Suncor Firebag
2016 AER Performance Presentation
Commercial Scheme Approval No. 8870

June 27, 2016
Reporting Period: March 1, 2015 to February 29, 2016

Section 3.1.1 – Subsurface Issues Related to Resource Evaluation and Recovery

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- **Safety Moment – Daniela Montanez**
- Introduction – Doug Castellino
- Geoscience – Christina Enns
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- Drilling and Completions – Jeremy D'Mello
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- Scheme Performance – Kathy Cheung
- Future Plans – Daniela Montanez

Safety Moment – Operational Excellence Management System (OEMS)

- At Suncor, one of our values is **safety above all else:** do it safely, or don't do it.
- Our Operational Excellence Management System (OEMS) enables environmental, health and safety excellence.
- OEMS is a framework designed to eliminate the causes of unplanned events and incidents that result in poor execution and performance.
- OEMS includes consistent systems, processes and procedures to:
  - Manage risk
  - Operate safely and reliably
  - Mitigate environmental impacts
  - Develop and share best practices
  - Support continuous improvement.

Safety Moment – Operational Excellence Management System (OEMS)

- Our OEMS is organized into 18 elements, providing the minimum requirements, or controls, that we need to meet in all parts of Suncor.
- OEMS includes process safety standards to address hazardous risks and maintain safe, clean and reliable operations.
- Each element is found in the Plan-Do-Check-Act cycle to ensure the focus is on reducing risk and creating value.

- **Risk Assessments**
- **Process Hazard Analysis**

- **Management Review**

- **Training**
- **Operating Procedures**
- **Technical Procedures**
- **Best Practices**
- **Safe Work Practices**
- **Emergency Response Plans**

- **Incident Management**
- **Corrective Actions**

Safety Moment – Operational Excellence Management System (OEMS)

- By implementing and continuously improving our OEMS, we can reduce risk, enhance safety, reliability, and environmental sustainability, and achieve industry leading performance.

- A robust OEMS together with Operational Discipline – doing the right thing, the right way, every time – will help us achieve **Operational Excellence.**

OEMS x Operational discipline = Operational excellence

OPERATIONAL EXCELLENCE

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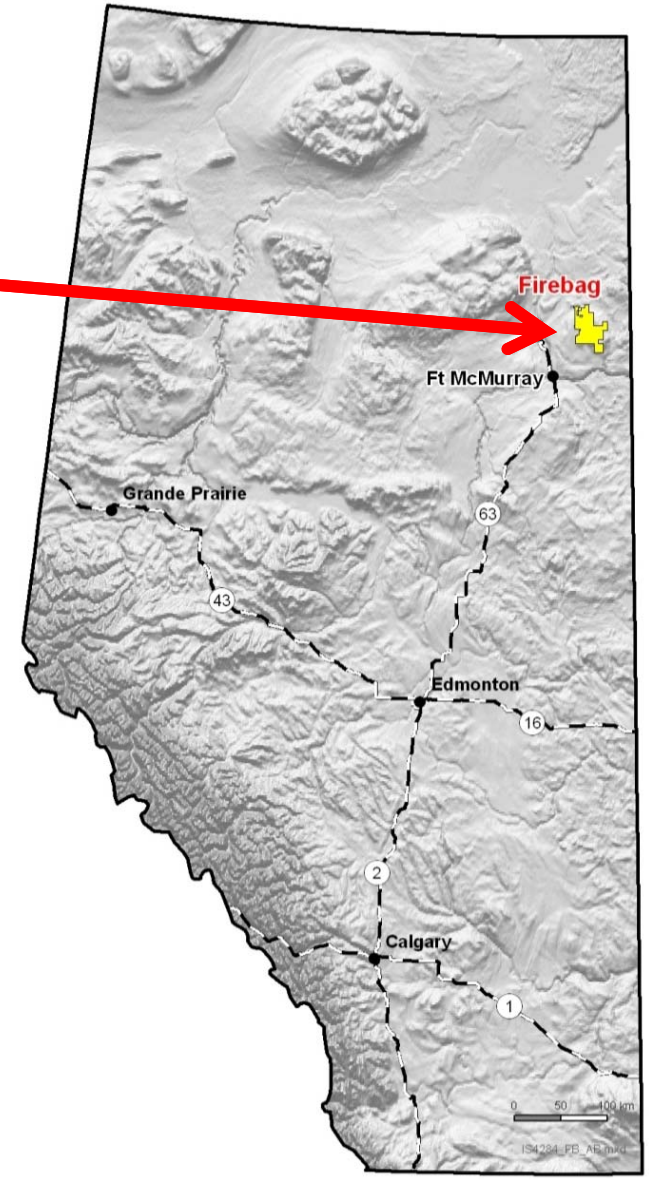
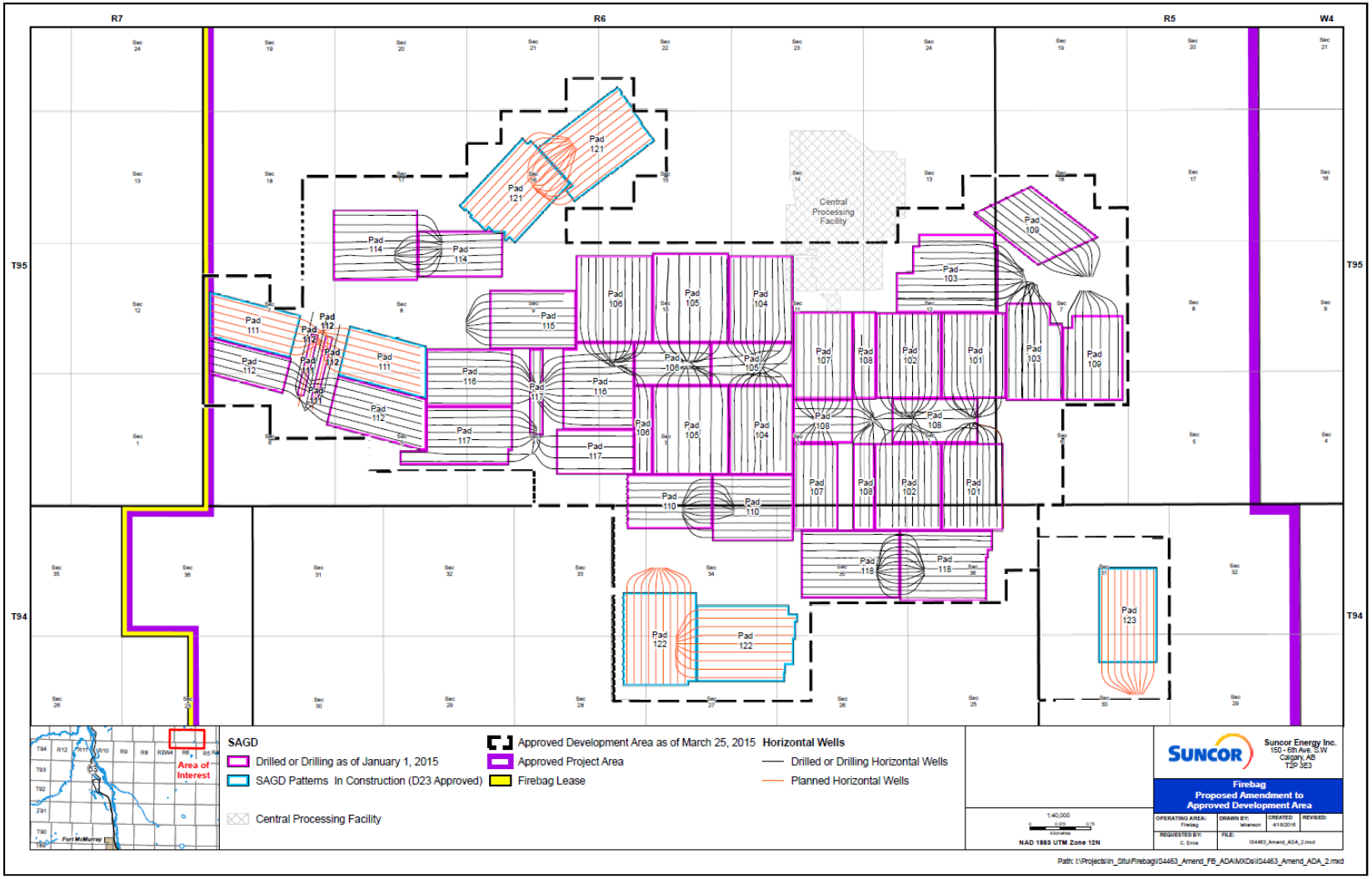
Firebag Project Overview



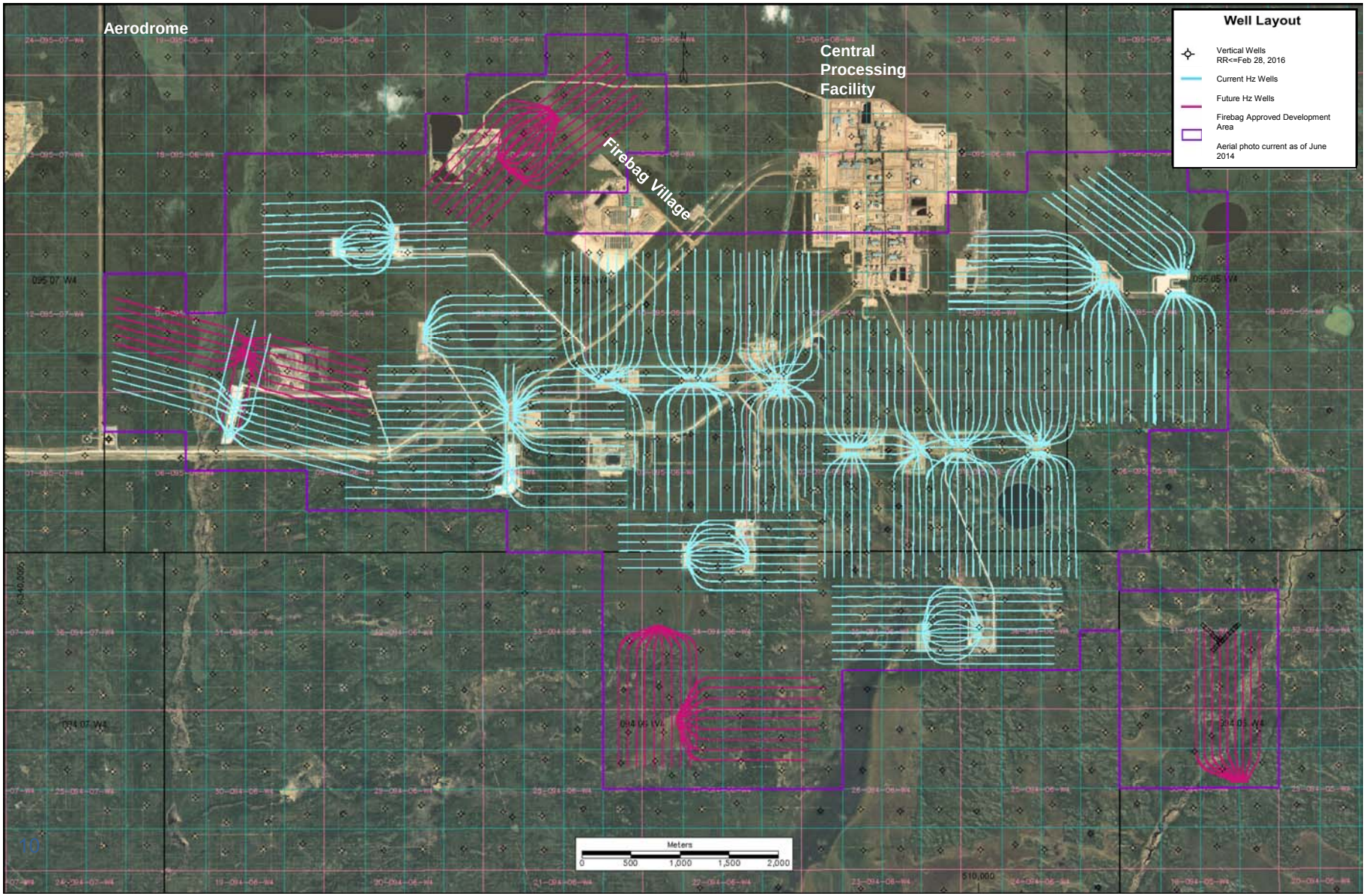
- The Firebag Project is a commercial Steam Assisted Gravity Drainage (SAGD) scheme
- Supplies bitumen to the Oil Sands Upgrader and sales to market
- Average production is 188,295 bbl/d (29,937 m^3/day) of bitumen with a Steam to Oil Ratio (SOR) of 2.62

AER Project & Approved Development Areas



Firebag Approval 8870 as of March 2016

Composite Aerial Photo of Firebag



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Firebag Stratigraphic Chart

GENERALIZED STRATIGRAPHY OF THE FIREBAG PROJECT
NORTHEAST ALBERTA, CANADA

ERATHEM	GROUP	FORMATION	MEMBER	SUB-MEMBER	DESCRIPTION	
CENOZOIC	Quaternary glacial, fluvial, and modern deposits				till, clay, sand, gravel, peat, and muskeg	
MESOZOIC	MANNVILLE	GRAND RAPIDS			mudstone >>> siltstone (lithic sand?)	CAPROCK
		CLEARWATER	upper Clearwater		shale, mudstone >>> siltstone	CAPROCK
			Wabiskaw	upper Wabiskaw	shale, mudstone, sand	CAPROCK
				lower Wabiskaw		RMZ
		MCMURRAY	upper McMurray		sand, mudstone, IHS, intraclast breccia, lignite, and karst breccia	RESERVOIR
			middle McMurray			RESERVOIR
			lower McMurray	lower McMurray 3		RESERVOIR
				lower McMurray 2		RESERVOIR
				lower McMurray 1		RESERVOIR
	BEAVERHILL LAKE	WATERWAYS	Firebag		fossiliferous calcareous mudstone	

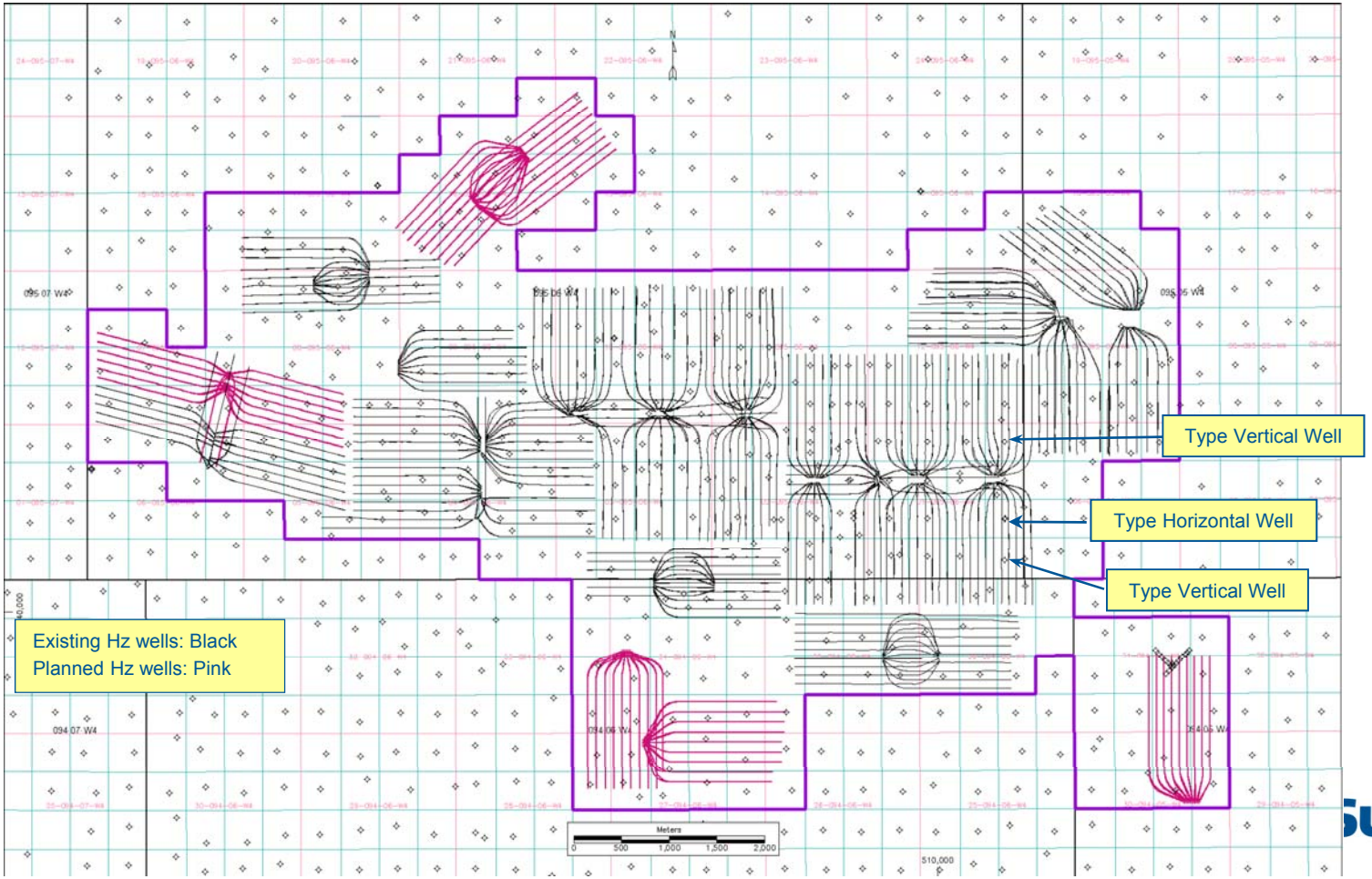
Type Well Location Map

Type Wells

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

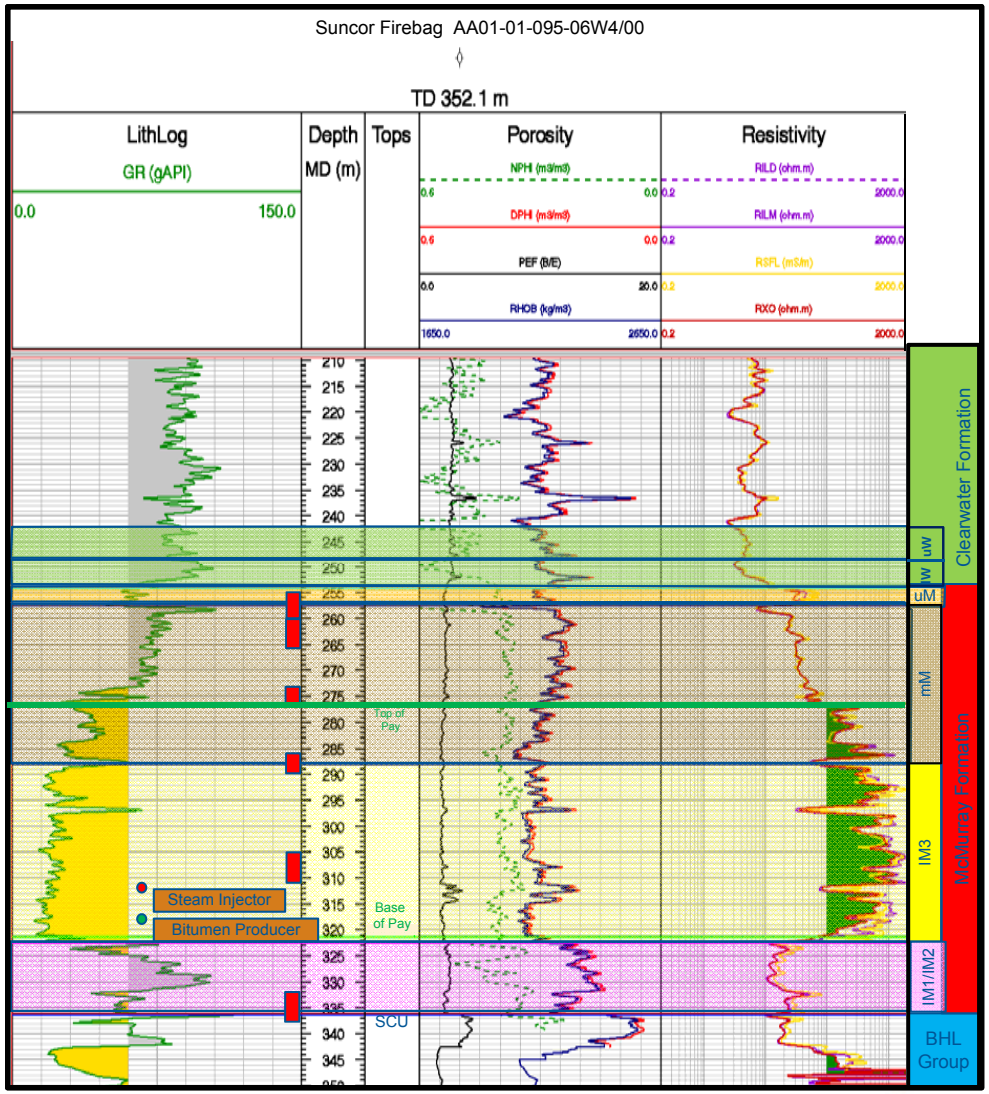
Type Horizontal Well

- Pad 101 Pair 7

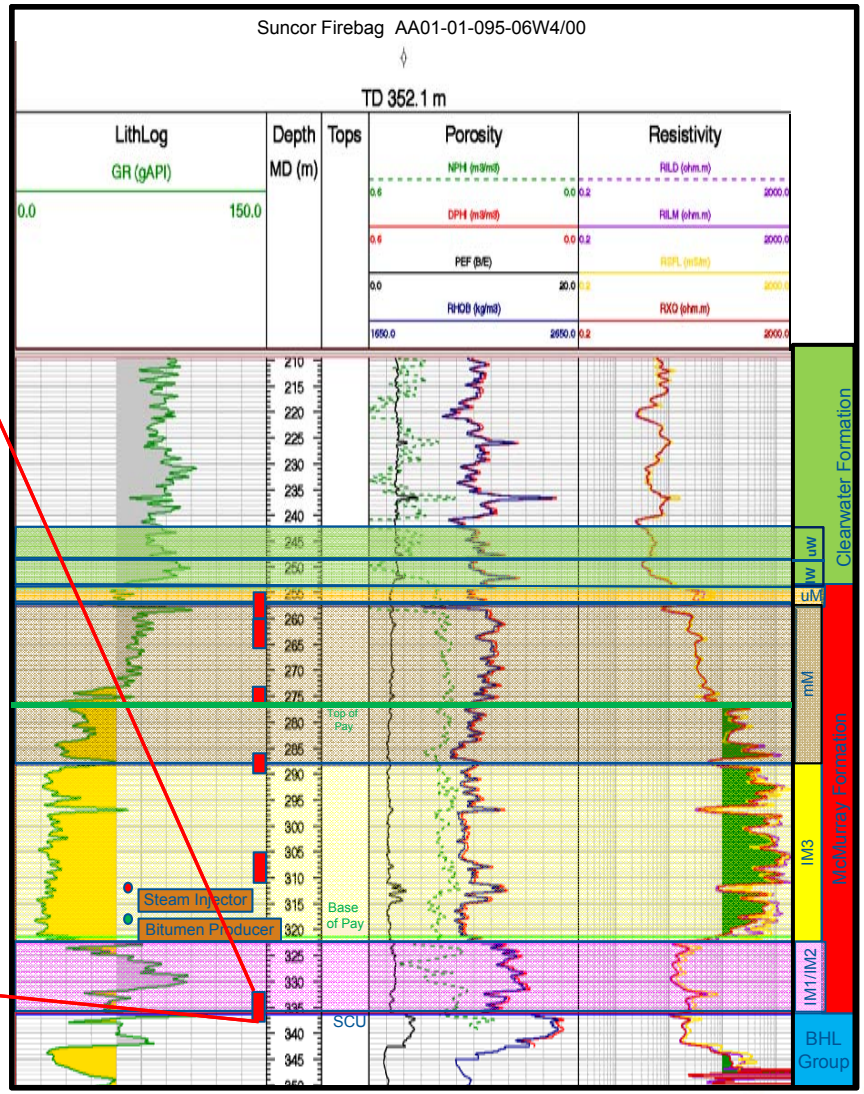


Firebag Type Well 1AA/01-01-095-06W4/00

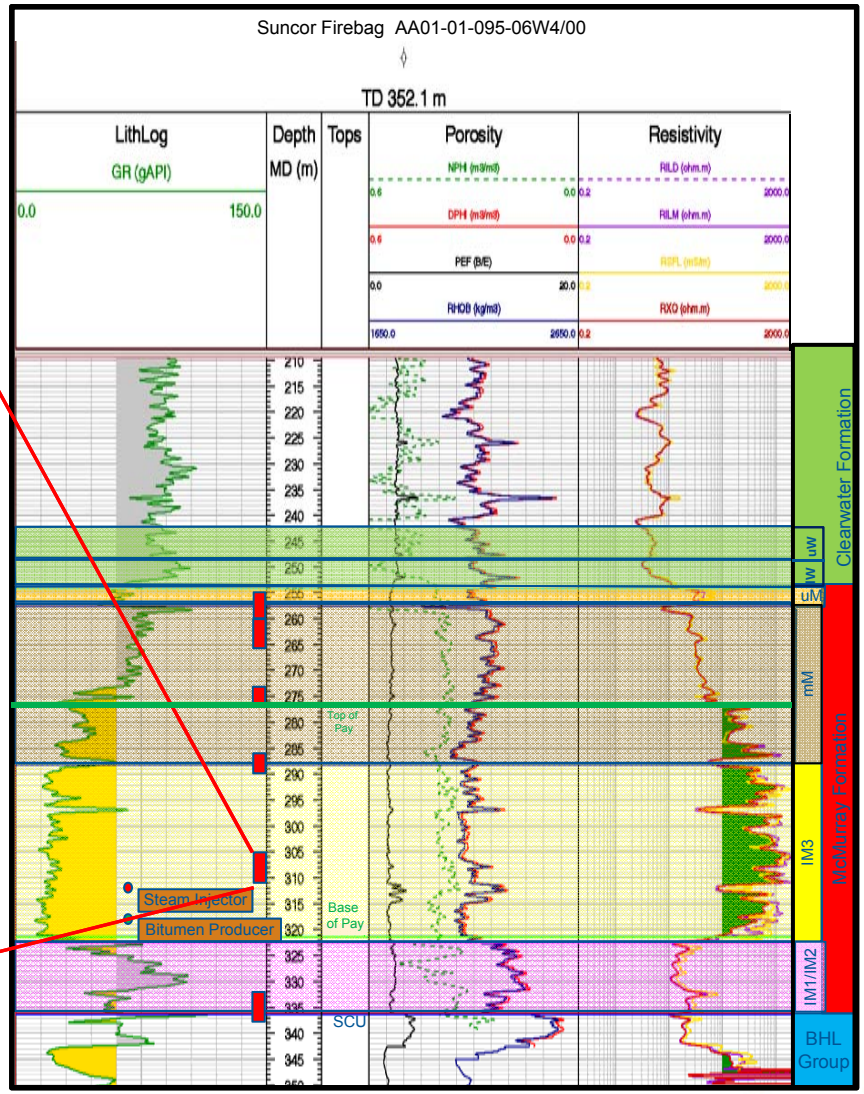
- McMurray Fm: 82.2 m
- upper McMurray: 3.2 m
- middle McMurray: 30.6 m
- lower McMurray 3: 34.4 m
- continuous pay zone:
  - Net Pay: 41.6 m
  - NTG: 0.98
  - Core Porosity: 35.7%
  - Core Sw: 21.9%
  - Kh: 8-10 D
  - Kv: 4-5 D
- lower McMurray 2: 13.6 m
- lower McMurray 1: 0.4 m
- 45 m west of Pad 101 Pair 7



