



SENEGAL SEDIMENTARY BASIN POTENTIAL

EXPLORATION UPDATE, OPEN ACREAGES



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OUTLINE



I. REGIONAL SETTING

II. SENEGAL BASIN

III. EXPLORATION & PRODUCTION HISTORY

**IV. REVIEW OF RECENT EXPLORATION & DEVELOPMENT
ACTIVITIES**

V. OFFSHORE AND ONSHORE OPEN BLOCKS

VI. PETROLEUM LEGISLATION

VII. CONCLUSION

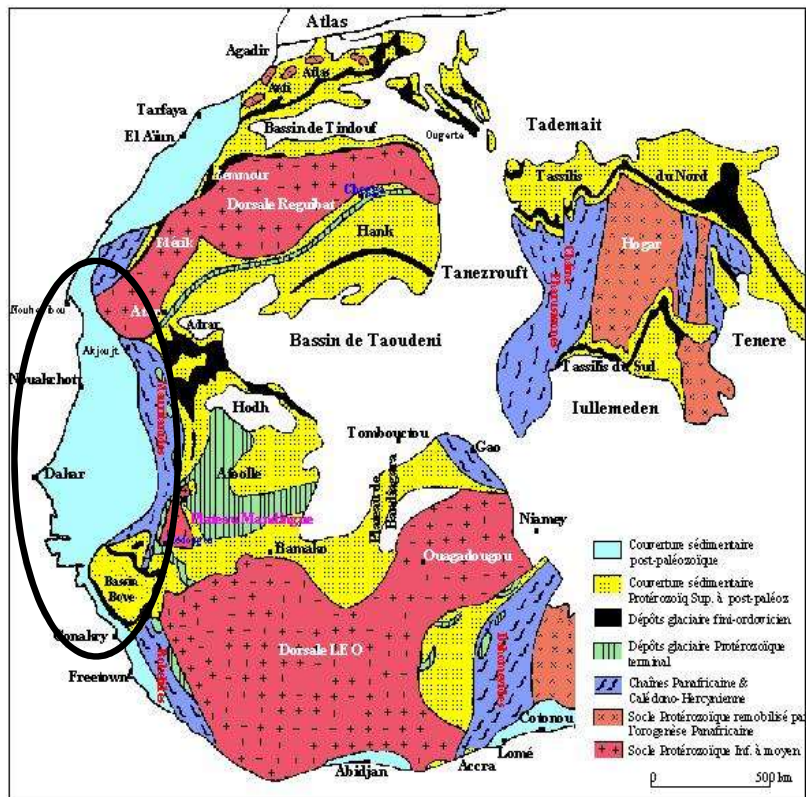


REGIONAL SETTING

□ The **Senegal Basin** occupies the central part of NW African coastal basin called the **MSGBC** (Mauritania-Senegal-Guinea-Bissau and Conakry Basin)

□ 230 000 km² (90.000 Km² are offshore)

□ **Mesozoic-Cenozoic Passive margin Basin**
- overlying a **Paleozoic basin**



LITHOSTRATIGRAPHIC COLUMN OF SENEGAL BASIN

STRATIGRAPHY		LITHOSTRATIGRAPHY	THICKNESS (m)	LITHOLOGY
CENOZOIC				
MESOZOIC	CRETACEOUS	POST - RIFT	300-1000	LIMESTONE, SAND STONE, SHALE
			200-1250	SAND STONE, SHALE & SAND
			100-450	SHALE & SAND
			150-1000	SAND STONE
			50-150	SHALE
			150-950	LIMESTONE, SAND STONE SHALE & SAND
			200-1200	LIMESTONE, SAND STONE SAND & SHALE
	JURASSIC	POST - RIFT	150-1400	ANHYDRITE, LIMESTONE SAND STONE, SAND & SHALE
			300-1200	LIMESTONE & SHALE
			? - 2000 ?	LIMESTONE & DOLOMITE
PALEOZOIC	TRIASSIC	SYN - RIFT	200-1500	SALT & ANHYDRITE
			200-1500?	SHALE & SAND STONE
	PERMIAN	SYN - RIFT	350	SANDSTONE SILTSTONE & SHALE
			350	SHALE & SAND
			300-1000	CONGLOMERATE, SANDSTONE & QUARTZITE
DEVONIAN	PRE - RIFT	500-3000	SANDY CONGLOMERATE	
		2000 - 4000	CONGLOMERATE, SHALE SANDSTONE, LIMESTONE & DOLOMITE	
PROTEROZOIC				
ARCHEAN				BASEMENT

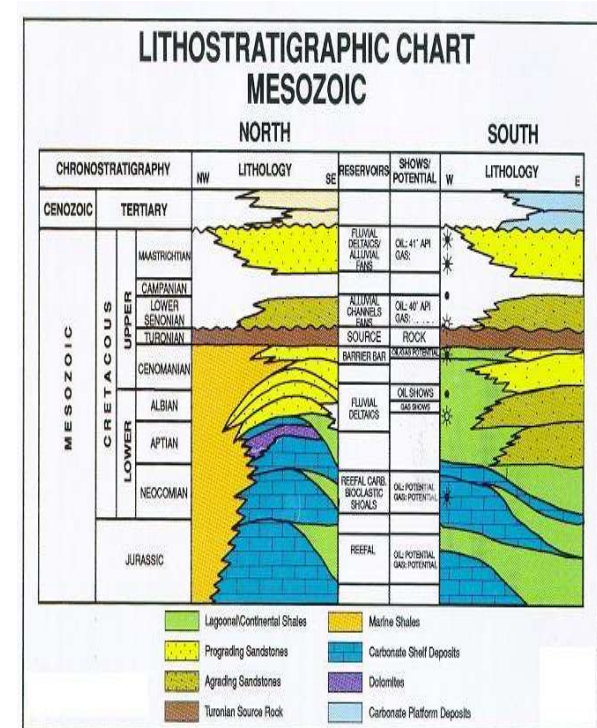
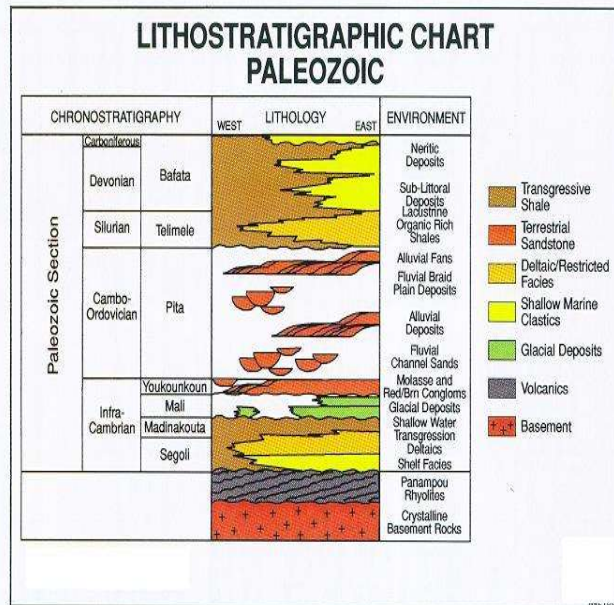
Post-rift stage
Mid Jurassic-Actual

