

18.03

Spent shale formations: Potential source for CO₂ sequestration

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When producing oil from shale in-situ, the shale is retorted in the geological formation without mining to the surface. The objective of the current study is to explore the possibility of using the (spent) shale repository as a potential source for geological sequestration of CO₂. Shale samples retorted at different temperatures were used for this study. We specifically address the problem of the response of different initial mineral matrices and unreacted organic components to CO₂ injection. The experimental apparatus consists of a series of four isolated high-pressure reactors operated at different conditions with pure CO₂ as feed gas at different temperatures. Initial XRD analysis of the raw and spent shale samples from Green River formation reveal carbonates, quartz and feldspars as the principal inorganic components. Nitro-calcite, calcite, and dolomite constitute the carbonate sections in the shale and microcline (K-feldspar) and plagioclase feldspar make up the silicate section. Kaolinite is also present in significant portions and silica is mainly present as quartz. SEM analysis of the reacted spent shale sample at 100°C reveal precipitation of calcite, magnesite and also possibly dolomite. Carbonation of feldspars was also observed leading to precipitation of the carbonates with the respective principal ions. These changes in rock mineralogy are complemented by the changes in brine chemistry. Base case kinetic models were developed using Geo-Chemists Work Bench (GWB). The results from these models indicate a much more rapid pace of sequestration reactions when compared to experiments. Thus this study provides useful laboratory data (with model comparisons) when considering CO₂ sequestration in different spent shale repositories.