OIL MINI-FRAC ANALYSIS

WELL NAME: **COPRC Mirror Lake**
WELL LOCATION:
Bottomhole Location: **300/N-20 65-00 126-45**
Surface.Location: 300/N-20 65-00 126-45
Well License #: **EL 470**

ZONE: **"UPPER" LOWER CANOL**

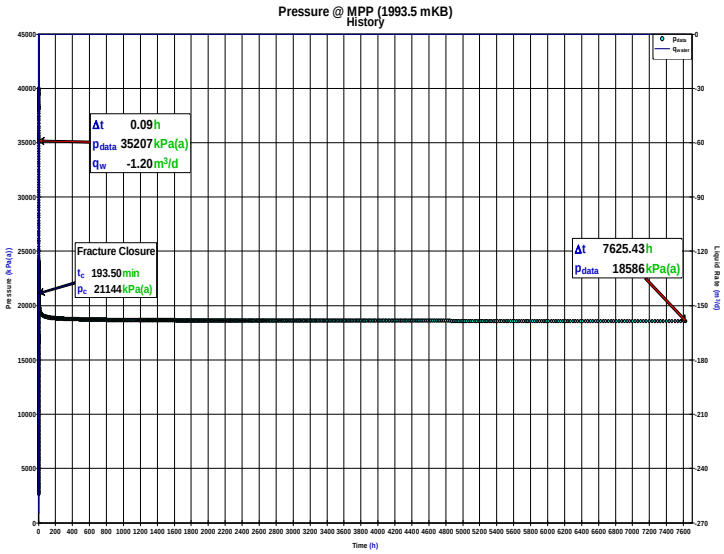
COST CENTRE: **10345530**

TEST DATE: **Mar 28/13 – Feb 9/14**

STAGE OF WELL TEST: **Post-Perf Inj-Falloff**

ORIENTATION: **Vertical**

TYPE/SIZE OF STIMULATION: **N/A**



Reservoir Properties

Injection Interval: 1993 – 1994 mKB		
Frac Height (h): 5 m (Estimate)	Porosity (ϕ): 13 %	Water Saturation (Sw): 14 %
Oil Gravity: 50 °API (Estimate)	H_2S Content: 0 %	BHT: 87.0 °C

Injection Data

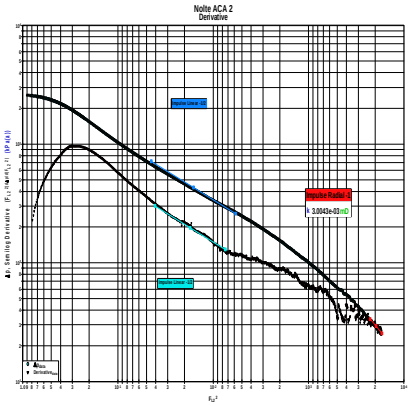
Test	Time	Final Rates				Final Pressures		
		Gas	New Oil	New H_2O	Load	Tubing	Casing	BHP
	Hours	e^3m^3/d	m^3/d	m^3/d	m^3/d	kPag	kPag	kPaa
Injection	0.1	---	---	---	1.2	N/A	0	35207
Shut-In	7625.4	---	---	---	0	N/A	0	18586

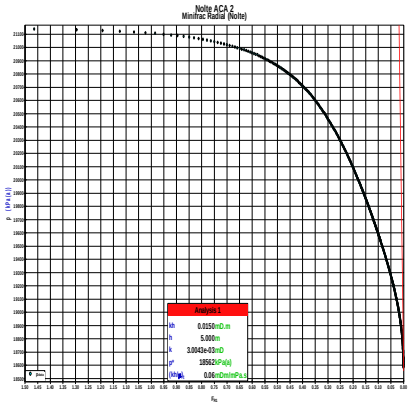
Injection Summary

New Fluid (m^3)				Load Fluid (m^3)		Remaining Load (m^3)	
Gas (E^3M^3)	Gas (MSCF)	Cond (m^3)	Water (m^3)	Oil (m^3)	Water (m^3)	Oil (m^3)	Water (m^3)
---	---	---	---	0	0.49	0	0.49

Pressure Transient Analysis Results Summary

Analysis Results	
P*	**18562 kPaa**
$(kh/\mu)_o$	**0.06 mD·m/mPa·s**
$(kh)_o$	**0.015 mD·m**
k_o	**0.003 mD**





Discussion

Test Procedure:

Segregated post-perf mini-frac tests were conducted on the "Basal" and "Middle" LOWER CANOL intervals. The mini-frac tests were conducted concurrently and as such, each interval was isolated below bridge plugs. On Mar 28th, 2013, the "Upper" LOWER CANOL interval was perforated. A retrievable bridge plug, with tandem electronic recorders hung below, was run in hole (center element at 1990 mKB). Fluid (70% Propylene Glycol / 30%) injection was initiated to achieve formation breakdown. Injection continued for several more minutes after breakdown, including for a brief period after the bridge plug setting mechanism was activated (dynamically set). The final water injection rate prior to shut-in was reported to be 1.2 m^3/d (0.8 l/min). The subsequent falloff was monitored for about 11 months (~7625 hrs). On Feb 15th, 2014, the bridge plug (including the recorders) was unset and recovered. The primary objectives of the mini-frac test were to obtain frac design and reservoir flow parameters. It is noted that the analyses / results for each of the zones have been provided in separate reports.

The test data (injection & falloff) from the subject test was corrected to the mid-point of the perforations (MPP=2023.5 mKB) using an estimated water gradient of 10 kP/m.

Analysis:

The mini-frac test data was analyzed using traditional techniques. Diagnostic plots, such as the G-Function & Sqrt (t) plots, were utilized first to confirm the occurrence of fracture closure. For the subject zone, the diagnostic plots indicated closure at about 3.2 hours (or ~193.5 minutes) of shut-in. Although the data was slightly noisy, the derivative plot suggested evidence of pseudo-radial flow. Consequently, after-closure analysis, via Nolte & Soliman / Craig techniques, was conducted in order to obtain estimates for reservoir parameters. The corresponding results / plots have been presented in this report.

Conclusions / Recommendations:

The test was successful in satisfying the primary objectives set forth at the onset of the test program. The test results suggested an effective permeability to oil of 0.003 mD (3 µD). However, it is noted that this oil permeability was calculated based on estimated values for frac height (5 m) & oil viscosity (50 °API oil with a viscosity of 0.26 mPa·s).

The corresponding extrapolated reservoir pressure was determined to be about 18.6 MPaa.

The overall confidence of the test results is considered to be fair.

