Sand Production Management: The Critical Challenge in Zawtika Gas Production*

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Abstract

Sand production continues to be a major challenge in many producing oil and gas assets worldwide. It can choke off production, reduce hydrocarbon recovery, eliminate the integrity of production facilities, and possibly cause disastrous facility failures and harm to personnel and the environment. As such, sand management becomes a priority when selecting appropriate sand control methods and equipment, and mitigation plans need to be addressed to reduce risks and harm resulting from sand production. Undertaken by PTTEPI, the Zawtika gas development project, located offshore Myanmar in the Moattama Basin, covering Block M-9 and a portion of Block M-11, lies within the Zawtika Development & Production Area. The area is situated approximately 300 km south of Yangon and 290 km west of Tavoy off the Myanmar coast. Nine structures of discovered gas resource volumes have been dedicated to the Zawtika gas development project. They will be developed over 3 phases, i.e. 1A, 1B and 1C, at a Daily Contract Quantity of 300 MMscfd sales gas. The GSA was concluded and signed between all parties on July 30, 2010. Gas production from Phase 1A development, comprising the first three 3 structures, has been being delivered to buyers since March 10th, 2014.

Sand Production Management:

The Critical Challenge in Zawtika Gas Production

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Rangsan Bhengbhun - PTTEP

AAPG Yangon Conference

November 19th 2015

Outline

- Why sand production management is important?
- Where is Zawtika field?
- Zawtika facilities
- Zawtika reservoir characteristics
- Challenges in Zawtika gas production
- Zawtika sand production management
  - Sand production observed from well testing
  - Geo-mechanical study (Sand production prediction modeling)
  - Causes of sand production
  - Zawtika Well Completion Strategy
  - Zawtika Well Operating Procedure
  - Zawtika Historical Production and Challenges
  - Mitigation plan and Way forward
- Q&A

Why sand production MNG is important?

