New Reserves Discovery :

Deep Oligocene Syn-Rift Reservoirs

Arthit Field, Gulf of Thailand

Outlines

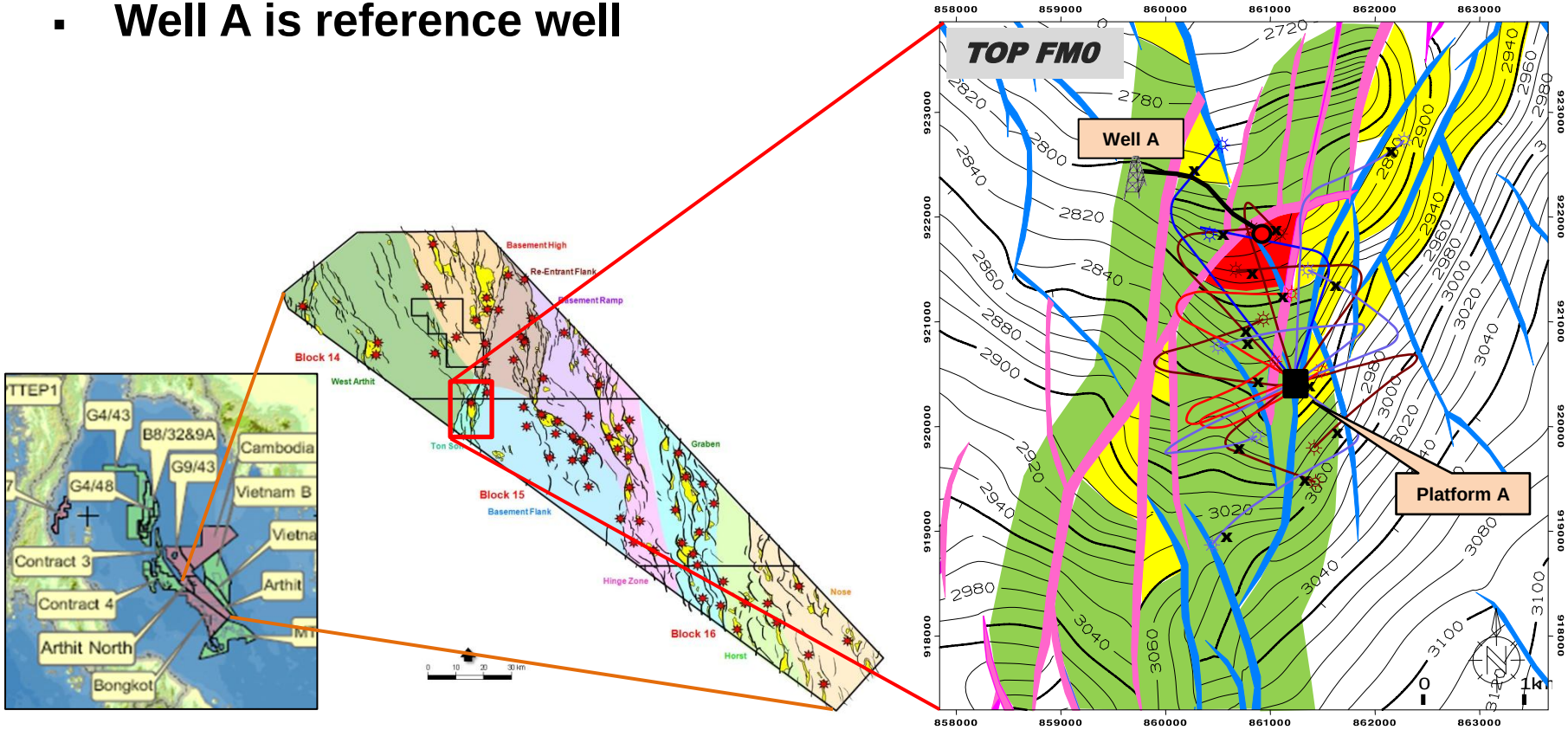
- Introduction
- Subsurface study
- Well Result
- Production performance
- Conclusions

Outlines

- **Introduction**
- Subsurface study
- Well Result
- Production performance
- Conclusions

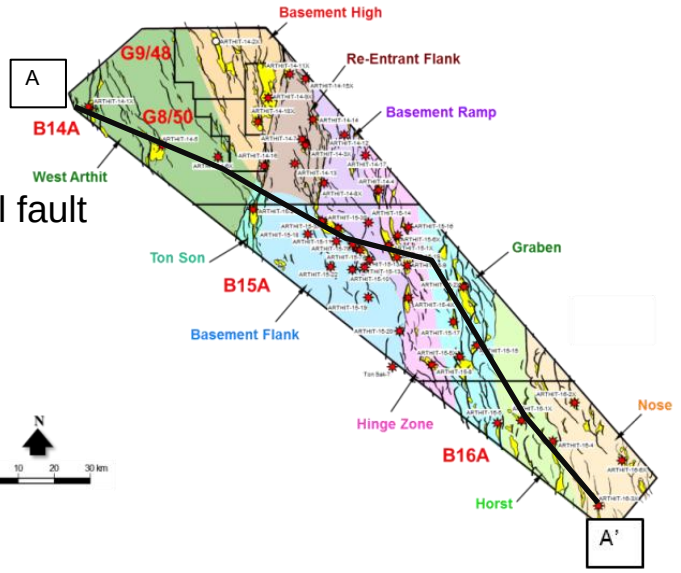
Introduction

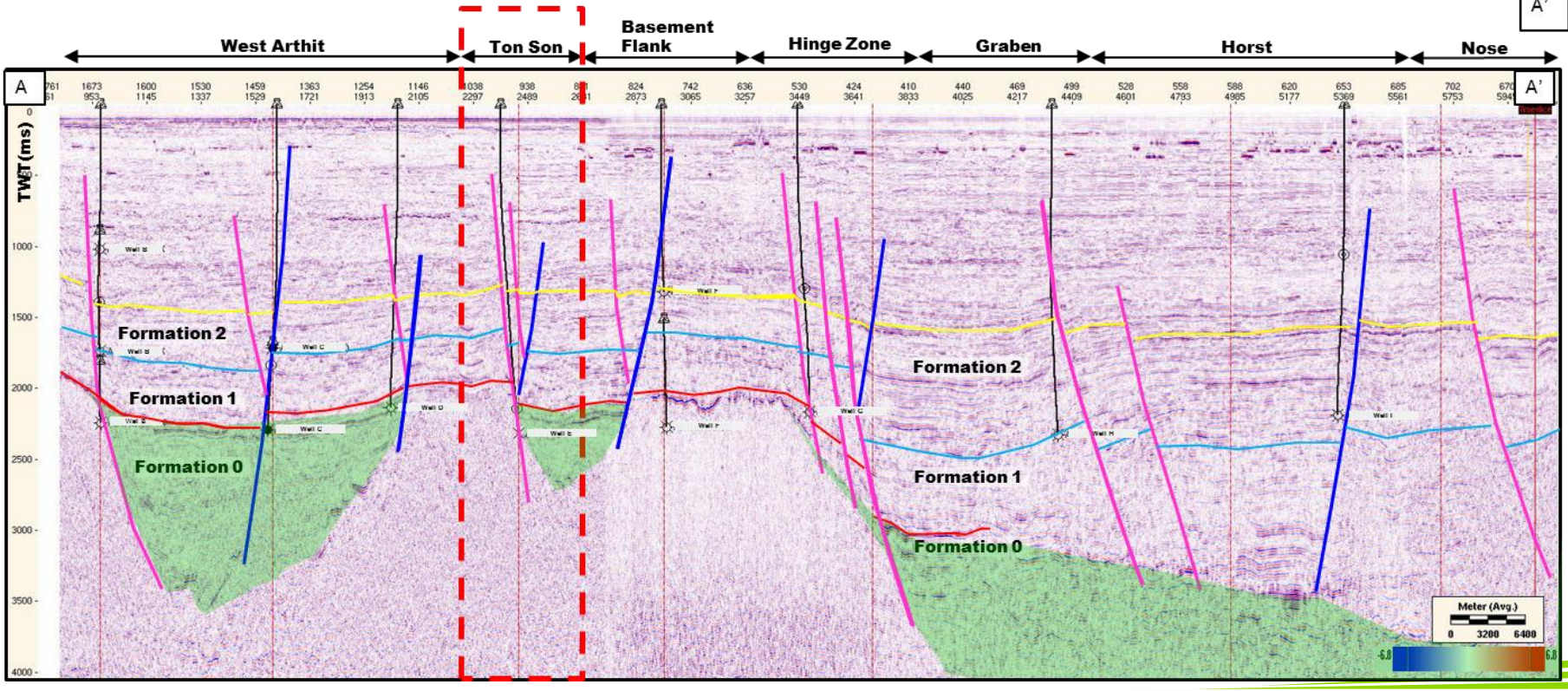
- Arthit Field is located in North Malay Basin
- Ton Son fault trend associated with a series of large displacement east-dipping normal faults and major faults are splayed and transformed to a series of N-S striking conjugate fault sets to the southward
- **Well A is reference well**