Analyzed by: **Al Kassam** **Report Date: Mar 20th, 2014**

Copy: **Kim Clarke** **Alex Novgorodova** **Well File**

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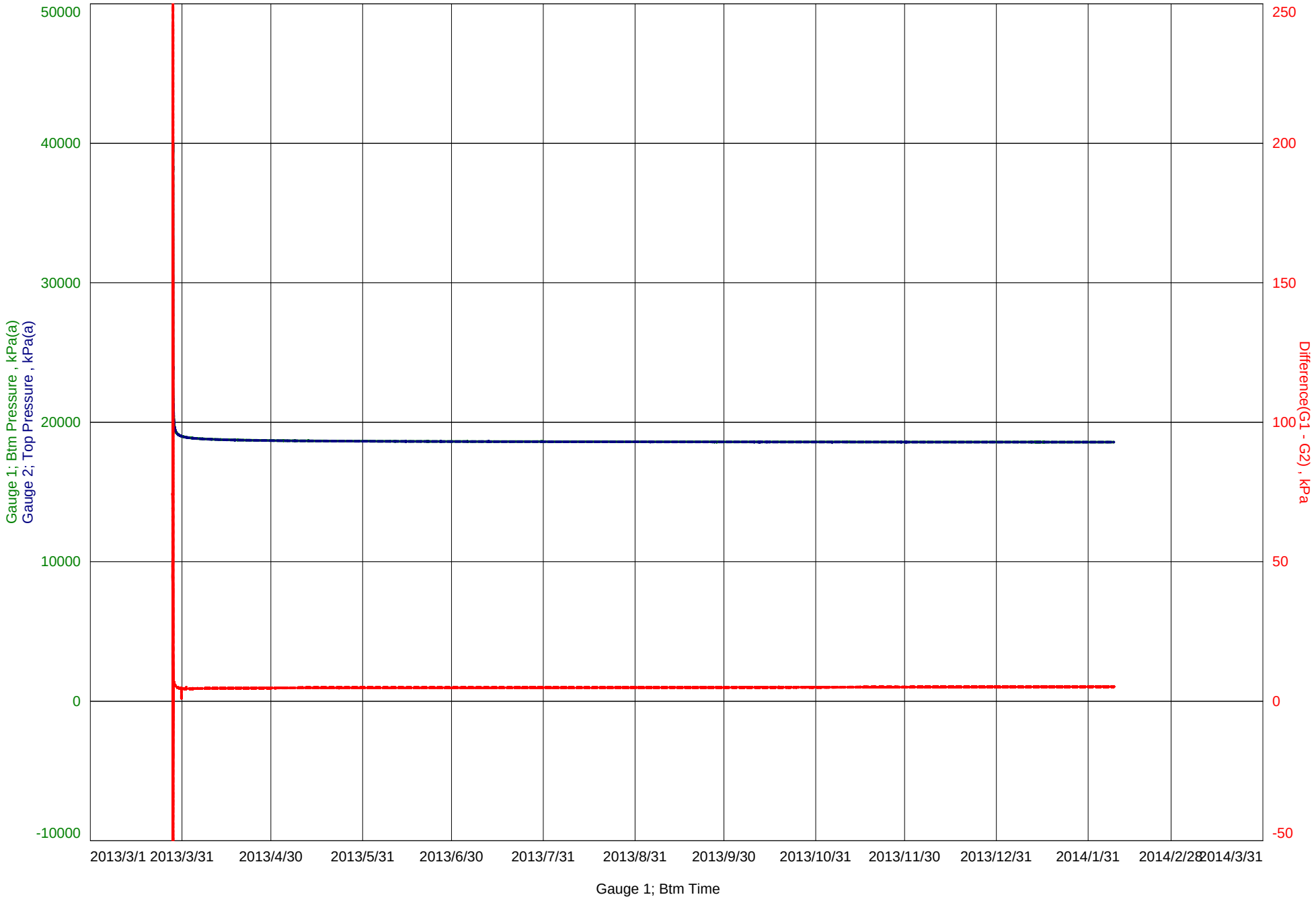
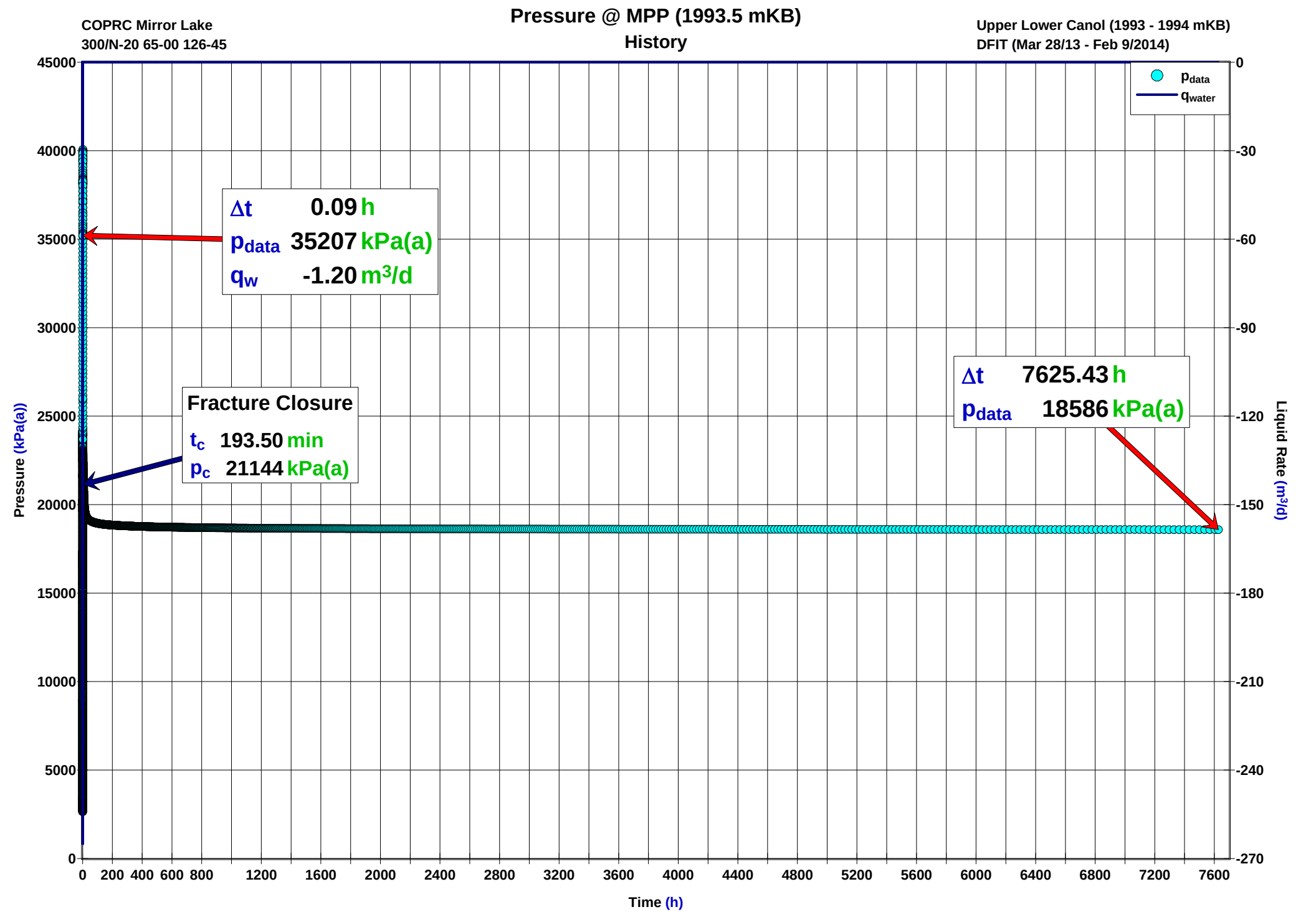
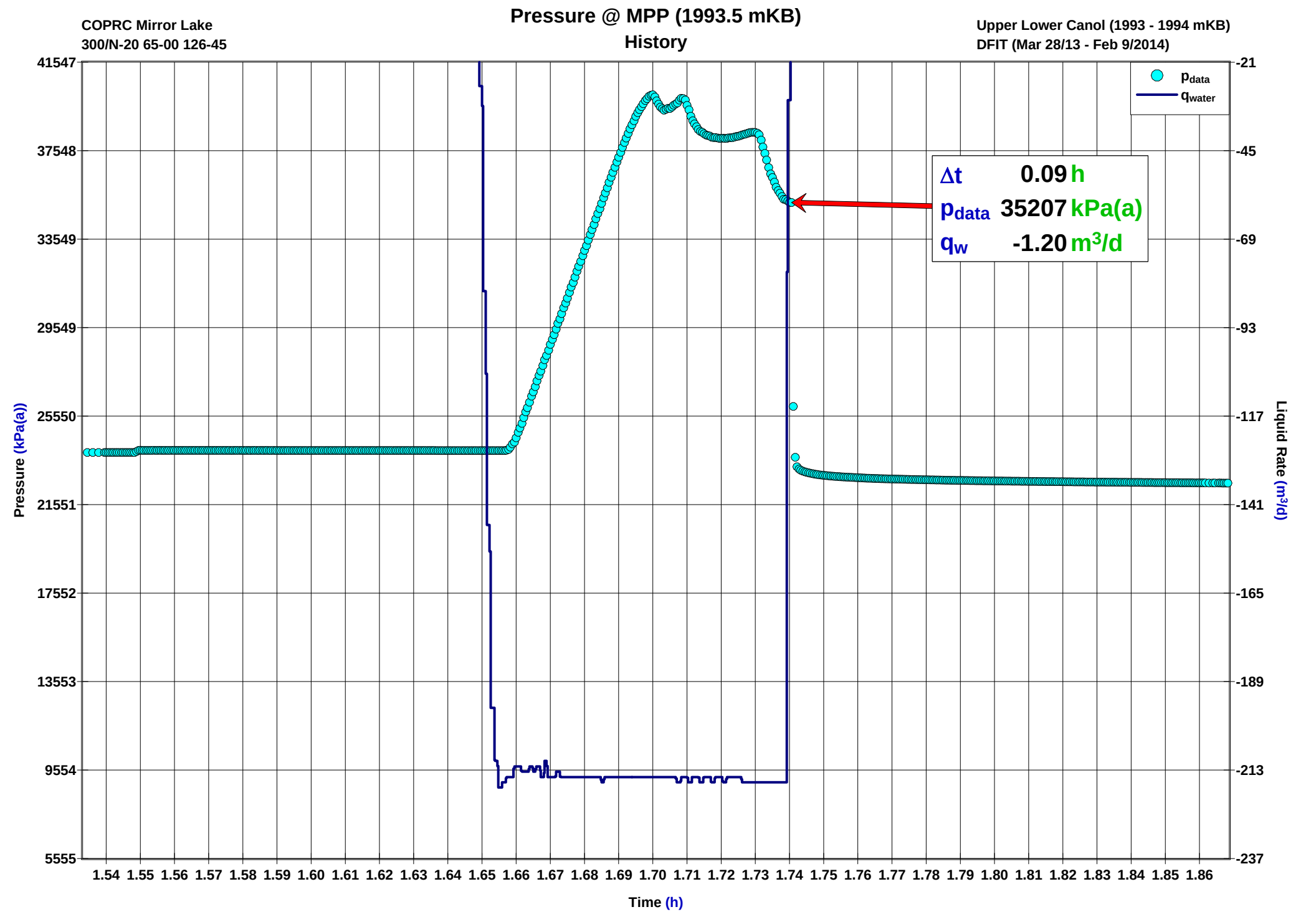
Recorder Data Plot

