

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: **“BASAL” LOWER CANOL**

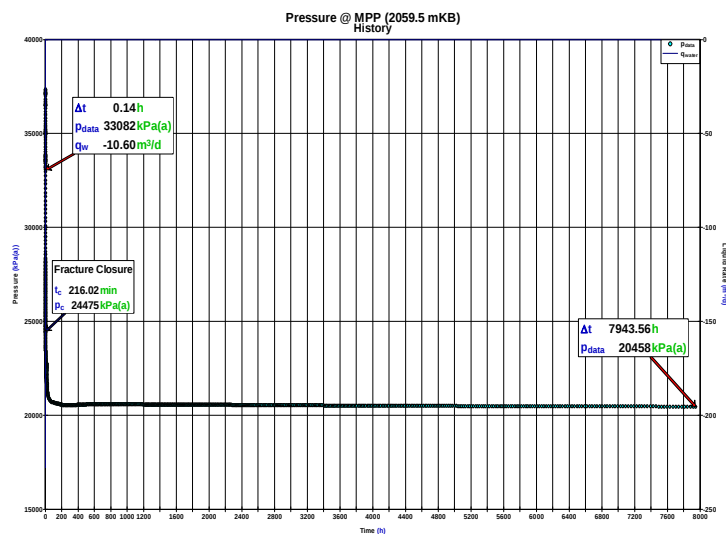
COST CENTRE: **10345530**

TEST DATE: **Mar 27/13 – Feb 21/14**

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

ORIENTATION: **Vertical**

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



Reservoir Properties

Injection Interval: 2059 – 2060 mKB		
Frac Height (h): 5 m (Estimate)	Porosity (φ): 16 %	Water Saturation (Sw): 11 %
Oil Gravity: 50 °API (Estimate)	H ₂ S Content: 0 %	BHT: 90.0 °C

Injection Data

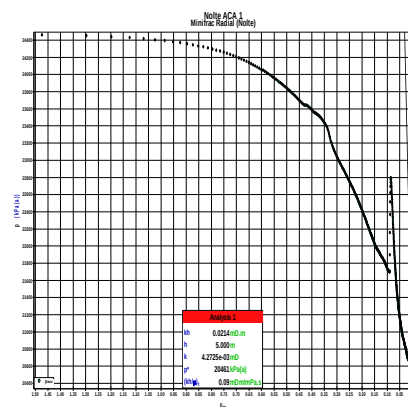
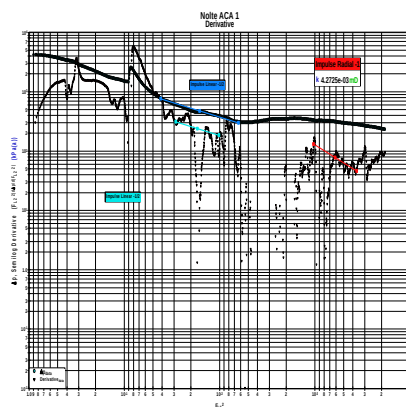
Test	Time	Final Rates				Final Pressures		
		Gas	New Oil	New H ₂ O	Load	Tubing	Casing	BHP
	Hours	e ³ m ³ /d	m ³ /d	m ³ /d	m ³ /d	kPag	kPag	kPaa
Injection	0.1	---	---	---	10.6	N/A	0	33082
Shut-In	7943.6	---	---	---	0	N/A	0	20458

Injection Summary

New Fluid (m ³)				Load Fluid (m ³)		Remaining Load (m ³)	
Gas (E ³ M ³)	Gas (MSCF)	Cond (m ³)	Water (m ³)	Oil (m ³)	Water (m ³)	Oil (m ³)	Water (m ³)
---	---	---	---	0	0.73	0	0.73

Pressure Transient Analysis Results Summary

Analysis Results	
P*	20461 kPaa
(kh/μ) _o	0.09 mD·m/mPa·s
(kh) _o	0.02 mD·m
k _o	0.004 mD



Discussion

Test Procedure:

The “Basal” LOWER CANOL interval was perforated on Mar 27th, 2013. A retrievable bridge plug, with tandem electronic recorders hung below, was run in hole (center element at 2056.5 mKB). Fluid (70% Propylene Glycol / 30% Water) 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 10.6 m³/d (7.3 l/min). The subsequent falloff was monitored for about 11 months (~7944 hrs). Another bridge plug was run in hole shortly thereafter. Completion and test operations were then carried out on the “Middle” and “Upper” intervals of the Lower Canol formation while the “Basal” interval falloff was in progress. After recovering the respective bridge plugs & recorders for each of the upper intervals, the bridge plugs immediately above the “Basal” interval were unset and recovered (including the recorders) on Feb 22nd, 2014. The primary objectives of the mini-frac test were to obtain frac design and reservoir flow parameters. The analyses / results for the “Middle” and “Upper” intervals 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=2059.5 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 after about 3.6 hrs (or ~216 minutes) of shut-in. Although an analysis of the data was conducted, there wasn't any definitive evidence of pseudo-radial flow on the derivative plot prior to the end of the test. It is noted however that the data was relatively noisy, resulting in ambiguous results. Regardless, after-closure analysis, via Nolte & Soliman / Craig techniques, was then conducted in an attempt to obtain estimates for reservoir parameters. It is also noted that the terminal portion of the data indicated the presence of non-reservoir effects, most likely as a result of uphole operations. Therefore, this portion of the falloff data was not used in the analysis. The corresponding results / plots have been presented in this report.

Conclusions / Recommendations:

