非线性AVO反演方法研究

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A study on nonlinear AVO inverse method

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摘要 与叠后地震数据相比,叠前地震数据包含有更多的反映地下地层特征的信息,利用AVO(Amplitude Versus Offset,振幅随偏移距的变化)信息通过求解Zoeppritz方程的近似公式,叠前反演可直接得到反映地下岩石特征的弹性参数——密度、纵波速度和横波速度.从本质上讲,叠前地震反演是非线性的,但目前多采用线性近似方法求解,降低了地震反演的精度.本文研究基于Aki-Richards近似公式的非线性叠前反演方法,分析了引起弹性参数非线性反演误差的因素,提出了反向加权系数的方法以均衡各反演参数的系数所引起的响应差异,并把具有较强的非线性搜索能力、能够更好地求取全局最优解的量子蒙特卡罗方法引入到叠前三参数非线性反演,改善了叠前反演的精度.理论和实例试验表明:该方法计算精度较高、稳定性较好.

关键词:　反向加权　 AVO反演　 非线性　 量子蒙特卡罗

Abstract： Comparing with post-stack data, the pre-stack seismic data contains more information of the underground stratigraphic characteristics. By using AVO information and solving the approximate formula of Zoeppritz equation, pre-stack inversion can get elastic parameters directly, including density, v_p and v_s. That can improve our understanding of the underground geology greatly. Pre-stack seismic inversion, being essentially a nonlinear problem, was mostly solved approximatively by linear methods at present, which reduces the precision of seismic inversion. Based on Aki-Richards approximate formula, the paper proposed a reverse weighted method to balance the response difference caused by each parameter coefficient, and introduced quantum Monte Carlo method, with strong nonlinear search ability to seek the global optimal solution, into the pre-stack inversion for solving nonlinear equations directly, which could improve the precision of pre-stack inversion and the ability of quantitative reservoir characterization. The numerical simulation and examples both denote that this method has high calculation accuracy and good stability.

Keywords： Reverse weighted　 AVO inversion　 Nonlinear　 Quantum Monte Carlo

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