

# Carbonate Reservoirs

## Abu Roash (F & D) Members

Successful Case study in BED-1 Brown field  
Abu Gharadig Basin-Western Desert of Egypt

**WEPCO**





# Agenda





# Agenda



**BED-1 Field Overview**

**BED-1 Field Production Milestone**

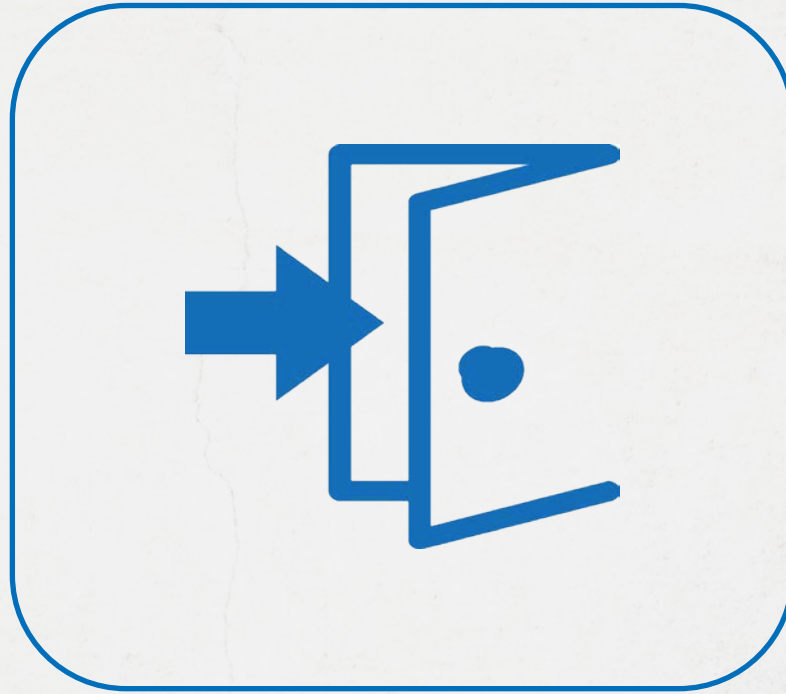
**ARF/ source Rock , and how it leaded to a new discovery**

**ARF/Reservoir History**

**ARD/ Geological Background**

**ARD/ Production History & Reserve**

**Conclusion**

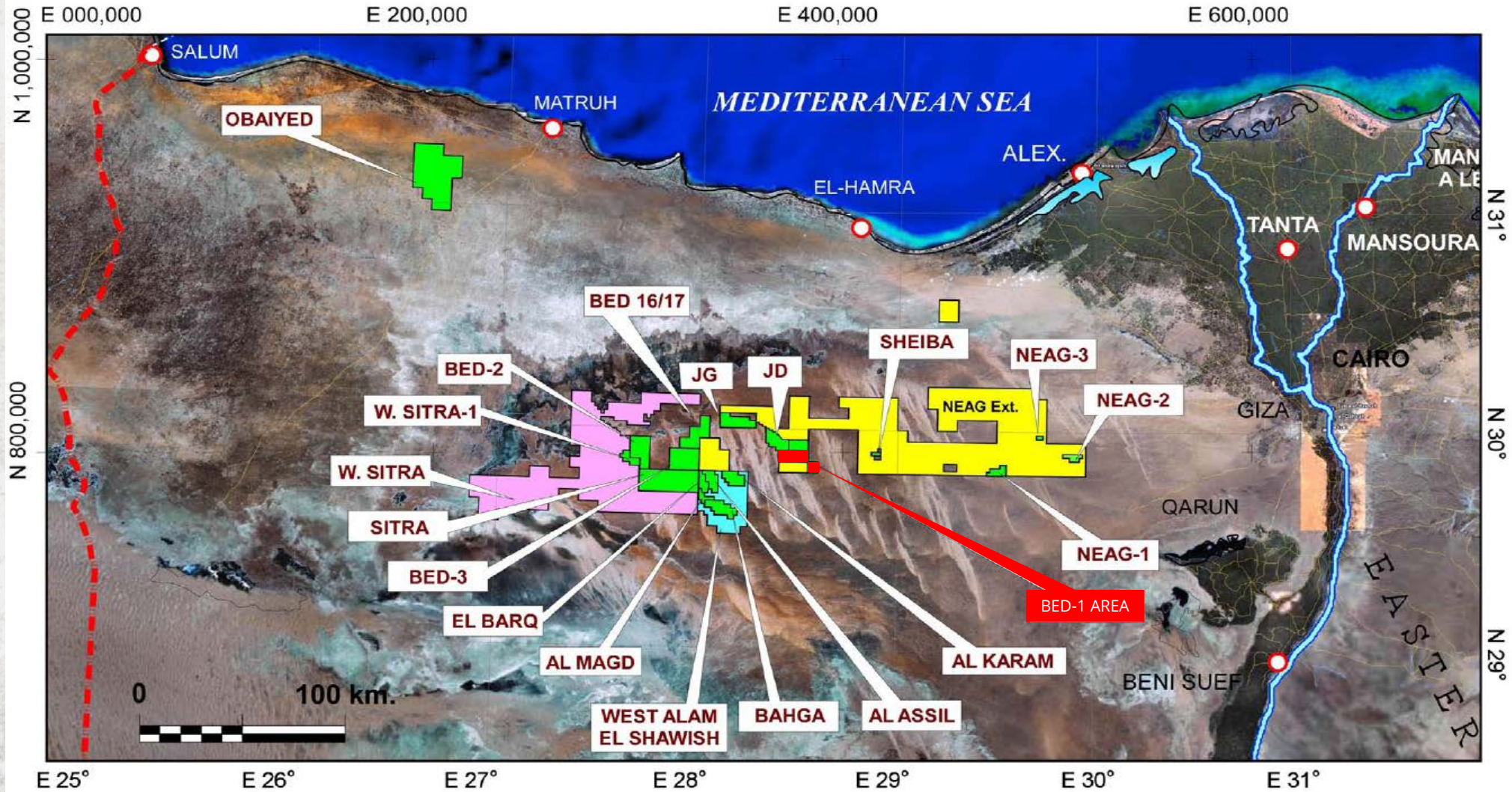


# BED-1 Field Overview





# BED 1



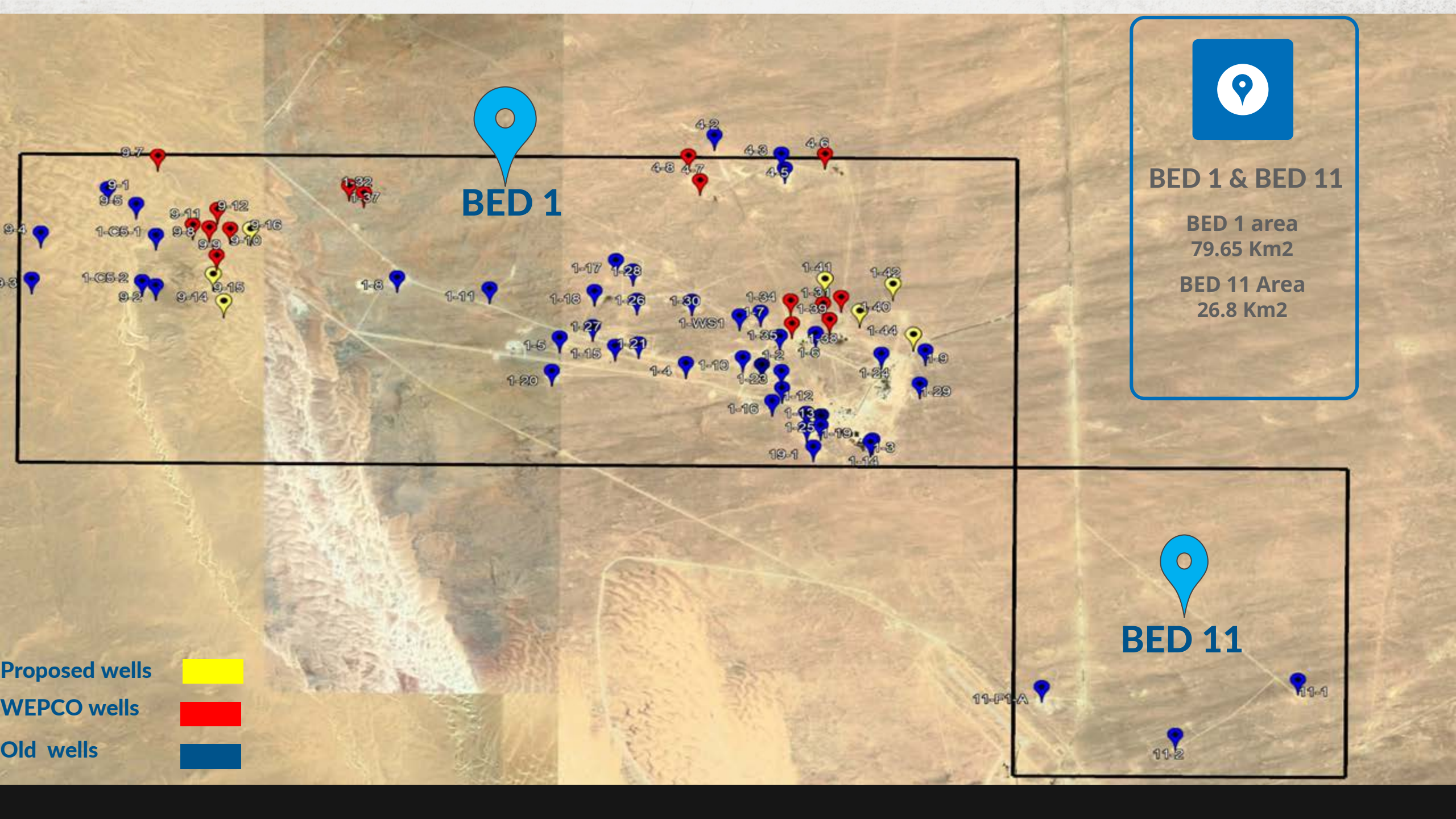




## BED 1 & BED 11

BED 1 area  
79.65 Km<sup>2</sup>

BED 11 Area  
26.8 Km<sup>2</sup>



## BED 1

## BED 11

Proposed wells  
WEPCO wells  
Old wells



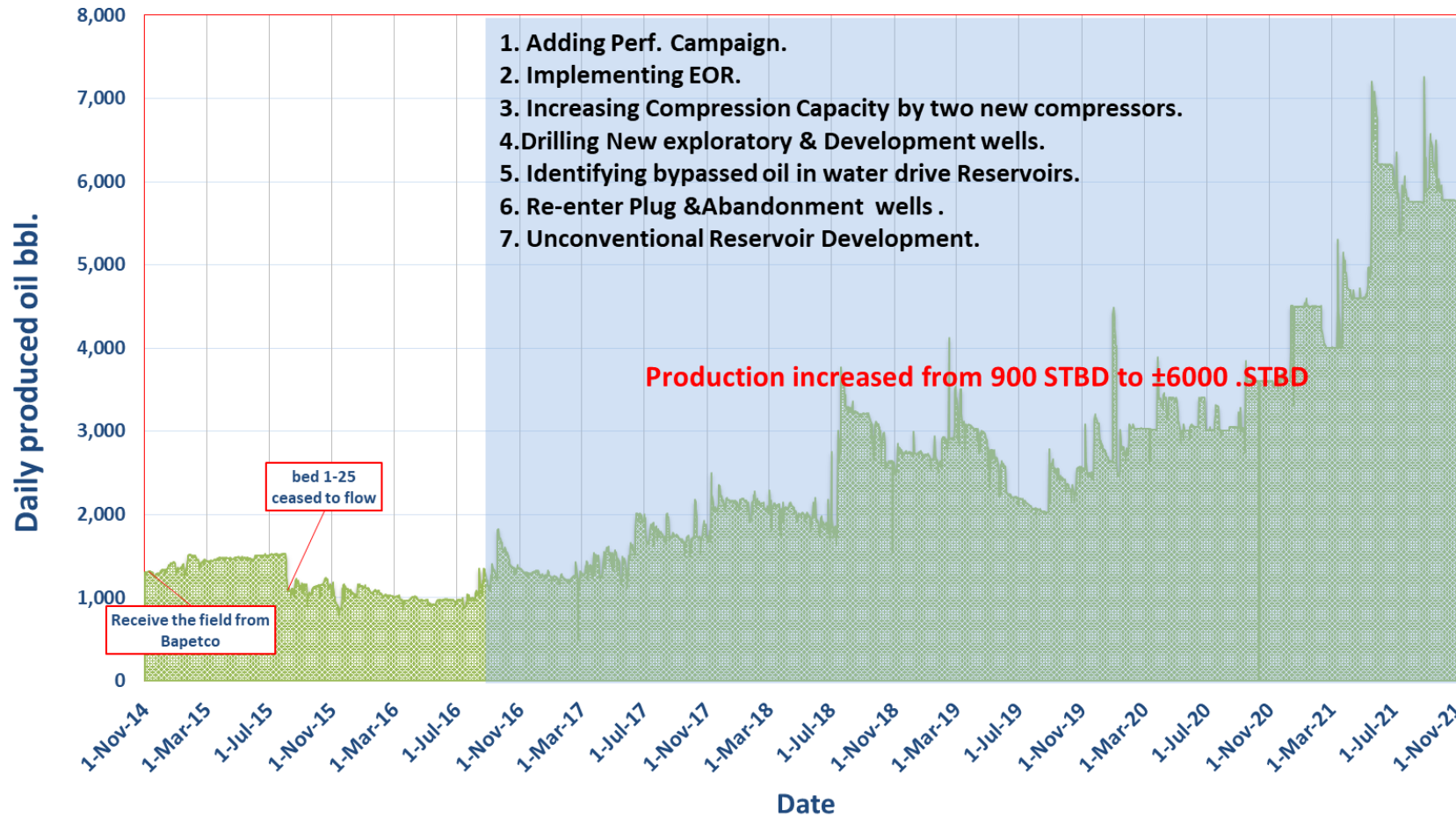




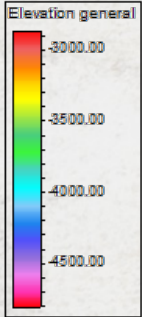
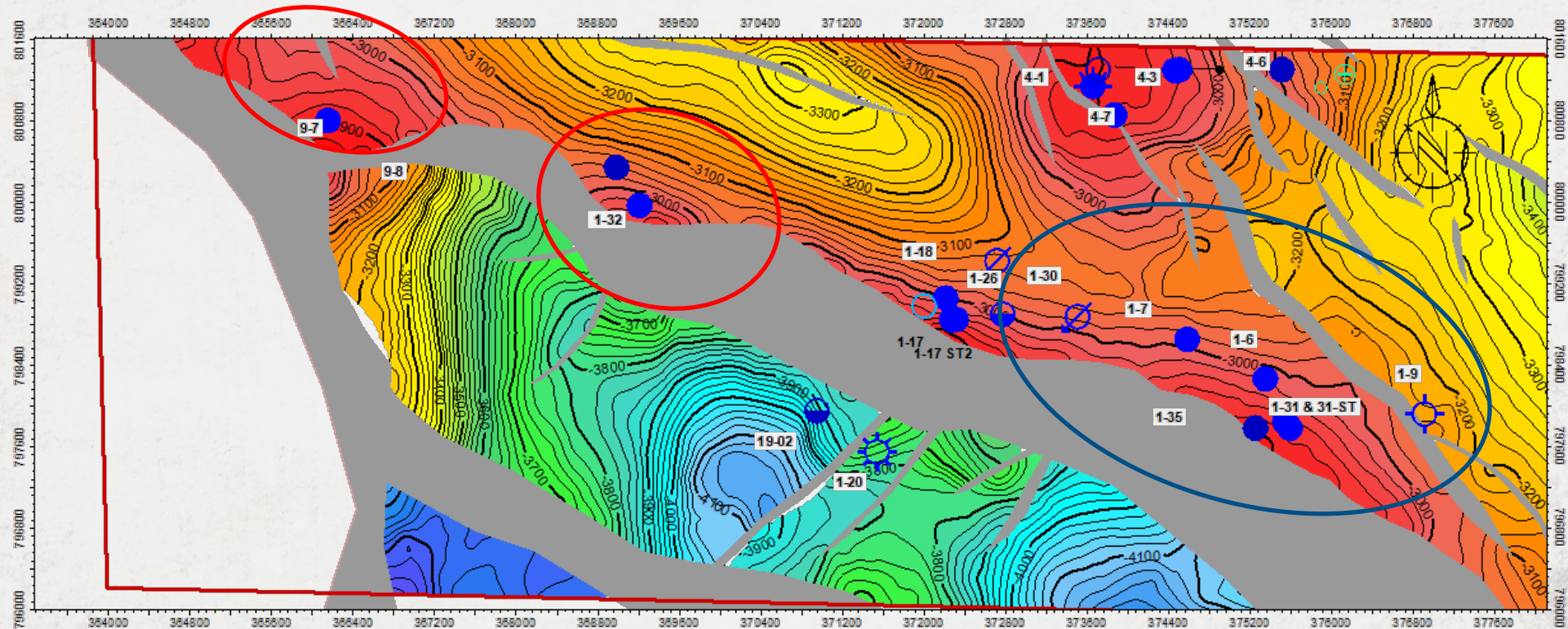
# BED-1 Field Production Milestone



