GRT mapping to the subsurface angle domain

Norman Ettrich¹*, Dirk Merten¹, Stig-Kyrre Foss², Erik Stangeland Karlsen², Joachim Mispel²
¹Fraunhofer ITWM; ²Statoil
*presenter; email contact: ettrich@itwm.fhg.de

Abstract: Seismic PreSDM defines a large data mapping problem for which 5D data (source/receiver-x/y and time) measured at the surface are mapped to 5D depth-domain output volumes. Implementing PreSDM as an input-oriented scheme, i.e., migrating sub-sets of the data to the (entire) output volume causes the need for keeping the output domain in computer memory while output-oriented schemes, i.e., collecting all input contributions to a sub-set of the output domain require multi-access to the data, thus the need for keeping the input data set in memory. If two of the five dimensions are identical for input and output domain, the problem reduces to a large number of 3D problems (i.e., common offset-style migration). This does not apply to migration methods for generating subsurface angle gathers as acquisition offset/azimuth of the input are different from the output subsurface angles of inclination and azimuth.

The concept of generalized Radon transform (GRT) allows formulating a true-amplitude migration (Brandsberg-Dahl et al, 2003, Ursin, 2004) that provides angle gathers (Koren et al, 2008). Migrated amplitudes are proportional to the local angle-dependent reflection coefficients if illumination compensation is properly implemented. Since the complete illumination is available not before having obtained the last contributing trace at each output location, GRT migration calls for an output-oriented strategy with all input data loaded into memory.

Our implementation of GRT angle-domain migration delivers angle gathers on a dense spatial output grid. Modern parallelization concepts like GASPI-GPI (e.g., Gruenewald, 2012) support asynchronous communication and allow for efficient and scalable code that moves Peta-Bytes orders of seismic traces during one migration run without influencing the computations. The fact, that the angular migration domain and the spatial data input domain are not identical, causes internal boundaries, in particular in complicated velocity models. Detecting and tapering such internal boundaries and interpolations between uniform and non-uniform grids of various kinds are essential pieces of the implementation to provide artefact-free migration results.

We explain the challenges of the output-oriented implementation of GRT and demonstrate its benefits, as GRT is a highly flexible migration method that poses no constraints to the regularity of the input data and offers additional features like dip-dependent illumination information and reflection enhancement.

References

