Reservoir and Production Challenges in Complicated Tight Carbonate Reservoir in the Bahrain Field*

Rabab Al Saffar[1], Mike Dowen[1], Ibrahim Jaber[1], and Khamis Al Abdali[1]

Search and Discovery Article #20385 (2017)**
Posted March 27, 2017

*Adapted from oral presentation given at AAPG Geosciences Technology Workshop, "Exploring Mature Basins," Amwaj Islands, Bahrain, April 11-13, 2016
**Datapages © 2017 Serial rights given by author. For all other rights contact author directly.

[1]Tatweer Petroleum, Bahrain (RababAli_Abdulla@tatweerpetroleum.com)

Abstract

The Ostracod and Magwa reservoir is the upper member of the Rumaila Formation in the Bahrain Field. The Ostracod-Magwa zones consist of interbedded limestone and argillaceous limestone layers. The matrix has very low permeability, well below production permeability. Estimated OOIP is more than one billion barrel of oil.

Previously Ostracod and Magwa reservoirs were treated as secondary targets when deeper wells were salvaged for completion in the Ostracod/Magwa zones. Tatweer launched a drilling program for dedicated Ostracod and Magwa wells in late 2010. While the initial production response was good, production from those wells declined rapidly. By 2013, it was realized that the Ostracod-Magwa wells had a large range of production performance and were generally not performing as well as it was initially expected.

The objective of this paper is to highlight current petrophysical and geological understanding of Ostracod Magwa carbonate reservoir and identify challenges associated with increasing reservoir productivity. The workshop will be utilized as a venue to discuss with petrophysical expertise the following challenges faced in the Ostracod Magwa development:

- The reservoir has low reservoir permeability with production behavior reflecting possible contribution from fractures: however, recent image log reviews do not support presence of fractures -- could be other type of secondary permeability?
- Understanding production conformance is challenging in Ostracod Magwa due to the low production (below production logging resolution). How can we understand the contribution of the 56 units in this interbedded tight limestone?
- Completion strategy is to perforate all net pay; therefore, there is an opportunity for improving cost efficiency if production contribution is clearly understood. The workshop will help to understand the production behavior of Ostracod Magwa. It is also expected to define technical solutions for understanding production conformance and, therefore, better define opportunities for future development.

AAPG
Advancing the World of Petroleum Geosciences.

Reservoir and Production Challenges in Complicated Tight Carbonate Reservoir in the Bahrain Field

Rabab Al Saffar, Mike Dowen,
Ibrahim Jaber , Khamis Al Abdali

AAPG
Advancing the World of Petroleum Geosciences.

Agenda

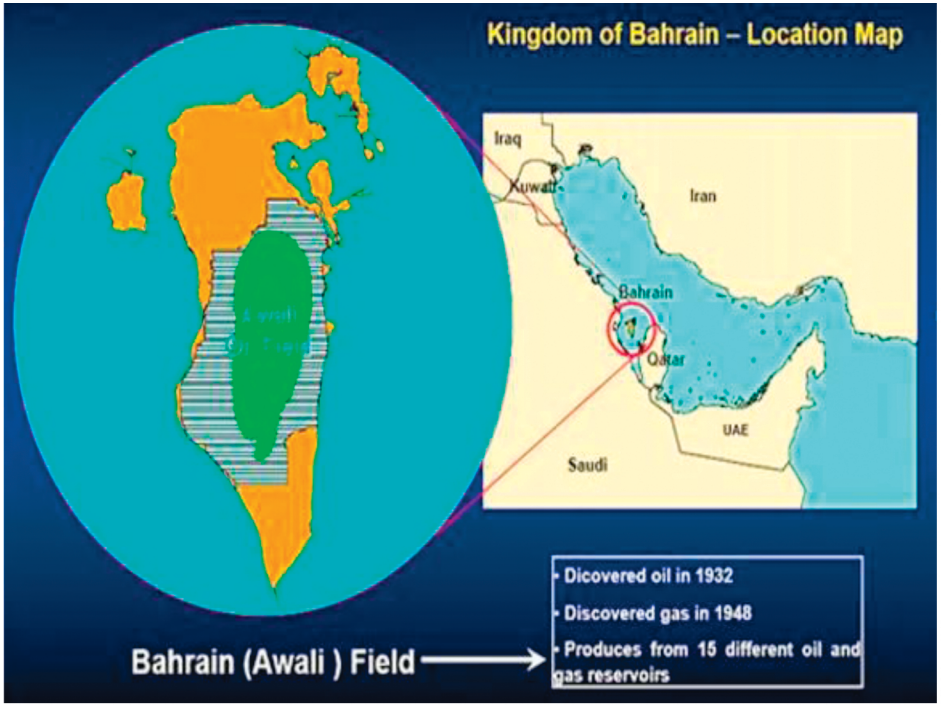
- Objective
- Reservoir overview
- Reservoir Challenges
- Summary

