



المكتب الوطني للهيدروكاربورات و المعادن
*ΣΟ.Θ.Σ.Ο. | ΗΦΣΛΟ:Κ.ΟΘ:Ο. + Λ Σ*84.*
OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

HYDROCARBON EXPLORATION CONCEPTS IN MOROCCO

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HYDROCARBON EXPLORATION CONCEPTS IN MOROCCO



1	Status of the Hydrocarbon Exploration <ul style="list-style-type: none">• Seismic and drilling achievements• Petroleum exploration results
2	Hydrocarbon plays (prospects/leads) and successful analogs <ul style="list-style-type: none">• Presalt• Overthrust and Subthrust• Subsalt and Inverted Mini Basins
3	Current Plays
4	Unconventional Hydrocarbons
5	Conclusions

STATUS OF THE HYDROCARBON EXPLORATION

SEISMIC & WELLS ACHIEVEMENTS (February 2019)

Seismic Acquisition:

Onshore

- 2D Seismic: 56 131 Km
- 3D Seismic: 2 336 Km²

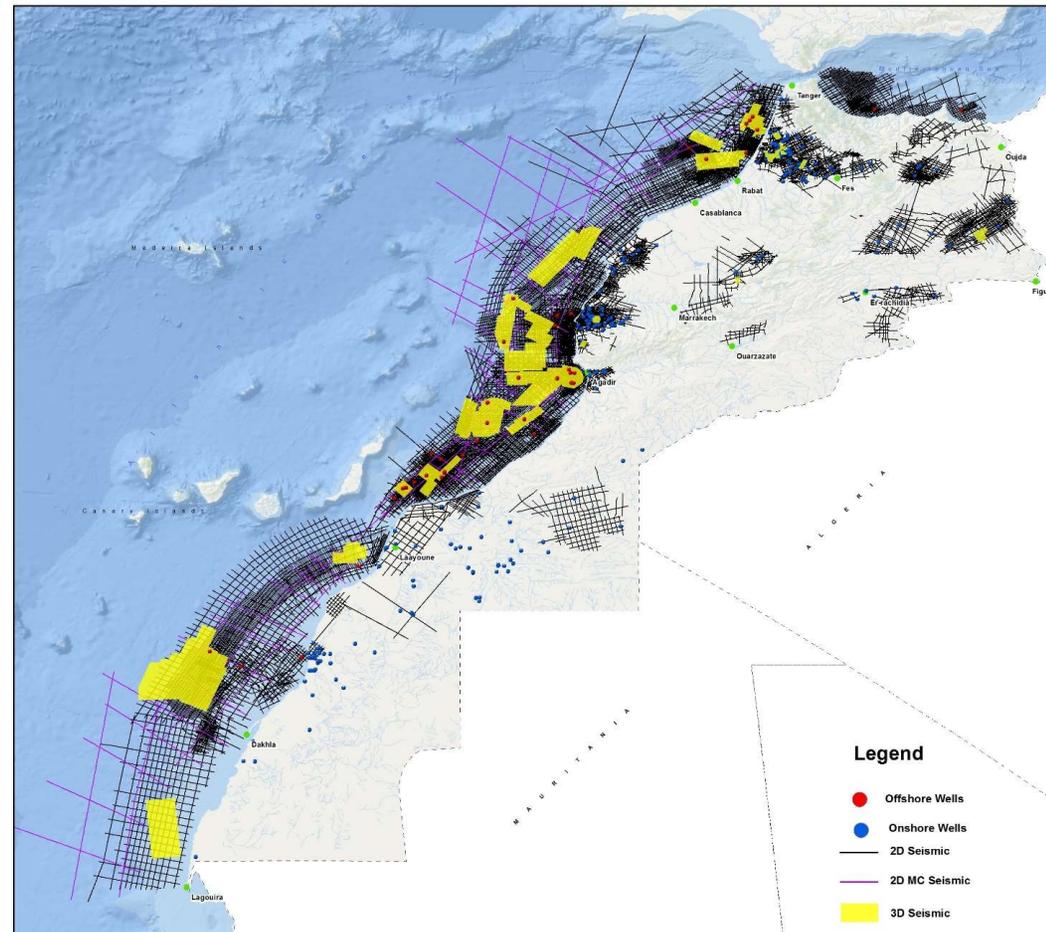
Offshore

- 2D Seismic: 174 267 Km
- 3D Seismic: 70 242 Km²
- In addition to 13 300 Km of 2D Multi-clients acquired by the end of 2017 in the Offshore Atlantic of Morocco

Most of the open blocks are covered by either 2D & 3D Seismic

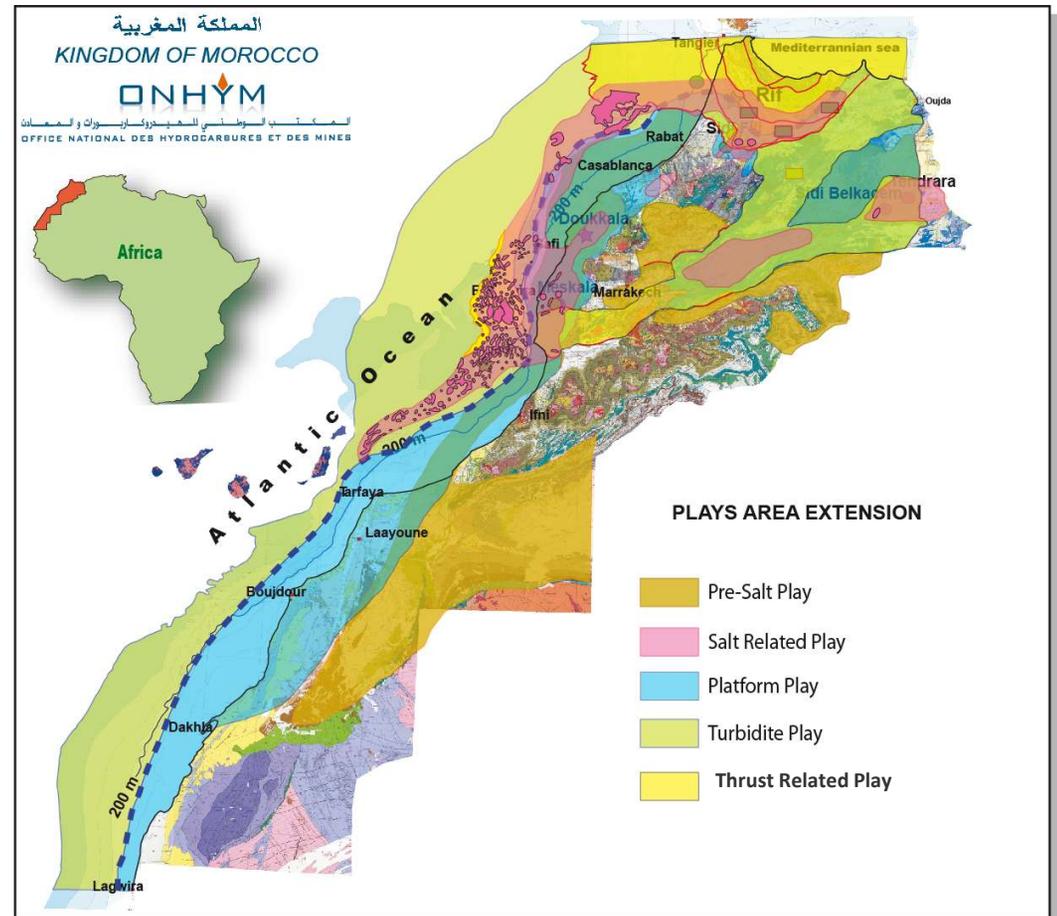
Exploration Drilling :

- 44 wells offshore (42 in the Atlantic & 2 in the Mediterranean)
- 307 wells Onshore



STATUS OF THE HYDROCARBON EXPLORATION

- Development of different plays widely extending in space and geological time:
 - Salt Related Play
 - Platform Play
 - Turbidite Play
 - Thrust Related Play
 - Pre-Salt Play
- These plays have been developed thanks to intensive 2D and 3D seismic acquisitions, processing and reprocessing during the last 2 decades
- Only few structures related to some of these play types were tested leading to limited hydrocarbon discoveries.

