Title
Field characterization of hydrate-bearing core using X-ray computed tomography

Author
Tomutsa, Liviu

Publication Date
2003-06-23

Field Characterization of Hydrate-Bearing Core Using X-Ray Computed Tomography

Barry M. Freifeld, Timothy J. Kneafsey, Jacob Pruess, and Liviu Tomutsa

Abstract

Natural gas hydrates are difficult to study because they are thermodynamically stable at temperature and pressure regimes that are drastically different from ambient conditions. Preservation and transport of hydrate-bearing samples from the field to the laboratory are controversial, with no clear scientific consensus on the best practice and possible adverse effects. To characterize hydrate-bearing samples in the field, we have developed a portable cone-beam x-ray computed tomography system that can determine the concentration and spatial distribution of hydrate in recovered samples. The x-ray system has been optimized to image whole-round cores (up to 9 cm in diameter) commonly retrieved during drilling operations. Tests on natural and synthetic cores (hydrate and sand mixtures) reveal the potential for this technique.

The field method is as follows: A recovered hydrate-bearing sample is preserved in an aluminum pressure vessel at the temperature and pressure of the natural environment from which it was retrieved. The aluminum vessel provides good transparency to x-rays and also reduces beam-hardening aberrations caused by a polychromatic x-ray source. By reducing the pressure and/or increasing the temperature outside the hydrate stability envelope, hydrate dissociation is induced. X-ray CT image sets are acquired during hydrate dissociation, and differences between the baseline image and subsequent images are used to determine the distribution and concentration of hydrate. Monitoring pressure and temperature changes, and measuring the volume of gas produced, provides a check on the total concentration of hydrate. We have determined kinetic properties of our dissociating synthetic hydrate/sand samples by studying the changes in the x-ray images as a function of time. Our results show that we can observe dissociation of a hydrate nodule a few millimeters in diameter, even when it resides in the center of a dense 75-millimeter core.