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基于Backus-Gilbert理论的孔隙介质核磁共振弛豫反演

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Inversion of NMR relaxation in porous media based on Backus-Gilbert theory

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摘要 孔隙介质核磁共振(NMR)弛豫数据的多指数反演在NMR测井和岩心分析中均非常重要.本文基于Backus-Gilbert(BG)理论,提出一种NMR弛豫多指数反演的新方法.从解的非唯一性出发,不仅构造出一种解估计,更重要的是评价各种可接受的解估计,通过引入解估计分辨率和解估计方差对解进行评价,找出最佳折中解.通过算例,比较了新方法与传统正则化方法的效果,结果表明新方法具有明显优越性,在低信噪比条件下解稳定.最后分析了新方法的影响因素.

关键词 NMR测井, T_2分布, BG理论, 解估计分辨率, 解估计方差

Abstract: Inversion of nuclear magnetic resonance (NMR) relaxation measurements in porous media is very important to NMR well logging and core analysis. This paper presents a new method for inversion of NMR relaxation measurements in porous media based on Backus-Gilbert (BG) theory. The BG theory is widely used in Geophysics. In view of the non-uniqueness of solution, we not only construct a solution estimate, but also evaluates the merits of acceptable solution estimates. Using resolution and variance of the solution estimates, this method provides an optimal trade-off solution from all possible solutions. Moreover, comparison of results from this method with conventional methods through simulated data shows that the new method is obviously excellent, and it is stable especially for low SNR data. The influence factors of this method, such as noise level, echo spacing and number of echoes, have been tested and discussed in details.

Keywords NMR logging, T_2 distribution, BG theory, Resolution of solution estimates, Variance of solution estimate

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