

MULTI-SCALE JOINT TOMOGRAPHY

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A 2D consistent imaging workflow based on slope (or slowness) tomography was developed during the last decade. Initially, the tools were devoted to reflection marine surface data. Applications to various pre- and post-drilling surface seismic real datasets have demonstrated the successful use of slope tomography for fast recovery of isotropic background media. The first key point of the method is the joint use of travel times and slopes as tomographic input data: a full constraint on the ray trajectory is obtained, and then the usual velocity/depth trade-off is significantly reduced. Second, the modelling is based on ray and paraxial ray tracing allowing fast propagation and Fréchet derivatives computation. Finally, the multi-scale implementation of the inverse problem leads both to fast computation and to better convergence towards a solution.

In the last years, the slope tomography was generalized in order to jointly use transmitted data in addition to reflections and diffractions, from various acquisition geometries. The slopes may be measured on the topography, on the sea floor or in boreholes. Consequently, the simulated slowness vectors are fully computed and then projected on the local measurement plane. In case of transmitted data, only one slope is necessary for constraining the propagation, compared to two slopes when considering reflection data.

For instance, we have illustrated on synthetics how Walk-Away transmitted arrivals, jointly inverted with surface reflections, do improve a model previously built from surface data only. The joint tomography also allows an intrinsic well-tie of reflection seismic. Moreover, thanks to the multi-scale approach, refinement of the model has been possibly obtained. The added value of transmitted arrivals was not only limited to the close vicinity of the borehole, but had a significant impact on the whole model. In the same way, combination of reflection and refraction data in land processing, thus combination of near-vertical and near-horizontal propagations, provides good independent constraints and increase the inversion reliability. New imaging opportunities may be considered in the future thanks to Seismic While Drilling or alternative acquisition geometries in case of difficult targets or masked structures.

In this context of data integration an important factor that must be accounted for is anisotropy. Isotropic slope tomography, as any other tomographic method, tends to produce systematic localization and velocity errors when the medium is anisotropic. Thus, the method was updated in order to estimate a velocity model which may be anisotropic (VTI). The main conclusions from applications of anisotropic integrated tomography are the following: the use of anisotropic integrated tomography significantly improves layer description, well-tie and convergence towards the final model.

The basic principles of the multi-scale joint tomography will be presented. The method will be illustrated on examples from synthetic and real data sets.