



المكتب الوطني للهيدروكربونات والمعادن
ΕΘΣΟ.Α.Ε.Ο. | ΗΦΣΛΟ:Κ.ΟΘ:Ο. + Λ Σ*84.*
OFFICE NATIONAL DES HYDROCARBURES ET DES MINES



HYDROCARBON POTENTIAL IN MOROCCO: STILL UNDEREXPLORED PROMISING BASINS



Hydrocarbon Exploration Outlook

Potential Petroleum Systems

Examples of untested Plays, Leads & Prospects

Offshore Atlantic Morocco

Offshore Mediterranean Morocco

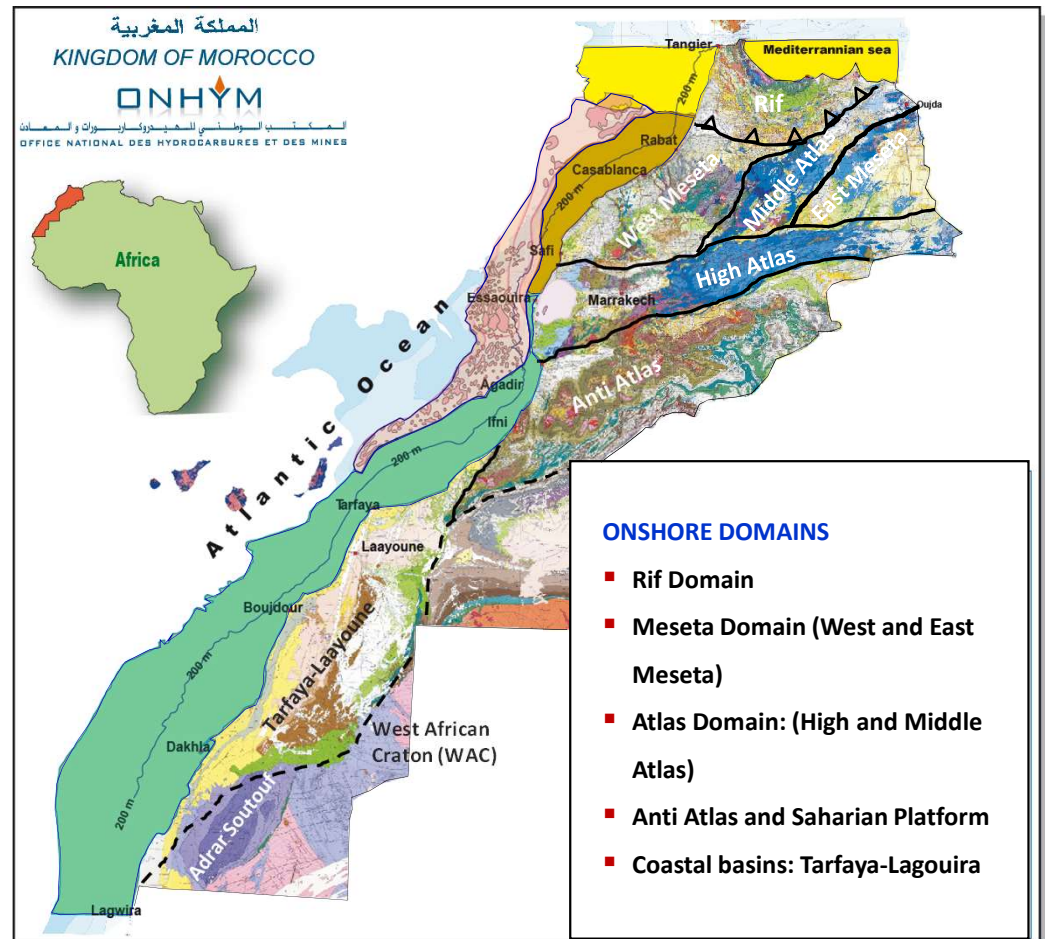
Onshore Morocco

Conclusions

OFFSHORE & ONSHORE MOROCCO: GEOLOGICAL SNAPSHOT

Main onshore structural domains and associated Petroleum Objectives

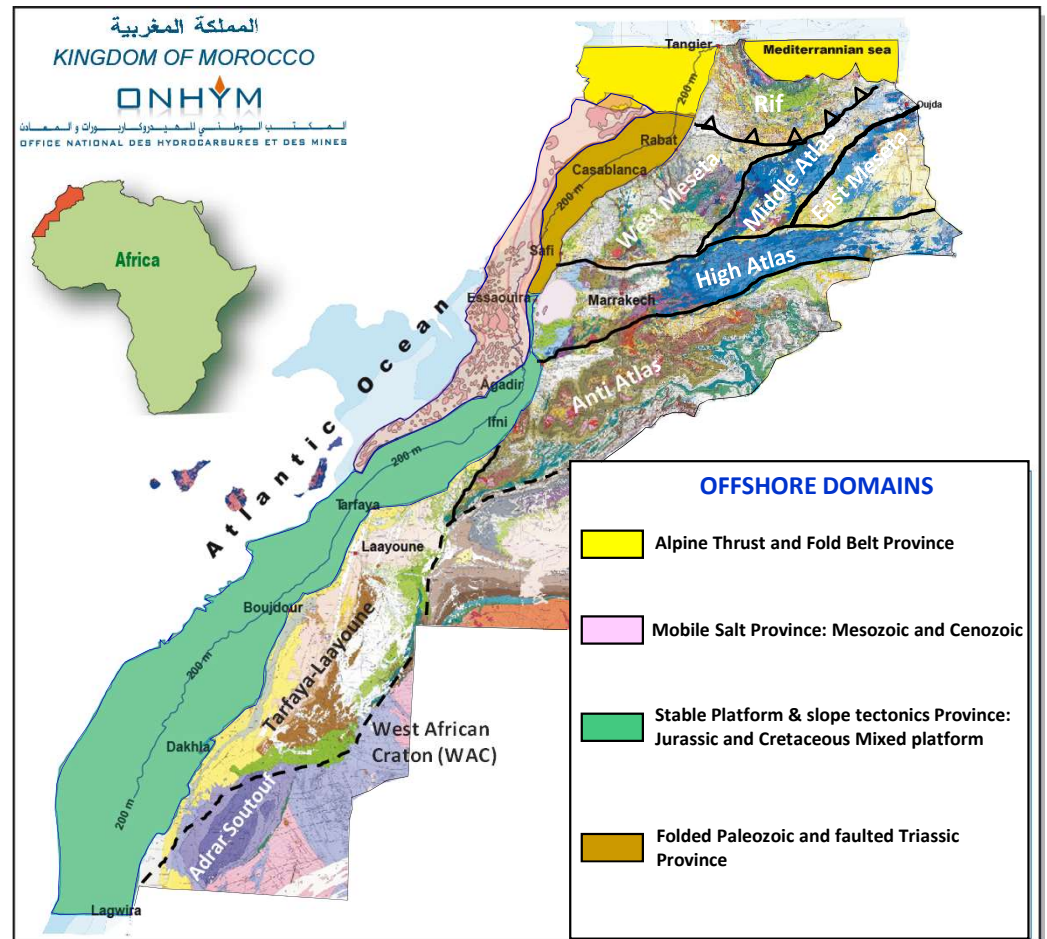
- **The Rif Domain:** Alpine folded and thrust belt (Mesozoic and Tertiary Objectives)
- **The Meseta Domain:** Hercynian Folded & thrust belt and Meso-Cenozoic rift & Passive margin (Paleozoic, Triassic and Jurassic objectives)
- **The Atlas Domain:** Early Mesozoic Tethysian Rift and Alpine Inverted and Folded belt (Triassic and Jurassic objectives)
- **The Anti Atlas and Saharian Platform:** Hercynian domain (Paleozoic objectives)
- **The Coastal basins:** Atlantic Mesozoic-Cenozoic Passive Margin (Triassic, Jurassic, Cretaceous and Tertiary objectives)



