



# Hydrocarbon Exploration in Morocco: Conventional & Unconventional

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ONHYM

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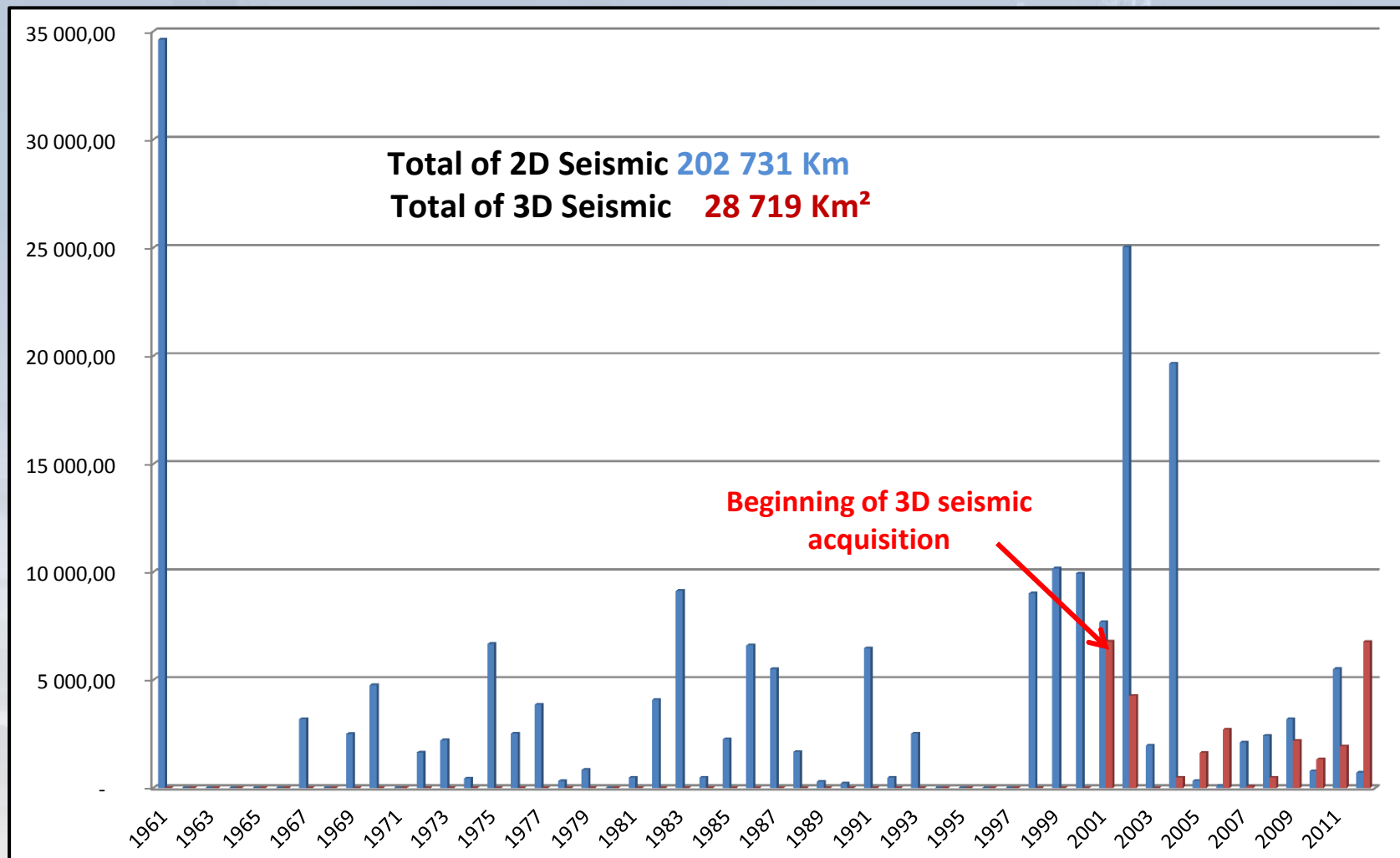
# Key Aspects

- Political and economic stability;
- Economic policy of integration at regional and international levels;
- Growing and developing infrastructure projects;
- Energy policy based on developing partner's activities in the petroleum research;
- Favorable and attractive hydrocarbon's terms.



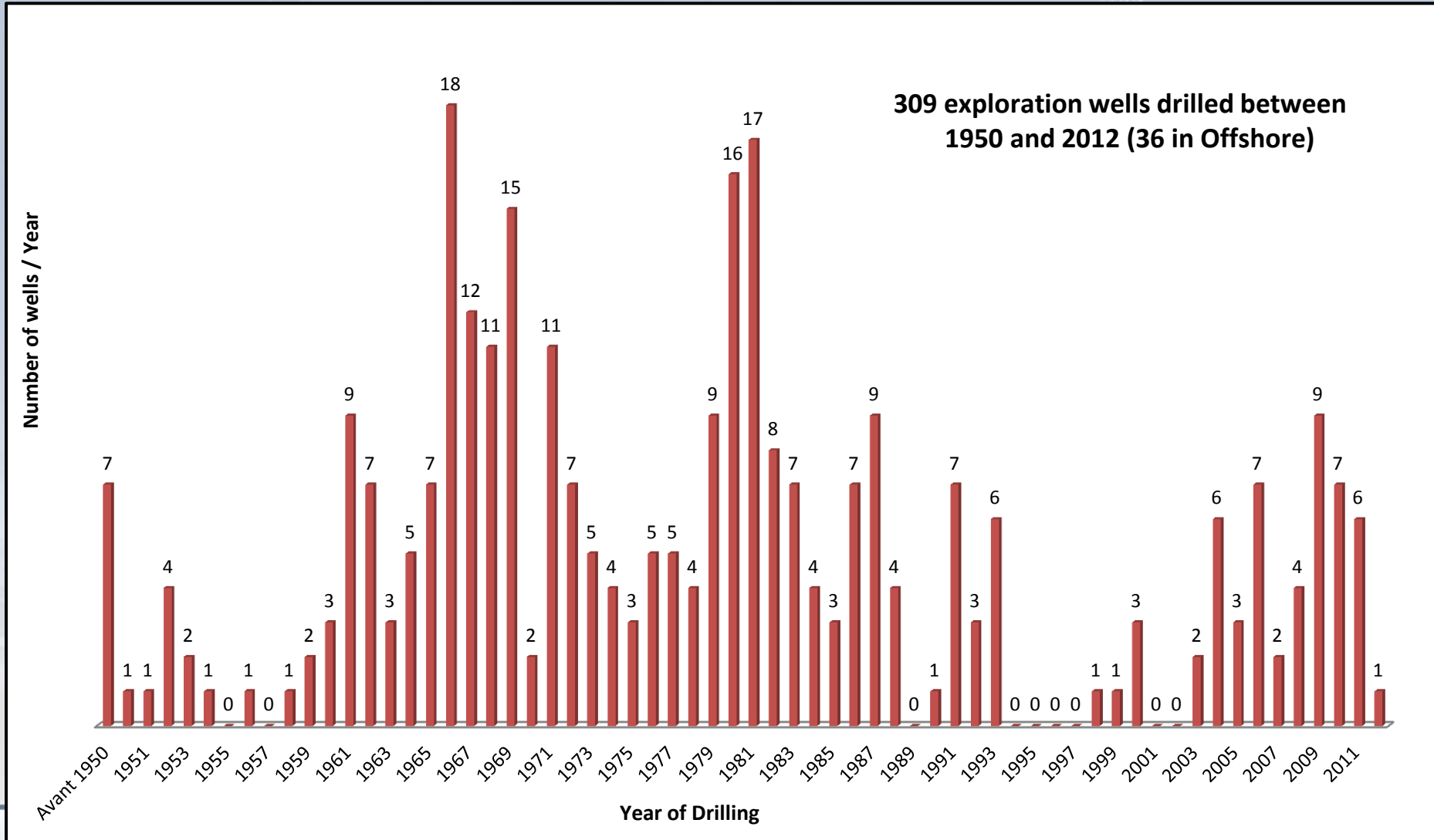
# Exploration History

## Seismic acquired between 1961 et 2012



# Exploration History

## Evolution of wells numbers between 1950 and 2012



# Exploration Status

المملكة المغربية  
KINGDOM OF MOROCCO  
**ONHYM**  
الهيئة الوطنية للهيدروكربونات والغاز الطبيعي  
NATIONAL HYDROCARBONS AND GAS AUTHORITY  
Petroleum Agreements,  
Reconnaissance Contracts  
and Open Acreages



