Seismic Expression of Miocene and Pliocene Proximal Lowstand Composite Sequences, Offshore and Onshore West Nile Delta, Egypt*

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Abstract

To date Pliocene and Miocene gas discoveries and production in the Western Nile delta are largely restricted to distal slope depositional settings. Recent work suggests there may be unrealized potential in proximal composite lowstand sequences. Our study included more than 3000 square kilometers of interpreted 3D seismic and a robust petrophysical and biostratigraphy database using 30 wellbores. Seismic reflection configurations and stratigraphic sequences were interpreted on a 200 by 200 meter grid.

The interpretations reveal a number of interesting features in proximal depositional settings. East-west strike oriented relict shelf breaks at type 1 unconformities contrast with the generally consistent northwest trending slope channels. Successive sequences repetitively exhibit upper slope proximal canyons and incised channels that trend northeast to due north at the sequence boundary surface. Depositional slope channels are disassociated from the initial erosive unconformity and trend northwest for the remainder of lowstand and transgressive systems tract deposition.

High frequency sequences overprint fundamental (third-order) sequences during lowstand deposition. This is observed in the proximal setting where the transgressive surface at the top of the initial lowstand prograding wedge translates basinward into a basal bounding type 1 unconformity. Associated with this higher order sequence boundary is another lowstand prograding wedge and slope fan. This configuration may occur multiple times in a single third-order sequence and is common throughout the Miocene and Pliocene succession. In this proximal setting high sediment input rates appear to be a major control whereas tectonic instability adds complexity to the more distal slope settings.

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Brief overview of the database

&

The high frequency nature of fundamental sequences in the Pliocene

&

Implications of the above for Miocene stratigraphic configurations

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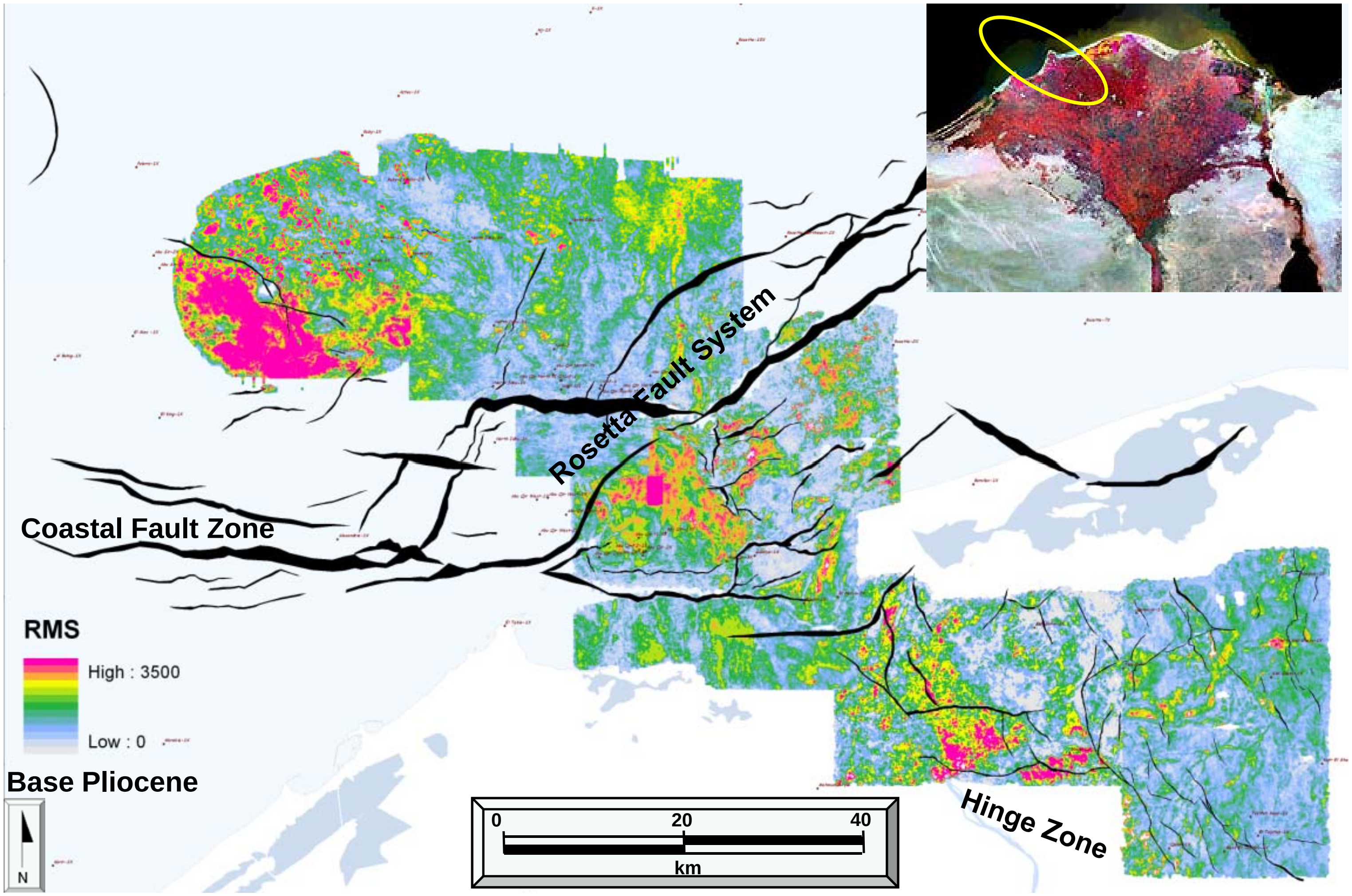
Location Map
West Nile Delta Prospectivity Study Area



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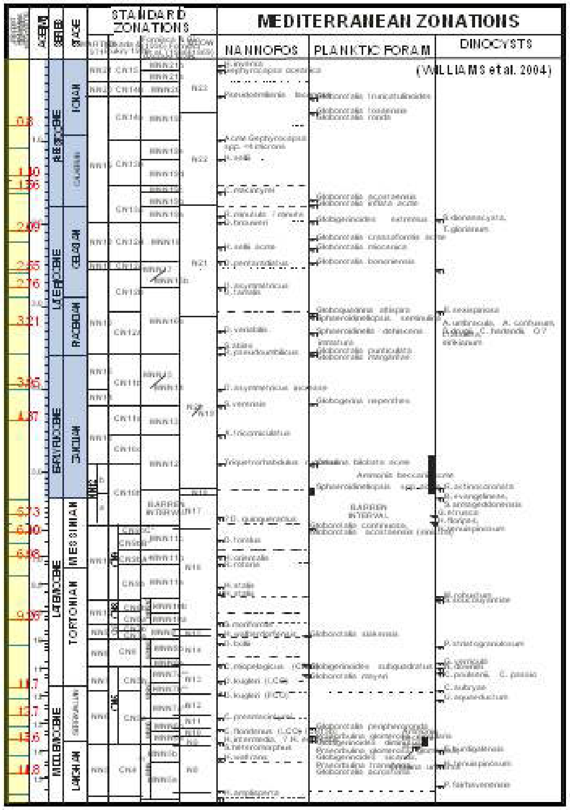
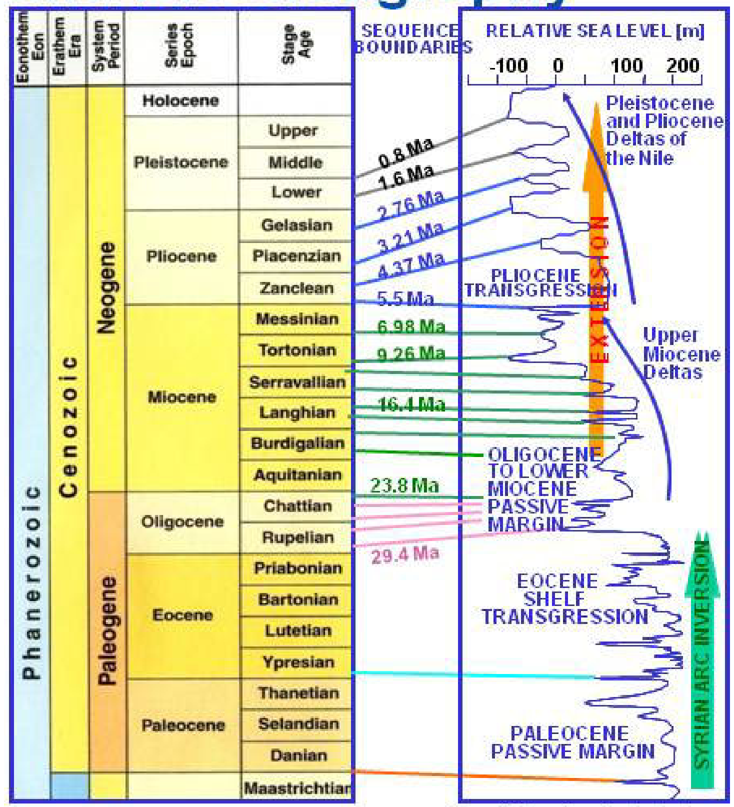
Sequence Stratigraphic Framework from Wells, Seismic and Biostratigraphy



RWE Dea in house work
by JUTSON D., YOUNG H.
& KELLNER A. (2006)



