Carbonate Reservoirs

GPC 2021 Workshop

General Petroleum Company

Brown Limestone Unconventional Reservoir
"The Treasury Needs to be Opened"

Agenda

- Conventional Vs. Unconventional Reservoir
- General Overview for Brown Limestone
- Pioneer cases for Brown Limestone in GPC.
  - Brown Limestone Production Examples
  - Recent GPC Success Story in N.W.O Field
- Conclusions and Recommendations

Conventional Vs. Unconventional Reservoir

The difference between conventional and unconventional reservoirs is about transport not storage.

Conventional Reservoir

$d_{pore} \geq 1\mu m$

$k \geq 1mD$

Micro-pores
(Darcy Flow)

Unconventional Reservoir

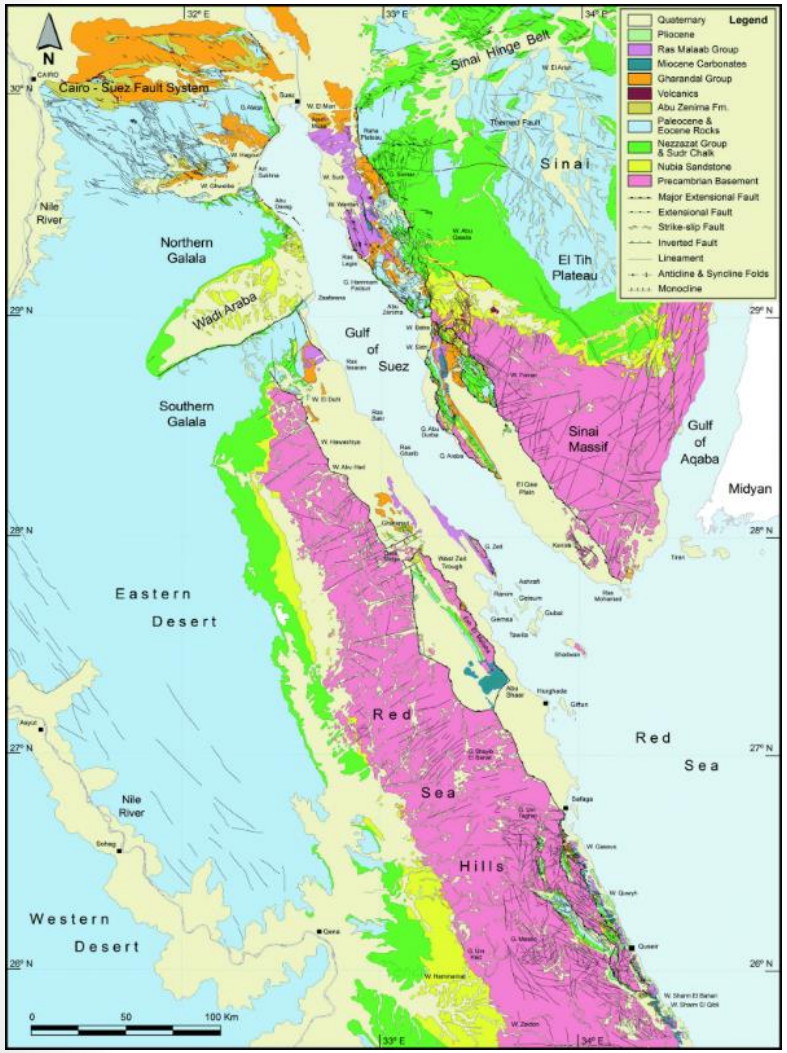
$10^{-1}\,\mu m \geq d_{pore} \geq 10^{-2}\,\mu m$

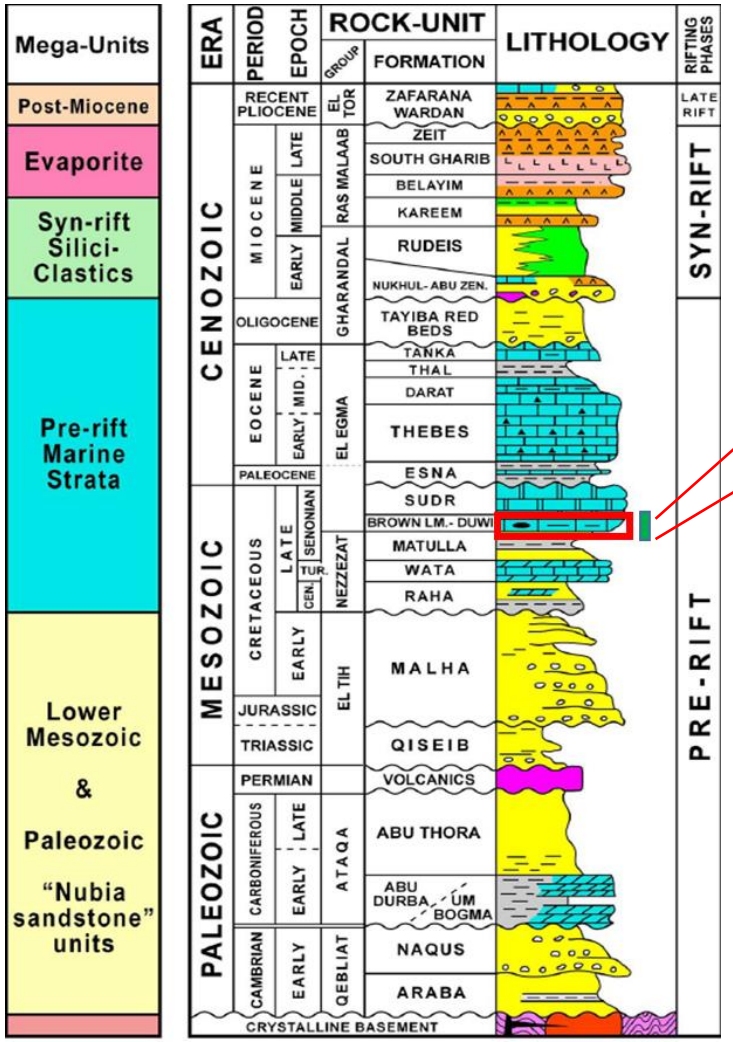
$1\mu D \geq k \geq 10^{-3}\,\mu D$

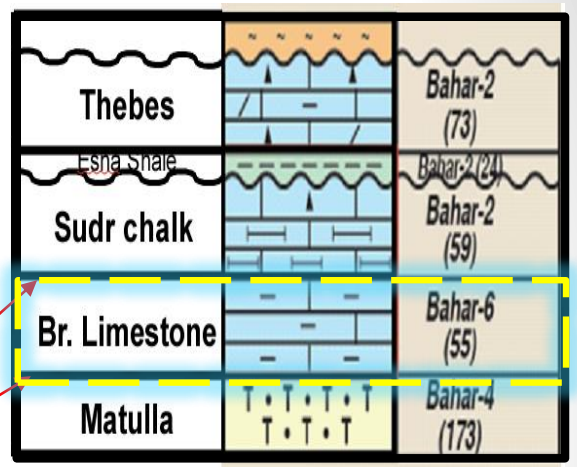
Nano-pores

In case of Brown Limestone, it's Unconventional reservoir that can't produce without enhancing productivity with by Secondary porosity with geologic factors or man-made stimulation

General overview

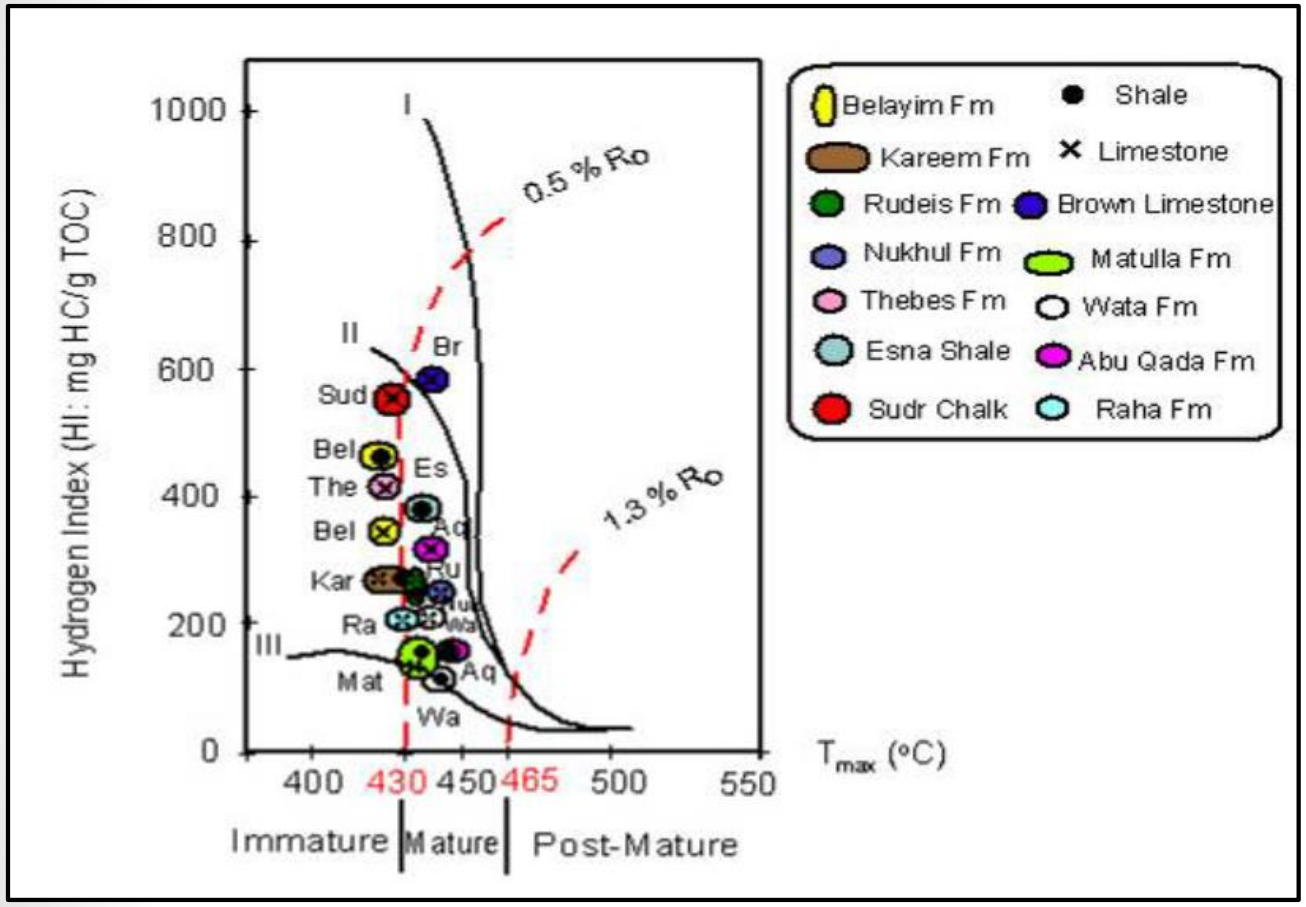




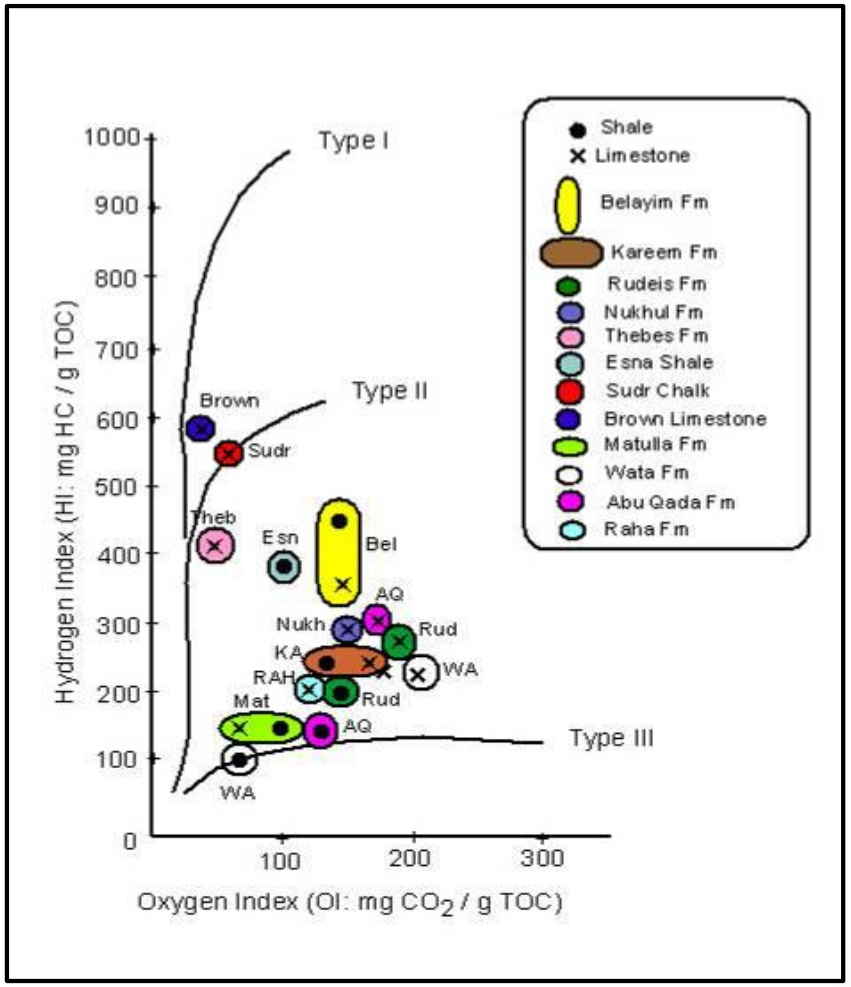


(Adel Ramadan and Khaled,2020)