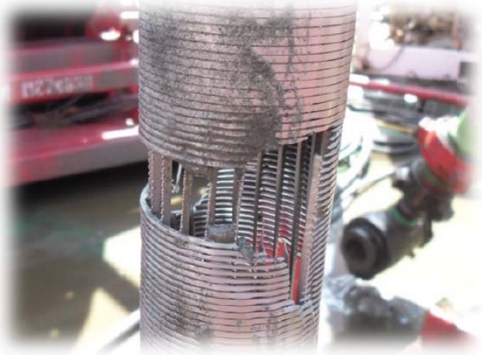
Leakage at downstream of choke valve

Choke valve totally damaged

Sand probe totally damaged

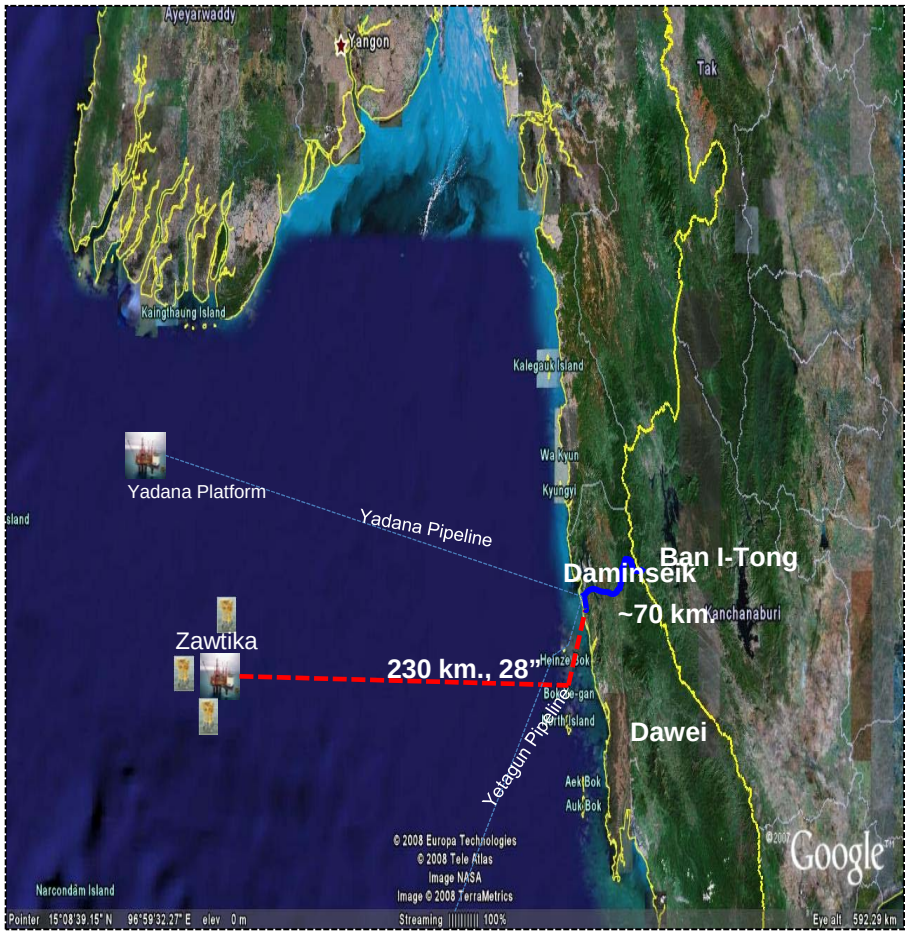
Sand recovered from monobore completion

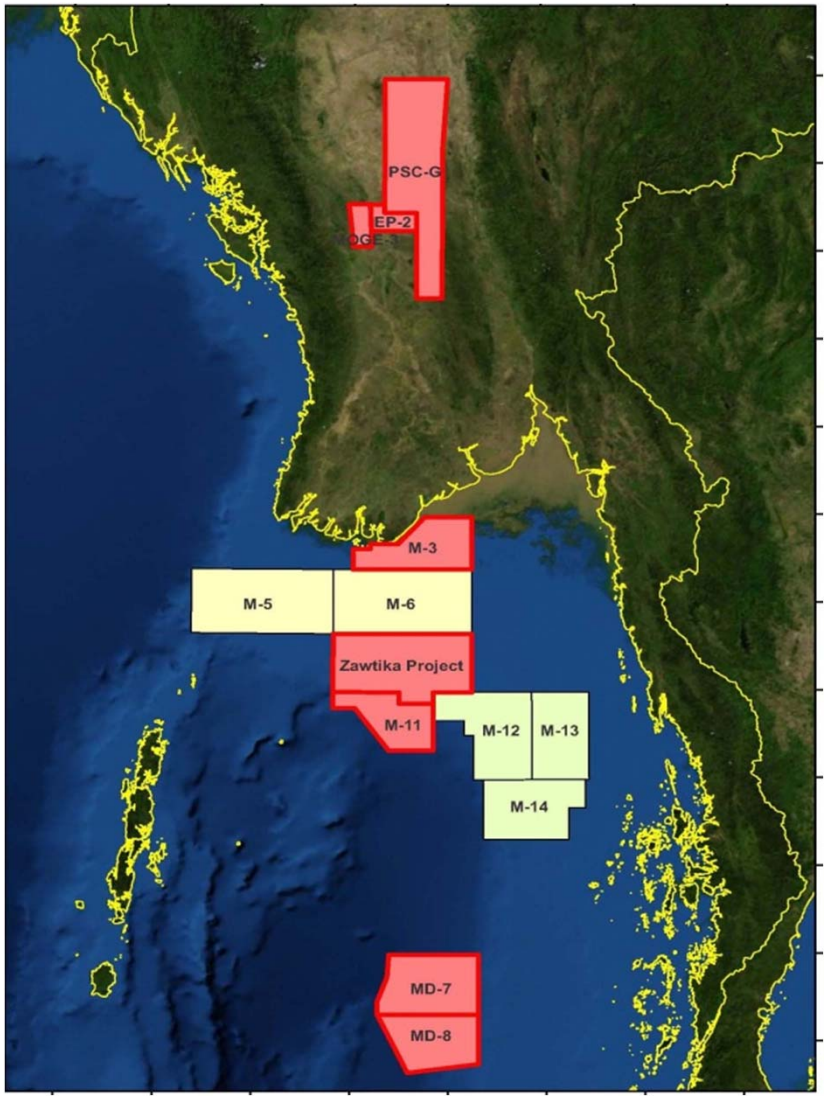
Erosion at Sandtrap while SCO operation



Leakage at inlet of gas buster while SCO operation

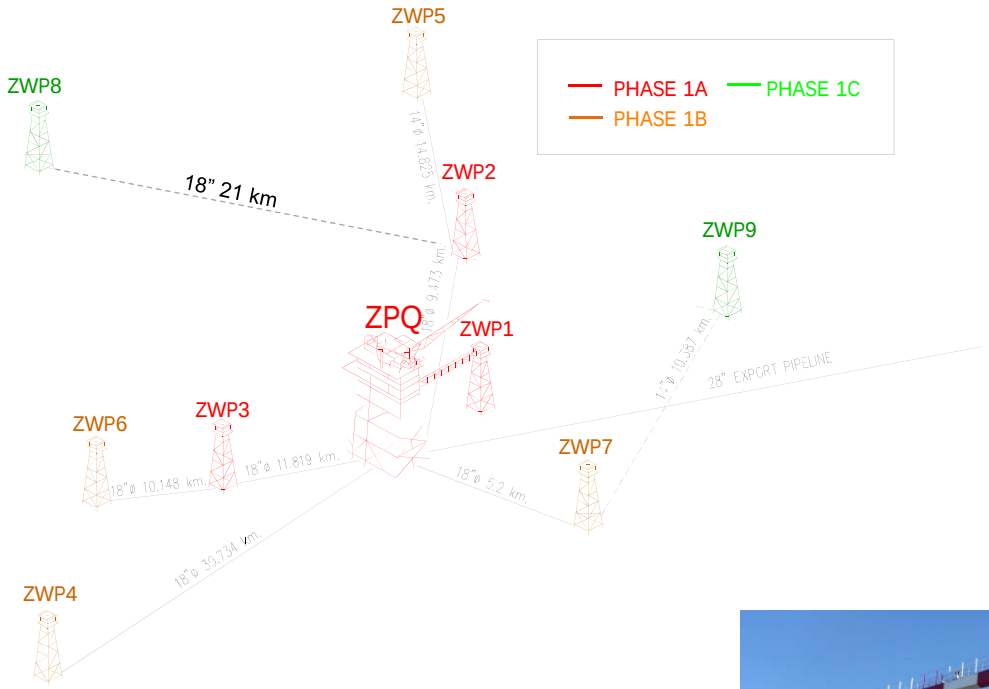
Where is Zawtika field?





- ZPQ (CPP + LQ)
- 3 Well Head Platform (Phase 1A) & Intra field Line
- 230 km. Offshore Export Pipeline
- 70 km. Onshore Export Pipeline
- Onshore Facilities, ZOC, ZMS, and 2 Block valves