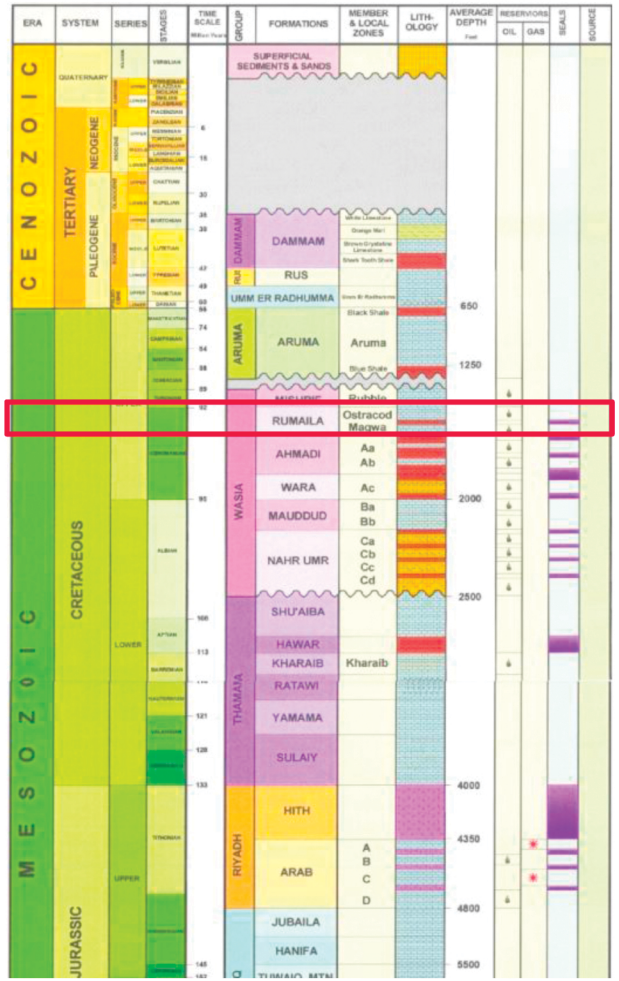
Objective

- Discuss current petrophysical and geological understanding of Ostracod Magwa carbonate reservoir
- Highlight challenges associated with fractured nature and producing units from Ostracod Magwa

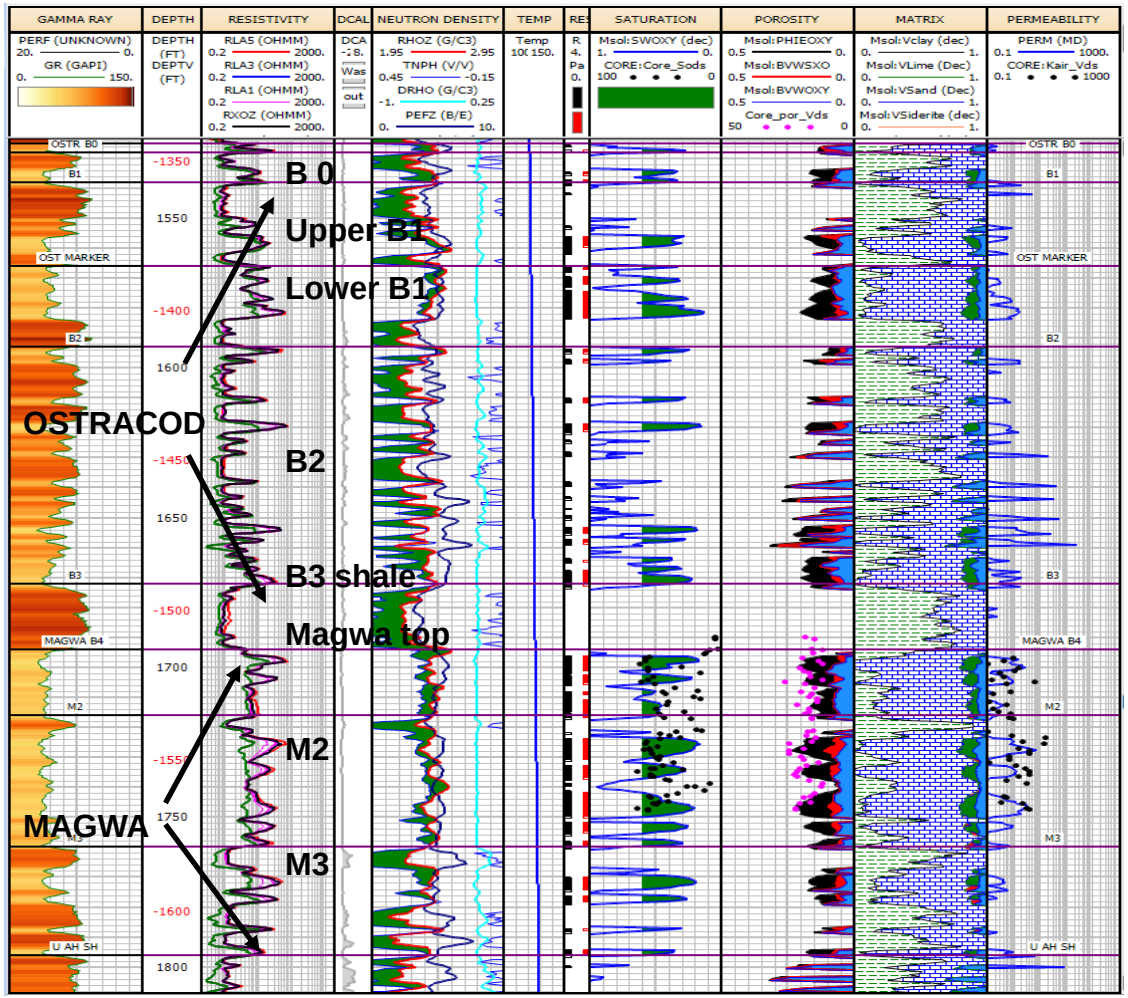
AAPG
Advancing the World of Petroleum Geosciences.

