3D symmetric sampling in practice

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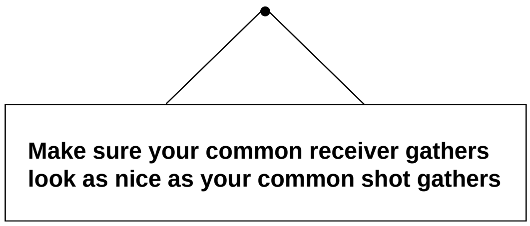
3D seismic surveys have become fully accepted in the industry as a means to get detailed information on the subsurface. Yet, the cost of 3D seismic data acquisition is and will always be very considerable, making it highly important to select a satisfactory 3D acquisition geometry. A few years ago, 3D symmetric sampling was introduced as a comprehensive theory about what constitutes a good 3D geometry (Vermeer, 1994). The theory may serve as a basis for 3D geometry design and analysis.

An essential element in 3D symmetric sampling are the spatial properties of a geometry. Spatial aspects are important because most seismic processing programs operate in some spatial domain, i.e., combine neighboring traces into new output traces, and because it is the spatial behavior of the 3D seismic volume which the interpreter has to translate into maps.

Over the course of time various survey geometries have been devised for the acquisition of 3D seismic data. Most geometries can be considered as a collection of three-dimensional subsets of the five-dimensional wavefield, each subset (also called *minimal data set*, Padhi and Holley, 1997) having only two varying spatial coordinates. The spatial attributes of the traces in each subset vary slowly and regularly, and this property provides spatial continuity to the 3D survey. The spatial continuity can be exploited optimally, if the subsets are properly sampled, and if their extent is maximized.



3D symmetric sampling simplifies the design of 3D acquisition geometries. A simple check-list of geophysical requirements (spatial continuity, resolution, mappability of shallow and deep objectives, and signal-to-noise ratio) limits the choice of survey parameters. In these considerations offset and azimuth distributions are implicitly being taken care of.

The table below lists the relation of those requirements with geometry parameters. The requirements apply directly to the orthogonal geometry (parallel shotlines orthogonal to parallel receiver lines) and have to be modified somewhat for the areal geometry (wide grid of receivers covered by dense grid of shots), whereas in a parallel geometry (parallel shotlines parallel to parallel receiver lines) the shallowest mappable horizon is taken care of automatically.

The concept of spatial continuity puts stringent requirements on how to deal with obstacles. Rather than aiming for midpoints centered in bingrid cells, shot and receiver lines should follow a smooth course around obstacles.

In a high-fold parallel geometry regularity of the offset distribution in each midpoint takes care of a good stack response. In the orthogonal and areal geometries a regular offset distribution is not possible, instead a distribution of offsets without any periodicities would lead to a flat stack response. This is achieved best with square geometries (maximum inline offset equals maximum crossline offset).

References

Padhi, T., and Holley, T.K., 1997, Wide azimuths – why not?: The Leading Edge, **16**, 175-177.

Vermeer, G.J.O., 1994, 3-D symmetric sampling: 64th Ann. Internat. Mtg., Soc. Expl. Geophys., Expanded Abstracts, 906-909.

Relation design requirements and parameters of geometry

Requirement		Parameter
spatial continuity	→	symmetric sampling
resolution	→	shot/receiver station intervals
shallowest horizon to be mapped	→	line interval
deepest horizon to be mapped	→	maximum offset
noise suppression	→	fold and offset distribution