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RESEARCH ARTICLE

ONSHORE SEISMIC IMAGING USING DIFFERENT DATA DOMAIN IN NORTHERN NIGER DELTA, NIGERIA

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ABSTRACT

Wide azimuth land acquisition, 3D data is spatially well sampled with a wide range of azimuth and the offsets distributed around those azimuths. This work examined how advance seismic processing technique has come onshore, using offset vector tile methods, high-fidelity, high-resolution is available for use on onshore data. Data were split into one hundred and twenty four vector tiles as a function of source-to-detector distance and azimuth relationship individual pre-trace is assigned an offset vector tiles number that is stored in the trace headers the number is based on the relative shot and receiver location for the trace. Data is regularized to maintain the necessary number of traces and the range of offset in each bin and allow to be filled then migration of the target lines and stacking. After regularization for both the common offset binning and the offset vector tiles (OVTs), it was observed that there is improved signal to noise ratio in the offset vector tiles as compare to the common offset binning, and there is overall improvement in event continuity on the OVTs result. Because onshore (land) data exhibit poor signal-to-noise ratios arising from irregular geometries and noise contamination a fundamental change in processing methods is required. The offset vector tiles (OVTs) have proven to be an effective and efficient tool for 3D wide azimuth acquisitions, the OVTs domain pre-processing, will yield a better imaging when compared to the common offset binning (COB) domain pre-processing.

KEYWORDS

Offset, Azimuth, Migration, Binning, Tiles.

1. INTRODUCTION

Wide azimuth land (onshore) 3-D seismic data, generate data that are spatial sampled with wide range of offset and azimuths distribution, wide azimuth acquisitions also provide a full azimuthal illumination of the sub-surface structure for a more accurate imaging, analysing azimuthal variations of the seismic response may offer additional information on fracture orientation (Claerbout, 1985). Meeting these objectives, it is essential that the character of the data is preserved throughout the processing sequence (Lecerf et al., 2009). In these view the concepts of offset vector tiles was introduced as an alternative to common offset binning (Vermeer, 2001; Cary, 1999). The discrepancy between narrow and wide azimuth survey is made on the basic of the aspect ratio. Aspect ratio which is defined by the cross-line dimension of the patch divided by the in-line dimension (Cordsen and Galbraith, 2002) defined wide azimuth as seismic with aspect ratio of 0.5 because aspect ratio close to one is most advantageous because they allow full azimuthal analysis, for practically all offset at the target depth.

Offset Vector Tiles This method is a technique used to group traces of similar offset and azimuth to create single fold data volume, in accomplishing this, each entity pre-stack traces are assigned an OVT number that is stored in the trace header, this digit is based on the relative shot and receiver location for the trace. Each offset vector tiles contain traces with the same collection of offset and azimuth, (Wilson and Mohammed, 2011). Generally matching pursuit multi-dimensional Fourier interpolation (MPFI) is used for regularization of the data prior to the forming of the offset vector tiles to gives the best and most equal distribution to avoid over and under populated tiles. These methods tried to avoid the mixing of more azimuths at far offsets, by breaking the azimuth/offset range into tiles of similar values, which are grouped together and given the nominal value of each tile range. Processing using the conventionally method of imaging normally have side effect of azimuthal mixing which leads to loss of azimuthal information and offset not preserved (Frydenlund, 2017).

For a particular survey the offset vector tile bin dimension can be chosen such that each bin defines a single cube over a survey area with traces with the same offset and azimuth. Understanding of these bin dimension are chosen, it is expedient to view an orthogonal land survey a collection of sub-surveys each acquired by a source-receiver line pair. These sub-surveys are referred to as cross-spread. Cross-spread is the building block of orthogonal survey.

2. STUDY AREA

The study area is within Edo State, onshore Northern Niger Delta region of Nigeria. Figure 1 shows the map of the study area. The area is geological characterized by deposit laid during the tertiary and the Cretaceous period (Reyment, 1965). The various formations are the Benin, Bende-Ameki, Ogwashi-Asaba, Imo, Nsukka formations (Asadu et al., 2015). The area is underlain by sedimentary rock with 90 percent sand stone and shale intercalation (Doust and Omatsola, 1990).

