

Annihilators of seismic data and their applications

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In reflection seismology one places point sources and point receivers on the Earth's surface. In global seismology, the sources are earthquakes and the receivers are (broad-band) seismic stations. The source generates elastic waves in the subsurface, which are reflected where the material or physical properties vary discontinuously. The recorded reflections that can be observed in the data are used to reconstruct these discontinuities. A key component in the development of reconstruction procedures is the understanding and use of redundancy in the data.

Seismic data are commonly modeled by a high-frequency single scattering approximation. This amounts to a linearization in the medium coefficients 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. Modelling and inverse scattering of seismic data have been formulated and carried out in terms of Fourier integral operators and their clean intersection calculus. The seismic data should be contained in the range of a modelling operator. This can be verified by background-model-dependent, pseudodifferential annihilators – directly related to the redundancy mentioned above – applied to the data, and yields a criterion for estimating a smooth background, i.e. reflection tomography. We discuss the construction of annihilators and show results of their application in reflection tomography. The annihilators can also be used to carry out continuation of data to source-receiver combinations that were not recorded. We will briefly discuss whether the annihilators are useful in the identification of multiple scattered wave constituents in the data.