Application of asymptotic solutions in full-wave inversion

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The computational cost of seismic data modeling for a typical acquisition system can be substantial, estimated at approximately 10^8 core-hours when performed on central processing units (CPUs). These estimates are for an isotropic elastic medium; as geological models increase in complexity, the demand for computational resources grows significantly. Consequently, developing efficient numerical methods for seismic wavefield modeling and accelerating these algorithms is an urgent task.

Asymptotic methods operate much faster than those based on finite differences or finite elements, which are commonly used in most inversion algorithms. A key advantage of asymptotic solutions is their applicability to acoustic, isotropic and anisotropic, and viscoelastic media. This allows them to account for complex geological features [1] without a corresponding increase in computational cost. It is important to note, however, that solutions obtained through asymptotic methods differ from those derived from classical approaches to solving the wave equation.

This paper investigates the application of an asymptotic solution to the Helmholtz equation for full-waveform inversion (FWI) [2] in a two-dimensional, frequency-domain formulation [3]. The study is conducted using a series of synthetic models and validated on real marine seismic data.

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Literature

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