Haq, B.U., Hardenbol, J.
& Vail, P.R. 1987

After Wornardt, W.,1999

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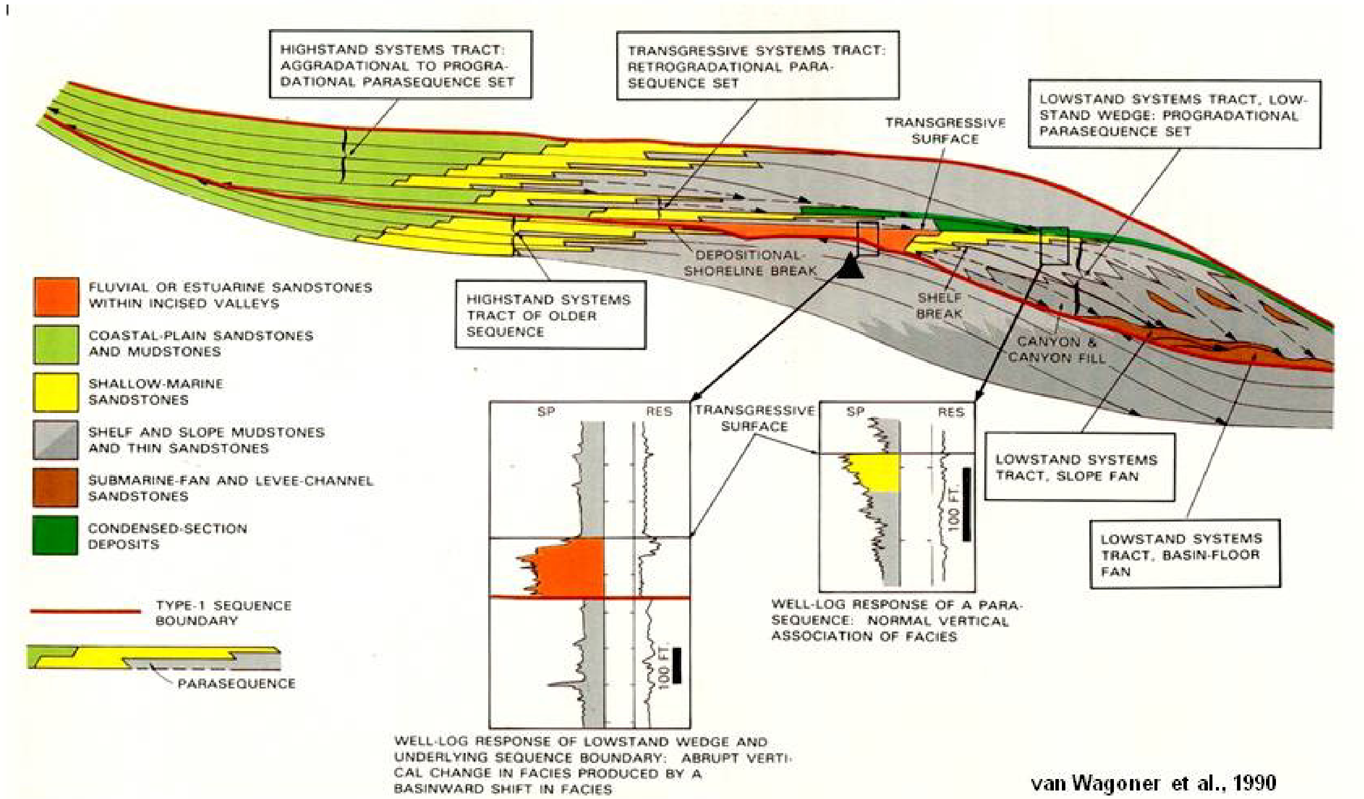
Notes by presenter:

ADOPTED A MEDITEREANEAN BIOSTRAT ZONATION SCHEME CALIBRATED TO THE HAQ SEA LEVEL CURVE AS ADAPTED BY WORNARDT. SOME 14 OLIGOCENE / MIOCENE BASAL BOUNDING SEQUENCE BOUNDARIES AND ASSOCIATED SURFACES. 5 FUNDAMENTAL PLIOCENE SEQUENCES.

Application of Sequence Stratigraphic Concepts

Using the classic approaches of Vail 1987, Posamentier et al., 1988; Posamentier and Vail 1988, Van Wagoner et al., 1988 & 1990, Brown et al., 1995, ………



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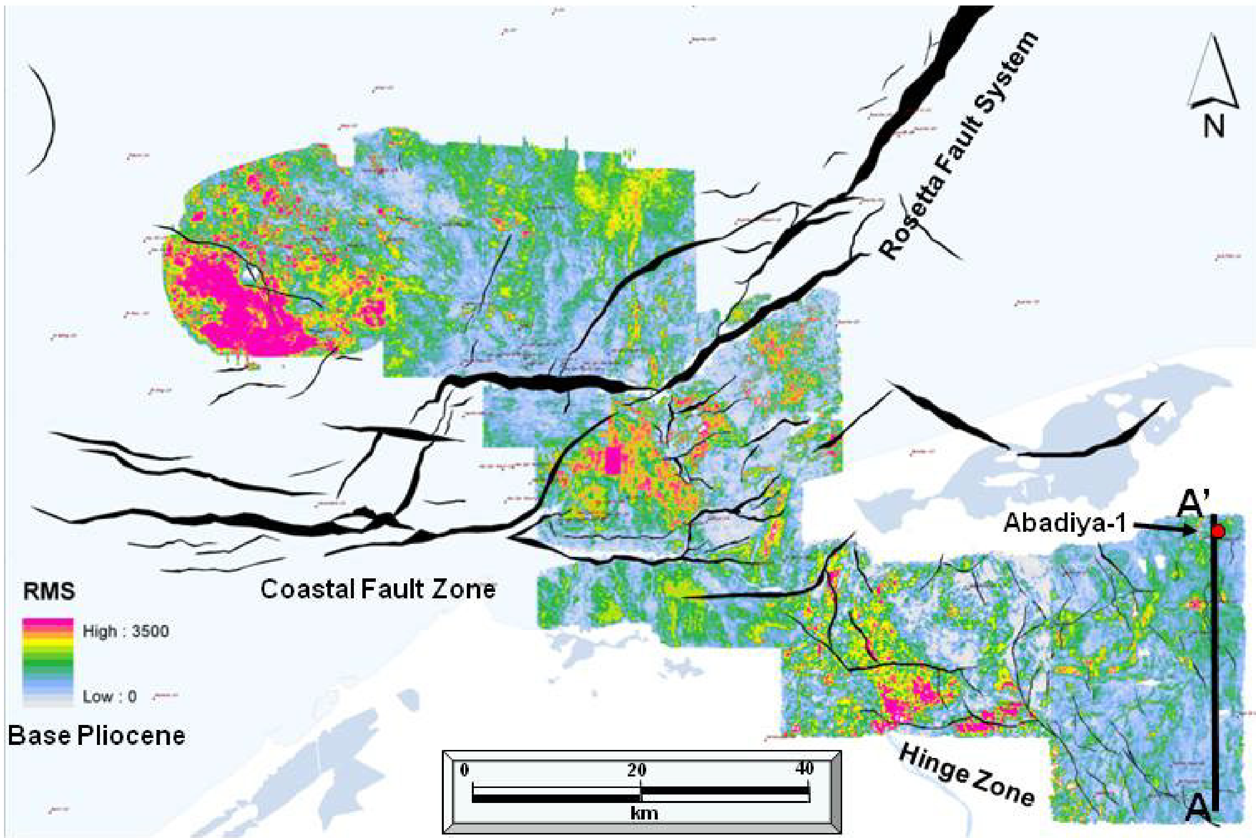
Notes by presenter:

APPLYING CONCEPTS AND PRINCIPLE’S WITH A GREAT DEAL OF SUCCESS . TODAY WE REMAIN IN PROXIMAL LOWSTAND SETTING UPPER SLOPE FAN / PROGRADING WEDGE AND TRANSGRESSIVE SURFACE.

