Membrane Morphology of Organic-Rich Eagle Ford Shale and its Implications for Rock Surface-Fluid Interaction

Anton Padin[1], Sebastian Ramiro[1], Azra Tutuncu[1], and Steve Sonnenberg[1]

[1]Colorado School of Mines

Abstract

This article is focused on exploring the microscopic composition and fabric of the Eagle Ford Formation and the existing relationships between mineralogy, organic matter, porosity and strength, along with the implication of these relationships for fluid-rock rheology. Previous research has focused on the different aspects of shale characterization, but only a few studies have deepened into the implications of shale physical morphology for multiphase fluid flow. The uniqueness of this research work is (1) that we adopt the perspective that organic-rich shale matrix acts as a semi-permeable membrane where rheology is not only influenced by clay minerals but also by the organic matter present in the matrix, and (2) that we characterize the rock before and after completion fluids are flowed through it.

The full range of experimental work used includes: well log analysis, sample description, bulk density, porosity, pore size distribution, XRD, petrographic thin section analysis (optical transmitted light microscope), Environmental Scanning Electron Microscope (E-SEM), Field Emission Scanning Electron Microscope (FE-SEM) of ion-milled and broken-surface samples, Qemscan Microanalysis, Source Rock Analysis (SRA), Rock-Eval pyrolysis, CEC, spontaneous imbibition, wettability and triaxial tests.

With available subsurface core data for two Eagle Ford, one Vaca Muerta and one Bakken wells, we have determined that (1) each reservoir shale contains a characteristic pore morphology and distribution, (2) that there is a strong relationship between mineralogy, organic matter distribution and porosity, and (3) that fluid rheology strongly depends on the differential wettability of the organic and inorganic pore systems. These findings have potential implications with regard to current stimulation operations and possibly to future enhanced oil recovery efforts in shale reservoirs.