

Fast Broadside Diffractors: A case history.

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Summary

Diffracted noise from shallow obstructions at seabed usually travels with water velocity. In a recent survey we encountered diffractions traveling with velocities a few hundred meters per second higher than the water velocity. We present a method to attenuate these diffractions.

Introduction

Diffracted energy in 2D marine surveys is a source of problem especially if they are broadside. Strong energy radiated from the source travels to the scatterers at the water bottom and gets scattered. This energy travels back in the water and is received by the receivers on the streamer. 2D processes, including 2D migration, cannot properly address such events. On the other hand, 3D migration in 3D surveys provides a means for collapsing such energy properly. Nevertheless, in deeper portions of the data diffracted noise is so high in energy and is so different in spectral content than the reflected energy that it might be desirable to attenuate such energy before some prestack processes if the number of such diffractors is so large to block the signal underneath.

Gulunay et al (2005) presented a method, called DSCAN, to address this problem for 2D as well as 3D marine surveys. In their study they encountered diffraction energy traveling with water velocity: 1525m/s-1550m/s. In recent surveys we have encountered cases where diffracted energy traveled with velocities between 1650 m/s and 1750 m/s. This paper is a about attenuating such diffractors on one of these surveys.

DSCAN Method

The method for attenuating diffracted energy is explained in the above given reference (Gulunay et al, 2005). Briefly, the method consists of scanning over the possible diffractor locations and for each such location calculating semblance of energy that is received from such a point at times given by the double square root equation using source and receiver coordinates of all the traces of a shot or a group of shots. Points of high semblance are selected as possible diffractor locations. Once diffractor positions are so determined one can calculate travel times from them to the receivers of a given shot and carve out the diffracted noise from those traces.

Field data

The data set is a 3D marine data with 8 streamers each with 352 receivers. The stack section from this data, Figure 1, exhibits shallow water bottom with abrupt changes. These locations are the cause of steeply dipping high frequency diffractions seen in the later portions of the same section (Figure 2). The deeper portions of this data also exhibit events which are difficult to distinguish from reflections as they are lower in frequency content than the diffractions traveling with water velocity. Study of these events in the common shot records, (see Figure 3 around 4800 ms), however, suggests that they may be broadside events, most likely with a higher velocity than water velocity.

Figure 3 has indeed steep linear diffracted energy from nearly inline anomalies (with respect to this particular subsurface line) in the water bottom and are traveling with water velocity. Initially we attempted processing this data with velocity of 1550 m/s which only handled this steeply dipping noise but not the broadside diffractors around 4800 ms. Such steeply dipping linear events could, indeed, be suppressed by Radon or F-K type filters after some dealiasing process and there is no need to apply DSCAN type processes for such noise. After realizing that we were not attenuating these broadside diffractions we decided to run a velocity analysis. We scanned for velocities between 1500 m/s and 1800 m/s with an increment of 50 m/s as shown in Figure 4.

Close inspection of Figure 4 suggests that the strongest diffractor is indeed almost broadside and its velocity is around 1650 m/s. To make sure we are getting the right velocity we built the diffraction model with different velocities from the picked strongest diffractors for each velocity. Figure 5 shows, for one of the cables (shown on the left) the noise models generated by DSCAN with different velocities. It is clear that velocity of the broadside diffractor is at least 1600 m/s. We later subtracted the noise models built for each velocity from the input. The results are shown in Figure 6. Close inspection of this figure suggests that either 1650 m/s or 1700 m/s could be used as diffractor velocity for the broadside diffractor.

Figure 7 shows the diffraction noise model for a few strong diffractors picked using a diffractor velocity of 1650 m/s. Figure 8 is the result after straight subtraction of the noise model from the input record shown in Figure 3. We notice that broadside diffractions are now well attenuated.

The stack of the shot records after attenuation of such noise traveling with velocity of 1650 m/s is shown in Figure 9.

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We see that broadside diffractions are reasonably attenuated from the stack section as well.

Conclusions

We have presented a case history of attenuating fast and broadside diffractions for a marine 3D data. These diffractors which interfere with prestack migration process were of high velocity as compared to water velocity. By

using a higher velocity, 1650 m/s, during diffractor semblance scanning as well as model building it is possible to model and as well as subtract the strong diffraction energy from deeper times. Although a simple double square root equation used here was sufficient to predict the arrival times, the actual propagation mechanism of these diffractions and the reason for higher velocities is not well understood.

