



26th Colloquium of African Geology (CAG26)



Structural Modelling and Seismic Attributes Analysis of Jay Field, Offshore Niger Delta

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PRESENTATION OUTLINE



- INTRODUCTION
- STUDY OBJECTIVES
- LOCAL GEOLOGY
- LOCATION AND DATA
- METHODOLOGY
- RESULTS AND DISCUSSION
- CONCLUSION

120 km

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INTRODUCTION

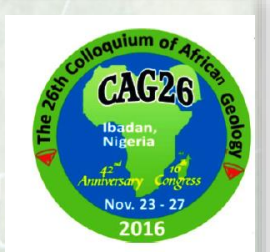


- Richard 2008, defined Seismic Attributes as all the information obtained from seismic data, either by direct measurements or by logical or experience based reasoning
- Seismic attributes are the quantities that are measured, computed or implied from the seismic data
- Seismic attributes: Introduction in the early 1970's **Many classes of attributes can be defined (Richard, 2008)**
- 3D seismic techniques and associated technologies
- Introduction of seismic sequence attributes,
- Coherence technology in mid 1990's,
- Spectral decomposition in late 1990's
- Introduction of 3D visualization techniques,

Attributes	Comment
Post-stack seismic	"Traditional"
Pre-stack seismic	AVO etc.
Impedances	Seismic inversion
Velocities	Imaging operations
Surfaces	Structural interpretation
CSEM, MT, Gravity, Aero-magnetic	Non-seismic attributes



AIM AND OBJECTIVES



Aim

This study aims at generating the structural model and carry out seismic attribute analysis on Jay field in order to enhance prospect evaluation, improve analysis and reduce risk, Offshore Niger Delta .

Objectives

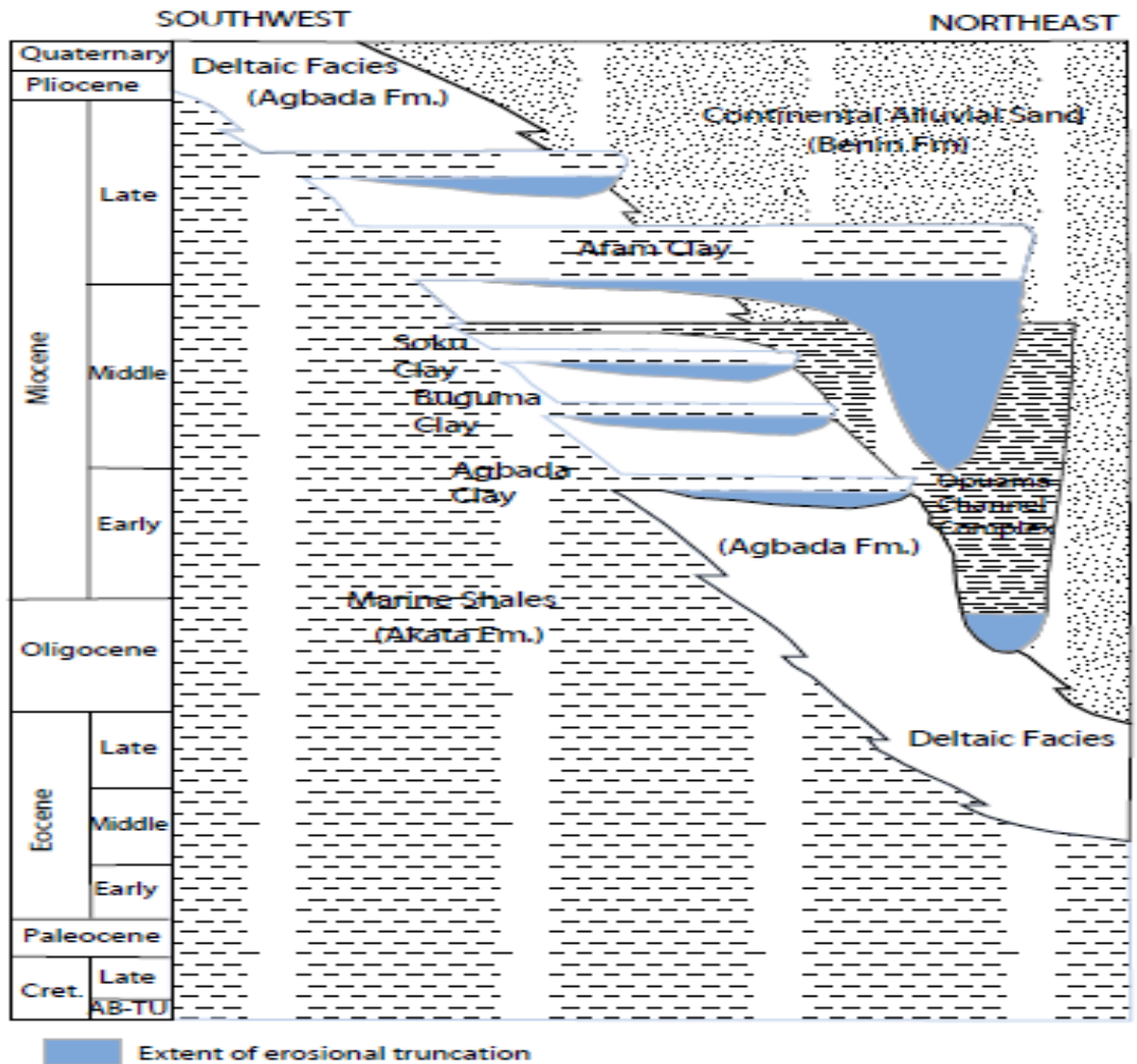
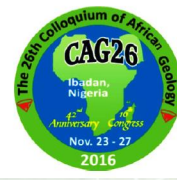
The objectives of this study include:

- Generate structural model of the field and its significance
- Identify what seismic attributes are applicable to Niger Delta offshore
- Delineate subsurface depositional features using seismic attribute analysis

2. Verify seismic attribute analysis as a substantive tool in the study area



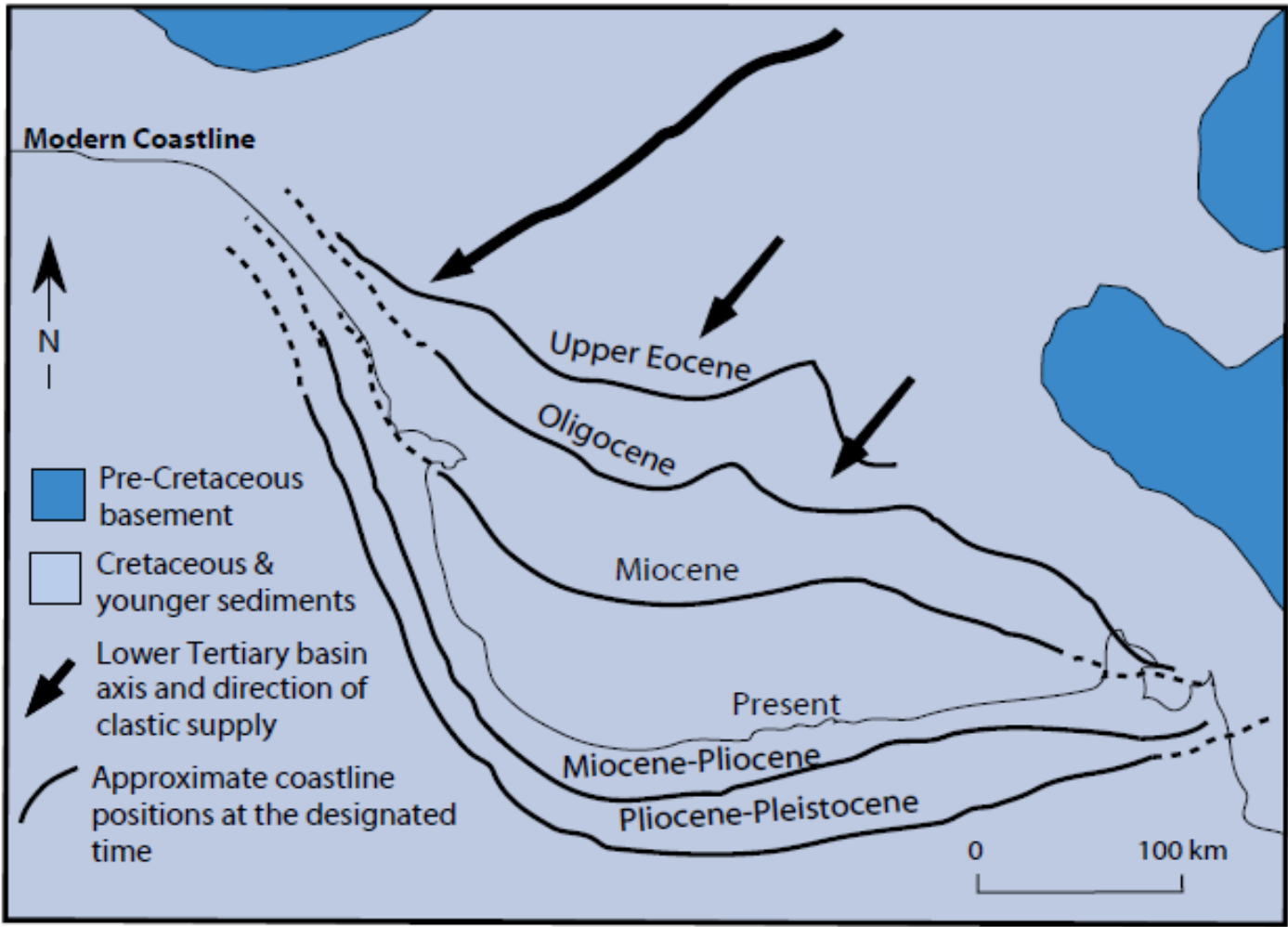
GEOLOGY OF THE STUDY AREA



Stratigraphic column showing the three formation of the Niger Delta (Modified from Channon and Naylor (1989) and Doust and Omotsola (1990))



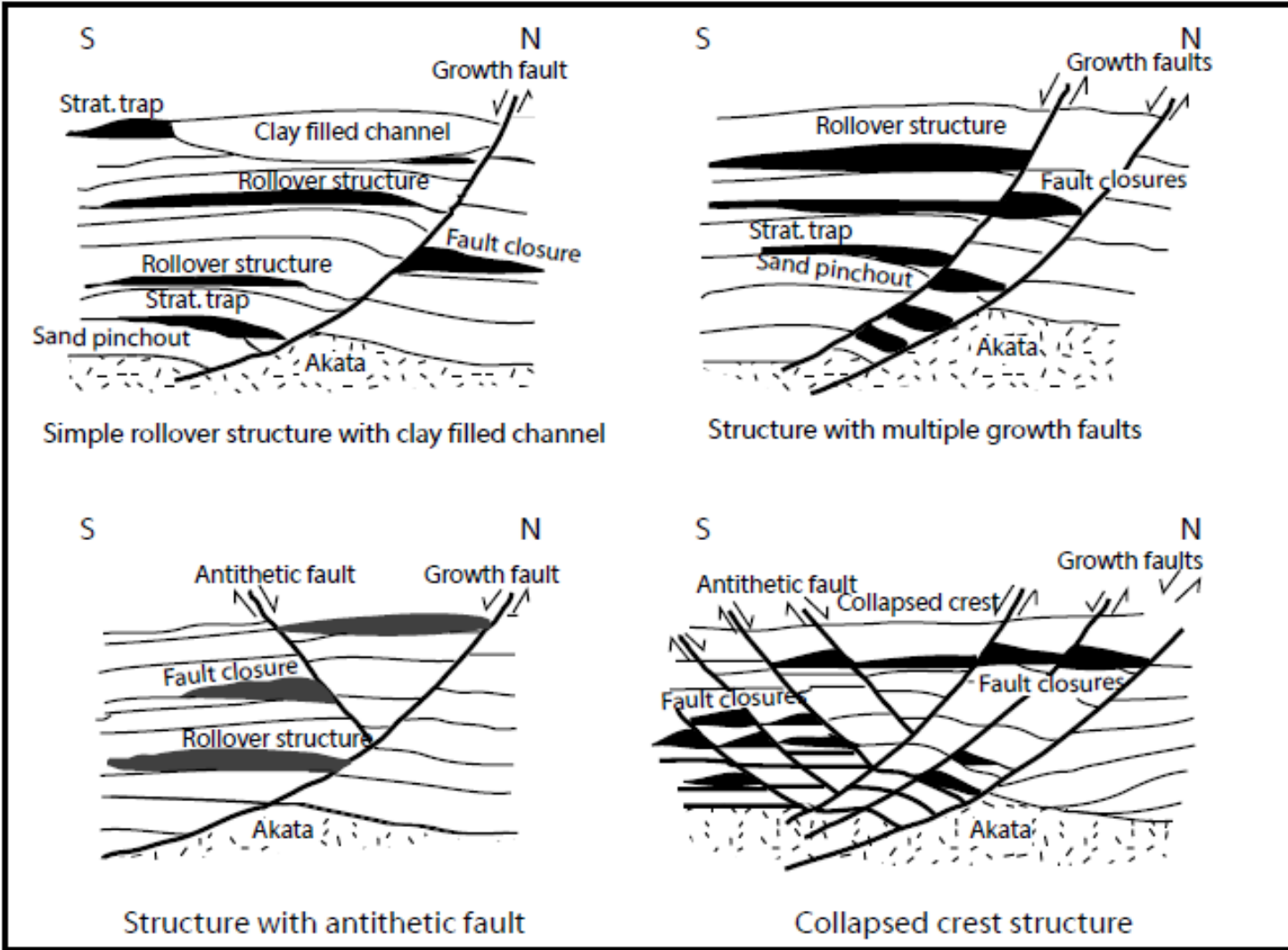
GEOLOGY OF THE STUDY AREA



Cartoon map showing how the coastline of the Niger Delta has progressed since 85 Ma (Modified from Whittam and Isola, 1990)



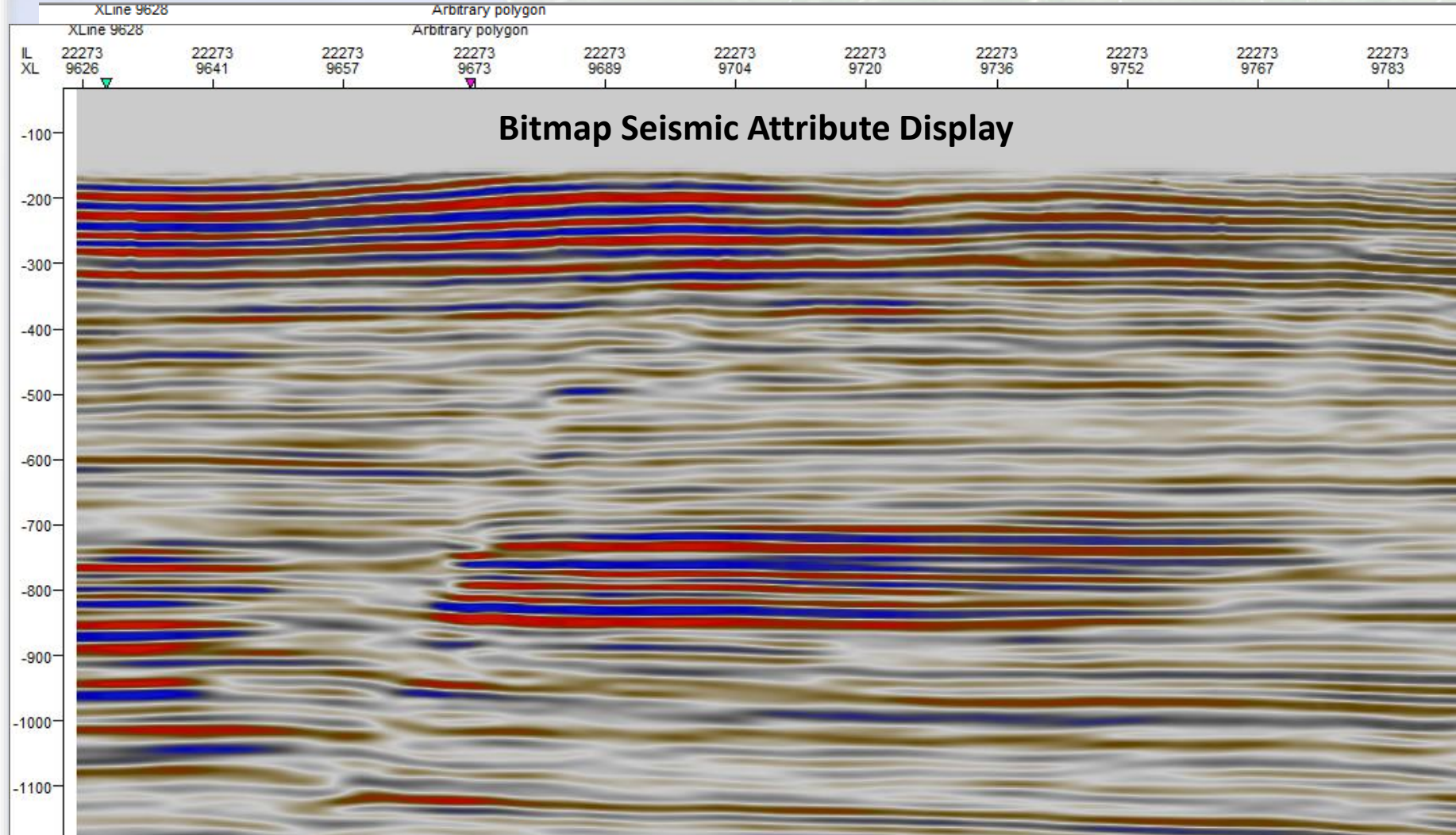
GEOLOGY OF THE STUDY AREA



Examples of Niger Delta oil field structures and associated trap types (Modified from D... and Omatsola, 1990 and Stacher, 1995)



