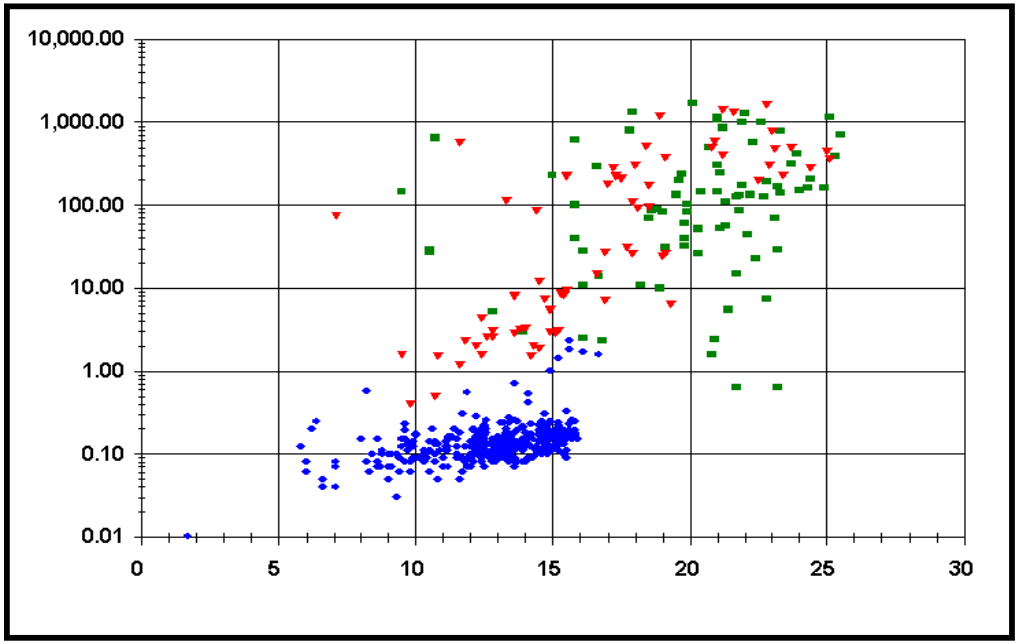
wintershall

BASF Gruppe

Tight Gas

Challenges



Tight Gas Challenges
- Presentation Outline

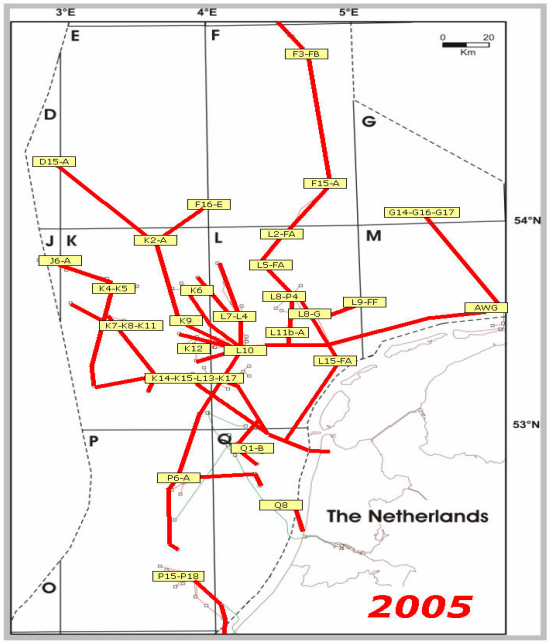
- E&P Challenges
- Definition Tight Gas
- Reservoir Characteristics
- Tight Gas Strategy
- P6-B4 Case History

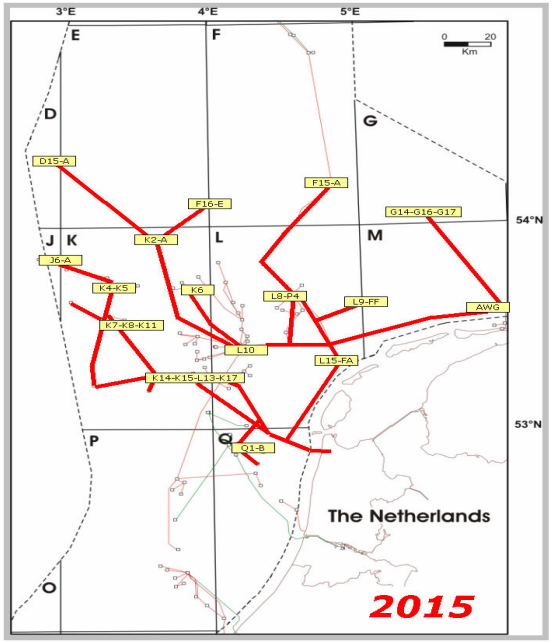
E&P Challenges - Dutch Offshore

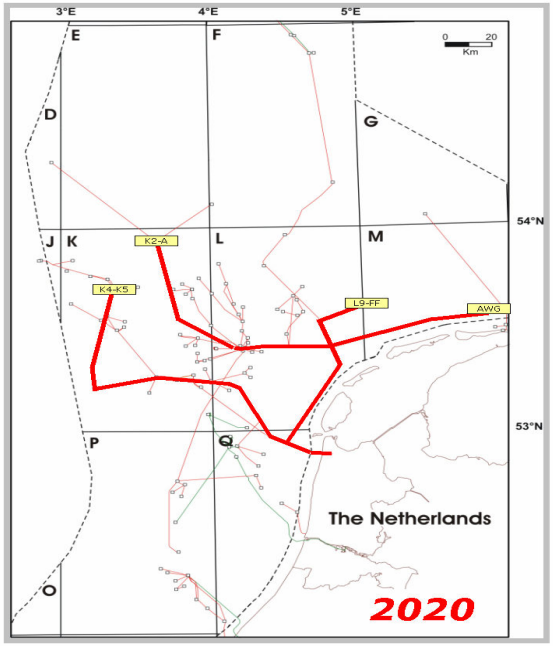
- Tight Gas-In-Place (WINZ acreage > 30 bcm)
- Infrastructure lifetime (10 – 15 years)
- Technological breakthroughs
- Gas price at record high (cost as well)
- Subsidy candidate

Infrastructure Dutch Offshore

- In case of no further developments the infrastructure in the Dutch offshore would be largely abandoned in 15 years time







E&P Challenges - Dutch Offshore

- Tight Gas-In-Place (WINZ acreage > 50 bcm)
- Infrastructure lifetime (10 – 15 years)
- Technological breakthroughs
- Gas price at record high (cost as well)
- R&D subsidy candidate

