OR/12/023 Introduction

Wragg, J, Rushton, J, Bateman, K, Green, K, Harrison, H, Wagner, D, Milodowski, A E, and West, J M. 2012. Microbial Impacts of CO2 transport in Sherwood Sandstone. *British Geological Survey Internal Report*, OR/12/023.

The success of carbon capture and storage (CCS) projects depend on the ability of storage sites to contain CO_2 thus mitigating release to the atmosphere. However, concerns about the technology have been raised in many countries and have resulted in difficulties in implementing projects (e.g. onshore storage projects in the Netherlands). These concerns usually focus on the effects of possible leakages from storage sites and the potential large-scale environmental consequences of CCS. To date, studies have focused on the physical and chemical impact of CO_2 in stable geological formations, with associated monitoring systems to assure that no significant leakage occurs to the surface. If leakage was to occur after formal closure of the injection site, this could be over small areas from discrete point sources, such as abandoned wells, resulting in locally high concentrations of CO_2 in near-surface ecosystems. Consequently, environmental impacts of localised elevated CO_2 on terrestrial and marine ecosystems are areas of active research (e.g. West et al, 2006[1]; Beaubien et al, 2008[2]; Maul et al, 2009[3]; Krüger et al, 2009[4]; 2011[5]). However a CO_2 storage site could also directly impact deep subsurface microbial ecosystems and biogeochemical processes.

It is well recognised that microbes can live in a wide range of subsurface environments where they have limited nutrient and energy supplies and exhibit very low metabolic rates (e.g. Lin et al, 2006[6]; D'Hondt et al, 2002[7]; West and Chilton, 1997[8]). Thus it is almost certain that microbes will be found at depths considered for CO_2 storage and, consequently, that CO_2 storage sites may contain microbes that could be affected by injected CO_2 and any associated impurities such as NO_x, SO_x and H_2S. Whilst it is extremely unlikely that microbes could survive exposure to super-critical CO_2, many will survive and thrive in contact with the gas or dissolved phases (Morozova et al, 2010[9]). The resulting impacts of microbial activity from these reactions could be both physical (e.g. altering porosity through the production of biofilms — Coombs et al, 2010[10]) and chemical (e.g. changing pH, redox conditions) and may result in intracellular or extracellular mineral formation or degradation (Ehrlich, 1999; Milodowski et al, 1990[11]; Mitchell et al, 2009[12]; Tuck et al, 2006[13]). These processes could all directly impact on the physical transport of CO_2 and/or impurities (as a gas or dissolved in fluid) through fractures and porous media. They could also have significant implications for groundwater quality, in terms of acidification and possible dissolution of minerals and mobilisation of elements (Kharaka et al, 2006[14]), many of these reactions being known to be microbially catalysed (West et al, 2011[15]). The potential role of microbes in CO_2 storage was described by West et al, (2011)[15] and has been identified by the Risk Assessment network of the International Energy Agency Greenhouse Gas Research and Development programme (IEA-GHG, June 2011) as an area that needs to be addressed (IEA-GHG report in preparation).

Work carried out by BGS and the Japan Atomic Energy Authority (JAEA), using BGS in-house developed apparatus, has shown that microbial processes can have profound effects on the transport properties of host rock (i.e. the movement of fluids and contaminants through the host material) relevant to radioactive waste disposal (Harrison et al, 2011[16]). Recent research, performed as part of the BGS Radtran project, has examined Sherwood Sandstone samples in the context of radioactive waste disposal has also shown similar effects on the transport properties of this formation (Wragg et al, 2012[17]). This particular formation is also a potential reservoir for CO_2 storage in the UK.

As a result of these findings, a pilot study was set up to evaluate, for the first time, the interactions between fluids saturated with CO_2, Sherwood Sandstone and the microbe *(Pseudomonas aeruginosa)* in transport experiments, using the BGS Biological Flow Apparatus (BFA) under pressurised subsurface conditions. This report details the results from these experiments.

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