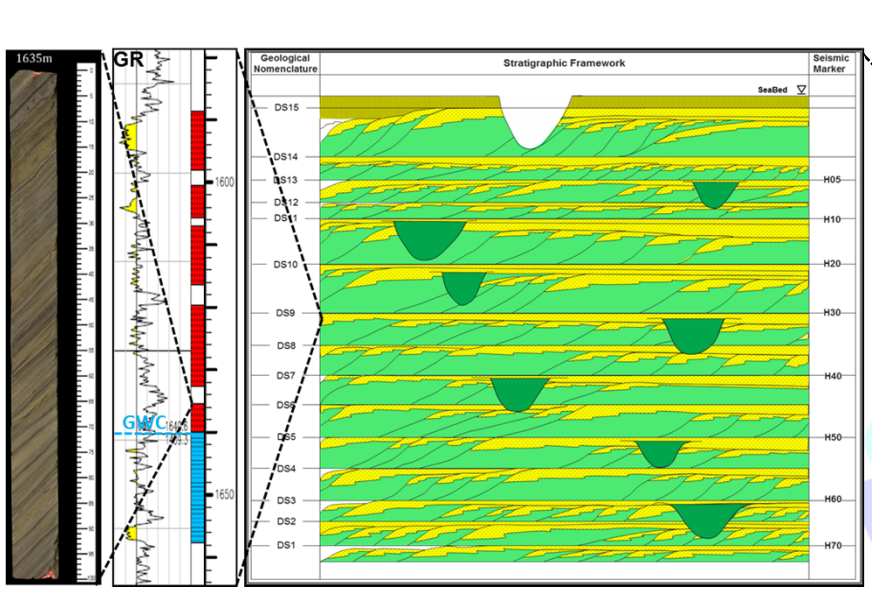
Zawtika Facilities

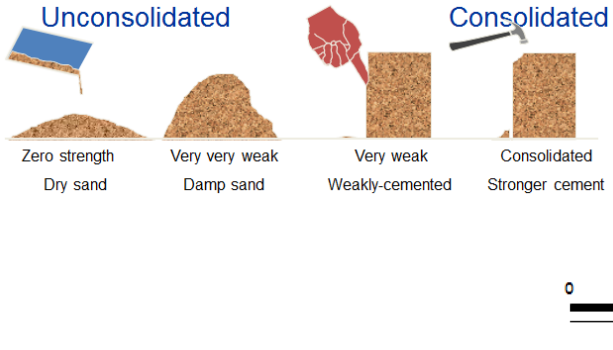


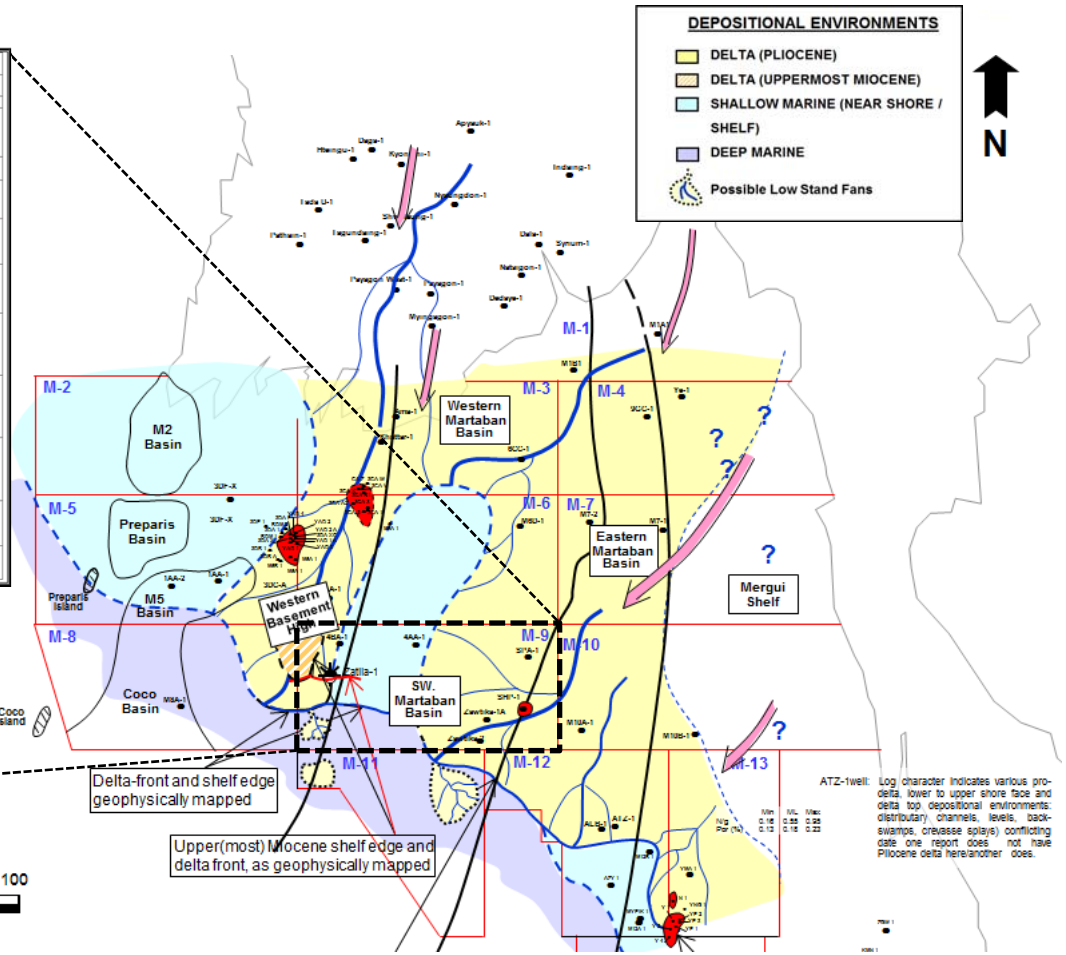
ZPQ and Wellhead Platform 1

Wellhead Platform 2

Zawtika reservoir characteristics

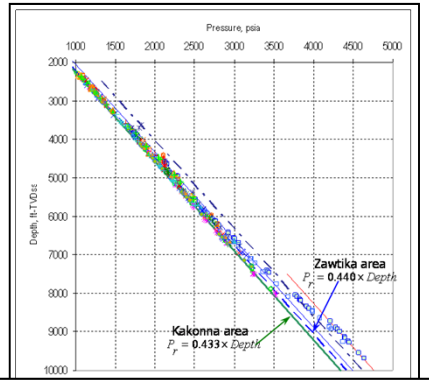


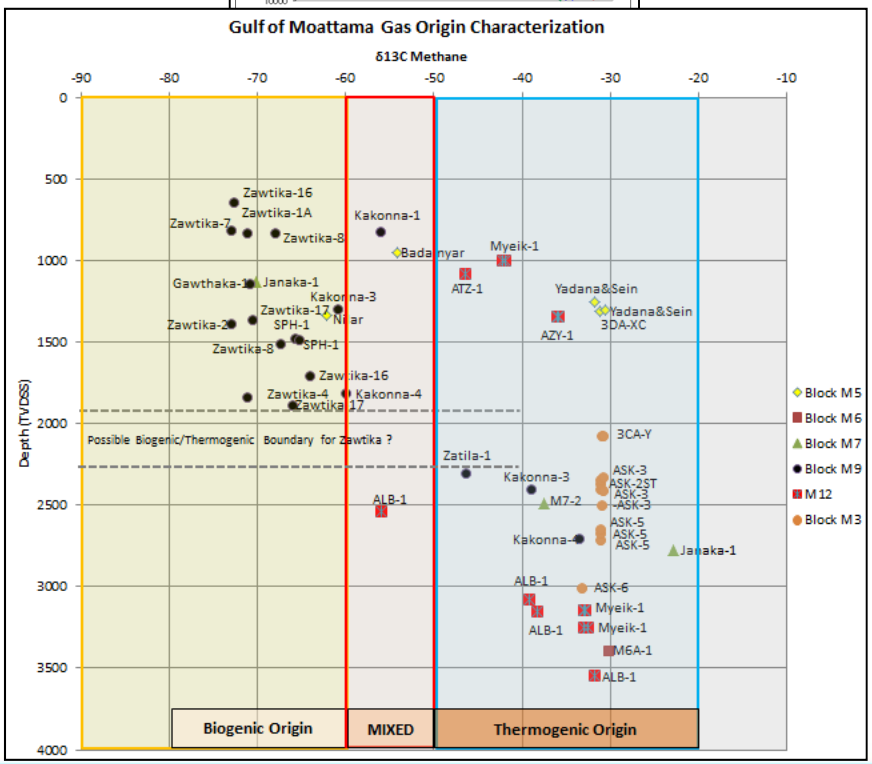




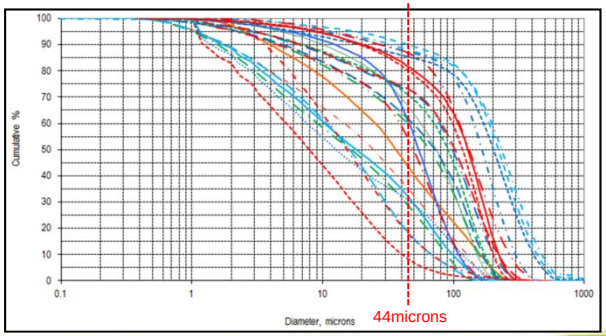
- Series of tidal delta plain, shoreface and shelfal deposits
- Unconsolidated to weakly consolidated sands from Pliocene to Pleistocene geologic sequences
- Multi-stacked reservoirs with sand shale lamination and mostly with underlying fluid contacts
- Highly faulted area resulting multiple isolated structures

Zawtika reservoir characteristics (cont'd)