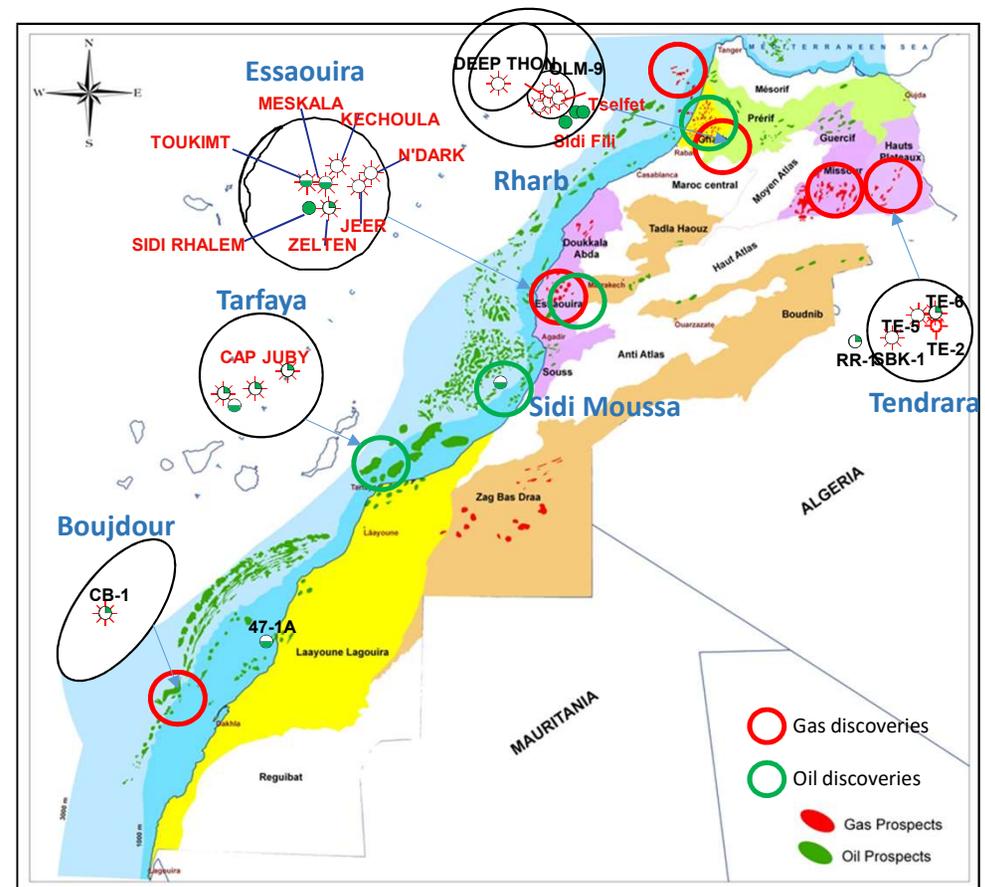


STATUS OF THE HYDROCARBON EXPLORATION

TO DATE EXPLORATION RESULTS

- More than **800** prospects & leads of various plays have been identified in the onshore and the offshore. Some of these prospects were tested successfully
 - Pre-Salt and Salt related Play
 - Gas and condensate fields
 - Paleozoic Source Rocks
 - Jurassic carbonate Platform Play
 - Oil fields and sub-commercial accumulations
 - Jurassic Source Rocks
 - Turbidite Play
 - Gas and condensate shows and sub-commercial accumulations
 - Thrust and Sub-thrust Play
 - Oil fields and numerous oil seeps
 - Jurassic Source Rocks

- Still considerable number of mature prospects deserves to be drilled.



STATUS OF THE HYDROCARBON EXPLORATION

Licensing status

Exploration permits

- 20 offshore 34 971,97 km²
- 30 onshore 45 830,43 km²

Reconnaissance licenses

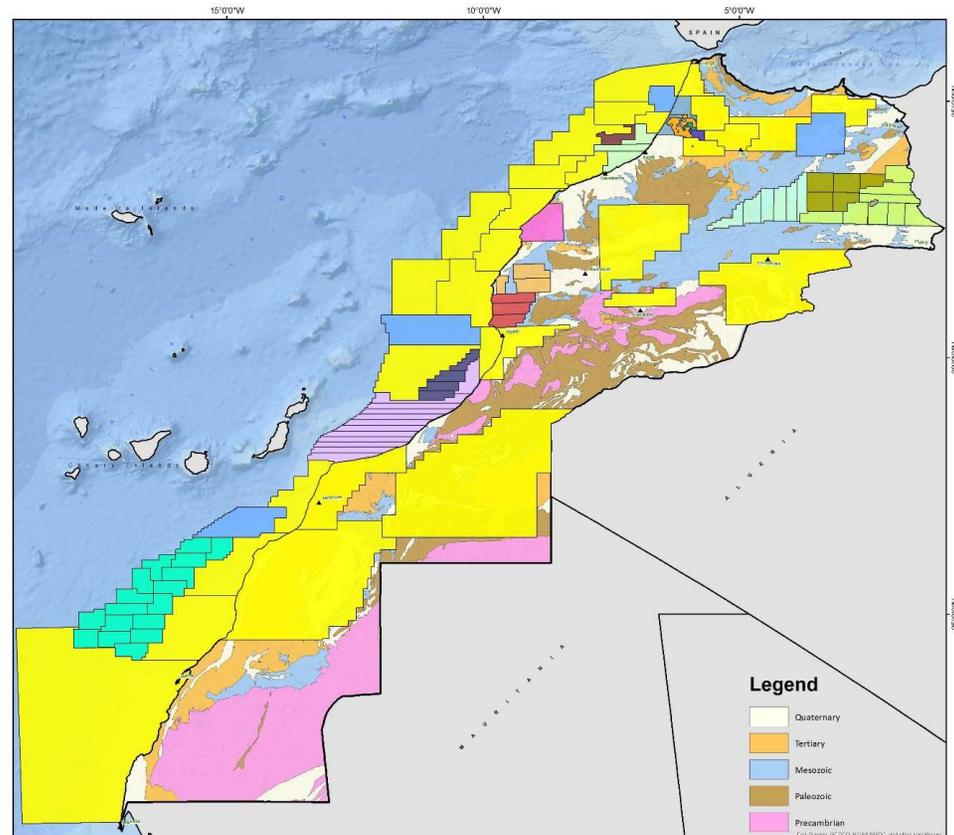
- 1 onshore 4 989,90 km²

Exploitation concessions

- 8 Exploitation 161,14 km²
- 1 ONHYM 38,71 km²

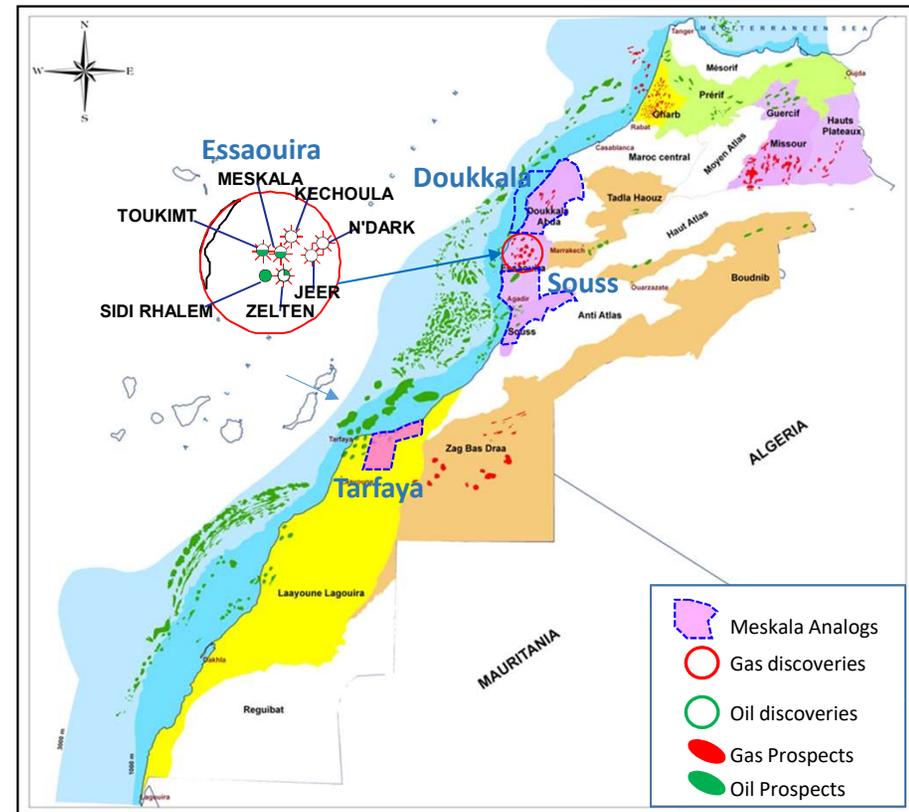
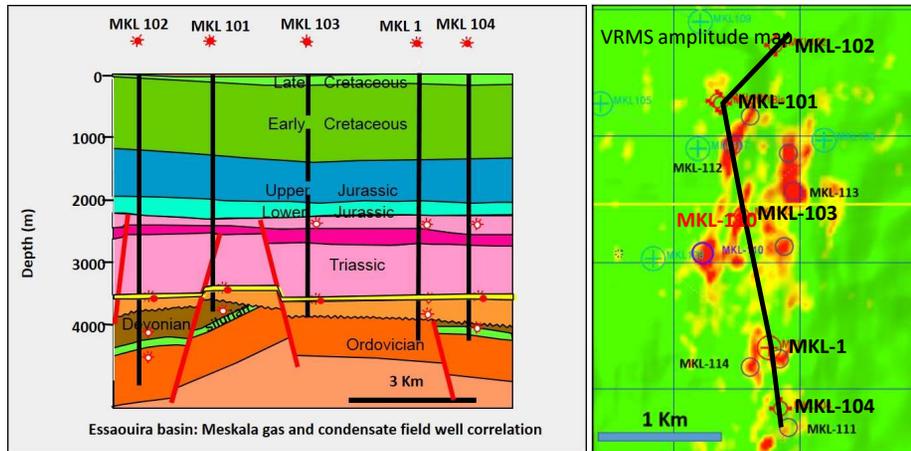
Open blocs

