



A Comparative study of Wide Azimuth data and conventional datasets in Cachar fold belt area.

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Summary:

Designing of proper acquisition geometry is an optimizing exercise to achieve proper subsurface illumination by suitable placement of receivers and shots. Due to the resource constraint, most of the conventional surveys are carried out with lesser crossline sampling than inline sampling. The data is acquired generally in the dominant dip direction and perpendicular to the faults. This often leads to better imaging along the dip direction and slightly inferior strike direction imaging. The azimuthal content in the conventional geometry is often poor. Authors of this paper have tried to assess the impact of a wide azimuth survey upon structural delineation in geologically complex area. For this datasets acquired by three different geometries in the same area, were processed using the same processing flow including the processing parameters and the results were compared.

Introduction:

Different methods of acquisition geometries evolved over the years viz., parallel line, orthogonal, slant, zig-zag, brick etc. Each of these methods offer different advantages and disadvantages both technically as well as in practical aspects of implementation.

Technical requirement of acquisition geometry attributes are discussed by Vermeer (2003) and other design experts over the years, and are summarised below:

- Full Azimuth Coverage with good offset distribution within each Azimuth range
- Single Line Roll-Over for Subsequent Swaths to avoid possibility of acquisition footprints
- Equal surface sampling of sources and receivers in X and Y directions
- All aspect ratio(s) to be equal to One

- Square Bins
- Equal Max. Offset on All sides of Shot
- Equal RLI & SLI
- Equal In-Line & Cross Line Fold is preferred
- The range of variation in Near and Far offset must be minimum across Bins
- Uniform distribution of fold in near / mid / far offset ranges
- 3-D sampled Shot gathers

In spite of this, compromises are made in geometry parameters, especially, when the channel availability with the crew is limited. In most of the conventional geometries crossline fold is sacrificed for the inline fold. The azimuthal distribution is generally skewed. In such cases subsurface geology is seismically illuminated only from one particular shooting direction. We assume that most coherent noise types are well behaved and we can remove them in processing. We assume that the target illumination is acceptably uniform, and we can produce clean seismic images. This study is a comparison between the processed outcomes of WAZ dataset with two datasets acquired using conventional geometry ; dataset A and dataset B.

This study has been done from a processor point of view due to which it has been assumed that the field operations while conducting both the survey has been carried out with utmost caution, ensuring proper geophone plantation and selection of proper optimum depths for shot placement throughout the area. Since the area under study didn't have much logistic difficulties, respective nominal folds were observed in the area under study in both the datasets.

Method

Two areas were chosen for this comparative study . These are the regions where WAZ overlaps with

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Survey A (Fig1) and Survey B separately (Fig. 2). This region has been chosen on account of the subsurface complexity. The study area falls over the concealed Banaskandi anticlinal structure with in the fold belt of East Cachar region. This region has proven Upper Bhuban pays and isolated bright amplitude anomalies in the region has proved to be gas bearing.

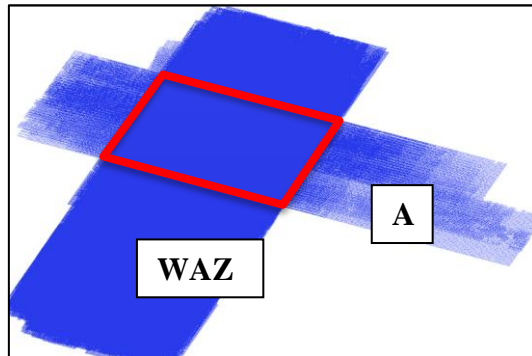


Fig. 1-The data within the overlap region of WAZ survey and survey A has been chosen for the study. Area is enclosed within red polygon.

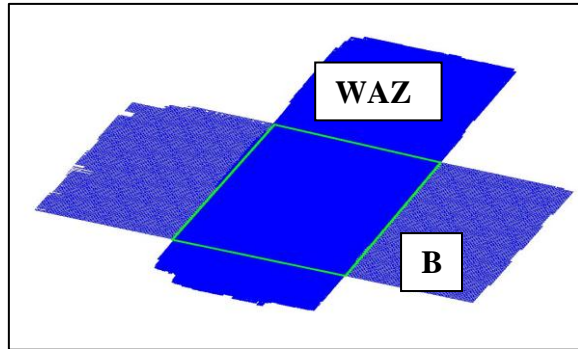


Fig. 2-The data within the overlap region of WAZ survey and survey B has been chosen for the study. Area is enclosed within green polygon.

The overlap region of Survey A on WAZ lies to the North east of overlap region of Survey B . In effect both the surveys together span the area covered by WAZ.

The acquisition geometry parameters of the surveys is tabulated in Table. 1 and Table 2 and the respective templates illustrated in Fig. 3 to Fig. 5

Table 1: Comparison between WAZ and Survey A parameters

	WAZ	Survey A
Shooting configuration	Sym split spread	Sym split spread
Bin size	20x20 m	20x40 m
Fold	(8x8)=64	80
No. of receiver lines	11	8
No of shots /salvo	16	48
Min offset	28 m	28 m
Max offset	4950 m (restricted to 3200m for comparison)	3180 m
Aspect ratio	1	0.61
Shot line interval (SLI)	440 m	320 m
Shot point Interval (SI)	440 m	80 m
Receiver line interval	40 m	240 m
Group interval	40 m	40 m
No. of receivers per line	176	160

Table 2: Comparison between the acquisition parameters of WAZ survey and survey B

	WAZ	Survey B
Shooting configuration	Sym split spread	Sym split spread
Bin size	20x20 m	20x40 m
Fold	(8x8)=64	40
No. of receiver lines	11	4
No of shots /salvo	16	32
Min offset	28 m	40
Max offset	4950 m (restricted to 3600m for comparison)	3600
Aspect ratio	1	
Shot line interval (SLI)	440 m	360m
Shot point Interval (SI)	440 m	80m
Receiver line interval	40 m	320m
Group interval	40 m	40m
No. of receivers per line	176	180

