SENEGAL SEDIMENTARY BASIN

PETROLEUM OPPORTUNITIES AND NEW DEVELOPMENTS




Summary

I - THE COUNTRY

II - PETROSEN

III - THE SEDIMENTARY BASIN AND
EXPLORATION & PRODUCTION HISTORY

IV – PLAY TYPES & NEW DEVELOPMENTS

V – PETROLEUM POTENTIAL OF PALEOZOIC BASIN

VI – WHY INVEST IN E&P IN SENEGAL




THE COUNTRY




THE COUNTRY

- **Official Name :** Republic of Senegal**.**
- **Capital :** Dakar.
- **Currency:** Franc CFA (1 Euro = 655.96 Francs CFA and 1 US Dollar = about 500 Franc CFA).
- **Official :** French.
- **Area :** 196 722 km²
- **Population** : About 12 millions
- **Main Rivers** : Senegal River
  Gambia River
  Casamance River

SENEGAL NATIONAL OIL COMPANY « PETROSEN »




PETROSEN

Creation in 1981 → **Since 1994**

MISSIONS

Upstream

- Periodic Evaluation of the Petroleum Potential of the Basin;
- Promotion of this potential to the International Oil & Gas Market;
- Participation with the companies to E&P activities ;
- Technical Control of Petroleum Operations.

Downstream

- Participation in joint venture to the Downstream Activities.



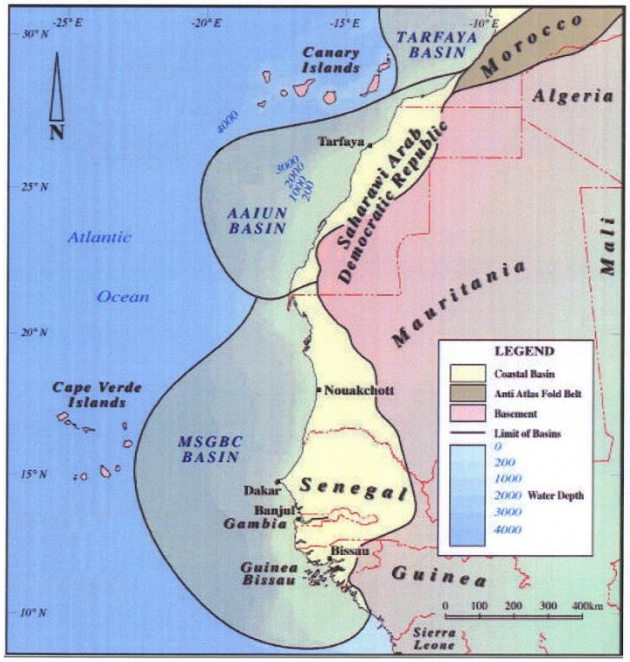

THE SEDIMENTARY BASIN AND EXPLORATION & PRODUCTION HISTORY

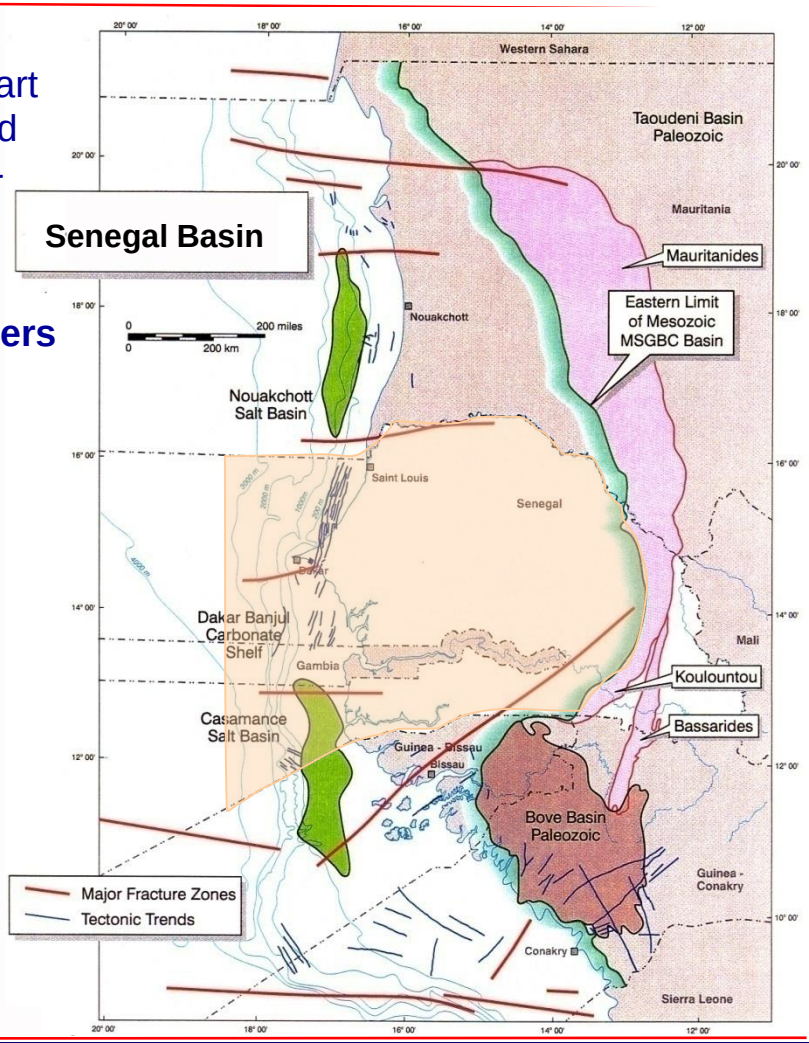



MSGBC Basin

The Senegal sedimentary basin occupies the central part of the large North-Western African coastal basin called MSGBC (Mauritania – Senegal – Gambia – Bissau – Conakry), which extends from Reguibat shield in its Northern limit to Guinea fracture zone to the South.