RMS Amplitude Map MFS 5.5



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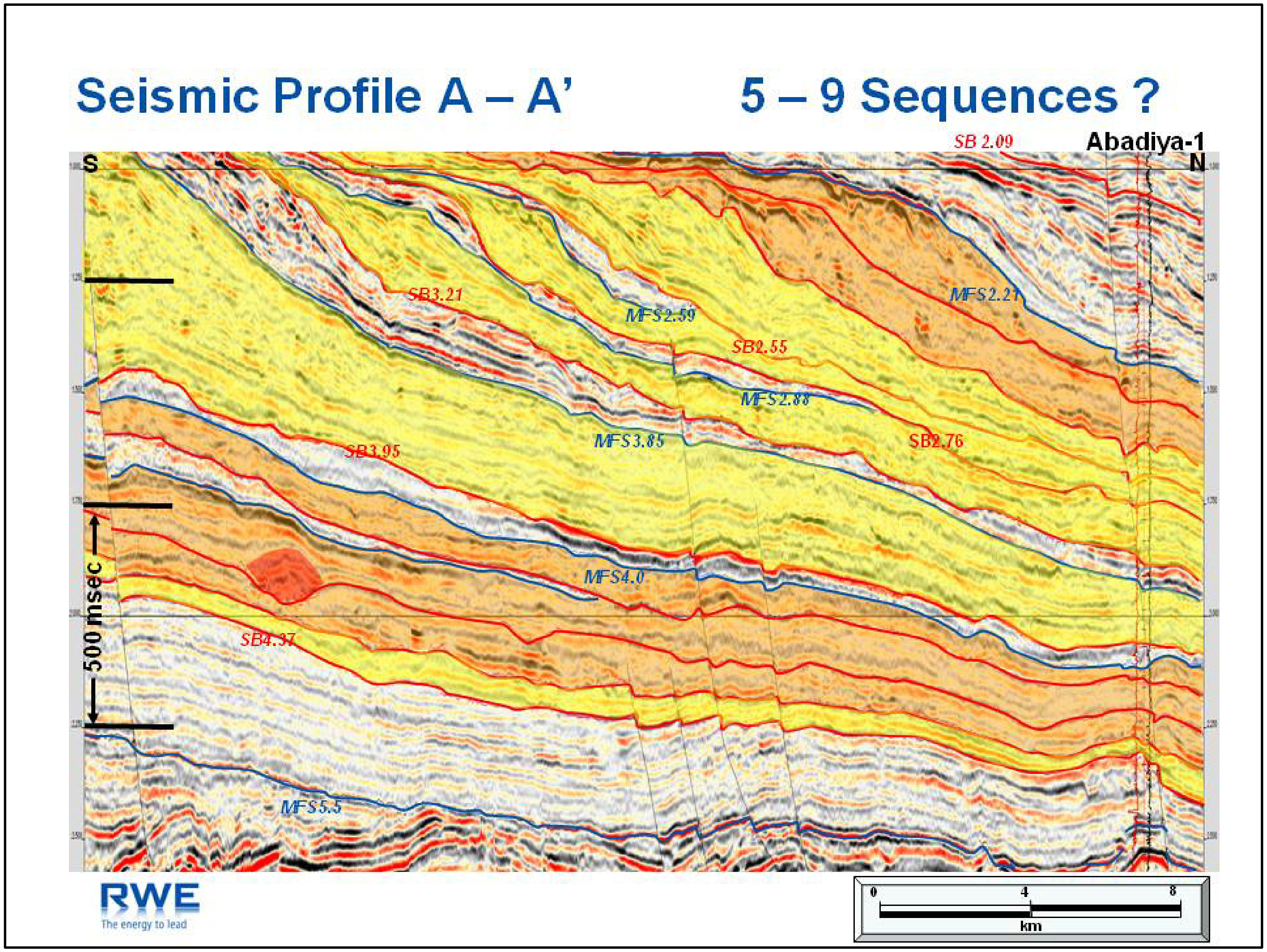
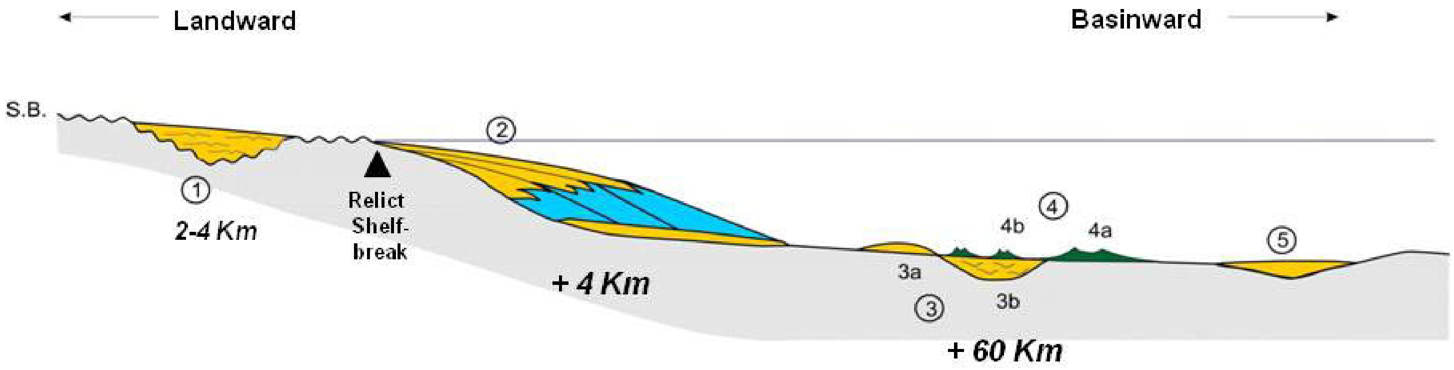
Notes by presenter:
MAP INTRODUCED BEFORE RMS AMPLITUDE OF INTERVAL 5.5 TO 250 MSEC.GRID DENSITY IN AREAS OF COMPLETION TYPICALLY 200 / 250 M. CURRENTLY IN CENTRAL ONSHORE.
INTRO A-A’



Notes by presenter:
EACH SECTION SHOWS 500 MESC INTERVALS IN THE BLACK LINES
DISTANCE OF 30 KM30 Km long section, 2.5 sec (3000m). FIVE FUNDAMENTAL PLIOCENE SEQUENCES WITH UNCONFORMITIES IN RED , MFS IN BLUE. UNDIFFERENTIATED LST/TST IN YELLOW.
2 COMPOSITE LOWSTAND SEQUENCE SETS ADDED. IN ALL PRACTICALITY INTERESTED IN THE GENETIC DEPOSITIONAL SYSTEMS I.E. SLOPE CHANNELS ON THE UNCONFORMITIES.
NOTE LACK OF PRESERVED HST ESPECIALLY IN COMPOSITE LST/TST COUPLETS.

Play Types
Nile Delta Lowstand Systems Tract



1. Incised Valley Fills

2. Prograding Complex; confined – upper slope canyon

3. Slope Channel Fills a) confined channel complex
   b) unconfined crevasse splays & terminal lobes

4. Channel-Levees a) confined / unconfined
   b) unconfined abandonment facies

5. Ponded / silled basin floor fans

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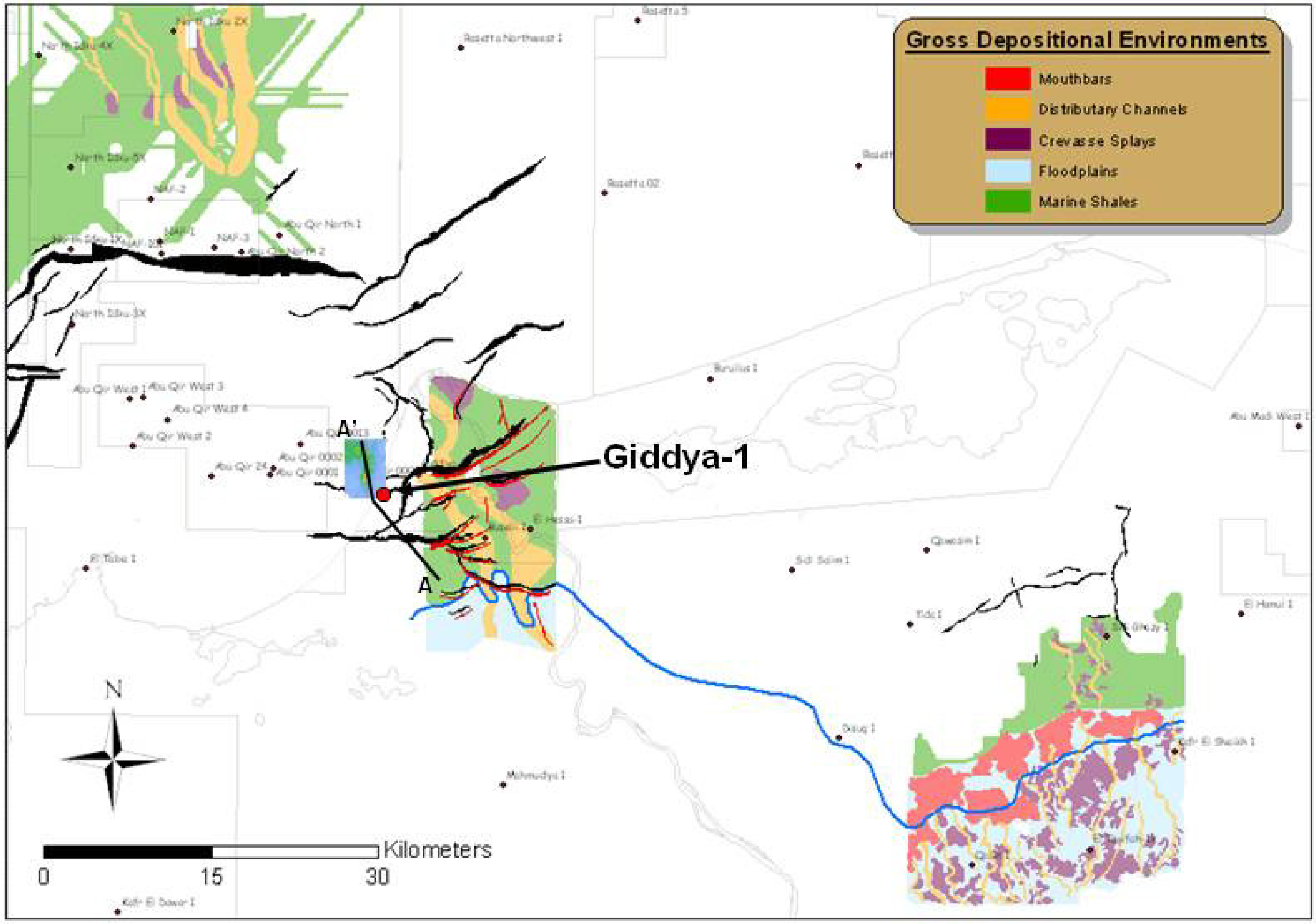
Notes by presenter:
SLOPE CHANNEL FILLS / CHANNEL / LEVEE / SPLAYS PROLIFIC PRODUCERS. MUCH OF OUR ACREAGE AREA IN PROXIMAL LST PROGRADING WEDGE AREA.

