شركة بترول بلاعيم

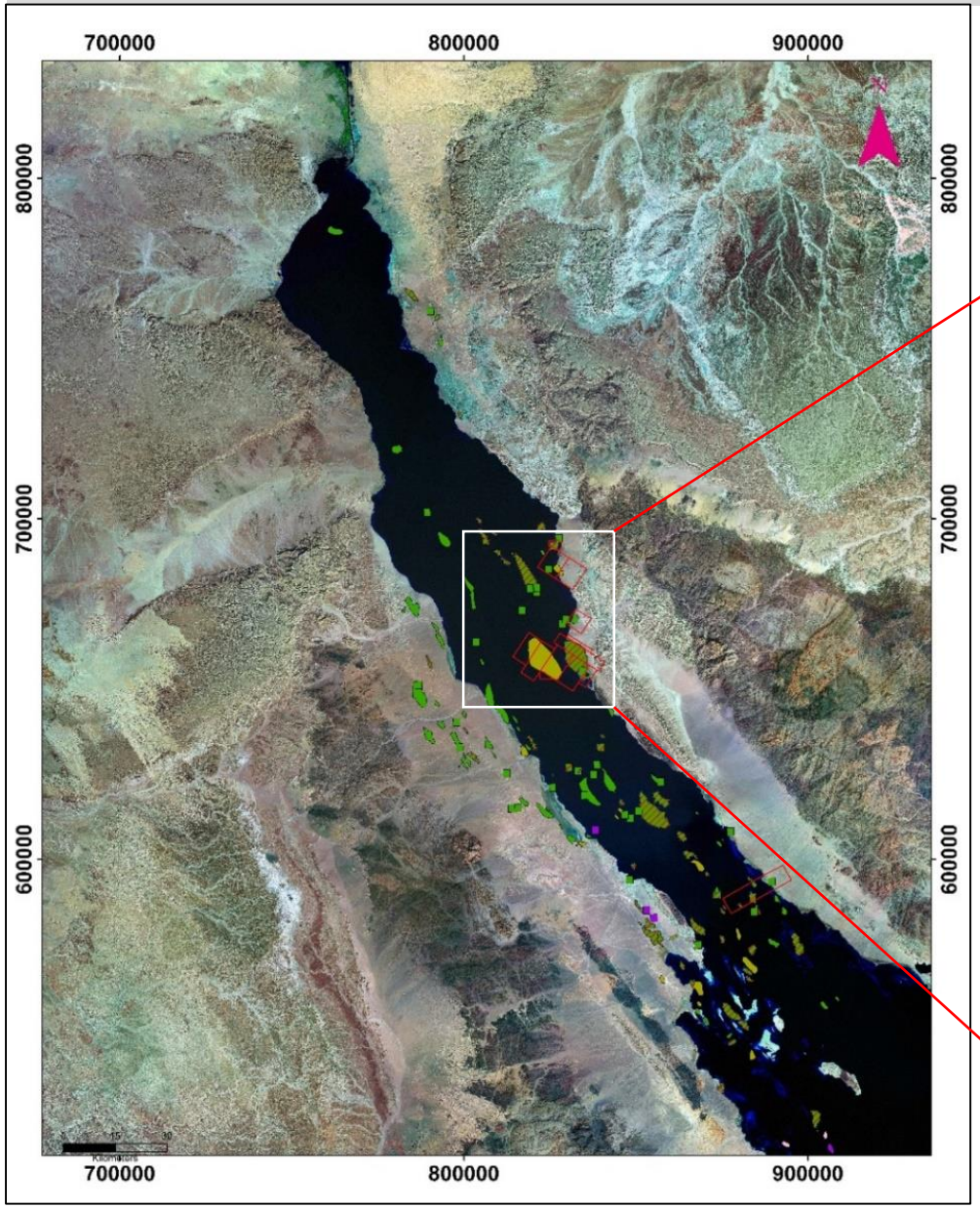
Belayim Petroleum Company

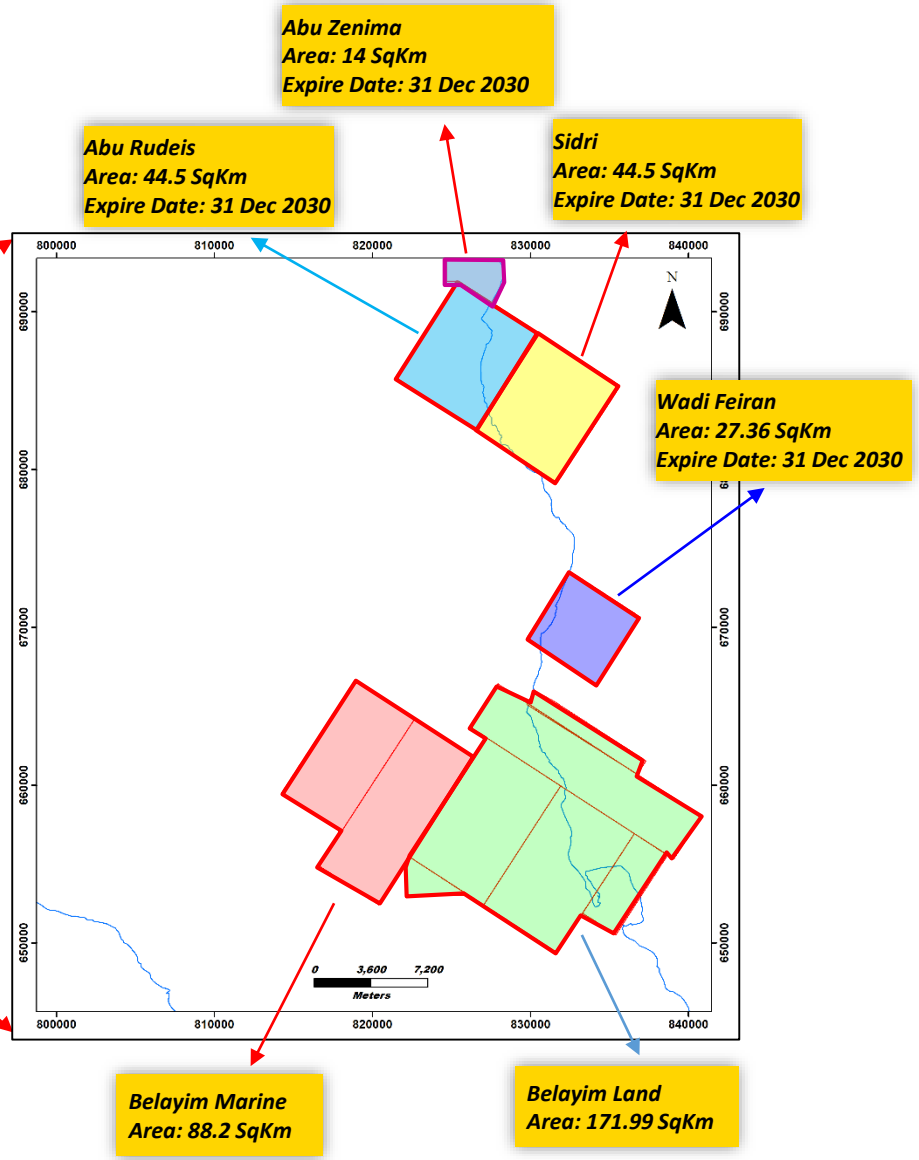
Production Improvement in a mature field by opening the unconventional locked reservoir

Belayim marine and Rudeis / Sidri fields, Gulf of Suez (Belayim petroleum company, case study)

2023

Location Map of Sinai Fields

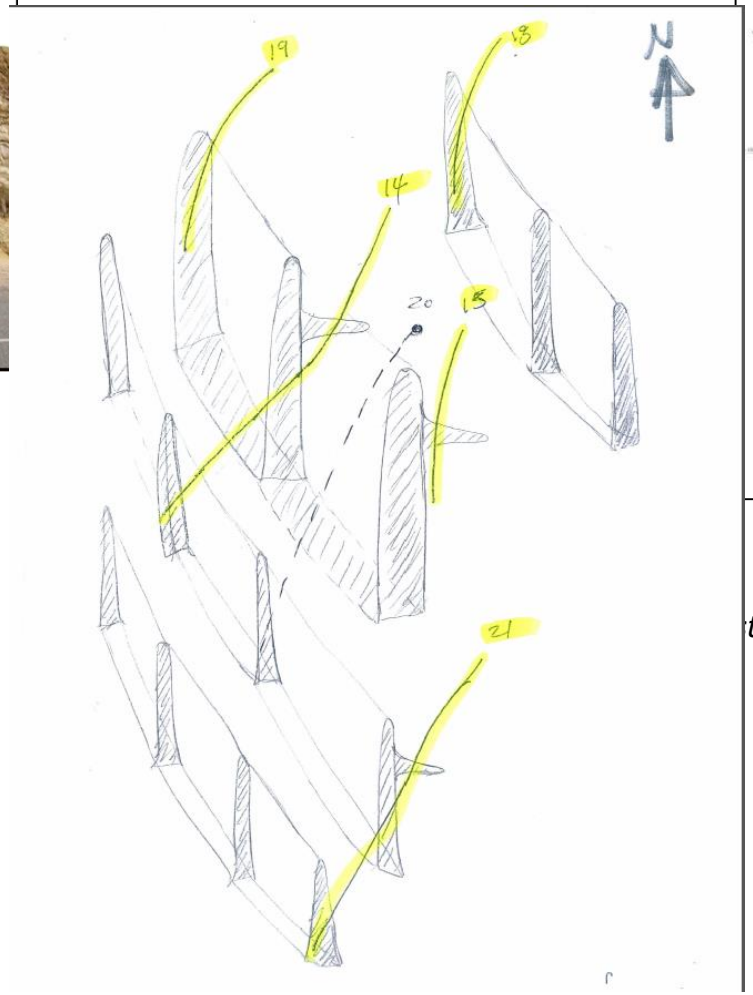


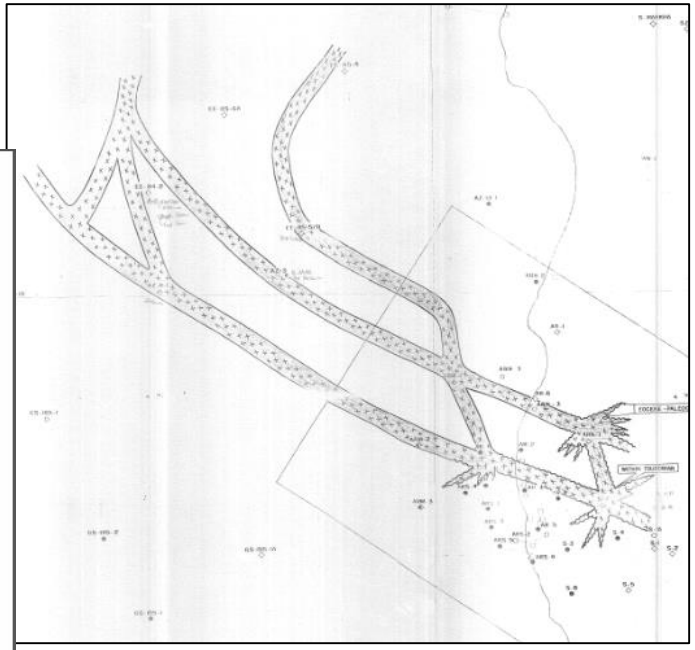


Igneous Intrusion (Igneous Rock)
EOCENE (limestone)
Basement

Igneous Intrusion – Geological insight

Surface example of Igneous intrusion phenomena



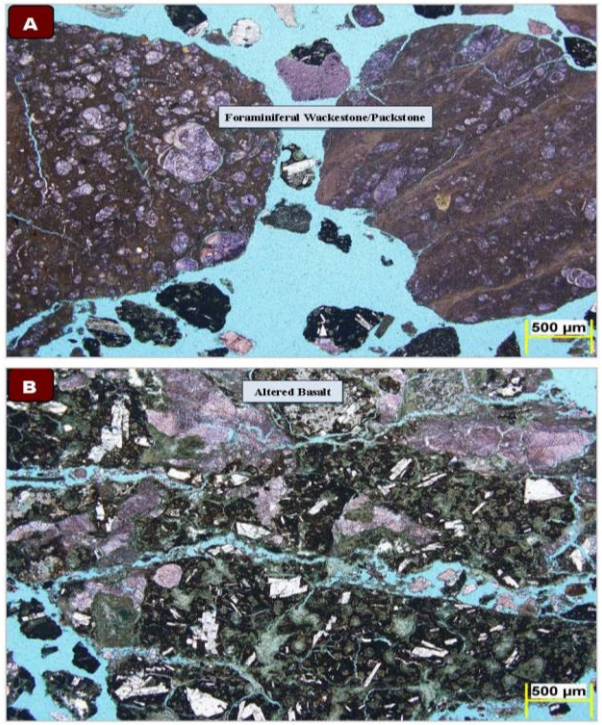


timated schematics in the subsurface

Igneous Intrusion – Geological insight

Wells		Fracture Intensity [fr/m]	Fracture Quality			Gases
			Open	Semiconductive	Conductive	
ARM-14		2.2	100%			C5
ARM-15		3.8	100%			C5
ARM-16		4.1	2%	72%	25%	C3
ARM-17		6.0	70%		20%	C5
ARM-18		1.2	60%	40%		C4
ARM-19		1.8	87%	12%	1%	C4
ARM-21	1st Igneous Intrusion	2.01	86%	13%	1%	C4
	2nd Igneous Intrusion	1.03	60%	31%	9%	C4