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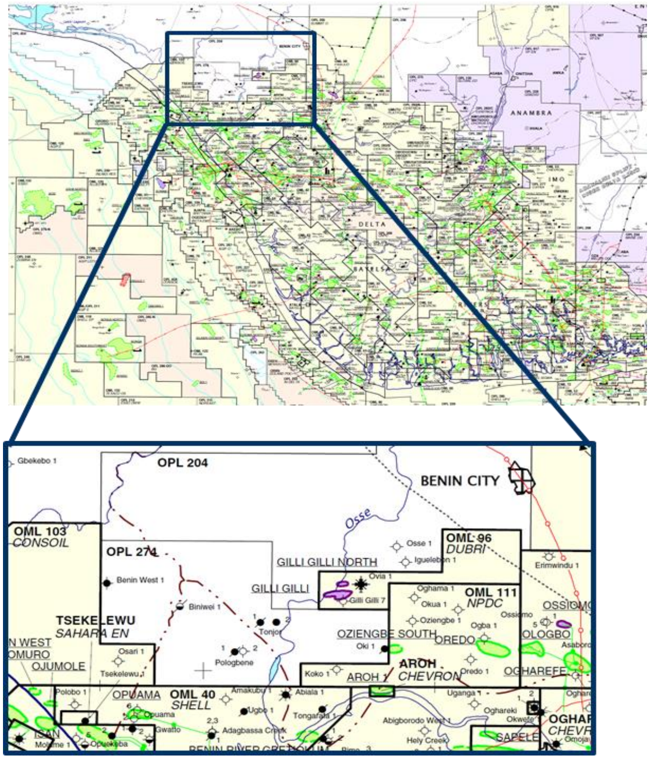

Figure 1: Map of the Study Area

3. Materials and Methods

3.1 Materials

The materials used for this research include Western Geco Omega2 (Schlumberger) software, Microsoft Excel spread sheet

3.1.1 Data Records

The data available for this research is the 3-D seismic volume which is provided in SEG-Y format. The seismic data acquisition was carried out in three phase while this research was carried in the phase two which is 130 sqkm.

3.1.2 Acquisition Parameters

The Shot point Spacing is 50m, the Receiver line Spacing is 400m, the Receiver point Spacing is 50m, the Shot line Spacing is 400m, Source Depth is 40m, Fold of Coverage is 56, Hole Type Single Deep Hole and Bin Size is 25m by 25m.

3.2 Method

The workflow of offset vector tiles (OVTs) and the common offset binning (COB) presented in Figure 2 shows the stages of the method utilized for this research.

3.2.1 Data Loading

Field upload Tapes received from the field were uploaded using tape drives located in Computer Room, each tape drive is accessible through any of the different servers. Once seismic data is being collected, it needs to undergo pre-conditioned process.

3.2.2 Data Split

Data were split into 124 vector tiles as a function of source-to-detector distance and azimuth relationship. Individual pre-trace is assigned an offset vector tiles number that is stored in the trace headers, the number is based on the relative shot and receiver location for the trace. Internally, the algorithm splits the data into four azimuth quadrants (0-90, 90-180, 180-270, and 270-360), in each quadrant, the data is then assigned to the tiles as a function of their respective source-to-detector distance and this information is stored in the trace headers.

Data Split for COB domain is done by splitting into 56 offset groups shown in Table 1, the first offset has a range of 0-400m to increase fold coverage due to insufficient sampling of the near offsets from acquisition subsequent offset groups increment every 100m. There are several ways to split to common offset plane firstly we group the real traces into common offsets with no regularization or interpolation and apply fold-based normalization, secondly borrowing traces from the previous/next offset plane to fill in gaps in under populated planes and lastly regularize shot and/or receiver lines to ideal geometry to allow one trace per bin; only use fold-based normalization to deal with gaps.

3.2.3 Regularization and Interpolation

The data were regularized to maintain the necessary number of traces and the range of offset in each bin, irregular sampling can occur due to undershooting on land which can affect data analysis, introduce noise, phase and amplitude distortion and probably degrade the final image. Regularization and interpolation place the acquired data on a regular grid and allow holes to be filled fully or partially, regularize the fold of coverage, improved the stacked response and amplitude stripe reduction during migration.