Formation: Upper Lower Canol




COPRC Mirror Lake
300/N-20 65-00 126-45
Pressure @ MPP (1993.5 mKB)
History
Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)
pdata
qwater
Δt 0.09 h
pdata 35207 kPa(a)
qw -1.20 m3/d
Fracture Closure
tc 193.50 min
pc 21144 kPa(a)
Δt 7625.43 h
pdata 18586 kPa(a)
Pressure (kPa(a))
Liquid Rate (m3/d)
Time (h)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-30
-60
-90
-120
-150
-180
-210
-240
-270
0 200 400 600 800 1200 1600 2000 2400 2800 3200 3600 4000 4400 4800 5200 5600 6000 6400 6800 7200 7600


Pressure @ MPP (1993.5 mKB)
History
COPRC Mirror Lake
300/N-20 65-00 126-45
Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)
pdata
qwater
Δt 0.09 h
pdata 35207 kPa(a)
qw -1.20 m3/d
Pressure (kPa(a))
Liquid Rate (m3/d)
Time (h)
41547
37548
33549
29549
25550
21551
17552
13553
9554
5555
-21
-45
-69
-93
-117
-141
-165
-189
-213
-237
1.54 1.55 1.56 1.57 1.58 1.59 1.60 1.61 1.62 1.63 1.64 1.65 1.66 1.67 1.68 1.69 1.70 1.71 1.72 1.73 1.74 1.75 1.76 1.77 1.78 1.79 1.80 1.81 1.82 1.83 1.84 1.85 1.86

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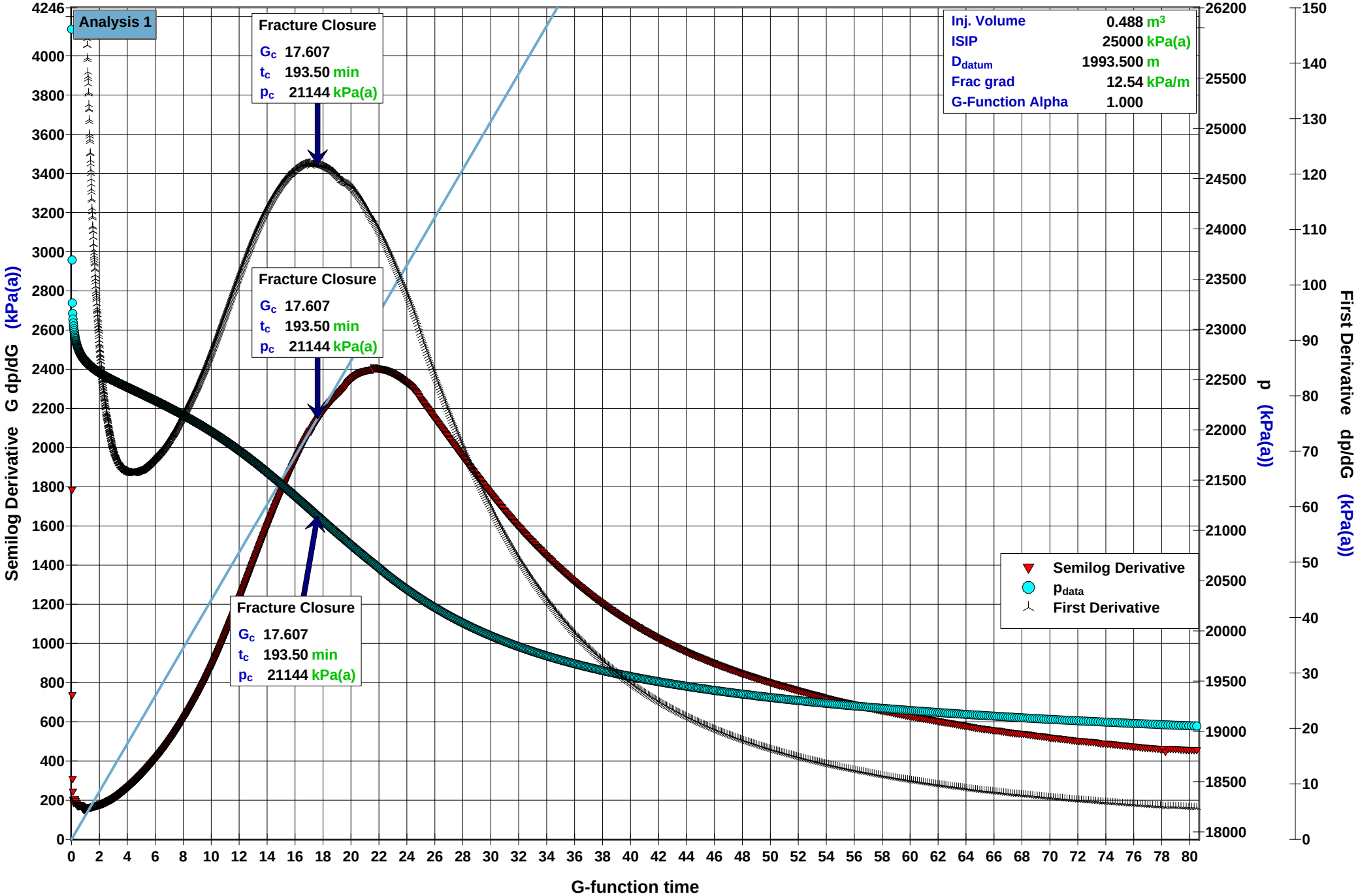
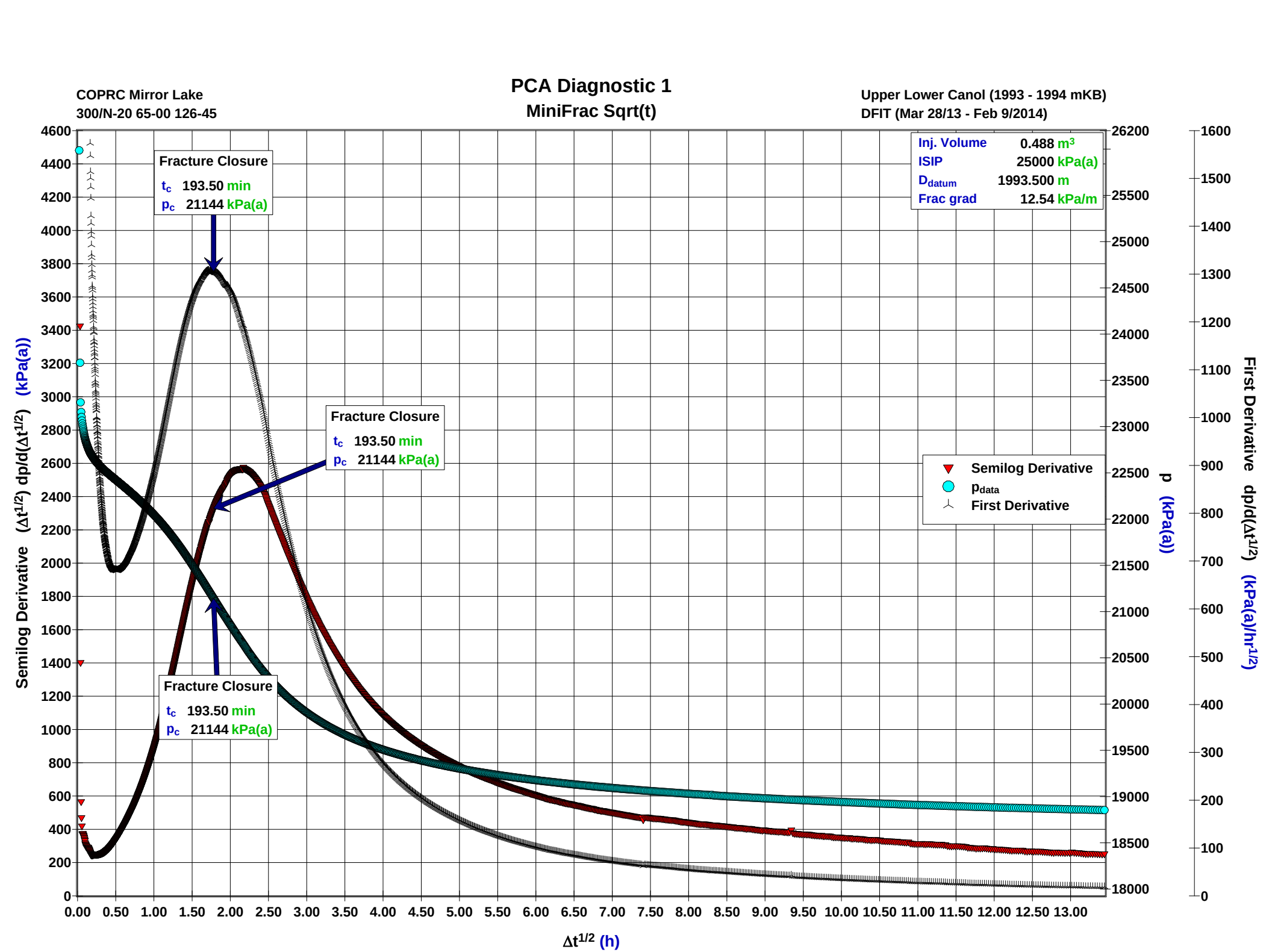
PCA Diagnostic 1
G-Function

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)

