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المكتب الوطني للهيدروكاربورات و المعادن

ⵜⴰⵙⴷⴰⵡⵉⵜ ⵏ ⵍⵀⵉⴷⵔⵓⴽⴰⵔⴱⵓⵔⴰⵜ ⴷ ⵜⵎⵙⵙⵓⵔⵉⵏ

OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

27 February – 1 March Islington, London
PROSPECT AND PROPERTY EXPO
APPEX GLOBAL 2018

Hosted by: AAPG Europe Region

Endorsed by: International Pavilion

DEVELOPED PLAY CONCEPTS

IN PROMISING

MOROCCAN SEDIMENTARY BASINS

K. GUERNOUCHE

WHY TO EXPLORE IN MOROCCO?





- Stable and attractive country with market place that is rapidly deregulating and opening.

- Promising Potential
  - Most of the nation's territory is under explored
  - Wherever adequately explored, Moroccan sedimentary basins have produced Hydrocarbons.

- Opportunities that combine low entry cost and suitable exit options.

- Fully shared vision with partners.

- One of the most attractive fiscal regime worldwide.

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LEGAL FRAMEWORK

The Moroccan Hydrocarbon Law : One of the most attractive in the world

- **Government interest share : 25% maximum**
- **Corporate tax : total exemption for ten-year period**
- **Surtax : None**
- **Tax exemption**
  - **With-holding tax on profits**
  - **Value added tax**
  - **Business activity tax**
  - **Urban tax**
  - **Tax on non-improved urban land**

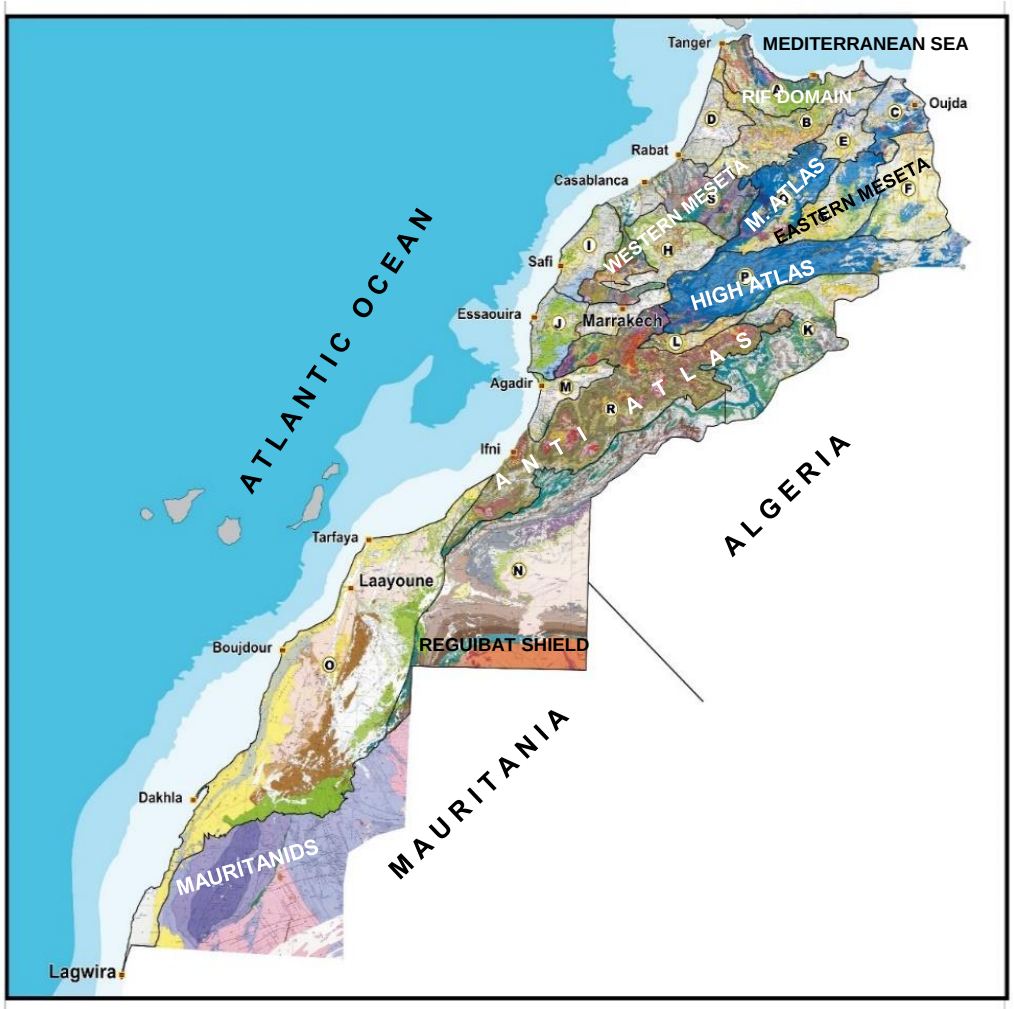
MOROCCAN SEDIMENTARY BASINS

- **Large and diverse sedimentary basins, of various geological ages and structural styles.**
  Total area : 918 237 Km².

- **A very extended offshore domain: 3 000 km on the Atlantic and 500 km on the Mediterranean sea coast lines.**

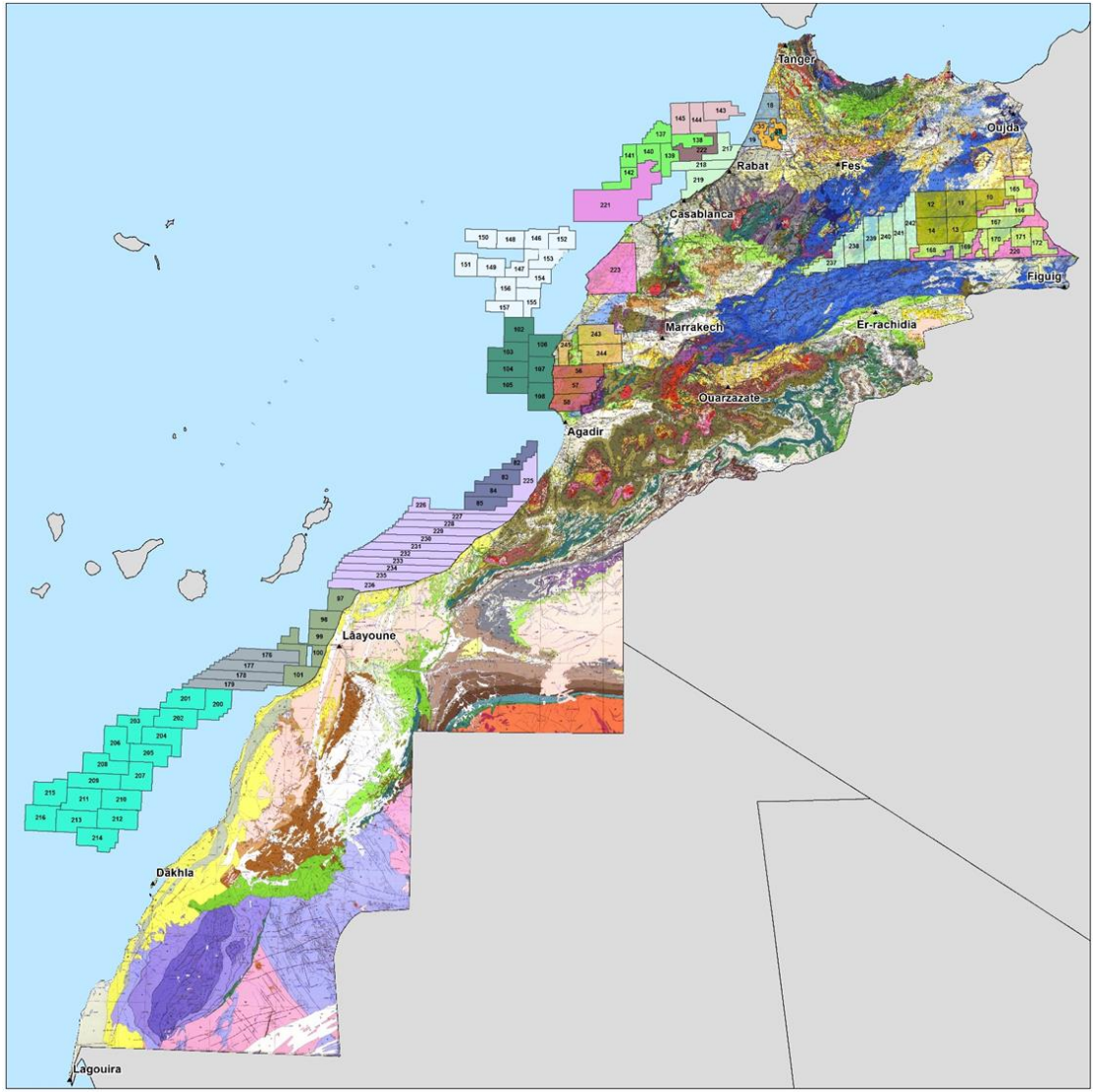
  Total area: 300 000 Km² (to 4 000 m bathymetry), consisting of Mesozoic and Cenozoic sedimentary basins.

