THE IMPORTANCE OF WIDE AZIMUTH IN IMAGING

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Summary
Comparing 3D depth migrated streamer data and 3D depth migrated OBC data from the same area, it is demonstrated that the better quality of OBC data is related to the relatively wider azimuths used in the OBC data acquisition geometry.

Introduction
The benefits of wide azimuth acquisition geometries have been recognized for a long time in land seismics (Cordsen and Galbraith, 2002). Offshore true 3D OBC data has recently become available and the importance of better azimuth coverage both for imaging and fracture characterization is starting to be realized (S. Hall et al 2002, Kommedal et al 2002). Streamer geometries are however still strongly azimuth limited, but proposals for wide azimuth multi boat operations are starting to appear (Sukup, 2002). In this paper we compare streamer and OBC images from the same area and demonstrate that the superior quality of the OBC data is due to the much wider azimuths employed.

Data acquisition
The Gullfaks Sør field is located in the North Sea and is a satellite to the larger Gullfaks field. A pilot OBC survey was acquired in the year 2000 to access the quality of OBC data in the area. The acquisition geometry consisted of three receiver cables spaced at 400 meters, each cable was 6 km long with 25 meter group interval. A flip-flop source configuration was used and the shot lines arranged such that an area of 12 by 2.8 km was covered by a 50 by 50 meter shooting grid. The three cables were positioned in the centre of the shot patch such that the maximum in line offset from each end of the receiver cables was 3 km, while the largest cross line offset was 1.8 km.

Depth processing
The vertical geophone component and the pressure data were combined using a conventional PZ-summation technique. Further multiple removal was achieved using a Tau-p decon technique.

For imaging the data a 3D prestack wave equation depth imaging technique was used (Arntsen and Røsten, 2002). The migration algorithm is based on a finite difference technique and is implemented as a shot profile method. By using the reciprocity principle the shot points at the surface are converted into receivers and the receivers at the seafloor become sources. Each common receiver gather then effectively becomes a shot gather. Wavefield extrapolation using finite-difference migration operators are applied to each gather. The source wavefield is extrapolated simultaneously in depth and a cross correlation between the extrapolated data and source becomes the depth image. The migrated gathers are then stacked together to produce the final image.

Previously a conventional streamer survey covering the area had been acquired. The data from this survey was imaged using a ray based kirchhoff depth imaging approach and migration velocity analysis was performed using a conventional tomographic method. This resulted in a velocity depth model which was used for the final migration of the streamer data and for the wave equation depth imaging of the OBC data.

Azimuth and image quality

The maximum cross line offset of the OBC data is not larger than 1.8 km, but this is significantly larger than the typical cross-line offsets of a few hundred meters in a streamer survey. Figure 1 shows the streamer corresponding to the central inline of the OBC survey. Comparing this image with the image in figure 2 where OBC data has been used, a significant difference in quality is seen. Note in particular the differences in the Base Cretaceous reflector between 2.5 s and 2.9 s. Also note that the flanks of the fault blocks between 3.1 s and 3.3 s are almost invisible in the streamer image, but clearly defined in the OBC image.There are a number of possible reasons for this quality difference, including better multiple removal due to the PZ-summation of the OBC data. However, the most immediate and obvious difference between OBC and streamer data is the data acquisition geometry.

By decimating the OBC data in the cross-line direction and repeating the processing sequence to produce new images, the significance of the cross-line offsets for image quality can be estimated.
Figure 3 shows the same inline as in figure 2, but the cross-line offset of the input data has been restricted to a maximum of 350 m. There is a significant reduction in quality compared to the OBC line in figure 2 containing cross-line offsets up to 1.8 km.
A further reduction of cross-line offsets produces the image shown in figure 4. The maximum cross-line offset is here only 90m and the reduction in quality relative to the image in figure 2 is dramatic.
Note in particular the change of the Base Cretaceous reflector, which shows similar features as in the streamer image of figure 1. Also the faults block between 3.1 and 3.3 s are not very well imaged.
Obviously the illumination of the Base Cretaceous reflector and the flanks of the fault blocks are greatly improved by the larger cross line offsets used in the OBC data set.

Conclusion

The quality of seismic images using OBC data is greatly improved relative to streamer surface data from the same area in the North Sea. By reducing the cross-line offsets of the OBC data it is demonstrated that the image quality can be attributed to the larger cross-line offsets used in the OBC acquisition geometry.