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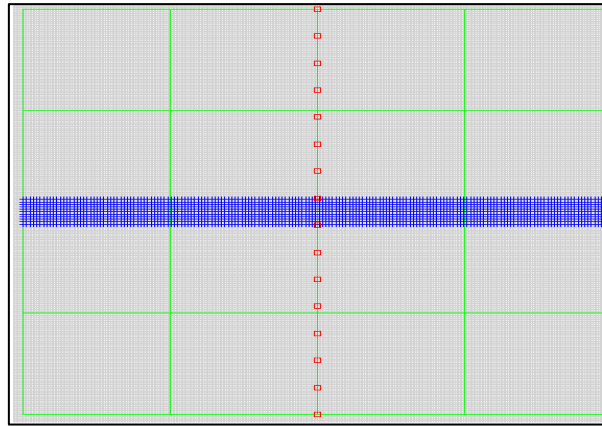


Fig.3 : Unit template of WAZ

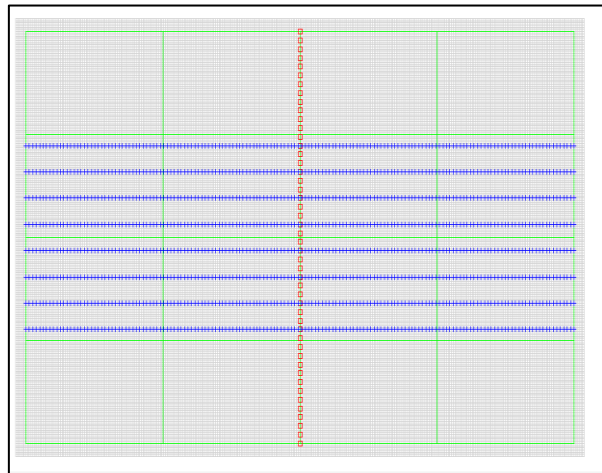


Fig.4 : Unit template of Survey A

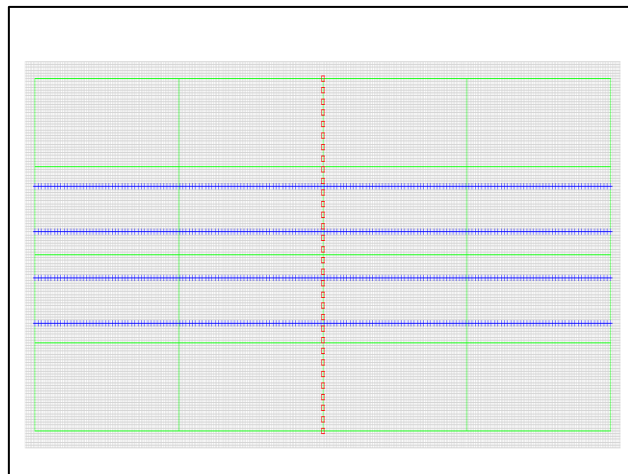


Fig.5 : Unit template of Survey B

The main aspect that makes the WAZ survey unique and unconventional as compared to the conventional survey A and B is the lack of any preferential directionality in the shot and receiver placement. The shot grid consists of shots at every 440m grid. Shot point spacing as well as shot line spacing is 440m. In the case of receivers , all receivers are spread out on a 40 m X 40m grid. Survey B can be referred as “directionless”. Shooting of WAZ survey is as shown in Fig.6. It has a good azimuthal content. The rose diagram of the surveys are given in Fig 7 to Fig 9. The rose diagram of WAZ survey is indicative of rich azimuthal content as compared to that of survey A and survey B.

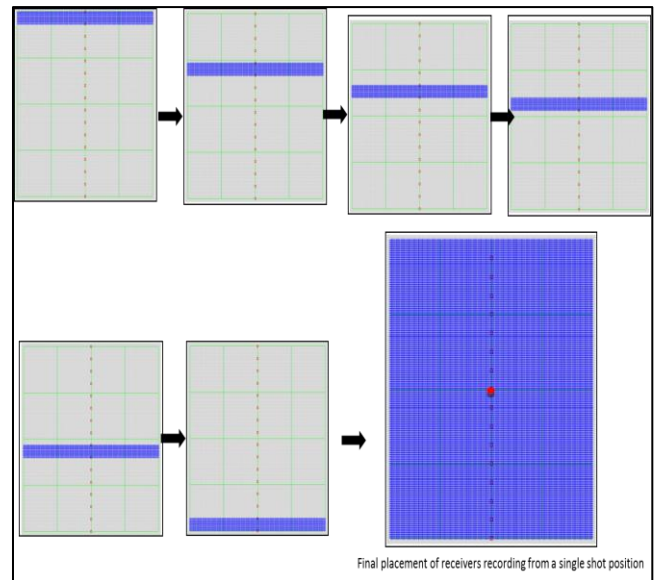


Fig.6 :Shooting of WAZ survey. The shots are repeated and the receiver lines are shifted . Final active receiver placement for a single shot after all shots have been taken is as shown in the bottom right of the figure. Shot is marked in red colour