Source Rock Evaluation (Brown Limestone)



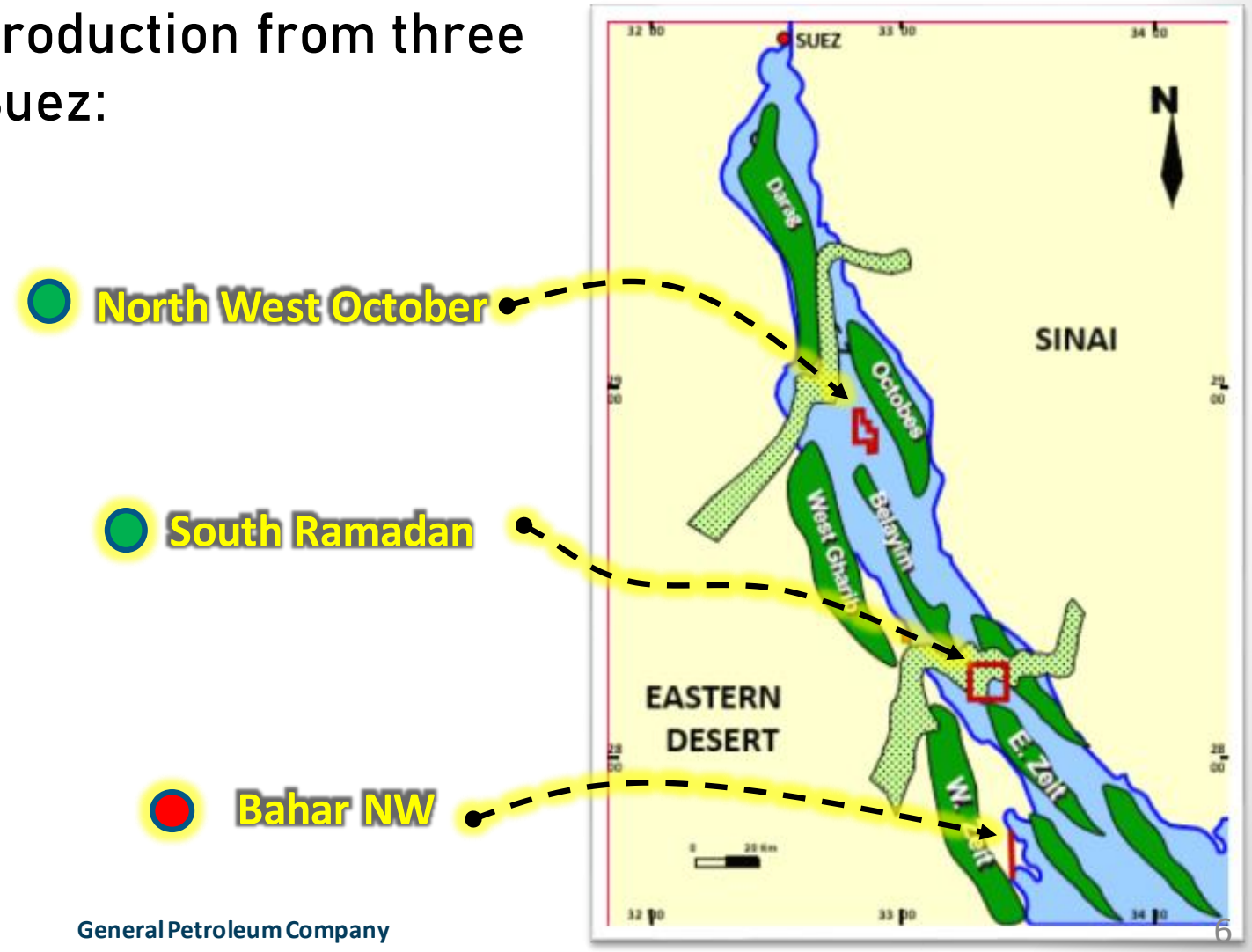
(Khaled A. Khaled et al.2009,after Delvaux et al., 1990)



(Khaled A. Khaled et al.,2009, after Van Krevelen, 1961)

Pioneer Cases For Brown Limestone in Gpc

GPC Sucesses to stablish Production from three Concessions in the Gulf Of Suez:

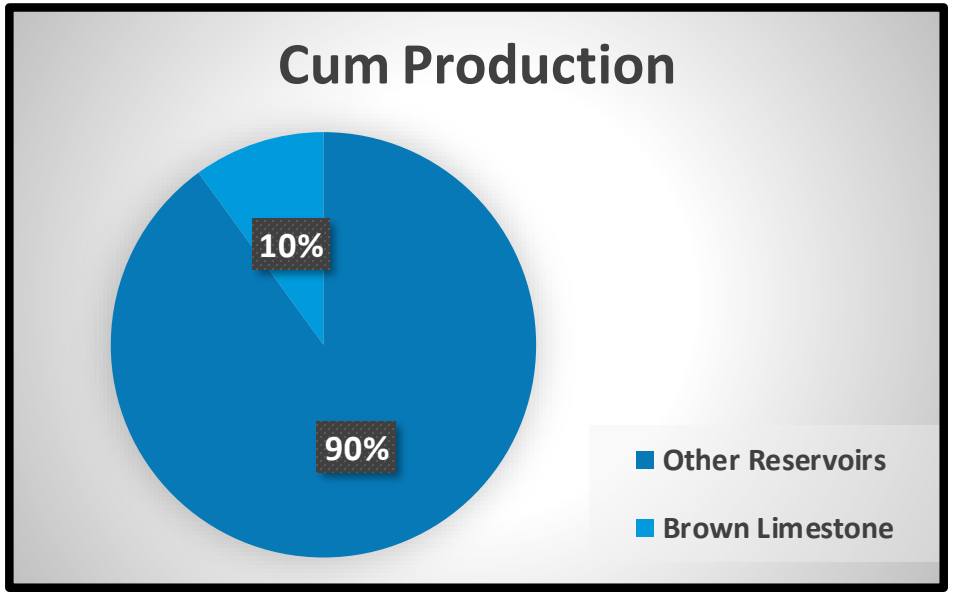


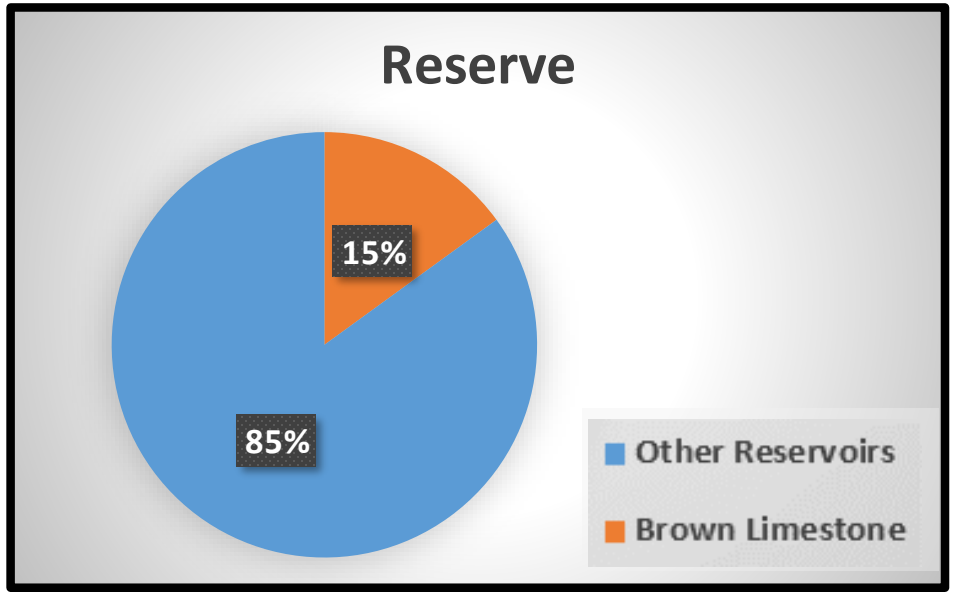
Offshore Oil Field

Onshore Gas Field

Brown limestone Production

Case 1: South Ramadan

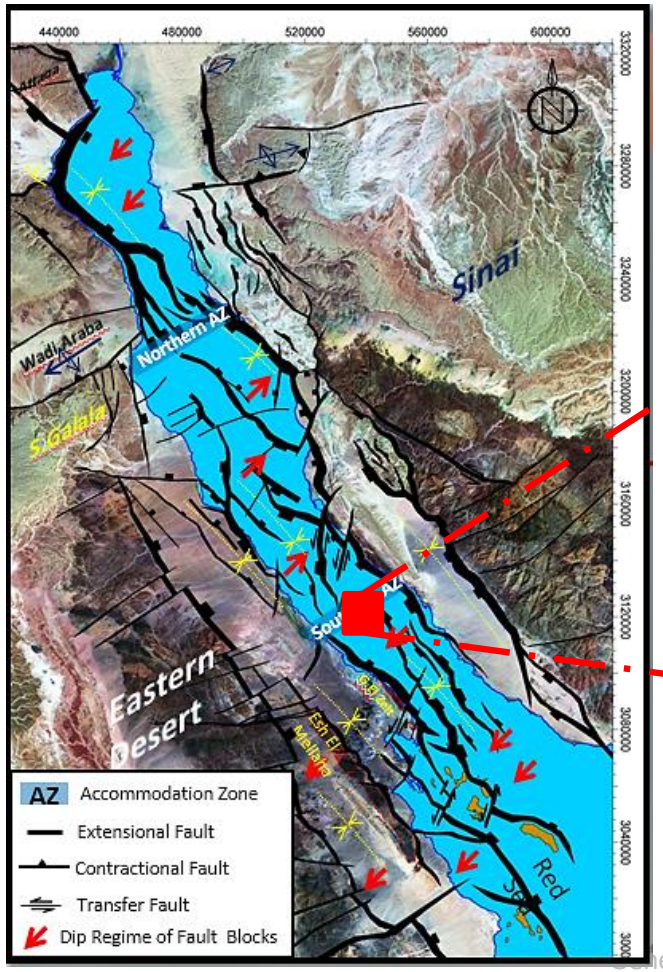




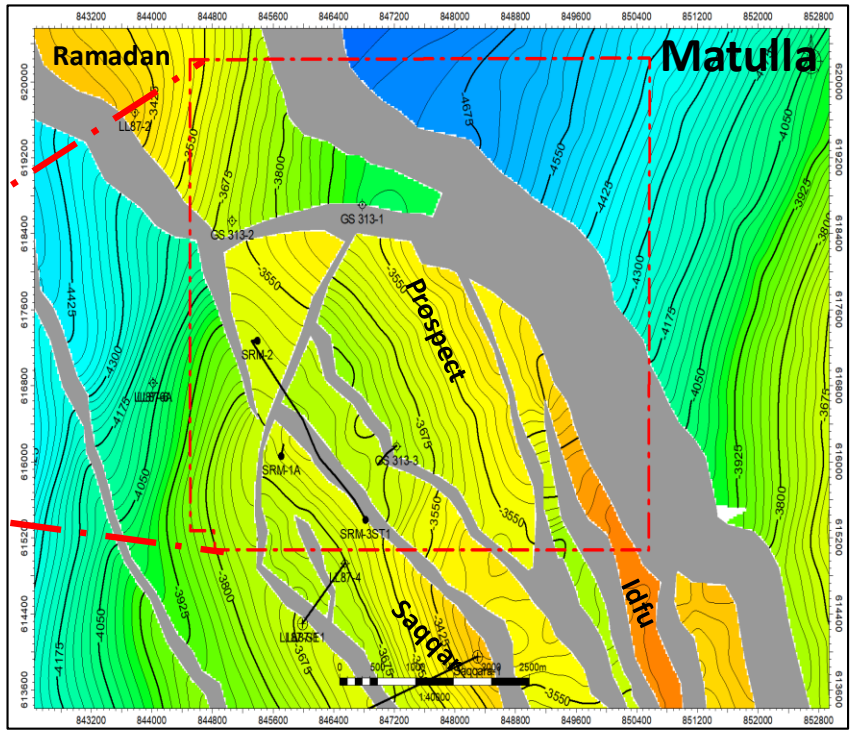
Brown Limestone Potential	
Cum Production, MMSTB	0.7
OOIP, MMSTB	20
Reserve, MMSTB	2

