

OIL MINI-FRAC ANALYSIS

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

ZONE: "MIDDLE" LOWER CANOL

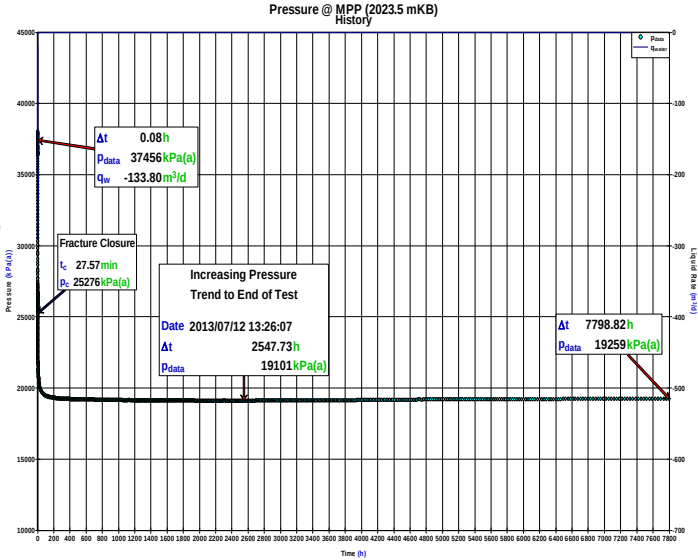
COST CENTRE: 10345530

TEST DATE: Mar 28/13 – Feb 16/14

STAGE OF WELL TEST: Post-Perf Inj-Falloff

ORIENTATION: Vertical

TYPE/SIZE OF STIMULATION: N/A



Reservoir Properties

Injection Interval:	2023 – 2024 mKB
Frac Height (h):	5 m (Estimate)
Porosity (φ):	8 %
Oil Gravity:	50 °API (Estimate)
H ₂ S Content:	0 %
Water Saturation (S _w):	29 %
BHT:	88.1 °C

Injection Data

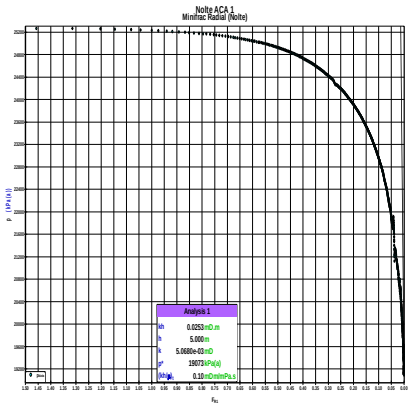
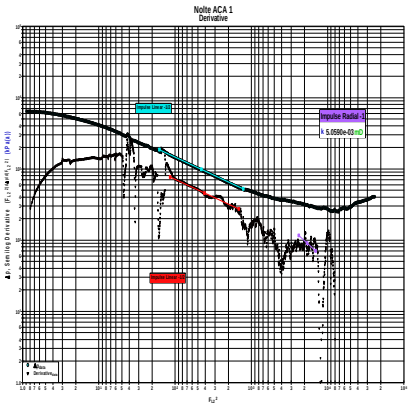
Test	Time	Final Rates				Final Pressures		
		Gas	New Oil	New H ₂ O	Load	Tubing	Casing	BHP
	Hours	e³m³/d	m³/d	m³/d	m³/d	kPag	kPag	kPaa
Injection	0.1	---	---	---	133.8	N/A	0	37456
Shut-In	7798.8	---	---	---	0	N/A	0	19259

Injection Summary

New Fluid (m³)				Load Fluid (m³)		Remaining Load (m³)	
Gas (E³M³)	Gas (MSCF)	Cond (m³)	Water (m³)	Oil (m³)	Water (m³)	Oil (m³)	Water (m³)
---	---	---	---	0	0.41	0	0.41

Pressure Transient Analysis Results Summary

Analysis Results	
P*	19073 kPaa
(kh/μ) _o	0.10 mD·m/mPa·s
(kh) _o	0.025 mD·m
k _o	0.005 mD



Discussion

Test Procedure:

A segregated post-perf mini-frac test was conducted on the “Basal” Lower Canol interval. This interval was subsequently isolated below bridge plugs. On Mar 27th, 2013, the “Middle” LOWER CANOL interval was perforated. A retrievable bridge plug, with tandem electronic recorders hung below, was run in hole the following day (center element at 2020.5 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 133.8 m³/d (92.9 l/min). The subsequent falloff was monitored for about 11 months (~7799 hrs). On Feb 18th, 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 upon isolating this interval, operations were conducted to carry out a mini-frac test on the “Upper” Lower Canol. 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 about a half hour (or ~28 minutes) of shut-in. Although an analysis of the data was conducted, there wasn't any conclusive evidence of pseudo-radial flow on the derivative plot prior to the end of the test. However, it is noted that the data was relatively noisy, resulting in ambiguous results. In addition, it is also noted that the actual pressure indicated an upward trend starting from Mid-July 2013 to the end of the test. It is not apparent at this time as to attributing factor for this phenomenon. Regardless, after-closure analysis, via Nolte & Soliman / Craig techniques, was then conducted in an attempt to obtain estimates for reservoir parameters. 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 evident, most likely as a result of poor data quality. Therefore, the reported reservoir flow parameters ($k_o = 0.005$ mD, $P^* = 19.1$ 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 0.26 mPa·s).