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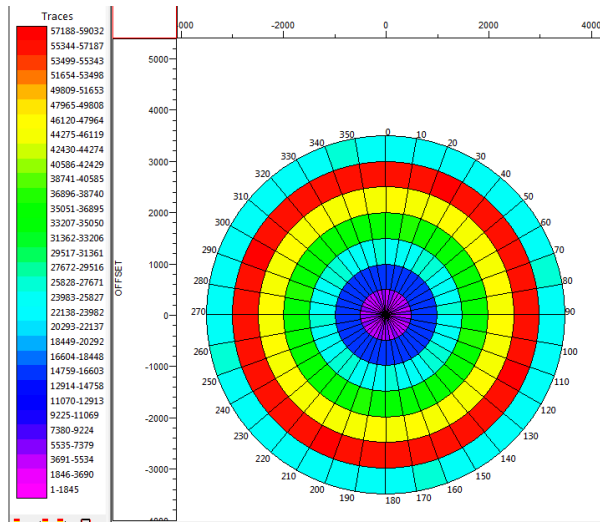


Fig. 7 : Azimuthal distribution in WAZ

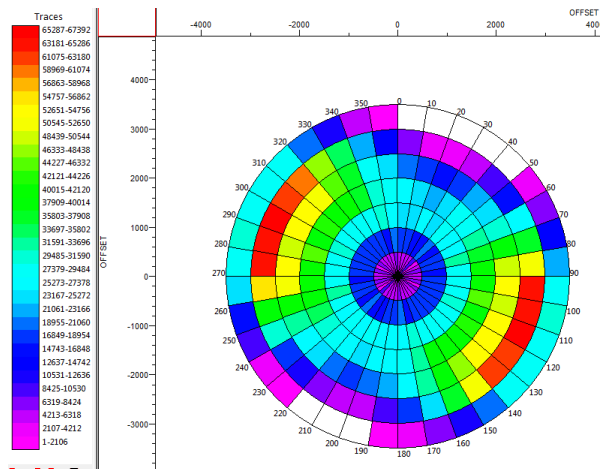


Fig. 8 : Azimuthal distribution in dataset A

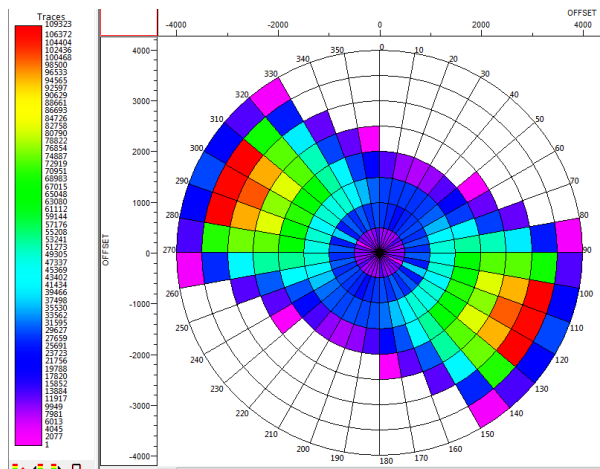


Fig. 9: Azimuthal distribution in dataset B

Since shot placements are farther apart in WAZ survey than other surveys, better planning can be done in areas where there are logistics difficulties such as towns and proximity to houses. Since there are no directional constraints, shooting sequence can be conveniently decided. The receiver patch area of the template is reduced to a large extent and maintaining the line connectivity becomes easier. As we have receivers at 40 m. interval in all directions of the shot location, using this fully sampled shot gather of Geometry B, all types of shot generated coherent noises from any direction of the shot can be effectively suppressed in processing.

Processing sequence

All datasets, WAZ, A and B were processed using the same processing flow. Denoising was done in the Fourier domain and spiking deconvolution with an operator length of 300 ms was applied on both datasets. Residual statics was computed using Monte-carlo statics computation method. Data was regularized using 5d interpolation module. But datasets has not been regularized in the azimuthal dimension. At no stage of processing, the parameterization for processing data for datasets under comparison differed. Stacking velocity at different stages as well as RMS velocity used for migration were kept same so that the difference in the final processed output need not be attributed to such factors. Anisotropy has not been taken into consideration as offsets were restricted. A level playing field was provided to both the datasets due to which a conventional processing flow was chosen rather than WAZ friendly processing flow. Azimuthal dependence of velocity has been discarded.

It can be observed from Fig 1 and Fig2 that both the survey strips are perpendicular to WAZ orientation. Finally, in order to compare the processed output, both the surveys has been brought to the same grid. Since bin size of WAZ survey is 20m X 20m as compared to the 20m X 40 m bin size of other surveys, the final processed section of other surveys when converted upon to WAZ grid suffered heavy degradation in quality. So in each comparison the grid of the respective conventional geometry was chosen as the common grid. There wasn't much variation the quality of WAZ setion inspite of grid change .

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This can be attributed to the lack of preferred directionality in the WAZ data .

Result

Comparison between migrated sections of WAZ and survey A

The final migrated sections are given below. Few sections along inline and few along crossline direction are given for comparison.