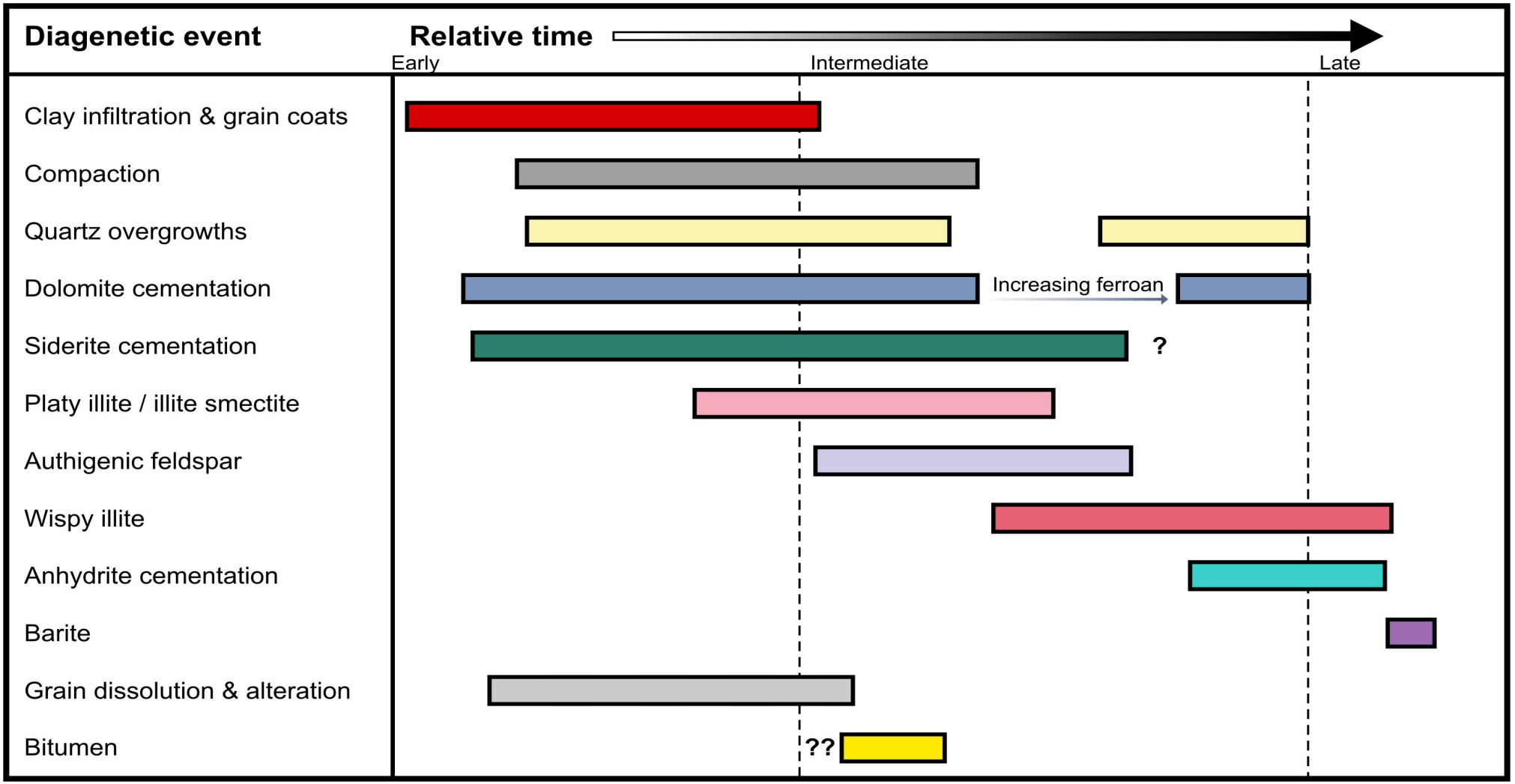
Definition “Tight Gas”

- “Gas discoveries that cannot be made commercial using conventional methods due to low productivity”
  - Permeability (K): < 1.0 mD (traditional 0.1 mD)
  - Permeability-thickness (Kh): < 50 mD.m ?

Reservoir Characteristics

- Tight gas occurs in both Clastic and Carbonate reservoirs (Chalk, Bunter, Zechstein, Rotliegend)
  - Low Permeability (K_r)
    - Facies
    - Diagenesis (compaction, illite)
  - High water saturation
    - Large transition zone
    - Excessive mud (filtrate) invasion
    - $K_{rg} << K_r$
    - Large Sw_{irr} (low recovery)
  - Small permeability-thickness (Kh)
    - Reservoir thickness
    - Lateral continuity ($K_{test} < K_{core}$)

