“Integration of Petrophysical Data: Key to Mature Fields Rejuvenation"

HALLIBURTON

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Port Harcourt, Nigeria, March 2nd, 2017

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“Integration of Petrophysical Data: Key to Mature Fields Rejuvenation"

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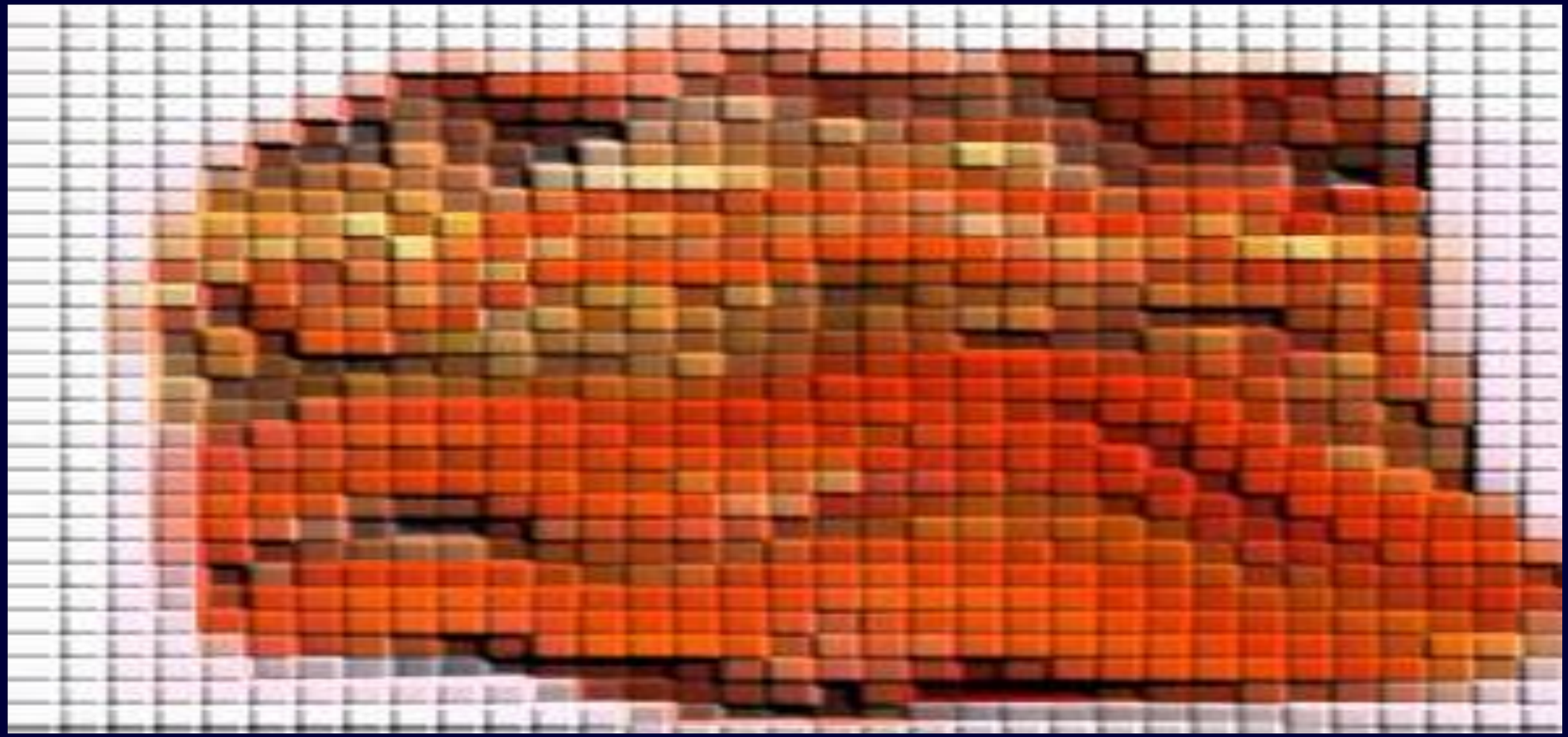

“Integration of Petrophysical Data: Key to Mature Fields Rejuvenation"

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Mature fields have been traditionally defined and managed from the production decline perspective with the recovery factor used as benchmark criteria. The current industry climate has forced this approach to be revised and in many cases reversed.

The complexity grows with field maturation, requiring an increased skilled taskforce and a proactive approach towards use of baseline and timelapse dynamic measurements to validate and update the reservoir static models.

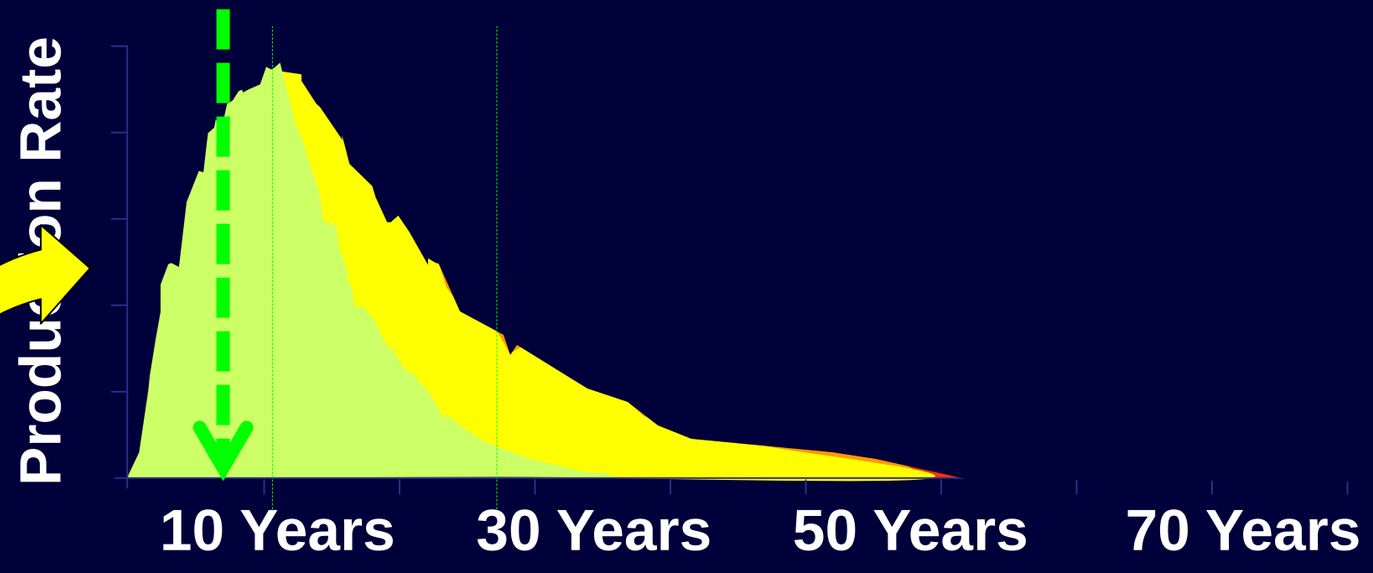
This leads to a better understating of the uncertainty associated with the field’s economic value. Best practices indicate that integration of wellbore petrophysical data, static and dynamic, is the key for mature fields rejuvenation and to increase their recovery factor.

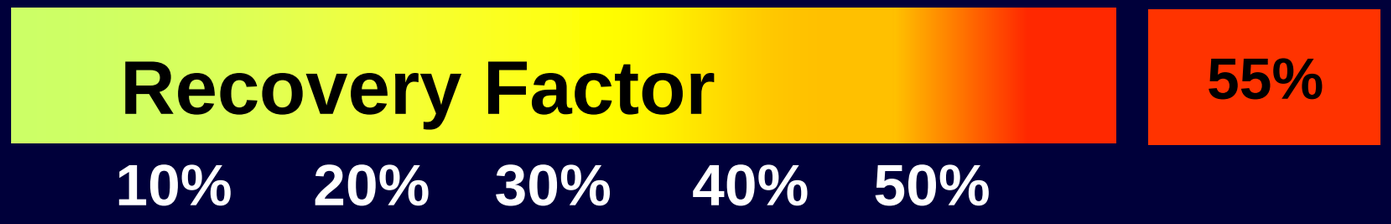
Keywords

Mature Fields

Keywords

- Production decline
- recovery factor
- complexity
- skilled taskforce
- economic value
- uncertainty
- integration



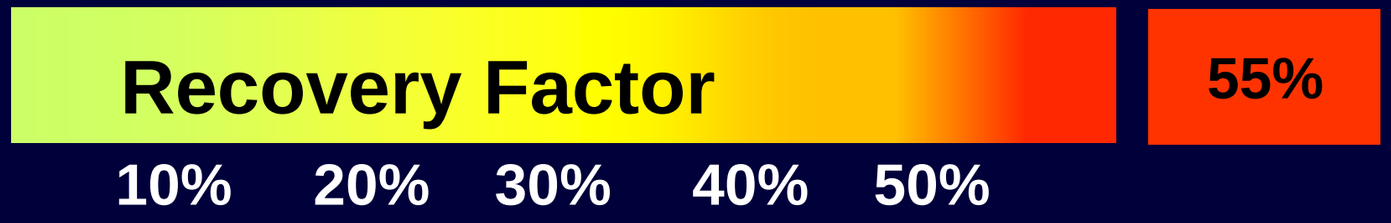


When can/do we notice a sub-optimum Recovery Factor?

Mature Fields

Keywords

- Recovery factor
- Production decline
- complexity
- skilled taskforce
- economic value
- uncertainty
- integration



At first the energy is abundant

Then we help with some energy

Then we identify unswept zones

Then we modify the behaviour of the molecules!

Mature Fields

Keywords

- Recovery factor
- Production decline
- Complexity
- Skilled taskforce
- economic value
- uncertainty
- integration

Primary

Secondary

Improved

Enhanced

Recovery Factor **55%**

10% 20% 30% 40% 50%

$$r(t) = \left[\left(\gamma_{LG} \frac{96 \lambda V^4}{\pi^2 \eta} (t + t_0) \right)^{\frac{1}{2}} + \left(\frac{\lambda (t + t_0)}{\eta} \right)^{\frac{2}{3}} \frac{24 \rho g V^{\frac{3}{8}}}{7 \cdot 96^{\frac{1}{3}} \pi^{\frac{4}{3}} \gamma_{LG}^{\frac{1}{3}}} \right]^{\frac{1}{6}}$$