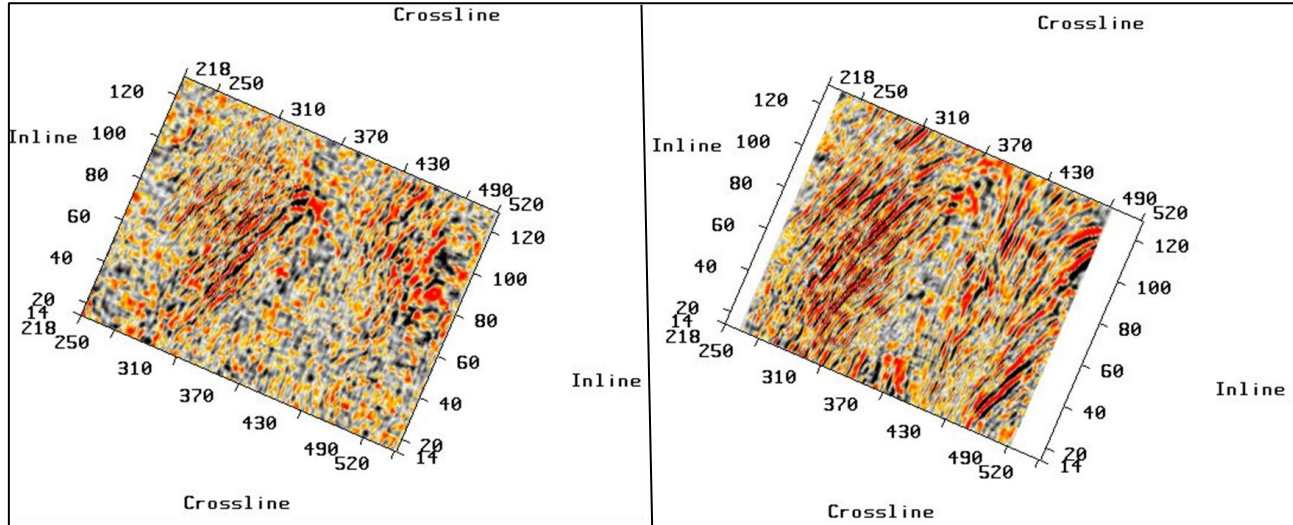


Fig.10:Time slice map at 1000ms showing the inlines and crosslines of survey A on left and WAZ on right

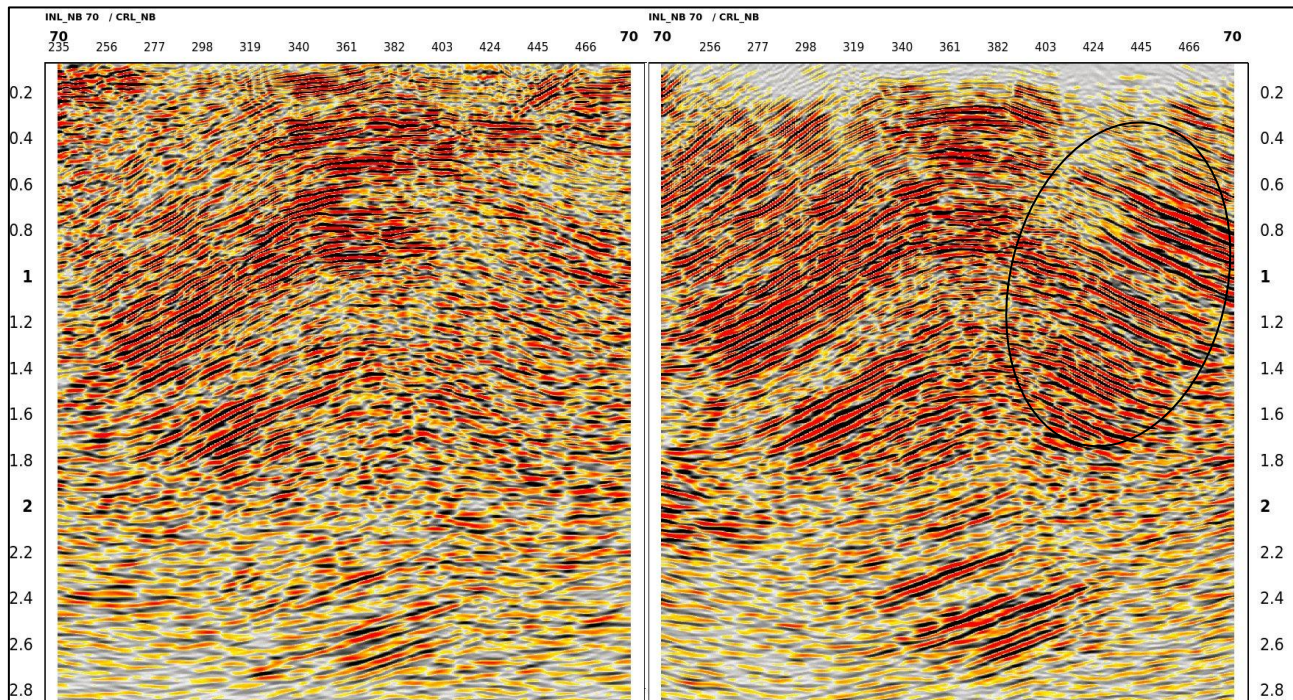


Fig.11:Final prestack time migrated section along Inline70 of Survey A and WAZ survey. Section of SurveyA on left and WAZ section on the right side . Within the encircled region, WAZ showed improvement over Survey A.