Typical Rotliegend Diagenesis



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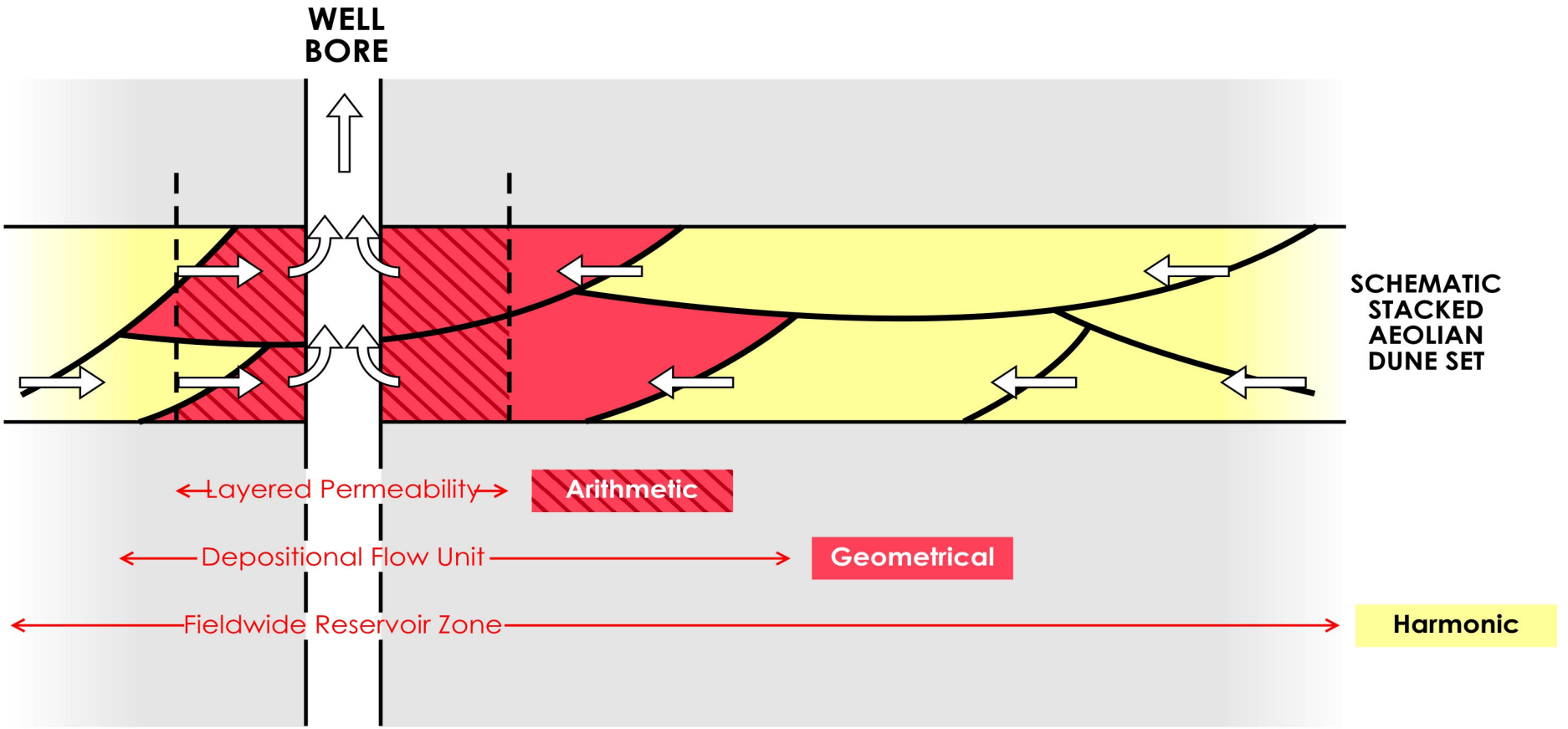
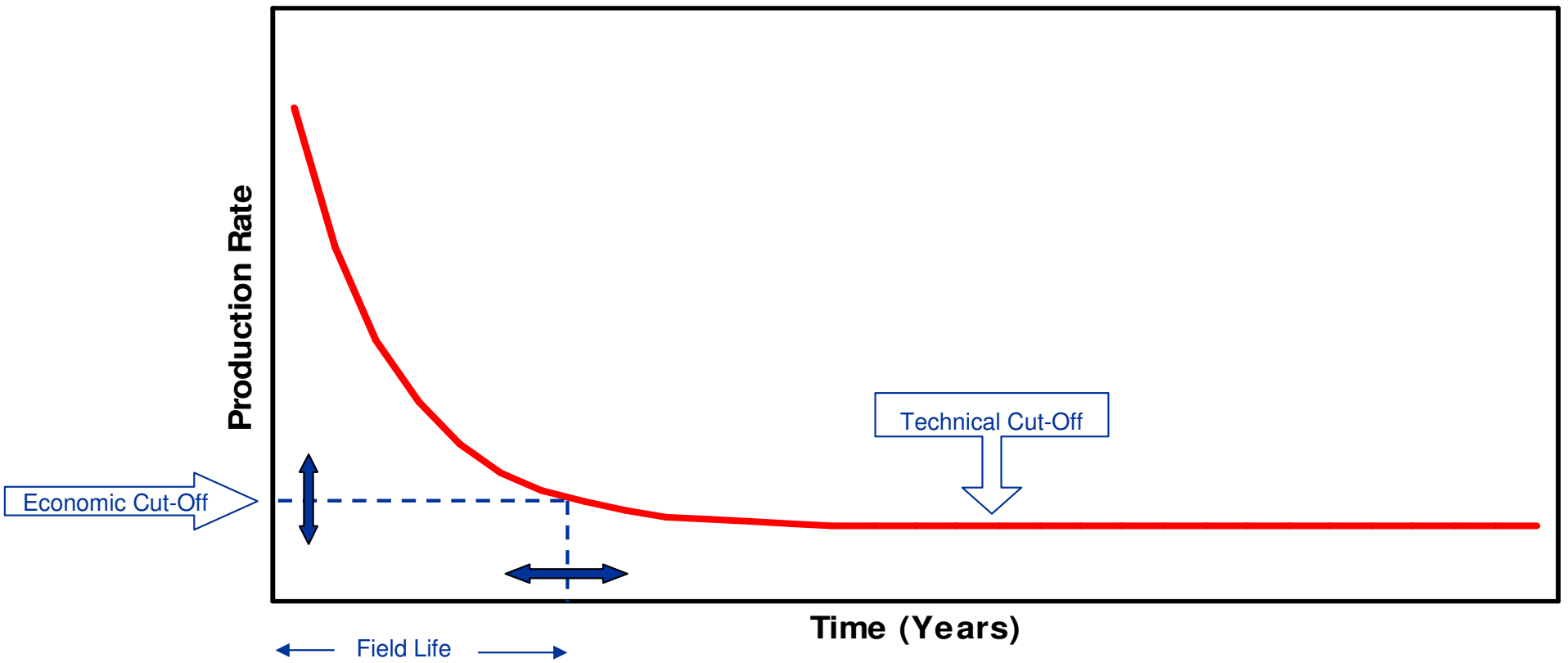
Lateral continuity



Permeability Averaging

Tight Gas Performance

Typical Tight Gas Production Profile



Tight Gas Strategy

- Increase Net Present Value (NPV)
  - Boosting productivity
  - Reducing Capital Investment (?)
  - Reducing Operational Cost (RCO)
  - Remote Controled Operations
    - Pilot Control Room in Rijswijk

Tight Gas Strategy
- Boosting Productivity

- Chasing high K conduits
  (natural fractures, leached zones, aeolian layers)
  - Large number of wells
  - Horizontal / slanted wells (geosteering, geochemical analysis)
  - Multi-lateral wells (borehole accessibility)
  - Hydraulic frac (multiple)
- Avoid borehole damage
  - Underbalanced drilling
  - Acid wash (Carbonates)
  - Hydraulic frac
- Reduce minimum FWHP
  - Wellhead compression (multiphase)
  - Use as fuel gas (< 100,000 m^3/d)

