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***Seismic inverse scattering in the ‘wave-equation’
approach***

This research was carried out in collaboration with C.C. Stolk and J.L. Le Rousseau. Part of this research was carried out at the Mathematical Sciences Research Institute, Berkeley CA, USA

In reflection seismology one places point sources and point receivers on the Earth’s surface. The source generates acoustic waves in the subsurface, that are reflected where the medium properties vary discontinuously. The recorded reflections that can be observed in the data are used to reconstruct these discontinuities.

Seismic data are commonly modeled by a high-frequency single scattering approximation. This amounts to a linearization in the medium coefficient about a smooth background. The discontinuities are contained in the medium perturbation. Both the smooth background and the perturbation are in general unknown and have to be reconstructed jointly. The wave solutions in the background medium admit a geometrical optics representation. Here we describe the wave propagation in the background medium by a one-way wave equation. Based on this we derive the double-square-root equation, which is a first-order pseudodifferential equation, that describes the continuation of seismic data in depth. We consider the modeling operator, its adjoint and reconstruction based on this equation in the framework of microlocal analysis. If the rays in the background that are associated with the reflections due to the perturbation are nowhere horizontal, the singular part of the data is described by the solution to an inhomogeneous double-square-root equation. We derive a microlocal reconstruction equation for the medium perturbation. Finally, pseudodifferential annihilators based on the double-square-root equation are constructed. These annihilators form the criterion to determine the smooth background medium. We illustrate the mentioned inverse scattering procedure in the so-called generalized screen approximation which follows an expansion of the symbol of the one-way wave operator into elementary symbols.