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PCA Diagnostic 1
MiniFrac Sqrt(t)
Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)
Inj. Volume 0.488 m3
ISIP 25000 kPa(a)
Ddatum 1993.500 m
Frac grad 12.54 kPa/m
Fracture Closure
tc 193.50 min
pc 21144 kPa(a)
Fracture Closure
tc 193.50 min
pc 21144 kPa(a)
Fracture Closure
tc 193.50 min
pc 21144 kPa(a)
Semilog Derivative
pdata
First Derivative
Semilog Derivative (Δt1/2) dp/d(Δt1/2) (kPa(a))
p (kPa(a))
First Derivative dp/d(Δt1/2) (kPa(a)/hr1/2)
Δt1/2 (h)

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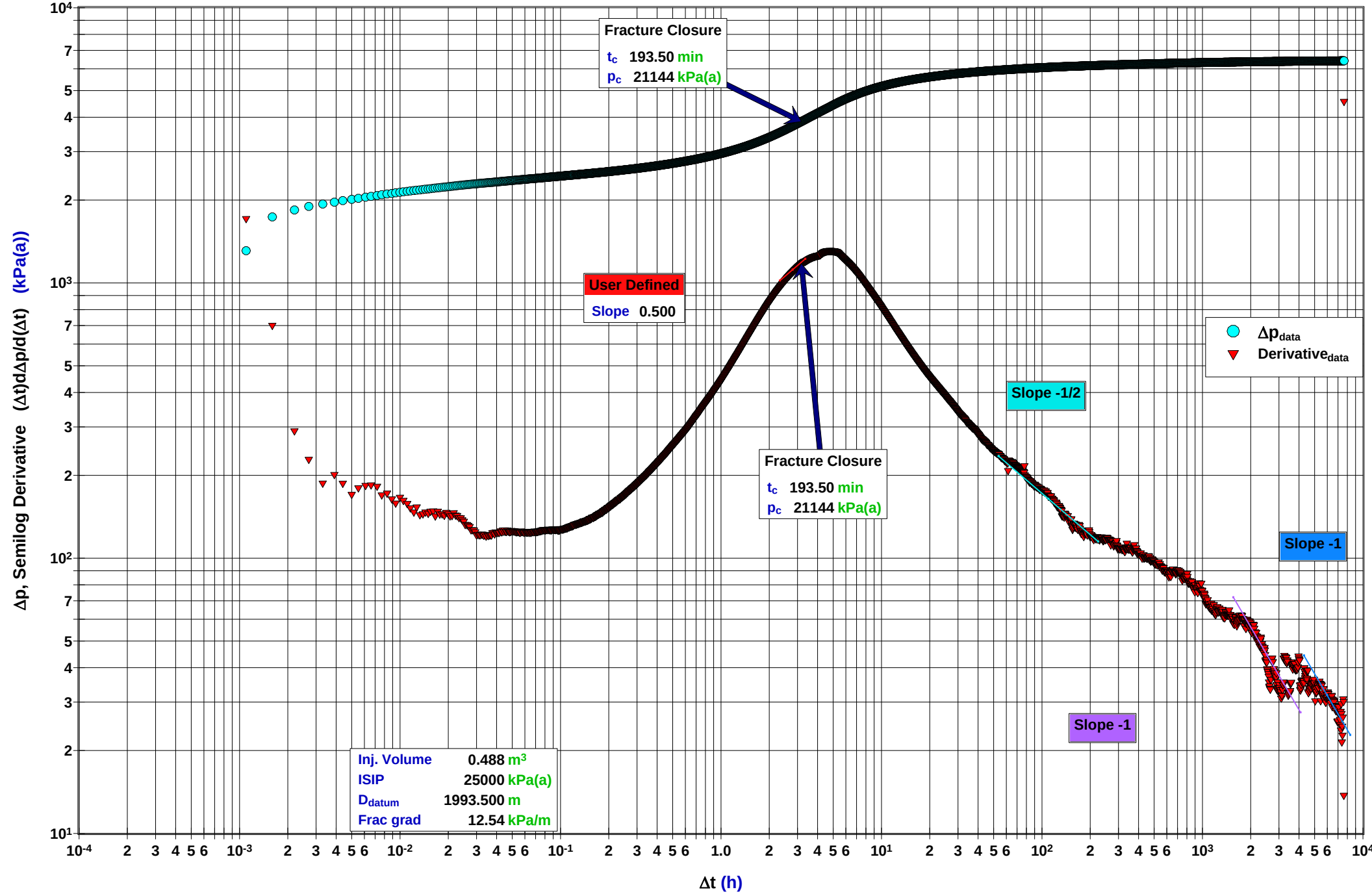
PCA Diagnostic 1
Derivative

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



PCA Diagnostic 1

Input Data

Injected Volume	0.488 m^3
Datum Depth	1993.500 m

Results

ISIP	25000 kPa(a)
Fracture Gradient	12.54 kPa/m

Closure Marker 1

Closure time (t_c)	3.2250 h
Closure pressure (p_c)	21144 kPa(a)
Net Frac Press (Δp_{net})	3856 kPa
G-Function at Closure (G_c)	17.607
Fluid Efficiency (η)	89.80 %

Closure Marker 2

Closure time (t_c)	3.2250 h
Closure pressure (p_c)	21144 kPa(a)
Net Frac Press (Δp_{net})	3856 kPa
G-Function at Closure (G_c)	17.607
Fluid Efficiency (η)	89.80 %

Fluid Properties

Oil Gravity (γ_o)	49.9 °API
Bubble Point Pressure (p_{bp})	18573 kPa(a)
Oil Formation Volume Factor (B_o)	1.522
Oil Viscosity (μ_o)	0.2645 mPa.s
Oil Compressibility (c_o)	3.2194e-06 1/kPa
Solution Gas Ratio (R_s)	152.70 m^3/m^3

Reservoir Properties

Reservoir Temperature (T_{resv})	87.0 °C
Reservoir Pressure (p_{resv})	18580 kPa(a)

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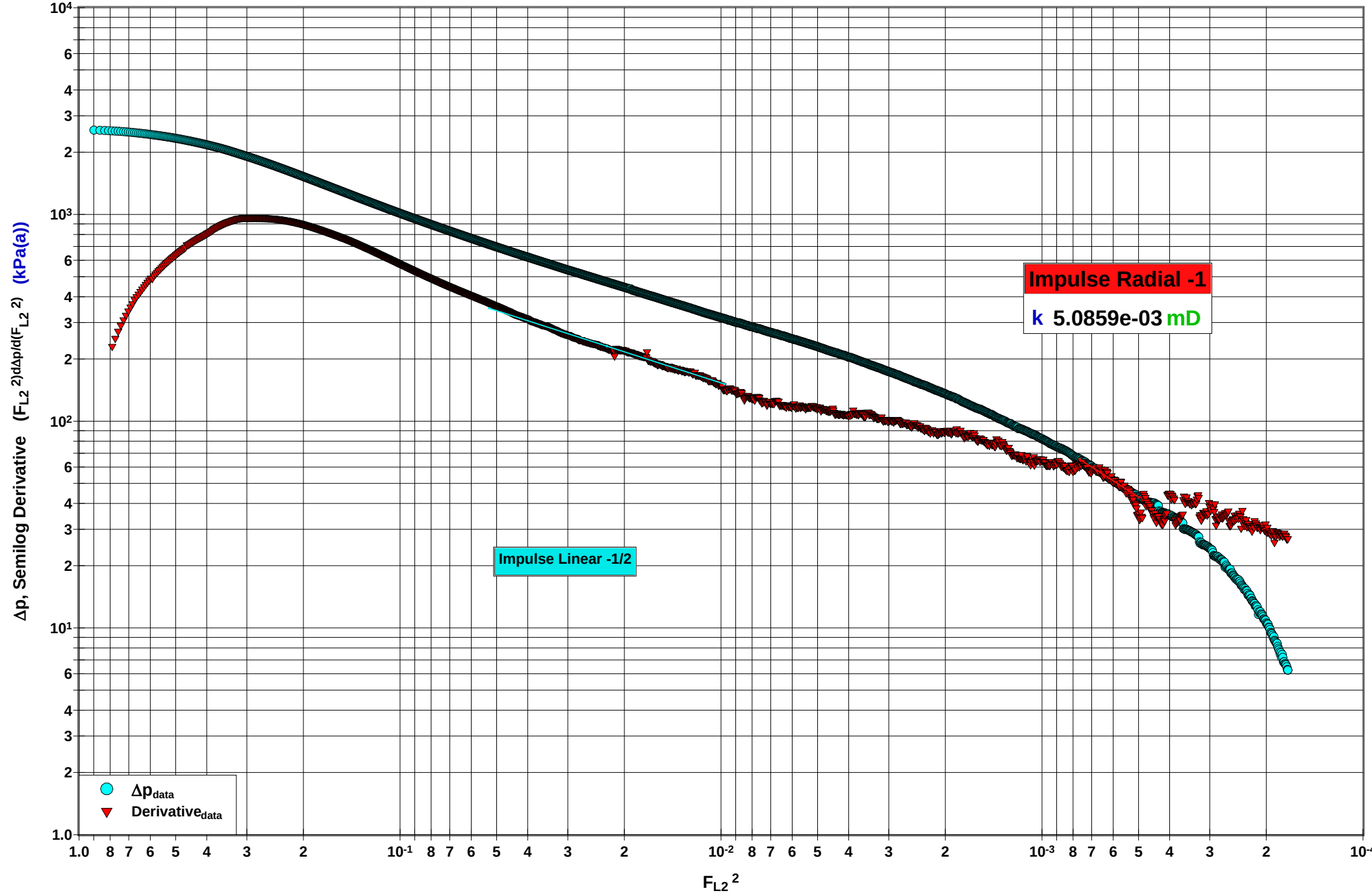
Nolte ACA 1
Derivative