where

γLG = Surface tension of the fluid

V = Drop volume

η = Viscosity of the fluid

ρ = Density of the fluid

g = Gravitational constant

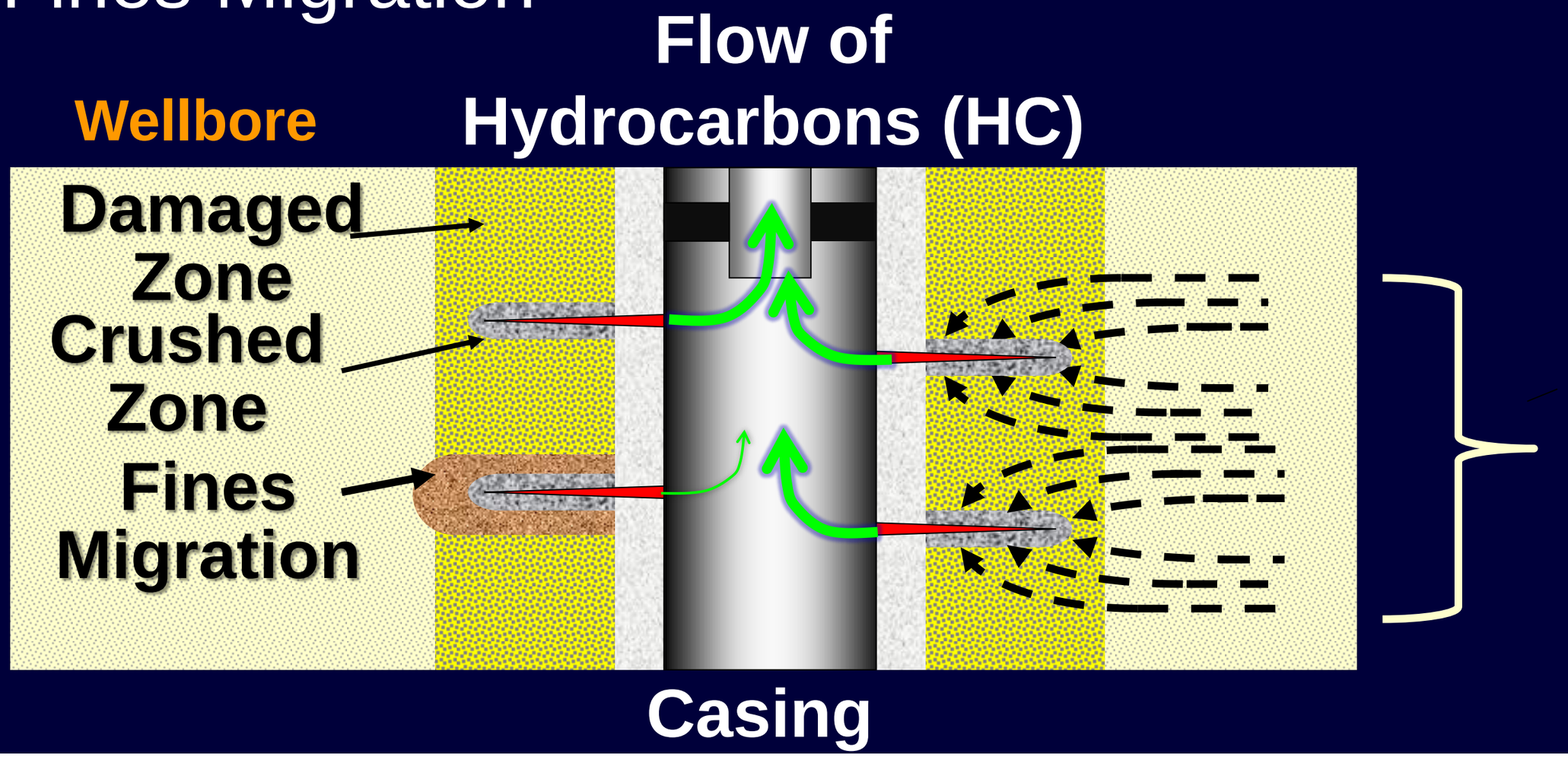
λ = Shape factor λ = 37.1 m−1

t0 = Experimental delay time

re = Drop radius in the equilibrium

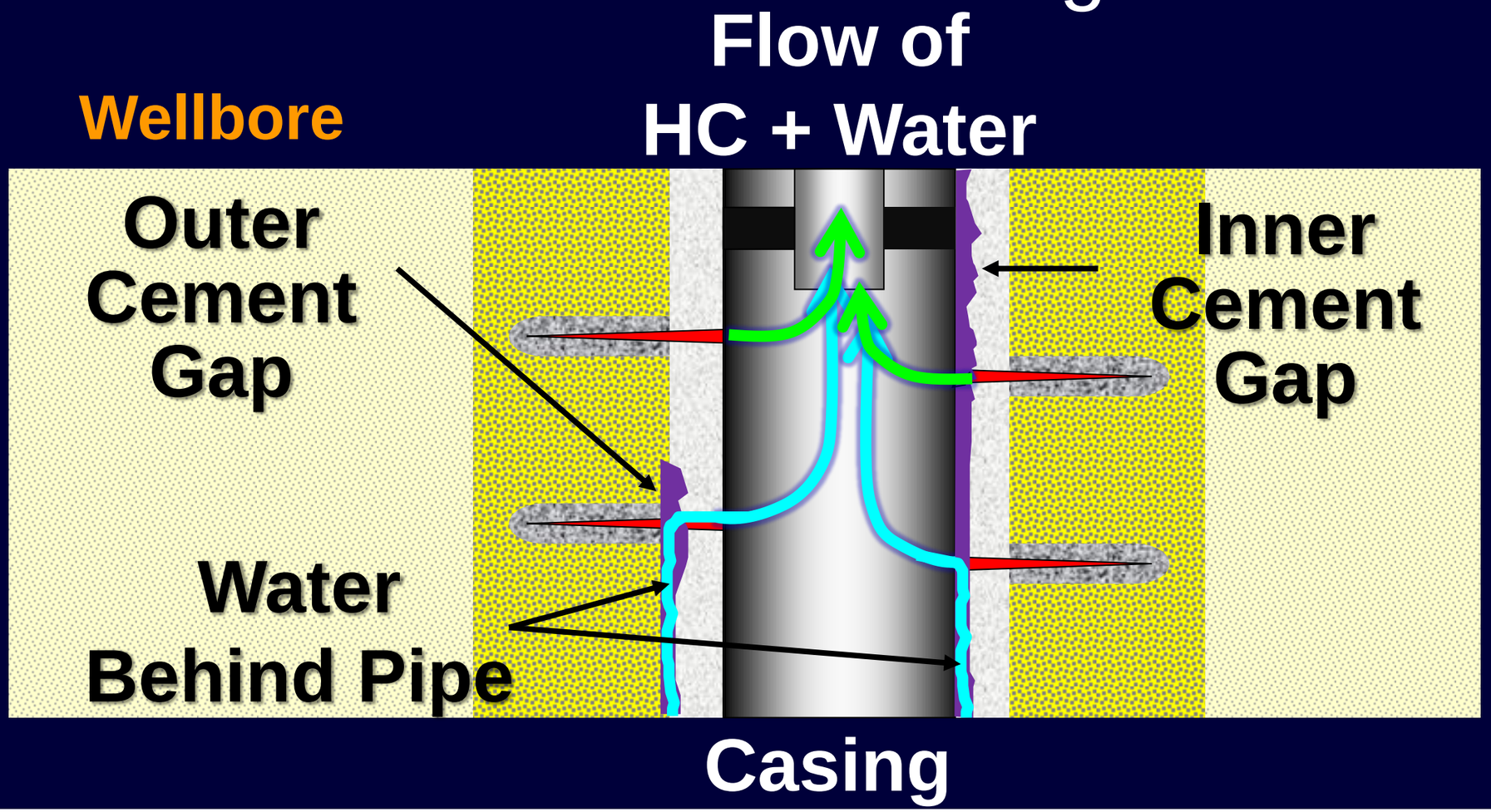
Sub-Optimum Recovery

- Fines Migration



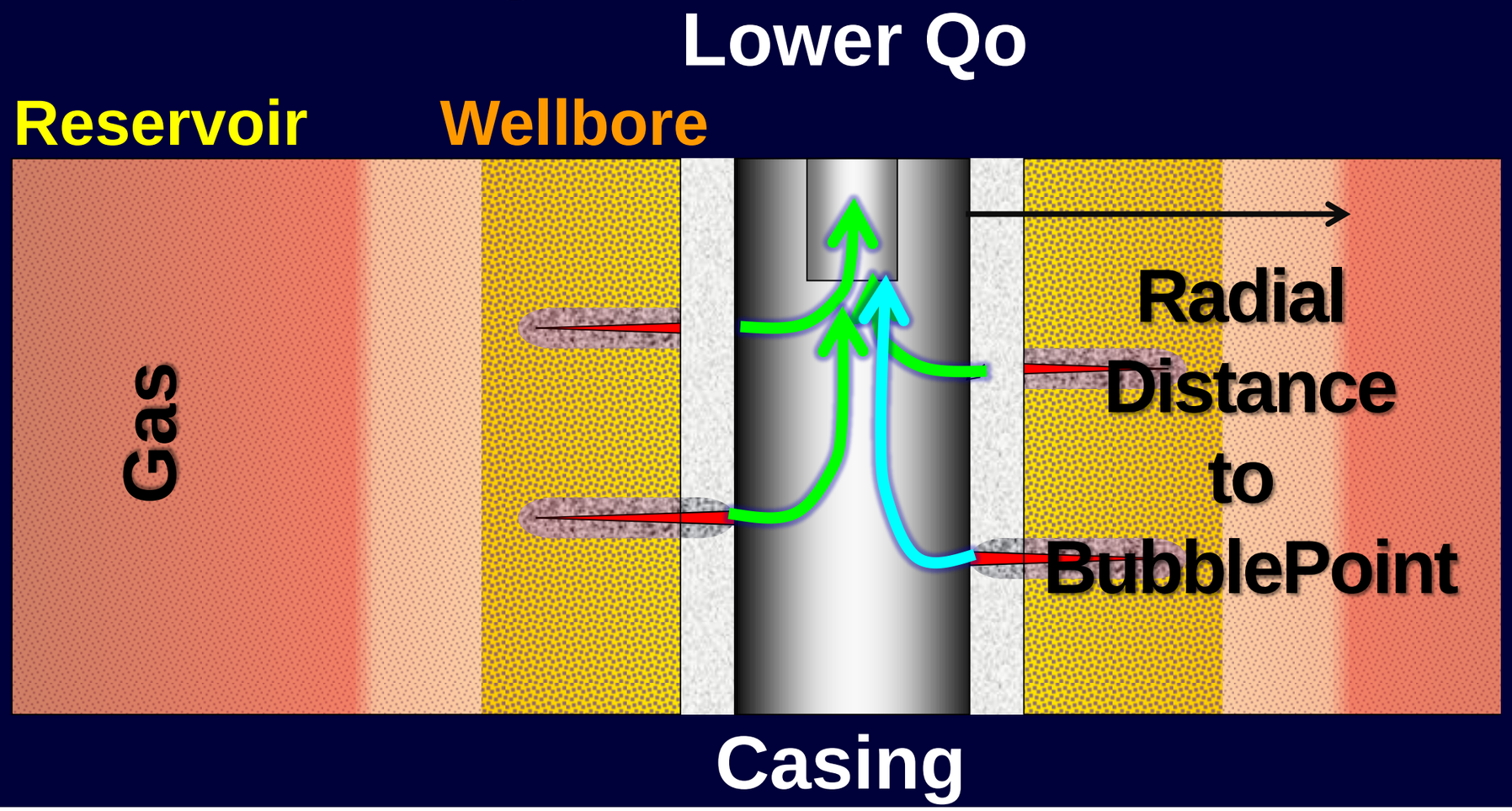