- **A various onshore sedimentary basins (620 000 Km²): Objectives ranging from Paleozoic to Neogene in age.**



HYDROCARBON EXPLORATION STATUS

PARTNERSHIP



17 ONHYM Partners on:

- **106** Exploration Permits
- **3** Reconnaissance Licenses
- **9** Concessions
- **Total : 181 070.12 km²**

KOSMOS ENERGY
REPSOL
Chevron
CHARIOT OIL & GAS
Genel Energy
eni
Circle Oil Plc
SOUND ENERGY MOROCCO
قطر للبترول Qatar Petroleum
NewAge
SDX ENERGY

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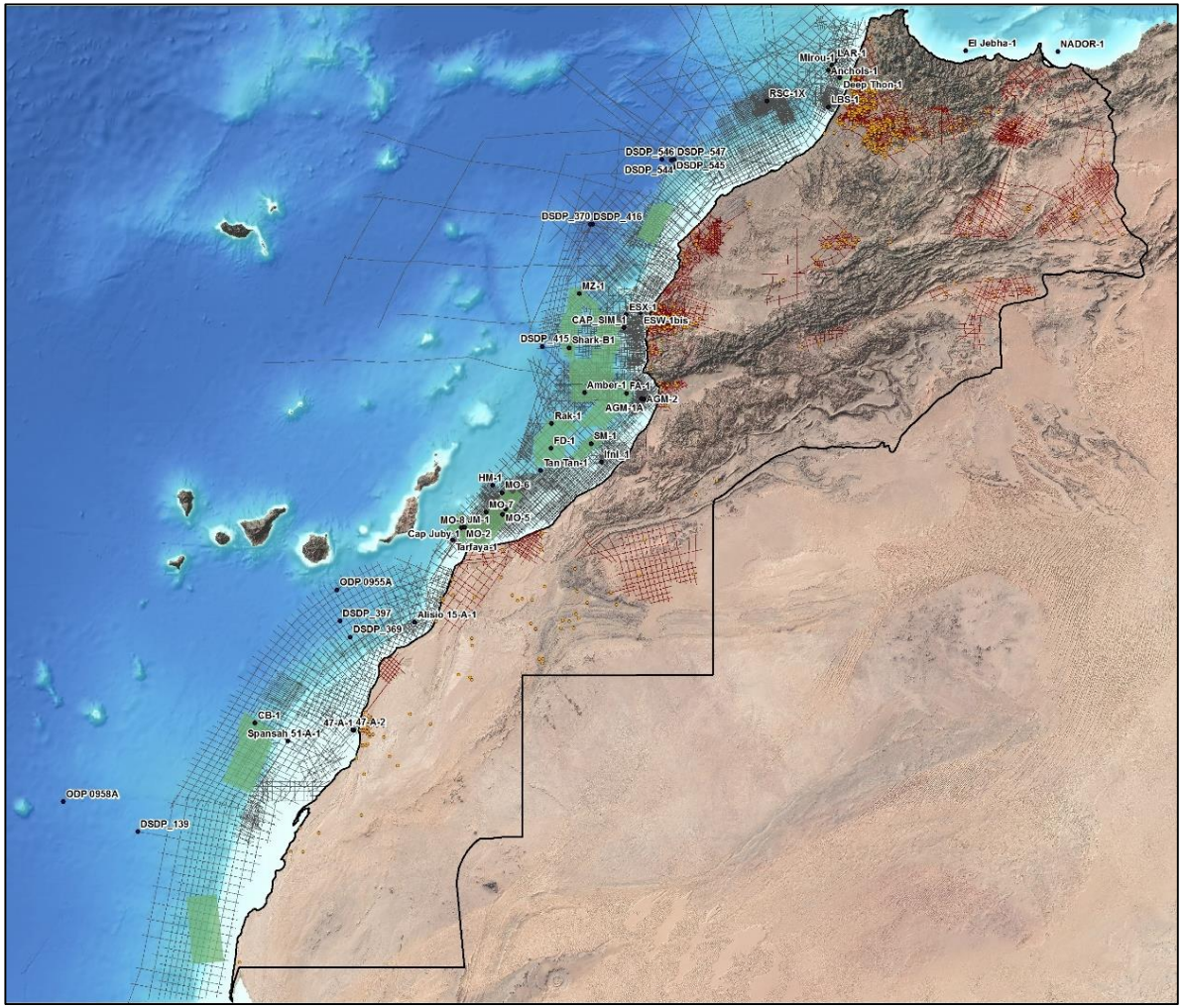
EXPLORATION SNAPSHOT : OFFSHORE & ONSHORE



SEISMIC & WELLS DATABASE

Seismic (Feb. 2018)

- 2D Seismic: 228147 Km
- 3D Seismic: 59589 Km²
- Additional 2D & 3D seismic to be acquired in 2018

Exploratory Wells (Feb. 2018)

- 43 wells offshore (41 in the Atlantic & 2 in the Mediterranean)
- 302 wells Onshore

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HYDROCARBON EXPLORATION : DRILLING ACTIVITY SUMMARY

Drilling Activity between 2013/2017

OFFSHORE:

- **5/7 wells drilled offshore encountered either oil or gas shows or heavy oil and 1 well hit a non commercial gas and condensate accumulation.**

ONSHORE :

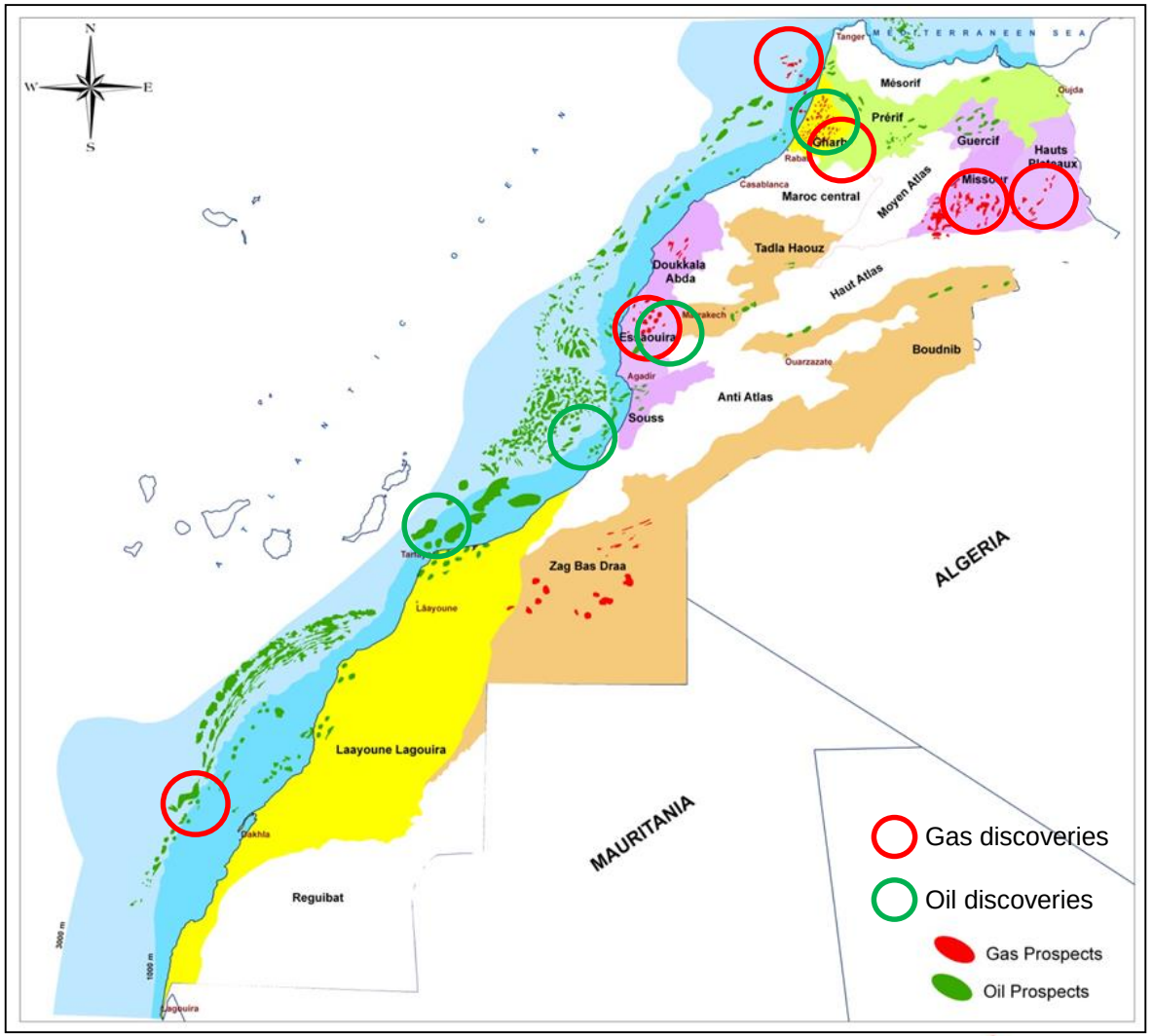
- ***Essaouira basin:*** **2/4 wells drilled in hit gas discovery (to be confirmed with cased hole testing program and delineation wells);**
- ***Gharb basin*** **: 9/17 wells drilled identified the presence of commercial biogenic gas accumulations;**
- **High Plateaux: 2/3 wells drilled encountered gas discovery.**

