Prediction the Effect of Diagenetic Alteration on Two Phase Flow Properties in Tight Gas Sands

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We use quantitative grain-scale models to predict the variation of capillary pressure curves and relative permeability curves in tight gas sandstones. We model several depositional and diagenetic processes important for porosity reduction in tight gas sands, such as sorting, average grain size and quartz cementation. The model is purely geometric and begins by applying a cooperative rearrangement algorithm to produce dense, random packings of spheres of different sizes. We simulate the evolution of this model sediment into a low-porosity sandstone by quartz precipitation. The overgrowth or rim cement was modeled by uniformly increasing the radius of all the grains, while holding their centers fixed. The drainage curve for different model rocks was computed using invasion percolation in a network taken directly from the grain-scale geometry and topology of the model. The predicted curves show several trends that agree with experimental data of a tight gas reservoir in Anadarko basin. The drainage curve shifts to larger pressures as the amount of cement increases, the grain size decrease, or the sorting becomes poorer. Also, by adding more cement the irreducible water saturations of the packing increases. The predictions show a range of porosity at which significant fraction of the pore throats are closed by cement. This causes a characteristic large shift in the drainage curve for small changes in porosity. This in turn has a large effect on the gas phase relative permeability in this subset of tight gas sandstones. This sensitivity may contribute to large variations in producibility from well to well in a reservoir.