Fracture Intensity, Quality & Gas Components of Igneous Wells



Micro Fracture example

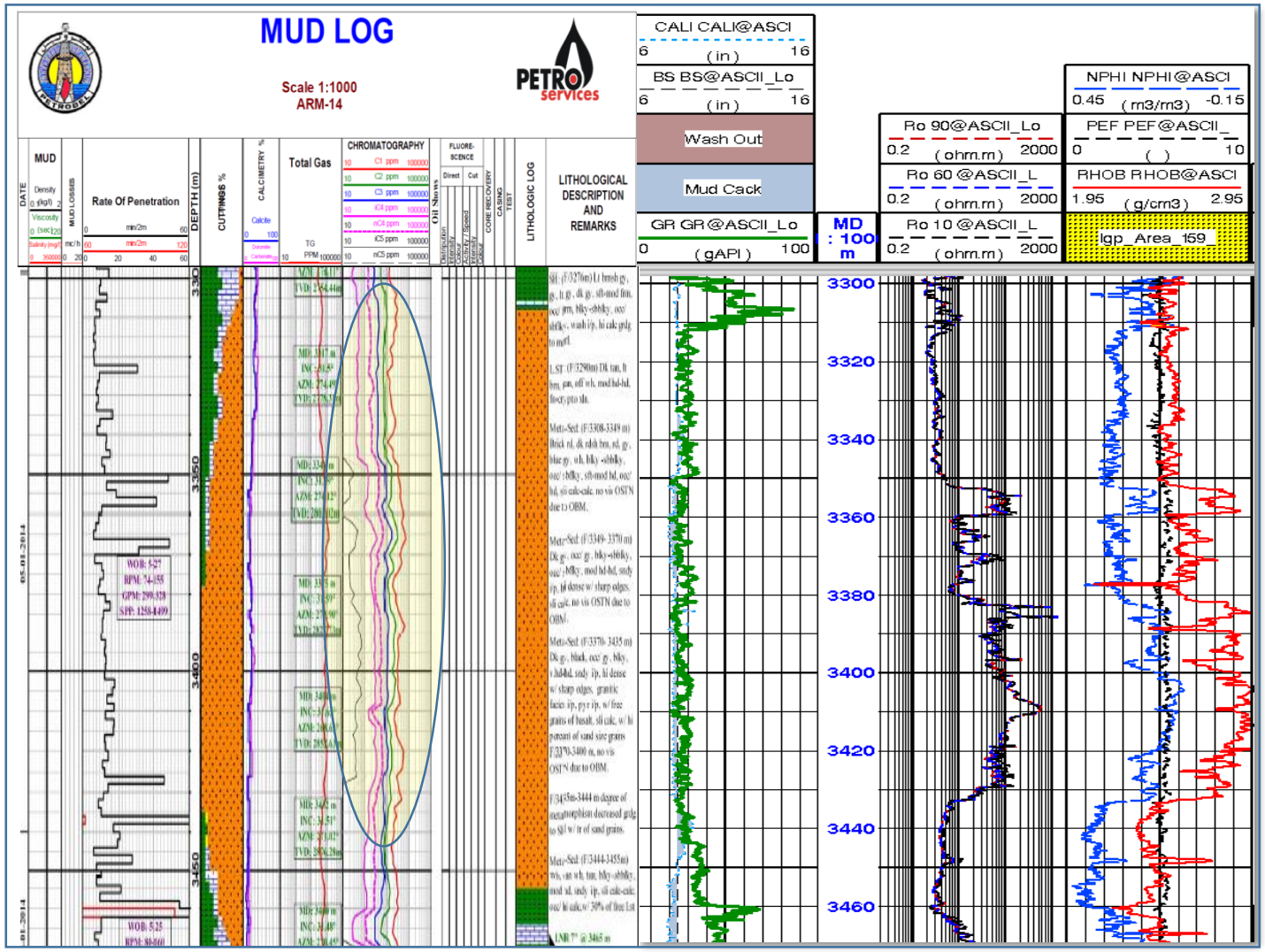
Macro Fracture example

Reservoir	COMPOSITION (wt%)						
	ILLITE	CHLORITE	KAOLINITE	QUARTZ	PLAGIOCLASEFELDSPARS	CALCITE	DOLOMITE
Igneous Intrusion	0.0	5.2	1.7	6.7	26.5	57.7	9.7

XRD analysis on Drill Cuttings thin Section

Flow capacity mainly linked to Fracture presence

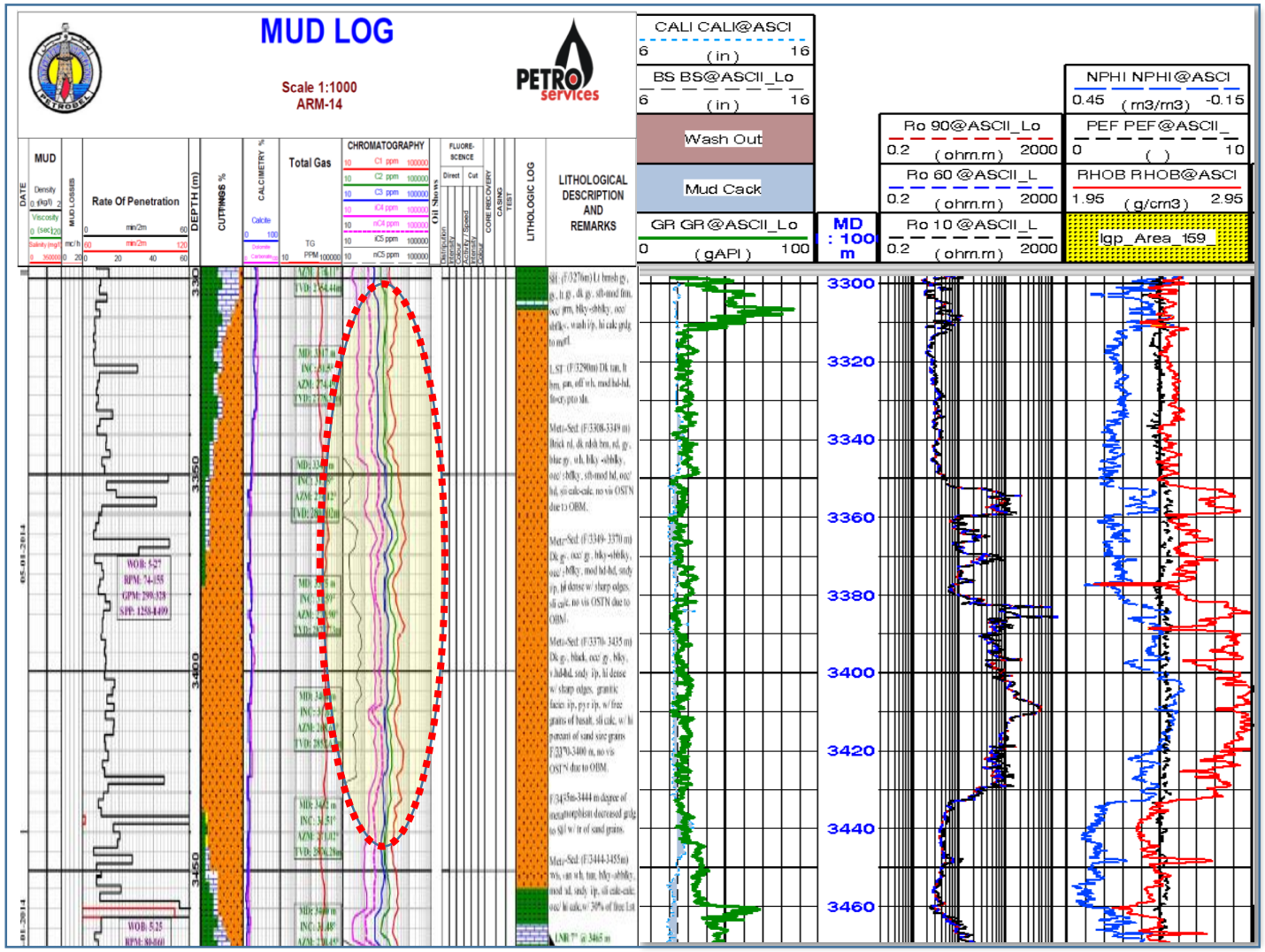
Igneous Intrusion – Identification of OP candidates



CRITERIA

1. ***Gas Show***

Igneous Intrusion – Identification of OP candidates



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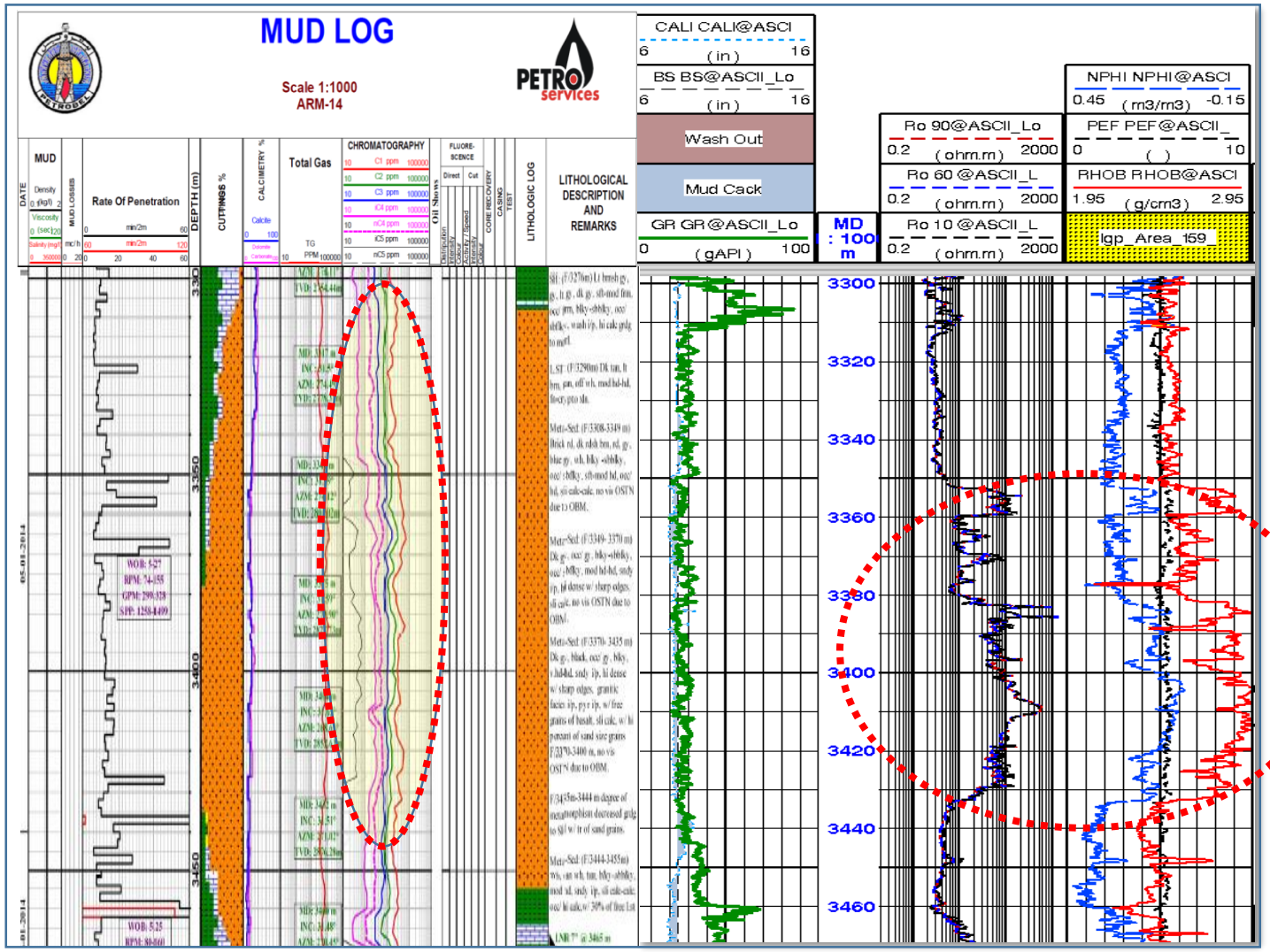
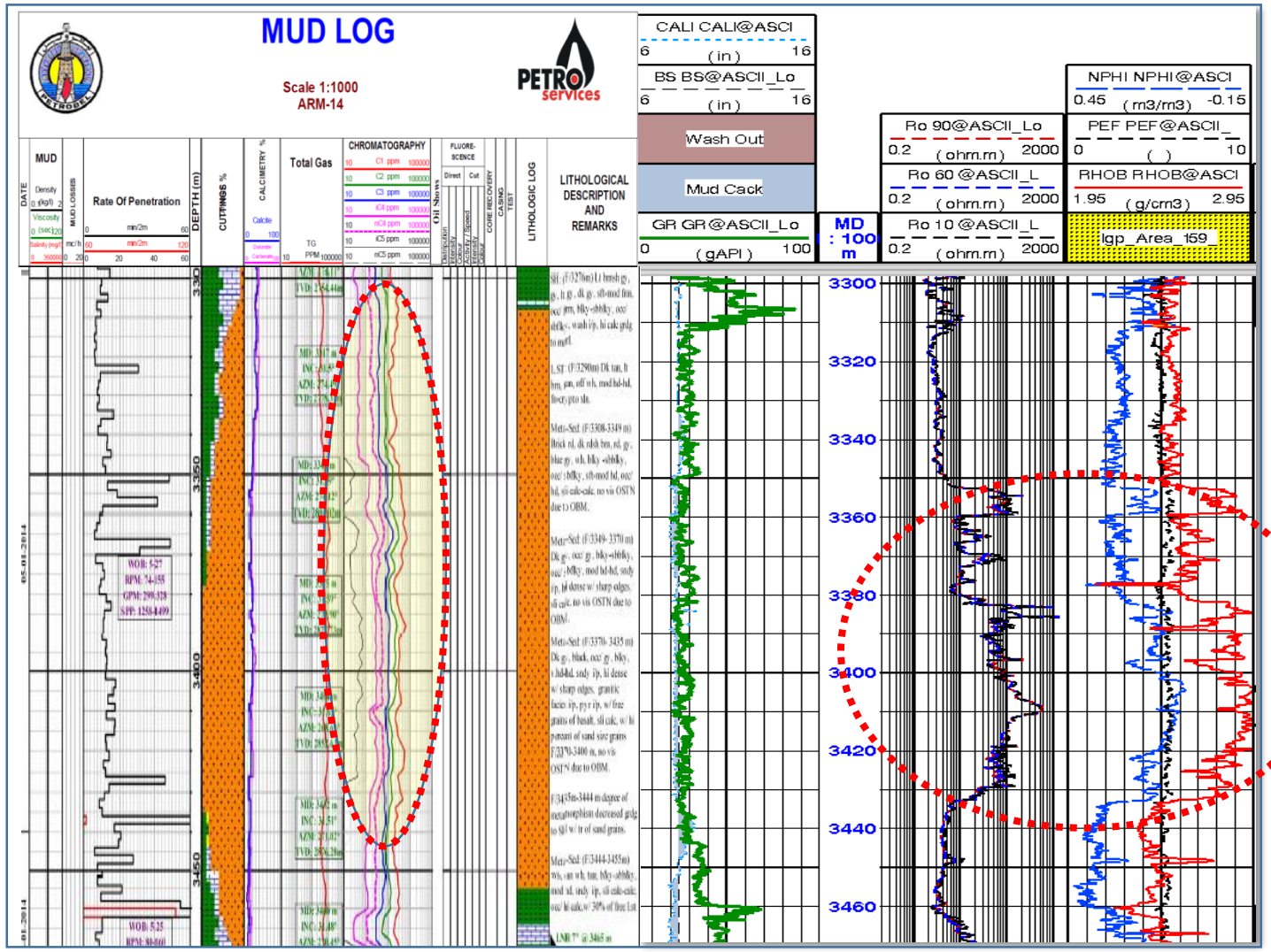


CRITERIA

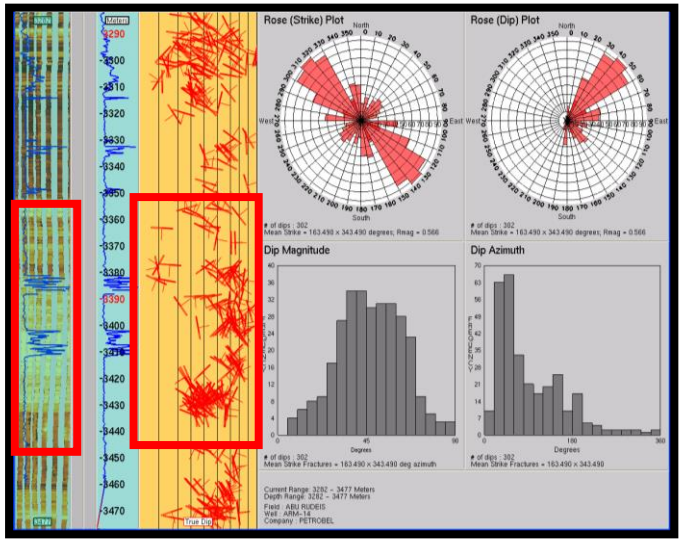
1. ***Gas Show***
2. ***Density Neutron + Resistivity***