HYDROCARBON EXPLORATION: PROSPECTS & LEADS

- More than 800 prospects & leads have been identified in the different plays, onshore and offshore:
  - Pre-Salt Play
  - Salt Related Play
  - Platform Play
  - Turbidite Play
  - Thrust Related Play

- The prospects drilled so far showed some hydrocarbon accumulations and modest discoveries that have proven the identified plays

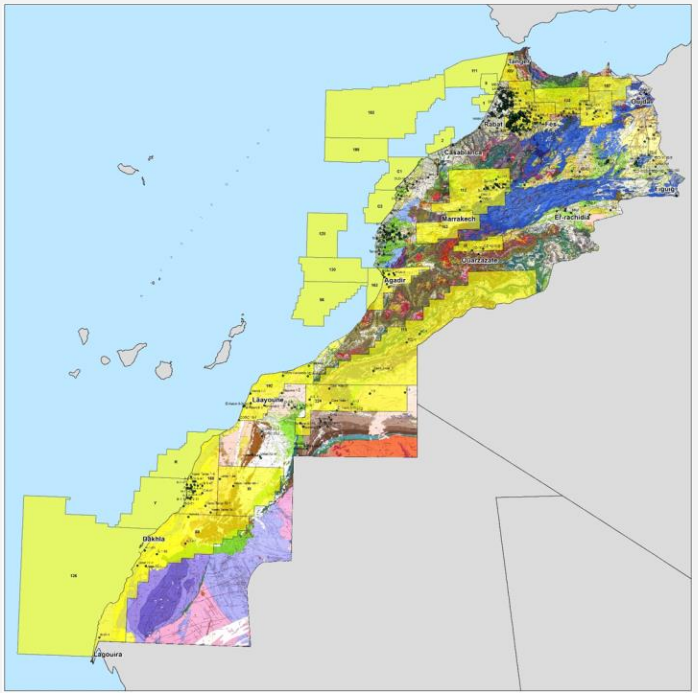
- Still considerable number of mature prospects deserves to be drilled.



OPEN ACREAGE:

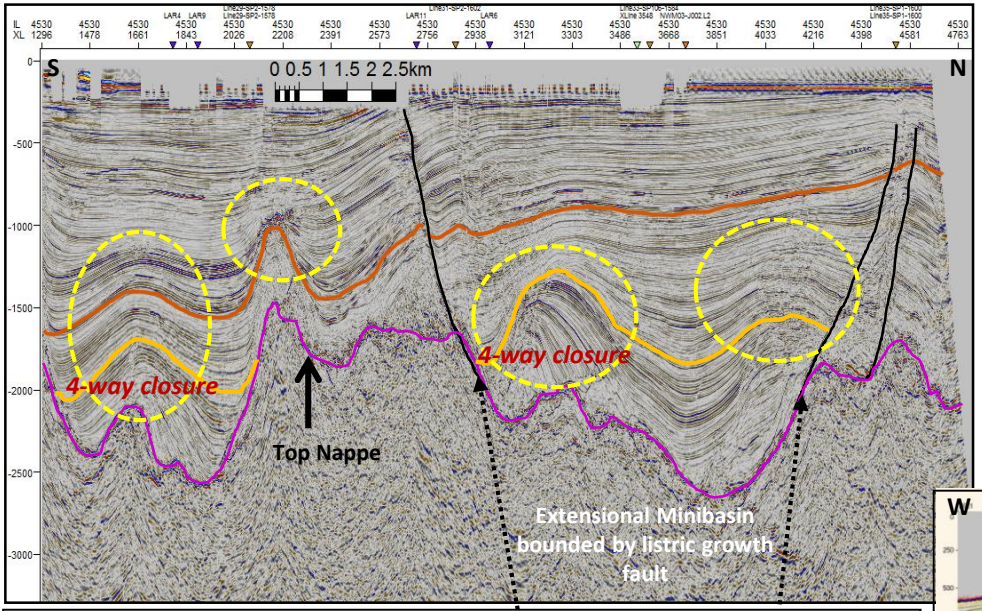
EXAMPLES OF PROSPECTS & LEADS-

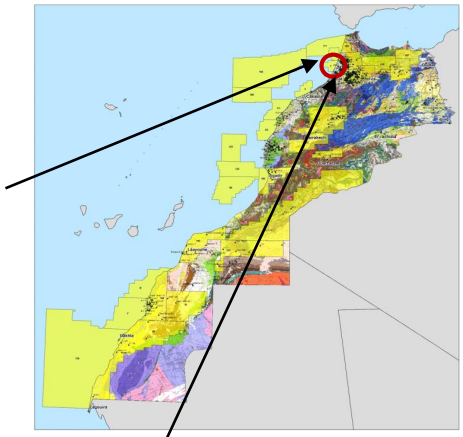
OFFSHORE ATLANTIC MOROCCO



HYDROCARBON EXPLORATION: PROSPECTS & LEADS

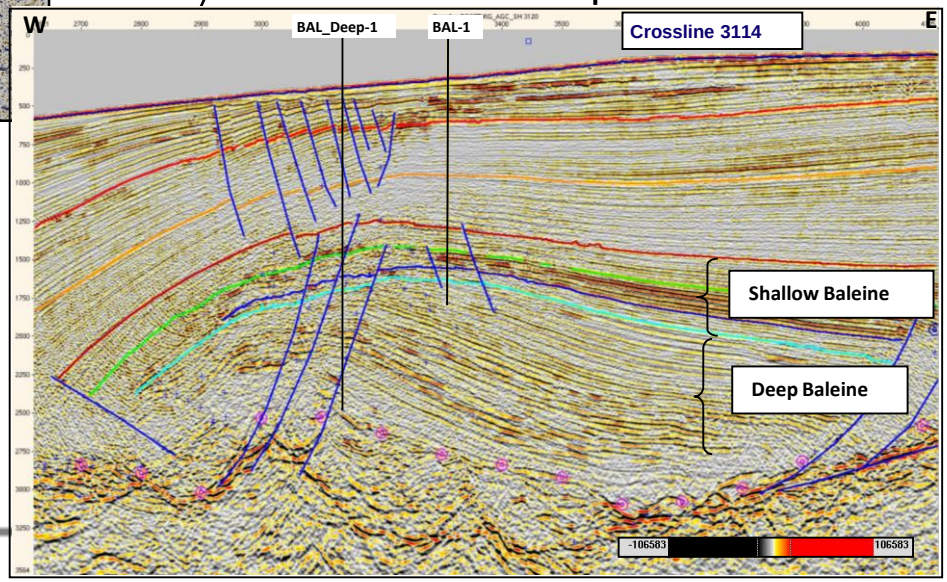
Example of Tertiary 4-way closure structures (Gharb Offshore)
Amplitude supported play





Baleine prospect	
Water Depth (m)	253
Closure (Km²)	11.4
P mean Resources (BCF)	209.9