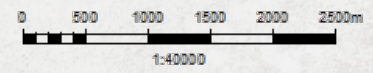
### BPCO production Performance







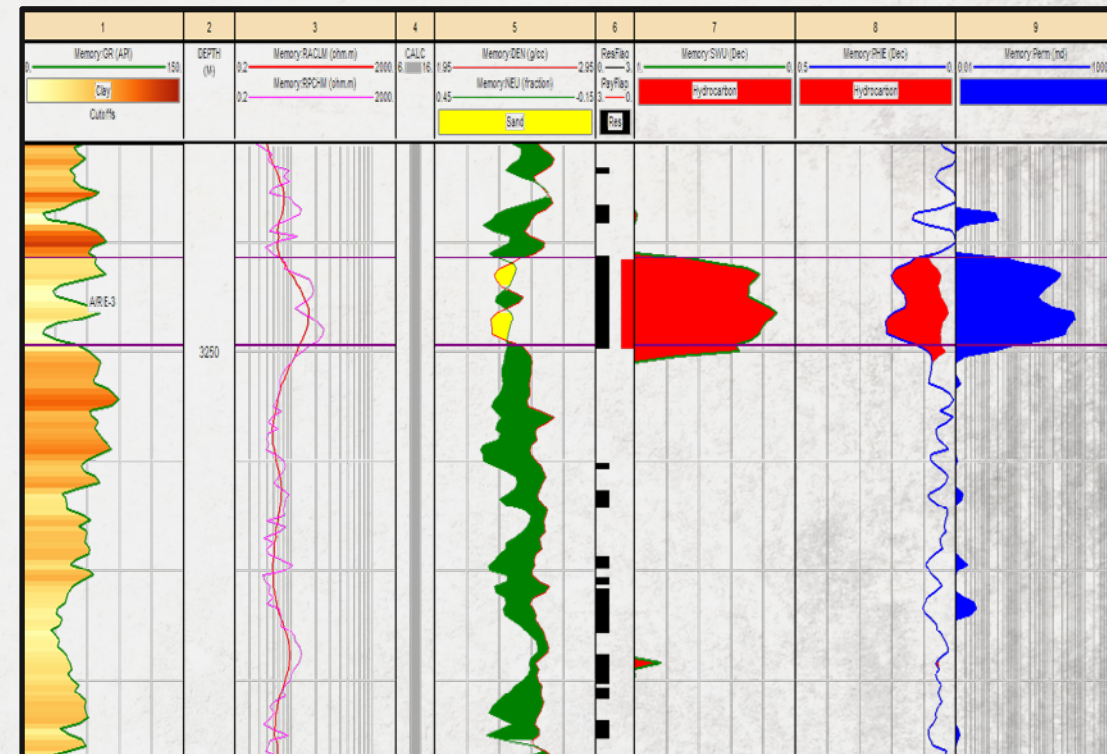
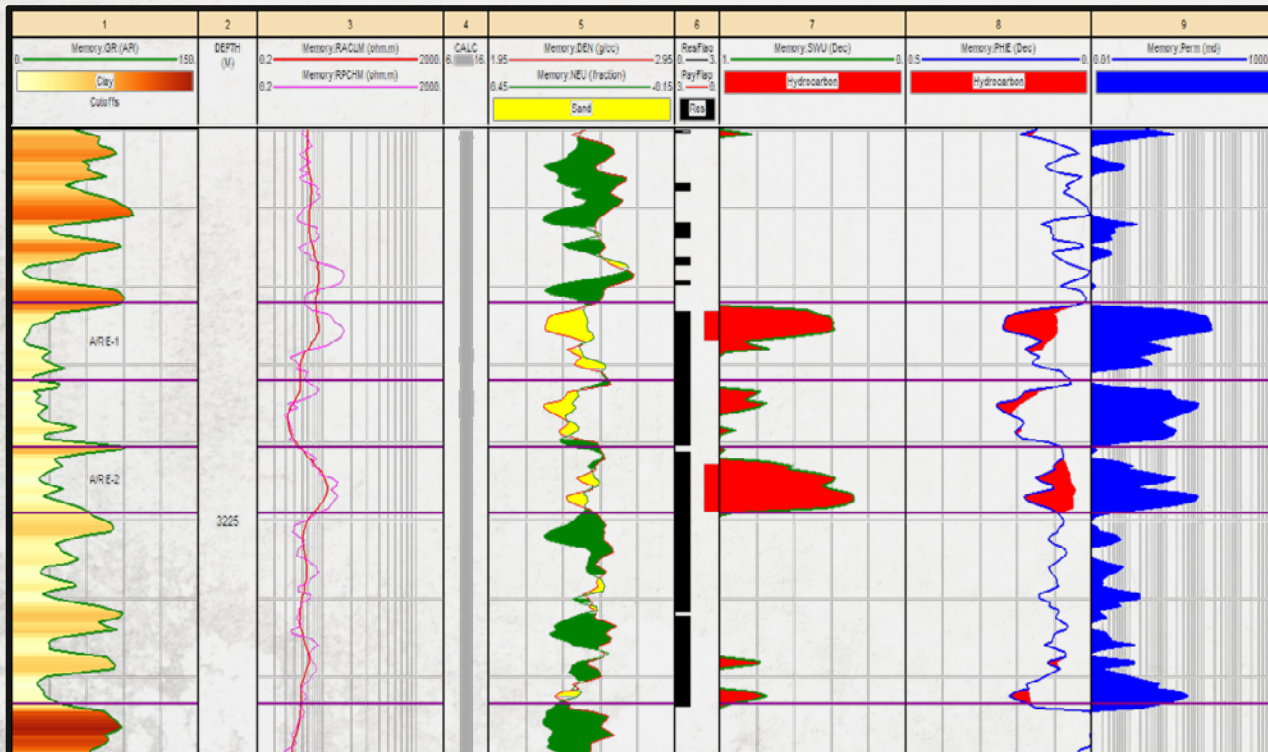
TopARE MbrDepth map	
Badr petroleum company	Contouring 20
BED 1 Block	Date 20/11/2021
Scale 1:40000	Att.







# BED 9-7



**A/R E:**  
**Net-Pay: 10 M.**  
**PHIE: 16 %**  
**So: 65 %**





# Source Rock oil correlation

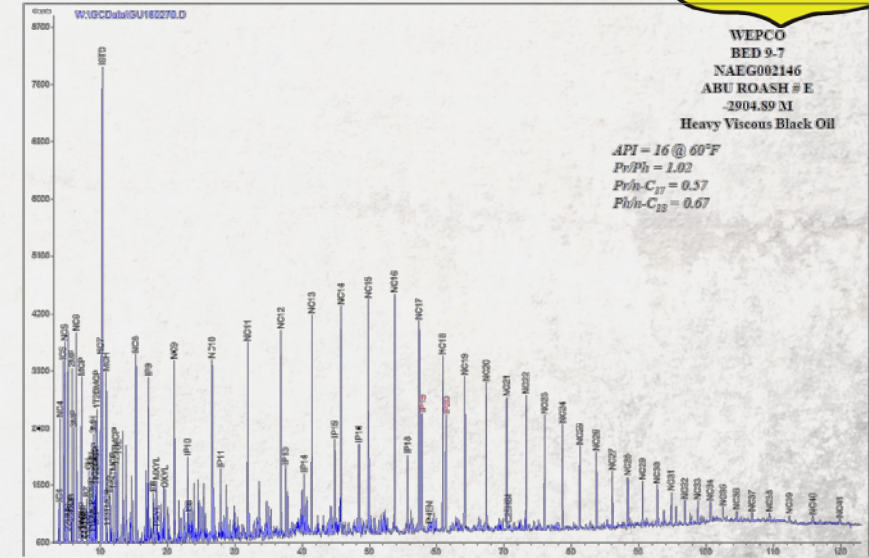
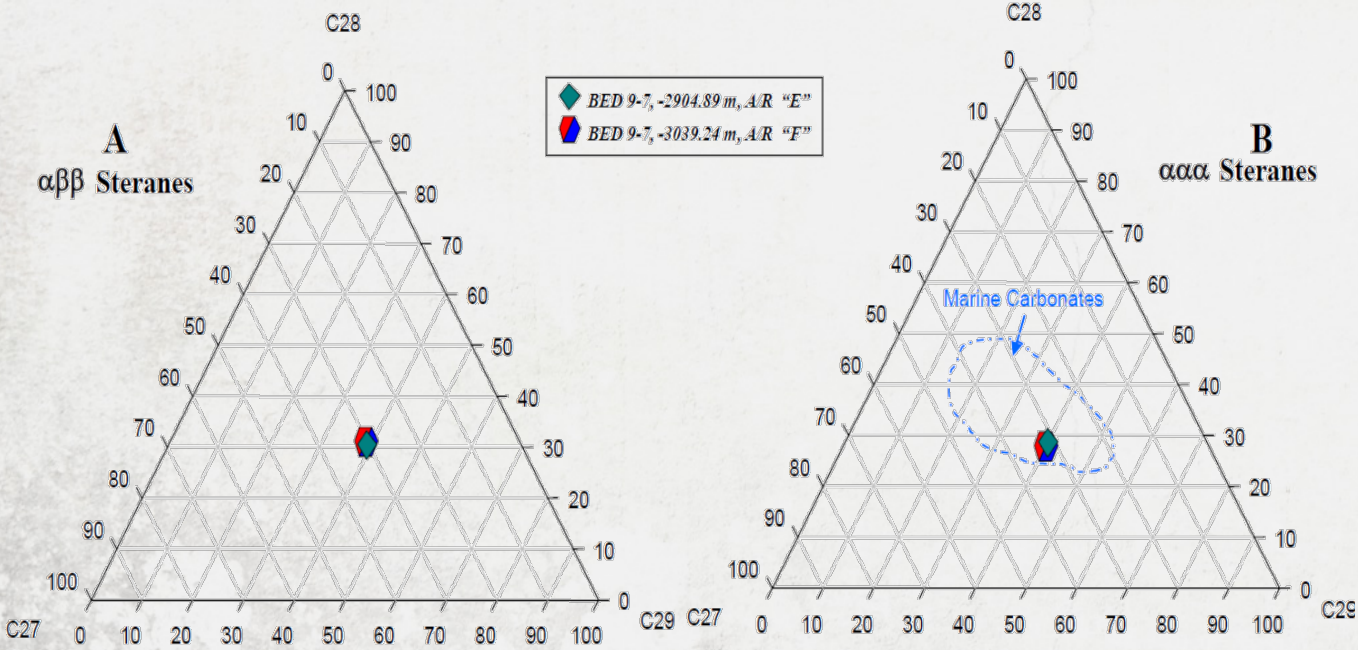


Figure 2a: Gas chromatogram for the oil recovered from The A.R. "E" Member (-2904.89 M) from BED 9-7 well.

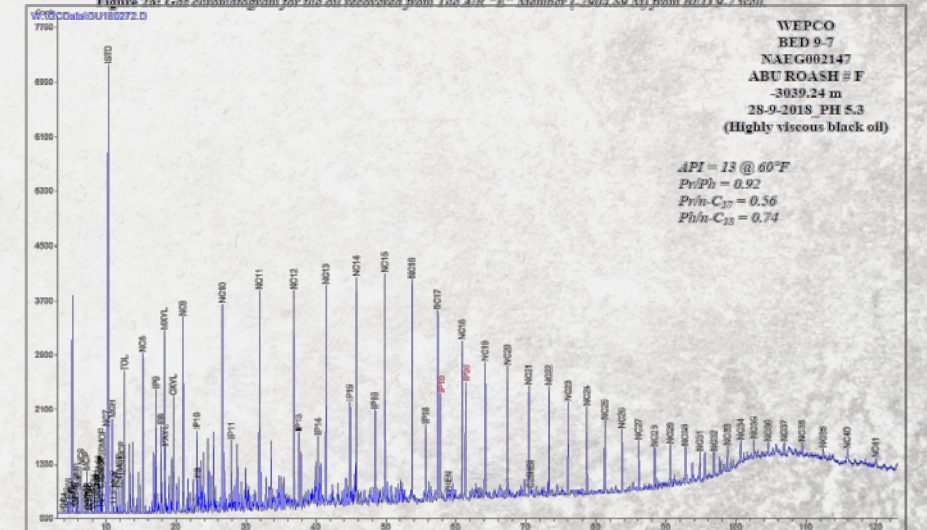
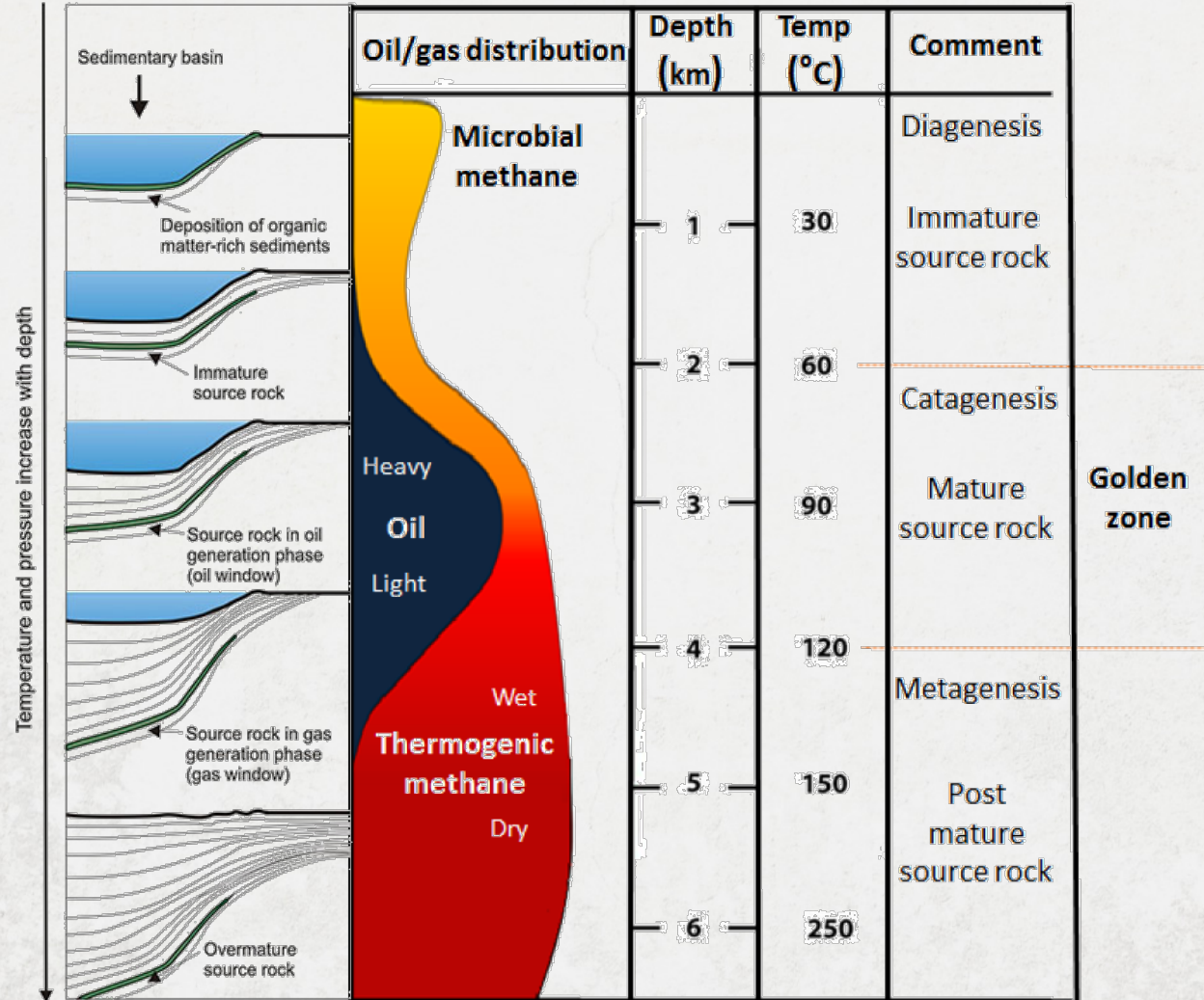


Figure 3a: Gas chromatogram for the oil recovered from The A.R. "F" Member (-3039.24 M) from BED 9-7 well.