Total surface : 230 000 square kilometers








Exploration : from 1952 to Present

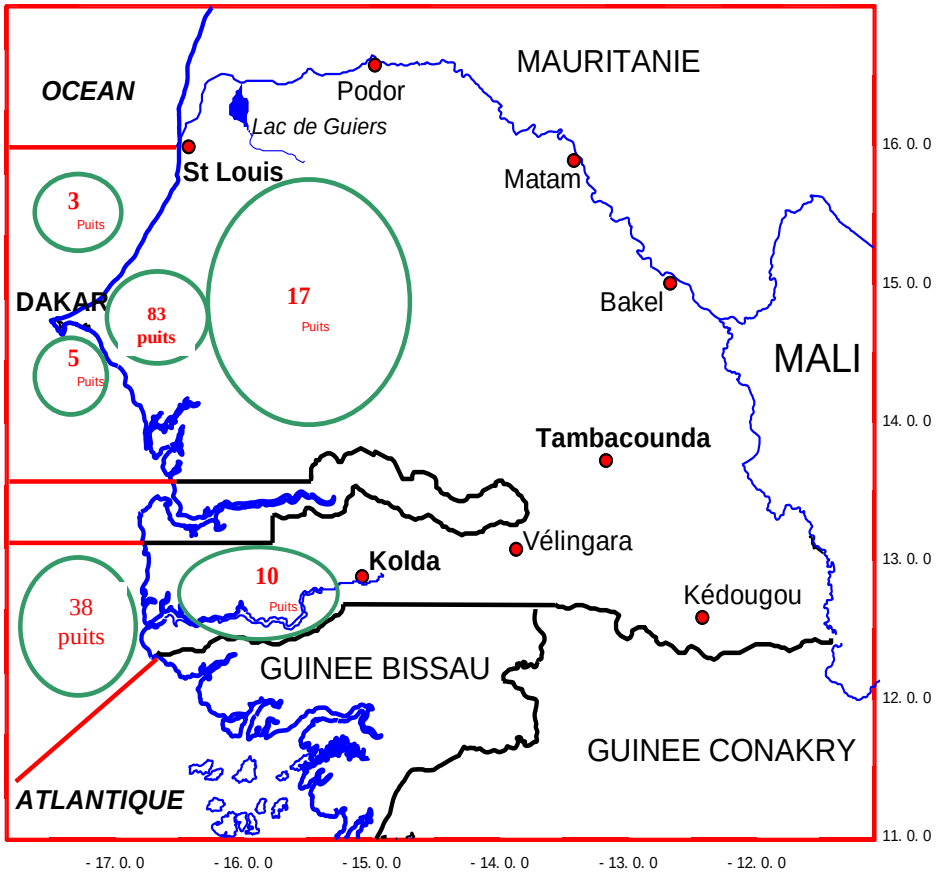
Seismic Acquisition

- 56 500 km of 2D seismic
- 9 300 km² of 3D seismic

Exploration Wells

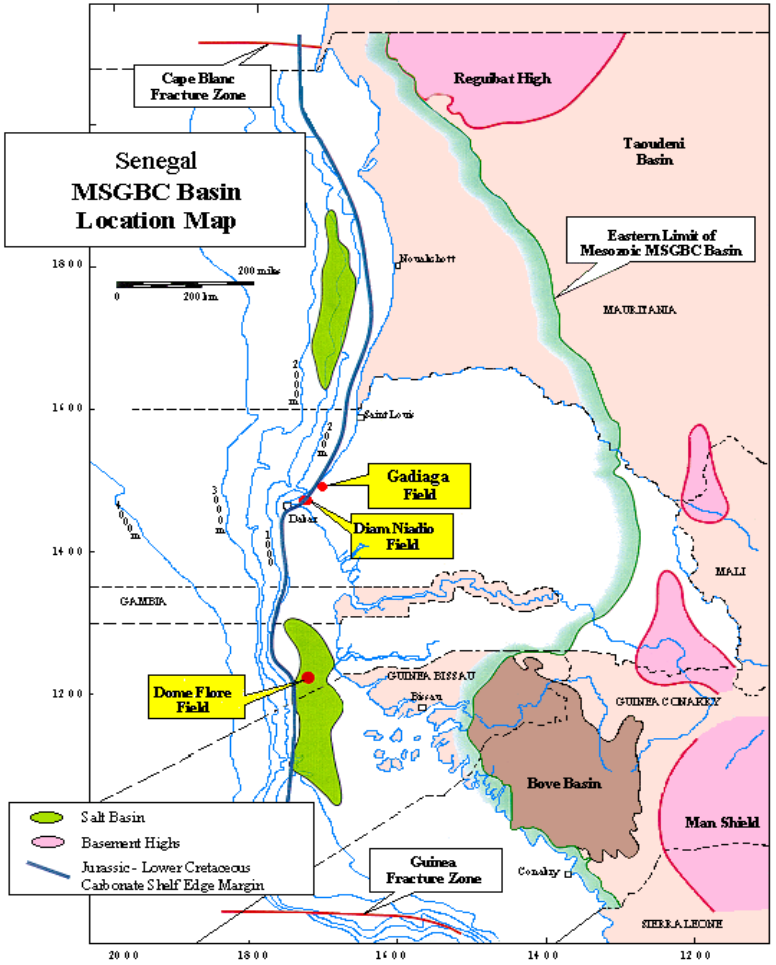
- A total of 156 exploration wells
- Average of 1 well of 1 600 km²
- Most of the wells reached shallow targets

The Basin remain under-explored






Hydrocarbon shows and Production



- **Diam Niadio in 1961**

Many small oil and gas fields in the Maastrichtian section

- **Dome Flore & Gea in 1967**

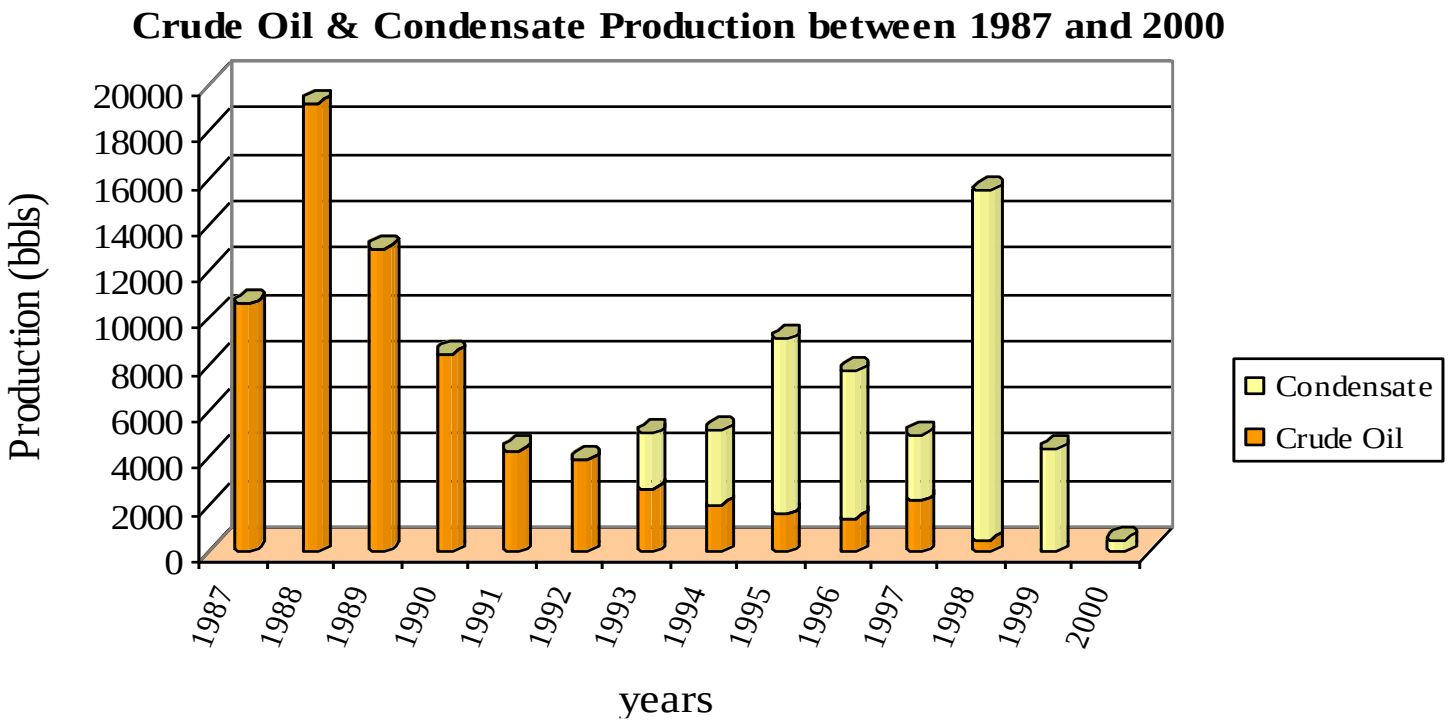
About 1 billion barrels of heavy oil in the Oligocene limestone

- **Gadiaga in 1976 / 1997**

Very important gas reserves in Campanian and Senonian sandstones.

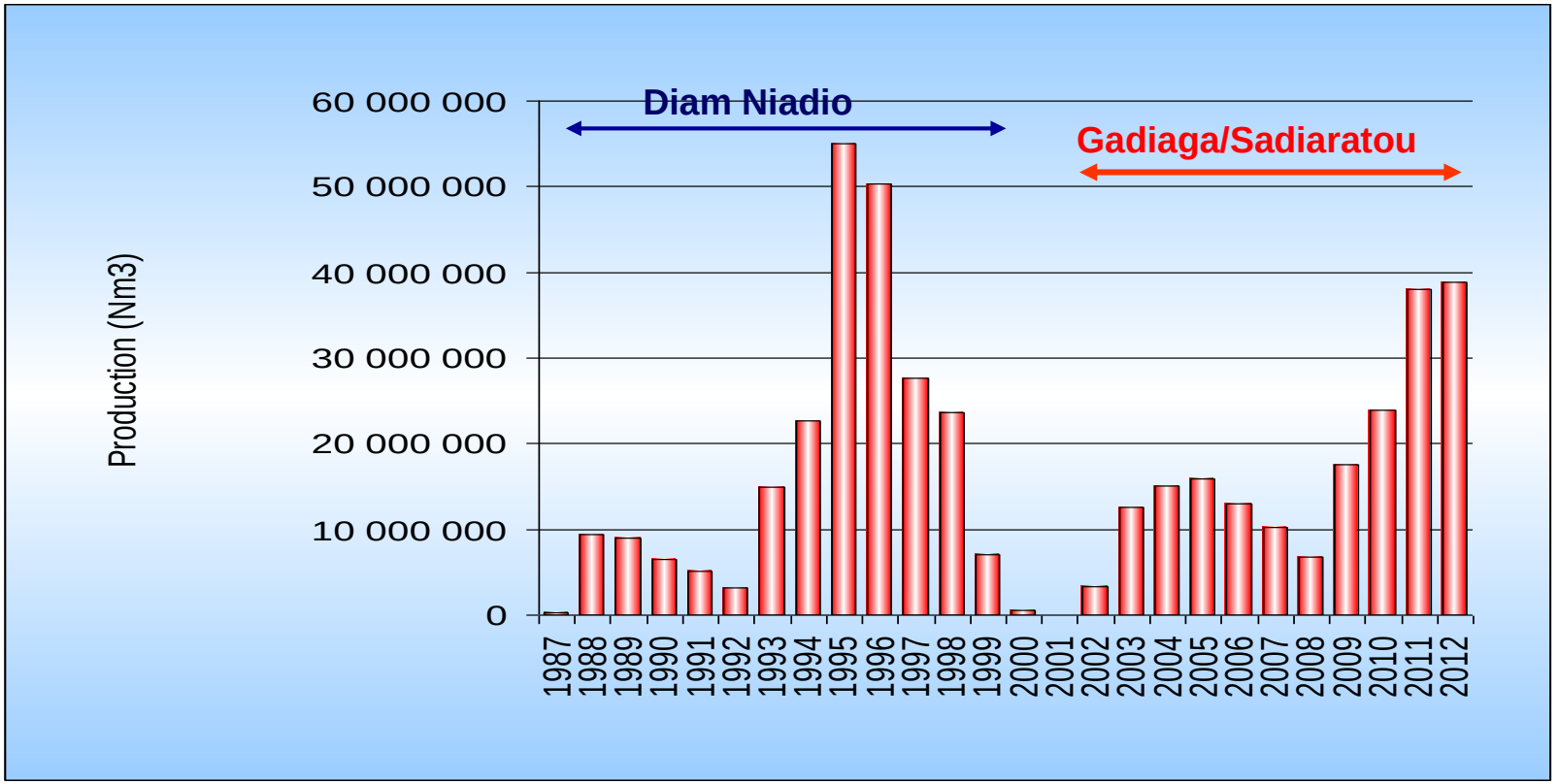



Crude Oil Production: 1987 to 2000



- 62.500 barrels of crude oil (34° API)
- 35.600 barrels of condensate

Gas Production : 1987 to 2012



- Diam Niadio : 235 000 000 Nm3 of natural gas (~8,8 BCF)
- Gadiaga/Sadiaratou : 195 000 000 Nm3 of natural gas (~7,3 BCF) (under development)