- 17 offshore
- 13 onshore

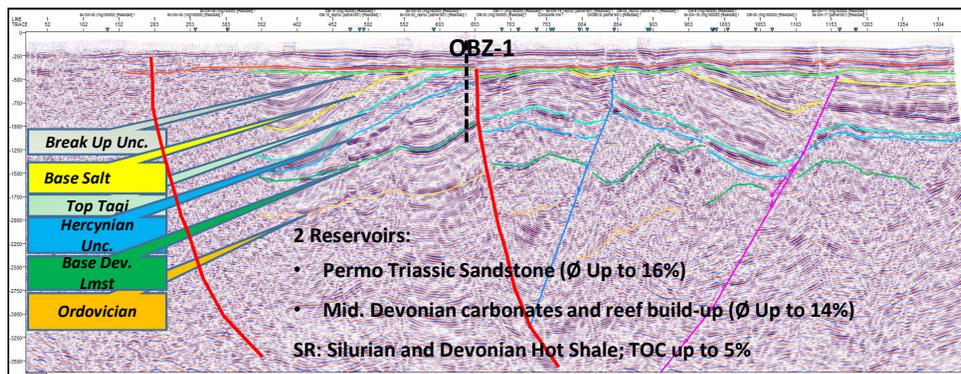


UNTESTED PRESALT PROSPECTS/LEADS AND ANALOGS

Positively tested presalt play (Meskala gas and condensate field in Essaouira basin)



Untested Presalt play related prospects in the Dokkala basin

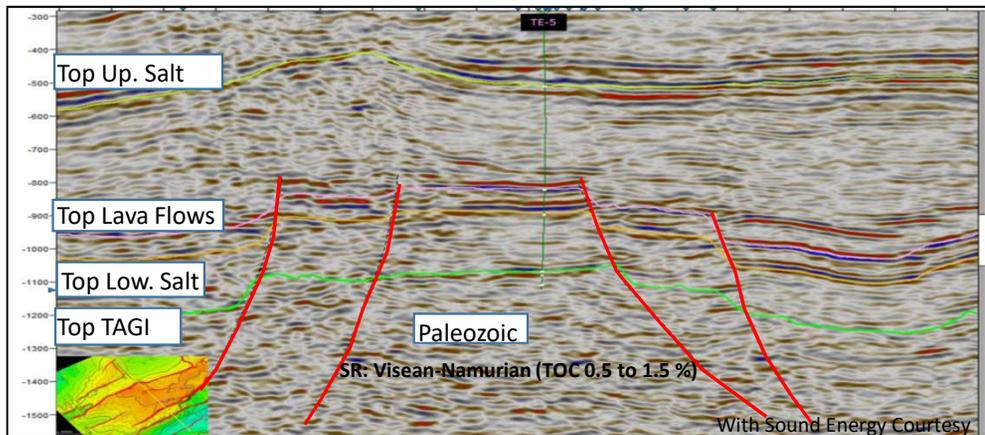


Presalt Play in the Atlantic Rift Basins

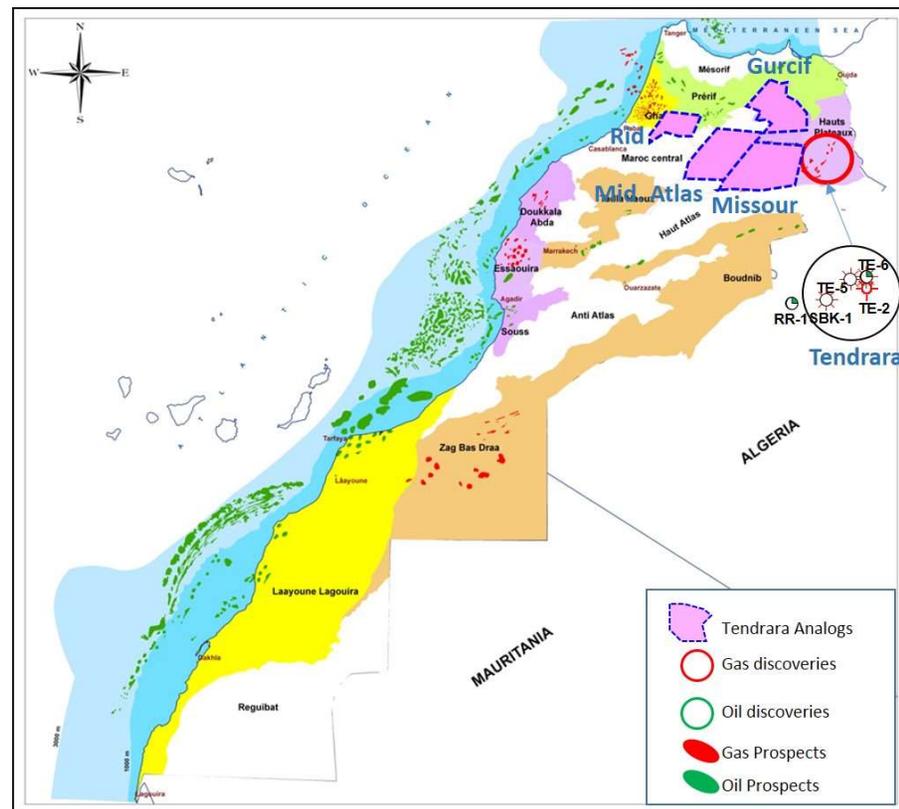
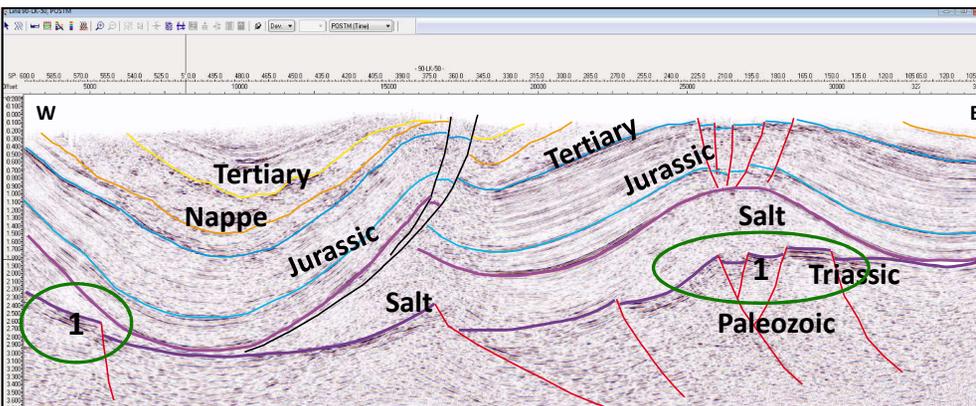
The suggested new Triassic prospective area lies in sag between coastal shallow paleozoic and an inland Hercynian front. The Middle Devonian reefal complex is located at the same area of Triassic sag.

UNTESTED PRESALT PROSPECTS/LEADS AND ANALOGS

Positively tested presalt play in Tendirra Area



Untested Presalt play related prospects in the Prerif Ridges



Untested targets: Presalt Play in the Tethys Rift Basins

- Pre-salt: 1
 - Triassic fluvial sandstones

UNTESTED SUBTHRUST PROSPECTS/LEADS AND ANALOGS

Subthrust Play main drivers

Hydrocarbon occurrences:

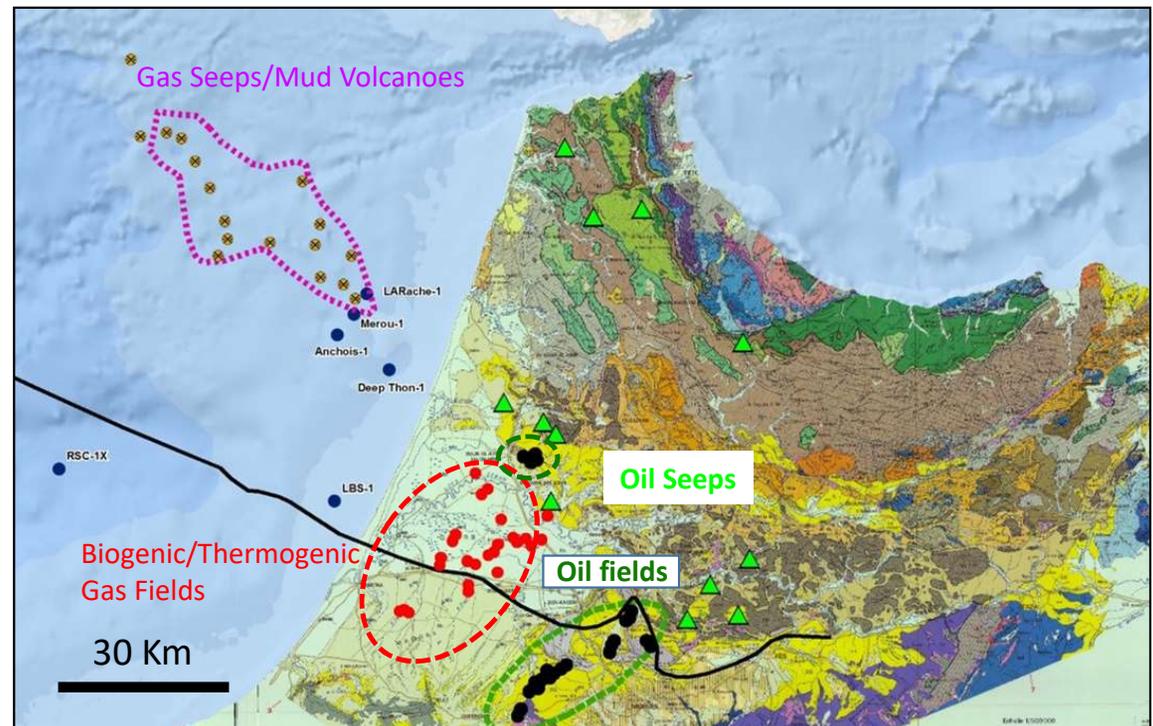
- Oil seeps (Aïn Hamra)
- Oil fields (Sidi Fili)
- Biogenic and thermogenic gas
- Gas seeps associated with mud volcanos.