BASIC CONCEPT: SEISMIC ATTRIBUTES



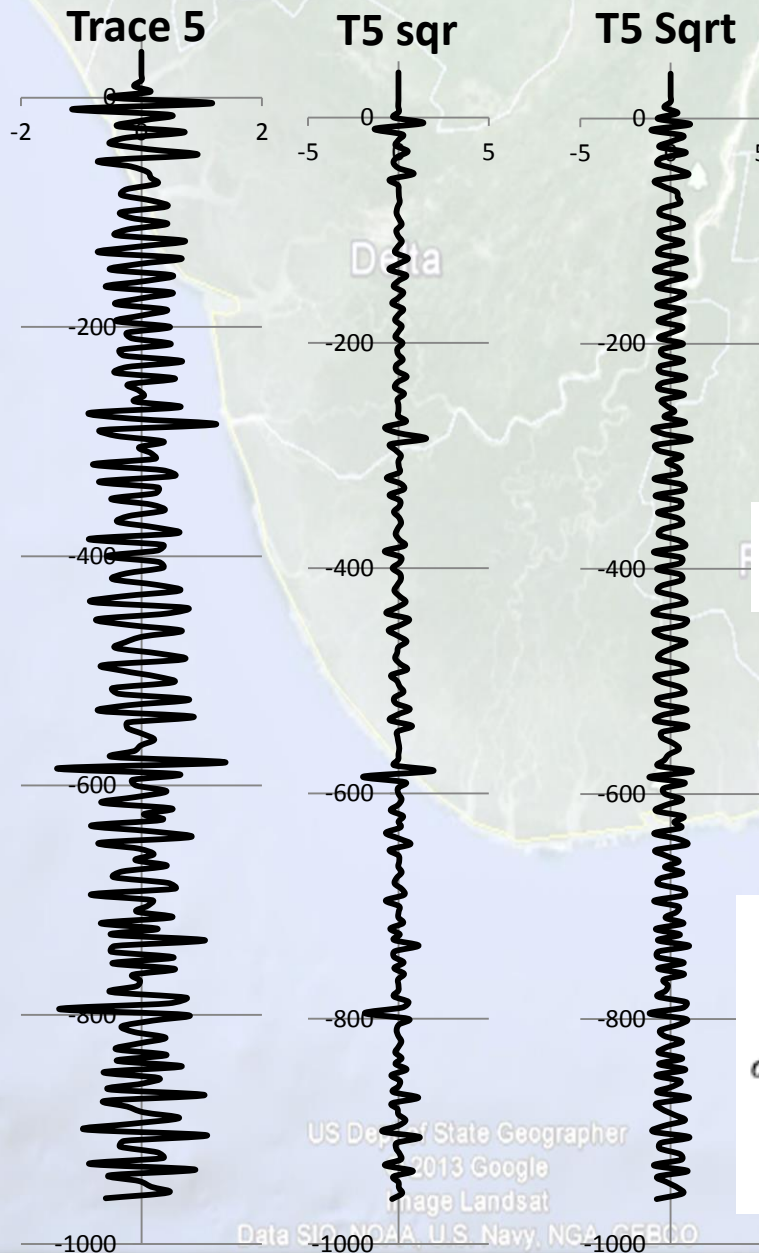
120 km



BASIC CONCEPT: SEISMIC ATTRIBUTES



Trace	Time	Amp	Amp Sqr	Amp Sqrt
5	0	-0.5108	-0.2609	-0.7147
5	5	1.1705	1.37007	1.0819
5	95	0.4181	0.17481	0.64661
5	100	-0.3421	-0.117	-0.5849
5	105	-0.1634	-0.0267	-0.4042
5	145	-0.0291	-0.0008	-0.1706
5	205	-0.234	-0.0548	-0.4837
5	210	-0.1548	-0.024	-0.3934
5	215	0.4873	0.23746	0.69807
5	220	-0.3542	-0.1255	-0.5951
5	225	-0.2901	-0.0842	-0.5386
5	230	0.6765	0.45765	0.8225
5	235	-0.241	-0.0581	-0.4909
5	240	-0.4338	-0.1882	-0.6586
5	245	0.5576	0.31092	0.74673
5	305	-0.0387	-0.0015	-0.1967
5	310	0.1541	0.02375	0.39256
5	345	0.2345	0.05499	0.48425
5	400	-0.5708	-0.3258	-0.7555
5	405	0.2846	0.081	0.53348
5	410	0.3615	0.13068	0.60125
5	415	-0.256	-0.0655	-0.506
5	420	-0.4762	-0.2268	-0.6901
5	425	0.2535	0.06426	0.50349
5	430	0.6308	0.39791	0.79423
5	435	-0.3152	-0.0994	-0.5614
5	440	-0.8158	-0.6655	-0.9032
5	445	0.7512	0.5643	0.86672
5	450	0.4197	0.17615	0.64784
5	525	0.7926	0.62821	0.89028
5	530	-0.2212	-0.0489	-0.4703
5	565	-0.0101	-0.0001	-0.1005
5	570	-0.1232	-0.0152	-0.351
5	575	-0.4868	-0.237	-0.6977
5	580	1.387	1.92377	1.17771
5	585	-1.395	-1.946	-1.1811
5	590	0.6149	0.3781	0.78416
5	595	-0.1431	-0.0205	-0.3783
5	655	-0.0524	-0.0027	-0.2289
5	660	0.2034	0.04137	0.451
5	665	-0.1004	-0.0101	-0.3169
5	670	0.4201	0.17648	0.64815
5	675	-0.322	-0.1037	-0.5675
5	680	-0.4594	-0.211	-0.6778



RMS Amplitude

$$A_{RMS}(t) = \sqrt{\frac{1}{N} \sum_{k=-N/2}^{N/2} (f(t+k))^2}$$

Complex Trace Attribute

$$F_{HI} = H\{f(t)\} = \left(\frac{1}{\pi}\right) PV \int_{-\infty}^{+\infty} \frac{f(\tau)}{t-\tau} d\tau$$

Variance

$$\sigma^2 = \sum_{i=1}^l (x_i - \bar{x})^2$$

$$\sigma_t^2 = \frac{\sum_{j=t-L/2}^{j=t+L/2} w_{j-t} \sum_{i=1}^l (x_{ij} - \bar{x}_j)^2}{\sum_{j=t-L/2}^{j=t+L/2} w_{j-t} \sum_{i=1}^l x_{ij}^2}$$

US Dept. of State Geographer

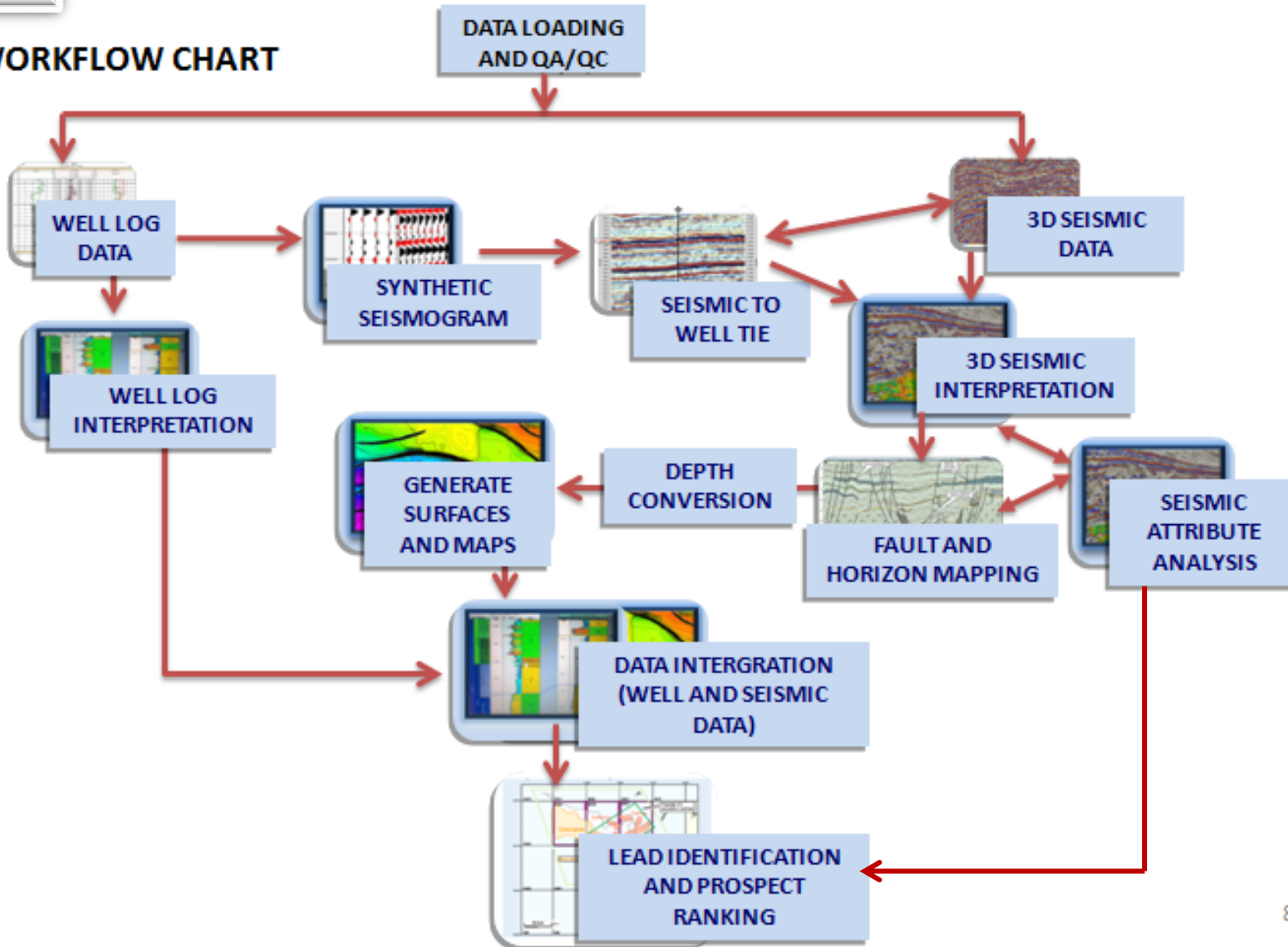
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Image Landsat