OFFSHORE & ONSHORE MOROCCO: GEOLOGICAL SNAPSHOT

Main offshore structural domains and associated Petroleum Objectives

- **Alpine thrust and folded belt province:**
Extension of the Rif domain (Jurassic, Cretaceous and Tertiary Objectives)
- **Folded Paleozoic and faulted Triassic Province:**
Extension of the Meseta (Paleozoic and Triassic Objectives)
- **Mobile salt province:** Mesozoic Atlantic Rift & Passive Margin (Triassic, Jurassic, Cretaceous and Tertiary Objectives)
- **Platform and Deep Marine Province:** Mesozoic Atlantic Rift & Passive Margin (Jurassic, Cretaceous and Tertiary Objectives)



OFFSHORE & ONSHORE MOROCCO : HYDROCARBON EXPLORATION STATUS

SEISMIC & WELLS DATABASE

Offshore Atlantic

- 2D Seismic: 163 366 Km
- 3D Seismic: 70 242 Km²
- 2D Multi-clients: 13 195.9 Km in Offshore Atlantic Morocco
- 42 exploration wells

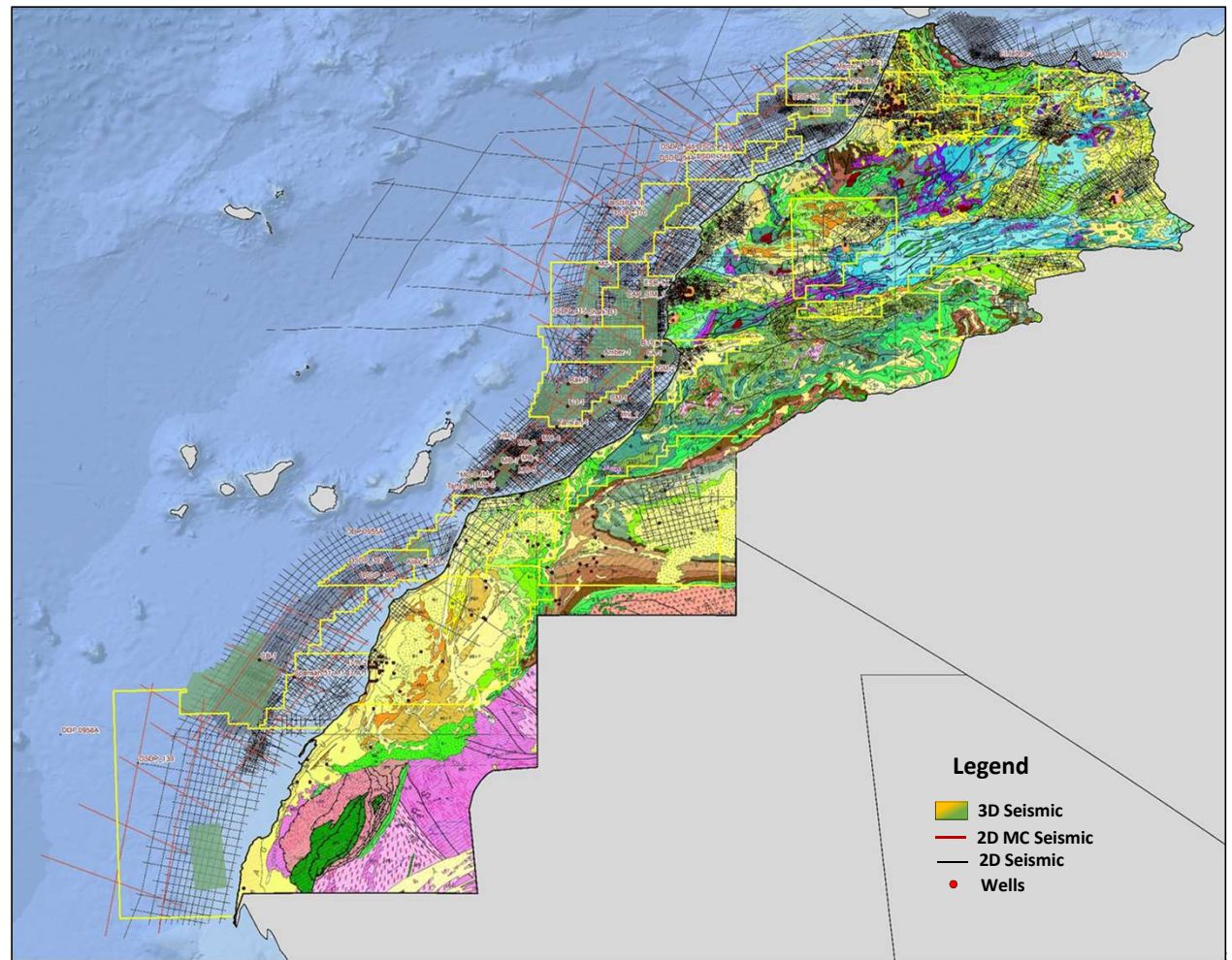
Offshore Mediterranean

- 2D Seismic: 10 901 Km
- 2 Exploration wells

Onshore

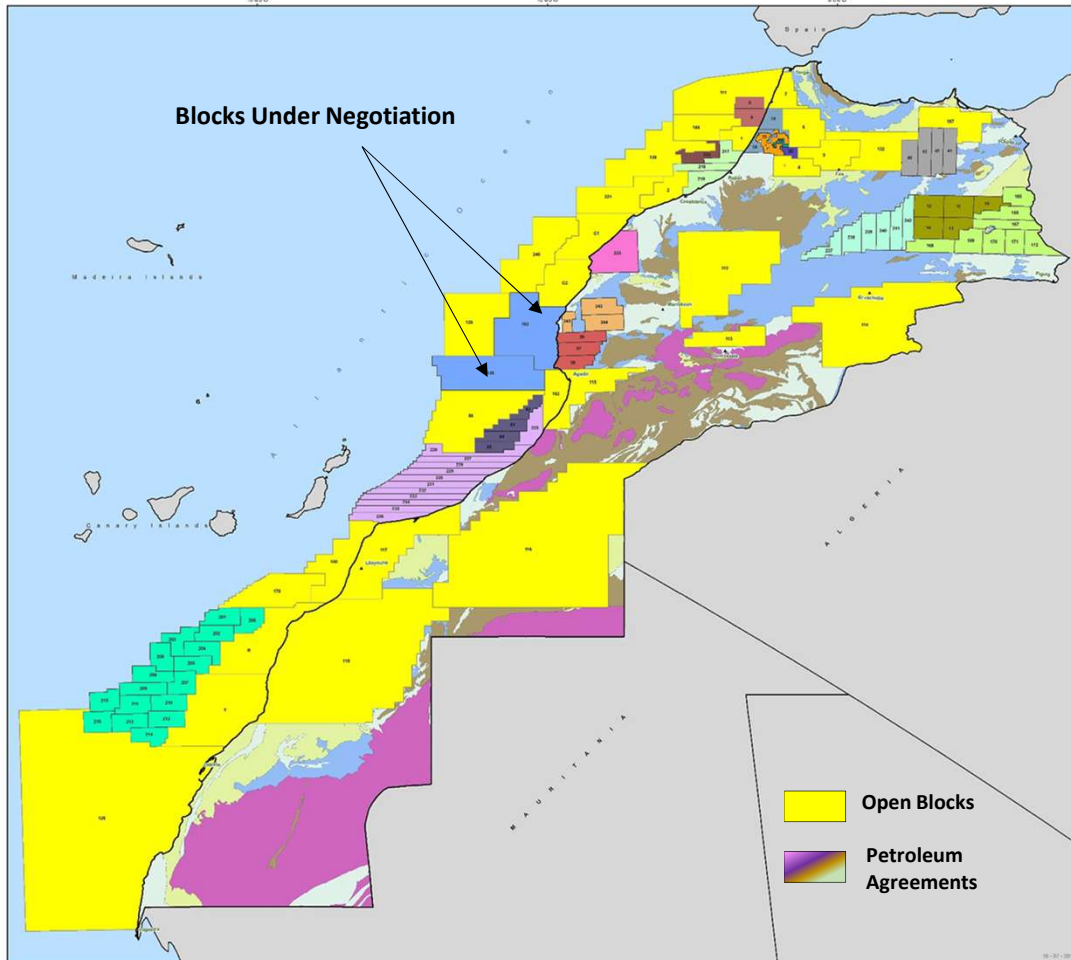
- 2D Seismic: 56 131 Km
- 3D Seismic: 2 336 Km²
- 307 Exploration wells

