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Study on the effect of natural gas hydrate cementation mode on the permeability property of rocks

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Natural gas hydrate is ice-like crystal compound formed by water and natural gas molecules under certain temperature and pressure, which widely distributed in terrestrial permafrost and deep sea sediments. Natural gas hydrate as the most promising development clean energy, can effectively solve the energy crisis and environment pollution problems [1]. Nowadays, the microscopic distribution pattern of hydrate and sediment particles can be roughly classified into contact type, cemented type and suspension type [2-4]. The cemented type as one of the most important types in the microcosmic distribution of hydrate, study on the effect of hydrate cementation mode on the permeability property of rocks is of great significance to geophysical exploration and evaluation of resources for hydrate reservoirs.

The hydrate cementation mode have changed the conductivity and compressive ability of the rock, which have great effect on the effective pore structure and pore connectivity, and then influence the permeability property of rocks [5]. There are mainly three different cementation mode for cemented hydrate, including homogeneous growing on the rock particle surface (mode I), precipitating within pores (mode II) and occurring in the pore throats (mode III). It is of great significance to tease out the effect of different hydrate cementation mode on the permeability properties of hydrate reservoir rocks. So, three dimensional digital rock with different hydrate cementation mode was constructed by process simulation method and the algorithm of hydrate cementation and growth, then lattice Boltzmann method were used to study the effects of hydrate cementation mode on the permeability properties of rocks.

From the perspective of digital rocks construction, the addition and cementation of hydrate means that transform the pixel characterizes rock pores into hydrate, and finally obtain hydrate digital rocks with different cementation mode, then it can be used to evaluate and analyze the permeability properties. Among the three hydrate cementation modes, the permeability of cementation mode II is the smallest, because the permeability of the rock is mainly affected by the pore connectivity, and mainly depends on the wide part of the pore connectivity, hydrate precipitating within pores blocked the fluid flow. Under the same hydrate saturation condition, hydrate cementation mode III resulting in pore space narrowing, that is, in this cementation mode, the permeability is the smallest, although the initial porosity of the rock is high. By contrast, as for hydrate cementation mode III, hydrate mainly occurring in the pore throats, which have a little effect on the fluid flow. Although the porosity is decreases, the rock still have a higher permeability than cementation mode II, which may lead to the formation of low porosity and high permeability phenomenon for the hydrate reservoir. It also can be seen that the cementation mode II is the most sensitive mode to permeability characteristics of three cementation modes.

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