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

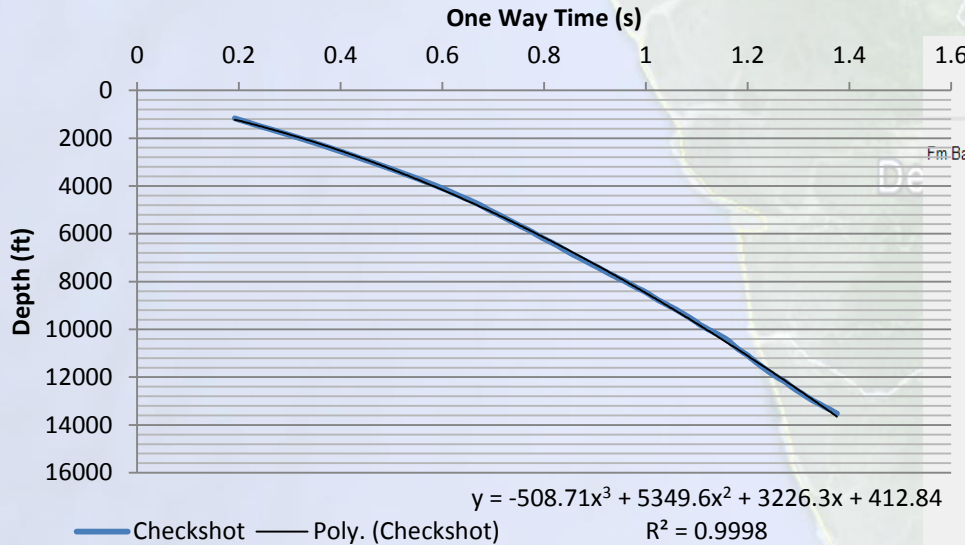
METHODOLOGY

WORKFLOW CHART

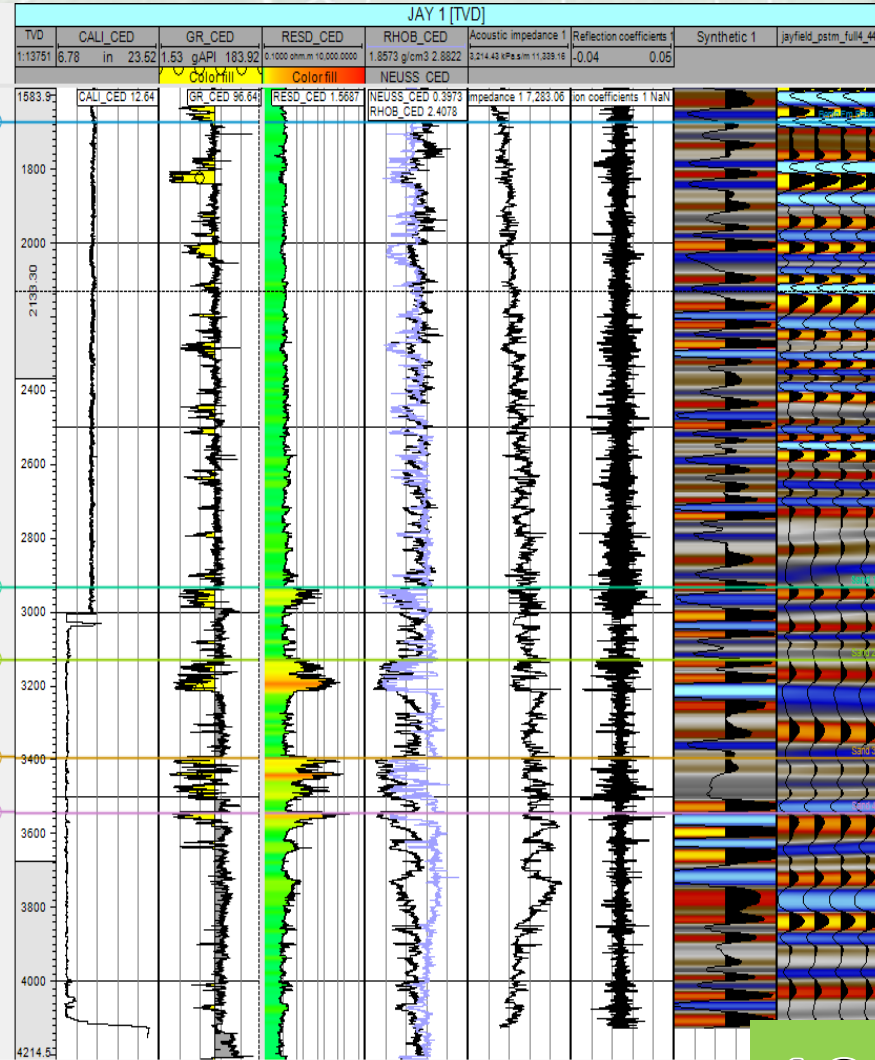




METHODOLOGY



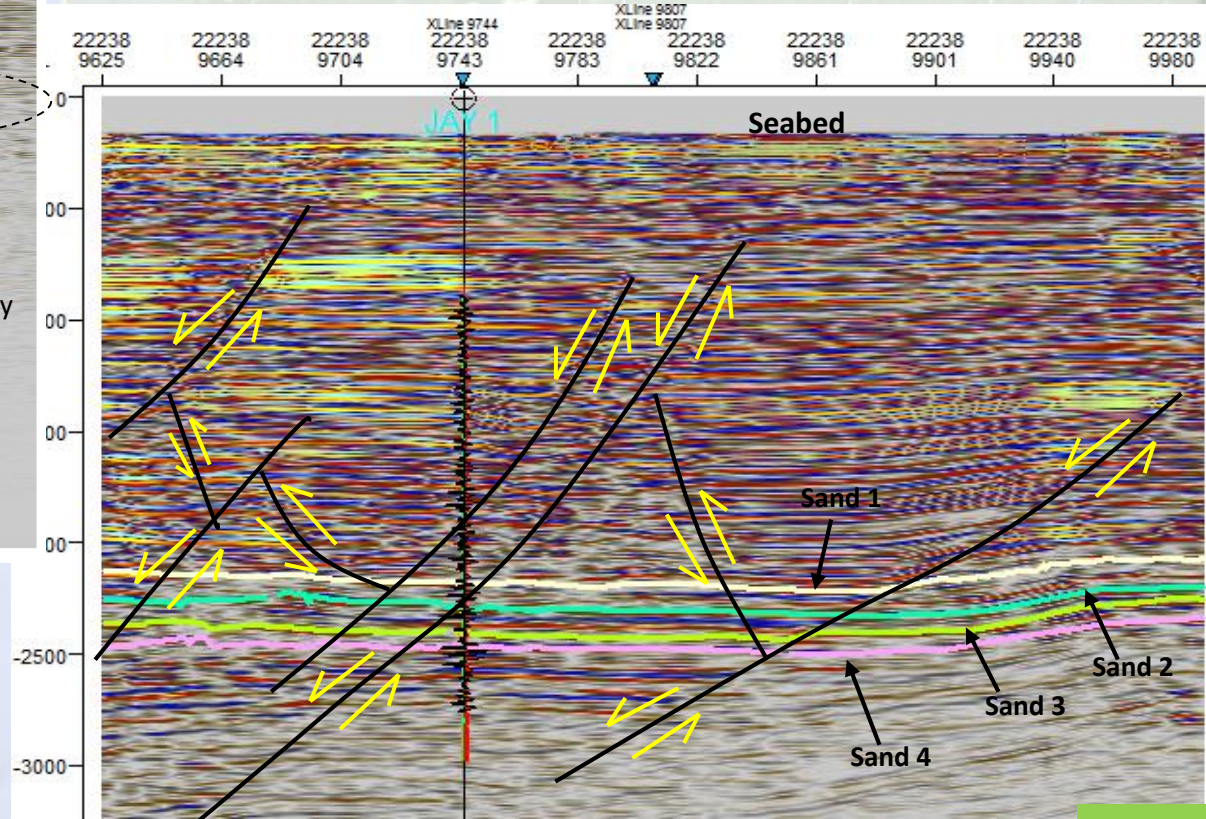
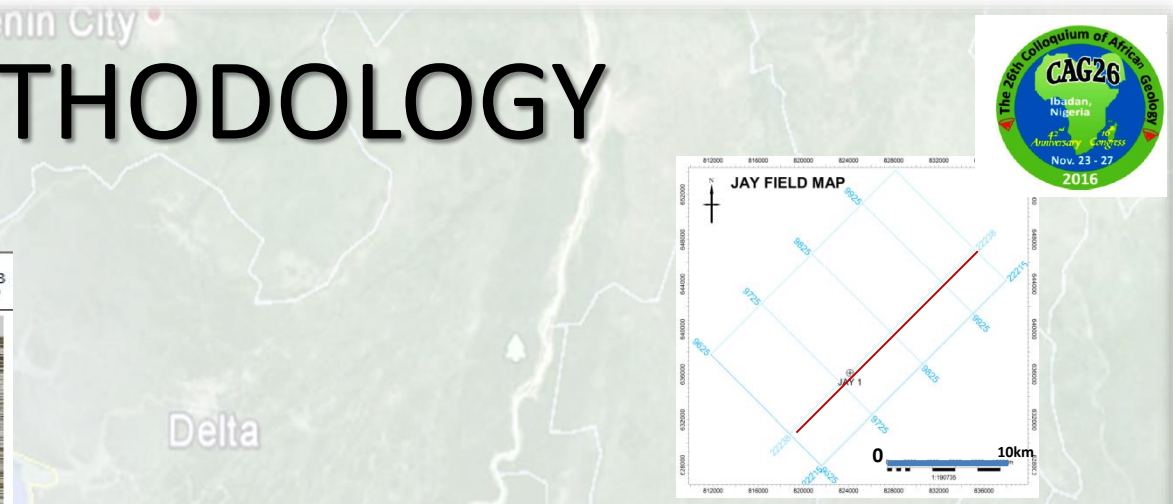
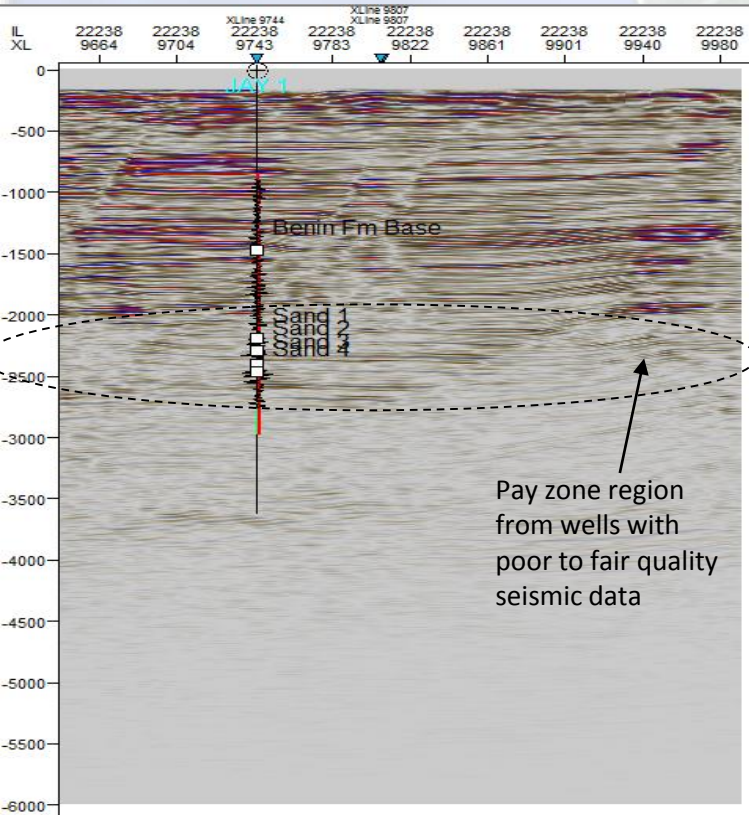
Plot of checkshot data used as the Time-Depth relationship



Well to seismic tie section: Track 5 to 8 is the AI, RC, Synthetic and Seismic section respectively



METHODOLOGY



Inline 22238 showing good reflection patterns near surface and poor patterns at 2 to 6 secs

Inline 22238 showing good mapped faults and horizons

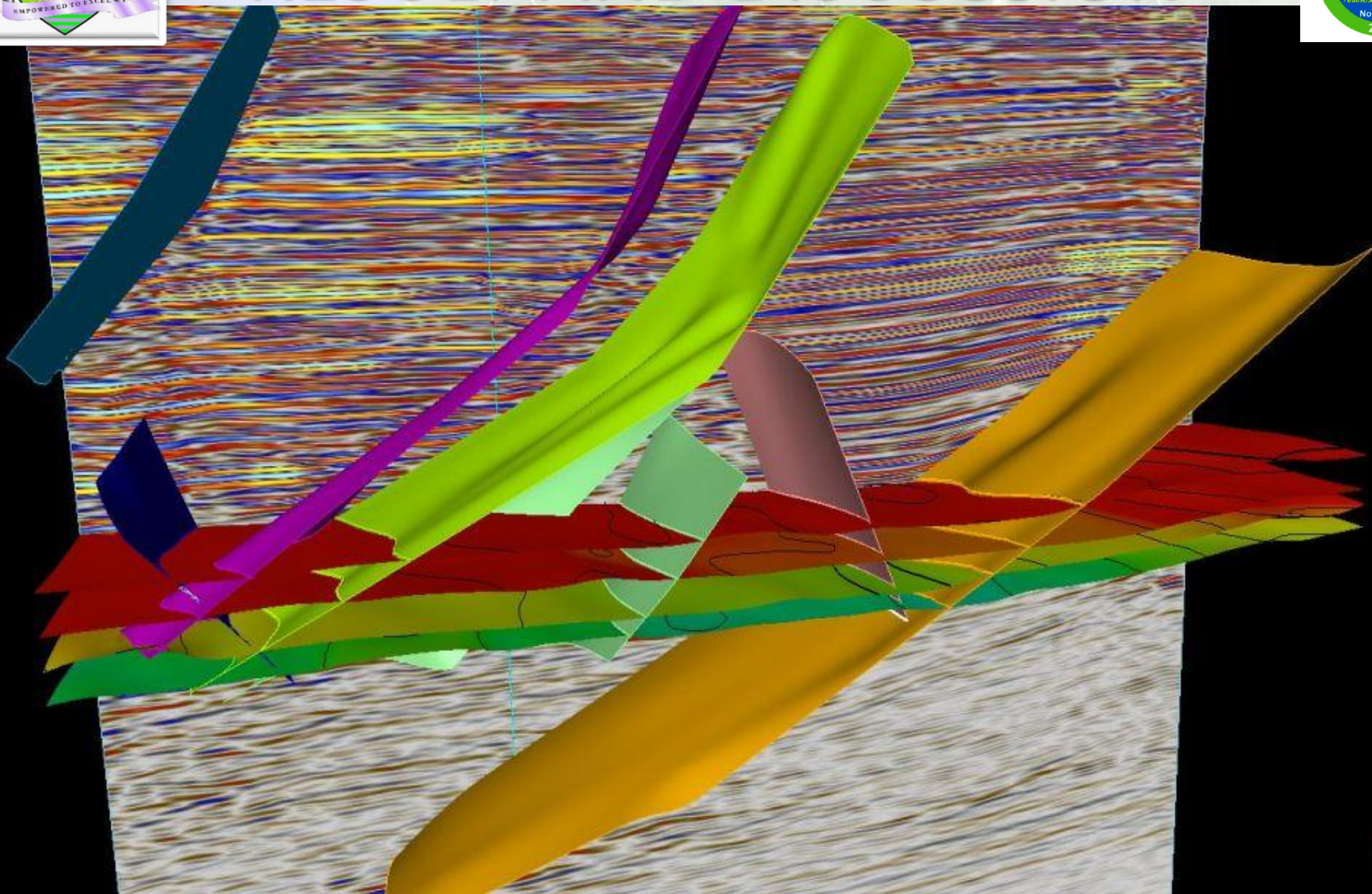
Gulf of Guinea

120 km



Benin City

RESULT AND DISCUSSION

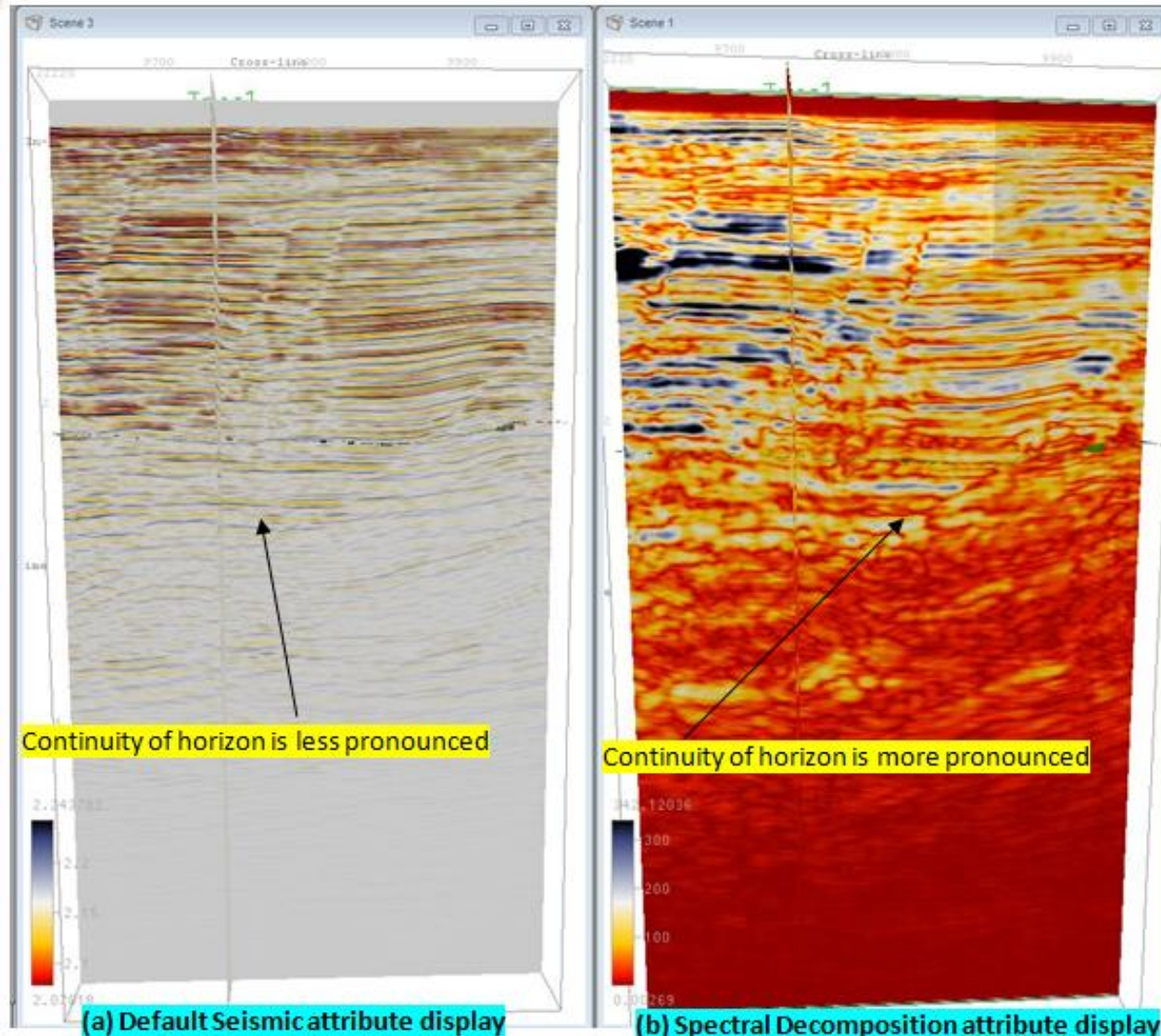
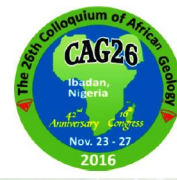


120 km

US Dept of State Geographer
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO



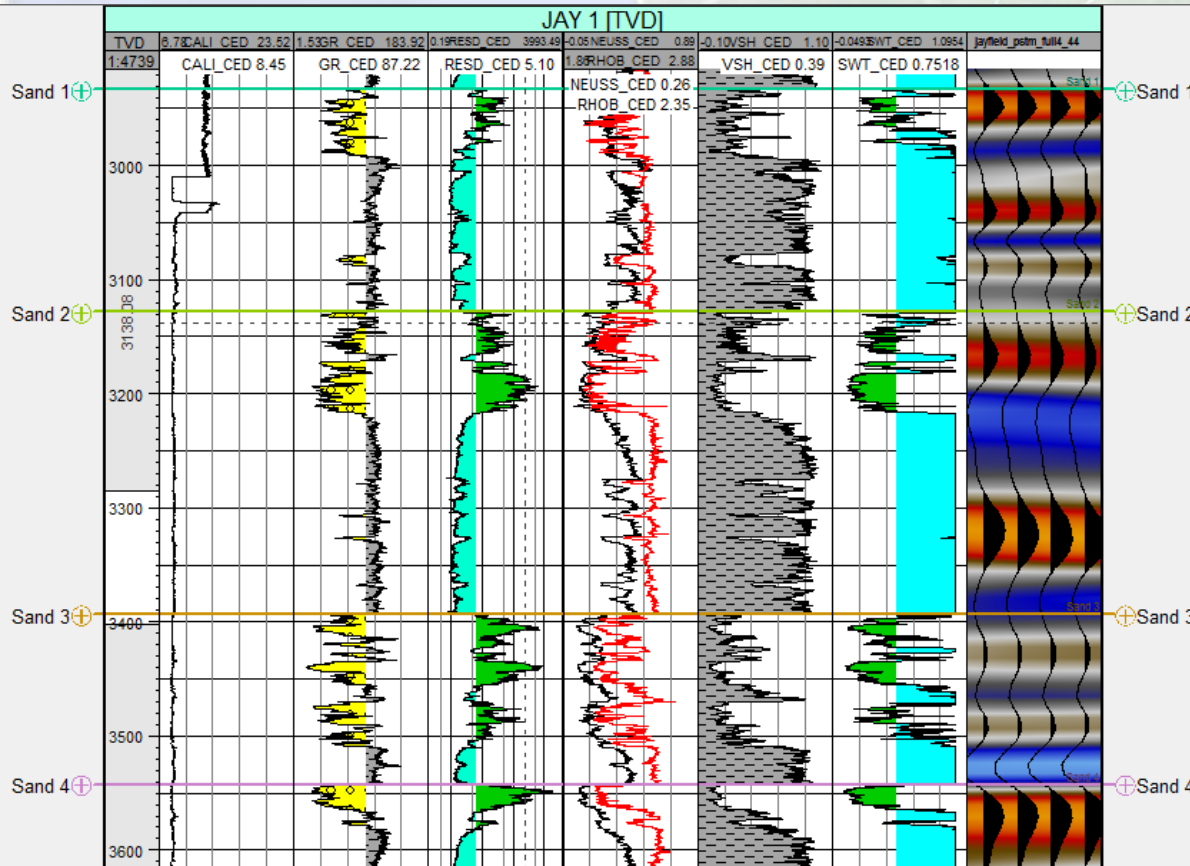
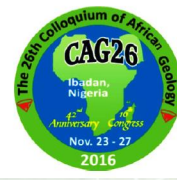
RESULT AND DISCUSSION



120 km



RESULTS AND DISCUSSION



Calculated Petrophysical Parameters for Reservoirs in Well Jay 1

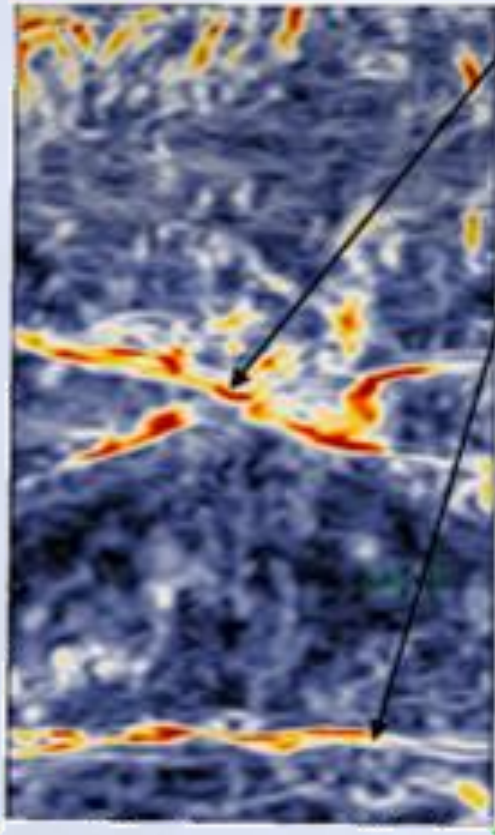
Reservoir	Porosity	S_w	$S_h = (1 - S_w)$	NTG
SAND 1	0.26	0.34	0.66	0.54
SAND 2	0.24	0.28	0.71	0.73
SAND 3	0.22	0.31	0.69	0.58
SAND 4	0.21	0.28	0.72	0.91

Identified hydrocarbon bearing reservoirs from the well log interpretation

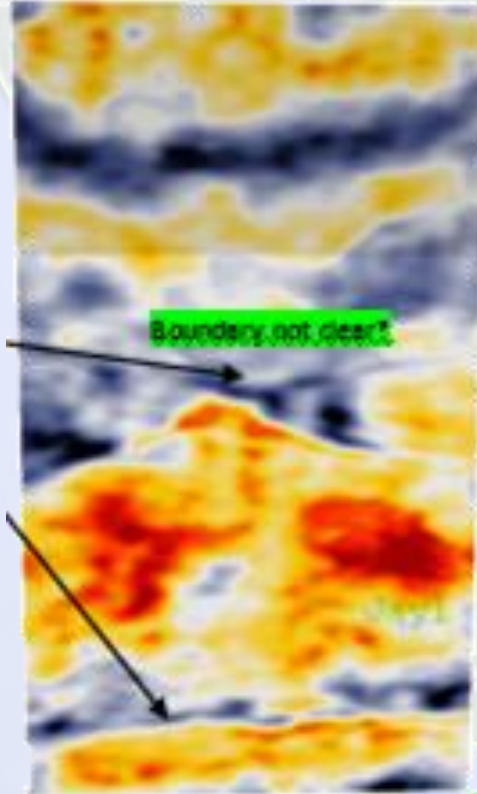
Gulf of Guinea

120 km

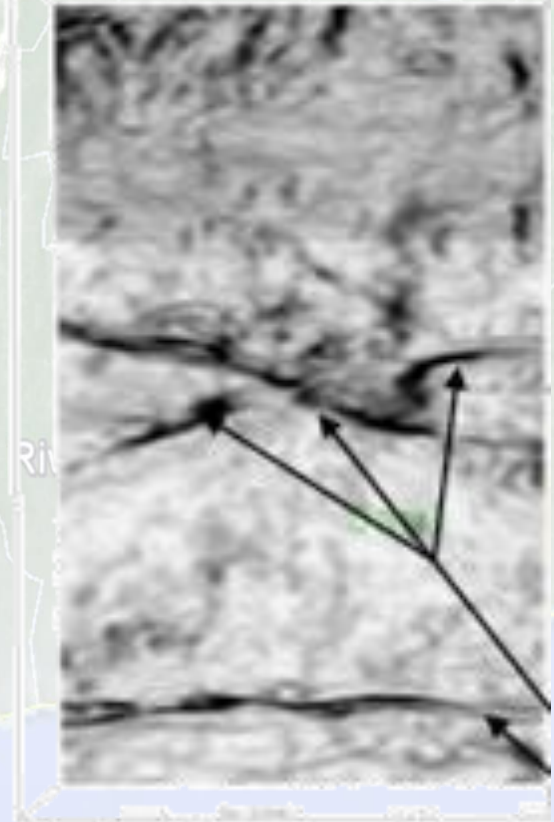
RESULT AND DISCUSSION



Spectral Decomposition



Seismic default



Similarity



Gulf of Guinea

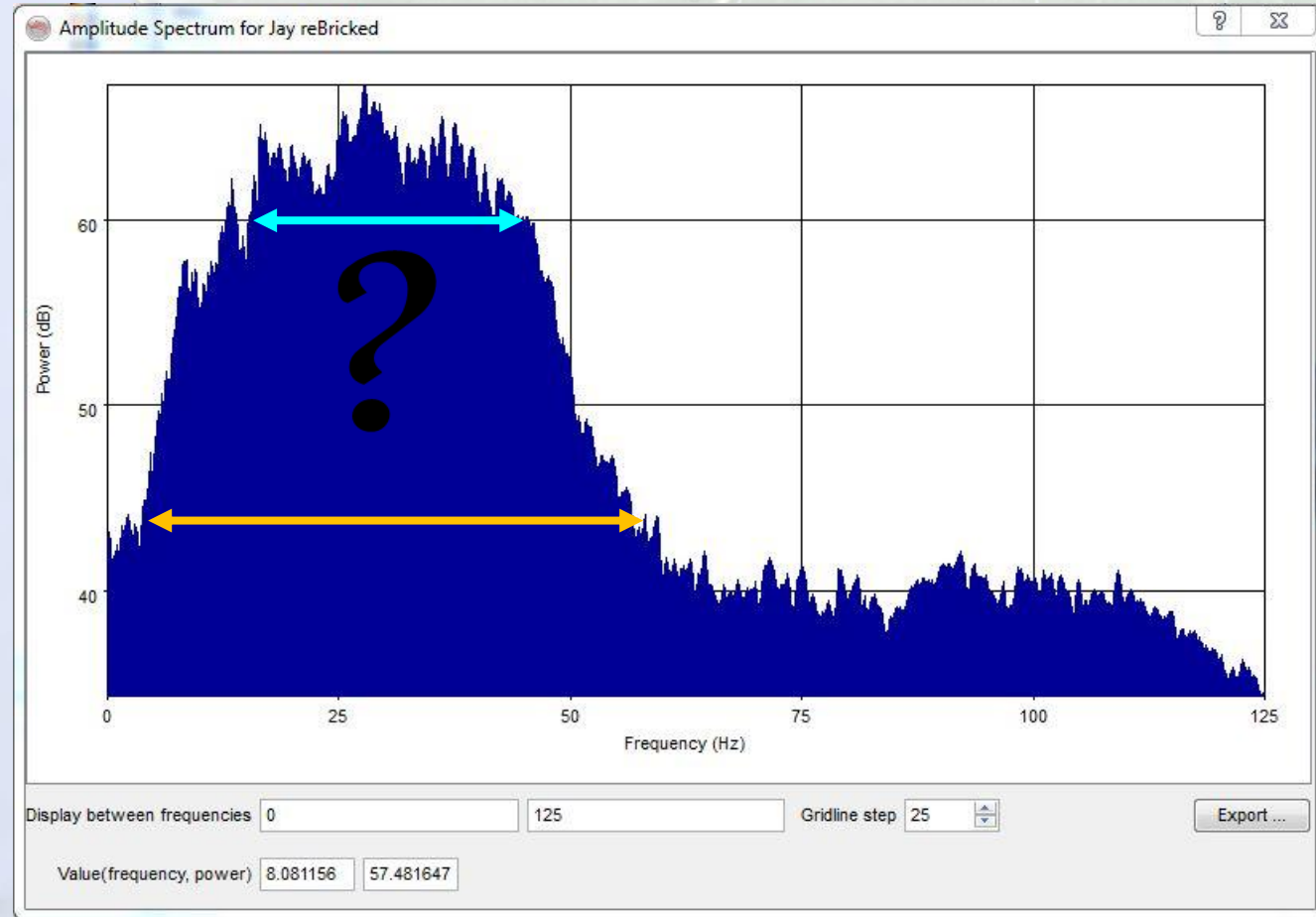
120 km



RESULT AND DISCUSSION



Spectral Decomposition Analysis



Gulf of Guinea

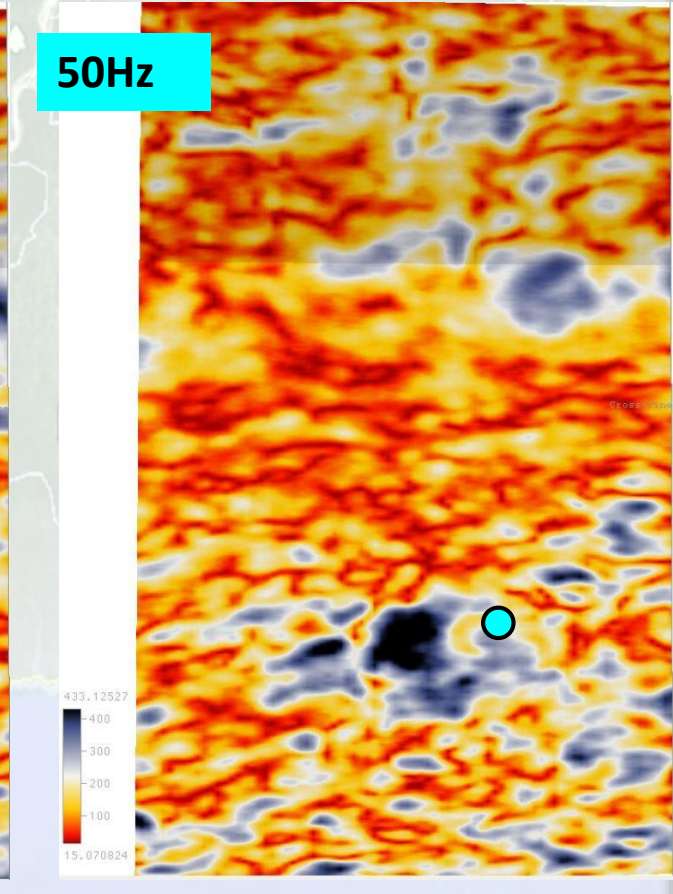
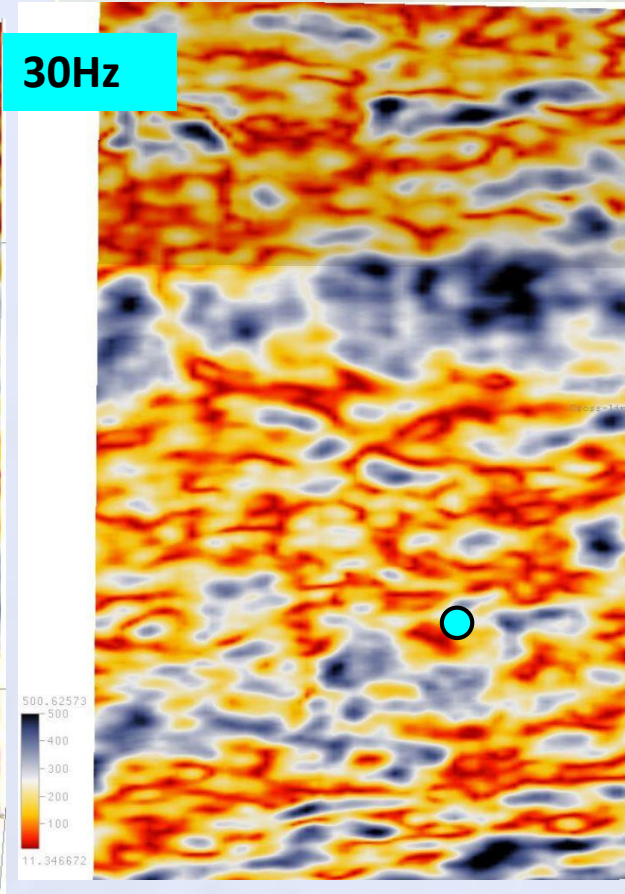
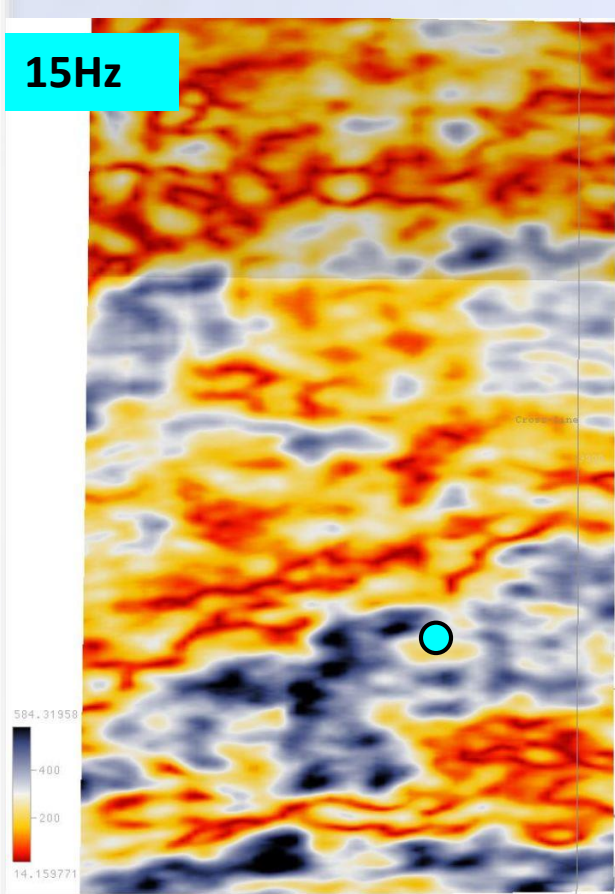
120 km



RESULT AND DISCUSSION



2182ms (Sand 1)



