Suncor Firebag
2019 AER Performance Presentation
Commercial Scheme Approval No. 8870

Reporting Period: March 1, 2018 to February 28, 2019

Section 3.1.1 – Subsurface Issues Related to Resource Evaluation and Recovery

Table of Contents

- Introduction
- Geoscience
- Surface Heave and Caprock Integrity
- Drilling and Completions
- Artificial Lift
- Instrumentation in Wells
- 4D Seismic
- Scheme Performance
- Future Plans
- Compliance Commitments

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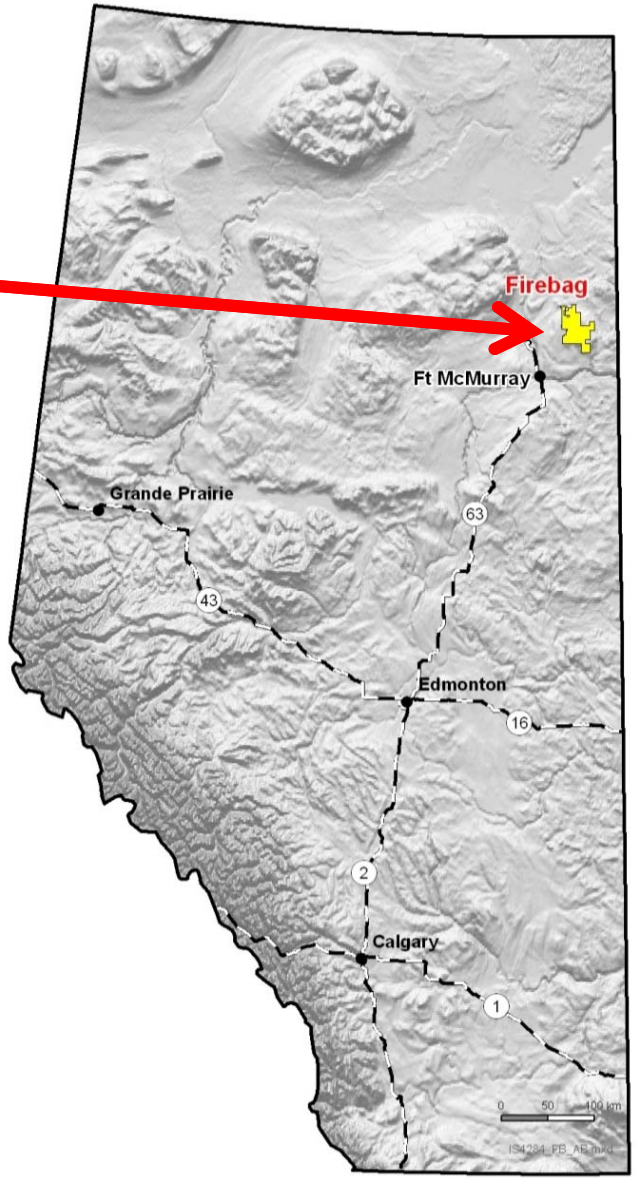
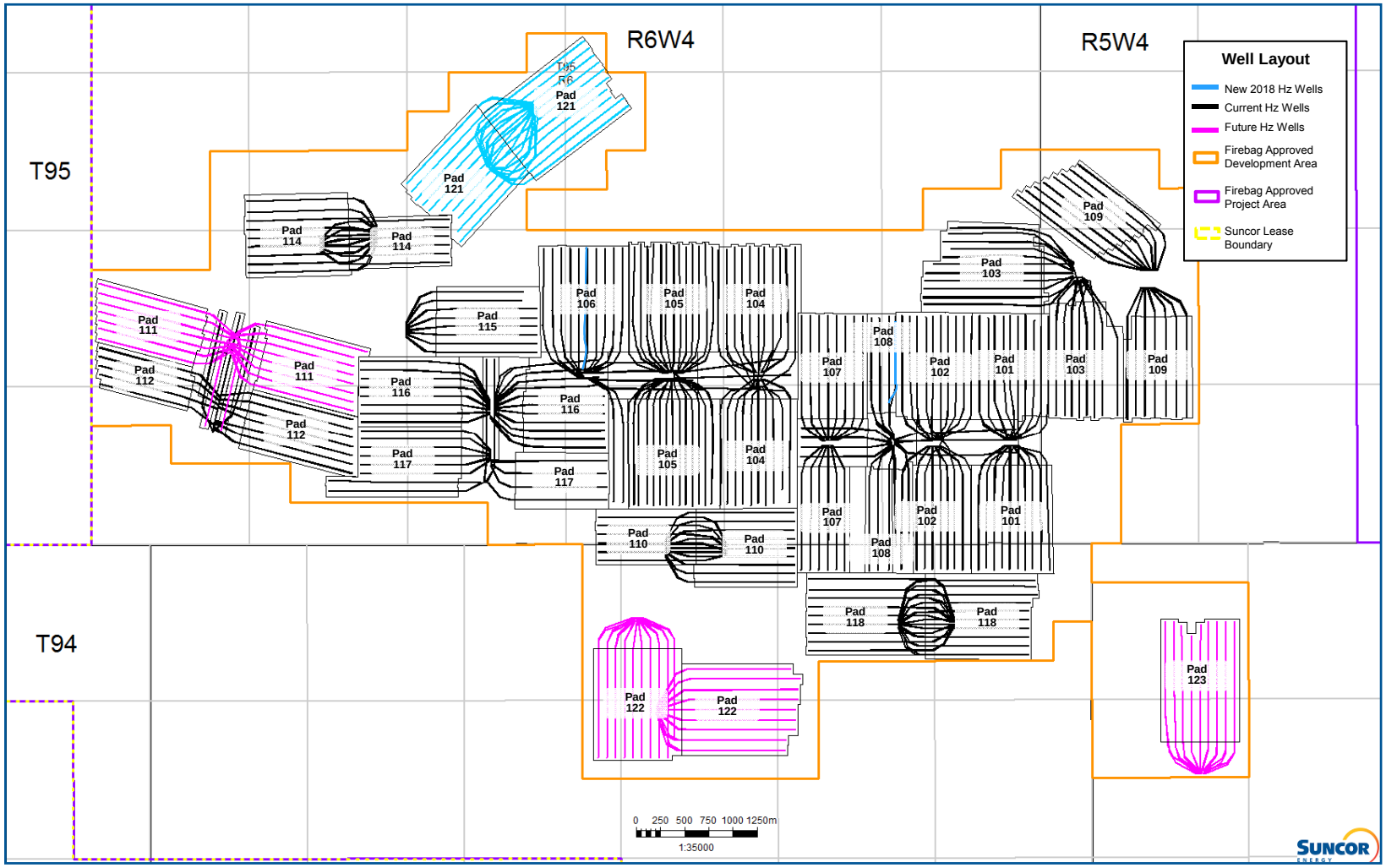
Firebag Project Overview



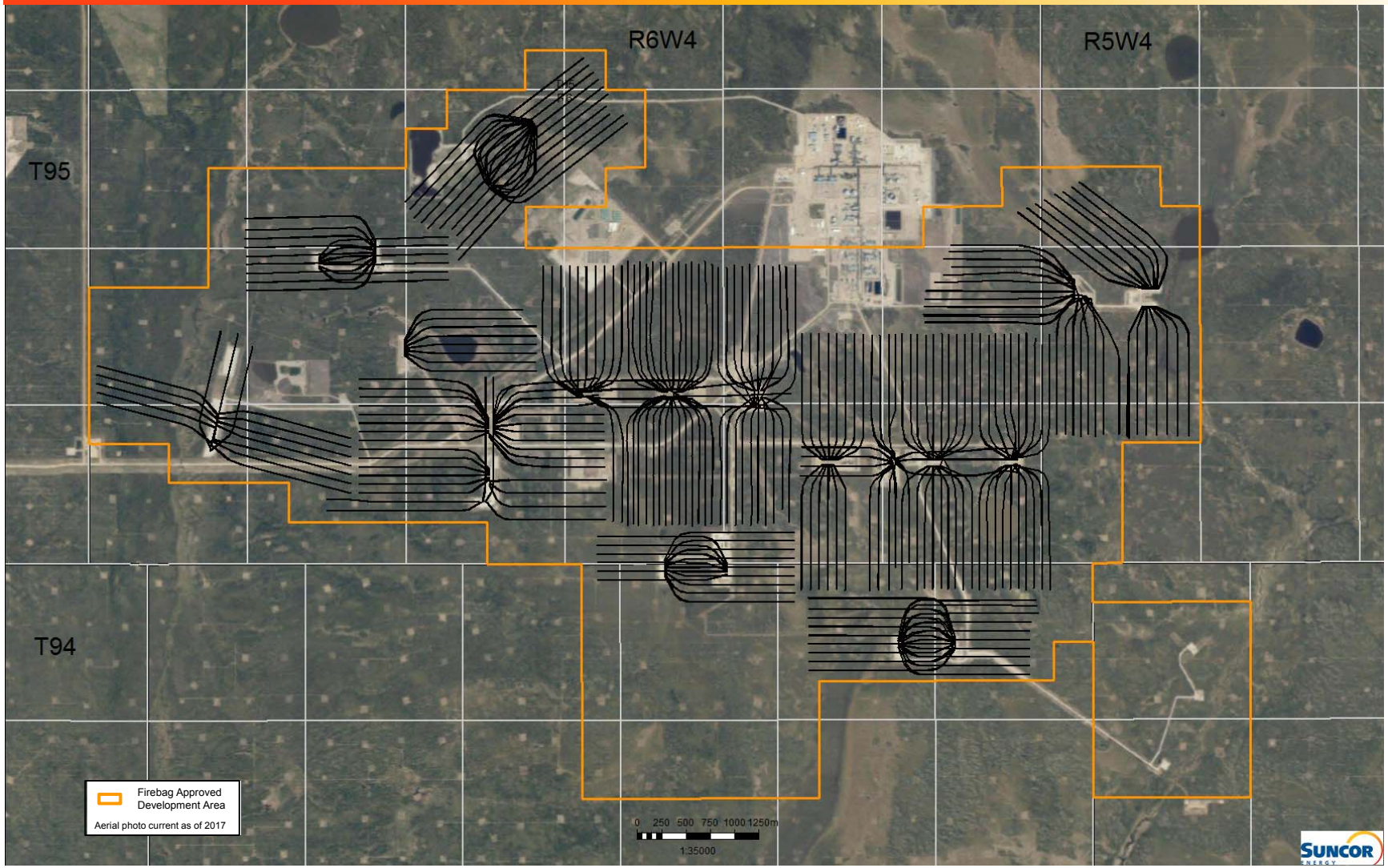
- The Firebag Project is a commercial Steam Assisted Gravity Drainage (SAGD) scheme
- Supplies bitumen to the Oil Sands Upgrader and sales to market
- Average production is 200897 bbl/d (31939 m^3/day) of bitumen with a Steam to Oil Ratio (iSOR) of 2.85

AER Project & Approved Development Areas



Firebag Approval 8870 as of January 2019

Composite Aerial Photo of Firebag



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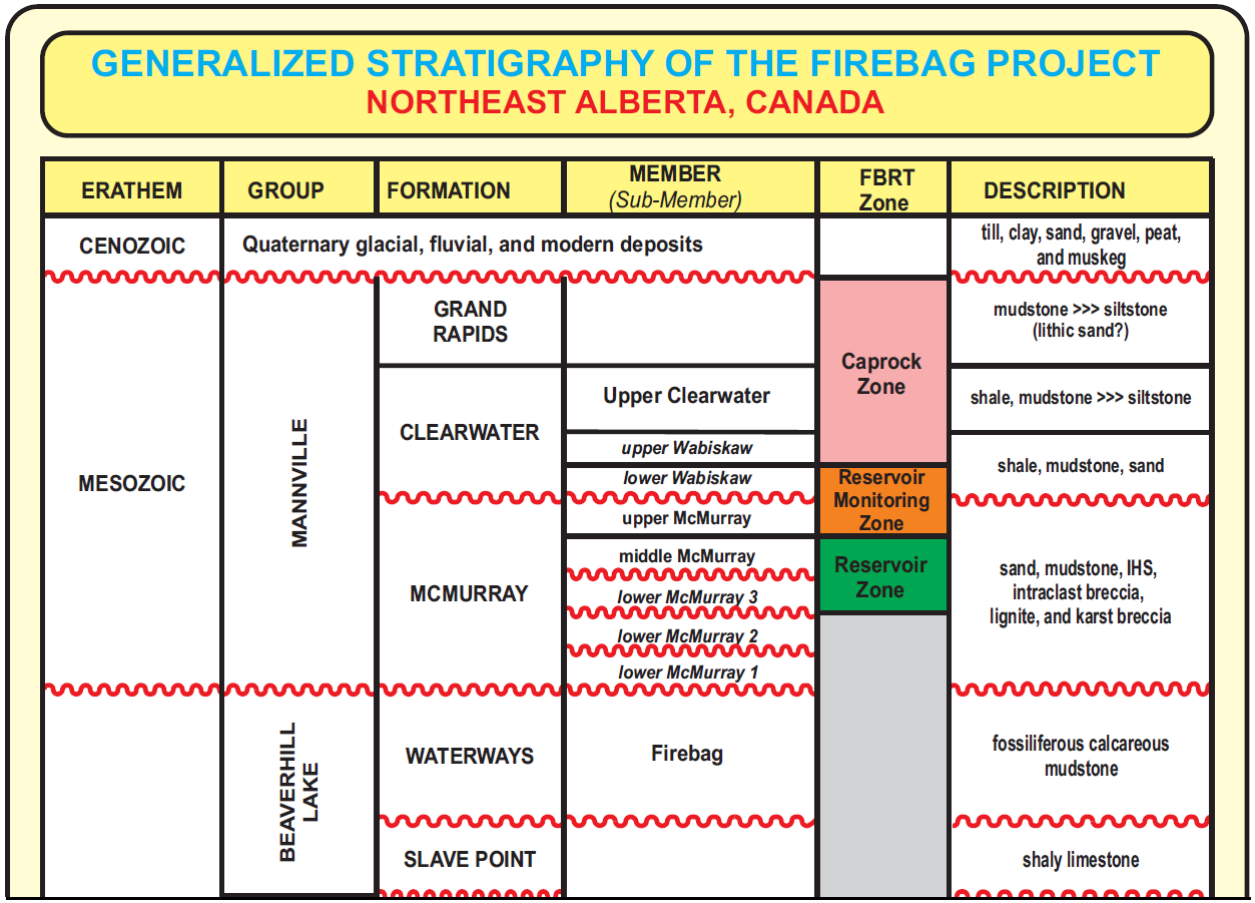
Firebag Stratigraphic Chart



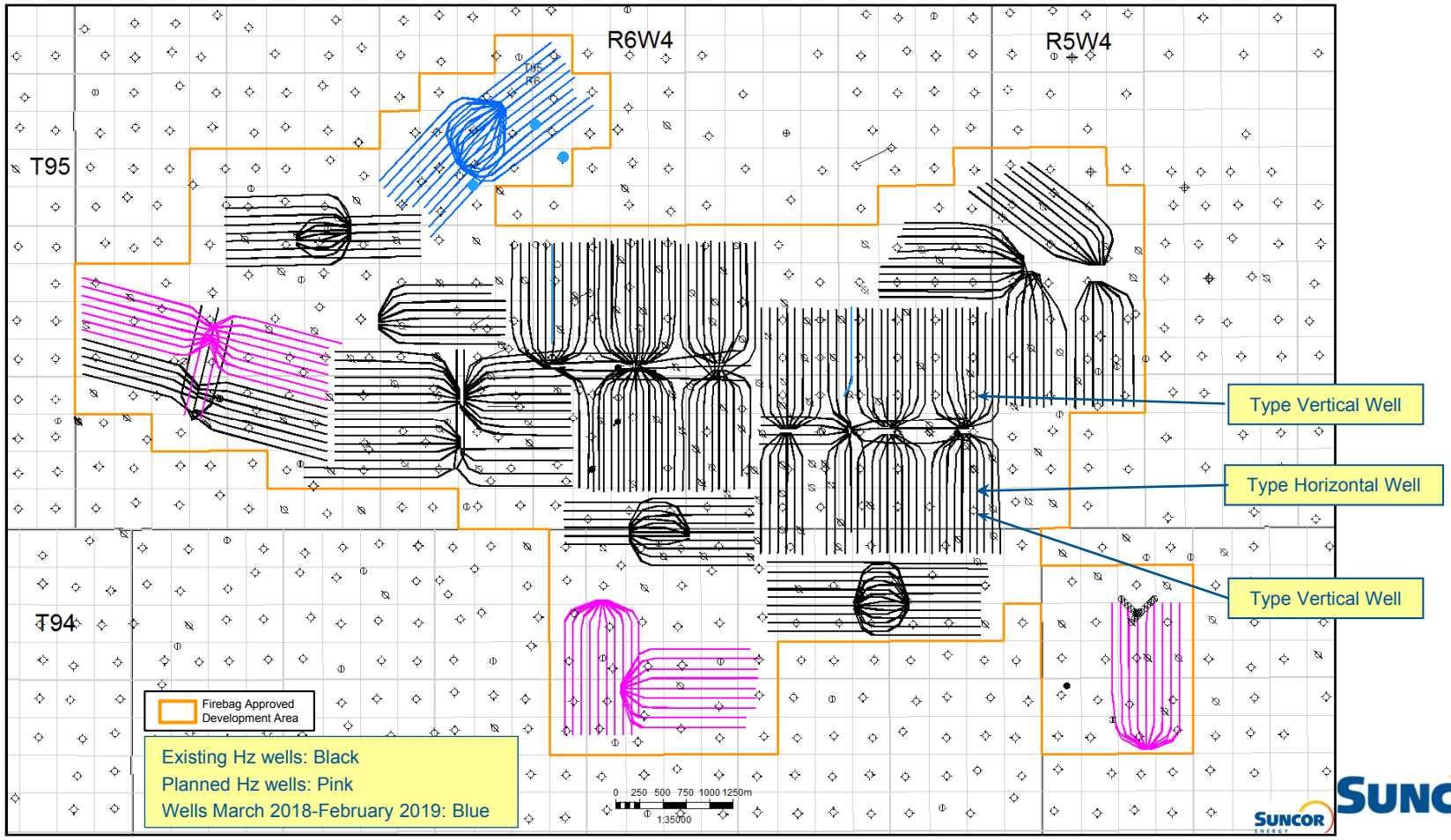
Type Well Location Map

Type Wells

- 1AA/01-01-095-06W4
- 1AA/16-01-095-06W4

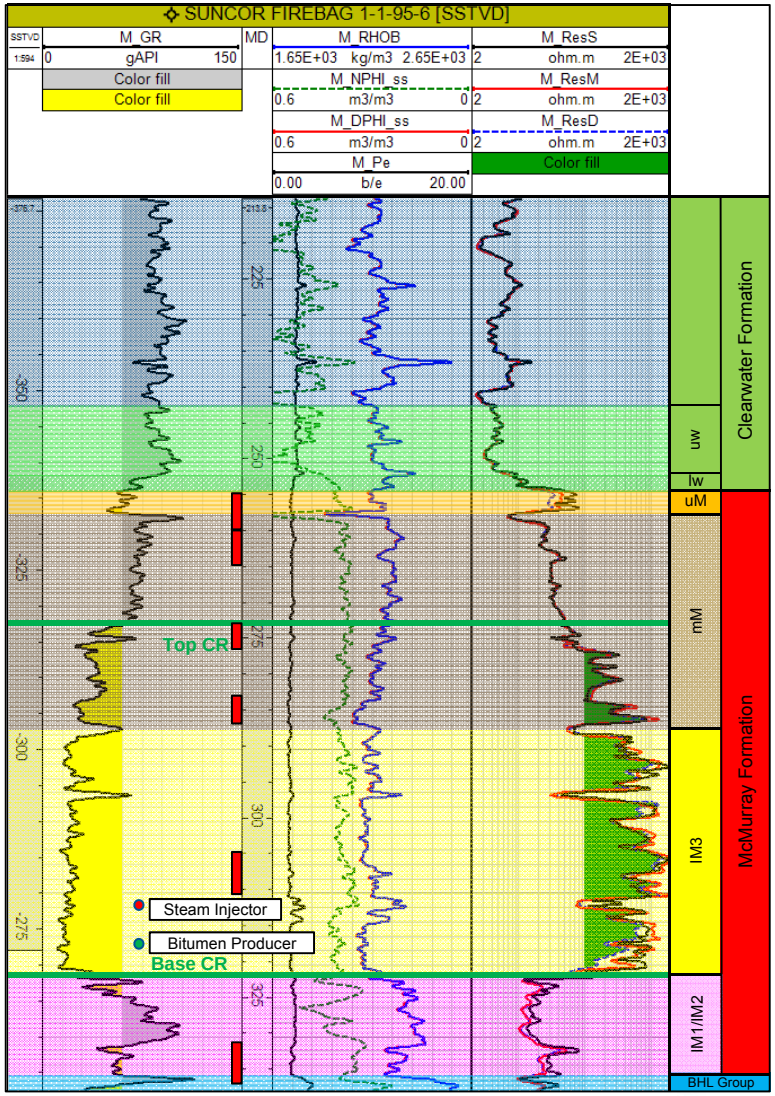
Type Horizontal Well

- Pad 101 Pair 7

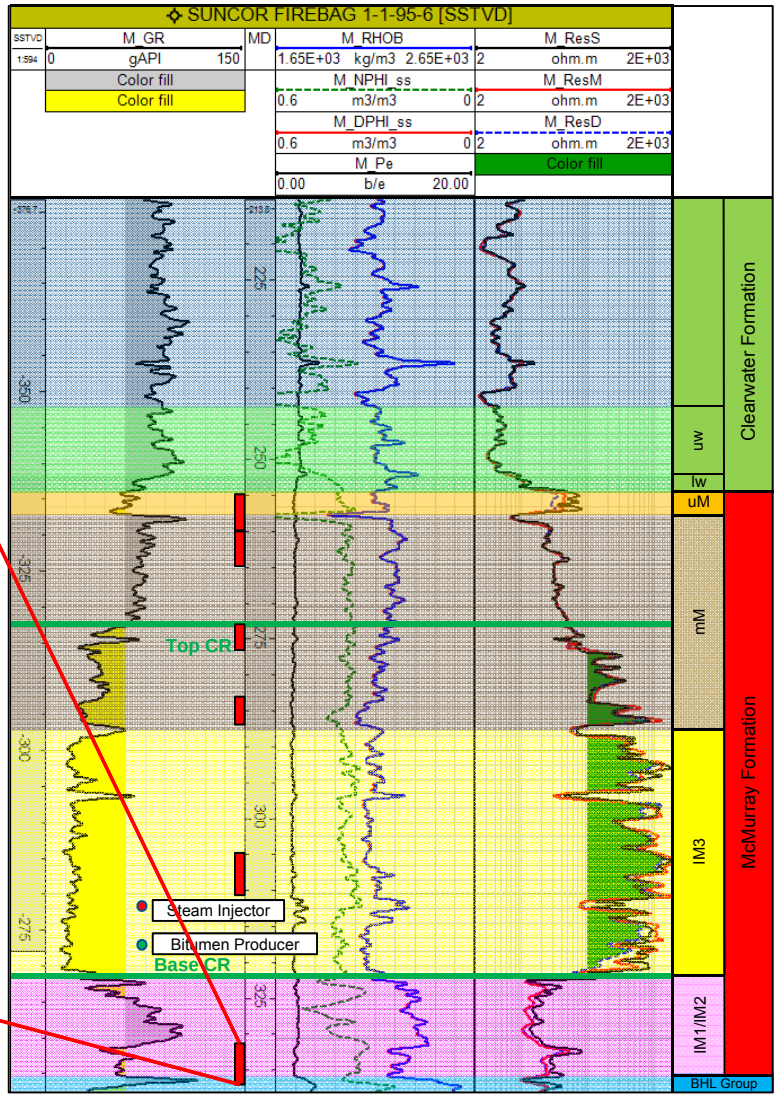


Firebag Type Well 1AA/01-01-095-06W4/00

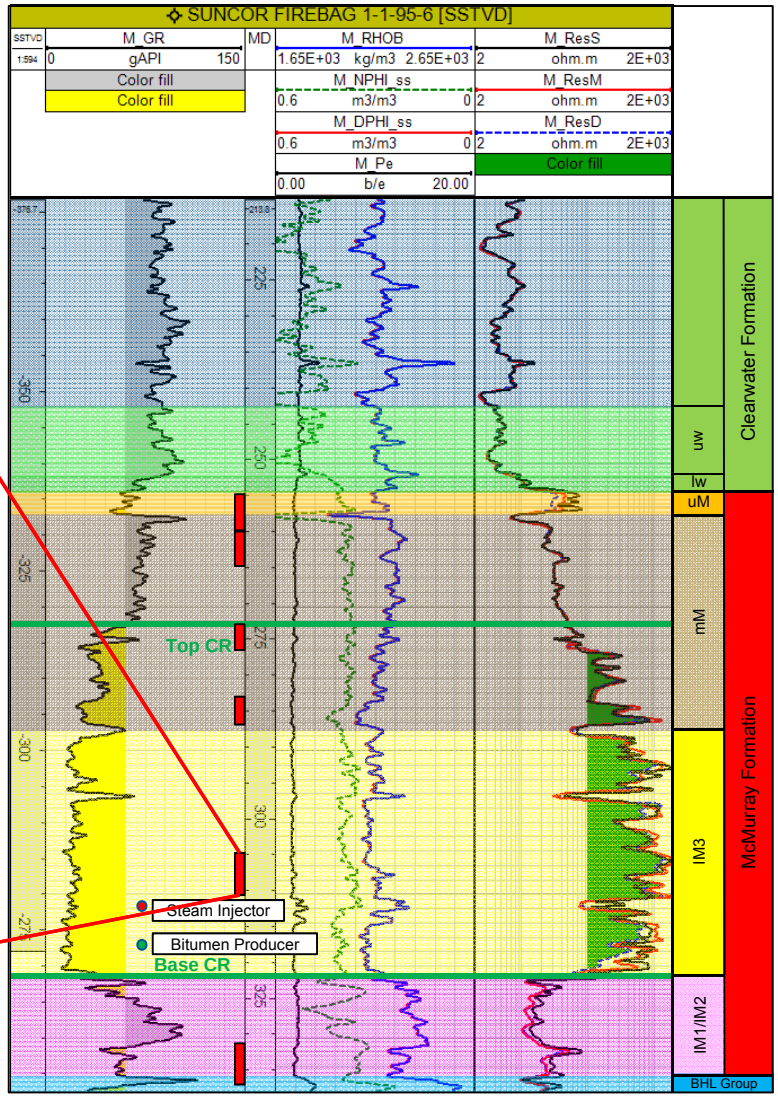
- McMurray Fm: 82.2 m
- upper McMurray: 3.2 m
- middle McMurray: 30.6 m
- lower McMurray 3: 34.4 m
- lower McMurray 2: 13.6 m
- lower McMurray 1: 0.4 m
- Continuous Reservoir (CR) zone:
  - CR thickness: 49.2 m
  - Core Porosity: 35.7%
  - Core Sw: 21.9%
  - Kh: 8-10 D
  - Kv: 4-5 D
- 45 m west of Pad 101 Pair 7



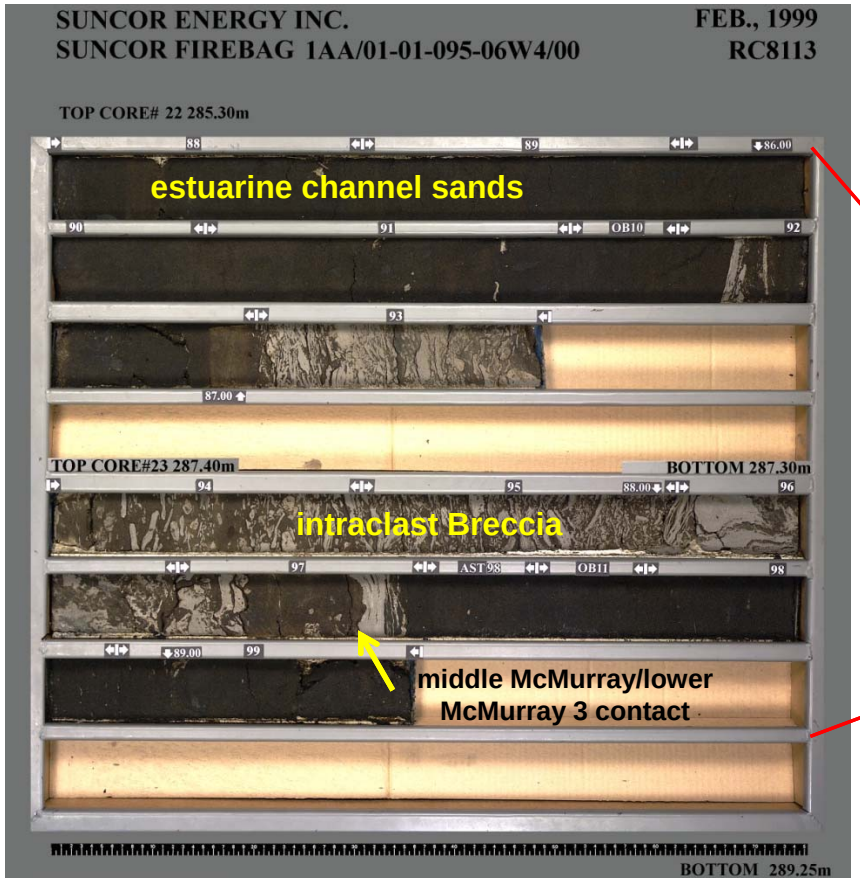
Lower McMurray 1 & 2 Units (Non Reservoir)

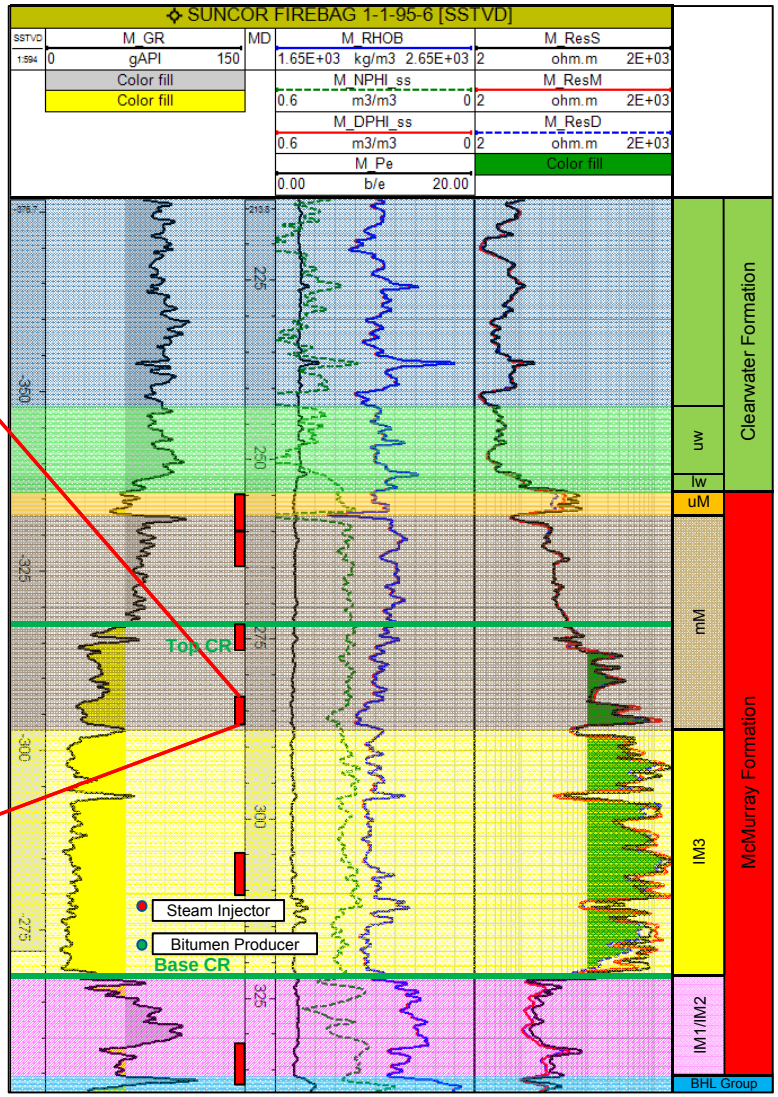


Lower McMurray 3 Oil Sands Reservoir

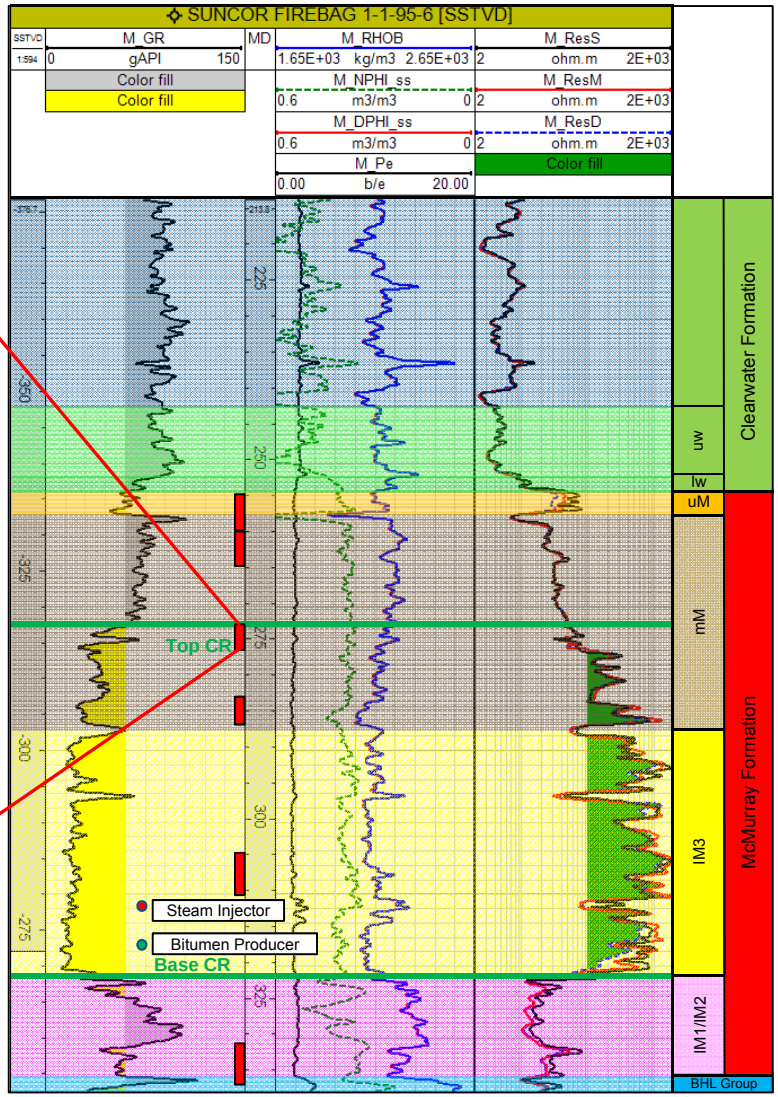


Middle McMurray - Intraclast Breccia





Middle McMurray Estuarine Channels and Associated Point Bars



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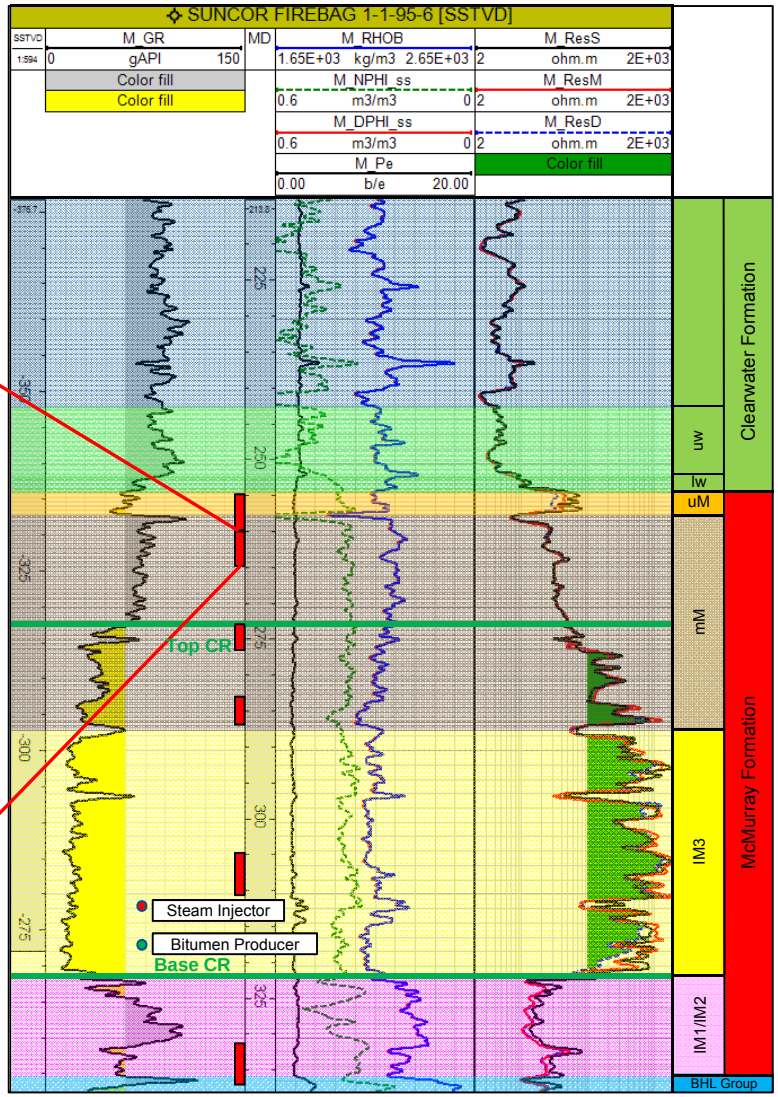
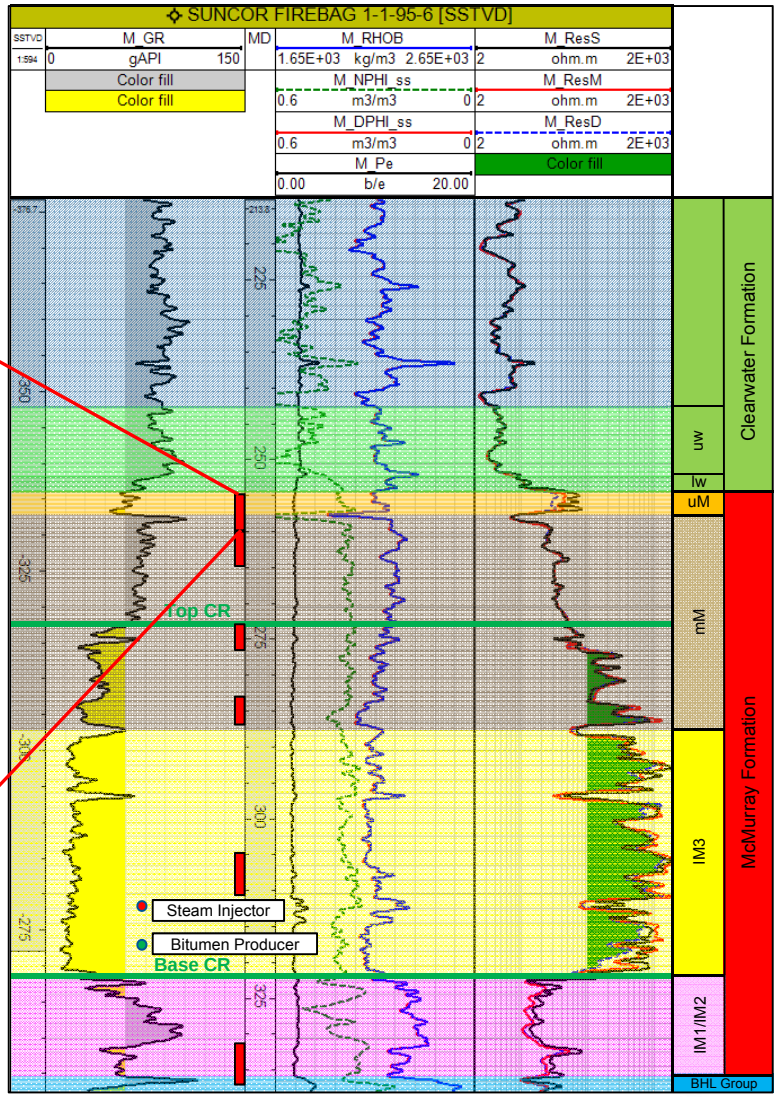
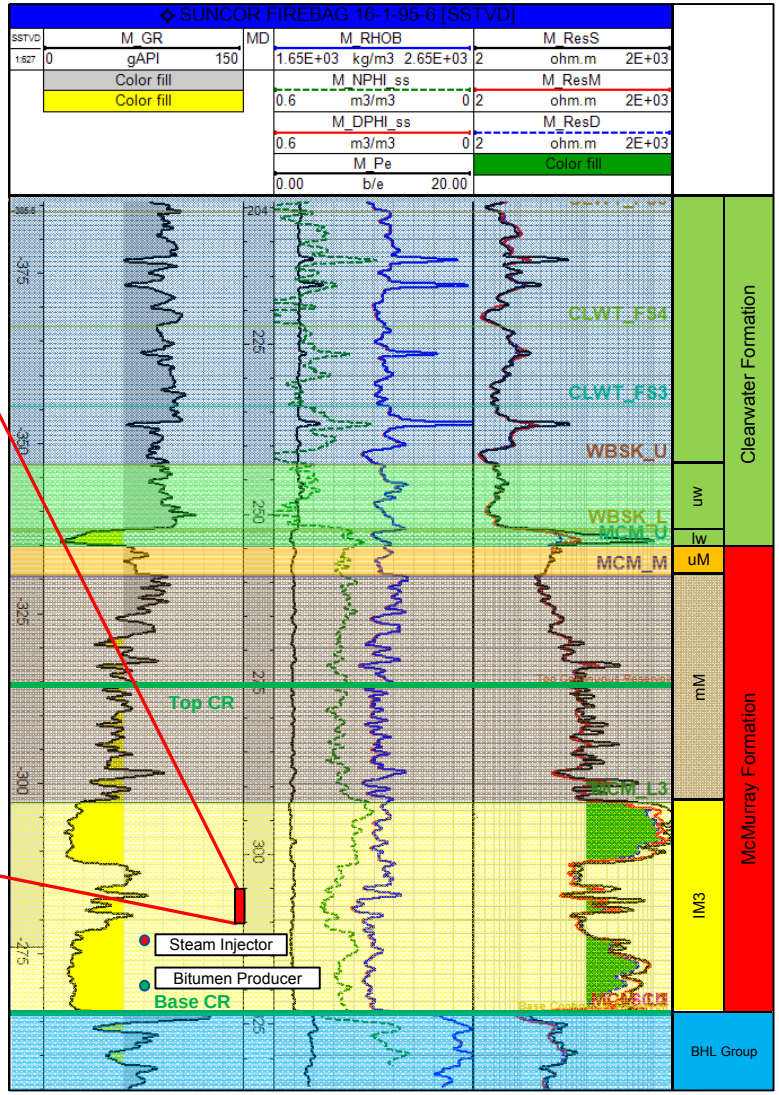


Middle McMurray and Upper McMurray Units

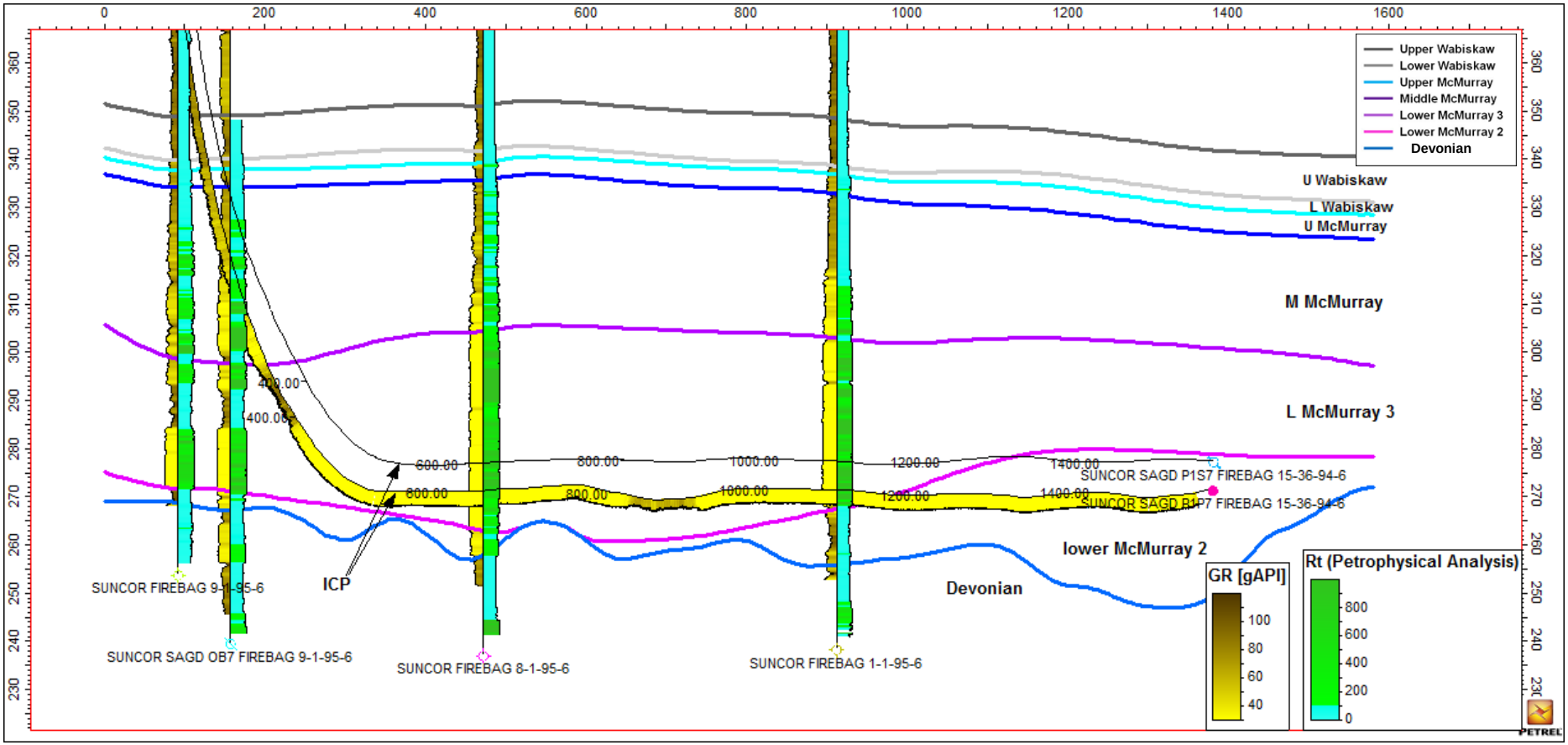


Firebag Type Well 1AA/16-01-095-06W4/00



- Lower McMurray 3 floodplain mud
- Reservoir quality within McMurray varies and can present challenges

Pad 101 Pair 7 Structural Cross Section



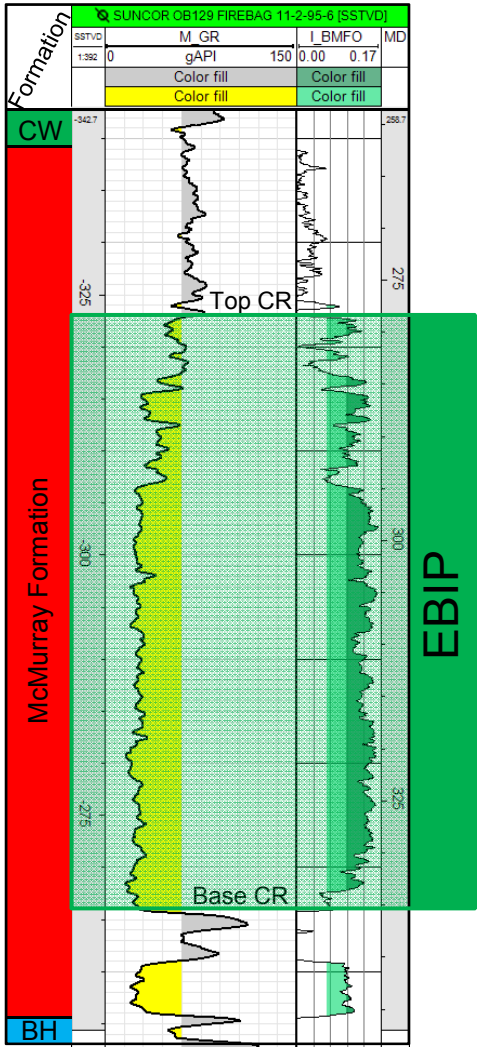
*Coreholes are projected onto cross section

EBIP Methodology

- EBIP is defined in each well by the top and base of Continuous Reservoir. It is selected at the base of a continuous sand unit either developed or most likely to be developed.
  - Continuous Reservoir base: lowest portion of the continuous reservoir sandstone with BMFO cut off of 6%, <3 m of >50% mud/breccia in the lower portion.
  - Continuous Reservoir top: 2 m of mudstone, no BMFO or porosity cut offs.

- Upper Lean, Middle Lean, Gas Zones that are in pressure communication with the continuous reservoir are included, with no thickness cutoffs.

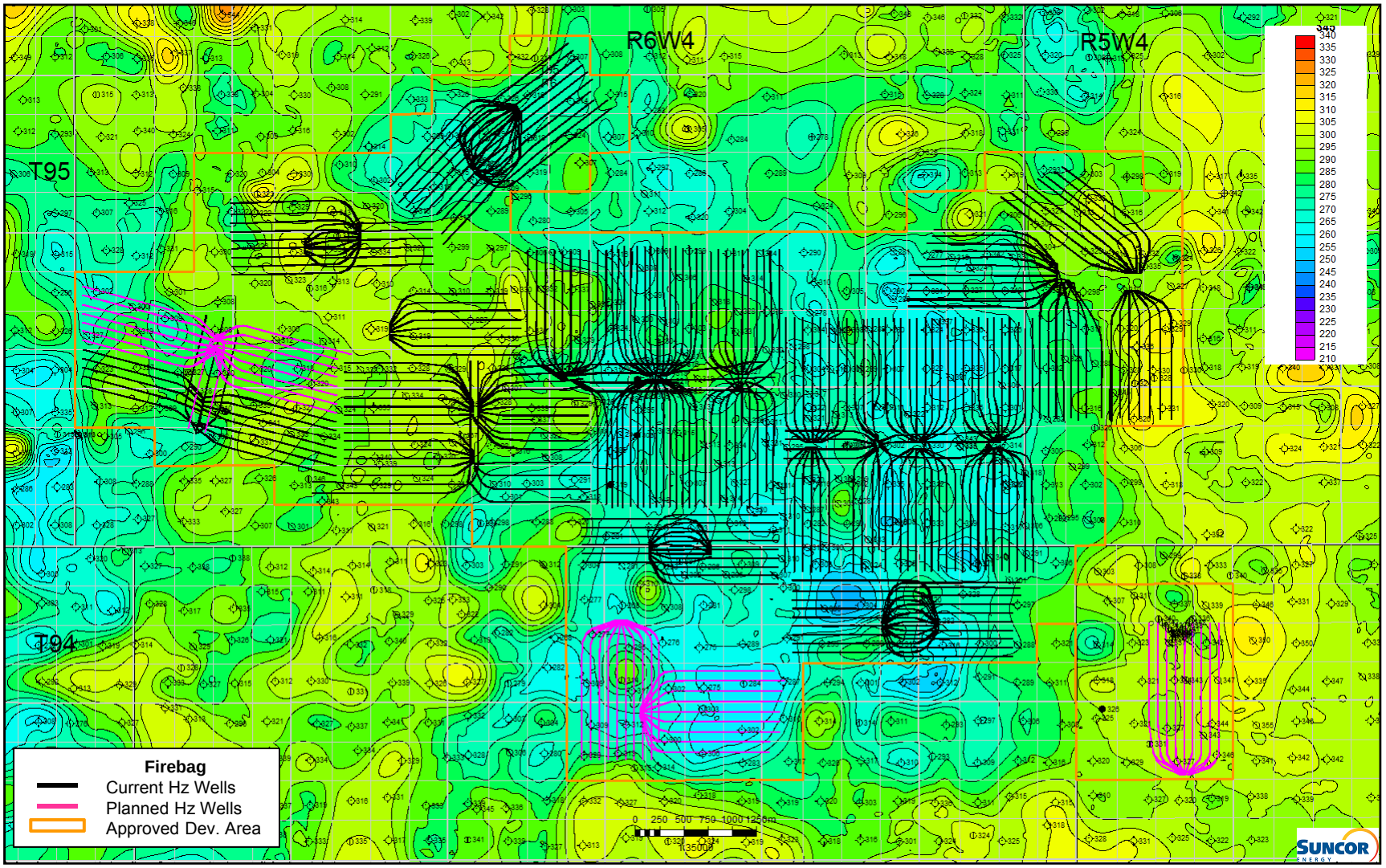
- Observation wells and 4D seismic will take precedence over the geology pick.



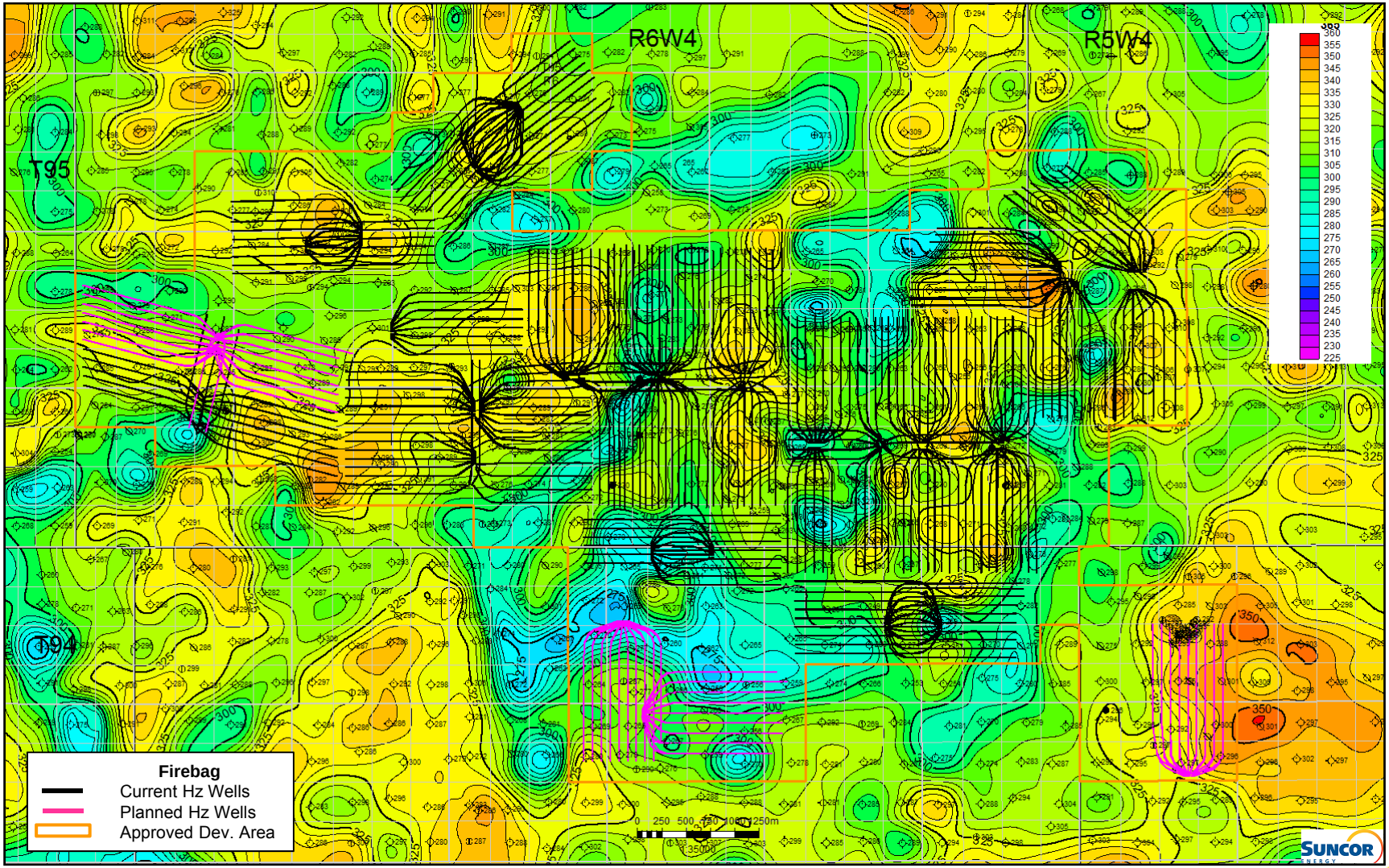
CW: Clearwater Formation
BH: Beaverhill Lake Group

EBIP: Exploitable Bitumen in Place

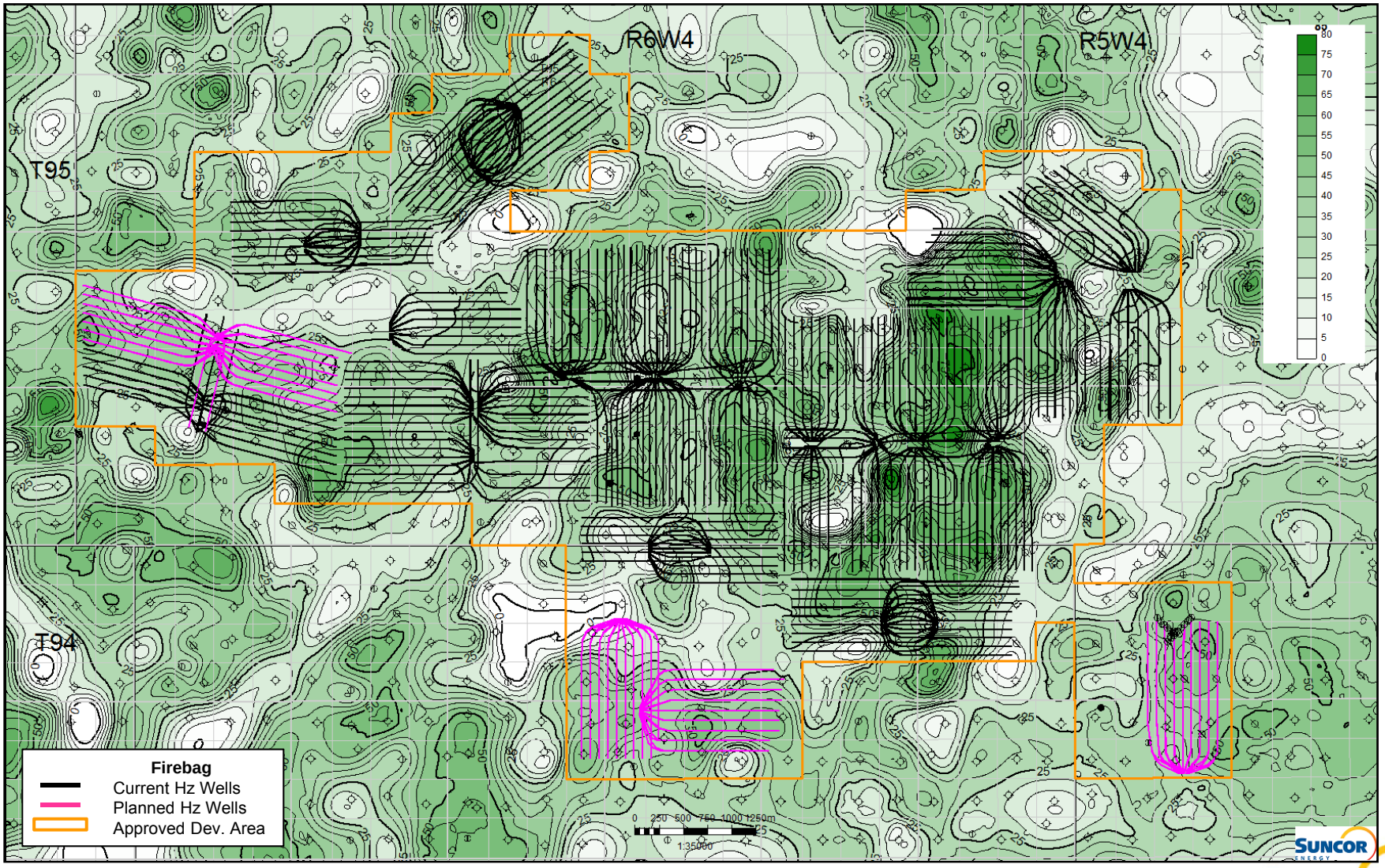
Structure Map of Base Continuous Reservoir



Structure Map of Top Continuous Reservoir



Isopach Map of Continuous Reservoir



Exploitable Bitumen in Place (EBIP) & Average Reservoir Properties

	HC Area (m^2)	Continuous Reservoir Thickness (m)	Continuous Reservoir Volume (e^6m^3)	Porosity	Oil Saturation	Formation Volume Factor	EBIP[1] (e^6m^3)	EBIP[1] (MMbbl)
SAGD Pad 101	1,808,412	53.5	97	0.320	0.78	1	24.1	151.9
SAGD Pad 102	1,537,454	52.2	80	0.318	0.75	1	19.1	119.8
SAGD Pad 103	1,924,325	42.4	83	0.317	0.74	1	19.7	124.1
SAGD Pad 104	1,834,349	45.3	83	0.320	0.76	1	20.4	128.0
SAGD Pad 105	2,625,740	36.9	93	0.325	0.78	1	23.5	147.9
SAGD Pad 106	1,684,110	36.7	67	0.325	0.80	1	17.4	109.2
SAGD Pad 107	1,381,092	38.2	53	0.319	0.75	1	12.7	79.8
SAGD Pad 108	1,701,256	42.1	73	0.321	0.74	1	17.6	110.6
SAGD Pad 109	1,485,780	24.3	36	0.328	0.76	1	9.0	56.5
SAGD Pad 110	1,448,999	26.8	41	0.322	0.71	1	9.1	57.4
SAGD Pad 111	1,603,843	32.7	54	0.328	0.79	1	13.8	86.7
SAGD Pad 112	1,453,328	35.6	57	0.336	0.78	1	14.6	91.9
SAGD Pad 114	1,468,799	33.5	50	0.323	0.77	1	12.3	77.7
SAGD Pad 115	779,666	29.0	23	0.327	0.74	1	5.4	34.2
SAGD Pad 116	1,660,636	38.8	65	0.326	0.78	1	16.5	103.5
SAGD Pad 117	1,573,171	32.3	53	0.322	0.73	1	12.5	78.8
SAGD Pad 118	2,027,666	37.0	75	0.313	0.76	1	17.9	112.7
SAGD Pad 121	2,265,594	41.9	95	0.327	0.72	1	22.6	140.7
SAGD Pad 122	2,160,572	35.4	77	0.314	0.69	1	16.7	104.9
SAGD Pad 123	1,004,661	41.7	42	0.318	0.75	1	10.0	63.1
SAGD TOTAL	**33,429,452**	**37.7**	**1295**	**0.324**	**0.76**	**1**	**314.7**	**1,979.2**
Firebag Approved Project Area	**192,168,761**	**29.6**	**5,680**	**0.319**	**0.71**	**1**	**1,282**	**8,065**

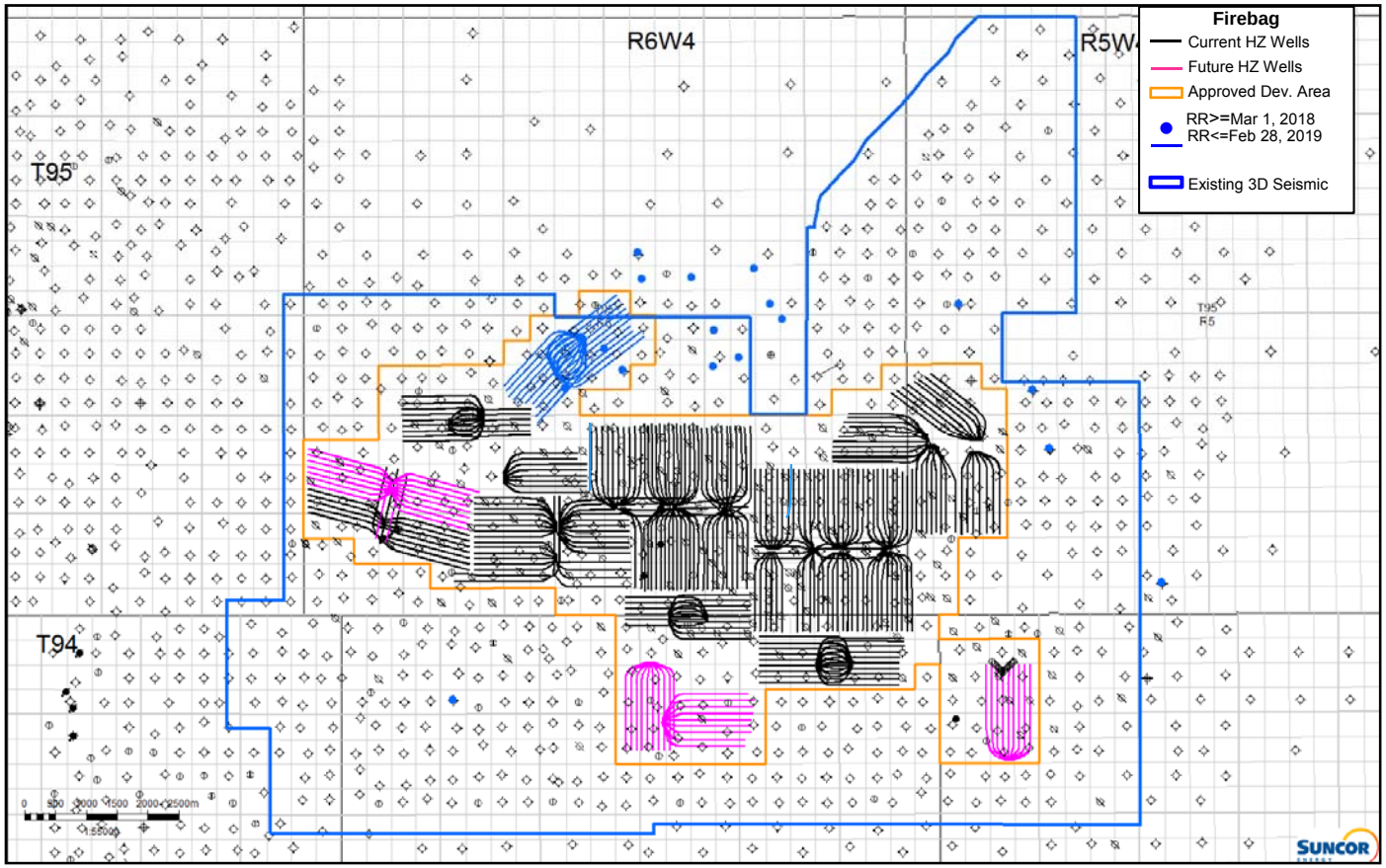
EBIP: Exploitable Bitumen in Place
HC: Hydrocarbon

Changes from last year reflect data from new coreholes, observation wells, time lapse seismic and some reinterpretation. EBIP procedure remains unchanged

Average Reservoir Properties

- Average reservoir properties for the operating portion of the scheme (Pads ***101-110*** and Pads ***114 - 118***)
  - Initial reservoir pressure: 800kPa
  - Initial reservoir temperature: 8°C
  - Average continuous reservoir= 38.0 m
  - Average porosity = 0.324
  - Average oil saturation = 0.76
  - Effective horizontal permeability: 3 to 4 D
  - Effective vertical permeability: 2 to 3 D
  - Viscosity: ~ 11cp @ 215°C

2018/2019 Winter Delineation Program



- Existing wells in black
- Planned wells in pink
- Wells rig released between Mar 1, 2018 – Feb 28, 2019 in blue

2018/2019 Testing Activity

- McMurray Injectivity Tests in NE and SE of Firebag
  - Test objective was to measure water and gas mobility across McMurray zone to optimize SAGD development
  - Tests were conducted as per AER approvals
  - Tests were completed in March 2019

- Micro-Fracture Injection Testing (Mini-frac)
  - OB 145 in the McMurray and Clearwater
  - OB 148 in the Clearwater

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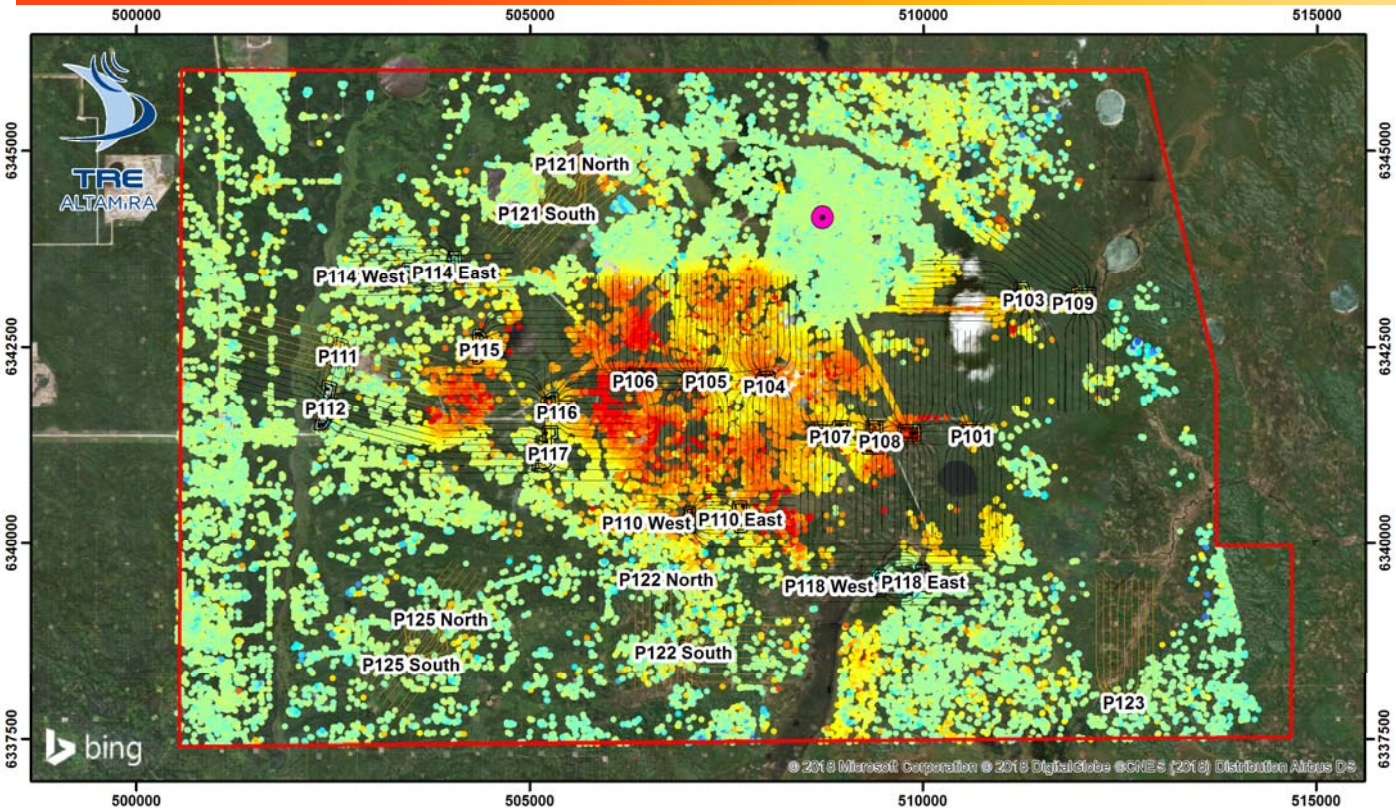
Firebag InSAR Cumulative Heave May 2013 to Oct 2018



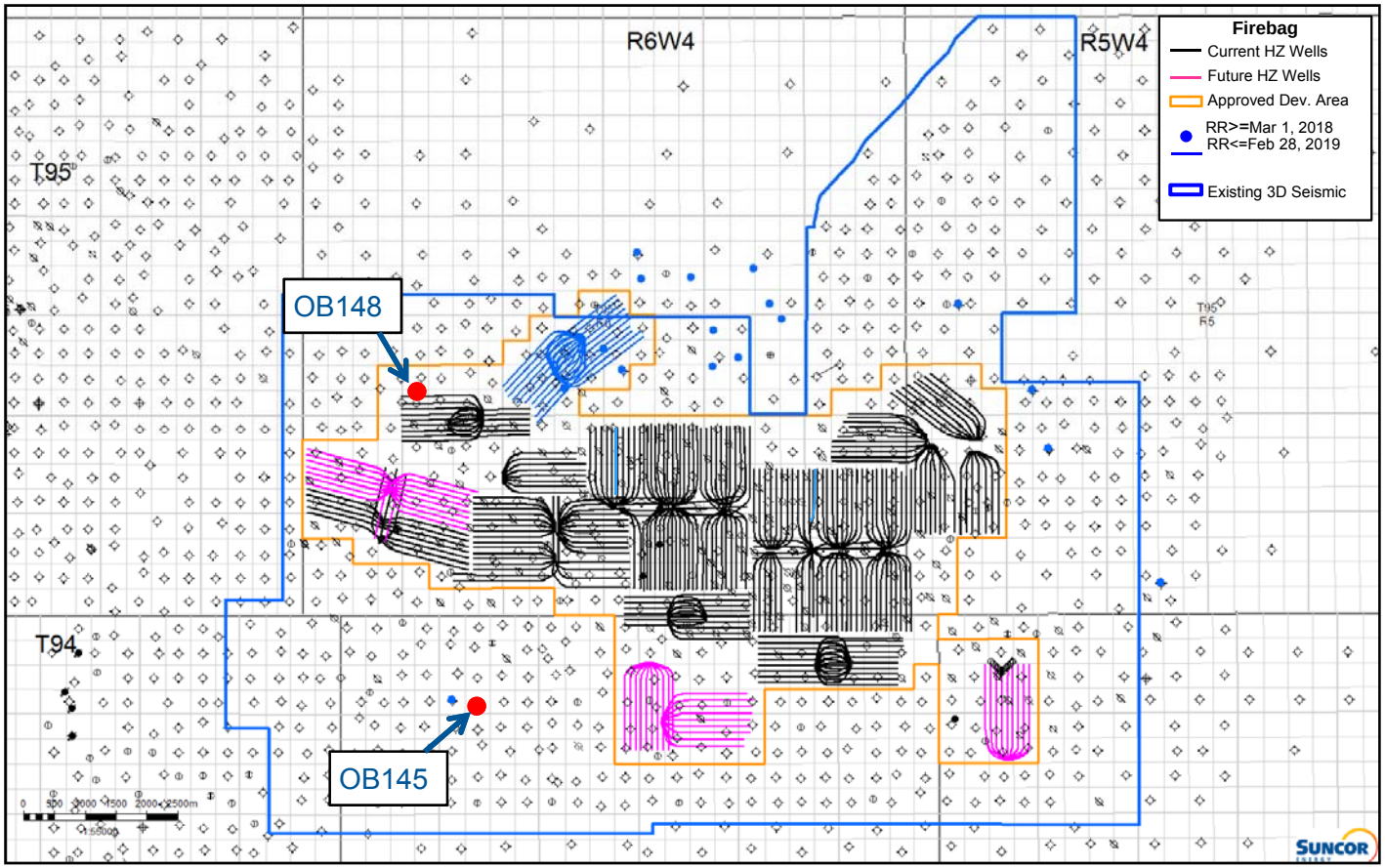
Cumulative Displacement [mm]

≤-150 0 ≥+150

- Maximum heave of 212 mm observed at Pad 105 / Pad 106
- Heave data is used to:
  - Calibrate geomechanical models
  - Monitor subsurface safety (flag areas which look anomalous)

Caprock – Geological Activity

- New Mini-frac data for the following wells
  - OB145: McMurray and Clearwater
  - OB148: Clearwater
- New wells and seismic surveyed:
- **2017/2018 Summary**
  - OB 224, 226
- **2018/2019 Summary**
  - OB 221, 222, 223, 225, 227, 228, 229



Caprock Integrity Assurance

- Two new mini-fracs in the reporting period
  - OB 145 to assess the McMurray and Clearwater in the SW
  - OB 148 to assess the Clearwater in the NW
- Suncor Geomechanical Modeling
  - Geomechanical simulations are run to assess all new pad startups

- All of these activities confirm that operating at the approved MOP does not impact Firebag Caprock Integrity

Reservoir Fracture Closure Gradients 2019 (2 new wells)

Date	Well	Well Alias	TVD Perforated Interval (mKB)	Target	Minimum Stress (kPaa)	Fracture Closure Gradient (kPag/mGL)
15-Mar-12	01-16-095-06W4	OB134	297-298	lower McMurray 3 sand	5238.9	17.6
17-Mar-12	09-09-095-06W4	OB135	263-264	middle McMurray sand	5106.1	19.3
13-Mar-12	11-10-095-06W4	OB136	268-269	middle McMurray sand	4835.6	18.0
23-Feb-14	16-07-095-05W4	OB205	273-274	lower McMurray 3 sand	4319.7	15.7
11-Feb-15	05-07-095-06W4	OB147	255-258	middle McMurray sand	3868.3	15.1
10-Feb-16	15-26-094-06W4	OB140	296-299	middle McMurray sand	6171.9	20.6
8-Jan-19	03-32-094-06W4	OB145	272-275	middle McMurray sand	5330.4	19.5
16-Mar-12	01-16-095-06W4	OB134	277-278	middle McMurray mudstone	5398.7	19.4
18-Mar-12	09-09-095-06W4	OB135	247.5-248.5	middle McMurray mudstone	4020.2	16.1
13-Mar-12	11-10-095-06W4	OB136	257-258	middle McMurray mudstone	4910.0	19.0
24-Feb-14	16-07-095-05W4	OB205	247-248	middle McMurray IHS	4407.6	17.7
12-Feb-15	05-07-095-06W4	OB147	227-228	middle McMurray mudstone	4111.5	18.0
10-Feb-16	15-26-094-06W4	OB140	276-277	middle McMurray mudstone	4731.0	16.9
16-Mar-12	01-16-095-06W4	OB134	253.5-254.5	Wabiskaw/lower Clearwater	5482.5	21.6
18-Mar-12	09-09-095-06W4	OB135	231-232	Wabiskaw/lower Clearwater	5060.2	21.9
14-Mar-12	11-10-095-06W4	OB136	238-239	Wabiskaw/lower Clearwater	4532.7	19.0
5-Mar-13	01-09-095-06W4	OB182	232.5-233.5	Wabiskaw/lower Clearwater	5237.2	22.5
25-Feb-14	16-07-095-05W4	OB205	225.5-226.5	Wabiskaw/lower Clearwater	4952.2	22.0
12-Feb-15	05-07-095-06W4	OB147	209.5-210.5	Wabiskaw/lower Clearwater	4679.0	22.3
11-Feb-16	15-26-094-06W4	OB140	250.5-251.5	Wabiskaw/lower Clearwater	5434.6	22.3
16-Feb-17	07-31-094-05W4	OB184	225.5-226.5	Wabiskaw/lower Clearwater	4915.9	22.2
10-Jan-19	03-32-094-06W4	OB145	229.0-230.0	Wabiskaw/lower Clearwater	5464.9	23.8
3-Feb-19	04-17-095-06W4	OB148	219.5-220.5	Wabiskaw/lower Clearwater	4993.3	22.7

Note - Suncor limits Fracture Closure Gradient to Overburden Gradient (~21.5 kPag/mGL)

- No change recommended to currently approved injection pressures:
  - 4,040 kPag Startup MOP based on an 80% S.F. overburden based closure pressure
  - 3,570 kPag MOP during production phase

Pressure Monitoring

- Surface injection pressure is limited to approved overburden based MOP during startup and production phase
- All existing injection wells are set up to monitor downhole pressure
  - Some wells have thermocouple or fiber optic temperature monitoring along the horizontal for startup
- Production wells capable of periodically monitoring pressure via blanket gas during startup period

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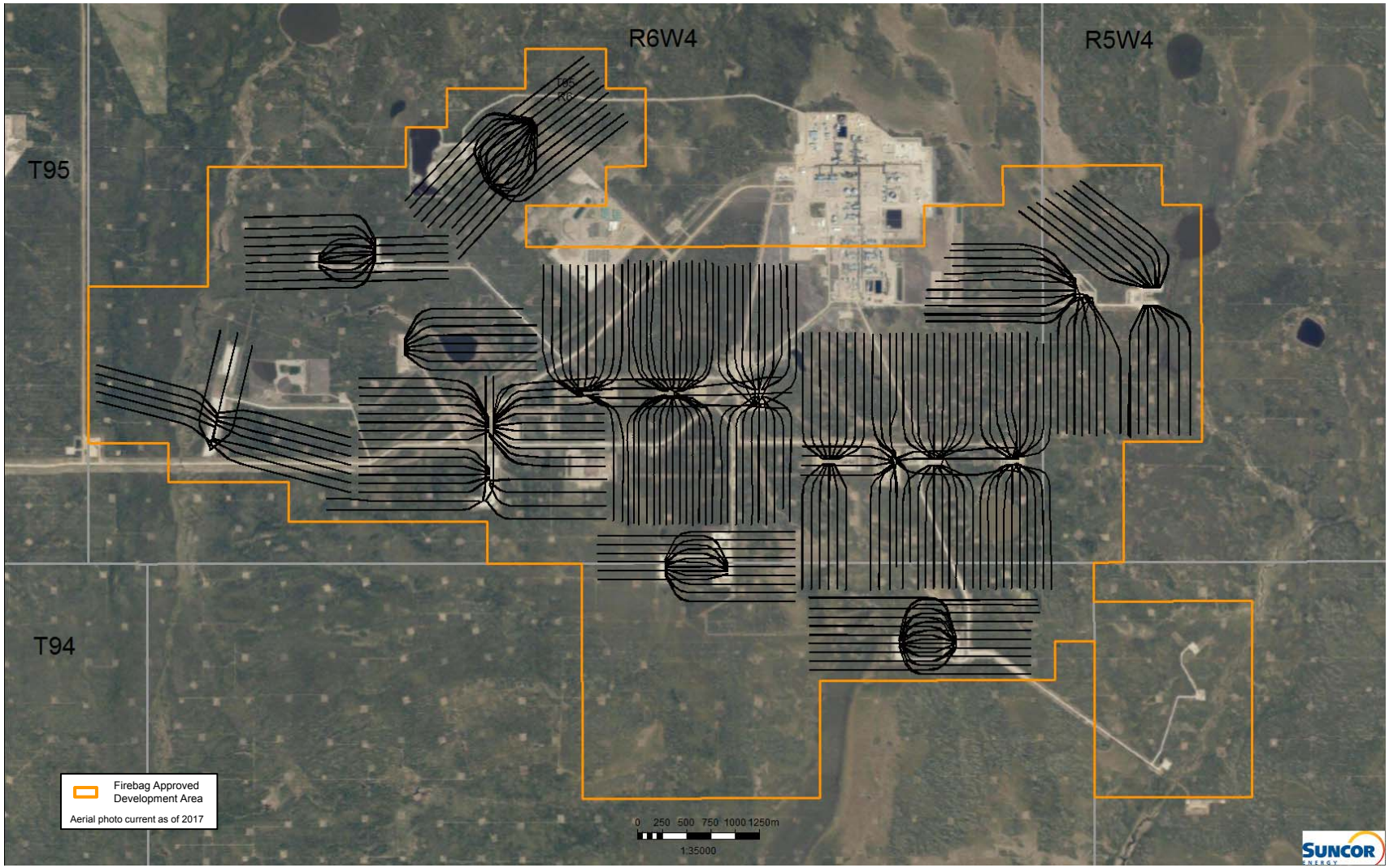
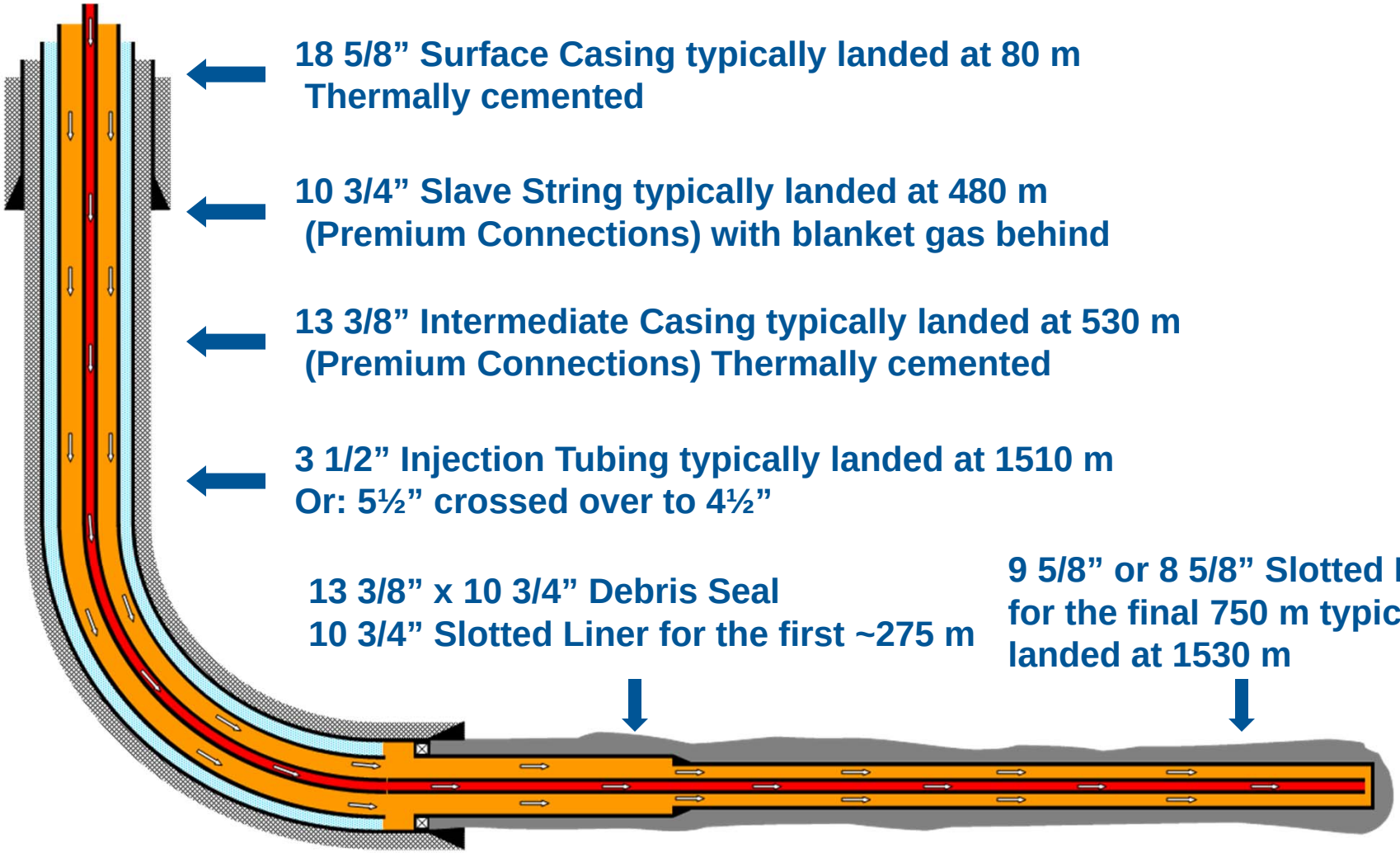
SAGD Well Layout



Drilled SAGD Pads Interwell Spacing

Pad	Average Interwell Spacing (m)
SAGD Pad 101	160
SAGD Pad 101 Post -infills	80
SAGD Pad 102	160
SAGD Pad 102 Post -infills	80
SAGD Pad 103	160
SAGD Pad 103 Post -infills	80
SAGD Pad 104	160
SAGD Pad 104 Post -infills	80
SAGD Pad 105 North & South	130
SAGD Pad 105 North & South Post -infills	65
SAGD Pad 105 East	120
SAGD Pad 106	90
SAGD Pad 107	90
SAGD Pad 108 North & South	90
SAGD Pad 108 East	115
SAGD Pad 108 West	100
SAGD Pad 109 North	90
SAGD Pad 109 South	100
SAGD Pad 110	90
SAGD Pad 112	90
SAGD Pad 114	90
SAGD Pad 115	90
SAGD Pad 116	90
SAGD Pad 117 North	80
SAGD Pad 117 East	135
SAGD Pad 117 West	90
SAGD Pad 118 (P1-P2)	45
SAGD Pad 118 (P3-P17)	90
SAGD Pad 118 (P18-P19)	110
SAGD Pad 121	90

Typical SAGD Injector



18 5/8” Surface Casing typically landed at 80 m
Thermally cemented

10 3/4” Slave String typically landed at 480 m
(Premium Connections) with blanket gas behind

13 3/8” Intermediate Casing typically landed at 530 m
(Premium Connections) Thermally cemented

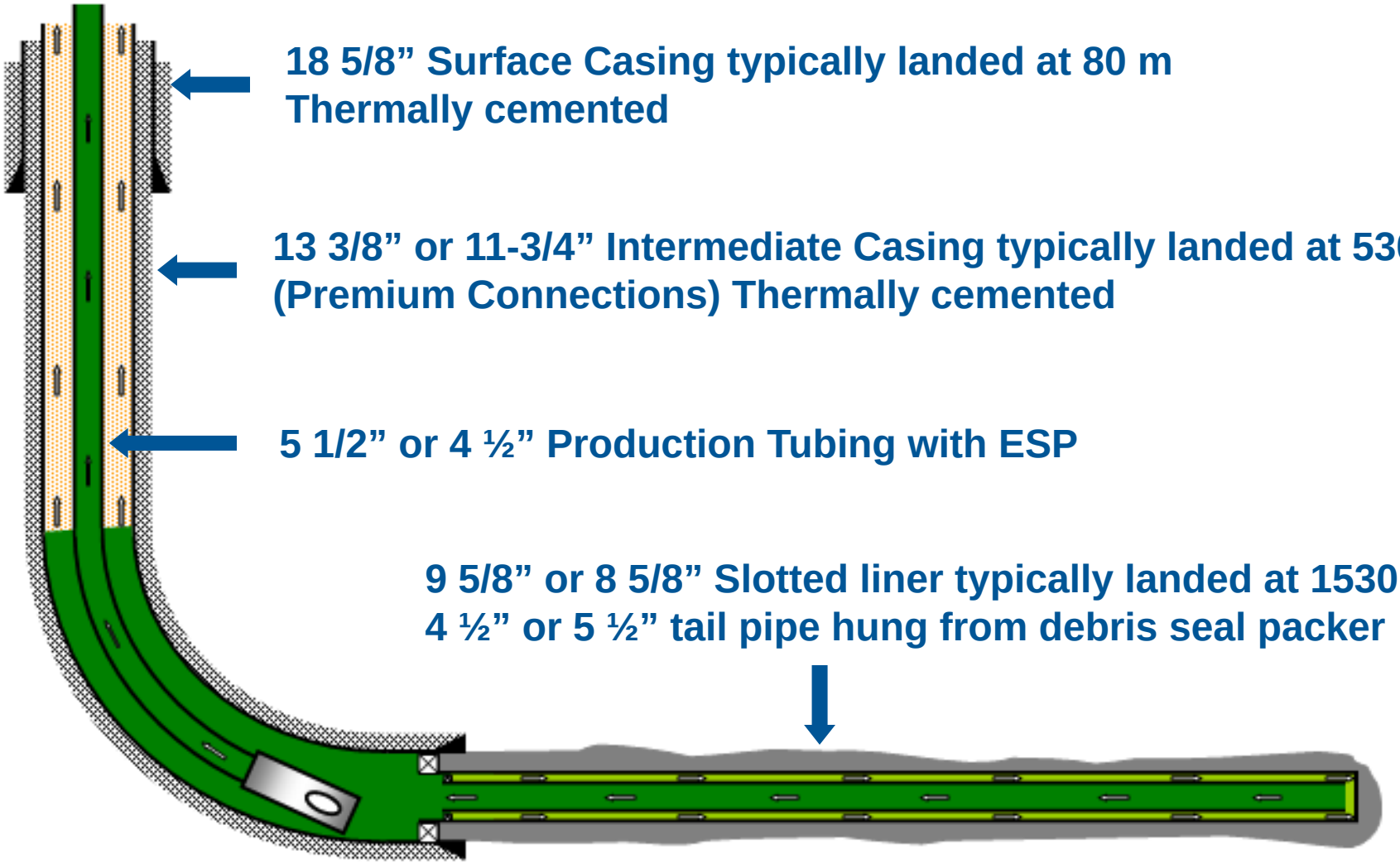
3 1/2” Injection Tubing typically landed at 1510 m
Or: 5½” crossed over to 4½”

13 3/8” x 10 3/4” Debris Seal
10 3/4” Slotted Liner for the first ~275 m

9 5/8” or 8 5/8” Slotted Liner
for the final 750 m typically
landed at 1530 m

SUNCOR

Typical Concentric Producer ML-SAGD



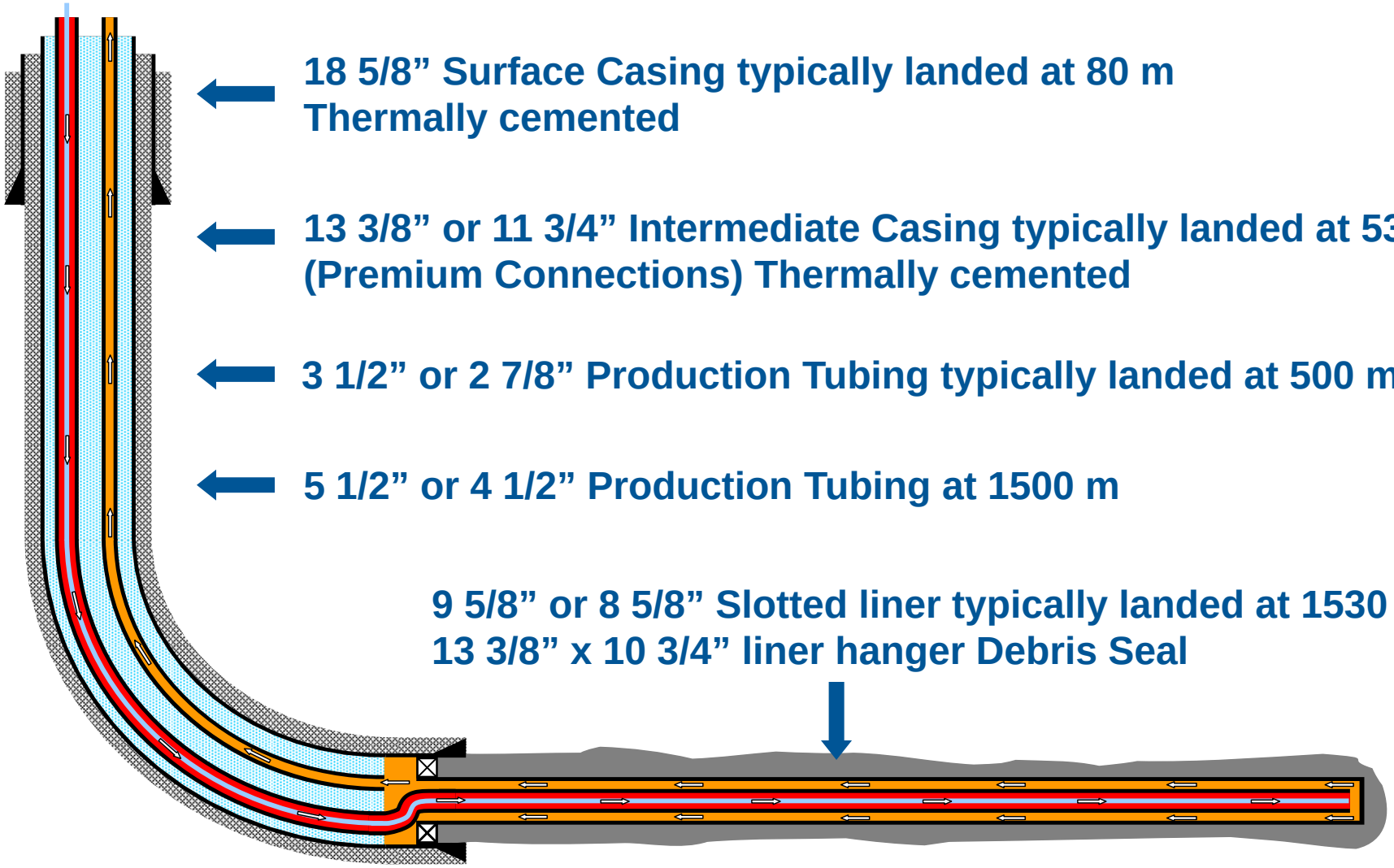
18 5/8” Surface Casing typically landed at 80 m
Thermally cemented

13 3/8” or 11-3/4” Intermediate Casing typically landed at 530 m
(Premium Connections) Thermally cemented

5 1/2” or 4 ½” Production Tubing with ESP

9 5/8” or 8 5/8” Slotted liner typically landed at 1530 m
4 ½” or 5 ½” tail pipe hung from debris seal packer

Typical Producer Startup Setup



18 5/8” Surface Casing typically landed at 80 m
Thermally cemented

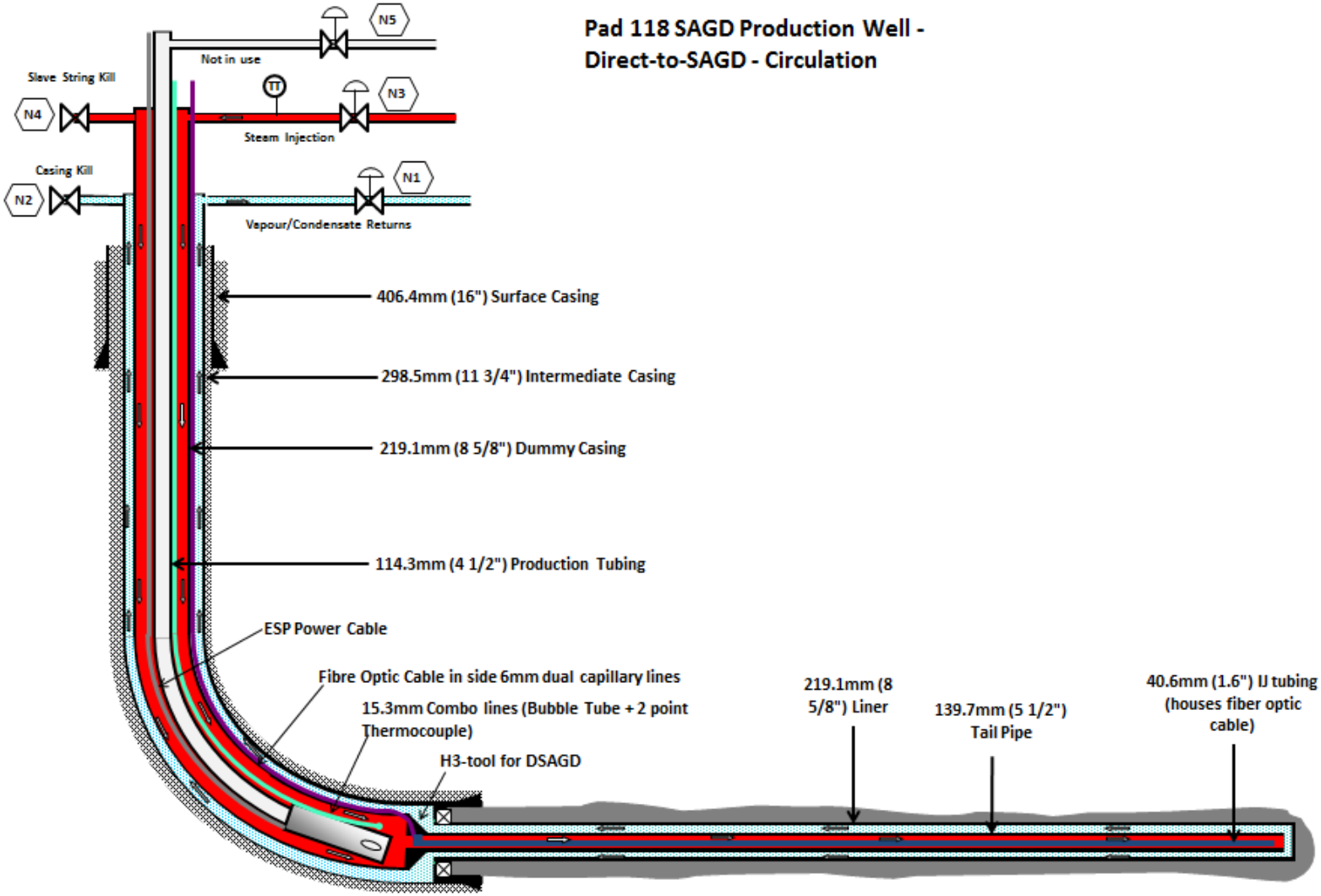
13 3/8” or 11 3/4” Intermediate Casing typically landed at 530 m
(Premium Connections) Thermally cemented

3 1/2” or 2 7/8” Production Tubing typically landed at 500 m

5 1/2” or 4 1/2” Production Tubing at 1500 m

9 5/8” or 8 5/8” Slotted liner typically landed at 1530 m
13 3/8” x 10 3/4” liner hanger Debris Seal

Typical DSAGD Completion



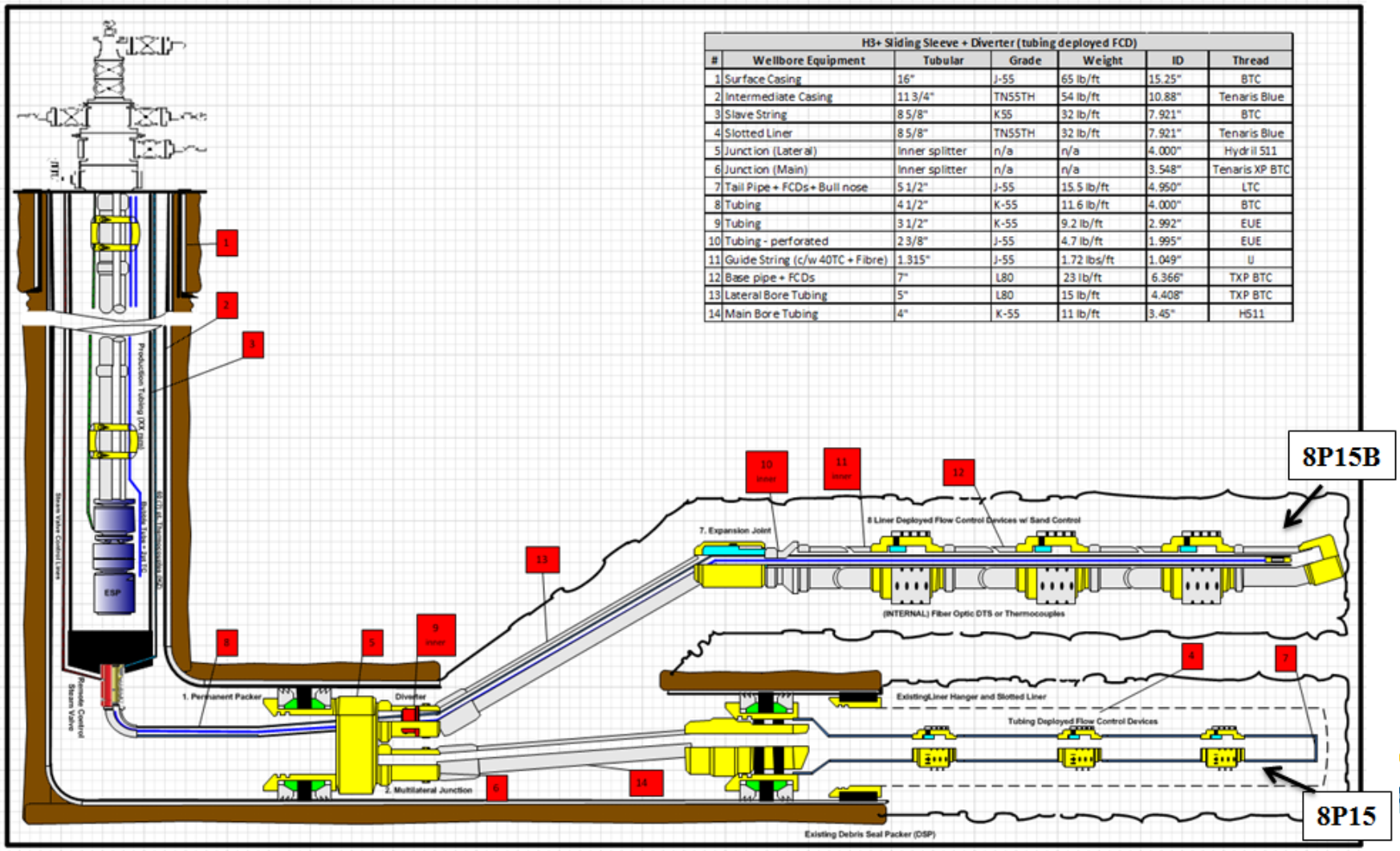
Multilateral Pilot Completion

Currently, only one multilateral well exists at Firebag – 108P15 & 108P15B

SAGD Multilateral Completion

Updated: 11/29/2017 – Marcelo

H3+ Sliding Sleeve + Diverter (tubing deployed FCD)						
#	Wellbore Equipment	Tubular	Grade	Weight	ID	Thread
1	Surface Casing	16"	J-55	65 lb/ft	15.25"	BTC
2	Intermediate Casing	11 3/4"	TN55TH	54 lb/ft	10.88"	Tenaris Blue
3	Slave String	8 5/8"	K55	32 lb/ft	7.921"	BTC
4	Slotted Liner	8 5/8"	TN55TH	32 lb/ft	7.921"	Tenaris Blue
5	Junction (Lateral)	Inner splitter	n/a	n/a	4.000"	Hydril 511
6	Junction (Main)	Inner splitter	n/a	n/a	3.548"	Tenaris XP BTC
7	Tail Pipe + FCDs + Bull nose	5 1/2"	J-55	15.5 lb/ft	4.950"	LTC
8	Tubing	4 1/2"	K-55	11.6 lb/ft	4.000"	BTC
9	Tubing	3 1/2"	K-55	9.2 lb/ft	2.992"	EUE
10	Tubing - perforated	2 3/8"	J-55	4.7 lb/ft	1.995"	EUE
11	Guide String (c/w 40TC + Fibre)	1.315"	J-55	1.72 lbs/ft	1.049"	U
12	Base pipe + FCDs	7"	L80	23 lb/ft	6.366"	TXP BTC
13	Lateral Bore Tubing	5"	L80	15 lb/ft	4.408"	TXP BTC
14	Main Bore Tubing	4"	K-55	11 lb/ft	3.45"	H511



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- 4D Seismic
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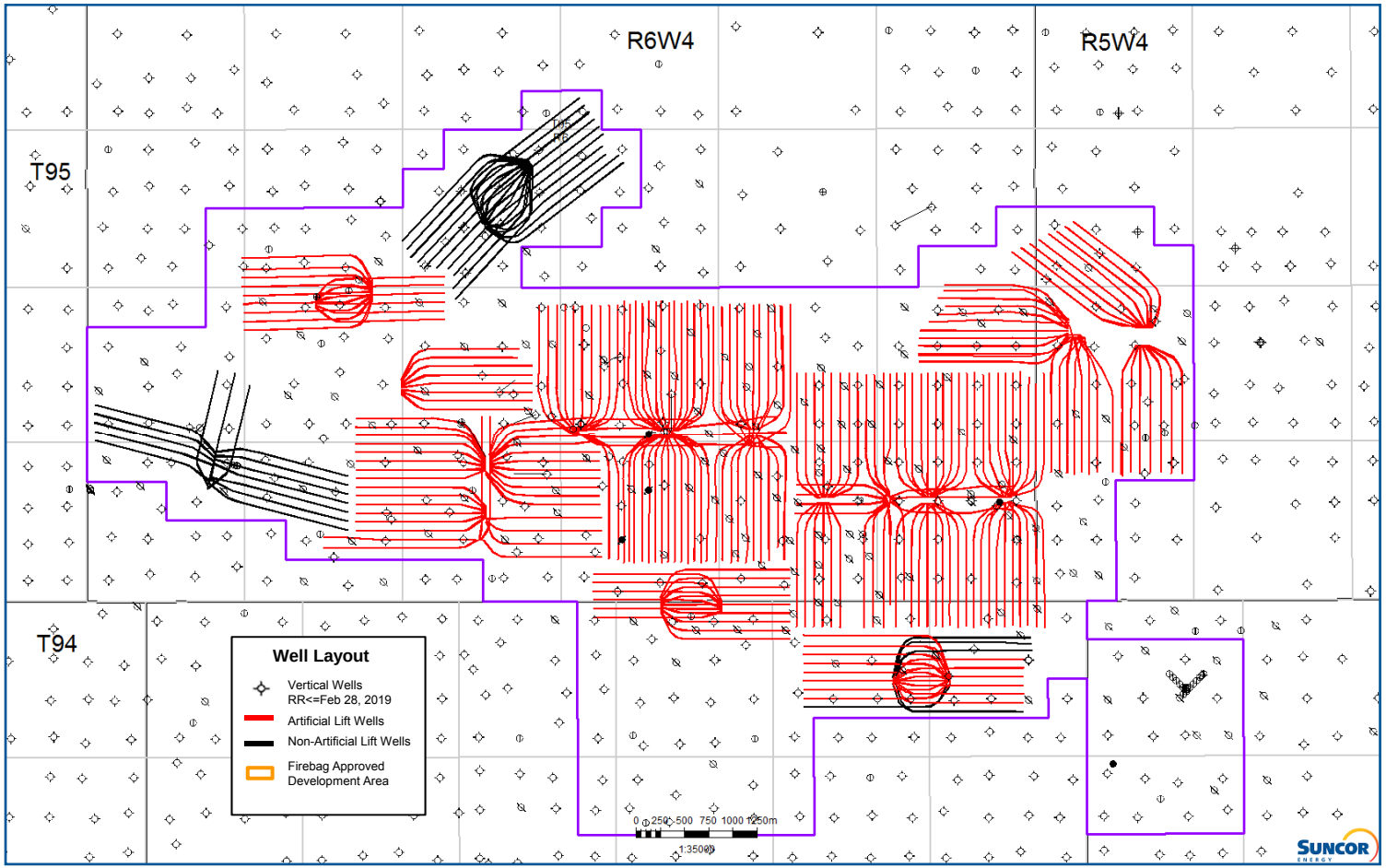
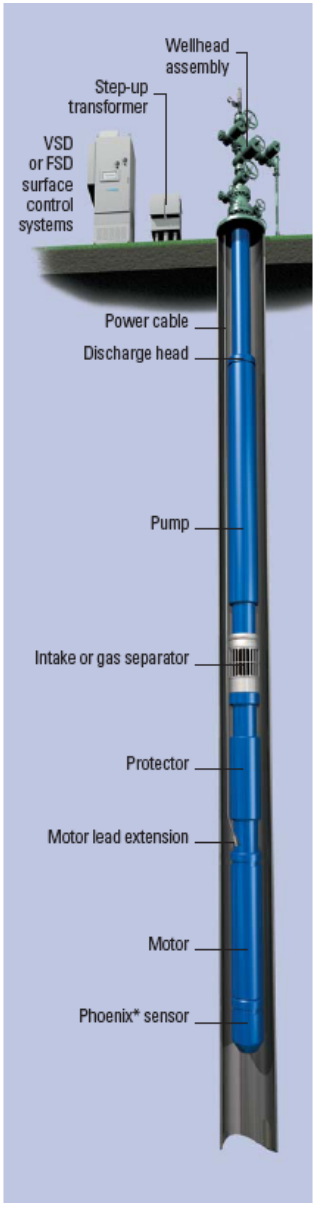
- Compliance Commitments

Artificial Lift Wells

- Wells highlighted in red have been converted to artificial lift



Artificial Lift Performance



- Mechanical Lift
  - Electric submersible pumps (ESP)
  - 12 – 36 Stages depending on application
  - Total fluid lift capacity ranges from 100 to 3,000 m^3/d depending on pump size
  - Averaged 585 m3/d total fluid production per well over reporting time frame
  - Maximum operating temperatures ~ 250ºC, as measured at the pump
    - Pumps generally run between 135ºC and 220ºC
  - Pump mean time to failure since day 1 is 717 days
  - Run-life is increasing as operational practices and pump technology improve

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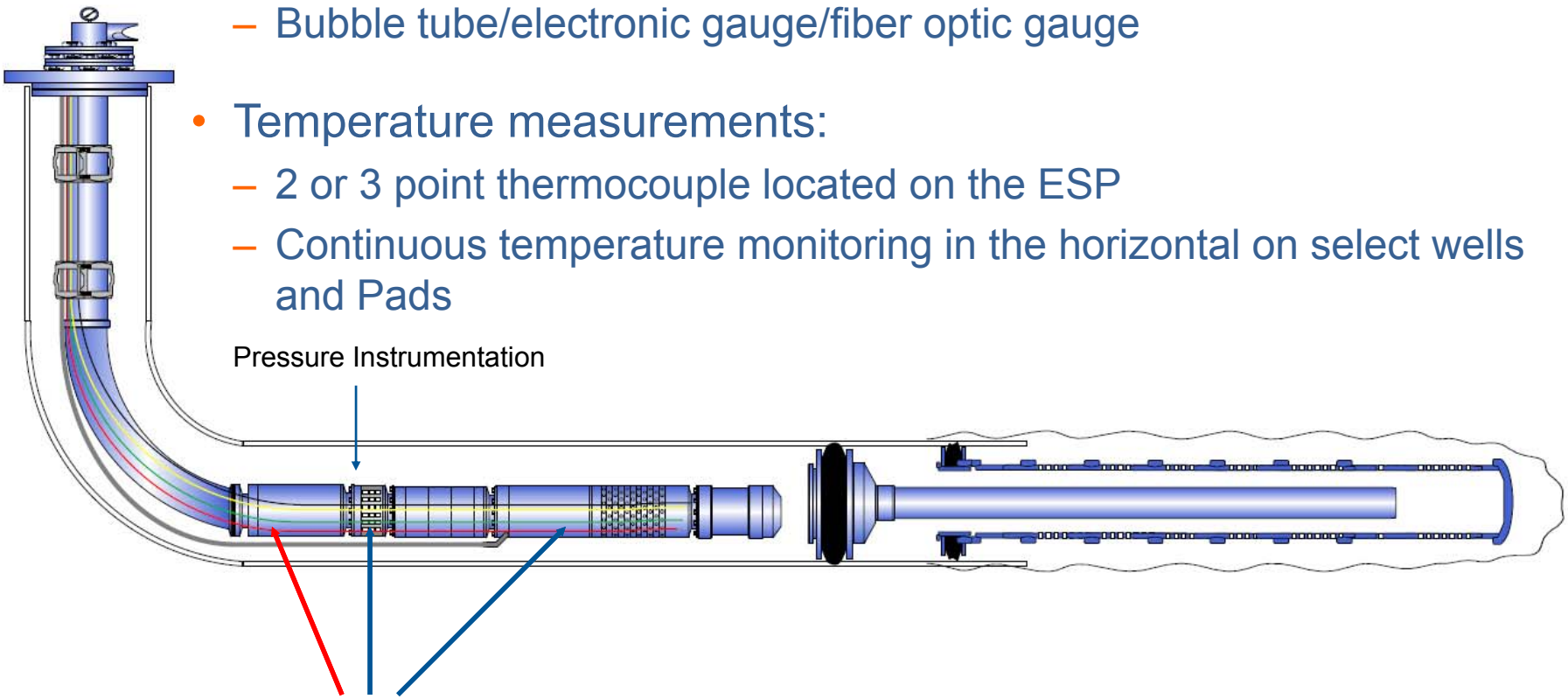
Typical SAGD Producer Well – Instrumentation Locations

- Pressure measurements:
  - Located on the ESP
  - Bubble tube/electronic gauge/fiber optic gauge
- Temperature measurements:
  - 2 or 3 point thermocouple located on the ESP
  - Continuous temperature monitoring in the horizontal on select wells and Pads



Instrumentation - SAGD Wells

Pad #	Temperature	Pressure
Pad 101 (including infills)	- 2-3 pt. ESP Thermocouple - Fiber in 1P6B - Motor winding/intake (infills)	- Bubble Tube - 1P6B – Piezometer - Intake gauge (infills)
Pad 102 (including infills)	- 2-3 pt. ESP Thermocouple - Motor winding/intake (infills)	- 2P1/2/4/5/7/8 – gas gauge - 2P3/10 – Piezometer - Bubble Tube (infills)
Pad 103/104 (including infills)	- 2-3 pt. ESP Thermocouple - 3P9 internal motor TC - 104 N infills, 4N9, 4N10, 4N11 and 3N8 Fiber	- Bubble Tube - P/T Intake gauges (infills) - 3N3/N9/N10/N11 - Piezometer
Pad 107/108	- 2-3 pt. ESP Thermocouple - 7P5 Motor winding/intake, 8P14 6pt TC	- Bubble Tube
Pad 105	- 2-3 pt. ESP Thermocouple	- Bubble Tube
Pad 106	- 2 pt. ESP Thermocouple - Fiber in 6P2/4/6/8 - 6 pt. Thermocouple - 6P5 2 pt. Combo Line TC only	- Bubble Tube
Pad 115	- 2 pt. ESP Thermocouple - 6 pt. Thermocouple (15P4/6/8)	- Bubble Tube
Pad 116	- 2 pt. ESP Thermocouple - 6 pt. Thermocouple 16P1/2/3/4/7/8/10/11/12/14/17/19 - Fiber in 16P5/6/9/13/15/16/18	- Bubble Tube
Pad 110	- 2 pt. ESP Thermocouple - Fiber in 10P2/3/4/5/6/7/8	- Bubble Tube - 10P3 - Piezometer
Pad 109	- 2 pt. ESP Thermocouple - 6 pt. Thermocouple in 9P2/4/6/8/10	- Bubble Tube
Pad 117	- 2 pt. ESP Thermocouple - 6 pt. Thermocouple in 17P2/4/6/7/8/10/12/15	- Bubble Tube
Pad 118	- 2 pt. ESP Thermocouple - DTS Fiber in 18P1, 18P3 - 18P19, 18P2 – N/A	- Bubble Tube
All Injectors	- 6pt TC (15S4, 15S6, 15S8, 9S11), 15S5 (fiber)	- Blanket Gas

FCDs (Flow Control Devices)

- Defined as downhole tools that limit the inflow or outflow of fluid <u>at different points</u> along the horizontal
  - Note: tail pipe (scab liners), and steam diverters do not satisfy this definition
- Firebag has flow control devices installed in:
  - (11) Production wells
  - (0) Injection wells
- Main Learnings:
  - Hot spots can develop in a wellbore due to well operating practices or reservoir heterogeneity
    - We believe FCDs choke steam production, aiding in steam trap control. This allows us to increase drawdown and improve production conformance

Location of Production Well FCD Installations at Firebag

Pad	Wells	Type
Pad 101	1P6B	Series of orifices
Pad 103	3N8	Series of orifices
Pad 104	4N8	Impinging orifices
Pad 110	10P2/4/6/8	Series of orifices
Pad 116	16P6/18	Series of orifices
Pad 108	8P15/8P15B	Series of orifices

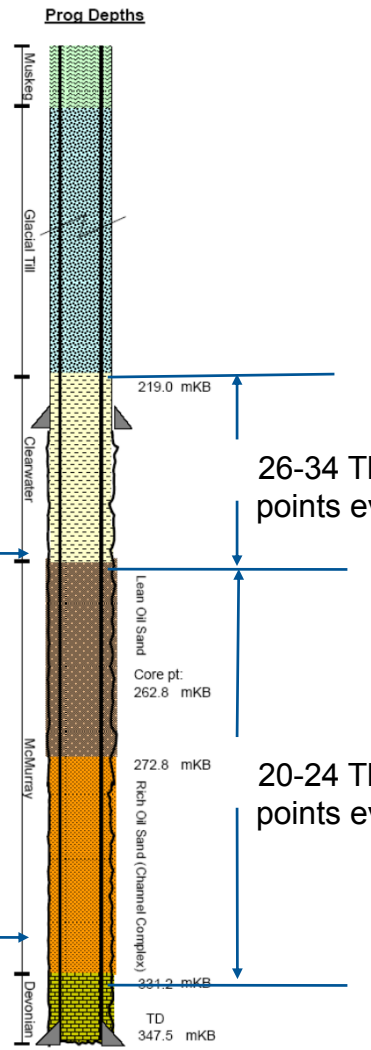
Typical SAGD Observation Wells

Pressure Instrumentation

Two Piezometers

Location:

1. Lower Wabiskaw
2. 15 m above base of McMurray



Piezometer #1

Piezometer #2

26-34 Thermocouple points evenly spaced

20-24 Thermocouple points evenly spaced

Temperature Instrumentation

Standard Obs well:

- Base to top of McMurray
- 20-24 TC spaced every 3 to 4 m

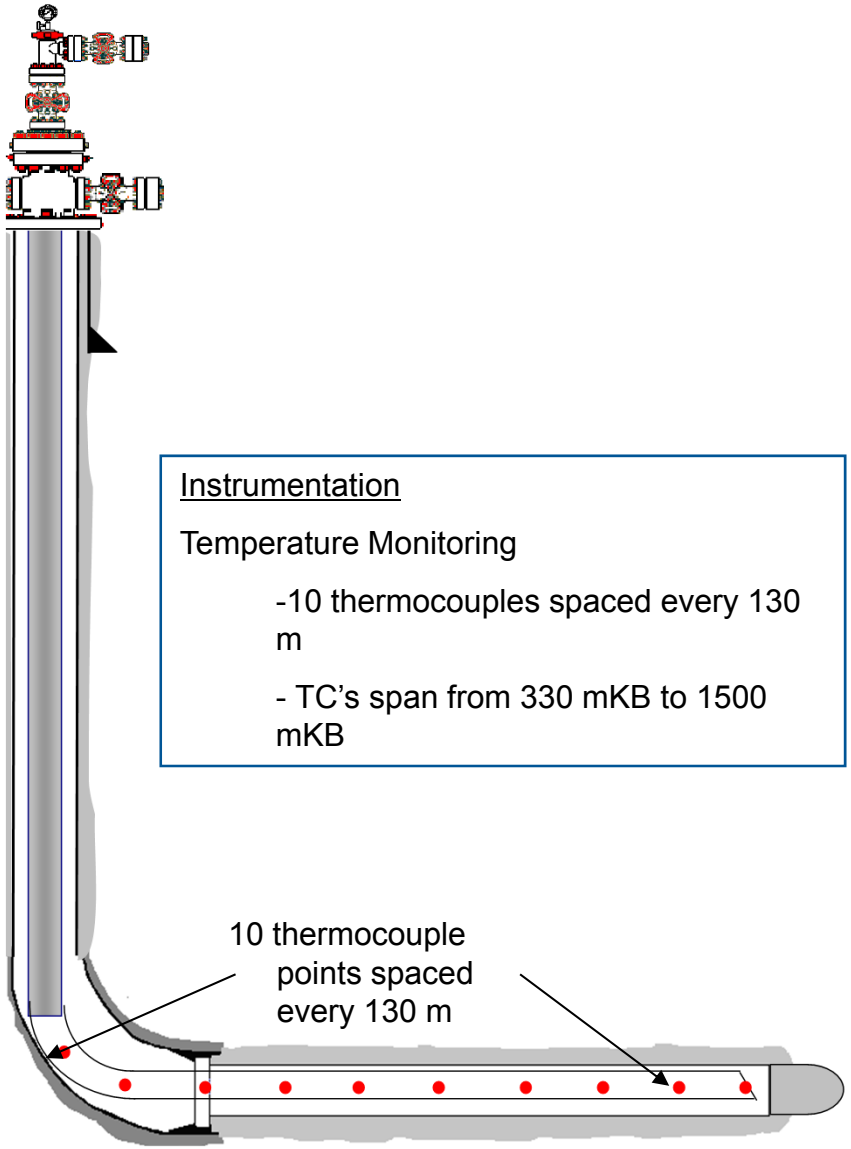
Clearwater Obs well (2010):

- Base of RMZ to top of Clearwater
- 26-34 TC spaced every 2 m

Instrumentation strapped to outside of casing string

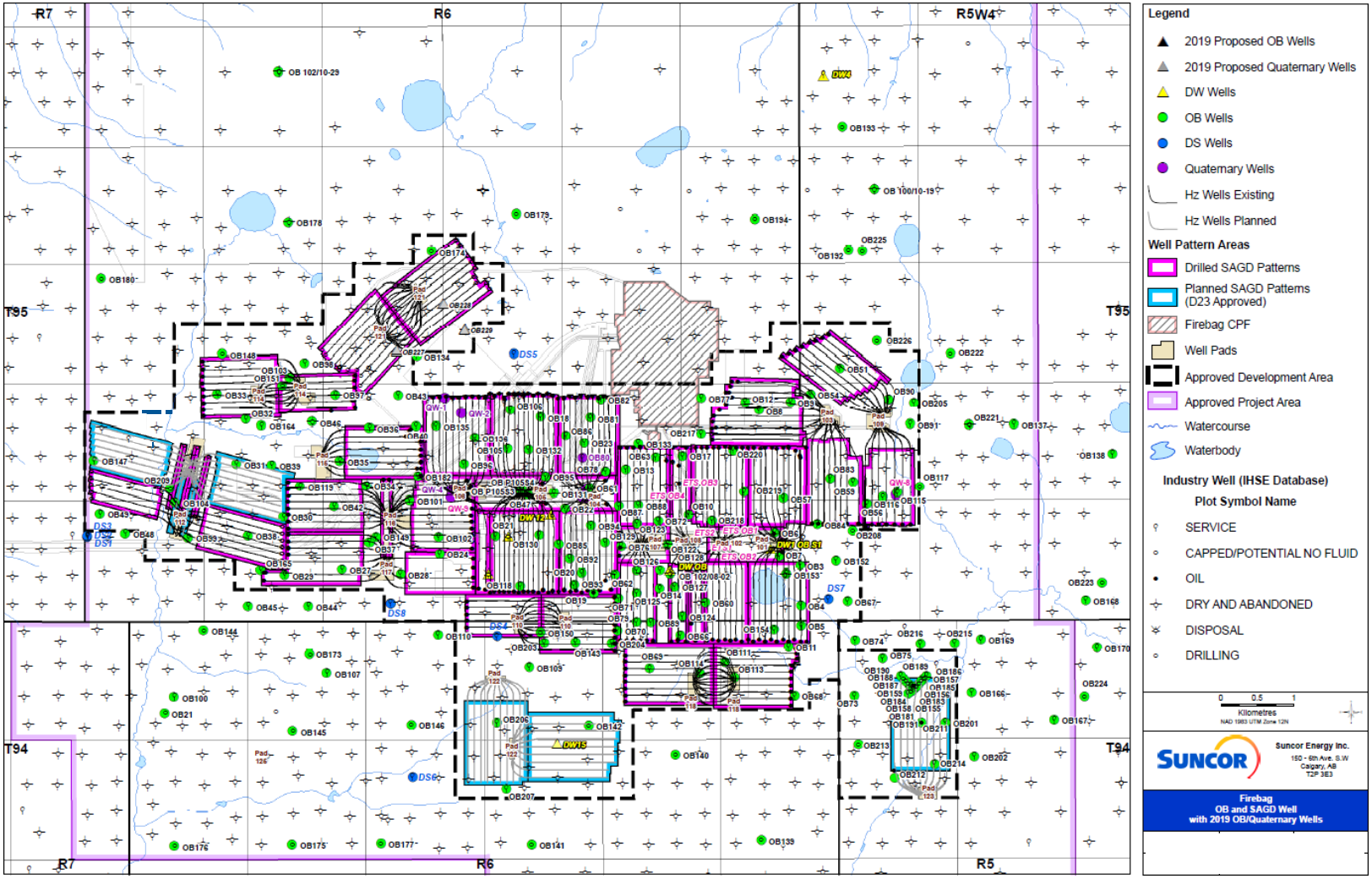
- Process and Field Improvements
  - Annual preventative maintenance program
  - Equipment upgrades
    - Power Systems
    - SCADA communications

Horizontal Observation Well Configuration



- Observation wells ETS1, 5S2, 5S3 and 5S4 have 10 point thermocouples placed in horizontal sections

Observation Well Location Map



Chemical Stimulation: March 2018 - Feb 2019

- Initial Chemical stimulations limited to Plant 92 wells (Pad 103 & 104) to avoid flow back to WLS
  - 2 Stimulations in Q2 2018 **- 3P8 & 4N6**
    - Focused on full tailpipe completions, modified treatment based on past learnings
  - 1 Stimulation in Q4 2018 **- 8P7**
    - Test flowback to Plants 93/94 is ongoing

Instrumentation – SAGD Observation Wells

Well Name	Instrumentation
7-31-94-05	1 Piez
9-31-94-05	1 Piez
DS1	3 Piez
DS2	3 Piez
DS4	6 Piez
DS5	3 Piez
DS6	5 Piez
DS7	5 Piez
DS8	4 Piez
DW OB1	1 Piez, 1 PG
ETS 1	10pt T/C
ETS OB4	24pt T/C
OB DW12	1 PG
OB DW4	2 PG & 1 TG
OB10	3 Piez
OB101	54pt T/C, 2 Piez
OB102	54pt T/C, 2 Piez
OB103	54pt T/C, 2 Piez
OB105	54pt T/C, 2 Piez
OB106	54pt T/C, 2 Piez
OB107	2 T/C, 2 Piez
OB11	1 Piez
OB110	2 T/C, 2 Piez
OB111	1 T/C, 1 Piez
OB114	1 T/C, 1 Piez
OB115	24pt T/C
OB116	24pt T/C, 2 Piez
OB117	24pt T/C, 2 Piez
OB118	40pt T/C, 2 Piez
OB119	40pt T/C, 2 Piez

Well Name	Instrumentation
OB12	24pt T/C
OB122	40pt T/C
OB123	40pt T/C
OB124	40pt T/C
OB125	40pt T/C
OB127	40pt T/C
OB128	40pt T/C, 1 Piez
OB129	40pt T/C
OB13	24pt T/C
OB130	40pt T/C
OB131	40pt T/C, 2 Piez
OB132	40pt T/C
OB133	40pt T/C
OB134	40pt T/C, 2 Piez
OB135	40pt T/C, 1 Piez
OB136	40pt T/C, 1 Piez
OB137	1 Piez
OB138	1 Piez
OB14	24pt T/C
OB143	40pt T/C
OB147	1 Piez
OB149	1 Piez
OB152	24pt T/C, 5 Piez
OB153	40pt T/C, 5 Piez
OB154	40pt T/C, 5 Piez
OB155	6 Piez
OB158	1 Piez
OB164	5 Piezo
OB165	6 Piez
OB166	3 Piez

Well Name	Instrumentation
OB167	2 Piez
OB168	2 Piez
OB169	3 Piez
OB17	24pt T/C
OB170	2 Piez
OB18	24pt T/C
OB182	24pt T/C, 2 Piez
OB186	5 Piez
OB189	50pt T/C, 4 Piez
OB19	2 Piez
OB190	5 Piez
OB20	24pt T/C
OB201	3 Piez
OB202	30 pt T/C, 3 Piez
OB203	40 pt T/C, 4 Piez
OB204	40 pt T/C, 4 Piez
OB205	1 Piez
OB206	54 pt T/C, 3 Piez
OB207	54 pt T/C, 3 Piez
OB21	24pt T/C
OB211	70 pt T/C, 7 Piez
OB212	50pt T/C, 4 Piez
OB213	2 Piez
OB214	70 pt T/C, 7 Piez
OB215	1 Piez
OB216	1 Piez
OB217	50 pt T/C, 4 Piez
OB218	50 pt T/C, 6 Piez
OB219	50 pt T/C, 6 Piez
OB22	24pt T/C

Instrumentation – SAGD Observation Wells

Well Name	Instrumentation
OB220	50 pt T/C, 4 Piez
OB221	3 P&T ERD
OB222	1 Piezo
OB223	2 P&T ERD
OB225	3 P&T ERD
OB226	1 Piezo
OB23	24pt T/C
OB24	1 Piez
OB27	24pt T/C
OB28	24pt T/C
OB29	24pt T/C
OB30	24pt T/C
OB31	24pt T/C
OB32	24pt T/C
OB33	24pt T/C
OB34	24pt T/C
OB35	24pt T/C
OB36	24pt T/C
OB37	24pt T/C, 2 Piez
OB38	24pt T/C, 2 Piez
OB39	24pt T/C, 2 Piez
OB40	24pt T/C, 2 Piez
OB42	24pt T/C
OB43	24pt T/C
OB44	24pt T/C
OB45	24pt T/C
OB47	24 pt T/C
OB48	24pt T/C, 2 Piez
OB49	24pt T/C, 1 Piez
OB51	24pt T/C, 1 Piez

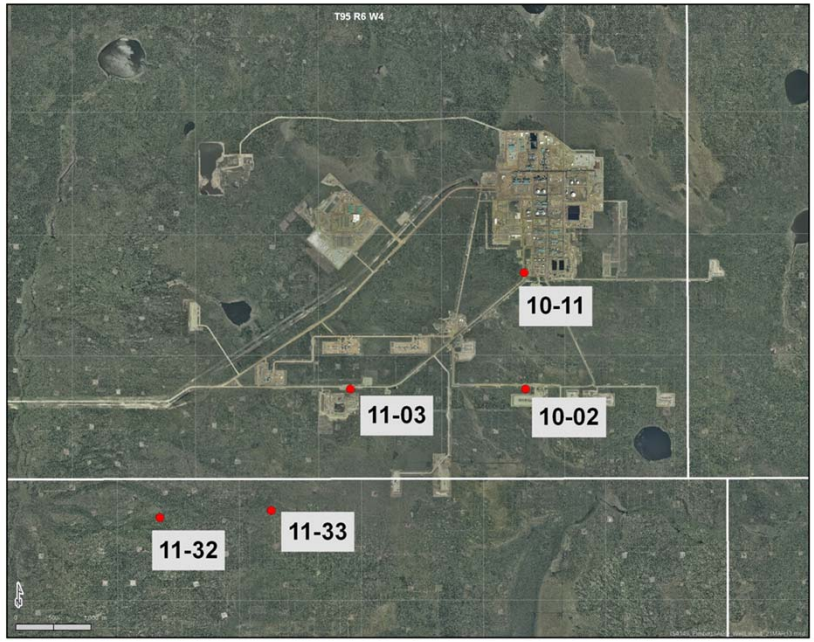
Well Name	Instrumentation
OB54	24pt T/C, 1 Piez
OB56	24pt T/C, 1 Piez
OB57	56pt T/C, 2 Piez
OB59	54pt T/C, 1 Piez
OB6	24pt T/C
OB60	58pt T/C, 2 Piez
OB61	58pt T/C, 1 Piez
OB62	24pt T/C, 1 Piez
OB63	24pt T/C, 3 Piez
OB66	54pt T/C, 2 Piez
OB67	2 T/C, 2 Piez
OB68	2 T/C, 2 Piez
OB69	2 T/C, 2 Piez
OB7	24pt T/C
OB70	54pt T/C, 2 Piez
OB71	54pt T/C, 2 Piez
OB72	54pt T/C, 2 Piez
OB73	54pt T/C, 2 Piez
OB74	2 T/C, 2 Piez
OB75	2 T/C, 2 Piez
OB76	54pt T/C, 2 Piez
OB77	54pt T/C, 2 Piez
OB78	54pt T/C, 2 Piez
OB79	54pt T/C, 2 Piez
OB8	2 Piez
OB80	54pt T/C, 1 Piez
OB81	54pt T/C, 2 Piez
OB82	54pt T/C, 2 Piez
OB83	54pt T/C, 2 Piez
OB84	54pt T/C, 2 Piez

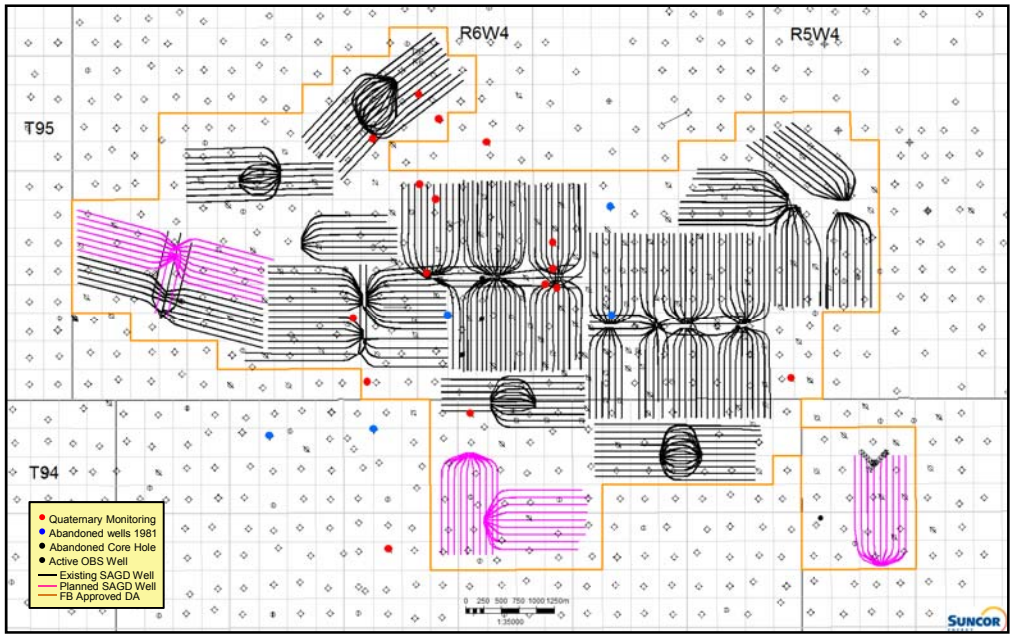
Well Name	Instrumentation
OB85	54pt T/C, 2 Piez
OB86	54pt T/C, 2 Piez
OB87	54pt T/C, 2 Piez
OB88	54pt T/C, 2 Piez
OB89	54pt T/C, 2 Piez
OB9	24pt T/C
OB90	54pt T/C, 2 Piez
OB91	54pt T/C, 2 Piez
OB92	54pt T/C, 2 Piez
OB93	54pt T/C, 2 Piez
OB94	54pt T/C, 2 Piez
OB95	54pt T/C, 2 Piez
OB96	54pt T/C, 3 Piez
OB97	54pt T/C, 2 Piez
OB98	54pt T/C, 2 Piez
P5S2 OB	10pt T/C
P5S3 OB	10pt T/C
P5S4 OB	10pt T/C
PP7/DW22	2 Piez
QW1	1 Piez
QW2	1 Piez
QW4	1 Piez

1981 Abandoned Wells

- Five wells were drilled as per regulatory standards in 1981
  - The wells were abandoned with Oilwell G cement, not Thermal 40
  - Following a detailed risk assessment and discussion with the AER, the decision was made to monitor the wells for any noticeable changes along with yearly inspections
  - Field visits have been conducted at these locations and there have been no noticeable changes
  - Nearby observation wells monitor Quaternary pressure and temperature which is consistently stable

1981 Abandoned Wells Locations





UWI	License #	Spud Date	Distance to Planned Steam Operations (m)	Closest Well	Closest Quaternary Observation Well
10-02-095-06W4	A0088049C	2/4/1981	Approx. 3	Pad 108, 8S10	102051109506W400 – 1333 m (OB80)
11-03-095-06W4	A0088049D	1/27/1981	Approx. 34	Pad 116, 16P9	109041009506W400 – 670 m (QW4)
10-11-095-06W4	A0088049E	2/14/1981	Approx. 355	Pad 104, 4N6	102051109506W400 – 966 m (OB80)
11-32-094-06W4	A0088049B	1/18/1981	Approx. 1060	Pad 117, 17S7	100020409506W400 – 1583 m (DS8)
11-33-094-06W4	A0088048E	1/28/1981	Approx. 876	Pad 117, 17P6	100020409506W400 – 667 m (DS8)

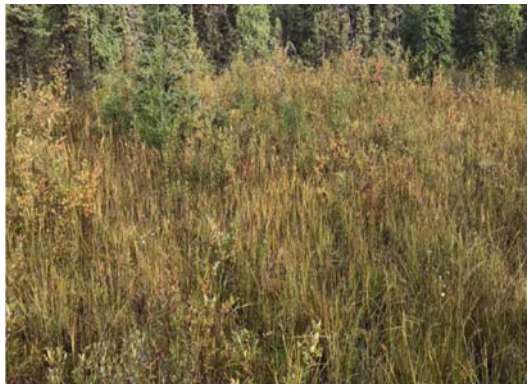
1981 Abandoned Wells Locations Continued

- All 1981 Abandoned Wells were inspected September 2, 2018

10-11-95-06-W4M

10-02-95-06-W4M

11-32-94-06-W4M



11-33-94-06-W4M

11-03-95-06-W4M

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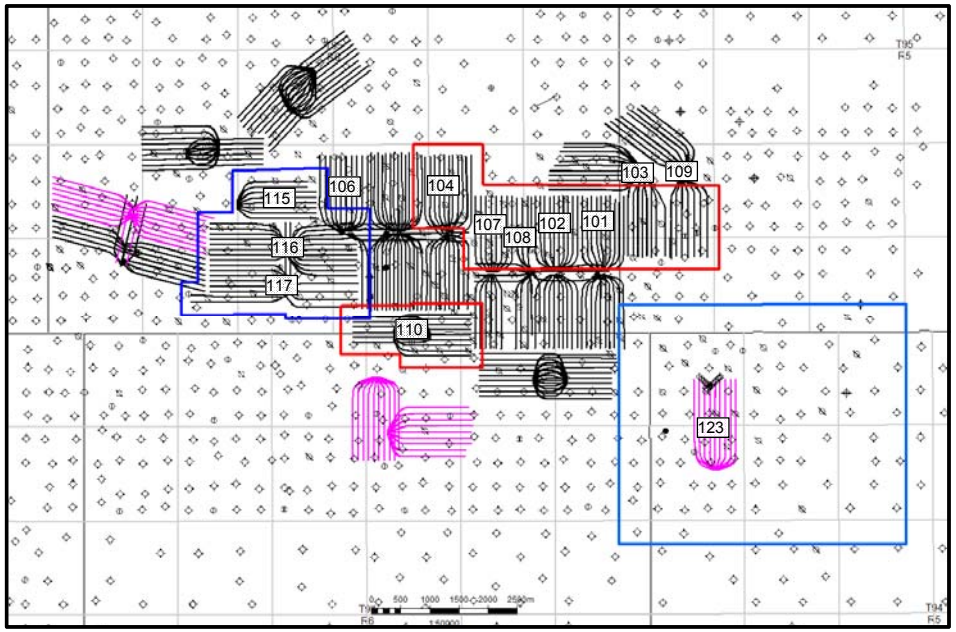
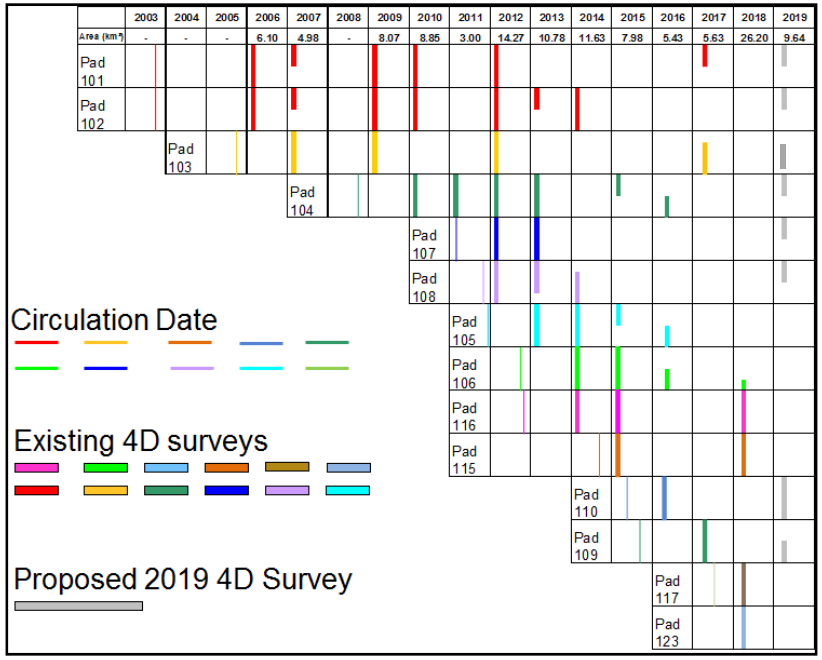
4D Seismic Survey Outlines

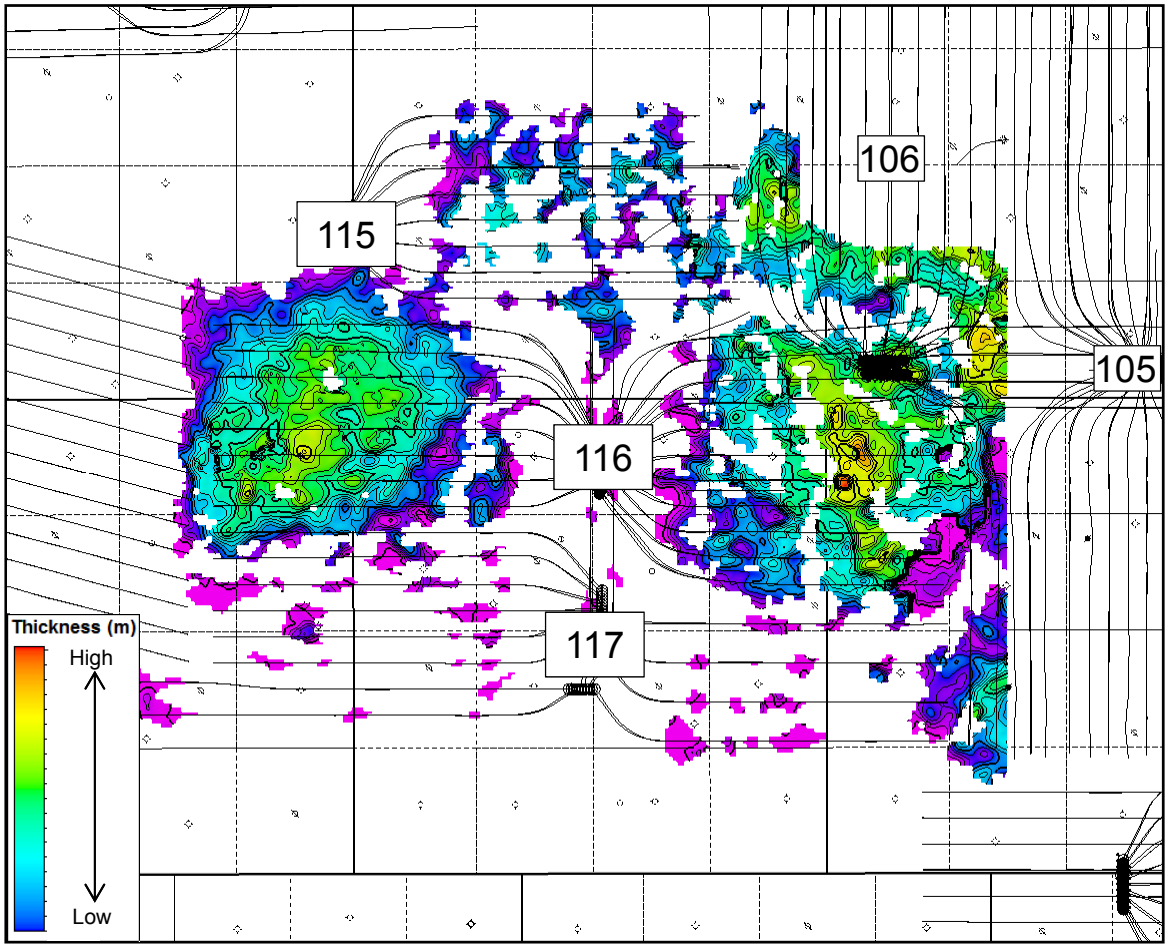
- Data were collected in the year indicated and interpretation reported the following year due to required process and interpretation time



Current Horizontal Wells
Planned Horizontal Wells
2018 4D Seismic
2019 4D Seismic



2018 4D Seismic - Steam Chamber Thickness Map



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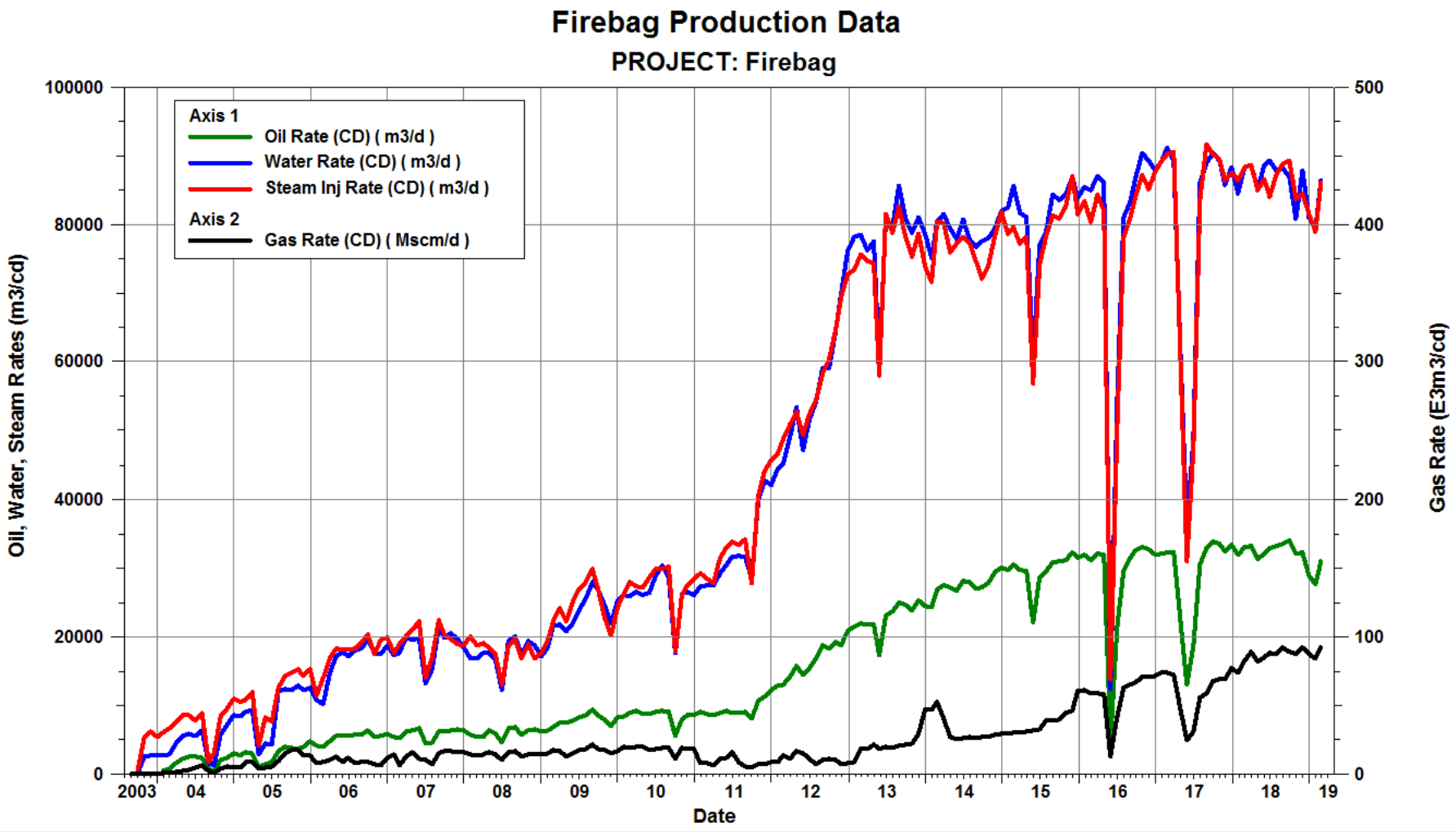
Methodology for Predicting Performance

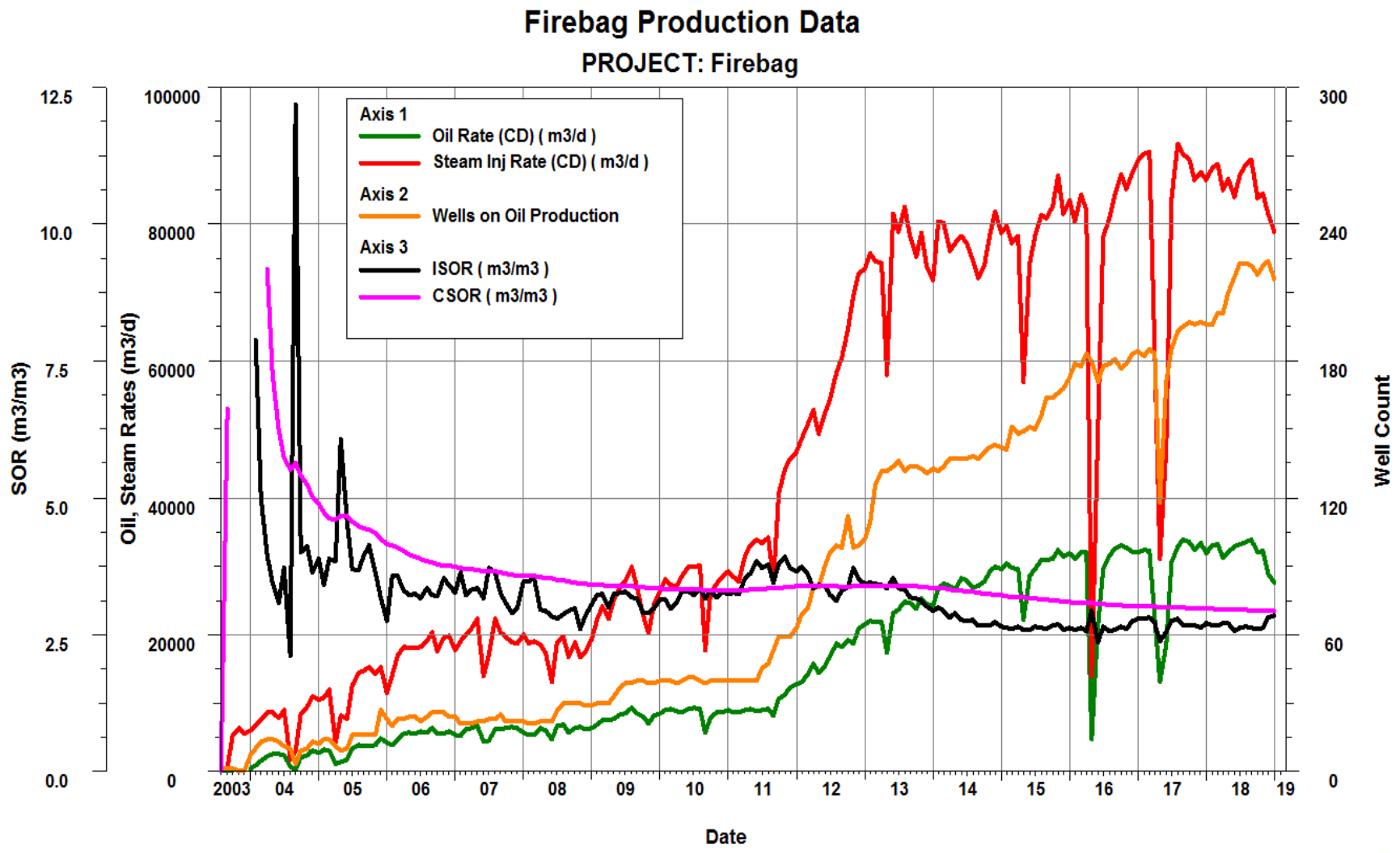
- At Firebag, future performance is predicted by leveraging multiple tools
  - Analytical Models:
    - Based on Modified Butler's equations and energy balances
    - Oil, steam, and water production profiles are generated
  - Analytical models and flow simulations are history matched on a well pair, pattern and field level

- Constraints are applied to the forecast
  - Plant turnarounds
  - Well downtime
  - New plant expansion and development pad schedule / availability

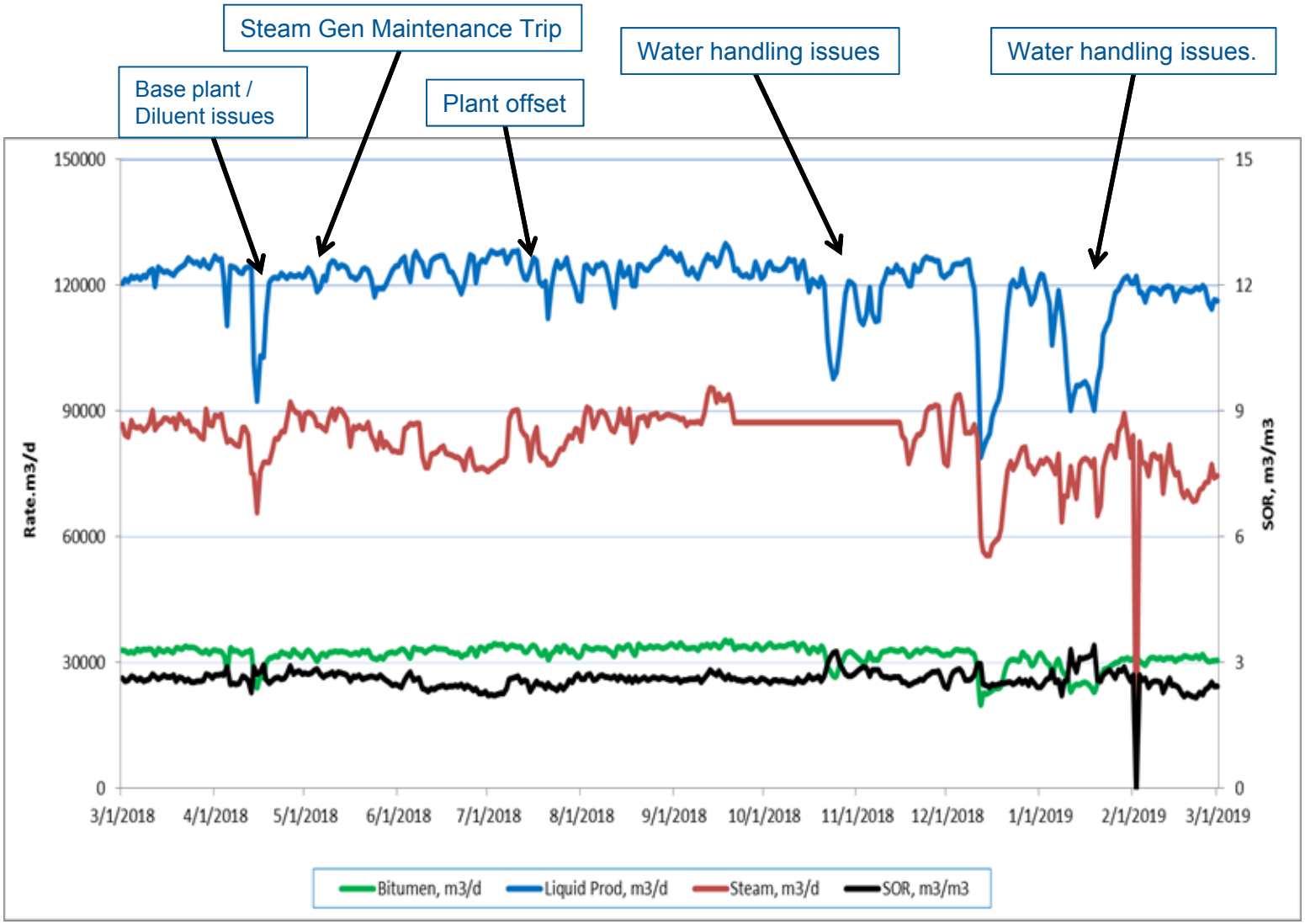
Scheme Performance – Well Production History



Scheme Performance – Well Production History



Issues and Milestones



Firebag Production

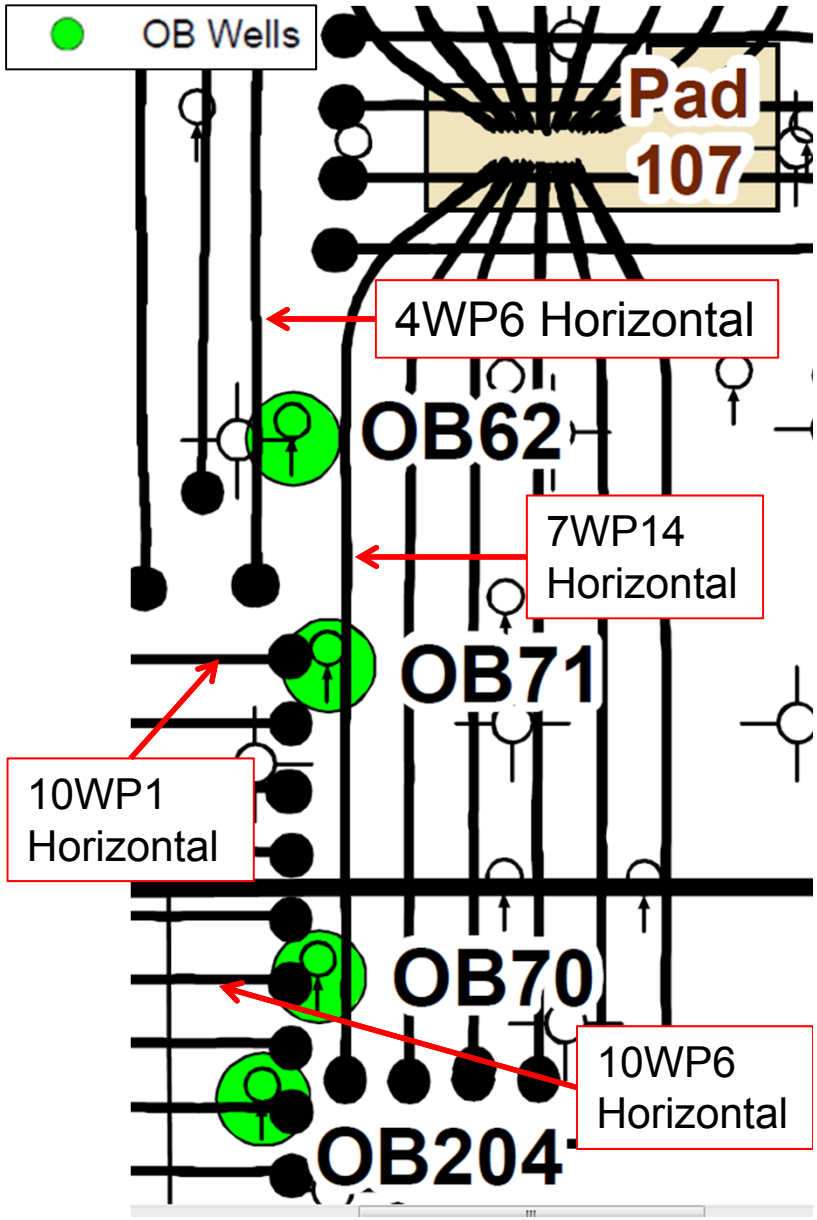
- Highest monthly average bitumen production over reporting period was ~214,000 bopd (~33,967 m^3/cd) and occurred in September 2018
  - Stages 1, 2, 3, and 4 currently on production
  - Ramp up pads: Pad 114 (15 Well pairs) and Pad 117 (14 Well pairs)
  - New Pads: Pad 118 (19 Well pairs, first steam in Sept 2018)

- SOR Discussion
  - As of Feb. 28, 2019 cumulative SOR at Firebag is 2.93 m^3/m^3
  - ISOR over the reporting period was 2.85 m^3/m^3
    - ISOR has gradually reduced by 8% from same period last year

- Infill Wells
  - Pads 101, 102, 103, and 104, 105
  - Positive impact on rate and recovery as well as SOR

Steam Chamber Discussion – 7WP14 / Pad 110 / 4WP6

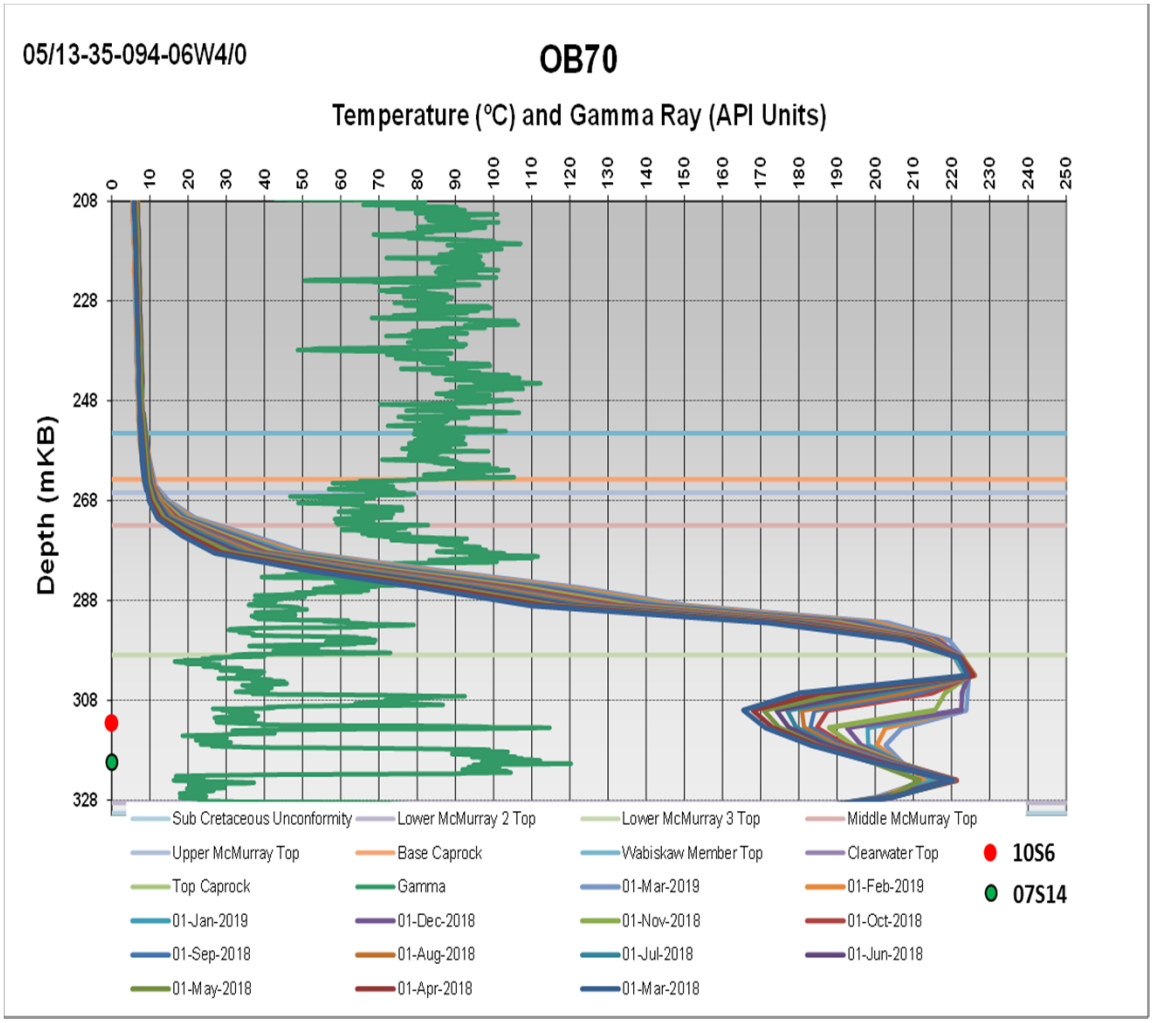
- OB70 located near the toe of 7WP14 and east of 10WP6 toe
  - 38.7m W of 7WP14
  - 38.8m E of 10WP6
- OB71 located near the middle of 7WP14 and east of 10WP1 toe
  - 25.7m W of 7WP14
  - 52.5m E of 10WP1
- OB62 located near the heel of 7WP14 and toe of 4WP6
  - 51m E of 4WP6
  - 73m W of 7WP14
- First steam dates:
  - 7WP14 in May 2011
  - 4WP6 in October 2008
  - 10WP1 and 10WP6 in April 2015



Steam Chamber Discussion – 7WP14 / 10WP6

OB70 – Toe of 7WP14 and 10WP6

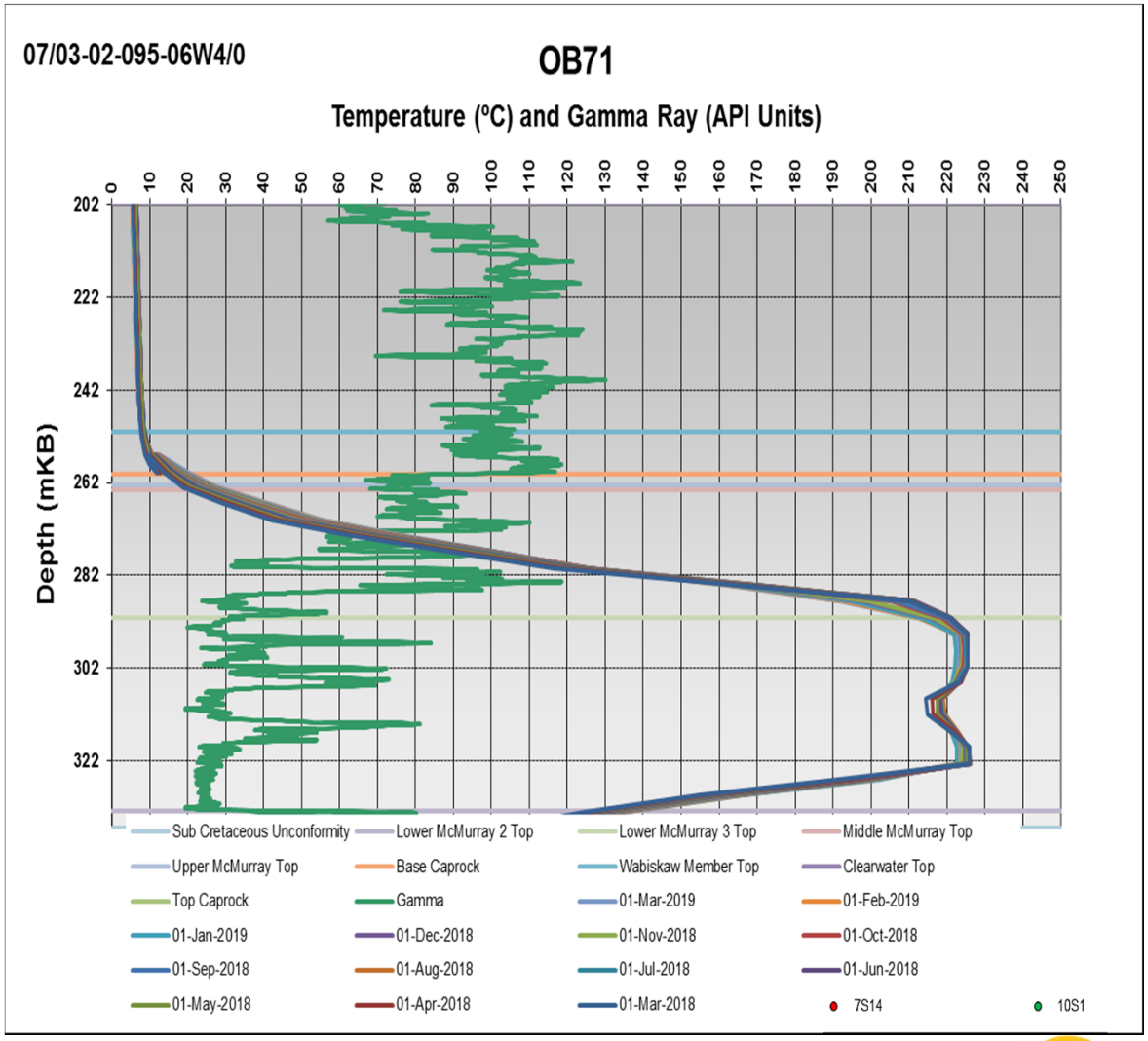
- 38.7m W of 7WP14 and 38.8m E of 10WP6
- Instrumented with 56-point thermocouples covering from the lower McMurray 3 and into the Clearwater formation
- Temperature began increasing in August 2012, 7WP14 first steam in May 2011
- Steam chamber top capped underneath mud at 323mKB from 2012 to Jan 2019
- Steam chamber observed above the mud at 323mKB since Jan 2017, but steam chamber observed below a second mud layer at 300mKB



Steam Chamber Discussion – 7WP14 / 10WP1

OB71 – Middle of 7WP14 and Toe of 10WP1

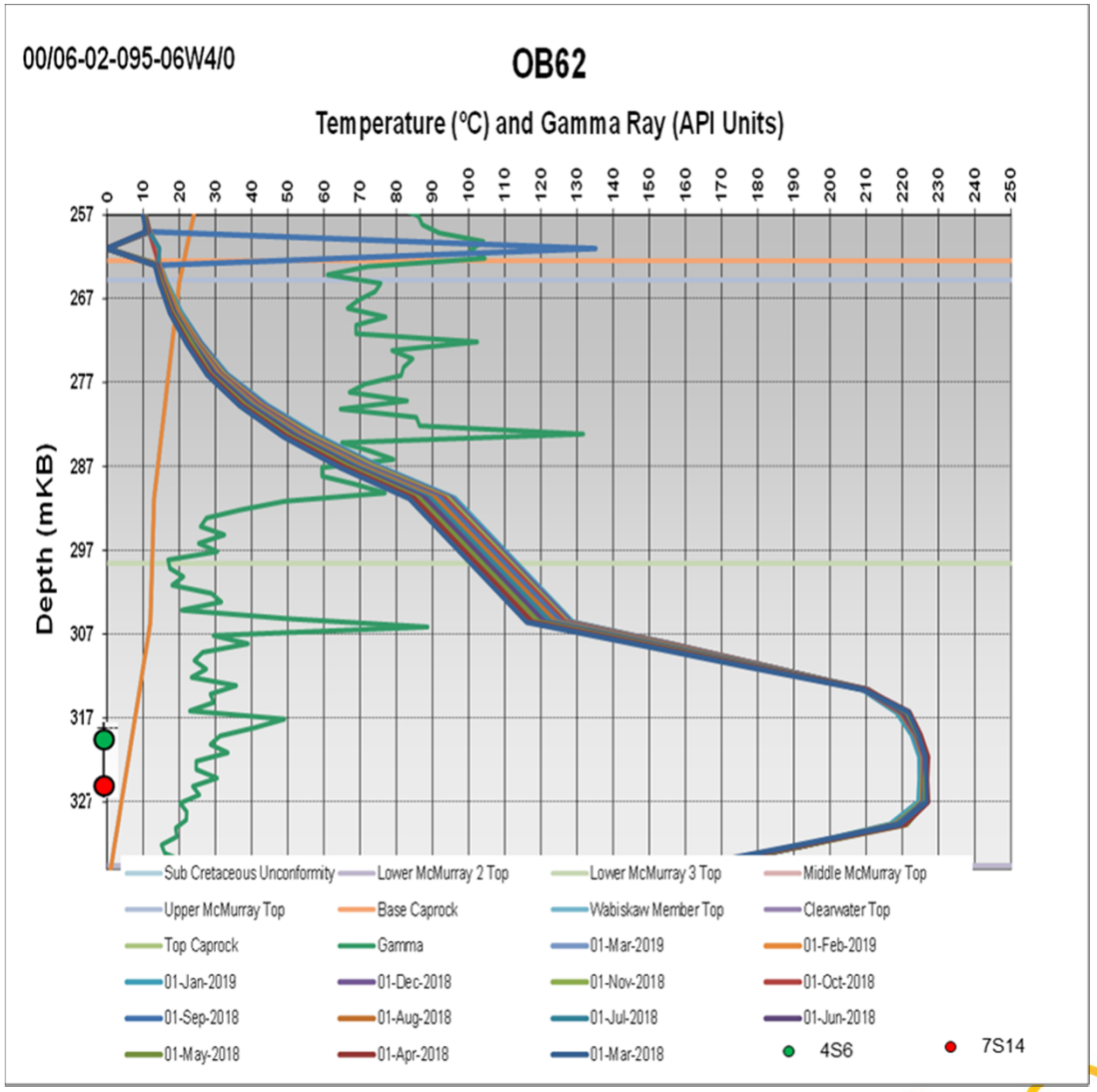
- 25.7m W of 7WP14 and 52.5m E of 10WP1
- Instrumented with 56-point thermocouples covering the lower McMurray 2 and into the Clearwater
- Temperature began increasing in August 2012, 7WP14 first steam in May 2011
- Steam chamber top capped underneath a mud at 318mKB from 2012 to May 2015, 10WP1 first steam in April 2015
- Temperature rise was first observed above the mud at 318mKB in June 2015, and steam chamber has been capped at 290mKB since April 2016.