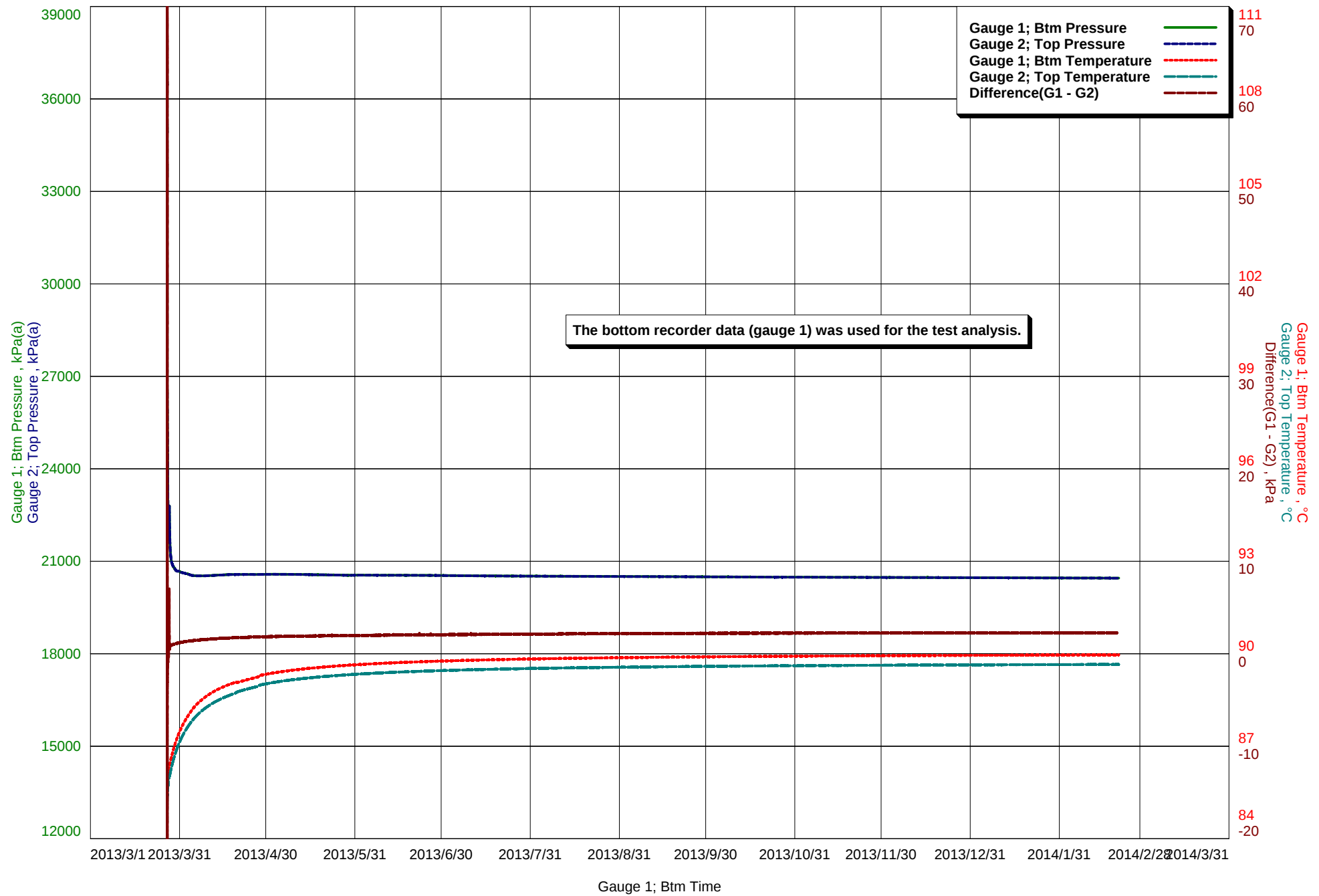
The test was only partially successful in satisfying the primary objectives set forth at the onset of the test program. Although closure was achieved, pseudo-radial flow was not conclusive prior to the end of the test. Therefore, the reported reservoir flow parameters ($k_o = 0.004$ mD, $P^* = 20.5$ MPaa) should be used with **caution**. Consequently, the overall confidence of the test results is considered to be poor. It is also noted that the oil permeability was calculated based on estimated values for frac height (5 m) & oil viscosity (50 °API oil with a viscosity of 0.25 mPa·s).