Lowstand Sequence 2.55



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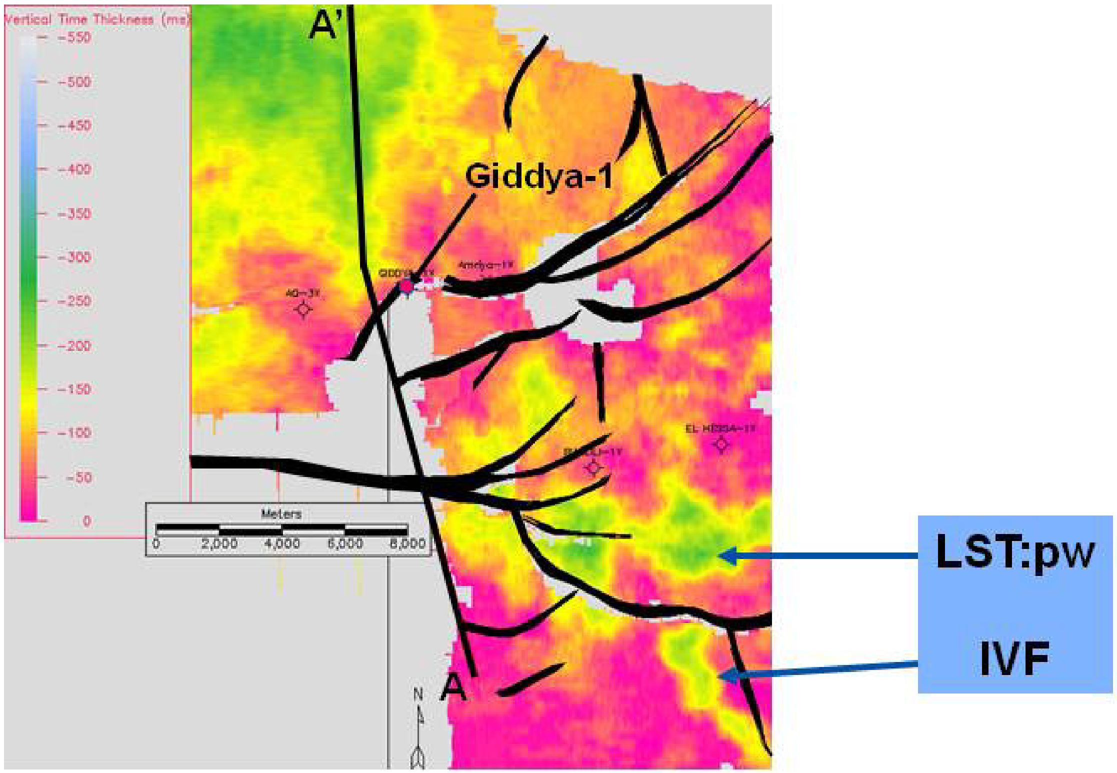
Notes by presenter:
TO GET A SPATIAL FEEL, EXAMPLE OF PROXIMAL LOWSTAND SYSTEM 2.55 AT THE COAST ON-SHELF. UPPER AND LOWER SLOPE SETTING. FEATURE 10 KM NORTH OF RELICT SHELF BREAK.

LST Thickness SB 2.55



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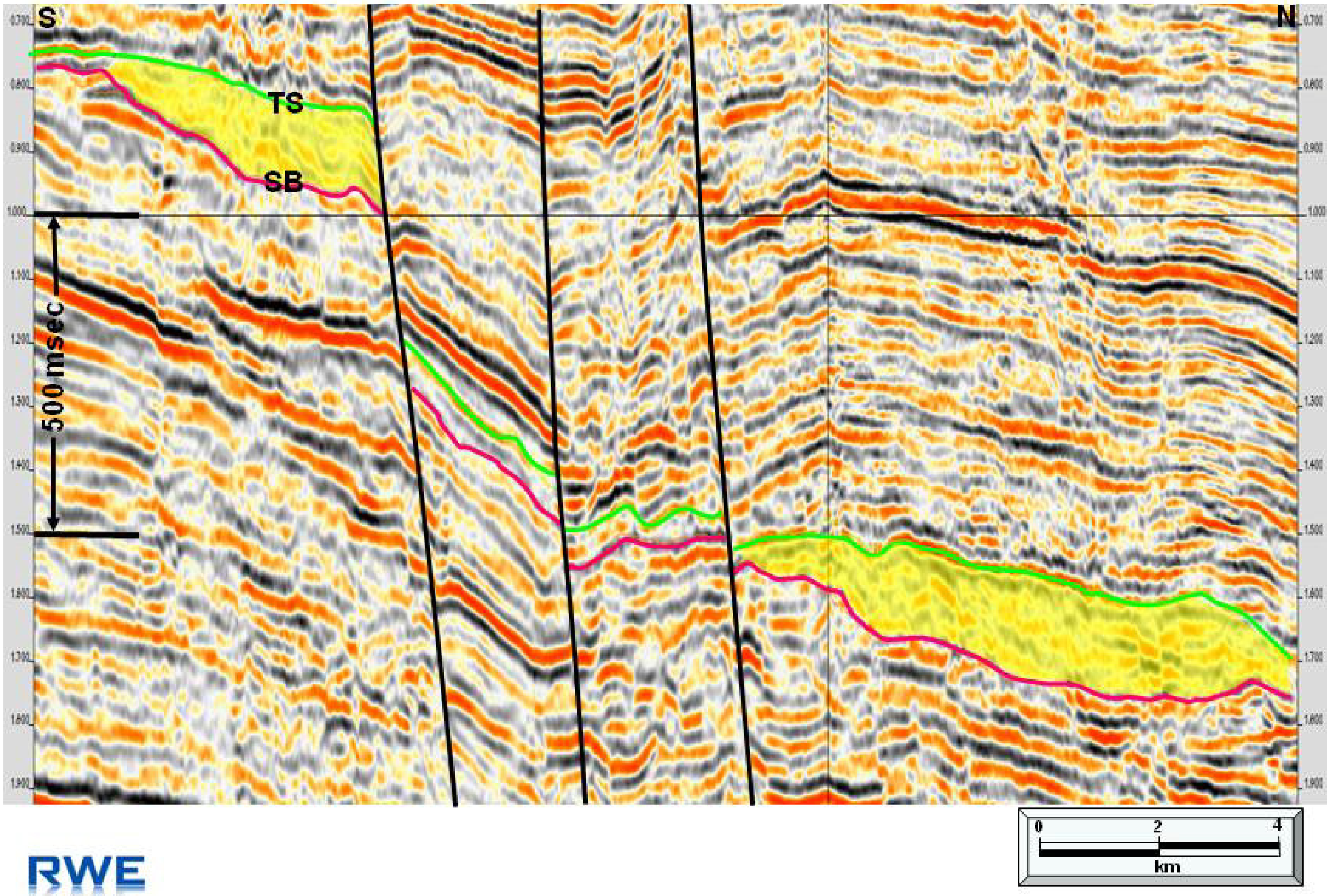
Notes by presenter:
INCISED VALLEY FILL, LOWSTAND PROGRADING WEDGE DEPOCENTRE. 2.5 KM STRIKE-SLIP ON COASTAL FAULT2.5
LINE A-A’

Seismic Profile A – A'

Merged offshore/onshore seismic volume



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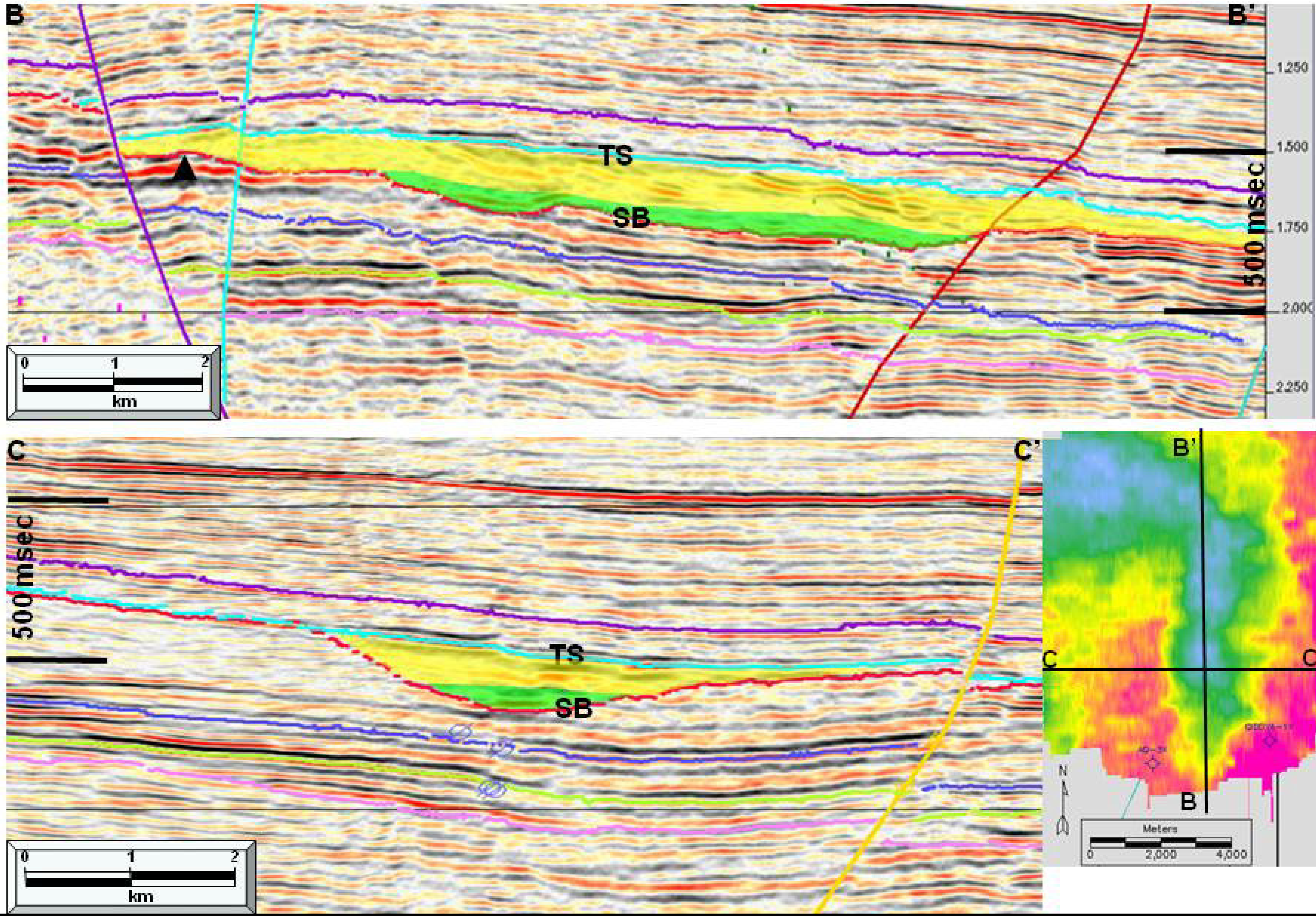
Notes by presenter:
2 LOWSTAND PROGRADING WEDGES SUGGEST THAT THE TRANSGRESSIVE SURFACE RELATES TO HIGHER ORDER SEQUENCE BOUNDARY BASINWARD.