# AR/F Source Rock

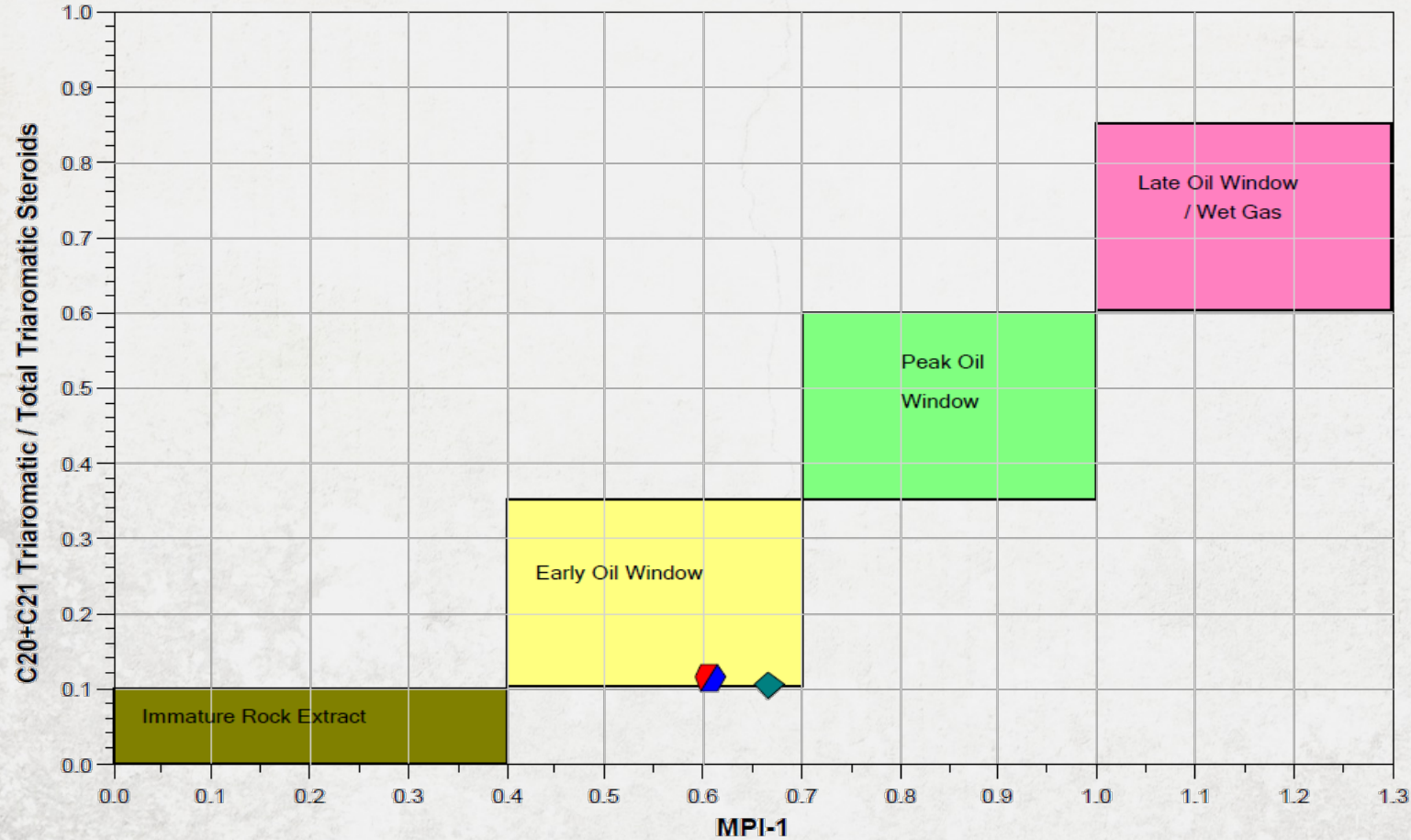


Different temperature conditions for microbial gas, oil and thermogenic gas. Modified from: (Earle, 2015; Alain Perrodon, 1983; Rice et al., 1981)

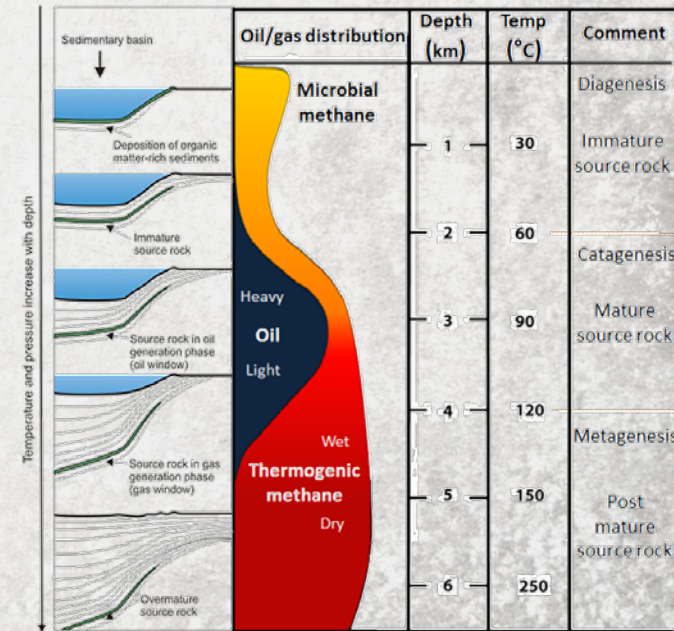




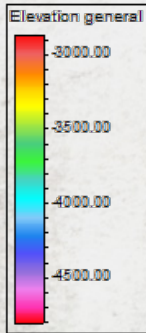
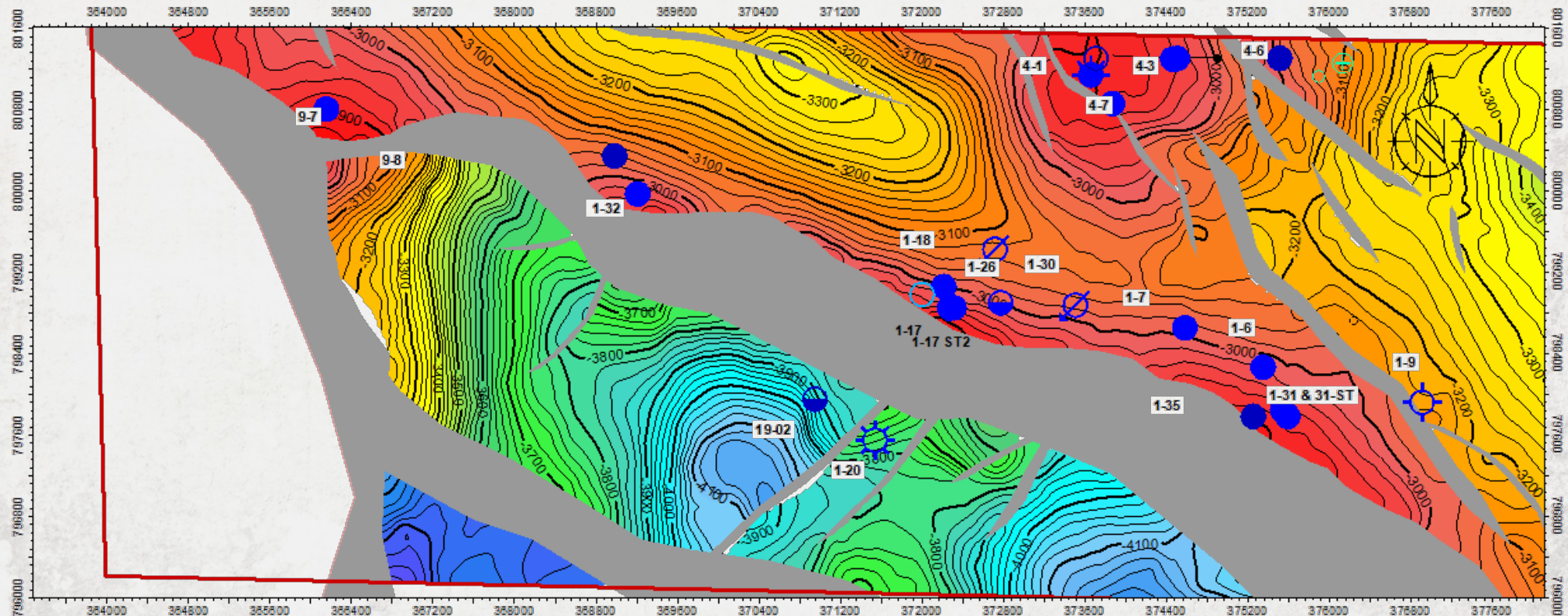
# AR/F Source Rock



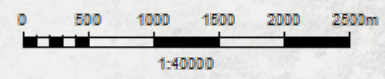
◆ *BED 9-7, -2904.89 m, A/R "E"*  
◆ *BED 9-7, -3039.24 m, A/R "F"*



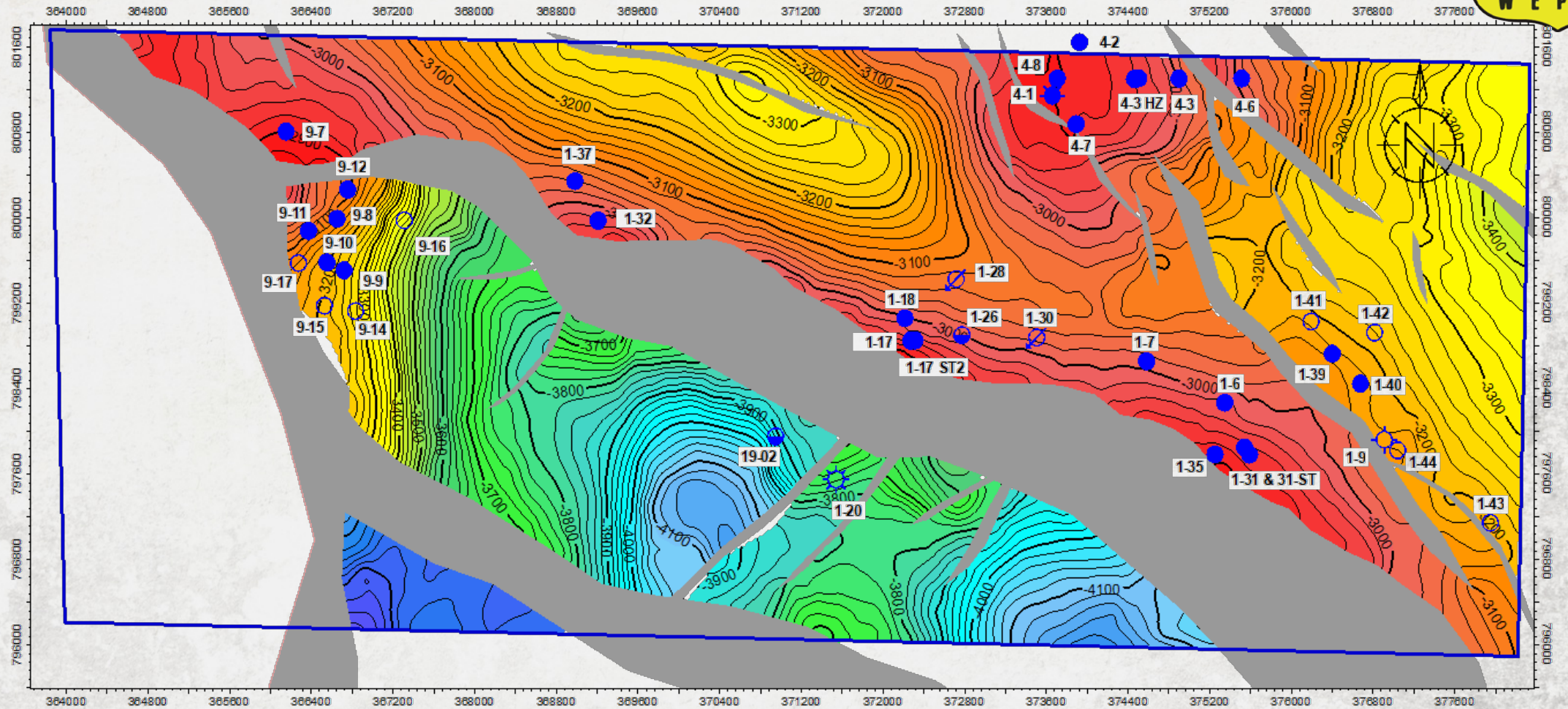




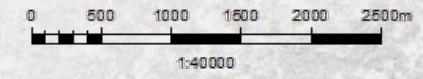
TopARE MbrDepth map	
Badr petroleum company	Contouring 30
BED 1 Block	Date 20/11/2021
Scale 1:40000	Attc.







TopARE Mbr Depth map	
Bed petroleum company	Contour inc
BED 1 Block	Date 22/08/2021
Scale 1:40000	Atto.