References

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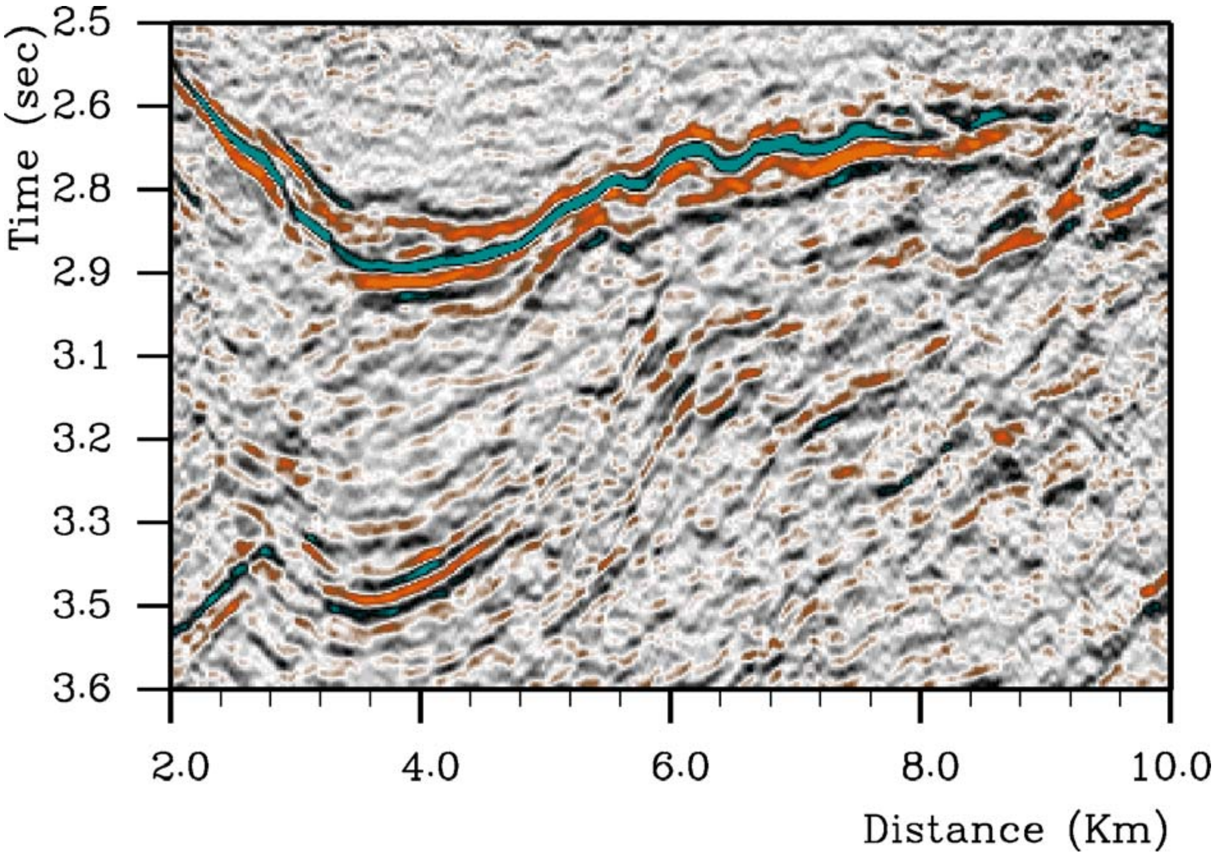

