Variations in Pore Size Distributions in organic matter and clay minerals from dissolution studies

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Unconventional reservoir rocks have a 10-fold larger surface area than conventional sandstones due to clay minerals, fine-grained colloidal silica and carbonate ooze, and nano-porous organic matter. Thermal maturation and diagenesis of each component lead to complex pore development history. Oil and gas generated by organic maturation migrate to form conventional petroleum accumulations. Expulsion efficiency and its control factors are poorly constrained. For example, hydrocarbon expulsion can lead to molecular and stable isotopic fractionation of the residual and expelled products.

Kerogen porosity generated during maturation is poorly understood. It can be preserved if the kerogen is sheltered by load bearing minerals. Similarly, tactoid-level clay porosity is not affected by compaction, but it can be affected by interactions between electrically charged clay mineral surfaces and polar functional groups present in organic matter. Adsorption and absorption of hydrocarbon in various shale components affect storage and fluid flow. Maturation byproducts can occupy clay porosity in the early stages of oil generation. At high maturity, clay dehydration might occur due to loss or displacement clay-bound water. Organic functional groups preferentially adsorbed at clay exchange sites can replace clay bound water. Clay dehydration, with it, a change in cation exchange capacity will decrease porosity and increase resistivity.

We present chemistry of stored fluids and the pore systems that host them in organic-rich Bakken source rocks of varying maturities. We have measured pore size distributions (PSD) and specific surface areas (SSD) in native state and after successive extraction of the rocks with solvents of increasing polarities. The PSD and SSA measured after each washing show an increase with every successive washing. Most significant is the recovery of clay-hosted pores with removal of hydrocarbons. With the highest polarity solvent, there is a significant collapse of pores. By comparison with pure clay end members, we find that clay-hosted pores in smectites collapse with solvents of high polarity.