A practical rock physics model for AvO studies in clastics and carbonates

Jarrod Dunne, Nexus Energy

A rock physics model for typical oil company AvO modelling and inversion applications would ideally possess the following attributes: 1) a sound physical basis; 2) as few free variables as possible; and 3) would predict measured P- and S-wave velocities for any lithology, porosity, pressure, temperature, pore-shape and pore-fluid. A formulation based on the doctoral research of Y. F. Sun into the dynamical theory of fractured porous media strikes a practical balance between these attributes, which are to some extent conflicting.

For a known lithology and porefill, the "Sun model" has only three parameters: porosity, gamma_K and gamma_Mu. A physical interpretation of the gamma_K and gamma_Mu parameters can be made by reformulating the original "Sun model" in terms of the dry rock bulk and shear moduli, where it becomes clear that they act as interpolators between the Voigt and Reuss bounds. In doing so, they elegantly bundle the remaining variables (i.e., pressure, temperature and pore-shape, to name a few) that, for a given porosity, can act to stiffen or soften a rock frame. They therefore represent coefficients in determining the stiffness of the pore-space to impinging compressional and shear waves.

These pore stiffness coefficients are claimed to be independent of porosity, which can be verified using well log datasets with high quality shear sonics. Applying this rock physics model to well log data from both clastic and carbonate environments results in a better fit to the data than many well known models. The examples also show that gamma_K and gamma_Mu are not generally equal in magnitude, which via the "Sun model" equations then implies that V_P/V_S ratios are porosity dependent. This challenges the assumption of linear V_P-V_S trends that is made in many seismic amplitude workflows.

Technical Area: Seismic attribute interpretation - distinguishing fluid and lithology signatures

PRESENTER PROFILE

Jarrod Dunne is a geophysicist at Nexus Energy in Melbourne. Prior jobs with Shell International and Woodside contributed to his special interest in seismic amplitude interpretation and its role in exploration and development. In 1996 he completed a Ph.D at Melbourne University focussing on seismic processing of deep seismic data from the Gippsland Basin. More recently his interests have broadened into petrophysics, rock physics, seismic interpretation and portfolio management. He is a member of the ASEG and SEG.

Email: jdunne@nxs.com.au