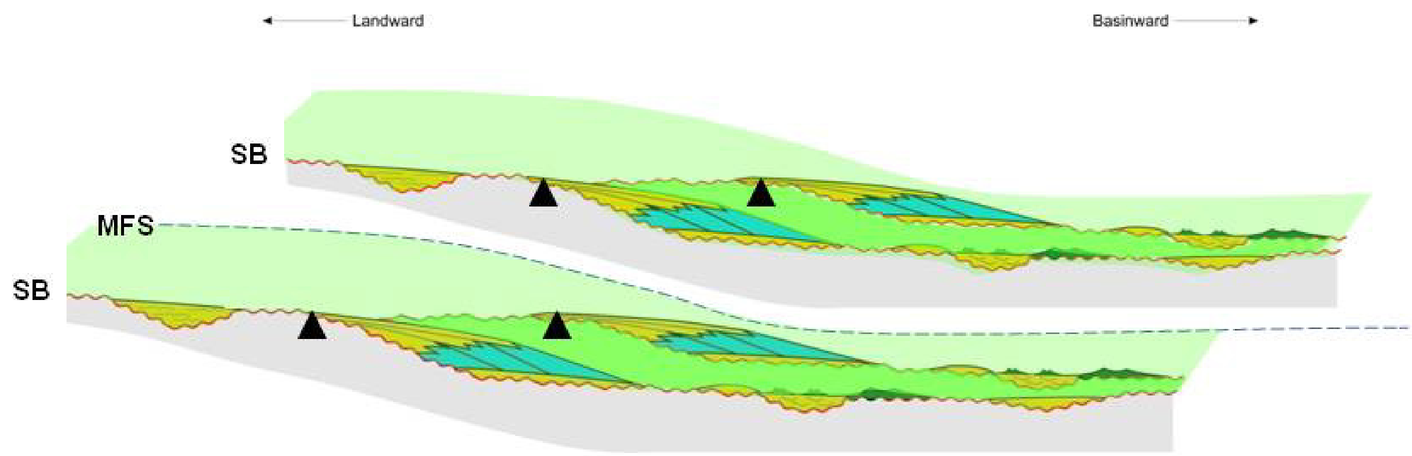
Seismic Profiles B – B' and C – C'

Offshore seismic volume



Notes by presenter:
ILLUSTRATION OF PROGRADING WEDGE ON GOOD QUALITY OFFSHORE DATA. UPPER SLOPE CANYON, UPDIP SF FILL & LOWSTAND PROGRADING WEDGE. NOTE TS=SB

Pliocene Progradationally Stacked Composite Lowstand Sequences



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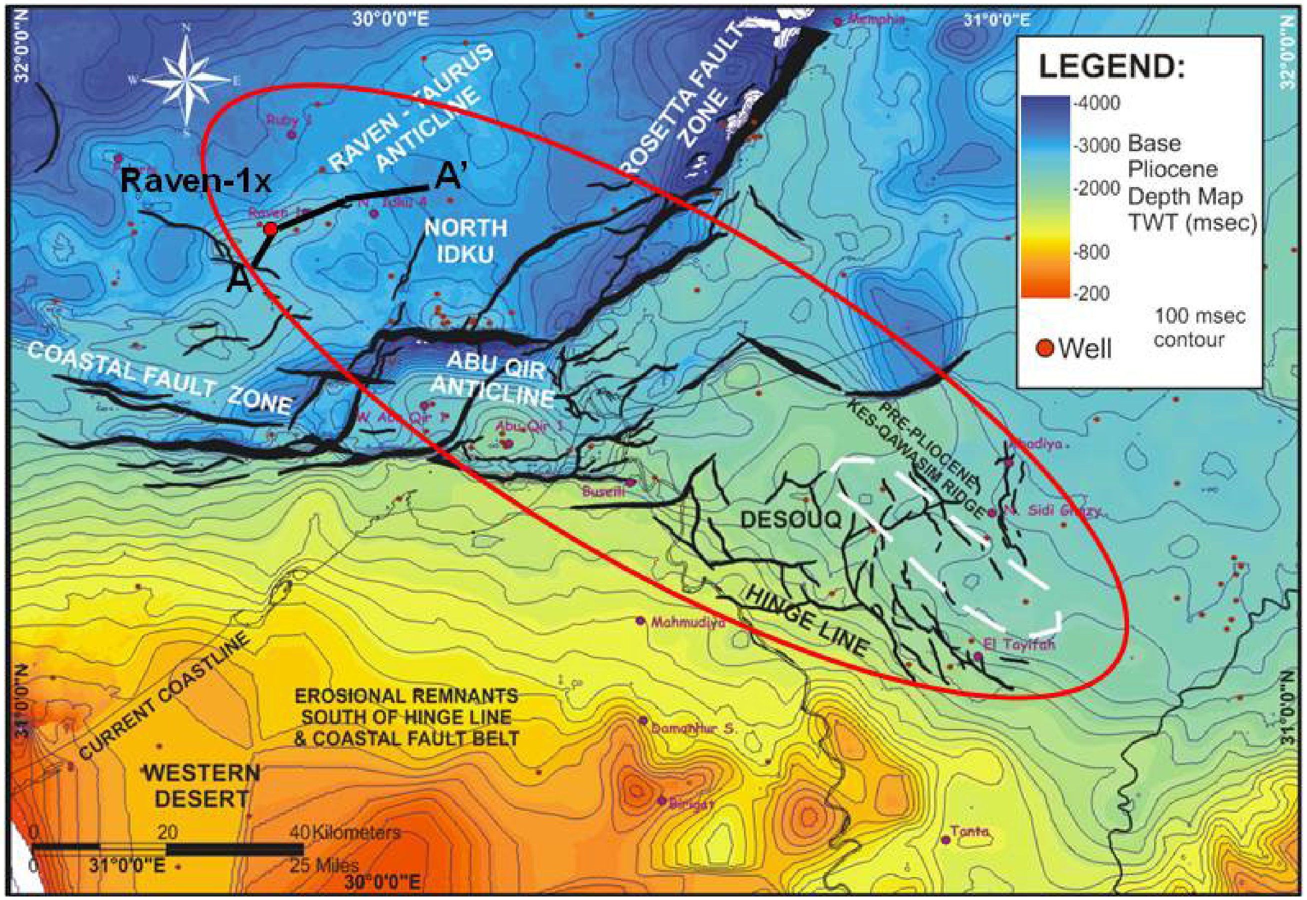
Notes by presenter:
IN THE PLIOCENE TRANSGRESSIVE SURFACE, AT LEAST AT SEISMIC RESOLUTION APPEAR TO TRANSLATE TO THE FOLLOWING UNCONFORMITY IN COMPOSITE LOWSTAND SEQUENCE SETS.