P6-B4 Case History

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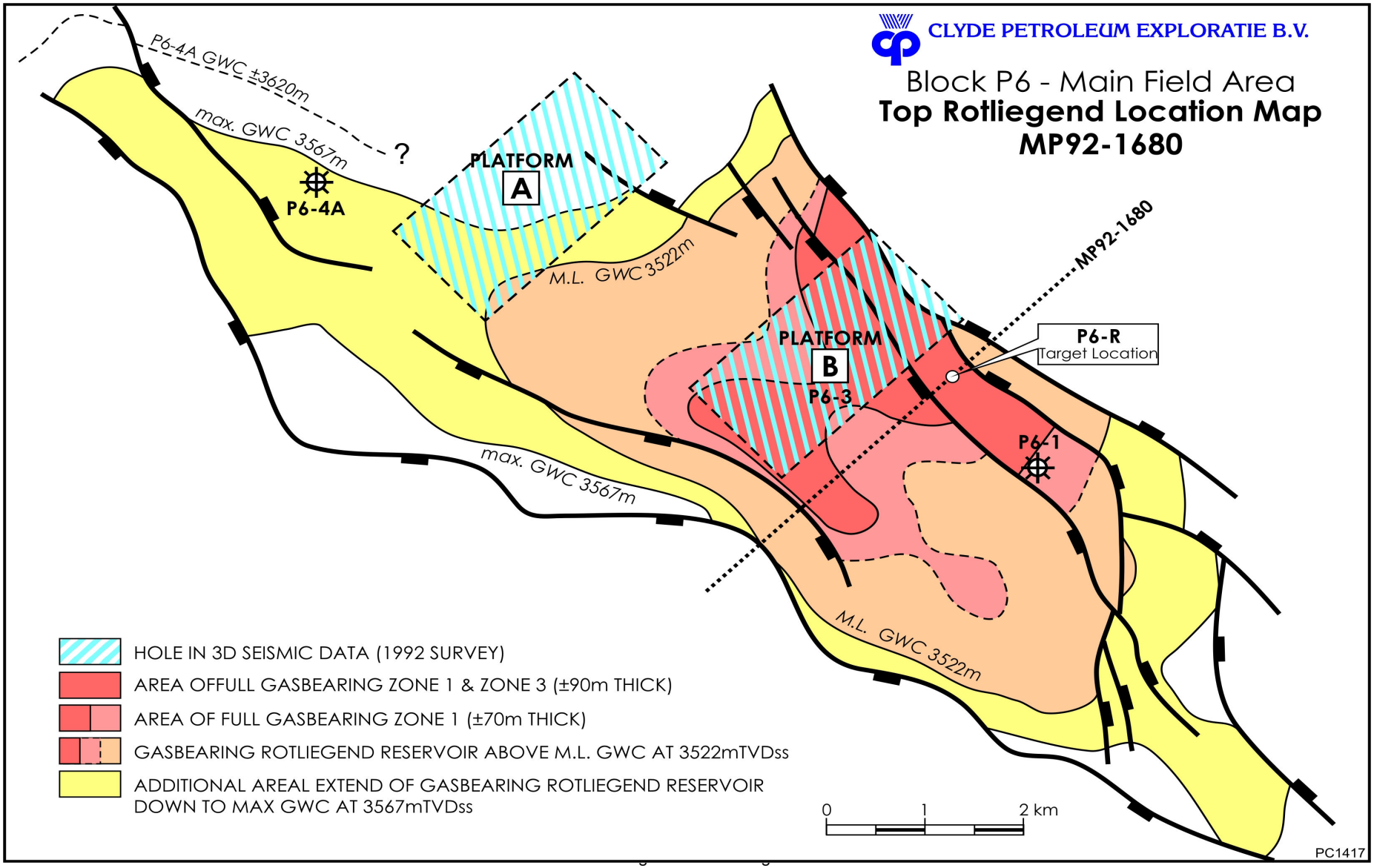
P6-B4 Case History