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



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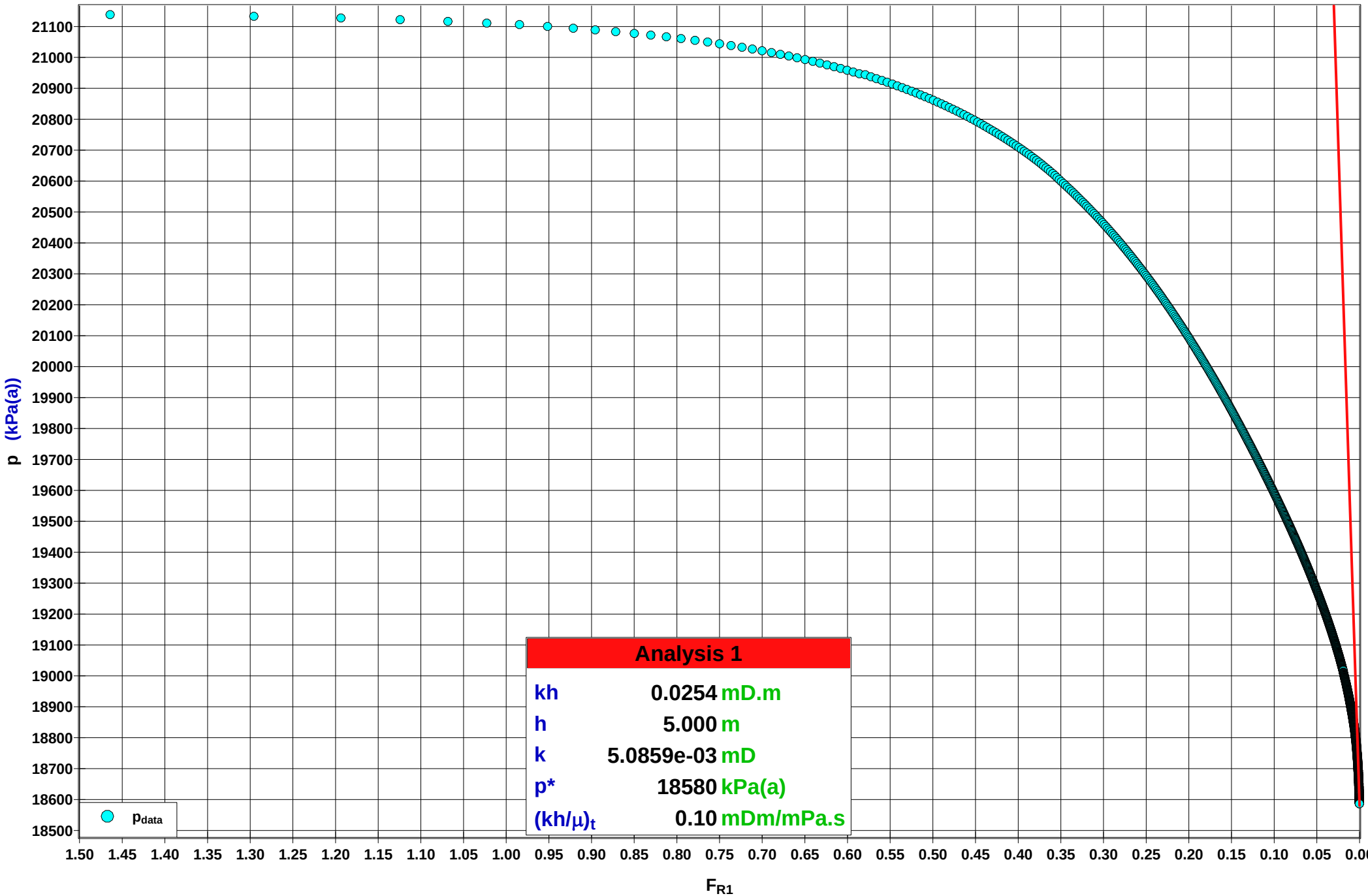
Nolte ACA 1
Minifrac Radial (Nolte)

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



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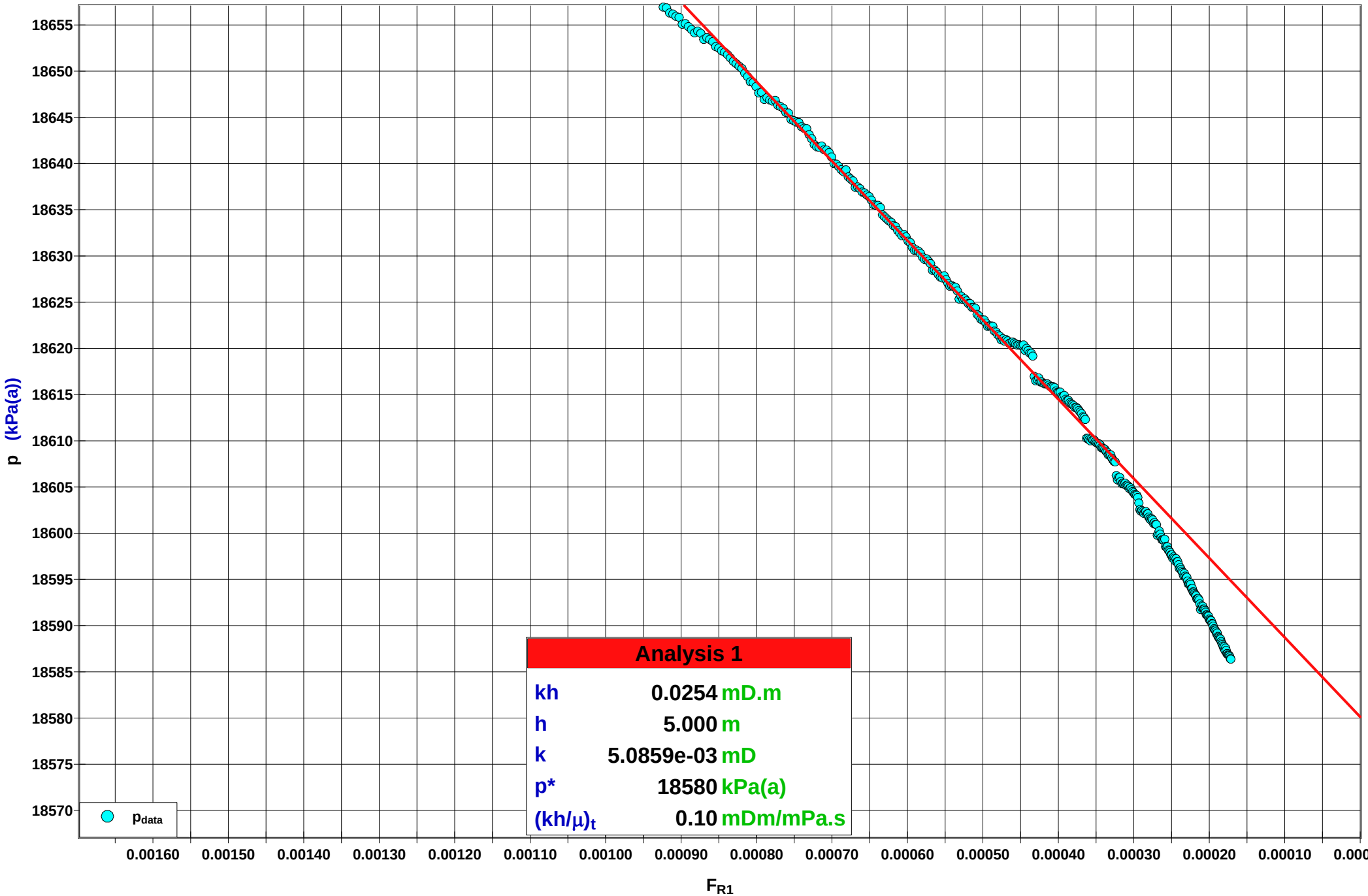
Nolte ACA 1
Minifrac Radial (Nolte)

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



Nolte ACA 1

Linear Analysis (FL)

Flow Capacity (kh)		mD.m
Effective Permeability (k)		mD
Extrapolated Pressure (p*)	18588	kPa(a)
Closure Pressure (pc)		kPa(a)
Reservoir Leakoff Coefficient (CR)		$m/min^{1/2}$
Total Leakoff Coefficient (CT)		$m/min^{1/2}$

Radial Analysis (FR)

Flow Capacity (kh)	0.0254	mD.m
Effective Permeability (k)	5.0859e-03	mD
Extrapolated Pressure (p*)	18580	kPa(a)

Input Parameters

Estimated Initial Pressure (p_i)	18580	kPa(a)
Closure time (t_c)	193.50	min

Fluid Properties

Oil Gravity (γ_o)	49.9	°API
Bubble Point Pressure (p_{bp})	18573	kPa(a)
Oil Formation Volume Factor (B_o)	1.522	
Oil Viscosity (μ_o)	0.2645	mPa.s
Oil Compressibility (c_o)	3.2194e-06	1/kPa
Solution Gas Ratio (R_s)	152.70	m^3/m^3