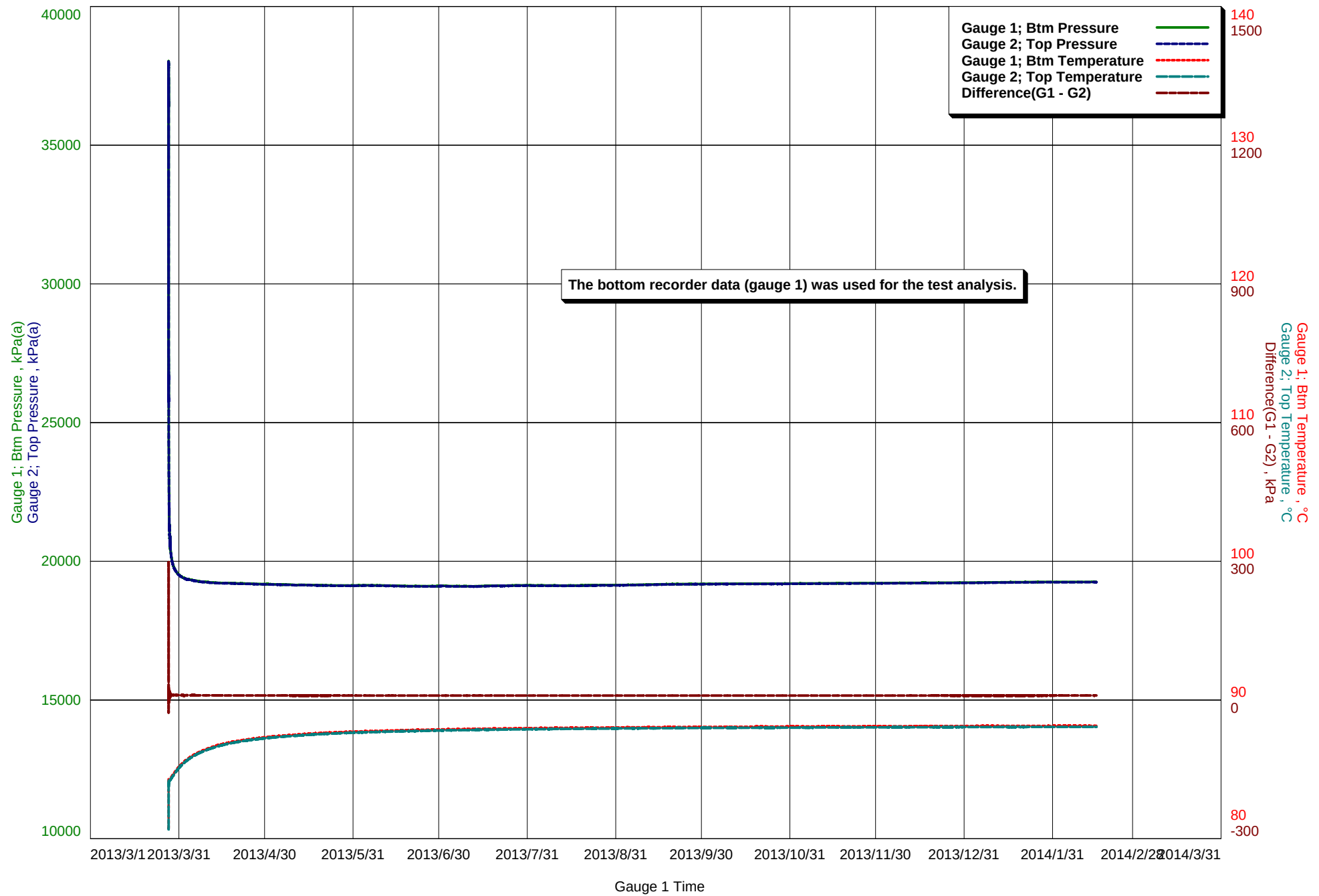
Analyzed by: Al Kassam

Report Date: Mar 20th, 2014

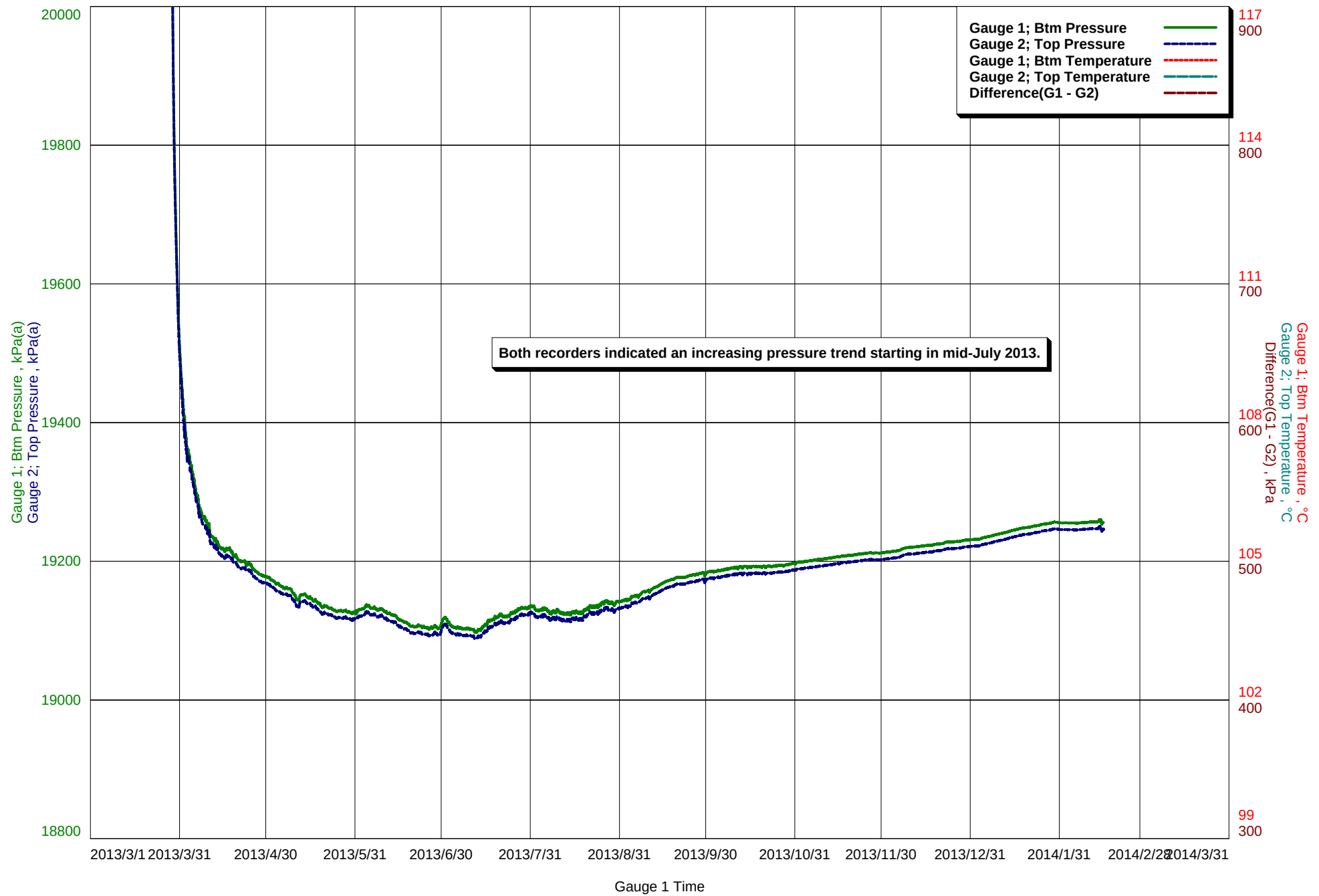
Copy: Kim Clarke Alex Novgorodova Well File