Steam Chamber Discussion – 7WP14 / 4WP6

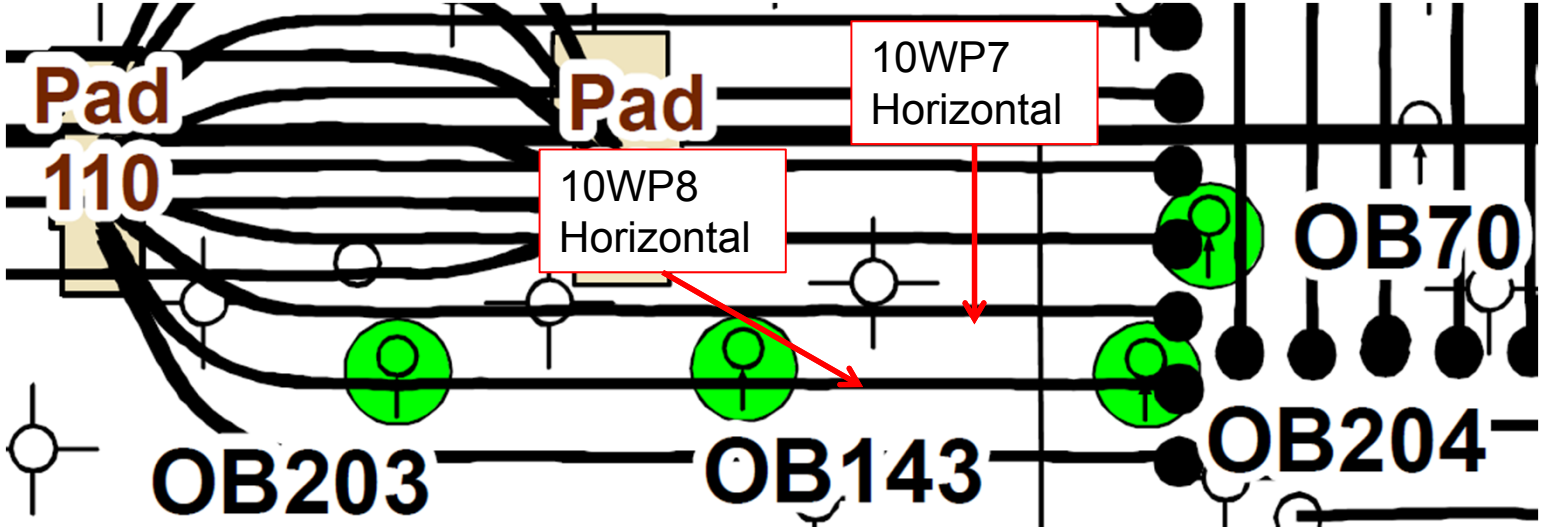
OB62 – Near the heel of 7WP14 and toe of 4WP6

- 51m E of 4WP6 and 73m W of 7WP14
- Instrumented with 20-point thermocouples covering the lower McMurray 3 and into the Wabiskaw
- Temperature began recording in March 2011 and seeing temperature increase.
- 7WP14 first steam in May 2011 and 4WP6 first steam in October 2008
- Steam chamber top is at 320mKB



Steam Chamber Discussion – 10WP7 / 10WP8

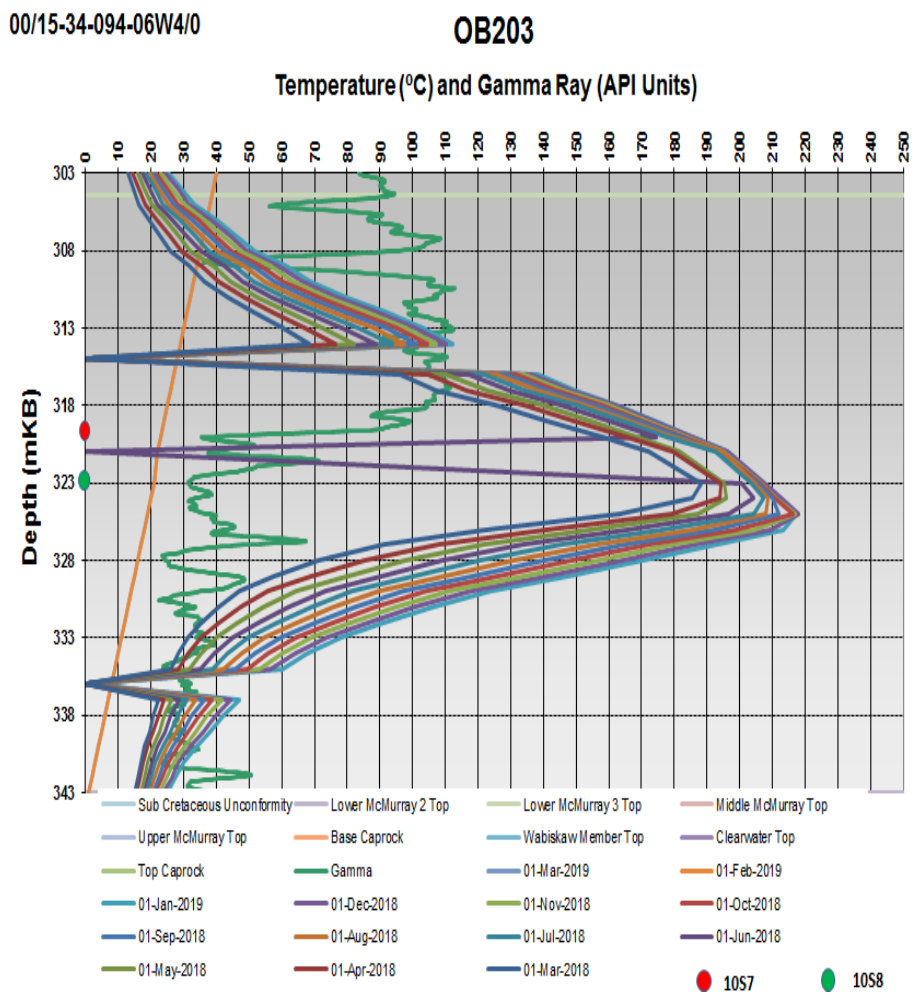
- OB203 located near the heel of 10WP7 and 10WP8
  - 18m N of 10WP8, 71m S of 10WP7
- OB143 located near the middle of 10WP7 and 10WP8
  - 15m N of 10WP8, 76m S of 10WP7
- OB204 located near the toe of 10WP7 and 10WP8
  - 14m N of 10WP8, 81m S of 10WP7
- First steam dates:
  - 10WP7 and 10WP8 in April 2015



Steam Chamber Discussion – 10WP7 / 10WP8

OB203 – Heel of 10WP7 and 10WP8

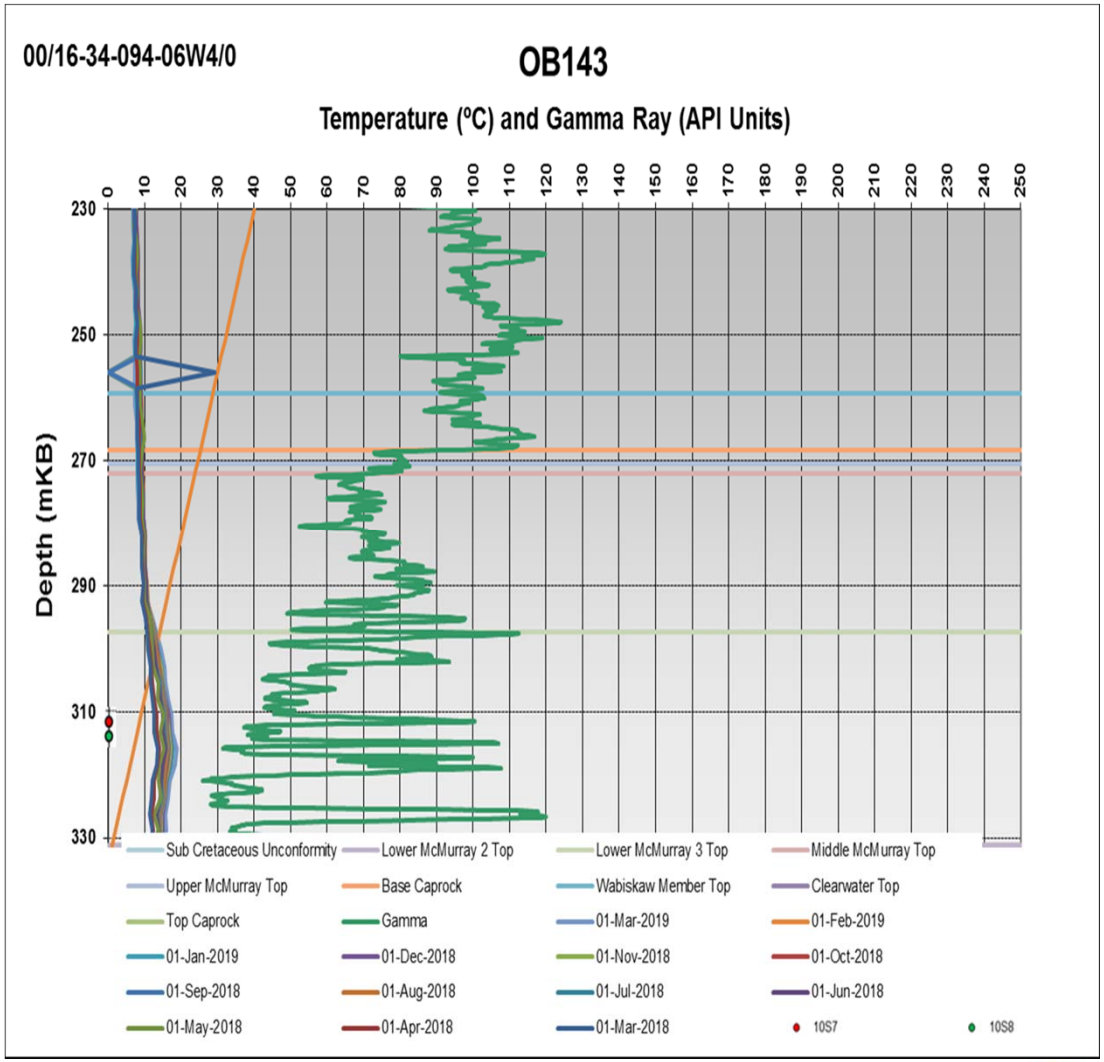
- 18m N of 10WP8, 71m S of 10WP7
- Instrumented with 40-point thermocouples covering the lower McMurray 3
- Temperature began increasing in December 2017 at 323 mKB and continues to grow. Steam chamber capped at 321mKB around September 2018.
  - 10WP7 and 10WP8 first steam in April 2015
- Temperature growth slower along the heel of the well compared to temperature measurement from OB204 at the toe



Steam Chamber Discussion – 10WP7 / 10WP8

OB143 – Middle of 10WP7 and 10WP8

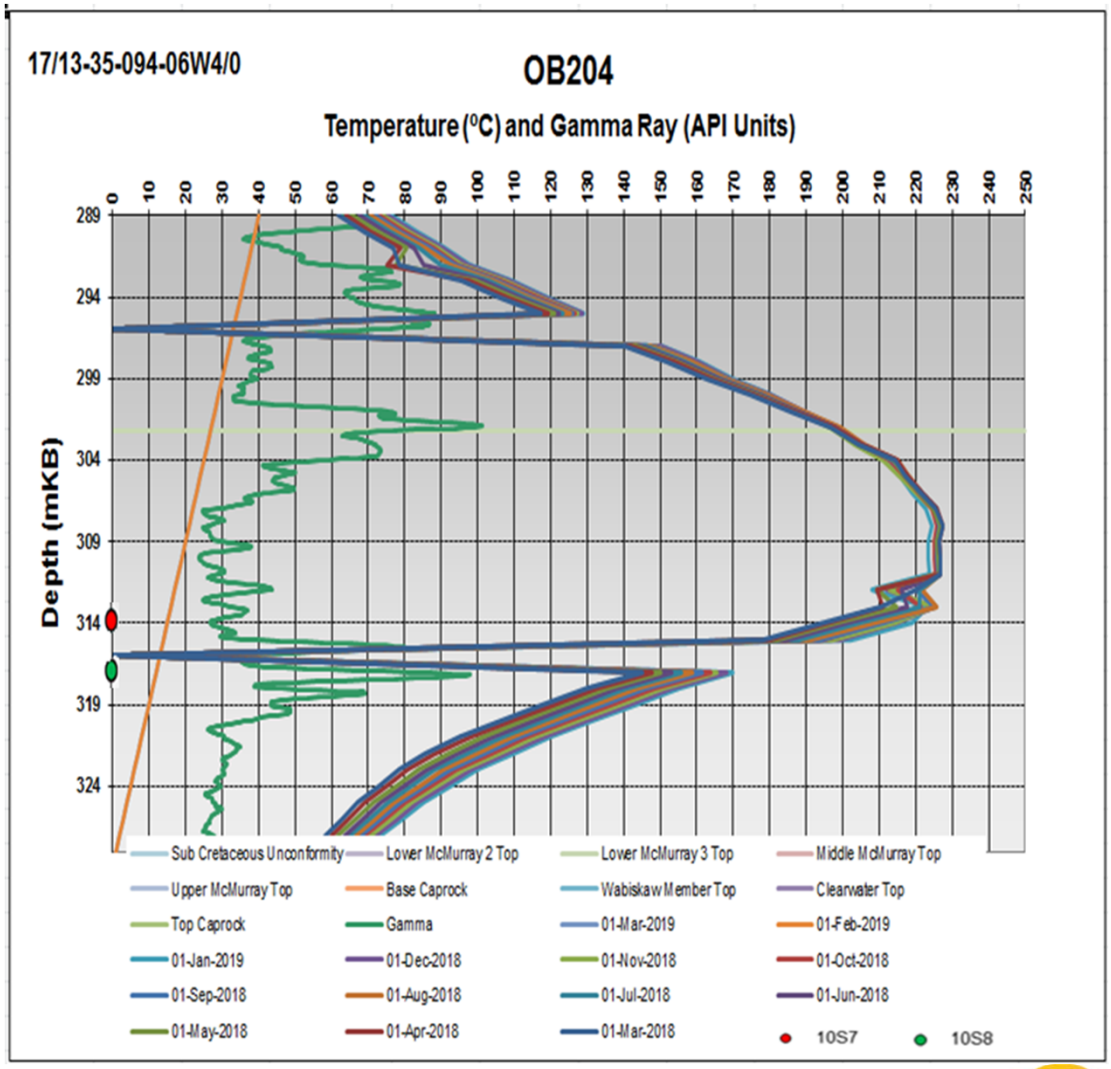
- 15m N of 10WP8, 76m S of 10WP7
- Instrumented with 40-point thermocouples covering the lower McMurray 3 and into the Clearwater
- Temperature grown over 20 deg C around the middle of horizontal section of 10WP8 and 10WP7, from last reporting period.
  - 10WP7 and 10WP8 first steam in April 2015



Steam Chamber Discussion – 10WP7 / 10WP8

OB204 – Toe of 10WP7 and 10WP8

- 14m N of 10WP8, 81m S of 10WP7
- Instrumented with 40-point thermocouples covering the lower McMurray 3 and into the middle McMurray
- Temperature began increasing in September 2015, first region along the 10WP7/8 horizontal section to see steam
  - 10WP7 and 10WP8 first steam in April 2015
- Steam chamber has continued to grow and the top is at 304 mKB



Pad Recoveries

Pad	101	102	103	104	Stage 1 & 2 Totals
Recovery to Date, e3m3	15,004	12,608	10,699	10,435	48,746
Recovery Factor to Date, %	62%	66%	54%	51%	59%
Expected Ultimate Recovery, e3m3	18,887	15,758	14,060	13,583	62,288
Expected Ultimate Recovery Factor, %	78%	83%	71%	67%	75%
EBIP, e3m3	24,146	19,052	19,736	20,356	83,290

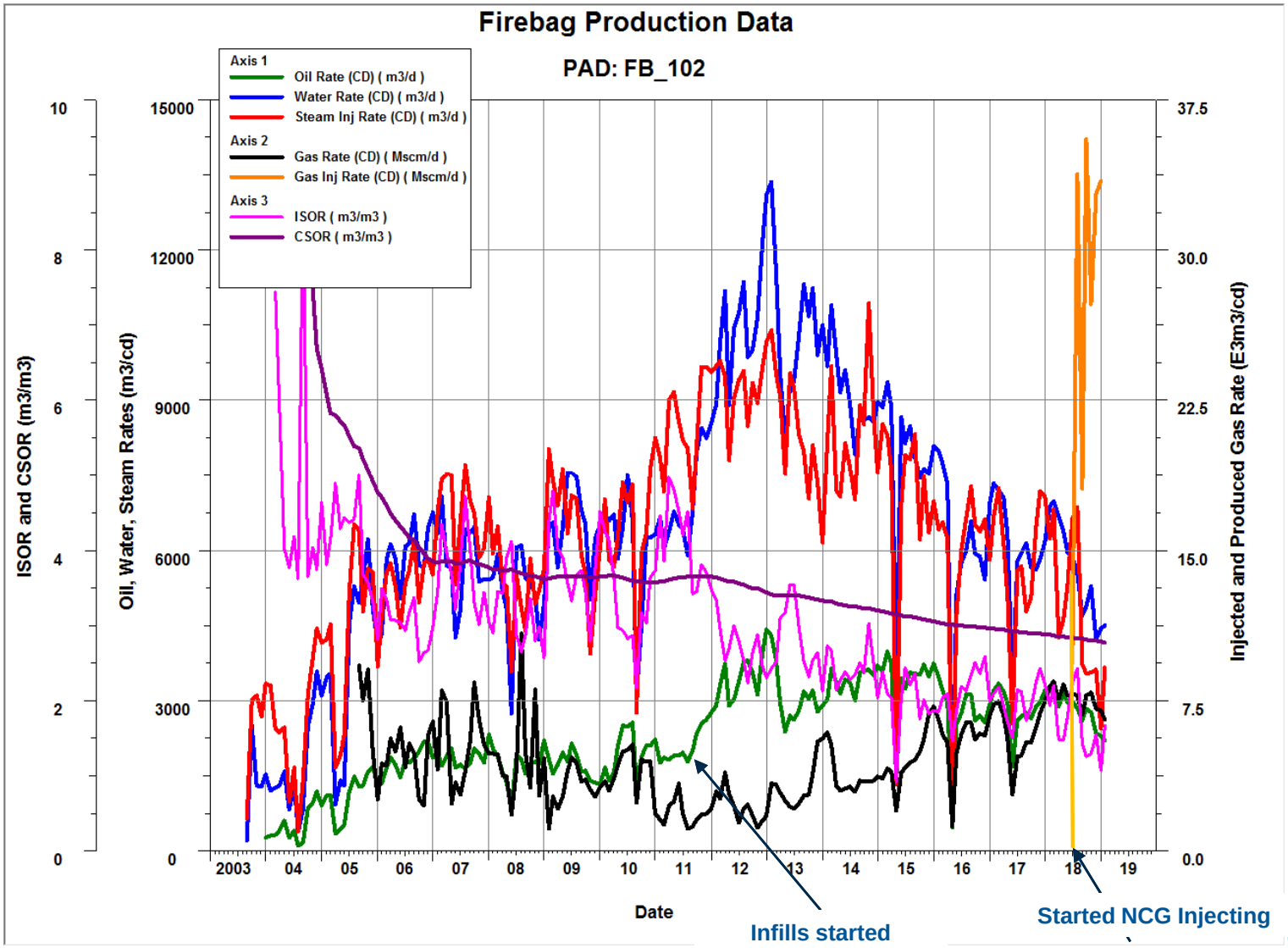
Pad	105	106	107	108	109		
Recovery to Date, e3m3	8,910	5,892	5,821	4,530	1,428		
Recovery Factor to Date, %	38%	34%	46%	26%	16%		
Expected Ultimate Recovery, e3m3	15,456	8,881	8,214	8,212	5,151		
Expected Ultimate Recovery Factor, %	66%	51%	65%	47%	57%		
EBIP e3m3	23,512	17,366	12,696	17,590	8,980		
Pad	110	114	115	116	117	118	Stage 3 & 4 Totals
Recovery to Date, e3m3	1,932	394	1,483	6,371	895	22	37,678
Recovery Factor to Date, %	21%	3%	27%	39%	7%	0%	28%
Expected Ultimate Recovery, e3m3	5,212	7,193	3,345	8,676	7,514	10,453	77,854
Expected Ultimate Recovery Factor, %	57%	58%	62%	53%	60%	58%	57%
EBIP e3m3	9,132	12,347	5,435	16,454	12,531	17,914	136,042

- Expected Ultimate Recovery is estimated internally

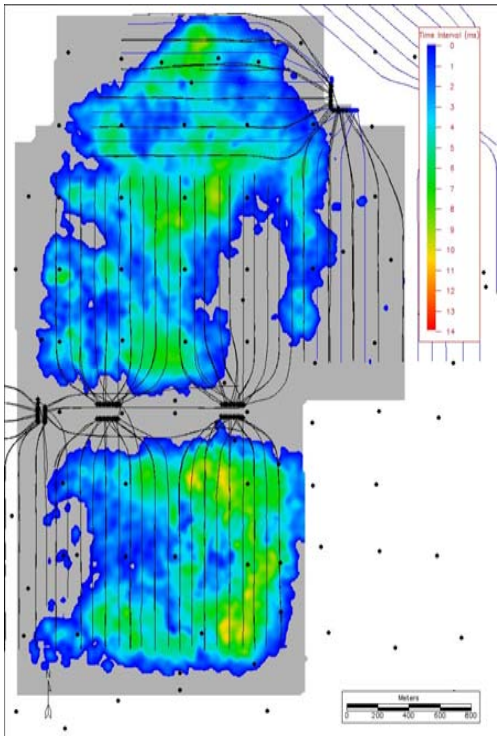
Pad 102 Performance – High Recovery Pad

- Pad 102 (Pad 102 North and Pad 102 South)
  - Mature pad
  - 14 wells on production
    - 5 well pair producers and 9 infills
  - Monthly steam chamber pressures:
    - Average: ~2200 kPag
  - Performance as of Feb. 28, 2019:
    - Cumulative steam injected is ~35,200,000 m^3
    - Cumulative oil produced is ~ 12,700,000 m^3
    - Cumulative SOR = 2.78 m^3/m^3
    - Recovery Factor of 65%
  - NCG Injection
    - Pad wide NCG injection commenced in July 2018
  - Pad Learnings
    - Base wells continue to decline, while infills maintain their strong performance and improving SOR
    - Optimizing steam injection for wells within pad and managing subcool control during operation

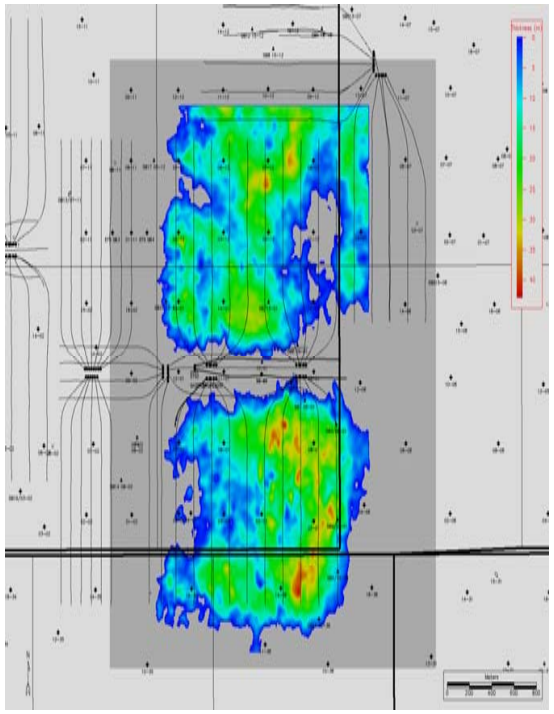
Pad 102 Performance



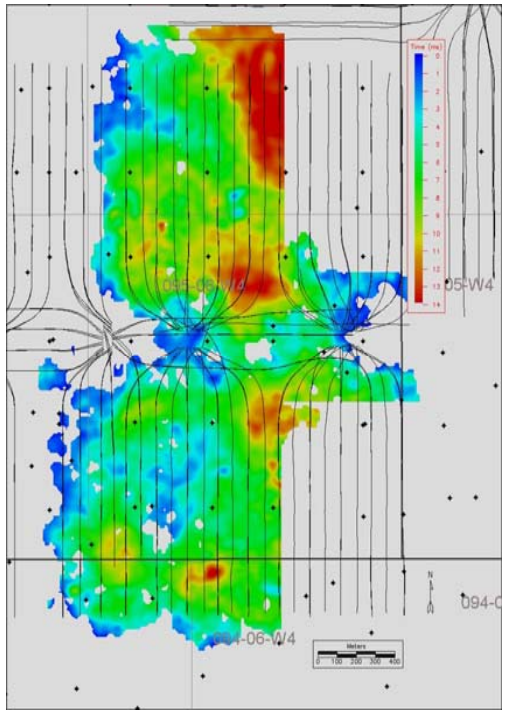
Pad 102 Performance – 4D Seismic Overview (Time delay)



2009



2010

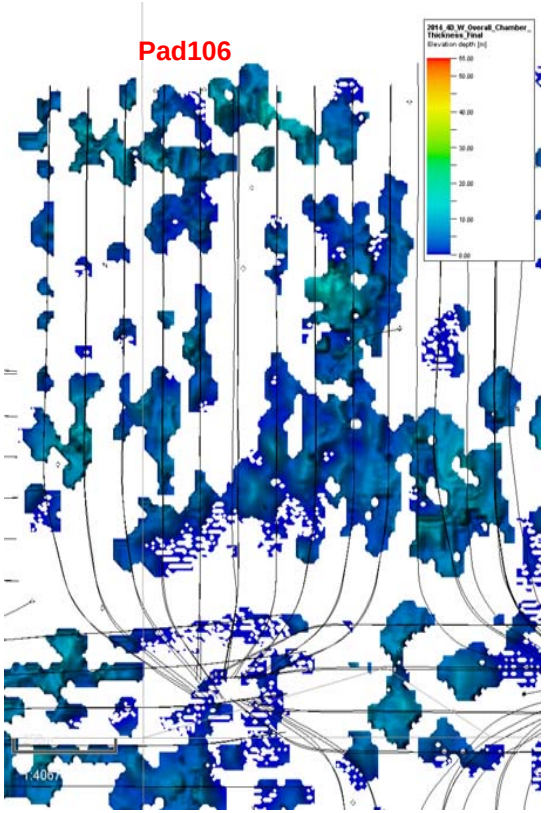


2014

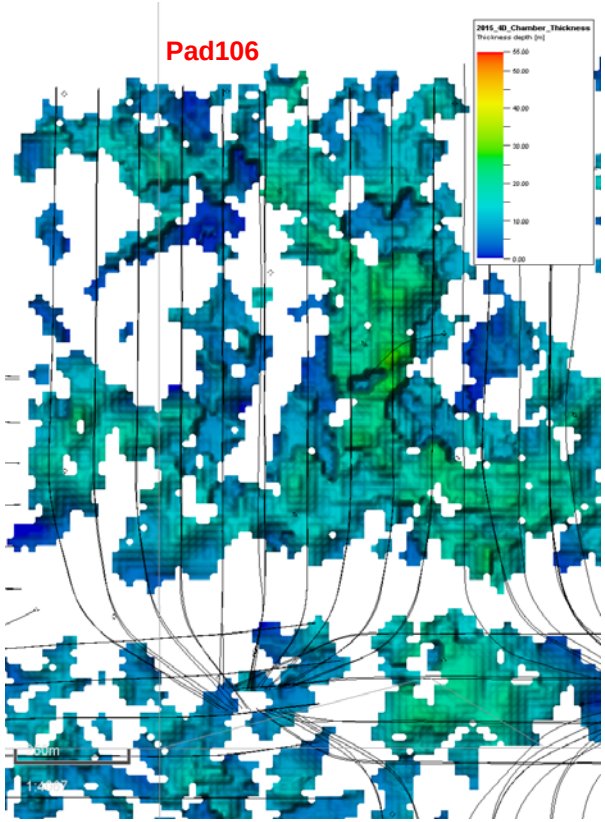
Pad 106 Performance - Medium Recovery Pad

- Pad 106
  - 16 wells currently on production
  - First oil in Oct 2012
  - Monthly steam chamber pressures:
    - Average: ~2050 kPag
  - Performance as of Feb. 28, 2019:
    - Cumulative steam injected is ~17,700,000 m^3
    - Cumulative oil produced is ~6,000,000 m^3
    - Cumulative SOR = 2.97 m^3/m^3
    - Recovery Factor of 47%
  - Pad Learnings
    - Balancing chamber pressure across this pad, optimizing steam injecting through different wells, to improve the chamber growth and obtain better well conformances

Pad 106 Performance – 4D Seismic Overview (Time Delay)

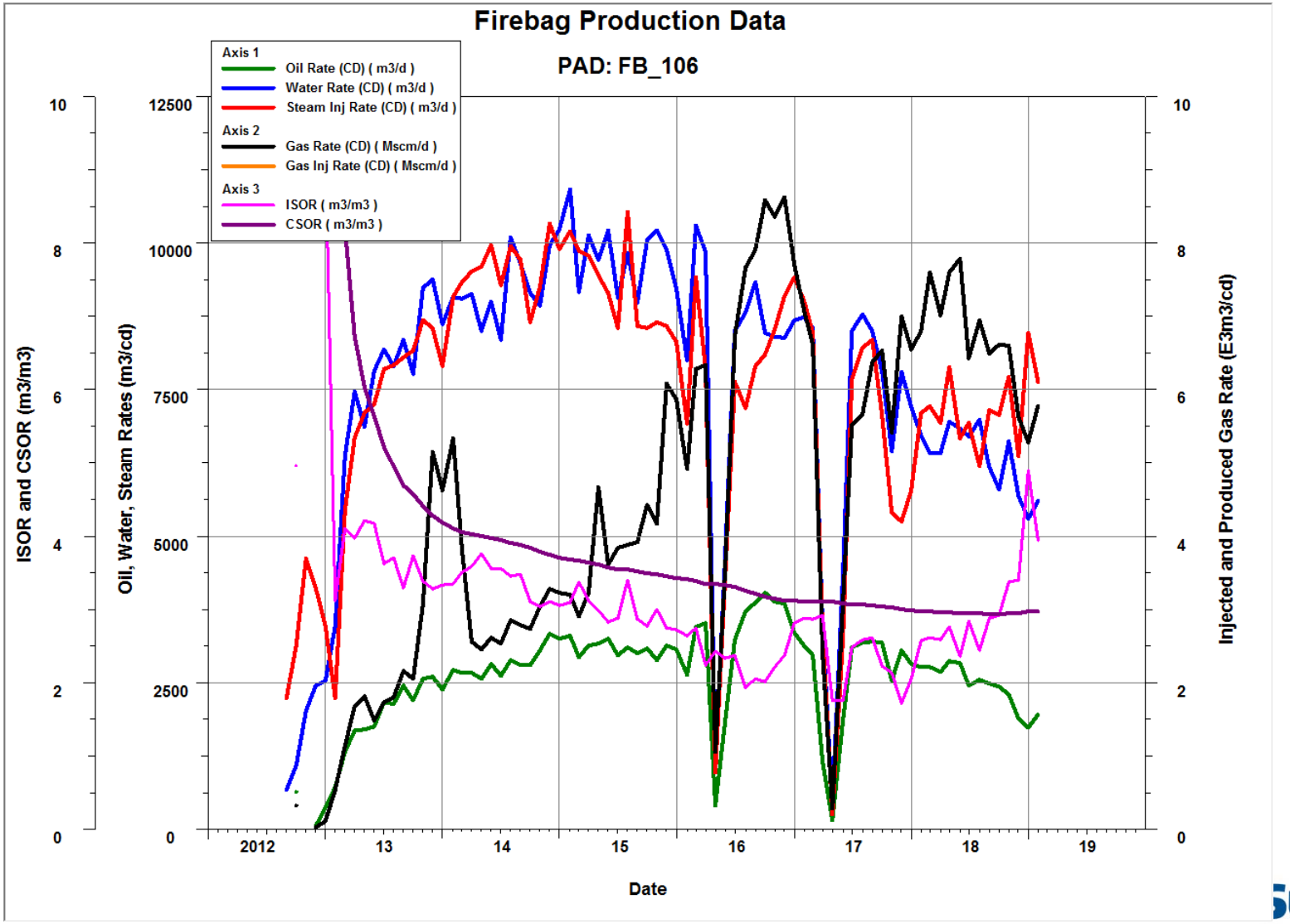


2014



2015

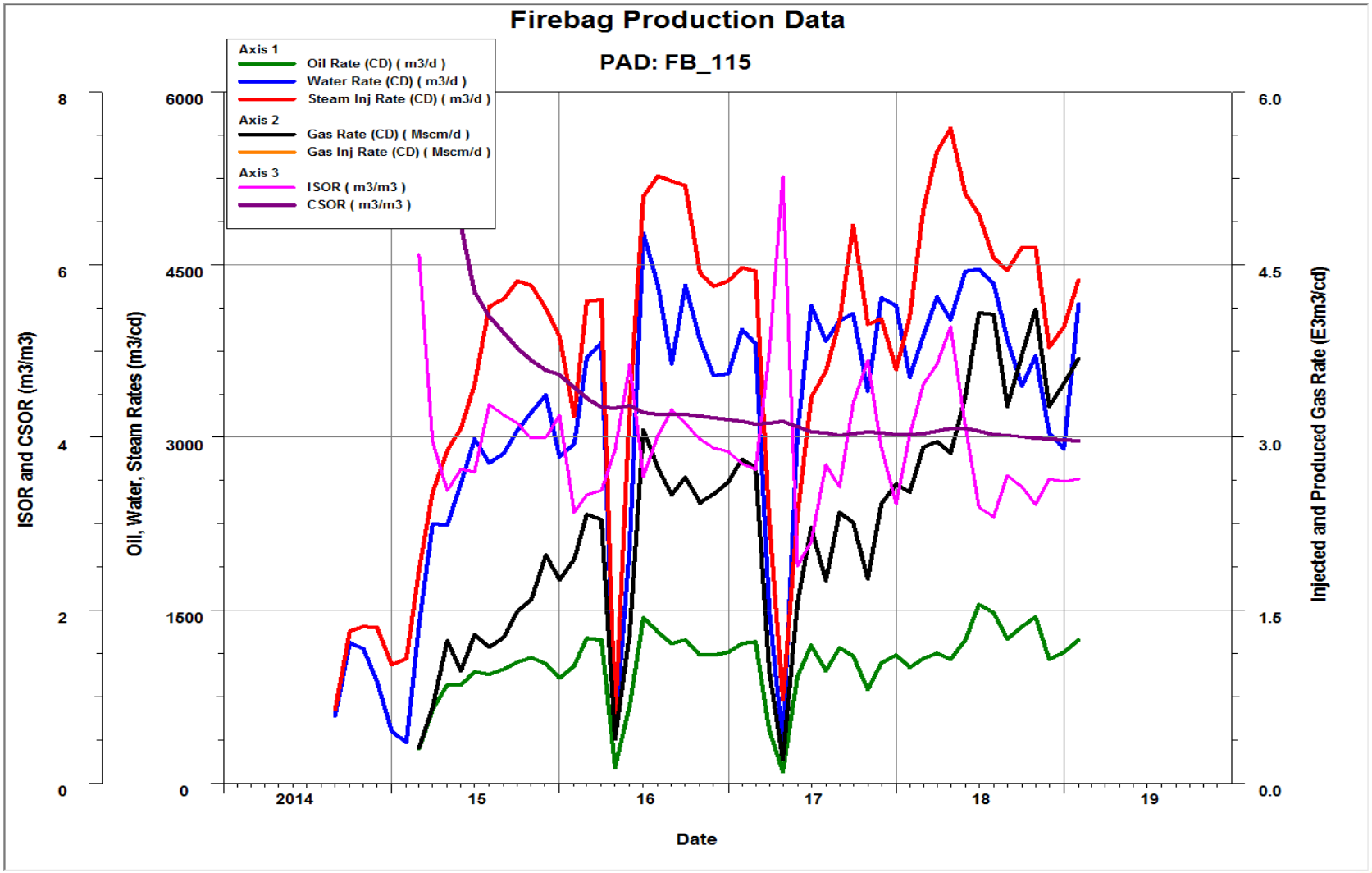
Pad 106 Performances



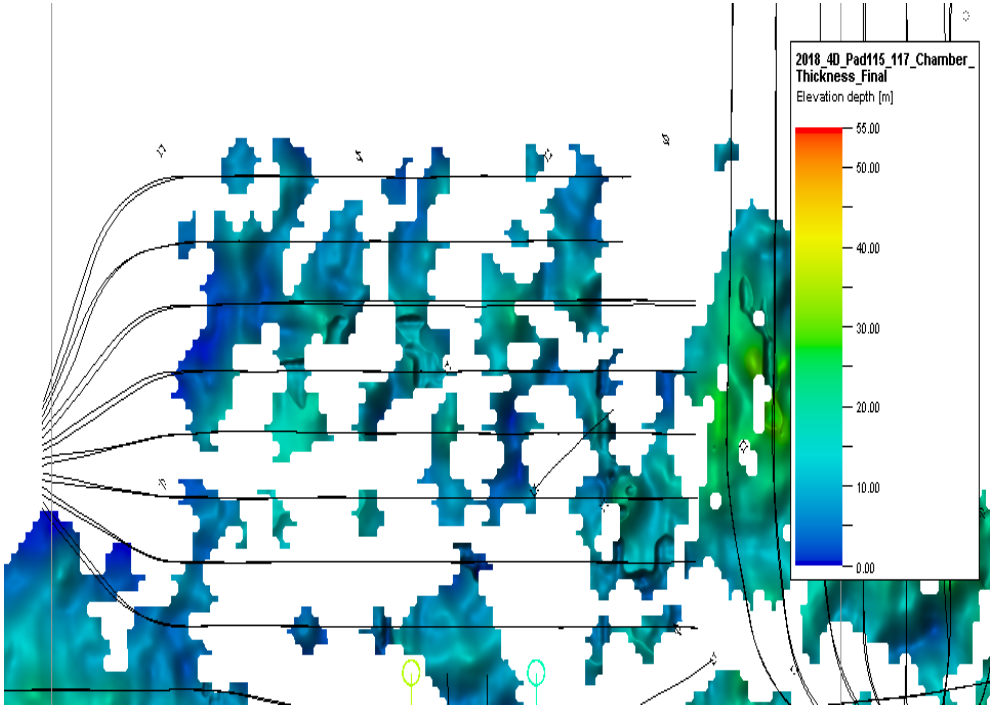
Pad 115 Performance - Low Recovery Pad

- Pad 115
  - 8 wells currently on production
  - First oil in Mar 2015
  - Monthly steam chamber pressures:
    - Average: ~2000 kPag
  - Performance as of Feb. 28, 2019:
    - Cumulative steam injected is ~6,000,000 m^3
    - Cumulative oil produced is ~1,520,000 m^3
    - Cumulative SOR = 3.95 m^3/m^3
    - Recovery Factor of 31%
  - Pad Learnings
    - Geological complexities cause well to perform challenges;
    - Slower growth of steam chamber into lower quality reservoir could have tendency to pressure up quickly and to create hot spots towards producer

Pad 115 Performances



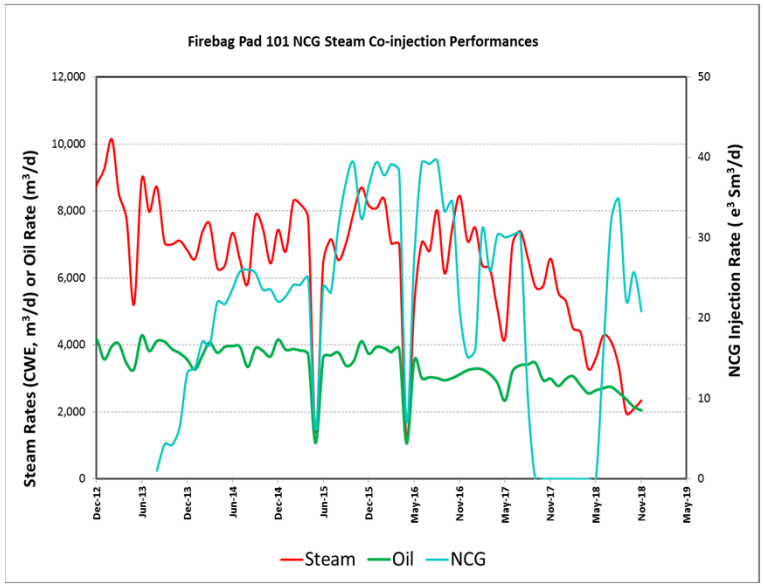
Pad 115 Performance – 4D Seismic Overview

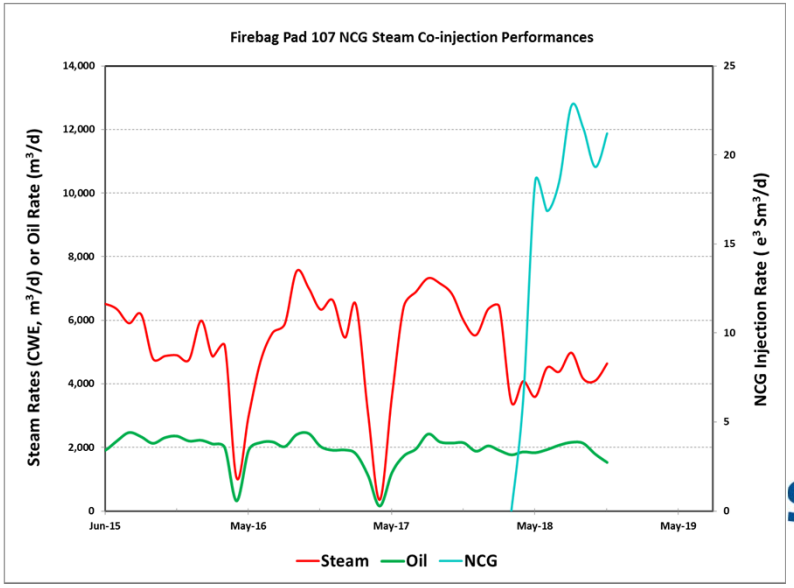


(2018)

NCG Steam co-injection

- NCG steam co-injection has been implemented in Firebag Pad101, Pad102, Pad104, Pad107
- Key Observations and Learnings
  - No negative impacts have been observed as a result of NCG co-injection on oil rates or resource recovery
  - Steam chamber pressures have been maintained with NCG injection
  - NCG steam co-injection benefits has also been observed
  - Produced gas separators show slightly increased gas production





Future Plans – Pad Abandonments

- Do not anticipate abandonment of any SAGD pads within the next 5 years

Steam Injection Properties

- Approved MOP of currently producing pads:
  - 4,040 kPag (251°C) during startup
  - 3,570 kPag (243°C) during SAGD
- Average monthly casing injection pressure during Feb. 2019 (as measured by blanket gas) was 2,248 kPag (218°C)
- These conditions are in line with those in the original design
- Steam quality decreases between the central plant and the pads.
  - Due to carryover, steam quality leaving the plant is approximately 94-95% at 10.6 MPag (typical operating pressure)
  - Quality decreases to approximately 91-93% at the pads and further decreases downstream as it splits to individual injecting wells

Steam Injection Properties

- The transportation distance from the central plant to the pads in which steam can be delivered at reasonable qualities will vary depending upon:
  - Line size
  - Insulation thickness
  - Initial pressure
  - Desired steam rate

- Steam transport distance remains economic at approximately 10 km from Firebag facility
  - Current longest steam transport distance to an operating pad is approximately 6 km

Steam Strategy

- Operating Pressure
  - Operating pressures ranged from 1,900-2,400 kPag chamber pressure in SAGD, depending on the pad
  - Plan to drop chamber pressures on mature wells over next few years

- Under normal operating conditions, steam is allocated to balance chamber pressures across patterns

- In periods of lower steam supply, priority generally given to younger wells

Summary of Key Learnings

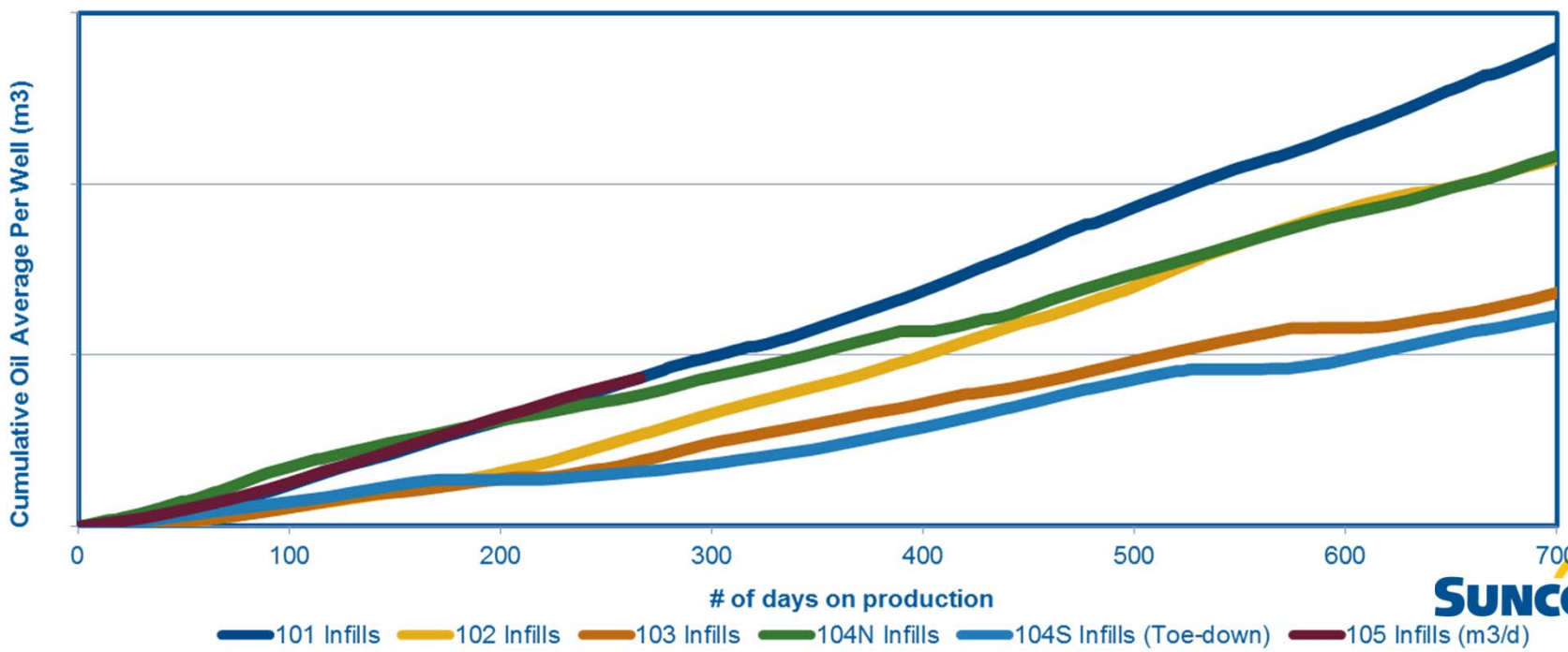
- Infill Performance and Operation
- Bullheading for SAGD startup
- NCG Co-injection Phase 1 (Pad 101, 102, 104 and 107)
- Advanced reservoir management for improved energy efficiency

Summary of Key Learnings

- Infill Performance
  - Total 51 infills to date, average oil production of 1,081 bopd (172 m^3/d/w)
  - Bottom hole temperatures vary greatly from well to well
    - Depends on nearby wells' steam chamber development
    - Some infills require multiple steaming cycles (e.g. 4N11) while others encounter steam chamber (e.g. 3N7)
    - Most recent infills (e.g Pad105) are ramping up production.
  - Optimal timing on infill well drilling is highly variable and needs to be assessed based on geology/steam chamber development in infill location (use of 4D seismic data)
  - During production, infill/base well interaction needs to be managed to optimize performance at a steam chamber level
  - Positive impacts on SOR and WOR, which improve overall field performance

Summary of Key Learnings

- Infill Performance
  - Infill wells drilled too low from the offset producers can cause issues with infill start-up, limiting inflow during production.
  - Recent infill wells have comparative performance with the earliest infills.



Summary of Key Learnings

- Bullheading Startup
  - Operates within AER approved MOP
  - Injects steam into the reservoir without circulating a portion of the steam back to surface
  - By not taking returns, bullheading:
    - Requires less cumulative steam to achieve the same reservoir heating as circulation
    - Reduces CSOR and thus emissions/bbl produced
  - Bullheading startup to date: 105, 107, 108, 109, 110, 116, 104/103 Infills, 115, 117, 114 and 118.
  - Circulation considered, when bullheading is unable to achieve target steam injection rate within AER approved MOP

Summary of Key Learnings

- Advanced reservoir management for improved energy efficiency
  - Leak-off optimized from edge well pairs to avoid losing injected energy
  - Steam chamber pressures balanced between pads for operation optimization and also heat efficiency improvement
    - Avoid energy loss through fluid migration into cold regions between steam chambers due to differential chamber pressures
  - Allocate steam from mature pads to new pads that are coming online
    - Steam to new pads is given highest priority to ensure stable steam chamber development
    - Increased well count is managed through improvements in automating steam distribution

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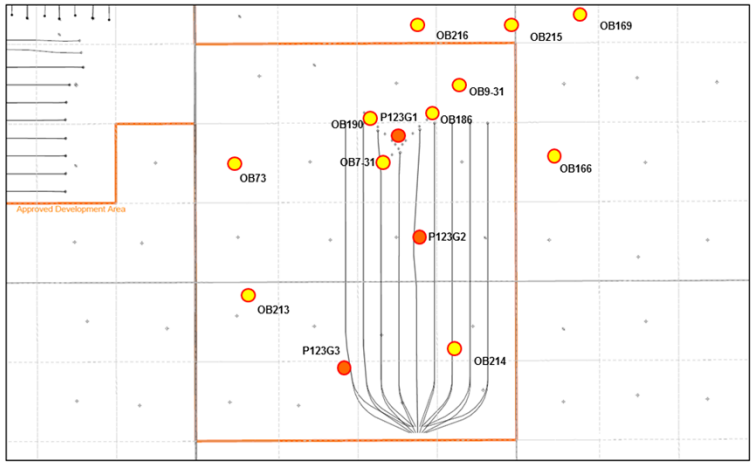
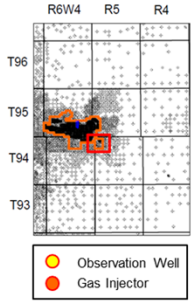
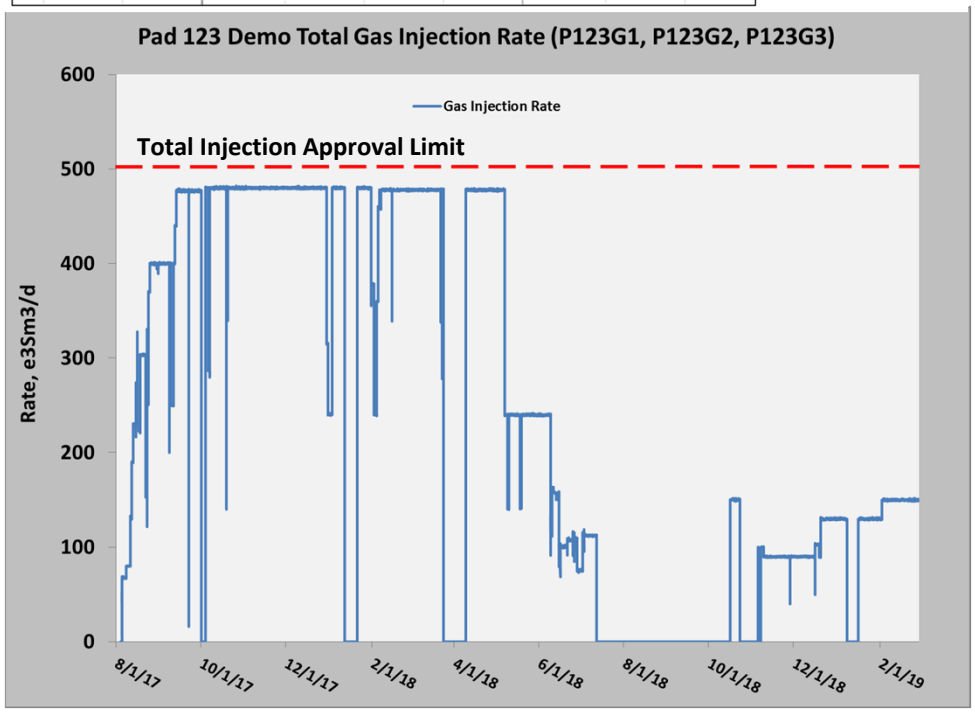
- **Future Plans**
- Compliance Commitments

Pad 123 Gas injection demonstration update & Future Plan







- Suncor started gas injection in Pad 123 on August 5, 2017 as per AER approval
- Suncor has safely ramped up to the total injection rate of 480 e3Sm3/d of gas while adhering to the terms of AER approval and with respect to containment of gas in McMurray zone.
- Firebag fuel gas (mainly methane) is used for the current injection scheme
- All 3 gas injectors (P123G1, P123G2,P123G3) are utilized. Injection pressure has been monitored and kept below approved MOP during operation.
- Suncor has optimized the gas injection rate/pressure in accordance with long term steam chamber operation of SAGD in Pad 123.
- Optimized gas injection schedule is being implemented in preparation of Pad 123 start-up (first steam is Oct 2020)

Future Plans – Regulatory Applications

- Approved Applications

Directive 78 Amendments	Description	Date Submitted	Date Approved	Approval
Pad 123 – Well Spacing & Drainage Polygon Amendment	Pad 123	April 13th, 2018	May 7th, 2018	8870WWW
Temporary Variance to Sulphur Recovery guidelines due to maintenance and unplanned outages	Firebag	July 16th, 2018	July 30th, 2018	8870XXX
Suncor Firebag NCG Co-injection Field Wide Application	Current and future Pads	May 8th, 2018	August 23rd, 2018	8870YYY
Firebag 2018/19 Firebag Water and N2 Injectivity Test	NE & E Firebag	September 10th, 2018	November 13th, 2018	8870ZZZ
Application to Amend Surface Layout at Pad 111	Pad 111	October 24th, 2018	November 30th, 2018	8870AAAA
Alberta Sulphur Recovery Guidelines (Interim Directive 2001-03) Request for Temporary Variance	Firebag	January 11th, 2019	January 21st, 2019	8870BBBB

- Future Applications
  - Pad 124, 125, 126, 128, 129, 130, 131, 132 and SW_F D78 Well-pad Applications
  - Geoscience and Reservoir Development teams are continuing work to determine optimal depletion plans for current and future pads
  - Continuing work on NCG co-injection next phase development

Future Plans – Drilling Activities

- Horizontal Drilling Activities
  - Pad 106 P6 sidetrack competed in May 2018
  - Pad 108 P15 sidetrack multilateral well was completed in May 2018
  - Pad 118 additional 2 injectors – S1 & S19 completed in May 2018
  - Pad 121 wells were completed in March 2019

- Future Drilling
  - The following drilling is expected to commence:
  - Pad 111 SAGD well-pairs: Q1 2019
  - Pad 123 SAGD well-pairs: Q3 2019

  - Coreholes/observation wells will be drilled as necessary to:
    - Adequately delineate the resource
    - Monitor SAGD operations
    - Further caprock integrity analysis
    - Conduct hydrogeology analysis
    - Conduct Water disposal analysis
    - Allow Land retention

SUNCOR

Future Plans – Pilots

- Pad 109 South Expanding-Solvent SAGD (ES-SAGD) Pilot
  - First injection to commence in Q1 2019

Future Plans – Pad Development

- Pads 112 and 121
  - First steam planned in Q2 and Q4 2019
- Pads 111, 122, 123, 125, 126, 128, 129 and 131
  - First steam planned between 2020-2022

- Development plans are evaluated annually and therefore subject to change

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4P10 Repair of Surface Casing Vent Flow Deferral Approval

- As per Nov 10, 2016 approval, Suncor has drilled 3 Quaternary monitoring wells on Pad 104 in a triangular formation around 4P1
- Samples have been collected on a quarterly basis since Q1 2017
- Too soon to draw statistical trends and no evidence of contamination has been observed
- Analytical results are below the Tier 1 Groundwater Guidelines and accepted variability

Compliance with Daily Average Maximum Operating Pressure

- Following occurrences are reported as per the daily average MWHIP approval (No. 8870LLL):

Well	Number of Occurences	Date of Occurrence(s)	Severity
101S03 Tubing	2	11-May-18	Peak Pressure: 3,575 kPa Daily Average Injection Pressure: 2,995 kPa Duration: 1 min
		1-Jul-18	Peak Pressure: 3,570 kPa Daily Average Injection Pressure: 2,933 kPa Duration: 1 min
101S05 Tubing	1	10-May-18	Peak Pressure: 3,630 kPa Daily Average Injection Pressure: 2,905 kPa Duration: 2 min
101S10 Tubing	1	10-May-18	Peak Pressure: 3,650 kPa Daily Average Injection Pressure: 3,269 kPa Duration: 1 min
102S01 Casing	1	18-Sep-18	Peak Pressure: 6,040 kPa Daily Average Injection Pressure: 2,434 kPa Duration: 1 min
102S02 Casing	1	18-Sep-18	Peak Pressure: 6,671 kPa Daily Average Injection Pressure: 2,320 kPa Duration: 1 min
103S07 Tubing	1	9-Nov-18	Peak Pressure: 3,629 kPa Daily Average Injection Pressure: 3,299 kPa Duration: 1 min
105S01 Tubing	1	25-Aug-18	Peak Pressure: 3,825 kPa Daily Average Injection Pressure: 2,554 kPa Duration: 1 min

- All of the events were < 2 mins in duration. Corrective actions have been implemented to improve controller valve tuning to optimize valve response and decrease the likelihood of reoccurrence
- When necessary, maintenance work has been done to repair the affected equipment

Section 3.1.2 – Surface Operations, Compliance and Issues Not Related to Resource Evaluation and Recovery

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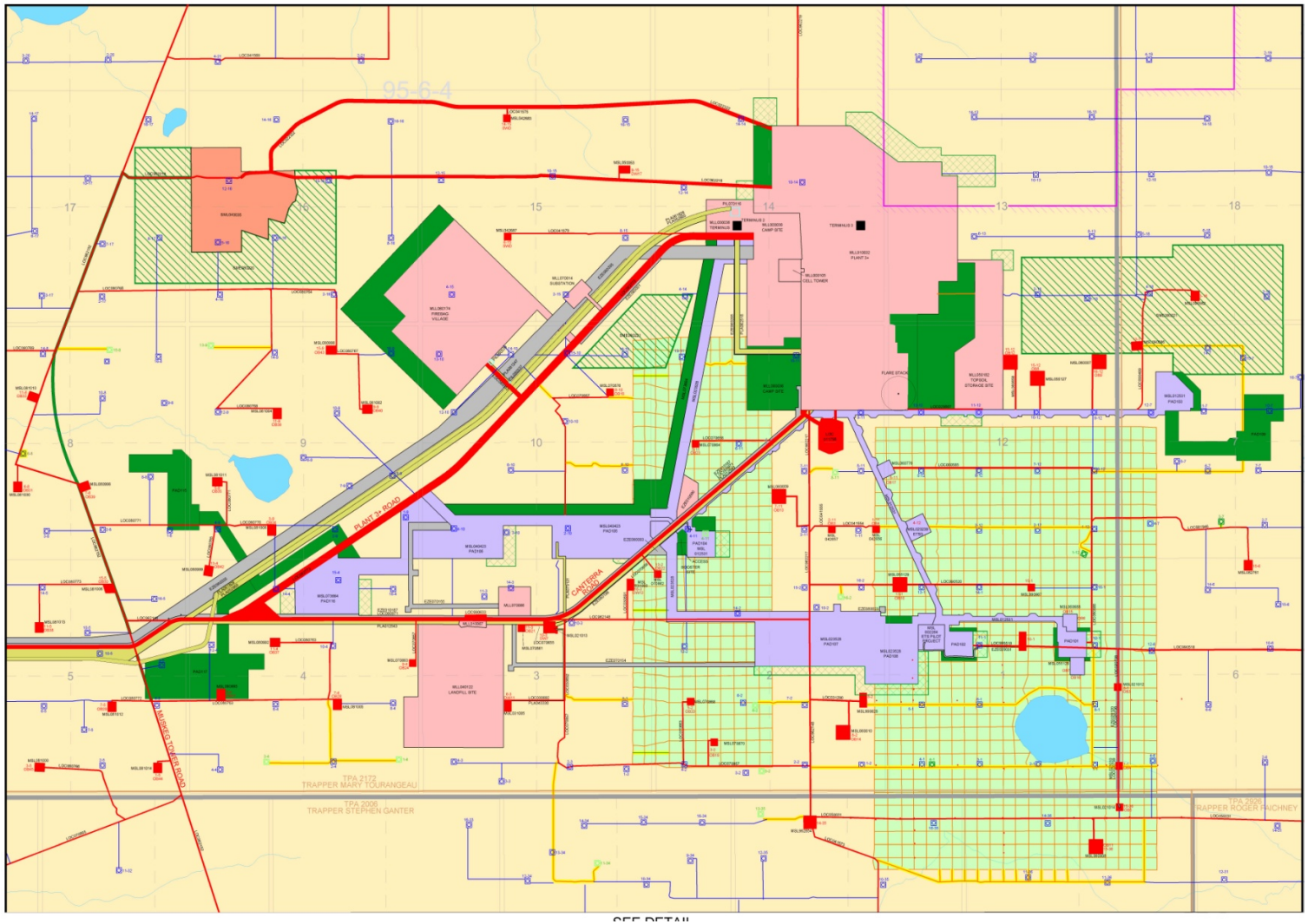
- Measurement and Reporting
- Water Production, Injection and Usage
- Sulphur Production
- Environmental Performance
- Future Plans

Firebag Performance Presentation

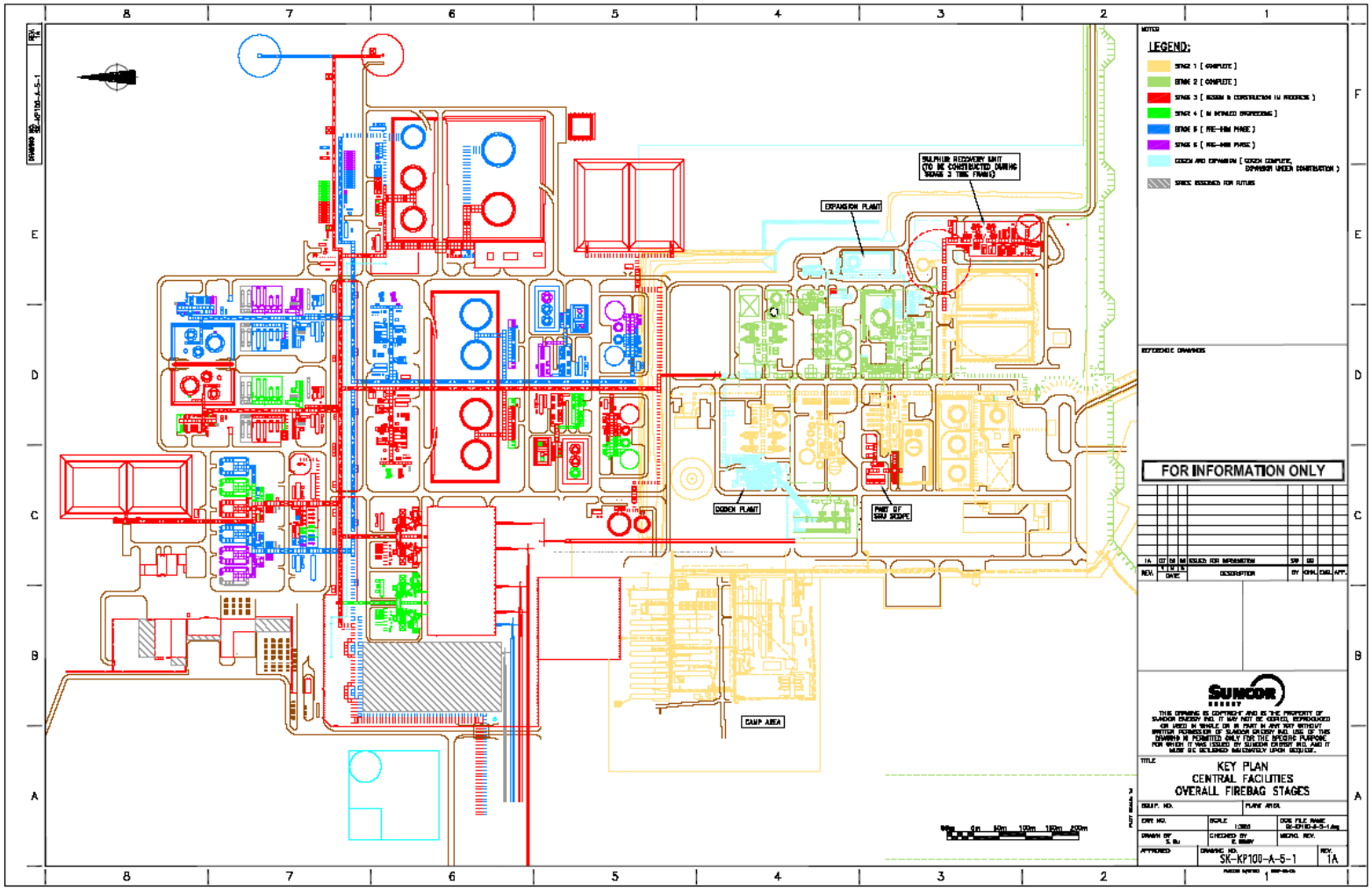
Operations and Facility Performance

May 1st, 2019

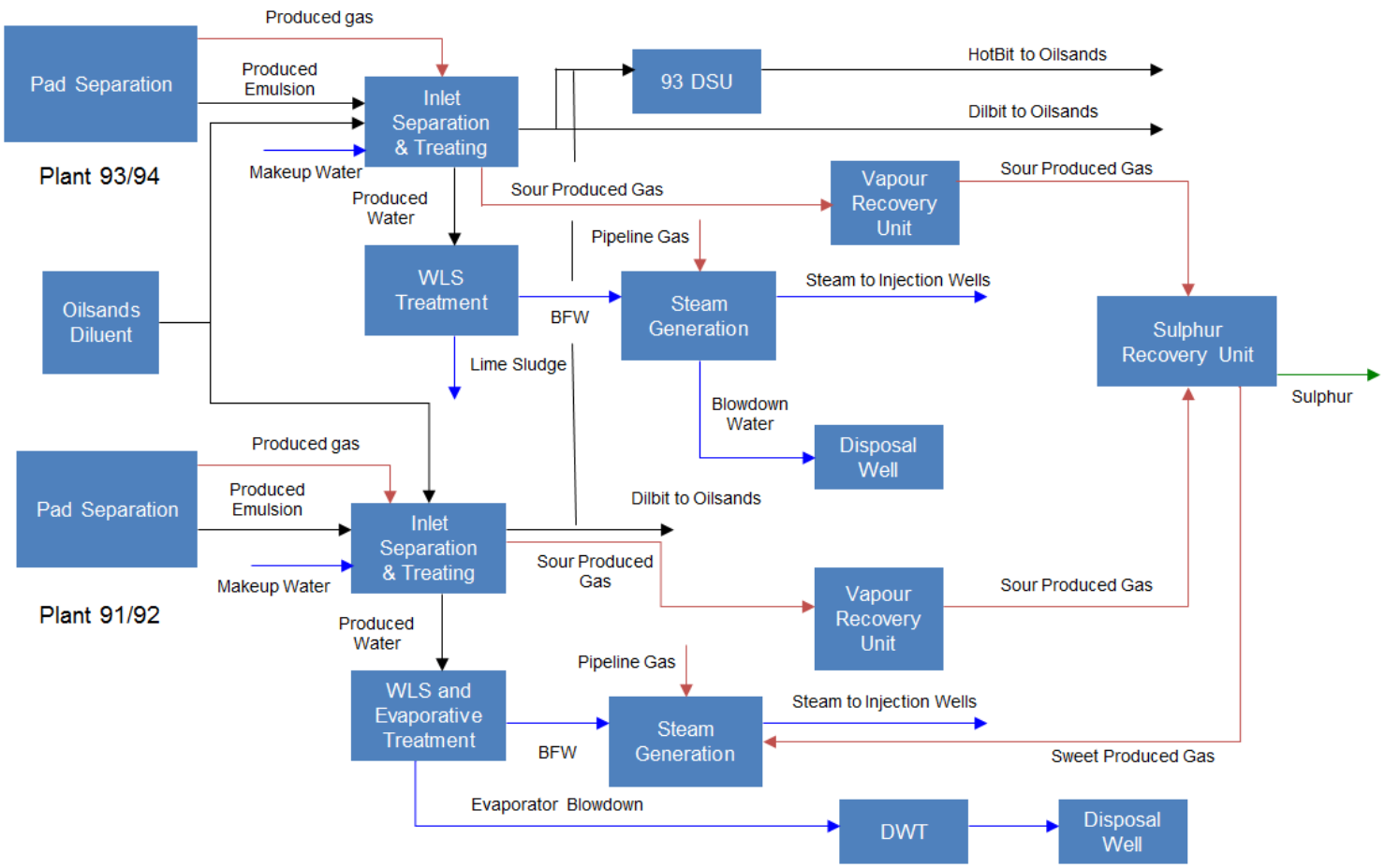
Site Survey Plan



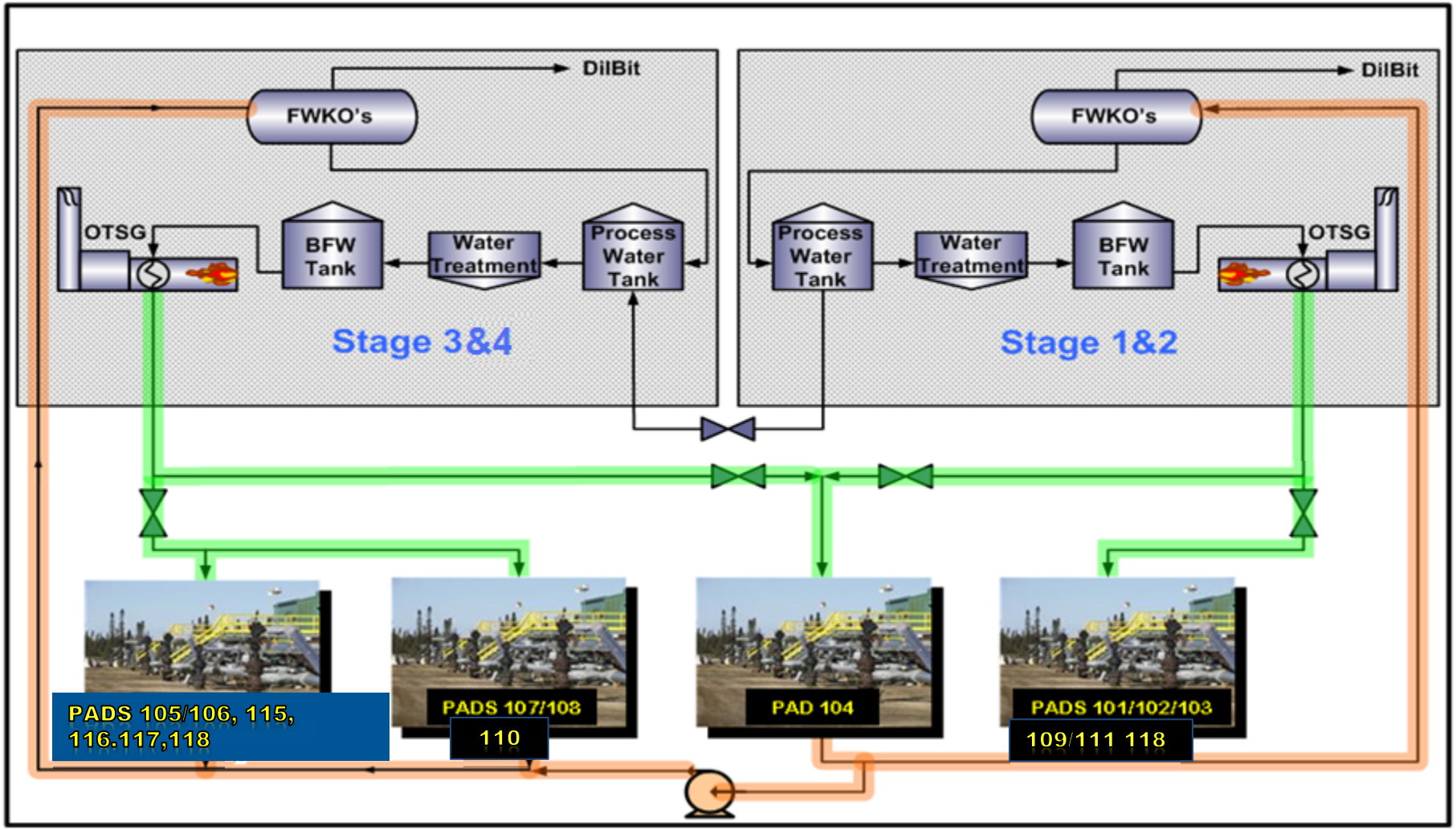
Firebag Site Layout



Firebag Simplified Process Block Diagram



Stages 1, 2, 3 & 4


DilBit
FWKO's
OTSG
BFW Tank
Water Treatment
Process Water Tank
Stage 3&4
DilBit
FWKO's
Process Water Tank
Water Treatment
BFW Tank
OTSG
Stage 1&2
PADS 105/106, 115, 116.117,118
PADS 107/108
110
PAD 104
PADS 101/102/103
109/111 118

Oil Treatment Technologies

- All Plants
  - Free Water Knockout Drums and Treaters for bitumen separation
  - Inject diluent upstream of the free water knockout drum

- Plant 93/94 primary differences from Plant 91/92:
  - Produced gas cooling and liquid removal at the pads
  - Electrostatic grids in the Treaters
  - Spiral Produced Water Coolers versus conventional shell and tube
  - Oil Removal Filters (ORF's)

- Skim Tanks in Plant 91/92

- Micro-Bubble Flotation (MBF) in 92 Expansion and Plant 93/94

- Diluent Stripping Unit (DSU) that produces Hotbit and recovers diluent from Dilbit

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Oil Treatment Risks and Opportunities

- All Plants
  - Ongoing operation improvement to reduce venting incidents
    - Multidisciplinary venting task force created to effectively address root causes.
  - Electrostatic treater grid optimization
    - Optimized electrostatic grid to better deal with emulsion rag layer, leading to more consistent dilbit and produced water quality.
  - Produced water cooler chemical re-use program
    - Implemented a new cleaning strategy to effectively reuse cleaning solution multiple times, reducing disposal requirement.
  - Treater REB injection
    - Commissioning REB injection skid at Treater to optimize overall chemical usage.
  - Diverter valve produced water cooler
    - Achieved extended exchanger run with challenges on valve maintenance and reliability.
  - Re-commission Plant 92 Inlet Separator to improve Plant overall performance.
    - Currently in Development stage evaluating the relief capacity requirement of the vessel

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Water Treatment Technologies

- Water treatment technology used at Firebag:
  - Plant 91 - Warm Lime Softening (WLS), Filtration (Anthracite), Weak Acid Cation Exchange (WAC)
  - Plant 92 - Evaporators and Disposal Water Treatment (DWT) Technology
  - Plant 93 – WLS, Filtration (Walnut Shell), WAC
  - Plant 94 – WLS, Filtration (Walnut Shell), WAC

Water Treatment Risks and Opportunities

- 91 – WLS Performance
  - Ongoing sludge recirculation issues
  - Chemical Optimization
  - Reduction off-spec incidents

- 92 – Evaporator Performance
  - Improvement and Optimization of Evaporator cleaning cycles
  - DWT loss of containment ongoing concern
    - Improvement on materials and root cause analysis
  - DWT Optimization initiatives

- 93 – WLS Performance
  - Improvement of chemical system reliability
  - Chemical Reduction and Optimization
  - Reduction off-spec incidents
    - Fixed Glycol leak in DSU leading to improved WLS performance
    - Floating Skimmer on pond return flow

Steam Generation Risks and Opportunities

- Steam Header Corrosion
  - Plan in place to replace/upgrade where required in April 2019
- Optimization of steam generation capacity during steam long situations
- HRSG Rerate trial to increase steaming capacity with existing equipment
- Optimization of Iron Dispersant with on demand usage.
- Trialing new tube differential pressure monitoring equipment to help understand impact of water quality excursions
- Improved pigging frequency and use to maximize steam generator usage
- Improved fouling monitoring
- Reducing downtime caused by equipment failure by replacing vortex meters with ultrasonic meters. All 93/94 OTSGs now utilize ultrasonic flow meters
- Improved reliability of 93/94 OTSGs with installation of Heat Shields to protect from steam blanketing on inlet radiant section

Sulphur Recovery Technologies

- The Firebag Sulphur Recovery Complex (SRC) came online successfully in February 2011
- It consists of both an Amine Stripping Unit (ASU) and a Sulphur Recovery Unit (SRU)
- The SRC is an integral part in the development and operation of Firebag
- Two ASU Trains using MDEA for sour gas sweetening
- Two SRU trains utilizing a three stage Claus process. The capacity of each train is 13.5 T/day sulphur
- The Amine unit sweetens the produced gas which is used as fuel gas
- Since start-up, several constraints and challenges have been overcome to achieve a high sulphur recovery level

Sulphur Recovery Plant Risk and Opportunities

- Increased Produced Gas from the Pads area resulting from optimization projects which requires us to run both Produce Gas Compressors.
- Improve plant reliability by reducing foaming upset condition through continues skimming
- Improve plant reliability by running two SRU trains in parallel
- Project to Debottleneck PG Compressors and ASU Plant
- ASU/SRU Turnaround May 2019.
- Improve performance of ASU contactors with changing ASU train-B contactor trays from bubble cap to high efficient valve trays

	Average Inlet Sulphur (tonnes/day)	Sulphur Recovery (%)	Sulphur Balance (%)	Sour Gas Flared (e3m3)	Sulphur Flared (tonnes)
Q2 2018	13.94	98.1%	1.9%	5.5	0.8
Q3 2018	14.53	97.3%	0.9%	1.2	1.3
Q4 2018	14.25	97.9%	0.4%	22.8	2.4
Q1 2019	13.20	97.3%	2.1%	23.8	5.8

Pads/Gathering Technologies

- Currently: 250 Producing Wells
- New Pads: Pad-118, Pad-117
- Pad NCG Co-Injection into Wells
- Future Pads: 112, 121, 123, 122 (Firebag development program)
- Solvent Injection Trial to Pad-109 ES-SAGD
- Lean Zones Gas Injection Project
- Booster pumps reversal project through Pumps bypass valve to transfer some of the emulsion from Stage-3+ Pads to Plant-91/92 to maximize production flexibility

Boiler Feed Water (BFW) Quality

	Plant 91	Plant 92	Cogen (HRSG)	Plant 93/94
Total Dissolved Solids (mg/L)	1600	580	800	2100
Reactive Silica (mg/L)	38	12	17	20
Hardness (mg/L as $CaCO_3$)	<0.3	<0.3	<0.3	<0.3

Plant Improvements

- Continuous optimization of the Free Water Knockout (FWKO) and Deoiling to ensure on spec Basic Sediment & Water (BS&W) in Dilbit and Oil in Water.
- Completion of HRSG re-rate trial to generate additional steam from existing stage 3&4 Cogeneration Units
- Ongoing chemical injection metering improvements for better reliability and prevent upsets stemming from poor separation due to chemical injection imbalance.
- Continued study and balance of emulsion flows from Pads to CPF as reservoir development matures to ensure optimized production between the Firebag stages
- Produced Water Coolers spent water reduction to reduce liquid waste flow needed to be handled in the Ecopit.
- Evaporator chemical cleaning procedure improvement completed – extending time between manned vessel entries and reduce downtime during cleanings
- Improved the foaming issue in Amine unit significantly by automated skimming of water from stripper column reflux drum and testing wash water system for gas conditioning
- Reduction in SOR assisted with higher DilBit production (“Oil Mode” when well long)

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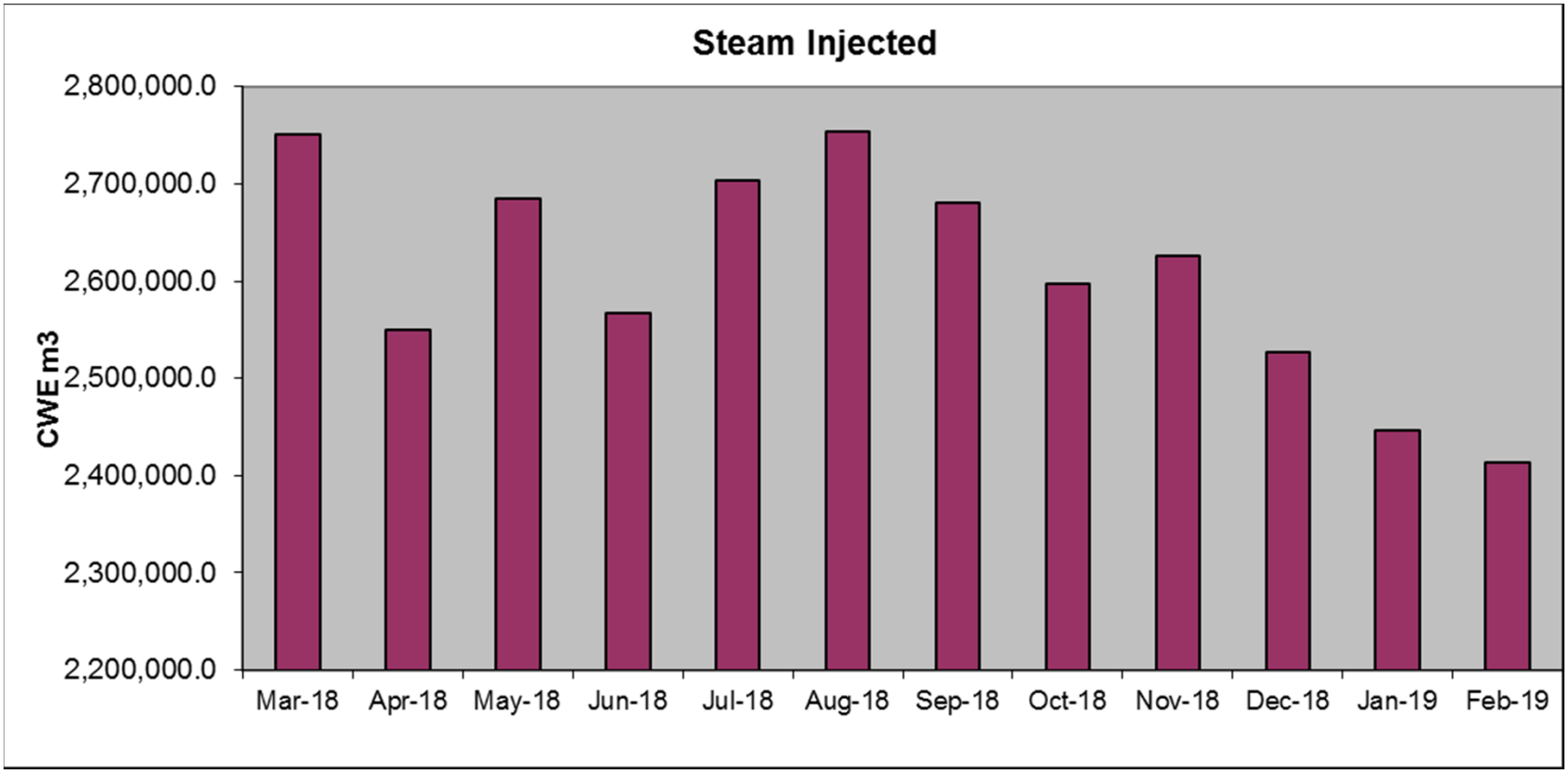
Steam Injected

From March 2018 to February 2019 Firebag injected on average 85,771.5 m3/day of steam into the wells.



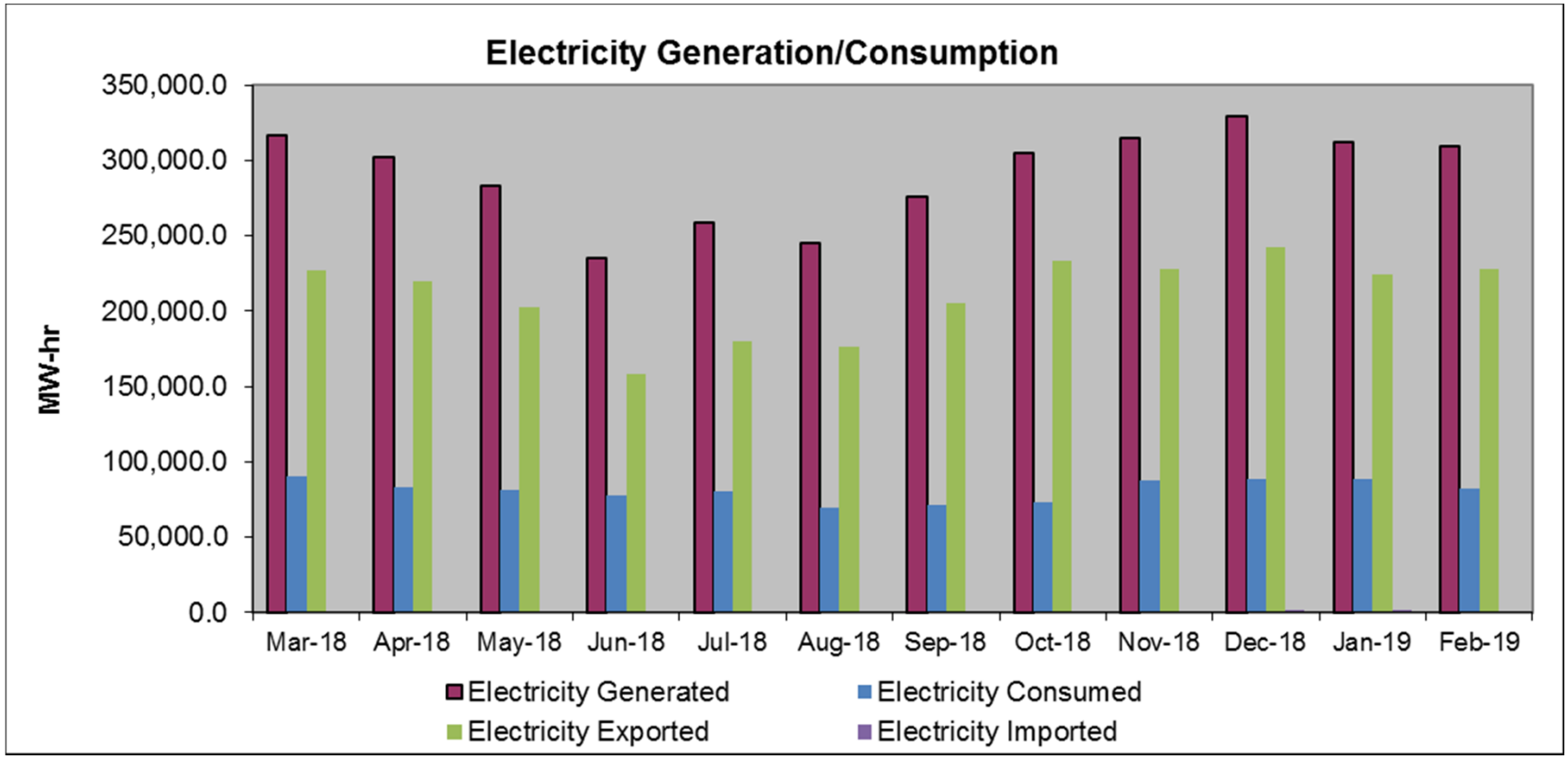
Steam Qualities

	Plant 91 OTSGs	Plant 92 OTSGs	Plant 91 Cogen	Plant 93 OTSGs	Plant 93 Cogens	Plant 94 OTSGs	Plant 94 Cogens
Mar-18	73.8	76.6	72.8	74.0	77.6	73.8	77.2
Apr-18	73.1	76.8	75.9	75.5	76.8	74.1	77.6
May-18	70.2	76.3	76.8	75.6	76.4	75.9	75.9
Jun-18	69.6	76.7	75.9	74.1	75.8	76.6	75.1
Jul-18	73.8	77.8	76.9	74.0	75.4	77.1	77.1
Aug-18	73.7	75.7	75.4	75.8	76.2	75.3	77.2
Sep-18	71.8	76.7	75.2	76.4	77.1	76.1	76.6
Oct-18	68.6	76.1	76.8	74.2	77.2	76.2	76.9
Nov-18	67.9	77.2	76.6	72.6	77.3	76.7	76.6
Dec-18	69.3	77.2	77.0	74.1	75.7	76.8	77.0
Jan-19	69.7	76.6	76.0	74.2	74.9	77.4	76.2
Feb-19	67.7	78.3	76.9	76.3	76.6	76.9	78.0
Average	**70.8**	**76.8**	**76.0**	**74.7**	**76.4**	**76.1**	**76.8**

*Steam qualities in percentage

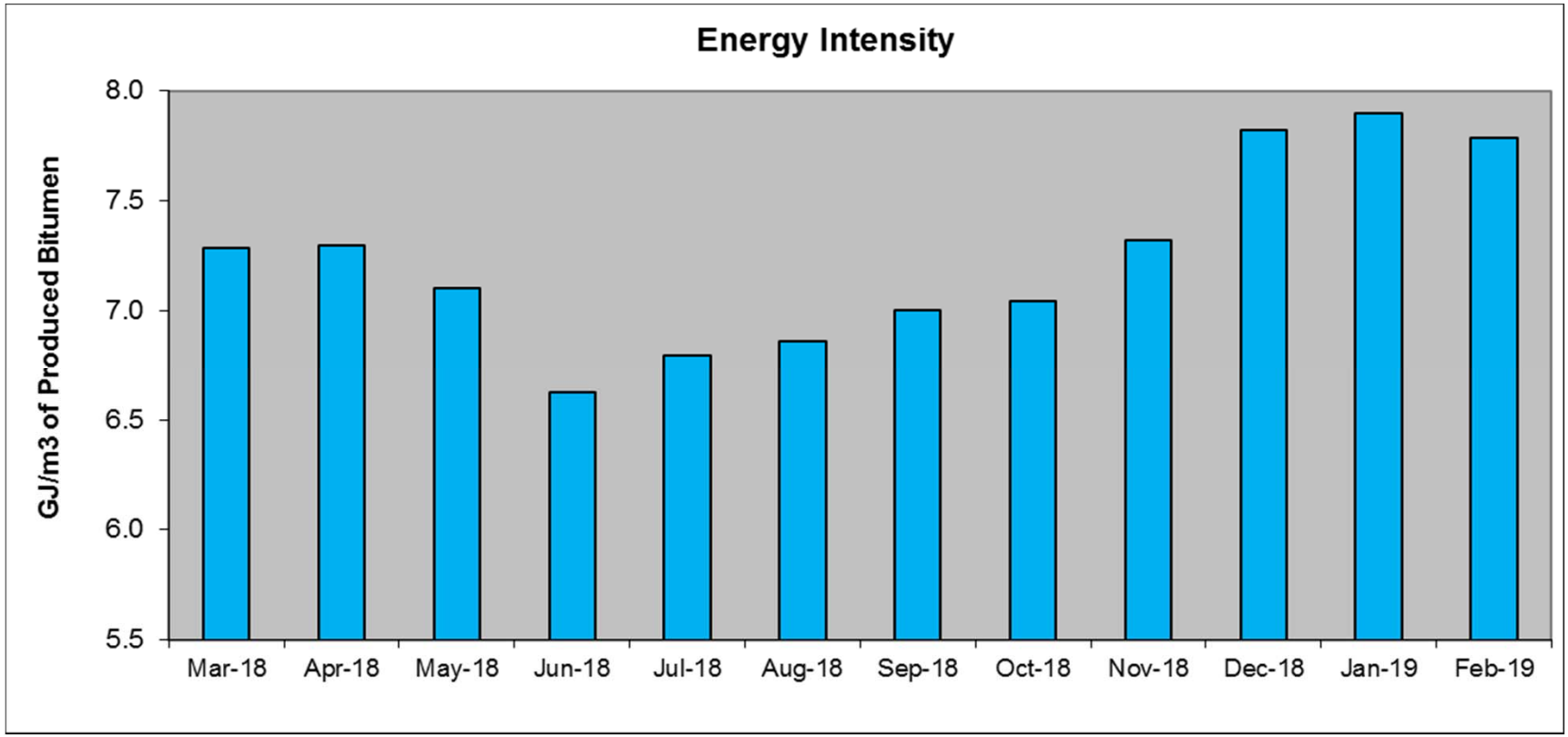
Electricity Generation/Consumption

From March 2018 to February 2019 Firebag generated 3,487.9 GW-hours of electricity, with 2,526.4 GW-hours being exported for sale.



Energy Intensity

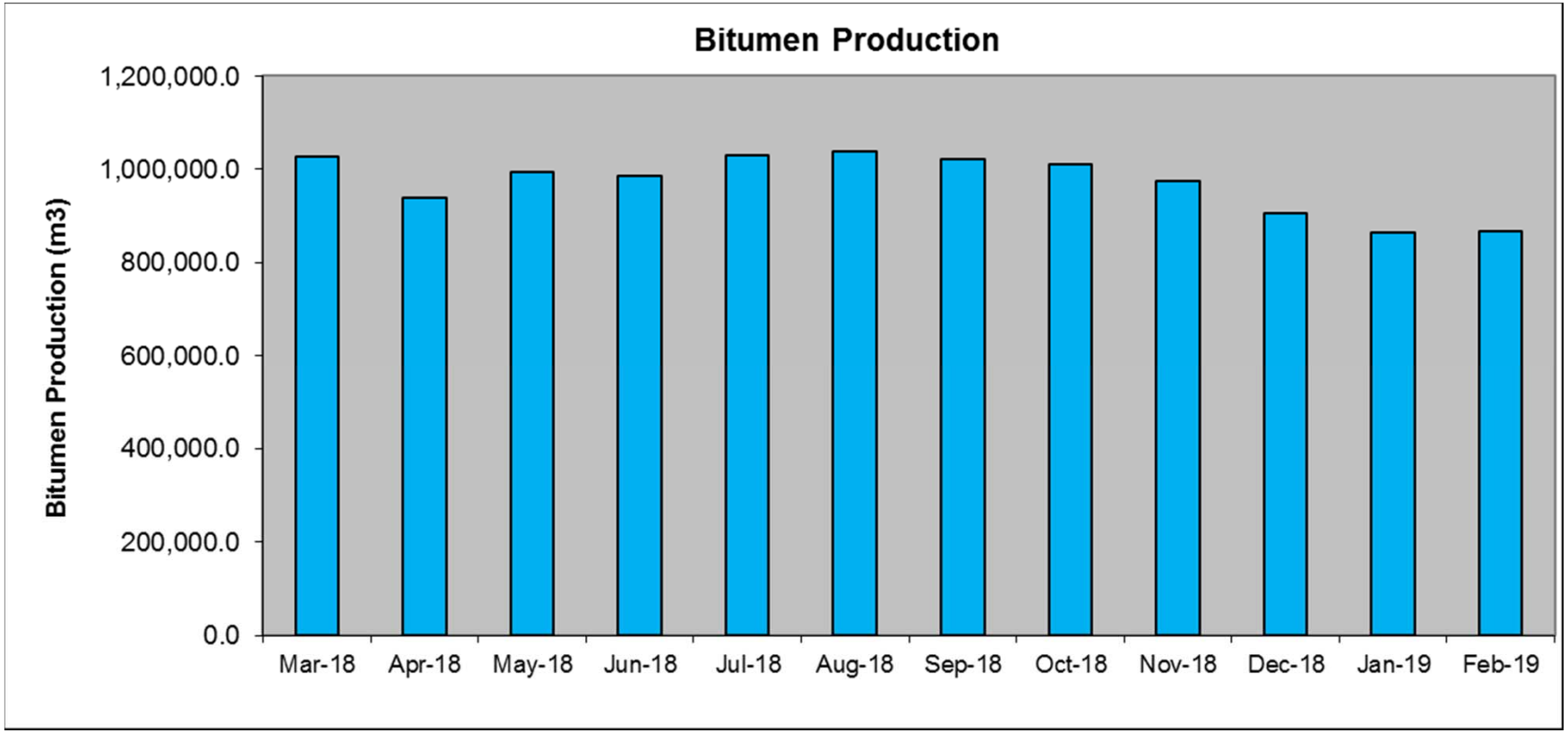
From March 2018 to February 2019 Firebag's average Energy Intensity was 7.23 per m3 of bitumen production.



Note: Energy Intensity includes all facility gas consumption and both electricity imported and exported

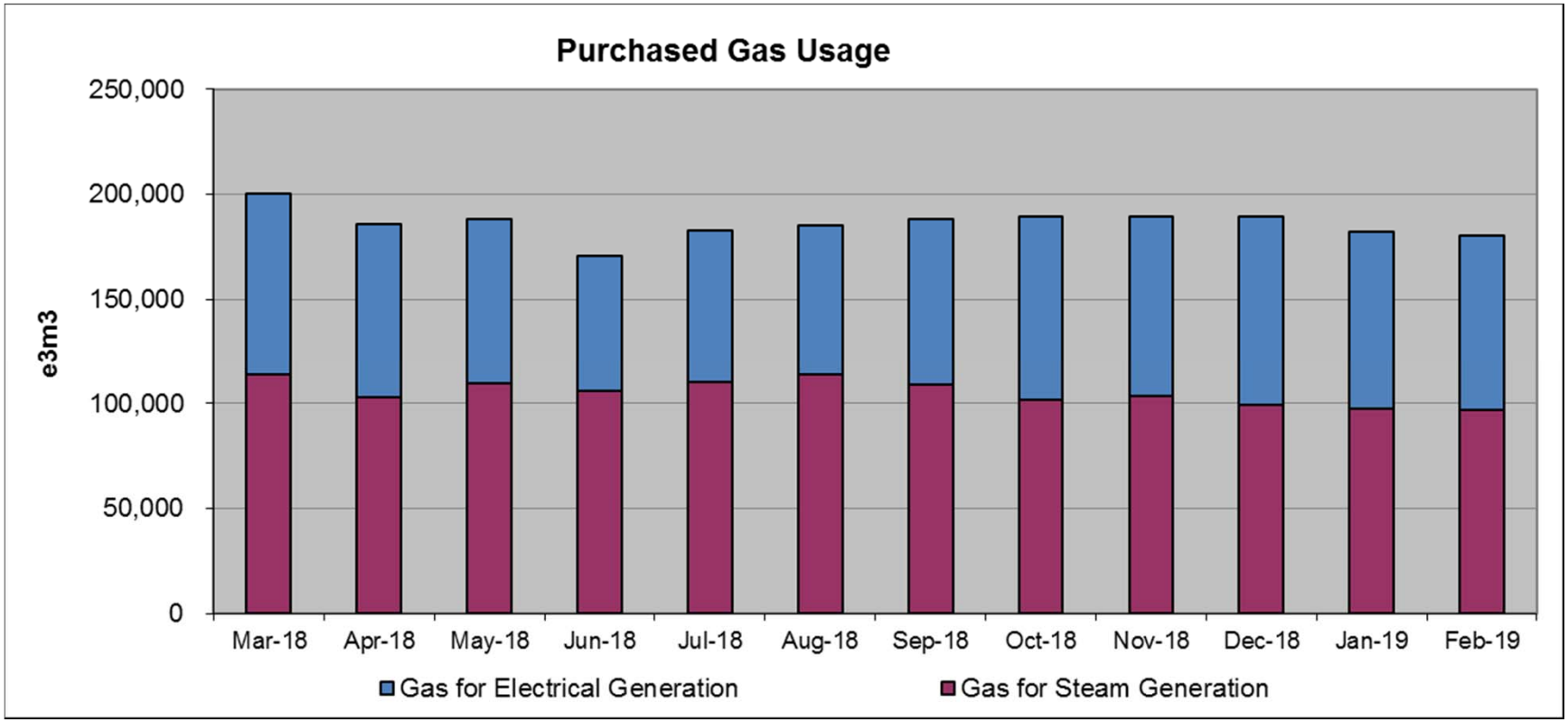
Monthly Bitumen Production

From March 2018 to February 2019 Firebag averaged 31,939.1 m3/day (200,897 BBD) of bitumen production.



Purchased Gas Usage

From March 2018 to February 2019 Firebag used on average 7,012.3 e3m3 of natural gas per day



Facility Environmental Performance

Emissions Parameter	Mar 2018 - Feb 2019
Solution Gas Produced (e^3m^3)	32197.78
Solution Gas Flared (e^3m^3)	50.54
Solution Gas Vented[1] (e^3m^3)	45.75
Solution Gas Recovery	99.7%
Total Gas Flared (e^3m^3)	118.3
Total Gas Vented[3] (e^3m^3)	49.54
H_2S Emissions[2] (kg)	2551.7

[1] Solution gas vented = gas vented from tanks upstream of produced gas separators (i.e. production tanks)

[2] H_2S emissions = H_2S gas vented at Firebag as communicated through the Digital Data Submission System (DDS)

[3] Total Gas Vented = gas vented at Firebag as communicated through the Digital Data Submission System (DDS)

GHG Emission Parameter	Jan 2018 – Dec 2018
2017 GHG Emissions (tonnes CO2e) Calendar Year	5329586.0
2017 GHG Emission Intensity (tonnes CO2e/m3 bitumen) Calendar Year	0.372

❖CO_2e is based on AENV SGER Reporting for the 2018 calendar year

Venting and Flaring Data (March 2018-Feb 2019)

Month	Flaring	Venting	Notes
	m3/month	m3/month	
Mar-18	13510.0	1420	
Apr-18	440.0	3060	
May-18	6620.0	13380	High venting volume due to consecutive 99-4000 VRU trips resulting in 38 minutes of venting from diluent and dilbit tanks.
Jun-18	1110.0	5910	
Jul-18	20161.0	3420	High flaring volume due to routine startup of CoGens 193 and 194.
Aug-18	790.0	1950	
Sep-18	3640.0	250	
Oct-18	2410.0	20	
Nov-18	23750.0	8240	High flaring volume due to routine startup of CoGen 194 and planned flaring events for maintenance. High venting volume due to consecutive 93-2000 VRU trips resulting in 36 minutes of venting from the MBF tank.
Dec-18	360.0	7560	High venting volume due to 99-4000 VRU trip resulting in 25 minutes of venting from the hotbit tank.
Jan-19	32410.0	480	High flaring volume due to routine start up of CoGen 192, restarting Pad 117 after power loss, and planned flaring events for maintenance.
Feb-19	12530.0	2400	

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- Operations and Facility Performance
- **Measurement and Reporting**
- Water Production, Injection and Usage
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- Future Plans

Firebag Performance Presentation

Measurement and Reporting

May 1th, 2019

Measurement, Accounting and Reporting Plan (MARP)

- MARP updates include:
  - Pad 105 infills
  - Pad 118
  - Pad 109 ES-SAGD

- Completed external EPAP audit in February 2018
  - Declaration due April 30th 2019

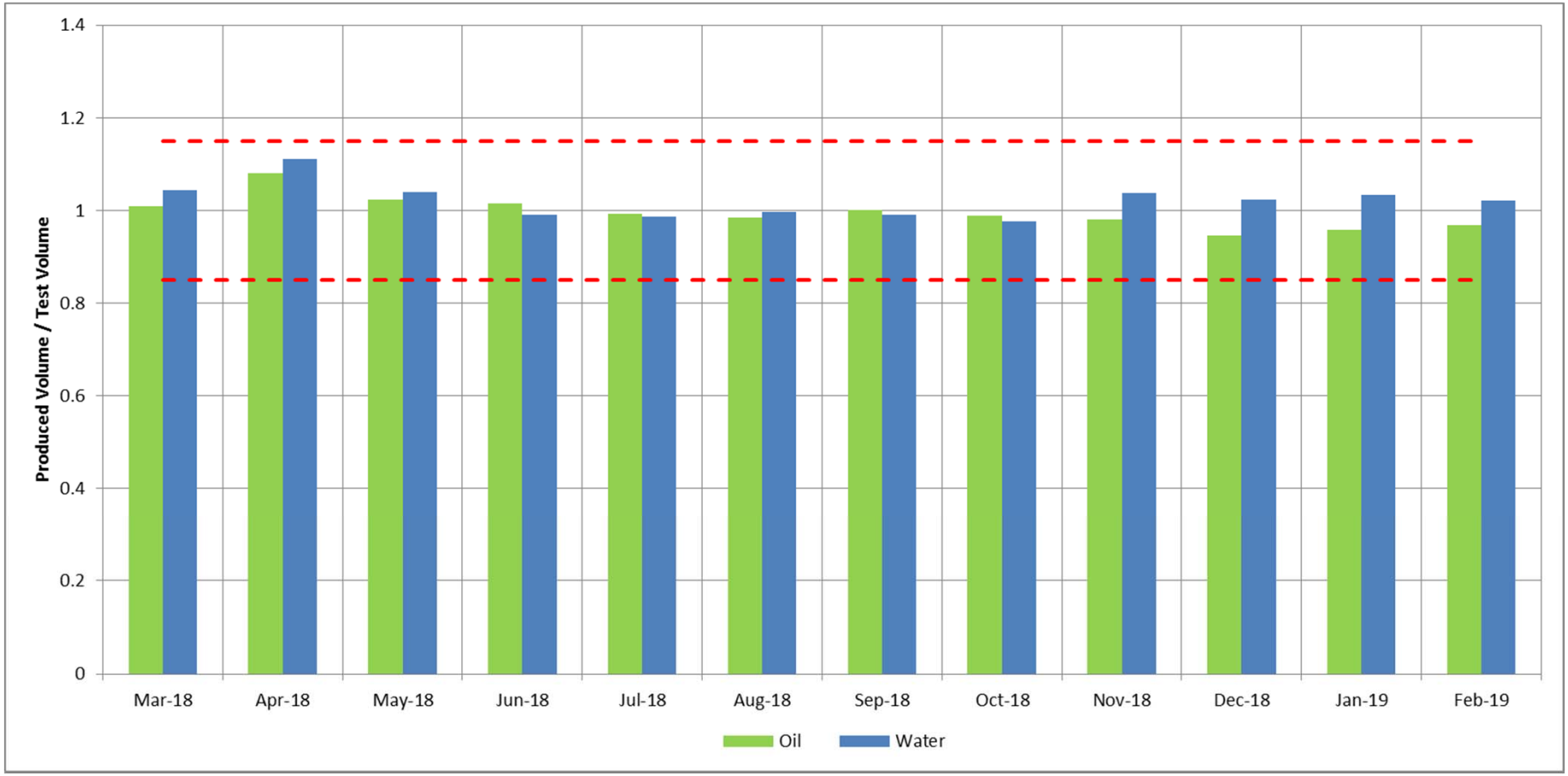
Estimating Well Production & Steam Injection Volumes

- Fluid production tests are performed as per Directive 17 requirements
- BS&W metering and manual cuts are applied to emulsion to determine water and oil production
- Well test bitumen is prorated based on facility bitumen production
- Well test water production is prorated on facility produced water
- Steam volumes are metered at the wellheads and prorated against the plant steam

Testing Improvements

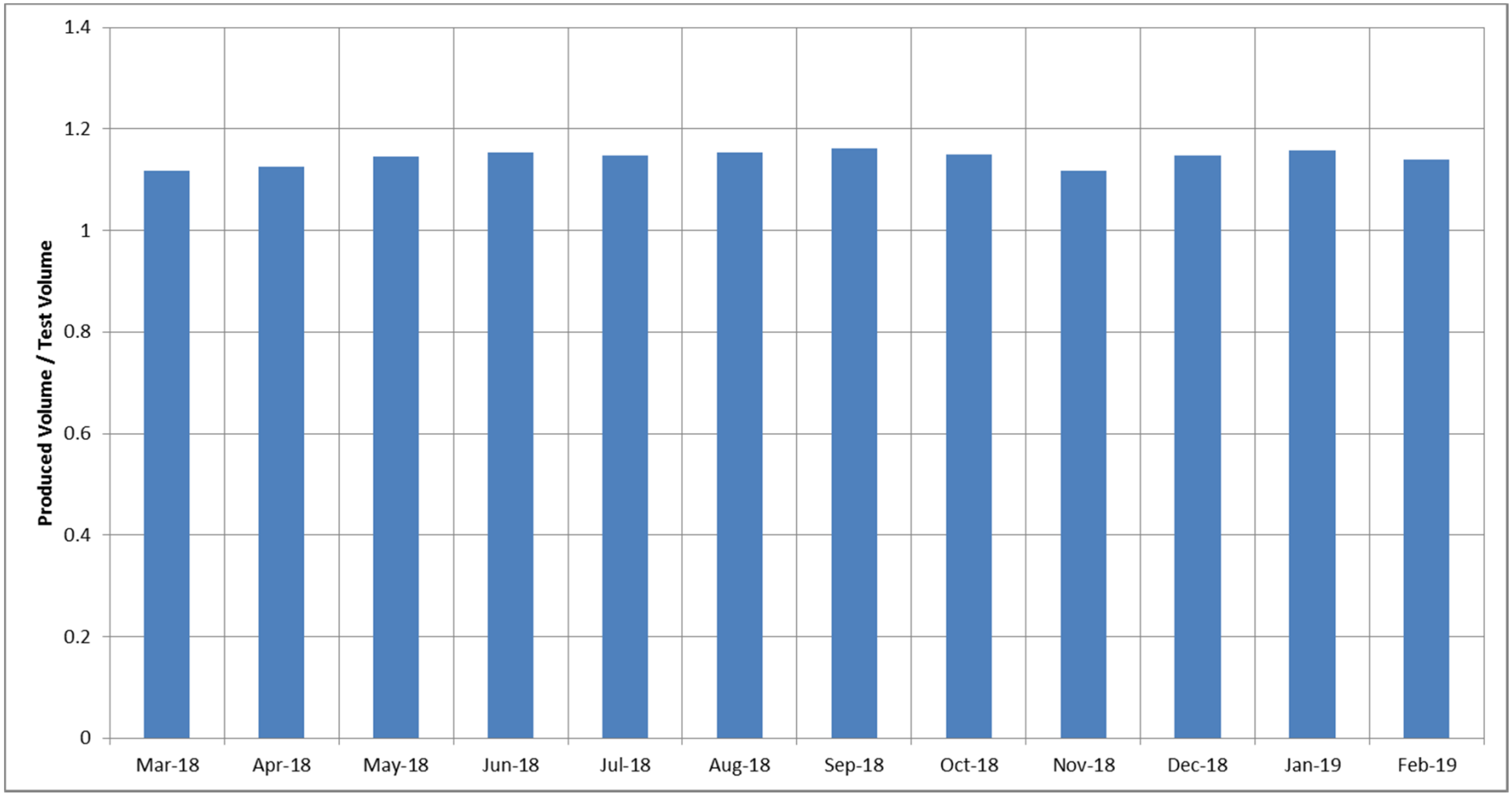
- Dec. 16, 2011 received approval for Multiphase Flow Meter (MPFM) on Pad 105 and future developments
- Fit for purpose Well Production Test software (WPT)
- MPFM now present on Pads 101 infills, 102 infills, 103 infills, 104 infills, 105, 106, 108 North, 115, 116, 110, 109, 117,118

Oil and Water Proration Values



Oil and water proration factors consistently within Directive 17 limits through the reporting period

Steam Proration Values



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Firebag Performance Presentation

Water Production, Injection and Usage

May 1th, 2019

Water Sources

- Primary makeup water source for process operations is one waste water stream from Oil Sands Base Plant:
  - Pond Effluent Water (PEW): The total volume of PEW used from March 2018 to February 2019 was 46,881.9 m3 (2018 calendar year usage was 50,022.3 m3)

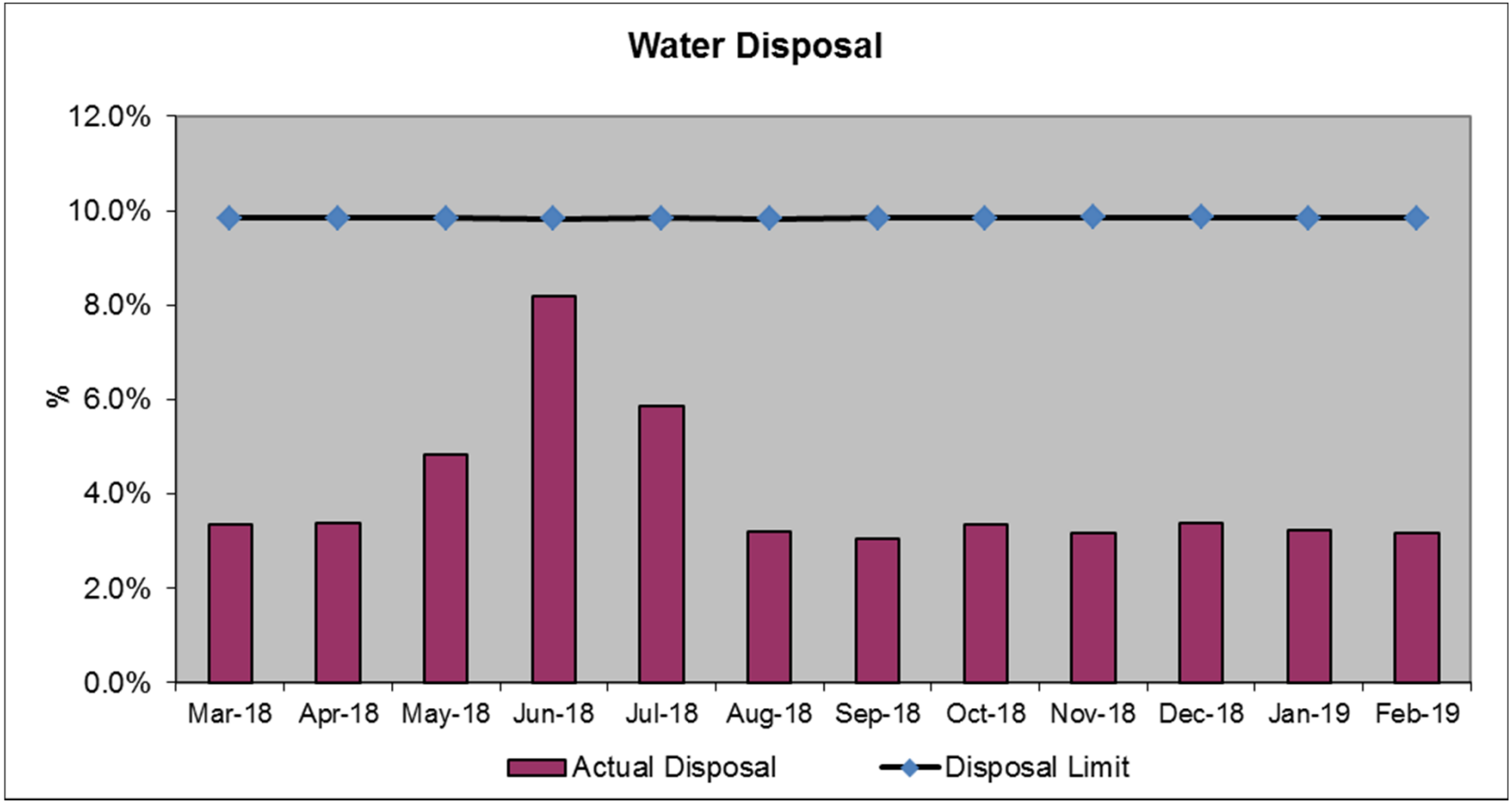
Water Usage

- Site runoff water (rainfall and snow melt) is routed to the site process ponds and reused in the process

- A total of 13,607 m^3 of storm water runoff water was diverted for process use from March 2018 to February 2019 (for the 2018 calendar year, usage was 4,173 m^3).
  - Water Act Approval 00310571-00-00 for ponds in NE 11-095-06-04-W4 (Stages 1/2 Area) for diversion of up to 95,000 m^3 annually
  - Water Act Approval 00310571-00-00 for ponds in SW 13-095-06-W4, NW 12-092-06-W4 and NE 14-095-06-W4 (Stages 3/4 Area) for diversion of up to 250,000 m^3 annually.

- Water Act License 00233808 for Production Well 03-05 and 11-14-095-04-W4 as back-up supply for up to 620,500 m^3 annually. TDL 425723 was issued to allow an additional 121,472 m^3 water diversion for a combined total of 741,972 m^3. A total of 645,142 m^3 of well water was diverted for process use (utility water and firewater make-up) from March 2018 to February 2019 (for the 2018 calendar year, usage was 627,405 m^3).

Disposal Limits and Actual Disposal



- Calculated as per formulas stated in Directive 81: *Water Disposal Limits and Reporting Requirements for Thermal In Situ Oil Sands Schemes*
- There was a line 17 reversal during June and July. Water was sent out of the Firebag facility to Suncor Base Plant and the volume is included in the disposal volume calculations.

Waste Management – Disposal

Disposal Well Locations

- Current disposal wells:
  - 100/10-03-095-06W4/00
  - 100/06-03-095-06W4/00
  - 100/02-10-095-06W4/00
  - 109/13-03-095-06W4/02
    - Newly approved and converted to disposal well, has not begun injection
- All disposal wells approved for use as per Approval Class 1b Approval No. 9487J (November 30, 2018)

Overall Facility Water Balance

Water Balance for Overall Firebag Injection Facility

	Fresh Water			Steam	Produced Water				Disposal	Imbalance
	FW1	FW4	FW5	INT	PW1	PW8	PW4	PW5	DIT	Scheme
	m3			m3	m3	m3	m3	m3	m3	
Mar-18	59403.6	24099.7	24188.2	2750477.3	2852513.4	113234.8	154674.7	170545.5	93310.1	-1.9%
Apr-18	57850.3	24188.2	24182.8	2549842.5	2636888.3	87480.2	170545.5	179000.1	87738.3	-1.3%
May-18	60465.8	24182.8	23674.6	2685491.7	2823682.3	87773.2	179000.1	177663.0	135271.8	-0.7%
Jun-18	61440.0	23674.6	21242.2	2567377.7	2767287.2	94382.2	177663.0	209402.3	221489.2	-1.3%
Jul-18	63376.4	21242.2	24123.1	2702922.8	2819557.7	105157.9	209402.3	182455.5	164561.1	-2.1%
Aug-18	66018.9	24123.1	24222.1	2753619.9	2831785.4	104953.7	182455.5	199933.0	88837.9	-2.1%
Sep-18	58931.8	24222.1	24234.3	2680947.2	2709533.6	105990.7	199933.0	183996.2	81686.8	-2.8%
Oct-18	53021.0	24234.3	22806.9	2597189.3	2624749.0	113625.3	183996.2	176216.5	86006.4	-3.8%
Nov-18	55454.4	22806.9	24318.1	2626431.2	3044957.8	407243.9	176216.5	190363.9	84551.0	1.9%
Dec-18	63540.8	24318.1	24366.8	2526397.0	2915664.5	395841.2	190363.9	184751.8	87298.5	1.9%
Jan-19	53156.1	24366.8	24036.9	2447094.1	2946047.0	478338.2	184751.8	185791.9	87019.9	-0.4%
Feb-19	53140.8	24036.9	24382.2	2413189.5	2922282.2	506892.0	185791.9	159330.4	80092.2	0.04%

Waste Management – Disposal

Disposal Information – 100/10-03-095-06W4

(data shown is averaged across the month)

Month	Injection Rate (Sm3/day)	Wellhead Pressure (kPa-g)	Downhole Pressure (kPa-g)	Injection Temperature (^{o}C)
March-2018	637	1462	5246	57
April-2018	633	1381	5168	57
May-2018	585	1199	5000	58
June-2018	402	1063	4906	57
July-2018	571	1315	5119	57
August-2018	570	1347	5150	61
September-2018	589	1325	5090	57
October-2018	729	1485	5165	57
November-2018	569	1312	5152	55
December-2018	548	1318	5146	56
January-2019	572	1398	5168	55
February-2019	577	1442	5256	55

Waste Management – Disposal

Disposal Information – 100/06-03-095-06W4

(data shown is averaged across the month)

Month	Injection Rate (Sm3/day)	Wellhead Pressure (kPa-g)	Downhole Pressure (kPa-g)	Injection Temperature (^oC)
March-2018	573	1464	5346	54
April-2018	563	1380	5270	55
May-2018	506	1190	5087	55
June-2018	326	1094	5006	54
July-2018	519	1318	5209	55
August-2018	534	1338	5227	58
September-2018	406	1258	5160	54
October-2018	1	1663	4881	51
November-2018	473	1388	5295	52
December-2018	526	1354	5308	52
January-2019	422	1128	5223	51
February-2019	445	1403	5389	51

Waste Management – Disposal

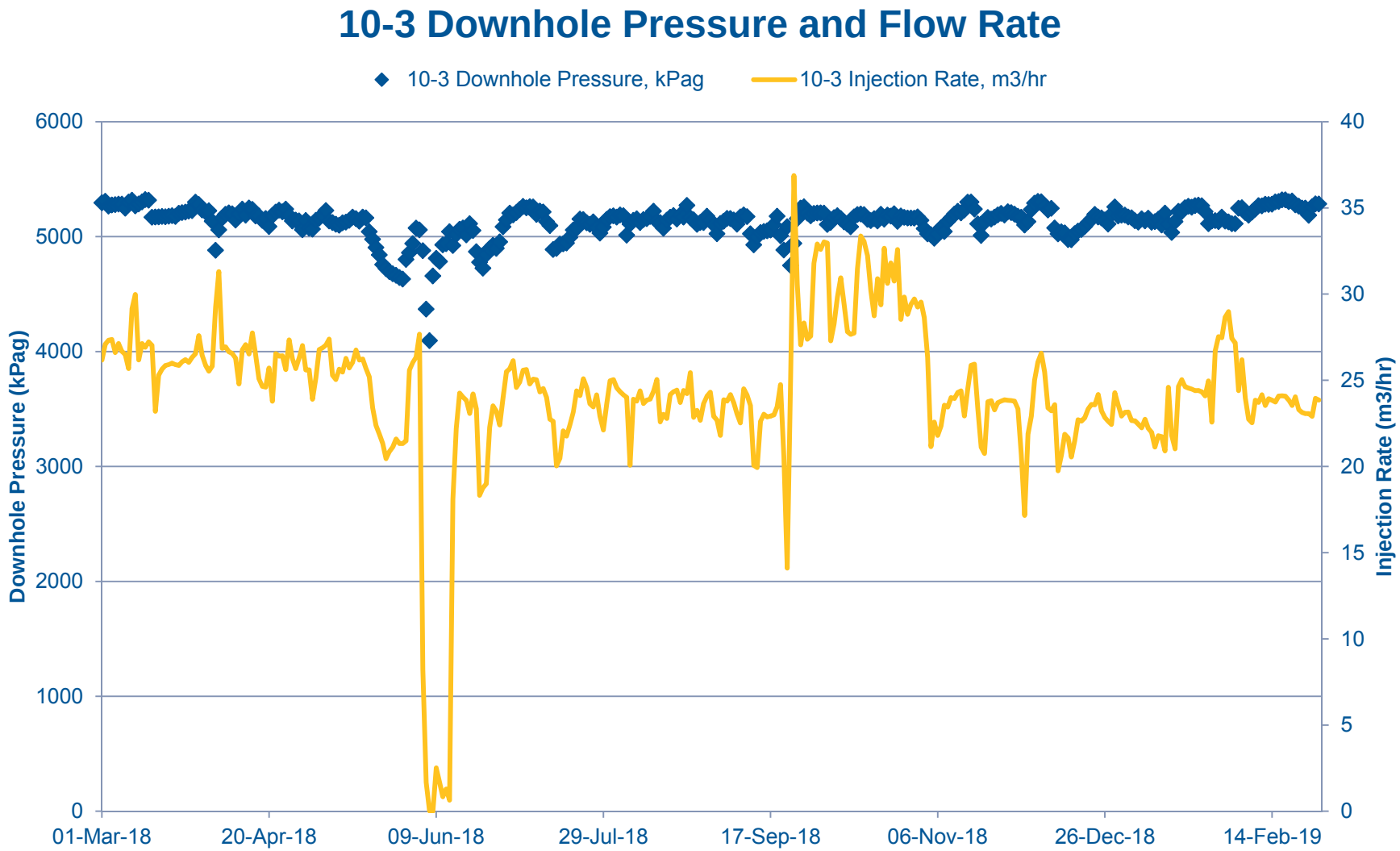
Disposal Information – 100/02-10-095-06W4

(data shown is averaged across the month)

Month	Injection Rate (Sm3/day)	Wellhead Pressure (kPa-g)	Downhole Pressure (kPa-g)	Injection Temperature (^oC)
March-2018	1808	1572	Failed	57
April-2018	1740	1452	Failed	57
May-2018	1717	1307	Failed	58
June-2018	1700	1200	Failed	57
July-2018	1757	1433	Failed	57
August-2018	1776	1464	Failed	61
September-2018	1719	1373	Failed	57
October-2018	2047	1579	Failed	57
November-2018	1776	1442	Failed	55
December-2018	1735	1426	Failed	56
January-2019	1823	1515	Failed	55
February-2019	1830	1557	Failed	55

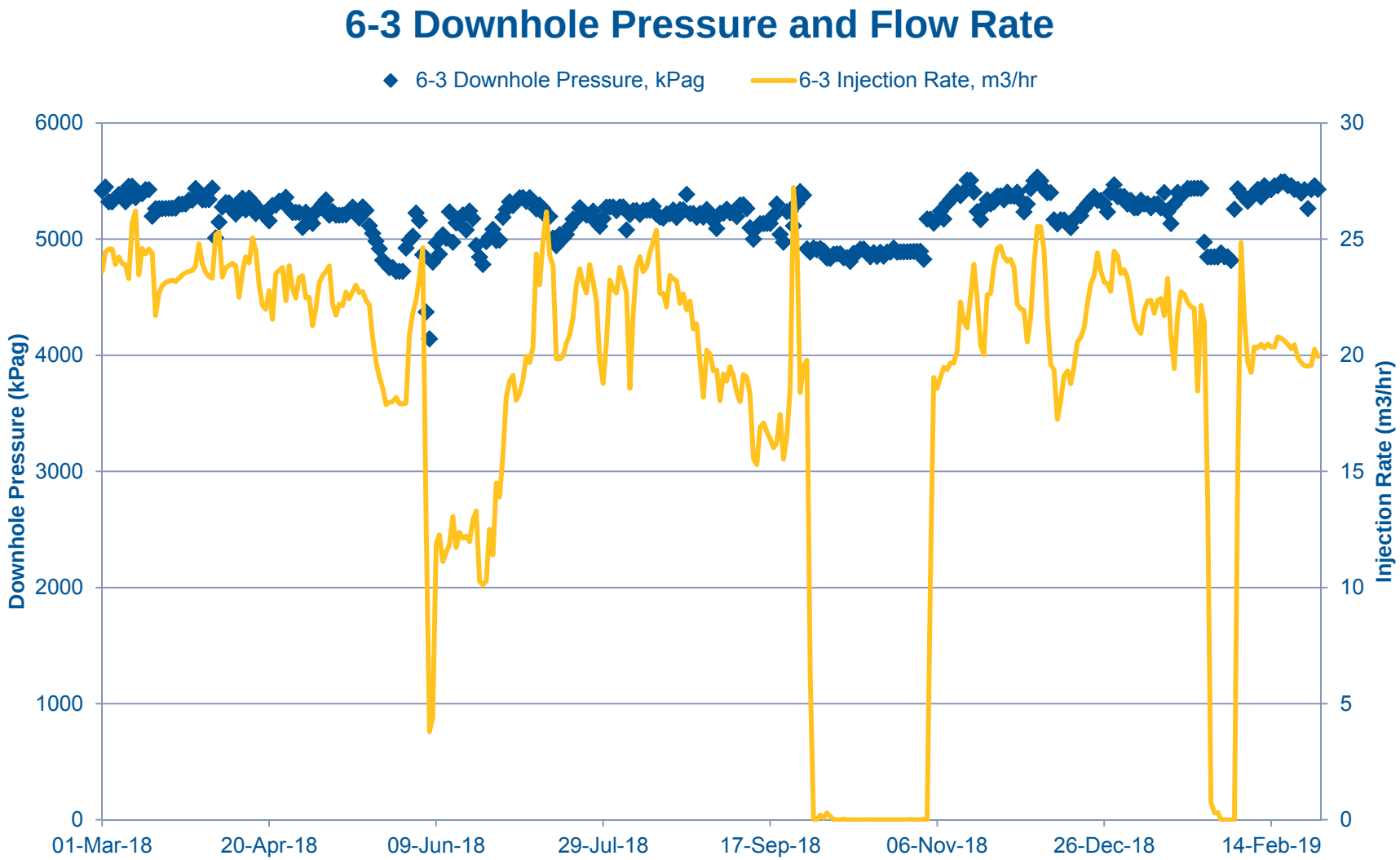
Waste Management – Disposal

Disposal Information – 100/10-03-095-06W4 (daily data)



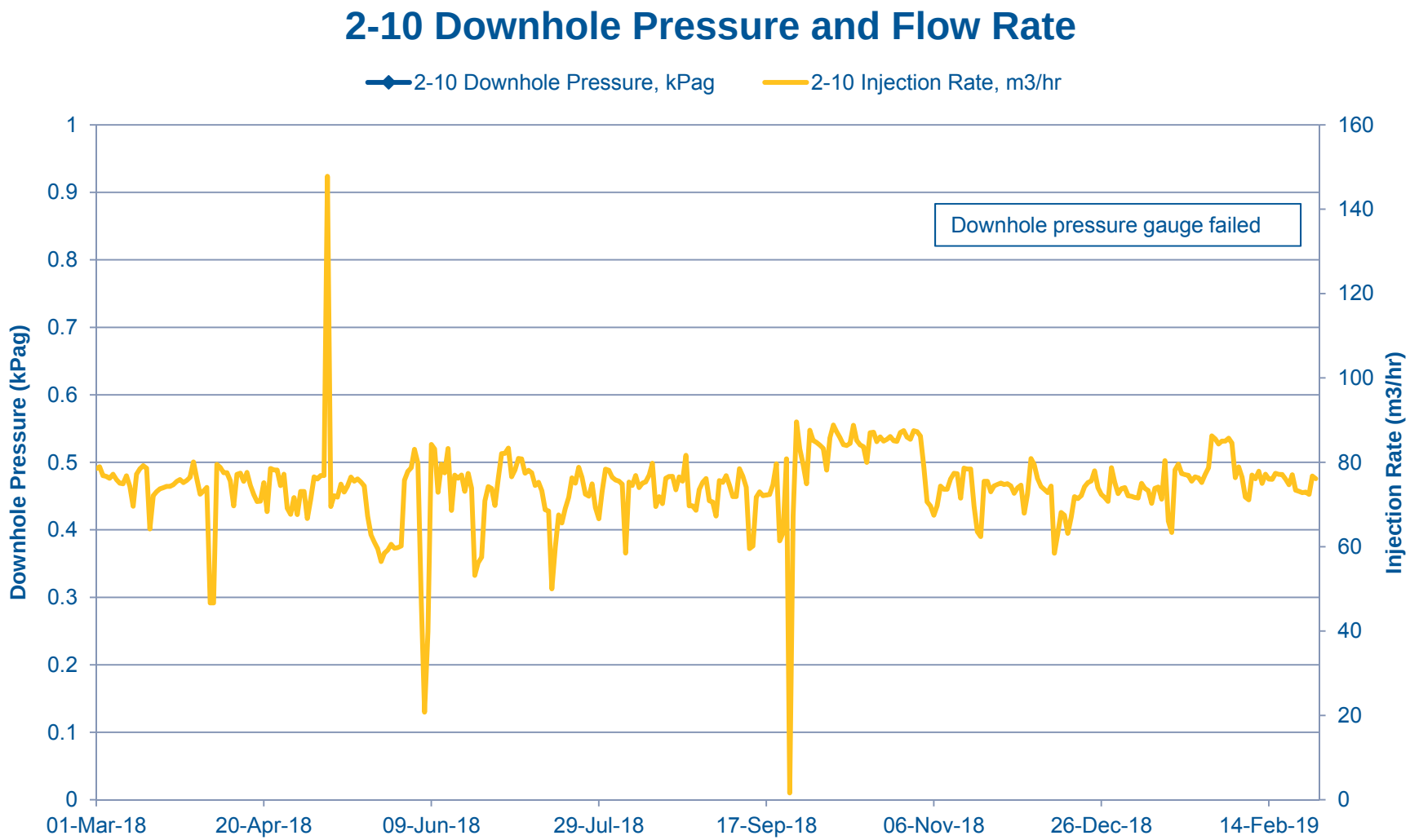
Waste Management – Disposal

Disposal Information – 100/06-03-095-06W4 (daily data)



Waste Management – Disposal

Disposal Information – 100/02-10-095-06W4 (daily data)



Waste Management – Disposal

Disposal Observation Well Locations

- Current Observation Wells:
  - *100/12-06-095-06W4/00 (DS1)*
  - *103/12-06-095-06W4/00 (DS3)*
  - *100/13-34-094-06W4/00 (DS4)*
  - *100/02-15-095-06W4/00 (DS5)*
  - *100/11-28-094-06W4/00 (DS6)*
  - *100/04-06-095-05W4/00 (DS7)*
  - *100/02-04-095-06W4/00 (DS8)*
  - *109/13-03-095-06W4/00 (PP7/DW22)*
    - *Converted to injection well in Feb 2019*
  - *100/08-02-095-06W4/00 (DW OB1)*
  - *100/16-03-095-06W4/00 (DW12)*
  - *1AA/12-30-095-05W4/00 (DW4)*

Waste Management – Disposal

- During the reporting period, the following was completed:
  - Sampled chemistry at DS5, DS6, and DS8 per Approval Class 1b Approval No. 9487J
  - Monitoring of downhole pressures and temperatures continued at all disposal observation well locations
  - All results (chemistry, pressure and temperature) will be reported as part of the annual disposal well monitoring report, to be submitted October 31 of each year
- Disposal well 2-10 downhole pressure gauge failed 26 Jan 2018
  - Disclosed to AER in VSD on Feb 27th which was accepted (on Mar 13th) and waived requirement for downhole pressure monitoring
- Disposal well 13-03 downhole gauges had power failure on 22 Jan 2018
  - Non-compliance disclosed to AER on October 9th, 2018
  - AER investigation closed by Jan 8th, 2019
- Numerical modeling, based on all data acquired to date, is ongoing
- Application for conversion and disposal into 13-03 (PP7) approved Mar 16, 2018.
  - Contingent on the successful drilling, completion, and sampling of an additional on-reef disposal support well, DS9.

Table of Contents

- Operations and Facility Performance
- Measurement and Reporting
- Water Production, Injection and Usage
- **Sulphur Production**
- Environmental Performance
- Future Plans

Firebag Performance Presentation

Sulphur Production

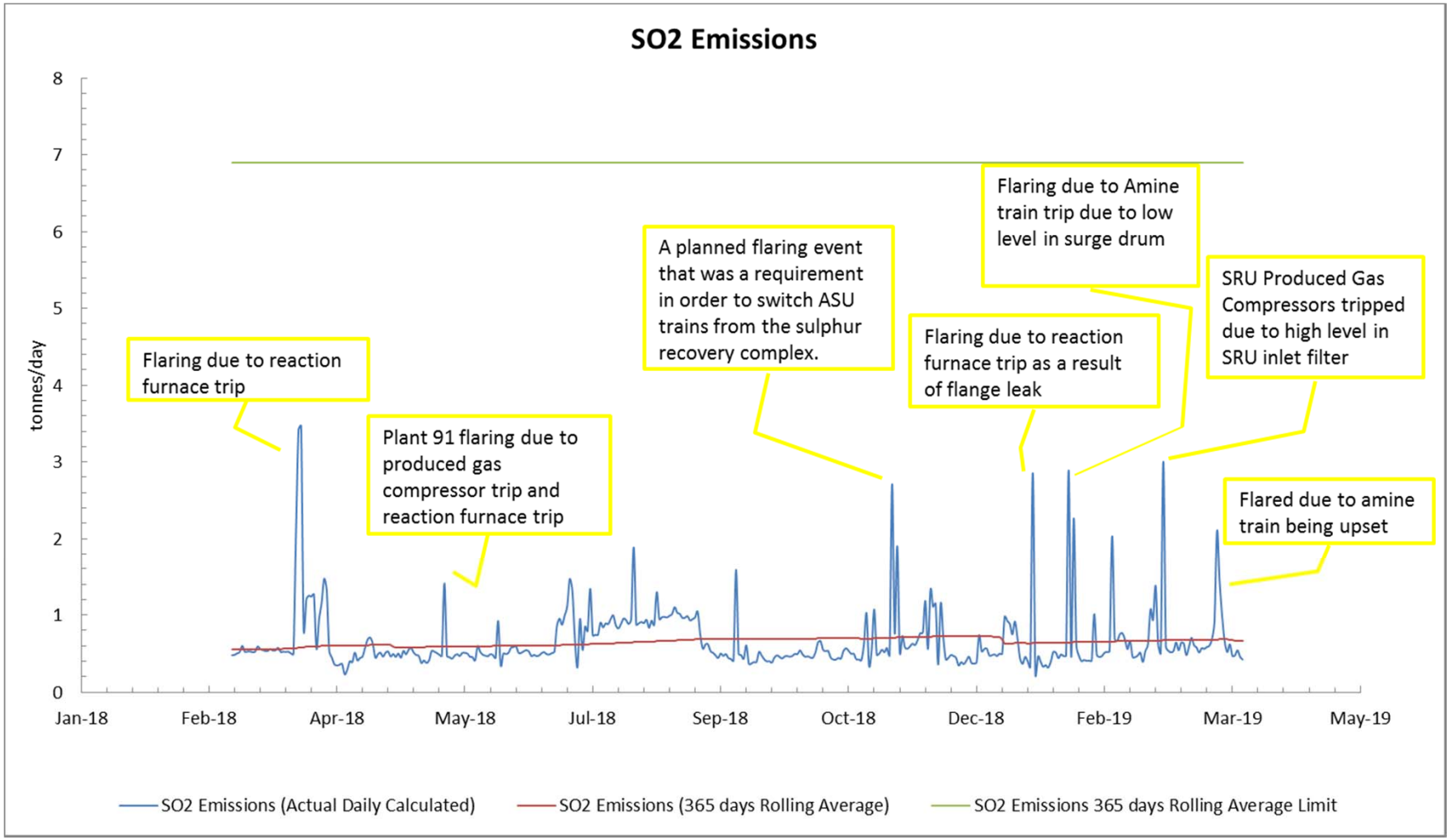
May 1^{1h}, 2019

Sulphur Recovery

	Average Inlet Sulphur (tonnes/day)	Sulphur Recovery (%)	Sulphur Balance (%)	Sour Gas Flared (e3m3)	Sulphur Flared (tonnes)
Q2 2018	13.94	98.1%	1.9%	5.5	0.8
Q3 2018	14.53	97.3%	0.9%	1.2	1.3
Q4 2018	14.25	97.9%	0.4%	22.8	2.4
Q1 2019	13.20	97.3%	2.1%	23.8	5.8

- Regulatory requirements of >95.9% sulphur recovery per calendar quarter for Inlet rates > 10-50 TPD
- Sulphur recovery rates in 2018 and 2019 YTD have been above these requirements

SO_2 Emissions



SO_2 Emissions

- EPEA SO_2 Limit for Firebag Stages 1 to 4 =< 6.9 tonnes/day rolling 365-day average
- SO_2 Daily Average = 0.676 tonnes/day
- SO_2 Total = 246.7 tonnes
- Average Inlet H_2S Concentration = 5.4%

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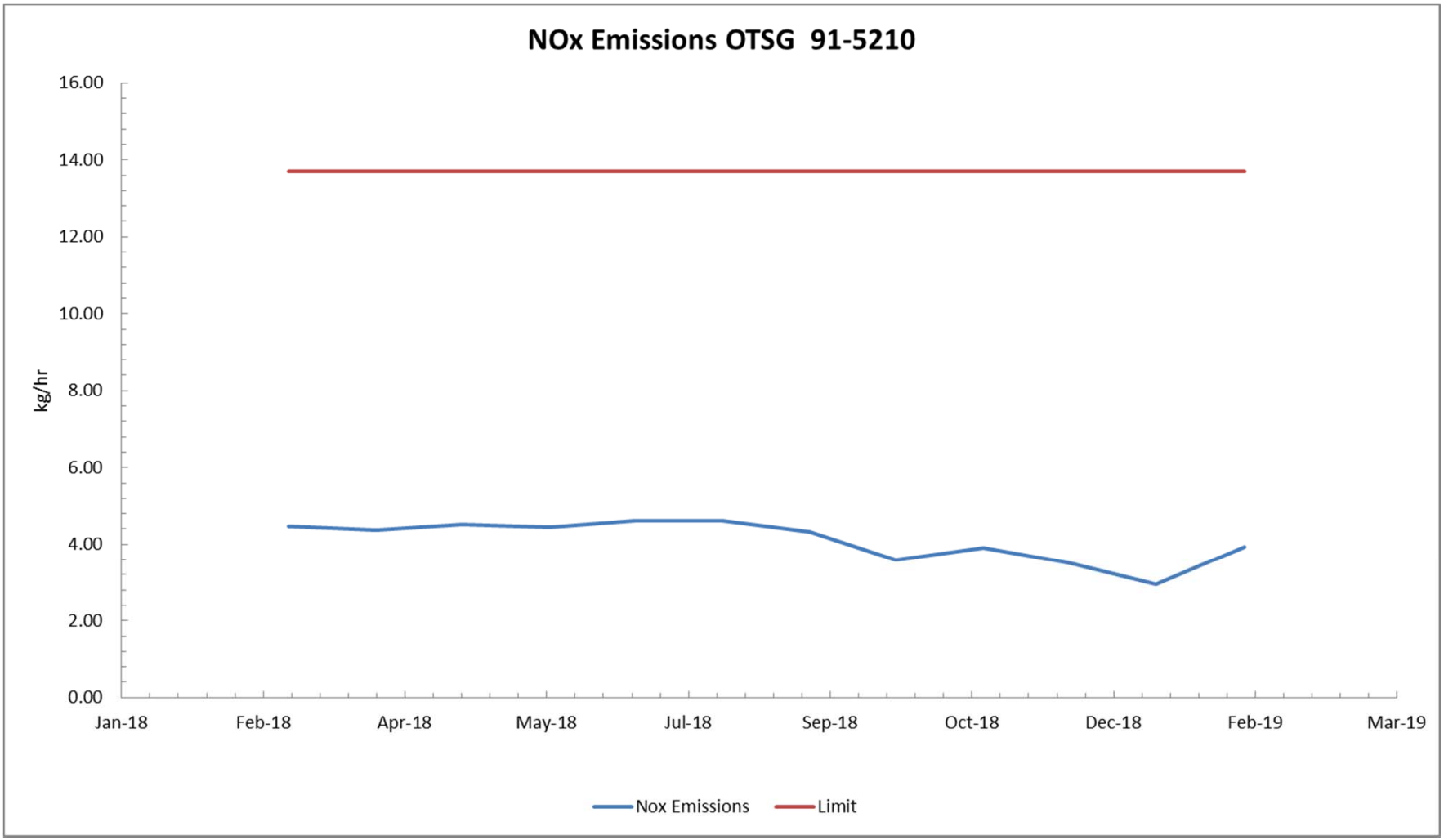
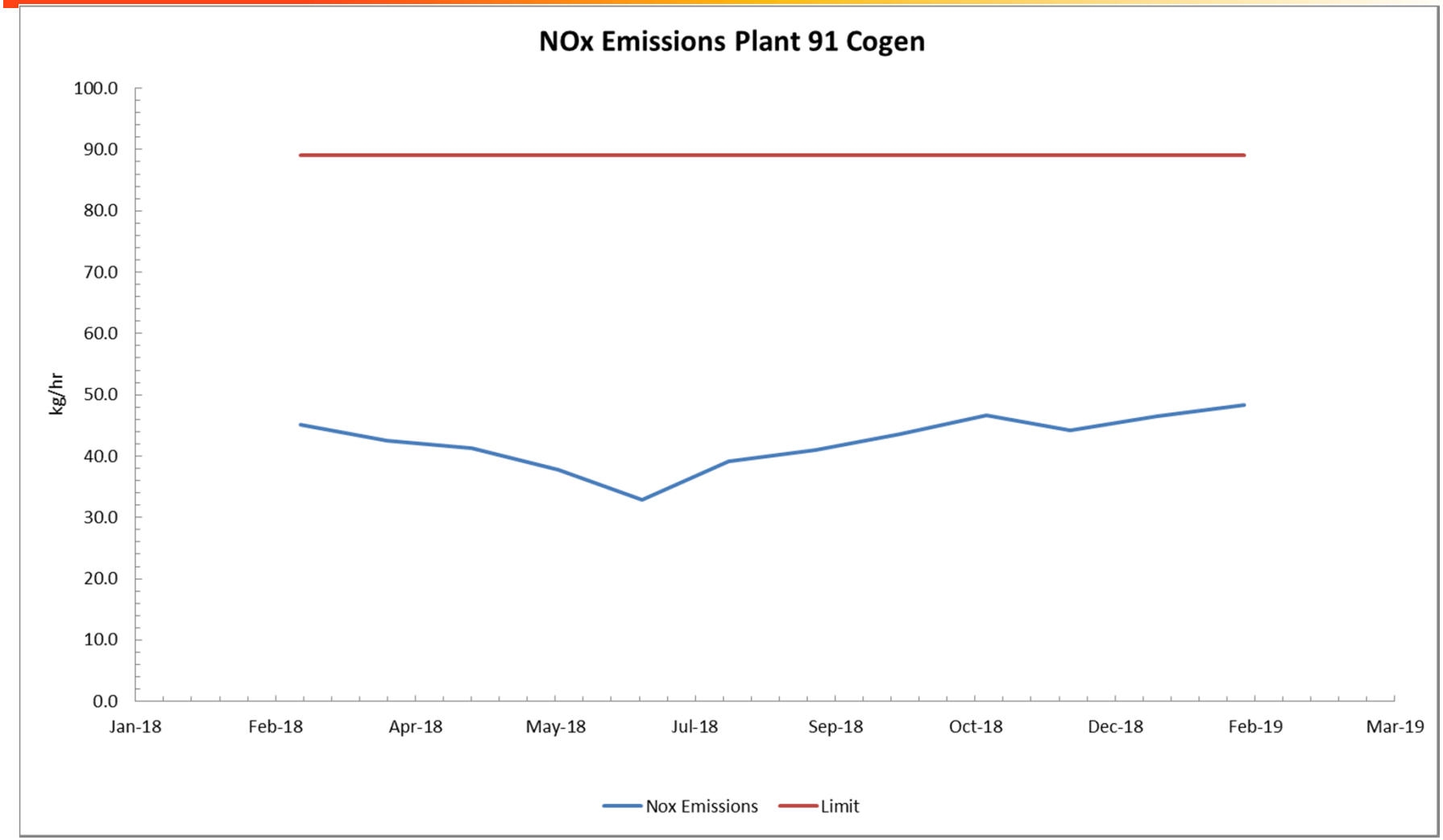
NOx Emissions Plant 91 OTSG (91-5210)



NOx Emissions Plant 91 Cogen (91F-5710)



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Firebag Performance Presentation

Environmental Performance

May 1th, 2019

DIVERTED SURFACE WATER RUNOFF

The 2018 runoff data is in compliance with the Firebag EPEA Approval 80105-01-00.

Location	Number of Releases	Total Volume Released (m^3)	Chlorides (mg/L)	pH
			Maximum	Minimum/Maximum
(Landfill) BP 11 Storm Pond NW3-95-6-W4	39	101,672	32	7.40/8.15
ETS NW1-95-6W4	13	7,677	32	7.24/8.49
Pad 101	22	33,093	32	6.92/8.34
Pad 102	25	24,311	32	7.46/8.51
Pad 103	25	15,966	32	6.49/9.25
Pad 104	34	19,489	32	6.67/8.67
Pad 105 SE10-95-6-W4	31	52,921	44	6.75/9.24
Pad 106 SW10-95-6-W4	31	55,668	32	7.06/9.32
Pad 107 N 02-95-6-W4	31	46,732	32	6.79/8.99
Pad 108 NW 01-95-6-W4	18	11,282	32	7.78/8.54
Pad 109 NE 07-095-05-W4M	37	28,519	72	7.20/8.94
Pad 110 East	31	20,354	32	7.11/9.24
Pad 110 West	28	13,932	32	7.11/8.60
Pad 112 NE-06-095-06W4M	49	48,826	32	6.97/8.43
Pad 114 East - North Basin	12	9,339	38	7.86/8.52
Pad 114 East - South Basin	17	9,741	32	7.02/8.54
Pad 114 West NW-08-095-06W4M	33	25,006	65	7.08/8.94
Pad 115	26	23,005	32	7.34/8.32
Pad 116 N4-95-6-W4	43	67,279	32	7.32/9.08
Pad 117 East Basin	28	14,824	32	7.23/8.75
Pad 117 NW Basin	25	14,665	32	7.09/8.98
Pad 117 South Basin	13	11,297	32	6.65/8.79
Pad 118 East	22	15,866	72	6.76/9.03
Pad 118 West	16	9,194	72	7.81/9.03
SED Ponds C4	51	127,808	127	7.17/8.41
SED Ponds C1	62	132,028	46	7.40/8.31
SED Ponds C2	49	107,956	42	7.19/8.27
SED Ponds C3 NW12-95-6-W4	45	121,342	82	6.52/9.05
Terminus 2	40	23,632	130	7.30/8.46
Village Dev Runoff NE9-95-6-W4	130	269,589	66	7.08/8.77

CPF Storm Runoff Ponds

Other Environmental Initiatives

- Suncor is an active member of:
  - Canada's Oil Sands Innovation Alliance (COSIA)
  - Cumulative Environmental Management Association (CEMA)
  - Wood Buffalo Environmental Association (WBEA)
  - Alberta Biodiversity Monitoring Institute (ABMI)
  - Alberta Water Council (Watershed Planning Advisory Council)
  - Boreal Leadership Council (BLC)

Regulatory Compliance Summary

- Suncor Firebag is in compliance with all regulatory approvals, decisions, regulations and conditions; except for compliance items identified in this presentation or otherwise disclosed

Regulatory – AER Compliance Items

1-Mar-18 to 28-Feb-19	Number of Occurences	Reference Number(s)	Date(s) of Occurrence	Details of Occurrence	Suncor Actions
NOx CEMS Exceedance	1	347667	16-Dec-18	There was one incident where the NOx limit was exceeded on Cogeneration Unit 193F-5000.	This incident was caused by primary flame scanners detecting a "flame exist" condition in the primary zone of the turbine. This type of event can be caused by many factors including cleanliness of the air/fuel mixture, primary flame was ignited by small foriegn object(s), and incorrect primary/secondary split from DLN tuning. Suncor continues to monitor each situation for a potential repeat occurrence. Vendor recommends to inspect fuel filter and inlet filters to ensure the cleanness on fuel/air. If this continually happens, perform a base load split check or a DLN re-tuning.
SO2 CEMS Exceedance	5	336129 336220 336480 347339 347961	27-Mar-18 28-Mar-18 07-Apr-18 04-Dec-18 28-Dec-18	There were 5 SO2 exceedances from the Sulphur Recovery Units incinerator stacks.	Suncor process engineers continue to assist in troubleshooting upset conditions within the Sulphur Recover Complex to improve the stability and reliability operations. Each upset condition seem to be unique and creates learning curve for the operations team.
Venting	38	DDS and /or CIC	Various Dates	There were 38 venting incidents reported to the AER during this reporting period via the CIC and/or DDS system.	Suncor continues to address the number and duration of venting incidents by identifying root causes and implementing corrective actions for each venting event to prevent future occurrences. Firebag has been trending a positive direction since 2016. A reduction of venting on site from 2016 to 2018 with the number of venting incidents in 2016 at 56, 2017 at 46 and 2018 at 38.
CEMS Monthly Operational Update <90%	2	337237 340337	30-Apr-18 30-Jun-18	The CEMS units for Plant 99 Sulphur Recovery Unit 99F-1113 and Plant 92 Once Through Steam Generator 92F-5251 did not meet the 90% minimum data availability requirement for month of April and June 2018 respectively.	Both incidents occurred when the actual operational time of the units were only running for ~30% of the month. This drastically effects the amount of downtime available for the CEMS before not meeting the 90% requirement. The root cause for both these incidents was determined to be human error, were the technicians had left the CEMS in maintenance mode beyond the required time. The incident findings were communicated with all personnel involved. All technicians have reviewed the incident and signed off on the CEMS awareness training understanding the importance of monthly CEMS availability.