Reservoir Properties

Reservoir Temperature (T_{resv})	87.0	°C
Reservoir Pressure (p_{resv})	18580	kPa(a)
Net Pay (h)	5.000	m
Total Porosity (ϕ_t)	13.00	%
Gas Saturation (S_g)	0.00	%
Oil Saturation (S_o)	86.00	%
Water Saturation (S_w)	14.00	%
Formation Compressibility (c_f)	6.3246e-07	1/kPa
Total Compressibility (c_t)	3.4634e-06	1/kPa

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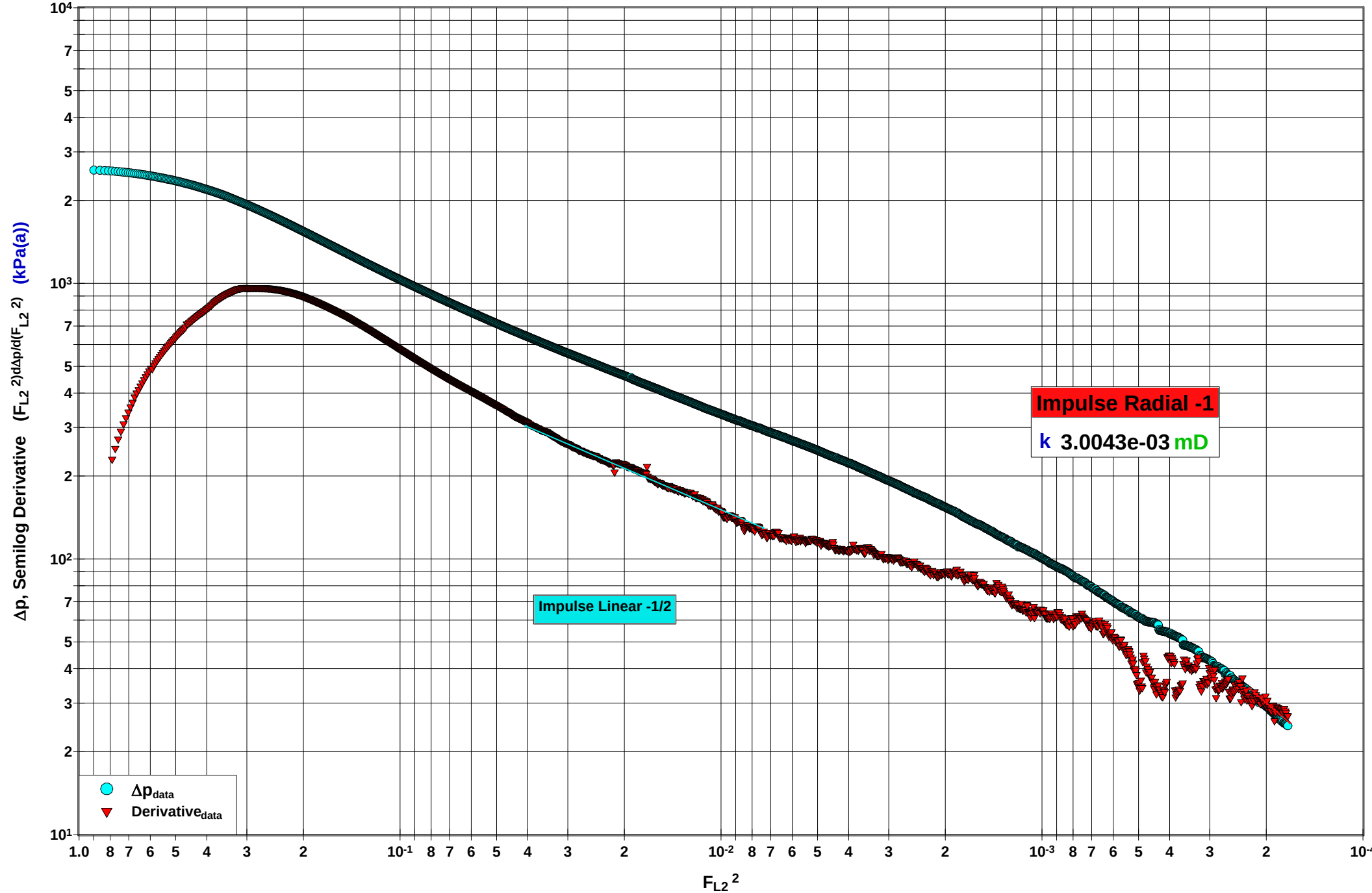
Nolte ACA 2
Derivative

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



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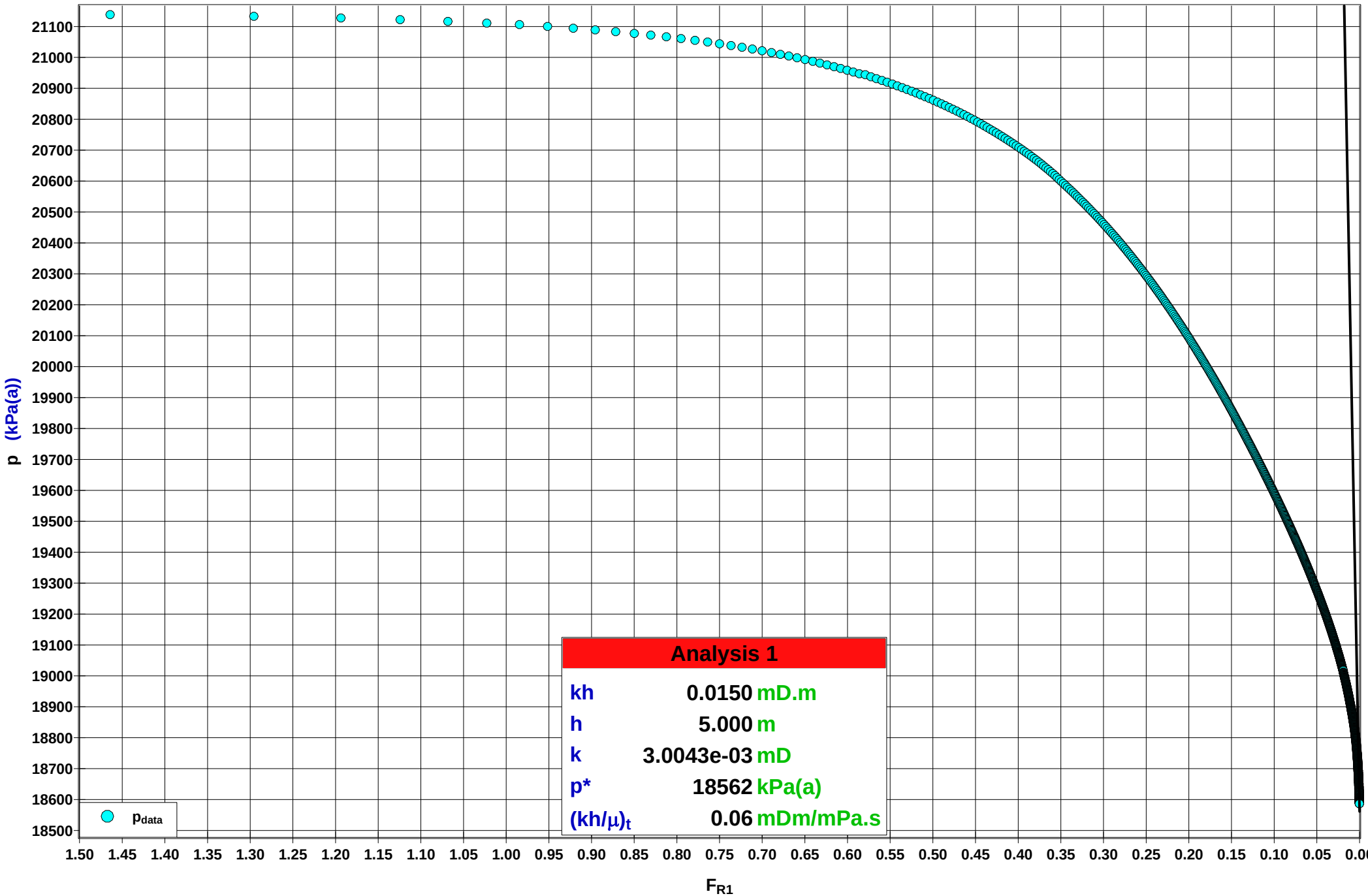
Nolte ACA 2
Minifrac Radial (Nolte)