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



OFFSHORE & ONSHORE MOROCCO : HYDROCARBON EXPLORATION STATUS

E&P ACTIVITIES



Main ongoing Exploration Activities in Offshore & Onshore Morocco:

Partners

- 3D & 2D seismic processing (Recent seismic acquisitions in 2018)
- G&G Evaluation of the Areas of Interest

ONHYM

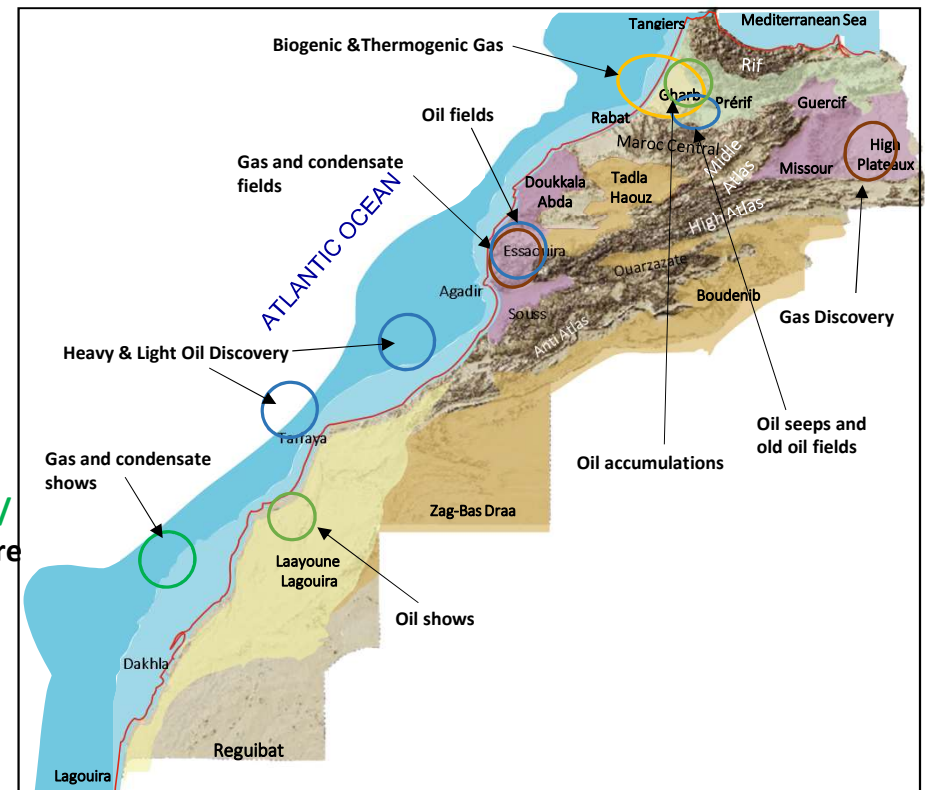
- Integration of the new well results into regional studies (Reservoir distribution & geochemical modelling)
- G&G Evaluation of the open blocks
- Data room organization in ONHYM Offices (**17** data room in 2018)

PROJECTS ONHYM/E&P INDUSTRY PARTNERS

- Cooperation with universities and Groups of Research (NARG, IMMAGE, Colorado School of Mines, ...)
- Cooperation with OERA & DOEM from Nova Scotia
- 2D MultiClients (GeoX) in Offshore Atlantic
- Seismic Reservoir Characterization in Offshore Agadir (CGG/Ongoing study)

OFFSHORE & ONSHORE MOROCCO : PETROLEUM SYSTEMS

- The petroleum systems are widely extended in stratigraphic time from Paleozoic into Tertiary. These are proven in the Onshore and Offshore Moroccan sedimentary basins through hydrocarbon occurrences (discoveries, shows, surface oil seeps). The main peers are:
 - **Palaeozoic petroleum systems (Silurian/Triassic & Silurian/Ordovician-Devonian):** e.g. Meskala gas & condensate field and High Plateaux gas discovery
 - **Jurassic petroleum systems (Toarcian-Callovian/ Jurassic):** e.g. oil fields in the rides prerifaines & Essaouira and oil discovery in the Offshore
 - **Lower cretaceous petroleum systems (Jurassic-Lw. Cretaceous/ Lw. Cretaceous):** e.g. oil and gas shows encountered in Offshore Atlantic
 - **Upper cretaceous petroleum systems (Cenomanian-Turonian/Upper Cretaceous-Tertiary):** e.g. Ain Hamra oil accumulation and oil shows in the Onshore
 - **Tertiary petroleum systems (Tertiary/Tertiary):** e.g. biogenic gas fields in Gharb basin





OFFSHORE ATLANTIC MOROCCO: EXAMPLES OF UNTESTED PLAYS, LEADS & PROSPECTS

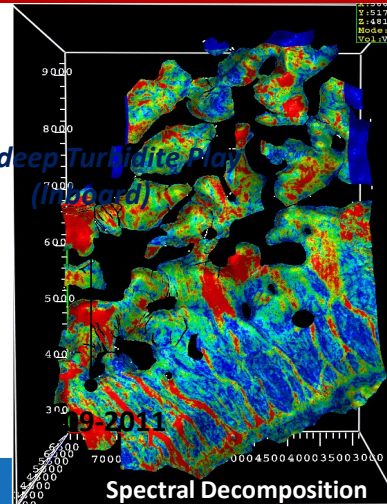
OFFSHORE ATLANTIC MOROCCO : PLAY CONCEPTS HISTORY

Carbonate Platform Play
(Inboard)