Sub-Optimum Recovery

- Water Intrusion – Channeling

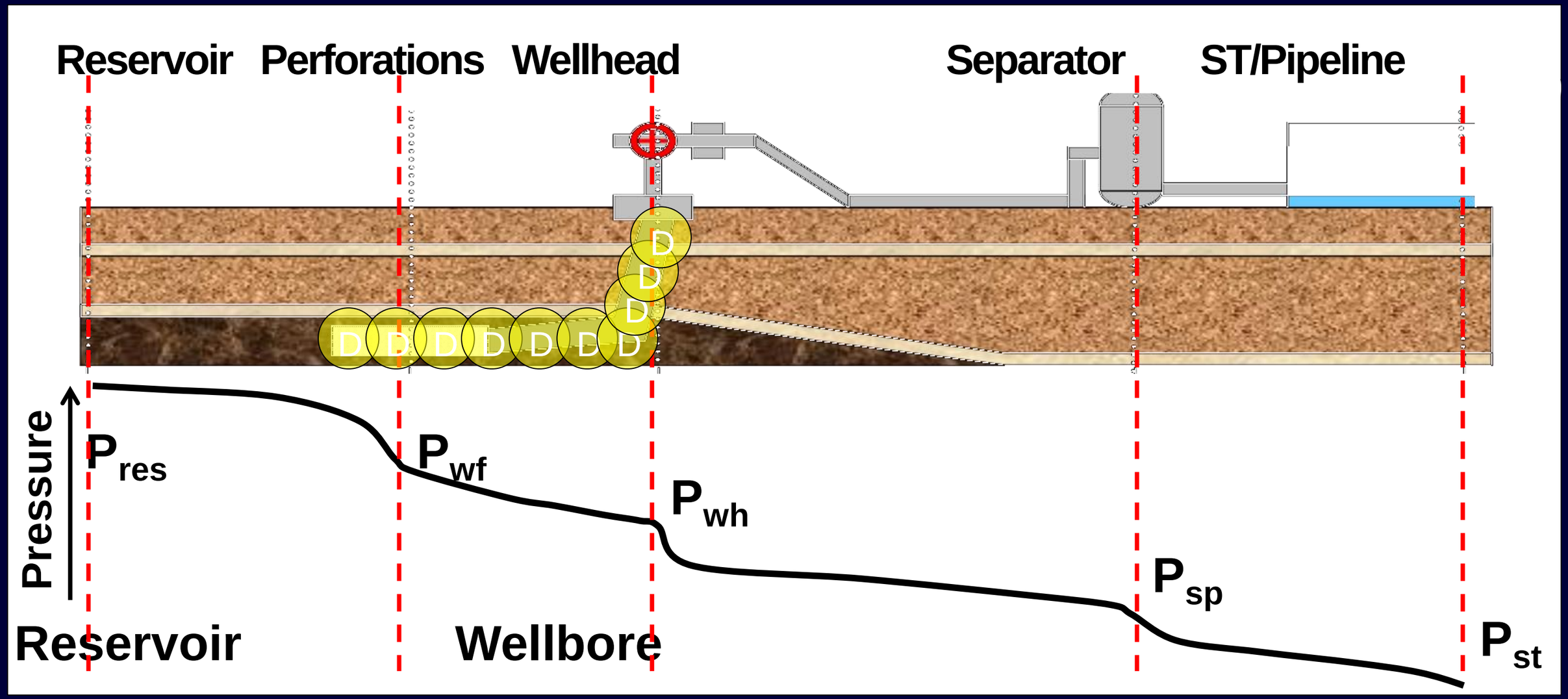


Sub-Optimum Recovery

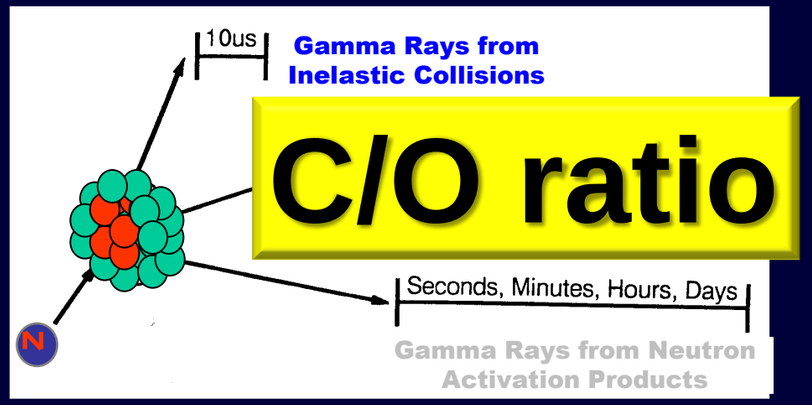
- Gas Blockeage

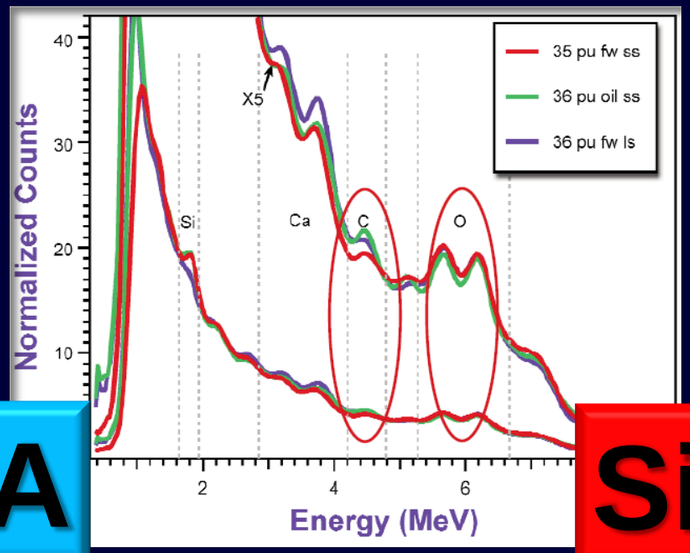


Sub-Optimum Recovery



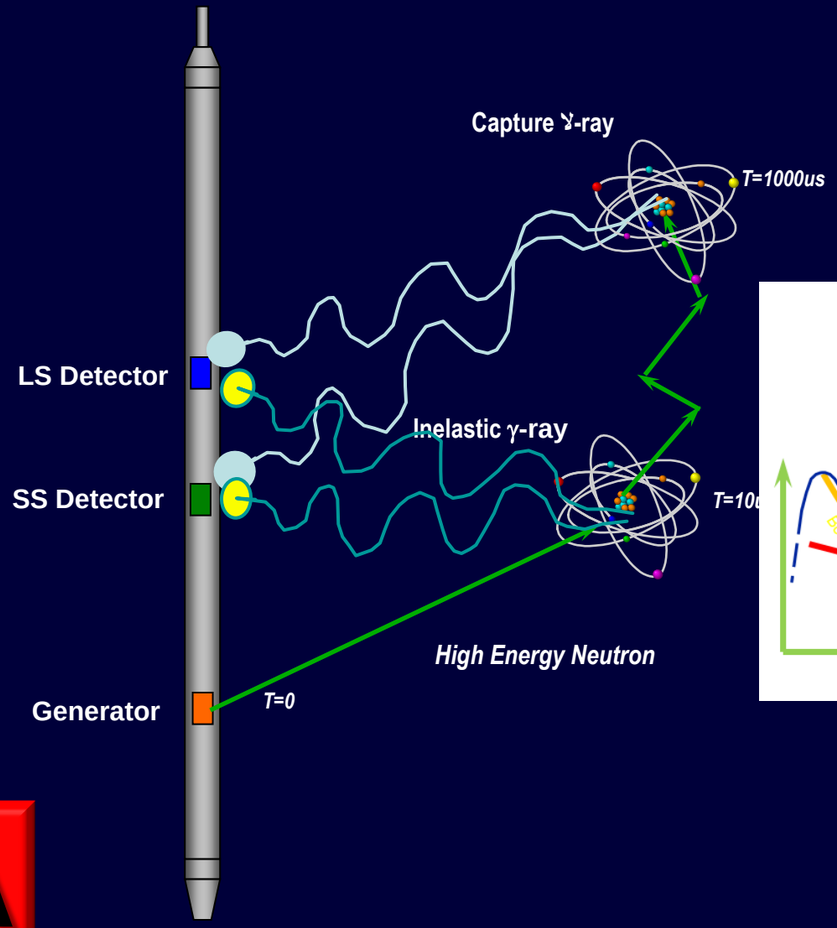
Surveillance Tools & Sensors



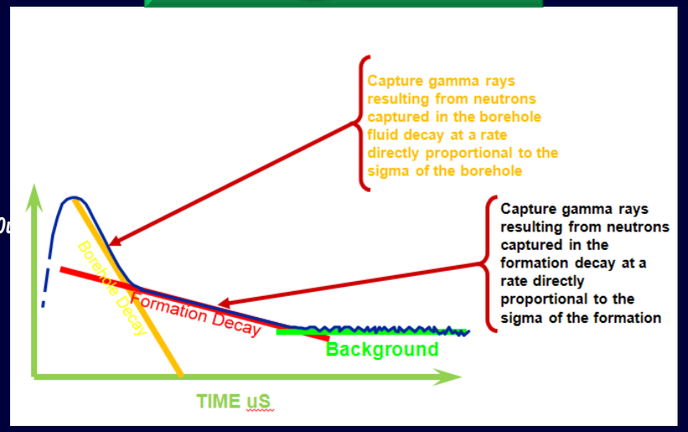


O-A

Si-A