# ARF/Reservoir History

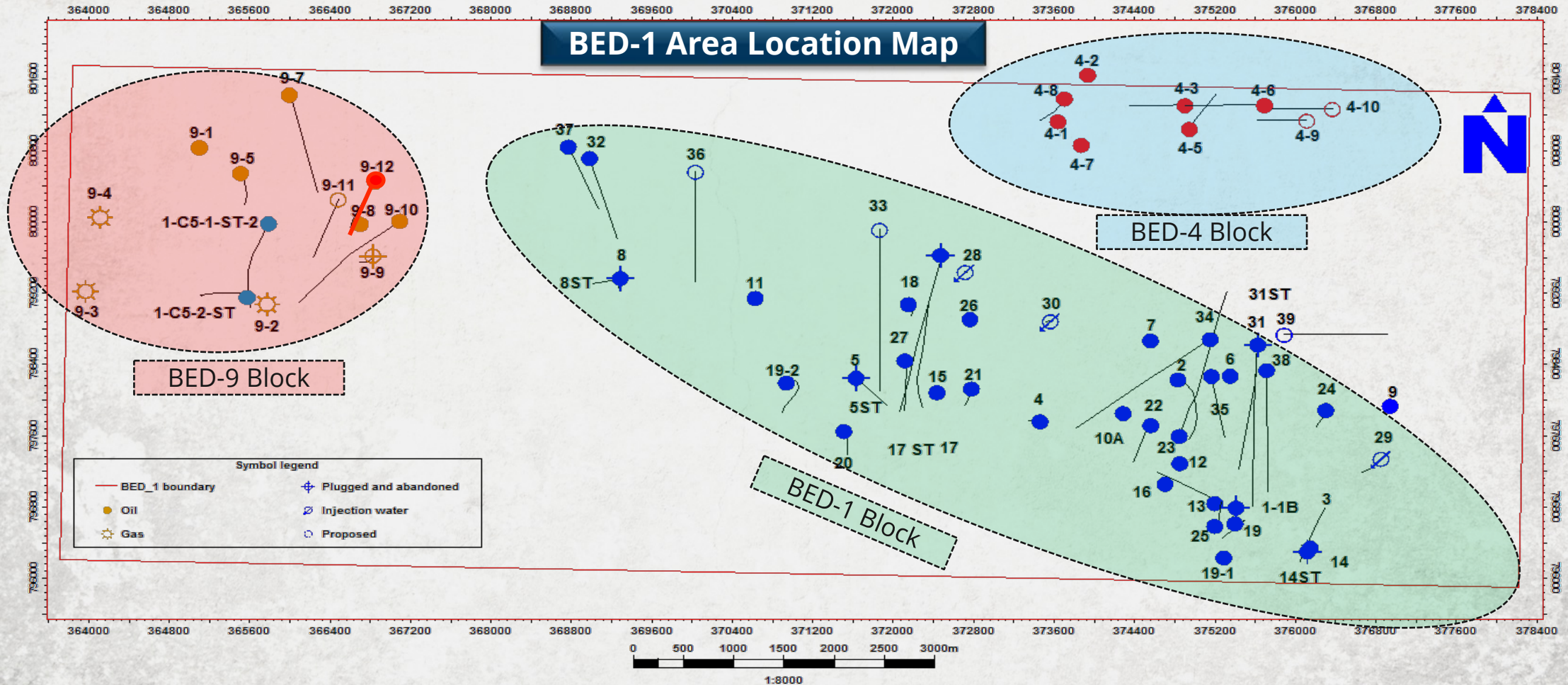




# AR/F Reservoir



## BED-1 Area Location Map







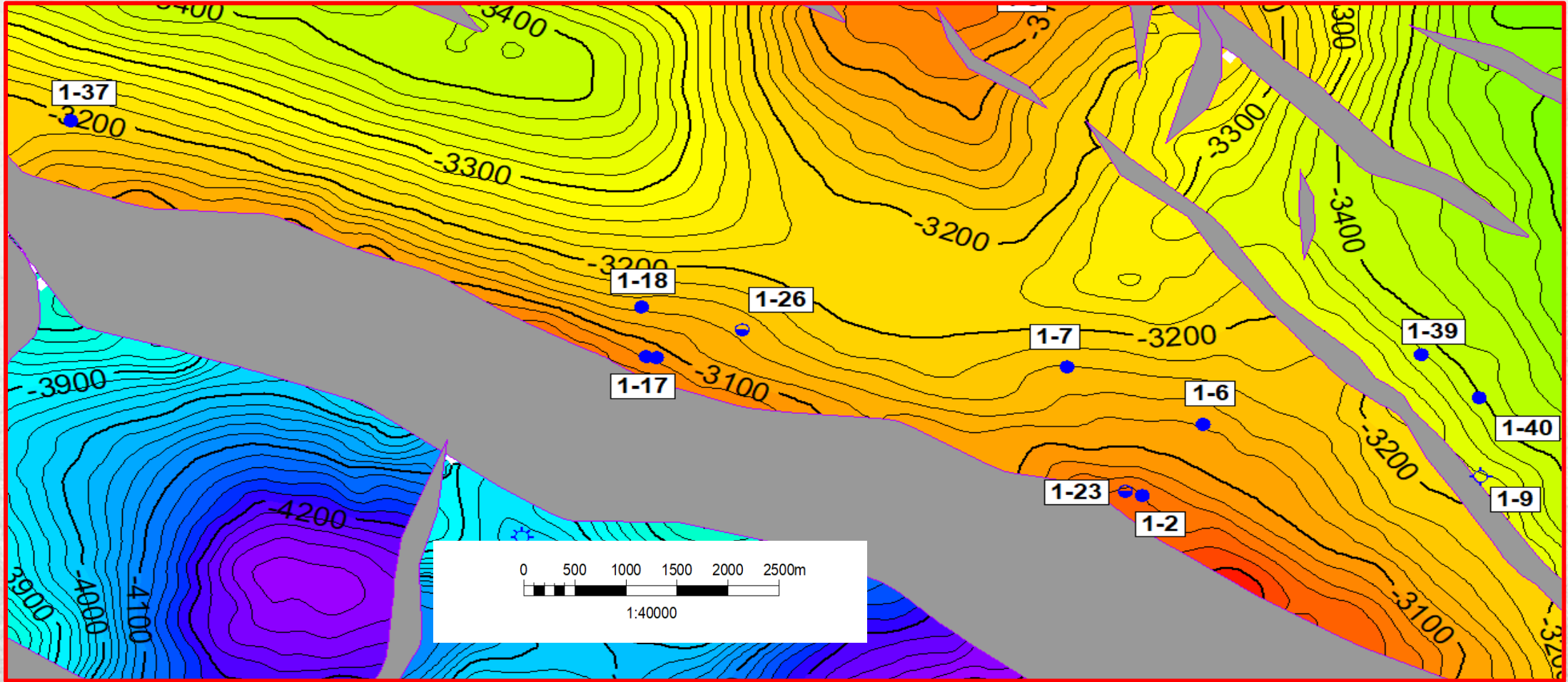
**BED 1**





# AR/F Structure Map

BED 1 Area

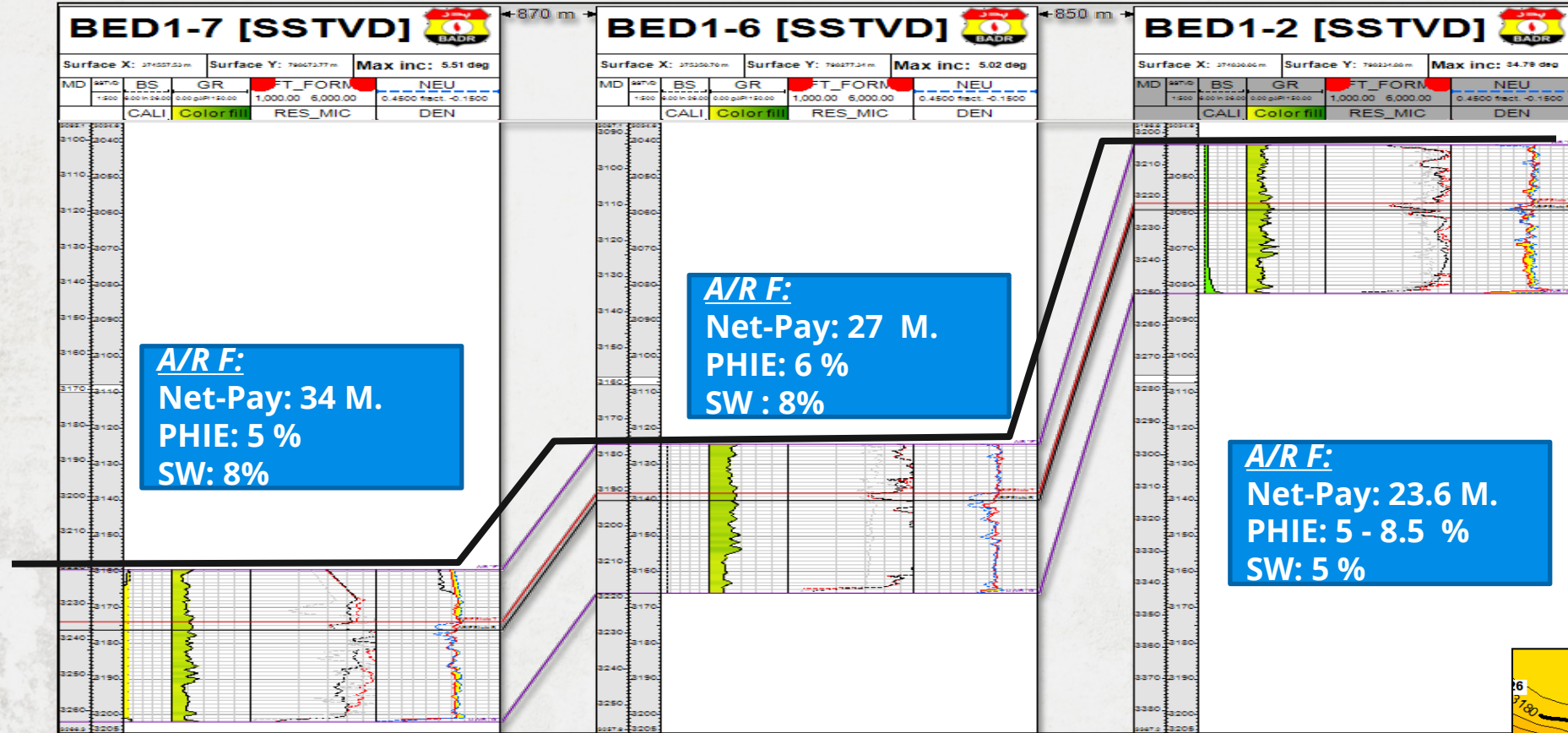




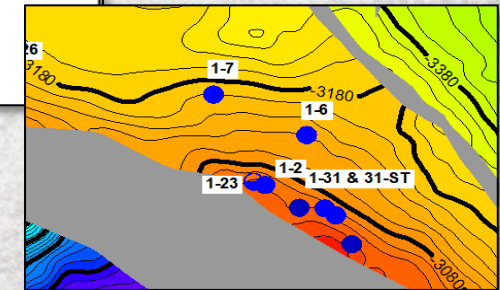


# AR/F Reservoir

## Structural Cross Section Through BED-1 Block on AR-F Level



AR-F

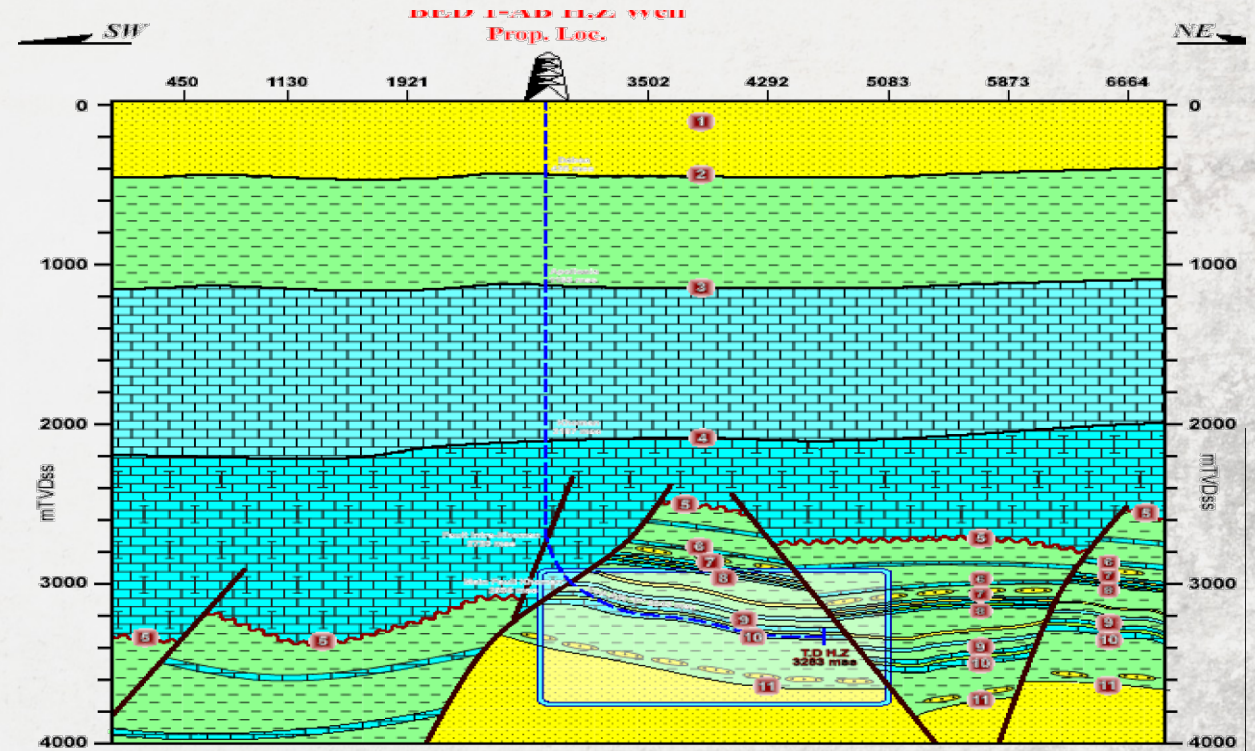
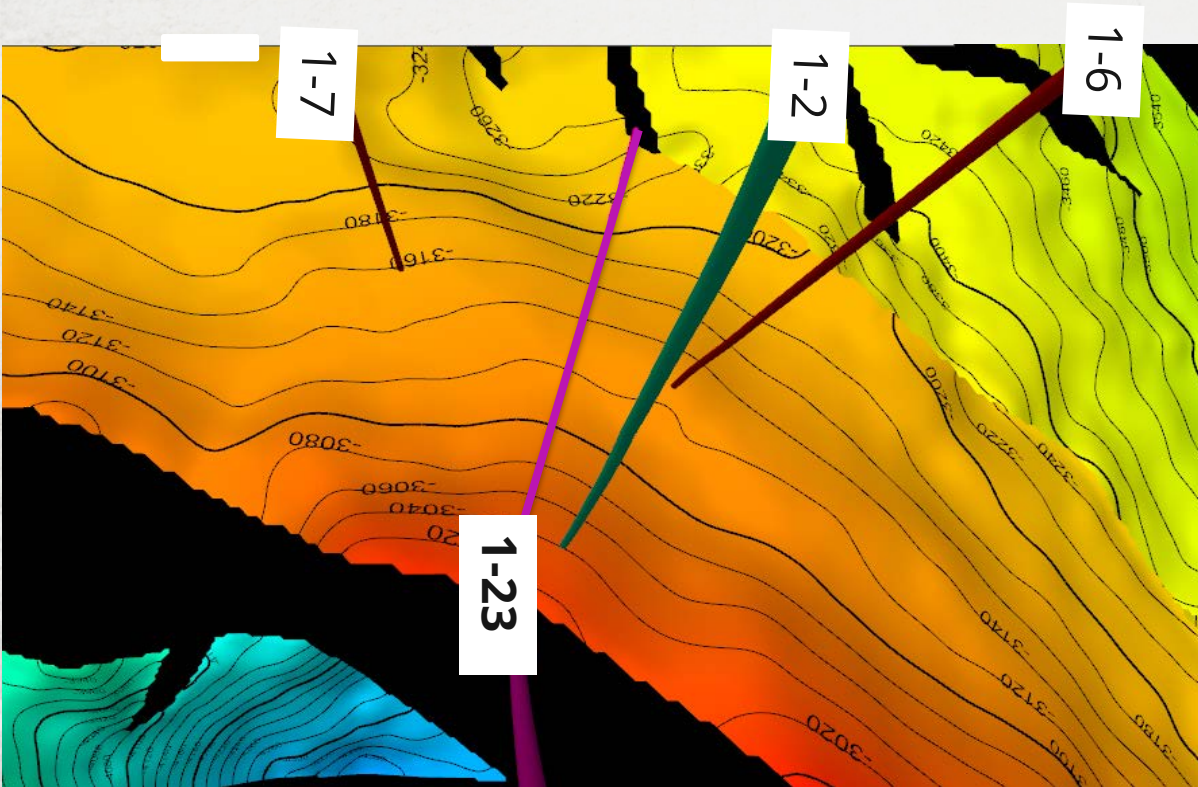






# AR/F Reservoir

## BED 1-23 Horizontal Well

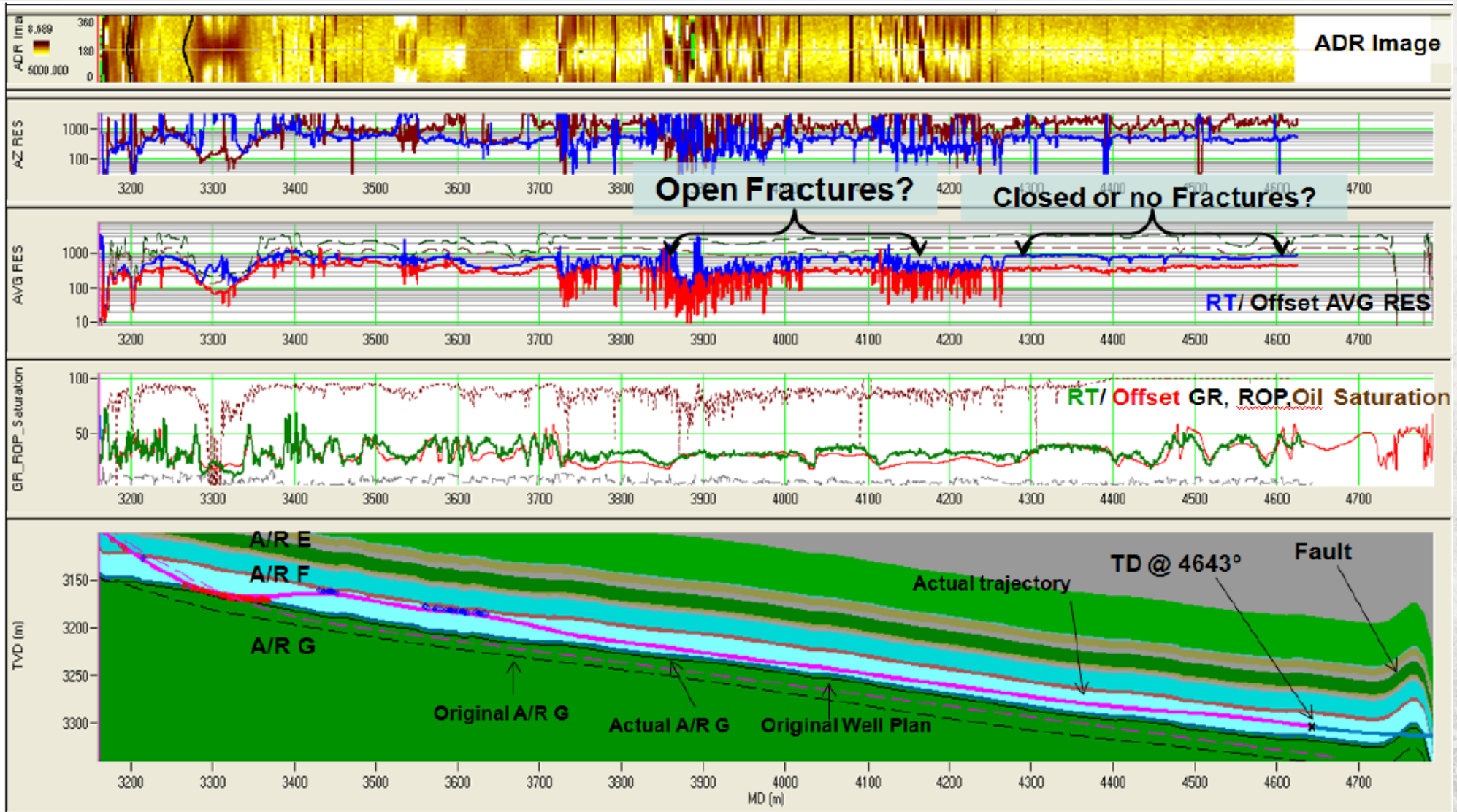






# AR/F Reservoir

## BED 1-23 Horizontal Well





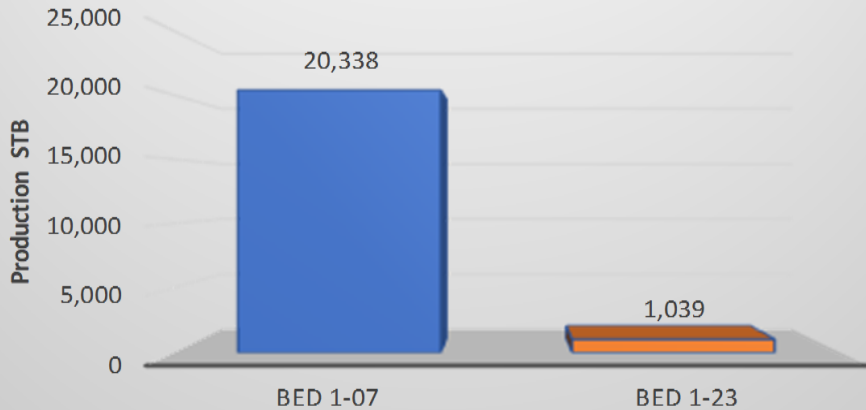


# AR/F Reservoir

BED 1-23 & Bed1-7



## BED-1 AR/F



	bed 1-07	bed 1-23
Prod STB	20,338	1,039

## Bed 1-7:

- On 1987 March, The well start production from A/R "F" formation with 400 STBD through bare foot with over pressured 6500 psia
- On 1989 February ,the well decline in production rate to some 35 STBD

## Bed 1-23

- On NOV.2010 BED1-23 was drilled to appraise the natural fracture system in A/R "F" formation along the crest of BED 1 structure, The well was drilled to total depth 4643 MBDF and with horizontal section 1479 meter.
- On October 2021 static and flowing survey are 3800 psi and 1320 psia – with flowing rate (Oil 400 STBD), then decline till ceased flow.