Four (4) proven marine and organic rich source rocks :

- Miocene up to 10% Toc
- Cenomanian-Turonian 0.6 to 10.7%Toc
- Toarcian 0.5 to 2.5 % Toc
- Domerian 0.5 to 1.2 % Toc

Four (4) proven reservoir intervalles:

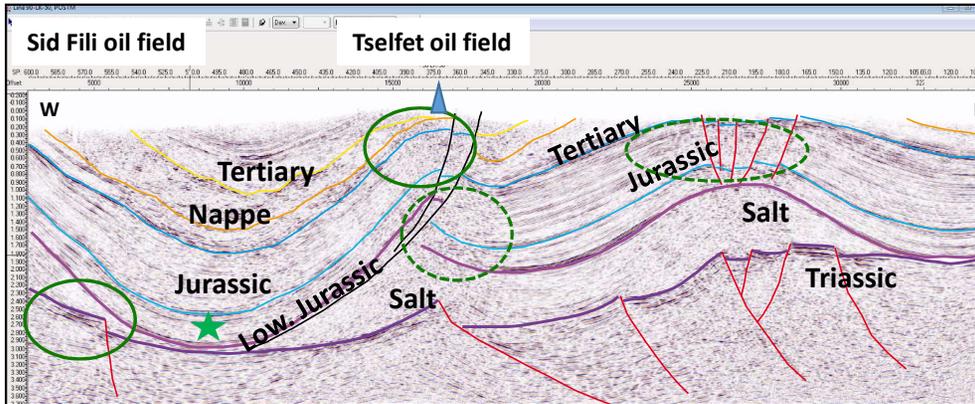
- Miocene turbidite sandstones
- Mid. And Up. Jurassic deltaic and turbidite sandstones
- Low. And Mid. Jurassic carbonates
- Triassic fluvial sandstones



Hydrocarbon Occurrences in the Moroccan Alpine (Rif) folded and thrust belt

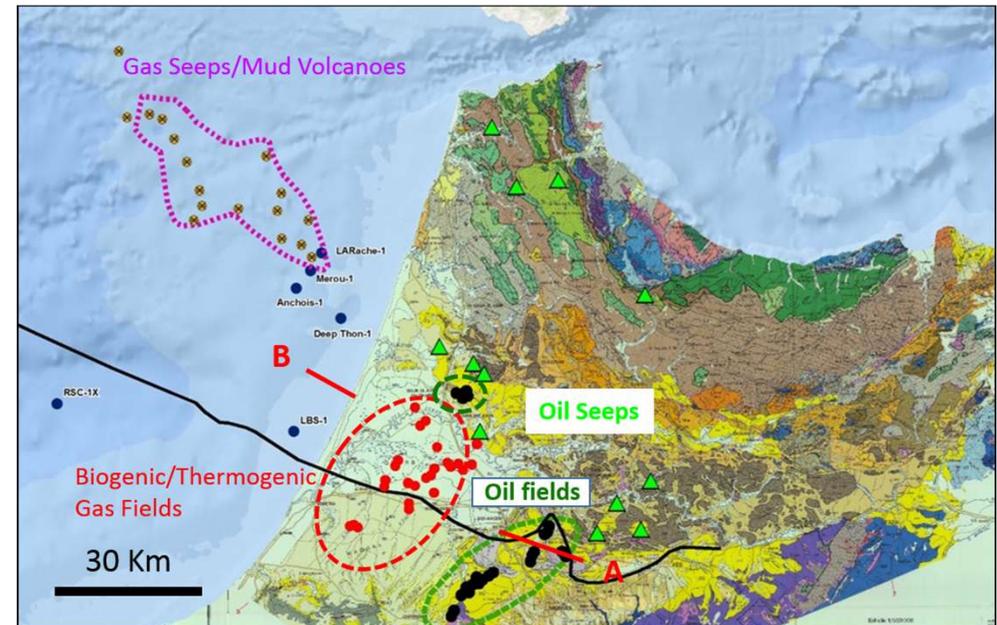
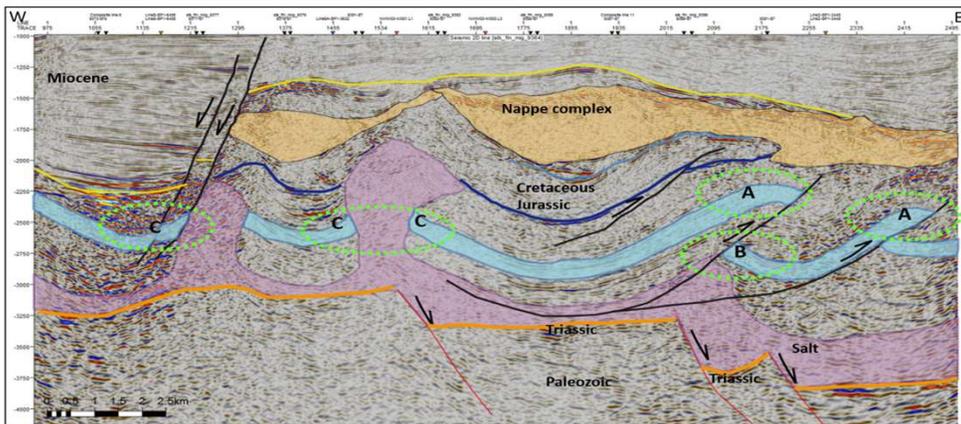
UNTESTED SUBTHRUST PROSPECTS/LEADS AND ANALOGS

Onshore Line A: Jurassic play positively tested in overthrust structures



- Onshore overthrust structures positively tested: Tselfet, Bou Draa, Ain Hamra, Baton etc...
- Source Rock: is lower Jurassic black shales (TOC up to 8%)
- Offshore Overthrust (A), subthrust (B) and salt related structures (C) remain untested

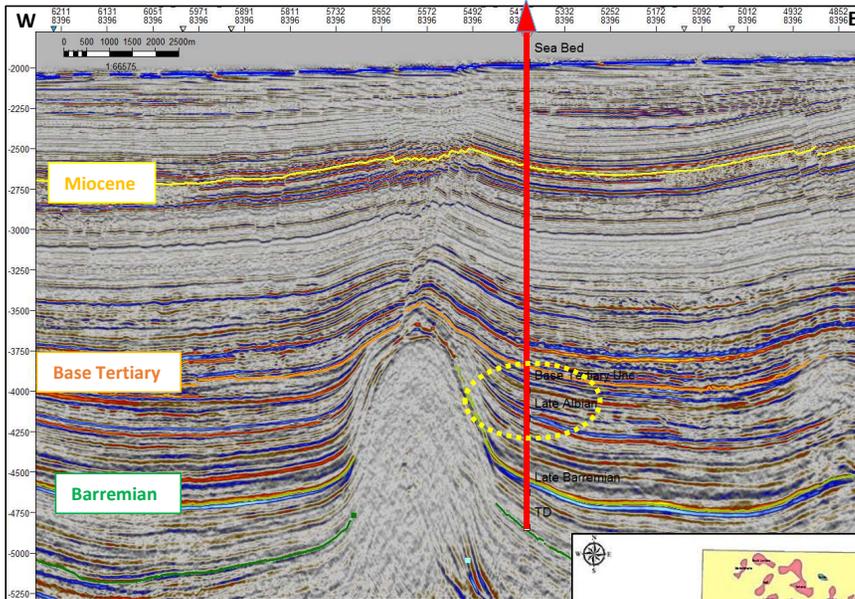
Offshore Line B: Untested Jurassic play



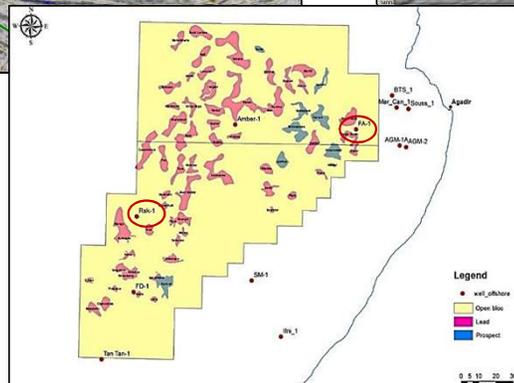
SALT RELATED PLAY: UNTESTED INVERTED MINI BASINS

RAK-1 & FA-1 WELLS DRILLED IN OFFSHORE AGADIR

RAK-1/2004 (WD : 1967.3m)

