ONHYM

المكتب الوطني للهيدروكاربورات و المعادن

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OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

SEG | AAPG image '22

International Meeting for Applied Geoscience & Energy

28 Aug - 1 Sep 2022 – Houston, USA

Moroccan HC Exploration Opportunities in Promising Basins in Morocco

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Last update: 10.08.2022

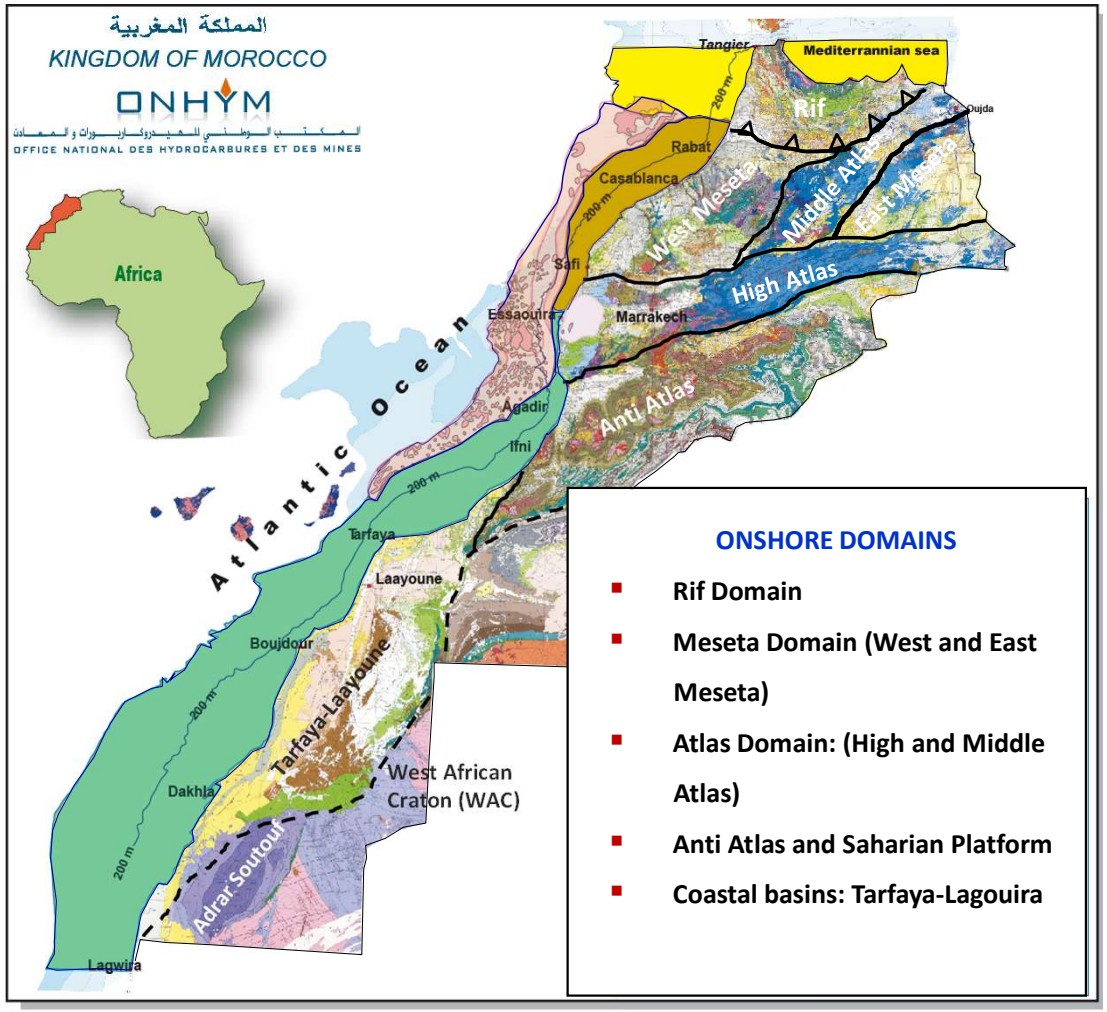
AGENDA

- Hydrocarbon Exploration Overview
- Petroleum Systems
- Moroccan Basins Analogues
- Examples of untested Plays, Leads & Prospects
- Morocco Incentives
- Conclusions

OFFSHORE & ONSHORE MOROCCO: GEOLOGICAL SNAPSHOT

Main Onshore Structural Domains and associated Petroleum Objectives

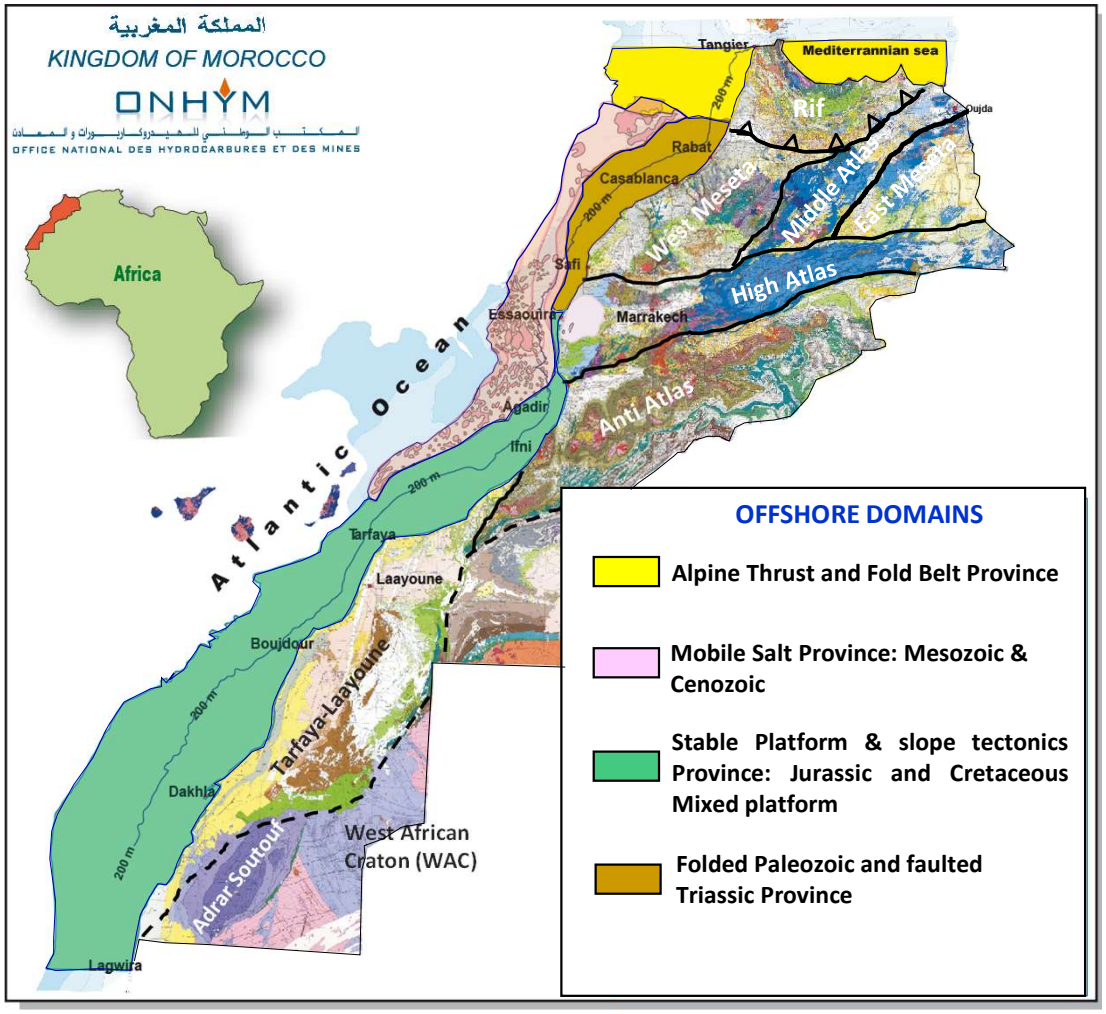
- **The Rif Domain:** Alpine folded and thrust belt (Mesozoic and Tertiary Objectives)
- **The Meseta Domain:** Hercynian Folded & thrust belt and Meso-Cenozoic rift & Passive margin (Paleozoic, Triassic and Jurassic objectives)
- **The Atlas Domain:** Early Mesozoic Tethysian Rift and Alpine Inverted 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