Igneous Intrusion – Identification of OP candidates

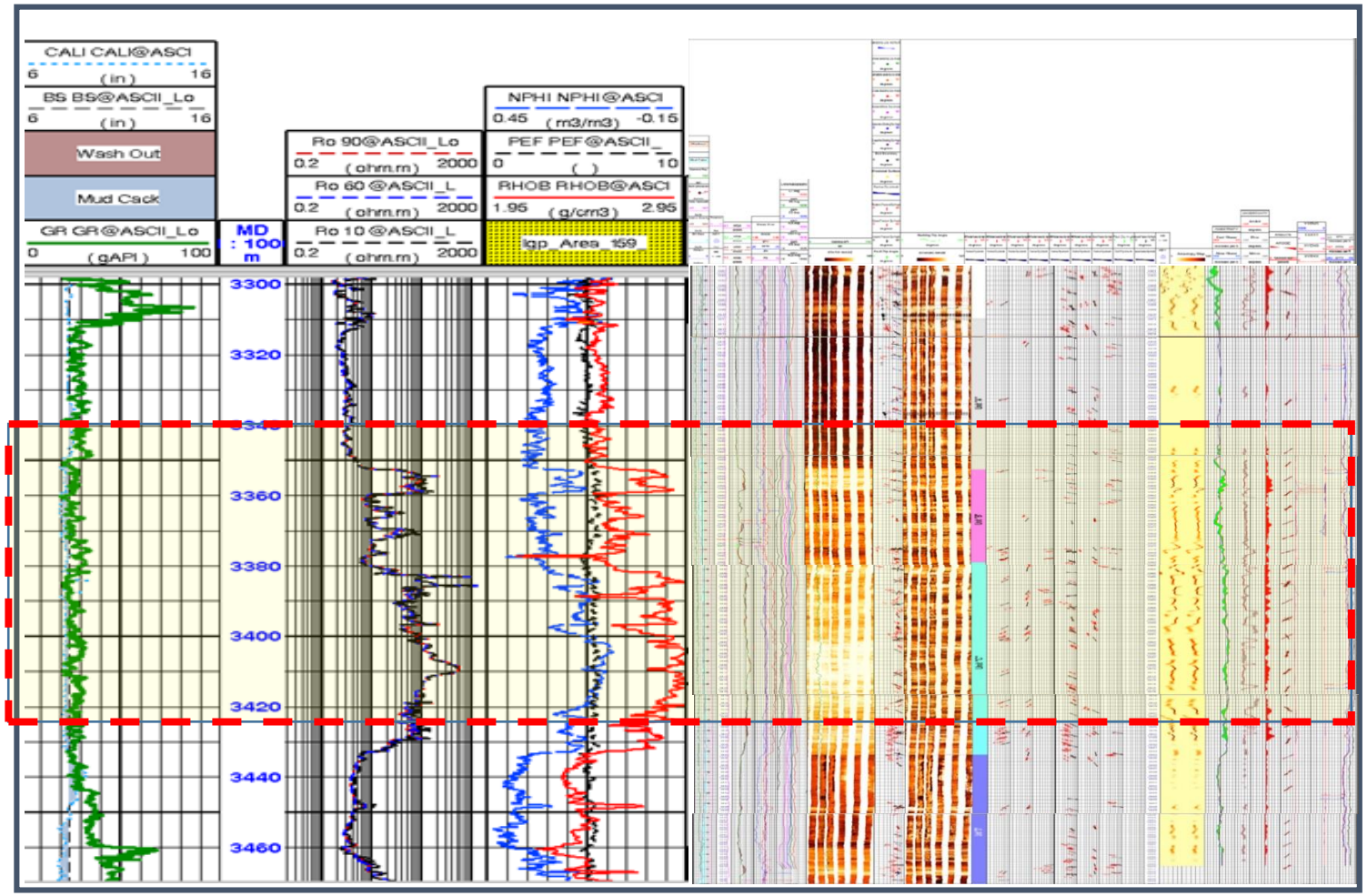


CRITERIA

1. *Gas Show*
2. *Density Neutron + Resistivity*
3. *Fracture density*



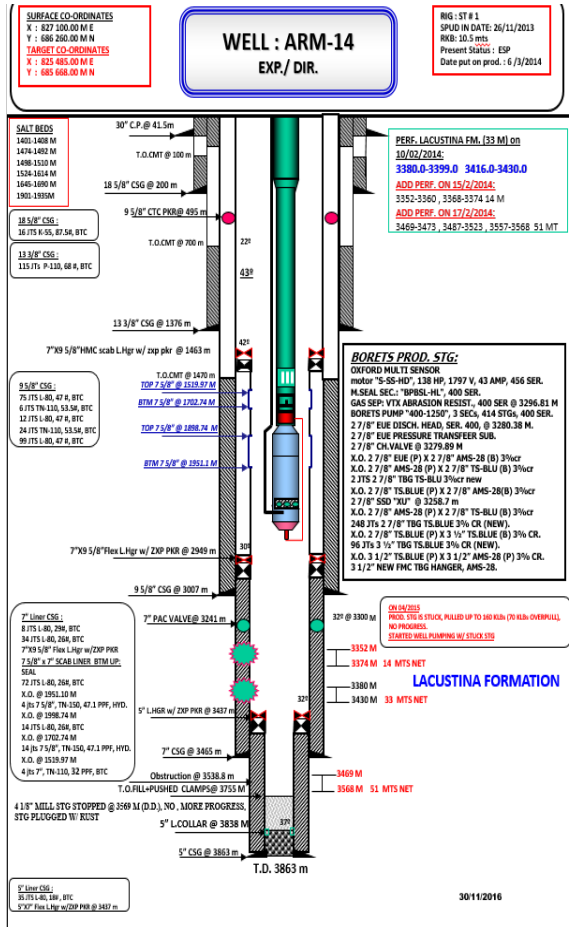
Igneous Intrusion – Identification of OP candidates



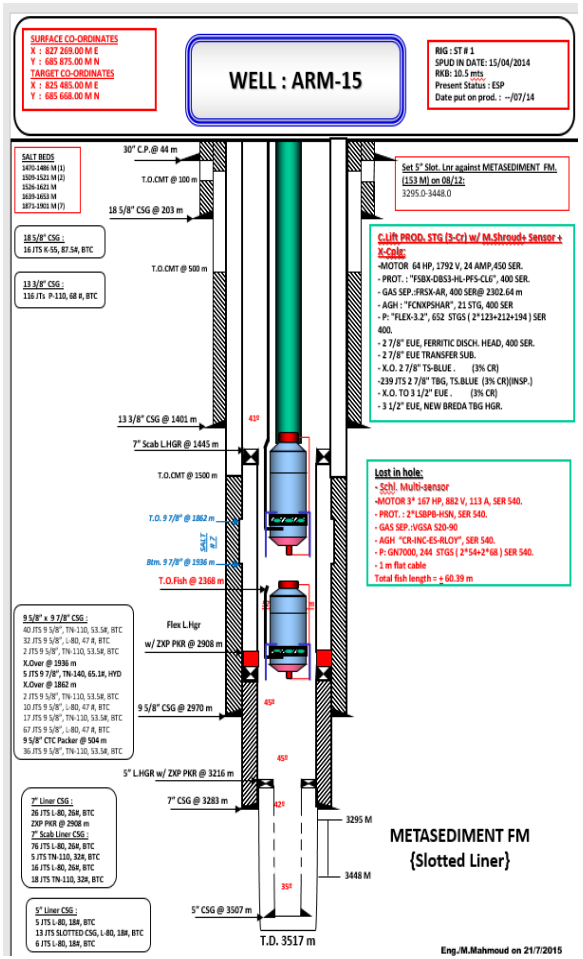
CRITERIA

1. ***Gas Show***
2. ***Density Neutron + Resistivity***
3. ***Fracture density***
4. ***Sonic logs (Shear Anisotropy)***

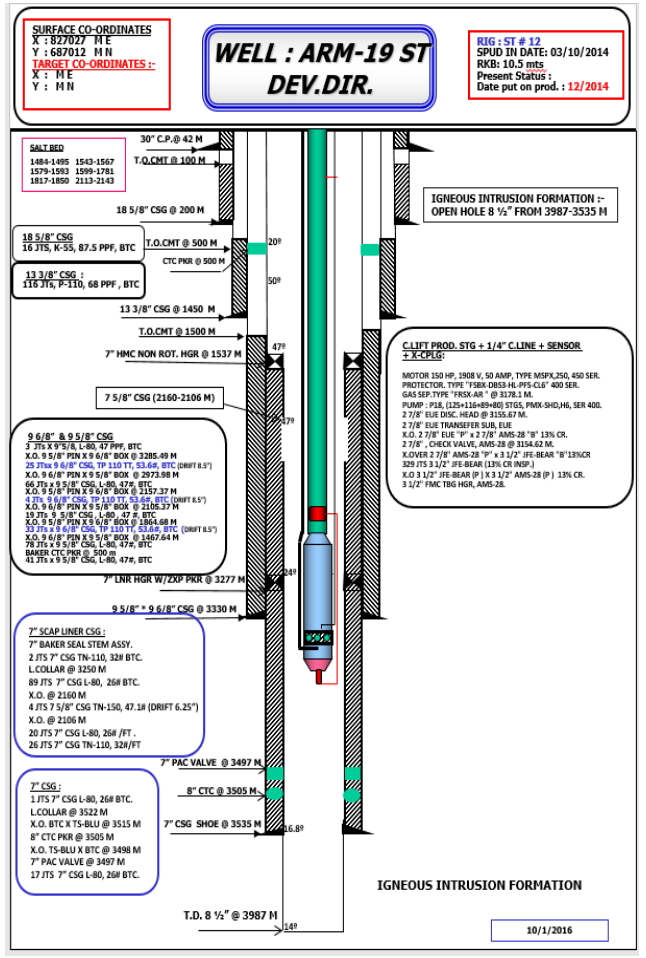
Igneous Intrusion – Completion strategy optimization