Analyzed by: Al Kassam

Report Date: Mar 20th, 2014

Copy: Kim Clarke Alex Novgorodova Well File

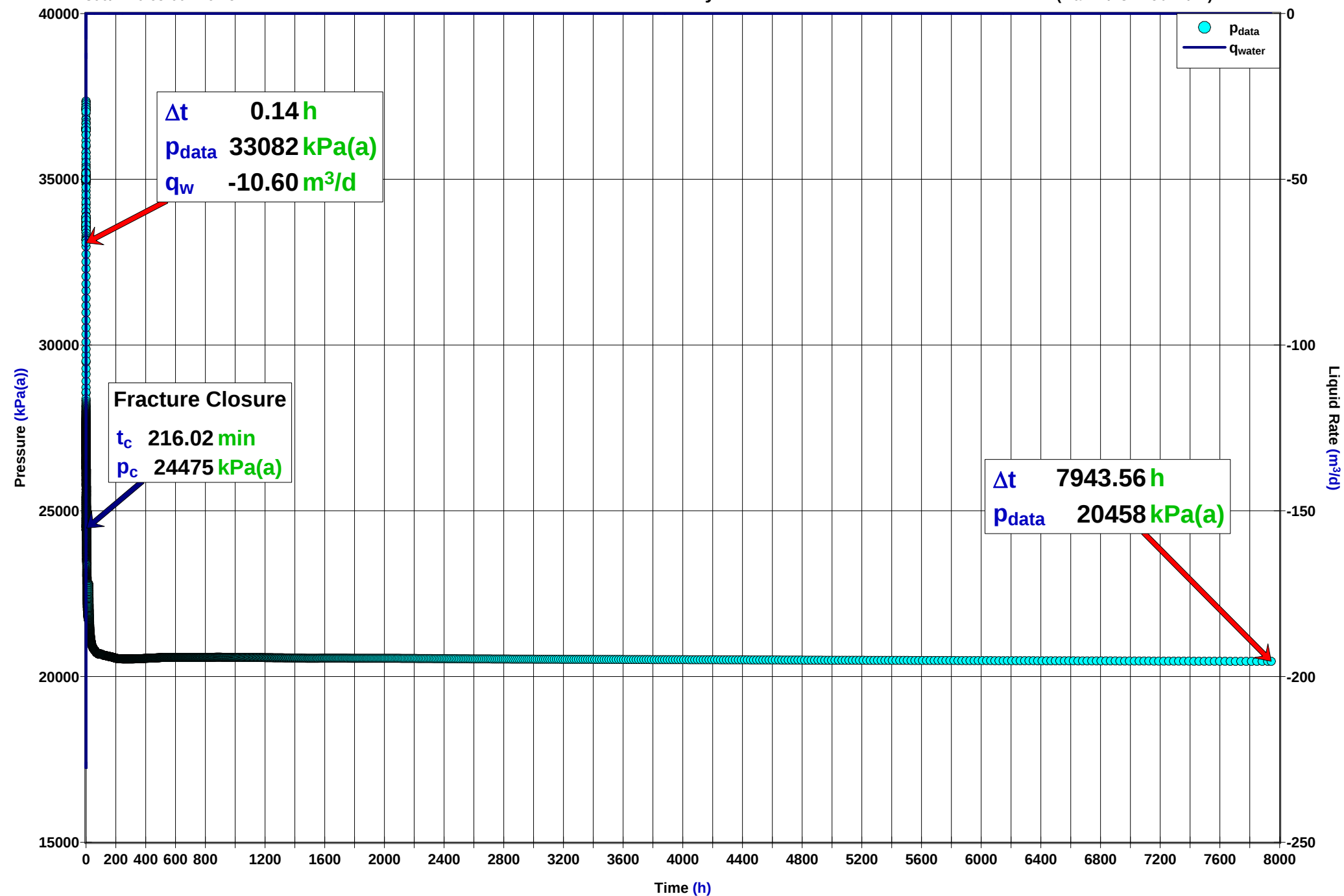
Recorder Data Plots



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Nolte ACA 1 History

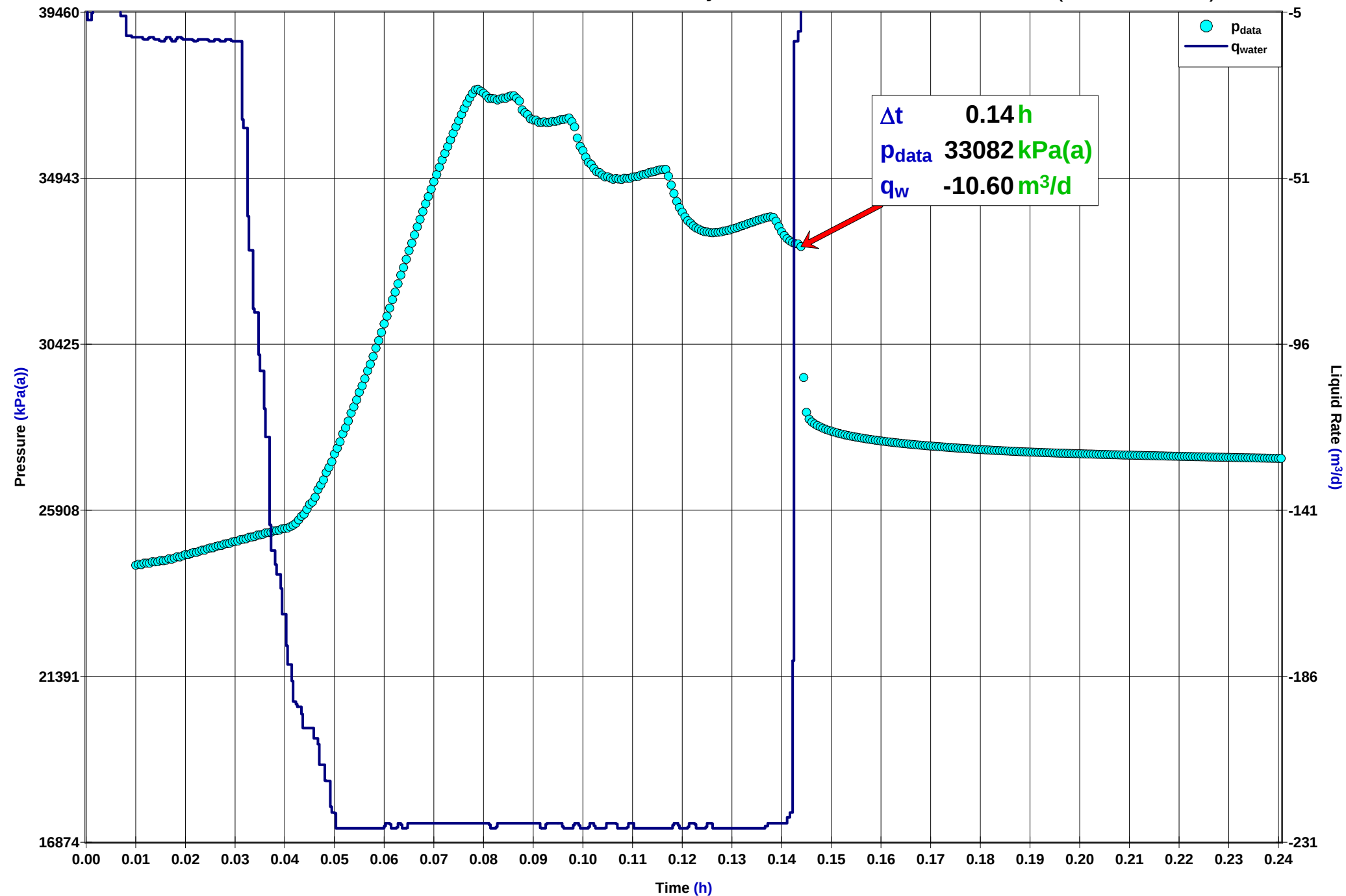
Basal Lower Canol (2059 - 2060 mKB)
DFIT (Mar 27/13 - Feb 21/14)



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Nolte ACA 1 History

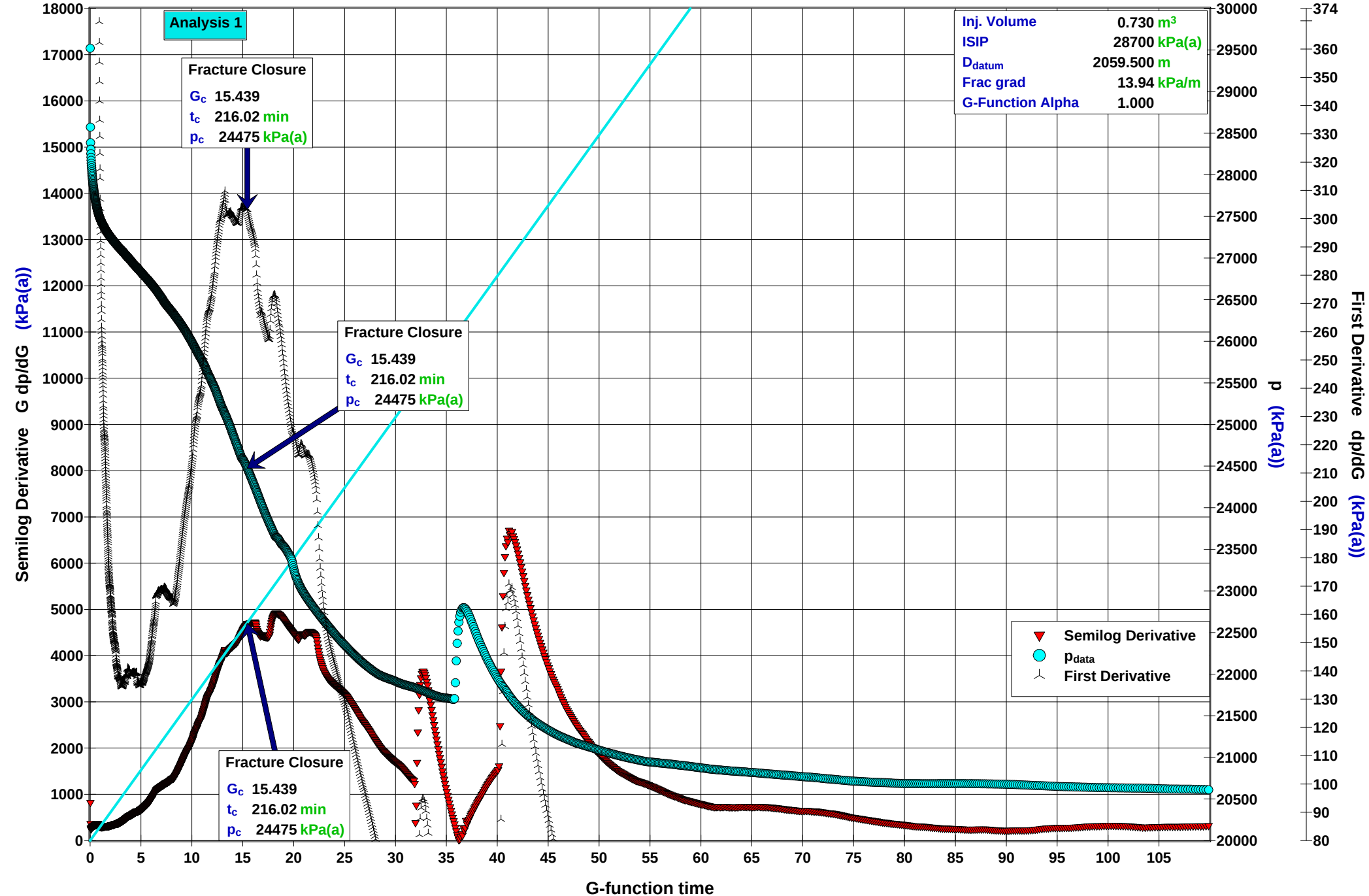
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PCA Diagnostic 1 G-Function

