[PS]Rates of Faulting and Sedimentation in a Continental Rift Setting Constrained by Biostratigraphic, Structural and Seismic Studies - Implications for Reservoir Architecture, Dentale Formation, Gabon*

A. Aramowicz[1], A. Robinson[1], G. Ageneau[1], J.L. Ruiz Corregidor[1], B. Arnon[2], and P. Chimienti[1]

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Abstract

The Addax-operated Obangue field in the South Gabon Basin is a sub-salt play type structure. Half of the field's oil production comes from the Late Barremian/Early Aptian Dentale Formation whose structure and facies distribution have been poorly understood. The Dentale reservoir rocks are clastic, terrigenous sediments deposited in an active continental rift environment where faults provide major control on the pattern of sedimentation.

Constraints on timing and amplitude of faulting are a key input into modelling of reservoir continuity and connectivity while knowledge of geometry and thickness of discrete lithostratigraphic units have direct impact on reservoir dynamics and recoverable volume estimates.

By applying palynological and micropaleontological analysis, combined with detailed correlations and analysis of seismic reflectors, the current study aims at verifying the existence of faults and identifying their temporal (syn- versus post-sedimentary) and spatial extent. The variations of biozone thickness are indicators of sedimentation rates and provide insight into the internal stratification of the Dentale Formation in order to aid optimal well placement and volumetric calculations.

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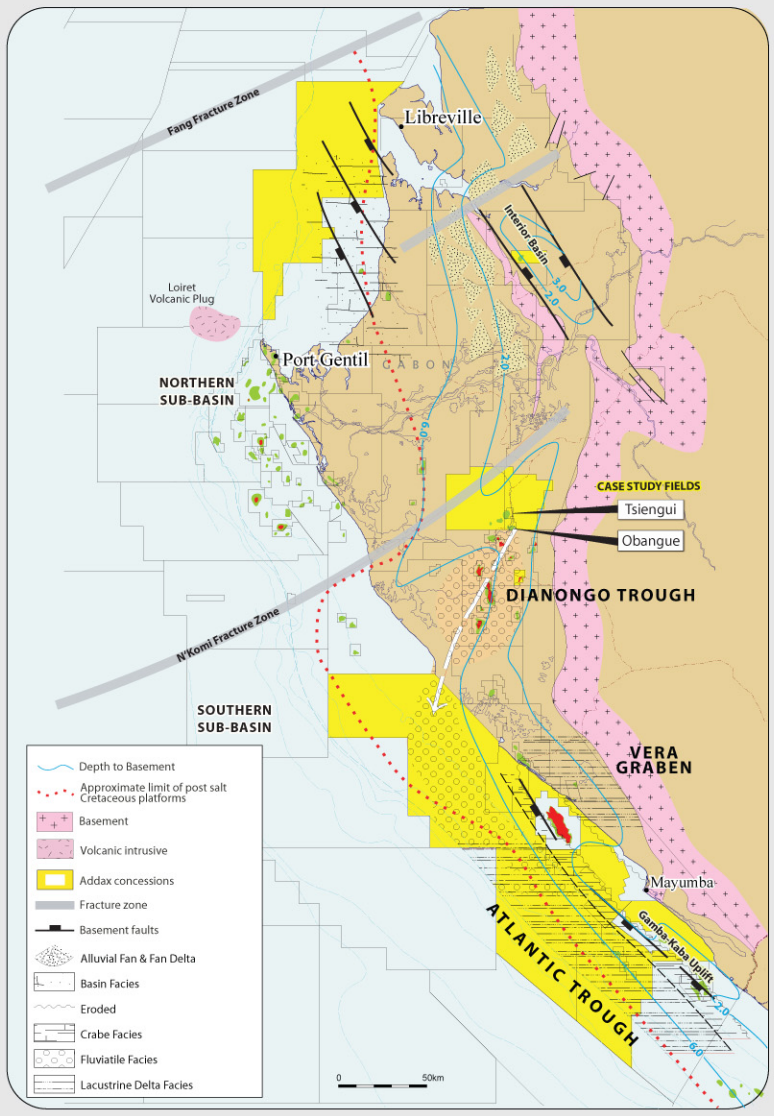
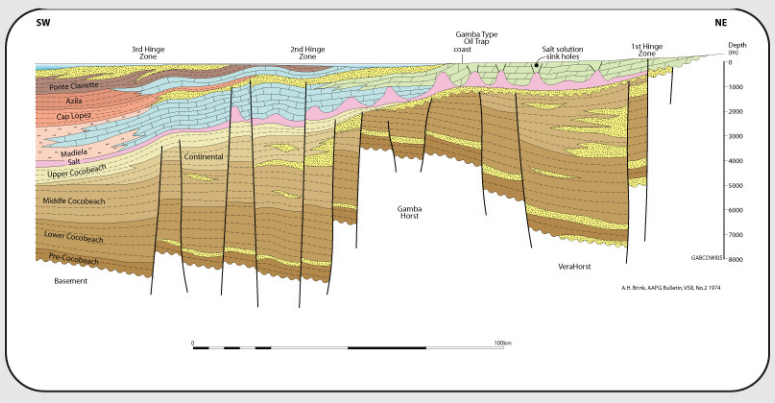
REGIONAL SYNOPSIS





