation of mineralized outcrops and accompanying alteration haloes. The topography is rugged with dense coniferous forest cover, lacks access roads, and is characterized by long and extreme winter weather conditions with very high precipitation. Biogeochemical signatures from black spruce twigs show elevated concentrations of U and pathfinder elements Be, Ag, Pb, and Sb over mineralized areas. A PCA plot of the data discriminated the bedrock mineralization with good anomaly contrast for uranium and related pathfinder elements (Be, Ag, Sb, V and Pb). Bark samples of black spruce generally showed weak to moderate anomaly contrasts. Labrador Tea leaves and stems defined very low anomalies or none at all; and possibly attributable to the shallow root system of the shrub. There is metal enrichment and an expression of the bedrock mineralization in the B-horizon soil. The distribution of U, Sb, Cu, Pb and to a less extent V in the soil exhibit anomalous signatures that may reflect a primary mineralized halo associated with the Jacque's Lake U prospect. Uranium concentrations (mixed acid digest) in soil ranged from 0.01 – 867 ppm. Areas of anomalous U concentration in B-horizon soils coincide with the airborne magnetic and radiometric and black spruce twig uranium anomalies that defined the Jacque's Lake deposit.