Element mobilization from interaction of fracking fluids with Bowland Shale (UK)

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Shale gas has the potential to provide greater energy security, growth and jobs, but there are associated environmental concerns. Shale gas is an unconventional hydrocarbon resource trapped within low permeability rocks. It is exploited by hydraulic fracturing (also called fracking), whereby an engineered fluid composed of water, proppants and chemical additives is injected under high pressure into a horizontal well to initiate small fractures into the shale formation. The generated fractures act then as pathways for gas to move from the shale to the production well. Hydraulic fracturing calls for wastewater management, since produced water can contain high total dissolved solids, challenging for fluid treatment and reuse.

To ensure safe and environmentally sound exploitation of shale gas, we need to better understand shale-bound element mobilization. The current study focuses on evaluating the impact of fluid acidity, type of acid, and redox conditions on element mobilization during interaction of simulated fracturing fluids with organic-rich Carboniferous Bowland Shale samples. The mineralogy of the samples reveal high concentrations of quartz and calcite, and some pyrite, dolomite and clays, through powder X-ray diffraction and mineral liberation analyses. Fluid-rock batch reactor experiments demonstrate fast dissolution of calcite in the samples, and a positive correlation between the amount of calcite dissolved and both, fluid acidity (HCl concentration) and temperature. In contrast, Mg is only slowly released over time in the slightly acidic (HCl) fluids. Fluids with citric acid cause dissolution of pyrite, releasing iron and sulphur in solution. The experiments also show that more oxidative conditions favour more Mg release from the rocks, as well as more Cr release and more pyrite dissolution. No mobilization of elements at hazardous levels have been identified in these 95-hour long batch experiments with 1/100 rock-fluid ratio.

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