CASE STUDY

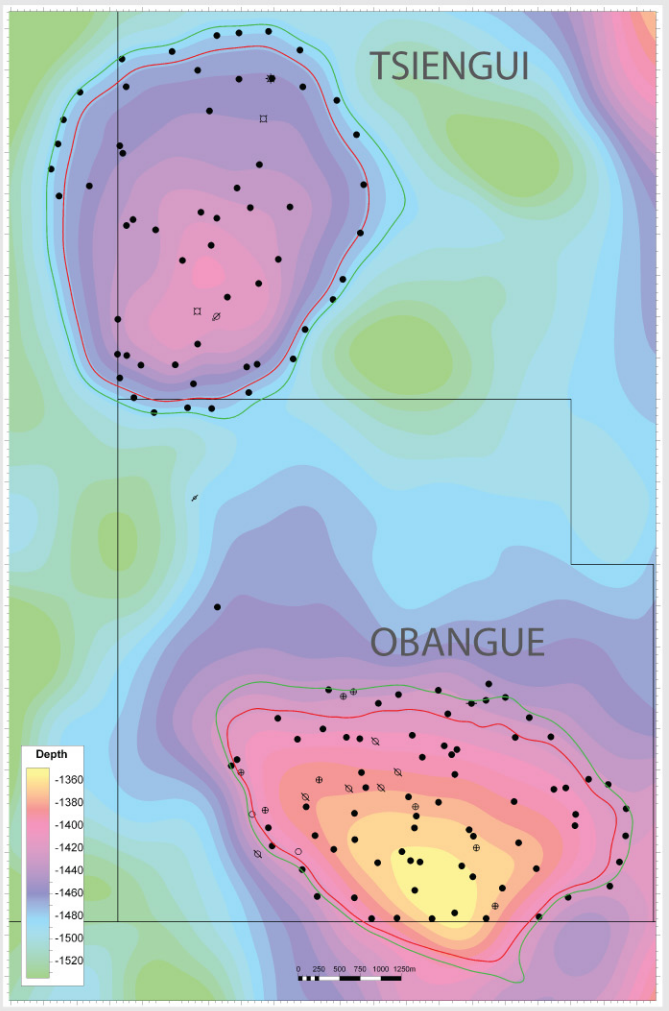
TSIENGUI FIELD

- Thin oil rim (33°API, 6-7 cp oil)
- 14m oil column
- Primary reservoir: Gamba Sandstone;
  Secondary reservoir: Dentale Formation
- Discovered in 2001, producing since 2005
- 43 Horizontal Producers
- Cumulative production: 31 MMstb

OBANGUE FIELD

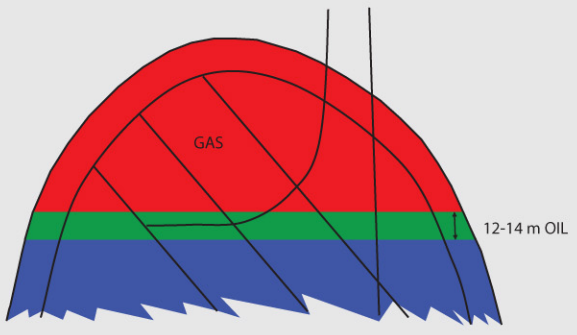
- **Thin oil rim (33°API, 6-7 cp oil)**
- **12m oil column**
- **Two reservoir zones: Gamba Sandstone and Dentale Formation sharing STOIIP in equal %**
- **Discovered in 1988, producing since 1998**
- **65 Horizontal Producers**
- **Cumulative production: 15 MMstb**