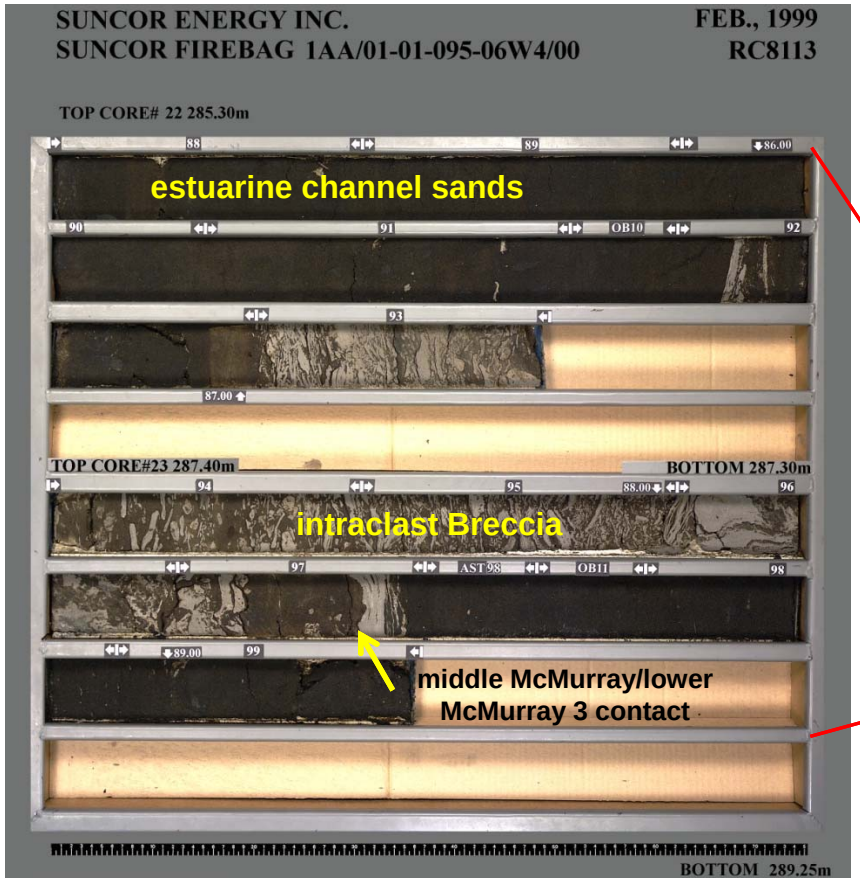
Lower McMurray 1 & 2 Units (Non Reservoir)

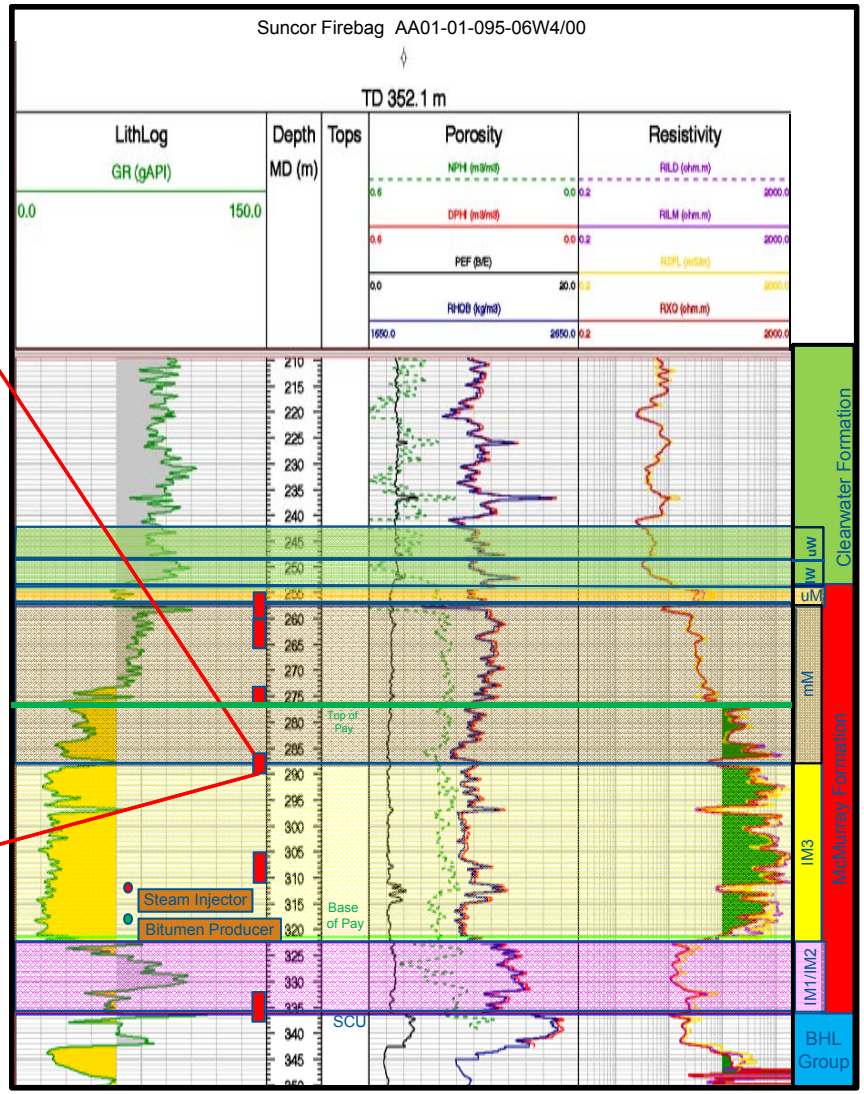


Lower McMurray 3 Oil Sands Reservoir

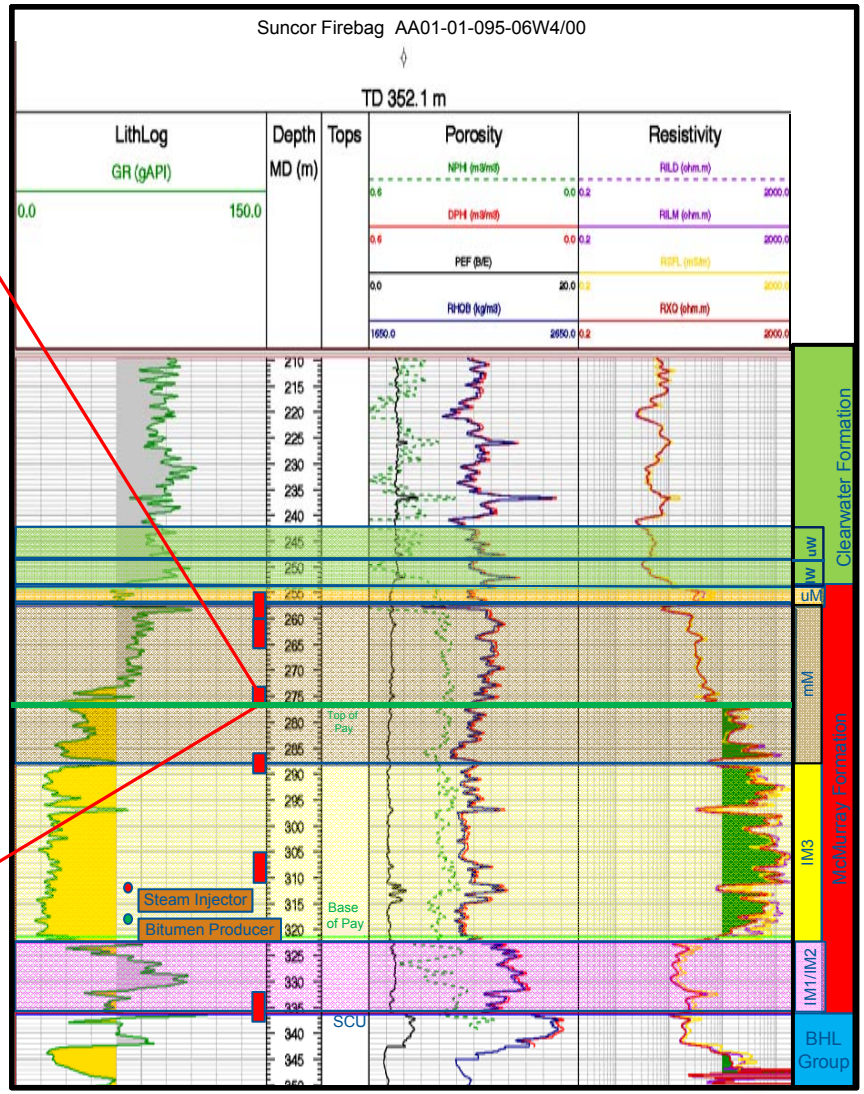


Middle McMurray - Intraclast Breccia





Middle McMurray Estuarine Channels and Associated Point Bars



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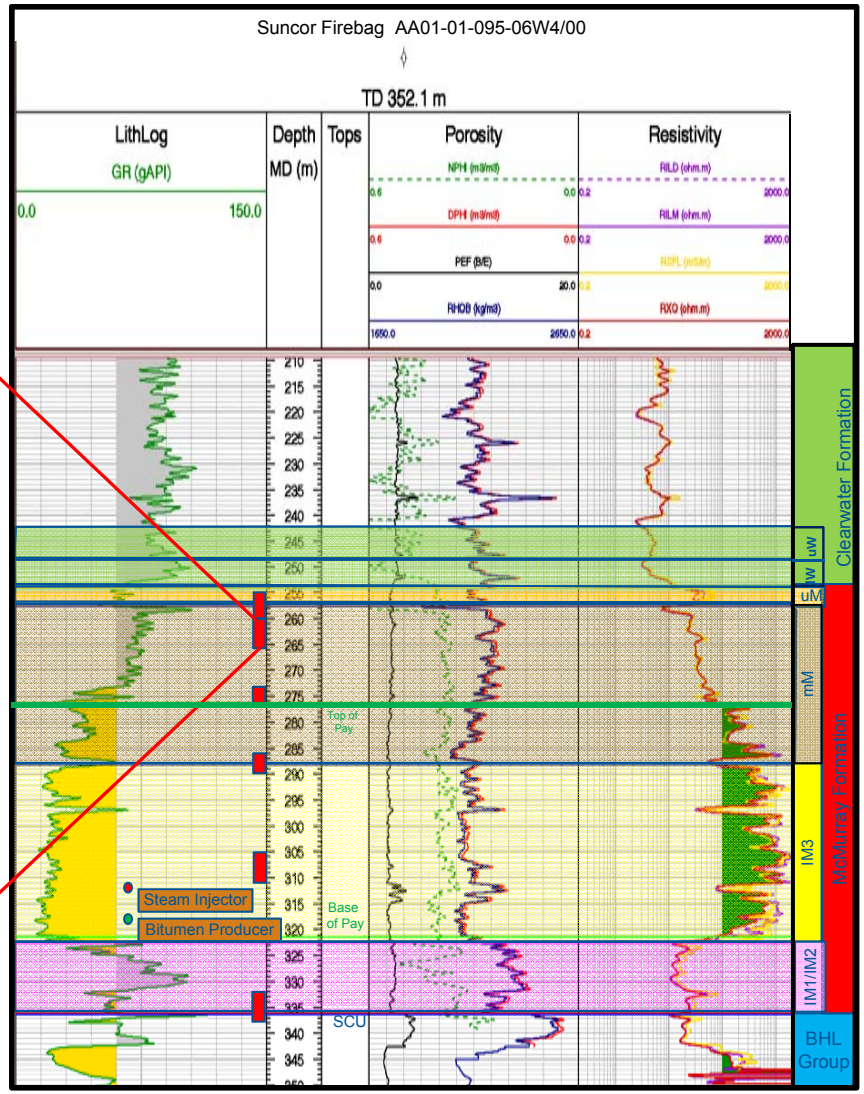
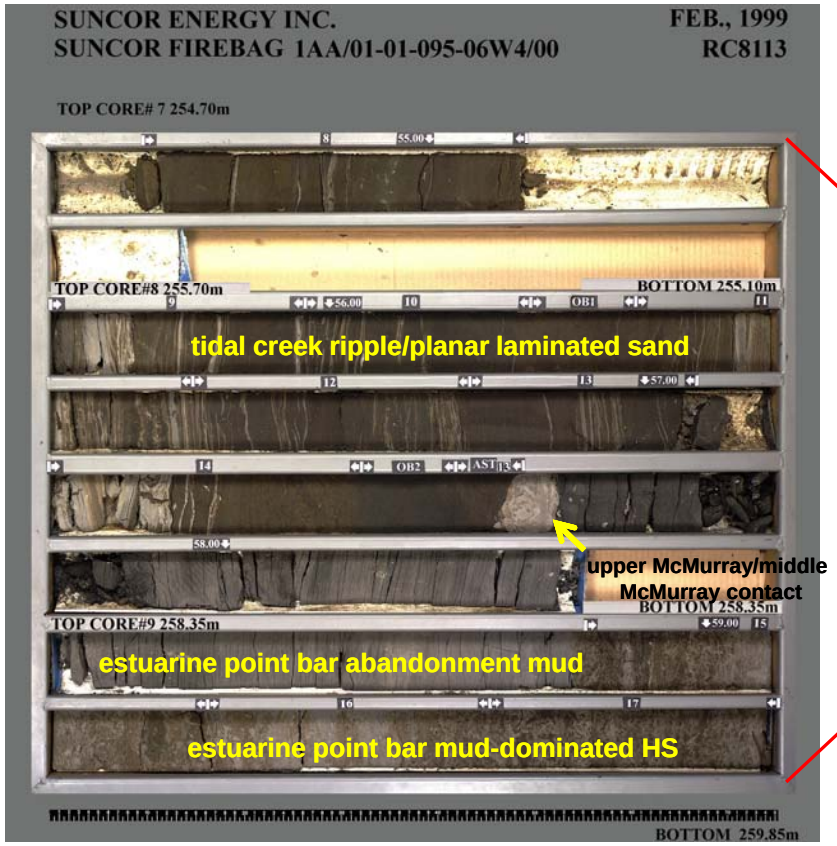
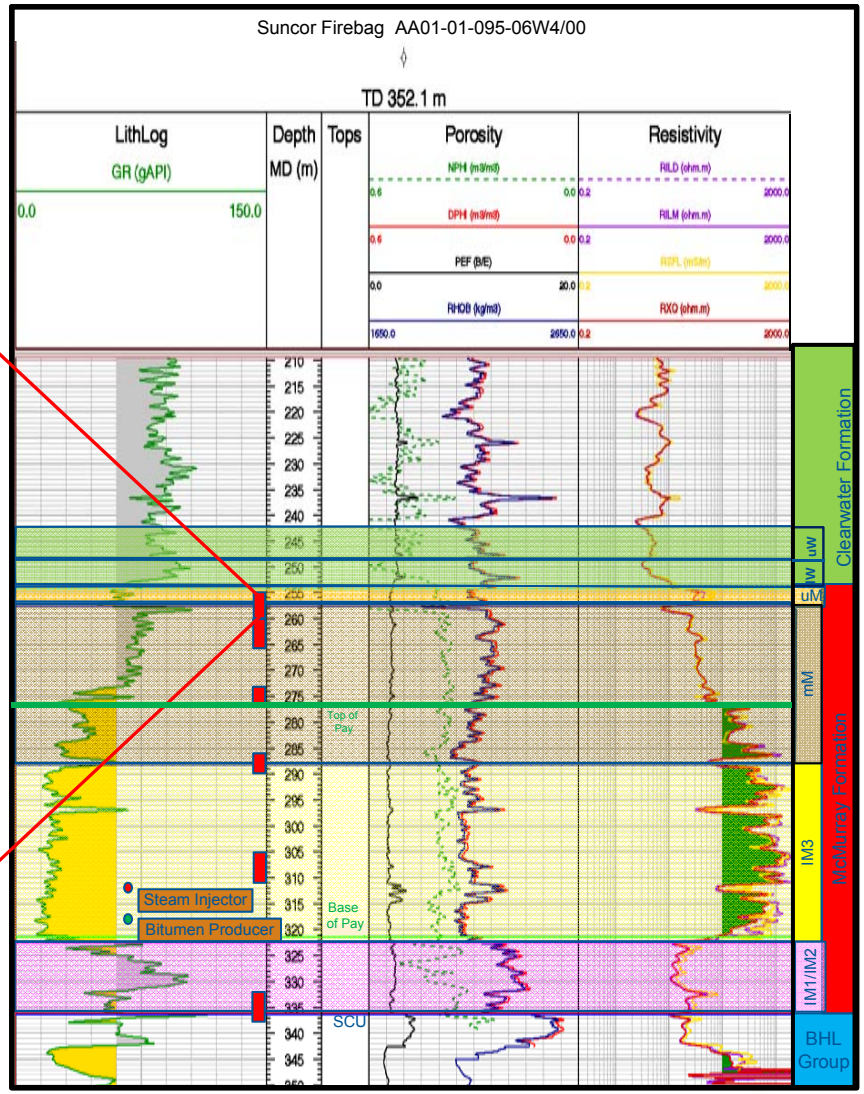
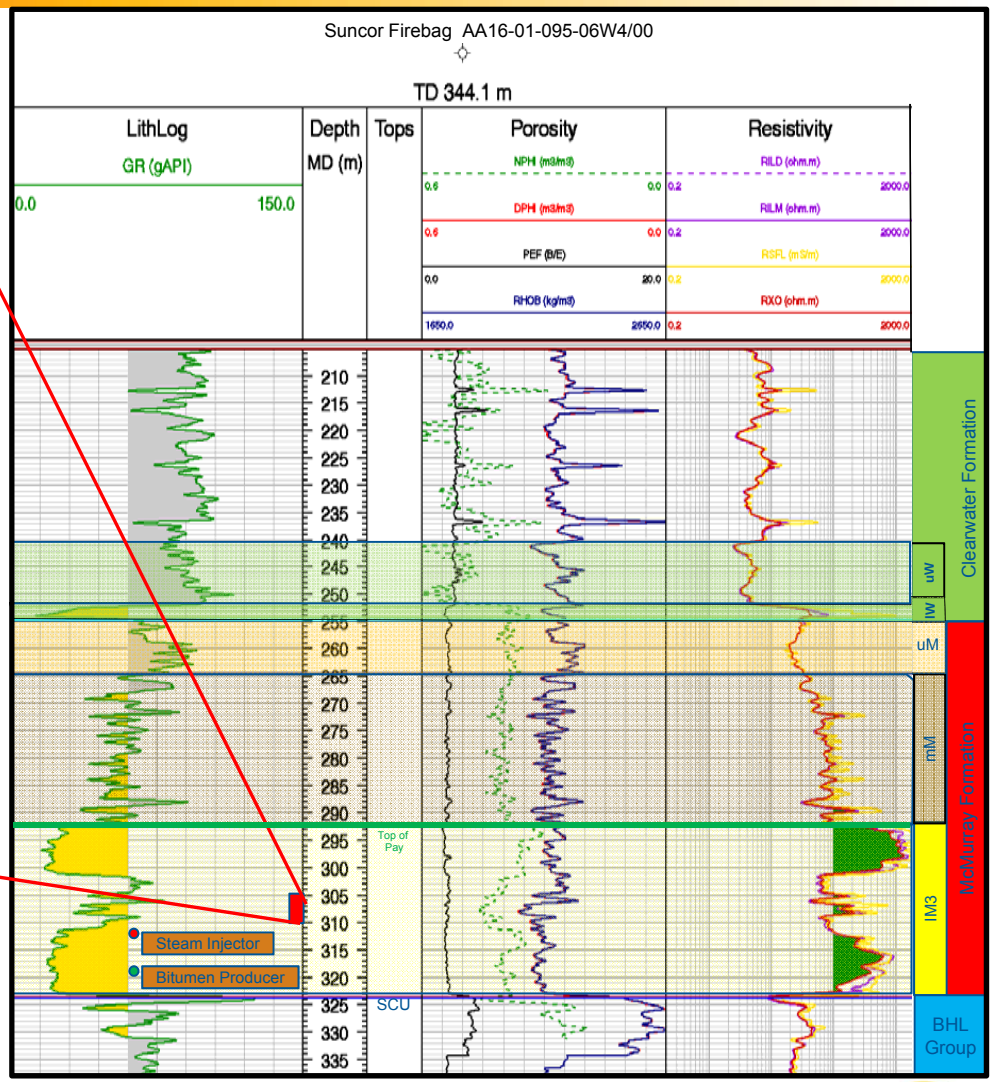


Middle McMurray and Upper McMurray Units



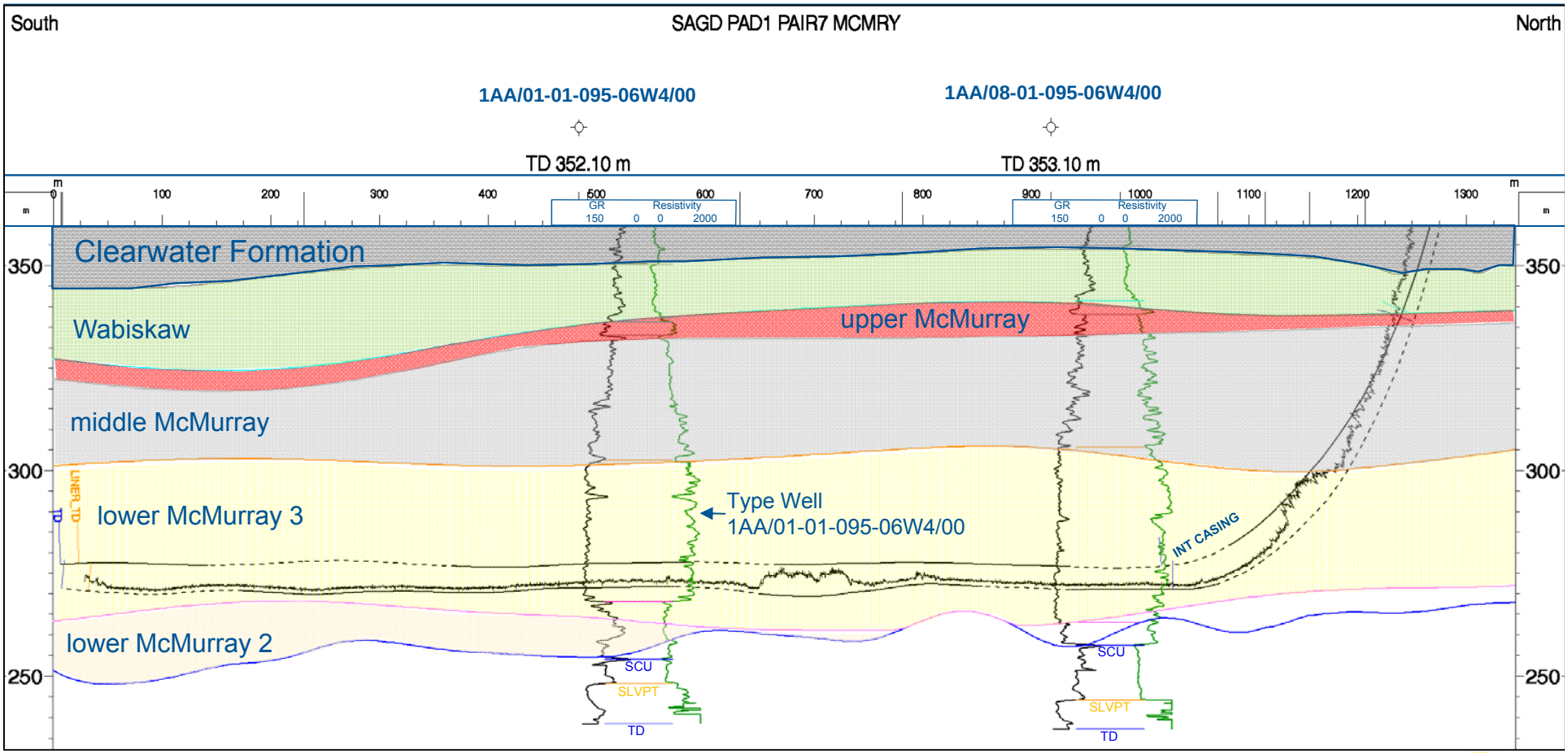


Firebag Type Well 1AA/16-01-095-06W4/00



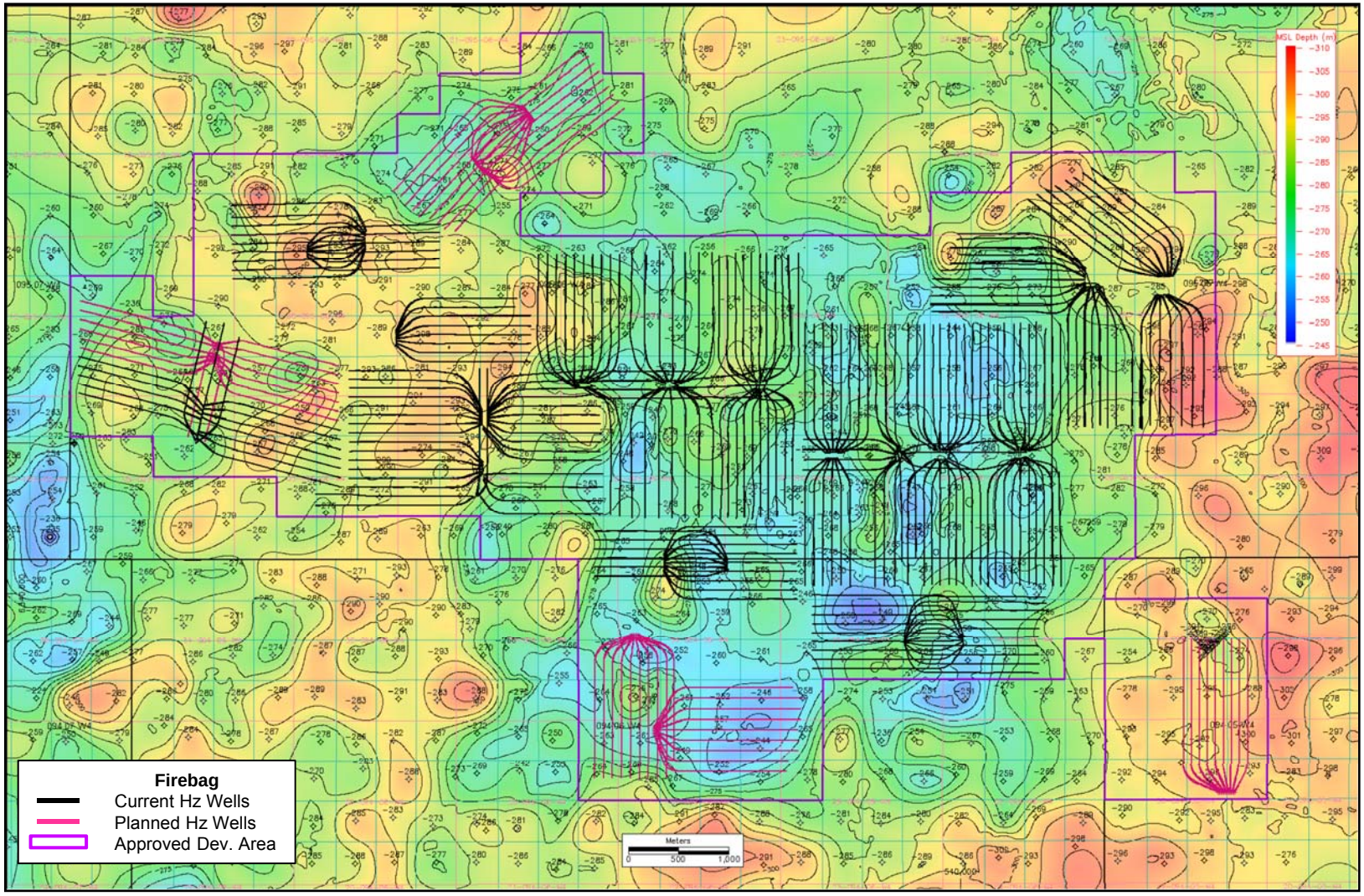
- Lower McMurray 3 floodplain mud
- Reservoir quality within McMurray varies and can present challenges