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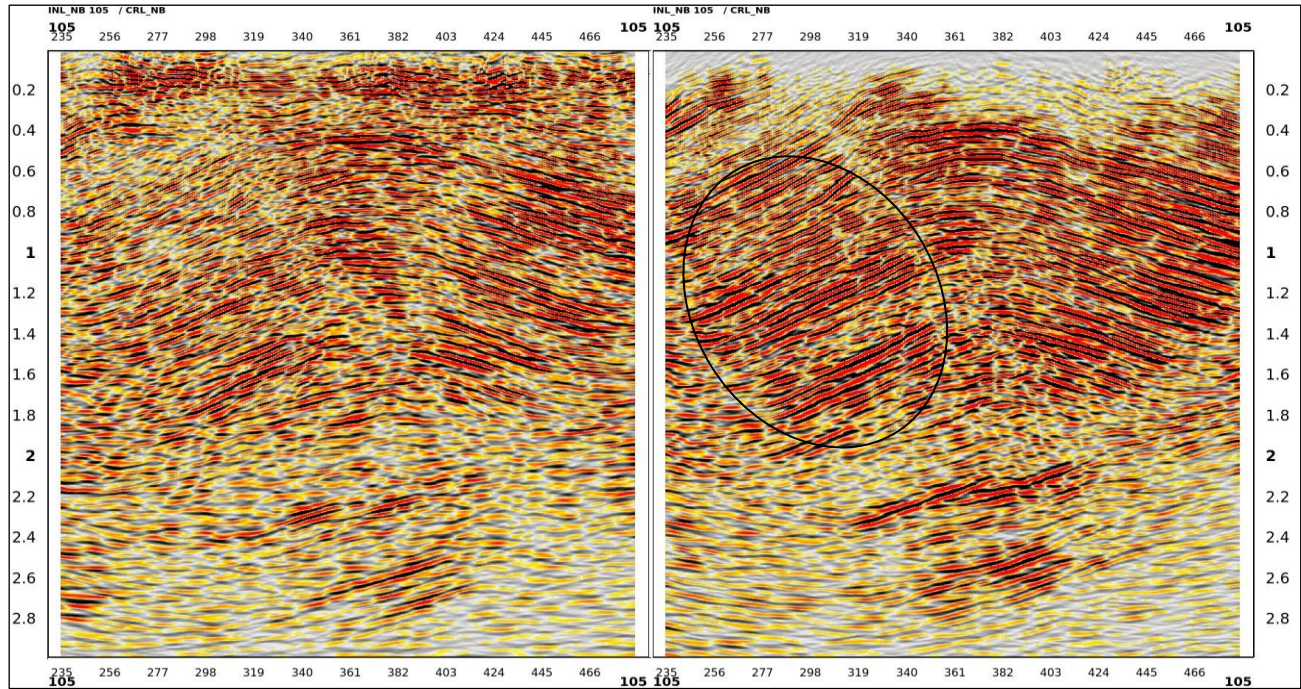


Fig.12: :Final prestack time migrated section along Inline105 of Survey A and WAZ survey. Section of SurveyA on left and WAZ section on the right side . Within the encircled region, WAZ showed improvement over Survey A.

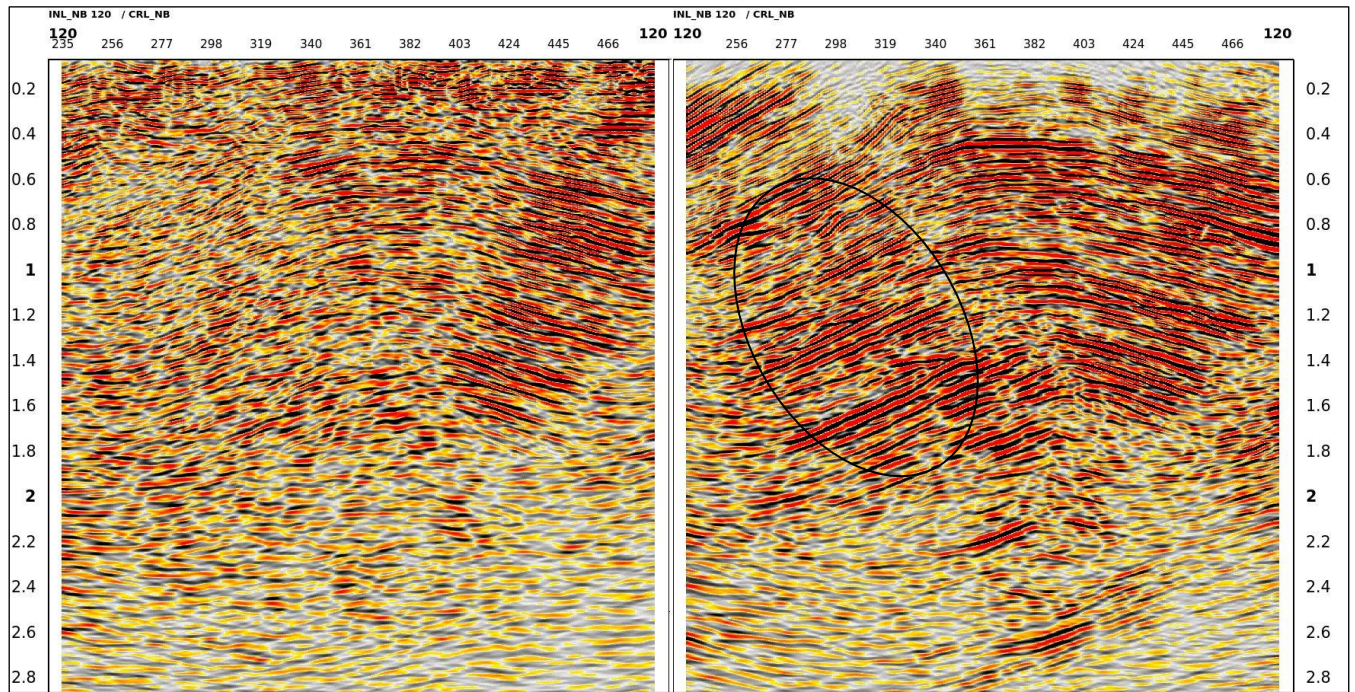


Fig.13: :Final prestack time migrated section along Inline120 of Survey A and WAZ survey. Section of SurveyA on left and WAZ section on the right side. Within the encircled region, WAZ showed improvement over Survey A.