Baleine Prospect

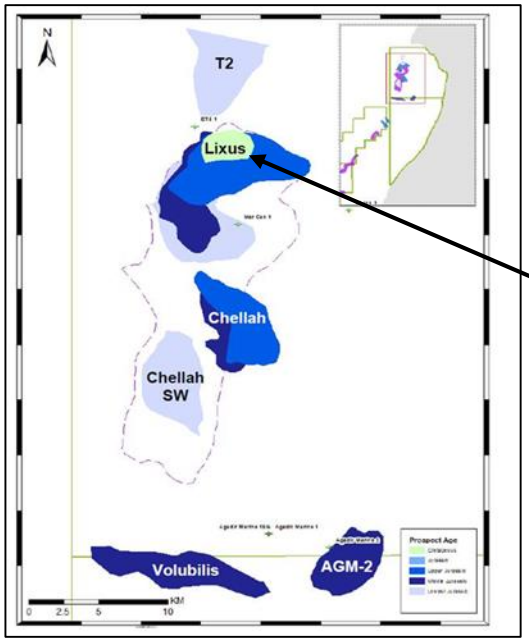


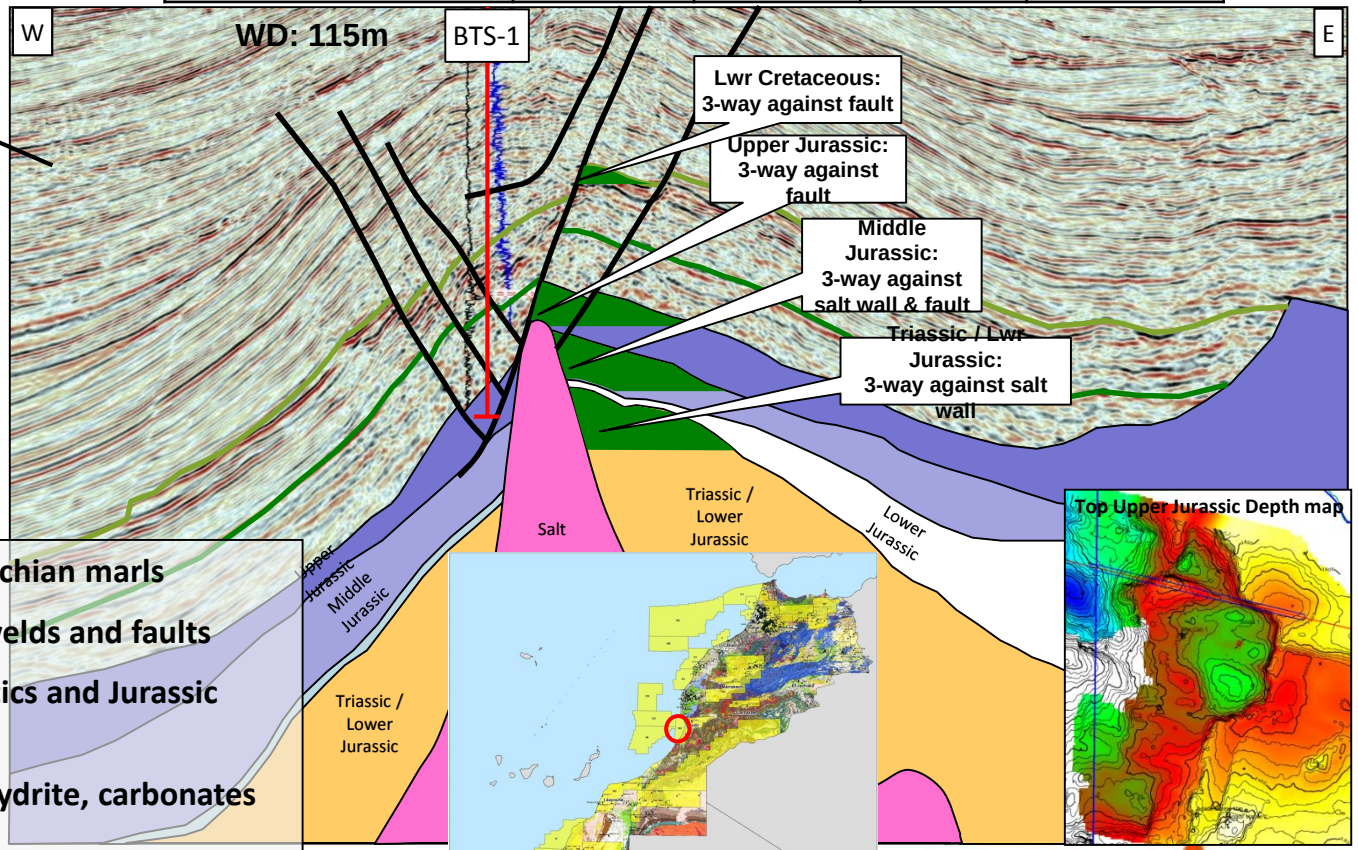
1. Source Rock: Miocene/Cenomanian-Turonian marls in mini basins
2. Migration: Vertical short pathway through faults
3. Reservoir: Mio-Pliocene turbidite channel sandstones
4. Seal: Plio-Pleistocene hemipelagic shale draping over reservoir sand beds
5. Trap: 4 & 3-way closure roll overs

HYDROCARBON EXPLORATION: PROSPECTS & LEADS

Example of 3-way closures with multi-targets (Mir Left Offshore)

Target	Lw Cret	Up Jur	Mid Jur	Lw Jur
Reservoir Crest (m)	1880	2560	2900	3150
Mean STOIIP (MMbbls)	164	441	286	565



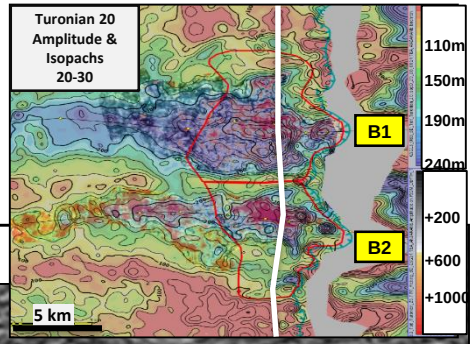


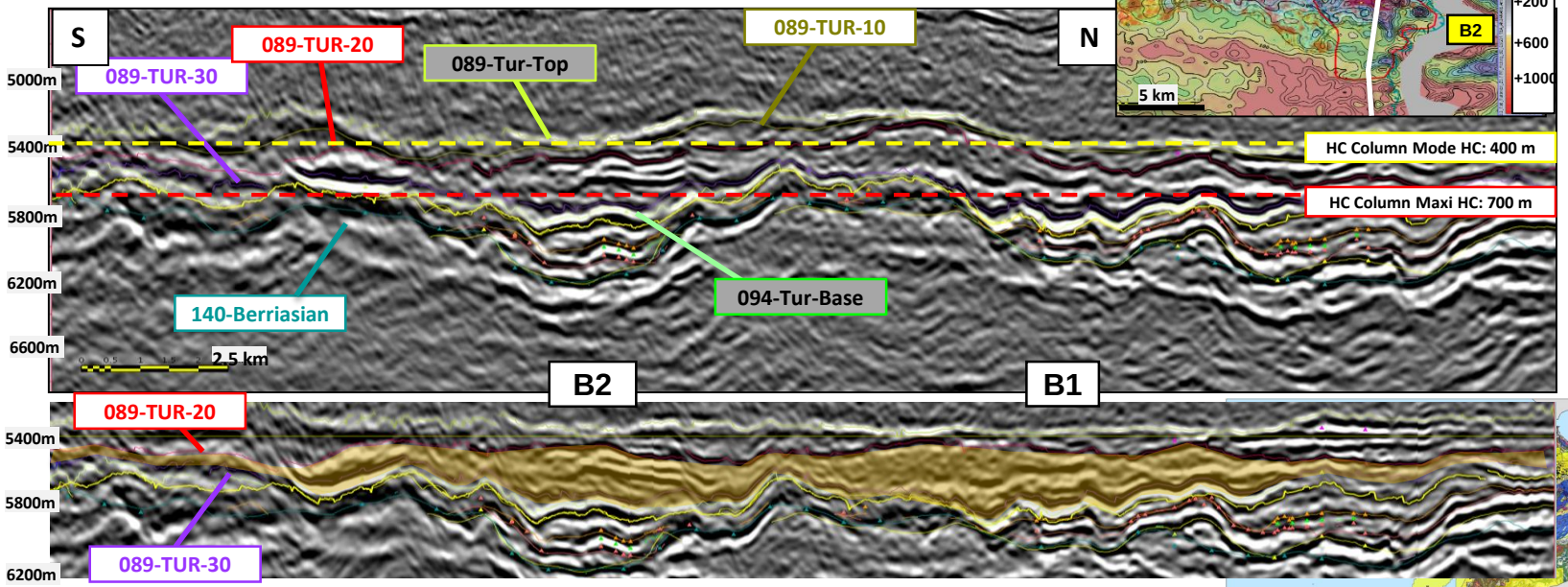
1. Source Rock: Toarcian to Pliensbachian marls
2. Migration: Vertical through salt welds and faults
3. Reservoir: Lower Cretaceous clastics and Jurassic carbonates
4. Seal: Jurassic and Cretaceous anhydrite, carbonates and transgressive shale
5. Trap: Structural and Stratigraphic