Syn-rift stage
Permo Triassic- lower Jurassic

Pre-rift stage
Upper Proterozoic-Paleozoic



RESERVOIRS & SEALS



- **Upper Devonian shales;**
- **Devonian sandstones** : fine to coarse grained, often oolitic with porosities ~ 15% - 20%;
- Silurian shales
- **Ordovician sandstones** : no primary porosity, but very fractured, good secondary porosities, having excellent deliverability

- **Upper Tertiary shaly sequences**
- **Lower Tertiary clastics and carbonates**
- **Lower and Upper Cretaceous sand and shale sequences**
- **Jurassic - lower Cretaceous carbonate section**

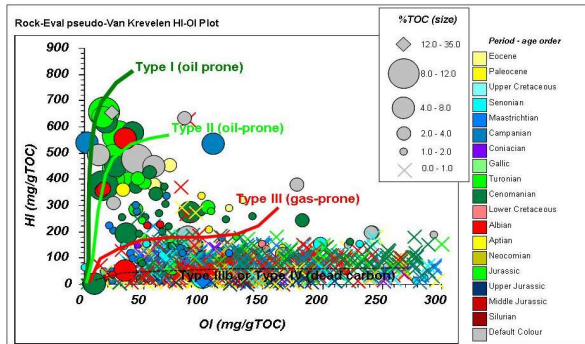


SOURCE ROCKS & MATURATION



MESO-CENOZOIC SECTION

PALAEOZOIC SECTION



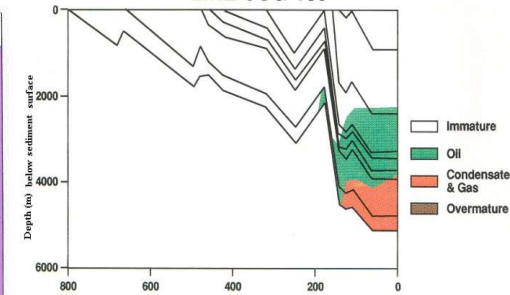
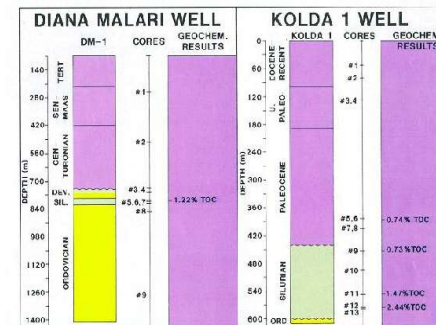
Silurian shales :
 best regional source rocks
 TOC ~ 1% - 5%
 Ro ~ 0.95 - 1.3

Oil windows should occur
 between 1850/2400 m to
 3400/4000 m

Cenomanian-Turonian

Best regional source rocks, and secondary **Albian-Aptian**

- in CM-7
 Cenomanian level at 2608 m with
 TOC = 8.72 %
 HI = 660 mg/g
- in CM-10
 Turonian level at 2554 m with
 TOC = 5.25 %
 HI = 638 mg/g



SOME PALAEOZOIC ANALOGOUS

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



EXPLORATION & PRODUCTION HISTORY: 1952 - 2019

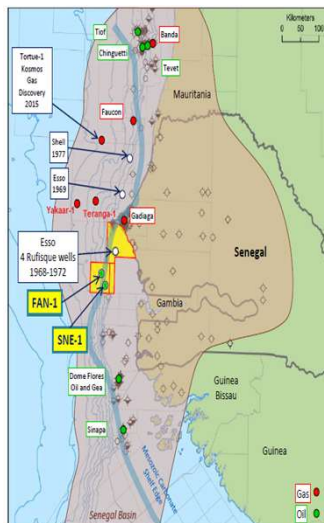


SEISMIC DATA

- ❑ 60 900 km of **2D** seismic
- ❑ 27150 km² of **3D** seismic
- ❑ Good offshore coverage

WELL DATA

- ❑ 174 Exploration Wells (1 well per 1337 km²).
- ❑ It is an **under explored basin**



HYDROCARBON DISCOVERIES, PROSPECTS AND LEADS

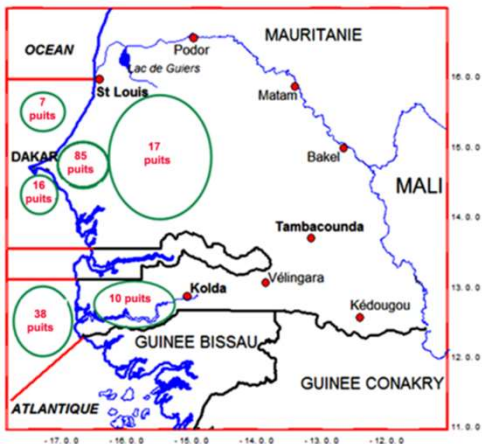
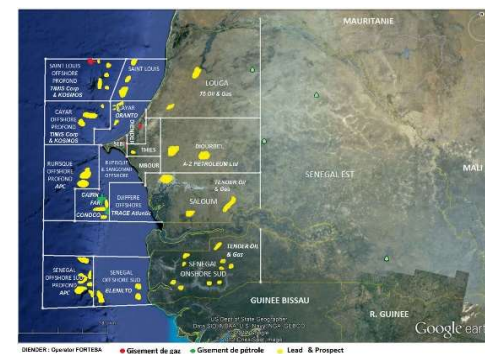
- ❑ Many small oil and gas producing fields in the onshore
- ❑ Reservoirs in Maastrichtian, Campanian and lower Senonian sandstones :
 - Diarniadio oil and gas fields (1961 to 2000)
 - Gadiaga gas fields in 1996 to actual
- ❑ Major Heavy oil fields in the offshore southern part of the basin
 - Dome Flore &
 - Dome Gea in 1967

About 1 billion barrels of heavy oil in the Oligocene-Miocene limestone & light oil in the Maastrichtian reservoirs.

- ❑ Many prospects and leads to be drilled through the basin

❑ Major offshore oil & gas fields discoveries

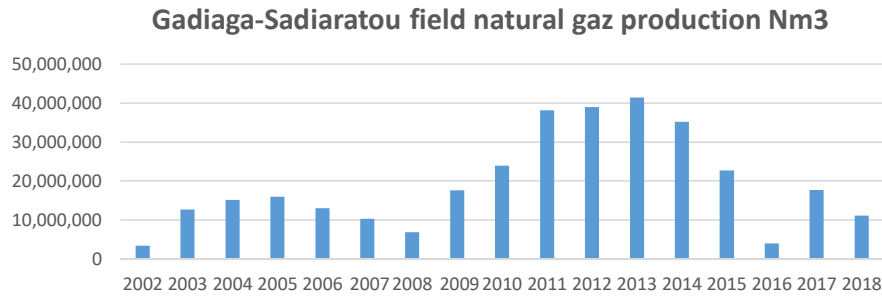
- with 4 oil & gas discoveries in Albian reservoirs :
 - FAN 1, SNE, SNE North & Fan South oil and gas fields in Sangomar Offshore Profond block i(2014, 2017),
- 3 world class gas discoveries in Cenomanian & Albian reservoirs
 - Tortue gas field Saint Louis offshore Deep block 2015
 - Teranga & Yakaar gas fields in Cayar offshore Profond in 2016 & 2017