Reservoir overview 1-Reservoir Location





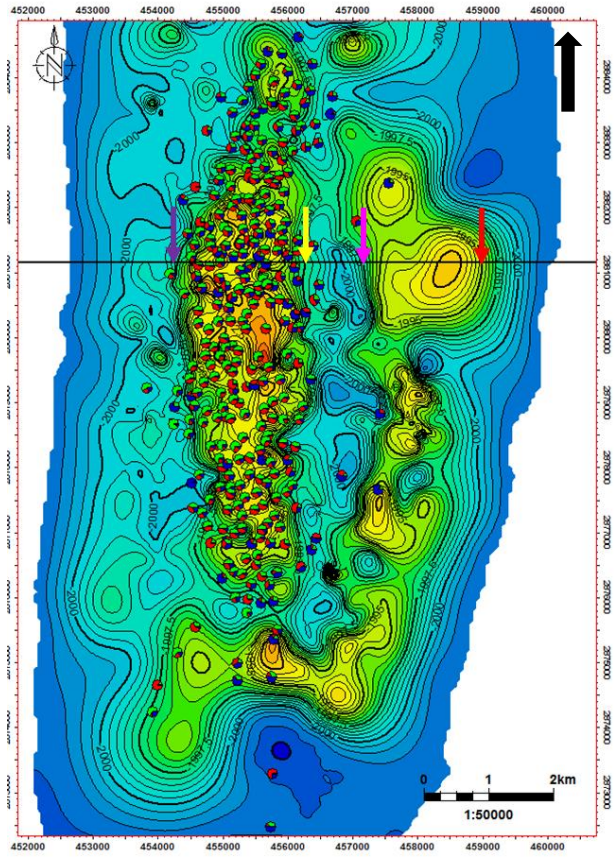
Reservoir overview 2-Reservoir Properties



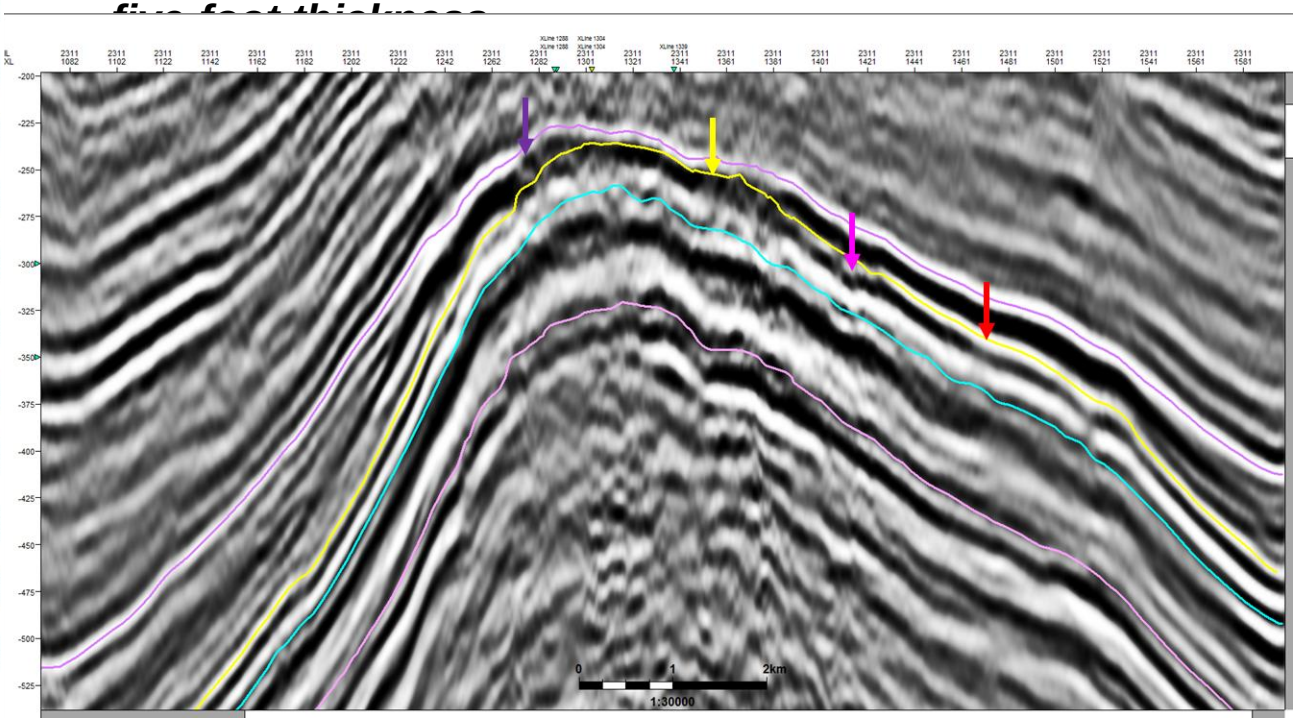
- Interbedded limestone and shale.
- Note the Blue shale on the crest and the Rubble on the flanks.
- OST thickness =Gross 160 ft, Net 48 ft
- MAG thickness = Gross 130 ft, Net 46 ft
- Thin bedded (1-10 ft)
- Low perm < 1md
- 14% -16% average porosity
- Swi = 40-50 %
- MAG is slightly better than OST.
- OOIP = 1.2 billion BO
- RF = 1%

