AAPG Datapages/Search and Discovery Article #90282 © 2016 AAPG Latin America & Caribbean Region Geoscience Technology Workshop, Buenos Aires, Argentina, November 16-18, 2016

Experimental and Theoretical Study of Water and Solute Transport Mechanisms in Organic-Rich Carbonate Mudrocks

Anton Padin[1]

[1] Colorado School of Mines

ABSTRACT

The objective of this research is to determine the physicochemical processes underlying water and solute transport in organic-rich source rocks. Experiments were performed on Eagle Ford shale samples composed of organic-rich, low-clay carbonates using a high pressure triaxial assembly with novel design. Experimental results were successfully matched with a numerical chemical transport model. The mathematical formulation of this model relies on the chemical osmosis principles driving low-salinity brine into high salinity core samples. The results of this research should be beneficial for design of EOR processes in organic-rich shale.

A custom-designed experimental apparatus was constructed to conduct flow tests. The apparatus is capable of maintaining core samples at reservoir pressure, temperature, and confining stress. In addition, a new mathematical model was formulated to simulate flow into the core as a porous medium rather than as a molecule-selective membrane. This new model is based on the following principles: (1) the solvent (low-salinity water) selectively enters the pores by diffusion mass transport and (2) the dissolved salt molecules (which are ionized) are restrained by internal electrostatic forces from diffusing in the opposite direction of the low-salinity brine molecules entering the pore network.

The mathematical model closely matches the experimental results and, more importantly, only very few assumptions were made in matching experiments. For instance, the critical model input data, such as permeability, porosity, and rock compressibility, were obtained from flow experiments on twin cores, and the diffusion coefficient was chosen by history matching. The strengths of the numerical simulation include the following: (1) the mathematical model is based on the mass transport fundamental principles, (2) the model does not require the use of the ambiguously- defined membrane efficiency term, and (3) the chemical potential gradient is the reason for the low-salinity brine entering the high-salinity brine cores to generate osmotic pressure within the cores. The latter implies that osmotic pressure is the consequence of water entering the cores, not the cause.