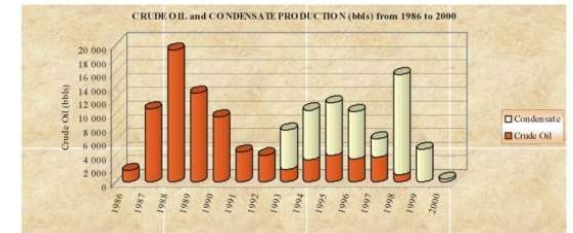
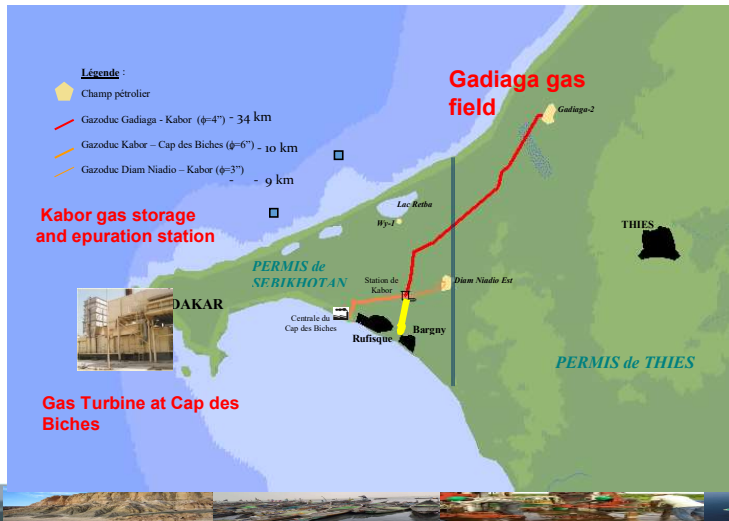


PRODUCING FIELDS & GAS NETWORK

CURRENT NATURAL GAS PRODUCTION IN SENEGAL



NATURAL GAS TRANSPORT NETWORK (~60km)

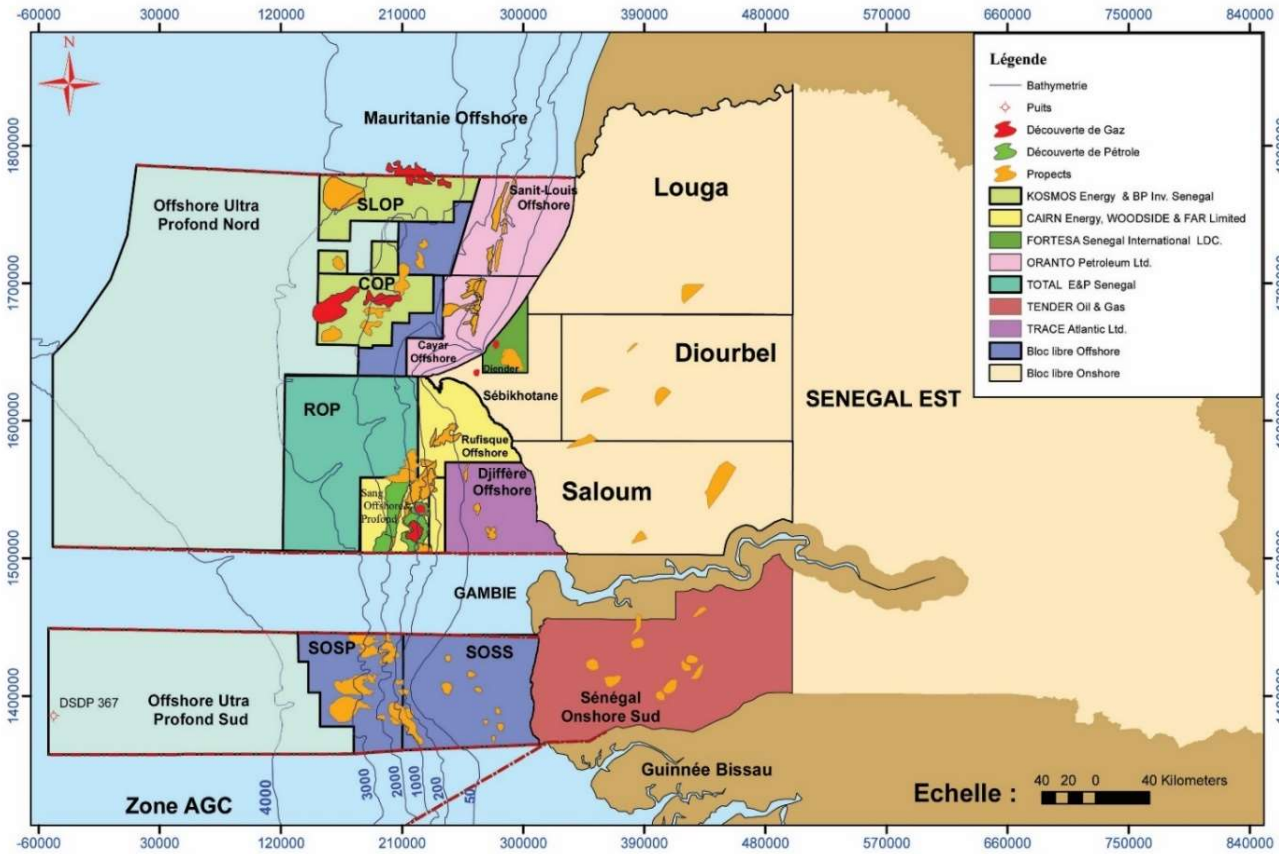




REVIEW OF RECENT EXPLORATION and DEVELOPPEMENT ACTIVITIES



CURRENT EXPLORATION ACTIVITIES



Contacts

- 7 offshore PSCs
- 1 onshore PSC

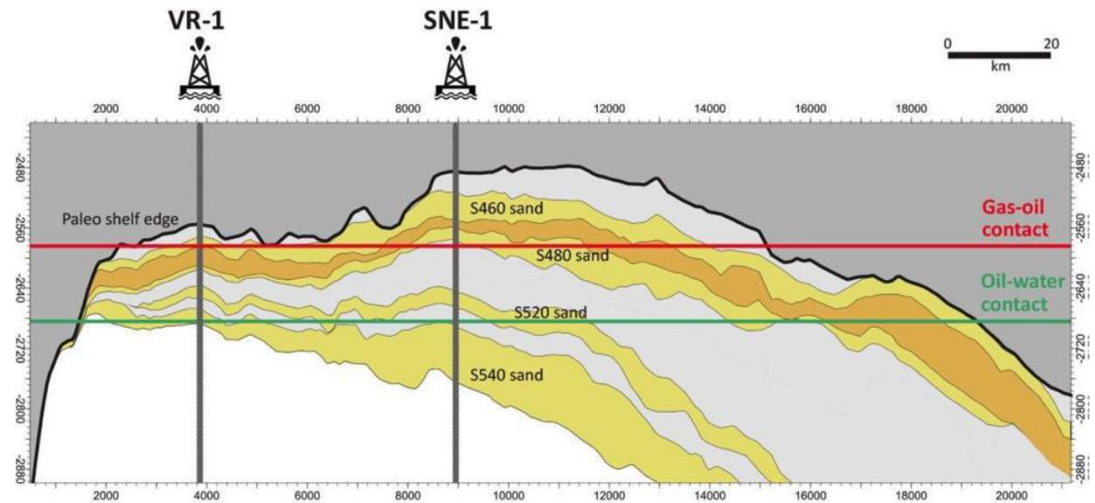
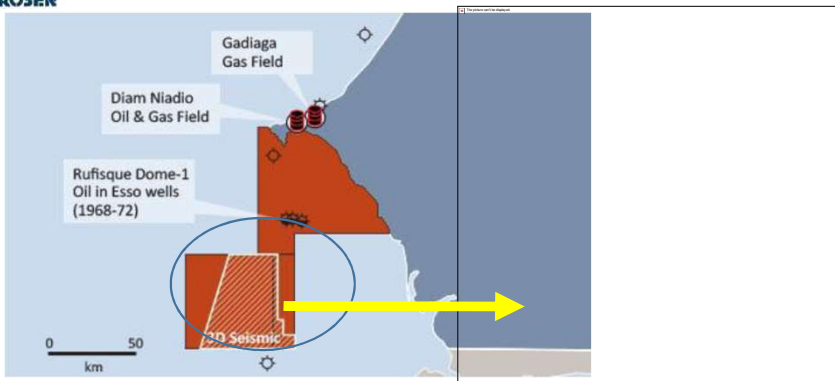
Presently available