Top reservoir (Gamba Sandstone) depth map

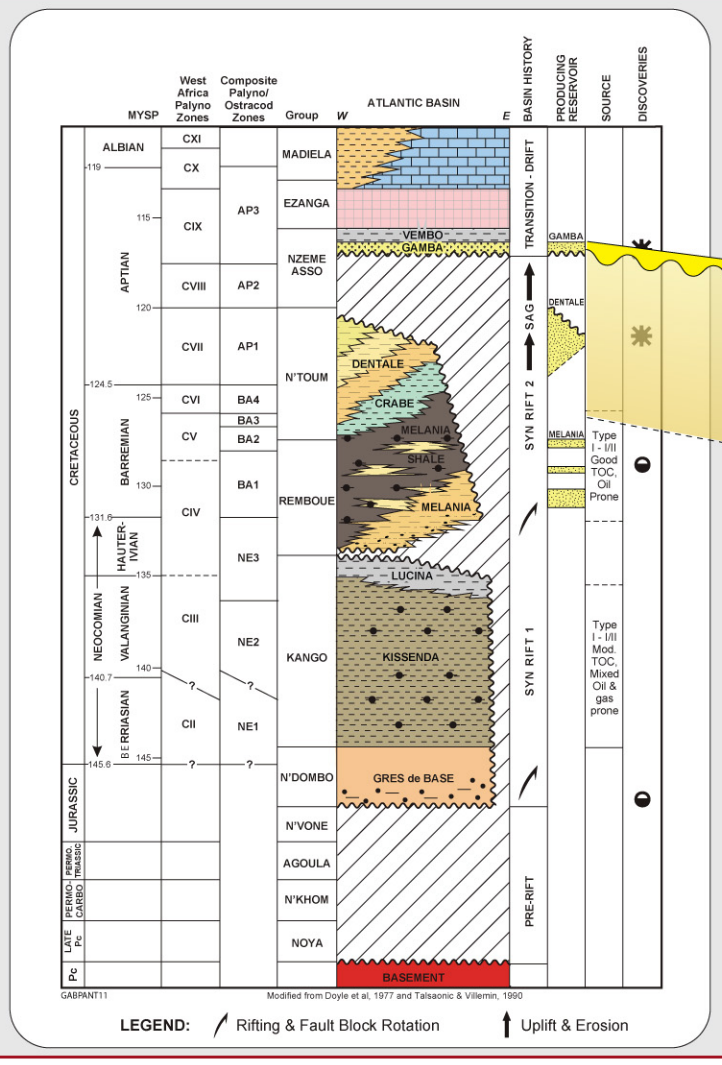


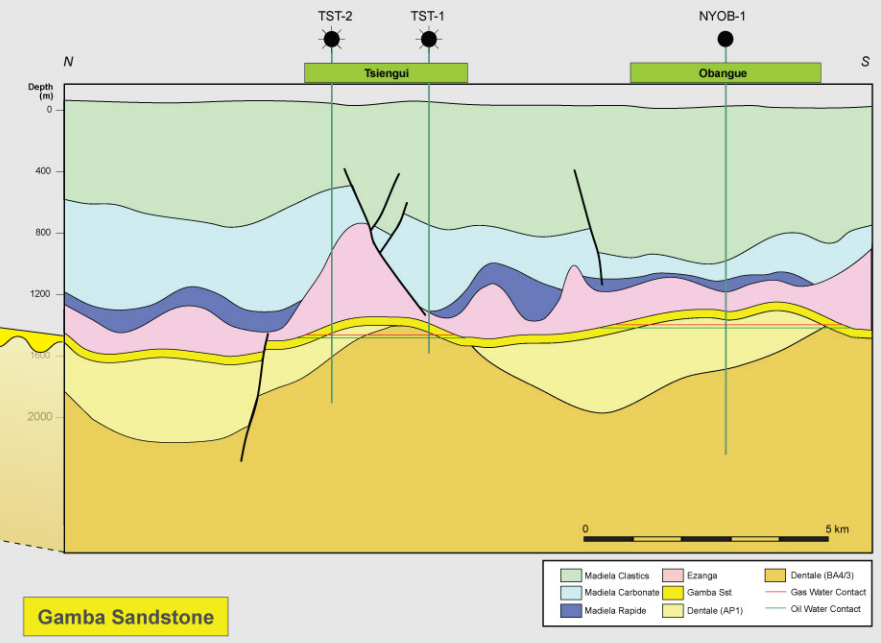
PLAY TYPE

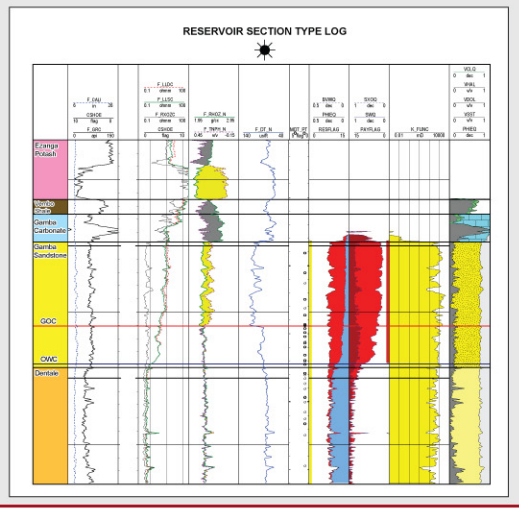
- Sub-Salt type
- 4-way closure
- Large gas cap
- Thin, viscous oil rim
- Development with horizontal drains