Casing and Cement + TCP



Slotted Liner



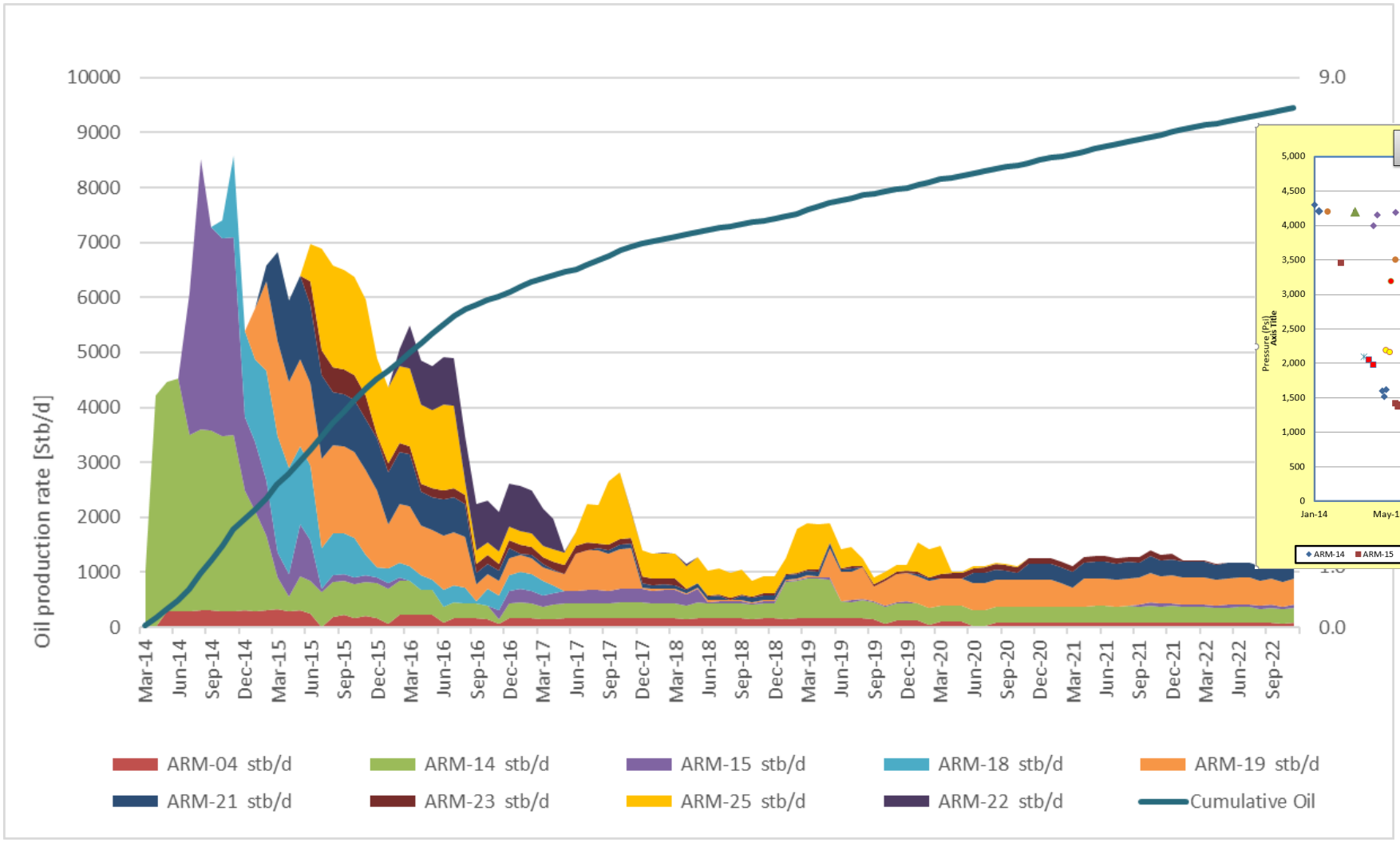
Open Hole

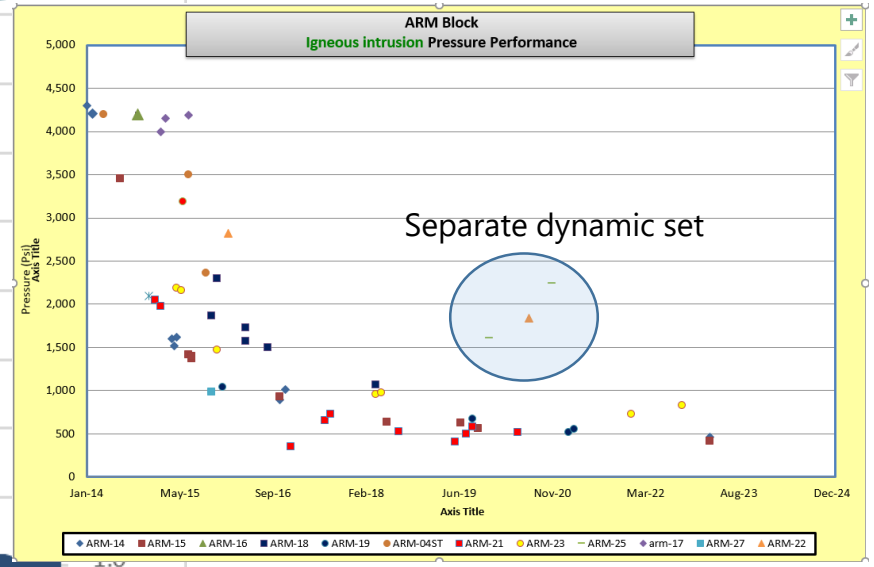
Sensible SKIN reduction achieved

Completion Comparison

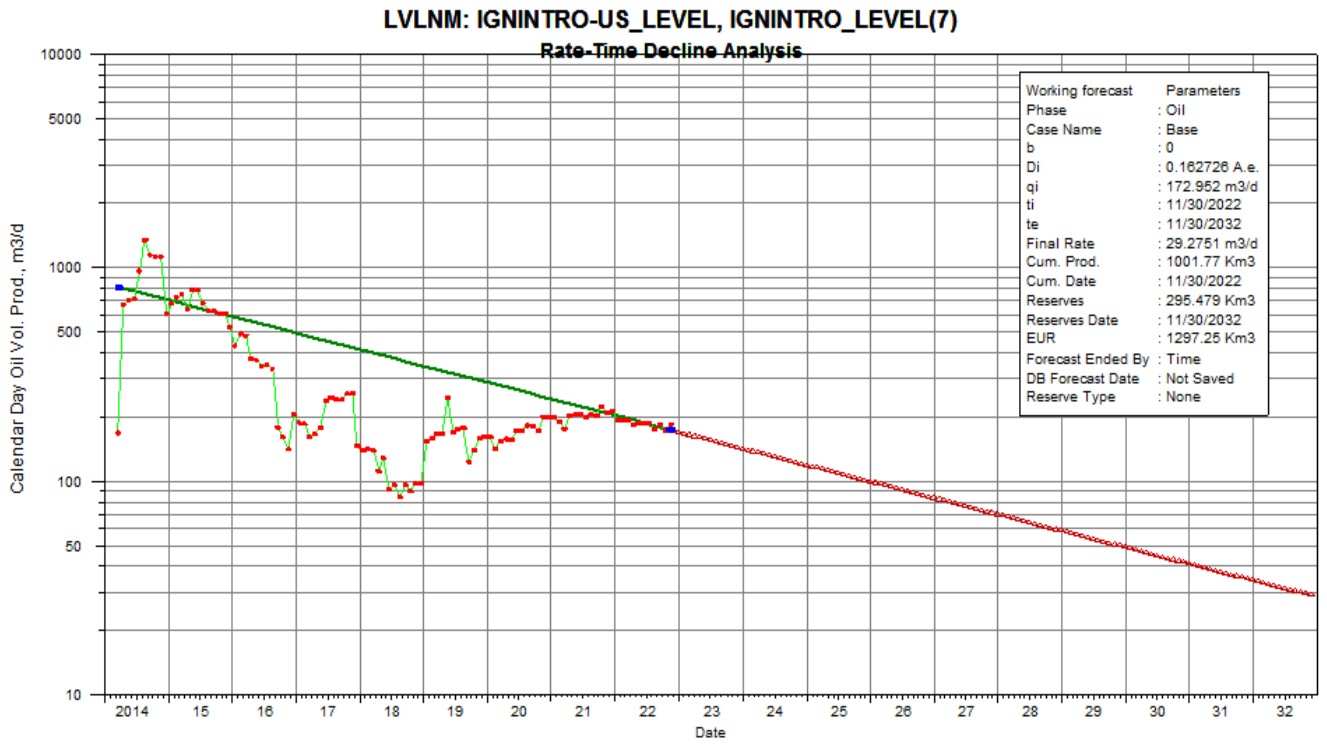
	ARM-14	ARM-15	ARM-16	ARM-18	ARM-19	ARM-04ST
Basaltic intrusion	1st between Eoc & L.Sen 2nd below Tur.	Below Eoc. (Upper Sen)	Below Eoc. (Upper Sen)	Below Cen. (Nubia)	Below Eoc. (Upper Sen)	1st Bottom of Eoc. 2nd Upper Sen.
Vertical Thickness, m	85	110	47.5	98	413	72
Measured Thickness, m	98	135	54	113	452	95
Completion	7" CSG+ CMT	5" Perforated liner	5" CSG+ CMT	Open hole	Open hole	5" CSG+ CMT
Losses	Yes	Yes (480 bbl)	No	Yes	Yes	Yes
Treatment (Type)	No	No	Yes (Acid)	No	Yes (Acid)	Yes (Acid)
Sensor Jan-15	Stopped	Working	Stopped	Working	Working	Working
Pump Depth (Pwf)		2042 (475)		3146 (2284)	2474 (1460)	2259 (1055)
Pwf at 9000ft		1349		1782	1795	1659
VSD	No	No	No	No	Yes	Yes
PI	1.5 (22 m) 3 (Total)	10 (Open hole) 3 (Perforated liner)	0.35	1.5	7	0.25

Igneous Intrusion – Production data



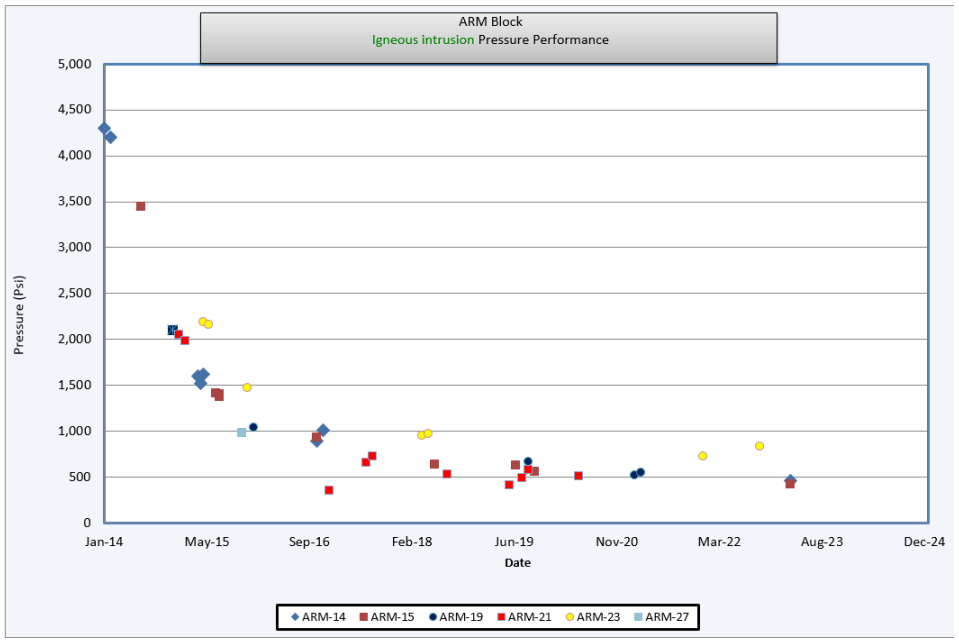


Igneous Intrusion – DCA and estimation of residual potential



Exponential decline to match Historical performance	**q(t) = qi * exp[-Di * t] Di=0.16**
Cum. Prod @ 12/2022 [MMstb]	**6.3**
Estimated remaining Reserves @ 12/2032 [MMStb]	**1.8**

- 6 Wells in the analysis (ARM-4/14/15/19/21/23)
- Economical cut-off at 30cm/d in total

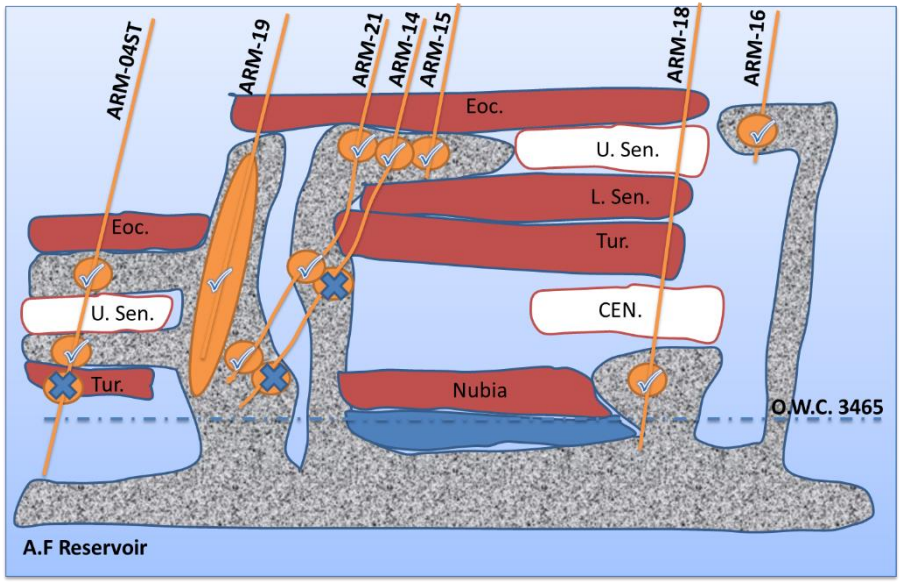


Conclusion and way forward

Main Remarks

- INTRUSION mainly to be considered as IGNEOUS rock with limited extension and high potential (high fracture density overall, most of fractured opened)

- INTRUSION **proved to have potential** if:
  - Fractured system is identified (with good storage capacity)
  - Presence of anisotropy
  - Good gas reading



Way forward

- **Screening of existing wells** (in downtime or low productivity) crossing INTRUSION in good petrophisical areas

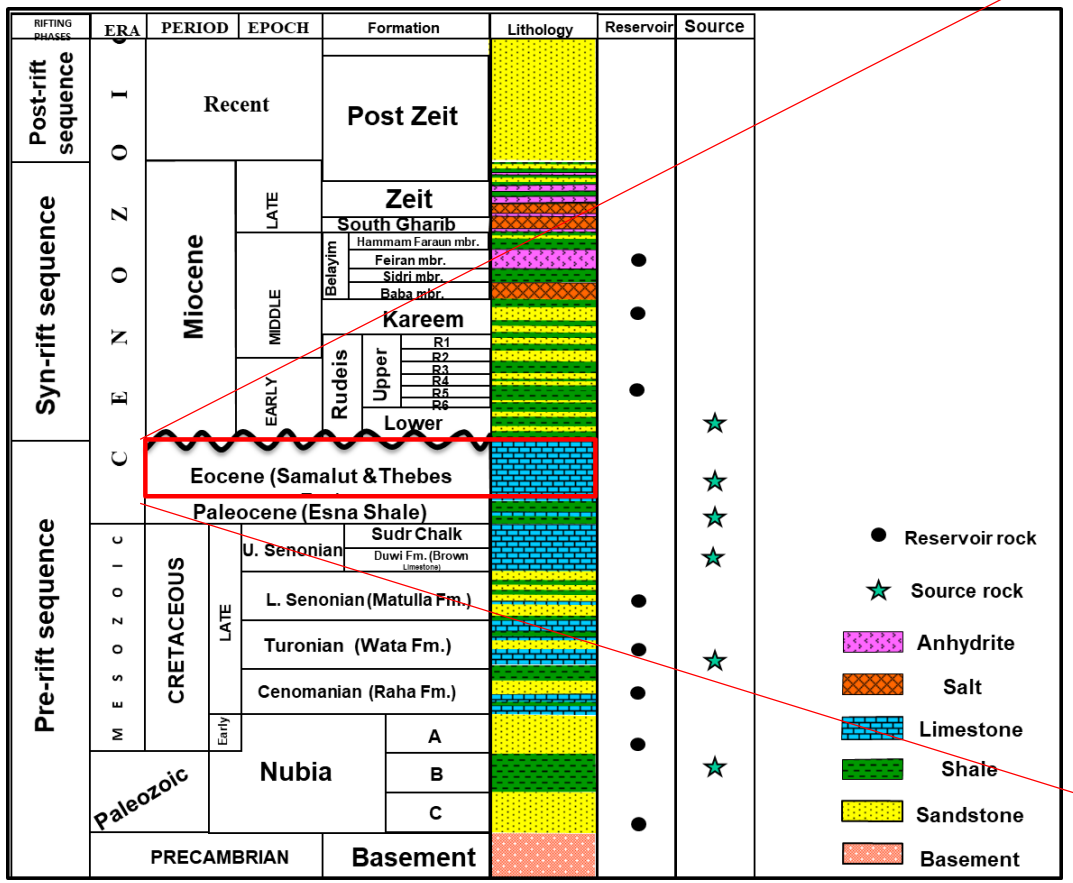
- Identification of best **candidates for recompletion** in INTRUSION

- Select the optimized water injection method for pressure support

Eocene in Belayim Marine

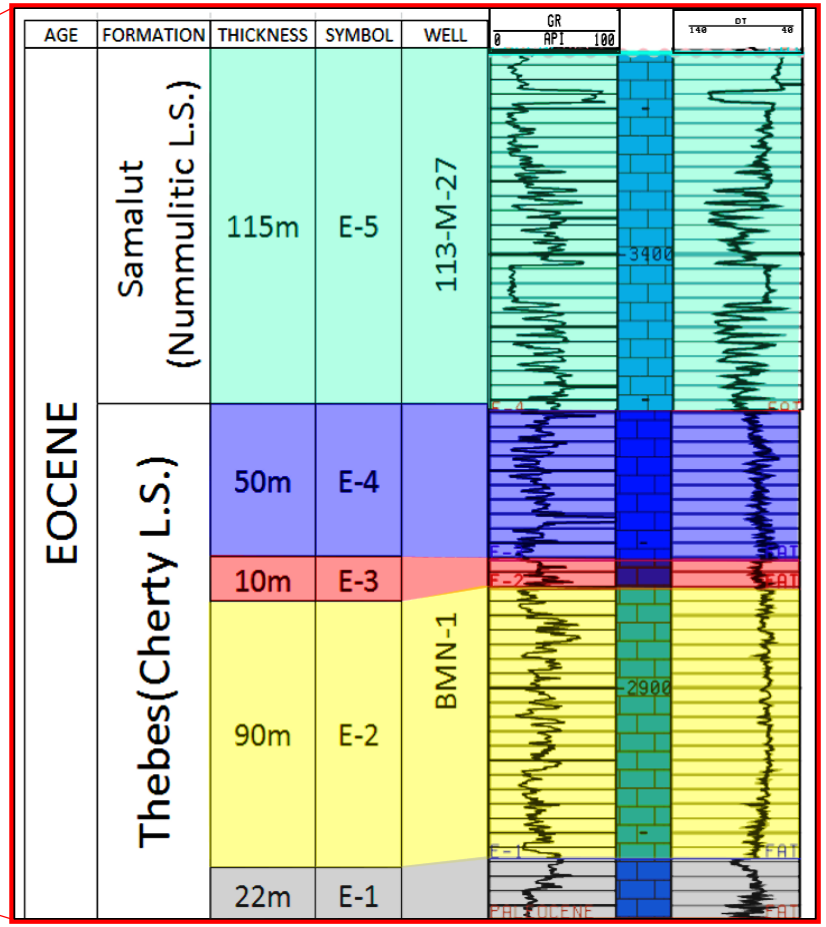
Geological Insight – Eocene in Belayim Marine

Stratigraphic Column



Uplift created unconformity between Eocene and Miocene sediment → exposure to weathering and erosion

Eocene sub-division



NB:
91 wells entered Eocene down to E3
59 wells entered down to E2
18 Wells Entered all the way down to E1

