

应用地球物理学

用于零偏移距VSP资料的自适应波形反演方法研究

高静怀<sup>1</sup>,汪超<sup>1</sup>,赵伟<sup>2</sup>

1 西安交通大学电信学院波动与信息研究所, 西安 710049

2 中海石油研究中心, 北京 100027

收稿日期 2009-6-28 修回日期 2009-11-29 网络版发布日期 2009-12-20 接受日期

摘要 提出一种利用零偏移距VSP资料初至下行波(即直达波)反演介质品质因子Q及层速度V等参数的方法,称为自适应时域波形反演法(ATWI).为了充分地利用有效信息,该方法根据实际VSP资料的信噪比及直达波与上行波干涉的程度,自适应最大限度地选取未受干扰的初至波片段,并用该片段构造目标函数;通过恰当地构造数据加权矩阵提高目标函数对Q值变化的敏感性;为克服非线性反演的病态问题,采用近来发展的乘性正则化方法,并通过约束条件限制待求参数的取值范围;文中推导出了雅可比矩阵各元素的解析表达式,从而减小了反问题的计算量.合成数据反演结果表明,与谱比值法和子波包络峰值瞬时频率法相比较,ATWI法受上行波影响相对较小、抗噪性能更强.实际资料算例进一步证明了ATWI方法的有效性.

关键词 [反演](#) [品质因子](#) [黏弹性介质](#) [VSP资料](#)

分类号 [P631](#)

DOI: [10.3969/j.issn.0001-5733.2009.12.018](#)

On the method of adaptive waveform inversion with zero-offset VSP data

GAO Jing-Huai<sup>1</sup>, WANG Chao<sup>1</sup>, ZHAO Wei<sup>2</sup>

1 Institute of Wave and Information, Xi'an Jiaotong University, Xi'an 710049, China

2 China Offshore Oil Research Center, Beijing 100027, China

Received 2009-6-28 Revised 2009-11-29 Online 2009-12-20 Accepted

**Abstract** In this paper, we propose a waveform inversion method to estimate the interval velocity and quality factor  $Q$  in time domain using the direct downgoing wave of the zero-offset VSP data. According to the signal-to-noise ratio and the interference of upgoing wave, our method can automatically choose the undisturbed segment of the direct downgoing wave, so it can sufficiently make use the data. A new data weighting scheme is used to make the object function more sensitive to  $Q$ . To deal with the ill-posed nature of inversion, we adopt the recently developed multiplicative regularization approach. A nonlinear transform is applied on the model parameters to constrain them within their upper and lower bounds. For reducing computational cost, the analytic expressions of the elements of the Jacobian matrix are given. The application of this method on the synthetic VSP data and real data example demonstrates the effectiveness of this method, and comparing with the spectral ratio method and the envelope peak instantaneous frequency method, our method is more stable and precise, and less sensitive to upgoing waves.

**Key words** [Inversion](#); [Quality factor](#); [Viscoelastic material](#); [VSP data](#)

通讯作者:

高静怀 [jhgao@mail.xjtu.edu.cn](mailto:jhgao@mail.xjtu.edu.cn)

作者个人主页: 高静怀<sup>1</sup>;汪超<sup>1</sup>;赵伟<sup>2</sup>

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