Regulatory – AER Compliance Items

1-Mar-18 to 28-Feb-19	Number of Occurences	Reference Number(s)	Date(s) of Occurrence	Details of Occurrence	Suncor Actions
SRU Incinerator Stack Temperature Violation	1	347339	4-Dec-18	The Sulphur Recovery Unit (SRU) tail gas thermal oxidizer stack 99F-1213 had 2 x hourly average stack top temperature exceedance (< 538°C).	During the switch of amine trains sweet gas was misdirected to the reation furnace causing high temperature trip. Leading to lower stack top temperature violations. Investigation determined the root cause to be procedural issue and Suncor updated the startup procedure to mitigate reoccurance.
Diversion Water Licence Limit Exceeded	1	343106	23-Aug-18	Licence to Divert Water 310571-00-00 Schedule A; The source of water was from Ditch 3 with a maximum annual limit of 10,000m3. The limit was exceeded in August 2018 with a value of 12,324m3.	Ditch 3 water source was shutdown as of August 22, 2018 and no further water was diverted from this location. Suncor is in the process of amending the Fenceline Water Act Licence to allocate water from other locations within the Licence to Ditch 3. Suncor automation has created a computer program to track the water diverted for all the locations within this licence. Email alerts are sent to a distribuiton list when 80% of the capacity of water has been diverted for the year.
Pad 108 non-compliance of AER Directive 17	1	NA	17-Aug-18	Suncor was not able to meet the requirement of one valid test hour per 40 hours of production for Pad 108 as a result of a meter failure	A new meter was installed.
Non-Compliance to Class 1B Disposal Approval No. 9487I Clause 2 and 5	1	NA	22-May-18	Maximum Wellhead Injection Pressure exceedance in disposal well100/10-03-095-06W4/0 (10-03) and failure to provide monitoring data	Suncor has developed an Incident Learning and Prevention (ILP) plan to assist in preventing similar future occurrences of disposal well over pressure..
Non-Compliance to Class 1B Disposal Approval No. 9487I Clause 6	1	NA	9-Oct-18	Failure to provide monitoring data	Suncor replaced the surface power equipment at this location to gather the current data.

Firebag Performance Presentation

Future Plans

May 1th, 2019

Future Plans

- Suncor is continually investigating opportunities to improve process efficiency

Appendix - Surface

Overall Facility Water Balance

Below are a set of definitions of the terms used in the water balance table provided in this presentation

Freshwater

- REC (FW1): The sum of all freshwater streams received. Firebag receives water from the Suncor Oilsands site (AB OS 0077189) and from surface runoff (AB RO). Firebag also has source water wells (AB WI 100151109506W400) and (AB WI 100151409506W400). Water Received from Diluent into Firebag
- INVOP (FW4): Fresh water tank opening inventory. This volume is carried forward from last month's closing inventory.
- INVCL (FW5): Fresh water tank closing inventory. This volume takes into consideration levels in Fresh water tanks.

Steam

- INJ (INT): The total steam injected at the wells. Steam is metered at each of the steam generators in Plants 91-94 OTSGs and Cogeneration units.

Water

- REC (PW1): The water received from the wells. This includes produced water from the wells, plus (PW8) the steam condensate sent to the Pads and a portion of the volume is collected at the steam traps and sent to the CPF, the remaining condensate is injected into the wells.
- DISP (PW8): Steam and condensate sent to the oil battery (AB BT 0078417). This water is received back into the injection facility along with the produced water from the wells.
- INVCL (PW5): Water tank closing inventory. This volume takes into consideration levels in water tanks.
- INVOP (PW4): Water tank opening inventory. This volume is carried forward from last months closing inventory.
- INJ (DIT): Water injected to the two disposal wells (AB WI 100060309506W400, AB WI 100100309506W400 and AB WI 100021009506W400).

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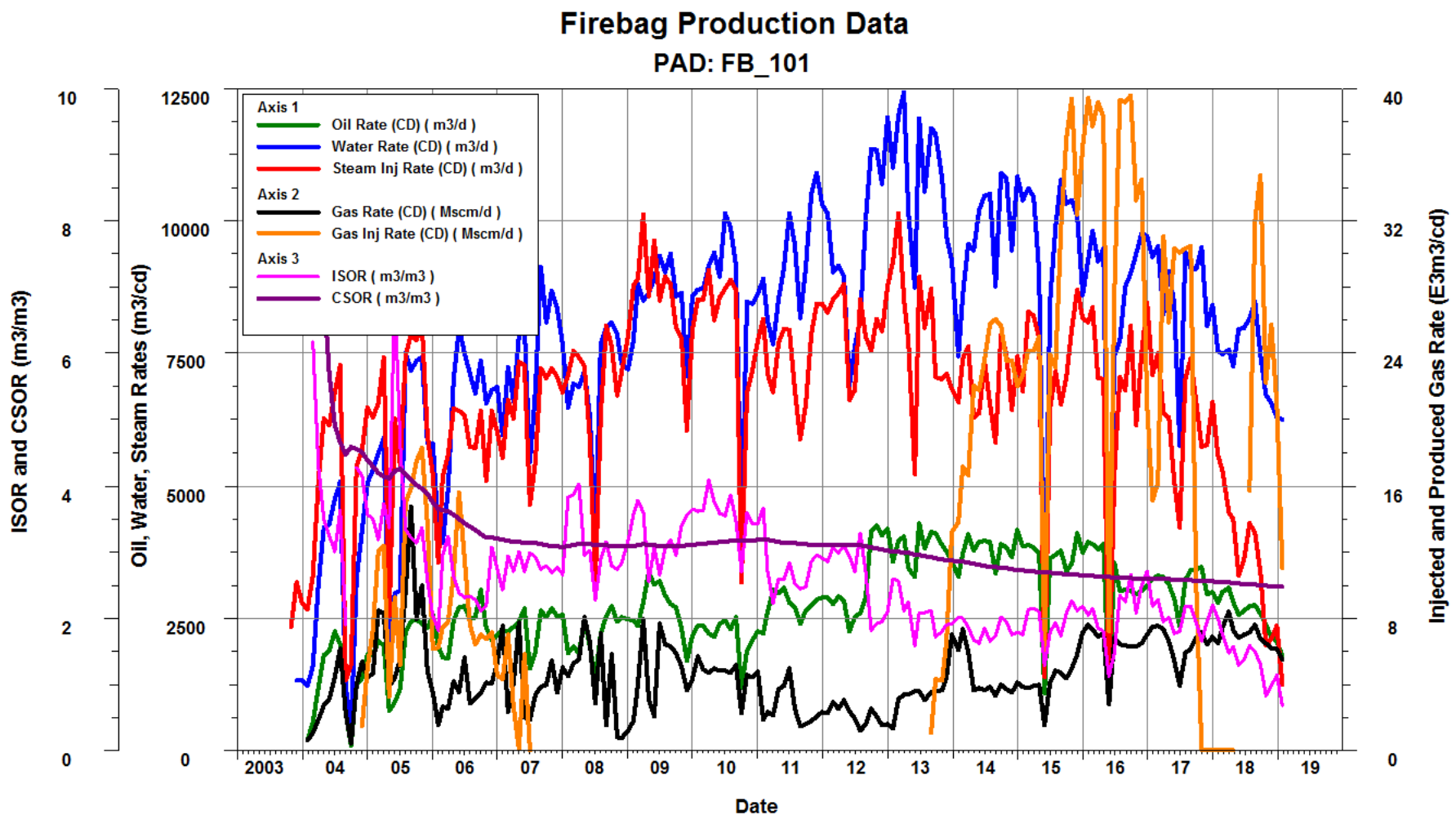
Appendix
2019 Appendix to AER Subsurface Presentation

May 9, 2019
Reporting Period: March 1, 2018 to February 28, 2019

Pad Produced & Injected Fluids Plots



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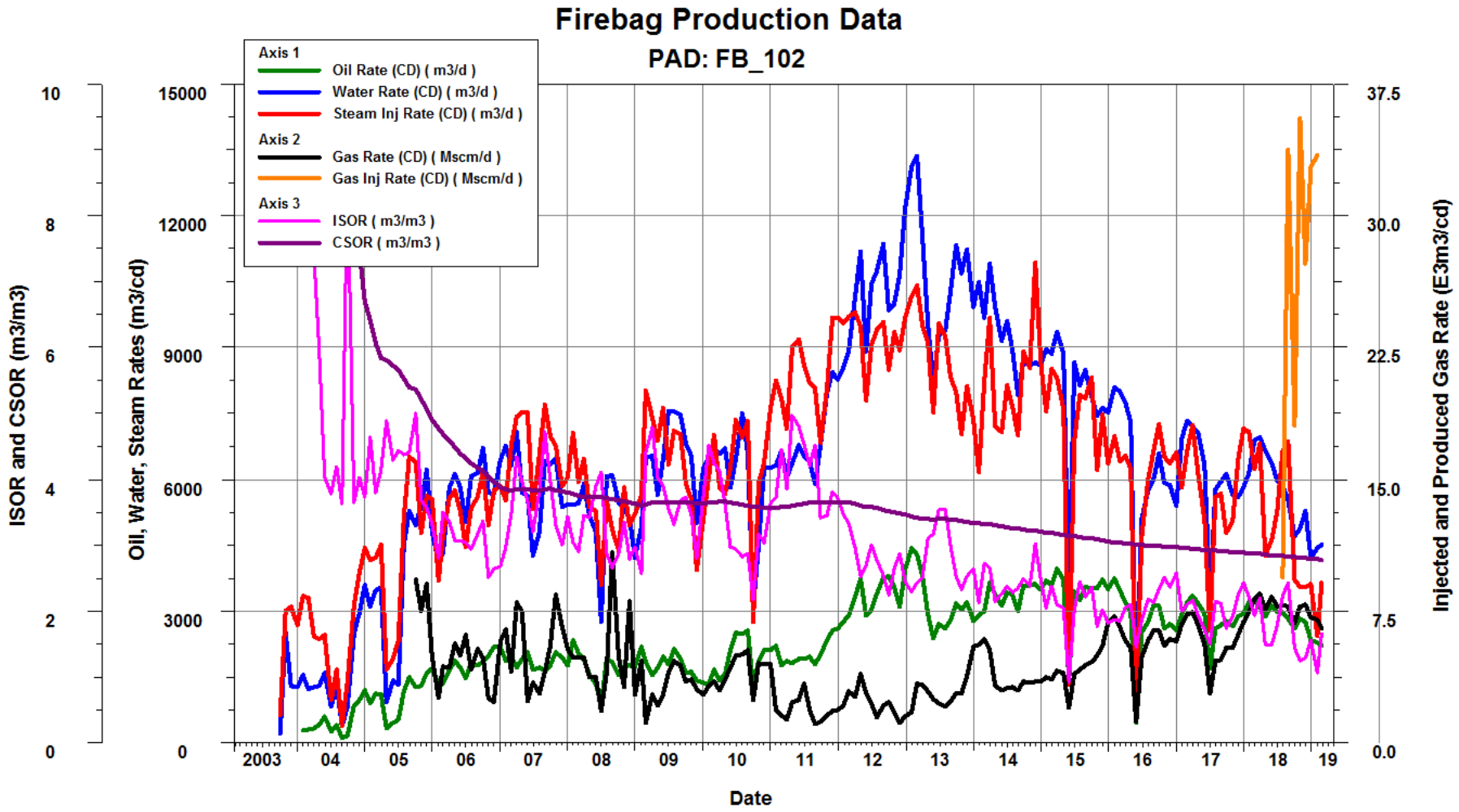

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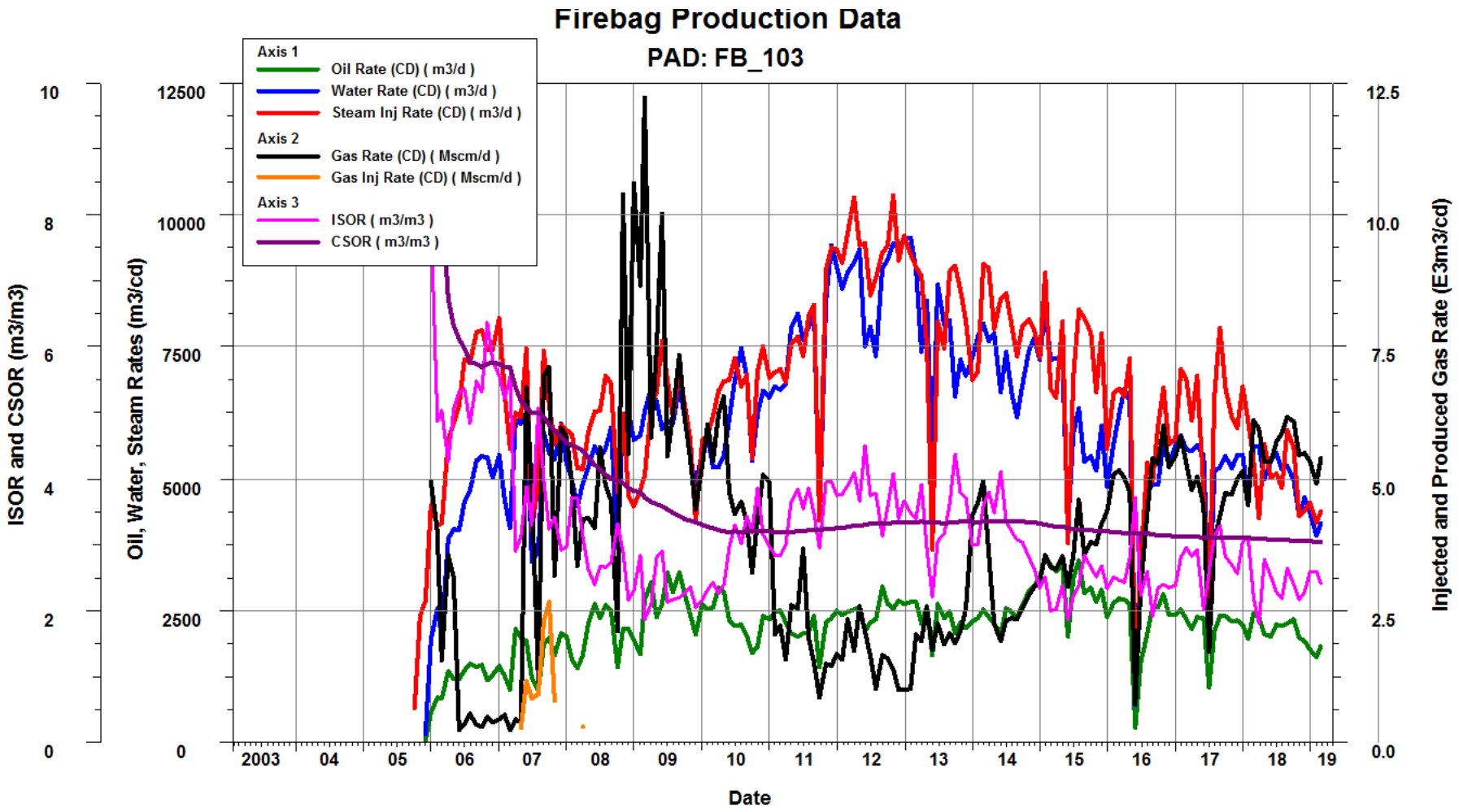

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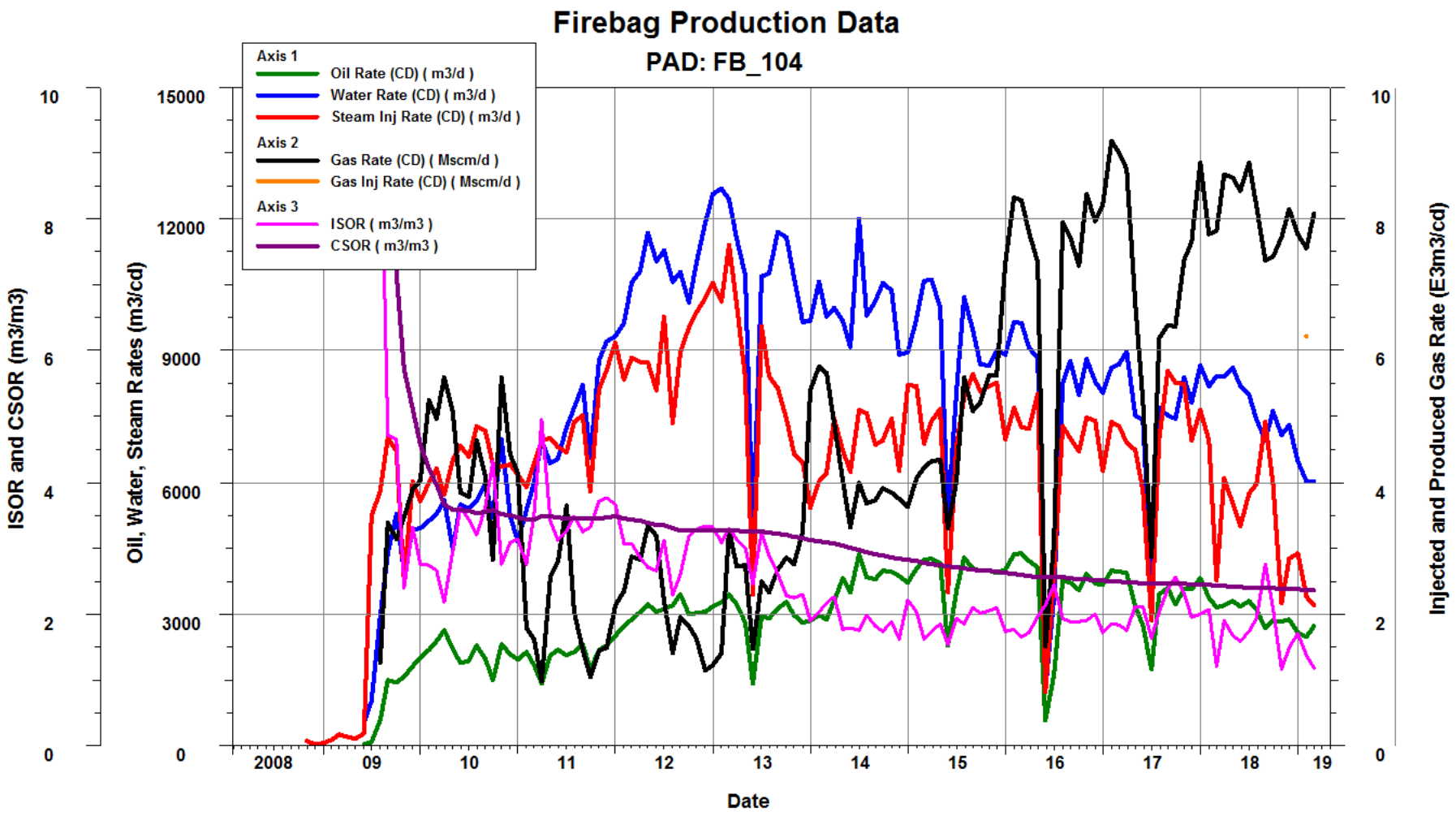

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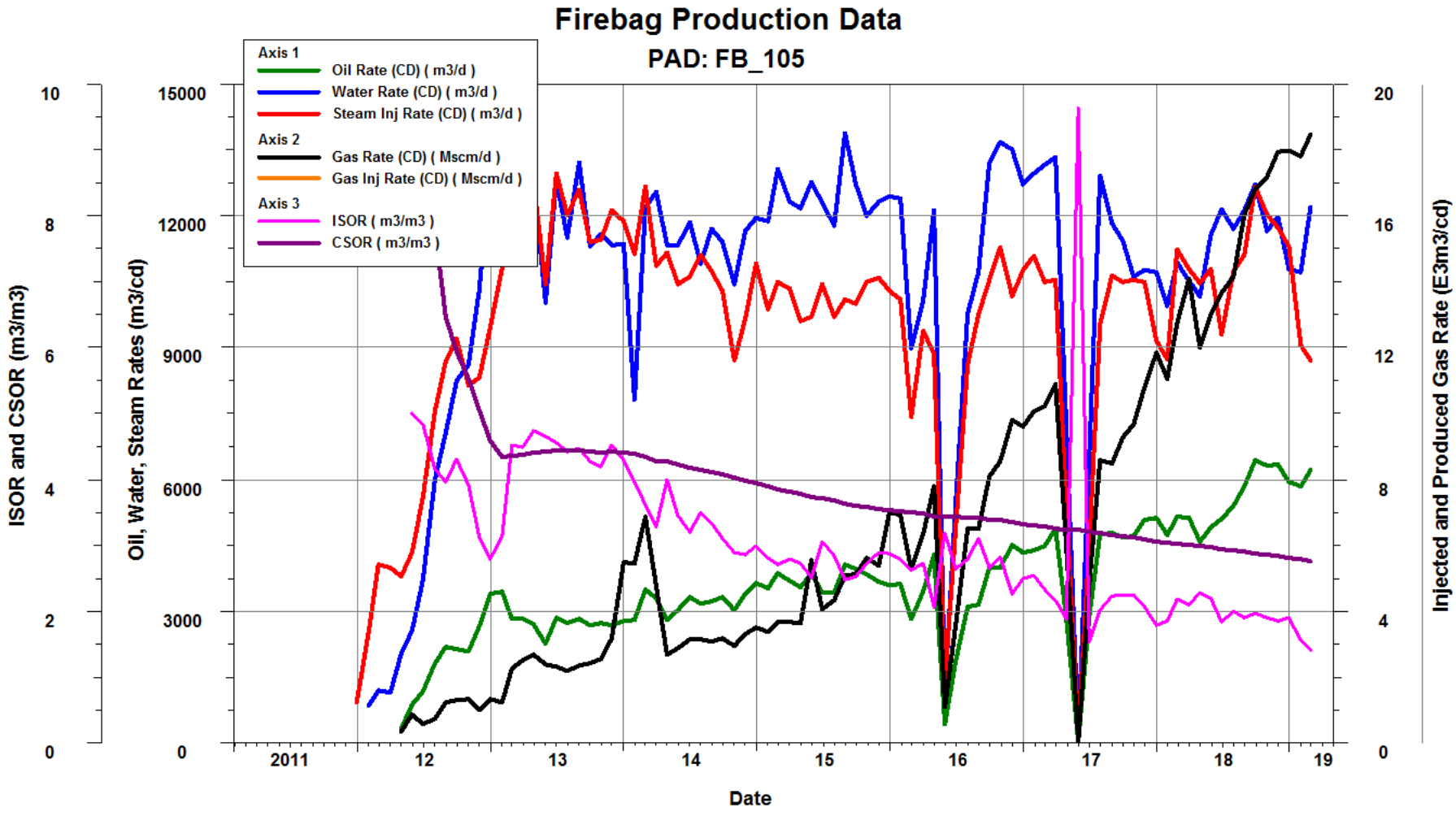

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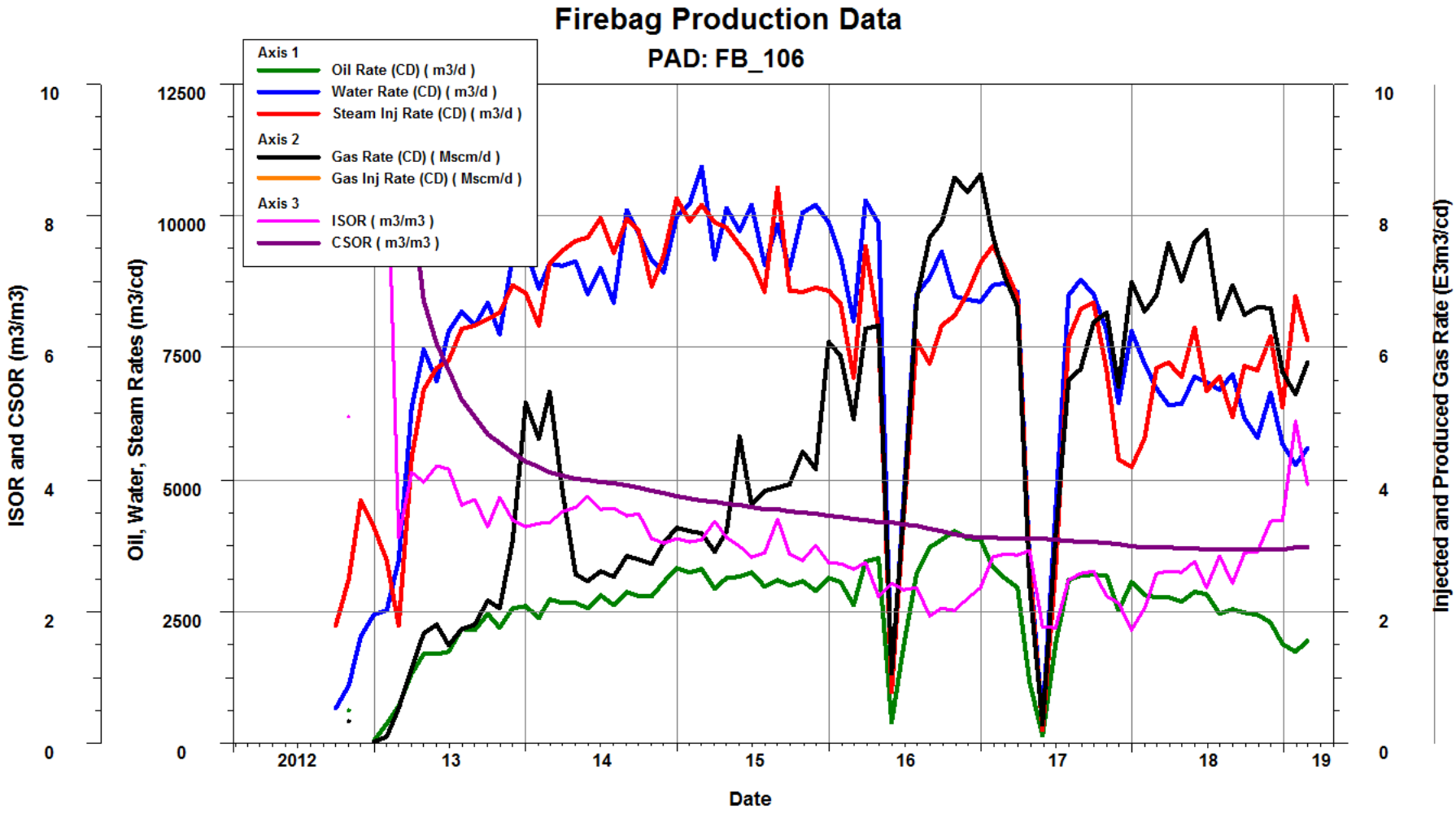

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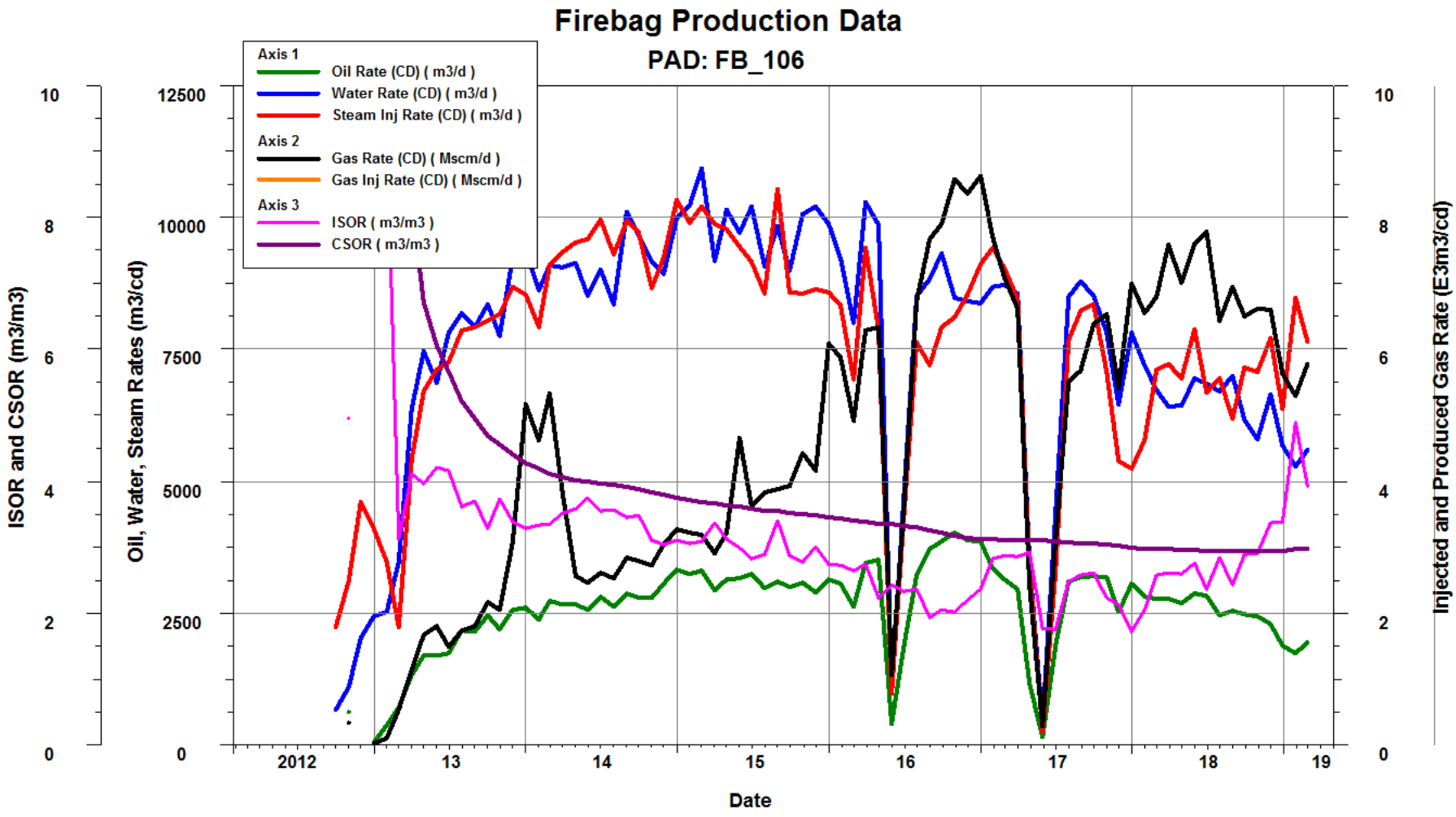

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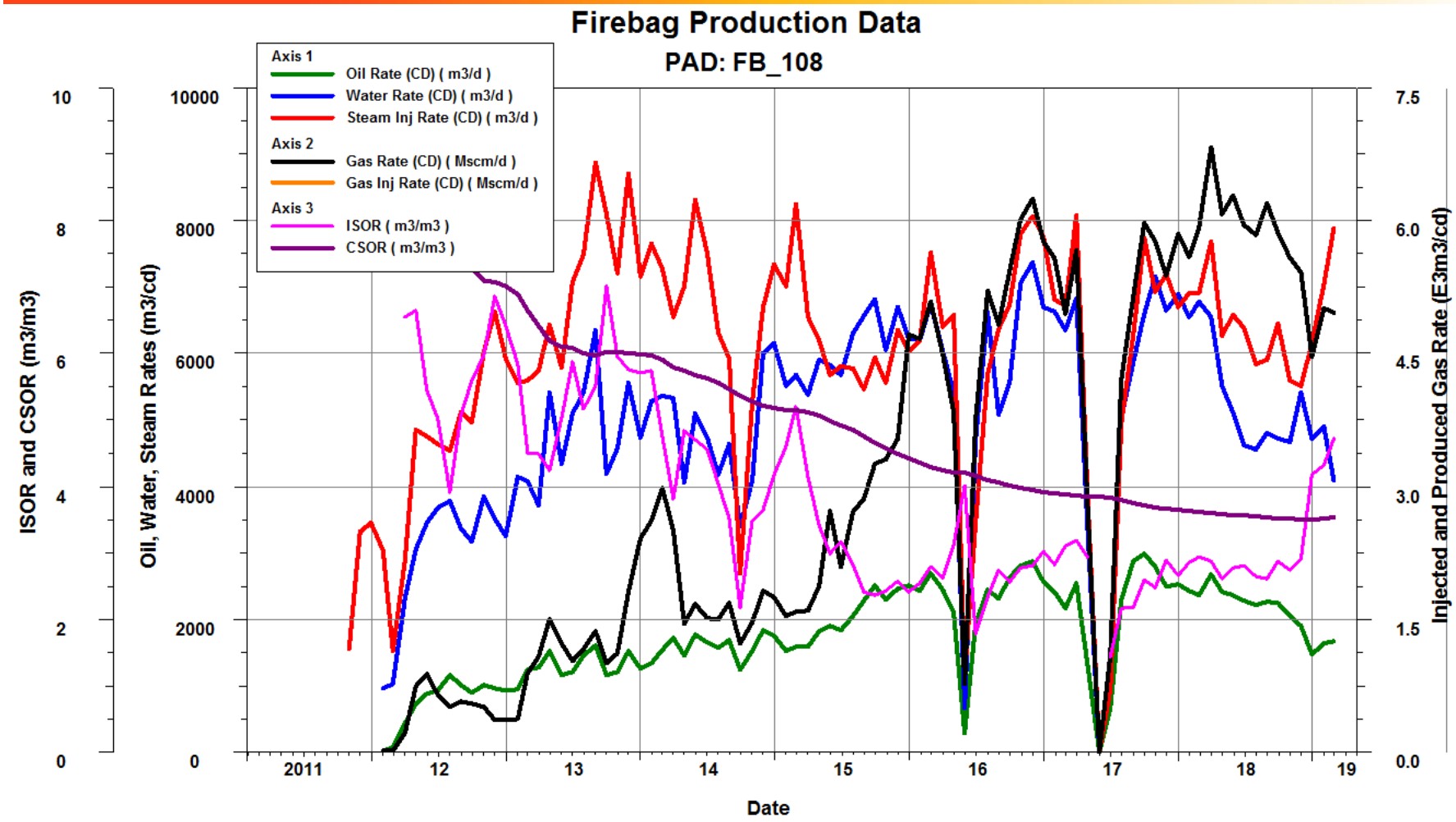

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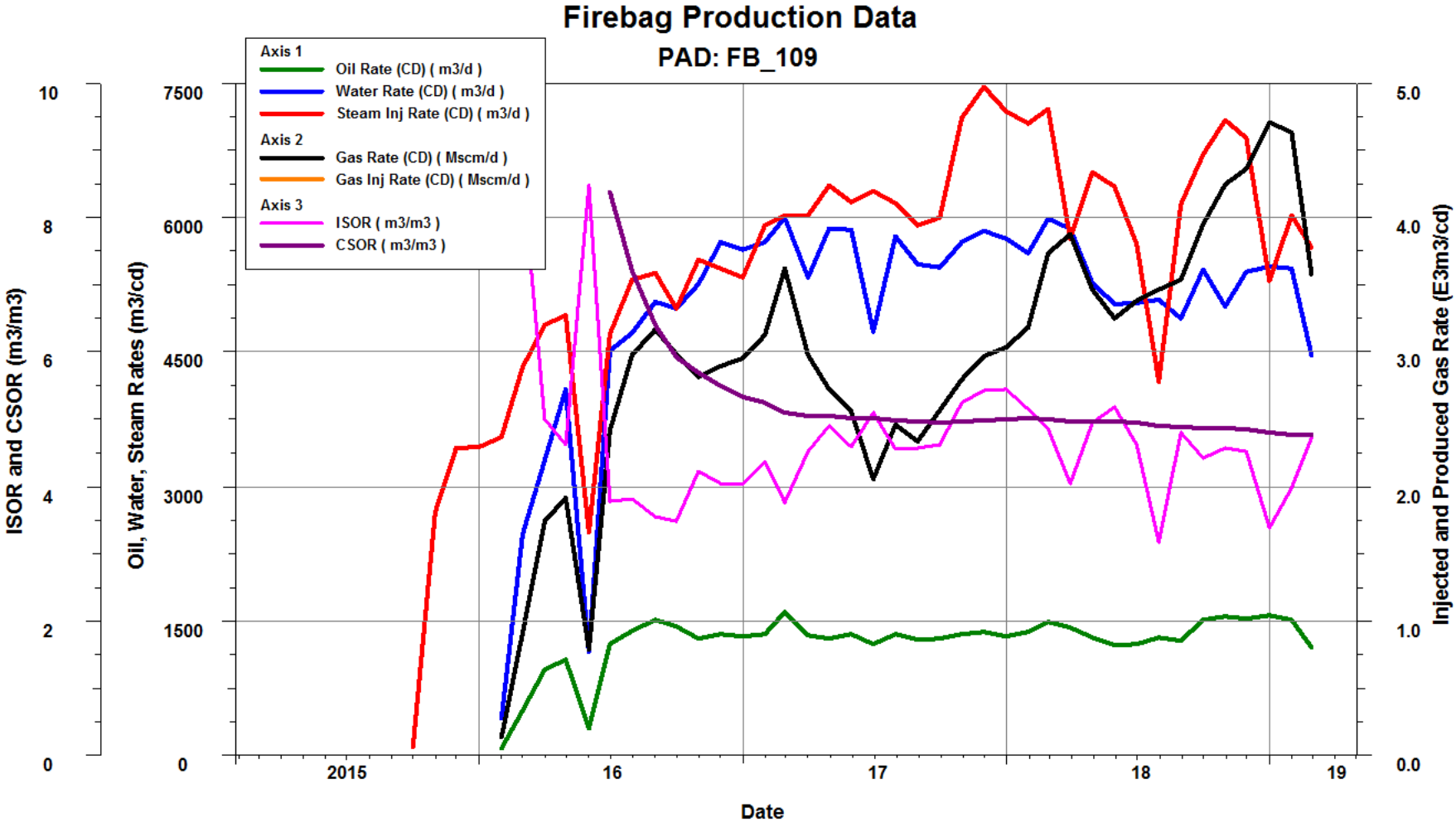

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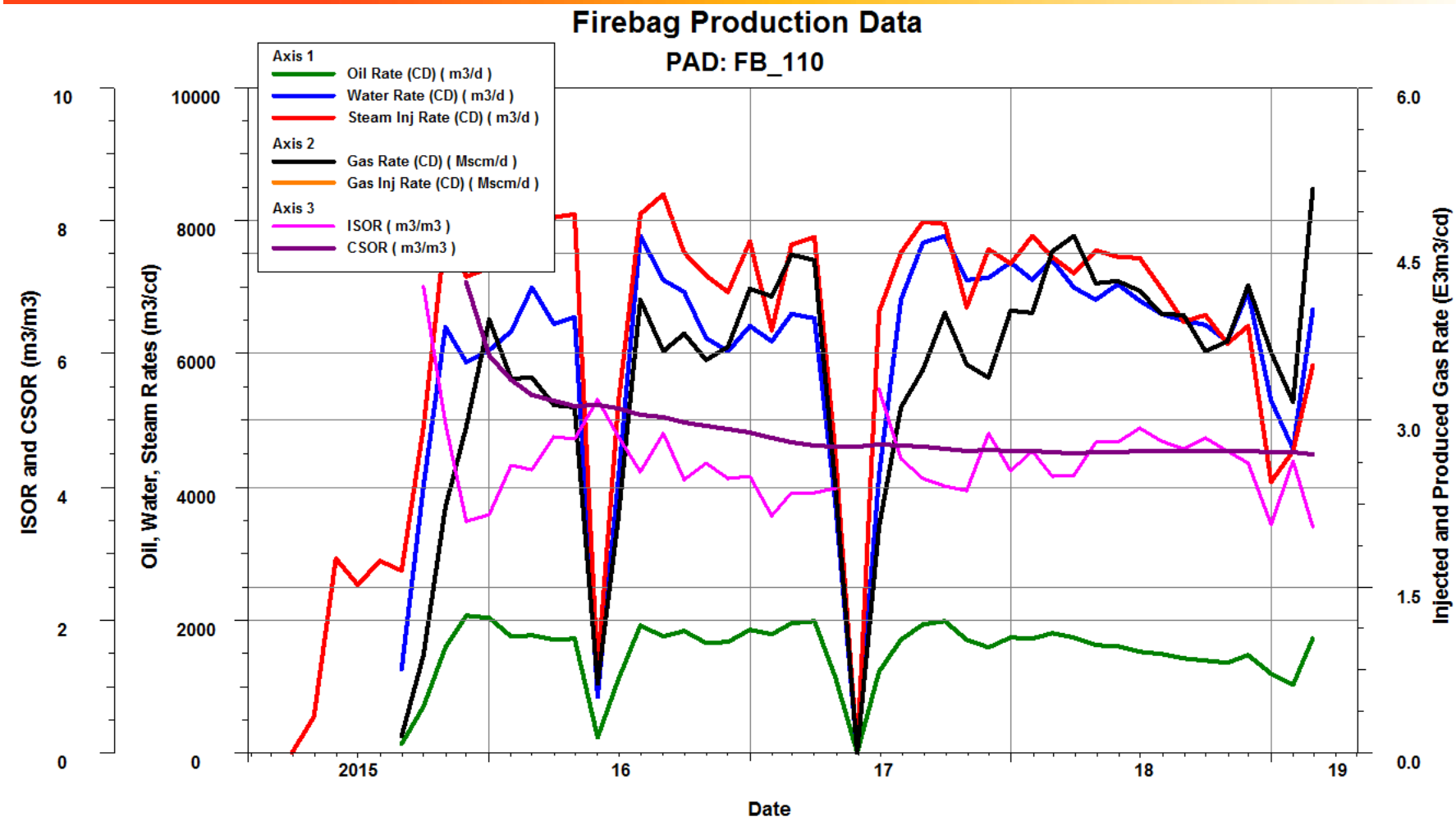

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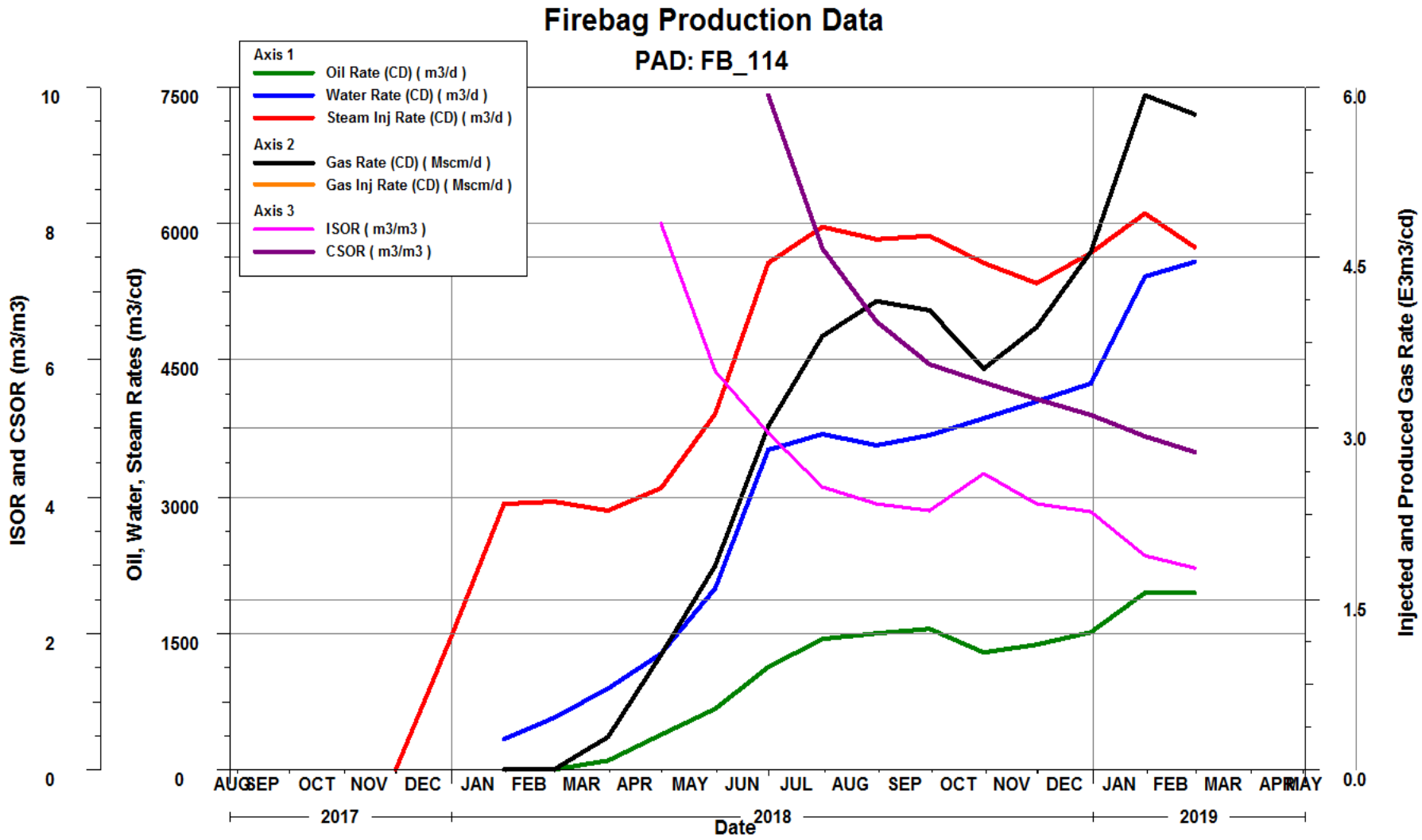

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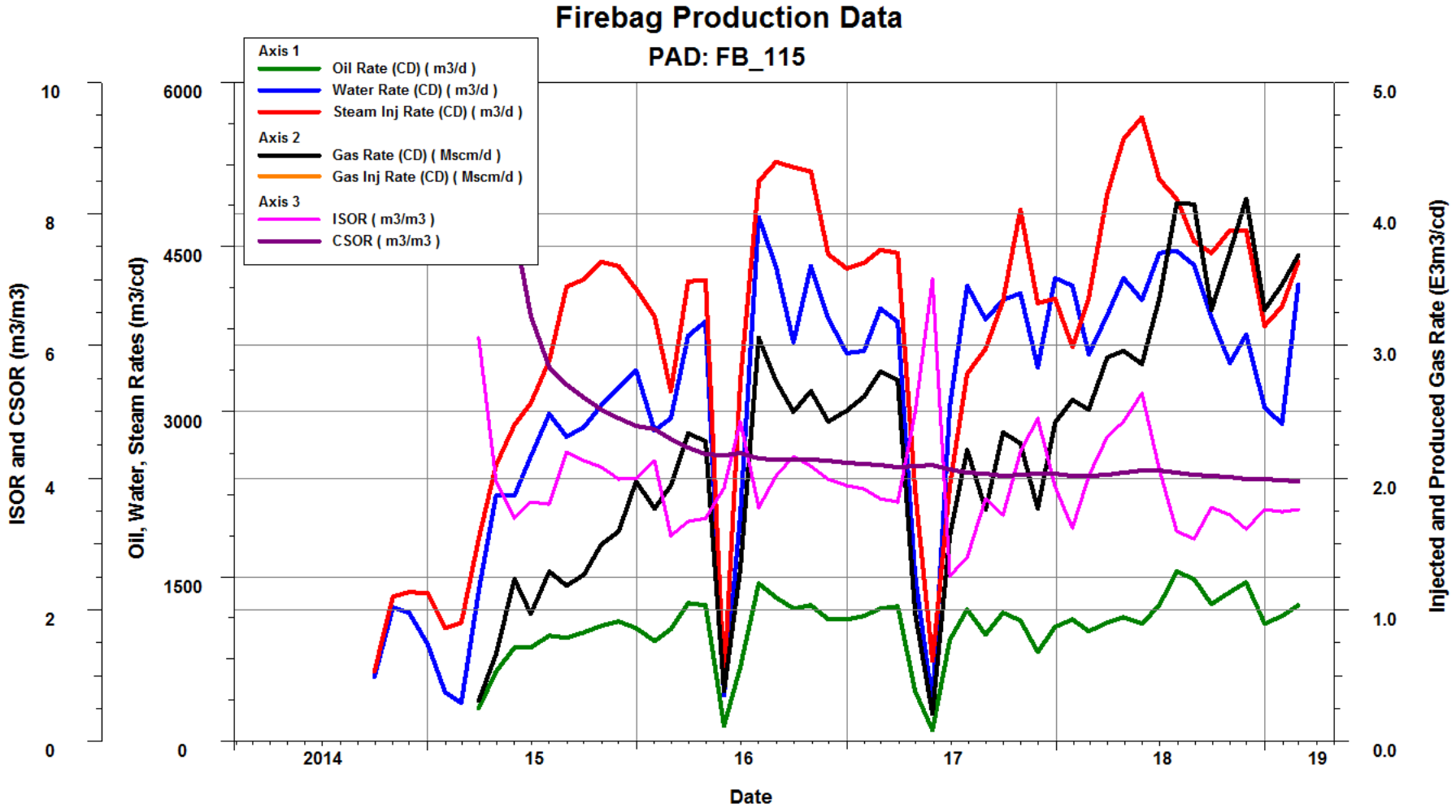

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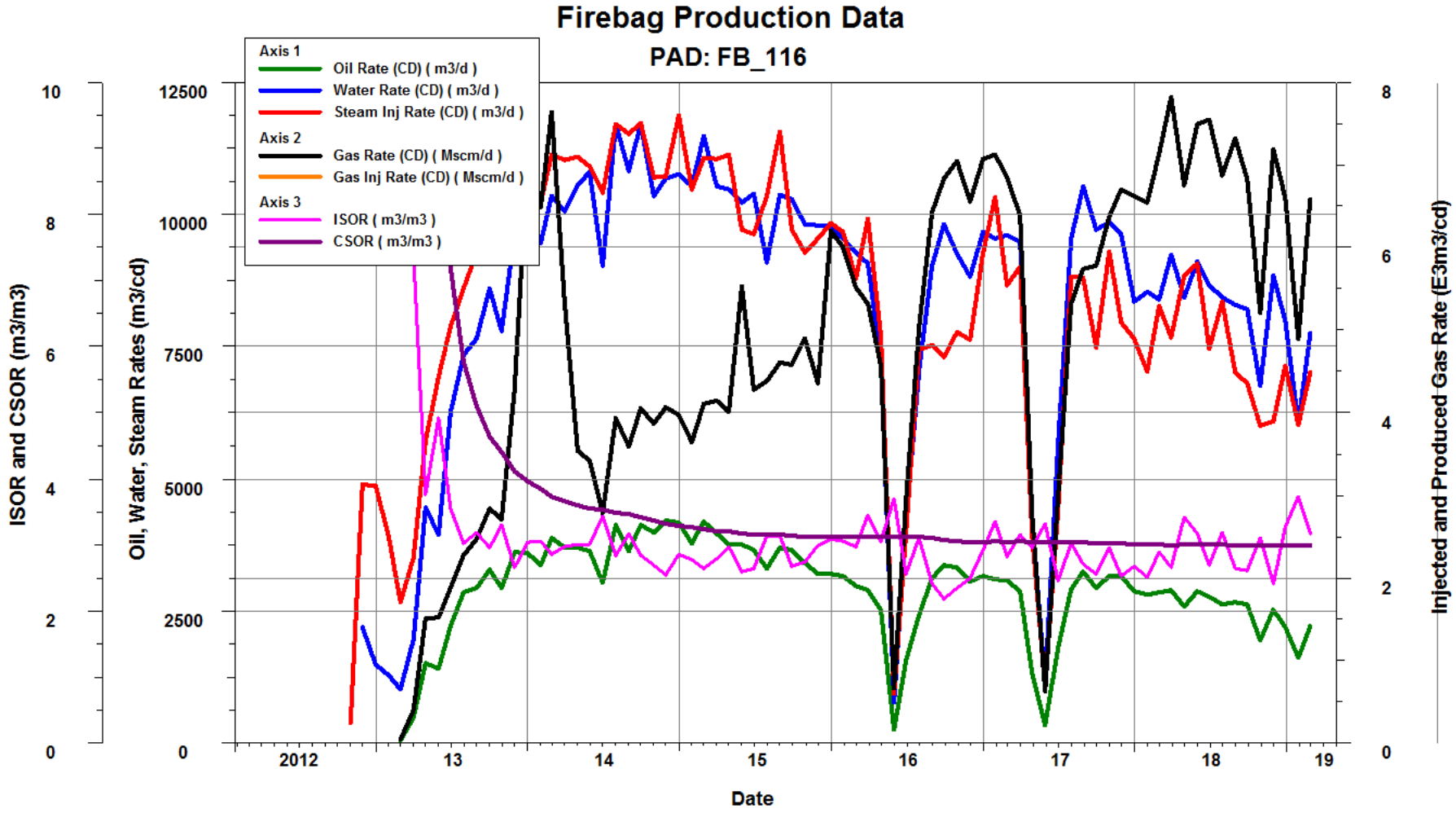

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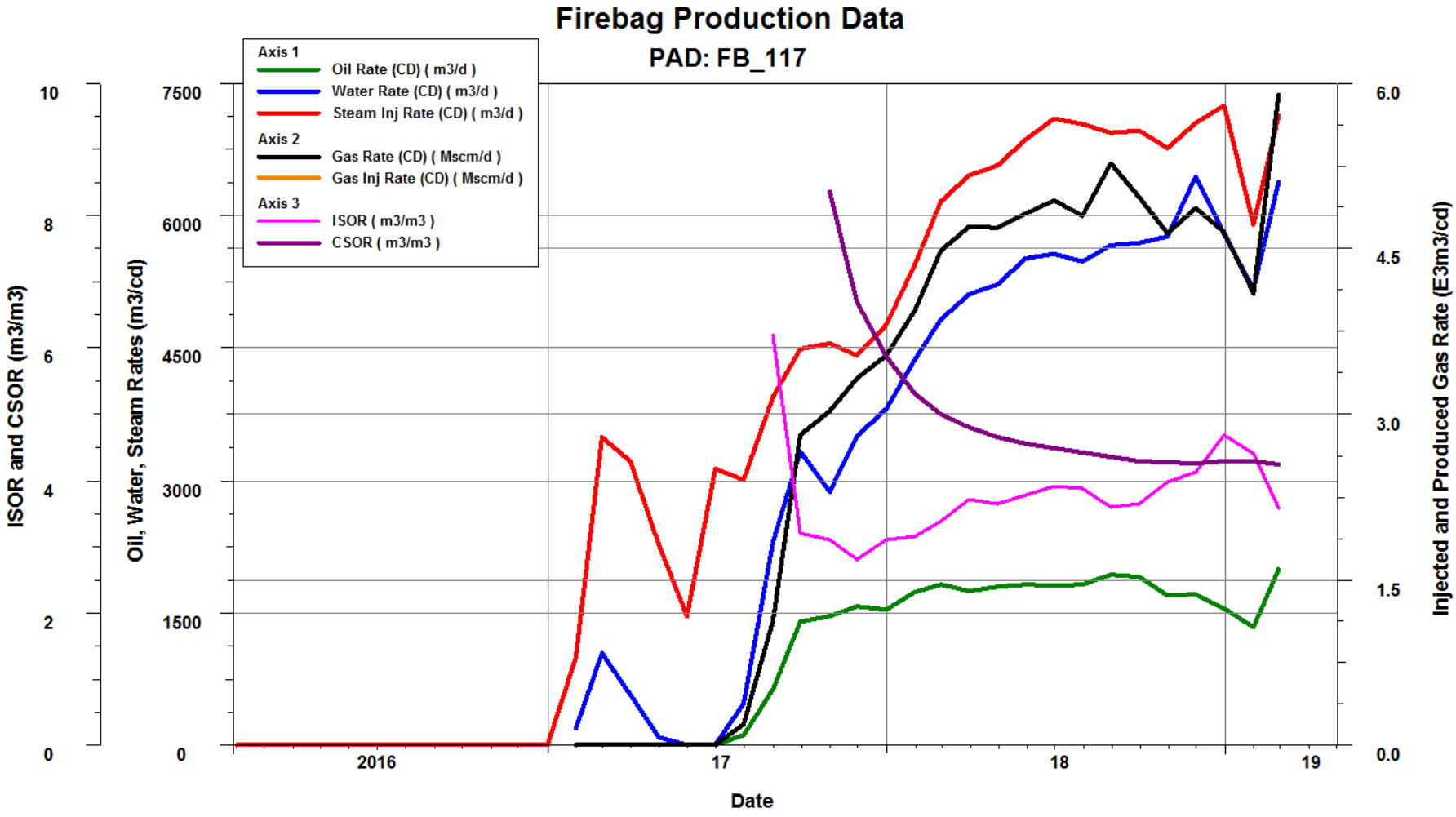

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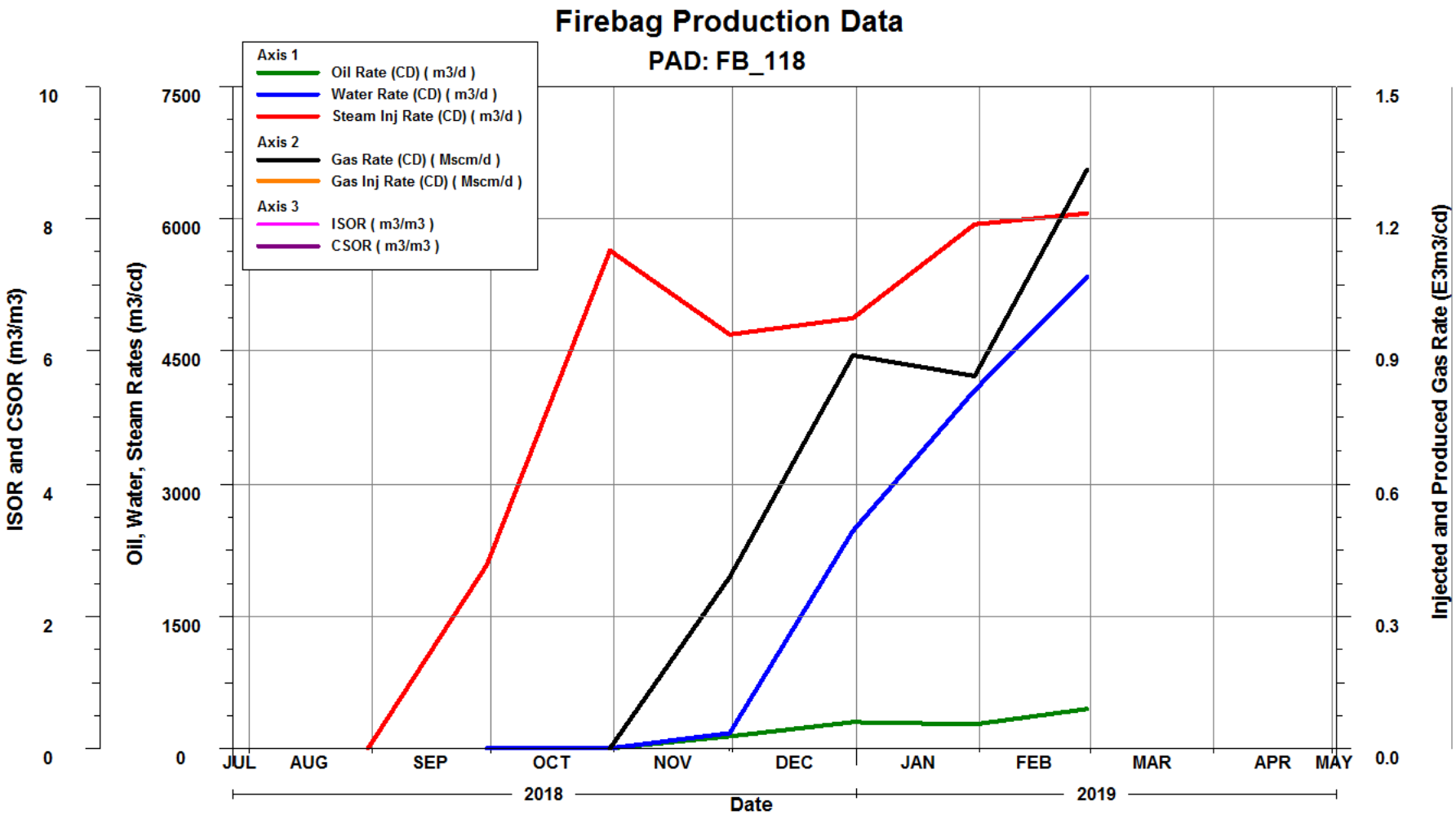

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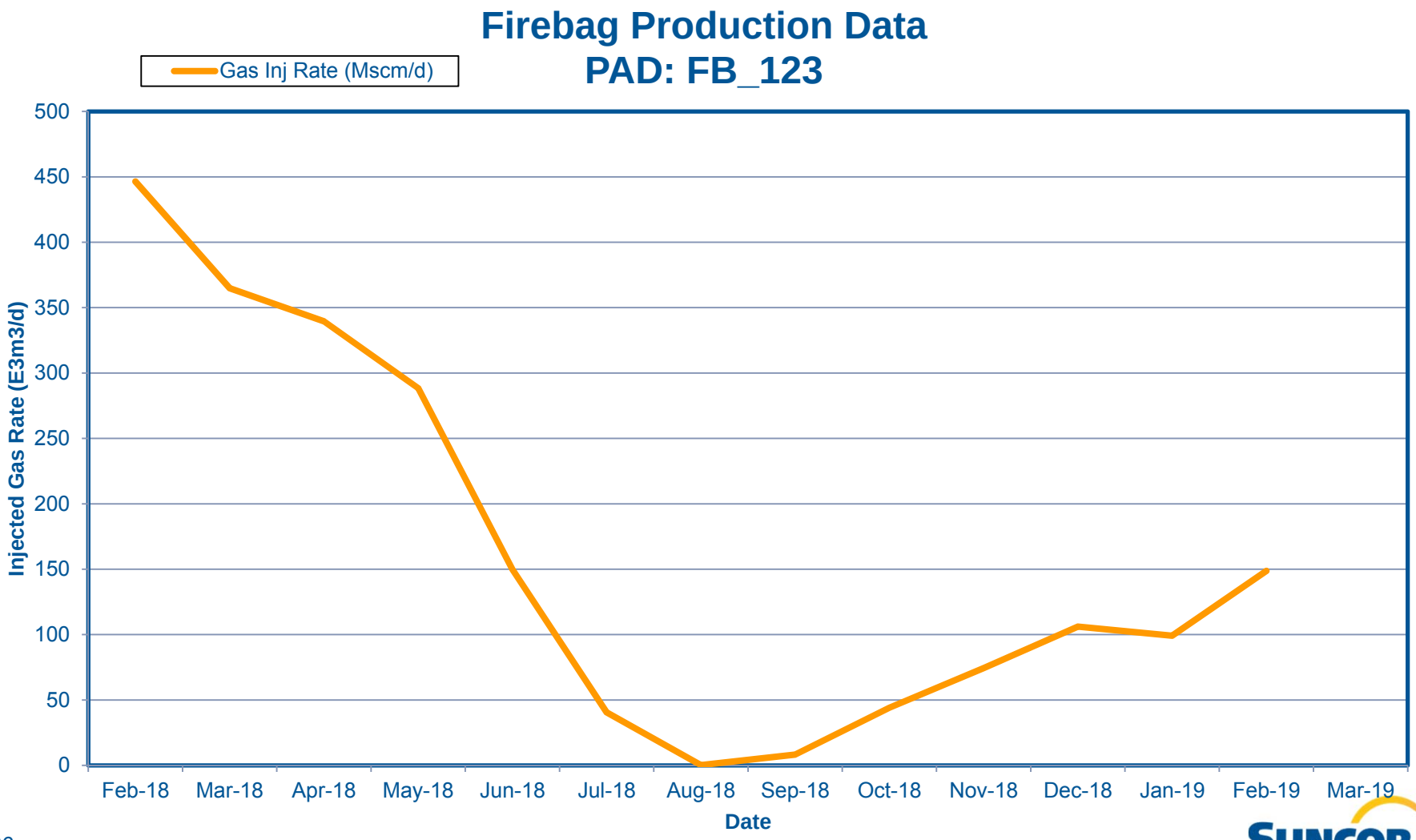


SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
DS1	00/12-06-095-06W4/0	P12P12_planned	512 m SW	262.6
DS2	02/12-06-095-06W4/0	P12P12_planned	504 m SW	262.6
DS4	00/13-34-094-06W4/0	P10P10	31 m S	329.7
DS5	00/02-15-095-06W4/0	P5P3	568 m N	314.5
DS6	00/11-28-094-06W4/0	P10P10	2117 m SW	313.52
DS7	00/04-06-095-05W4/0	P1S6	383 m E	310
DS8	00/02-04-095-06W4/0	P17P6	299 m S	318 m MD
DW OB1	00/08-02-095-06W4/0	P8P6	20 m W	313.6
ETS 1	00/12-06-095-05W4/0	P8P1 (ETS 1 heel) P8P1 (ETS 1 heel) P1N5 (ETS 1 toe) P8P1 (ETS 1 toe) P8P2 (ETS 1 toe)	27 m S 52 m N 235 m SW 303 m SE 297.5 m NE	313.8 m TVD 318.3 m TVD 318.1 m TVD 312.68 m TVD 323.5 m TVD
ETS OB4	02/01-11-095-06W4/0	P8P13B P814B	57.6m E 35.9m W	315.0m MD 316.0m MD
OB10	00/13-01-095-06W4/0	P8P15 P2S1 P2P1	38 m E 91.5 m W 91.5 m W	328 m MD 319.55 m MD 326.59 m MD
OB101	00/02-09-095-06W4/0	P16S3 P16P4	41 m S of horizontal 21.6 m N of horizontal	287.9m MD 293.9m MD
OB102	02/09-04-095-06W4/0	P16P9 P16P10	24.3 m S of horizontal 65.2 m N of horizontal	304m MD 309.7m MD
OB103	00/02-17-095-06W4/0	P15P1 P6P1 P16P19	965 m NW of horizontal 1890 m NW 1439 m N	290.2m MD 288.5m MD 285.4m MD
OB105	02/07-10-095-06W4/0	P5S2 P5P3	53.5 m E of horizontal 86.5 m W of horizontal	310.8m MD 320.25m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB106	12/15-10-095-06W4/0	P5P2B P5P3	81.3 m E of horizontal 44.3 m W of horizontal	319.7m MD 318.7m MD
OB107	00/10-32-094-06W4/0	P17P7	1245 m S	297 m MD
OB11	06/15-36-094-06W4/0	P1S7 P1P7	76 m S of toe 76 m S of toe	312.83 m MD 318.61 m MD
OB110	00/15-33-094-06W4/0	P10P10	397 m E	326 m MD
OB111	02/12-36-094-06W4/0	P2N8 P2P8	298.5m S of toe 299.1 m SE of toe	320.7 m MD 319.7m MD
OB114	00/09-35-094-06W4/0	P2P10 ST1 P2P9	447.6 m SE of toe 450.4 m SW of toe	311.8 m MD 311.7 m MD
OB115	00/01-07-095-05W4/0	P9P3 P9P2	39.6 m E 70.5 m W	275.7 m MD 275.7 m MD
OB116	00/02-07-095-05W4/0	P9P5 P9P4	58.7 m E 51.3 m W	278.7 m MD 276.7 m MD
OB118	07/07-03-095-06W4/0	P5P16 P5P15 P10P15	88.0 m E 44.9 m W 199.2 m N	328.4 m MD 327.3 m MD 328.1 m MD
OB119	00/01-08-095-06W4/0	P16P19 P16P18	59.1 m S 31.3 m N	285.0 m MD 285.9 m MD
OB12	02/15-12-095-06W4/0	P3S9 P3P9	21.6 m N 26 m N	302.05 m MD 314.91 m MD
OB122	00/09-02-095-06W4/0	P7NP10_planned P8P9 P8P8	1.0 m S 50.1 m S 49.4 m N	315.4 m MD 315.4 m MD 315.4 m MD
OB123	02/15-02-095-06W4/0	P7P3 P7P4 P8P10	47.0 m E 42.9 m W 135.8 m N	323.7 m MD 326.0 m MD 319.1 m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB124	04/04-01-095-06W4/0	P8P5 P8P4	56.6 m E 50.1 m W	313.9 m MD 313.3 m MD
OB125	00/02-02-095-06W4/0	P7P12 P7P11	43.8 m E 47.4 m W	325.6 m MD 324.3 m MD
OB127	04/08-02-095-06W4/0	P8P6 P8P5	45.5 m E 46.0 m W	312.9 m MD 315.3 m MD
OB128	05/08-02-095-06W4/0	P7P9 P8P6 P8P7	96.3 m E 155.6 m W 200.6 m S	327.2 m MD 314.0 m MD 315.9 m MD
OB129	10/11-02-095-06W4/0	P4P7 P4P6	77.4 m E 82.9 m W	319.1 m MD 326.1 m MD
OB13	10/07-11-095-06W4/0	P7S2 P7P2 P7P1	16.8 m W 14.9 m W 74.2 m E	322.66m MD 322.7m MD 318.5m MD
OB130	02/09-03-095-06W4/0	P5P14 P5P13	78.7m E 58.8 m W	324.7 m MD 324.8 m MD
OB131	10/01-10-095-06W4/0	P5P8 P5P10	95.2 m S 5.0 m N	311.3 m MD 311.3 m MD
OB132	03/07-10-095-06W4/0	P5P4 P5P5	64.7 m E 66.8 m W	312.3 m MD 312.4 m MD
OB133	11/07-11-095-06W4/0	P7P3 P7P4	88.7 m NE 61.6 m NW	325.6 m MD 330.1 m MD
OB134	00/01-16-095-06W4/0	P6P1	582.6 m NW	292.1 m MD
OB135	06/09-09-095-06W4/0	P6P2 P6P3	42.7 m E 45.7 m W	296.7 m MD 296.2 m MD
OB136	00/11-10-095-06W4/0	P6P8 P6P9	31.2 m E 59.0 m W	299.0 m MD 301.8 m MD
OB137	00/09-08-095-05W4/0	P9P1	1475.8 m NE	276.9 m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB138	00/07-09-095-05W4/0	P9P1	2765.3 m E	274.5 m MD
OB14	03/08-02-095-06W4/0	P8P6 P7P9	160.2 m W 91.2 m E	312.4m MD 325.0m MD
OB143	00/16-34-094-06W4/0	P10P8 P10P7	18 m N 71 m S	322 m MD 319 m MD
OB147	00/05-07-095-06W4/0	P11P11_planned P11P10_planned	58.7 m E 51.3 m W	270.9 m MD 270.9 m MD
OB149	02/11-04-095-06W4/0	P17P1 P16P12 P17P14	101 m W 155 m SE 193 m SE	287.7 294.7 292.2
OB152	00/06-06-095-05W4/0	P3P3B P3PB P1P6	523 m S 512 m S 508 m E	299.18 300.17 315
OB153	03/08-01-095-06W4/0	P1P7 P1N7	32 m W 37 m E	320.6 322.1
OB154	09/14-36-094-06W4/0	P1P8 P1N8	39 m W 41 m E	319.6 321
OB164	02/11-08-095-06W4/0	P14P7_planned	164 m S	281.3
OB165	00/06-05-095-06W4/0	P17P8	54 m NW	289 m MD
OB166	00/05-32-094-05W4/0	P1P6	2448 m SE	308.71
OB167	00/01-32-094-05W4/0	P1P6	3635 m SE	313.96
OB168	00/03-04-095-05W4/0	P1P6	3923 m E	309.1
OB169	00/13-32-094-05W4/0	P1P6	2467 m E	309.2
OB17	05/05-12-095-06W4/0	P2P1 P7P8	199.7 m W 202.3 m E	326.5m MD 313.5m MD
OB170	00/13-33-094-05W4/0	P1P6	4058 m SE	307.06
OB18	00/09-10-095-06W4/0	P5P6 P5P5	33.8 m W of horizontal 100 m E of horizontal	319m MD 320 m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB182	03/01-09-095-06W4/0	P15P8 P16P1	5 m S 127 m N	285.5 (-303.5 m SS) 305.0 (-284 m SS)
OB186	03/10-31-094-05W4/0	P23P6_planned	60 m NE of toe	283
OB189	09/07-31-094-05W4/0	P23P5_planned P23P4_planned	75 m W 6 m E	283 285
OB19	06/03-02-095-06W4/0	P4S7 P4P7	83.5 m E of toe 49.9 m S of toe	319.31 m MD 326.4 m MD
OB190	02/10-31-094-05W4/0	P23P2_planned	57 m NW of toe	284
OB20	00/05-02-095-06W4/0	P4S9 P4P9	78.4 m E of horizontal 74.9 m E of horizontal	317.28 m MD 323.23 m MD
OB201	00/01-31-094-05W4/0	P23P9_planned	42 m E	278
OB202	00/13-29-094-05W4/0	P23P9_planned	438 m E	289
OB203	00/15-34-094-06W4/0	P10P8 P10P7	15 m N 76 m S	331 327
OB204	17/13-35-094-06W4/0	P10P8 P10P7	14 m N 81 m S	321 318
OB205	00/16-07-095-05W4/0	P9P15	480 m SE of ICP	293
OB21	00/11-03-095-06W4/0	P5P18 P5P17	21.3 m E of horizontal 116.8 m W of horizontal	325 m MD 326.6 m MD
OB211	00/02-31-094-05W4/0	P23P5_planned P23P6_planned	31 m E 49 m W	283.96 284.90
OB212	00/11-30-094-05W4/0	P23P1_planned	23 m W	277.49
OB213	F1/13-30-094-05W4/0	P23P1_planned	514 m W	282.87
OB214	00/16-30-094-05W4/0	P23P7_planned P23P8_planned	53 m E 26 m W	285.89 283.10
OB215	F1/16-31-094-05W4/0	P23P9_planned	529 m NE	278.31
OB216	F1/15-31-094-05W4/0	P23P5_planned	508 m N	282.4
OB217	03/12-12-095-06W4/0	P3N7	146 m W	314.26

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB218	00/14-01-095-06W4/0	P2P2 P2N2	68 m E 30 m W	327.63 330.40
OB219	00/02-12-095-06W4/0	P2P5 P2N5	25 m E 60 m W	330.45 331. 60
OB22	00/13-02-095-06W4/0	P5P11 P4P10 P5P12	80 m S 90 m N 200 m NE	313.33 m MD 318.4 m MD 319.1 m MD
OB220	09/06-12-095-06W4/0	P2P4 P2N4	37 m E 49 m W	328.25 332.64
OB23	00/05-11-095-06W4/0	P4S3 P4P3	41.7 m W of horizontal 42.7 m W of horizontal	311.87 m MD 318.49 m MD
OB24	00/09-04-095-06W4/0	P17P3 P16P11	63 m N 72 m S	312 m MD 312 m MD
OB27	00/05-04-095-06W4/0	P17P9 P17P8	16 m S 73 m N	294 m MD 297 m MD
OB28	00/07-04-095-06W4/0	P17P5 P17P4	101 m NW of ICP 118 m SW of ICP	316 m MD 317 m MD
OB29	00/07-05-095-06W4/0	P17P8 P17P7	28 m S 84 m N	292 m MD 292 m MD
OB3	02/08-01-095-06W4/0	P1S6 P1P6	2.7 m E 1 m E	310.06 m MD 316.58 m MD
OB30	00/15-05-095-06W4/0	P16P14 P16P13	63.4 m SW of toe 87.6 m NW of toe	285.5m MD 288m MD
OB31	00/06-08-095-06W4/0	P16P19 P15P1	750 m NW of toe 795 m SW of ICP_PLAN	275.75m MD 275.5m MD
OB32	00/11-08-095-06W4/0	P15P1	476 m W of horizontal	277m MD
OB33	00/13-08-095-06W4/0	P15P1	868 m W of horizontal	270.5m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB34	00/03-09-095-06W4/0	P16P19 P16P18	90.4 m SE of ICP 97.6 m NE of ICP	285.75m MD 286.2m MD
OB35	00/05-09-095-06W4/0	P15P6 P15P5	92.6 m NW of ICP_PLAN 119 m SW of ICP_PLAN	285m MD 285m MD
OB36	00/11-09-095-06W4/0	P15P1	206.5 m N of horizontal	286.4m MD
OB37	00/11-04-095-06W4/0	P17P13 P17P12	107 m E of ICP 134 m E of ICP	287 m MD 288 m MD
OB38	00/11-05-095-06W4/0	P16P12	557 m SW of toe	288m MD
OB39	00/07-08-095-06W4/0	P16P19 P15P1	320 m NW of toe 539 m SW of ICP_PLAN	281.2m MD 280.6m MD
OB4	W2/01-01-095-06 W4/0	P1S6 P1P6	3.1 m E 4 m E	310.33 m MD 316.61 m MD
OB40	00/09-09-095-06W4/0	P6P1 P15P1	132.7 m W of horizontal 229 m N of horizontal	291m MD 288.4m MD
OB42	00/13-04-095-06W4/0	P16P15 P16P16	27.5 m N of horizontal 60.5 m S of horizontal	288.7m MD 288.3m MD
OB43	00/15-09-095-06W4/0	P6P1 P15P9	383 m NW of toe 658 m N of horizontal	292.2m MD 289.2m MD
OB44	00/01-05-095-06W4/0	P17P7	339 m S	294 m MD
OB45	00/03-05-095-06W4/0	P17P7	394 m S	294 m MD
OB47	05/16-03-095-06W4/0	P5P13 P5P14	16.2m W of ICP 121.5m E of ICP	329m TVD 574m MD
OB48	02/11-06-095-06W4/0	P16P12	2229 m SW of toe	274.8m MD
OB49	00/13-06-095-06W4/0	P16P14	2582 m W of toe	262.8m MD
OB51	00/03-18-095-05W4/0	P9P12 P9P11	289 m SW 83 m NE	293 m MD 293 m MD
OB54	00/13-07-095-05W4/0	P3S10	53m NE of heel	299.67 m MD 302.91 m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB56	00/15-06-095-05W4/0	P9P7 P9P6	11 m E 72 m W	300 m MD 280 m MD
OB57	00/01-12-095-06W4/0	P1S4 P1P4	77.9 m W of horizontal 78.6 m W of horizontal	316.76 m MD 324.6 m MD
OB59	00/03-07-095-05W4/0	P3S2 P3P2 3WP1	85.46 m E of horizontal 85.0 m E of horizontal 76m W of hz	304.39 m MD 311.11 m MD 303.5m MD (prod)
OB6	05/09-01-095-06W4/0	P1S2 P1P2 P8P1	165 m SE of heel 165 m SE of heel 16.5 m N	318.65 m MD 324.2 m MD 309.2m MD
OB60	00/04-01-095-06W4/0	P2S9 P2P9 P8P12 P2N9	25.1 m W of horizontal 22.5 m W of horizontal 56.6 m E of horizontal 101.9 m W of horizontal	305.27 m MD 312.29 m MD 333.5 m MD 326.0 m MD
OB61	00/04-11-095-06W4/0	P4S4 P4P4	27.13 m E of heel 3.32 m E of heel	211.76 m MD 157.52 m MD
OB62	00/06-02-095-06W4/0	P4P6_ST1N P7P14	51 m E of horizontal 73 m W of horizontal	325m MD 331.1m MD
OB63	07/08-11-095-06W4/0	P7P6 P7P7	34 m E of horizontal 55 m W of horizontal	323.6m MD 316.6m MD
OB66	11/15-35-094-06W4/0	P8S5 P8S4	31.2 m E of horizontal 75.3 m W of horizontal	307.2m MD 307.3m MD
OB67	00/03-06-095-05W4/0	P1S6	645.3 m E of Horizontal	308m MD
OB68	00/07-36-094-06W4/0	P1S7	747.3 m SE of toe	316.5m MD
OB69	00/11-35-094-06W4/0	P7S9	365.5 m SW of toe	320.1m MD
OB7	02/09-01-095-06W4/0	P1S8 P1P8 P8P3	138.5 m NE of heel 138.5 m NE of heel 60.6 m N	313.49 m MD 320.94 m MD 320.0m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB70	05/13-35-094-06W4/0	P7P14	38.7 m W of horizontal	326.4m MD
OB71	07/03-02-095-06W4/0	P7P14	25.7 m W of horizontal	326.2m MD
OB72	00/16-02-095-06W4/0	P7S6 P7S7	68.5 m E of horizontal 19.6 m W of horizontal	316.5m MD 310.5m MD
OB73	00/05-31-094-05W4/0	P1S6	1041.5 m SE of toe	307.5m MD
OB74	00/13-31-094-05W4/0	P1S6	738.1 m E of horizontal	307.5m MD
OB75	00/11-31-094-05W4/0	P1S6	1141 m SE of toe	below TD of OB well
OB76	09/11-02-095-06W4/0	P8S8 P8S9	25 m N of horizontal 73.5 m S of horizontal	309.6m MD 311.9m MD
OB77	00/13-12-095-06W4/0	P3P9 P3P10	353.4 m NW of toe 350.8 m SW of toe	317m MD 313m MD
OB78	07/03-11-095-06W4/0	P4P4 P4P5	94.7 m E 61.2 m W	319.1m MD 326.2m MD
OB79	10/14-35-094-06W4/0	P7S12 P7S11	40.8 m E of horizontal 48.2 m W of horizontal	320m MD 321.2m MD
OB8	00/15-12-095-06W4/0	P3P9 P3P8	98.3 m S 89 m N	N/A - between P3P8 and P3P9
OB80	02/05-11-095-06W4/0	P4P3 P4S2	71.4 m W of horizontal 92.7 m E of horizontal	319.8m MD 307.2m MD
OB81	02/12-11-095-06W4/0	P4S3 P4S4	40.8m E of horizontal 113.7m E of horizontal	309.6m MD 314.6m MD
OB82	05/14-11-095-06W4/0	P4S4 P4P5	29.9 m E of horizontal 94.8 m W of horizontal	313.5m MD 326.5m MD
OB83	03/04-07-095-05W4/0	P3P4B P3P3B	81.6 m E of horizontal 59.4 m W of horizontal	302m MD 301m MD
OB84	06/13-06-095-05W4/0	P3S5 P3S4	70.45 m SE of horizontal 87.6 m W of horizontal	297m MD 294m MD

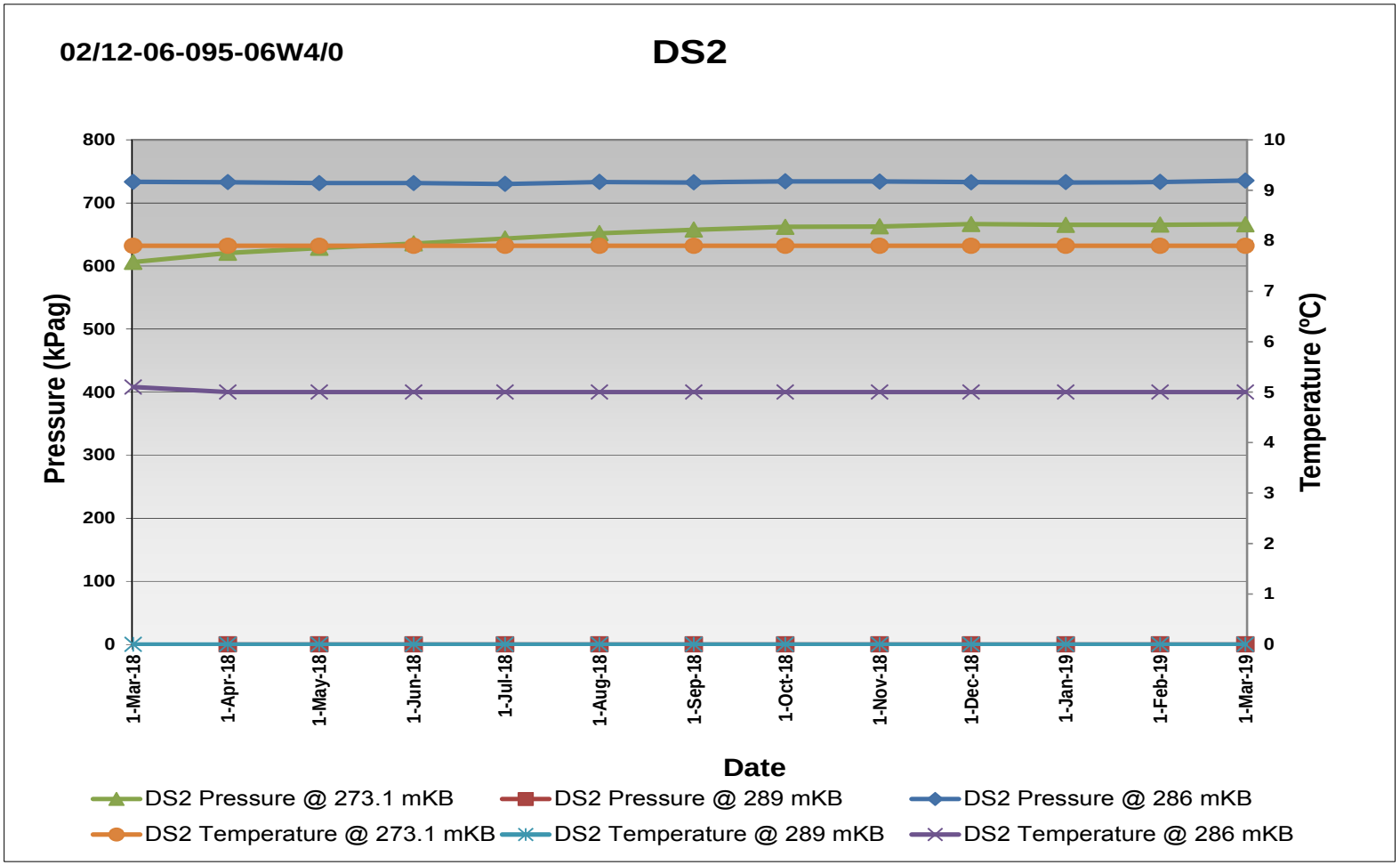
SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB85	00/09-03-095-06W4/0	P5P12 P4P10	73.8 m E of horizontal 78.8 m W of horizontal	322.1m MD 321.9m MD
OB86	00/12-11-095-06W4/0	P4S1 P4S2	24.4 m E of horizontal 131.9 m W of horizontal	305.4m MD 311.4m MD
OB87	04/14-02-095-06W4/0	P4S6 P7S1	105 m NE of horizontal 25.5 m W of horizontal	311.3m MD 316.4m MD
OB88	00/15-02-095-06W4/0	P7P3 P7S4	63.6 m E of horizontal 25.1 m W of horizontal	325.4m MD 322.8m MD
OB89	09/14-35-094-06W4/0	P7S10 P7S9	59.9 m E of horizontal 29.3 m W of horizontal	319.6m MD 319.2m MD
OB9	02/16-12-095-06W4/0	P3S9 P3P9	18.7 m N 20 m N	303.67 m MD 311.52 m MD
OB90	00/15-07-095-05W4/0	P9P15 P9P14	63 m W 19 m E	283 m MD 280 m MD
OB91	00/09-07-095-05W4/0	P9P1 P9P2	357 m NE from ICP 379 m NE from ICP	275 m MD 275 m MD
OB92	00/12-02-095-06W4/0	P4P10 P4P9	70.1 m E of horizontal 91.5 m W of hoizontal	323.5m MD 321.8m MD
OB93	02/05-02-095-06W4/0	P4P10 P4S9	129.8 m E of horizontal 29.3 m W of horizontal	321.5m MD 312.9m MD
OB94	02/13-02-095-06W4/0	P4S8 P4S7	44.4 m E of horizontal 114.9 m W of horizontal	313m MD 313.6m MD
OB95	09/01-10-095-06W4/0	P5P6 P5P7	59.2 m E of horizontal 61.25 m W of horizontal	319.3m MD 317.6m MD
OB96	00/05-10-095-06W4/0	P6S6 P6P7	65.1 m E of horizontal 24.3 m W of horizontal	285.8m MD 294.7m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB97	00/13-09-095-06W4/0	P15P1 P6P1 P16P19	487.5 m N of horizontal 1241 m W 1203 m N	295.5m MD 290.5m MD 287.4m MD
OB98	00/01-17-095-06W4/0	P15P1 P6P1 P16P19	1023.8 m NW of horizontal 1729 m NW 1633 m N	294.2m MD 290.7m MD 287.6m MD
P5S2 OB	06/15-10-095-06W4/2	P5P2	0m	10.47 m MD
P5S3 OB	05/15-10-095-06W4/0	P5P3	0m	17.16m MD
P5S4 OB	04/02-10-095-06W4/0	P5P4	0m	13.45m MD
QW1	11/13-10-095-06W4/0	P6P4 P6P3	19 m W 71 m E	296.1 297.6
QW2	00/12-10-095-06W4/0	P6P7 P6P6	58 m W 33 m E	295.5 293.2
QW4	09/04-10-095-06W4/0	P16P2 P16P3	7.5 m S 81 m N	303.6 304.3

Piezometer Plots & Temperature vs Depth Plots



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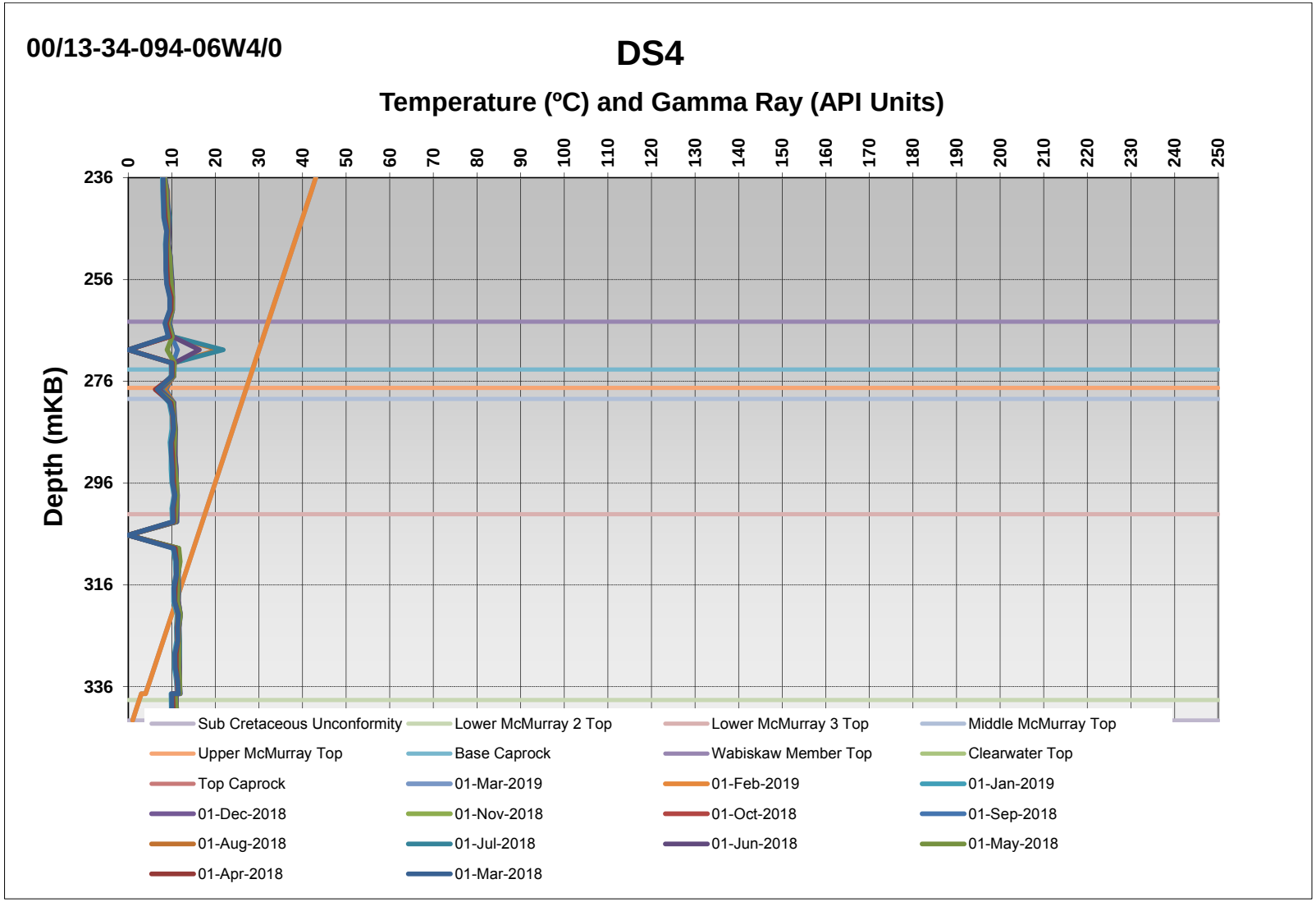

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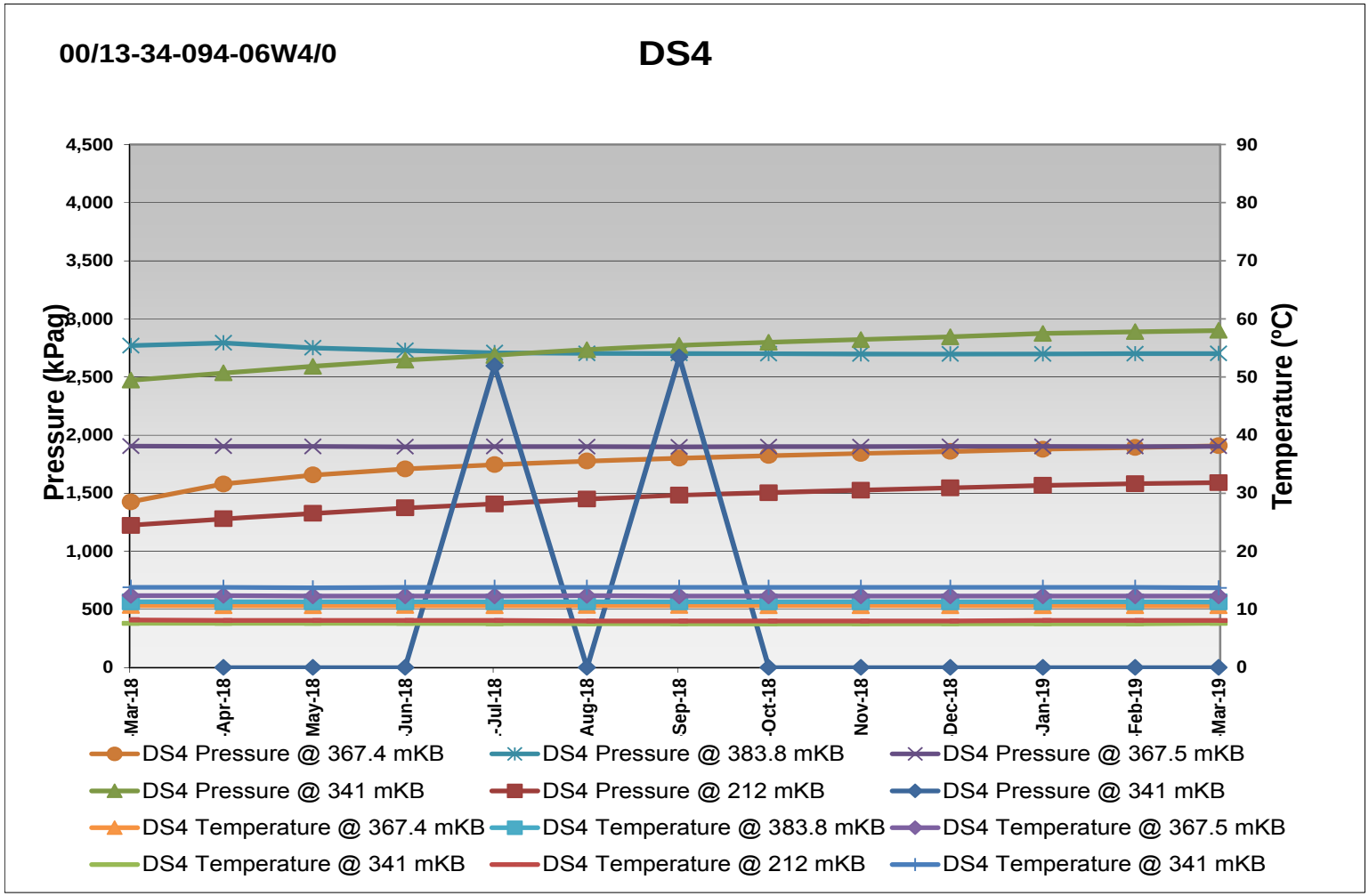

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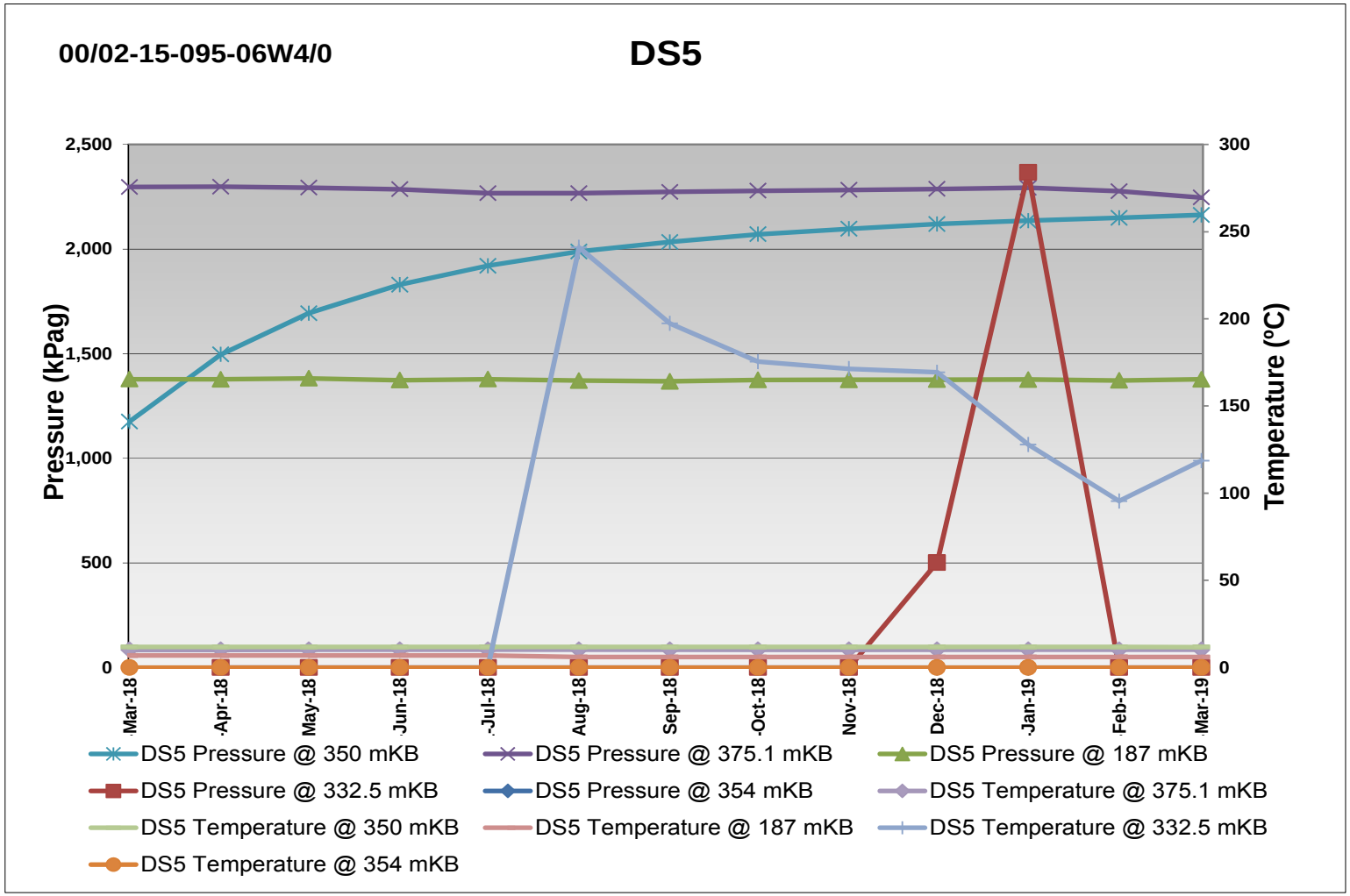

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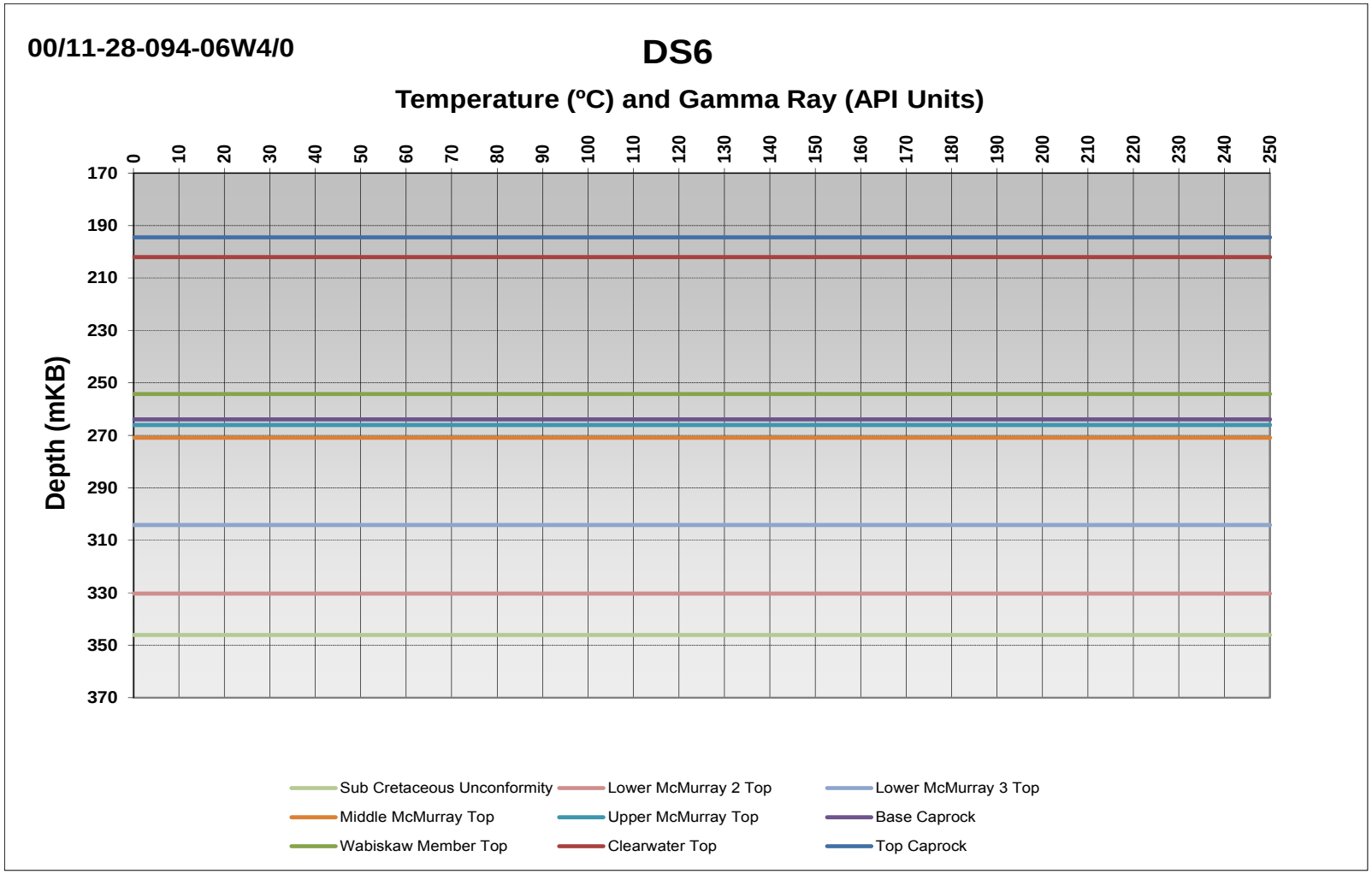

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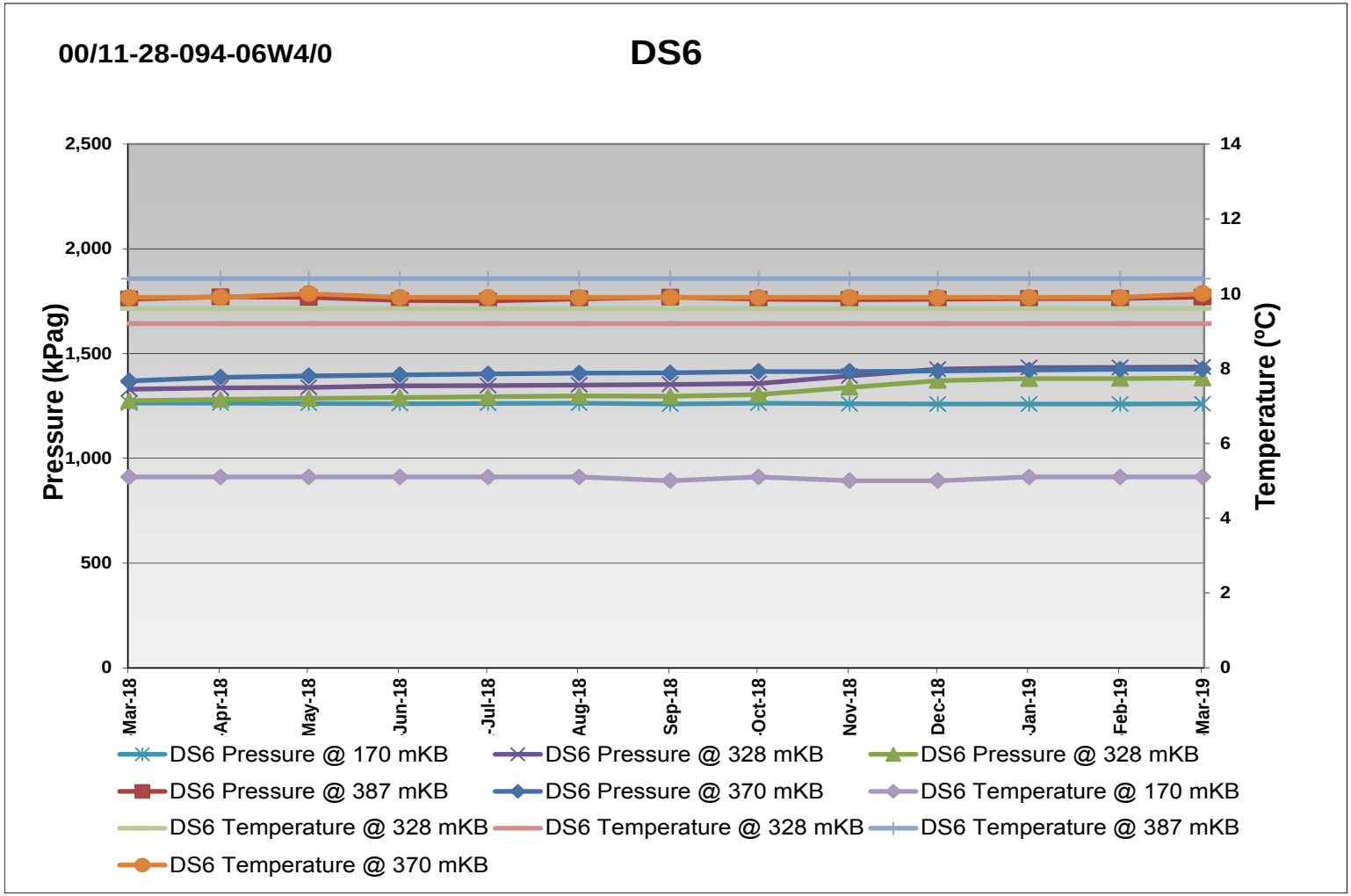

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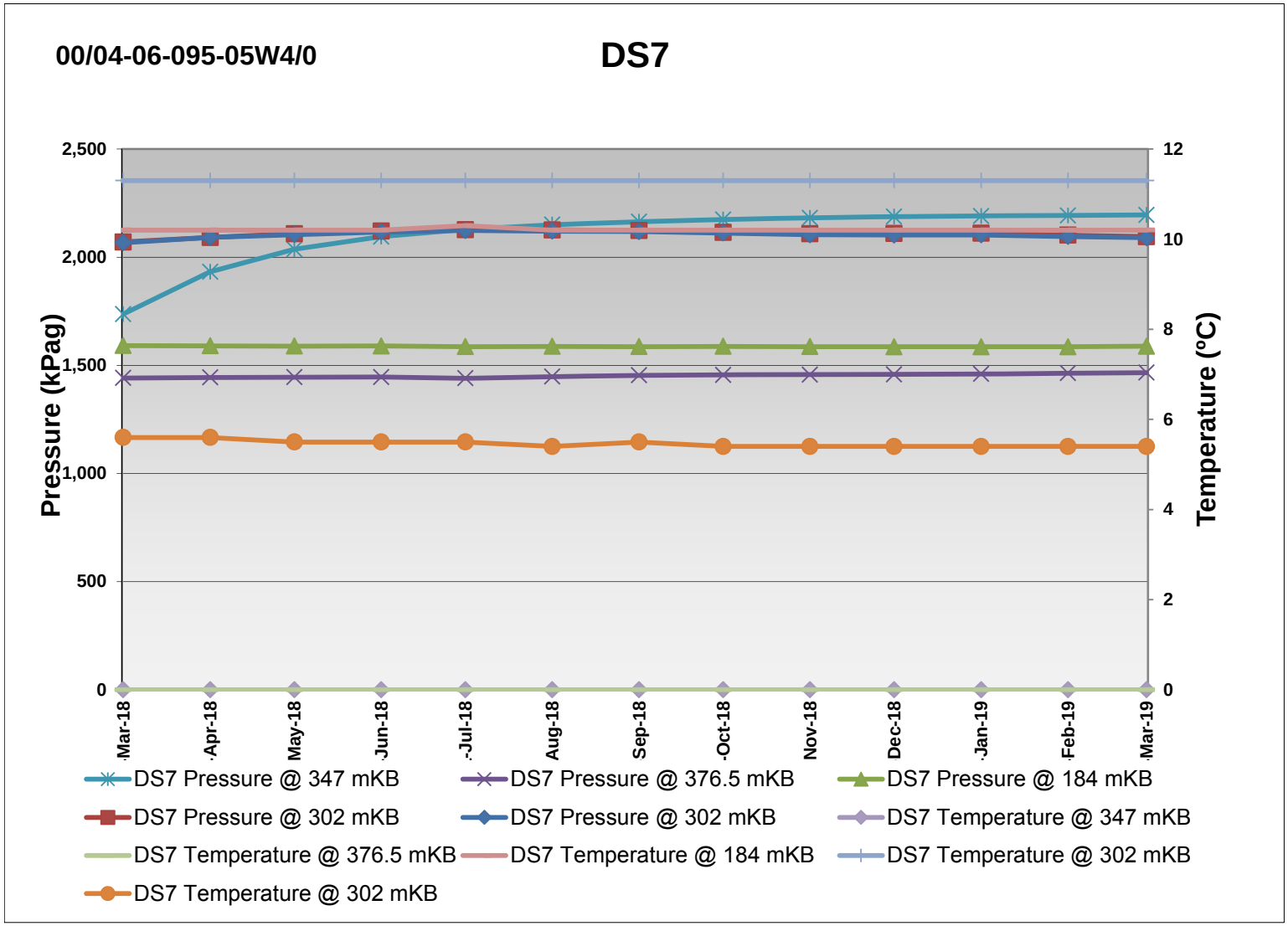
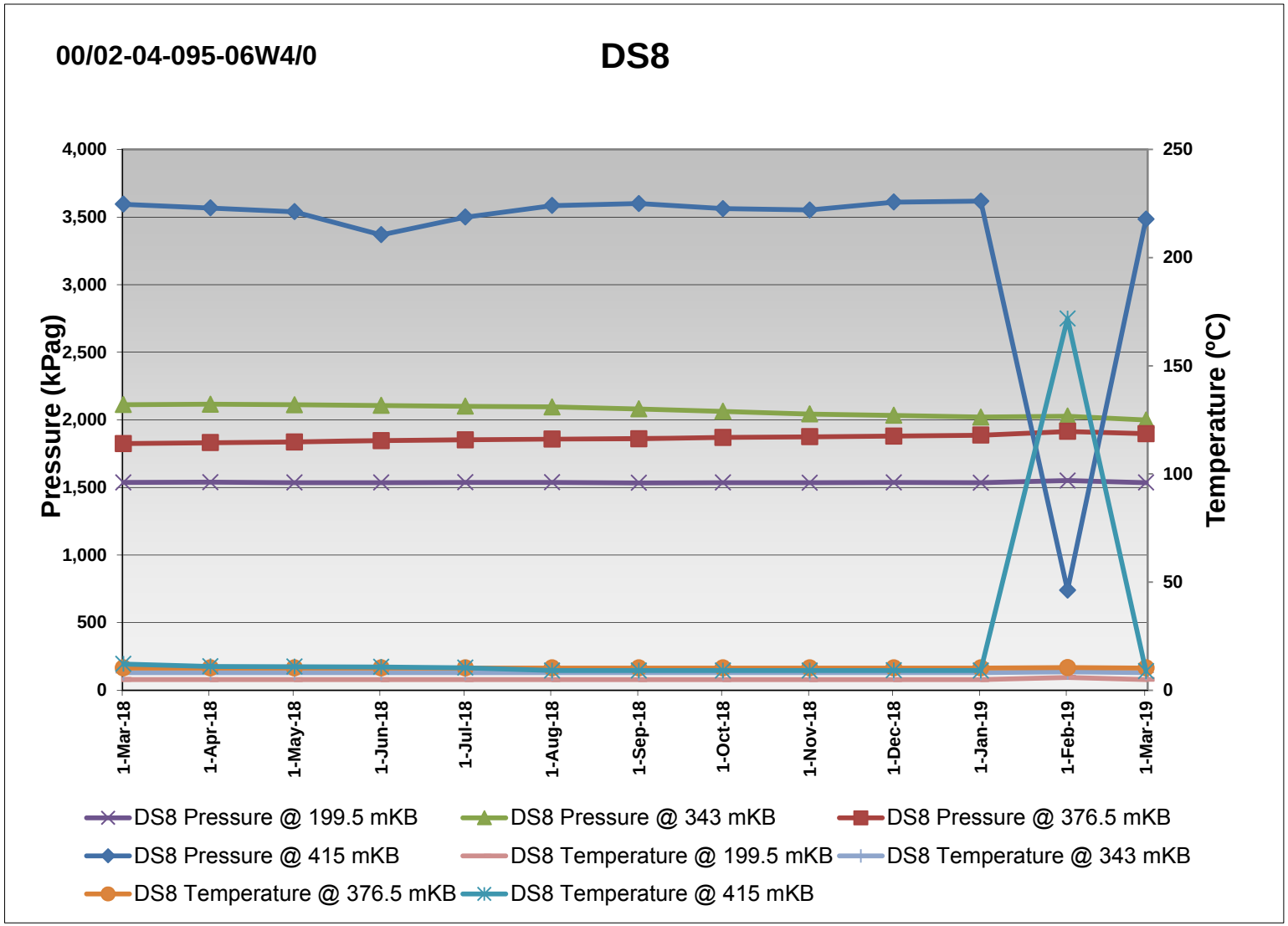
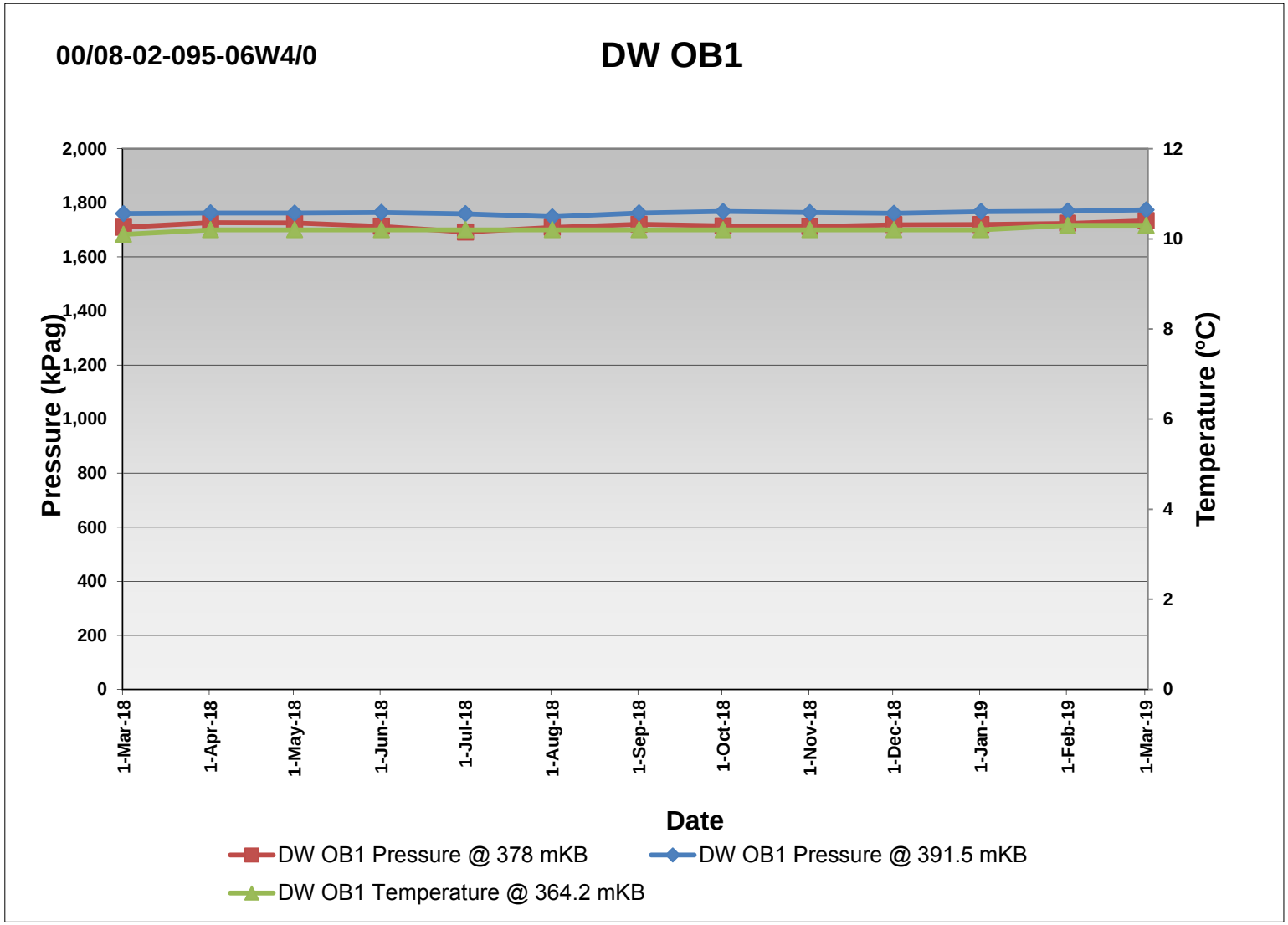


Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



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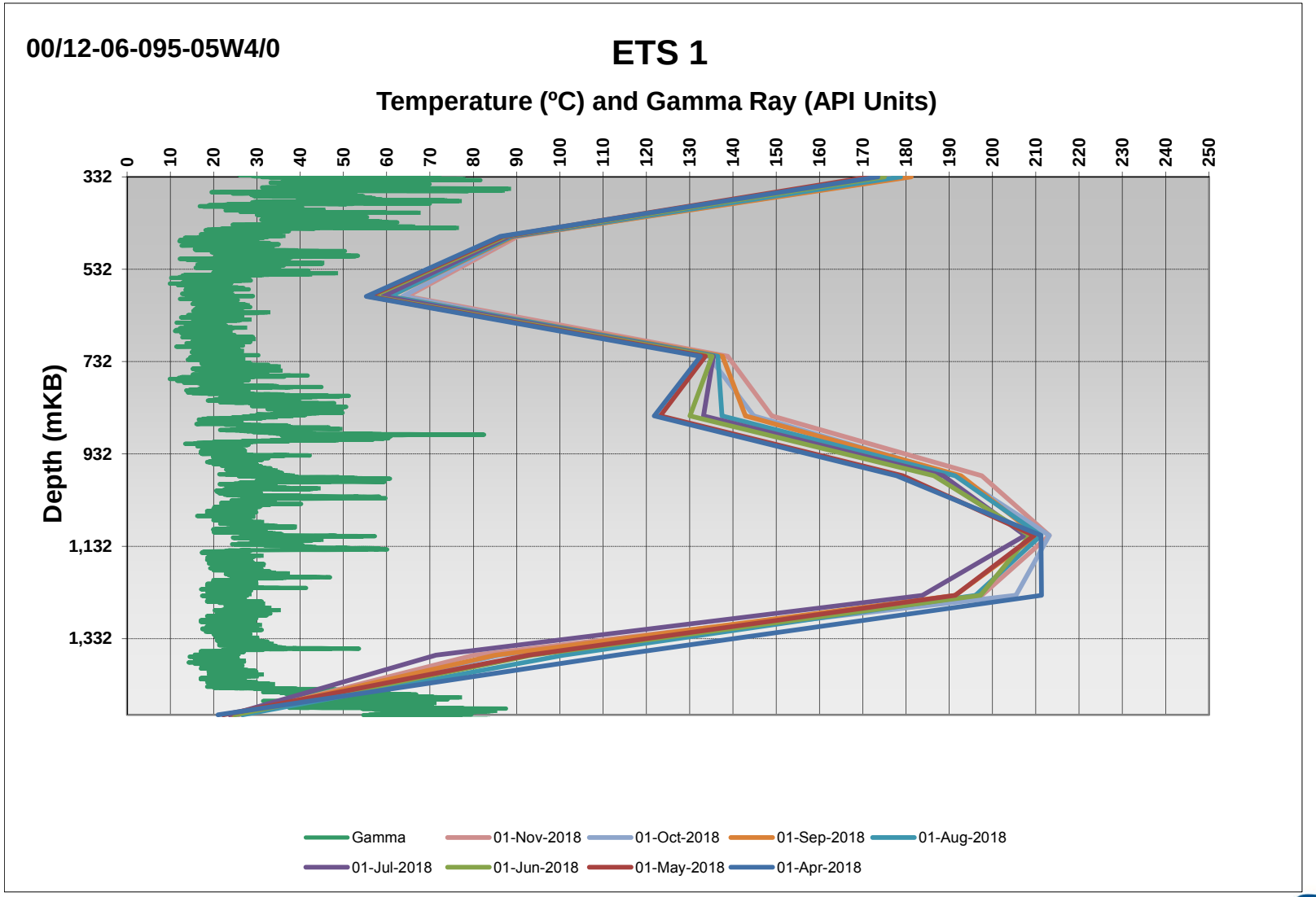

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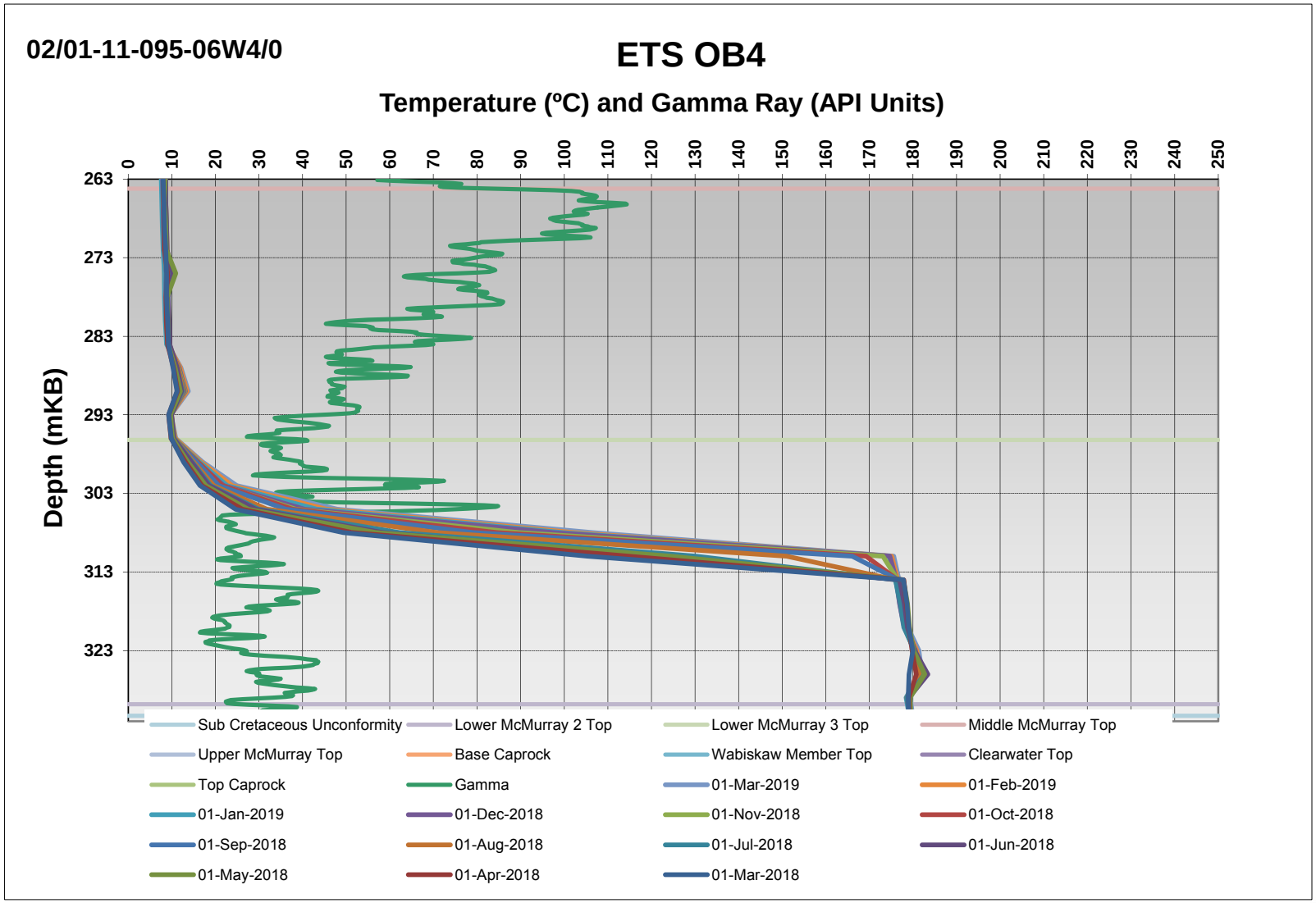
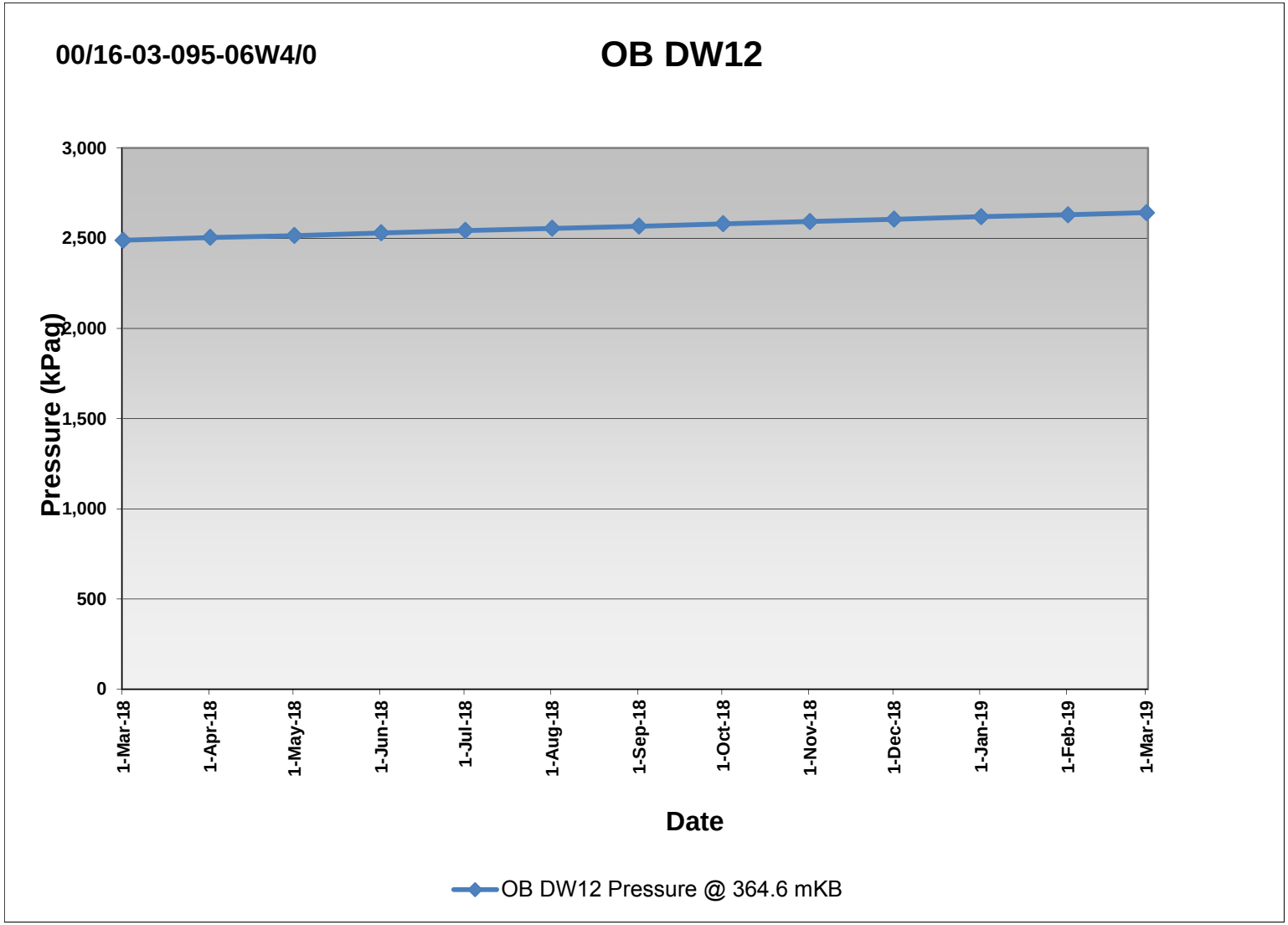


Piezometer Plots & Temperature vs Depth Plots



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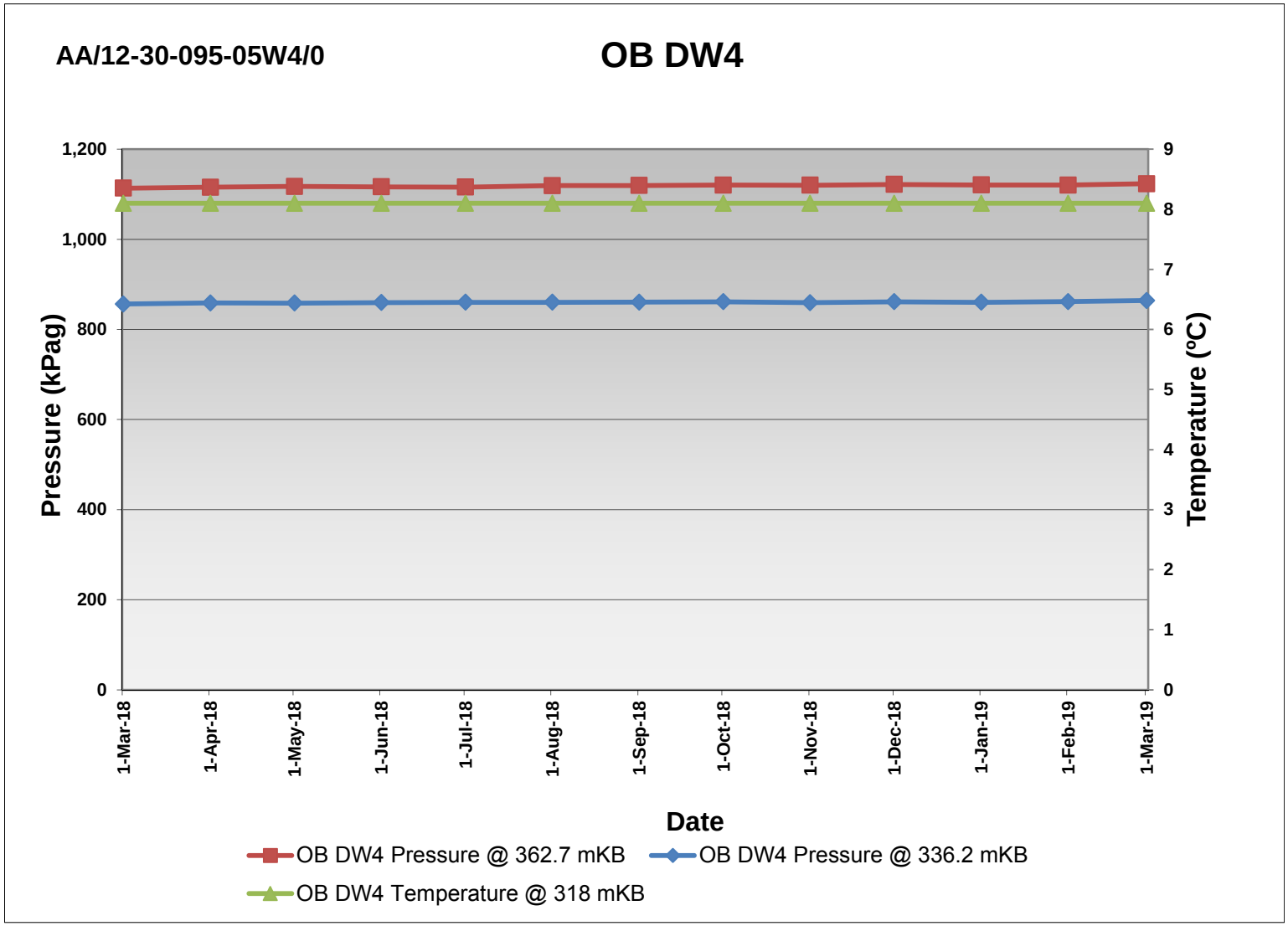

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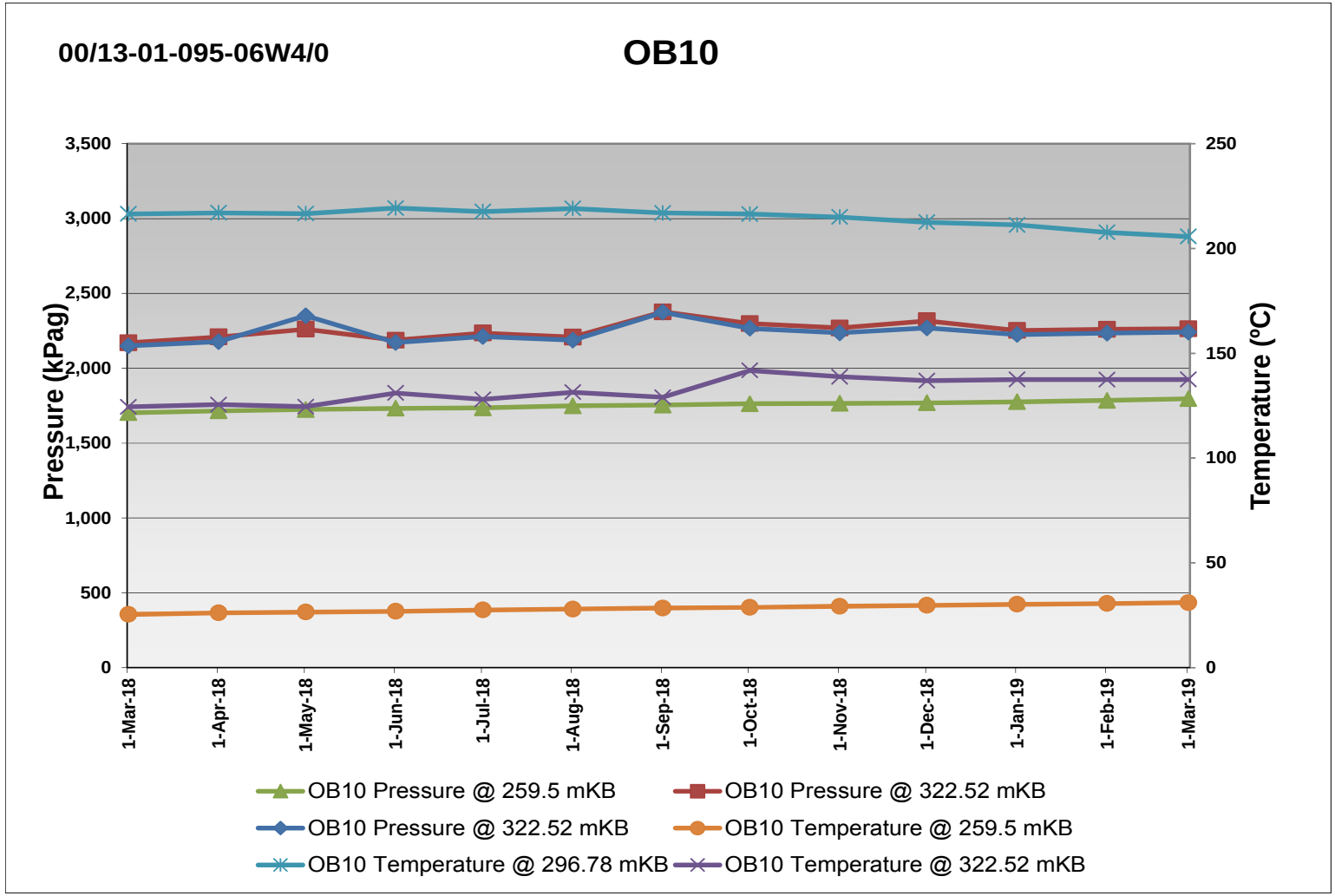

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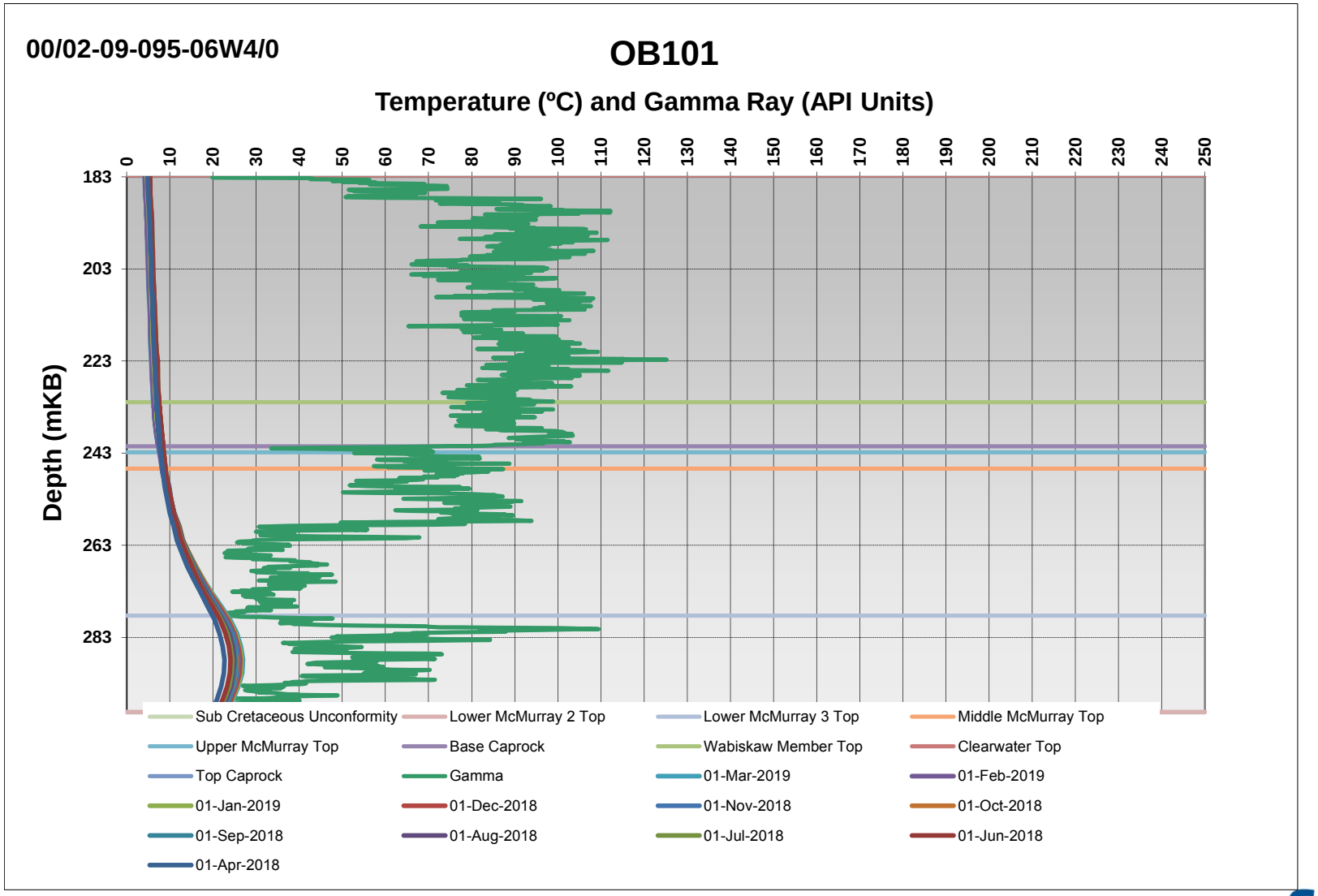

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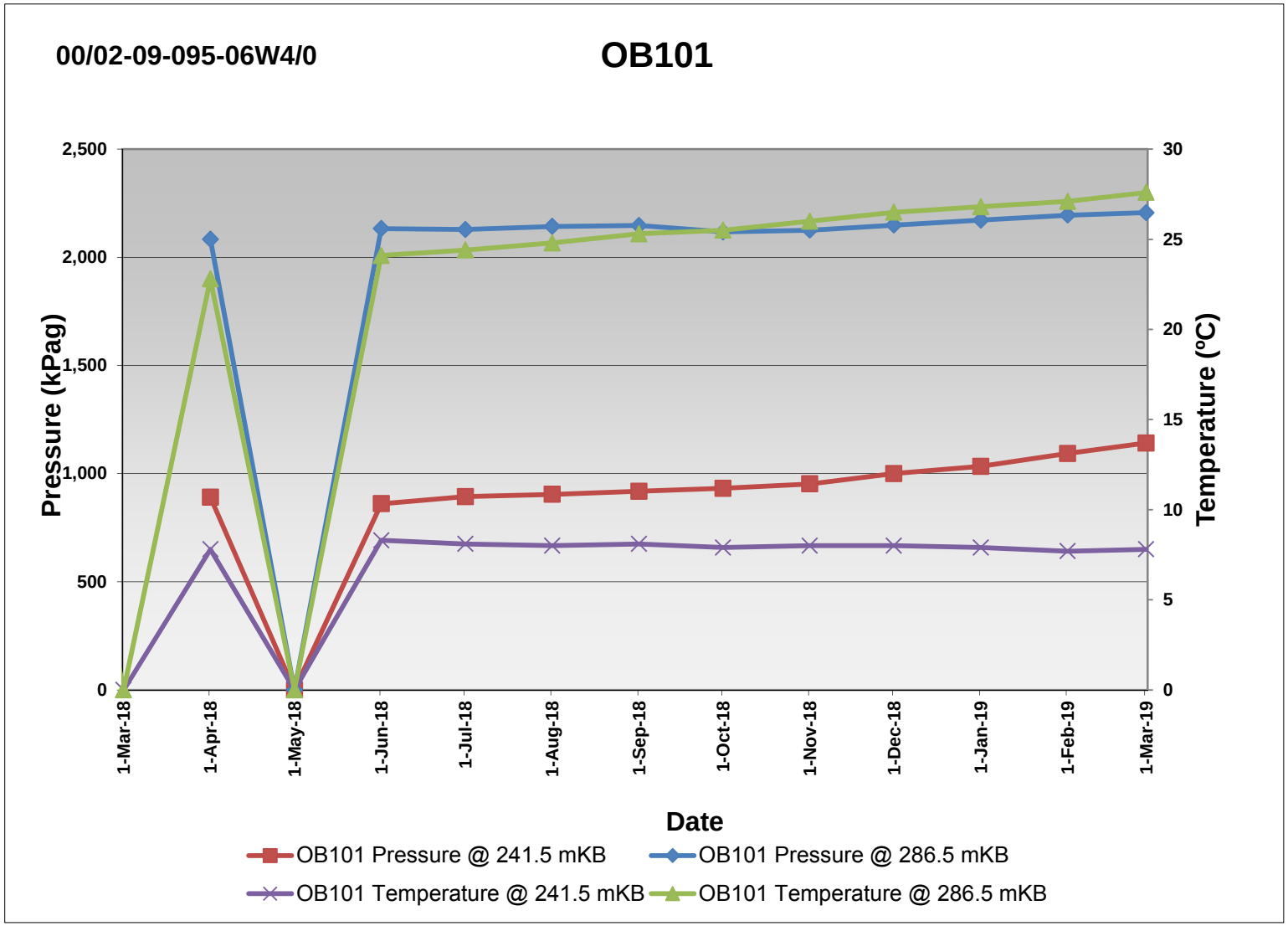

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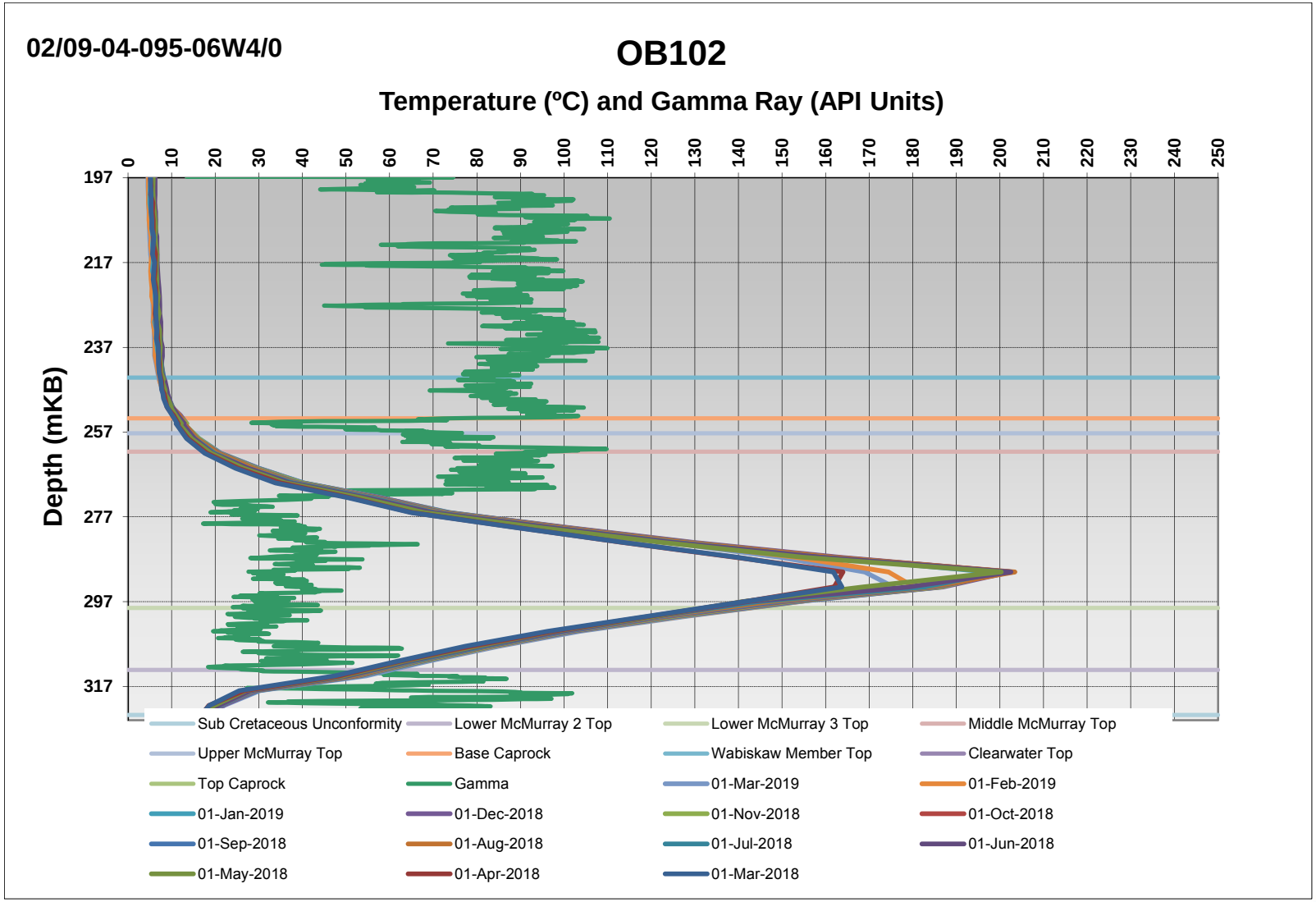

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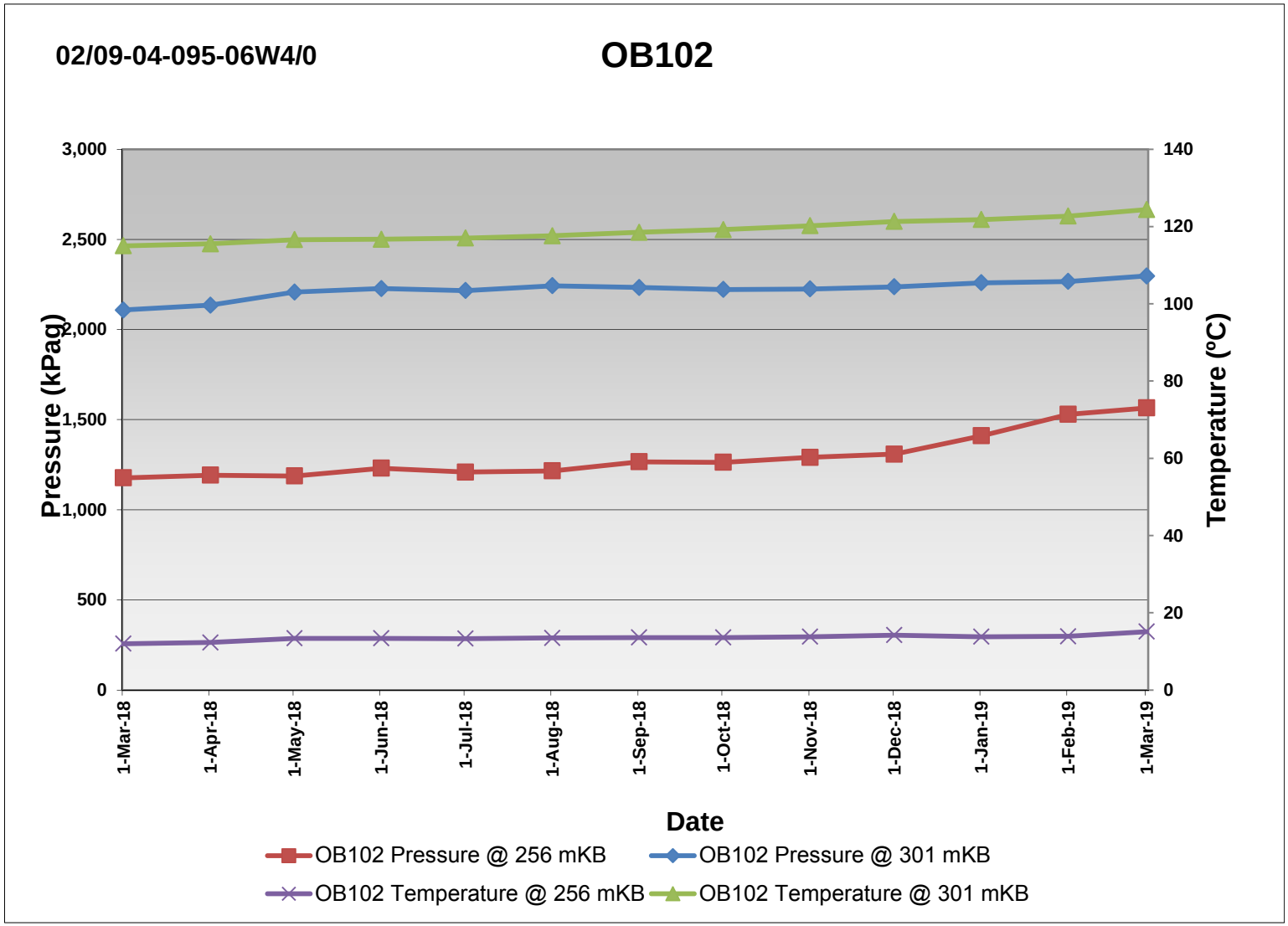

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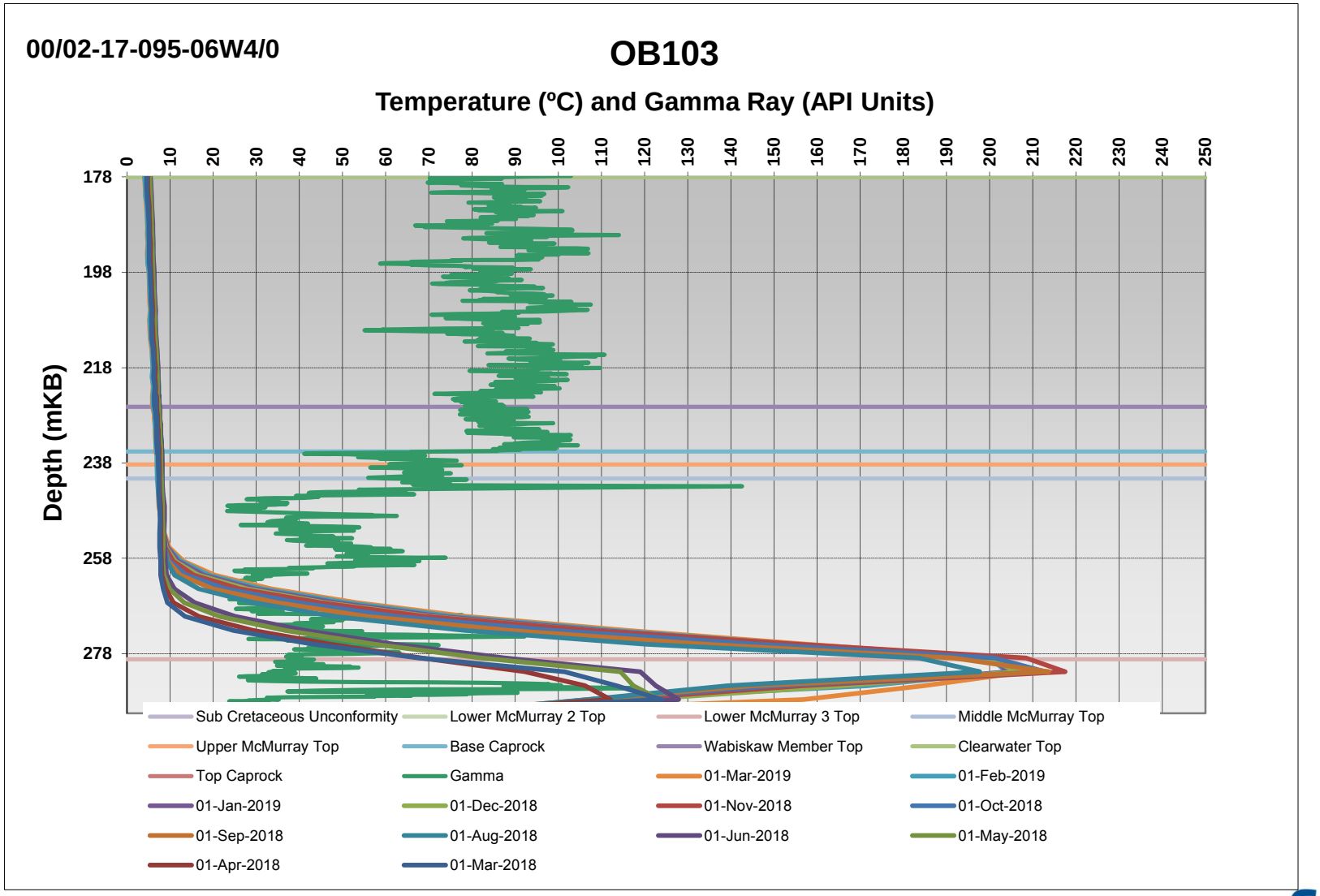

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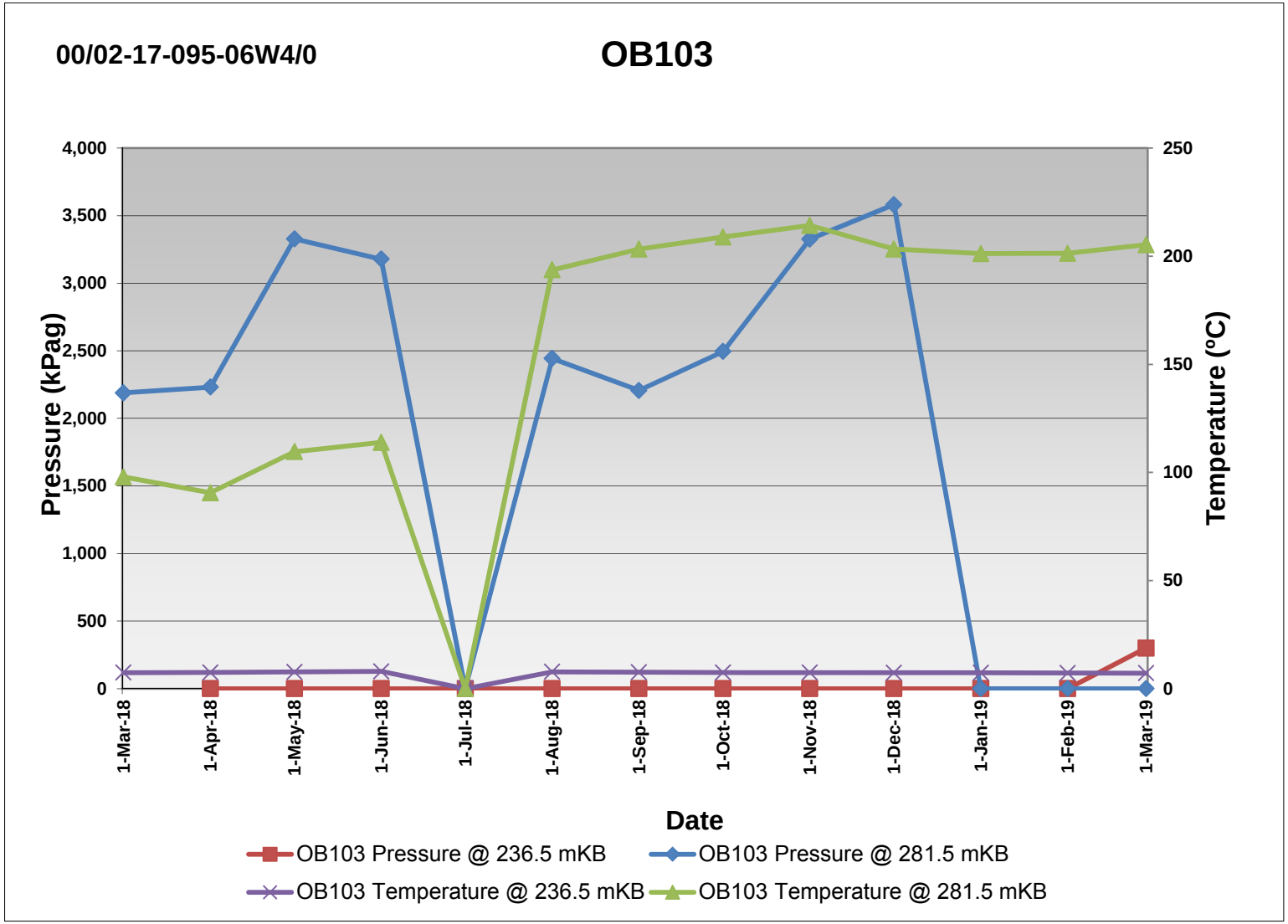

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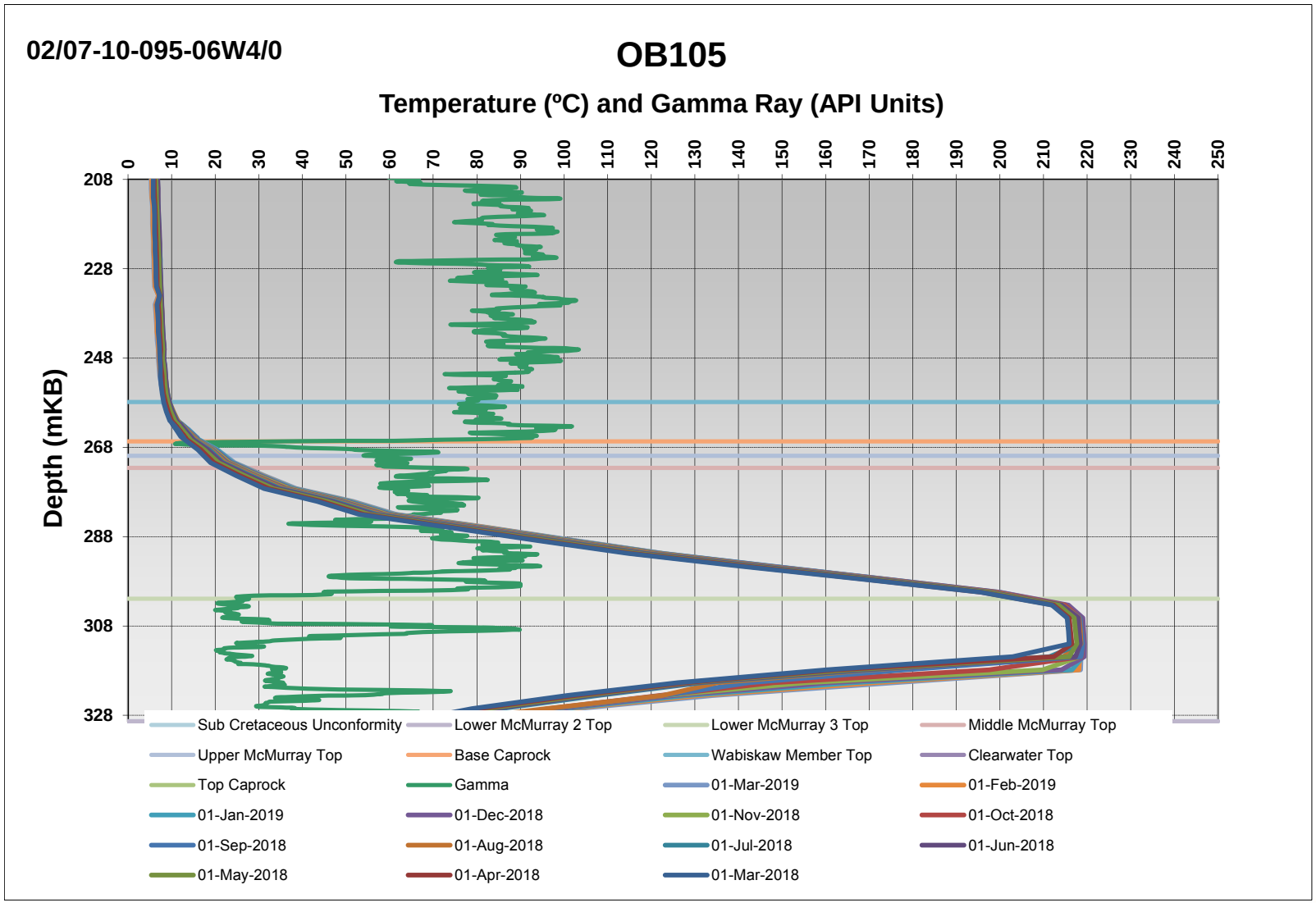