3.2.4 Migration

Migration which moves dipping event to their true sub-surface position collapses diffraction and increase the spatial resolution. The Kirchhoff depth migration was used in this research.

3.2.5 Stacking

Stacking is the summation of traces from different records with common reflection point to form a single trace, thereby reducing the amount of data by factor called fold, reduce noise and improve overall data quality.

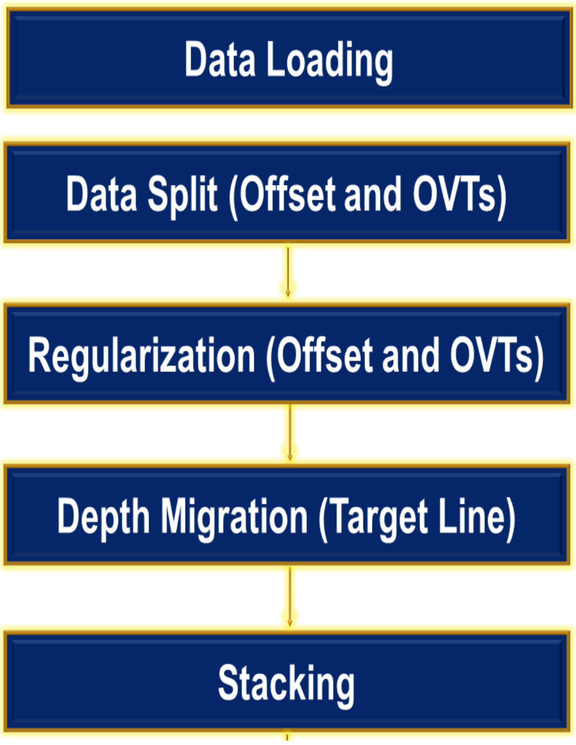

Figure 2: Workflow on OVTs and COB

4. Results and Discussion

4.1 Results

4.1.1 Data Quality Check

The result inline 1350 are presented in Figures 3 and 4 and show the post marching pursuit Fourier interpolation of the common offtset binning domain and the OVT domain. After migration, the migrated stacked inline 1191 are presented in Figures 5 and 6 of the COB domain and the OVT domain, migrated stacked inline 1511 are presented in Figures 7 and 8, migrated stacked inline 1331 are presented in Figures 9 and 10.

Table 1: Values of Different Offset Ranges

Offset Group	Minimum Offset (m)	Maximum Offset (m)	Central offset (m)
1	0	400	350
2	400	500	450
3	500	600	550
4	600	700	650
5	700	800	750
6	800	900	850
7	900	1000	950
8	1000	1100	1050
9	1100	1200	1150
10	1200	1300	1250
11	1300	1400	1350
12	1400	1500	1450
13	1500	1600	1550
14	1600	1700	1650
15	1700	1800	1850
16	1800	1900	1950
17	1900	2000	2050
18	2000	2100	2150
19	2100	2200	2250
20	2200	2300	2350
21	2300	2400	2450
22	2400	2500	2550
23	2500	2600	2650
24	2600	2700	2750
25	2700	2800	2850
26	2800	2900	2950
27	2900	3000	3050
28	3000	3100	3150
29	3100	3200	3250
30	3200	3300	3350
31	3300	3400	3450
32	3400	3500	3550
33	3500	3600	3650
34	3600	3700	3750
35	3700	3800	3850
36	3800	3900	3950
37	3900	4000	4050
38	4000	4100	4150
39	4100	4200	4250
40	4200	4300	4350
41	4300	4400	4450
42	4400	4500	4550
43	4500	4600	4650
44	4600	4700	4750
45	4700	4800	4850
46	4800	4900	4950
47	4900	5000	5050
48	5000	5100	5150
49	5100	5200	5250
50	5200	5300	5350
51	5300	5400	5450
52	5400	5500	5550
53	5500	5600	5650
54	5600	5700	5750
55	5700	5800	5850
56	5800	5900	5950

