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PORE-NETWORK MODEL PREDICTIONS OF MULTI-PHASE FLOW FUNCTIONS FOR CARBONATE RESERVOIRS BASED ON ACCURATE MATCHING OF THE PORE SIZE DISTRIBUTION

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Summary. Carbonate reservoirs contain a large fraction of the remaining oil reserves, but their highly heterogeneous structures, at the pore scale, make them difficult to characterize and this is one of the main reasons for their low recovery factors. Pore space imaging and reconstruction techniques are often used to characterize the pore space topology and geometry. However, the wide range of pore sizes encountered in carbonates, including submicron microporosity, usually renders these techniques unsuitable. A classic technique to approximate the pore size distribution (Ritter and Drake) is based on inversion of the mercury intrusion capillary pressure (MICP) curve. However, this technique is inaccurate due to the lack of accessibility of the large pores before the percolation threshold is reached.

In this paper, we use a simple lattice network, characterized by an average co-ordination number, a pore volume-vs-radius power law and a pore radius size distribution (PSD) with an arbitrarily large range of radii, to match the MICP curve.

Additionally, the network model contains a conductance-vs-radius power law and a contact angle distribution to compute two-phase and three phase flow properties. In the present approach the PSD has a given number of non-constant radius classes (bins), for which the probabilities need to be determined. As an initial guess, we take the Ritter and Drake PSD, based on which the non-fixed bin widths are determined, using principal theorems derived in information theory and data compression. Then, the class probabilities, the co-ordination number and the volume exponent are optimized to match the experimental MICP, using a method from statistical physics. The inversion method is based on a Bayesian framework which uses a biased Markov Chain Monte Carlo strategy for sampling the posterior distribution.

The method has successfully been applied to two synthetic cases and three carbonate samples from a Middle East reservoir presenting three different carbonate facies. Subsequently, two phase drainage, imbibition and secondary drainage capillary pressures were well matched. However, the lack of dynamic data to calibrate the conductance made it difficult to predict relative permeability.