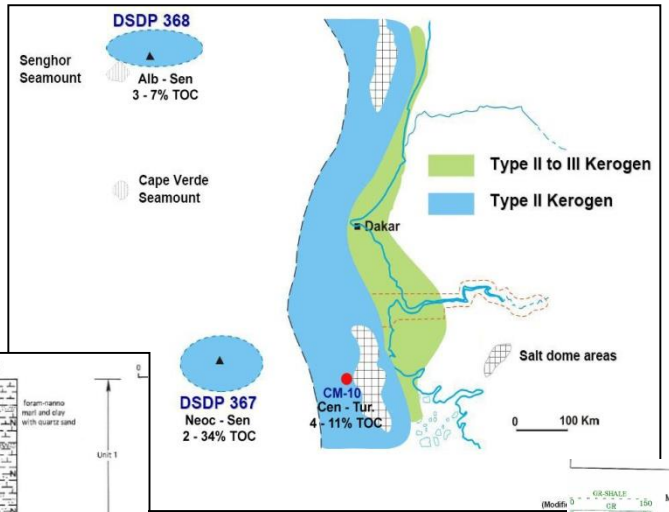



PLAY, PROSPECTIVITY AND NEW DEVELOPMENTS

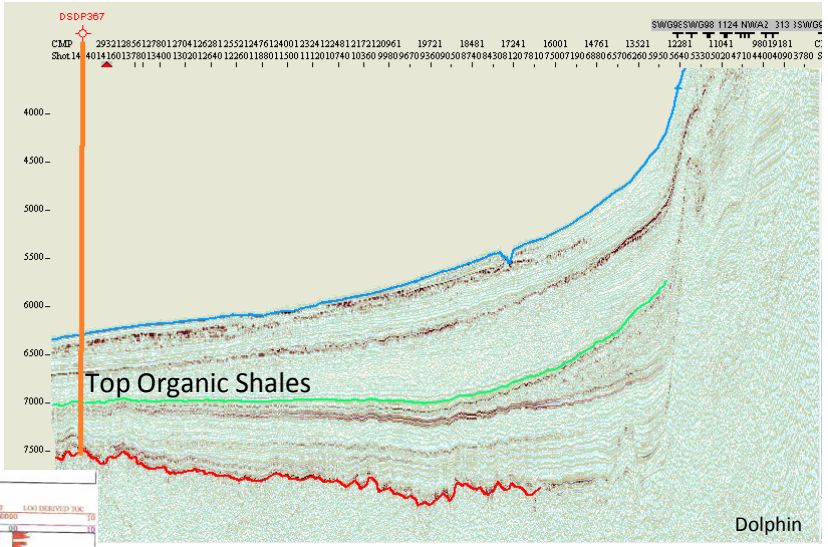


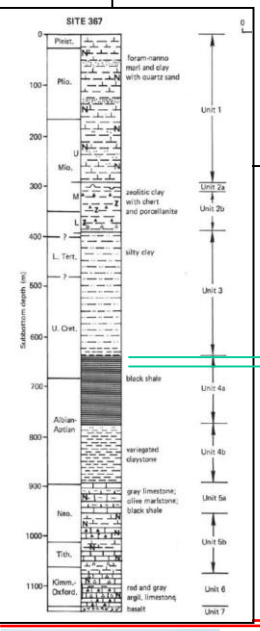

Source Rock

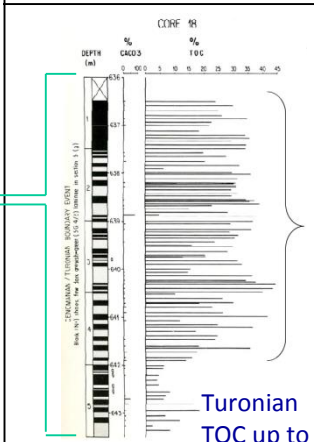
Cenomanian – Turonian Source Rock Distribution



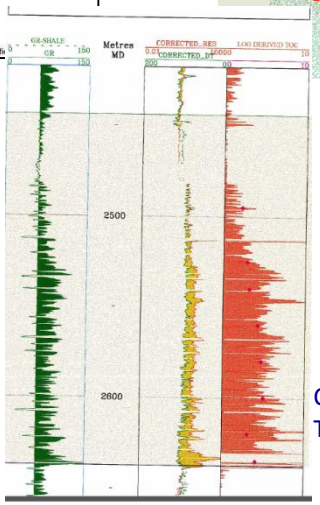
NWAAM 1038 through DSDP 367







Turonian
TOC up to 35%



- **Primary Source rock** : Cenomanian-Turonian Shales
- **Secondary Source Rock** : Albian-Aptian Shales
- Possible source rock from Jurassic

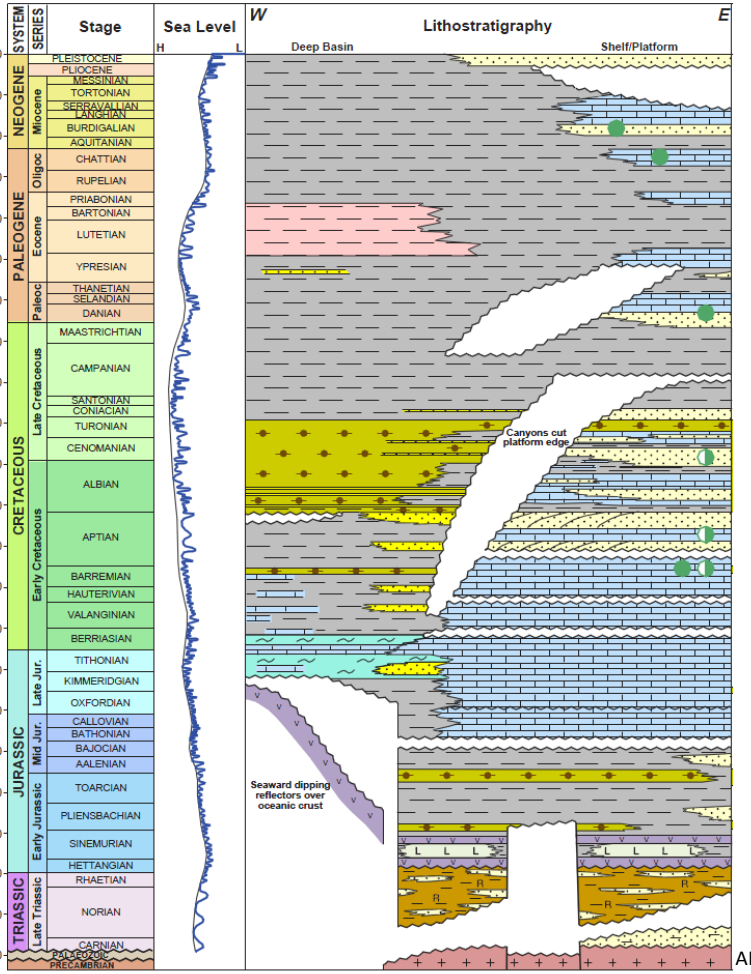
Cenomanian - Turonian at CM-10
TOC up to 11%




Reservoirs

Reservoirs Age:

