How to Increase the Bandwidth of your Plains Data

Rob Holt*
WesternGeco, Calgary, AB
rholt@westerngeco.com

Summary

In this paper, we present comparisons of poststack time migration, prestack time migration, and anisotropic depth migration of a Canadian Plains data set. All of the comparison data sets were processed using the same software, pre-migration signal processing, and statics, enabling a fair comparison of these different migrations. We observe the highest bandwidth, best-focused amplitudes, and the clearest imaging of stratigraphic features such as channel flanks, faults, and fractures on the anisotropic depth migration stack.

Introduction

Theoretically, a more advanced migration will give a more accurate seismic image of the subsurface. In other words, prestack time imaging (PSTM) should be better than poststack time imaging (PoSTM), anisotropic prestack time imaging (APSTM) should be better than isotropic prestack time imaging, and anisotropic prestack depth imaging (ADM) should be better than anisotropic prestack time imaging, all other factors being the same.

It is relatively easy to convince interpreters working with clean marine seismic data that anisotropic depth migration gives the best imaging with significantly clearer fault planes and improved reservoir positioning. There have also been many published Foothills case histories that show that anisotropic depth imaging can give significant positioning and imaging improvements beneath dipping clastic layers. In the Plains, conventional wisdom suggests that poststack time migration gives an excellent image and little uplift is expected from more advanced migration technologies due to the simplicity of the velocity field. For this reason, there have been few papers presented at the CSEG annual meeting showing imaging improvements on Canadian Plains data using anisotropic depth migration (e.g. Holt et al., 2004; Vestrum et al., 2005).

In this paper, we present the results of an anisotropic prestack depth migration test run on the WesternGeco multiclient Wembley Valhalla merge data set that was previously processed through poststack time and prestack time migration. We believe this is the most detailed comparison of time and depth imaging of a Canadian Plains data set published to date.

Processing

Typical pre-processing, migration, and post-migration processing techniques were applied by WesternGeco during the three generations of processing (PoSTM, PSTM, and ADM) that generated the comparison data sets. These data sets have the following in common:

- The pre-migration signal processing and statics were the same for all three data sets.

- The prestack time and depth migrations used the same migration input data.
- All migrations used standard migration parameters including the migration aperture.
- Very similar post-migration processing sequences were applied for the prestack time and depth migrations.

However, it is important to note that certain key aspects of the processing workflows are necessarily different and they exclude the possibility of absolute apples-to-apples comparisons. Examples are:

- The input to the poststack time migration was stacked and cleaned, whilst the prestack time and depth migrations were stacked and cleaned post-migration.
- The time migrations were run isotropically, the depth migration was run anisotropically.
- Different stacking mutes were used in the isotropic and anisotropic workflows.

Data Comparison Highlights

Every effort was made to generate fair comparisons and we believe the imaging comparisons are representative of these three types of migration applied to this Plains data set. For ease of comparison, the anisotropic depth migration stack was stretched back to time to compare to the poststack and prestack time migrations. Here we show an inline (Figure 1), coherence volume slices (Figure 2), and an amplitude slice (Figure 3).