STRATIGRAPHY AND RESERVOIR ZONES







Gamba Sandstone

Net to Gross	>95%
Average Porosity	26%
Average Sw	25%
Permeability	>2000mD

Dentale Formation

Net to Gross	50-80%
Average Porosity	17-25%
Average Sw	33-37%
Permeability	200-1000mD

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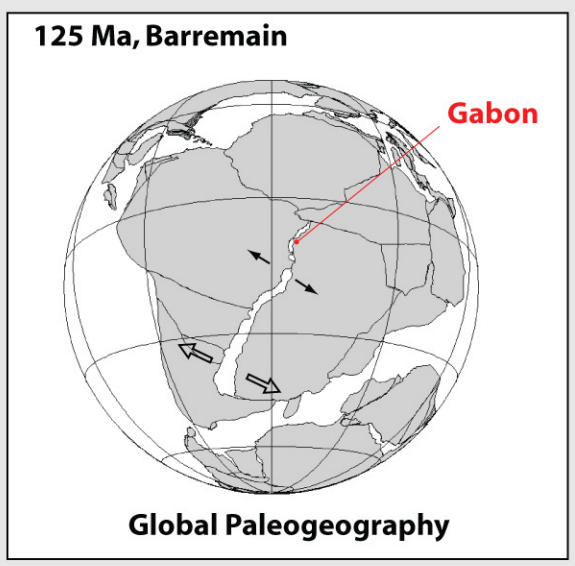
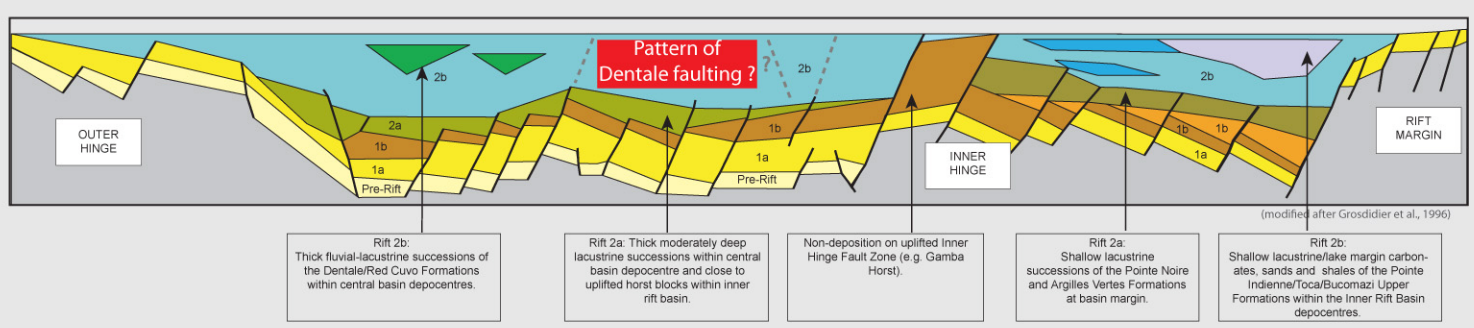
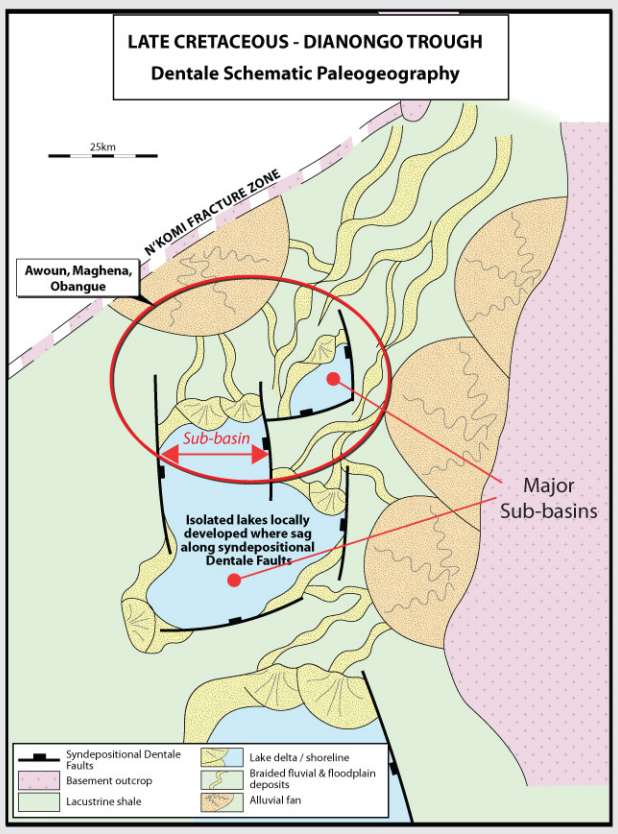
DENTALE FORMATION IN THE RIFT FRAMEWORK





