地球物理学报 » 2012, Vol. 55 » Issue (1) :252-259 doi:10.6038/j.issn.0001-5733.2012.01.024
应用地球物理学

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引用本文(Citation):
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LIU Fu-Ping, MENG Xian-Jun, WANG Yu-Mei, SHEN Guo-Qiang, XIAO Jia-Qi.Multi-angle inversion of formation densities based on the accurate solutions of Zoeppritz's partial derivative equations.Chinese J.Geophys. (in Chinese),2012,55(1): 252-259,doi: 10.6038/j.issn.0001-5733.2012.01.024

基于Zoeppritz偏导方程精确解的地层密度多角度反演

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Multi-angle inversion of formation densities based on the accurate solutions of Zoeppritz's partial derivative equations

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摘要 基于Zoeppritz方程对介质密度偏导数所建立的偏导方程的精确解,构造了多角度反演地层介质密度的反演方程,在偏导数求解过程中考虑了介质密度对波速度的影响因素,并由此实现了利用反射系数梯度精确解计算地层密度的多角度联合反演.通过数值算例考察了计算方法,结果显示:反演方法对层状地层模型不论反射波是否存在相干现象均获得了较好的反演结果,反演迭代10次后计算结果的最大相对误差能够收敛到1%之内;随着反演角度的增加地层介质密度反演的精度逐步提高,反演具有自动校正能力,有快的计算速度.本方法克服了传统AVO(Amplitude Versus Offset)基于Zoeppritz方程近似所遇到的困难,不受反演角度大小及反射界面对波反射强弱的限制,为地层介质密度的多角度包括大角度反演提供了一种新的快速有效的计算方法.

关键词 Zoeppritz偏导方程, 地层介质密度反演, 反射系数梯度, 大角度反演

Abstract: Based on the accurate solutions of Zoeppritz's partial derivative equations, which is the derivative equations of Zoeppritz equations with respect to densities of formation, we have constructed the multi-angle inverse equations for inversion of formation densities, and realized the multi-angle inversion of formation densities with the accurate solution of reflected coefficient's grads of seismic wave. We have also given numerical examples for different stratum models. The results show that whether there is interference between two reflected waves from different reflection interfaces or not, the precisions of inverse results are very good, if only the iterative times of inversion are over 10, the largest relative error of inverse results is less than 1%; with the increasing of inverse angles the precision of multi-angle inverse results is gradually improved; the inversion has emending function itself, and has high running speeds. This method has overcome the difficulty that conventional AVO(Amplitude Versus Offset) approximate methods are confronted with, and is not restricted with the magnitude of incidence angle whether the reflection interface is strong reflection or not. This method offers a new computational method for us to invert for the densities of strata with multi-angles.

Keywords Zoeppritz's partial derivative equations, Inversion of formation densities, Grads of reflected coefficients of seismic wave, Large-angle inverse

Received 2011-07-14;

Fund:

北京市属市管高等学校人才强教计划项目(PHR201107145),国家高技术研究发展计划(2007AA060500)资助.

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