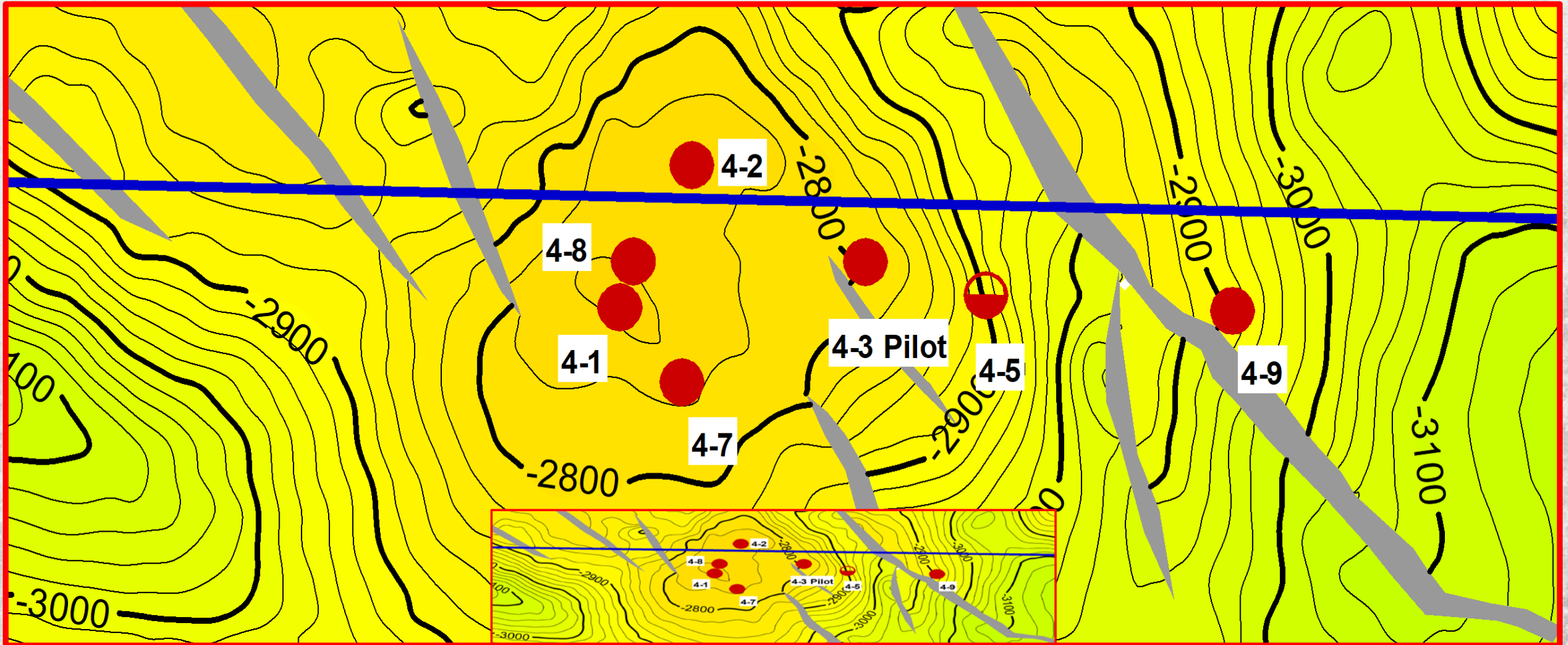
**BED 4**





# AR/F Structure Map

BED 4 Area

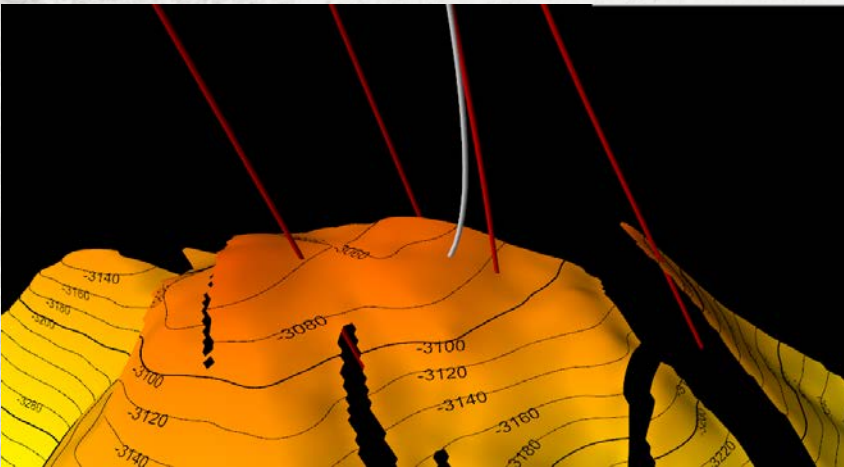
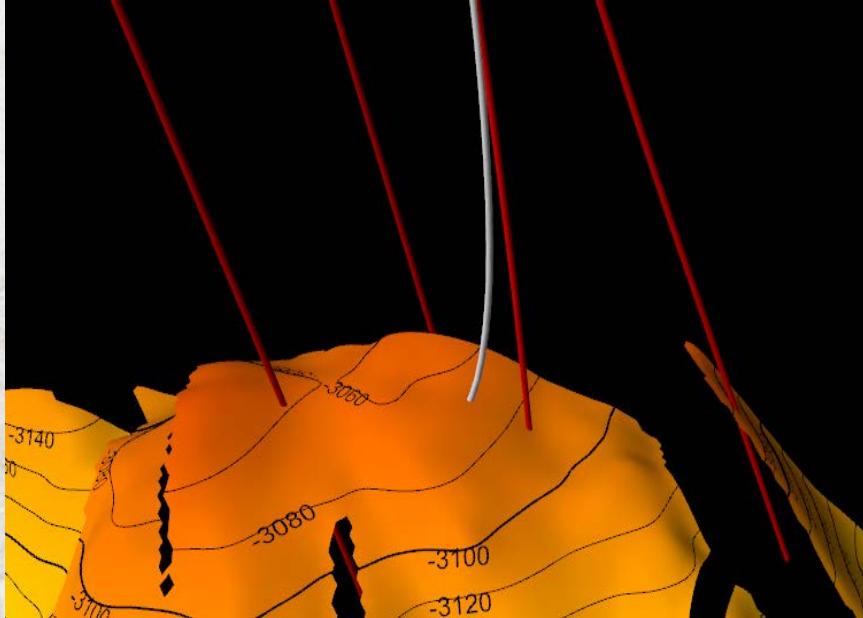






# AR/F Reservoir

## Structural Cross Section Through BED-4 Block on AR-F Level



The rock succession is dissected by 595 fractures, the majority of these fractures are open and partial open fractures type, all of them are striking due NW-SE and dipping in two directions due NE and SW and 9 closed fractures are picked in the basal part of the imaged interval all of them have NW-SE strike and dipping toward SW

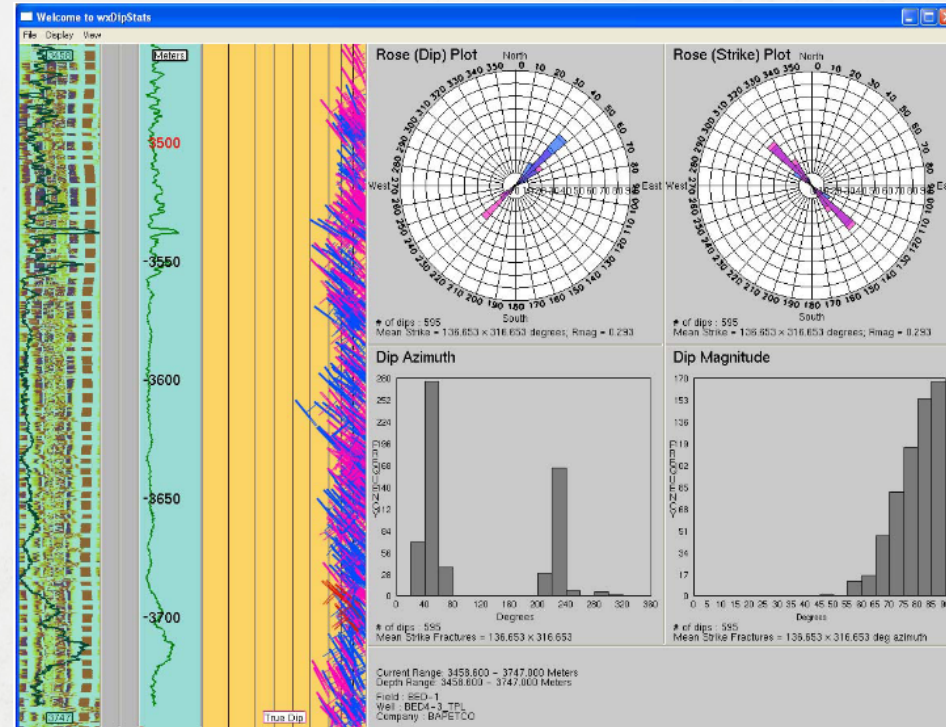


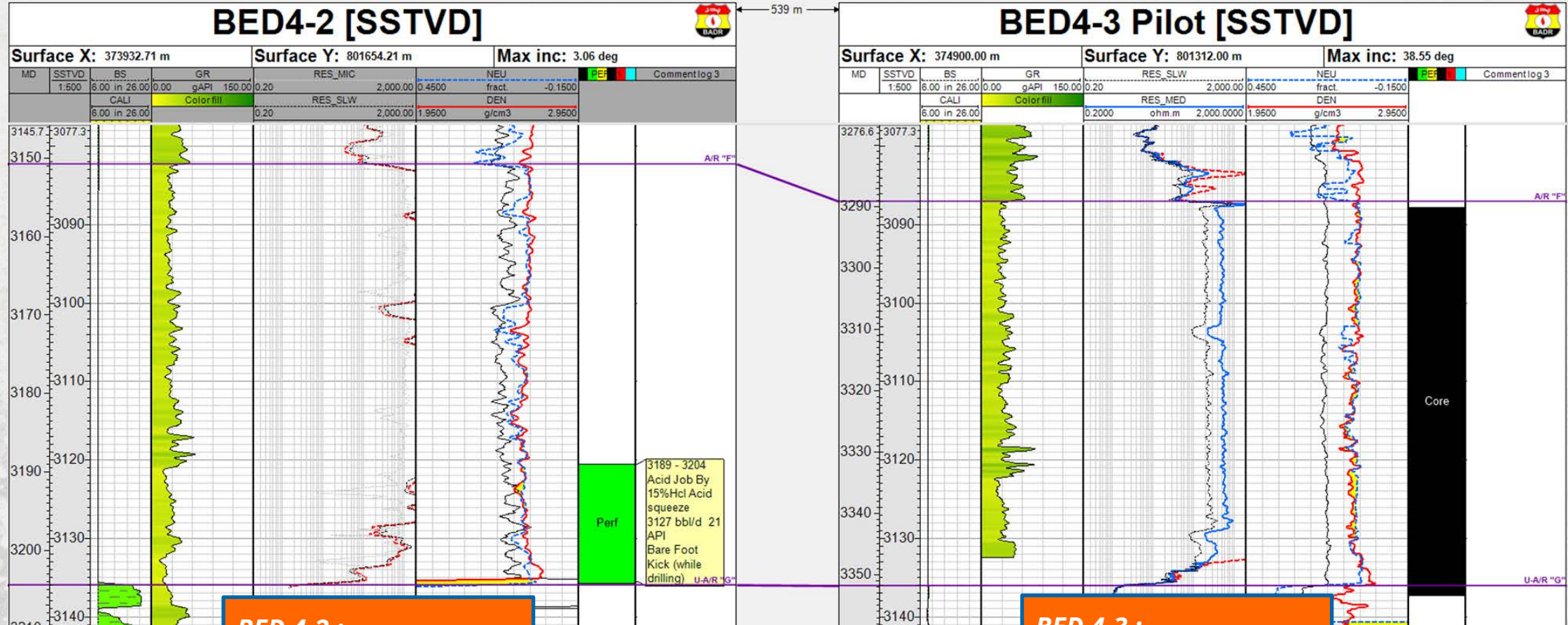
Fig. 3: Rose plots and histograms of all picked structural elements dissecting the imaged rock succession in Well BED4-3. Magenta tadpoles refer to the partly opened fractures while blue tadpoles refer to open fractures while the red tadpoles refer to closed fractures.





# AR/F Reservoir

## Structural Cross Section Through BED-4 Block on AR-F Level



**BED 4-2 :**  
 Net-Pay: 53.3 M.  
 PHIE: 7 %  
 SW: 5%

**BED 4-3 :**  
 Net-Pay: 258.3 M.  
 PHIE: 4 %  
 SW: 21%



# BED-4 AR/F



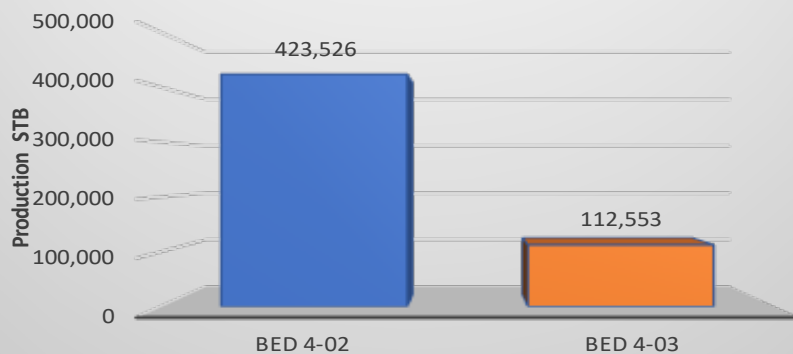
## Bed 4-2:-

- On Sep,1986 the well started production , With 650 STBD , after +/- **80,000 BBLS** cumulative Prod. in Feb,1987 the well stopped producing naturally due to drop in reservoir pressure
  - At the end of Aug 1987, it was decided to Produce commingle A/R 'F' with A/R'E' in order to lift A/R'F', the Daily rate from both intervals was some 900 STB/D.
- N.B: The well produces after each shut in period(From 2-9Months)

## Bed 4-3:-

- The well was drilled as horizontal well to indicated that AR''F'' oil bearing reservoir with natural fractures system in Bed-4
  - On Nov 2010, the well started production with 298 STBD till reach 35 STBD in August 2012.
- N.B: The well produces after each shut in period(From 10-20 Days) with average start rate 350 STBD till Ceased to flow .

## BED-4 AR/F



	bed 4-02	bed 4-03
Prod STB	423,526	112,553





**AR/D**



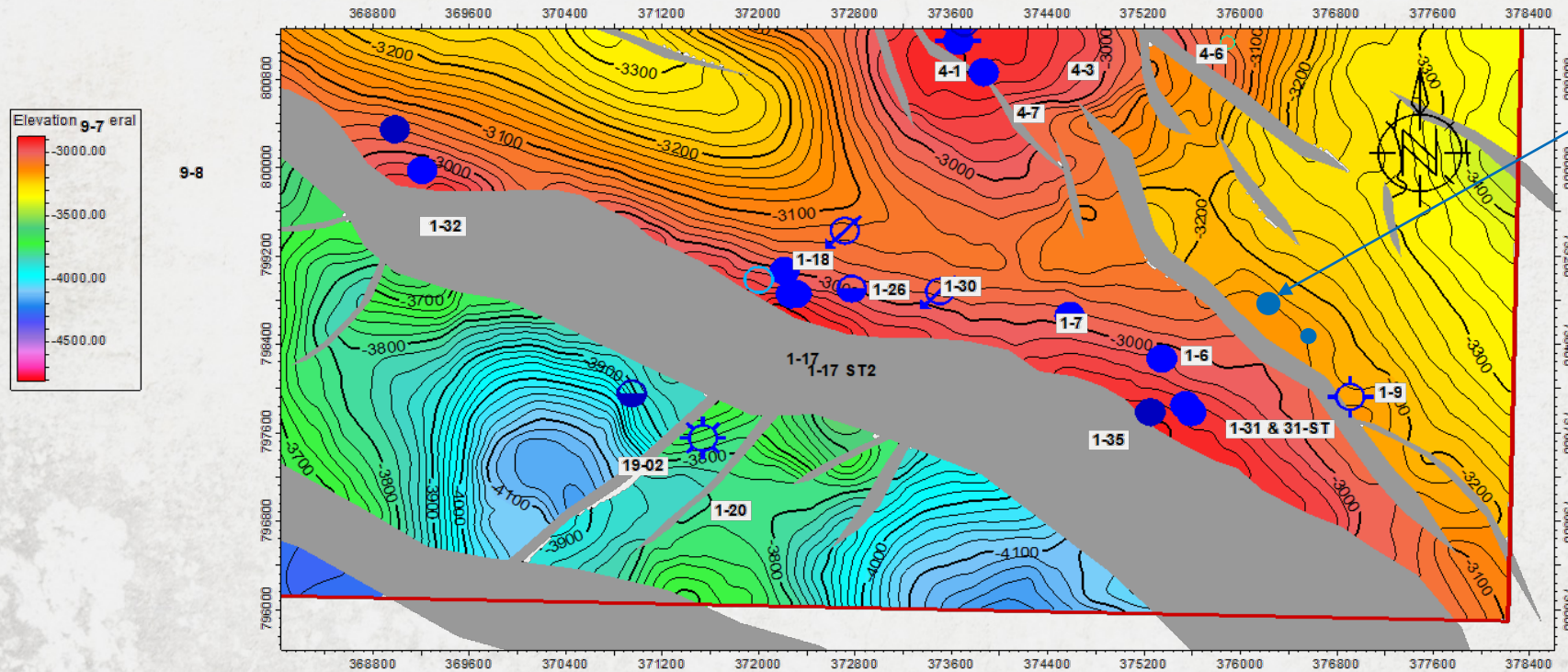
# BED 1-39 Block



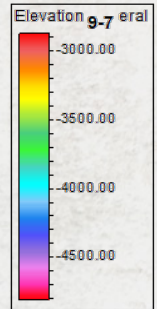


# AR/D Structure Map

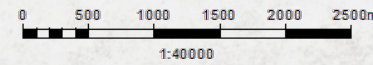
## BED 1-39 Area



1-39 Exploratory well



Top ARE Mbr Depth map	
Badr petroleum company	Contour inc
BED 1 Block	Date 22/11/2021
Scale 1:40000	Atto.