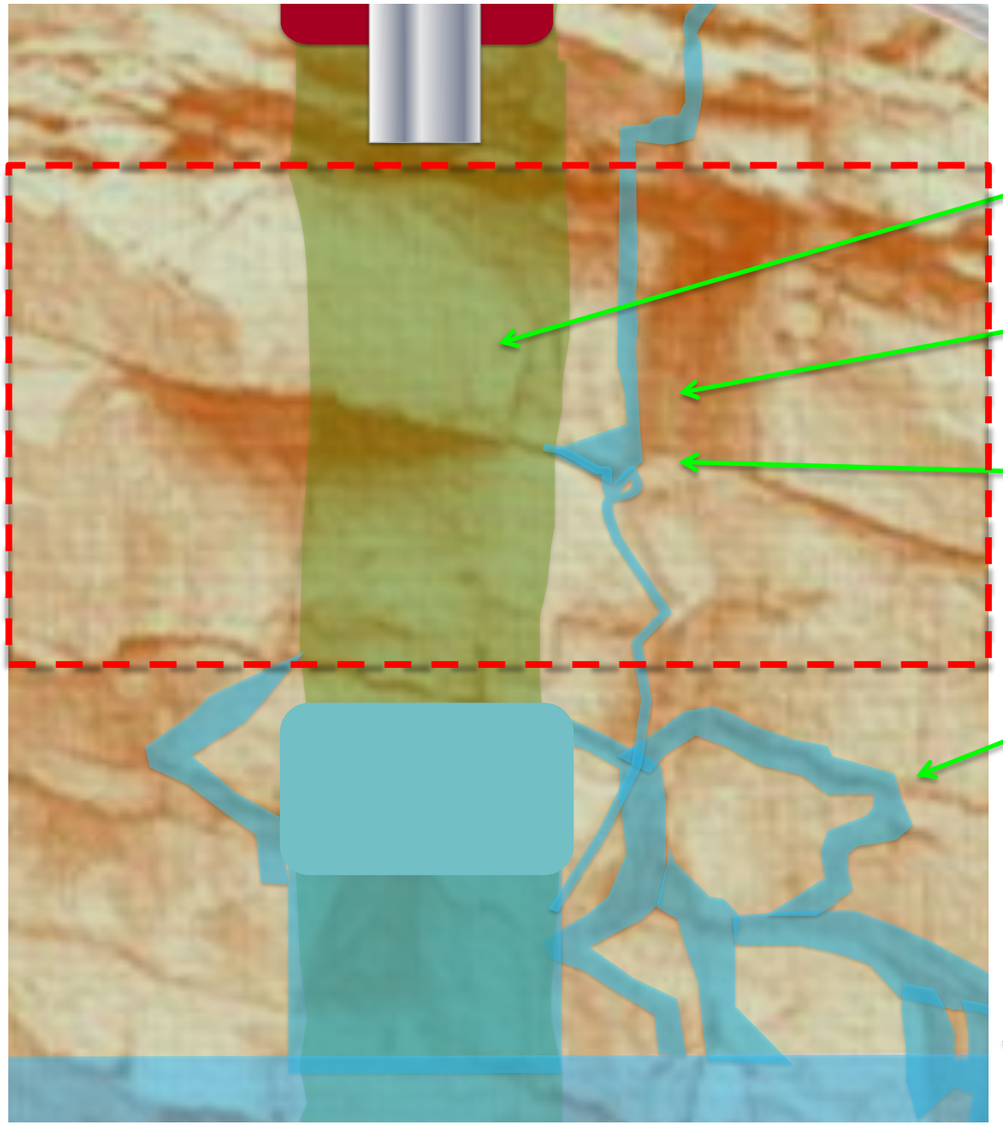


Sigma

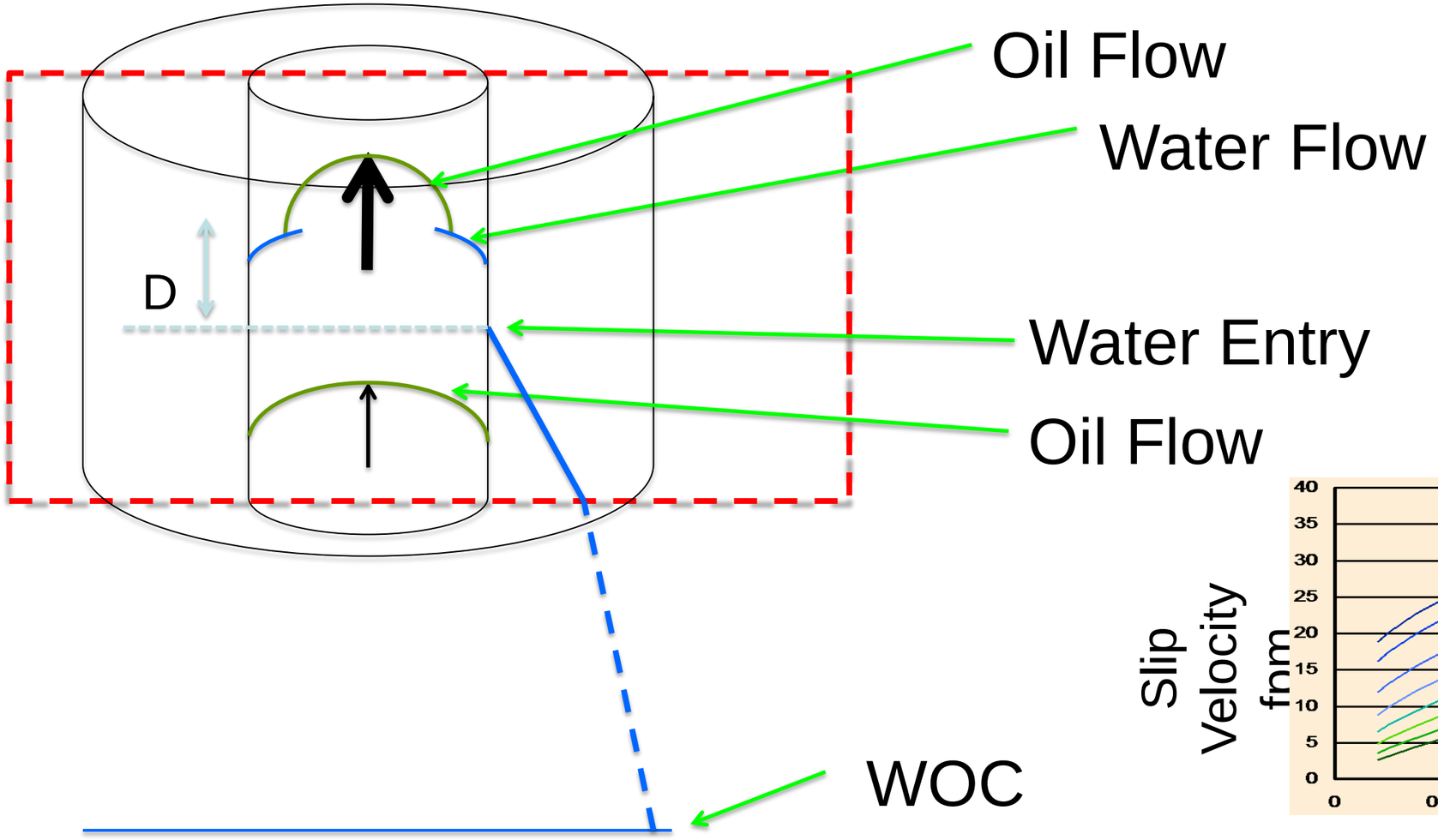


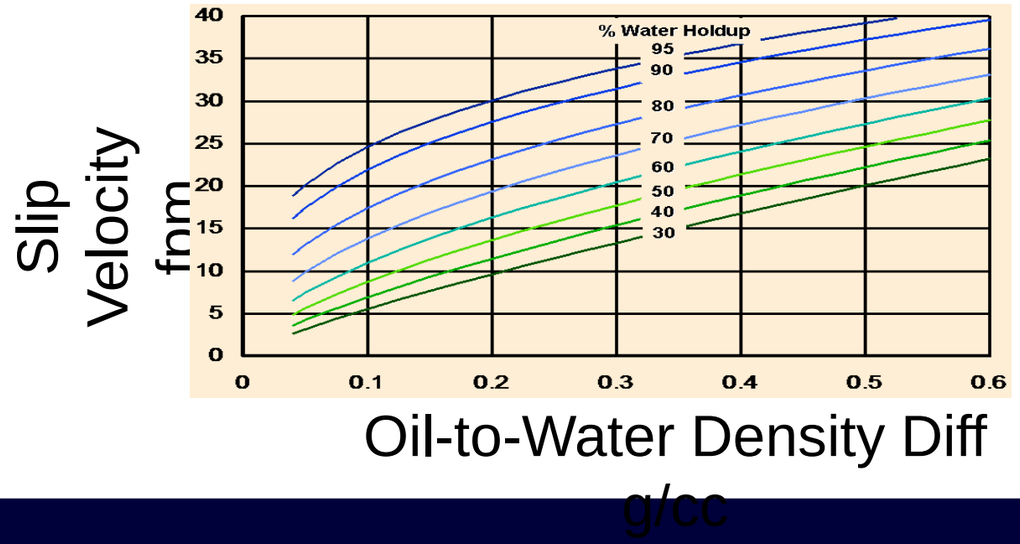
High Energy Pulsed Neutrons

Schematic of the Challenge

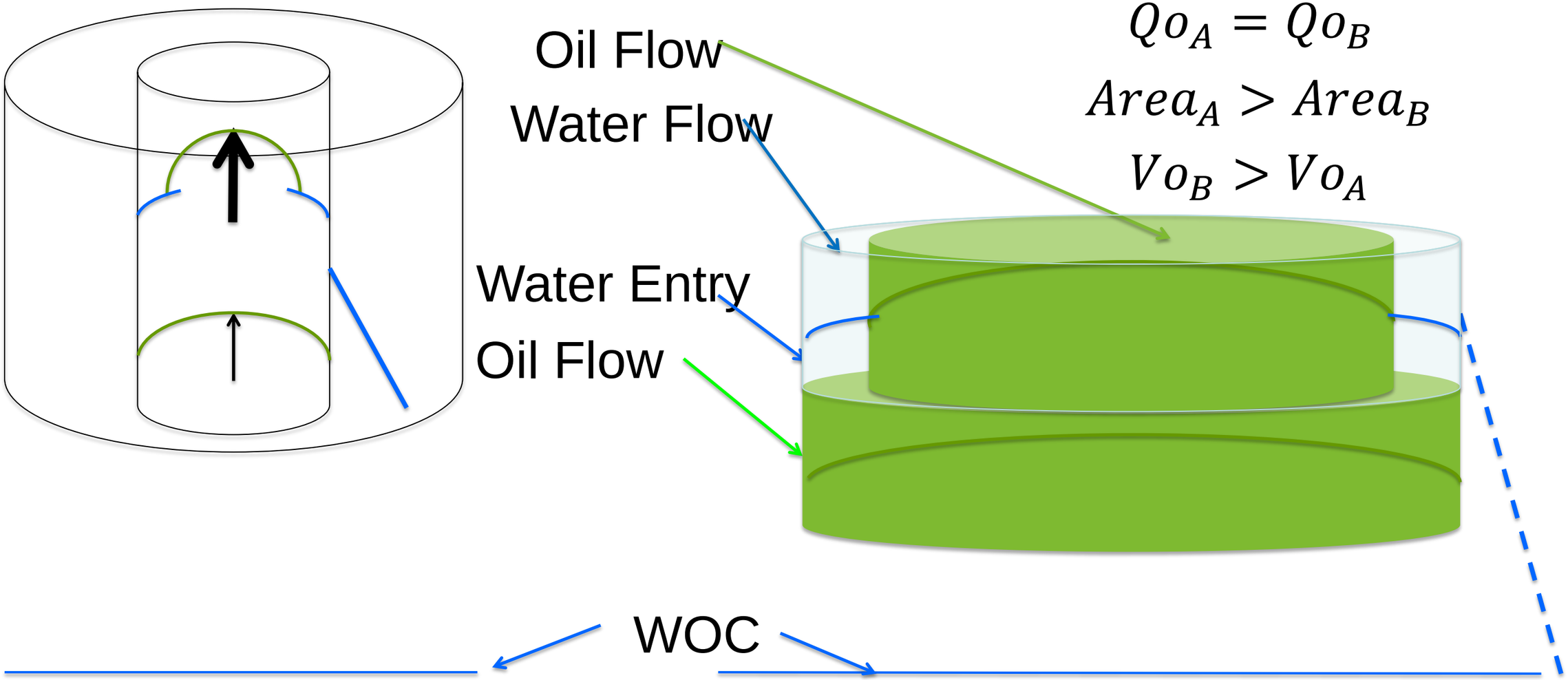


Schematic of the Challenge





Schematic of the Challenge

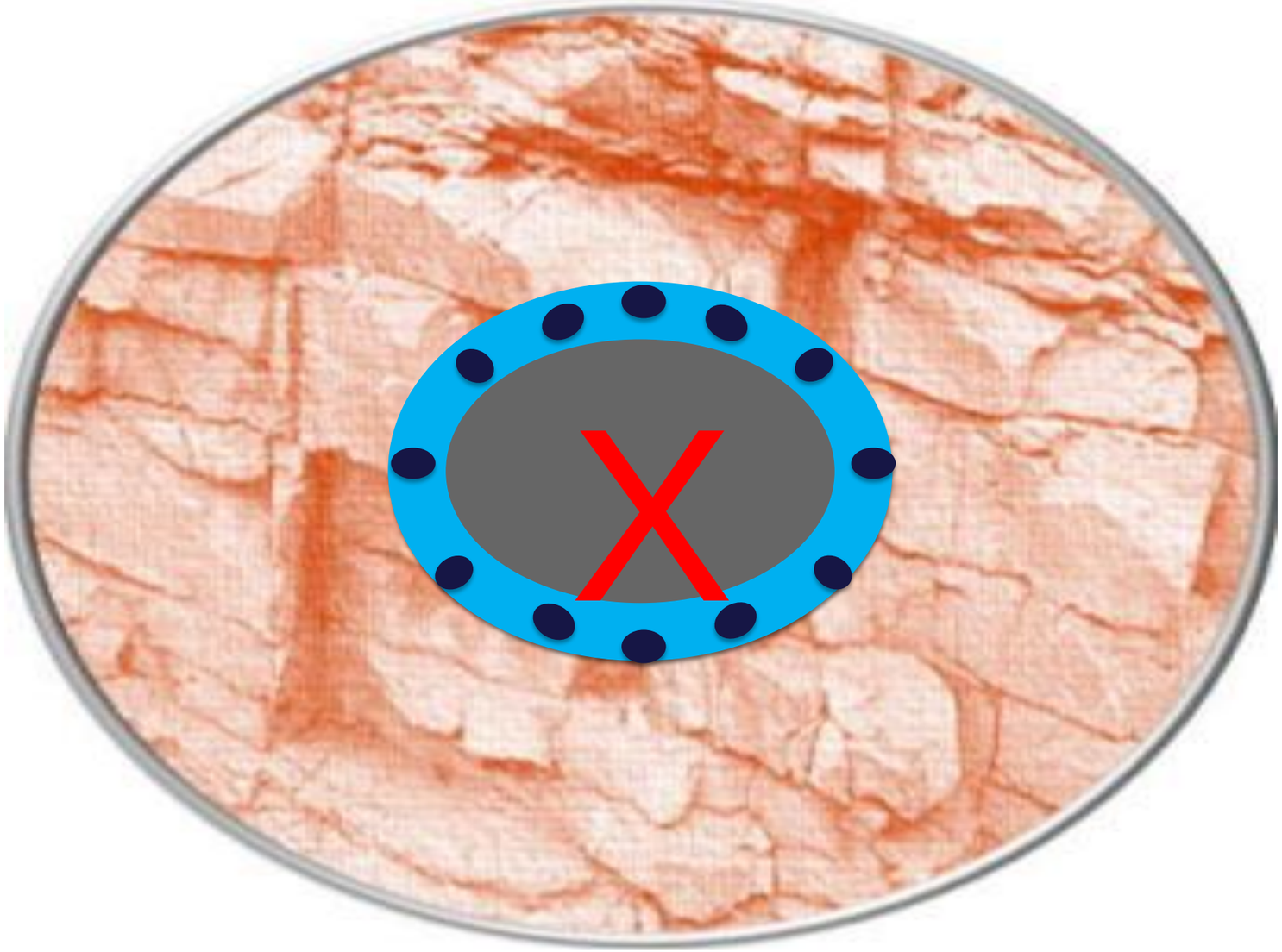


$$Qo_A = Qo_B$$

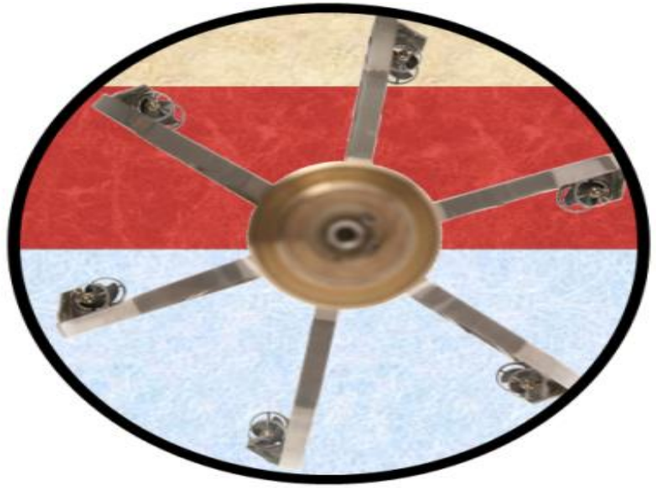
$$Area_A > Area_B$$