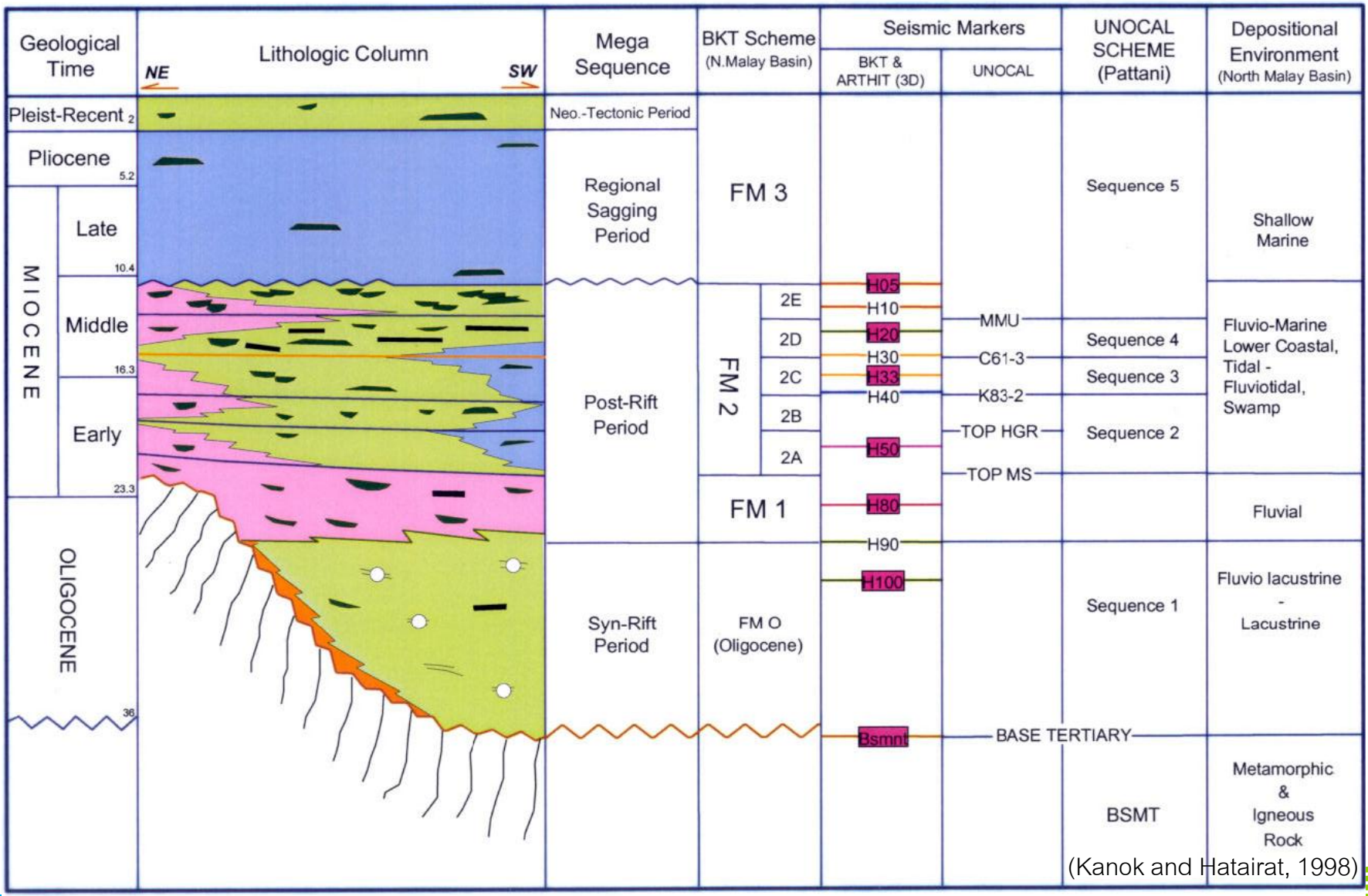
Structural Setting

- The main fault orientation is in N-S and NW-SE striking normal fault
- The fault forming is affect to the structural trends in Arthit field





Arthit Stratigraphy

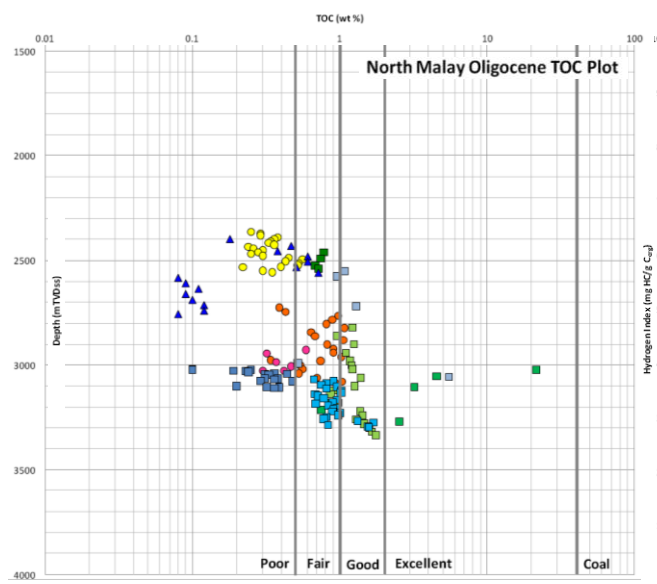


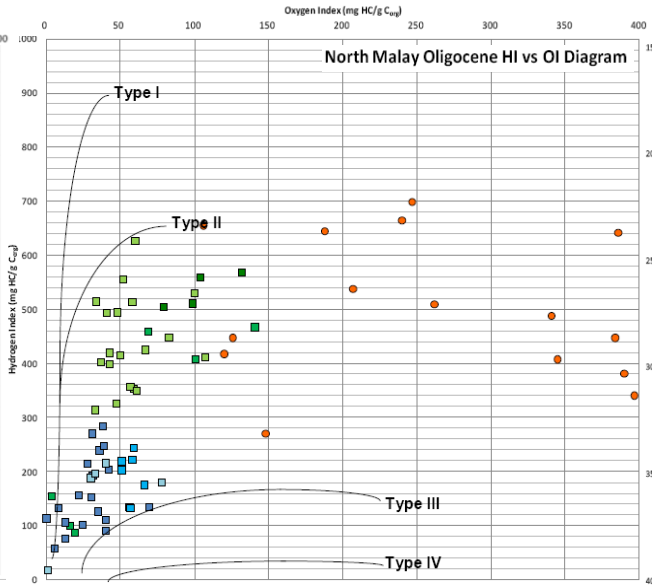
(Kanok and Hatairat, 1998)

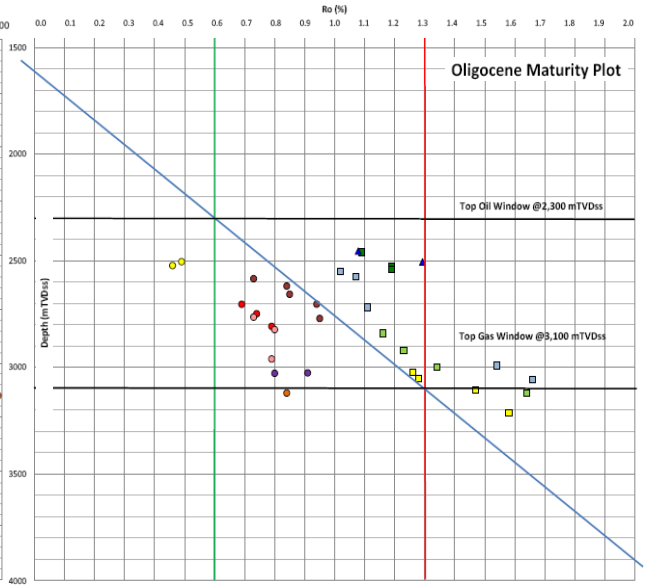
Outlines

- Introduction
- **Subsurface study**
- Well Result
- Production performance
- Conclusions

Petroleum System:
Source Rock, Maturity and Migration



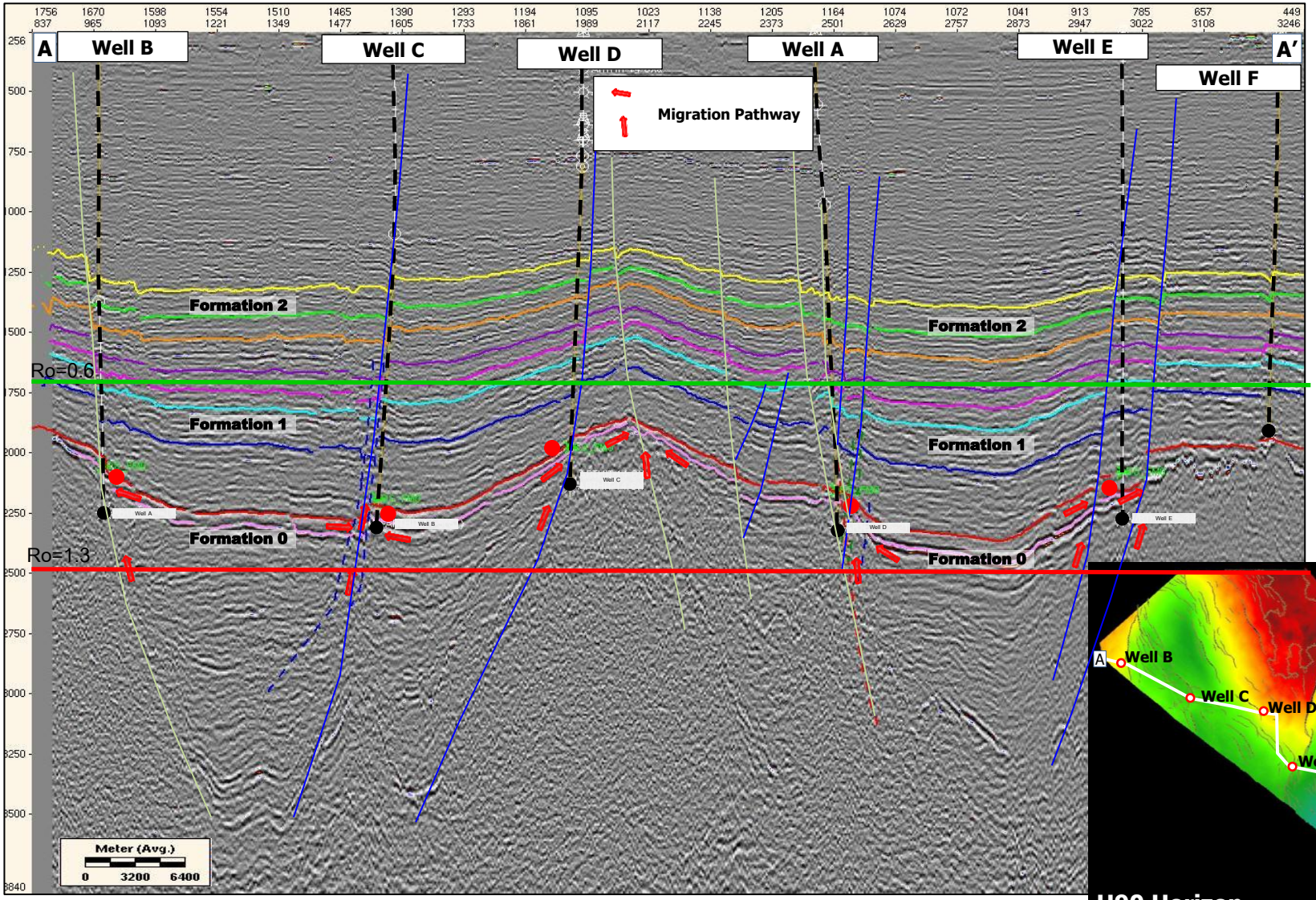


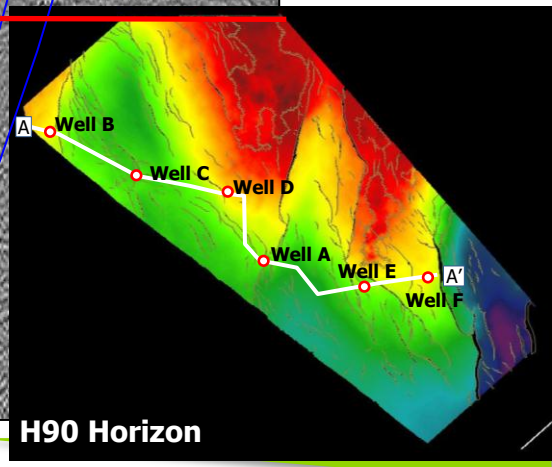


- Oligocene Lacustrine Shale, FM0
- TOC: mainly poor to good (0.1- 2% TOC)
- Kerogen: Mixing Type II and Type III (Type II dominant)
- Maturation: Top oil window is at 2,300 m TVDSS (Ro 0.6%)

  and top gas window is at 3,100 m TVDSS (Ro 1.3%)