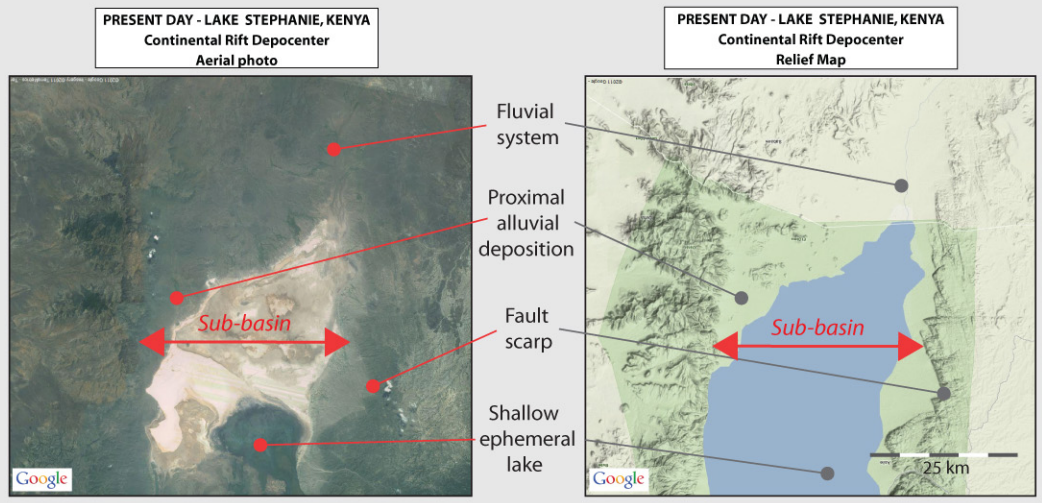
- Phase 2 of the rift succession is defined as a period of renewed, rapid subsidence combined with uplift of internal fault blocks (previously depocenters of Phase 1) and uplift of the rift basin margins
- Dentale formation belongs to Phase 2b reflecting regression and alluvial plane / shallow lake infill of the rift basin depocenters
- ***What is the control of faults on the structure and facies distribution in the basin ?***

DENTALE DEPOSITIONAL ENVIRONMENT AND PRESENT-DAY ANALOGUE



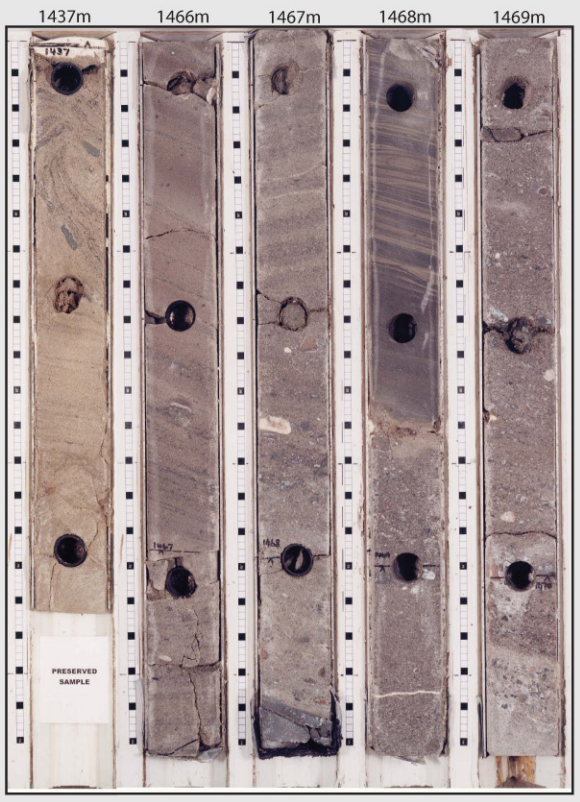
- Dentale formation found in the Tsiengui and Obangue fields broadly represents an infill of a regional tectonic depression - Dianongo Trough which accumulated sediment shed from the adjacent elevated blocks
- On a more local scale (10-50 km) deposition took place in sub-basins where sediment supply and facies distribution was controlled by activity of bounding faults
- Dominant facies are moderate - to high energy fluvial channel sandstones characterized by cross-bedding, conglomeratic intervals and rip-up clasts
- Fluvial sandstones are interbedded with shaly intervals representing overbank levee fines and shallow lake deposits