Brown limestone Production

Case 1: South Ramadan

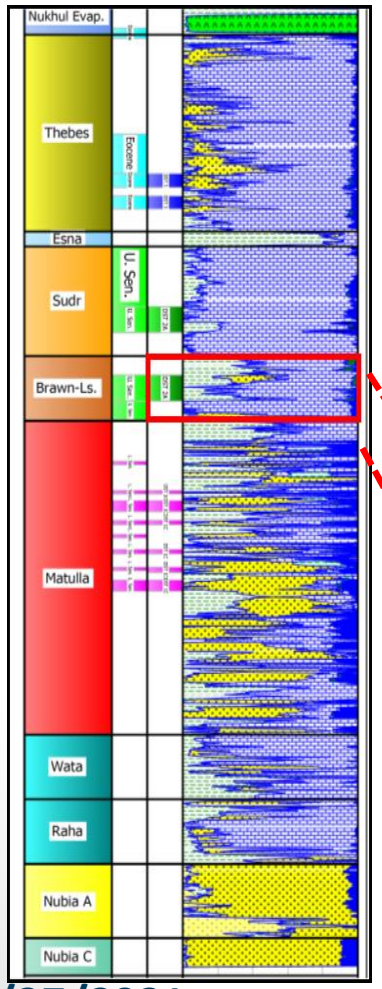


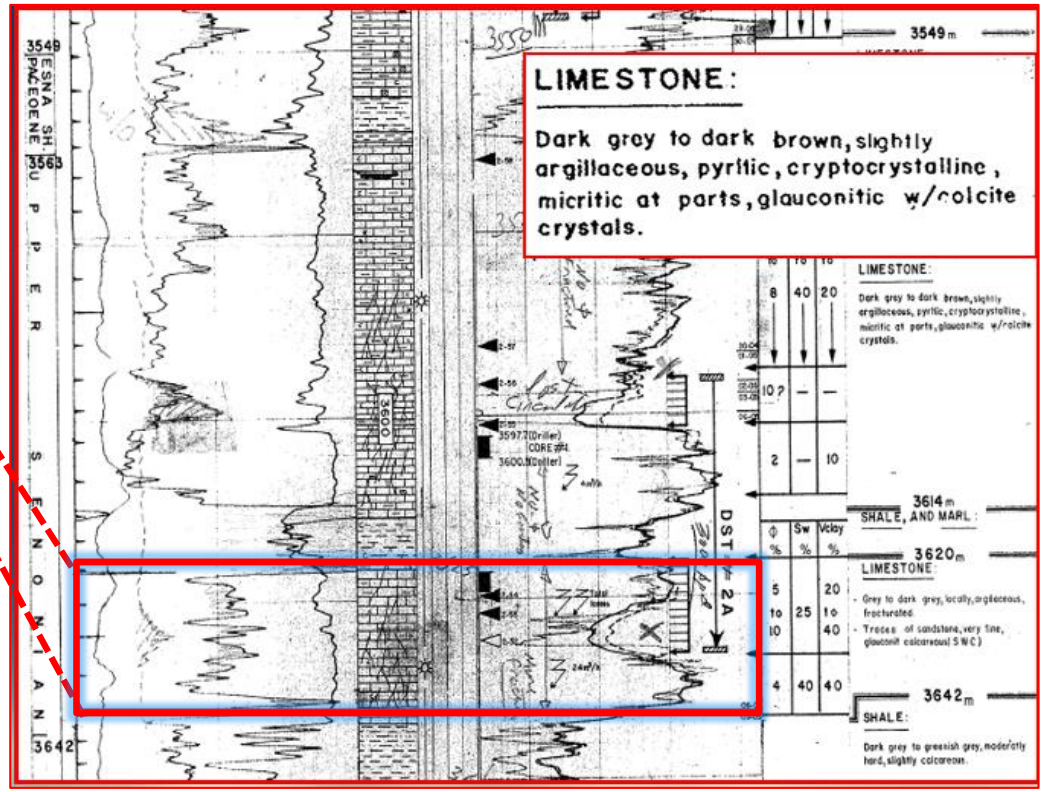
As the field is located in accommodation zone with high change is dipping that resulted in creating secondary porosity which was the main promoter for production

