Petrophysical Properties of Hydrate-Bearing Siltstone from UT-GOM2-1 Pressure Cores

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Abstract

Petrophysical properties are one key control on hydrate formation and dissociation but are still poorly understood. We study the petrophysical properties (i.e., porosity, intrinsic permeability, effective permeability, and capillary behavior) of a sandy silt hydrate reservoir in Green Canyon (GC) block 955 in the deepwater Gulf of Mexico by analyzing pressure core samples. The effective permeability of hydrate-bearing sandy silts is ~0.5 mD (5.0×10-16 m2) in cores with 80% hydrate saturation at in-situ stress. The sandy silts were also reconstituted to the in-situ porosity after hydrate dissociation and found to have an intrinsic permeability that is 20 times greater (11.8 mD or 1.18×10-14 m^2), which is similar to the intrinsic permeabilities measured in intact cores from hydrate reservoirs of similar grain size offshore Japan (Nankai Trough) and offshore India. Clayey silts interbedded with the hydrate-bearing sandy silts were also reconstituted to the in-situ effective stress and found to have a much lower intrinsic permeability of 3.84 ×10-4 mD (3.84 ×10-19 m^2). Mercury injection capillary pressure measurements also demonstrate that at the hydrate saturation from 90% to 93%, a free gas column from ~20 to ~60 m can be trapped by the hydrate formation. This suggests that the reservoir itself can act as a hydrocarbon seal. Clayey silt has a much higher capillary entry pressure resulting in the ability to seal a gas column of over 200 m. We also interpret that the methane solubility in pores of clayey silt lithofacies is always less than that necessary to form hydrate, which explains why no hydrate is present in the clayey silt. We conclude that permeability and capillary behavior in the hydrate reservoir are lithology dependent. This study will inform reservoir simulation models with petrophysical properties at scales of individual lithofacies to predict hydrate reservoir formation and production.

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