Noise Attenuation Challenges For Combined OBC, Transition And Land Seismic Survey

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Sandwiched between two existing 3D seismic surveys, the Antares 3D marine and Heytesbury 3D land, the Speculant 3D survey was acquired by Origin Energy Ltd with a combination of Ocean Bottom Cable (OBC), land geophones, airguns and Vibroseis. This rare and complex configuration was necessary due the challenges presented by the location. Situated on the southwest coast of Victoria, the terrain covered by the Speculant 3D is characterised by karst landscape, high cliffs, rough surf and shallow water. Access restrictions along the surf zone further impact the survey, in the form of a near offset 600 m (average) gap, is evident from the survey plot in Figure 1.

Fig. 1. Survey plot. (Aouad, 2012)

A schematic representation of the acquisition configuration is shown in Figure 2. Each combination of source and receivers resulted in records with different noise characteristics. Hence the approach in processing was to treat each of these as a separate survey and apply the most appropriate noise attenuation to each individually. Added to this are complex static, designature and phase matching requirements of this acquisition configuration. These required detailed and variable picking of mutes followed by multiple iterations of careful velocity picking to better image the target. This article looks at how each of these processing challenges was addressed.

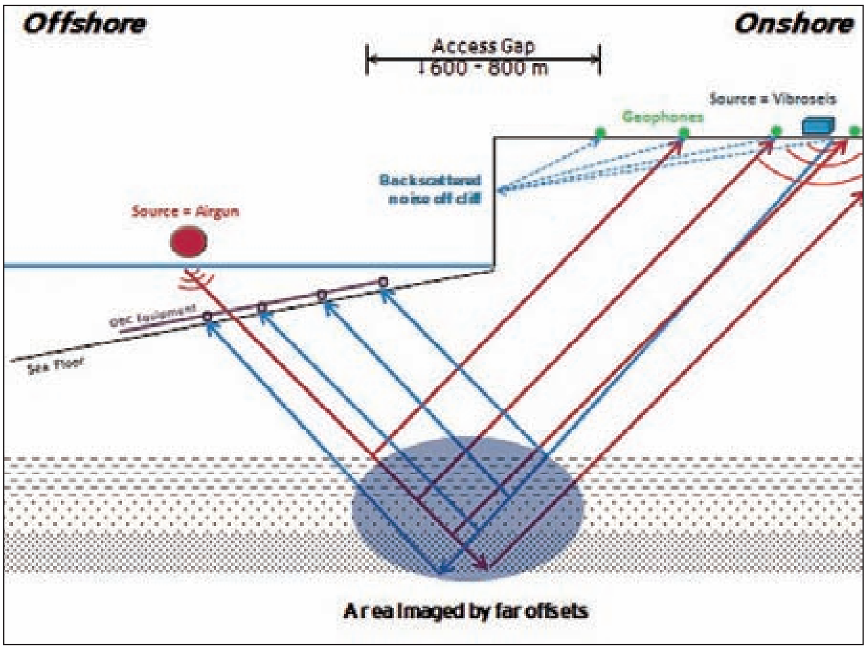

Fig. 2. Acquisition Configuration. (Aouad, 2012)

The acquisition configuration resulted in six different source/receiver combinations, each with their own processing challenges, particularly with respect to noise. Figure 3 shows shot gathers for each of the three receivers with the airgun source. Where Vibroseis is the source significantly more noise on the data can be seen as shown in Figure 4. It was clear from these shot gathers that each of the six source/receiver combinations required different noise attenuation. Each of the six underwent noise removal in the receiver, shot and CMP domains.

After a number of tests it was determined that all the OBC geophone data, from both sources, were of too poor a quality to be of use. The land geophone data was deemed to be of use even though of comparatively low quality to the remaining data (Figure 7 and Figure 8). Its susceptibility to near surface scattering meant that it was treated as a separate volume for all except velocity analysis and static corrections. At the end of the first pass of noise removal four source/receiver combinations remained as input to further processing; airgun to land geophone, Airgun to OBC hydrophone (Figure 5 and Figure 6), Vibroseis to land geophone (Figure 7 and Figure 8), and Vibroseis to OBC hydrophone (Figure 9 and Figure 10).

While treating this single survey as four separate volumes was effective for the purposes of noise removal, a merged volume was required for velocity picking, residual statics, and stacking. This led to an iterative approach of splitting the data into the four source/receiver combinations and remerging, then repeating the split for further noise removal.