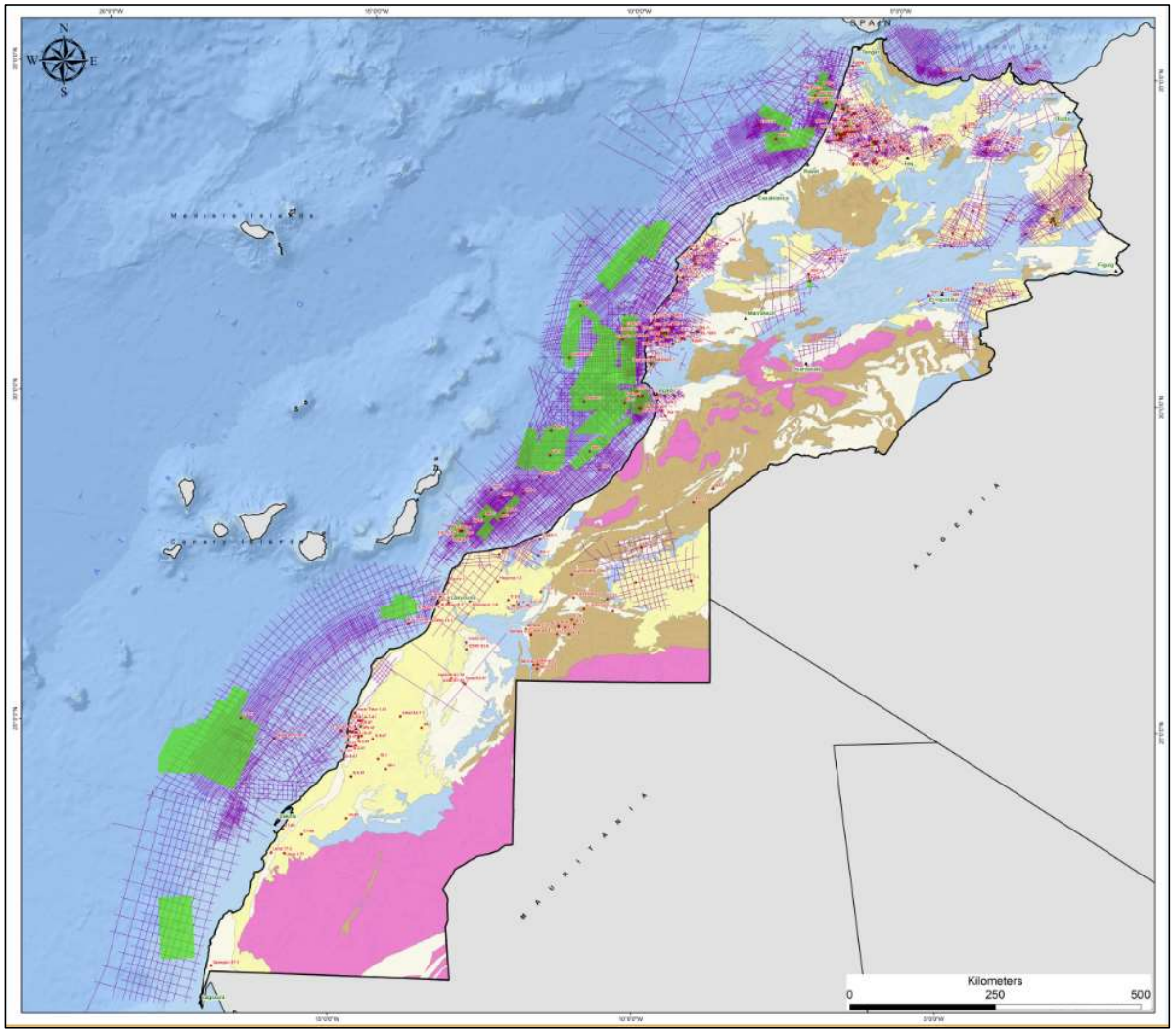
- 2D Seismic: 164 808 Km
- 3D Seismic: 72 310 Km²
- 2D Multi-clients: 13 195.9 Km
- 43 Exploration wells

Offshore Mediterranean

- 2D Seismic: 10 745 Km
- 2 Exploration wells

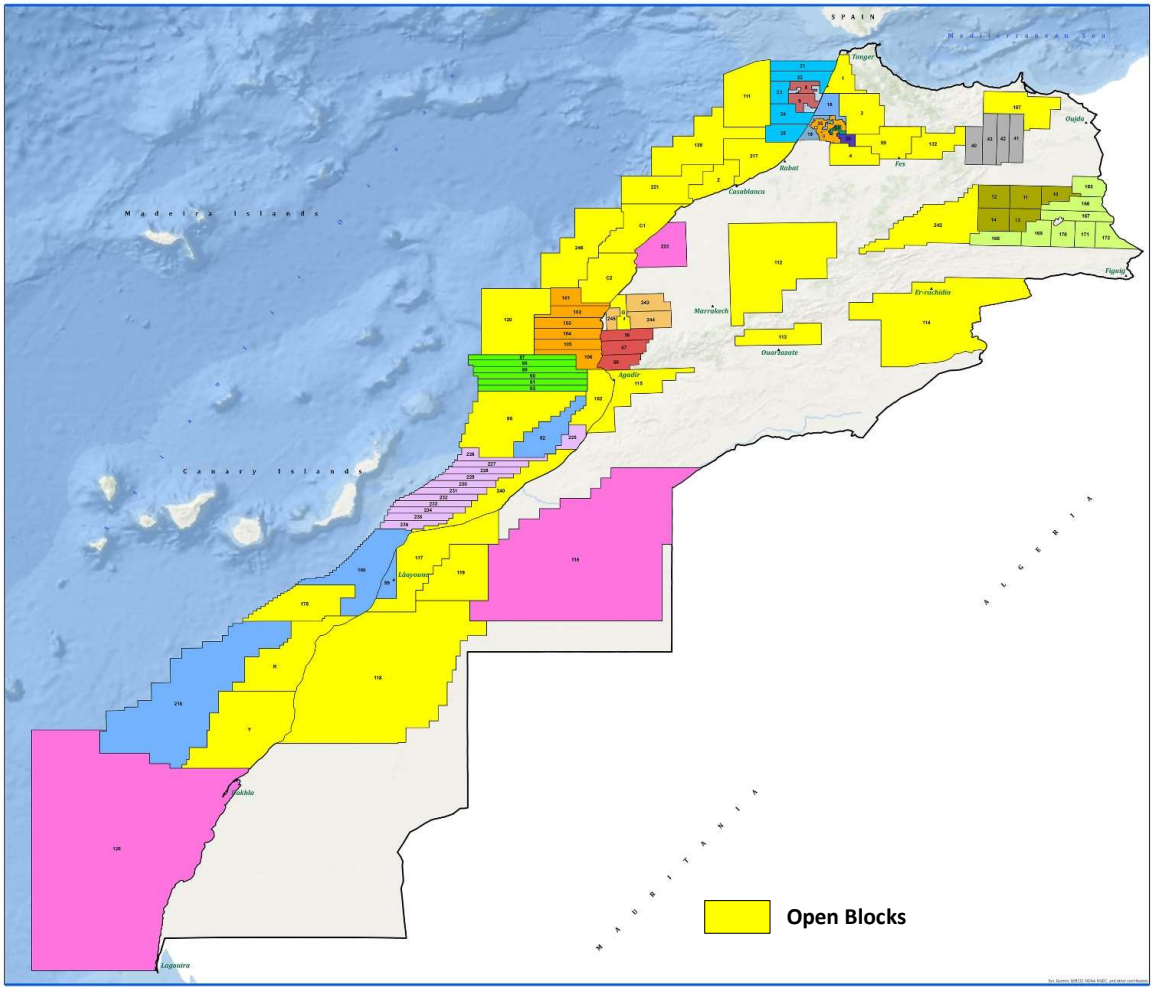
Onshore

- 2D Seismic: 56 808 Km
- 3D Seismic: 2 217 Km²
- 322 Exploration wells



OFFSHORE & ONSHORE MOROCCO : HYDROCARBON EXPLORATION STATUS

E&P ACTIVITIES



Licensing status

58 Exploration Permits: 31 Offshore & 27 Onshore

3 Reconnaissance Licenses: 1 Offshore & 2 Onshore

10 Exploitation concessions (including 1 ONHYM)

30 Open Blocks: 15 Offshore & 15 Onshore

5 Blocks under negotiation

Main ongoing Exploration Activities in Offshore & Onshore Morocco (ONHYM & Partners)

- 3D & 2D seismic processing
- Acquisition of 1250 Km of 2D seismic in the Zag Basin in 2022
- G&G Evaluation of the Areas of Interest
- Reservoir distribution studies & geochemical modelling
- Drilling activity in the Rharb onshore Basin
- Mid stream project
- Organization of In-Person & Virtual Data Rooms

- Hydrocarbon Exploration Overview
- **Petroleum Systems**
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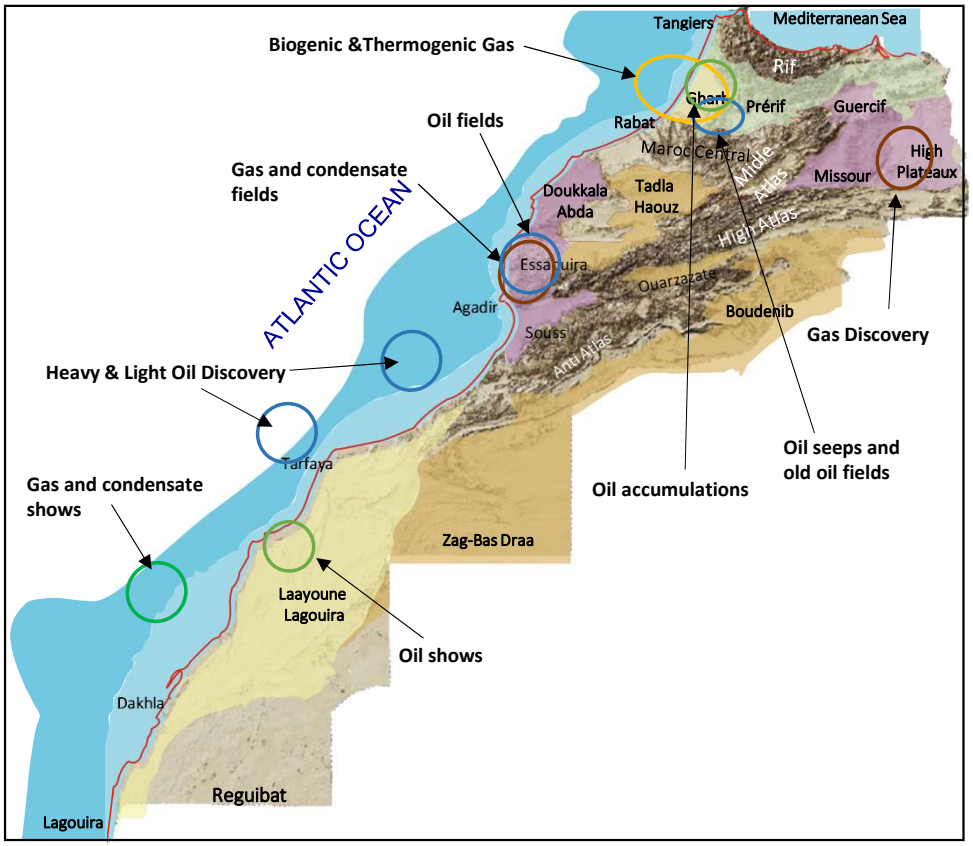
OFFSHORE & ONSHORE MOROCCO : PETROLEUM SYSTEMS