70s-80s

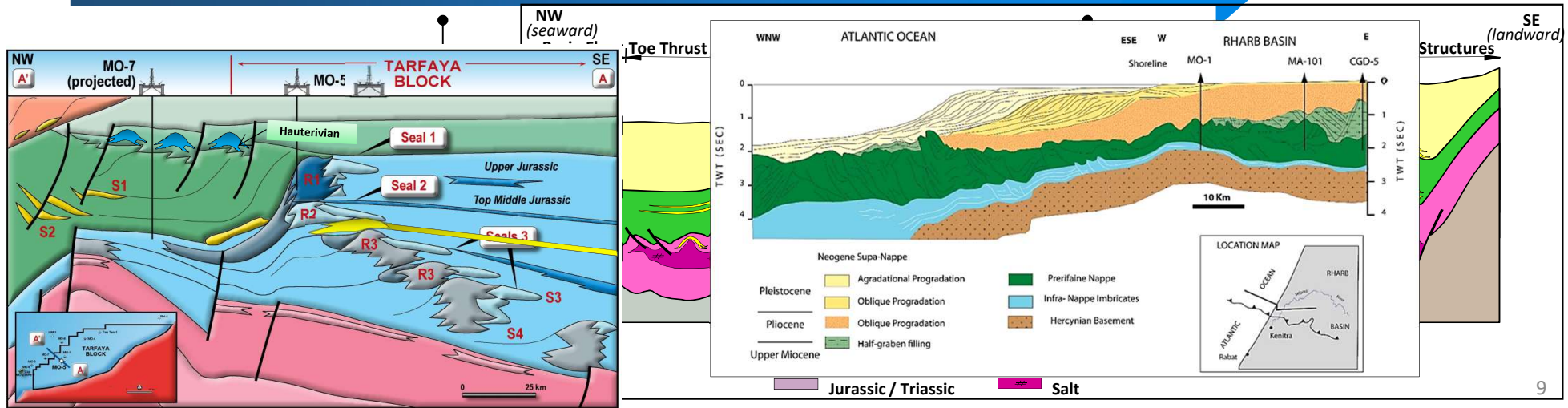
2000-2008

Foredeep Turbidite Play
(Inboard)



2013-2018

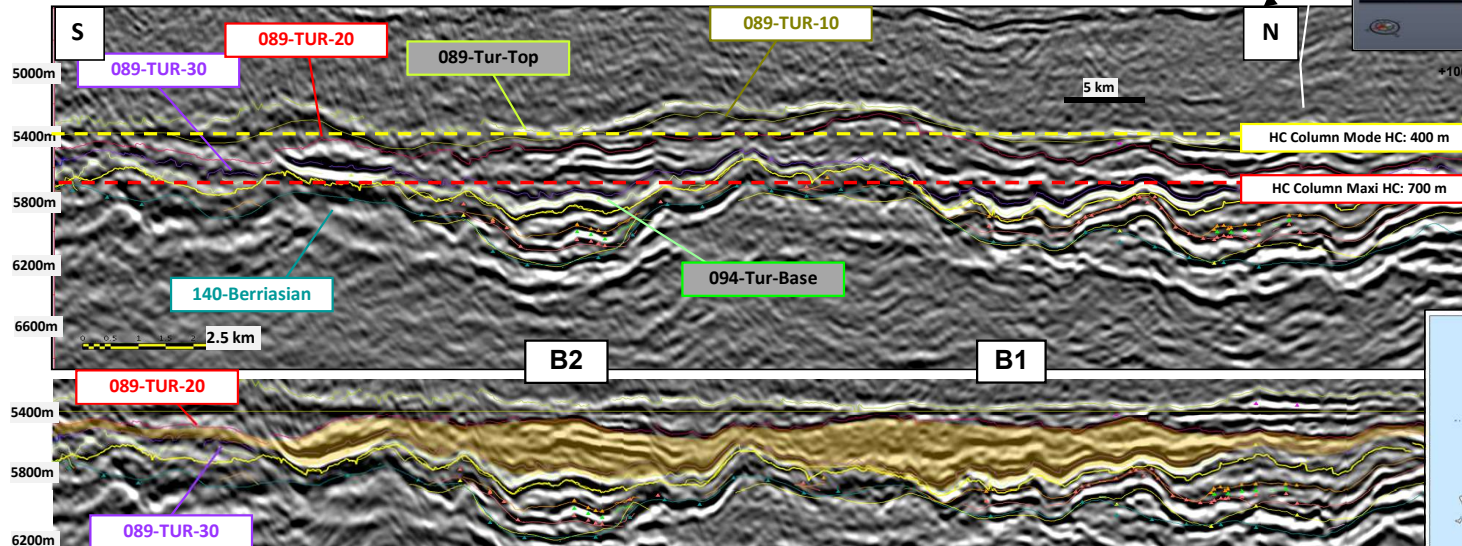
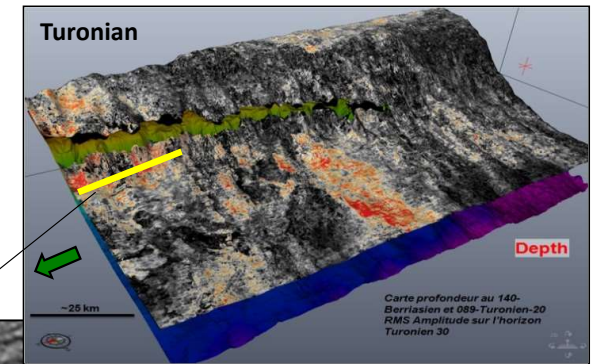
DEVELOPED PLAY CONCEPTS



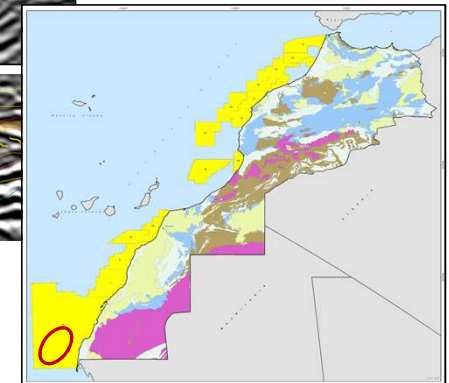
OFFSHORE ATLANTIC MOROCCO : TURBIDITE PLAY

UPPER CRETACEOUS CANYONS (UNTESTED OBJECTIVES)

	Water Depth (m)	Closure (Km ²)	Unrisked recoverable resources-Mean (MMbbls)
Prospect B1	1200	7-61	169
Prospect 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

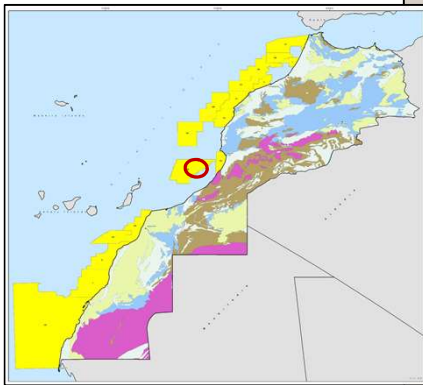
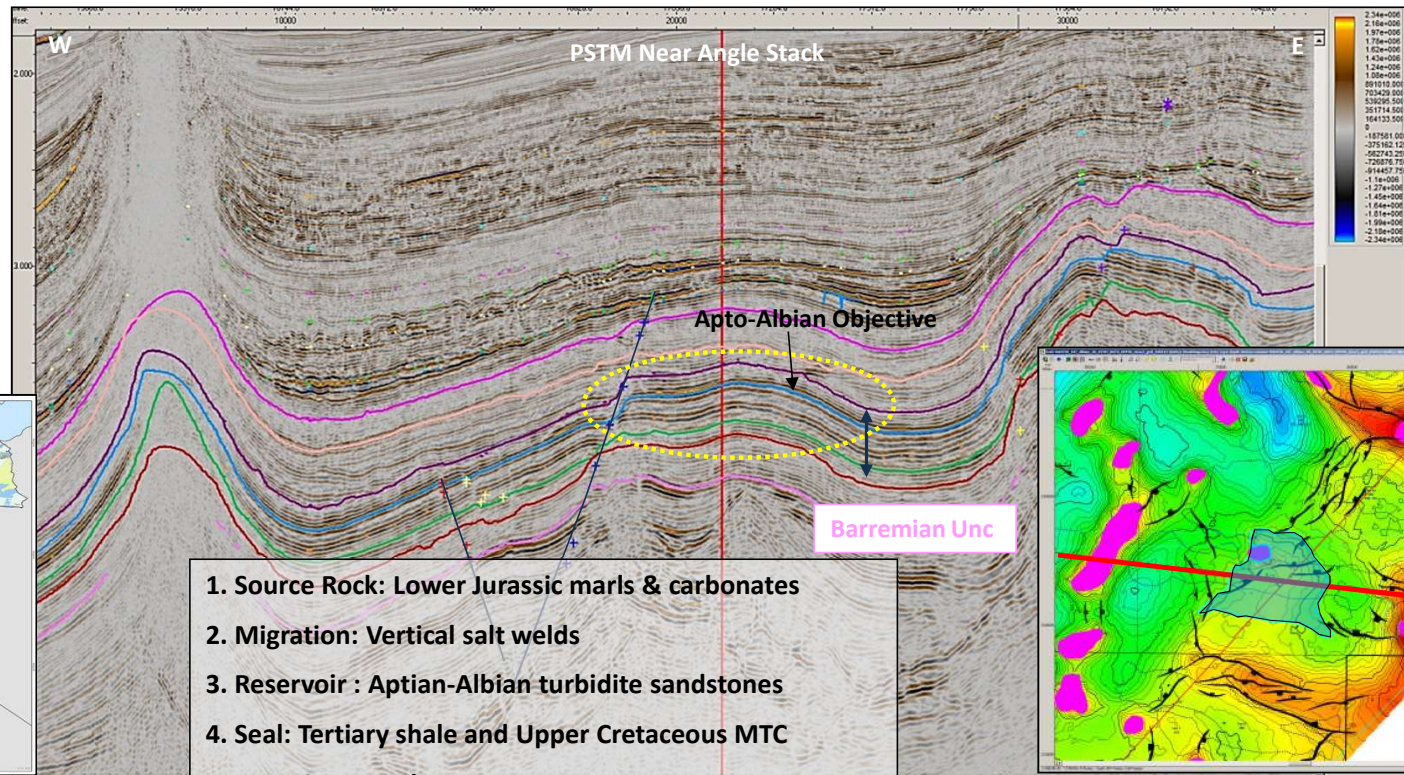


