

论文

矿井突水灾变过程电阻率约束反演成像实时监测模拟研究

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摘要:

为实现矿井突水灾变的实时监测与灾变前兆的预警, 提出了突水灾变过程电阻率约束反演成像实时监测方法。首先, 将表征网格电阻率变化范围的不等式约束施加到电阻率反演成像方程中, 并设计了快速反演算法, 有效地改善了反演的多解性与计算效率, 据此建立了电阻率约束反演成像实时监测方法。同时, 开展了隐伏断层底板突水约束反演成像实时监测的数值试验, 利用灰度相关性系数理论定量评价了突水过程中的电阻率反演图像主要响应特征: 表现为反演图像中岩层断裂、突水通道形成等重要事件及图像灰度相关性系数的基本持续单调发展或信息突变。最后, 将实时监测方法应用到矿井突水物理模拟试验中, 实现了对裂隙萌生、扩展、岩层断裂等重要突水过程的较真实动态成像, 提前813 s准确捕捉到灾变前兆信息, 表明电阻率约束反演成像实时监测方法用于突水灾害监测与预警具有良好的可行性。

关键词: 矿井突水; 实时监测; 电阻率约束反演成像; 灾变前兆; 灰度相关性系数; 定量分析

Research on simulation of mine water inrush real time monitoring of using electrical resistivity constrained inversion imaging method

Abstract:

For real time monitoring of mine water inrush catastrophic process and early warning of precursory, electrical resistivity constrained inversion imaging method was proposed. First, inequality constraints characterizing variation range of grid resistivity was introduced into electrical resistivity inversion imaging equation. Multiplicity of inversion was inhibited by the means of inequality constraints. Meanwhile, fast inversion algorithm was designed to effectively improve computational efficiency. Then, numerical experiment of micro faults water inrush real time monitoring using constrained inversion imaging method was carried out. And, by gray correlation theory, inversion image responses characteristics to water inrush precursors were evaluated quantitatively, in which the abnormal events (e.g., strata fracturing, water inrush channel forming) and gray correlation coefficient of inversion images exhibit monotonic developments or mutation. Finally, real time monitoring method was applied to physical model test of mine water inrush. It achieves realistically dynamic imaging and monitoring on important processes of water inrush, such as crack generation and propagation, and strata fracturing. And precursor information of water inrush hazard was precisely captured, 813 s ahead of inrush. It suggests that real time monitoring using electrical resistivity constrained inversion imaging method is feasible for mine water inrush monitoring and early warning.

Keywords: mine water inrush; real time monitoring; electrical resistivity constrained inversion imaging; water inrush precursor; gray correlation coefficient; quantitative evaluation

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