ON THE SEISMIC RESPONSE OF FRACTURES AND INDUCED ANISOTROPY IN FLUID-SATURATED POROUS MEDIA

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ABSTRACT

A planar fracture embedded in a fluid-saturated poroelastic - Biot - medium can be modeled either as a extremely thin, highly permeable and compliant porous layer or employing suitable boundary conditions. First we analyze the seismic response at a single fracture separating two poroelastic half spaces. Then the macroscale seismic response of an heterogeneous Biot medium containing a dense set of aligned fractures is determined using a Numerical Rock Physics approach. Under symplifing hypothesis, it has been shown that this medium behaves as an effective transversely isotropic and viscoelastic (TIV) medium. Our approach allows to determine the complex TIV coefficients for the general case of highly heterogeneous saturant fluids and fracture petrophysical properties. P-waves and S-waves seismic waves traveling in this type of medium show frequency and angular variations of velocity and attenuation due to the mesoscopic loss mechanism caused by slow (diffusion) Biot waves generated at mesoscopic-scale heterogeneities. We apply a set of compressibility and shear harmonic finite-element (FE) experiments on representative samples of fractured highly heterogeneous Biot media to determine the five complex and frequency dependent stiffnesses characterizing the equivalent TIV medium at the macroscale. Also, we illustrate the propagation of waves at the macroscale for the case of horizontal and vertical aligned fractures employing the equivalent TIV media determined using our Numerical Rock Physics approach.