References

Gulunay, N., Magesan, M., and Connor, J., 2005, Diffracted noise attenuation in shallow water 3D marine surveys, 75th Ann. Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts.

Acknowledgments

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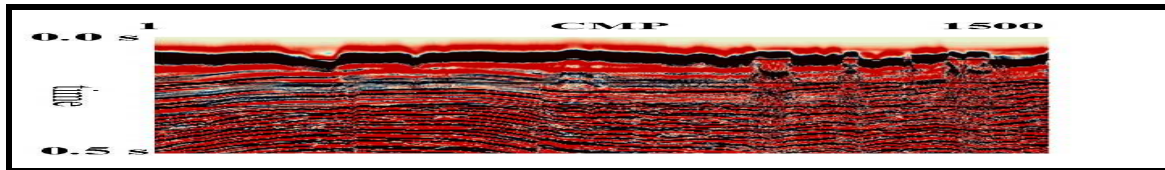


Figure 1. A surface line from a shallow 3D marine survey.

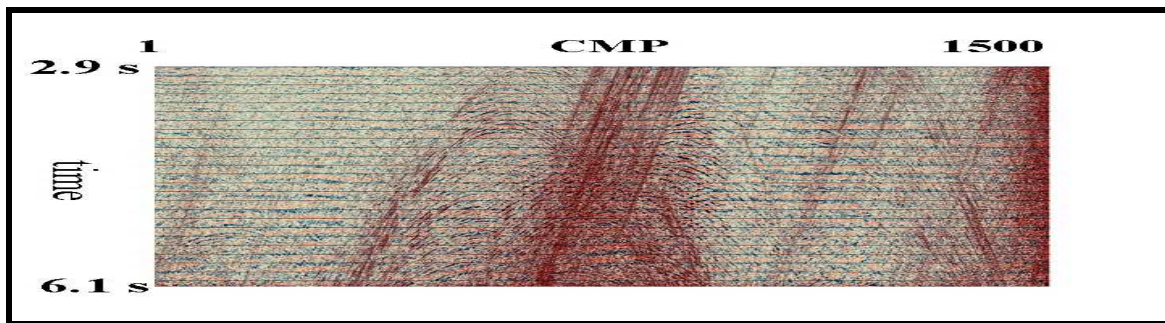


Figure 2. Deeper portions of the same subsurface line in Figure 1. Note the broadside as well as linear diffractions.

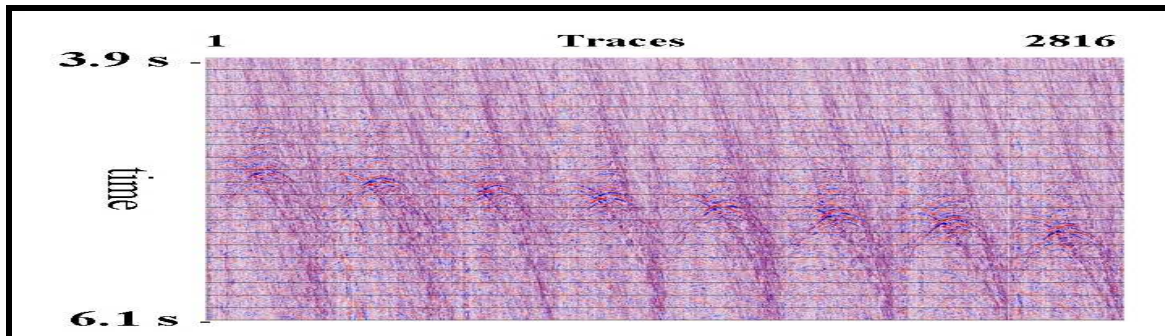


Figure 3. A 3D shot with 8 cables. Note the broadside as well as steep linear diffractions.

