Geophysical Research Abstracts
Vol. 12, EGU2010-12431-2, 2010
EGU General Assembly 2010

Numerical interpretation of self-potential (SP) data in the context of CO_2 storage

Johanna Smaczny, Christoph Clauser, Norbert Klitzsch, and Roland Blaschek

RWTH Aachen University, E.ON Energy Research Center, Applied Geophysics and Geothermal Energy, Aachen, Germany (jsmaczny@eonerc.rwth-aachen.de)

Self-potentials (SP, natural electrical potentials) arise due to electrokinetic phenomena, e.g. SP signals are caused by fluid flow in rocks. Hence, the CO_2 moving inside a reservoir and the water displaced by the CO_2 injection are expected to cause SP signals as well as the rising CO_2 of a reservoir leakage.
We study numerically if self-potential measurements can be used to monitor CO_2 flow in reservoirs (due to injection) and if SP could be a tool to detect leakages.
Simulating electrokinetic potentials for CO_2 applications leads to special challenges as multiphase flow has to be dealt with, e.g. a precise definition of the coupling process between the electric potentials and two immiscible fluids (water as the wetting phase and supercritical or gaseous CO_2 as the nonwetting phase) is needed and the dependence between saturation and the coupling coefficient has to be investigated in detail. With the implementation of multiphase flow (using the van Genuchten or the Brooks and Corey model to describe the permeability of partially water-saturated rocks) the dependence of the electrical resistivity on water saturation has to be considered. Results will be illustrated using COMSOL Multiphysics to describe the injection of supercritical CO_2 in a fully saturated porous medium showing the effect of displacing the wetting phase. An applied pressure gradient produces the streaming current and the coupled electric potentials.
We use analogue studies, exploiting the data obtained at natural CO_2 sources, to study the SP signals caused by leaking reservoirs and to infer coupling coefficients. We introduce the modelled SP data in comparison to the SP data, resistivity distribution, and CO_2 flow rates gathered by Flechsig et al. (2008) at the Hartoušov Moffete field (natural CO_2 source) in the Cheb basin (Czech Republic). Furthermore, we introduce the modelled SP signals for the CO_2 sequestration site Ketzin near Potsdam (Germany). Here, we start from the reservoir model exploiting the data (e.g. injection rates, pressures, resistivity distribution etc.) obtained in the CO2Sink project. The studies are employed to enhance our numerical approach and to assess the SP method as a monitoring tool for CO_2 injection as well as for CO_2 leakage. Monitoring concepts in terms of electrode arrangements and optimized signal to noise ratio will be deduced.