MIGRATION VELOCITY ANALYSIS USING VELOCITY CONTINUATION OF SEISMIC IMAGE GATHERS

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Abstract. Seismic refection data, in the single scattering or Born approximation, are commonly modelled by a Fourier integral operator (FIO) mapping a medium image (velocity contrast containing reflectors), given a background medium (velocity model), to a data (wavefeld at the surface containing reflections). Migration of seismic reflection data is then described by a FIO adjoint to modelling operator. Usually seismic data space is of greater dimension compared to the model space (the subsurface). Then one can map seismic data into extended image (common-image gathers) of the same dimension. We will consider the class of FIOs the canonical relations of which are graphs, and which are invertible. Thus canonical relations describing propagation of singularities are canonical transformations (and diffeomorphisms).

The notion of velocity continuation can be introduced: the continuation of common-image gathers (CIG) following a path of background media without remigrating the data. Continuation of CIG in background velocity can be exploited in developing a method for determining it (migration velocity analysis): CIG should be flat in particular direction p for true velocity model.

Velocity continuation operators can be viewed as solution operators to pseudodifferential evolution equations (globally). Thus, continuation operators attain the form of propagators. The evolution equation leads to the introduction of a global Hamiltonian and continuation bicharacteristics which describe the propagation of singularities by continuation.

Global Hamiltonian provides geometry of velocity continuation. Then reflectors present in CIG can be viewed as 'fronts' evolving with a continuation parameter. For true background velocity the curvature of this 'front' should vanish in particular direction p.

Global evolution equation forms the basis for wave equation velocity continuation of CIG and migration velocity analysis. However, the continuation operator itself typically does not have an explicit form that complicates its numerical implementation (compared to calculating geometry). In order to cope with this issue, we will employ a dyadic parabolic wave packet (curvelet) decomposition of the continuation operator, as it is specially designed to maximally exploit bicharacteristics for solving evolution equations.

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