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3D Seismic survey using swath or patch-centered shooting: A comparative analysis

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Summary

Survey design is an integral part of any 3D seismic survey programme. Cost-effective design which helps in meeting the geological objectives is a necessity. Generally, swath shooting is carried out in the 3D surveys. Presently, the shooting pattern has shifted from swath based to patch centred shooting. In patch centred shooting, the shots are always at the centre of a template. Both the swath shooting and patch centred shooting have their own advantages and disadvantages. The detailed analysis of both types of shooting show that geophysical attributes are better achieved in patch-centred shooting whereas swath shooting serves better for operational purposes during implementation in the field. The detailed analysis of both types of 3D acquisition geometries is carried out and the inferences drawn from the same are presented in this paper.

Introduction

The swath shooting is a common practice in the industry today in 3D seismic data acquisition. In swath shooting, the receiver lines are fixed and all the shots pertaining to the swaths are recorded with the same set of fixed receiver lines. Swath shooting is characterized by uneven distribution of offsets from bin to bin though the pattern of a family of offset distribution repeats from one set of bins to another. On the other hand, in the recent times, swath shooting is replaced by patch-centred shooting. In this shooting, the shot is considered to be at the centre of the patch and the data is recorded accordingly. In this type of shooting, the inherent problem of swath shooting of uneven distribution of offsets can be overcome to a large extent. In this paper, theoretical block areas are considered and thereafter, attributes resulting from both the types of shooting are generated. The comparative study of the attributes is presented in this paper.

Methodology

In this study, we have considered a theoretical prospect of 20 Km X 20 Km in size. Different acquisition geometries are simulated considering both swath and patch centred shooting considering eight, twelve and sixteen line shooting operation respectively. From the simulated results of the theoretical 3D geometry attributes like offset and azimuth distribution are extracted and displayed.

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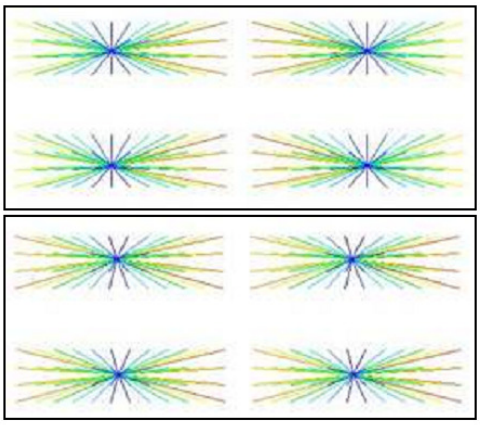

Fig.1*:* No significance difference between azimuth distributions in (a) swath and (b) patch-centred shootings in narrow geometries.

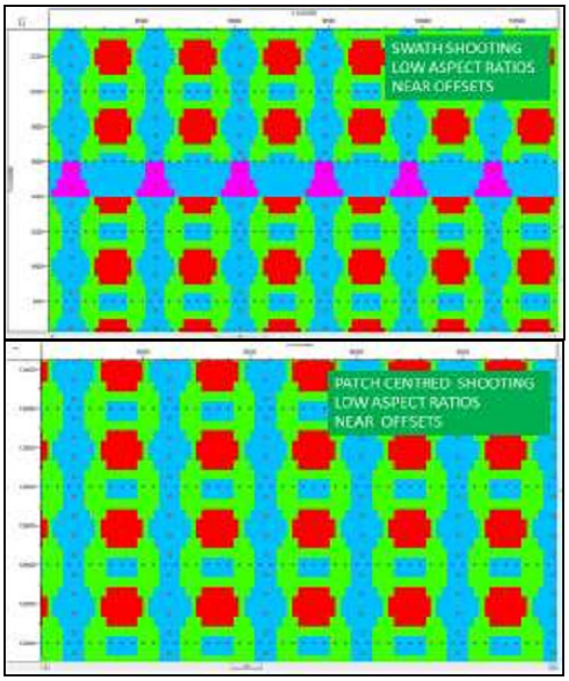

Fig. 2: Fold at near offsets in narrow geometries for swath sequential (upper one) and patch centred shooting. (Similar observations found in mid and wide azimuth geometries).