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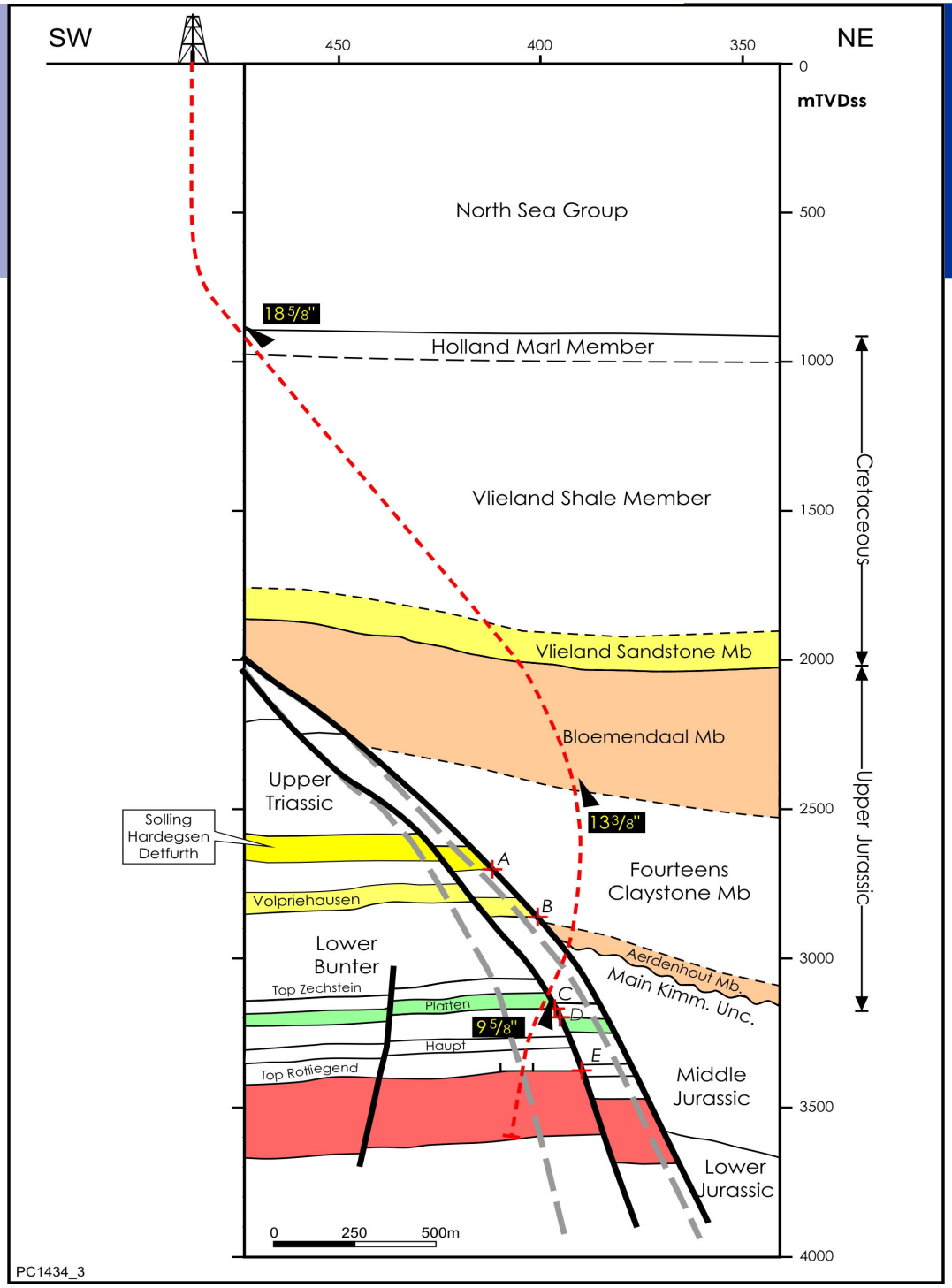
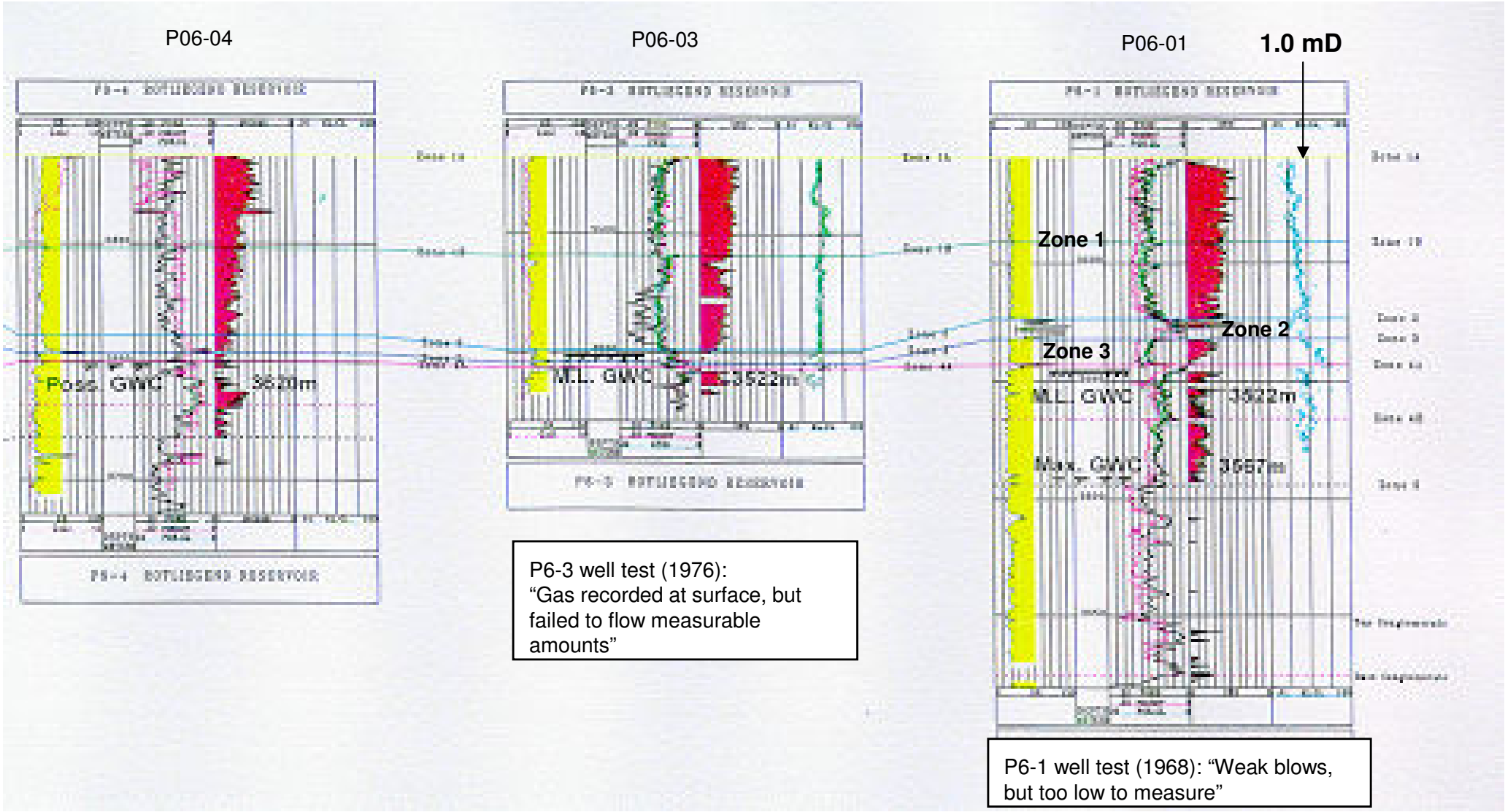
P6-B4 Case History

- Geological cross-section along the P6-B4 well trajectory
  - Complex well path due to depleted Bunter
  - Higher deviation at 9 5/8” shoe for sidetrack horizontal well
  - Less than 10° deviation over reservoir section to optimise hydraulic frac intersection



