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基于伪谱法的VSP逆时偏移及其应用研究

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VSP reverse time migration based on the pseudo-spectral method and its applications

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摘要

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摘要 逆时偏移被认为是对于地下复杂构造进行成像的精确偏移方法,尤其是能够有效地对回转波、绕射波、多次波等各种波动现象进行成像.近几年来随着并行计算机和存储设备的快速发展,逆时偏移方法备受关注.本文采用伪谱法实现了VSP逆时偏移,该方法不仅实施简便,而且计算效率高,精度好.并运用反周期扩展法来消除伪谱法中特殊的周期性边界效应问题.对VSP绕射点模型进行试算,分析了因覆盖次数不足在近井区产生的假象问题.对地堑模型和半圆隆起模型也获得了较好的VSP逆时偏移成像效果.并分别对VSP全波场及分离出的上行波场进行了逆时偏移成像,可明显发现直达波在炮点和检波点位置处收敛成像,也产生了很强的成像噪声.最后对某地区实际观测的VSP资料进行了逆时偏移成像,并与Kirchhoff法VSP偏移结果和地面地震偏移结果进行了对比,显示了VSP逆时偏移在近井区成像上的优势.

关键词: VSP逆时偏移 伪谱法 反周期扩展法 边界条件 Laplacian滤波

Abstract: This paper mainly introduces VSP reverse time migration (RTM), based on the pseudo-spectra method to solve the two-way wave equations. RTM is a well known imaging method which takes advantage of all the wave phenomena to image complex structures. Recently, with the rapid development of high performance parallel computers and efficient storage devices, RTM becomes a practical imaging technique and has drawn a lot of attentions. The pseudo-spectra based RTM is an accurate algorithm which does not suffer from spatial numerical dispersion problem as conventional finite difference methods do. In this paper, to remove the wraparound noise caused by the periodic boundary conditions imposed by the Fourier transform, we adopt an efficient technique which is called antiperiodic extension. The diffractor model test shows that VSP RTM introduces migration artifacts in the vicinity of the well. We compare the RTM image from the full VSP data with the image from its up-going wave component only, and we confirm that the first break and down-going wave are both imaged at the locations of shots and receivers. The graben model and the semicircular model are well imaged by VSP RTM. Finally, the comparison of RTM and Kirchhoff migration of field VSP data shows that RTM provides superior image near the well. As a conclusion, VSP RTM is a good candidate to image complex structures.

Keywords: VSP reverse time migration Pseudo-spectral Antiperiodic extension Boundary condition Laplacian filter

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