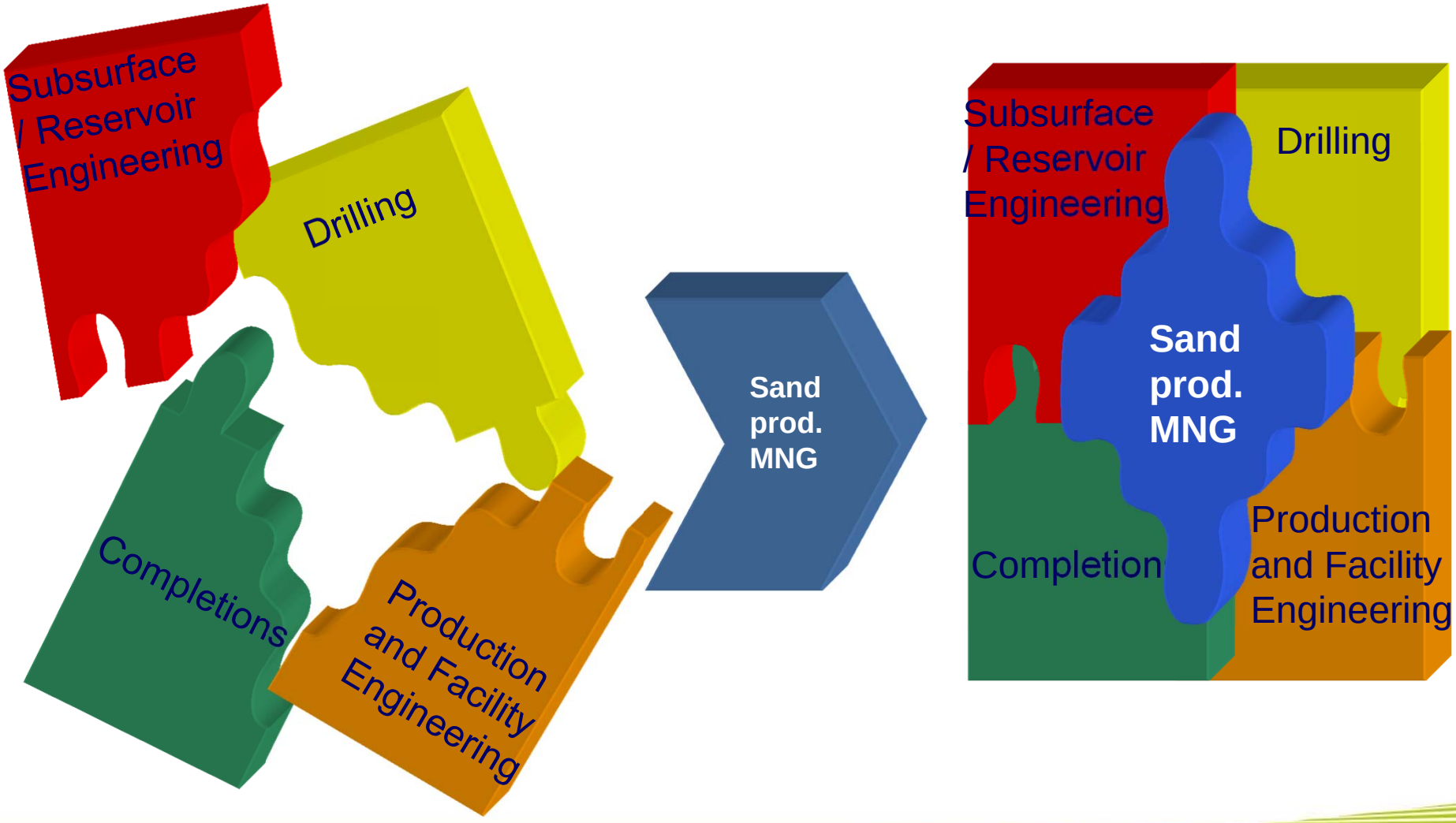
- Normal reservoir pressure & temperature,
  Hydrostatic gradient 0.433 – 0.44 psi/ft
  Temperature 40-120degC
- Dry gas with low CO_2 (0.1-0.4%) and no H_2S and Hg with max N_2 25% in KKN area.
- Heating value in the range 850-1,000 BTU/SCF
- Poor to fair reservoir with permeability 30-900mMD
  **poor due to clay contents & very fine grain size*
- Very fine to medium grain size with poor-moderate to moderate sorting
- Clay content in the range 10-40%, illite & mica, kaolinite, chlorite and mixed-layer illite/smectite and etc



Challenges in Zawtika gas production

- Unconsolidated sands are major reserves contributions for Zawtika (60% of Reserves)
- Zero or minimal critical drawdown pressure for onset of sand production in shallow and intermediate reservoirs.
- Large variation in particle size distribution and poorly sorted, large percentage of fines (<44 μm) → Challenge in Sand Control Completion Selection & Design.

Sand Production Management – Part of the multidisciplinary team!



Sand production observed from well testing

	Reservoir Name	Formation Unit	SPH-1 Gas Rate (MMscfd)	Zawtika-1A Gas Rate (MMscfd)	Zawtika-2 Gas Rate (MMscfd)	Zawtika-3 Gas Rate (MMscfd)	Zawtika-4 Gas Rate (MMscfd)	Zawtika-5 Gas Rate (MMscfd)	Zawtika-8 Gas Rate (MMscfd)	Zawtika-9 Gas Rate (MMscfd)	Kakonna-1 Gas Rate (MMscfd)	Kakonna-2 Gas Rate (MMscfd)	Kakonna-3 Gas Rate (MMscfd)	Kakonna-4 Gas Rate (MMscfd)	Gawthaka-1 Gas Rate (MMscfd)
S	Res.07-00	5F													
	Res.08-00			SandProd.					SandProd.						
	Res.09-00	5E													
	Res.09-45														SandProd.
	Res.10-40											Sand free			SandProd.
	Res.10-90	5D		Sand free					SandProd.		SandProd.				
	Res.12-50									SandProd.					
I	Res.13-30	5C	Sand free	Sand free	Sand free		Sand free	Sand free			SandProd.				
	Res.14-00											SandProd.			
	Res.14-75					Sand free			SandProd.						
	Res.15-25													Sand free	
	Res.16-50	5B			Sand free										
	Res.17-90				Sand free		Sand free	Sand free		Sand free					
D	Res.19-05	5A											Sand free		
	Res.20-50														
	Res.21-60													Sand free	
	Res.23-50	4											Sand free	Sand free	