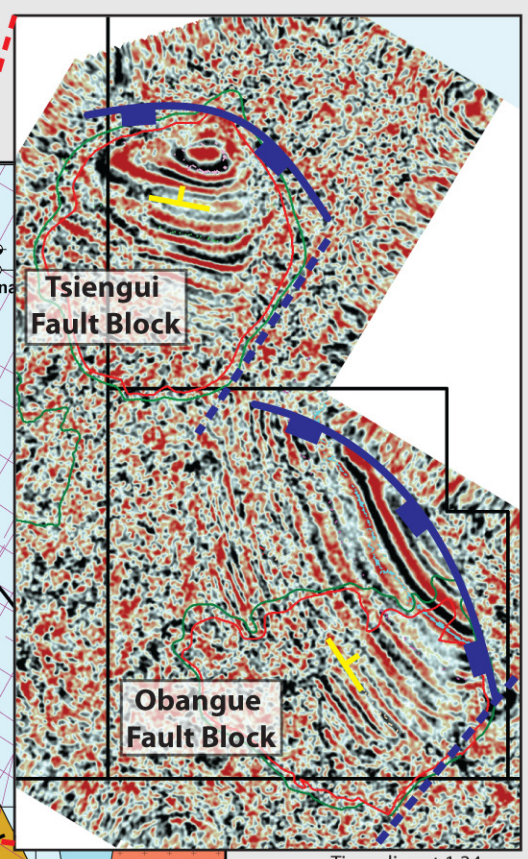
POSSIBLE ANALOGUE FOR DEPOSITIONAL ENVIRONMENT OF DENTALE



This analogue is one of many similiar settings located within the East African Rift. It has been chosen to represent a width of 25-30 km, comparable to major Dentale sub-basins within the Dianongo Trough.

Dentale cores from NZOB-7 well





Tsiengui block was controlled by a fault located to NNE

Seismic interpretation and dip direction of Dentale units indicate that the Obangue field developed in a graben which was controlled by a fault located to the East. The sediment was supplied predominantly from the high Eastern border (rift margin)

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DENTALE STRUCTURE - SIMPLE OR COMPLEX ?

• Seismic demonstrates an internal structure of the Dentale formation being an infill of a fault bounded and rotated half-graben. Growth can be observed within the sedmiment fill demonstrating differing rates of fault movement at time of depostion.

• The dip angle of the seismic reflectors is in a general agreement with well-based correlation.

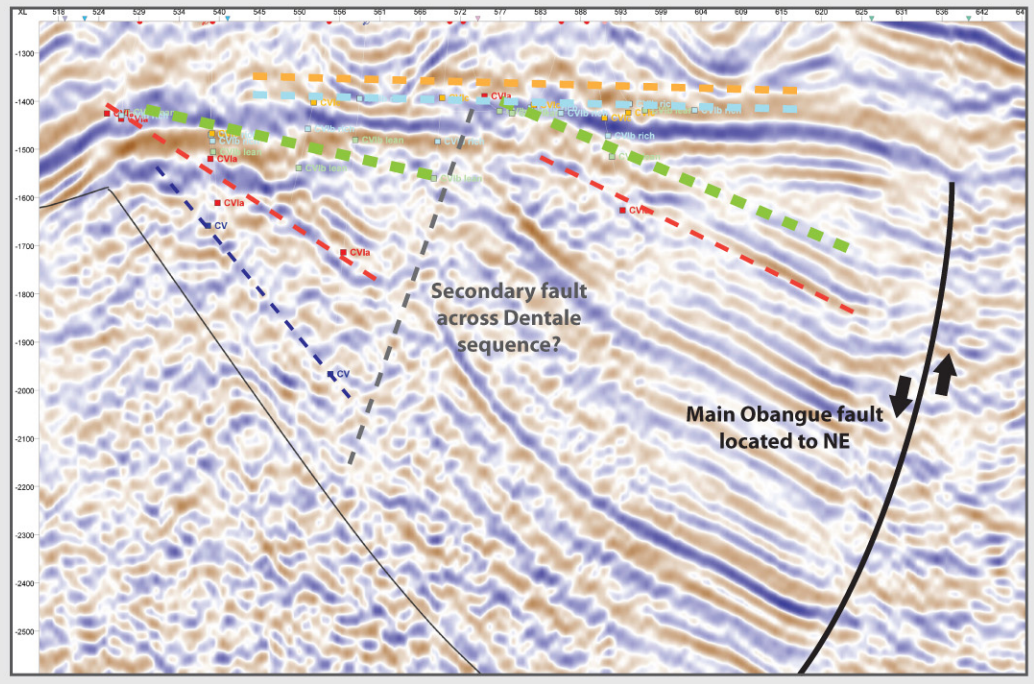
• Several wells have been analysed to determine their relative age based upon palynomorphs and ostracods.

