New Advances in 3D Imaging of Sea-bottom EM Data for Offshore Petroleum Exploration

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During recent years a significant progress has been made in developing new mathematical methods and computer codes for interpretation of the sea-bottom electromagnetic (EM) data for offshore petroleum exploration. In this paper I present an overview of effective imaging techniques, which include the fast sea-bottom EM imaging based on the principles of electromagnetic migration, different types of integral representations for EM responses in the receivers, and regularized inversion. Electromagnetic migration, similar to seismic migration, is based on a special form of downward continuation of the observed field, which can be computed as a solution of the boundary value problem for the adjoint Maxwell's equations, in which the boundary values of the migration field on the earth's surface are determined by the observed EM data. It is shown that EM migration can be treated as an approximate solution of the corresponding EM inverse problem.

Another approach is based on iterative quasi-linear (QL) inversion with the accuracy control using rigorous integral equation (IE) method. In the framework of this approach the background conductivity may be formed by a layered formation, or may be described by arbitrary conductivity distribution. This allows us to incorporate known information about the geoelectrical structures in the inversion and keep it unchanged during the inverse process.

The new imaging methods are tested on the typical models of the sea-bottom EM surveys for offshore petroleum exploration, including magnetotelluric (MT) surveys and Seabed Logging (SBL) synthetic data.