Recorder Data Plot

Formation: Middle Lower Canol



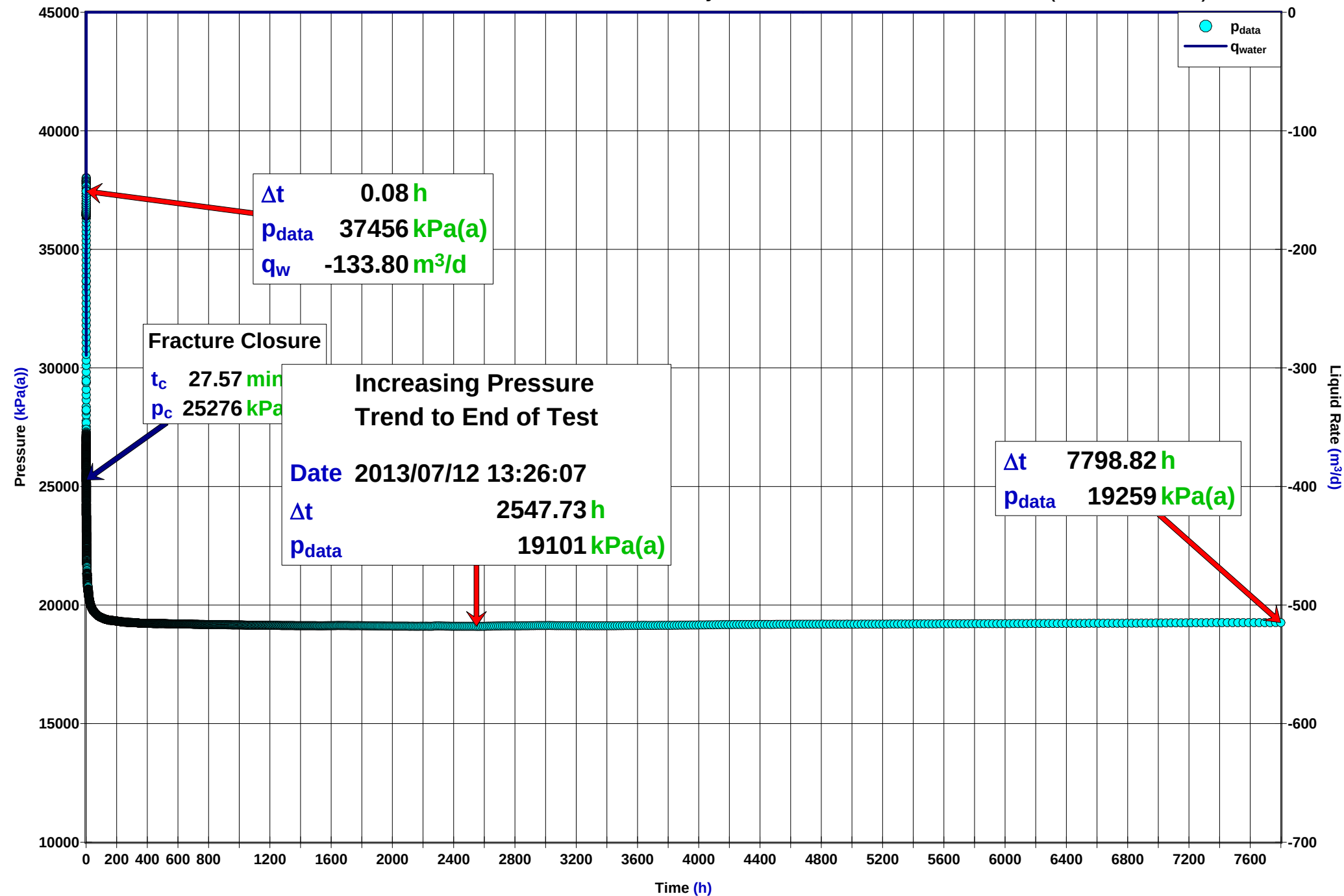
Recorder Data Plot



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300/N-20 65-00 126-45

Pressure @ MPP (2023.5 mKB) History

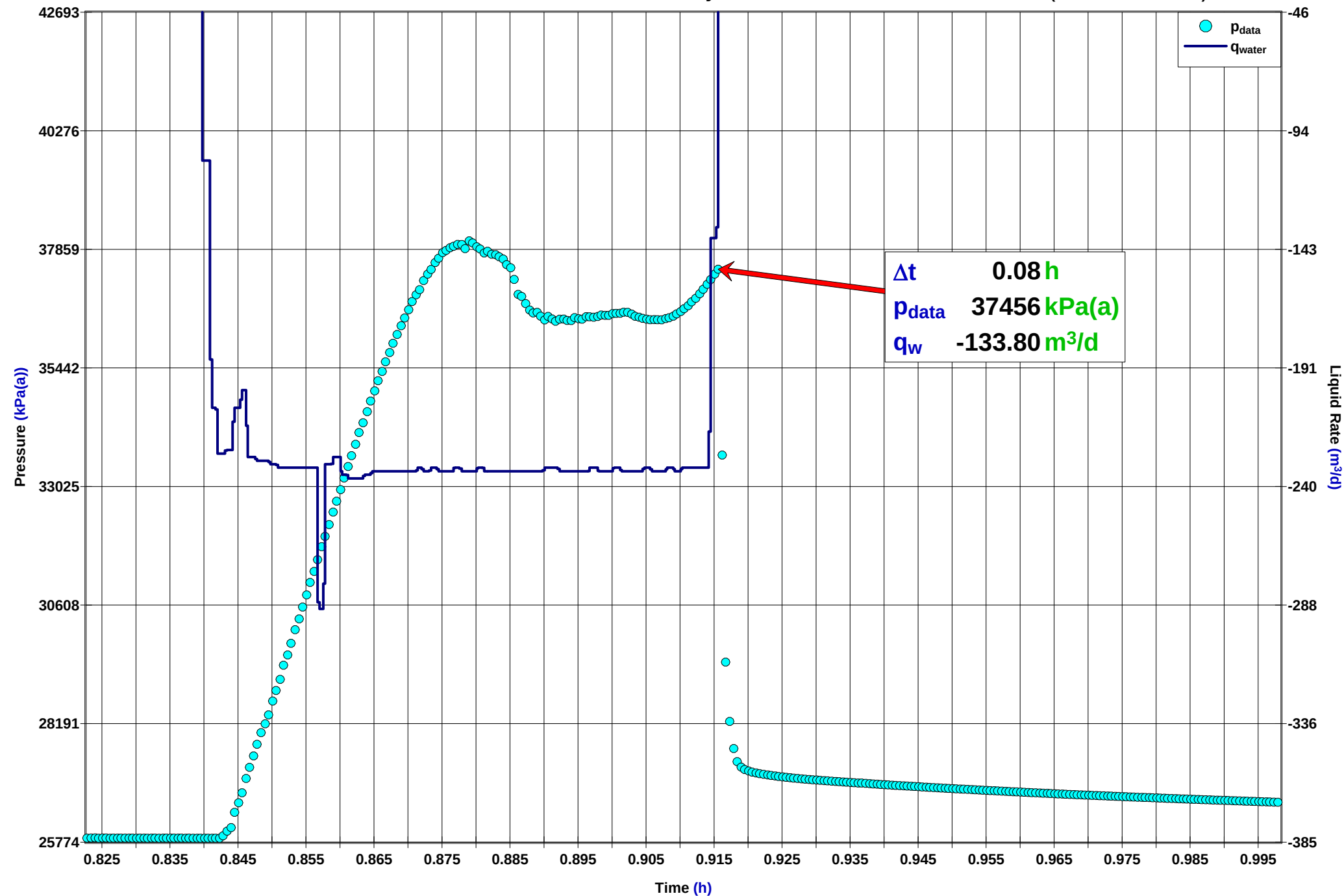
Middle Lower Canol (2023 - 2024 mKB)
DFIT (Mar 28/13 - Feb 16/14)