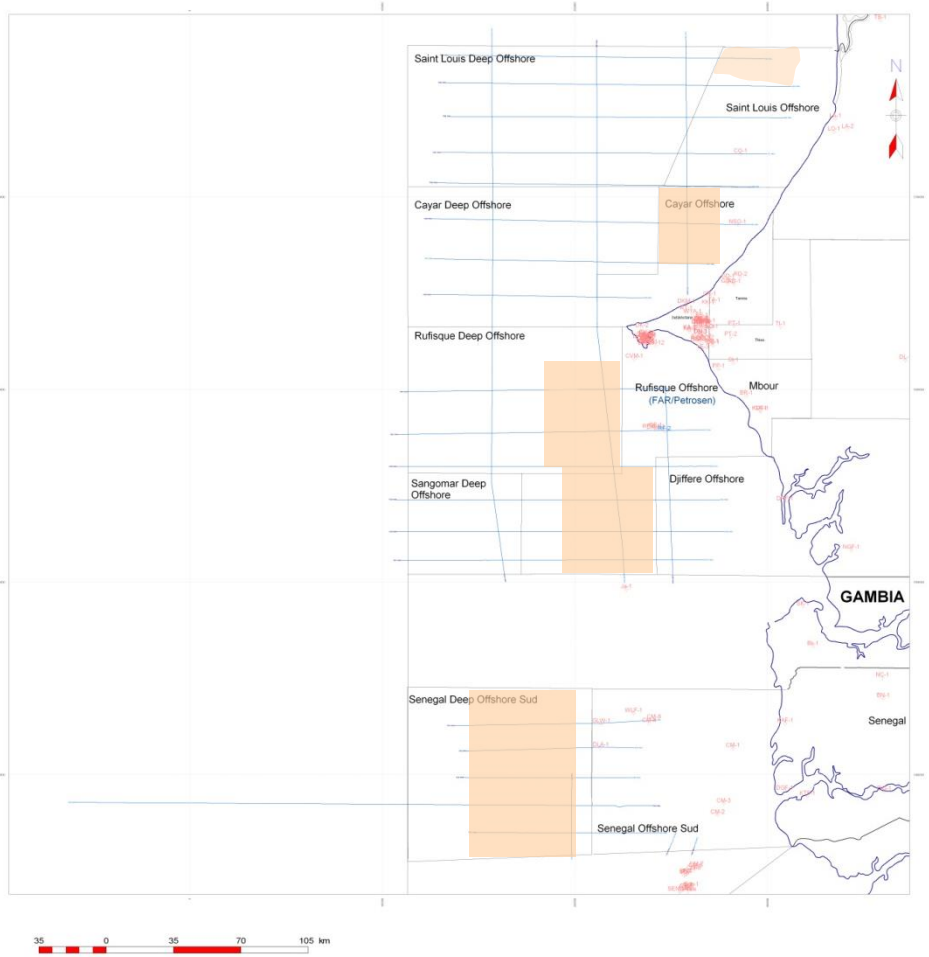
- Miocene (Dôme Flore),
- Oligocene (Dome Flore),
- Maastrichian (Diam Niadio & Dome Flore),
- Campanian (Gadiaga & Rufisque Offshore),
- Lower Senonian (Gadiaga),
- Cenomanian,
- Albian & Aptian.



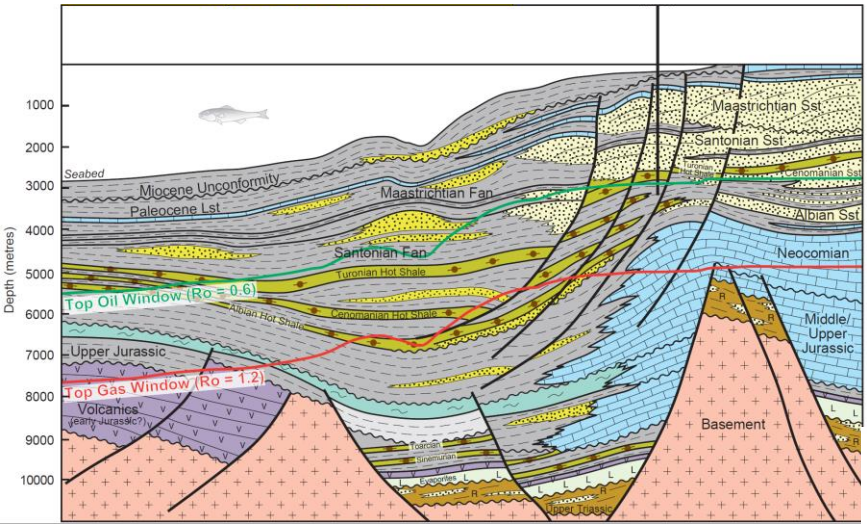
Play Types

New Seismic data

- About 4600 Km of NWAAM 2D Seismic (DOLF
- About 9163 Km² of 3D seismic Data
- Good improvement on play types definition.



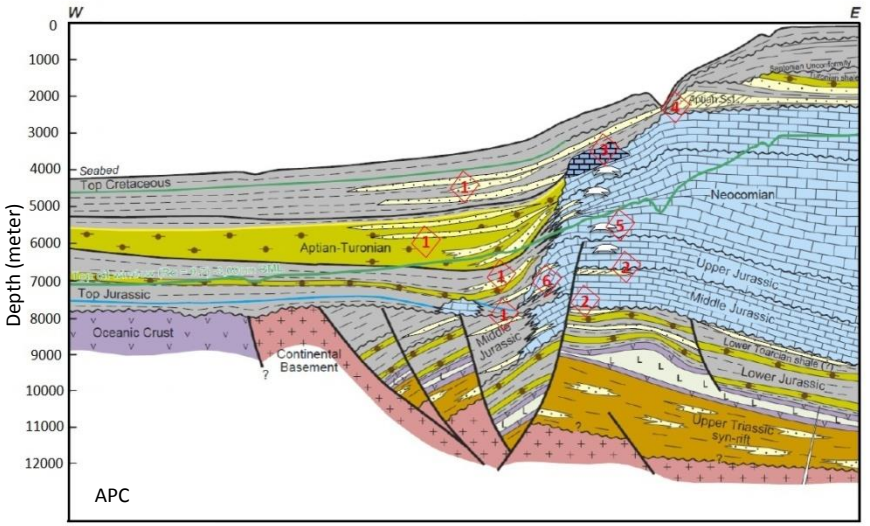
Play Types



PETROTIM

OFFSHORE NORTH PLAY TYPES

1. Roll Over Play
2. Four Way Dip Closure Play
3. Channel Fill Play
4. Turbidites Play
5. Mass Flow



APC

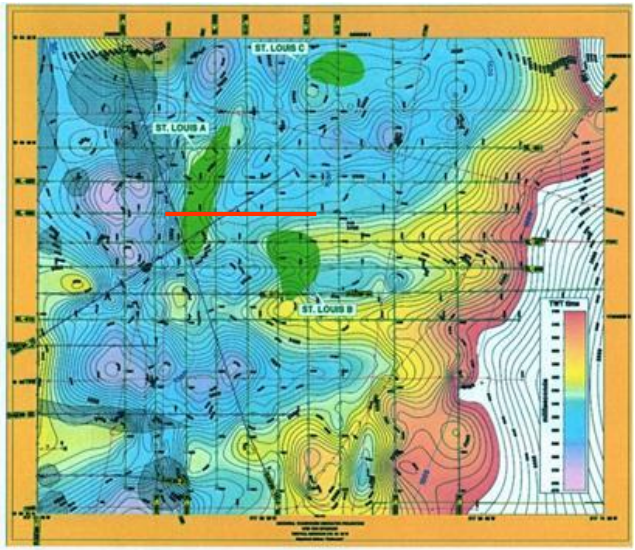
SENEGAL OFFSHORE SOUTH PLAY TYPES

1. Deep Water Fans : Channel Levee Complex
2. Late Jurassic Clastic Progrades
3. Carbonate 4-Way Dip Closures
4. Clastic Progrades (Unconformity Trap)
5. Karst Features in Carbonate Platform
6. Intra-carbonate Clastic Truncations