HYDROCARBON EXPLORATION: PROSPECTS & LEADS

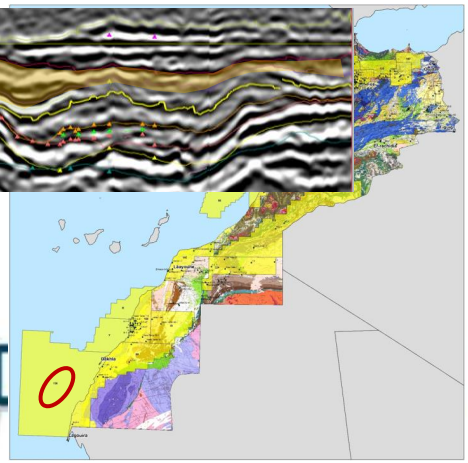
Example of Upper Cretaceous canyons (Dakhla Offshore)

	Water Depth (m)	Closure (Km²)	Unrisked recoverable resources-Mean (MMbbls)
Canyon B1	1200	7-61	169
Canyon B2	980	7-45	133





1. Source Rock: Turonian marls
2. Migration: Vertical short pathway
3. Reservoir: Turonian sands
4. Trap: Stratigraphic
5. Seal: Vertical regional MFS and lateral pinch-out on the carbonate platform



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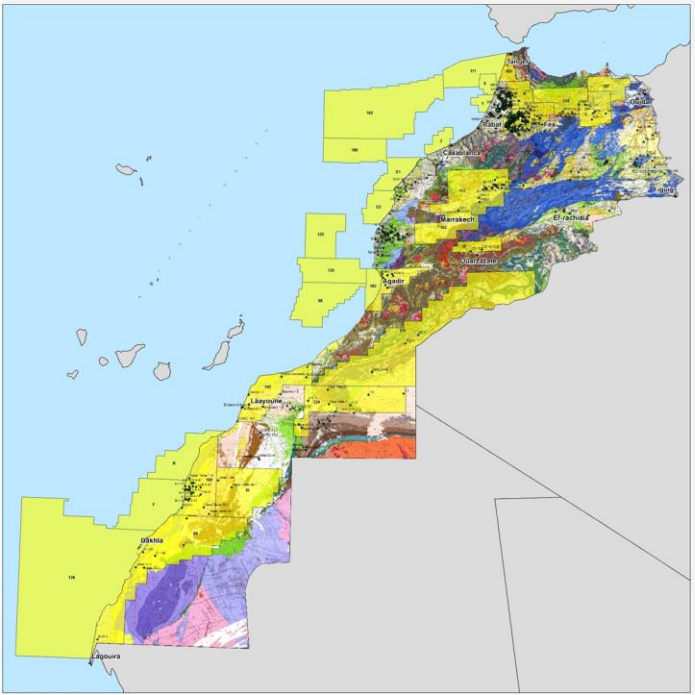
OPEN ACREAGE:

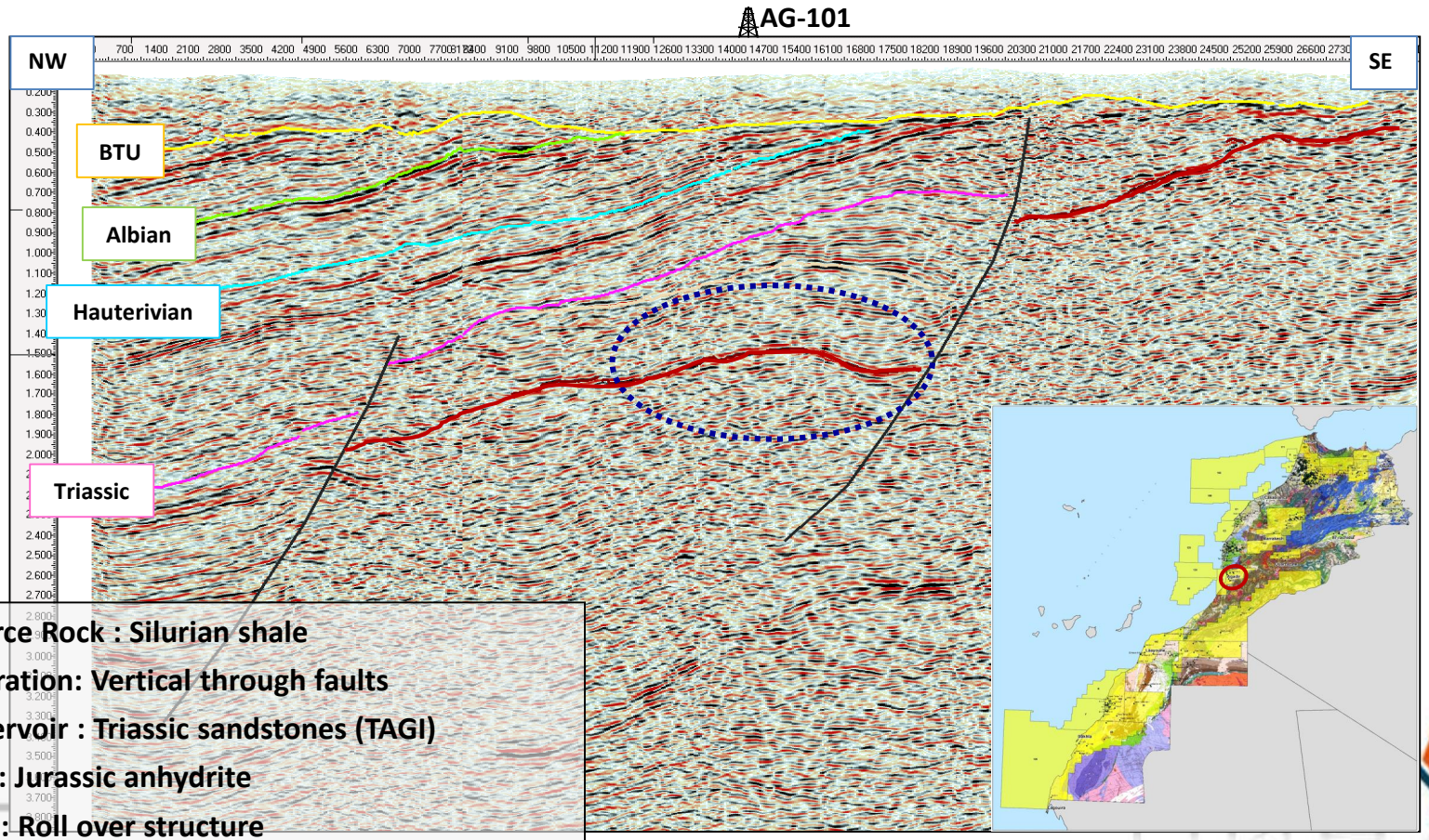
EXAMPLES OF PROSPECTS & LEADS-

ONSHORE MOROCCO



Example of Triassic structures (Souss basin)

	Areal Closure (Km^2)	Recoverable resources (Gas case-BCF)	Recoverable resources (Oil case-MMBO)
El Khemis Lead	40	457	63