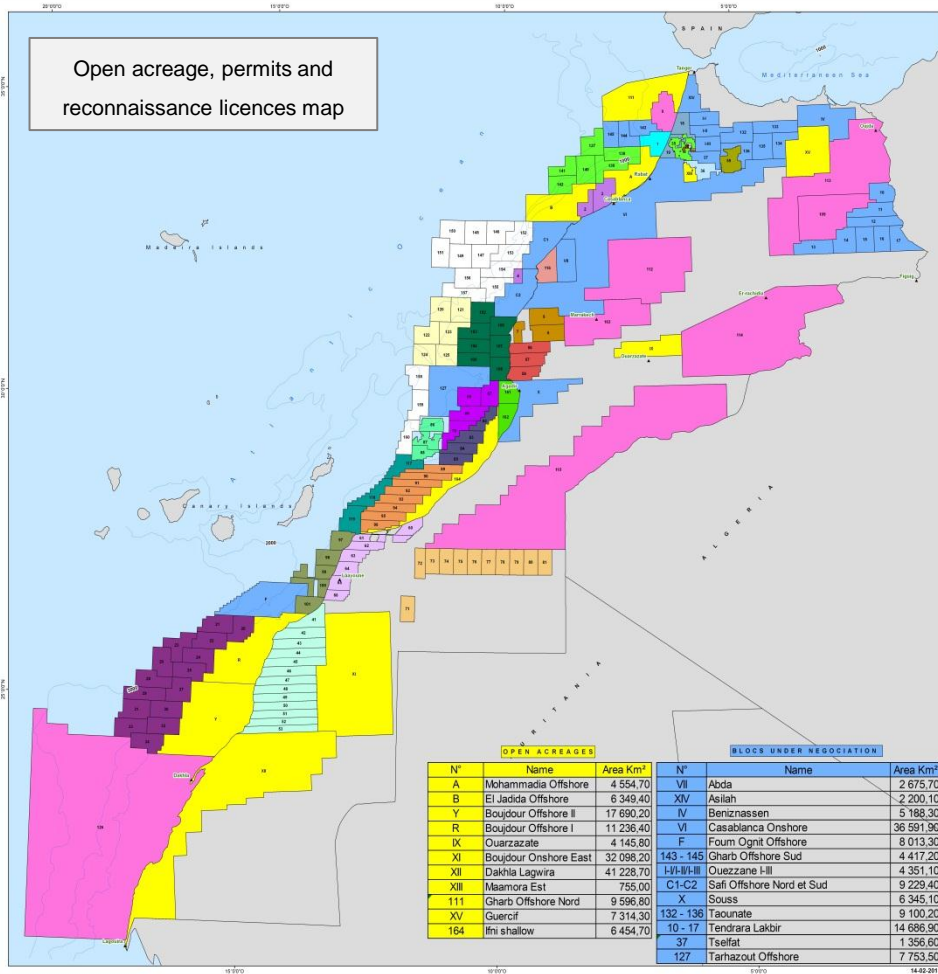
## PETROLEUM AGREEMENTS

N°	Exploration Zones	Company	Area Km²
2-3	Lozans offshore I	ONHYM-CHARLOT	1.925,00
4	Casablanca offshore A-B		3.500,00
4	Safi offshore I		1.780,40
5	Sidi Mokhtar Nord		1.999,20
7	Sidi Mokhtar Sud	ONHYM-MPE-LONGREACH	733,30
7	Sidi Mokhtar Ouest		1.371,20
19	Lalla Mimouna Nord	ONHYM-CIRCLE OIL	840,10
19	Lalla Mimouna Sud		29.740,70
35-36	Cap Boujdour Offshore I-IV	ONHYM-KOSMOS	1.350,70
35	Rhads centre	ONHYM-CABRE	1.357,50
36	Rhads Sud	ONHYM-CIRCLE OIL	134,70
36	Sabou		25.184,90
41-53	Boujdour Onshore I-XIII	ONHYM	4.919,00
56-58	Haha 1-3	ONHYM-PEL	1.599,80
59	Fis	ONHYM-CABRE	7.720,50
60-66	Tarfaya onshore 1-7	ONHYM-SAN LEON-LONGREACH	6.473,10
67-76	Foum Assaka Offshore I-IV	ONHYM-KOSMOS-PATHFINDER	14.625,30
71-81	Zag 1-11	ONHYM-SAN LEON-LONGREACH	5.919,00
82-85	Sidi Moussa Offshore 1-4	ONHYM-GENEL-SERICA-SAN LEON-LONGREACH	3.349,80
86-88	Foum Disa Offshore 1-3	ONHYM-CAPROCO-SERICA-SAN LEON-LONGREACH	11.281,90
89-96	Tarfaya Offshore I-VIII	ONHYM-EVM	7.244,40
97-101	Boujdour Offshore Shallow I-IV	ONHYM-TEREDO	11.730,80
102	Essaouira Offshore I-VI	ONHYM-KOSMOS - CANAMENS	1.997,80
116	DOUKKALA	ONHYM-EAST WEST	5.859,40
120-125	JUBA MARITIME I-II	ONHYM-AUTICAL-SARRUS	10.897,40
127-142	MAZAGAN OFFSHORE I-VI	ONHYM-PURA VIDA	10.761,80
143-145	Rabat deep offshore I-III	ONHYM-CHARLOT	11.787,80
146-151	Cap Carten Deep Offshore I-B	ONHYM - CHEVRON	11.868,80
152-157	Cap Carten Deep Offshore I-V		5.581,20
158-160	Cap Riv' Deep Offshore I-III	ONHYM - GENEL	3.289,27
161-162	Mir salt offshore I-II		2.744,00

## RECONNAISSANCE CONTRACTS

N°	Exploration Zones	Company	Area Km²
9	Tanger-Larache Offshore	ONHYM-REPSOL - DANA - GAS NATURAL	8.973,33
109	Masour Est 2	ONHYM-EGO	18.845,00
112	Tadla I	ONHYM-REPSOL	23.356,50
113	Haha Plateaux	ONHYM-REPSOL	32.938,80
114	Boudend	ONHYM-ANADARKO	54.828,10
115	Assa	ONHYM-TOTAL	100.926,70
126	Anzarane Offshore	ONHYM-VERMILION Morocco Exploration BV	9.468,90
163	Hazou		

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N°	Name	Area Km²
A	Mchammadia Offshore	4 554,70
B	El Jadida Offshore	6 349,40
Y	Boujdour Offshore II	17 690,20
R	Boujdour Offshore I	11 236,40
IX	Ouarzazate	4 145,80
XI	Boujdour Onshore East	32 098,20
XII	Dakhla Lagwira	41 228,70
XIII	Maamora Est	755,00
111	Gharb Offshore Nord	9 596,80
XV	Guercif	7 314,30
164	Mir shallow	6 454,70

N°	Name	Area Km²
VII	Abda	2 675,70
XIV	Asilah	2 200,10
IV	Benizassen	5 188,30
VI	Casablanca Onshore	36 591,90
F	Foum Ognit Offshore	8 013,30
143 - 145	Gharb Offshore Sud	4 417,20
I-IV-II-III	Ouezzane I-III	4 351,10
C1-C2	Safi Offshore Nord et Sud	9 229,40
X	Souss	6 345,10
132 - 136	Taouat	9 100,20
10 - 17	Tendrarra Lakbir	14 688,90
37	Tessalt	1 356,60
127	Tarhazout Offshore	7 753,50

