Introduction

The development of geometry has experienced a long history in production practice process. The seismic geometry plays important role in seismic acquisition. Initially seismic crew deployed receivers along one axis and sources along an orthogonal axis, forming a spread that resembled a cross. Using this method with source and receiver spacing of equal distance, the common midpoints formed a square. The same pattern was also achieved when the source and receiver axes were arranged in an L-shape which we call it geometry. A number of practical situations encountered during land surveys prompted the development of 3D seismic acquisition techniques with geometry. Especially for the complicated geological structure of subsurface conventional geometry can get more information from underground than the single line. The main seismic data acquisition method is by swath in seismic data acquisition process. The swath and geometry establish a basic frame of seismic data acquisition. Many seismic data acquisition concepts have relation with swath.

With the wide application of 3D seismic data acquisition methods, more and more geometry methods are used in seismic production. According to the different ways of shooting, these geometries mainly include the following three kinds: middle shooting, shooting on both sides of the swath and shooting on one end of the swath (hereinafter referred to as conventional geometry). The middle shooting geometry includes the coil geometry (Fuhao Jiang, 2014). For the middle shooting geometry, it is mainly applicable for geophones which lay out easily and the simple surface conditions, where there are fewer obstacles near surface. And it is difficult to carry out shooting, such as in the plain area, transition zone and urban area, where sometimes the explosive sources and vibrators have to be applied. For both sides of swath shooting geometry, it is suitable for high channel and highly efficient seismic data acquisition project (Liu Yi, 2014) in desert province, where geophones are easy to lay out and the shooting mode is mainly by vibrators. The both sides of swath shooting geometry can bring high coverage, but generally, the azimuth is narrower than middle shooting geometry at same situation. For one end of swath shooting geometry, it is common in offshore streamer seismic data acquisition projects, or some special seismic data acquisition projects.

The geometry is a template, which defines a certain relationship between shot point and receiver point. The conventional geometry including middle shooting, both sides shooting and one end shooting geometry uses the template of geometry to shoot one by one swath. Only a small part of geophones is involved in receiving the seismic reflection signals, and most of the remaining geophones in field are in silent status. It will waste the utilization of seismic acquisition equipment in seismic operation. The convertible geometry can make up for the shortage of conventional geometry in these aspects, so it can make great sense to study convertible geometry.

Convertible Geometry principle and implementation method

Currently, geophysical exploration technology is the most effective scientific methods for locating underground geological targets. The ultimate goal of geophysical exploration is to define the precise location of the oil well. Accurate well locations depend on a high-quality seismic imaging. The choice of geometry is an important influence factor for high-precision seismic imaging. Therefore, the geometry will play an important role in locating the oil well location. The geometry determines the distribution relationship between receiver points and shot points. Theoretically, by using previous seismic data in an area with seismic data, referring to seismic data obtained from other prospecting methods such as gravitational and electromagnetic methods, and according to the conditions of the subsurface geological structures, the convertible geometry can effectively avoid spatial aliasing. In one sense, the convertible geometry determines the quality of field seismic data. Therefore, it will make sense to carry out further research on convertible geometry. In the process of 3D seismic data acquisition, the seismic data are acquired from swaths. At the beginning, the concept of swath was proposed to solve the problem caused by the near surface conditions on the survey line. One of these situations was the need to acquire data from mountainous terrain, where it is extremely difficult and expensive to acquire data along straight lines. In this case, the survey line becomes curved, which is called crooked line. One solution was to construct a swath of lines parallel to the general direction of
the original crooked line, separating the swath lines by spacing of a certain distance. This design ensured that the lines included all of the locations covered by the crooked line. Then, all of the common midpoints could be assigned to the nearest line, giving rise to a swath of substacks that minimized the reflection point smearing. So the separated swath method solves those problems well.

