

P362

Polarity Blind and Polarity Sensitive Gather Flattening Methods

N. Gulunay* (CGGVeritas Services)

SUMMARY

The need for applying gather flattening process on Multi Azimuth (MAZ) gathers where three or more narrow azimuth (NAZ) surveys were merged on the same common midpoint gather as well as the need for better alignment of noisy land data gathers created a need for stronger alignments than our current polarity blind gather flattening method provides. That is, we need to align peaks-to-peaks and troughs-to-troughs. We call this process a polarity sensitive gather flattening. This paper studies the performance of polarity sensitive gather flattening on three such surveys.

Introduction

Trim statics programs were used as a method in increasing stack quality before the advent of surface consistent statics methods in early 1980's. The emergence of commercial surface-consistent statics methods and their reliability made us all forget about trim statics.

Around the year 2000 the geophysical industry started to see the need for gather flattening in conjunction with imaging and AVO (Hinkley, 2004). In fact, we ourselves presented a few papers on the subject where we illustrated one such method that preserves class2 AVO (Gulunay et al, 2007a, 2007b, and, 2008). We had to make the alignment process polarity blind to achieve that property. Such a process could align troughs to peaks if need be.

Then the need for applying such a process on Multi Azimuth (MAZ) gathers, where three or more narrow azimuth (NAZ) surveys were merged on the same common midpoint gather occurred. This is where we first saw the need for stronger alignments; i.e. alignment of peaks-to-peaks and troughs-to-troughs. This paper describes the illustration of such a process on three different surveys. We will call this method polarity sensitive flattening.

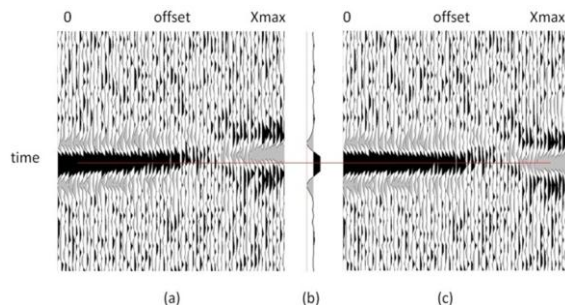


Figure 1a) Synthetic gather with Class 2 AVO anomaly **b)** Near offset stack **c)** After polarity blind gather flattening

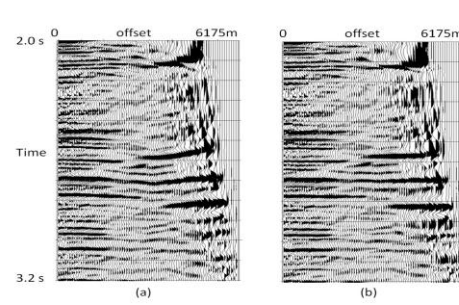


Figure 2a) Image gather with large RMO **b)** Gather after 5-trace polarity blind alignment

Polarity Blind versus Polarity Sensitive gather flattening

A gather flattening method that preserves class 2 AVO was illustrated in Gulunay et al (2007a). They showed a synthetic gather (Figure 1a) where one event with amplitude variation, polarity reversal, and residual moveout is present with some added random noise. Their method, with the use of absolute values in cross correlation, was able to push down the far offsets, properly preserving class 2 AVO (Figure 1c), despite the fact that a pilot trace (Figure 1b) that resembles only the inner offsets was used to derive the statics. This polarity blind gather alignment method was later illustrated by Gulunay et al (2007b, 2008) on real data where 2-trace event tracking as well as 5-trace tracking algorithms were used instead of correlating traces to a pilot stack. The algorithm consisted of a t-x domain moveout mapping, followed by moveout editing and moveout application using 3-point quadratic interpolators. The moveout map was obtained by tracking event wavelets from offset to offset at each time sample. This process was used successfully in the following years with some modifications. Figure 2 presents a typical run on a gather. The quality of gather flattening on such gathers is excellent.