## Open acreage

- 06 blocks offshore
- 05 blocks onshore

## Under negotiation

- 04 blocks offshore
- 09 blocks onshore

## PA & RL

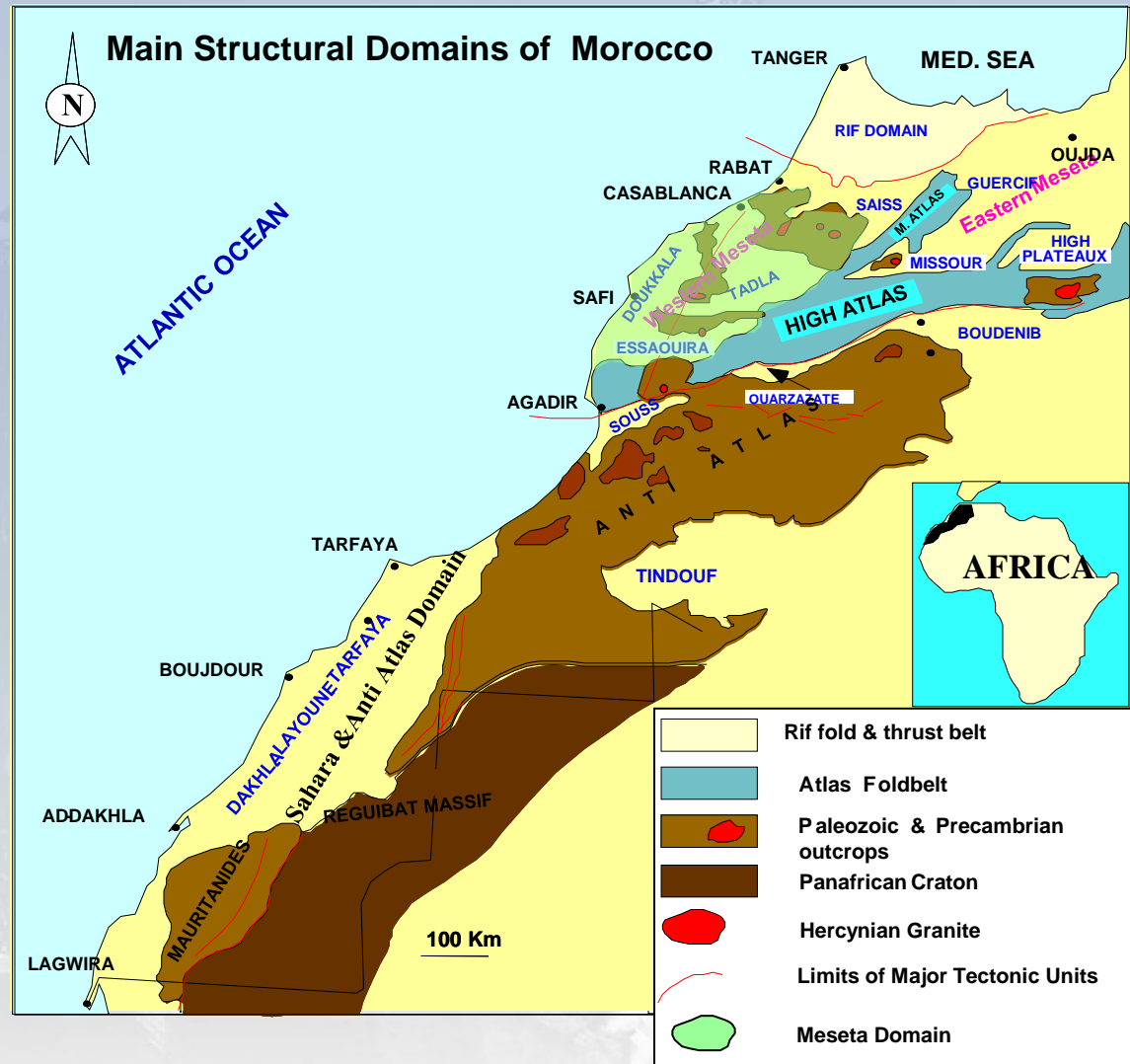
- 31 Petroleum Agreements offshore and onshore
- 08 Reconnaissance Licenses (6 onshore and 2 offshore)



# Geological Snapshot: Onshore

Objectives ranging from Precambrian to Neogene in five major geological domains :

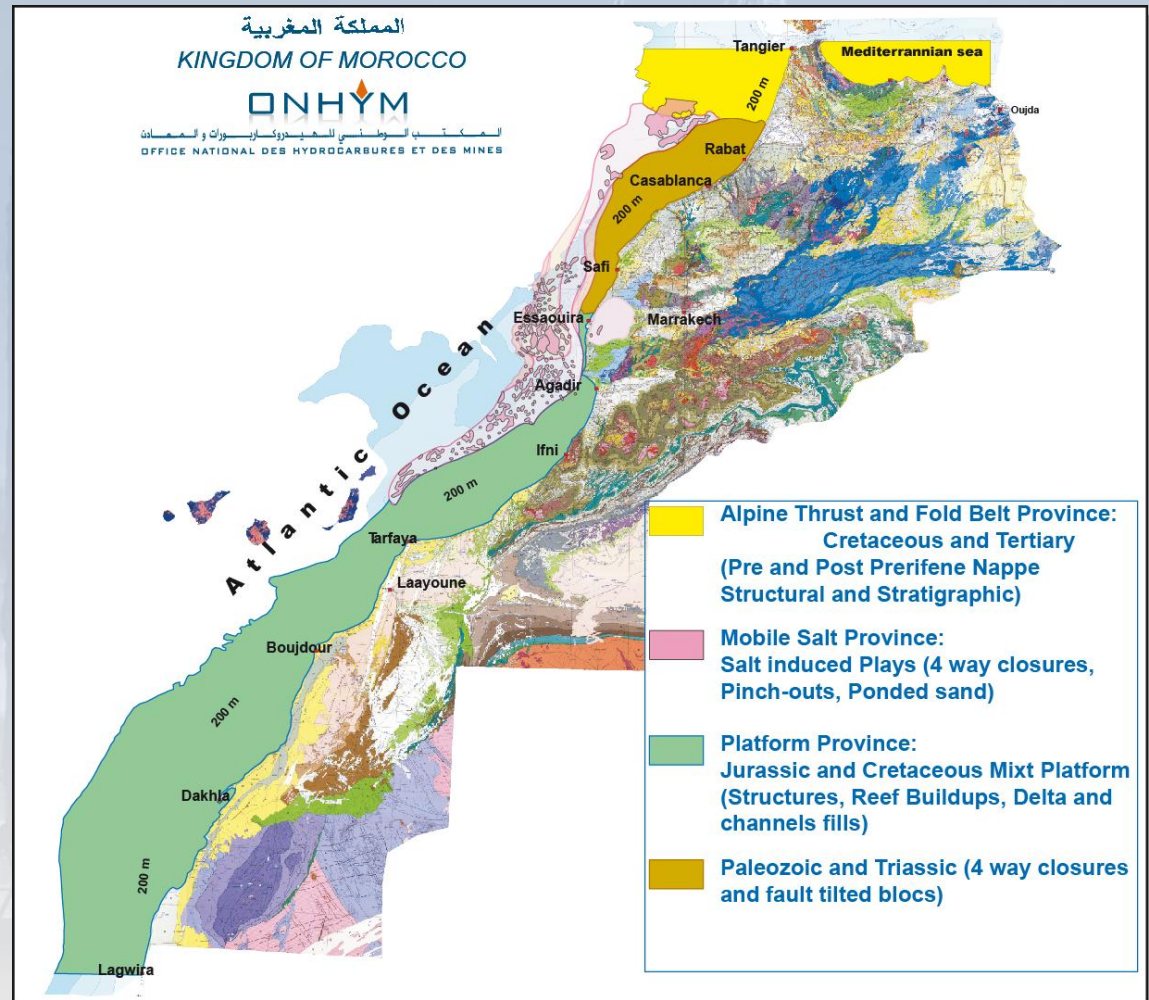
- The Anti Atlas and Saharian domain (Paleozoic objectives )
- The Costal Meseta domain (Paleozoic, Triassic and Jurassic objectives)
- The Atlasic domain (Triassic and Jurassic objectives)
- The Atlantic passive margin (Jurassic, Cretaceous and Tertiary objectives)
- The Rif domain (Mesozoic and Tertiary objectives)



