

Reaction of Bunter Sandstone with CO₂ and gaseous impurities (NO₂, H₂S, SO₂) - implications for CCS

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Carbon dioxide capture and storage (CCS) is regarded as a key technology for the reduction of CO₂ emissions from power plants and other industrial facilities at the European and international level. This experimental study provides data from experiments lasting approximately 3 and 9 months, designed to evaluate the chemical processes occurring in the storage formation. In particular, the effects of impurities (NO₂, SO₂, H₂S), representing some of the trace impurities that may be present in an injected CO₂ stream, depending upon the method of CO₂ capture (i.e. pre- versus post-combustion), were investigated.

A series of experiments were conducted using samples of Bunter Sandstone interval of UK sector North Sea. These were reacted at 140 bar (14 MPa), and 70°C, with and without added NO₂, SO₂, H₂S to assess the impact of these impurities.

In all the experiments containing impurities, and for the CO₂-only experiments, carbonate dissolution is the dominant early reaction with steady state conditions being achieved after about 500 hours reaction. In most cases the addition of the acid gas impurities resulted in enhanced dissolution of the silicates, as indicated by the changes in fluid chemistry but the levels of dissolution were too small to produce unequivocal evidence in the mineralogical analysis. When H₂S was present there was some evidence for the formation of Fe+S bearing secondary phases. In general, the addition of NO₂ had a slight increase in reaction followed by H₂S and the greatest changes were seen in the addition of SO₂.

Overall, the addition of the acidic impurities (NO₂, H₂S, or SO₂) resulted in slightly enhanced dissolution of the sandstone which was dominated by changes due to the acidification of the fluids and the subsequent dissolution of carbonates with the release to solution of Ca and associated elements present in the carbonates. Levels of (alumino)silicate dissolution were, within the timeframe of these experiments, probably too small to significantly affect the integrity of the sandstone, though dissolution of the carbonates could have an impact on sandstones that were weakly cemented by carbonates.