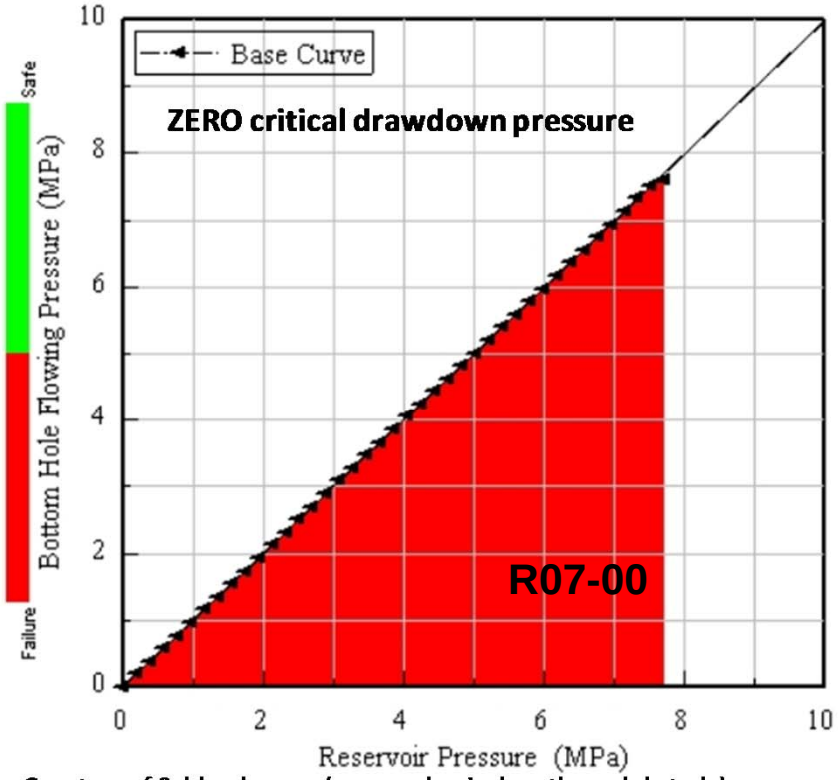
Legend:
- Sand production
- Sand free

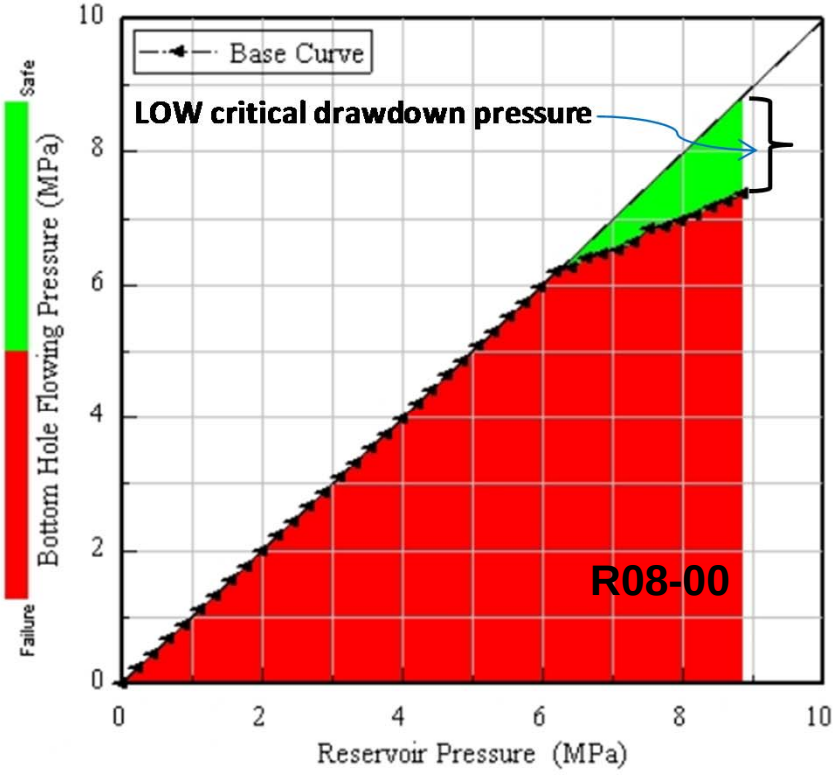
Shallow → observed sand most of TSTs

Intermediate → Some TSTs found sand

Deep → No sand found from all TSTs

Zawtika Sand Production Prediction Modeling





Courtesy of Schlumberger (per mechanical earth model study)

- Sand production prediction modeling highlighted that:
  - HIGH sanding risk for sands <1150 mTVDss (**S**hallow reservoir)
  - HIGH to moderate sanding risk for sands 1150-1700 mTVDss (**I**ntermediate reservoir)
  - LOW sanding risk for sands >1700 mTVDss (**D**eep reservoir)

Causes of sand production

Static → Formation or reservoir factors

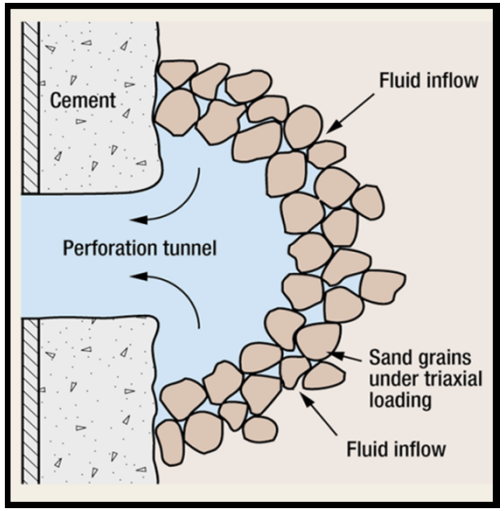
- Poorly consolidated formation, generally a **"young sandstone problem"**

	Epoch	Period	Era	Eon
0	Recent	Quaternary		
0.01	Pleistocene		Cenozoic	Phanerozoic
1.6	Pliocene	Tertiary		
5.3	Miocene			
24	Oligocene			
37	Eocene			
57	Paleocene			
66		Cretaceous	Mesozoic	
144		Jurassic		
208		Triassic		
245		Permian	Paleozoic	
286		Carboniferous		
360		Devonian		
408		Ordovician		
438		Silurian		
505		Cambrian		
570				Proterozoic

- **Rock mechanics**
  e.g. overburden, intergranular friction
- **Formation lithology**
  e.g. cementing material, particle size, shape
- **Reservoir fluid characteristics**
  e.g. viscosity, velocity (friction)

Dynamic → Fluid flow effect

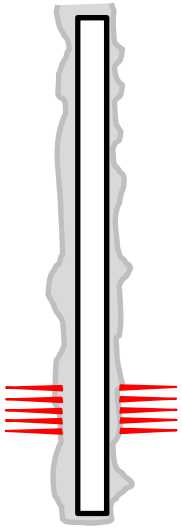
- Other factors influencing tendency of a well to produce sand is **"fluid flow effects"**

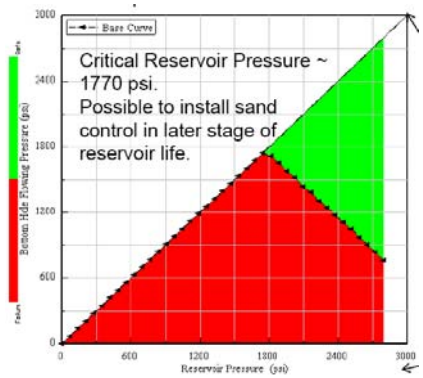


- **Depletion of reservoir pressure**
- **Production rate**
  Higher production rate, increase drawdown pressure
- **Increase of water production,**
  Tends to weaken cohesion between sand grains

Zawtika Well Completion Strategy

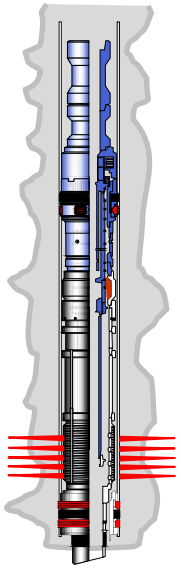
3-1/2” Monobore completion

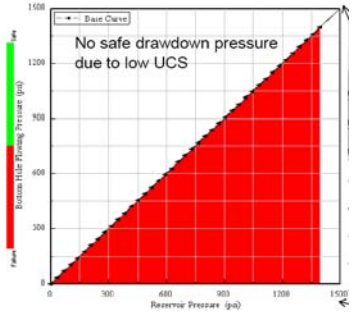


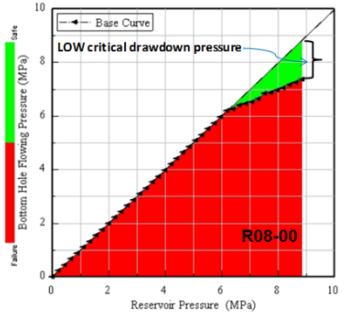


- For **D**eep reservoirs below 1,700 mTVDss
- Allow sand free production until 40% of reservoir pressure depletion.
- No need sand control completion in early stage of reservoir life.
- Sand management policy at surface is strictly applied.
- At later stage of reservoir life when sand production starts to observe, other sand control technologies will be considered e.g. Thru-tubing gravel pack (TTGP) and sand consolidation technology