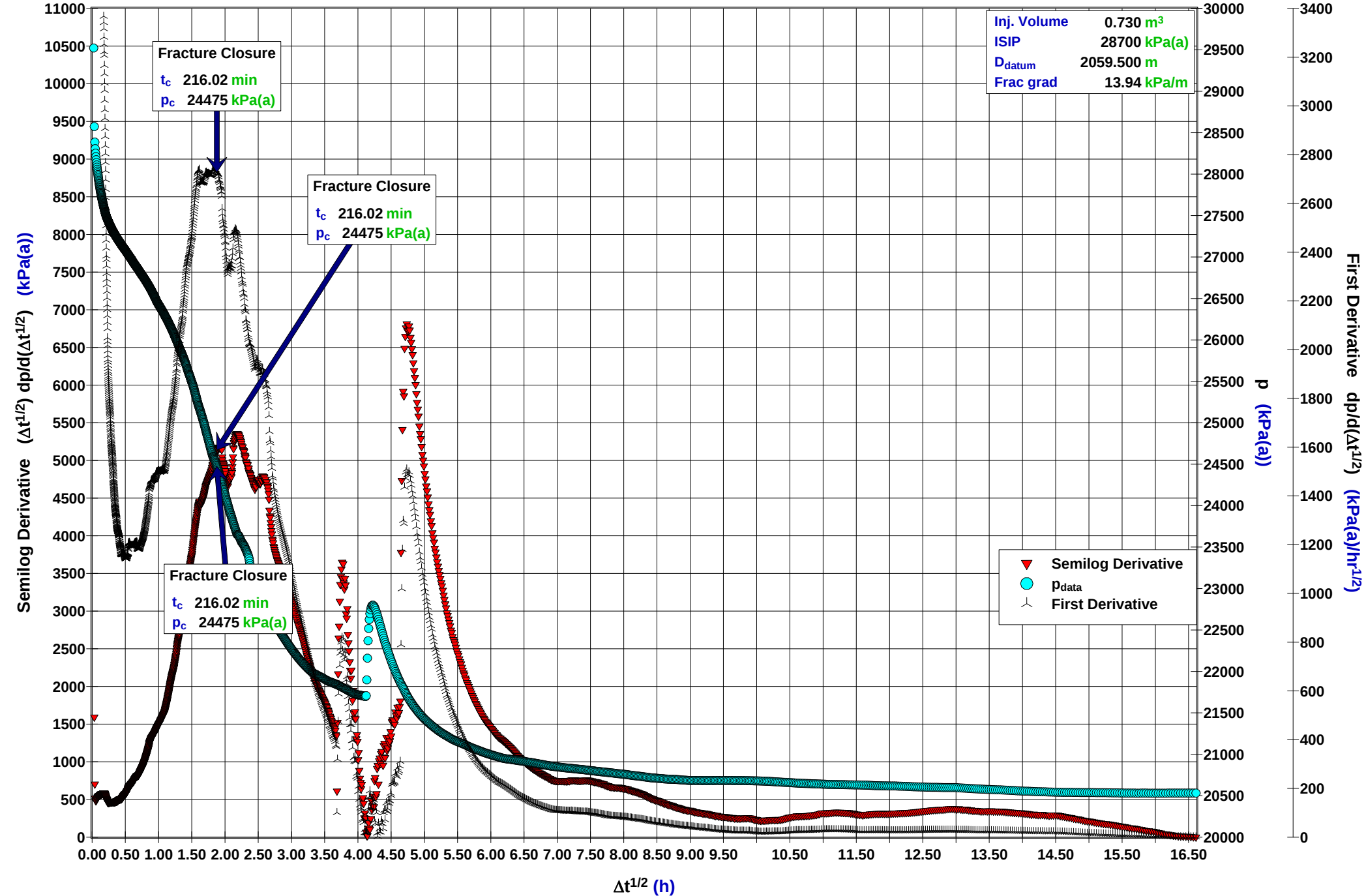
Basal Lower Canol (2059 - 2060 mKB)
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PCA Diagnostic 1 MiniFrac Sqrt(t)

Basal Lower Canol (2059 - 2060 mKB)
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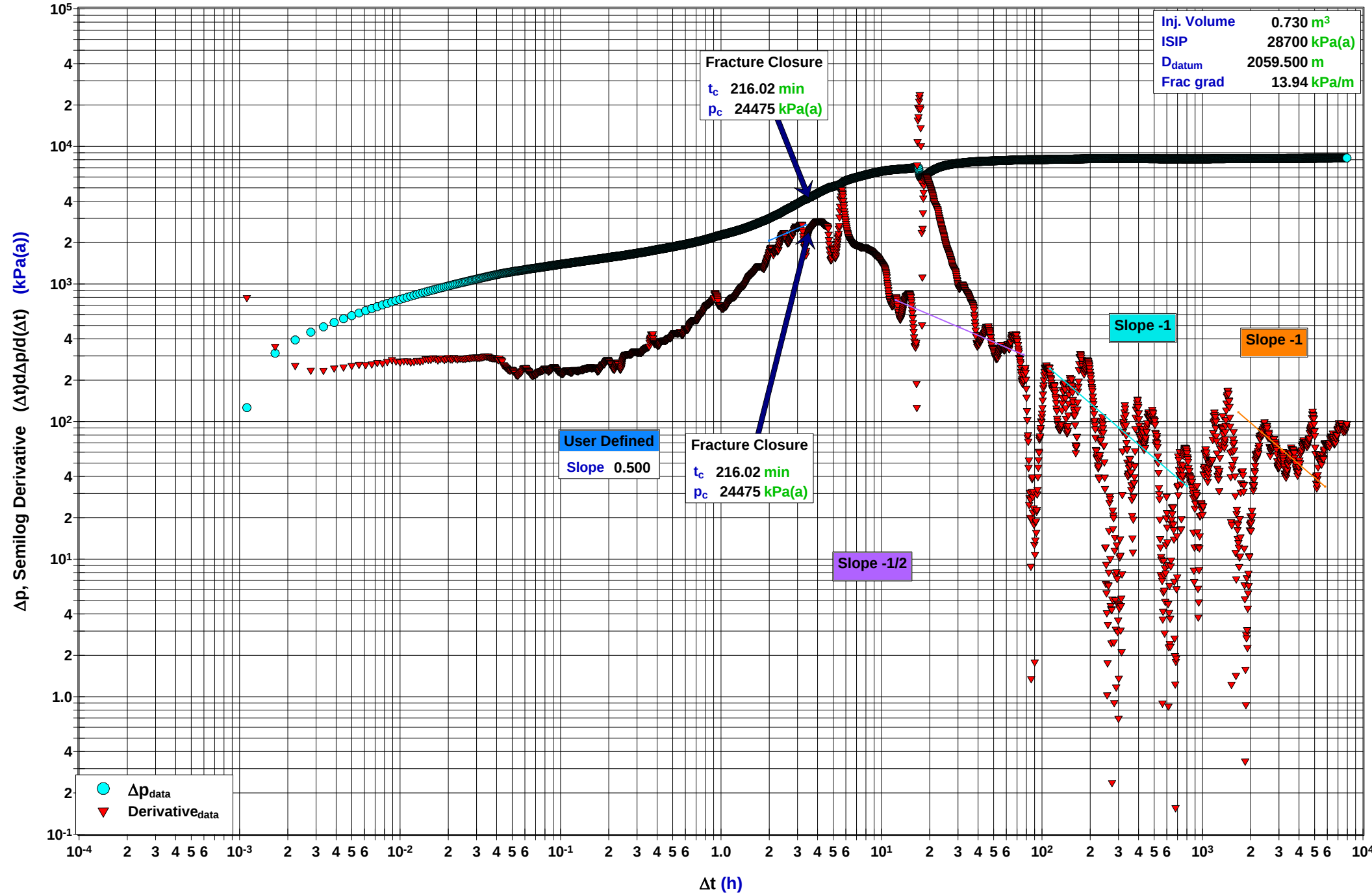


