C013 ABOUT THE RELATION BETWEEN THE EFFECTIVE MODEL OF LAYERED FLUID-SOLID MEDIUM AND TRANSVERSELY ISOTROPIC BIOT MODEL

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Investigation of wave propagation in porous and fractured media is usually carried out on basis of effective models because it is impossible to solve the wave diffraction problem on one or several pores of arbitrary shape. One of such model is effective model of layered solid-fluid medium. This model with describing equations have been derived by one of the authors in 1979 [1]. New method have been developed while deriving this model. It generalized well-known results of G.Backus on constructing of averaged models of layered media [2] and permitted to derive a number of another effective models. Using deduced equations of the effective model formulae for wavefields in such medium were constructed and investigated. In particular the wavefronts from a point source were derived (Fig.1). Mentioned effective model was experimentally verified in work of T.Plona, K.Winkler and M.Schoeneberg [3]. Theoretical investigation of the model was also carried out by M.Schoeneberg [4]. He has deduced slowness relations and constructed wavefronts from slowness curves for long waves which are coincident with that of Fig.1.

Another model of porous and fractured medium is Biot model [5]. Both mentioned effective models are two-phase and applicable only when pores and fractures are densely distributed. Both models have high-frequency limitation which is not essential for real seismic media. In this paper we establish relation between these two models of porous and fractured media.

Since effective model of alternating fluid-solid medium is transversaly isotropic it is appropriate to compare it with transversaly isotropic Biot model. As this Biot model is characterized by 13 parameters while the effective model of layered medium is defined by only 7 ones then it is useful to consider several intermediate models for establishing their relation. In order to account all parameters of 3-dimensional wavefield in transversaly isotropic Biot model it is sufficient to investigate separately 2-D waves $P_2 - P_1 - SV$, analogous to $P - SV$ waves in elastic medium, and SH waves. For every intermediate model we construct wavefronts from point source and determine velocities of wave propagation along anisotropy axes. The equations and expressions for kinetic and potential energy are given for every 2-D model. As a result of investigations we conclude that the effective model of layered fluid-solid medium is a partial case of transversaly isotropic Biot model. To some extent this conclusion justifies Biot model derived on basis of physical hypotheses because the effective model of alternating fluid-solid medium corresponds to the wavefield asymptotics when interfaces are very dense [6].

Additional result of this investigation is discovery of complex loops on SV wavefronts which we call double loops (Fig.2). It is known that on wavefronts in elastic media only

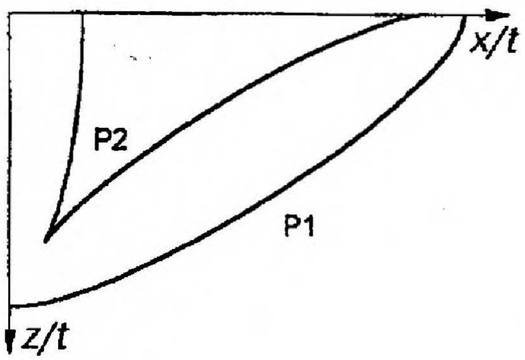

Fig. 1. Wavefronts in the effective model of layered fluid-solid medium

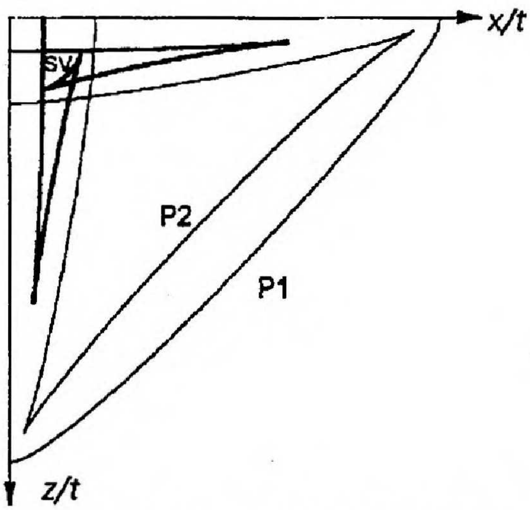

Fig.2. Double loops on SV wavefront in transversaly isotropic Biot model

single loops may exist which are situated ahead of the front and have concave regions between cusps. Double loops in transversaly isotropic Biot model have additional loop which is behind of main one and has convex region between cusps. Another feature of anisotropic Biot model is that on the same wavefront polarization may change from pure longitudinal to pure transverse and vice versa. Mentioned features of wave propagation in Biot model are unique and do not exist in nonporous media and consequently may be used for direct detection of anisotropic reservoirs. A part of results of this paper is presented in [7].

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