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2.5D complex resistivity modeling and inversion using unstructured grids

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The characteristic of complex resistivity on rock and ore has been recognized by people for a long time. Generally we have used the Cole-Cole Model(CCM) to describe complex resistivity. It has been proved that the electrical anomaly of geologic body can be quantitative estimated by CCM parameters such as direct resistivity(ρ_0), chargeability(m), time constant(τ) and frequency dependence(c). Thus it is very important to obtain the complex parameters of geologic body. It is difficult to approximate complex structures and terrain using traditional rectangular grid. In order to enhance the numerical accuracy and rationality of modeling and inversion, we use an adaptive finite-element algorithm for forward modeling of the frequency-domain 2.5D complex resistivity and implement the conjugate gradient algorithm in the inversion of 2.5D complex resistivity.

An adaptive finite element method is applied for solving the 2.5D complex resistivity forward modeling of horizontal electric dipole source. First of all, the CCM is introduced into the Maxwell's equations to calculate the complex resistivity electromagnetic fields. Next, the pseudo delta function is used to distribute electric dipole source. Then the electromagnetic fields can be expressed in terms of the primary fields caused by layered structure and the secondary fields caused by inhomogeneities anomalous conductivity. At last, we calculated the electromagnetic fields response of complex geoelectric structures such as anticline, syncline, fault. The modeling results show that adaptive finite-element methods can automatically improve mesh generation and simulate complex geoelectric models using unstructured grids.

The 2.5D complex resistivity invertion is implemented based the conjugate gradient algorithm.The conjugate gradient algorithm doesn't need to compute the sensitivity matrix but directly computes the sensitivity matrix or its transpose multiplying vector. In addition, the inversion target zones are segmented with fine grids and the background zones are segmented with big grid, the method can reduce the grid amounts of inversion, it is very helpful to improve the computational efficiency. The inversion results verify the validity and stability of conjugate gradient inversion algorithm.

The results of theoretical calculation indicate that the modeling and inversion of 2.5D complex resistivity using unstructured grids are feasible. Using unstructured grids can improve the accuracy of modeling, but the large number of grids inversion is extremely time-consuming, so the parallel computation for the inversion is necessary.

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