Initially, velocities were picked on each of the different source/receiver combinations independently; at this stage the lack of near offsets in the receiver gap was much more difficult. Subsequent velocity picking on a merged and denoised volume, while easier, also required consideration of the source/receiver combinations. Mutes also varied substantially

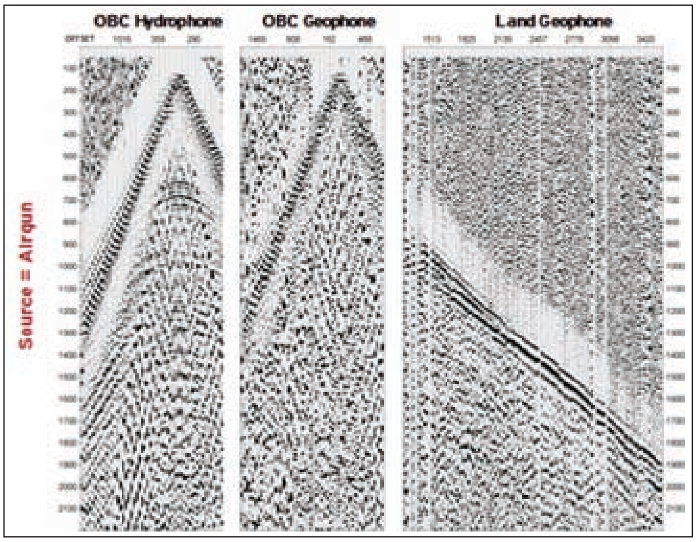

Fig. 3. Shot gathers for the airgun source and each of the receiver types.

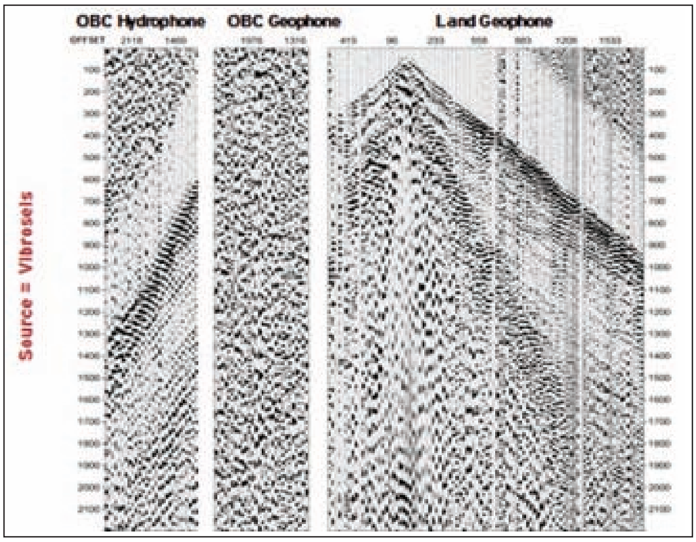

Fig. 4. Shot gathers for the Vibroseis source and each of the receiver types.

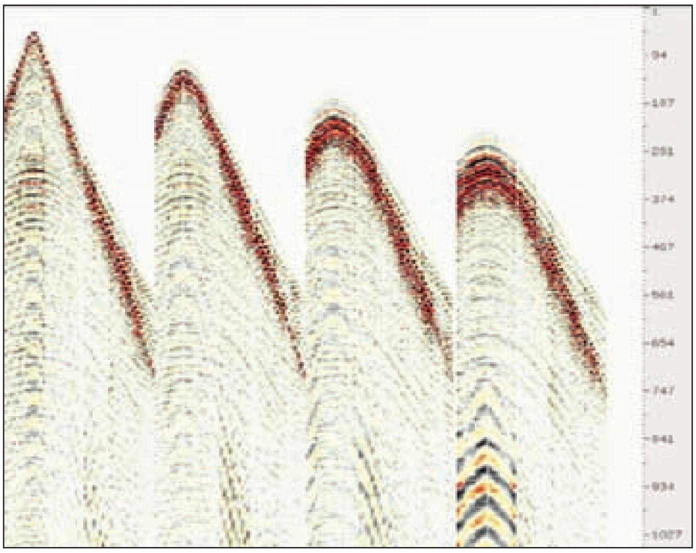

Fig. 5. Airgun to OBC hydrophone.

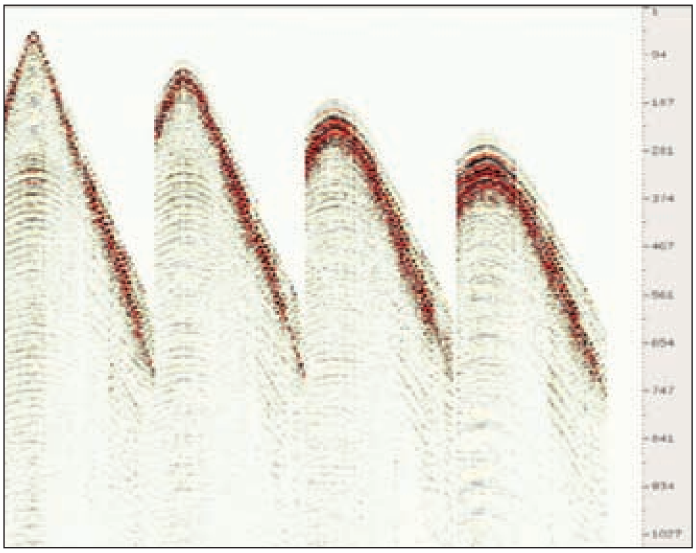

Fig. 6. Airgun to OBC hydrophone with mudroll removal.

