Geophysical Research Abstracts
Vol. 12, EGU2010-9070-1, 2010
EGU General Assembly 2010

The fractionation of Fe and Cu between brine and CO_2 at up to 130 °C and 8.4 MPa, with implications for metal mobilization in CO_2 storage reservoirs

Kirsten U. Rempel (1,2), Axel Liebscher (1,3), Georg Schettler (1,4), Wilhelm Heinrich (1,5)

(1) GFZ German Research Centre for Geosciences, (2) rempel@gfz-potsdam.de, (3) alieb@gfz-potsdam.de, (4) schet@gfz-potsdam.de, (5) whsati@gfz-potsdam.de

In order to better understand the long-term effects of CO_2 storage in saline aquifers, there has been increasing interest in the mobilization of metals in brine-CO_2 systems, in the context of both permanent mineral trapping and the potential spreading of contaminants. Owing to the fact that the brine is a stronger solvent than $CO_2$for polar metal complexes, previous studies have focused primarily on brine-reservoir rock interactions (e.g., Gunter et al., 1997; Wigand et al., 2008), and the role of CO_2 as a separate solvent has yet to be considered. While CO_2 may not be a strong solvent, even ppm-level metal concentrations represent a considerable amount of mobilization in reservoirs that are host to millions of tonnes of CO_2, so a quantitative evaluation of this process is desirable.

To this end, we have conducted an experimental investigation of vapour-liquid equilibria in the systems $FeCl_3$-NaCl-CO_2-H_2O and $CuCl_2$-NaCl-CO_2-H_2O at 60-130˚C and 6.5-8.5 MPa. The experiments were carried out in a large-volume autoclave loaded with a solution containing 20 wt% NaCl and either 100 ppm Fe or 1000 ppm Cu, as well as pressurized CO_2. Paired samples of brine and CO_2 were extracted from separate capillary lines at successive pressure-temperature intervals, and analyzed for Fe and Cu using ICP-AES. The CO_2 samples were found to contain concentrations of 0.5 to 2.0 ppm Fe and 0.5 to 6.7 ppm Cu, which generally displayed a positive correlation with fluid density. Given the relatively small degree of metal fractionation into the CO_2 as compared to the brine, the concentrations in the brines remained constant at 100 ppm Fe and 1000 ppm Cu. From these data, it can be seen that the Fe and Cu concentrations in the CO_2 are approximately 1% and 0.1% of those in the brine, respectively.

Considering the metal concentrations typical to brines that have reacted with CO_2 and sandstone (20-200 ppm Fe, 1 ppm Cu; e.g., Gunter et al., 1997; Wigand et al., 2008), these results suggest that a plume of injected CO_2 could contain up to 0.2-2 ppm Fe and 0.001 ppm Cu. At a hypothetical injection site used to store 10 Mt of CO_2, this would lead to the mobilization of 20 t of Fe and 0.01 t of Cu. Further, as the dissolution of Fe and Cu is chemically similar to that of other metals such as Pb and Zn, the relocation of significant quantities of additional metals may also be expected. The potential consequences of these results for long-term CO_2 storage include the precipitation of metal carbonate minerals in shallower, more distal regions of the aquifer and the transferral of metals to adjacent aquifer systems.

References

Gunter, W.D., Wiwchar, B. and Perkins, E.H. (1997) Aquifer disposal of CO_2-rich greenhouse gases: extension of the time scale of experiment for CO_2-sequestering reactions by geochemical modelling. *Miner. Petrol.* 59, 121-140.

Wigand, M., Carey, J.W., Schütt, H., Spangenberg, E. and Erzinger, J. (2008) Geochemical effects of CO_2 sequestration in sandstones under simulated in situ conditions of deep saline aquifers. *Appl. Geochem.* 23, 2735-2745.