地球物理学报 » 2012, Vol. » Issue (6) :2141-2152 doi:10.6038/j.issn.0001-5733.2012.06.036
应用地球物理

引用本文(Citation):
张烨, 汪宏年, 陶宏根, 杨守文.基于耦合标势与矢势的有限体积法模拟非均匀各向异性地层中多分量感应测井三维响应. 地球物理学报, 2012,(6): 2141-2152,doi: 10.6038/j.issn.0001-5733.2012.06.036

ZHANG Ye, WANG Hong-Nian, TAO Hong-Gen, YANG Shou-Wen.Finite volume algorithm to simulate 3D responses of multi-component induction in inhomogeneous anisotropic formation based on coupled scalar-vector potentials.Chinese J.Geophys. (in Chinese),2012,(6): 2141-2152,doi: 10.6038/j.issn.0001-5733.2012.06.036

基于耦合标势与矢势的有限体积法模拟非均匀各向异性地层中多分量感应测井三维响应

张烨[1], 汪宏年[1], 陶宏根[2], 杨守文[1]*

1. 吉林大学物理学院, 长春 130012;
2. 大庆钻探工程公司测井公司, 大庆 163412

Finite volume algorithm to simulate 3D responses of multi-component induction tools in inhomogeneous anisotropic forma based on coupled scalar-vector potentials

ZHANG Ye[1], WANG Hong-Nian[1], TAO Hong-Gen[2], YANG Shou-Wen[1]*

1. School of Physics, Jinlin University, Changchun 130023, China;
2. Wireline Logging Company, Daqing Drilling Engineering Company, Daqing 163412, China

摘要 | 参考文献 | 相关文章

Download: PDF (2441KB) HTML 1KB Export: BibTeX or EndNote (RIS) Supporting Info

摘要 为快速有效地研究、考察各向异性地层条件下多分量感应测井的响应特征,本文利用电场标势与矢势的有限体积法研制出三维频率域电磁场响应的数值模拟算法,克服由低频发射或高阻地层产生的低感应数问题,有效提高了三维电磁数值模拟算法的应用范围和计算效率.首先利用电场的标势与矢势将Maxwell方程转化为满足库仑规范条件的耦合势Helmholtz方程,以Yee氏交错非均匀网格中不同位置上的节点为中心建立四种控制体积单元,通过对控制体积单元中电磁场与电导率的积分平均实现耦合势方程和磁偶极子旋度的离散,并得到一个对角占优的大型稀疏复线性代数方程组,然后,通过不完全LU分解预处理和稳定双共轭梯度法快速求解离散方程.数值结果证明了该算法的有效性,并进一步考查了仪器偏心、倾斜井、垂直裂缝等复杂条件下多分量感应的响应特征.

关键词 多分量感应测井, 有限体积法, 非均匀各向异性介质, 稳定双共轭梯度法

Abstract: In order to efficiently investigate the 3D responses of the multi-component induction logging (MCIL) tool in complex anisotropic formations, we apply a novel finite volume forward method to establish the 3D numerical simulation of the EM fields based on the coupled scalar-vector potentials. As the results, we overcome the low induction number problems (LINs) in both the low frequency domain and high resistivity formation, extend the application range of the 3D EM modeling and enhance its efficiency. We first reformulate Maxwell's equation into Helmholtz equations in terms of coupled scalar-vector potentials with Coulomb gauge. According to the different location of node in the Yee's non-uniform staggered grids, we set up four kinds of control volume cells. With volume integral averaging of both the EM fields and conductivity tensor on the control volume, we discretize the Helmholtz equations and the rotations of magnetic dipole sources successfully. After that, we obtain a large, sparse and complex linear system with a block diagonally dominant structure. A combination of bi-conjugate gradient stabilization (BICGSATB) with an incomplete LU-decomposition preconditioner is efficiently applied to iteratively solve the system. Numerical results validate the algorithm and we further investigate the characteristics of MCIL responses in the different cases such as tool eccentricity, dipping well and vertical fracture.

Keywords Multi-component induction logging (MCIL), Finite volume method, Inhomogeneous anisotropic media, Bi-conjugate gradient stabilization (BICGSATB)

Received 2011-10-31;

Fund:

(40874058) (41104064) .

Service
把本文推荐给朋友
加入我的书架
加入引用管理器
Email Alert
RSS
作者相关文章
张烨
汪宏年
陶宏根
杨守文