New Approach to Aid Multi-Scale Imaging and Characterization of Heterogeneous Carbonate Rocks Using Epoxy-Pore Casts

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ABSTRACT

Epoxy resin-pore casting is an extensively used method to study geological thin-sections and pore geometries in hydrocarbon reservoirs. Despite the significance and abundant usage of this process, currently there exists no standard or readily applicable methodology that can rapidly combine the virtues of digital rock physics and epoxy-pore casting. We propose a new multi-scale imaging approach that employs Confocal Laser Scanning Microscopy (CLSM) in conjunction with Scanning Electron Microscopy (SEM) to obtain high resolution 3D images of epoxy-pore casts of heterogeneous carbonate rocks. We applied the proposed methodology to well-known carbonate samples with variable pore types and geometries, and then extended to rock samples from a carbonate outcrop stratigraphically analogous to the Arab-D reservoir in Saudi Arabia. We developed an in-house resin impregnation procedure for producing high quality fluorescent epoxy-pore casts. High resolution 2D and 3D images of the resulting epoxy pore-casts were obtained using SEM and CLSM. The high resolution CLSM images were then used for characterization of rock petrophysical properties (e.g. porosity, pore-size distribution) . We validated these results with the standard petrophysical property measurements obtained from mercury intrusion porosimetry. The various pore types identified from high resolution SEM and CLSM images of the epoxy-pore casts of the standard rock types, namely inter- and intra-granular microporosity, vuggy and moldic porosity, were corroborated with published studies. The 3D pore structures of the studied rock samples were hence effectively captured by the suggested epoxy-pore casting and multiscale imaging approach, qualitatively and quantitatively.