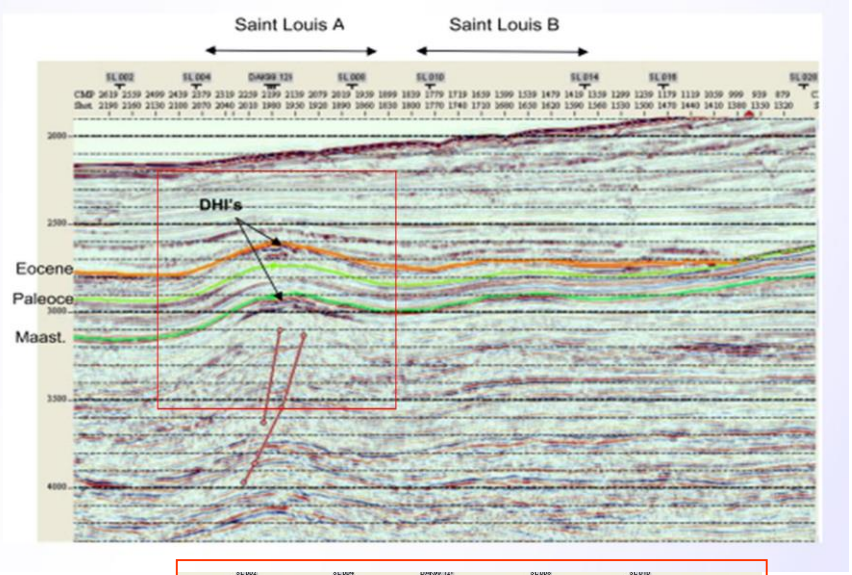

Plays: Forway Closure

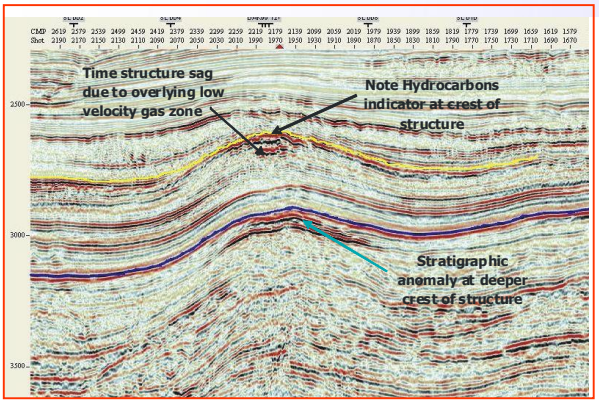
Saint Louis Offshore Deep



Map showing the Saint Louis A, B and C prospects location

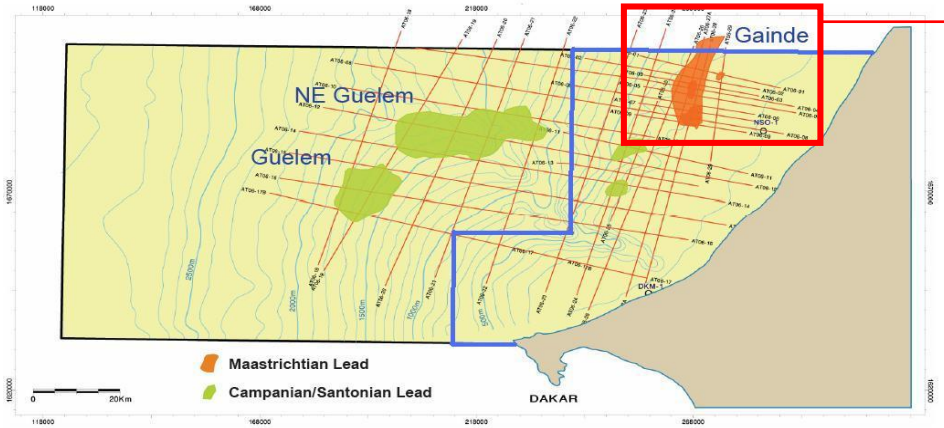
Seismic Section through A prospect

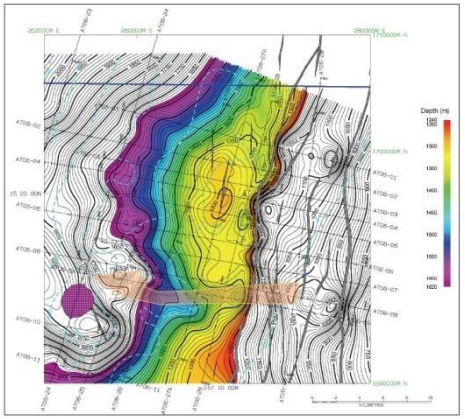




Plays : Anticline Against Listric Fault

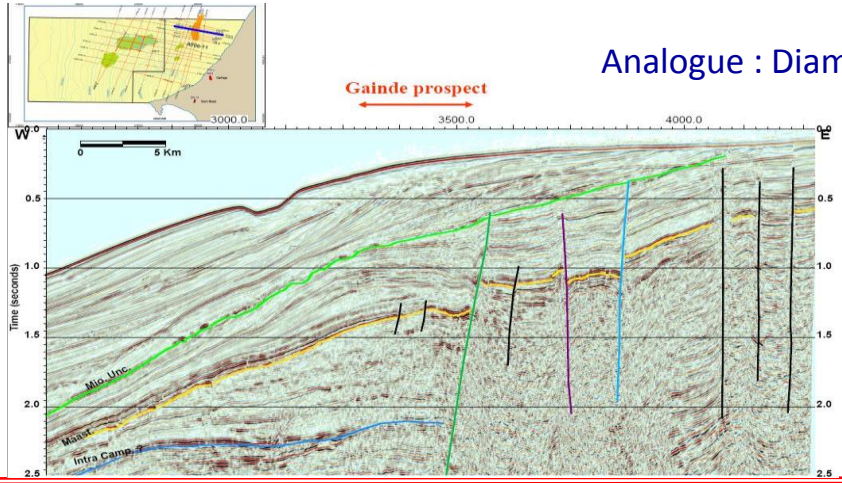
Cayar Offshore





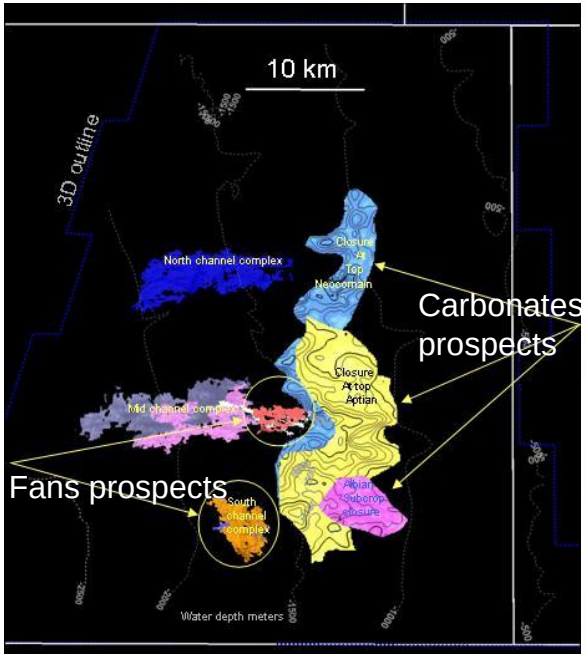
Gainde Prospect

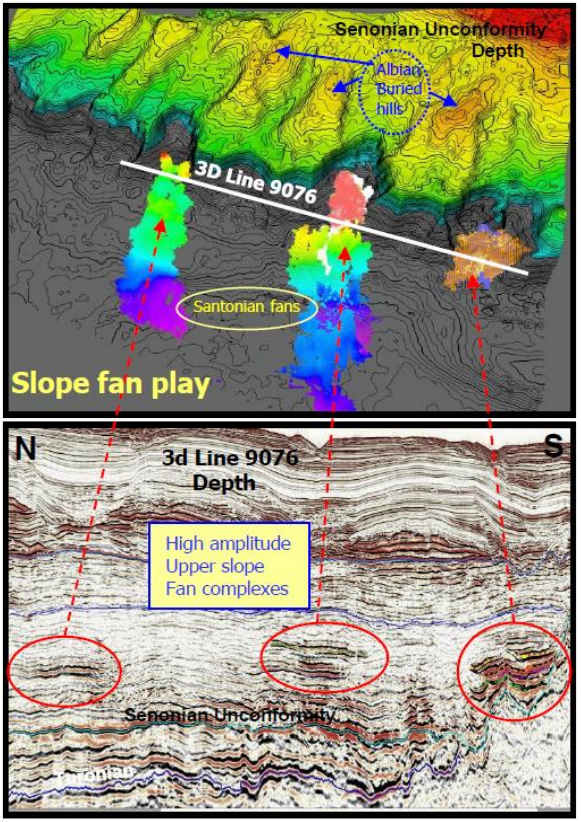
Analogue : Diam Niadio & Gadiaga Fields

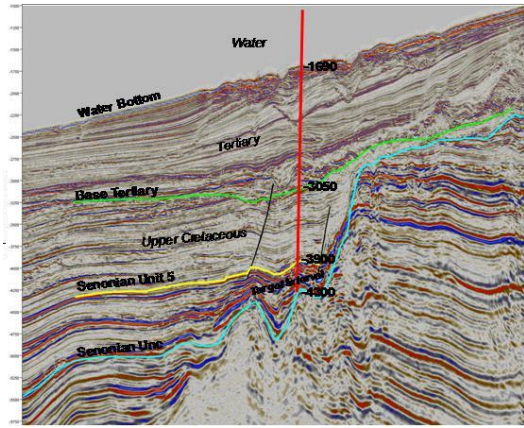


Plays : Chenal Fans Complex