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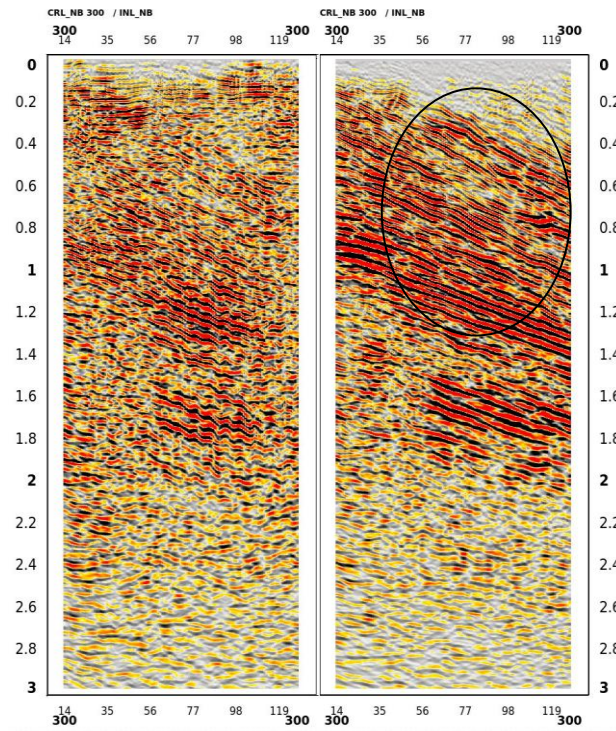


Fig.14:Final prestack time migrated section along Crossline 300 of Survey A and WAZ survey. Section of SurveyA on left and WAZ section on the right side . Within the encircled region, WAZ showed improvement over Survey A.

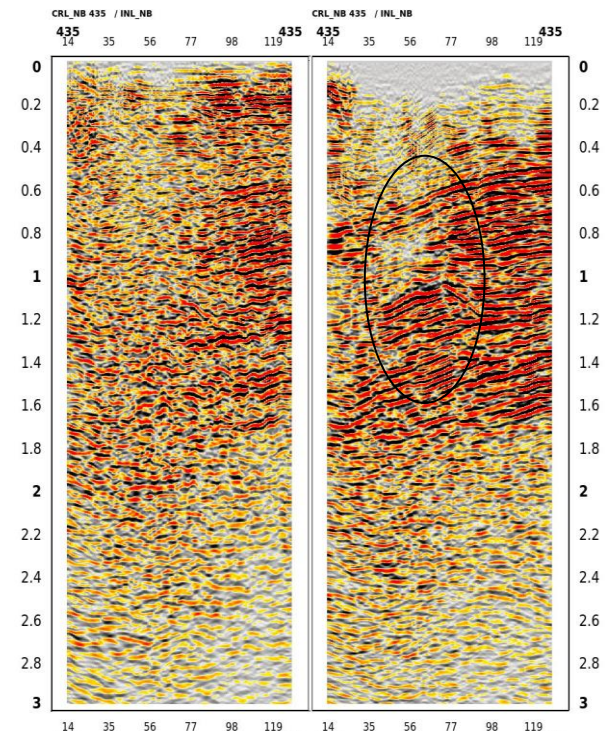


Fig.15: :Final prestack time migrated section along Crossline 435 of Survey A and WAZ survey. Section of SurveyA on left and WAZ section on the right side . Within the encircled region, WAZ showed improvement over Survey A

Comparison between migrated sections of WAZ and survey B

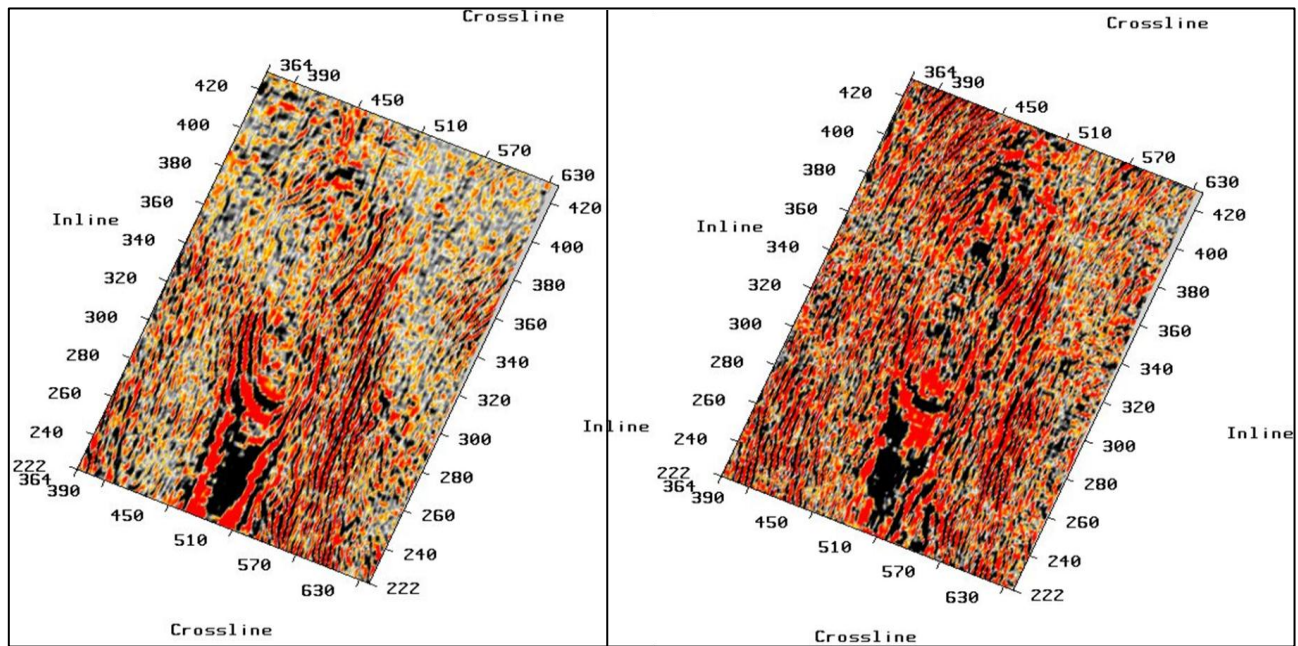


Fig.16:Time slice map at 600ms showing the inlines and crosslines of survey B on left and WAZ on right