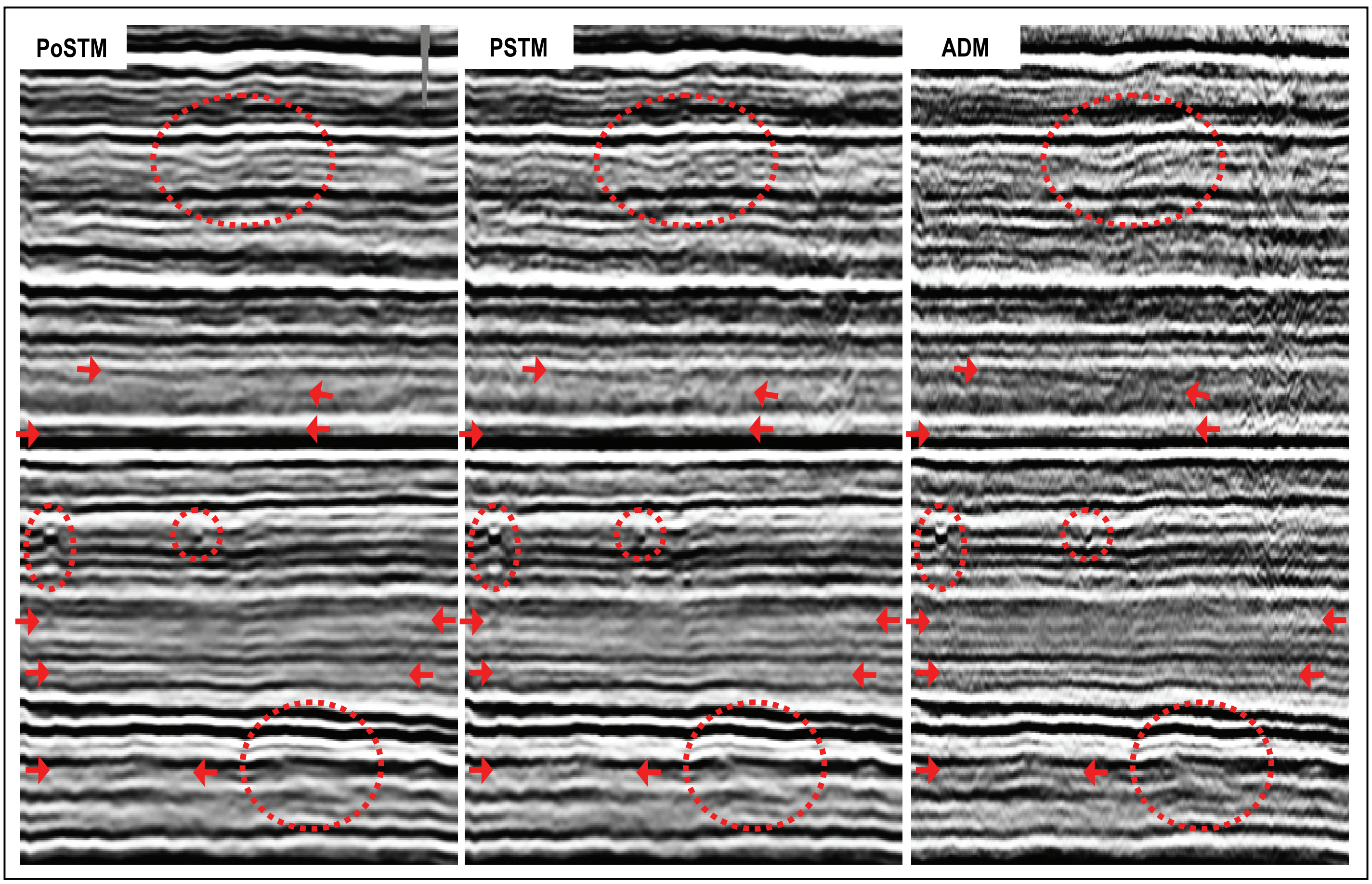

Figure 1: Inline comparison. Data shown are a 700 ms window centered on the flattened Paddy horizon. The line length is 9 km. Note the improvements within the red ovals and between the red arrows. Also note that at this scale some small features including faults, channels and better-focused amplitudes may look like noise on the stack.