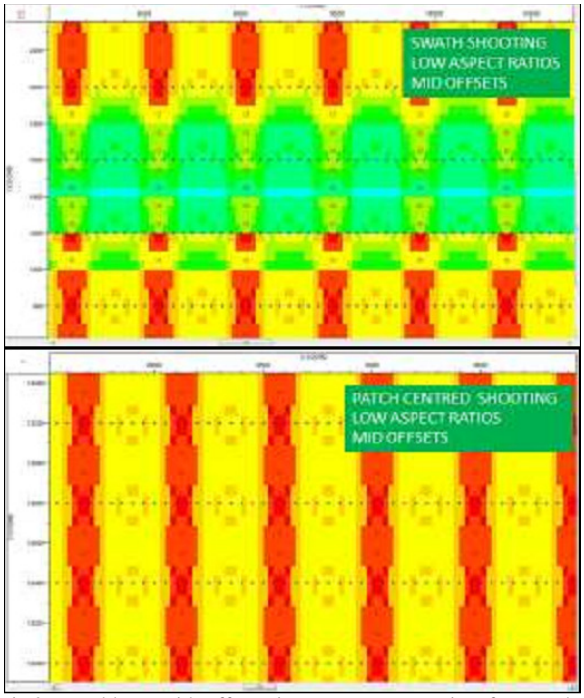

Fig.3*:* Fold at mid offsets in narrow geometries for swath sequential (upper one) and patch centred shooting, (similar observations found in mid and wide azimuth geometries).

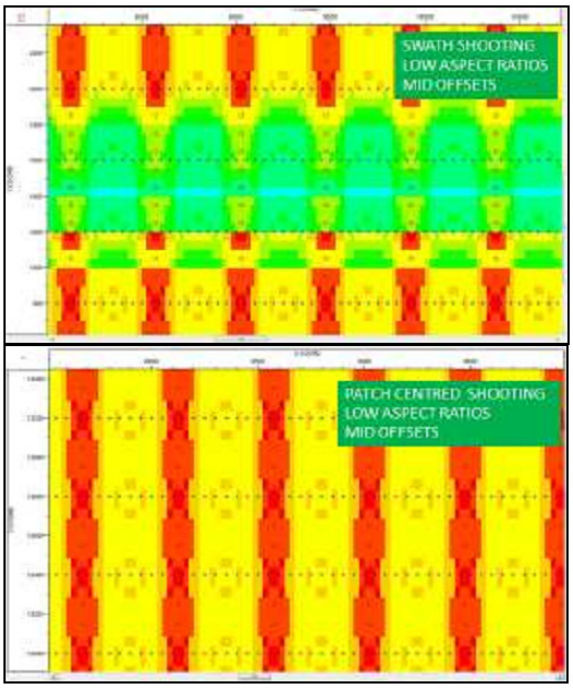

Fig.4*:* Fold at far offsets in narrow geometries for swath sequential (upper one) and patch centred shooting, (similar observations found in mid and wide azimuth geometries).

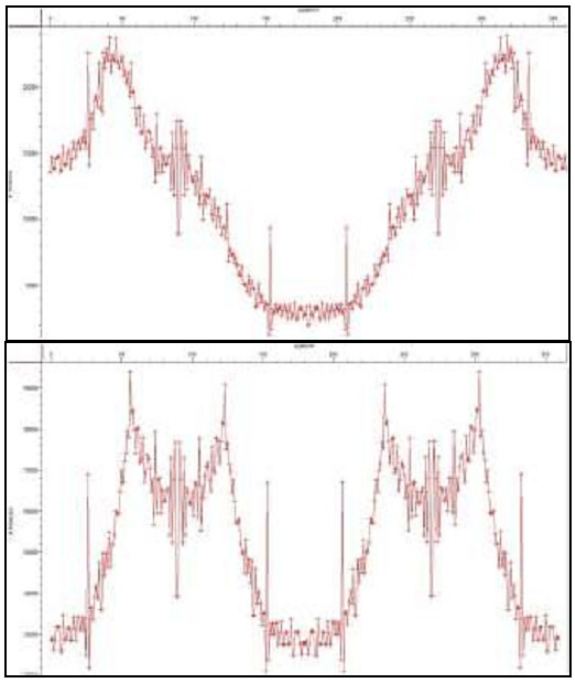

Fig.5: Azimuth vs. Trace count Plot in mid azimuth geometries for swath sequential (upper one) and patch centred shooting.

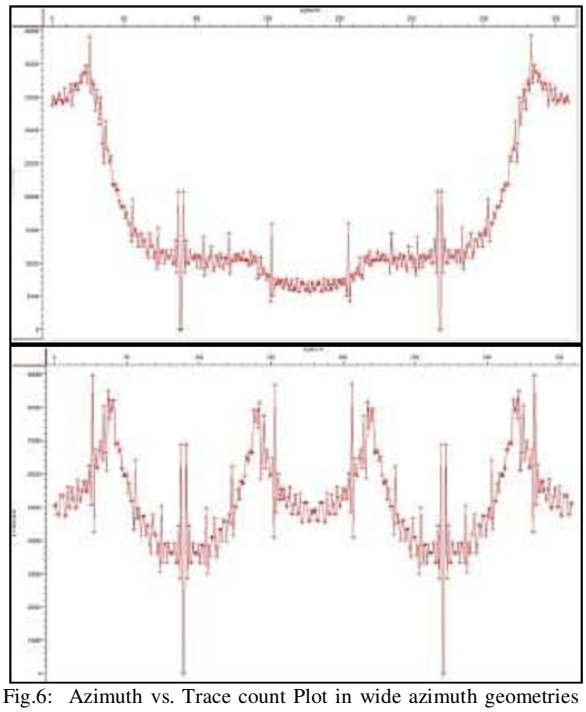

Fig.6: Azimuth vs. Trace count Plot in wide azimuth geometries for swath sequential (upper one) and patch centred shooting.

