Velocity Measurements of Transverse-Isotropic GoM-EI Mudrocks

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ABSTRACT

Clay rich sediments are inherently anisotropic. This anisotropy is primarily due to the process of sedimentation followed by predominantly one-dimensional compression. The influence of the elastic anisotropy on the seismic velocities can often be quite strong. Having a better understanding of the magnitude of anisotropy in wave velocities will result in more accurate seismic imaging, soil properties interpretation, and pore pressure predictions. This research studies the evolution of elastic anisotropy with uniaxial compression. The measurement of five independent velocities make it possible to compute the stiffness and compliance matrix of a TI material at each stress level; the vertical and horizontal compressional and shear velocities, and the inclined compressional phase velocity that is calculated using the measured group velocity. Test results are provided for GoM-EI in the stress range of 1 to 10 MPa.

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$$\begin{bmatrix} \frac{1}{E_h} & \frac{-\nu_{hh}}{E_h} & \frac{-\nu_{vh}}{E_v} & 0 & 0 & 0 \\ \frac{-\nu_{hh}}{E_h} & \frac{1}{E_h} & \frac{-\nu_{vh}}{E_v} & 0 & 0 & 0 \\ \frac{-\nu_{vh}}{E_v} & \frac{-\nu_{vh}}{E_v} & \frac{1}{E_v} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2G_{vh}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2G_{vh}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{2G_{hh}} \end{bmatrix}$$

Fig 1: Compliance matrix including the moduli

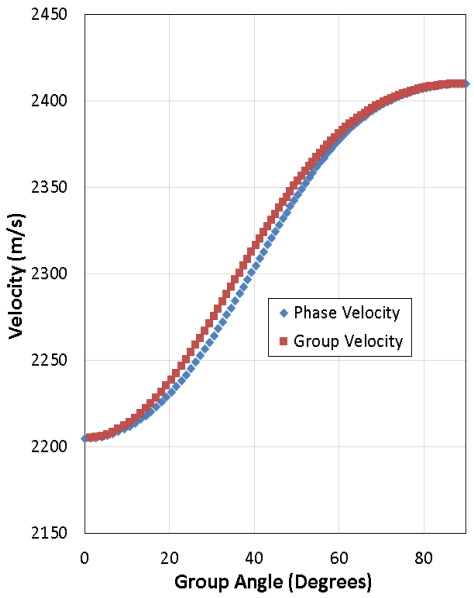

Fig 2: Phase angle and phase velocity are calculated using the measured velocities and angle, and a truncated Fourier-type cosine series

$$\begin{bmatrix} \frac{1}{E_h} & \frac{-\nu_{hh}}{E_h} & \frac{-\nu_{vh}}{E_v} & 0 & 0 & 0 \\ \frac{-\nu_{hh}}{E_h} & \frac{1}{E_h} & \frac{-\nu_{vh}}{E_v} & 0 & 0 & 0 \\ \frac{-\nu_{vh}}{E_v} & \frac{-\nu_{vh}}{E_v} & \frac{1}{E_v} & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2G_{vh}} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2G_{vh}} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{2G_{hh}} \end{bmatrix}$$

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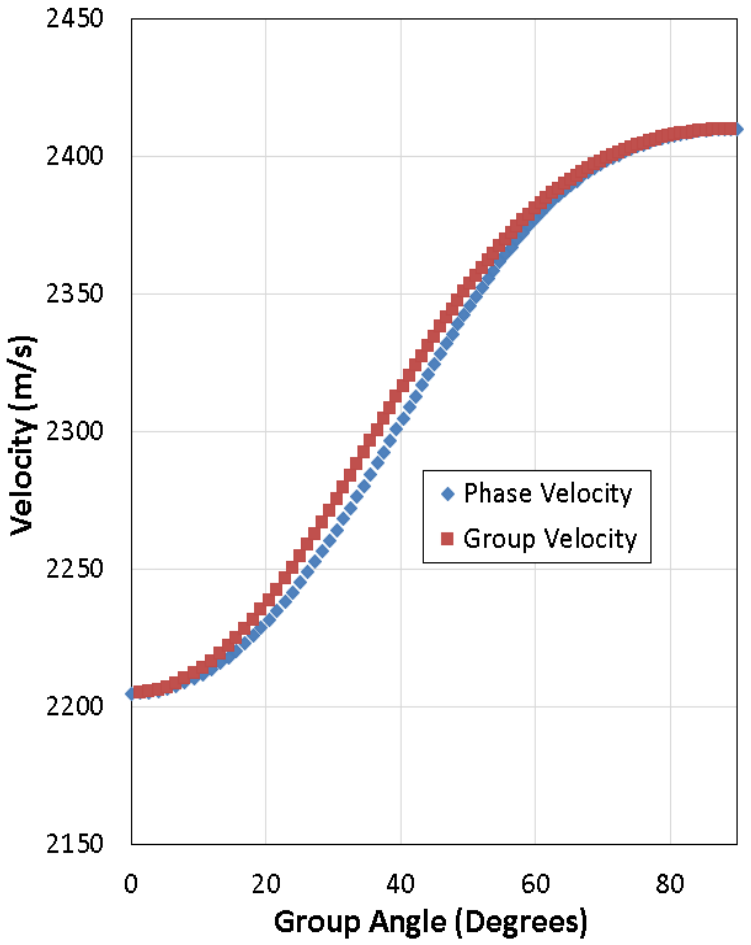

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