Sangomar Offshore Profond : 3 fans prospects were mapped using the 3D seismic







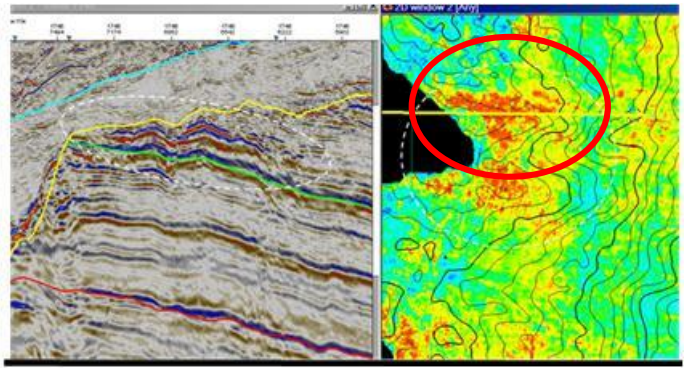
South fan Prospect

FAR

Plays : Carbonates

Sangomar Offshore

Carbonate Prospect



Camposa Field, Spain

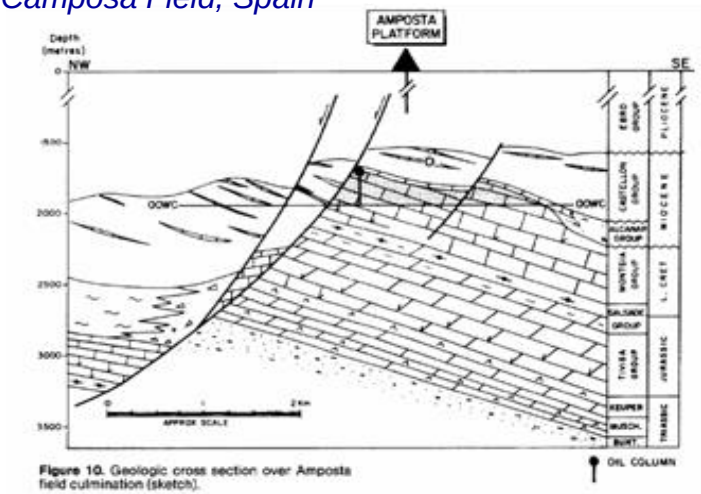
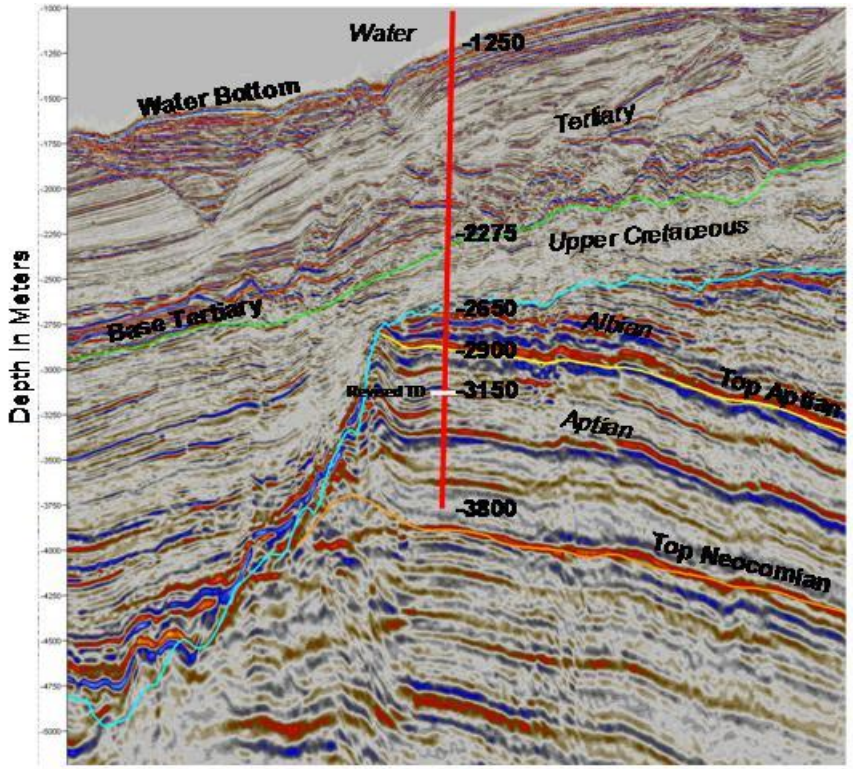


Figure 10. Geologic cross section over Amposta field culmination (sketch).

Carbonate Prospects



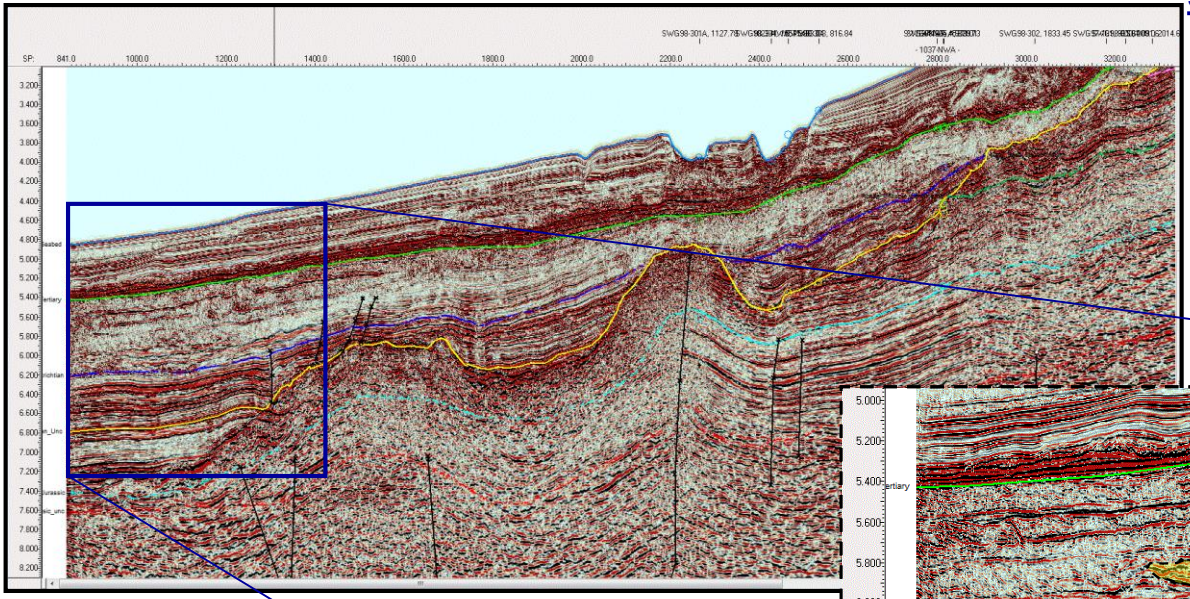
Carbonate Prospect : Proposed well location

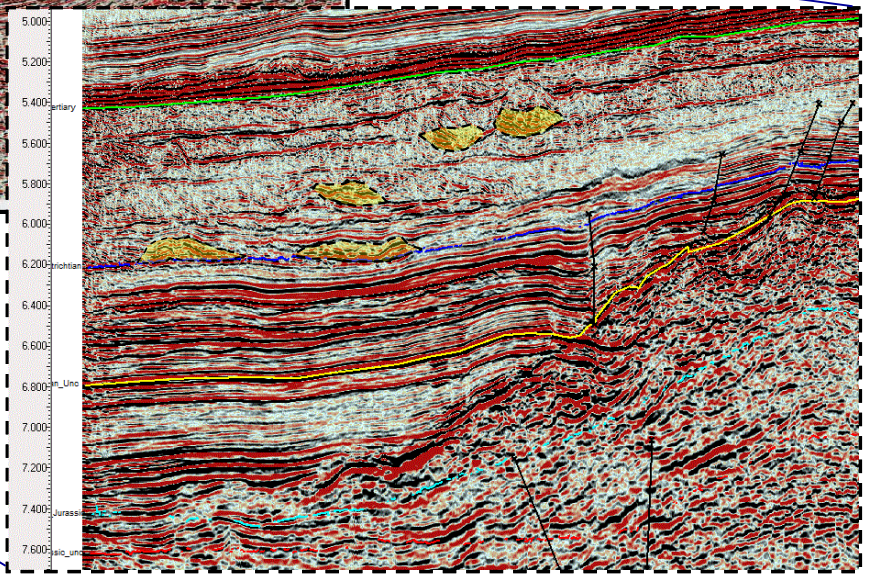
FAR

Plays : Chenal Complex

Senegal Offshore South Deep

- Possible Maastrichtian deep water channels/fans.