MAZ data example and Polarity Sensitive gather flattening

Then came the time when we applied such a method to multi-azimuth (MAZ) surveys recorded in the Mediterranean Sea, where three or more narrow azimuth (NAZ) surveys were combined in super gathers to be stacked. In such super gathers there are large jumps from azimuth to azimuth and we wanted to correct such shifts before stacking as short (spatial) period statics. In this case the polarity blind gather flattening method left a lot to be desired from the alignment process, as the magnitude of statics from trace to trace was quite large and troughs were sometimes getting aligned with peaks. We then tried a polarity sensitive flattening method, by using signed cross-correlations which align peaks to peaks and troughs to troughs, obtaining better results. In this form our method becomes similar to

standard trim statics, except that we derive statics by event tracking (or by statics calculation with respect to a reference stack) at every time sample, and then creating a moveout map from them, and then editing the moveout map, and applying statics at every time sample using this moveout map. In the standard trim statics methods statics are calculated only for a small number of time gates. As one can see from the example given in Figure 3, for a narrow azimuth gather this moveout mapping approach results in better alignment of events.

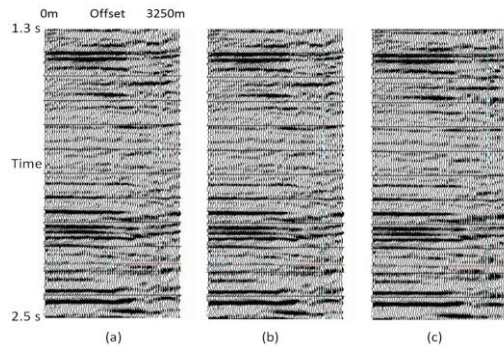


Figure 3a) input gather **b)** Standard trim statics **c)** Trim statics at every time sample using moveout mapping

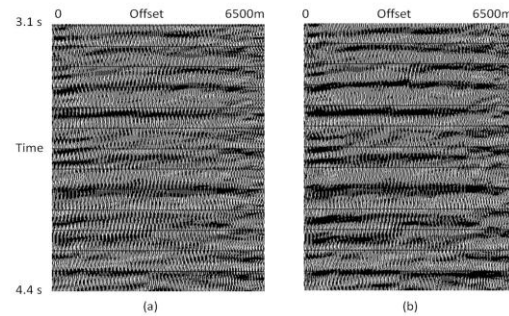


Figure 4a) A MAZ gather made of 3 NAZ surveys **b)** Same gather after polarity sensitive alignment

We show, in Figure 4a, a MAZ gather which exhibits the standard jitter that is created by the merge of three azimuths in the same offset sorted gather. Figure 4b shows the same gather after polarity sensitive short period alignment. This was achieved by using signed cross correlations, using a 5-trace running space window (Gulunay 2007b), to track event times to create the moveout map, subtracting the spatially smoothed version of the moveout map to keep only short spatial period components and then applying them. We see that at many locations alignment of different azimuths is achieved.

The stacks of the gathers before and after such polarity sensitive flattening of MAZ gathers are shown in Figures 5a and 5b respectively. Increase in stack amplitude due to better alignment of azimuths is evident from the comparison of these two stacks.

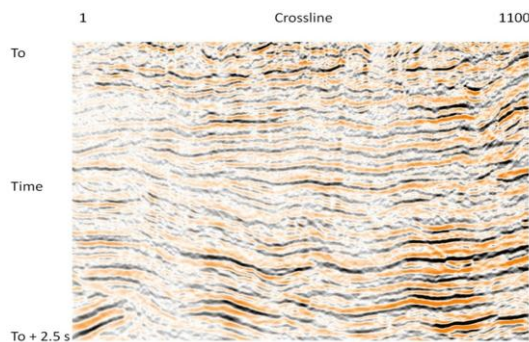


Figure 5a Stack of MAZ gathers before polarity sensitive alignment of different azimuths (3 azimuths are used)

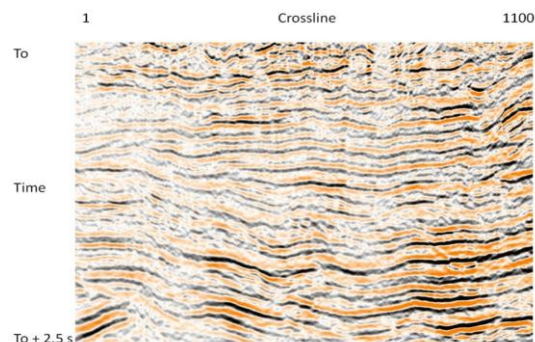


Figure 5b Stack of MAZ gathers after polarity sensitive alignment of different azimuths (3 azimuths are used)

Controlled Beam Migration Example

Migrated gathers generally need moveout alignment despite best efforts in improving velocity models. In Figure 6a we show three gathers from a common offset vector (COV) domain Controlled Beam Migration (CBM). There is jitter on these gathers. Figure 6b shows the same gathers after polarity sensitive alignment. One observes that most of the jittering is corrected. Stacks before and after polarity sensitive alignment are shown in Figures 7a and 7b respectively. These show increase in stack amplitudes at many locations as well as better fault definition.