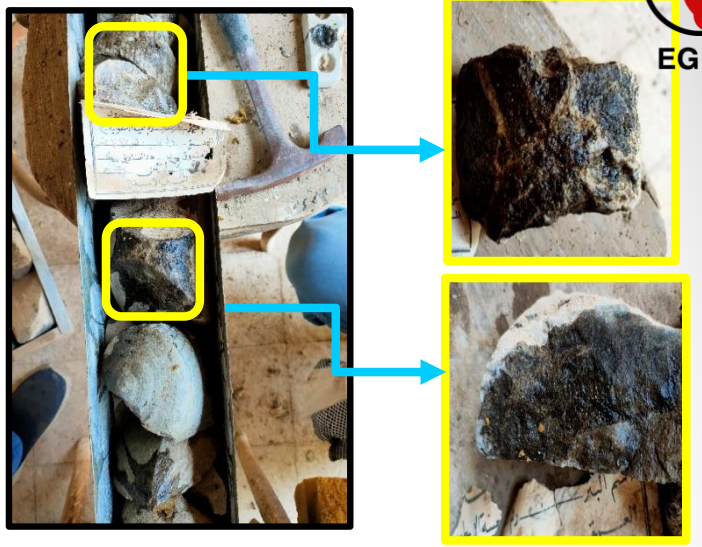


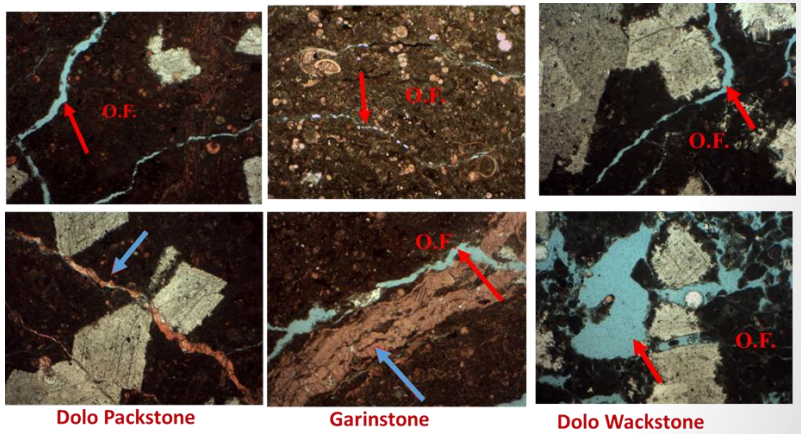
Brown limestone Production

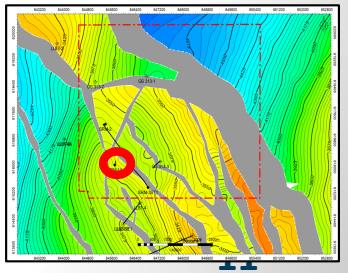
South Ramadan: SR -1A well





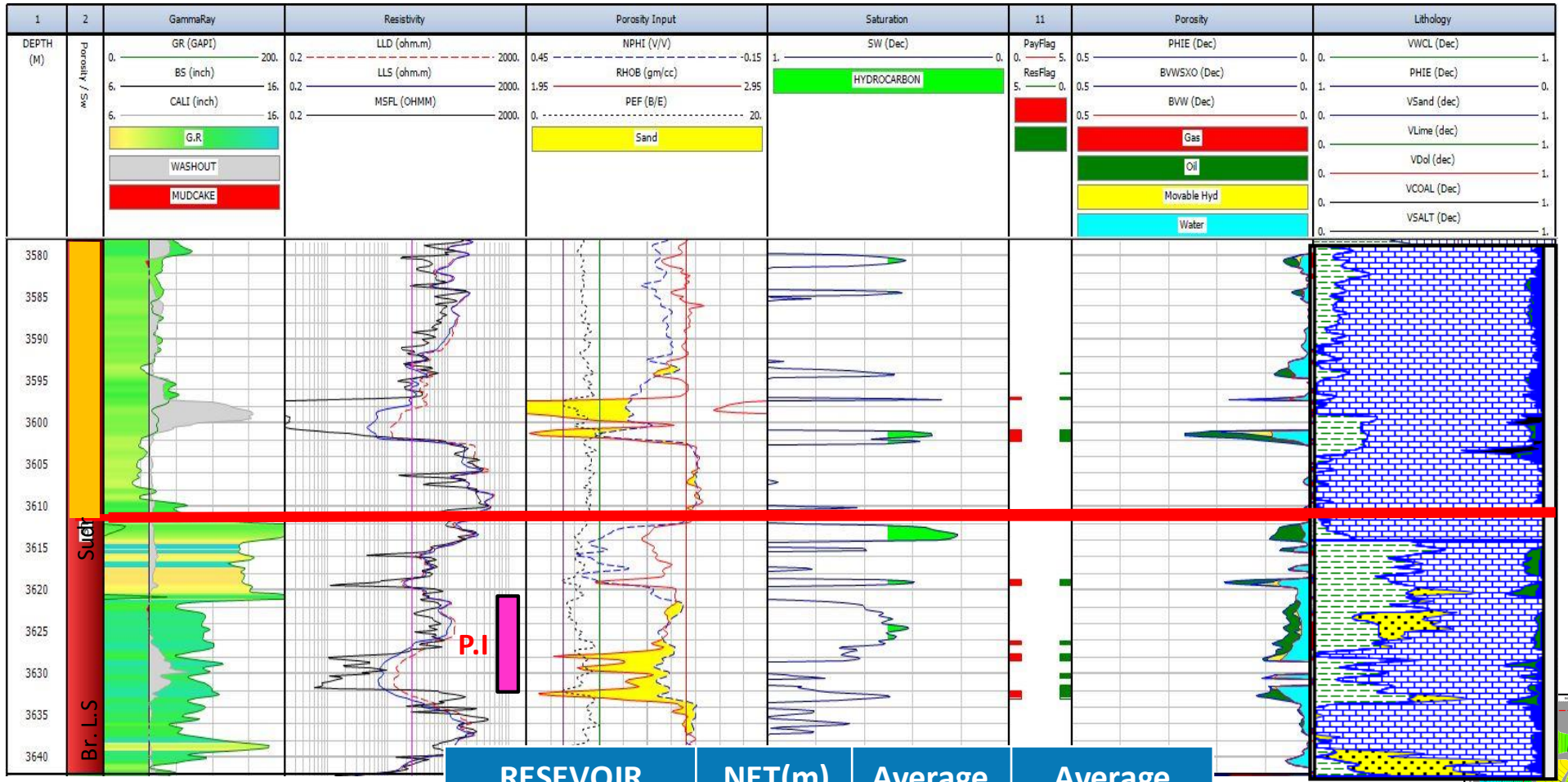






Brown limestone Production

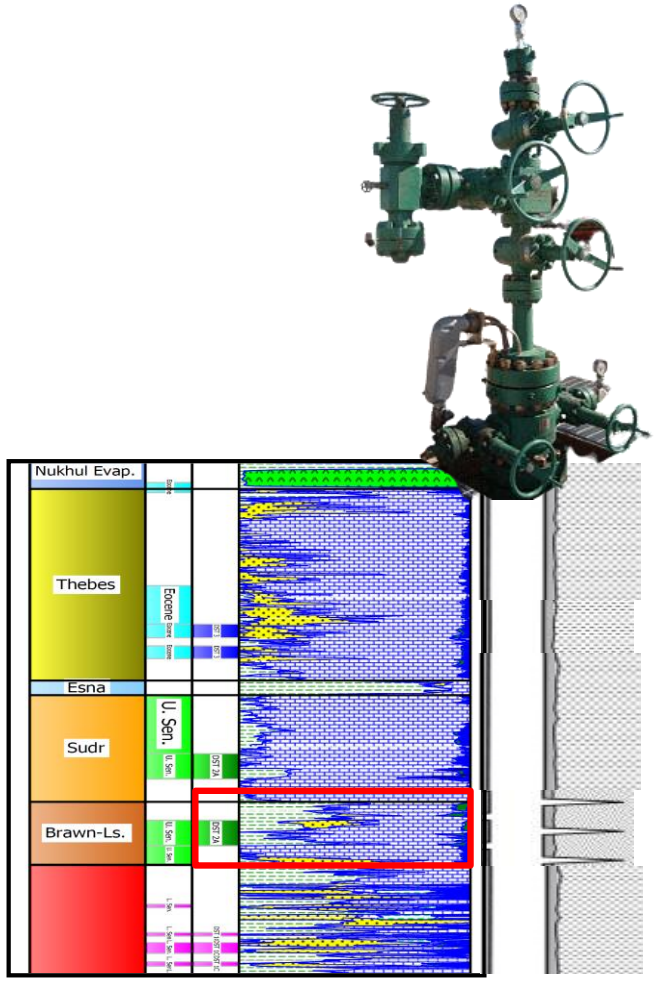
South Ramadan: SR -1A well



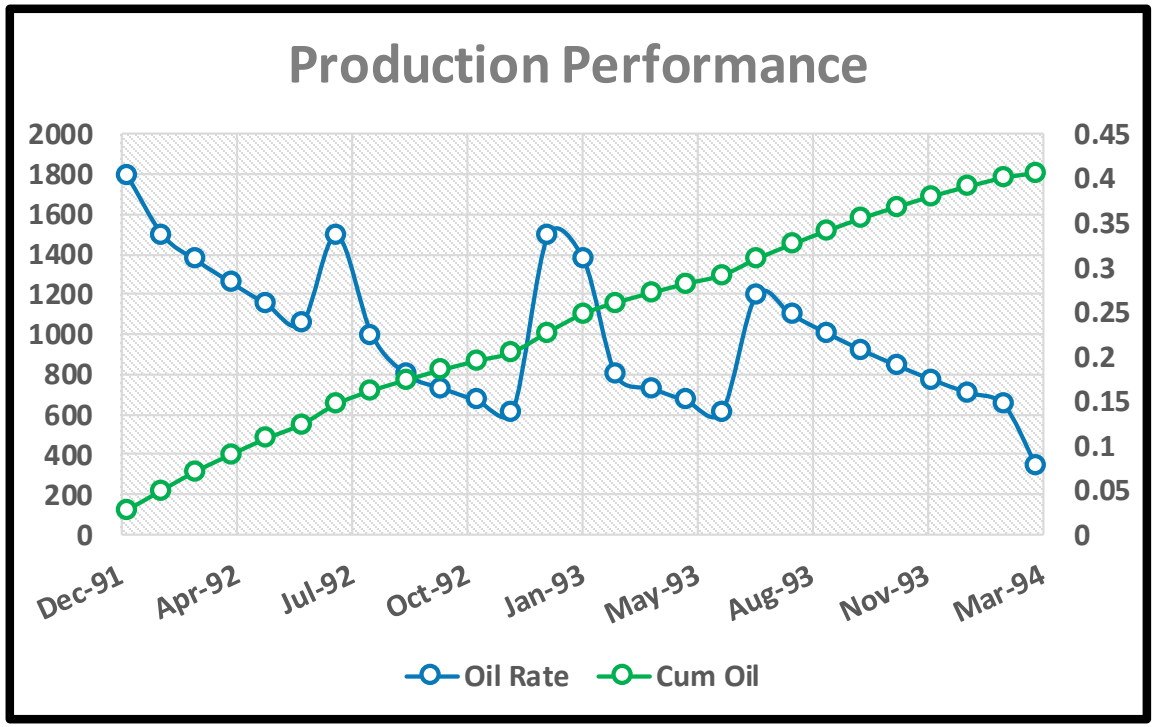
RESEVOIR	NET(m)	Average Sw %	Average PHIE %
BROWN L.S	10	33	8-10

Brown limestone Production

Production Brown Limestone: SR -1A well



Prod. Test: 1600 BBL Oil/D



Brown limestone Production

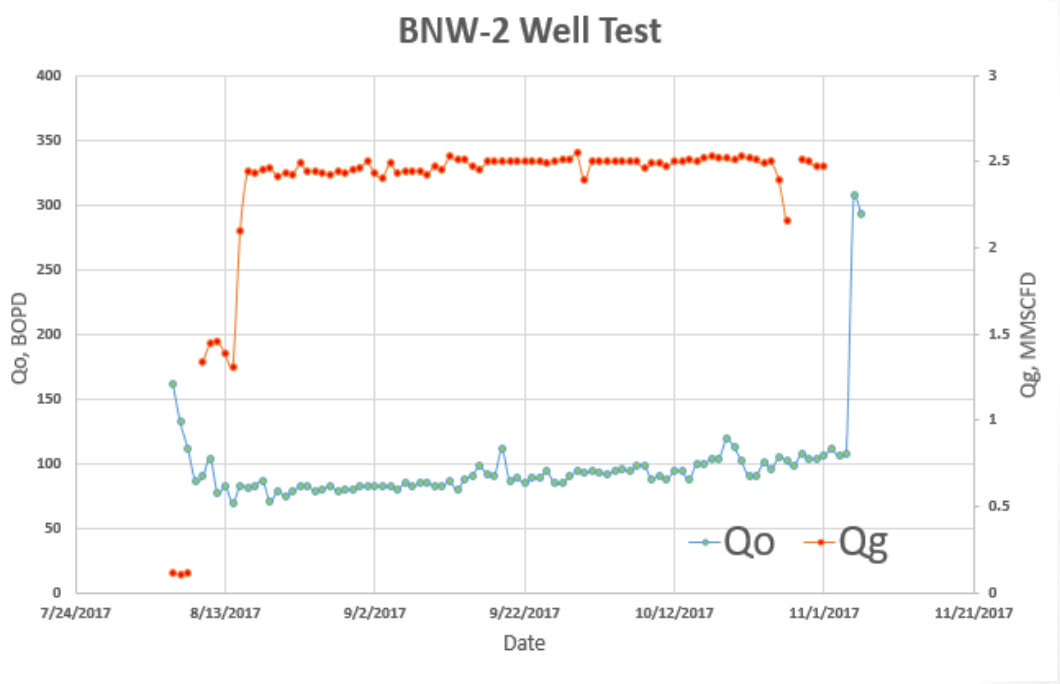
Case 2: Bahar North West

Well: BNW-2

Perforated Interval:(1594.5-1599) MT

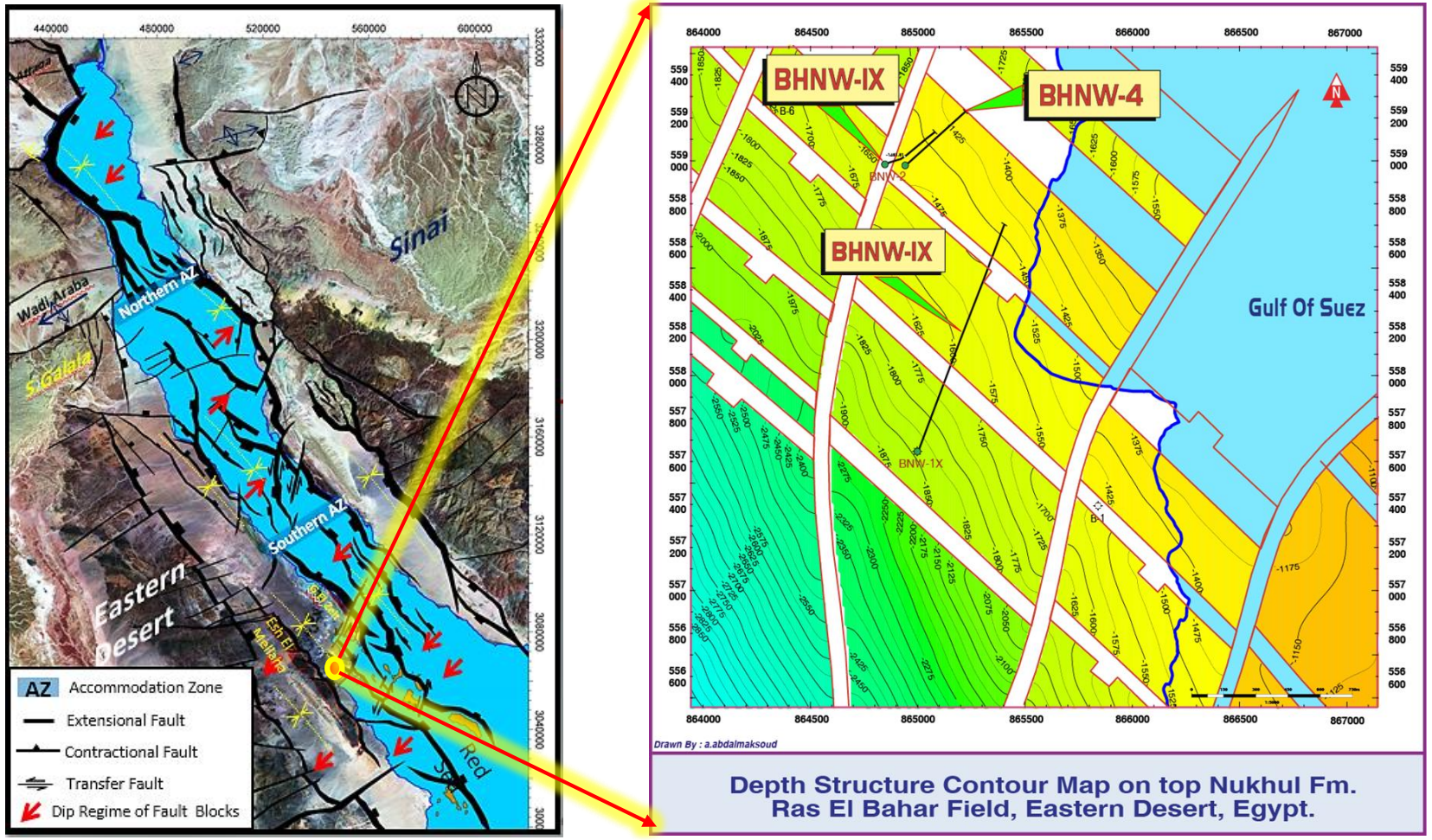
Test Type: Multi Rate Test

Period	B.S.	Pressure	Oil	WC	Gas
		WHP (Up/Down)			
hr	IN	PSI-G	STB/D	%	MMSCF/D
8	1/4	1910/95	176	0	1.9
8	1/2	1440/130	379	0	5
8	3/4	920/180	443	0	7.6



