CO2 injection in a coal seam - Insights from the European CARBOLAB project with focus on water geochemical monitoring

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GAL Frédérick[1], PROUST Eric[1], LEYNET Aurélien[1]

[1]BRGM, 3 avec Claude Guillemin, 45060 Orléans, France

Abstract

The CARBOLAB project is funded by the European program RFCS (Research Fund for Coal and Steel). It gathers six partners from Spain, France and Poland. One of the main tasks of this project is to perform in-situ CO_2 injection in a coal seam located at 464 m depth in the Montsacro pit, Asturias, Spain. Injection of CO_2 in coal seams is one of the options for climate change mitigation but it presents lots of uncertainties and technical difficulties. Therefore work is needed to better constraint the processes especially the adsorption of CO_2 and the subsequent desorption of CH_4. This work consists in experimental laboratory work, modelling aspects and real tests. This paper is focused on this last topic and more specifically on the water monitoring aspects. Complementary investigations on the gas phase can be found in other works presented by Lafortune *et al.* in this conference.

In-situ injection of CO_2 has been performed in July 2013 in one selected coal seam. The CO_2 is injected directly in the vein and monitoring boreholes are located at the wall and in the surrounding sedimentary formations. The aim is to get a detailed and representative overview of the consequences of the CO_2 injection. Here the focus is on the geochemical monitoring.

Baseline acquisitions have been performed in 2012 and early 2013. This allowed to define a strategy mainly focused on the monitoring of the saturated zone albeit the site was initially thought to be drier. Acquisitions in the unsaturated zone (free gas phase) have also been done but in a less extent.

Chemical logging of water saturated boreholes (GC1S and GC3N, parallel to the seam) revealed, even at short distance, the existence of different water masses from one side of the coal vein to the other. This is mainly linked to a difference in the amount of dissolved solids in water. During the injection experiment, no noticeable deviations from the baseline values were found for GC1S borehole. At the opposite, the bottom of GC3N experienced strong changes: decrease of more than 2.5 pH units, rise of the electrical conductivity (+29%) and of the alkalinity (+23%). Breakthrough in GC3N cannot be timed precisely as work in the gallery was not continuous, but occurred sometime in between the 05 and the 08 of July (the injection started on the 03 July).

The changes on the physico-chemical parameters are linked to changes in concentrations for some major elements and some trace elements. Ca and Mg concentrations were progressively enriched in

the water phase whereas species like Na or K remained at stable levels in lien with the geology of the rock formations. Trace elements such as Sr, Ni, Mn, Zn or Ba have experienced rises of their concentrations by factors of 2 to 10. Changes in dissolved gas concentrations were also found for GC3N borehole, the enrichment in CO_2 being prominent (2 orders of magnitude enrichment).

The monitoring of the free gas phase suggests that the main part of the CO_2 has not been injected in the coal seam but rather in the aquifer, on the side of GC3N borehole. Moreover, a strong leakage has been noticed close to the injection borehole wellhead, quantification of the flux with appropriate flux chamber leading to leakage rates of around 20 to 70 l/h.

Carbon isotope ratios may suggest a little influence of the seepage from the wellhead in the atmosphere of the gallery, a depletion of the ratio being noticed at the end of the monitoring period. The free gas phase existing at the top of GC3N was not really enriched in CO_2 (the water phase does) but on the contrary deviations of the carbon ratio from baseline data are obvious. Such statements have been done *e.g.* in Norway during a similar CO_2 injection in rock formations (Gal et al., 2013).

Even if the injection has suffered from deviations from the initial plan, it has been possible to detect the injected CO_2 on all the monitored compartments but only on one borehole. Geochemical monitoring methods prove once again their sensitivity and their adaptability to changing conditions.

References:

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