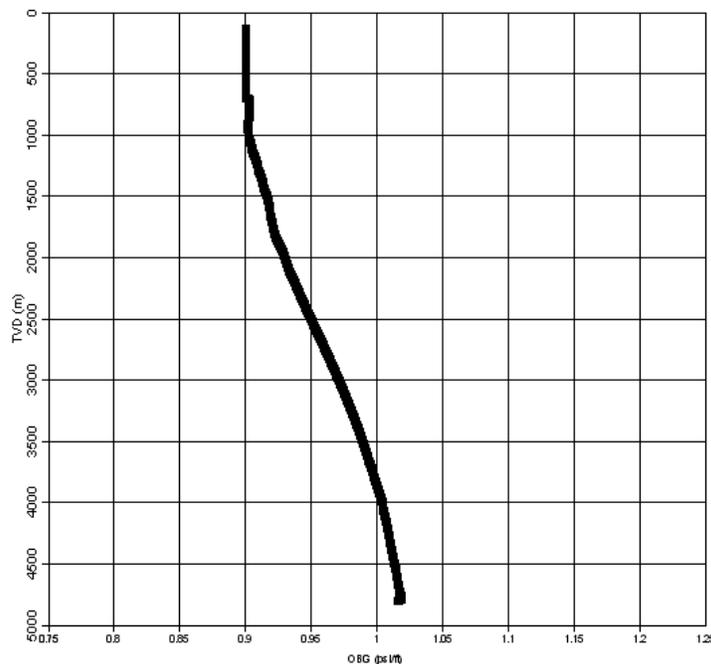


Rock Mechanical Properties Log Evaluation

Rock elastic properties are invaluable when designing well casing and mud weight programs, hydraulic (fracture) stimulation design and performing formation failure analysis. Prior to calculating formation elastic properties, shear and compressional sonic measurements and bulk density data are borehole corrected and normalized and then reconstructed over intervals where log data is invalid.

Afterwards, the classical elastic properties including Poisson's ratio, Young's modulus, Bulk modulus and Shear modulus are computed. Additionally, the Fracture Toughness Modulus¹ and the v_p/v_s ² ratio are computed.

Formation pressure stress properties are then computed. The first parameter needed is the overburden gradient (OBG) needs to be computed. Often the value is assumed to be 1 psi/foot. Although a reasonable assumption, the overburden gradient is not constant and the variability with depth can be critical with offshore wells drilled in deep water. The overburden gradient is determined by integrating the reconstructed bulk density data. The typical overburden gradient as a function of depth appears below.



Next, formation pressures are determined. They can be estimated, or can be derived from other measurements, such as formation testers or leak-off tests.

With Poisson's ratio, overburden and formation pressures known, the minimum and maximum horizontal stress and fracture initiation pressure can be determined by using the Terzaghi equation. Leak off tests can then be used as a test of computed results. When a sufficient number of leak-off tests have been performed, the leak-off tests can be used to calibrate fracture initiation models by modifying the Terzaghi assumptions and modeling formation anisotropy.

Fracture stimulation can be optimized by choosing intervals that are bounded by zones that have a higher fracture initiation pressure than designed constraints. The boundaries prevent migration of fractures into wet zones. By using the boundaries to keep the size of the fracture job within the limits of pumping equipment, adverse events can be prevented.

The elastic properties, fracture toughness modulus and v_p/v_s ratio, are plotted and boundaries can be readily recognized.