Reservoir overview

3-OST/MAG SoPHih

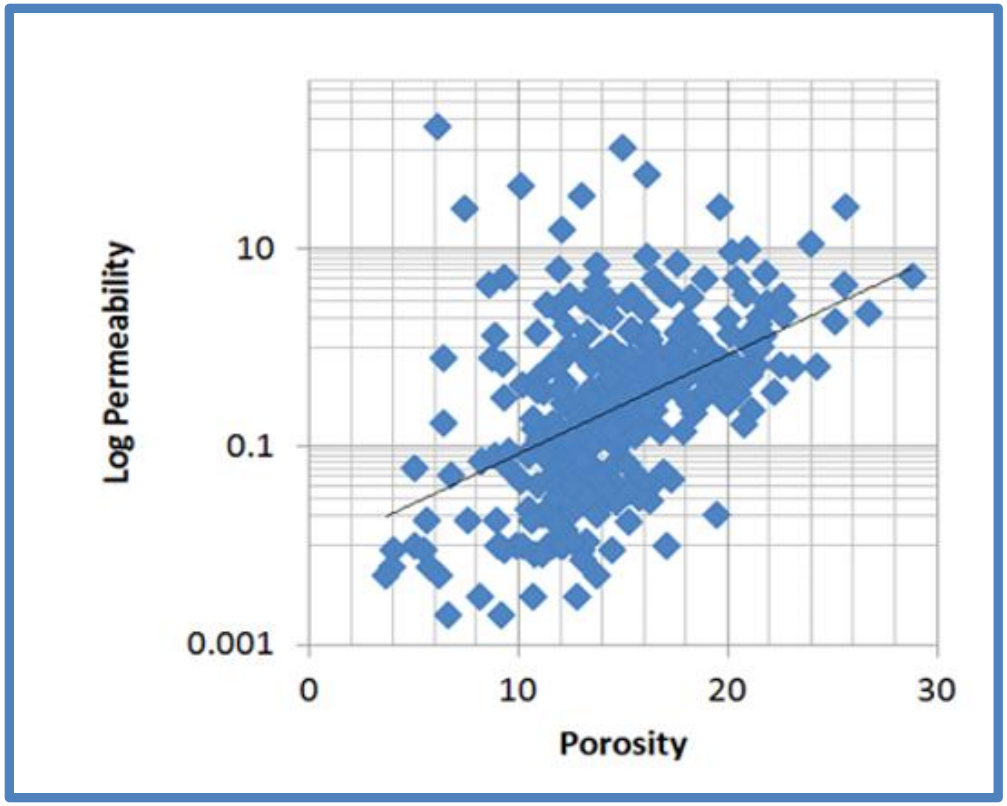


The colored arrows shown on the map and their corresponding match on the seismic section are pointing to likely faults which might create compartments especially with the target reservoir of five foot thickness



