

Seismic Implications of Moveable Fluids

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ABSTRACT

Research into mesoscopic-scale heterogeneities and the associated fluid flow have indicated a possible mechanism for attenuation within the seismic bandwidth. This attenuation is due to a pressure gradient on the subwavelength scale as the fluids are pushed through the pores (Muller and Gurevich, 2005, Muller et al. 2010). In addition, the attenuation has an associated dispersion. This combination will lead to a frequency dependent effect at the interface of a porous zone with a non-porous zone and within the porous zone. Several authors have proposed effective-medium models for studying these mesoscopic-scale systems.

Silin & Goloshubin, (2010) demonstrated that parameters such as tortuosity and pore size becomes negligibly small at seismic frequencies and proposed an asymptotic solutions to seismic wave propagation in porous layers. White et al. (1975) and White (1975) developed a patchy saturation model which included a low-frequency approximation of the effective P-wave in a medium with spherical inclusions. Several studies have been derived from this work. These include Dutta and Seriff, 1979 and Johnson 2001. Carcione et al. 2003 and Carcione and Picotti, 2006 derived the equations for a visco-elastic effective-medium model from White (1975) and recently, Kudaraova et al. 2013 and Kudaraova et al. 2014 have proposed a poroelastic model for wave propagation in periodically layered media. The attenuation and dispersion effects in these various models result in a frequency dependent velocity (FDV) in the porous layer.

Considering the possibility of a frequency dependent velocity due to fluid effects in a porous/permeable layer, raises the question of what is the effect on seismic data. How does it alter the frequency content and the phase of the reflected wave and what effect does it have on the amplitude. To investigate these questions, we developed a simple modeling algorithm which includes Shuey's approximation to Zoeppretz's reflection coefficients and FDV in selected layers.