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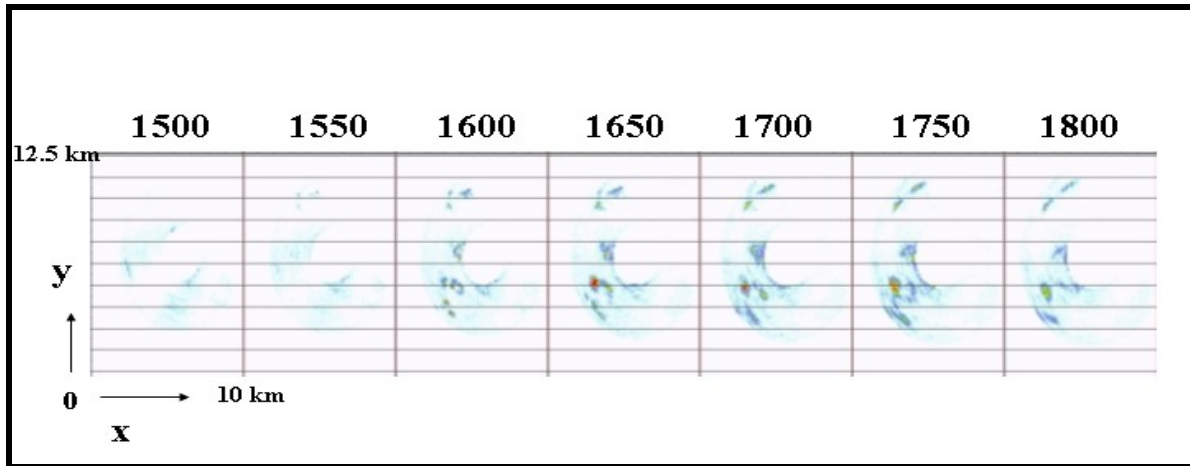


Figure 4. DSCAN with velocities varying from 1500 m/s to 1800 m/s. Red points are high semblance positions.

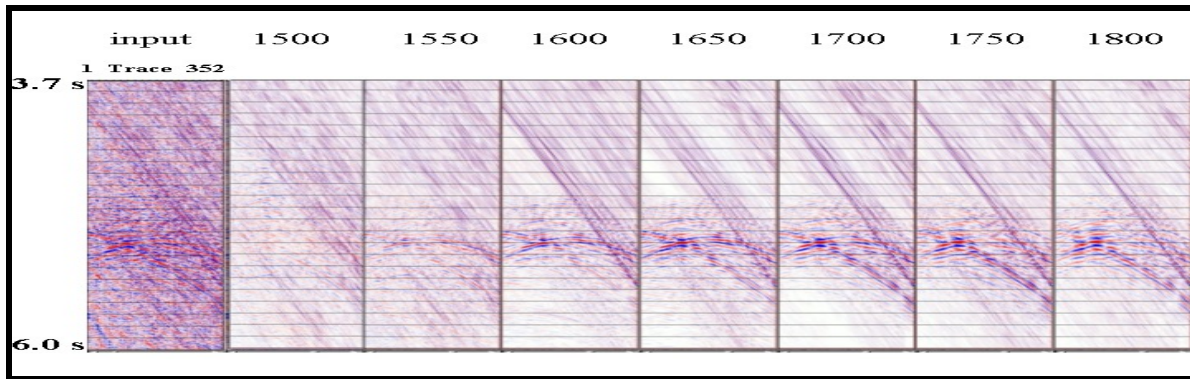


Figure 5. One input cable (on the left) and diffractions built for that cable with various velocities.

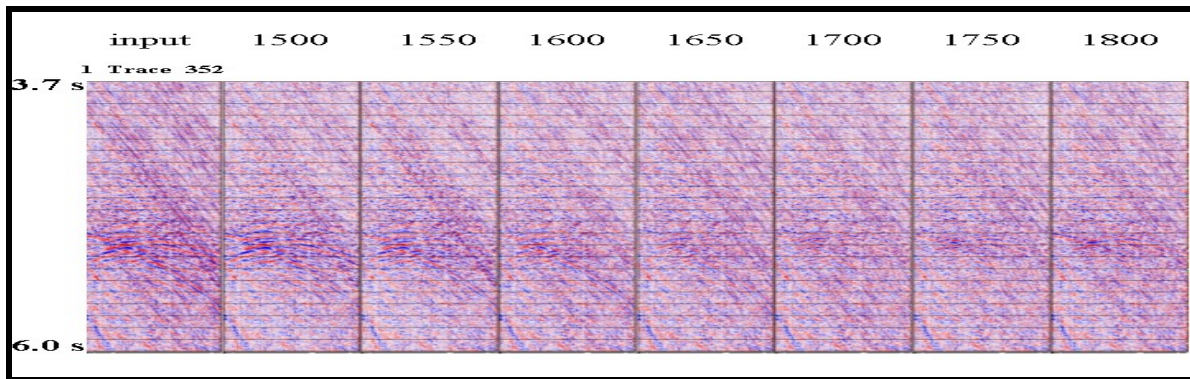


Figure 6. Same input cable in Figure 5 and after subtracting the noise models in Figure 5.