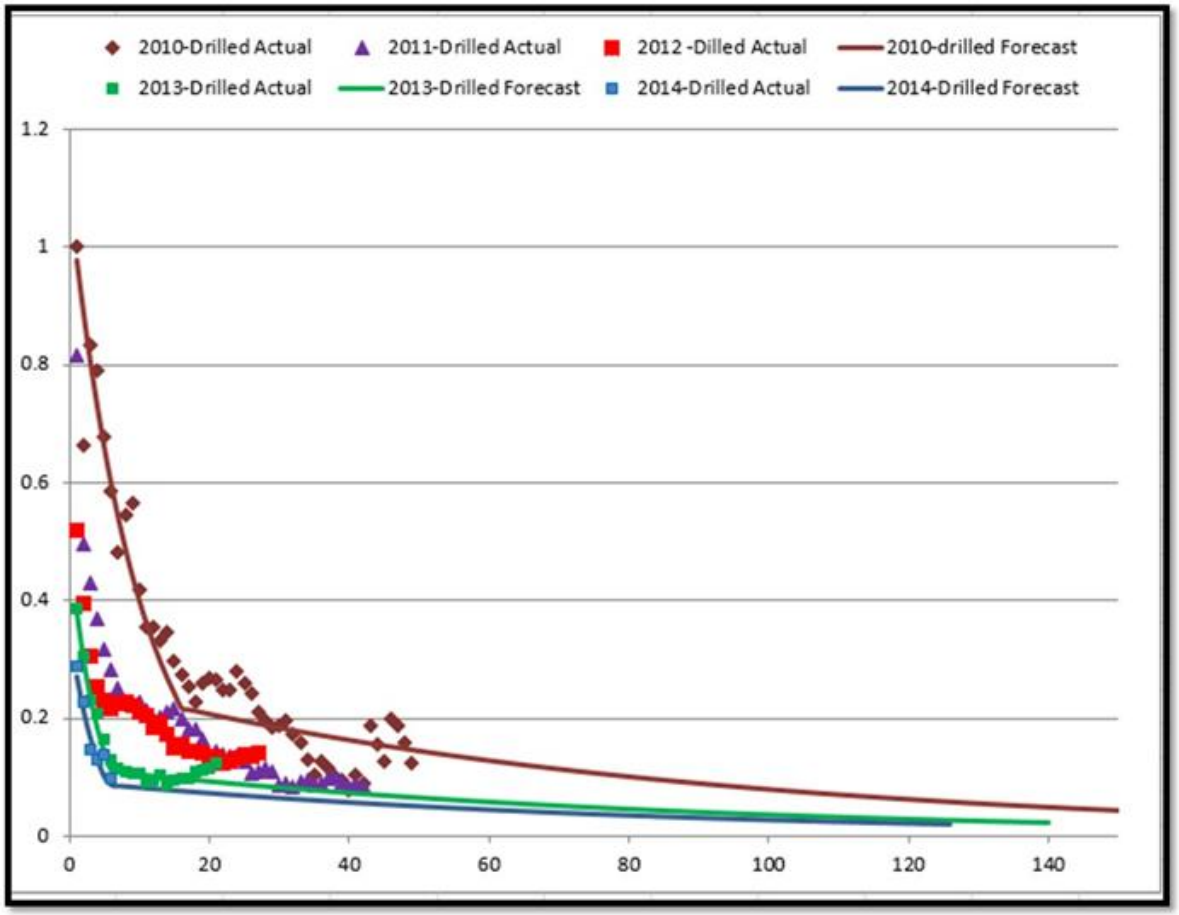
Reservoir Challenges

Poro - Perm



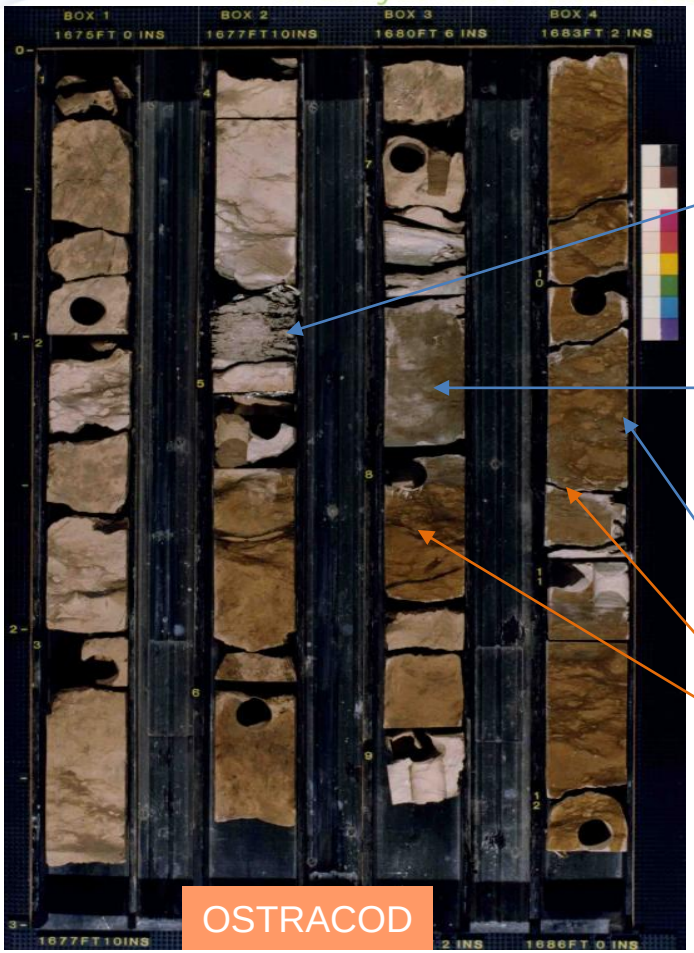
AAPG
Advancing the World of Petroleum Geosciences.

well production



AAPG
Advancing the World of Petroleum Geosciences.