Figure 1: Depth migrated streamer inline 1057

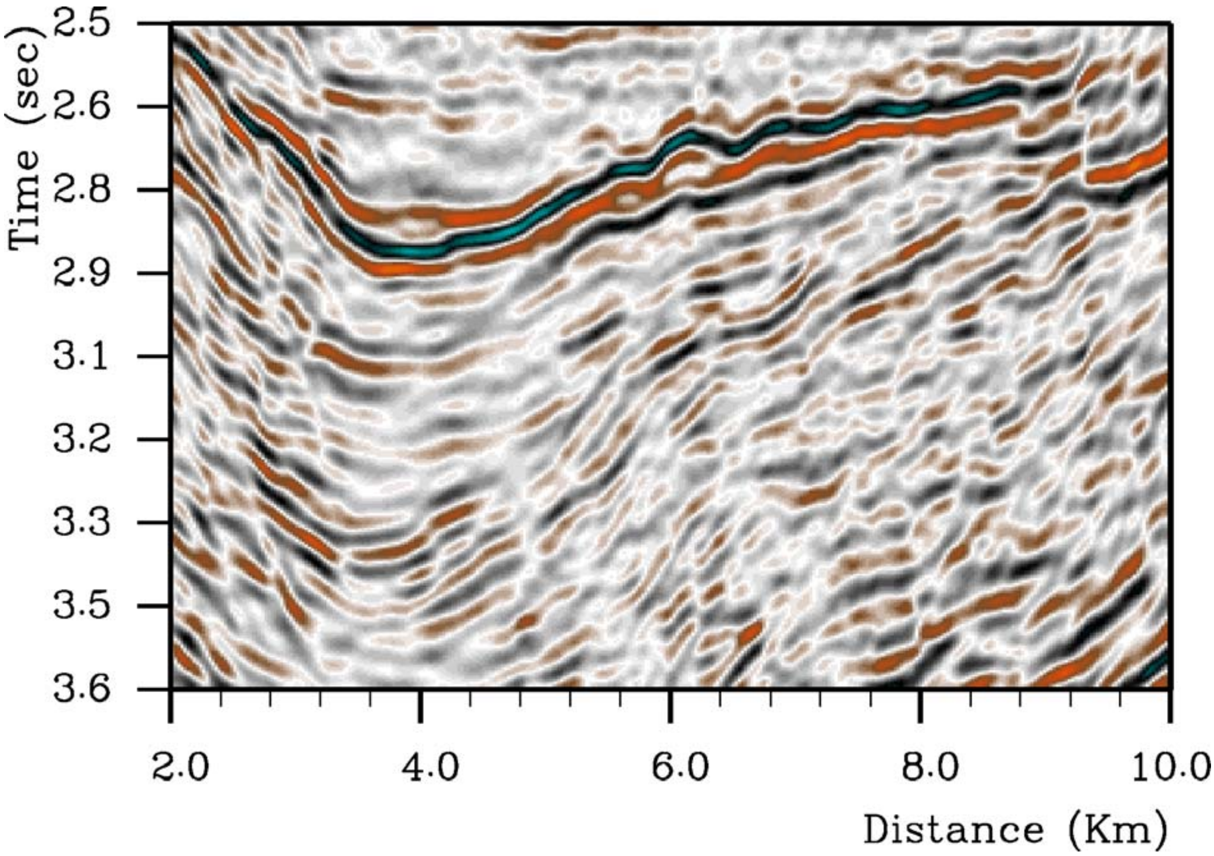

Figure 2: Depth migrated OBC inline 1057 using cross-line offsets up to 1.8km

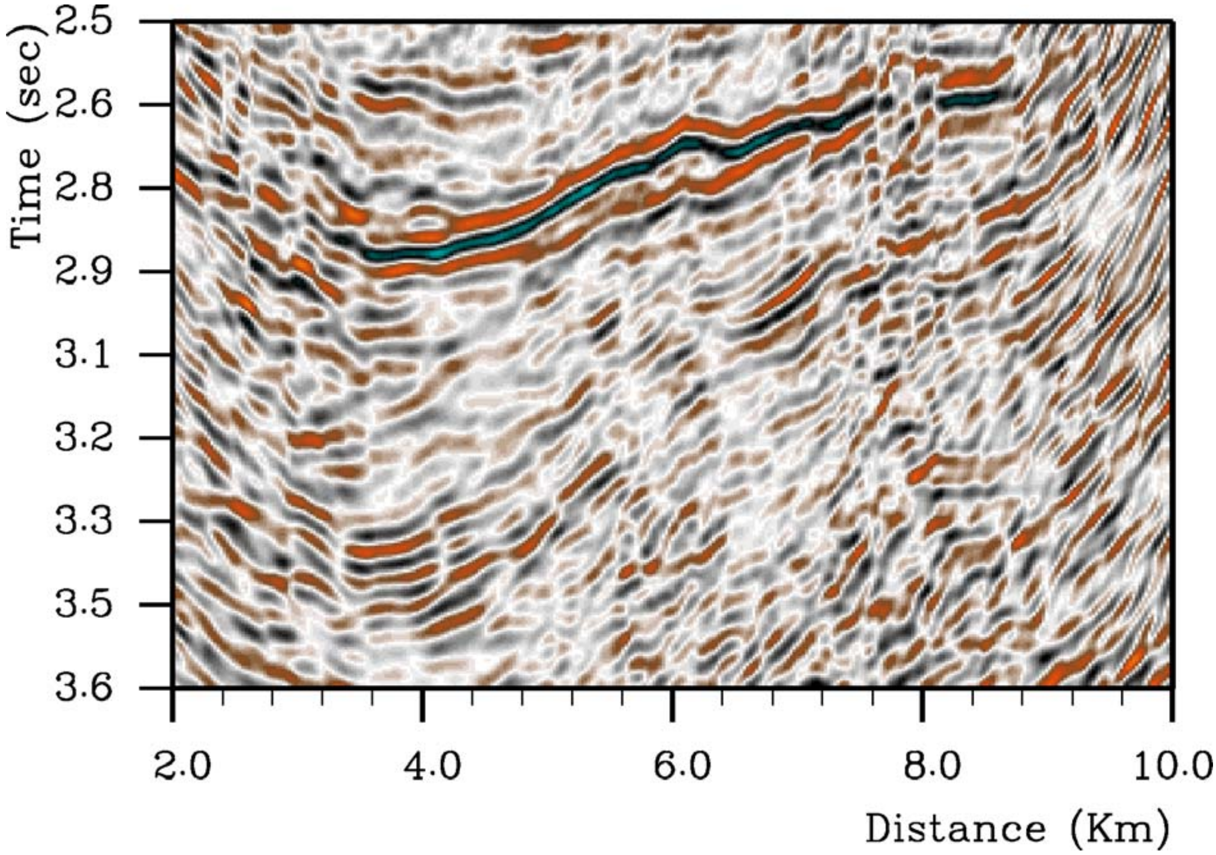