- **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):**

  - **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 & thermogenic gas fields in Gharb basin**



- Hydrocarbon Exploration Overview
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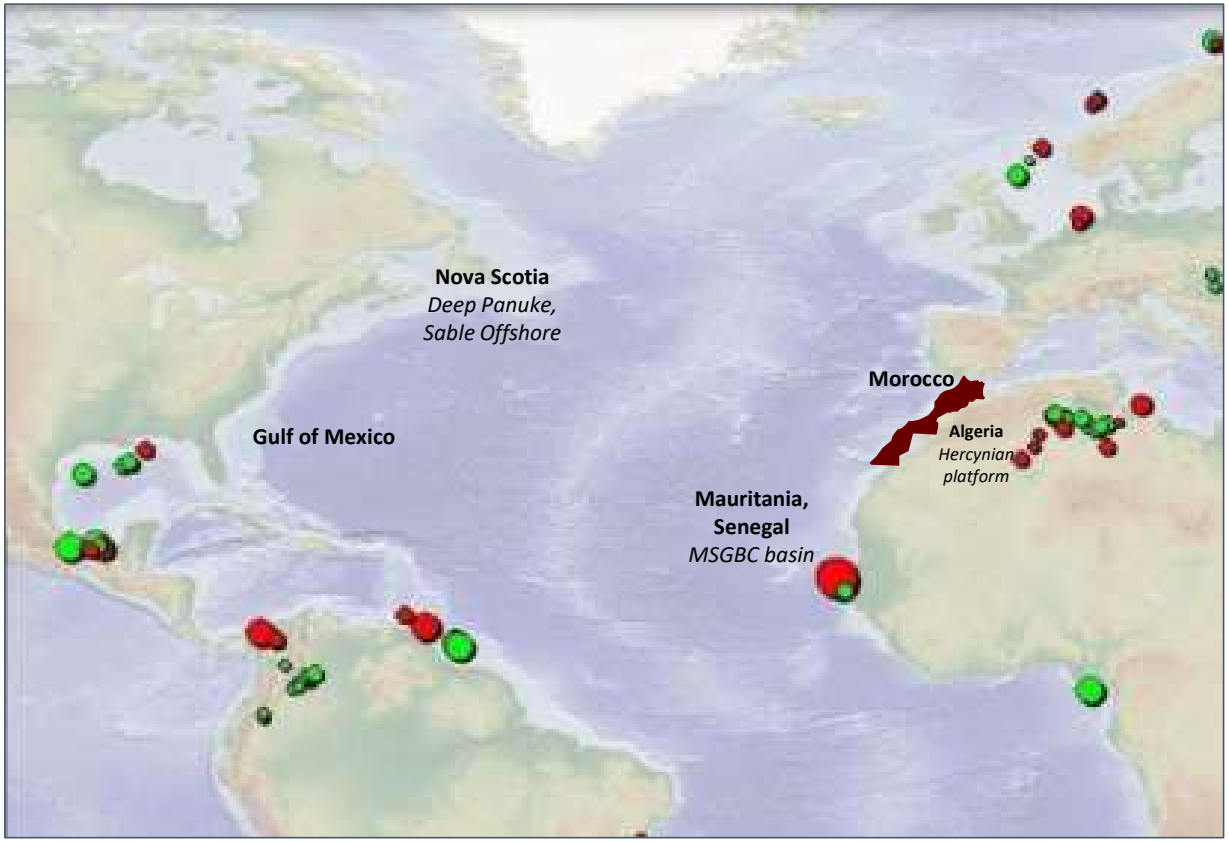
ANALOGIES WITH MAJOR RECENT DISCOVERIES

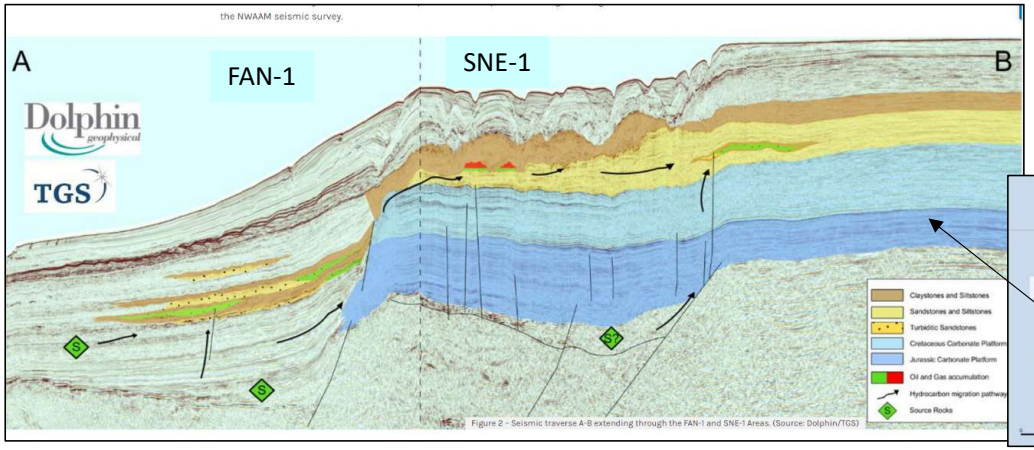


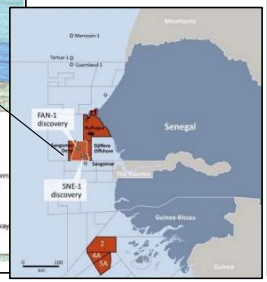
- Morocco basins have analogies with many recent discoveries and some of the biggest producing fields in the world.
- Continuity of the Algerian Triassic Province and the Saharan Hercynian platform in Eastern Morocco.
- Morocco is part of the Atlantic Mesozoic - Cenozoic Passive Margin where recent big discoveries have been made (MSGBC Basin).
- Nova Scotia analogies : Sable basin and Deep Panuke field.
- Gulf of Mexico in terms of salt tectonics.