P6-B4 Case History - Correlation Panel



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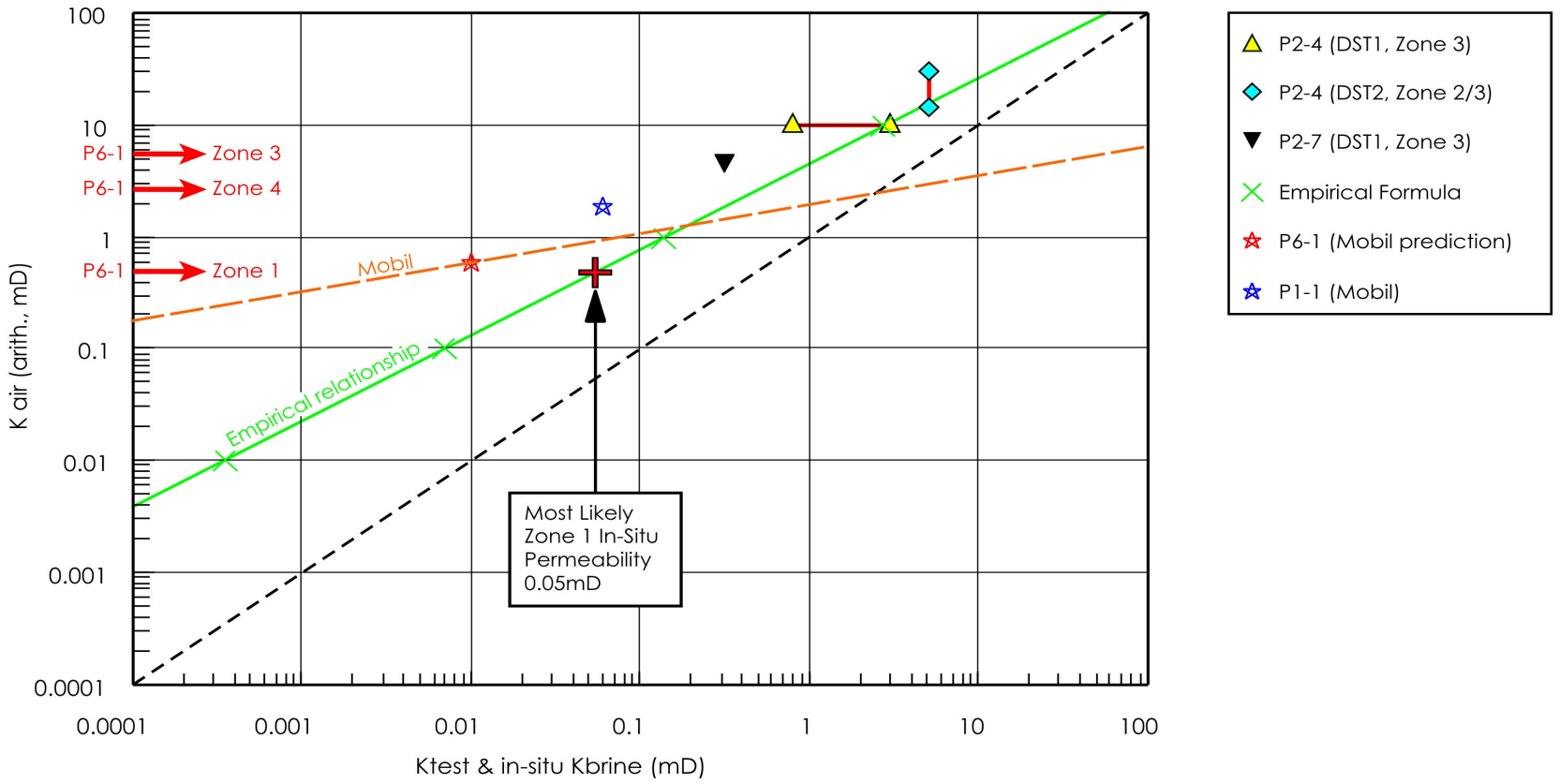
P6-B4 Case History



Rotliegend In-Situ Permeability Correction

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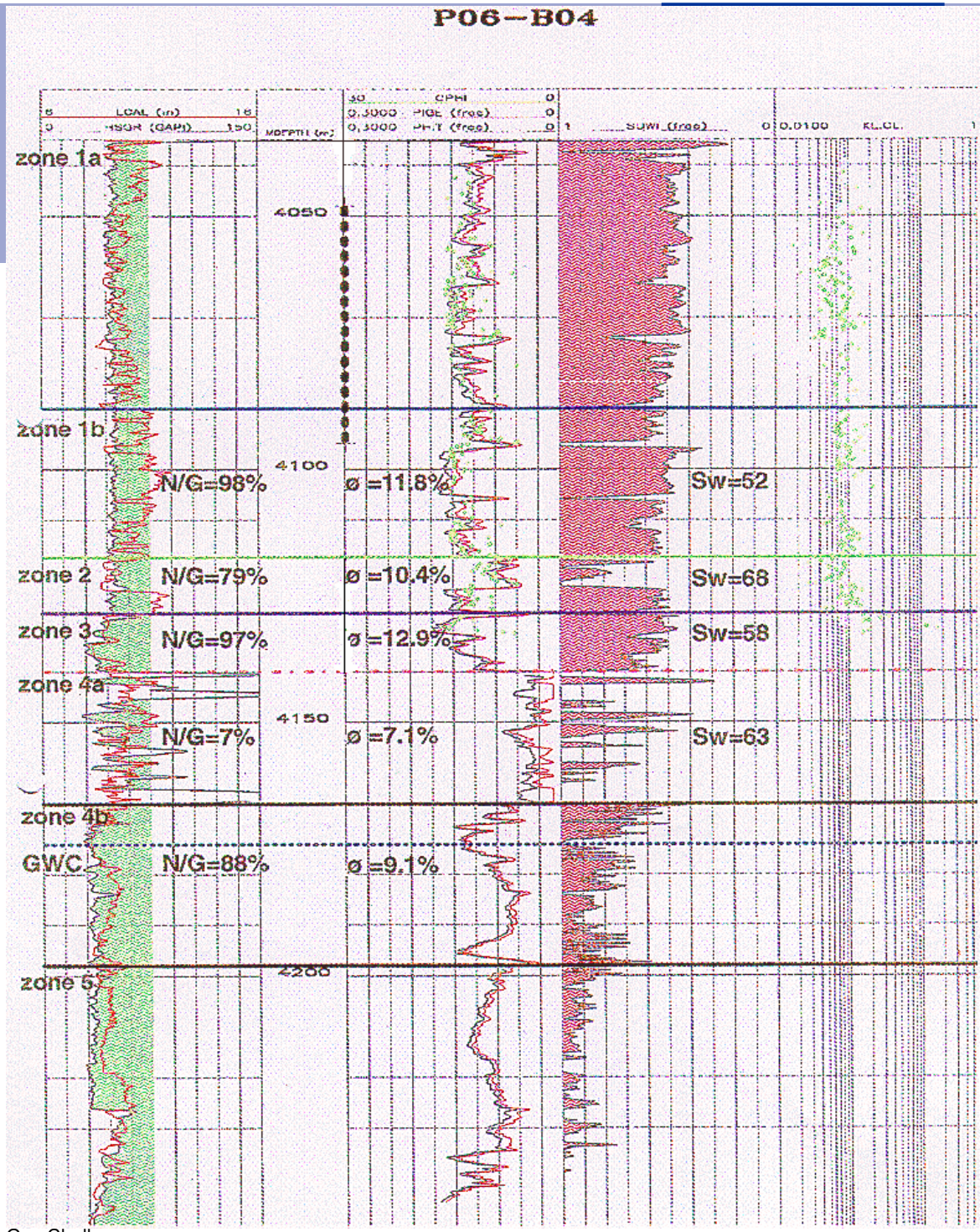
P6-B4 Case History