DOLPHIN & APC

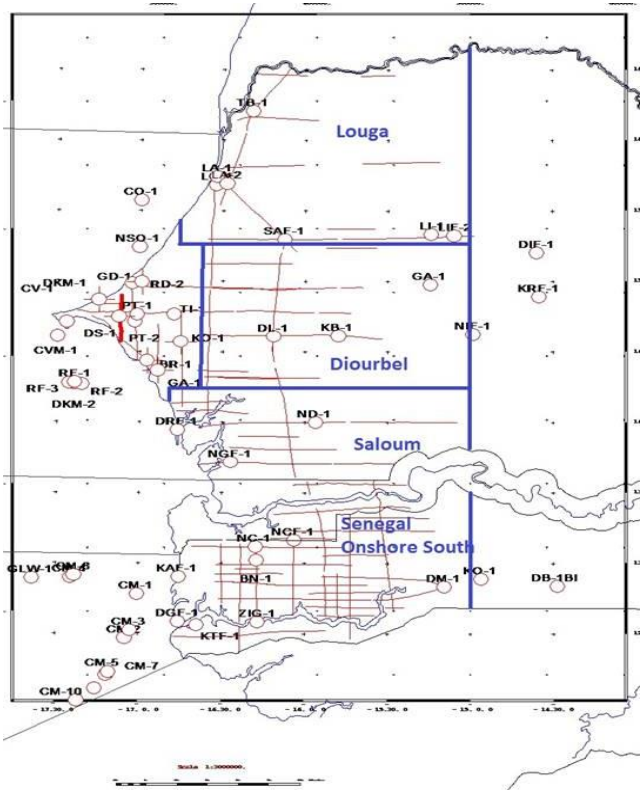



PETROLEUM POTENTIAL OF PALEOZOIC BASIN

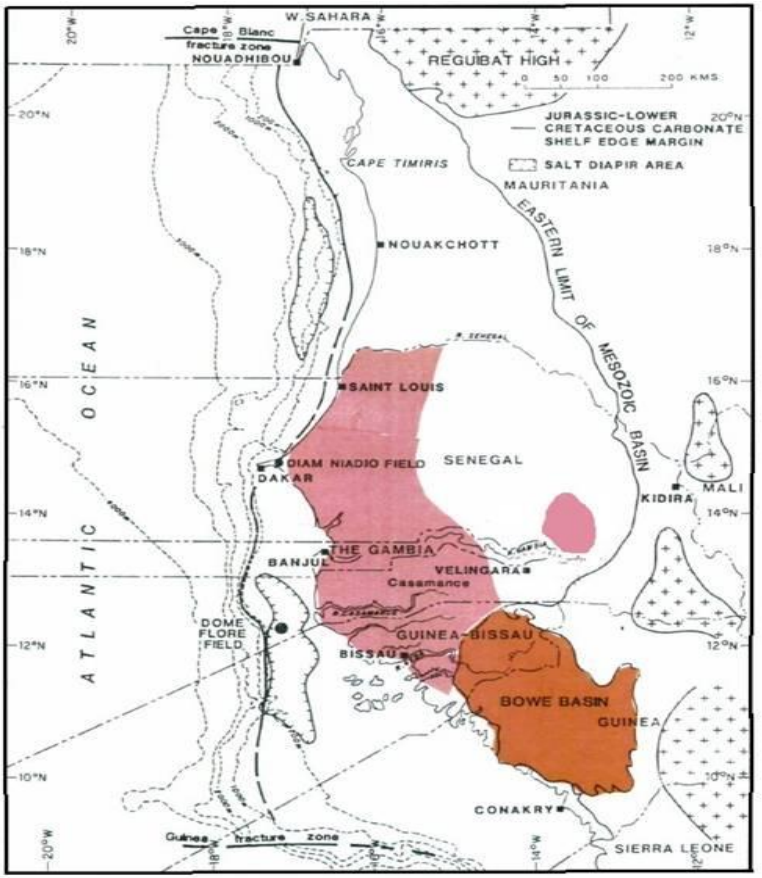



Paleozoic Basin

- Surface : About 60 000 km²
- Two sub-basins in Senegal East Area



seismic coverage



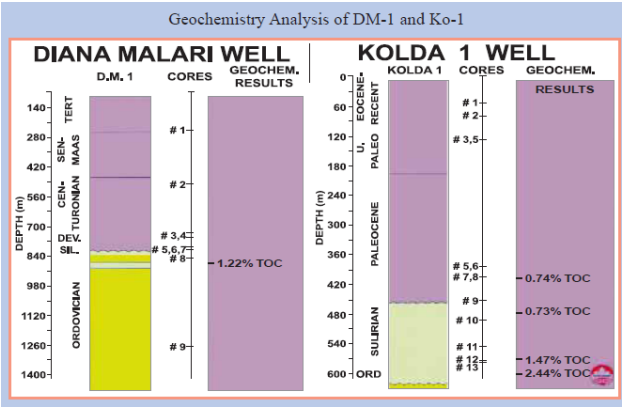
Extension of the Paleozoic Basin in Senegal & Guinea Bissau




Paleozoic Basin : Source rocks & reservoirs

Source Rocks

- Silurian black shales with TOC between 1 to 3% and vitrinite reflectance between 0.95 to 1.3



Gas Shale Field	Depth (m)	Sediment	TOC (%)	Vitrinite: Ro (%)
Antrim (Michigan – USA)	228.5 – 914	Devonian Shales	0.3 – 8	0.6
Barnett (Texas – USA)	1981 – 2438	Devonian Mississippian Mudrock Shales	3 – 5	0.6 – 2.1
Woodford (Oklahoma – USA)	1829 – 3657.6	Miss/Devonian Shales	1 – 14	0.8 – 4.7
Fayetteville (Arkansas – USA)	609.6 – 1981	Devonian Mississippian Shales	1 – 5	1.3
Bossier-Haynesville (Texas/Louisiana – USA)	3048 – 4876.8	Jurassic Shales - Mudstone	0.3 – 4.5	0.9 – 2.6
Tanezzuft - ALGERIA	1200 –1600	Silurian shales	0.8 – 8	1.1 – 1.75
Tanezzuft - ALGERIA	800 – 1200	Middle to Upper Devonian Shales	2 – 8	1.1 – 1.3
SENEGAL Onshore South Block	543 – 789	Silurian shales	1 – 3	0.95 – 1.3

Reservoirs

- The Ordovician quartzitic sandstones, interspersed with shales. Their porosity and permeability are almost nil but they are generally highly fractured, which gives them a good secondary porosity.

The seal for these reservoirs could be represented by interspersed shales or by overlying Silurian shales

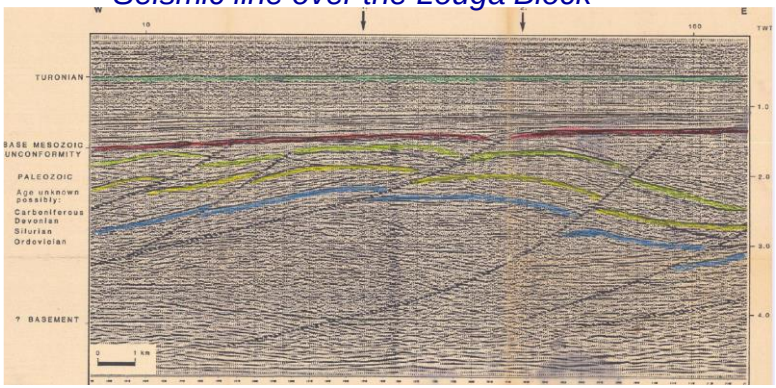
- The Devonian sandstones can constitute important reservoirs of hydrocarbon generated by Silurian shales and sealed by argillaceous formations of the upper Devonian



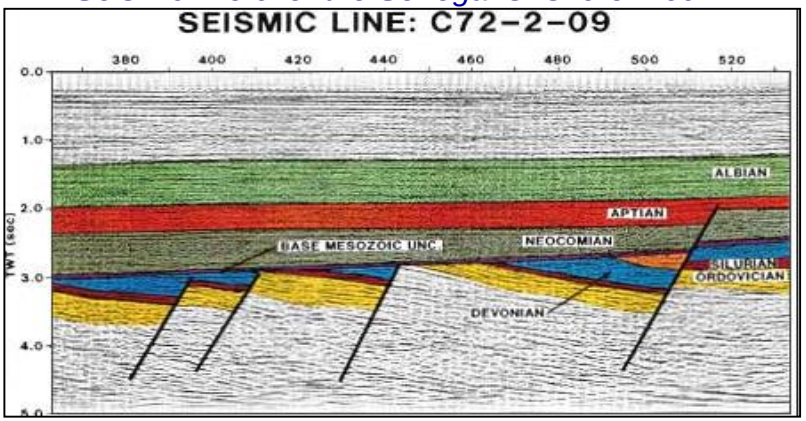

Structures

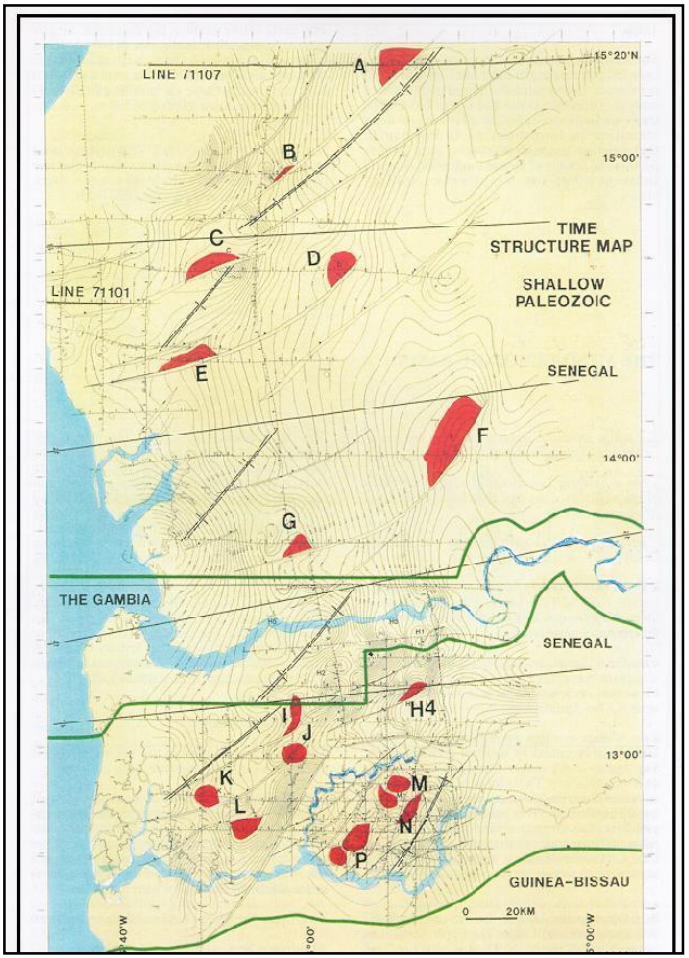
About 17 structures were mapped using seismic data from Shell 1970's and Petrosen/PetroCanada 1990's

