Petrophysical Properties and Multi-Scale Analysis of Connected and Isolated Porosity in Carbonate Reservoirs

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ABSTRACT

The estimation of flow behavior in carbonate reservoirs often suffers from uncertainties associated with pore network configurations. Especially the relationships of connected versus unconnected pores are of prime importance for quantitative reservoir models. It is the aim of this study to establish a workflow for better characterization of pore types and their distributions and thus the effective porosity in carbonates. A multiple-analyses approach has been developed including Micro-Computed Tomography, Virtual Microscopy, Laser Scanning Confocal Microscopy (LSMC), Broad Ion Beam Electron Microscopy (BIB-SEM) as well as Spectral Induced Polarization (SIP) and Mercury Injection Capillary Pressure (MICP). Resulting parameters were correlated with observations from petrographic analyses on a nano- to millimeter-scale. In a carbonate reservoir case study with Petroleum Development Oman, we used five samples from the Permo-Triassic Khuff Formation which were analyzed applying the introduced workflow. As a result, three rock types can be distinguished in which high permeability can be associated with homogeneously distributed and well-connected intercrystal and moldic porosity while low permeability is associated with either poorly connected moldic porosity and/or patchy and heterogeneously distributed intercrystalline porosity. Further, analyses revealed a strong correlation between resistivity and permeability.