



25th world gas conference
"Gas: Sustaining Future Global Growth"

The potential of shale gas plays in Algeria

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SONATRACH EXPLORATION, ALGERIA

Date: Thursday 7th June 2012

Venue: Monday 4th June 2012



Patron



Host

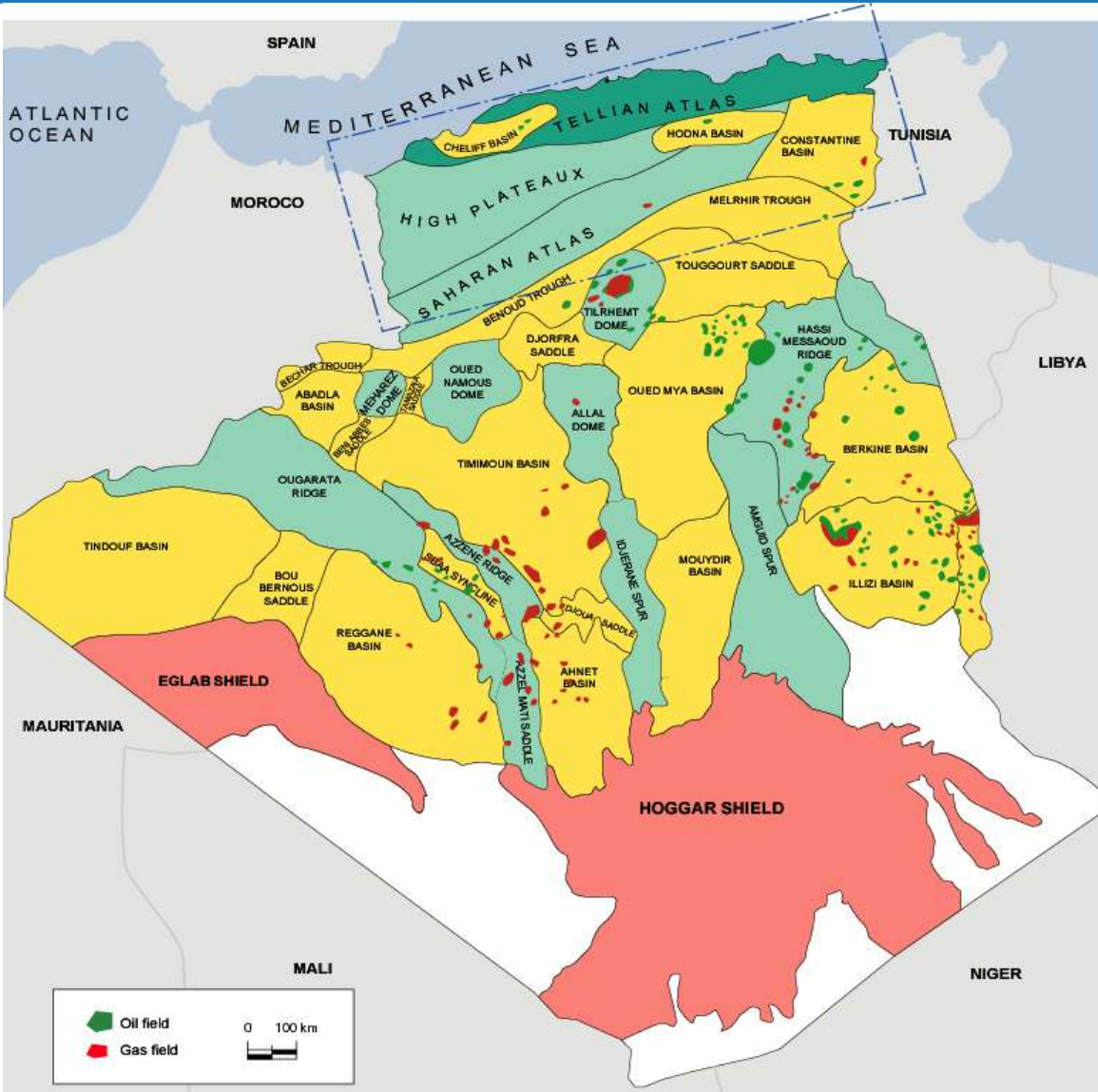


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- **Regional geology of Algeria**
- **Characteristics of Algerian hot shales**
- **Regional mapping of potential shale gas plays**
- **Preliminary results of specific gas shale evaluation**
- **Comparison of Algerian gas shales with the main US Gas Shale plays**
- **Resource estimates & way forward**

Sedimentary basins of Algeria



The Algerian territory extends over:
2 381 741 km².

Area of the mining domain:
1 553 488 km²

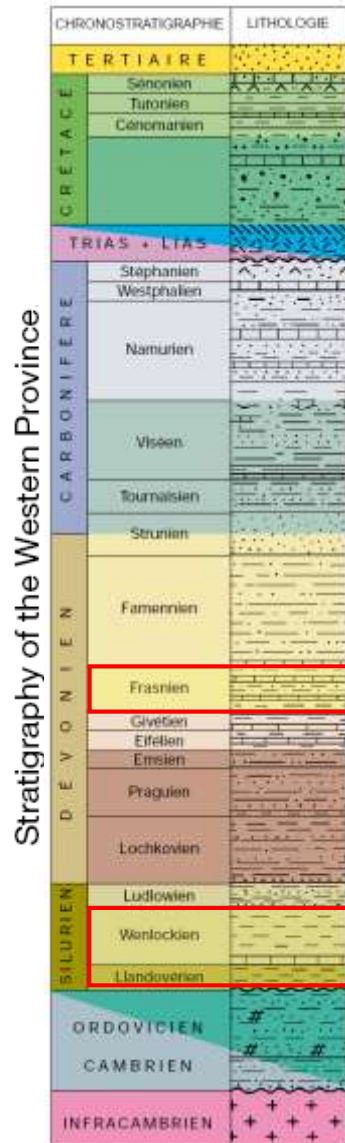
- Offshore: **93 500 km² (6%)**
- Onshore: **1 460 000 km²**

Algeria is structurally subdivided into two major tectonic units separated by the south Atlas fault:

- In the north, an Alpine domain including offshore basins covers a surface area of 410000 km².
- In the South, the Saharan platform having an overall surface area of 1 143 600 km² is the site of most of the hydrocarbon resources discovered in Algeria.