# Geological Snapshot: Offshore

Objectives ranging from Paleozoic to Neogene in four main provinces

- Alpine thrust and fold belt province (Cretaceous and Tertiary objectives)
- Paleozoic and Triassic Province
- Mobile salt province (Jurassic, Cretaceous and Tertiary objectives)
- Platform Province (Jurassic and Cretaceous objectives)



# Petroleum Systems: Source Rocks

## Paleozoic Source Rocks

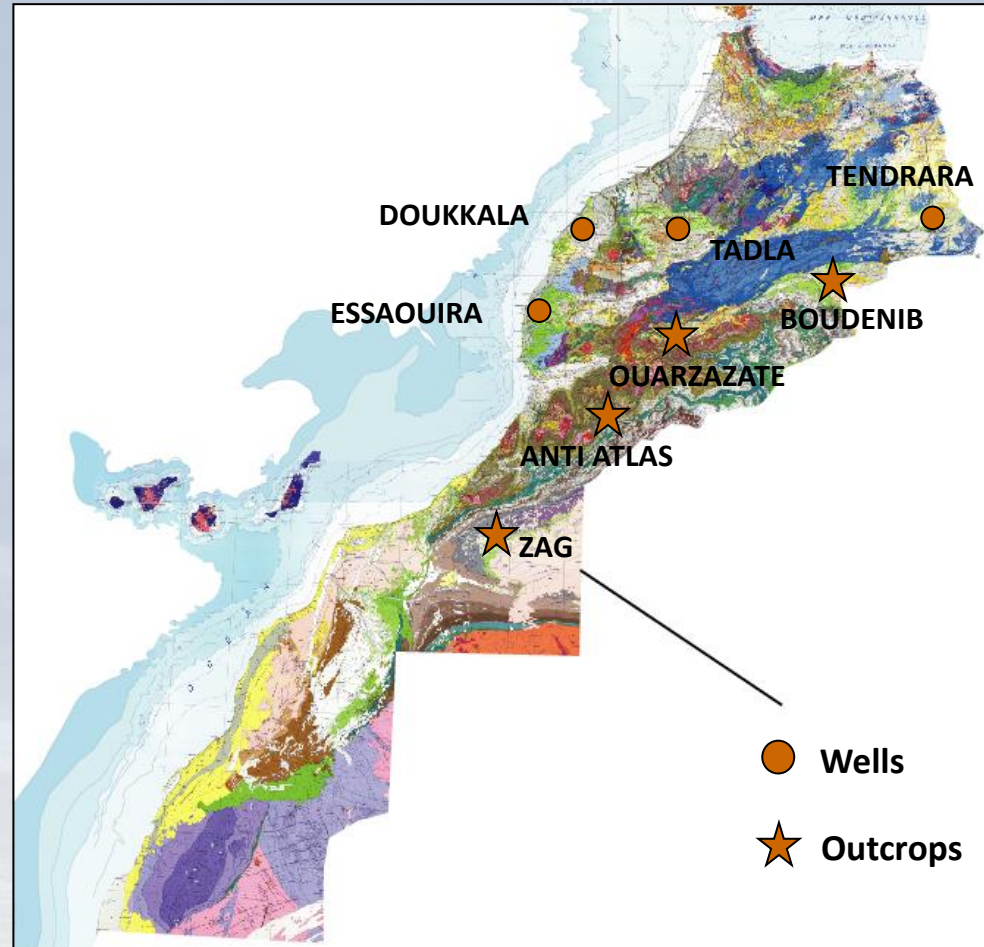
(Silurian, Devonian & Carboniferous)

### ACCUMULATIONS

- Tendirara Gas Field (High Plateaux)
- Meskala, Kechoula, Jeer, Ndark and Zelten Gaz fields (Essaouira)

### WELLS AND OUTCROPS

- Tadla Basin TOC up to 12.12%
- Doukkala Basin TOC up to 5%
- Anti Atlas TOC up to 12.1%
- Ouarzazate TOC up to 11%
- Boudenib Basin TOC up to 3.2%
- Zag basin TOC up to 1.89% and OD-1 Oil and Gas shows.





# Petroleum Systems: Source Rocks

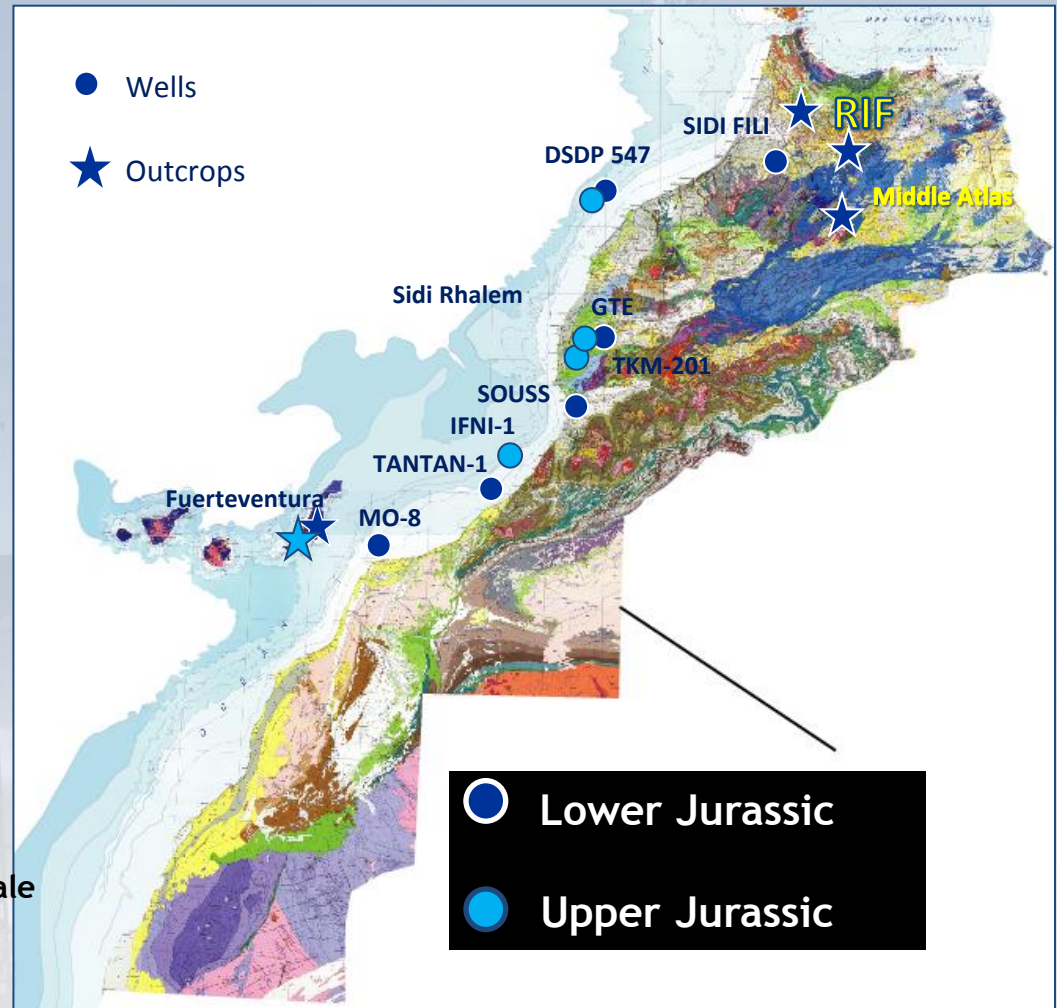
## Jurassic Source Rocks

### Lower & Middle Jurassic

- Sidi Fili oil field: TOC up to 5.5%
- Rif and Middle Atlas oil seeps (TOC up to 3.4%)
- GTE-1 oil shows?
- MO-8 Light oil
- DSDP-547 up to 8.9 %TOC & 48.5 mg/g S2
- TanTan-1 well up to 2.5 % TOC; 800 HI
- Souss basin (EGA-1 TOC up to 2.74%)
- Fuerteventura black shale

