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Shafer, J. L., Boitnott, G. N., and Ewy, R. T. (2008) "Effective Stress Laws for Petrophysical Rock Properties" Proceedings of SPWLA 49th Annual Logging Symposium, 25-28 May, Austin, Texas, 2008

Abstract

Effective stress laws and their application are not new, but are often overlooked or mis-applied. As we observe in deepwater GoM Lower Tertiary (LT) sands, the effective stress coefficient deviates significantly from one and can be quite different for different rock properties of interest.

As petrophysicists, log and core analysts, we need to be aware that pore pressure can have a significant impact on reservoir properties in ways not easily described using a simple effective stress law. These effects must be taken into account when applying measurements made in the laboratory for calibration of reservoir engineering models and calculation of rock mechanical properties from acoustic logs.

An effective stress law is a means to convert two variables, external stress (σ) and pore pressure (P p), into one equivalent variable (σ effective). One such expression would be σ effective = σ- a P p, where a is the "effective stress coefficient".

Every rock property; e.g. permeability, compressibility, and acoustic velocities, has its own effective stress coefficient. This coefficient is found to be less than 1.0 for many rock properties, is commonly thought to be 1.0 for strength and static elastic constants, and can be greater than 1.0 for permeability. Typically, the magnitude of the effective stress coefficient is dependent on the stiffness of the rock. Rocks having higher bulk compressibility tend to be characterized by effective stress coefficients closer to a value of 1.0 for a wider range of properties. However, when one combines stiff rock with very high pore pressures, as we observe in LT sands, the effective stress coefficients for many properties can be quite different from 1.0, and can be variable for different properties of interest. The effective stress coefficient for bulk volume compressibility, the Biot Coefficient a, is probably the most recognized. Often we find that it is substituted for the effective stress coefficient in effective stress laws for other rock properties such as S and P velocities. We will show that in many cases this may not be appropriate, and can lead to erroneous estimates of in situ stress, pore pressure, wellbore stability, and permeability

Contact NER for more information.