A New Method to Predict Organic Matter Porosity in Unconventional Shale Reservoirs

Wayne K. Camp

Anadarko Petroleum Corporation, 1201 Lake Robbins Dr., The Woodlands, Texas 77380

ABSTRACT

A new method is proposed to predict organic matter porosity in unconventional shale (mudstone) reservoirs based on a pyrobitumen porosity model that is constrained by extensive scanning electron microscopic (SEM) observations from several major North American shale plays. The pyrobitumen porosity model is based on the hypothesis that the effective organic matter porosity occurs within an interconnected network of secondary, void-filling organic matter, interpreted as solid bitumen (pyrobitumen). The origin of the void-filling solid bitumen is interpreted as a thermal alteration product of residual oil retained within intergranular pores (and other preserved voids) within the source rock. Pores are interpreted to develop within the solid bitumen as a result of thermal cracking and gas generation at elevated levels of thermal maturity to form insoluble pyrobitumen. The development of pores within pyrobitumen may be analogous to the formation of pores within petroleum coke during the refining of heavy crude oils. This new organic porosity prediction technique requires: (1) an estimate of the preserved intergranular porosity at the onset of oil generation based on compaction curves and burial history models; (2) average peak oil saturation (oil saturation index); and (3) the fraction of organic matter converted to porosity (porosity conversion ratio). The last two parameters are derived from SEM digital image measurements of analogous shale reservoirs. Further research is required to refine and test the proposed porosity prediction method.

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