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Determination of elastic constants using extended elastic impedance

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The accurate determination of physical properties such as porosity and permeability of reservoir rocks is essential in the evaluation of a petroleum reservoir. These properties are affected by the relevant elastic constants such as bulk modulus, Young modulus, shear modulus etc. Bulk modulus is a measure of a material's resistance to change in volume and is also known as incompressibility. The presence of porosity in a rock decreases the rock's resistance to change in volume and hence decreases its bulk modulus. This makes the bulk modulus a good porosity indicator especially in the presence of stiff rocks like carbonates. Young's modulus, also known as stiffness modulus, is a measure of the stiffness of a material. Again, increasing porosity of a rock decreases its stiffness and thus lowers its Young's modulus. However, this effect is not as strong as it is for bulk modulus because even with the lowering of the moduli with increase of porosity a carbonate rock frame is typically stiffer than other rocks such as shales and sandstones .In the light of above statements, Young's modulus can be a good lithology indicator. Further, such mechanical properties are needed by engineers engaged in hydraulic fracing, who are interested in the determination of the rock strength and pressure environments to optimize fracture treatments. Geologists and engineers are also interested in these properties to know in-situ stress regimes in naturally fractured reservoirs and to predict overpressured formations to reduce the risk of blow out. Thus, the determination of elastic constants is very important for drilling programs and the development plans for a reservoir. To address this, we have followed the extended elastic impedance inversion approach in order to characterize a reservoir comprising the Fernie Formation which is composed of sandstone, limestone and shale. Additionally, the presence of glauconite in the upper part of Fernie Formation compels us to identify it in the formation due to its importance for the interpretation of depositional environment and unconformities, stratigraphic correlation and reservoir quality prediction.

In this study, the different properties of a reservoir were obtained by following the extended elastic impedance and model based inversion. The computed $\lambda\rho$ and $\mu\rho$ showed a very good match with the computed logs. Considering the bulk and Young's modulus, one can gauge lithology and porosity variation in the considered reservoir. The volume of shale attribute was also obtained which showed encouraging results. The results were consistent with the available lithology information for the area of interest.