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起伏地表叠前逆时偏移理论及GPU加速技术

刘红伟[1], 刘洪[1], 李博[1], 王鑫[2], 佟小龙[3], 刘钦[3]*

1. 中国科学院地质与地球物理研究所 中国科学院油气资源研究重点实验室,北京 100029;
2. 中国石化胜利油田分公司勘探项目管理部,东营 257000;
3. 北京吉星吉达科技有限公司,北京 100029

Pre-stack reverse time migration for rugged topography and GPU acceleration technology

LIU Hong-Wei[1], LIU Hong[1], LI Bo[1], WANG Xin[2], TONG Xiao-Long[3], LIU Qin[3]*

1. Key Laboratory of Petroleum Resources Research, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China;
2. SINOPEC Shengli Oilfield Company, Exploration Project Management, Dongying 257000, China;
3. Beijing Geostar Science and Technology Co. Ltd, Beijing 100029, China

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摘要 从起伏地表直接进行叠前逆时偏移是解决地表起伏大并且地下构造复杂这种双复杂结构地区成像问题的有力工具.本文给出了起伏地表直接进行叠前逆时偏移的实现过程,针对有限差分方法处理起伏地表自由边界条件的复杂性,采用了一种简化的自由边界条件,避免了大量的逻辑判断,在此基础上,采用图形处理器(Graphic Processing Unit,简称GPU)将算法加速,比传统的CPU计算速度提高了一个数量级.文中对理论模型进行了计算,并与起伏地表直接进行单程波叠前偏移方法做比较,结果表明:起伏地表叠前逆时偏移有效突破了成像倾角限制,对起伏地表浅层构造以及地下高陡构造成像效果显著提高.关于逆时偏移成像噪音去除以及存储量等问题,笔者已有文章介绍,本文将不再涉及.

关键词: 起伏地表 自由边界 叠前逆时偏移 GPU加速

Abstract: Pre-stack reverse time migration (RTM) for rugged topography is a very useful tool for seismic imaging in the areas with rugged surface topography andcomplex subsurface structures. In this paper, we illustrate the implementation process of RTM for rugged topography. For the difficulty in dealing with the rugged free boundary condition with the finite difference method, we employ a simplified boundary condition which can avoid the abundant logical judgment. On this basis, we use the Graphic Processing Unit (GPU) algorithm to accelerate RTM and get an order of magnitude higher speedup ratio compared to the traditional CPU algoritm. The tests on synthetic data and the comparison with the pre-stack one-way wave method for rugged topography prove that RTM does not have the imaging dip limit, and the imaging results for near surface structures and subsurface steep structures are significantly improved. The problems of imaging noise removal and massy memory demand of RTM have been stated previously and will not be discussed in this paper.

Keywords: Rugged topography Free boundary Pre-stack Reverse time migration GPU accelerating

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Corresponding Authors: 刘 洪,男,1959年生,研究员,主要从事油储地球物理方面的研究. E-mail:liuhong@mail.iggcas.ac.cn Email: liuhong@mail.iggcas.ac.cn

About author: 刘红伟,男,1982年生,中国科学院地质与地球物理研究所在站博士后,主要从事地震成像及高性能计算方面的研究. E-mail:liuhw@mail.iggcas.ac.cn

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