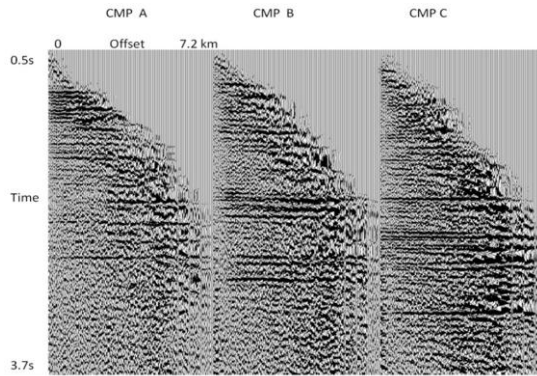


Figure 6a Three image-gathers from COV domain CBM

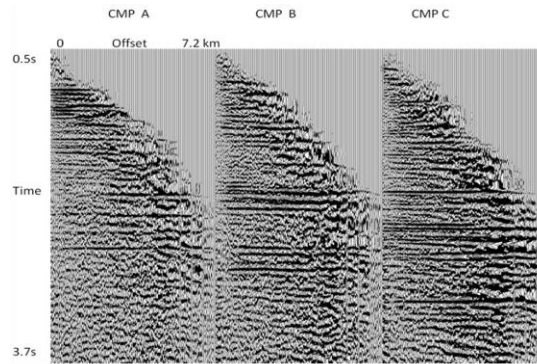


Figure 6b Gathers after polarity sensitive alignment

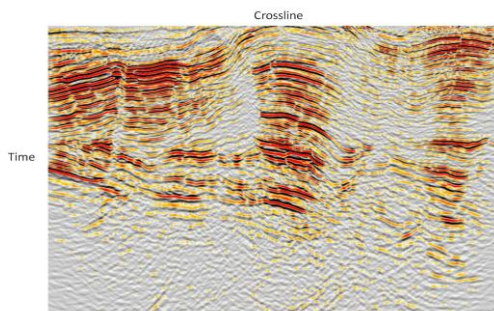


Figure 7a Stack of image gathers from COV domain CBM

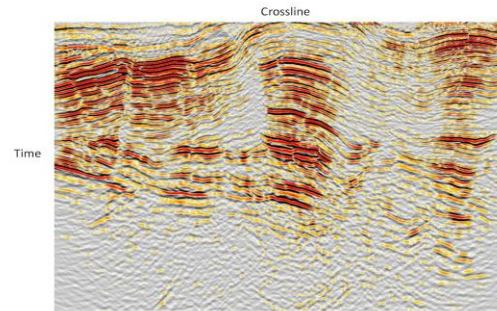


Figure 7b Stack after polarity sensitive alignment

Land data set Example

Here, in Figure 8a, we show some land gathers which are naturally noisy. The gathers have jitter that is causing degradation of the stack quality. Figure 8b shows the same gathers after polarity sensitive gather alignment. Here we used the same short period alignment method that was described above for the CBM gather example. Stacks of the gathers before and after polarity sensitive gather alignment are shown in Figures 9a and 9b respectively. Increase in stack quality especially in deeper horizons is evident.