ANALOGIES WITH MAJOR RECENT DISCOVERIES

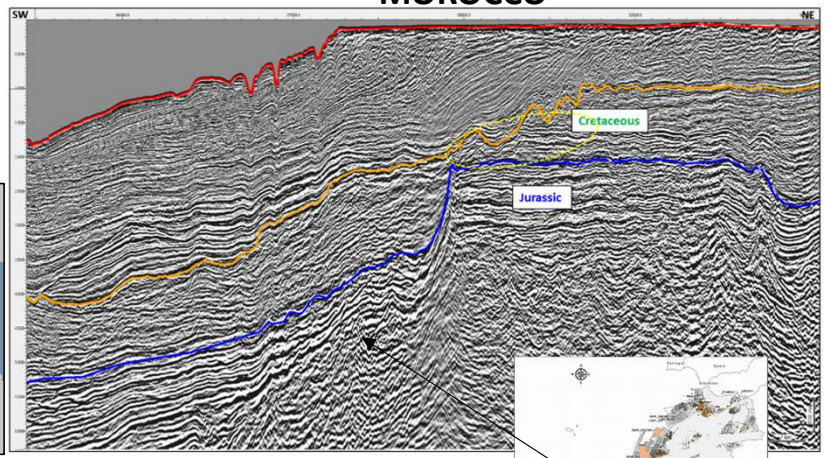
MSGBC BASINS

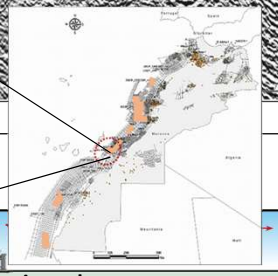
SENEGAL





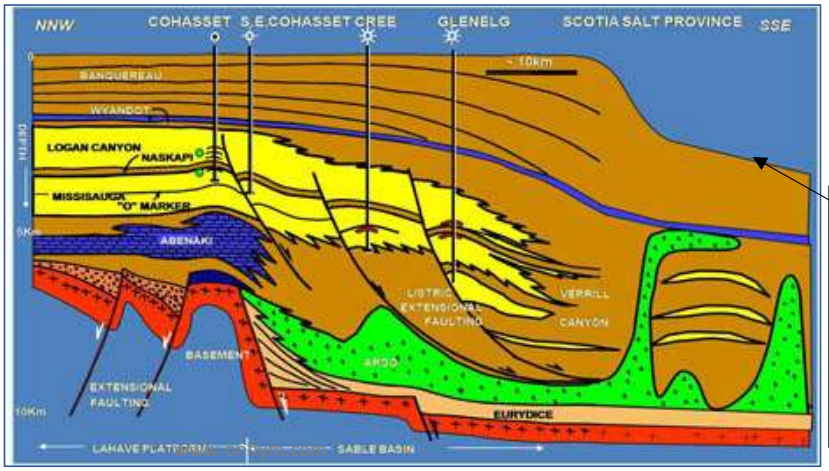
MOROCCO

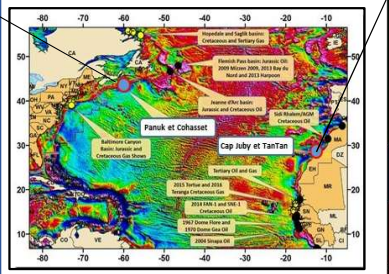




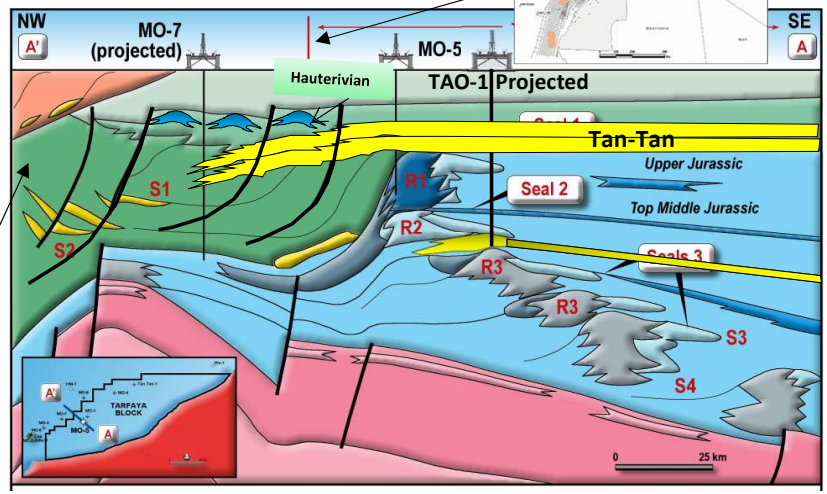
ATLANTIC CONJUGATE MARGINS

NOVA SCOTIA





MOROCCO



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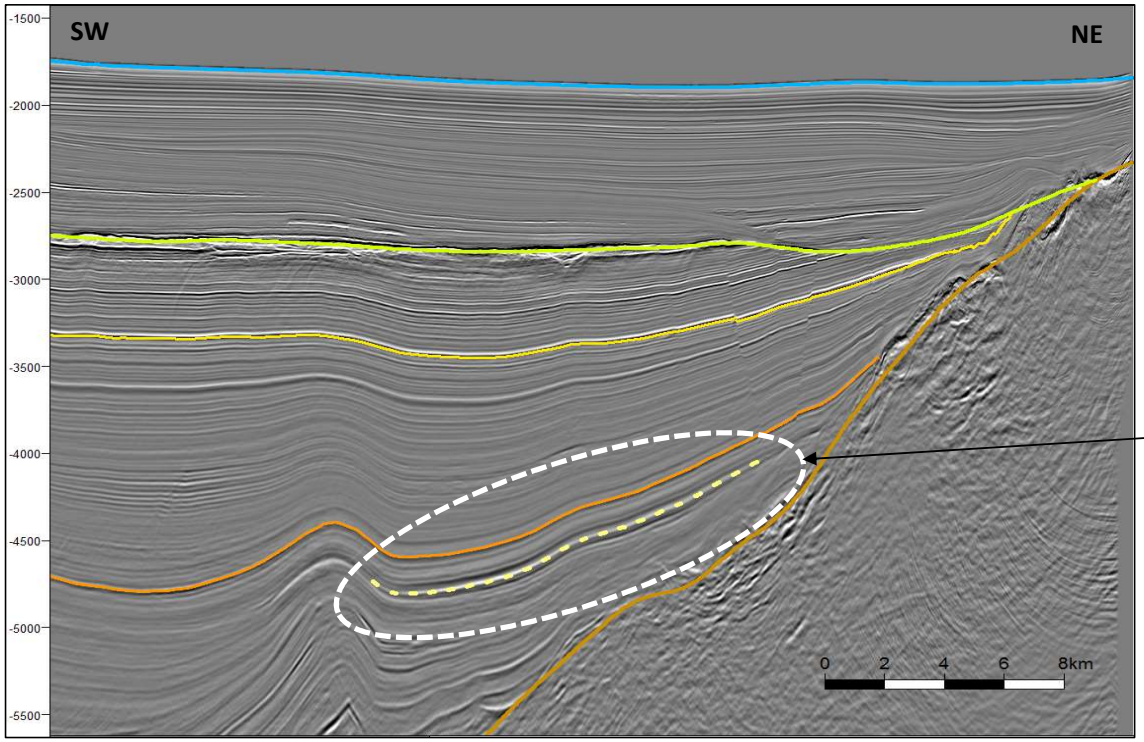
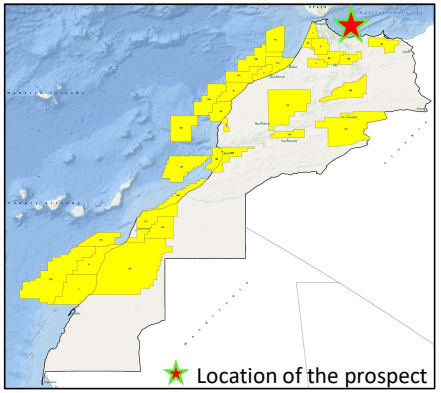
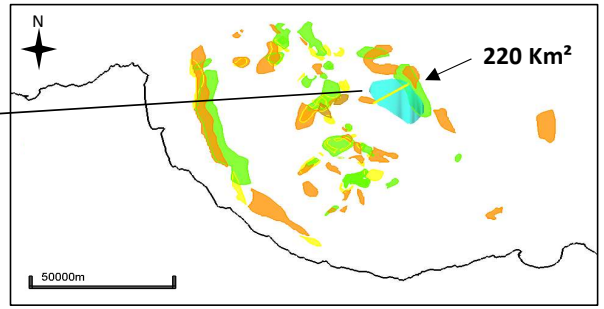
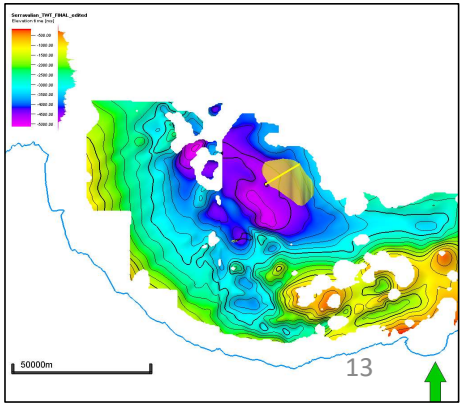
OFFSHORE MEDITERRANEAN MOROCCO : HYDROCARBON PLAYS

SERRAVALIAN TURBIDITE LOBE









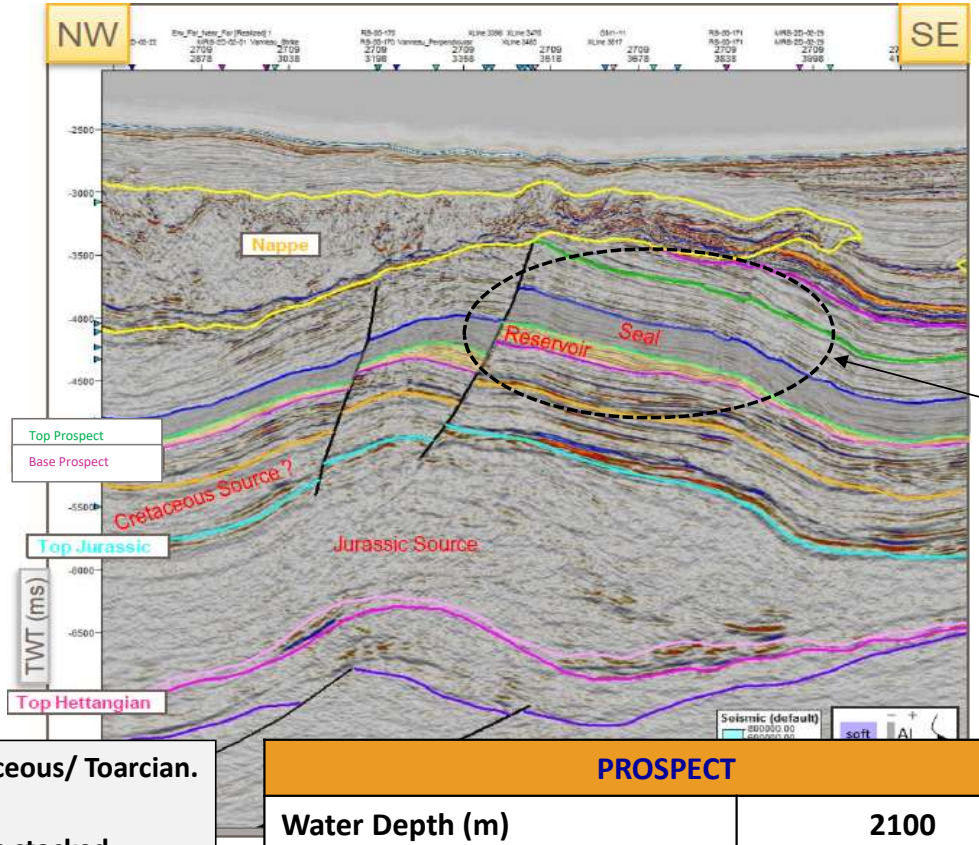
1. Source Rock: Paleogene/ Early to Middle Miocene age
2. Migration: Vertical
3. Reservoir: Serravalian turbidite sandstones
4. Seal: Tertiary interbedded Marls & shale
5. Trap: Stratigraphic

