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高分辨率非线性储层物性参数反演方法和应用

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摘要 对于陆相沉积环境下的复杂隐蔽岩性储层，由于观测信息不准确，如信息重叠、信息缺失和噪音污染，以及岩石物理关系模糊等原因，储层横向预测存在不惟一性、不稳定性和不确定性.基于线性假定的常规储层横向预测技术已不适用于复杂隐蔽岩性储层的勘探.本文采用一种非线性储层岩性物性褶积模型，建立波阻抗与孔隙度/泥质含量的函数关系；通过多级结构分解和双向边沿子波检测来刻画复杂岩石物理关系；通过Caianiello褶积神经网络实现确定性反演、统计反演和非线性理论三者有机结合；最后联合应用基于逆算子的反演方法和基于正算子的重建算法实现了综合地质、测井和地震波阻抗信息进行高分辨率储层物性参数反演.非线性储层物性参数反演采用多井约束机制和分频反演方式，在陆相和近海油气勘探资料的实际应用中，取得了明显应用效果.

关键词 非线性反演,物性参数,褶积模型,Caianiello褶积神经网络,边沿检测子波,分频反演

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A high-resolution nonlinear inversion method of reservoir parameters and its application to oil/gas exploration

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Abstract In the prediction of complex reservoir in continental deposition environment, because of inexact data (e.g., information-overlapping, information-incomplete, and noise-contaminated) and ambiguous physical relationship, inversion results suffer from nonuniqueness, instability, and uncertainty. Thus, reservoir prediction technologies based on linear assumption are unsuited for these complex areas. By means of nonlinear rock physical models, the method presented in the paper establishes a relationship between impedance and porosity/clay-content. Through multistage decomposition and bidirectional edge wavelet detection, it can depict more complex rock physical relationship. Moreover, it uses the Caianiello neural network to implement the combination of deterministic inversion, statistical inversion and nonlinear theory. Last, it incorporates geological information, well data and seismic impedance to perform petrophysical parameters inversion by combined applications of model-based and deconvolution-based methods. The joint inversion consists of four steps: (1) multistage vertical edge detection wavelets extraction at the wells and nonlinear factor estimation, (2) initial petrophysical parameters estimation by vertical edge detection wavelets, (3) multistage transverse edge detection wavelets extraction and nonlinear factor estimation, (4) final petrophysical parameters reconstruction by transverse edge detection wavelets. The scheme adopts multi-well constraint and separate-frequency inversion mode and achieves good results in the application on some continental and near-sea exploration data.

Key words Nonlinear inversion Petrophysical parameters Convolution model Caianiello neural network Edge detection wavelet Separate-frequency inversion

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