Brown limestone Production

Case 2: Bahar North West

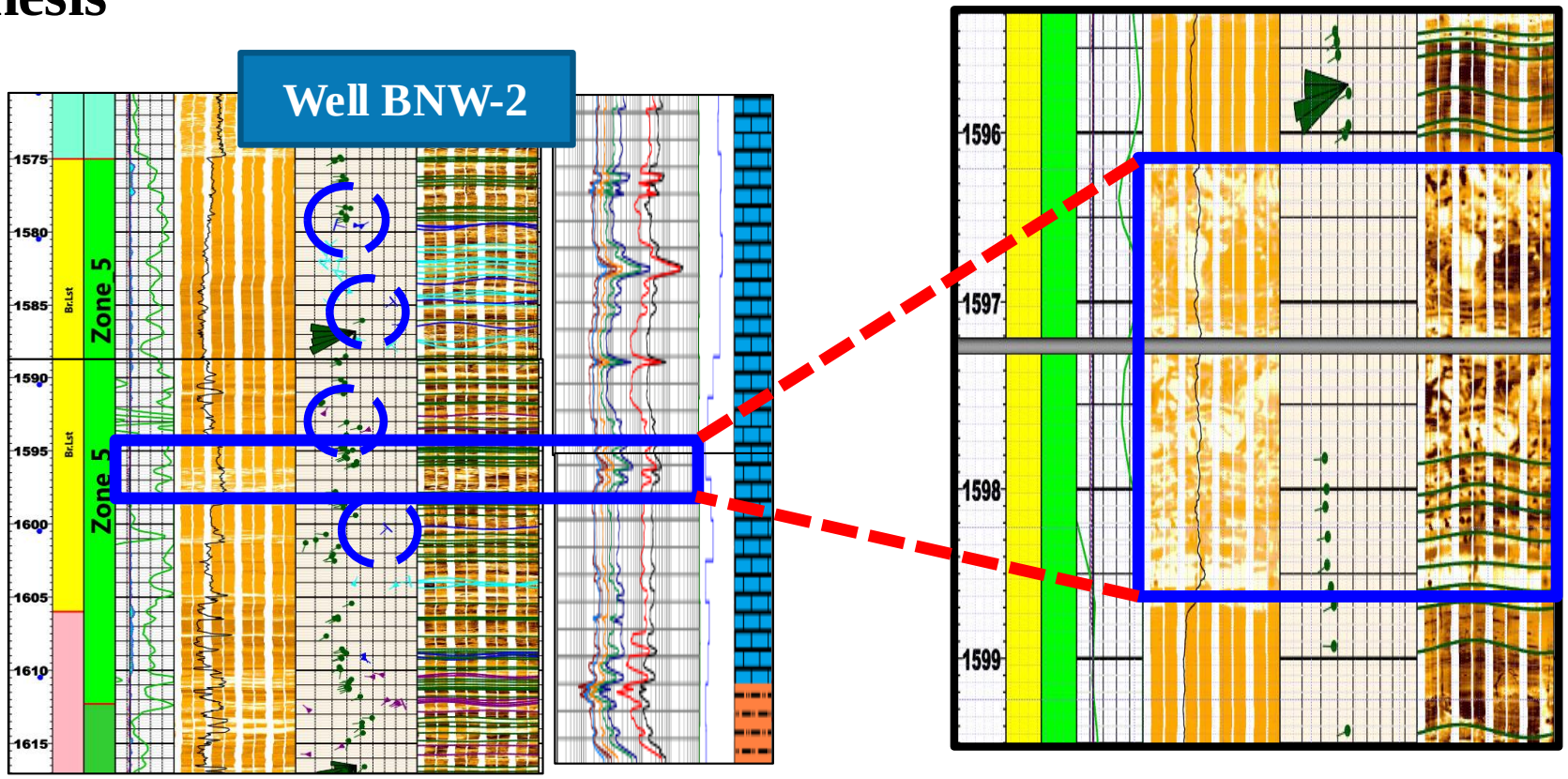


Brown limestone Production

Case 2: Bahar North West

1. Secondary porosity (Fractures)

2. Diagenesis

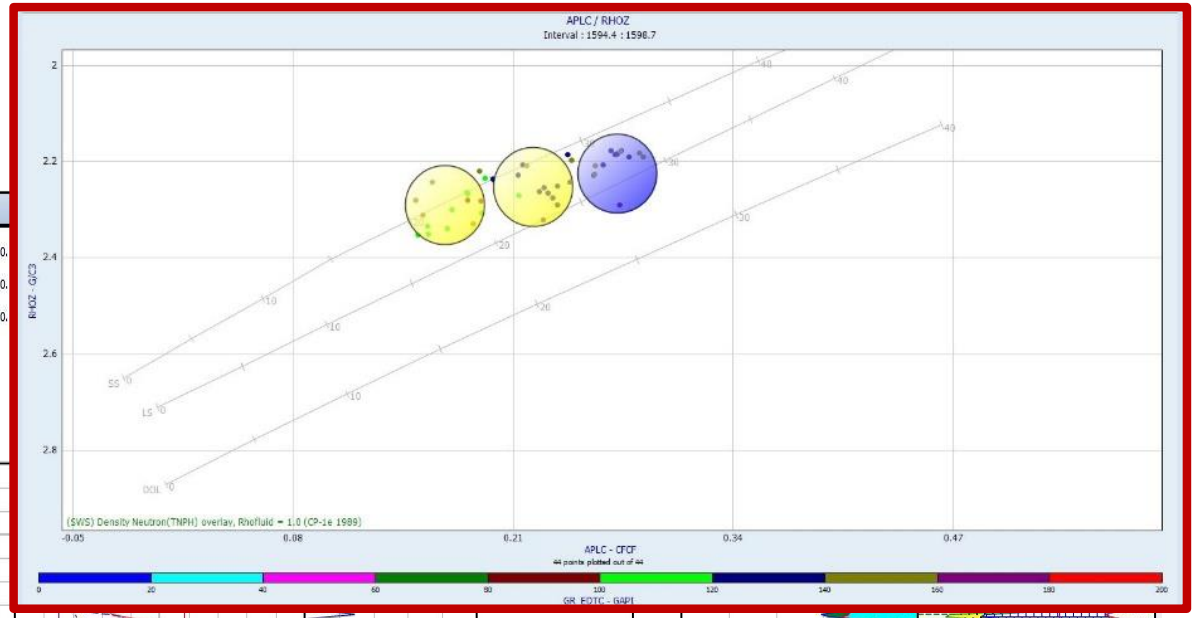


Brown limestone Production

Case 2: Bahar North West

2. Diagenesis

Neutron vs. Density cross plot

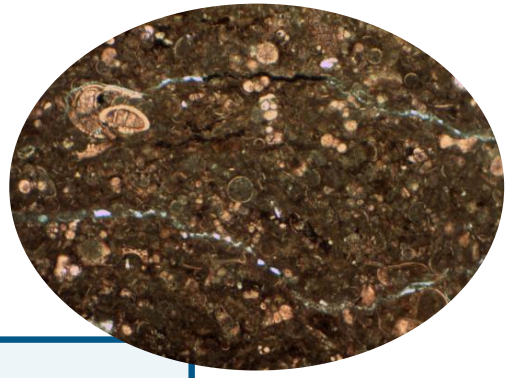


Bahar NW-2

RESEVOIR	NET(m)	Average Sw %	Average PHIE %
BROWN L.S	5	25	20-22

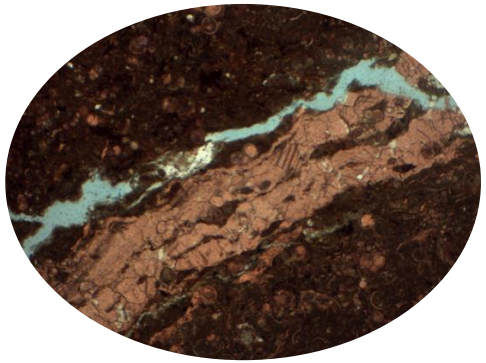
Brown limestone Production

Main Factors enhance Production from Brown Limestone

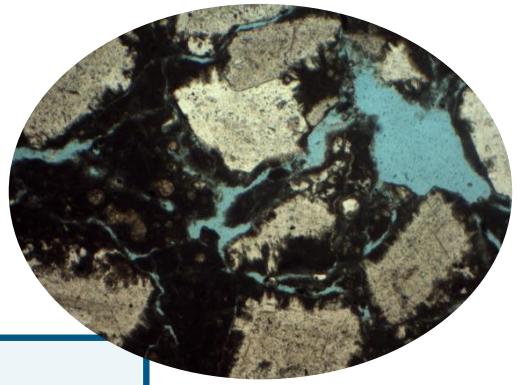


Garinstone