OFFSHORE ATLANTIC MOROCCO : SALT RELATED PLAY

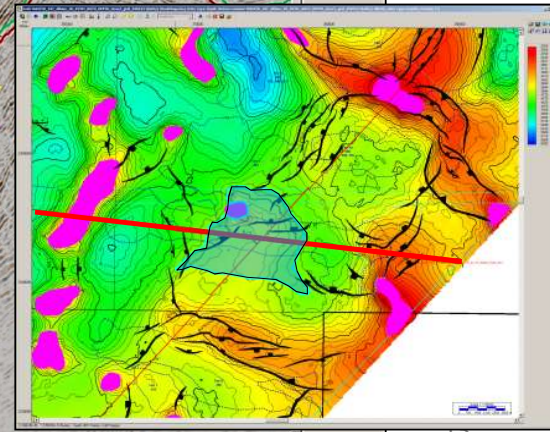
LOWER CRETACEOUS SALT RELATED STRUCTURE (UNTESTED OBJECTIVES)

- 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



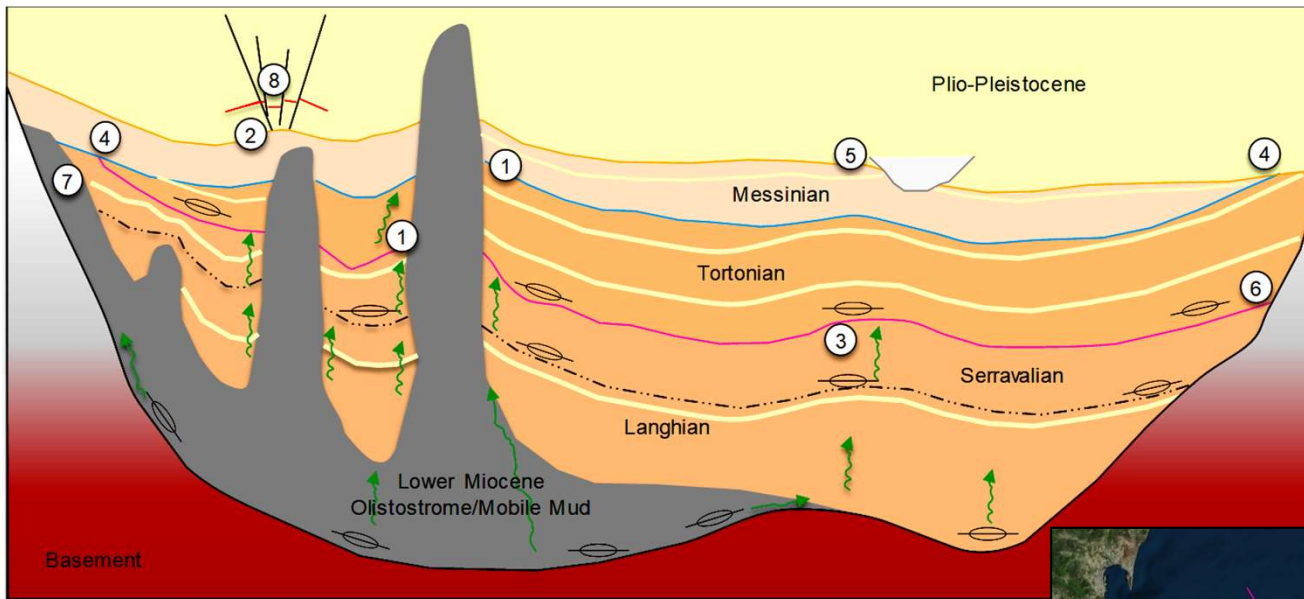
1. Source Rock: Lower Jurassic marls & carbonates
2. Migration: Vertical salt welds
3. Reservoir : Aptian-Albian turbidite sandstones
4. Seal: Tertiary shale and Upper Cretaceous MTC
5. Trap: Structural





OFFSHORE MEDITERRANEAN MOROCCO: EXAMPLES OF UNTESTED PLAYS, LEADS & PROSPECTS

OFFSHORE MEDITERRANEAN MOROCCO : HYDROCARBON PLAYS



Area

■ 24 500 Km²

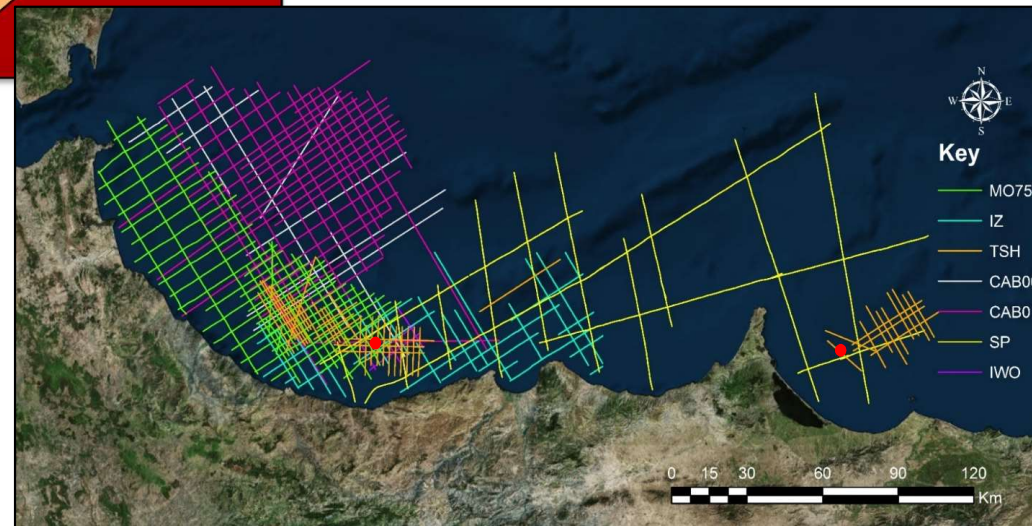
Seismic

■ 2D Seismic: 10 901 Km (Between 1975 & 2001)

