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Nader C. Dutta[1], Mike Zimmer[2], Manika Prasad[2] (1) WesternGeco, Houston, TX (2) Stanford University, Stanford, CA

Rock Physics based Overpressure Detection

Shallow water flows (SWF) and over-pressured zones are a major hazard in deepwater drilling projects. Their detection prior to drilling would save millions of dollars in lost drilling costs. We investigate the sensitivity of seismic methods for this purpose. Using P-wave information alone can be ambiguous, because a drop in Vp can be caused both by overpressure and by the presence of gas. Since P-wave velocity in a suspension is slightly below that of the suspending fluid and Vs=0, Vp/Vs and Poisson's ratio must increase exponentially as a load bearing sediment approaches a state of suspension. On the other hand, presence of gas will also decrease Vp but Vs will remain unaffected and Vp/Vs will decrease. Thus Vp/Vs, which increases with overpressure and decreases with gas saturation, can help differentiate between the two cases. Analyses of ultrasonic P- and S-wave velocities in sands show that the Vp/Vs ratio, especially at low effective pressures, decreases rapidly with pressure. At very low pressures, Vp/Vs values can be as large as 10.

These laboratory measurements can be used to model seismic response of overpressure prone sediments. We present calculations of seismic reflectivity and AVO response of gas- and water saturated sands. We show how using rock physics based seismic simulations, we can not only differentiate between gas- and water-saturated sands, but also predict pressure changes within each case.