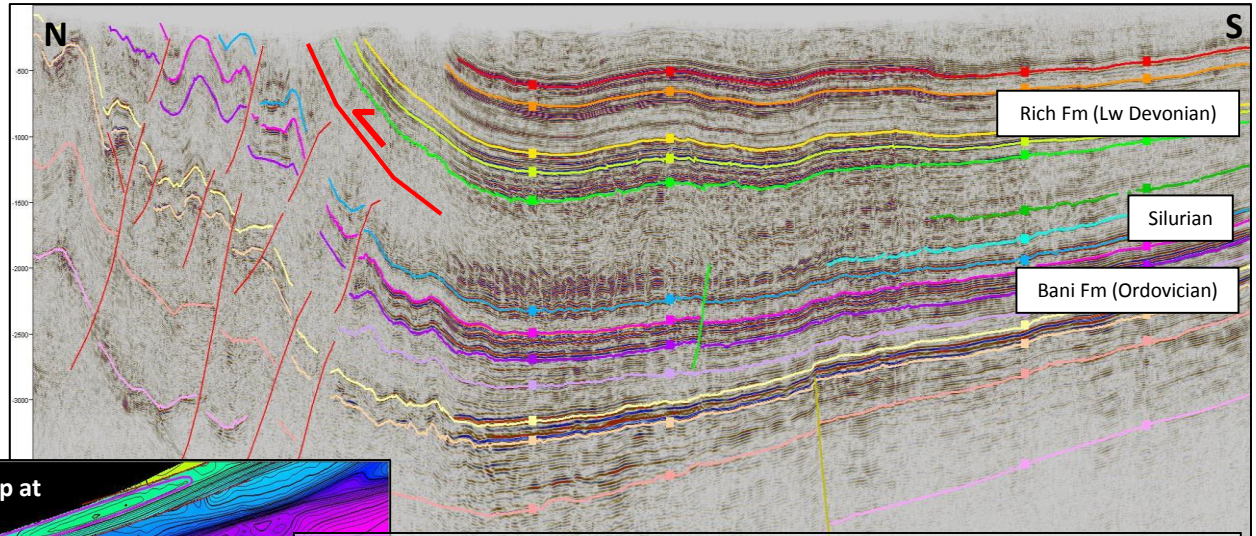


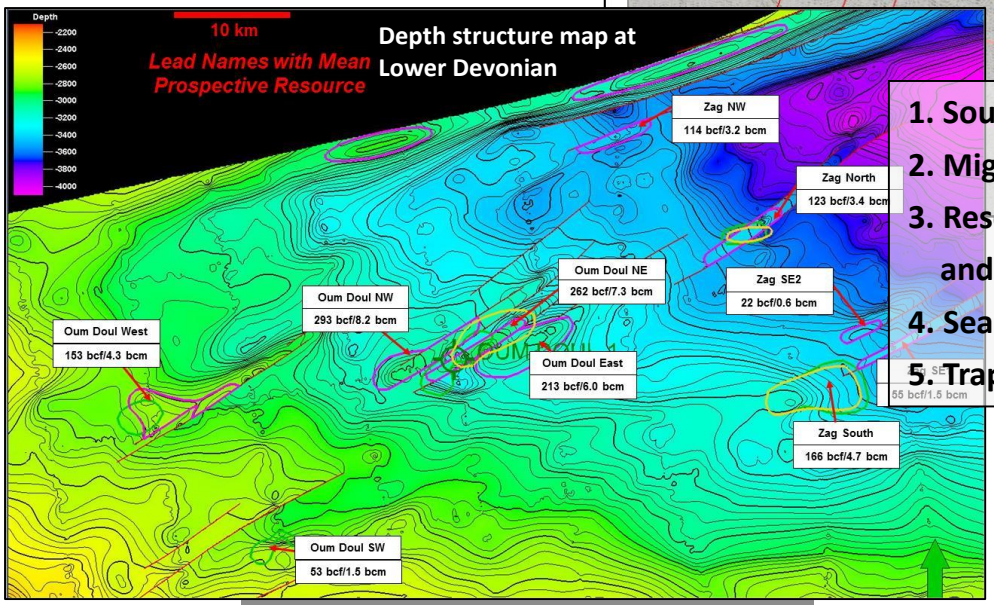
1. Source Rock : Silurian shale
2. Migration: Vertical through faults
3. Reservoir : Triassic sandstones (TAGI)
4. Seal: Jurassic anhydrite
5. Trap: Roll over structure

HYDROCARBON EXPLORATION: PROSPECTS & LEADS

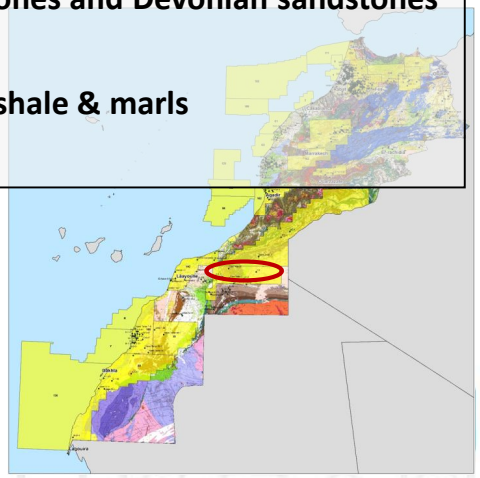
Example of Palaeozoic structures (Zag Basin)

- Several 3 to 4-way closures were identified at the Palaeozoic. These closures are comprised between 3 Km² and 30 Km².





1. Source Rock : Silurian hot shale & Frasnian shale
2. Migration: Vertical through faults & lateral
3. Reservoir : Ordovician Sandstones and Devonian sandstones and carbonates
4. Seal: Palaeozoic interbedded shale & marls
5. Trap: Hercynian structures



Total Gas resources: 1.454 Tcf

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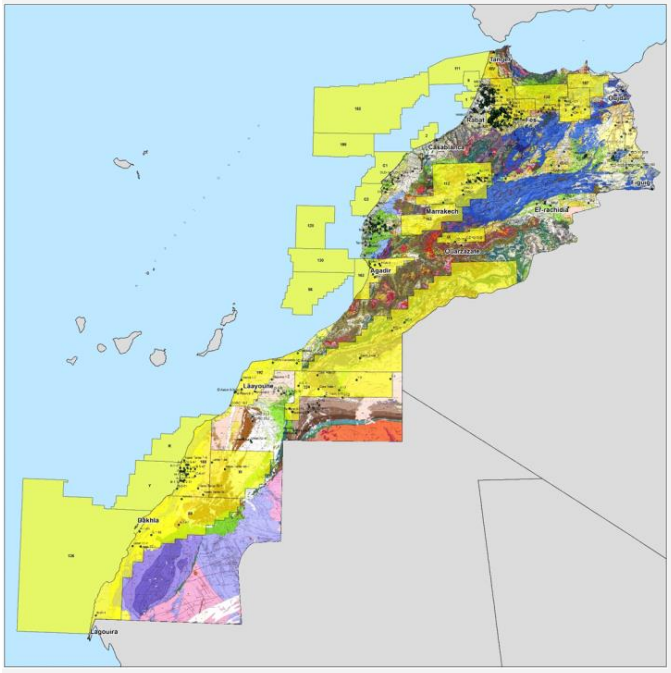
HYDROCARBON EXPLORATION:

