应用地球物理

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测井约束地震波形反演的同伦摄动法

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A homotopy perturbation method for well log constrained seismic waveform inversion

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摘要 测井数据和地震数据是地震勘探中两种最重要的资料. 测井约束地震波形反演是在非线性波形反演的基础上,利用已知测井资料详细的垂直分辨能力和地震资料均匀密集的水平采样特点, 通过迭代反演来求取一个具有较高分辨率的速度参数.本文建立了测井约束反演模型,研究了测井约束下地震波形反演的同伦摄动求解方法.同伦摄动法作为一种新的、求解数学物理中各种非线性问题的有效方法,具有计算速度快、计算精度高的优点.这对于提高反演的精度和效率是十分有益的. 为了表征该方法的有效性和稳定性,分别对水平层状介质模型和逆冲断层带模型进行了数值模拟,并与Landweber迭代法相对比,结果表明该算法具有更好的收敛性,能够取得更为满意的反演效果.

关键词 测井资料约束, 速度反演, 同伦摄动法, Landweber方法

Abstract：The well logging data and seismic data are two most important data in the seismic prospecting. Well log constrained seismic waveform inversion is based on the nonlinear waveform inversion techniques. It makes full use of detailed vertical resolution of well log data and horizontal dense sampling of seismic data. Its core is to obtain an approximate velocity parameter of higher resolution by iterative inversion. This paper established the well log constraint inversion model, and studied homotopy perturbation method for solving this problem. Homotopy perturbation method is a novel and effective method, and can solve various nonlinear equations of various branches in mathematics and physics. This method has the advantages of fast computation and high precision. This improves the accuracy and stability in inversion. In order to show the effectiveness and stability, we carried out numerical simulations of the horizontally stratified medium and the thrust fault belt model, and compared with Landweber iteration. Numerical results show that the new method improves the convergence, and can produce more satisfactory effect.

Keywords Well log constraint, Seismic waveform inversion, Homotopy perturbation method, Landweber method

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