Impacts of CO_2 perturbation on well composite samples: experiments and numerical simulations

J. TREMOSA[1], S. MITO[2], P. AUDIGANE[1] AND Z. XUE[2]

[1] BRGM, 45060 Orléans, France; (j.tremosa@brgm.fr)
[2] RITE, Kyoto, 619-0292, Japan; (mito@rite.or.jp)

Abandonned wells in the depleted reservoirs envisaged to host CO_2 geological storages are the main possible leakage pathways of CO_2 towards shallow aquifers. Then, for impact assesment, the alteration of well materials with CO_2 in the reservoir conditions requires to be characterized.

Here, the interaction of a composite well sample – formed of steel casing, surrounded by Portland cement, itself surrounded by sandstone – with wet CO_2 and CO_2-saturated brine under pressure and temperature controlled conditions was studied combining a set of batch experiments [1] and reactive transport modeling. In the experiments, lasting up to 8 weeks, noticeable mineralogical changes were observed in the cement, at the interface with the sandstone, leading to a carbonation of the cement. Main mineralogical changes consisted in dissolution of portlandite, replacement of CSH phases rich in Si by Ca-rich CSH phases and precipitation of calcite, amorphous silica and zeolite [1]. Interestingly, no re-dissolution of calcite was observed at the outer boundary of the cement, in relation with the penetration of the carbonation front, as observed in experiments involving only cement and CO_2-saturated brine [2]. For the two other components of the composite well samples, few changes were observed. The steel shown a moderate corrosion with some precipitations of Fe-oxides at its surface. No changes were observed in the sandstone.

These changes in mineralogy were reproduced with the reactive transport model, which highlights the successive dissolution/precipitation reactions. A good agreement was also obtained with the brine composition evolution record during the experiment. It is worth noting that the model suggested slight mineralogical changes in the sandstone consisting in dissolution of carbonates at the boundary of the sample, in direct contact with the CO_2-saturated brine. This observation, in link with the experimental observations in the cement, indicate a buffering effect of the rock on the CO_2 perturbation. This possible buffering was observed by observations at a larger scale on industrial analogue well samples [3] and suggests a preservation of the well integrity.

[1] Asahara et al. (2013). Energy Procedia, GHGT11. [2] Kutchko et al. (2007). Environ. Sci. Technol., 41, 4787-4792. [3] Carey et al. (2007). Int. J. Greenhouse Gas Control, 1, 75-85.

Benthic nitrogen fixation and Mn/Fe reduction in the Mauritanian oxygen minimum zone: Two overlooked processes?

TREUDE T.[1]*, BERTICS VJ[2], GIER J[3] AND SOMMER S[4]

[1]GEOMAR Helmoltz Centre for Ocean Research Kiel, Wischhofstr. 1-3, 24148 Kiel, Germany, (ttreude@geomar.de)(*presenting author)
[2]Harvard University, Biological Laboratories, 16 Divinity Avenue, Cambridge, MA 02138, USA, (vbertics@fas.harvard.edu)
[3]GEOMAR Helmoltz Centre for Ocean Research Kiel, Wischhofstr. 1-3, 24148 Kiel, Germany, (jgier@geomar.de)
[4]GEOMAR Helmoltz Centre for Ocean Research Kiel, Wischhofstr. 1-3, 24148 Kiel, Germany, (ssommer@geomar.de)

Oxygen minimum zones (OMZ) are currently in the focus of many marine biogeochemical studies, especially since their spreading has been discovered and associated with climate change. Understanding element cycling of OMZ is an important key to predict dynamics of this systems as well as feedbacks to environmental changes. Nitrogen and iron are two central elements in cycling processes of OMZ; however, budgeting and following the fate of these elements still remain challenging. Here we present two benthic processes, microbial N_2 fixation and Mn/Fe reduction, from the Mauritanian OMZ, which were measured at six stations along a depth transect between 50 and 1100 m water depth. N_2 fixation was deduced from nitrogenase activity via the acetylene reduction method. Mn/Fe reduction was measured indirectly via total anaerobic production of dissolved inorganic matter after subtraction of sulfate reduction activity. Highest integrated nitrogenase activity (~360 μmol C_2H_4 m^{-2} d^{-1} down to 20 cmbsf) and Mn/Fe reduction (~29 mmol m^{-2} d^{-1} down to 10 cmbsf) was found within low oxygen zones (45 to 56 μM O_2) beneath water depths of 100-240 m. Both processes generally decreased with greater water depths. The percentage of Fe/Mn reduction in total anaerobic organic matter degradation in the top 10 cm increased from ~65% to over 90% downslope. We are convinced that both processes play an important role for element budgeting of OMZ and should be considered in future studies. Especially in developing OMZ featuring terrestrial dust/iron input to the seafloor, such as the Mauritanian OMZ, iron reduction could play a key role for delaying the buildup of sulfidic conditions during organic matter degradation.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.20