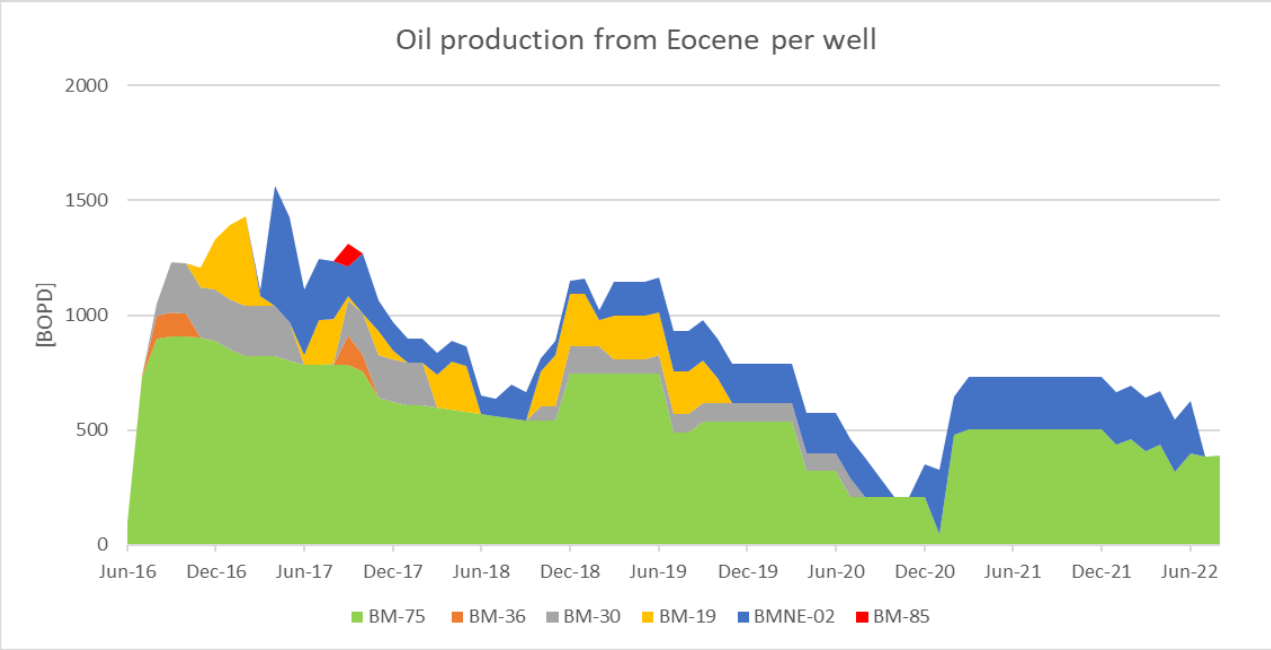
Only 7 Wells produced from Eocene fm

E5: chalky limestone of Middle Eocene age

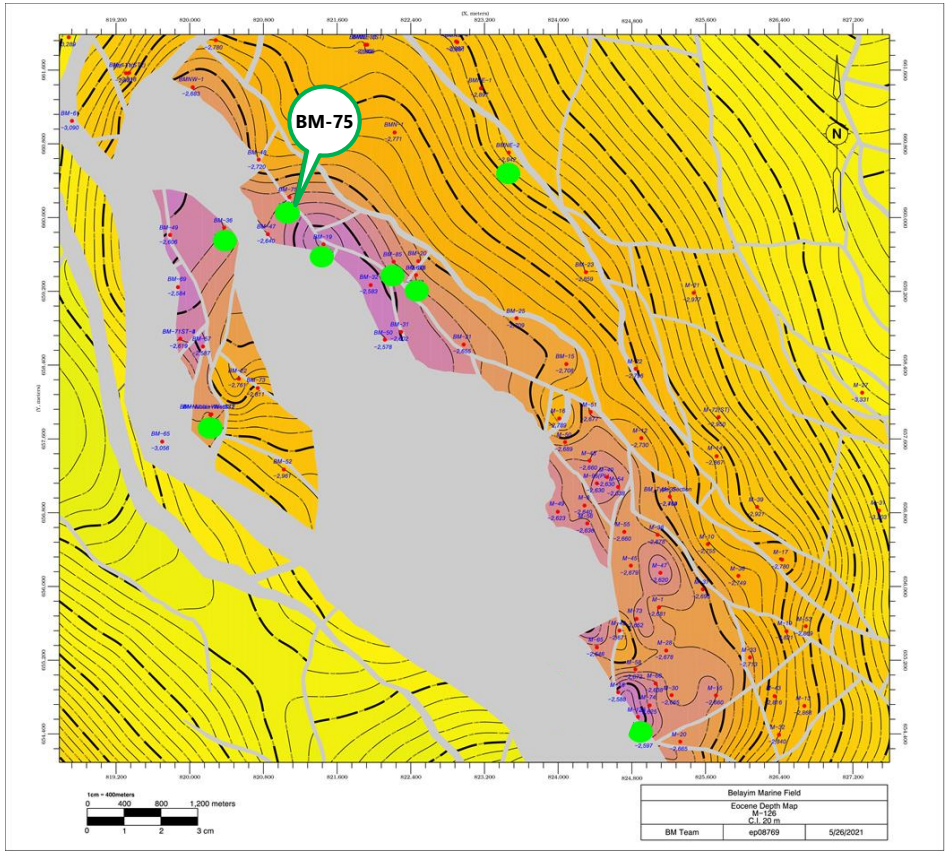
E4-E3-E2:cherty lime stone of the Lower Eocene age

E1: argillaceous limestone of the Lower Eocene age

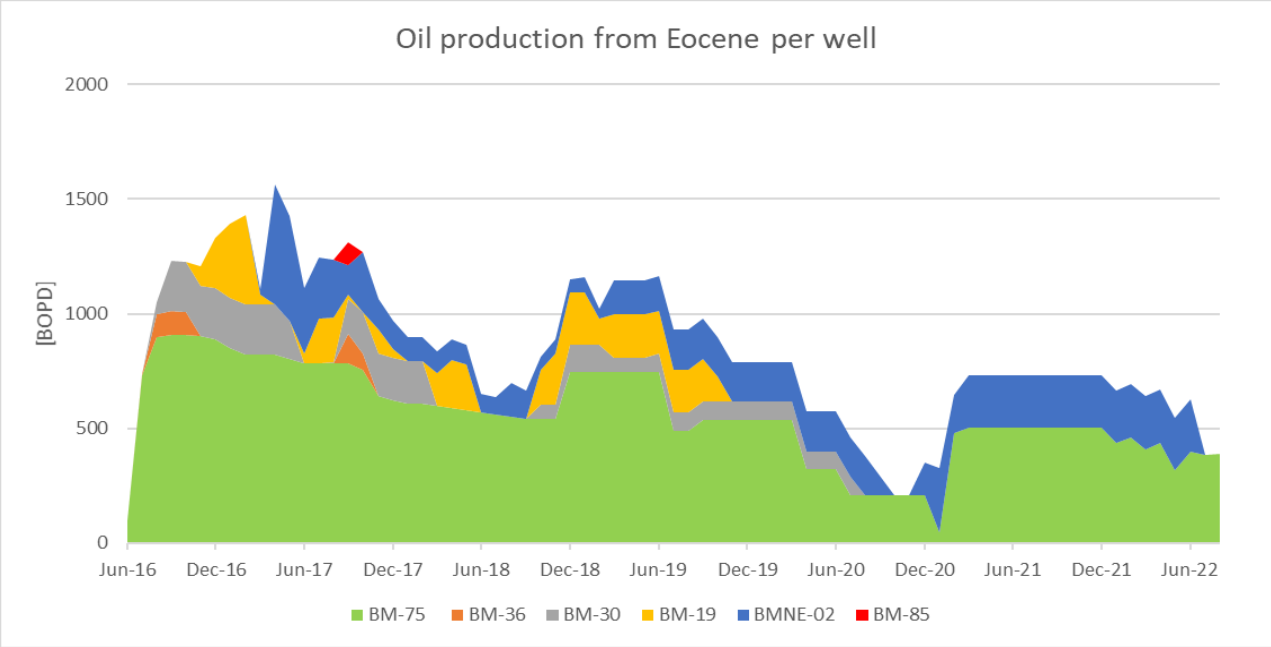
Production figures – Eocene in Belayim Marine BM-75



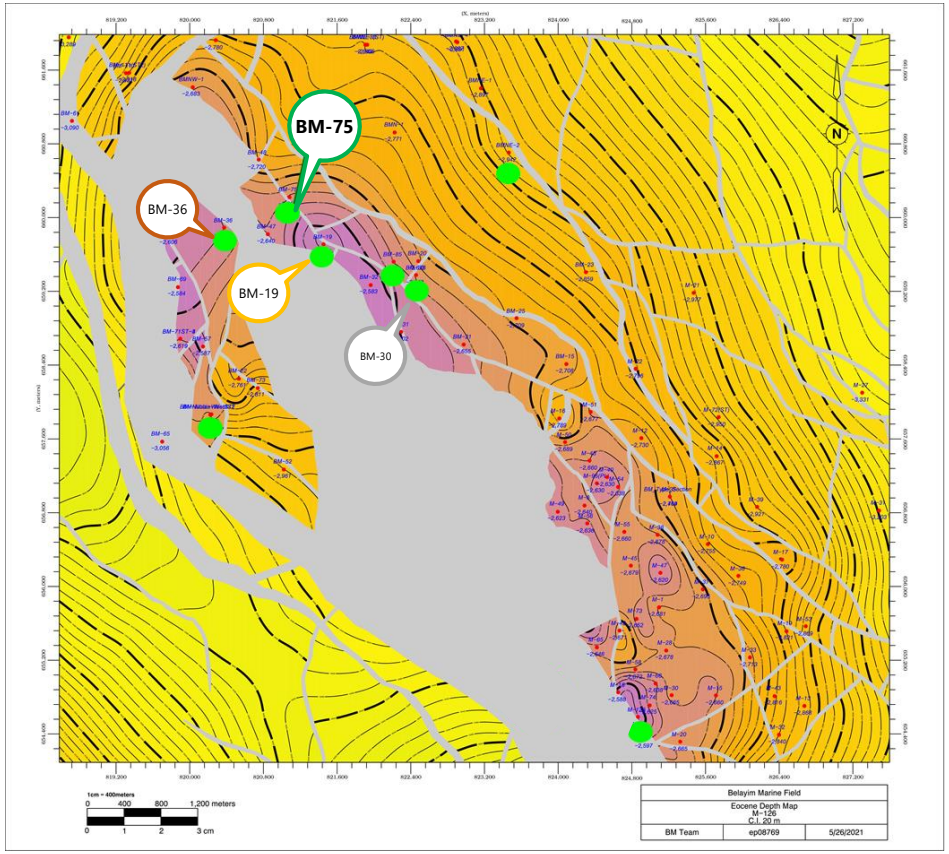
Well	S/U date	S/U Rate [bopd]	Initial WCT [%]	Last net rate [bopd]	Last WCT [%]	Cum oil vol [MMstb]
BM-75	Jun-16	830	1	250	30	1.3



Production figures – Eocene in Belayim Marine - BM-33/30/19

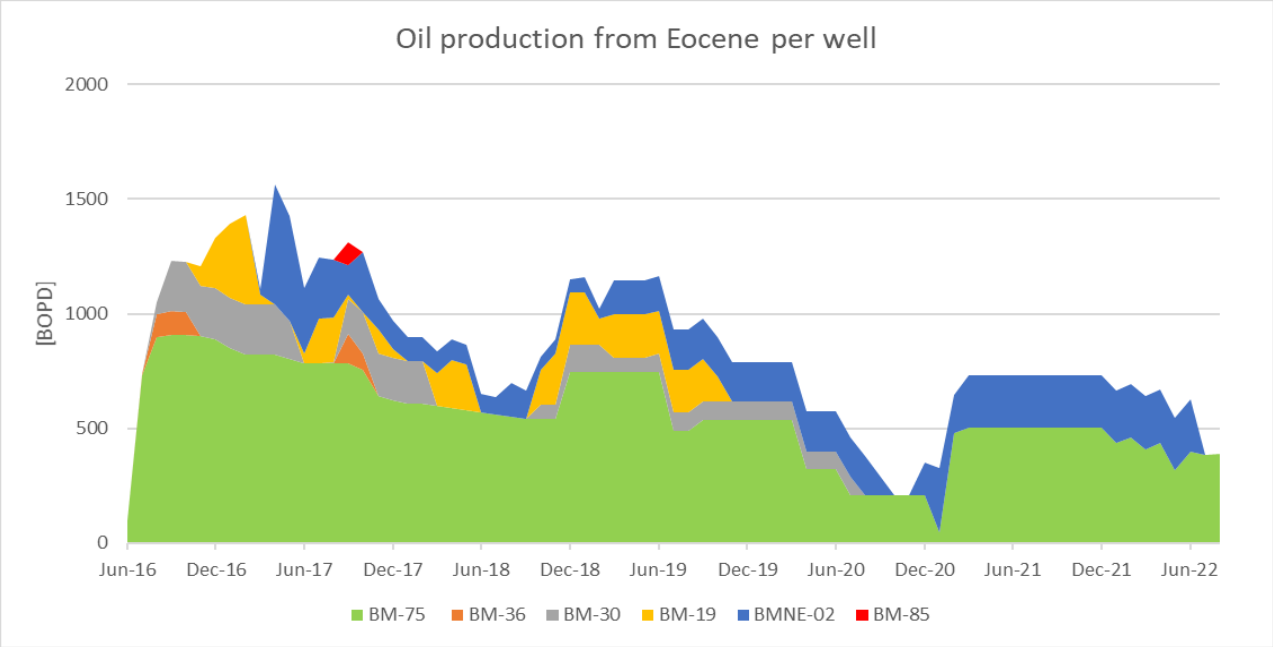


Well	S/U date	S/U Rate [bopd]	Initial WCT [%]	Last net rate [bopd]	Last WCT [%]	Cum oil vol [MMstb]
BM-75	Jun-16	830	1	250	30	1.3
BM-36						0.015
BM-30	Aug-16	230	20	75	85	0.15
BM-19	Dec-16	250	20	230	40	0.14