- 4 onshore open blocks
- 4 offshore open blocks
- Offshore Ultra-deep blocks to be open by mid 2019





SANGOMAR OFFSHORE PROFOND DISCOVERIES

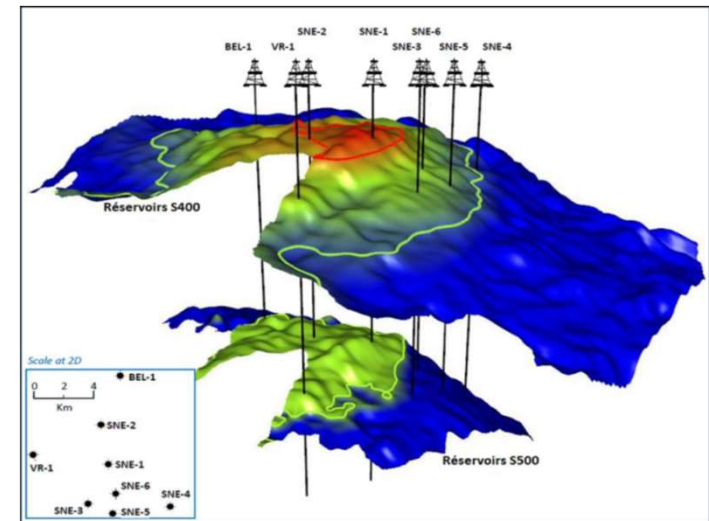


EXPLORATION & APPRAISAL

- 2014, two Exploration Wells discoveries **FAN-1** and **SNE-1**
- 7 SNE Appraisal Wells: SNE-2, SNE-3, SNE-4, BEL-1, SNE-5, VR-1 and SNE-6
- **Reserves Estimate (2C) : 563 MMSTB oil + 1.3 Tcf of gas associated and non associated**
- Oil 31°API
- 2017, **FAN South** discovery: 152 millions barrels and
- **SNE North** discovery: 83 millions barrels and 378 Bcf of gas

SNE DEVELOPMENT PLAN

- ❑ FPSO
- ❑ Daily production : About 100 000 barrels/day
- ❑ About 20 production and injection wells for phase1
- ❑ About 54 wells full field development
- ❑ First Oil : expected in 2022

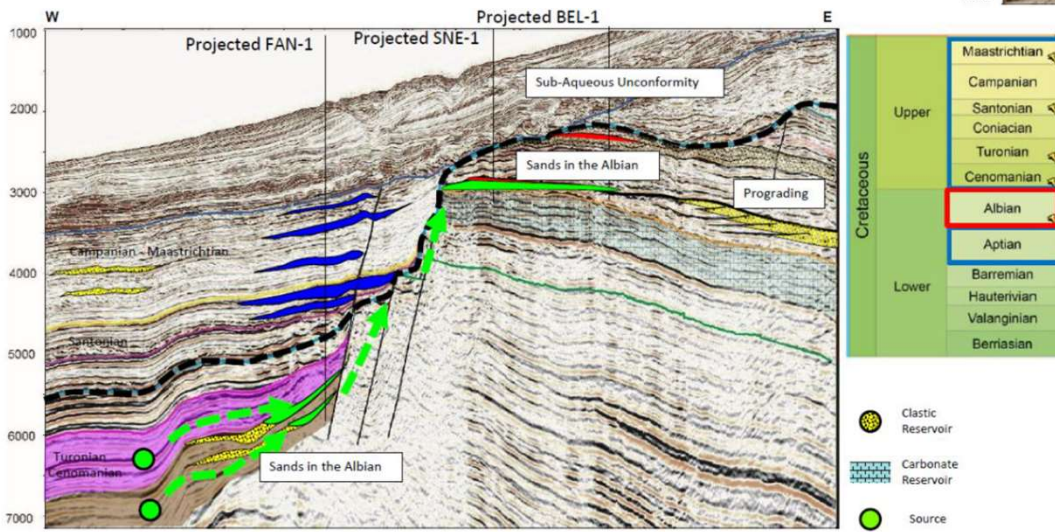
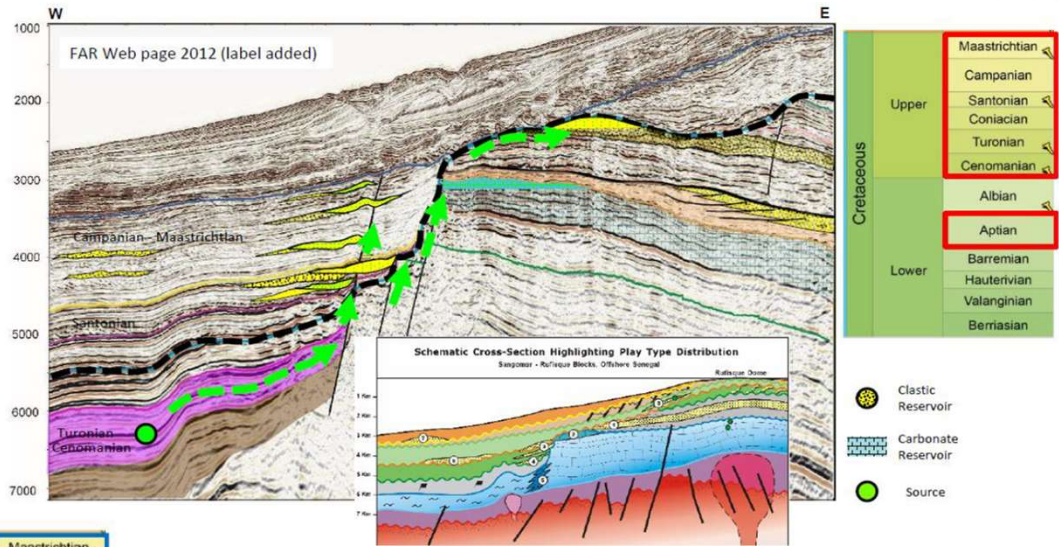




