

Mineral alterations due to accessory gases in the geological storage of CO₂

K. HEESCHEN*, A. RISSE, S. STADLER AND
C. OSTERTAG-HENNING

Federal Institute for Geosciences and Natural Resources
(BGR), D-30655 Hannover, Germany
(*correspondence: Katja.Heeschen@bgr.de)

To establish reliable numerical models that depict the geochemical processes caused by the storage of CO₂ in saline aquifers it is essential to have an applicable database. This has to include thermodynamic properties and kinetic data of those gas mixtures occurring in the captured CO₂ gas stream, which will contain minor amounts of gases such as O₂, N₂, NO_x, SO_x, CO, H₂S. However, quantitative measures of the chemical alterations due to these accessory gases are scarce at relevant conditions.

The COORAL project “CO₂ Purity for Capture and Storage”, concentrates on the effects of accessory gases during all four processes: capture, transport, injection and storage. At BGR it is the storage that is in focus. High-pressure-high-temperature (HPHT) experiments are carried out using unstirred batch-reactor systems ($P \leq 590$ bar; $T \leq 350^\circ\text{C}$) to elucidate mineral and fluid alterations and quantify kinetic rates for different mineral–fluid–CO₂–co-injected gas system.

A first set of experiments using pure CO₂ and carbonates allowed testing the laboratory set-up and adjusting the modelling environment (PHREEQC). Dolomite-brine-CO₂ experiments exhibited a very good reproducibility of the increase in cation concentrations at the different stages of the experiment. Release rates for both, Mg and Ca, vary between $2 \cdot 10^{-10}$ mol s⁻¹ cm² at the very beginning and $4 \cdot 10^{-13}$ mol s⁻¹ cm² just before approaching steady state. There is a tendency towards slightly higher rates for Ca release during the first stage of the experiment.

The main target of the running experiments is set on the effects of binary gas mixtures in the system mineral–fluid–CO₂–O₂ (this contribution) and mineral–fluid–CO₂–SO₂ [1]. The mineral phase consists of carefully crushed, sorted and cleaned natural mono-minerals while the natural saline water is represented by a Na-Cl solution of 150 g/l NaCl in most cases.

[1] Risse *et al.* (2011), *MinMag*, this volume.

Comparison of land-based REE ore deposits with REE-rich marine Fe-Mn crusts and nodules

JAMES R. HEIN^{1*}, TRACEY CONRAD¹ AND
ANDREA KOSCHINSKY²

¹USGS, Menlo Park, CA, 94025, USA
(*correspondence: jhein@uss.gov)

²Jacobs University, Bremen, Germany
(a.koschinsky@jacobs-university.de)

REEs are essential for a large variety of high-tech and green-tech applications. The global market has been supplied over the past 10 plus years, from a single source, China. China's domestic needs have meant that its export of REEs has and will continue to decrease significantly. Consequently, other land-based sources of REEs are being explored and mines developed. Deep-ocean deposits may offer a partial solution to this projected shortage, but marine deposits have not been evaluated. Here we compare data for the Clarion-Clipperton Mn Nodule Zone (CCZ) in the NE Pacific and the prime Fe-Mn crust zone (PCZ) in the central Pacific with the two largest land-based mines, Mountain Pass (MP) in USA and Bayan Obo (Obo) in China. The land-based deposits are lower tonnage deposits, but higher grade (MP $0.9 \cdot 10^8$ tons at 5% total REEs as oxides (TREO); Obo, $8 \cdot 10^8$ tons at 6% TREO), compared to the CCZ ($211 \cdot 10^8$ tons at 0.10% TREO) and PCZ ($75 \cdot 10^8$ tons at 0.3% TREO). These grades and tonnages correspond to tons of TREO of $4.9 \cdot 10^7$ Obo, $0.45 \cdot 10^7$ MP, $2.1 \cdot 10^7$ CCZ, and $2.3 \cdot 10^7$ PCZ. The land-based deposits have <1% heavy REEs, whereas the CCZ has 10% HREEs and the PCZ, 6.3% HREEs. An important environmental issue is the high Th contents in the land-based deposits (100s of ppm) in contrast to the low Th in marine deposits (mean 14 ppm CCZ; 11 ppm PCZ).