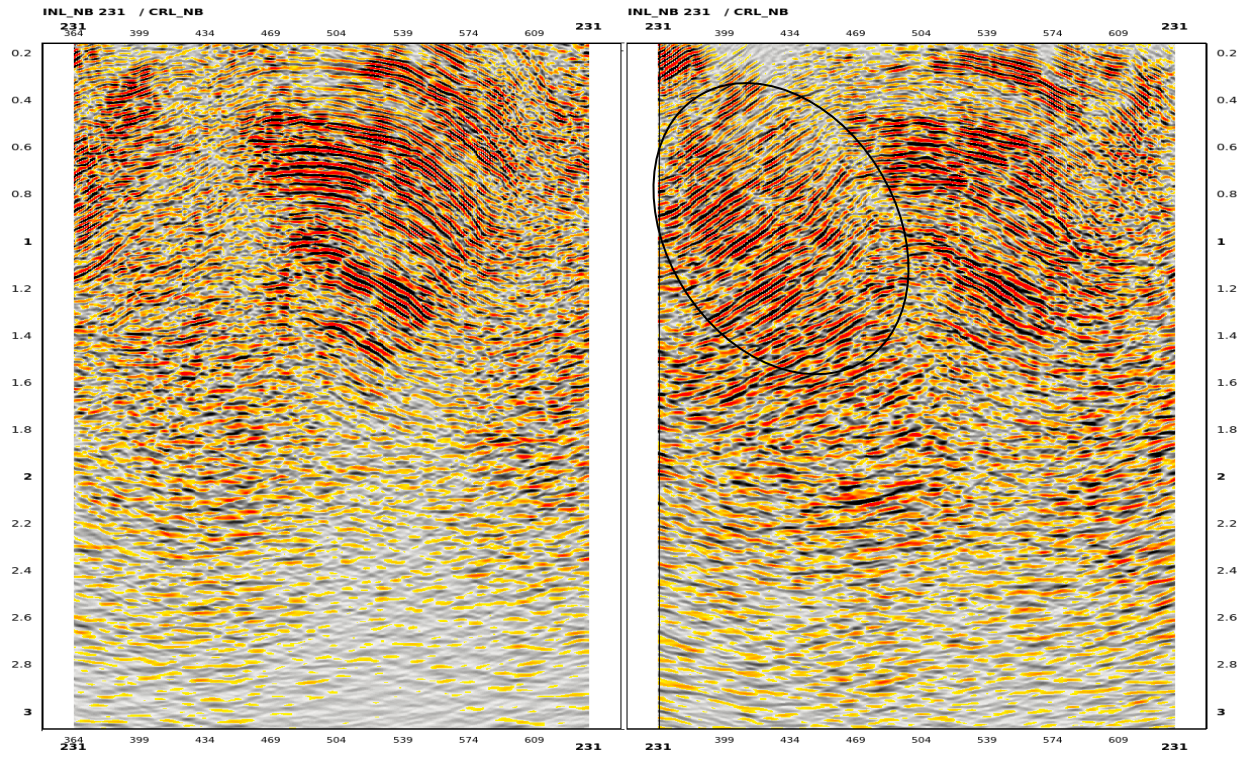


Fig.17:Final prestack time migrated section along Inline231 of Survey B and WAZ survey. Section of Survey B on left and WAZ section on the right side . Within the encircled region, WAZ showed improvement over Survey B.

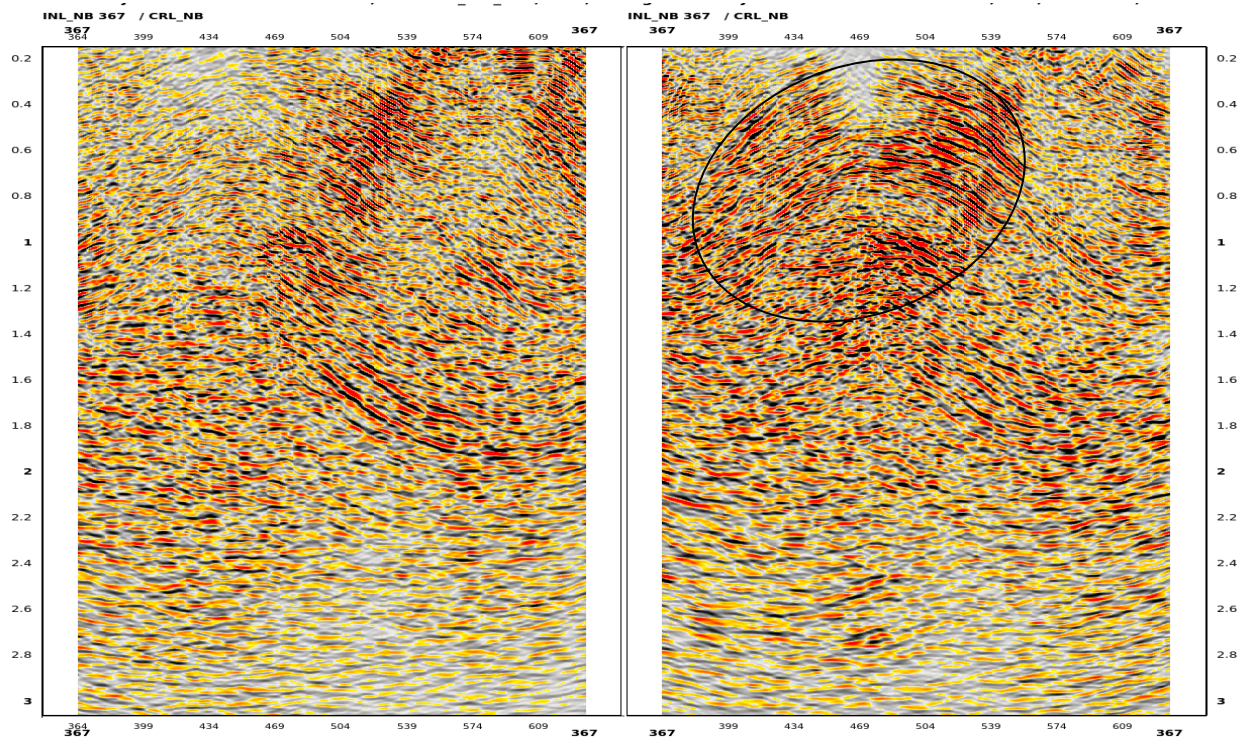


Fig.18:Final prestack time migrated section along Inline367 of Survey B and WAZ survey. Section of Survey B on left and WAZ section on the right side. Within the encircled region, WAZ showed improvement over Survey B.