COPRC Mirror Lake
300/N-20 65-00 126-45

Pressure @ MPP (2023.5 mKB) History

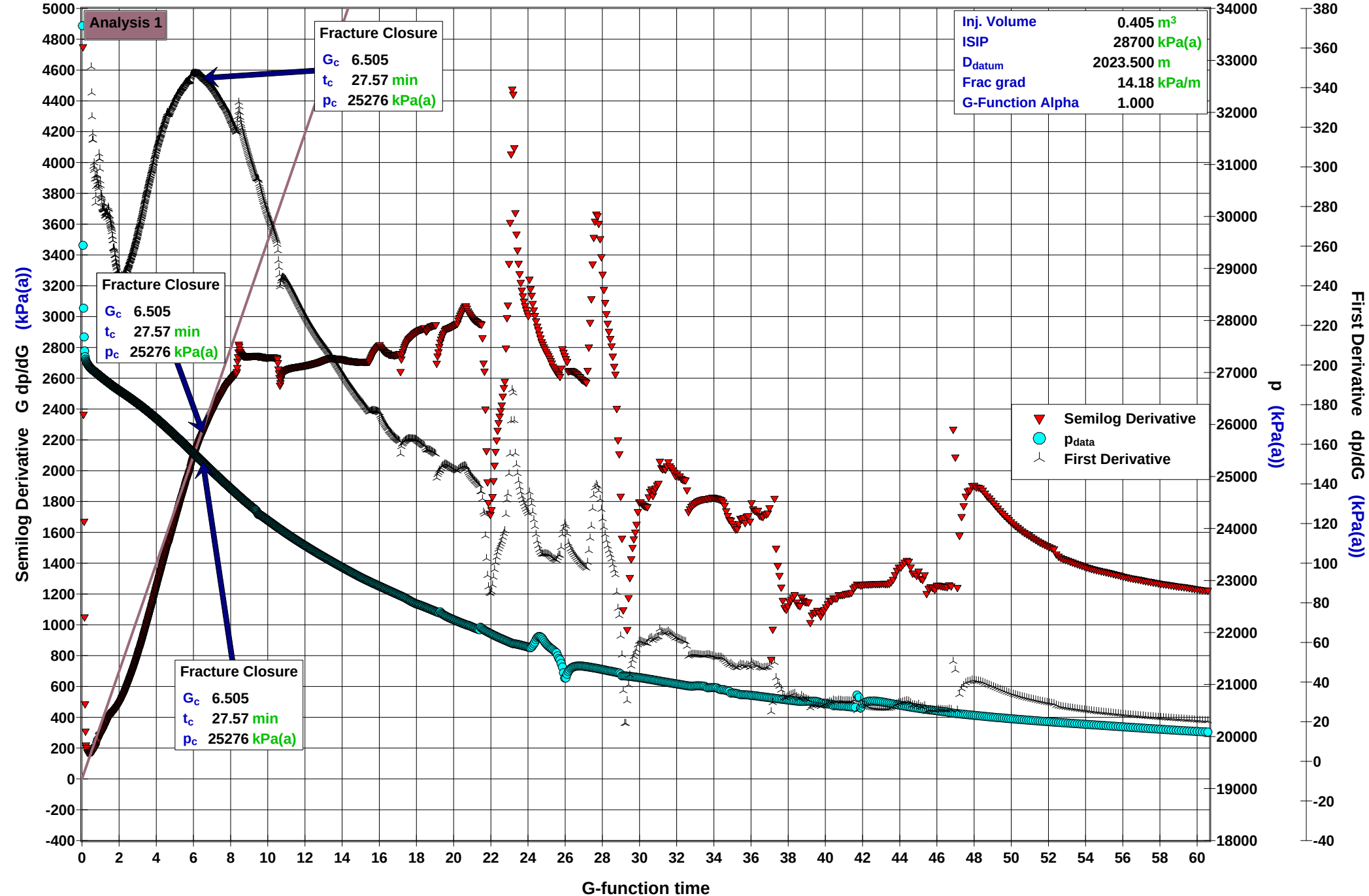
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COPRC Mirror Lake
300/N-20 65-00 126-45

PCA Diagnostic 1 G-Function

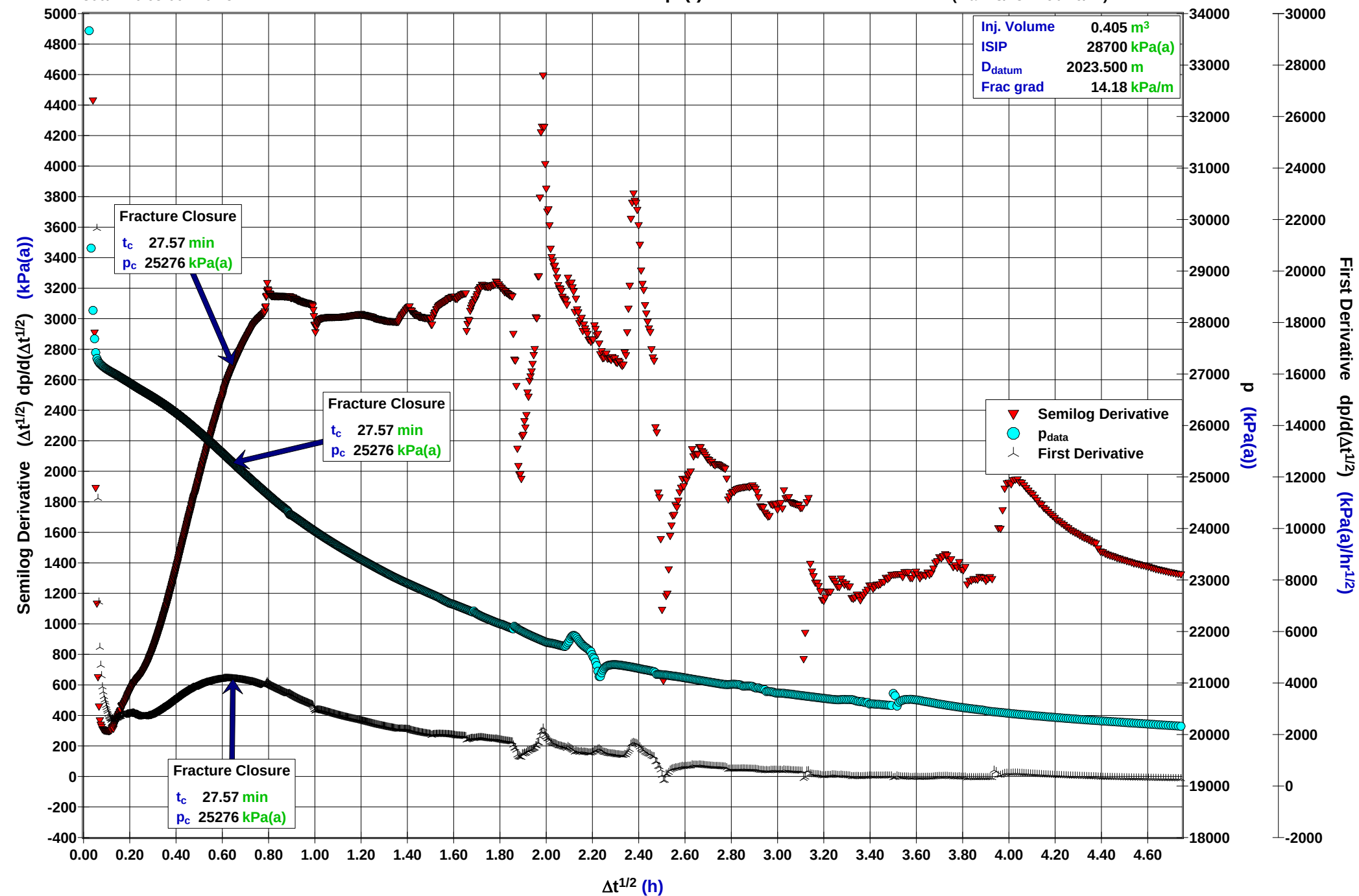
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COPRC Mirror Lake
300/N-20 65-00 126-45

PCA Diagnostic 1 MiniFrac Sqrt(t)