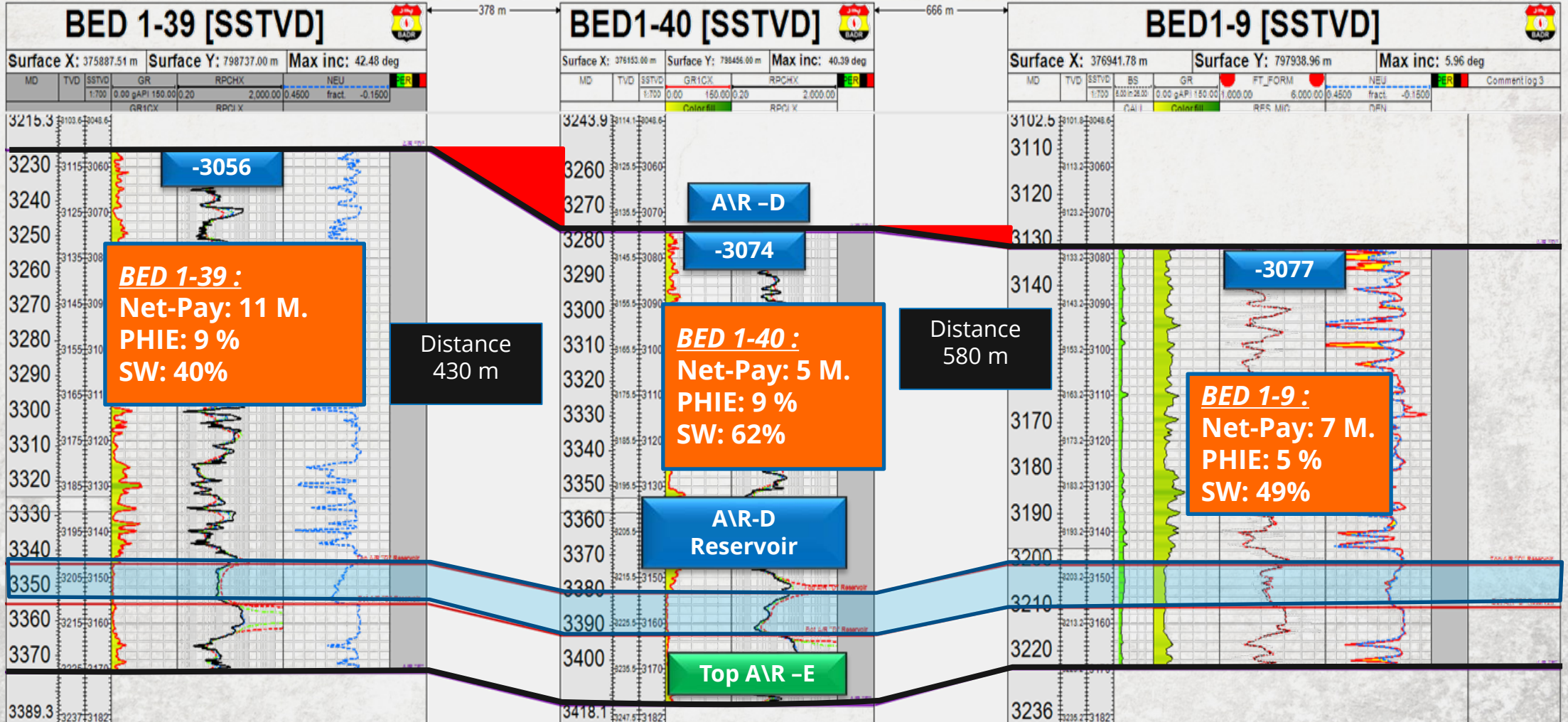






# AR/D Reservoir

## Structural Cross Section Through BED 1-39 ,BED 1-40 & 1-9 Wells







# AR/D Reservoir

BED 1-39 ,BED 1-40 & 1-9 Wells

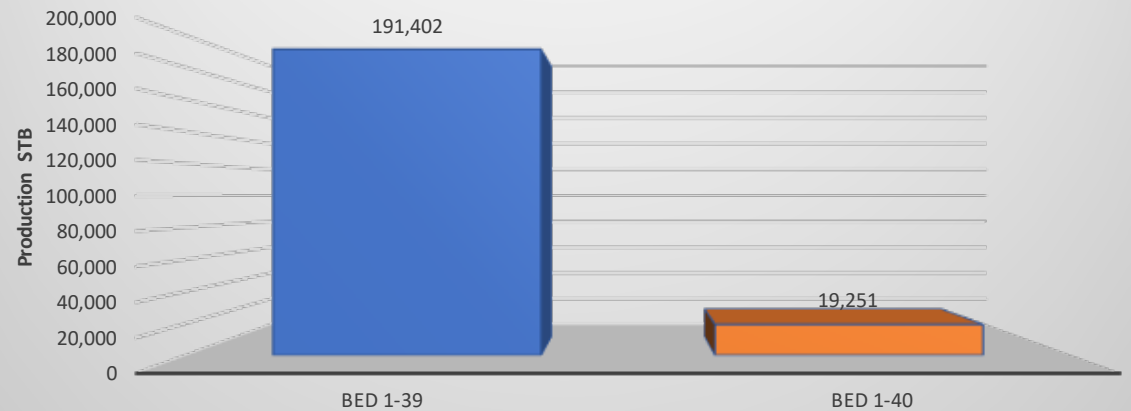


On March 2021 Based on the facies of bed 1-39 it decided to perform acid to produce it the stabilized rate was 1200 STBD

On July 2021 The same scenario happened after drill Bed 1-40. the daily rate after stabilized was 430 STBD

Re-enter Bed 1-9 (change artificial lift from G/L to ESP )performed acid stimulation but due to bad productivity it decided to frac it to increase the productivity and invaded formation .

AR/D  
BED 1-39 AREA



	bed 1-39	bed 1-40
Prod STB	191,402	19,251



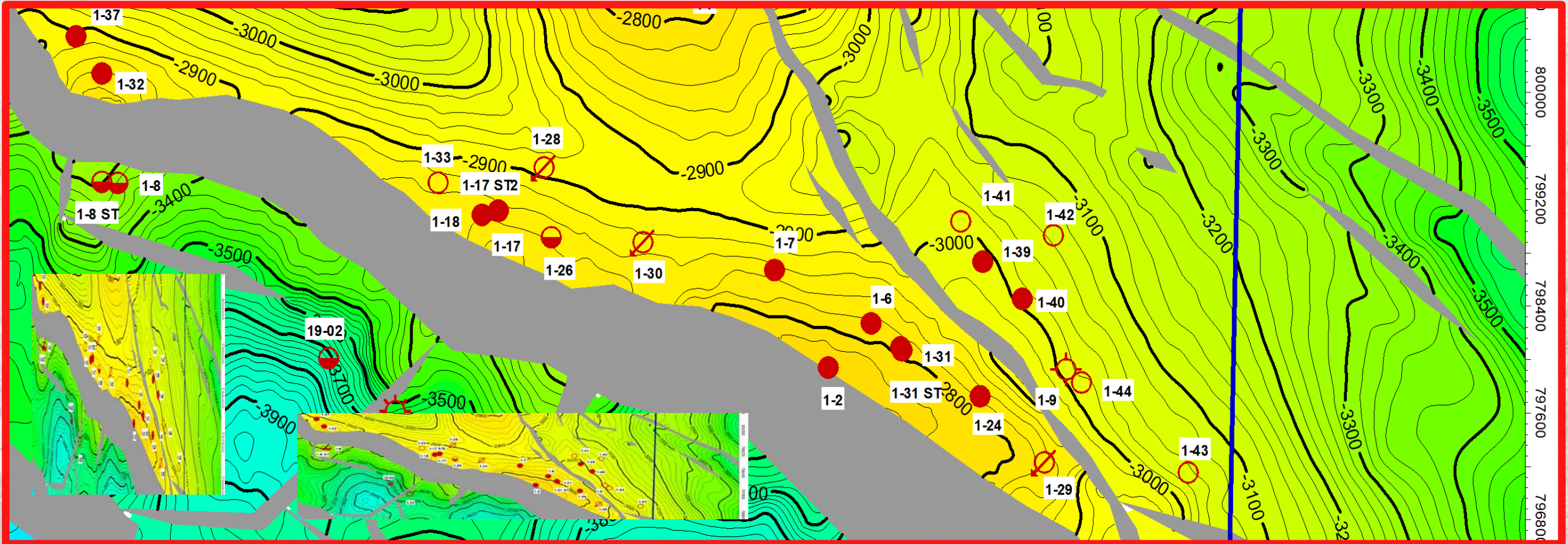


**BED 1**



# AR/D Structure Map

## BED 1 Area

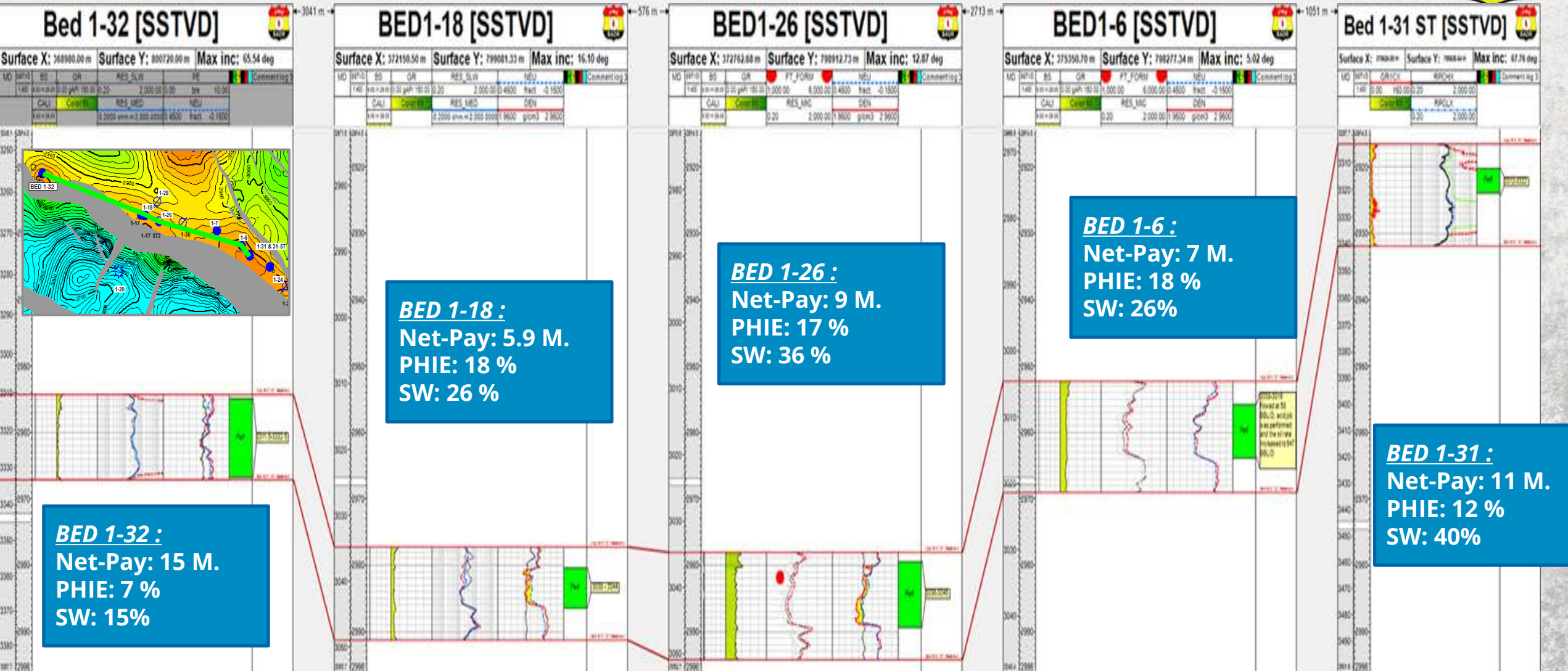






# AR/D Reservoir

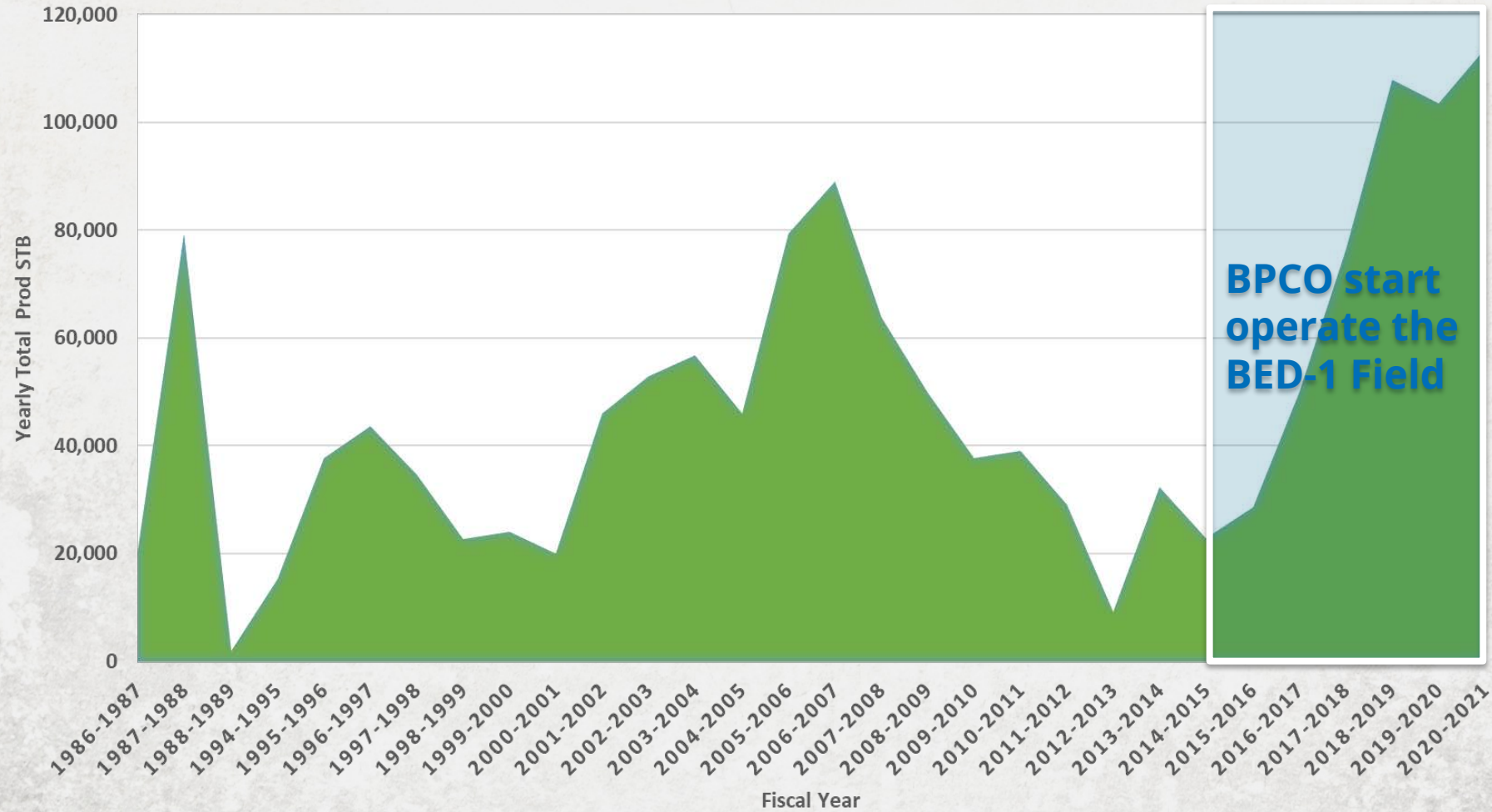
## Structural Cross Section For BED-1





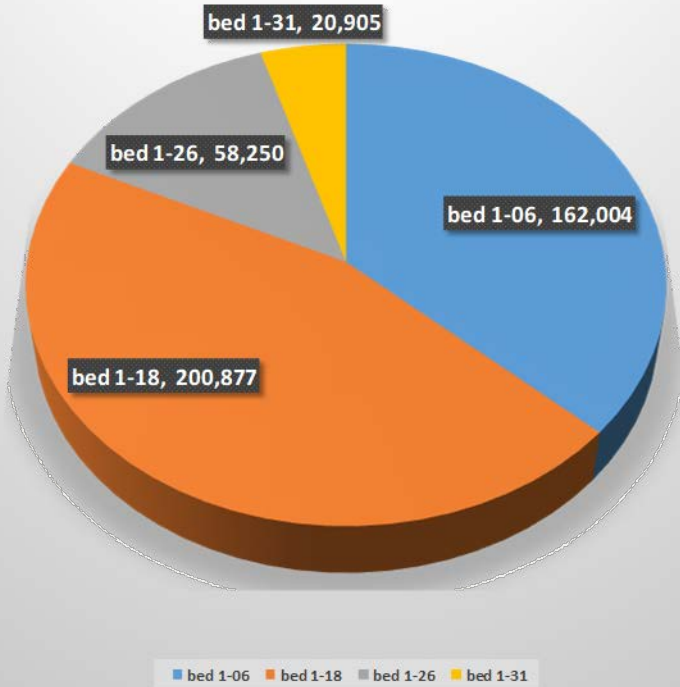
# AR/D Reservoir

BED-1 AREA

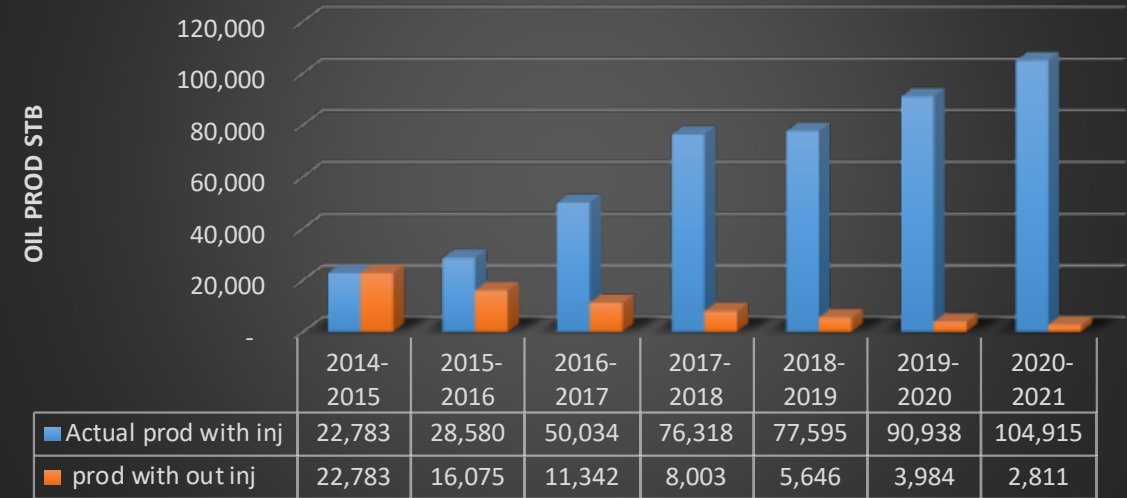




### Wells Producing From AR/D



### Fiscal Year BED-1 ARD Prod.



# Water Flooding Project for AR/D

*To maximize the recovery from AR "D" reservoirs, water flood was implemented, and the wells started injection on March 2016 by using (3injector Wells).*

The incremental production from AR/D since start the project is **392,193** STB.



