地球物理学报 » 2012, Vol. 55 » Issue (7) :2422-2431 doi:10.6038/j.issn.0001-5733.2012.07.026
应用地球物理学

引用本文(Citation):
王守东, 王波.时移地震资料贝叶斯AVO波形反演. 地球物理学报, 2012,55(7): 2422-2431,doi: 10.6038/j.issn.0001-5733.2012.07.026

WANG Shou-Dong, WANG Bo.Time-lapse Bayesian AVO waveform inversion.Chinese J.Geophys. (in Chinese),2012,55(7): 2422-2431,doi: 10.6038/j.issn.0001-5733.2012.07.026

时移地震资料贝叶斯AVO波形反演

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Time-lapse Bayesian AVO waveform inversion

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摘要 针对时移地震差异数据,给出了一种基于贝叶斯理论的AVO波形反演方法.该方法可以利用时移地震差异数据同时反演出纵波阻抗、横波阻抗和密度的变化.利用时移地震资料进行反演,由于采集和处理过程中存在一定的差异,不同年份地震资料在非注采过程影响区域也会存在一定的变化,而该变化会导致反演结果在非注采区域有较大的变化.针对这一问题,本文采用贝叶斯理论框架,将待求的纵横波阻抗、密度变化的先验信息和包含在地震数据中的信息结合起来,对于纵横波阻抗和密度变化,假设其服从Gauss分布,并以时移地震分别反演的结果作为其期望,同时,为了更好地表征储层属性变化,提高分辨率和抑制非注采区域弹性参数的变化,假设弹性参数变化的导数服从改进的Cauchy分布.数值模拟试验和实际资料处理结果皆表明,本文提出的反演方法能够有效地抑制假象,突出储层性质的变化,得到高分辨率的弹性参数变化信息,为研究储层属性的变化和优化开采方案提供更多的有效的信息.

关键词 时移地震, 贝叶斯, AVO反演, 高分辨率, Cauchy分布

Abstract: Aiming at the difference of time-lapse seismic data of different vintages, a Bayesian AVO waveform inversion method is given in this paper. This method can obtain the changes of compressional/shear impedance and density simultaneously using the pre-stack seismic data in different vintages. Because of the differences in the process of data acquisition and processing in the seismic data of different vintages, when the time-lapse seismic inversion is made, changes exist in the region where the process of injection and production does not have impacts, and these changes will lead to some obvious changes in the inversion results in this region. To solve the problem, in this paper, Bayesian theoretical framework is used to combine the prior information of the changes of the elastic parameters with information contained in the seismic data. We assume the changes of compressional/shear impedance and density follow the Gaussian distribution, whose expectation is the answer of time-lapse seismic uncoupled inversion. Meanwhile in order to better characterize the changes in reservoir properties and improve the resolution of the results and inhibit the artifacts in the non-production region, we also assume that the derivatives of changes of elastic parameters follow the improved Cauchy distribution. Tests on synthetic data and practical data show that the proposed inversion method can effectively inhibit the artifacts, highlight the changes of reservoir properties, get the changes of elastic parameters of high-resolution and provide more effective information for the study of reservoir properties and the optimization of recovery scheme.

Keywords Time-lapse seismic, Bayes, AVO inversion, High-resolution, Cauchy distribution

Received 2012-01-04;

Fund:国家重点基础研究计划项目(973)(2007CB209604)和国家科技重大专项项目(2011ZX05023-005-005)资助.

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