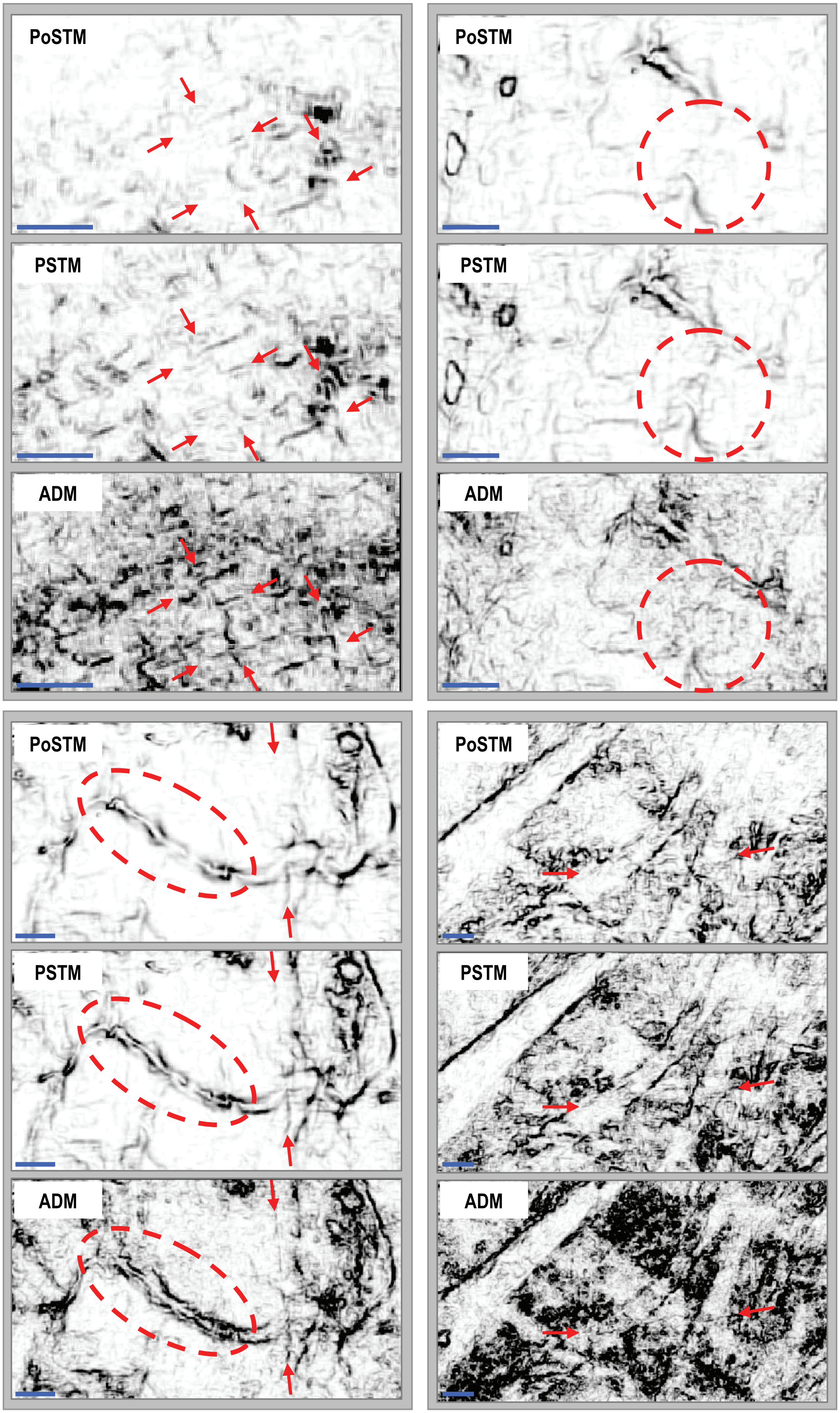

Figure 2: Coherence slice comparisons (3x3 traces, 10 ms window). All slices displayed at the same gain. The blue scale bar is 1 km in length.

Top left: ADM better images fractures 90 ms above the Paddy.

Top right: Detail of Gething level levee breach best imaged after ADM (circled).

Bottom left: Gething level channel and fault detail clearest after ADM.

Bottom right: Aside from stronger contrast 30 ms below the Banff horizon note the imaging of a fault on the ADM not seen on the time images (between the arrows).