In the current 3-D seismic data acquisition process, before kicking off a project there are a lot of work that needs to do including parameter analysis and demonstration, and estimating the depth of the target layer, then what kind of geometries is more effective to the project. Once the geometry is determined, this geometry will regard as an acquisition template for repeated shooting in each swath, and full fold coverage is the maximum value in this acquisition template. In the three-dimensional geometry, except for the roll-in and roll-out parts in every line, the receiver line is symmetrical, that is, in the direction of a receiver line, the shot point is in the centre, and the number of receivers in two directions is same, and the distance from the centre to the two ends is equal, so the maximum offset of each shot is a fixed value. In this case, the number of receivers used by each shot is limited, and the corresponding offset and azimuth are limited, that is, a certain value. The values depend on the template of the conventional geometry which the number of the receivers are used. It is a conventional three-dimensional swath model for seismic data acquisition (Figure 1). In order to briefly and clearly show the acquisition method, 12-line 4 shots geometry was used for seismic data acquisition. In this geometry, the number of receivers used by each shot is 80 channels. When each shot is fired, the remaining receivers are idle. Thus, this geometry causes waste of acquisition equipment in field.

![Figure 1 the geometry of conventional 3-D swath which simplifies the acquisition diagram. The green points denote receiver points which are receiving the reflecting signals from underground, the red points denote the shot points, and the blue points denote the receiver points which are not receiving signals.](image)

The convertible geometry is suitable for various terrain conditions, and it is an efficient, high-fold-coverage seismic data acquisition geometry. This convertible geometry requires more acquisition equipment in field, and the acquisition efficiency will increase sharply. This method can provide convenient methods for efficient seismic data acquisition, and can make full use of acquisition equipment in field. The concept of swath fades in convertible geometry. In a project, when we lay out all the receivers, the seismic data acquisition can start. We preplan all the shot points, and the shots can be fired in random order. It is not necessary to shoot swath by swath, so the acquisition efficiency will be higher than using conventional geometry. In convertible geometry, seismic data can be
acquired by more efficient acquisition methods. For each shot, all of the receivers in field can receive the reflective seismic wave from underground. The simultaneous shots can be separated by deblending methods (Shuangwei Gan, 2015).

In the convertible geometry acquisition, the survey crew lays out all the lines for one time, and only a small part of the reserve acquisition equipment is ready to replace the acquisition equipment that does not work normally during the seismic acquisition process. All the geophone arrays are active, and all the geophone arrays are receiving seismic reflective signals with each shot. There is no concept of roll-in and roll-out in the convertible geometry, and the geophones used in each shot are the same, that is, one shot includes the seismic signals received by all geophones in the working area. Figure 2 are shooting schematic diagrams of convertible geometry. The green dots denote the receiver points, and the red dots denote the shot points. All the geophones in the working area can receive the reflective signals generated by this shot point.

Figure 2 shooting schematic diagrams of convertible geometry. The green dots denote the receiver points which are receiving the reflecting signals from underground, and the red dots denote the shot points. When shooting there are no receiver points keeping silent, and all receivers are active.

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**Seismic data processing**

The seismic data acquisition method has changed and the seismic data processing method should change with. Seismic data processing is the key for convertible geometry studies. In seismic data processing, the acquired seismic data is processed by different geometries according to the different geological targets. Many related seismic processing methods will be utilized in seismic data process. For example, separation of multi-source acquisition and wavelet inversion will apply to the simultaneous seismic data which is produced by multiple sources simultaneously with full receivers in field. Compared with seismic data processing with different geometries, the underground geological structure imaging with convertible geometry is more accurate. The convertible geometry can make full use of big data management and big data seismic data processing techniques, which will change the conventional seismic data acquisition method and data processing method. As the large scale offset becomes larger and larger and the number of full fold coverage is increased greatly, the convertible geometry can image the structure of the underground stratum from full azimuth.

**Conclusion**

The convertible geometry is a highly efficient (Liu Yi,2014), full azimuth angle, high-precision imaging seismic data acquisition method, especially for the subsurface complicated geological structures. In theory, each shot point in the convertible geometry contributes to the binning affected by the physical gap where the shot point cannot be implemented due to obstacles. The convertible geometry is suitable for all seismic data acquisition methods, and the streamer is a special case of the convertible geometry. The convertible geometry isn’t in accordance with the conventional method shooting by swath, and it can make full use of the acquisition equipment in field for seismic data acquisition, which makes the seismic data acquisition simple and easy greatly. In seismic data processing, according to different geological targets, the relevant processing methods are applied to the acquired seismic data, and those seismic data has gotten by convertible geometry, which can get high-quality seismic images.

**References**