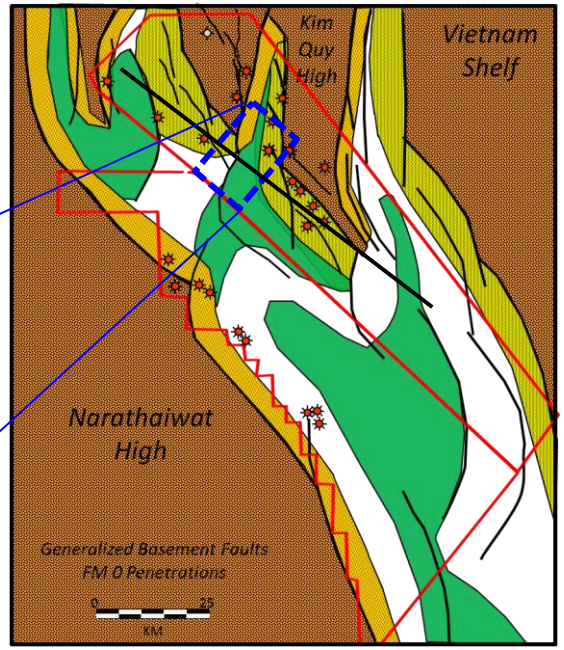
Petroleum system: source rock-maturity-migration

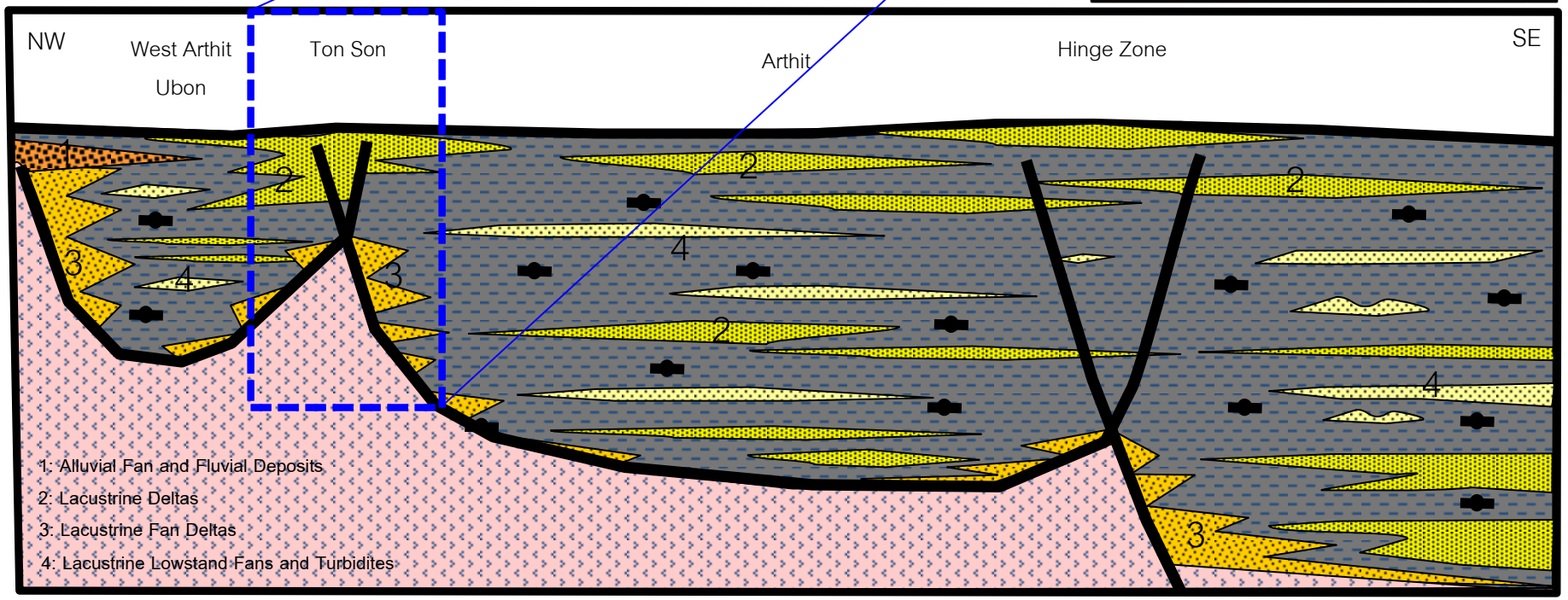




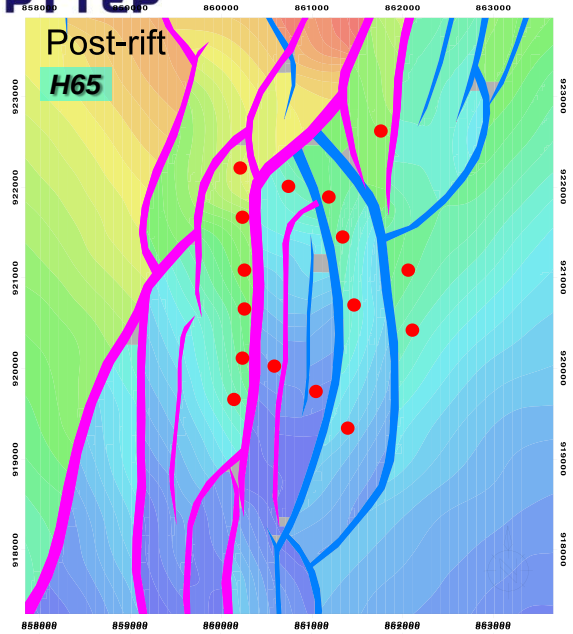
Petroleum System:
Play Types and Reservoir

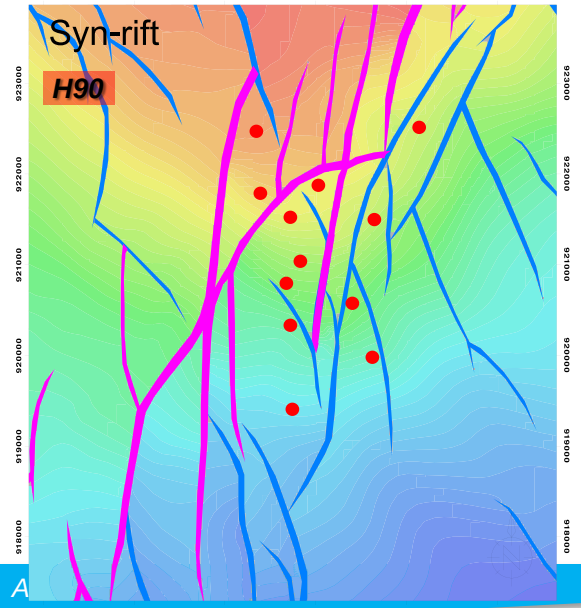
- Deposited during Oligocene aged (24-28 MYA) during Initial-rift basin
- **Lacustrine deltas reservoir**
- Interbedded sand-shale layers