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PCA Diagnostic 1 Derivative

Basal Lower Canol (2059 - 2060 mKB)
DFIT (Mar 27/13 - Feb 21/14)

Inj. Volume	0.730 m ³
ISIP	28700 kPa(a)
D _{datum}	2059.500 m
Frac grad	13.94 kPa/m



PCA Diagnostic 1

Input Data

Injected Volume 0.730 m³
Datum Depth 2059.500 m

Results

ISIP 28700 kPa(a)
Fracture Gradient 13.94 kPa/m

Closure Marker 1

Closure time (t_c) 3.6003 h
Closure pressure (p_c) 24475 kPa(a)
Net Frac Press (Δp_{net}) 4225 kPa
G-Function at Closure (G_c) 15.439
Fluid Efficiency (η) 88.53 %

Closure Marker 2

Closure time (t_c) 3.6003 h
Closure pressure (p_c) 24475 kPa(a)
Net Frac Press (Δp_{net}) 4225 kPa
G-Function at Closure (G_c) 15.439
Fluid Efficiency (η) 88.53 %

Fluid Properties

Oil Gravity (γ_o) 49.9 °API
Bubble Point Pressure (p_{bp}) 20451 kPa(a)
Oil Formation Volume Factor (B_o) 1.571
Oil Viscosity (μ_o) 0.2483 mPa.s
Oil Compressibility (c_o) 3.1887e-06 1/kPa
Solution Gas Ratio (R_s) 168.60 m³/m³

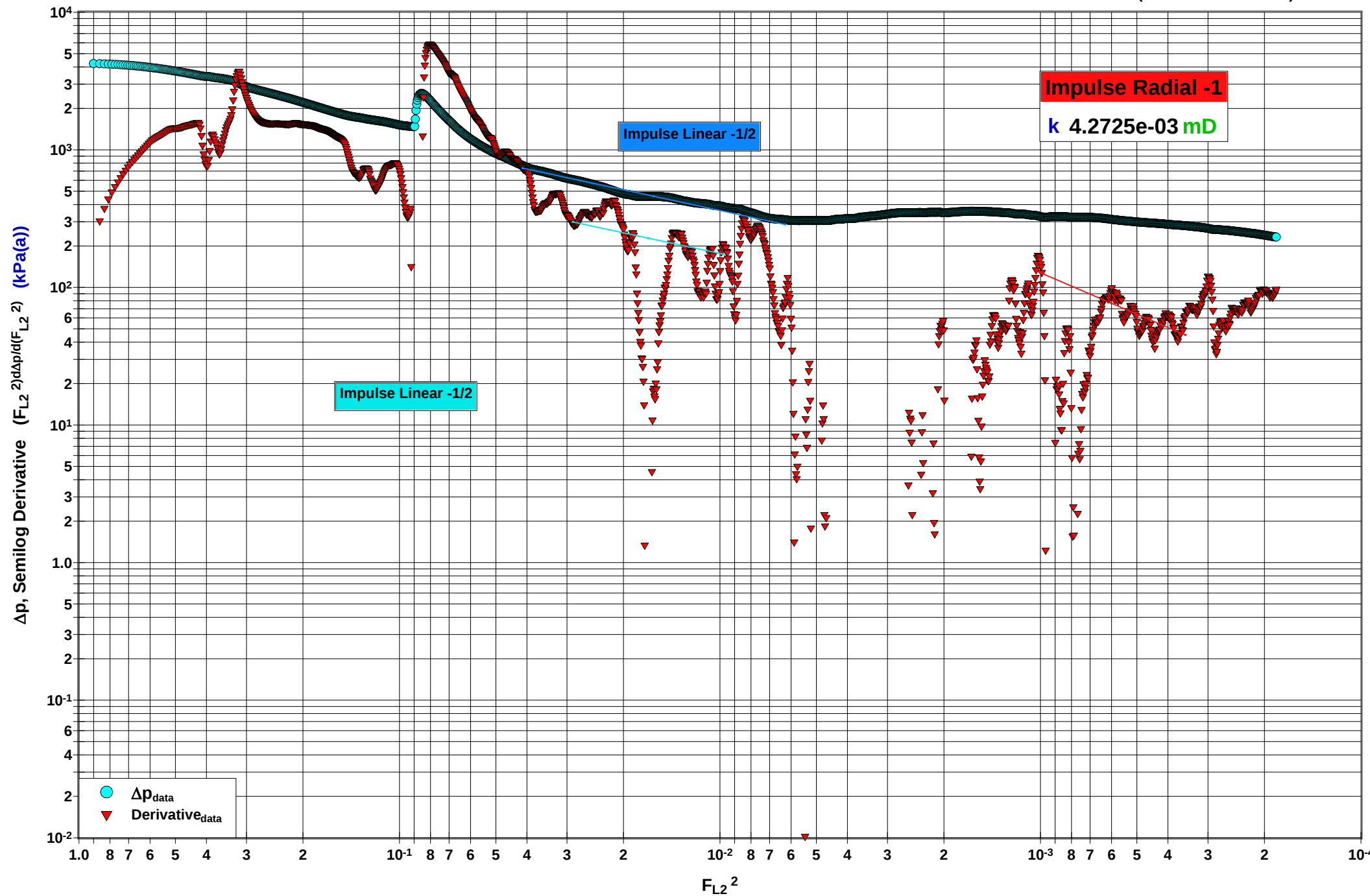
Reservoir Properties

Reservoir Temperature (T_{resv}) 90.0 °C
Reservoir Pressure (p_{resv}) 20458 kPa(a)