Downhole Sand control completion

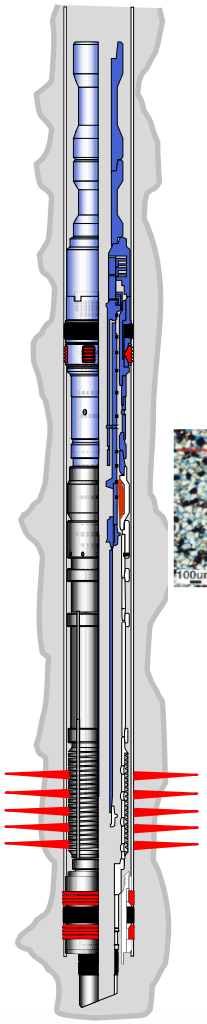




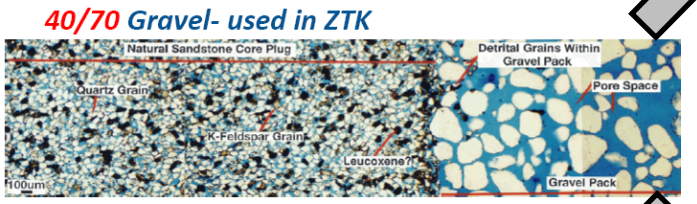


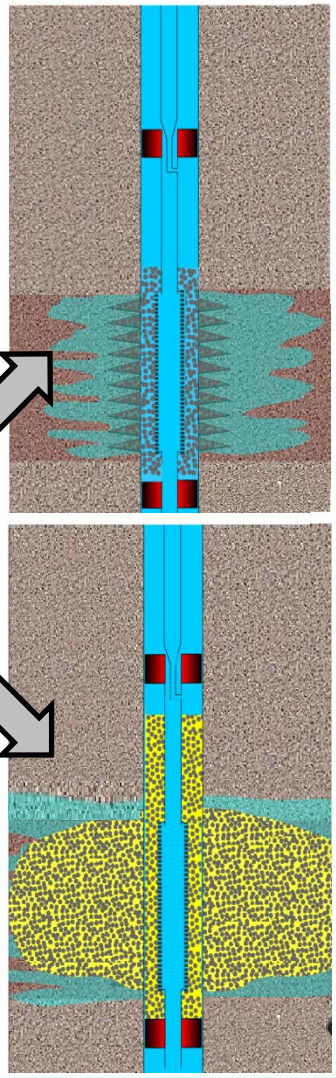
- For **S**hallow and **I**ntermediate reservoirs above 1,700TVDss .
- High risk of sand production since early stage of reservoir life due to no & marginal critical drawdowns
- Sand control completion is a must in early stage of reservoir life.

Zawtika Well Completion Strategy (cont'd)



Cased hole gravel pack (CHGP) completion





High rate water pack (HRWP)

- Limited sand thickness/gas column
- Ensure proper proppant placement into all perforation tunnels and obtain a high quality annular pack

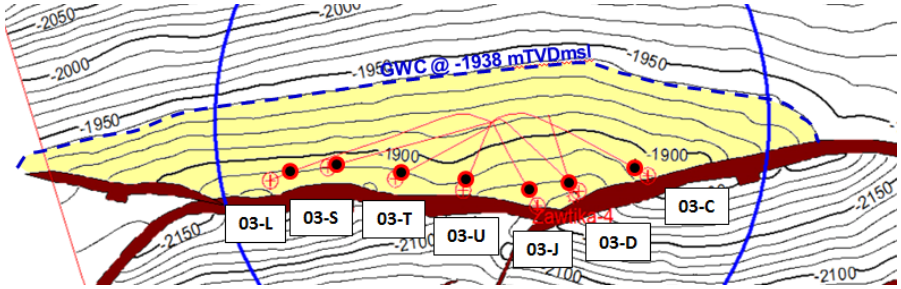
Frac-pack (STIMPAC)

- Sufficient sand thickness/gas column
- Allow higher volumes of proppant to be placed deeper behind casing
- Well productivity and well service life can be enhanced

Zawtika Well Completion Strategy (cont'd)

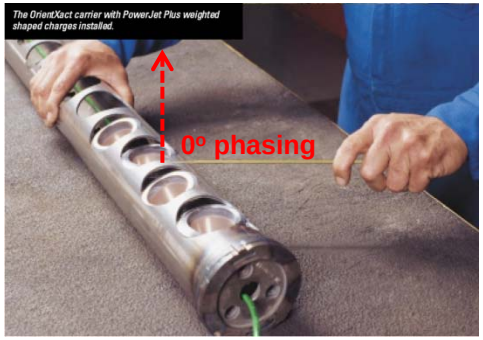
Well location

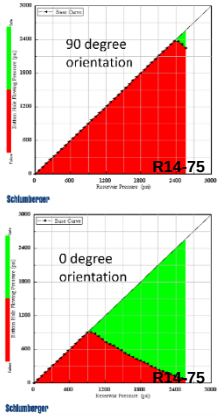
- Development wells have been placed at crestal locations to delay water encroachment to the well



Well inclination > 45º and Oriented-perforation with 0º phasing (MNB)

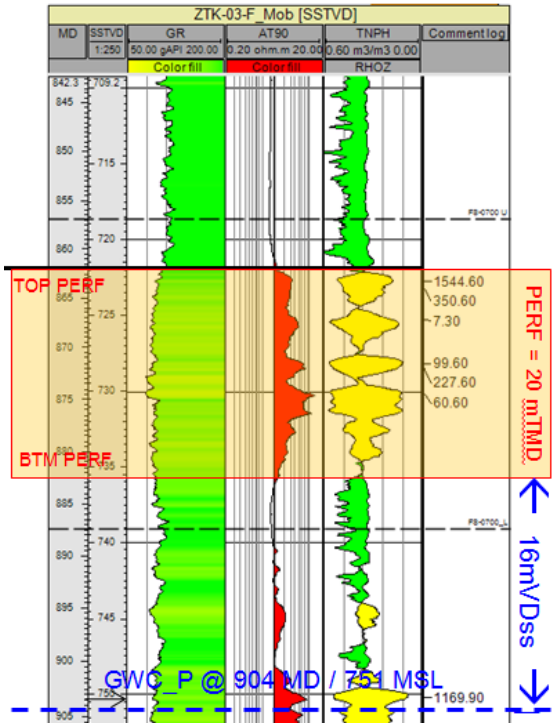
- Provide more stable perforation tunnels achieved by lower stress anisotropy under influence of the 2 horizontal stresses





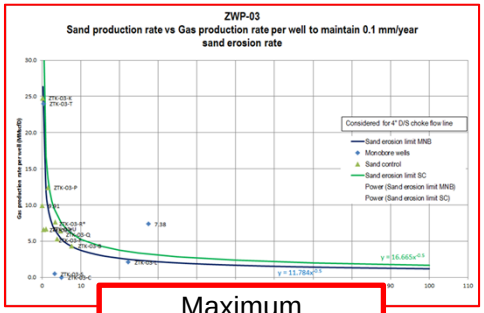
Perforation stand-off & perforation length

- Optimize perforation interval length and maximize perforation stand-off above GWC to delay water production



Zawtika Well Operating Procedure

Start Up → **Production Optimization** → **Well Life**



- Data from E&A Well Testing
- Sand prediction model

- **Well start-up**
- **Bean up/bean down policy**
- **Well prioritization**
- **Choke opening procedure**
- **Regular well clean-out**

Well Operating Procedure

Maximum Allowable Sand Rate (MASR)

Maximum sand Free Rate (MSFR)

Confirm Metal Loss/Sand rate

Production Test (Monthly)

Sample Analysis

Real Time Sand Monitoring (Sand probe) + Acoustic Sand Monitoring (ClampOn)

Real Time Water Monitoring through Well Surveillance Workflow

Real-time wellhead Monitoring

Production Test (Monthly)

Sample Analysis

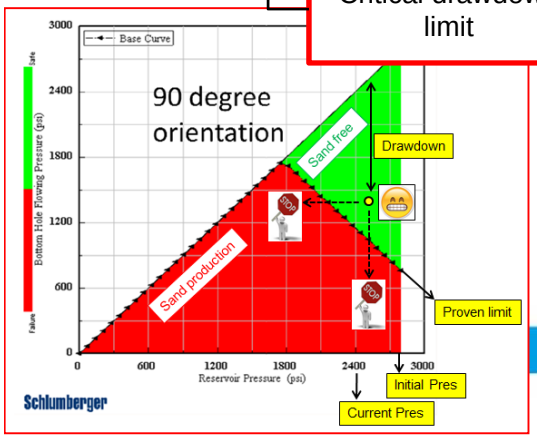
Water Coning

Water Breakthrough

Maximum sand Free Rate (MSFR)

Maximum Allowable Sand Rate (MASR)

