Applications of wide-azimuth seismic surveying for signal to noise enhancement and multiple suppression in N. W. Europe

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Wide azimuth seismic surveys have recently 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. Many land surveys have also been acquired with a wide-azimuth geometry over many years but often without the same improvement in signal to noise and multiple suppression being noted.

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 noted before.

However, it is not only the stack process that can benefit from a wide–azimuth geometry. Processing of conventional 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. Furthermore, it will be shown that to optimize 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 obvious way to potentially achieve a significant uplift in sub-basalt data quality. Offshore Norway, we often observe a rugged seabed that can generate strong, multiple 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 the more mature basins of the N. Sea.