Core Photography



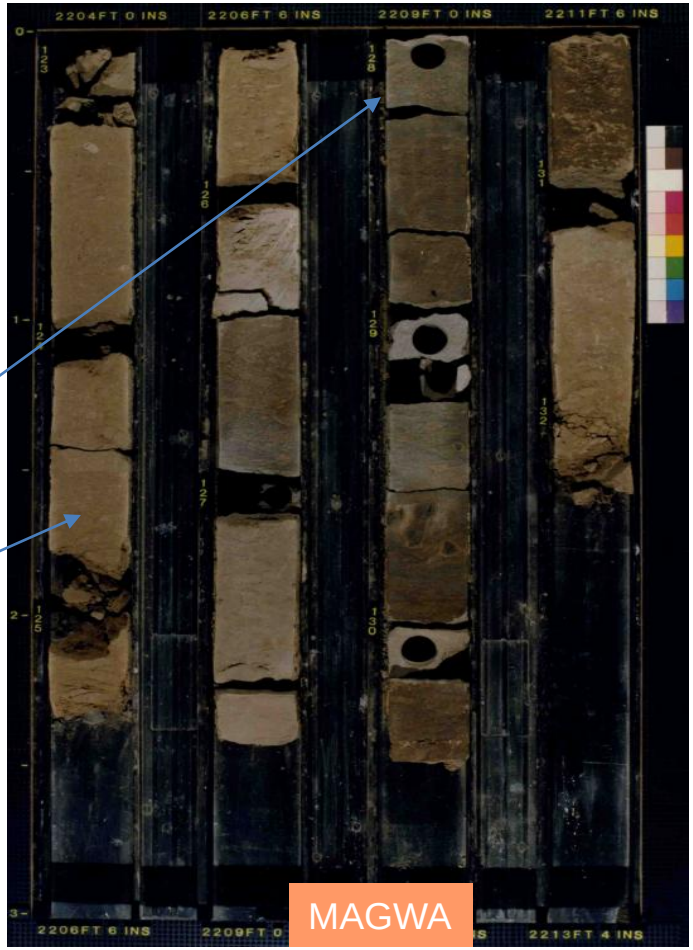
OSTRACOD

Limy mudstone (Shale)

Argillaceous lime wackestone

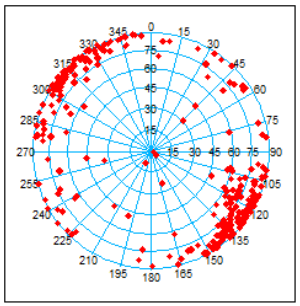
Clean lime wackestone.

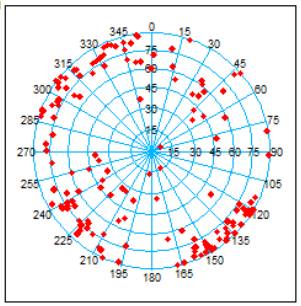
fractures

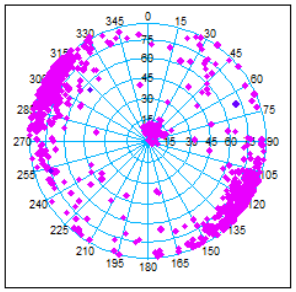


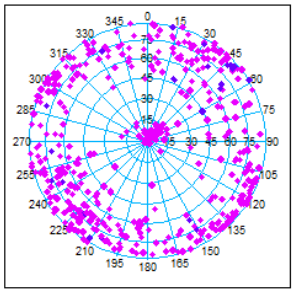
MAGWA

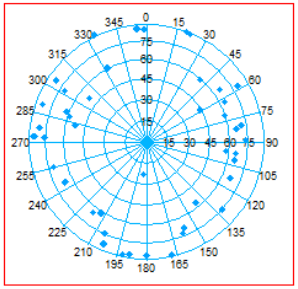
OST-MAG: Image Analysis

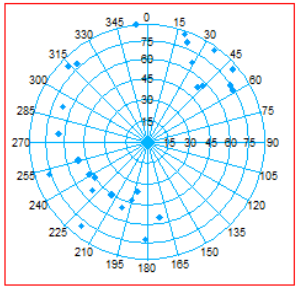












OSTRACOD

MAGWA

- Both open and resistive fractures trend NE-SW in Ostracod.
- Orientation of resistive and conductive fractures in Magwa is bimodal (NE-SW and NW-SE).
- Limited faulting in FMI, but oriented NW-SE in both formations.