Pad 101 Pair 7 Structural Cross Section

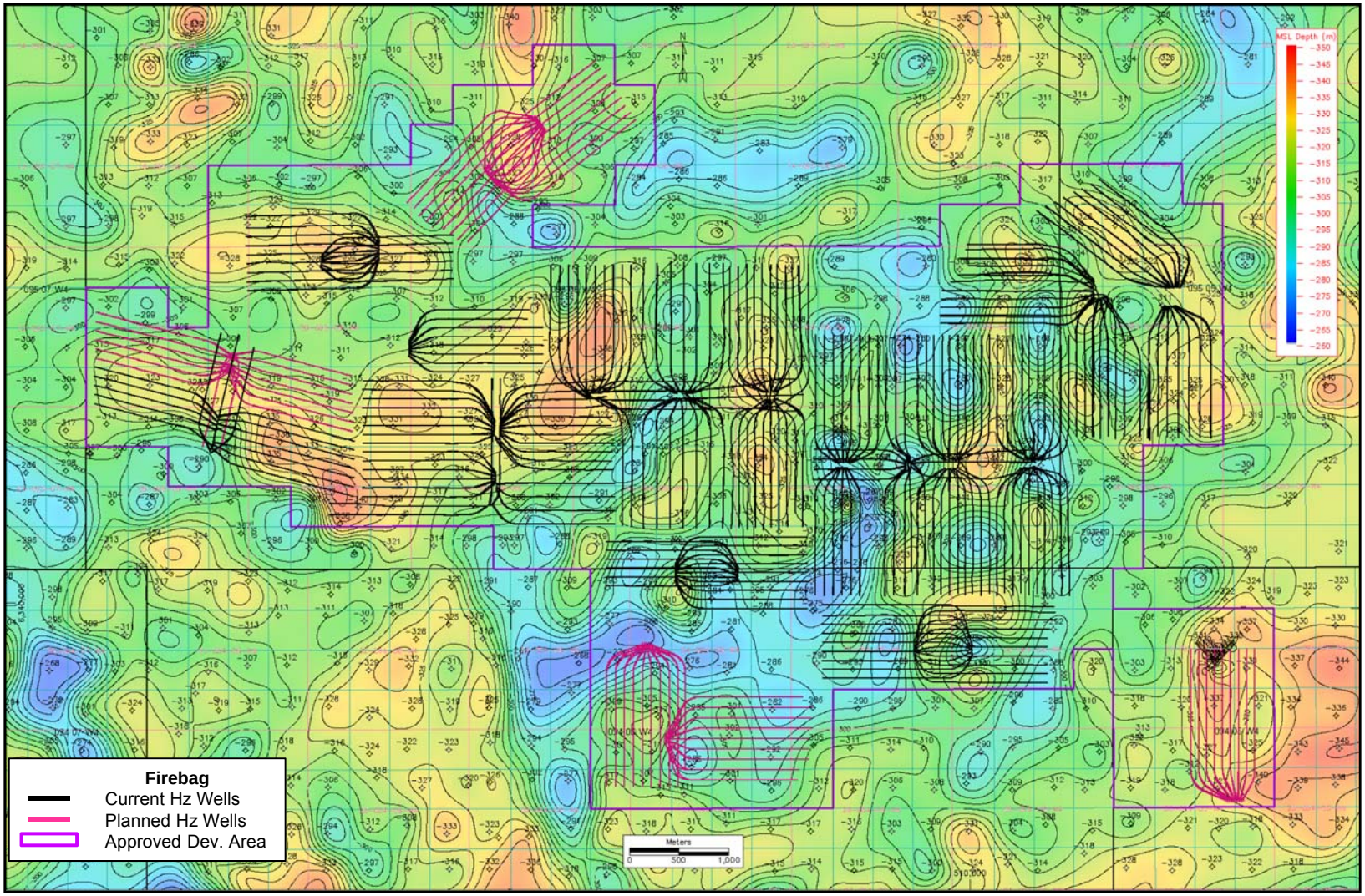


*Coreholes are projected onto cross section

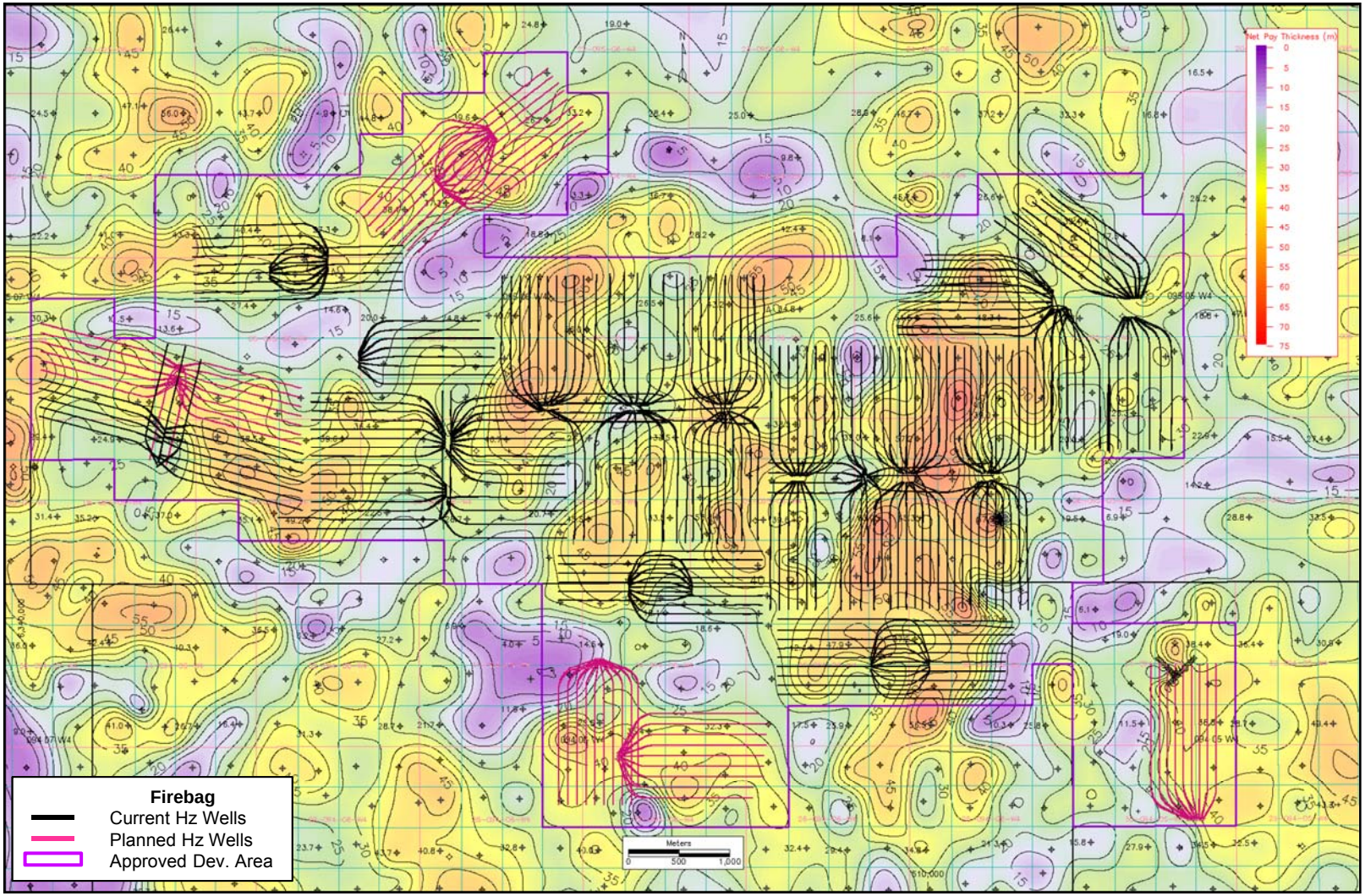
Structure Map of Base of Gross Bitumen Pay Interval



Structure Map of Top of Gross Bitumen Pay Interval



Isopach Map of Cumulative Net Bitumen Pay



- No bottom or top water has been identified within the project area
- Lean bitumen has been identified below, within, and on top of the pay within the project area

Original Bitumen in Place (OBIP) & Average Reservoir Properties

	Area (m^2)	Gross Thickness (m)	Gross Rock Volume (e^6 m^3)	Net-to-Gross Ratio[1]	Net Pay Thickness (m)	Porosity	Oil Saturation	Formation Volume Factor	OBIP[2] (e^6 m^3)	OBIP[2] (MMbbl)
SAGD Pad 101	1,676,270	52.4	87.7	0.89	47.0	0.34	0.87	1	23.1	145.3
SAGD Pad 102	1,748,969	55.7	97.5	0.86	47.7	0.34	0.84	1	23.4	147.2
SAGD Pad 103	1,930,447	47.0	90.7	0.81	37.9	0.32	0.85	1	20.0	125.8
SAGD Pad 104	1,720,517	46.8	80.5	0.86	40.5	0.31	0.86	1	18.5	116.4
SAGD Pad 105	2,617,022	36.8	96.4	0.88	32.6	0.32	0.86	1	23.3	146.6
SAGD Pad 106	1,755,033	44.9	78.8	0.87	39.3	0.31	0.86	1	18.5	116.4
SAGD Pad 107	1,394,006	42.1	58.6	0.78	32.8	0.32	0.85	1	12.6	79.3
SAGD Pad 108	1,243,933	54.5	67.8	0.81	44.3	0.32	0.85	1	15.2	95.6
SAGD Pad 108 North	307,575	38.1	11.7	0.77	29.4	0.32	0.88	1	2.5	15.9
SAGD Pad 109	1,500,886	36.8	55.3	0.83	30.7	0.33	0.82	1	12.6	79.3
SAGD Pad 110	1,463,974	43.2	63.2	0.74	31.8	0.32	0.82	1	12.0	75.5
SAGD Pad 111	1,406,408	40.6	57.0	0.83	33.7	0.31	0.82	1	12.2	76.5
SAGD Pad 112	1,447,415	46.2	66.9	0.83	38.2	0.32	0.81	1	14.2	89.0
SAGD Pad 114	1,512,000	36.7	55.4	0.84	30.7	0.31	0.83	1	11.9	74.9
SAGD Pad 115	749,429	34.2	25.6	0.75	25.6	0.32	0.80	1	4.9	30.8
SAGD Pad 116	1,684,175	43.5	73.3	0.89	39.1	0.31	0.85	1	17.3	108.8
SAGD Pad 117	1,525,139	36.3	55.3	0.81	29.7	0.32	0.82	1	11.7	73.8
SAGD Pad 118	2,010,652	47.5	95.4	0.84	39.7	0.32	0.84	1	21.3	134.0
SAGD Pad 123	848,565	44.6	38.8	0.81	36.2	0.30	0.84	1	7.7	48.3
SAGD Pad 121	1,935,515	43.4	83.9	0.79	34.2	0.31	0.81	1	16.8	105.4
SAGD Pad 122	2,135,632	44.7	95.4	0.80	35.7	0.29	0.80	1	17.9	112.4
SAGD TOTAL	32,613,561	44.0	1435.3	0.83	36.6	0.32	0.84	1	317.5	1997.1
Firebag Approved Project Area	193,970,483	35.9	6,970.1	0.74	26.7	0.31	0.84	1	1,299.3	8172.6

[1] Net-to-Gross Ratio: Net pay cutoffs applied are GR>60 API, Porosity < 0.22, and Sw > 0.50.

[2] OBIP: Original Bitumen in Place

From Pad 122 D23 Application

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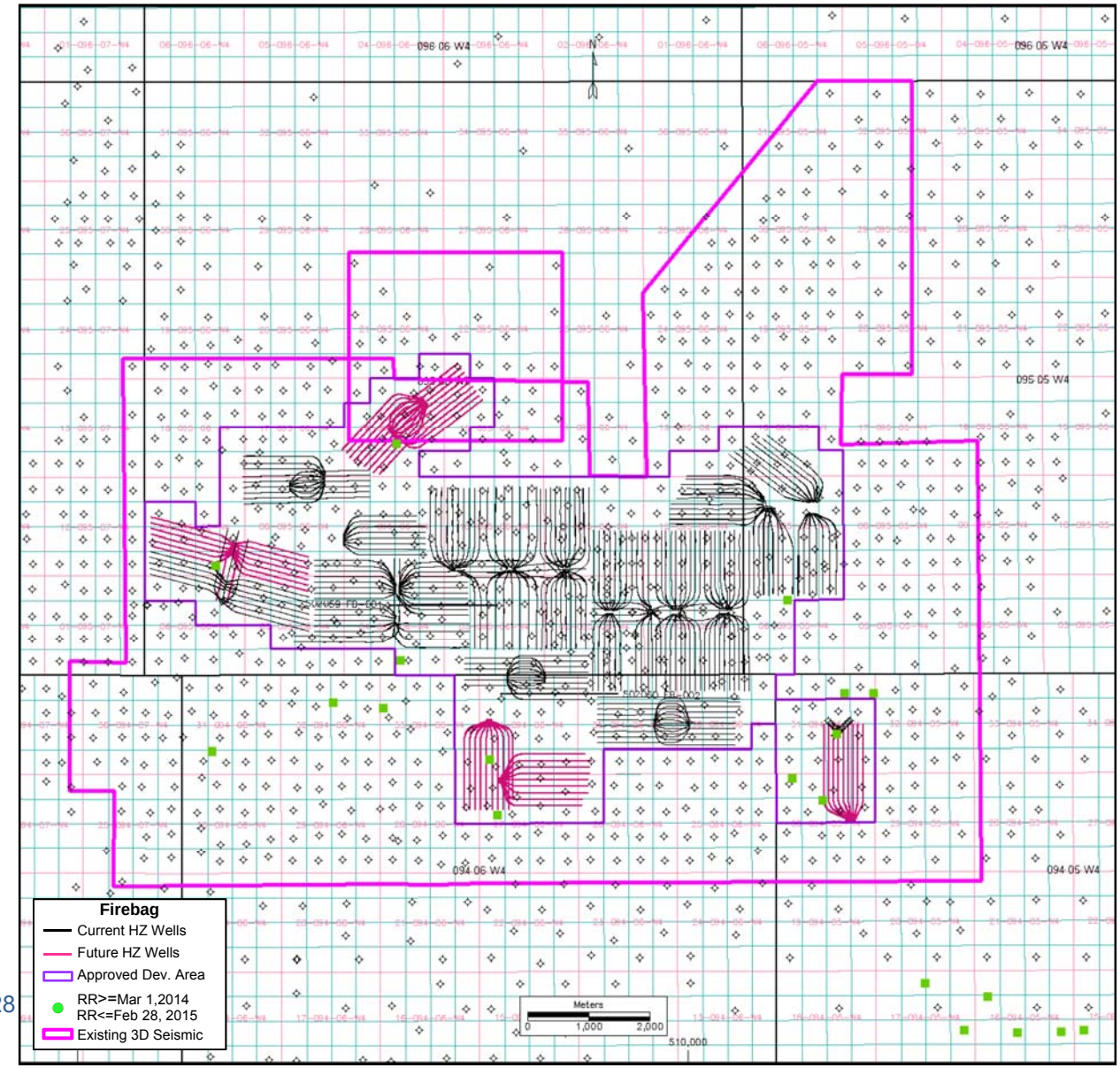
Average Reservoir Properties

- Average reservoir properties for the operating portion of the scheme (Pads ***101-108***, ***108N***, Pads ***109-110*** and Pad ***115 - 116***)
  - Initial reservoir pressure: 800kPa
  - Initial reservoir temperature: 8°C
  - Average gross pay = 44.4 m
  - Average net pay = 37.4m
  - Average porosity = 0.323
  - Average oil saturation = 0.847
  - Effective horizontal permeability: 3 to 4 D
  - Effective vertical permeability: 2 to 3 D
  - Viscosity: ~ 11cp @ 215°C

2014/2015 Winter Delineation Program and 3D Seismic



- Existing wells in black
- New wells 2014-2015 Drilling Program (RR Mar. 01, 2014 to Feb. 28, 2015) in green
- No 2015-2016 Drilling Program (RR Mar. 01, 2015 to Feb. 29, 2016)

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InSAR Cumulative Heave May 2013 to October 2015

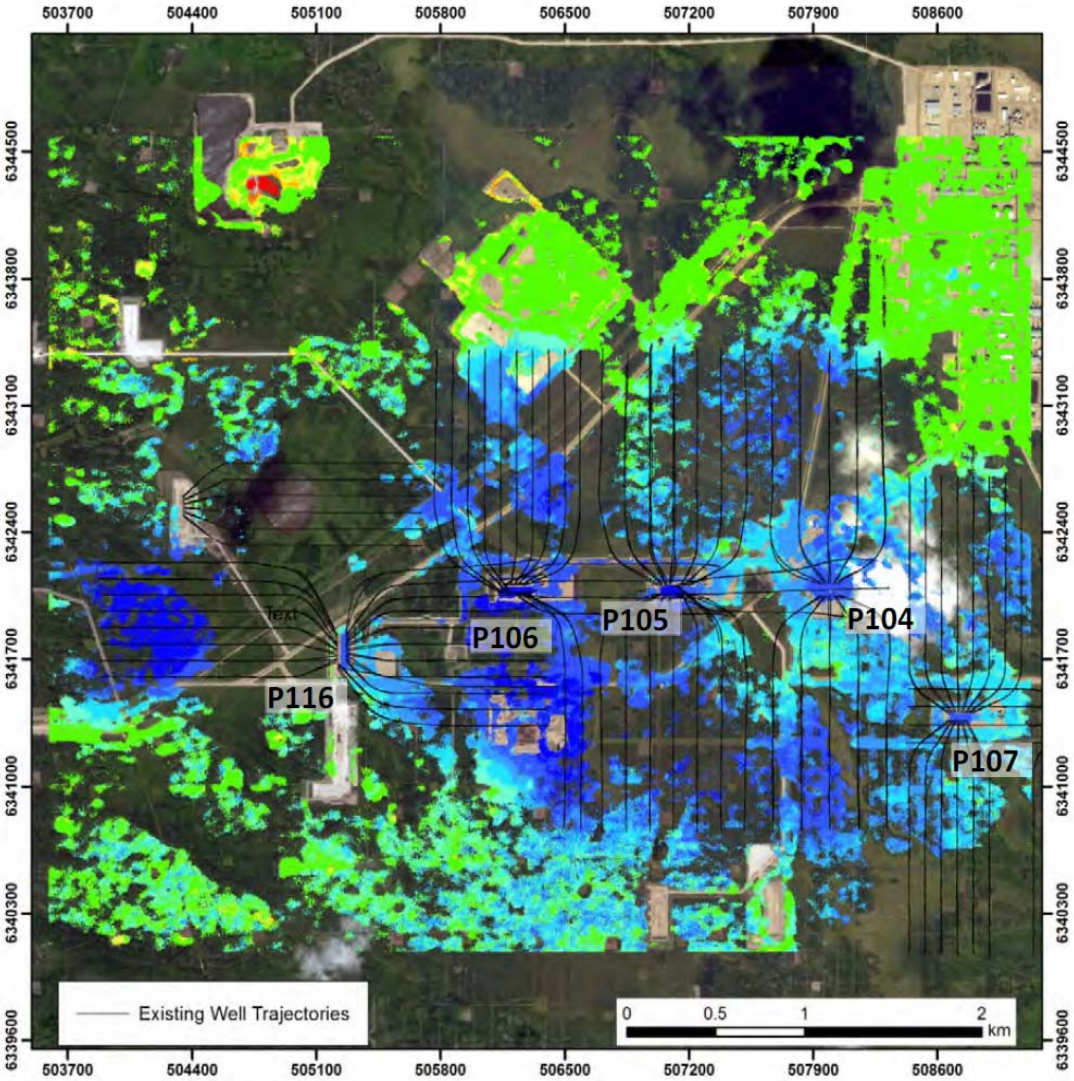
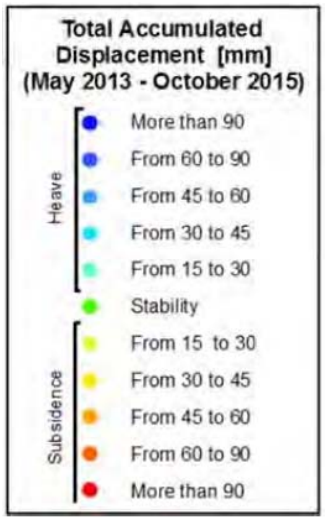


Figure 4: Total accumulated displacement map from May 2013 to October 2015 for the area of interest

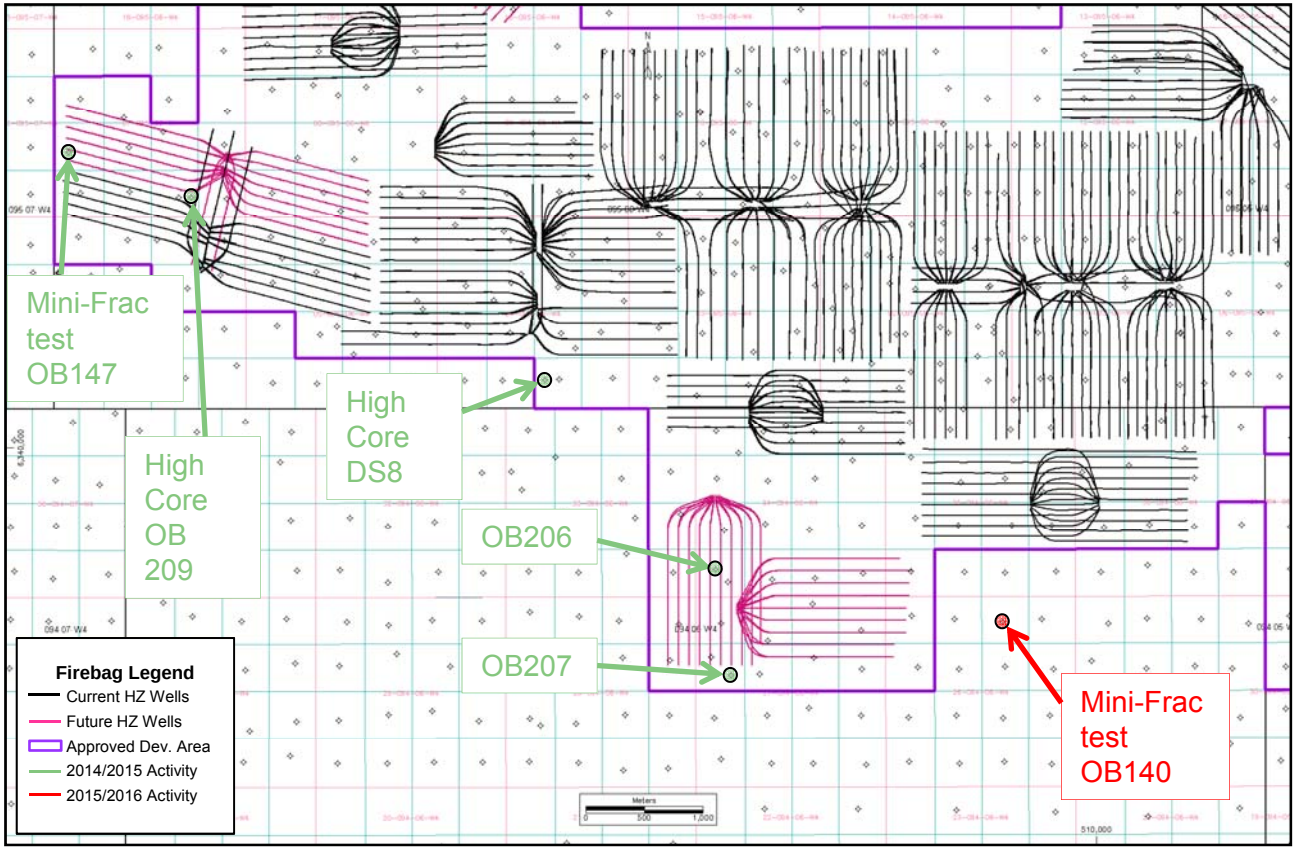
- Maximum heave observed of 140 mm on Pad 106 and 116



- The heave surveys are used for Geomechanical model calibration

Caprock – Geological Activity

- 2014/15 Summary
  - OB 206 & OB207
    - 3 pt. Piezometer pressure measurement, 2 thermocouple bundles, cored in the lower McMurray 2 & 3, middle McMurray, upper McMurray and Wabiskaw
  - Mini-Frac test at OB 147
  - High core collection at DS8 and OB209
    - Natural fracture characterization
- 2015/16 Summary
  - No new observation wells
  - Mini-Frac test at OB 140
  - No new high core collection



Caprock Integrity Assurance

- Mini-Frac in 2016 to provide coverage for Pad 118
  - OB140 (100/15-26-094-06W4/0) tested the lower McMurray 3, upper McMurray (Res. Monitoring Zone), and Clearwater via mini-frac in 2016
  - Data was analyzed in-house and is consistent with SPE Paper 157843 (Ken Powless April, 2012) and SPE Gulf Coast Section Completions & Production Study Group Luncheon: Re-examining DFIT Interpretation Methods (Dave Cramer Oct, 28, 2015)

- 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

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Reservoir Fracture Closure Gradients 2016

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
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	21.5

- 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 will be limited to approved overburden based MOP during startup and production phase
  - Friction losses will provide an extra margin of safety for protecting the reservoir
- All existing injection wells are set up to monitor downhole pressure
  - Some wells have thermocouple monitoring temperatures along the horizontal for startup
- Production wells capable of periodically monitoring pressure via blanket gas during startup period

