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Review of inversion techniques using analysis of different tests

T. A. Smaglichenko
Institute of Oil and Gas Problems, Russian Academy of Science, Moscow, Russian Federation (krutas39@yahoo.com)

Tomographic techniques are tools, which estimate the Earth's deep interior by inverting seismic data. Reliability of visualization provides adequate understanding of geodynamic processes for prediction of natural hazard and protection of environment. This presentation focuses on two interrelated factors, which affect on the reliability namely: particularities of geophysical medium and strategy for choice of inversion method. Three main techniques are under review. First, the standard LSQR algorithm is derived directly by the Lanczos algebraic application. The Double Difference tomography widely incorporates this algorithm and its expansion. Next, the CSSA technique, or method of subtraction has been introduced into seismology by Nikolaev et al. in 1985. This method got farther development in 2003 (Smaglichenko et al.) as the coordinate method of possible directions, which has been already known in the theory of numerical methods. And finally, the new Differentiated Approach (DA) tomography that has been recently developed by the author for seismology and introduced into applied mathematics as the modification of Gaussian elimination. Different test models are presented by detecting various properties of the medium and having a value for the mining sector as well for prediction of seismic activity. They are: 1) checker-board resolution test; 2) the single anomalous block surrounded by an uniform zone; 3) the large-size structure; 4) the most complicated case, when the model consist of contrast layers and the observation response is equal zero value. The geometry of experiment for all models is given in the note of Leveque et al., 1993. It was assumed that errors in experimental data are in limits of pre-assigned accuracy. The testing showed that LSQR is effective, when the small-size structure (1) is retrieved, while CSSA works faster under reconstruction of the separated anomaly (2). The large-size structure (3) can be reconstructed applying DA, which uses both Lanczos's method and CSSA as composed parts of the inversion process. Difficulty of the model of contrast layers (4) can be overcome with a priori information that could allow the DA implementation. The testing leads us to the following conclusion. Careful analyze and weighted assumptions about characteristics of the being investigated medium should be done before start of data inversion. The choice of suitable technique will provide reliability of solution. Nevertheless, DA is preferred in the case of noisy and large data.