### Upper Jurassic

- Sidi Rhalem oil field
- TKM well: Oxfordian shale up to 4.3 % TOC
- DSDP-547 up to 1.9 %TOC
- IFNI-1 up to 3.36 % TOC
- Fuerteventura Island: 80m Oxfordian black shale



# Petroleum Systems: Source Rocks

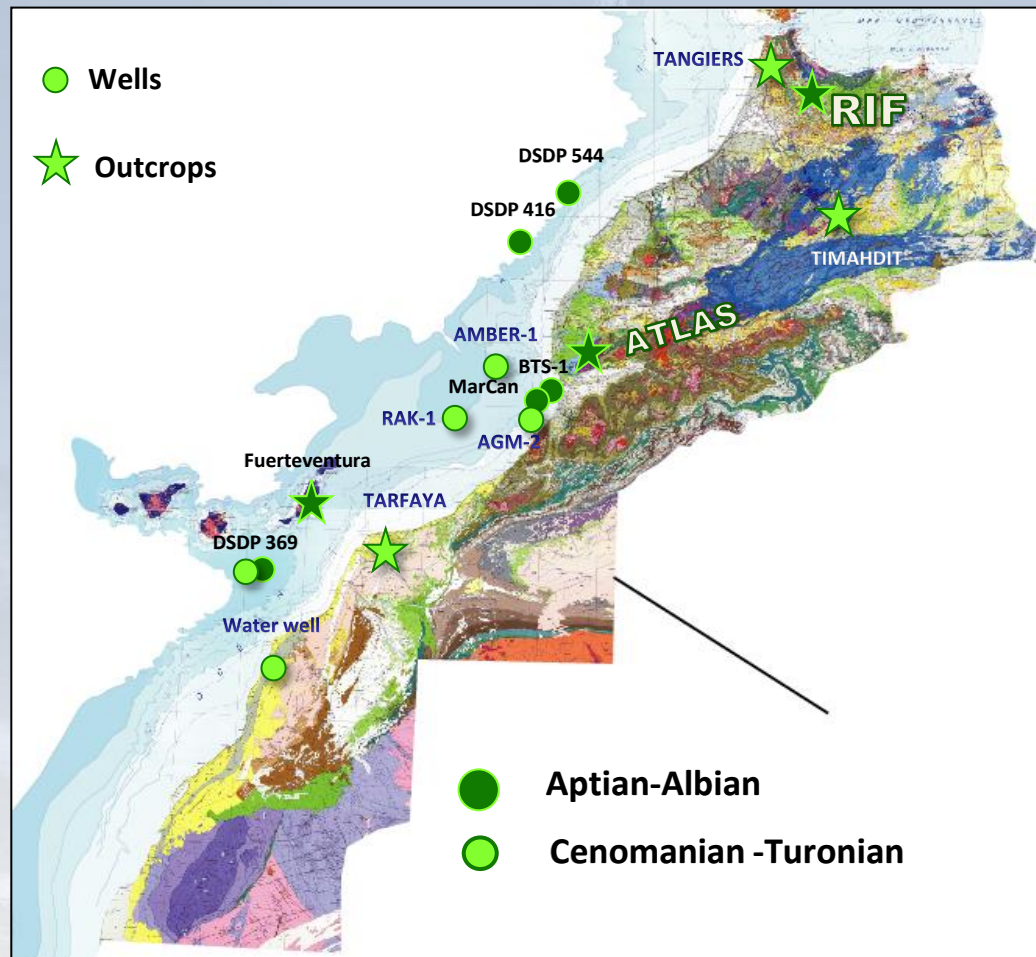
## Cretaceous Source Rocks

### Aptian-Albian:

- Locally developed thin “bituminous shales” onshore in the Rif and western High Atlas
- DSDP 544: TOC to 4.5%
- BTS-1: tested minor trace of oil; TOC 2 - 4% and a HI of 280-340
- DSDP 370/416: TOC to 6.2% &  $S_2$  to 31 mg/g
- MarCan-1: TOC to 2.4% &  $S_2$  to 8.9 mg/g 82% type II and 18% type III
- 40 m organic rich black shale crops out in Fuerteventura
- DSDP-369 up to 3%.

### Cenomanian-Turonian:

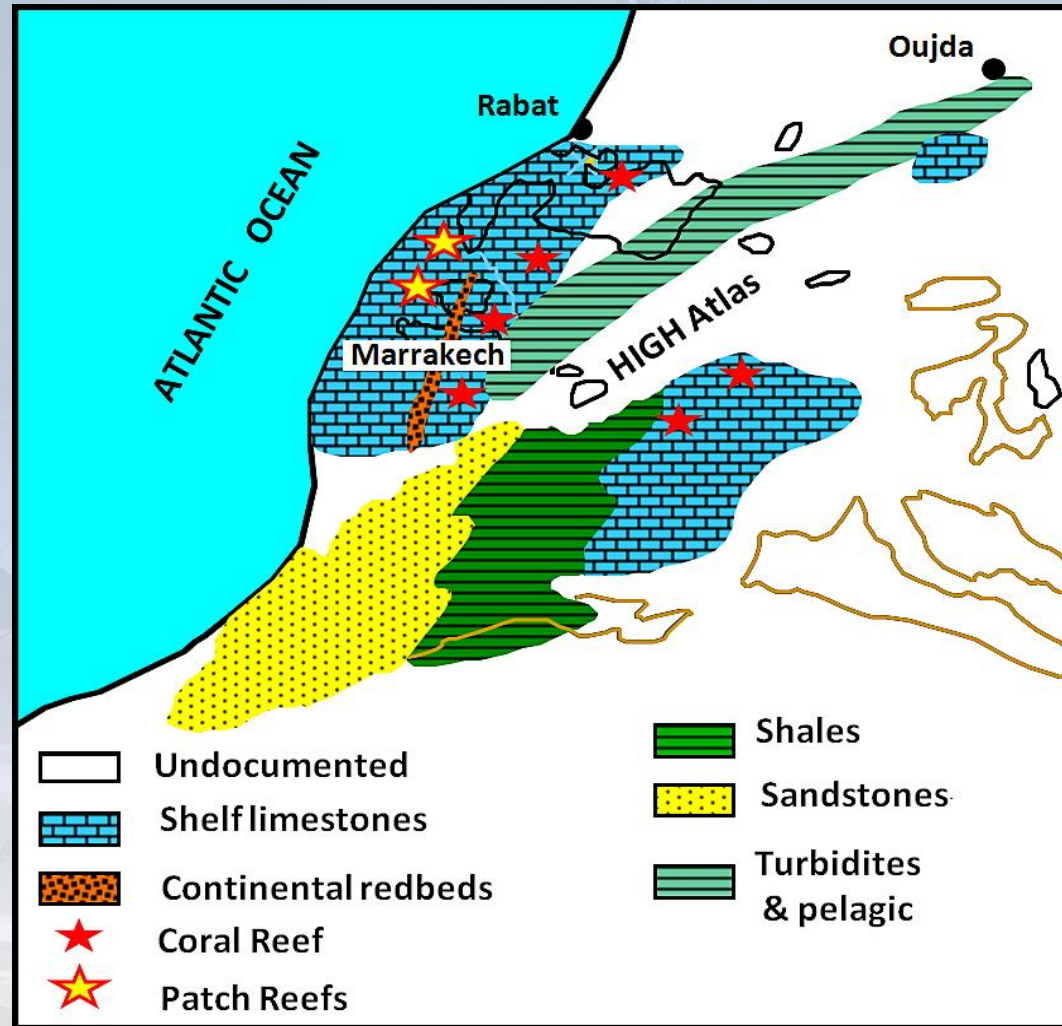
- Tarfaya oil shale quarry, the source rock interval is 50 m thick, with a TOC of 2-19%
- AGM-2 3.5% TOC, 574 HI
- Amber-1 well 26 m thick section Turonian interval 12.5% to 15.9% TOC
- RAK-1 well encountered organic rich laminae.