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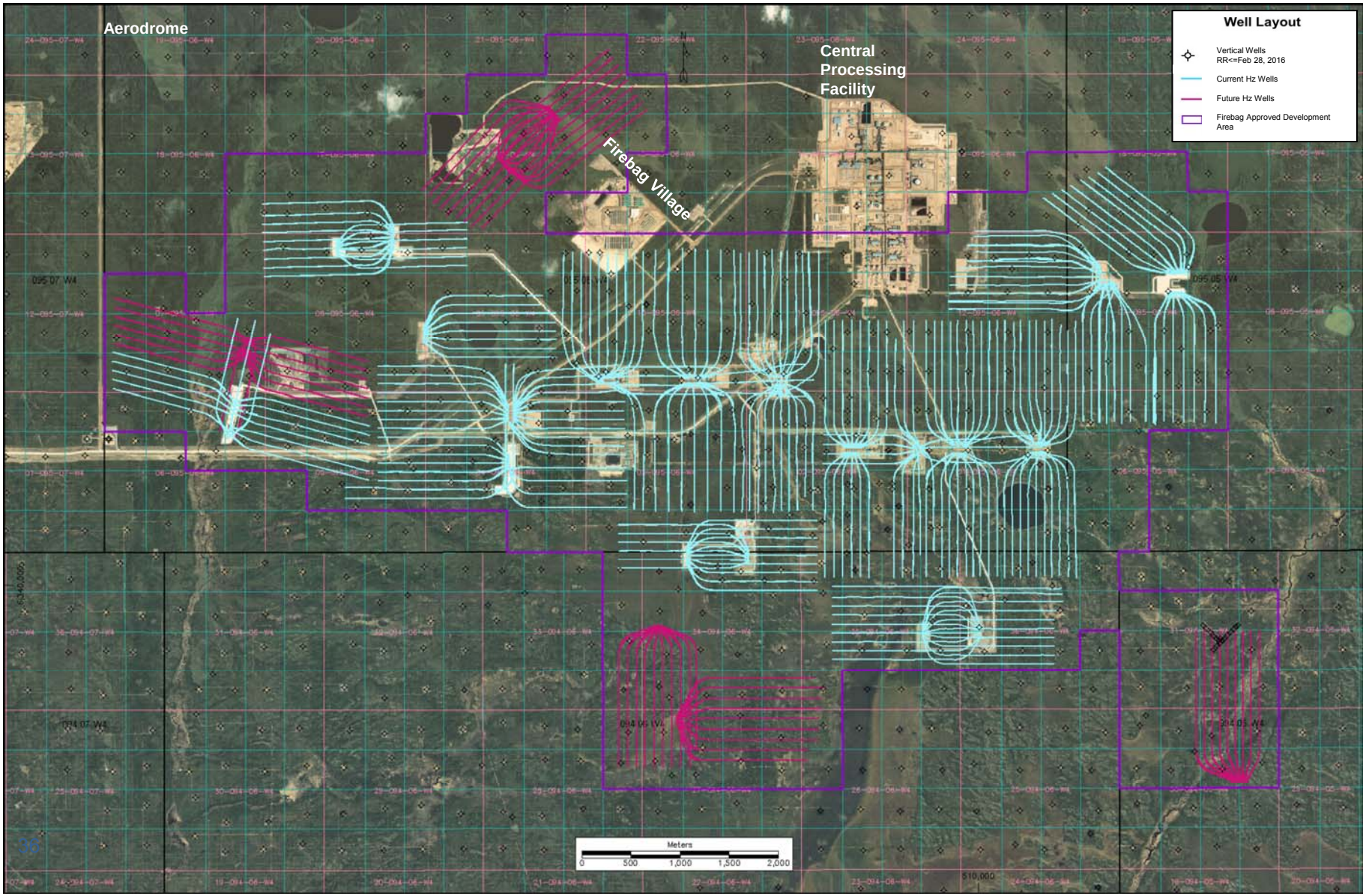
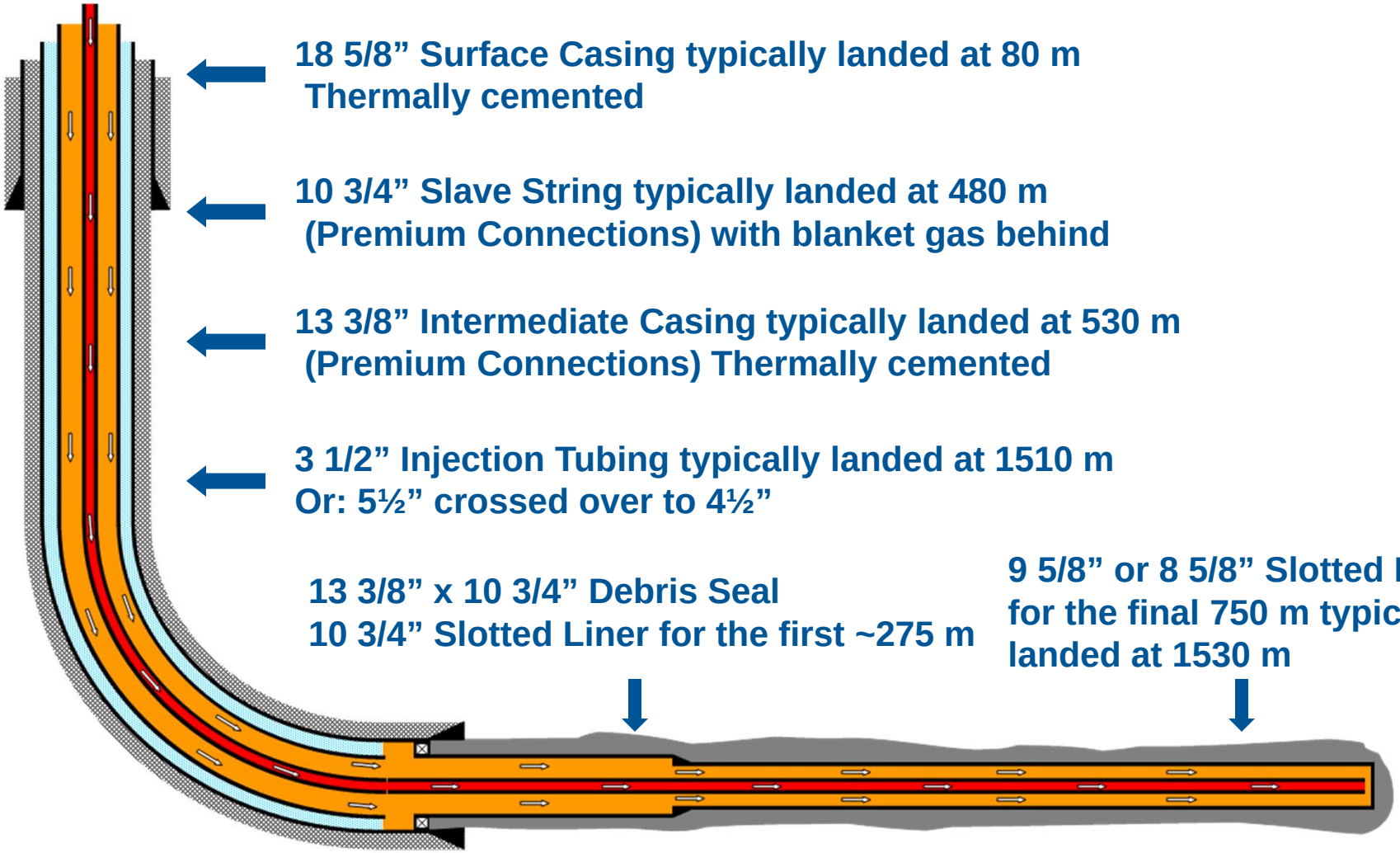
SAGD Well Layout



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 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	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

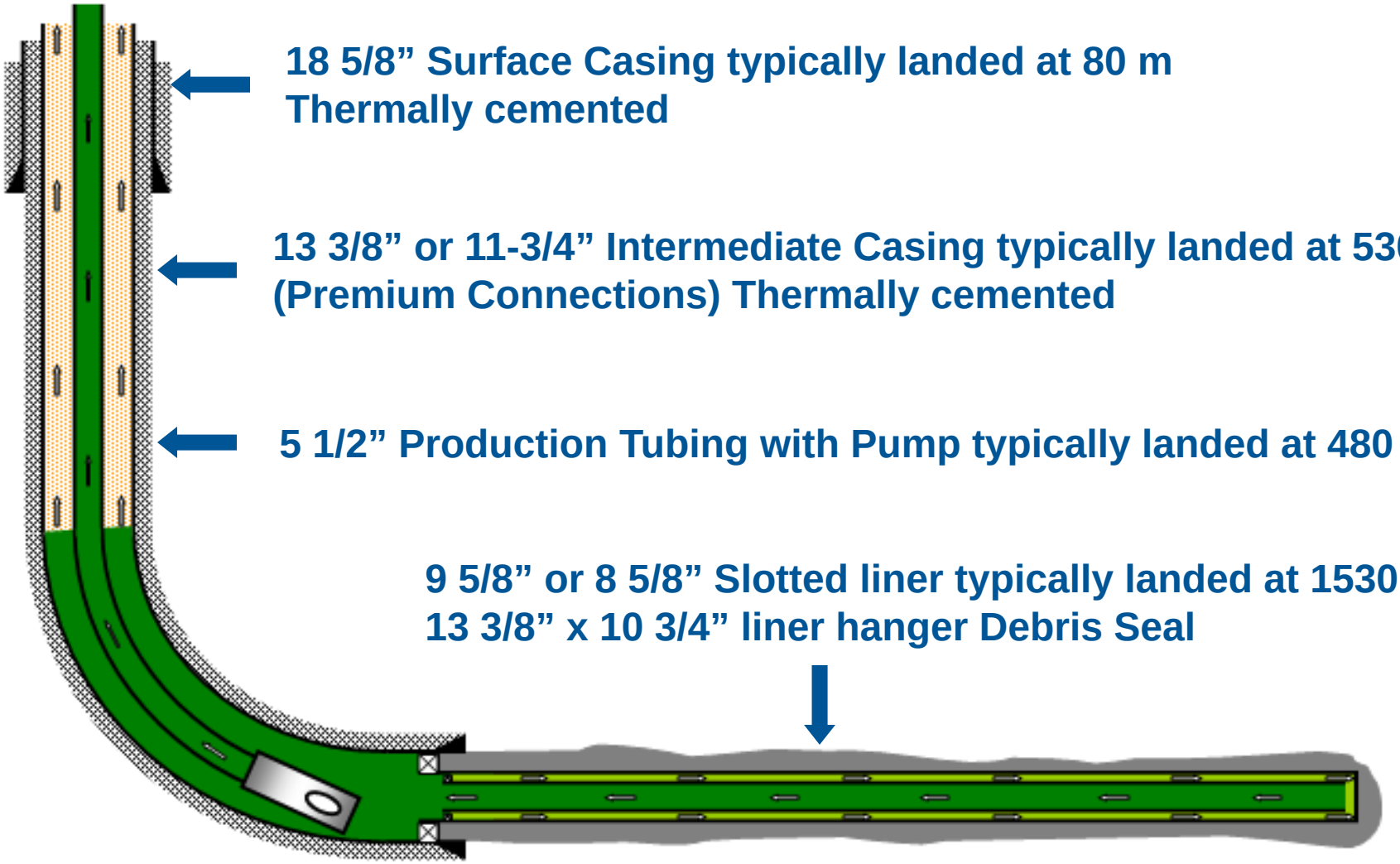
13 3/8” Intermediate Casing typically landed at 530 m
(Premium Connections) Thermally cemented

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

Typical Concentric Producer ML-SAGD (includes infills)



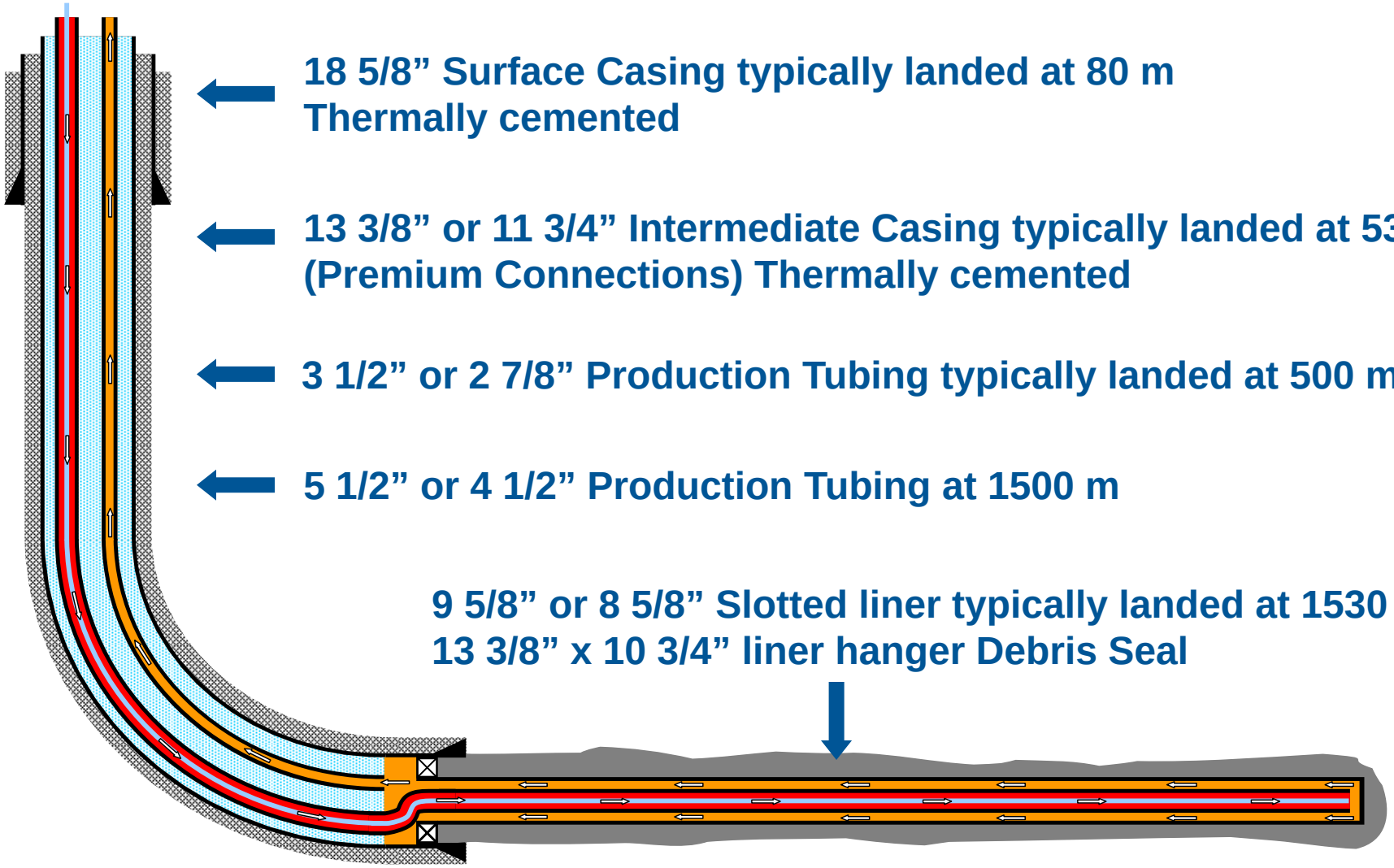
18 5/8” Surface Casing typically landed at 80 m
Thermally cemented

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

5 1/2” Production Tubing with Pump typically landed at 480 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 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

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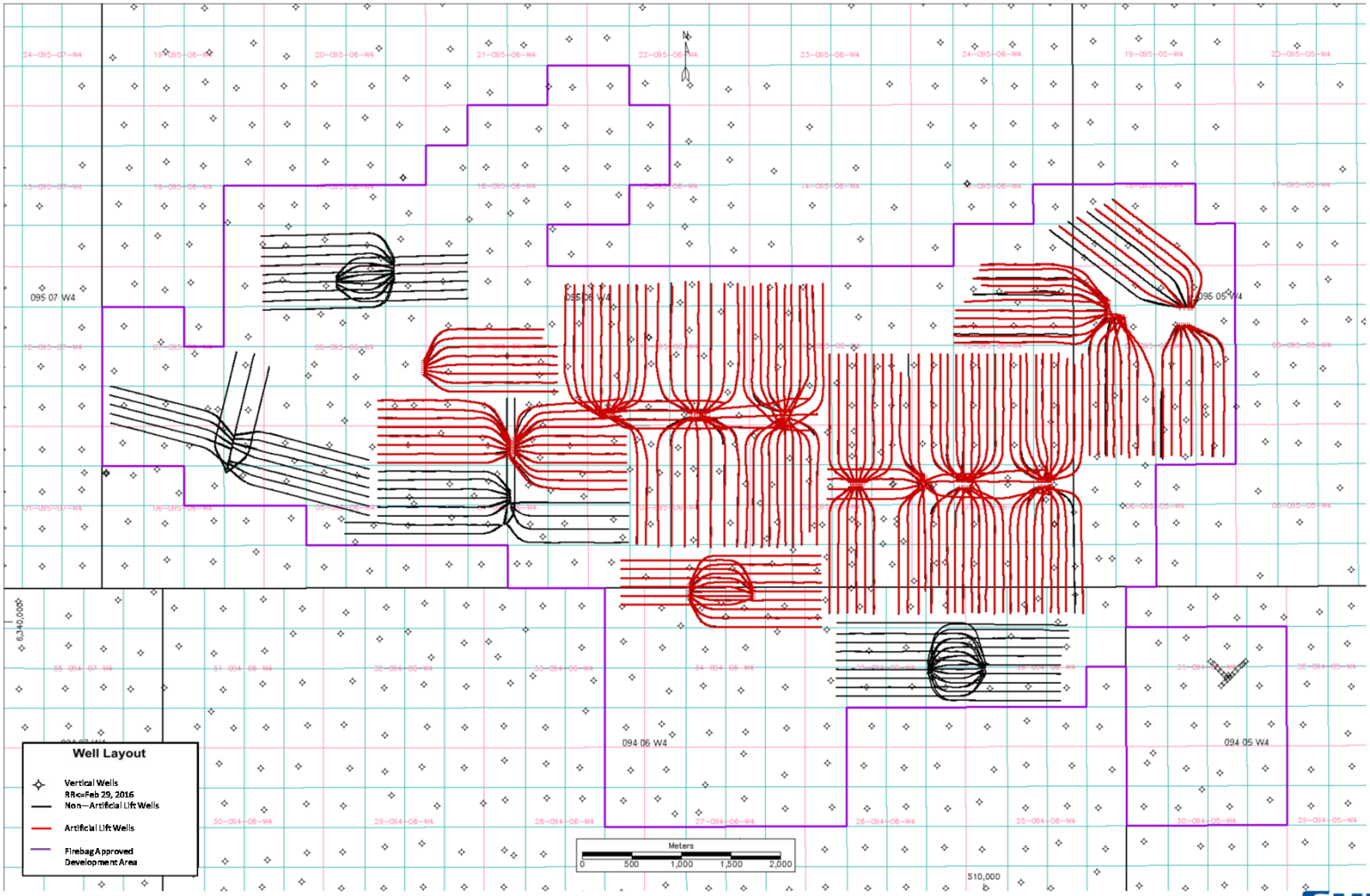
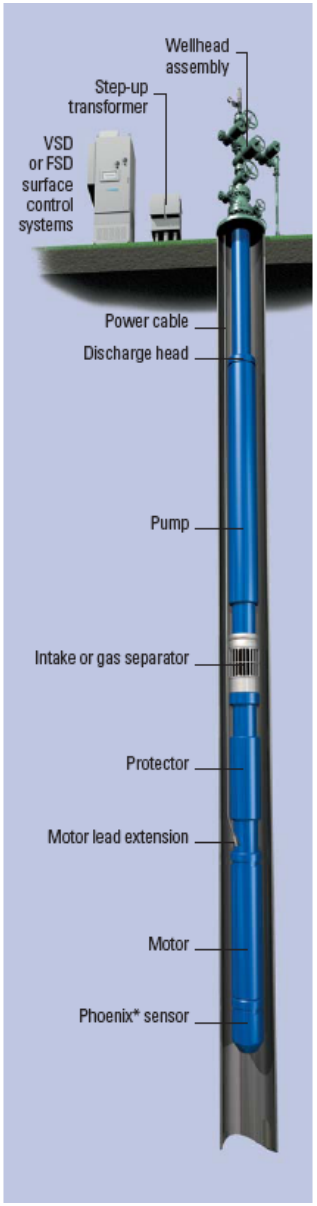
Artificial Lift Wells

- Wells highlighted in red have been converted to artificial lift (189 wells)



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 800 m^3/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 (UHT and SA-3)
  - Pump mean time to failure since day 1 is 633 days
  - Run-life is increasing as operational practices and pump technology improve

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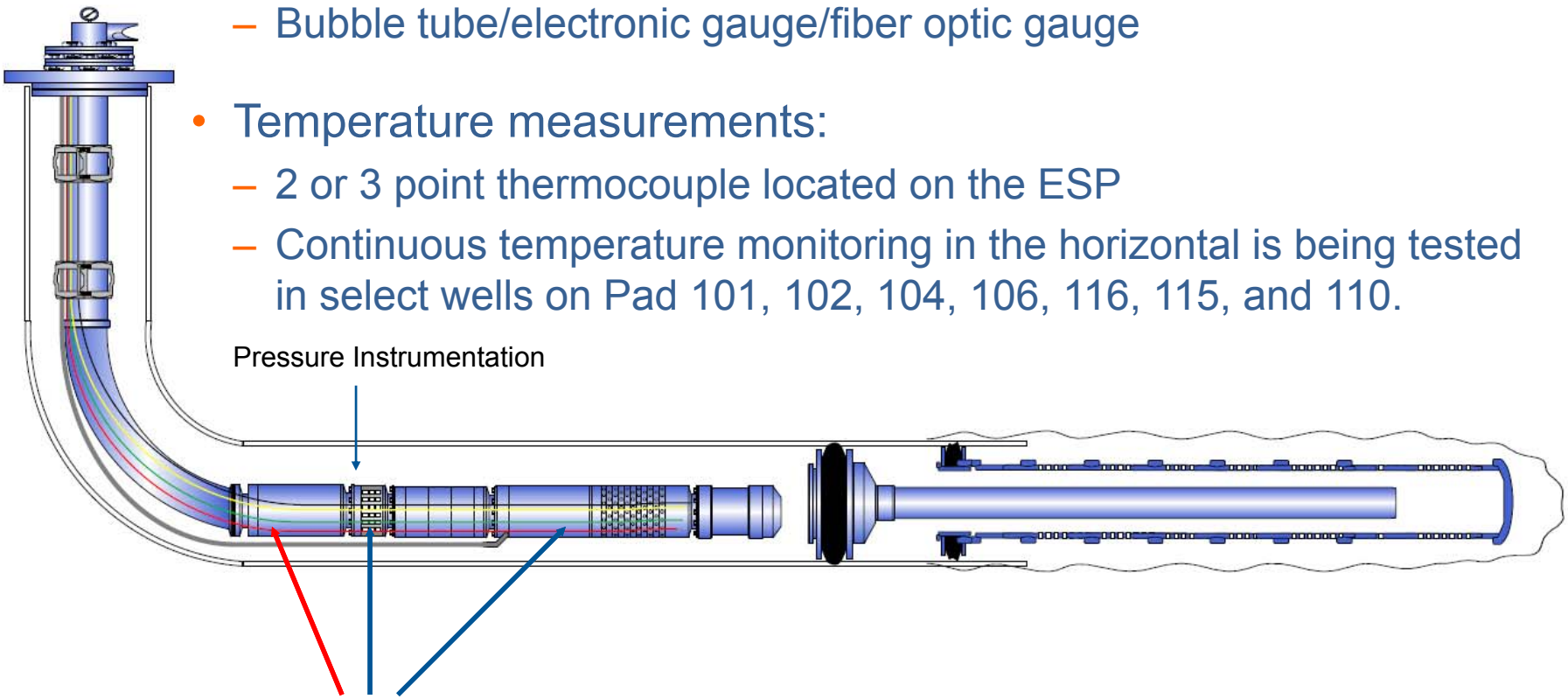
Instrumentation - SAGD Wells

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 - Fiber in 2N2/3 - Motor winding/intake (infills)	- EZ Chamber 2P1/2/4/5/7/8 - 2P3/10 – ERD Gauges - Bubble Tube (infills)
Pad 103/104 (including infills)	- 2-3 pt. ESP Thermocouple - 3P9 internal motor TC - 104 N infills, 4N9, 4N10 and 3N8 Fiber	- Bubble Tube - P/T Intake gauges (infills)
Pad 107/108	- 2-3 pt. ESP Thermocouple - 7P5 Paine & RTD sensor	- Bubble Tube
Pad 105	- 2-3 pt. ESP Thermocouple - Fiber in 5P15	- 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 (2/4/6/8)	- 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 16P5/9/13/15/16/18	- Bubble Tube
Pad 110	- 2 pt. ESP Thermocouple - Fiber in 10P2/3/4/5/6/7/8	- Bubble Tube
Pad 109	- 2 pt. ESP Thermocouple - 6 pt. Thermocouple in 9P2/4/6/8/10	- Bubble Tube
All Injectors	- 15S4 (6pt TC), 15S5 (fiber)	- Blanket Gas

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 is being tested in select wells on Pad 101, 102, 104, 106, 116, 115, and 110.



Downhole Instrumentation Learnings

- The following has been learned through continuous downhole temperature measurement in the horizontal of SAGD production wells:
  - Confirm ‘steam-to-toe’ during start-up phase to ensure even heating of reservoir
    - Suncor has adjusted startup strategy by changing injection rates and monitoring instrumentation to determine when steam has reached the toe of the horizontal well
  - Ability to assess temperature differences along the well and relate to
    - Wellbore deviation
    - Completion
    - Geology
  - Identification of steam breakthrough zones using downhole temperature
    - Suncor is able to diagnose the location of steam breakthrough zones when they exist
    - Steam breakthrough zones may hurt production, as steam will be preferentially produced over emulsion. Steam will also gas lock the ESP and cause a trip or unstable operation
    - Suncor has improved production rates on certain wells utilizing work-overs designed to restrict flow from steam breakthrough zones

Future SAGD Well Instrumentation Plans

- Suncor Firebag is currently reviewing the following down hole pressure and temperature measurement schemes against their technical and economic merit:
  - Integrated pressure and temperature sensors with ESP
  - ESP Discharge pressure gauge
  - Temperature measurement in horizontal

- These technologies will be given consideration against the current pressure and temperature monitoring requirements for both producers and injector wells

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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:
  - (7) Production wells
  - (0) Injection wells

Location of Production Well FCD Installations at Firebag

Pad	Wells	Type
Pad 101	1	Series of orifices
Pad 104	1	Impinging orifices
Pad 106	1	Series of orifices
Pad 110	4	Series of orifices

- Main Learnings:
  - Hot spots can develop in a wellbore due to well operating practices or heterogeneous geology
    - We believe FCDs choke steam production, aiding in steam trap control. This allows us to increase drawdown and improve production conformance
  - Vendors are supplying FCDs developed for conventional wells
    - A purpose built SAGD device could be a game changer if it blocked steam better

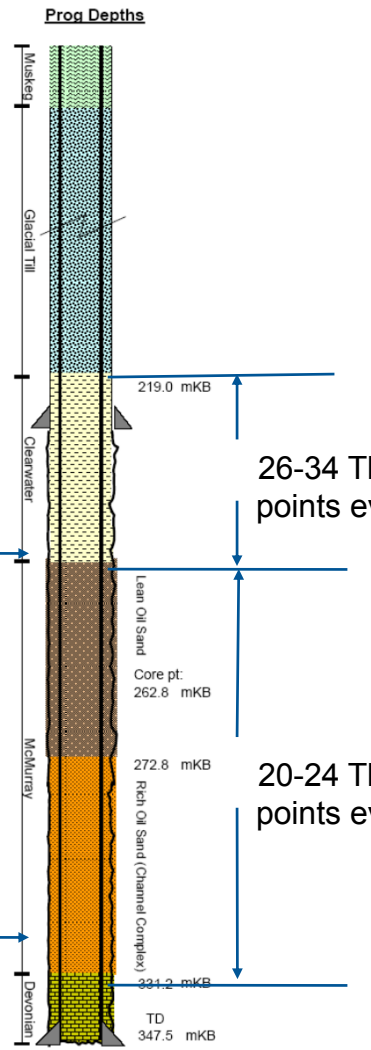
Typical SAGD Observation Wells

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:

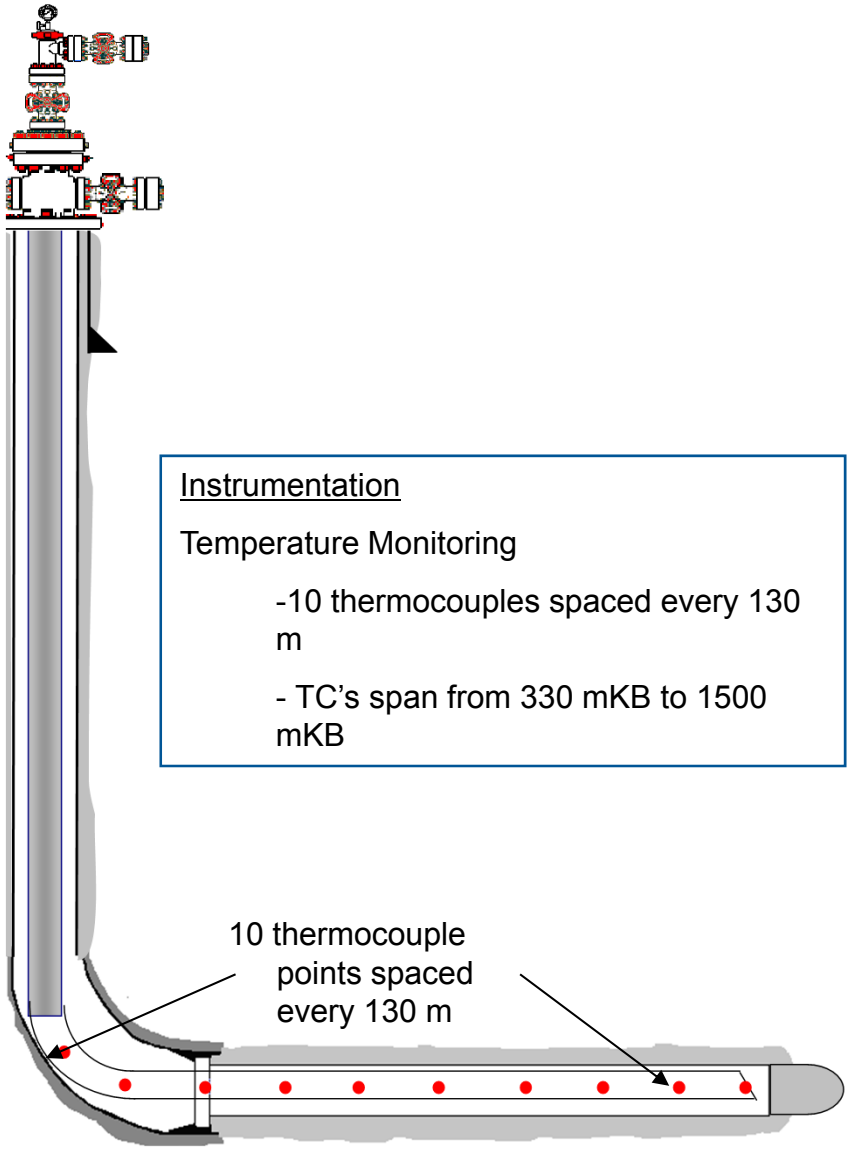
- Base to top of McMurray
- 20-24 TC spaced every 3 to 4 m