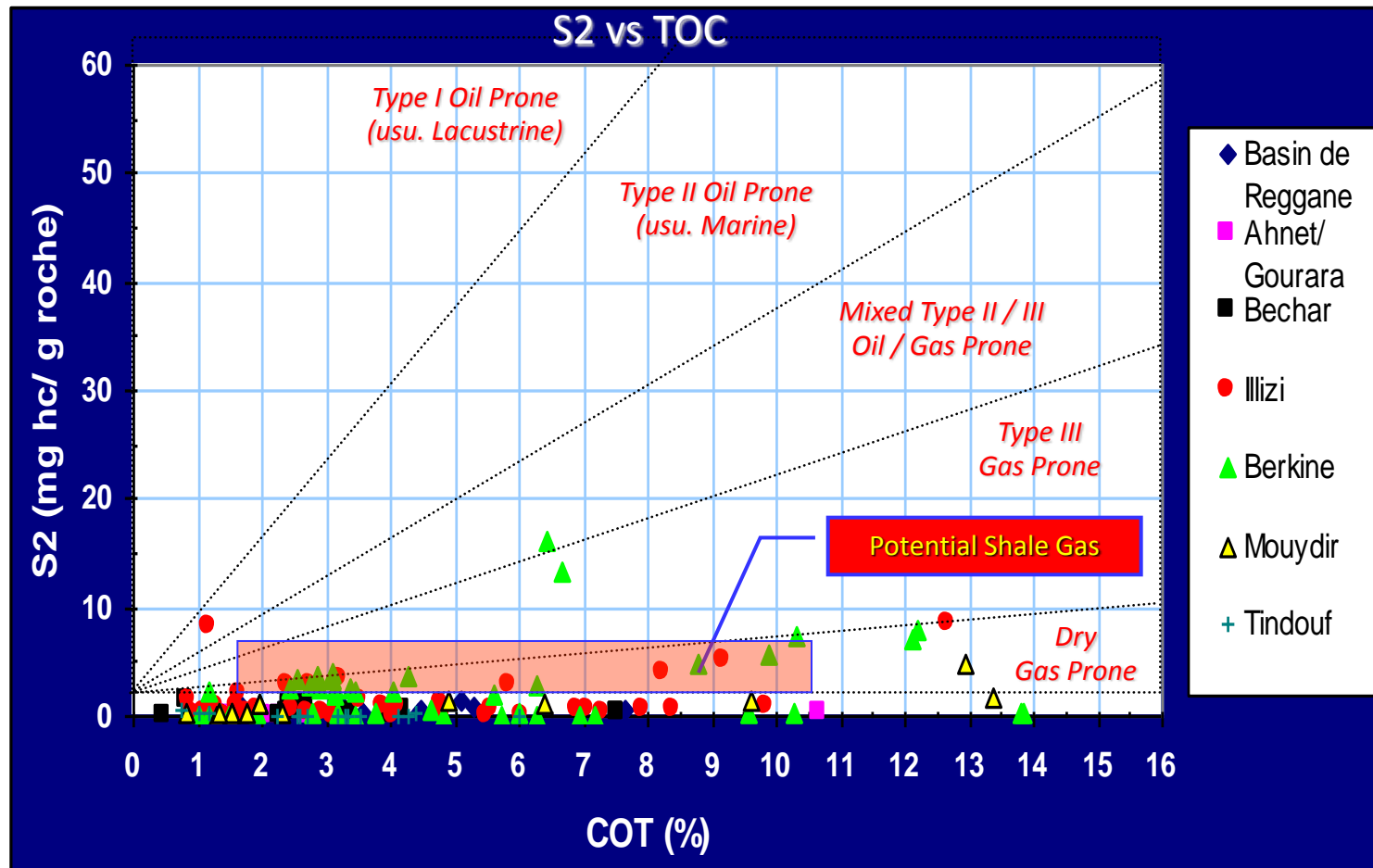
Palaeozoic Stratigraphy and Source Rocks of Saharan Basins, Algeria

The Silurian and Frasnian hot shales having a very high TOC and wide extension (across Algeria, South Tunisia and Libya) are classified as first class source rocks.

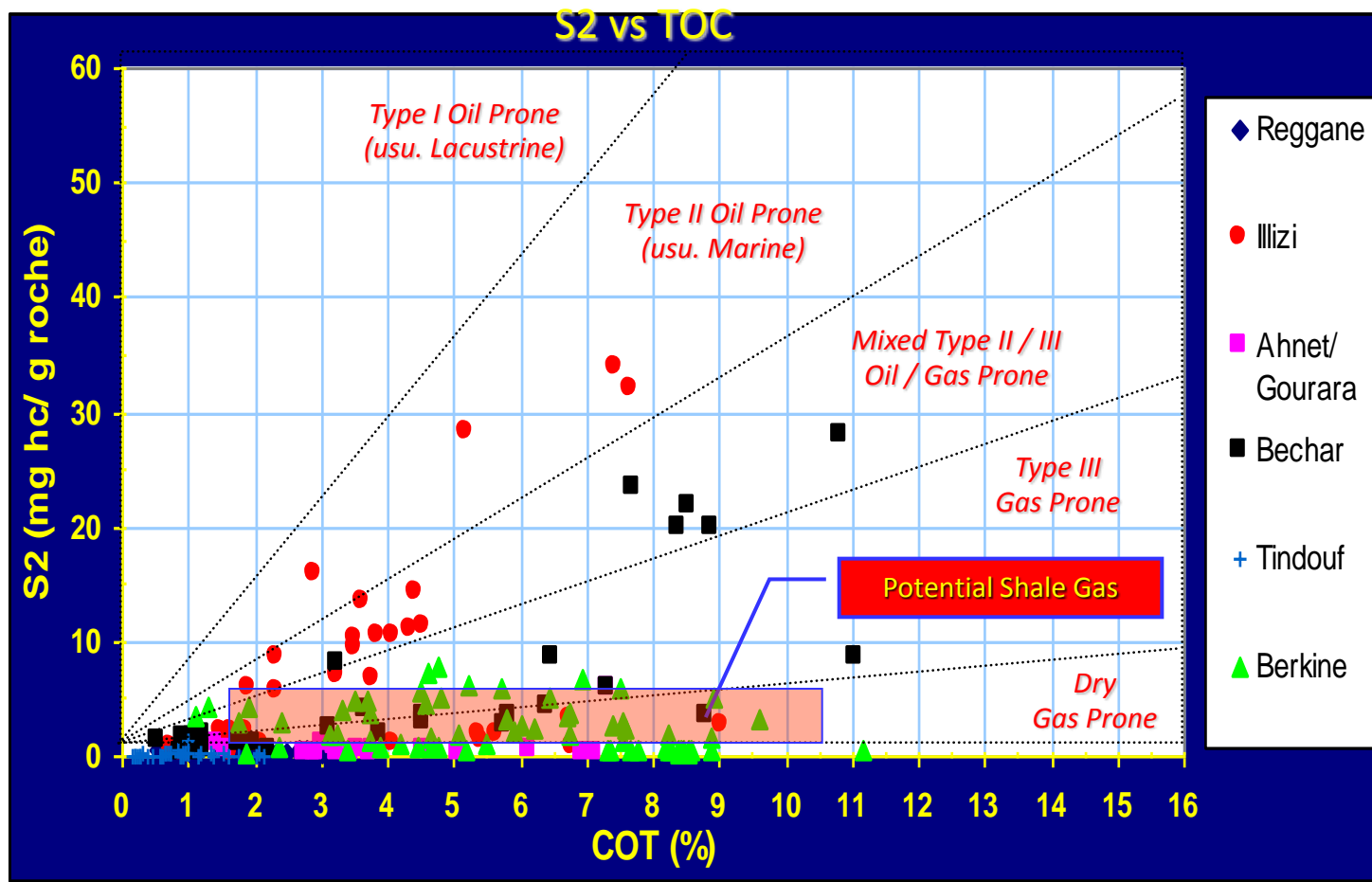


Stratigraphic levels	Basin	hot shales thickness (m)	TOC (%)
Silurian	Illizi	10 - 100	2 - 10
	Berkine	10 - 60	2 - 8
	Mouydir	5 - 35	2 - 4
	Oued Mya	30 - 60	4 - 10
	West Hassi R'mel (Tilrhemt – Djofra)	50 - 150	2 - 10
	Cuvette de Sbaa	10 - 140	2 - 6
	Reggane	40 - 100	3 - 5
	Tindouf	15 - 20	2 - 6
	Béchar	10 - 200	0,5 - 4,5
	Ahnet	50 - 150	1,5 - 4
Frasnian	Illizi	0 - 50	2 - 6
	Berkine	15 - 160	3 - 10
	Reggane	30 - 80	1,5 - 2,8
	Béchar	0 - 50	4
	Ahnet	10 - 140	4