# Petroleum Systems: Reservoir Rocks

## Paleozoic Reservoir Rocks

- Cambrian and Ordovician shallow marine sandstones;
- Devonian Platform carbonates with Coral reef and patch reefs;
- Upper Devonian and Carboniferous turbidite sandstones.



Devonian Paleogeographic map

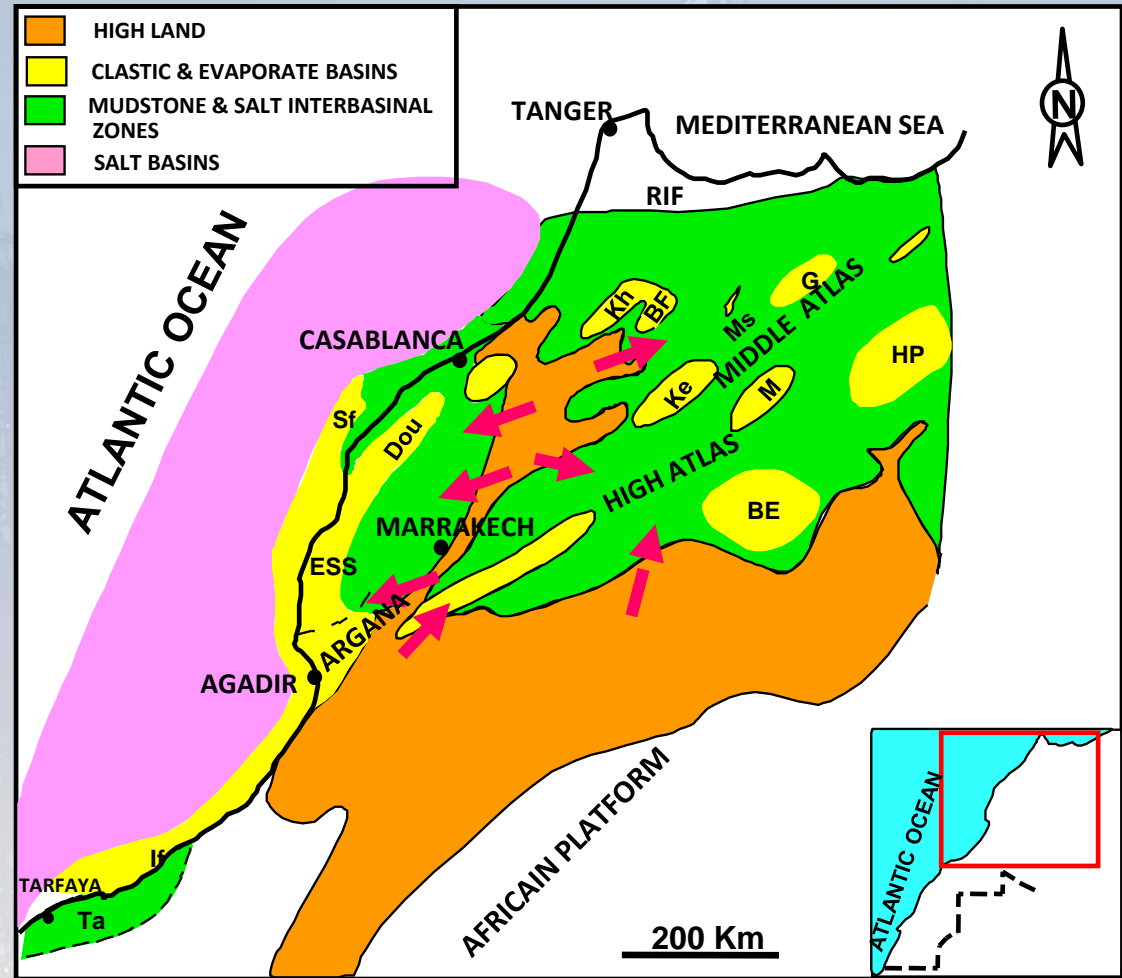


# Petroleum Systems: Reservoir Rocks

## Triassic Reservoir Rocks

four potential reservoir intervals have been identified: porosity range between 10% & 16% and thickness between 10 & 200 m

- The outcropping T4 and T6 sandstone formations in the Argana valley and their lateral equivalents in the Meskala field;
- The Lower Lias sandstones of the zelten field
- The Permian sandstones of Doukkala and Essaouira basins



Facies distribution at Upper Triassic



# Petroleum Systems: Reservoir Rocks

## Jurassic Reservoir Rocks

- Silicoclastic sediments derived from Paleozoic hinterland (metasediments and granites);
- Platform carbonates with coral reefs and shallow marine sandstones.

## Cretaceous Reservoir Rocks

- Lower Cretaceous fluvio-deltaic systems, deltaic and/or fan apron sandstones & turbidite fans;
- Lower Cretaceous platform carbonates;
- Lower Cretaceous clastics were encountered onshore and have not yet been penetrated offshore.
- Upper Cretaceous turbidite sandstones of the Lowstand System Tracks.

## Tertiary Reservoir Rocks

- Incised slope canyon sands (Lower Tertiary);
- Turbidite sandstones.

# Play Concepts

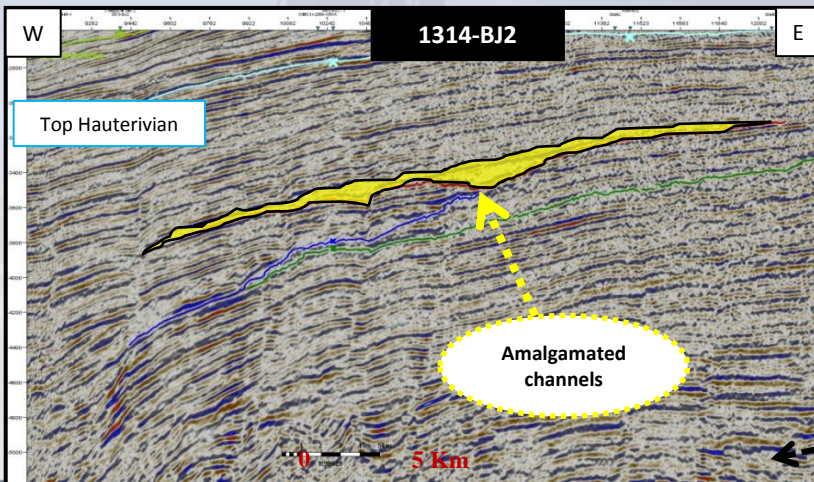
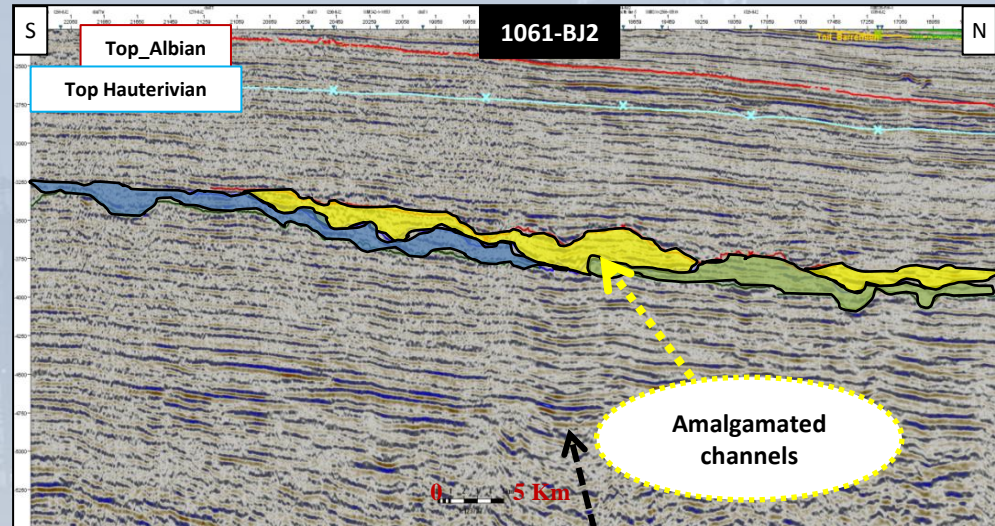
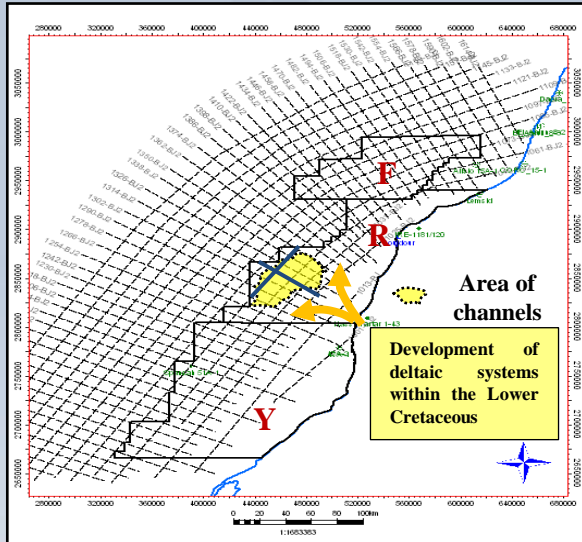
- Paleozoic folded and faulted plays (Devonian reefs and Ordovician sandstones)
- Triassic alluvial & fluvial tilted blocks ;
- Folded and faulted Mesozoic plays;
- Subthrust Mesozoic plays;
- Tertiary foreland & foredeep turbidite sandstones;
- Well Developed Toe-Thrust Trend;
- Extensive Sub-Salt Potential;
- Salt related structures;
- Reef build ups structures;
- Platform Carbonates.



