Geophysical Research Abstracts
Vol. 14, EGU2012-7129-1, 2012
EGU General Assembly 2012

Measurements of Gas-Water Relative Permeability for Methane-Hydrate-Bearing Sediments using X-ray Computed-Tomography

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Oceanic gas hydrate deposits at high saturations have been found within sandy sediments in areas such as the Eastern Nankai Trough and the Gulf of Mexico. The recent discovery of these deposits has stimulated research and development programs exploring the use of gas hydrates as energy resources. Depressurization is thought to be a promising method for gas recovery from gas hydrates deposits; however, considerable water production is expected when this method is applied for oceanic gas hydrate deposits. The prediction of water production is a critical problem for successful gas production from these deposits. The gas-water relative permeability of gas-hydrate-bearing sediments is a key parameter to predict gas-water-ratio (GWR) during gas production. However, the experimental measurement of gas-water relative permeability for gas-hydrate-bearing sediments is a challenging problem due to a phase change (gas hydrate formation/dissociation) during gas-water flooding test.
We used X-ray computed tomography (CT) and a newly-developed core holder to measure gas-water relative permeability for gas-hydrate-bearing sediments. X-ray CT was used to image a displacement front and quantify density changes during water flooding test in methane-hydrate-bearing cores. We obtained CT images every two minutes during a water flooding test for a gas-saturated methane-hydrate-bearing core. The movement of displacement front was captured from these CT images. Quantitative analysis of density change was also done to analyze the change of gas/water saturations. We developed a multi-sensor-tap core holder to minimize capillary end effect on the pressure measurements. To be able to obtain CT images by X-ray, the core holder was made of aluminum alloy. We successfully measured pressure differences of the intermediate section of the core during water flooding test. The change of pressure differences during water flooding test showed strong correlation with the movement of displacement front. By combining the date of density changes and pressure differences, we calculated water/gas effective permeability in gas-hydrate-bearing sediments.