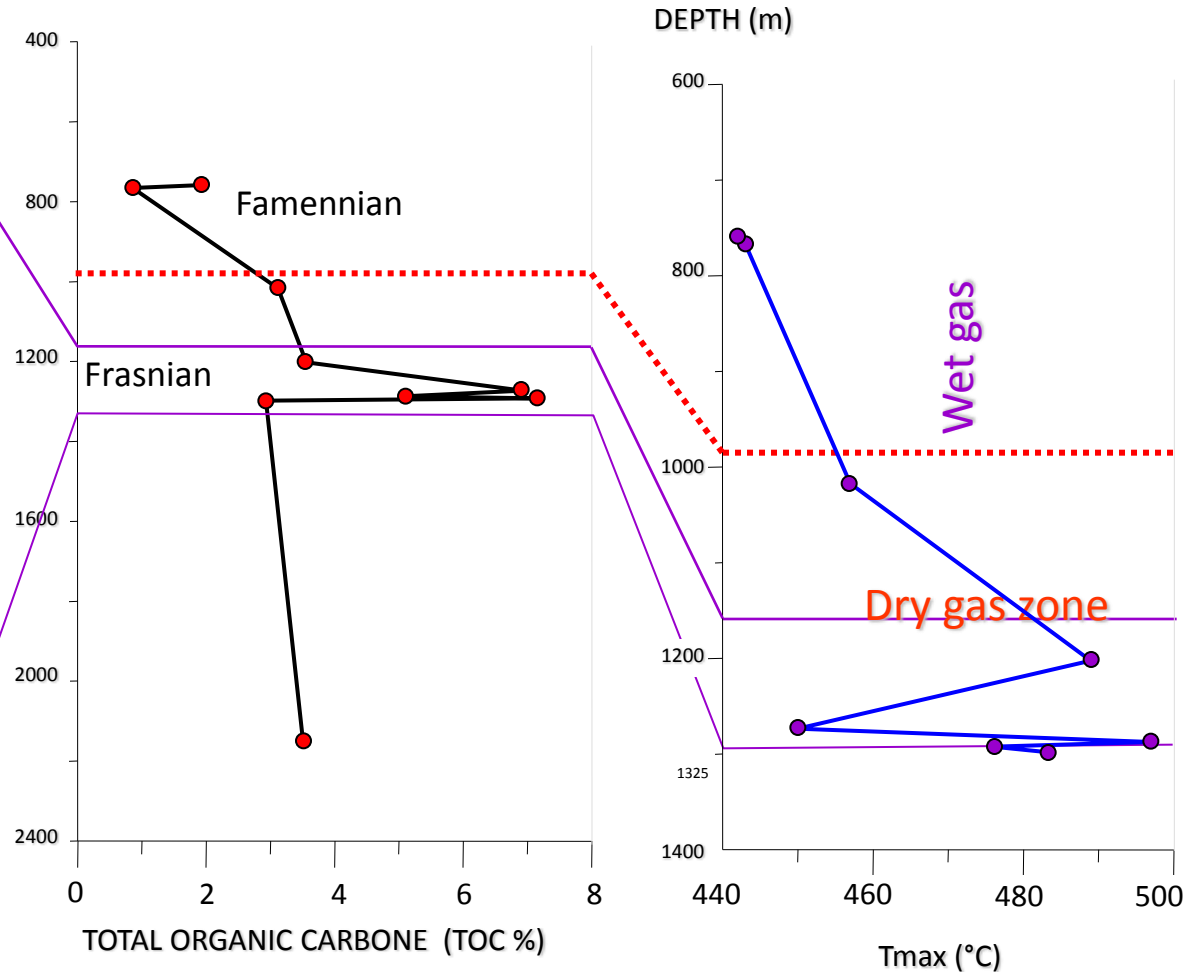
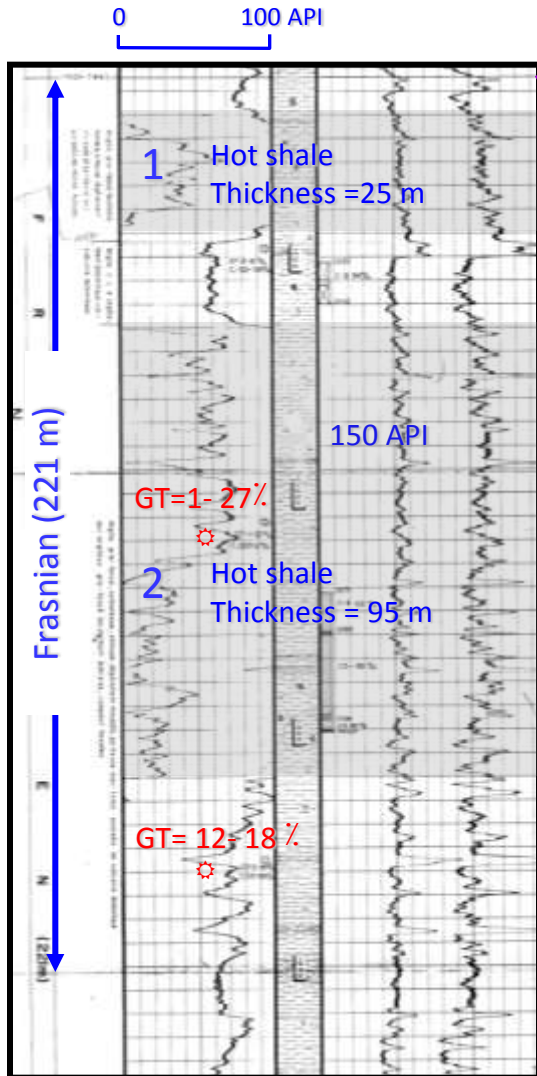
Potential Shale Gas of Silurian hot shales



Potential Shale Gas of Frasnian hot shales



Frasnian Source Rocks, Ahnet Basin



Famennian: TOC = 2- 3 %. Variable Maturity (wet gas window in the studied wells).

Frasnian: 2- 8 %, dry gas window in the studied wells

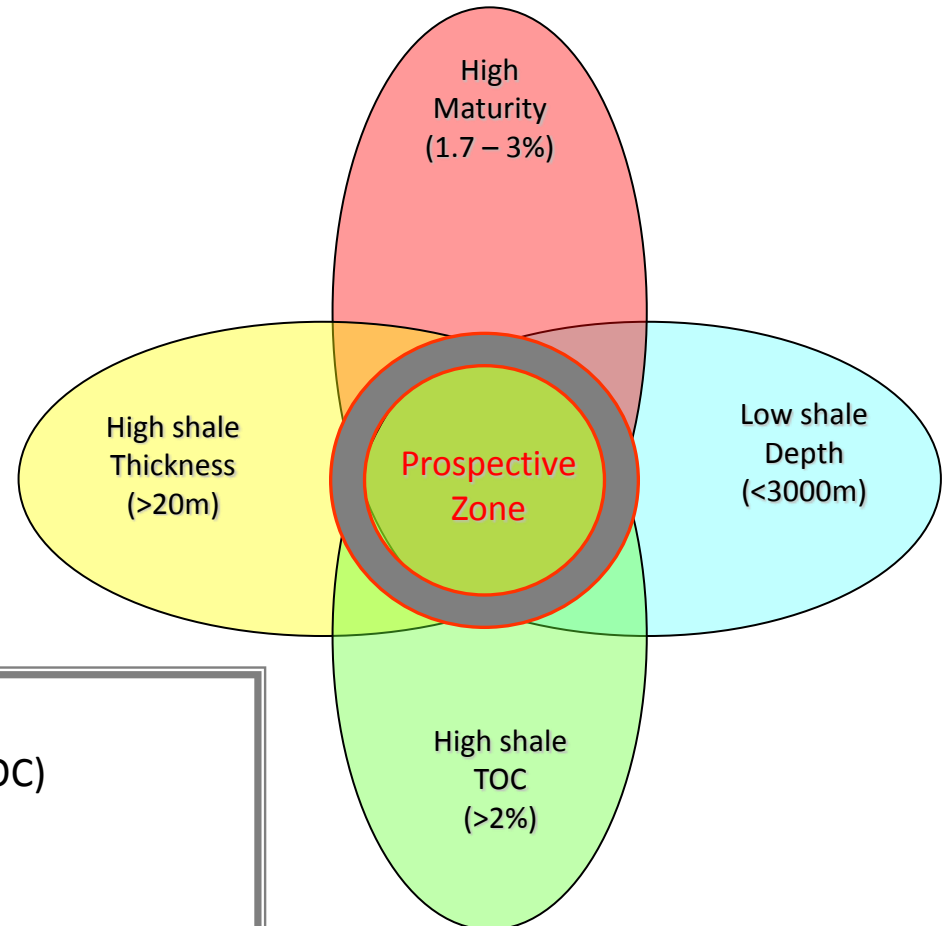
Silurian: Residual TOC= 2- 4 %, the organic matter is in dry gas window in most of the basin.
Type of Organic matter: type II marine kerogen for both source rocks.

