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Marine Wide-azimuth Seismic for Signal to Noise Enhancement and Multiple Suppression

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SUMMARY

Wide azimuth marine surveys have been successful in the deep water Gulf of Mexico at imaging beneath mobile salt. They have also shown that wide azimuth surveys can have benefits for multiple and noise suppression. Therefore, we should ask if these effects will be of benefit in other parts of the world with multiple and noise problems - do they still apply in shallower water, or in provinces with faster sedimentary velocities. The simplest answer is yes, but sampling criteria are likely to mean we will need to use different recording geometries for different geological settings - just as we do for conventional surveys.

Wide azimuth seismic surveys have been highly successful in imaging beneath extensive, tabular salt in the deep water Gulf of Mexico. Although originally designed for illumination around the salt, one of the most striking results of several such surveys has been the improvement in signal/ noise and in particular multiple suppression produced by an areal stack. Several examples have been published of PSDM sections with no multiple suppression other than stack having less multiple content than corresponding, conventional narrow-azimuth PSDM data with a full suite of de-multiple techniques applied. Similarly, multi-azimuth surveys offshore Egypt have shown the benefits of stacking over azimuth as well as offset for suppression of scattered and diffracted energy. In contrast, land surveys have been acquired with a wide-azimuth geometry over many years but without the same improvement in signal to noise and multiple suppression.

At its simplest, a wide-azimuth recording geometry introduces a non-linear offset weighting of flat reflections during stack. However, for dipping, non-aliased events, further benefits may occur. In particular, diffracted multiples can be attenuated by stacking over azimuth if adequately sampled. It should be noted that in this instance adequate sampling is required in both inline and crossline directions. The fact that most land wide-azimuth surveys are coarsely (under-) sampled may explain why the multiple suppression benefits have not been observed before.

It is not only stacking that benefits from a wide-azimuth geometry. Processing of narrow-azimuth surveys typically involves mainly 2D algorithms apart from 3D prestack migrations and possibly 3D SRME. Wide-azimuth surveys can benefit from further applications of 3D algorithms throughout the processing sequence. Indeed, to optimise the use of wide-azimuth data, 3D algorithms are not only an option but a requirement.

The recognition and understanding of these potential improvements lead to consideration of where wide-azimuth surveying may be of benefit in areas without deep water and tabular salt. For example, it is well known that longer inline offsets have helped improve the signal to noise ratio beneath basalt in the West of Shetland region, but crossline offsets have not been extended. Therefore, wide-azimuth surveys provide an potential way to achieve a significant uplift in sub-basalt data quality. Offshore N. Africa, we often observe a rugged Messinian event that can generate strong, scattered energy that is difficult to remove with conventional techniques such as Radon de-multiple. Wide-azimuth surveys offer a potential method of tackling this difficult problem.

Beyond these two strong candidates and the already established illumination under obstacles such as tabular salt, there may also be more subtle benefits from acquiring data with a recording aspect ratio closer to 1 – more reliable amplitudes and images that are independent of a recording direction may in turn lead to more reliable inversions and hence better identification of stratigraphic traps in mature basins.