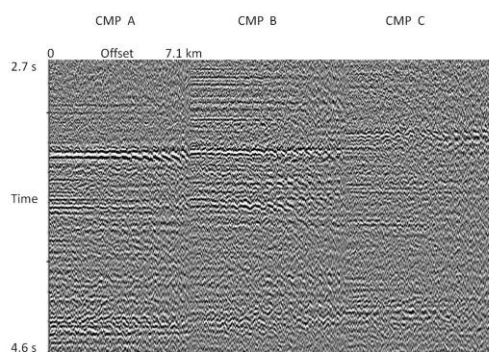


Figure 8a Three image-gathers from land PSTM

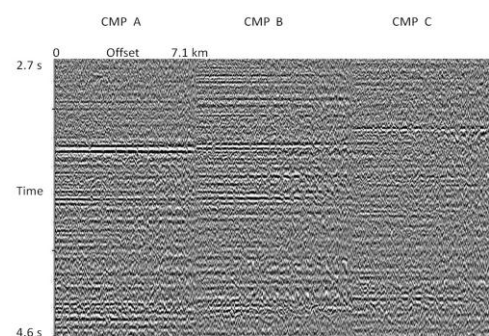


Figure 8b Same gathers after polarity sensitive alignment

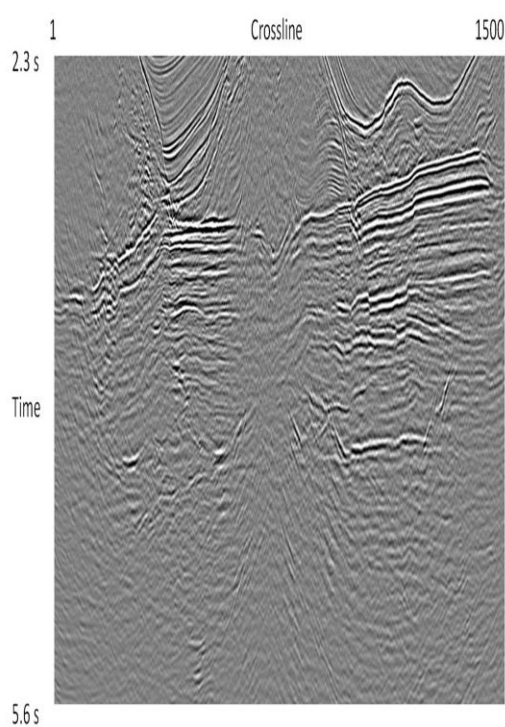


Figure 9a Stack of image gathers from land PSTM

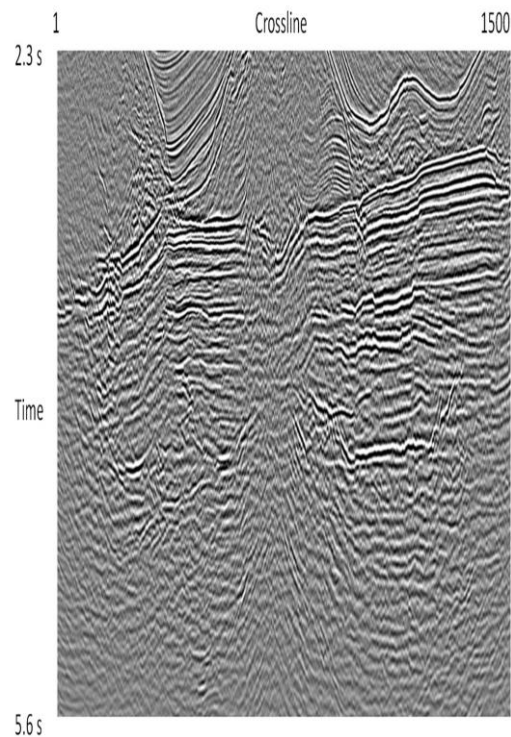


Figure 9b Stack after polarity sensitive alignment

Conclusions

Gather flattening recently became a necessity for better stacking of image gathers as well as for successful AVO analysis. As AVO analysis requires an AVO friendly gather flattening method, our earlier developments on gather flattening used a polarity blind method, where the absolute value of the cross-correlation function was used, so that class 2 AVO effects could be preserved. The alignment needs of MAZ gathers, as well as noisy land data, led us to investigate and develop the polarity sensitive gather flattening presented in this paper. We find the use of polarity sensitive alignment in gather flattening to be a powerful method of increasing the quality of stacks.

Acknowledgements

I thank Petroleum Development Oman (PDO) and The Ministry of Oil and Gas of Oman (MOG), for allowing me to show the images in Figures 8 and 9. I am grateful to my colleagues F. Gamar, H. Hoerber, and, O. Hermant for various discussions on gather flattening.

References

- Gulunay, N., F. Gamar, H. Hoerber, M. Dyce, C. MacKenzie, D. Whitcombe, 2007a, Robust Gather Flattening, 77th Annual International Meeting, SEG, Expanded Abstracts, 229-233.
- Gulunay, N., M. Magesan, and, H. Roende (2007b) Gather Flattening, The Leading Edge, December issue.
- Gulunay, N., M. Magesan, and, H. Roende, 2008, Gather flattening based on event tracking for each time sample, Extended Abstracts, P066, EAGE conference in Rome, Italy.
- Hinkley, D., G. W. Bear, and C. Dawson, 2004, Prestack gather flattening for AVO: 74th Annual International Meeting, SEG, Expanded Abstracts, 271-273.