Key Parameters for Gas Shale Plays

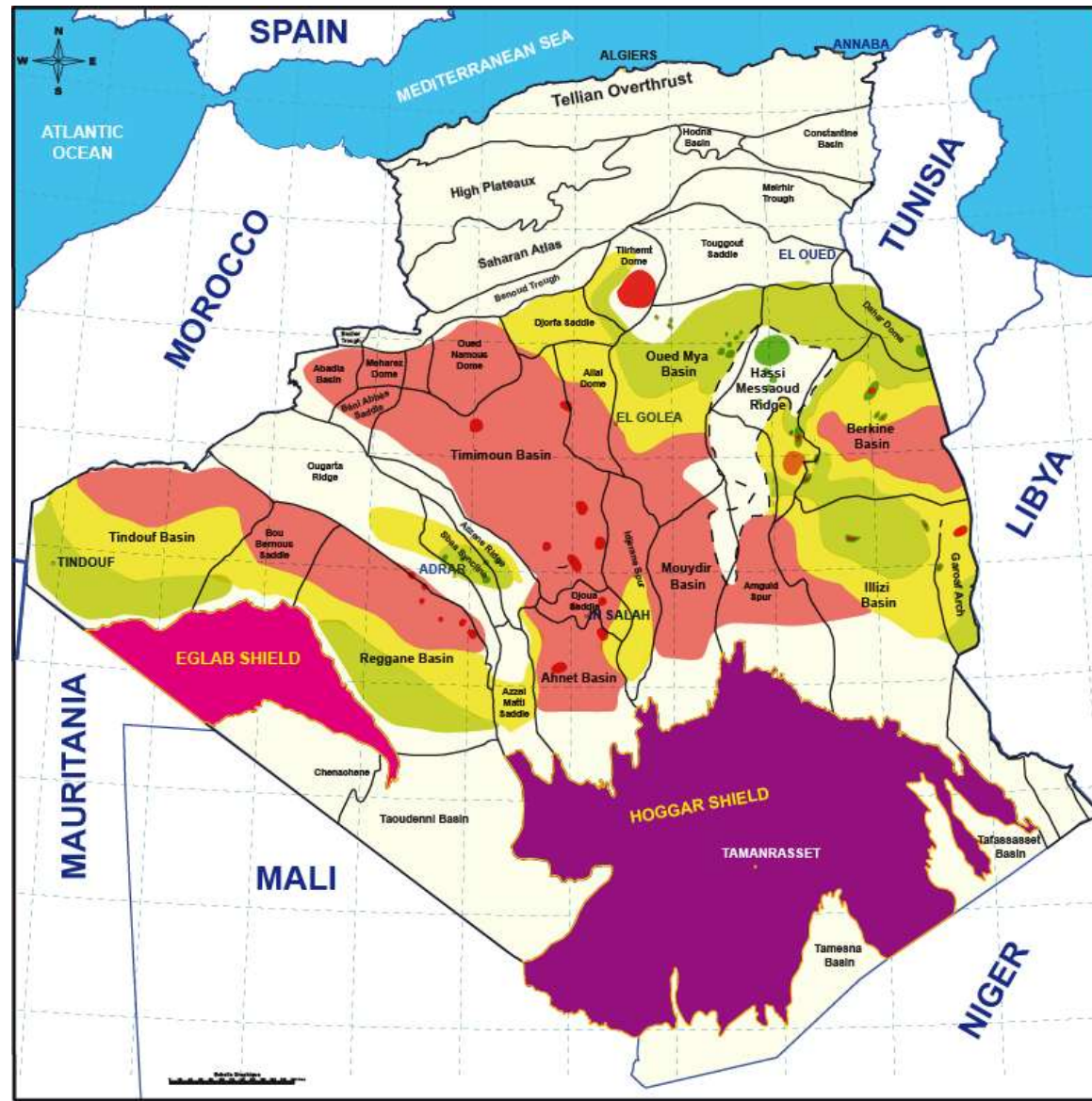
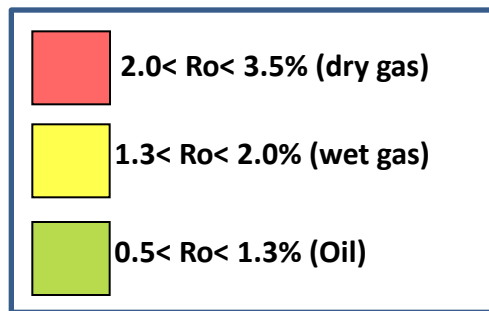
- Organic richness
- Thermal maturity (dry gas window)
- Kerogen type
- Mineralogy & clay rheology
- Faults & fractures
- Porosity & gas saturation
- Matrix permeability
- Objective depth
- Reservoir pressure

Initial focus on areas :