Location Line A - A' Offshore Raven Area



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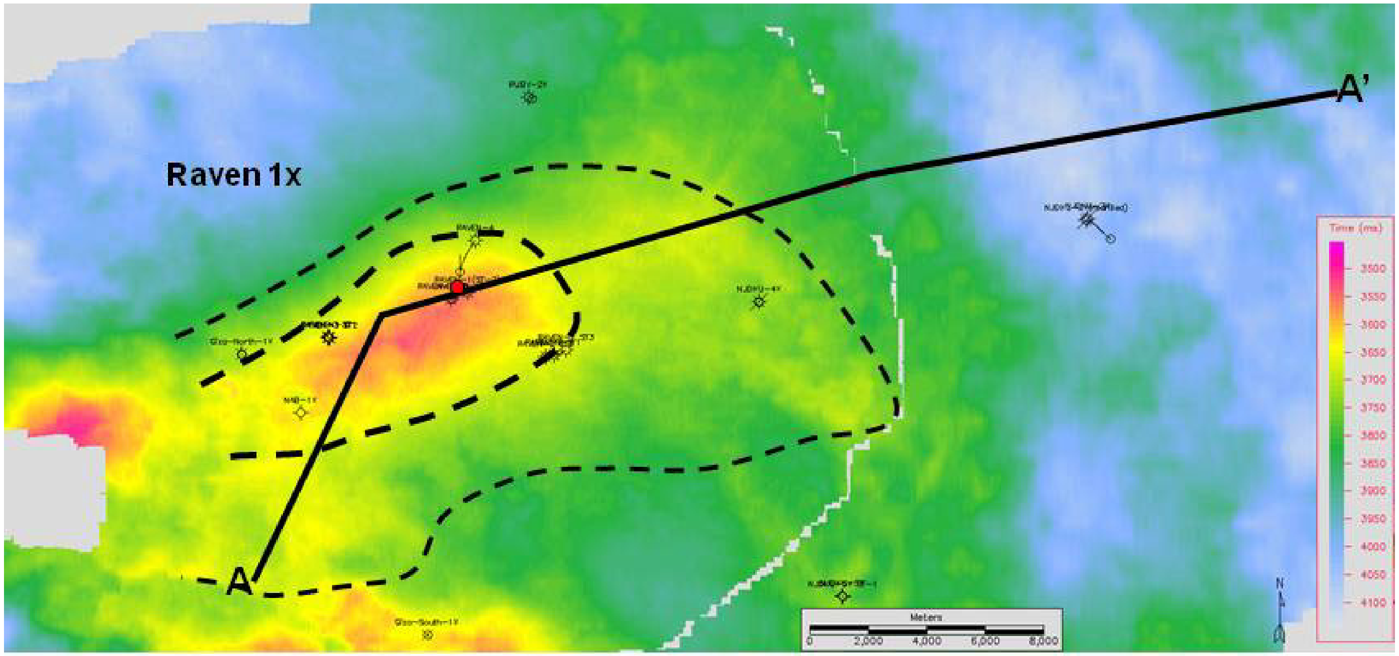
Notes by presenter:
MIOCENE DISCUSSION OFFSHORE SOME 120 KM FROM WHERE WE STARTED. BASE PLIOCENE ILLUSTRATE RAVEN HIGH.

Time Depth Map SB 11.7



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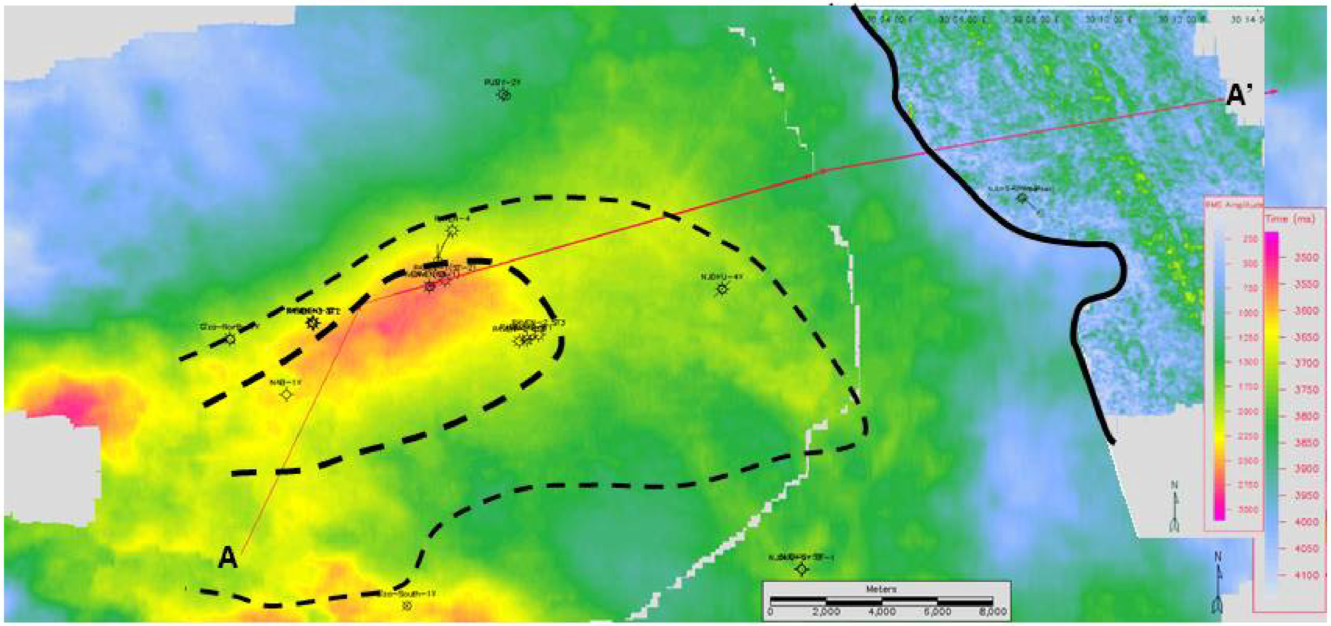
Notes by presenter:
ANTICLINAL NOSE OVER RAVEN AT 11.7 M.Y.
LINE SECTION MORE THAN 40 KM , EASTERN PART FIRST

Time Depth Map SB 11.7

RMS Amplitude 11.7 LST



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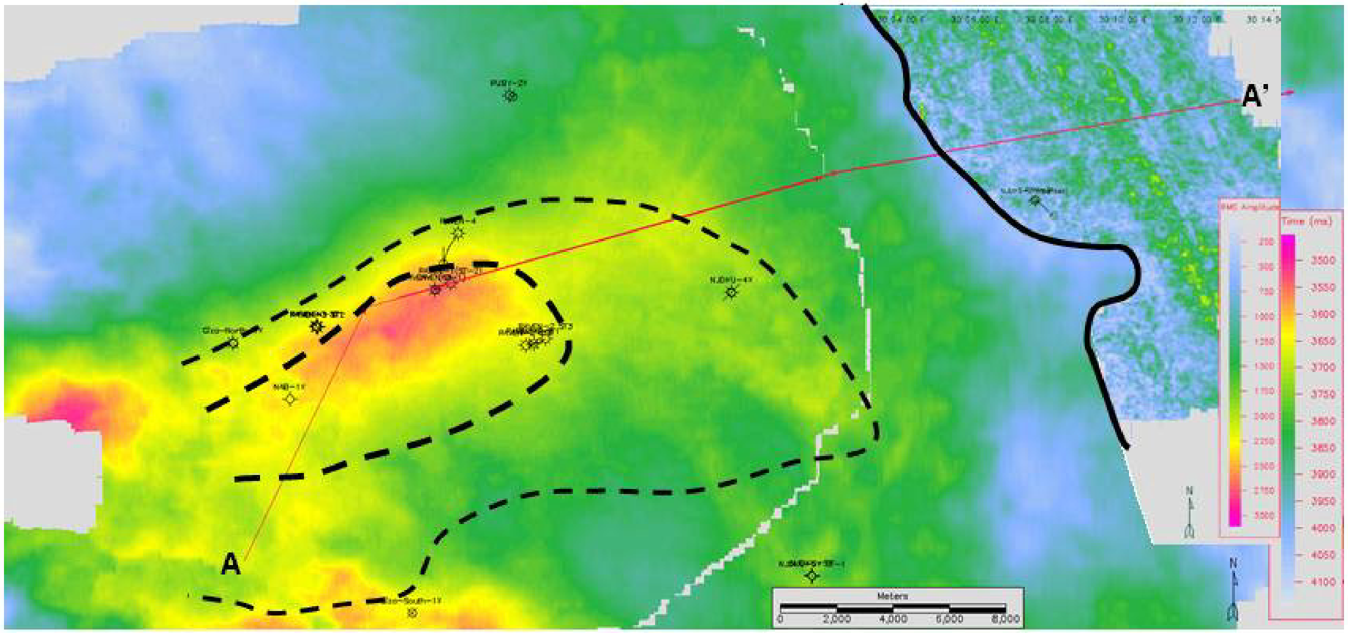
Notes by presenter:

FOCUS ON 11.7 SEQUNCE BOUNDARY. TWO CONFINED CHANNEL FEATURESD EVIDENT FROM AMPLITUDE CONTENT. TRANSGRESSIVE SURFACE OVER THE TOP MARKS PALEO RELIEF I.E ALSO EARLY RAVEN HIGH. NOTE: AMPLITUDE IN THE TST. IMAGE LOWSTAND BY ITSELF.