SANGOMAR OFFSHORE PROFOND DISCOVERIES



Before 2014 drilling program



After the 2014 program



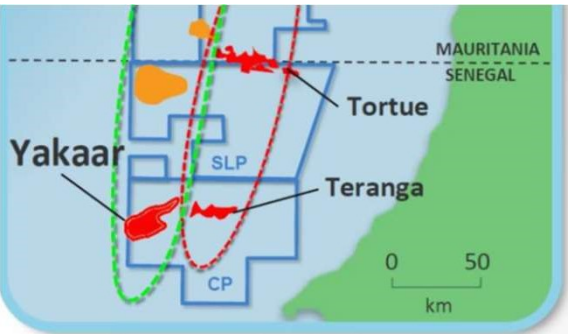


SAINT LOUIS OFFSHORE PROFOND & CAYAR OFFSHORE PROFOND PERMITS

KOSMOS ENERGY 30%

BP 60%

PETROSEN 10%

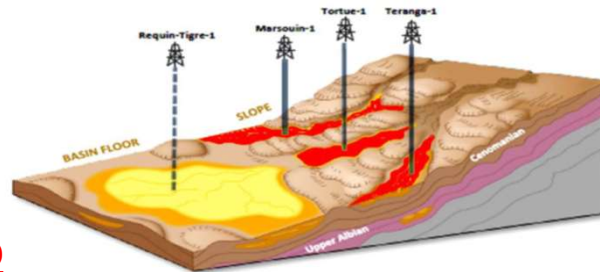


Découverte de gaz

Prospect

SAINT LOUIS OFFSHORE PROFOND

- Greater Tortue/Ahmeyin(GTA) field
- 3 wells drilled Tortue-1 (Aymeyin-1) et Aymeyin-2 in Mauritanie and Geumbeul-1 in Senegal
- Gas reserves: About 15 TCF
- Tortue tested at 60 mmscf/d confirming the target of 200 mmscf/d of gas production
- More Prospects et Leads to be drilled
- FID declared in 2018

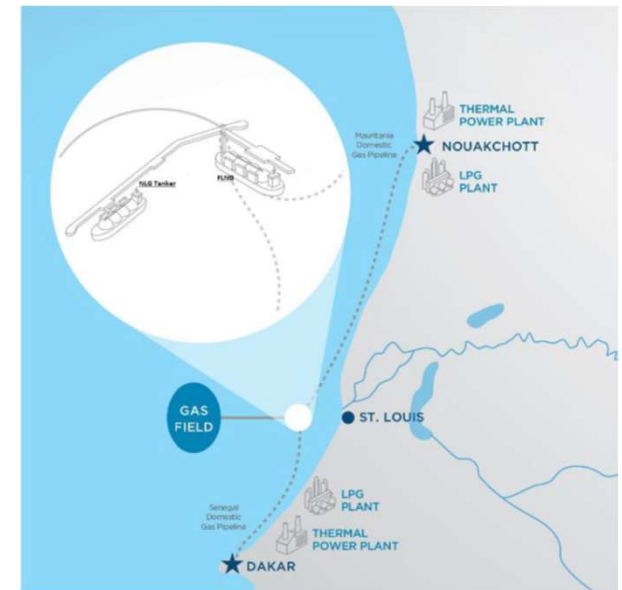


KOSMOS 2017

CAYAR OFFSHORE PROFOND

- Teranga-1 well drilled in 2016
- Gas resources in place : 5 Tcf
- Yakaar-1 well in 2017
- Resources estimate : 15 Tcf

GTA DEVELOPMENT PLAN



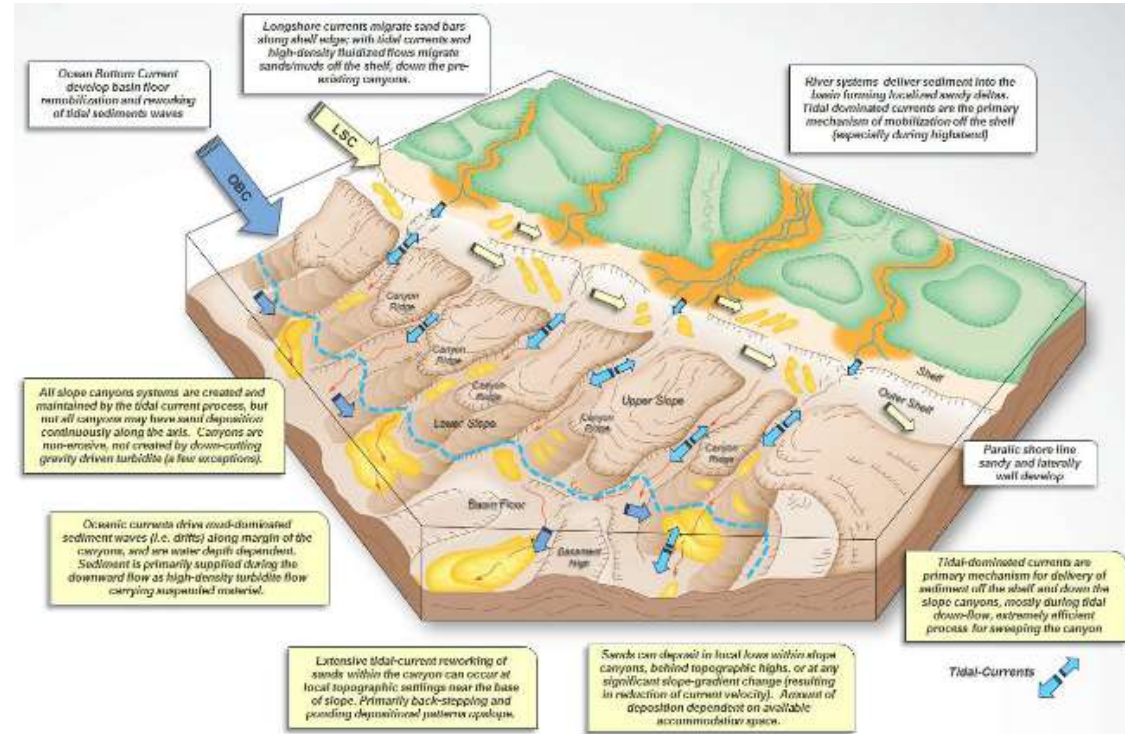
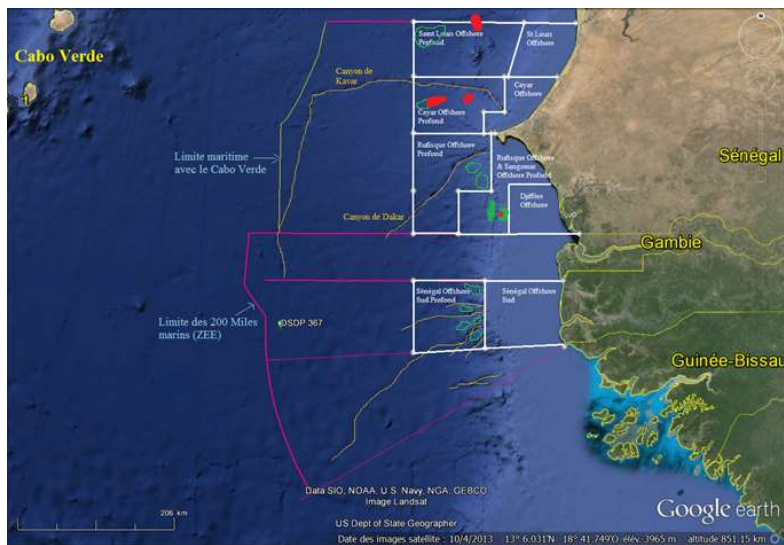
- Phase 1 –2,5 MTPA of LNG
- 70 mmscf/day of natural gas for domestic market
- First gas expected in 2022
- Up to 10 MTPA of LNG with the following phases