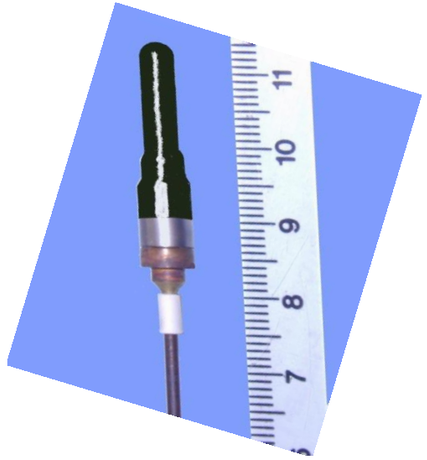
$$Vo_B > Vo_A$$

Mature Fields

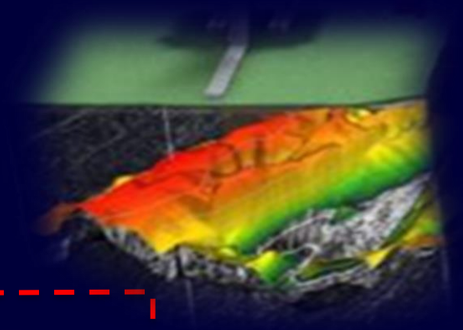


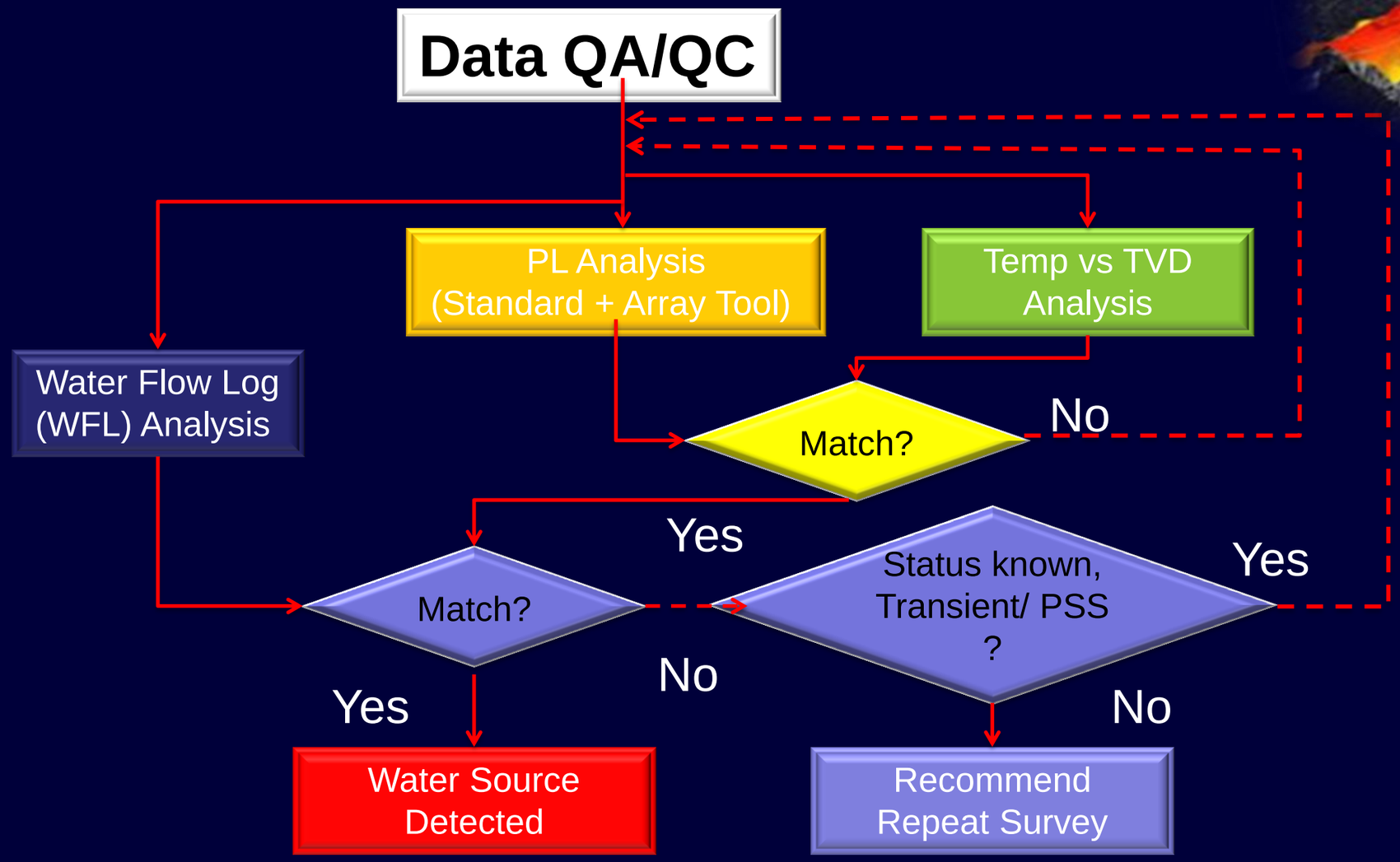
Mature Fields





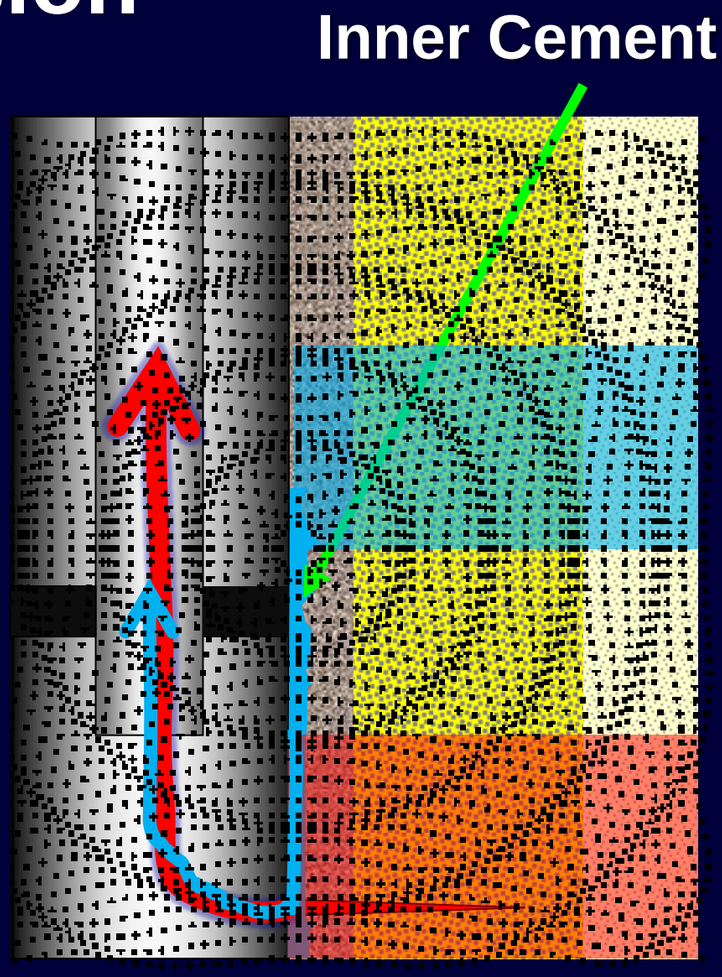
Integrated Workflow





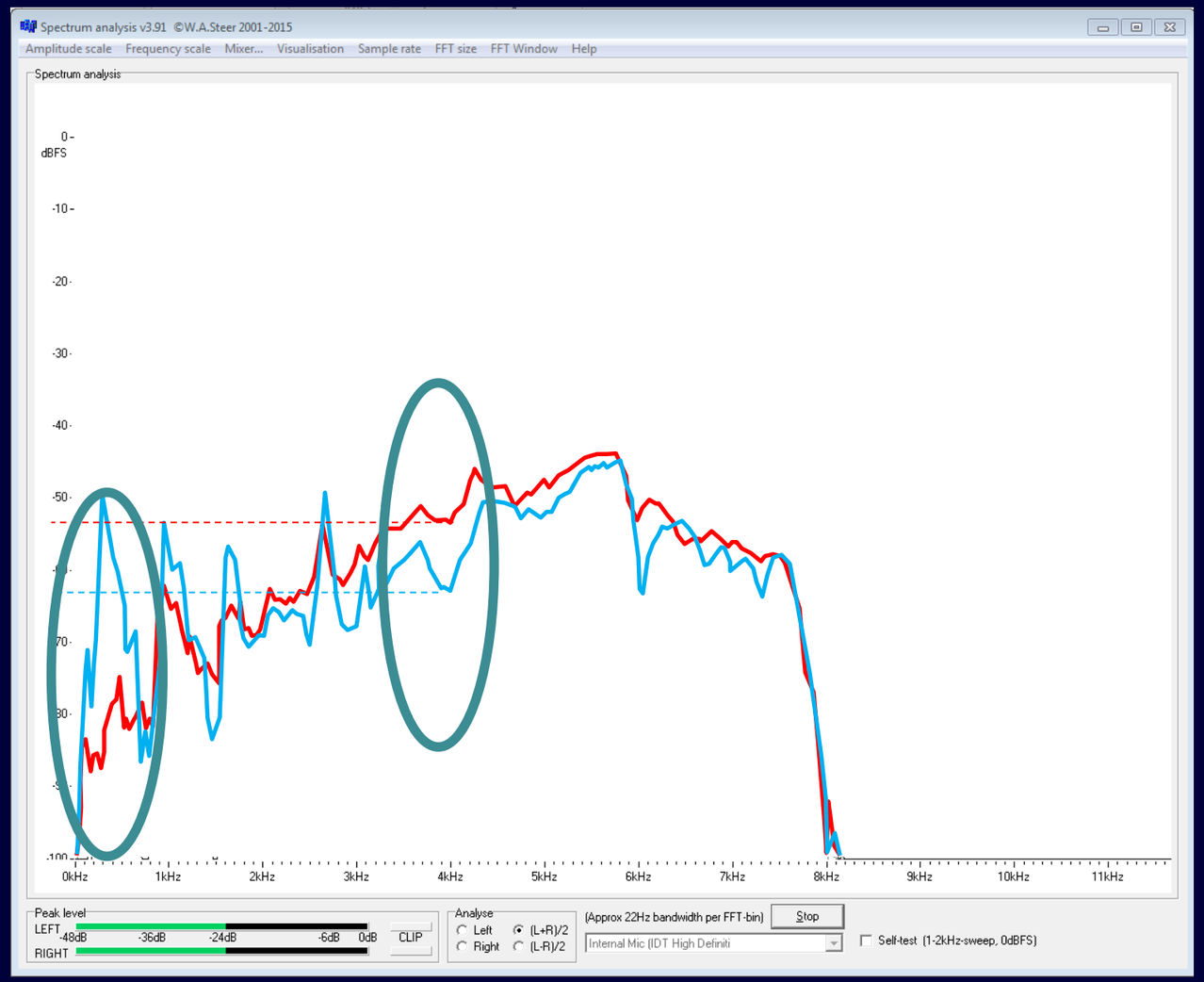
Surveillance Tools & Sensors

Water Intrusion

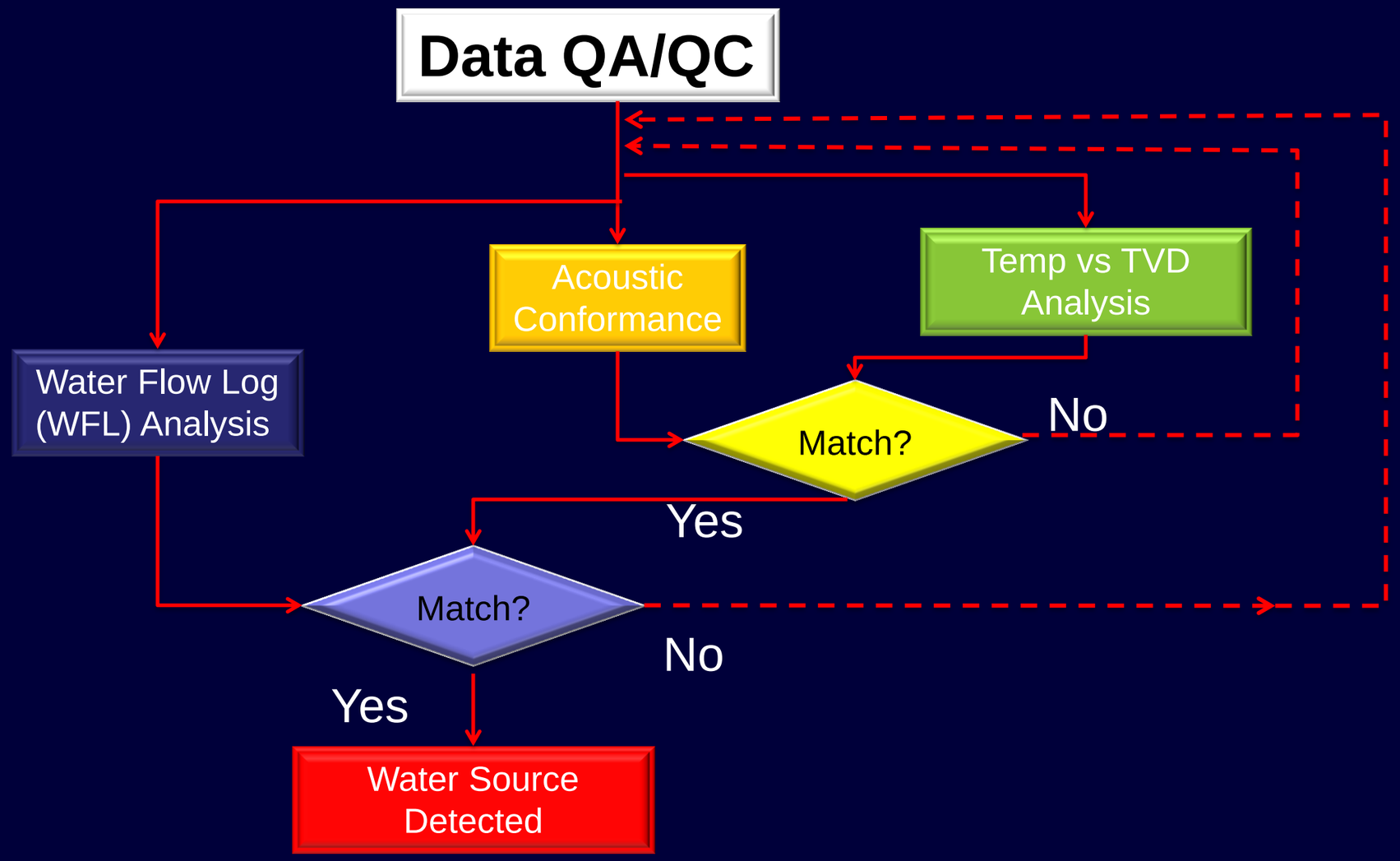


Acoustic Signal