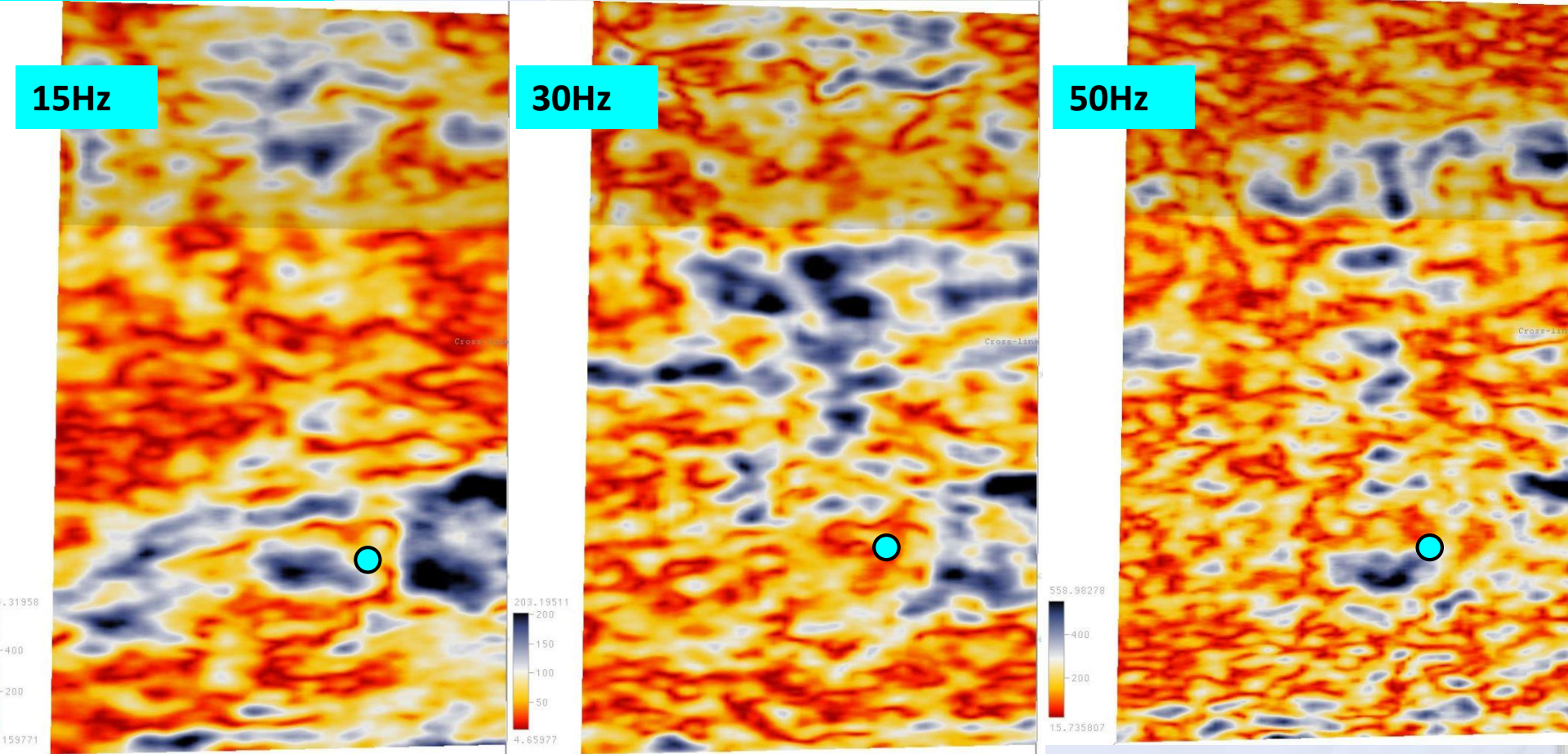
Sand 1 (2182ms)	Central Frequency (Hz)	5	15	25	30	40	50	60	75
	Amplitude	92	245	276	238	170	78	65	39



RESULTS AND DISCUSSION



2296ms (Sand 2)



Gulf of Guinea

Sand 2	Central Frequency (Hz)	5	15	25	30	40	50	60	75
	2296ms	65	177	272	180	101	56	23	14

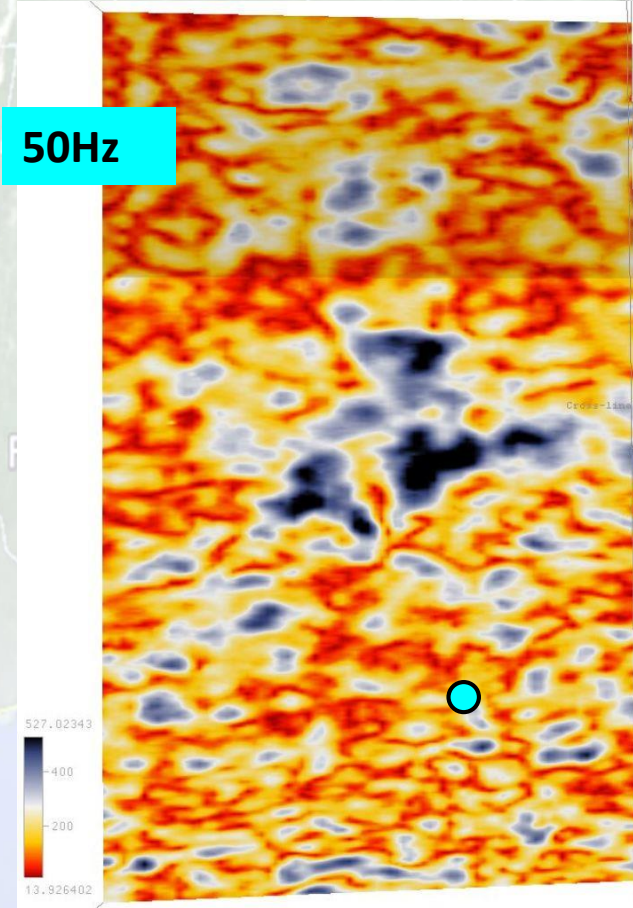
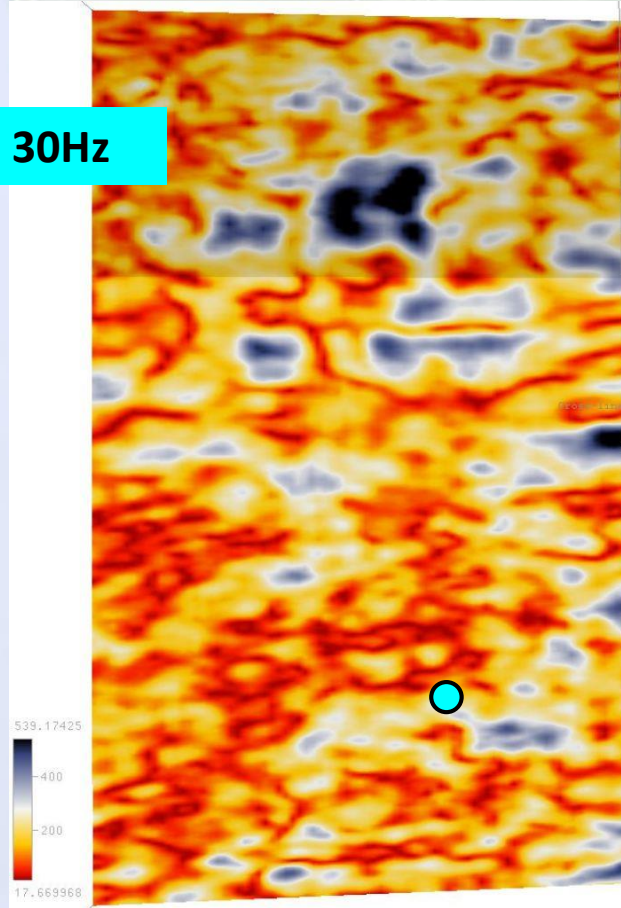
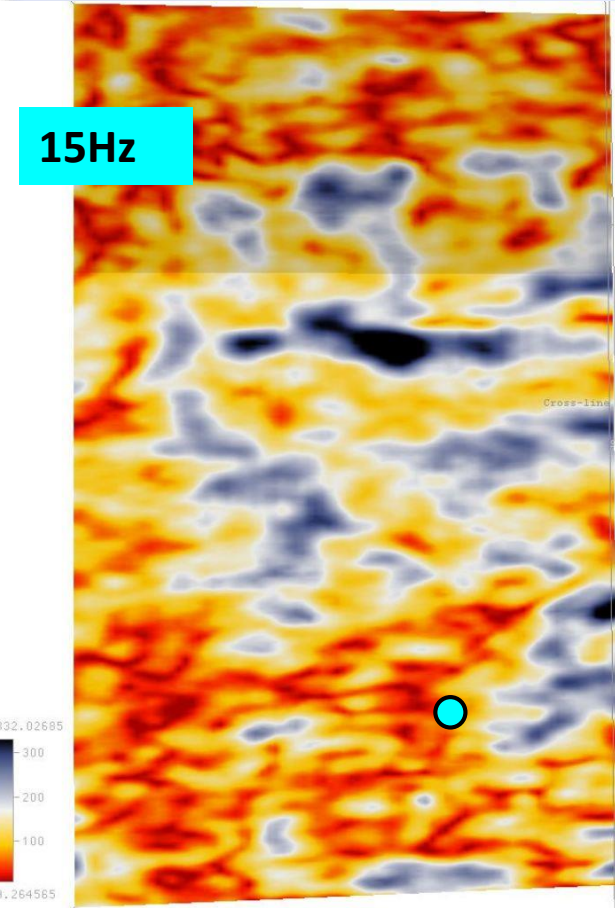
RESULTS AND DISCUSSION

2404 (Sand 3)

15Hz

30Hz

50Hz

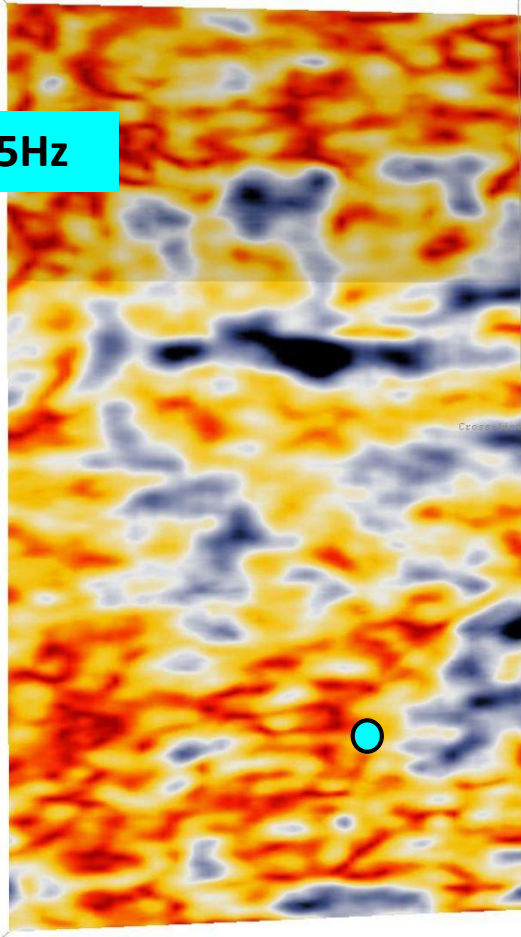


Sand 3	Central Frequency (Hz)	5	15	25	30	40	50	60	75
	2404ms	67	99	188	164	80	59	28	21

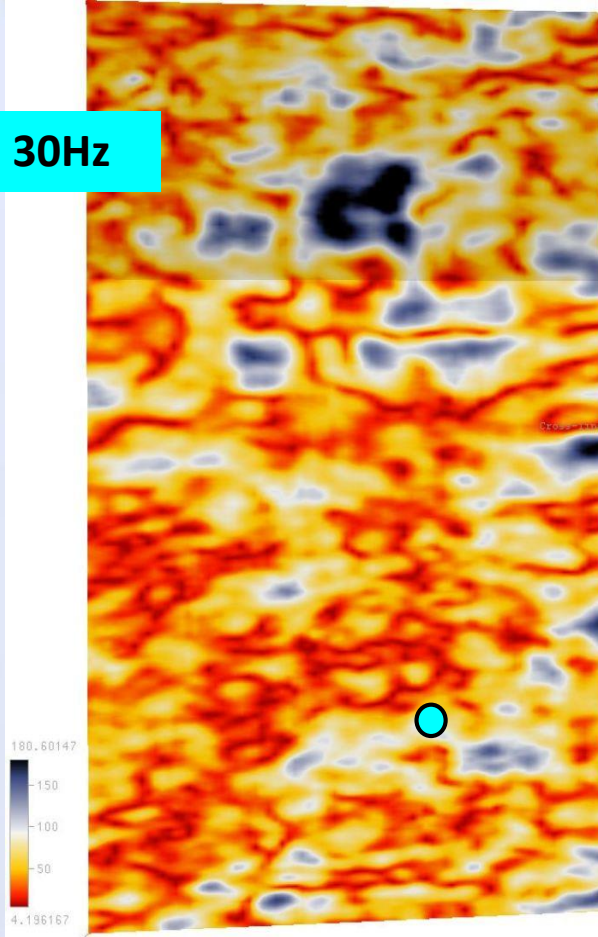
RESULTS AND DISCUSSION

2408 (Sand 3)