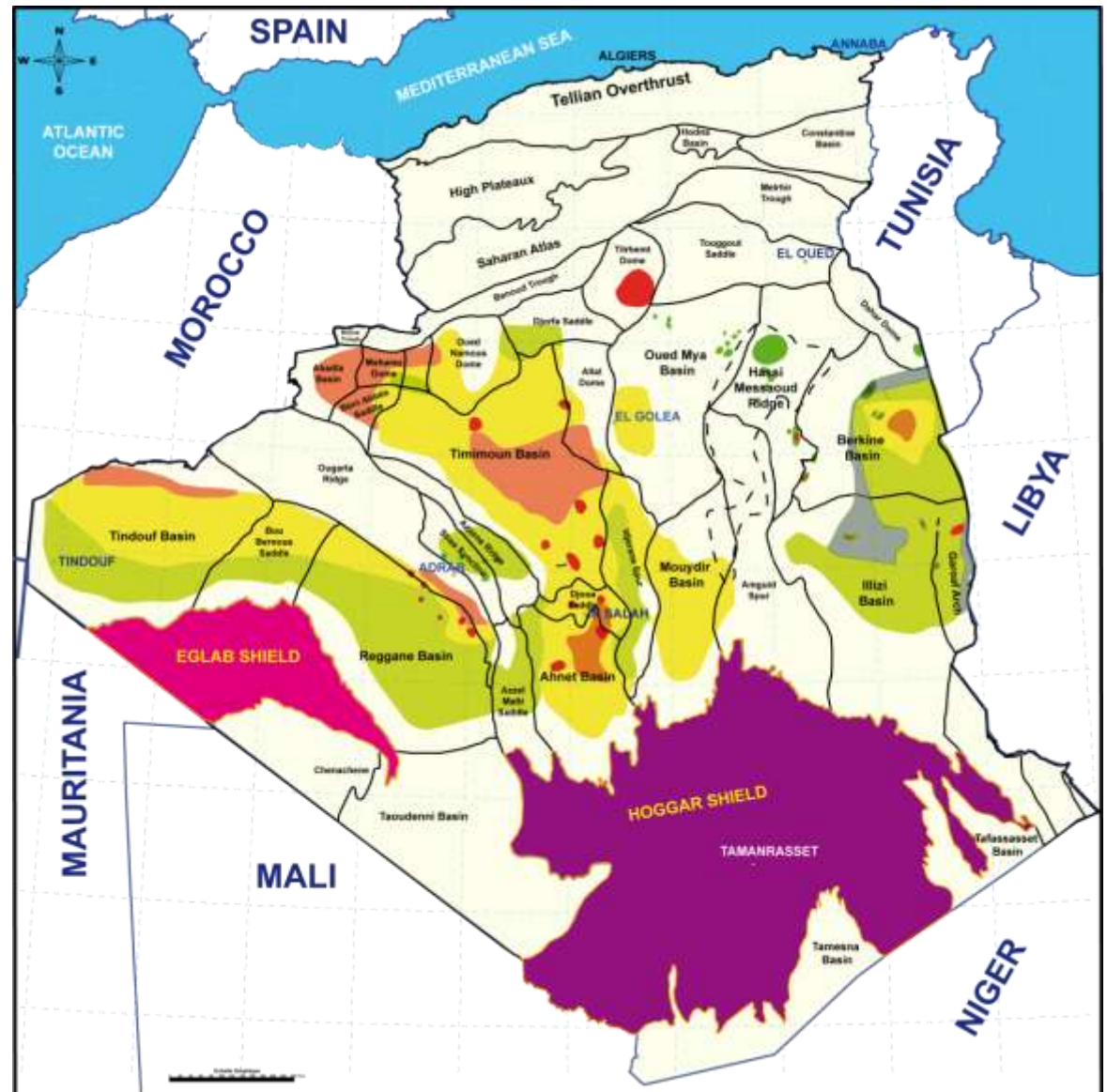
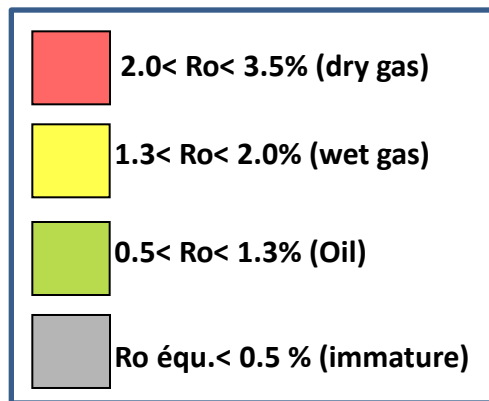
- Where shales have high Total Organic Content (TOC)
- Where “hot Shales” have high thickness
- Of high thermal maturity
- where “shale objectives” occur at low depth



Maturity of Silurian hot Shales



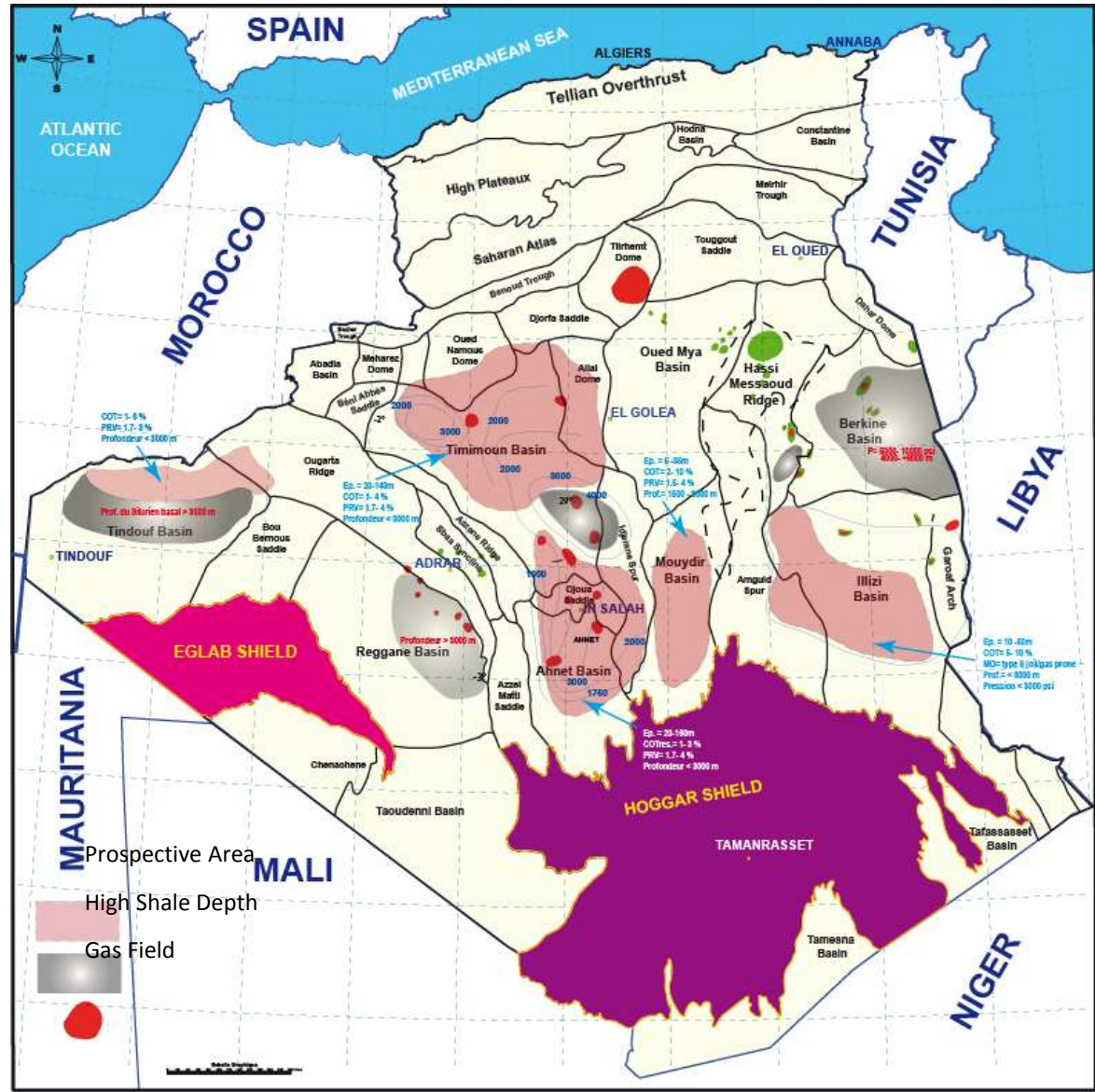
Maturity of Frasnian hot Shales



Prospectivity Map of Silurian Shale gas

SELECTION PARAMETERS :