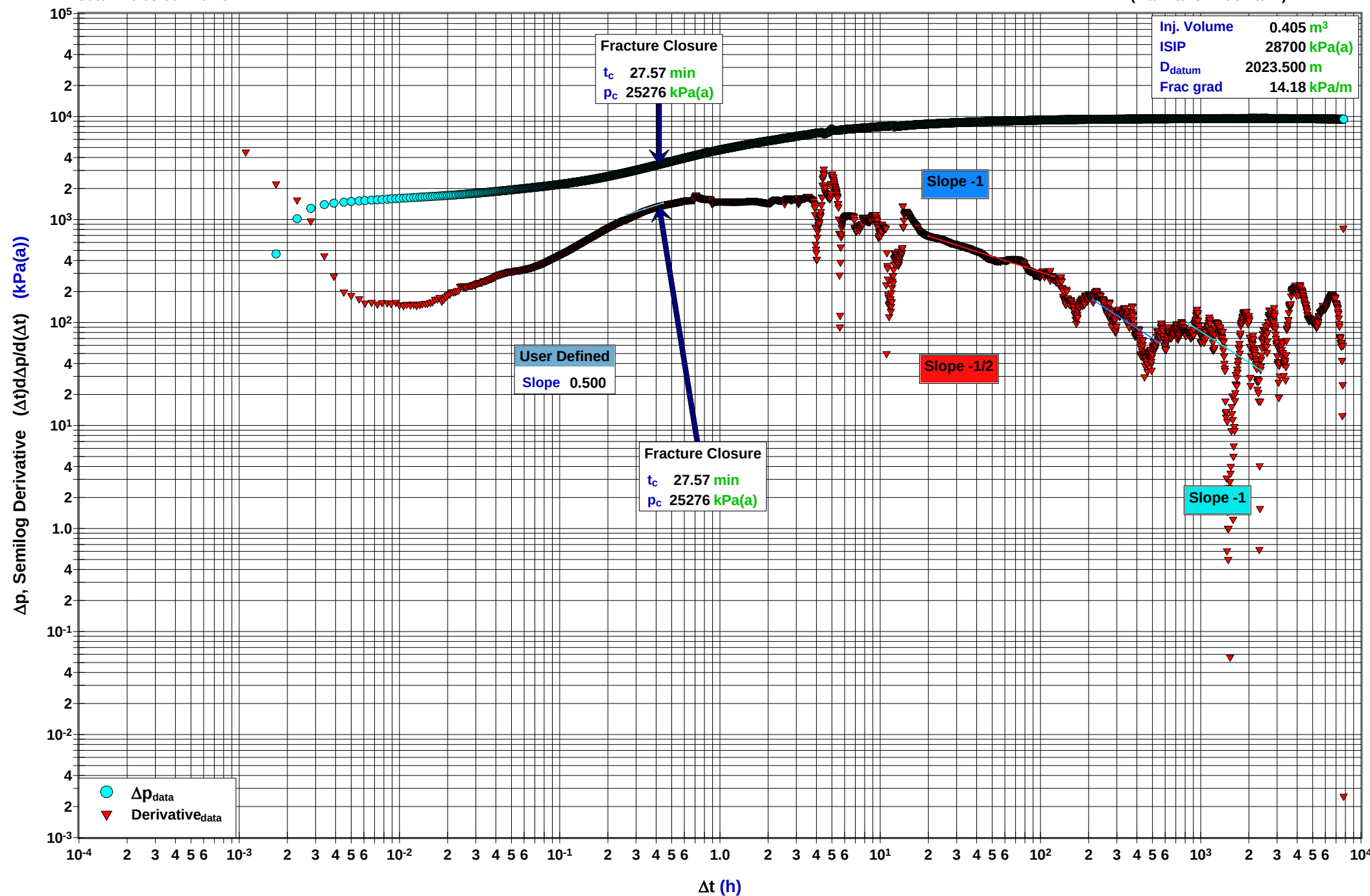
Middle Lower Canol (2023 - 2024 mKB)
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COPRC Mirror Lake
300/N-20 65-00 126-45

PCA Diagnostic 1 Derivative

Middle Lower Canol (2023 - 2024 mKB)
DFIT (Mar 28/13 - Feb 16/14)



PCA Diagnostic 1

Input Data

Injected Volume 0.405 m³
Datum Depth 2023.500 m

Results

ISIP 28700 kPa(a)
Fracture Gradient 14.18 kPa/m

Closure Marker 1

Closure time (t_c) 0.4595 h
Closure pressure (p_c) 25276 kPa(a)
Net Frac Press (Δp_{net}) 3424 kPa
G-Function at Closure (G_c) 6.505
Fluid Efficiency (η) 76.48 %

Closure Marker 2

Closure time (t_c) 0.4595 h
Closure pressure (p_c) 25276 kPa(a)
Net Frac Press (Δp_{net}) 3424 kPa
G-Function at Closure (G_c) 6.505
Fluid Efficiency (η) 76.48 %

Fluid Properties

Oil Gravity (γ_o) 49.9 °API
Bubble Point Pressure (p_{bp}) 19252 kPa(a)
Oil Formation Volume Factor (B_o) 1.540
Oil Viscosity (μ_o) 0.2583 mPa.s
Oil Compressibility (c_o) 3.2079e-06 1/kPa
Solution Gas Ratio (R_s) 158.45 m³/m³

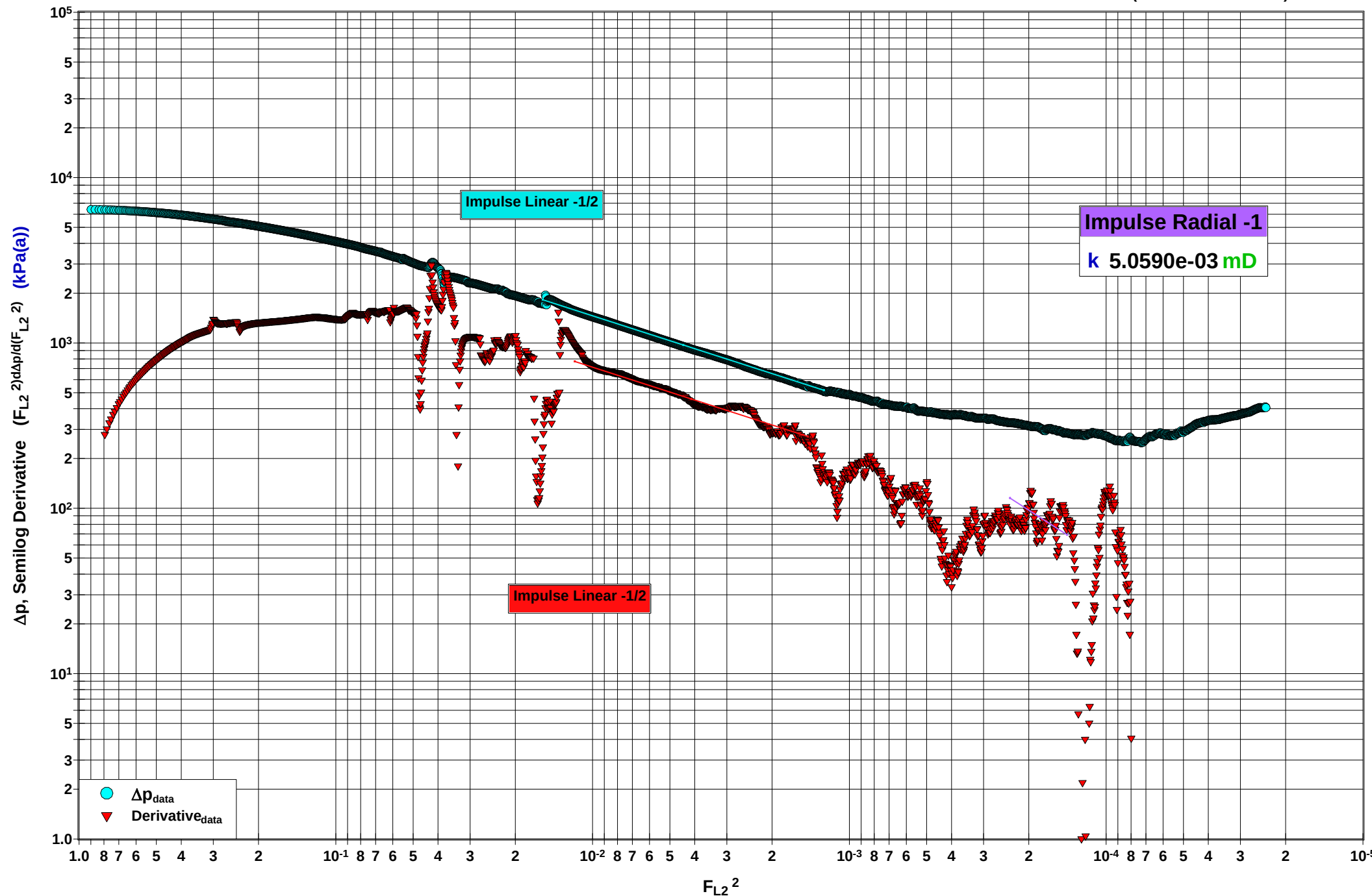
Reservoir Properties

Reservoir Temperature (T_{resv}) 88.1 °C
Reservoir Pressure (p_{resv}) 19259 kPa(a)