OFFSHORE ULTRA-DEEP



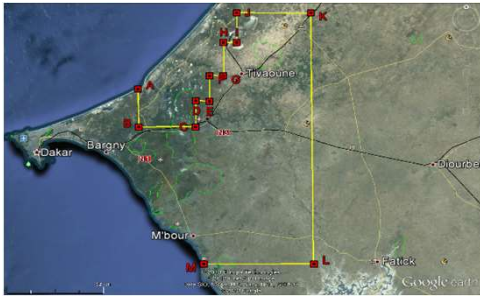
- Deep offshore Channel and turbidite deposits seems to extend to the west in the Ultra Deep



- 2D seismic data acquired in 2017
- Offshore Ultra-deep blocks to be open in the near future



NEW SEBIKHOTANE BLOCK

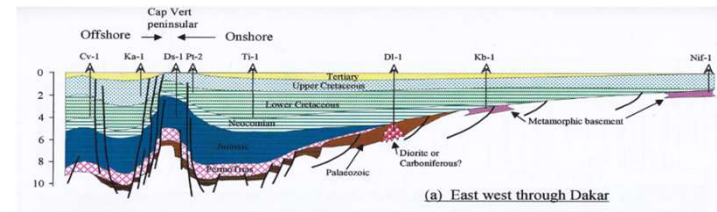
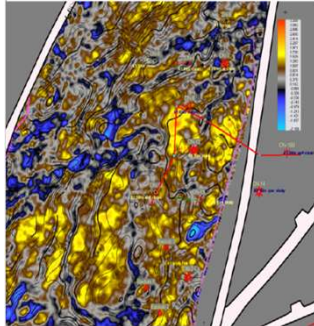
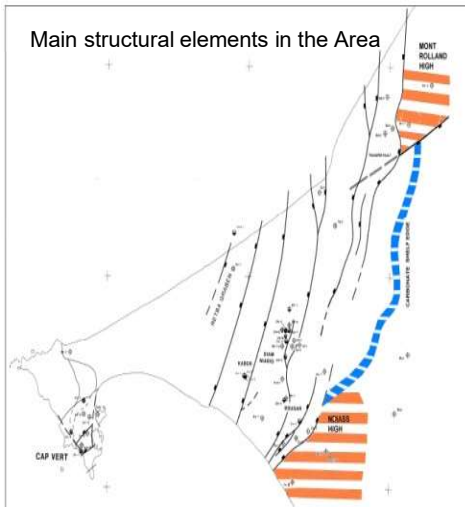


- ❑ Result into the fusion of trois former onshore blocks (Sebikhotane, Thies and Mbour)
- ❑ Acreage : 3788,205 Km²

❑ Traps

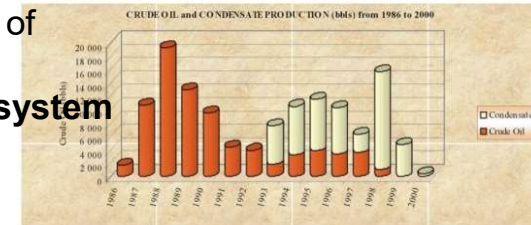
- - large anticlines;
- - fault closures;
- - pinch-outs on the local erosional surfaces;
- - bars and deltaic lobes.

- ❑ Play Types Roll Over, Rover Anticline;
- ❑ Probable onshore extension of Sangomar offshore Deep oil and gas fields;
- ❑ Many leads and prospects;
- ❑ Potential in Deeper targets (Albian) non explore yet



❑ Oil, Condensate and Gas Production

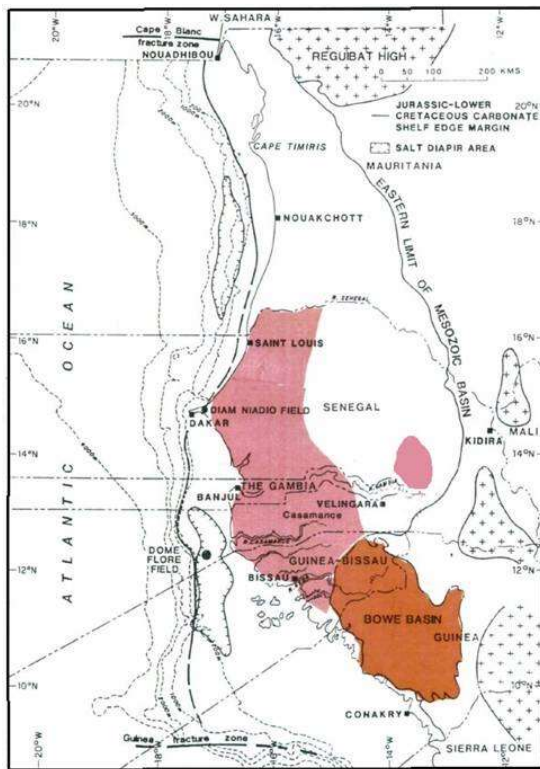
- 1 **oil** well (DN-4) with a total production of 62,642 bbl;
- 2 wells produced **condensate** with total production of 35,692 bbls;
- and **7 gas wells** with a total production of 217,393,033 normal cubic meters;
- Presence of a gas **network transport system**



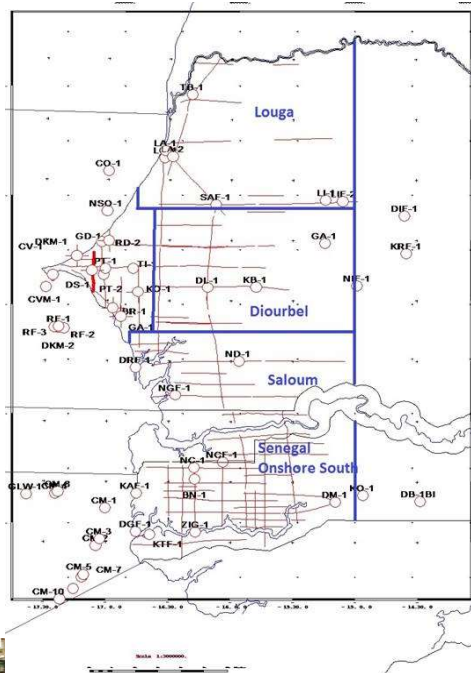
PALEOZOIC BASIN

□ Acreage ~ 60 000 km² onshore covering four blocks: Louga, Diourbel, Saloum and Senegal Onshore South Blocks

□ Two sub-basins in Senegal East Area



- 5630 km 2D in Louga, Diourbel, Saloum
 - 2770 km 2D in Senegal Onshore Sud ;



1 - LOUGA

- Acreage : 27000 km²
- 07 wells (1 well per 3857 km²)

2 - DIOURBEL

- Acreage : 17 265 km²
- 03 wells (1 well per 5 755 km²)