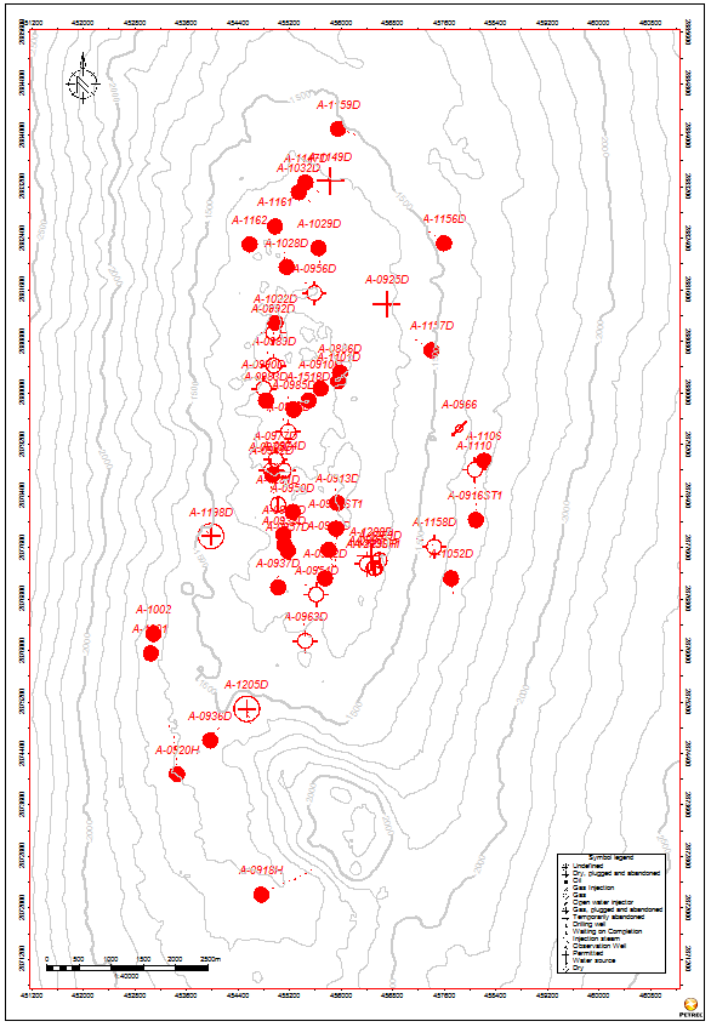
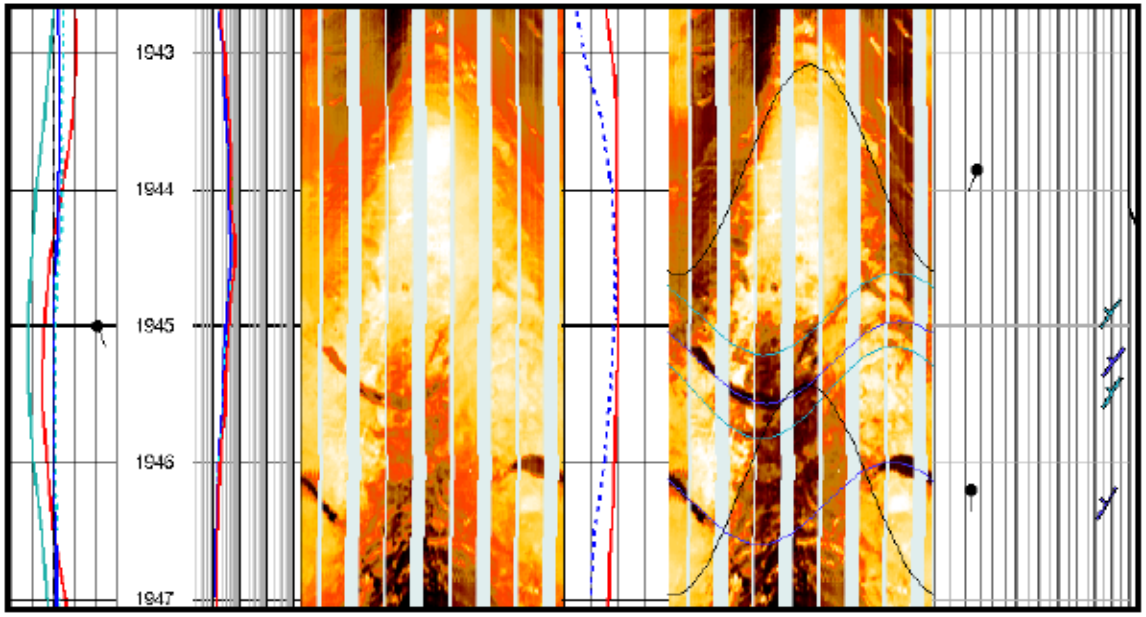