Seismic line over the Louga Block



Seismic line over the Senegal Onshore Block





Shallow Paleozoic Time Structure Map



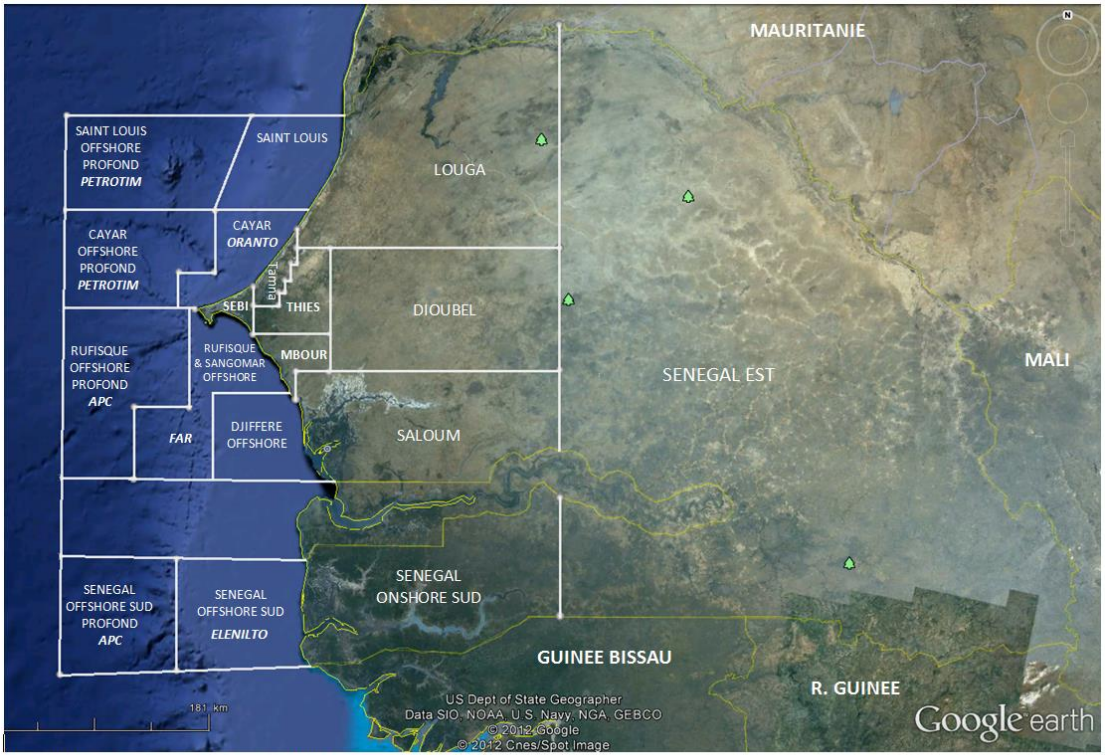

Licenses and Open Blocks Map

Licenses

- 8 PSC offshore
- 2 PSC onshore
- *10 Companies*

Available Blocks

- *1 open blocks offshore (under negotiation)*
- *6 open blocks onshore*
- *Many Express of interest from Companies*



Permis de Tamna : Opérateur FORTESA




Why Invest in Senegal?

7 REASONS TO INVEST

- A Stable and Open Country
- Modern Key Infrastructures
- Healthy and Competitive Economy
- Quality Human Resources
- Legal and Tax Incentive
- Privileged Access to Regional and International Markets
- An exceptional Quality of Life

Why Invest in E&P in Senegal?

8th REASON TO INVEST

Petroleum Potential

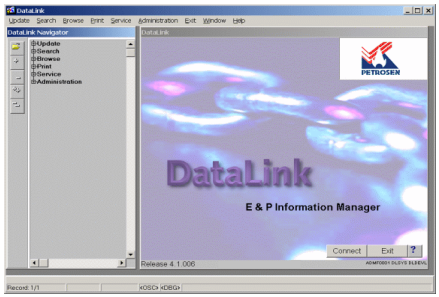
- Hydrocarbons Discoveries & Shows (Diam Niadio, Gadiaga, Dome Flore, Rufisque Offshore)
- Presence of Source Rocks : (Turonian, Cenomanian, Albo-Aptian & Silurian shales)
- **Multiples play types in the deep offshore**
- **Potential for gas shales onshore**

Legislation & Regulation

- Revision of the Petroleum Code with some improvements Focus also on Local Content & CSR
- Establishment of Petroleum Operations Regulation

Organized Data Center

Physical & Digital Data Management System



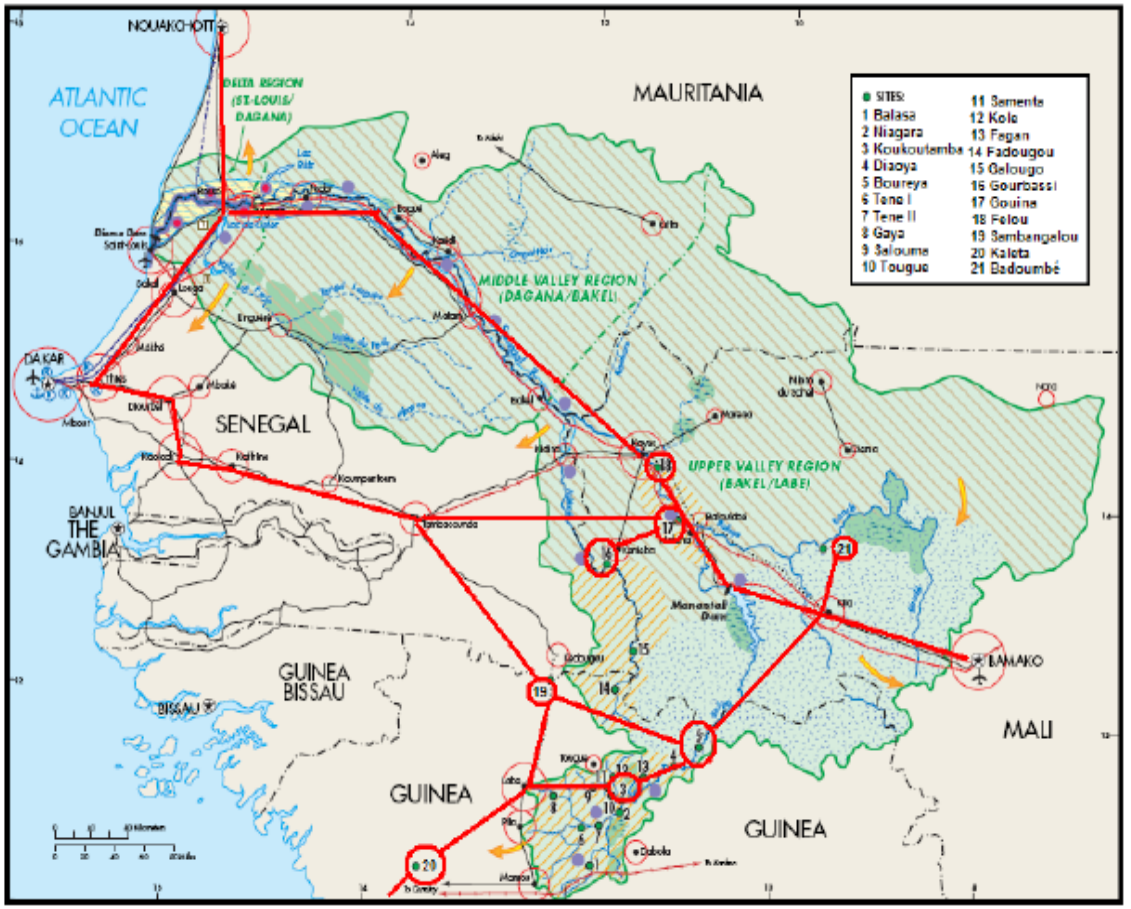
Copy & Transcription System




Why Invest in Gas Exploration in Senegal?

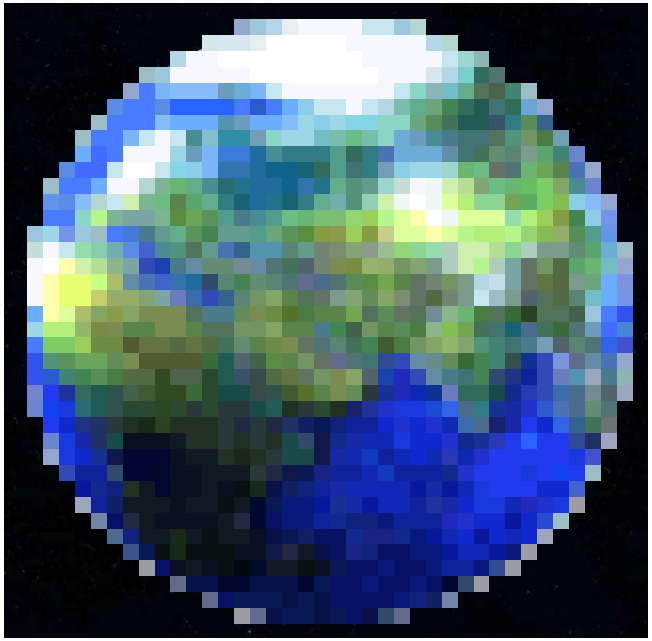
9th REASON TO INVEST

- Gas Potential!
- Need of Power in Senegal and the surrounding Countries
- Existence of a Power Network



C’est le pétrole qui fait tourner la Terre, quand y aura plus de pétrole, la terre ne tournera plus

“Les Nouvelles Brèves de Comptoir”



Thank you