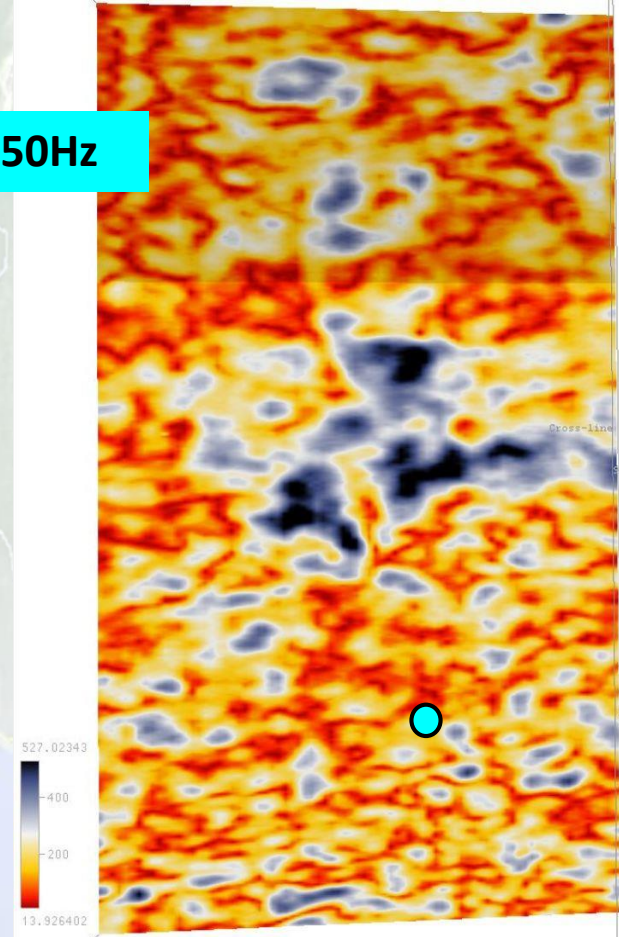
15Hz



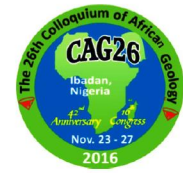
30Hz



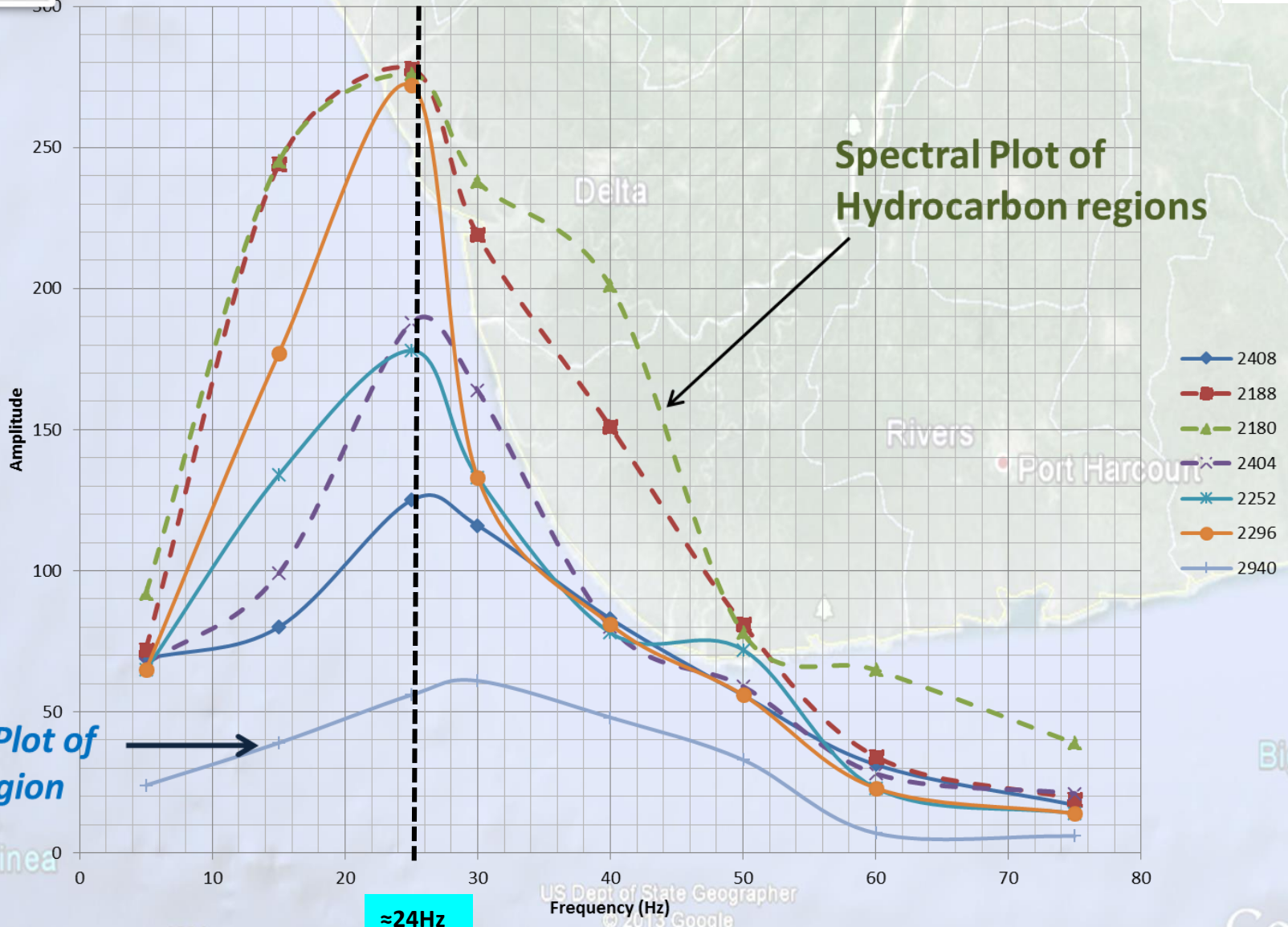
50Hz



Sand 3	Central Frequency (Hz)	5	15	25	30	40	50	60	75
	2408ms		68.8	80	125	116	83	55.9	31.3



RESULT AND DISCUSSION

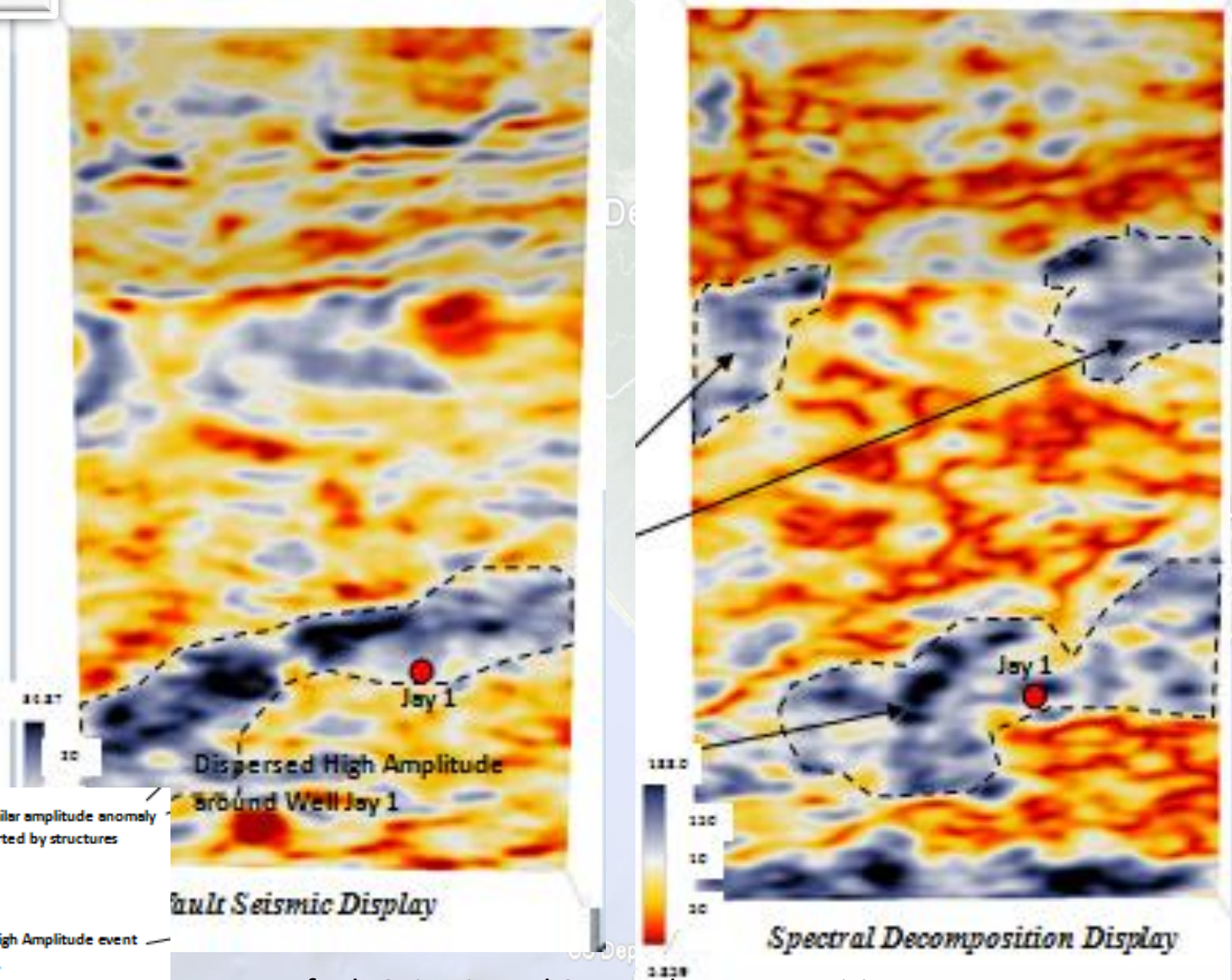


Spectral Plot of Water region

Spectral Plot of Hydrocarbon regions

≈24Hz

RESULT AND DISCUSSION



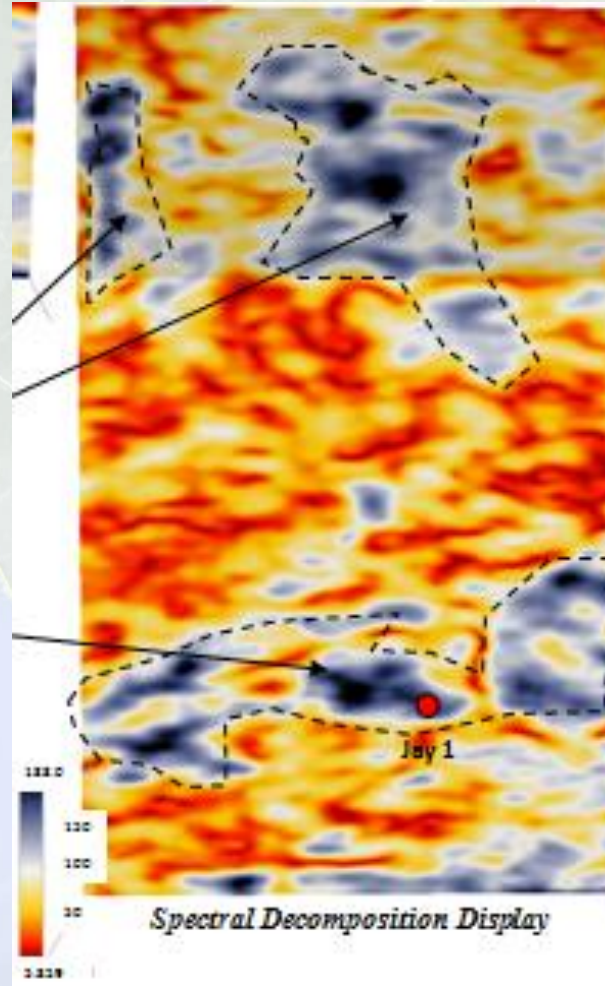
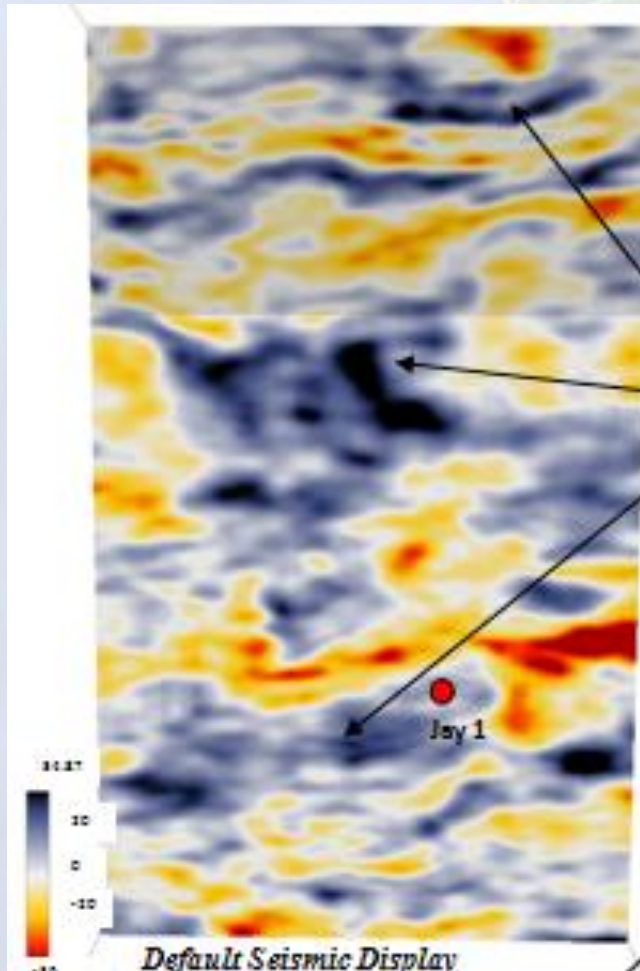
Other region with similar amplitude anomaly on Sand 1 also supported by structures

Better defined High Amplitude event around Well Jay 1

Default Seismic and Spectral Decomposition attribute display on time slice at 2182ms (Sand 1)

RESULTS AND DISCUSSION

2292ms (Sand 2)



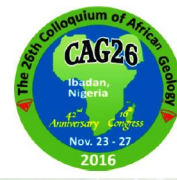
Other region with similar amplitude anomaly on Sand 2 also supported by structures

Better defined High Amplitude event around Well Jay 1

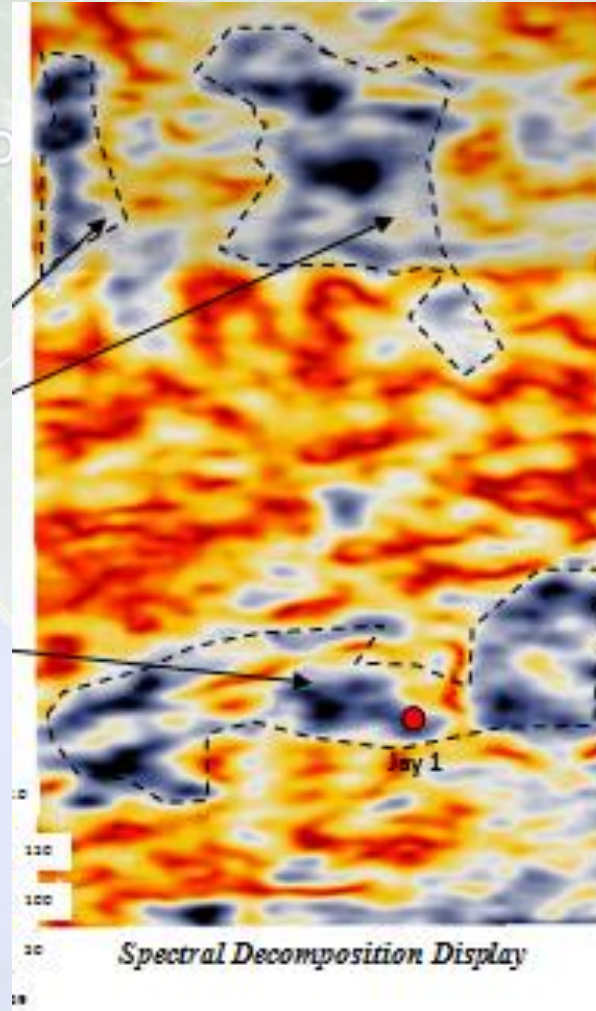
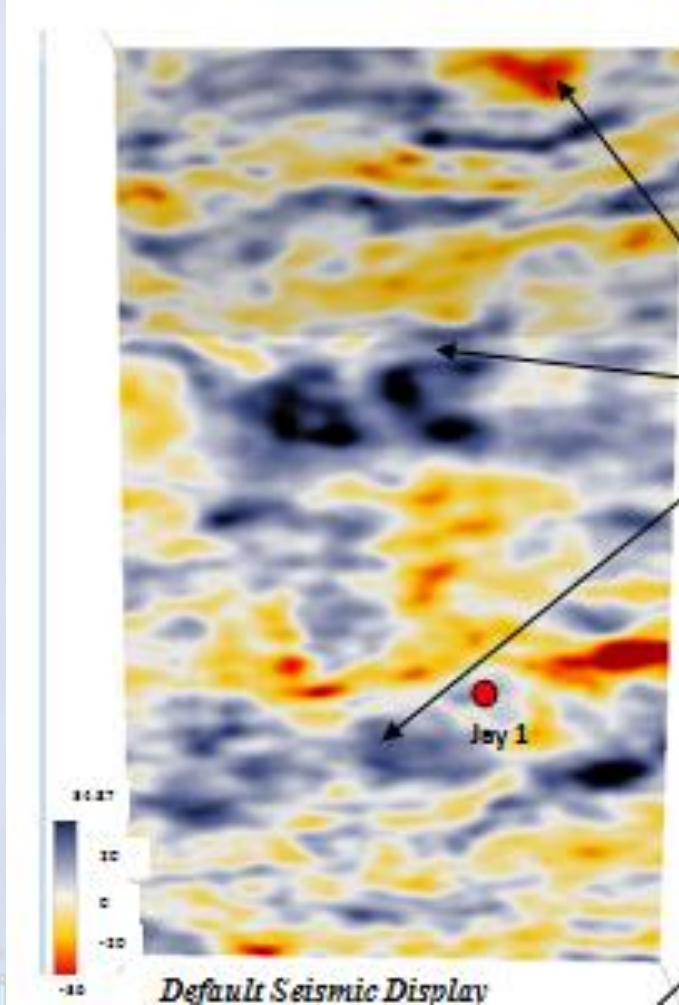
Default Seismic and Spectral Decomposition attribute display on time slice at 2292ms (Sand 2)



RESULTS AND DISCUSSION



2296ms (Sand 2)



Other region with similar amplitude anomaly on Sand 2 also supported by structures

Better defined High Amplitude event around Well Jsy 1

Default Seismic and Spectral Decomposition attribute display on time slice at 2296ms (Sand 2)