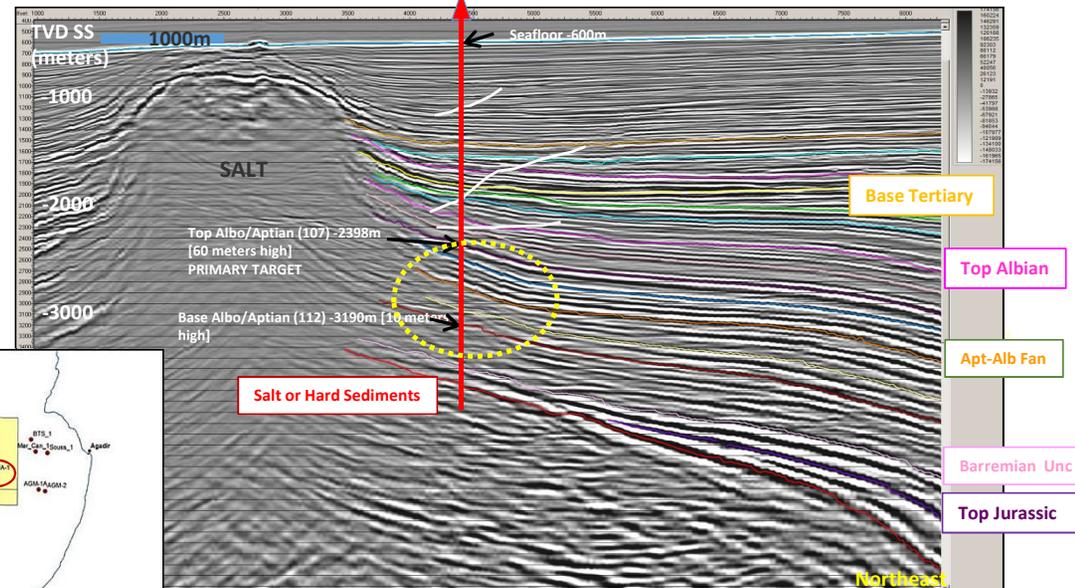


Final PSDM Depth, RAK-1 Well



- Either Oil and Gas shows (C1 to C5 along more than 400m column in FA-1 well)
- Thin sand beds in the Upper and Lower Cretaceous intervals

FA-1/2014 (WD : 600m)

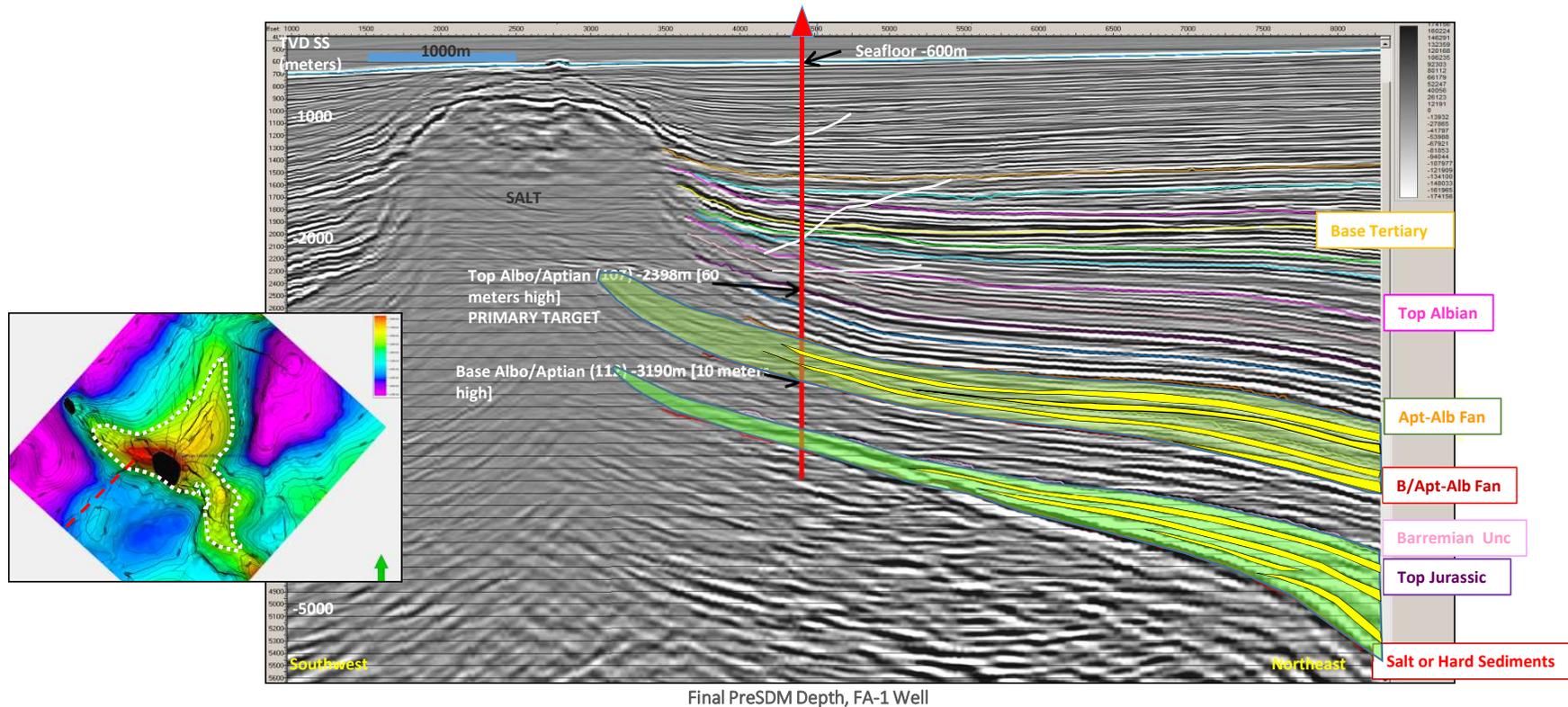


Final PreSDM Depth, FA-1 Well

SALT RELATED PLAY: UNTESTED INVERTED MINI BASINS

LESSONS LEARNED

- Thick turbidite sands would be deposited in intra growing salt diapirs minibasins, thus only thin bedded and fine grained sands were penetrated by the wells, on the flanks of the diapirs.

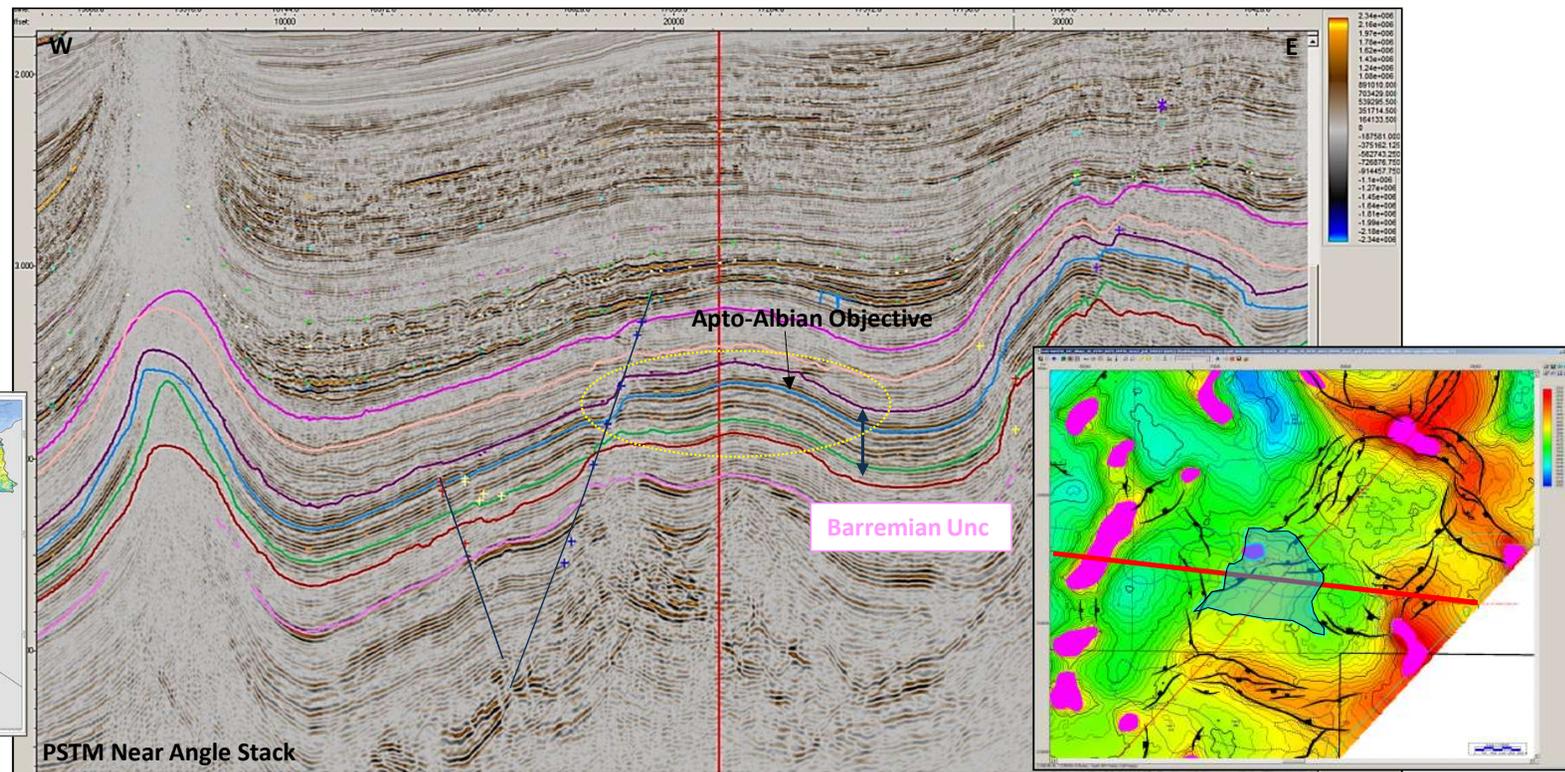
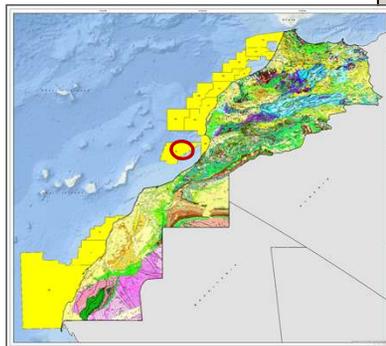


