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APPLICATION OF GASSMANN'S MODEL IN HYDROCARBON-BEARING RESERVOIR CHARACTERISATION

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The effect of gas saturation and resultant decrease in acoustic impedance (density x velocity) in sandstone and carbonate reservoirs can be predicted from seismic wave propagation in a porous fluid-filled media and is commonly used in detecting hydrocarbon from seismic data before drilling.

The use of observed high amplitude or 'bright spot' as a direct hydrocarbon indicator, tacitly assumes that any pronounced lateral change in relative amplitudes can be attributed to a change in the hydrocarbon contents of the reflecting horizon. However, many important gas discoveries have been made in the absence of any 'bright spot' build-up on the seismic sections. This study attempts to explain the general lack of anomalous high amplitudes in charging a water-bearing layer with a gas from an innovative application of the Gassmann's equation. Density and velocity values from selected well logs, in conjunction with a judicious adjustment of various elastic module, are used to calibrate the Gassmann acoustic model.

From this study, we conclude that if water charged reservoirs have an initial gas saturation of as little as 2.5%, subsequent increase in gas saturation will only be reflected in a furthur but minor decrease in compressional wave velocity in the porous medium. We suggest this initial gas saturation is innate and derived from a biogenic origin. This results in 'normal' reflection amplitudes.

Secondly, for a given input value of porosity and compressional wave velocity, reduction of the grain bulk modulus towards a critical value will narrow the percentage velocity drop between a 100% water charged reservoir and a similar with initial 2.5% gas saturation. At the critical limit, the porous rock behaves like an elastic isotropic medium where the computed matrix bulk modulus equals that of the assigned input mineral bulk modulus. The presence of clay, siltstone and bounded waters within the reservoir matrix changes the computed value of frame bulk modulus. This results in 'normal' reflection amplitudes.