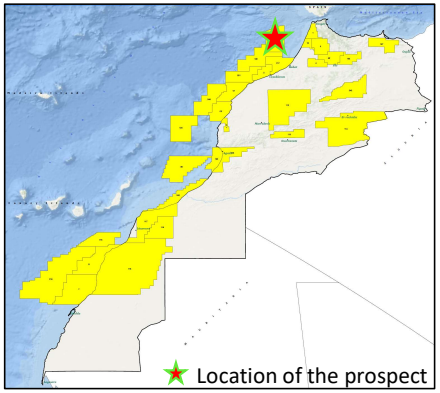
Lead	
Water Depth (m)	1600
Closure (Km²) (10)	220

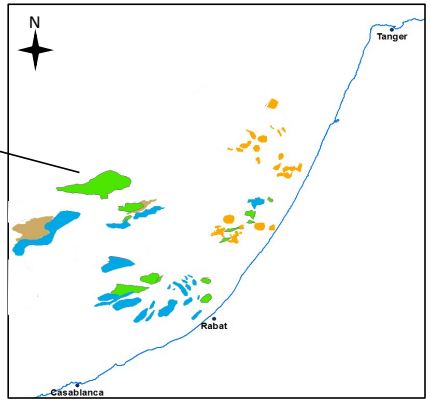
OFFSHORE ATLANTIC MOROCCO : TANGER-RABAT OFFSHORE

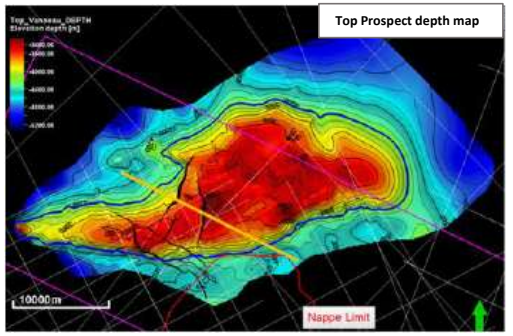
CRETACEOUS TURBIDITE SANDSTONES

- **4 way faulted structural closure anticline prospect**









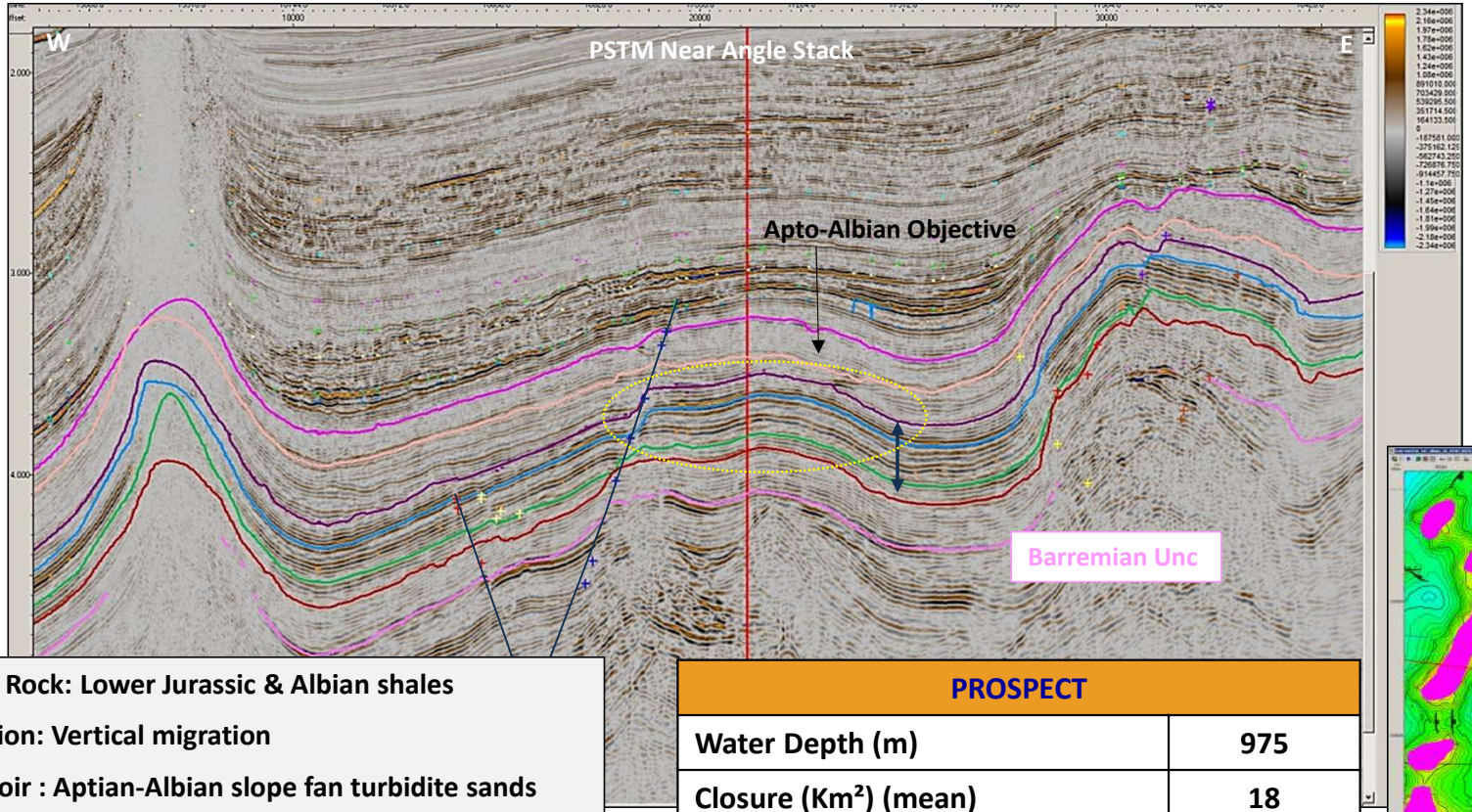
1. Source Rock: Mid & Lower Cretaceous/ Toarcian.
2. Migration: Vertical
3. Reservoir: Deep marine sand-rich stacked turbidite channels of Barremian age.
4. Seal: Marls-shales deep marine Aptian-Albian
5. Trap: 4-way structural closure anticline (faulted).

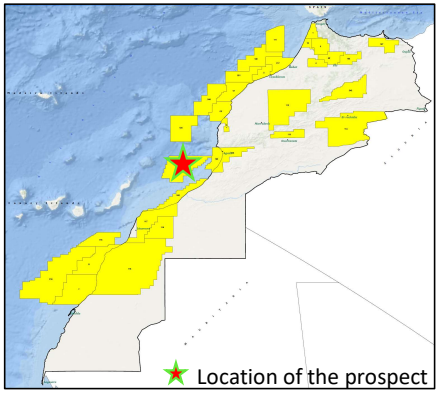
PROSPECT	
Water Depth (m)	2100
Closure (Km²) (mean)	21.58
P mean Resources (MMBO)	Oil case : 871 Gas case : 94.30 BCF

