P053
Deriving a Depth Velocity Model Using Time Migrated Data – Case Study

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SUMMARY

We present the application to a real dataset of a fast and accurate workflow for time to depth conversion. It allows taking full advantage of an existing time imaging project for leading a depth imaging project. We present here the various steps involved in the imaging sequence. It is based on a dense volumetric dip and residual move-out picking in the prestack time migrated domain. This kinematic information is then demigrated to compute multi-offset un-migrated attributes – called seismic invariants – used as input data for a multi-offset tomographic inversion. Finally the resulting depth velocity model is used for prestack depth migration. Our application to the real dataset demonstrates that accurate results can be obtained with a fast turnaround time.
Introduction

Reducing turnaround time for depth imaging projects is an important issue in seismic processing. In Lambaré et al. (2007), we proposed a fast and accurate workflow to allow us to take full advantage of a previous time migrated dataset to derive a depth migration velocity model. This approach mimics our “standard” depth imaging workflow (Guillaume et al., 2001, 2004) except that the dense volumetric dip and Residual MoveOut (RMO) automated picking is done on Pre-Stack Time Migration (PreSTM) gathers rather than on Pre-Stack Depth Migration (PreSDM) gathers. The benefits are to bypass the initial PreSDM required for the picking and to make use of the quality of the focusing of the PreSTM for the automated picking with no compromise on the accuracy.

In the present paper, we first recall the strategy described in Lambaré et al. (2007). We then detail the various steps involved in the workflow through an application to a real dataset.

Depth velocity model building from PreSTM gathers

The possibility to use kinematic information from PreSTM gathers to derive a depth velocity model comes from the use of “kinematic” invariant described in Guillaume et al., (2001). Consider a locally coherent event in a common offset depth migrated image (Figure 1). It is characterized by its central position and dip. By kinematic demigration it can be associated in the un-migrated domain to a set of source and receiver positions, S-R, two-way time, T_{SR} and a local slope, GradT. These parameters are independent of the velocity model used for migration and demigration, and are consequently called the kinematic invariants.

Figure 1: Computation of kinematic invariants by kinematic demigration.

The kinematic invariant can be used directly as input data for depth velocity model building by tomographic inversion (Guillaume et al., 2001), with the potential benefit of a single picking step. A “standard” depth imaging workflow based on kinematic invariants can then be proposed with the following steps:

1. Building of an initial depth velocity model,
2. PreSDM using the initial velocity model,
3. Dip and RMO picking on PreSDM gathers,
4. Kinematic demigration of picks for computing kinematic invariants,
5. tomographic inversion for updating the depth velocity model,
6. PreSDM using the final velocity model.

The strategy proposed by Lambaré et al. (2007) simply consists in performing dip and RMO picking and kinematic demigration from PreSTM gathers rather than from PreSDM gathers (steps 1 and 4). When the depth imaging project starts from an existing time imaging project this allows us to bypass the PreSDM in the initial velocity model (step 2) and favours the automated picking through the quality of the PreSTM results (Automated picking being easier when images are well focused!).
Figure 2 shows the processing flow used for computing kinematic invariants from PreSTM gathers. The PreSTM stack is used both for computing a skeleton (defining the location of the events) and for computing a dense dip field (which is assumed to be independent of the offset). The PreSTM gathers are used for computing RMO curves with the associated semblance (used as QC for the picking). The kinematic invariants are then computed by kinematic time demigration.

**Figure 2:** Flow for computing kinematic invariants from PreSTM gather.

Application to a real dataset

![Image](image.png)

**Figure 3:** Time imaging project. Left) the PreSTM stack, Right) some CIP gathers with superimposed RMO curves (location of the range of CIP gather is indicated on the stack by the two dotted lines).

As an application to our approach we lead a depth imaging project starting from a previous time imaging project. Figure 3 shows the PreSTM stack (left) and some time CIP gathers (right), where RMO curves picked with our automated RMO picking tool have been superimposed. Figures 4 and 5 show the various outputs of the workflow (Figure 2), i.e. the dip picking, the skeleton building, and the RMO parameters, respectively. A C2-C4 picking was performed in order to assess complex RMO curves. An initial depth velocity model (Figure 6 left) was obtained from the effective velocity model used in PreSTM using Dix conversion assuming zero dip. The Final depth velocity model (Figure 6 right) was obtained.
with the 3D tomographic inversion. On Figure 7 we see the PreSDM CIP gathers obtained with the initial (top) and final (bottom) depth velocity models.

**Figure 4:** PreSTM stack dip and skeleton building. On the dip panel (left) we have superimposed the PreSTM stack. The skeleton (right) insures a dense covering of the PreSTM image.

**Figure 5:** PreSTM RMO building. C\textsubscript{2} (left) and C\textsubscript{4} (right) dense panels obtained after dense RMO picking.

Note the improved fit of the updated depth velocity model with the PreSDM images (Figure 6).

**Figure 6:** Initial (left) and final (right) depth velocity models.
Figure 7: CIP gathers in the depth migrated domain for the initial (top) and final (bottom) depth velocity models. It clearly demonstrates the improvement in the flattening of PreSDM gathers.

Conclusion

We have demonstrated an application of a fast and accurate workflow for building a depth migration velocity model starting from time imaged gathers (preSTM). The combination of an automated dense volumetric picking with a kinematic invariants based tomographic inversion and an existing time imaged pre-stack dataset, ensures a fast turnaround. Whilst our approach also takes full advantage of optimally focused time migrated data to ensure the quality of the RMO curves used to build the depth velocity model.

Acknowledgments

We thank Jean-Paul Touré, Anthony Prescott, Ariane Herrenschmidt and Philippe Herrmann (CGG Massy) for their help.

References