• The Biostratigraphic palynozones identifed in the Dentale range from CV to CVI covering a time span of 3-4 Ma

• Prior to Full Field development and the drilling of 65 wells, the spatial analysis from biostratigraphic interpretation at the offset wells reveals that the stratigraphic correlation and seismic continuity mapped may not be as simple as initially observed.

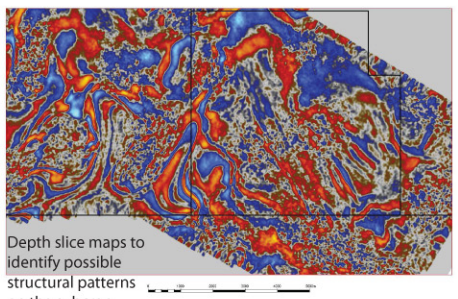
• Bio-zone correlations infer that in excess of 150m of apparent vertical displacement is required to restore sediment ages.

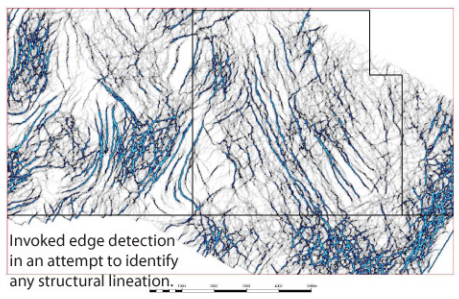
• This biostratigraphic "enigma" questioned the simplistic models and our studies attempted to identify if intra-field faulting and offset could be identified.

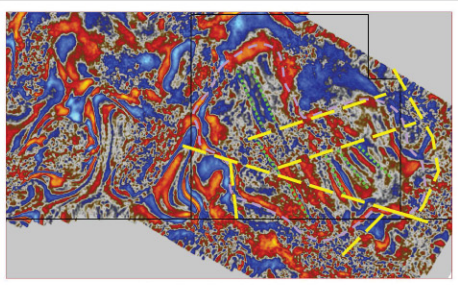


PSDM Depth slice : Uninterpreted and Annotated

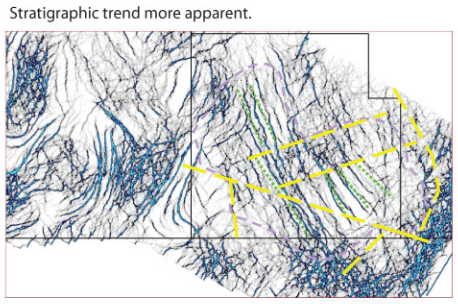
Edge detection depth slice: Uninterpreted and Annotated