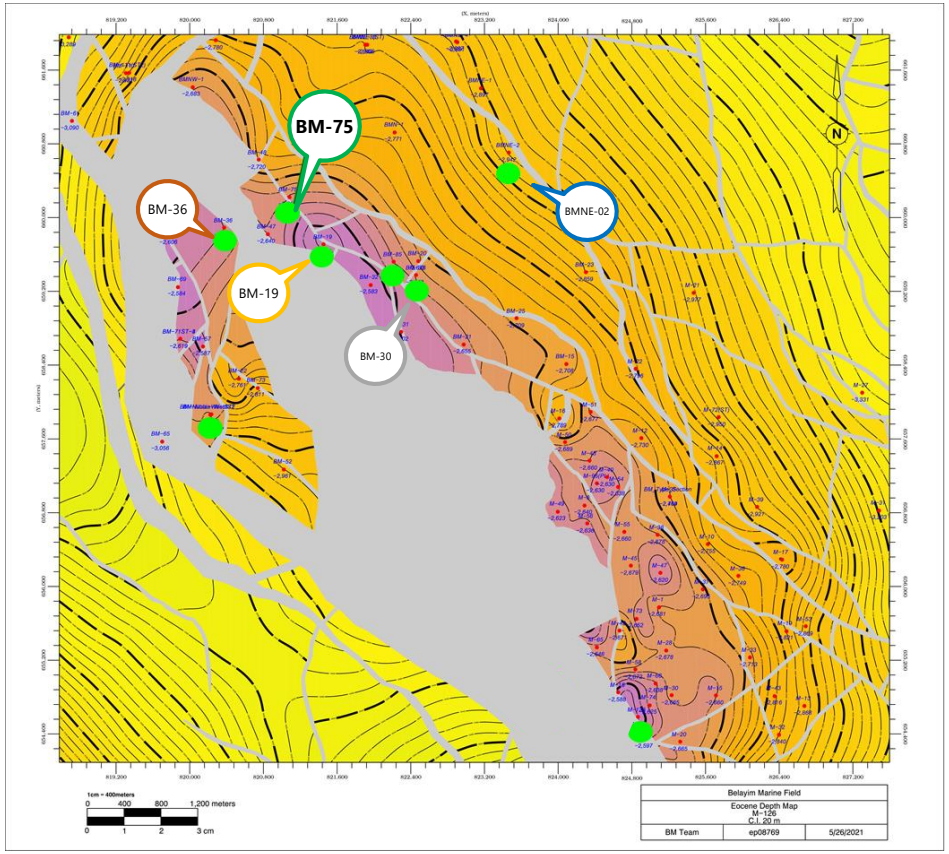


Info on BM-36/30/19

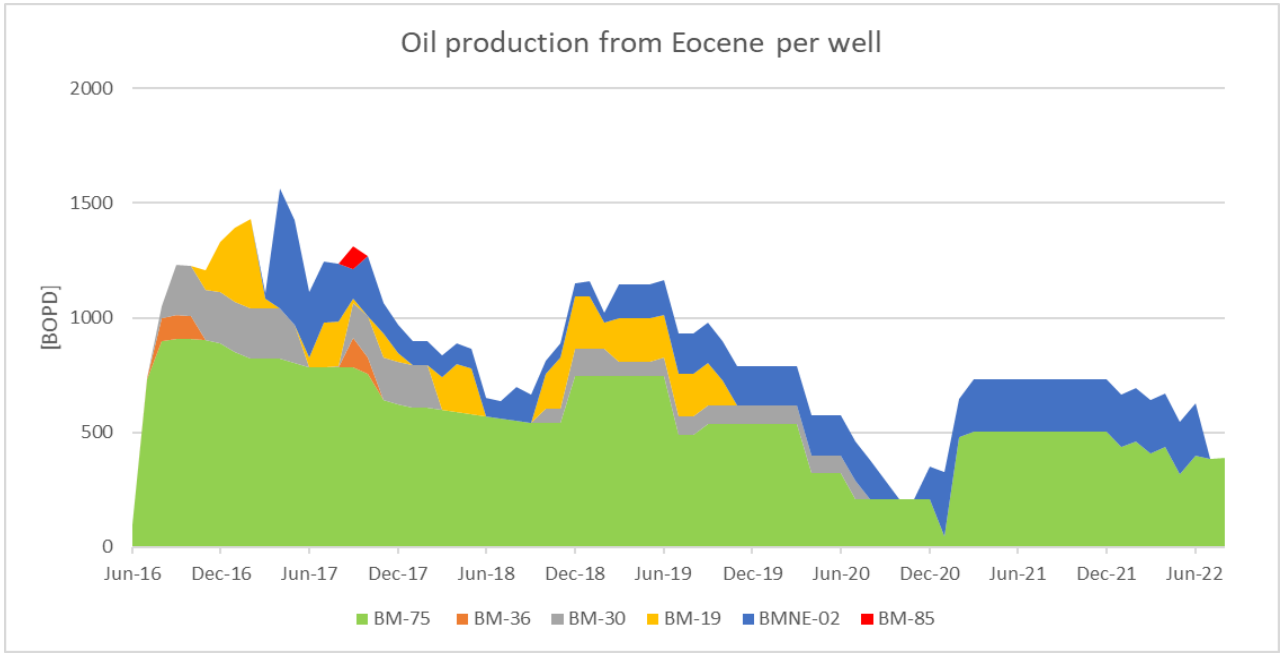
Production figures – Eocene in Belayim Marine – BMNE-02



Well	S/U date	S/U Rate [bopd]	Initial WCT [%]	Last net rate [bopd]	Last WCT [%]	Cum oil vol [MMstb]
BM-75	Jun-16	830	1	250	30	1.3
BM-36	July -16					0.015
BM-30	Aug-16	230	20	75	85	0.15
BM-19	Dec-16	250	20	230	40	0.14
BMNE-02	Mar-17	300	45	110	70	0.34

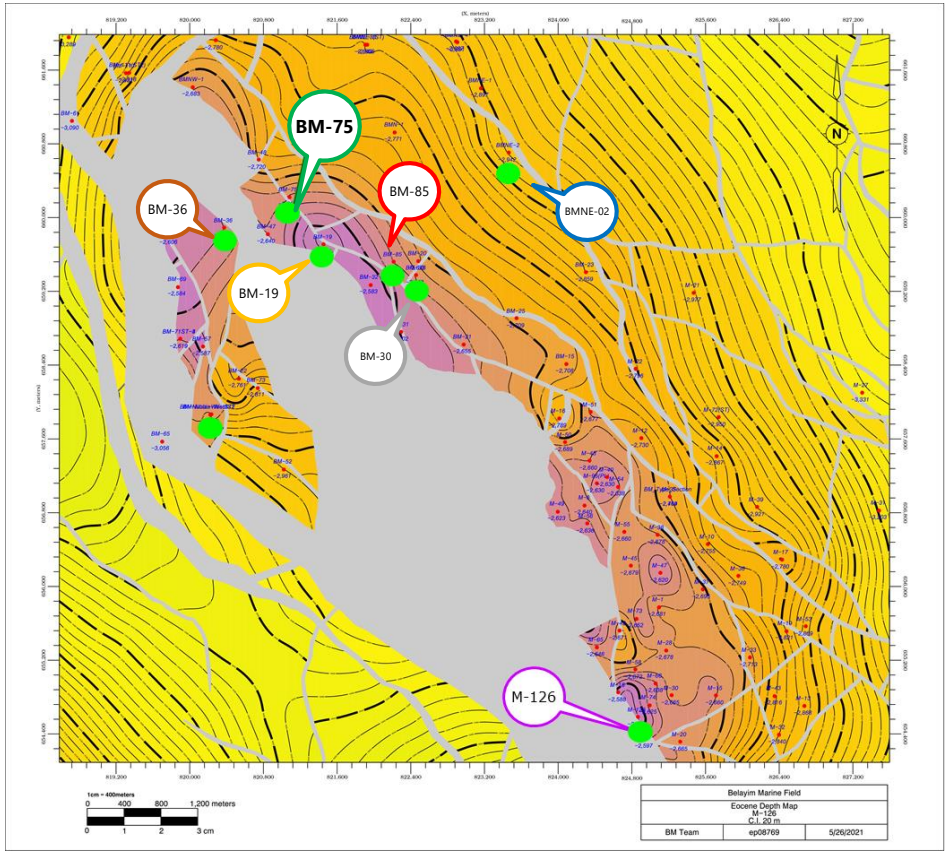


Production figures – Eocene in Belayim Marine – 113-M-126



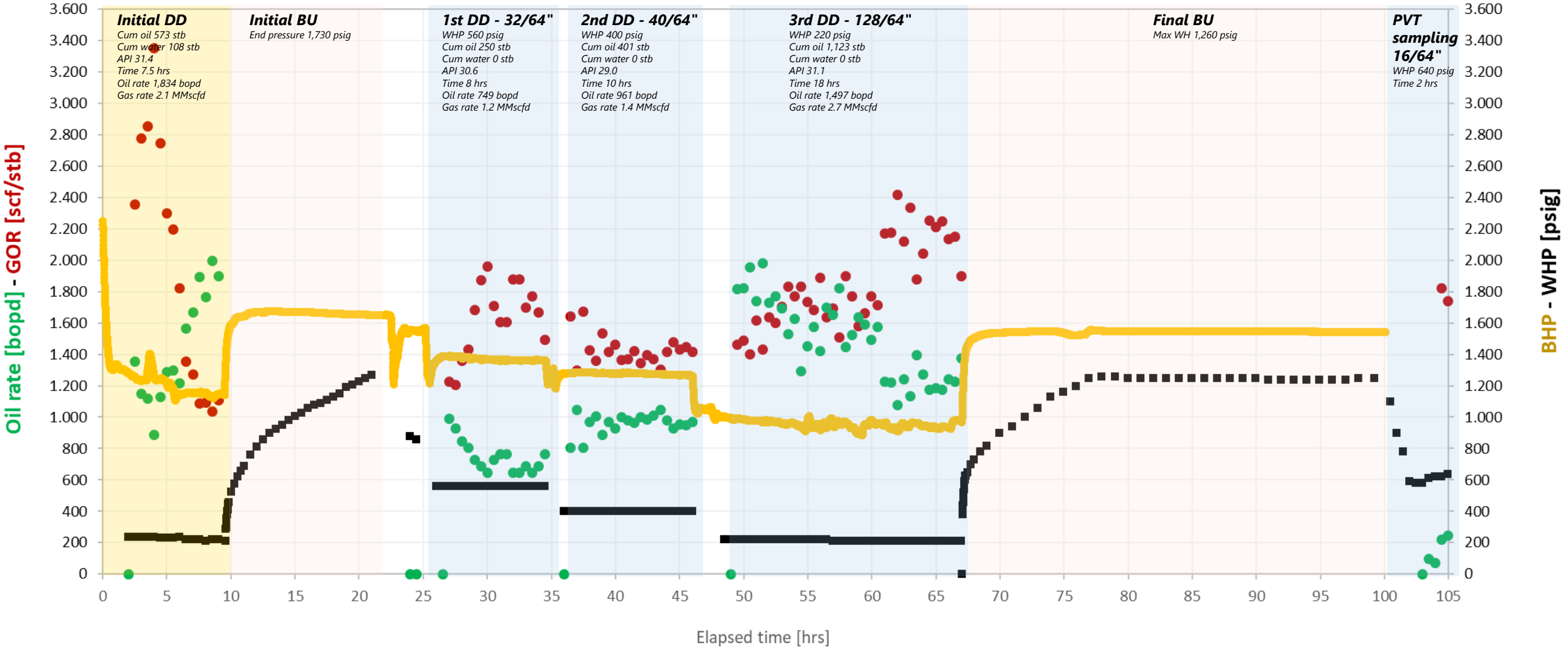
Well	S/U date	S/U Rate [bopd]	Initial WCT [%]	Last net rate [bopd]	Last WCT [%]	Cum oil vol [MMstb]
BM-75	Jun-16	830	1	250	30	1.3
BM-36	July -16					0.02
BM-30	Aug-16	230	20	75	85	0.15
BM-19	Dec-16	250	20	230	40	0.15
BMNE-02	Mar-17	300	45	110	70	0.35
BM-85	Sept-17		99			0.003
113-M-126	Jun-2021	1000-1500	0% but HIGH GOR (1400-2200)	NA	NA	Well test data

Total CUM. 2 MMBBLS

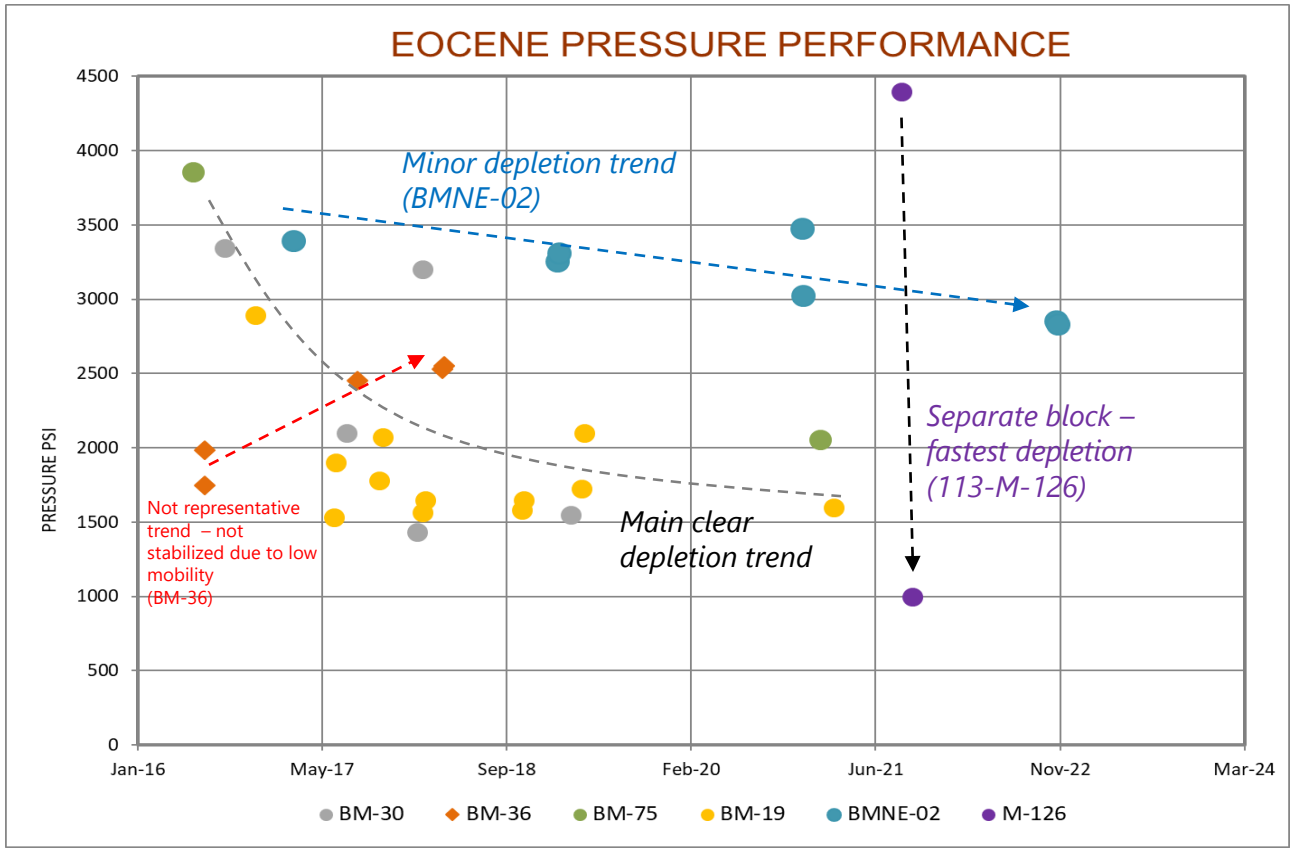


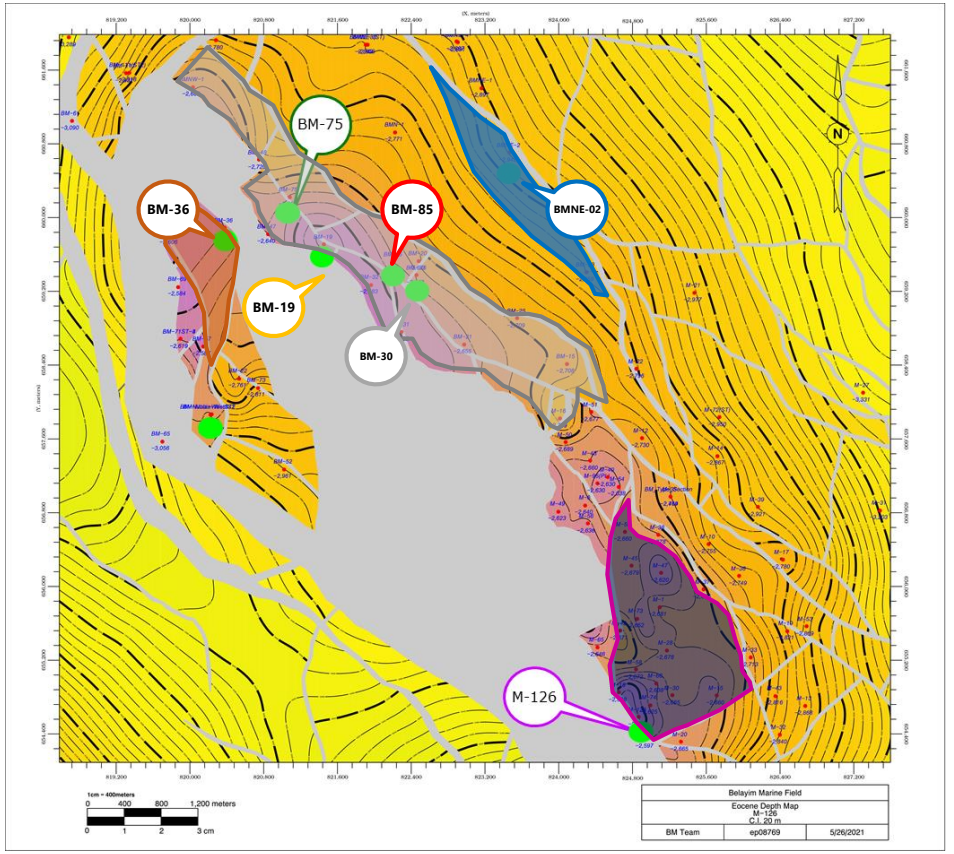
- *Eocene: 68 m TVD (RFT average formation pressure 4,340 psi)*
- *113-M-126 reached TD into Eocene Thebes Fm. @ 3,050 m MD with 6" phase*
- Eocene section completed with 5" slotted liner (85 mMD)

