Hydraulic fracture growth in transversely isotropic rocks

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Anisotropic rocks are ubiquitous in nature. In particular at metric to decametric scales, sedimentary rocks exhibit a transverse isotropy associated with beddings. In this talk, I will discuss the impact of such type of anisotropy on the growth of fluid-driven fractures in the case of normal and strike-slip in-situ stress regimes where the fractures grow vertical perpendicular to the horizontal layering. We will discuss the effect of both elastic properties and fracture energy on the development of hydraulic fracture from a wellbore under constant injection rate – assuming the rock to be impermeable for simplicity. A detailed presentation of the extension to transverse isotropy of numerical methods for the simulation of hydraulic fracture growth based on a level set description will be given. A number of verifications of the proposed numerical scheme will be presented against growth solutions in the toughness dominated regime for a specific type of fracture energy anisotropy leading to elliptical fractures. I will also highlight important gaps in our knowledge of anisotropic rock fracture properties, and especially how the detailed evolution of fracture energy between the so-called divider and arrester directions strongly impact the ultimate shape of hydraulic fractures. Typical transverse isotropy encountered in practice leads to significant horizontal elongation and is thus an intrinsic mechanism for the height containment of hydraulic fractures in the absence of in-situ stress contrast – possibly explaining why stronger height containment is observed compared to the predictions of isotropic models in practice.

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