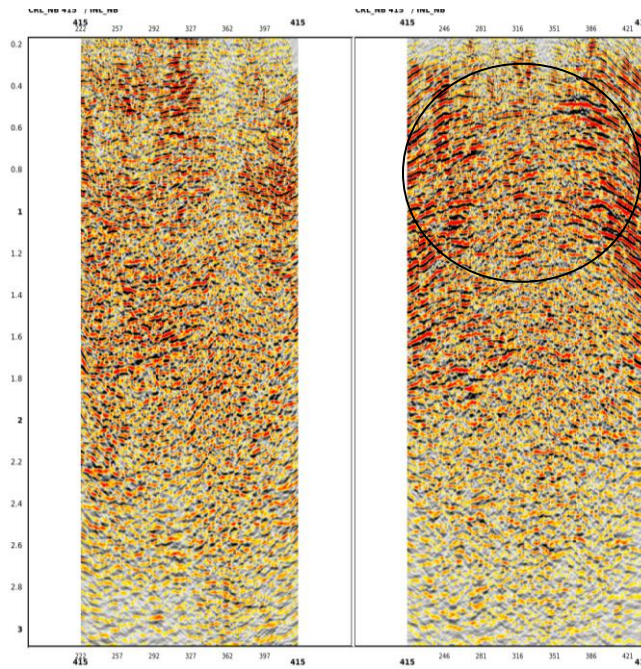


Fig.19:Final prestack time migrated section along Crossline415 of Survey B and WAZ survey. Section of Survey B on left and WAZ section on the right side. Within the encircled region, WAZ showed improvement over Survey B.

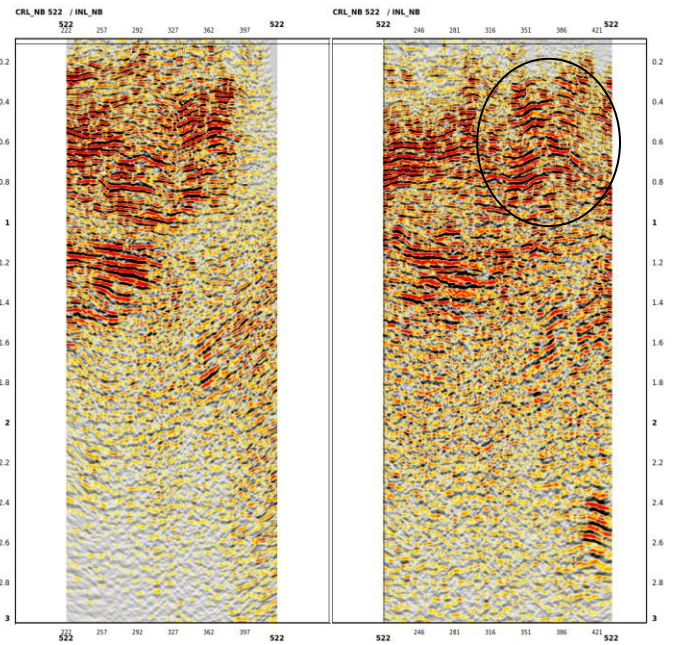


Fig.20:Final prestack time migrated section along Crossline451 of Survey B and WAZ survey. Section of Survey B on left and WAZ section on the right side. Within the encircled region, WAZ showed improvement over Survey B.

In each of the figures the encircled area shows considerable improvement in WAZ over survey A and Survey B. After comparing the prestack migrated sections of WAZ survey and survey A, it is observed that the anticline is more structurally defined in WAZ survey as compared to section A. In survey A, the clarity of the imaging is inconsistent as both flanks of the anticline couldn't be mapped in most of the inlines. Whereas in WAZ both flanks of the anticline could be consistently traced out. Through out the volume, WAZ was more superior to section A, both in inline as well as crossline direction. Fault definitions, isolated high amplitude anomalies, channel relicts and other relict features could be mapped better in WAZ rather than section A.

In case of comparison between pre stack time migrated sections of WAZ and survey B, it is observed that in WAZ survey both the flanks of the anticline could be structurally mapped. The quality of WAZ was observed to be more consistent than survey B. WAZ achieved good imaging in certain patches as compared to survey B though the extent of improvement varied from one location to another. In the crossline direction the

survey B lacked continuity of events as compared to WAZ survey

Conclusion

Since both the datasets under comparison have been processed using same parameters including velocities, it is reasonable to conclude that imaging difference among the two sections is a direct result of the inherent geometry design. Finer sampling of the wavefield is required in both dip and strike direction with rich azimuthal distribution in order to map subsurface complexities. In WAZ survey, a considerable improvement in the imaging of the Banaskandi anticline as well as certain relic features could be observed. With conventional processing flow itself the result of WAZ survey is far superior than data acquired using conventional geometry in this case. The authors of this paper restrain from making sweeping generalizations to all complex subsurface geological setting from this single comparative study presented in the paper. Further studies can be carried out in different



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regions and across different geometries before generalizing the result on a larger scale .

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Views expressed in this paper are those of the author(s) only and may not necessarily be of ONGC.

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