CHARACTERIZATION OF SATURATED POROUS ROCKS WITH OBLIQUELY DIPPING FRACTURES

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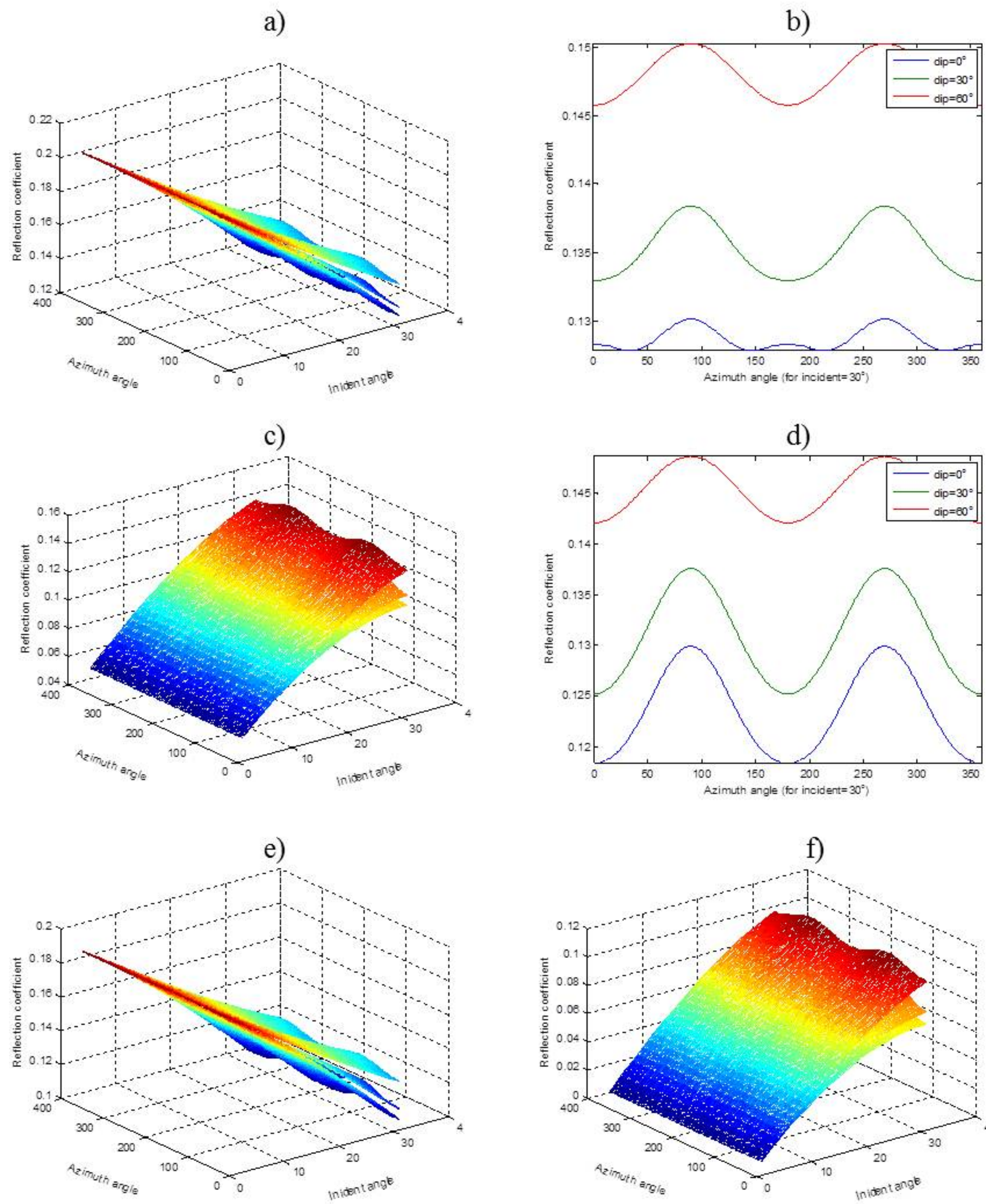
ABSTRACT

Elastic properties, fracture parameters and amplitude variation with offset and azimuth (AVOA) of fluid saturated porous media with obliquely dipping fractures are studied. Effective stiffness and anisotropy parameters for porous media with vertical fractures are studied using Gassmann's equation for linear-slip theory and fractured models developed by Hudson and Thomsen. Linear-slip theory and Hudson's model for penny-shaped cracks can be used to relate the anisotropic parameters to the fracture properties. Considering porous rocks with saturated penny-shaped cracks and hydraulically connected cracks and pores, normal and tangential weakness of the fractures are related to fluid factor, and can be obtained by making the anisotropic parameters for linear-slip model be identical to anisotropic parameters given by Thomsen. The effect of fluid infill on elastic properties is investigated. Using the Bond transformation, the stiffness matrix of the dipping fractured medium can be obtained. Then, characterization of fluid saturated porous rocks with obliquely dipping fractures is investigated, and variation of reflection coefficients as a function of azimuth and incidence angle is analyzed. For the saturated porous rocks with obliquely dipping fractures, the effect of porosity, fluid infill and dipping angle on horizontal and vertical velocities, anisotropic parameters and reflection coefficients are examined. In the end, we estimated the dip of dipping fractures by AVOA analysis, and obtained fracture parameters from synthetic reflection data. Results show that this estimation method yields dip angle with reasonable accuracy, and inversion results are consistent with the model.



The effect of porosity and fluid infill on amplitude variation with azimuth and incidence angle is shown. Small porosity of 10% and large porosity of 25% are considered. a) and b) are water saturated fractured porous model with porosity of 10%; reflection amplitude decreases with the increase of incident angle. c) and d) are water saturated model with porosity of 25%; reflection amplitude increase with the increase of incident angle. For small incident angle, reflection coefficient variation with azimuth is almost not visible. This is because the fracture density is small. The variation with azimuth is more visible for larger porosity. For gas saturated fractured porous rock e) and f), we obtained similar results.