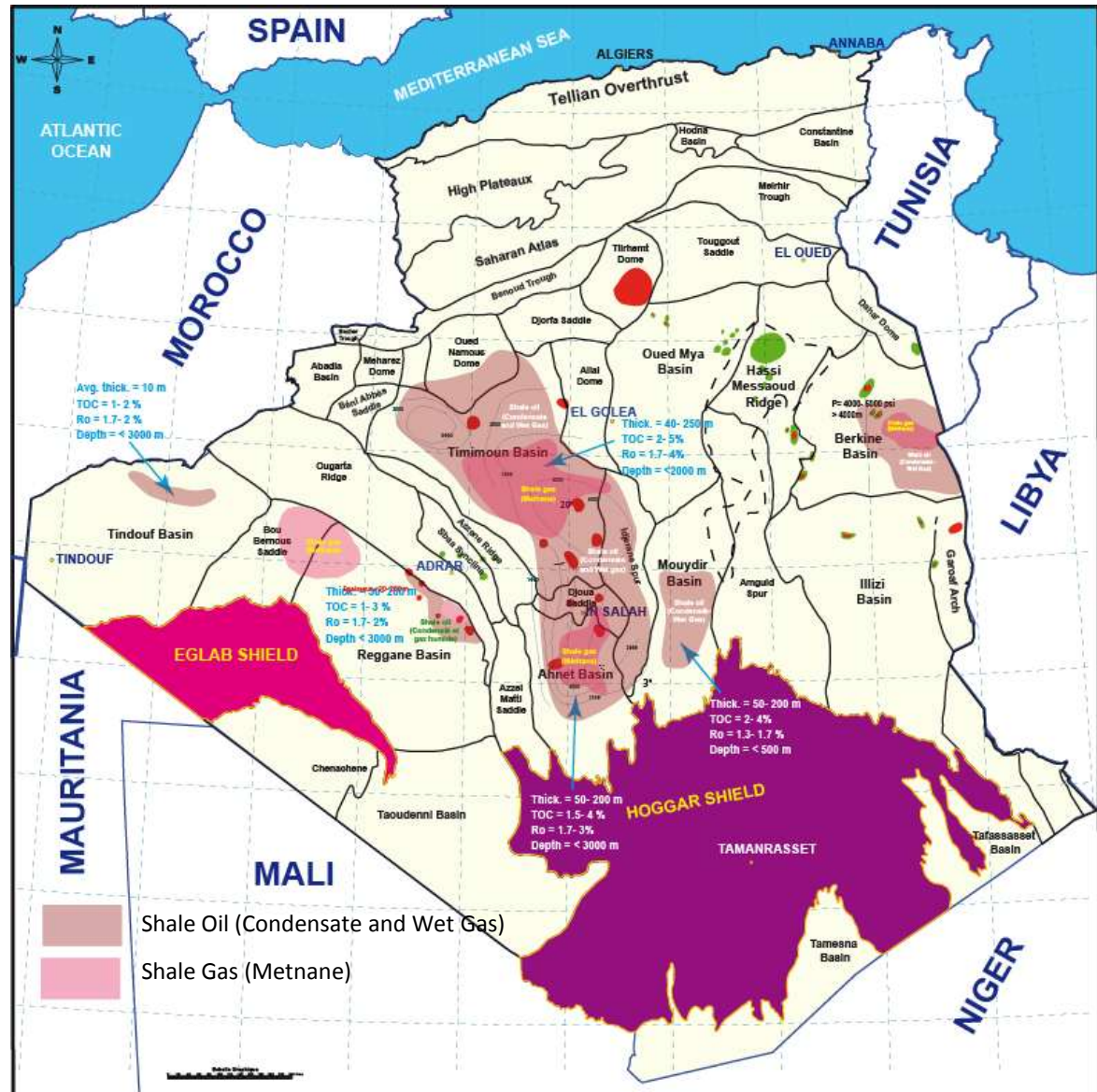
- ➔ Thickness = >20m
- ➔ TOC = >1%, Prefer > 3.5%
- ➔ Maturity (VR) = 1.7 – 3%
- ➔ Depth = < 3000 m



Prospectivity Map of Frasnian Shale gas

SELECTION PARAMETERS :

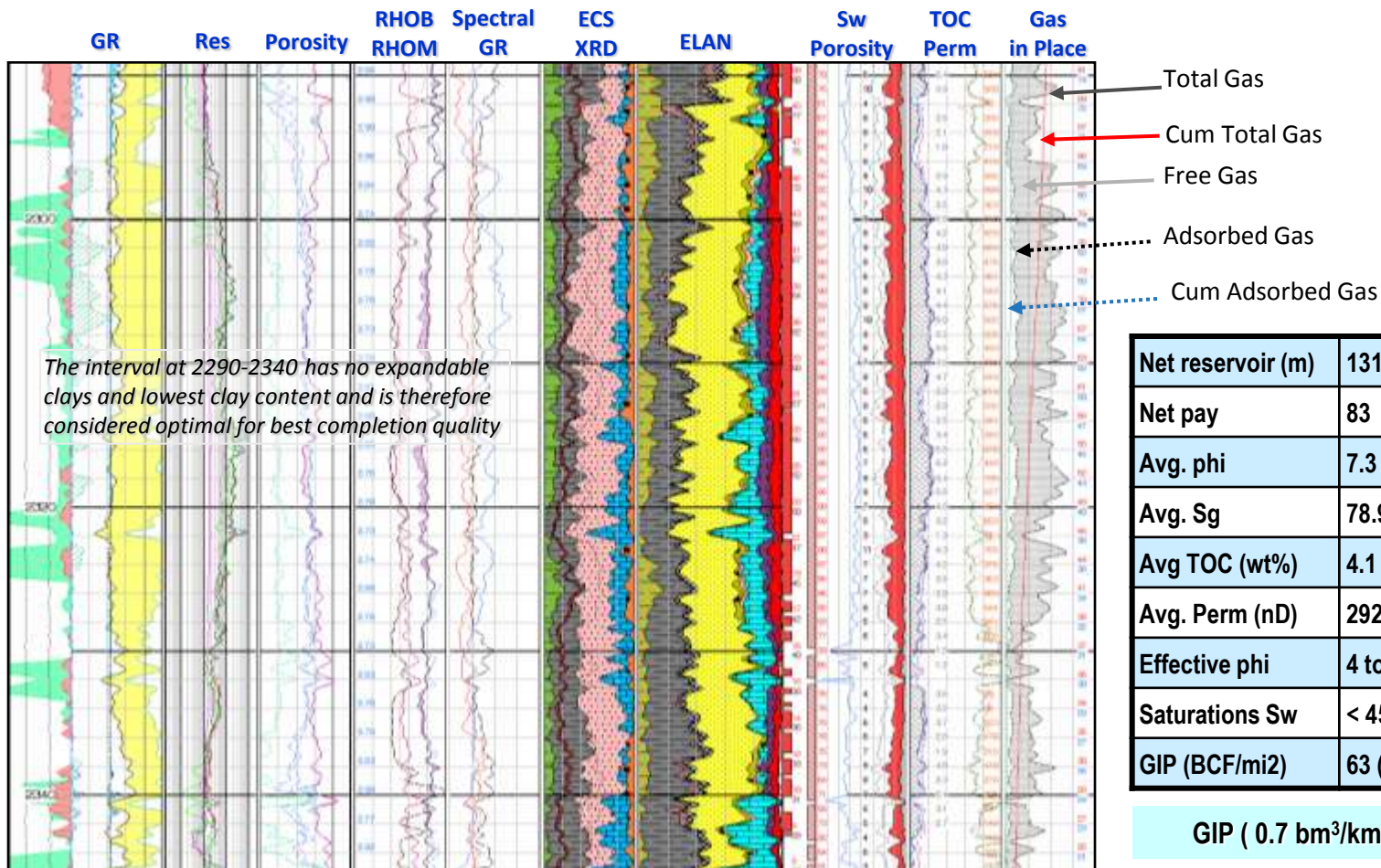
- ➔ Thickness = >20m
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- ➔ Maturity (VR) = 1.7 – 3%
- ➔ Depth = < 3000 m



ACQUISITION OF SPECIFIC DATA : Petrophysical Evaluation Results – Frasnian Interval

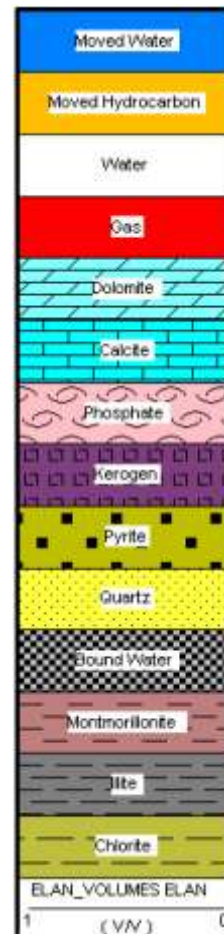
In order to assess reservoir quality, specific open hole logs have been acquired in shale gas sections of wells drilled for conventional objectives in sandstone reservoirs. The evaluation tools comprise :

Elemental device (spectroscopy), Array induction, Magnetic Resonance, Sonic with anisotropic determination, GR, Sonic, Resistivity, Image log & Neutron Density.