Fluid Unique Frequency Profile



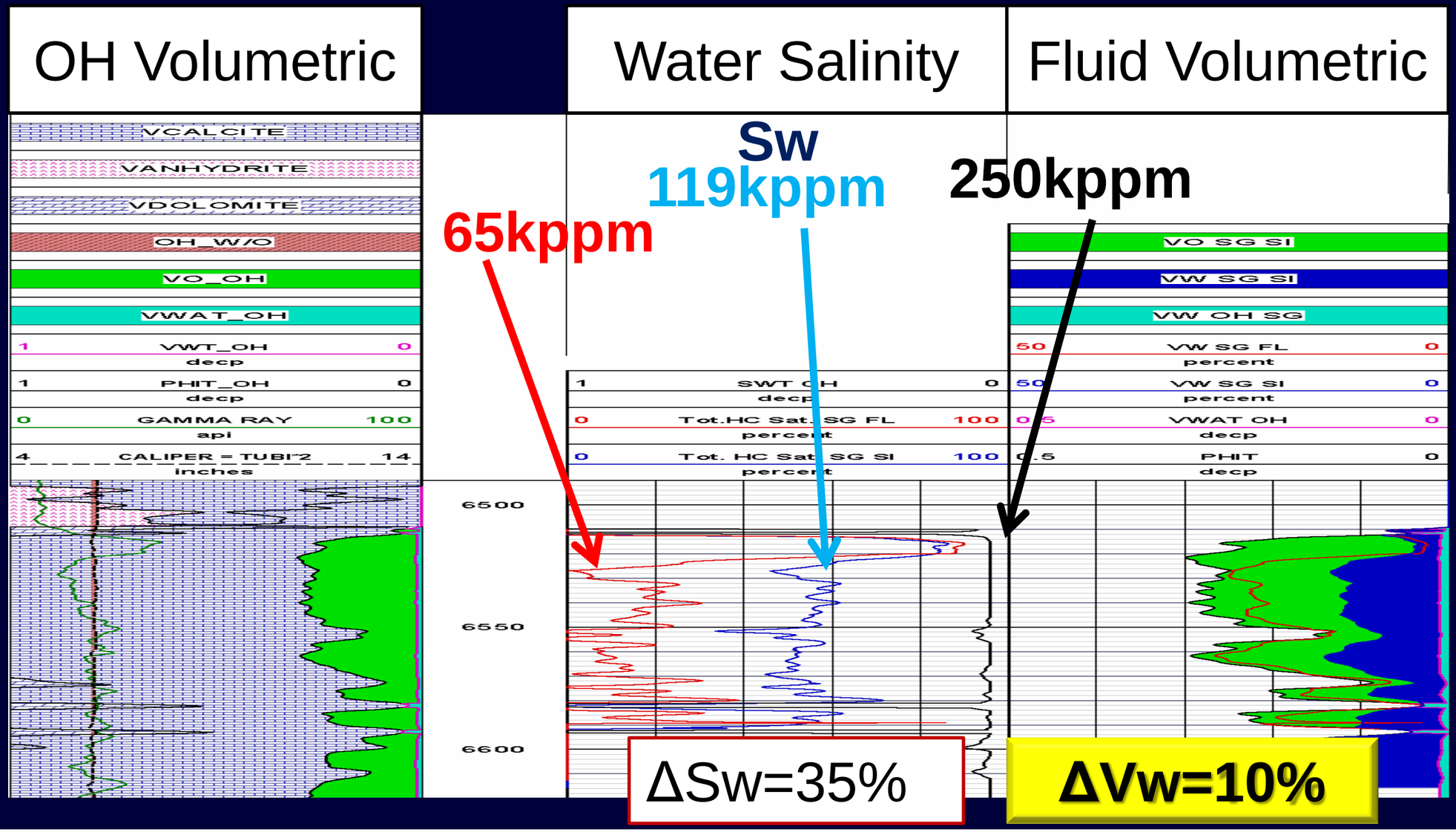
Integrated Workflow



Indirect access to perforations/flow interface

Middle East Well

Impact of Uncertainty



Integration

Asset Value
- Reserves
- Production
- Costs

Surveillance
- Behind Pipe
- Low RF
- Qo Gap

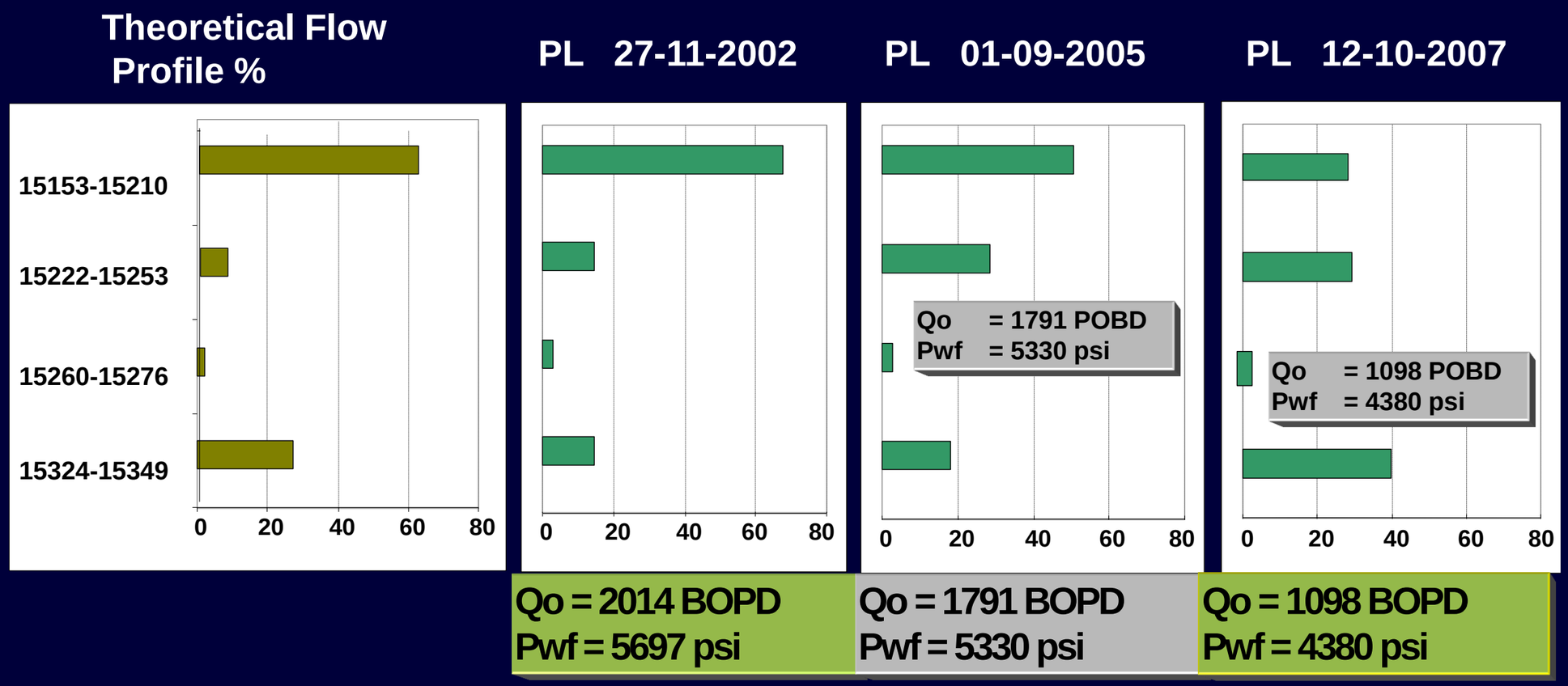
Characterization
- Saturation
- Area/Volume
- Pressure