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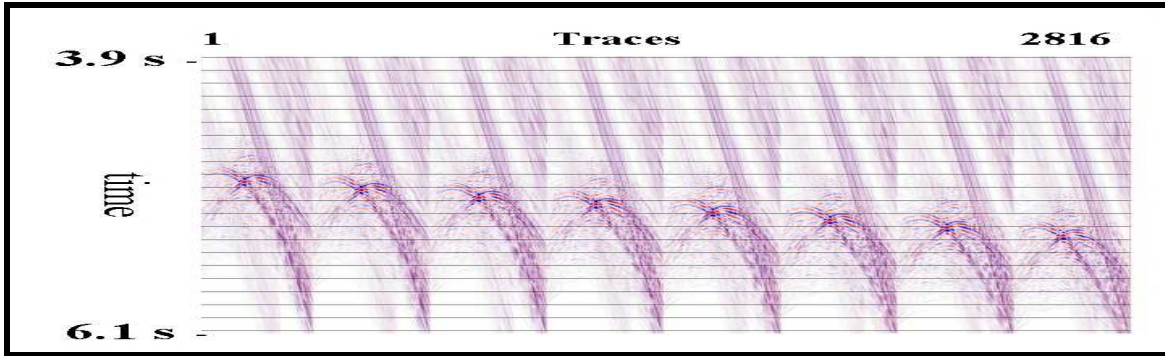


Figure 7. Noise model with $v=1650$ m/s for 8 cables for the record shown in Figure 3.

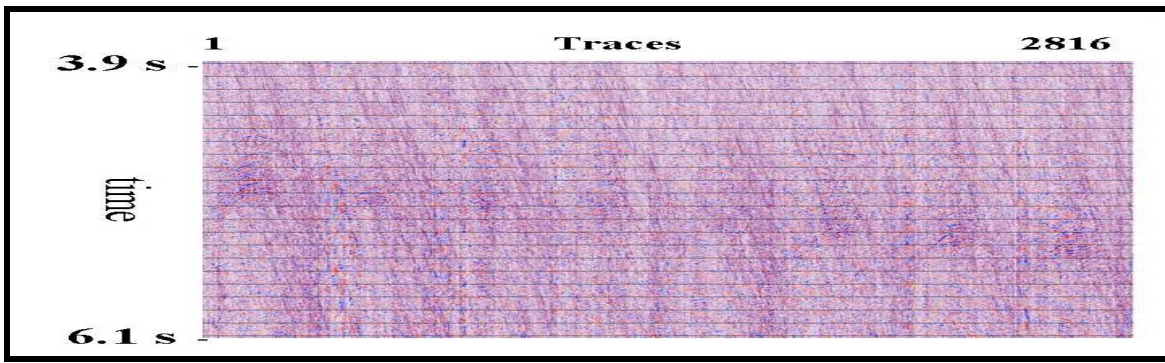


Figure 8. Same record in Figure 3 after subtracting the diffractions in Figure 7.

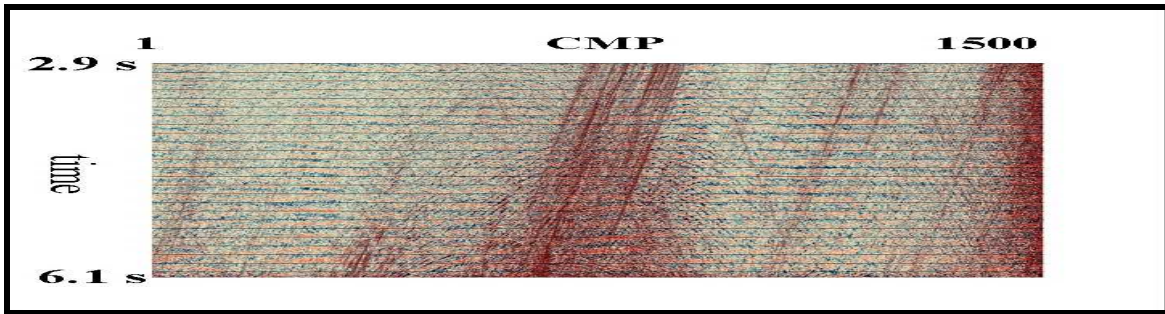


Figure 9. Stack section in Figure 2 after subtraction of diffractions with $v=1650$ m/s from the shot records.

EDITED REFERENCES

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REFERENCES

Gulunay, N., M. Magesan, and J. Connor, 2005, Diffracted noise attenuation in shallow water 3D marine surveys: 75th Annual International Meeting, SEG, Expanded Abstracts, 2138–2141.