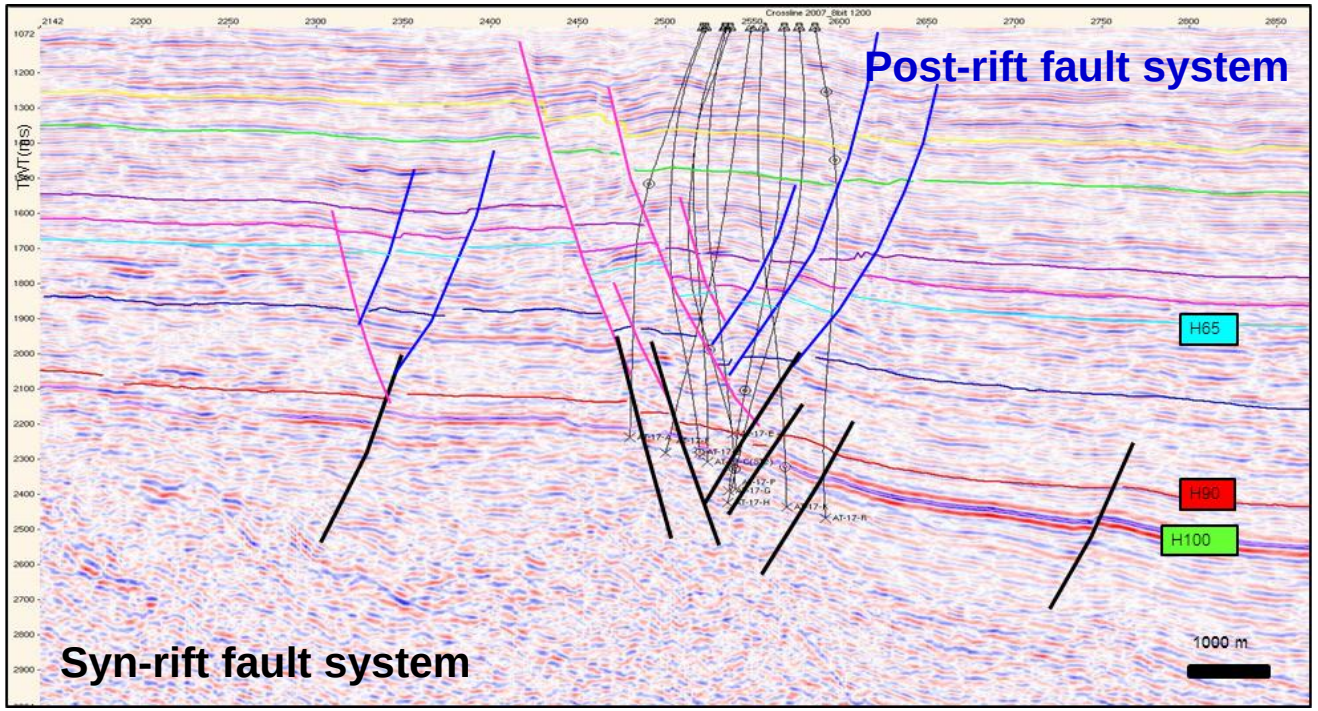


Petroleum System: Trap and Seal





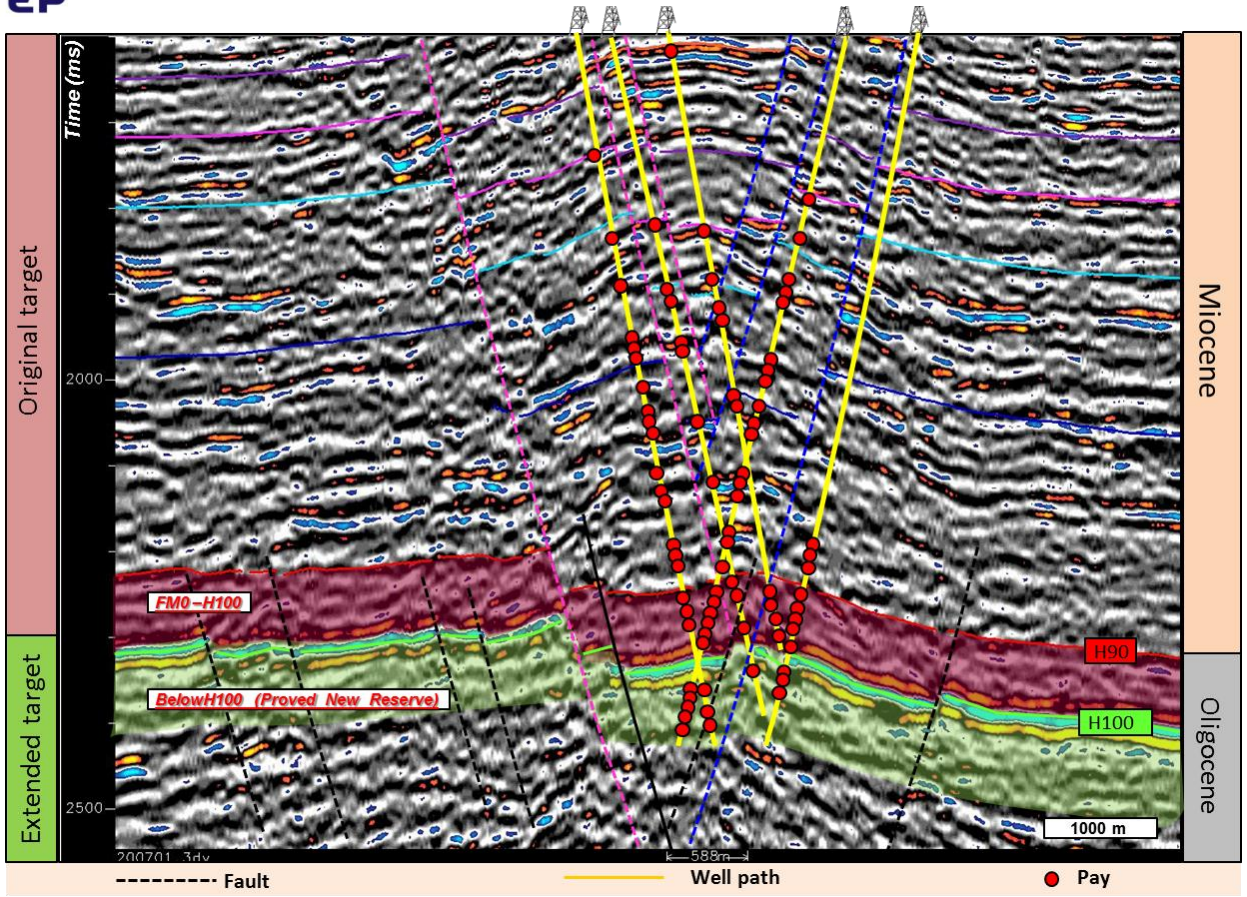
- Mostly in NW-SE and N-S orientation
- Construct structural closure and ramp structure
- Small fault throw (10-30m)

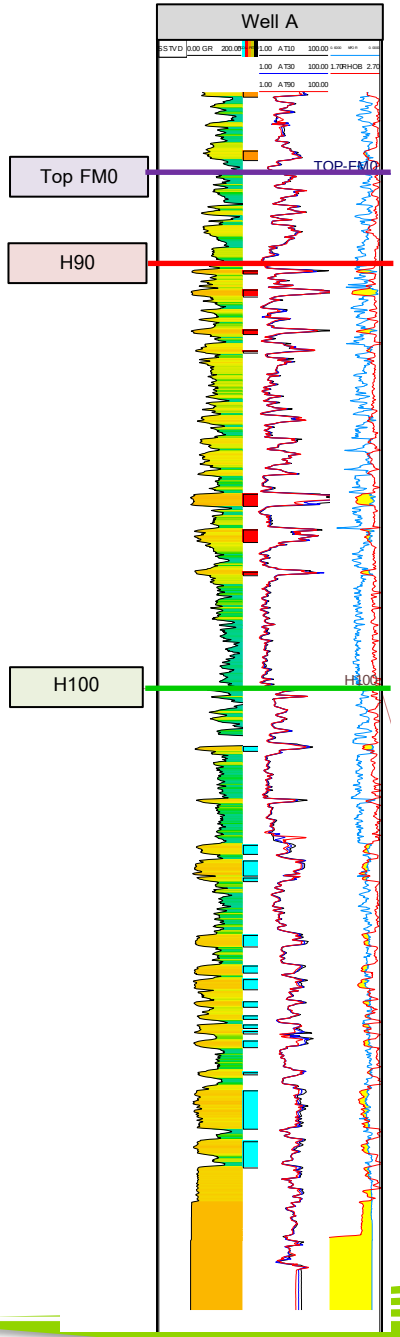


Outlines

- Introduction
- Subsurface study
- **Well Result**
- Production performance
- Conclusions