Conformance
- Water
- Sand
- Gas

Baseline
- Fluids
- Rock

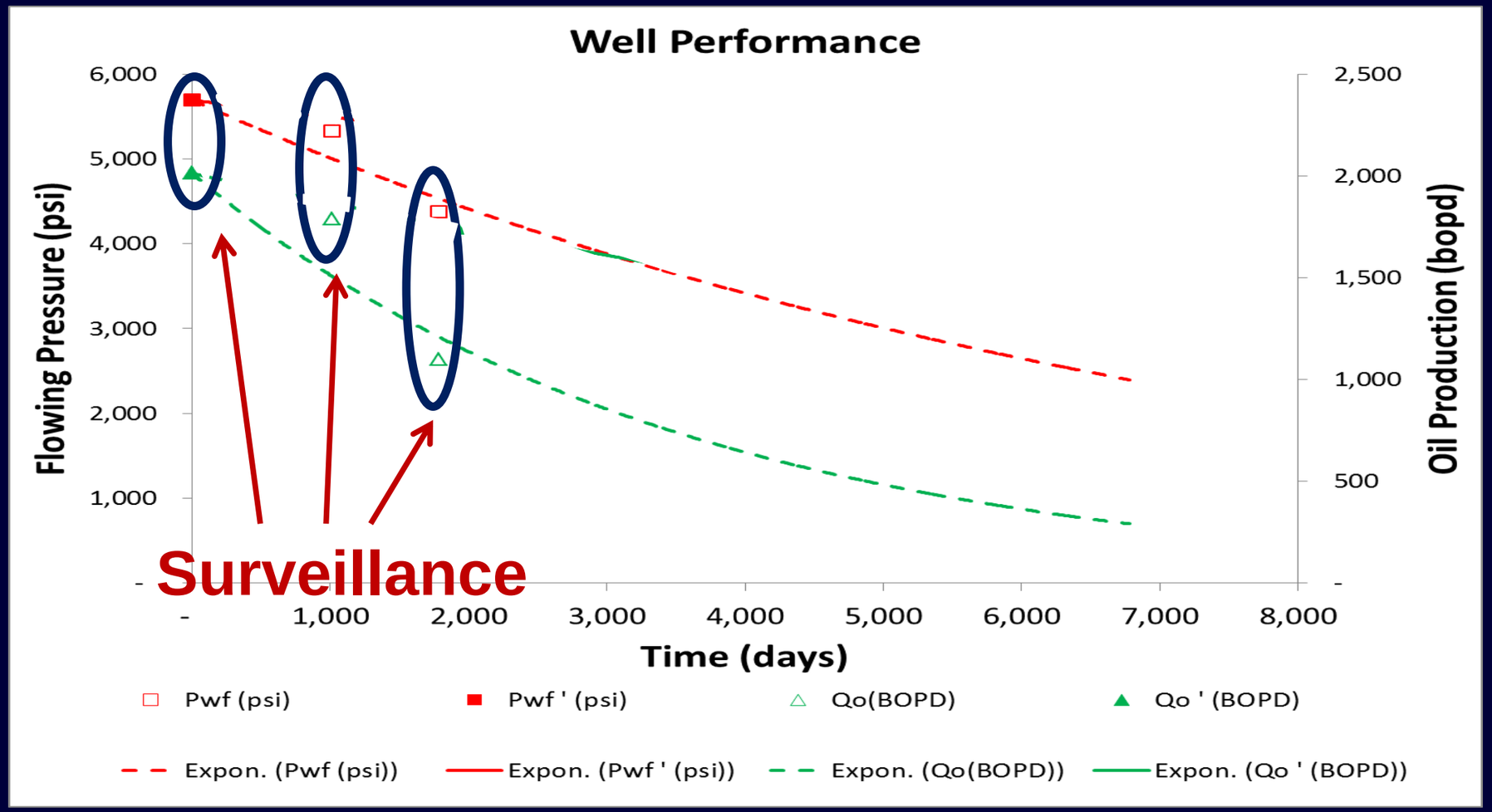
Integrity
- Scale
- Errosion
- Seal

Asset Value - Surveillance

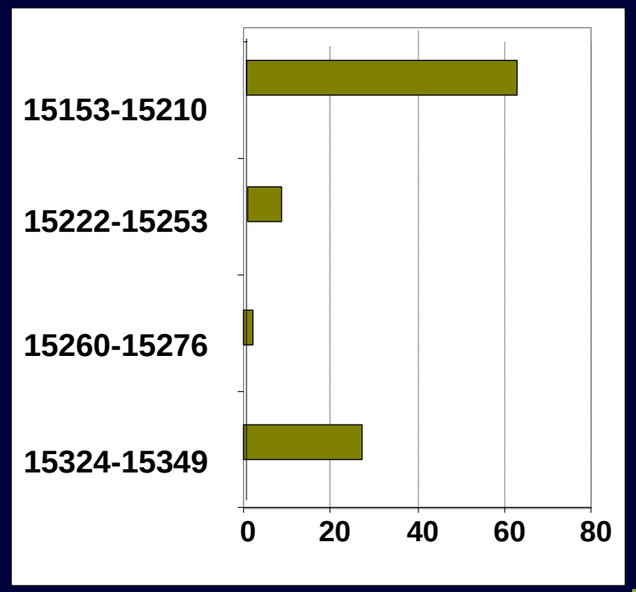


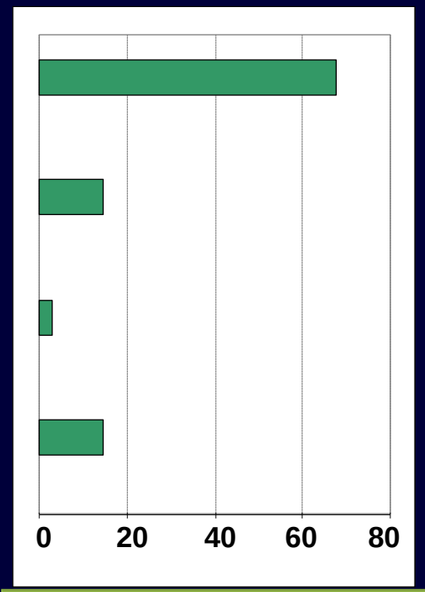
SPE 122199. Application of an Advanced Dynamic-Underbalance Perforating System for Improved Oil Production in Development Wells