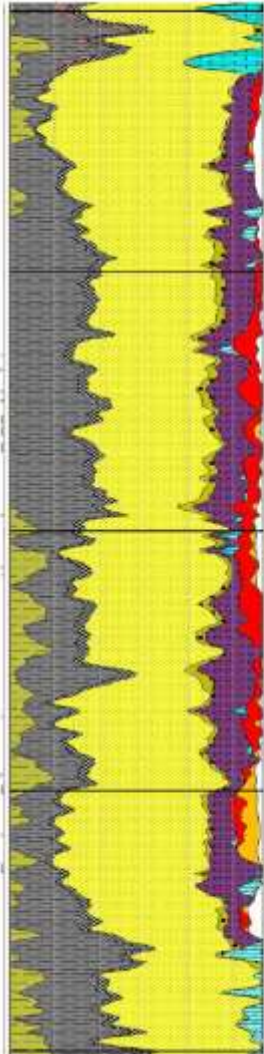
Net reservoir (m)	131
Net pay	83
Avg. phi	7.3
Avg. Sg	78.9
Avg TOC (wt%)	4.1
Avg. Perm (nD)	292
Effective phi	4 to 12 pu
Saturations Sw	< 45%
GIP (BCF/mi2)	63 (140)

GIP (0.7 bm^3/km^2)