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Nolte ACA 1 Derivative

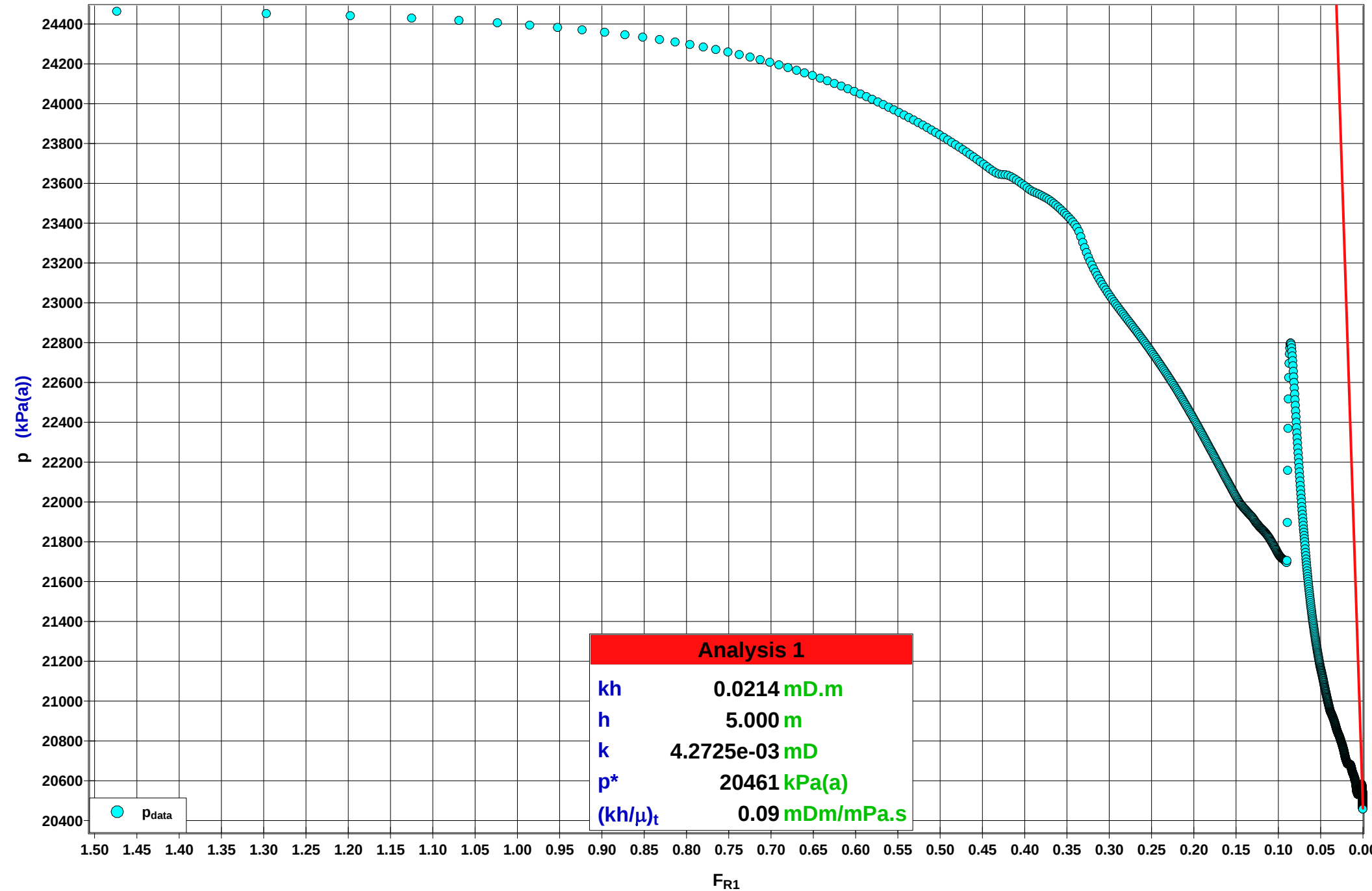
Basal Lower Canol (2059 - 2060 mKB)
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Nolte ACA 1 Minifrac Radial (Nolte)

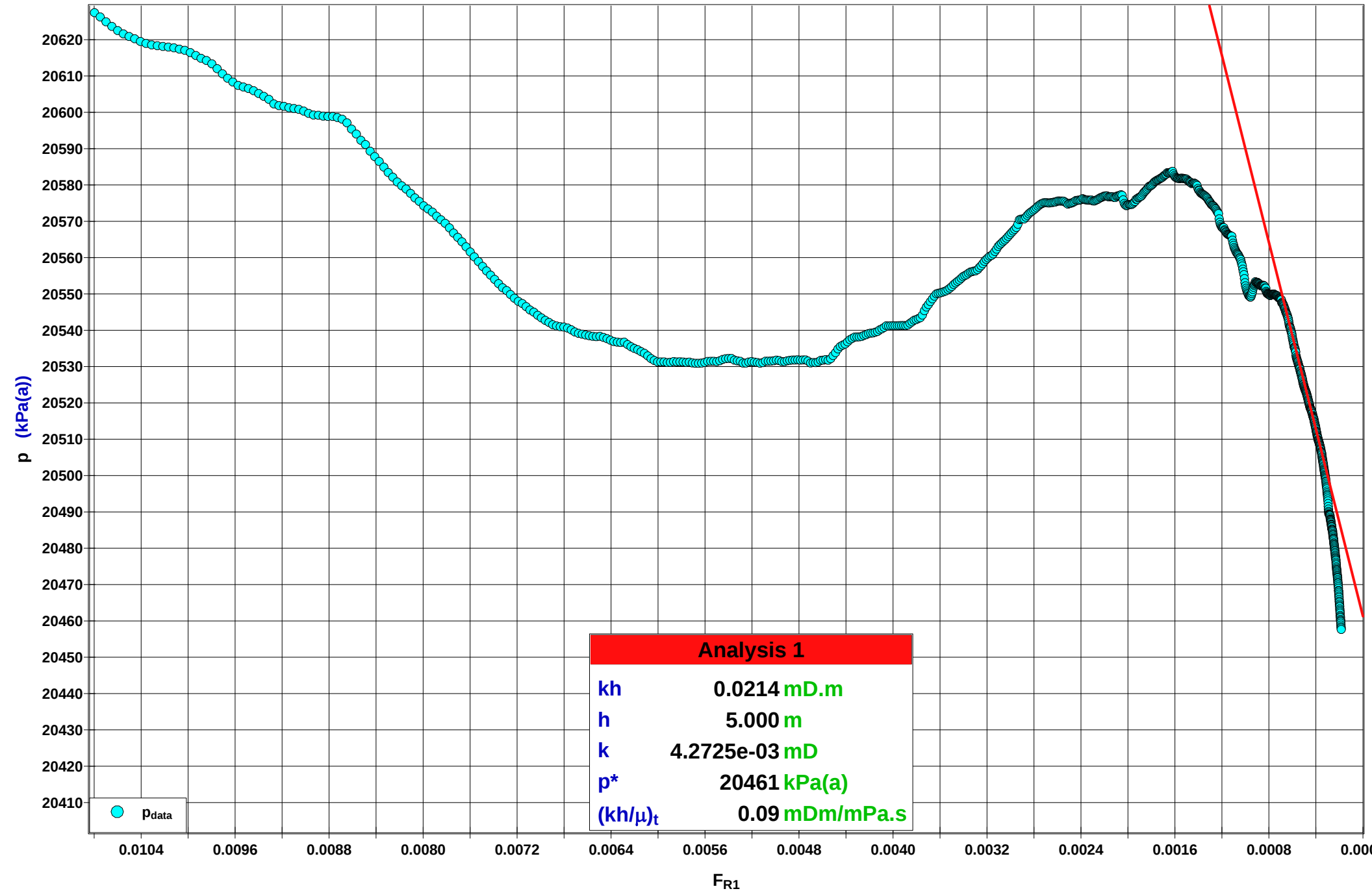
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Nolte ACA 1 Minifrac Radial (Nolte)

Basal Lower Canol (2059 - 2060 mKB)
DFIT (Mar 27/13 - Feb 21/14)



Nolte ACA 1

Linear Analysis (FL)

