EAGE

M04

Full Azimuth Modelling at Heidrun

M. Houbiers* (StatoilHydro), B. Arntsen (Norwegian University of Science and Technology), M. Thompson (StatoilHydro), E. Hager (WesternGeco), G. Brown (WesternGeco) & D. Hill (WesternGeco)

SUMMARY

A simulation study was initiated to investigate whether or not a marine full azimuth acquisition geometry improves the image of the subsurface at Heidrun. Full azimuth shot data was modelled with finite difference and one-way wave equation modelling, and images obtained from full, wide, and narrow azimuth survey geometries were compared with each other.

The study shows that a full azimuth geometry leads to better suppression of noise, less migration artefacts, more consistent amplitudes along horizons, and sharper fault planes than a narrow azimuth design. Attenuation of multiple energy is present, but less than expected.

The improvements in image quality can be obtained with a realistic 4-vessel wide azimuth design and a coil geometry, but the coil geometry has a smaller acquisition footprint in the shallower part. Based on the modelling results, a field trial with coil design was carried out at Heidrun.

Heidrun is located on the Norwegian continental shelf, 100 km from the coast of Mid-Norway. Similar to many fields in the Middle East and North Africa, Heidrun has a complex and extensively faulted geological structure, leading to challenging imaging conditions. A simulation study was initiated to investigate whether or not a marine full azimuth acquisition geometry improves the image of the subsurface at Heidrun. In the Gulf of Mexico (GoM), wide azimuth designs have lead to a better suppression of noise in the data, in particular multiples, and thus better images. However, the GoM has a very different geological structure, is much deeper than the reservoir at Heidrun, and targets have a different scale, so it is not *a priori* clear that a wide azimuth design is as beneficial at Heidrun as in the GoM.

For the simulation study, a model preserving the main features characterizing Heidrun was created. The model contains an overburden with weak lateral variation, a faulted reservoir section, and a section below the reservoir with two coal markers. Also, a small salt body was included in the model. Modelling was done with both 3D finite difference (FD) modelling and one-way wave equation modelling (WEM). Data sets with and without free surface multiples were generated using a full azimuth (FAZ) super-shot survey geometry, where the source is placed in the centre of a large and dense receiver grid. From the full data set, other geometries were extracted, among which a conventional narrow azimuth geometry (NAZ), and a realistic 4-vessel wide azimuth geometry. In addition, a coil geometry was modelled with WEM.

Figure 1 shows a vertical slice obtained from FD-modelling (with free surface multiples and depth migrated), where the FAZ image is compared with the NAZ image. Due to the low maximum frequency of 23 Hz used in FD-modelling, the resolution is limited, but despite this, one can clearly see differences in image quality, indicated by the letters in Figure 1.

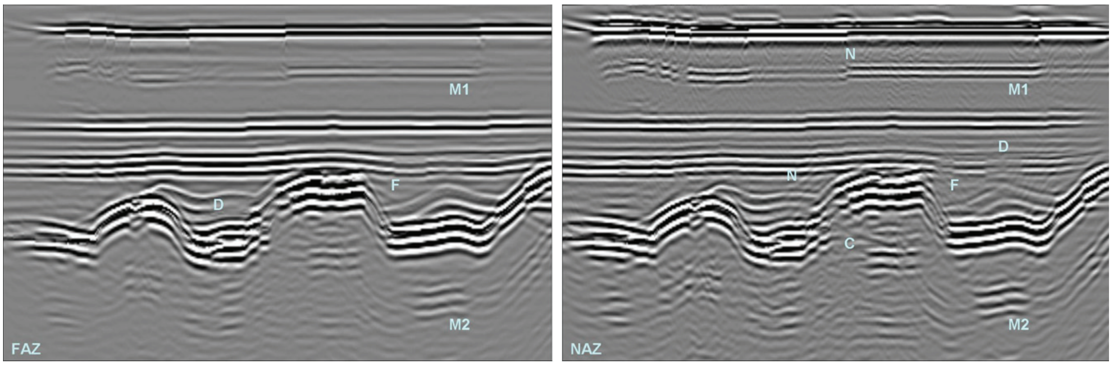

Figure 1. Images along arbitrary inline from FD modelling for FAZ (left) and NAZ (right). The letters indicate noise (N), seabed multiple (M1), coal marker multiples (M2), dimming of horizon (D), flank of structure (F), and conflicting dip (C).

The FAZ survey design with increased crossline offset and fold generally leads to fewer artefacts and better noise suppression in the data than the NAZ design. Attenuation of multiple energy with increased crossline offset and fold is present, but less than expected. Amplitudes along horizons are more consistent, and some steep flanks of the structure which are invisible in the NAZ design, are properly imaged in a full azimuth design. Also, in the NAZ configuration, conflicting dips occur due to contaminating multiple energy.

The results obtained from WEM modelling essentially agree with those obtained from FD modelling. Moreover, modelling shows that the improvements in image quality also can be obtained with a realistic 4-vessel wide azimuth design and a coil geometry. However, the acquisition footprint in the shallower part is much smaller for the coil design, and it has the additional advantage that only one streamer vessel needs to be mobilised. Based on the results from modelling, a field trial using a coil design was carried out at Heidrun. As similar focussed imaging is required in the Middle East & North Africa, the techniques employed in the Heidrun study are equally applicable for resolving imaging challenges there.