

地球物理学报 » 2011, Vol. 54 » Issue (6) : 1660-1671

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关威, 胡恒山, 汤天知, 程希. 声电效应测井电声比及其与地层渗透率的关系[J]. 地球物理学报, 2011, V54(6): 1660-1671, DOI: 10.3969/j.issn.0001-5733.2011.06.026

GUAN Wei, HU Heng-Shan, TANG Tian-Zhi, CHENG Xi. The ratio of the acoustoelectric field to the acoustic pressure in the borehole and its dependence on permeability. Chinese J. Geophys. (in Chinese), 2011, V54(6): 1660-1671, DOI: 10.3969/j.issn.0001-5733.2011.06.026

声电效应测井电声比及其与地层渗透率的关系

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The ratio of the acoustoelectric field to the acoustic pressure in the borehole and its dependence on permeability

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摘要

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摘要 基于流体饱和和孔隙介质中声波-电磁场耦合效应的测井方法具有潜在的应用价值. 本文从Pride动电耦合波方程组入手, 推导了伴随斯通利波的井孔电场与声压比值(电声比)的频率域表达式. 结果表明, 在较低频率条件下, 电声比幅角的正切值与渗透率呈反比. 在此基础上, 提出了利用低频的声电效应测井全波反演地层渗透率的方法. 针对砂岩地层, 从计算模拟的声电效应测井响应反演出了渗透率, 其值比利用声波测井斯通利波反演的渗透率更接近真实值.

关键词: 声电效应测井 孔隙介质 渗透率反演 斯通利波 动电耦合

Abstract: Acoustoelectric logging based on the coupling between elastic wave and electromagnetic field in fluid-saturated porous media has potential value in the detection of formation characteristics. Applying Pride's equations for the coupled poroelastic and electromagnetic fields, we derive the expression of the ratio of the borehole acoustoelectric field accompanying the Stoneley wave to the acoustic pressure (REP) in the frequency domain. It is shown that the tangent of the REP's argument is inversely proportional to permeability. On this basis, we propose a method to invert formation permeability from the full waveforms of the low-frequency acoustoelectric logging. Permeabilities of sandstones are estimated from the simulated acoustoelectric logs, and they are closer to the true values than those obtained by using the Stoneley wave of acoustic logging.

Keywords: Acoustoelectric logging Porous medium Permeability inversion Stoneley wave Electrokinetic coupling

Received 2010-06-24;

Fund:

国家自然科学基金项目(40874062), 公益事业(地震)行业专项基金(200808072), 中国石油天然气集团公司科研项目(2008A-2702), 教育部高校博士点新教师基金(20102302120024), 黑龙江省青年科学基金(QC2010025)和哈尔滨工业大学科研创新基金(HIT.NSRIF.2010071)资助.

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链接本文:

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