Experimental Investigation of Transport and Sorption Processes in Gas Shales in the Context of the European GASH Project

Bernhard M. Krooss, Matus Gasparik, Amin Ghanizadeh, Alexandra Amann, and Ralf Littke
RWTH Aachen University, Aachen, Germany

Gas shales are unconventional reservoirs characterized by low to extremely low permeabilities and significant physical sorption capacity. Depending on porosity, organic matter content, pressure and temperature varying portions of the shale gas are present as a free gas and in the sorbed state, respectively. The interrelation of sorption and transport properties is one of the main factors determining the producibility of shale gas plays, the other one being the rock mechanical properties. Transport of gas in shales is envisaged to occur by diffusion on short length scales (mm to m; in to ft) while pressure-driven volume flow is the more efficient process on larger scales.

For both, exploration and production purposes, the kinetics of sorption and desorption and the interrelation of sorption and transport processes is of crucial importance. The mass transfer between the matrix and natural or artificial fracture systems are of prime interest for quantitative descriptions and modelling. In carbonaceous shales, the connectivity of the pore and fracture systems determines the accessibility of the dispersed organic matter and its participation in gas transport. Capillary processes and two-phase (water/gas) transport are difficult to quantify due to low porosity, high irreducible water contents, high capillary entry/breakthrough pressures, and concomitant diffusive transport.

In the context of the European GASH project, combined fluid flow tests on cylindrical plugs and sorption experiments on powdered samples under controlled temperature, pressure and stress conditions are being conducted in our laboratory. The main goal is to study the interaction of gas sorption and transport processes in carbonaceous shales with a largely undisturbed fabric. The tests are performed with methane, CO_2, and non-sorbing inert gases (He, Ar). By systematic variation of the initial and boundary conditions, it is attempted to discriminate individual processes such as compressible Darcy flow, diffusion, capillary breakthrough, sorption and desorption kinetics and represent them by conceptual and numerical models. The research also involves comparison and optimization of different methodologies for the assessment of permeability coefficients in gas shales (e.g. steady-state vs. nonsteady-state). Selected results of the ongoing experimental work will be presented to illustrate this comprehensive experimental approach.