Sinai: 113-M-126 (Eocene) well testing summary



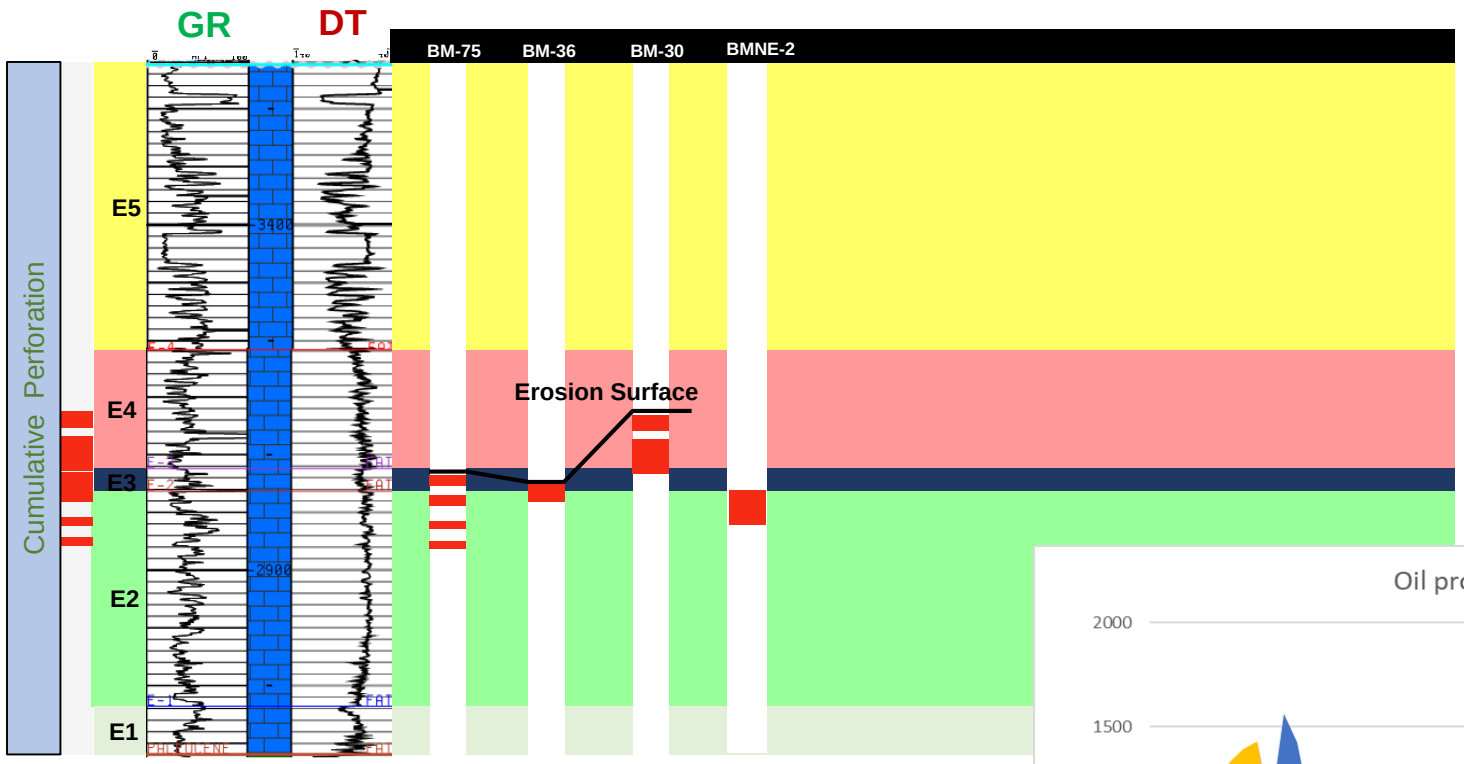
Static Pressure Trend



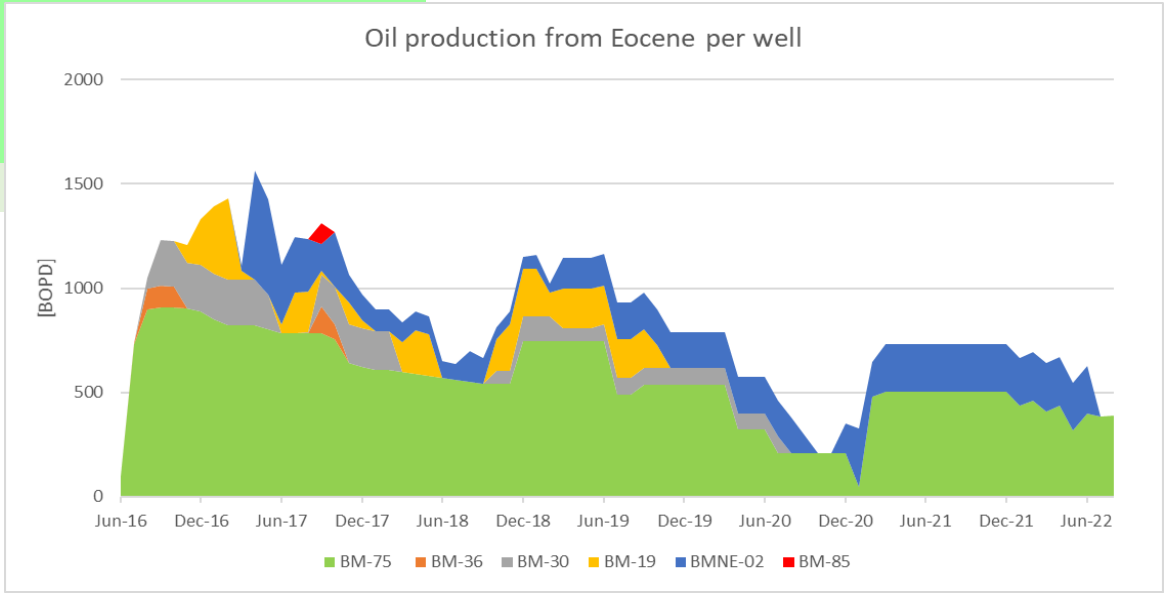


NB:
Pressure regime analysis suggest the presence of separated areas

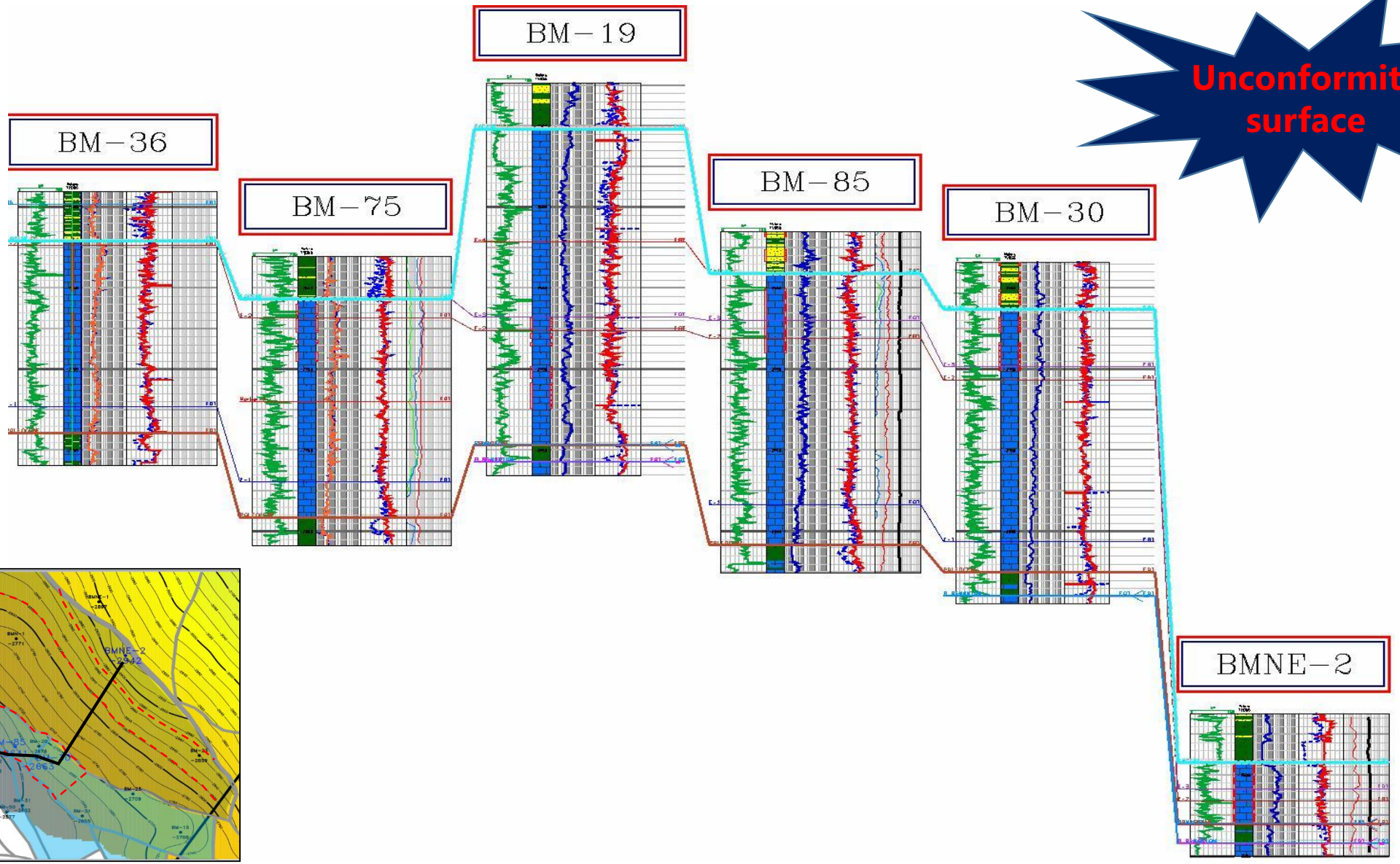
Productive Perforation Summary Of Eocene Reservoir in Marine



Total Cumulative Production from Eocene is ~2 MMStb



Structure Correlation Panel for Eocene



Eocene Stimulation Experience

Well Name	Perf interval [m]	Acid %	Porosity	Production Rate [m3/d]	Successful tag
BM- 75	27	10 % HCL + 15 % HCL	(16 –20) %	150	
BM-36	48	7.5 % HCL + 15 % HCL	(13 –16) %	20	
BM-30	36	7.5 % HCL+ 15 % HCL + 1.5 % HF + 2.5 % acetic	(13 –16) %	35	
BM-19	39	10 % HCL+10% acetic+ 9 % formic acid + 7.5 % MSR	(16 –20) %	75	
BMNE-2	37	7.5 % HCL + 15 % HCL		80	
BM-85	46	10 % MSR + 15 % MSR		80	But 100 % WC

Statistics of stimulated wells in Eocene - Belayim Marine

Stimulation of carbonate component of EOCENE soon after perforation ***PROVED*** *as effective approach*

Rate of success >80 %

Eocene in Abu Rudeis / Sidri

Abu Rudeis – Eocene experience summary

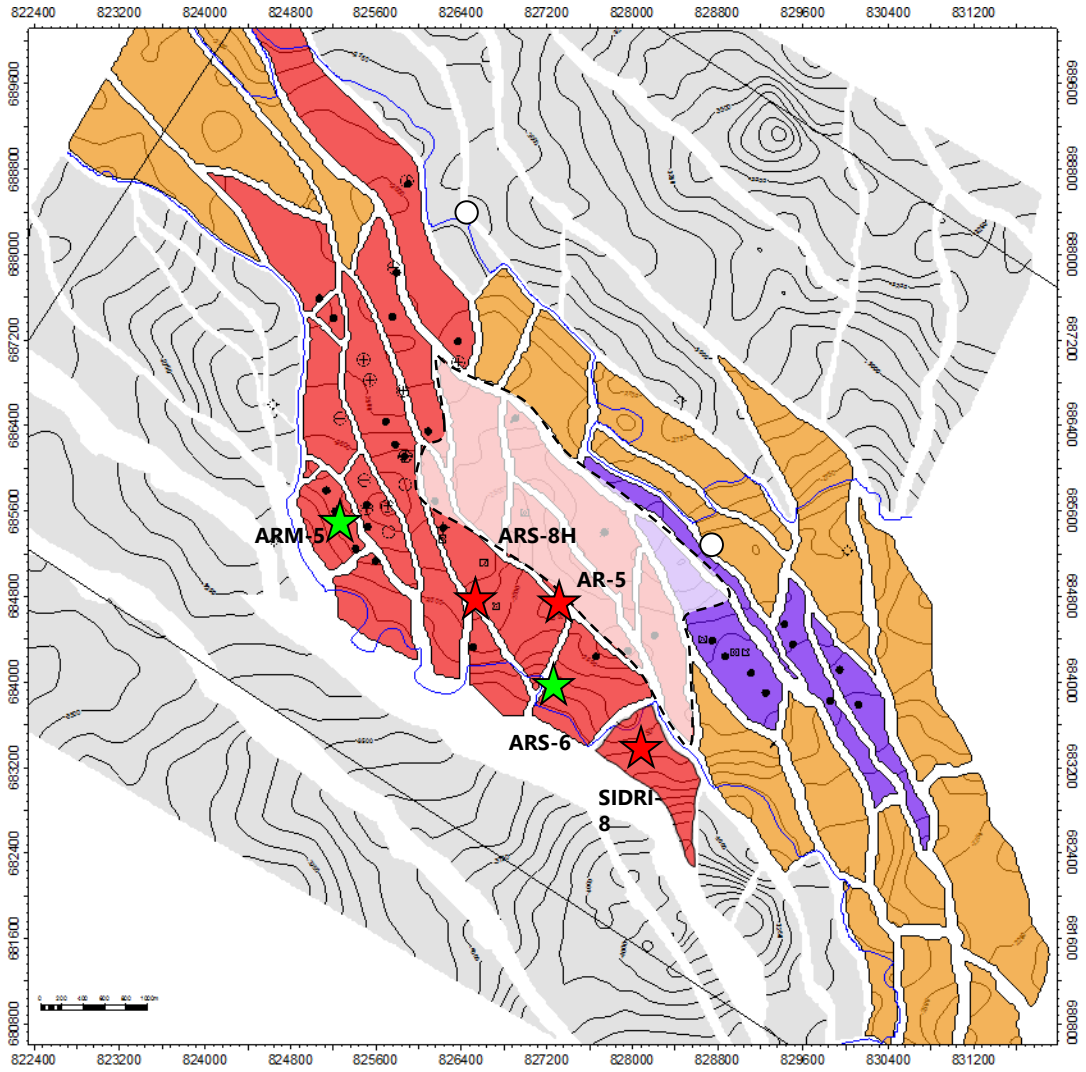
1- In 1981, while drilling the Eocene section of the well ARS-3, oil was kicked out with 10 bbls/hrs. The decision was taken to cut cores (oil staining along fractures) and to test the Eocene carbonates. The result was negative with very short oil flow after two acid jobs.

