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三维错格时域伪谱法在频散介质井中雷达模拟中的应用

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摘要 数值模拟对井中雷达数据的解释有重要意义.通常采用的时域有限差分法(FDTD)在网格足够细的情况下能够精确地模拟井中雷达，但对于相对较大的模型，要得到较好的精度其所需要的时间和计算机内存都非常大.我们尝试用伪谱法来模拟三维井中雷达，其在平缓介质中达到与FDTD相同精度每个波长所需的网格要少数倍，因此在保证精度的情况下使模拟范围大大增加.常规网格伪谱法常伴有Gibbs现象，本研究通过在一个方向以两点为源和采用交错网格的方法有效解决了上述问题.对于Debye频散介质，我们应用二阶显式Runge-Kutta方法求解时间步，该法较中心差分方法更直观、更简便，且在我们考虑的介质范围内是稳定的.

关键词 伪谱法 时域有限差分 井中雷达 完全匹配层(PML) Runge-Kutta方法

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A 3-D staggered grid PSTD method for borehole radar simulations in dispersive media

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Abstract A finite difference time domain (FDTD) method is usually used to simulate borehole radar. However, it takes too much time and space for simulating a model with a relative large scale. A pseudospectral time domain (PSTD) method has the advantage of saving time and computer memory for the same simulation accuracy as that of FDTD. Thus we adopted a PSTD to simulate 3-D borehole radar in dispersive media. In order to suppress the Gibbs phenomenon of point source for PSTD, we set two points as sources in one direction and introduced a staggered grid. As an example for Debye dispersive media, we applied the second order Runge-Kutta method to the calculation in the time domain. This approach is stable for the media we are interested in. Comparing with the central time-differencing method, the approach adopted in this study is much easier for programming.

Key words Pseudospectral time domain (PSTD); Finite difference time domain (FDTD); Borehole radar; Perfectly Matched Layer (PML); Runge-Kutta method

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