Rock Physics of Organic Shale and Its Implication

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Abstract

Using Eagle Ford shale as the main focus, we show most significant rock physics issues relating to both petrophysical and seismic inversion interpretation in organic shales in general. Starting with newly developed petrophysical model that allows us to quantify TOC, total porosity, organic porosity and saturation we proceed to the rock physics model designed for highly anisotropic unconventional reservoirs. The model is based on the key variables controlling elastic wave velocities: Mineral matrix, porosity, pore geometry, and effective stress. The latter is handled via the stress-dependent crack density term. Main aspects of anisotropy are treated using both small scale core measurements and Backus modeling of end-member lithologies to demonstrate that velocity anisotropy is primarily affected by clay particle and kerogen preferred orientation parallel to bedding plane. Anisotropic geomechanical properties of organic shales are investigated using both core and log data and rock physics templates are used to quanify fracture gradient from simultaneous acoustic and shear impedance inversion of prestack seismic data.