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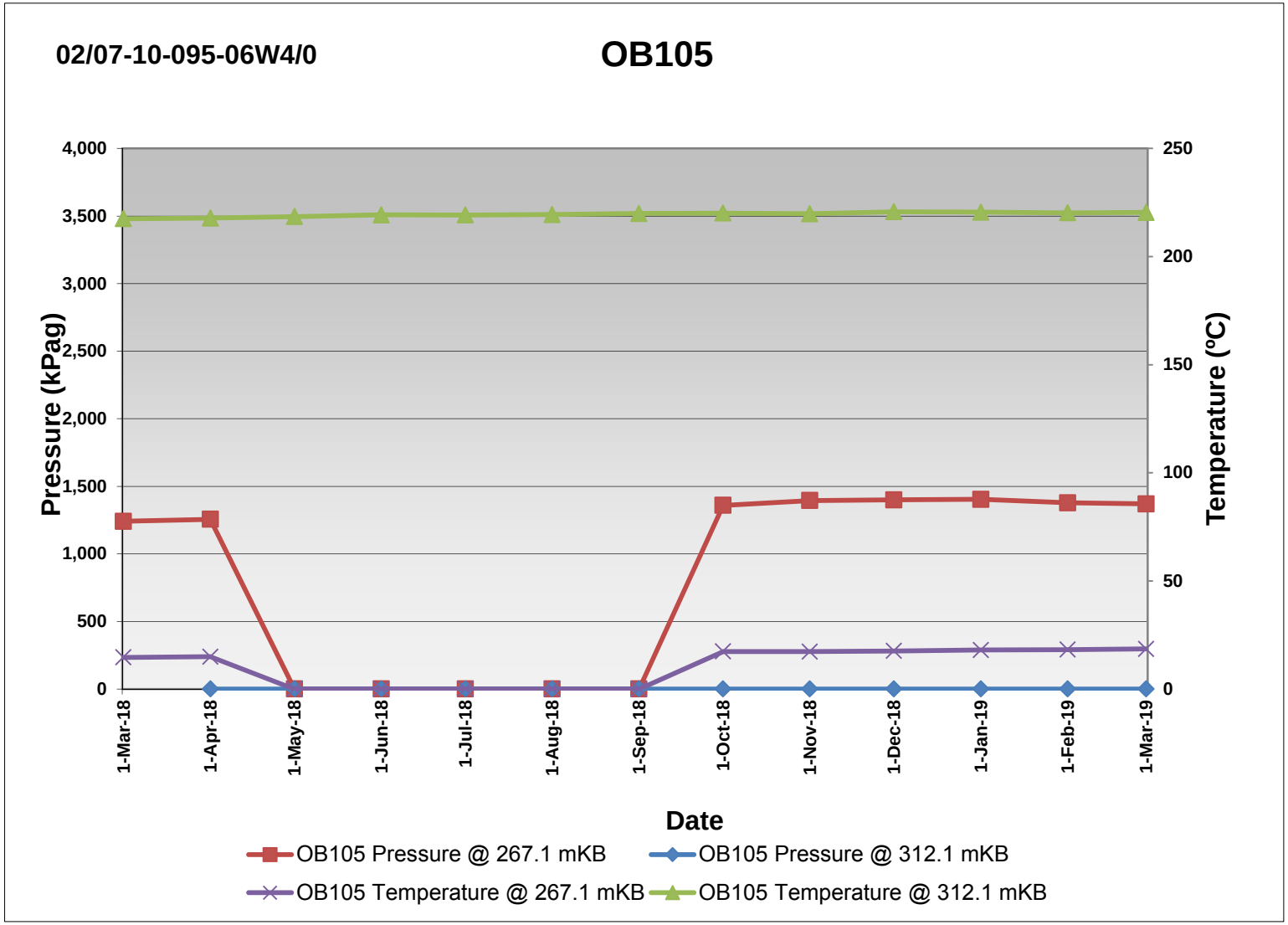

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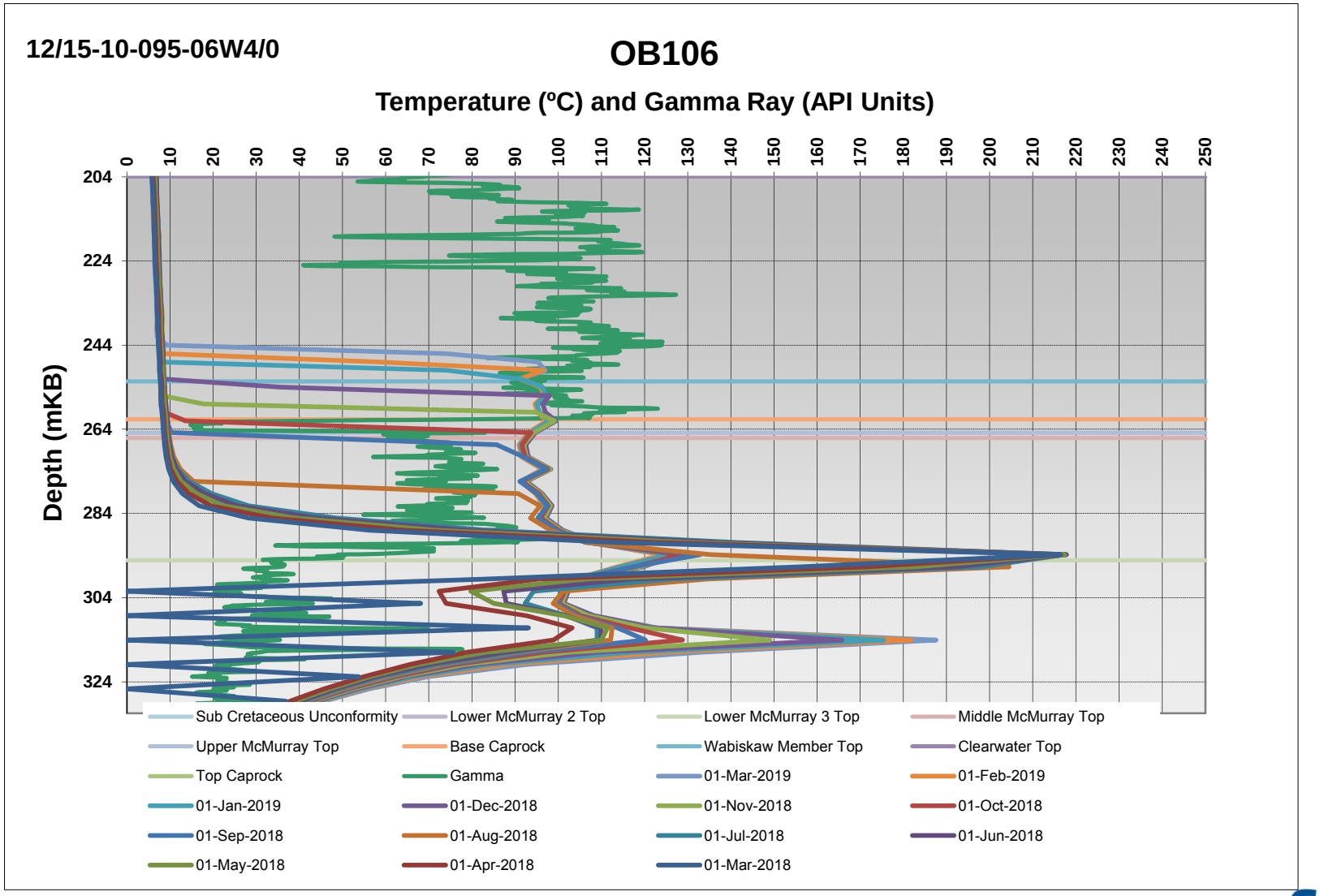

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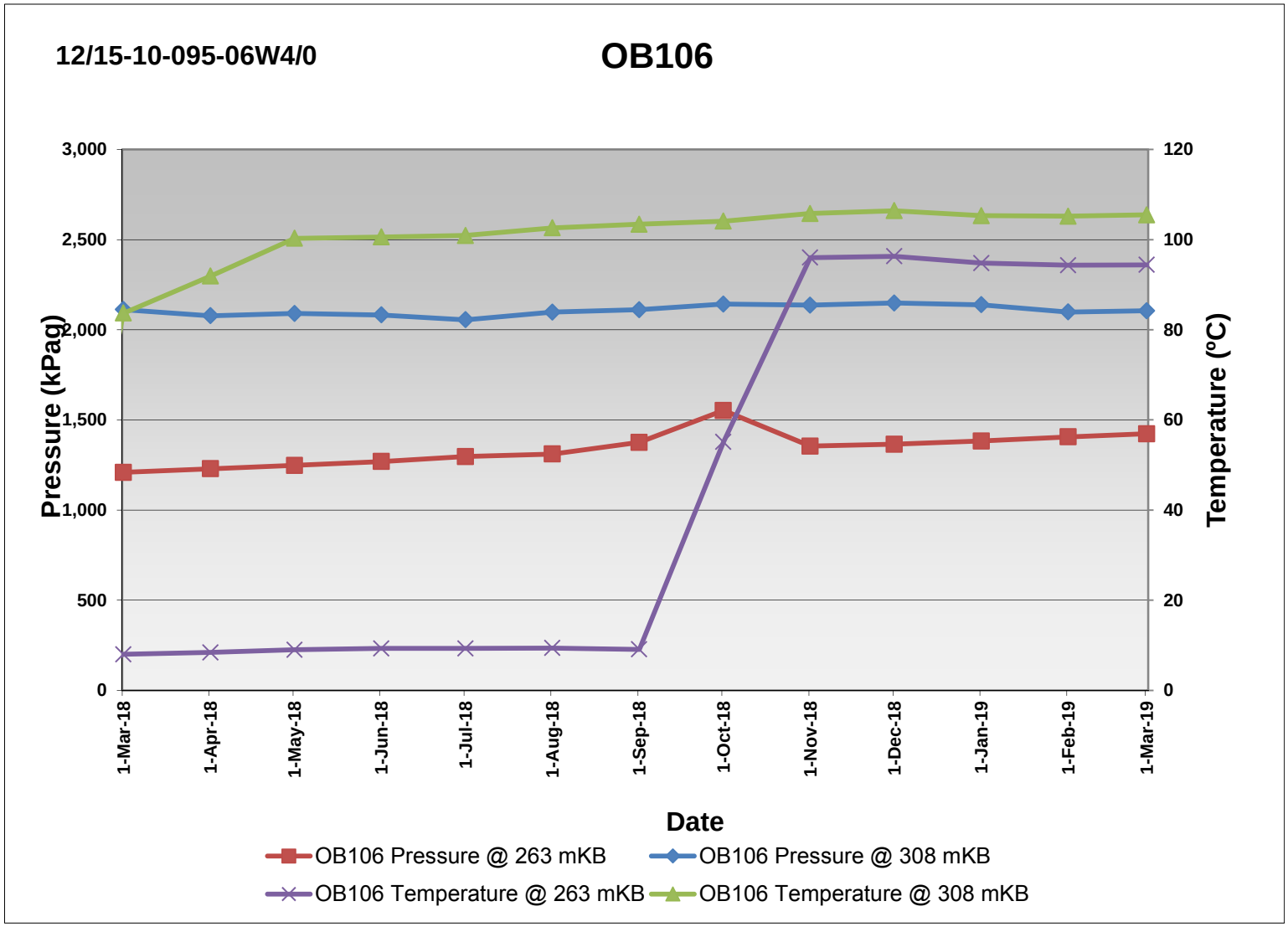

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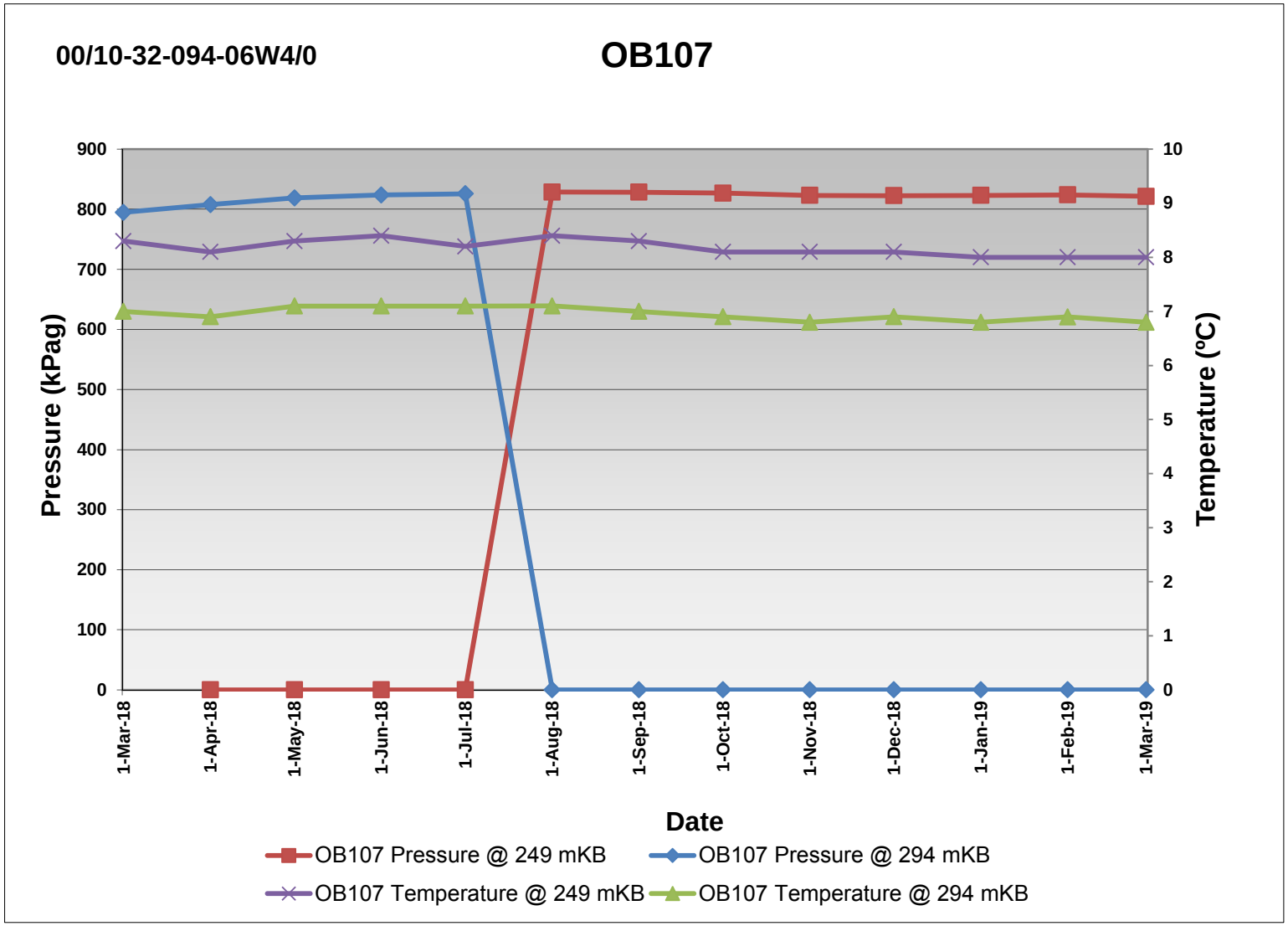

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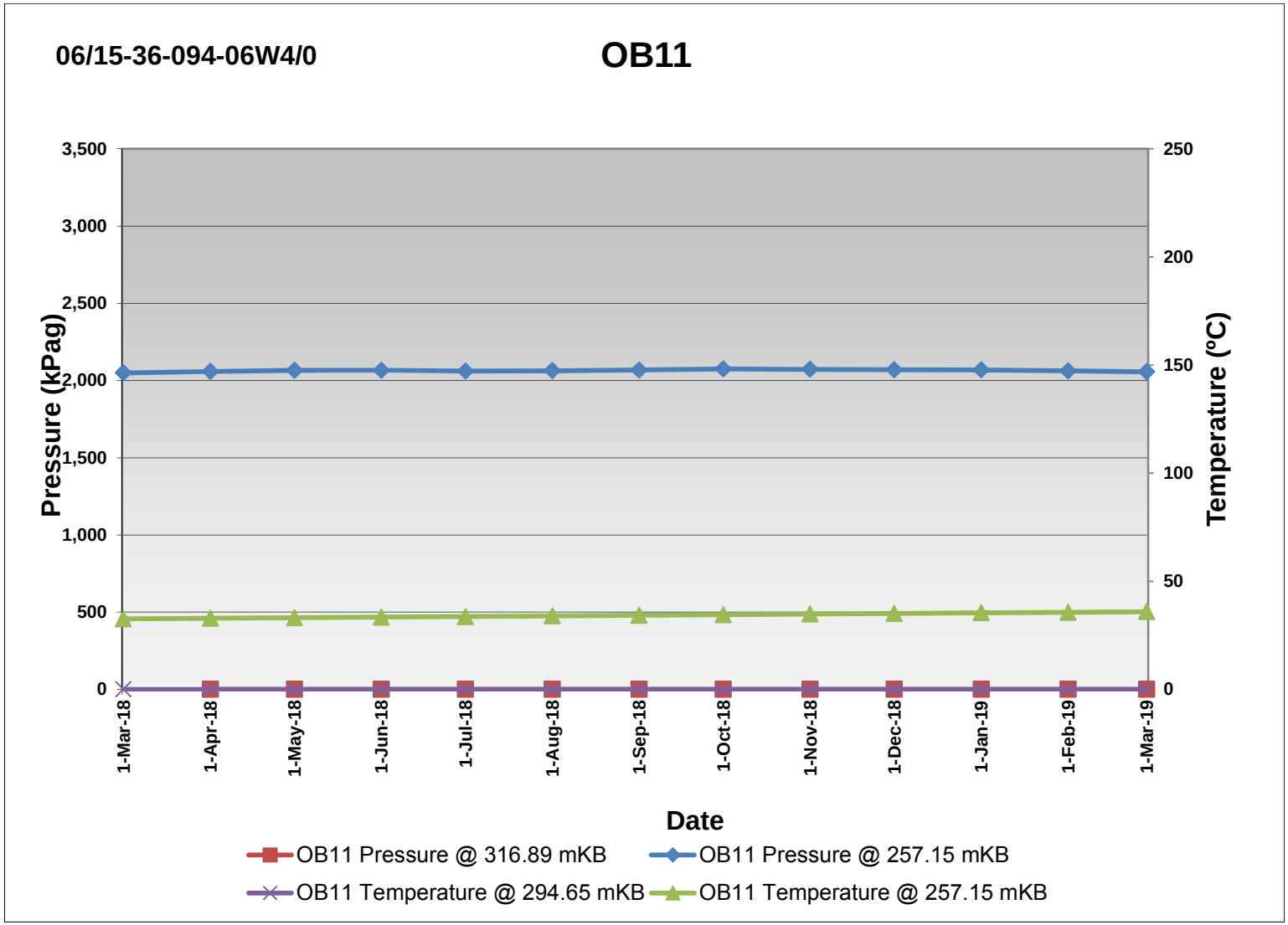

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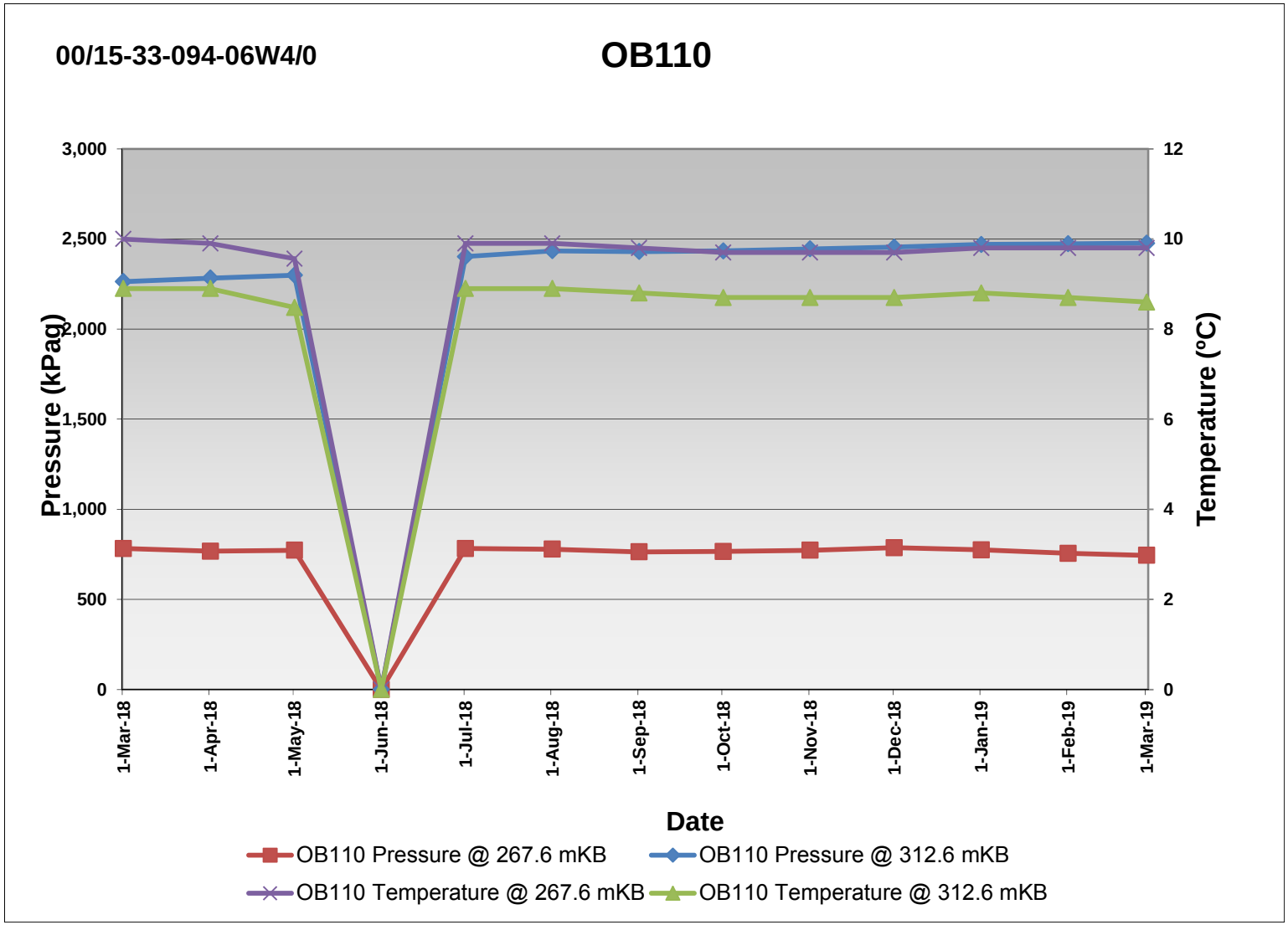

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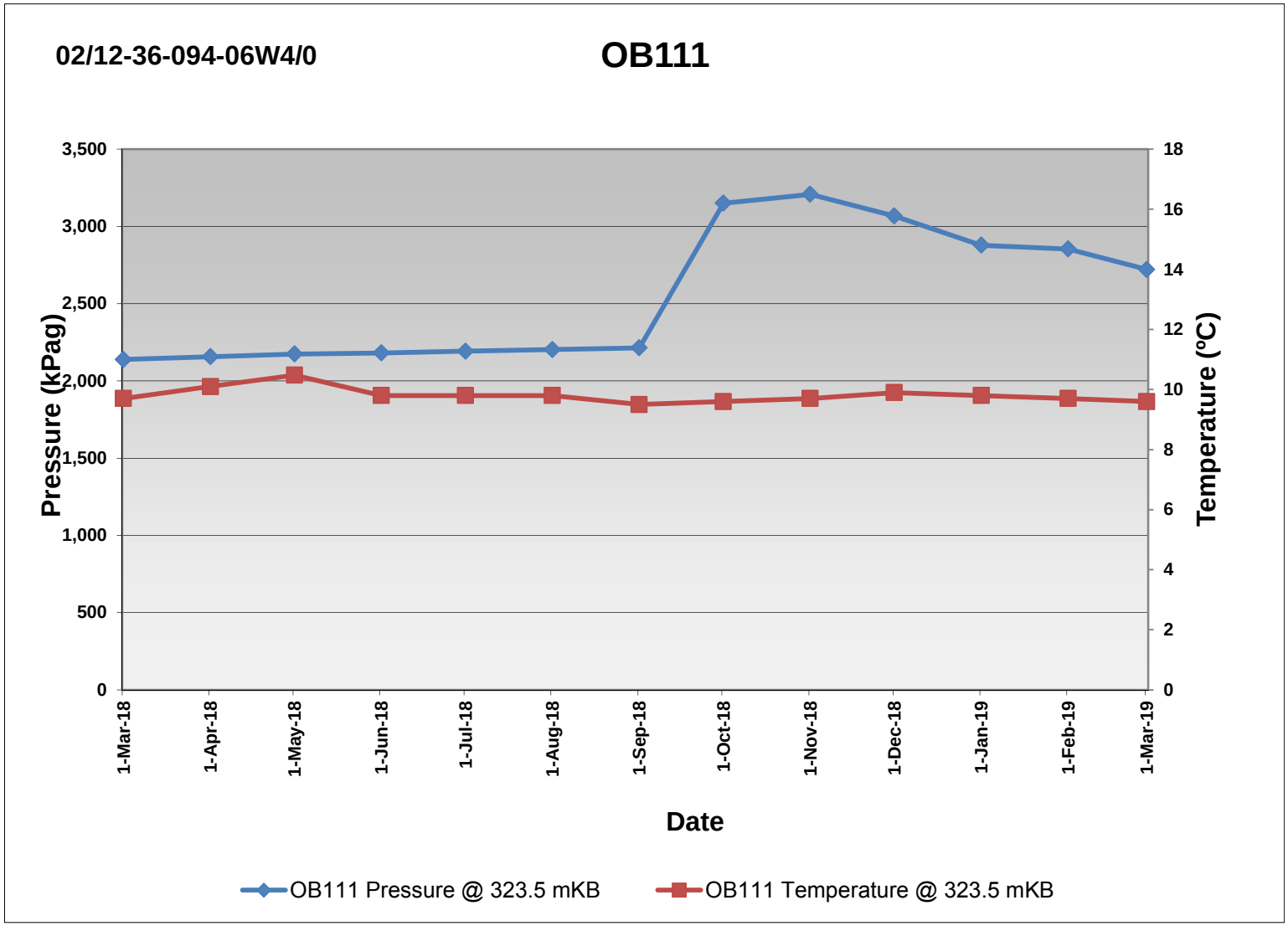

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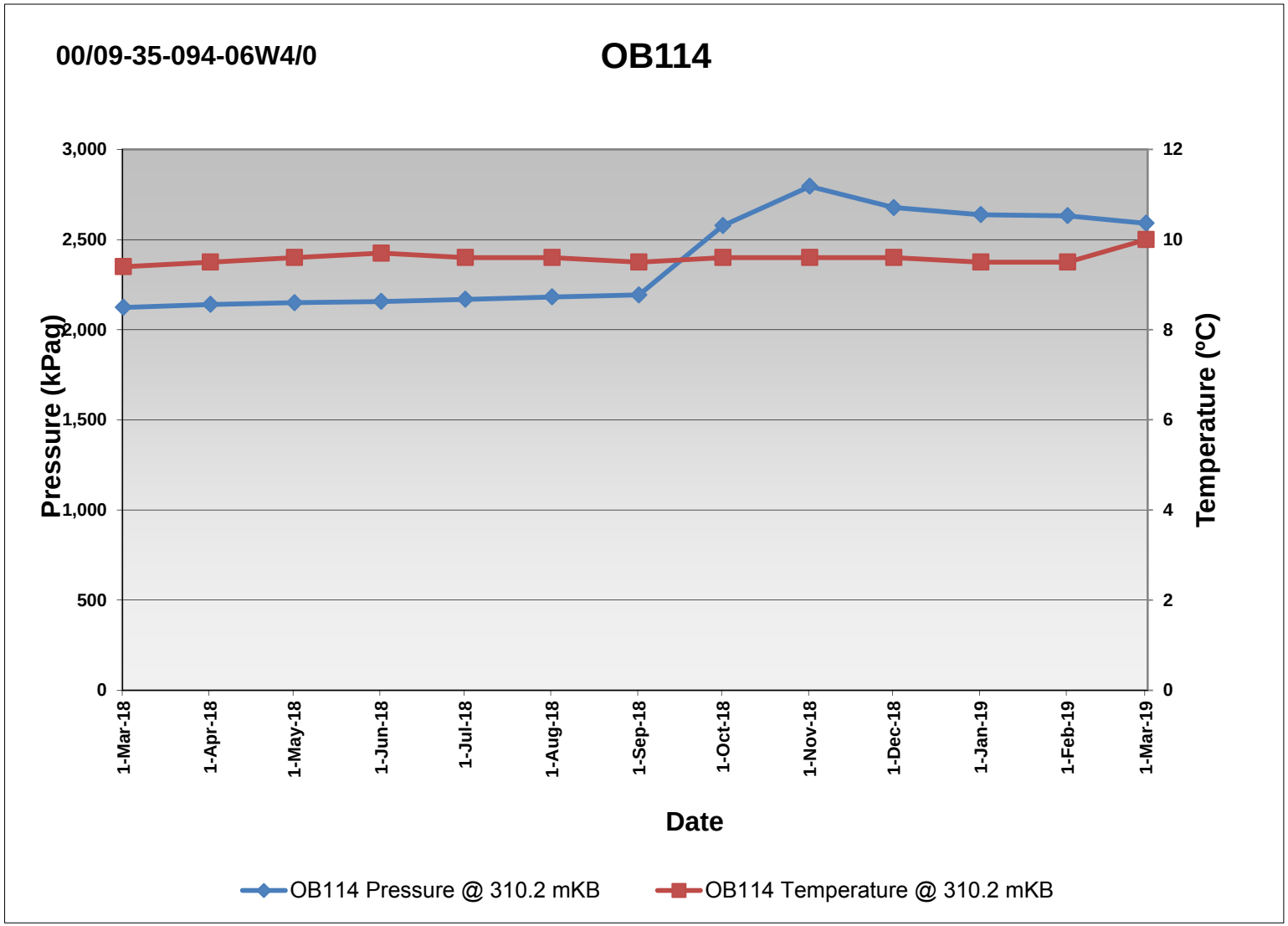

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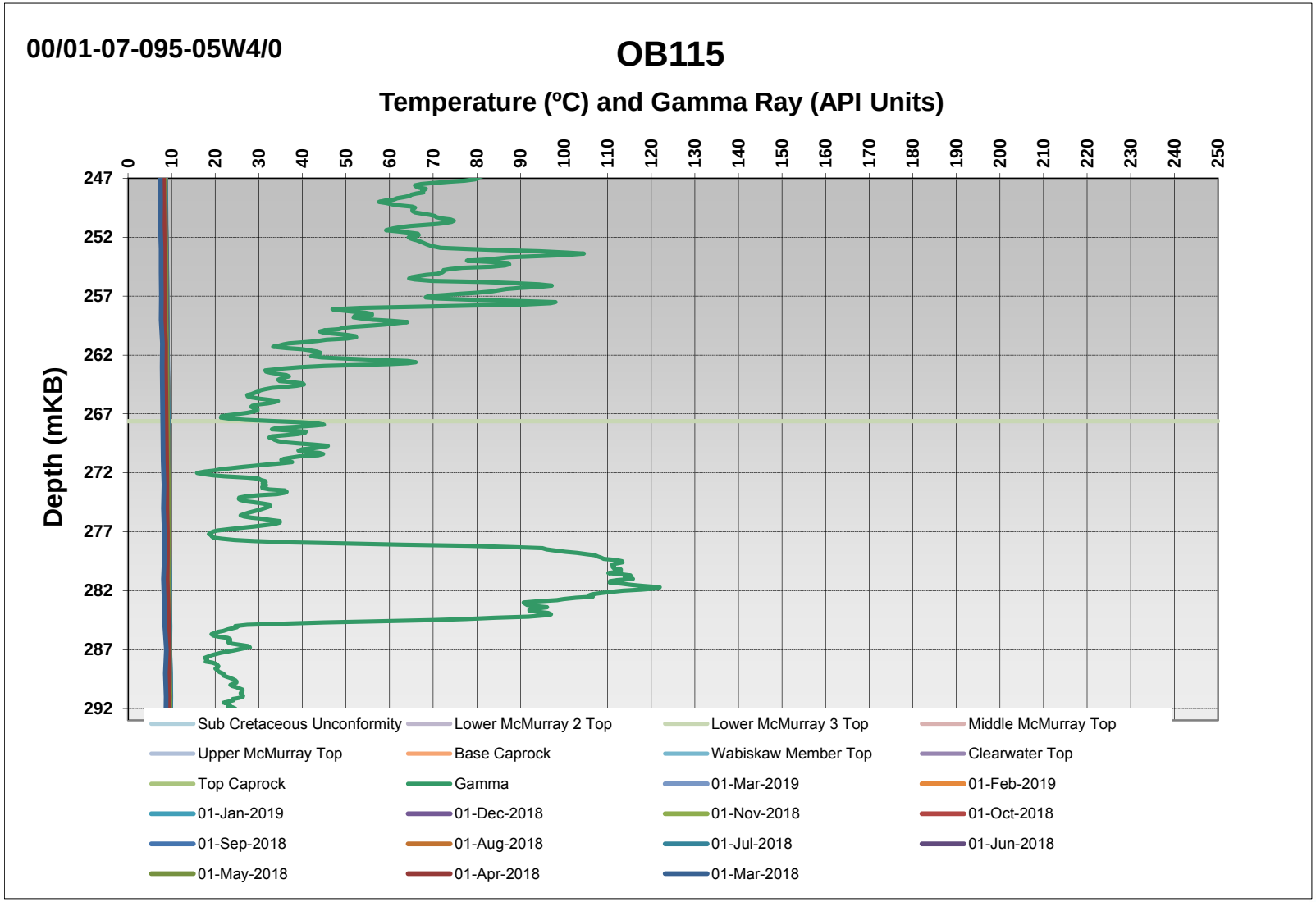

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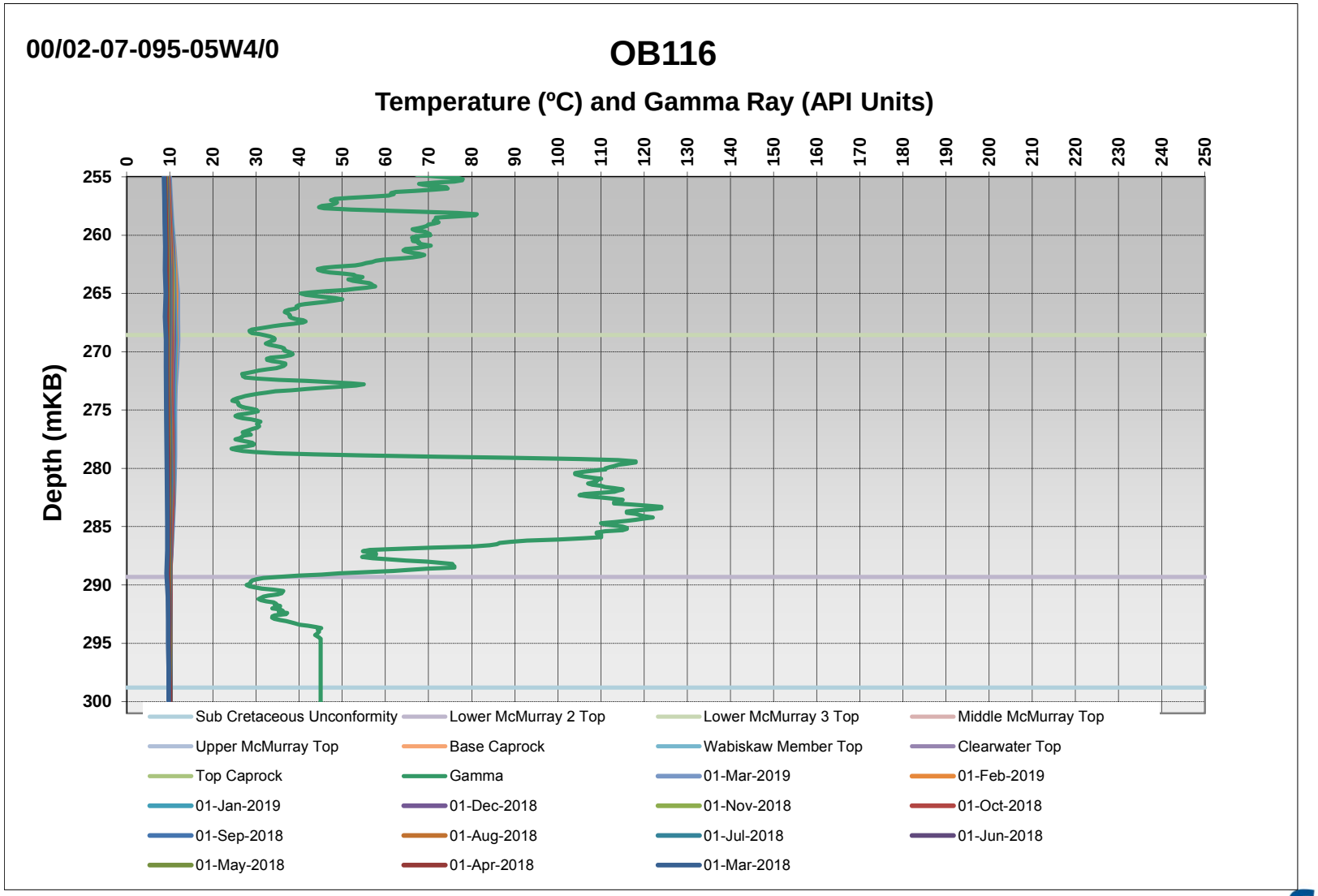

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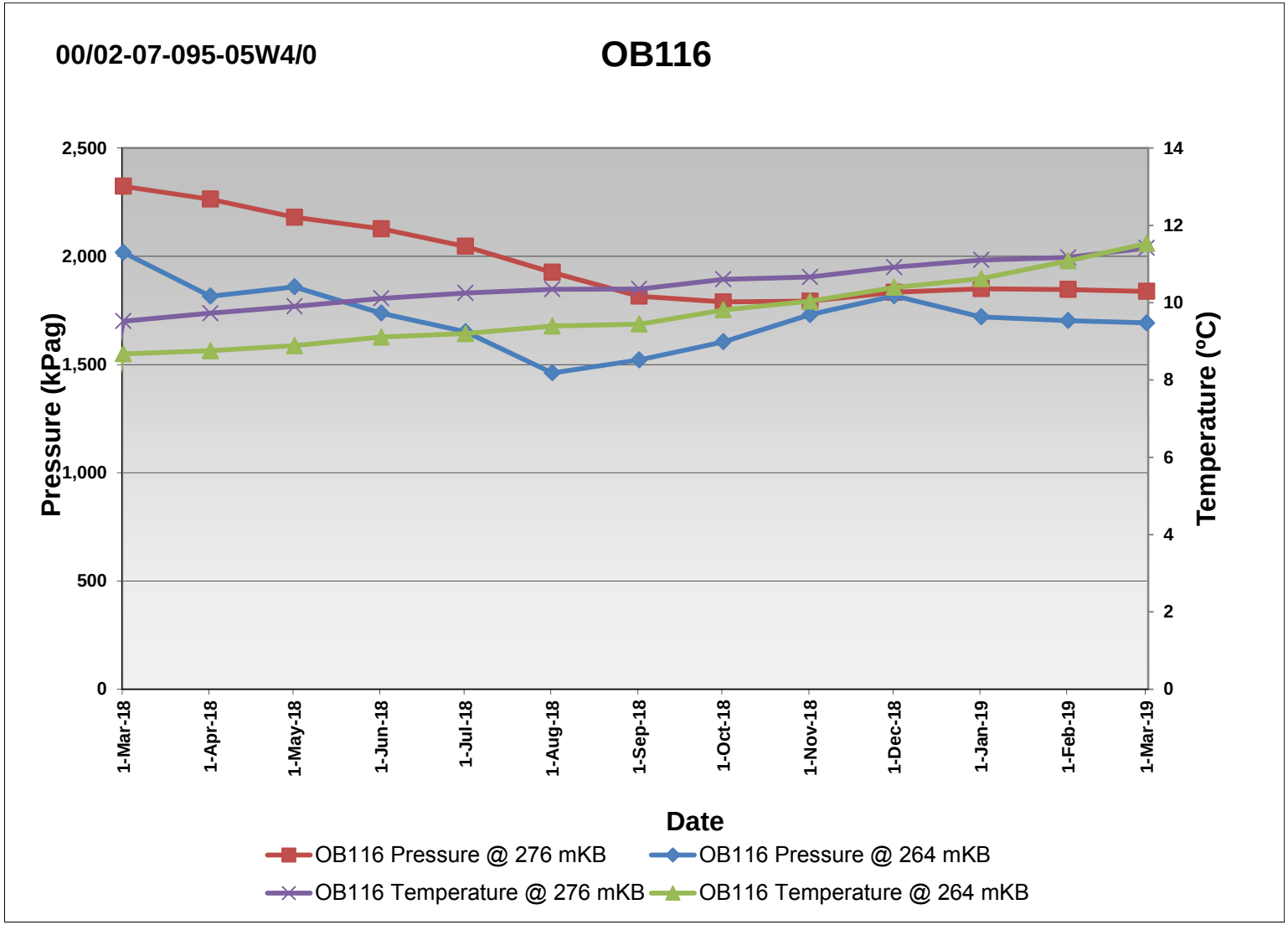

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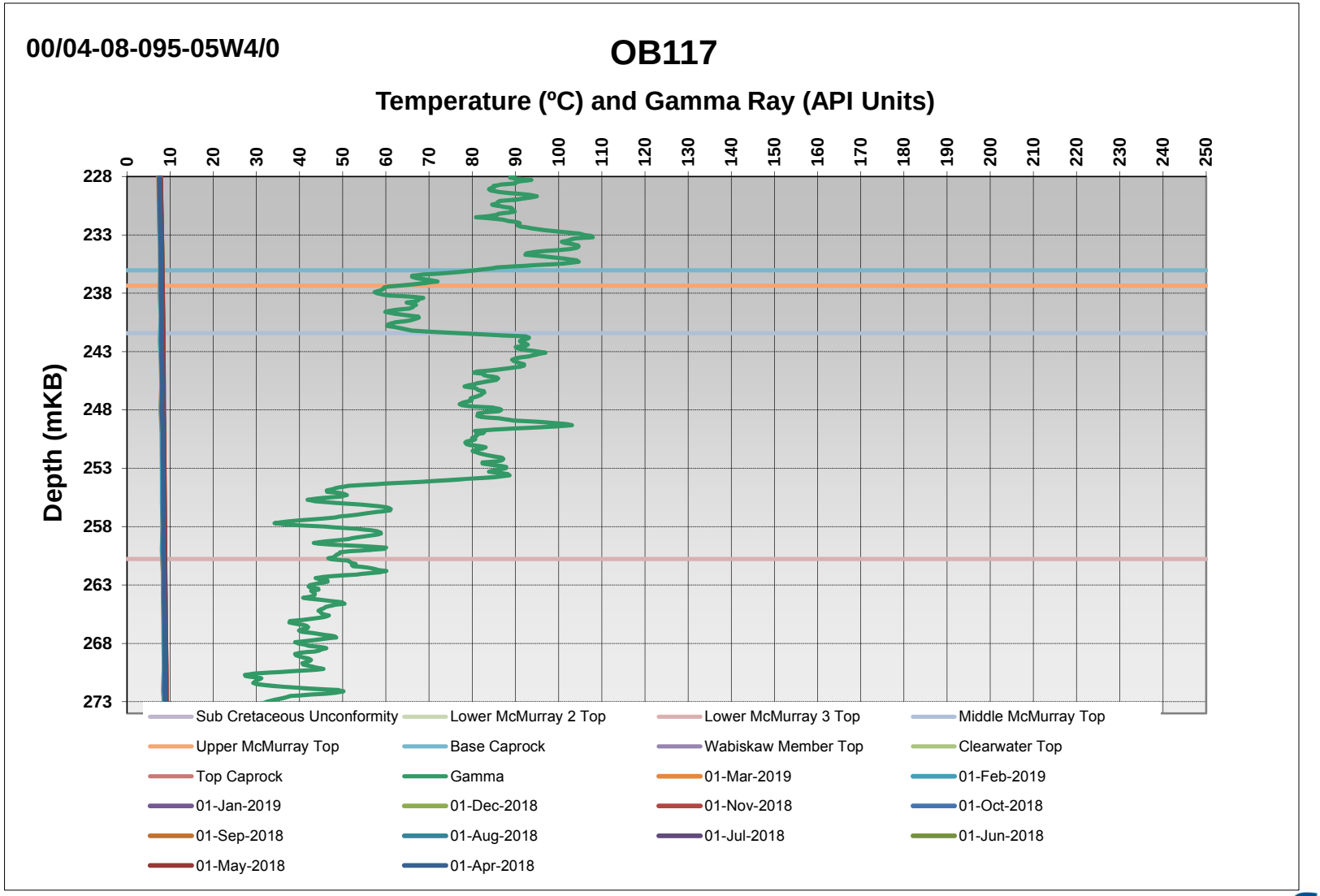

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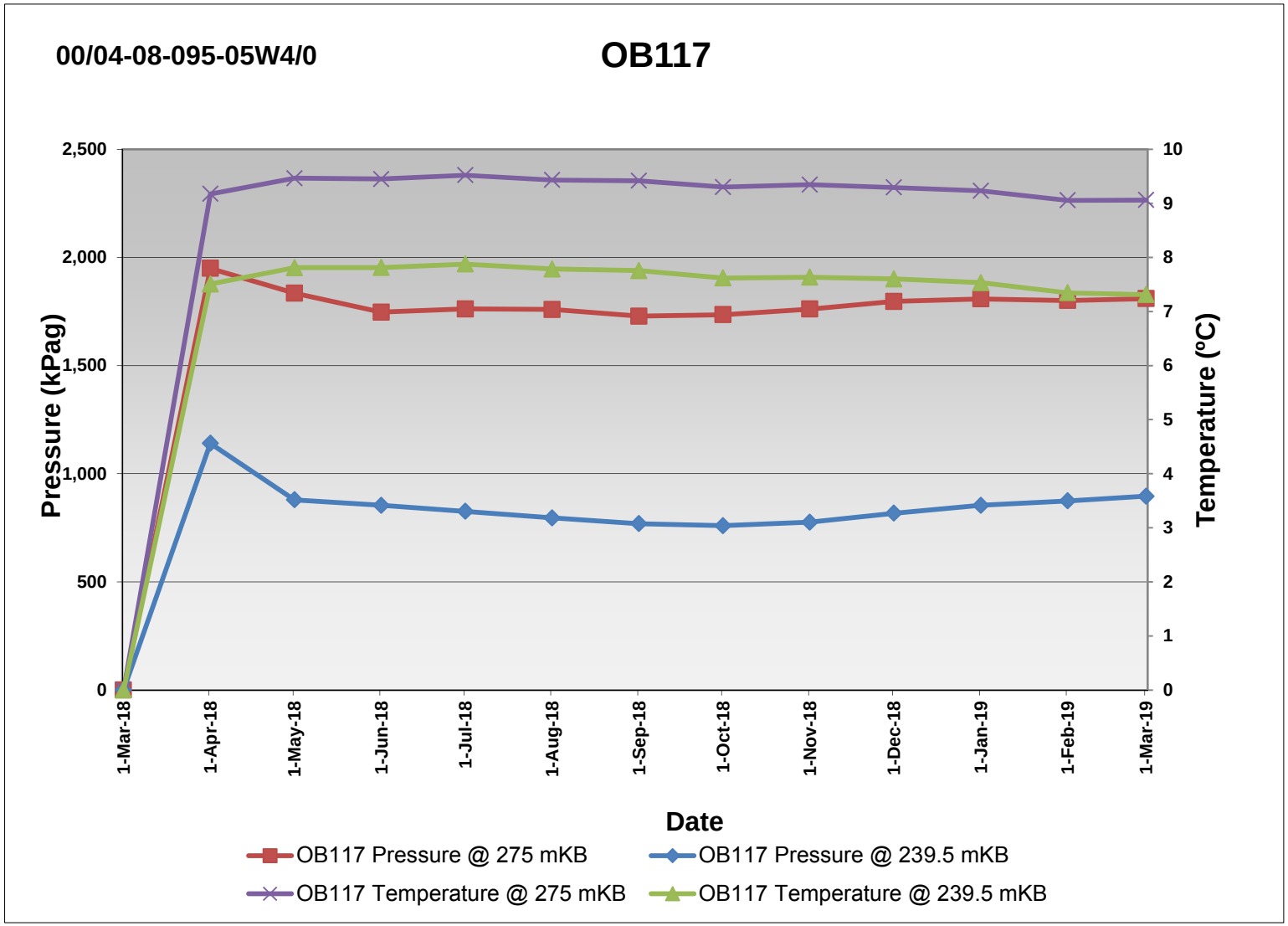

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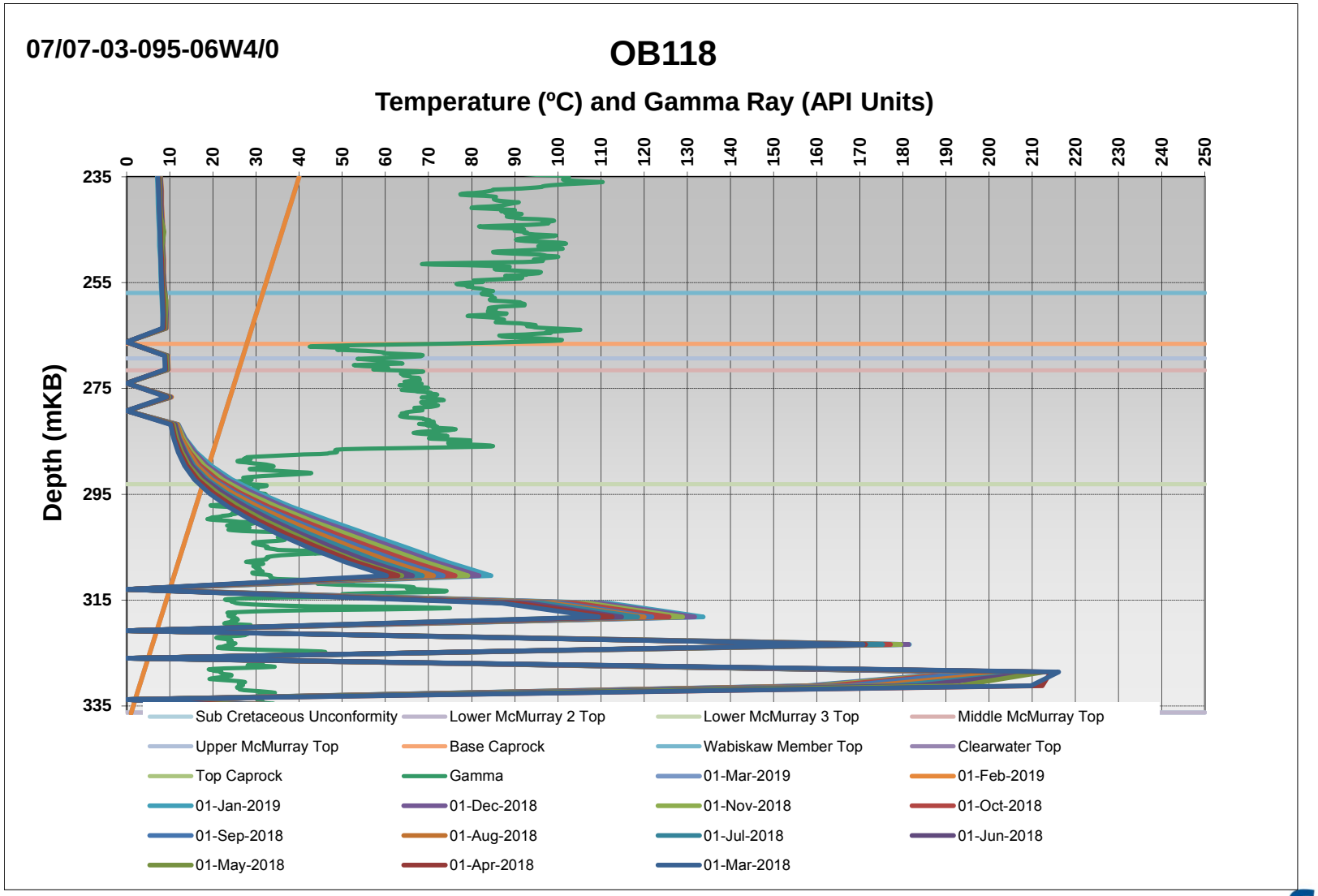

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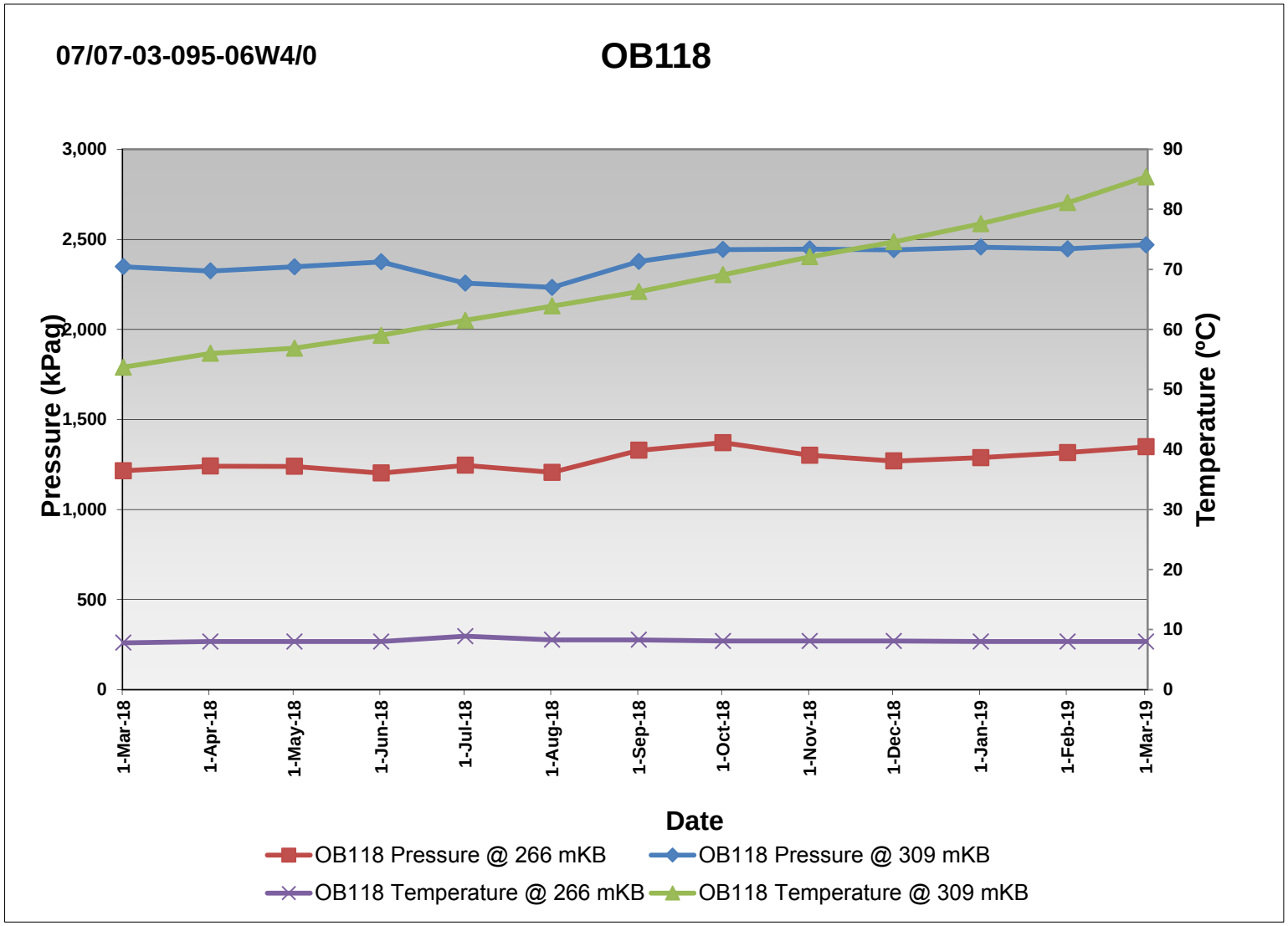

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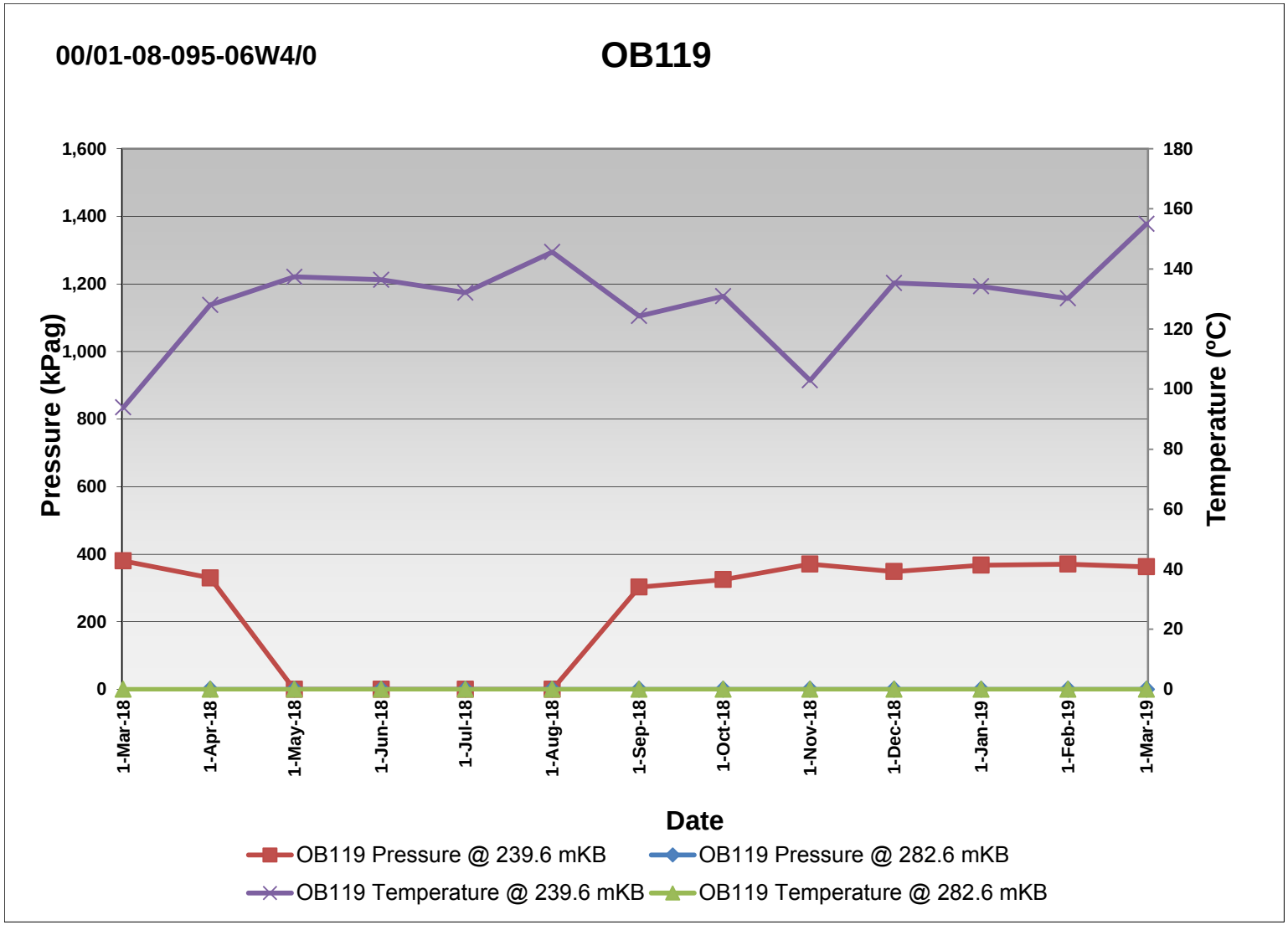

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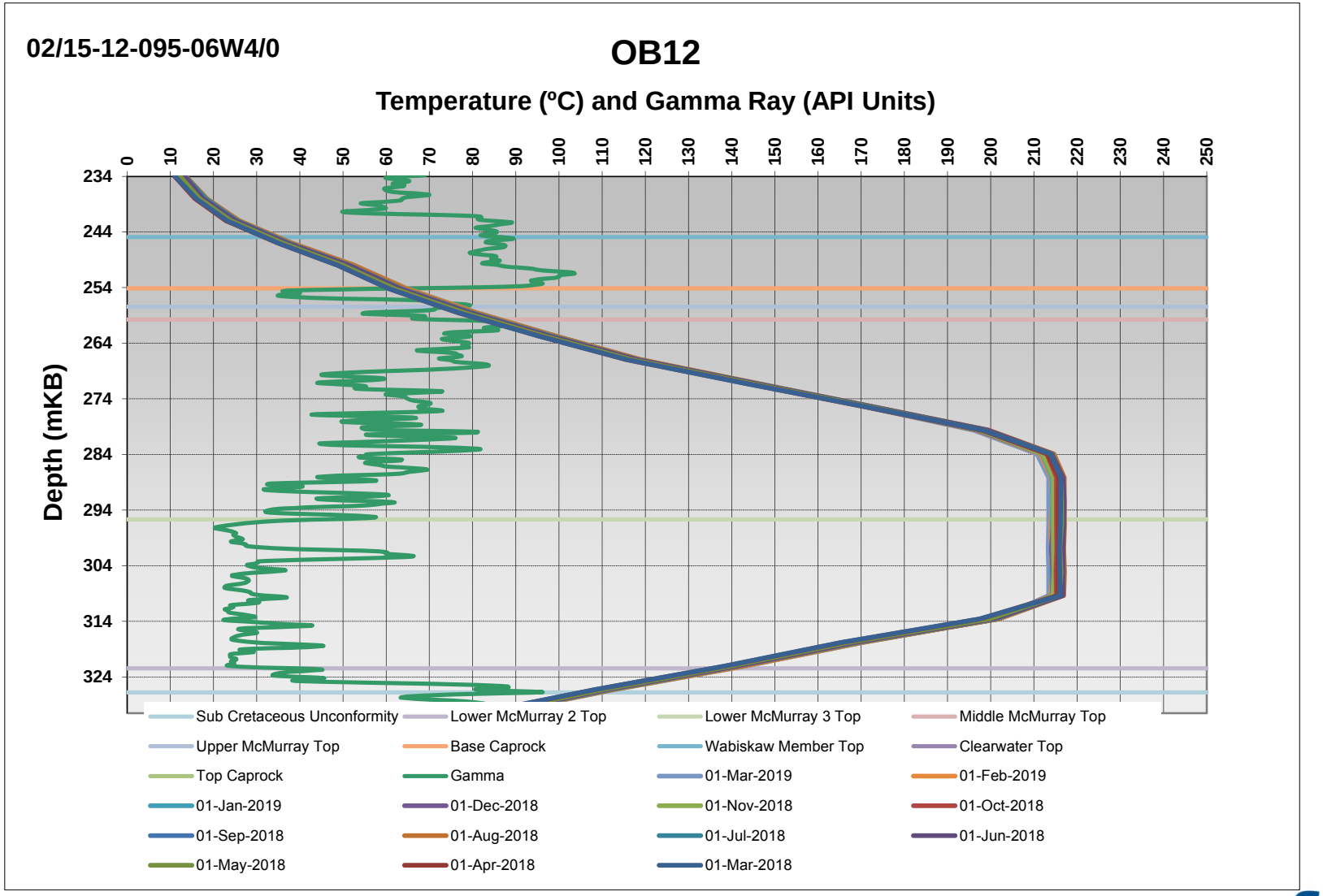

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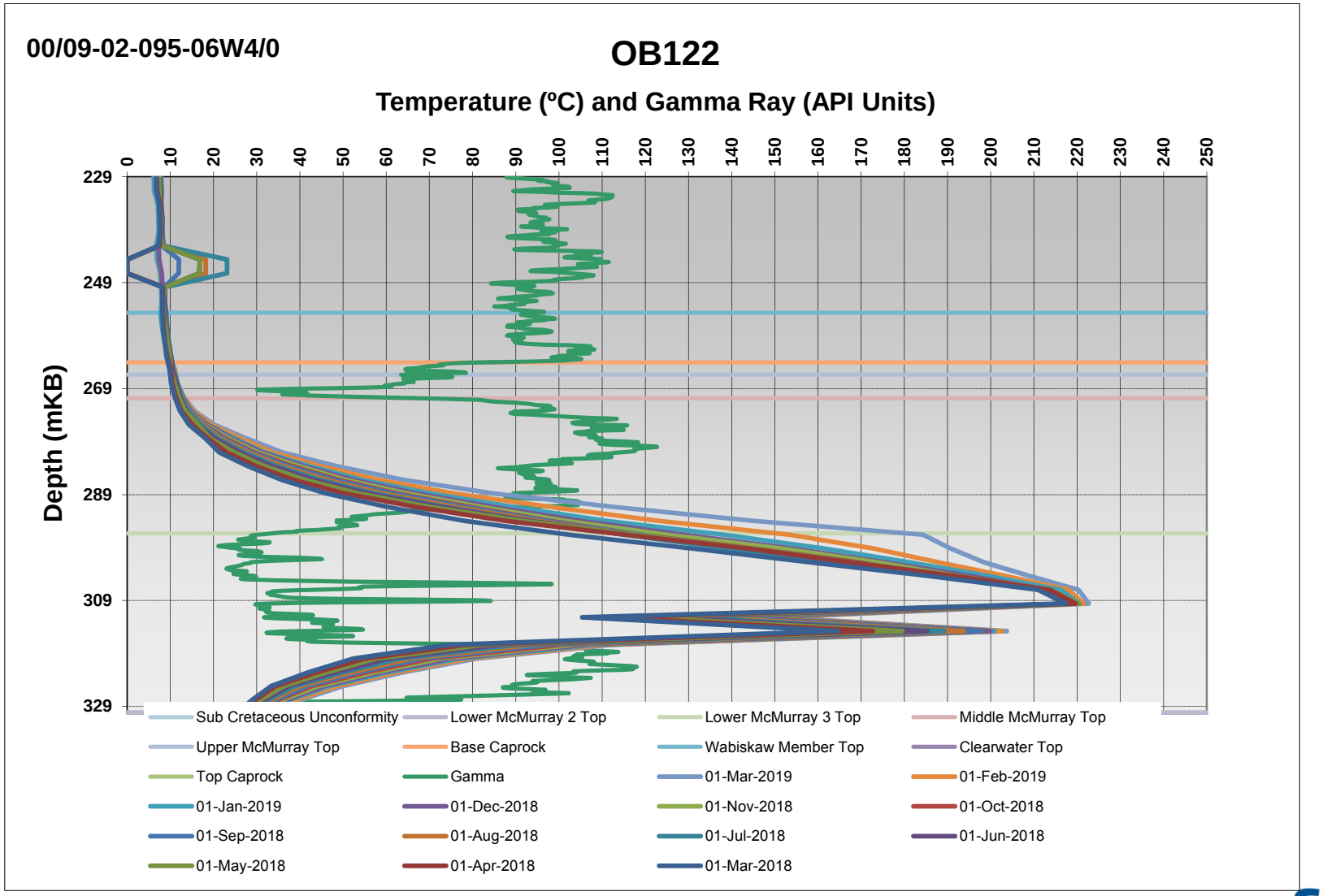

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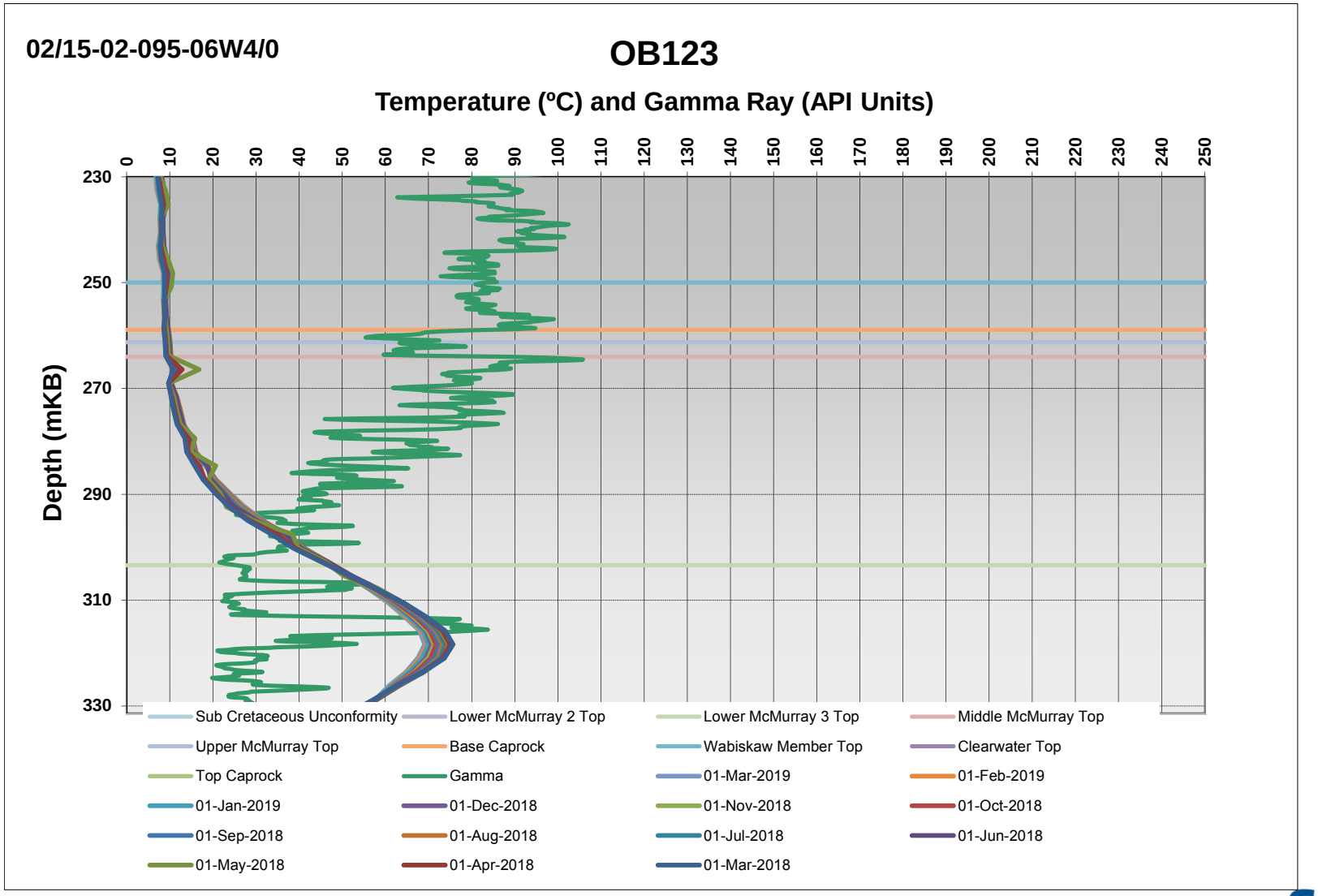

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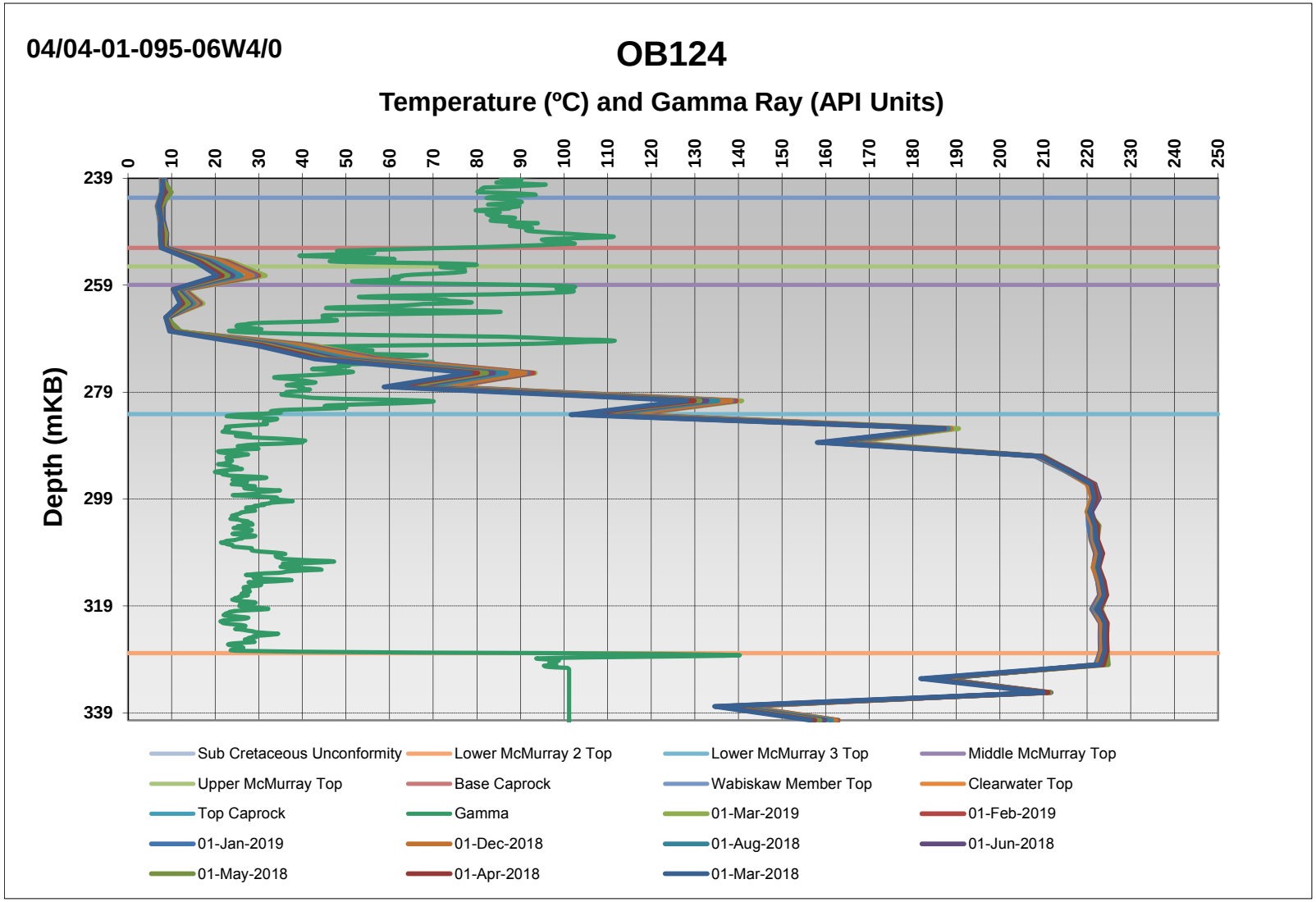

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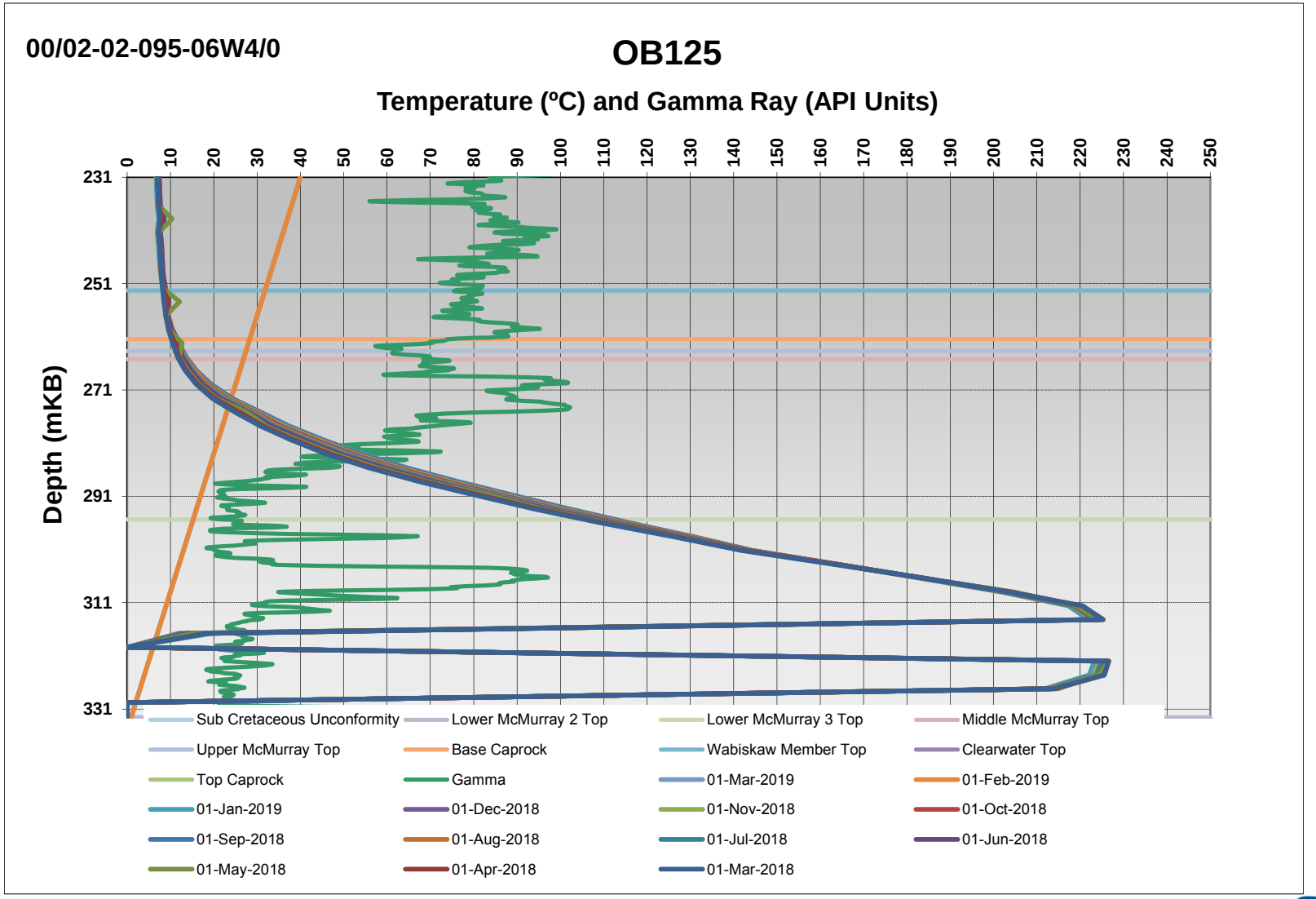

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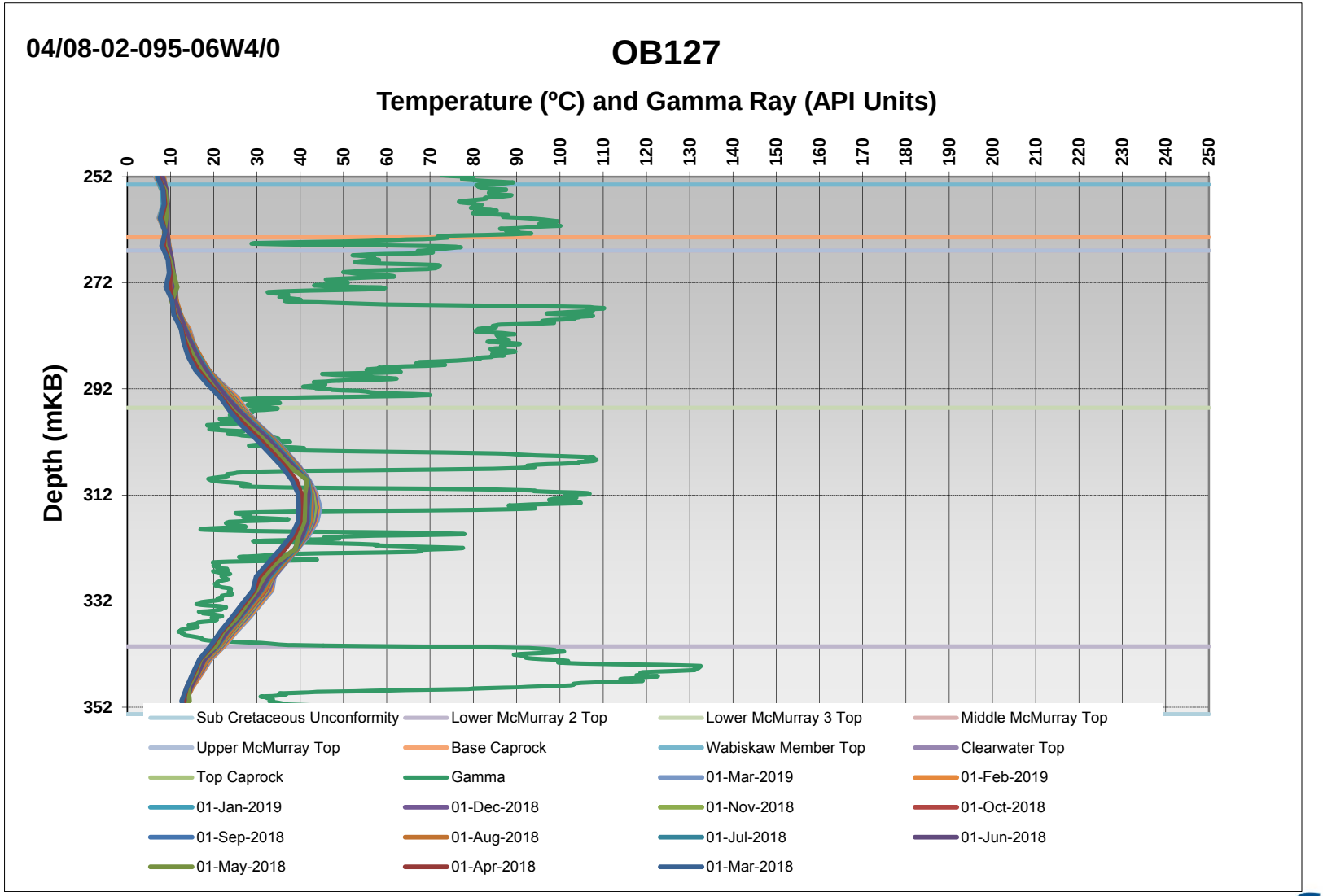

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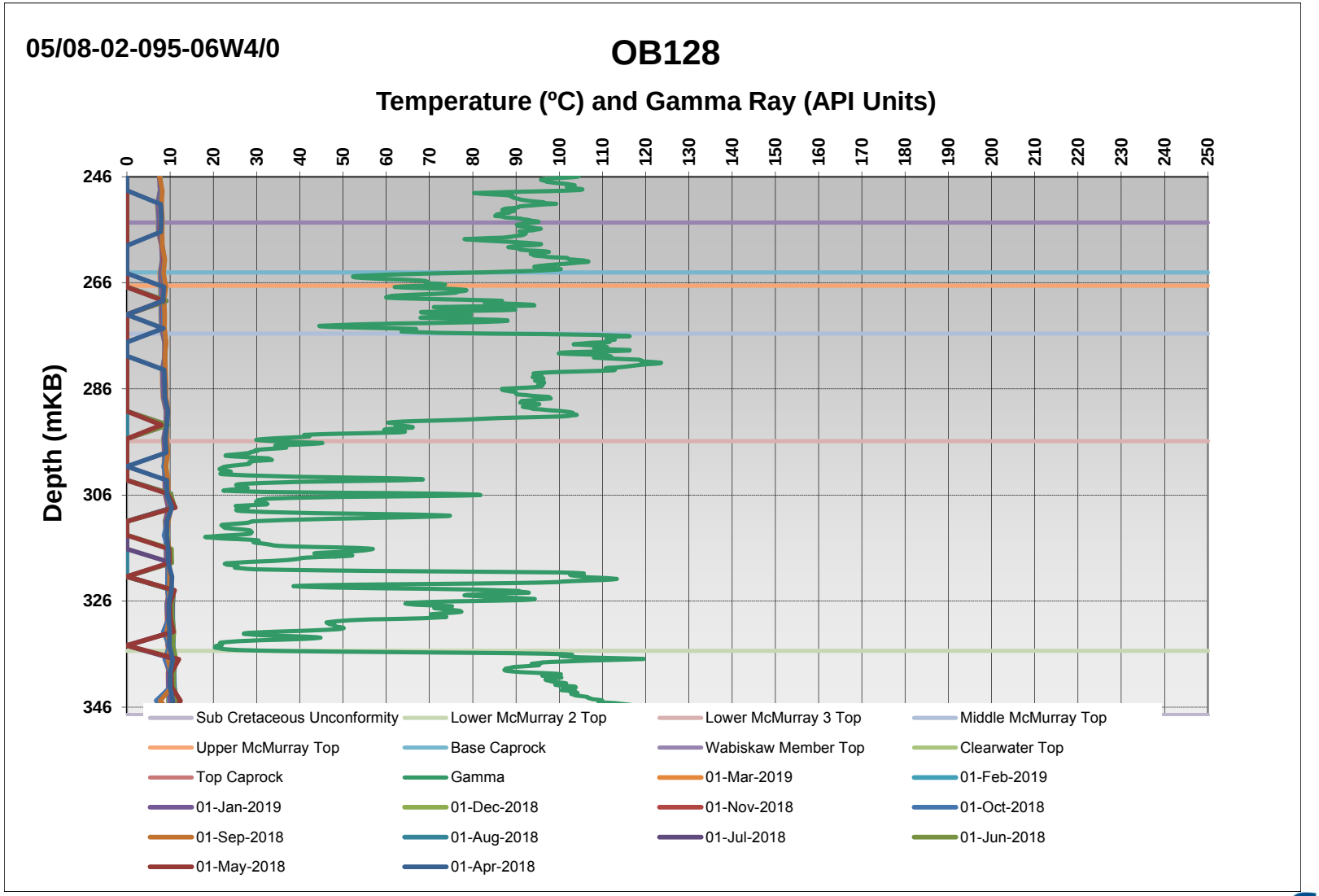

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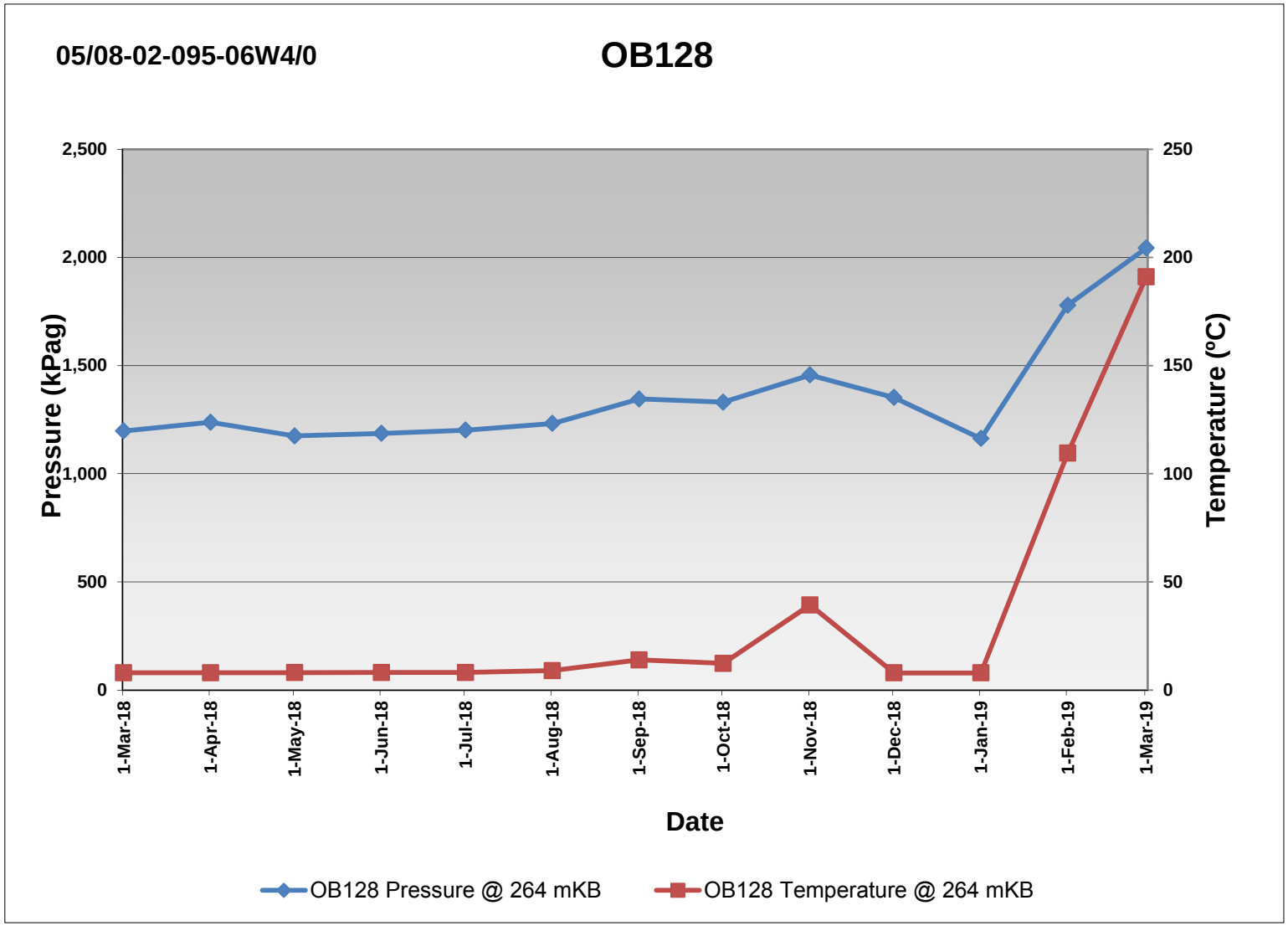

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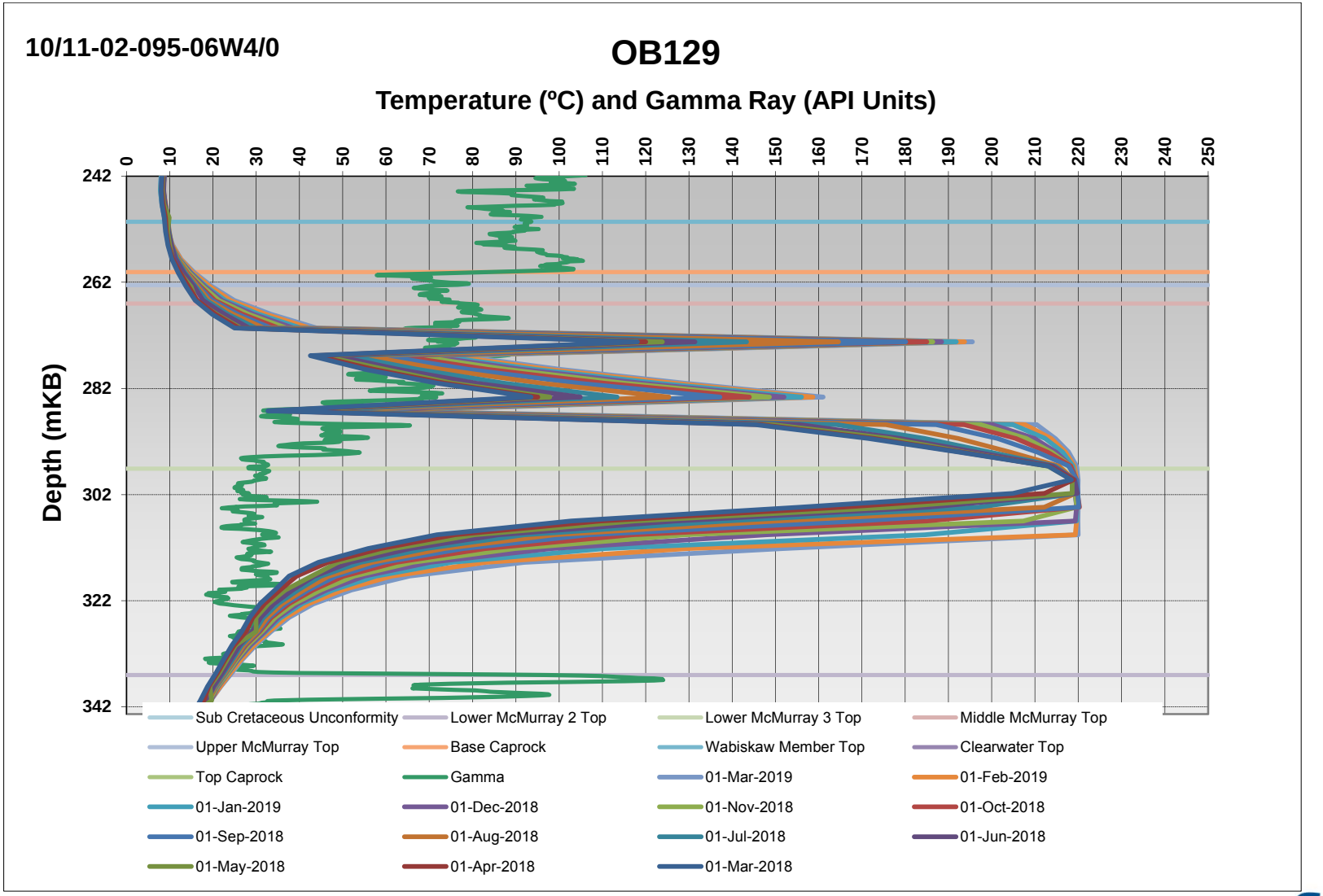

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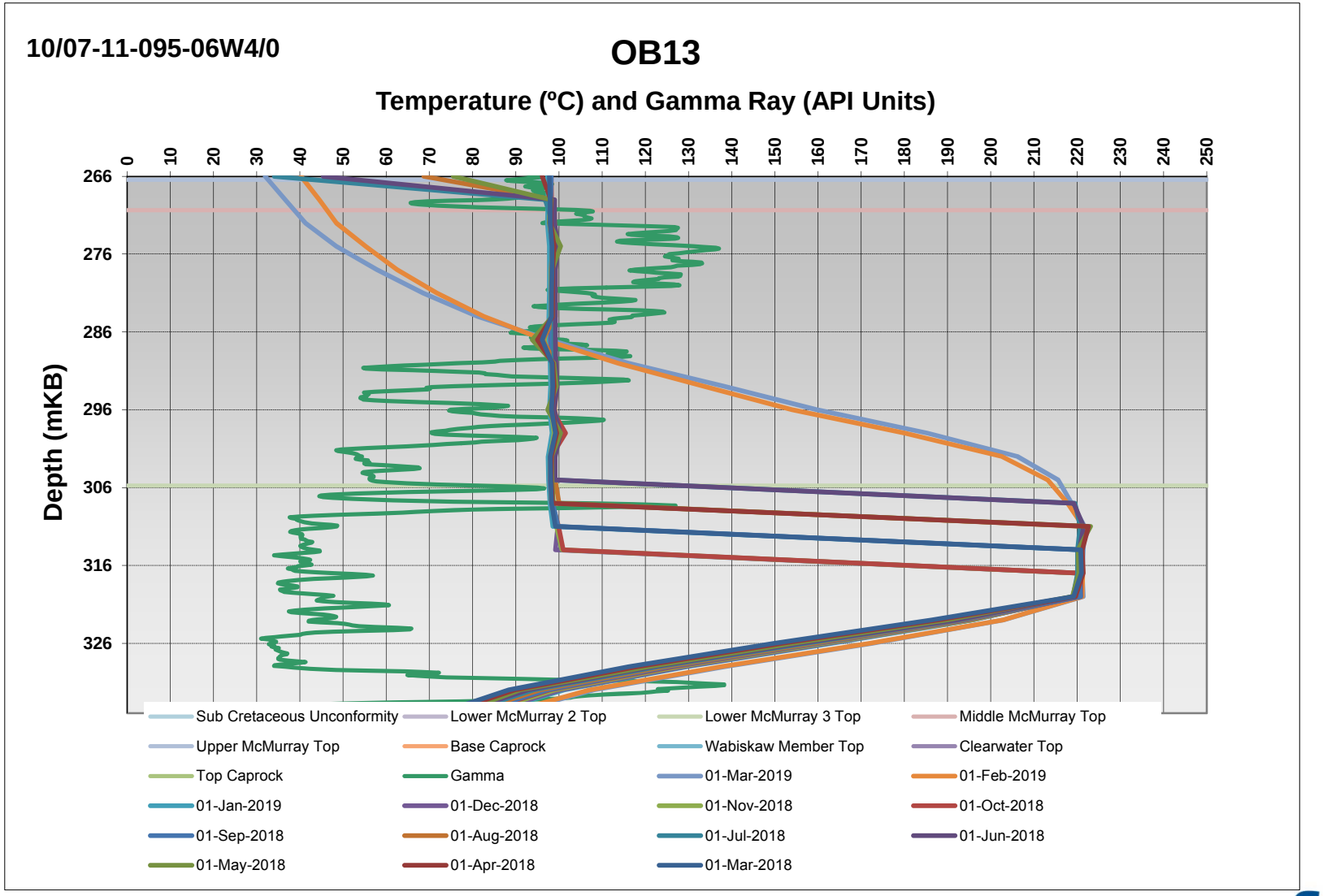

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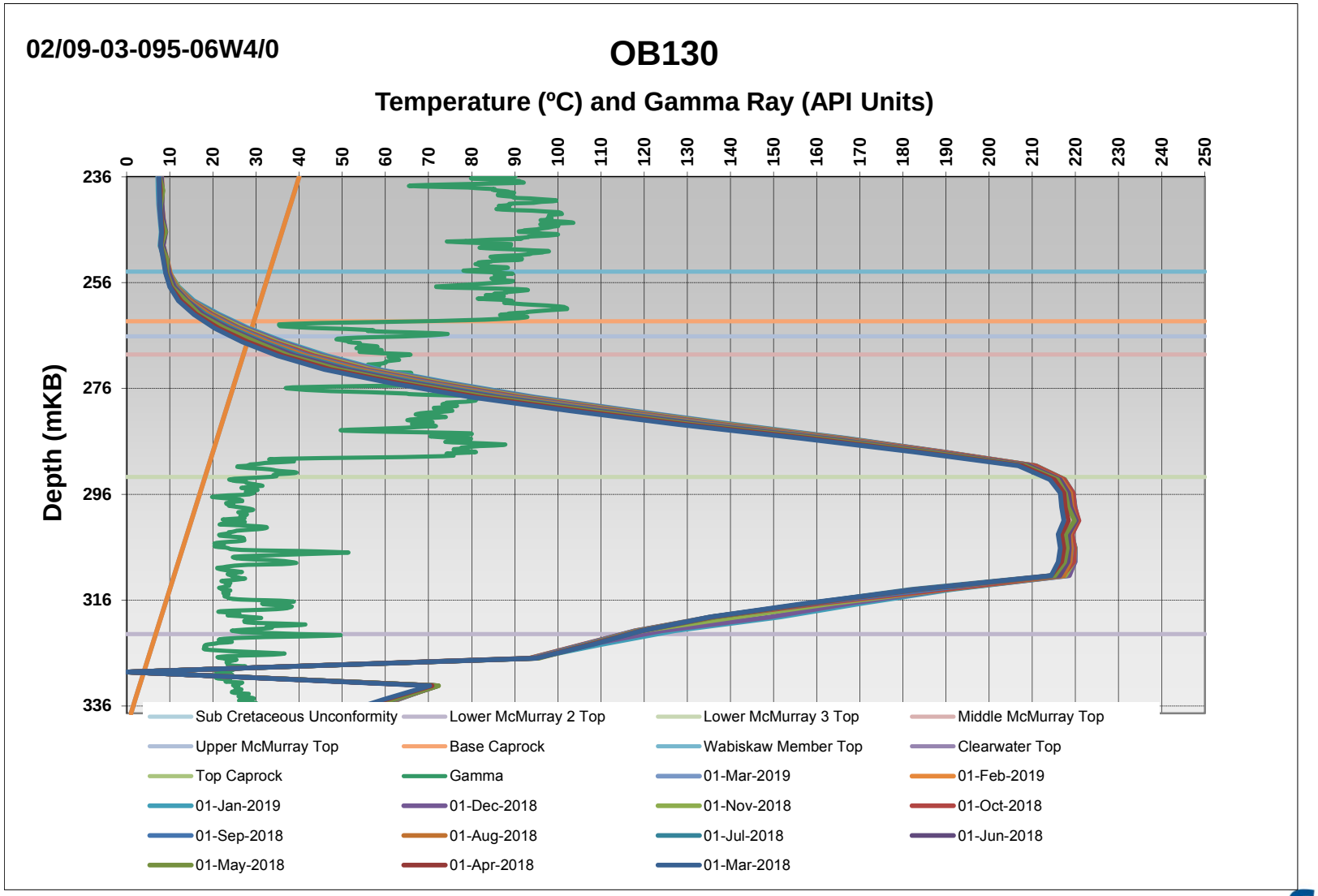

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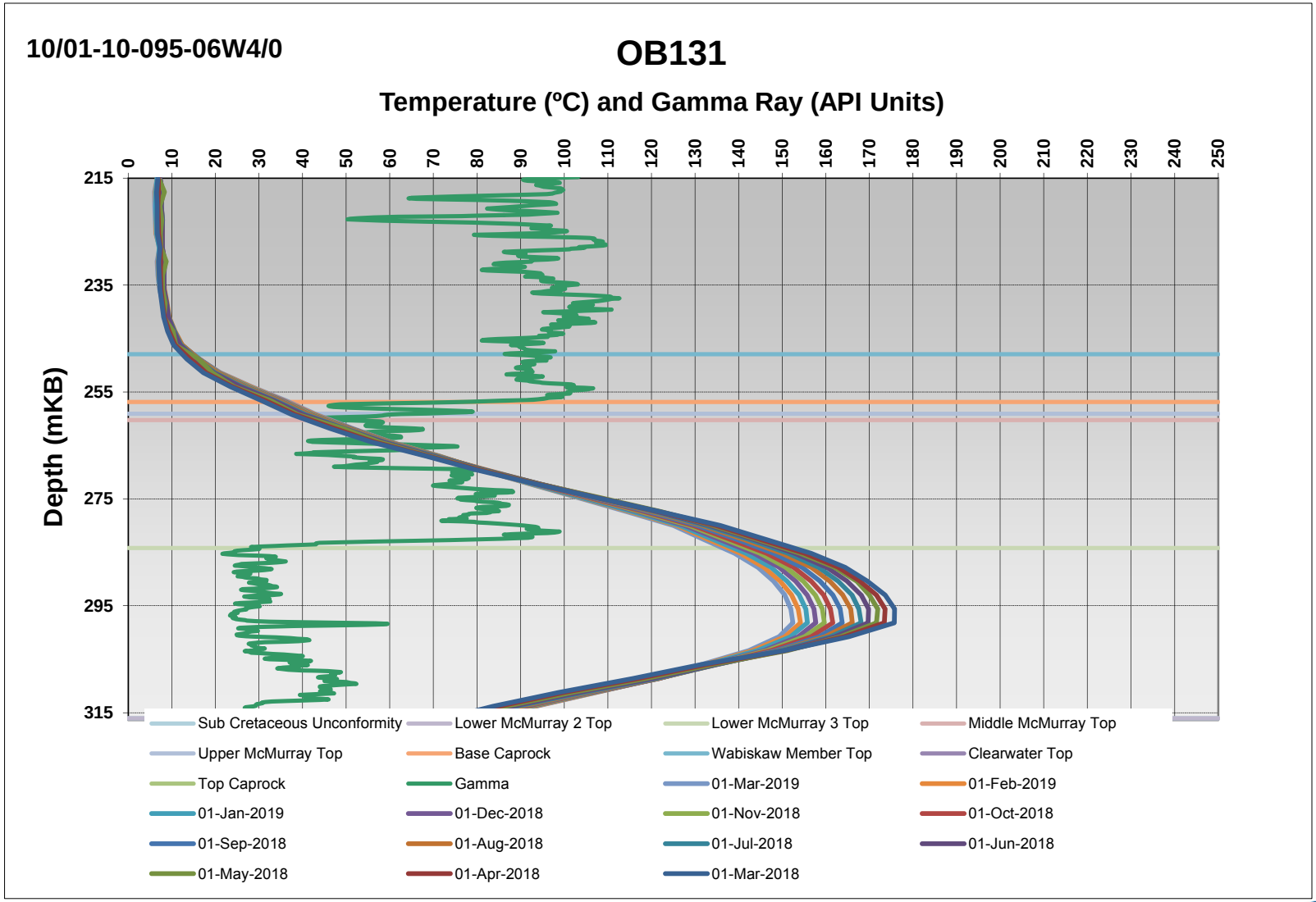

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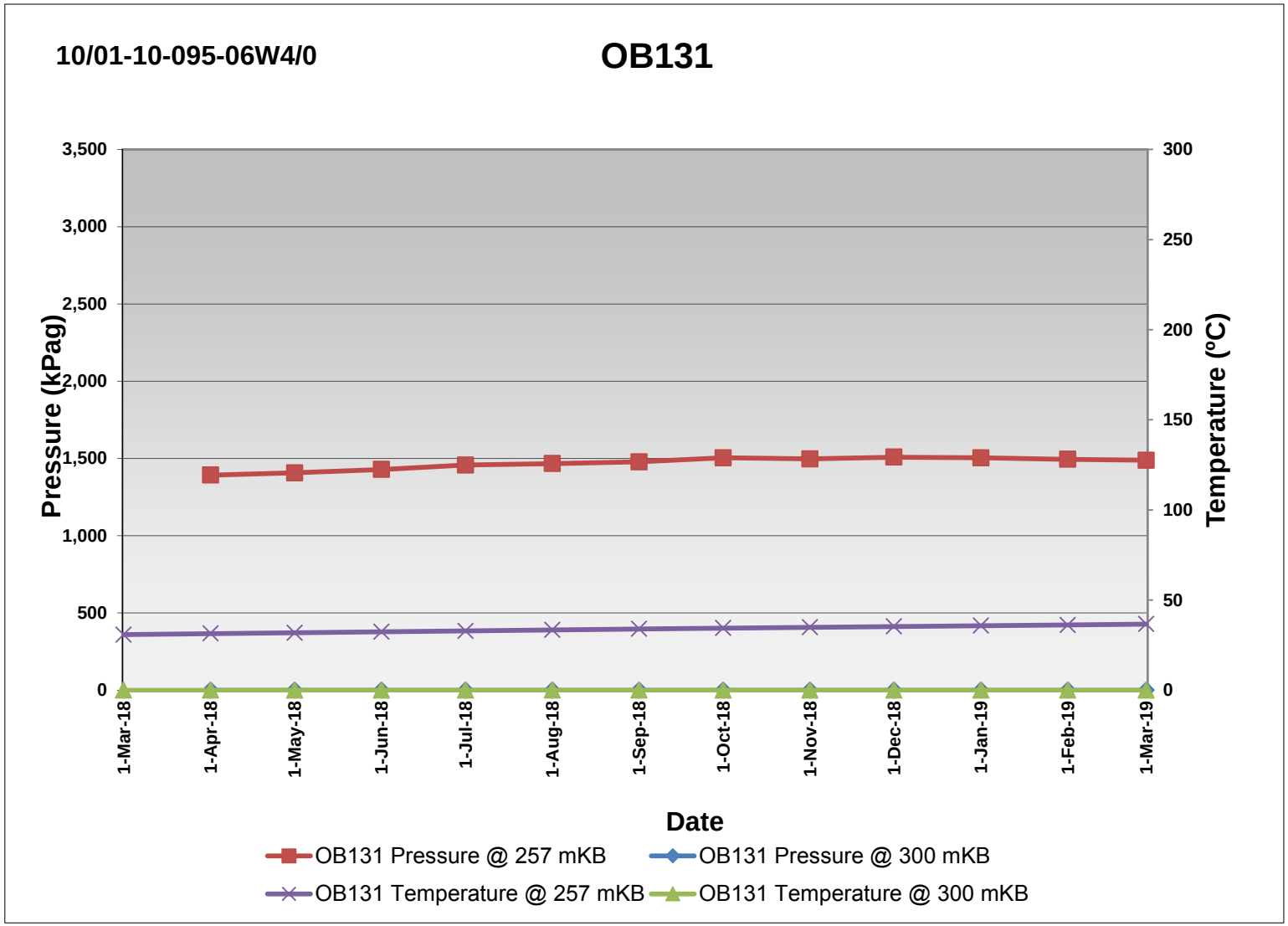

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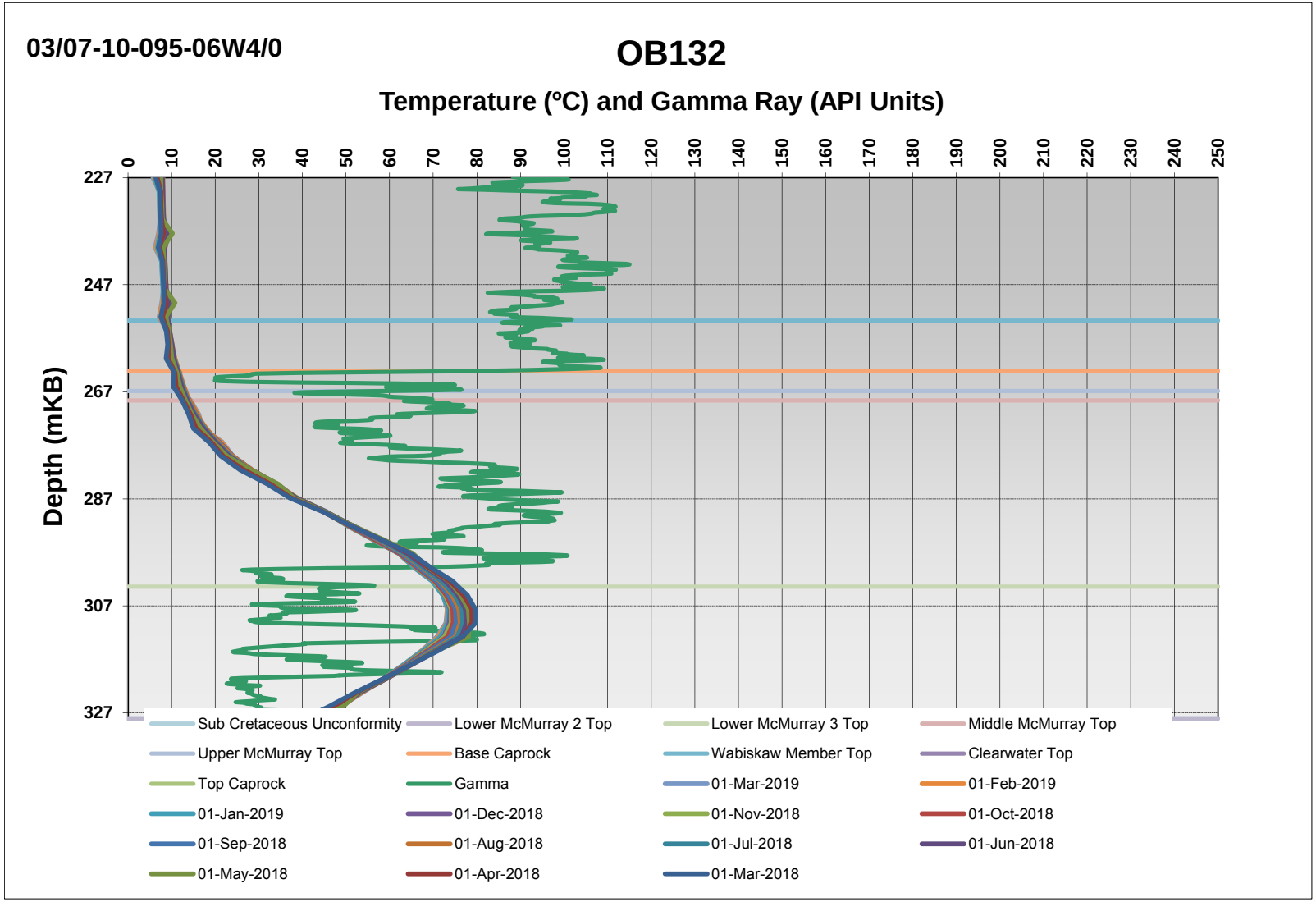

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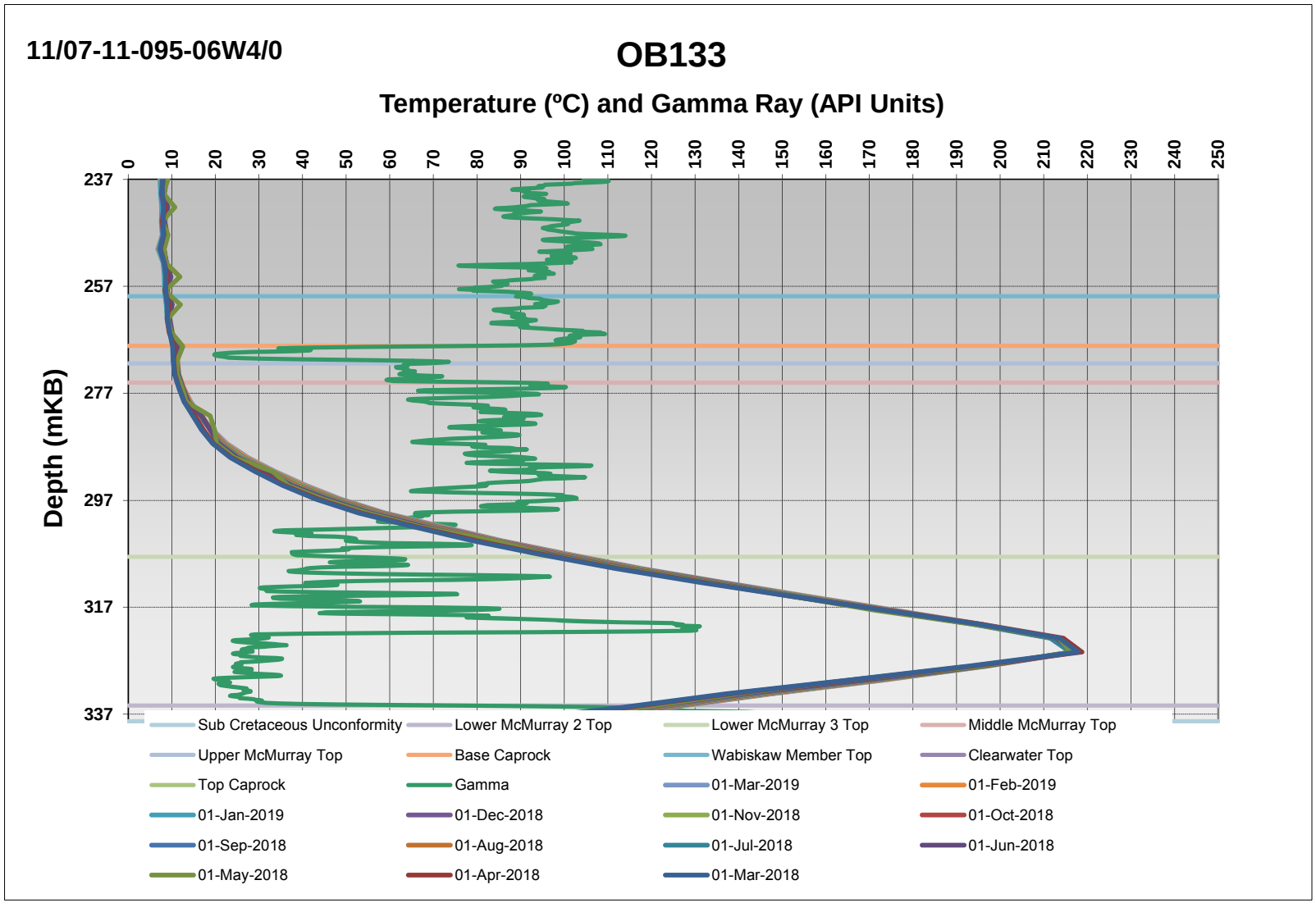

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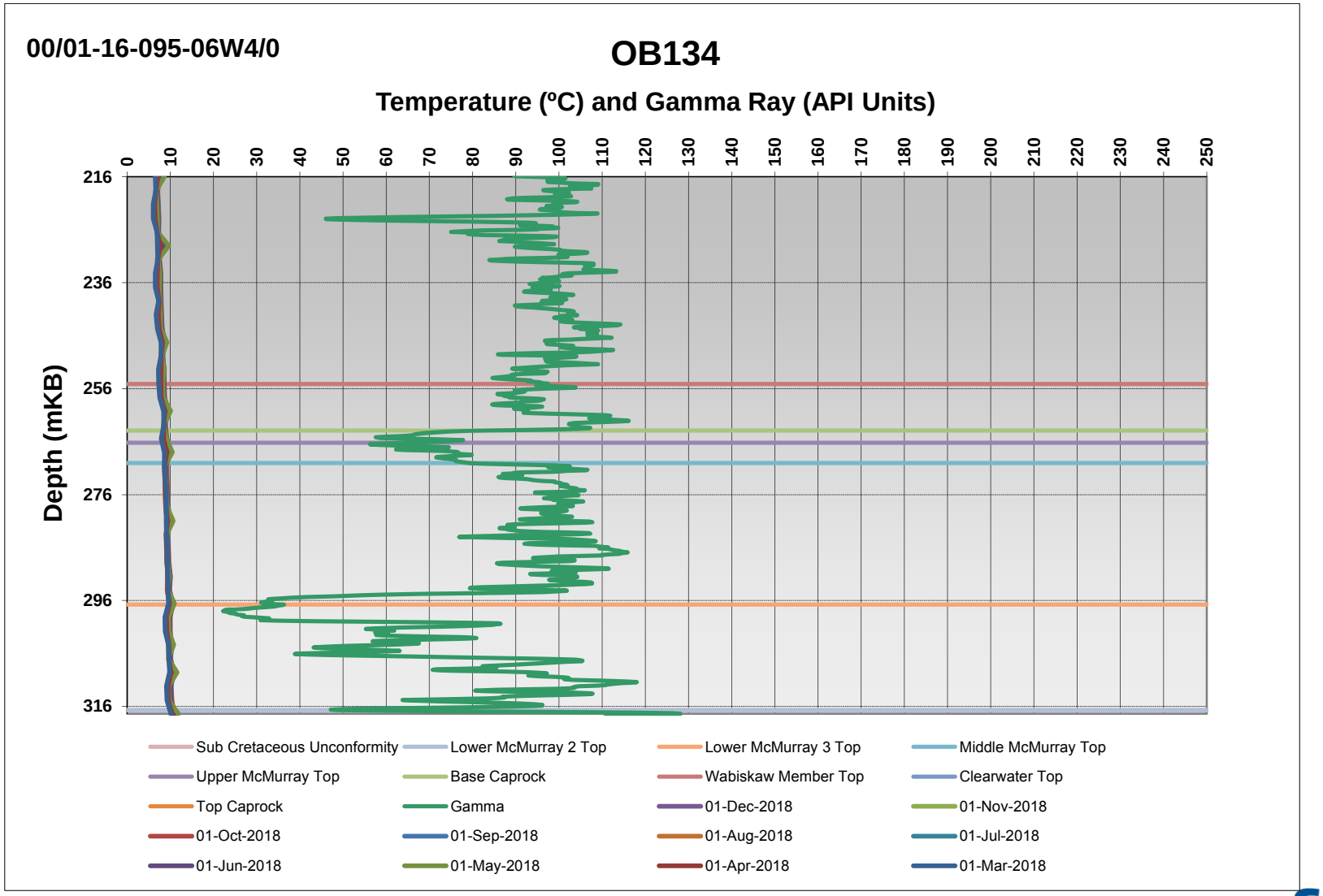

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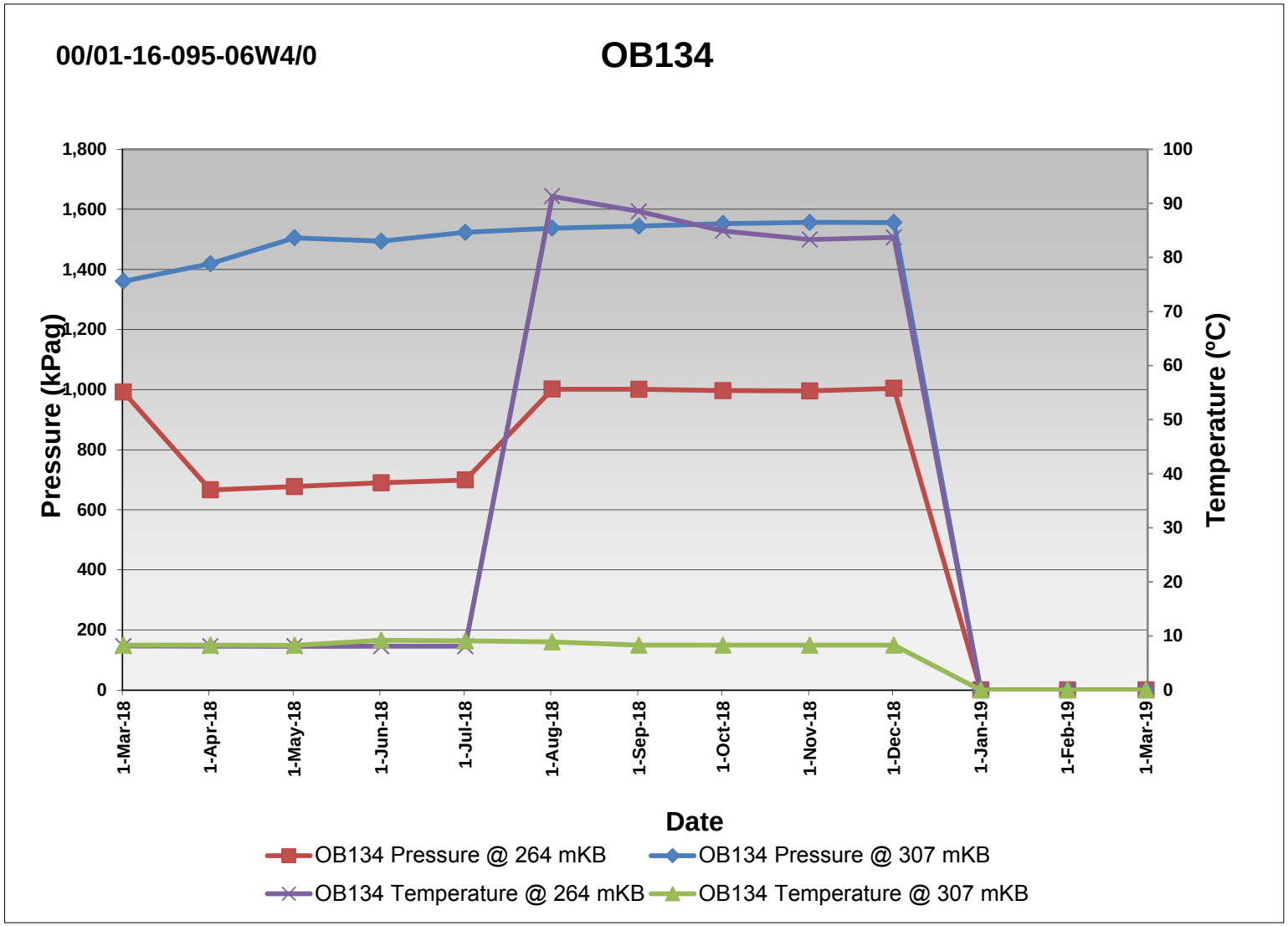

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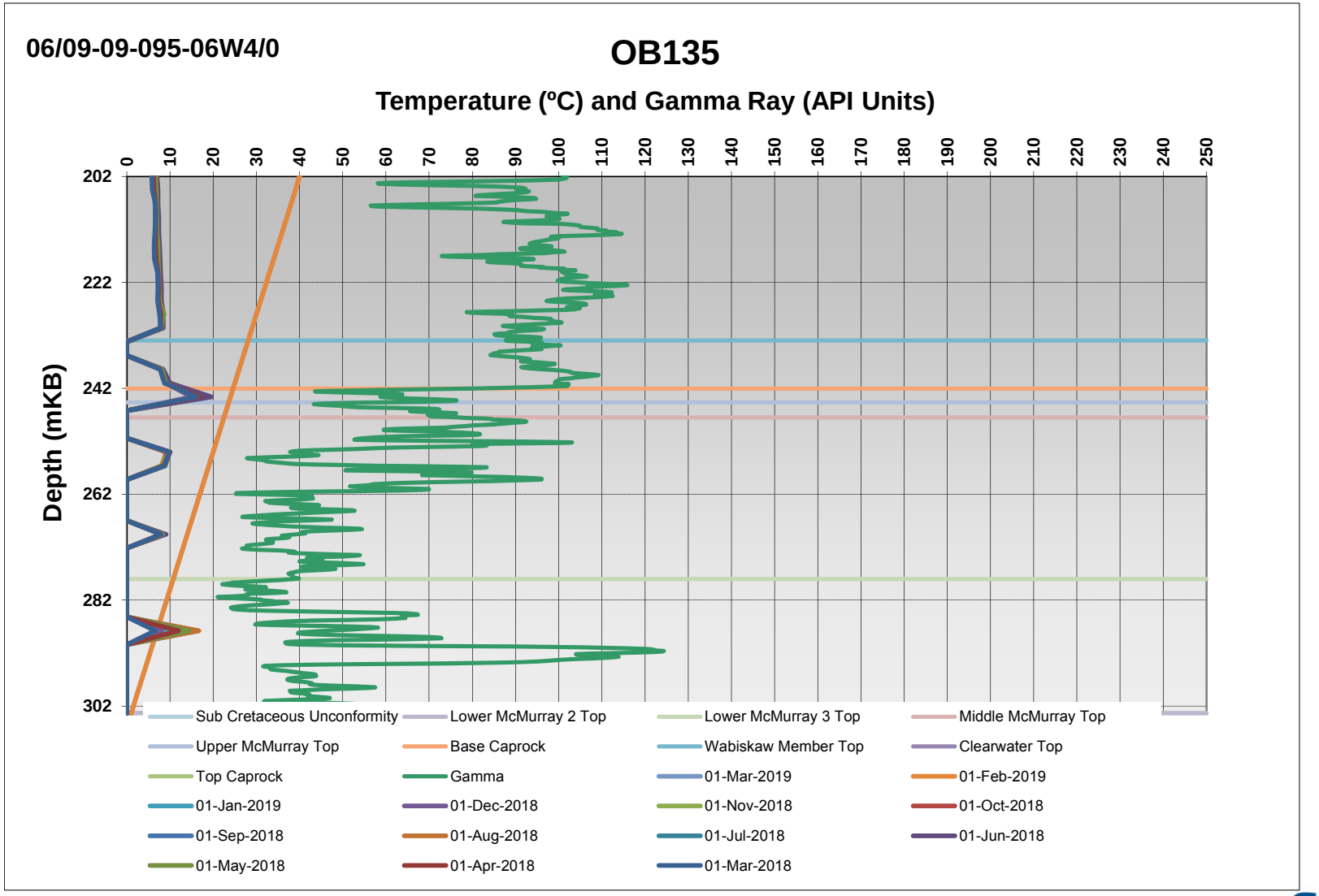

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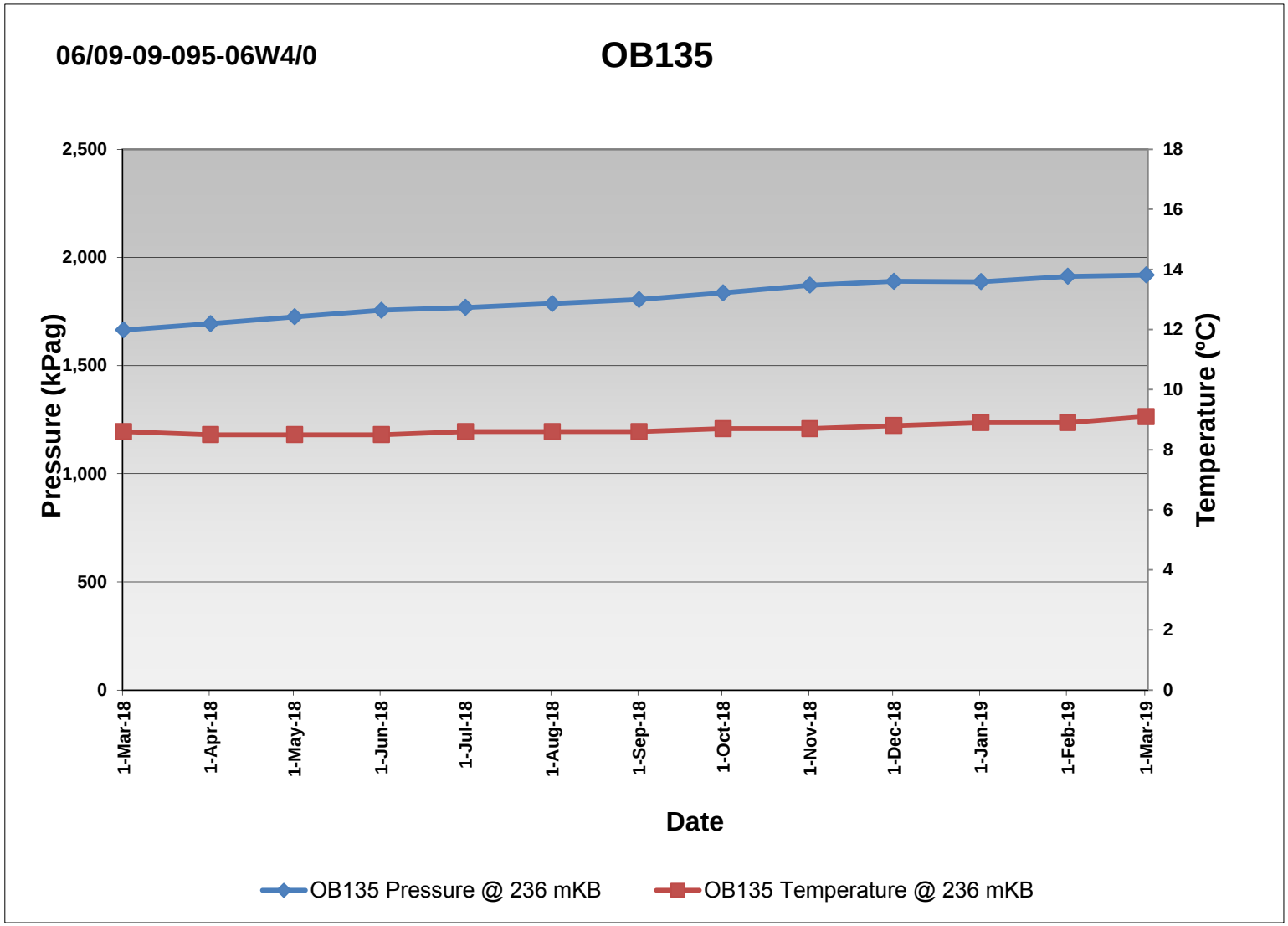

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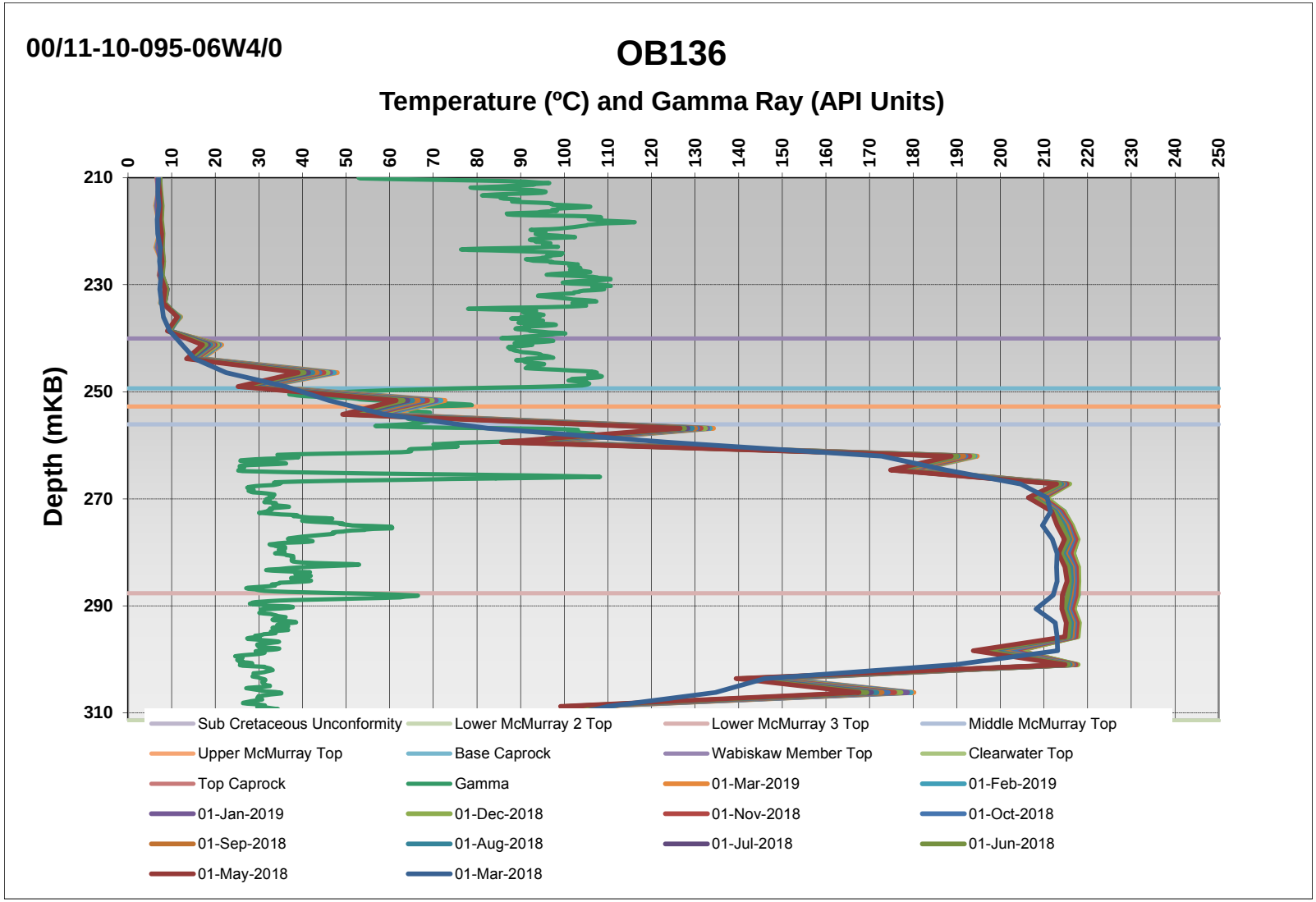

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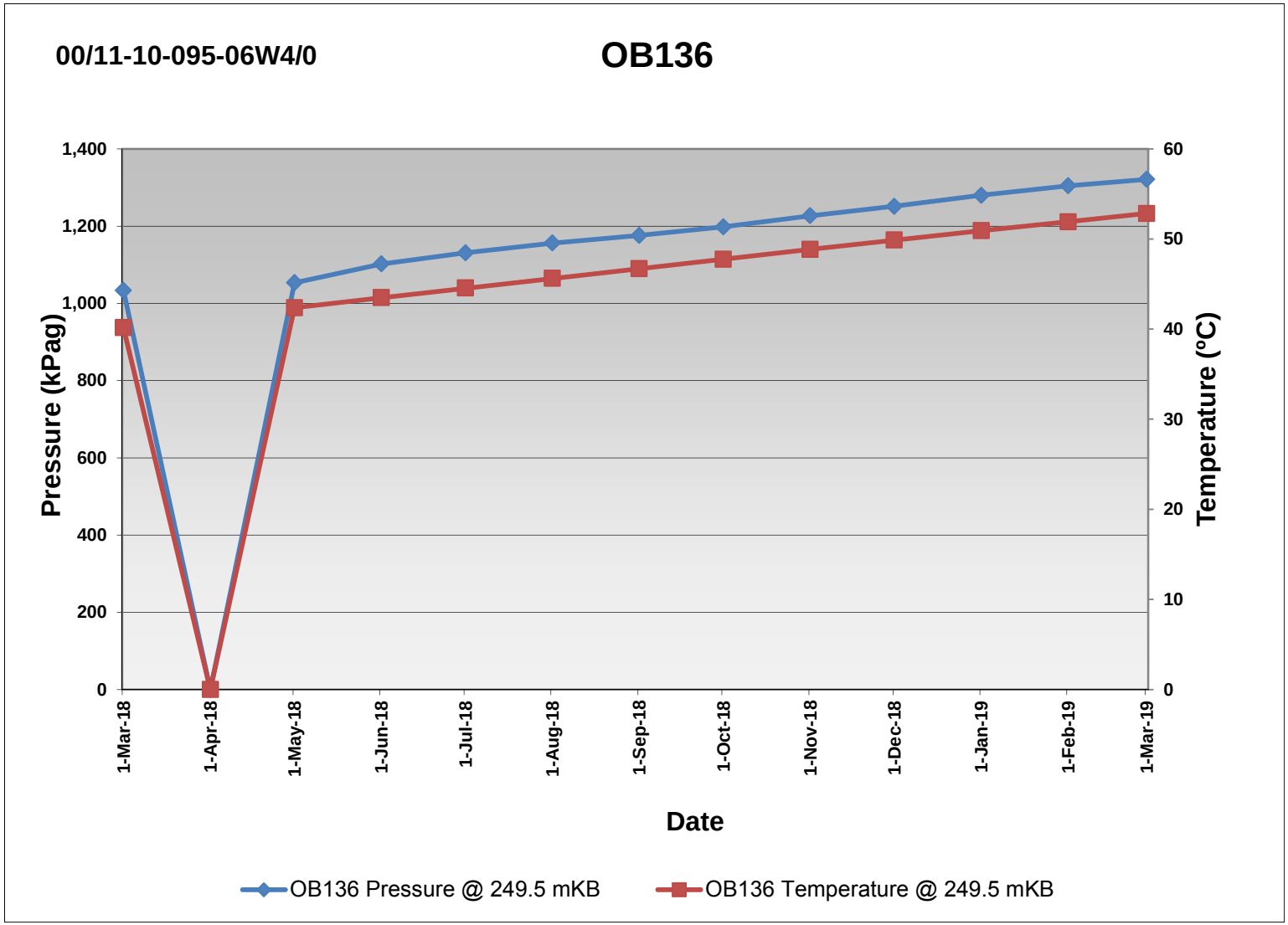

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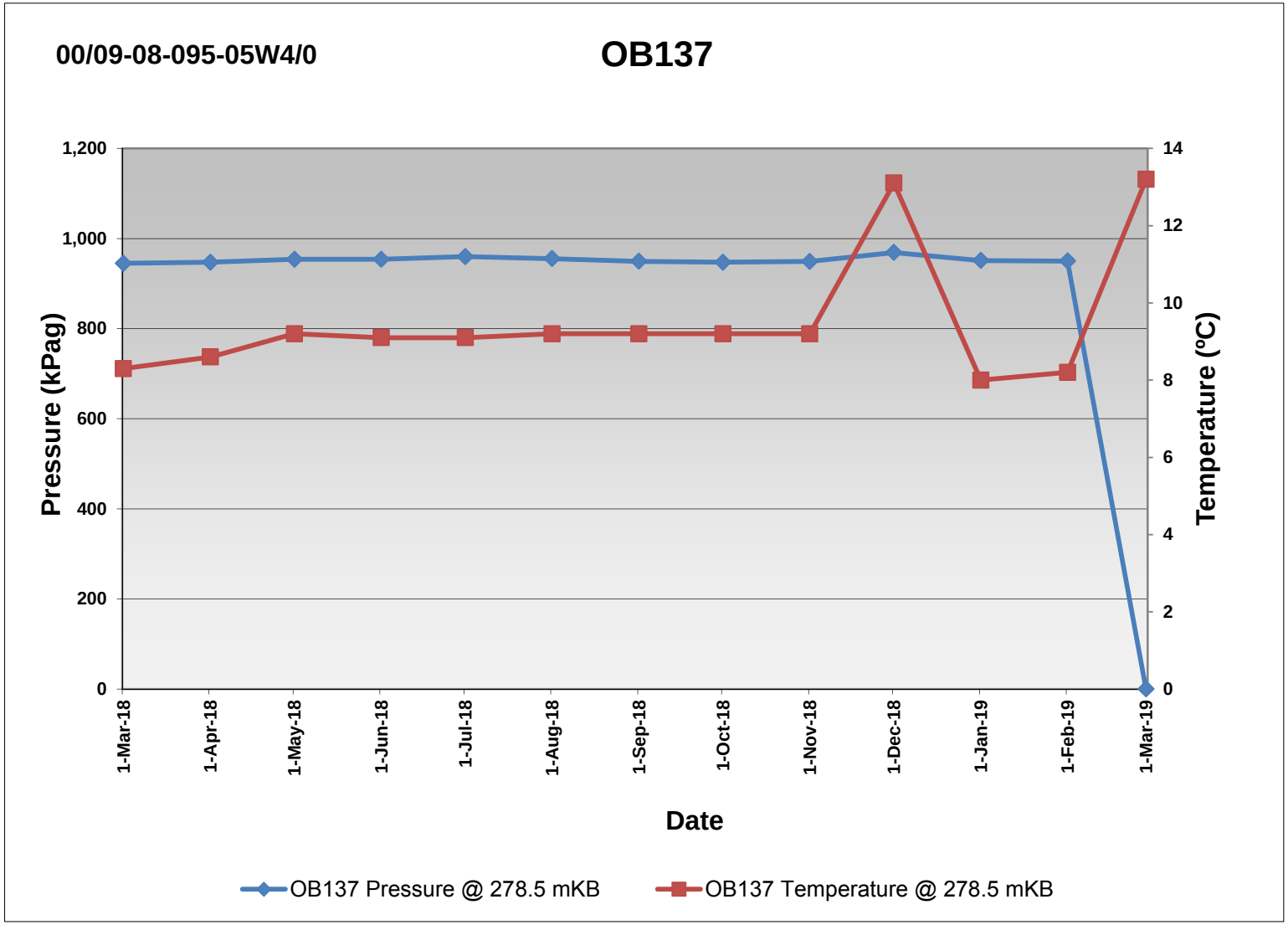

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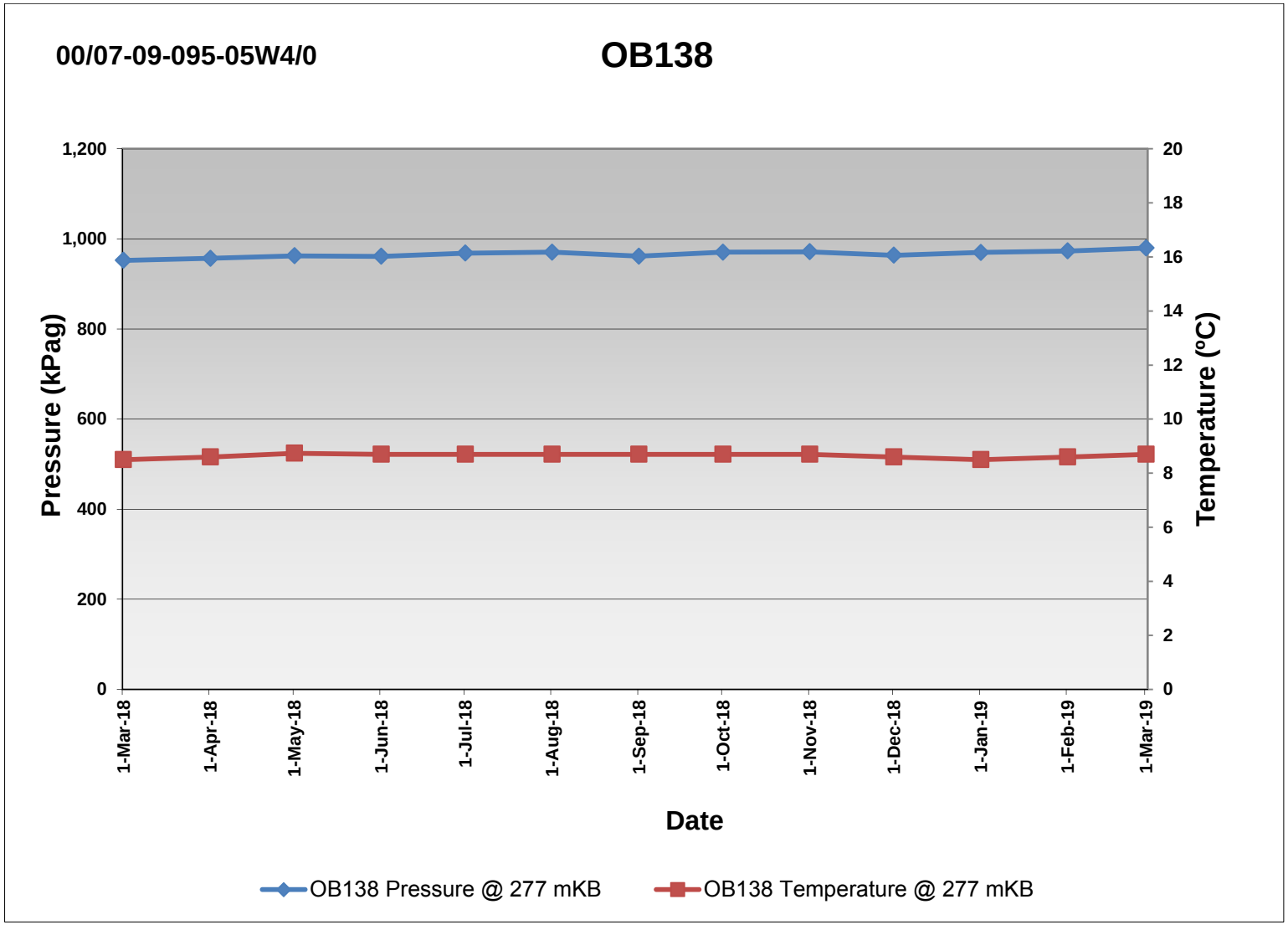

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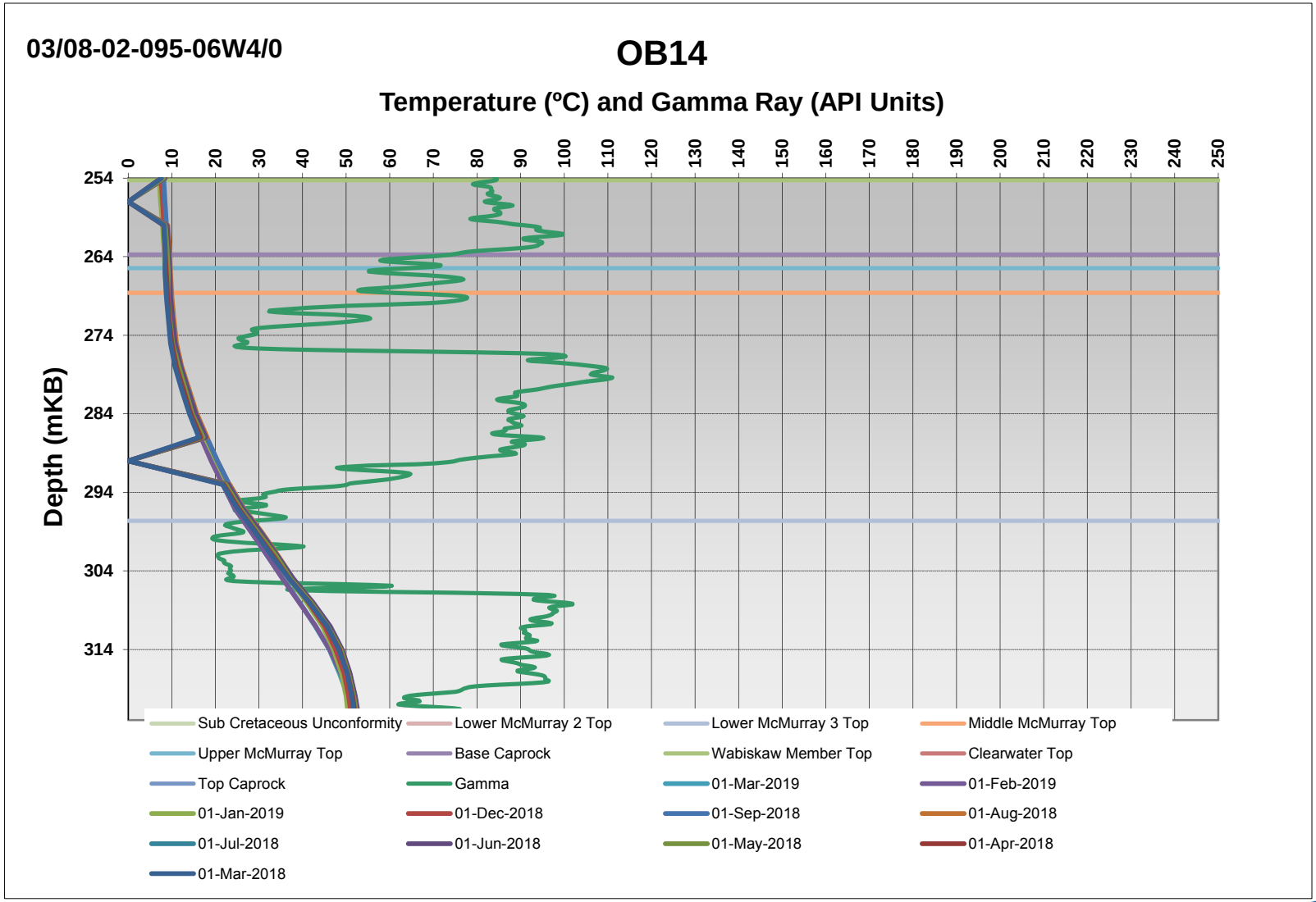

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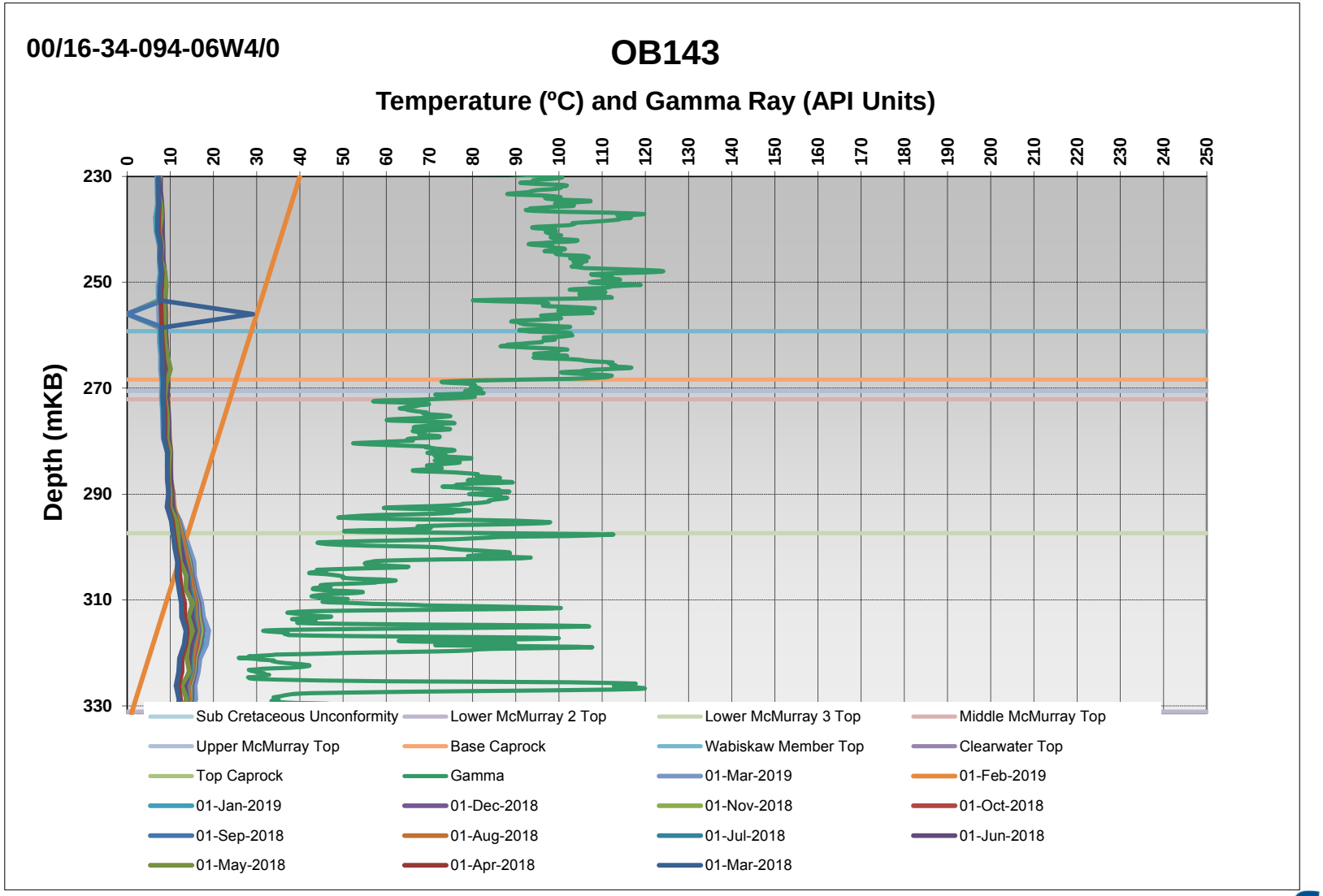
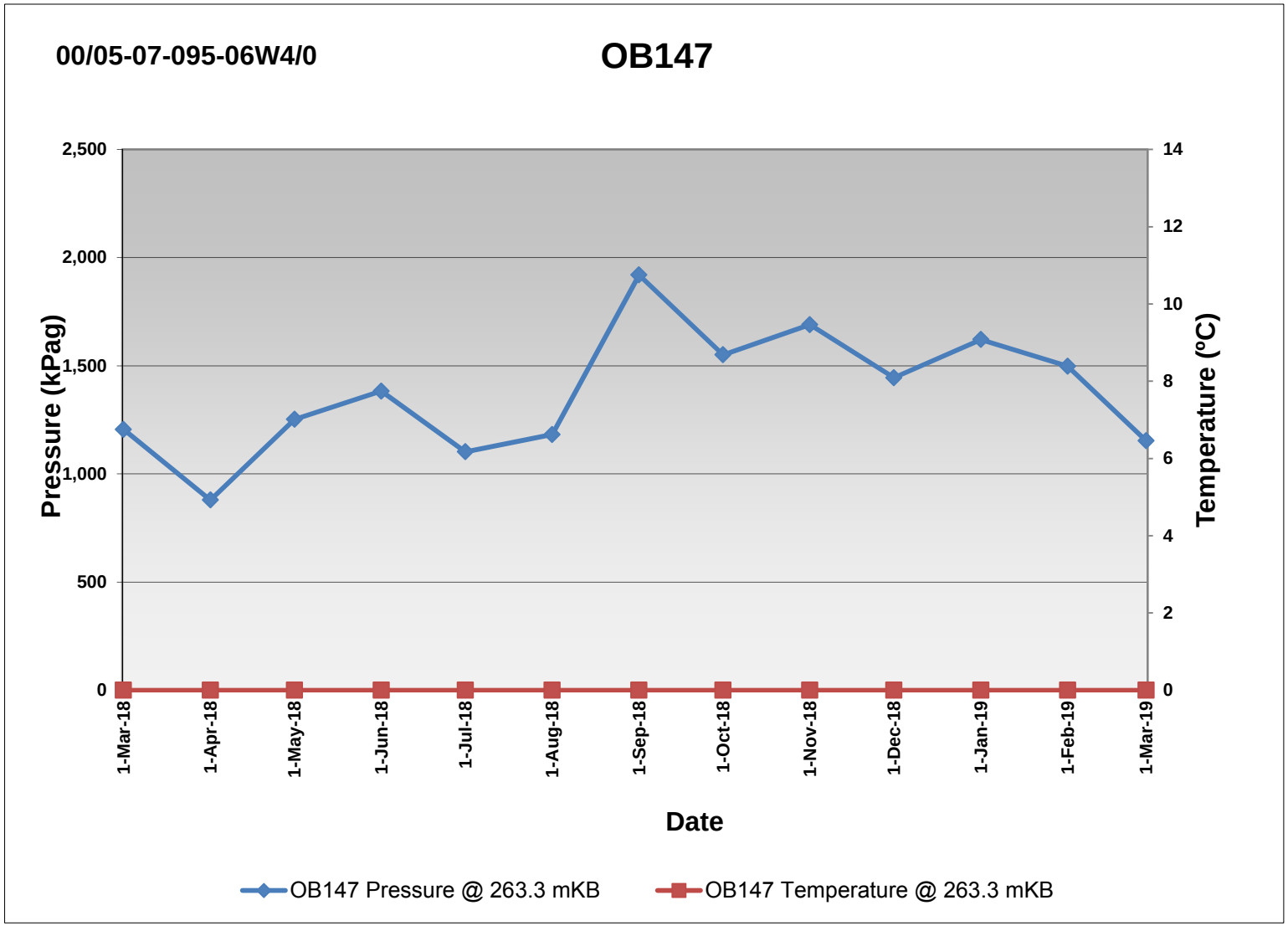


Piezometer Plots & Temperature vs Depth Plots



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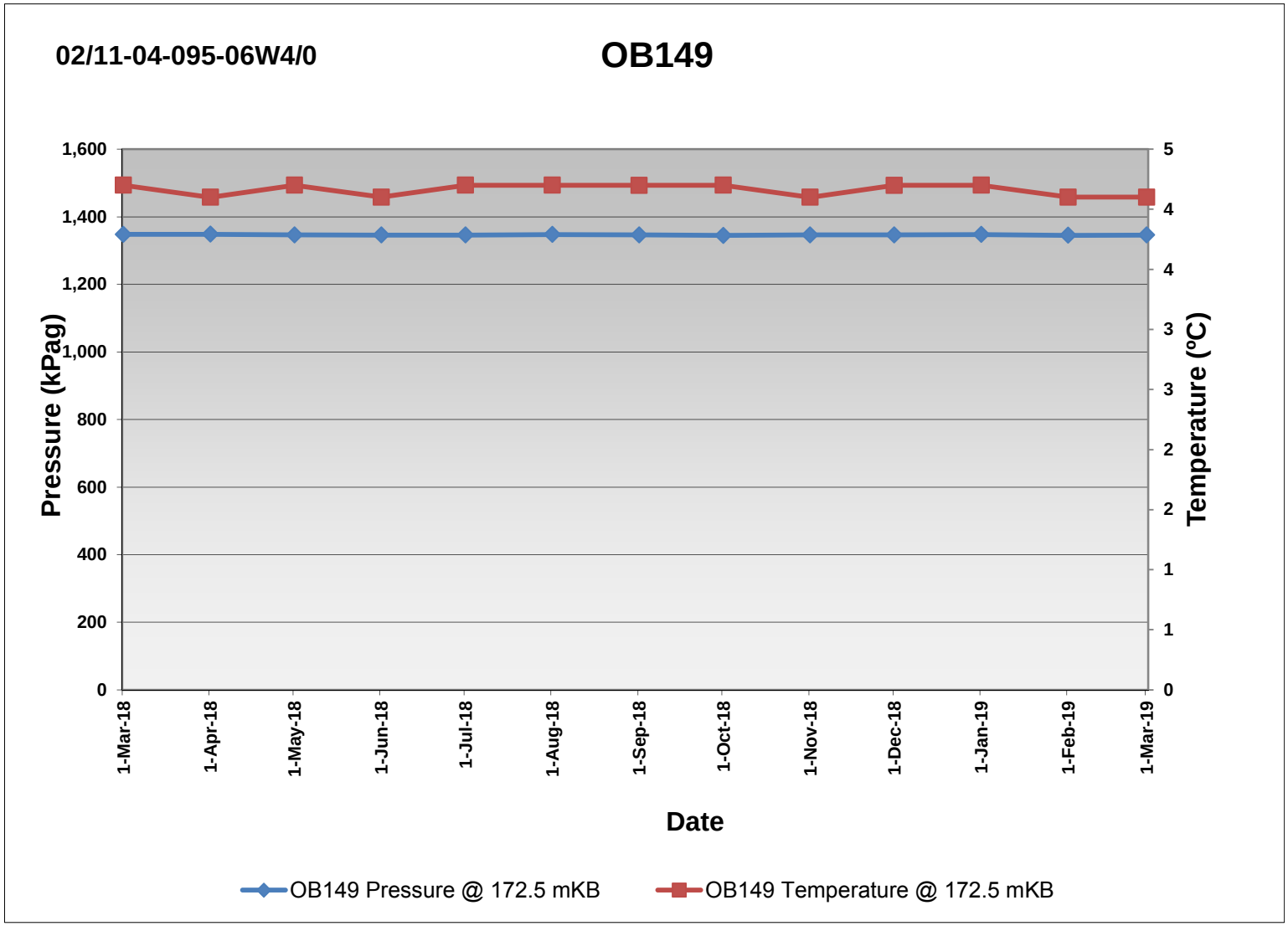

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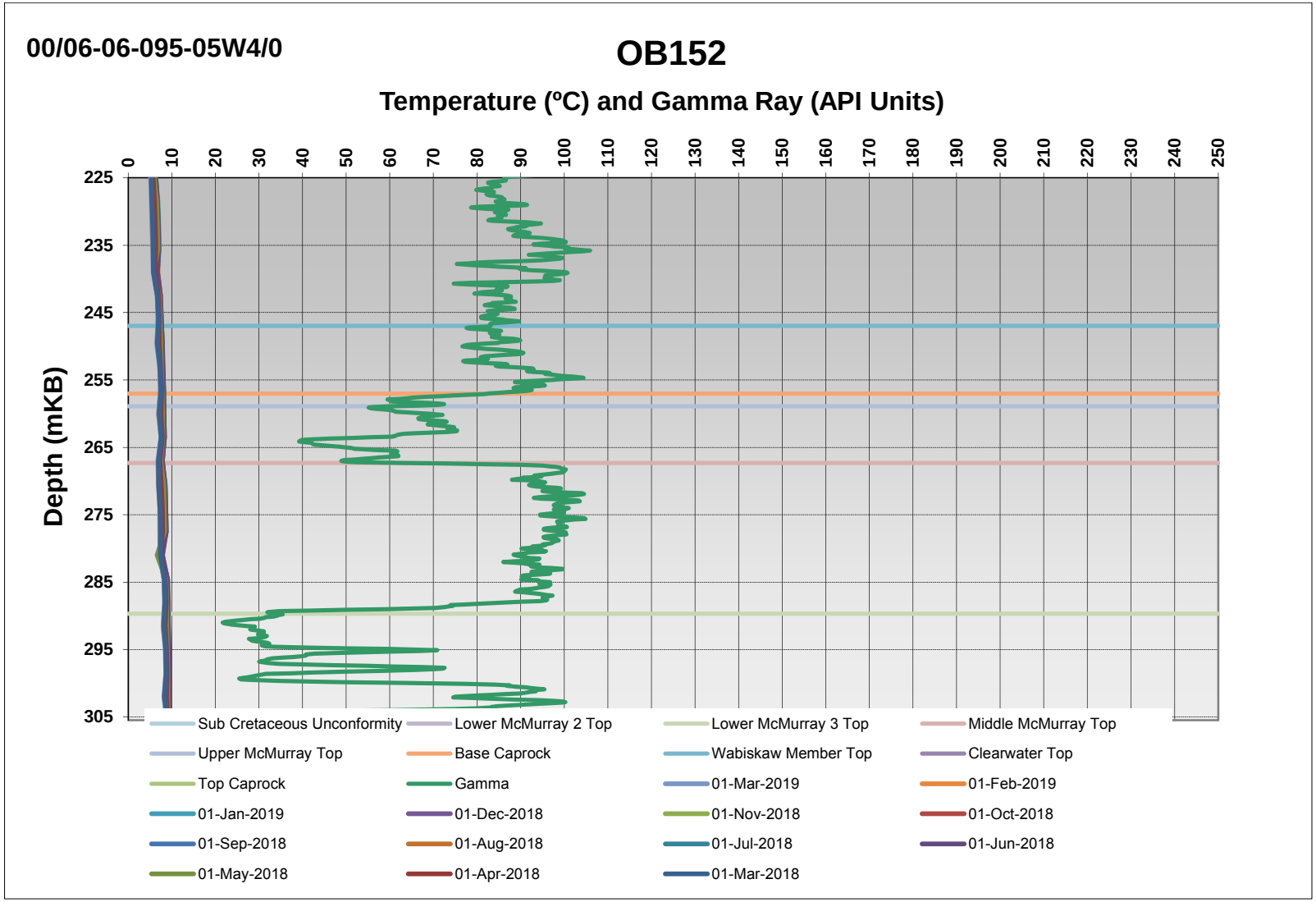