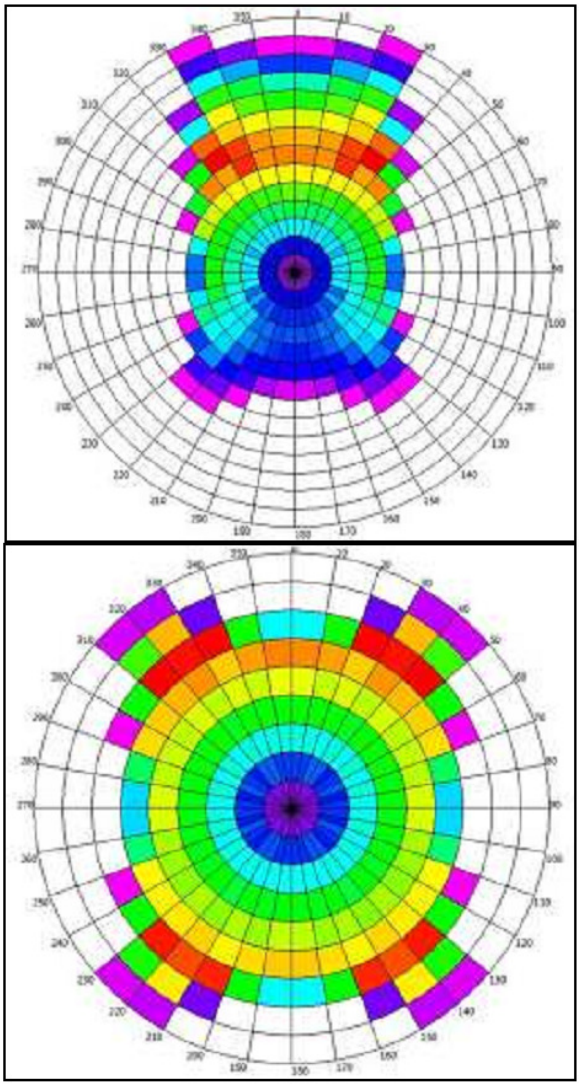

Fig.7: Rose Diagram in wide azimuth geometries for swath sequential (upper one) and patch centred shooting.

Analysis and Results:

The comparison plots between the two shooting schemes are presented for azimuth distribution and offset-wise-fold (i.e. fold at near, mid and far offsets) for narrow azimuth geometry in Fig 1, 2, 3 and 4 respectively. Comparison of

Trace count vs. Azimuth is presented in Fig 5 and 6. Finally rose diagram is compared for wide azimuth geometry in two shooting schemes.

Analysing the plots of the offset and azimuth distributions for different geometries the following salient points are observed:

- The distribution of offsets has shown a better spatial continuity, particularly at the higher offsets in case of patch – centred shooting w.r.t swath shooting (Fig. 4).
- Azimuth distribution found to be even in patch centred shooting, especially in high aspect geometries (Fig. 7).
- Higher no. of traces is found to be passing through wider side of azimuth in patch shooting (Fig. 5 &6).
- The more evenness of the distribution of offsets and azimuths may help in better pre-stack imaging of the sub-surface, angle-dependent velocity analysis and AVO-related studies.

From the above, it is very evident that the patch-centred shooting provides better geophysical attributes than the swath shooting. The pros and cons of the field implementation of both types of shooting geometries are also analysed which is given as follows:

- The patch-centred shooting requires laying down of about 50 percent more receiver lines;
- In view of significantly larger channel count, it requires both additional field effort and obviously cost involvement;
- The significantly large channel count in highly populated environment like most of the areas in India may be difficult to operate and may not be productive.

Conclusions

From the above analysis, it is evident that the geophysical attributes is better preserved in patch-centred shooting in comparison to that of swath shooting. The better distribution of offsets and azimuth of the traces also is critical in carrying out pre-stack imaging and AVO related studies. But it has its own operational constraint. The no. of receiver lines to be laid in the field at a time is significantly increased which in turn, leads to operational difficulty of the crews , particularly, in areas like populated areas like Upper Assam etc. In view of this, it is concluded that patch-centred shooting need to be considered in areas where it is operationally possible otherwise it is preferable to carry out data acquisition using swath geometry only.

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