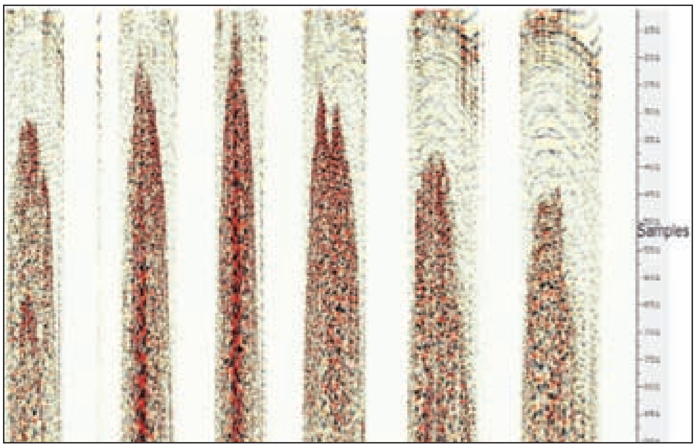

Fig. 7. Vibroseis to land geophone before noise attenuation.

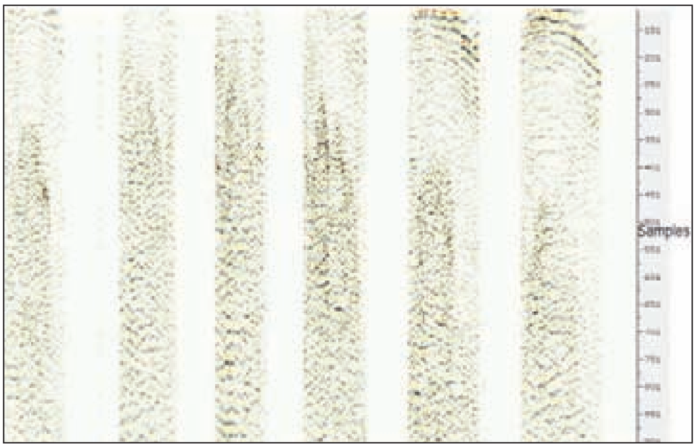

Fig. 8. Vibroseis to land geophone, after noise attenuation.

between the different source/receiver combinations.

Between the land and marine source and the receiver counterparts, due to the terrain, phase and amplitude matching was required to produce a consistent merged volume. The varying water bottom also presented challenges in creating a wavelet for designature.

All the previous images, showing the noise removal on the individual source/receiver combinations, show the uplift that can be achieved in image quality using a variety of de-noise techniques. However it is clear from the experience that had all of the de-noise techniques been applied to a single volume consisting of the all of the source receiver combinations, some signal degradation on part or all of the volume would have occurred.

Figure 11 and Figure 12 show the comparison of the brute stack with the final (de-noised)

Fig. 9. Vibroseis to hydrophone, before noise removal.

Fig. 10. Vibroseis to hydrophone, after noise removal.

stack for the offshore and onshore portions of the survey. The quality of the final image compared with the brute stack is significant.

A common noise attenuation for all source/receiver combinations and mutes which did not take into consideration the far offsets would have failed to image the complete section. The data in the centre of the survey, mainly far offsets, required an inner mute to sufficiently eliminate noise.

By using different noise attenuation for the different source/receiver combinations and an iterative approach to velocity and mute picking, both of which took into account the different source/receiver combinations, it was possible to successfully image the target, despite the complex acquisition design that was necessary.

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Works Cited

Aouad, A. T. (2012). Seismic on the Edge. ASEG. Brisbane. ■

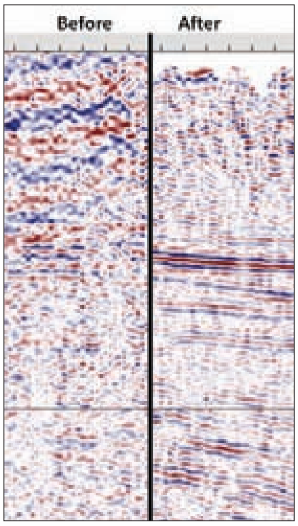

Fig. 11. Land side full fold stack before and after noise removal.

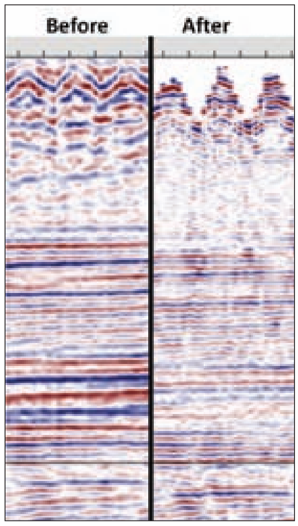

Fig. 12. Marine side full fold stack before and after noise removal.