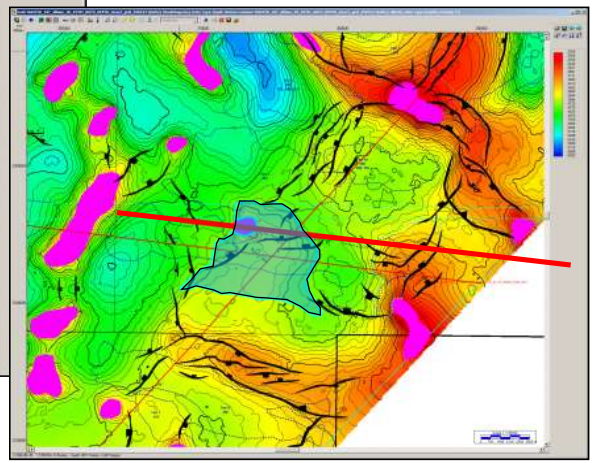
OFFSHORE ATLANTIC MOROCCO : SALT RELATED PLAY

LOWER CRETACEOUS SALT RELATED STRUCTURE

- **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).**





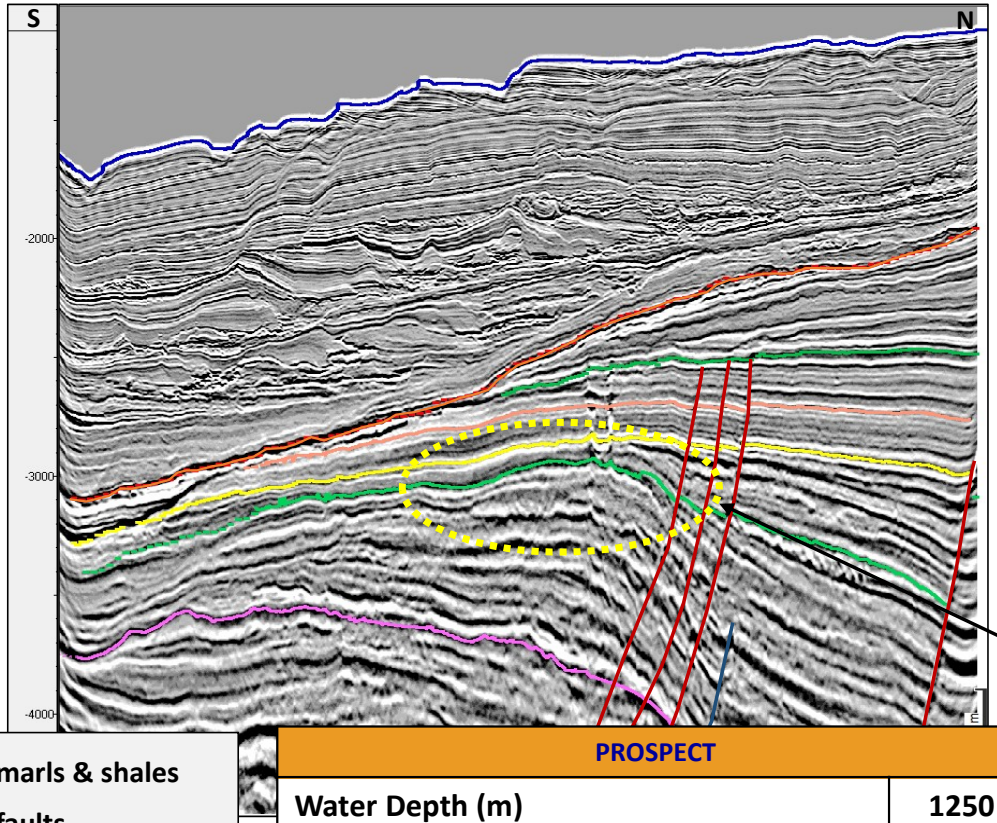


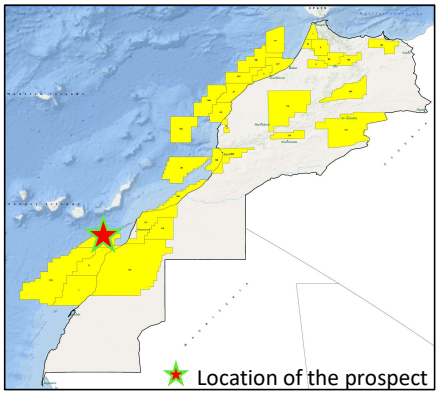
1. Source Rock: Lower Jurassic & Albian shales
2. Migration: Vertical migration
3. Reservoir : Aptian-Albian slope fan turbidite sands
4. Seal: Tertiary shale and Upper Cretaceous MTC
5. Trap: 4-way structural closure anticline (faulted).

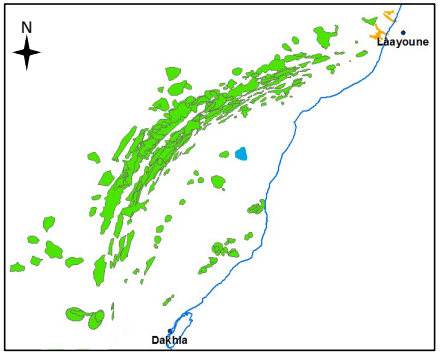
PROSPECT	
Water Depth (m)	975
Closure (Km²) (mean)	18
P mean Rec. Resources (MMBO)	281

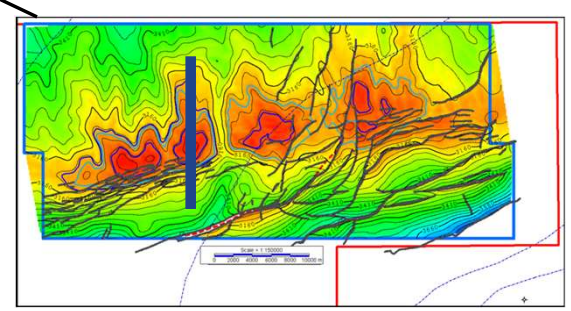
OFFSHORE ATLANTIC MOROCCO : SLOPE ROLLOVER PLAY

LARGE VALANGINIAN 4-WAY CLOSURE WITH GAS PIPES







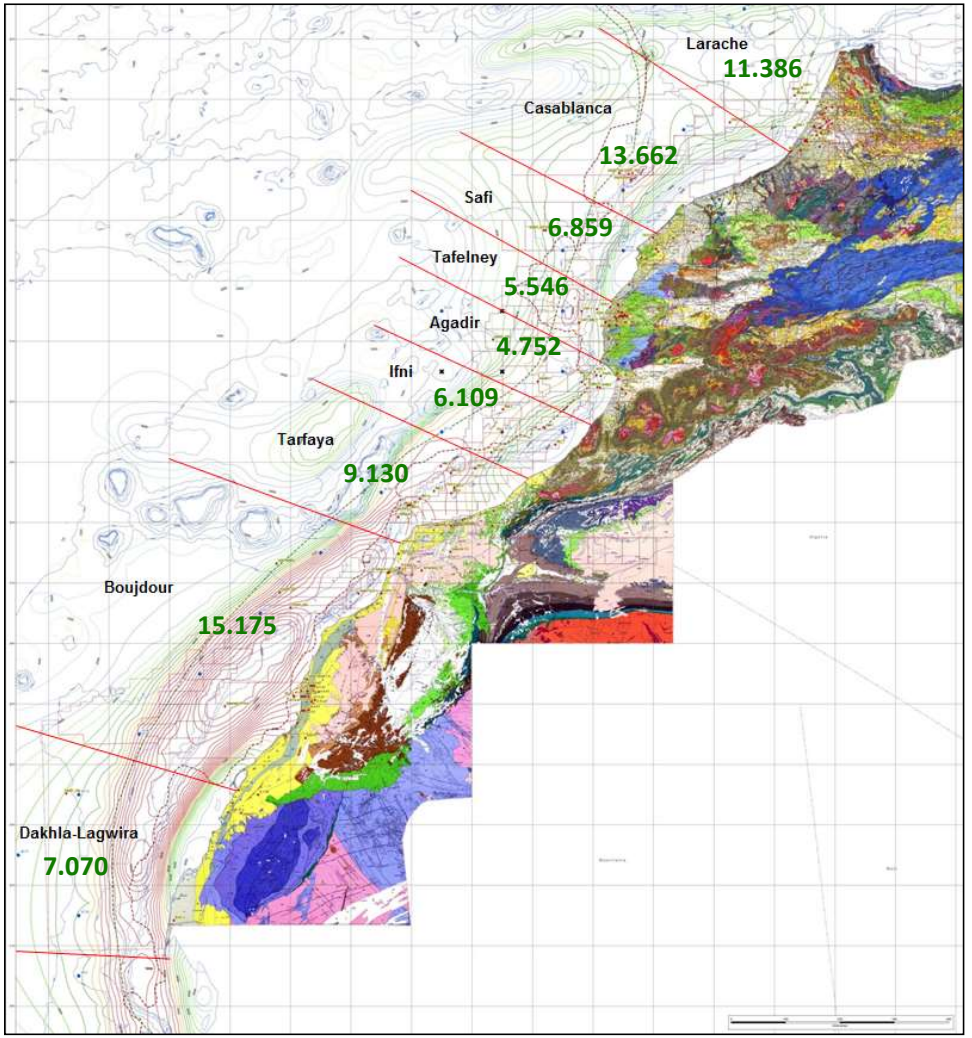


1. Source Rock: Callovian and Toarcian marls & shales
2. Migration: Vertical pathway through faults
3. Reservoir: Valanginian sands
4. Seal: U. Cretaceous & Tertiary Marls & shales
5. Trap: Structural (3 to 4-way closures)

PROSPECT	
Water Depth (m)	1250
Closure (Km²) (mean)	43
STOIIP (mean) (MMbbls)	1556
Recoverable resources (mean) (MMbbls)	470

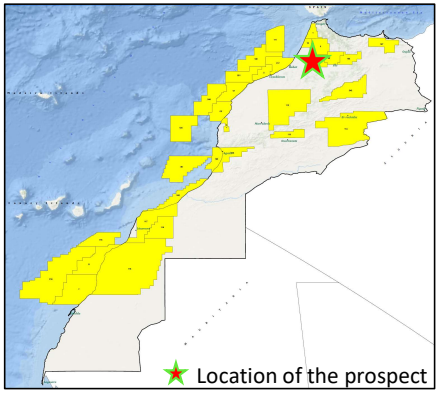
OFSHORE ATLANTIC MOROCCO: RESOURCES ASSESSMENT

- **Total unrisked generated volumes in the Moroccan Atlantic Margin about 79.7 BbblOE. These are comprising:**
  - **73.1 BbblOE from Jurassic and Lower Cretaceous source rocks ;**
  - **1.4 BbblOE from Mesozoic and Cenozoic source rocks in the thrust and melange zone ;**
  - **5.2 BbblOE from conjectural Triassic lacustrine and pre-salt sources.**