Asset Value - Surveillance

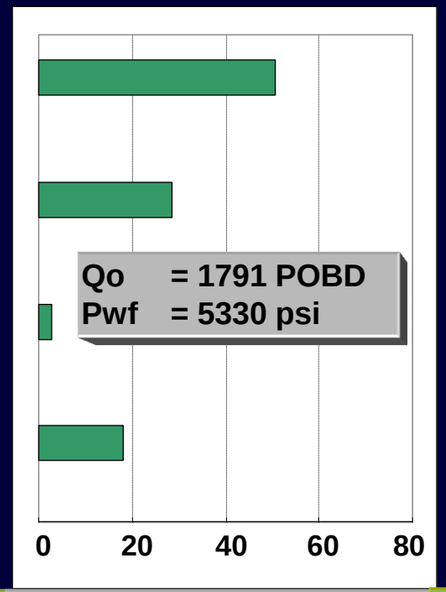


Asset Value - Intergration

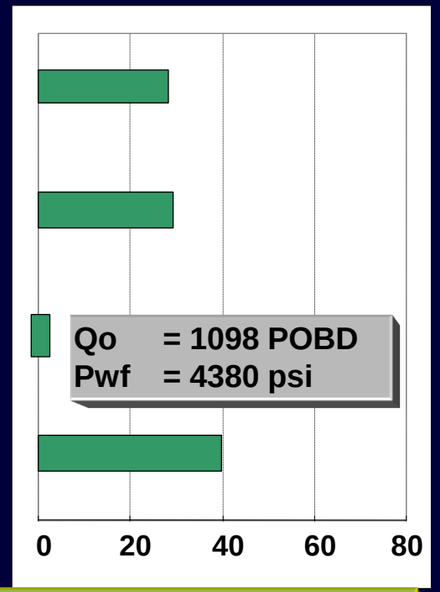




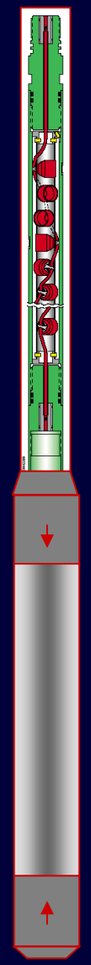
Qo = 2014 BOPD
Pwf = 5697 psi

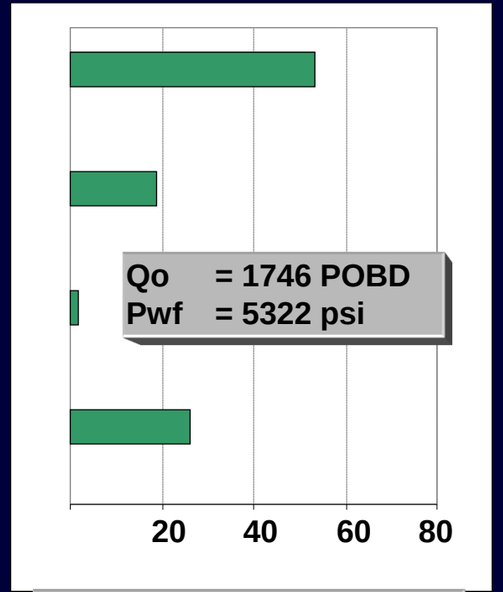


Qo = 1791 BOPD
Pwf = 5330 psi



Qo = 1098 BOPD
Pwf = 4380 psi

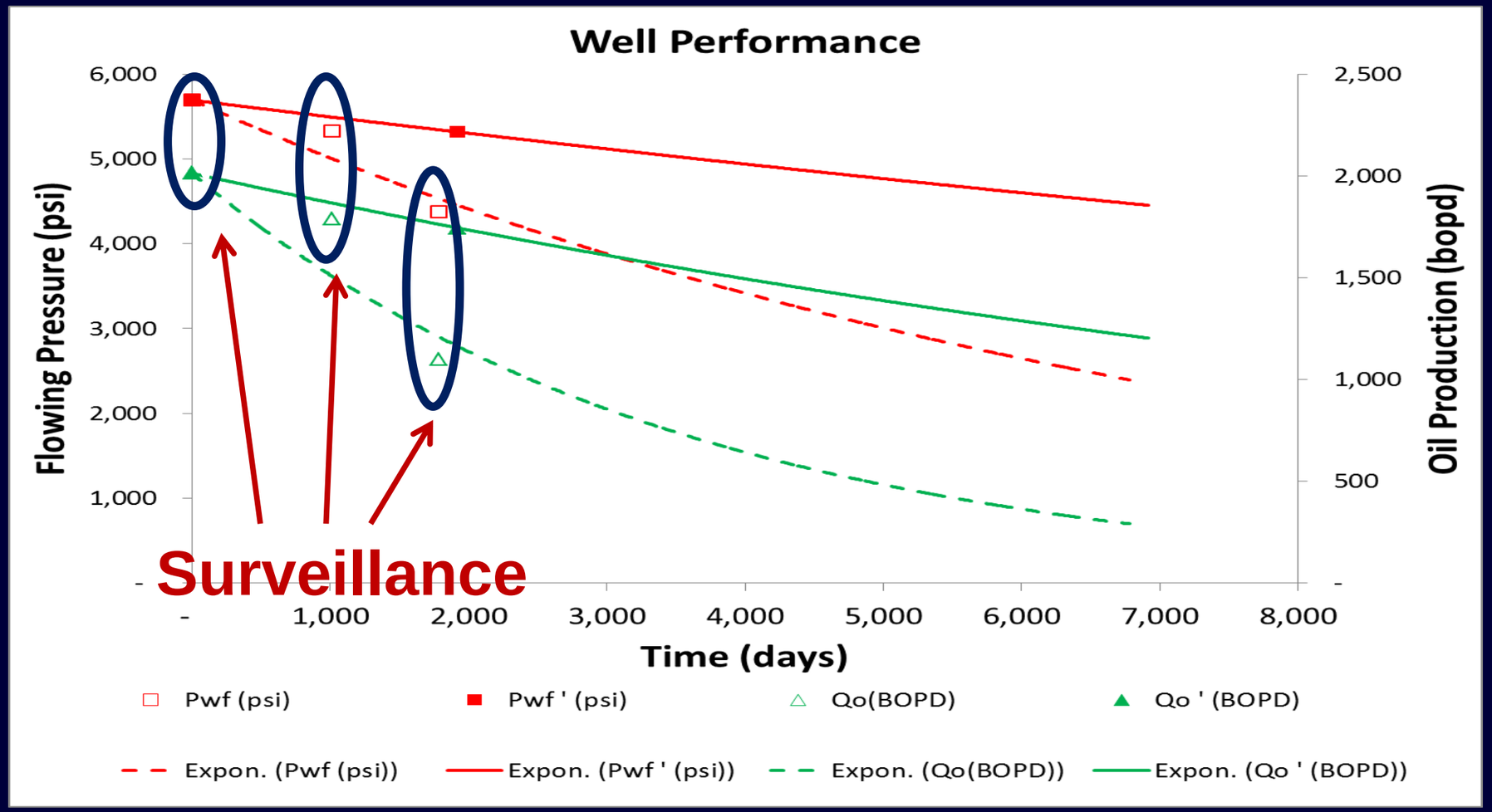




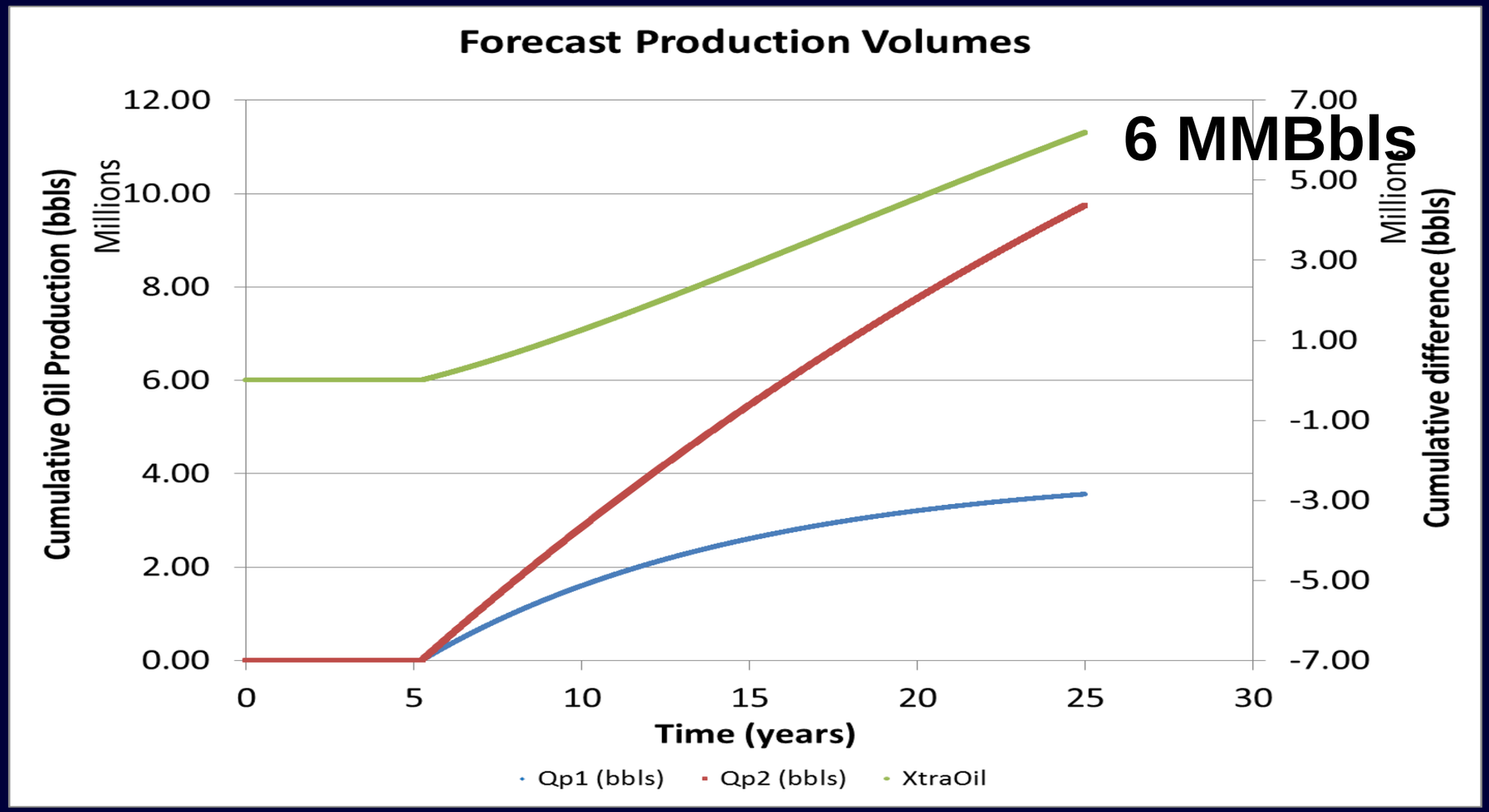
Qo = 1746 BOPD
Pwf = 5322 psi

SPE 122199. Application of an Advanced Dynamic-Underbalance Perforating System for Improved Oil Production in Development Wells

Mature Field - Intergration



Integration of Petrophysical Data



Mature Fields

Keywords

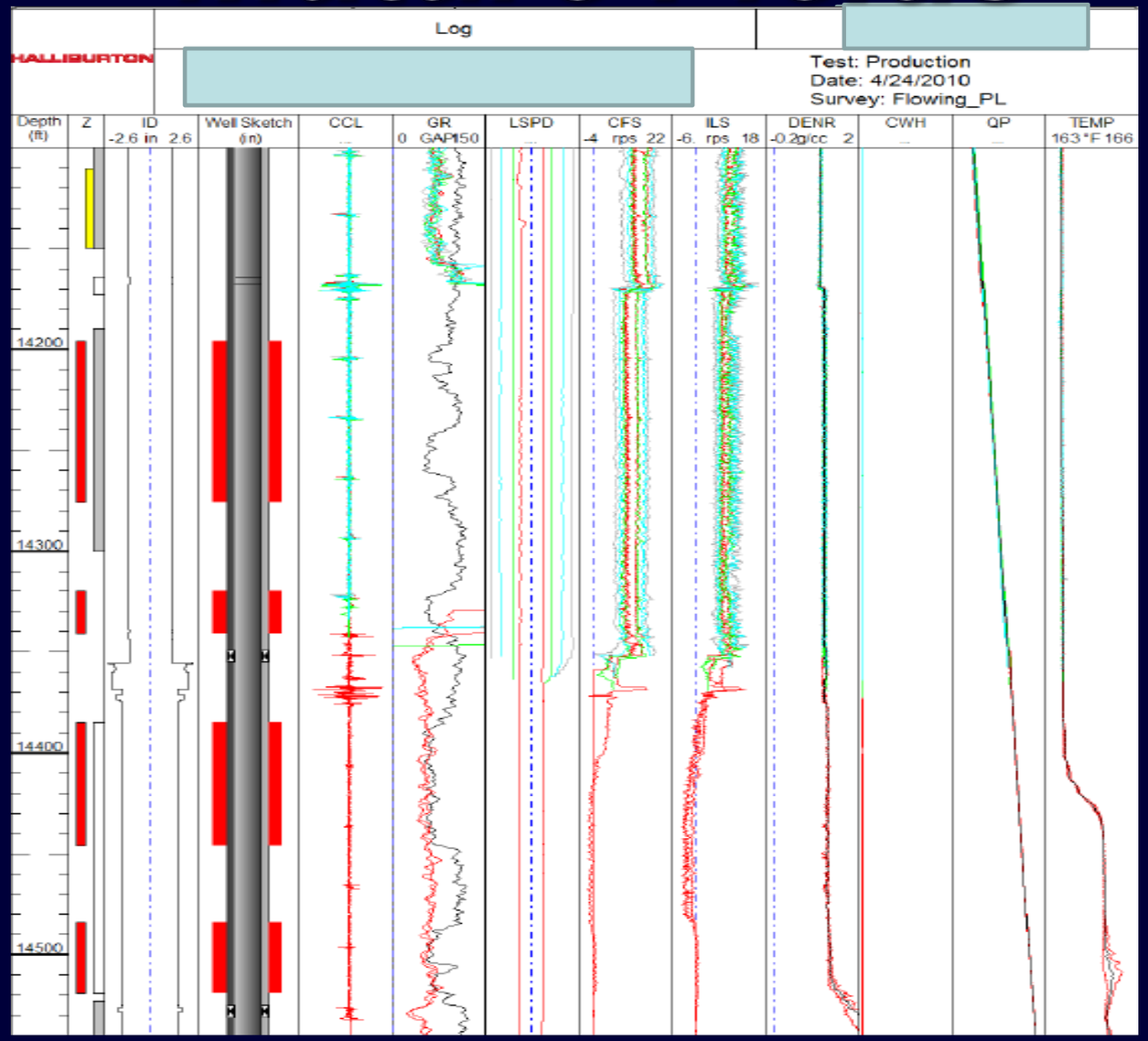
- Recovery factor
- Production decline
- Complexity
- **Skilled taskforce**
- Economic value
- Uncertainty
- **Integration**

Recovery Factor **55%**

"The best time to plant a tree was 20 years ago. The second best time is now." – Chinese Proverb

To improve Recovery in Mature Fields Integration of Petrophysical data (OH & CH) is mandatory, and must start Immediately!

Mature Fields



Mature Fields

WELL TEST SHEE

FTP	SITP	CSG	BOPD	BWPD	NET GAS MCFPD	GAS LIFT MCFPD	NET GOR	CK 64ths	BS&W
282	4085	12	2361	5367	2104	0	891	99%	75%
276	4085	12	2289	5525	2269	0	991	99%	75%
286	4085	12	2007	5480	2434	0	1213	99%	74%
294	4085	12	1926	5425	2417	0	1255	99%	73%
299	4085	12	1842	5095	2503	0	1359	99%	[illegible]
301	4085	12	1792	5267	259[illegible]				
271	4085	12	1837.5	5229.8	[illegible]00				
256	4085	12	1818	5174	192[illegible]				
375	2600	10	4647	360	492[illegible]				
357	2600	11	5154	214	663[illegible]				
355	2600	10	6107	404	5780	0	946	99%	6%
683	2600	10	5841	243	5324	0	911	48%	4%
681	2600	11	5713	238	5309	0	929	48%	4%

Increase of **3,400 BOPD**

Decrease **4,900 BWPD**

Thank you!

Questions?

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