Wells

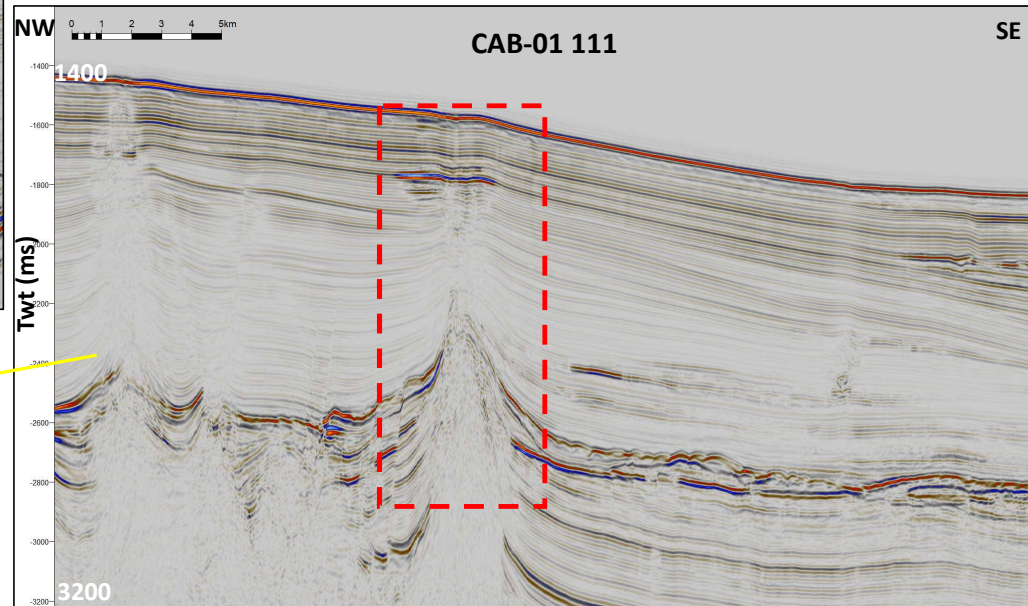
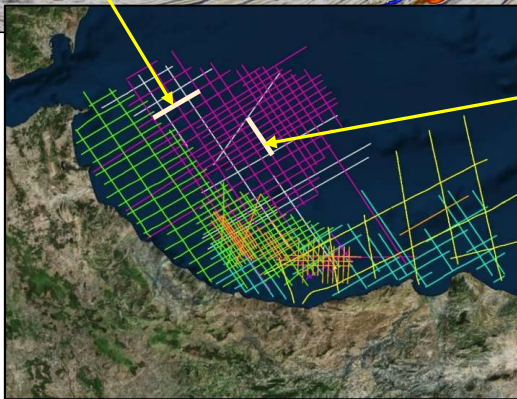
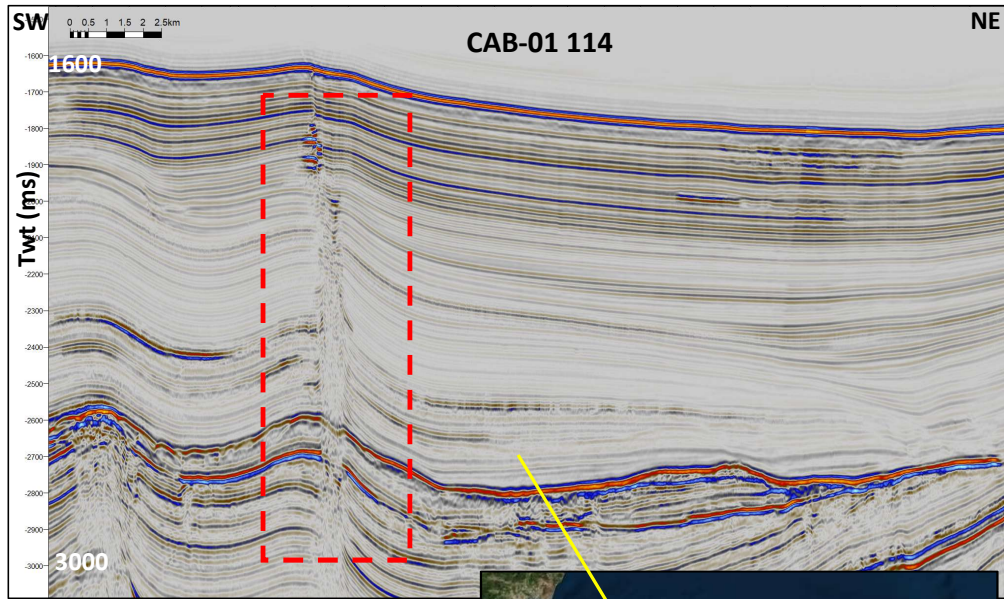
■ 2 Exploration wells

- | | |
|----------------------|---------------------|
| 1 – Mud diapir flank | 5 – Canyon flank |
| 2 – Mud diapir drape | 6 – Onlap basement |
| 3 – Inversion | 7 – Onlap on diapir |
| 4 – Truncation | 8 – Faulted drapes |