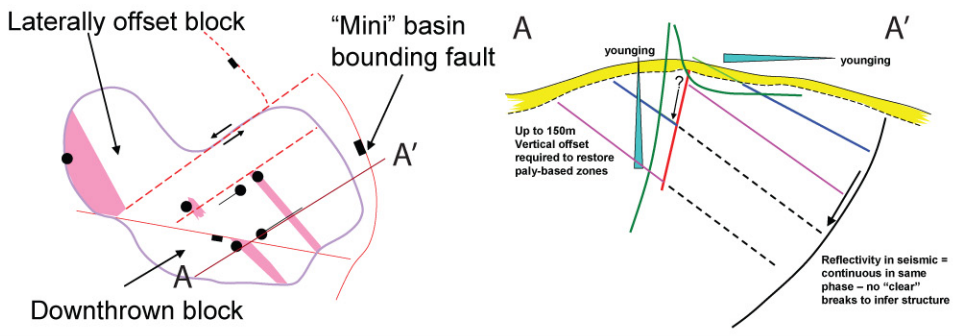


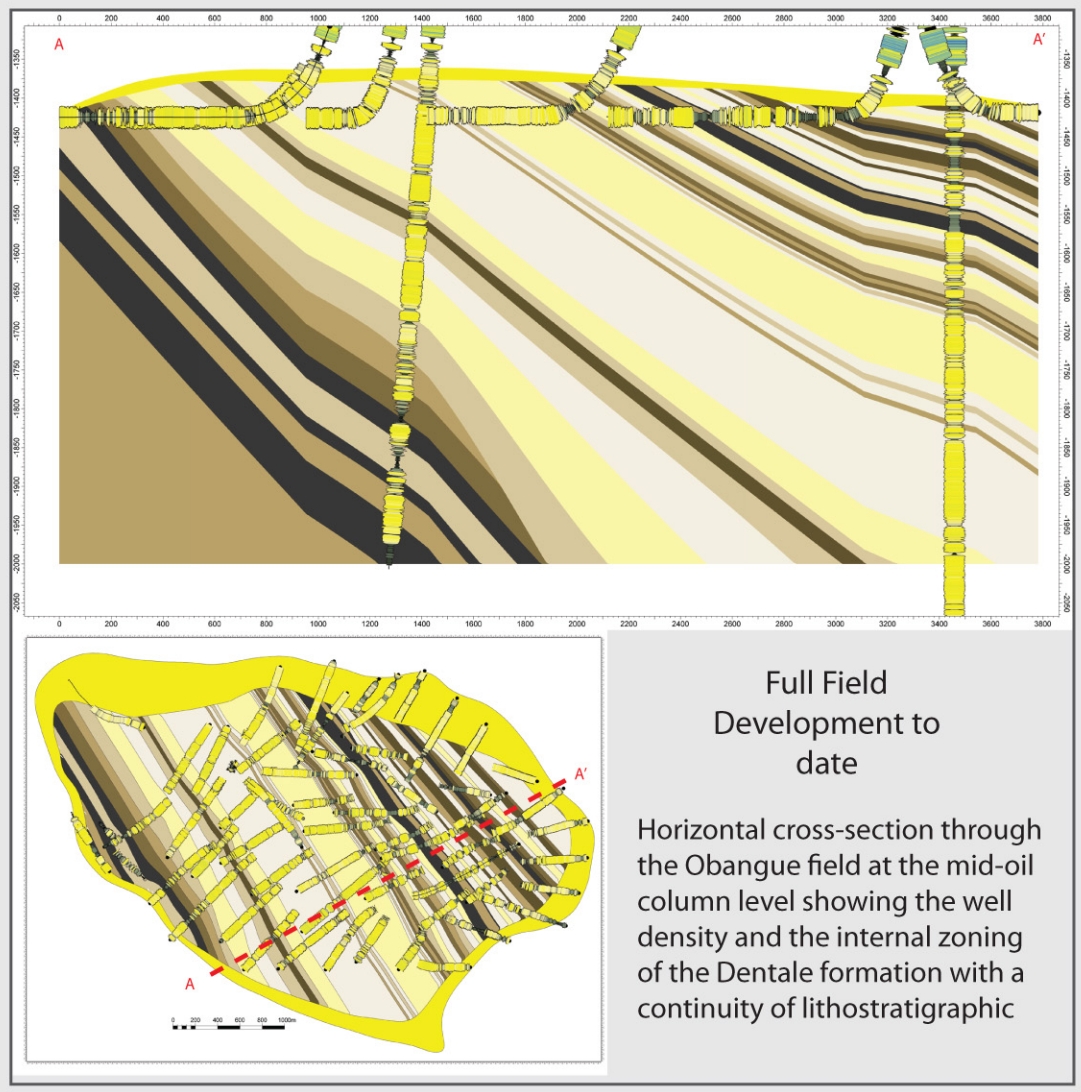


Stratigraphic trend more apparent.



Annotation shows conceptual structural configutration in an attempt to fit biostrat and the regional structural model





Full Field Development to date

Horizontal cross-section through the Obangue field at the mid-oil column level showing the well density and the internal zoning of the Dentale formation with a continuity of lithostratigraphic

• The program of biostratigraphic studies reveals liklihood of displacement not easily observed on seismic.

• However, advancing the field development through intensive drilling activity and with increased data aqcuisition revealed that it is relatively straightforward to correlate from well to well.

• The close spacing well data based on log correlations alone would support the seismic and disprove the biostratigraphic "enigma".

• However, advancing the biostratigraphic studies could reveal significant supprises in correlation and timing of deposition in the mini-basin.

• The palynology-based biostratigraphic determinations rely essentially on relative abundance of type specimen. Some of our samples were characterized by very low yields which may have skewed the assemblage statistics and compromised the accuracy of analysis.

• We are planning to acquire additional biostratigraphy data from several wells in the most enigmatic part of the field

• This case study provides a working example into the pitfalls of simple correlative assumptions for reservoir modelling, which could lead to misrepresentation of connectivities when planning a field development.

Further Reading

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Acknowledgements

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