Geophysical Research Abstracts
Vol. 19, EGU2017-1272, 2017
EGU General Assembly 2017

Geochemical modelling of worst-case leakage scenarios at potential CO_2-storage sites – CO_2 and saline water contamination of drinking water aquifers

Zsuzsanna Szabó (1), Nóra Edit Gál (2), Éva Kun (2), Teodóra Szőcs (2), and György Falus (1)

(1) Geological and Geophysical Institute of Hungary, Department of Geochemistry and Laboratories, Stefánia út 14., Budapest 1143, Hungary, (2) Geological and Geophysical Institute of Hungary, Department of Hydrogeology, Stefánia út 14., Budapest 1143, Hungary

Carbon Capture and Storage is a transitional technology to reduce greenhouse gas emissions and to mitigate climate change. Following the implementation and enforcement of the 2009/31/EC Directive in the Hungarian legislation, the Geological and Geophysical Institute of Hungary is required to evaluate the potential CO_2 geological storage structures of the country. Basic assessment of these saline water formations has been already performed and the present goal is to extend the studies to the whole of the storage complex and consider the protection of fresh water aquifers of the neighbouring area even in unlikely scenarios when CO_2 injection has a much more regional effect than planned. In this work, worst-case scenarios are modelled to understand the effects of CO_2 or saline water leaks into drinking water aquifers.

The dissolution of CO_2 may significantly change the pH of fresh water which induces mineral dissolution and precipitation in the aquifer and therefore, changes in solution composition and even rock porosity. Mobilization of heavy metals may also be of concern. Brine migration from CO_2 reservoir and replacement of fresh water in the shallower aquifer may happen due to pressure increase as a consequence of CO_2 injection. The saline water causes changes in solution composition which may also induce mineral reactions.

The modelling of the above scenarios has happened at several methodological levels such as equilibrium batch, kinetic batch and kinetic reactive transport simulations. All of these have been performed by PHREEQC using the PHREEQC.DAT thermodynamic database. Kinetic models use equations and kinetic rate parameters from the USGS report of Palandri and Kharaka (2004). Reactive transport modelling also considers estimated fluid flow and dispersivity of the studied formation. Further input parameters are the rock and the original ground water compositions of the aquifers and a range of gas-phase CO_2 or brine replacement ratios. Worst-case scenarios at seven potential CO_2-storage areas have been modelled. The visualization of results has been automatized by R programming.

The three types of models (equilibrium, kinetic batch and reactive transport) provide different type but overlapping information. All modelling output of both scenarios (CO_2/brine) indicate the increase of ion-concentrations in the fresh water, which might exceed drinking water limit values. Transport models provide a possibility to identify the most suitable chemical parameter in the fresh water for leakage monitoring. This indicator parameter may show detectable and early changes even far away from the contamination source. In the CO_2 models potassium concentration increase is significant and runs ahead of the other parameters. In the rock, the models indicate feldspar, montmorillonite, dolomite and illite dissolution whereas calcite, chlorite, kaolinite and silica precipitates, and in the case of CO_2-inflow models, dawsonite traps a part of the leaking gas.