Fractures

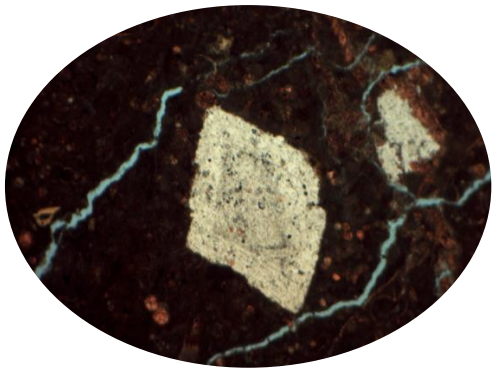


Garinstone



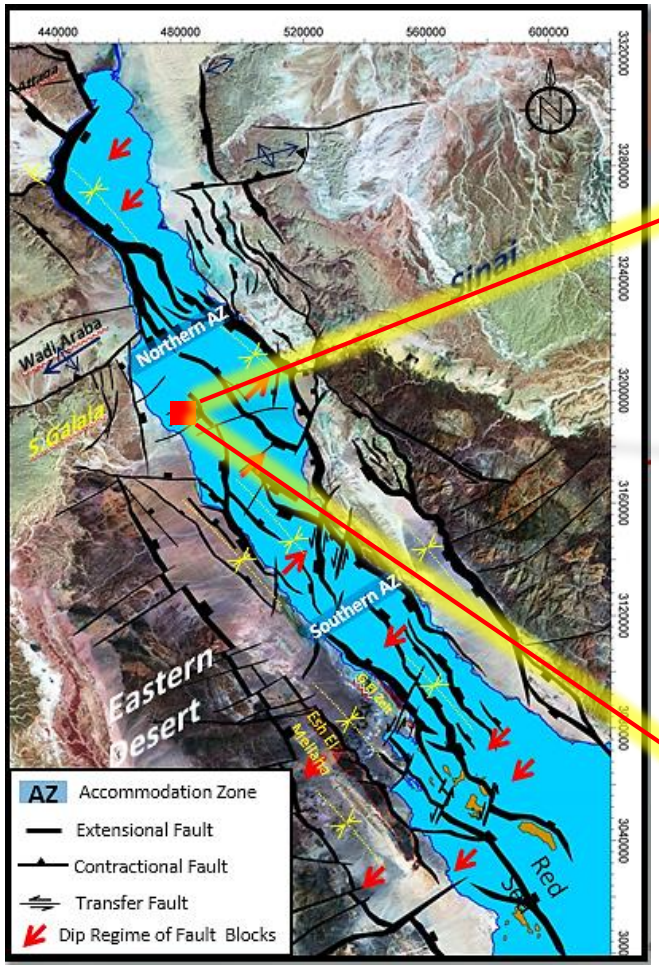
Dolo Wackstone

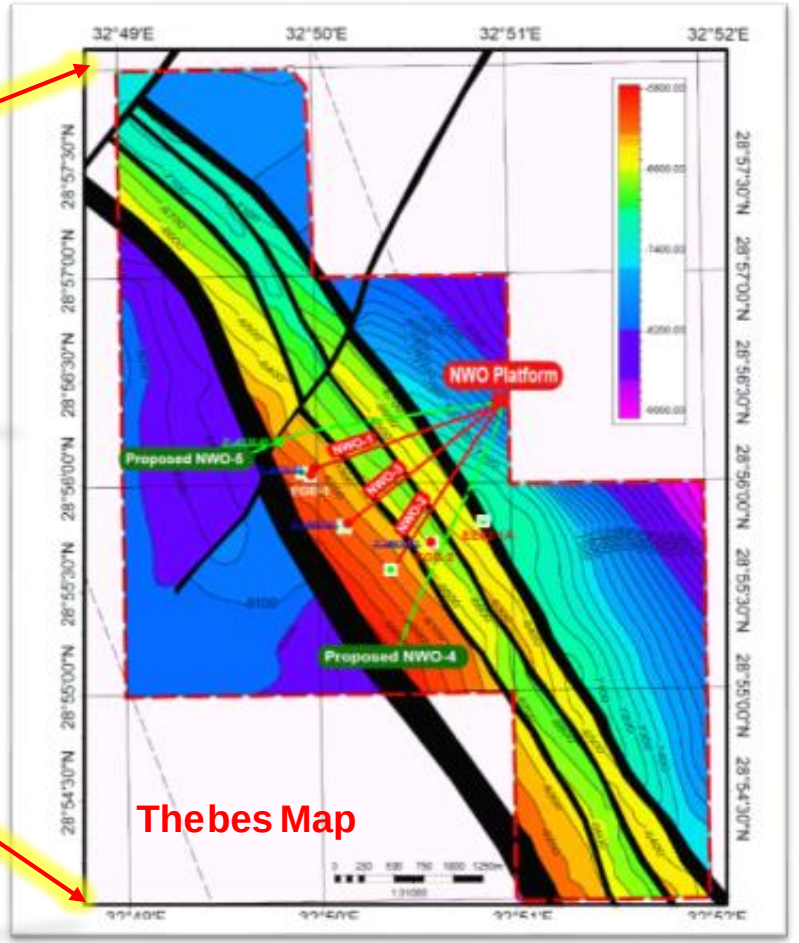
Diagnesis



Dolo Packstone

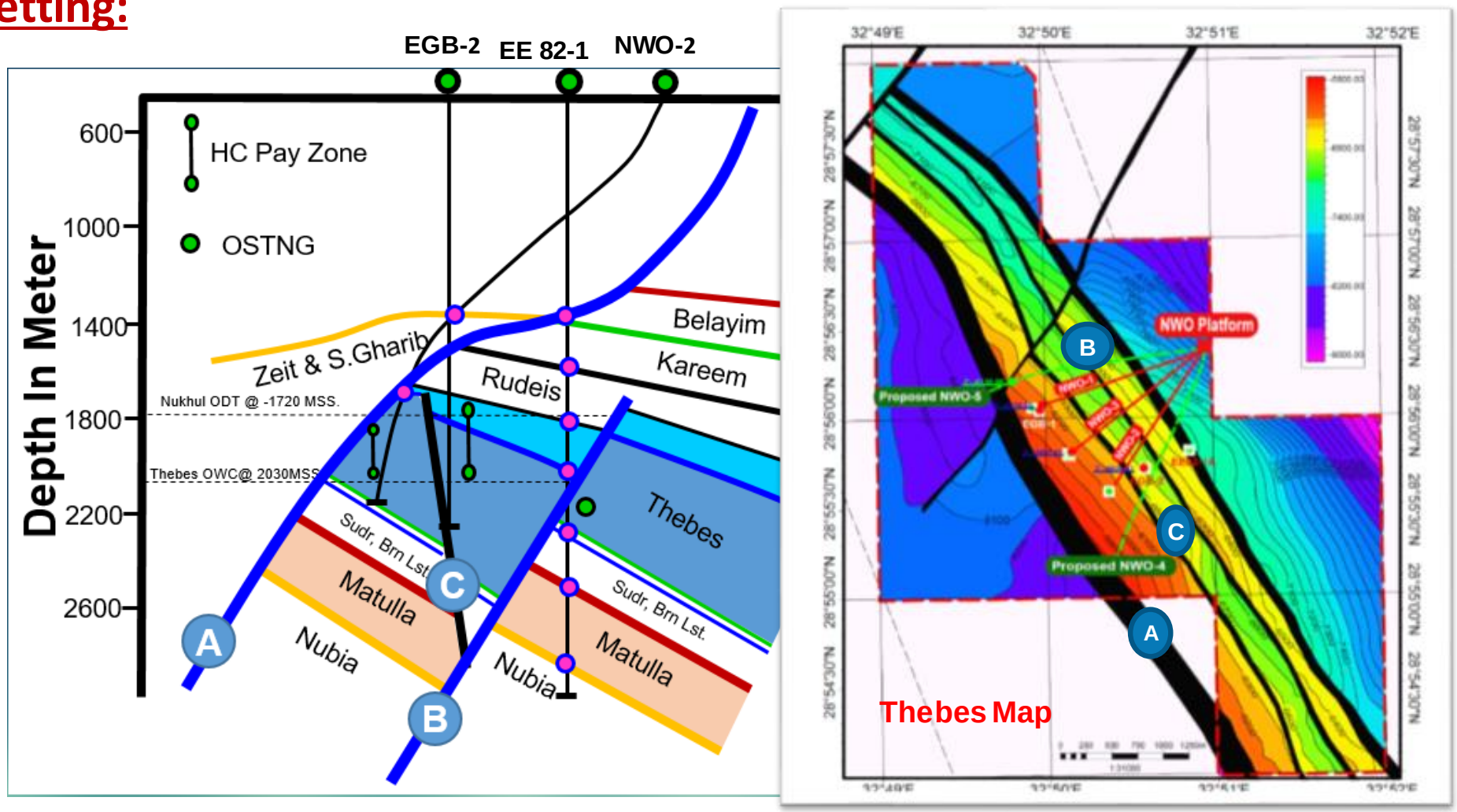
Recent GPC Success Story in N.W.O Field





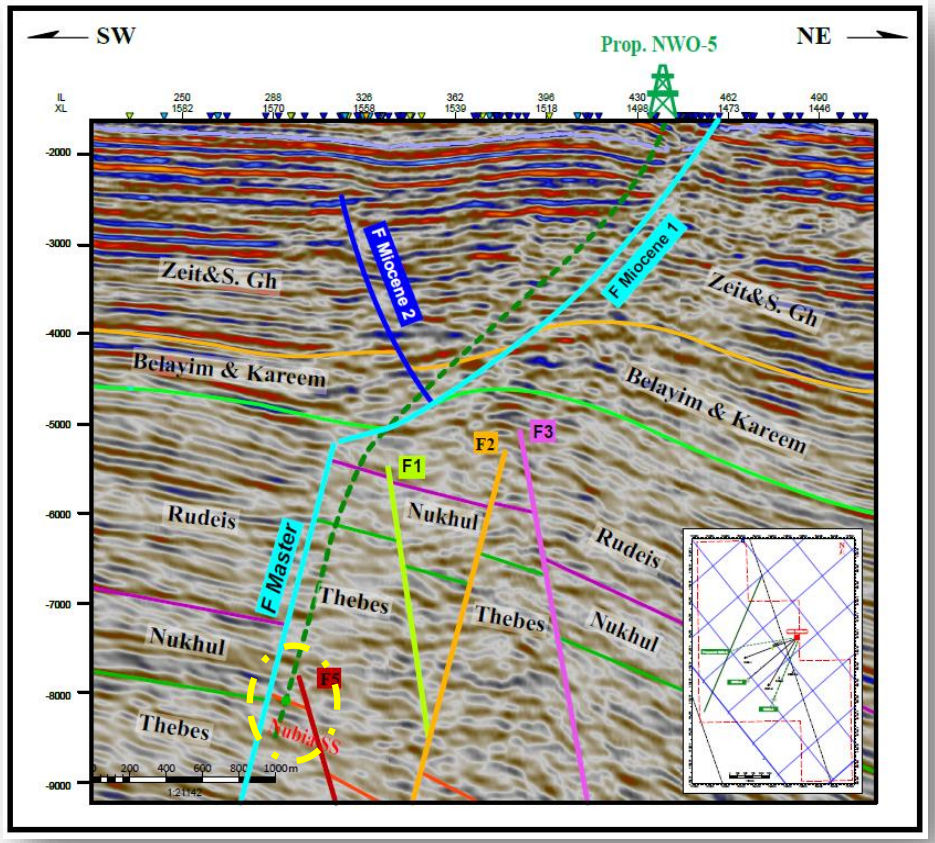
Recent GPC Success Story in N.W.O Field

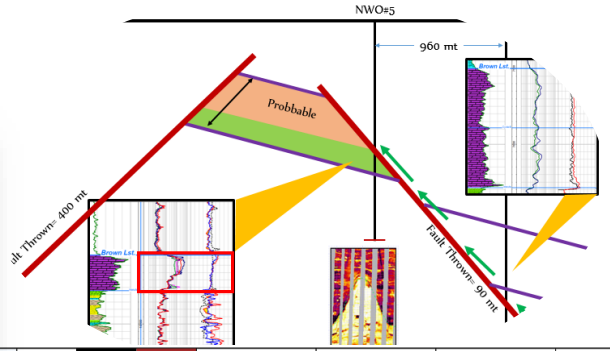
Structure setting:

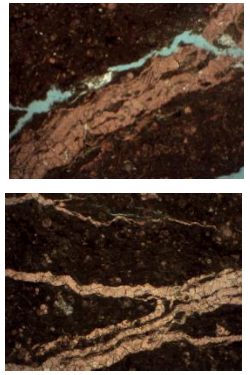


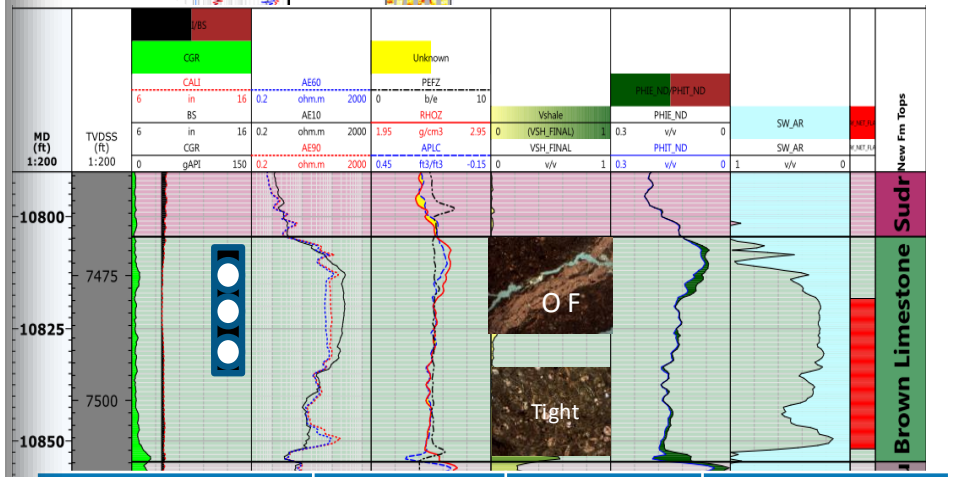
Recent GPC Success Story in N.W.O Field

Well N.W.O-5 was drilled to explore the cretaceous reservoirs based on oil shows in old wells