FM0 Character

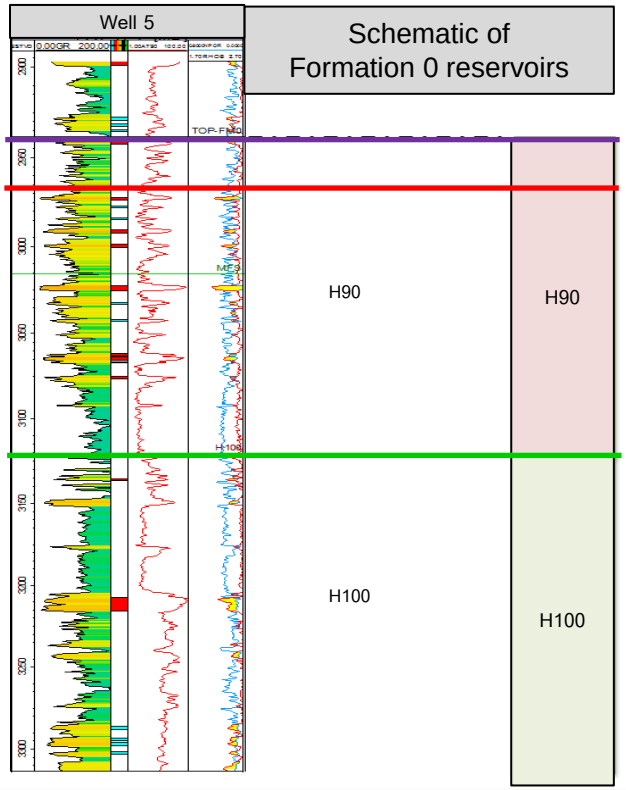


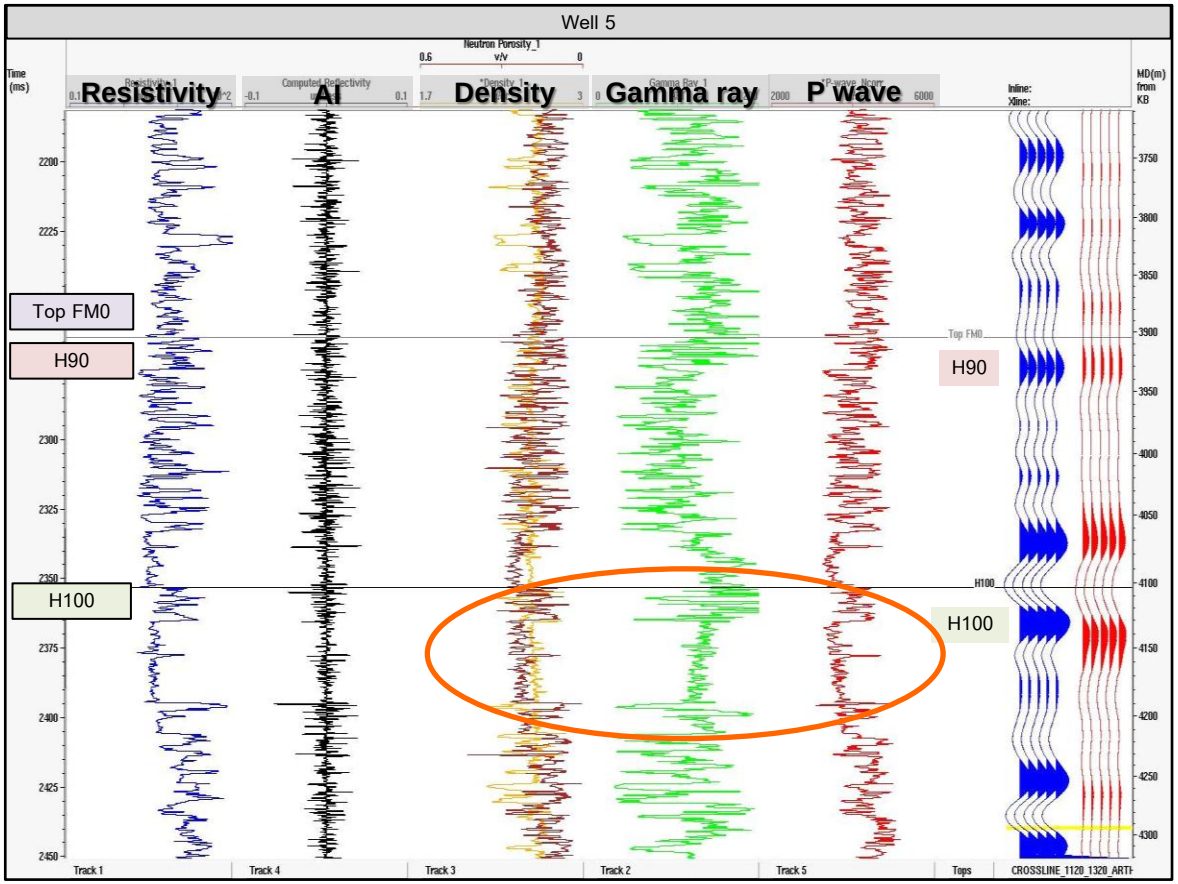


- FM0 is sub divided into 2 main units
  - *FM0 (H90-H100)*
  - *FM0 (belowH100)*

FM0 Character

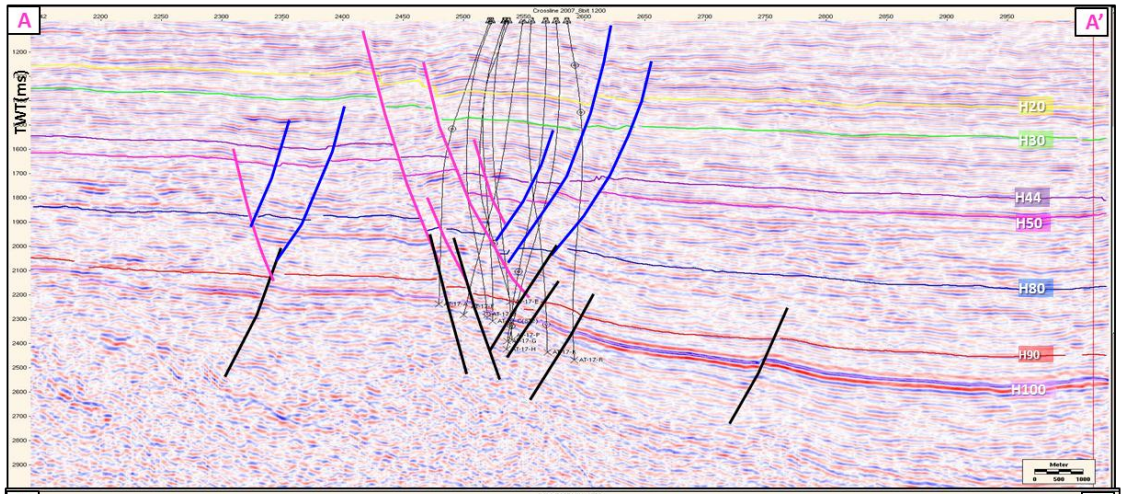
- H90 seismic trough corresponded to Top FM0
- H100 seismic trough corresponded to high velocity shale package

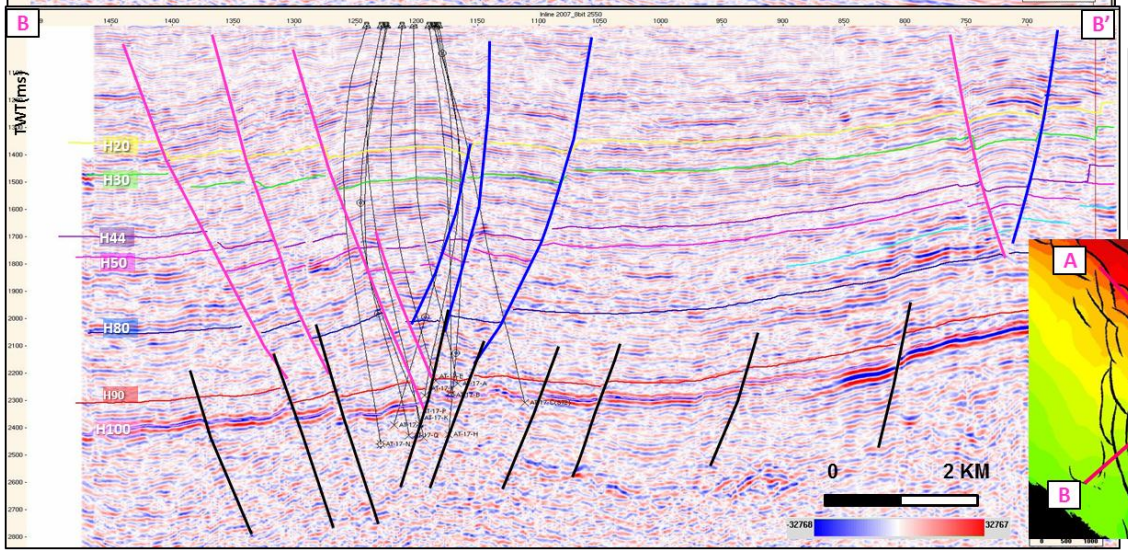


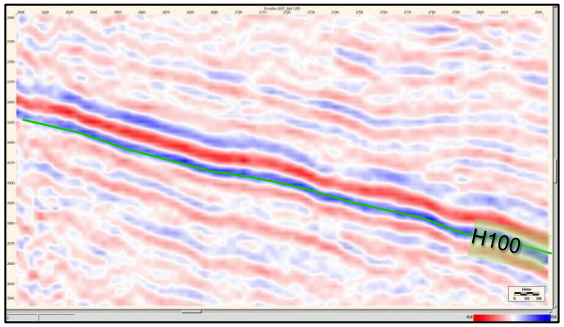


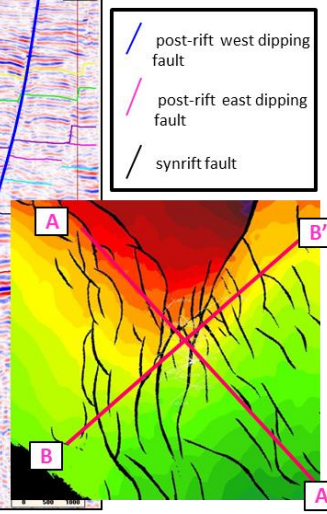
FM0 Character

- H100 exhibits continuous strong seismic reflectors
- Contains high seismic amplitude value and high seismic frequency content