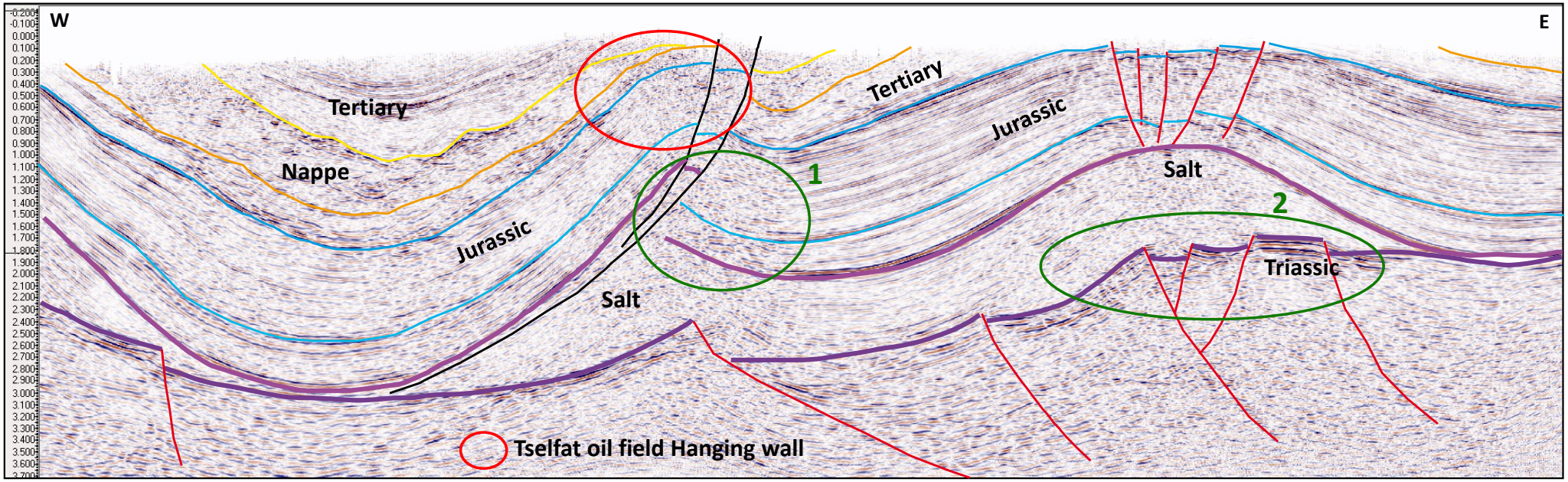
ONSHORE MOROCCO : HYDROCARBON PLAYS IN THE PRE-RIF BASIN

SUB-THRUST AND PRE-SALT STRUCTURES



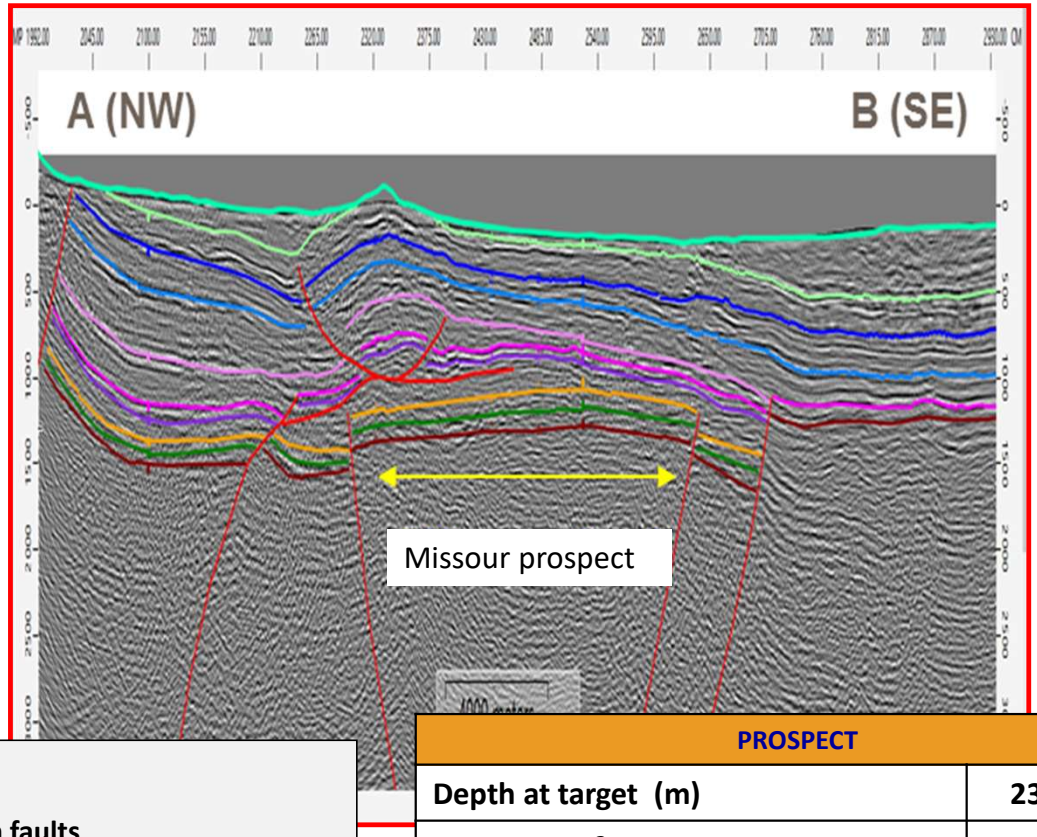
Untested targets:

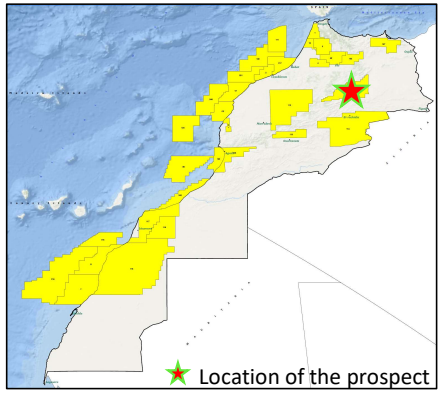
- **Sub-thrust: 1**
  - **Domerian platform limestone**
  - **Mid. Jurassic sandstones (Haricha formation)**
- **Pre-salt: 2**
  - **Triassic fluvial sandstones**

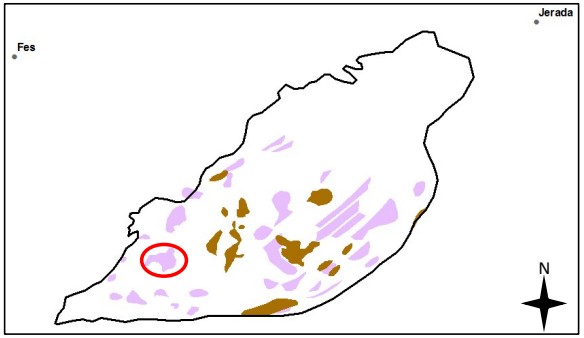


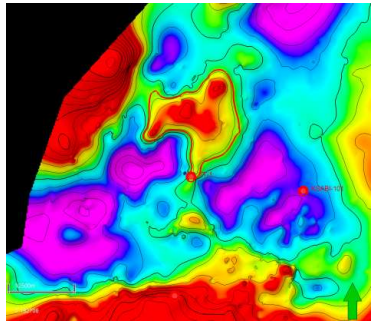
MISSOUR BASIN : TAGI SANDSTONES

- **The TAGI reservoir is of a high potential in both High plateaux and Missour basins**







