# Shear Velocity Prediction and its Rock Mechanic Implications

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## Abstract

Shear velocity is important in seismic inversion and petrophysical evaluation, particularly for evaluation of formation geomechanical properties. The shear (S-wave) velocity, compressional (P-wave) velocity and density can be used to estimate the Young's modulus, Poisson Ratio and Lame parameters in a petrophysical evaluation, which are helpful in determination of maximum and minimum horizontal stresses. However, the absence of the dipole shear sonic logs imposes severe limitations to such applications. Fortunately the S-wave velocity, P-wave velocity and density can be inverted using current advanced pre-stack seismic inversion technique from seismic AVO angle gathers (Russell et al. 2005). Like the petrophysical evaluations, the vertical stress, minimum and maximum horizontal stresses can also be estimated from the seismic inversion if the shear velocity is available. Gray (2010) has proposed method of estimating horizontal stresses for optimizing hydraulic fracturing locations using seismic data. In their stress estimations, however, no consideration was made to corporate petrophysical data.

In this paper, firstly we investigate the possibility to predict the shear velocity from well logs. Several methods have been proposed to evaluate rock mechanics dealing with sandstones with variable shale and hydrocarbon contents. Parameters for characterizing rock mechanical properties, such as Poisson Ratio, pore pressure and minimum/maximum horizontal stress can be estimated for each borehole with proper well logs. Whereas when seismic data is used for the same purpose, pre-stack seismic inversion is performed to estimate the S-wave velocity, P-wave velocity and density, and then calculate the Poisson ratio, pore pressure and minimum/maximum horizontal stress from the derivatives. Because of the uncertainty and resolution in seismic inversion, the direct method to infer the S-wave velocity and P-wave velocity from seismic data usually has limitation of poor resolution. Instead we propose the geostatistical inversion (Liu, 2009) to make the prediction of the shear velocity and other rock mechanical properties so that both seismic data and rock mechanical properties measured from well logs can be honored. The geostatistical inversion has proven to improve the inversion resolution and better incorporate the well logs.