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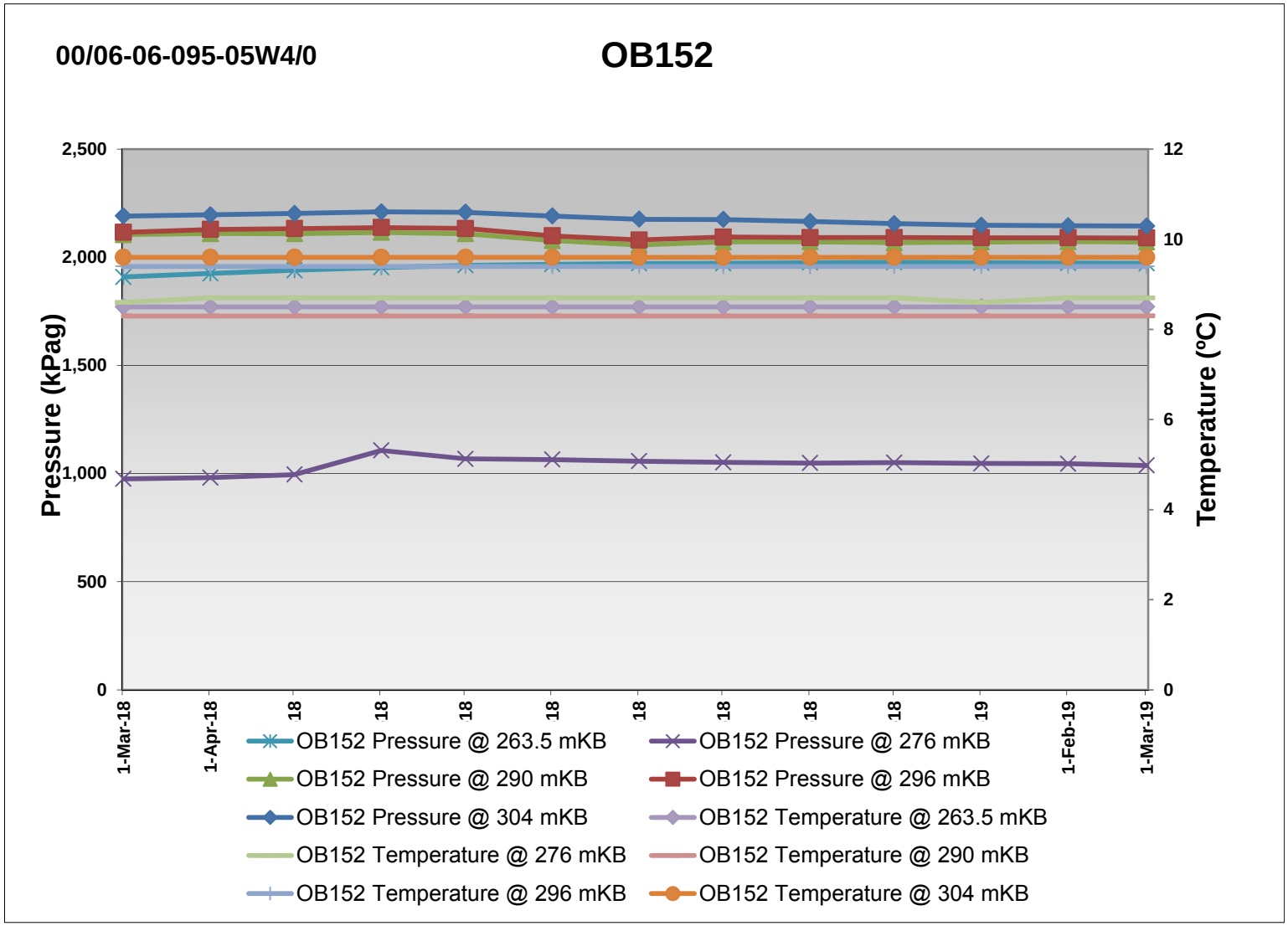

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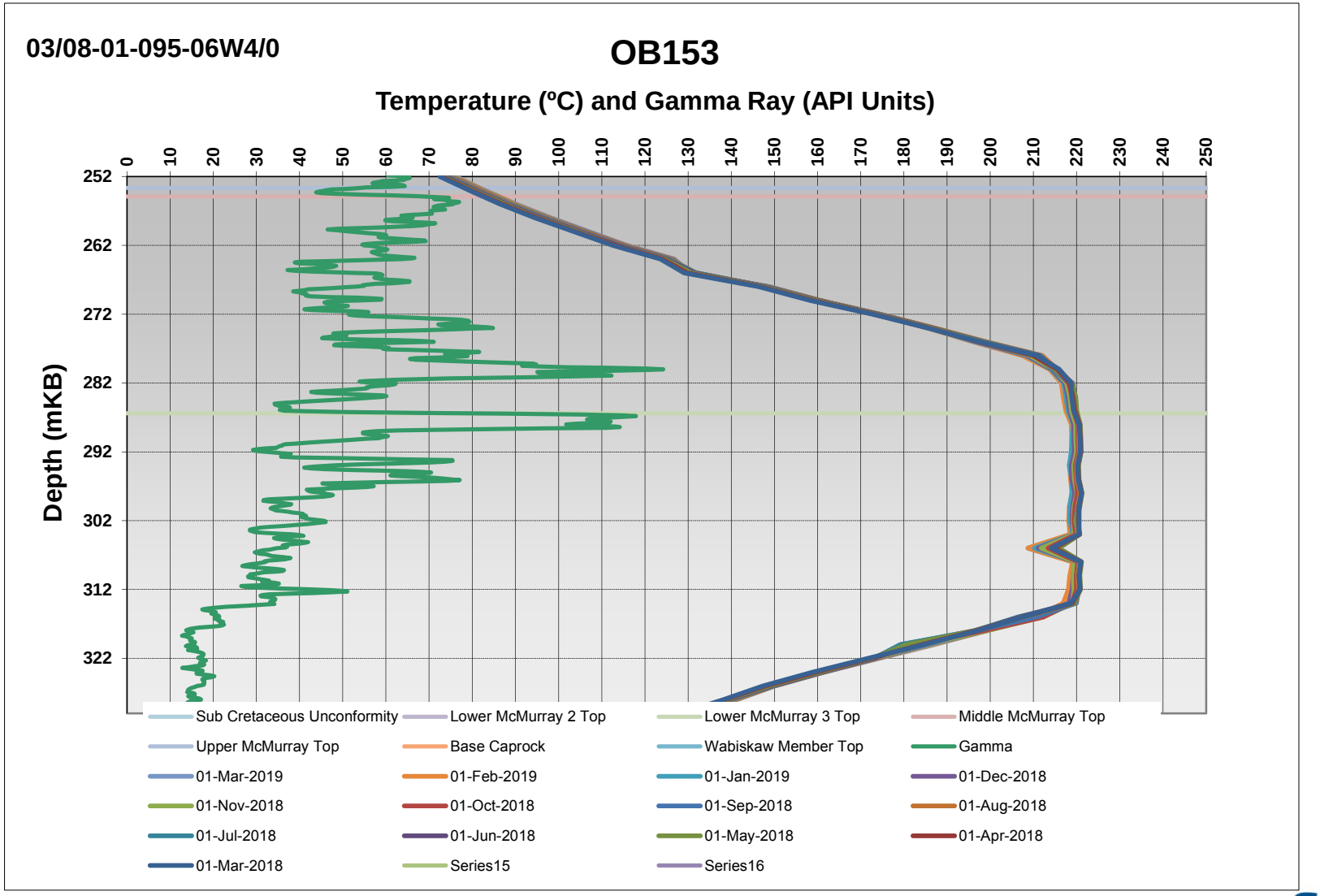

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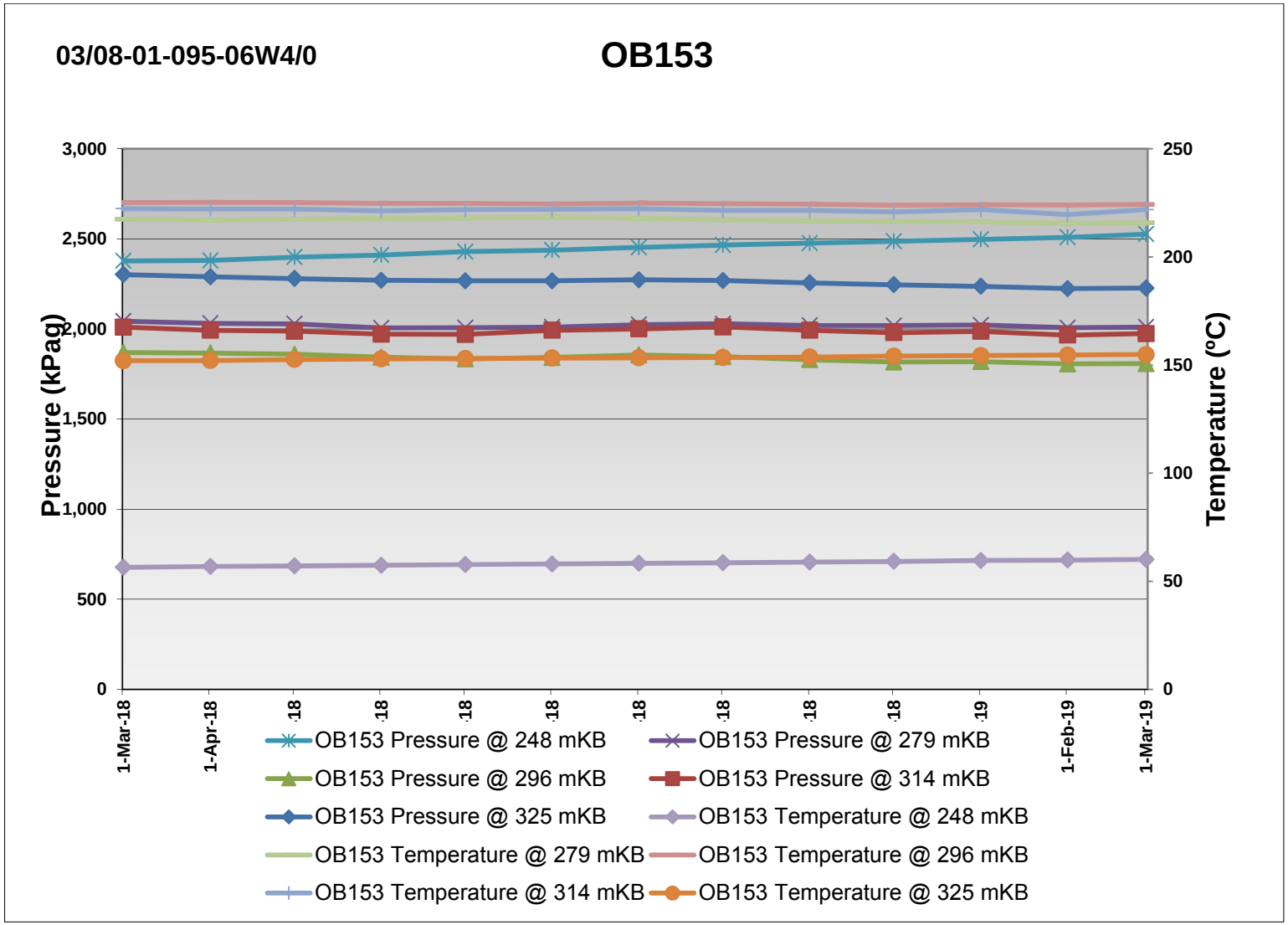

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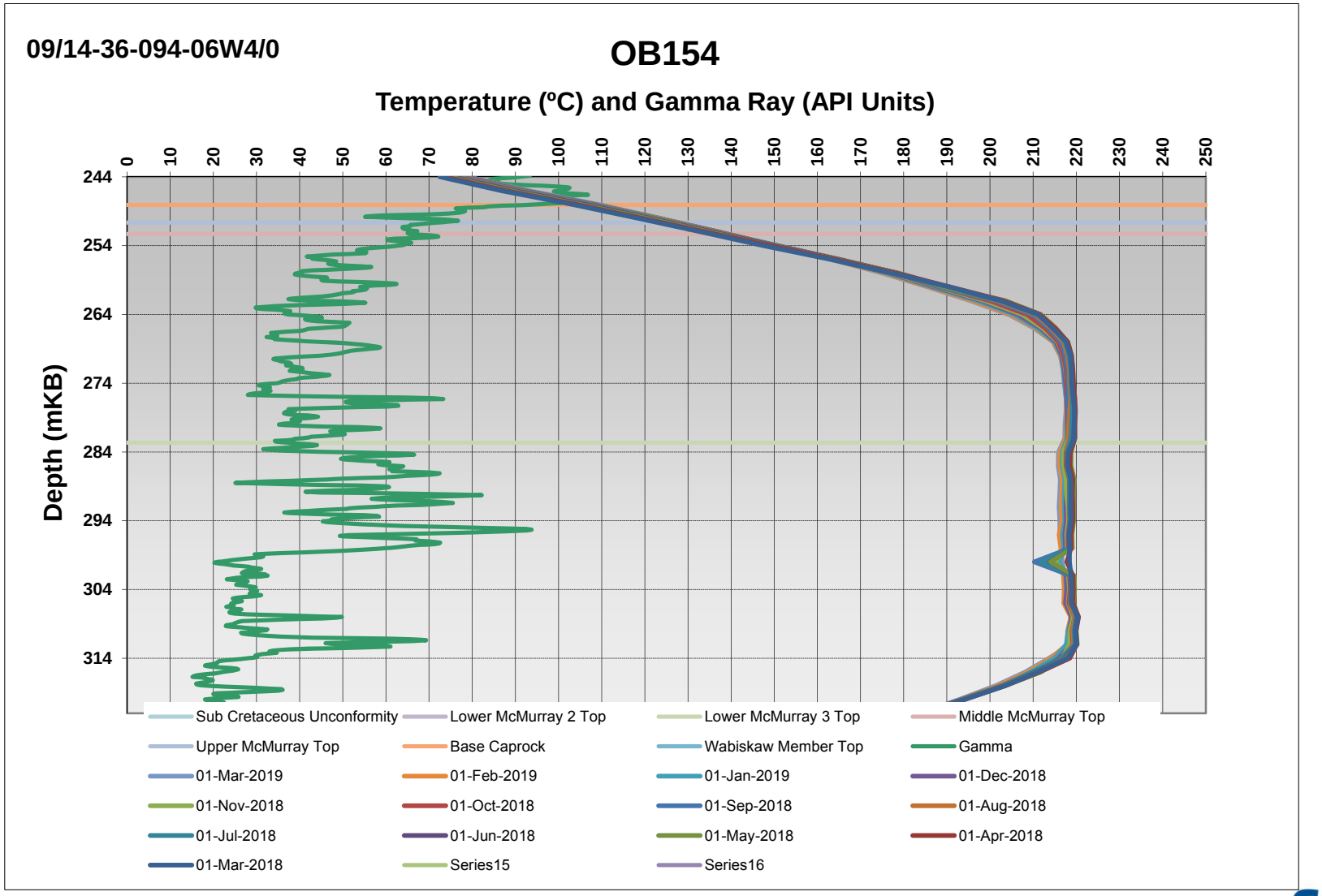

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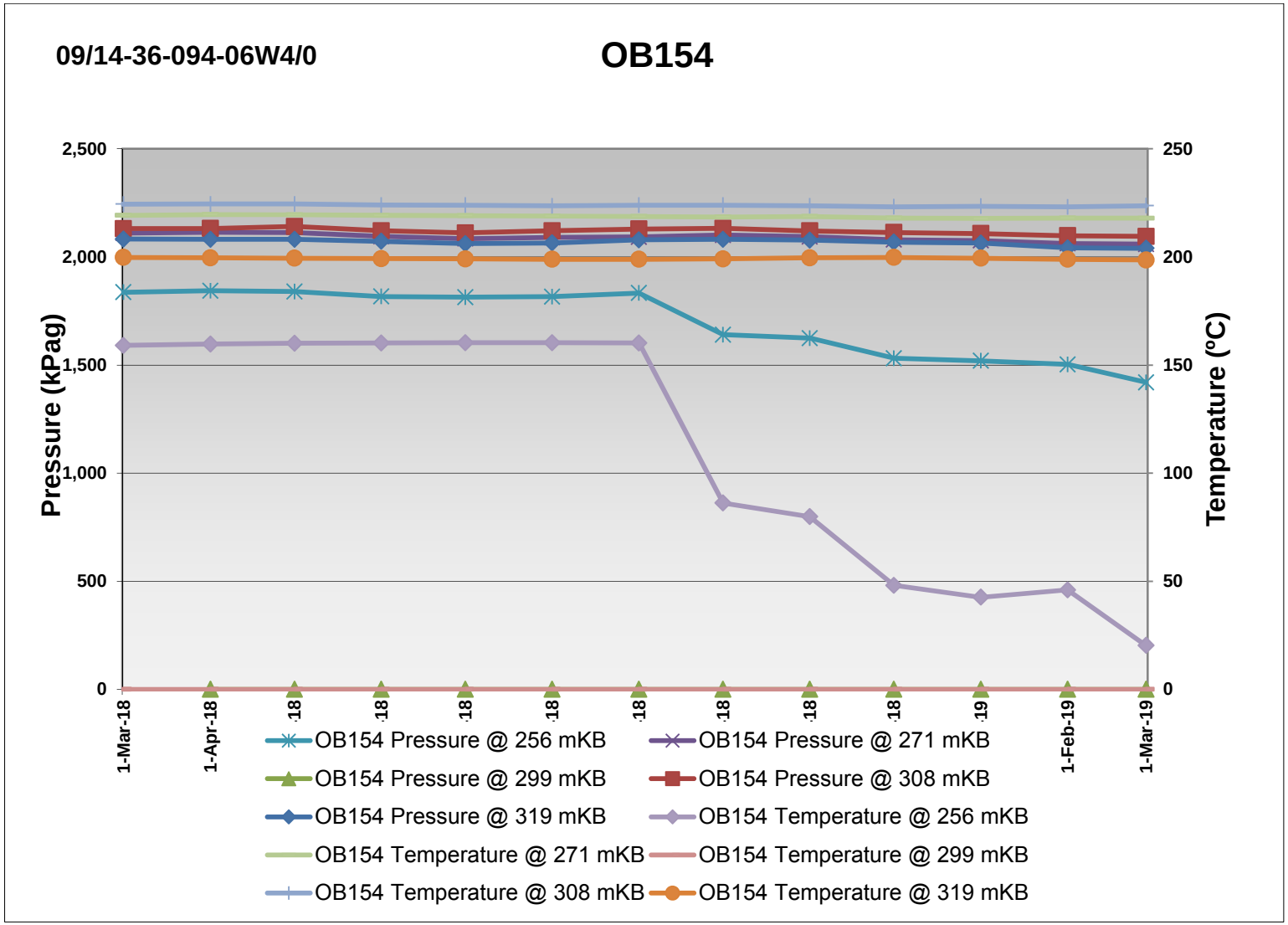

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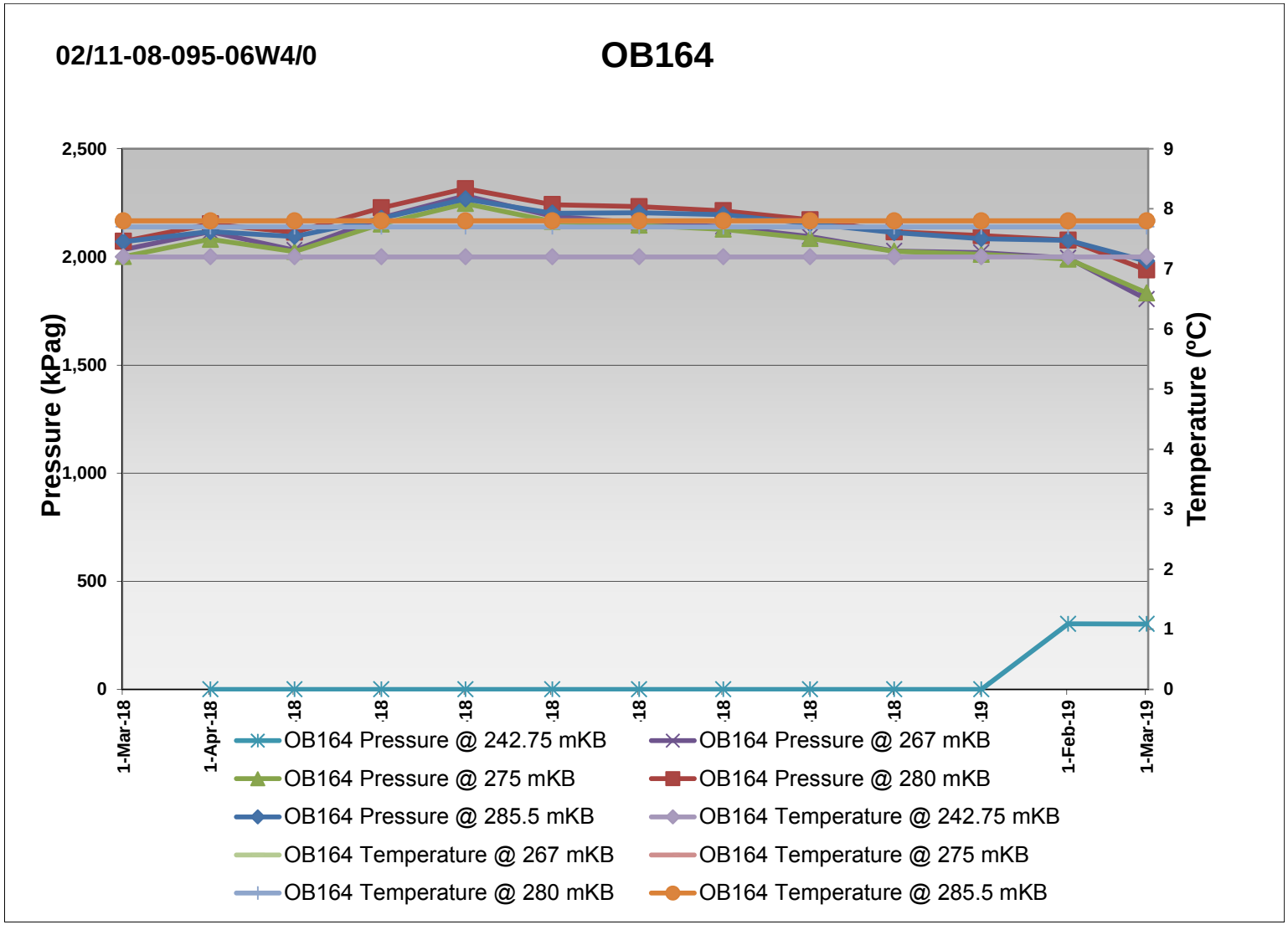

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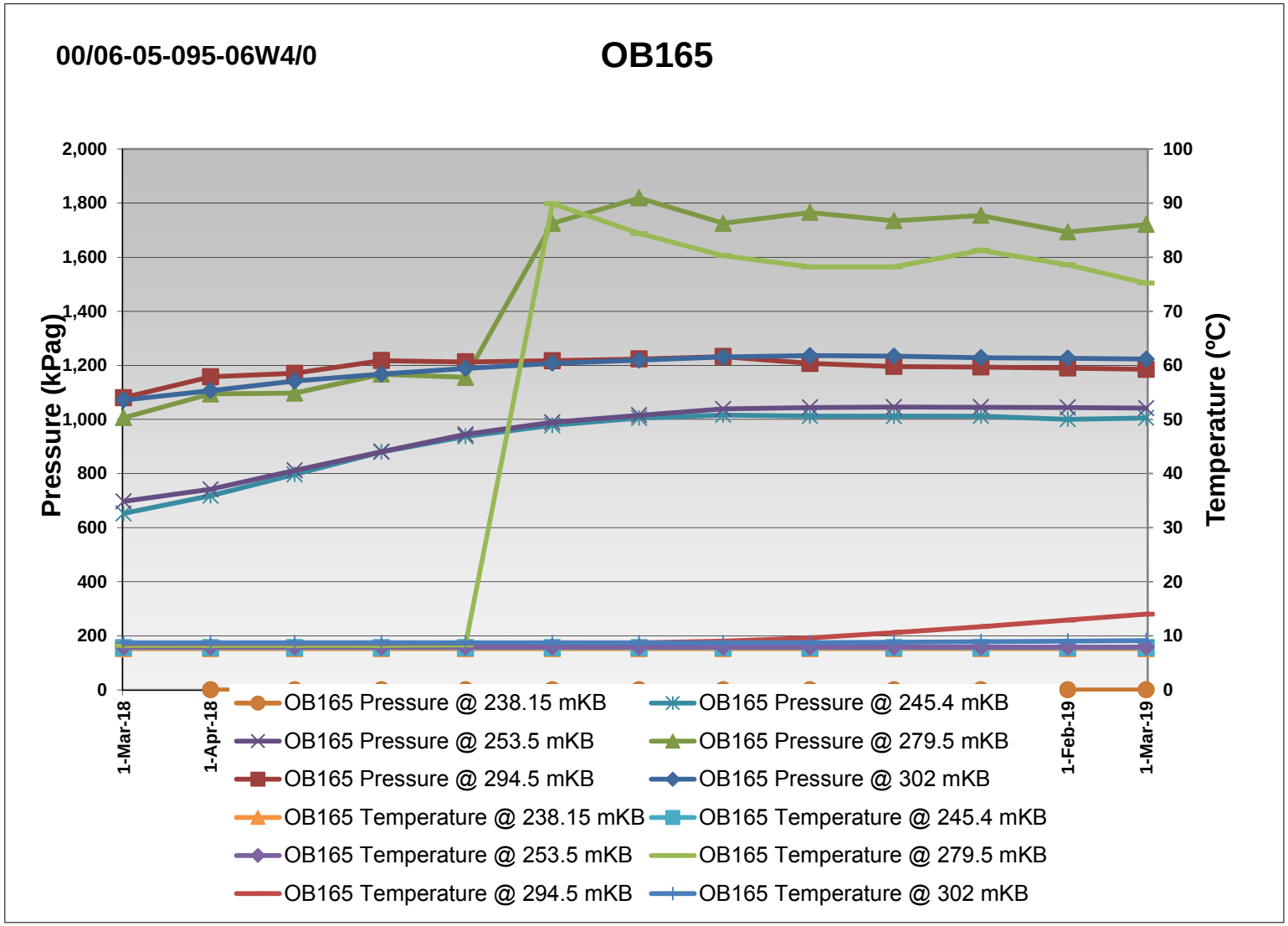

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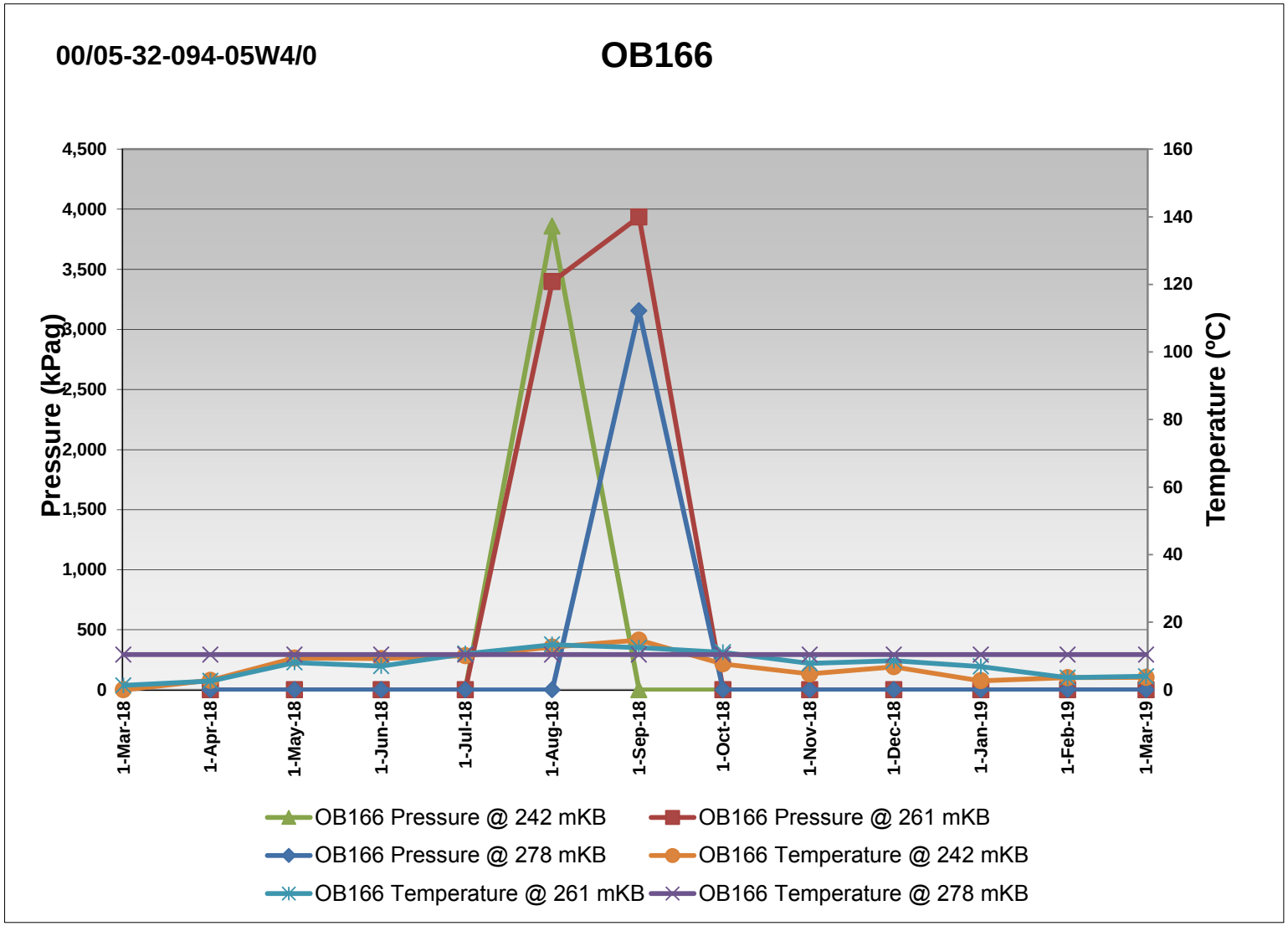

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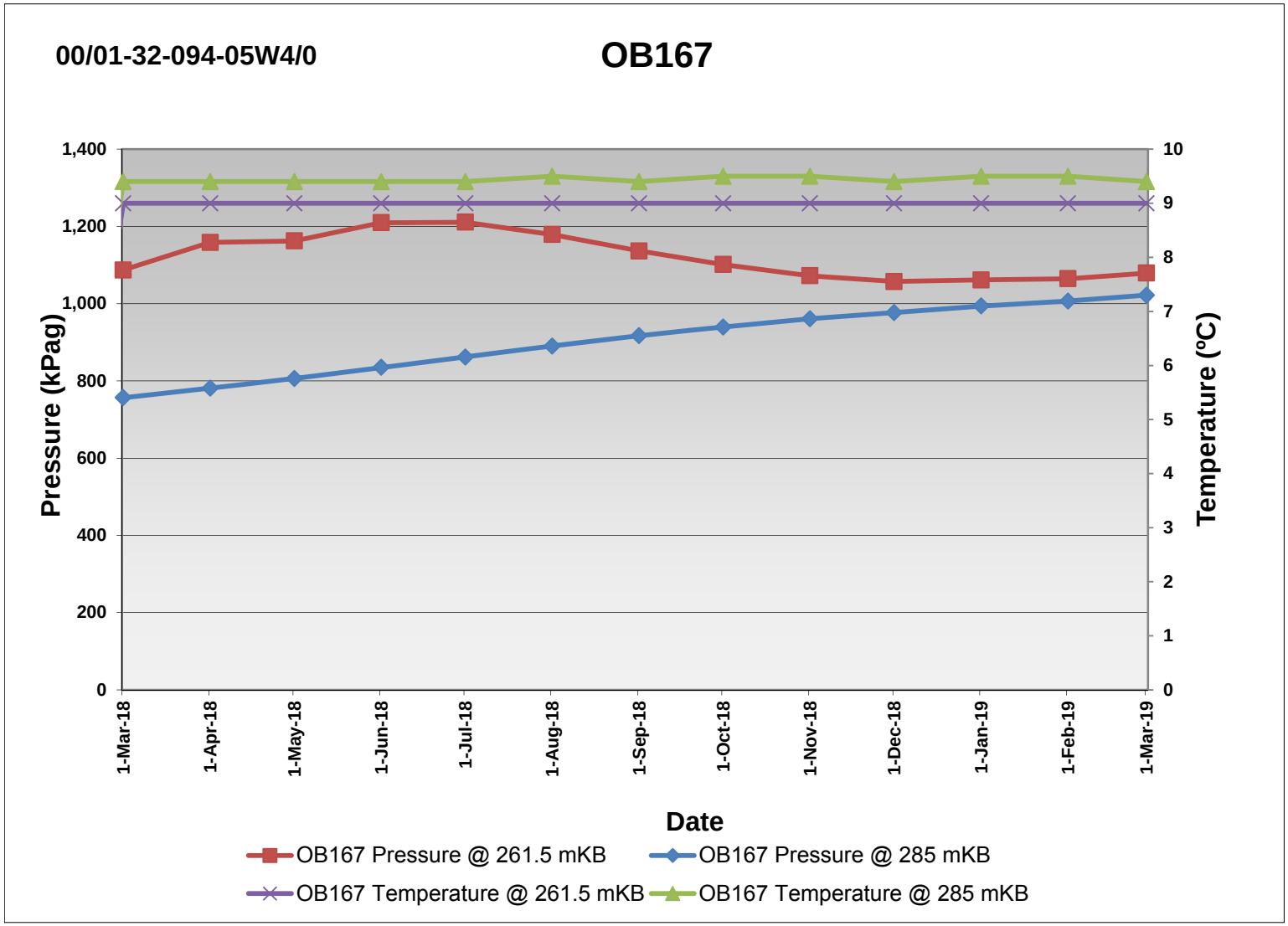

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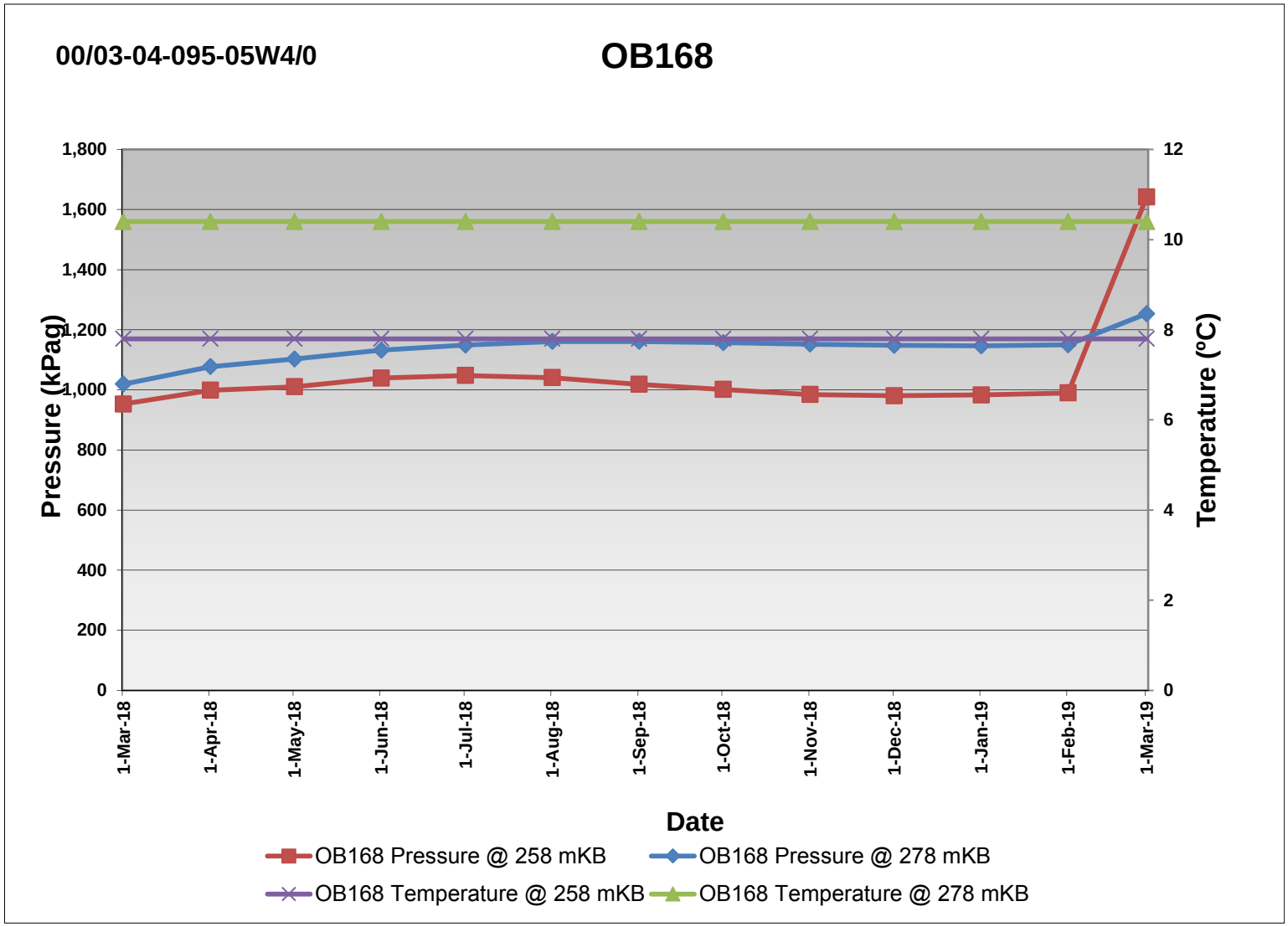

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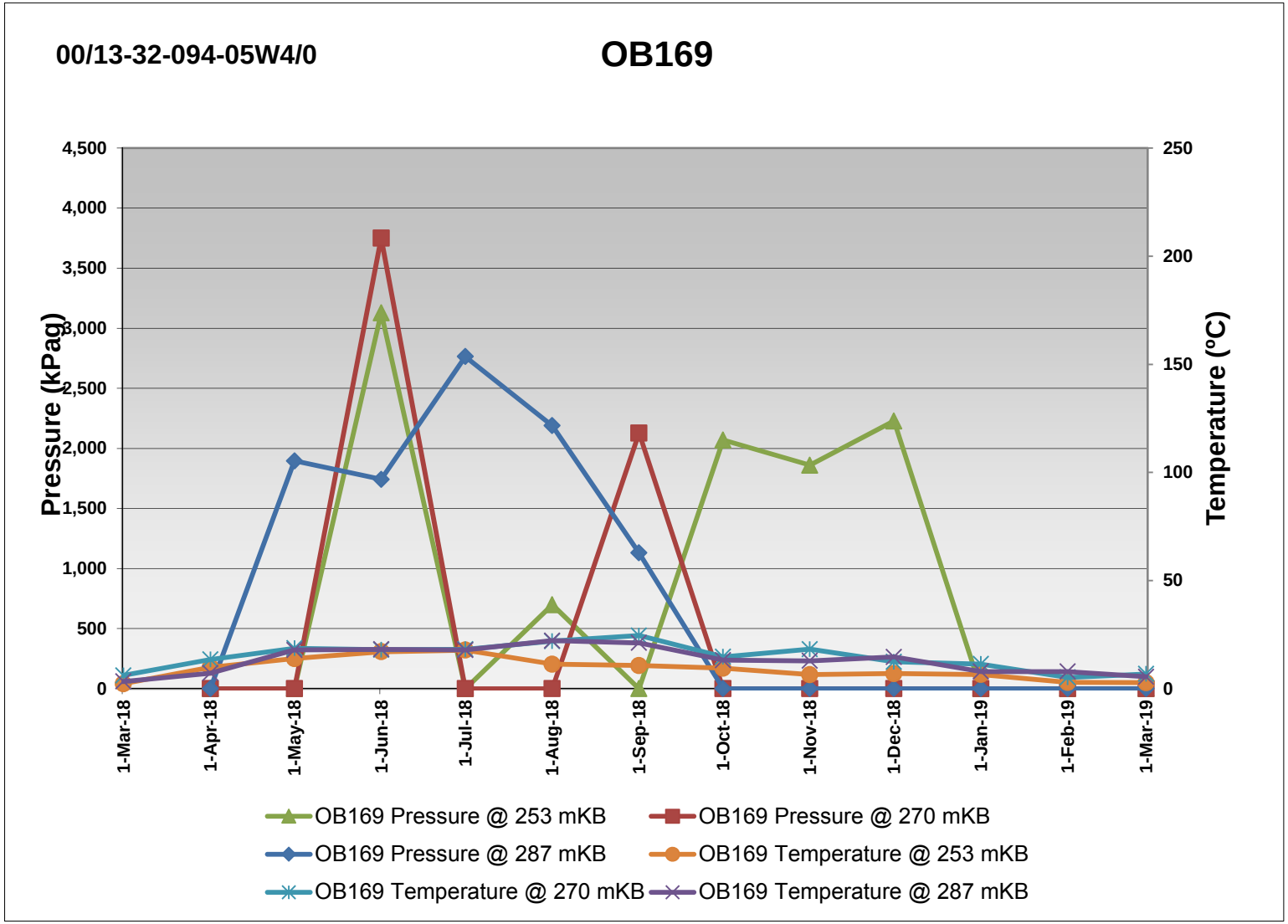

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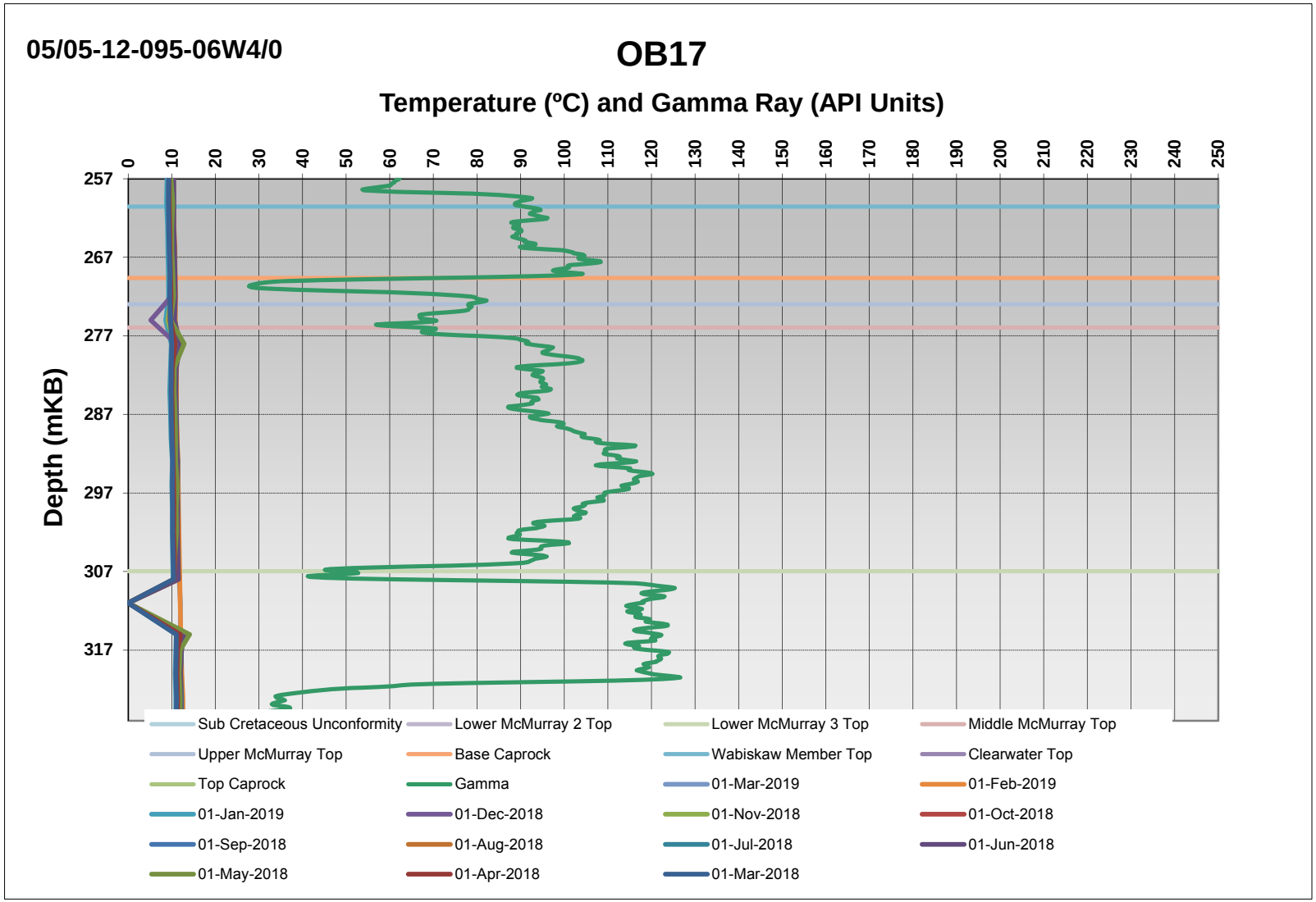

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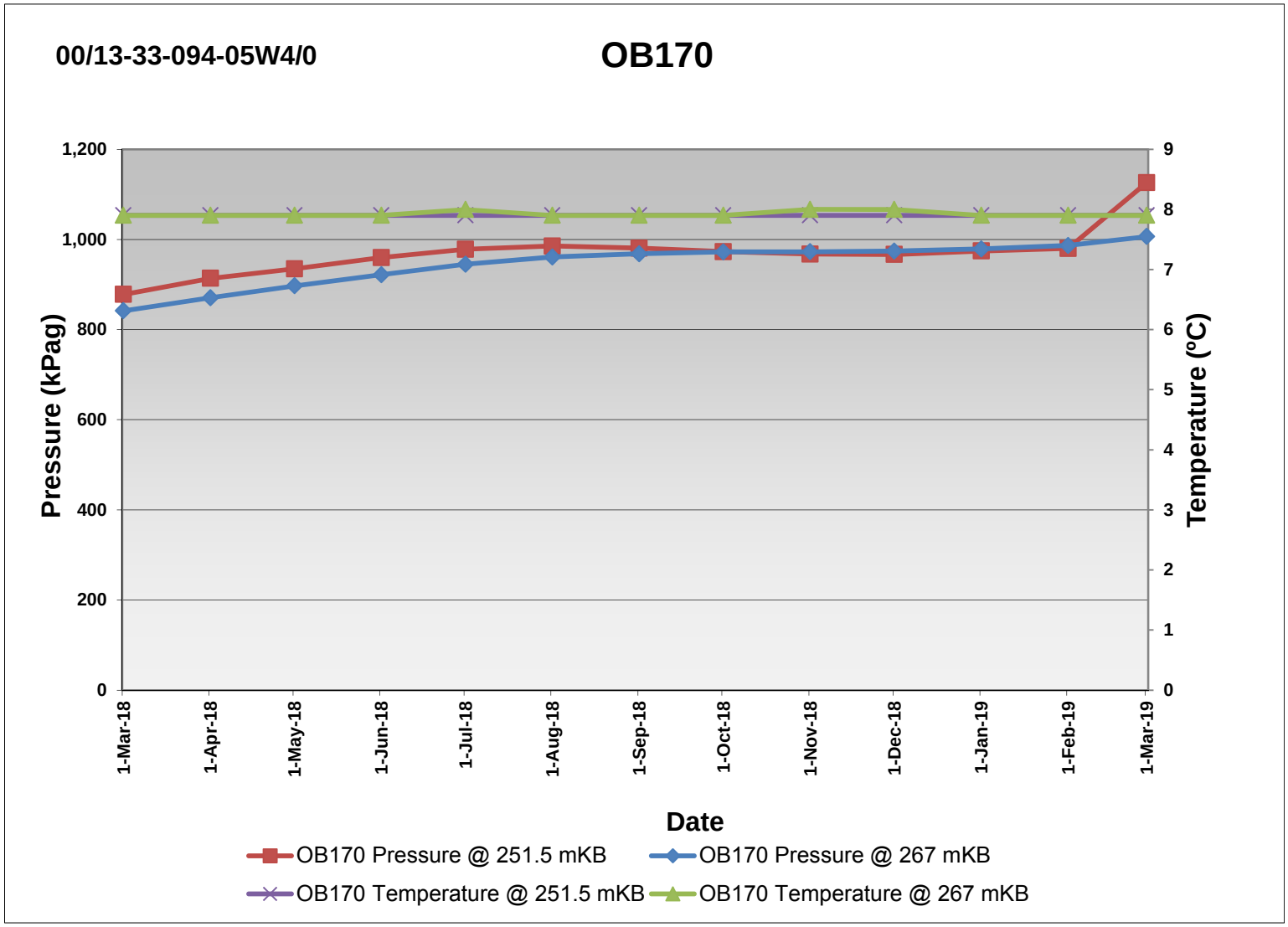

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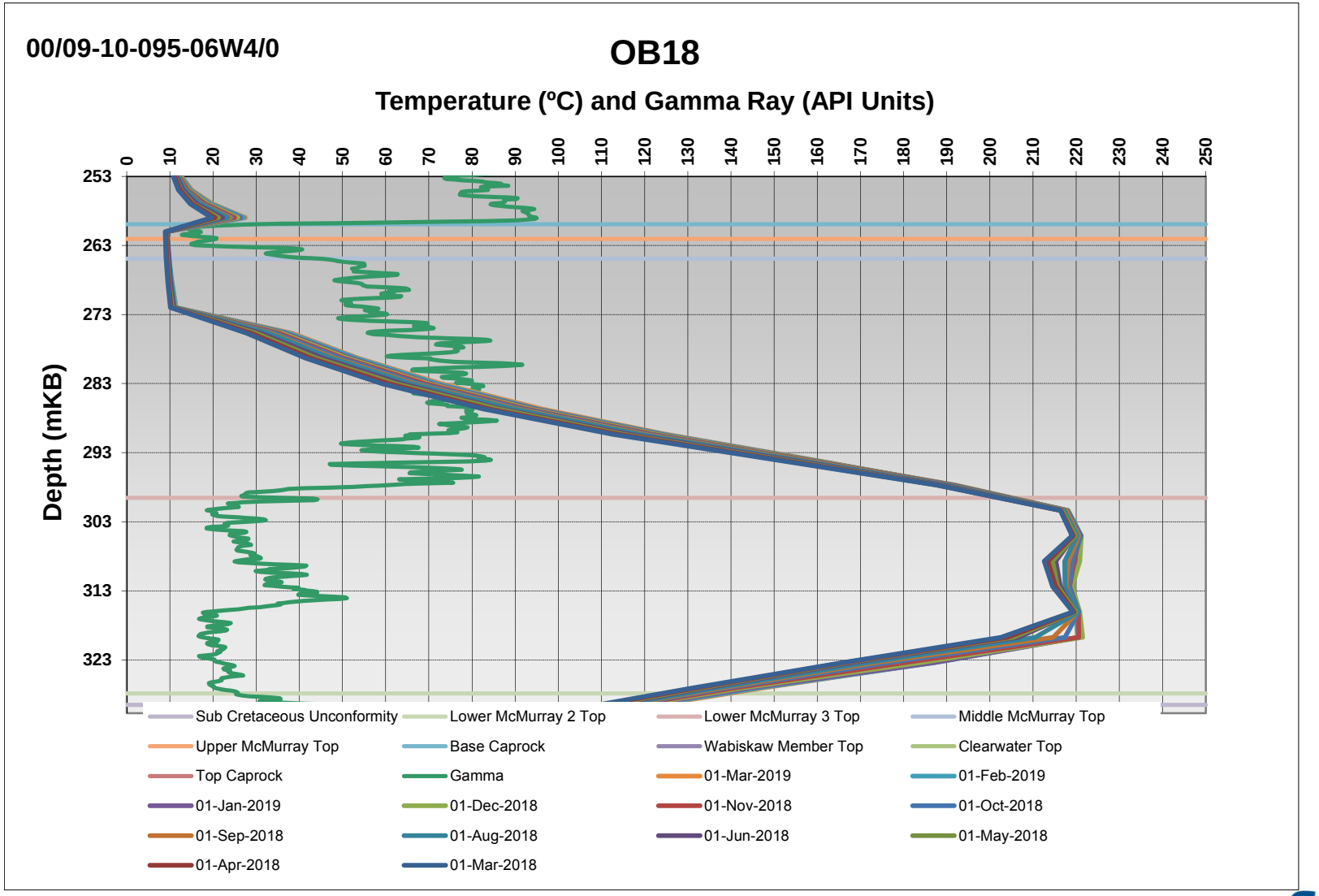

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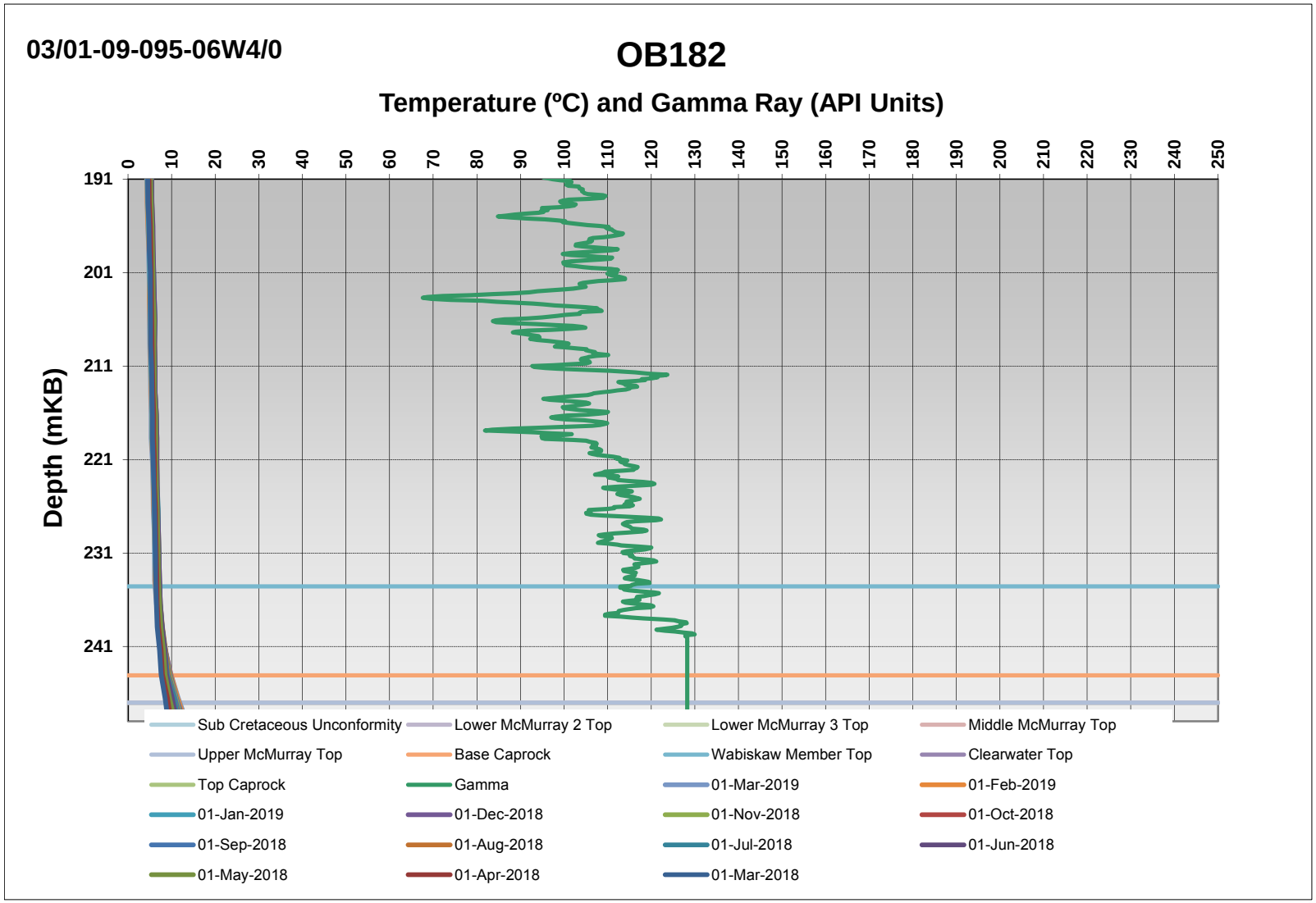

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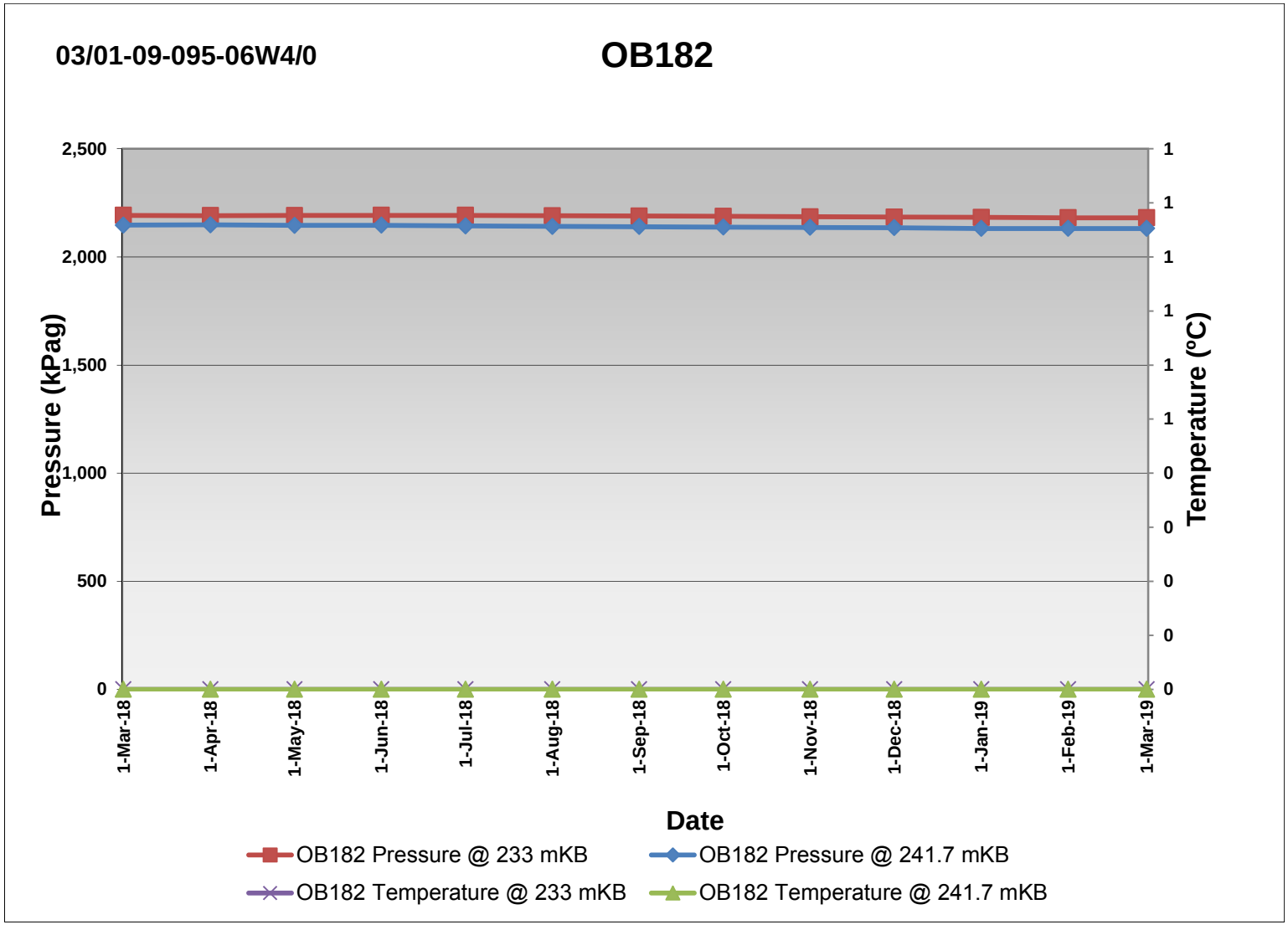

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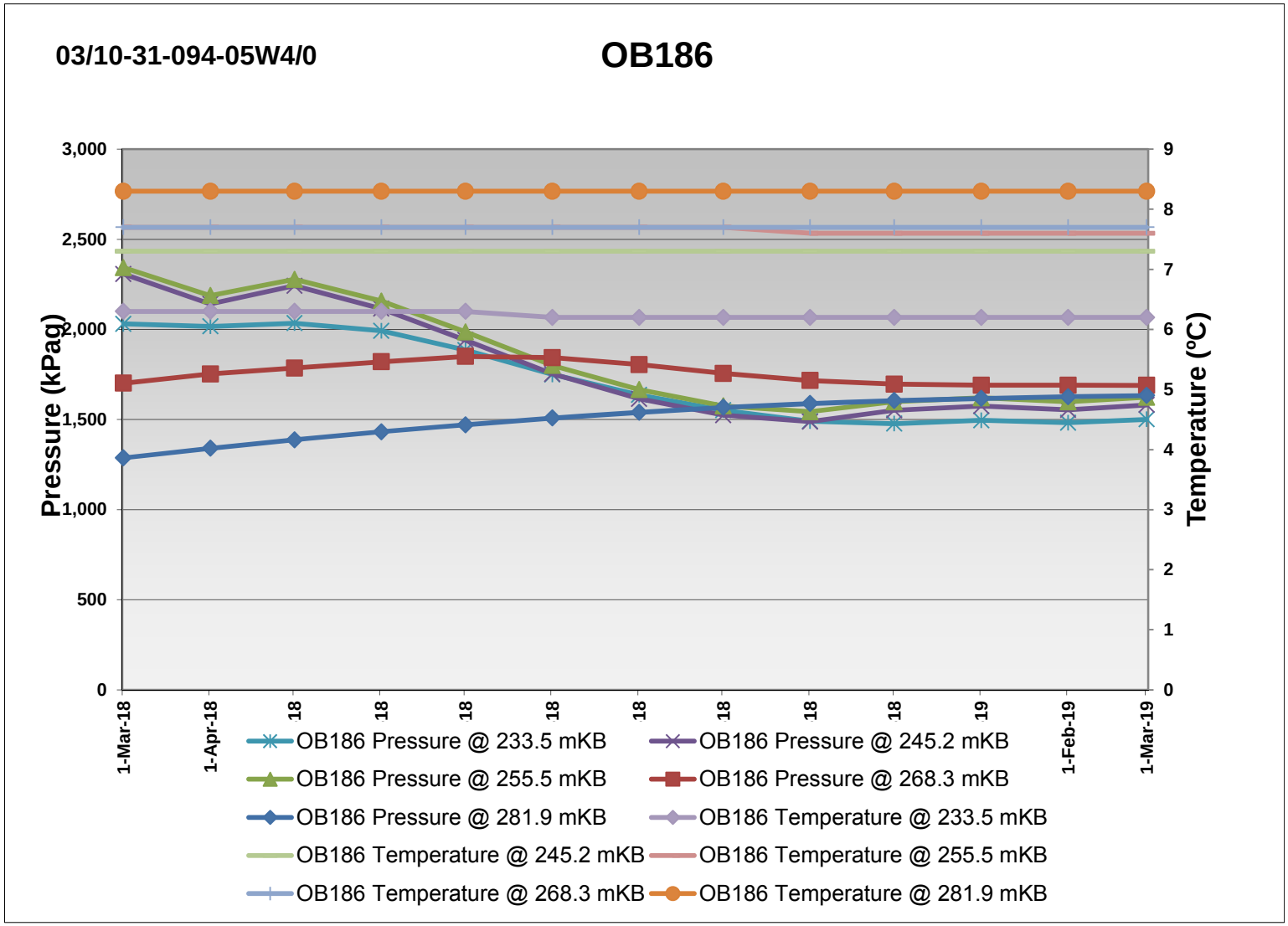

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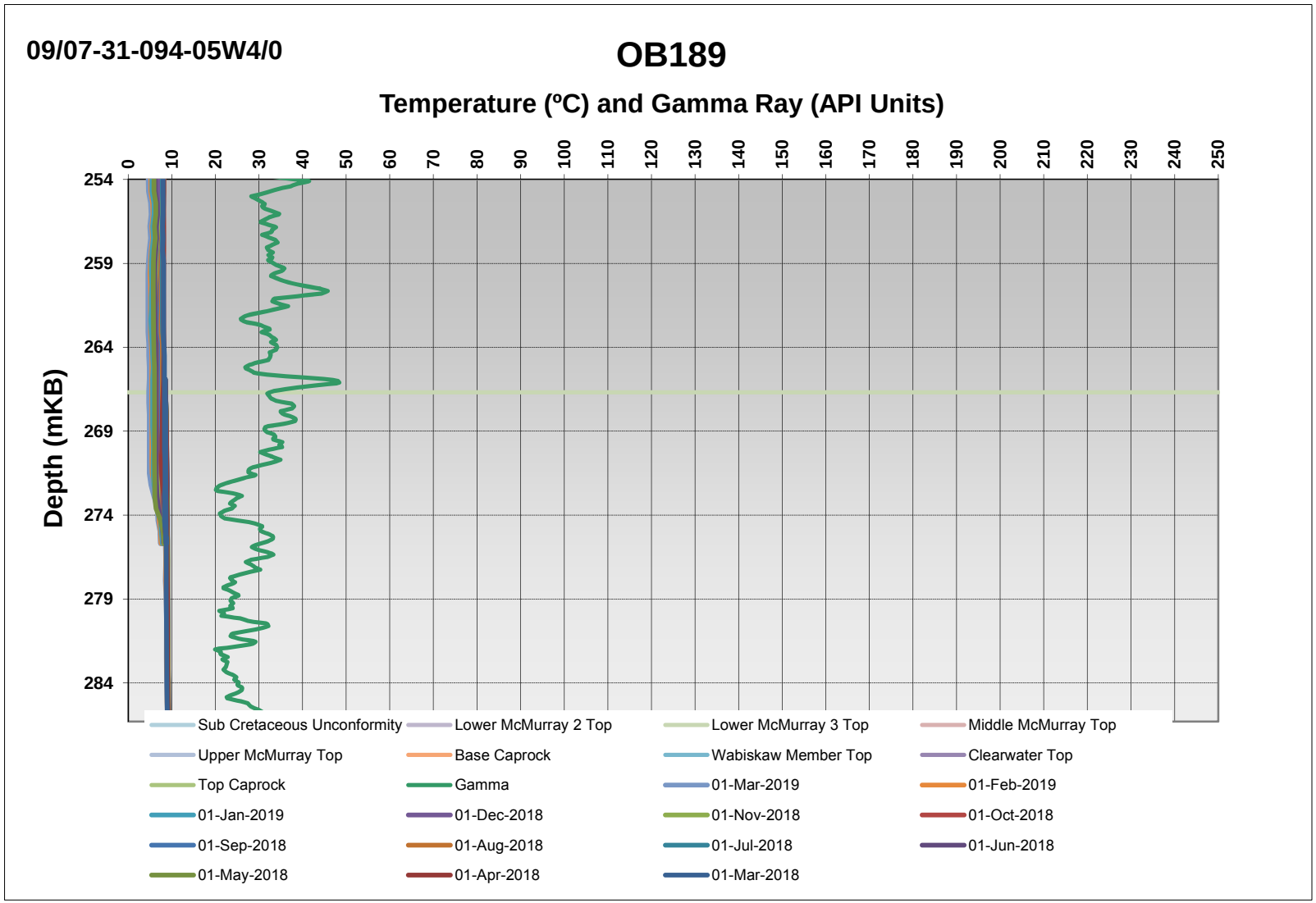

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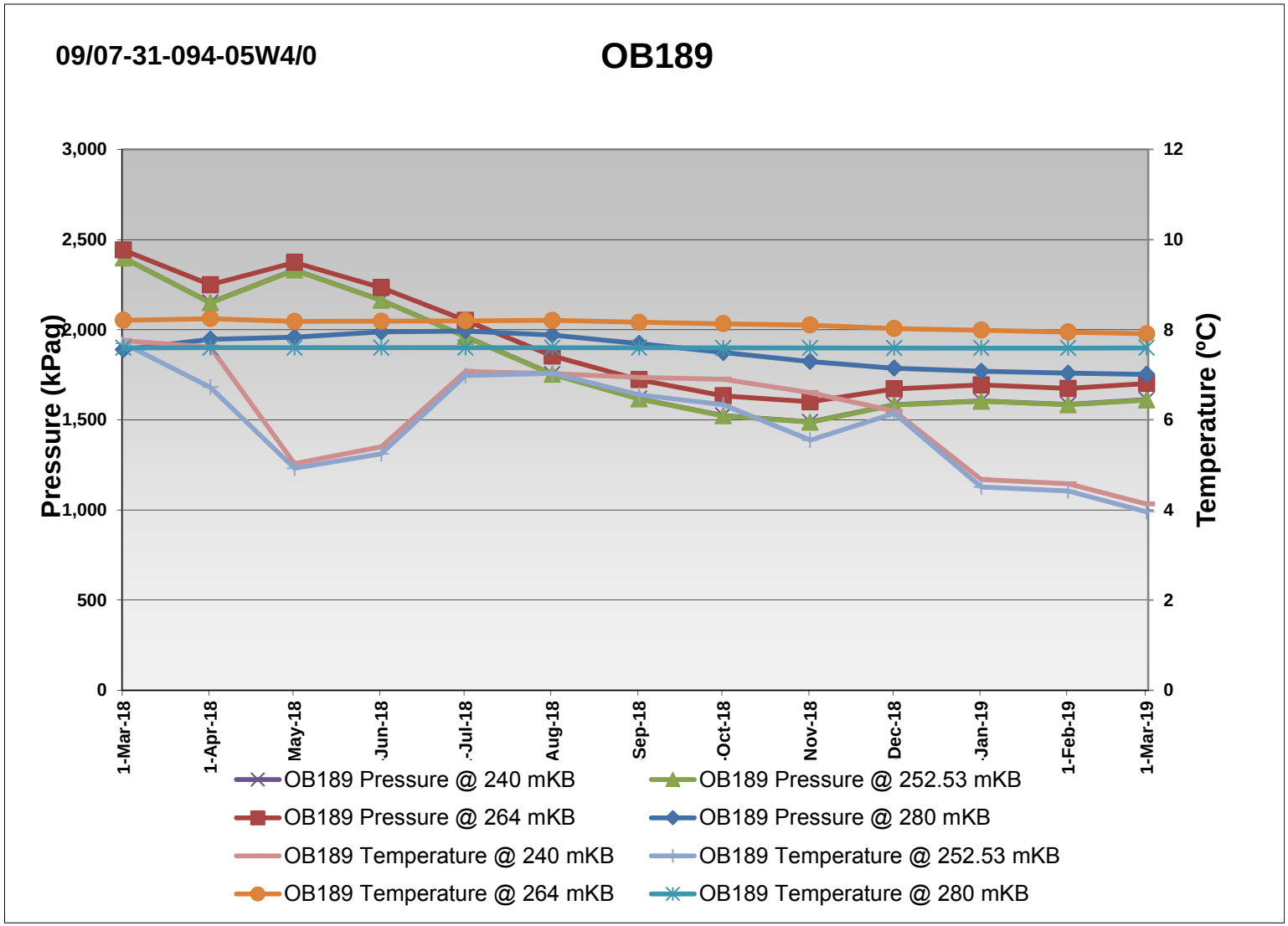

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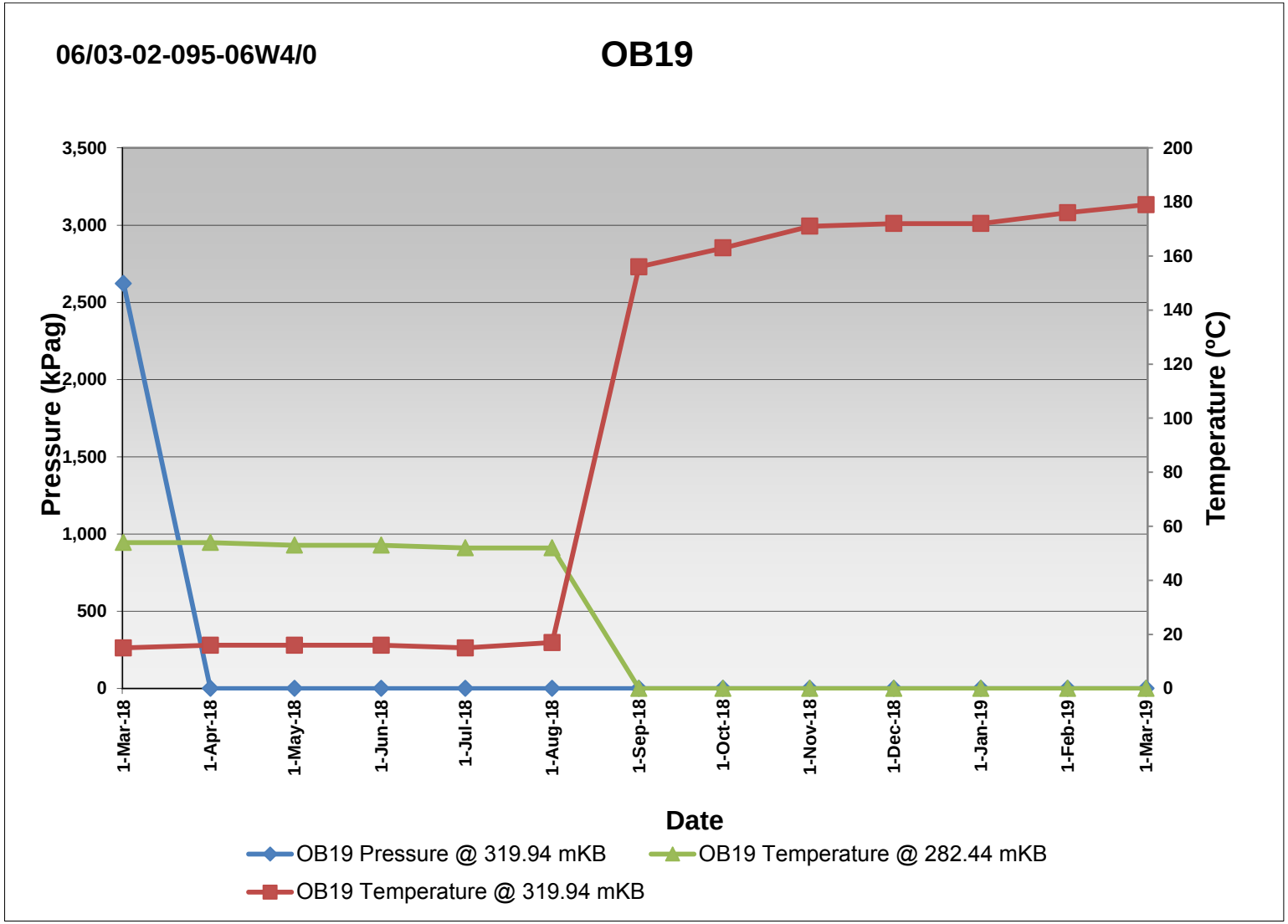

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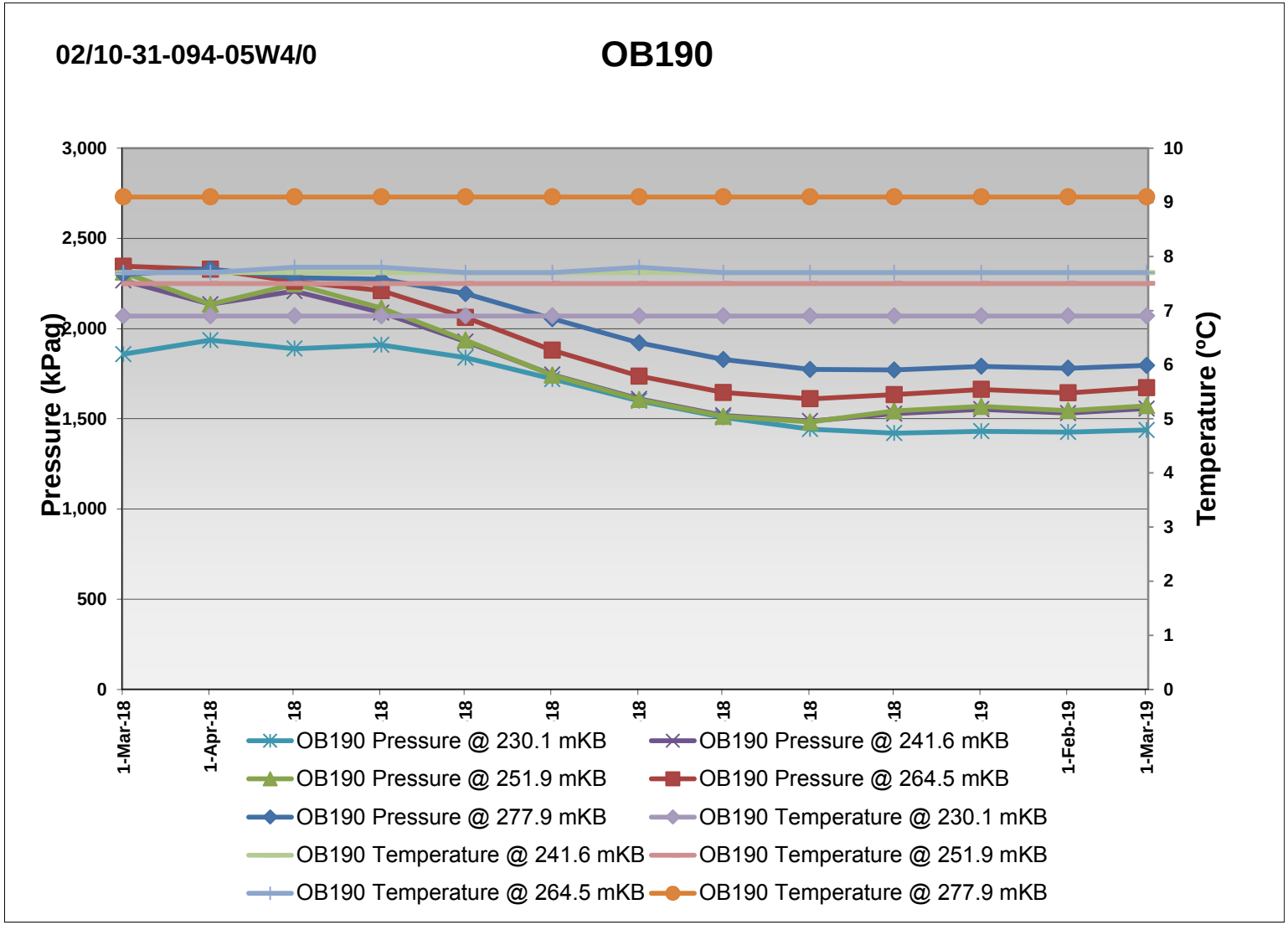

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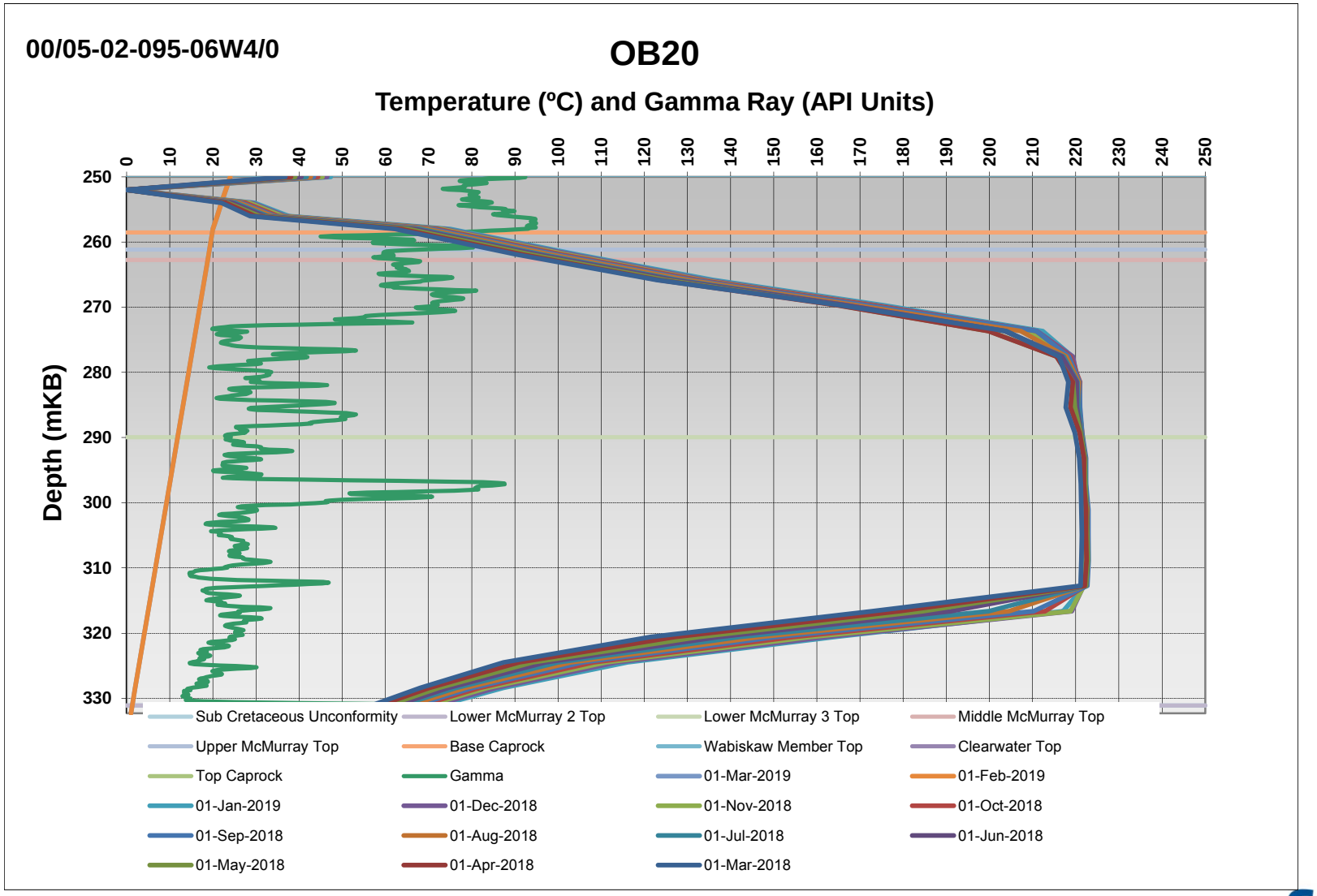

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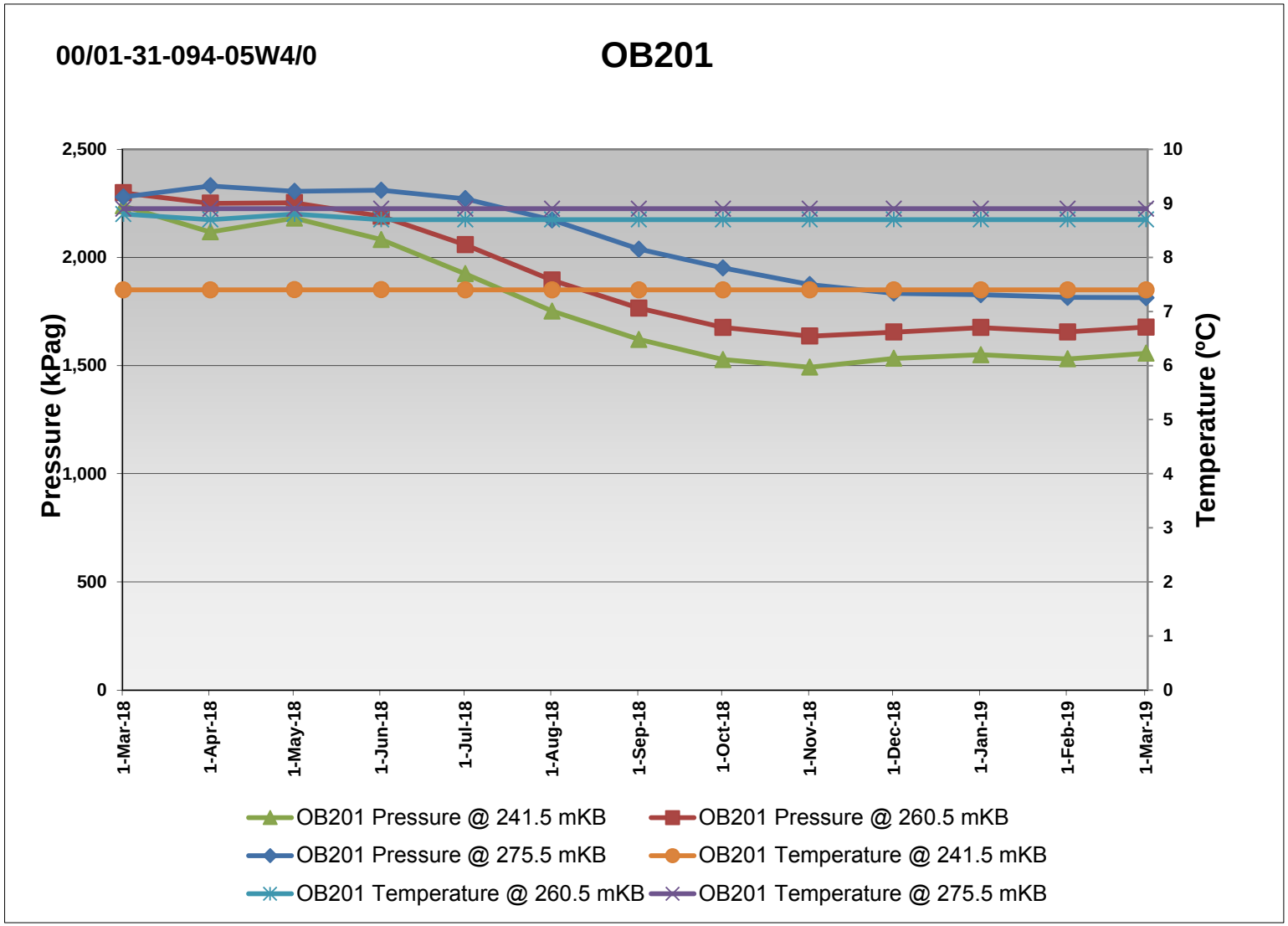

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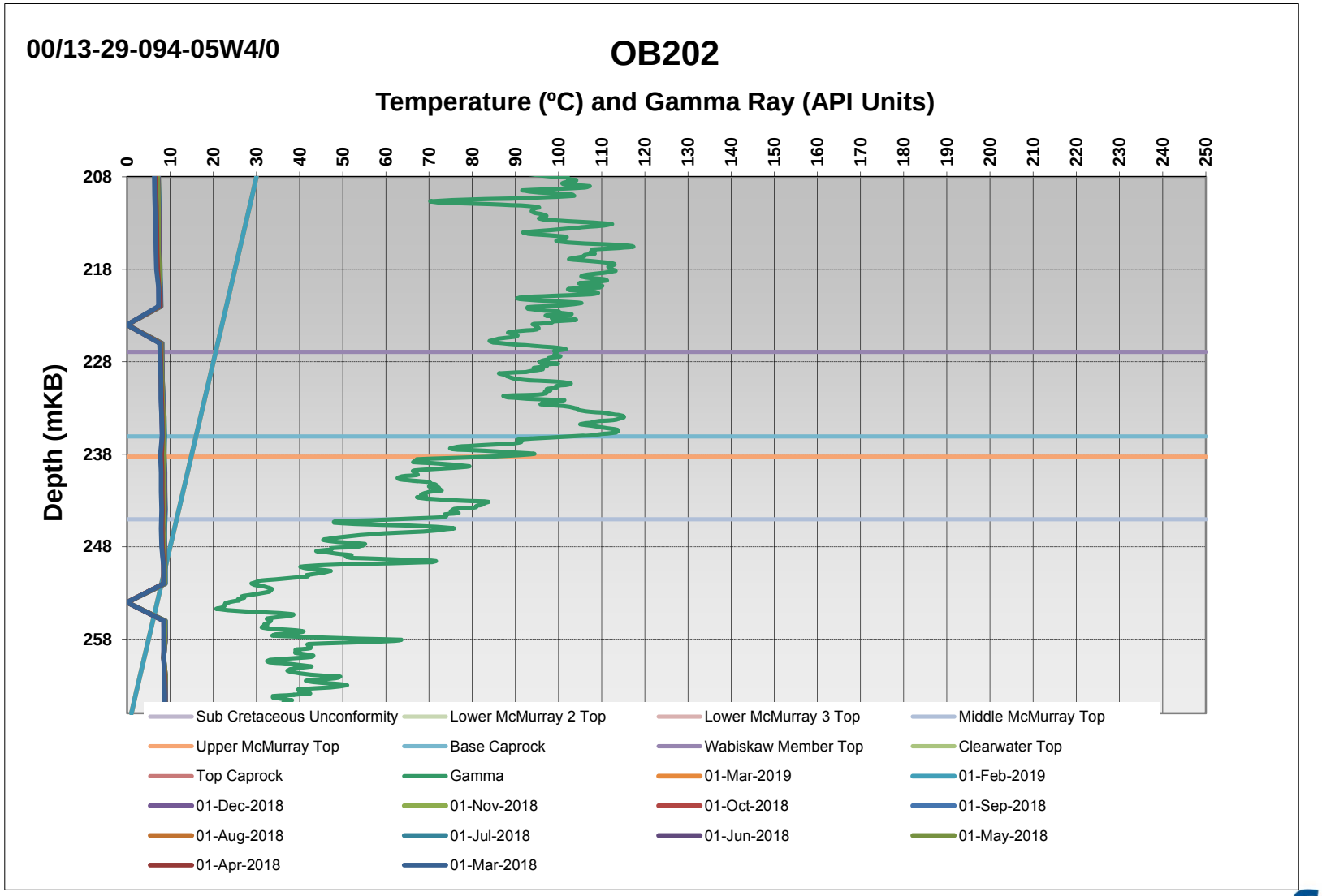

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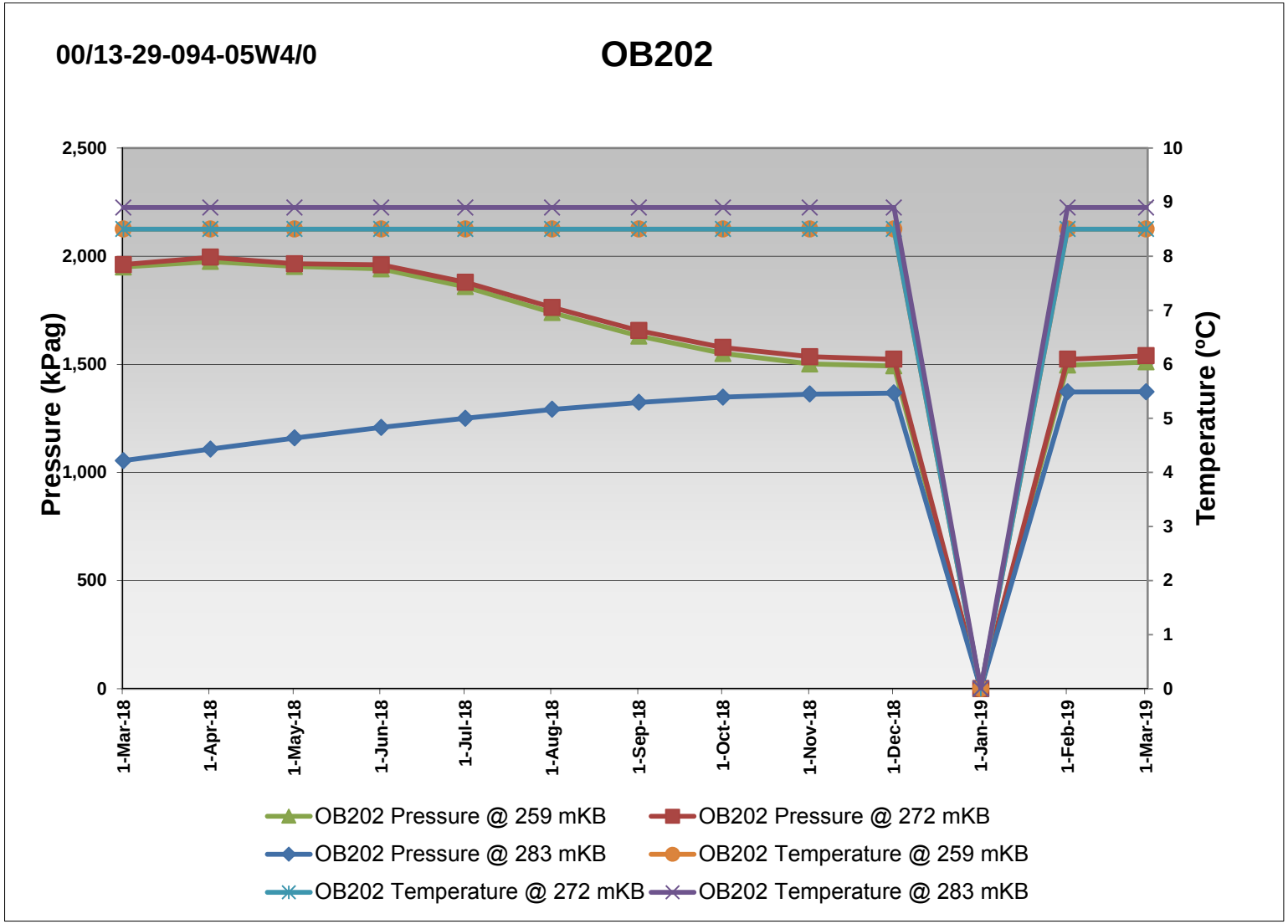

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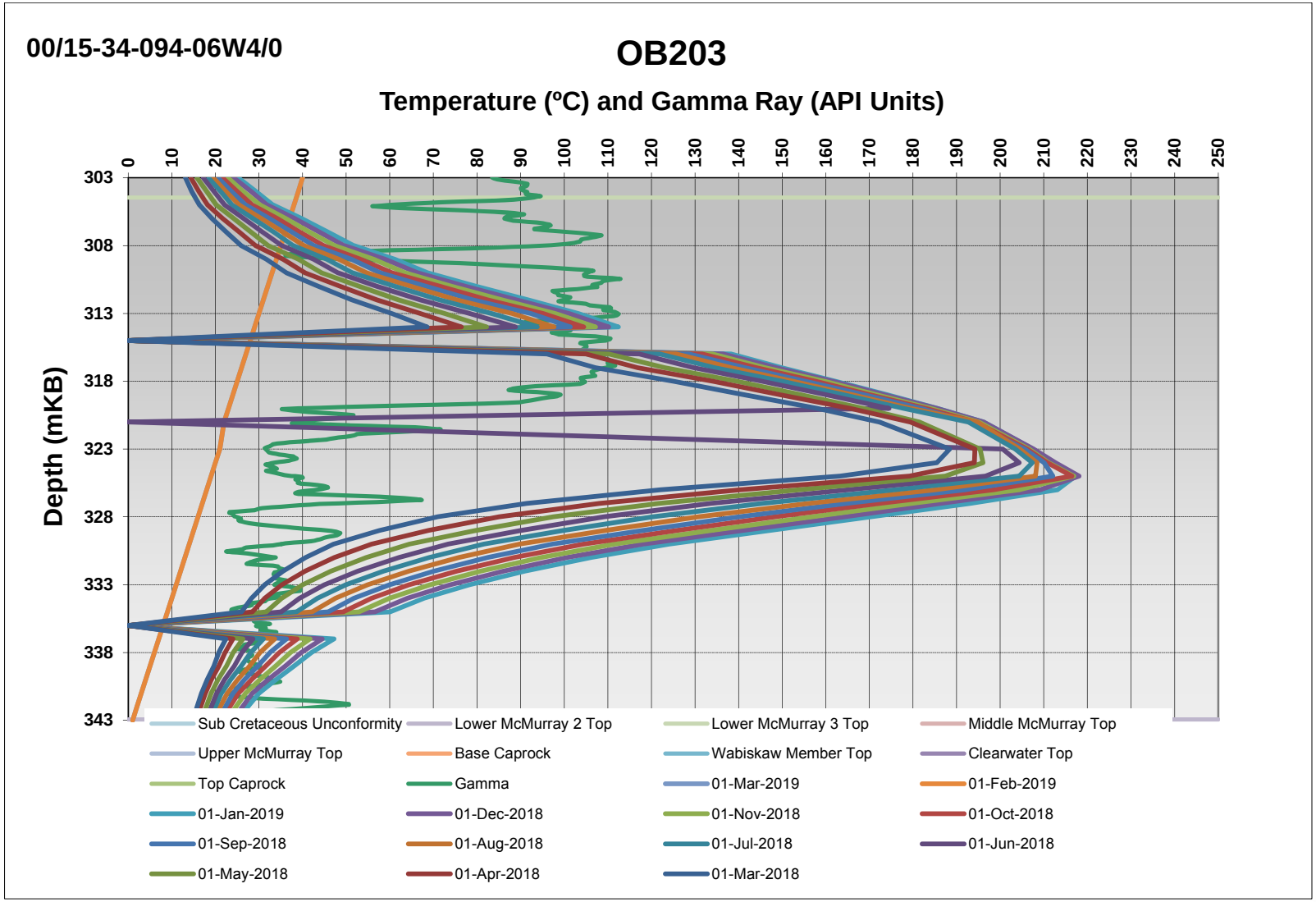

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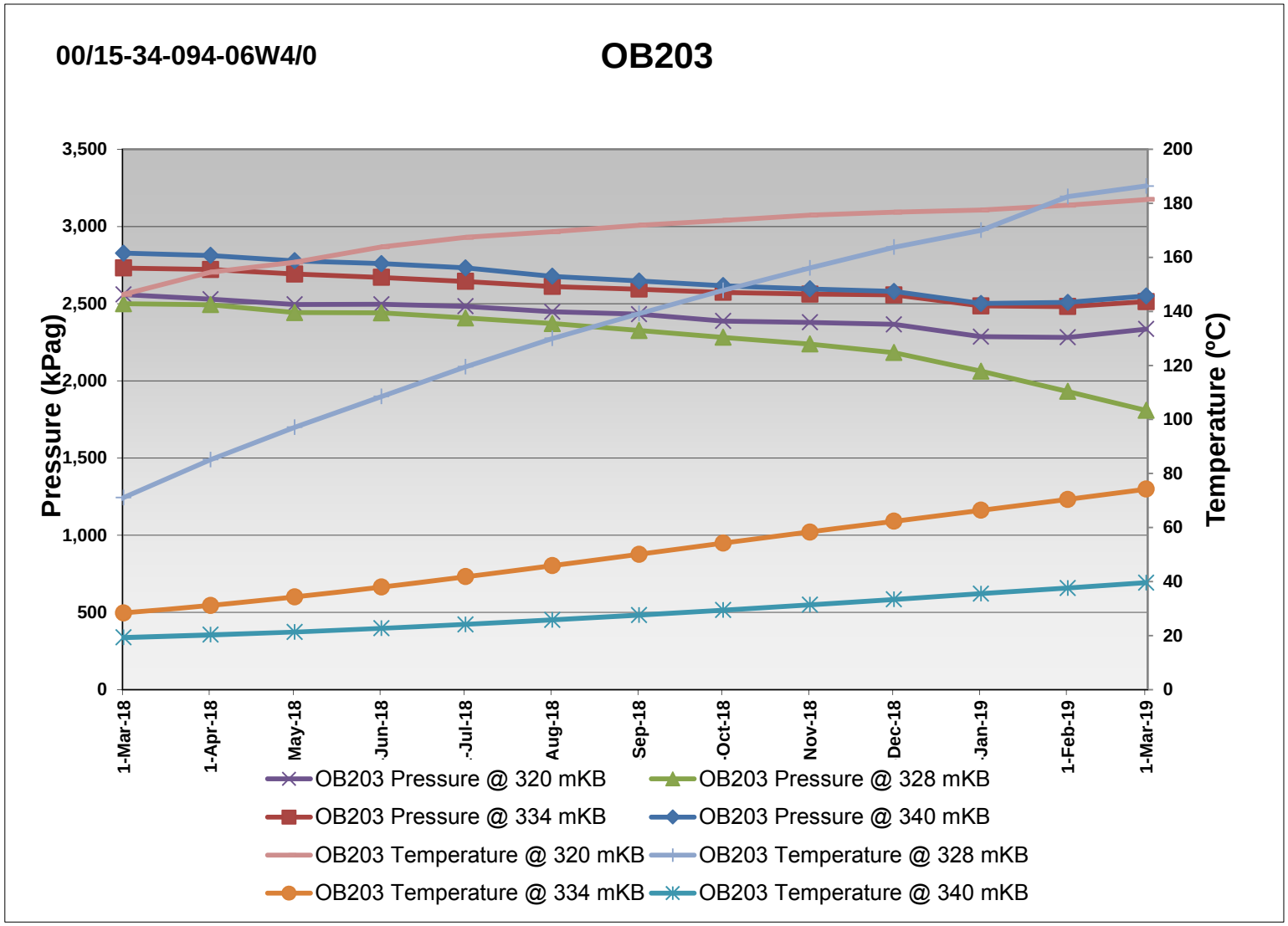

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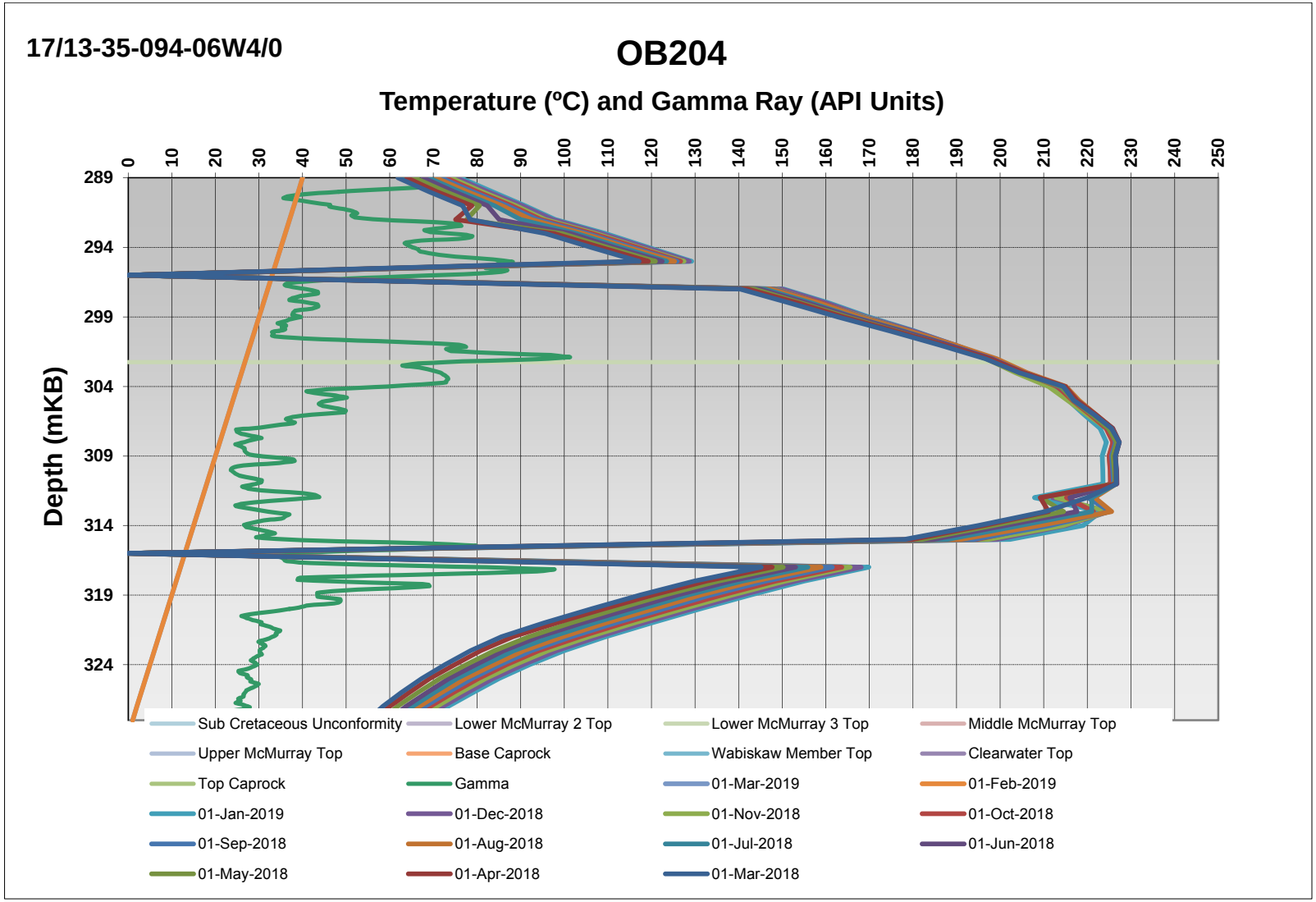

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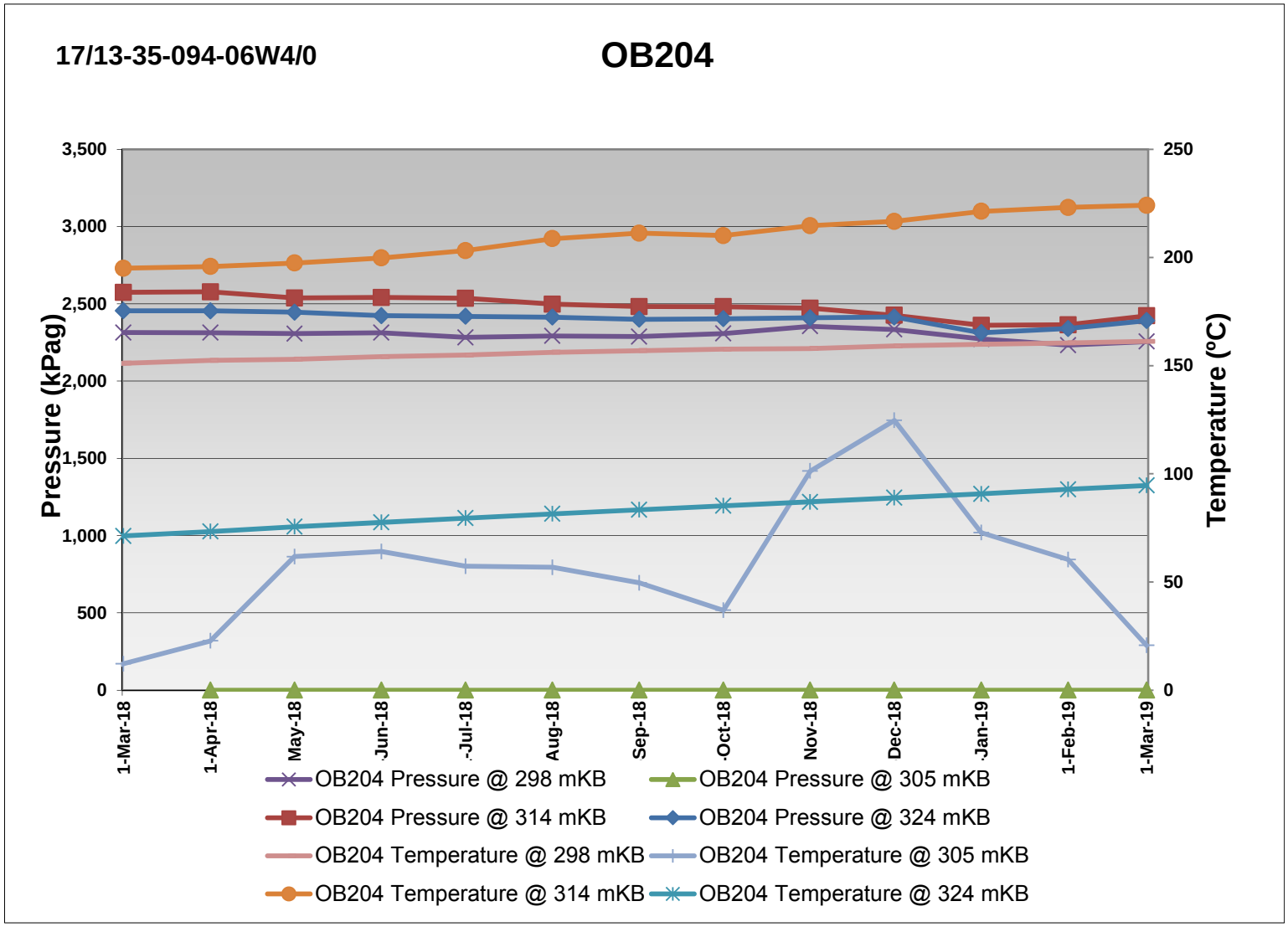

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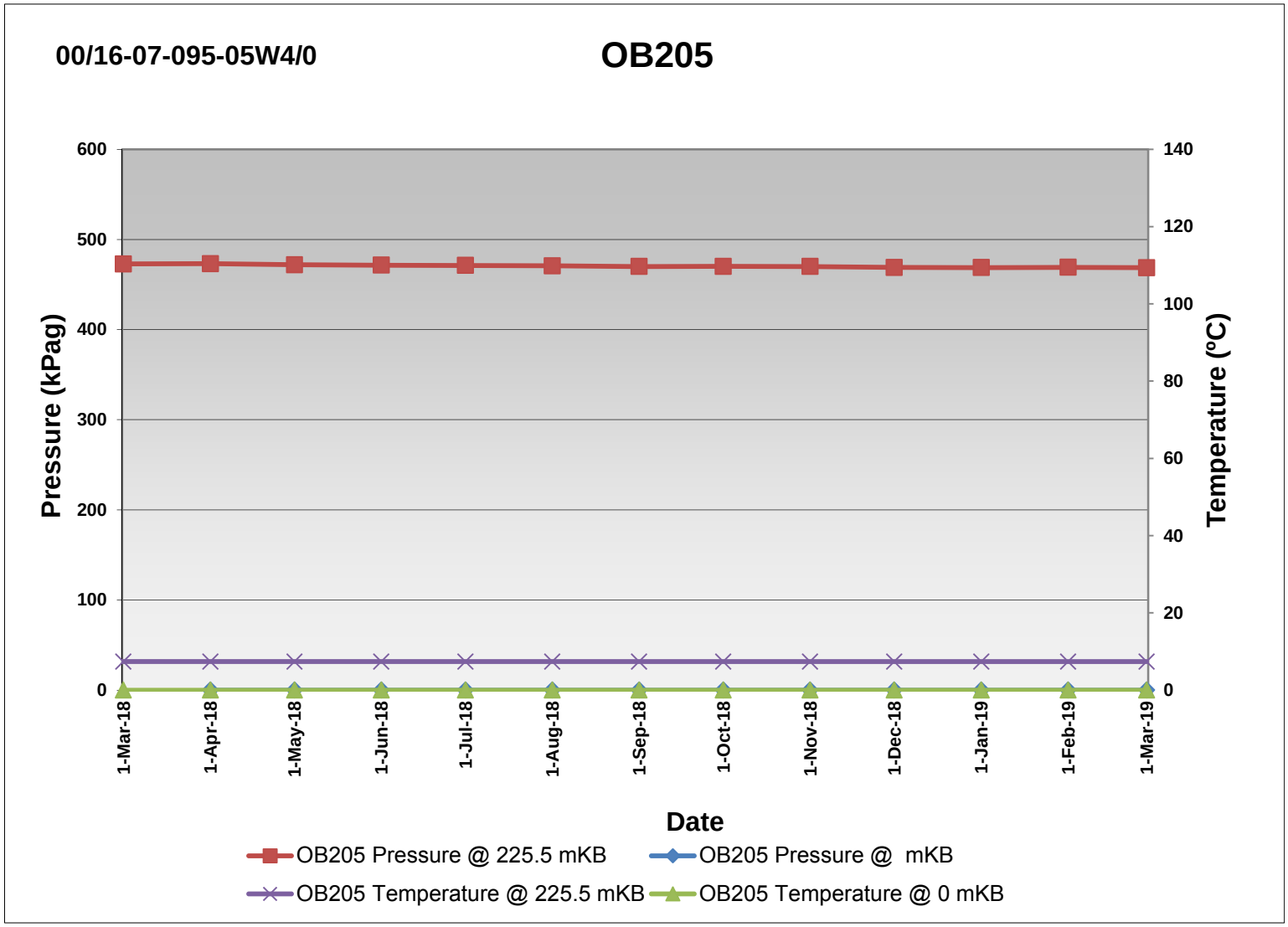

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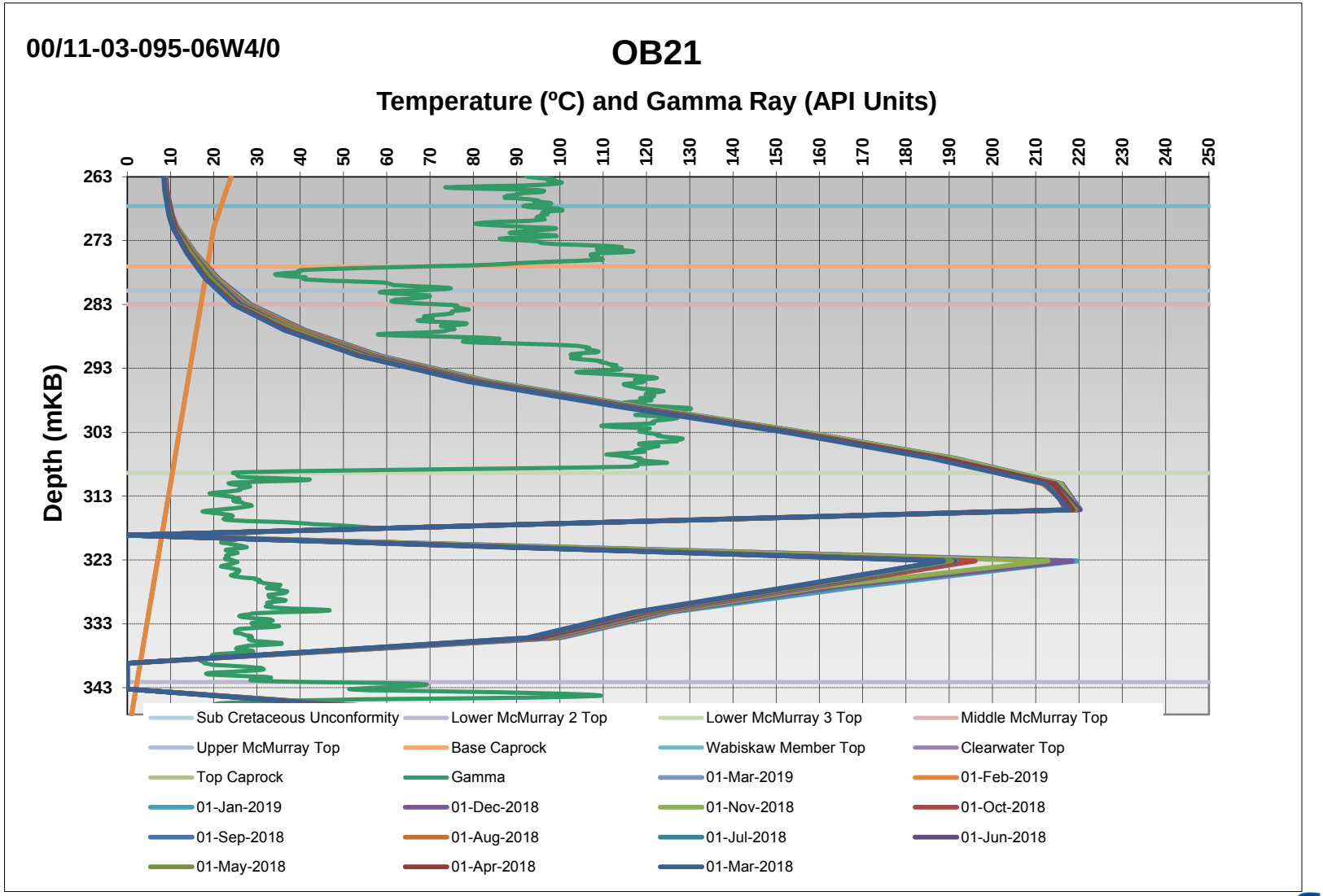

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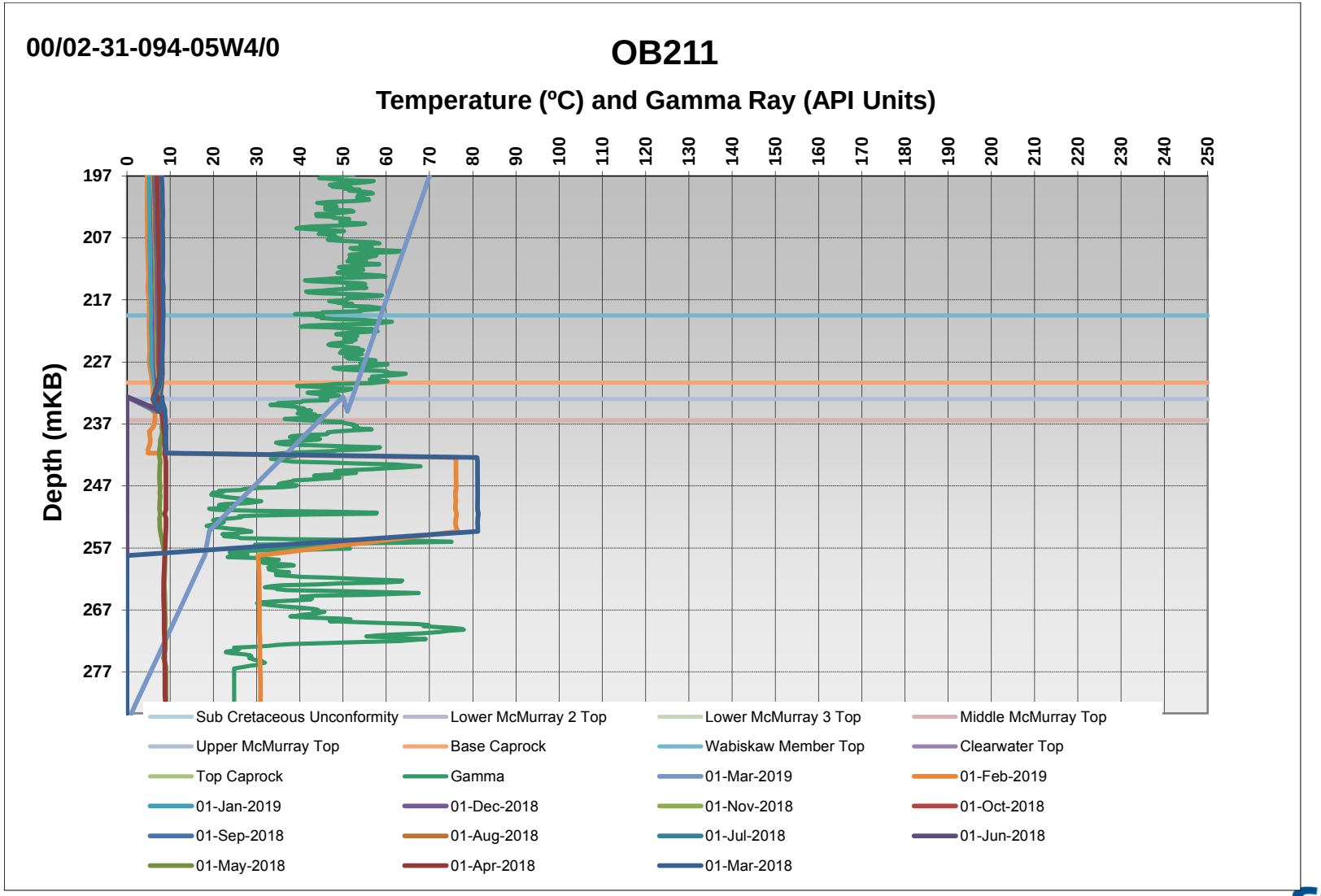

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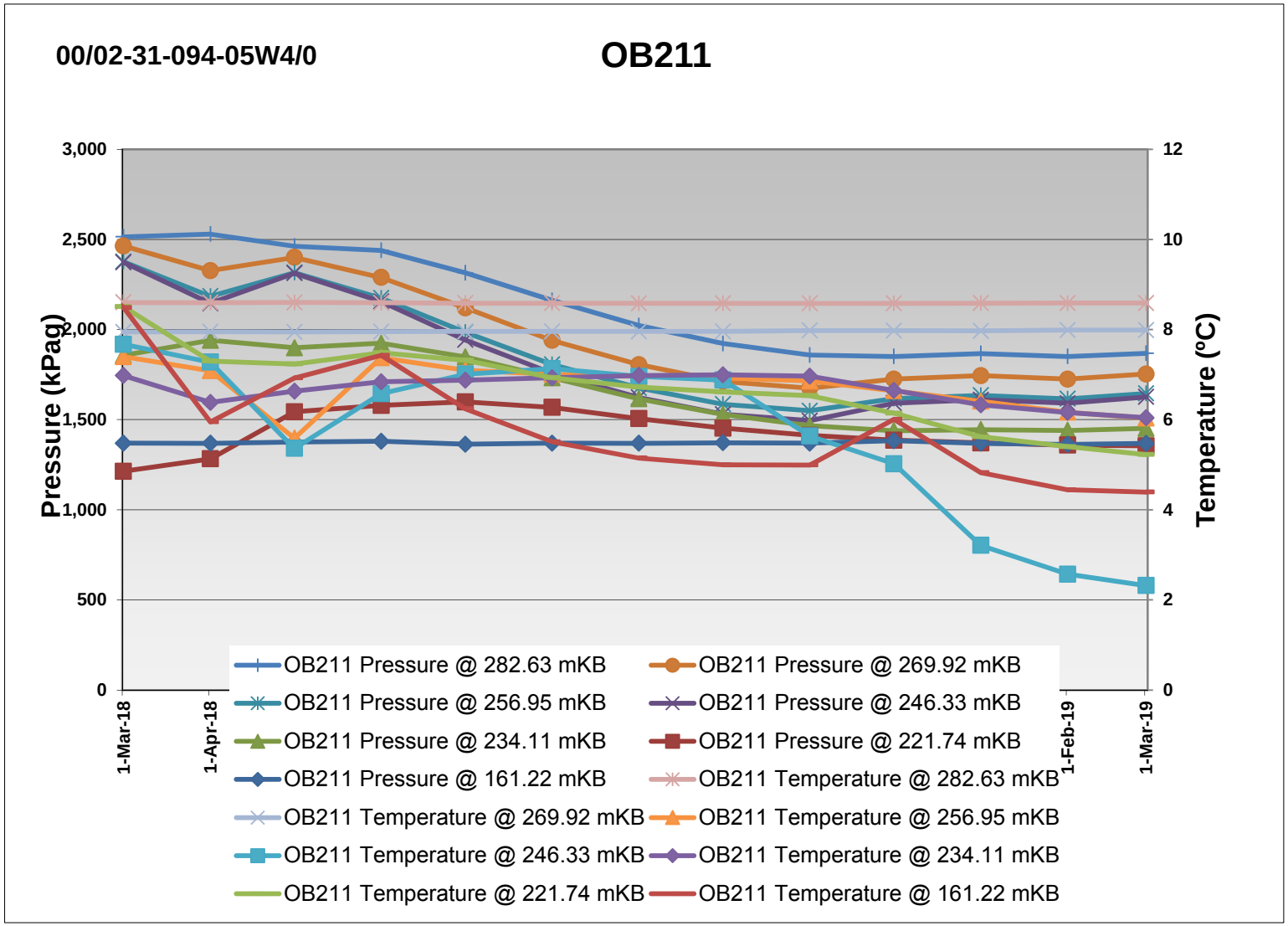

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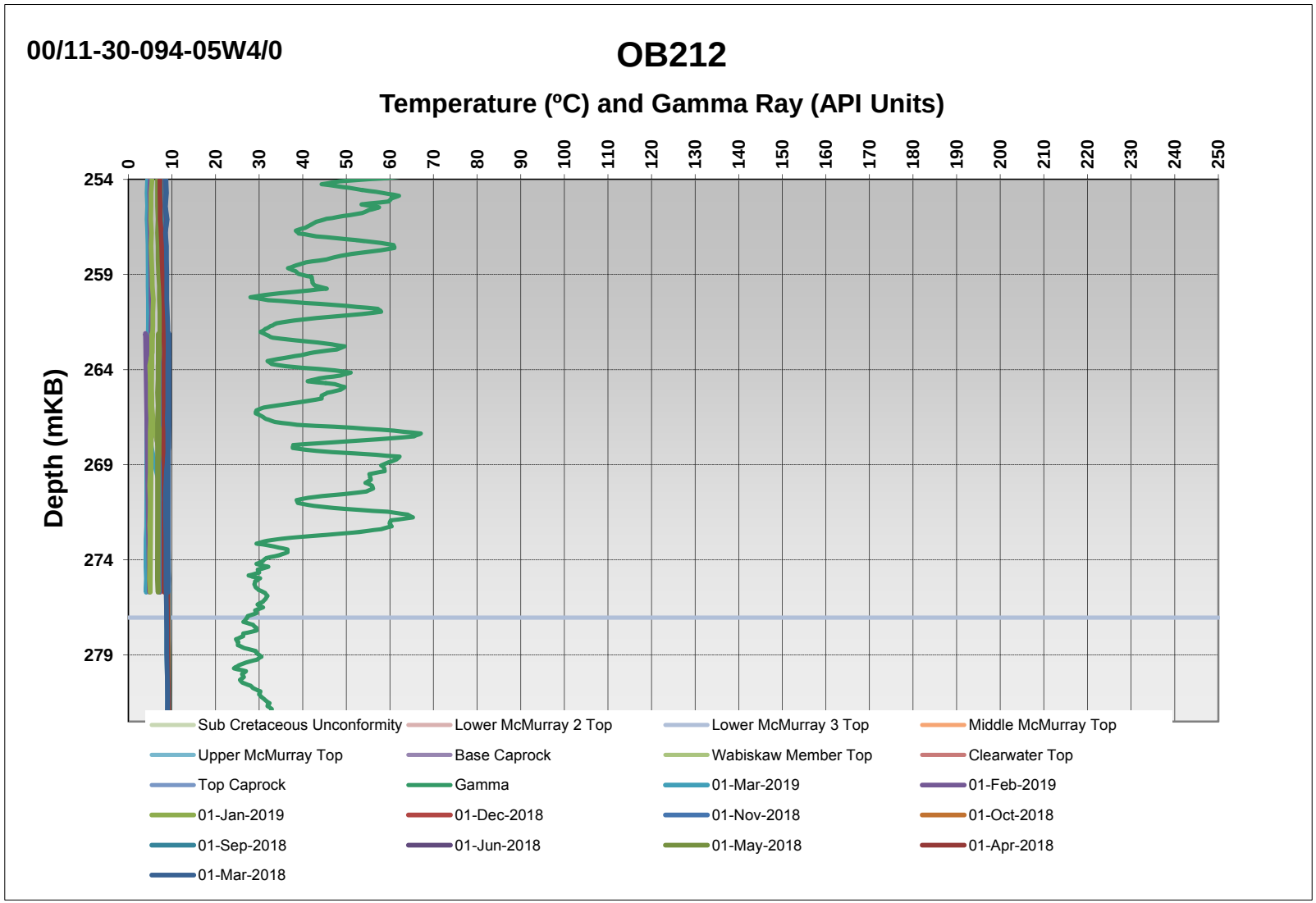

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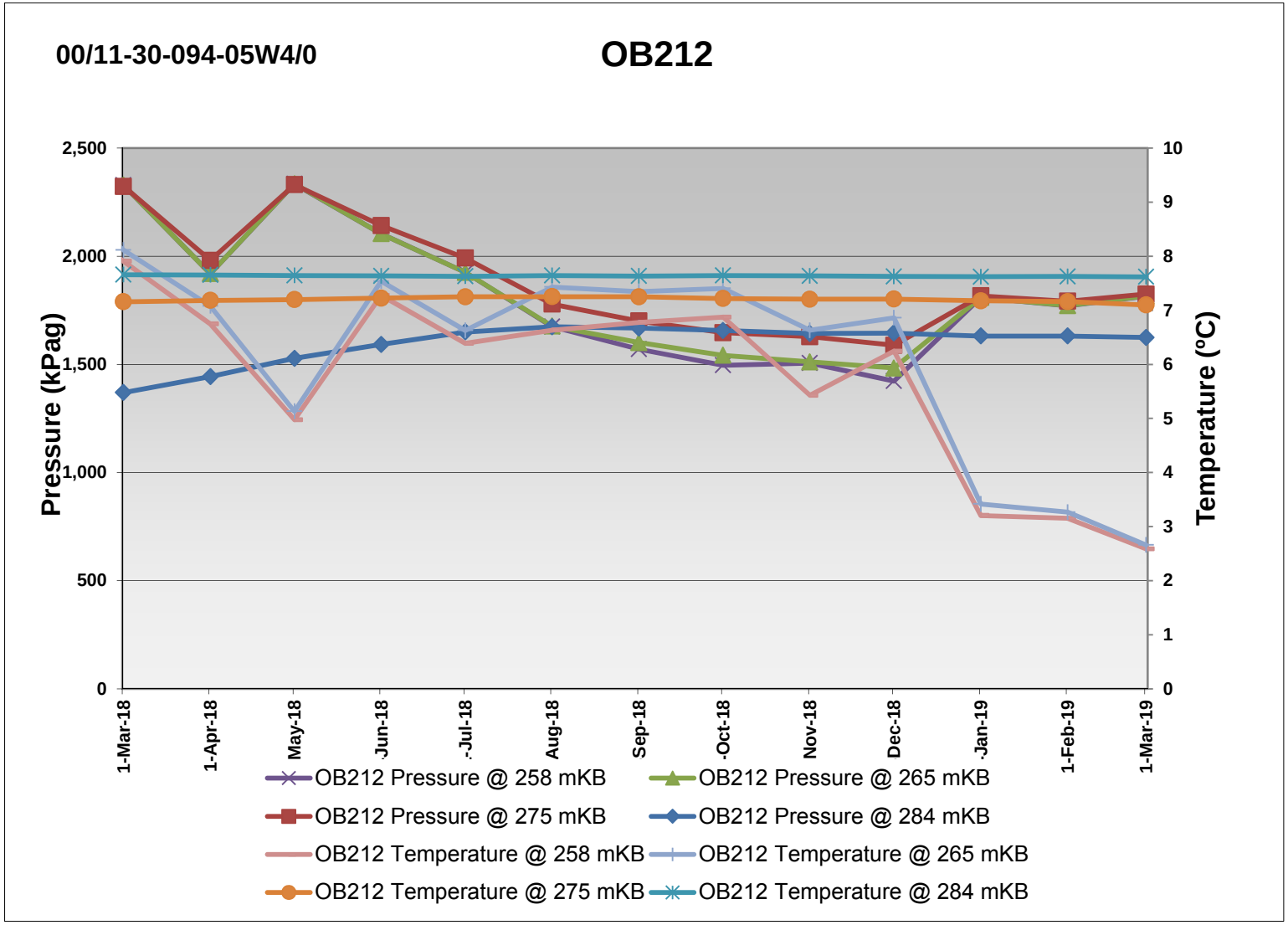

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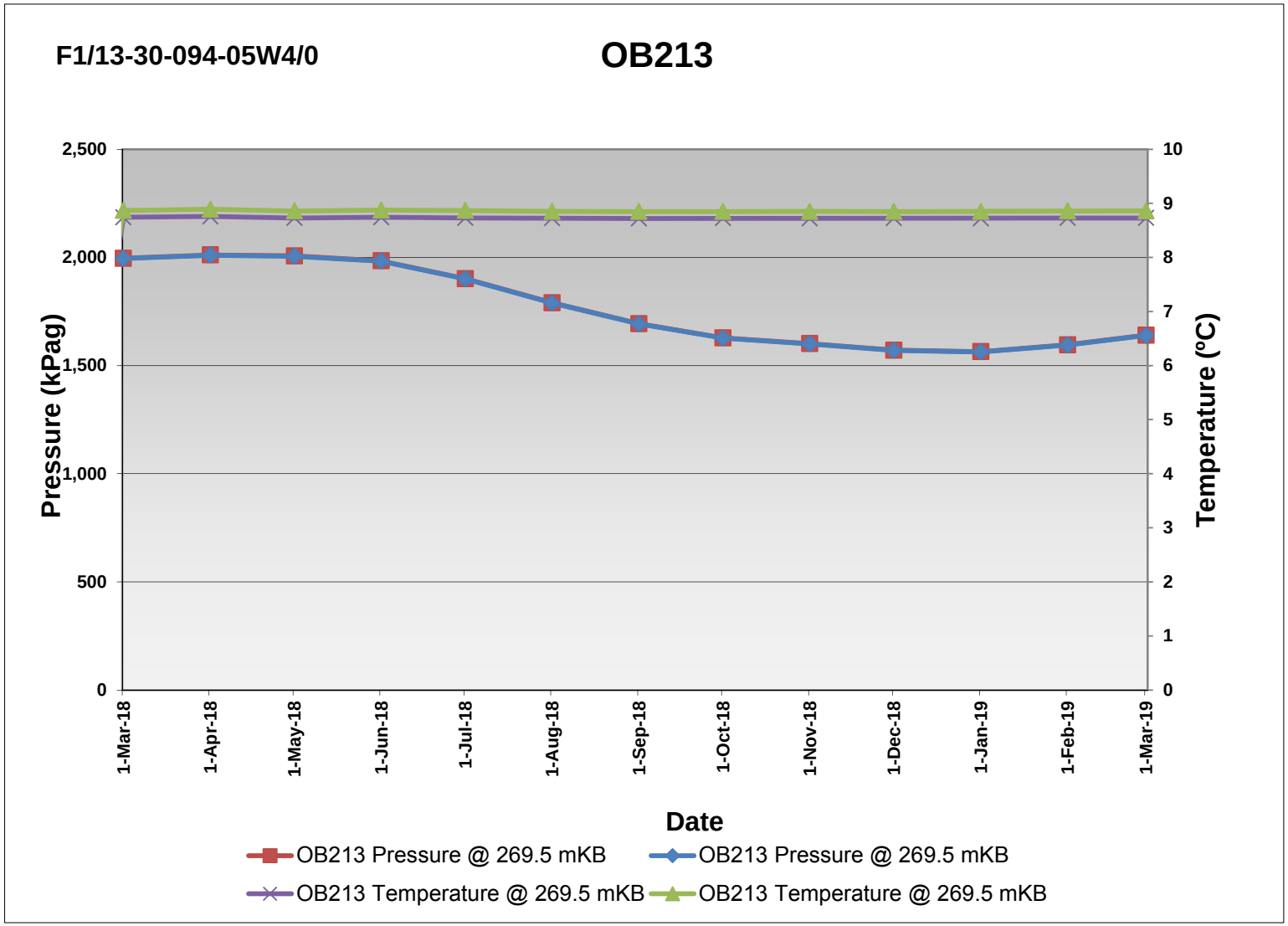

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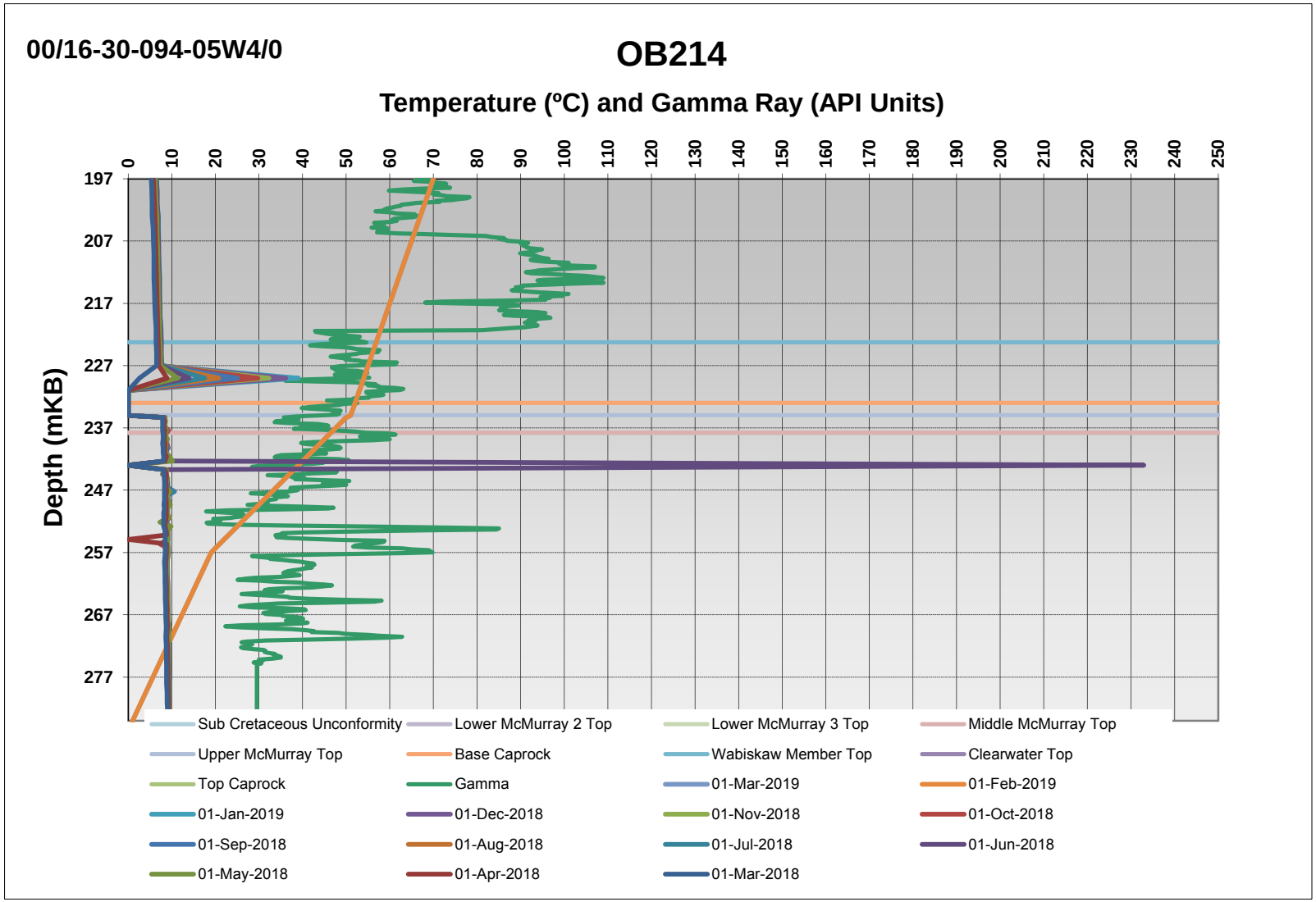

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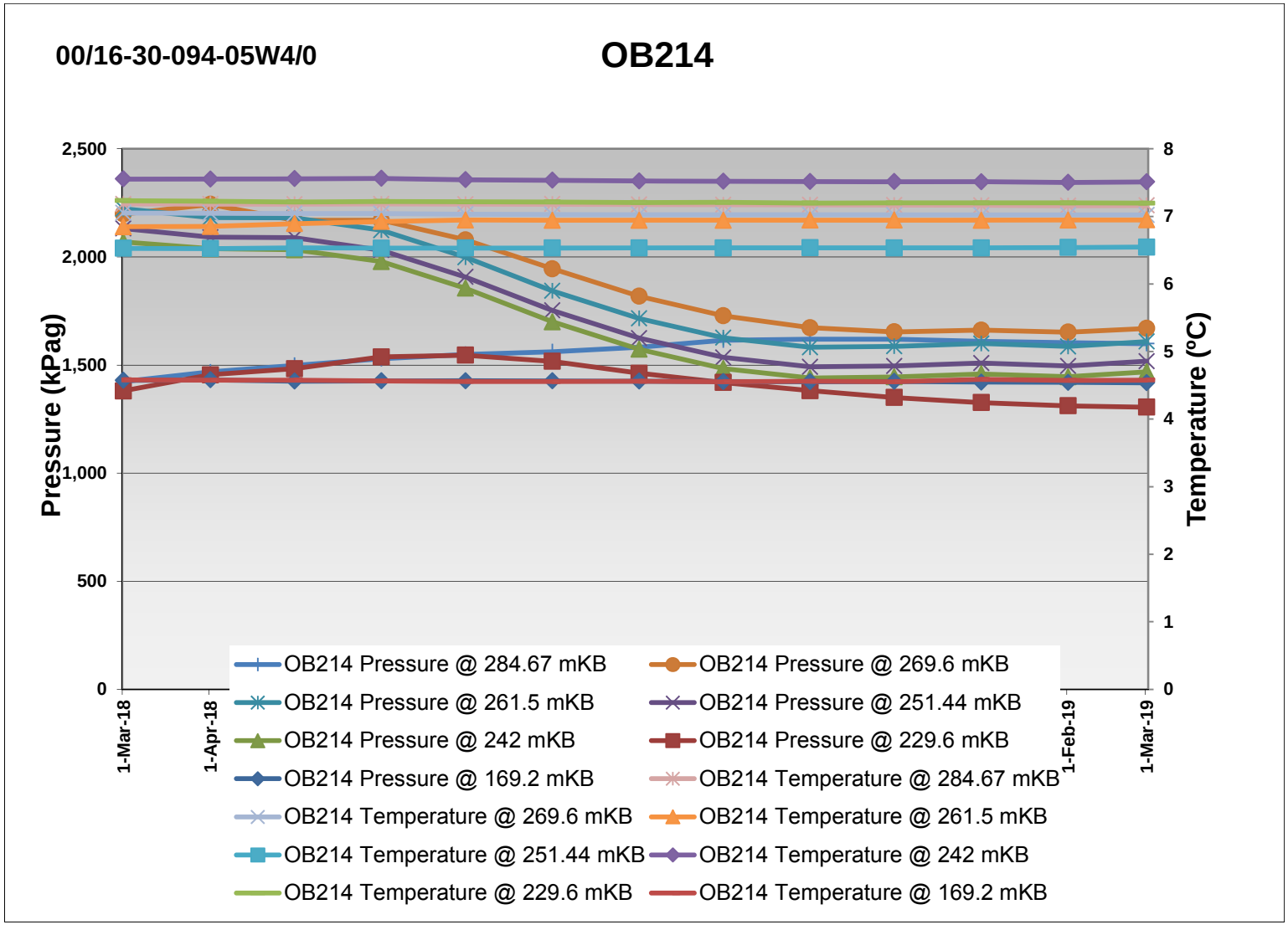

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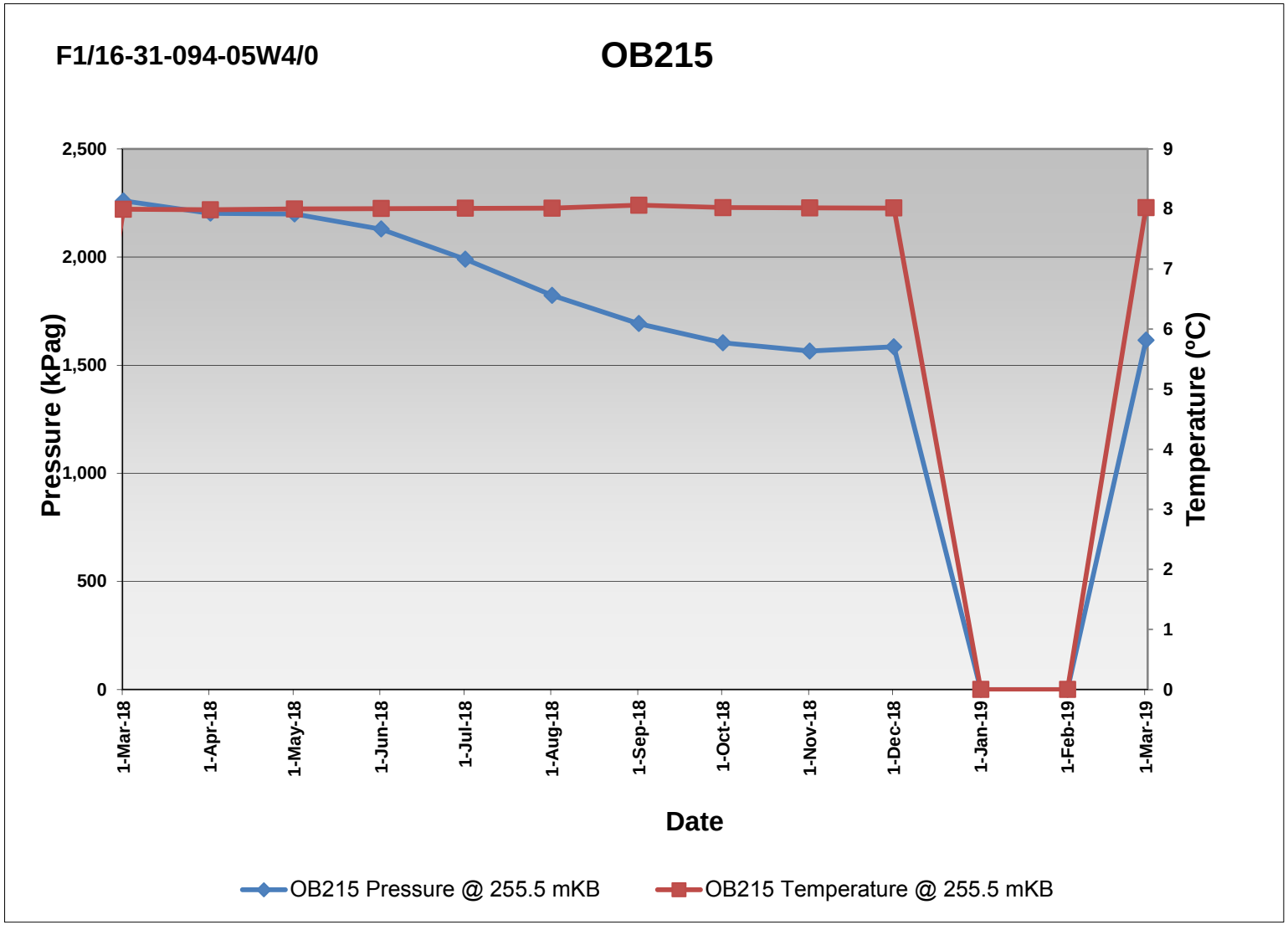

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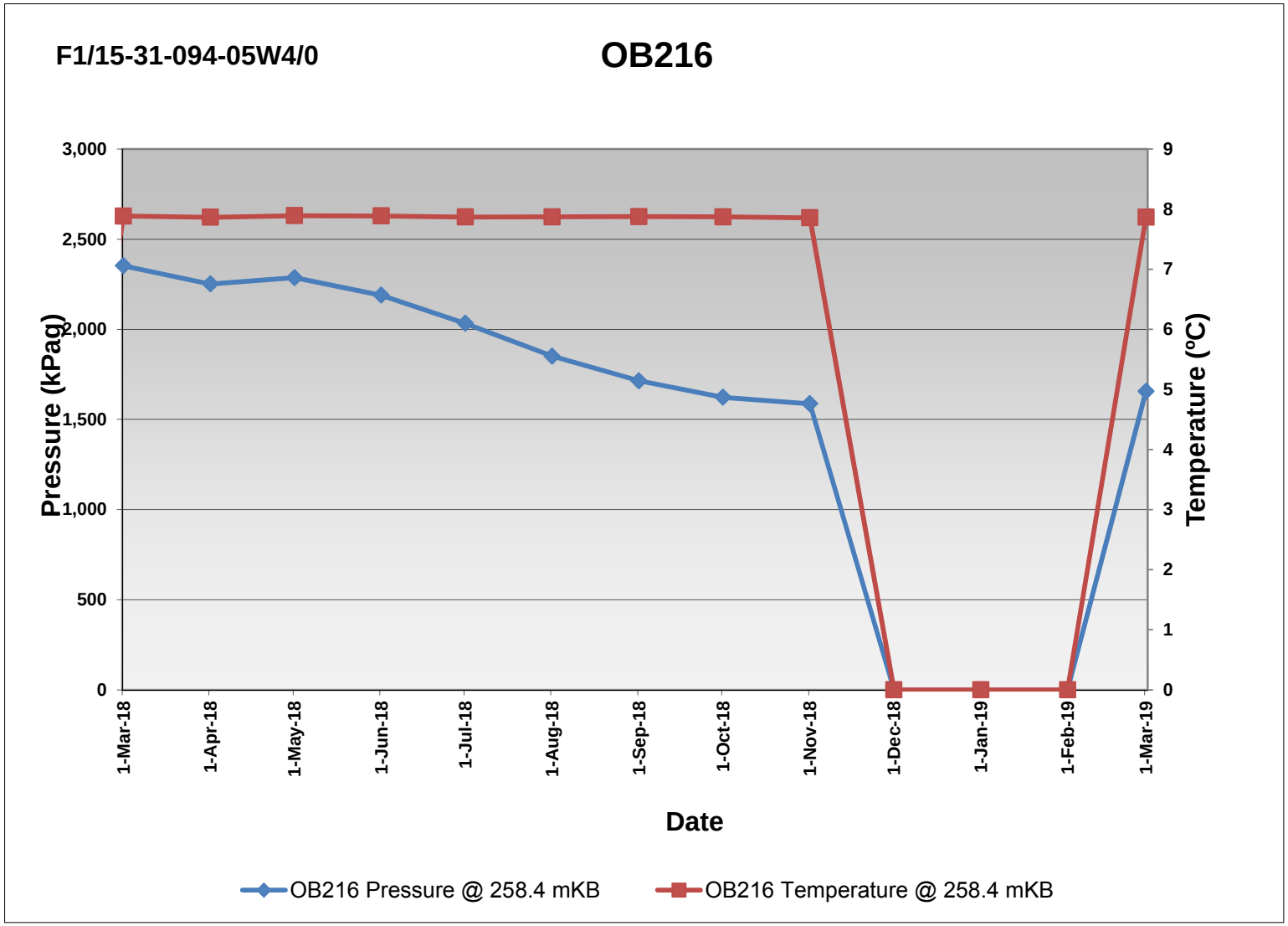

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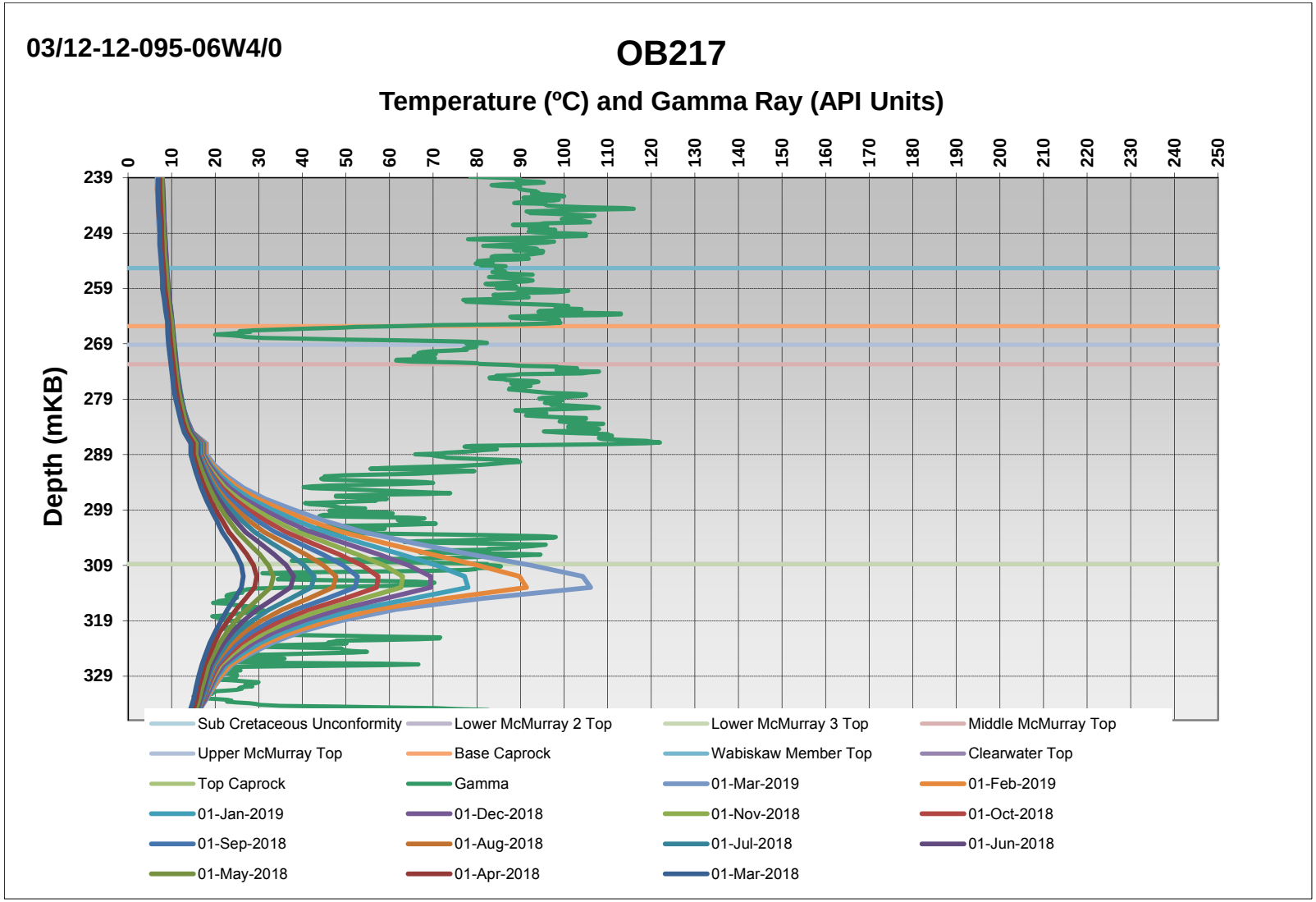

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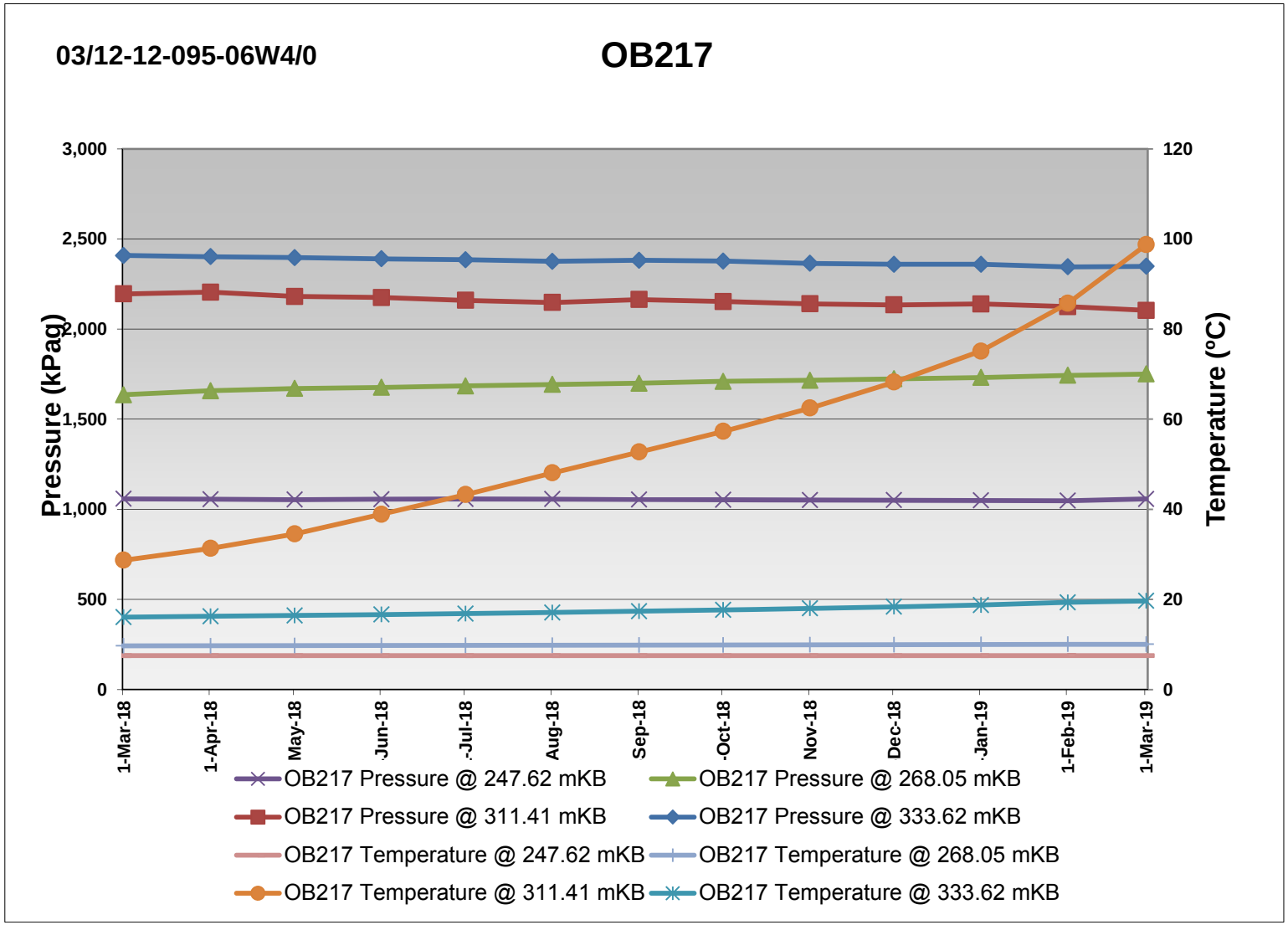

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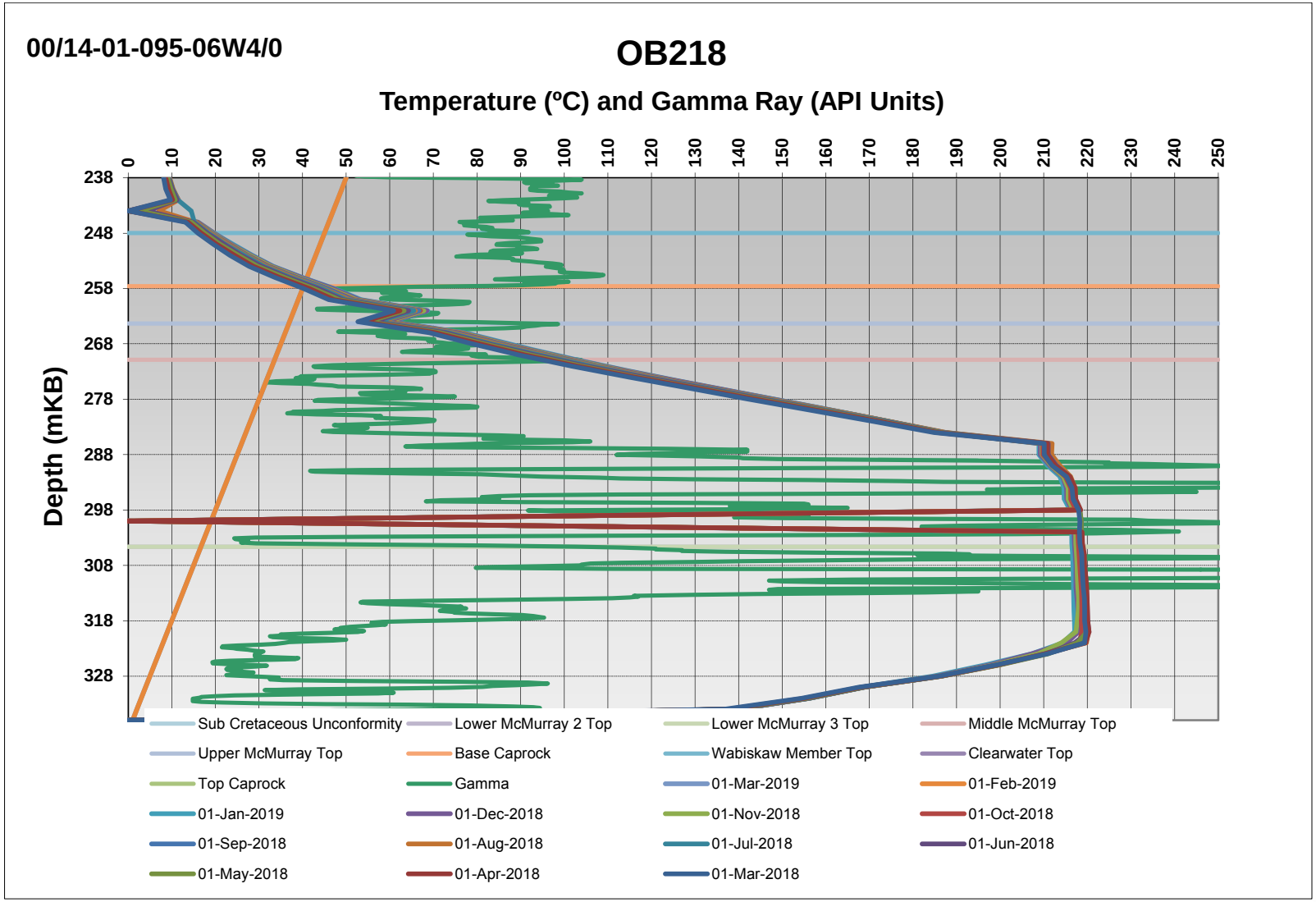

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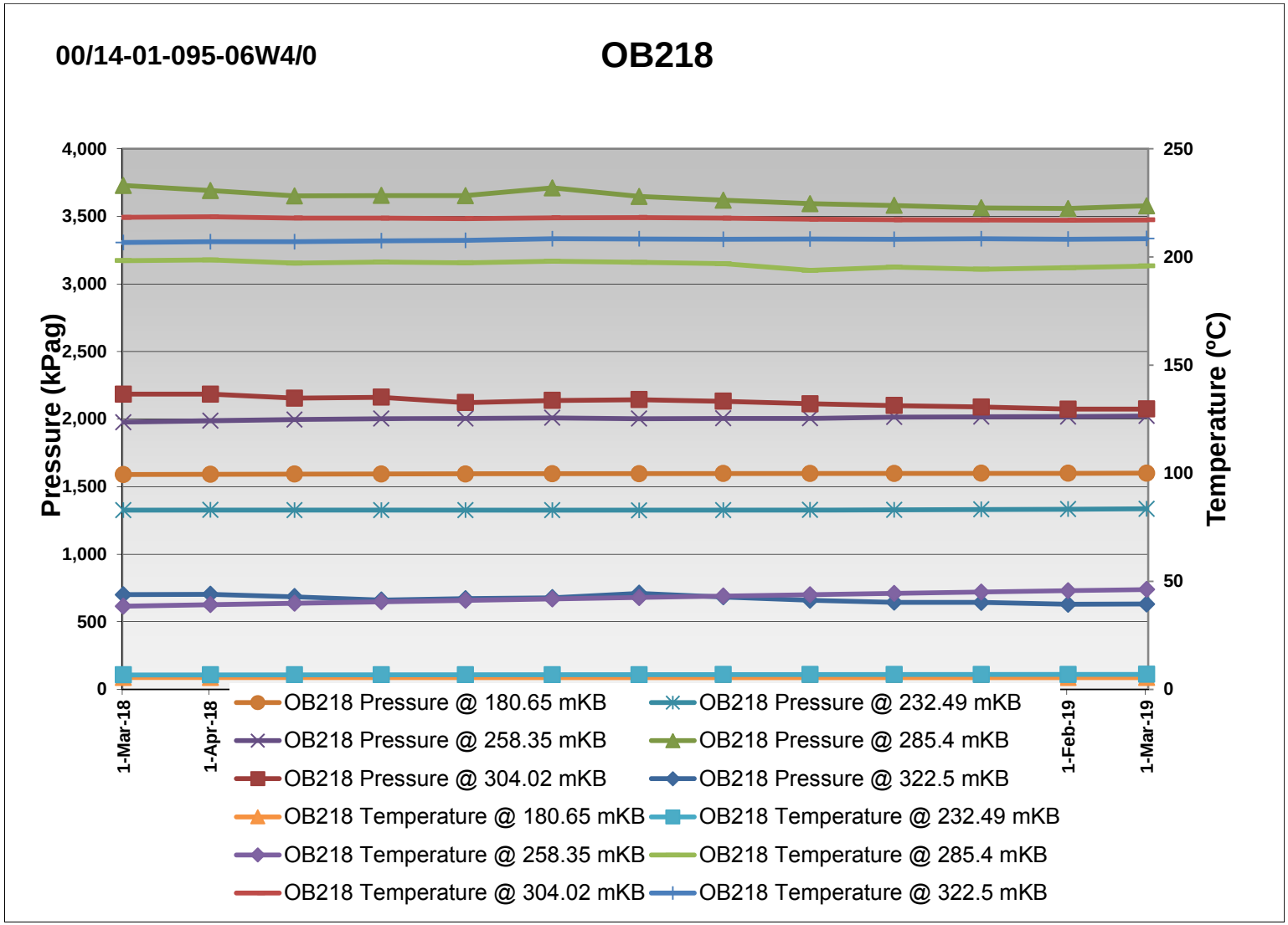