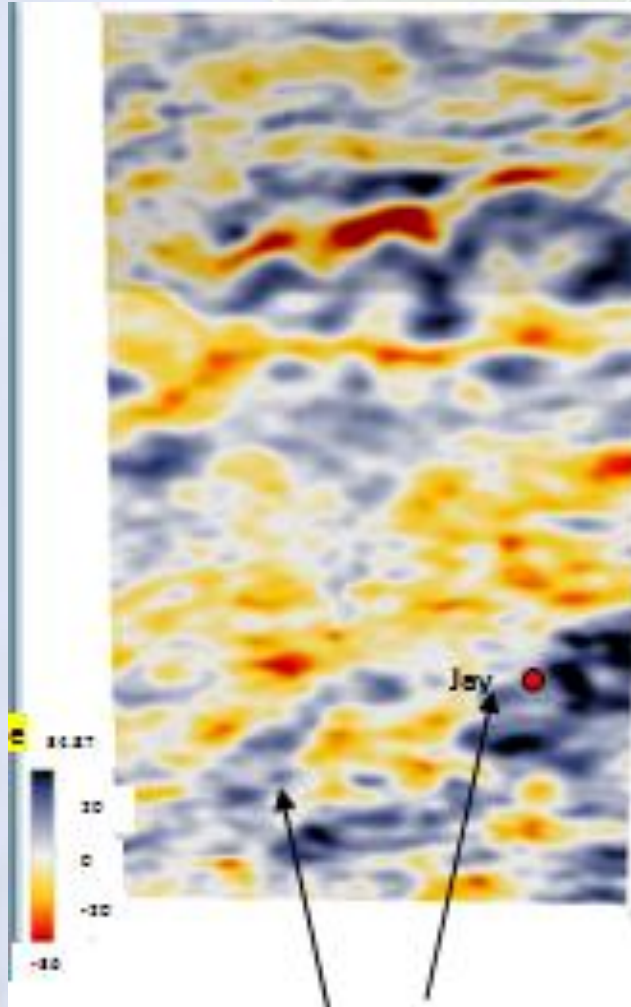
US Dept of State Geographer
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RESULTS AND DISCUSSION

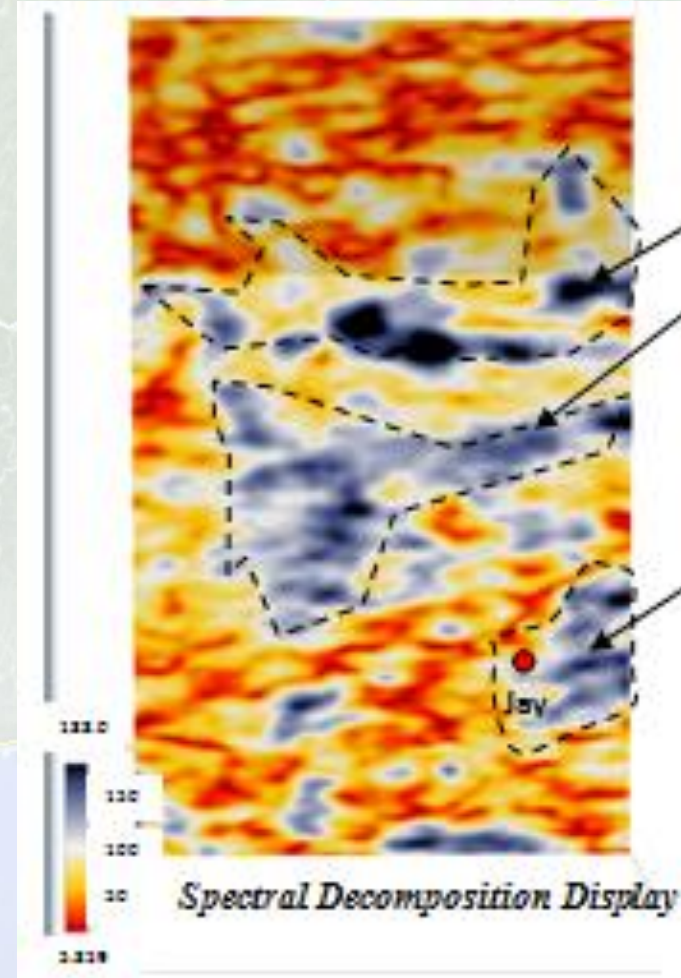


2404 (Sand 3)



Other region with similar attribute anomaly on Sand 3 also supported by structures

Better defined Anomalous event around Well Jey 1



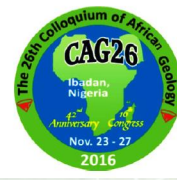
Gulf of Guinea

Default Seismic and Spectral Decomposition attribute display on time slice at 2404 (Sand 3)

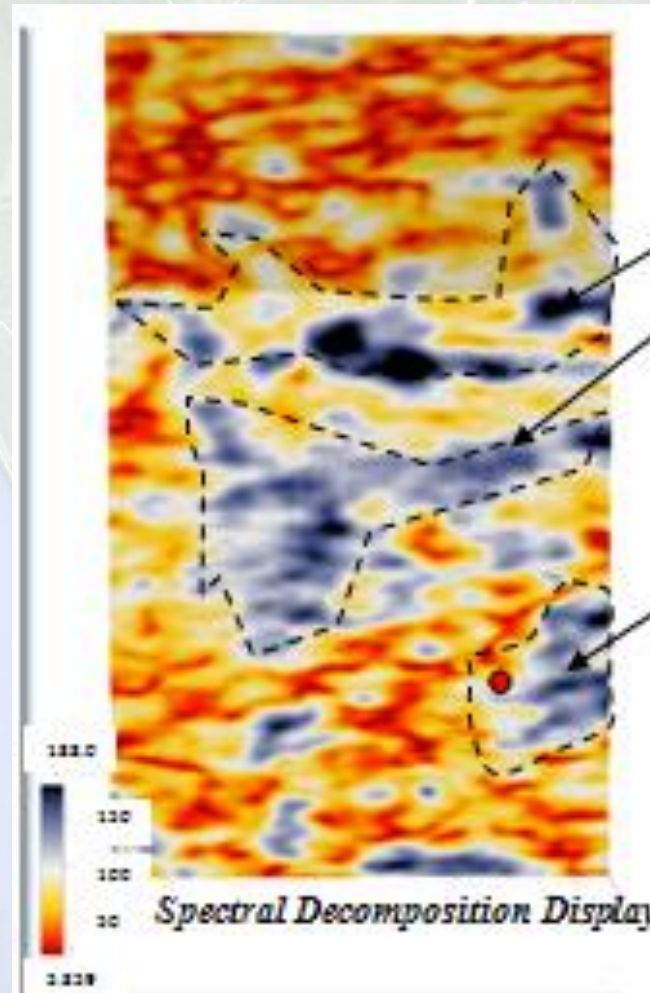
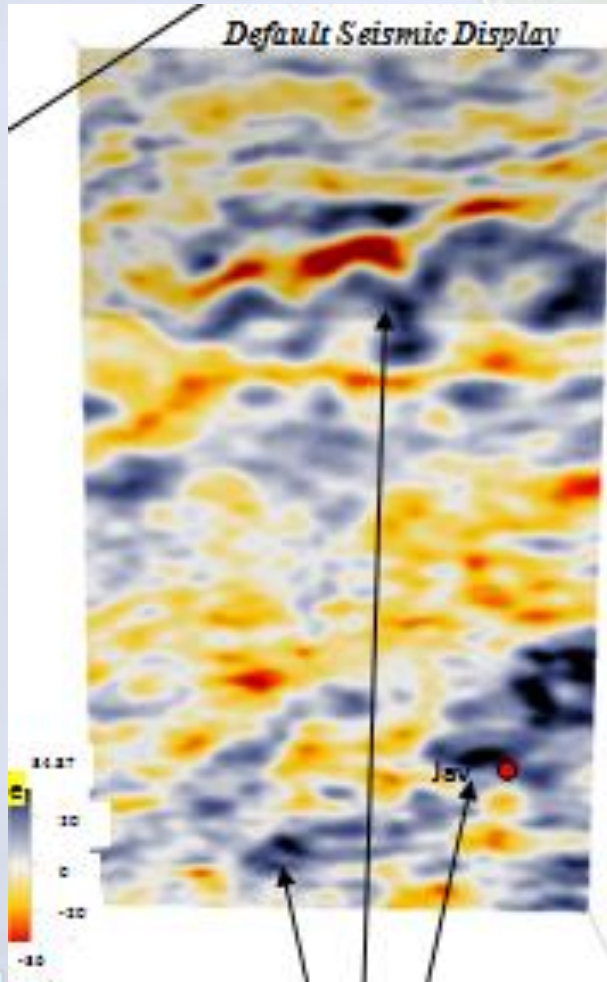
120 km



RESULTS AND DISCUSSION



2408 (Sand 3)



Other region with similar attribute anomaly on Sand 3 also supported by structures

Better defined Anomalous event around Well Jay 1

Default Seismic and Spectral Decomposition attribute display on time slice at 2408 (Sand 3)

120 km

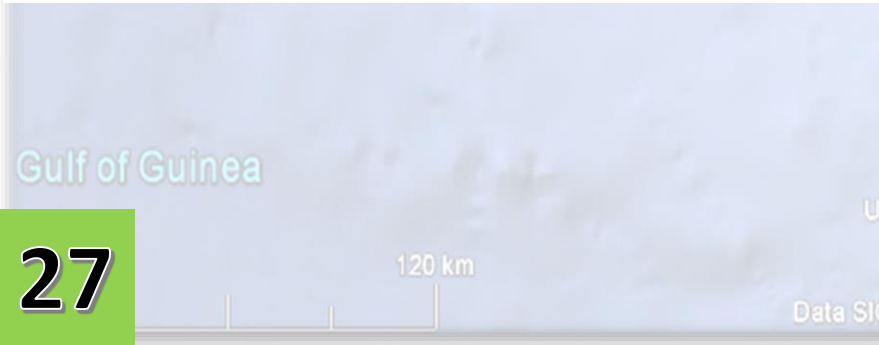
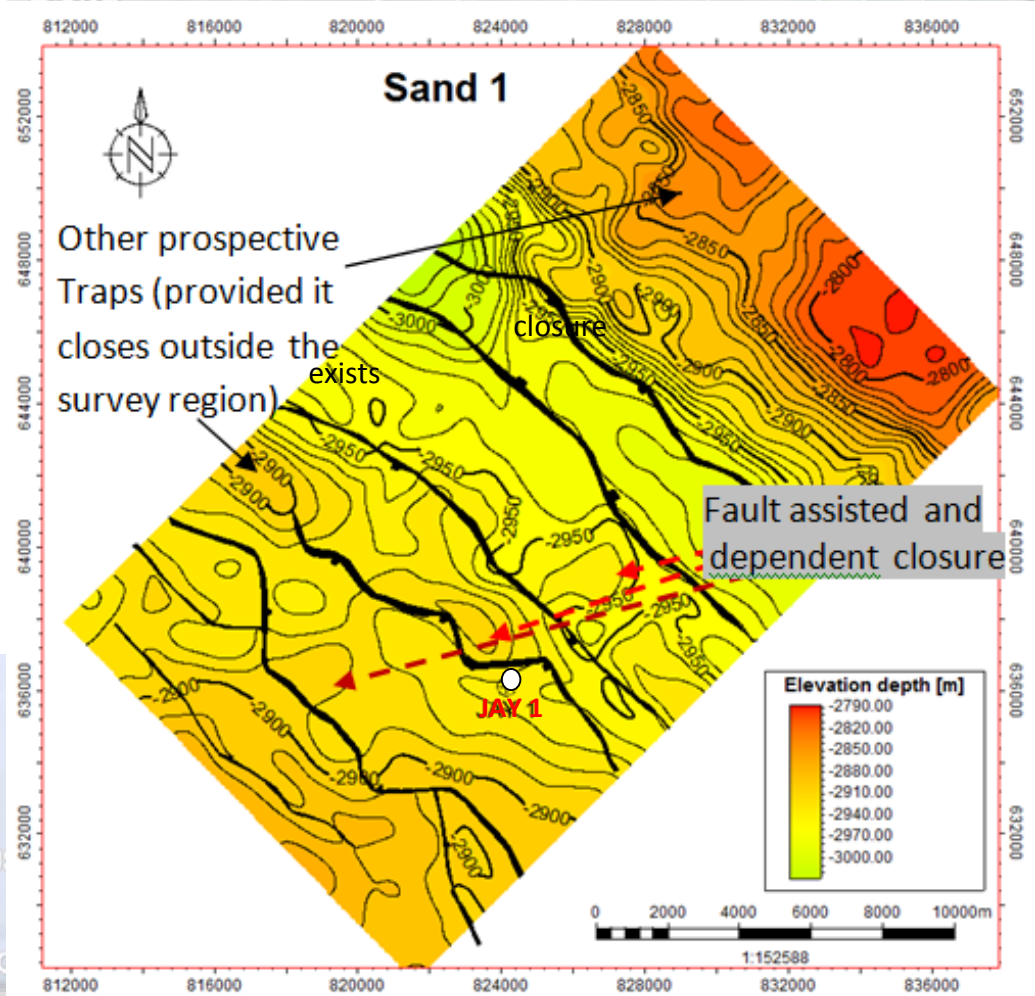
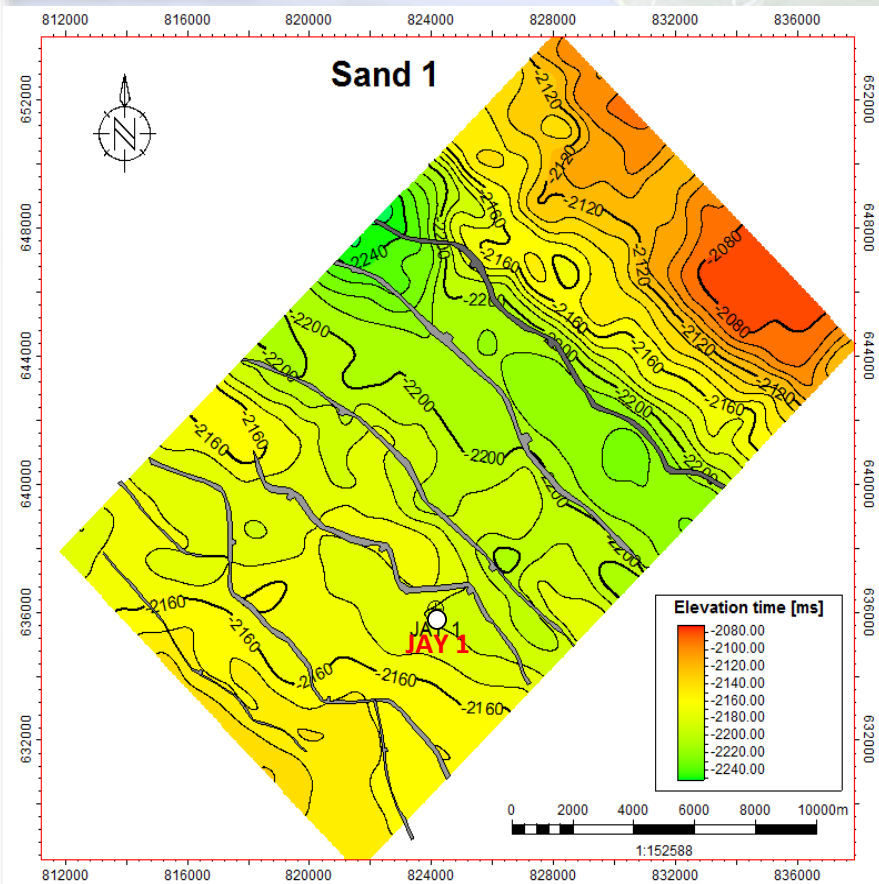
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Image Landsat

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

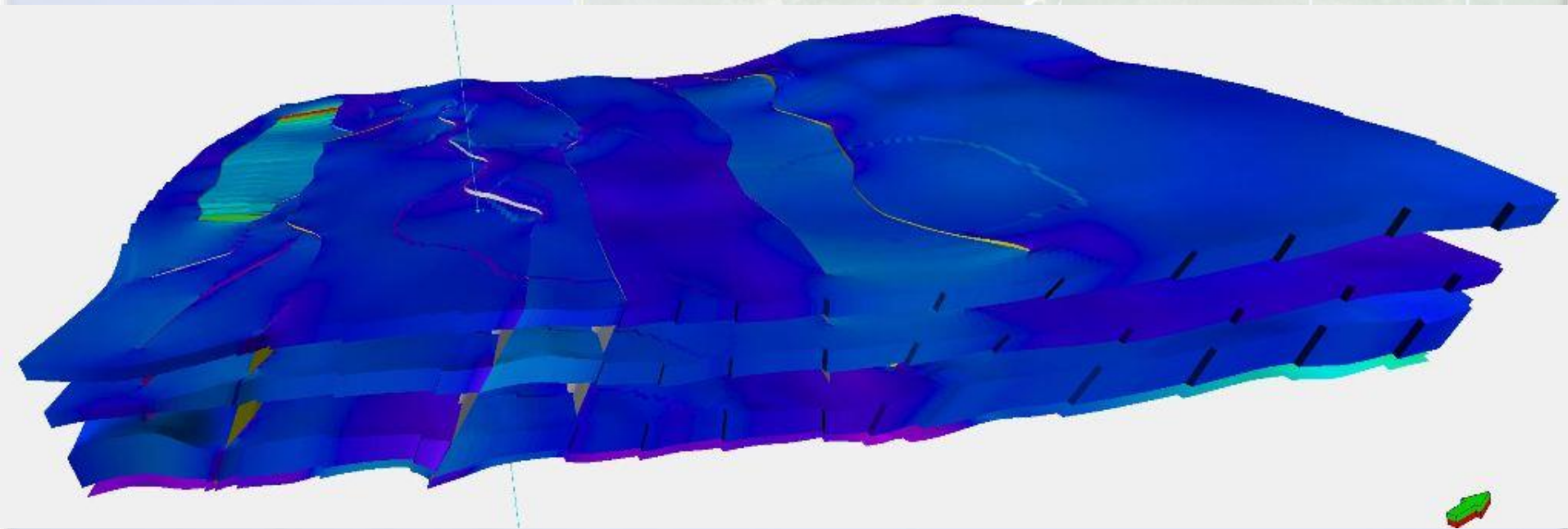
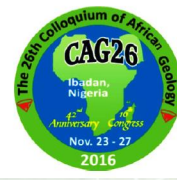


