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BA Jing, YAN Xin-Fei, CHEN Zhi-Yong, XU Guang-Cheng, BIAN Cong-Sheng, CAO Hong, YAO Feng-Chang, SUN Wei-Tao. Rock physics model and gas saturation inversion for heterogeneous gas reservoirs. Chinese Journal Geophysics, 2013, 56(5): 1696-1706, doi: 10.6038/cjg20130527

## 非均质天然气藏的岩石物理模型及含气饱和度反演

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Rock physics model and gas saturation inversion for heterogeneous gas reservoirs

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摘要

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摘要

非均质气藏中, 天然气一般呈“斑块状”分布于含水岩石内部, 这种非均匀分布特征会导致地震波显著的频散与衰减现象. 为发展适用于碳酸盐岩储层中流体检测的岩石物理模型, 本文基于Biot-Rayleigh波动方程, 实现了对非饱和岩石的多尺度理论建模, 预测了不同尺度下波响应与岩性、流体间的定量联系. 将此建模技术应用于阿姆河右岸的灰岩气藏, 给出了多尺度的岩石物理学图板. 通过与实验数据、测井精细解释结果及地震数据的对比分析, 本文论证了图板的正确性与可适用性. 结合叠后波阻抗反演与叠前弹性参数反演, 基于地震资料进行了储层含气饱和度与孔隙度的反演, 反演结果与各井实际的产气情况吻合.

关键词 岩石物理模型, Biot-Rayleigh理论, 非均质, 孔隙度, 饱和度, 气藏检测

Abstract:

In heterogeneous natural gas reservoirs, generally gas forms countless small "patchy"-like packets embedded in the host matrix of water-saturated rocks. This heterogeneity feature (also called the "patchy-saturation") causes significant velocity dispersion and attenuation phenomena for seismic wave propagation. To build an appropriate rock physics model for the application of fluid identification in carbonate reservoirs, multi-scale theoretical modeling is performed for partially-saturated rocks and the quantitative relations between wave responses in different scales and basic properties of lithology and pore fluids are predicted. This approach of modeling is applied in limestone gas reservoirs of the right bank block of Amu Darya river. A multi-scale rock physics template is presented. Comparisons with experimental data, fine interpretation results of log data and seismic data have proved its validity and applicability. In combination with the methods of post-stack wave-impedance inversion and pre-stack elastic parameter inversion, seismic data is used to estimate rock porosity and gas saturation of the reservoirs. The results of estimate are in good agreement with the production status of the wells.

Keywords Rock physics model, Biot-Rayleigh theory, Heterogeneity, Porosity, Saturation, Gas reservoir identification

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