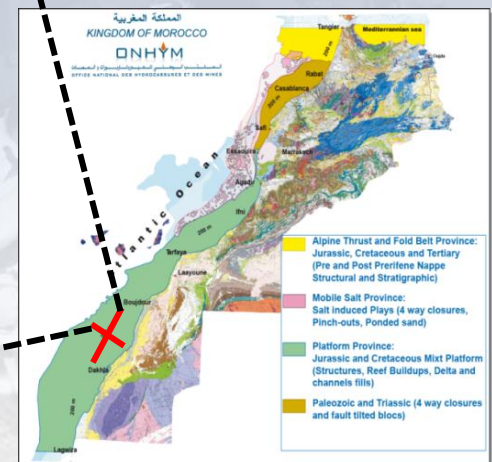
# Conventional Hydrocarbon Resources

## Offshore Basins

Example of play concepts : Lower Cretaceous lead in Offshore (Boujdour block)



- Traps : Stratigraphic (Amalgamated Channels)
- Reservoirs: Lower Cretaceous sandstones
- Source rocks: Aptian and Jurassic
- Seals: Tertiary & Upper Cretaceous marl and shale

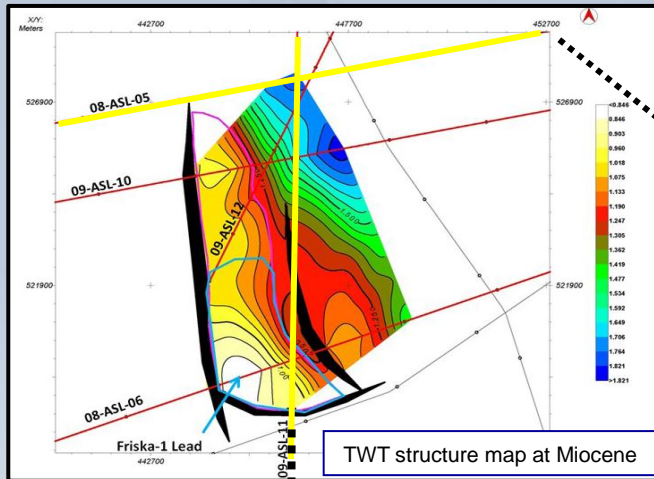




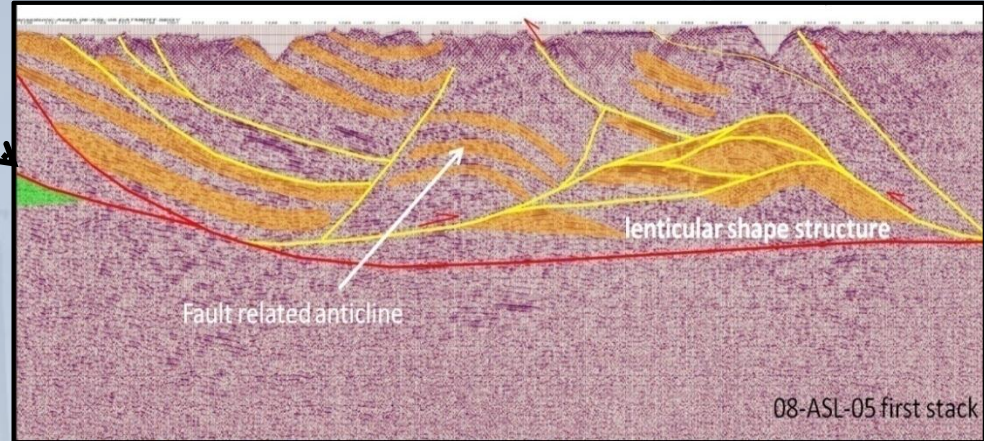
# Conventional Hydrocarbon Resources

## Onshore Basins

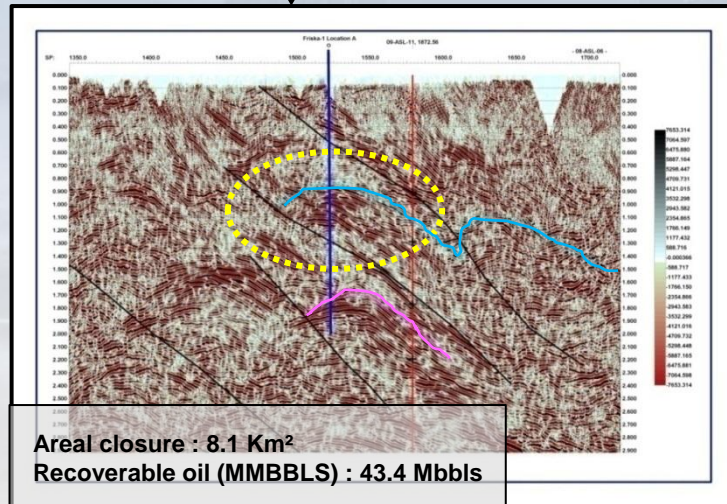
Example of play concepts : Tertiary lead in Onshore (Asilah block)