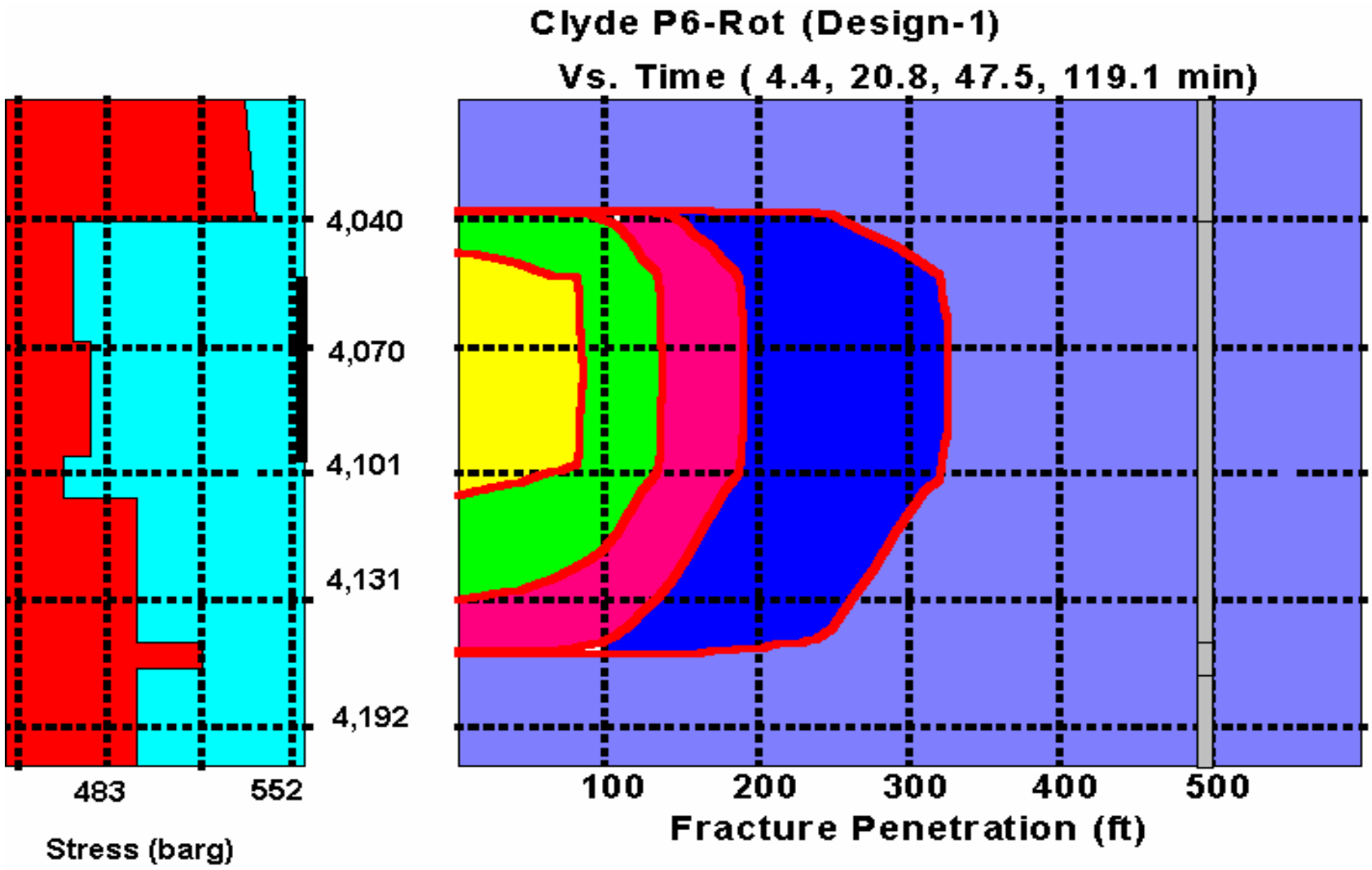
- P6-B4 Rotliegend log evaluation
  - Target zone 3 not similar to P6-1
  - Well came in deeper, which restricted perforation interval to Zone 1
  - Pre-frac well test gave no flow to surface
  - Frac justified by “now or never”



P6-B4 Case History

	Average Core Porosity and Permeability (Lab Condition)							
	P6-4A		P6-3		P6-B4		P6-1	
Reservoir Zone	Ø %	Kair (mD)	Ø %	Kair (mD	Ø %	Kair (mD	Ø %	Kair (mD
1	14.1	0.44	13.9	1.3	12.9	0.15	14.4	0.49
2			10.8	0.95	10.3	0.13	5.2	0.35
3			10.2	1.6	13.2	0.68	14.5	5.3
4			6.1	1.1			9.8	2.7

