Data Acquisition Technology for Full Wave Imaging

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What is Full Wave Imaging?

Over the past 25 years, traditional 3D has proven itself an invaluable tool in finding and producing hydrocarbons. However, as we seek to meet growing energy demand from a depleting resource base, new technologies are required to efficiently exploit smaller reservoirs and unconventional reserves, often located in more challenging areas (deep shelf gas, etc.). The principle of Full Wave Imaging is simple: "Don't leave information on the table". If we expend the resources to place a seismic receiver in the field, we should record all possible data available from that receiver station, and use all the information locked in that data.

This philosophy means going beyond traditional approximations.

- Record the full vector wavefield … use P and S waves, and deal with non-vertical emergence angles
- Use azimuthal anisotropy … treat it as information, not noise
- Use the full bandwidth of the data … for the full length of the seismic record

Acquisition technology issues

Full Wave Imaging requires us to rethink some fundamental issues of data acquisition and processing. (This paper will focus only on data acquisition.)

- In order to maximize the bandwidth of the data, we must select sensors that are capable of recording as many octaves as possible.
- By using accelerometers, rather than traditional geophones we can increase the usable dynamic range of the data.
- 3-component sensors can be used not just to record P and S waves, but also to characterize and remove various sources of noise.
- Wide-azimuth recording geometries are required to characterize anisotropy, which leads to a requirement for enhanced vector fidelity and point receivers (and sources).
- Point receivers will capture more signal, but care must be taken to deal with noise either through processing (vector filtering etc.) or through sensor packaging design and
- Wide azimuth, long offset survey designs require innovative equipment design and operational field procedures to ensure that the image is cost effectively acquired.

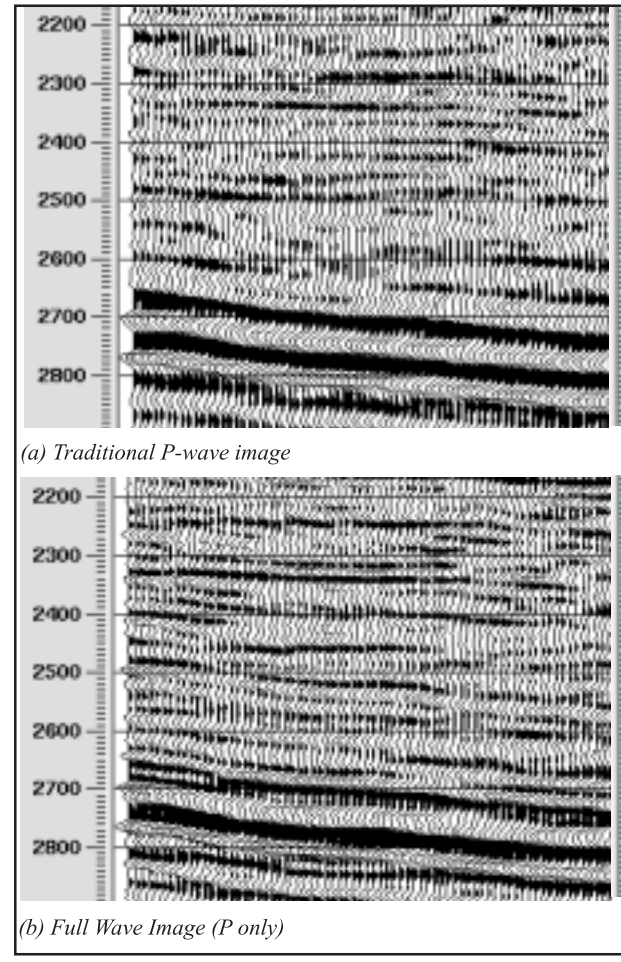

Fig.1: Data comparison shows significant improvement in resolution using Full Wave Imaging

Conclusion

Although more development in processing and interpretation technology is required, Full Wave Imaging is already demonstrating significant potential to deliver more

information to drillers, reservoir engineers and asset managers.

Further Reading

"Wind noise abatement for 3C phones", Bland et al, CREWES Research Report, 2001 "Ekofisk VectorSeis Test – Improvements in vector fidelity of 4C seismic data", Byerley et al, EAGE, June 2003.

"Why OBC is sensitive to the right sensor", Ridyard et al, First Break, Dec. 2004.

"Full wave acquisition and processing: the onshore requirement", Criss et al, First Break, Feb 2004.