COPRC Mirror Lake
300/N-20 65-00 126-45

Nolte ACA 1 Derivative

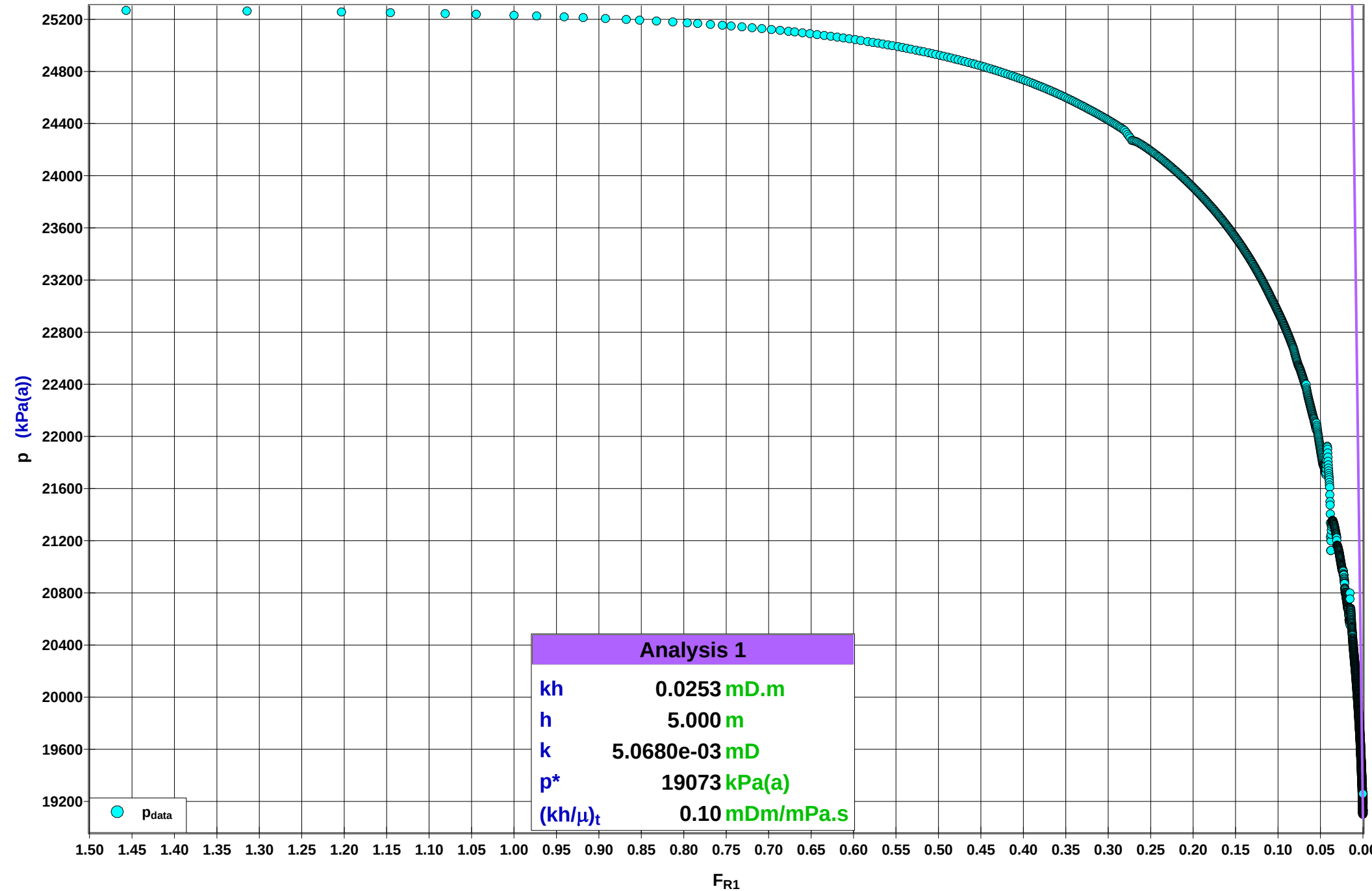
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COPRC Mirror Lake
300/N-20 65-00 126-45

Nolte ACA 1 Minifrac Radial (Nolte)

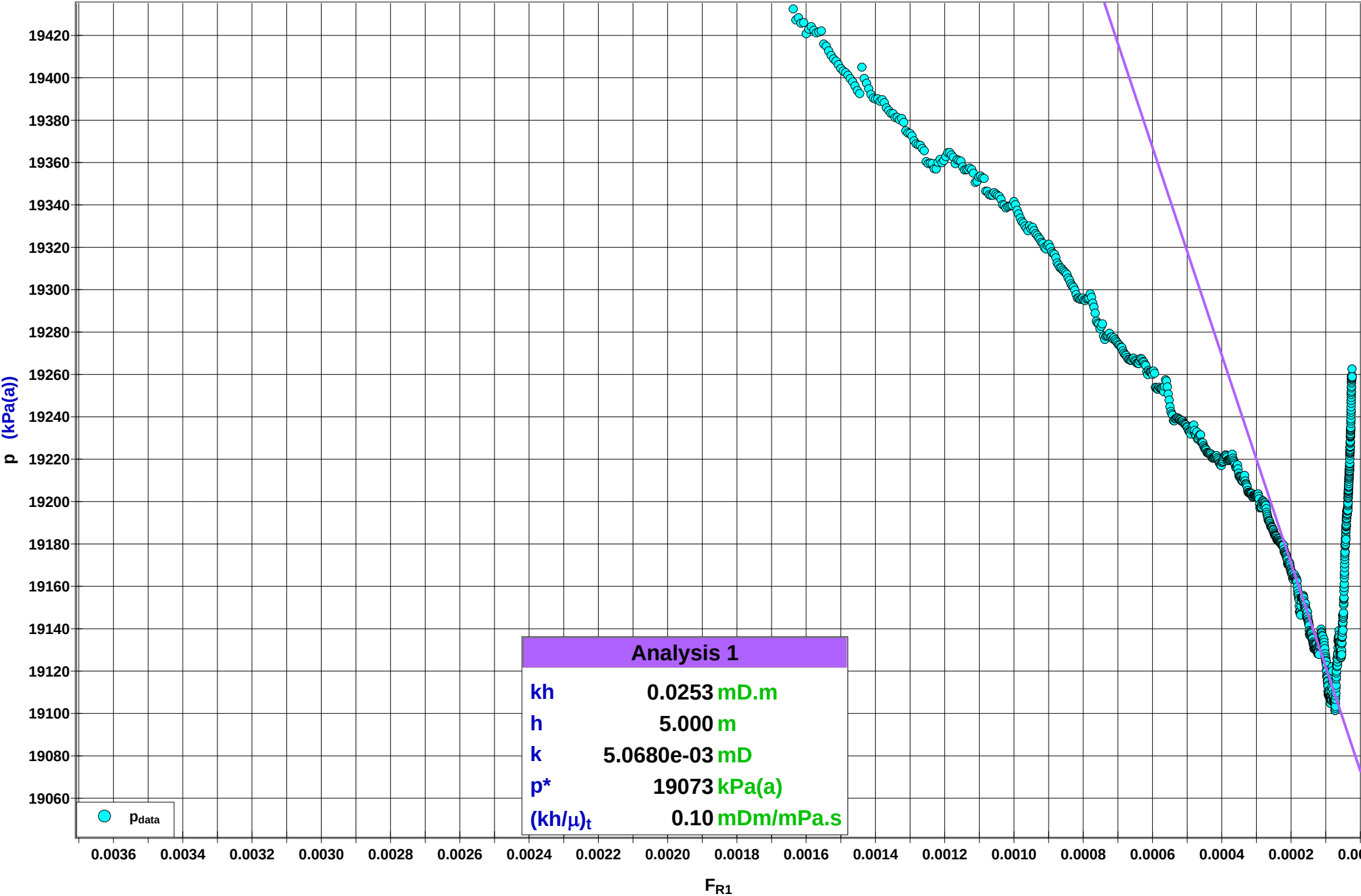
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COPRC Mirror Lake
300/N-20 65-00 126-45