P6-B4 Case History



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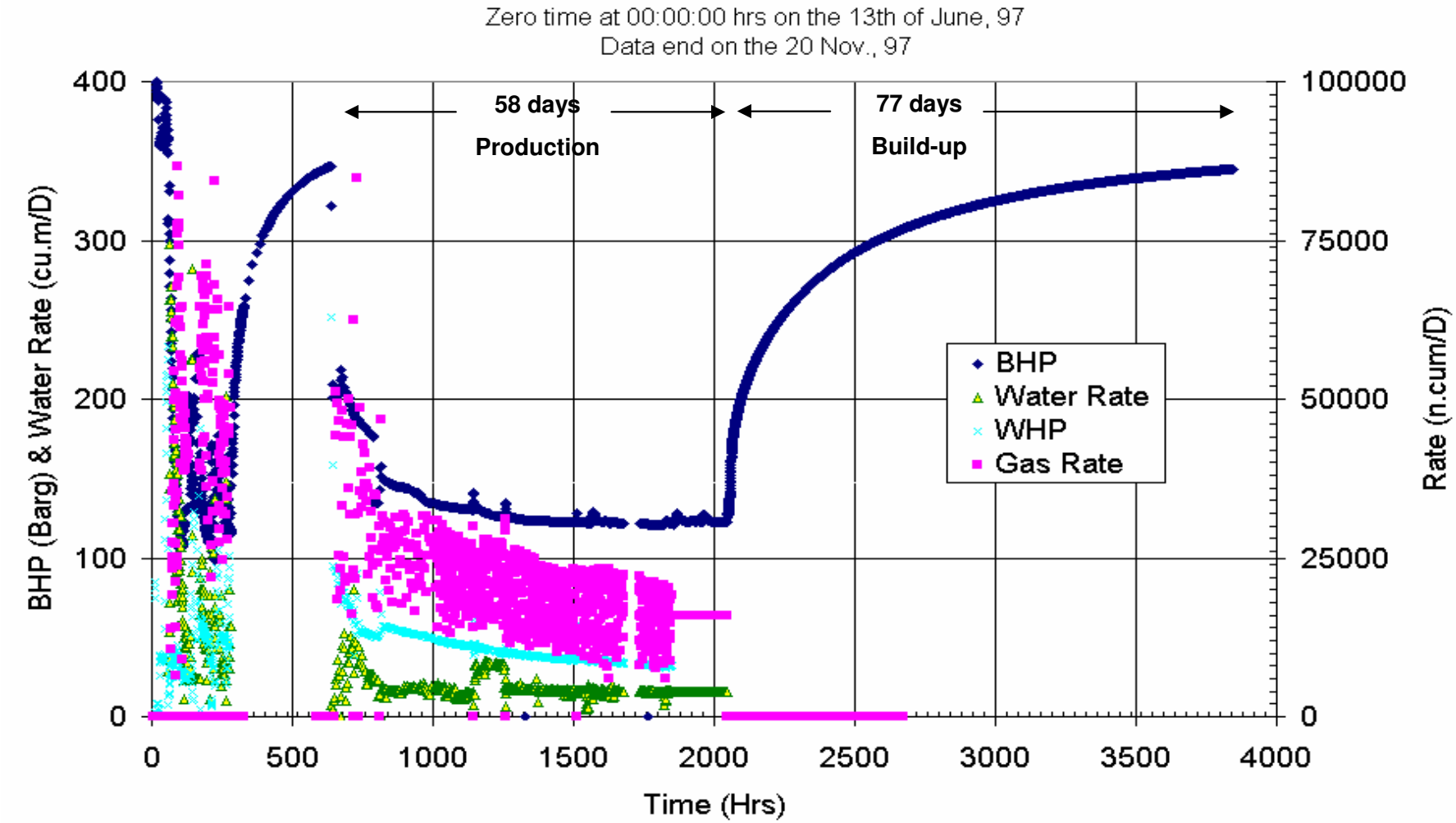
P6-B4 Case History



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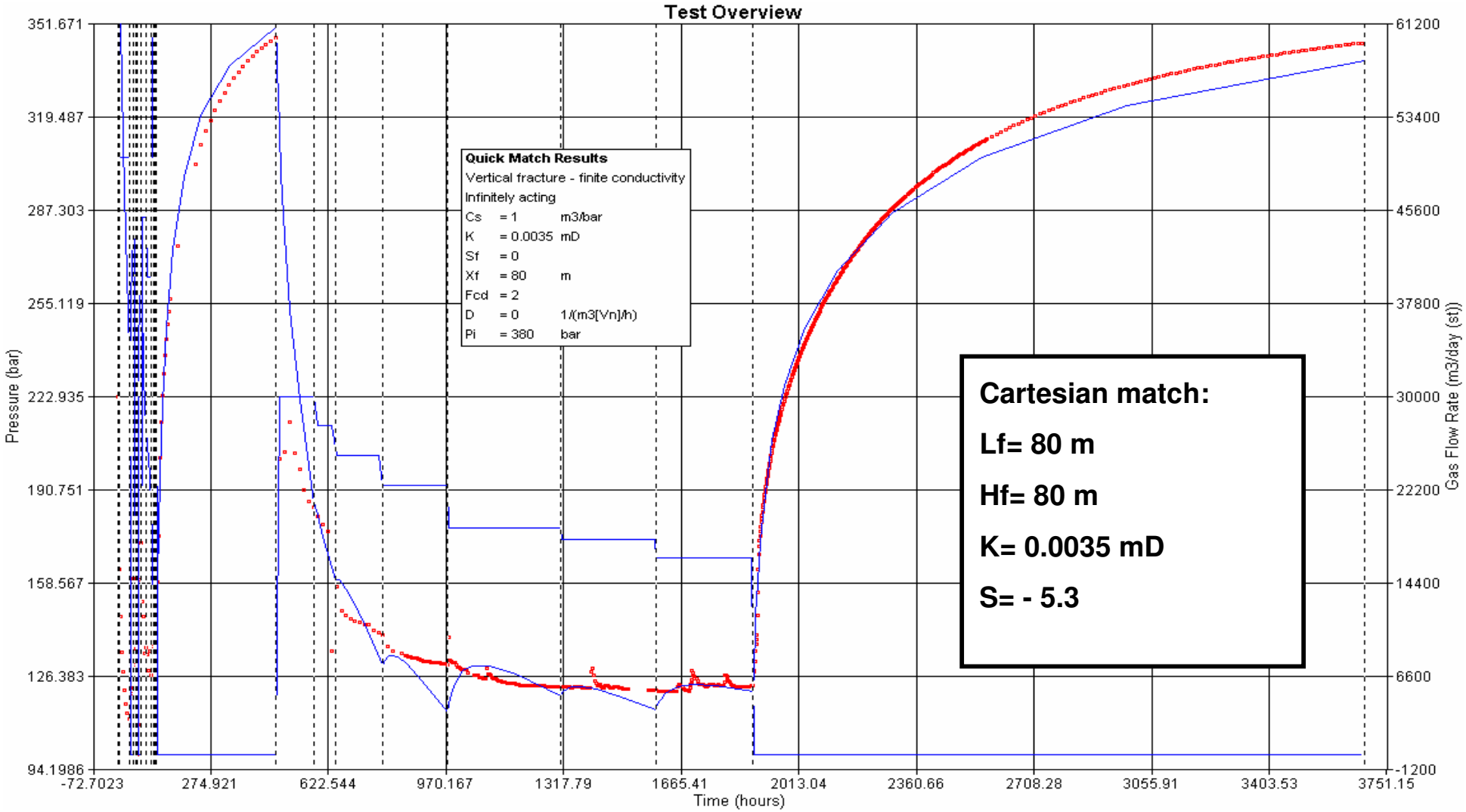
P6-B4 Case History



Some Tight Gas Considerations

- Sometimes tight means really tight
- Wispy illites don’t like frac jobs
- A good understanding of permeability data will hardly reduce the risk in tight gas development
- A long duration well test looks further into the reservoir than any core or log measurement
- For a tight gas development decision you need more data than from one discovery well
- Focus for tight gas development should be on horizontal wells with multiple fracs