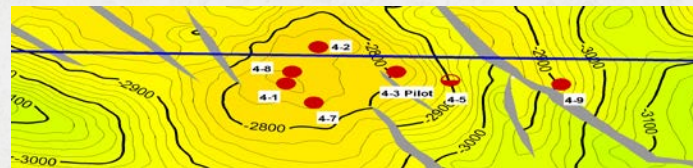
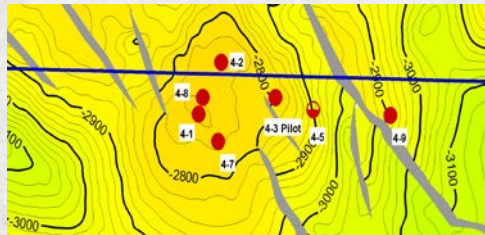
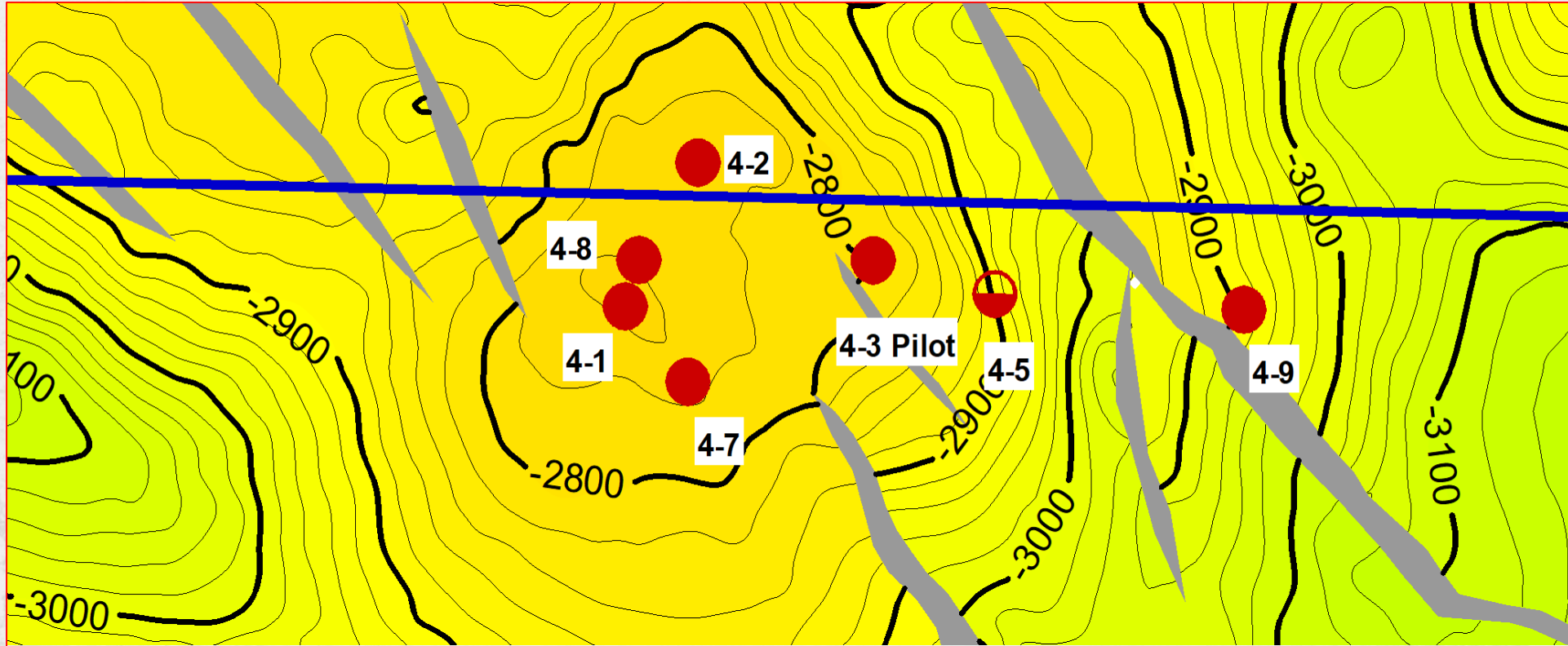
**BED 4**





# AR/D Structure Map

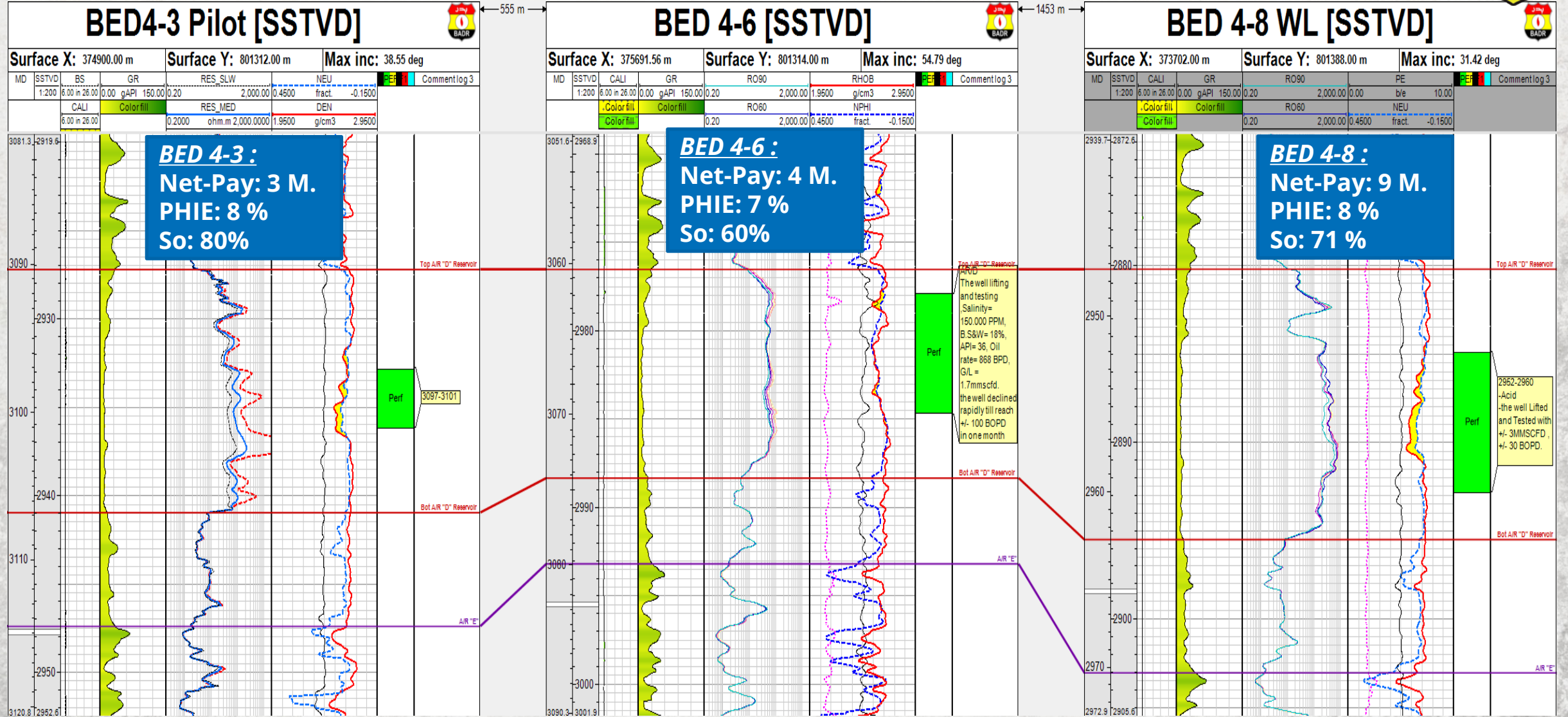
BED 4 Area





# AR/D Reservoir

## BED 4 Area







# AR/D Reservoir

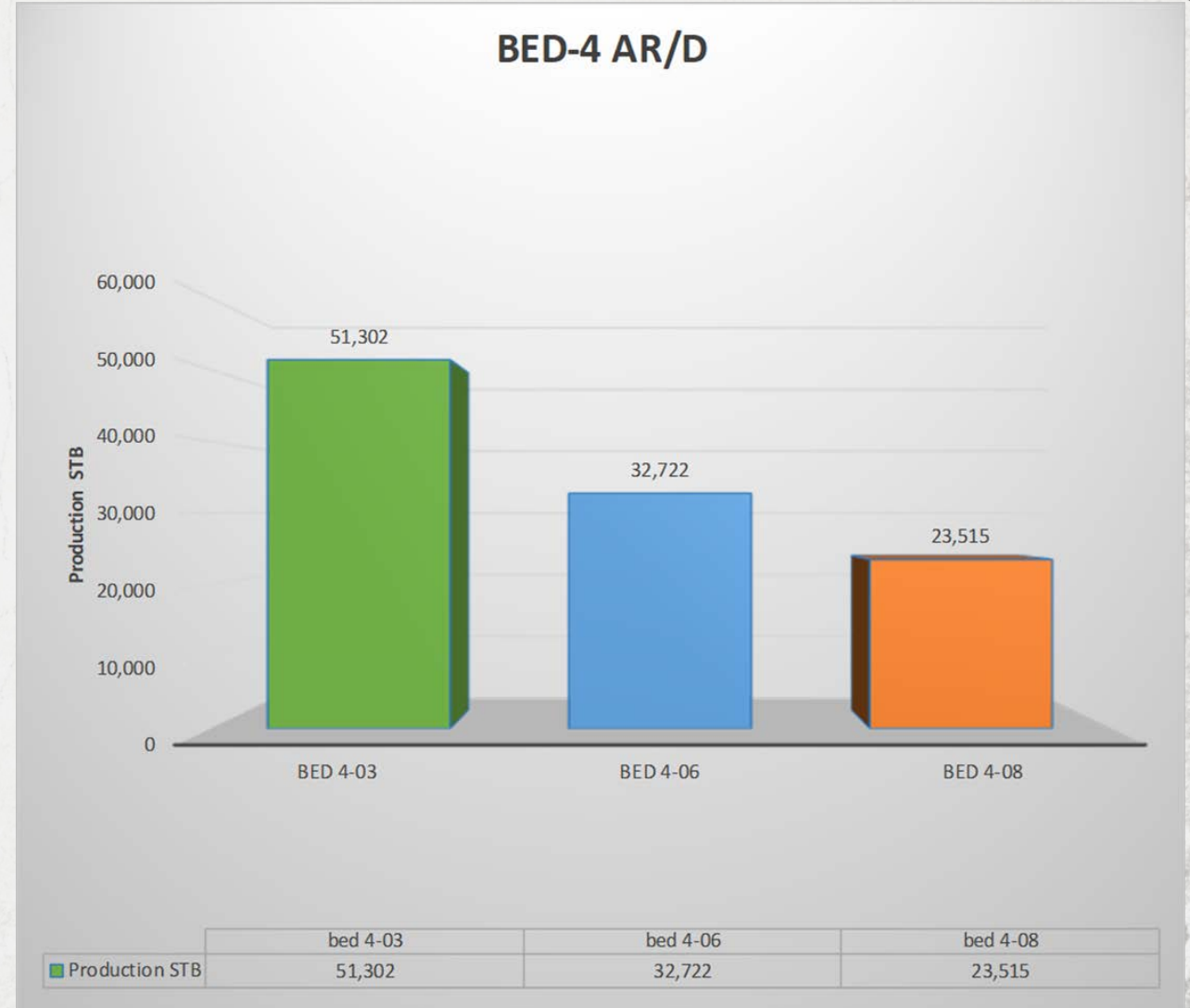
BED 4 Area



The first well perforated and Tested From ARD was Bed 4-3 in August 2016.

Then Bed 4-6 & Bed 4-8 drilled in March and June 2020.