RESULTS AND DISCUSSION

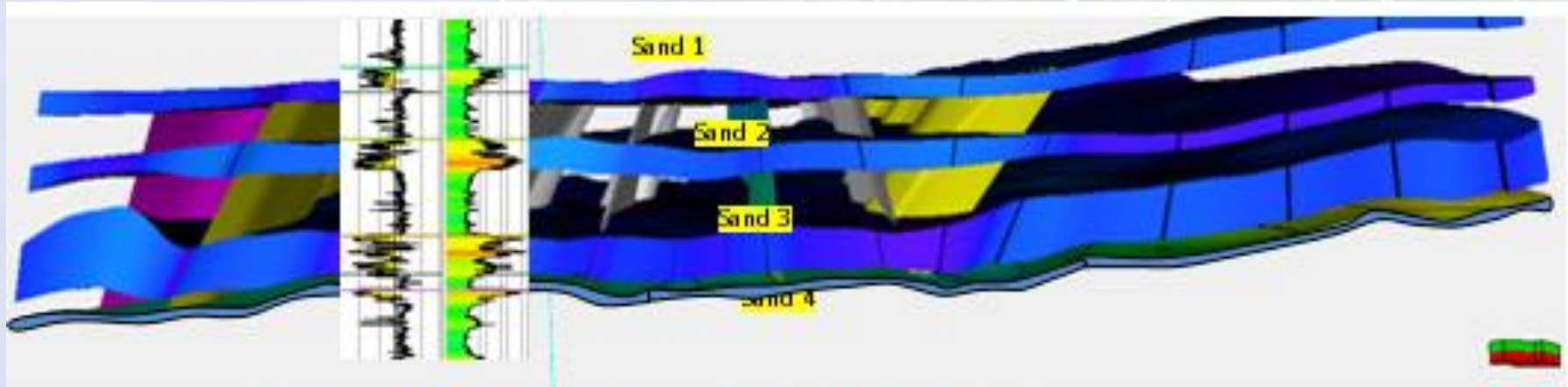




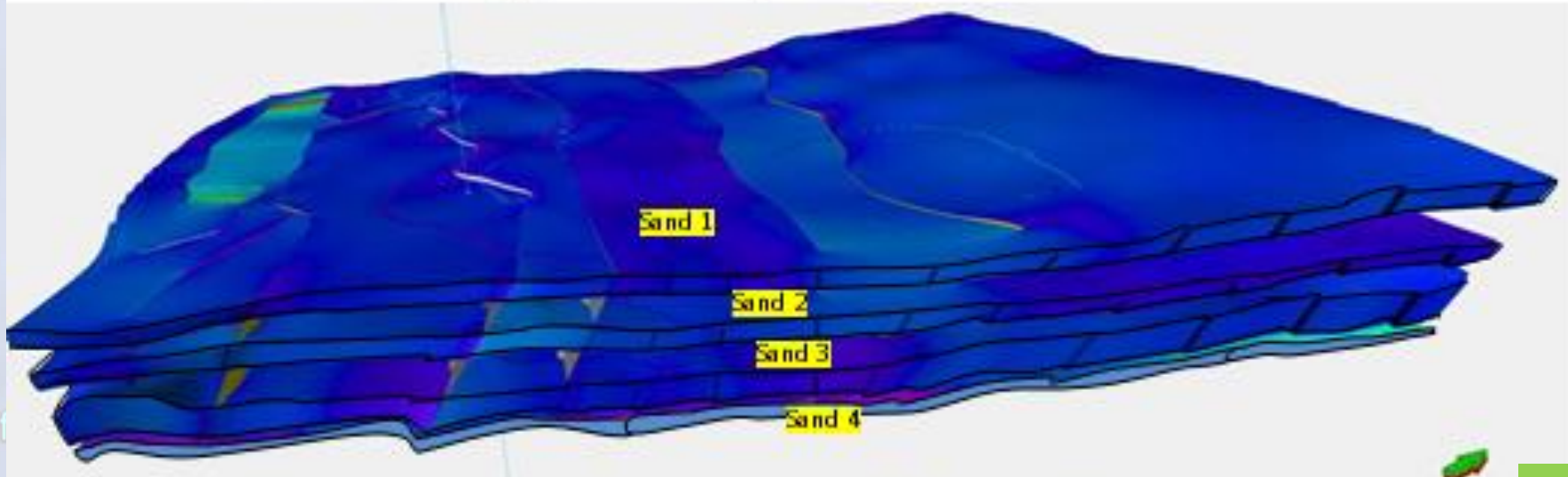
RESULTS AND DISCUSSION



RESULTS AND DISCUSSION



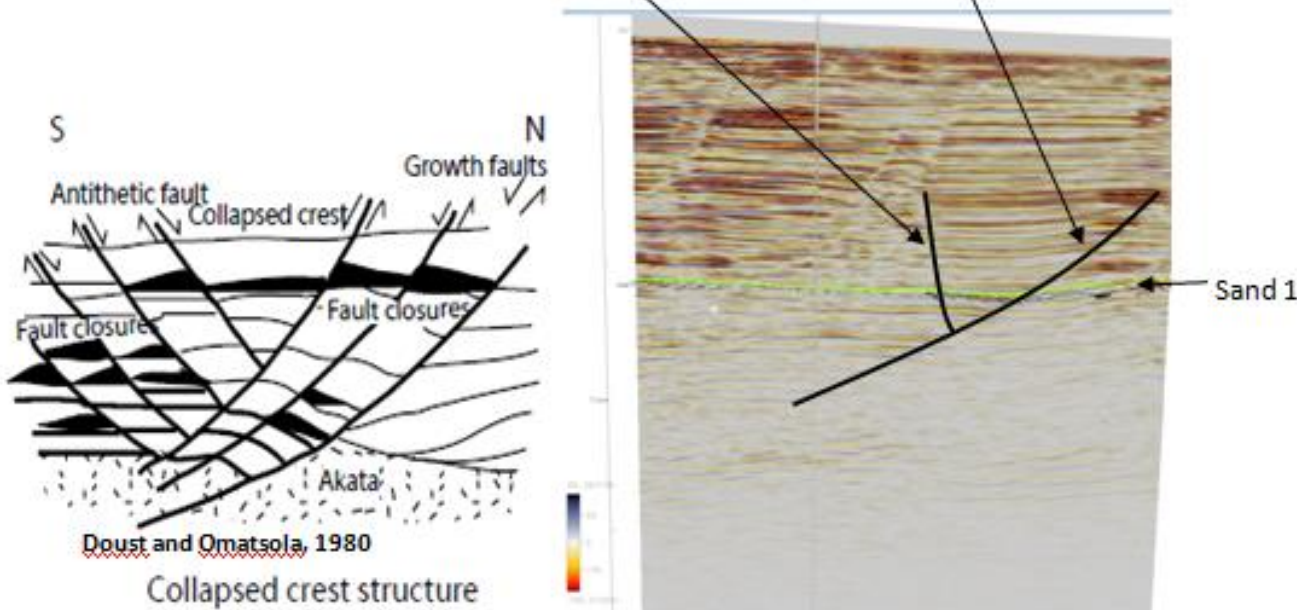
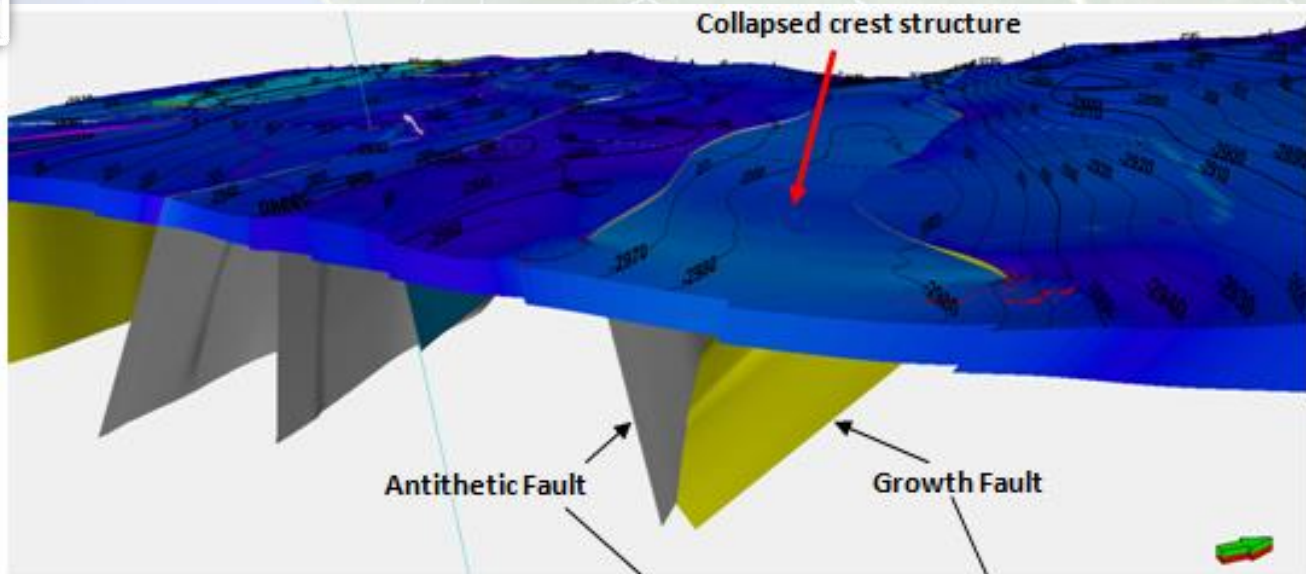
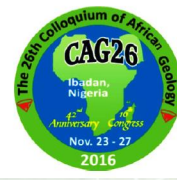
Cross section of mapped reservoir depth/thickness model



3-D view Cross section of mapped reservoir thickness model



RESULTS AND DISCUSSION



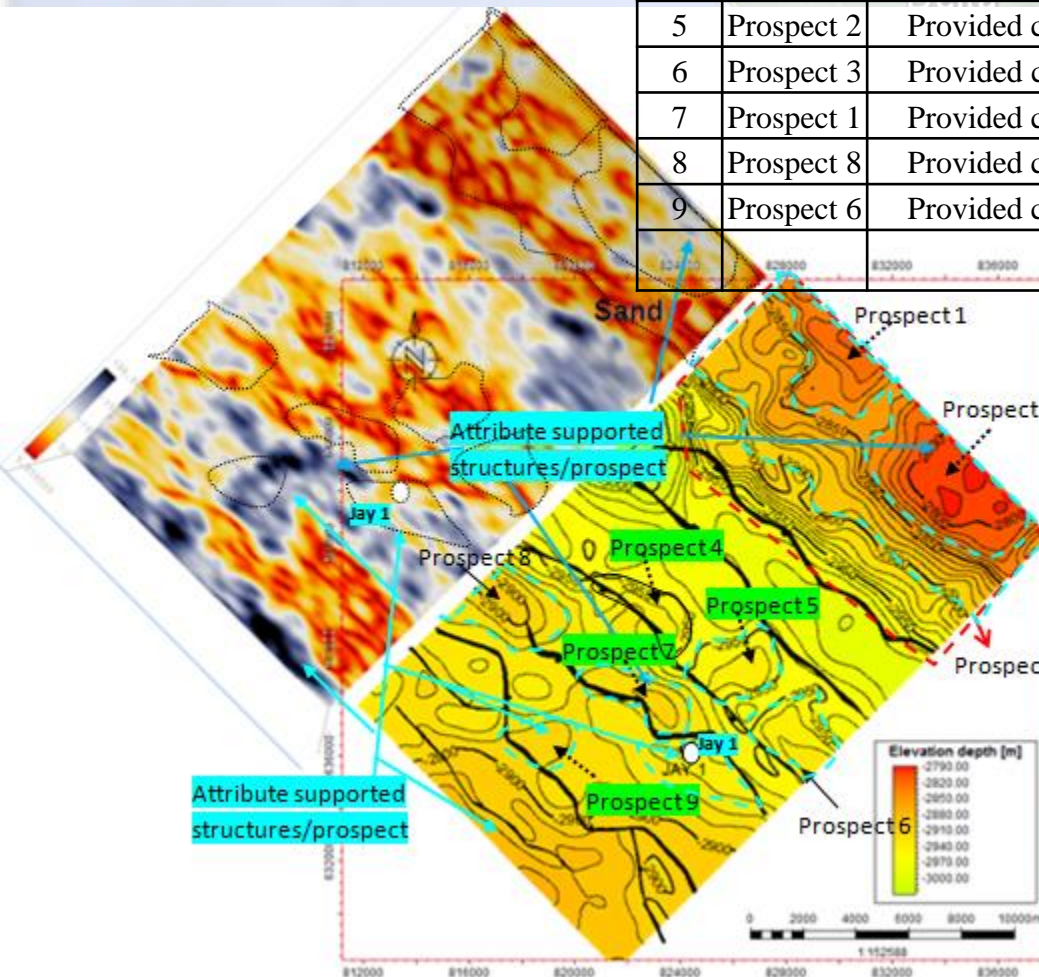


RESULTS AND DISCUSSION



Table 4.10 Estimated Reserves and Ranking in Jay field

Rank	Prospect	Remarks	Attribute Anomaly	Risk
1	Prospect 7	Fault assisted closure	Present	Low
2	Prospect 5	Fault assisted closure	Absent	Low
3	Prospect 9	Fault dependent closure	Present	Medium
4	Prospect 4	Fault dependent closure	Partial	Medium
5	Prospect 2	Provided closure exists outside the survey area	Present	High
6	Prospect 3	Provided closure exists outside the survey area	Partial	High
7	Prospect 1	Provided closure exists outside the survey area	Partial	High
8	Prospect 8	Provided closure exists outside the survey area	Partial	High
9	Prospect 6	Provided closure exists outside the survey area	Absent	High



Rivers
Port Harcourt

Juxtaposed Attribute and Depth Map generalised for Jay field in order to integrate attribute supported structures in Prospect Ranking

Geographer
gle
sat
ry, NGA, GEBCO



CONCLUSION

- Similarity attribute have helped in mapping fault
- Spectral decomposition and Energy attribute:
 - ✓ improving reflection pattern
 - ✓ anomalous amplitude that may be associated to hydrocarbon accumulation
- The hydrocarbon bearing reservoirs are with:
 - ✓ average porosity range of 21 to 26%,
 - ✓ average hydrocarbon saturation range of 66 to 72%,
 - ✓ thickness range of 24 to 114m
 - ✓ and net to gross range of 0.54 to 0.91.
- The traps mapped are structural with fault assisted and dependent closures.
- Seismic attributes such as Spectral decomposition, Energy and Similarity may be used to improve reflection pattern in poor to good seismic data Offshore Niger Delta.
- Spectral Analysis should be carried out on data sets before making deductions on Spectral Decomposition Attribute
- Attribute analysis should be integrated in reservoir modelling and ranking of prospects

120 km



ACKNOWLEDGEMENT



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- Chevron, NNPC, DPR and NAPIMS for the data
- Schlumberger for providing the Petrel[©] software.
- Danvic Concept & dGB Earth Sciences for the OpenDTect.



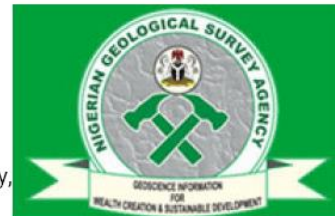
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Gulf of Guinea

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