Flow Capacity (kh)	mD.m
Effective Permeability (k)	mD
Extrapolated Pressure (p*)	20225 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)	0.0214 mD.m
Effective Permeability (k)	4.2725e-03 mD
Extrapolated Pressure (p*)	20461 kPa(a)

Input Parameters

Estimated Initial Pressure (p _i)	20225 kPa(a)
Closure time (t _c)	216.02 min

Fluid Properties

Oil Gravity (γ _o)	49.9 °API
Bubble Point Pressure (p _{bp})	20451 kPa(a)
Oil Formation Volume Factor (B _o)	1.571
Oil Viscosity (μ _o)	0.2483 mPa.s
Oil Compressibility (c _o)	3.1887e-06 1/kPa
Solution Gas Ratio (R _s)	168.60 m ³ /m ³

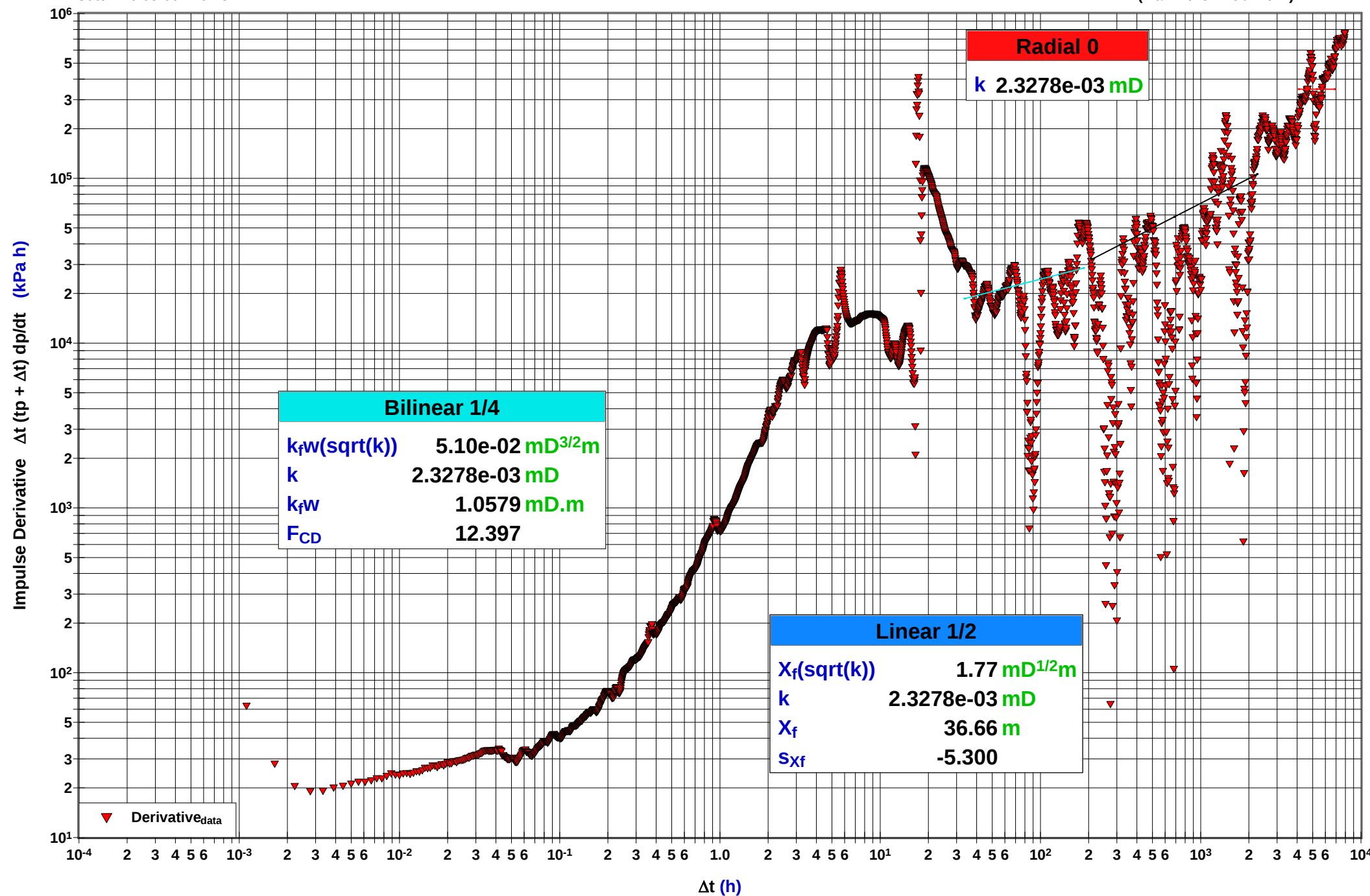
Reservoir Properties

Reservoir Temperature (T _{resv})	90.0 °C
Reservoir Pressure (p _{resv})	20458 kPa(a)
Net Pay (h)	5.000 m
Total Porosity (φ _t)	16.00 %
Gas Saturation (S _g)	0.00 %
Oil Saturation (S _o)	89.00 %
Water Saturation (S _w)	11.00 %
Formation Compressibility (c _f)	5.8025e-07 1/kPa
Total Compressibility (c _t)	3.4672e-06 1/kPa

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Soliman/Craig ACA 1 Derivative

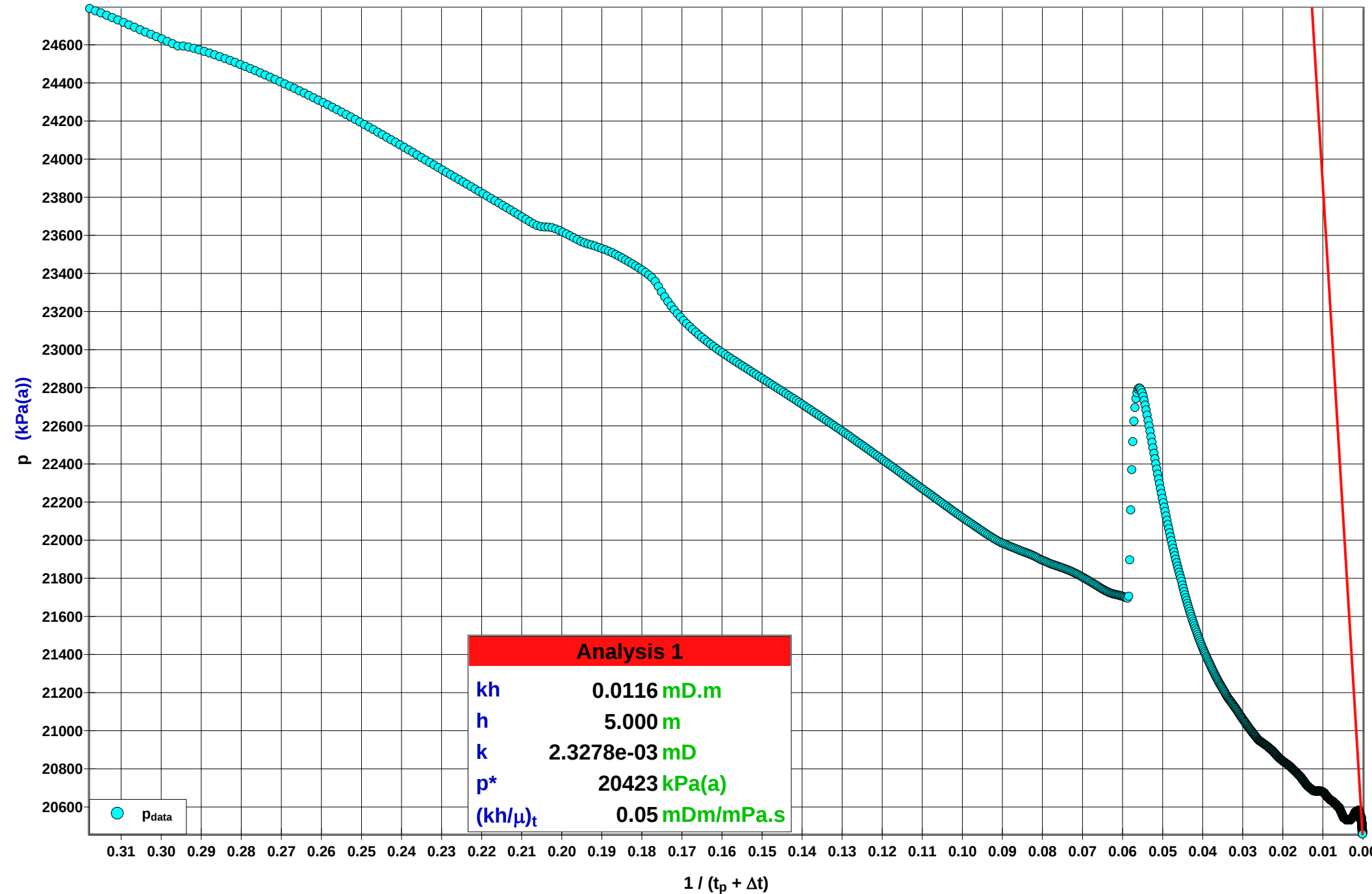
Basal Lower Canol (2059 - 2060 mKB)
DFIT (Mar 27/13 - Feb 21/14)



