# Digital Rocks Application to Refine Electrical Model of Microporous Carbonates

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**Abstract.** Low resistivity pays (LRPs) are reservoirs from which water free hydrocarbons are produced in the presence of erroneously interpreted water saturations. LRPs are often identified within laminated reservoir sequences / shaley lithologies, and formations with multi-modal pore-size characteristics or containing fresh formation waters identified on the basis of well logging, testing and core observations. The following study addresses the characterization of a microporous carbonate LRP formation using digital rock physics (DRP) analysis in various facies identified in 62 core plugs through digital imaging. A comprehensive DRP workflow was utilized to produce 3D digital rock models of rock samples through multi-resolution X-ray tomographic imaging and application of a machine-learning algorithm to characterize the internal fabric of the rock samples based upon the abundance of microporosity. The physical samples were also analysed using mercury injection capillary pressure (MICP) to allow calibration and to validate the 3D digital rock models. Numerical simulation of the electrical current flow through the samples showed the variation of Archie's saturation exponent "n" with water saturation, i.e., the increasing influence of the microporous regions as water saturation is decreased. The meso- and macropores were found to produce the moveable hydrocarbons due to their lower capillary pressure while the micropores holding immobile formation water. The DRP models were then used to simulate the drainage relative permeability curves to identify the water saturation causing the first water in-flow, and separate immobile and free-fluids. The wireline logs saturation profile was updated with these results. As shown by digital experiments, conducted on LRP, the water-filled micropores provide a continuous path for electric current, masking the hydrocarbons and overestimating the water saturation. Saturation calculation could be significantly refined, if LRP wireline petrophysical models are calibrated using DRP data by incorporating the modelled Archie's saturation exponent and first water in-flow from relative permeability curves.