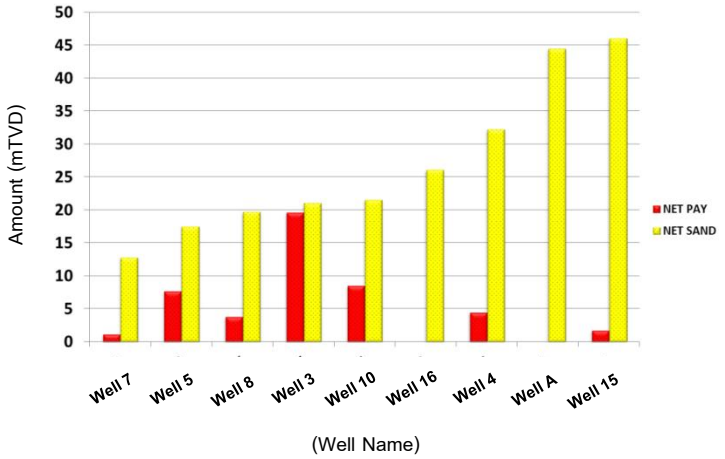


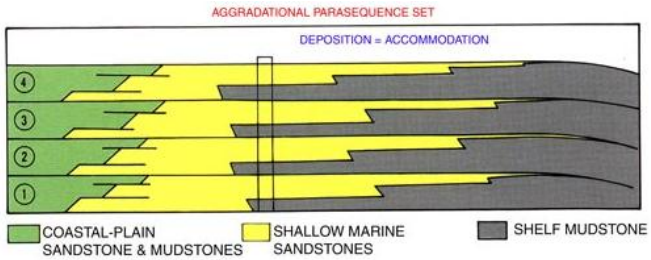


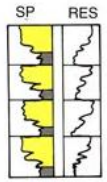


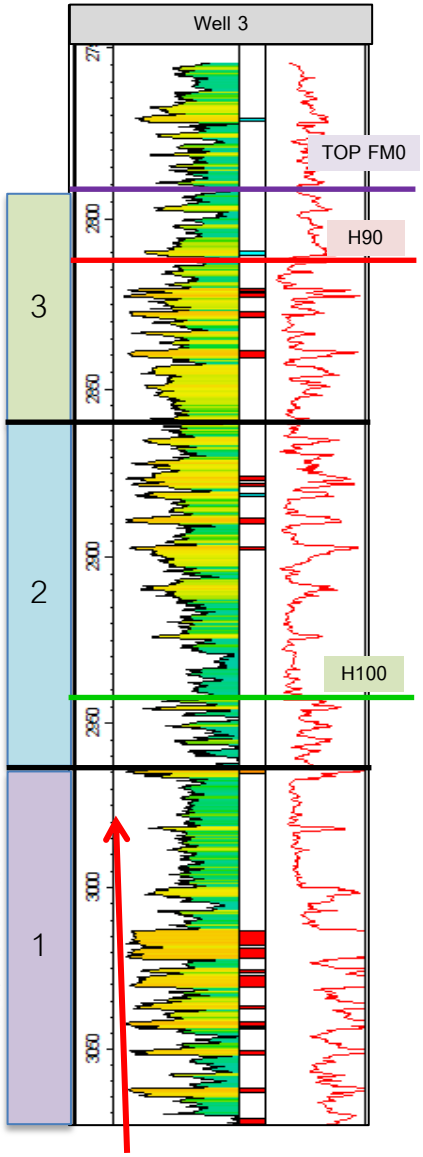


Below H100 Character



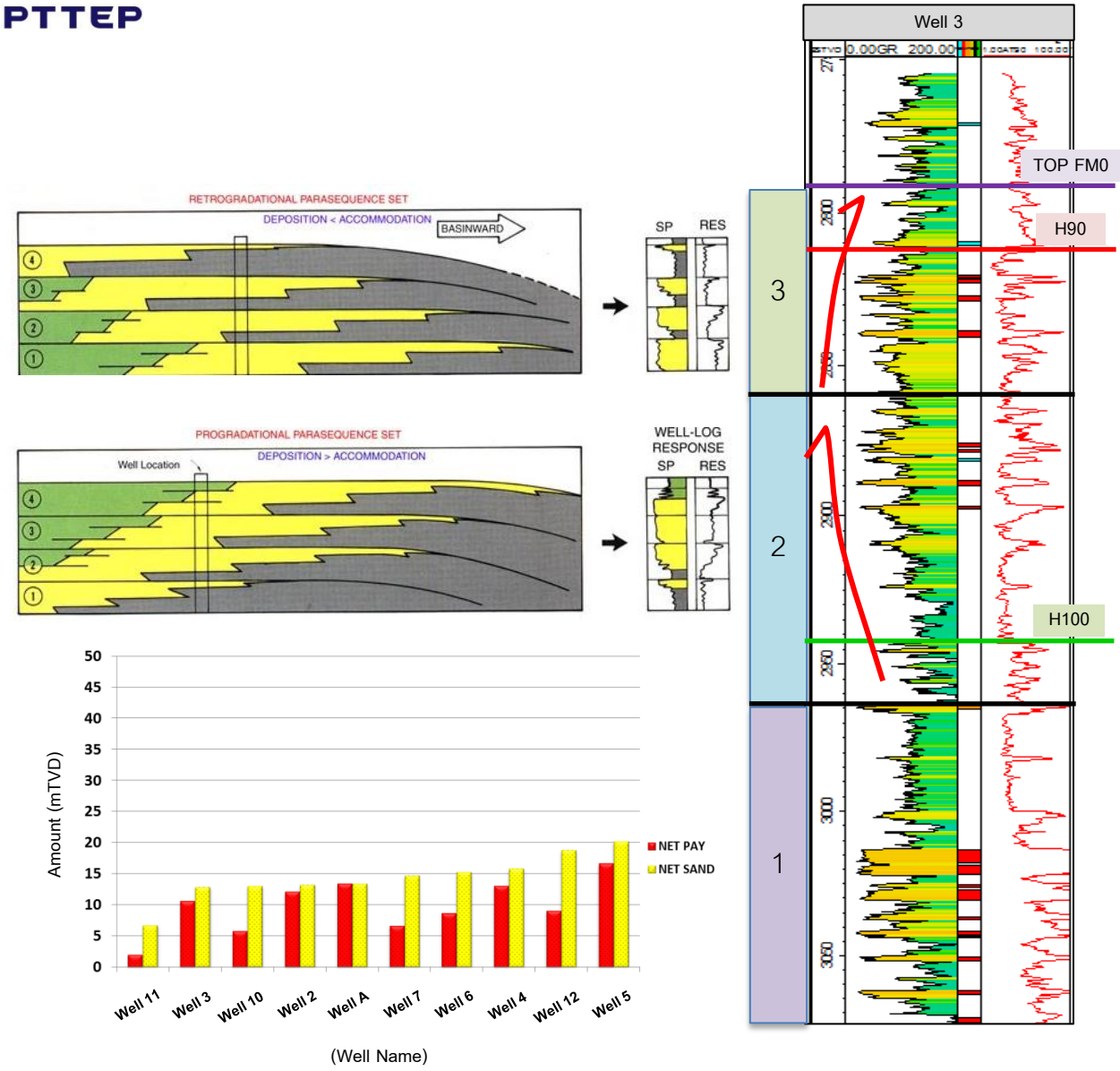






- Sequence 1 illustrate aggradation stacking pattern
- High net to gross interval is lead to establish the sand juxtaposition and low efficient of fault seal
- Below H100 interval the net pay result is varying base on trapping style and location of well.
- Structural closure is the best trap for hydrocarbon accumulation in H100 interval (i.e. Well 3)

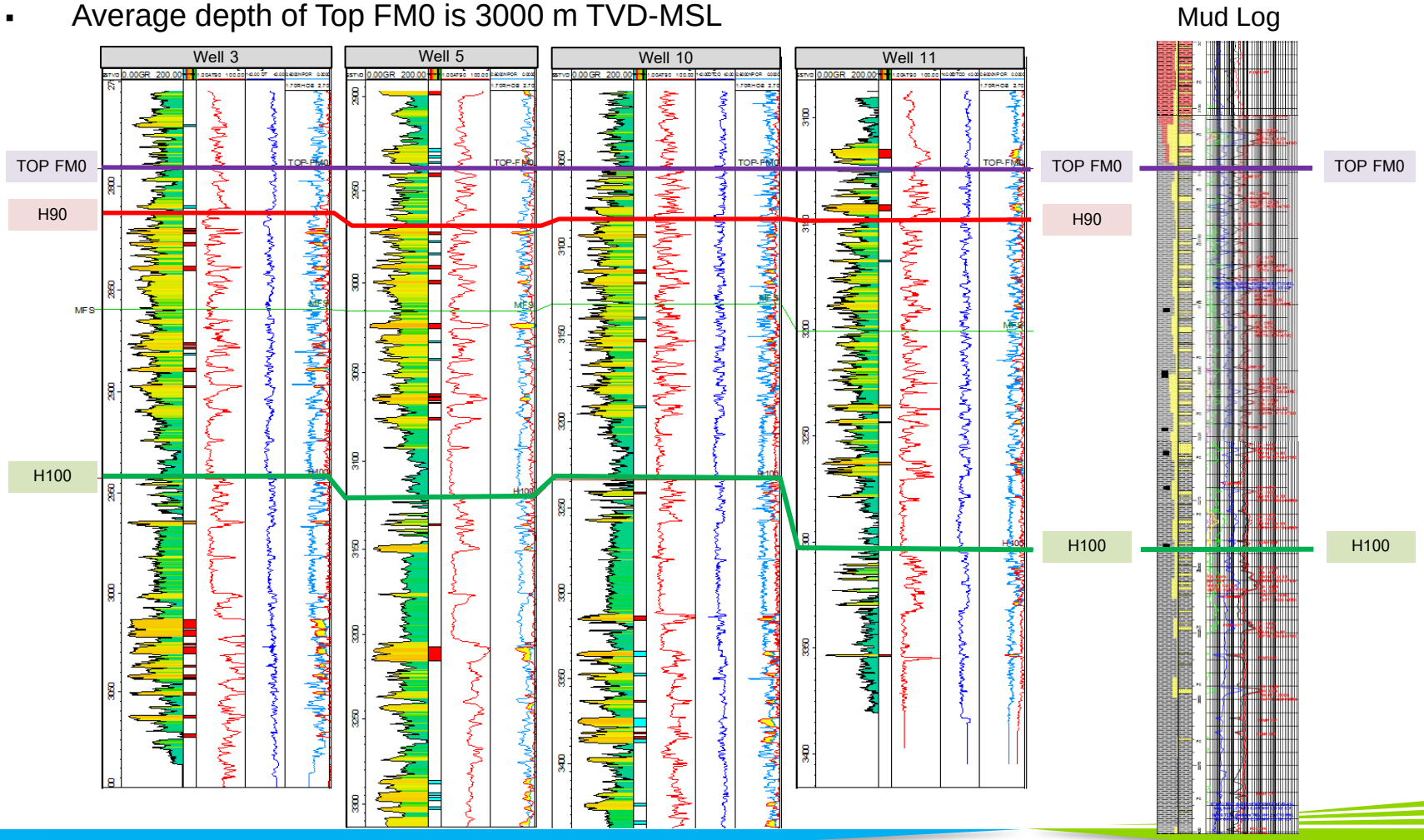
H90 – H100 character



- Sequence 2 illustrate progradation stacking pattern
- Sequence 3 illustrate retrogradation stacking pattern
- Low net to gross interval is require less fault displacement to create effective trap
- High filling ratio in H90-H100 interval compare with below H100 interval