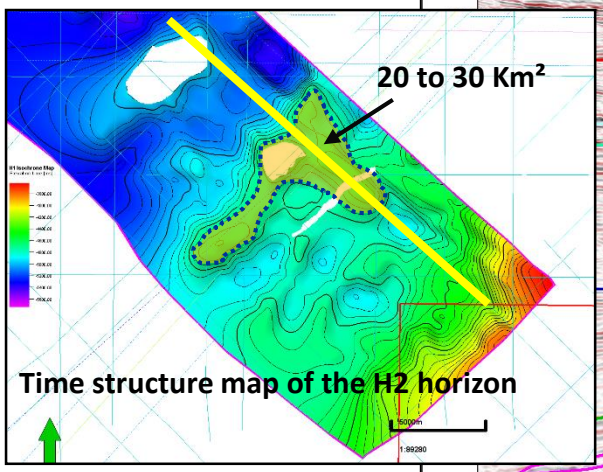
EXAMPLES OF NEWLY DEVELOPED

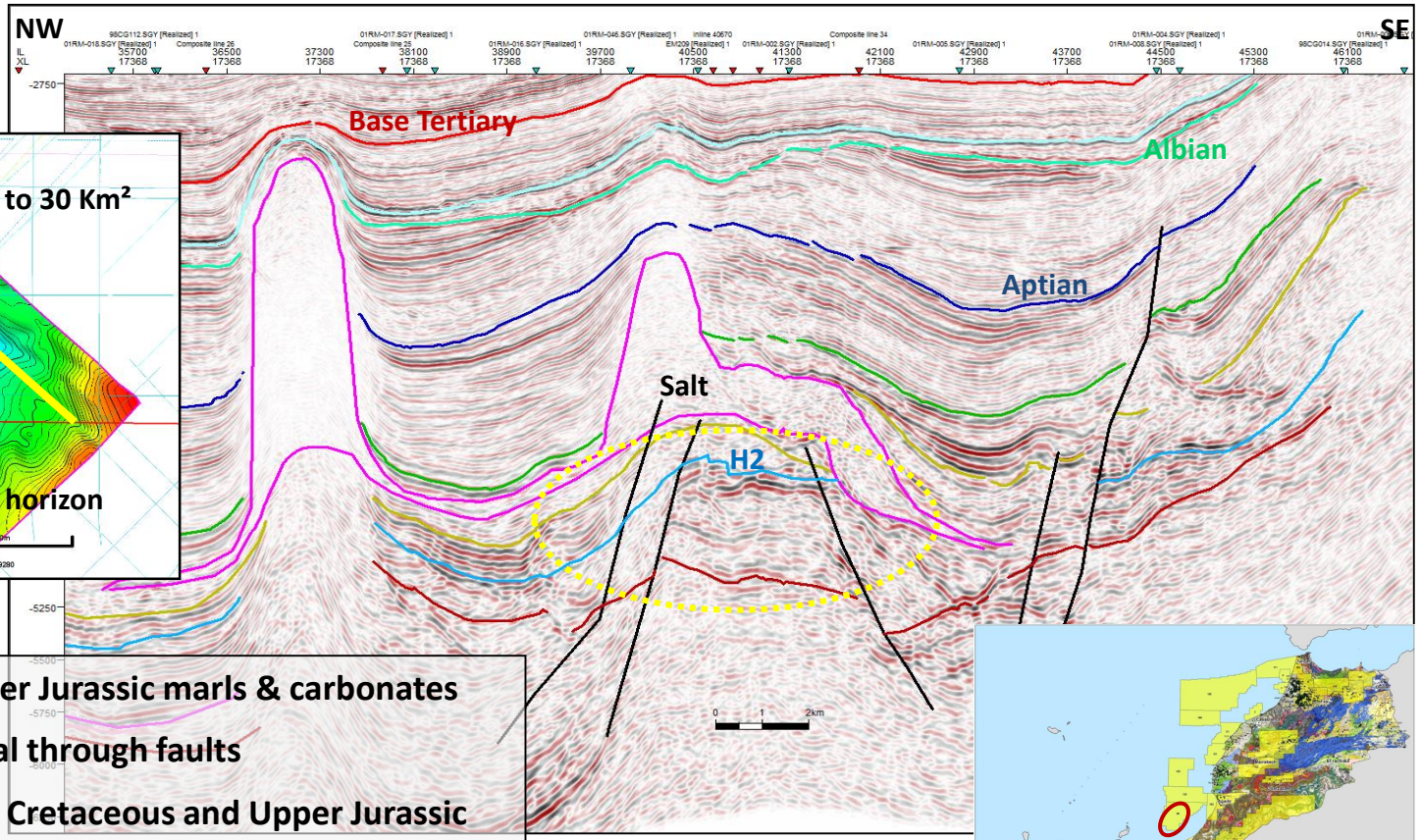
PLAY CONCEPTS



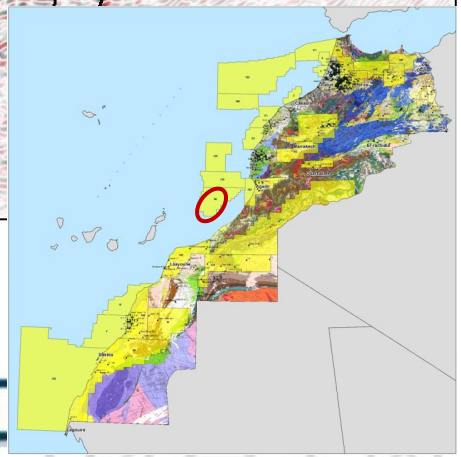
HYDROCARBON EXPLORATION: EXAMPLE OF PLAY CONCEPTS

Sub-salt play (Ifni Deep Offshore)



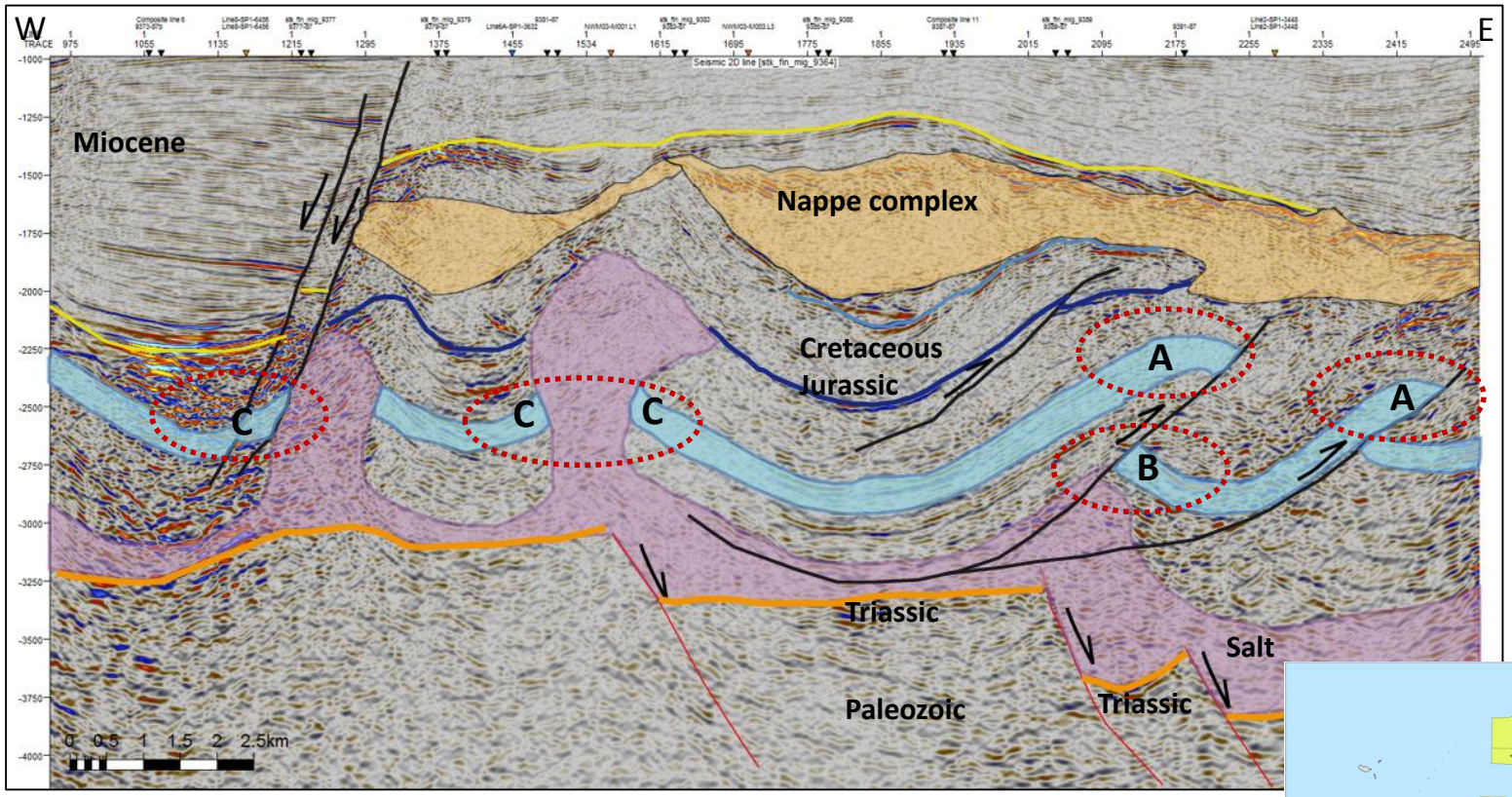


1. Source Rock: Lower Jurassic marls & carbonates
2. Migration: Vertical through faults
3. Reservoir : Lower Cretaceous and Upper Jurassic turbidite sandstones and carbonates
4. Seal: Overlying salt
5. Trap: Combined (sub-salt)

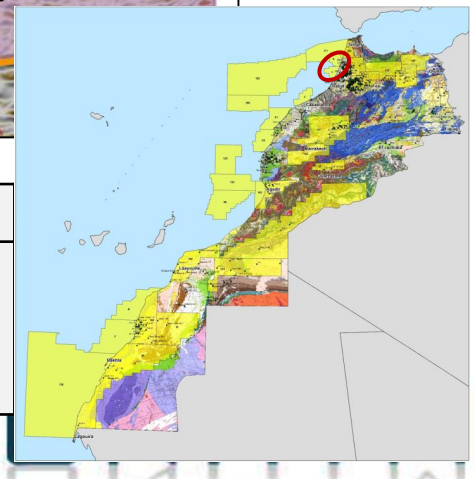


HYDROCARBON EXPLORATION : EXAMPLE OF PLAY CONCEPTS

Pre-nappe structures (Gharb Offshore)