2- In 1989, for the first time in Petrobel history, oil flowed at a commercial rate from the Eocene fractured limestone in the well ARS-6.

3- In 1990, while deepening the well R-5, it was recommended to test the stratigraphically equivalent interval to the producing horizon of the well ARS-6 and to run the Formation MicroScanner (FMS) log. Unfortunately, the test result was negative, in spite of the fact that the well R-5 is in structurally higher level than ARS-6.

4- In l995, the horizontal well ARS-8H was drilled according to the recommendation of AGIP study. The well was oriented in a NW direction parallel to the main NW trending fault, assuming that the well will intersect the highest number of fractures that oriented NE-SW orthogonal to the main NW trending fault.

Abu Rudeis – Eocene experience summary



No Data in Eocene

Abu Rudeis exploited Areas

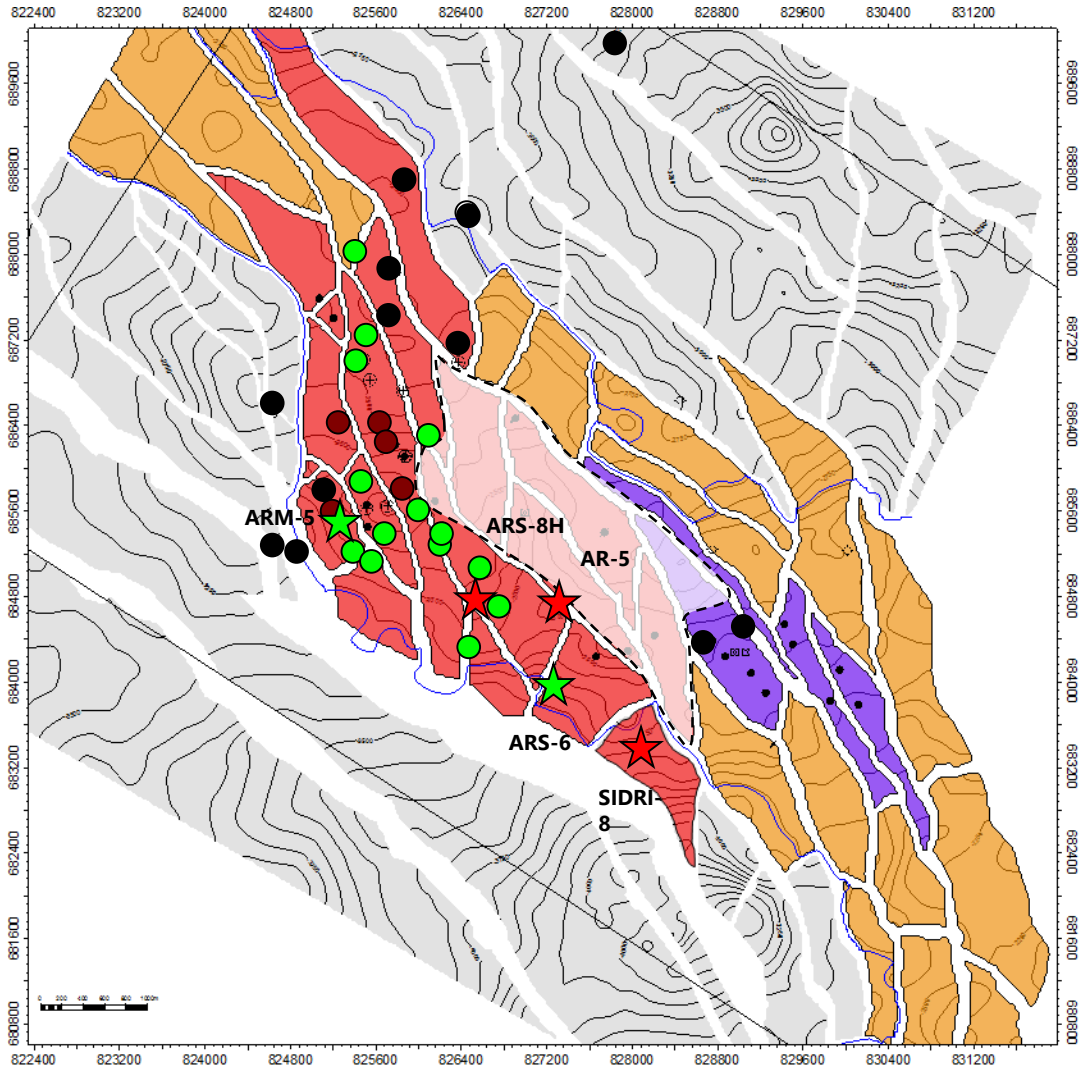
SIDRI exploited Areas

Un-appraised Areas

Wells producing from Eocene

Eocene Tested and Abandoned

Abu Rudeis – Eocene experience summary

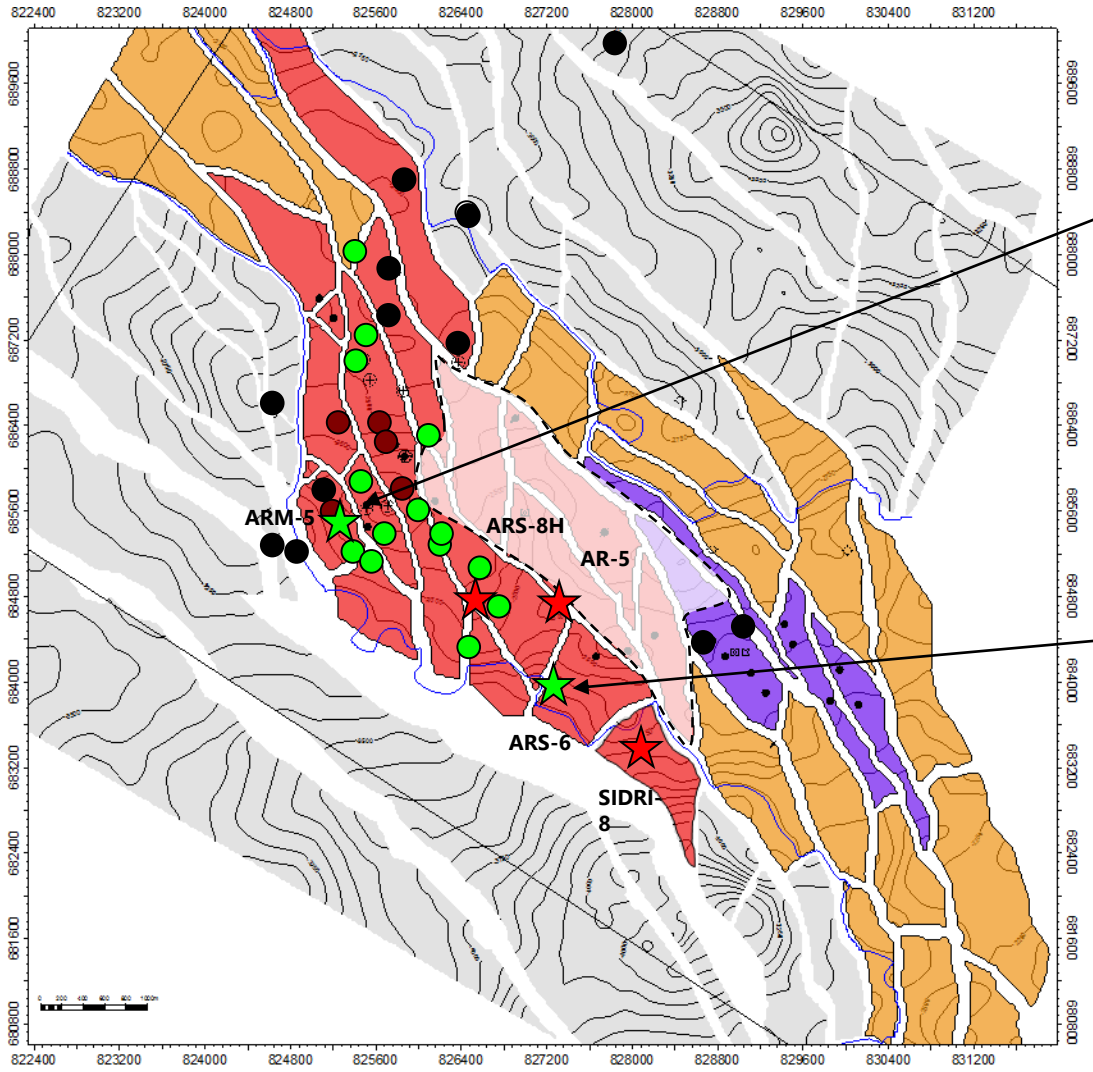


Eocene petrophysical properties and Production:

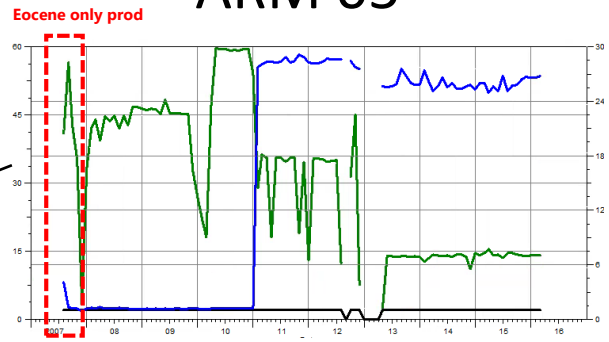
- Good petro and put in production : ARS-06 (1.5 MMstb) , ARM-05 (0.3 MMstb)
- Good petro, opened with poor results (without stimulation!) : AR-5, SIDRI-8, ARS-8 H
- Good Petro but never tested in Eocene: AR-8, ARS-01, ARS-03*, ARS-04, ARS-05, ARS-09, ARM-01, ARM-06, ARM-07, ARM-22, ARM-23, ARM-25, ARM-27, ARM-31.
- Low Porosity: ARN-02, ARN-03, SIDRI-4, SIDRI-9, ARM-02, ARM-3, ARM-8, ARM-9, ARM-16, ARM-17, ARM-35ST, ARM-36, AZSE
- Eocene serie replaced by metasediment: ARM-4ST1/2, ARM-14, ARM-15, ARM-19ST, ARM-21

- No Data in Eocene
- Abu Rudeis exploited Areas
- SIDRI exploited Areas
- Un-appraised Areas

Abu Rudeis – Eocene experience summary

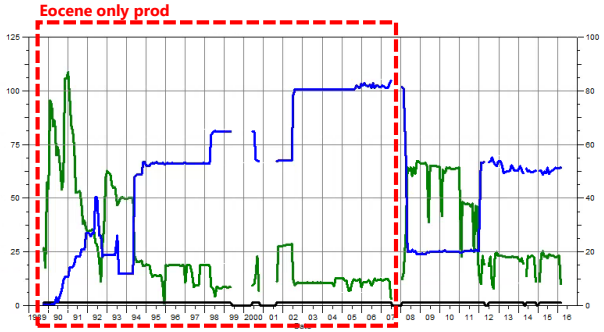


ARM 05



- The Eocene contribution only from july to decembre 2007.
- Later production in commingle Eocene + LS

ARS 06



- Production started sept 1989, with good oil rate (>600 Stb/d).
- Water production started july 1990 (600 stb/d).
- L. Senonian was opened in cmg later, in 2008.

No Data in Eocene

Abu Rudeis exploited Areas

SIDRI exploited Areas

Un-appraised Areas

CONCLUSION & WAY FORWARD

Conclusion and way forward

Main Remarks

- Eocene mainly to be considered as source rock with very limited reservoir potential (low porosity, low pore throat size, low fracture density overall)

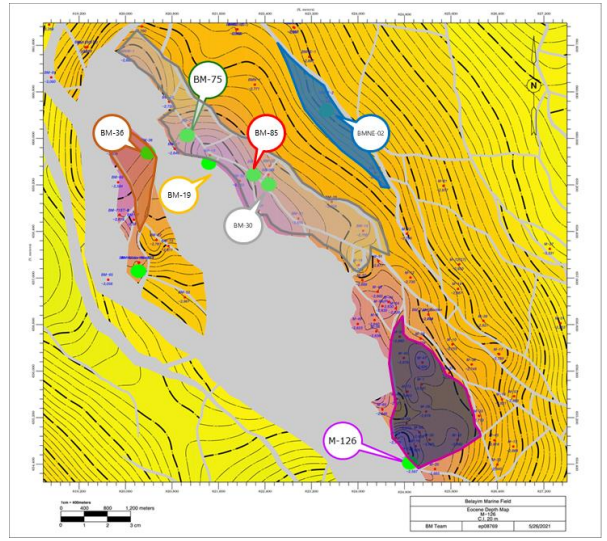
- Eocene **proved to have potential** if:
  - Fractured system is identified (with good storage capacity)
  - Presence of secondary porosity (to accommodate source oil)
  - Successful Acid stimulation (contact oil filled fractures)

Way forward

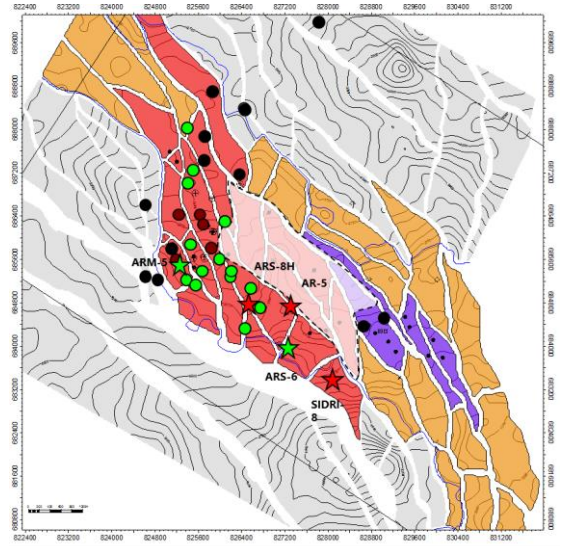
- **Screening of existing wells** (in downtime or low productivity) crossing EOCENE in good petrophisical areas

- Identification of best **candidates for recompletion** in EOCENE and stimulation (Hydraulic fracturing/Acid job)

Belayim Marine Eocene Map



Abu Rudeis Eocene Map



THANK YOU

QUESTIONS?