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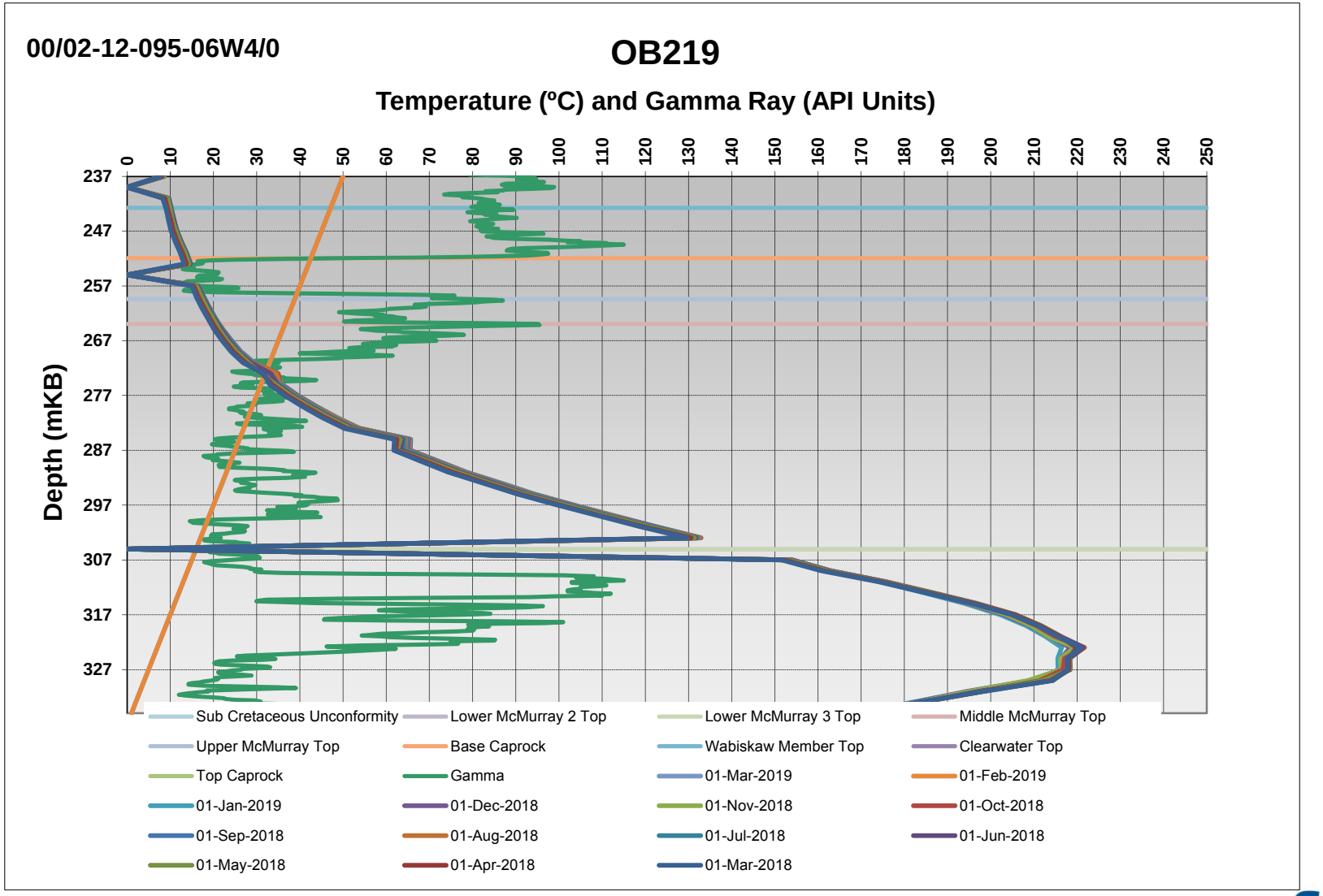

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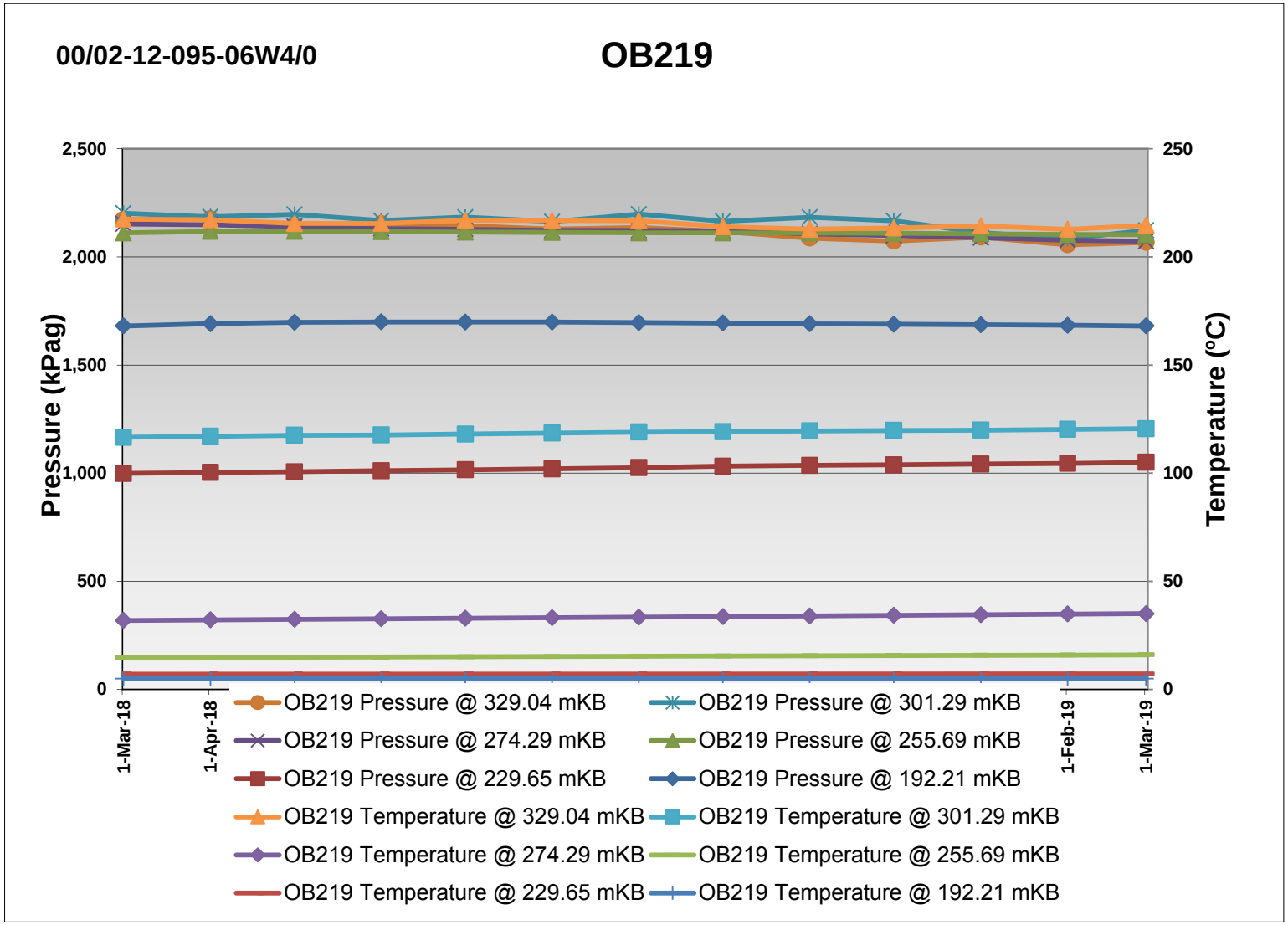

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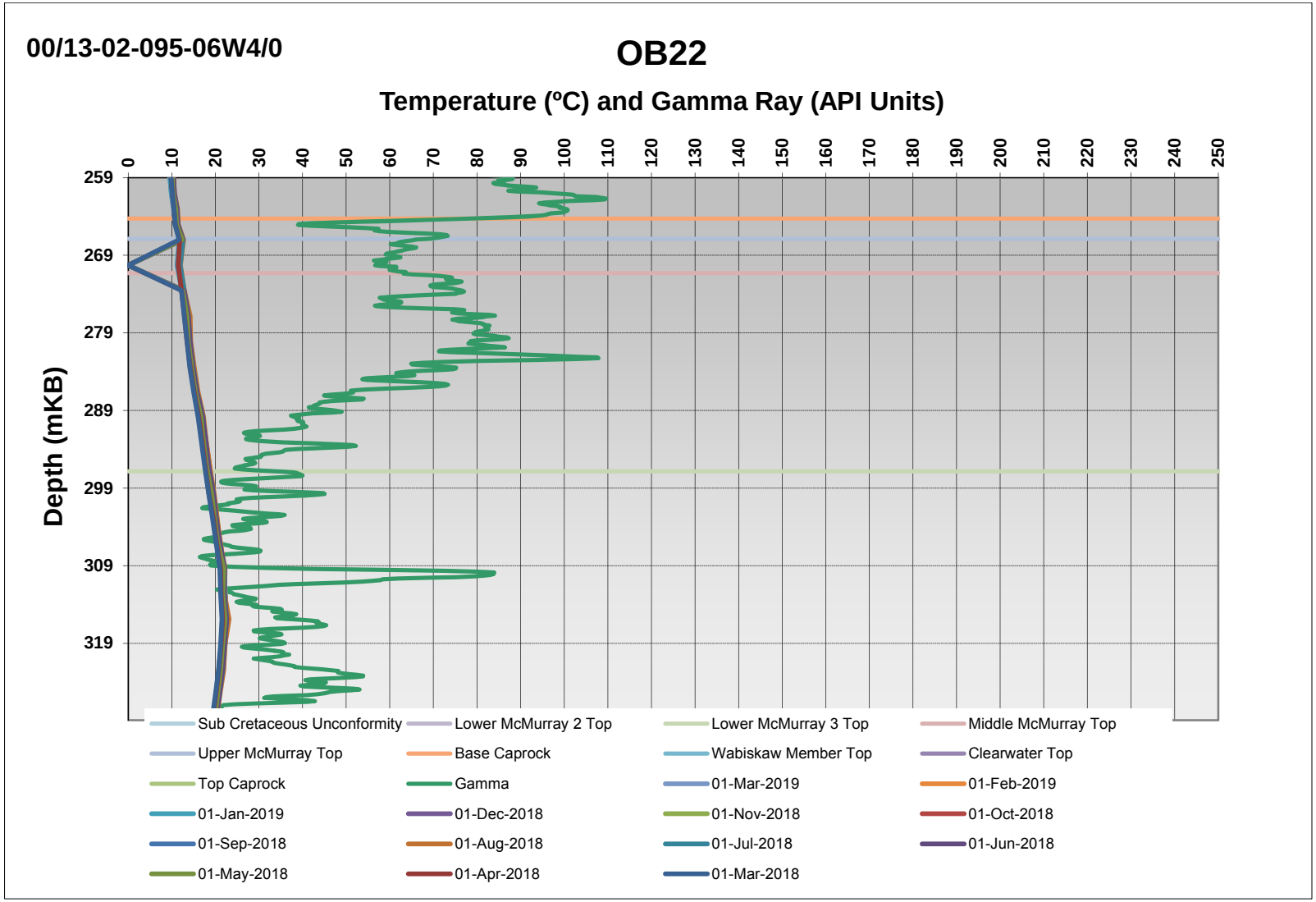

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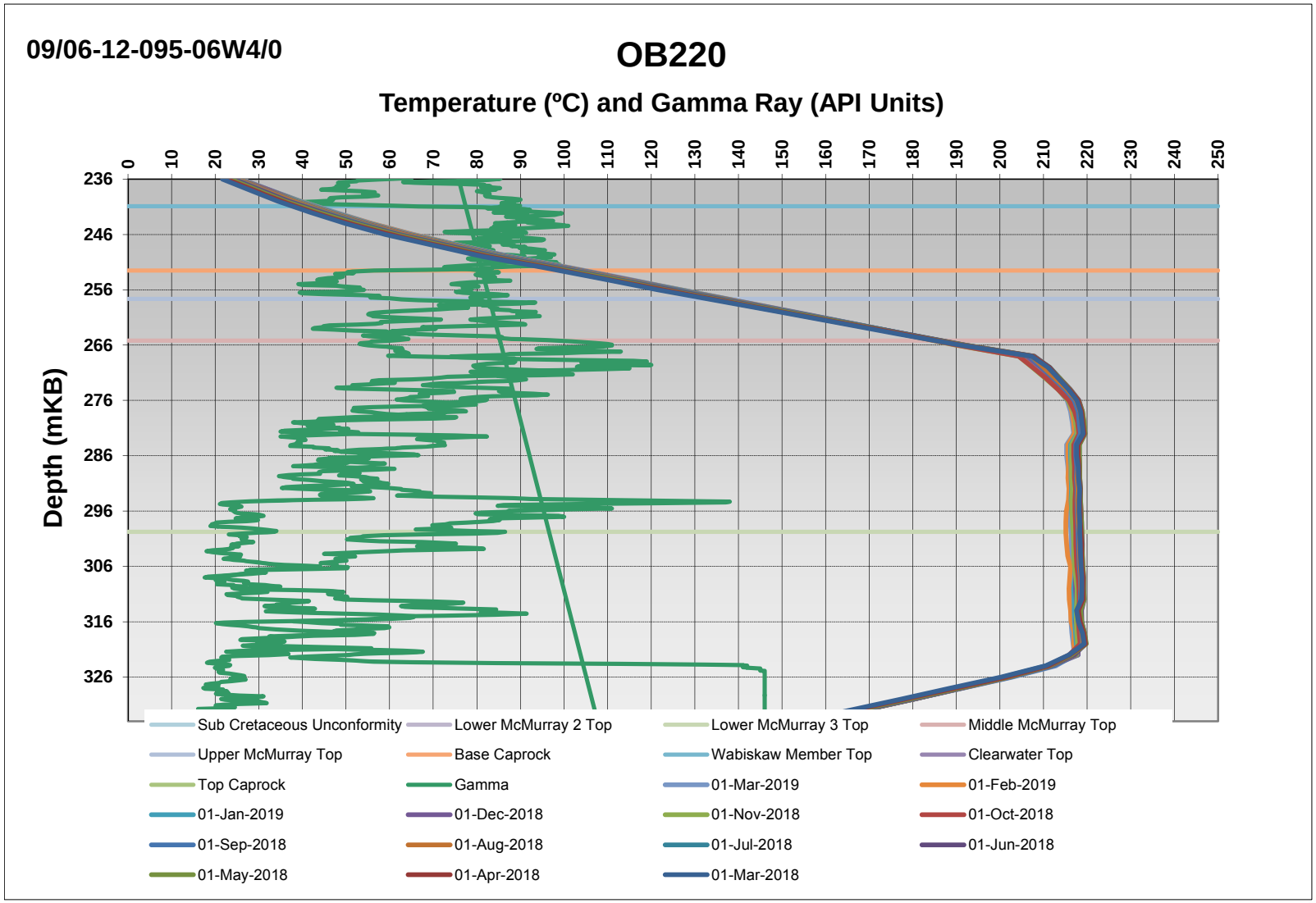
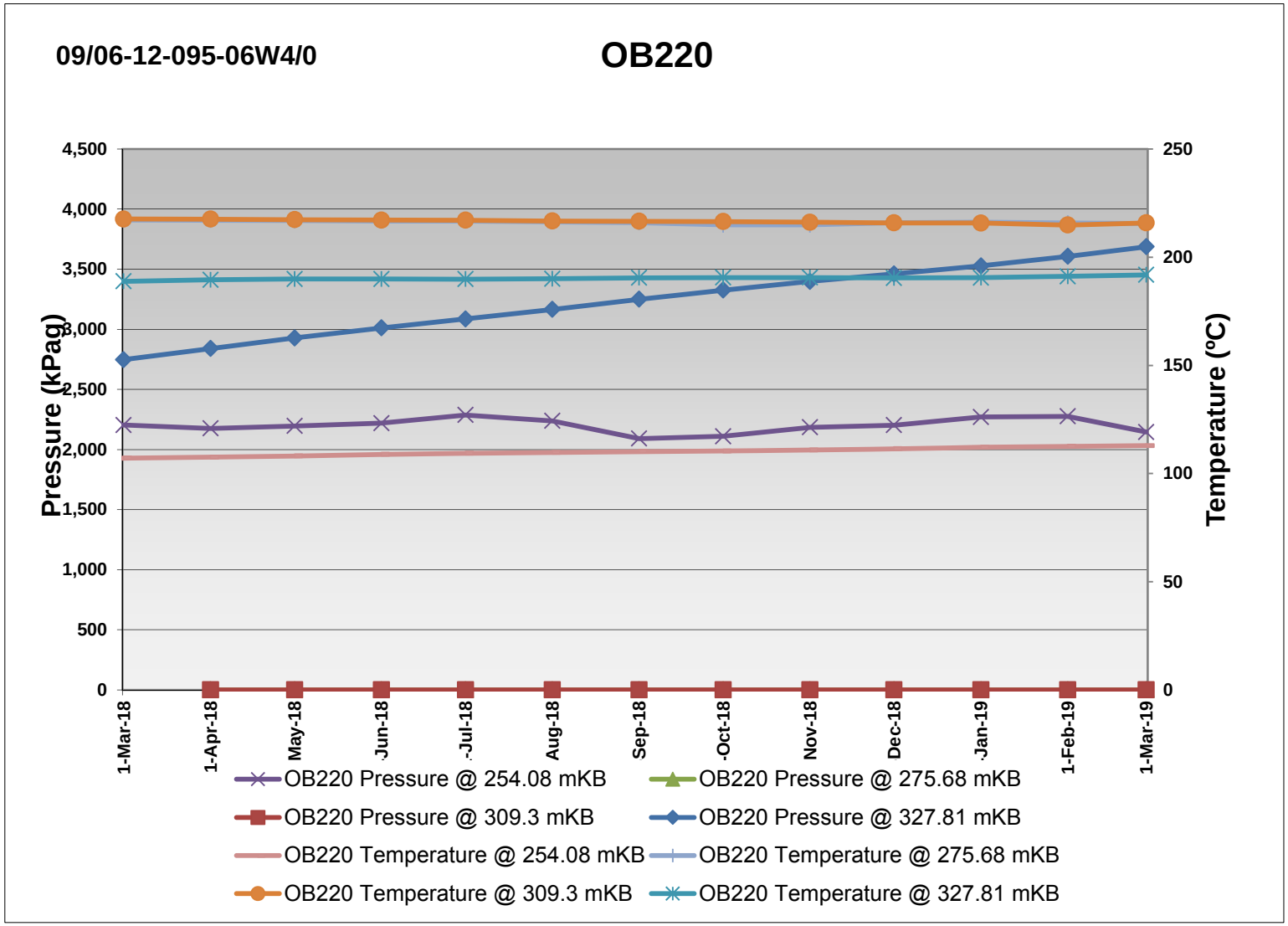
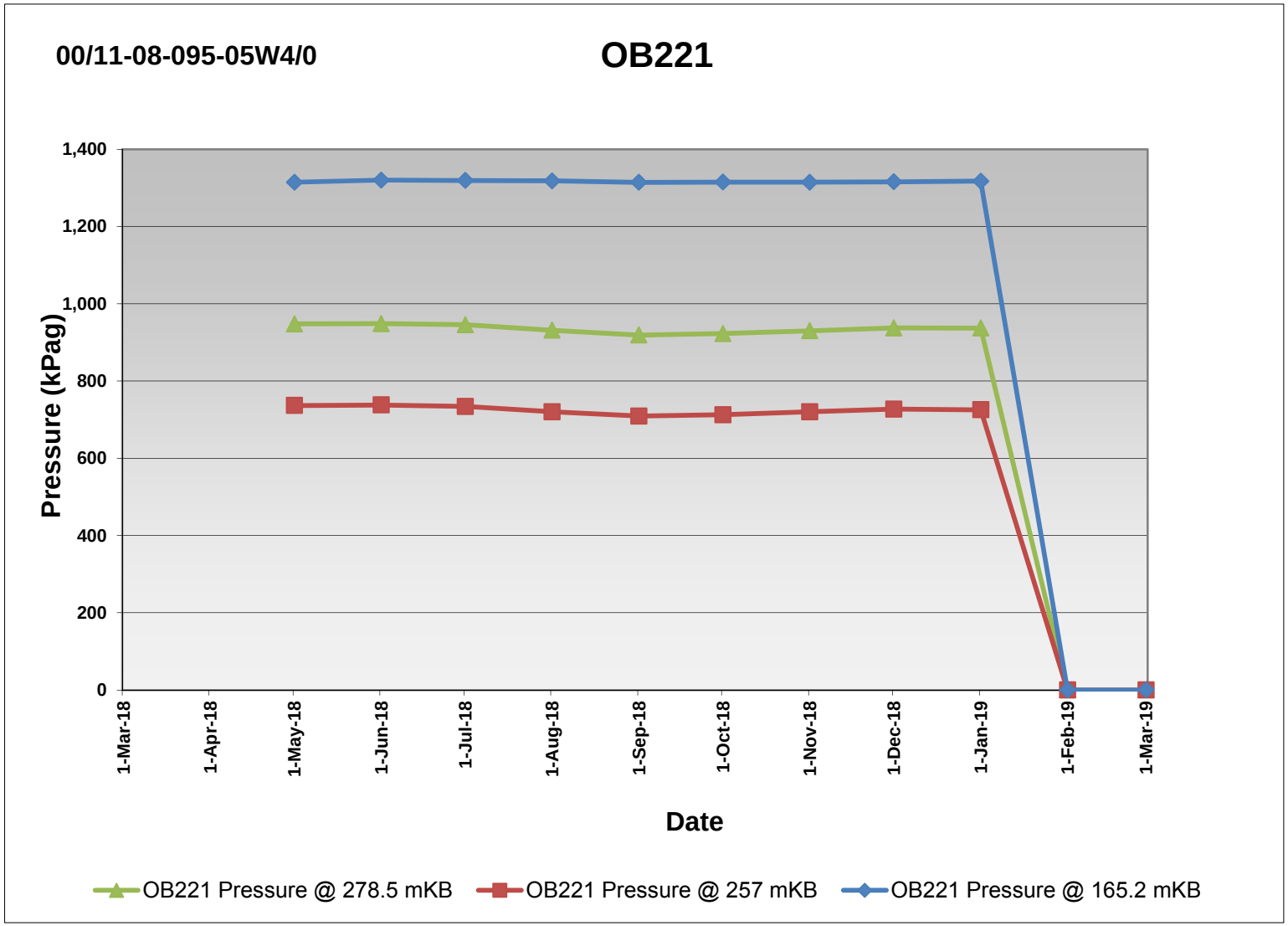


Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



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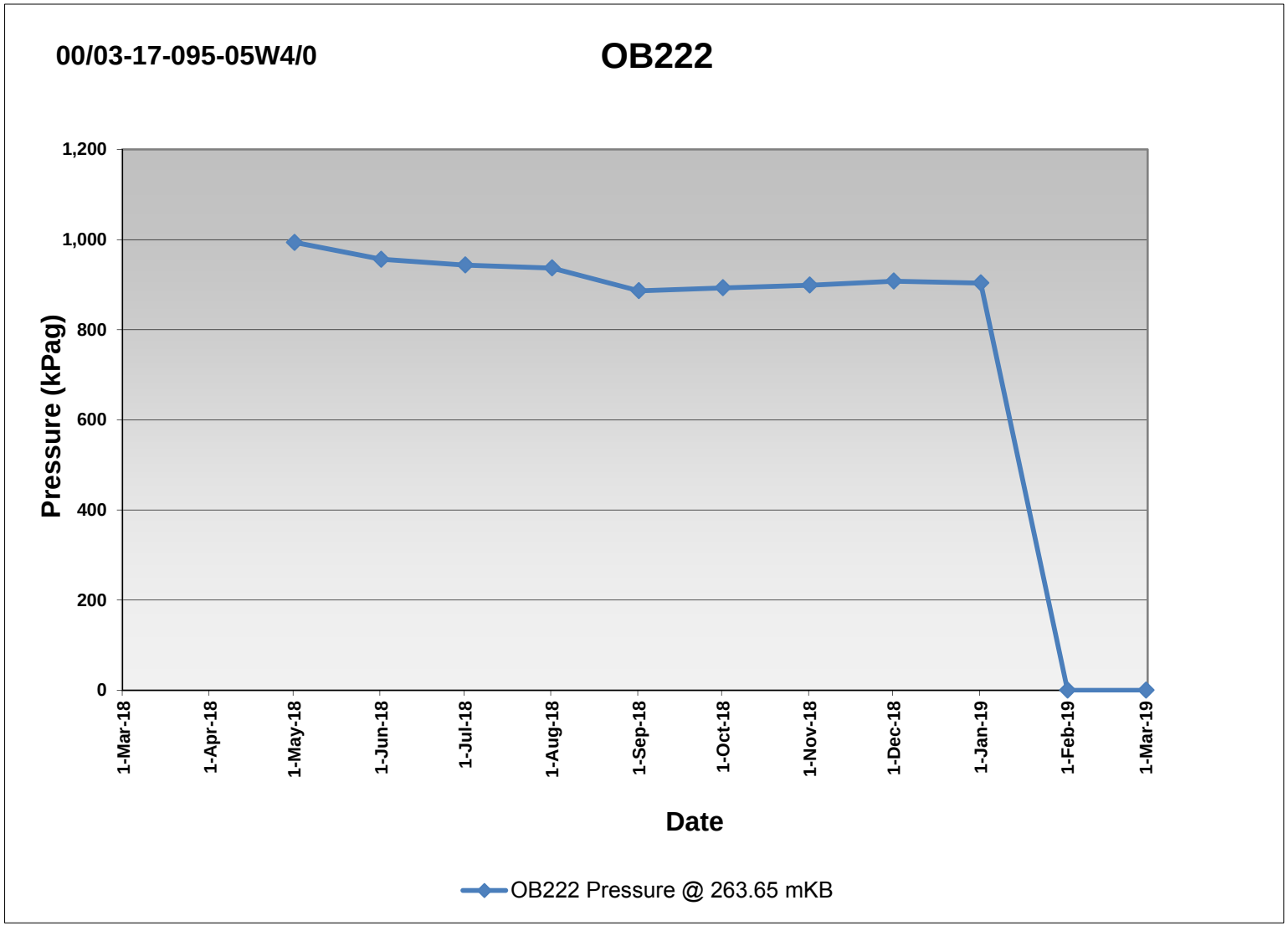

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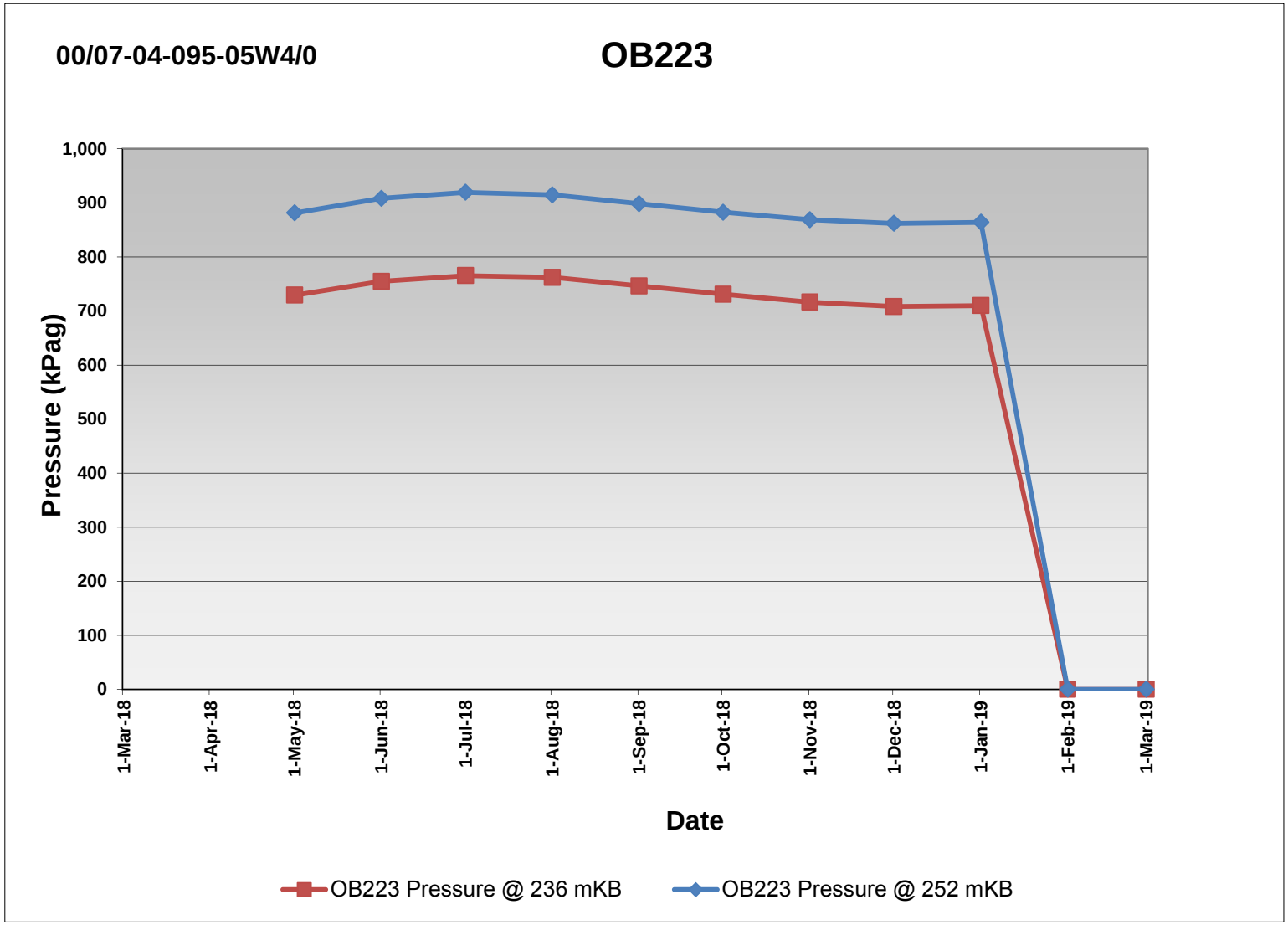

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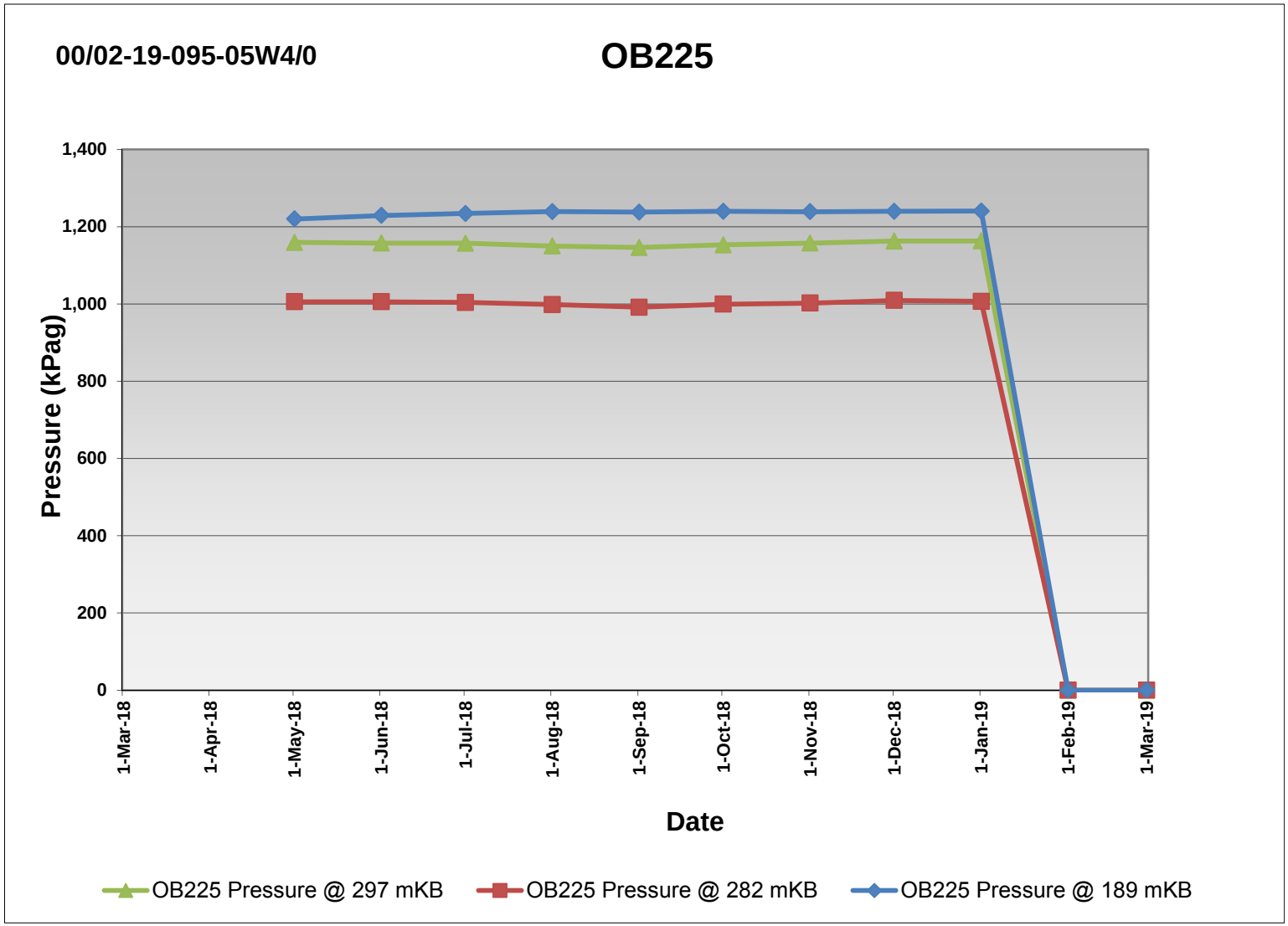

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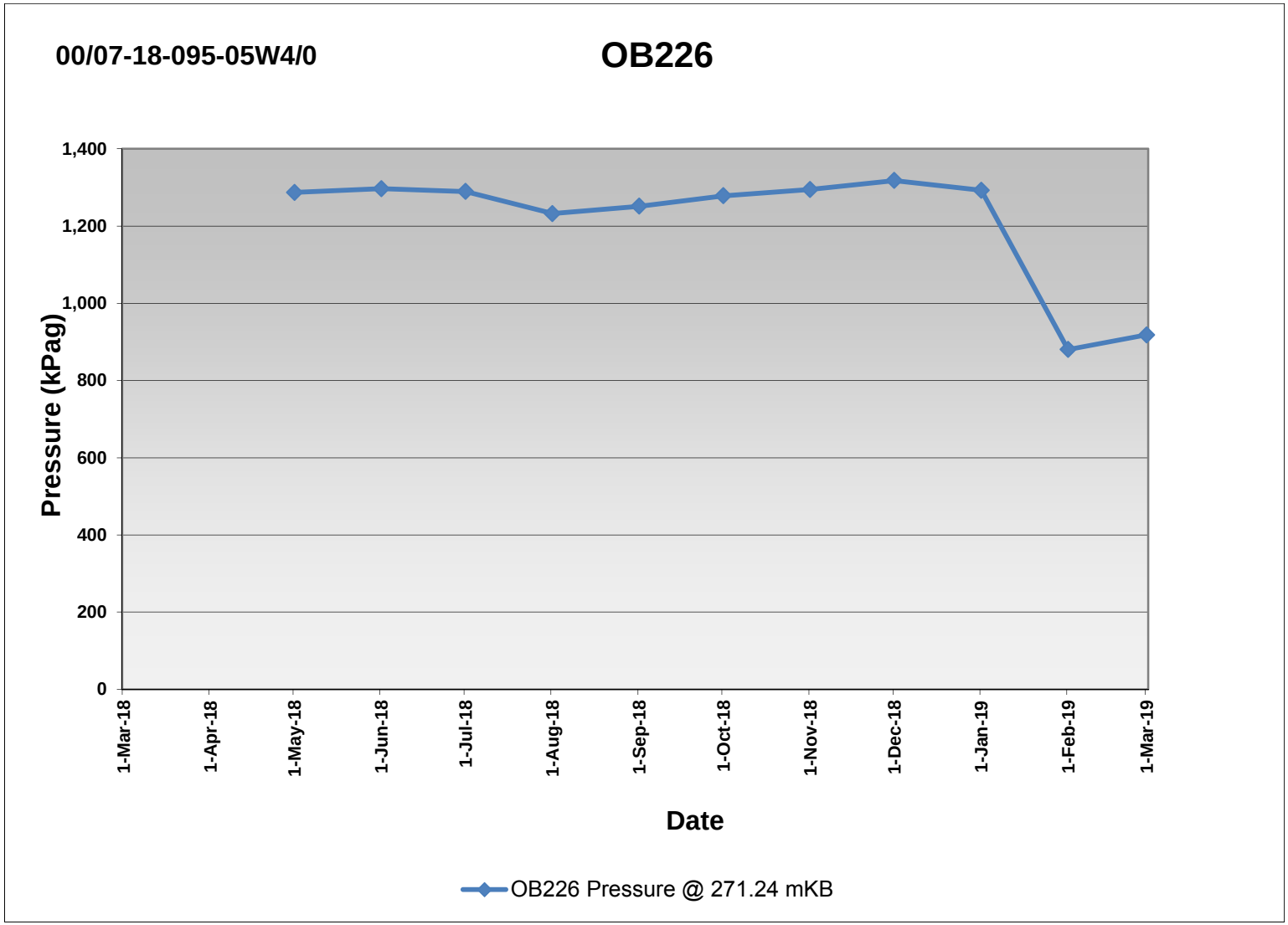

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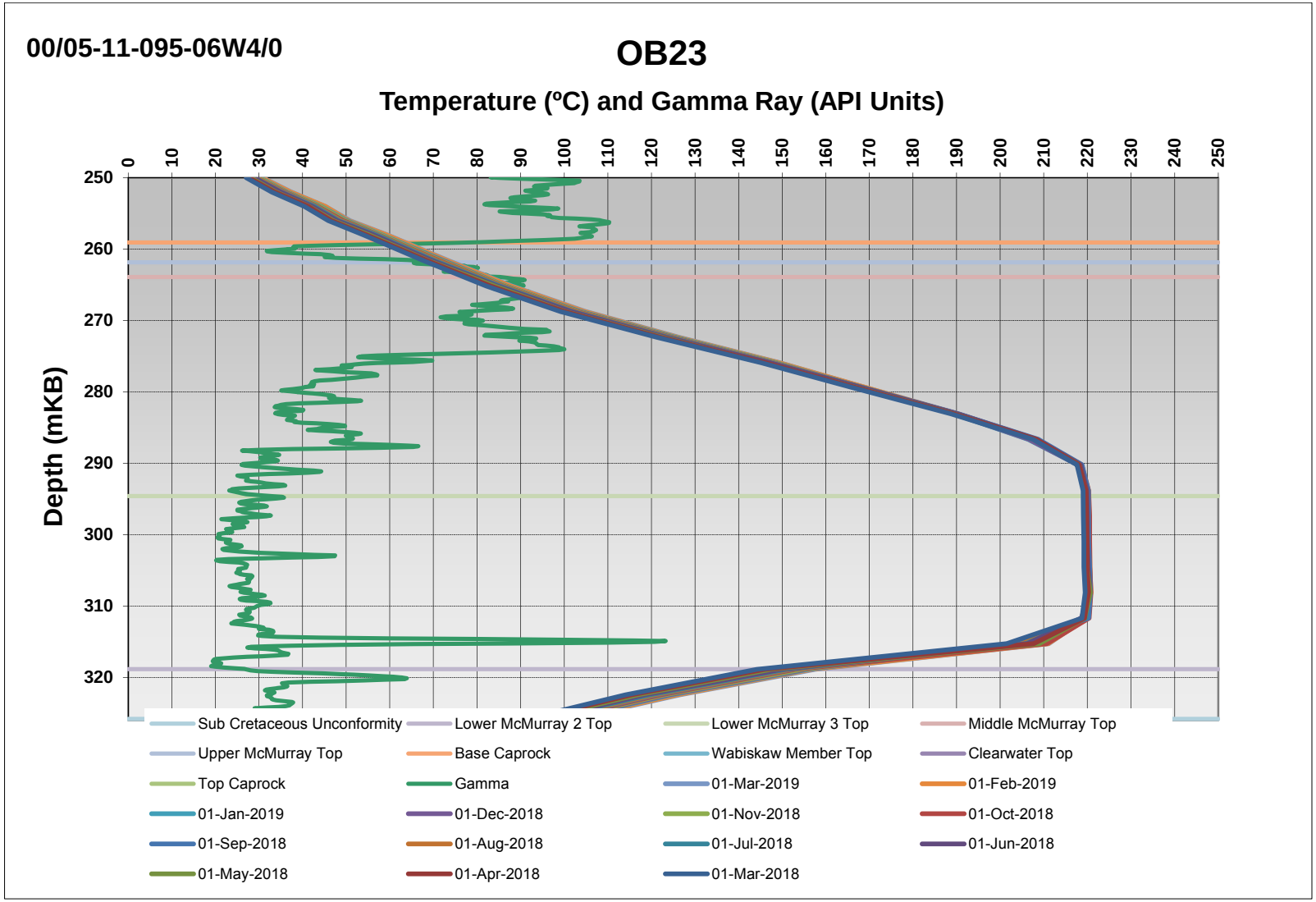

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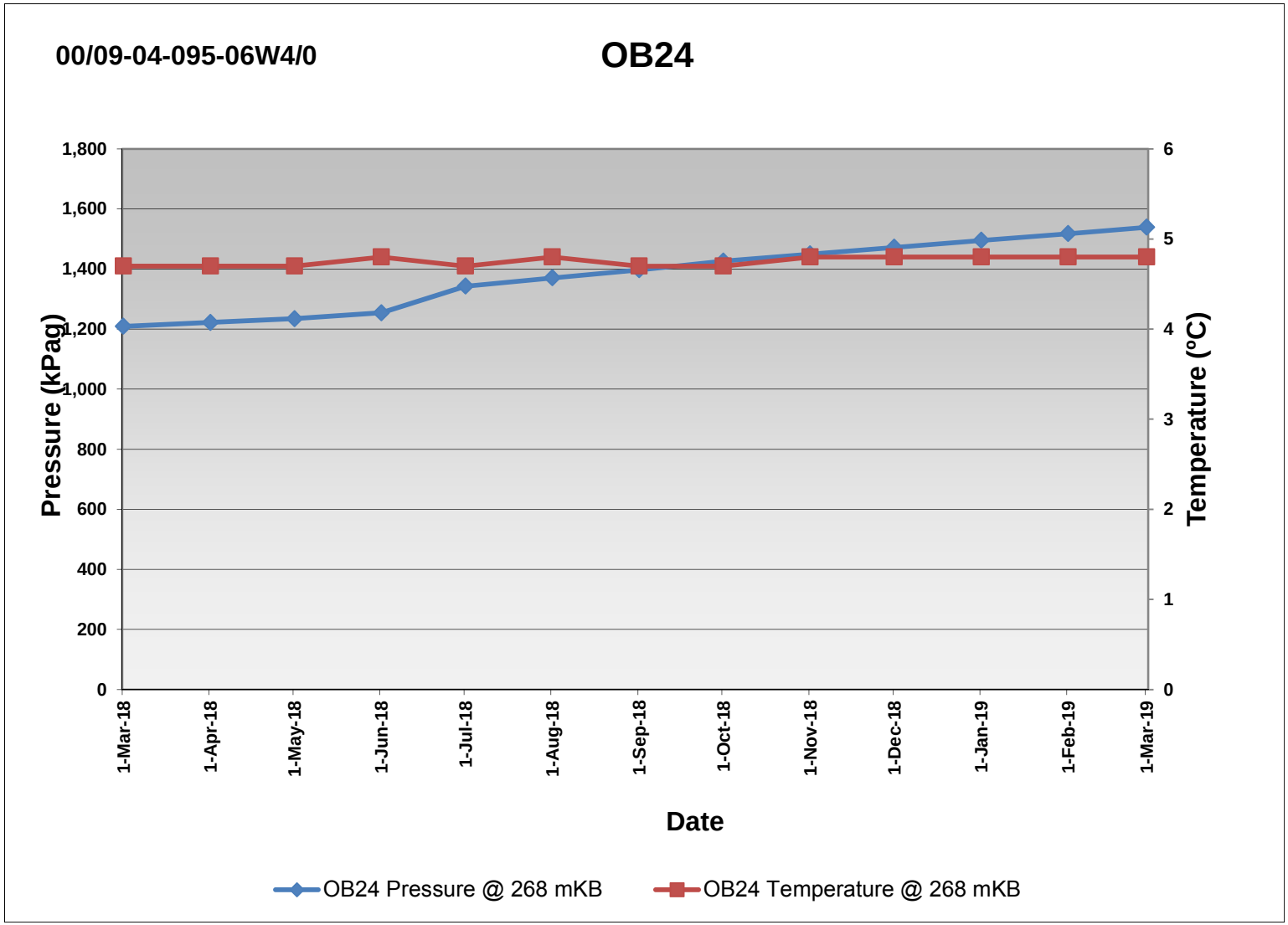

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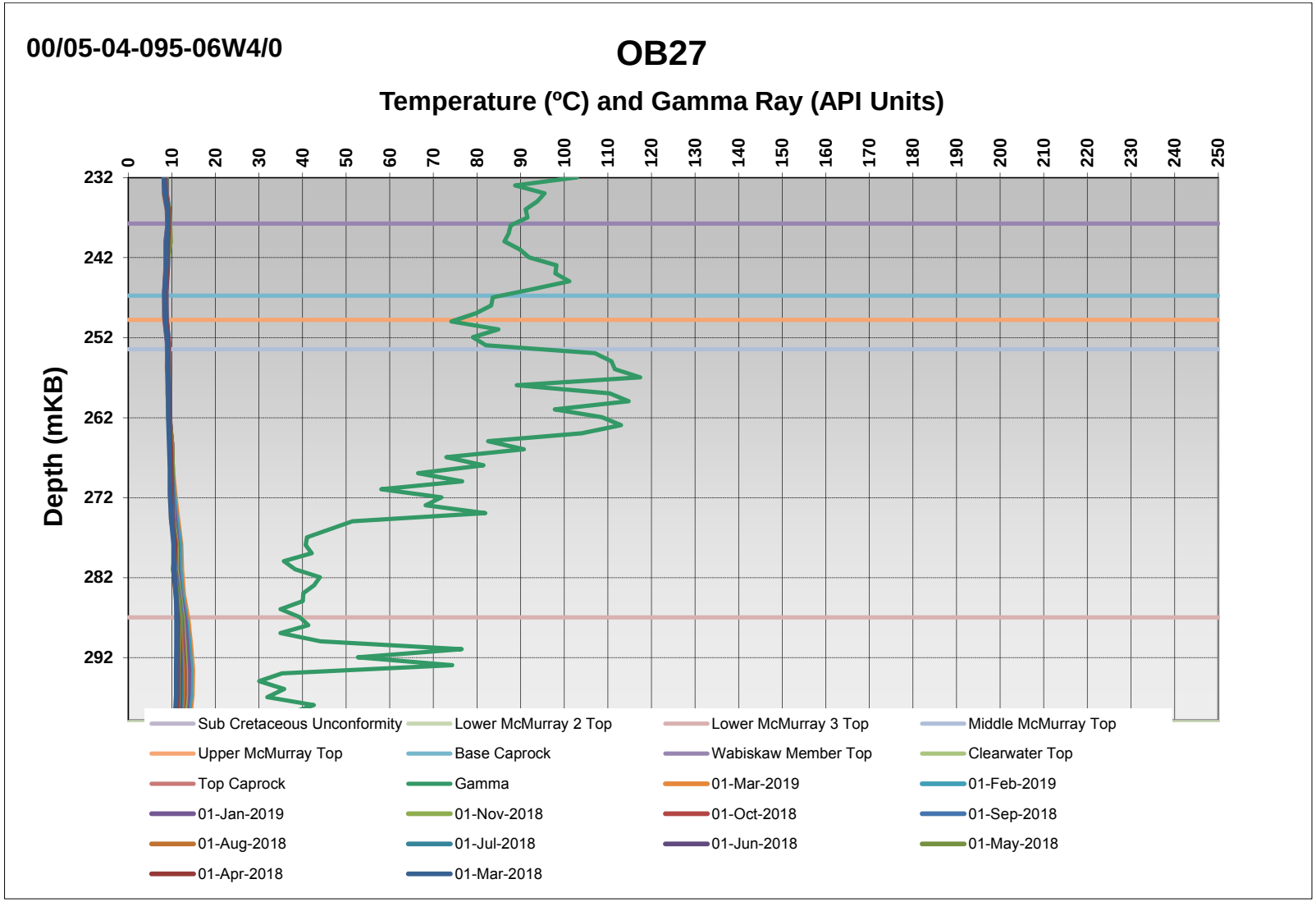

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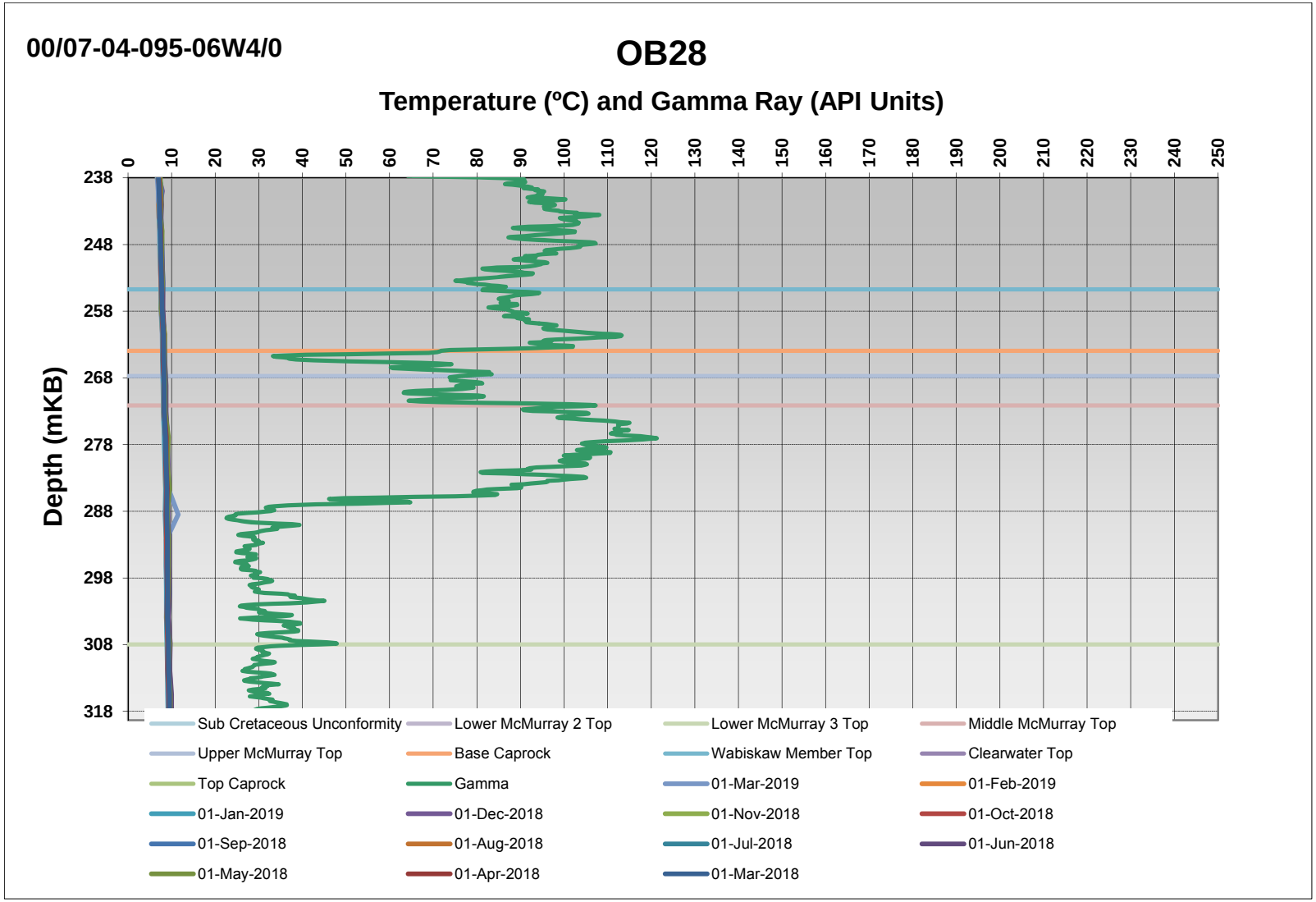

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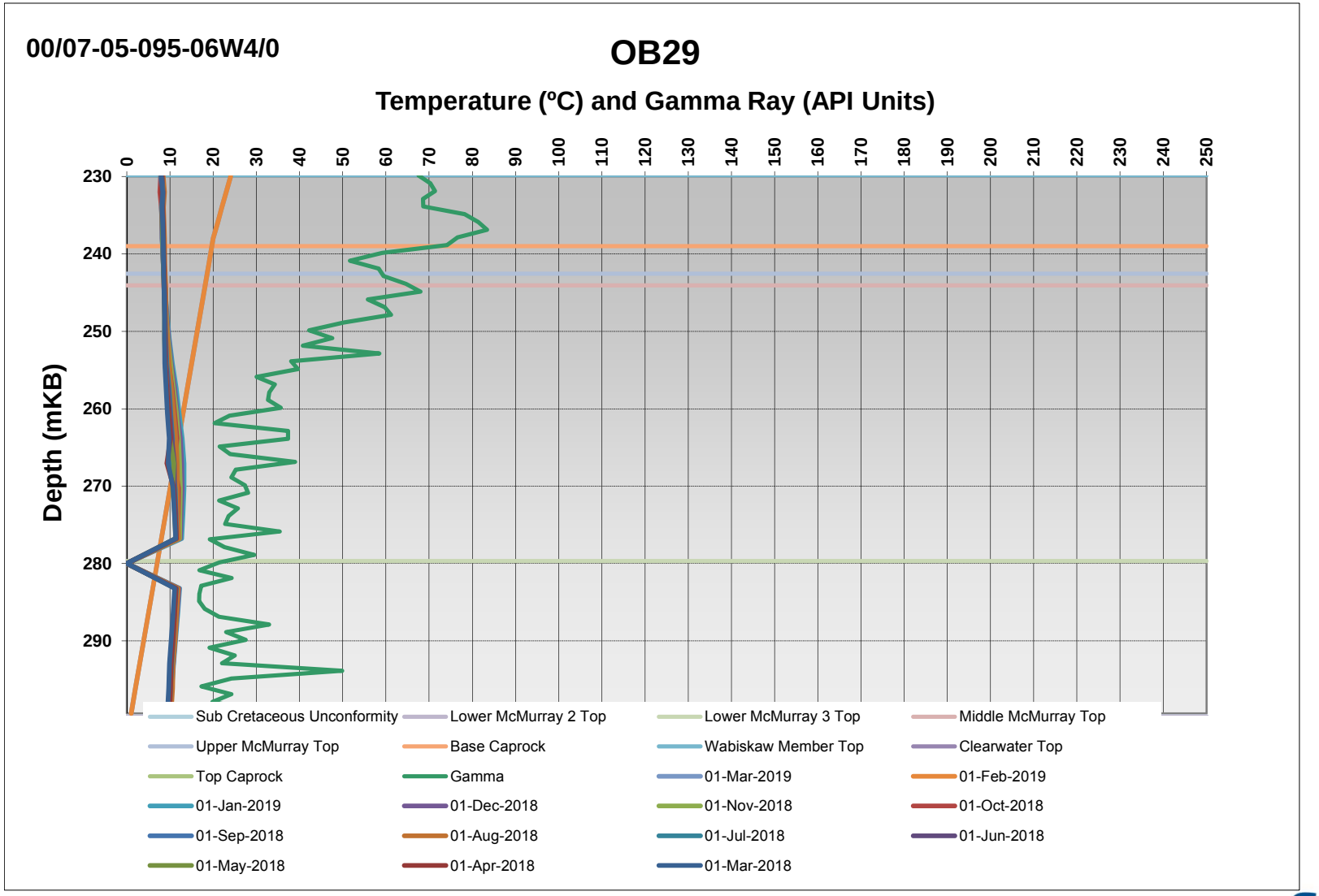

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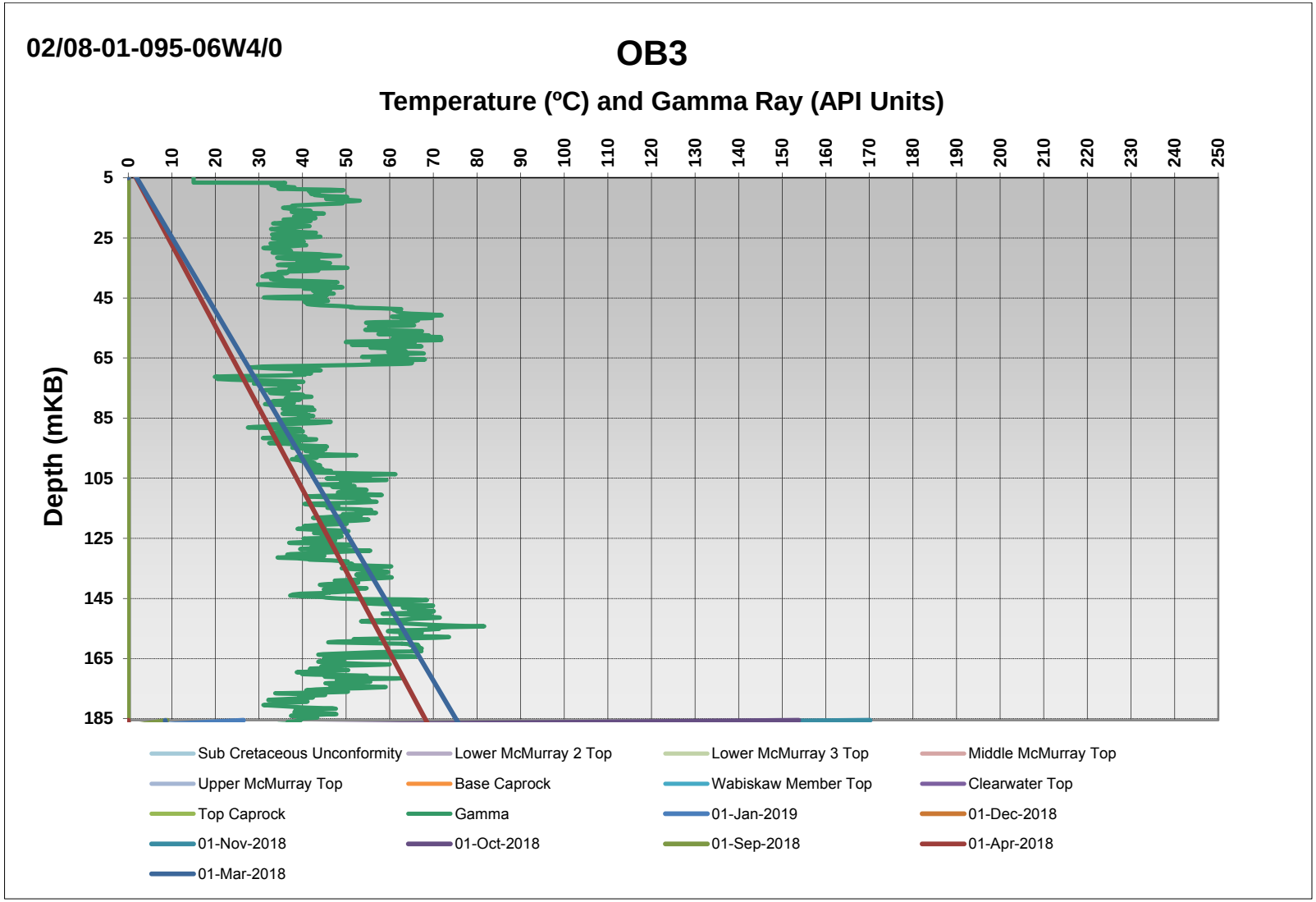

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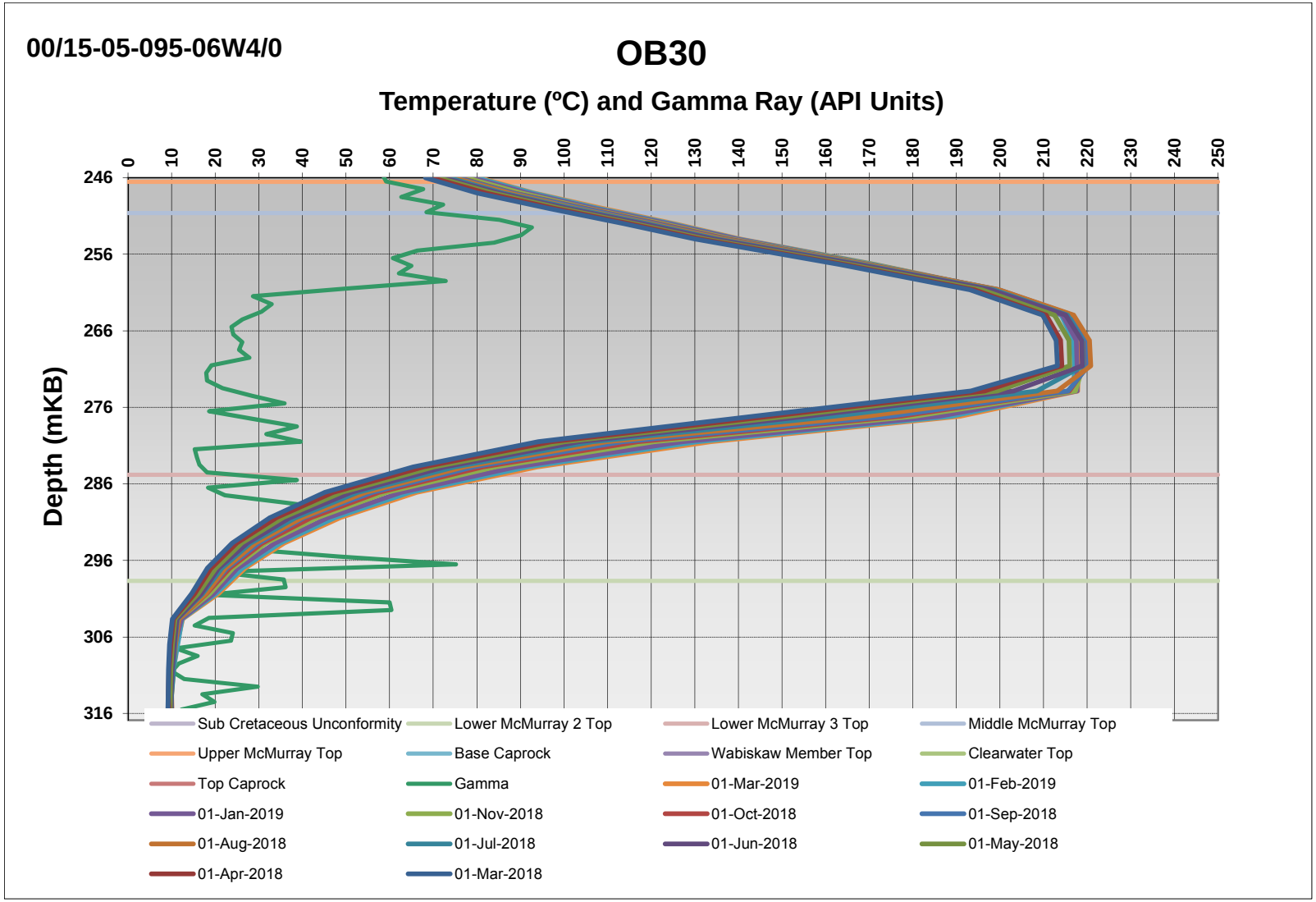

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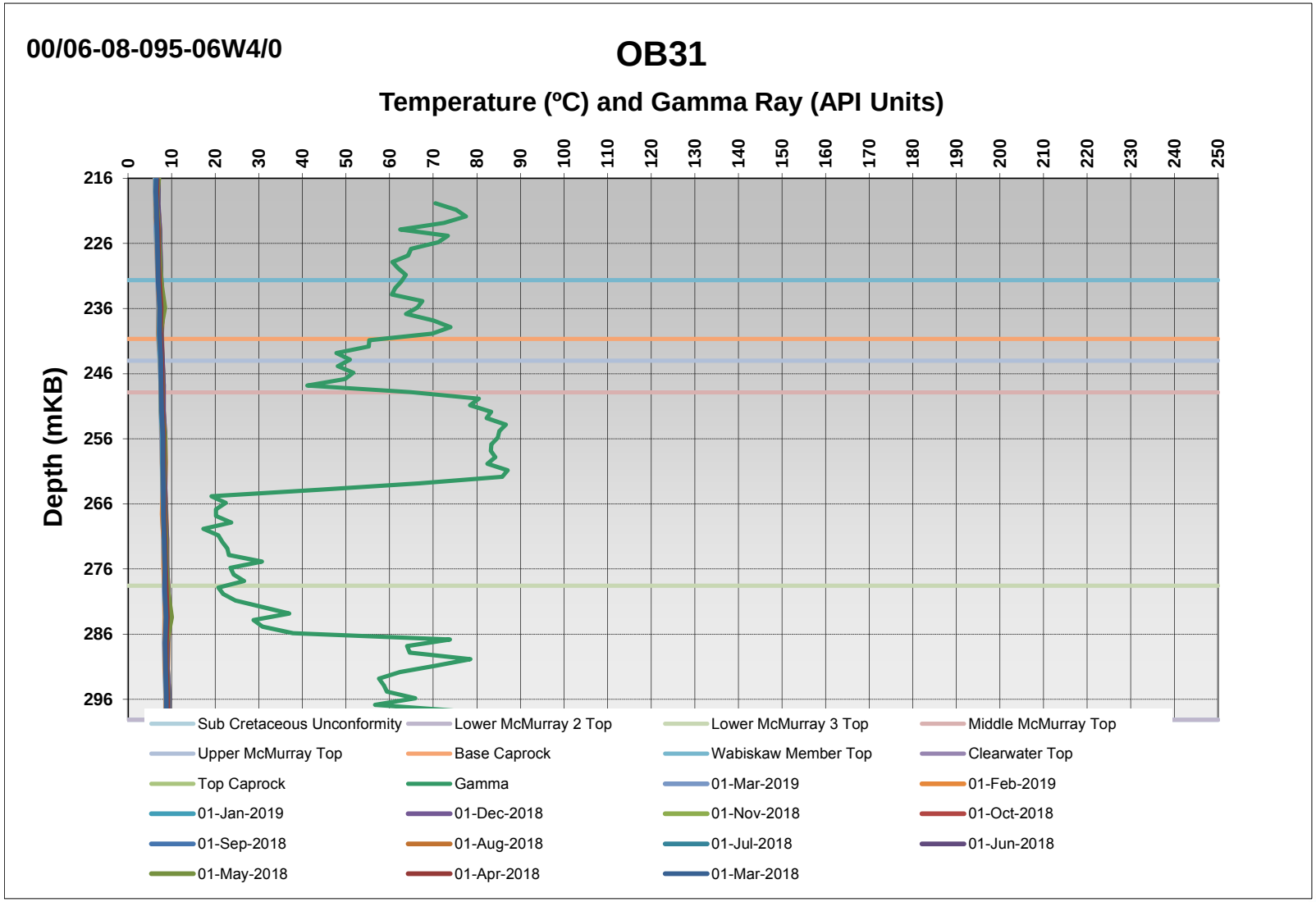

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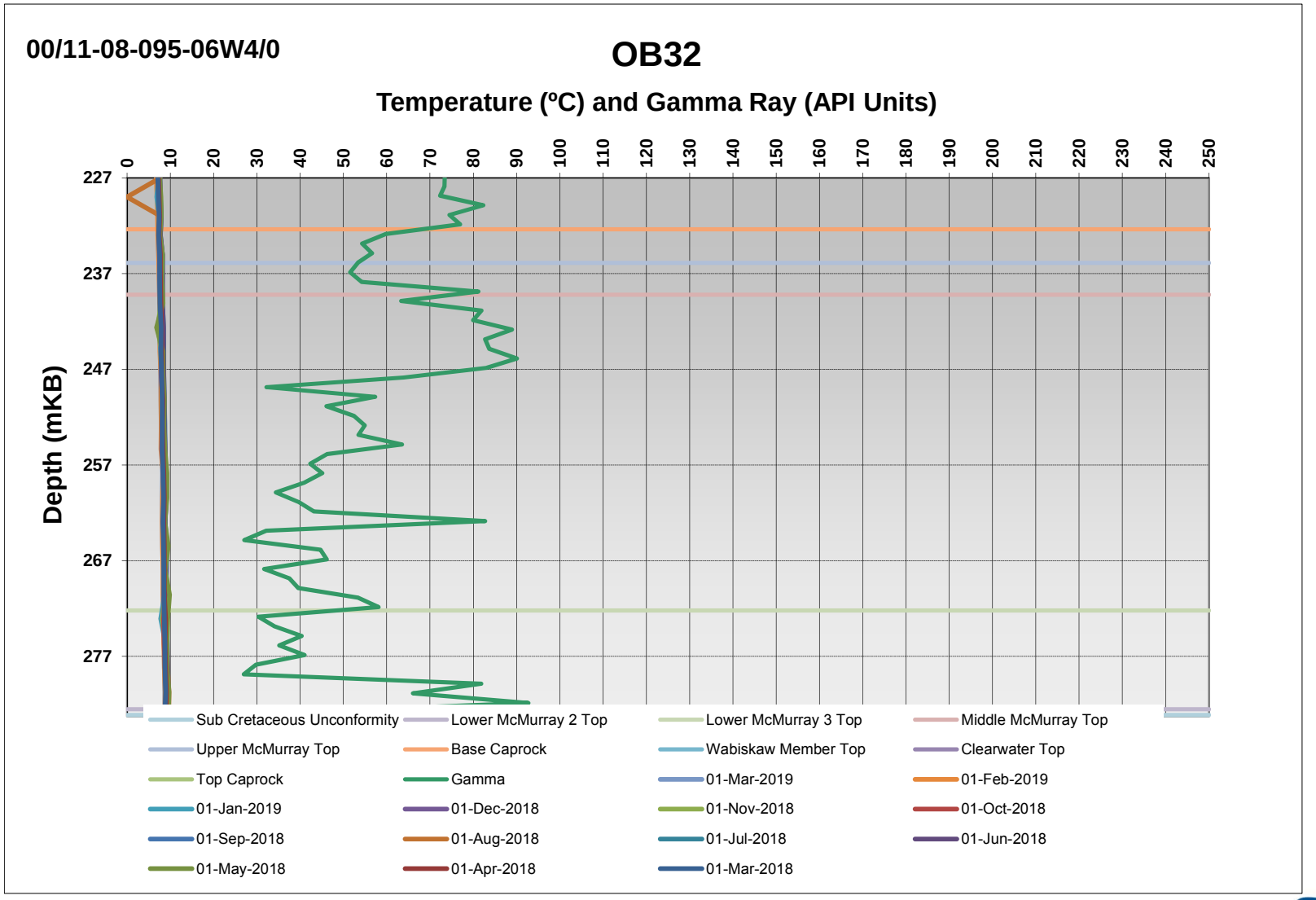

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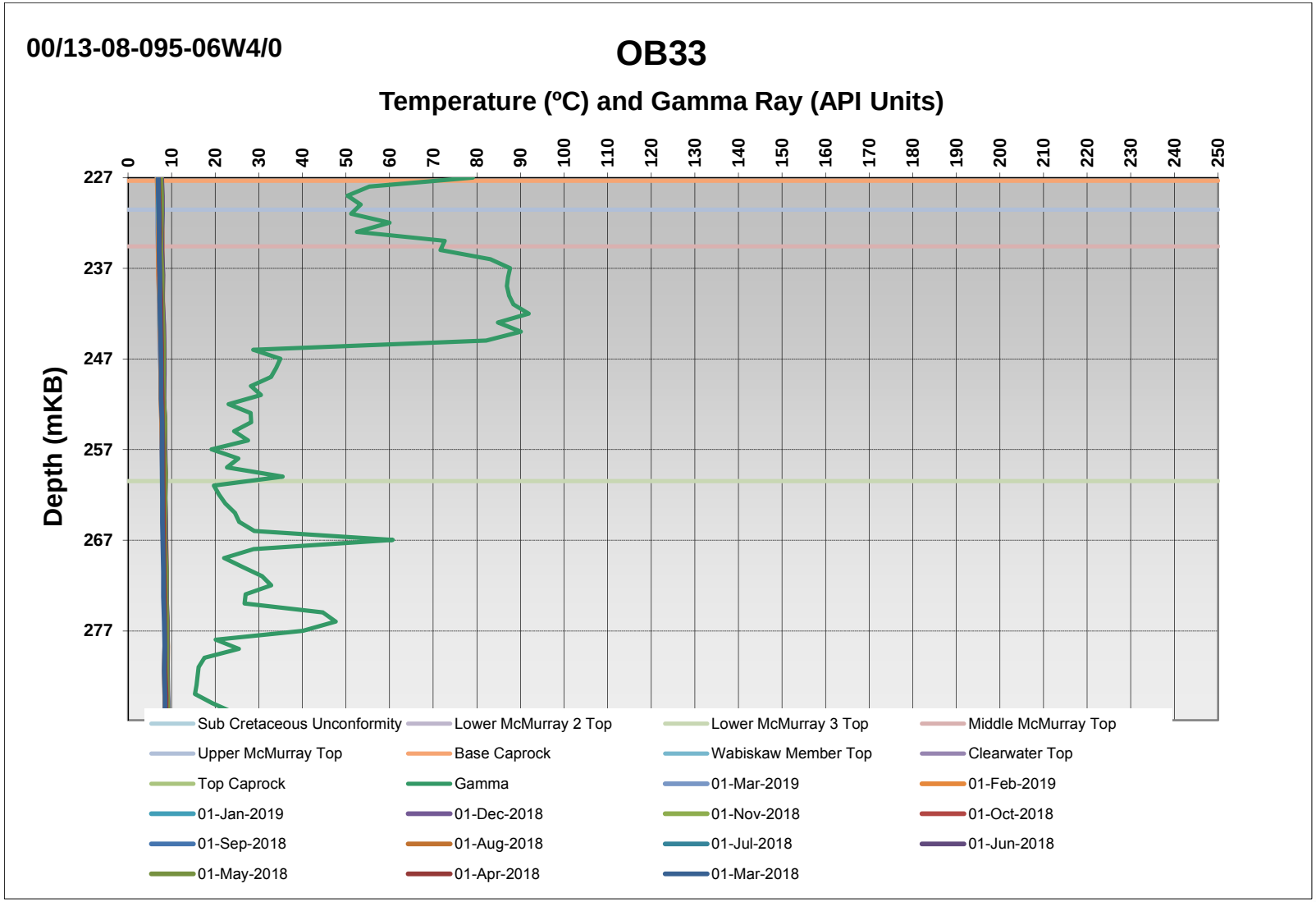

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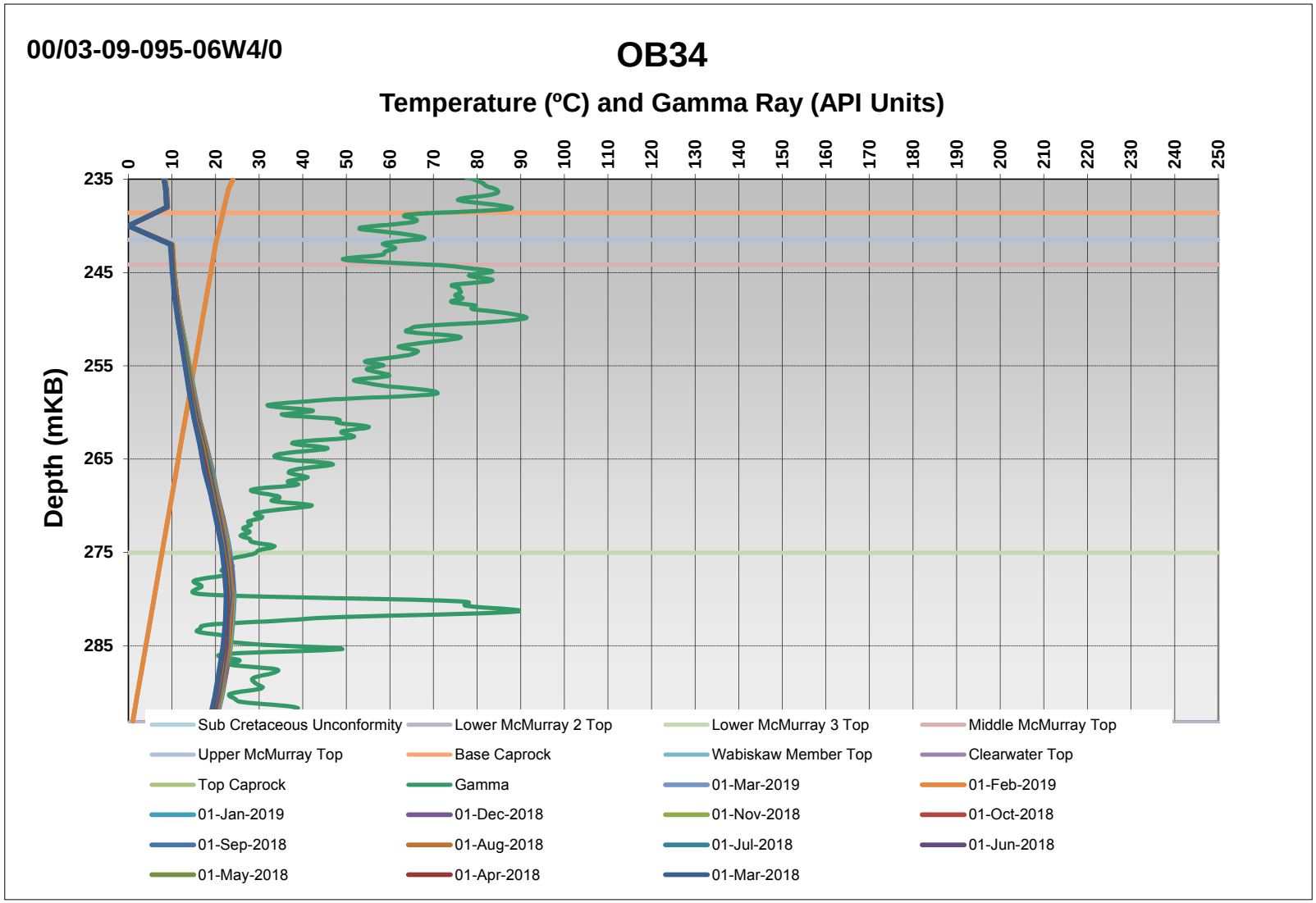

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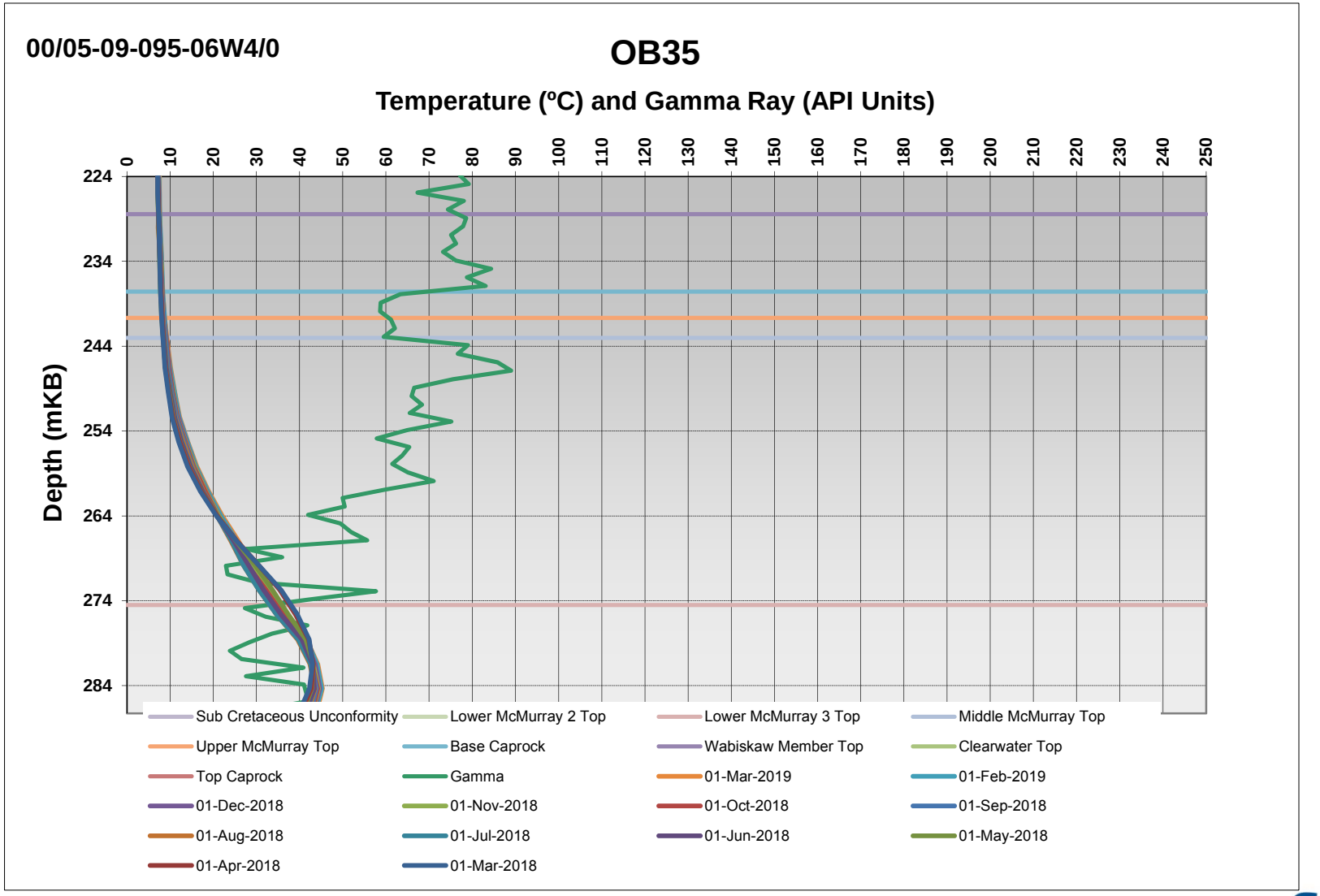

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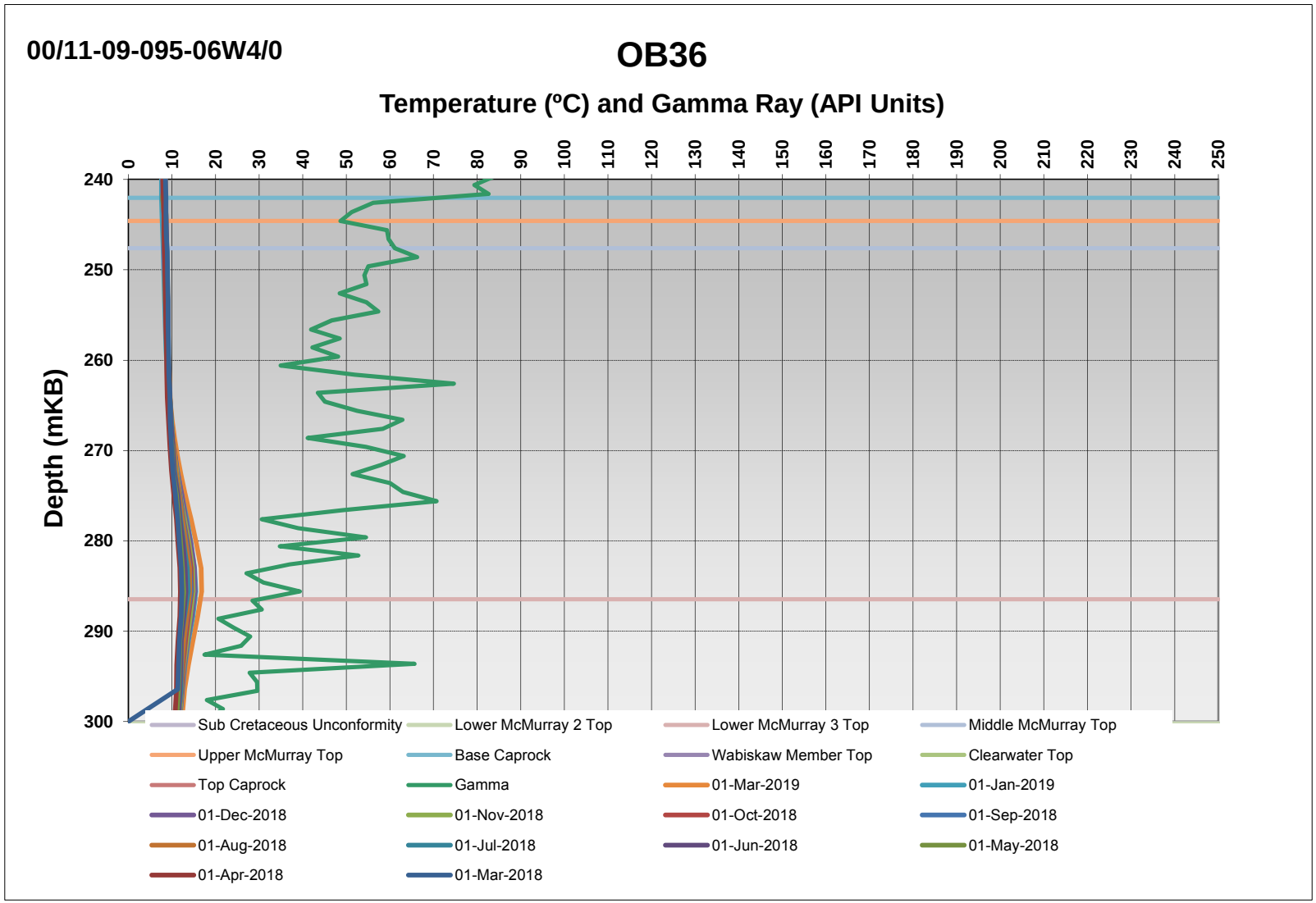

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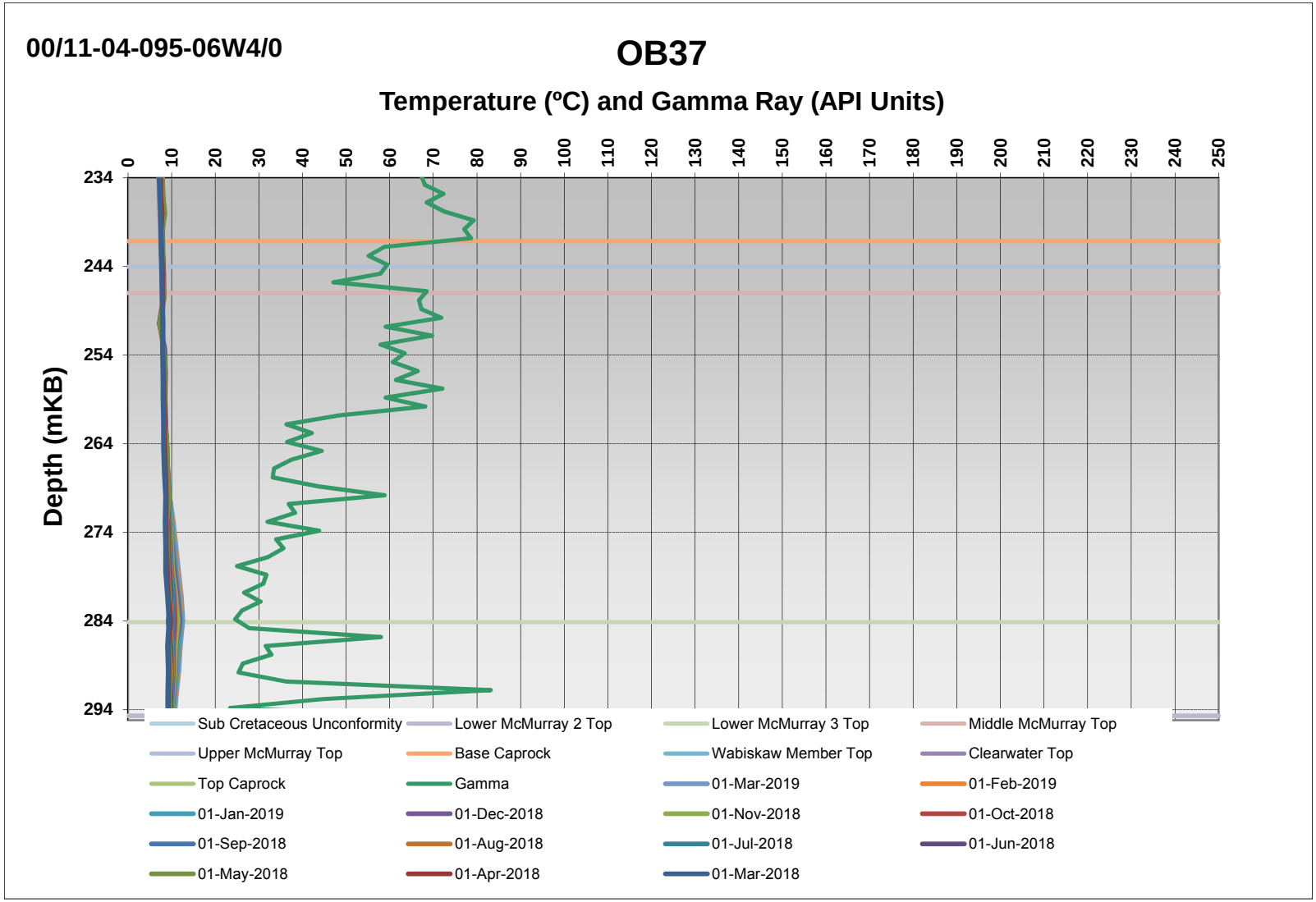

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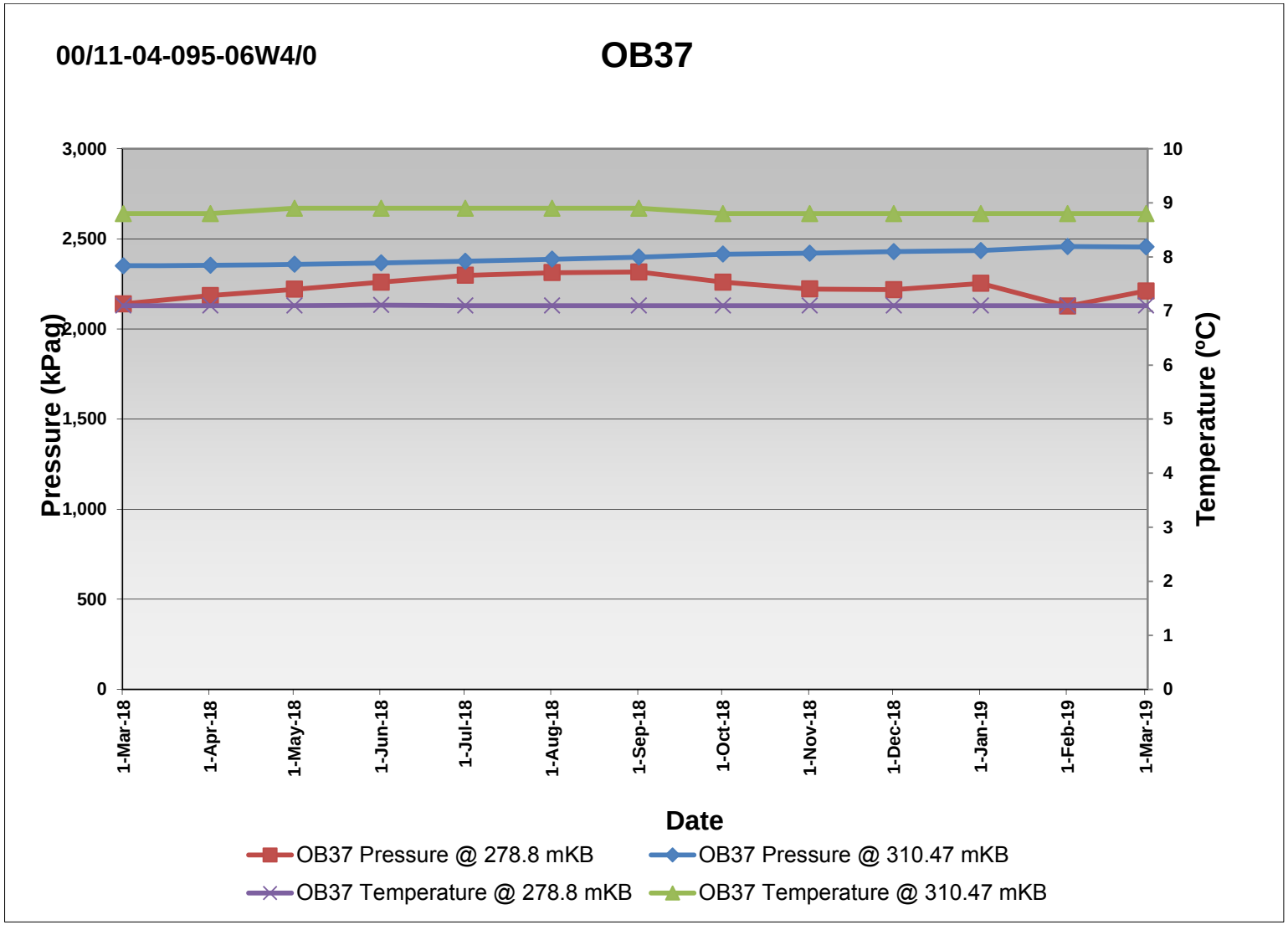

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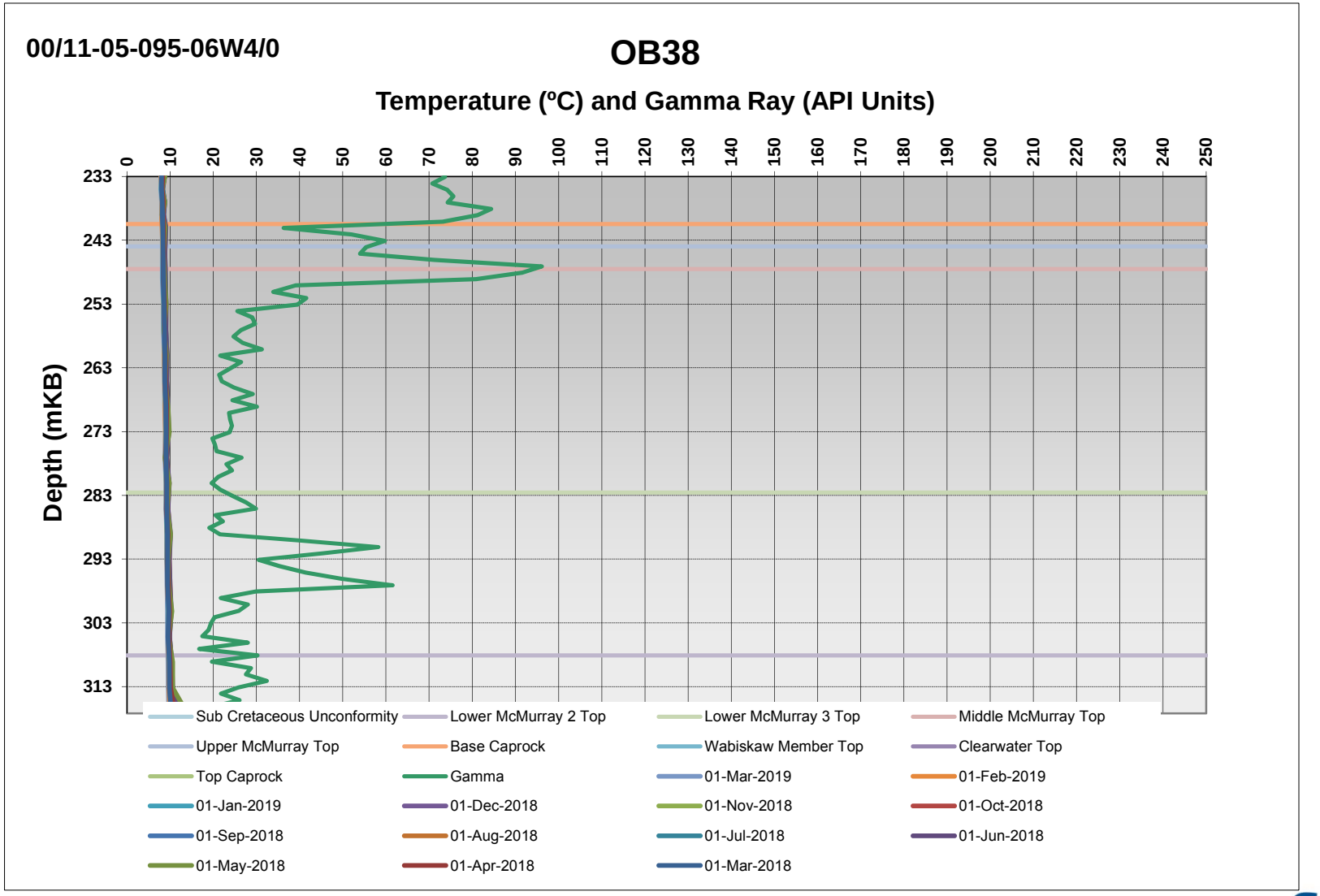

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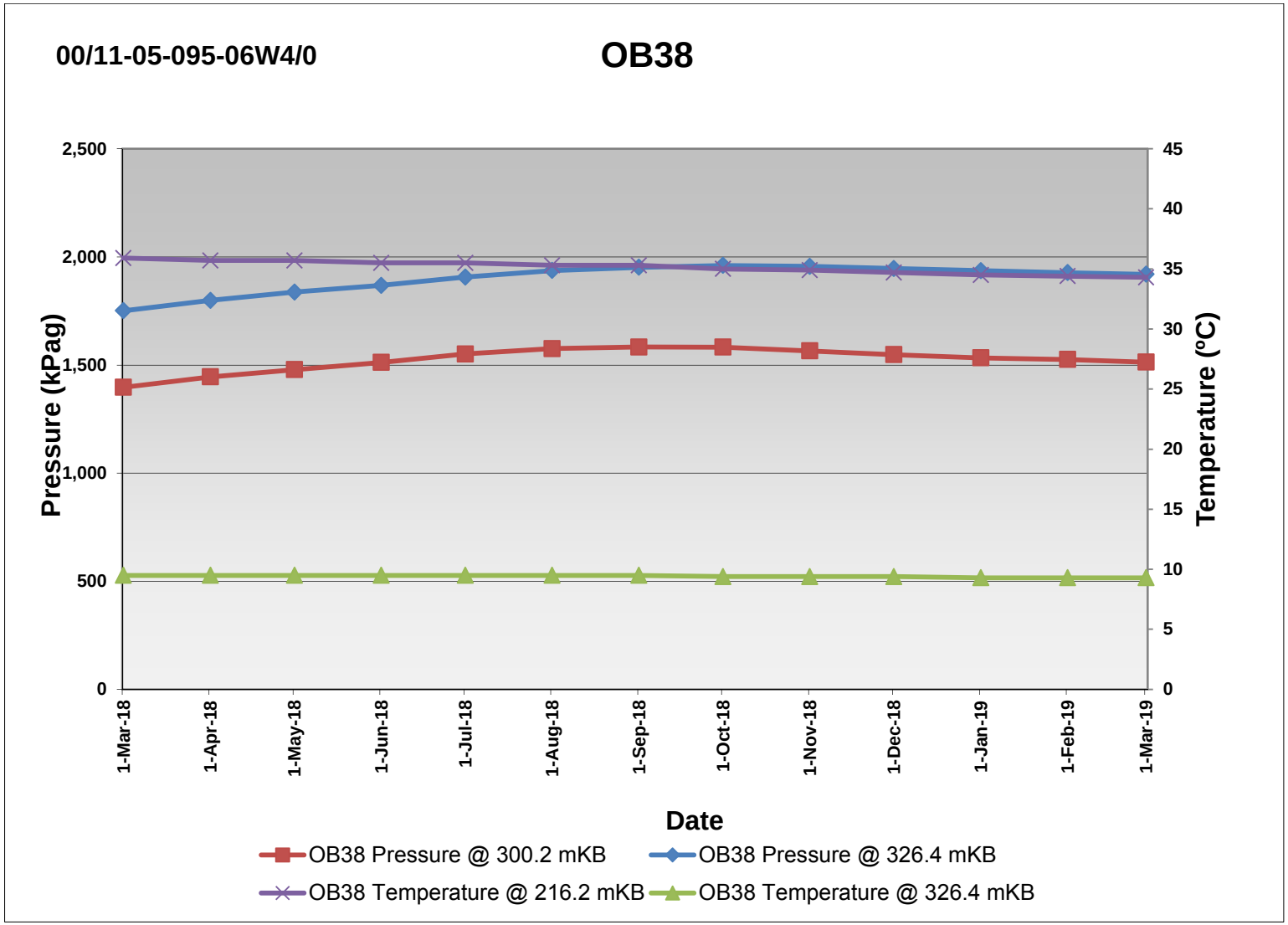

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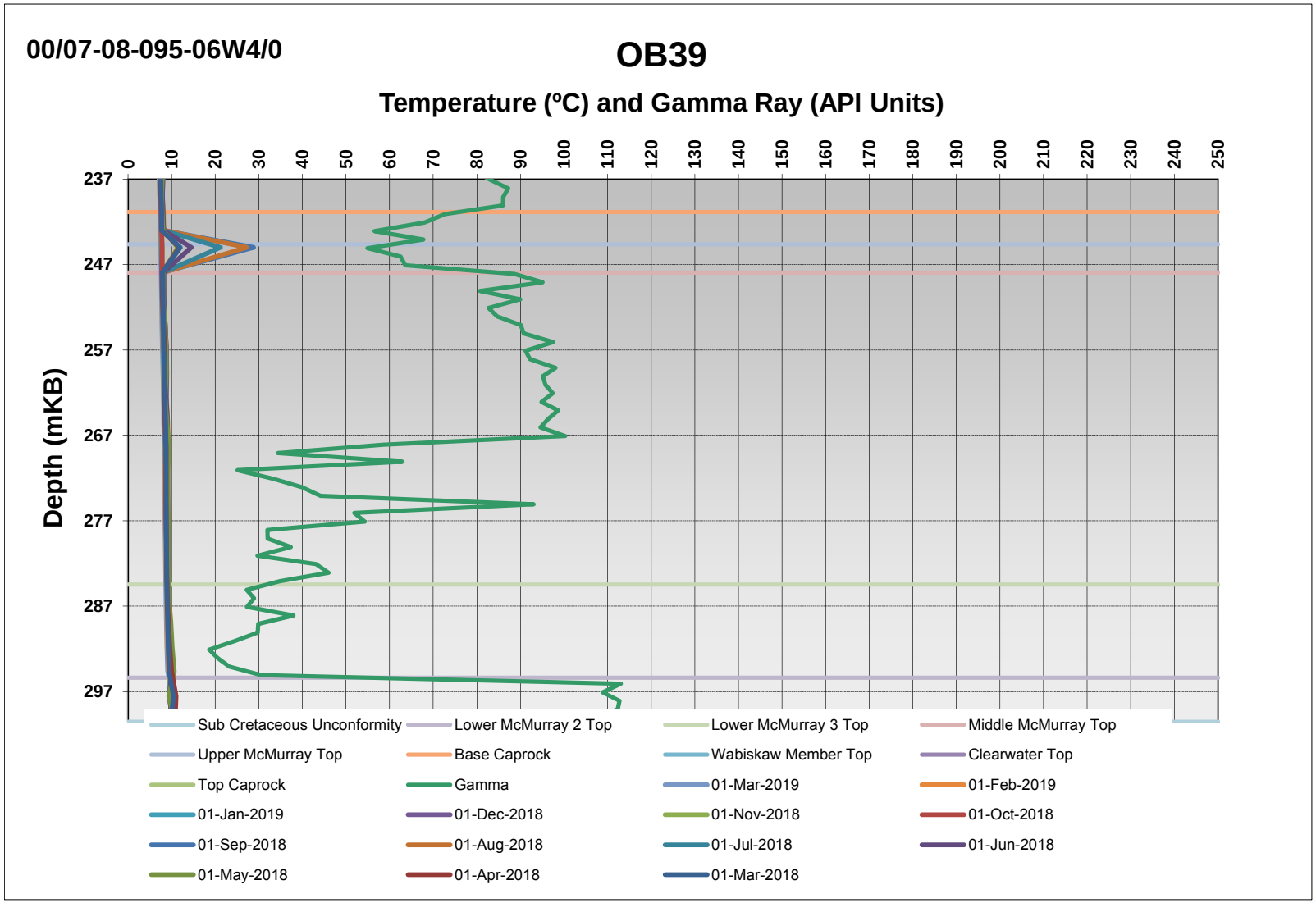

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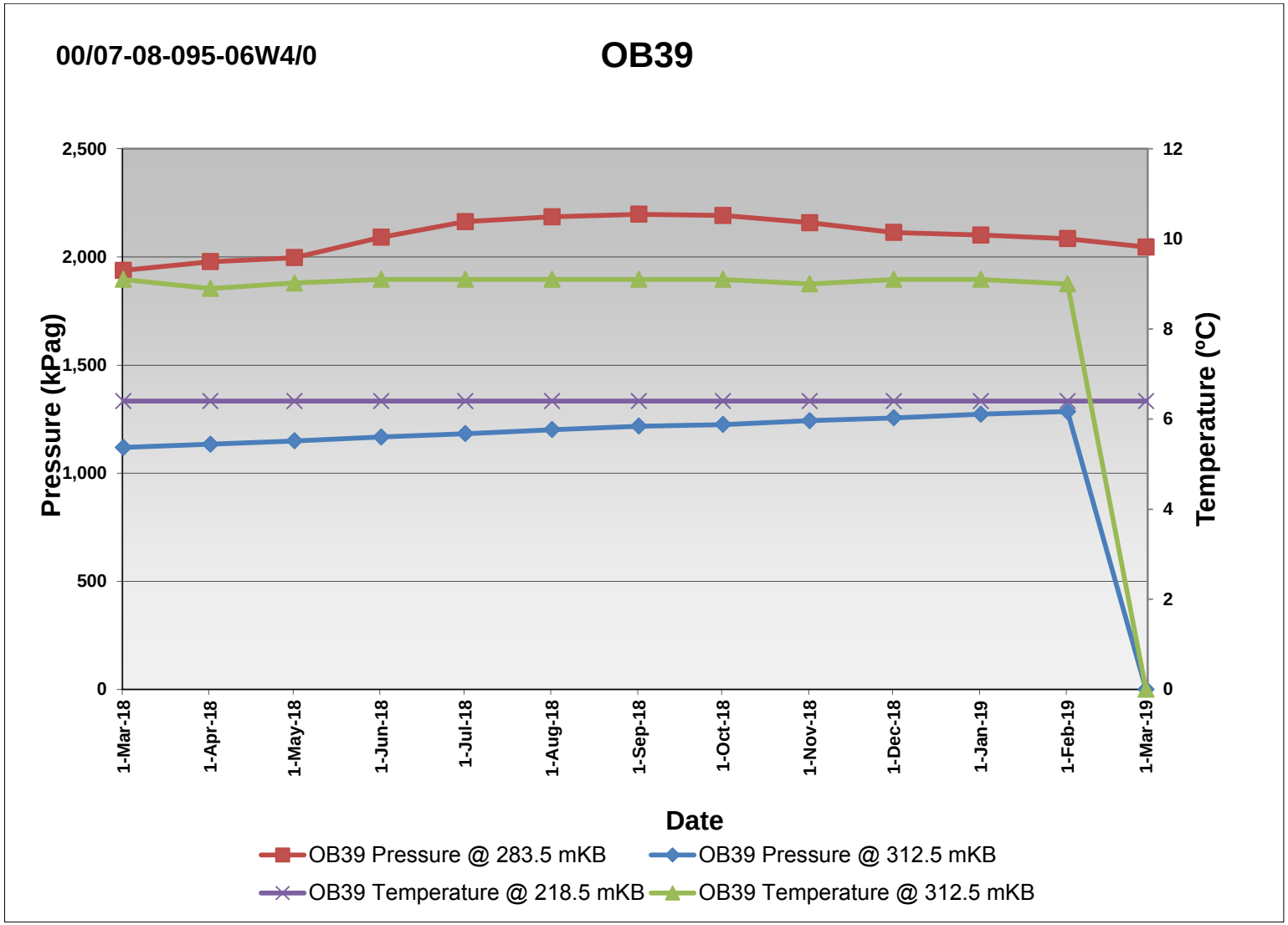

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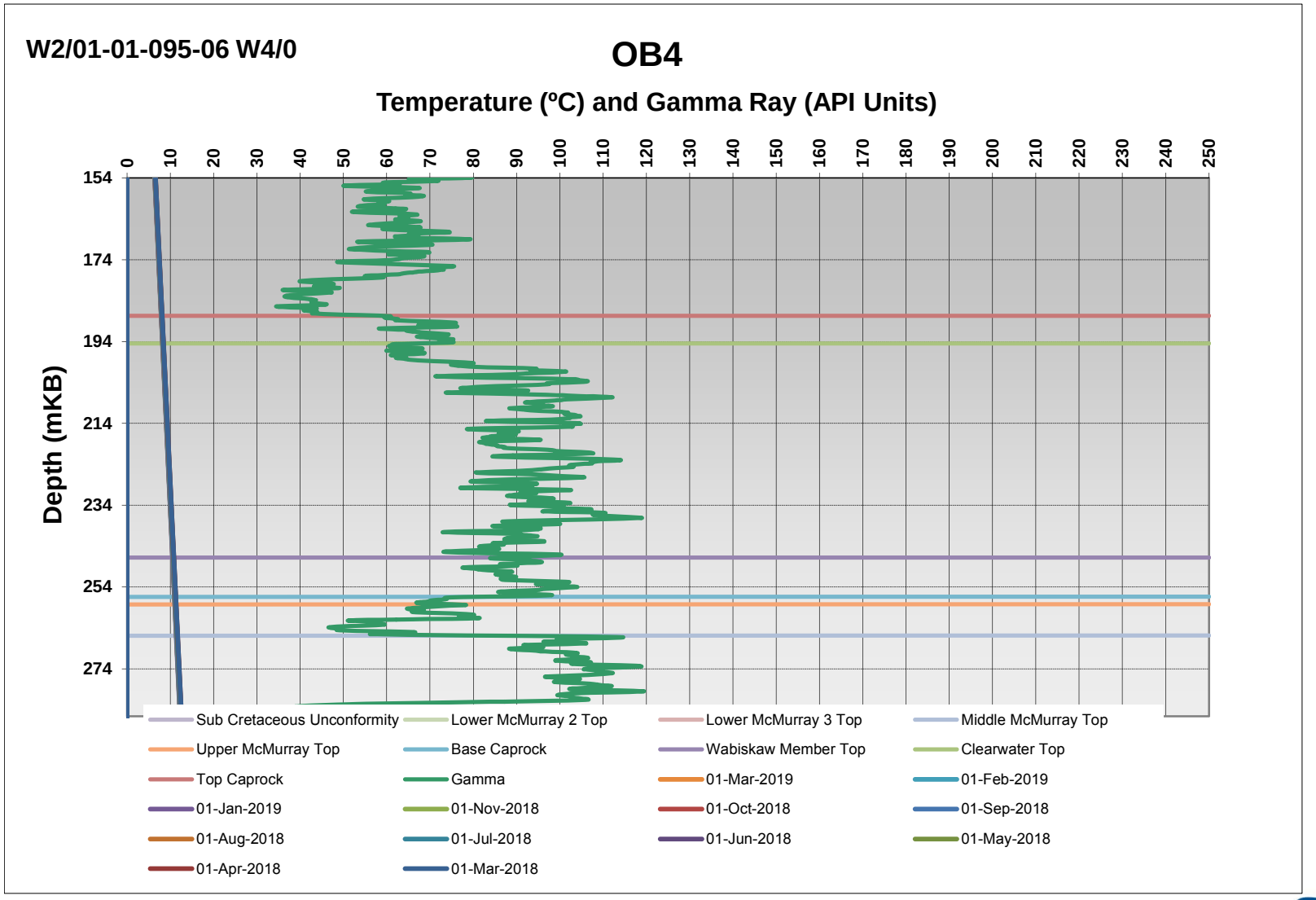

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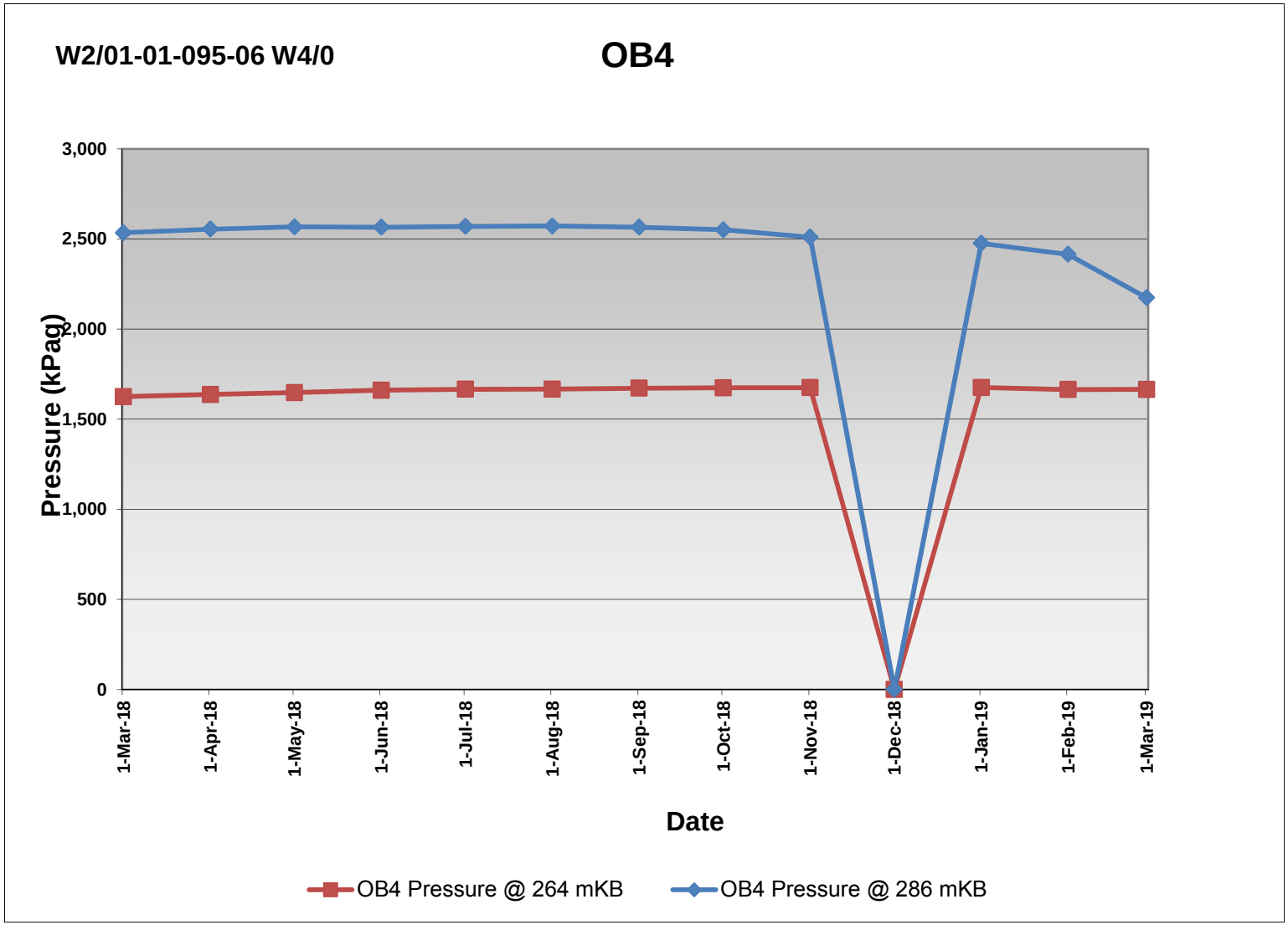

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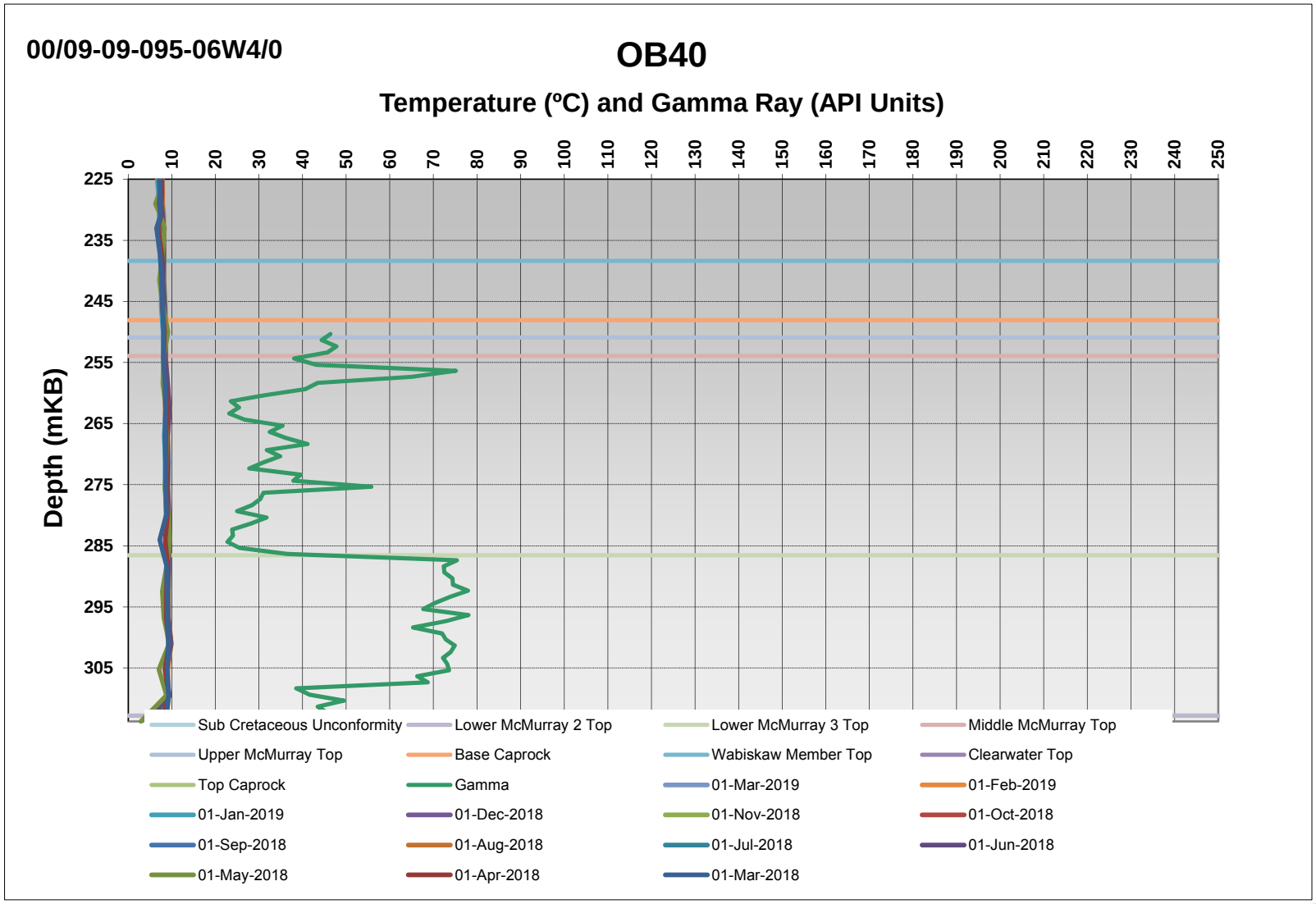

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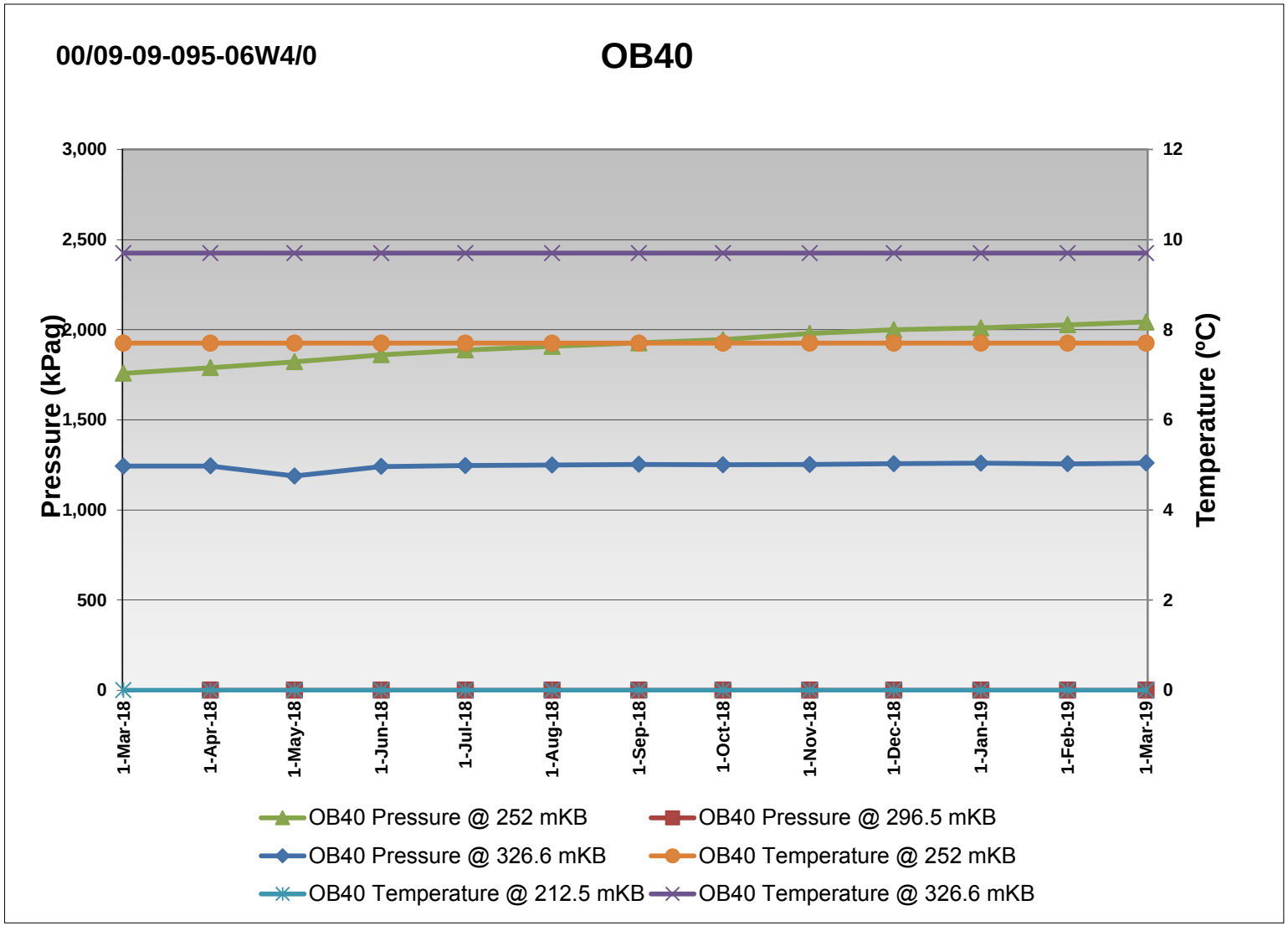

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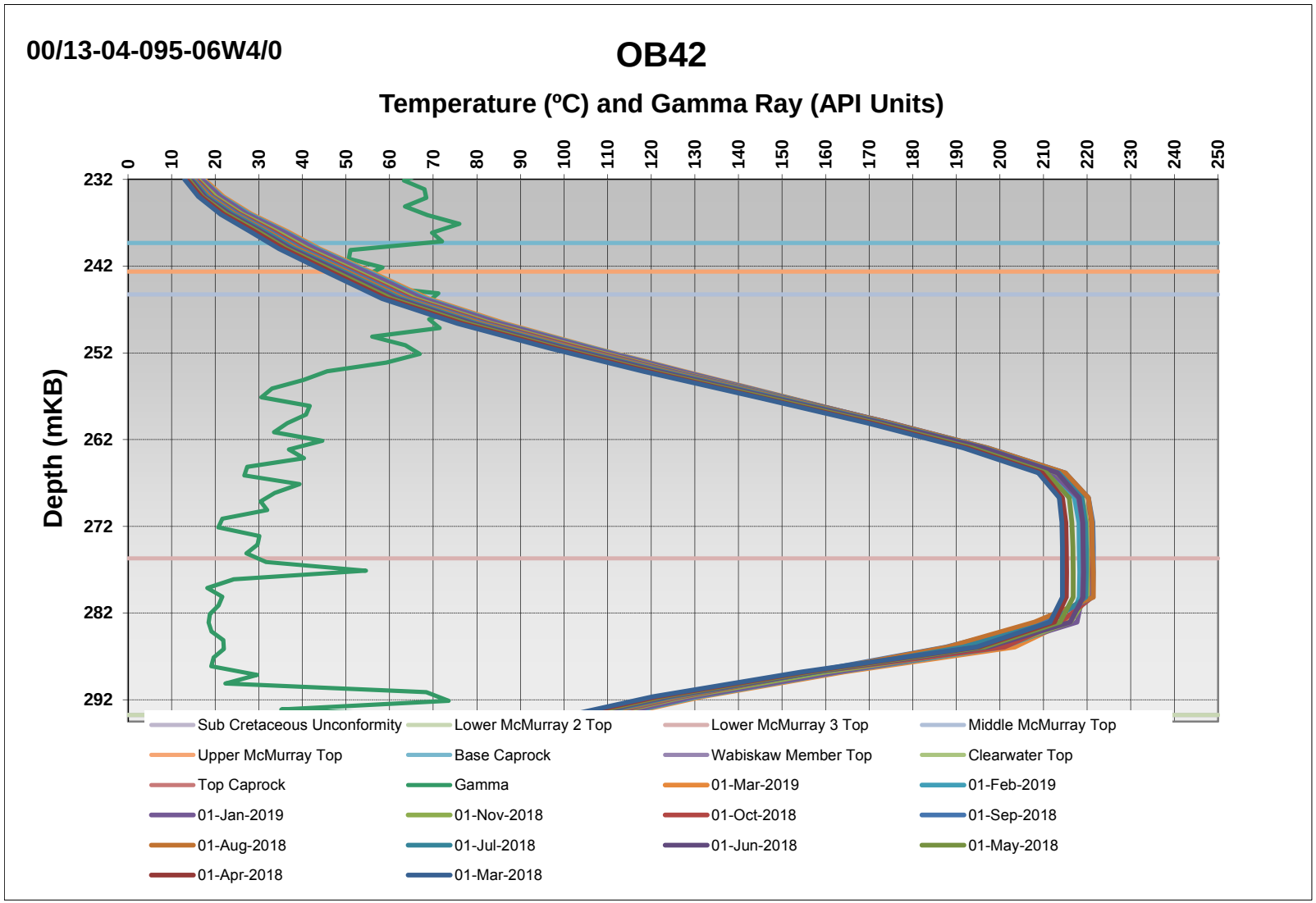

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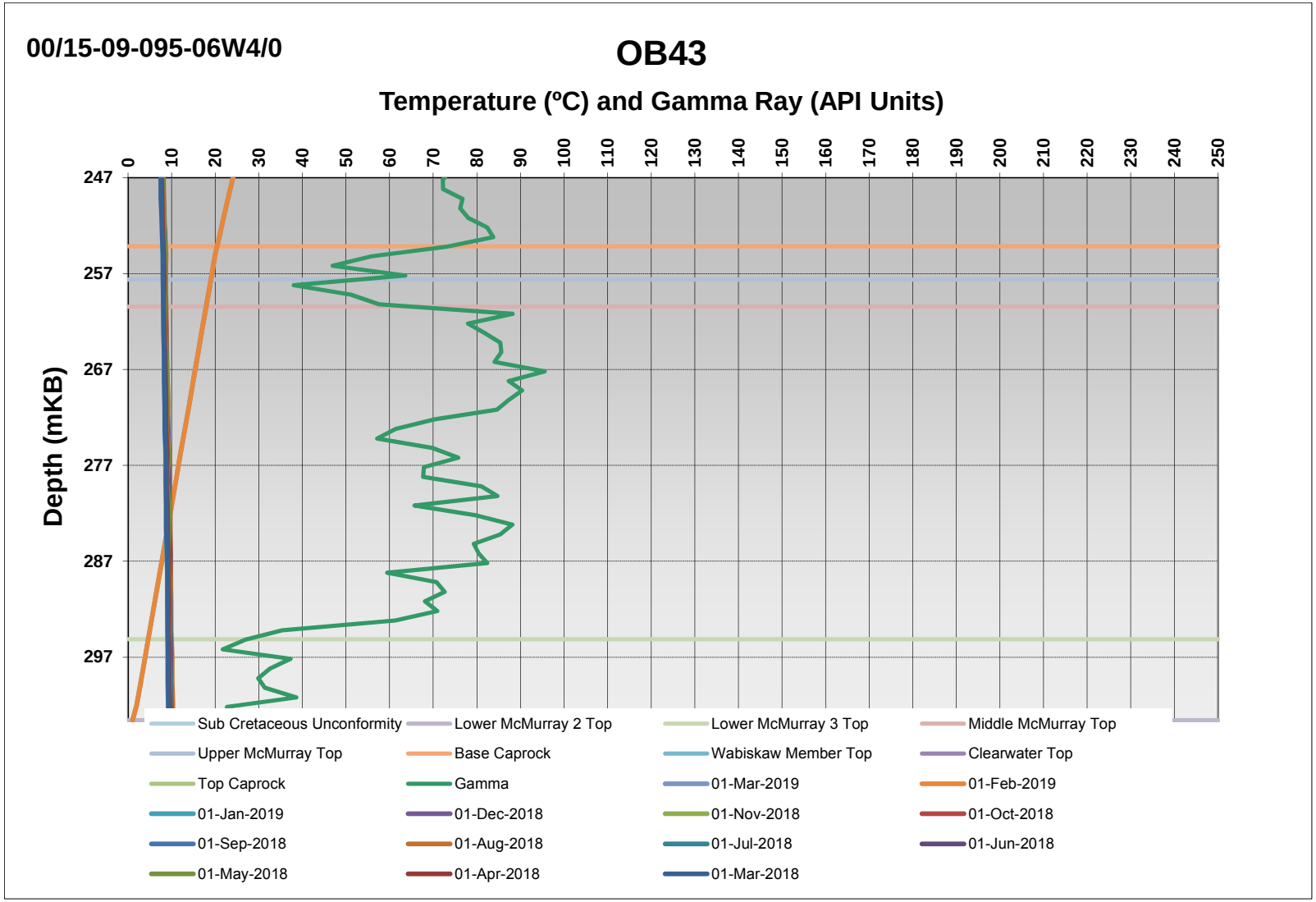

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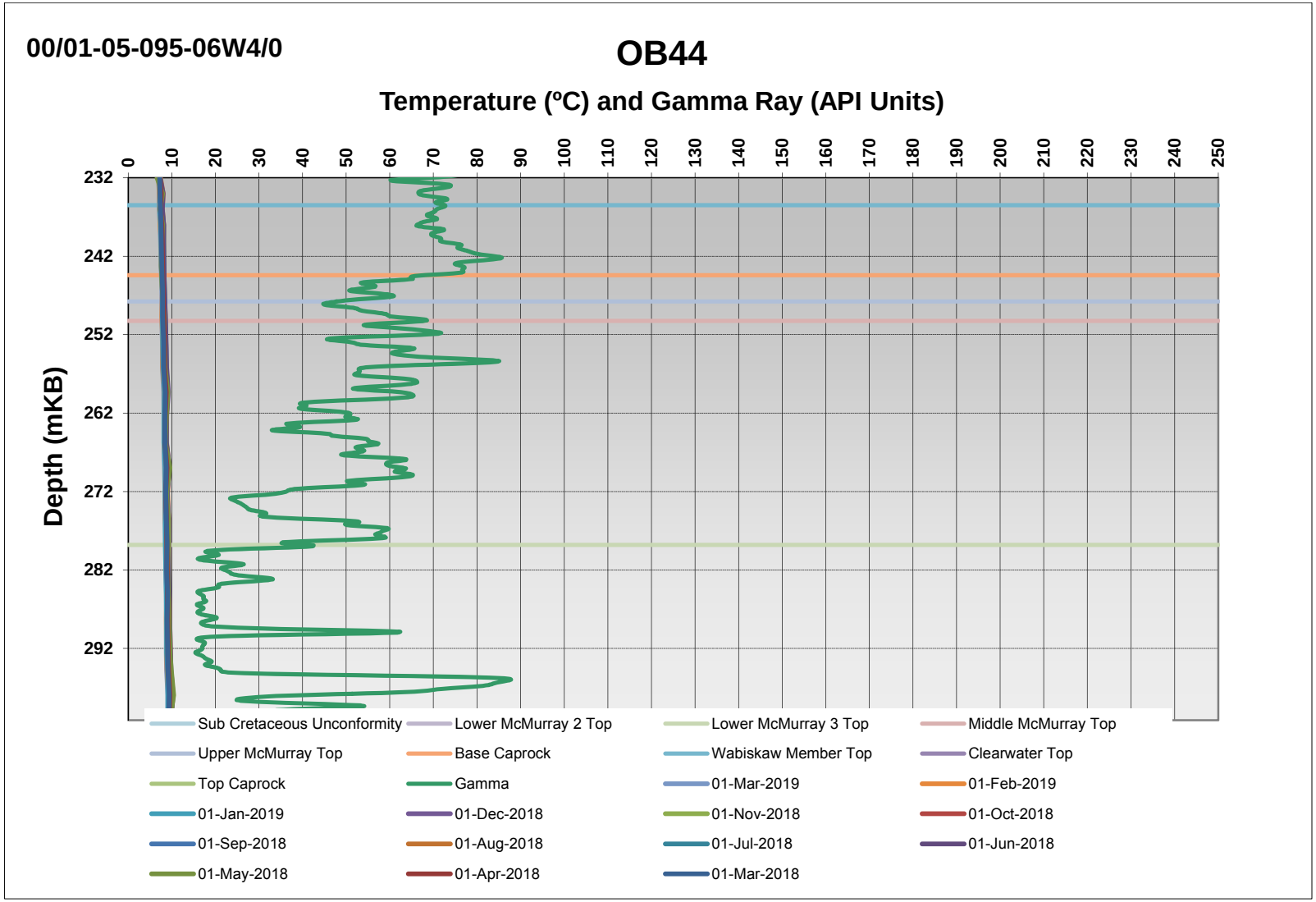

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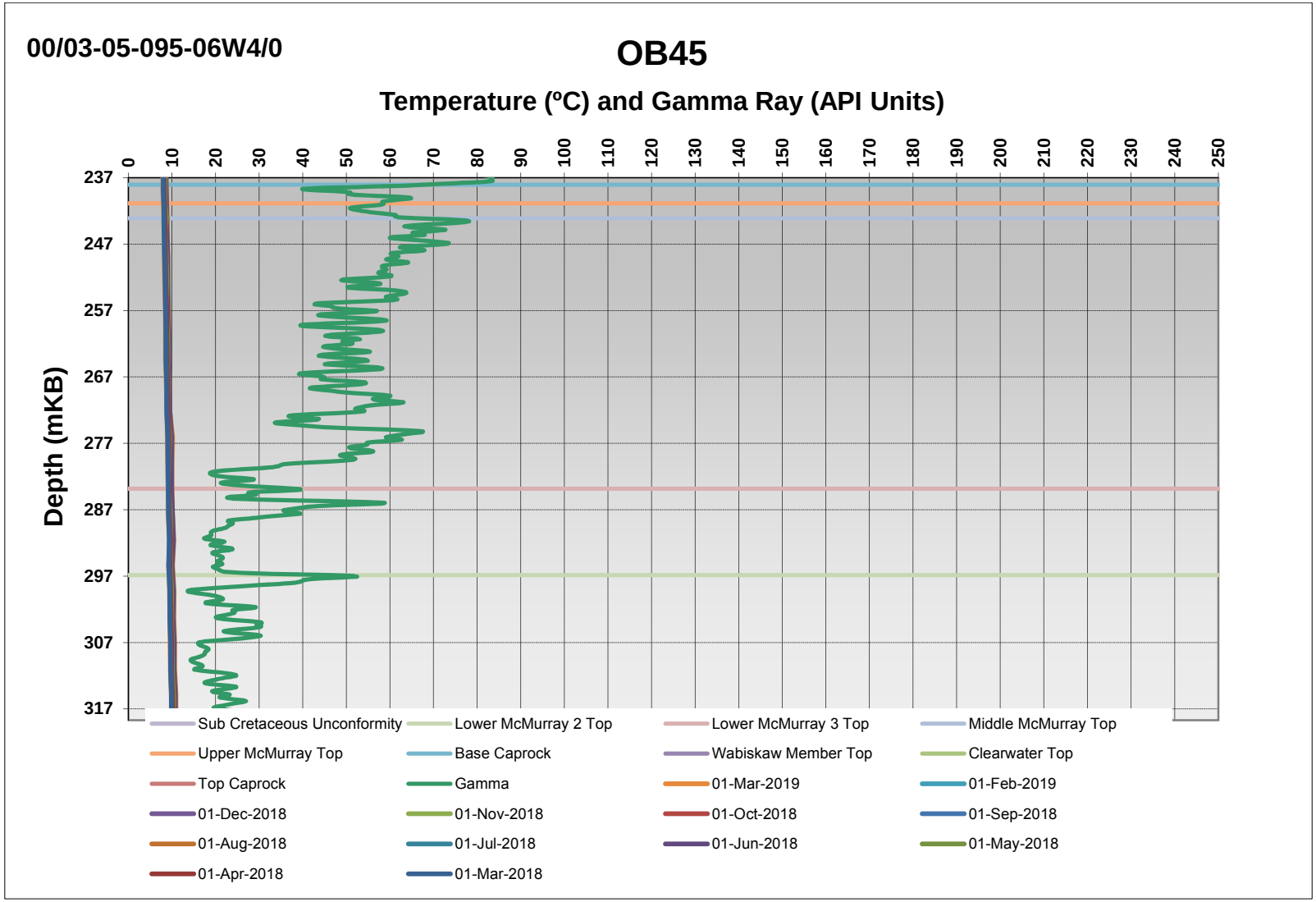

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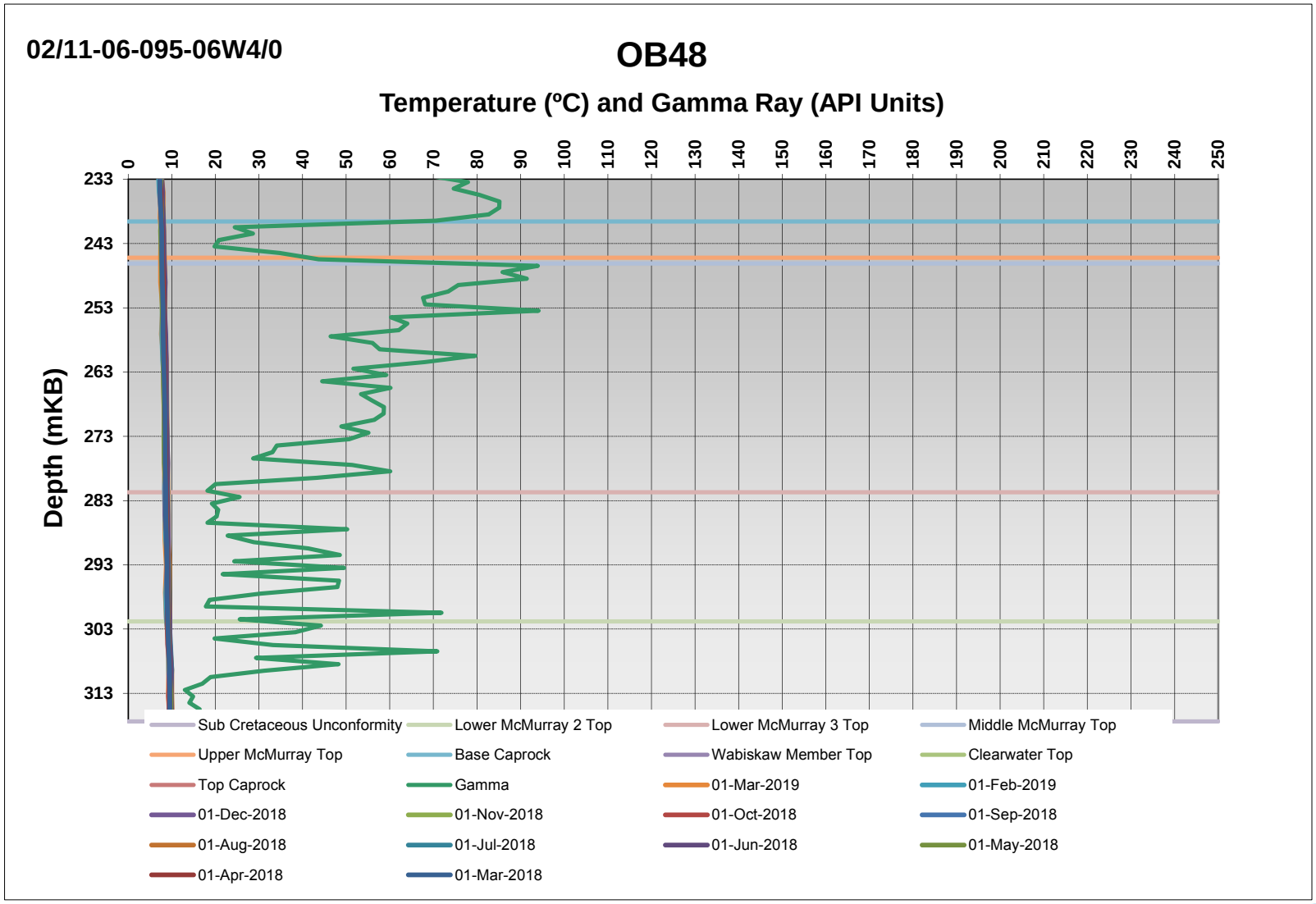

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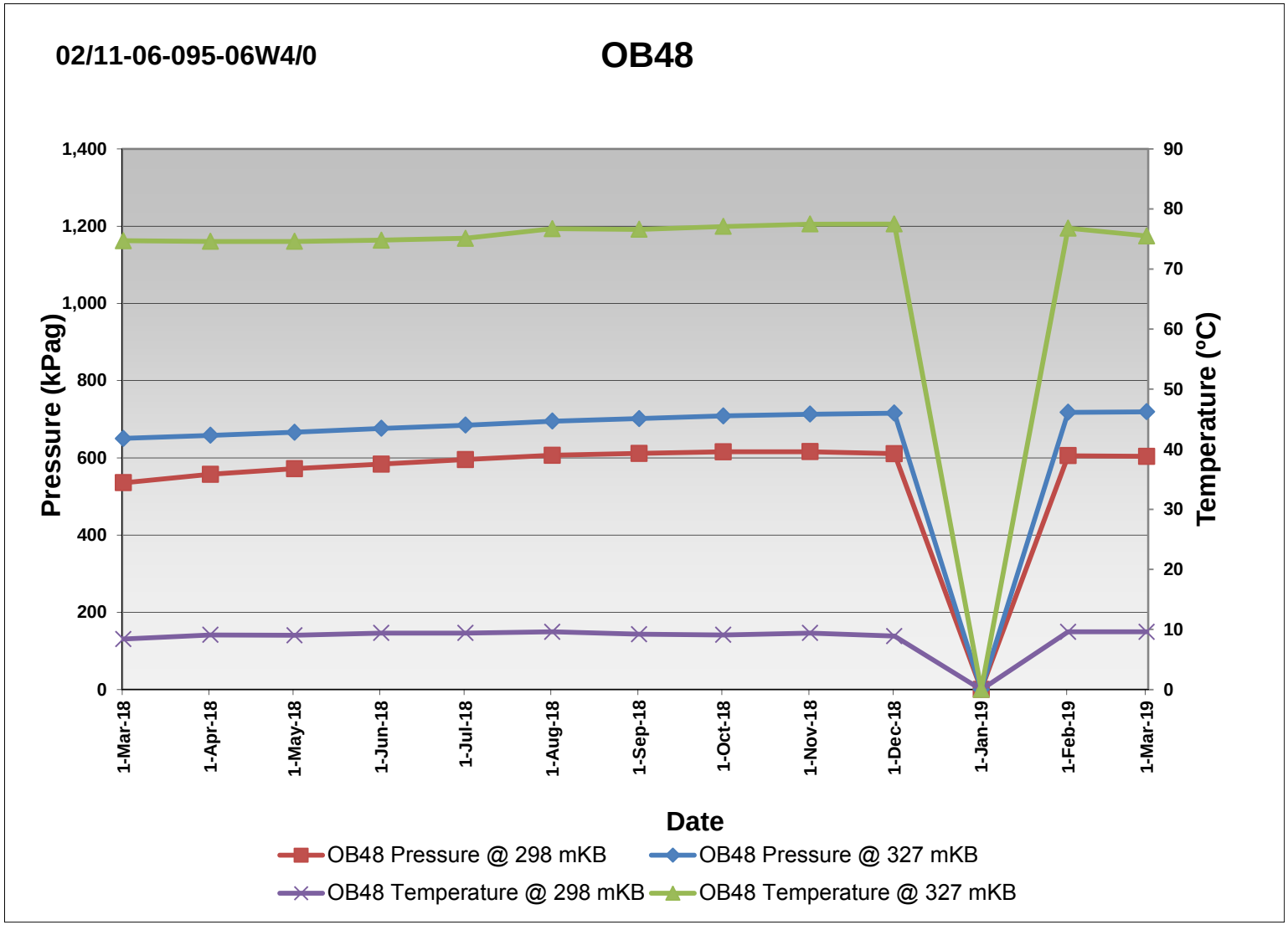

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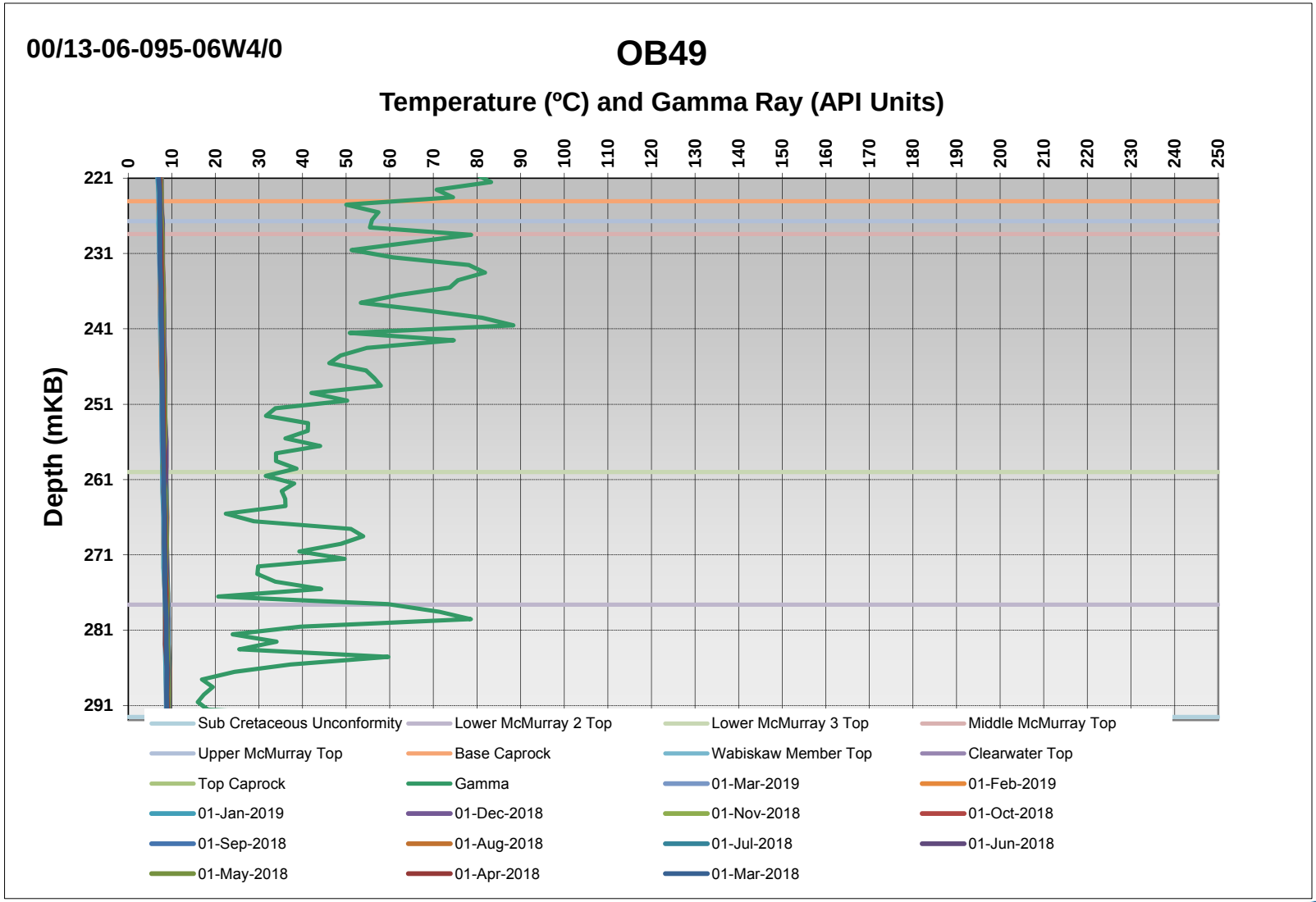

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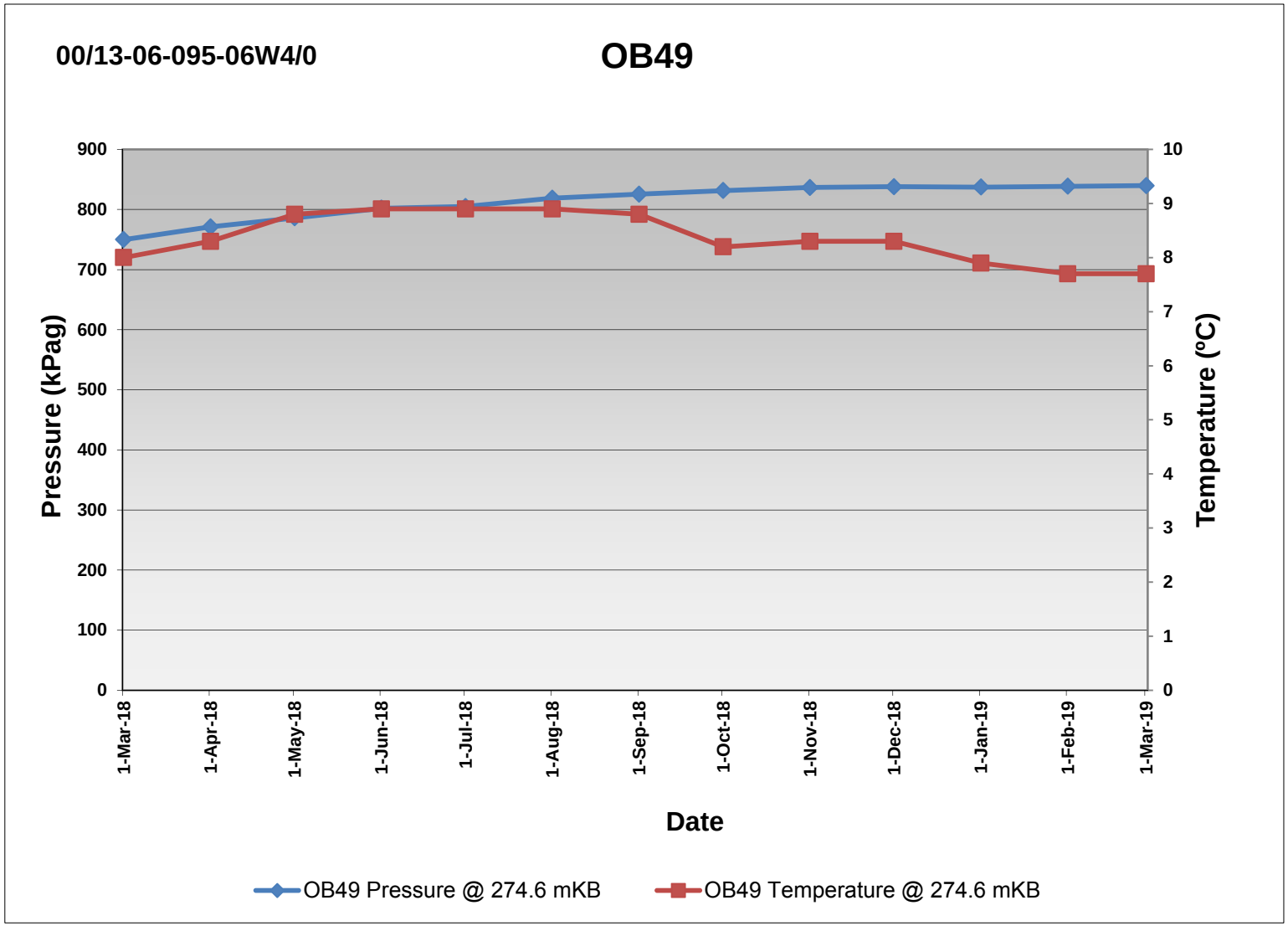

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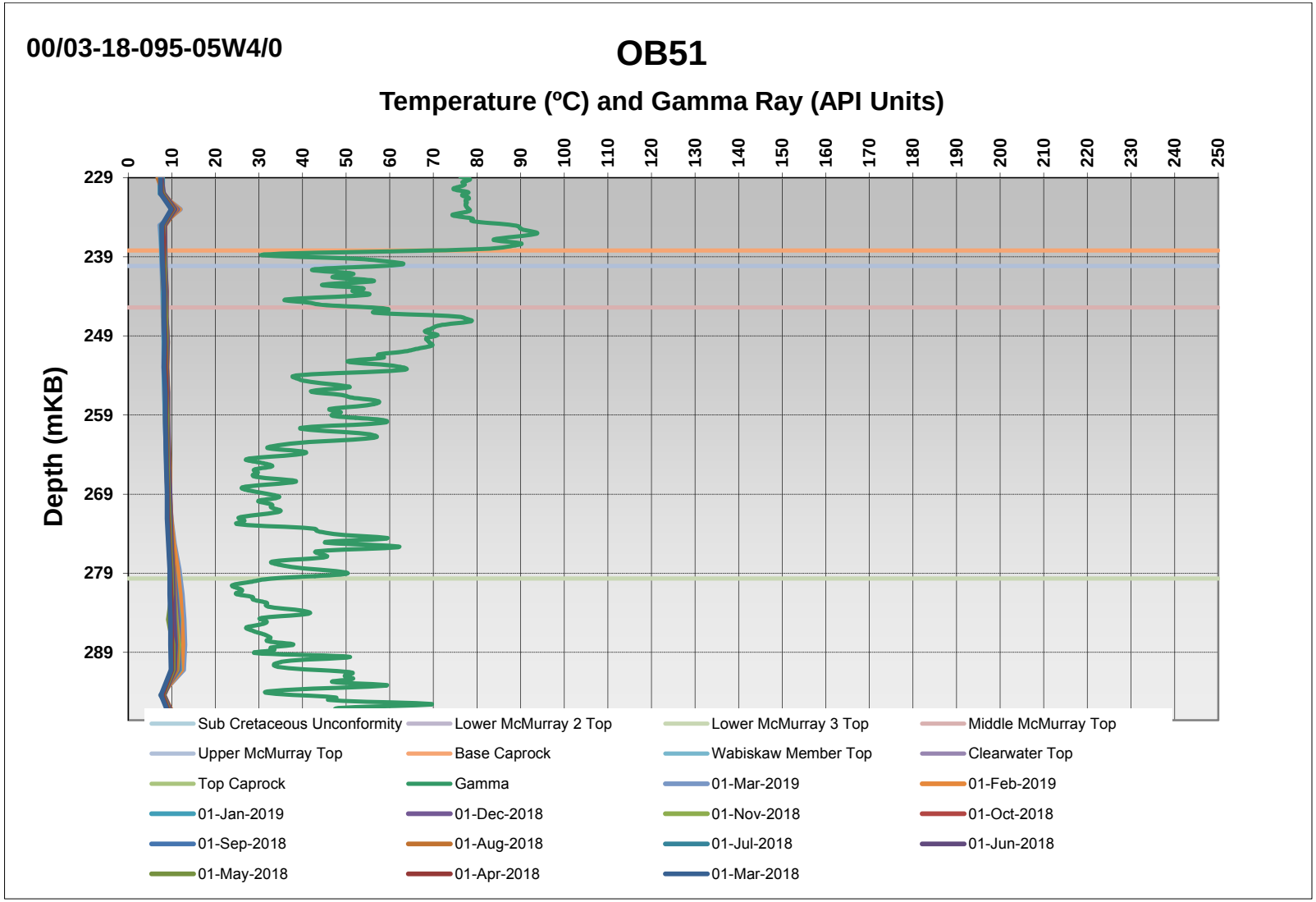

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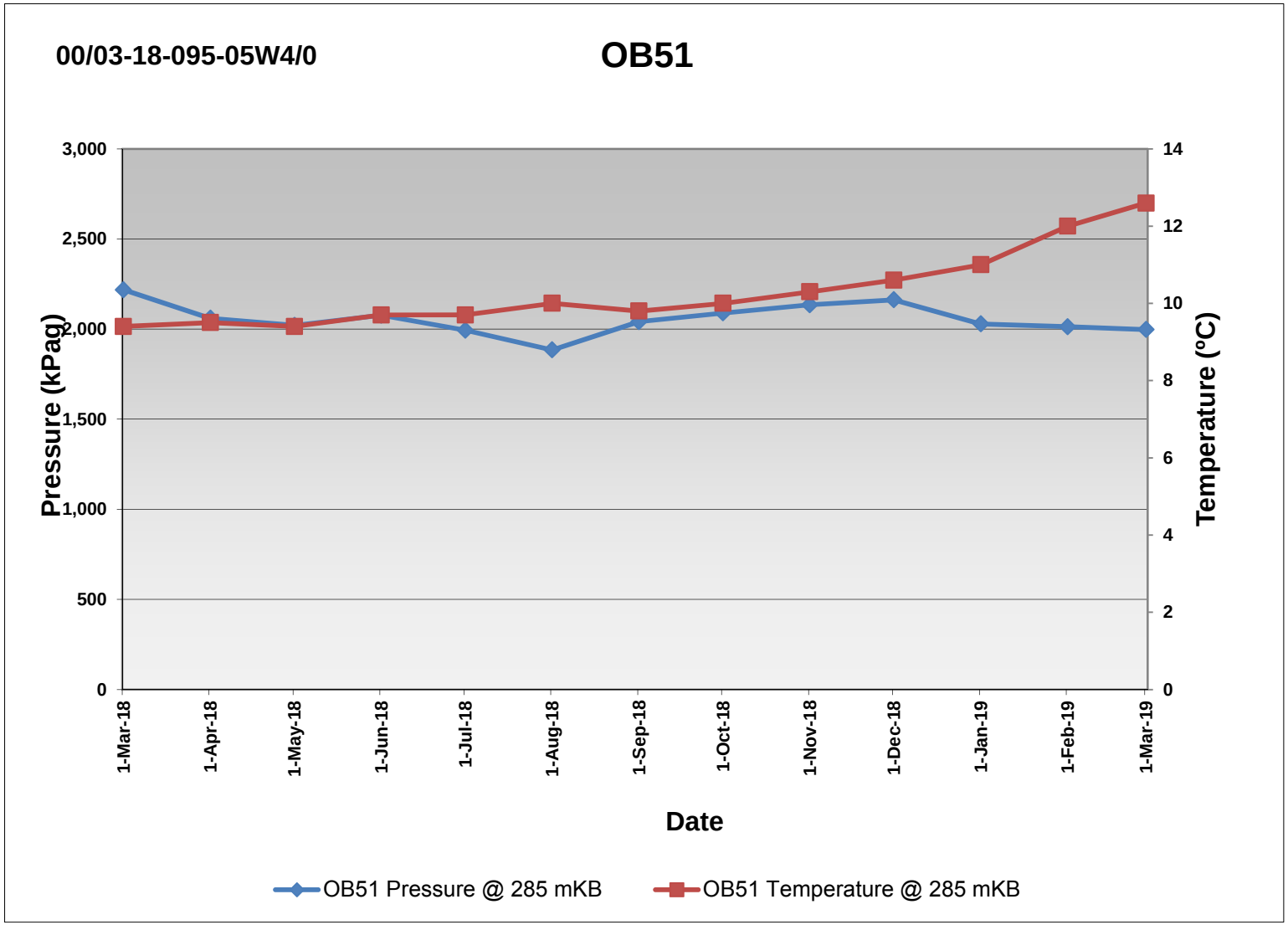

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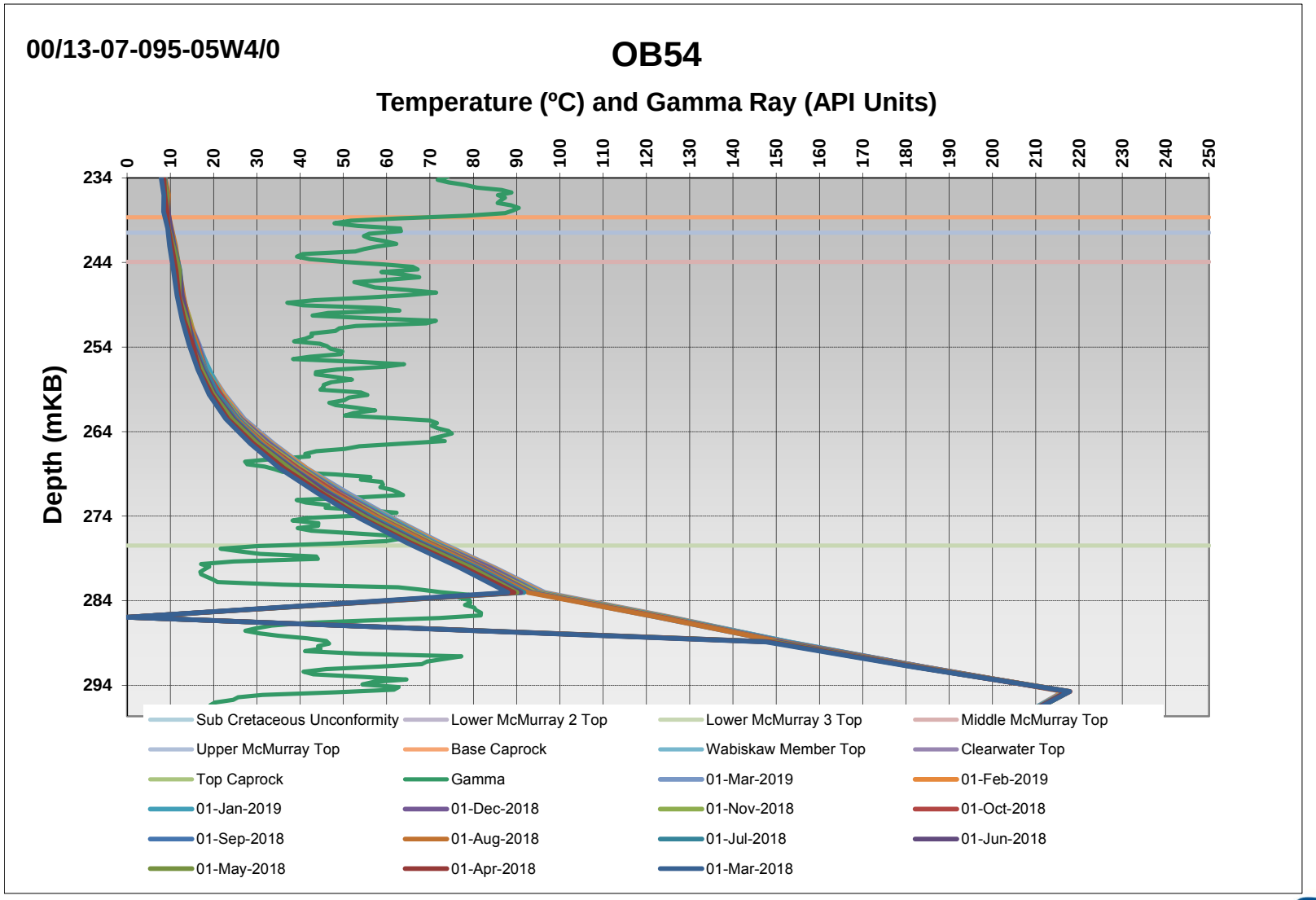