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

Horizontal Observation Well Configuration



Instrumentation

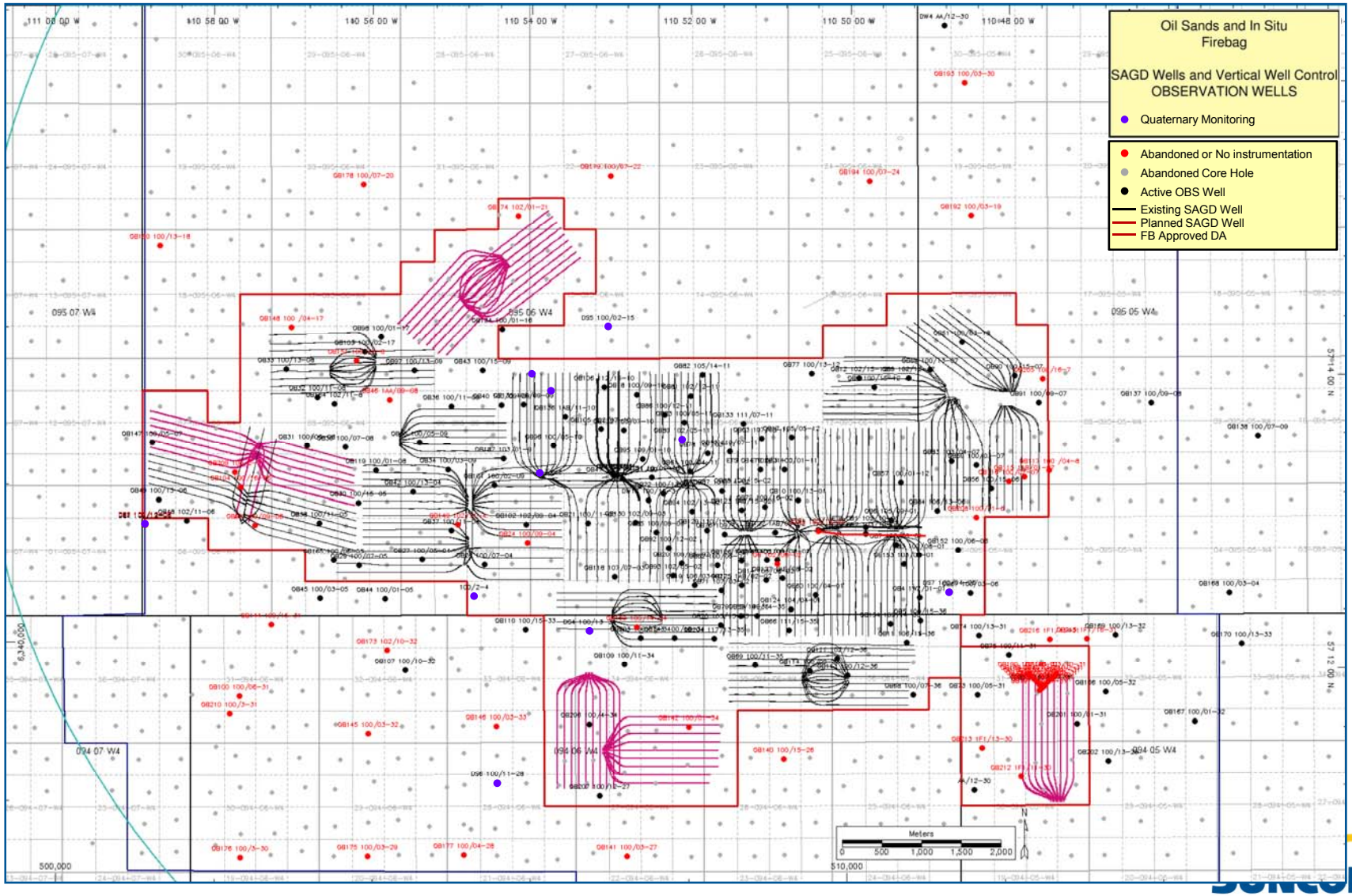
Temperature Monitoring

-10 thermocouples spaced every 130 m

- TC's span from 330 mKB to 1500 mKB

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

Observation Well Location Map



Instrumentation – SAGD Observation Wells

Well	Temperature	Pressure
OB111, OB114	1 Point Thermocouple	1 Piezometer
DW OB1, OB DW4	1 Point Thermocouple	2 Piezometers
OB10, OB107, OB110, OB19, OB37-40, OB67-69, OB74-75, OB8	2 Point Thermocouple	2 Piezometers
OB164	5 Point Thermocouple	5 Piezometers
OB165	6 Point Thermocouple	6 Piezometers
ETS1, P5S2-4 OB	10 Point Thermocouple	N/A
ETS OB1, ETS OB3, ETS OB4, OB12-14, OB17-18, OB20-23, OB27-36, OB42-45, OB47, OB6-7, OB9	24 Point Thermocouple	N/A
OB49, OB51, OB54, OB56, OB62	24 Point Thermocouple	1 Piezometer
OB48, OB182	24 Point Thermocouple	2 Piezometers
OB63	24 Point Thermocouple	3 Piezometers
OB152	24 Point Thermocouple	5 Piezometers
OB202	30 Point Thermocouple	3 Piezometers
OB122-127, OB129-130, OB132-133, OB143	40 Point Thermocouple	N/A
OB128, OB135-137	40 Point Thermocouple	1 Piezometer
OB118-119, OB131, OB134	40 Point Thermocouple	2 Piezometers
OB203-204	40 Point Thermocouple	4 Piezometers
OB153-4	40 Point Thermocouple	5 Piezometers
OB DS4	43 Point Thermocouple	6 Piezometers
OB57	46 Point Thermocouple	2 Piezometers

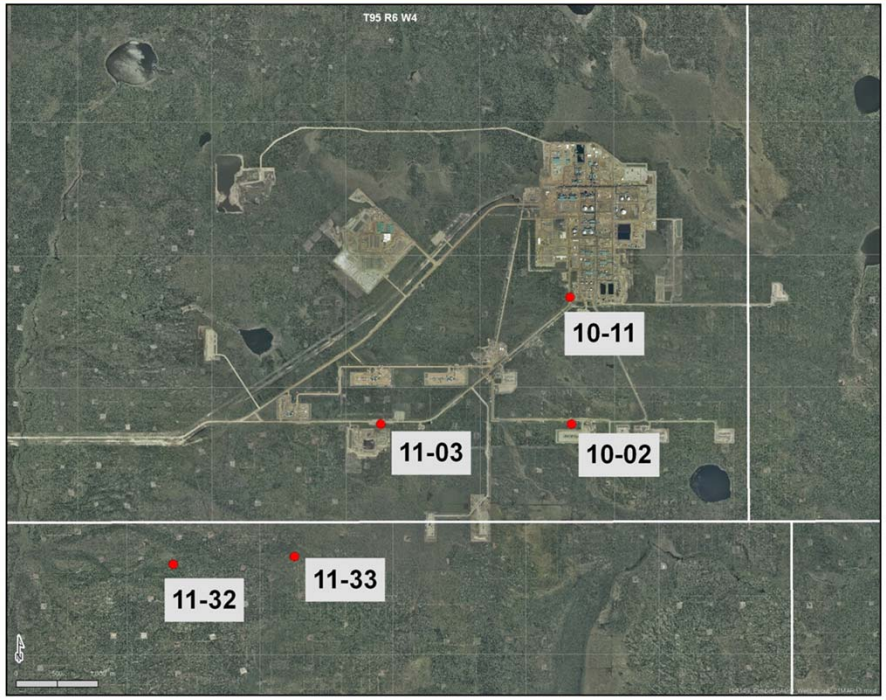
Instrumentation – SAGD Observation Wells

Well	Temperature	Pressure
OB3, OB5	54 Point Thermocouple	N/A
OB59, OB4	54 Point Thermocouple	2 Piezometers
OB66, OB70-73, OB76-98, OB101-103, OB105-106	56 Point Thermocouple	2 Piezometers
OB61	58 Point Thermocouple	1 Piezometer
OB60	58 Point Thermocouple	2 Piezometers
OB DW12, OB138, QW1-2, QW4, OB147	N/A	1 Piezometer
PP7, OB167-168, OB170, OB205	N/A	2 Piezometers
OB DS2, DS5, OB166, OB169, OB201	N/A	3 Piezometers
OB DS1	N/A	4 Piezometers
DS6	N/A	5 Piezometers

1981 Inactive Wells

- Five wells were drilled as per regulatory standards in 1981
  - The wells were cemented 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

1981 Inactive Wells Locations



UWI	License #	Spud Date	Distance to Planned Steam Operations (m)	Closest Well
10-02-095-06W4	A0088049C	2/4/1981	Approx. 3	Pad 108, 8S10
11-03-095-06W4	A0088049D	1/27/1981	Approx. 34	Pad 116, 16P9
10-11-095-06W4	A0088049E	2/14/1981	Approx. 355	Pad 104, 4N6
11-32-094-06W4	A0088049B	1/18/1981	Approx. 1060	Pad 117, 17S7
11-33-094-06W4	A0088049E	1/28/1981	Approx. 876	Pad 117, 17P6

1981 Inactive Wells Locations Continued

- All 1981 Inactive Wells were inspected Sept. 5 - 9, 2015

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

1964 Vintage Wells

- Six of seven 1964 vintage well sites in the Firebag thermal recovery area have been located and properly abandoned with thermal cement

UWID	License #	Spud Date	Distance from steam operations	Re-Abandonment Approved by AER	Comments
1AA/11-22-095-06W4/00	0025561D	3/24/1964	Approximately 3000m	Yes	Located & Abandoned 2009
1AA/05-28-094-06W4/00	0026040A	3/9/1964	Approximately 3000m	Yes	Located & Abandoned 2009
1AA/06-08-095-06W4/00	0026038A	3/15/1964	Approximately 4000m	Yes	Located & Abandoned 2010
1AA/15-32-095-06W4/00	0025561E	3/28/1964	Approximately 6000m	Yes	Located & Abandoned 2010
1AA/14-32-093-06W4/00	Y0002251	2/18/1964	Approximately 10000m	Yes	Located in 2011, Abandoned in 2012
1AA/08-22-093-06W4/00	0026039A	2/22/1964	Approximately 10000m	Yes	Located in 2011, Abandoned in 2012
1AA/16-15-096-06W4/00	0025561F	3/30/1964	Approximately 10000m	Yes	1 of 2 wells located in 2011, other to be located and both to be abandoned with indication of development in area

- 11-22, 6-8, 5-28, 15-32, 14-32, and 08-22 were abandoned with thermal cement and cut and capped according to current Directive 20 standards
- 2 joints of casing were cemented in place to ensure future identification
- 16-15 had two wellbores drilled originally
  - Have located the shallower of the two, will be abandoned at a later date
  - To be located and abandoned when development plans move north of current pads
  - Access to location has been built

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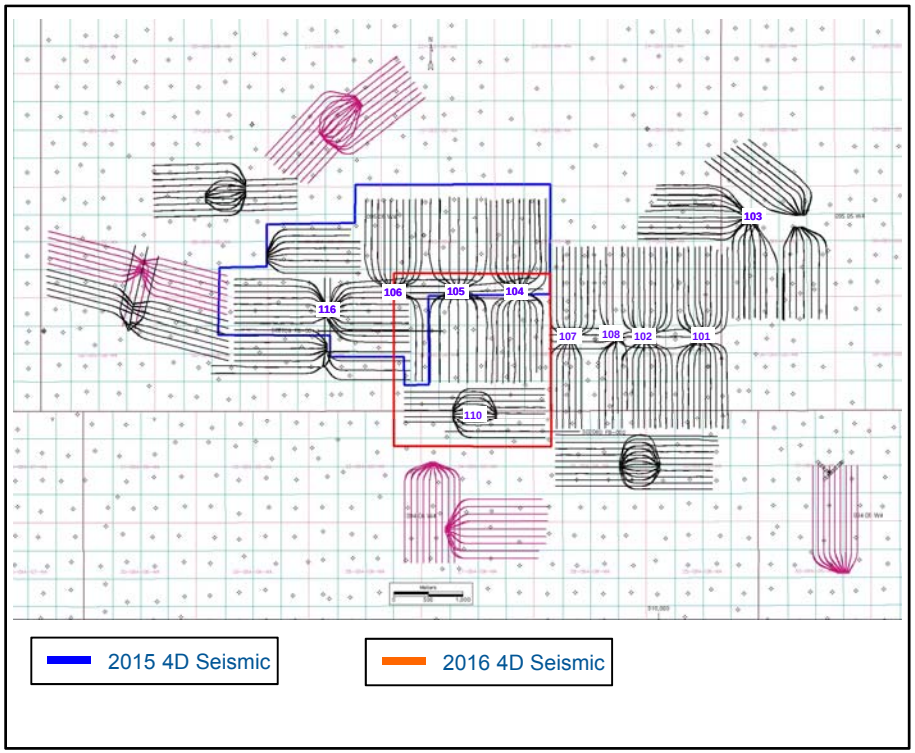
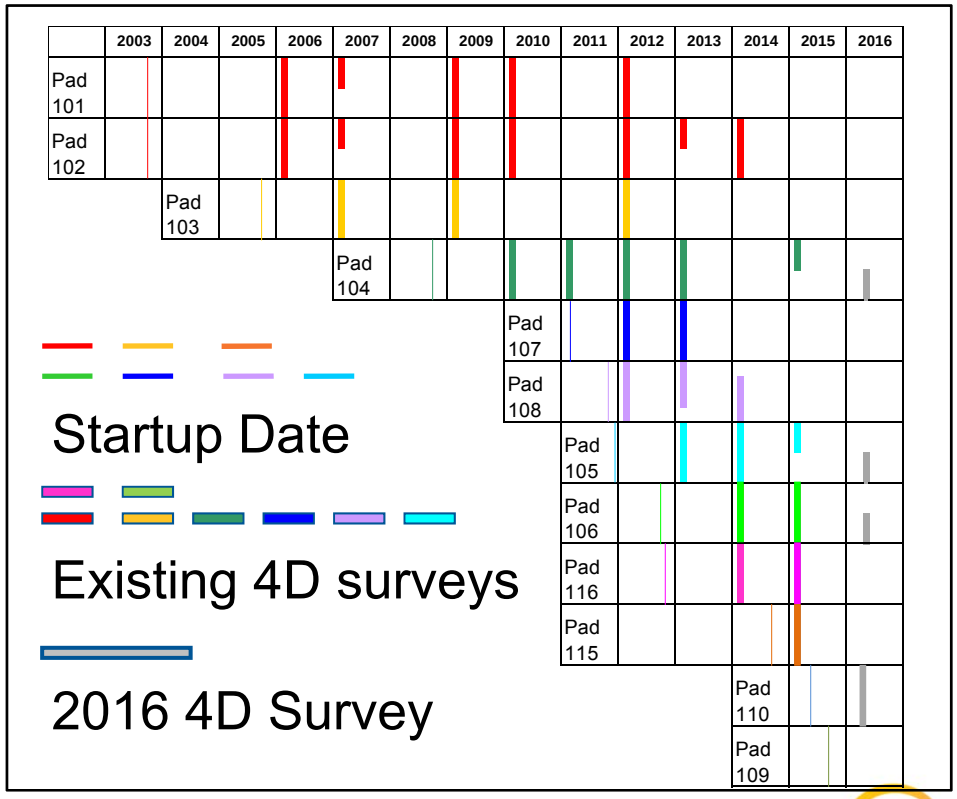
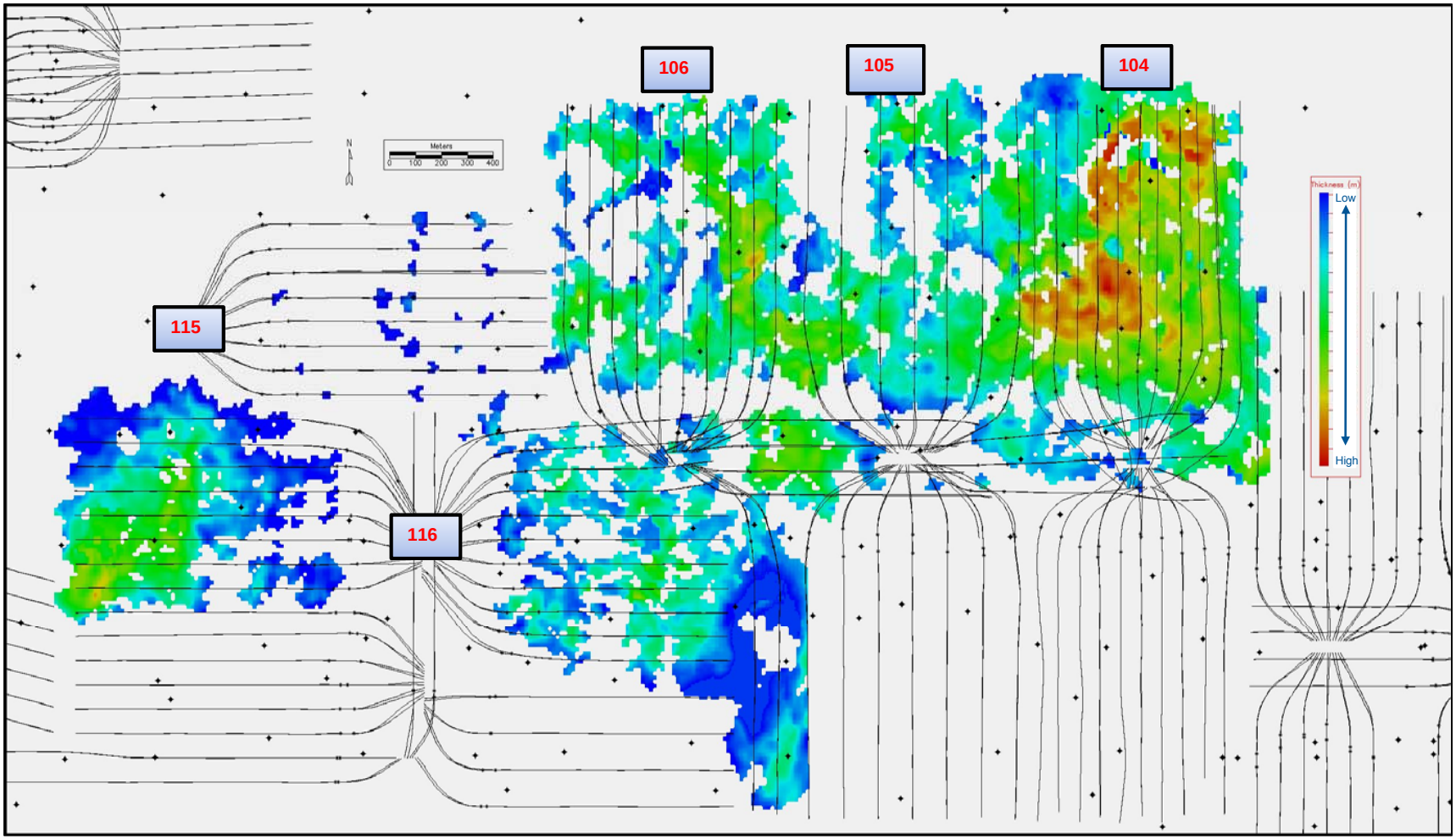
4D Seismic - Survey Outlines

- Suncor places a high value on 4D seismic
- Data were collected in the year indicated and interpretation reported the following year due to required process and interpretation time





2015 4D Seismic - Steam Chamber Thickness Map



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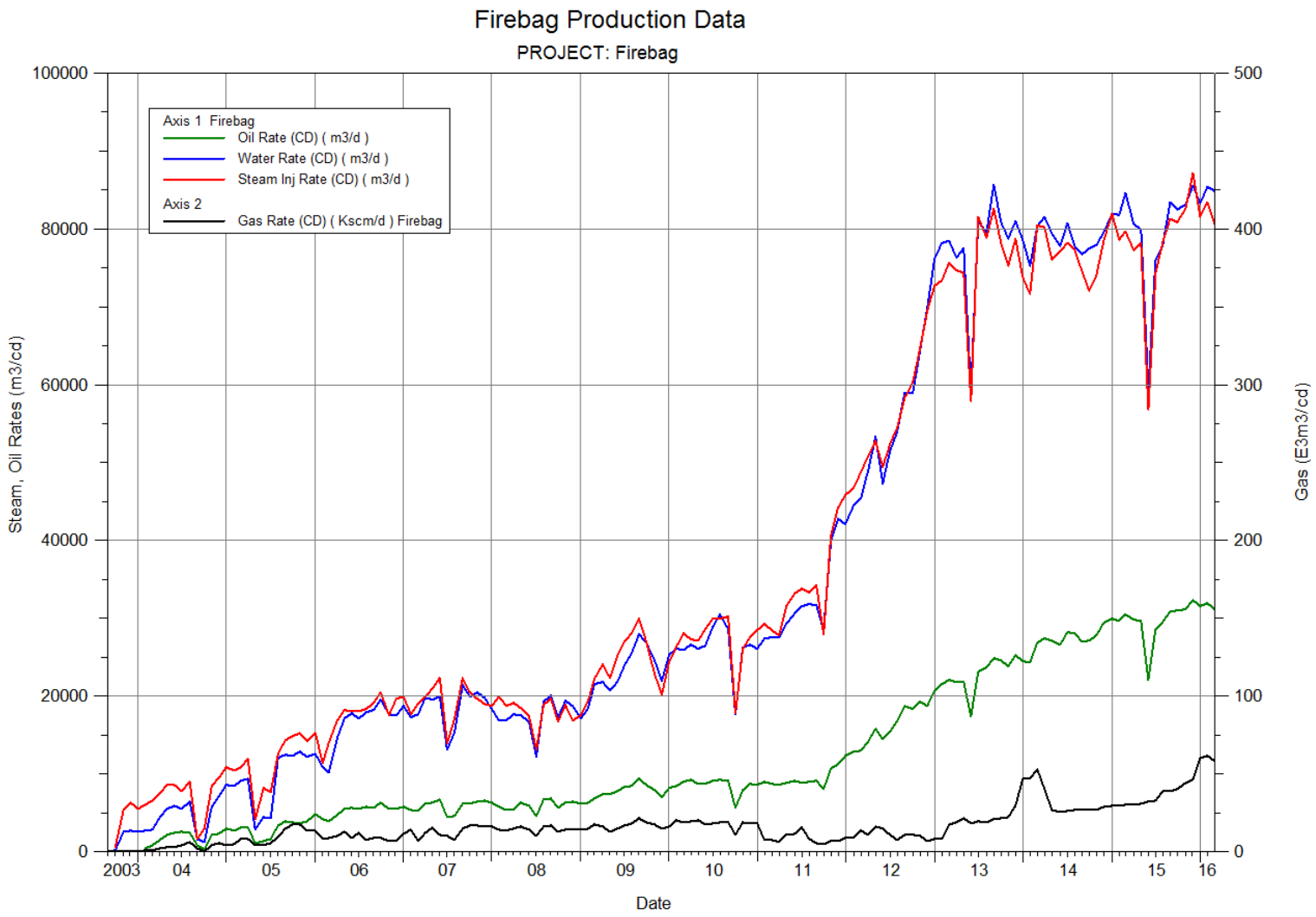
Methodology for Predicting Performance

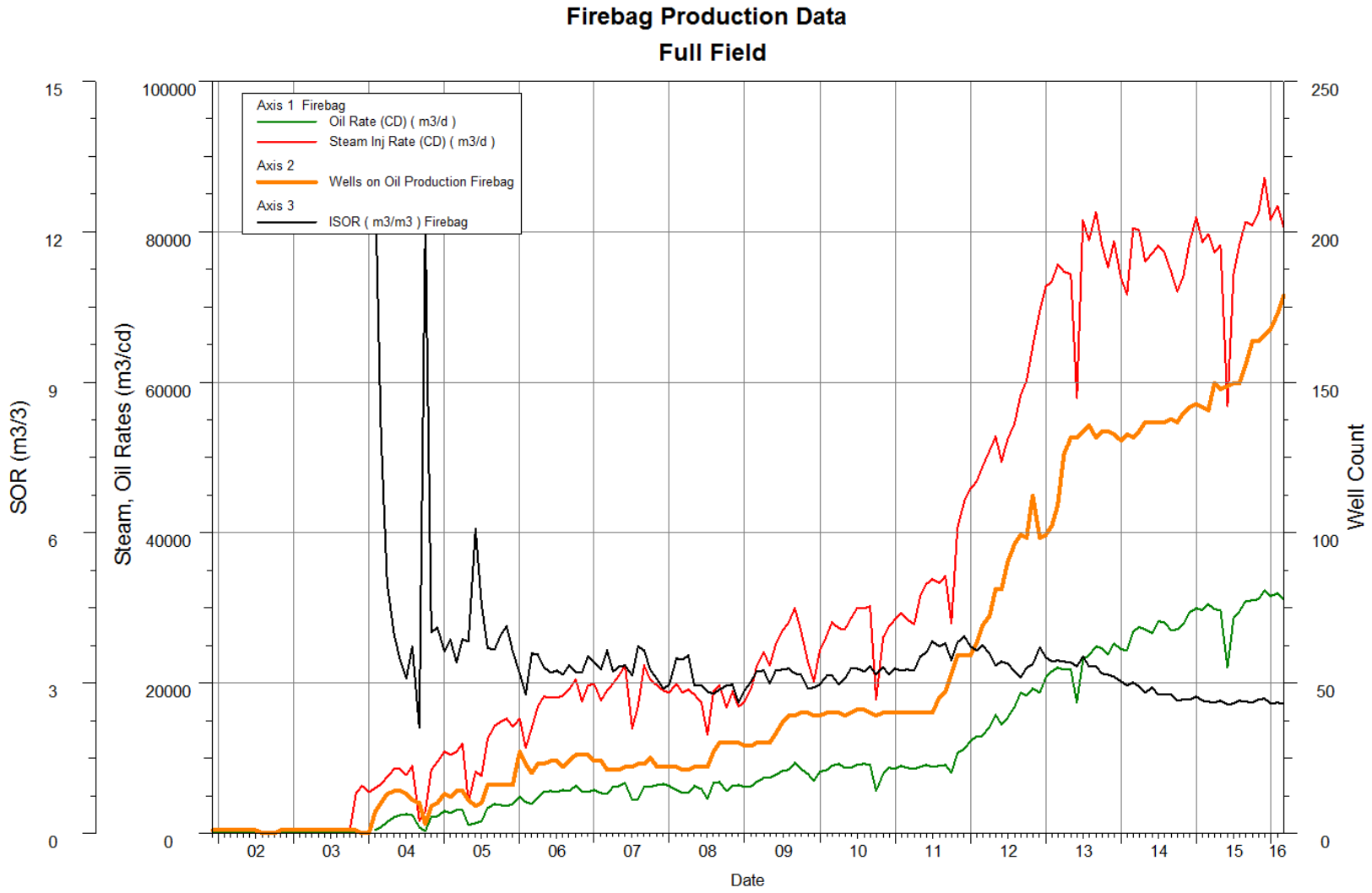
- At Firebag, future performance is predicted by leveraging multiple tools
  - Analytical Models:
    - Modified Butler's Tandrain equations
    - Water balance to monitor well communication
  - Analytical models and flow simulations are history matched on a well pair, pattern and field level