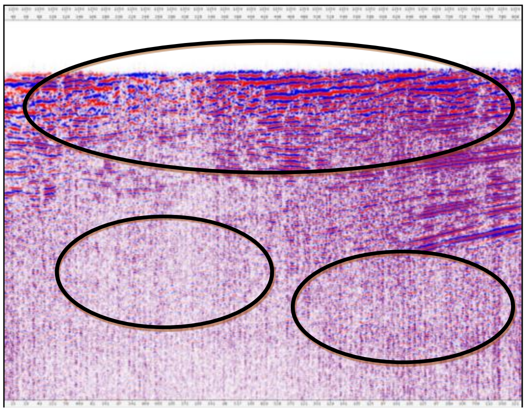

Figure 3: Inline 1350: Post MPFI (Offset Domain)

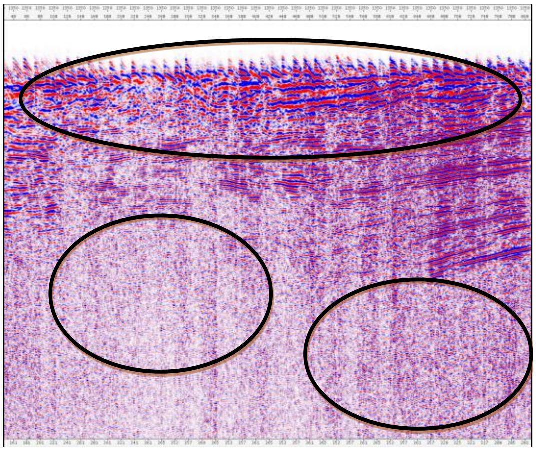

Figure 4: Inline 1350: Post MPFI (OVTs Domain)

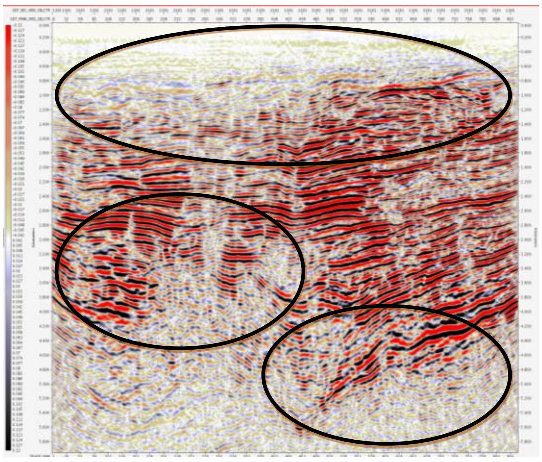

Figure 5: Inline 1191: Migrated Stacked (Offset Domain Pre-Processing)

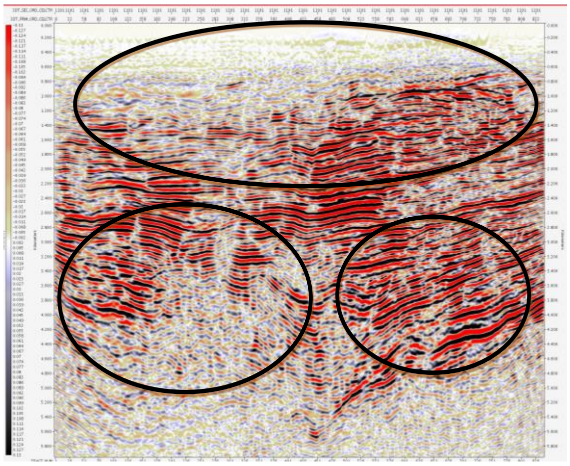

Figure 6: Inline 1 191: Migrated Stacked (OVTs Domain Pre-Processing)

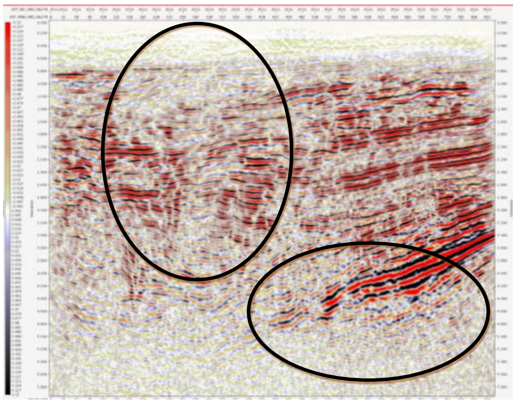

Figure 7: Inline1511: Migrated Stacked (Offset Domain Pre-processing)