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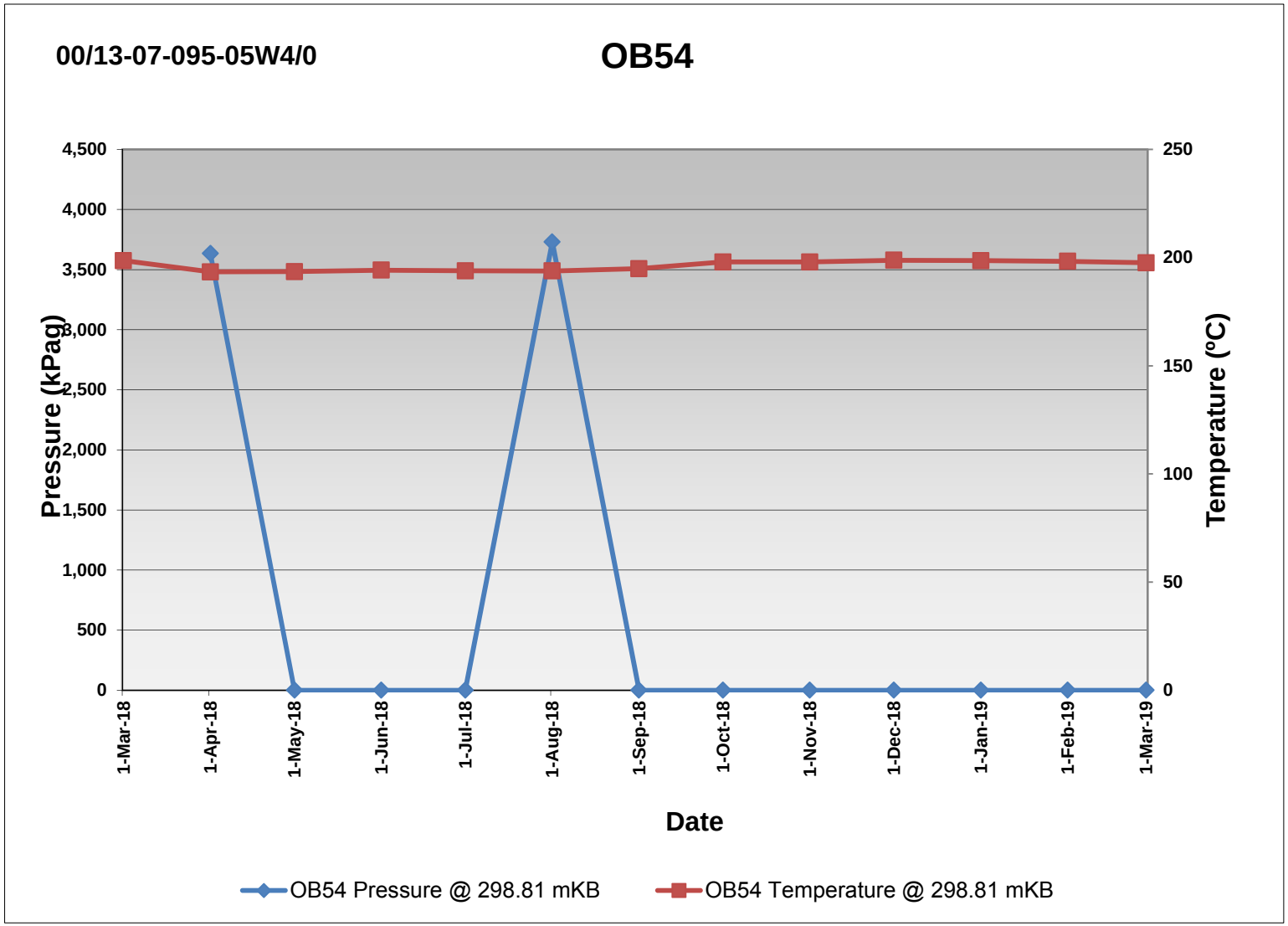

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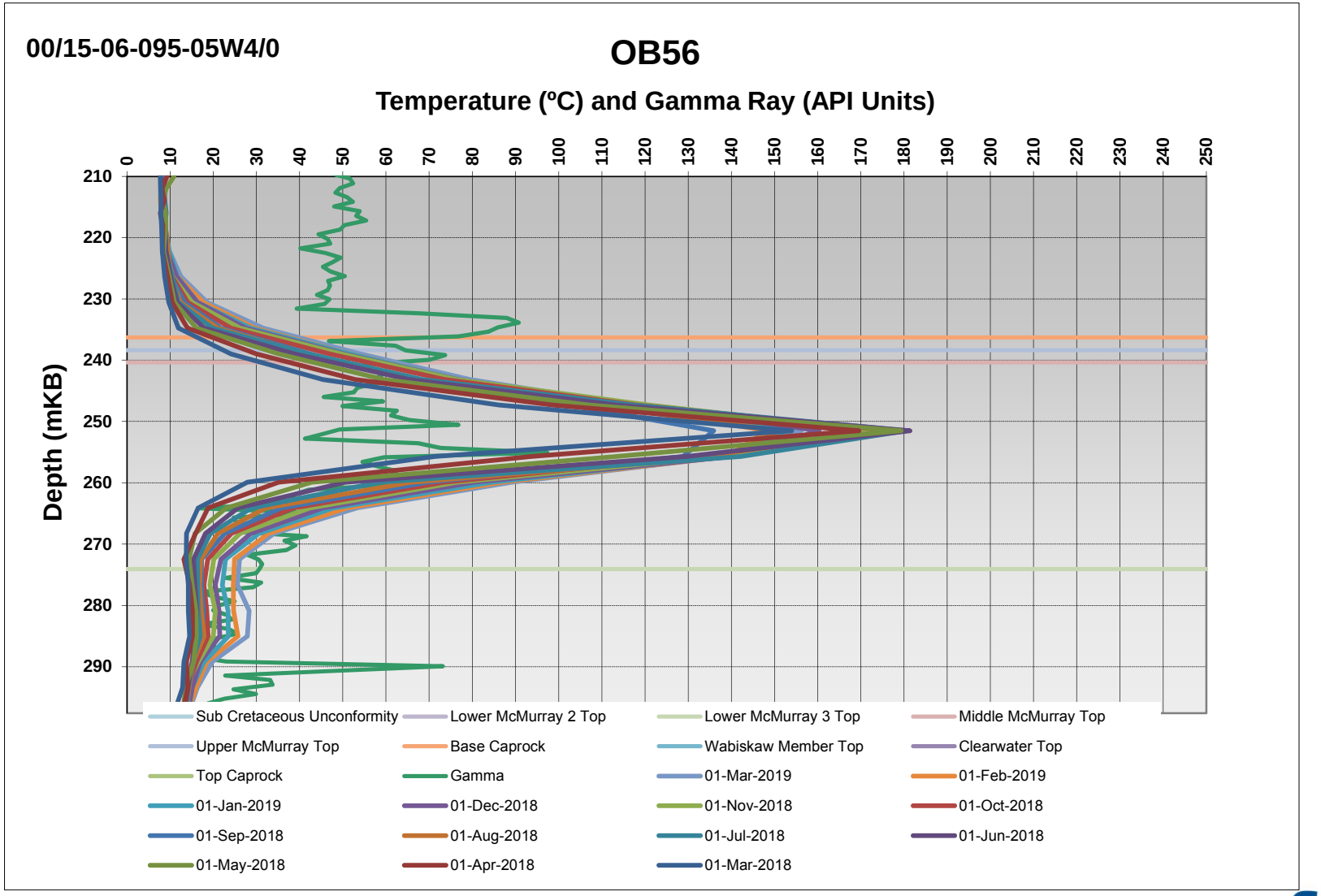

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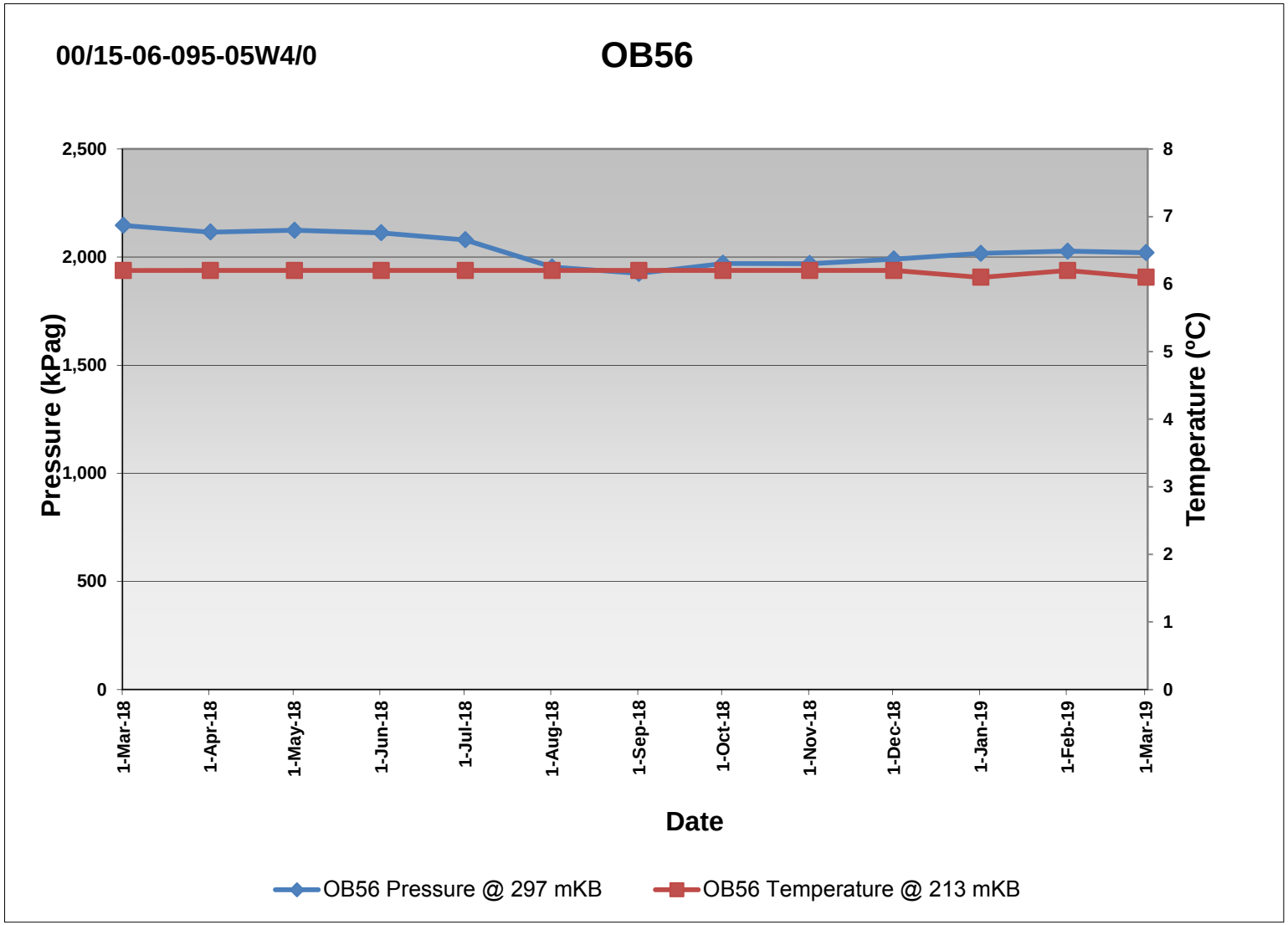

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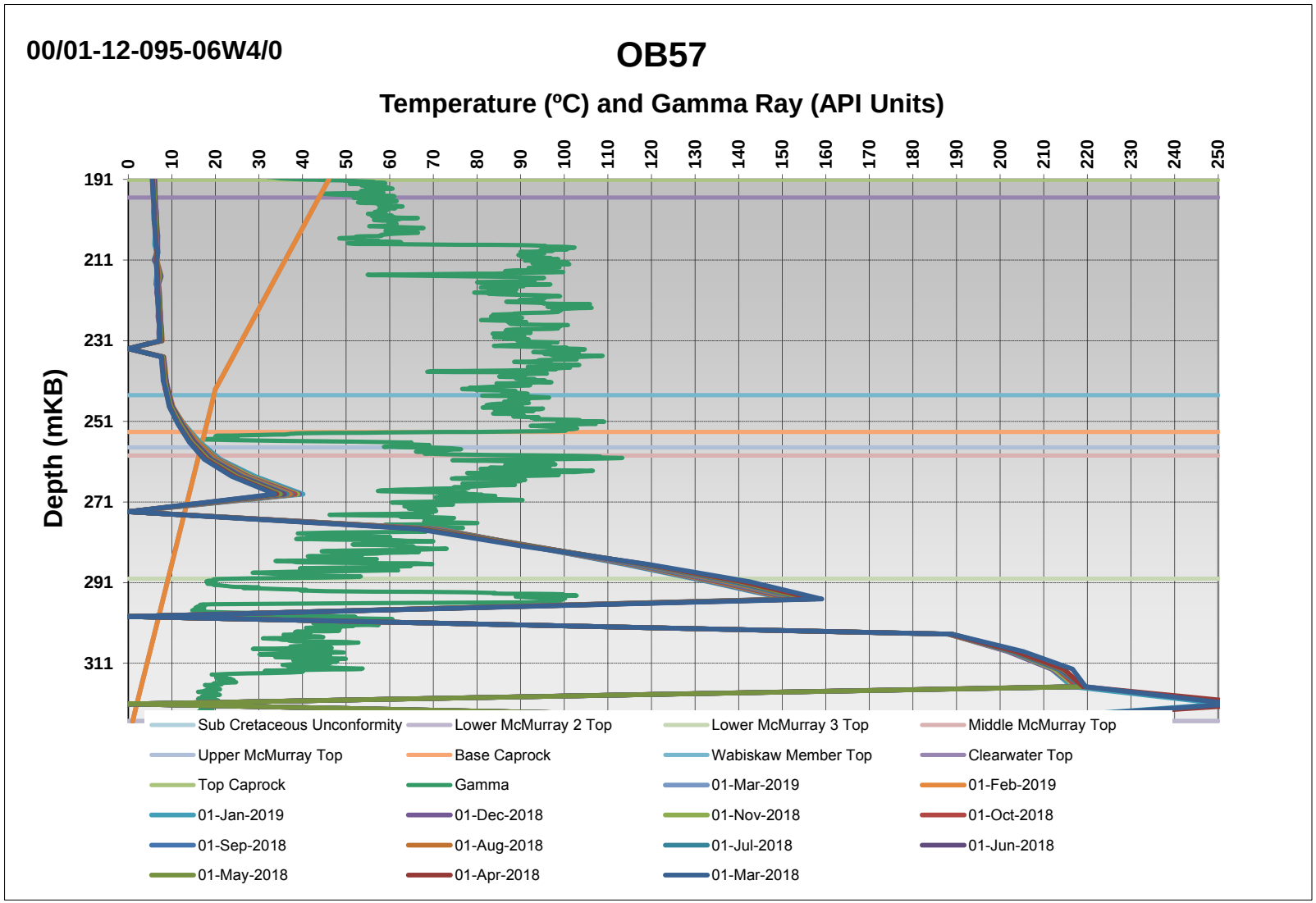

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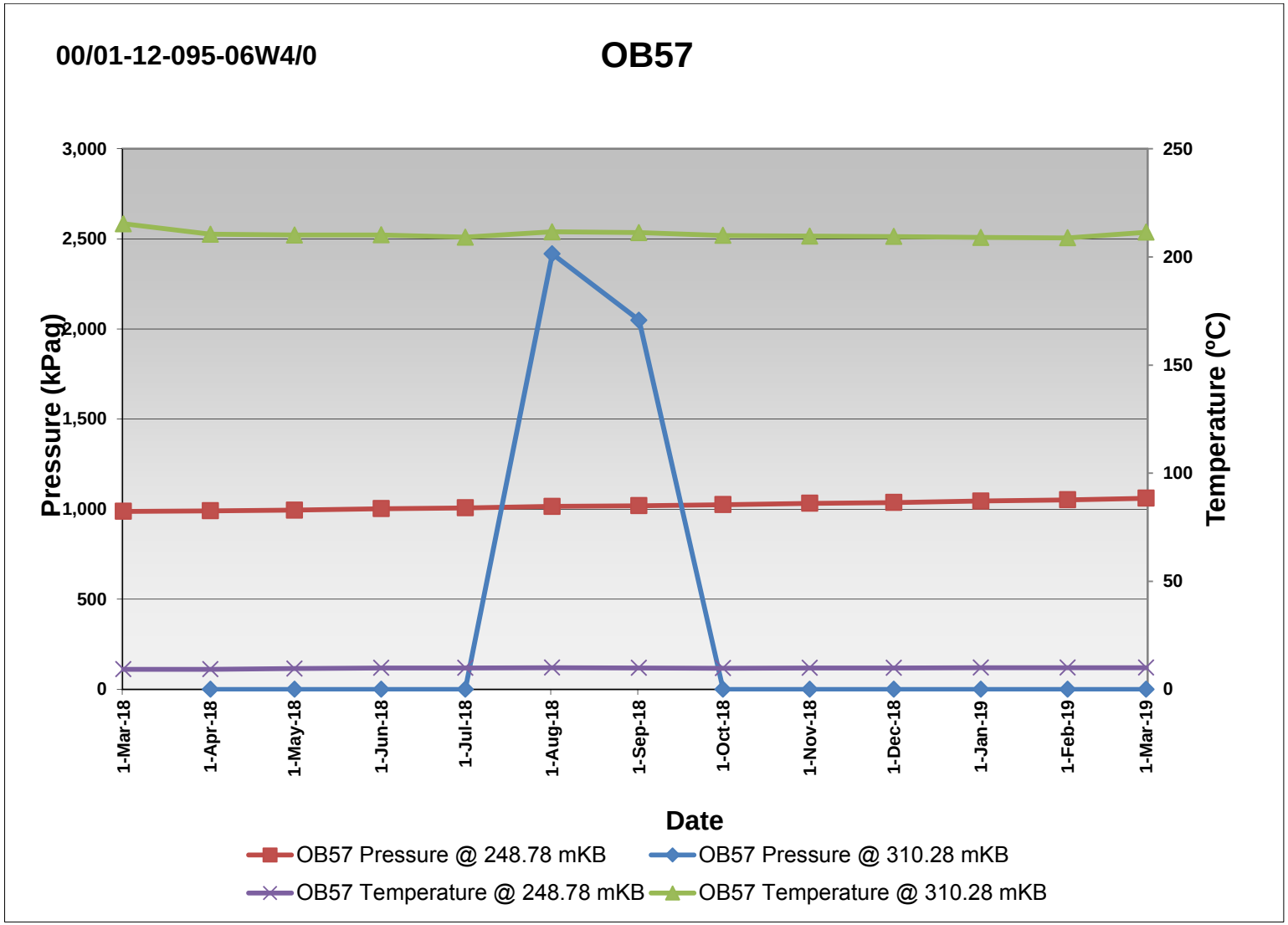

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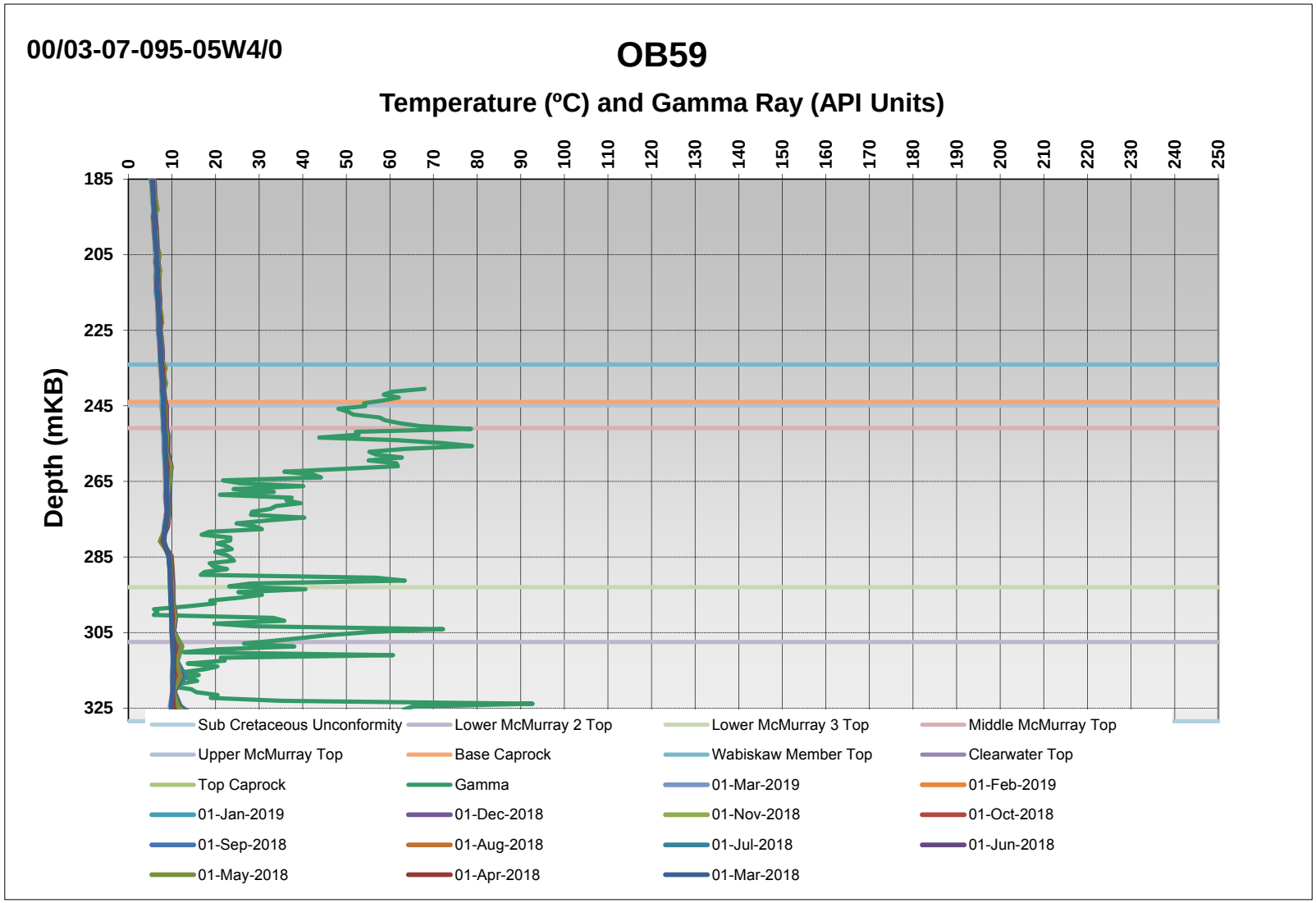

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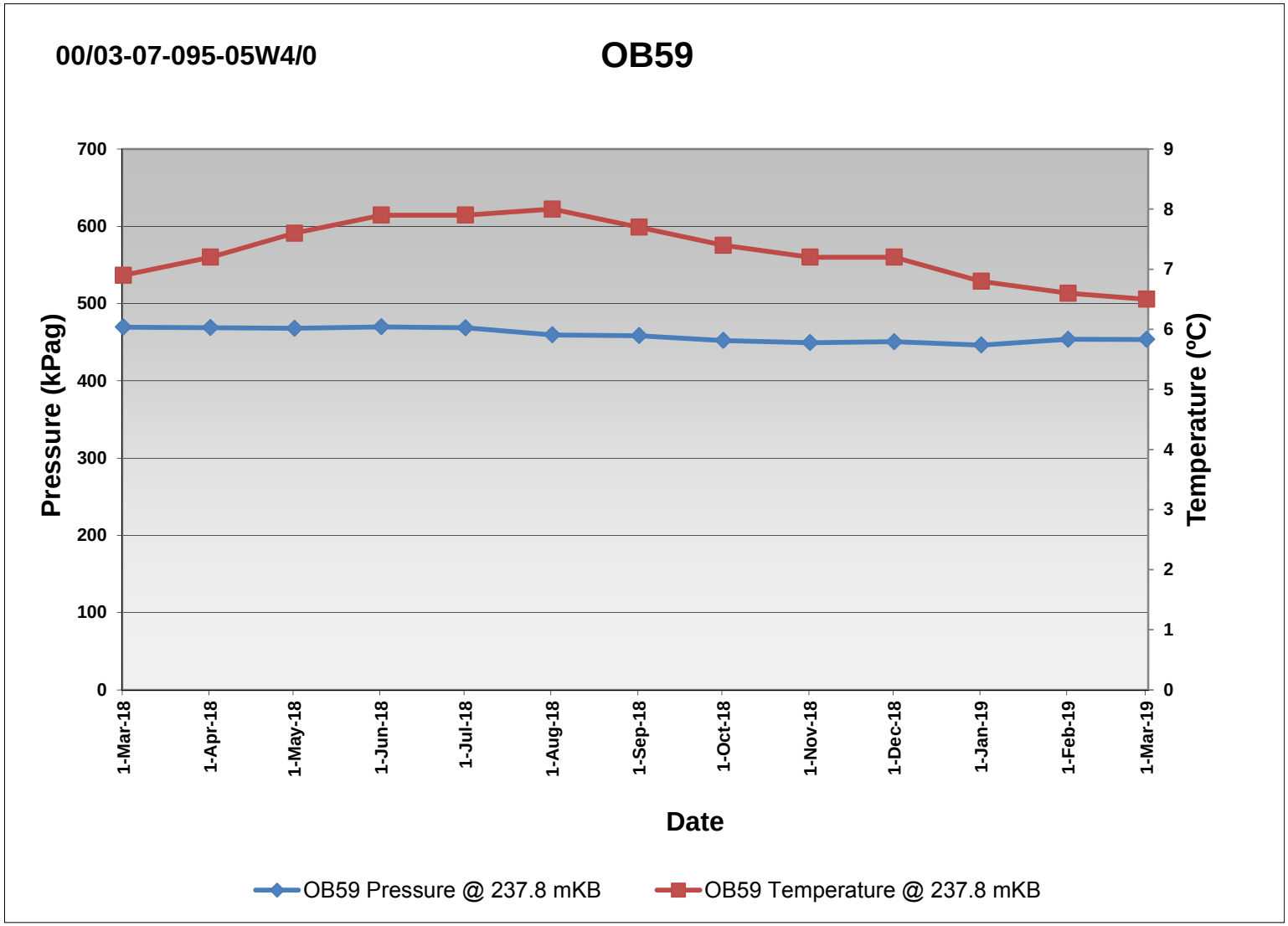

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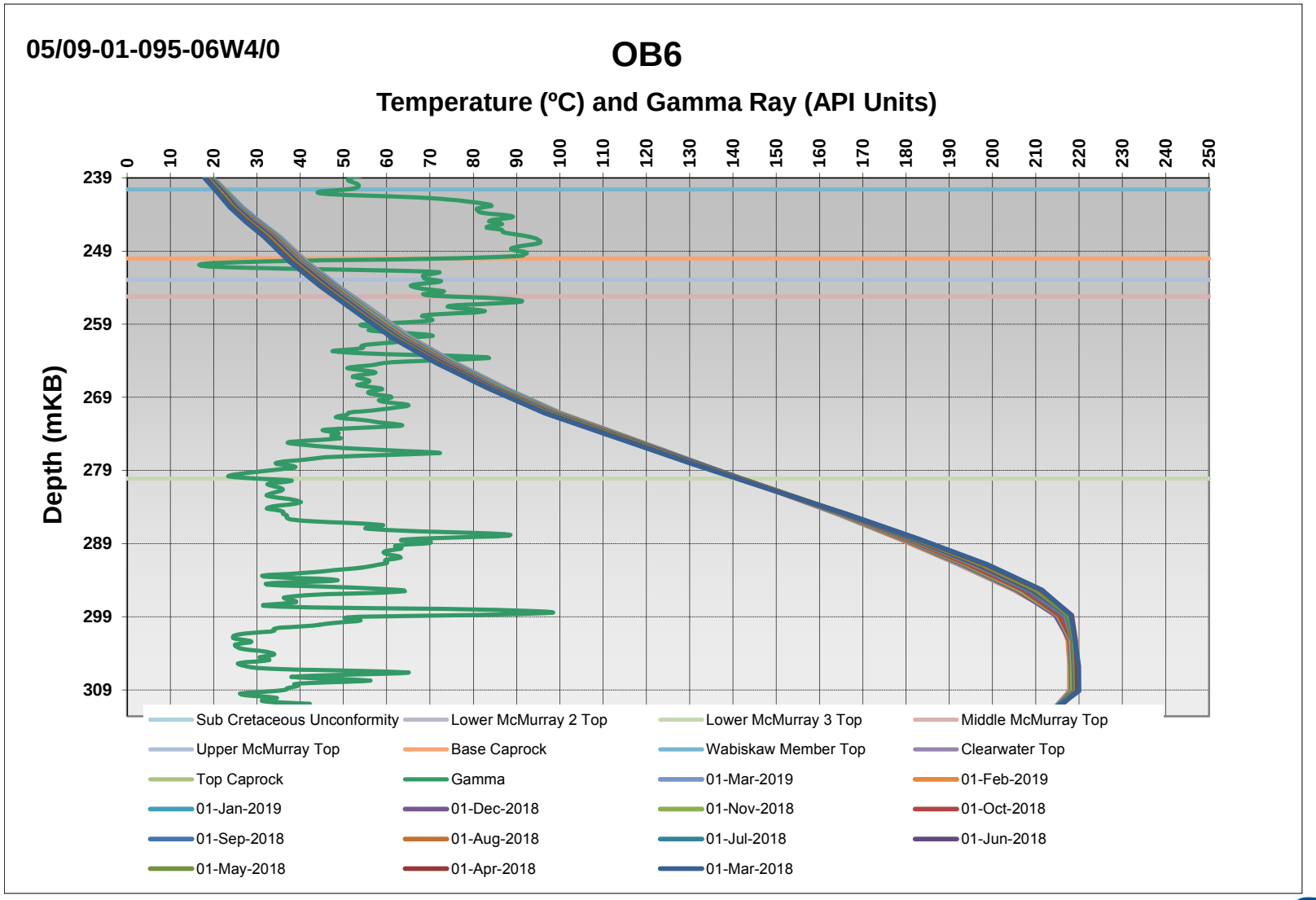

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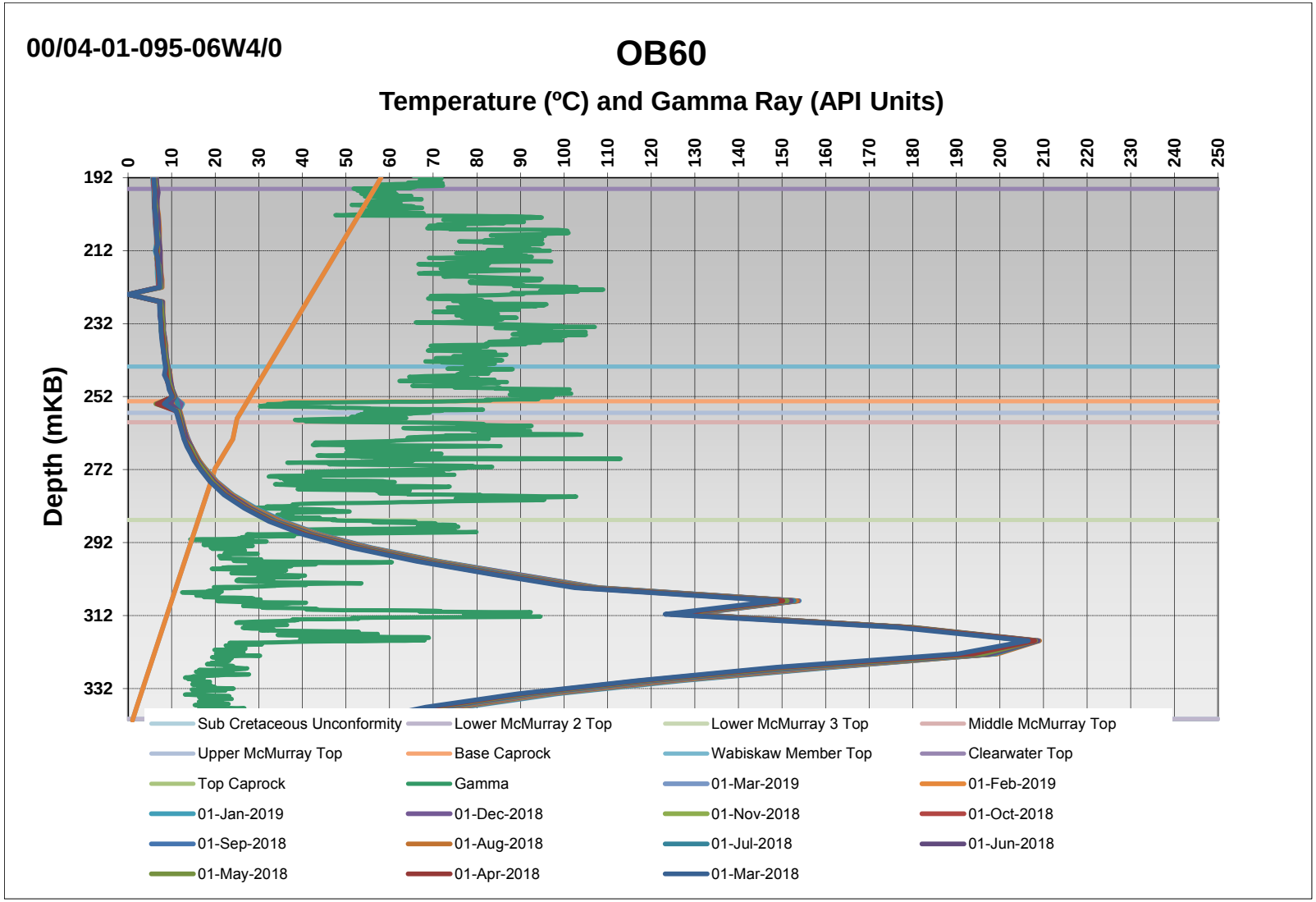

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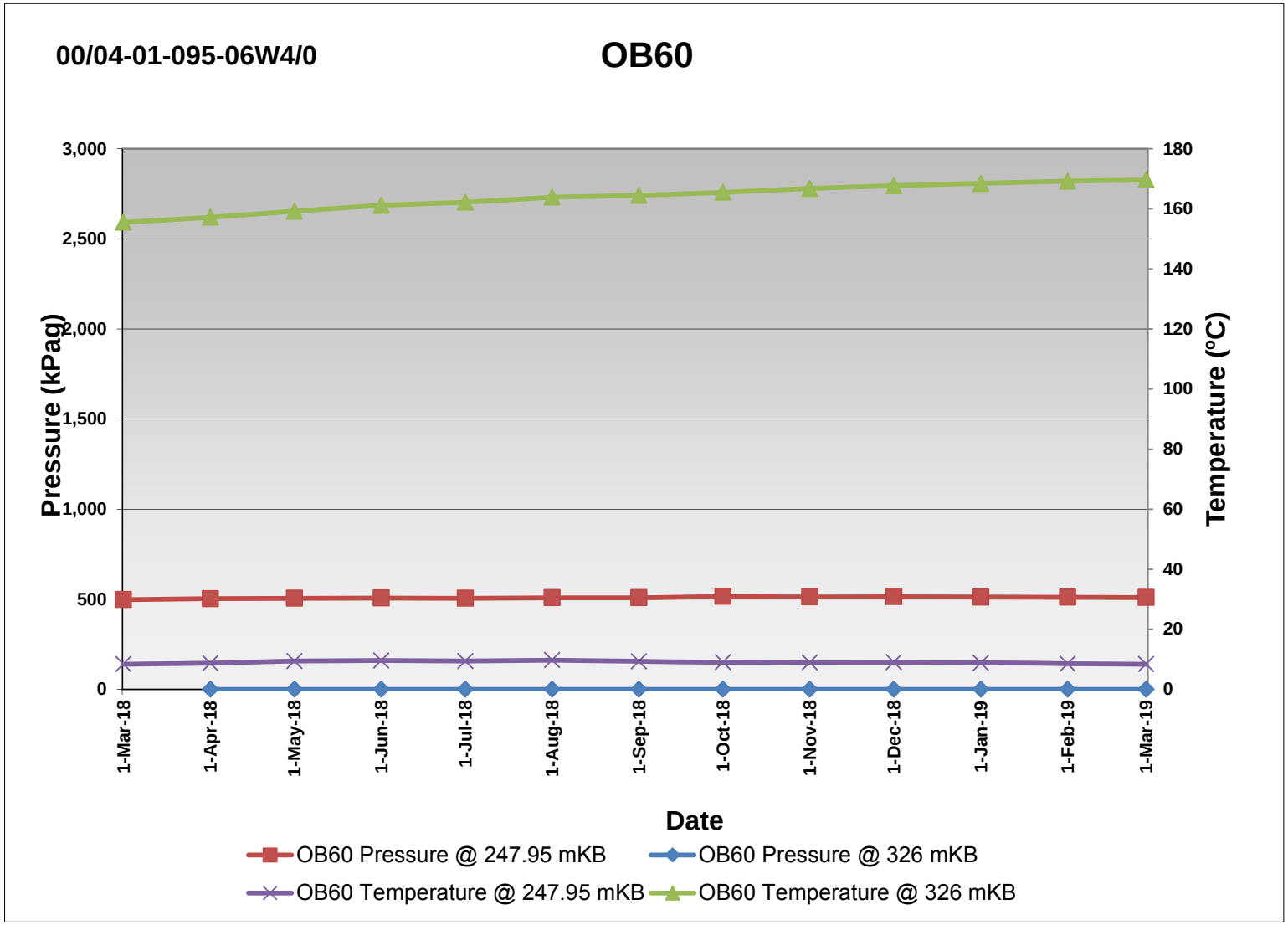

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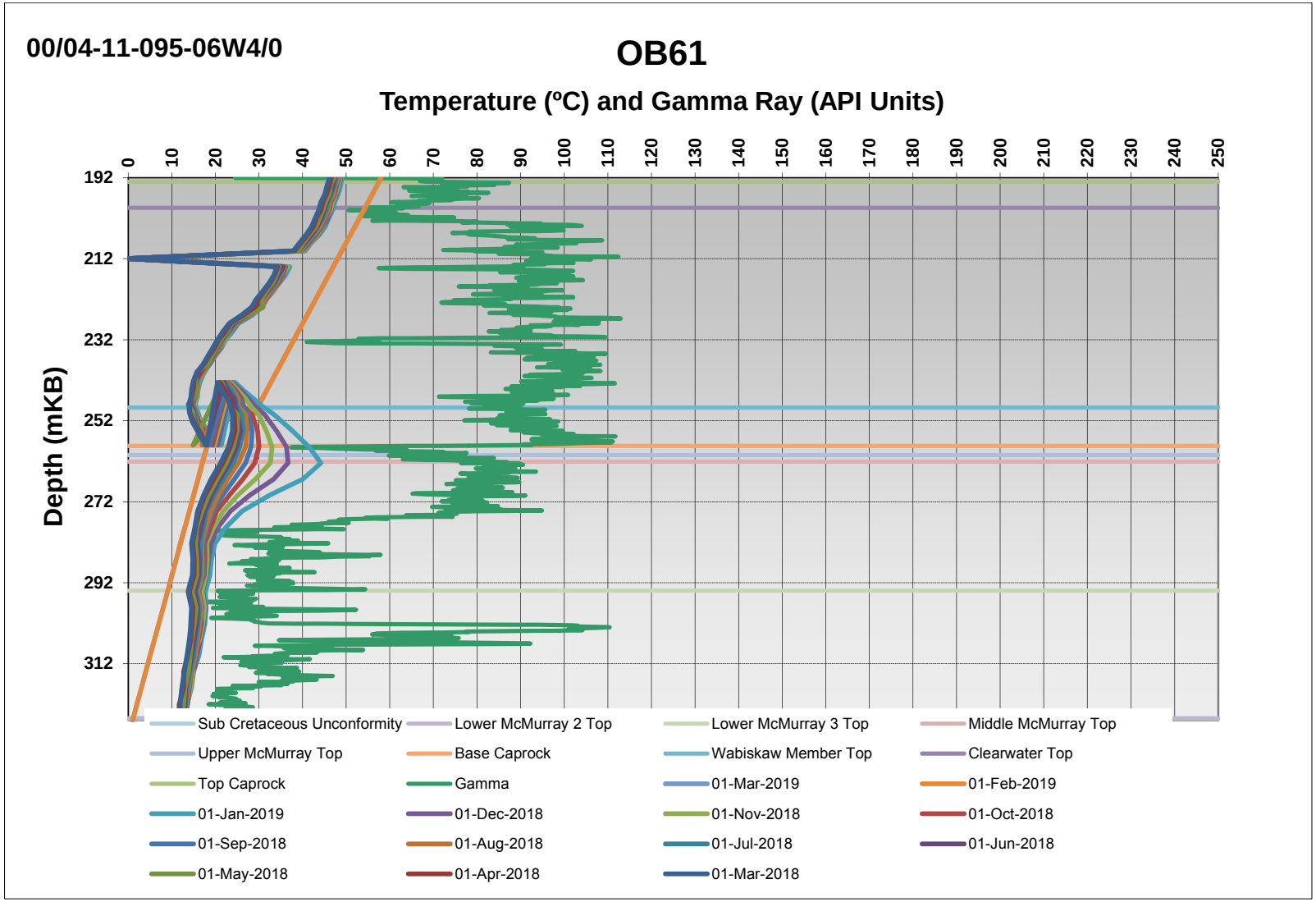
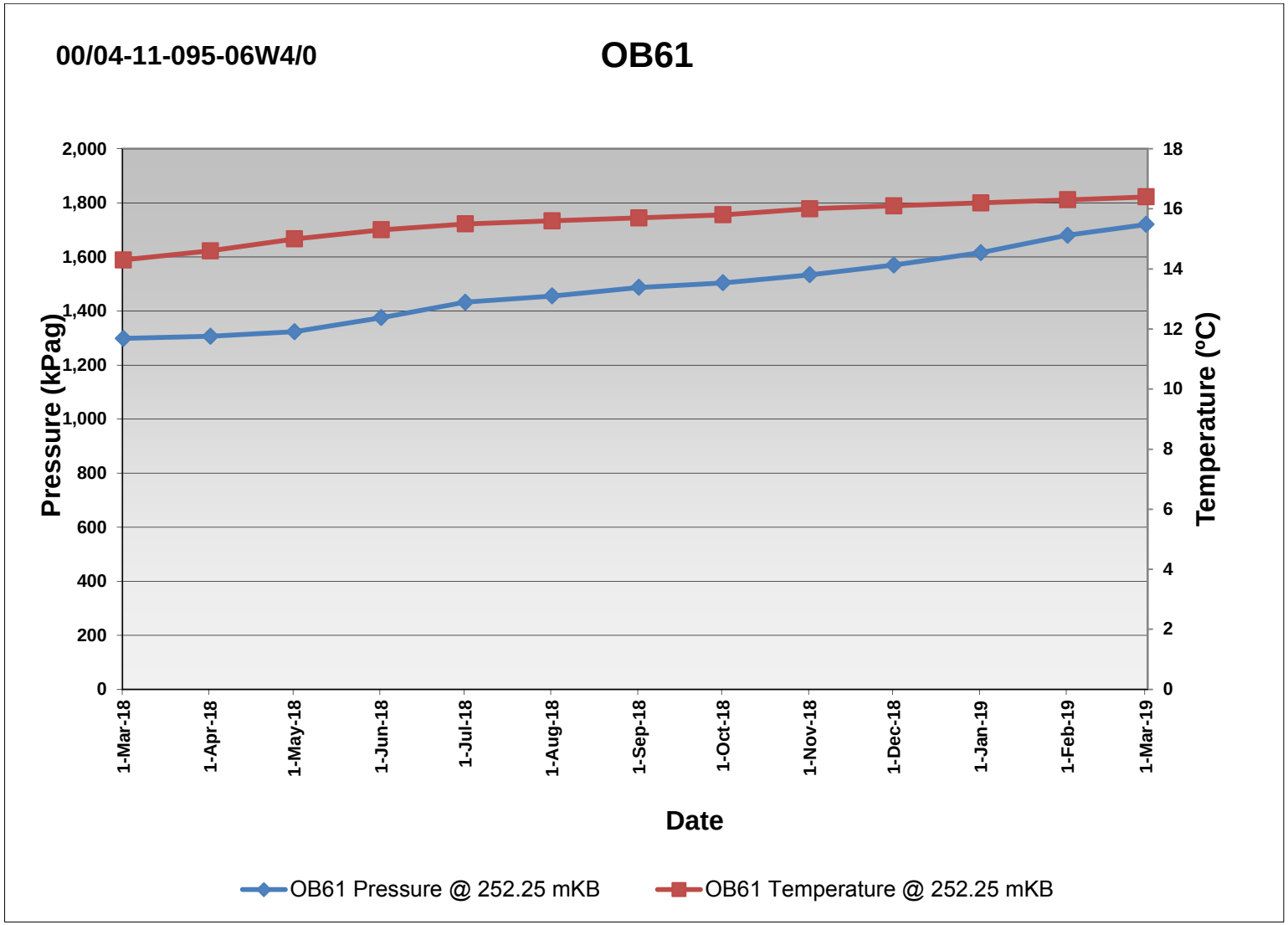


Piezometer Plots & Temperature vs Depth Plots



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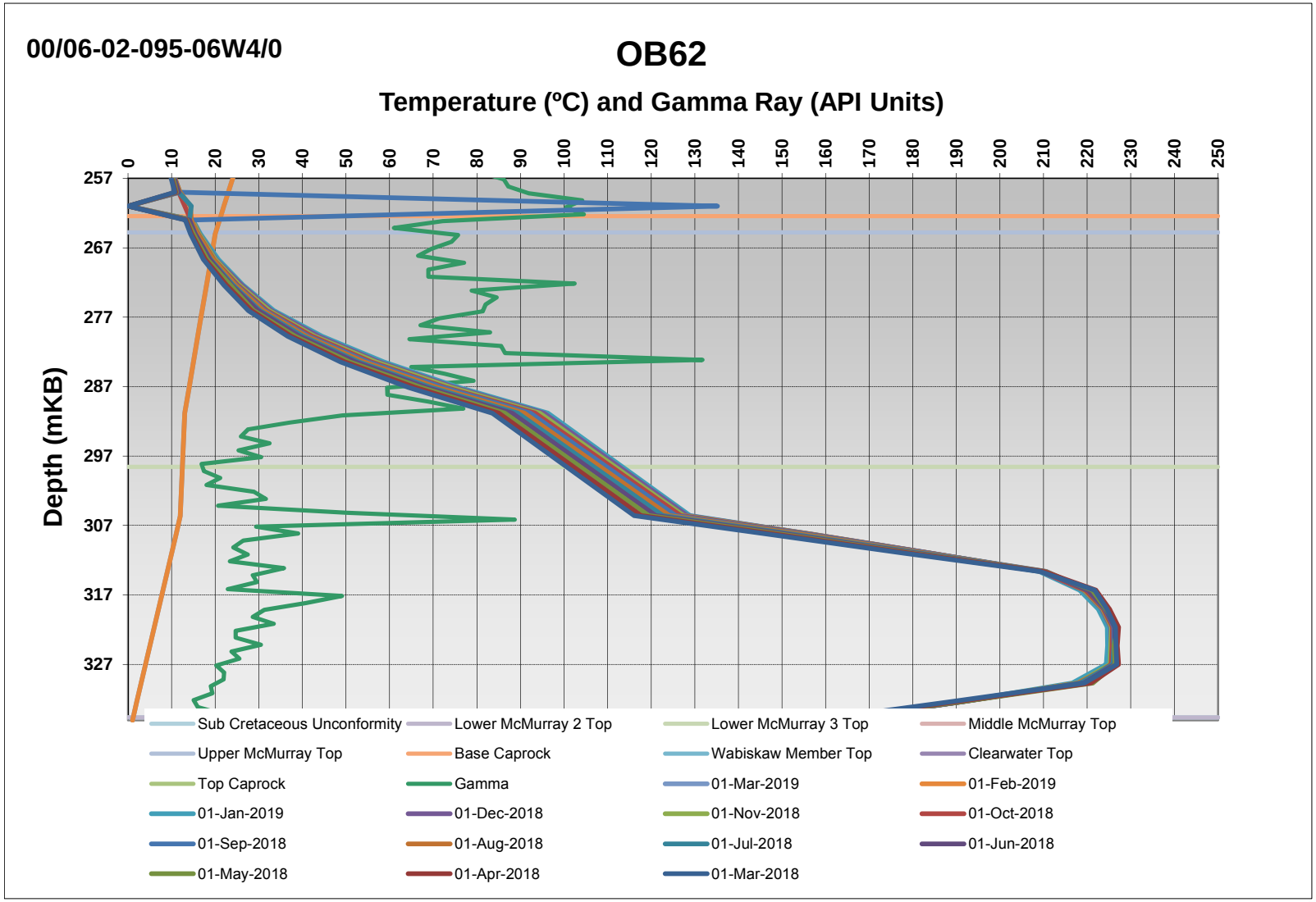

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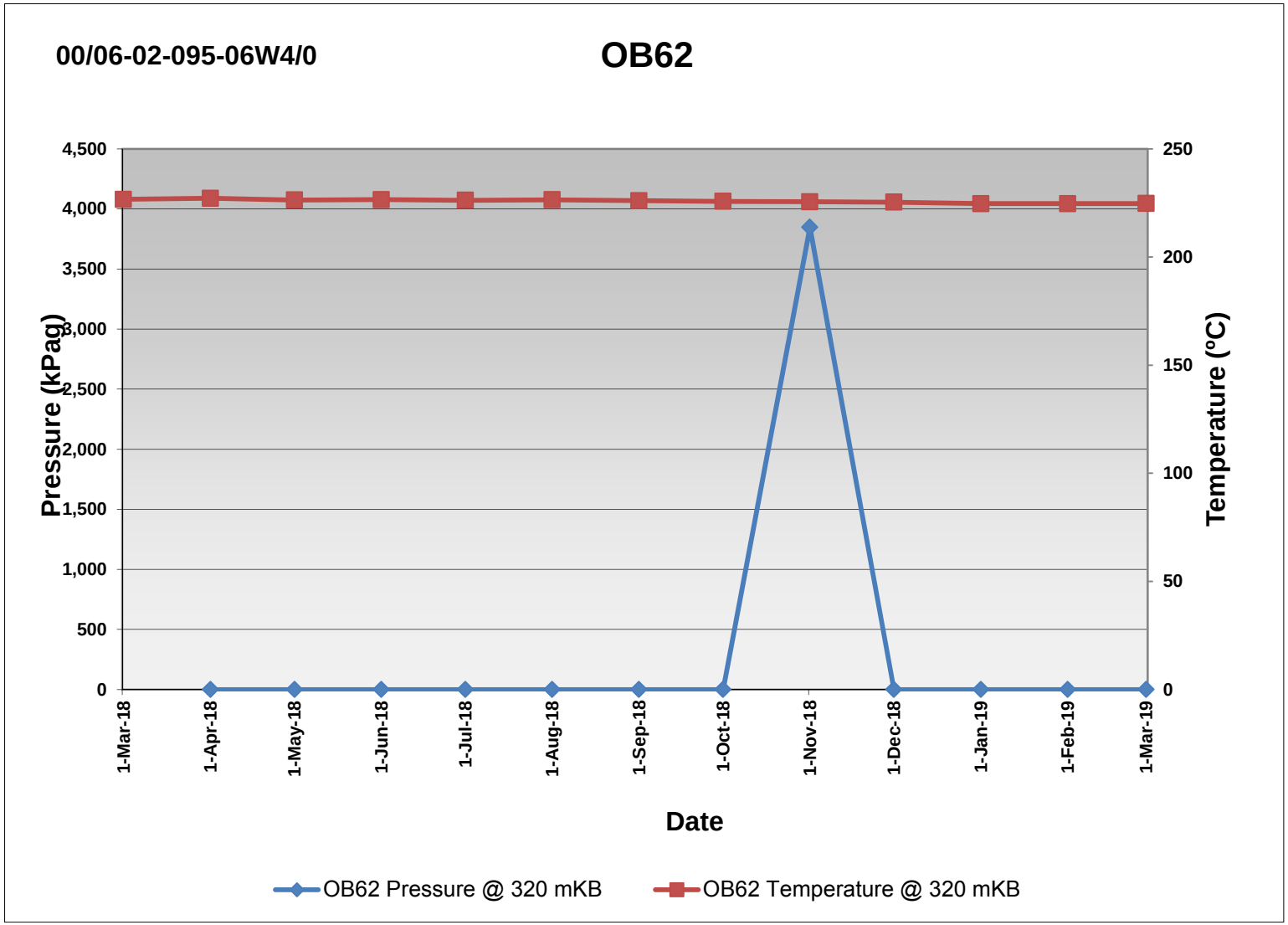

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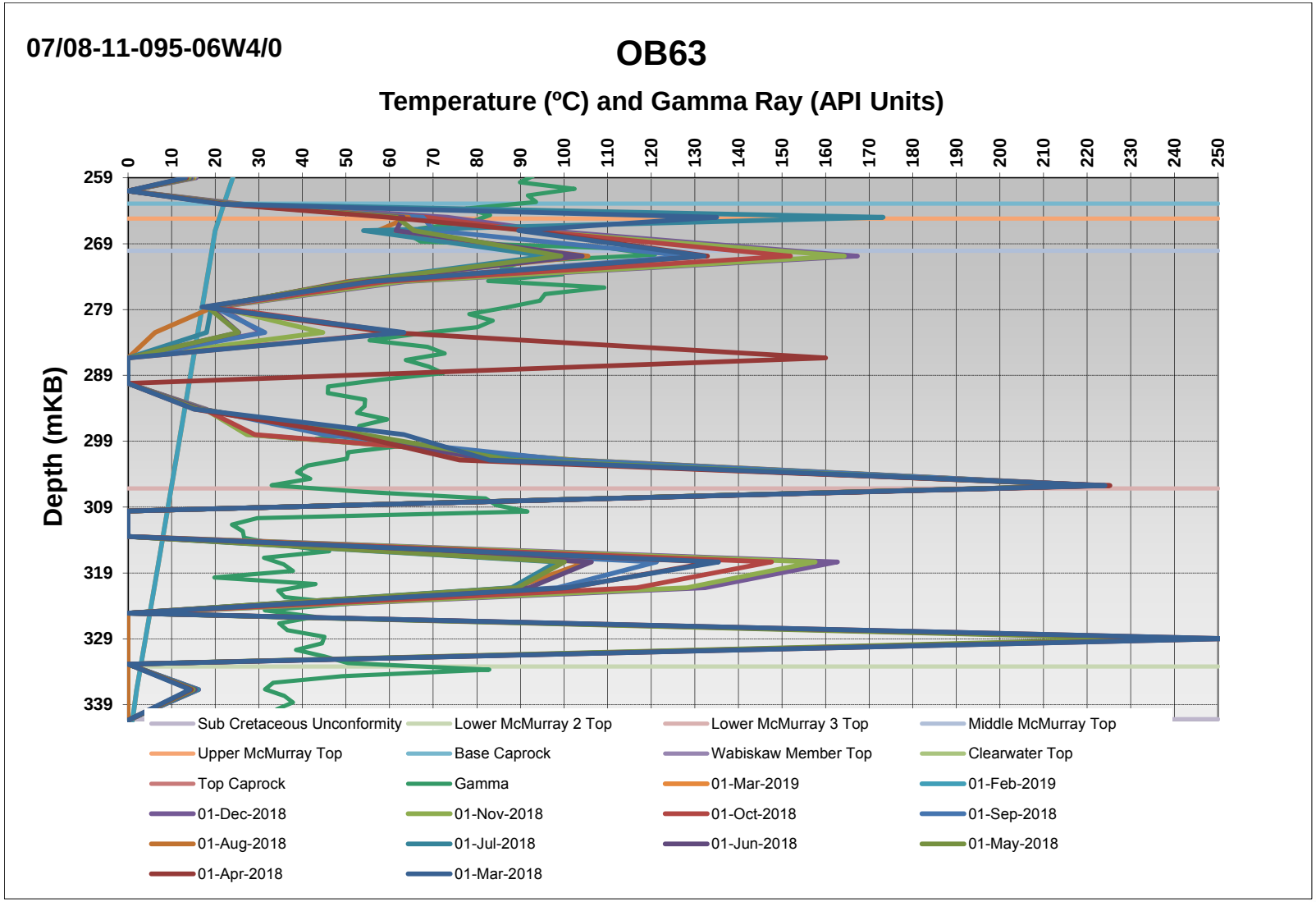

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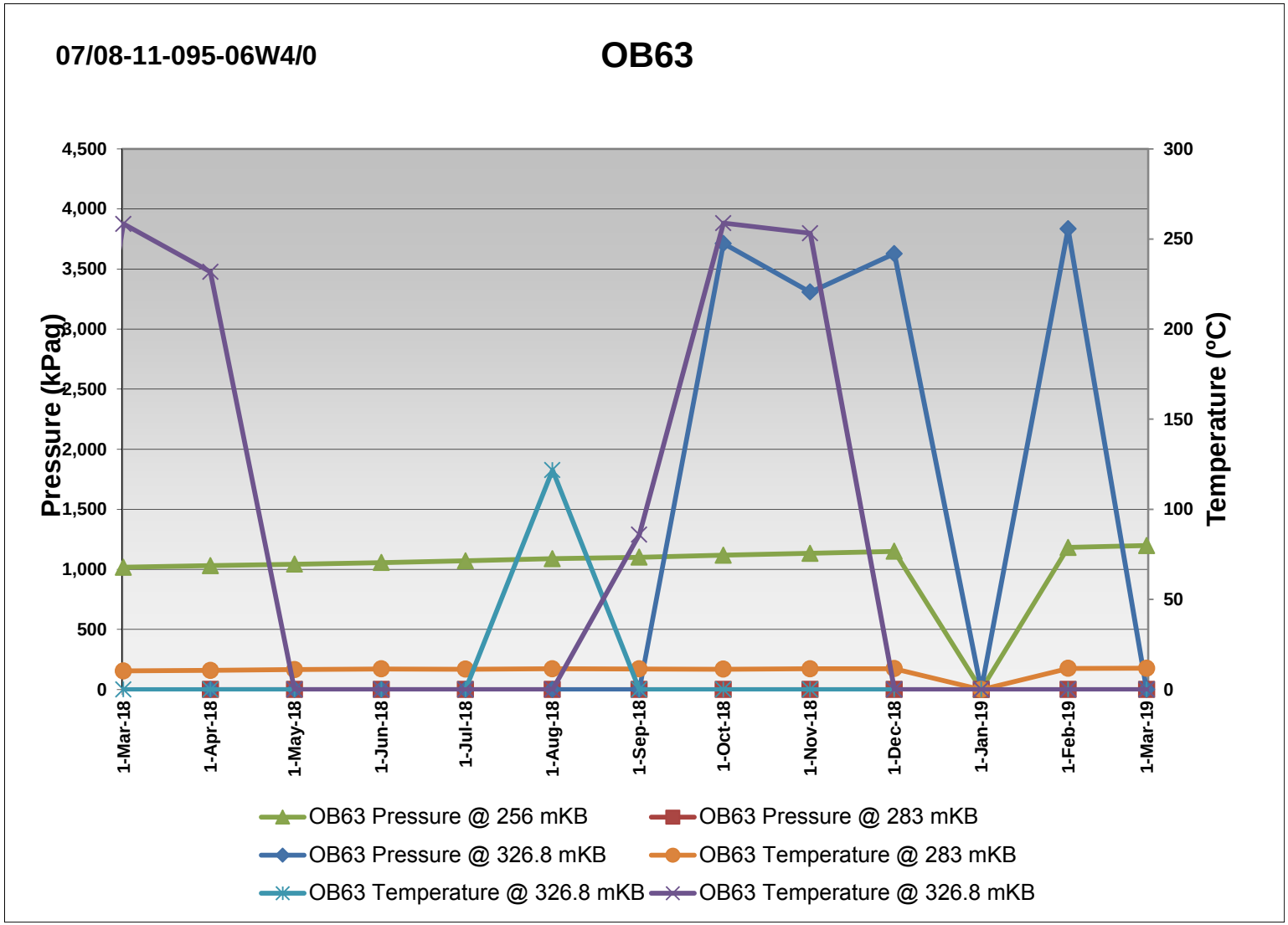

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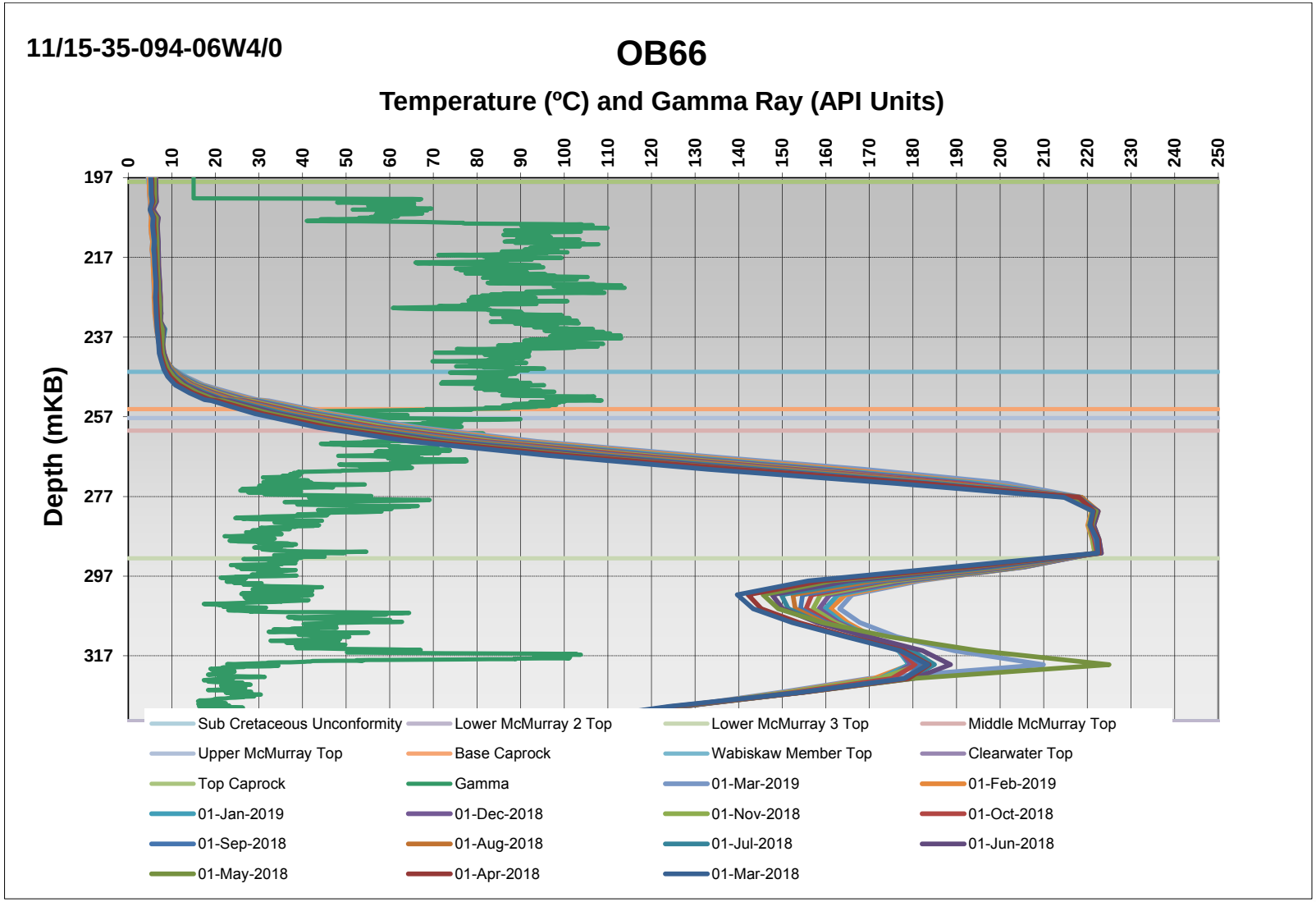

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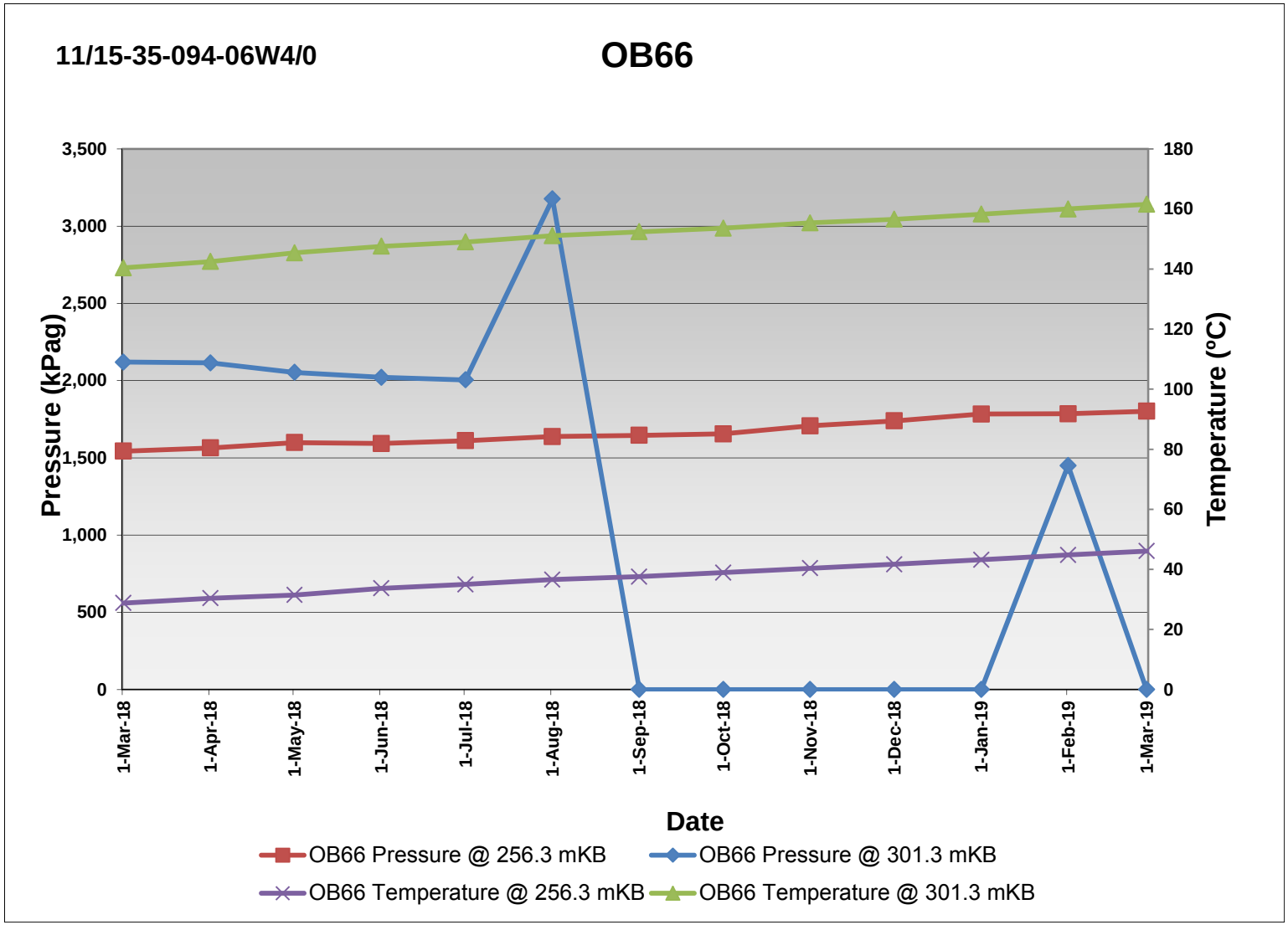

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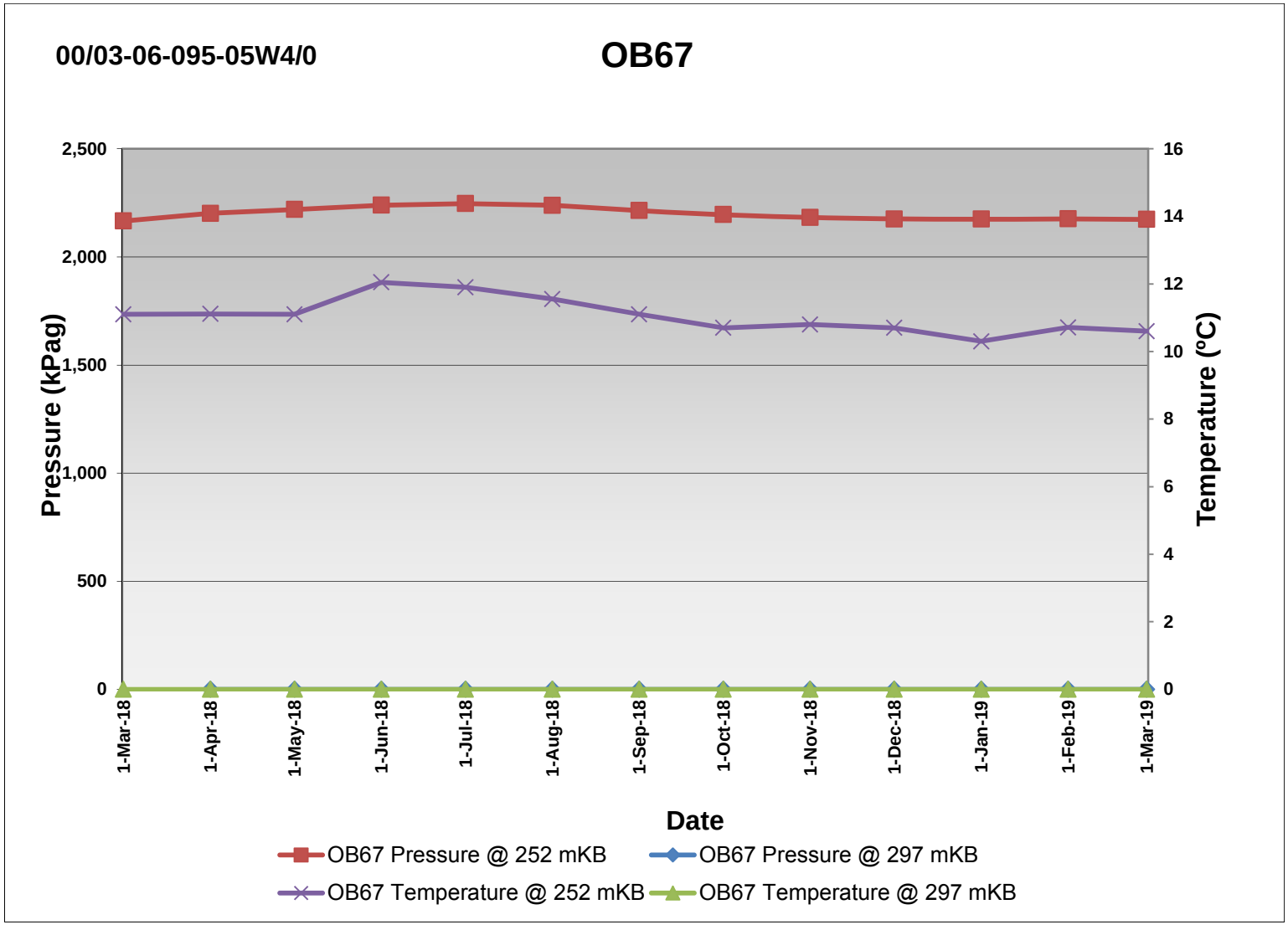

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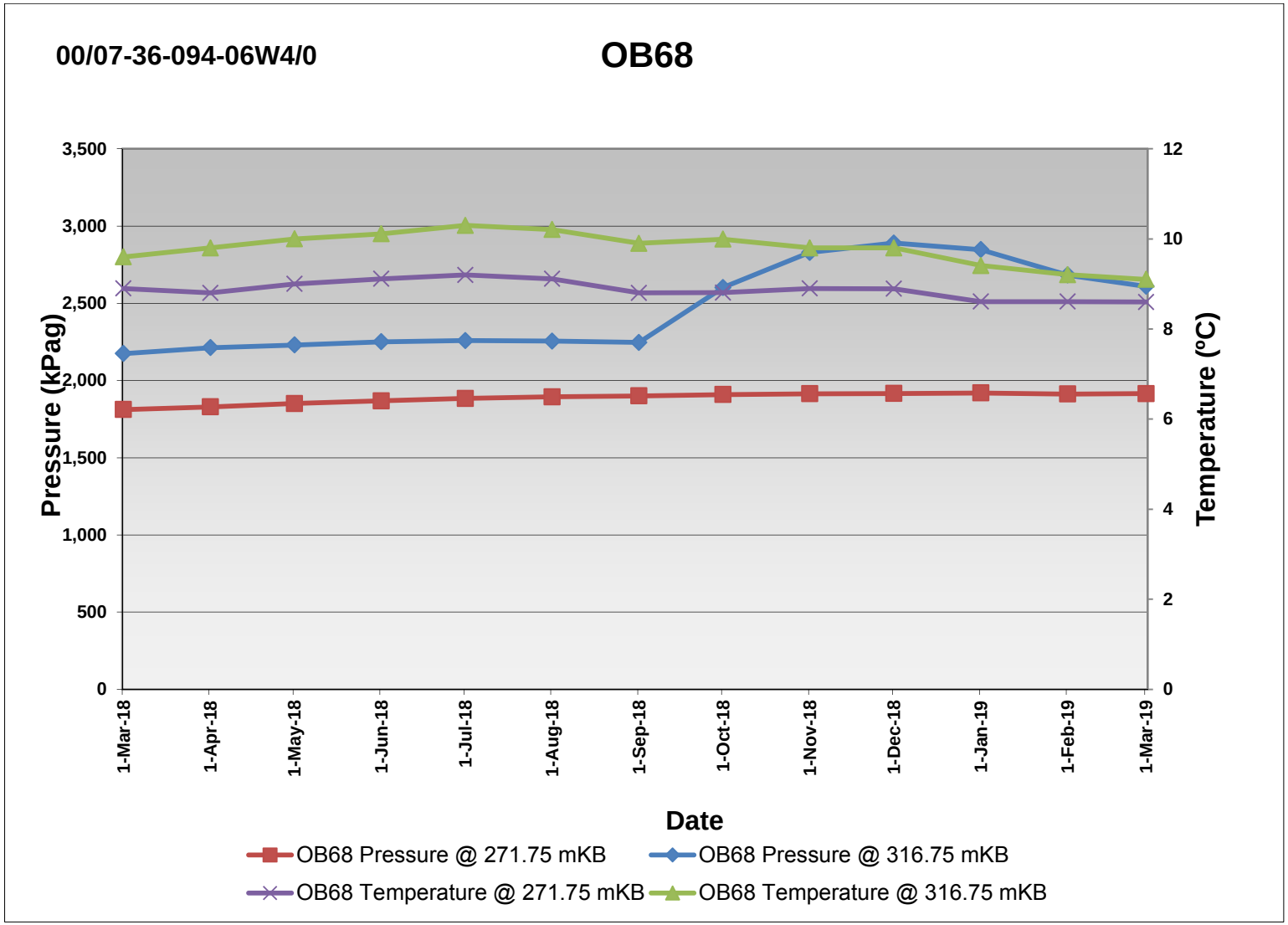

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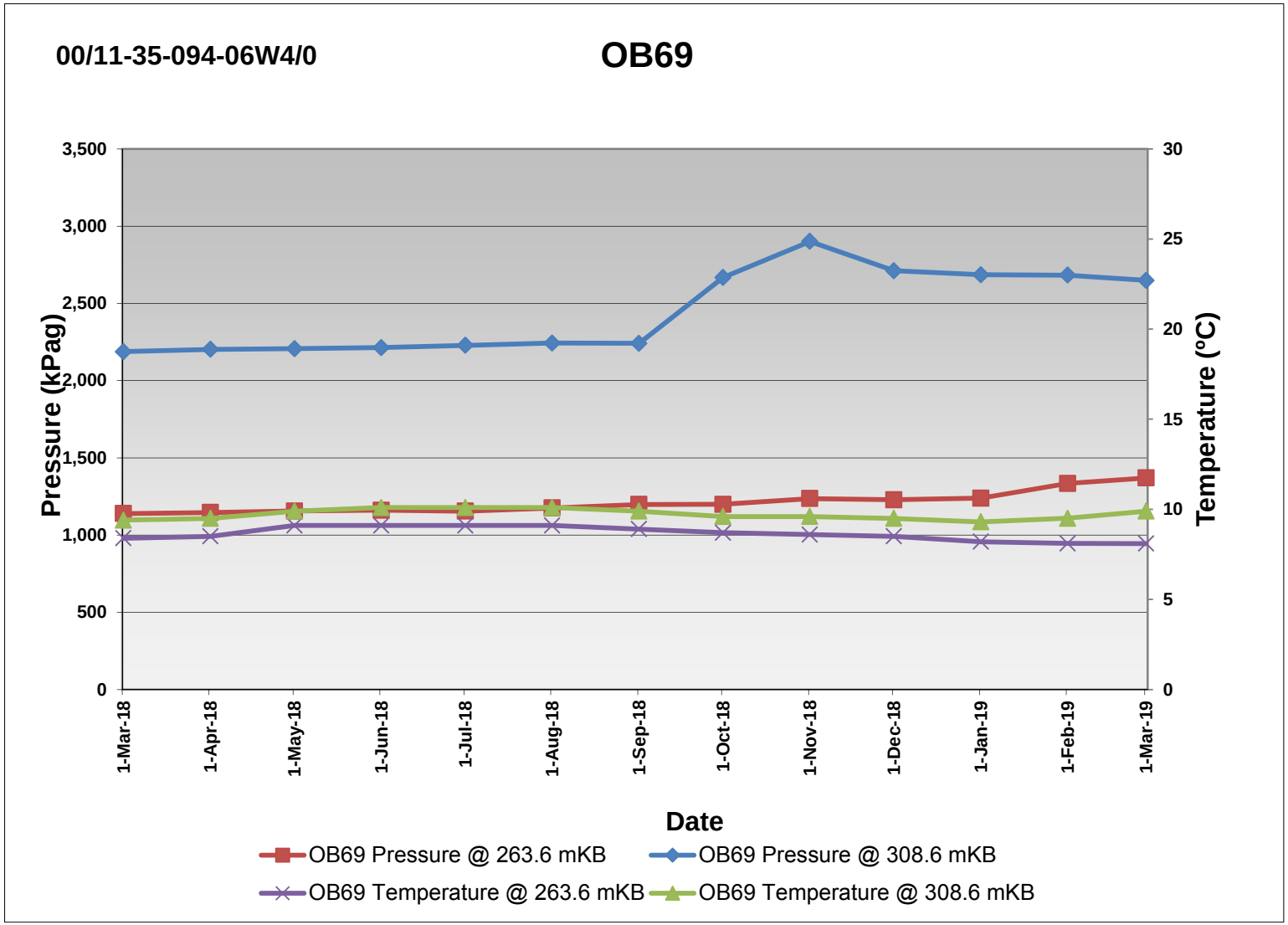

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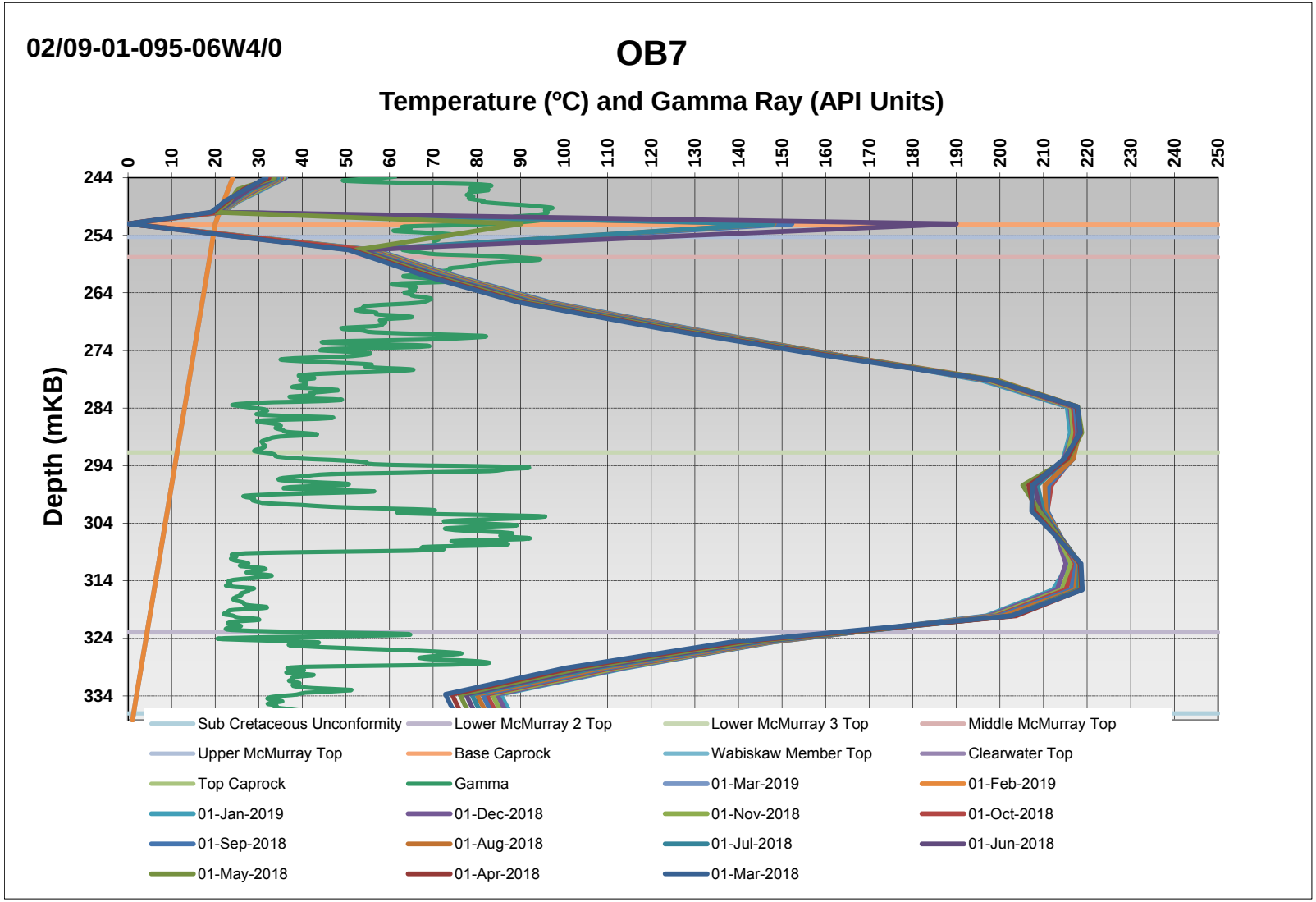

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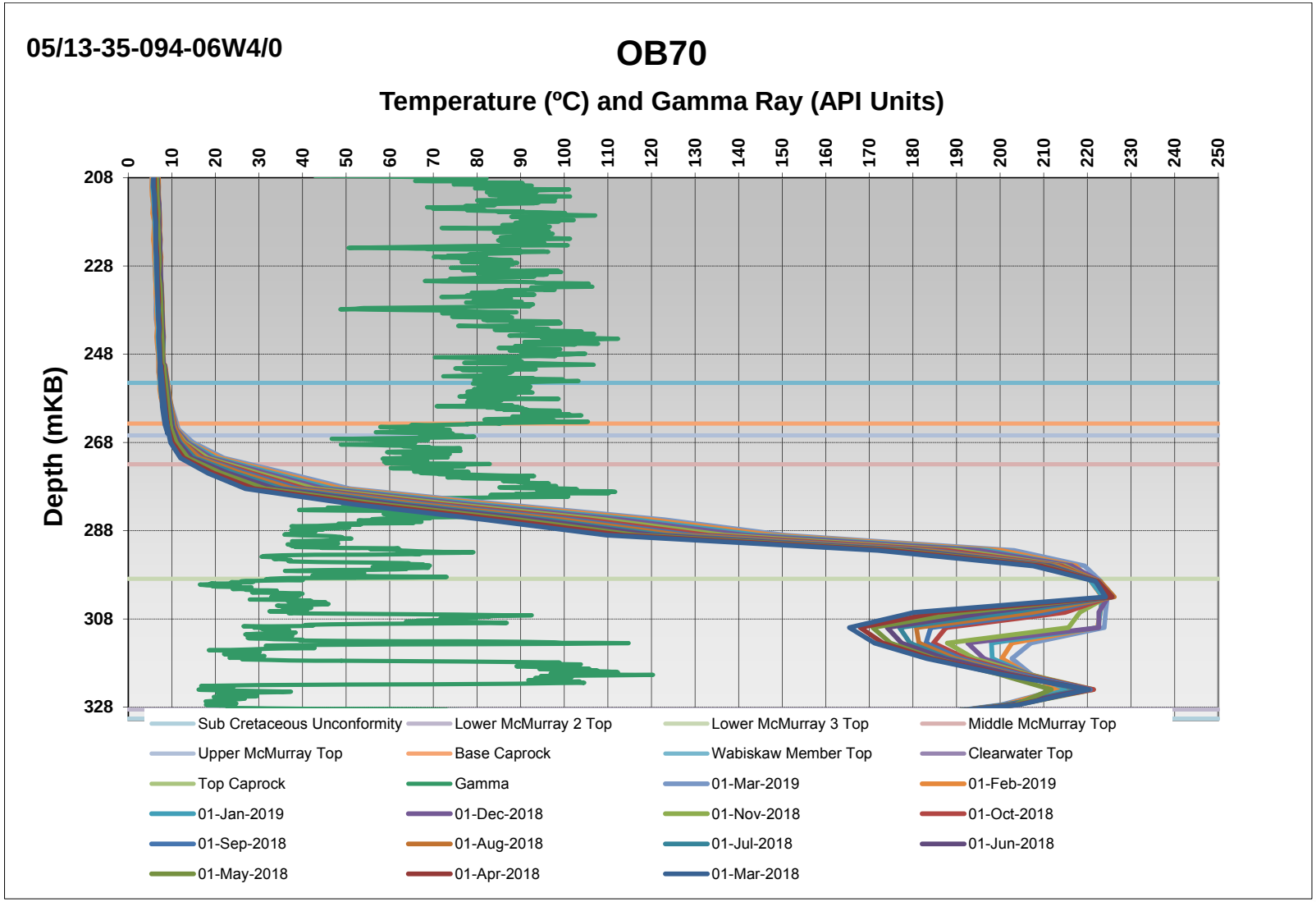

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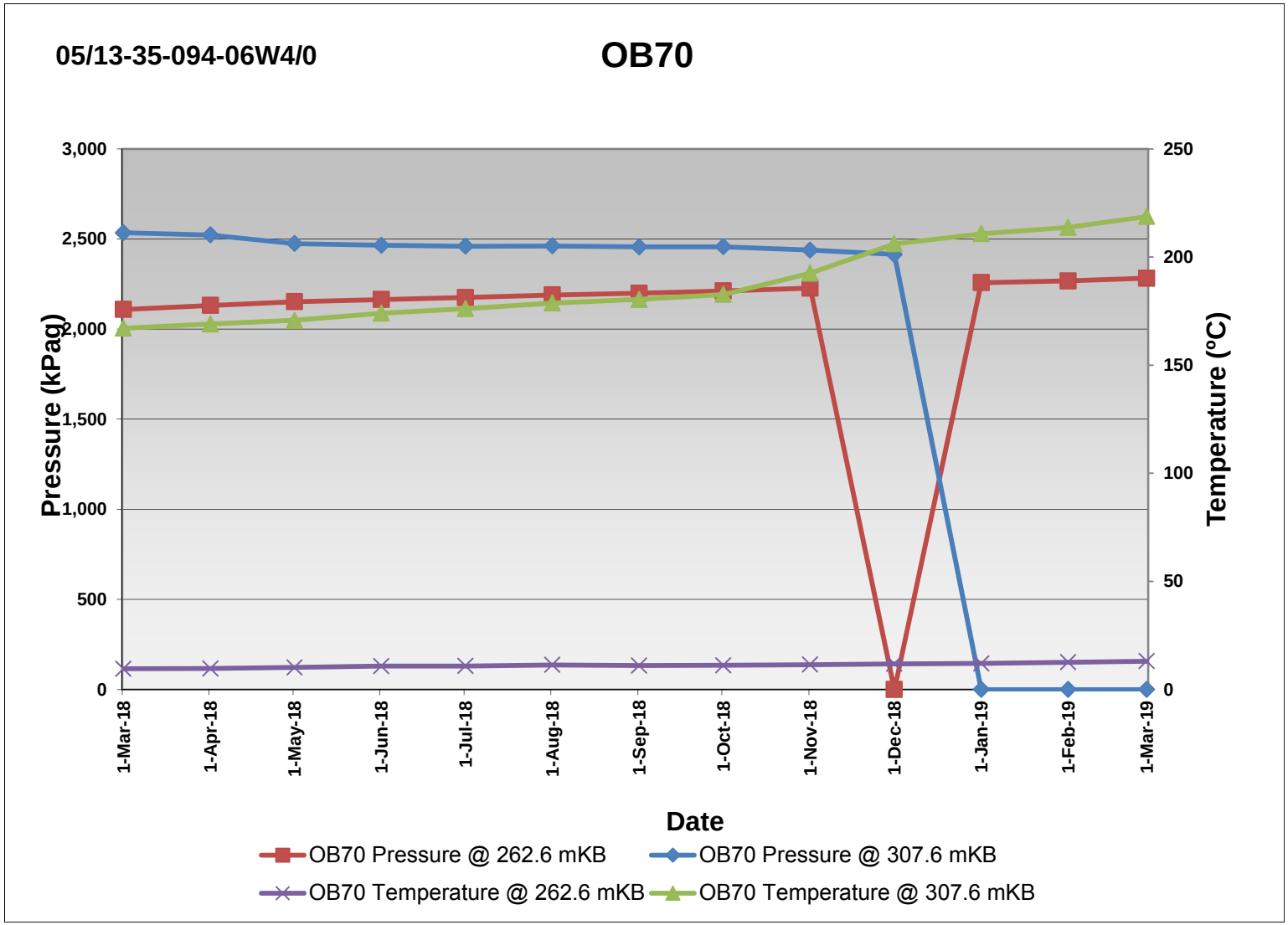

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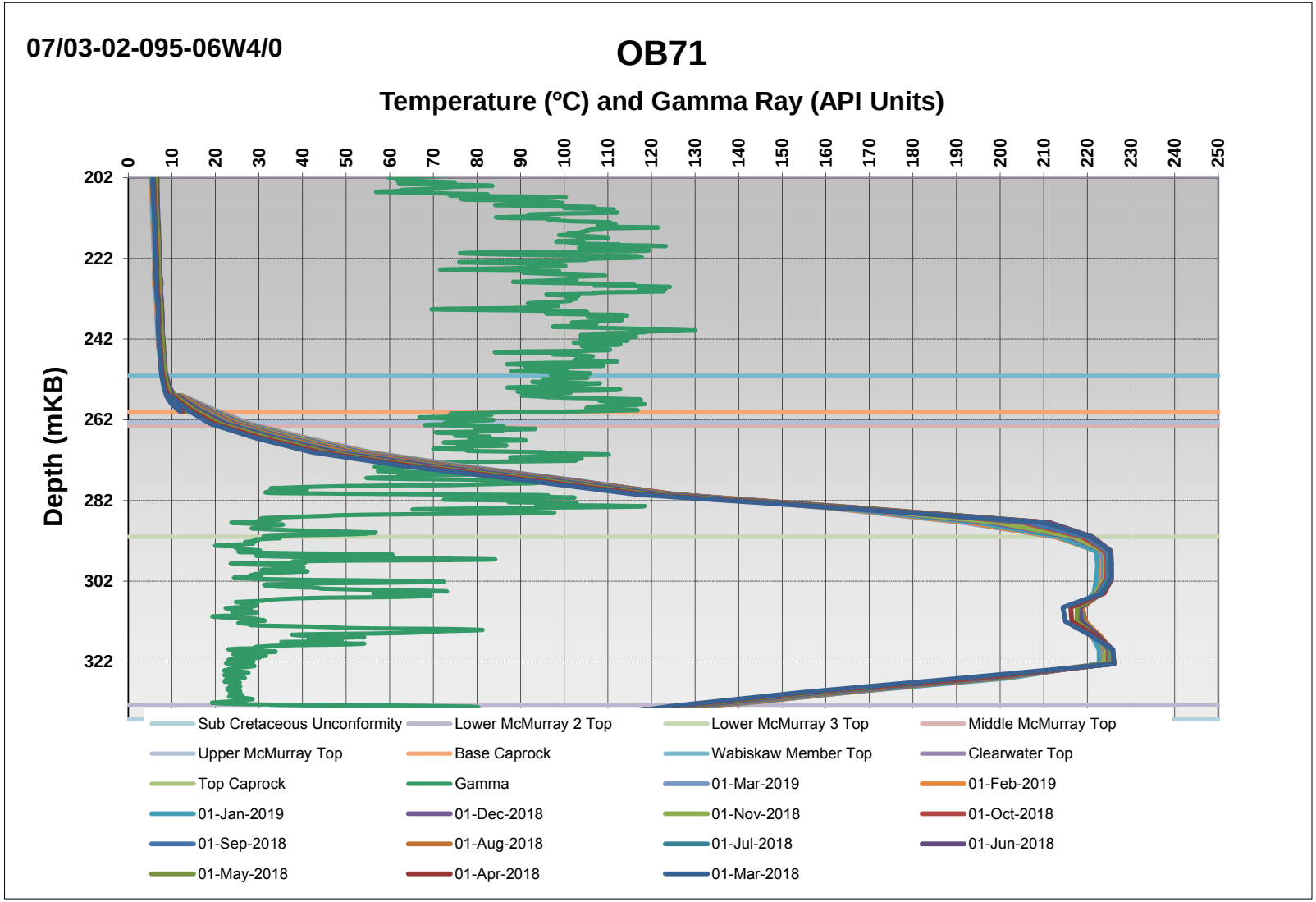

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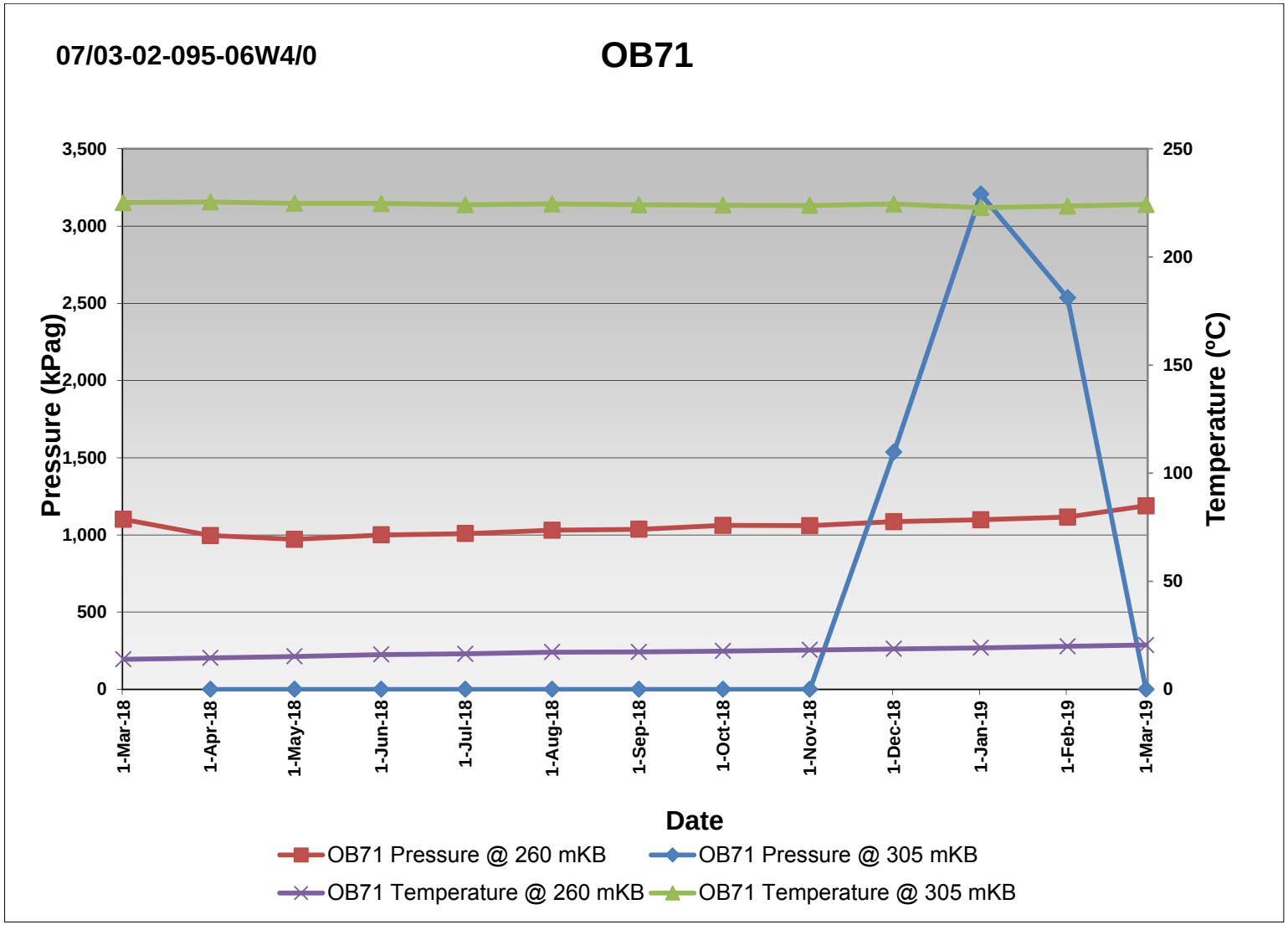

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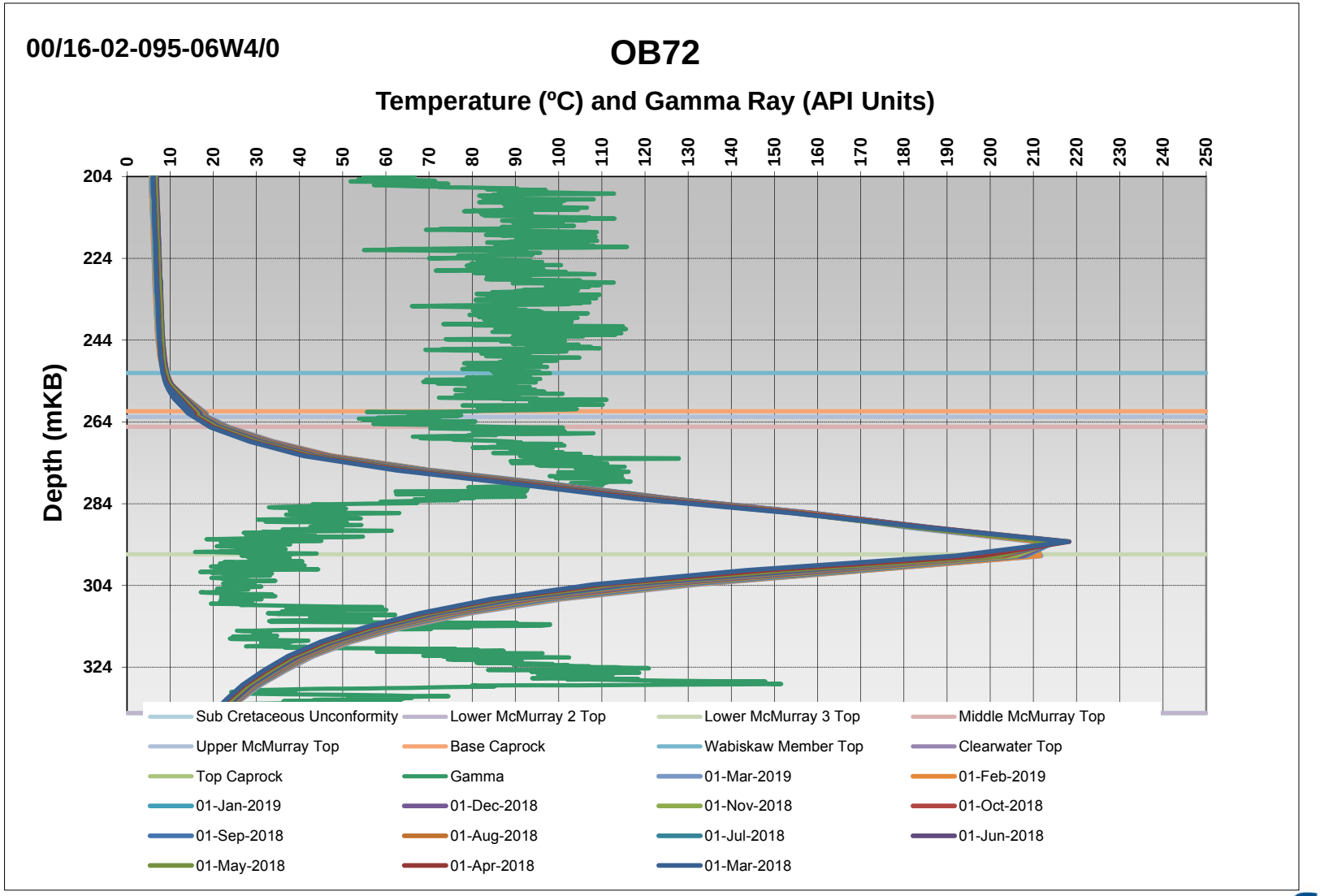

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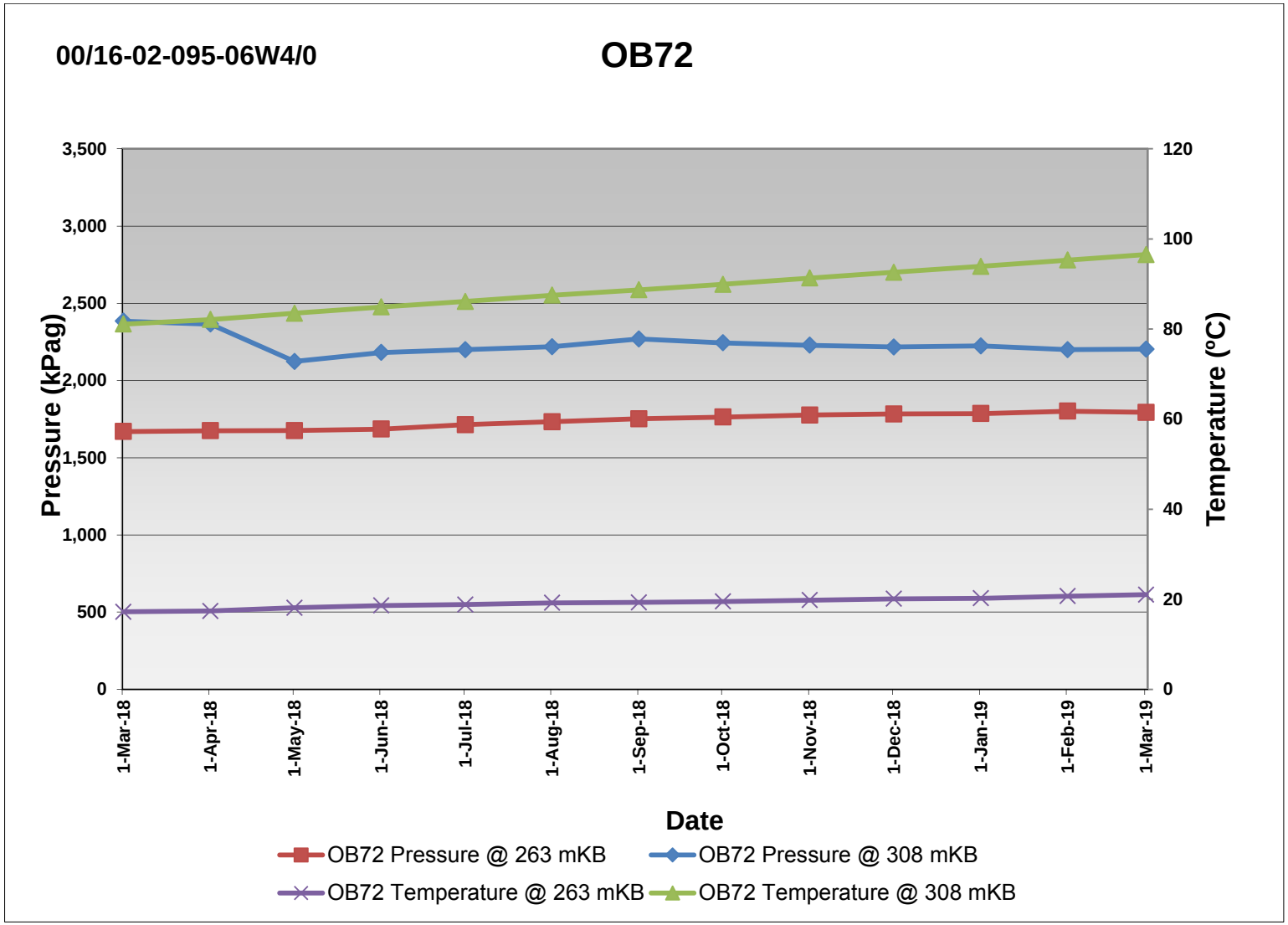

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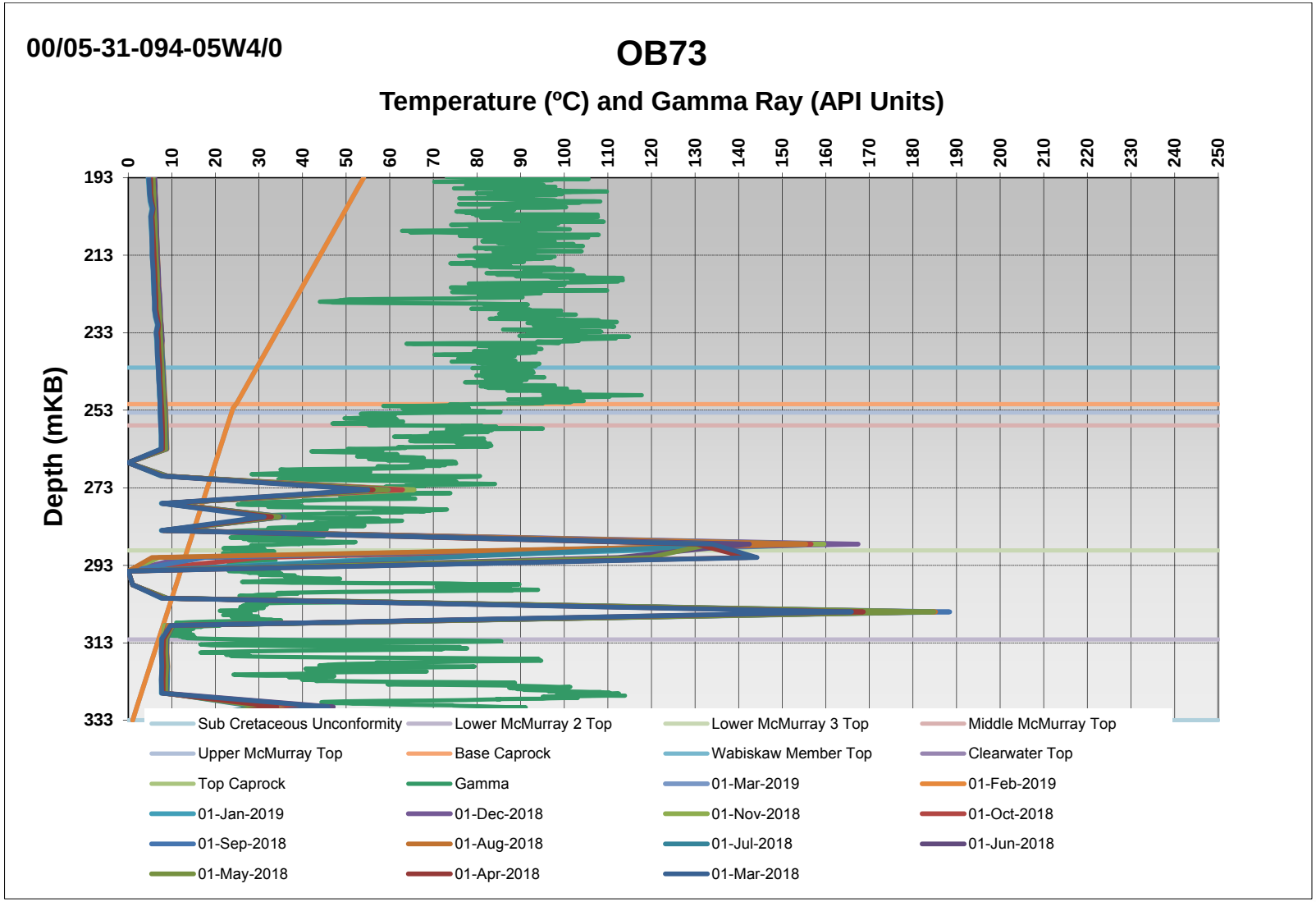

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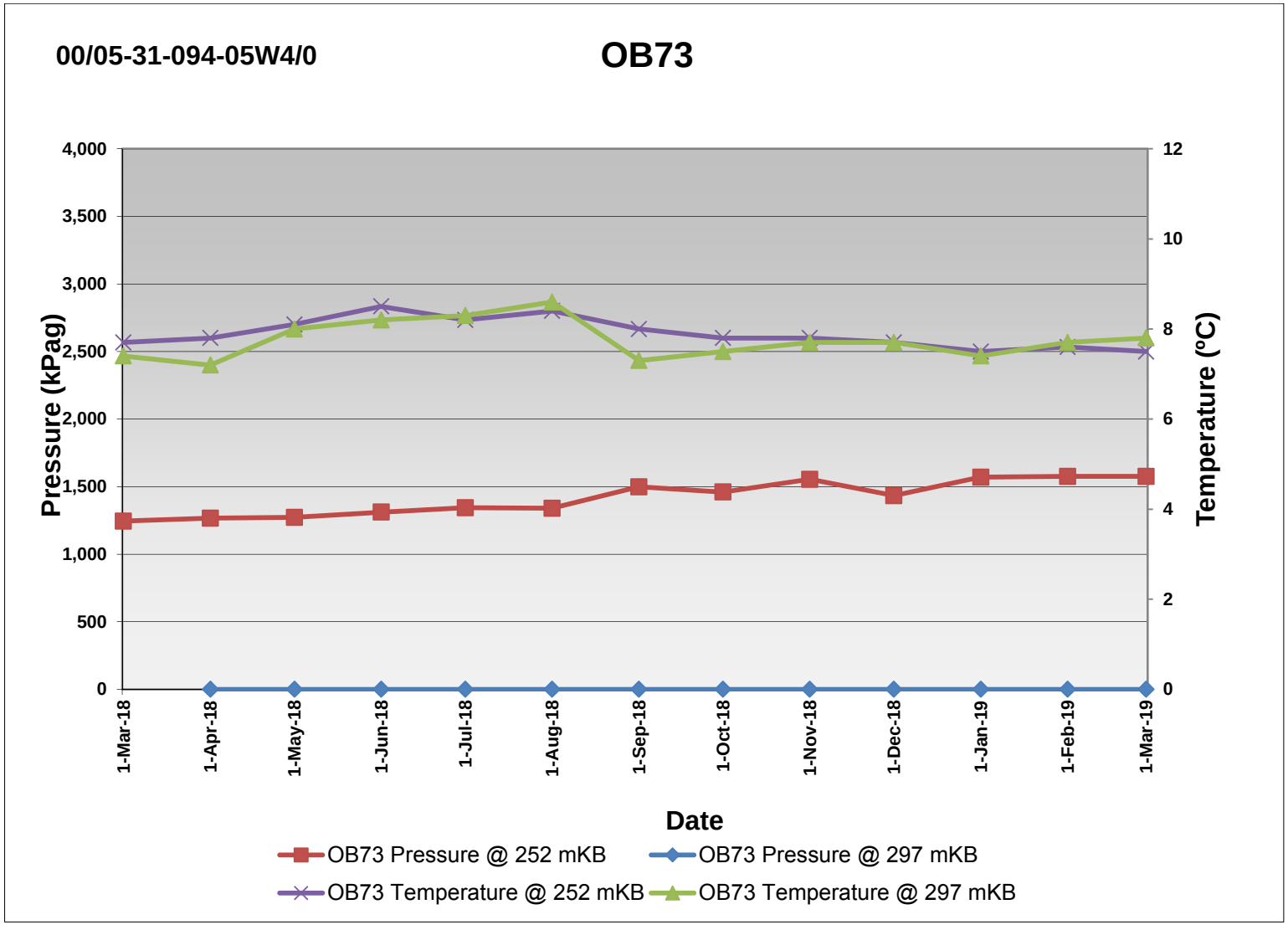

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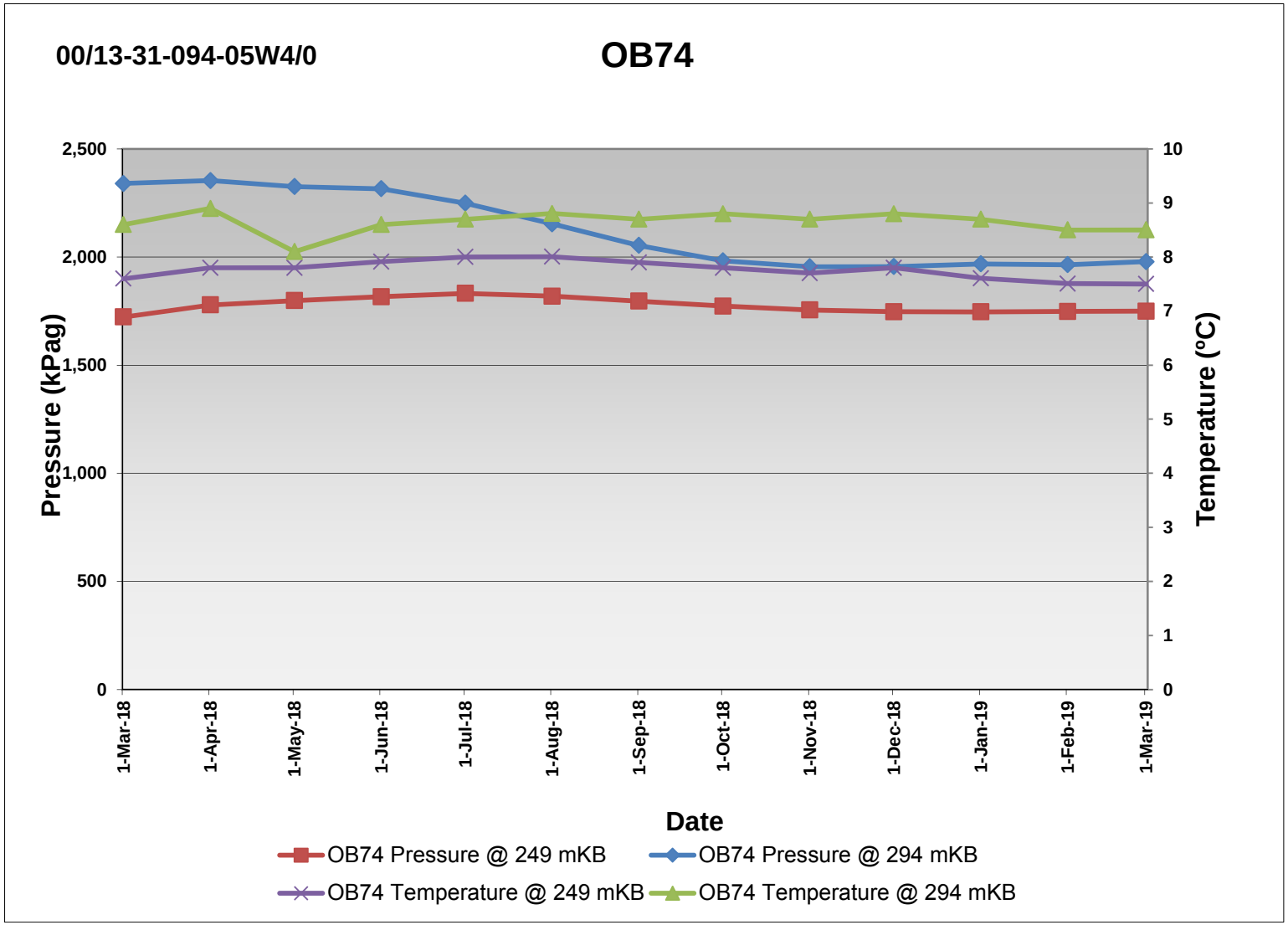

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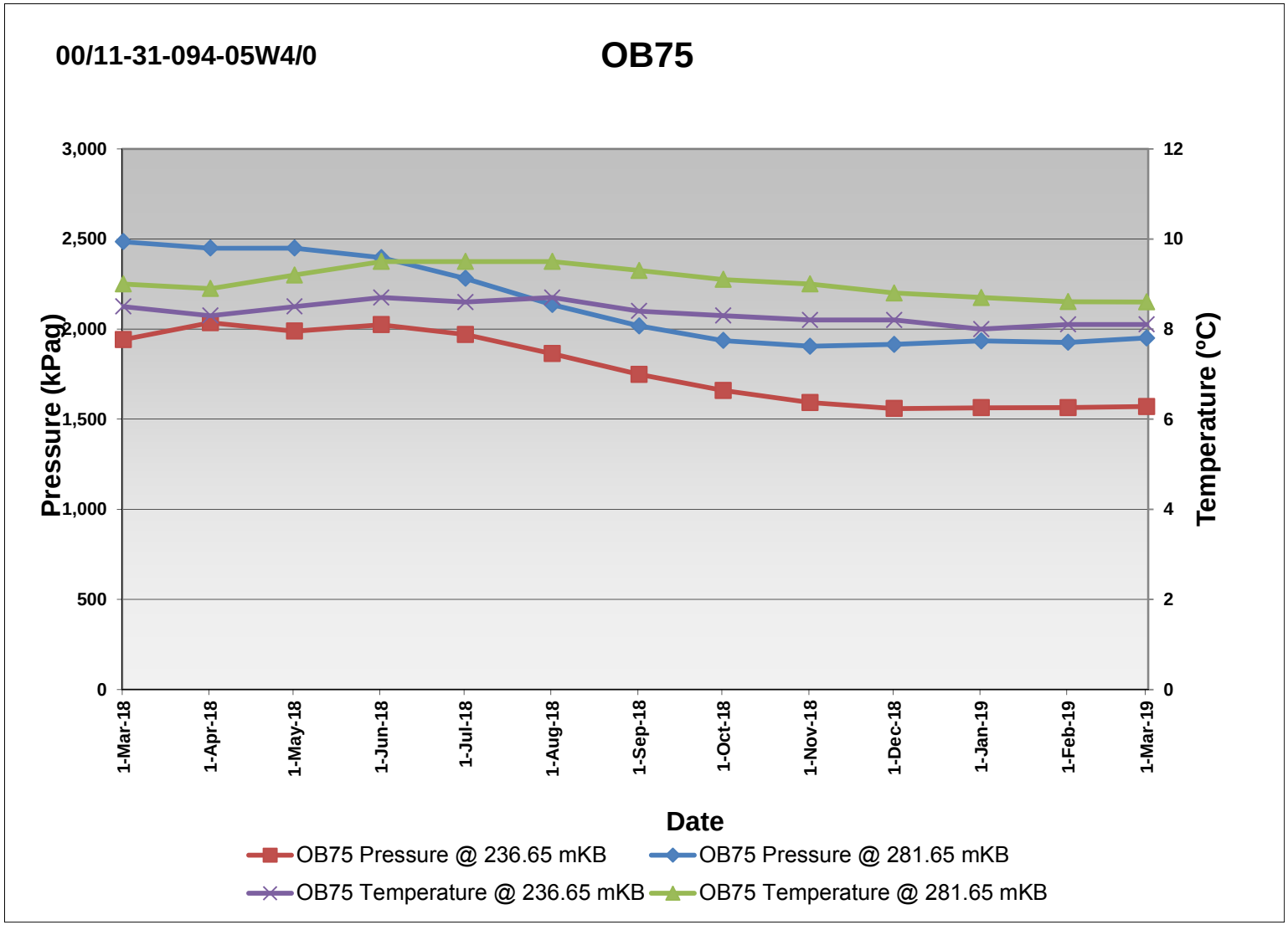

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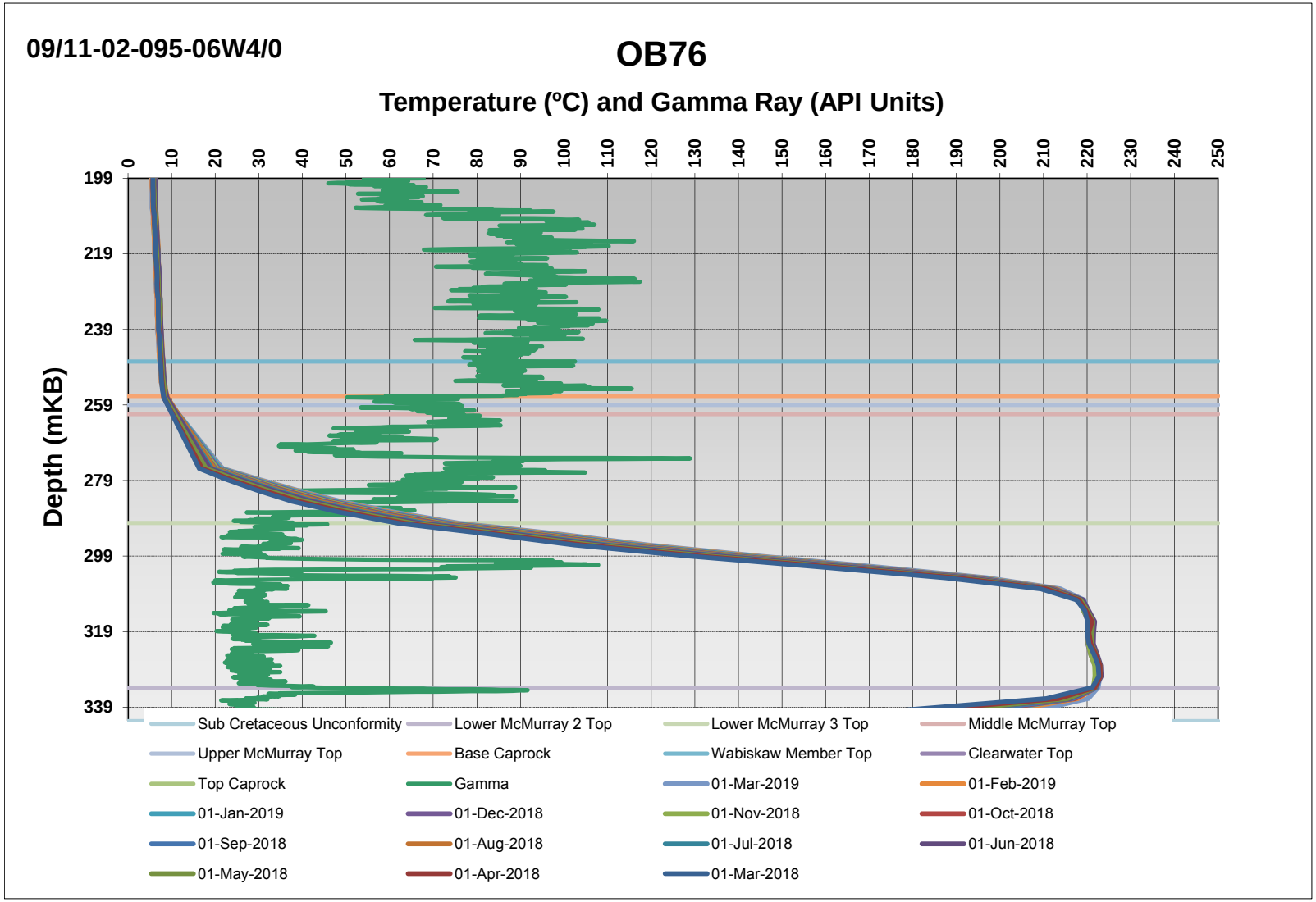

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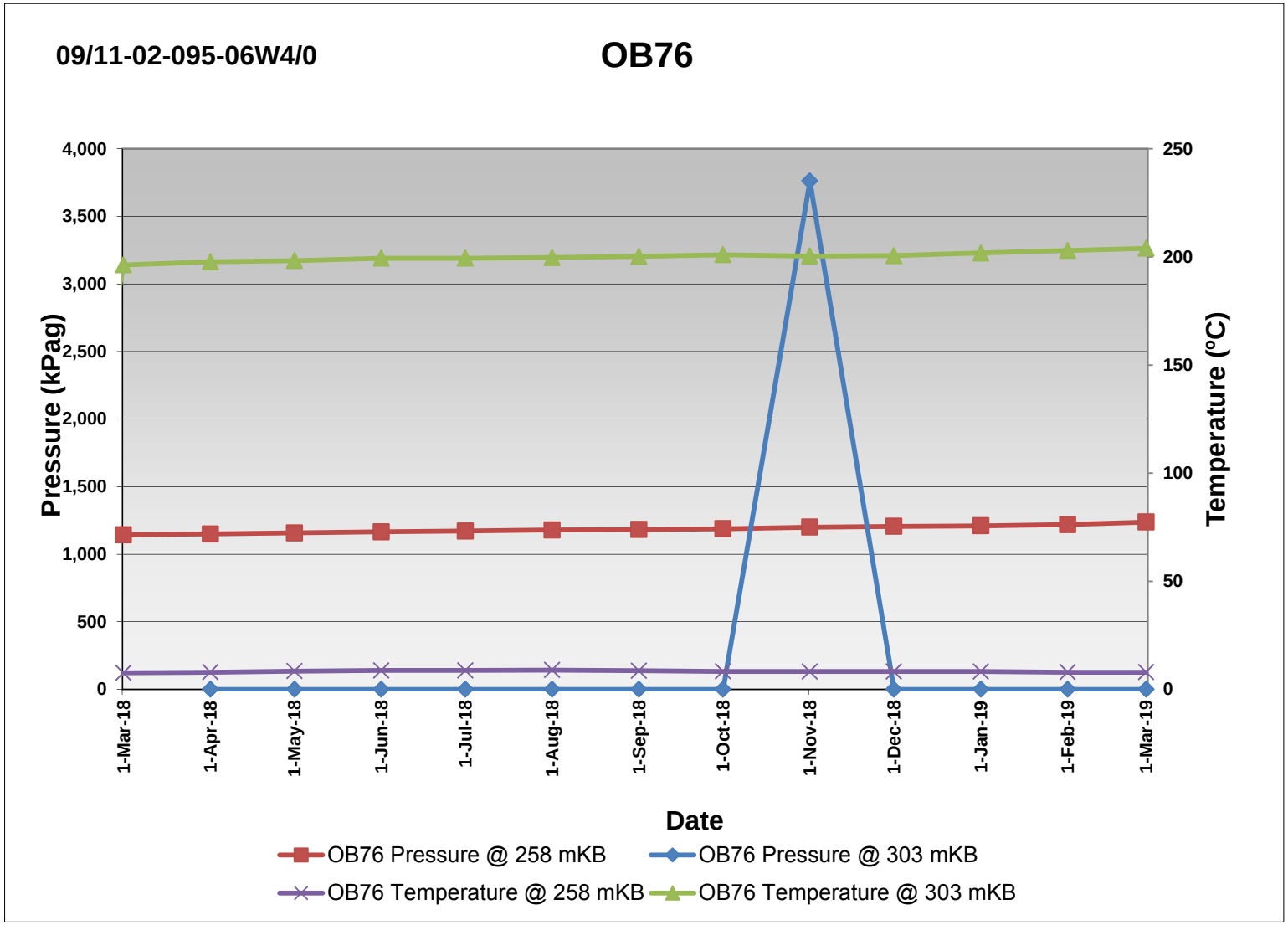

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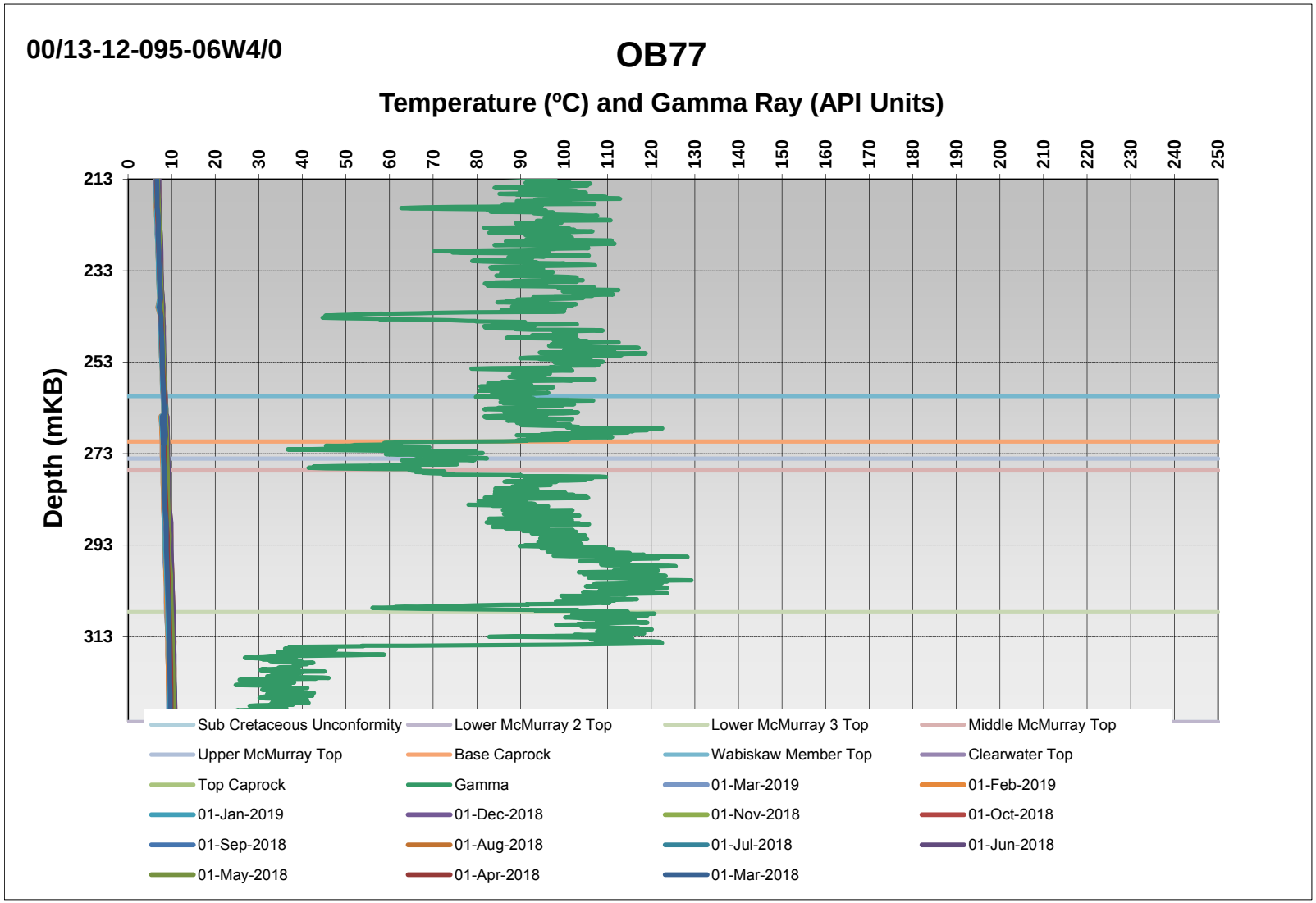

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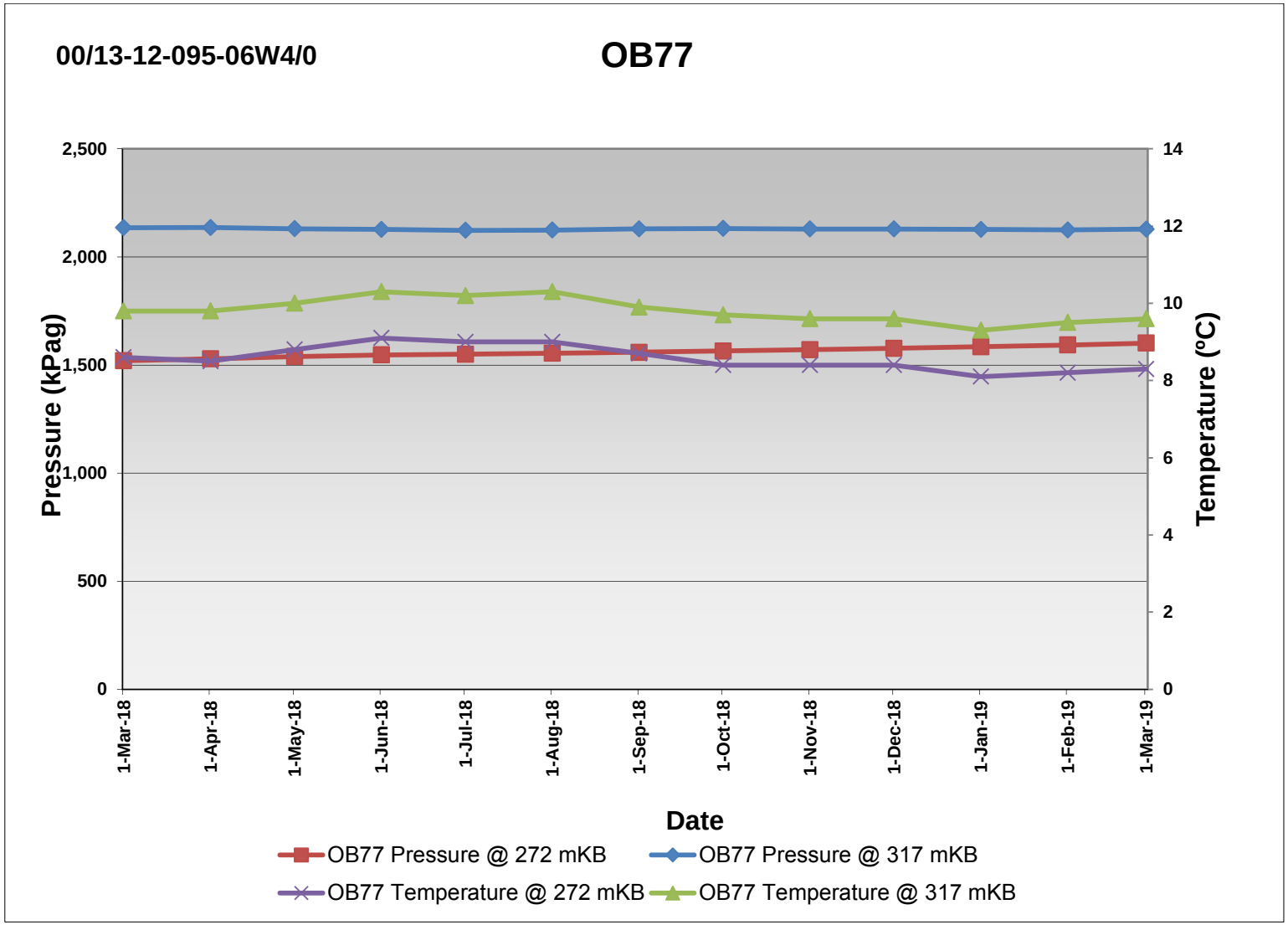

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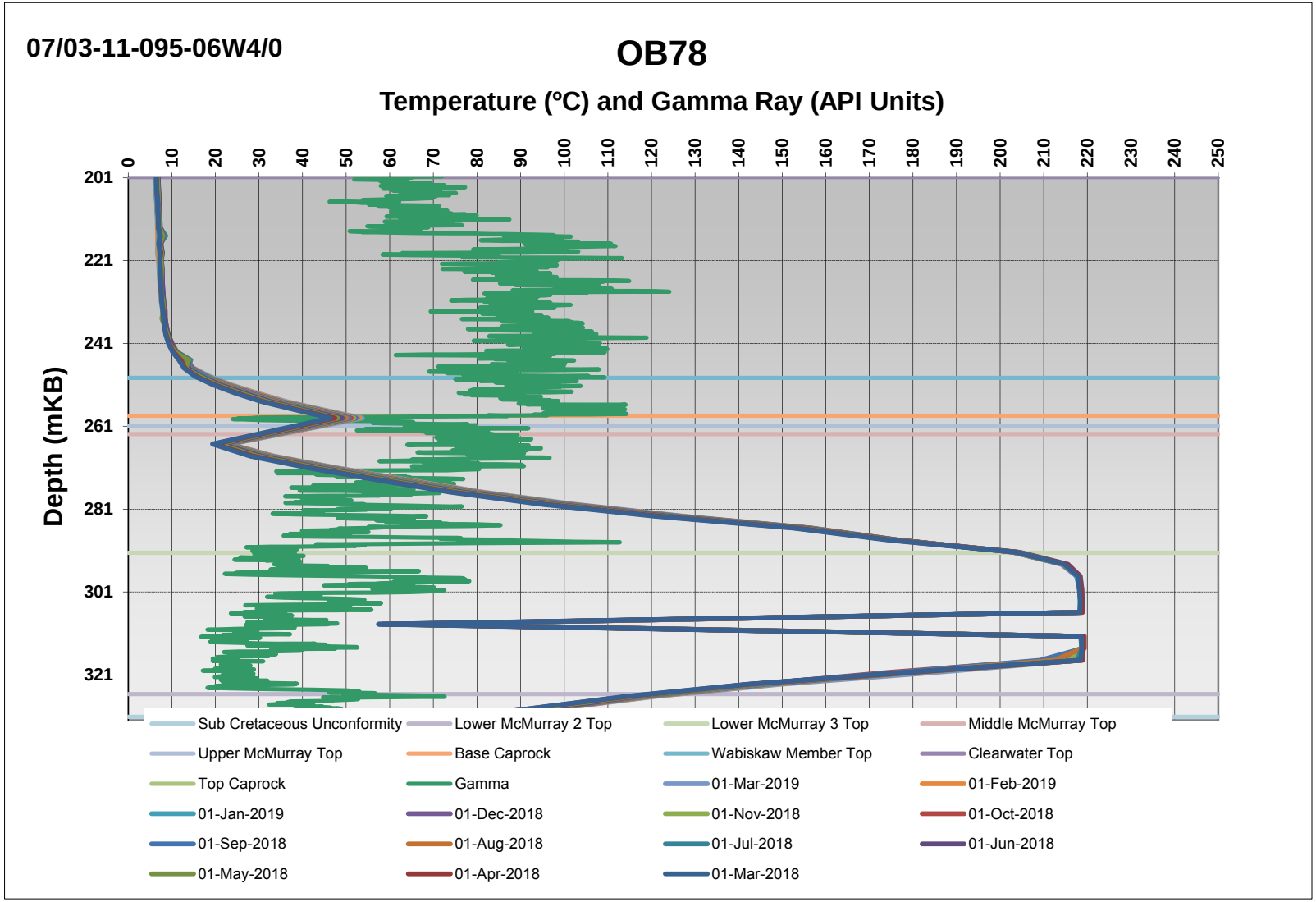

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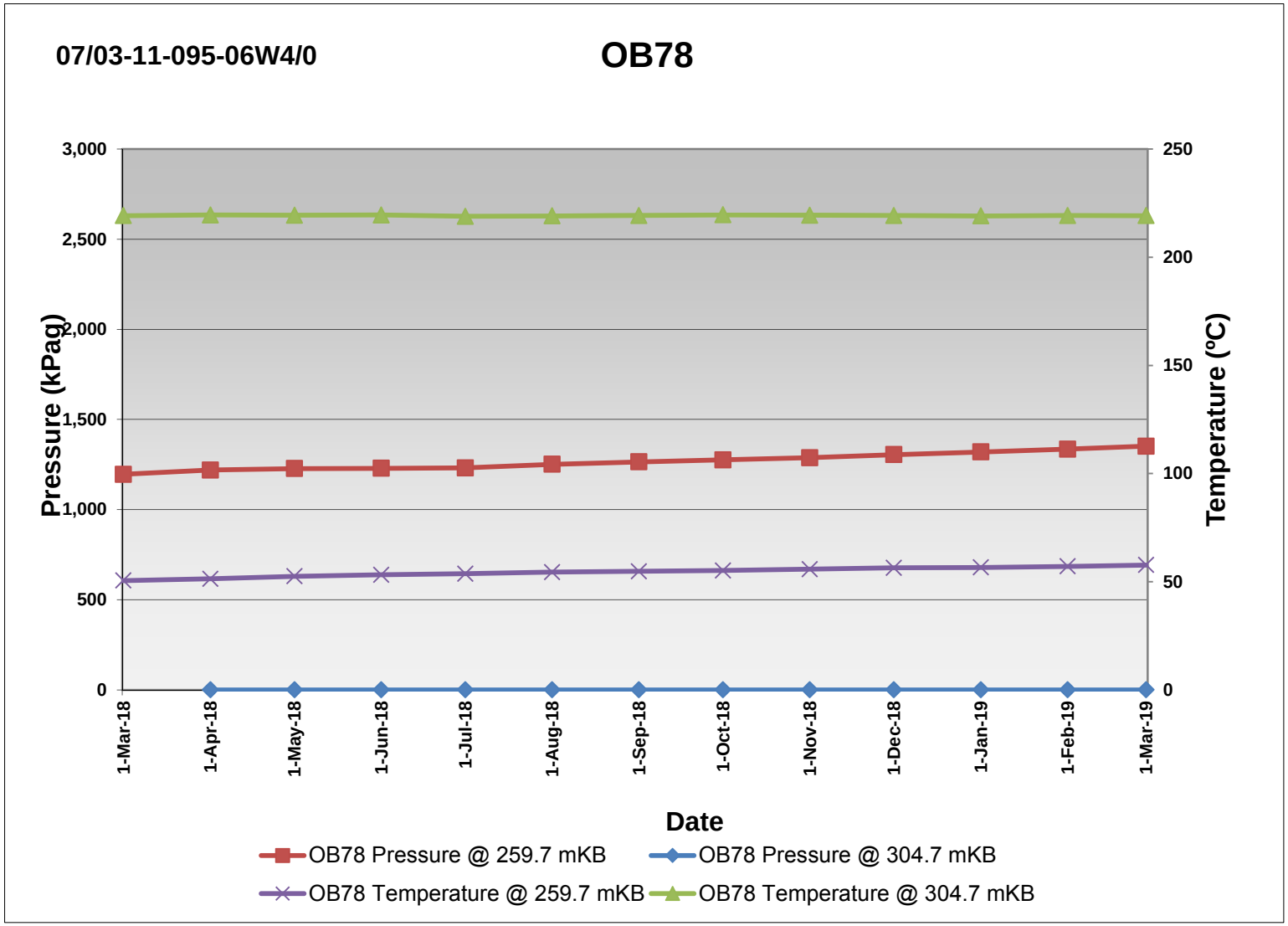

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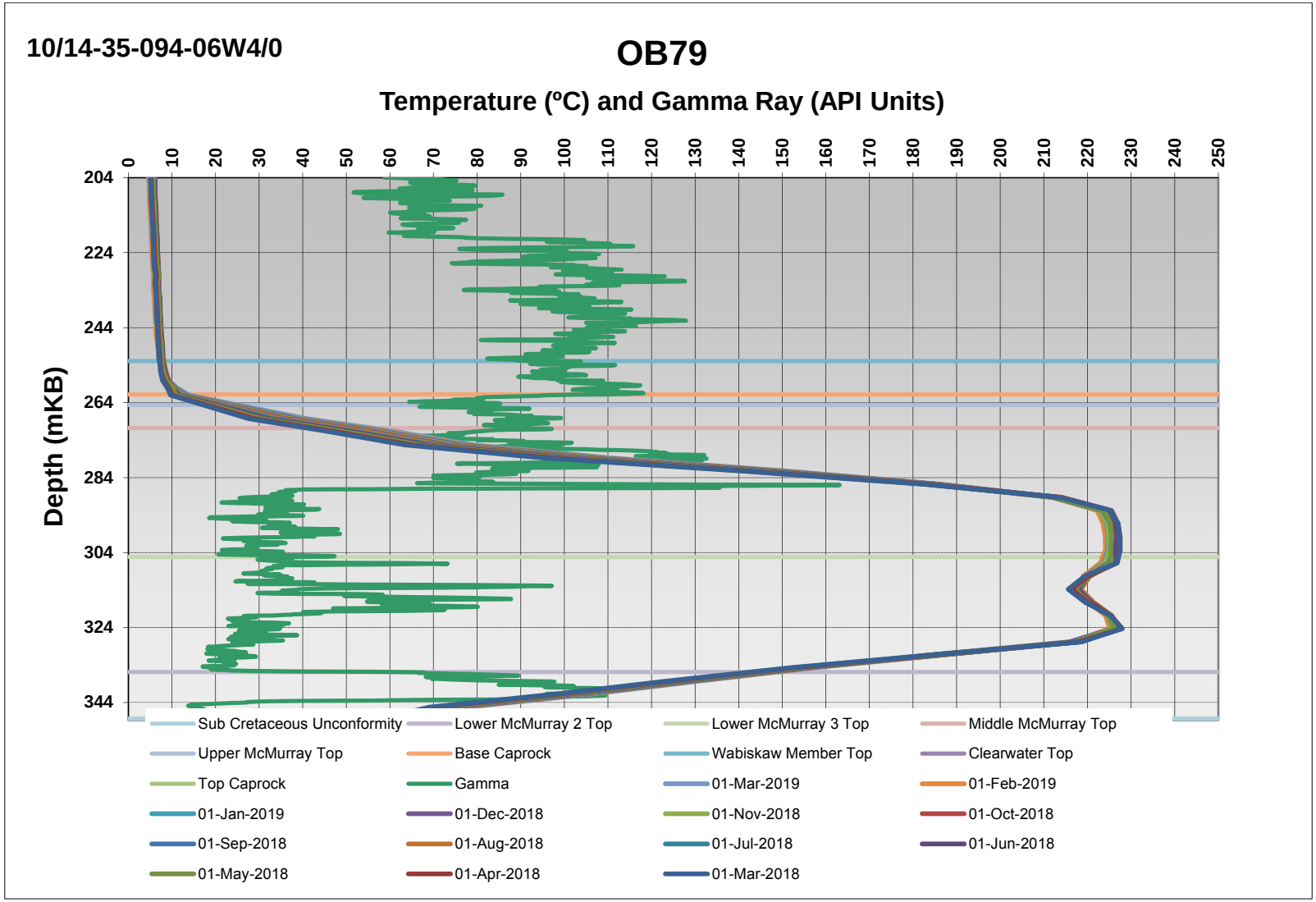

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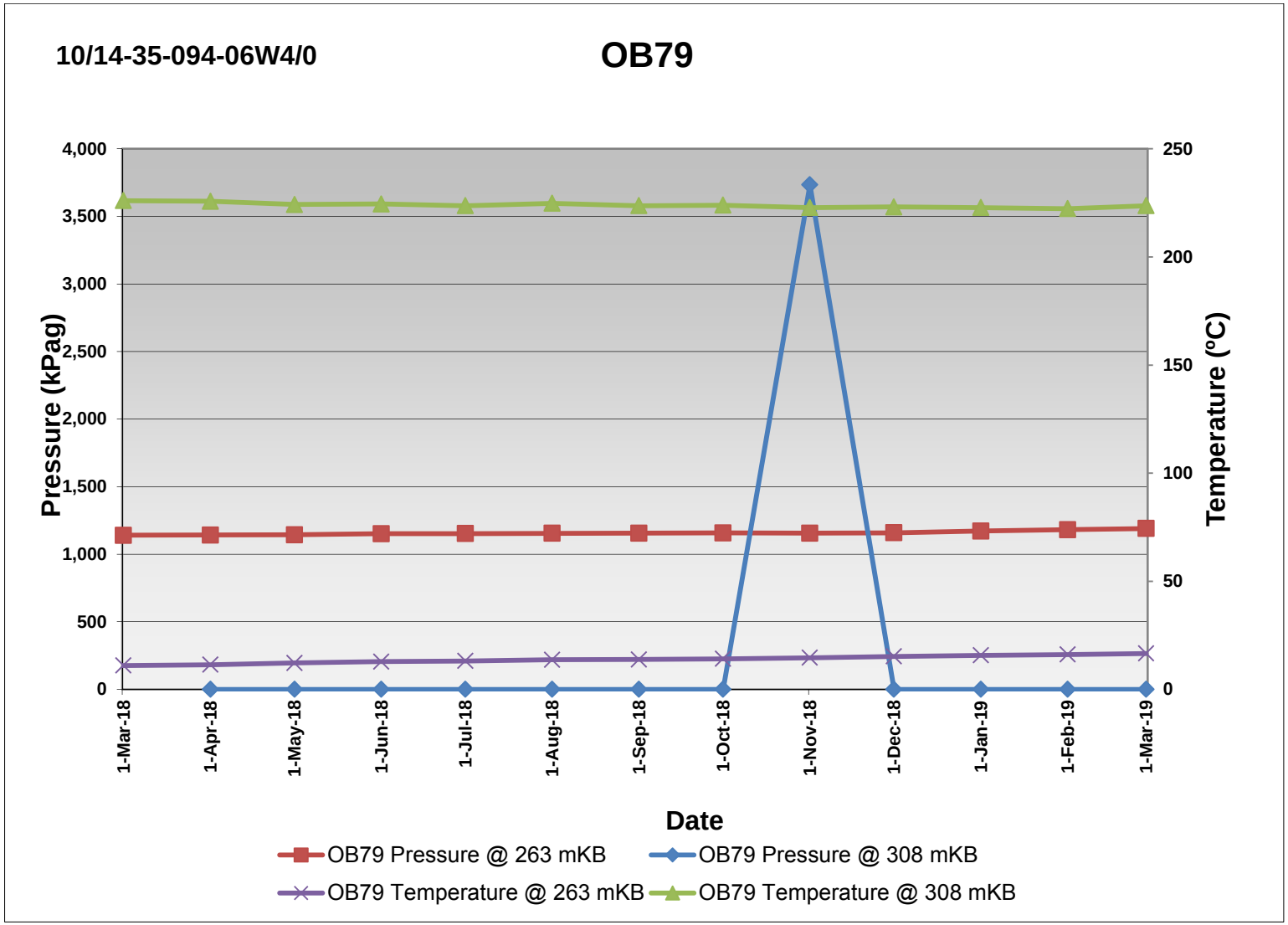

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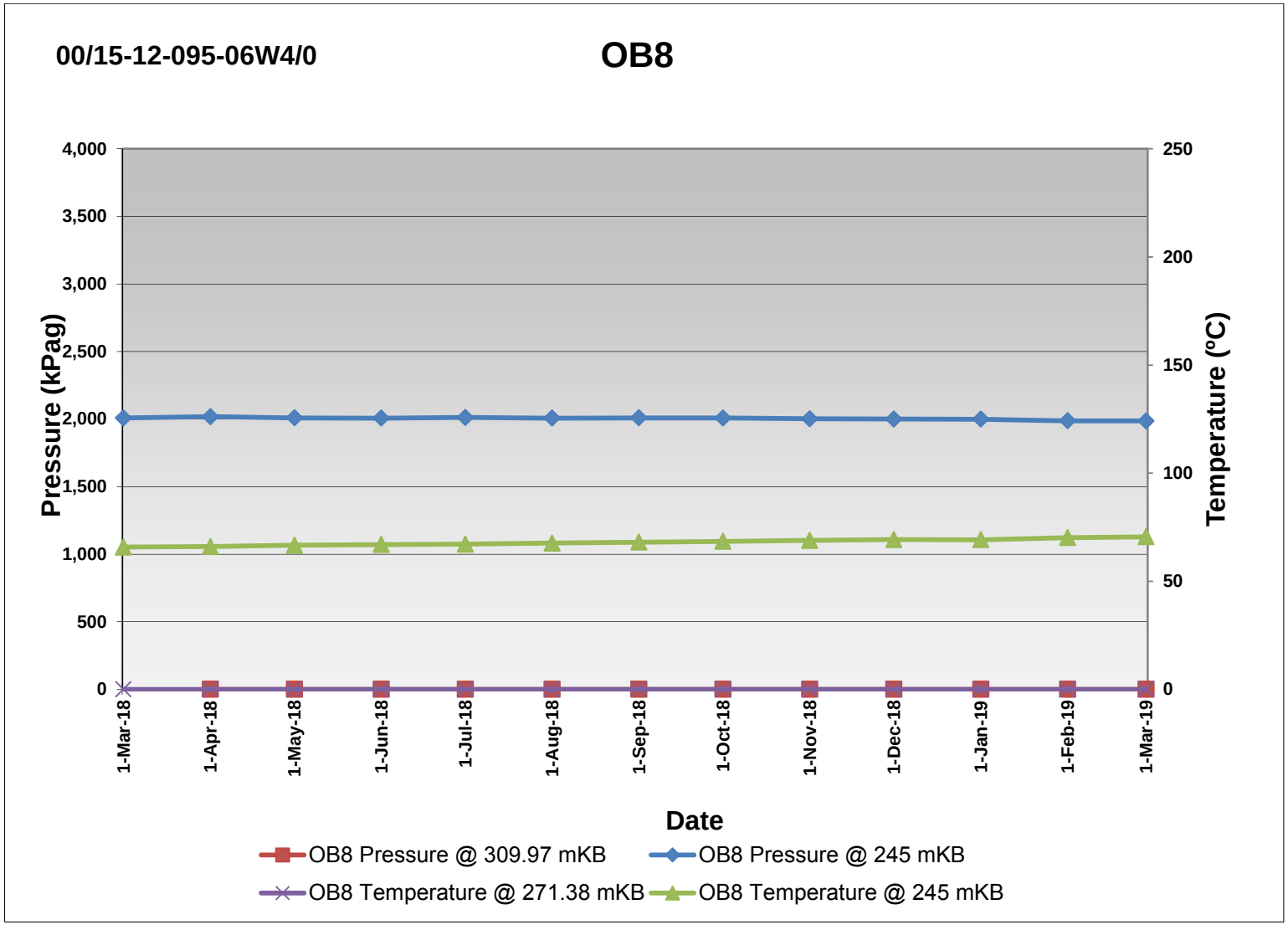

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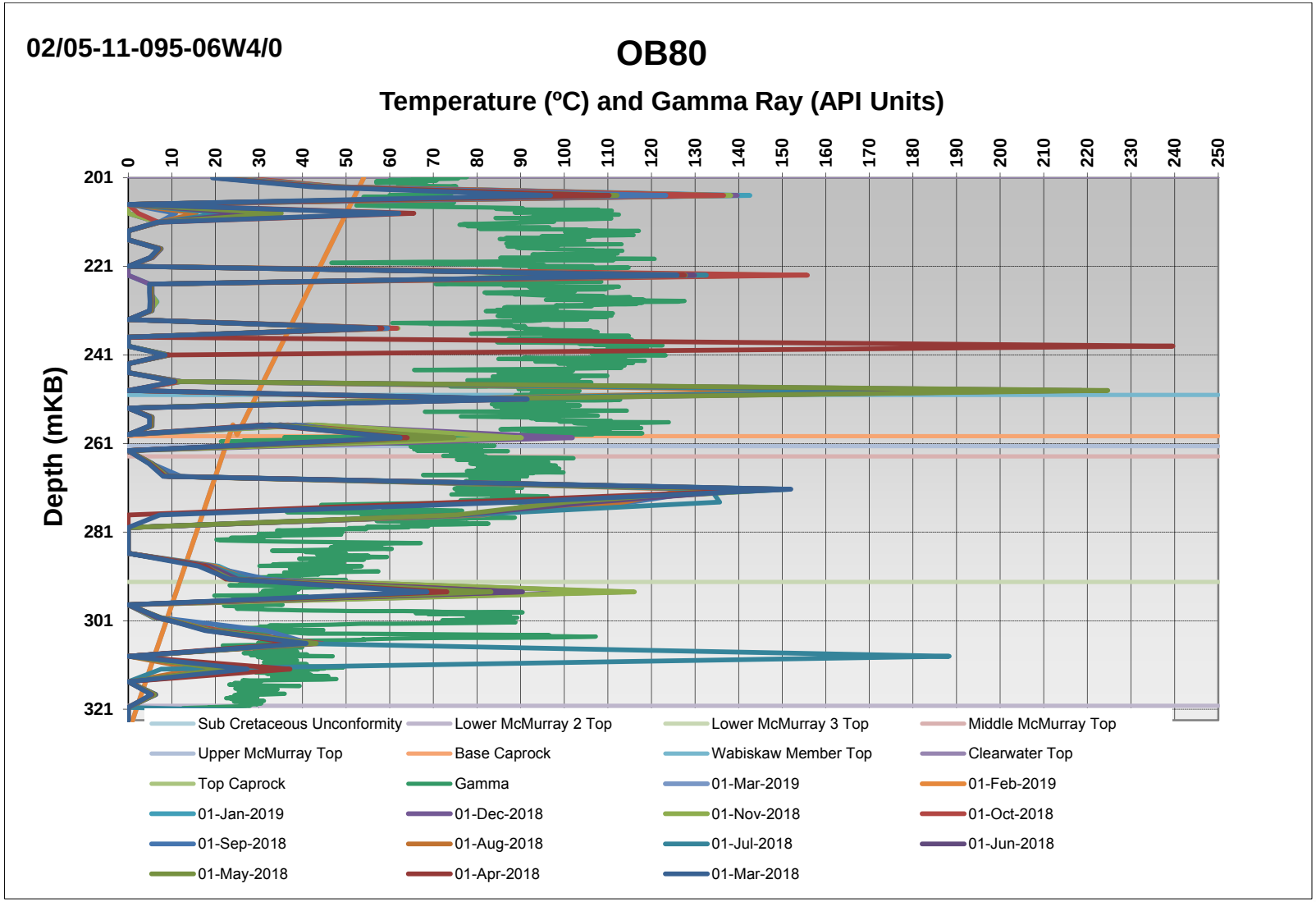

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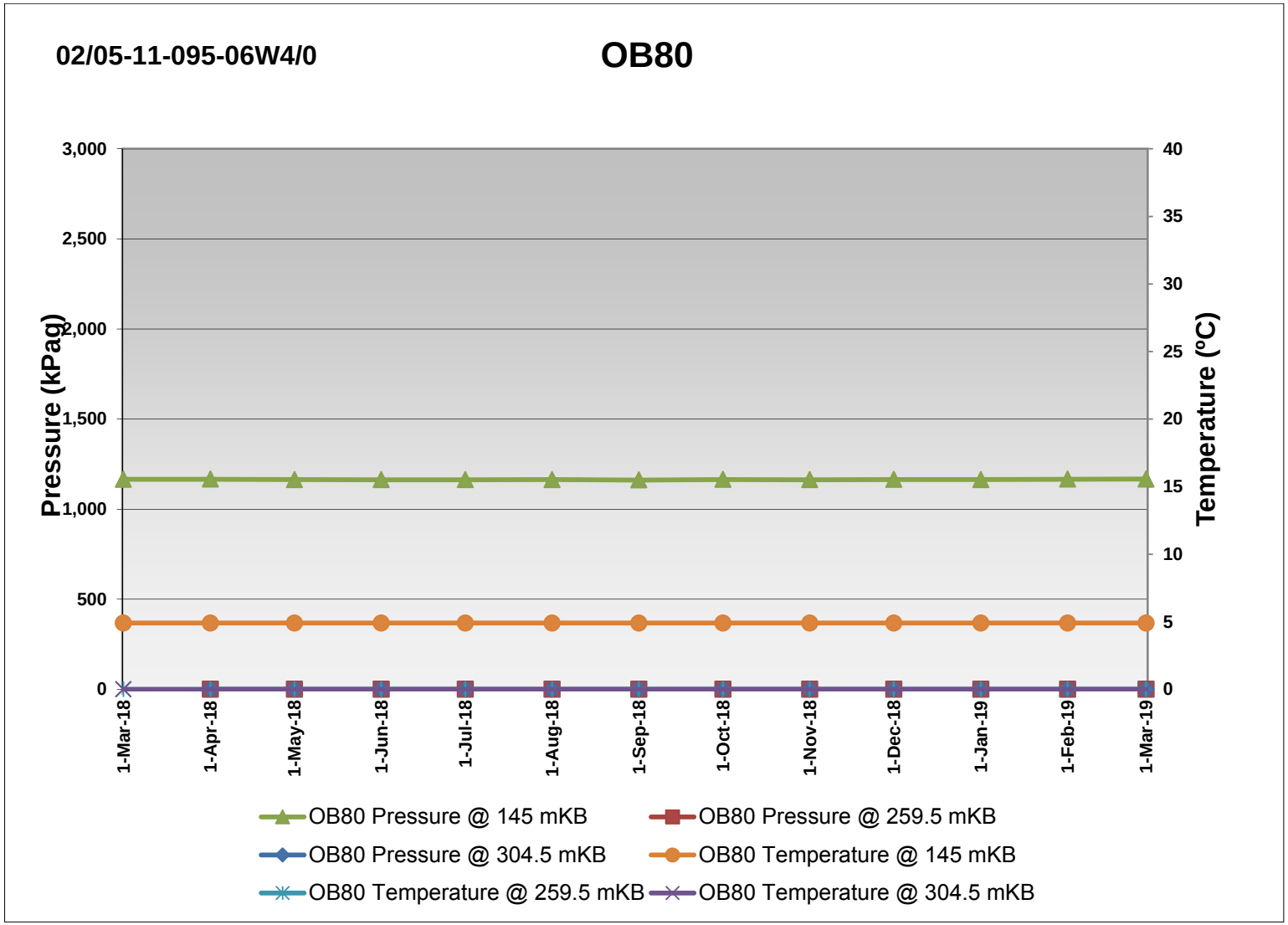