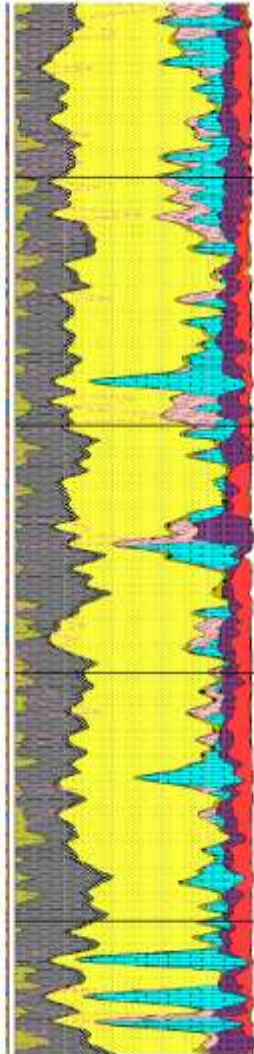


Comparison of the Ahnet Frasnian gas shale (Algeria) with the main US Gas Shales

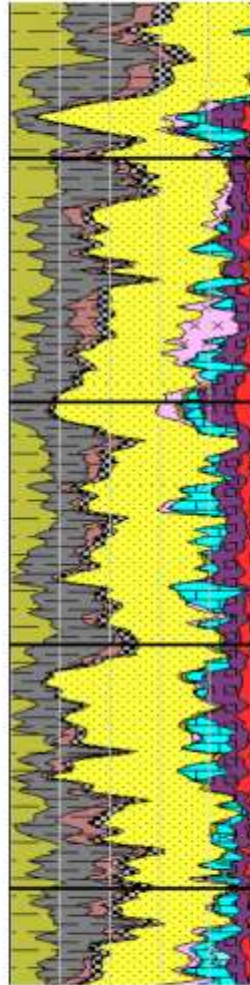
Woodford



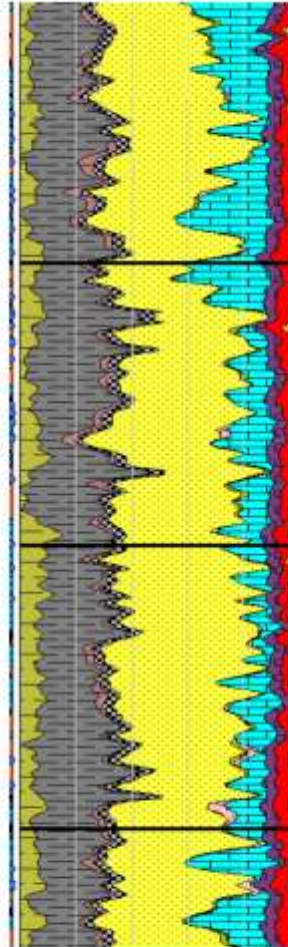
Barnett



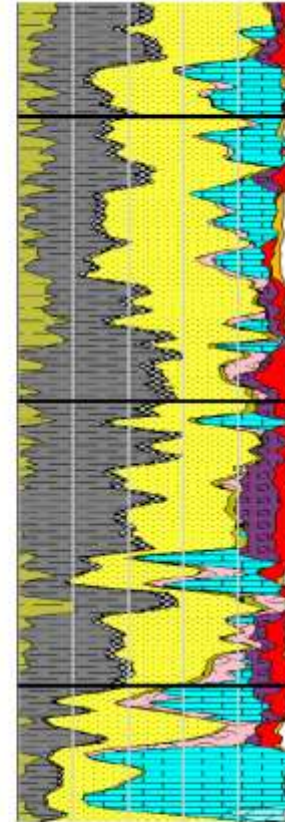
Fayetteville



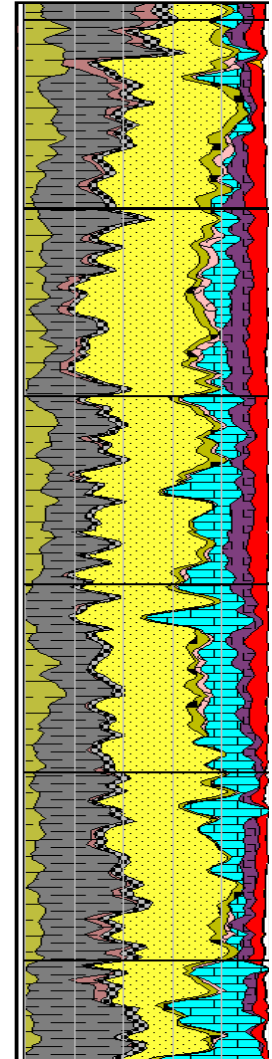
Haynesville



Marcellus



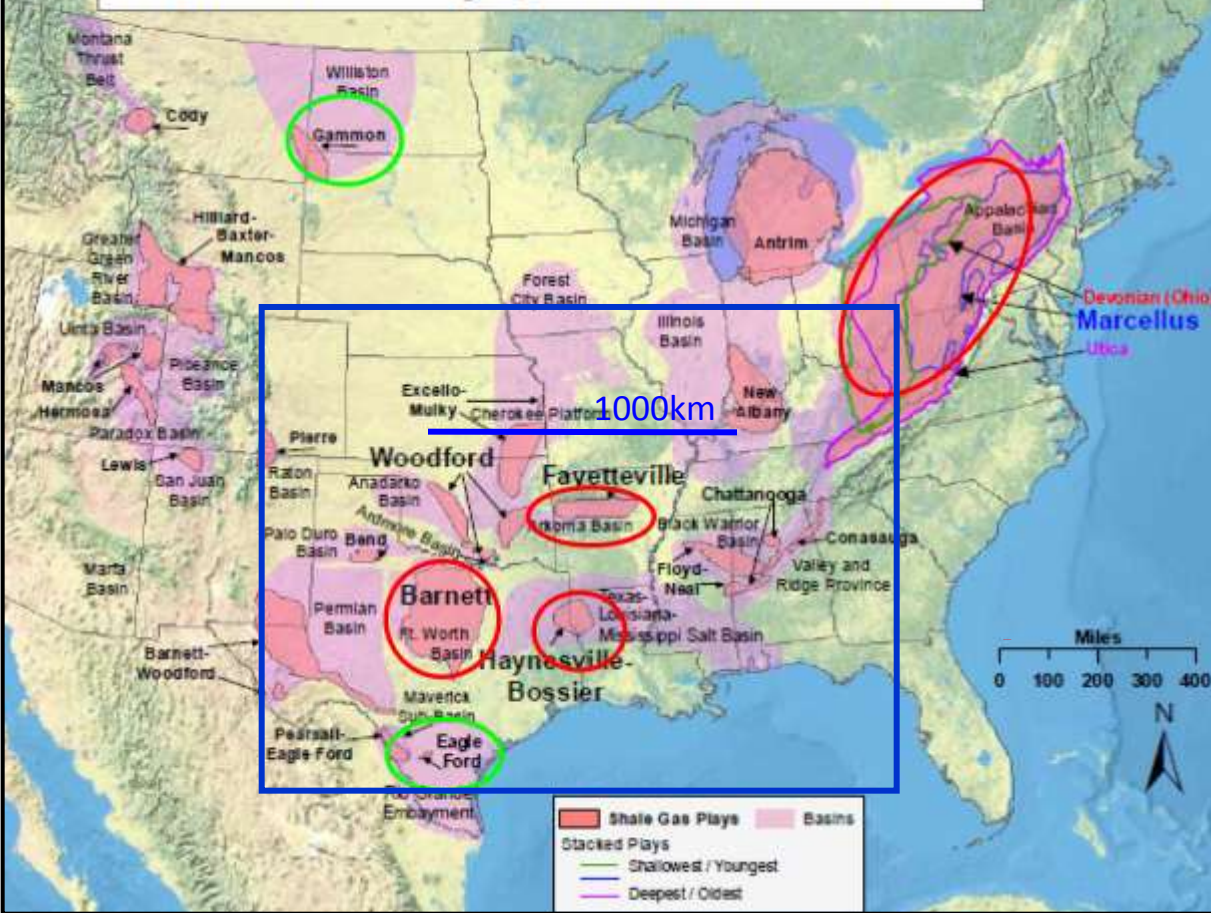
Frasnian, Ahnet



Some US Gas Shale Examples, from Rick Lewis & al.

SCALE COMPARISON: ALGERIA vs US Shale Gas Plays

Shale Gas Plays, Lower 48 States



ESTIMATES OF SHALE GAS RESSOURCES

ORGANIZATION/ COMPAGNY	ASSESSMENT	DATE	REMARKS
PETRENEL (Jessica Hill & Stewart Whiteley)	3954 Tcf (112 000 bm^3) Estimated Unrisked Shale GIIP Resources	April 2010	Petrenel (2010), unrisked shale GIIP is estimated to be 3954 Tcf (112 000 bm^3) for the Silurian and Devonian plays in Algeria.
DEGOLYER & MACNAUGHTON	3409 Tcf (96 200 bm^3) Mean Estimate and 644 Tcf recoverable	December 2010	The estimates of shale gas volumes was made for all the Algerian Saharan basins using a statistical aggregation method concerning Silurian shales.
SONATRACH EXPLORATION	2650 Tcf (75 000 bm^3) Residual gas remaining in the source rocks	November 2010	Resource Estimates from Geochemical Modeling, assuming that 10% of the generated volume (26 500 Tcf) remains in the source rocks (Silurian & Frasnian hot shales) after expulsion.

More recent detailed studies carried out on basin scale by International Consulting Firms show high volumes of the estimated hydrocarbon in place (GIIP) in the most prospective areas for Shale Gas exploration :

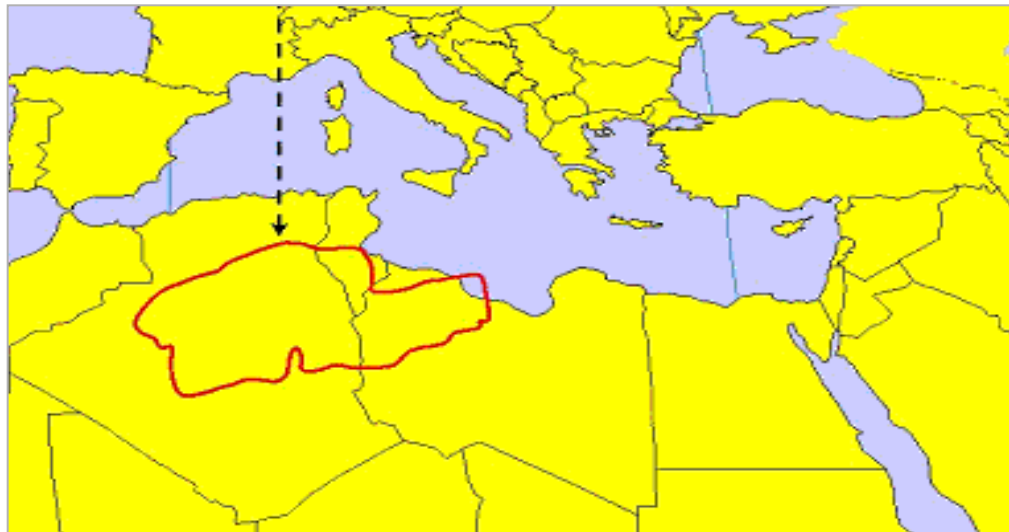
- Ahnet Basin: total GIP varies from 0.6 to 0.8 bm^3/km^2 in the Frasnian and 0.6 to 2.8 bm^3/km^2 in the Silurian.
- Timimoun Basin: varies from 0.36 to 0.67 bm^3/km^2 in the Frasnian and 0.6 to 0.94 bm^3/km^2 in the Silurian.

The first phase of regional studies and evaluation of the potential shale gas will be followed by drilling of the first Exploration wells (planned for the second half of the year 2012) in order to trial technology and drilling techniques in order to answer the questions of the volume of gas in place, manner of producing it (well & frac spacing), production and economic viability.

Given the importance of the expertise needed and the costs involved, the implication of specialized companies might be considered under one of the following terms:

- Strategic Partnership with companies having a well established knowledge;
- Share holding of independent companies and benefit from the transfer of their knowledge.
- Study Agreement with recognized consultancy in the field of Exploration & Production of Shale gas.

Main drivers and indicators for shale gas development in Algeria



- Huge resources as pointed out by International organizations estimates
- Possibility to produce dry gas and liquids (wide range of maturity)
- Less environment constraints as the desert is not populated
- Large concession block : easy access as the landowner is the government
- Surface facilities & infrastructures exist with gas pipelines to Europe
- Attractive Petroleum law and incentive fiscal terms for Exploration & Development of unconventional resources are in debate.
- The North Western Sahara Aquifer System shared by Algeria, Libya and Tunisia contains considerable water reserves which are nevertheless lowly renewable and not fully exploitable (40 000 billions m³).