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MultiFocusing Imaging for Seismic Data with Irregular Acquisition Design in Densely Populated Areas

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SUMMARY

Acquiring seismic 3D data in highly populated areas is very difficult. The design of such surveys is usually highly irregular and the processing of these data challenging. The MultiFocusing (MF) imaging technology, which belongs to the group of multi-parameter processing (MPP) methods, does not require a regular acquisition design and is especially suitable for such scenarios. We will illustrate this imaging technology and show MF data regularization results utilizing an irregular 3D dataset acquired in a populated area in the United States.

A 3D dataset that was acquired with a highly irregular design over a densely populated area was processed with a conventional processing sequence and with the multi-dimensional MF methodology. The MF data regularization was crucial for this dataset for subsequent prestack time and depth imaging. The first MF dataset had a 110ft x 110ft binning. Further testing showed that a binning of 55ft x 55ft produced the best results for horizon mapping and was used for the final PSTM delivery. For additional attribute work, the 110ft x 110ft binning was more suitable as it showed a higher frequency content.

Introduction

Acquiring seismic 3D data in highly populated areas is very difficult. The design of such surveys is usually highly irregular and the processing of these data challenging. The MultiFocusing (MF) imaging technology, which belongs to the group of multi-parameter processing (MPP) methods, does not require a regular acquisition design and is especially suitable for such scenarios. We will illustrate this imaging technology and show MF data regularization results utilizing an irregular 3D dataset acquired in a populated area in the United States.

3D seismic data acquisition design

The 3D data were acquired in a densely populated city, which was extremely challenging and difficult. Figure 1 displays a base map outlining the acquisition design, which by its nature clearly demonstrates the problems.

Figure 1 3D data acquisition design

MultiFocusing imaging

The MultiFocusing method (MF) was proposed by Berkovitch et al. (1994) and consists of constructing a zero-offset section wherein each trace of this section is computed from prestack traces arbitrarily located around an imaging position. This technology, based on multi-parameter stacking, is being applied to enhance time imaging sections by dramatically increasing the fold of coherent summation of seismic signals. The MF moveout correction formula is accurate, even for heterogeneous subsurface and strongly curved reflectors and does not require knowledge about the subsurface. It is valid for an arbitrary observation geometry thus perfectly suited for processing 3D data with an irregular acquisition design. In this case, it is crucial to apply MF data regularization and interpolation for subsequent time and depth imaging. The result of MF imaging is a 3D data set in time that includes optimally stacked time-migrated seismic events and can be output with pre-defined regular binning parameters.

Seismic imaging results

The 3D seismic data were processed with both, a conventional processing path and the MultiFocusing technology. Figure 2 displays a PSTM comparison of the results of the conventional processing on the left and the MultiFocusing imaging on the right. A few observations can be made. First, the signal to

noise ratio is greatly improved on the MF product, which allows for a more accurate interpretation. Second, the events in the shallow part are much better imaged, which again is useful for building a geological model of the sub-surface.

During the MF data regularization a dataset with a bin size of 110ft x 110ft was generated. More testing revealed an even better result for interpretation using a bin size of 55ft x 55ft, which was the final deliverable.

Figure 2 Conventional processing results on the left and MF results on the right with a 55ft x 55ft bin size.

Conclusions

A 3D dataset that was acquired with a highly irregular design over a densely populated area was processed with a conventional processing sequence and with the multi-dimensional MF methodology. The MF data regularization was crucial for this dataset for subsequent prestack time and depth imaging. The first MF dataset had a 110ft x 110ft binning. Further testing showed that a binning of 55ft x 55ft produced the best results for horizon mapping and was used for the final PSTM delivery. For additional attribute work, the 110ft x 110ft binning was more suitable as it showed a higher frequency content.

The results of the MF imaging display an improved signal to noise ratio, which allows for a more accurate and faster geological interpretation. As such, using a MPP method was worth the additional effort and produced superior results.

References

Berkovitch, A., Gelchinsky, B., and Keydar, S., [1994]. Basic Formula for MultiFocusing Stack, 56th EAGE Conference and Exhibition. Expanded Abstracts, **140**.