A GENERALIZED MODEL TO DESCRIBE THE ELASTIC STIFFNESS TENSOR OF MUDROCKS BASED ON THE FULL STRAIN TENSOR

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ABSTRACT

We develop a three-step framework to model the anisotropic elastic properties of a mechanically compacted mudrock based on the full strain tensor. We model the microstructure as an effective medium representative of locally aligned domains of clay grains and porosity with isolated quartz. Then we predict the orientation of these domains due to the application of any strain field. Finally, the previous two steps are combined to determine an effective medium model for the entire mudrock that predicts the elastic stiffness matrix. We focus on the relationship of deformation to porosity reduction and grain alignment in mudrocks. Our results show that the application of axial loading leads to the development of elastic anisotropy with stiffnesses increasing more rapidly in the direction perpendicular to the loading. These stiffness predictions closely match experimental data on a mudrock specimen from Eugene Island – Gulf of Mexico. We further apply our three-step framework to predict elastic stiffnesses in a salt basin based on the full strain tensor predicted by an evolutionary poromechanical model. This coupling allows us to predict elastic stiffnesses and anisotropy due to sediment deposition and non-uniaxial salt loading. Accurate estimation from elastic stiffnesses of mudrocks can help improve pressure prediction, seismic imaging in complex geologic environments, and prospect evaluation.

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