SALT RELATED PLAY: UNTESTED INVERTED MINI BASINS

NEXT SALT RELATED PLAY FOCUS

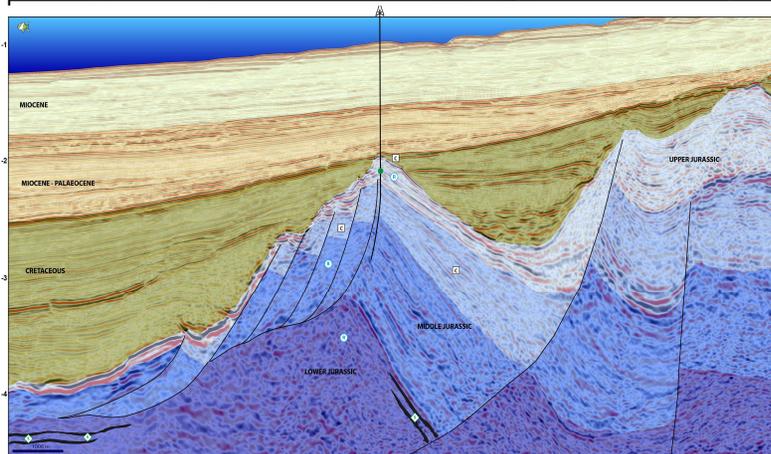
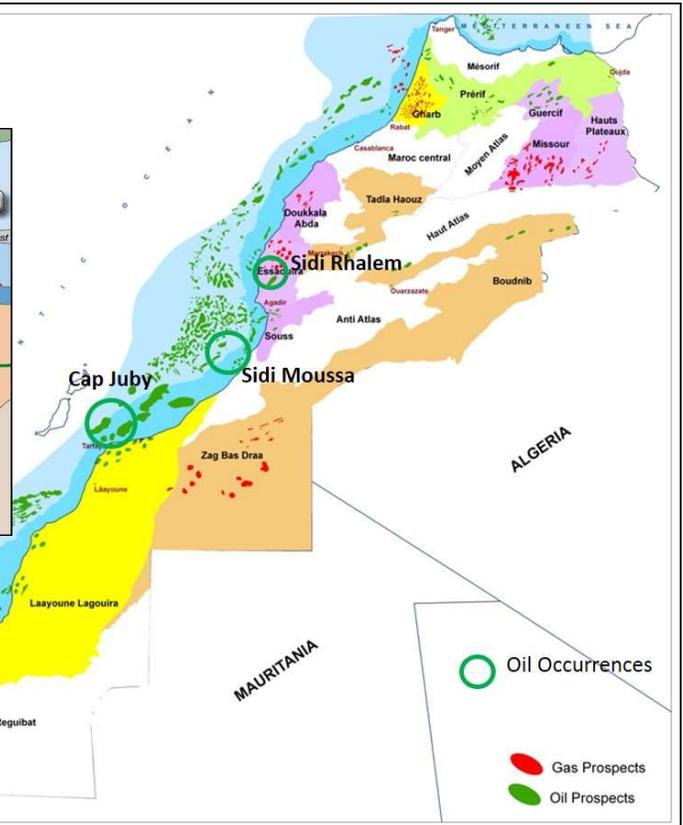
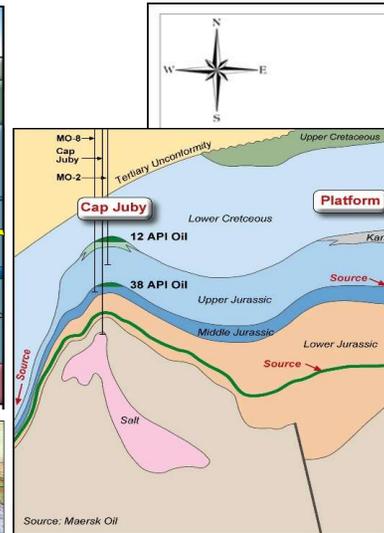
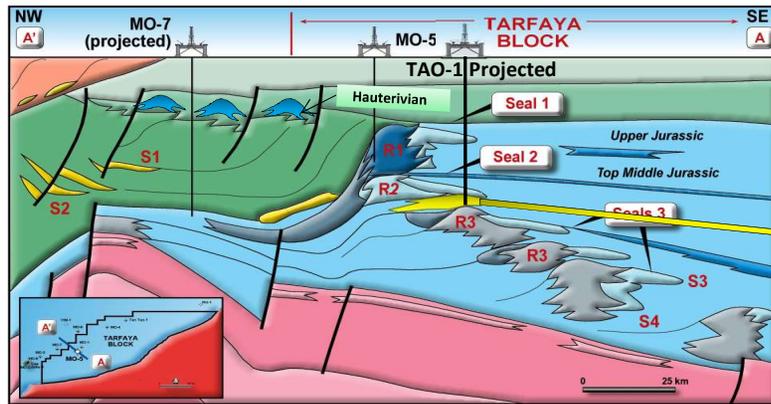
- Sand bearing Inverted minibasins would be the focus in the next phase of the exploration in the salt province (example of Apto-Albian fan complex).

PROSPECT	
Water Depth (m)	975
Closure (Km ²) (P10)	57
P mean Resources (MMBO)	871



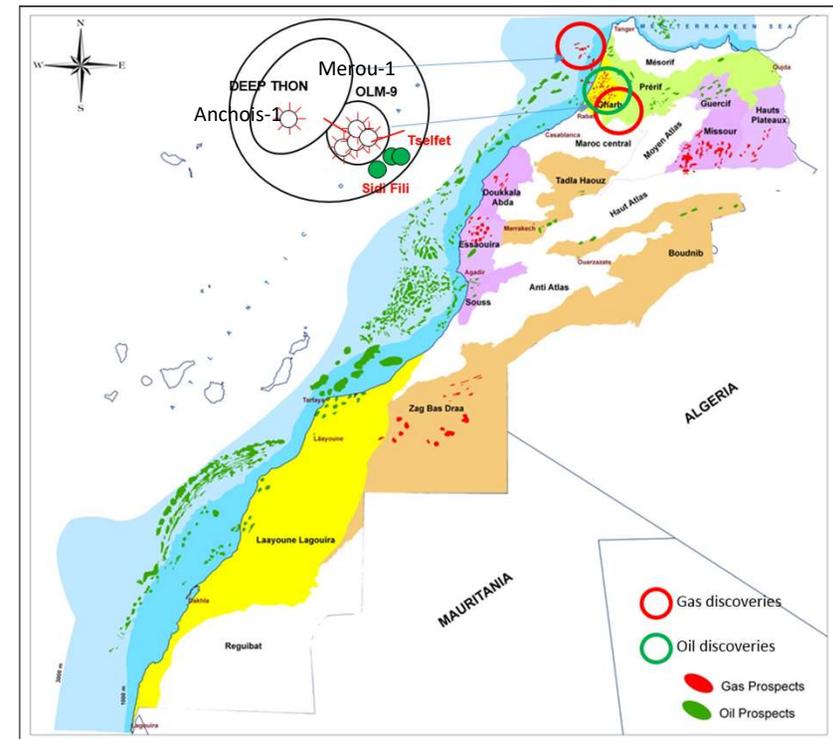
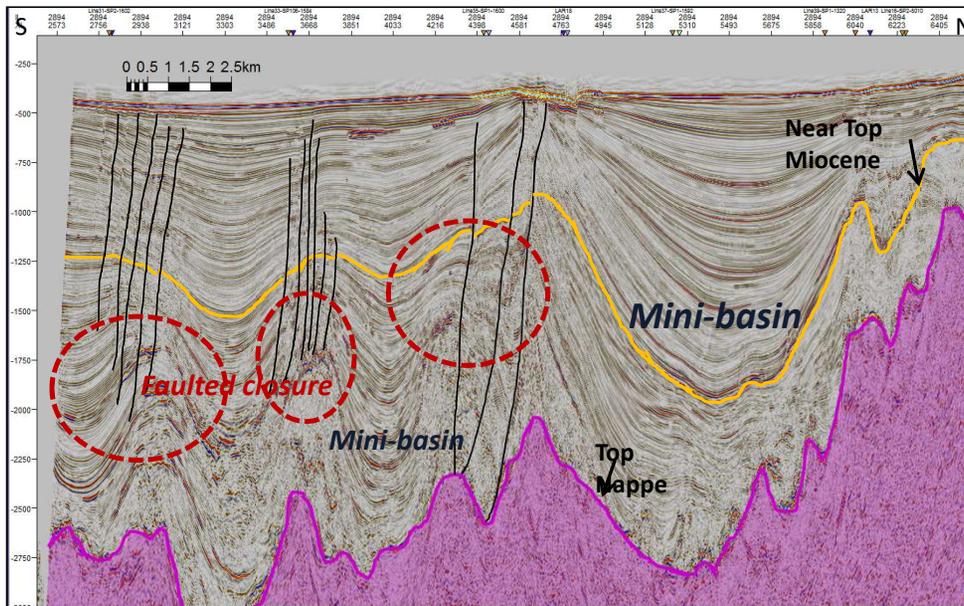
JURASSIC PLATFORM PLAY

- Oil field (Sidi Rhalem), heavy and light oils accumulations (Cap Juby and Sidi Moussa) are associated with the Jurassic platform play and give strong evidence of working petroleum systems.
- New focus on down faulted blocs, reefs and oolite shoals sealed by Cretaceous shale.