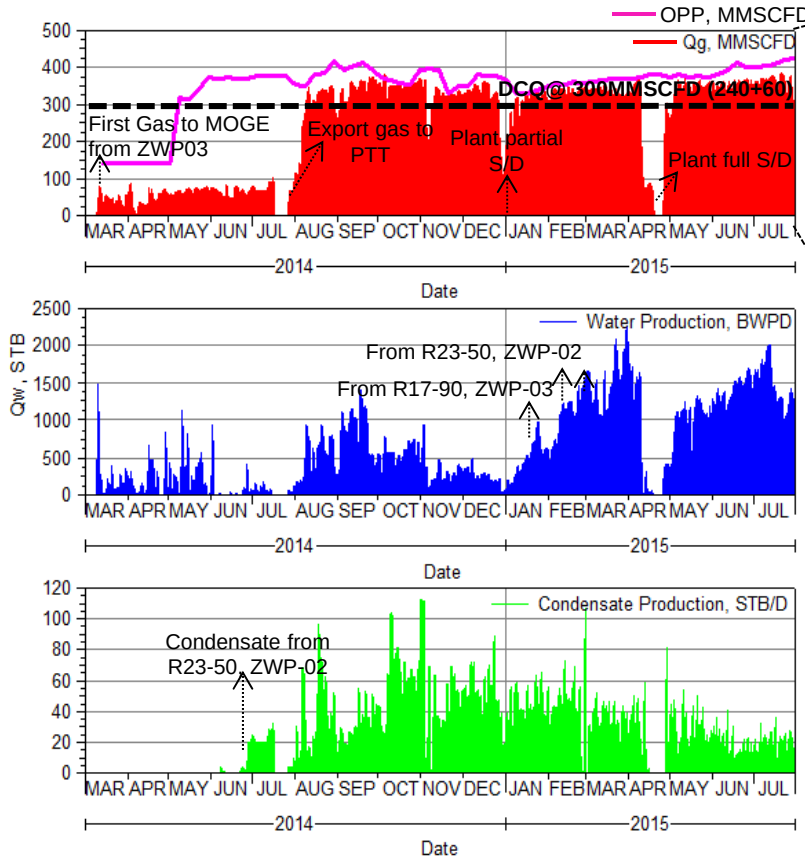
Critical drawdown limit



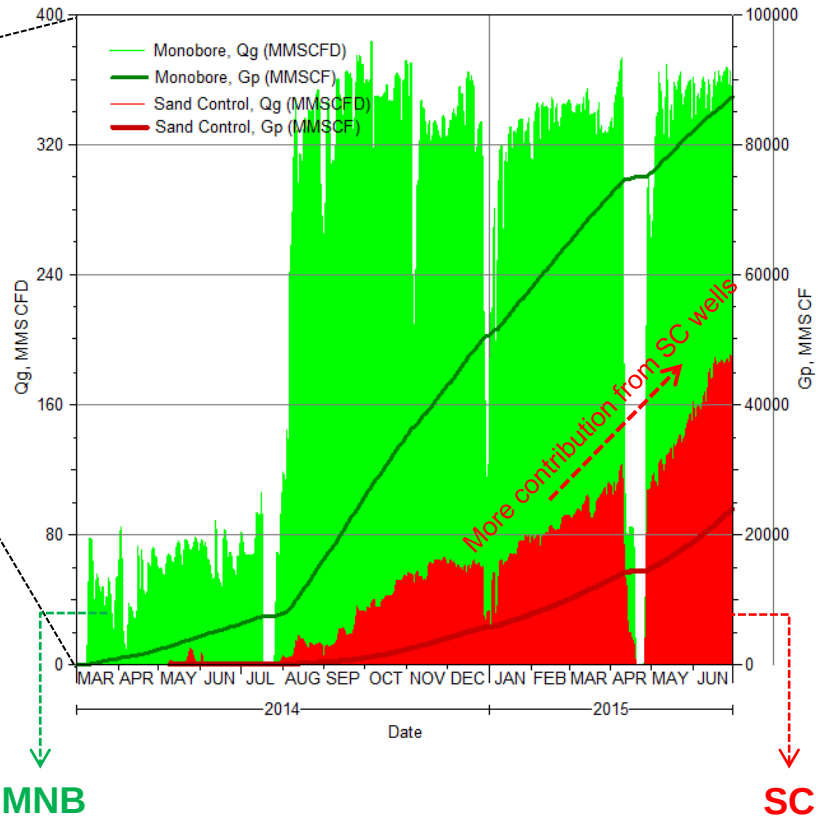
Passion to Explore for a Sustainable Future

Zawtika Historical Production and Challenges

Zawtika Historical Production



Gas Production By Completion Type



MNB **SC**

- **Production contribution from MNB decreases due to sand and water production**

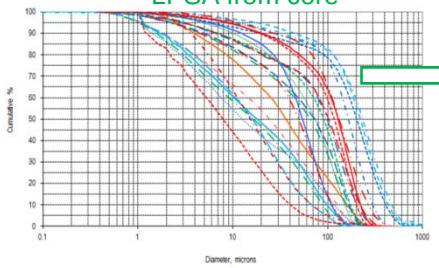
- **More wells become online after sand control completion is completed.**
- **Potential gain from well bean-up activities as per targeted at MSFR and MASR**

Mitigation plan and Way forward

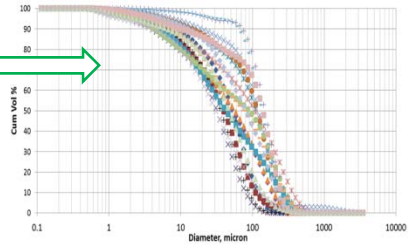
Well intervention

- HUD, downhole sample & LPSA

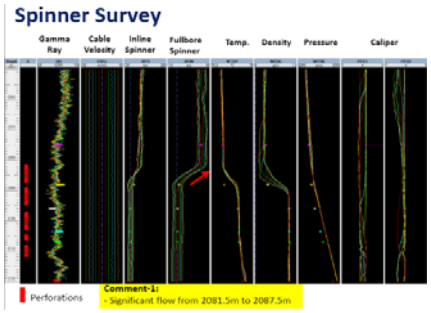
LPSA from core

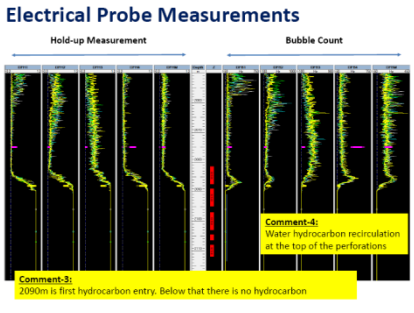


LPSA from produced sand



- PLT and water shut-off using tubing patch

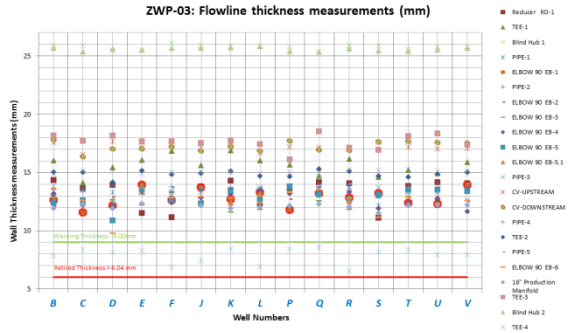




- Sand clean-out by CTU
- Additional perforation
- zone change for sand control well