Nolte ACA 1
Minifrac Radial (Nolte)

Middle Lower Canol (2023 - 2024 mKB)
DFIT (Mar 28/13 - Feb 16/14)



Nolte ACA 1

Linear Analysis (FL)

Flow Capacity (kh)	mD.m
Effective Permeability (k)	mD
Extrapolated Pressure (p*)	18852 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)	0.0253 mD.m
Effective Permeability (k)	5.0680e-03 mD
Extrapolated Pressure (p*)	19073 kPa(a)

Input Parameters

Estimated Initial Pressure (p _i)	18852 kPa(a)
Closure time (t _c)	27.57 min

Fluid Properties

Oil Gravity (γ _o)	49.9 °API
Bubble Point Pressure (p _{bp})	19252 kPa(a)
Oil Formation Volume Factor (B _o)	1.540
Oil Viscosity (μ _o)	0.2583 mPa.s
Oil Compressibility (c _o)	3.2079e-06 1/kPa
Solution Gas Ratio (R _s)	158.45 m ³ /m ³

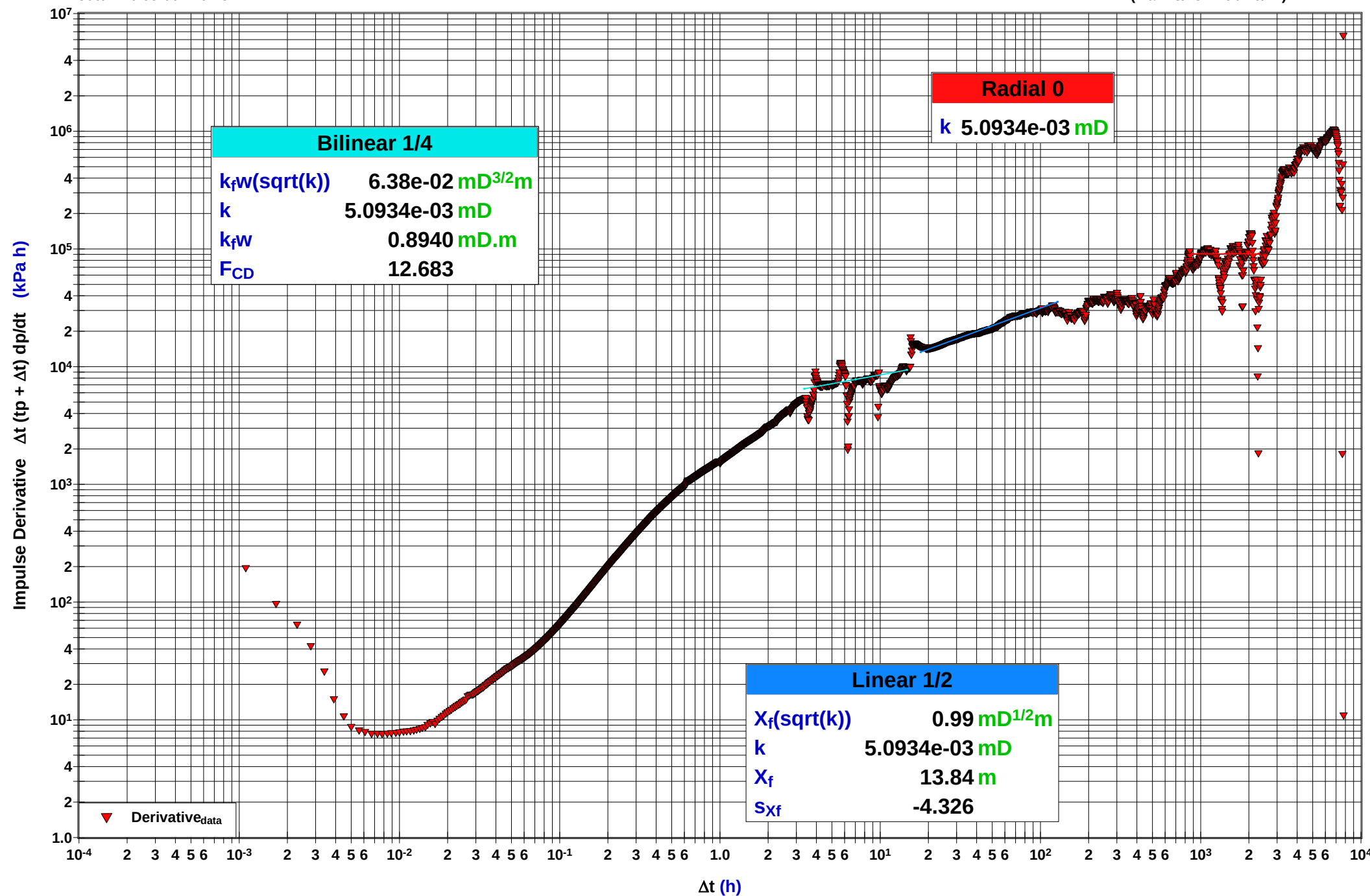
Reservoir Properties

Reservoir Temperature (T _{resv})	88.1 °C
Reservoir Pressure (p _{resv})	19259 kPa(a)
Net Pay (h)	5.000 m
Total Porosity (φ _t)	8.00 %
Gas Saturation (S _g)	0.00 %
Oil Saturation (S _o)	71.00 %
Water Saturation (S _w)	29.00 %
Formation Compressibility (c _f)	7.7364e-07 1/kPa
Total Compressibility (c _t)	3.1802e-06 1/kPa