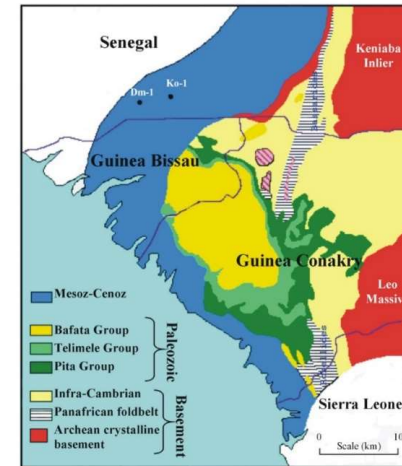
3- SALOUM BLOCK

- Acreage 14290 km²
- 03 wells

4- SENEGAL SOUTH BLOCK

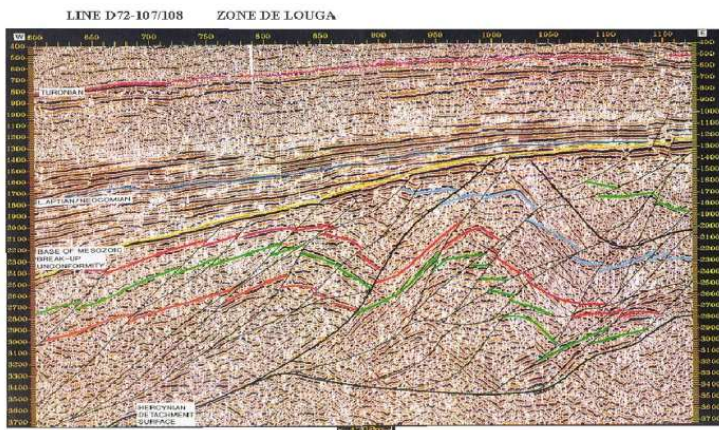
- 15231 km²
- 08 wells

Very underexplored Palaeozoic basin



TECTONIC STYLE

- ❑ **Compressional regime** in the rest of the Senegal basin resulting from the combined effect of Caledonian and Hercynian orogenies

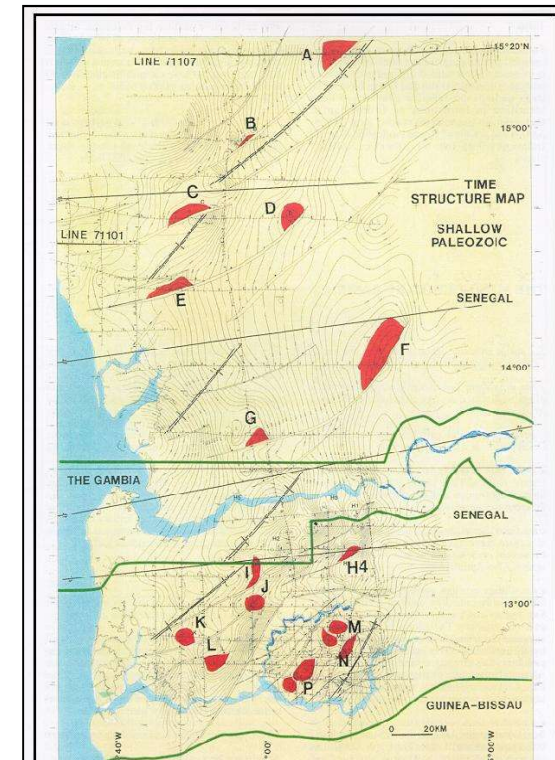
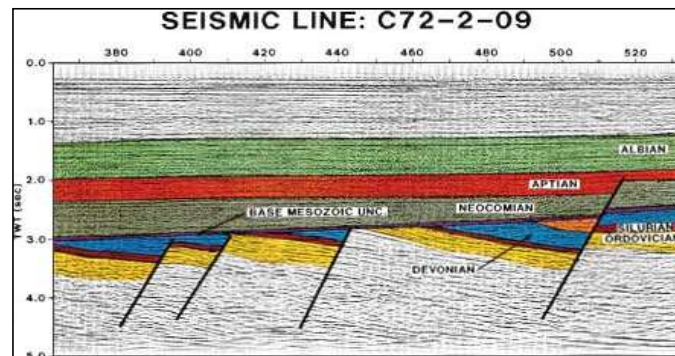


- ❑ **Extensional system in Eastern Casamance** in which a pre-Hercynian structural style of Horsts and Grabens and tilted fault blocks was preserved

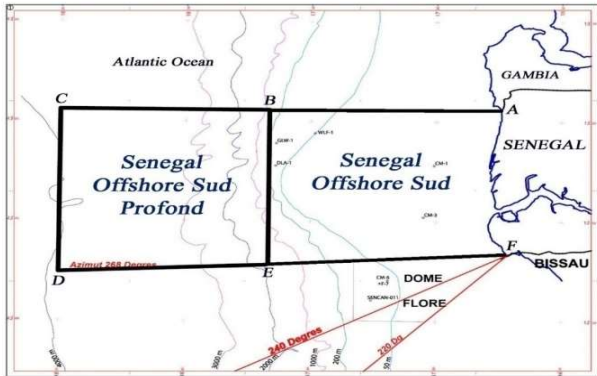
TRAPS AND PLAYS

- **15 anomalies** distributed at depth ranging from 2,600 to 5,700 m of Ordovician to Carboniferous age.

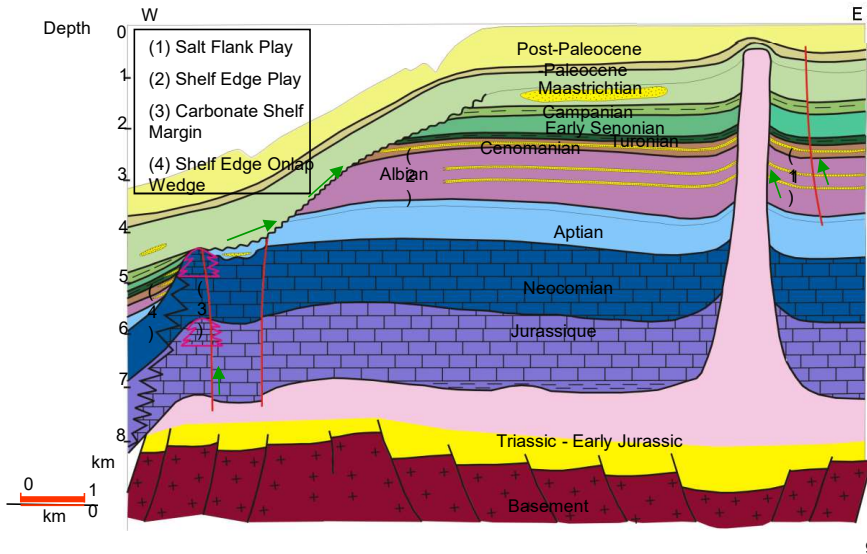
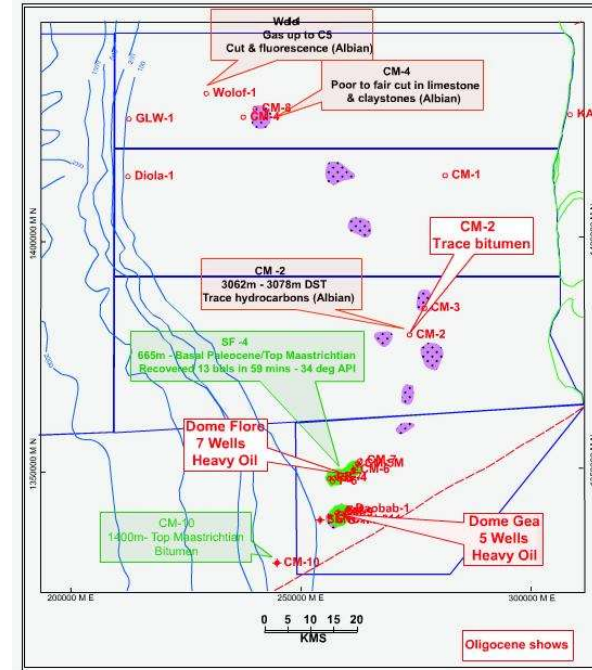
Trapping :
 trusted anticlines, complex faulted anticlines,
 four way closures, tilted fault blocks.