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

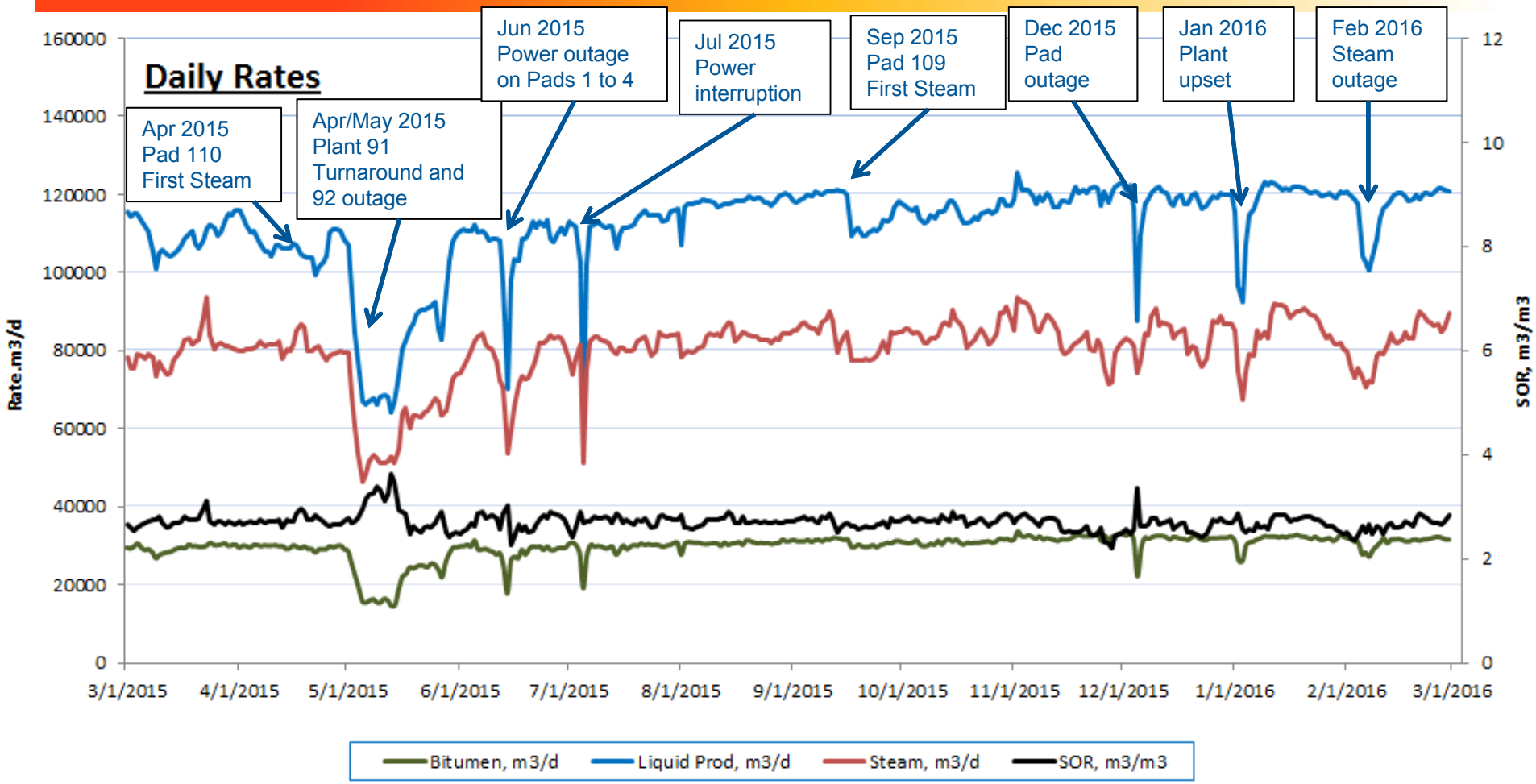
Scheme Performance – Well Production History



Scheme Performance – Well Production History



Issues and Milestones



Firebag Production

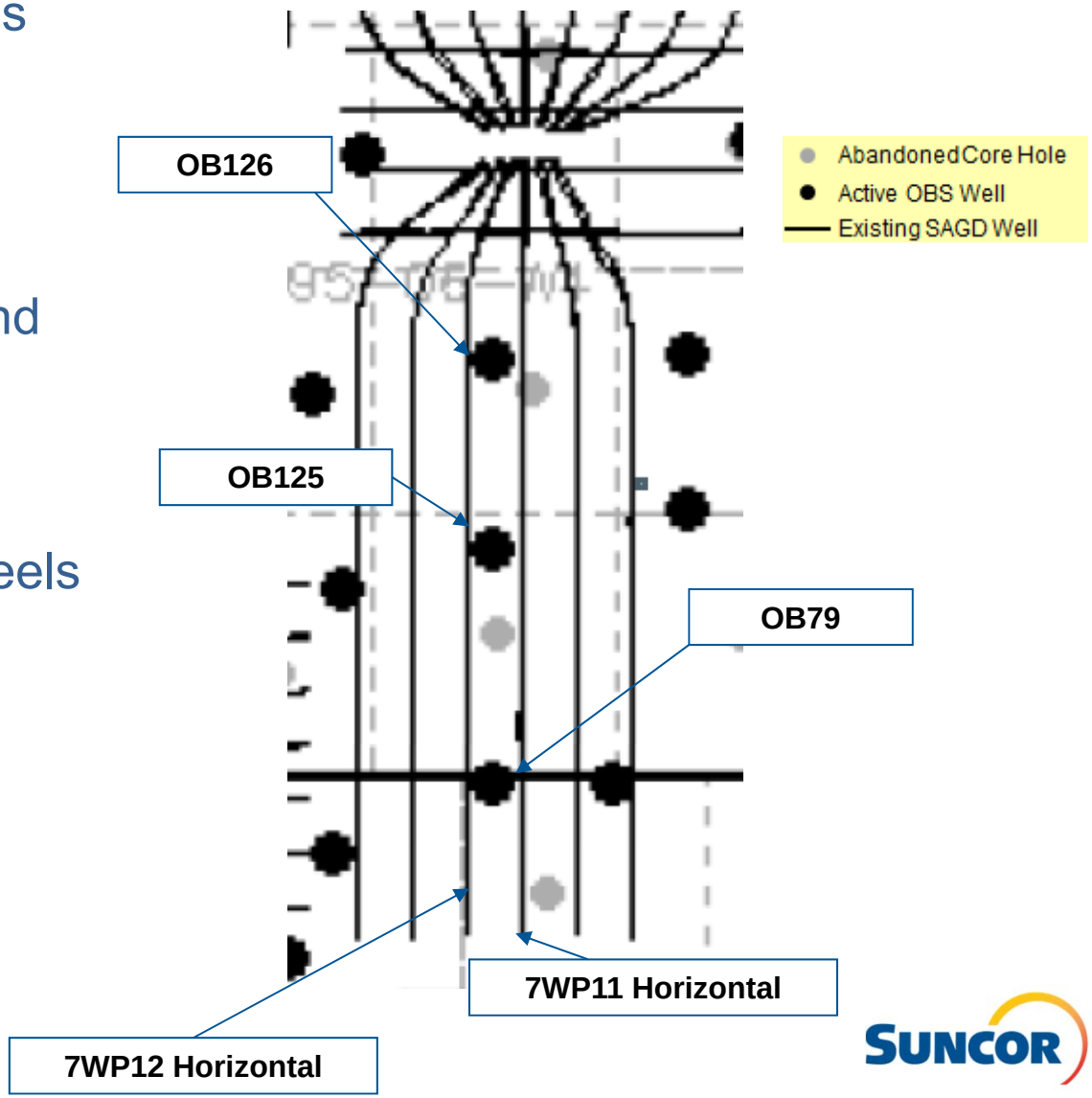
- Highest monthly average bitumen production over reporting period was 203,253 bopd (32,315 m^3/cd) and occurred in November 2015
  - Stages 1, 2, 3, and 4 currently on production
  - Producing well count up by 20% over reporting period

- SOR Discussion
  - As of Feb. 29, 2016 cumulative SOR at Firebag is 3.09 m^3/m^3
  - SOR over the reporting period was 2.62 m^3/m^3
    - SOR has been improving over the reporting period
    - Infill wells positively impacted SOR

- Infill Wells
  - Pads 101, 102, 103, and 104
  - Current interwell spacing of 80 meters
  - Positive impact on rate and recovery as well as SOR

Steam Chamber Discussion – 7WP11 / 7WP12

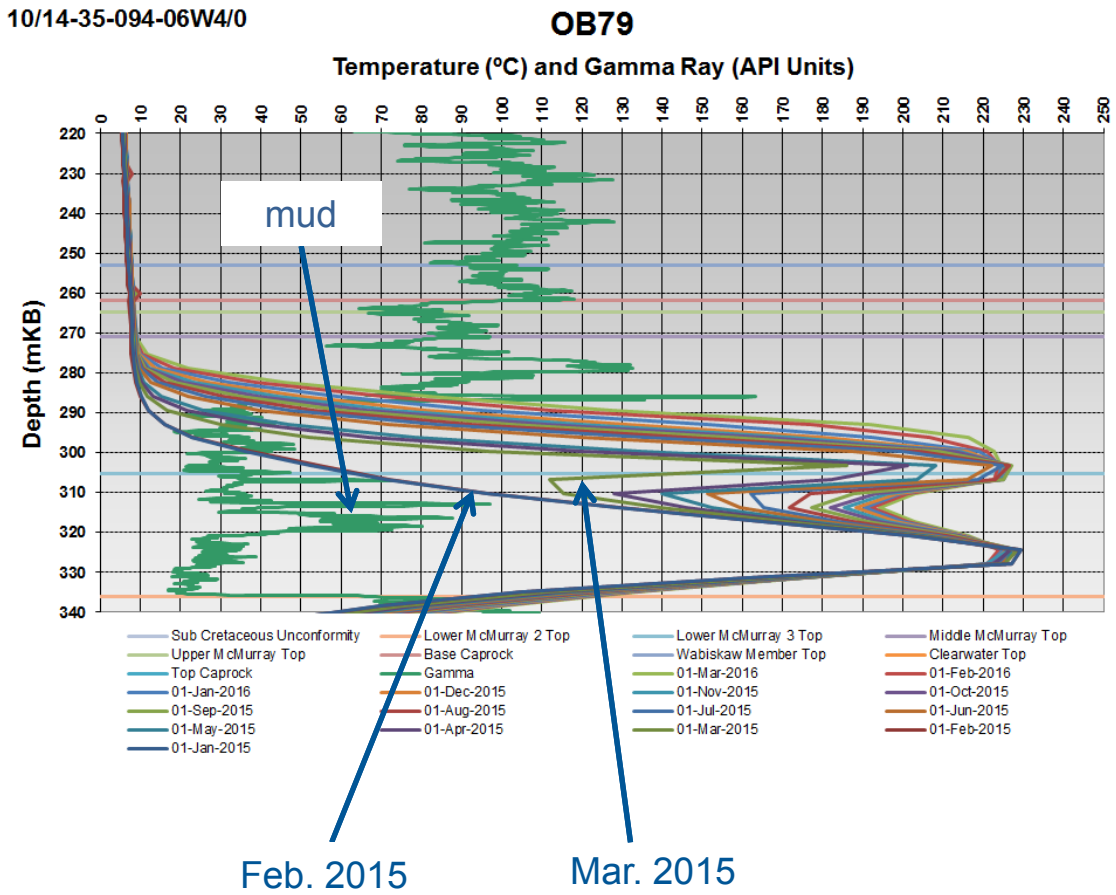
- OB79 located near the toes between 7WP11 and 12
  - 40.8m E of 7WP12
  - 48.2m W of 7WP11
- OB125 located near the middle between 7WP11 and 12
  - 43.8m E of 7WP12
  - 47.4m W of 7WP11
- OB126 located near the heels between 7WP11 and 12
  - 42.2m E of 7WP12
  - 45.1m W of 7WP11
- First steam dates:
  - 7WP11 in April 2011
  - 7WP12 in May 2011



Steam Chamber Discussion – 7WP11 / 7WP12

OB79 – Toe of 7WP11 and 7WP12

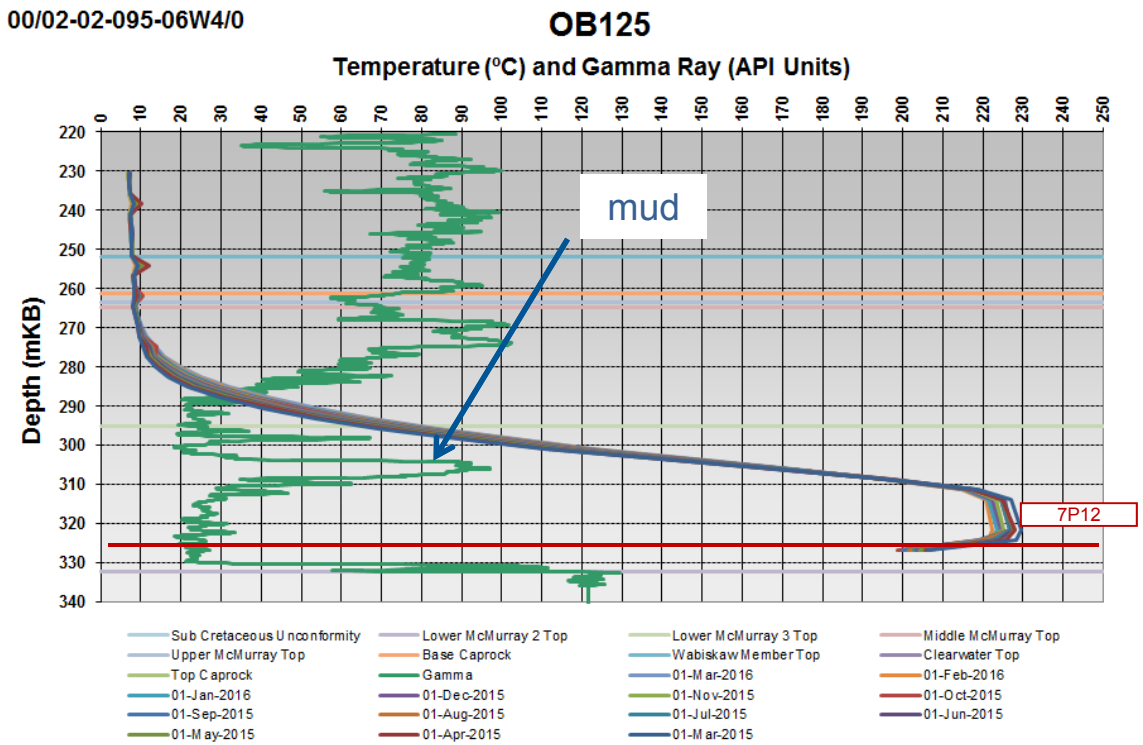
- 40.8m E of 7WP12 and 48.2m W of 7WP11
- Instrumented with 56-point thermocouples covering the lower McMurray 2 and into the Clearwater
- Temperature began increasing July 2012; 7WP11 first steam in April 2011 and 7WP12 first steam in May 2011
- Steam chamber top capped underneath a mud at 320mKB from 2012 to February 2015
- Steam temperature was seen above the mud since March 2015, indicating steam chamber is growing above



Steam Chamber Discussion – 7WP11 / 7WP12

OB125 – Middle Section of 7WP11 and 7WP12

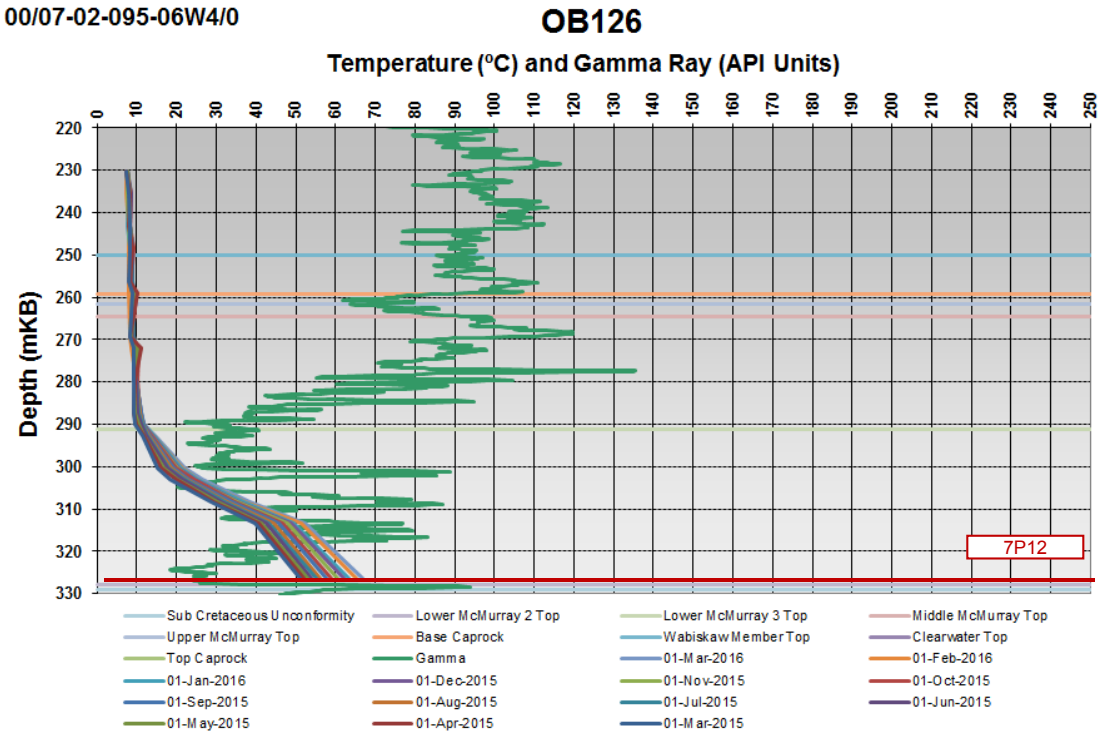
- 43.8m E of 7WP12 and 47.4m W of 7WP11
- Instrumented with 40-point thermocouples covering the lower McMurray 3 and into the Clearwater
- Temperature began recording in August 2012 and seeing temperature increase
- 7WP11 first steam in April 2011 and 7WP12 first steam in May 2011
- Steam chamber top capped underneath a mud at 310mKB



Steam Chamber Discussion – 7WP11 / 7WP12

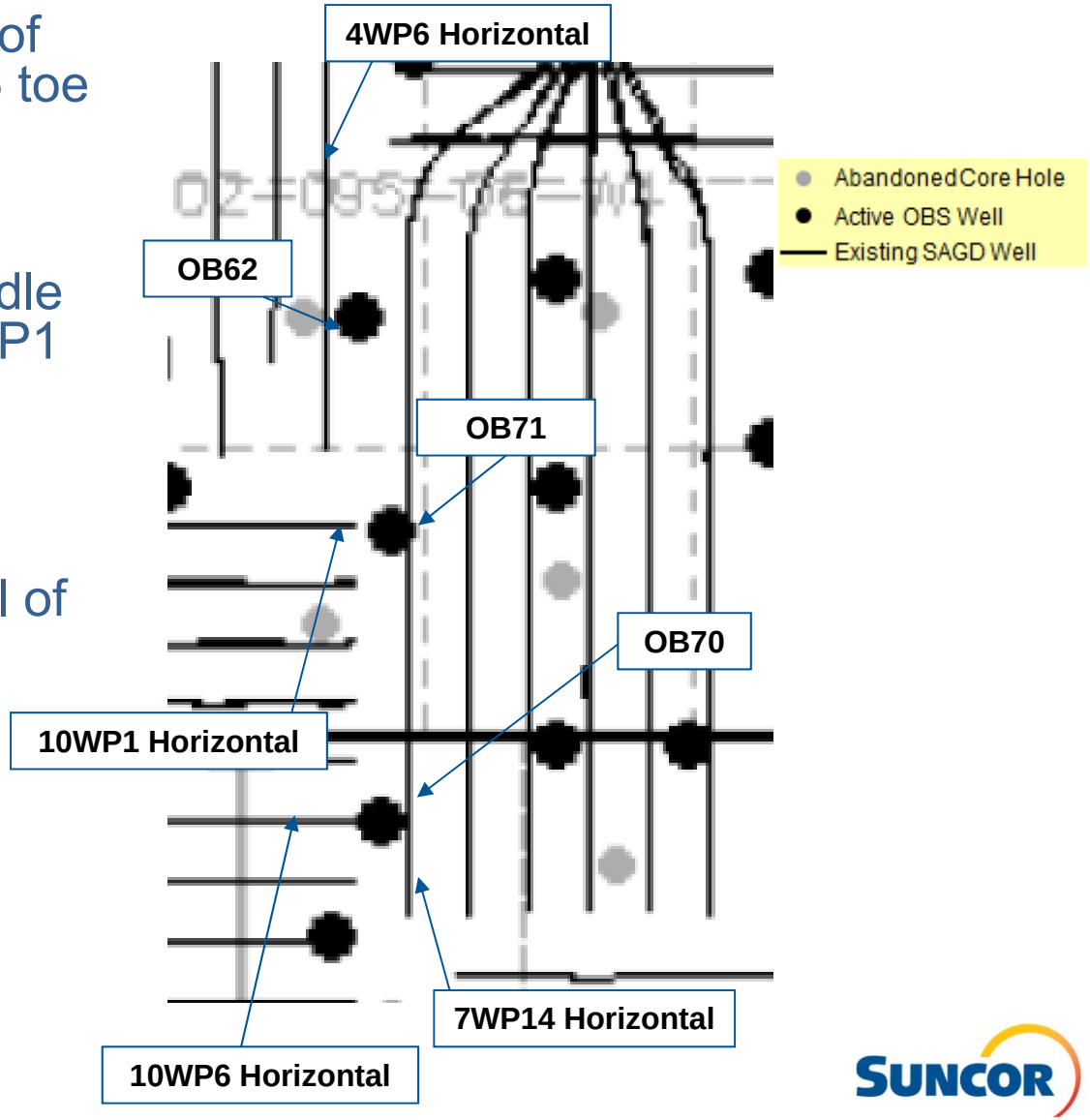
OB126 – Heel of 7WP11 and 7WP12

- 42.2m E of 7WP12 and 45.1m W of 7WP11
- Instrumented with 40-point thermocouples covering the lower McMurray 3 and into the Clearwater
- 7WP11 first steam in April 2011 and 7WP12 first steam in May 2011
- Temperature started increasing October 2013
- Chamber has been slowly growing towards this area



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

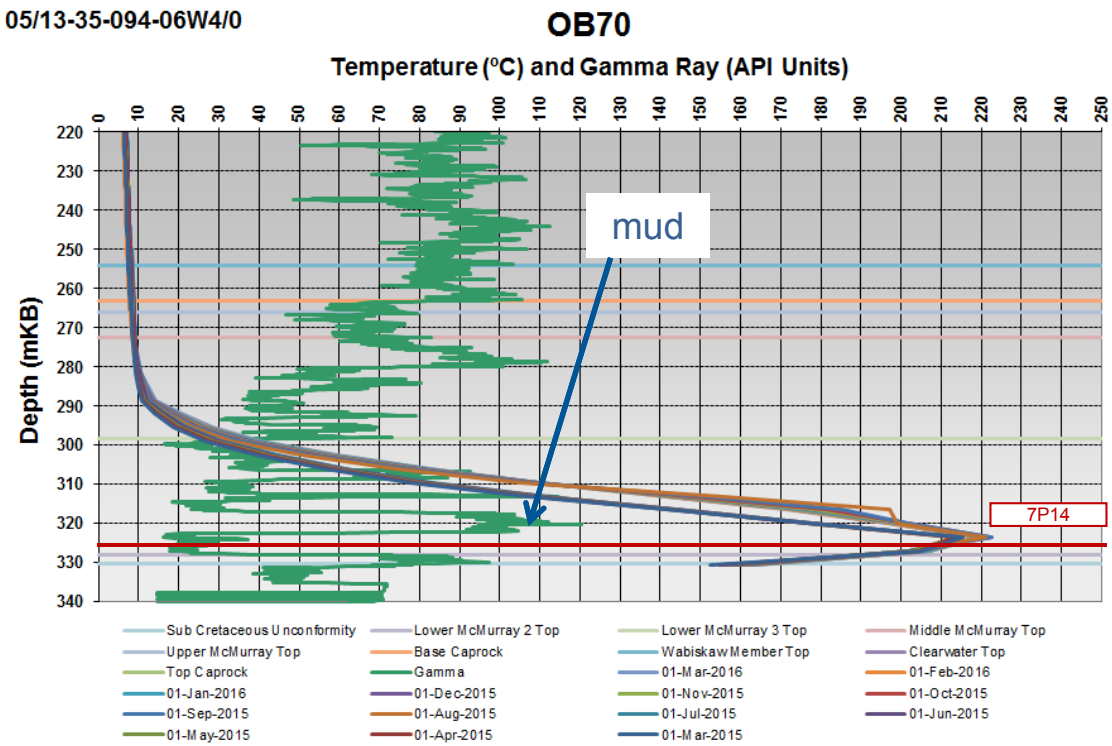
- OB70 located near the toe of 7WP14 and east of 10WP6 toe
  - 38.7m W of 7WP14
  - 38.8m E of 10WP6
- OB71 located near the middle of 7WP14 and east of 10WP1 toe
  - 25.7m W of 7WP14
  - 52.5m E of 10WP1
- OB62 located near the heel of 7WP14 and toe of 4WP6
  - 51m E of 4WP6
  - 73m W of 7WP14
- First 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

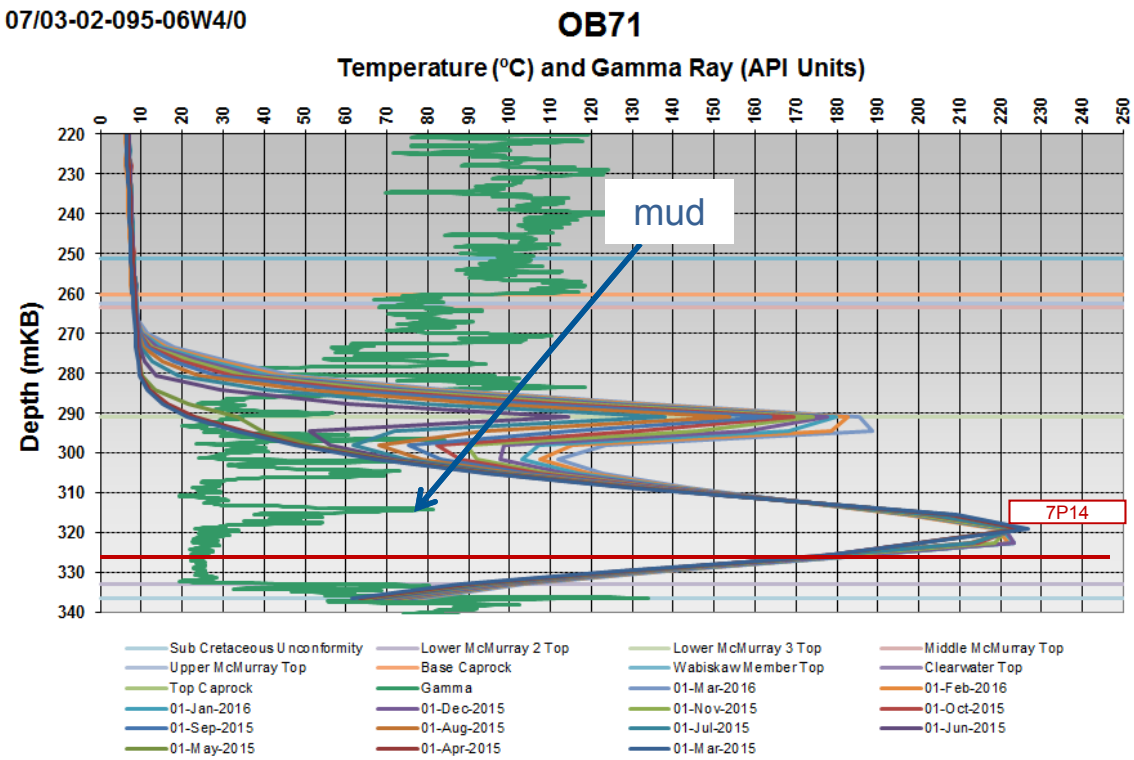
- 38.7m W of 7WP14 and 38.8m E of 10WP6
- Instrumented with 56-point thermocouples covering the lower McMurray 3 and into the Clearwater
- Temperature began increasing August 2012, 7WP14 first steam in May 2011
- Steam chamber top capped underneath mud at 323mKB