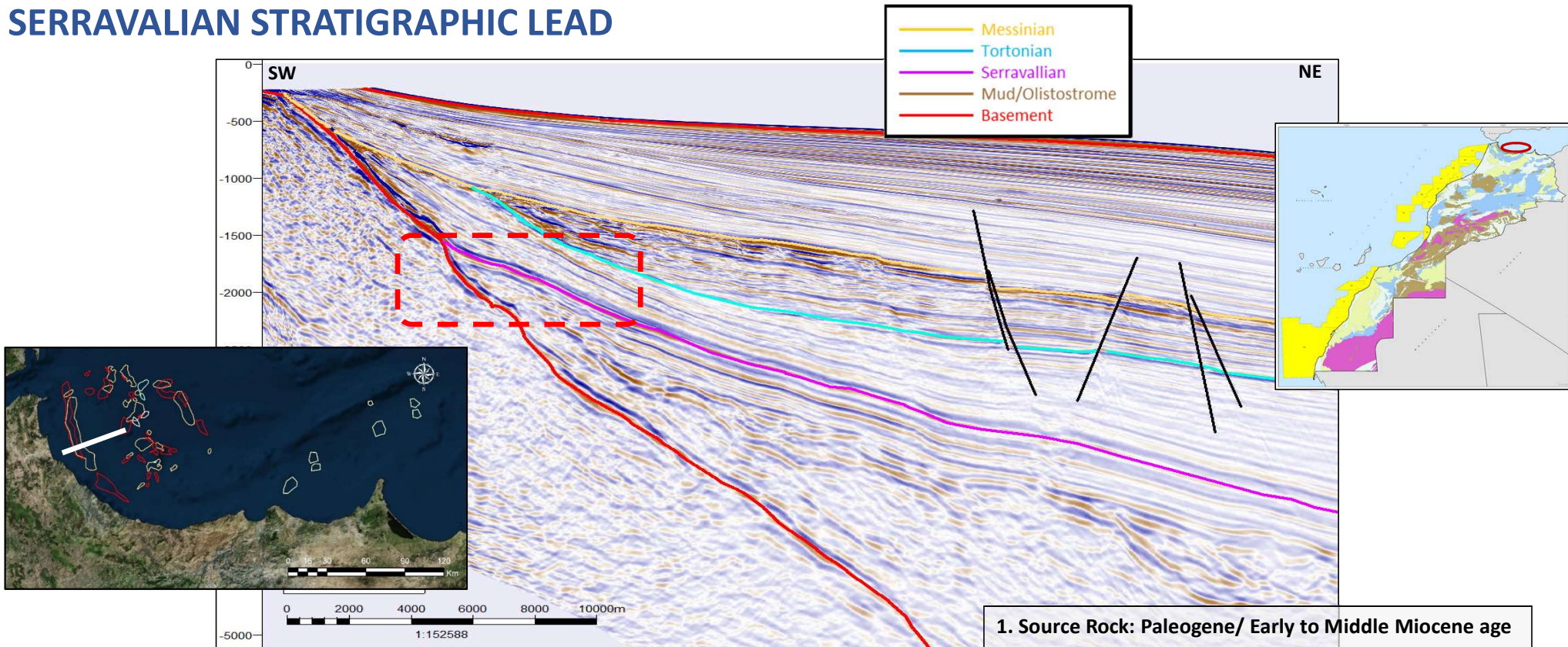
OFFSHORE MEDITERRANEAN MOROCCO : HYDROCARBON PLAYS

INTERPRETED GAS CHIMNEY AND BRIGHT SPOTS



OFFSHORE MEDITERRANEAN MOROCCO : HYDROCARBON PLAYS

SERRAVALIAN STRATIGRAPHIC LEAD



1. Source Rock: Paleogene/ Early to Middle Miocene age
2. Migration: Vertical
3. Reservoir: Serravalian turbidite sandstones
4. Seal: Tertiary interbedded Marls & shale
5. Trap: Stratigraphic (truncation beneath the unconformity)

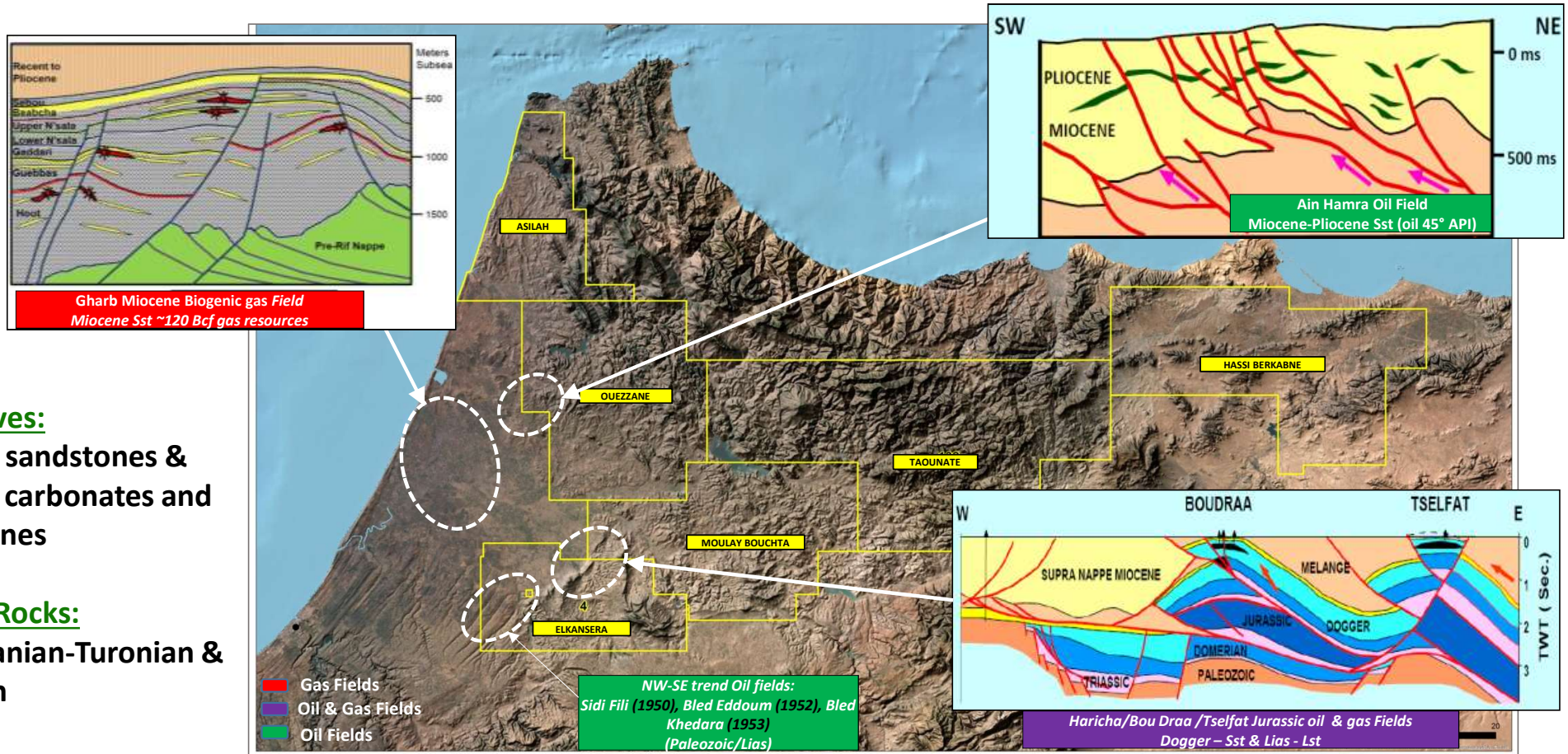
WD (m)	Area (Km ²)	Crest (m TVDSS)	Vertical relief (m)	BOE in place MMstb (unrisked) (Mean)
250	170	1,240	> 250	363



ONSHORE MOROCCO: EXAMPLES OF UNTESTED PLAYS, LEADS & PROSPECTS

ONSHORE MOROCCO : HYDROCARBON PLAYS

WORKING/PROVEN PLAYS IN THE PRE-RIF BASIN



Objectives:

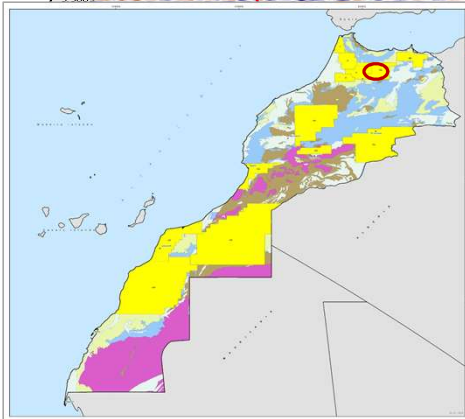
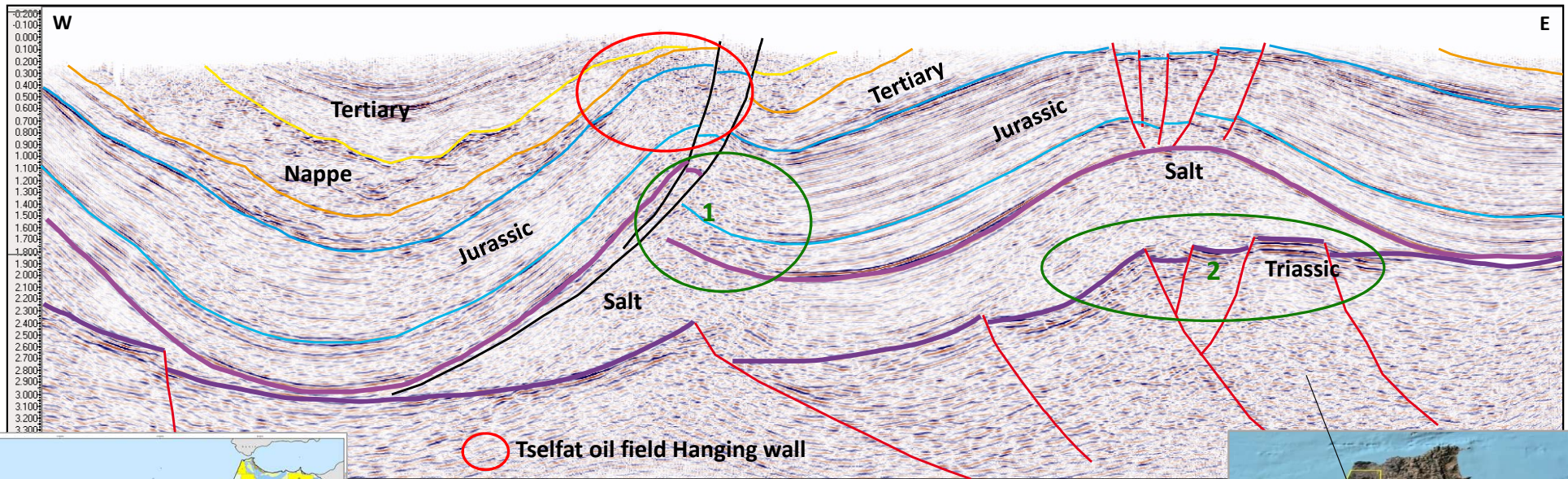
Tertiary sandstones & Jurassic carbonates and sandstones