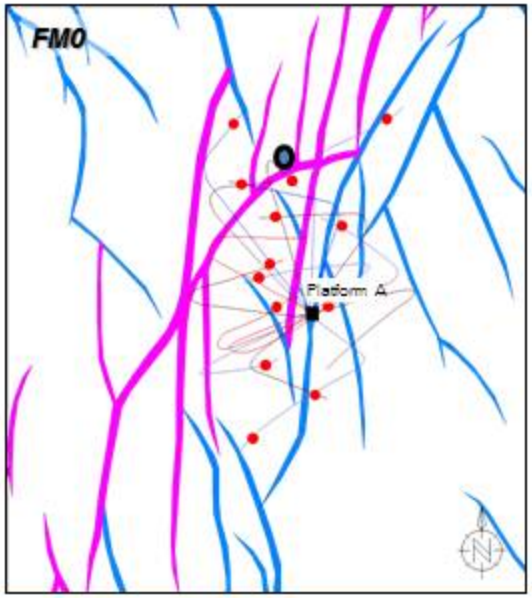
Platform A Well Correlation

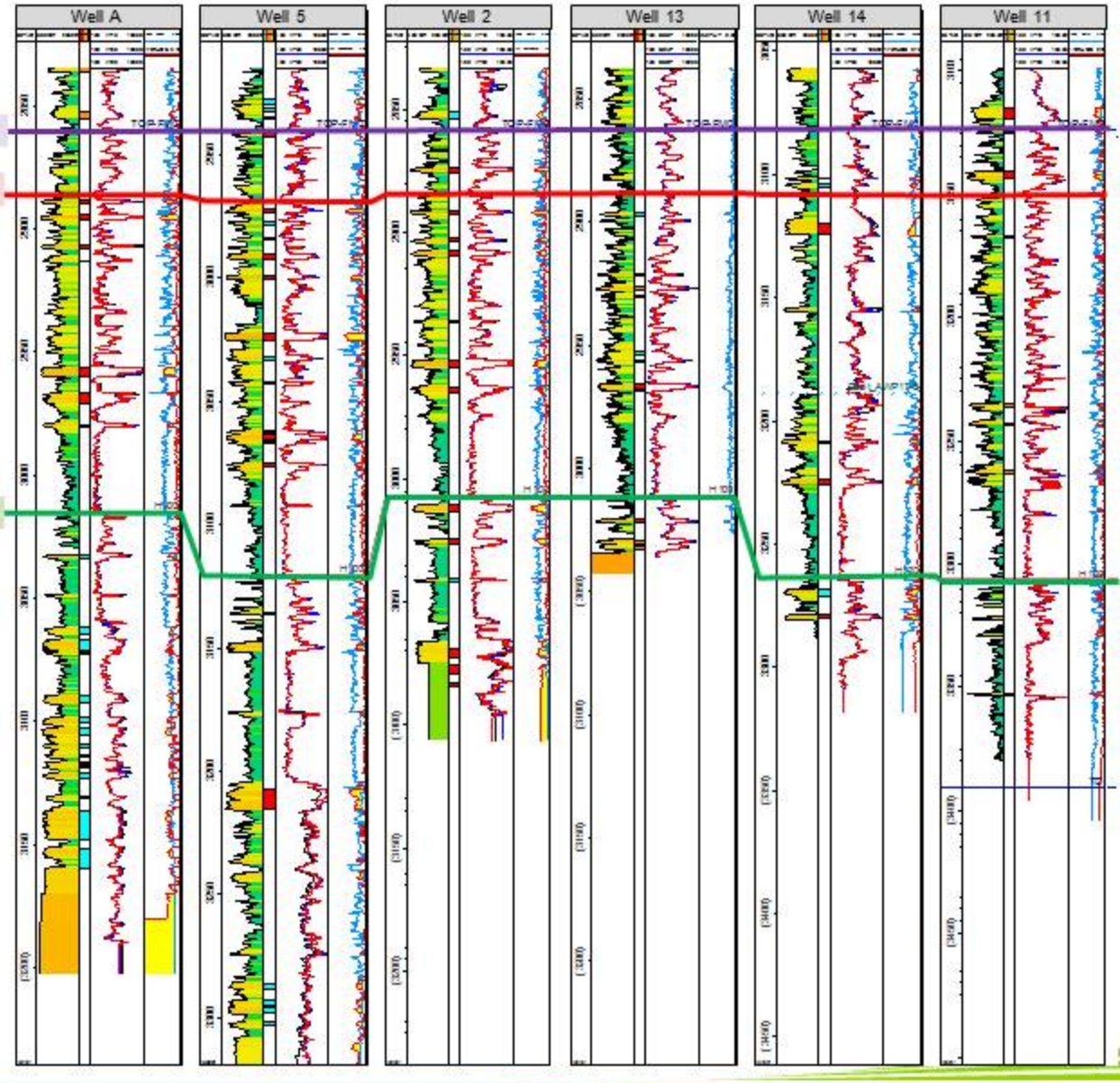
- Top FM0 was picked at low gamma ray reading and transition zone of claystone change from red to grey
- Average depth of Top FM0 is 3000 m TVD-MSL



Post-drilled Result

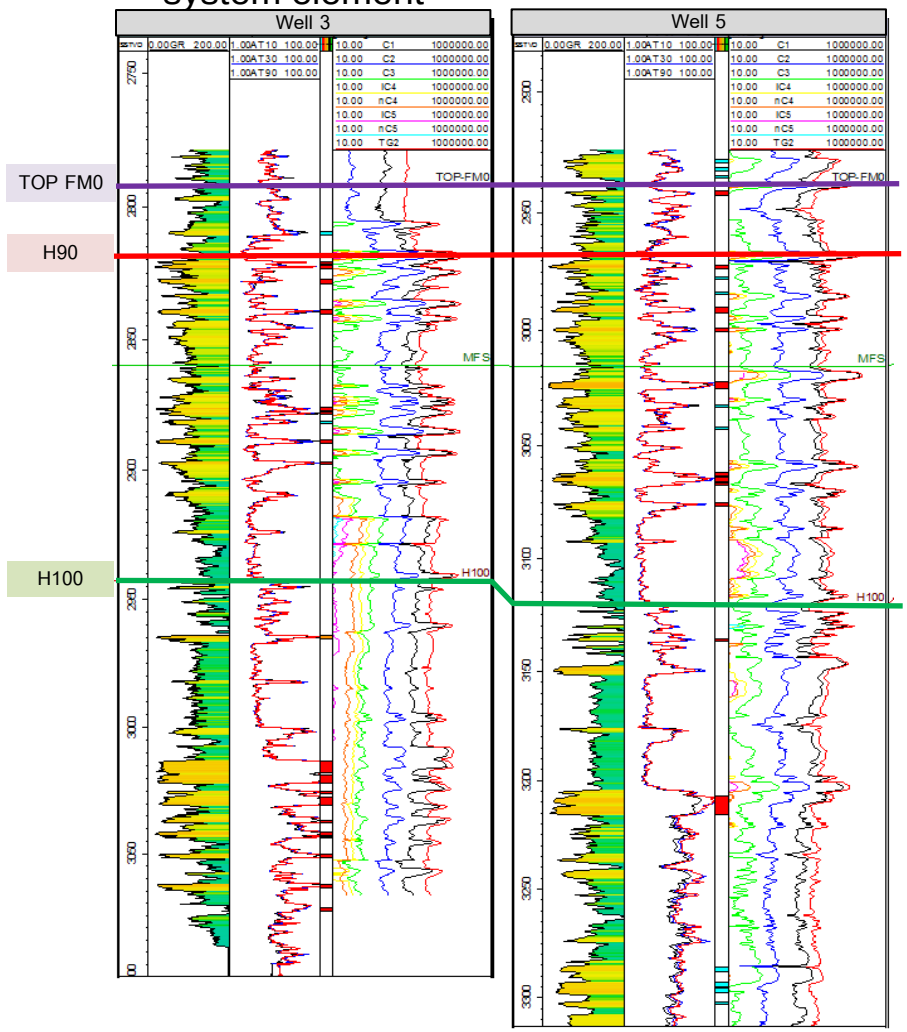
- High geothermal gradient
- Slightly high pressure
- CO_2 low to moderate in deep section
- Net pay result in FM0 ranging from 3 to 26 mTVD

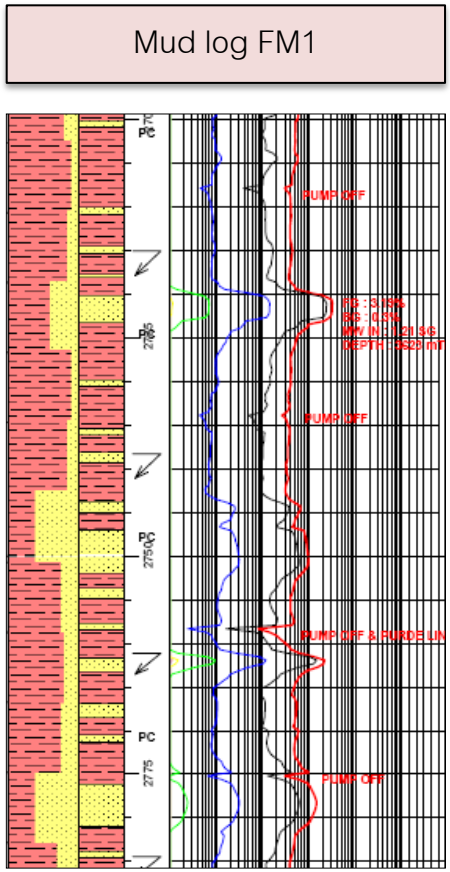


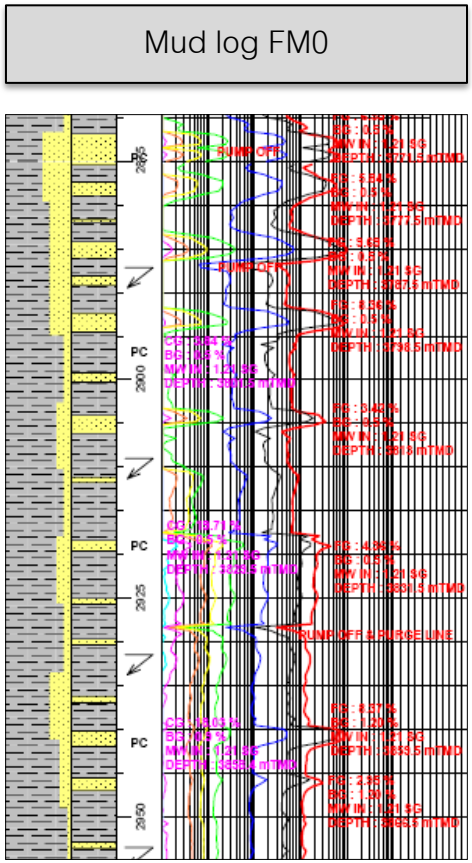


Platform A Mud Log Observation

- Observed heavy component of hydrocarbon in FM0 which show the completed of petroleum system element