Figure 3: Depth migrated OBC inline 1057 using cross-line offsets up to 350 m.

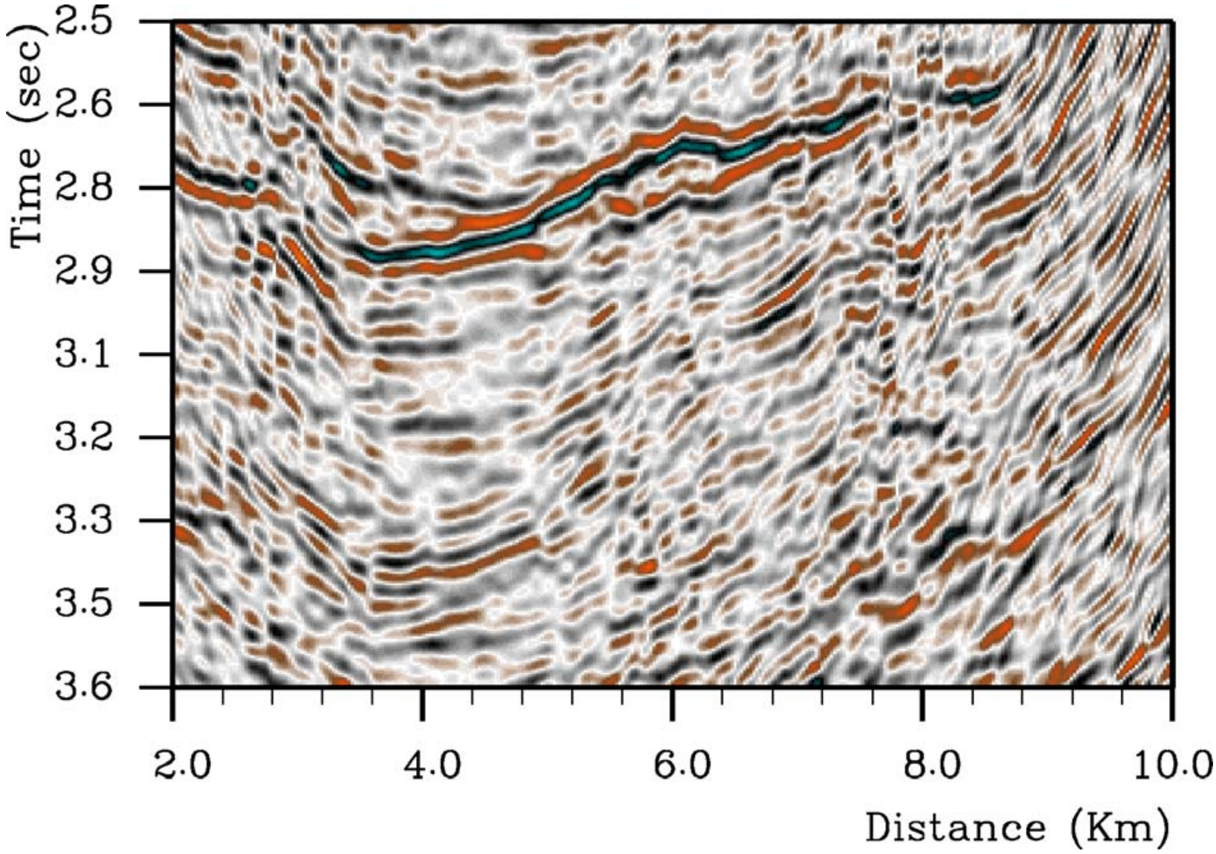

Figure 4: Depth migrated OBC inline 1057 using cross-line offsets up to 90 m.