Time Depth Map SB 11.7

RMS Amplitude 11.7 LST



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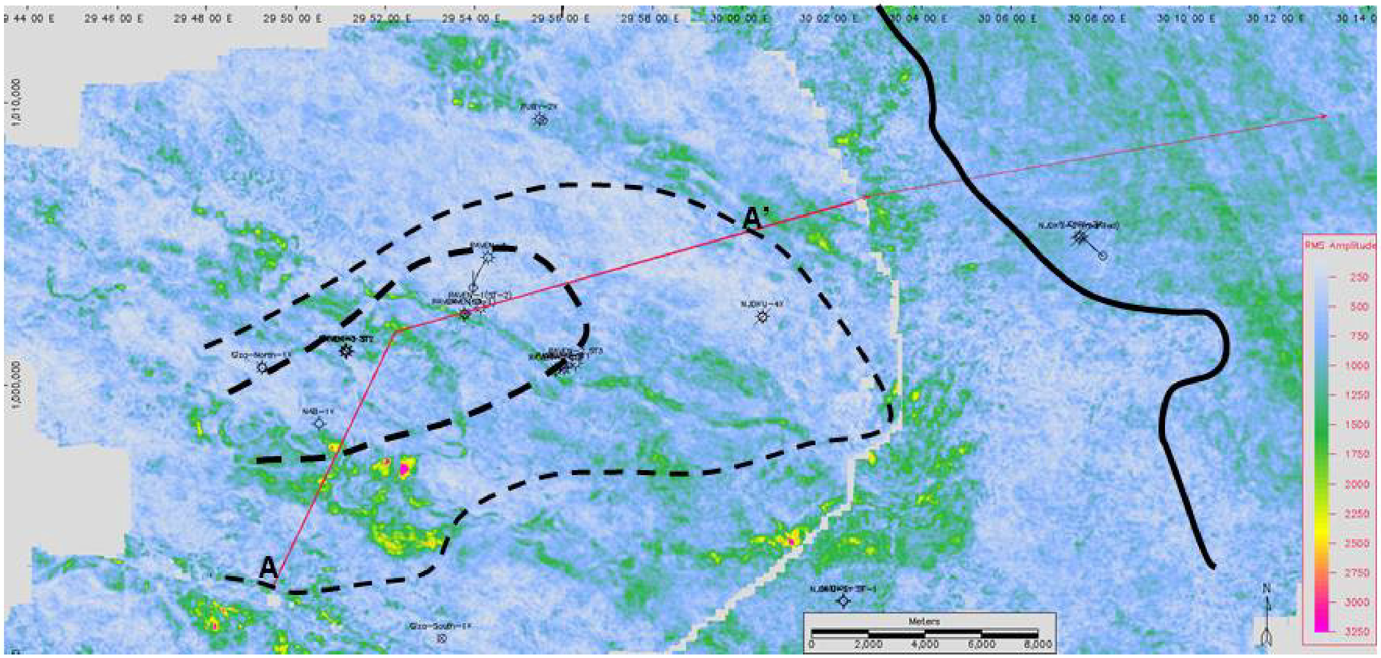
Notes by presenter:
RMS AMPLITUDE EXTRACTION INDICATE TWO STRAIGHT CHANNELS, DATA QALITY NOT BRILLIANT, REMAINDER ON MULTI AZIMUTH SURVEY IN THE BP JOINT VENTURE AREA.

RMS Amplitude 11.7 LST + TST



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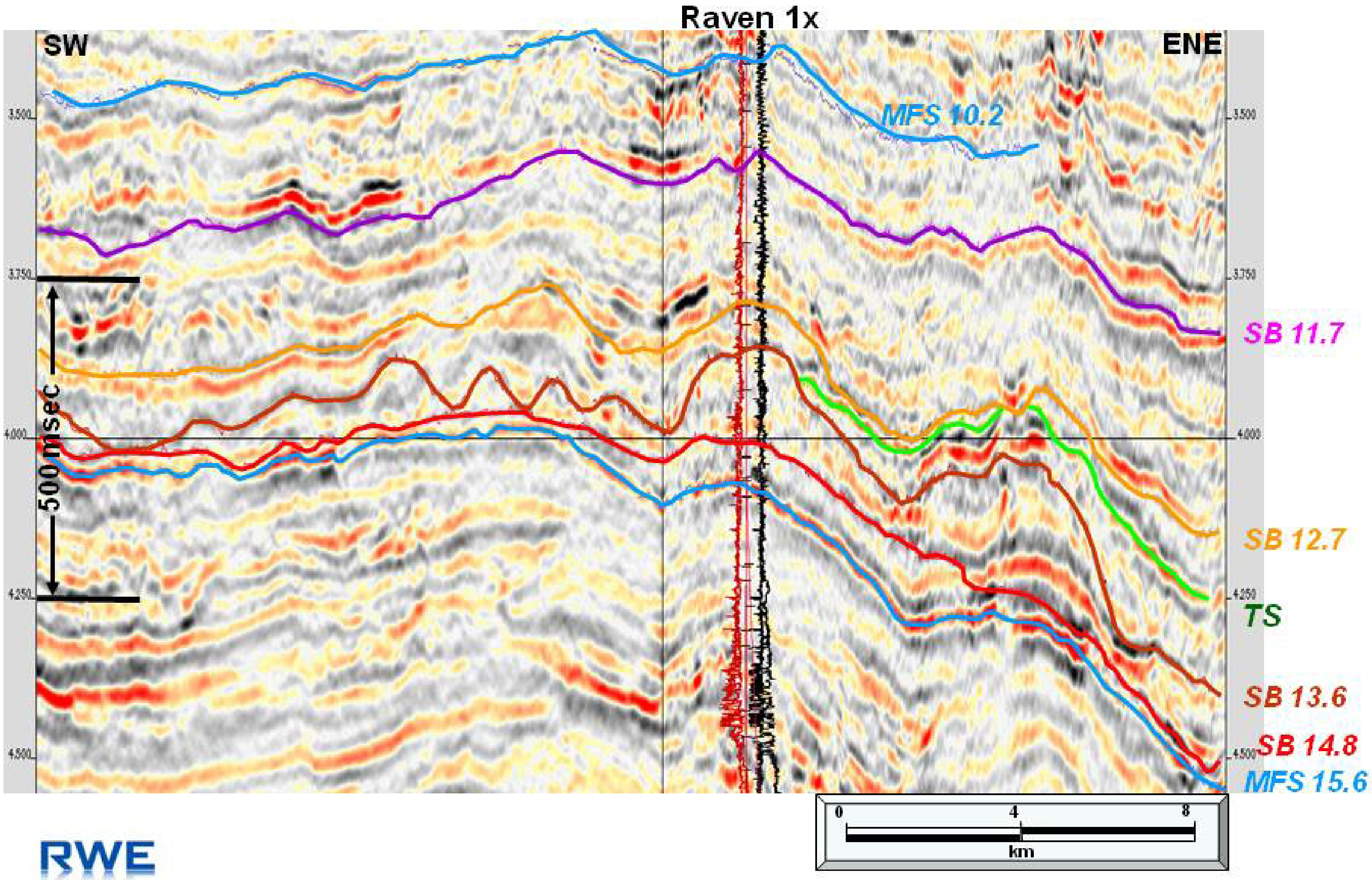
Notes by presenter:

TST AREA, RMS EXTRACTION INTERVAL 130 MSEC ABOVE THE SEQUENCE BOUNDARY. NOTABLE FEATURES; STRAIGHT CHANNEL / LEVEE WITH TERMINAL LOBE, 8 KM MEANDER BELT TO THE WEST BOUND BY LOW SINUOUSITY CHANNEL TO THE EAST

A- A' CONTINUED

Seismic Profile A – A' cont.



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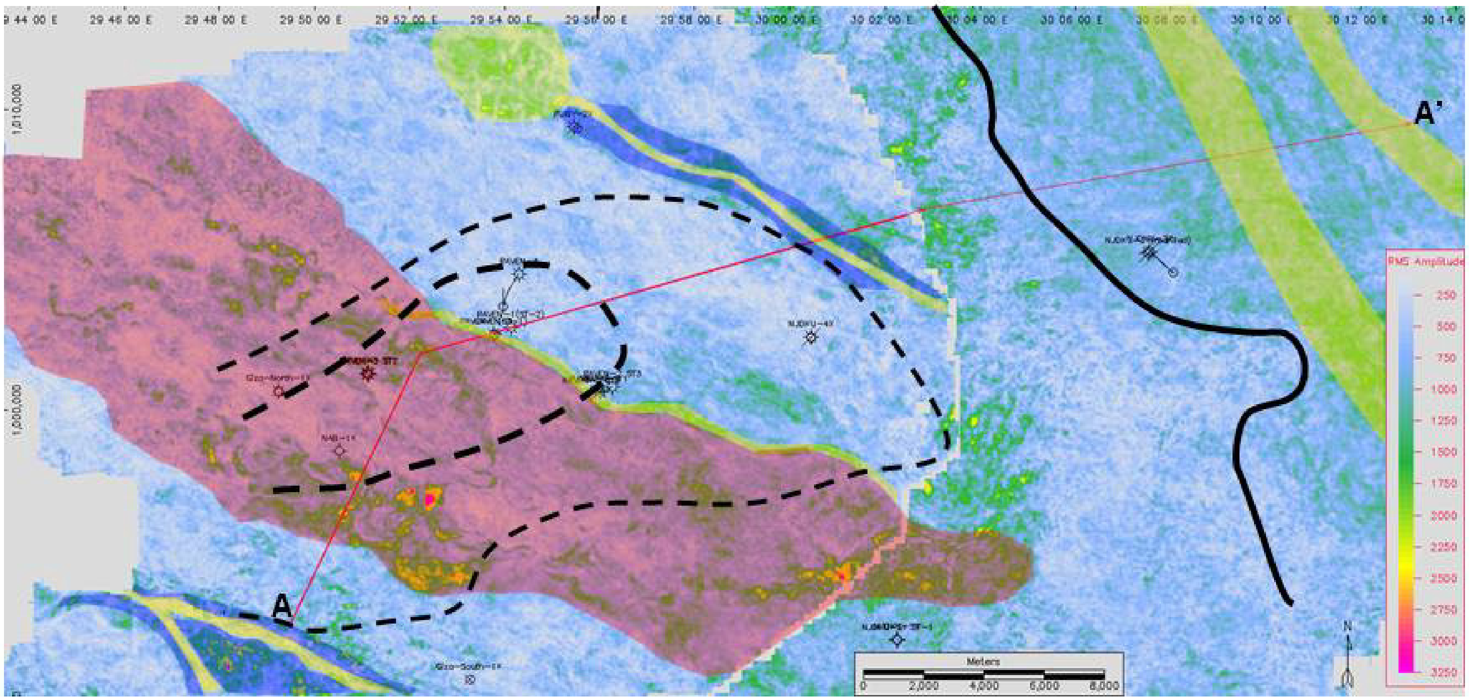
Notes by presenter:
AMPLITUDE FEATURE IN THE EAST, INCISED CAHNNEL AT THE WELLBORE AND UNCONFINED AMPLITUDE EVENTS IMMEDIATELY OVERLYING THE UNCONFORMITY.