CURRENT PLAYS

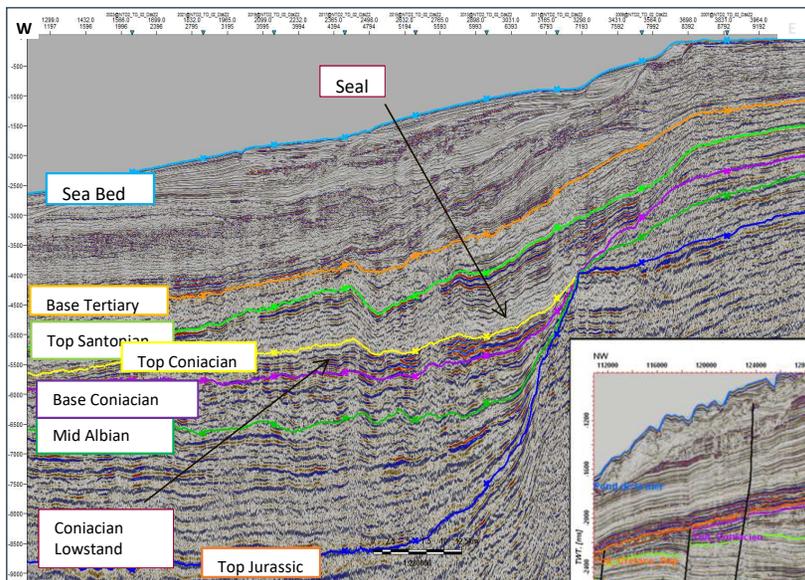
- Biogenic and thermogenic gas in the Miocene turbidite sandstones.
- Alpine tectonics related structures, involving Mesozoic strata within the accretionary wedge “Nappe” and underneath, show up on adequately reprocessed 3D seismic, to constitute new play in the area.



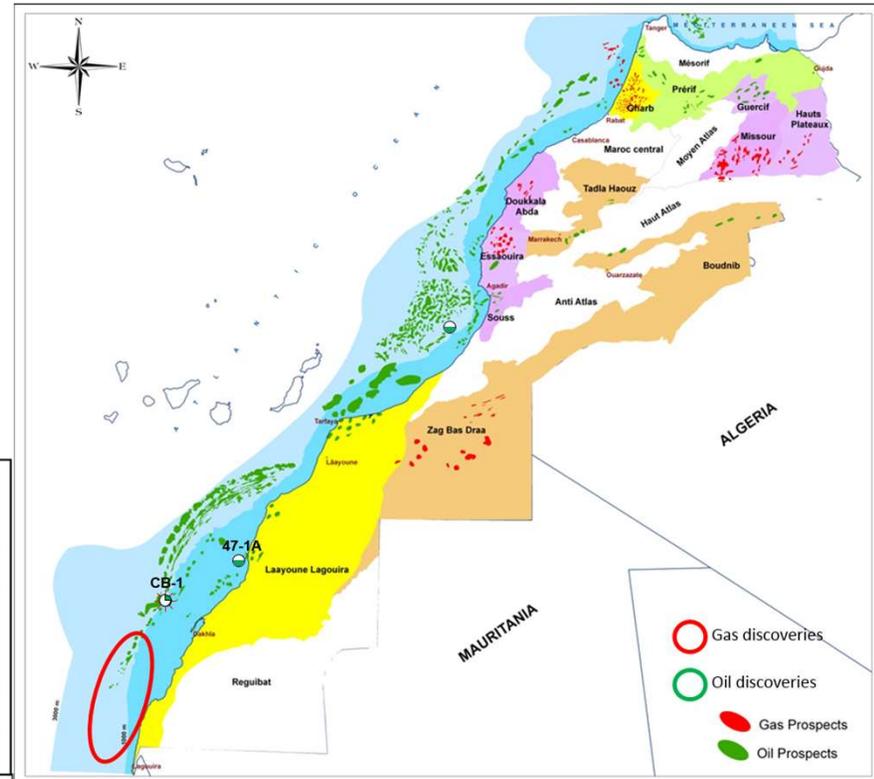
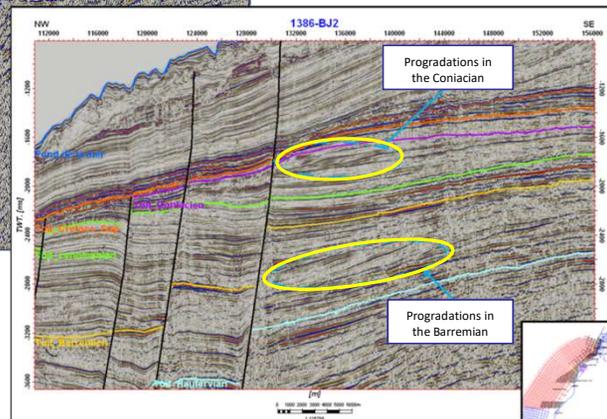
CURRENT PLAYS

Upper Cretaceous Turbidite Play

- Stratigraphic traps and slope tectonics related structures involving the Upper Cretaceous (Coniacian) turbidite sandstones to be sourced from underlying organic rich Cenomanian Turonian source rocks.

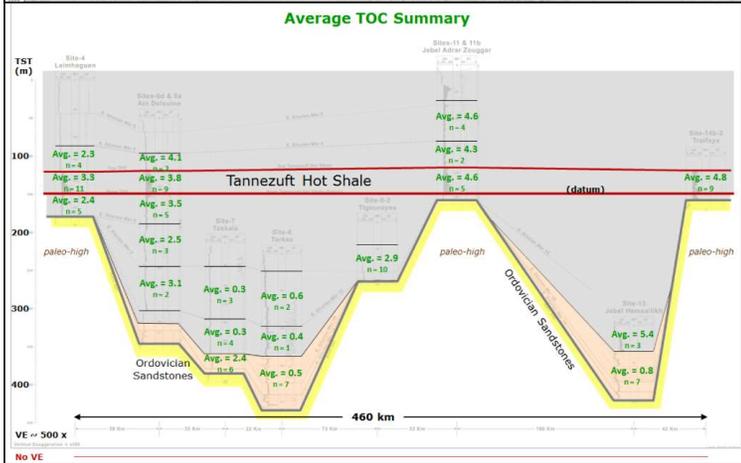
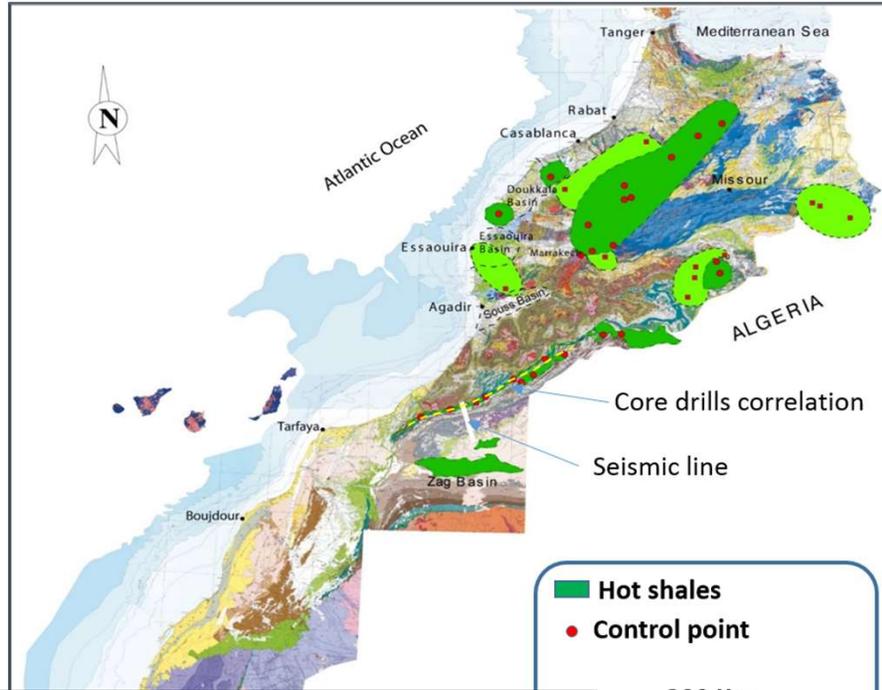
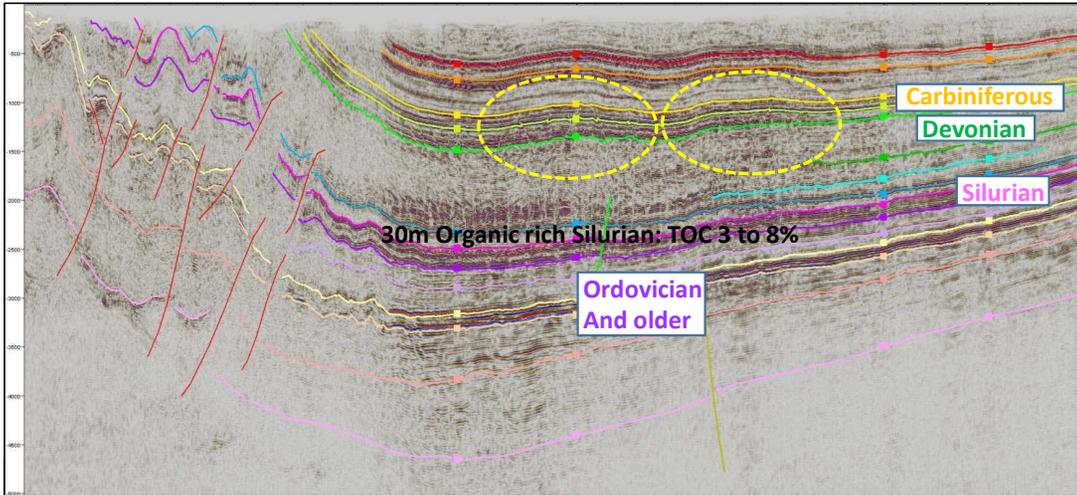


