Use of X–Ray CT Imaging and 2D Scanning Electron Microscope for Evaluation of Smackover Mudstone Reservoir Properties

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EXTENDED ABSTRACT

Digital rock physics analysis was utilized to investigate the unconventional reservoir properties of the Smackover mudstone in southern Arkansas through the techniques of high-resolution X–ray computed tomography (CT) imaging and 2D scanning electron microscope (SEM). X–ray CT scanning provides not only qualitative representation of the core in the form of CT images, but, more importantly, a quantitative measurement of rock properties. Changes in bulk density (RHOB) and photoelectric effect (PEF) that are computed for the imaged core are tied to variations in organic matter content and/or mineralogy. Core samples of the lower Smackover Formation in Talley No. 1–22 well, Columbia County, Arkansas, were imaged by high-resolution CT scanning and analyzed by logging to characterize rock type and choose plug sampling locations (Fig. 1). Population density cross plot indicates that the majority of cores are characteristic by high RHOB (low organic content) and high PEF (more calcite than quartz) (Fig. 2). Four plug samples, which are representative of dominant rock characteristics, were subsequently selected for X–ray fluorescence (XRF) and 2D SEM analyses. Abundances of major elements along with trace elements—thorium and uranium—were determined by XRF and converted to an approximate weight percent of silica, clay, and carbonate. The results of XRF show that most of samples are essentially composed of carbonate with minor presence of silica and clay (Table 1). SEM images were taken at the resolution of 15 nm per pixel and digitally analyzed to quantify organic matter, porosity, porosity in organic matter, and high density minerals (Table 2). For these four samples, organic matter averages about 1.2% with a low of 0.1% and a high of 3.4%. Both porosities in whole rock and in organic matter are roughly proportional to the abundance of organic matter. Whole rock porosity is up to 2.9% with an average of 1.2%. Porosity in organic matter varies from zero to 0.5%. The percentage of high density minerals ranges from none to 1.5% in the samples.

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