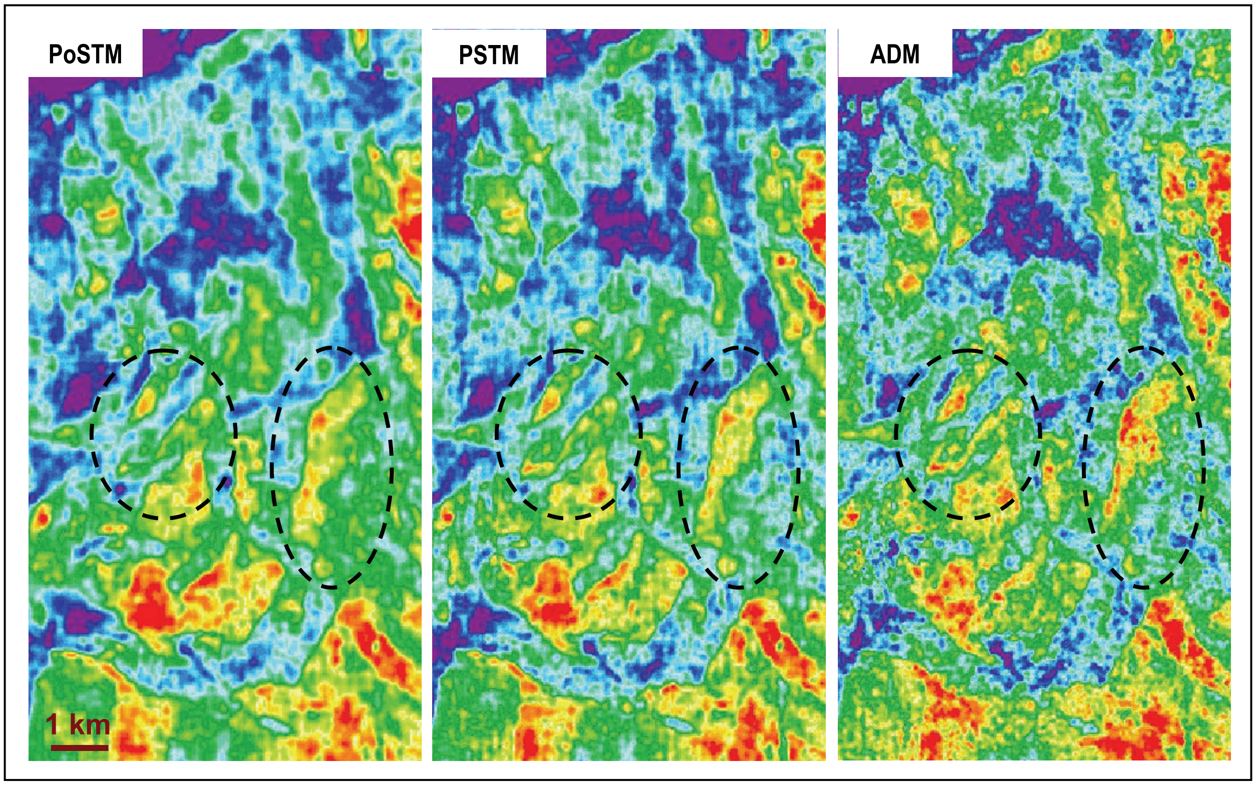

Figure 3: Comparison of amplitudes 10 ms above the flattened Debolt horizon. Note the progressive improvements in amplitude focusing from post-stack time to pre-stack time to anisotropic depth imaging.

Conclusions

We achieved improved imaging of the WesternGeco multiclient Wembley Valhalla Plains data set using anisotropic depth migration. Unlike previously-published Plains anisotropic depth migration case histories, all of the data shown in the comparisons presented here were processed by the same geophysical contractor, reducing the impact of different processing software and workflows on the comparisons. Imaging improvements observed after anisotropic depth imaging include:

- Higher bandwidth.
- Improved imaging of stratigraphic features including details of channels, fracturing and faulting on coherence volumes.
- Better-focused amplitudes.

Acknowledgements

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References

Holt, R., Joy, H., Culver, B., and Cheadle, S., 2004, Optimal Stratigraphic Imaging Using 3D Anisotropic Prestack Depth Migration. Annual Meeting, CSEG.

Vestrum, R., Link, B., and Mathewson, J., 2005, Why does depth migration work so well in the plains? Annual Meeting, CSEG.