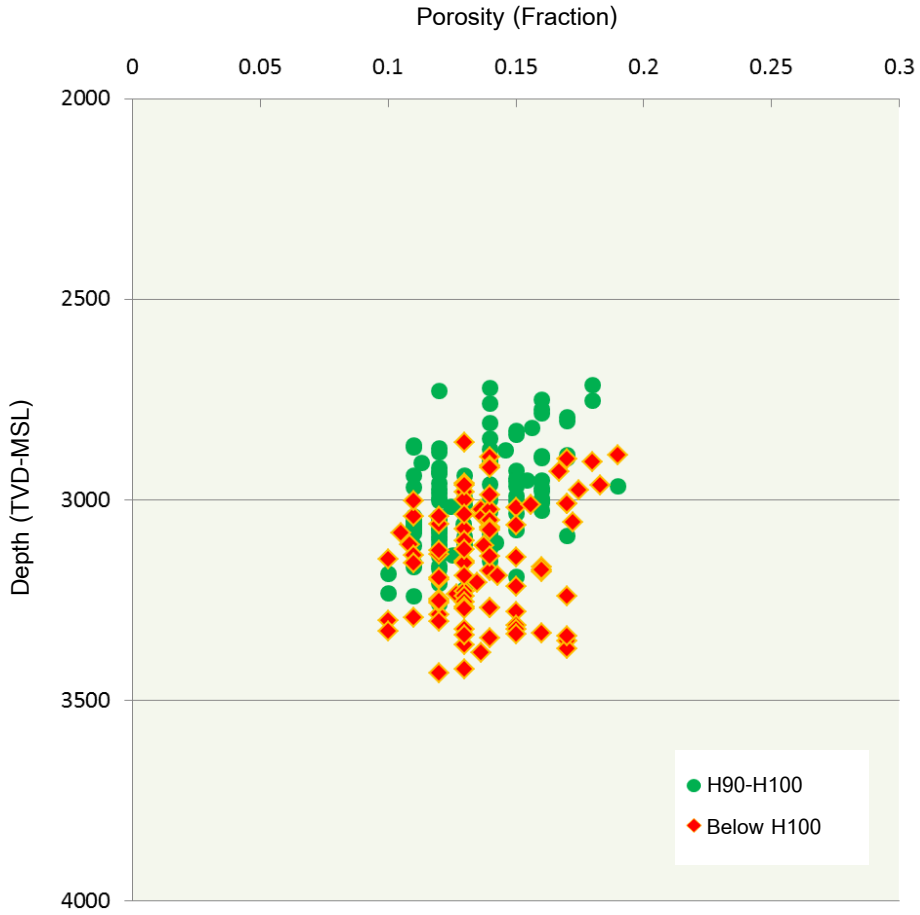




Outlines

- Introduction
- Subsurface study
- Well Result
- **Production performance**
- Conclusions

FM0 Reservoir Properties



- Porosity is ranging from 10 -21% in H90-H100 and 10-19 % below H100 interval
- FM 0 in Platform A area can still preserved porosity and permeability which proved by high initial production rate of Platform A
- Strong evident of moderate porosity in this area, confident to deep target in nearby area or infill well.

Production Performance

- **Initial perforation results**
  - Various initial gas flow rate
  - Most wells have high depletion rate but some wells (Well 3) still produce with high production rate
  - Some wells could not unload after perforation
  - Various reservoir properties (both tight and good reservoir qualities)

Production Performance

- **Fluid properties**
  - Moderate CO_2 ranging from 24-42 percent
  - Low condensate-gas ratio (mostly below 5 BBL/MMscf except Well 5)
  - Low gas heating value
- **Information utilization**
  - Adjust poro-permeability correlation for future nearby platform
  - Production to log calibration and development strategy

Outlines

- Introduction
- Subsurface study
- Well Result
- Production performance
- **Conclusions**

Conclusions

- Success of Oligocene play (FM0) in Platform A that established new reserves (below H100) for Arthit

- FM0 open opportunities to develop deep play in other areas which has never been fully explored and developed

- Detail subsurface study was performed in order to get better understand in below H100 petroleum system and also apply knowledge of deep Oligocene play to similar play type at other places.

Acknowledgement

Arthit Subsurface Team

Operation and Drilling Team

Arthit Management and Support Team

Thank You

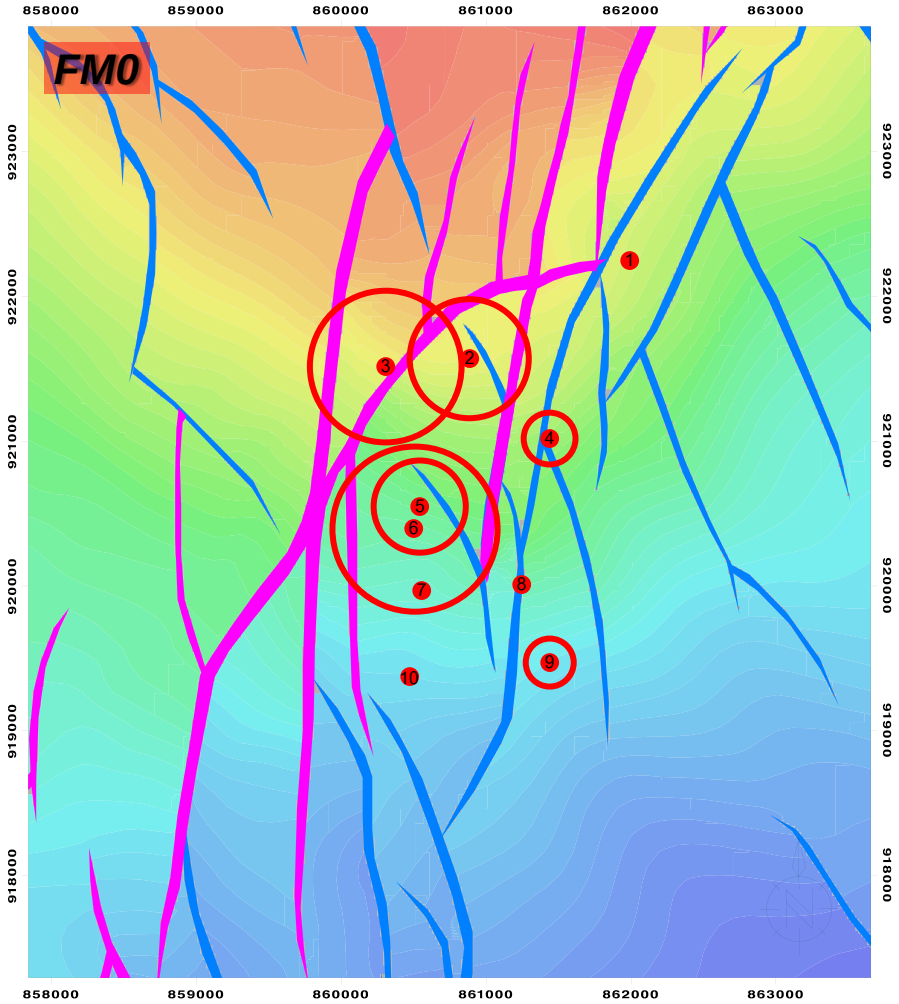
Q & A

Back Up

Production performance

- Initial perforation results

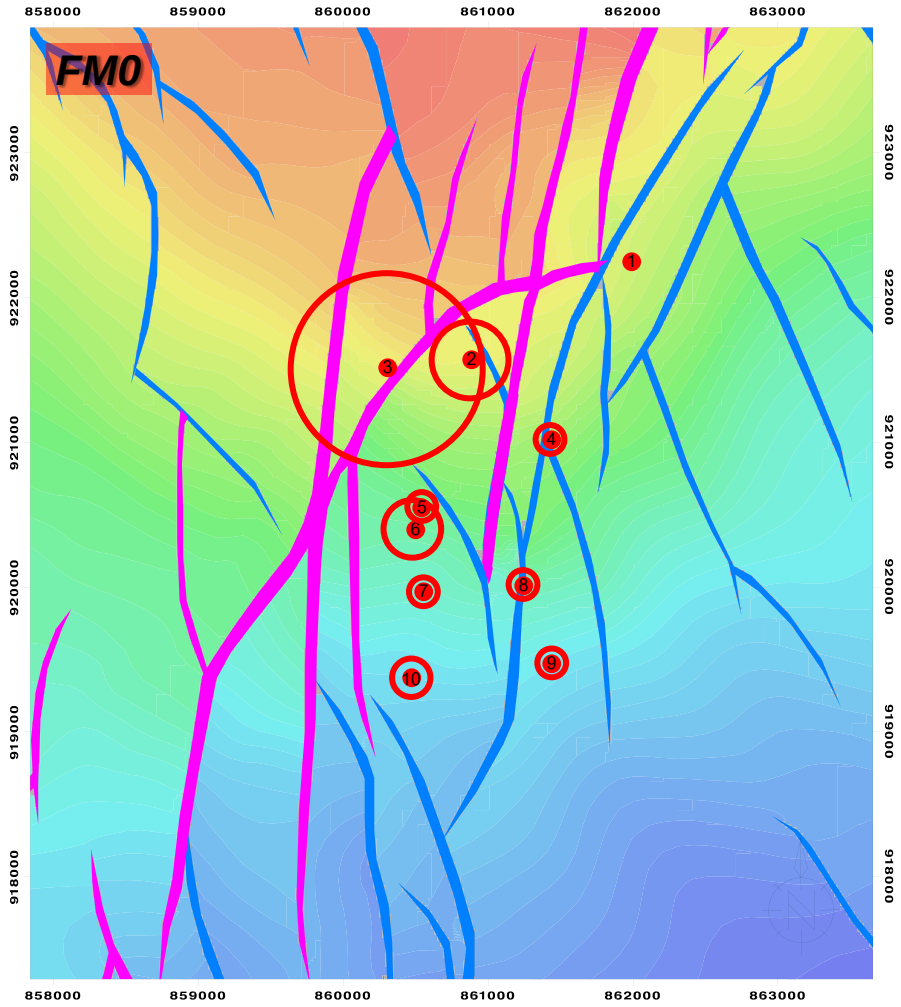
Well	Initial Gas rate (MMscfd)	CO_2 (%)	Remark
Well 2	9.6	30	WHFP 35.5 bar/ 100% choke
Well 1	-	-	Cannot unload well
Well 3	12.2	42	WHFP 139 bar/ 35% choke
Well 6	13.1	24	WHFP 123 bar/ 35% choke
Well 4	4.24	28	WHFP 31 bar/ 100% choke
Well 8	-	-	Cannot unload well
Well 9	3.74	32	WHFP 36 bar/ 100% choke
Well 10	-	-	Cannot unload well
Well 5	7.4	29	WHFP 36 bar/ 100% choke
Well 7	-	-	Cannot unload well



Production performance

- FM0 Cumulative Production

Well	Cum Date	Cumulative WH Gas Production (MMSCF)
Well 2	02/03/2013	440
Well 3	30/09/2013	2,103
Well 6	23/10/2012	217
Well 4	20/01/2013	7
Well 8	06/11/2012	22
Well 9	26/07/2012	35
Well 10	22/01/2013	95
Well 5	15/02/2013	20
Well 7	04/11/2012	45
Total		**2,983**



Note: The volume in table are WH gas volume which were produced only from FM0. Furthermore, FM0 production were also produced comminglely with FM1 in later on but they are not included in this table.