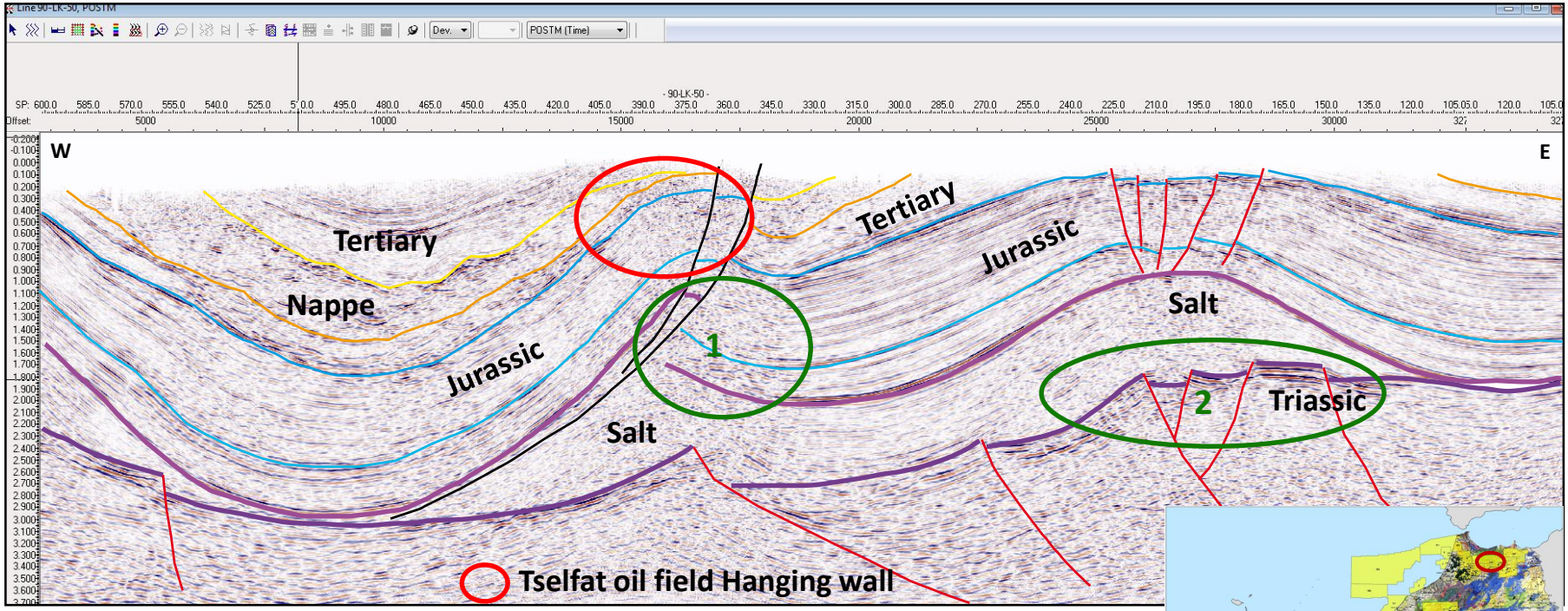


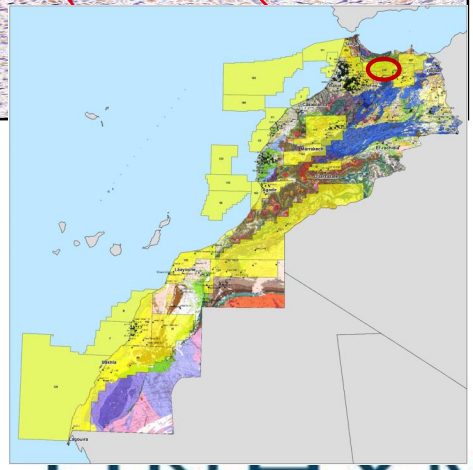
Traps	Source Rocks	Reservoir Rocks	Analogs
A: Over hang anticlines	Toarcian Organic rich shale	- Domerian oolitic limestone - Bajocian Sandstones	Tselfat and Bou Draa oil fields in the onshore Rides Prerifaines
B: Sub thrust			
C: Salt wall related			



HYDROCARBON EXPLORATION : EXAMPLE OF PLAY CONCEPTS

Sub-thrust and Pre-salt structures (Prerif basin-Prerifaines Ridges)





Untested targets:

- **Sub-thrust: 1**
  - Domerian platform limestone
  - Mid. Jurassic sandstones (Haricha formation)
- **Pre-salt: 2**
  - Triassic fluvial sandstones

CONCLUSIONS

- Moroccan geology is significantly favorable for oil and gas exploration and production : good evidences for the existence of viable petroleum systems ;
- Different plays were developed in the Moroccan sedimentary basins and have a wide stratigraphic and geographic extension ;
- The play concepts developed are analogue to those identified in North Africa, Nova Scotia, West Africa and the Gulf of Mexico;
- Countless prospects and leads were identified in different sedimentary basins and different geological times in Morocco ;
- The so far drilled wells have discovered modest local hydrocarbon to prove existence of working petroleum systems;
- New incentives and hydrocarbon potential has attracted and continue to attract new investors to explore in Morocco.

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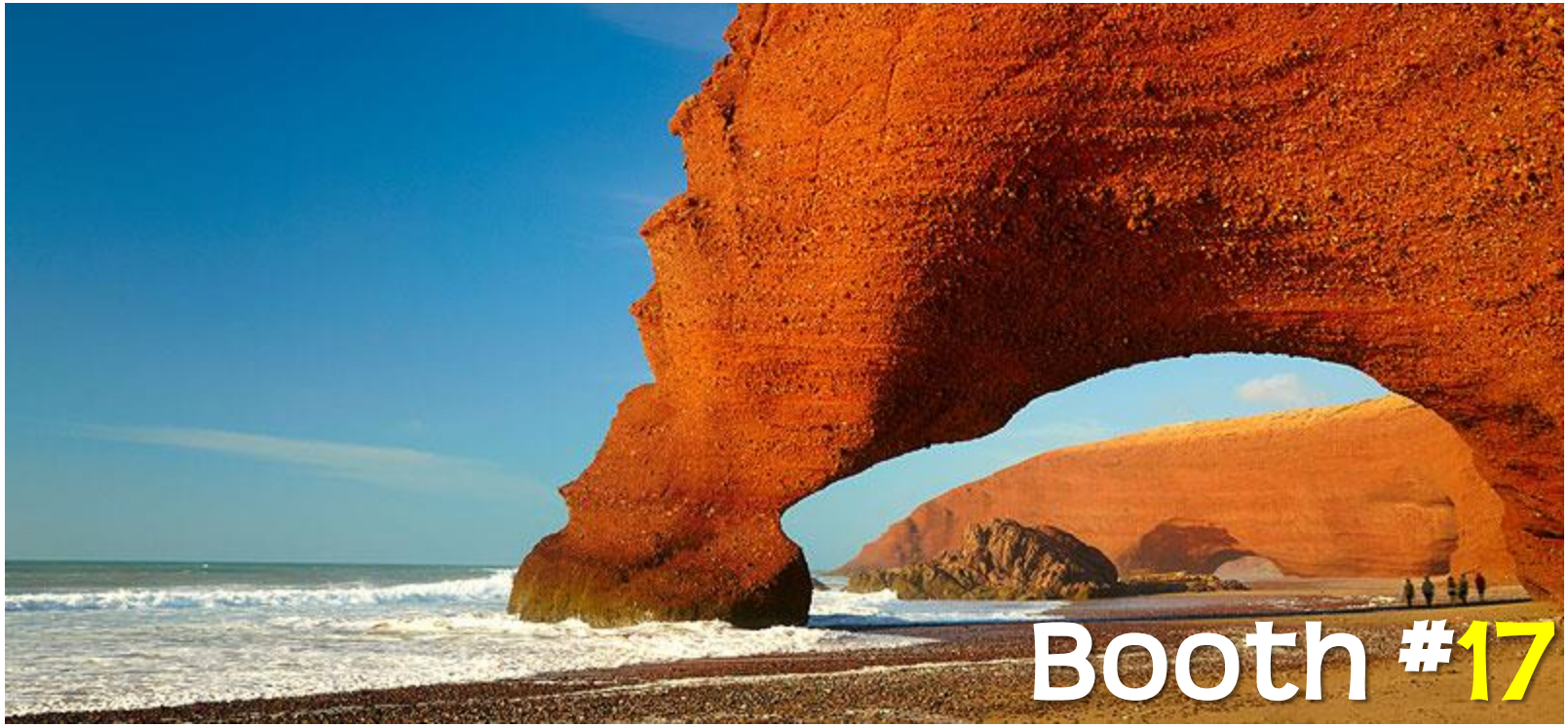
THANK YOU



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