Integrated Characterization of a Gas-Shale

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Gas-shales are characterized by centimeter-scale vertical heterogeneity making it difficult to correlate any field measurements to the actual rock petrophysical properties. Geological description based sampling of cores facilitated the analyses of heterogeneity and then to distinguish the critical petrophysical parameters. Tracking total organic carbon content (TOC)-rich zones is particularly important in identifying hydrocarbon-rich intervals in gas-shales; however, TOC cannot be measured directly from field measurements. Laboratory measured petrophysical properties such as (i) mineralogy, (ii) porosity, (iii) bulk density, (iv) grain density, (v) high pressure mercury injection, (vi) total organic carbon content (TOC) and maturity, (vii) one compressional and two shear velocities were analyzed along with the observations made at microscopic and SEM-scale to evaluate the relationships between TOC and other petrophysical properties. Analyses of a silica-rich gas-shale reveal positive-linear correlations between TOC and quartz and porosity. Microstructural analyses indicate the presence of most pore-spaces within organic matter. Bulk density and compressional velocity exhibited inverse correlations with TOC. Transferring such detailed correlations derived from both core and well log data to elastic parameters then helped me to illuminate TOC-rich (potential high productive zones) zones as low impedance areas on the 3D surface seismic data. Young's modulus (E) and Poisson's ratio (ν) extracted from the pre-stack seismic inversion volumes, helped to track comparatively brittle layers at a regional-scale. Combination of volumetric seismic attributes illuminating geomorphology and natural fractures, TOC-rich (low impedance) and comparatively brittle layers (high E, and low ν) helped to fine-tune the potential exploration targets.