Estimation of local anisotropy from the qP-wave VSP data

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Summary

In this contribution the inversion scheme proposed by Zheng and Pšenčík (2002) is further investigated. It is tested on synthetic qP-wave data from a multiazimuthal multiple-source offset VSP experiment. Two models of vertically inhomogeneous anisotropic factorized media are considered. The first is triclinic, see Eq.(12), the other is orthorhombic with inclined axis of symmetry, see Eq.(13).

The first model was used to study dependence of the results of the inversion on the choice of the wave normal n_i in the reference isotropic medium, on the choice of the velocity of the reference isotropic medium, on the number and orientation of profiles, number and type of the considered waves (direct, reflected qP wave). The second model was used to model the experiment in the Java Sea region, see Horne and Leaney (2000), Gomes et al. (2003). Configuration is shown in Fig.1.

For both models sensitivity analysis based on the study of the resolution matrix showed that the inversion results do not depend on the choice of the reference medium and on the choice of the wave normal in it. The analysis also showed which are the optimum profile configurations and which parameters can be found for a given number of profiles. Sensitivity analysis was followed by the study of stability of inverted parameters of the medium. The RHS of Eq.(8) was successively contaminated by the noise whose standard deviations varied from 1% to 50% of the maximum value of the RHS. For each noise level mean and standard deviations of the parameter estimates were calculated from results of 100 inversions. It was found that for anisotropy upto 20% and for strong heterogeneity, the results practically do not change if the wave normal is chosen in the direction connecting the source with the receiver, by ray tracing in the reference medium or by specifying it parallel to the observed polarization vector. It was also found that consideration of direct and reflected wave separately or together does not affect results very much. Joint inversion, however, increases stability of the well determined parameters.

Table 1 shows results for the the triclinic model with 10% noise used on the RHS of Eq.(8). The table contains exact (Exato) and estimated (Estim) values of the WA parameters, their standard deviation (Desv.padr.). For completness, also exact and estimated values of elastic parameters or of their combinations are shown in the two last columns of Table 1.

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The data for the second model were collected along a single profile like in the Java Sea experiment. Like in Gomes et al. (2003), three types of inversion were made: ANI - with no assumption about anisotropy of the medium, TIV - assuming transverse isotropy with vertical axis of symmetry and ISO - assuming isotropy of the medium. The results corresponding to the noise of 30% are shown in Table 2. Table 2 contains the same columns as Table 1. Only the last column shows range in which the estimated elastic parameters can vary. Figs. 2 and 3 correspond to Figs.2 and 3 of Gomes et al. (2003). In Fig.2, "observed" data contaminated by 30% noise are red, the results of inversion ANI are blue. In Fig.3, the "observed" data are again red, the ANI results are blue, TIV results are black and ISO results are violet. Results of the inversion indicate clearly that the studied medium does not have vertical axis of symmetry.

References

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