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预条件共轭梯度法在地震数据重建方法中的应用

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Application of the preconditioned conjugate gradient method to reconstruction of seismic data

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摘要

基于最小平方的Fourier地震数据重建方法最终转化为求解一个线性方程组, 其系数矩阵是Toeplitz矩阵,可以用共轭梯度法求解该线性方程组.共轭梯度法的迭代次数受系数矩阵病态程度的影响,地震数据的非规则采样程度越高,所形成的系数矩阵病态程度越高,就越难收敛和得到合理的计算结果.本文研究了基于Toeplitz矩阵的不同预条件的构造方法,以及对共轭梯度法收敛性的影响.通过预条件的使用,加快了共轭梯度法的迭代速度, 改进了共轭梯度算法的收敛性,提高了计算的效率.数值算例和实际地震数据重建试验证明了预条件共轭梯度法对计算效率有很大的提高.

关键词 预条件, 共轭梯度法, 地震数据重建, Fourier方法

Abstract:

Seismic data reconstruction based on the least-squares Fourier method is ultimately transformed into solving a linear equation.The coefficient matrix is Toeplitz matrix. The conjugate gradient method can be used to solve the linear equations. Pathological extent of matrix affects iterations of the conjugate gradient method. The more irregular sampled seismic data is,the more pathological the matrix is, then it is more difficult to get convergence and reasonable results. We study different construction methods of preconditions based on Toeplitz matrix and the effects of convergence of the conjugate gradient method. Through the use of preconditions, we can speed up the iterative speed of the conjugate gradient method, improve the convergence of conjugate gradient method and the efficiency of computation. Numerical examples and real seismic data reconstruction experiment show that the preconditioned conjugate gradient method has greatly improved efficiency of calculation.

Keywords Precondition, Conjugate Gradient Method, Seismic data reconstruction, Fourier method

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