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

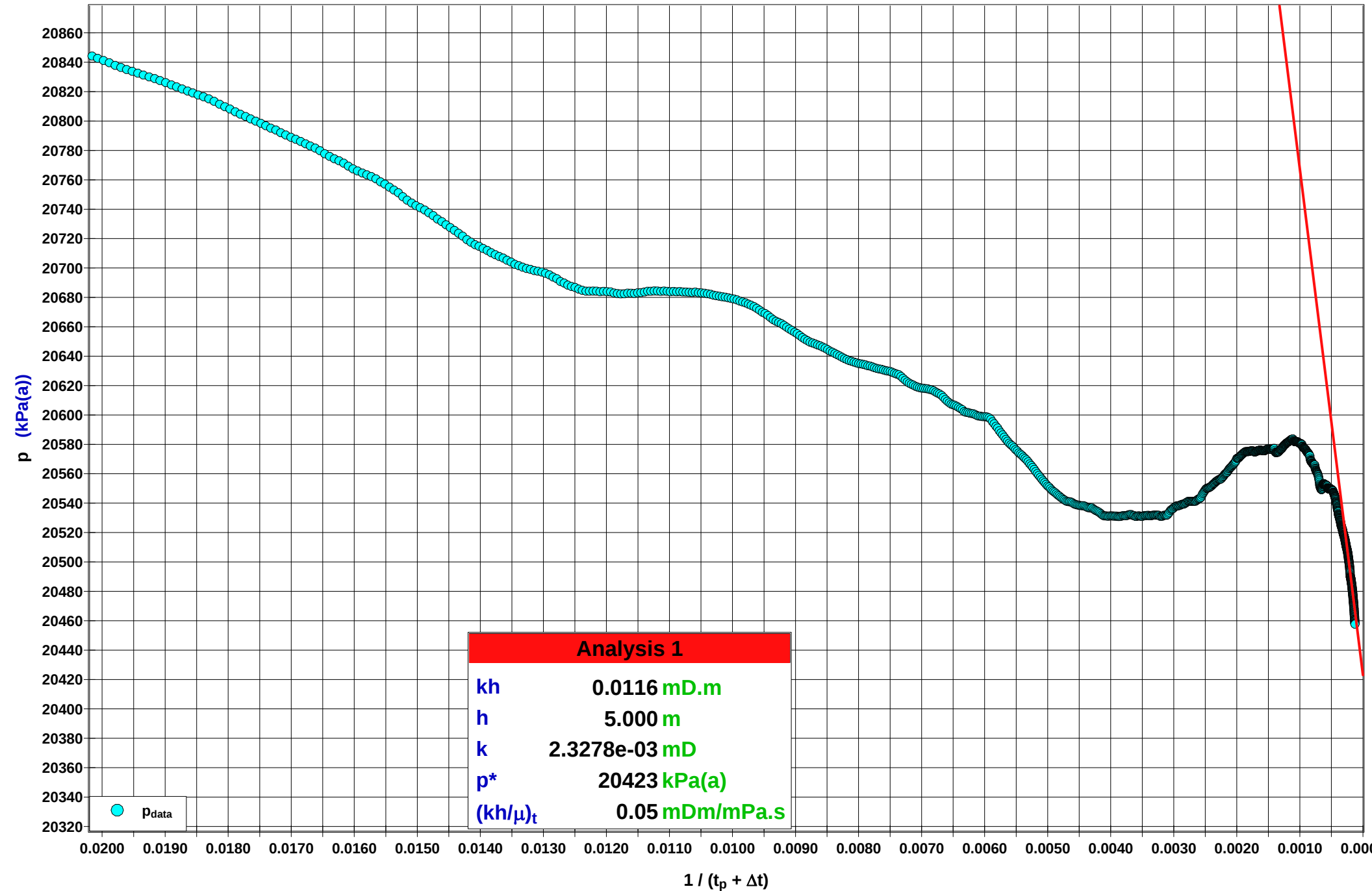
Basal Lower Canol (2059 - 2060 mKB)
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Soliman/Craig ACA 1 Minifrac Radial (Soliman-Craig)

Basal Lower Canol (2059 - 2060 mKB)
DFIT (Mar 27/13 - Feb 21/14)



Soliman/Craig ACA 1

Linear Analysis

$X_f(\sqrt{k})$	1.77 mD ^{1/2} m
Fracture Half-Length (X_f)	36.656 m
Effective Permeability (k)	2.3278e-03 mD
Skin Equivalent to X_f (S_{xf})	-5.300

Radial Analysis

Flow Capacity (kh)	0.0116 mD.m
Effective Permeability (k)	2.3278e-03 mD
Extrapolated Pressure (p^*)	20423 kPa(a)

Fluid Properties

Oil Gravity (γ_o)	49.9 °API
Bubble Point Pressure (p_{bp})	20451 kPa(a)
Oil Correlation	Vasquez and Beggs
Oil Viscosity Correlation	Beggs & Robinson
Solution Gas Ratio (R_s)	168.60 m ³ /m ³
Oil Viscosity (μ_o)	0.2483 mPa.s
Oil Compressibility (c_o)	3.1887e-06 1/kPa
Oil Formation Volume Factor (B_o)	1.571

Reservoir Properties

Reservoir Temperature (T_{resv})	90.0 °C
Reservoir Pressure (p_{resv})	20458 kPa(a)
Net Pay (h)	5.000 m
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