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



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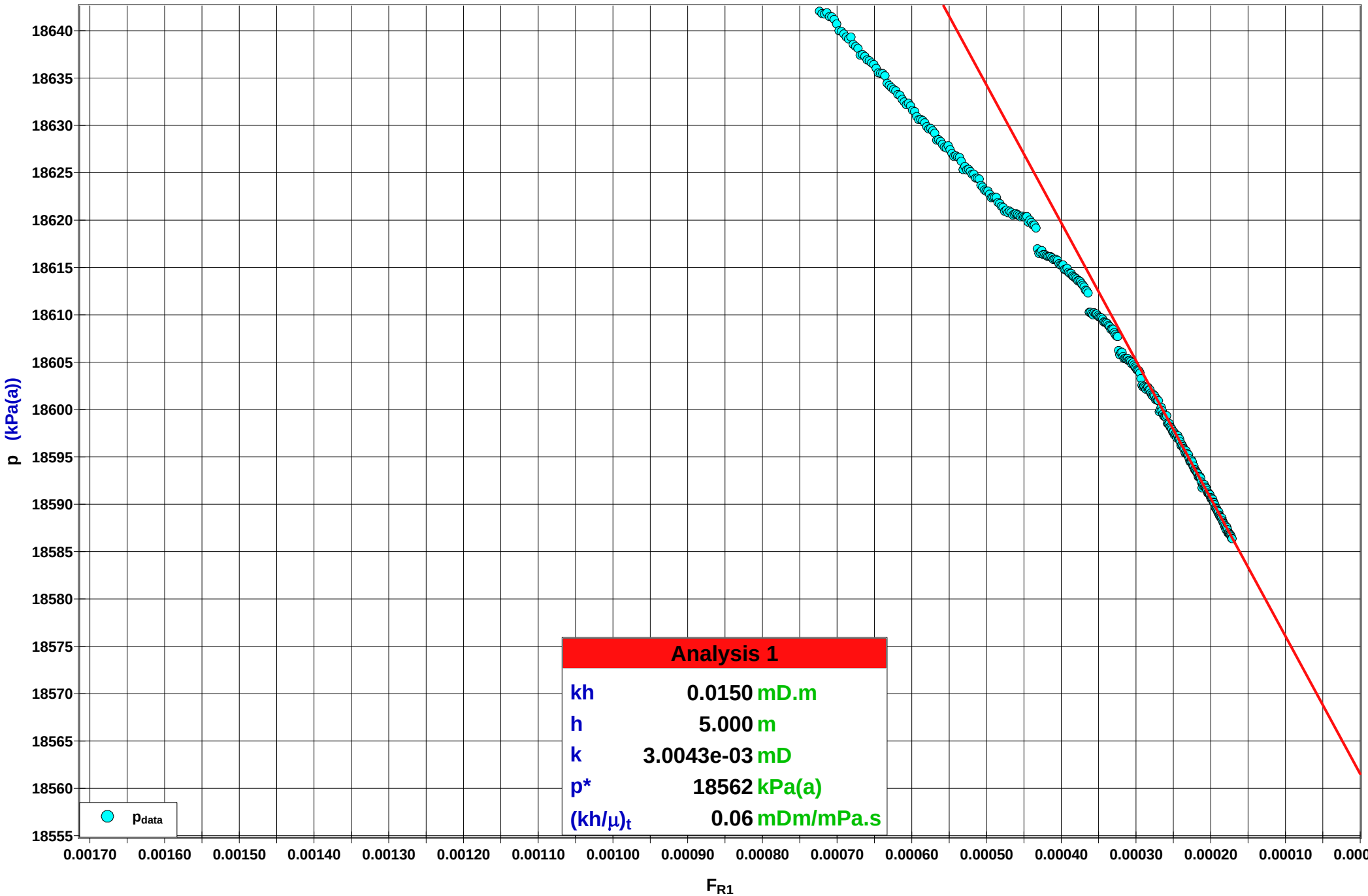
Nolte ACA 2
Minifrac Radial (Nolte)

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



Nolte ACA 2

Linear Analysis (FL)

Flow Capacity (kh)		mD.m
Effective Permeability (k)		mD
Extrapolated Pressure (p*)	18588	kPa(a)
Closure Pressure (pc)		kPa(a)
Reservoir Leakoff Coefficient (CR)		$m/min^{1/2}$
Total Leakoff Coefficient (CT)		$m/min^{1/2}$

Radial Analysis (FR)

Flow Capacity (kh)	0.0254	mD.m
Effective Permeability (k)	5.0859e-03	mD
Extrapolated Pressure (p*)	18580	kPa(a)

Input Parameters

Estimated Initial Pressure (p_i)	18562	kPa(a)
Closure time (t_c)	193.50	min

Fluid Properties

Oil Gravity (γ_o)	49.9	°API
Bubble Point Pressure (p_{bp})	18573	kPa(a)
Oil Formation Volume Factor (B_o)	1.522	
Oil Viscosity (μ_o)	0.2645	mPa.s
Oil Compressibility (c_o)	3.2194e-06	1/kPa
Solution Gas Ratio (R_s)	152.70	m^3/m^3

Reservoir Properties

Reservoir Temperature (T_{resv})	87.0	°C
Reservoir Pressure (p_{resv})	18580	kPa(a)
Net Pay (h)	5.000	m
Total Porosity (ϕ_t)	13.00	%
Gas Saturation (S_g)	0.00	%
Oil Saturation (S_o)	86.00	%
Water Saturation (S_w)	14.00	%
Formation Compressibility (c_f)	6.3246e-07	1/kPa
Total Compressibility (c_t)	3.4634e-06	1/kPa

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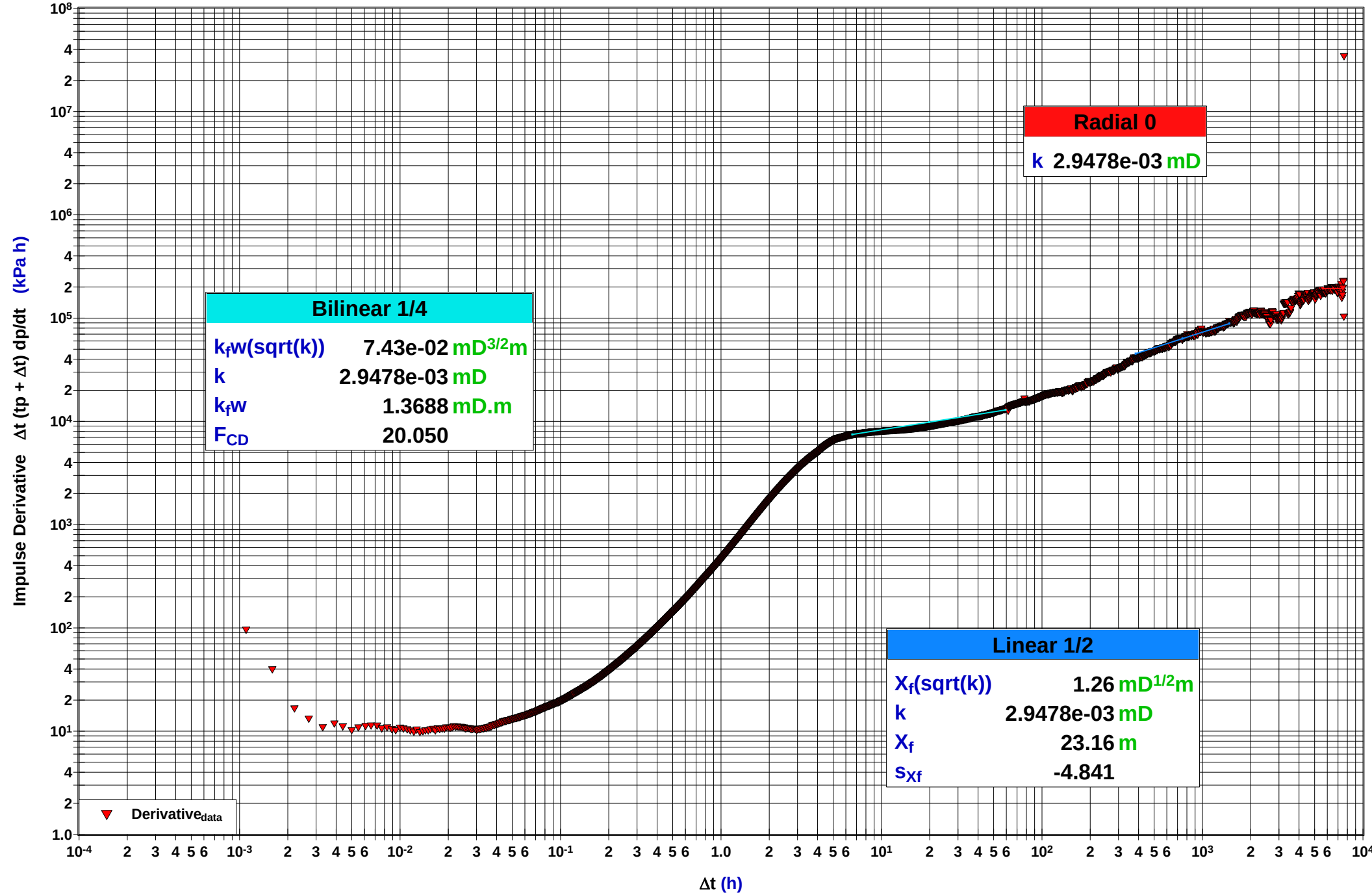
Soliman/Craig ACA 1
Derivative