Steam Chamber Discussion – 7WP14 / 10WP1

OB71 – Middle of 7WP14 and Toe of 10WP1

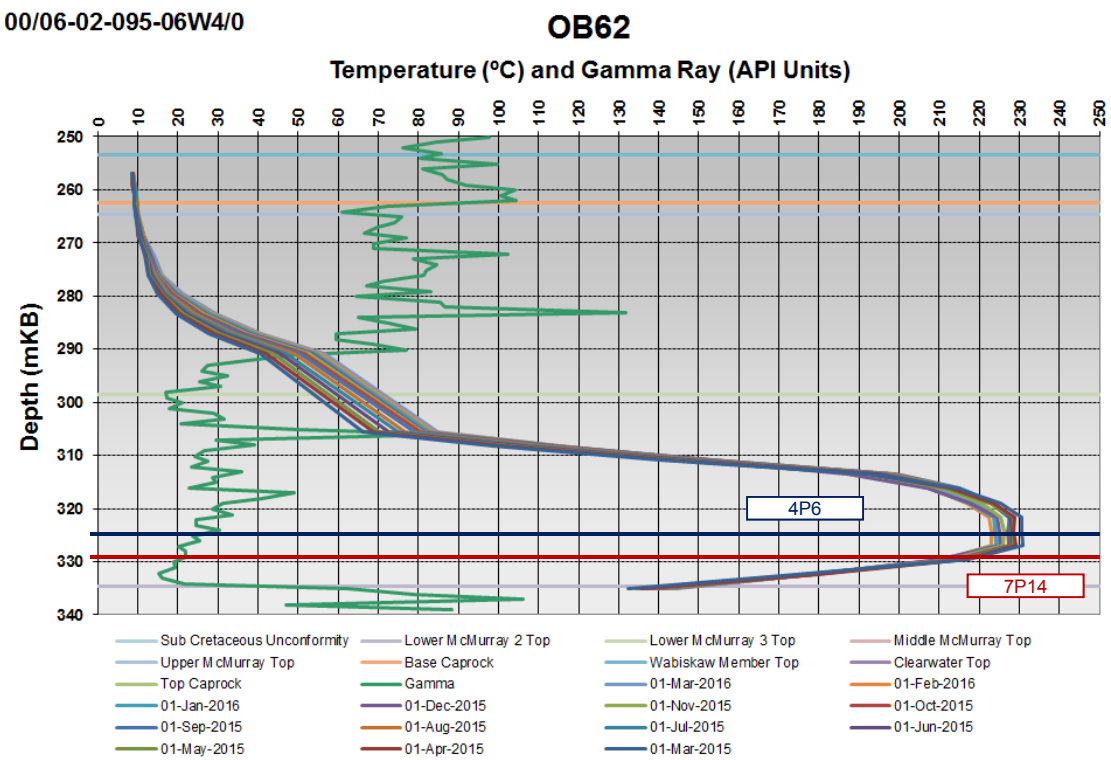
- 25.7m W of 7WP14 and 52.5m E of 10WP1
- Instrumented with 56-point thermocouples covering the lower McMurray 2 and into the Clearwater
- Temperature began increasing August 2012, 7WP14 first steam in May 2011
- Steam chamber top capped underneath a mud at 318mKB from 2012 to May 2015
- Steam temperature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



Steam Chamber Discussion – 7WP14 / 4WP6

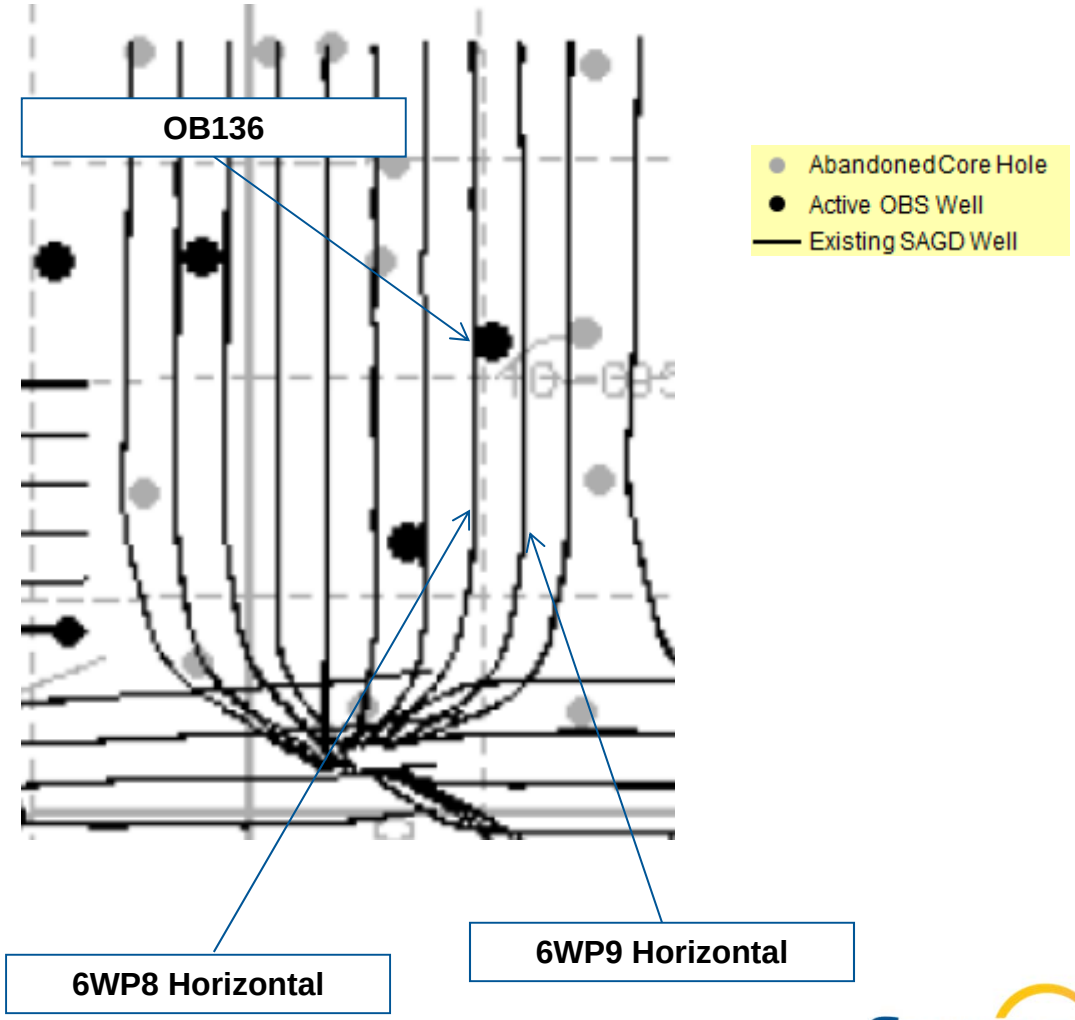
OB62 – Near the heel of 7WP14 and toe of 4WP6

- 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 – 6WP8 / 6WP9

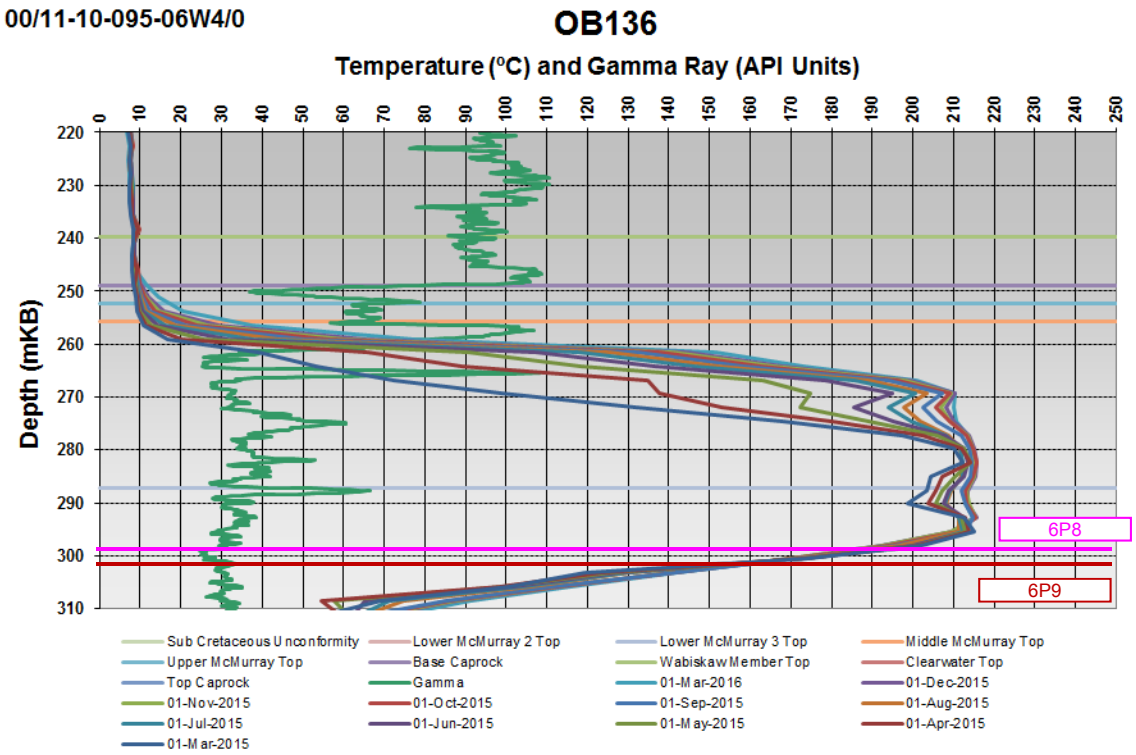
- 6WP8 and 6WP9 have one observation well in the middle section
- OB136 is located at
  - 31.2 m E of 6WP8
  - 59.0 m W of 6WP9



Steam Chamber Discussion – 6WP8 / 6WP9

OB136 – Mid-point of 6WP8 and 6WP9

- 31.2m E of 6WP8 and 59.0m W of 6WP9
- Instrumented with 40-point thermocouples covering the lower McMurray 3 and into the Clearwater
- First steam in September 2012
- Good steam chamber development, chamber top growth from 280mKB to 269mKB over the last year



Pad Recoveries

Pad	101	102	103	104	Stage 1 & 2 Totals
Recovery to Date, e^3m^3	11,916	9,658	8,404	7,010	36,988
Recovery Factor to Date, %	52%	41%	42%	38%	44%
Expected Ultimate Recovery, e^3m^3	14,539	13,788	12,431	11,895	52,653
Expected Ultimate Recovery Factor, %	63%	59%	62%	64%	62%
OBIP, e^3m^3	23,100	23,400	20,000	18,500	85,000

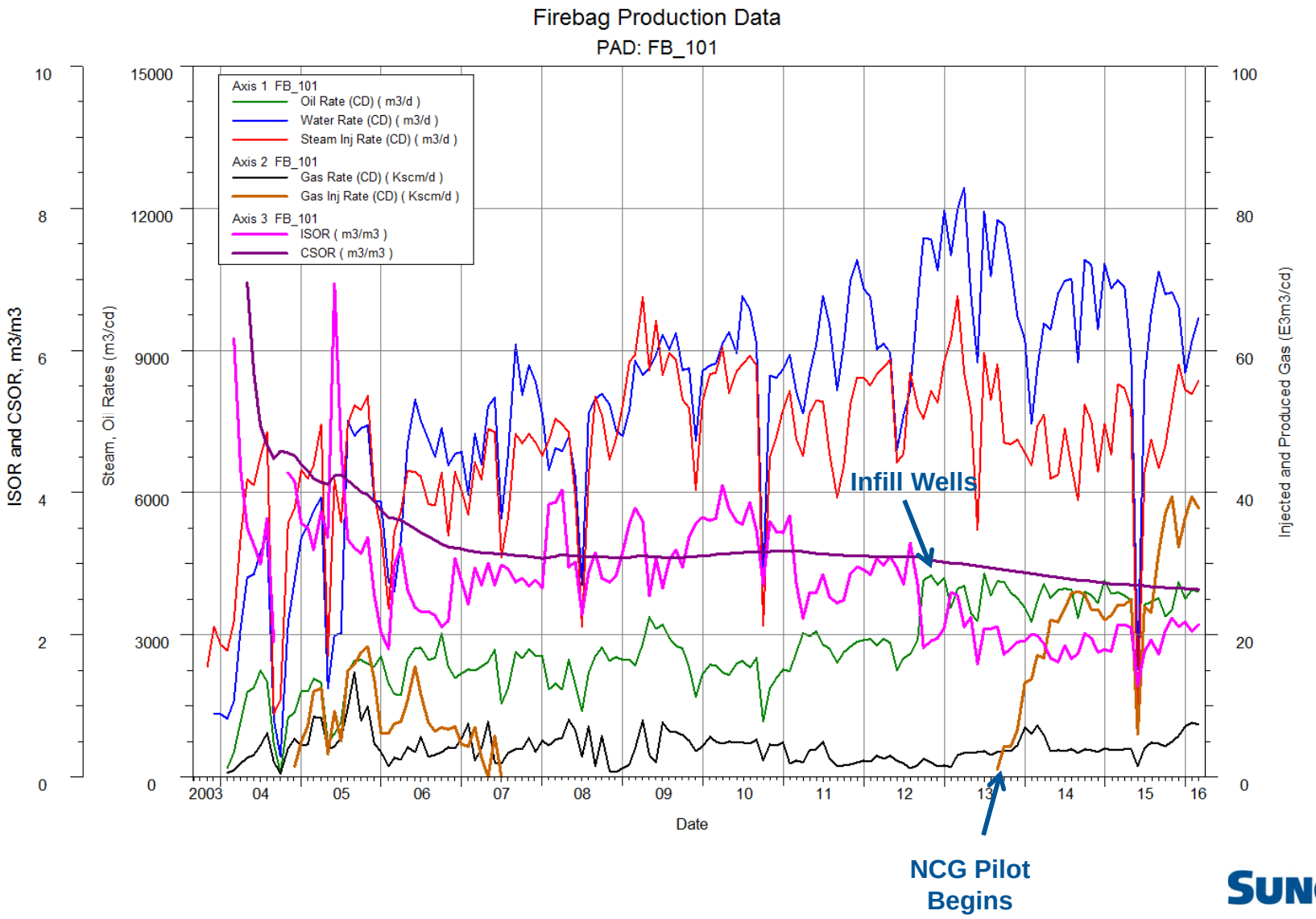
Pad	105	106	107	108	109	110	115	116	Stage 3 & 4 Totals
Recovery to Date, e^3m^3	4,239	2,994	3,852	2,217	17	305	324	3,652	17,600
Recovery Factor to Date, %	18%	16%	31%	13%	0%	3%	7%	21%	15%
Expected Ultimate Recovery, e^3m^3	12,974	9,015	7,763	7,548	6,260	6,286	2,714	10,865	63,426
Expected Ultimate Recovery Factor, %	56%	49%	62%	43%	50%	52%	55%	63%	53%
OBIP, e^3m^3	23,300	18,500	12,600	17,700	12,600	12,000	4,900	17,300	118,900

- Pads 109 and 110 are included

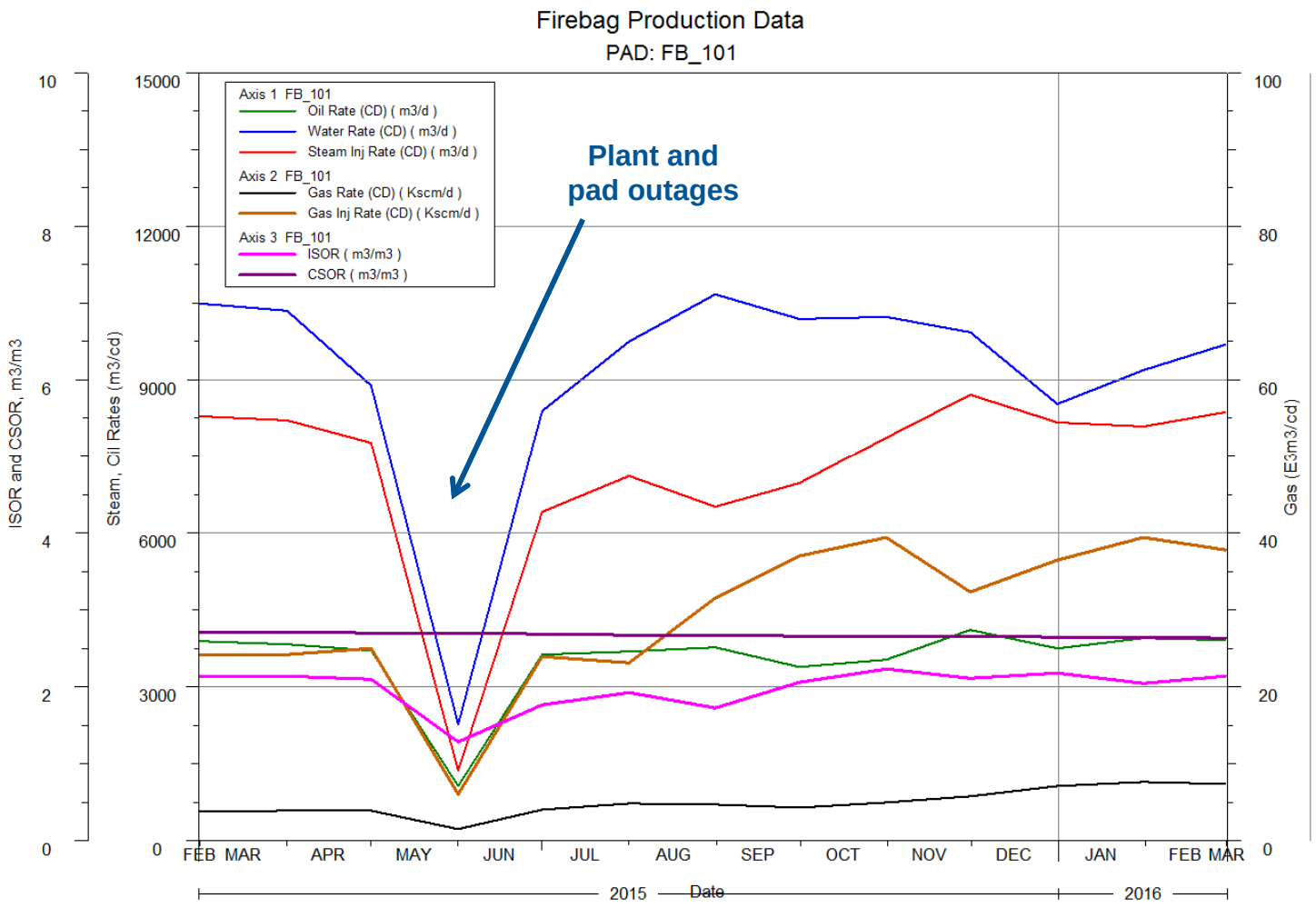
Pad 101 Performance

- Pad 101
  - Most mature pad
  - 17 wells on production
    - 7 well pair producers and 10 infills
  - Monthly steam chamber pressures:
    - Average: 2,240 kPag
    - Range: 2,160 kPag – 2,290 kPag
  - Performance as of Feb. 29, 2016:
    - Cumulative steam injected is 31,422,350 m^3
    - Cumulative oil produced is 11,915,760 m^3
    - Cumulative SOR = 2.64 m^3/m^3
    - Recovery Factor of 52%
  - Non-Condensable Gas Trial started Aug. 2013
    - 1WP6,7,8
  - Pad Learnings
    - Infill wells have shown varying degrees of interference effects on the existing well pairs and have improved performance and lowered SOR
    - Interactions between wells and offsetting pads is important in understanding performance
    - Mature pad with stable performance after shut-in during outages

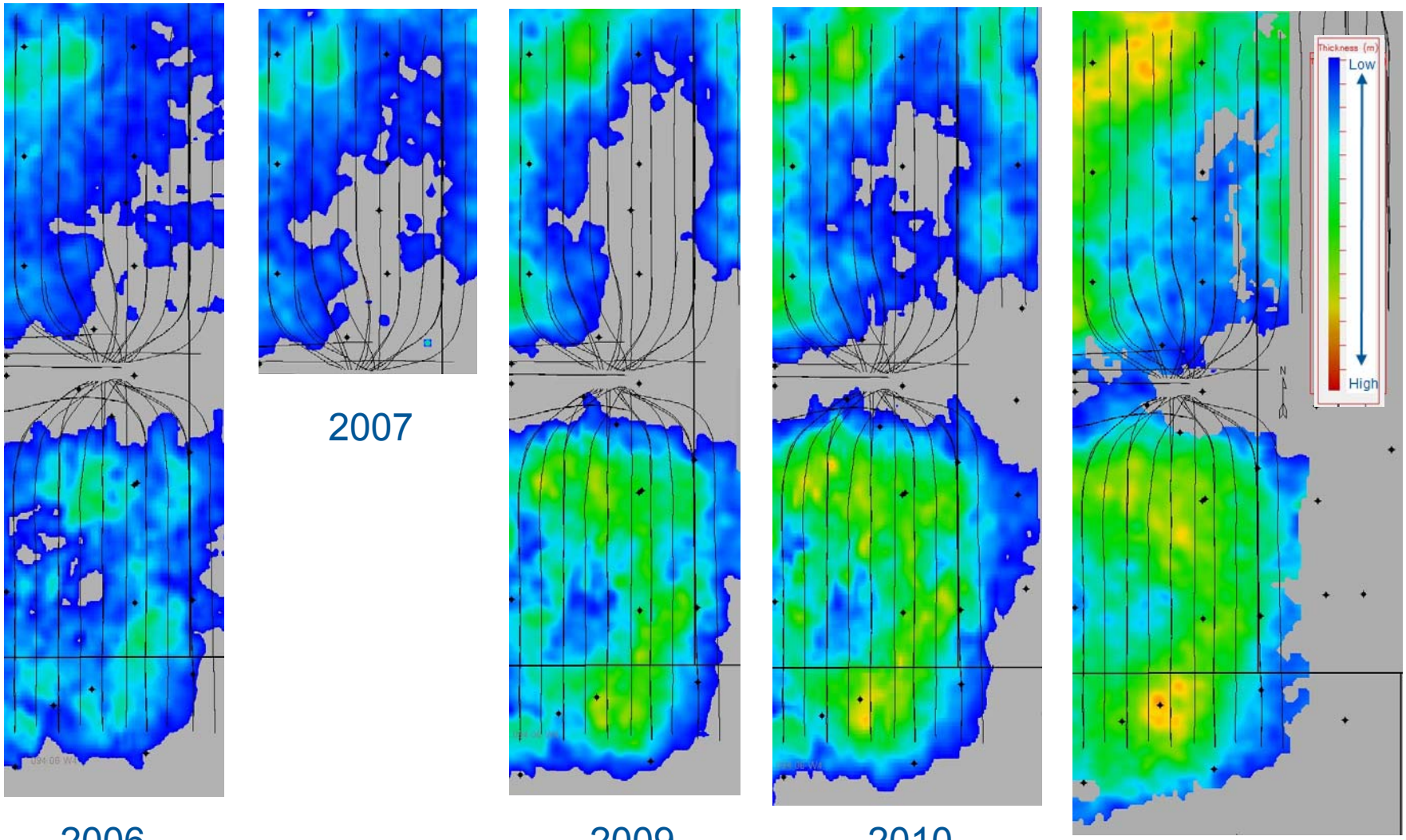
Pad 101 Performance



Pad 101 Performance



Pad 101 Performance - 4D Seismic Time Delay

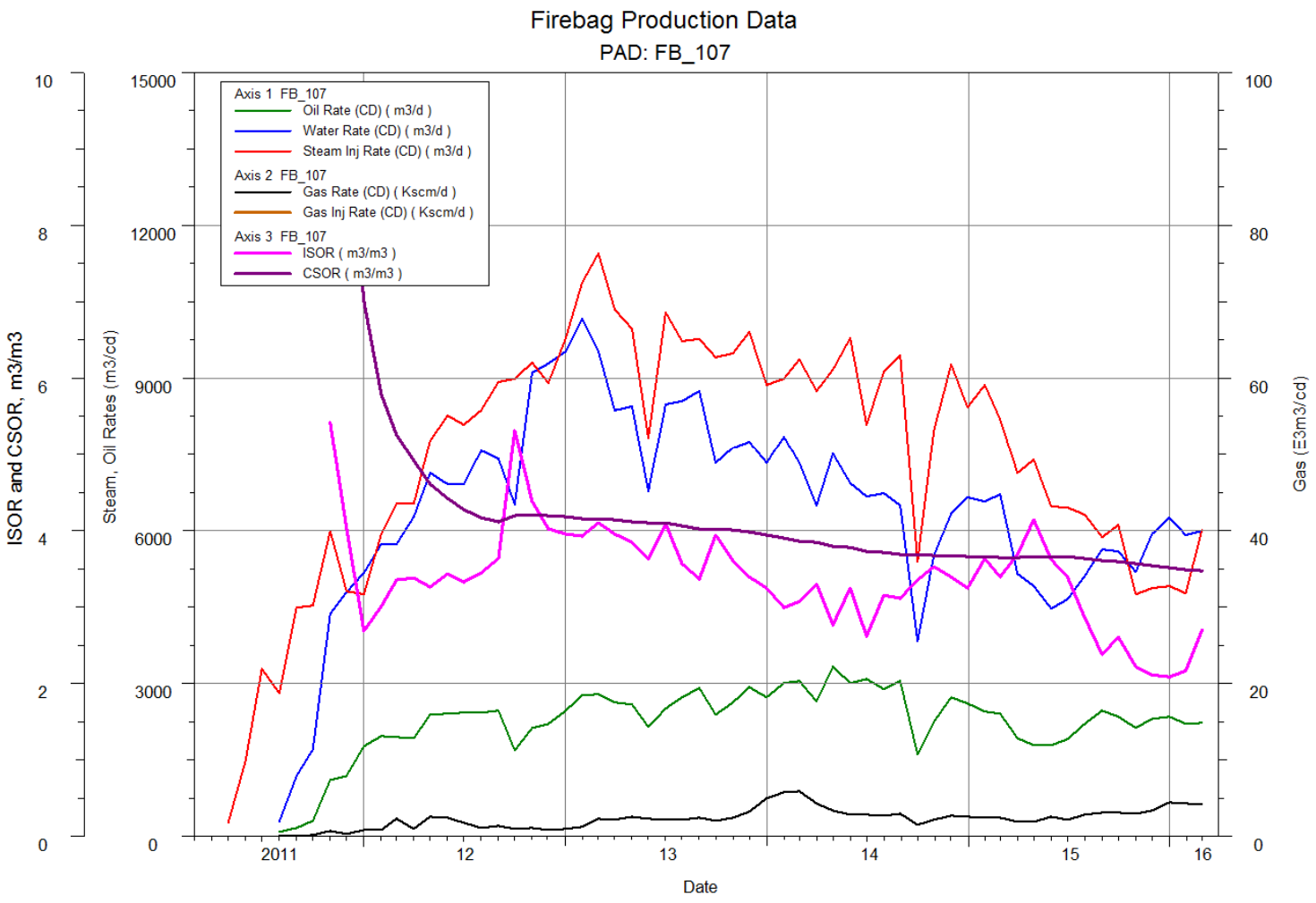


2006 2007 2009 2010 2012

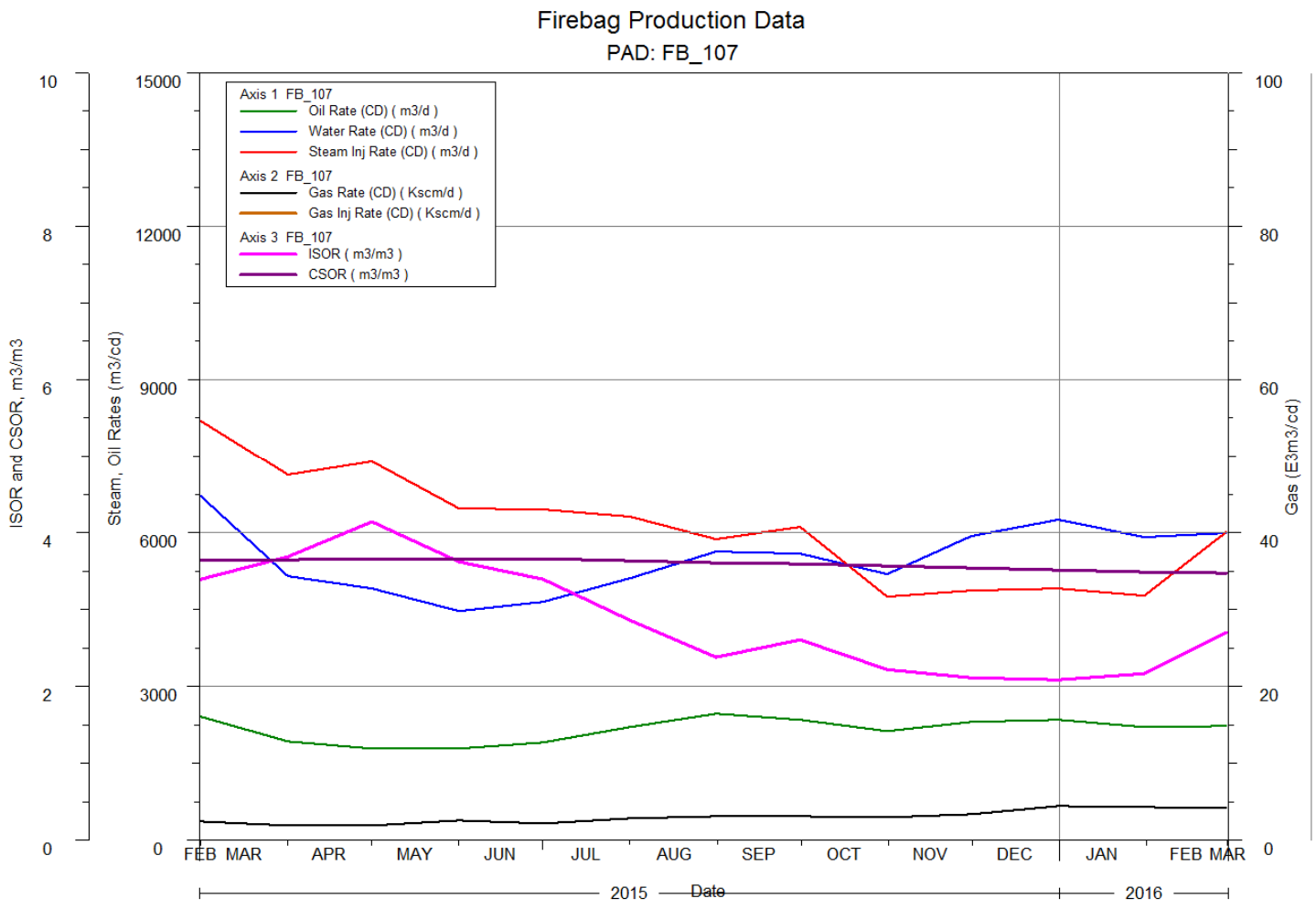
Pad 107 Performance

- Pad 107
  - 14 wells currently on production
  - First oil in July 2011
  - Monthly steam chamber pressures:
    - Average: 2,340 kPag
    - Range: 2,220 kPag – 2,420 kPag
  - Performance as of Feb. 29, 2016:
    - Cumulative steam injected is 13,375,011 m^3
    - Cumulative oil produced is 3,852,480 m^3
    - Cumulative SOR = 3.47 m^3/m^3
    - Recovery Factor of 31%
  - Pad Learnings
    - Differential chamber pressure with nearby pads can cause fluid migration
    - Geological complexities can cause performance issues