Image logs data from 57 wells

OST-MAG: Image Analysis
Revised

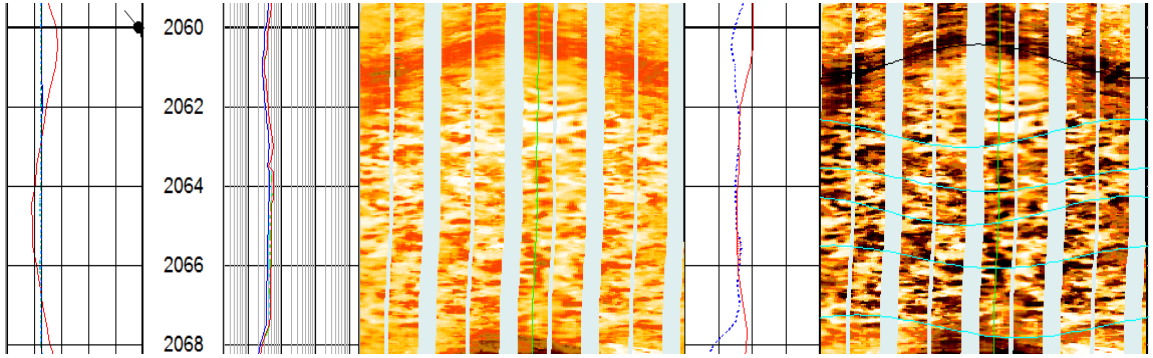
Ostracod



Conductive fracture

Resistive fracture

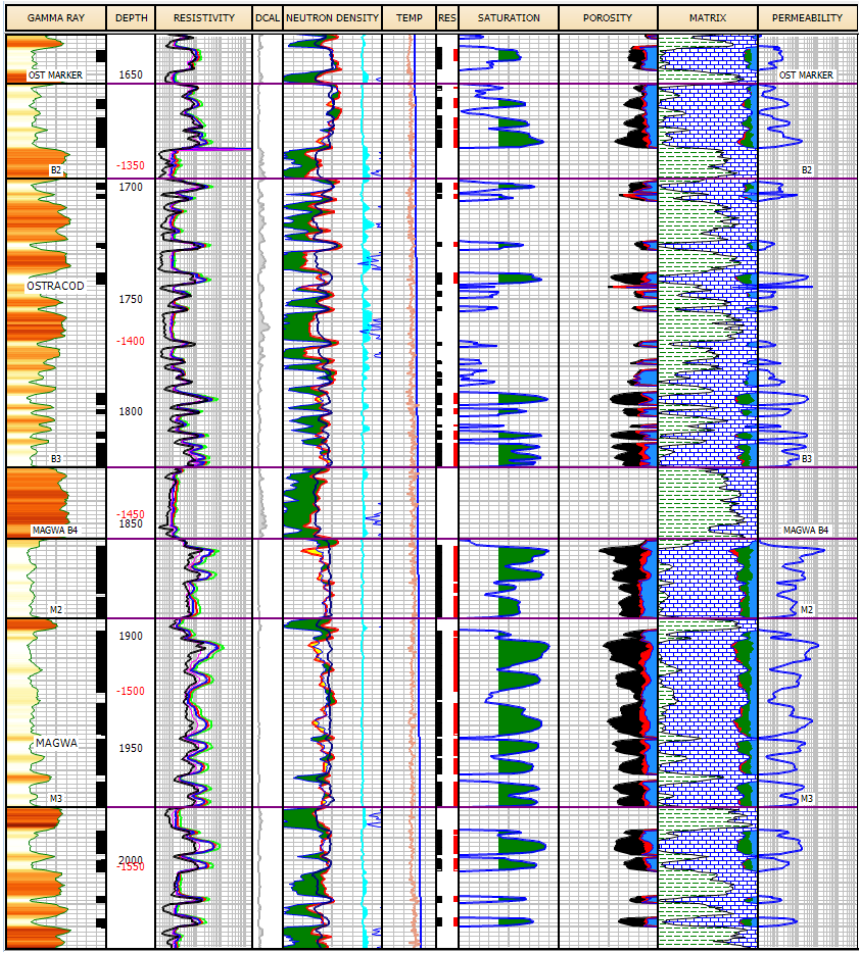
Magwa



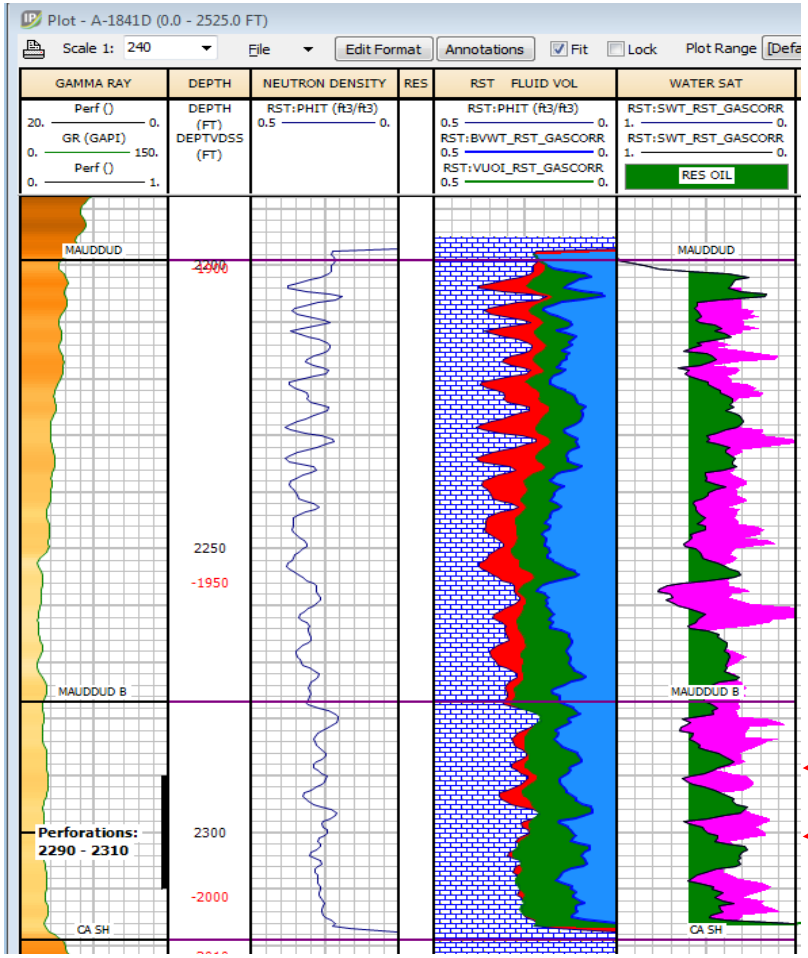
What is the nature of secondary porosity / perm?

AAPG
Advancing the World of Petroleum Geosciences.

Perforations



Flush for Perm



RST run after several days of “water flooding “ due to several well losses

Oil saturation reduced to residual, or less in perm layers

How to confirm producing zones in low-rate wells?

Summary

- Ostracod Magwa is extremely heterogeneous reservoir with high oil in place and low recovery factor
- Low reservoir permeability and production behavior reflect possible contribution from fractures; however, recent image logs review would indicate that fractures are not a significant contributor– could be other type of secondary permeability?
- Understanding production conformance is challenging in Ostracod Magwa due to the low production (below production logging resolution). How can we understand the contribution of 56 units in this interbedded tight limestone?
- Completion strategy is to perforate all net pay; opportunity for cost efficiency if production contribution is clearly understood.