Surface and subsurface measurement

- Monthly UT scan



- Choke valve passing test
- Monthly choke valve inspection & replacement

ZTK-03-S

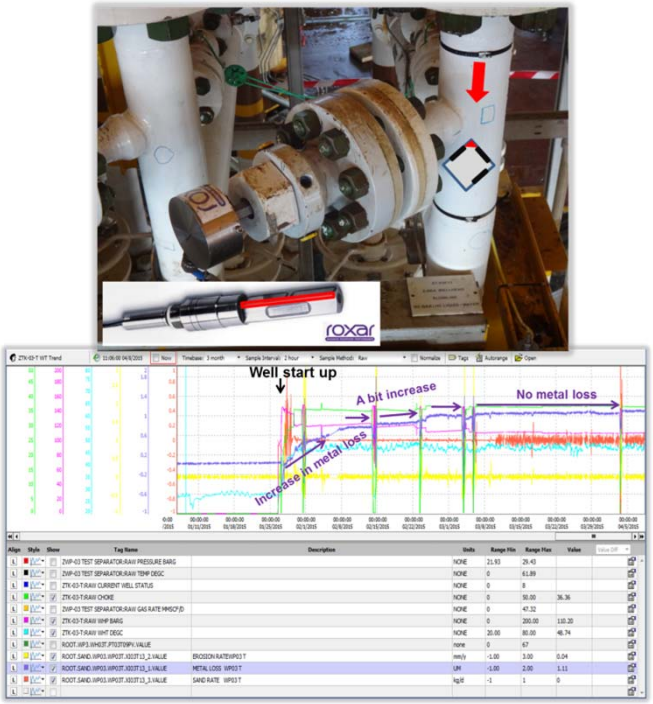
ZTK-02-R

- Tubing corrosion survey by EMIT tool

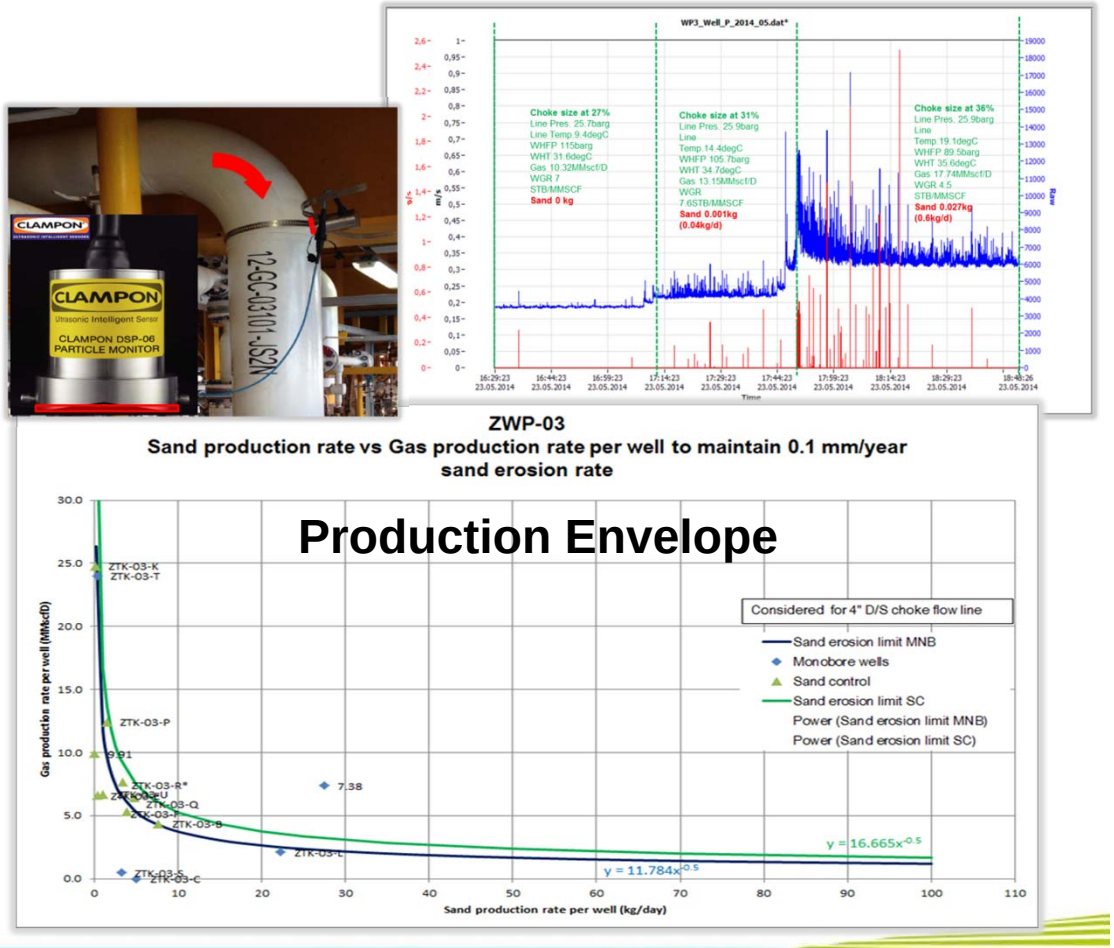
Mitigation plan and Way forward (cont'd)

Online sand probe + Acoustic sand monitoring and Production envelope

Online sand probe

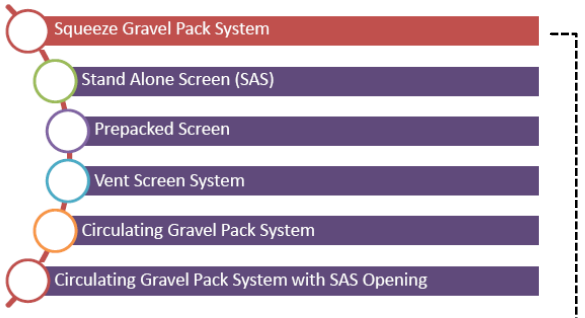


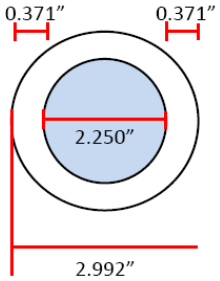
Acoustic sand monitoring and production envelope

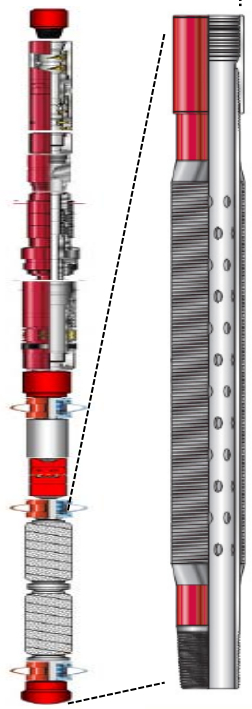


Mitigation plan and Way forward (cont'd)

Thru-tubing gravel pack (TTGP)

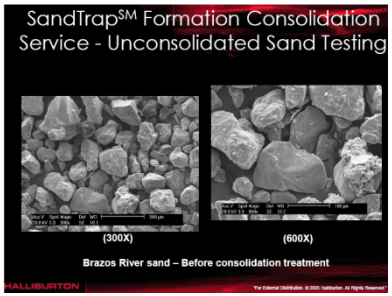


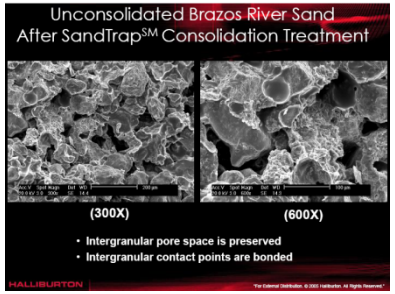




- Deployment by CTU
- Squeeze Gravel Pack System
  (Screen Stacks with Frac Valve System)
- Screen size
  ID = 1.61"
  OD = 2.25"
  Clearance diameter = 0.742"

Sand consolidation "SandTrap®"





- Overall results shows average of 55% retained permeability and UCS of 700 and 1,300 psi for top and bottom portions respectively
- Considered for short newly perforated interval

Horizontal well with gravel pack completion