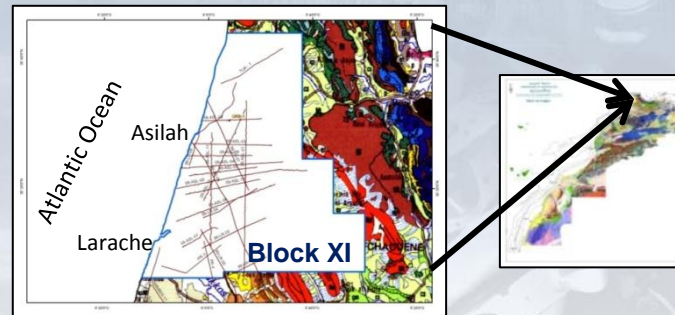
Friska - 1 Lead



Line 08-ASL-05, imbricated and folded Miocene play concept



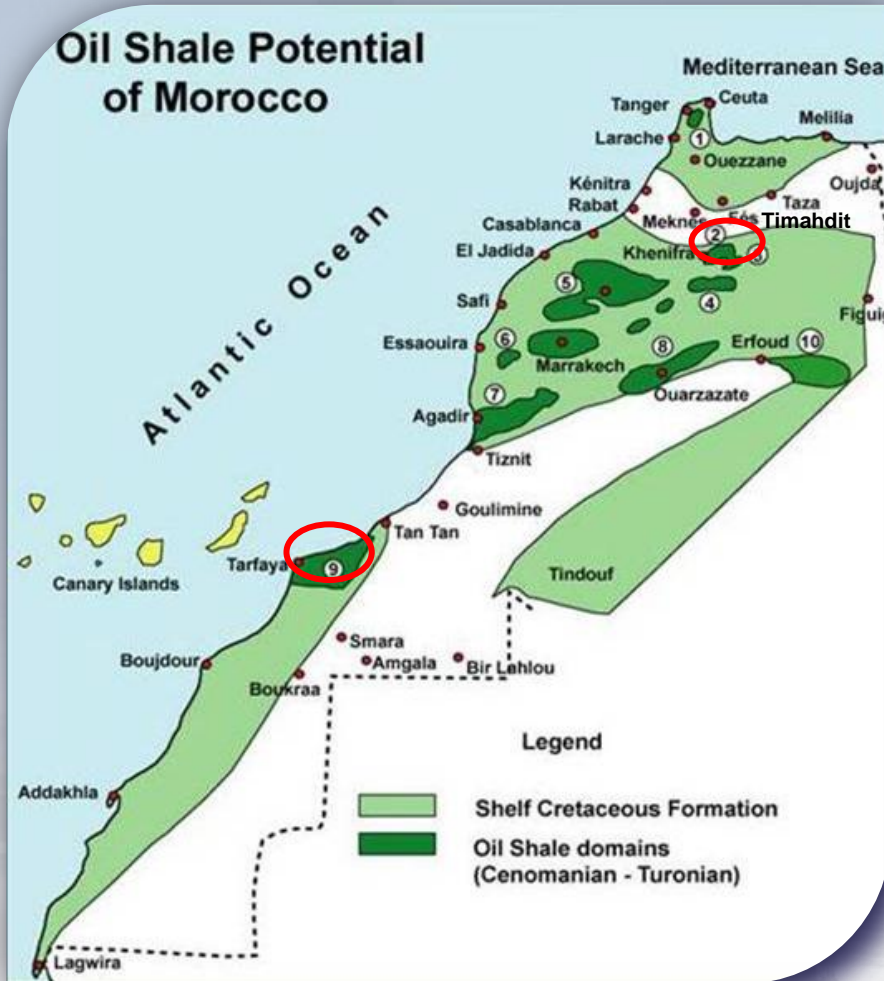
Line 09-ASL-11, through the Friska-1 Lead



- Traps : Faulted anticline structures
- Reservoirs: Cretaceous & Tertiary turbidites
- Source rocks: Cenomanian-Turonian Shale
- Seals: Tertiary shale

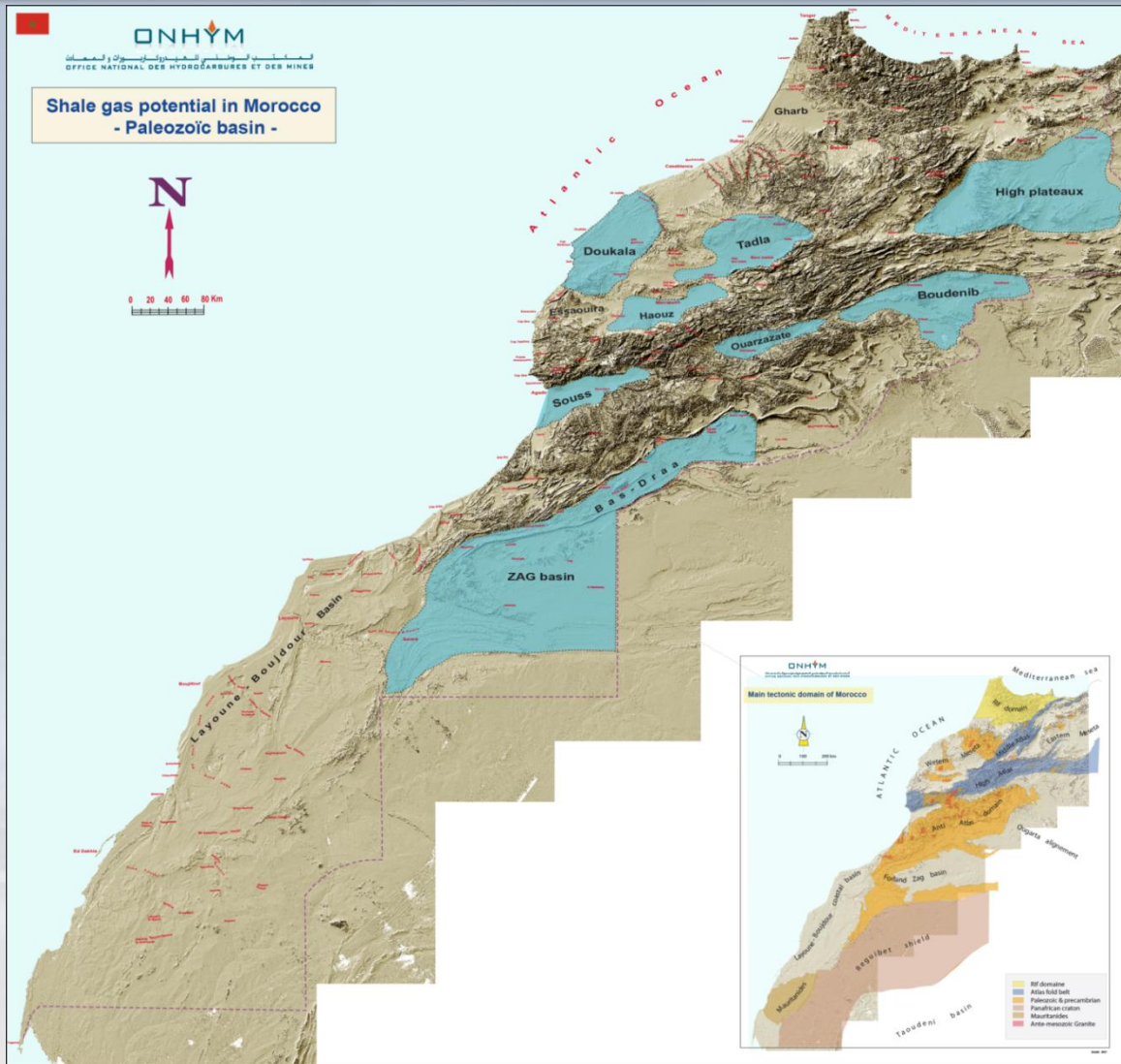


# Unconventional Hydrocarbons: Oil Shale



- Oil - shale deposits have been identified at ten localities in Morocco (map), the most important of which are Upper Cretaceous . The two deposits that have been explored most extensively are the Timahdit and the Tarfaya deposits ;
- Morocco has important oil reserves contained in the oil shales (approximately 50 billion barrels, just in Timahdit & Tarfaya).

# Unconventional Hydrocarbons: Shale Gas



- First geological and geochemical appraisal of the Paleozoic depositional systems ;
- Other basins worth a deep exploration work ;
- The Mesozoic and Tertiary sediments have a good potential and should be considered for future shale gas development plans.





# Summary

- Moroccan sedimentary basins, both onshore and offshore, remain under-explored;
- Exploration drilling activity, although limited, and outcrops have proven the presence of viable petroleum systems;
- New 3D seismic data have permitted to increase the rate of success and to delineate new prospects and play concepts ranging in age from Paleozoic to Tertiary, and of different types;
- In terms of unconventional hydrocarbons, Moroccan basins are believed to have a good potential and worth a deep exploration work.

## Future exploration orientations

- Reevaluation and upgrade of the previously identified prospects and leads to go ahead for drilling;
- Intensive exploration programs to prove the unconventional hydrocarbon potential of the Moroccan basins.





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