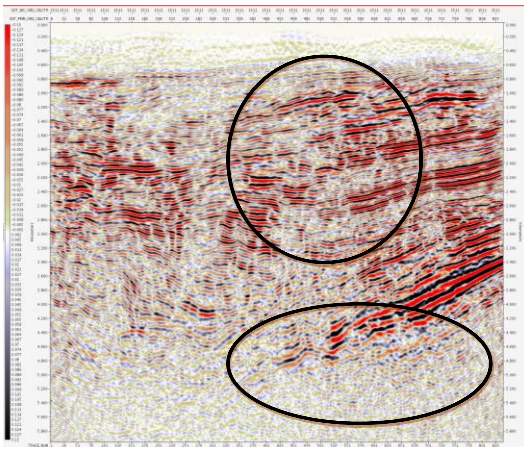

Figure 8: Inline1511: Migrated Stacked (OVTs Domain Pre-processing)

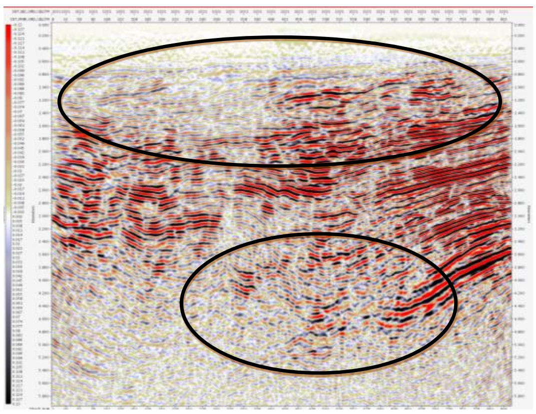

Figure 9: Inline 1311: Migrated Stacked (Offset Domain Pre-processing)

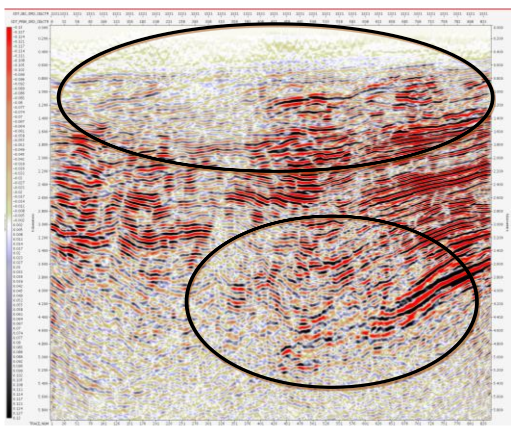

Figure 10: Inline 1331: Migrated Stacked (OVTs Domain Pre-Processing)

5. Conclusion

In conclusion, offset vector tiles (OVTs) have proven to be an effective efficient for 3D wide azimuth acquisitions onshore (Land), any pre-processing technique that preserves the inherent azimuthal information in the acquired seismic data, improving depth modeling due to more focused azimuth /offset group, the OVTs domain pre-processing, will yield a better imaging when compared to the common offset domain pre-processing. The pre-stack depth migration in the offset vector tile (OVTs) domain provide well sampled image gathers with regular trace distribution in a Cartesian coordinate system optimal for post-migration processing.

6. Recommendation

This study recommends the following for further studies

1. In preserving offset and azimuthal information which provide a full azimuthal illumination for sub-surface structure and analysing azimuthal variation of the seismic response which offer information on fracture orientation the OVTs should be done

2. To enhance resolution of overburden heterogeneity and better imaging of deep target the OVTs has proven to be a better method.

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For the success of this work, is as result of our effort that deserves applause and commendation. We want to thank God for his guidance, direction and strength. The authors are also grateful to the entire Western Geco team for support, for useful input, encouragement discussion and assistance in processing the data and the associated software, not forgetting Sahara Group for the permission to use the seismic images.

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