SENEGAL OFFSHORE SUD

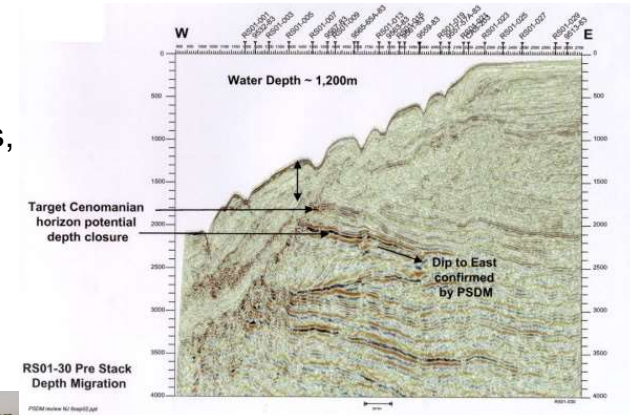


- About 10 000 km of 2D seismic from 1973 to 2001
- 8 wells
- 7 Salt Dome sub parallel to the coastline along a narrow trend approximately 400 km long and 30 km wide

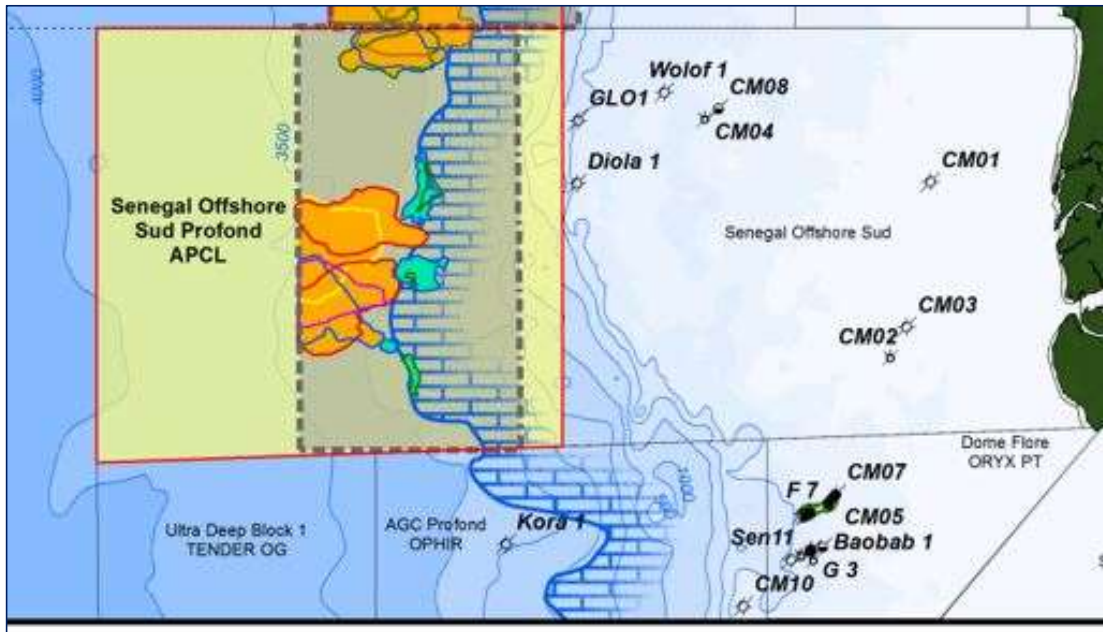


PLAY CONCEPT

- (1) Salt Flank Play
 - (2) Shelf Edge Play
 - (3) Carbonate Shelf Margin
 - (4) Shelf Edge Onlap Wedge
- Cretaceous turbidites wedges, and slope/ channels
 - Potential subsalt play
 - Many leads identified



SENEGAL OFFSHORE SUD PROFOND BLOCK



❑ **SEISMIC** : 3600 km² 3D in 2012

PLAY CONCEPT

- ❑ Shelf Edge Play
- ❑ Carbonate Shelf Margin
- ❑ Shelf Edge Onlap Wedge
- ❑ Cretaceous turbidites wedges, and slope/ channels

LEADS

- ❑ 8 large submarine fan leads identified with resource potential of over 1bn bbls each
- ❑ Additional Carbonate leads with over 600 mmbbls potential

❑ ANY WELL DILLED IN THE BLOCK YET



PETROLEUM LEGISLATION





LAW N° 2019-03 of January 24, 2019 (NEW PETROLEUM CODE)



□ PRODUCTION SHARING CONTRACT (PSC)

○ EXPLORATION PERIODE

- Initial Period: up to 4 years
- Renewal Periods: 3 - 3 years

○ EXPLOITATION PERIODE

- Initial Period: 20 years
- Extension Period : 10



- **PETROSEN PARTICIPATION**

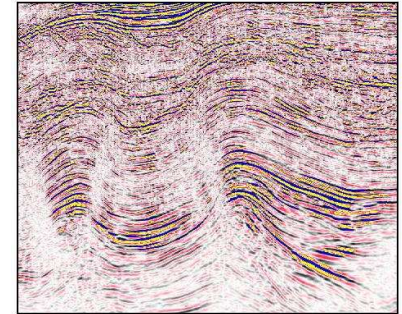
- Exploration phases : Carried Interest of 10 %
- After Commercial discovery : Working Interest 20 % not carried

LAW N° 2019-04 of January 24, 2019 (NEW)

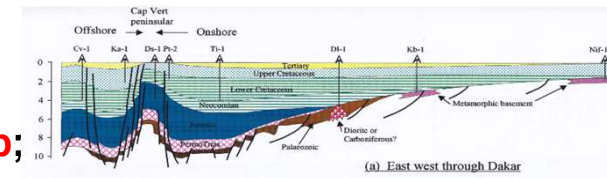
- LOCAL CONTENT LAW in the Hydrocarbure sector



CONCLUSION



- ❑ Senegal Basin has generated oil and gas in onshore and offshore areas Diamniadio, Gadiaga, Casamance Dôme Flore, Sangomar Offshore Deep, Saint Louis Offshore Deep and Cayar Offshore Deep ;
- ❑ Presence of world class source rocks in Turonian-Cenomanian, good in Albian-Aptian and potential Jurassic;
- ❑ Petroleum system in Offshore Shallow, Deep and Ultra Deep waters with various structural trends and traps;
- ❑ Recent exploration activities has **generated four world class Oil discoveries** and **tree world class Gas discoveries in the offshore deep**;
- ❑ Good potential in the Offshore Ultra Deep;
- ❑ A 60 000 km² acreage of underexplored Paleozoic onshore basin with good Silurian source rock, traps and plays identified;
- ❑ **Four open blocks in offshore and Four open onshore blocks**;



New Laws with flexible terms





THANK YOU FOR YOUR ATTENTION

