地球物理学报 CHINESE JOURNAL OF GEOPHYSICS

地球物理学报 » 2013, Vol. 56 » Issue (1) :269-279 doi:10.6038/cjg20130128

引用本文(Citation):

段鹏飞, 程玖兵, 陈三平, 何光明.TI介质局部角度域射线追踪与叠前深度偏移成像. 地球物理学报, 2013,56(1): 269-279,doi: 10.6038/cjg20130128

DUAN Peng-Fei, CHENG Jiu-Bing, CHEN San-Ping, HE Guang-Ming.Local angle-domain ray tracing and prestack depth migration in TI medium.Chi Journal Geophysics,2013,56(1): 269-279,doi: 10.6038/cjg20130128

TI介质局部角度域射线追踪与叠前深度偏移成像

段鹏飞[1], 程玖兵[1], 陈三平[2], 何光明[2]*

1. 同济大学海洋与地球科学学院, 上海 200092;
2. 中国石油川庆钻探工程有限公司地球物理勘探公司, 成都 610213

Local angle-domain ray tracing and prestack depth migration in TI medium

DUAN Peng-Fei[1], CHENG Jiu-Bing[1], CHEN San-Ping[2], HE Guang-Ming[2]*

1. School of Ocean and Earth Science, Tongji University, Shanghai 200092, China;
2. CNPC CDEC Sichuan Geophysical Company, Chengdu 610213, China

摘要

研究与实践表明,对于长偏移距、宽方位地震数据,忽略各向异性会明显降低成像质量,影响储层预测与描述的精度.针对典型的横向各向同性(TI)介质,本文面向深度域构造成像与偏移速度分析的需要,研究基于射线理论的局部角度域叠前深度偏移方法.它除了像传统Kirchhoff叠前深度偏移那样输出成像剖面和炮检距域的共成像点道集,还遵循地震波在成像点处的局部方向特征、基于扩展的脉冲响应叠加原理获得入射角度域和照明角度域的成像结果.为了方便快捷地实现TI介质射线走时与局部角度信息的计算,文中讨论和对比了两种改进的射线追踪方法:一种采用从经典各向异性介质射线方程演变而来的由相速度表征的简便形式;另一种采用由对称轴垂直的TI(即VTI)介质声学近似qP波波动方程推导出来的射线方程.文中通过坐标旋转将其扩展到了对称轴倾斜的TI(即TTI)介质.国际上通用的理论模型合成数据偏移试验表明,本文方法既适用于复杂构造成像,又可为TI介质深度域偏移速度分析与模型建立提供高效的偏移引擎.

关键词 横向各向同性, 射线追踪, 声学近似, 相速度, 局部角度域, 叠前深度偏移

Abstract:

Neglecting anisotropy in seismic imaging may result in remarkable positional errors and focusing problem, especially for long-offset and wide-azimuth seismic data. To meet the demands of seismic imaging and anisotropic velocity analysis in laterally heterogeneous transversely isotropic (TI) media, we present an angle-domain imaging approach for prestack depth migration based on two advanced anisotropic ray tracing algorithms. It not only outputs migrated section and offset-domain common image gathers, but also obtains incident angles domain and illumination angles domain imaging results according to the local angular characteristics at a subsurface image point based on extended superposition of the impulse responses. In order to efficiently calculate traveltimes and local angular attributes in TI medium, we discuss and compare two improved ray tracing systems. One is based on phase velocity, which is evolved from the classic ray tracing equation of anisotropic media. Another system is derived from qP wave equation with acoustic approximation for VTI medium, and is extended to tackle TTI medium through coordinate rotation. Numerical examples on the standard theoretical anisotropic models show that our approach can be used as imaging tool for complex geological structures and efficient migration engine for anisotropic migration velocity analysis and model building.

Keywords Transversely isotropic, Ray tracing, Acoustic approximation, Phase velocity, Local angle-domain, Prestack depth migration

Received 2012-01-11;

Fund:

(41074083) .