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Effective optimization methods of solving of inverse problems for horizontally-layered medium

ABSTRACT

of the dissertation on competition of a scientific degree of doctor of philosophy (PhD) on specialty 6D060100 – "Mathematics"

The relevance of the theme. In the problems of interpretation of geophysical data it is necessary to define not only electromagnetic parameters or elastic parameters, but also coordinates of the gap points of the layers. In geophysics there is a number of the ways for finding of these boundaries, but all these ways are not accurate and errors can reach several meters. For example, when defining of boundaries in the borehole the probe is attached to the rope, which may be stretched.

In this regard for application of an optimization method to determine the gap point of the medium needs to be able to differentiate residual functional with respect to a coordinate of gap point of the medium. When using the optimization method it is necessary to use iterative method, so we need to build economical method for solving direct and inverse problems.

Therefore development and theoretical researches of effective algorithms of an optimization method of solving the inverse coefficient problems for the equations of hyperbolic and parabolic type is actual.

The objects of research are the inverse and incorrect problems for the equation of electrodynamics and the theory of elasticity, and optimization methods of their solution.

The objects of research are the inverse coefficient problems for the equation of geoelectric and elasticity theory in the horizontally stratified medium.

The goal and objectives of research. The purpose of dissertation work is development and theoretical researches of effective methods of solving the inverse problems for the equations of geoelectric, elasticity theory in the horizontally stratified medium. Research problems consist in theoretical justification optimization methods of solving the inverse problems, also: proof of differentiability of residual functional with respect to a coordinate of gap point of medium for the equations of geoelectric and elasticity theory, conditional stability; development of effective algorithms for the numerical solving of considered inverse problems.

Scientific novelty of research is to obtain the following results:

- obtained the formulas for calculating the gradient of the functional for solving the inverse coefficient problems for the equation of geoelectric (taking into account air influence).
- obtained the estimate of conditional stability of solving the inverse problems for the equation the geoelectric, formulated in integrated statement;
- obtained formulas for calculating the gradient of the functional and proved its differentiability with respect to a coordinate of gap point of medium for the equation of geoelectric;

- proved the differentiability of the residual functional with respect to a coordinate of gap point of medium for the equations of elasticity theory;
- received an algorithm for the simultaneous determining of the coefficient and a coordinate of gap point for the geoelectric equation on the basis method of layer-by-layer recalculation;
- proved the coherence of differential algorithm of the interfaced task to initial in a discrete inverse coefficient problems for the equation geoelectric (in case of a time field;
- determined the criteria of a choice of frequency region on the basis of the numerical solution of the inverse coefficient problems for the geoelectric equation by a method of layer-by-layer recalculation;
- performed the analysis of numerical calculations of the geoelectric inverse problems by using the consistent difference algorithms;
- adduced the engineering techniques for interpretation of radarogram based on a series of experimental research using the device "GPR "Loza B".

The theoretical and practical importance of research is following:

- Estimation of conditional stability of the solution of the inverse geoelectric problem allows determine the domain of correctness and is used in the construction of numerical methods for solving inverse problems.
- Differentiability of residual functional with respect to the coordinates of gap points of medium for the solution of the inverse problems for the geoelectric equation and elasticity theory allows receiving a gradient of functional in an explicit form in the gap points and consequently to determine gap coordinates. It is important in problems of diagnostics of conditions of subsurface coverings, in particular diagnostics of runways of airfields.
- The method of layering recalculation taking into account coordinates of the gap points is used in the construction of efficient methods for solving inverse problems in acoustic, geoelectric, seismic data in the case of a horizontally stratified media.
- Algorithms according to the numerical solution of the inverse geoelectric problems in the time field are applicable in problems of reconstruction of conductivity of the medium at considerable depths.
- The theoretical importance of dissertation work consists in the developed technique of construction is coherence - conjugate finite schemes of solving the inverse problems in discrete statement by an optimizing method.

Results of the work are a contribution to development of theoretical justifications of numerical methods of the solution of the inverse coefficient problems of acoustic, geoelectrics, seismic and can be used by the research institutes dealing with issues of seismic exploration, electroinvestigation. The technique of creation of algorithms and theoretical justifications of numerical methods of the solution of the inverse problems considered in the thesis, can be applied in development and to theoretical researches of algorithms to the solution of the inverse problems for a wide class of the inverse problems the geoinvestigations, using nondestructive methods of research, that is with application of a georadar.

Publications. On the topic of the dissertation are published following works: 2 articles in the international scientific journals with an impact-factor, 7 articles in the scientific journals, which recommended by Committee on control in education and science of the Ministry of Education and Science of Republic Kazakhstan, 8 theses of the international conferences and congresses, 1 teaching methodical manual.

The structure and volume of the dissertation. The dissertation work consists of introduction, four chapters, conclusion, a list of used references of 88 items and annexes. The work is set out on 95 pages; there are 22 figures and 6 tables in annexes.