Source Rocks:

Cenomanian-Turonian & Toarcian

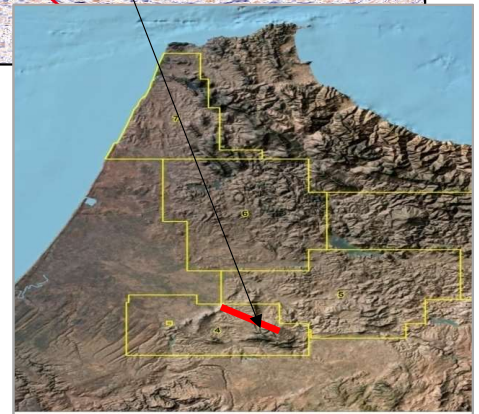
ONSHORE MOROCCO : HYDROCARBON PLAYS IN THE PRE-RIF BASIN

SUB-THRUST AND PRE-SALT STRUCTURES (UNTESTED OBJECTIVES)



Untested targets:

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



ONSHORE MOROCCO : HYDROCARBON PLAYS IN THE ZAG BASIN

PALAEOZOIC STRUCTURES (UNTESTED OBJECTIVES)

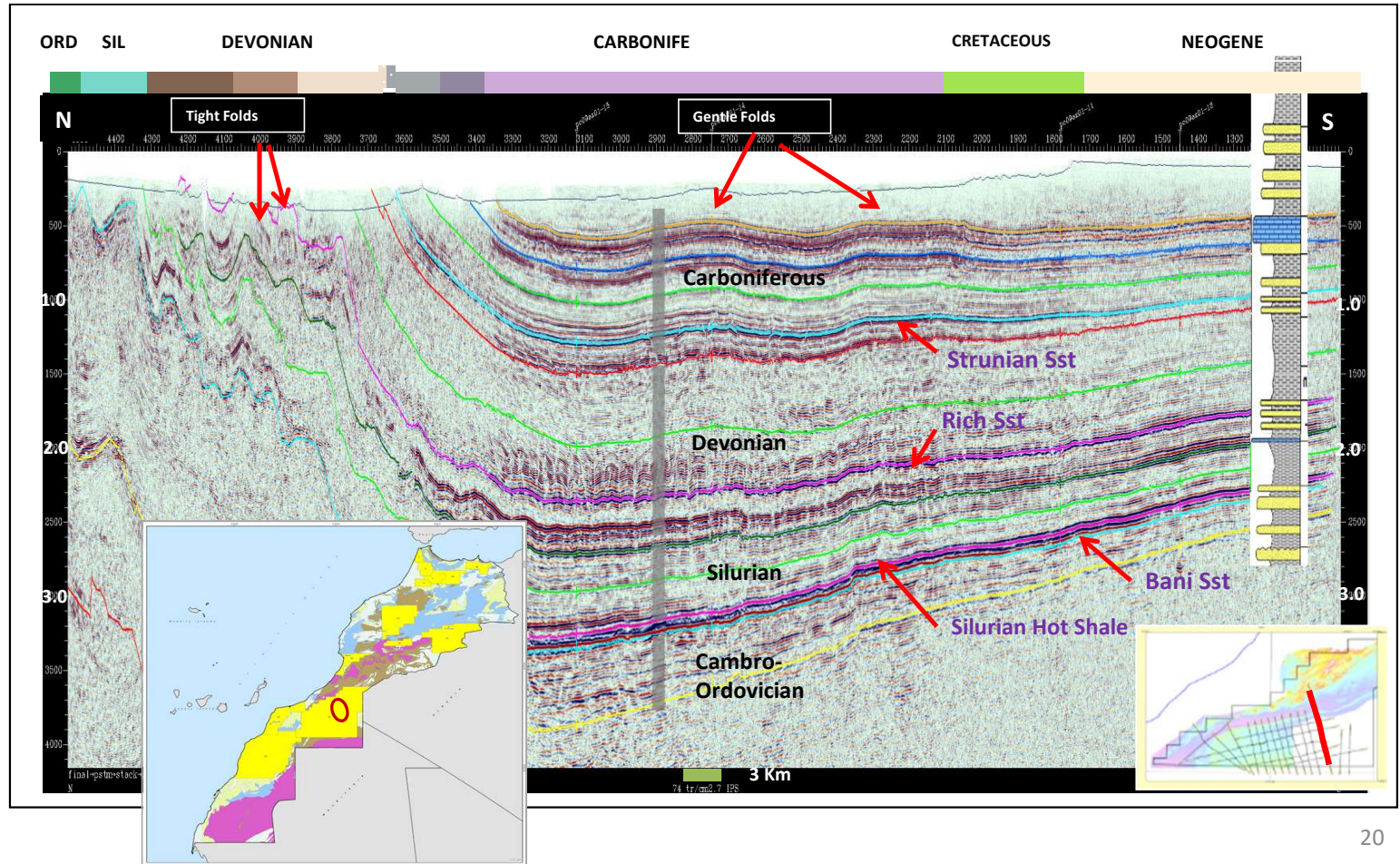
Objectives:

Strunian sandstones &
Lower Devonian sandstones
(Rich formation) &
Ordovician sandstones (Bani
formation)

Source Rocks:

Silurian hot shales and
Frasnian shales

Total Gas Recoverable
Resources (Lower
Carboniferous and Lower
Devonian) : 1.45 TCF



CONCLUSIONS

- Moroccan geology is, by its sedimentary and tectonic diversity, significantly favorable for oil and gas exploration and production : good evidences for the existence of viable petroleum systems ;
- The Offshore & Onshore Morocco are still largely underexplored with a total of 351 wells, of which 44 wells drilled in offshore ;
- The different play concepts developed have a wide stratigraphic and geographic extension and are analogue to those identified in North Africa, Nova Scotia, West Africa and the Gulf of Mexico ;
- Myriad of 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. However, there is more promising hydrocarbon potential which deserves to be assessed ;
- The exploration effort remains insufficient and in order to better assess the identified structures, acquiring 2D seismic or 3D seismic is required ;
- Morocco remains a point of interest and an attractive area. Its sedimentary basins are still underexplored and promising. ONHYM, with its partners, will continue the impulse of the Hydrocarbon Exploration.



المكتب الوطني للhydrocarbons والمعادن
ΕΘΣΟ | ΗΦΣΛΟΣΚ.ΘΕΣΟ.Α ΣΧΣΥ.Χ
OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