Based on Perforate and Drilled these wells the added reserve was 0.4 MMSTB





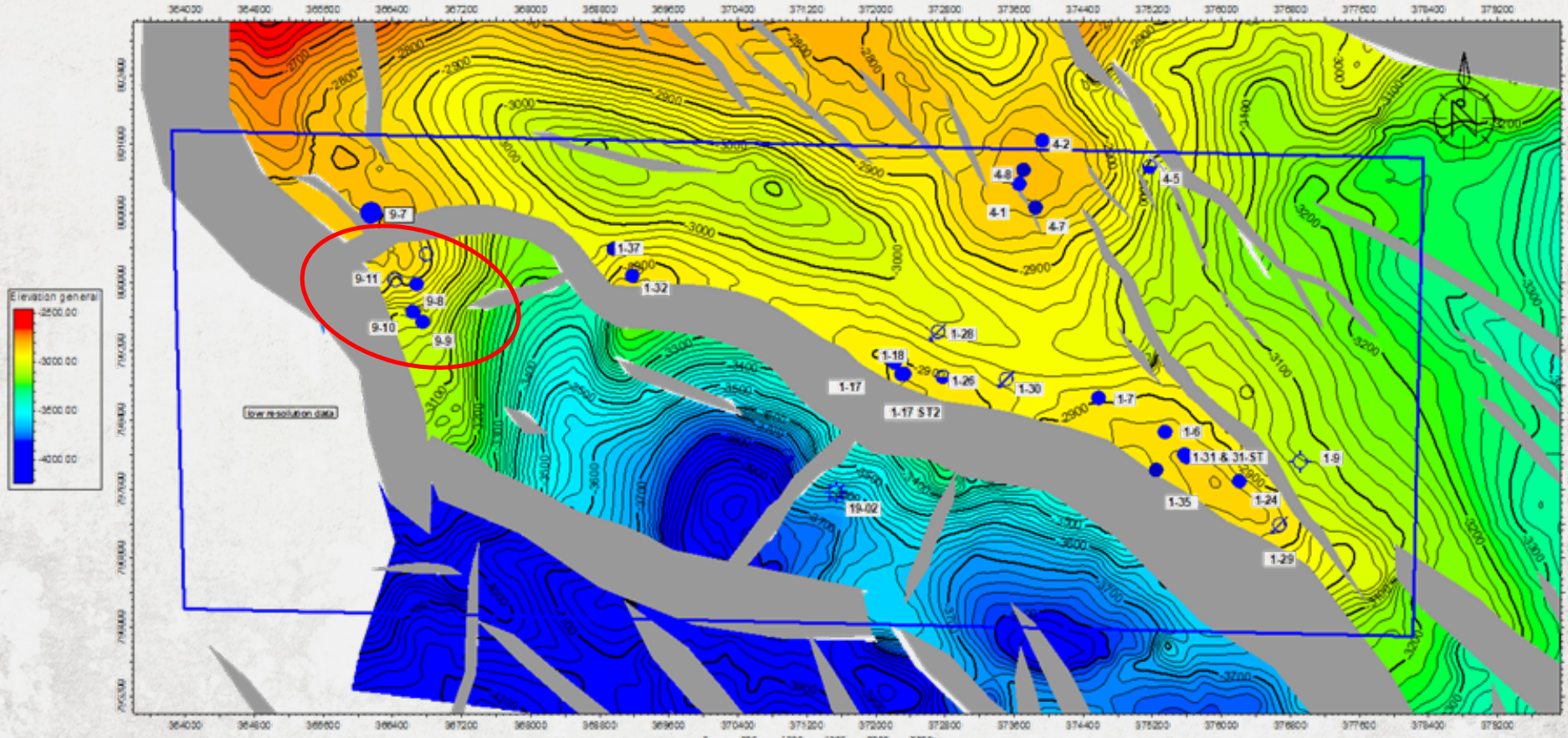
**BED 9**





# AR/D Structure Map

## BED 9 Area



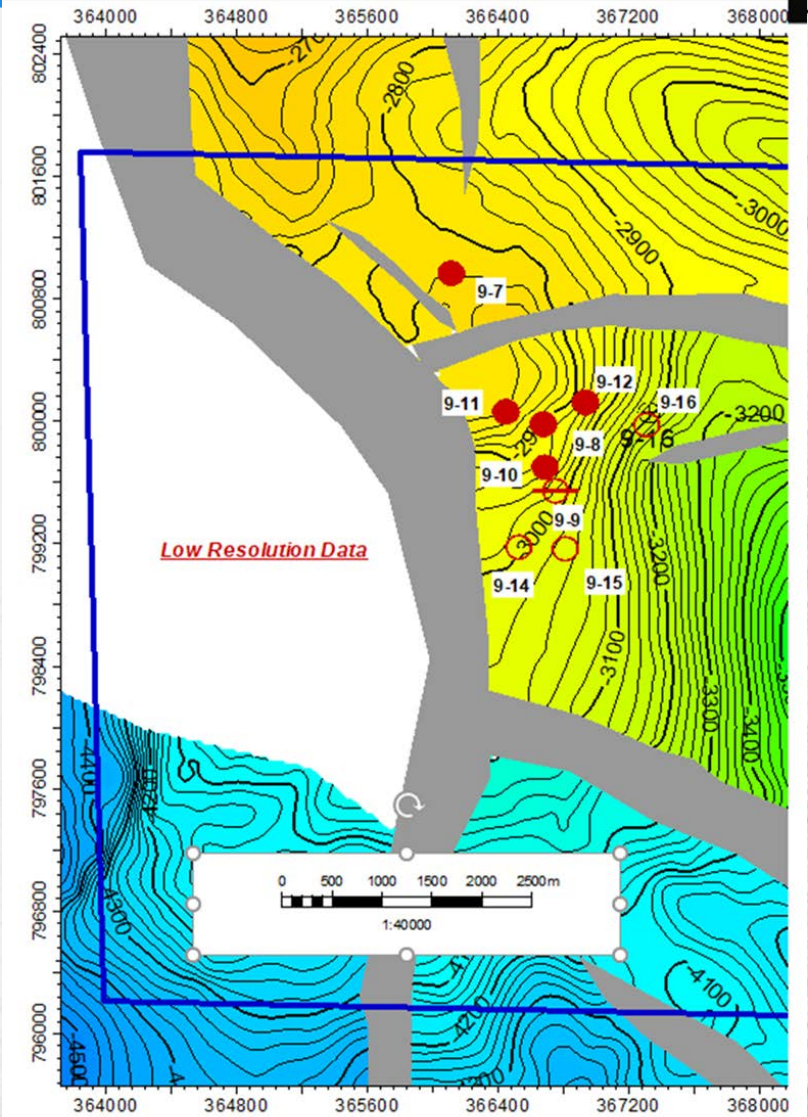
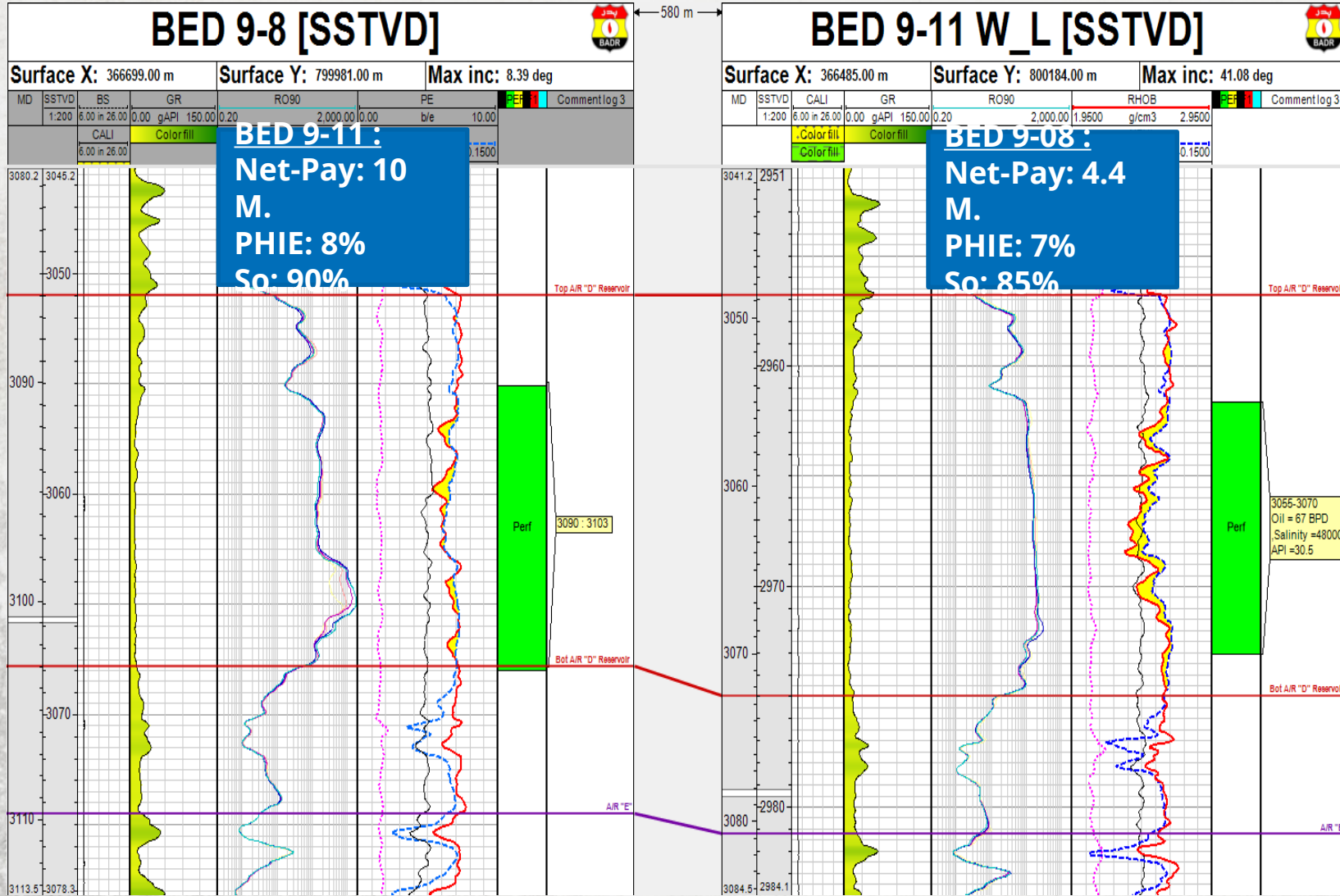
Top AR/D Mbr Depth Map	
Responsible company	Conoco Inc.
Map Title	Map
Date	2012/05/01
Scale	1:4000





# AR/D Reservoir

## Structural Cross Section. BED 9-11 ,BED 9-8

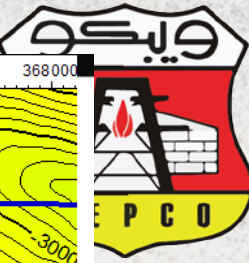






# AR/D Reservoir

BED 9 Area

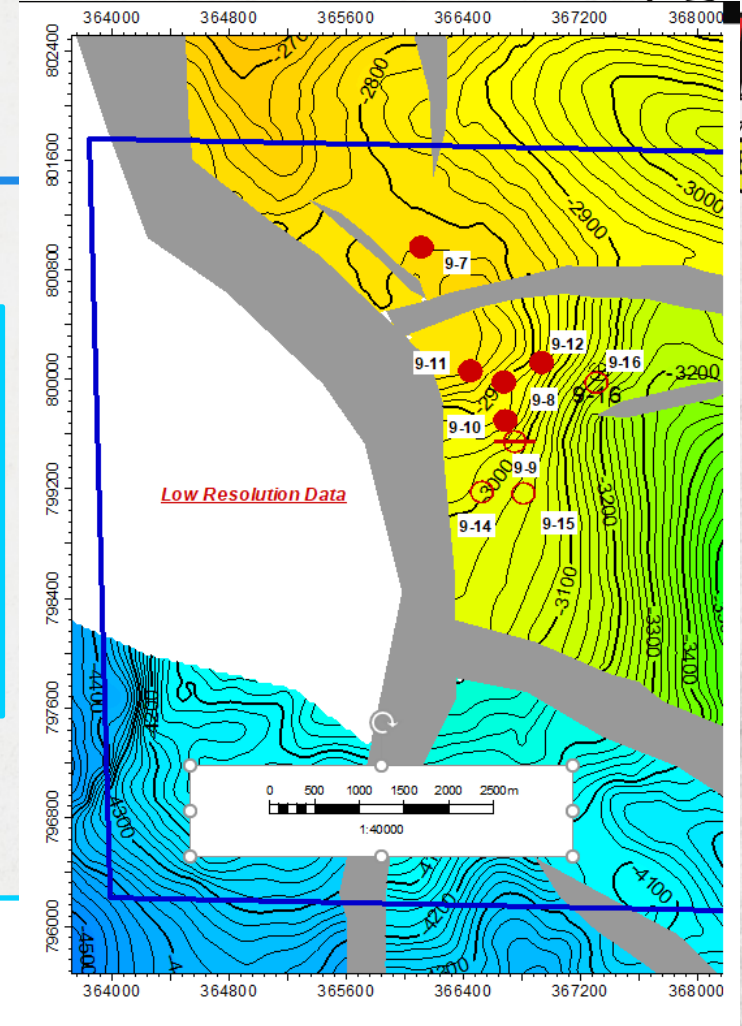


Apr. 2021

- perforated ARD & stimulate with Acid the test result was 143 STBD with sharp decline so it decided to Frac to increase the productivity and invaded zone the test result 250 STBD.

June 2021

- on June 2021 Bed 9-11 AR/D Perforated and hydraulic frac Performed the of the wells showed 200 STBD.





# AR/D Reservoir

## Added Reserve



### BED-1

Drilling Exploratory wells : **3.57 MMSTB**

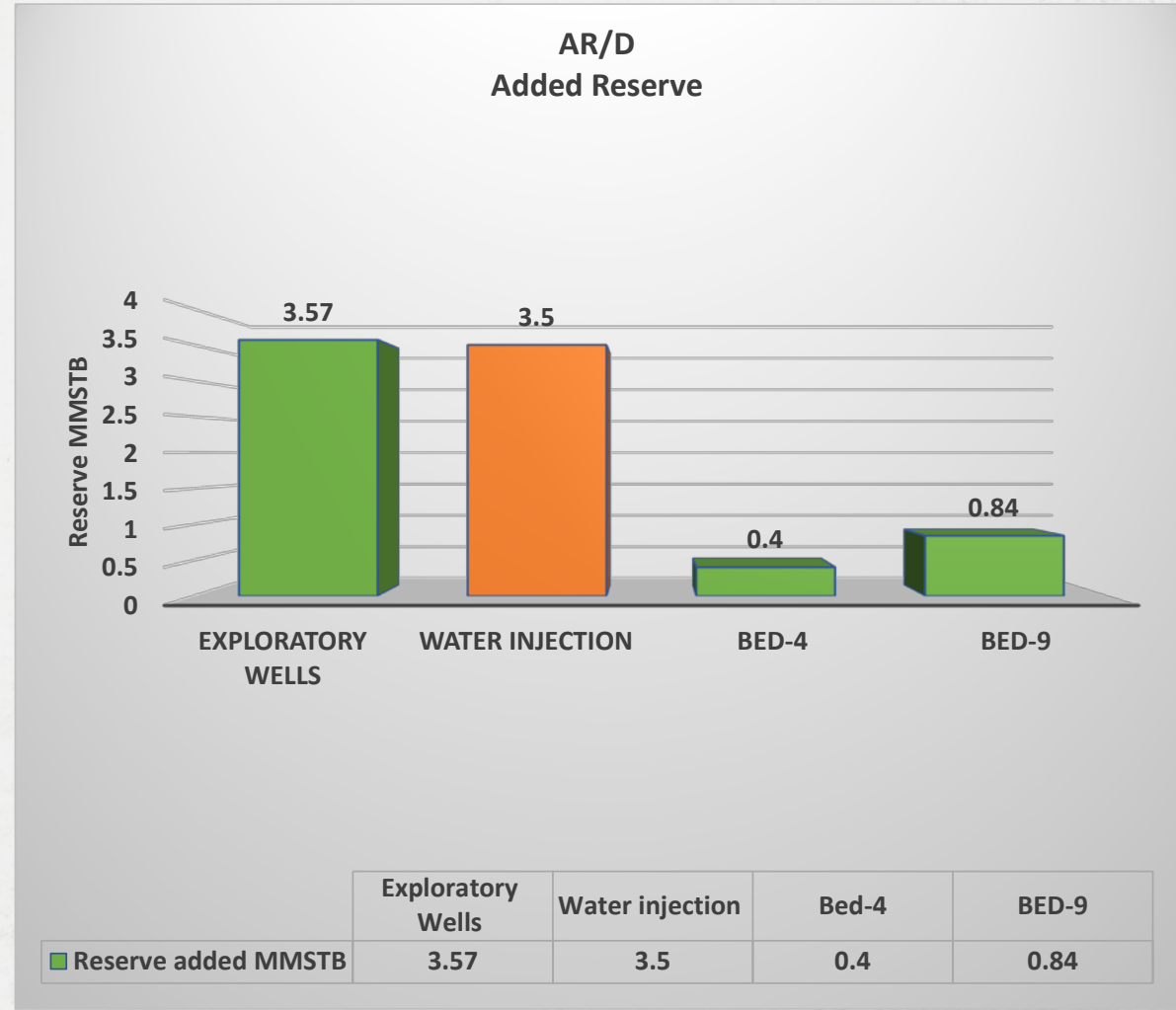
Water injection : **3.5 MMSTB**

### BED-4

After Perforate Bed 4-3 and drilled Bed 4-6 & Bed 4-8 ,the total added Reserve is **0.4 MMSTB**

### BED- 9

After tested ARD in BED 9-8 and Bed 9-11 ,the total added reserve is **0.84 MMSTB**







# CONCLUSION



# CONCLUSION



**The Key in making new discoveries in Brown field is understanding the reason behind P&A or unsuccessful wells .**



**WEPCO'S New Discoveries & water flooding project Increased Production in BED 1 Brown Field By 650 %**



**Carbonate reservoirs currently Produces more than 35 % Of the Total Production .**



**Total Added Reserve From carbonate reservoirs since Wepco operated Bed 1 increased by 8 MMSTB While the total Added Reserve is 12.5 MMSTB**

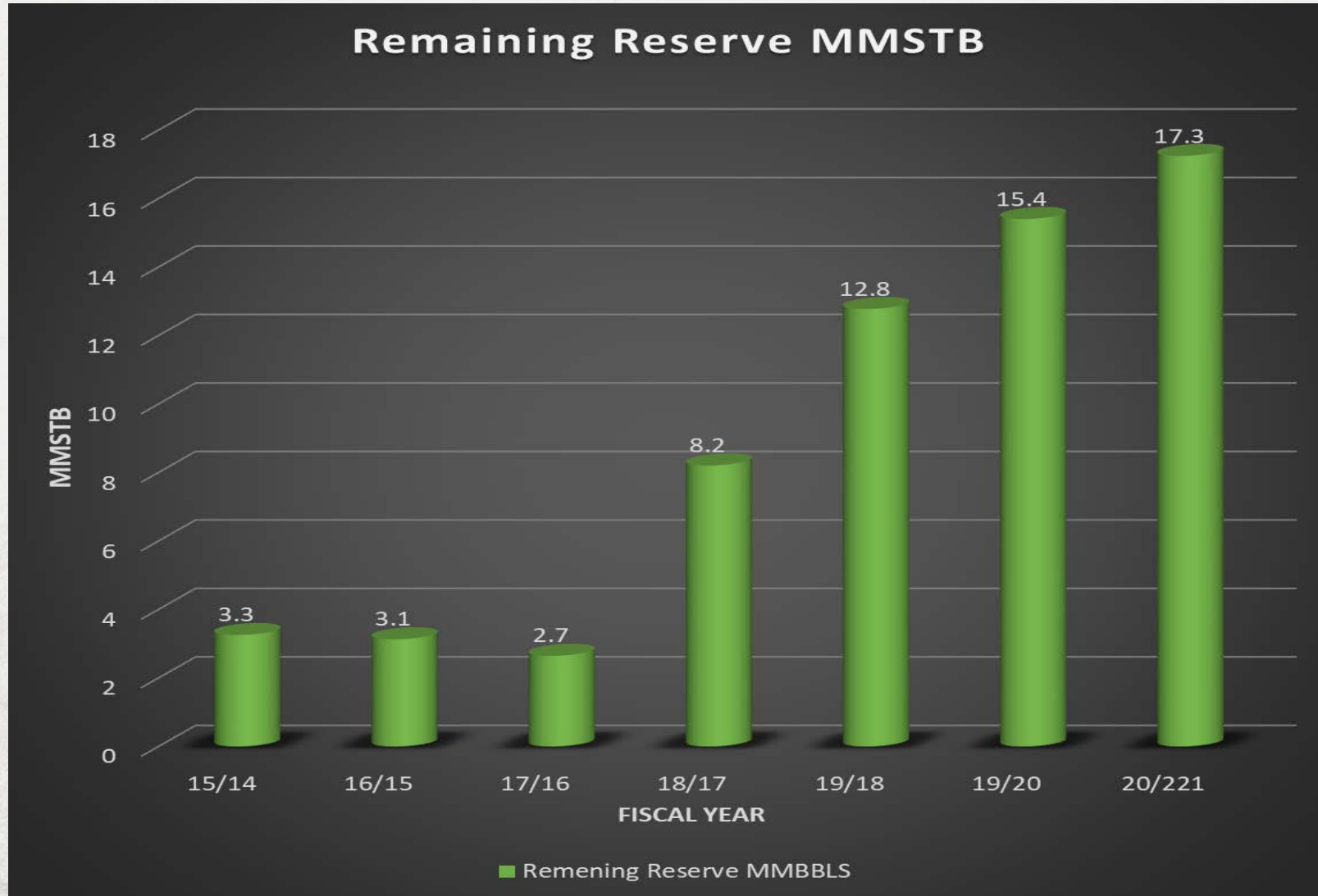


**Currently FDP of AR/F is ongoing**





# Total Added Reserve





# BPCO Oil daily & cum Prod

Actual Vs. Expected

