

引用本文(Citation):

卢回忆, 刘伊克, 常旭. 基于MSFM的复杂近地表模型走时计算. 地球物理学报, 2013,56(9): 3100-3108,doi: 10.6038/cjg20130922

LU Hui-Yi, LIU Yi-Ke, CHANG Xu. MSFM-based travel-times calculation in complex near-surface model. Chinese Journal Geophysics, 2013, 56(9): 3100-3108, doi: 10.6038/cjg20130922

## 基于MSFM的复杂近地表模型走时计算

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MSFM-based travel-times calculation in complex near-surface model

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摘要

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### 摘要

地震走时层析成像方法是解决复杂近地表模型速度建模问题的重要技术. 该方法是一种迭代反演方法, 在反演过程中需要反复计算地震射线走时. 故而, 高效高精度且能适应复杂模型的走时计算方法是地震走时层析成像实用化的关键技术之一. 本文引入医学成像领域研究的MSFM(Multi-stencils Fast Marching Methods)用于地震层析反演中的走时计算. 该方法在标准FMM(Fast Marching Methods)基础上利用坐标旋转生成新的FMM计算模板, 使计算网格点对角方向邻点参与计算, 改善了标准FMM存在对角方向误差大的缺陷. 本文分析对比了MSFM和标准FMM的计算精度和计算效率; 针对地震层析成像技术解决的起伏地表模型建模问题, 研究了起伏地表模型地震走时计算的MSFM实现方法; 采用炮点邻近区域局部细分网格技术只需增加很少的计算量即可大幅提高计算精度. 理论分析和模型试算表明MSFM算法明显改善了FMM的计算精度, 同时保持了FMM算法的高效性. 文章通过对崎岖地表模型的正演和层析反演试算, 验证了基于MSFM的地震走时计算方法对复杂模型有很强的适应能力. 研究表明该方法作为地震走时层析反演中高效高精度的正演算法, 有很好的应用价值.

关键词 地震走时层析, 射线追踪, FMM, MSFM

### Abstract:

Seismic traveltome tomography method is an important technique which is used to reconstruct complex near-surface velocity models. This is an iterative inversion method, whose process requires repeated calculations of seismic ray traveltome. Therefore, one of key practical technologies of tomography is to research a traveltome calculation method which is with high efficiency and precision and can adapt to the complex model. MSFM (Multi-stencils Fast Marching Method) proposed in the field of medical imaging will be introduced to traveltome calculations of seismic tomography. The method reduces large errors existed in the diagonal direction of standard FMM by generating new calculation stencils, which is based on coordinate rotation and make the diagonally adjacent grid points involve in the calculation. The calculation efficiency and accuracy of these methods will be analyzed and compared. The implementation scheme of MSFM for irregularly topographic complex near-surface model is studied. The local grid-refinement near source along the topography is adopted, which will largely improve the calculation precision by little calculation cost. Numerical analysis and experiments demonstrate that MSFM improves the accuracy while retaining the high efficiency of standard FMM. Test of traveltimes calculation forward and tomographic inversion for irregular model verifies the powerful applicable potency of MSFM applied in complex model. The study concludes that MSFM has very valuable application as an accurate and efficient traveltome calculation method in seismic traveltome tomography.

Keywords [Travel-time tomography](#), [Ray tracing](#), [FMM](#), [MSFM](#)

Received 2013-04-06;

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