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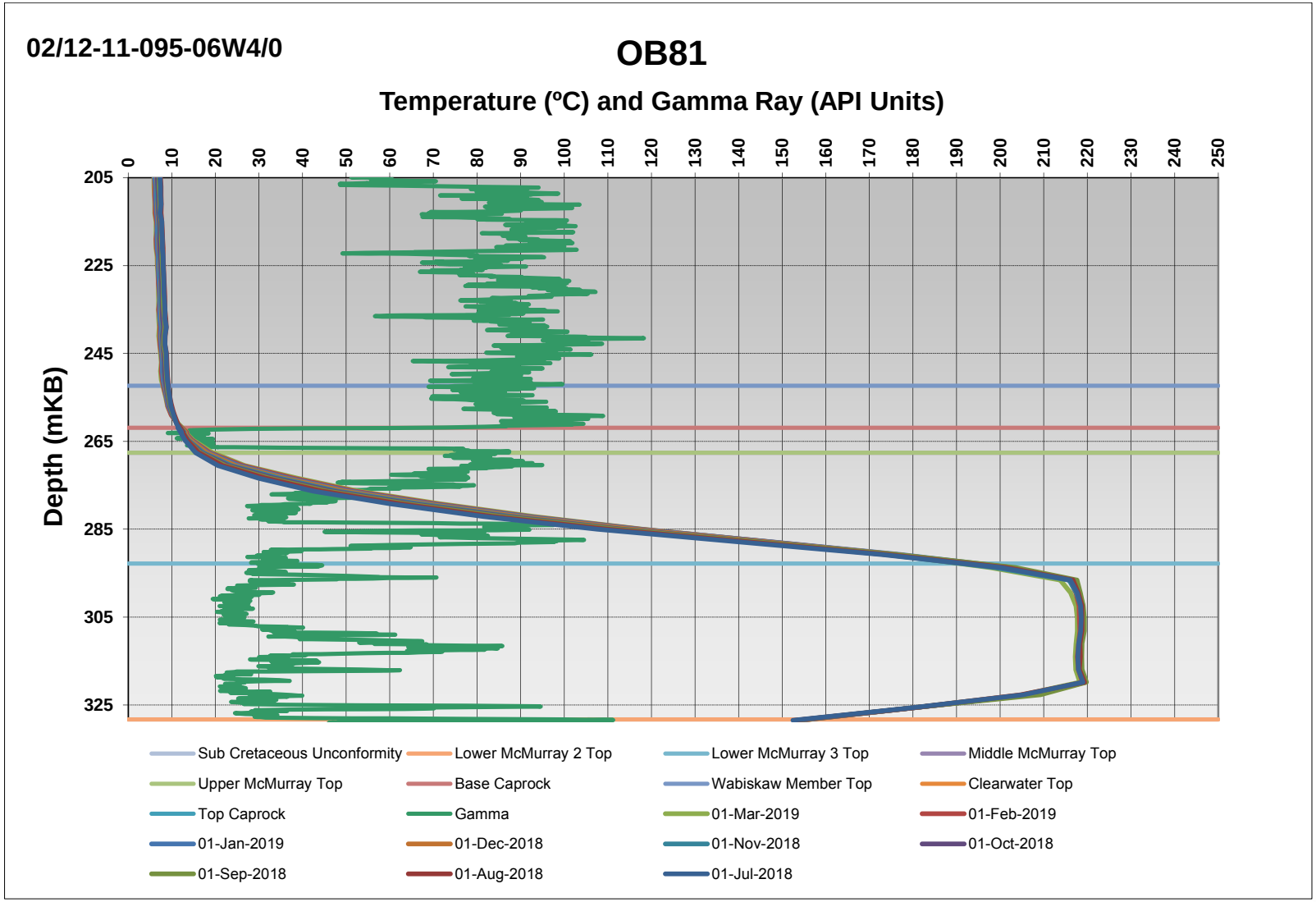

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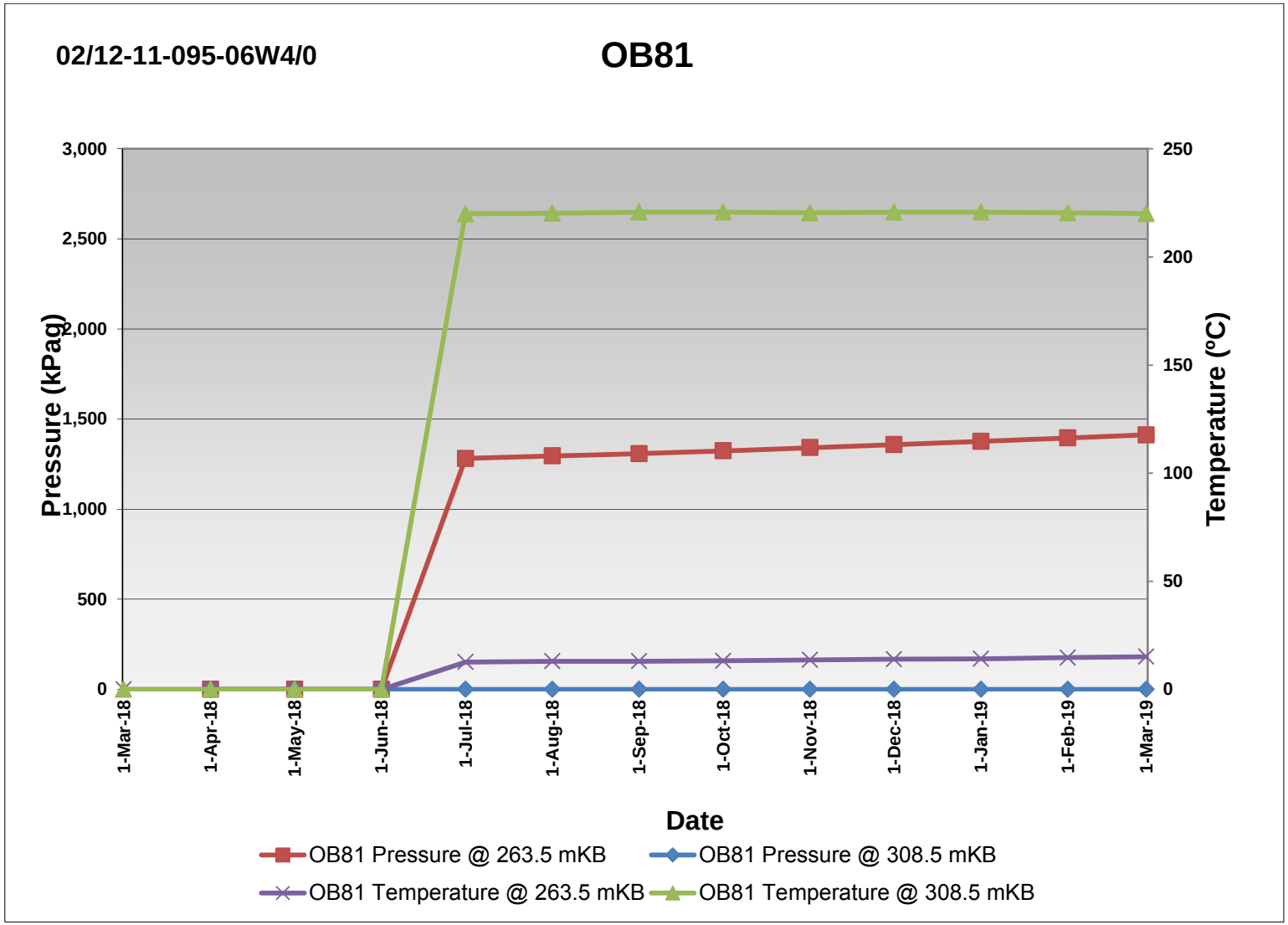

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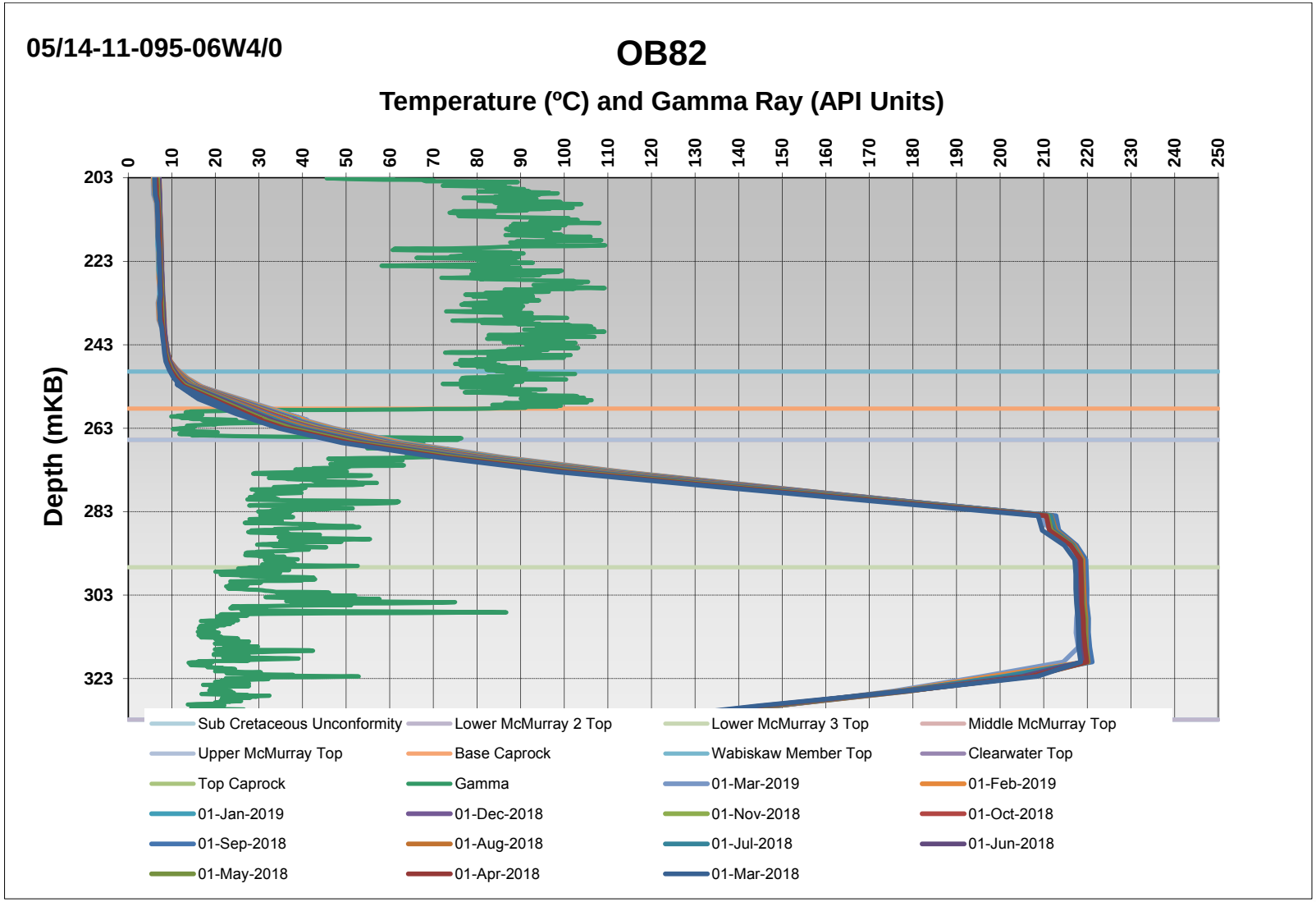

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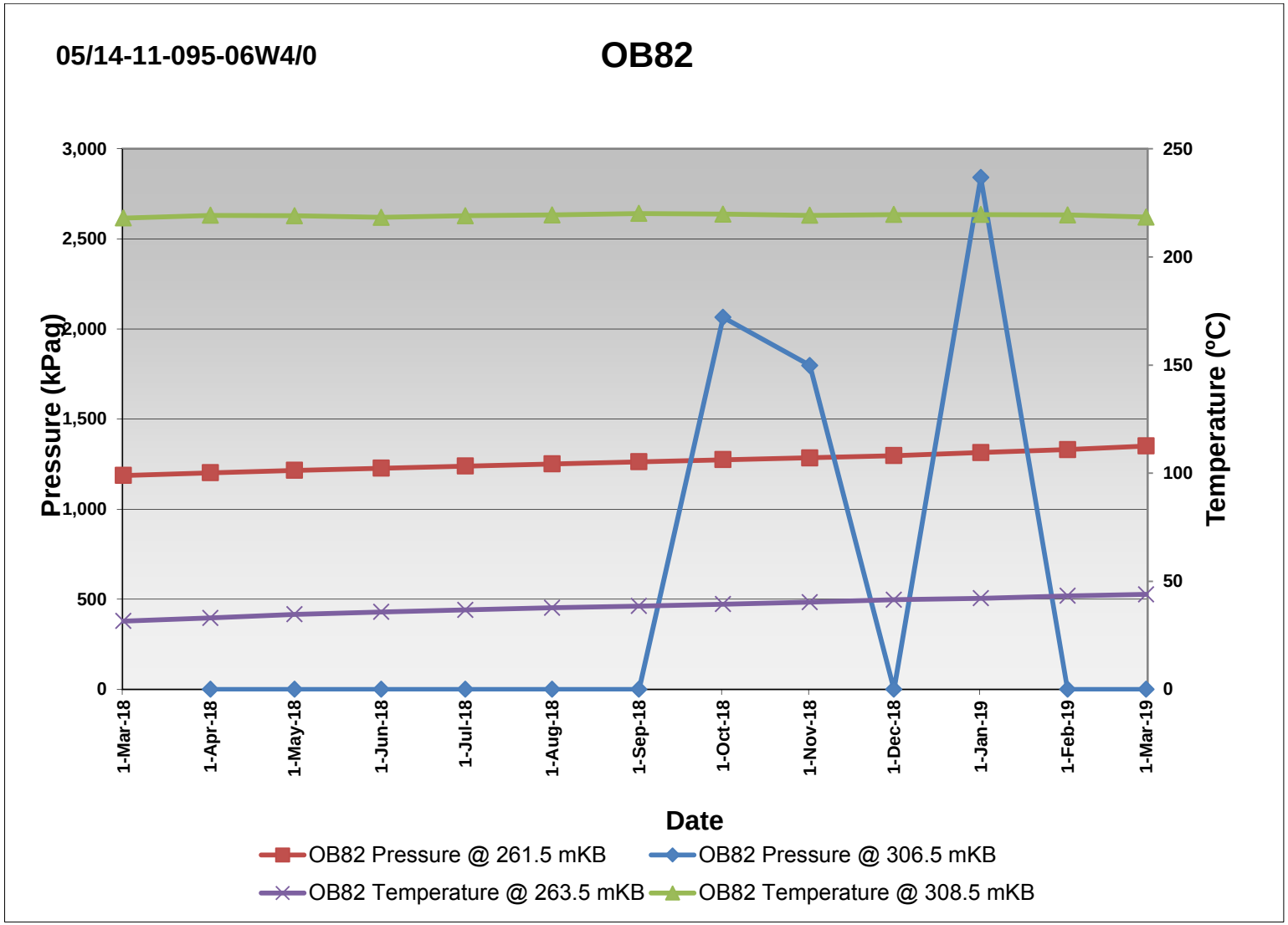

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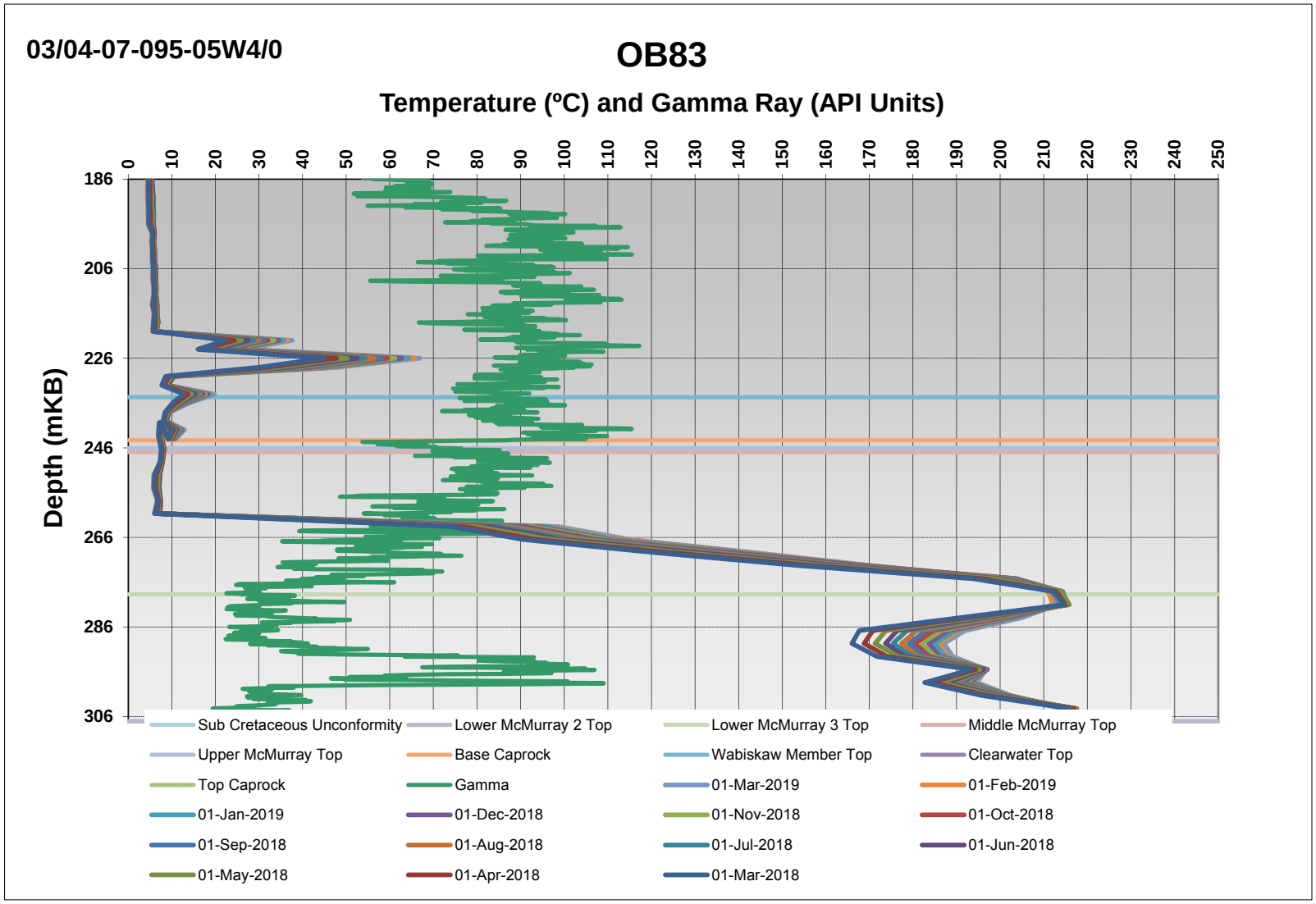

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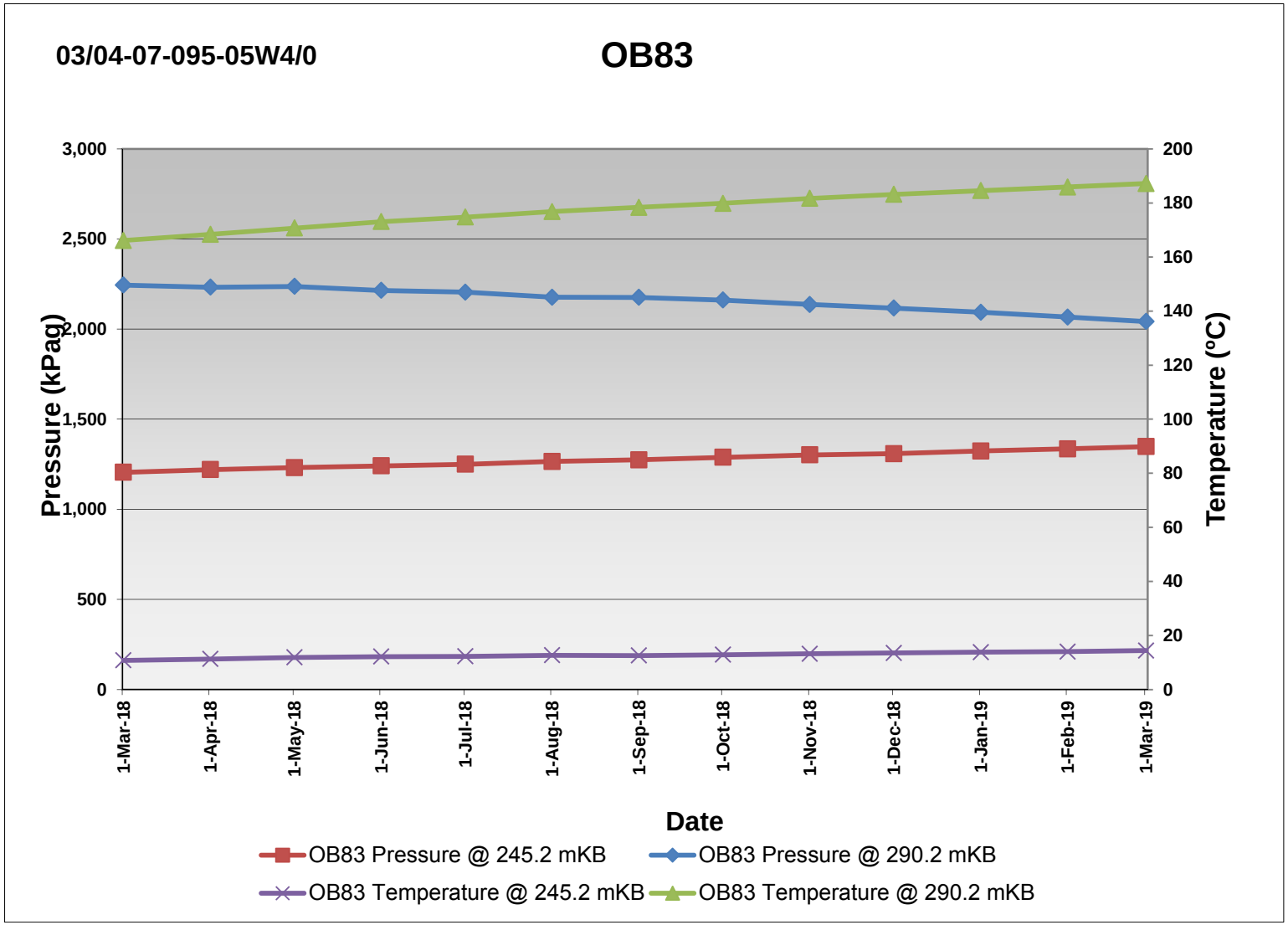

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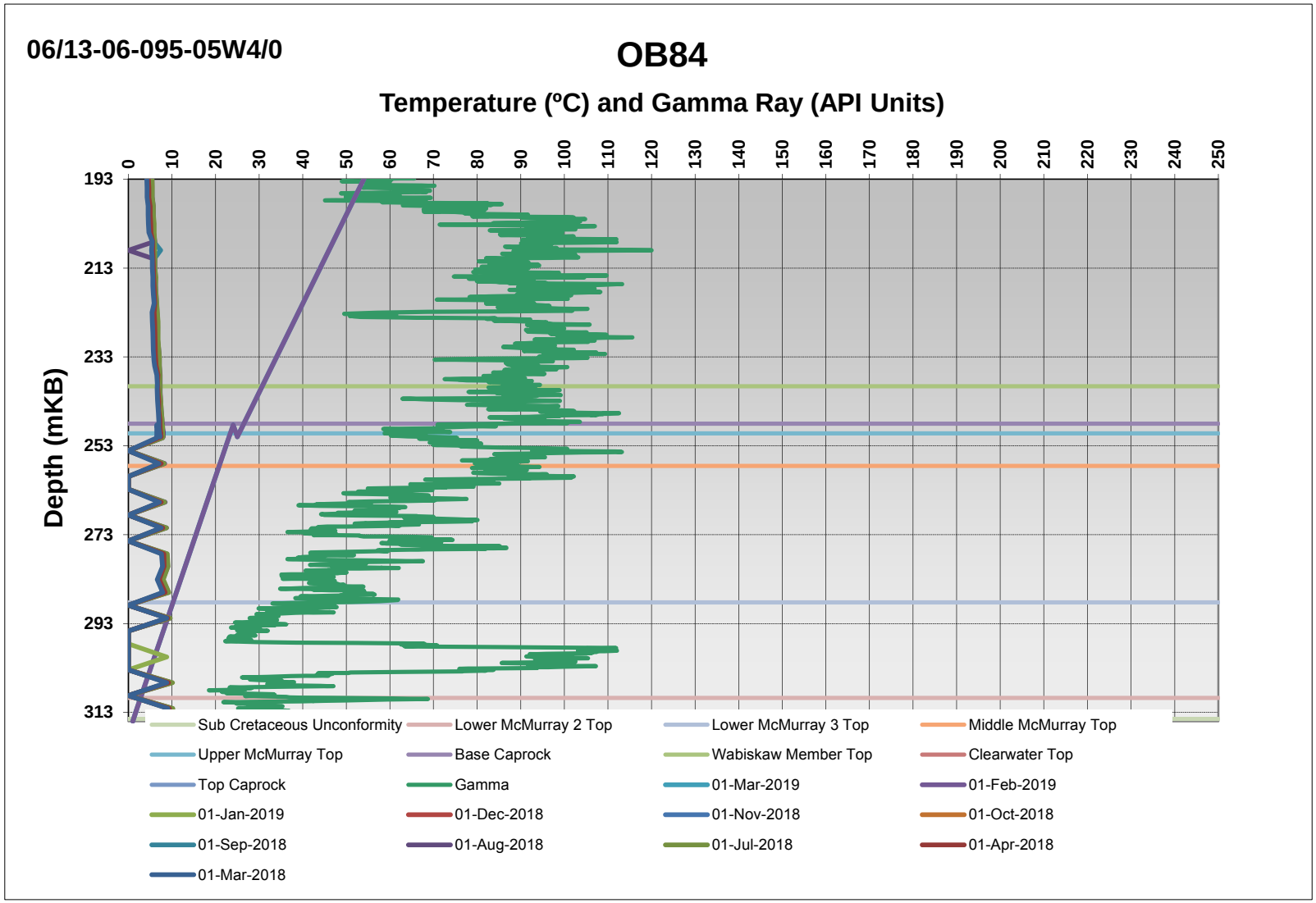

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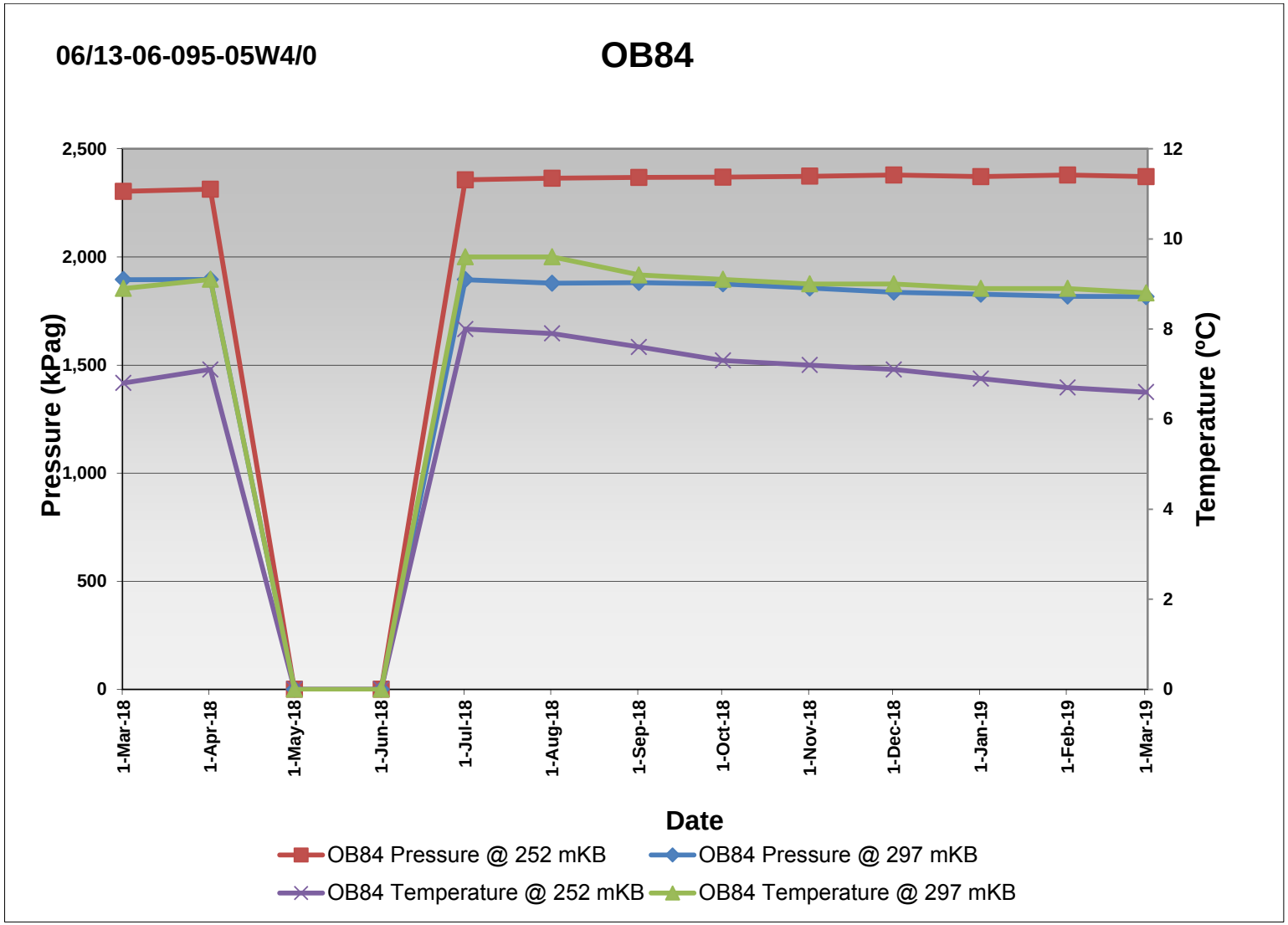

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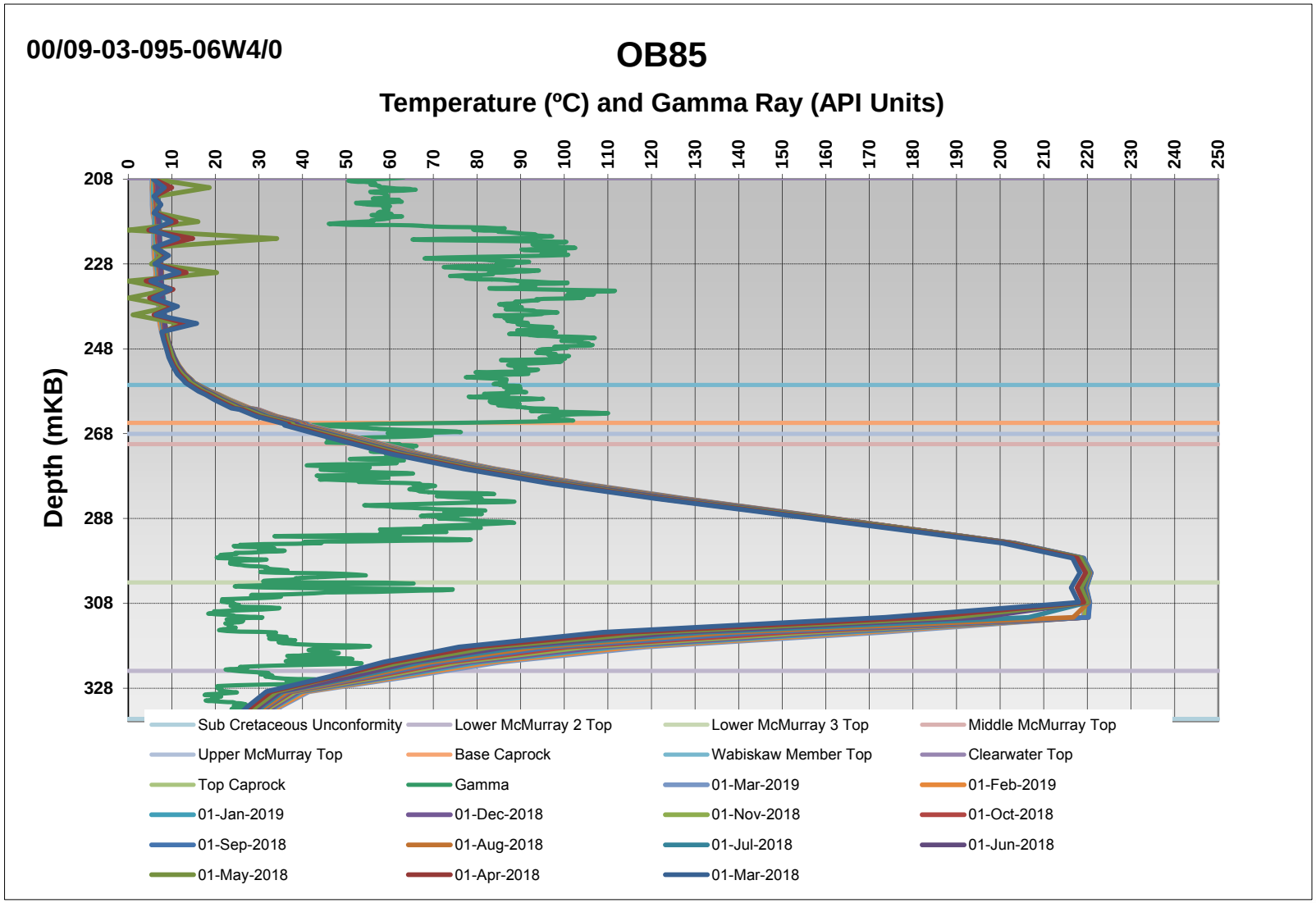

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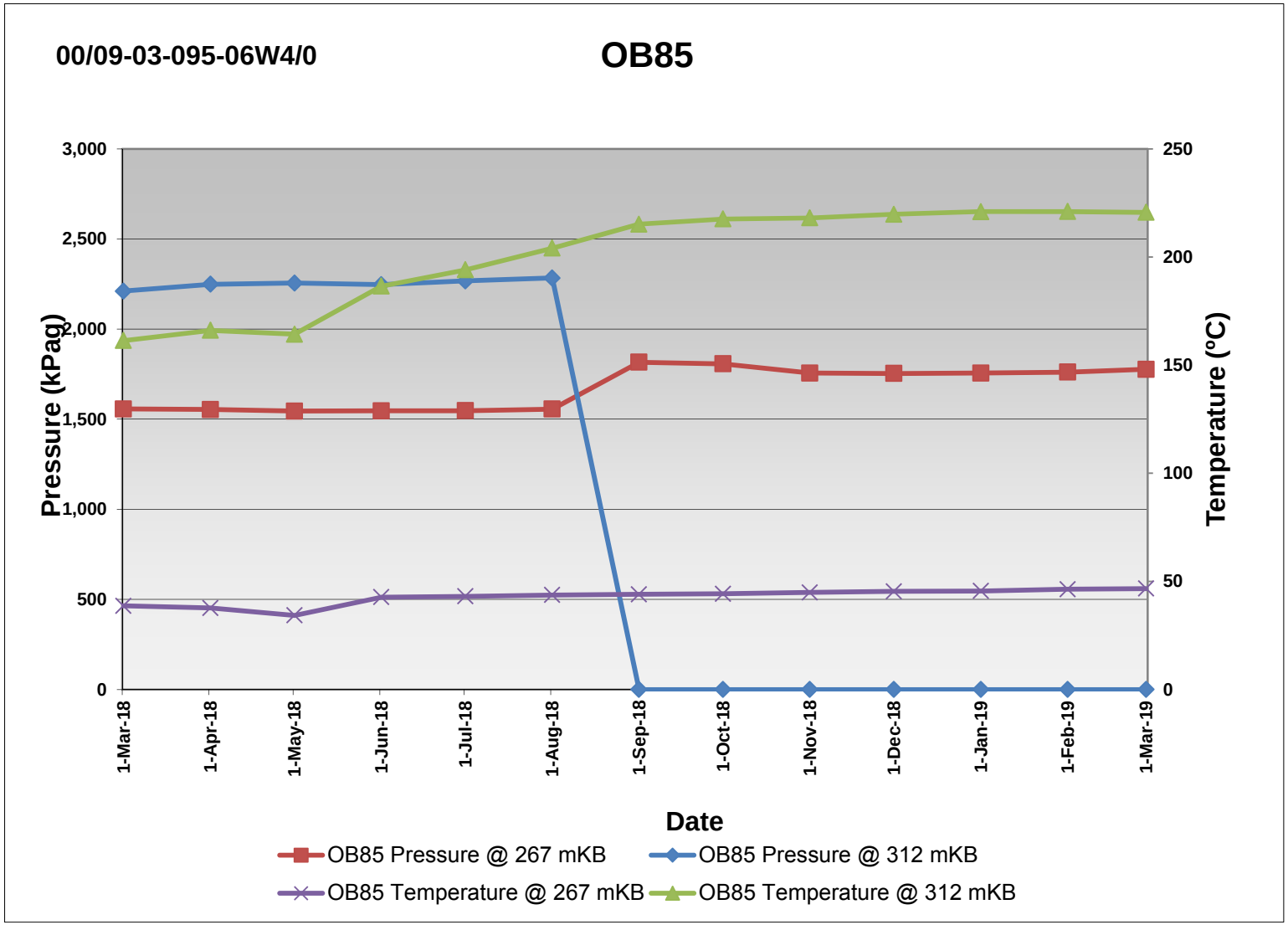

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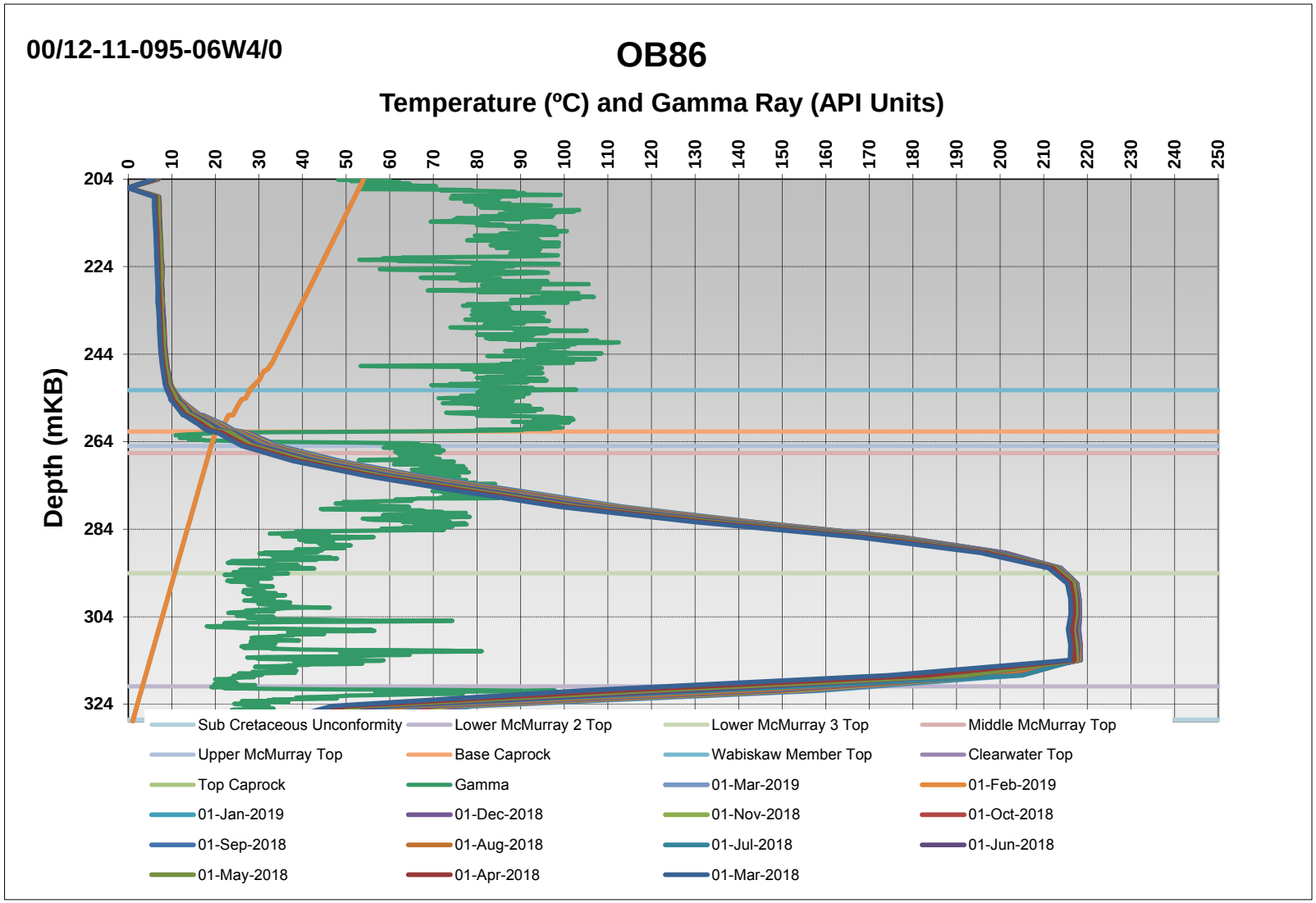

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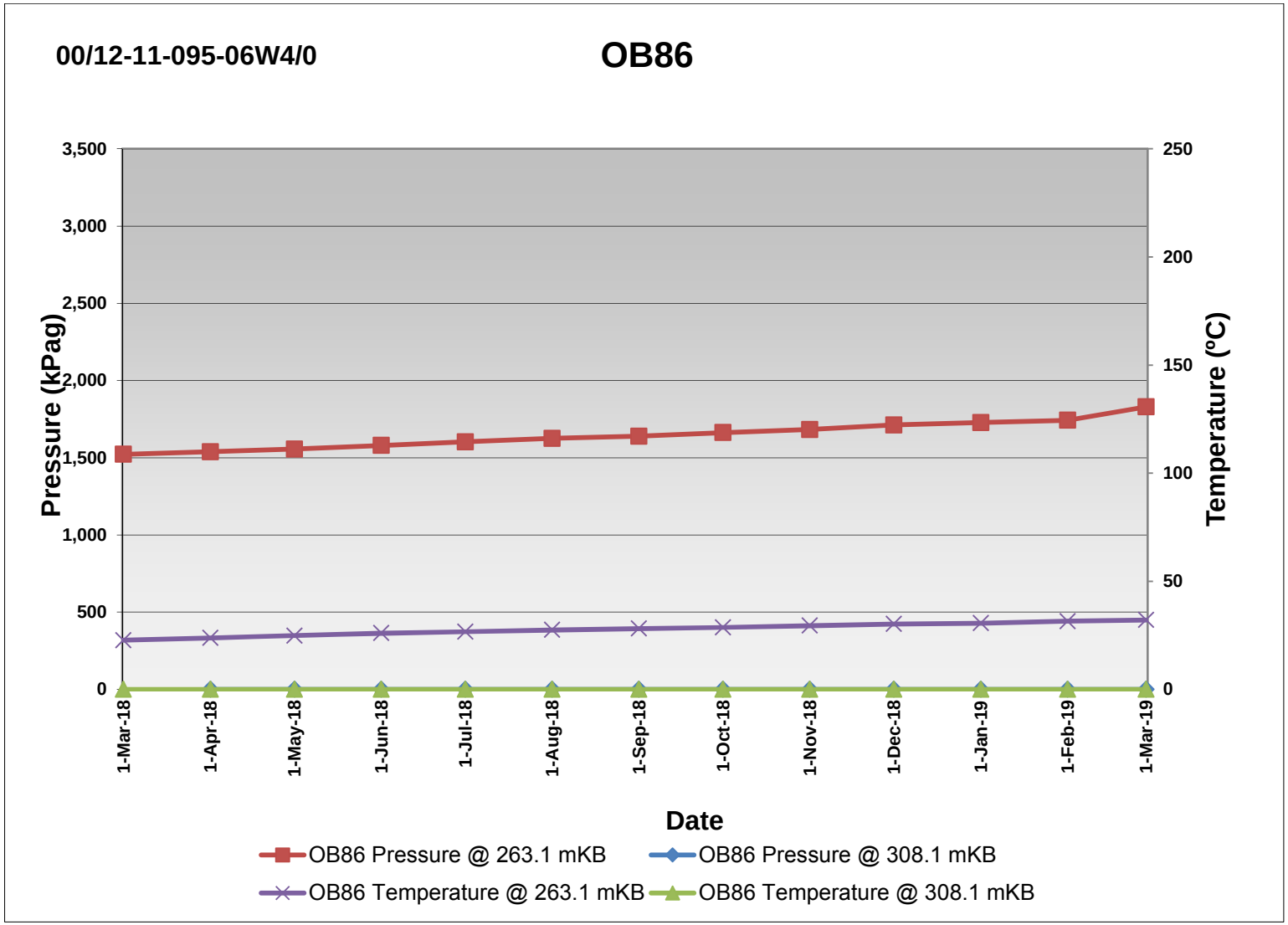

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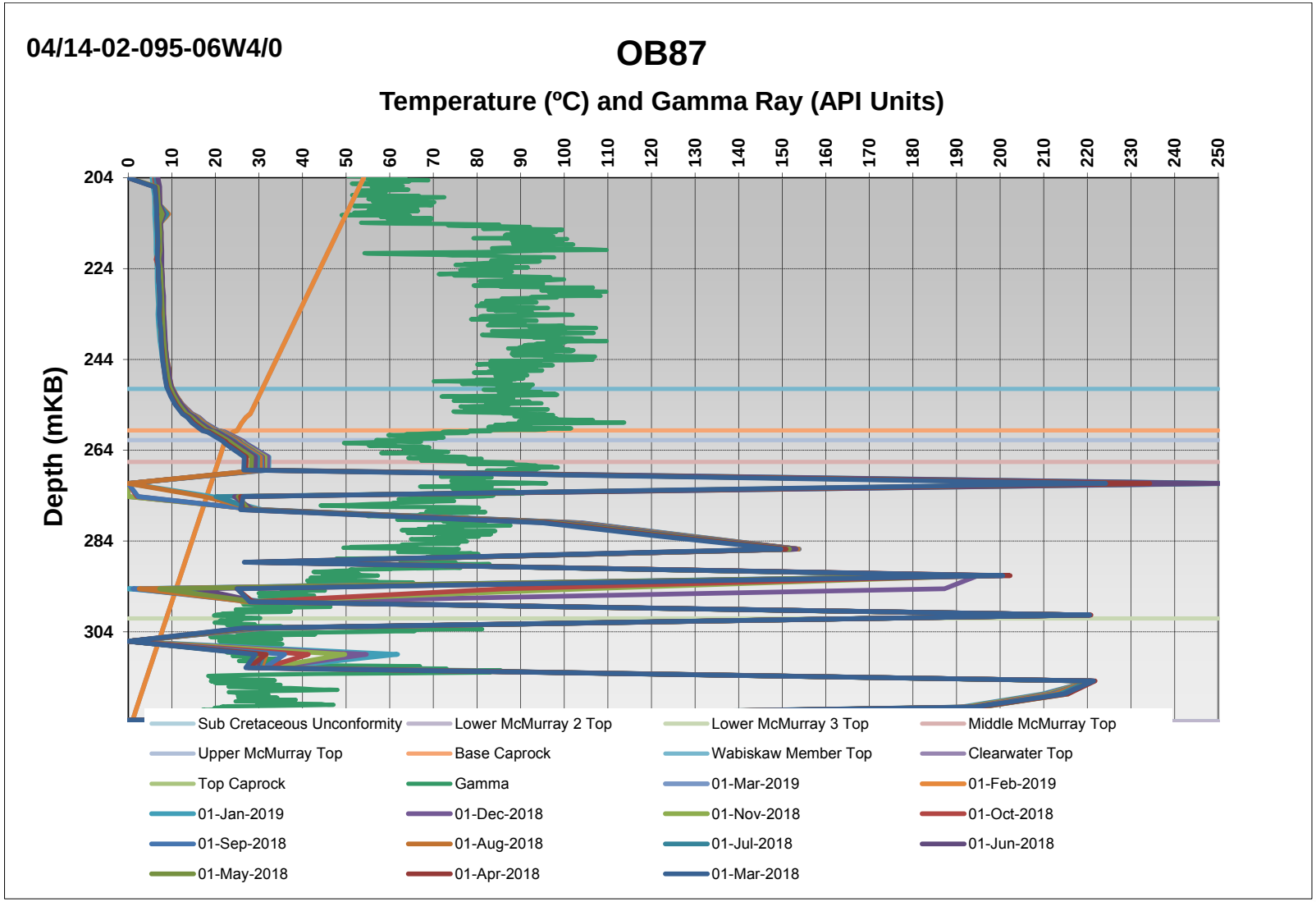

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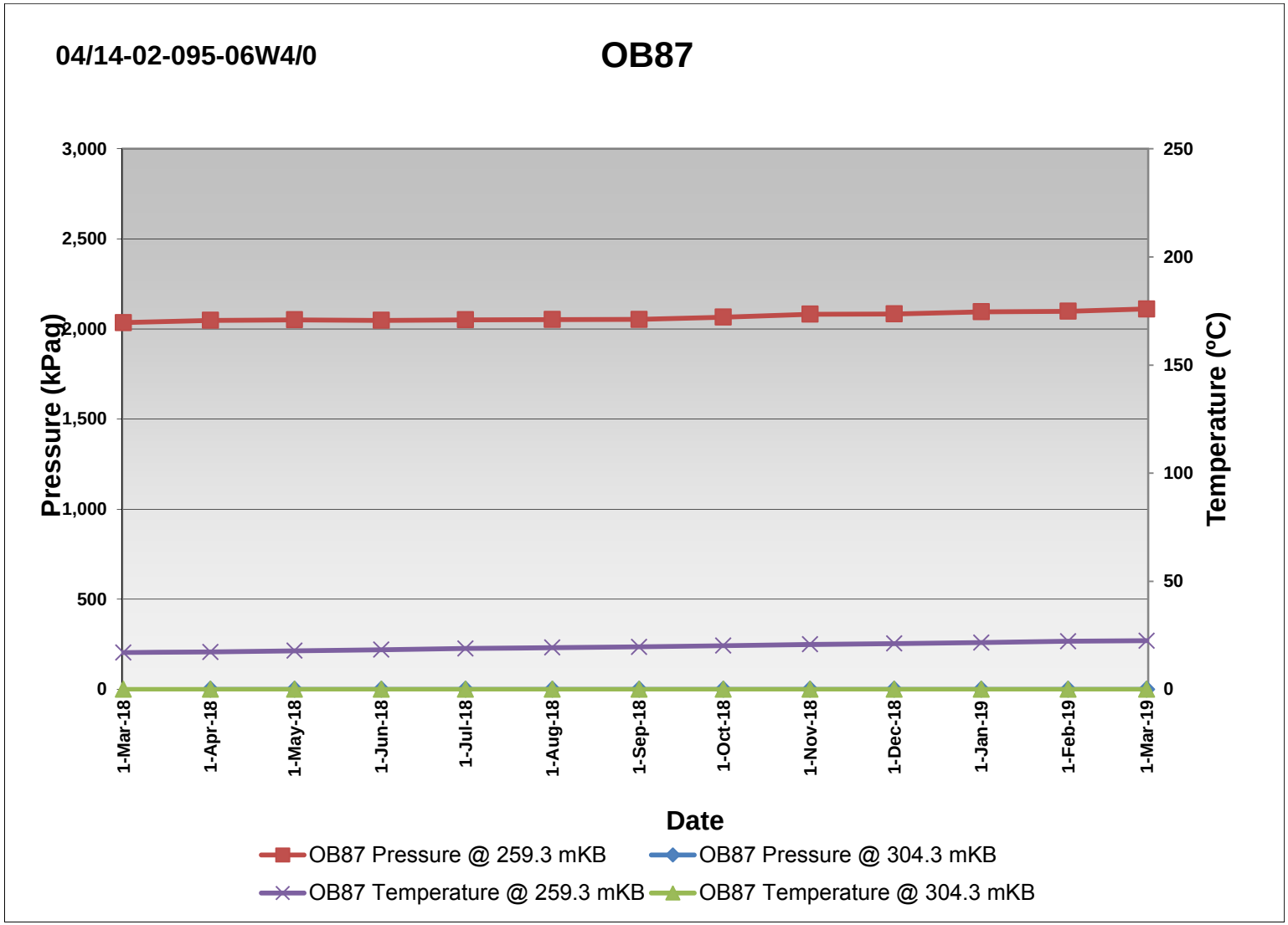

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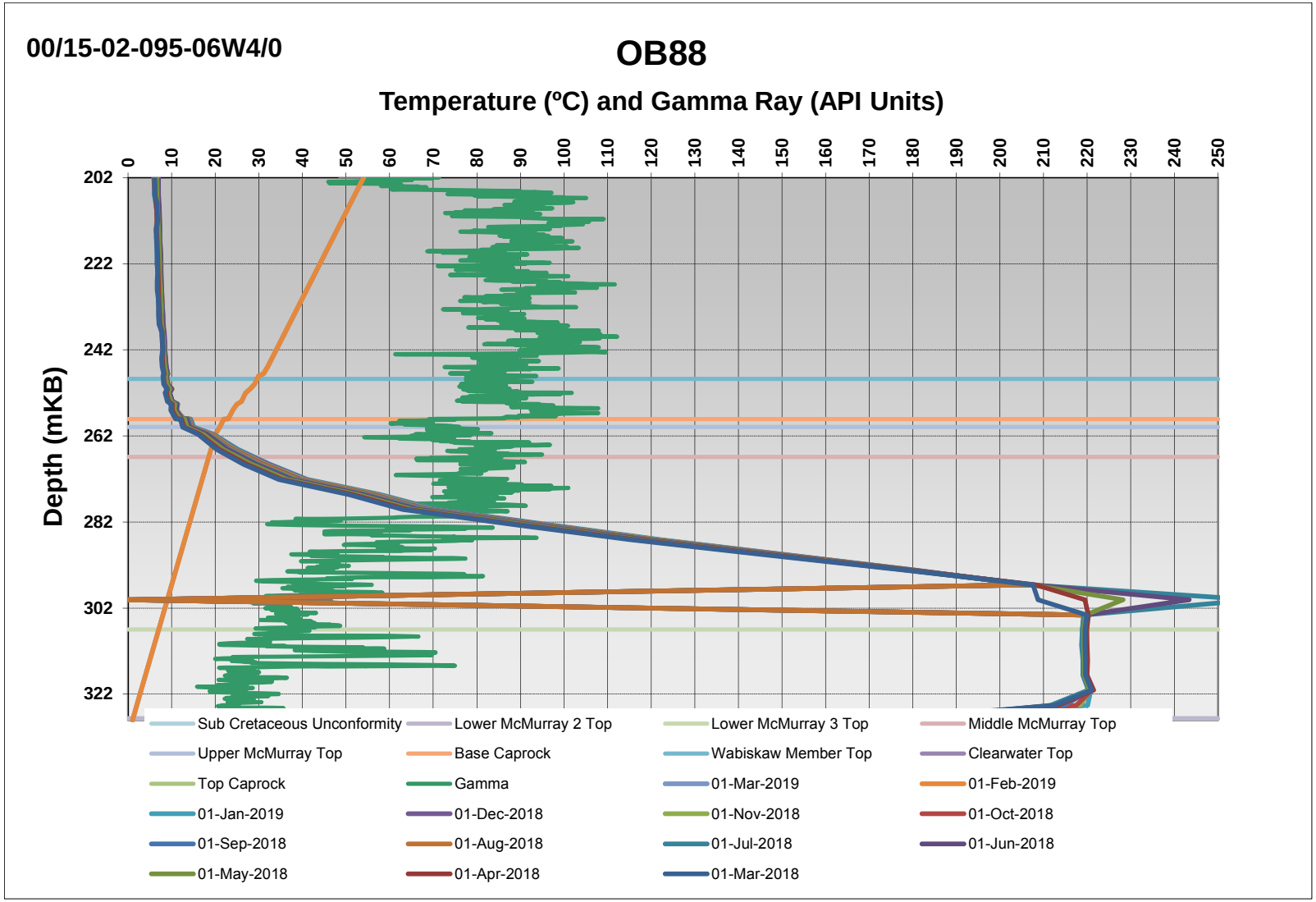

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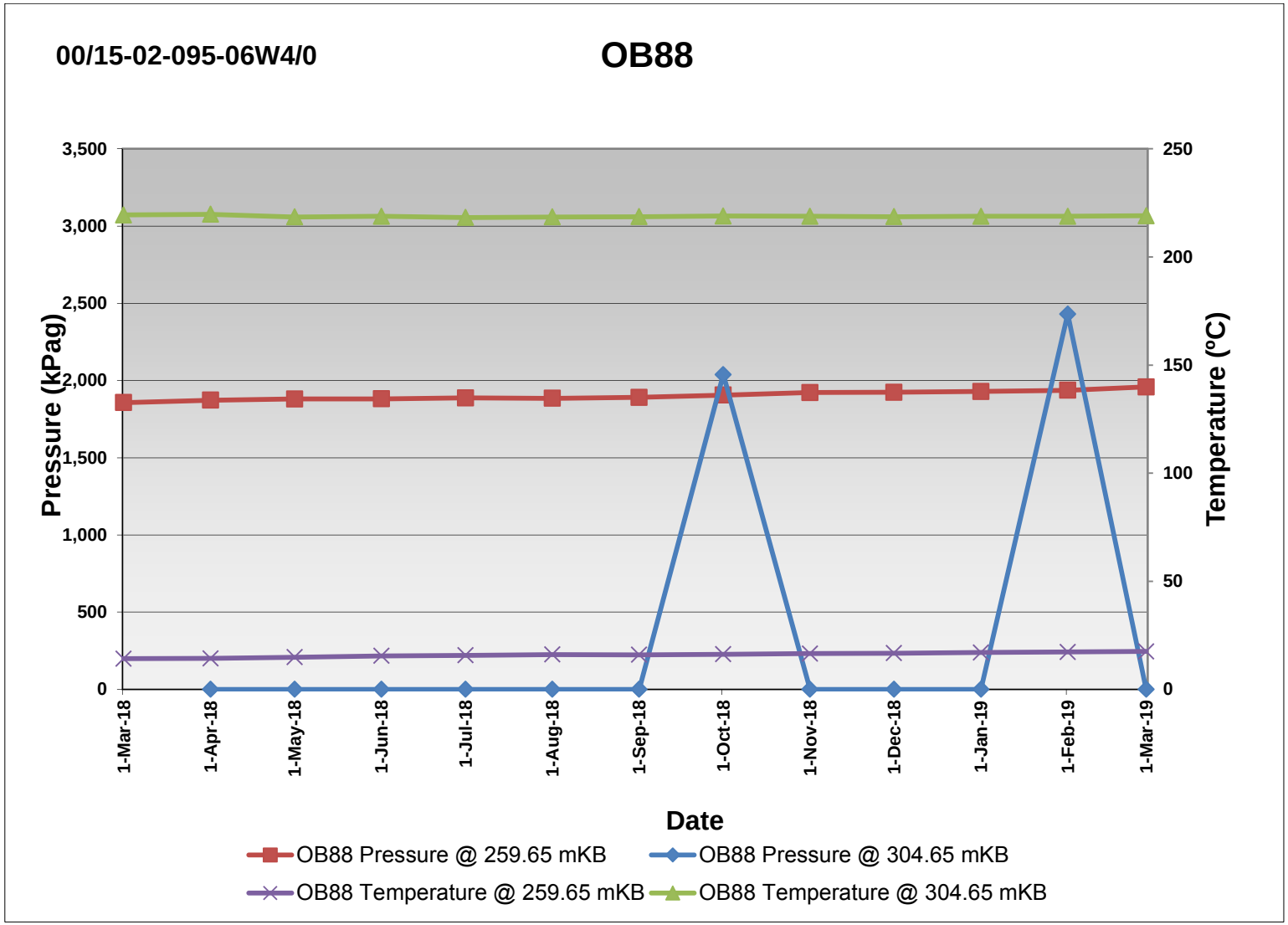

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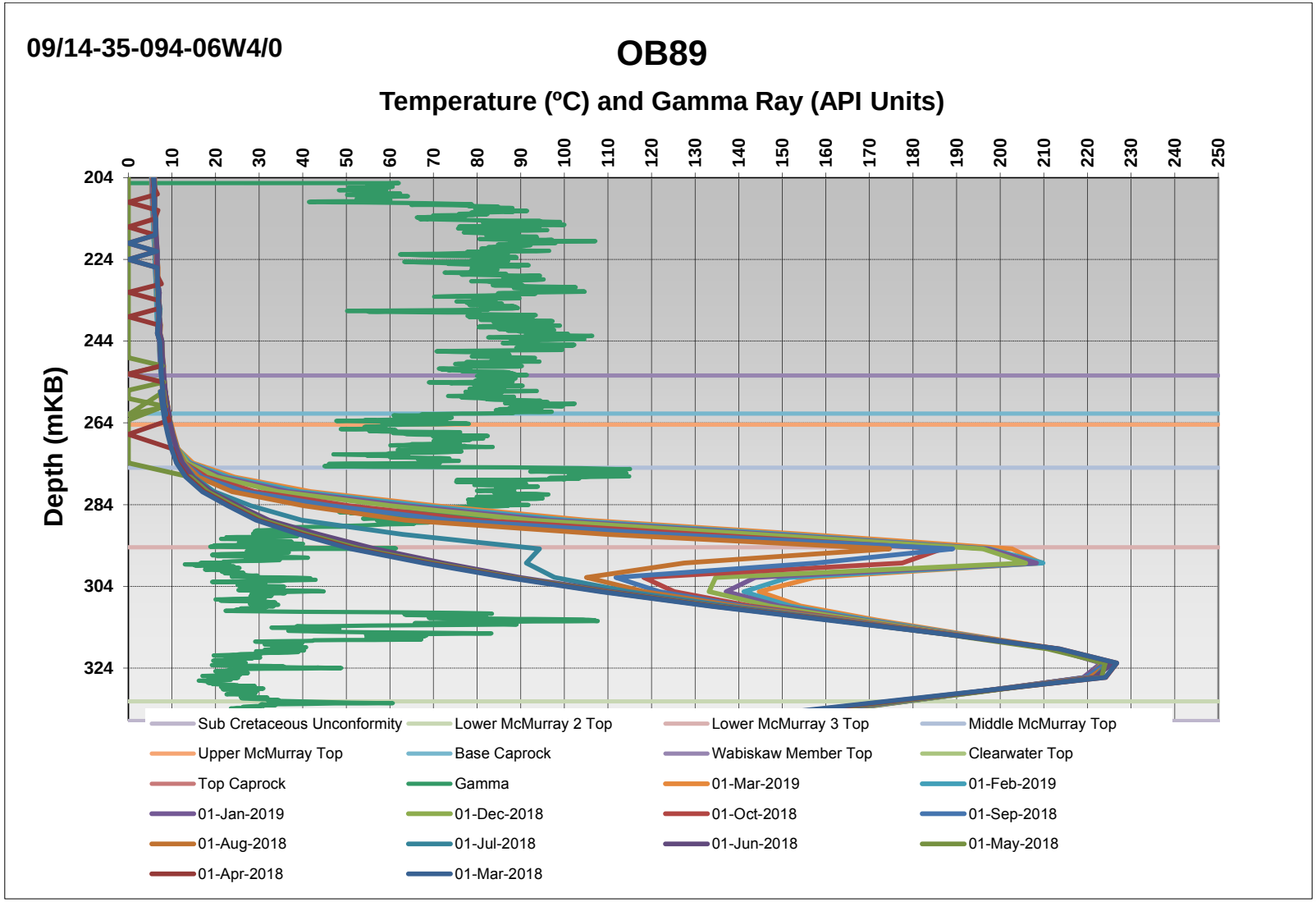

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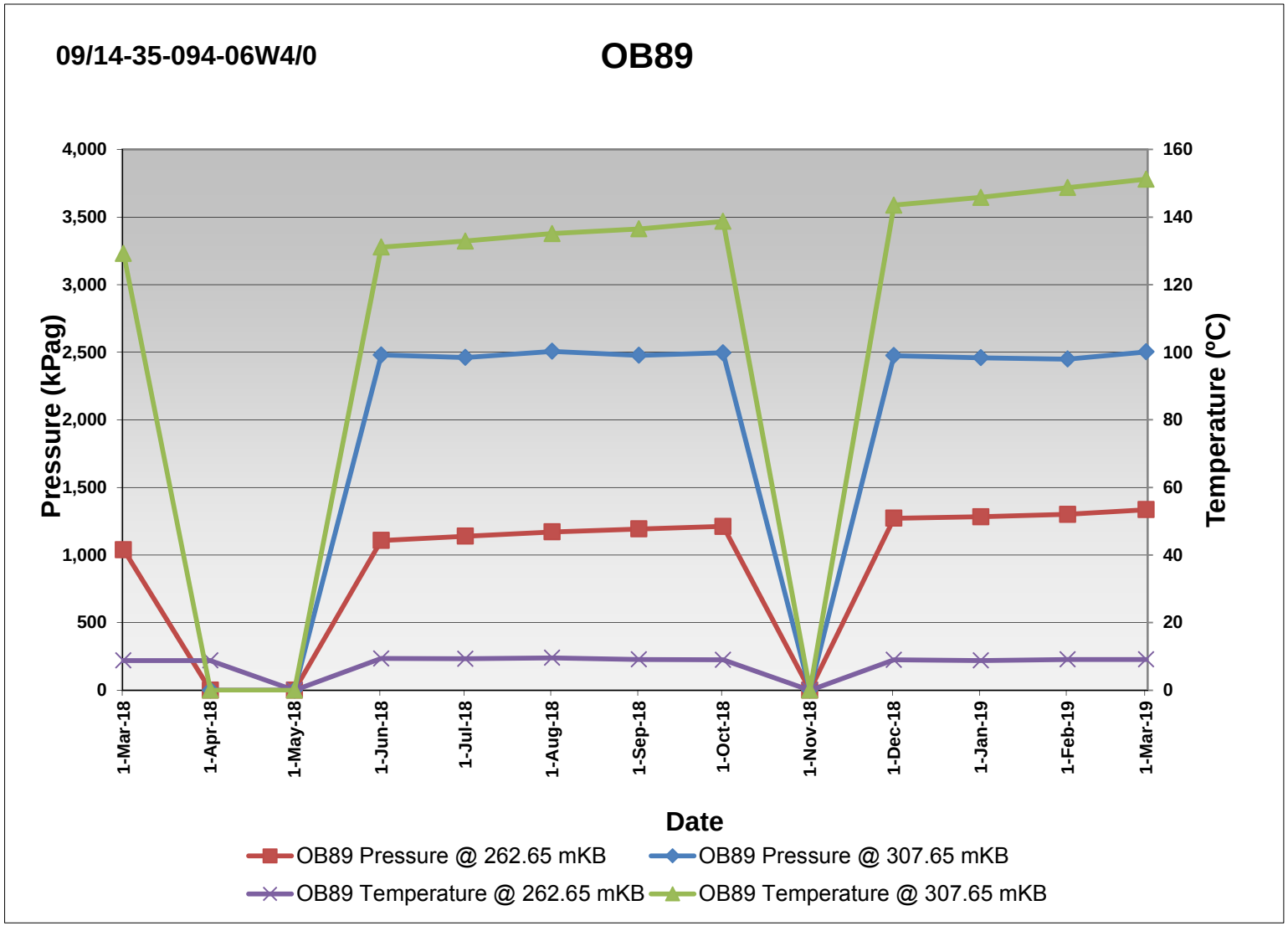

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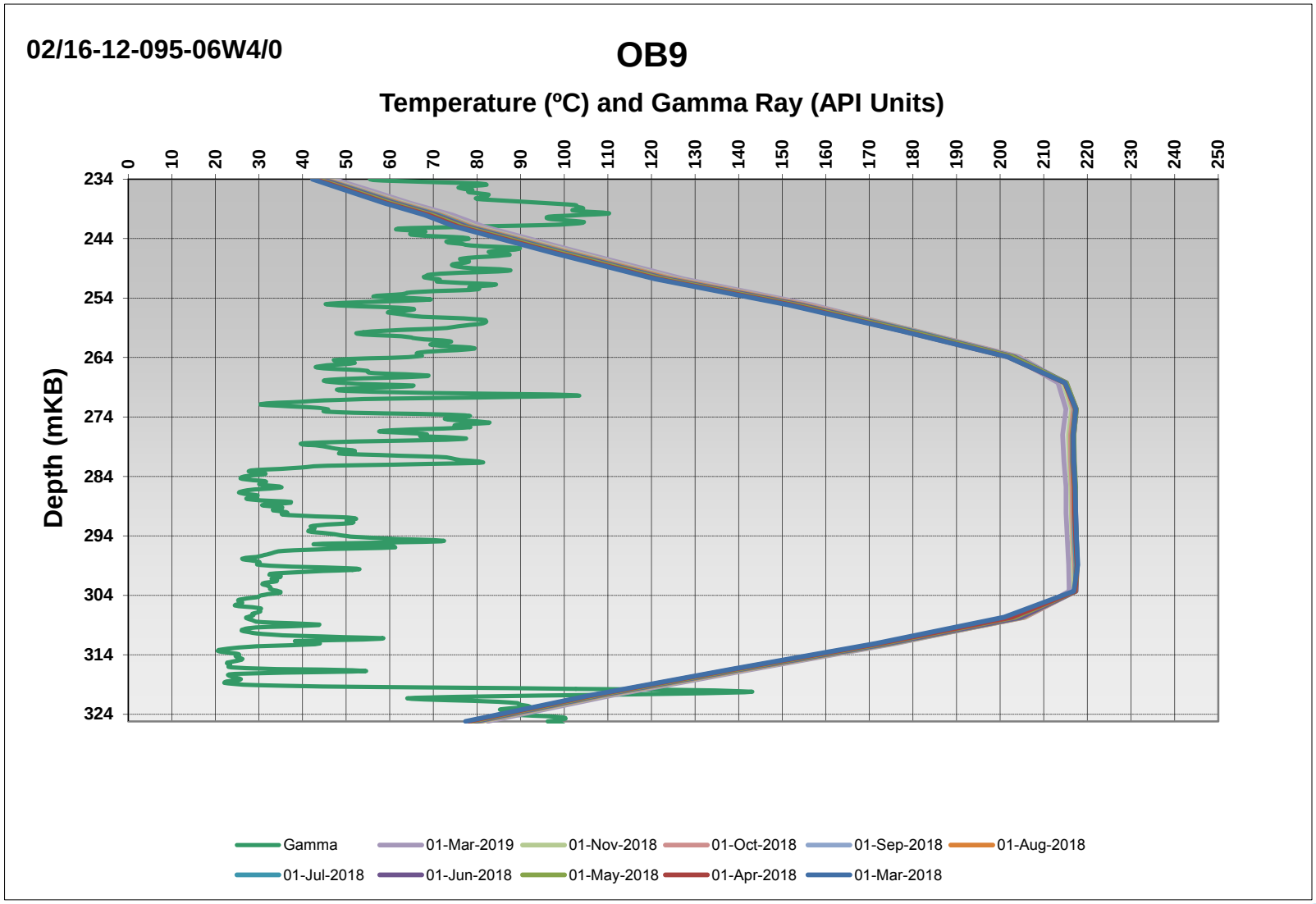
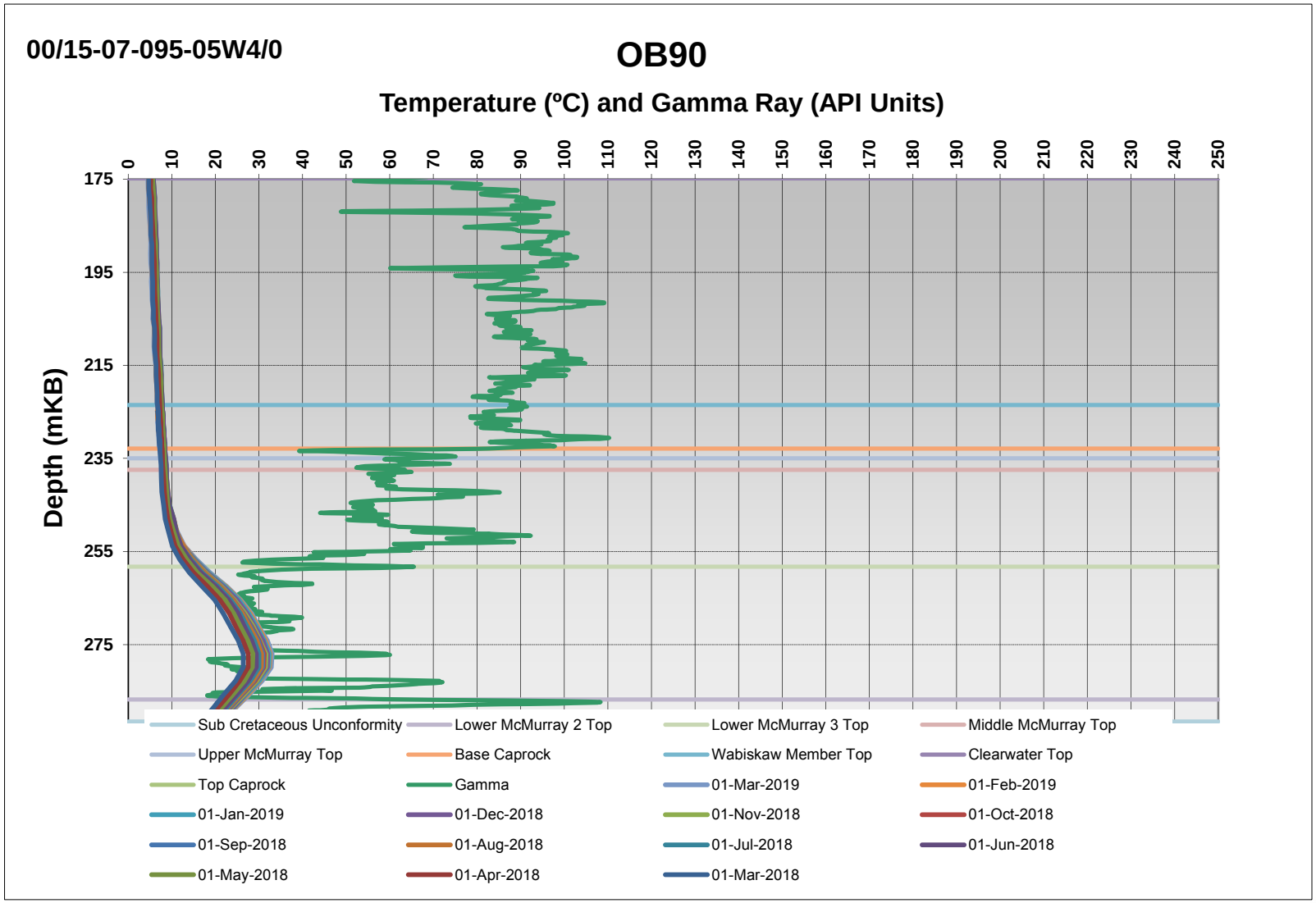
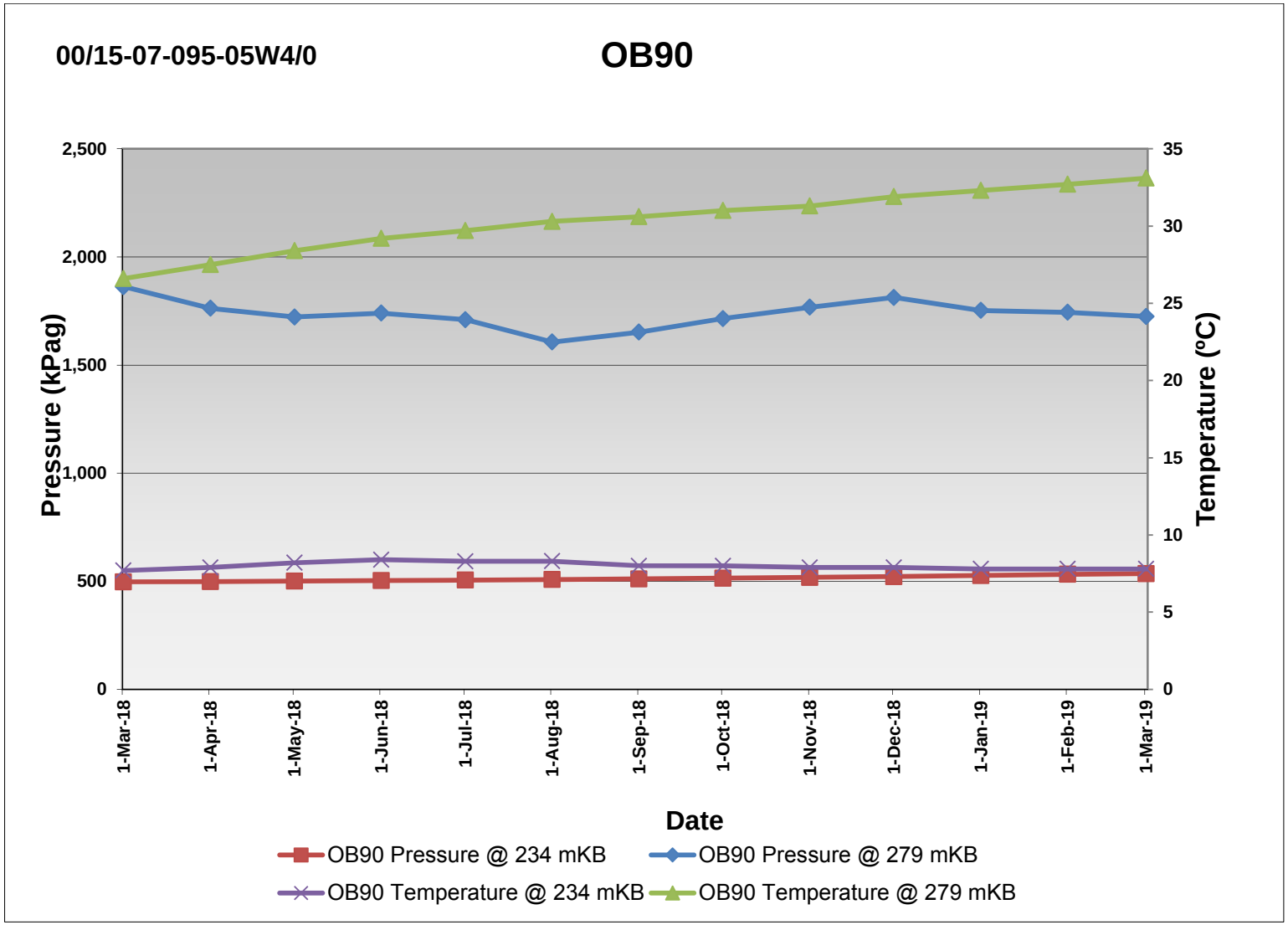


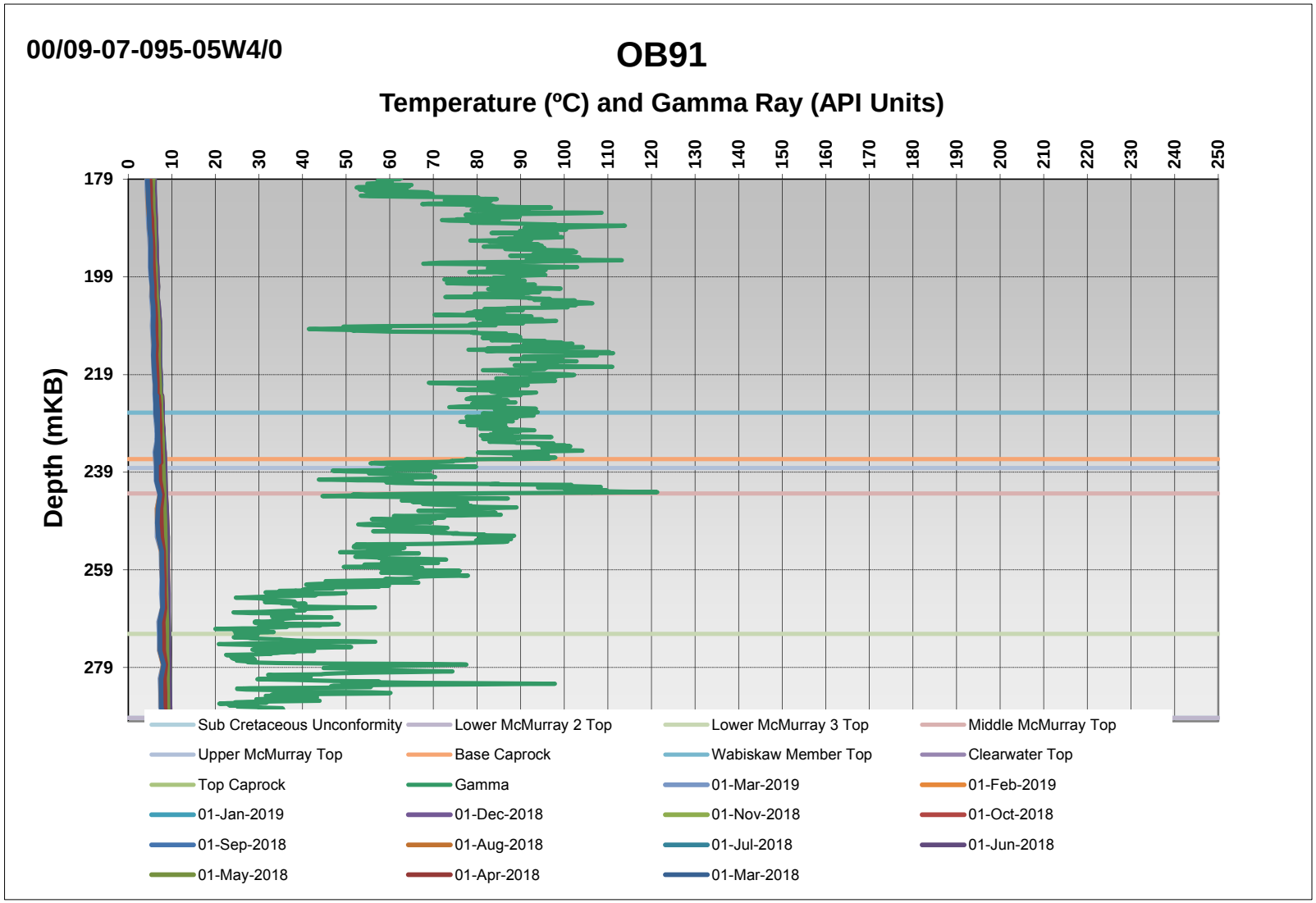
Piezometer Plots & Temperature vs Depth Plots



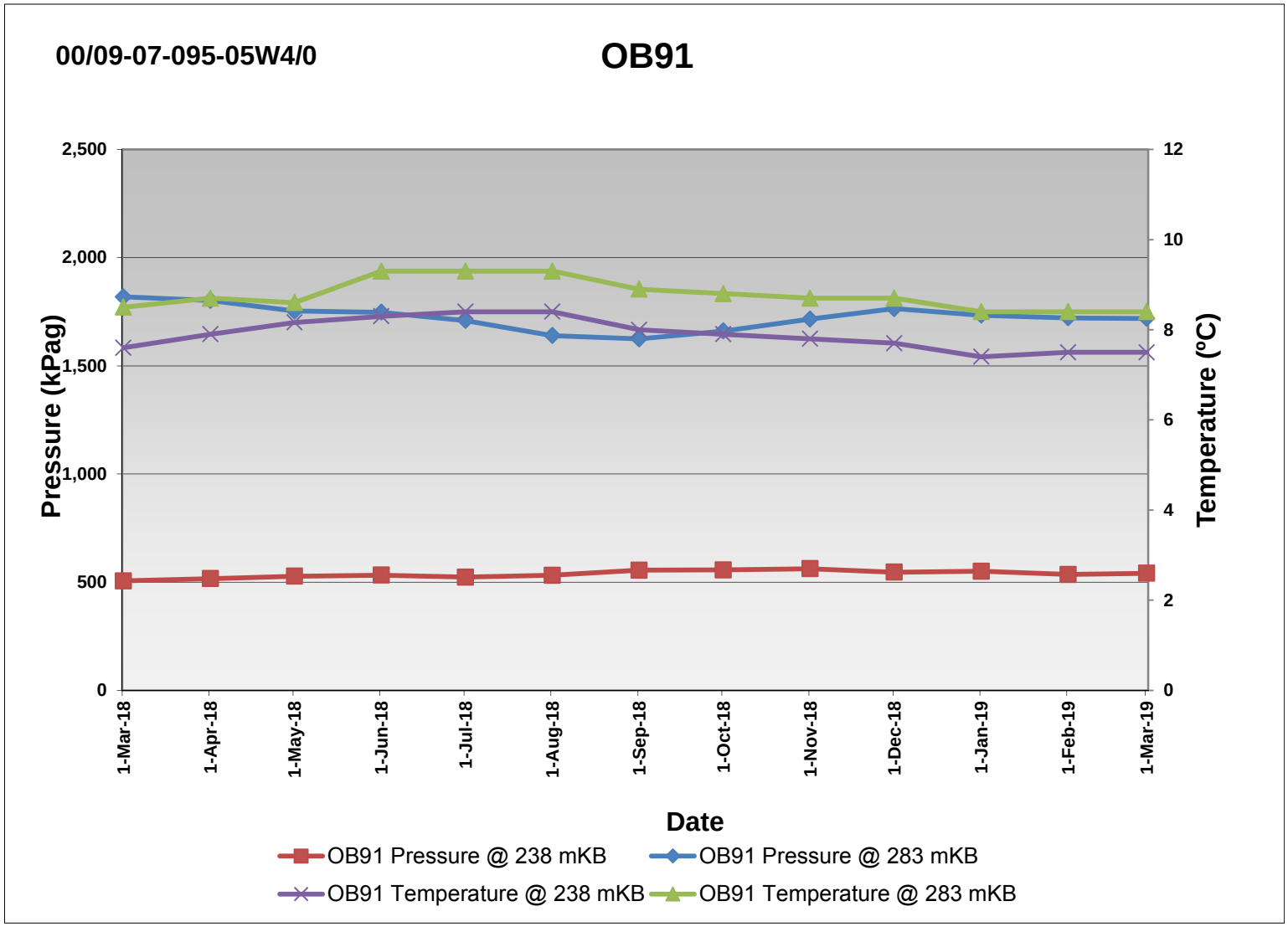
Piezometer Plots & Temperature vs Depth Plots



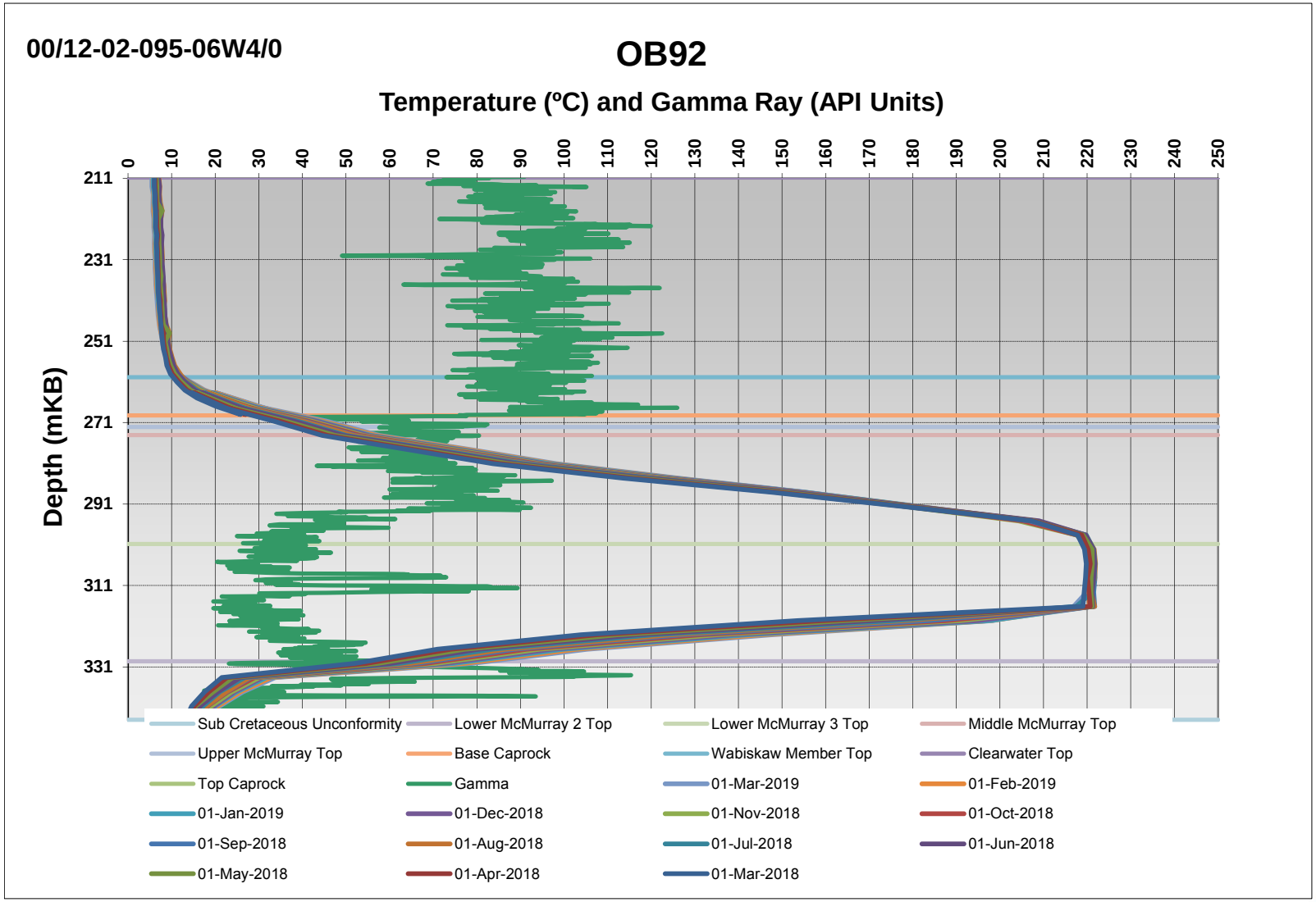
Piezometer Plots & Temperature vs Depth Plots



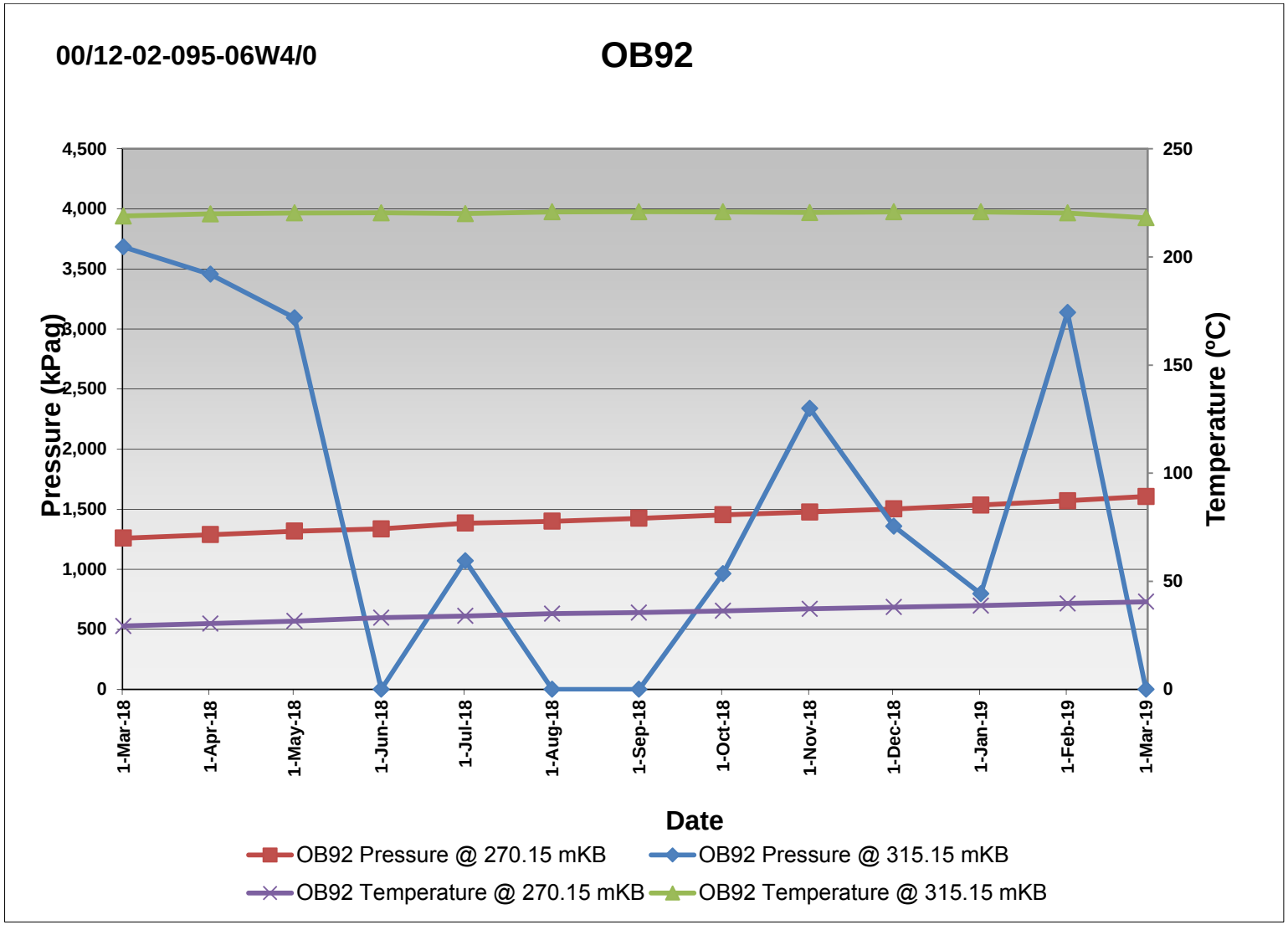
Piezometer Plots & Temperature vs Depth Plots



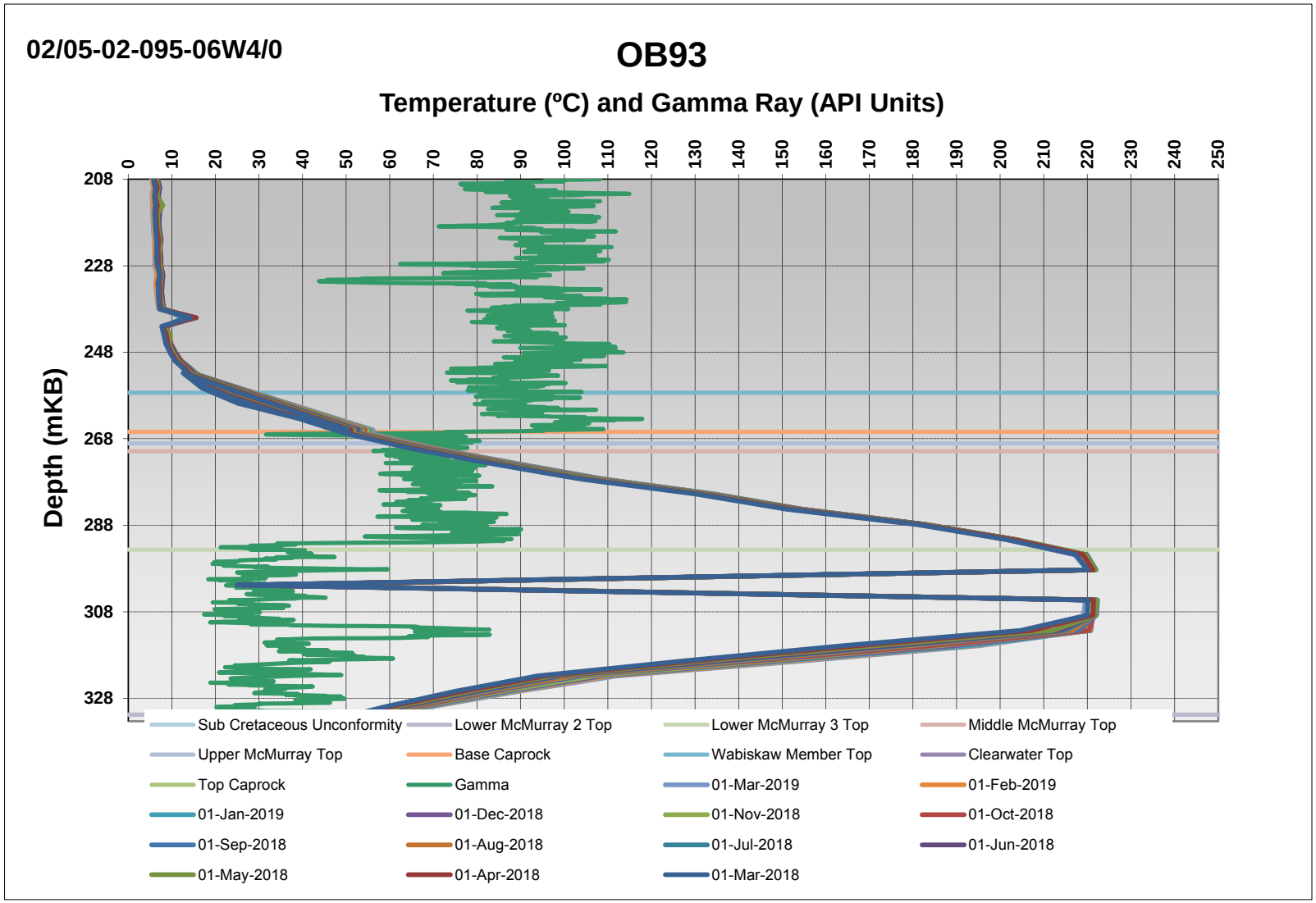
Piezometer Plots & Temperature vs Depth Plots



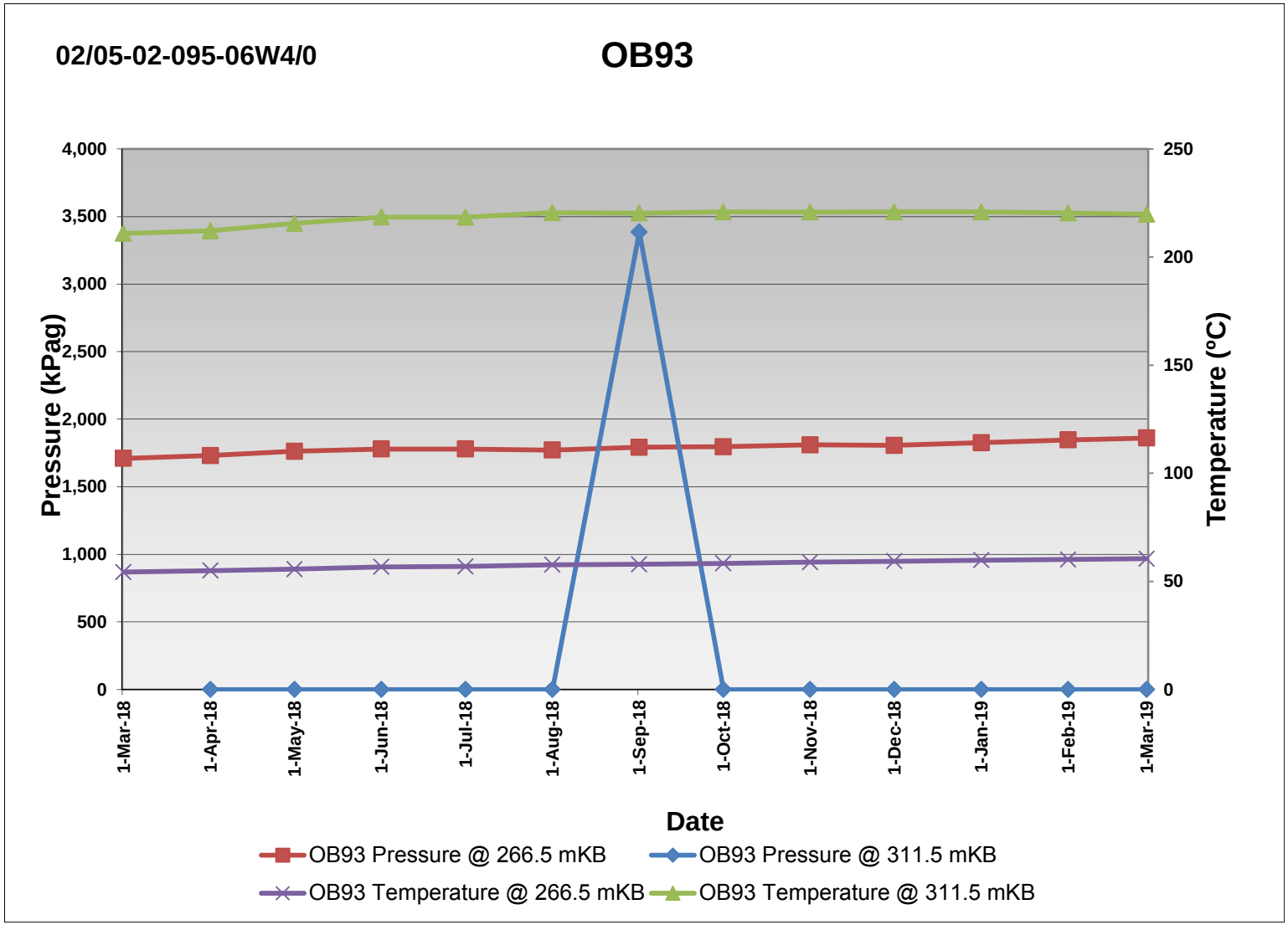
Piezometer Plots & Temperature vs Depth Plots



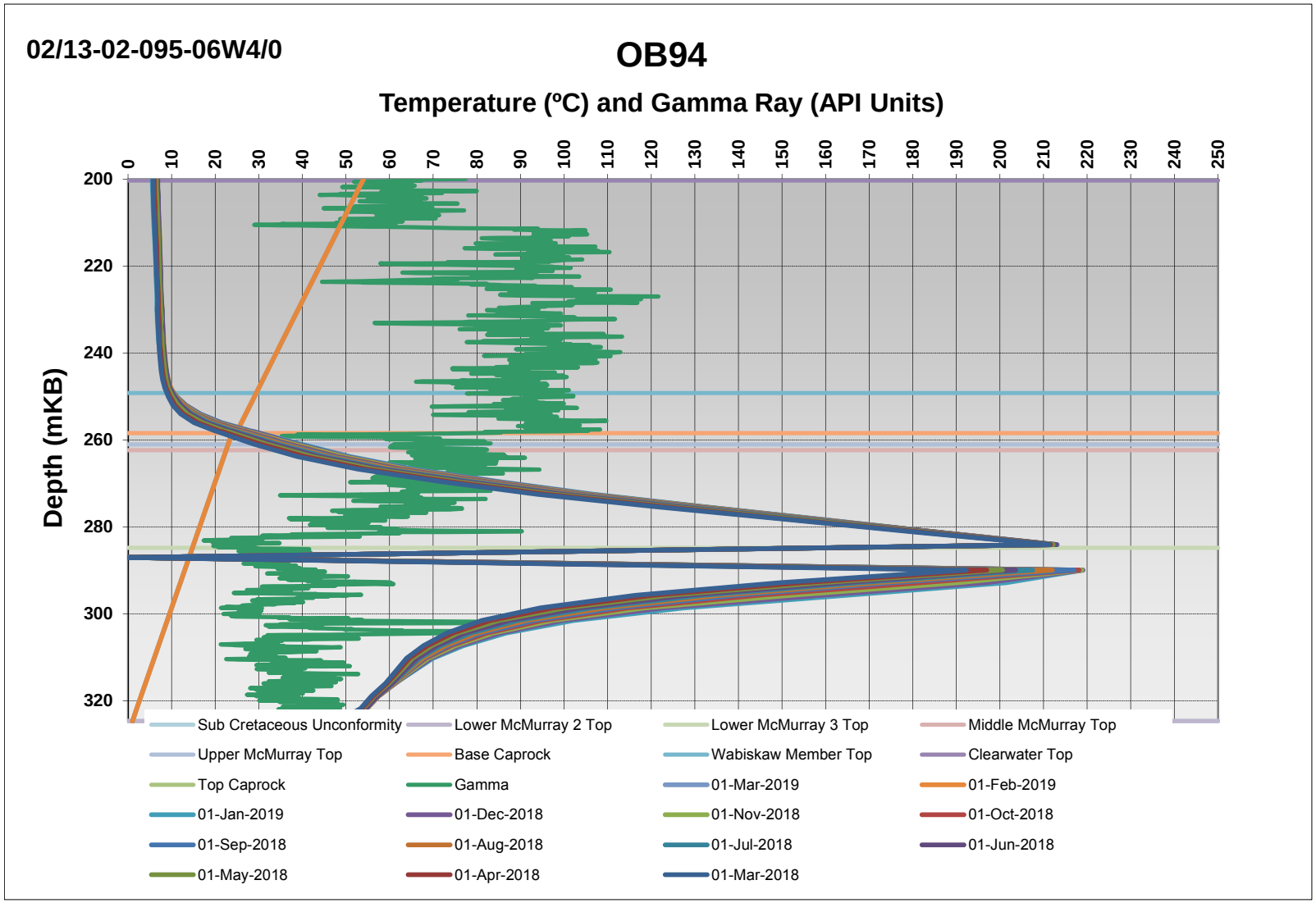
Piezometer Plots & Temperature vs Depth Plots



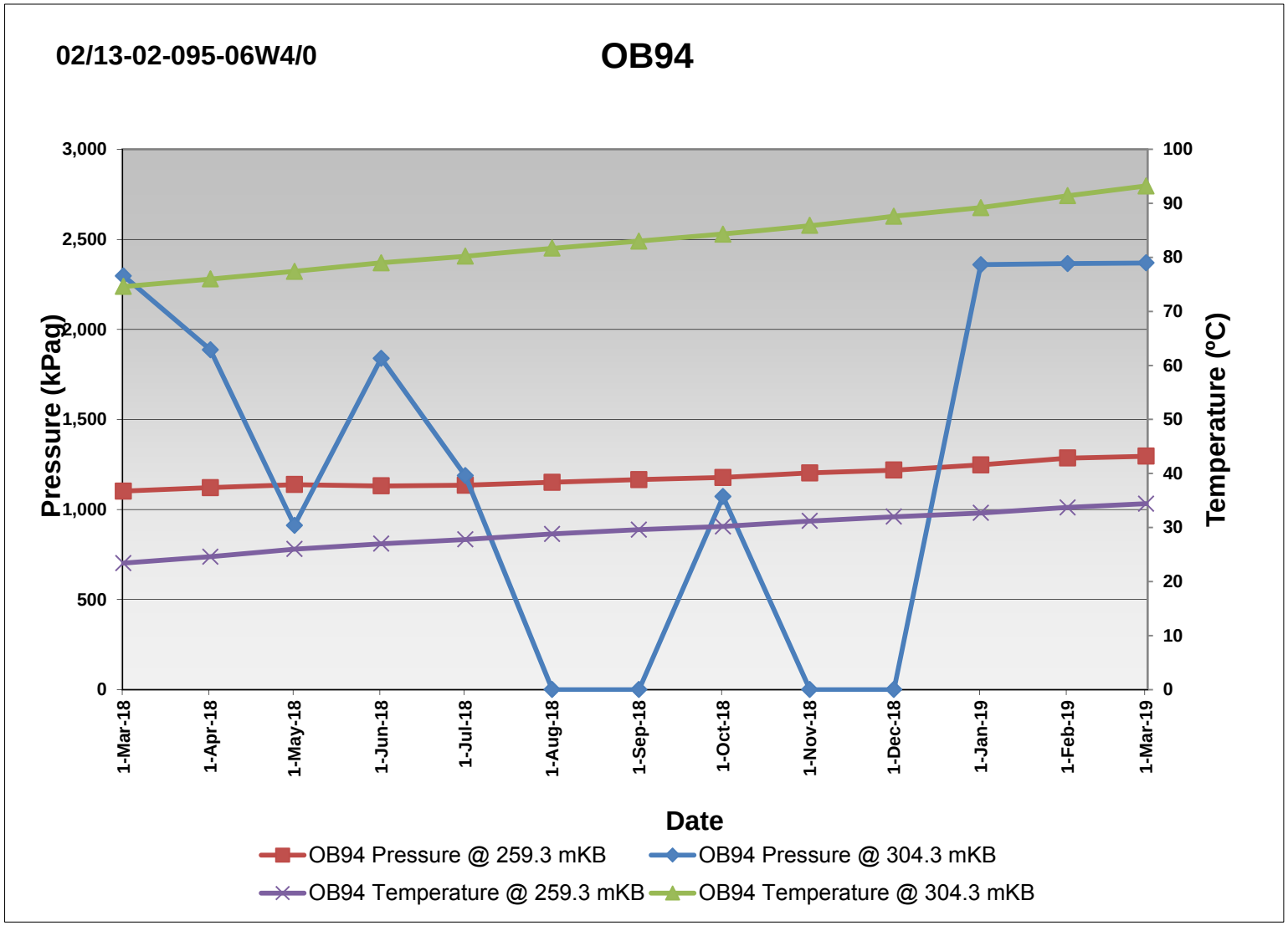
Piezometer Plots & Temperature vs Depth Plots



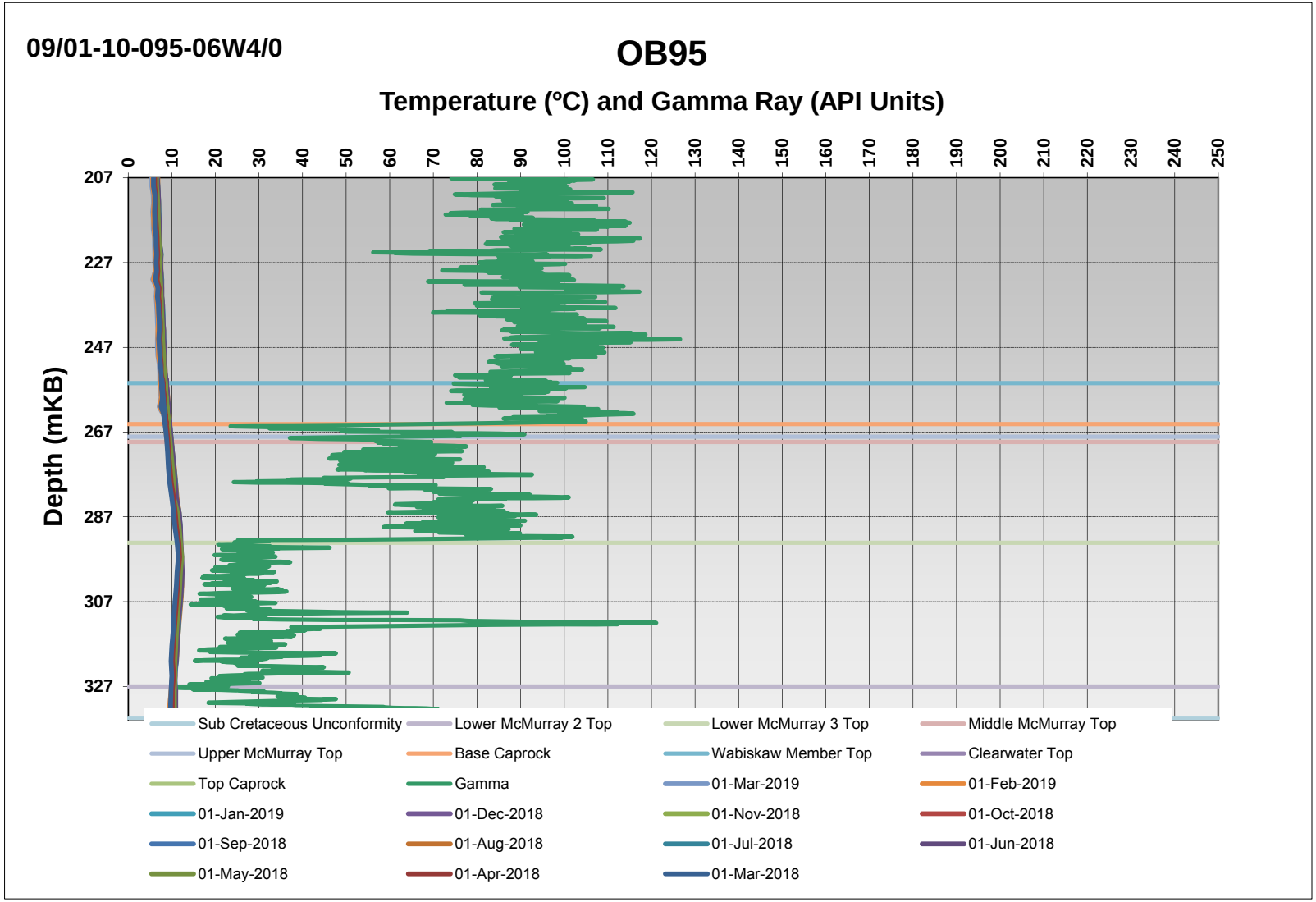
Piezometer Plots & Temperature vs Depth Plots



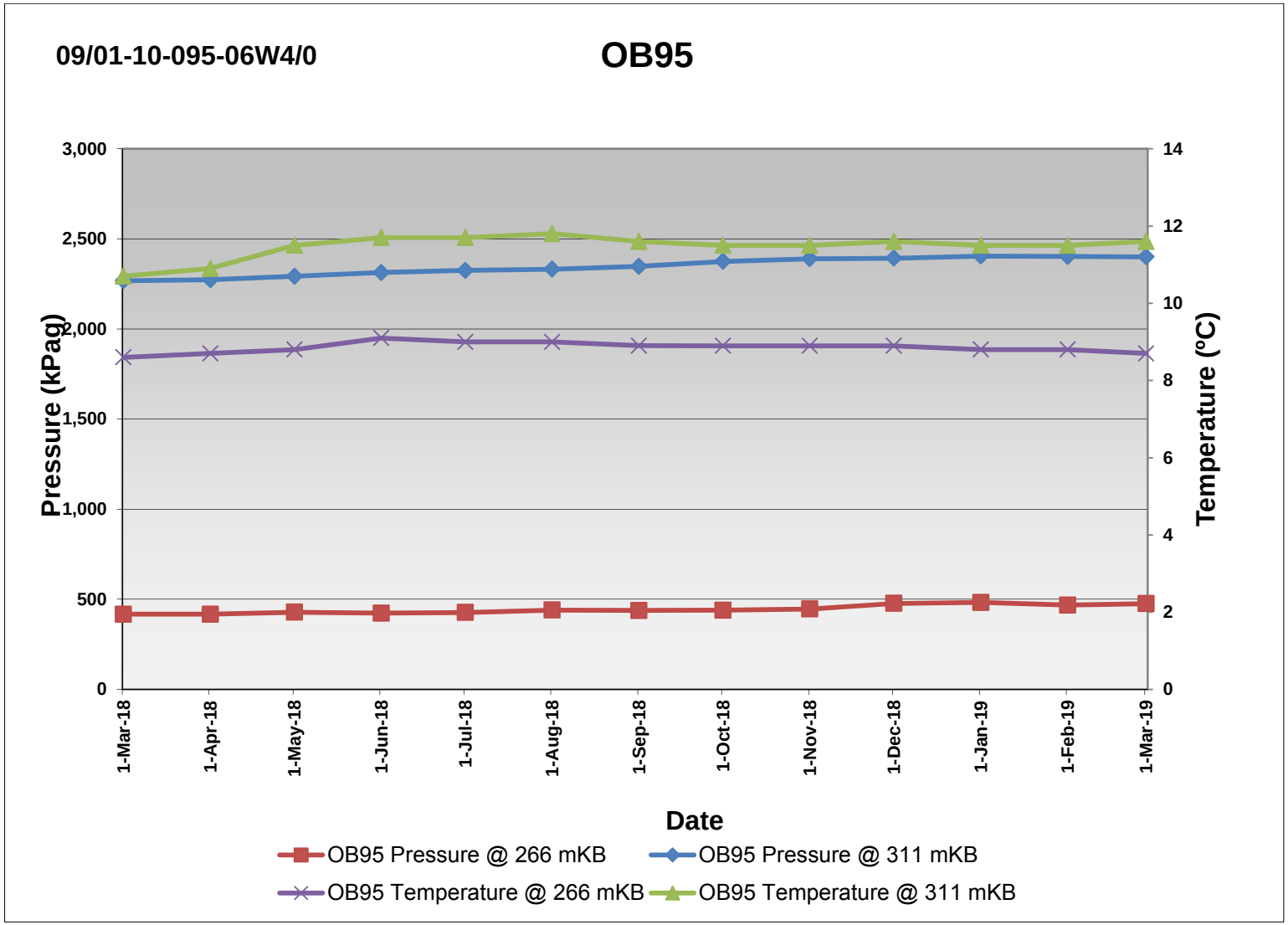
Piezometer Plots & Temperature vs Depth Plots



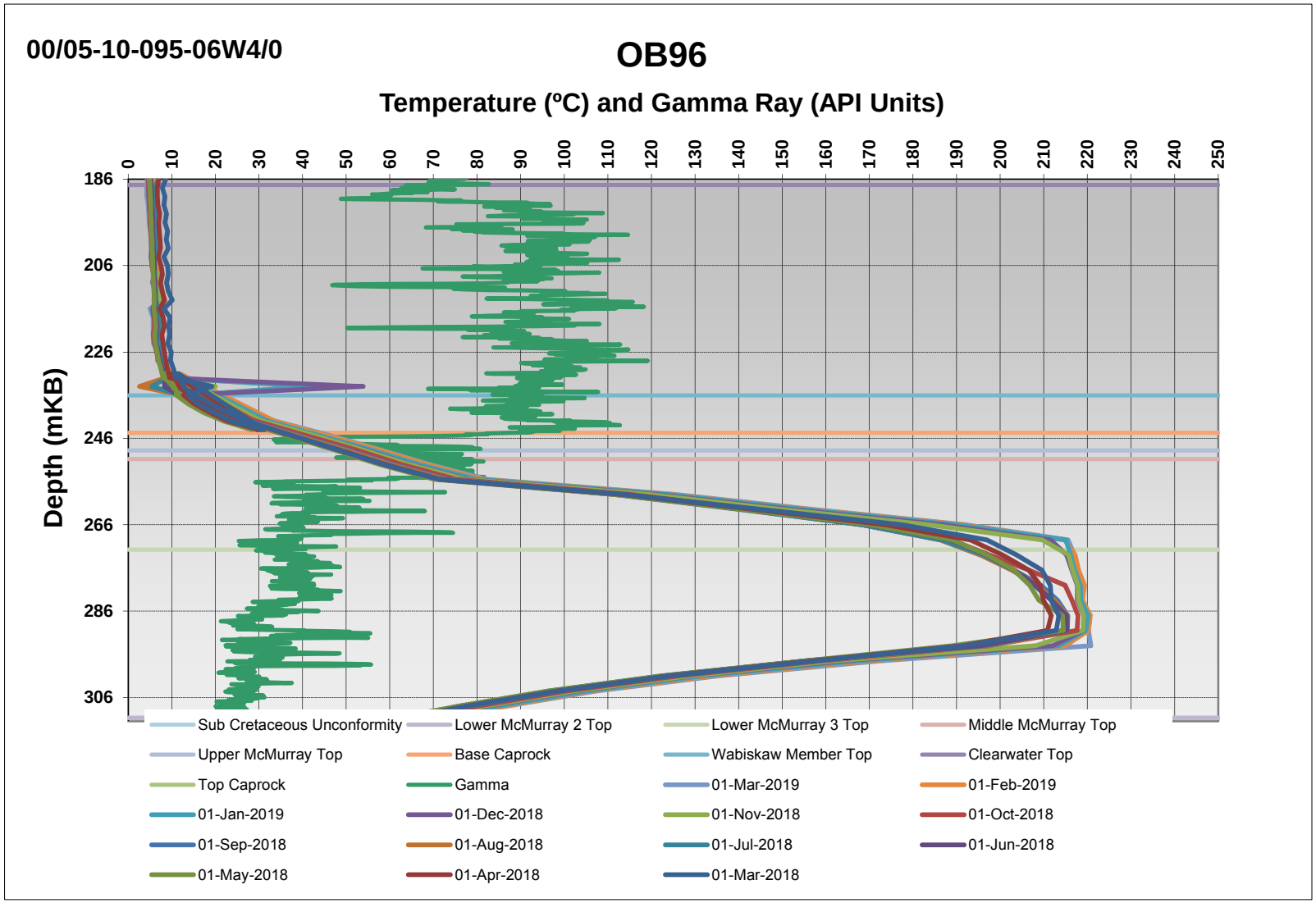
Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



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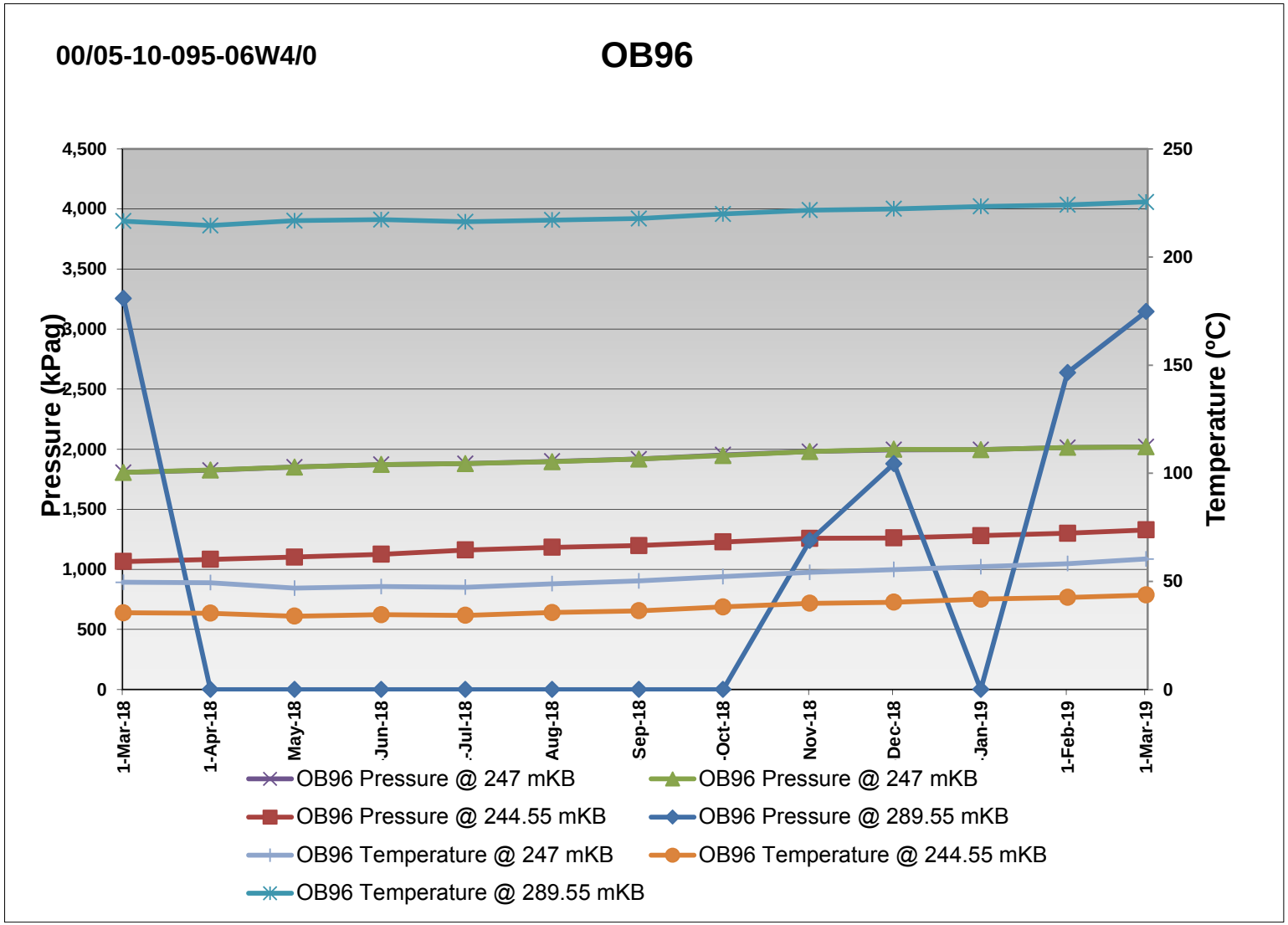

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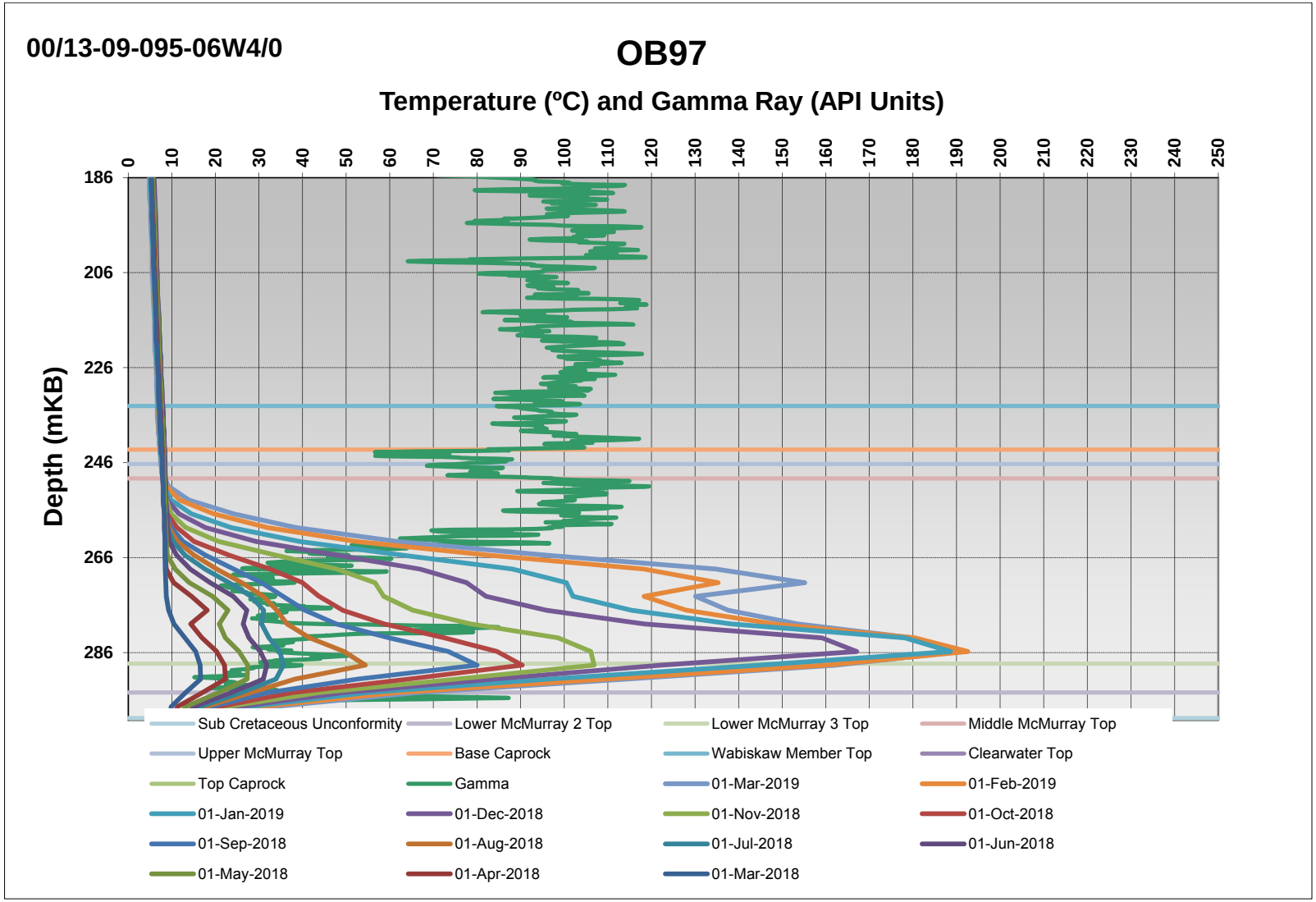

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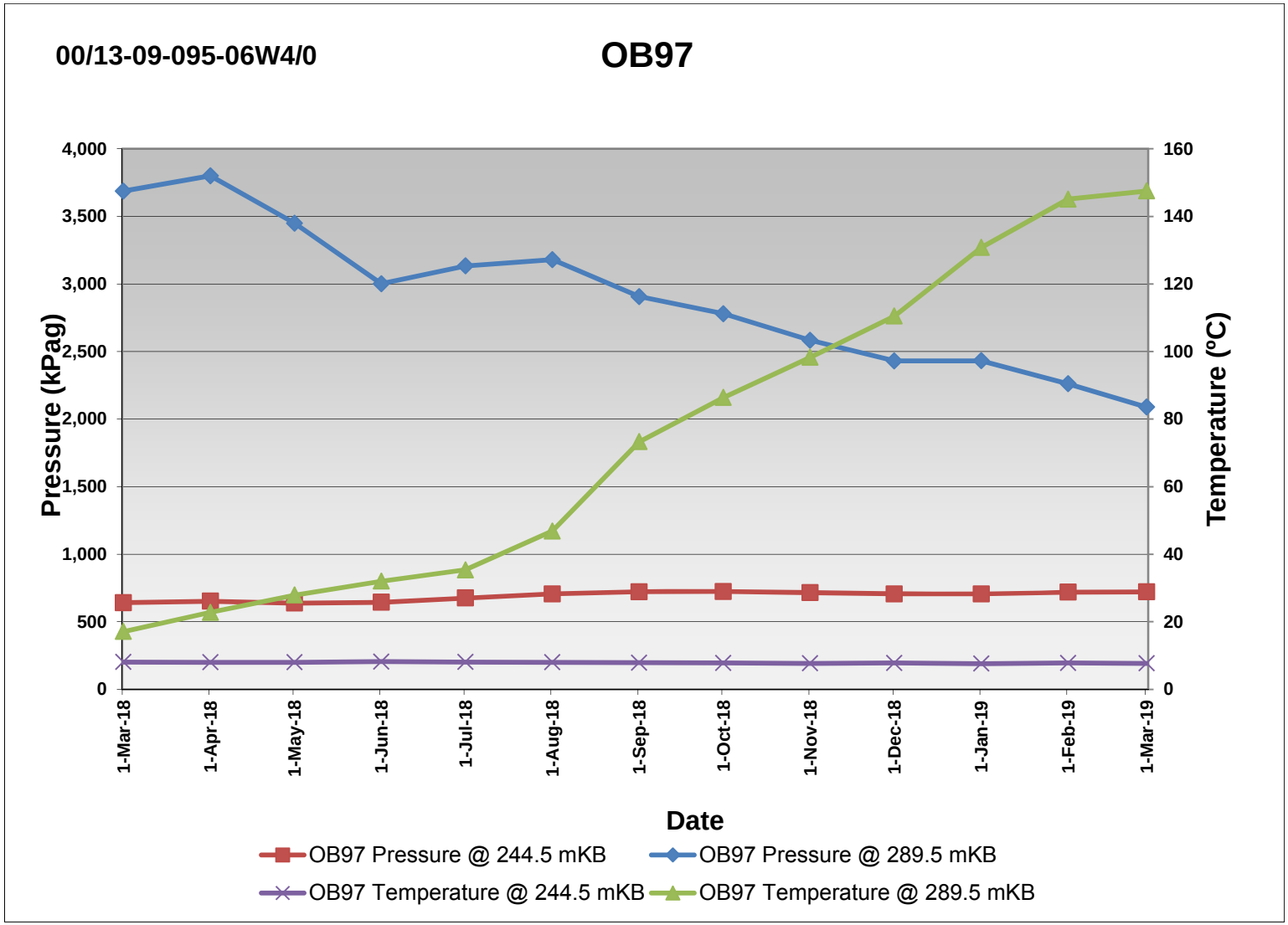

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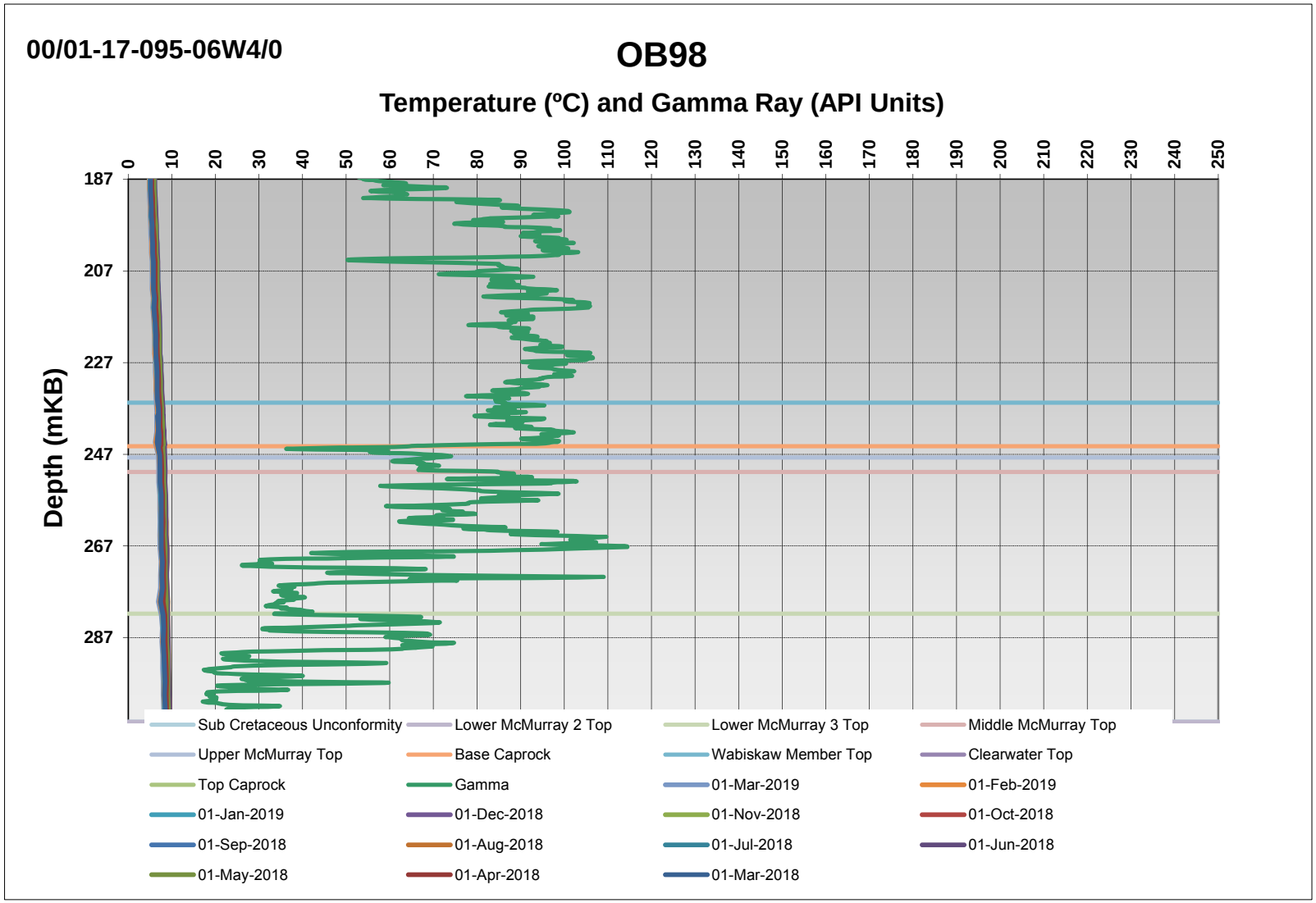
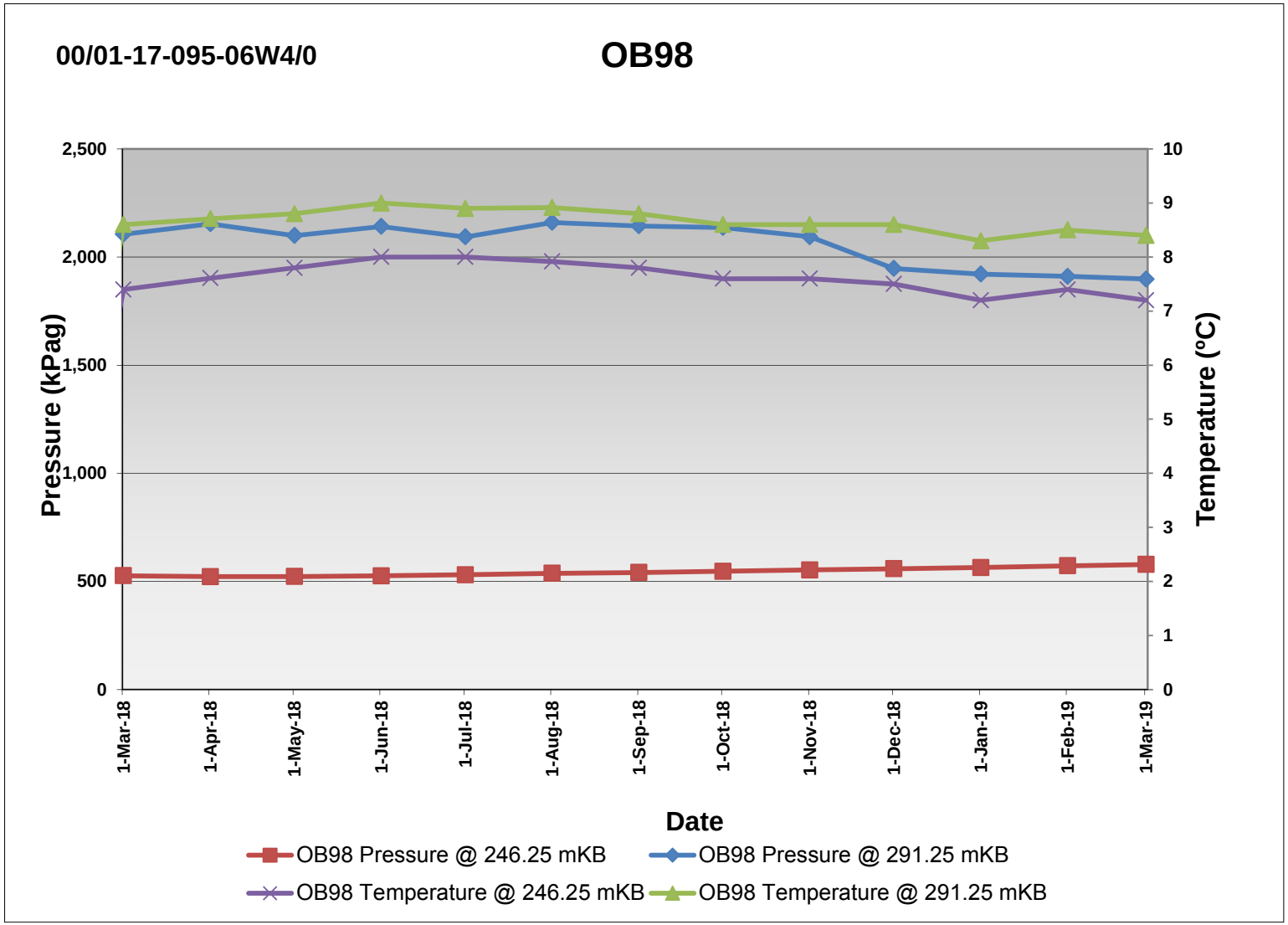
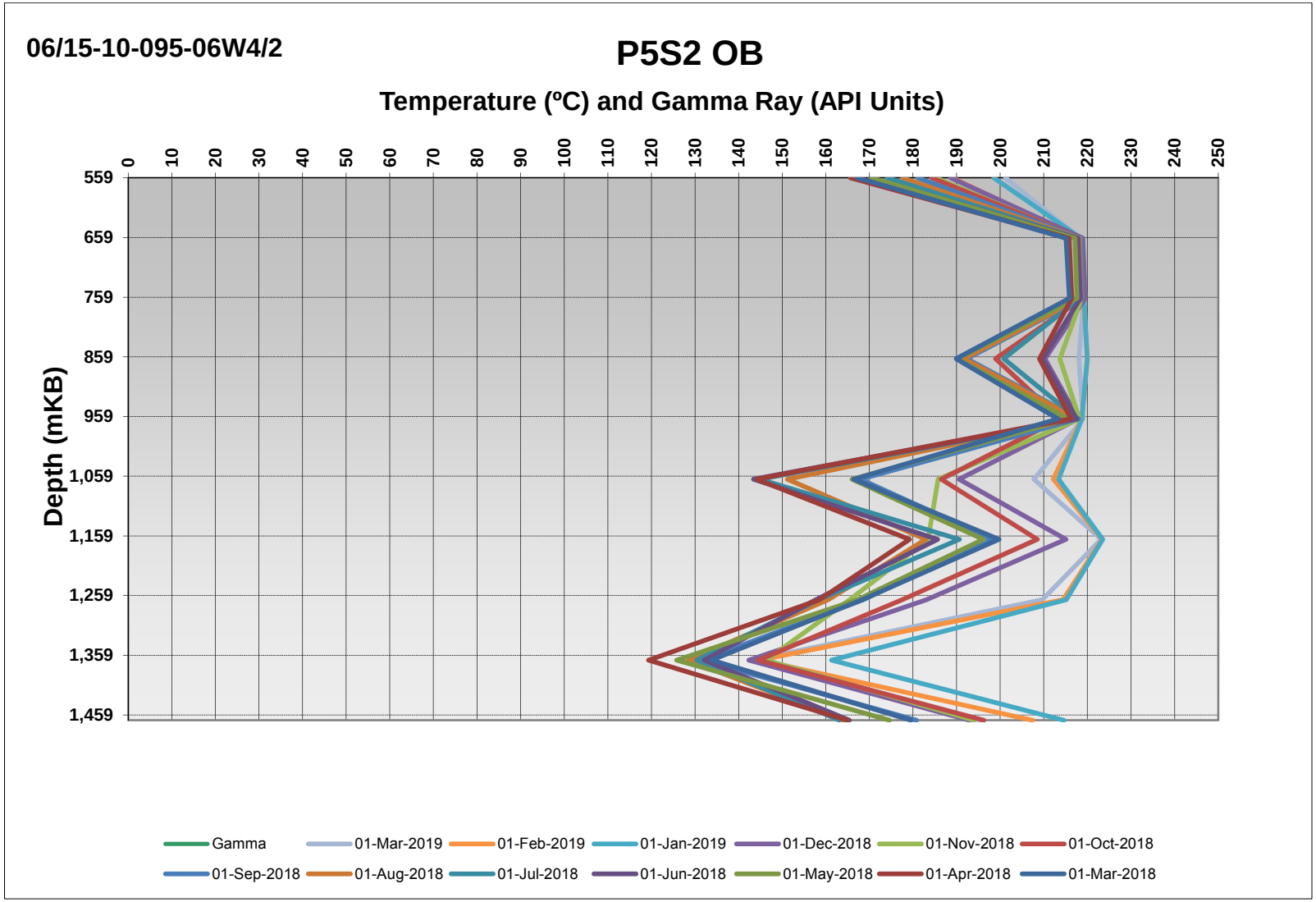


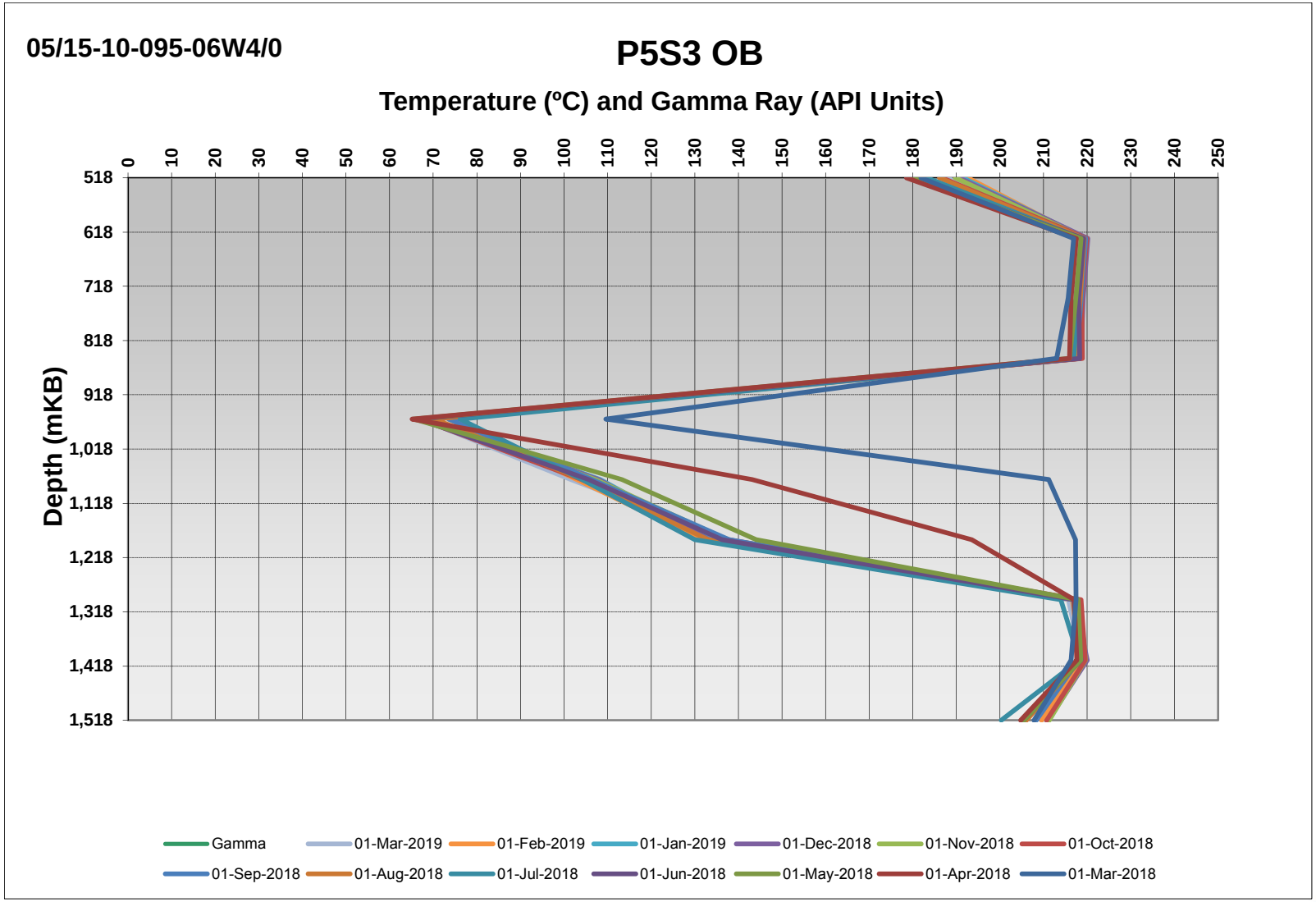
Piezometer Plots & Temperature vs Depth Plots



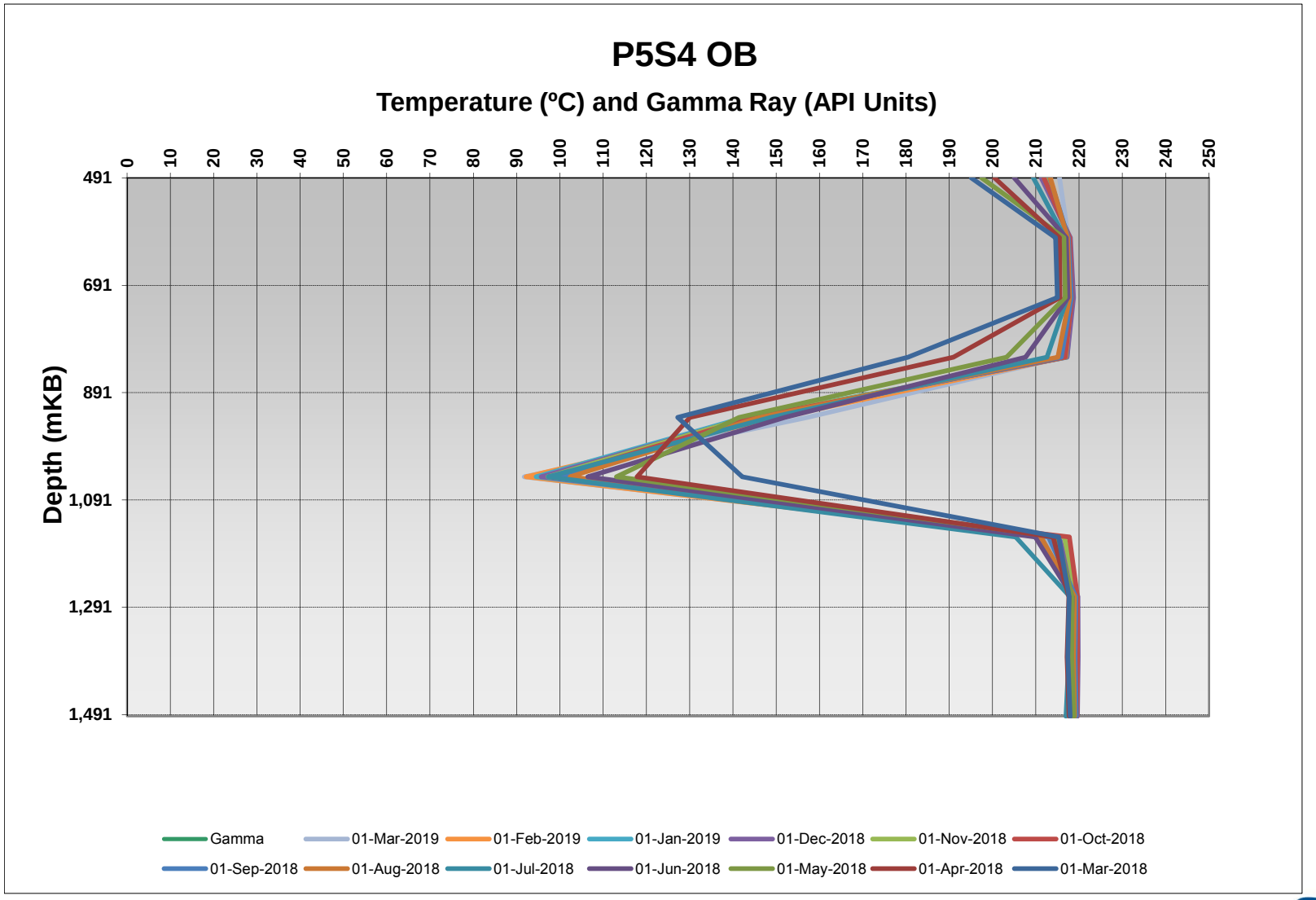
Piezometer Plots & Temperature vs Depth Plots



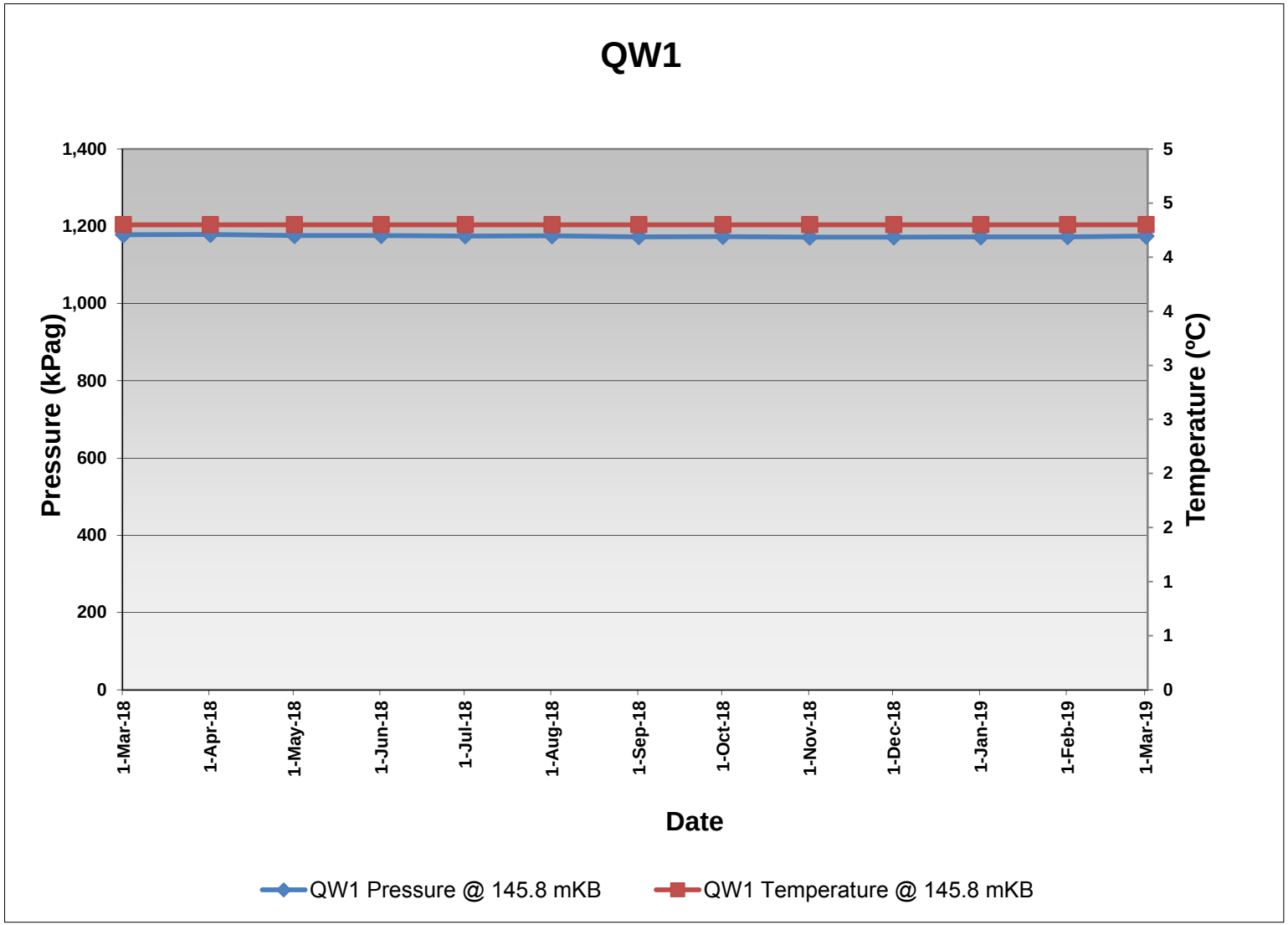
Piezometer Plots & Temperature vs Depth Plots



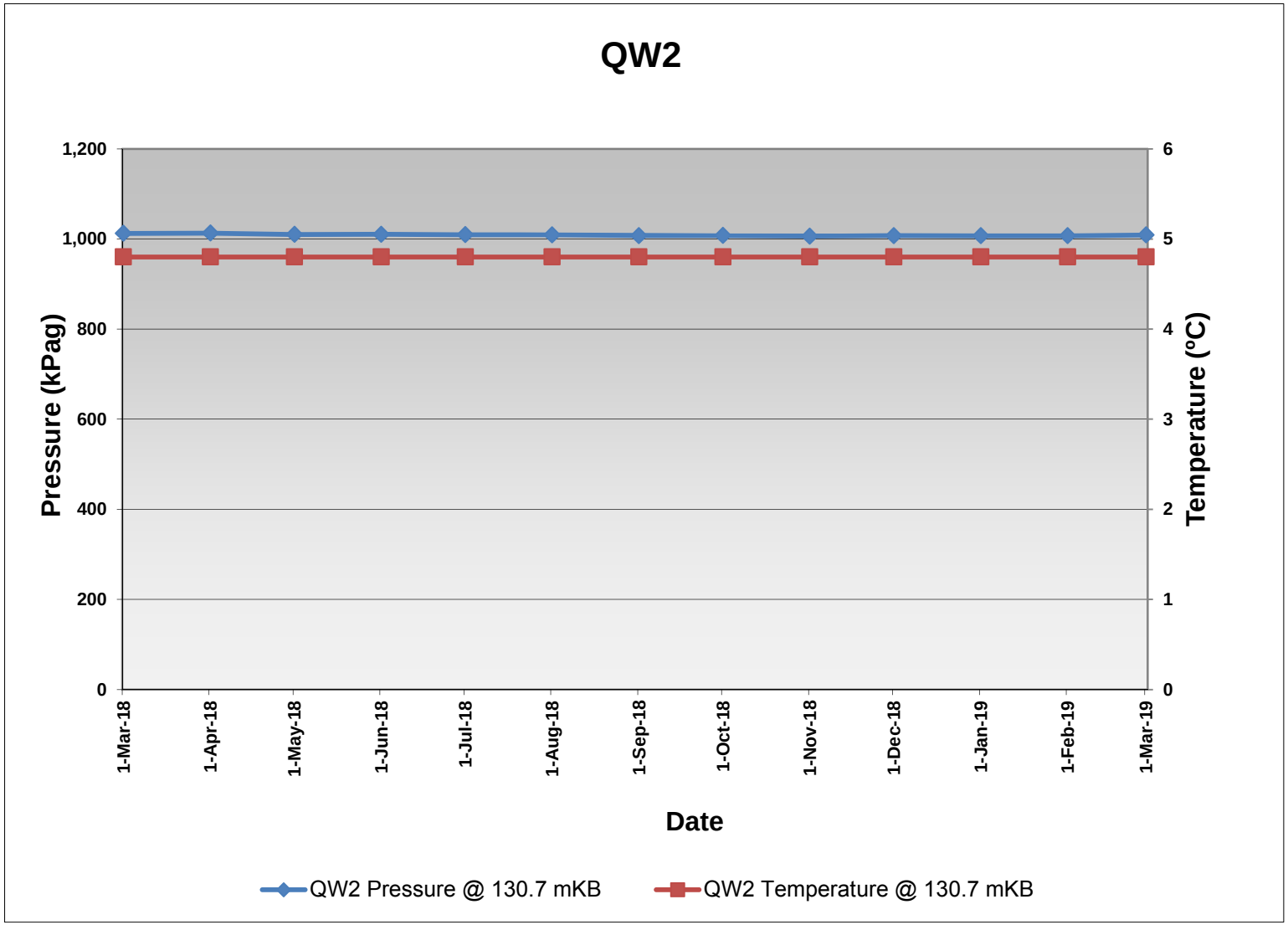
Piezometer Plots & Temperature vs Depth Plots



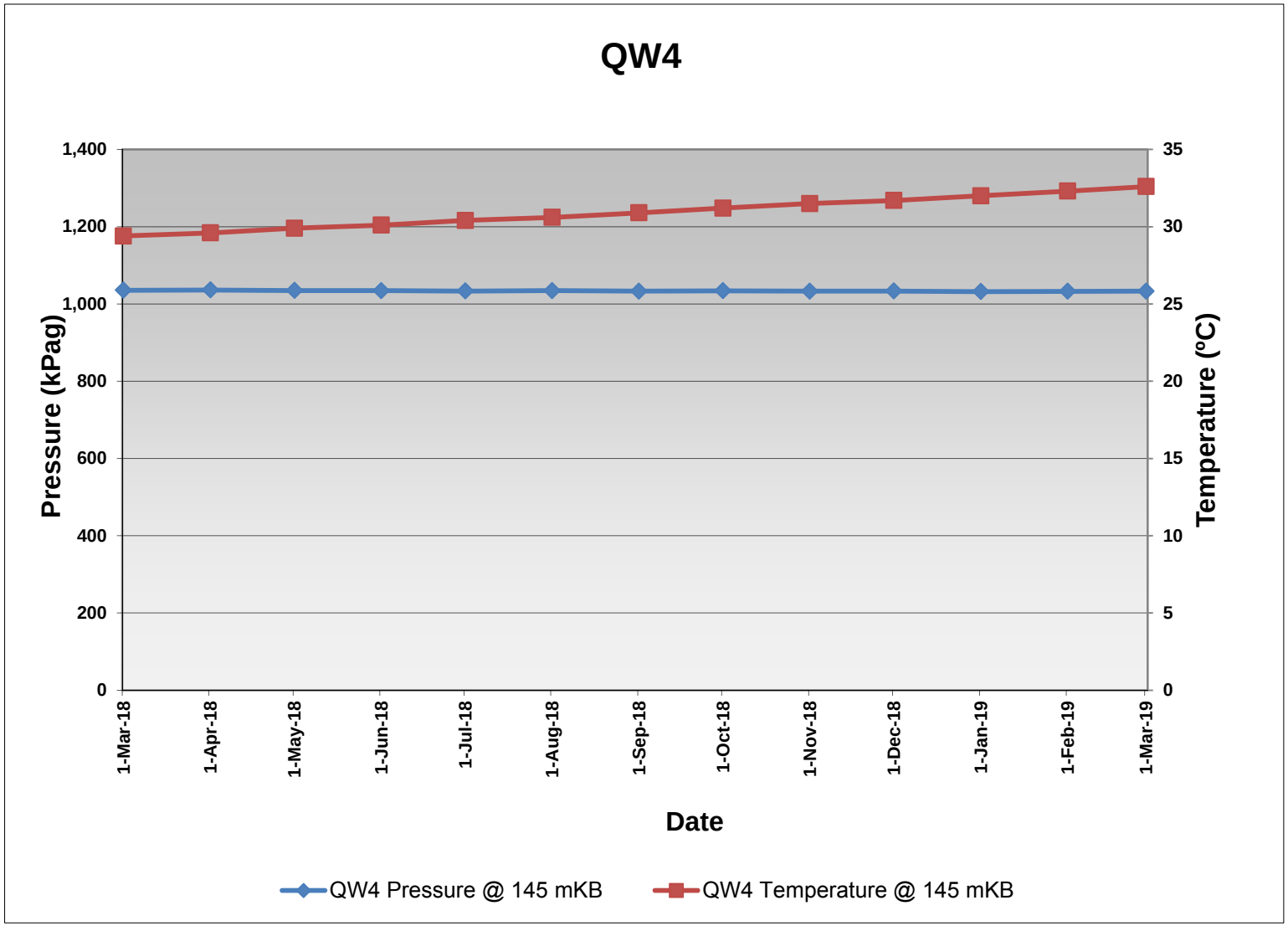
Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots

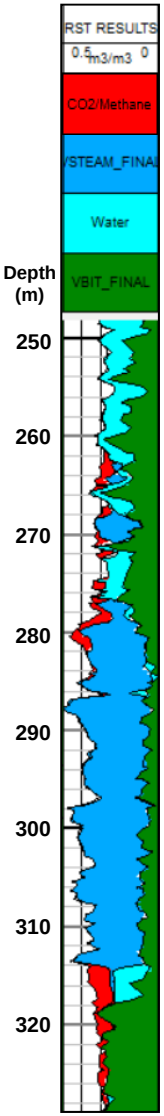


Piezometer Plots & Temperature vs Depth Plots

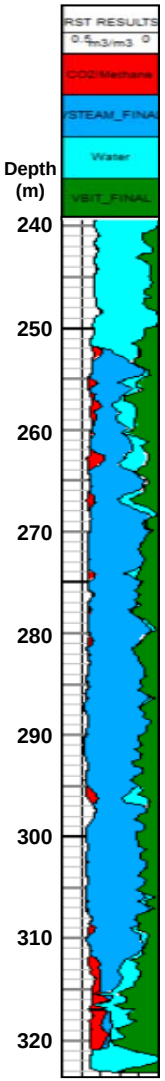


RST Logs

OB 153
03/08-01-095-06W4/0
January 2018



OB 154
09/14-36-094-06W4/0
January 2018



OB 218
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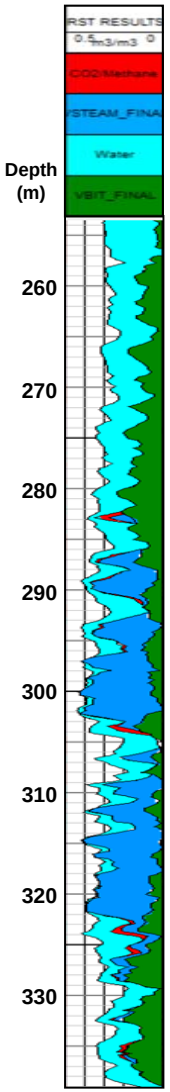
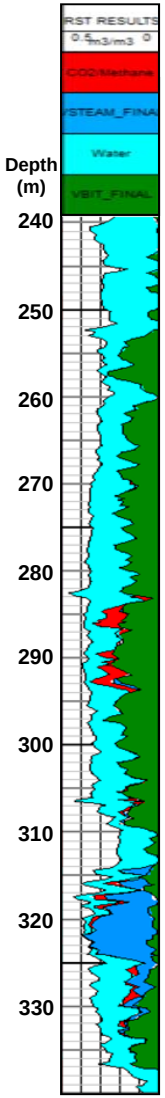
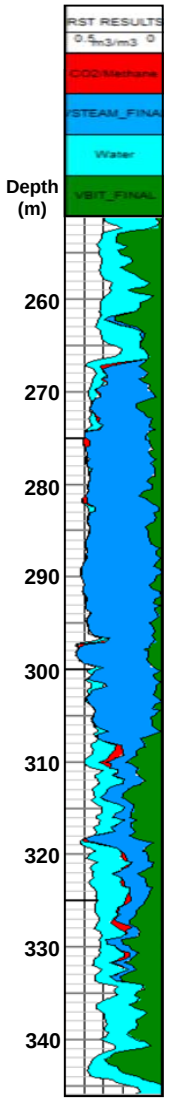
March 2017



OB 219
00/02-12-095-06W4/0
March 2017



OB 220
09/06-12-095-06W4/0
March 2017