

Isotropy: A Lethal Assumption in Geomechanical Modeling of Shale

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Abstract

By definition, anisotropy is variation of material properties with direction. Preferred orientations of minerals, layering, cleavage, schistosity, foliation, and micro-fractures are the main sources of rock anisotropy. Shales are composed of thinly layered sequences of aligned microscopic clay platelets and consequently exhibit strong anisotropic properties at any scales.

Anisotropy has a pronounced effect on the physical and mechanical properties of shale, including acoustic wave propagation, deformation, strength, failure mode, fracturing etc. These changes in the mode of deformation and failure, in turn, influence the routine geomechanical analyses such as wellbore stability, trajectory optimization, hydraulic fracturing, porosity-permeability evolution, and compaction. Dependent on the inclination of the anisotropy with respect to the principal stress direction, and of course, wellbore orientation, the effect of anisotropy on shale behavior can vary significantly. Ignoring anisotropy can impose significant additional cost to the shale oil/gas industry and sometimes can even lead to the failure of drilling and production operations.

In this presentation, the overriding effects of anisotropy on shale behavior and its importance in developing shale plays are discussed. Laboratory and field techniques to determine and include anisotropy in geomechanical studies are presented.