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



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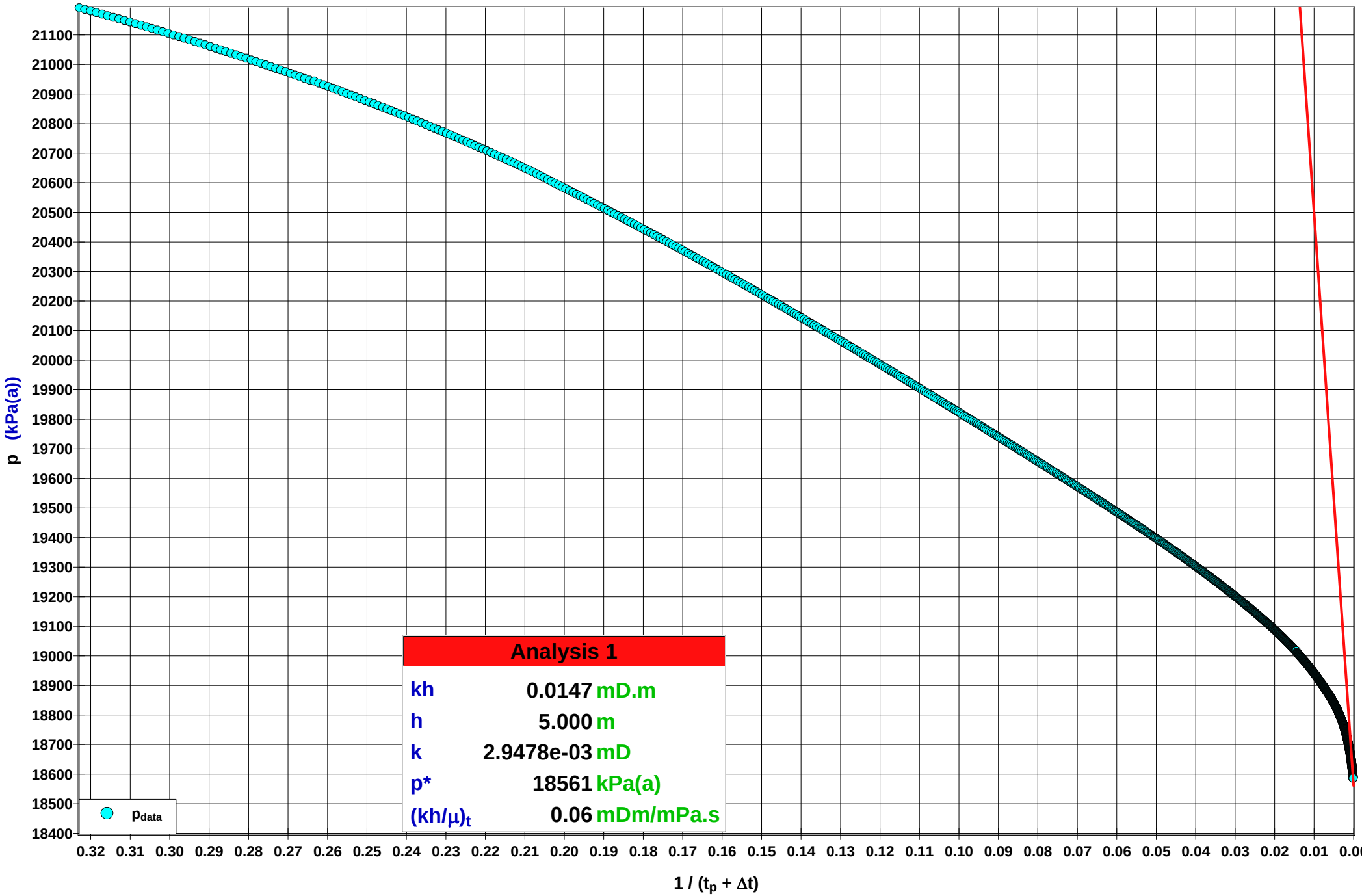
Soliman/Craig ACA 1
Minifrac Radial (Soliman-Craig)

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



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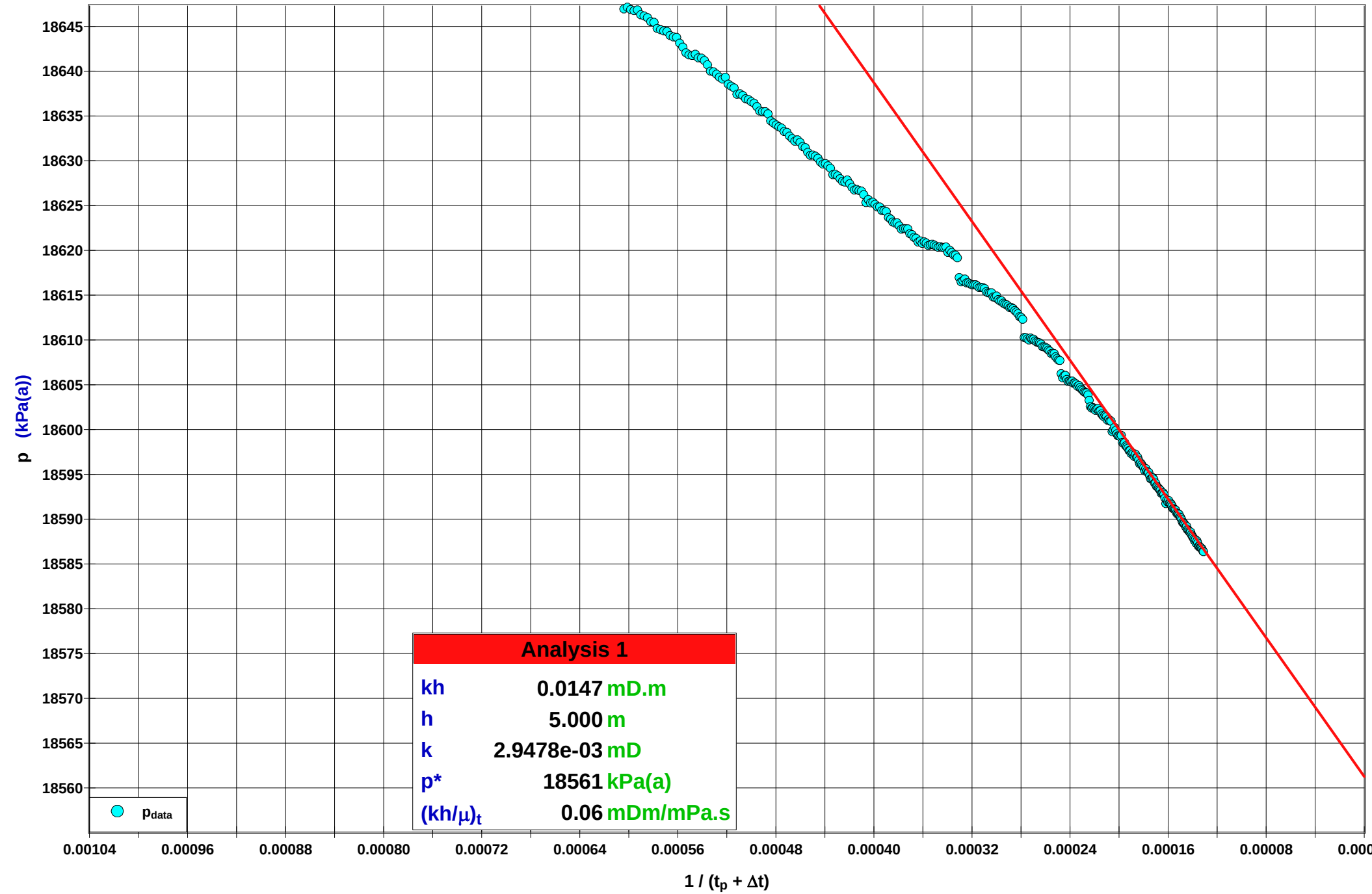
Soliman/Craig ACA 1

Minifrac Radial (Soliman-Craig)

Upper Lower Canol (1993 - 1994 mKB)
DFIT (Mar 28/13 - Feb 9/2014)



Soliman/Craig ACA 1

Linear Analysis

X_f(sqrt(k))	1.26 $mD^{1/2}m$
Fracture Half-Length (X_f)	23.263 m
Effective Permeability (k)	2.9478e-03 mD
Skin Equivalent to X_f (s_{Xf})	-4.846

Radial Analysis

Flow Capacity (kh)	0.0147 mD.m
Effective Permeability (k)	2.9478e-03 mD
Extrapolated Pressure (p*)	18561 kPa(a)

Fluid Properties

Oil Gravity (γ_o)	49.9 °API
Bubble Point Pressure (p_{bp})	18573 kPa(a)
Oil Correlation	Vasquez and Beggs
Oil Viscosity Correlation	Beggs & Robinson
Solution Gas Ratio (R_s)	152.70 m^3/m^3
Oil Viscosity (μ_o)	0.2645 mPa.s
Oil Compressibility (c_o)	3.2194e-06 1/kPa
Oil Formation Volume Factor (B_o)	1.522

Reservoir Properties

Reservoir Temperature (T_{resv})	87.0 °C
Reservoir Pressure (p_{resv})	18580 kPa(a)
Net Pay (h)	5.000 m
Total Porosity (ϕ_t)	13.00 %
Gas Saturation (S_g)	0.00 %
Oil Saturation (S_o)	86.00 %
Water Saturation (S_w)	14.00 %
Formation Compressibility (c_f)	6.3246e-07 1/kPa
Total Compressibility (c_t)	3.4634e-06 1/kPa