COPRC Mirror Lake
300/N-20 65-00 126-45

Soliman/Craig ACA 1 Derivative

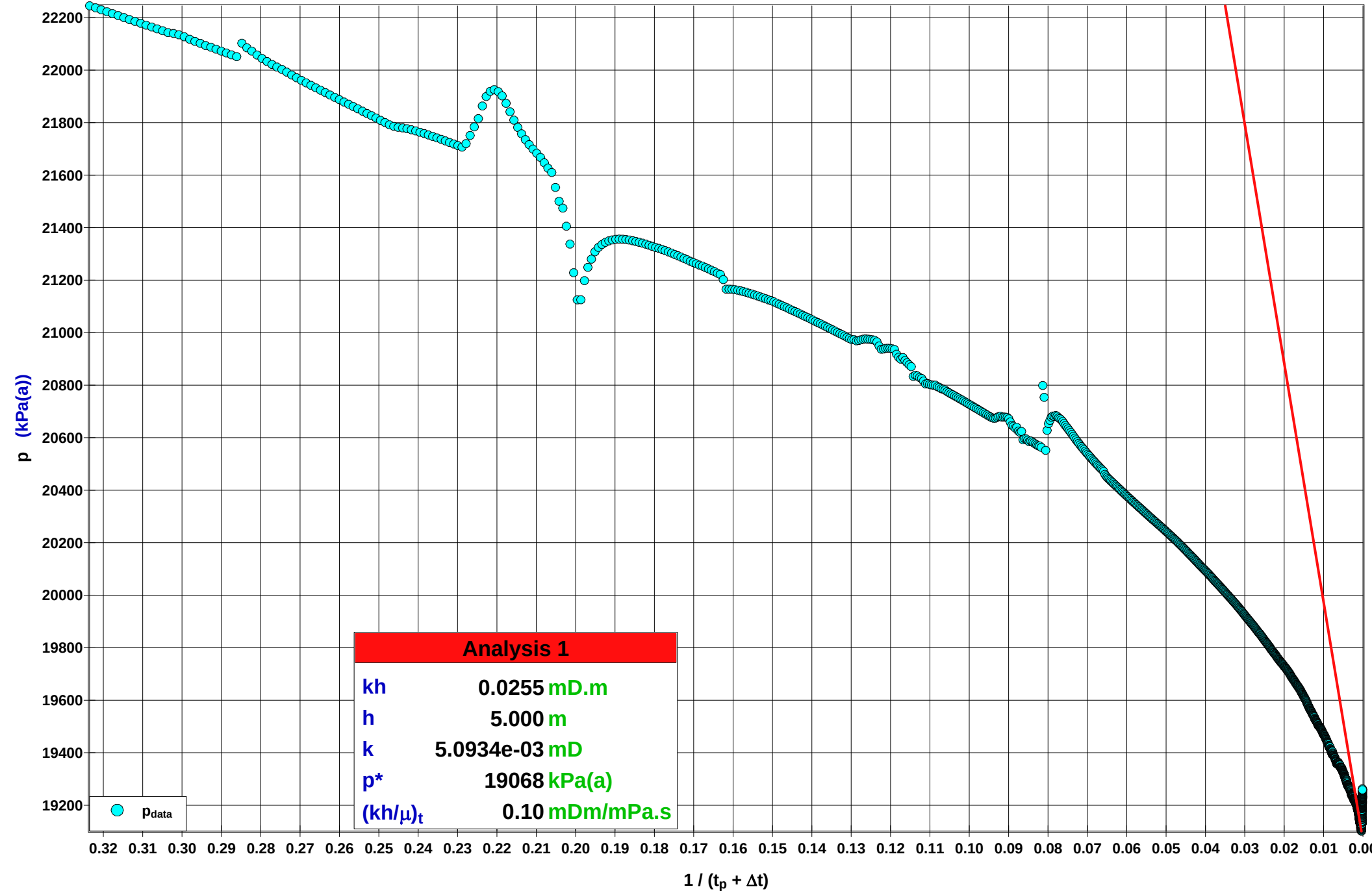
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COPRC Mirror Lake
300/N-20 65-00 126-45

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

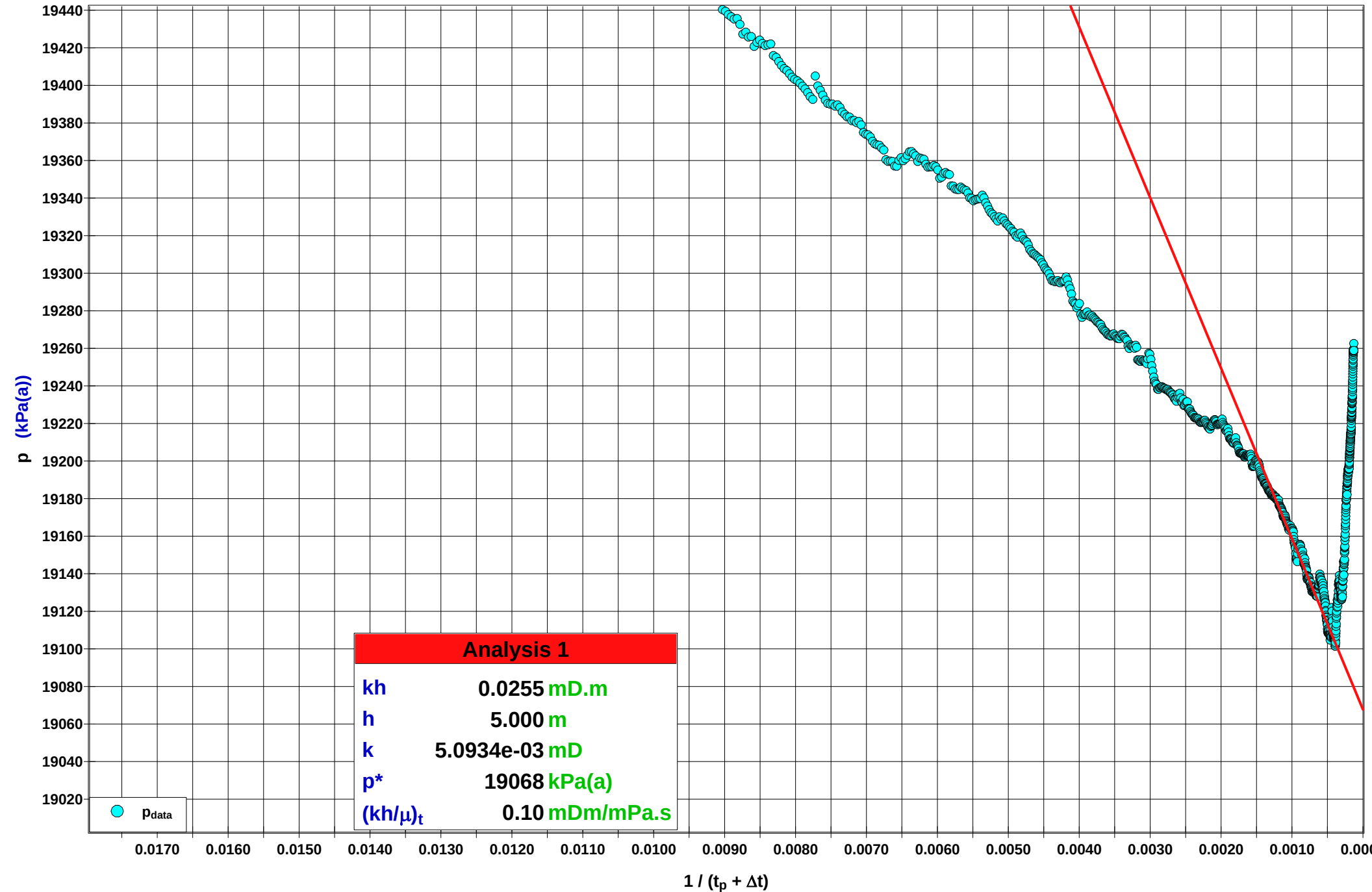
Middle Lower Canol (2023 - 2024 mKB)
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COPRC Mirror Lake
300/N-20 65-00 126-45

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

Middle Lower Canol (2023 - 2024 mKB)
DFIT (Mar 28/13 - Feb 16/14)



Soliman/Craig ACA 1

Linear Analysis

$X_f(\sqrt{k})$	1.00 mD ^{1/2} m
Fracture Half-Length (X_f)	13.839 m
Effective Permeability (k)	5.0934e-03 mD
Skin Equivalent to X_f (S_{xf})	-4.326

Radial Analysis

Flow Capacity (kh)	0.0255 mD.m
Effective Permeability (k)	5.0934e-03 mD
Extrapolated Pressure (p^*)	19068 kPa(a)

Fluid Properties

Oil Gravity (γ_o)	49.9 °API
Bubble Point Pressure (p_{bp})	19252 kPa(a)
Oil Correlation	Vasquez and Beggs
Oil Viscosity Correlation	Beggs & Robinson
Solution Gas Ratio (R_s)	158.45 m ³ /m ³
Oil Viscosity (μ_o)	0.2583 mPa.s
Oil Compressibility (c_o)	3.2079e-06 1/kPa
Oil Formation Volume Factor (B_o)	1.540

Reservoir Properties

Reservoir Temperature (T_{resv})	88.1 °C
Reservoir Pressure (p_{resv})	19259 kPa(a)
Net Pay (h)	5.000 m
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