CB-1: 14m of net Gas in Barriasian – Non Commercial
Analog: Albian-Turonian turbidites in Mauritania



UNCONVENTIONALS HYDROCARBONS

Conventional and non conventional

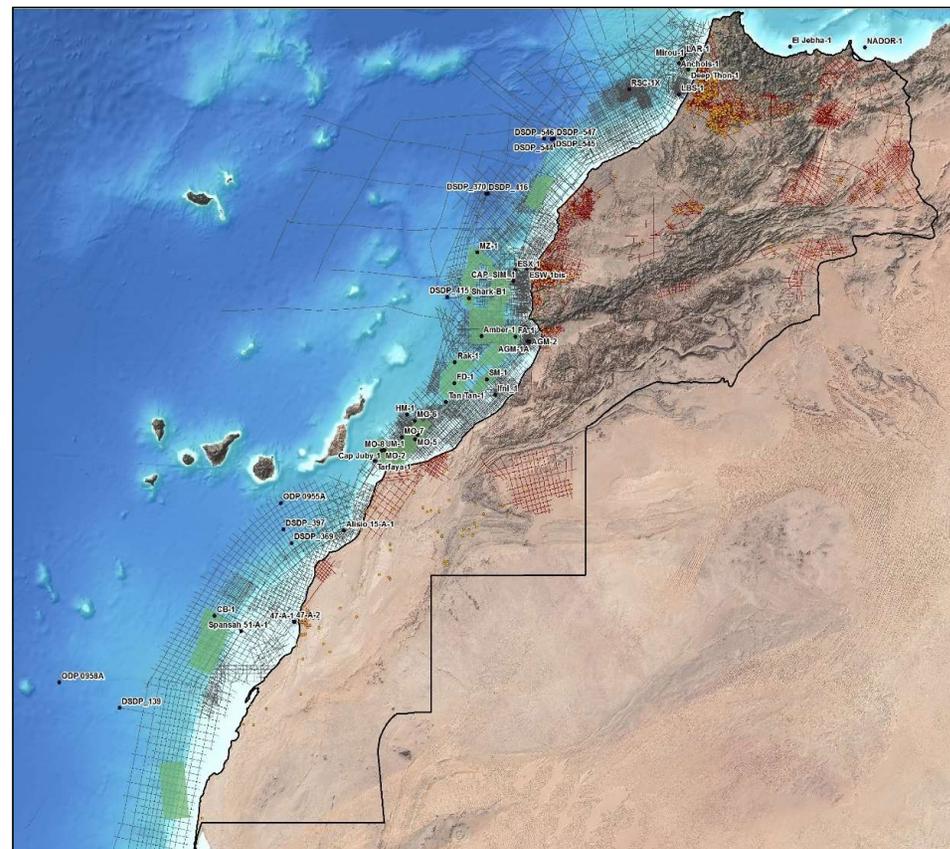


1. Source Rock : **Silurian hot shale & Frasnian shale**
2. Migration: **Vertical through faults & lateral**
3. Reservoir : **Carboniferous sandstones and Devonian carbonates/Sandstones (Ø up to 11% can be increased by fracturation)**
4. Seal: **Palaeozoic interbedded shale & marls**
5. Trap: **Structural (Hercynian structures:folding inverted structures and faulted blocs) and Stratigraphic (Lateral facies variation and syndepositional structure)**

ONHYM: ONGOING WORKS

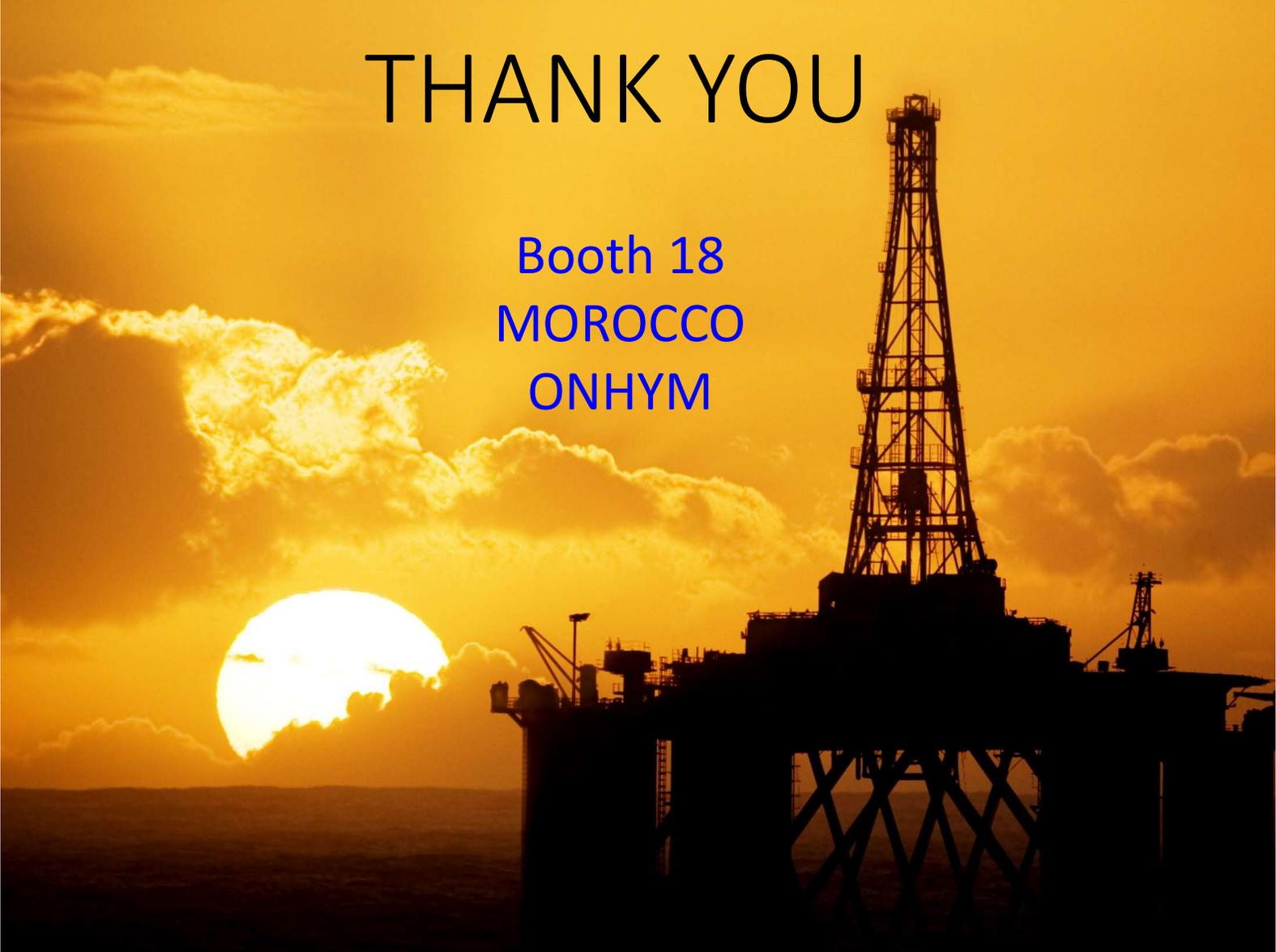
ONGOING WORKS

- **ONHYM Internal basins evaluations**
 - Integration of the new well results into regional studies (Reservoir distribution & geochemical modelling)
 - G&G Evaluation of the open blocks
 - Data room organization in ONHYM Offices (16 data room in 2018)
- **Seismic reservoir characterization in offshore Agadir**
 - (CGG/Started in February 2019)
- **Multi-client long offset 2D seismic interpretation and margin evaluation**
- **Seismic Reconstruction of the Moroccan & Nova Scotian margins (MOU between ONHYM and OERA of the province of Nova Scotia)**
 - Data sharing agreement
 - Joint effort to explore geology and petroleum opportunities in both margins



CONCLUSION

- **The Moroccan geology is, by its sedimentary and tectonic diversity, considerably favorable for oil and gas generation and production**
- **Strong evidences for the existence of several working petroleum systems, through producing fields, oil and gas accumulations or shows and oil or gas seeps ;**
- **Myriad of play concepts are developed in different sedimentary basins and different geological times in Morocco ;**
- **The so far drilled wells have tested two plays and encountered modest hydrocarbon or shows even though some did not penetrate thick reservoir intervals;**
- **The flagship exploration plays are driven by hydrocarbon occurrences in their neighborhood and their analogies with successful cases in Morocco;**

A photograph of an offshore oil rig at sunset. The sun is a large, bright yellow circle on the horizon, partially obscured by clouds. The sky is a deep orange and yellow. The rig is silhouetted against the bright sky, showing its complex structure of towers and platforms. The ocean is visible in the foreground, appearing dark.

THANK YOU

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MOROCCO
ONHYM