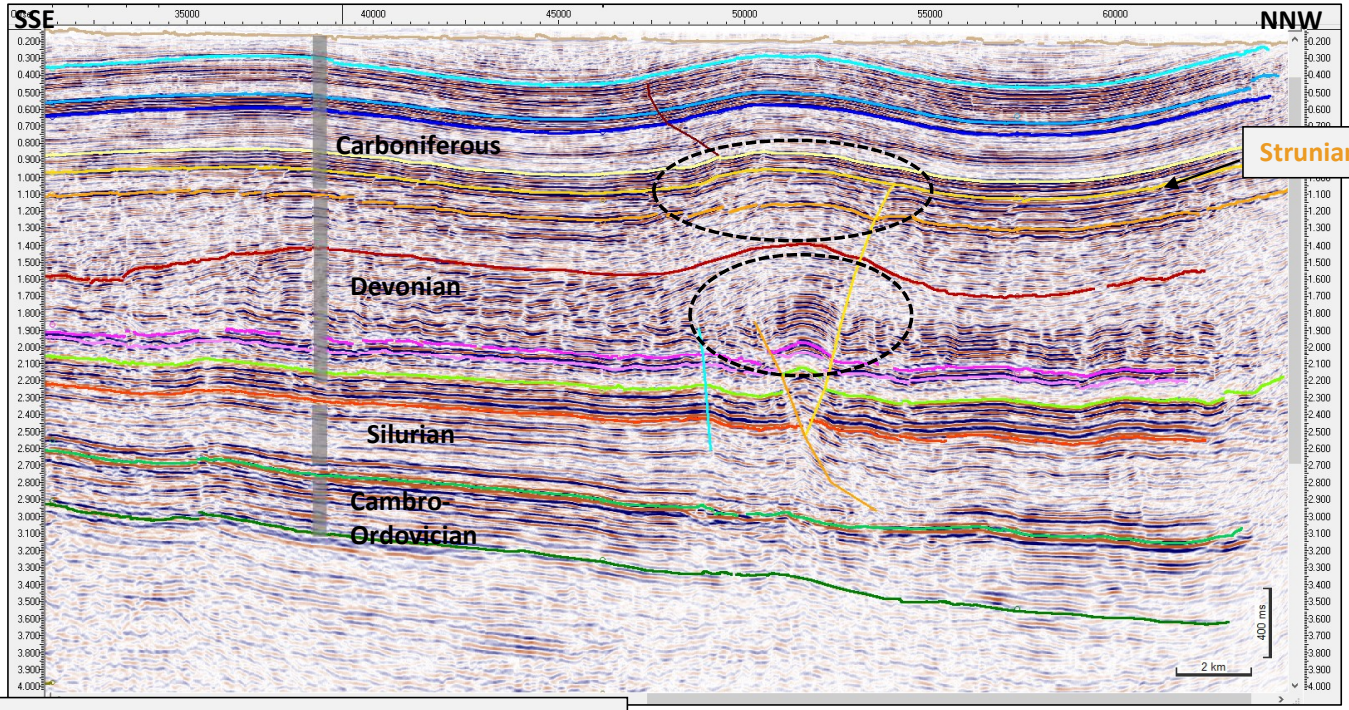


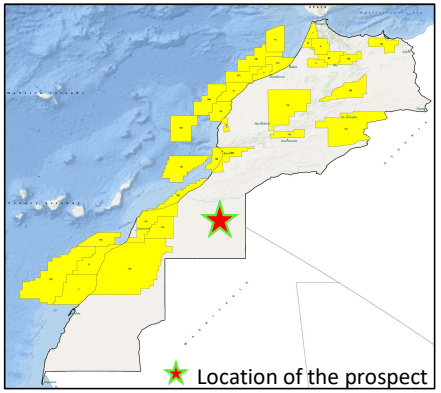
1. Source Rock: Silurian shales
2. Migration: Vertical pathway through faults
3. Reservoir: Upper Triassic and Carboniferous fluvial sandstones
4. Seal: Lower Jurassic & Carboniferous shales
5. Trap: Structural (3-way closures)

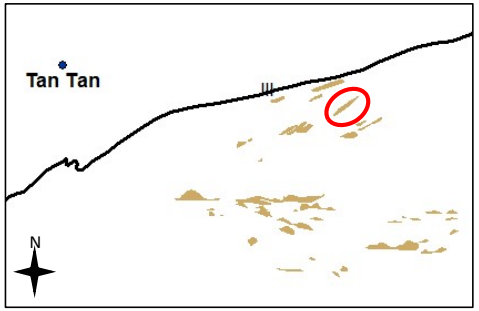
PROSPECT	
Depth at target (m)	2300-270
Closure (Km²) (mean)	60
Recoverable resources (mean) (BCF)	381
CoS	15%

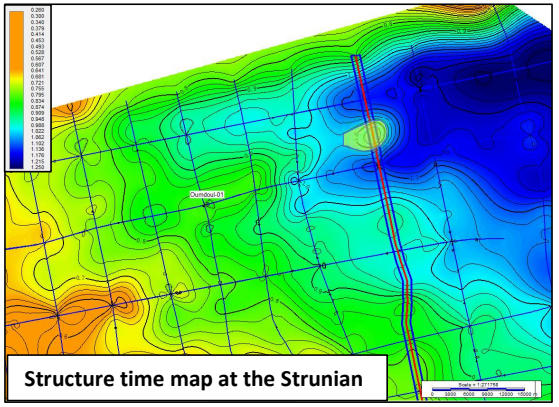
ONSHORE MOROCCO : PALAEOZOIC PLAY, ZAG BASIN

PALAEOZOIC MULTI TARGET STRUCTURES







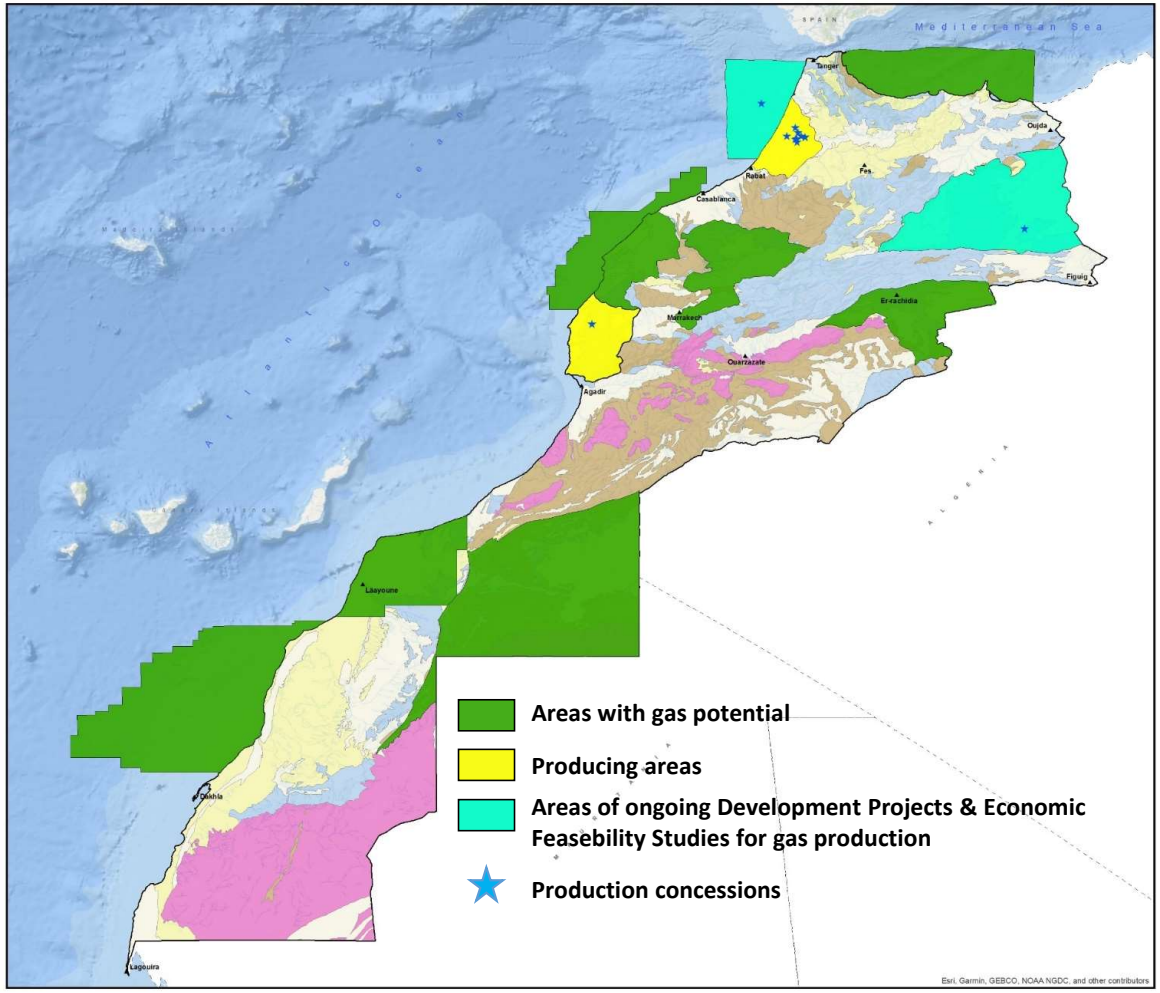


1. Source Rock: Silurian hot shales & Devonian shales
2. Migration: Vertical pathway through faults
3. Reservoir: Carboniferous & Lower Devonian sandstones
4. Seal: Palaeozoic interbedded shale & marls
5. Trap: Hercynian structures (3 to 4-way closures)

DOUBLE TARGET PROSPECT	
Primary target (Devonian) gas resources	276 Bcf
Secondary target (Lwr Carb.) gas resources	294 Bcf
Total	570 Bcf

MOROCCO : GAS POTENTIAL

Moroccan sedimentary basins with gas potential



www.onhym.com

Producing areas:

- Gharb Onshore Basin
- Essaouira Basin

Ongoing Development Projects:

- Gharb Offshore Basin
- Hauts Plateaux Basin

Areas with gas potential:

- Mediterranean Offshore basin
- Doukkala-Abda & Tadla-Haouz Basins
- Boudnib-Errachidia Basins
- Zag-Bas Draa Basins
- Safi-Casablanca Offshore
- Tarfaya Onhore
- Boujdour-Dakhla Offshore

- Hydrocarbon Exploration Overview
- Petroleum Systems
- Moroccan Basins Analogues
- Examples of untested Plays, Leads & Prospects
- **Morocco Incentives**
- Conclusions

MOROCCO: 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

- Hydrocarbon Exploration Overview
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MOROCCO HYDROCARBON EXPLORATION INCENTIVES

- Favourable Geology for oil and gas exploration and production
- Still largely underexplored onshore and offshore basins
- 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. The so far drilled wells have discovered modest local hydrocarbon to prove existence of working petroleum systems
- Favourable and attractive terms
- 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.

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OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

THANK YOU

SEG-AAPG 28 Aug – 01 Sep 2022 – Houston, USA