New England Research, Inc.
331 Olcott Drive, Suite L1
White River Junction, VT 05001 USA
+1 802.296.2401
www.ner.com

Boitnott, G. N., Miller, T. W. and Shafer, J. L. (2009) "Pore-Pressure Depletion and Effective Stress Issues in the Gulf of Mexico's Lower Tertiary Play" Proceedings of SPE Annual Technical Conference and Exhibition, 4-7 October, New Orleans, Louisiana, 2009.

Abstract

In this paper we present the results of our study of pore pressure depletion in the Gulf of Mexico's Lower Tertiary Play. Permeability and velocity measurements collected during multiple cycle stress paths are presented. We demonstrate how the data are used for evaluating effective stress coefficient and the calculation of net effective stress for compaction, permeability, and elastic wave velocities.

Rock properties models for the deep water Lower Tertiary sandstones need better calibration for conditions of high initial pore pressures and large pore pressure depletions. Available data indicates that inelastic pore compaction at high drawdowns is possible and significant permeability reduction may occur due to both elastic and inelastic deformations. Velocity changes in response to pore pressure need better calibration in order to improve both characterization and eventual reservoir monitoring activities.

Core measurements used to calibrate logs, interpret seismic data, and constrain reservoir simulations are commonly made at low pore pressures. To mimic reservoir conditions, the tests are performed at reduced external stresses, so as to compensate for the low pore pressures (P_p) used in rock testing. It is common practice to choose a net effective stress that is thought to result in identical rock properties. We show that due to a variety of pore pressure phenomena, the net effective stress for each property is different, and is a direct result of the fact that pore pressure and external stresses act in different ways, causing different stress distributions and deformations within the grains.

Our results lead to the conclusion that the "effective stress" should not be thought of as an equivalent state of stress. Failure to properly apply effective stress concepts can lead to potentially significant errors. For example, laboratory measurements of brine permeability indicate that for these sandstones, the routine core permeability measurements at low pore pressure may underestimate the in-situ rock permeability by 20% to 50% and underestimate permeability reduction due to depletion. Other examples include pore pressure effects that influence interpretation of stress and pore pressure from sonic and seismic data, where the effective stress coefficient has the added complexity of including both rock and fluid components.

Contact NER for more information.