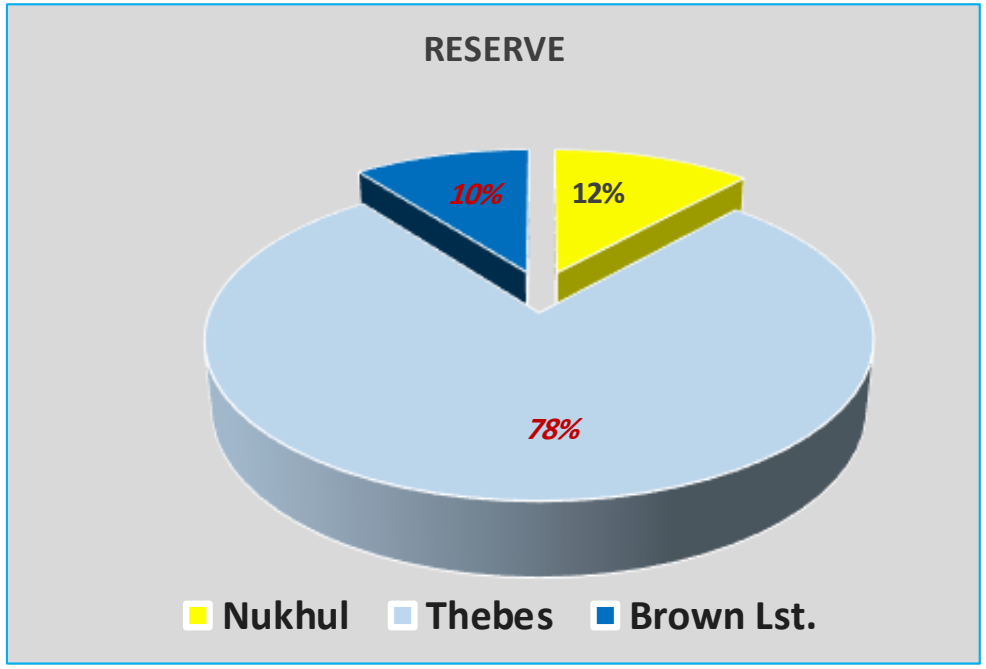


RESEVOIR	Net ft	Avg.Ø	Avg. SW
Brn. Lst	35	0.12	0.25

Recent GPC Success Story in N.W.O Field

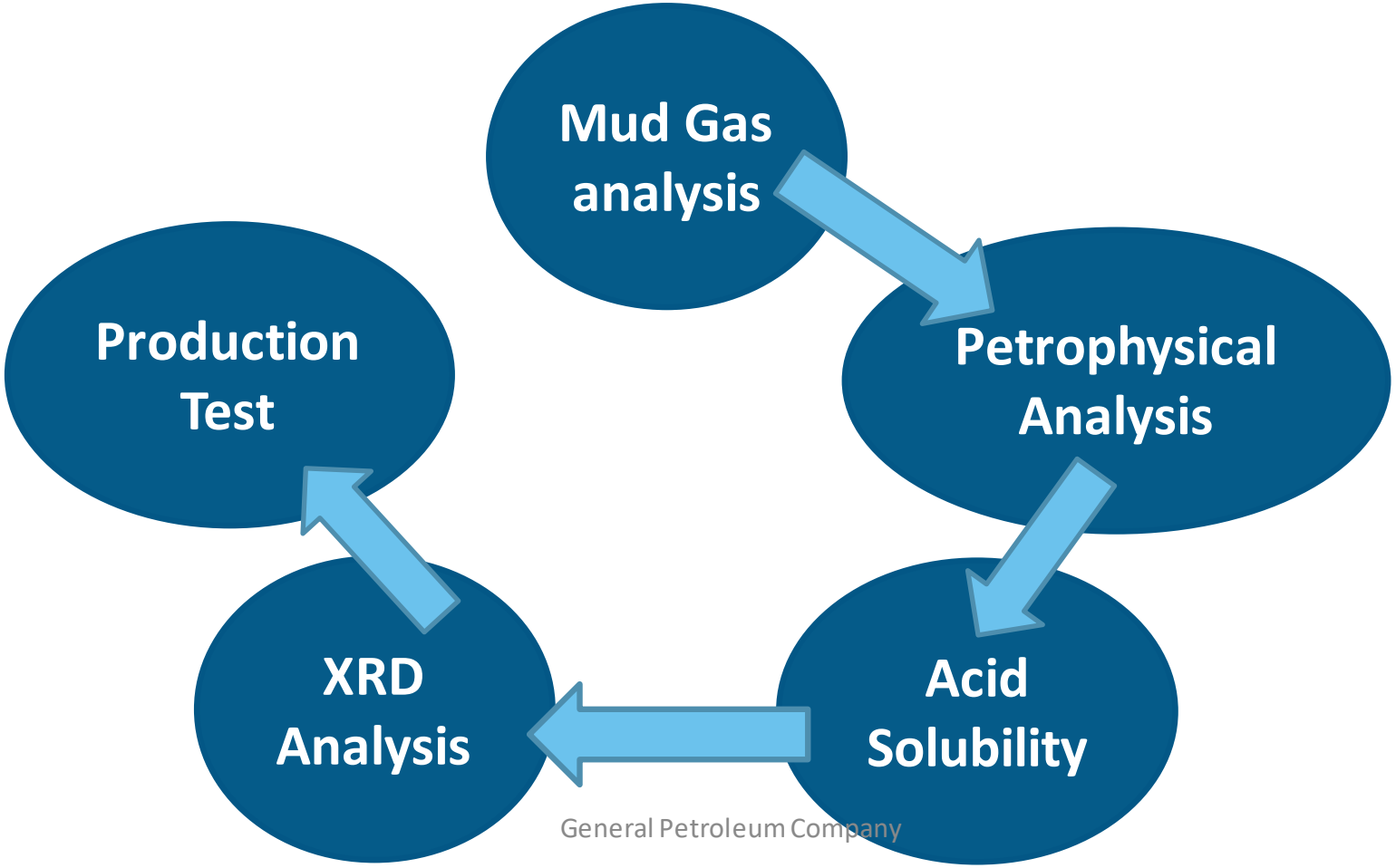
Case Summary

Well N.W.O-5 was tested successfully on Brown Limestone with average oil rate 800 BOPD adding a reserve of 3.7 MMSTB



Formation Evaluation Workflow

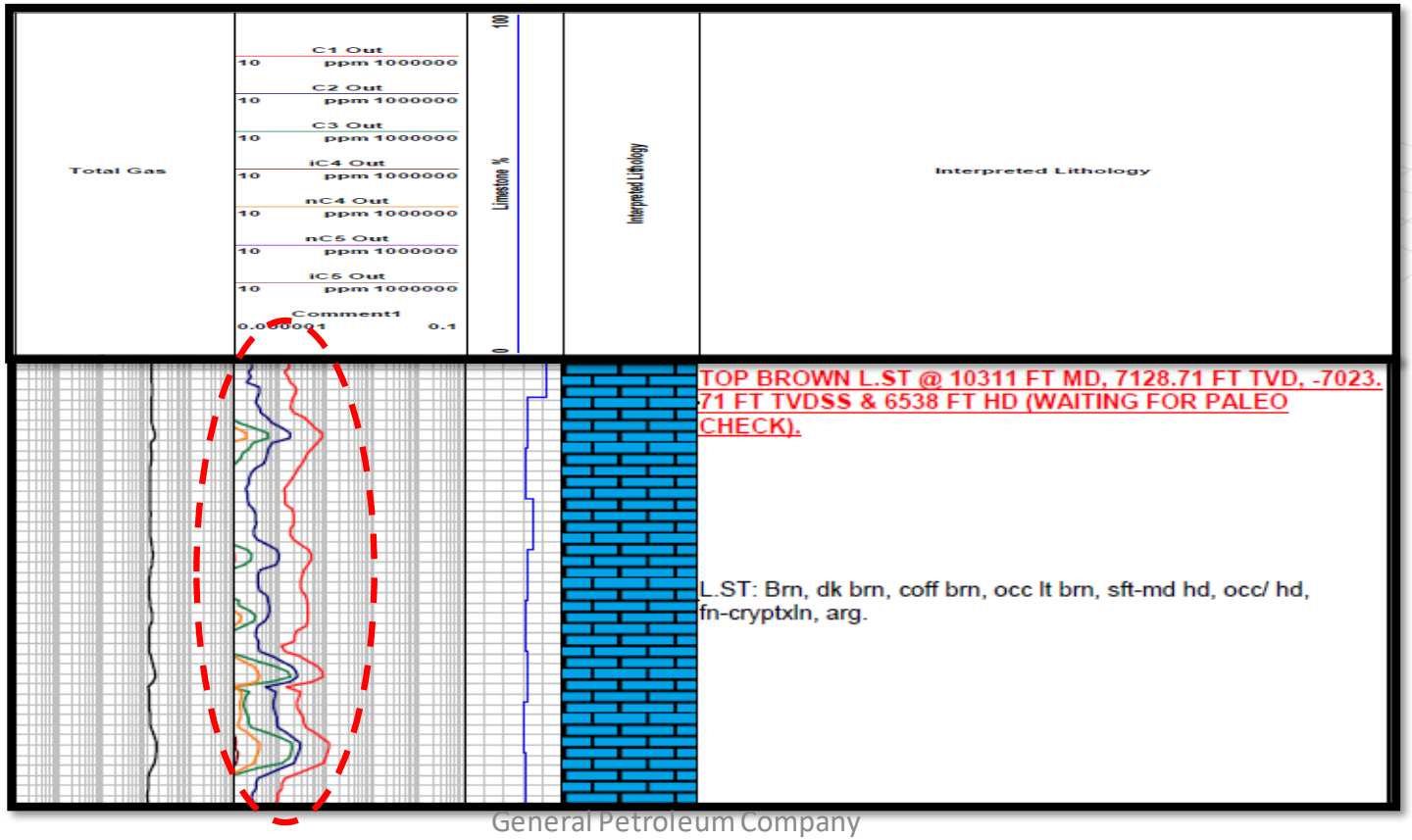
- It was adopted the following workflow to evaluate Brown Limestone reservoir:



Formation Evaluation Workflow

A) Mud Gas Analysis

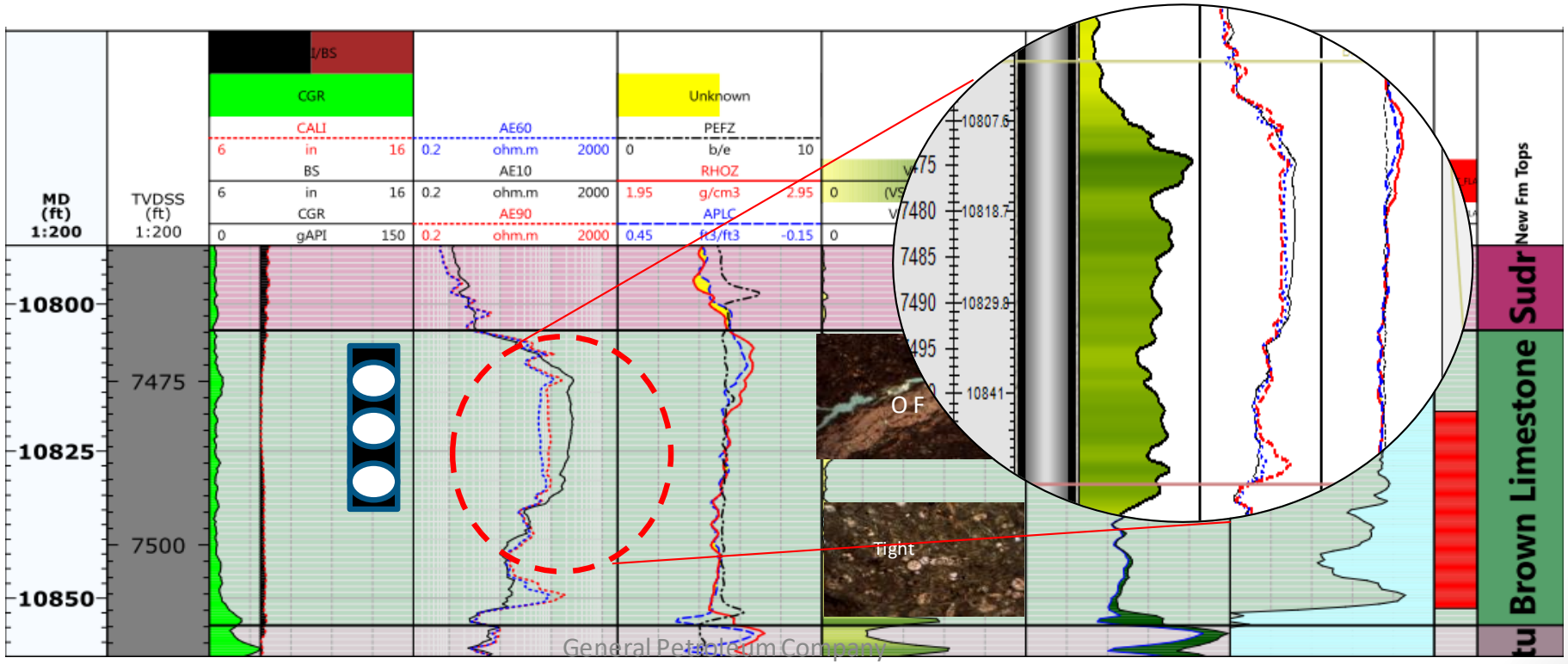
- The mud logging showed oil shows:



Formation Evaluation Workflow

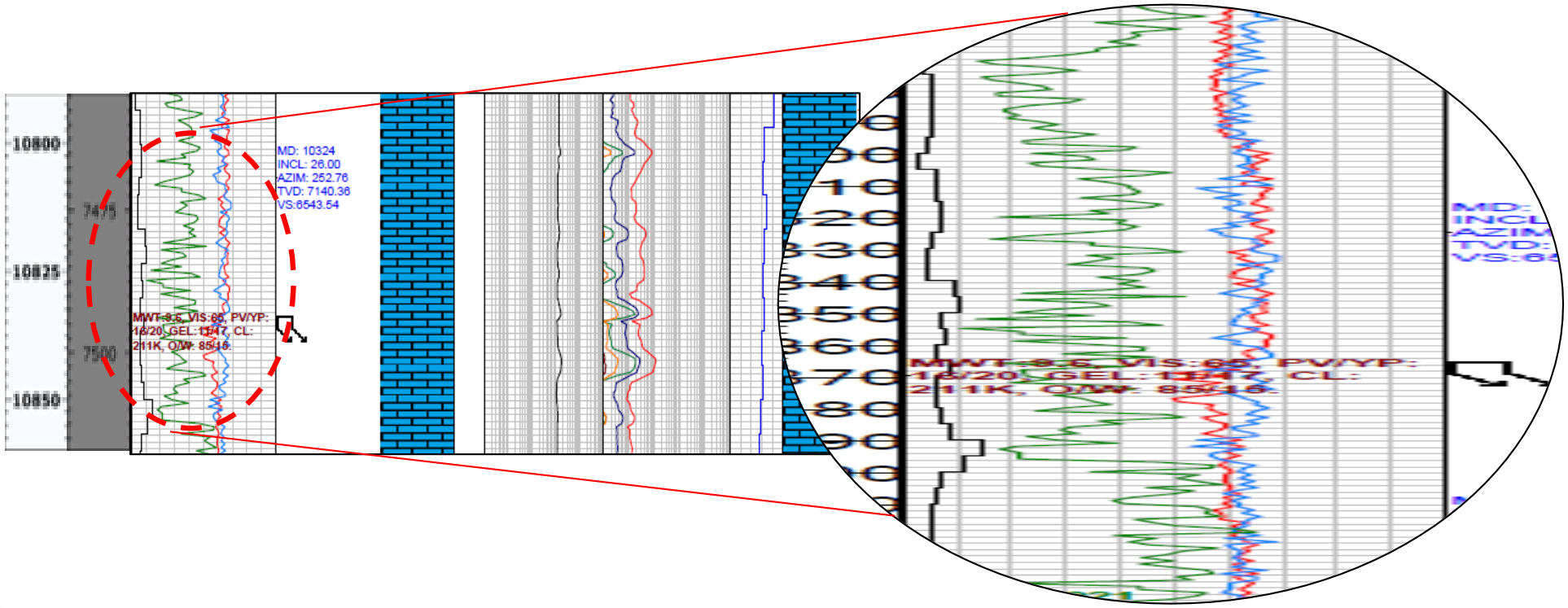
B) Petrophysical Analysis

- The petrophysical analysis indicated oil presence .
- It was recognized that we have a strange behavior of high separation in resistivity curves with tight porosity reading on Neutron – Density track .



Formation Evaluation Workflow

- Fracture existence scenario can be promoted by the increase in ROP as shown below:



Formation Evaluation Workflow

C) Acid Solubility Test

- The acid solubility test indicated very high solubility.

Solubility Percent %		
Brown Limestone	15% HCL	20% HCL
	87.12	90.74

Formation Evaluation Workflow

D) XRD Test

- XRD test indicated very high calcite percentage (86 %) that was the reason for high solubilty.

	Depth meter/feet		Framework Silicate			Total Clay	Carbonate				Other Minerals Grourps			Total
Well /Formation	Top Depth	Bottom Depth	Quartz %	Plagioclase %	K-feldspar %	Total Clay %	Calcite %	Dolomite %	Dolomite (Fe/Ca) %	Siderite %	Apatite %	Total Pyrite % (Mar+Pyr)	Barite %	Total %
NWO-05 Brown limestone Fm	10350.00 ft	10390.00 ft	5.0	0.0	0.2	3.1	86.8	3.6	0.5	0.4	0.0	0.3	0.2	100.00

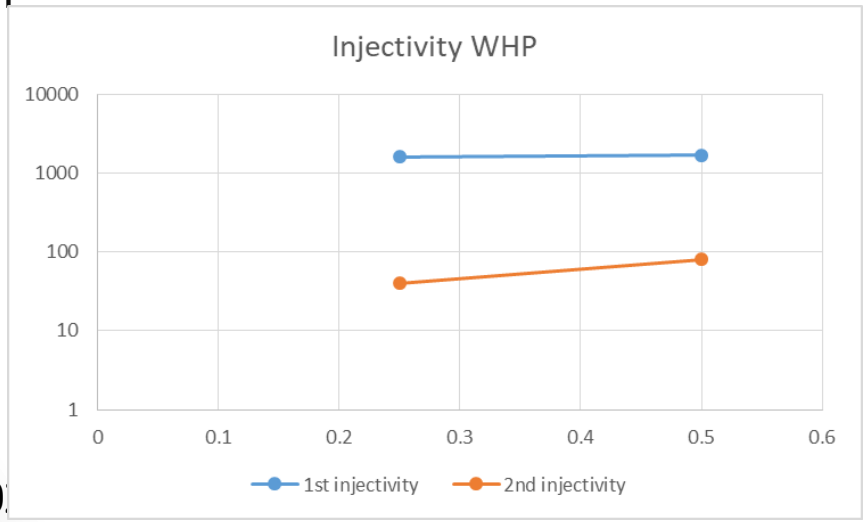
- The high calcite content promote the acid stimulation job that was performed successfully using 15% HCL

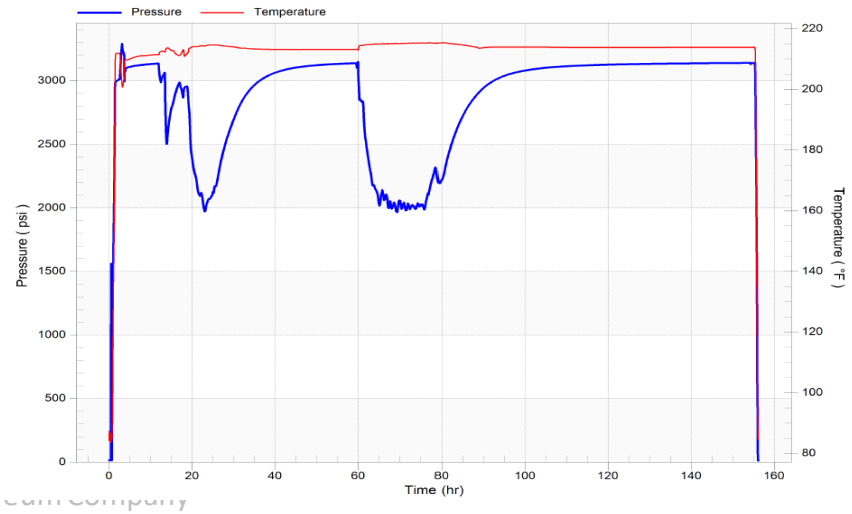
Recent GPC Success Story in N.W.O Field

Stimulation Job Execution

Job Sequence:

1. Initial injectivity test was –ve due to tight reservoir nature
2. Pumping 20 bbls acid break
3. Second injectivity test was +ve
4. Pre-flush stage then main treatment then post-flush stage were pumped with decreasing pumping WHP progressively.
5. The well was tested successfully tested by lifting with average oil rate 800 BOPD.
6. After retrieval the downhole pressure gauge, it indicated stabilized BHFP Indicating productivity index of 0.5 bbl/psi

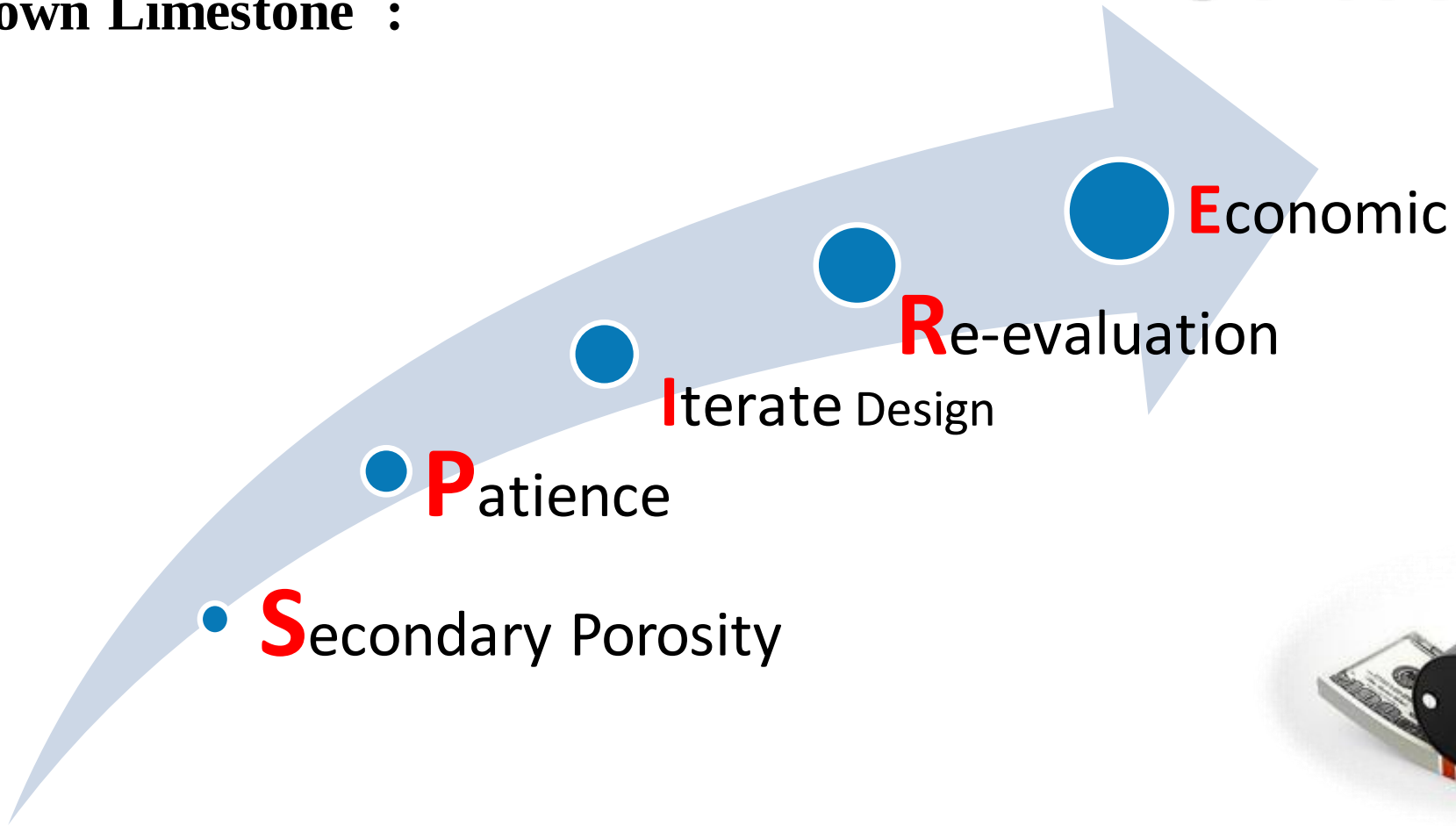




Conclusion & Recommendations

- **The secret Word to produce and increase STOIP from Brown Limestone :**

SPIRE



Thanks