RMS Amplitude 11.7 LST + TST
Depositional Environments



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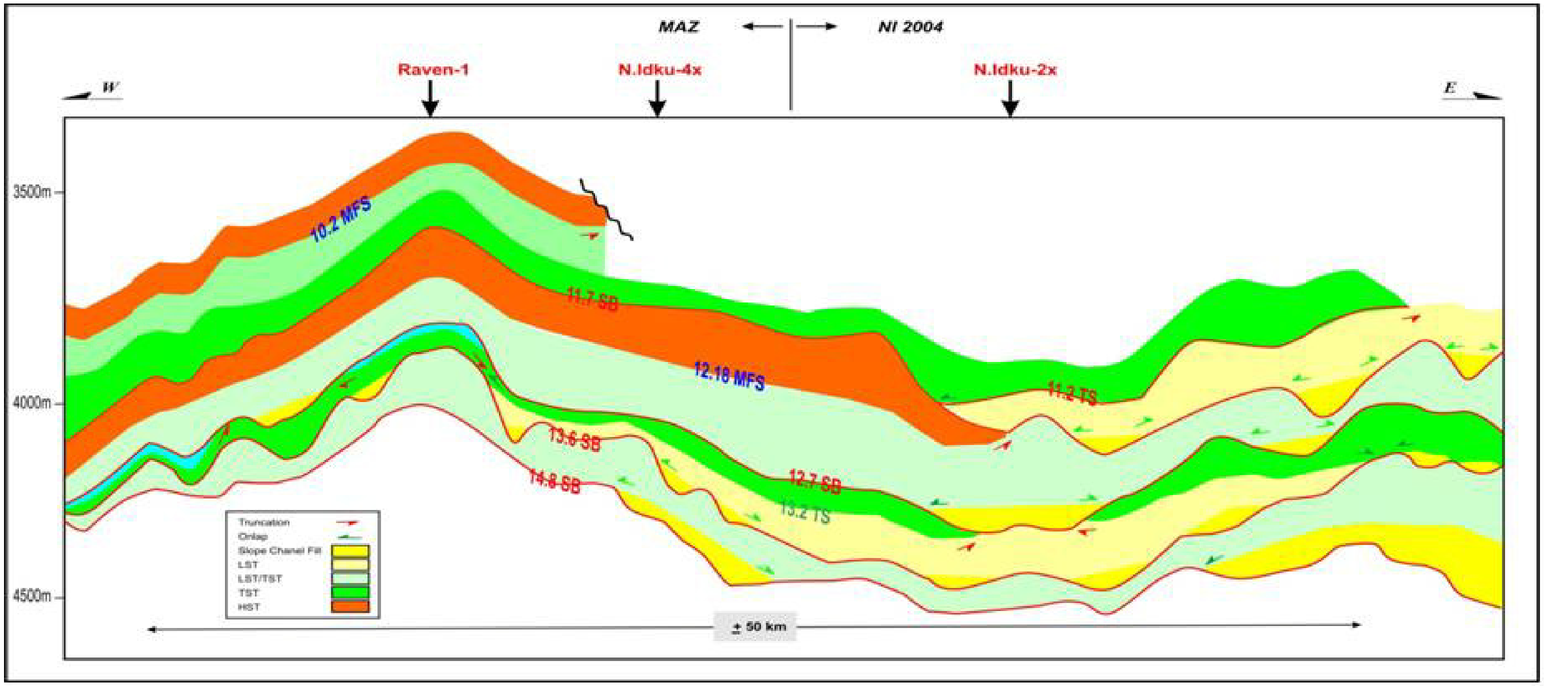
Notes by presenter:
LOWSTAND SLOPE CHANNELS AND EXPOSED PALEO RELIEF
EARLY TST ATTENDED BY 2 LOW-SINUOSITY CHANNELS IN HIGHER GRADIENT ENVIRONMENT AND SUGGESTED LOWER DELTA PLAIN MEANDERBELT OVER MUCH OF THE RAVEN HIGH.

Middle/Late Miocene LST, TST & HST Configurations



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Notes by presenter:
IDENTIFICATION OF NOT ONLY SB'S AND MFS BUT ALSO TRANSGRESSIVE SURFACE A KEY ELEMENT TO: INDICATE STRUCTURAL GROWTH TIMING AND SHALLOWING DEPOSITIONAL ENVIRONMENTS.

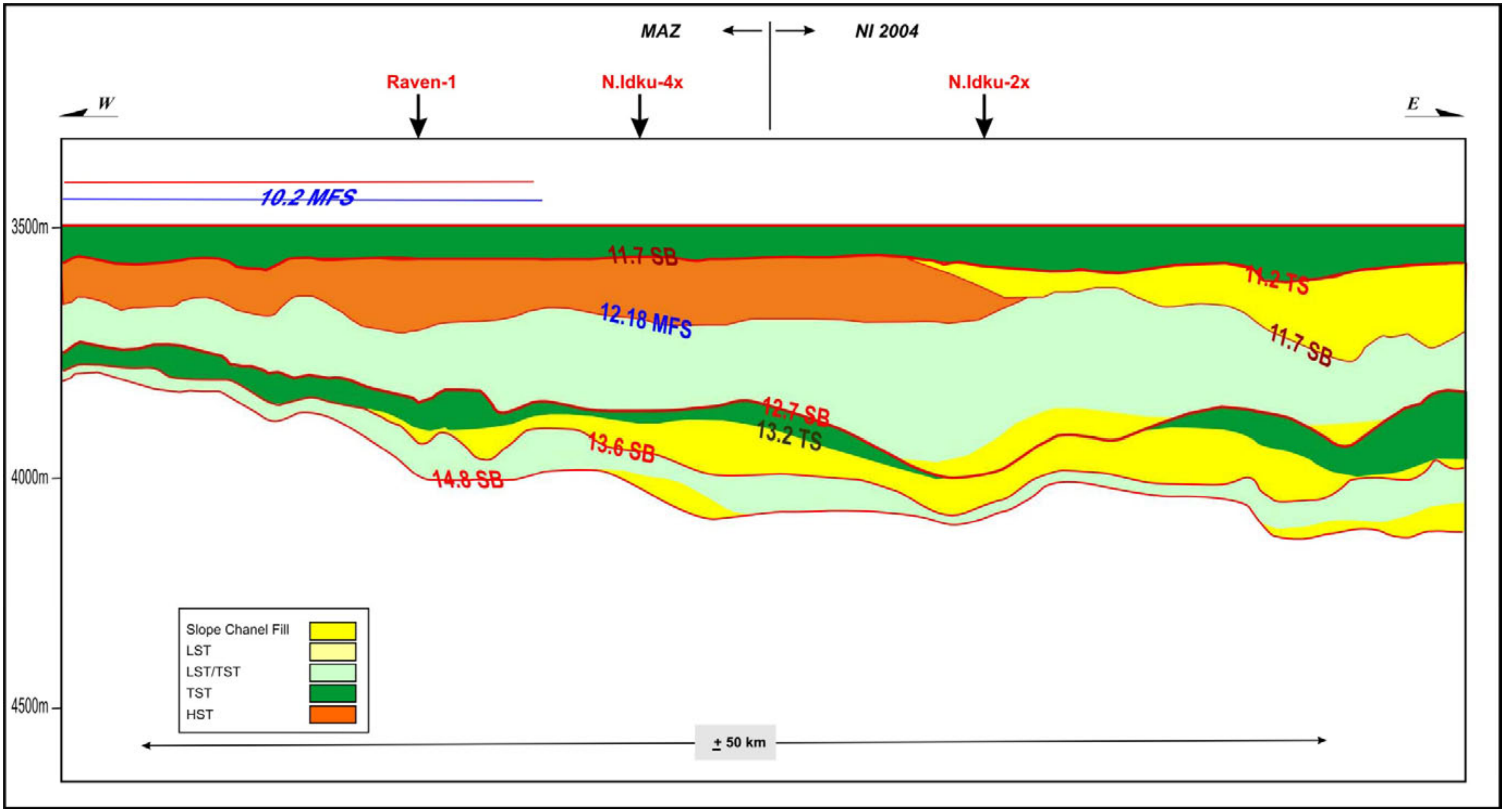
Conclusions

- The classic sequence stratigraphic approach is highly relevant to Nile Delta hydrocarbon prospectivity.

- Discrimination between lowstand and transgressive systems tracts marks the onset of incipient growth of the Raven anticlinorium during Miocene times. Typical slope channel deposition in a “distal” setting is interrupted by lower delta plain deposition.

- Very high sedimentation rates are the predominant cause of lowstand sequence set development in the Pliocene. Highstand deposition is notably poorly preserved in the “proximal” setting.

Middle/Late Miocene LST, TST & HST Configurations



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