ACOUSTIC PROPERTIES AND THEIR DEPENDENCE ON POROSITY, MINERALOGY, AND SATURATION: APPLICATIONS TO FIELD-SCALE MEASUREMENTS

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Abstract A laboratory study was conducted to investigate the influence of porosity, mineralogy (shaliness), partial saturation and frequency on P and S velocities. Acoustic measurements were conducted at sonic (20-50 kHz) and ultrasonic (300-700 kHz) frequencies on shaly sandstones covering a range of porosities from 1 to 14% and clay content from 0 to 50%. To quantify the influence of mineralogy on acoustic properties, elastic moduli of the mineral phase were measured directly from drained, unjacketed mechanical tests.

Results of this study show that most of the scatter in the velocity-porosity relations is attributed to mineralogy and may be accounted for from the knowledge of shaliness. This is especially true for shear velocity which is strongly affected by clay content. For partial saturation we find that the velocity versus saturation relation is not modeled adequately using the Gassmann theory (1951). This is due to heterogeneities in the saturation at the microscopic scale and velocity dispersion due to intrinsic attenuation. We propose a relationship that takes into account saturation heterogeneities and local flow dispersion mechanism to describe the velocity dependence on partial saturation.

Results of this laboratory study were applied to the interpretation of sonic measurements in terms of porosity and saturation.