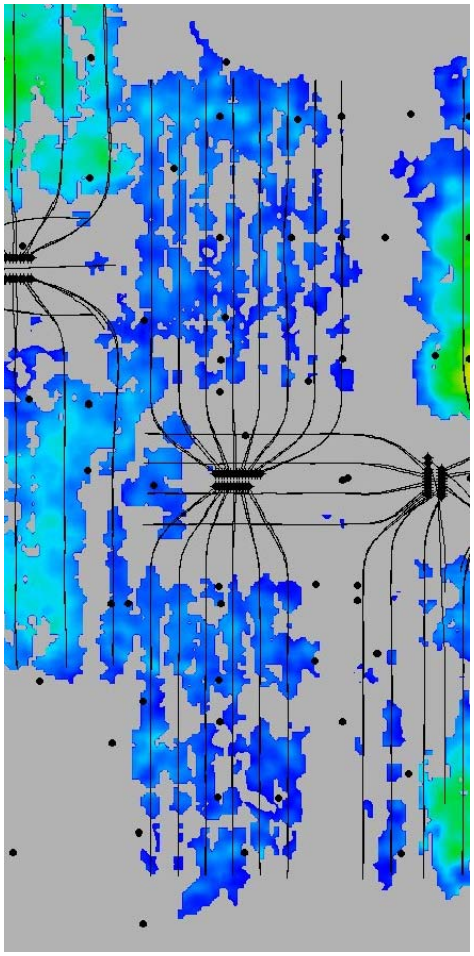
Pad 107 Performance



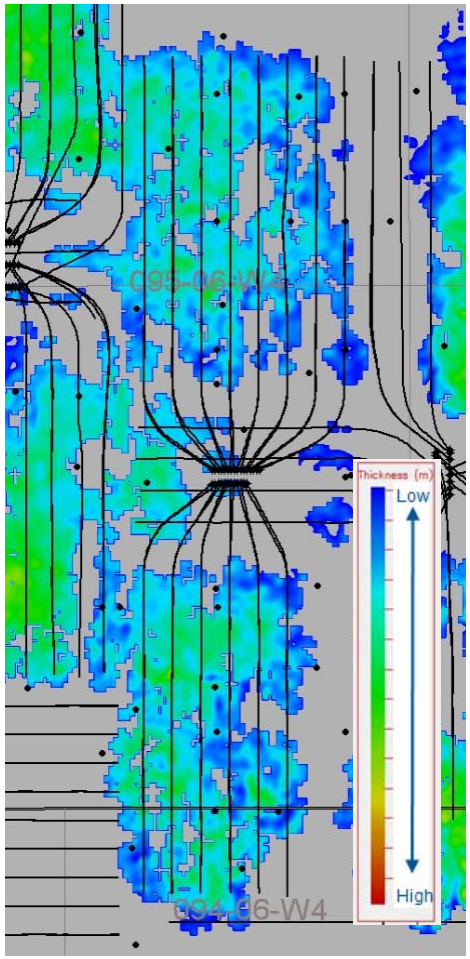
Pad 107 Performance



Pad 107 Performance - 4D Seismic Time Delay



2012

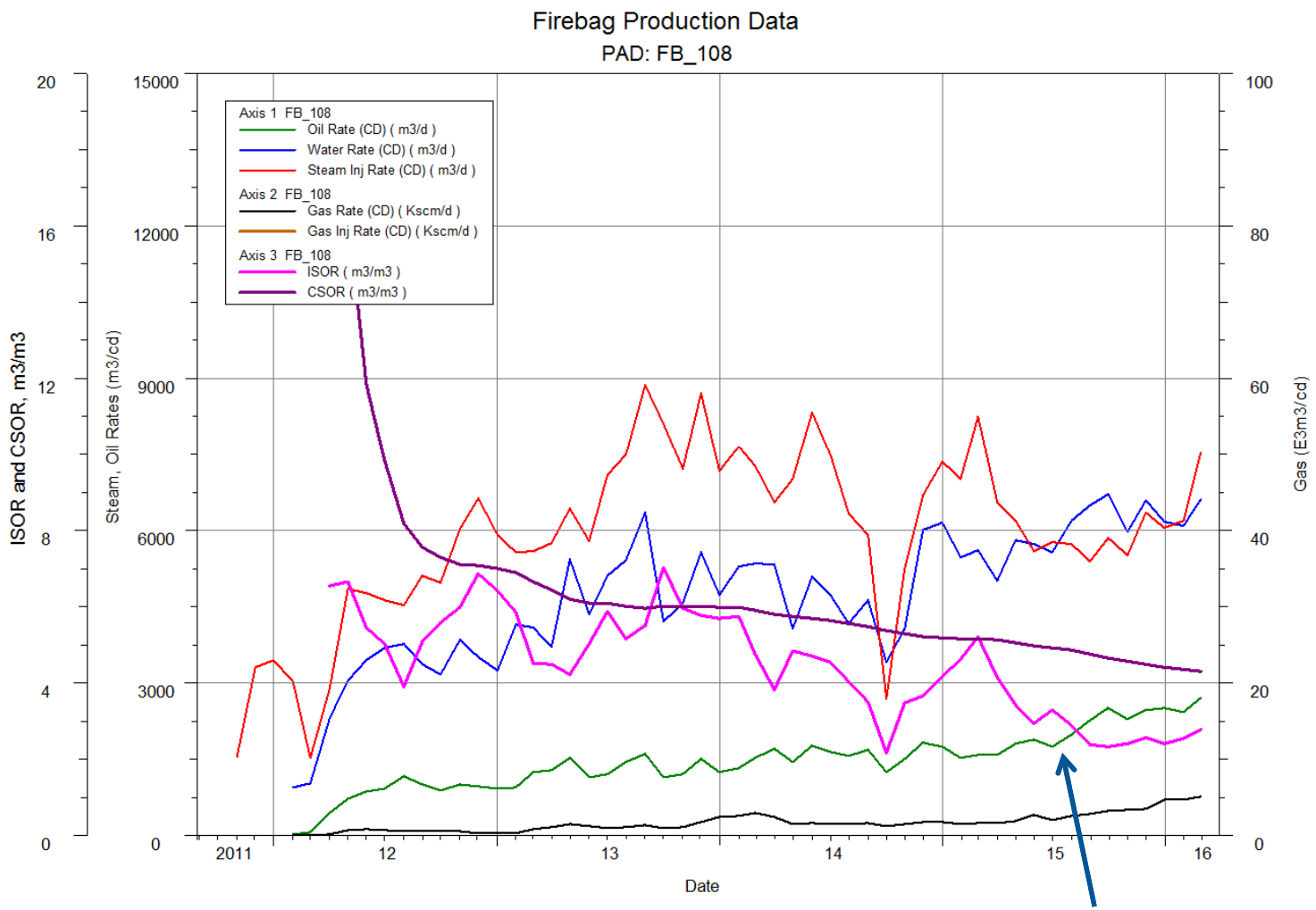


2013

Pad 108 Performance

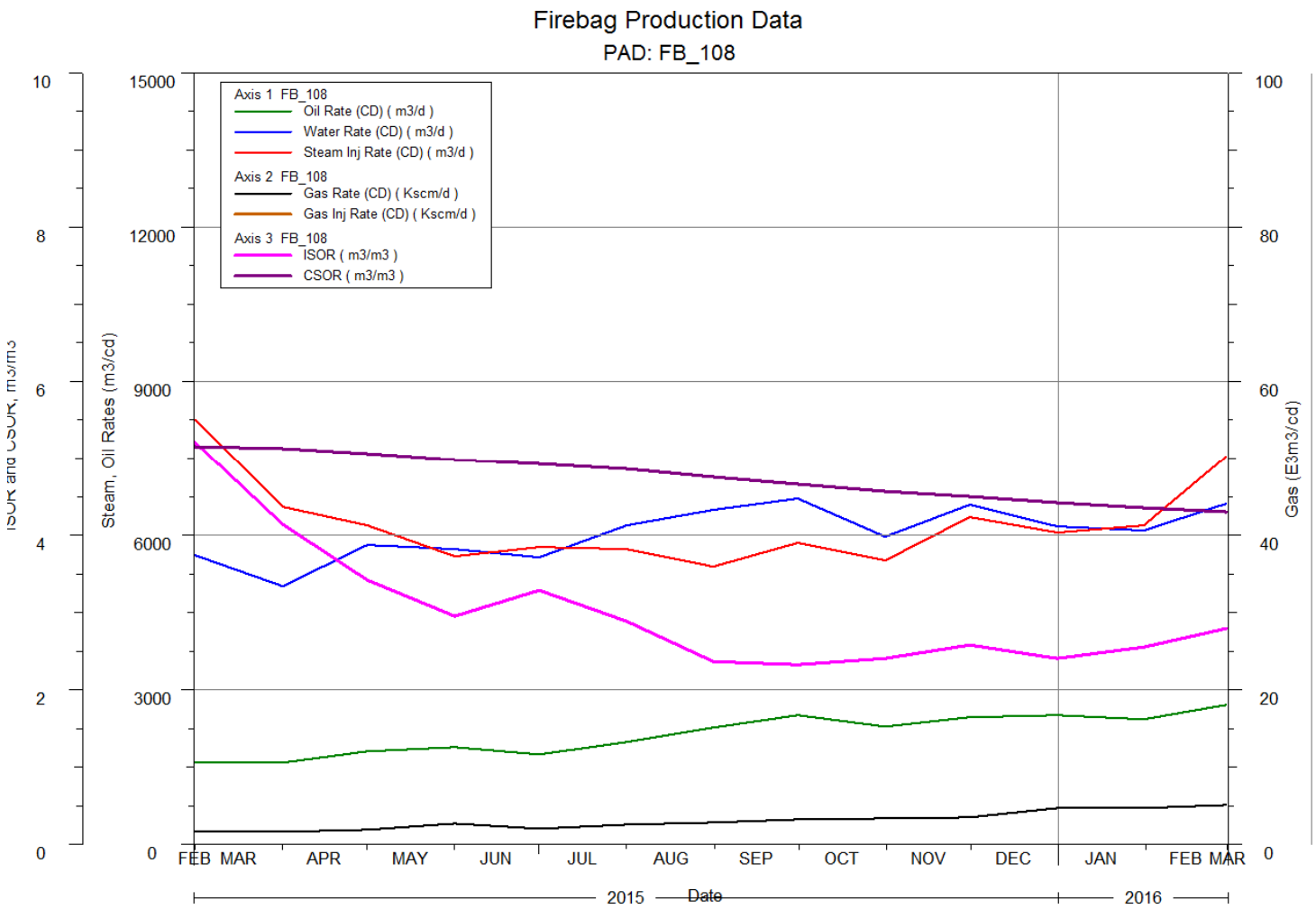
- Pad 108
  - 14 wells currently on production
  - 2 well pairs and one infill first oil in May 2015
  - Monthly steam chamber pressures:
    - Average: 2,350 kPag
    - Range: 2,260 kPag – 2,560 kPag
  - Performance as of Feb. 29, 2016:
    - Cumulative steam injected is 9,531,834 m^3
    - Cumulative oil produced is 2,217,470 m^3
    - Cumulative SOR = 4.30 m^3/m^3
    - Recovery Factor of 13%
  - Pad Learnings
    - Steam chamber coalescence with mature pads providing optimization opportunities
    - Geological complexities can cause performance issues

Pad 108 Performance

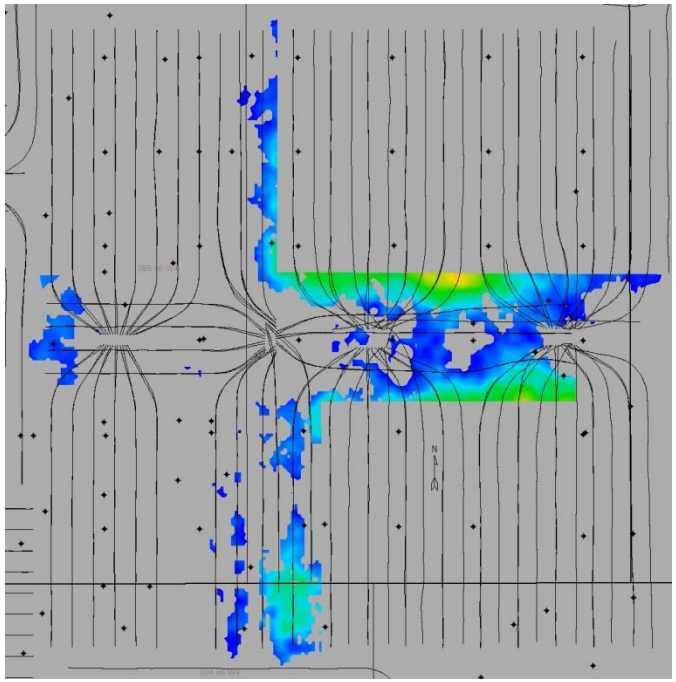


2 new wells
and 1 infill

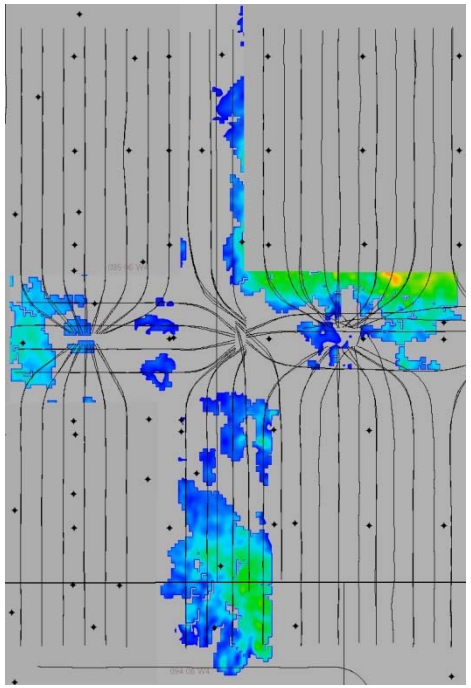
Pad 108 Performance



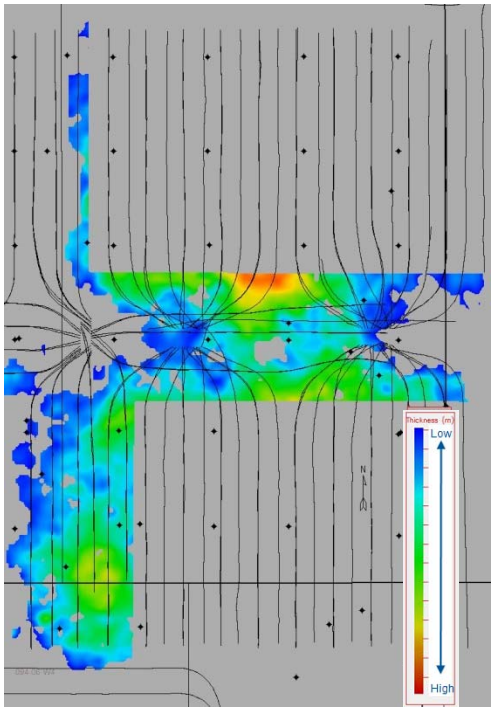
Pad 108 Performance - 4D Seismic Time Delay



2012



2013



2014

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. 2016 (as measured by blanket gas) was 2,390 kPag (224°C)
- Steam quality decreases between the central plant and the pads
  - Steam quality leaving the plant is approximately 100% at 11 MPag
  - Steam quality at the wellhead is not measured, but has been modelled and estimated to be 95%
- These conditions are in line with those in the original design

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 1,900-2,700 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
- Pad 101 NCG Pilot
- Pad 104 North Chemical Co-Injection Test
- Advanced reservoir management for improved energy efficiency
- Operating Strategy and Optimal Sub-cool Management

Summary of Key Learnings

- Infill Performance
  - Total 38 infills to date, average oil production of 1100bopd (175m^3/d)
  - Bottom hole temperatures vary greatly well to well
    - Depends on nearby wells' steam chamber development and when the infills are brought on production
    - Some infills require multiple steaming cycles while others encounter steam chamber and require suspension (e.g. 3N7)
  - 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 chamber level
  - Positive impacts on SOR and WOR, which improve overall field performance

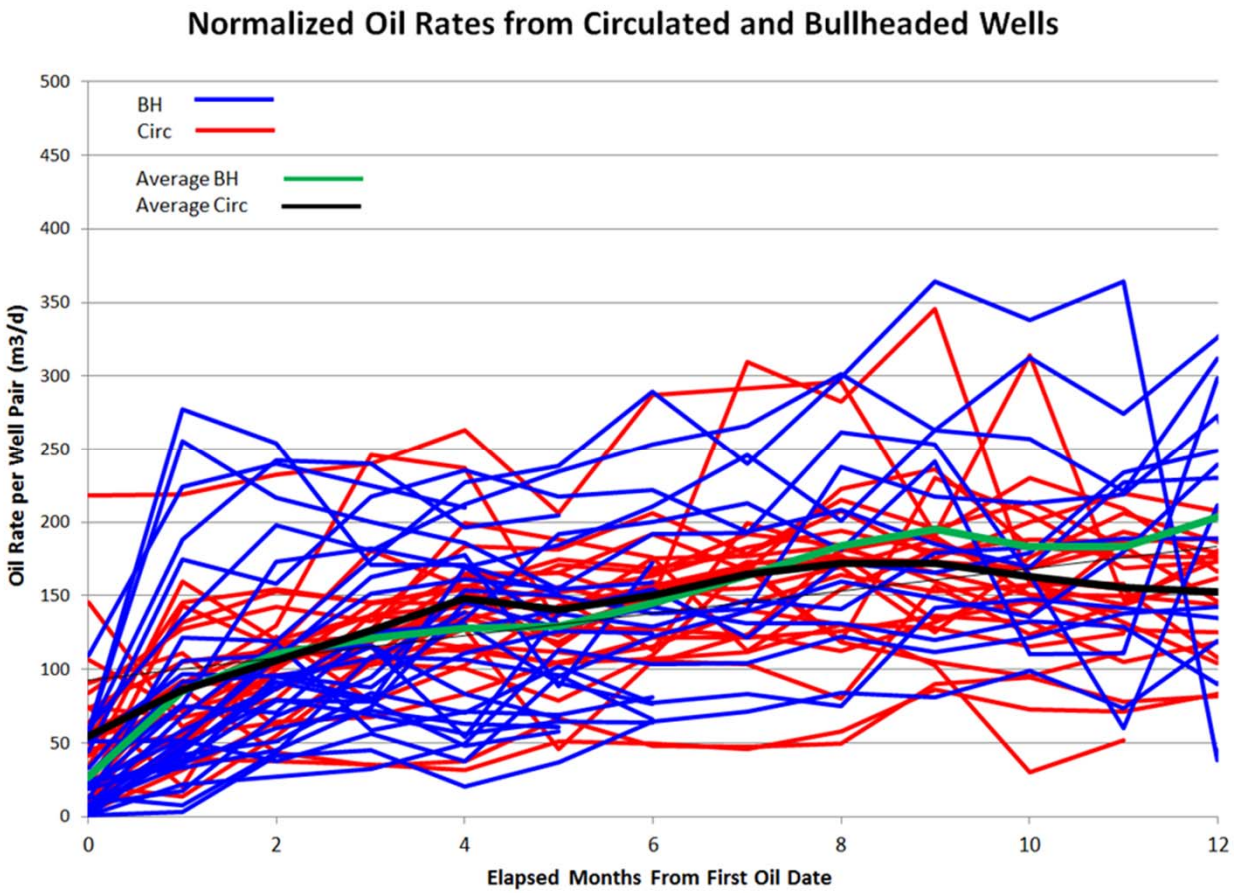
SUNCOR

Summary of Key Learnings

- Bullheading Startup
  - Operates within AER approved MOP
  - Injecting steam into the reservoir without circulating a portion of the steam back to surface
  - By not taking returns, bullheading:
    - Requires less cumulative steam
    - Achieves 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
  - No correlations observed between the injectivity tests performed prior to startup and likelihood of bullheading during Pad 110 startup
  - Circulation considered when bullheading is unable to achieve target injection rate under MOP

Summary of Key Learnings

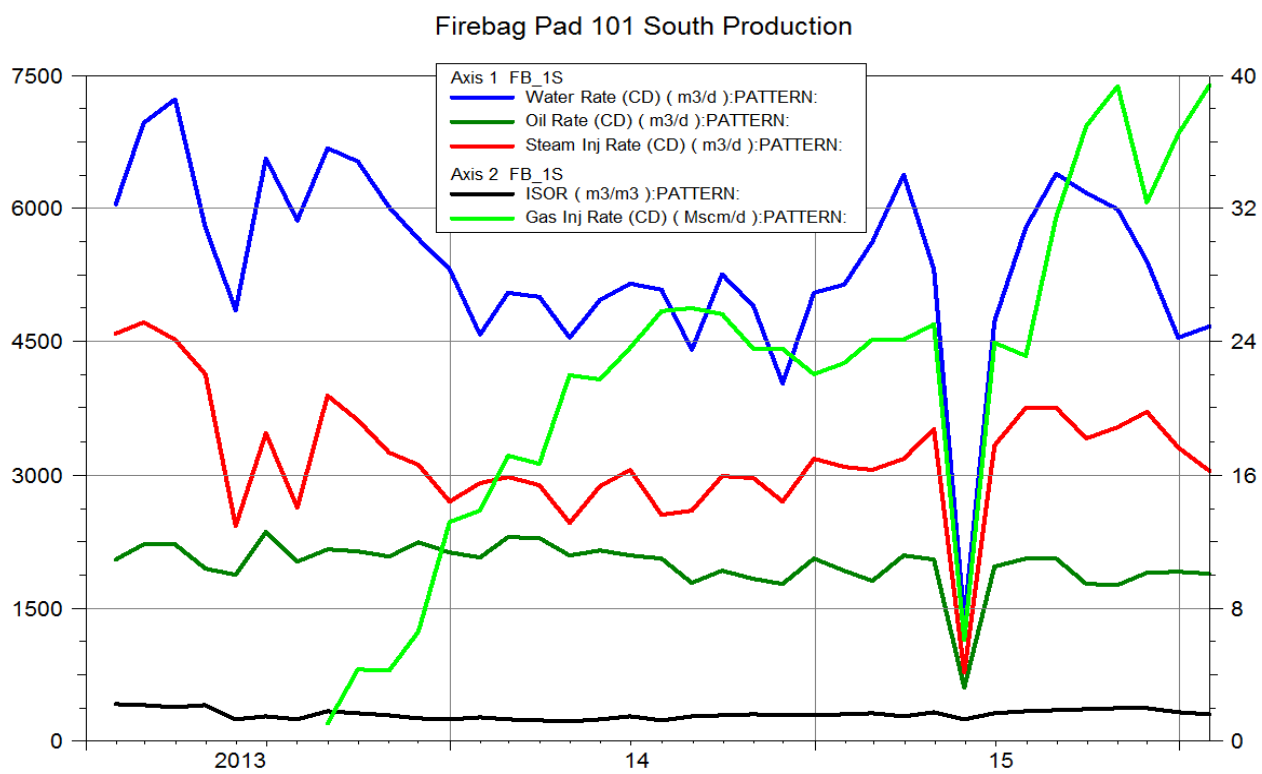
- Bullheading vs. Circulation Startup



- There are no noticeable differences in well performance between circulation and bullheading

Summary of Key Learnings

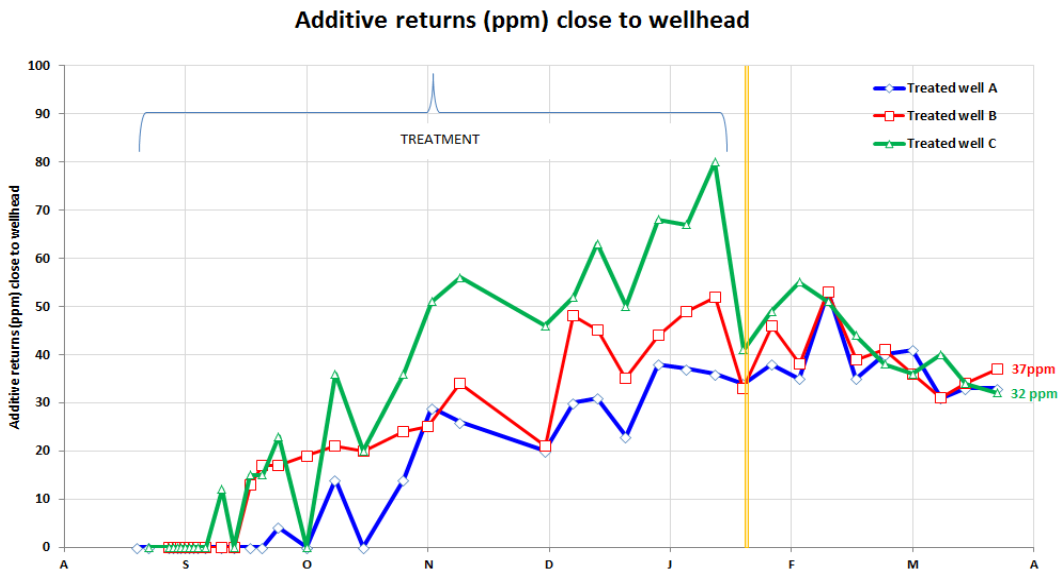
- Pad 101 NCG Pilot Co-injection
  - Impact to resource recovery is not anticipated
  - Significant NCG partial pressure effects have not been observed
  - NCG return production is not significant enough with current injection rates to be empirically substantiated
  - NCG injection increased in 2015 after commissioning of a compressor. It appears oil rate has been fairly constant since



2015 NCG Composition	
C1	91.90%
C2	5.02%
C3	1.38%
NC4	0.26%
IC4	0.20%
NC5	0.05%
IC5	0.06%
NC6	0.02%
NC7	0.01%
NC8	0.01%
HE	0.04%
H2	0.00%
N2	0.47%
CO2	0.59%
	100.00%

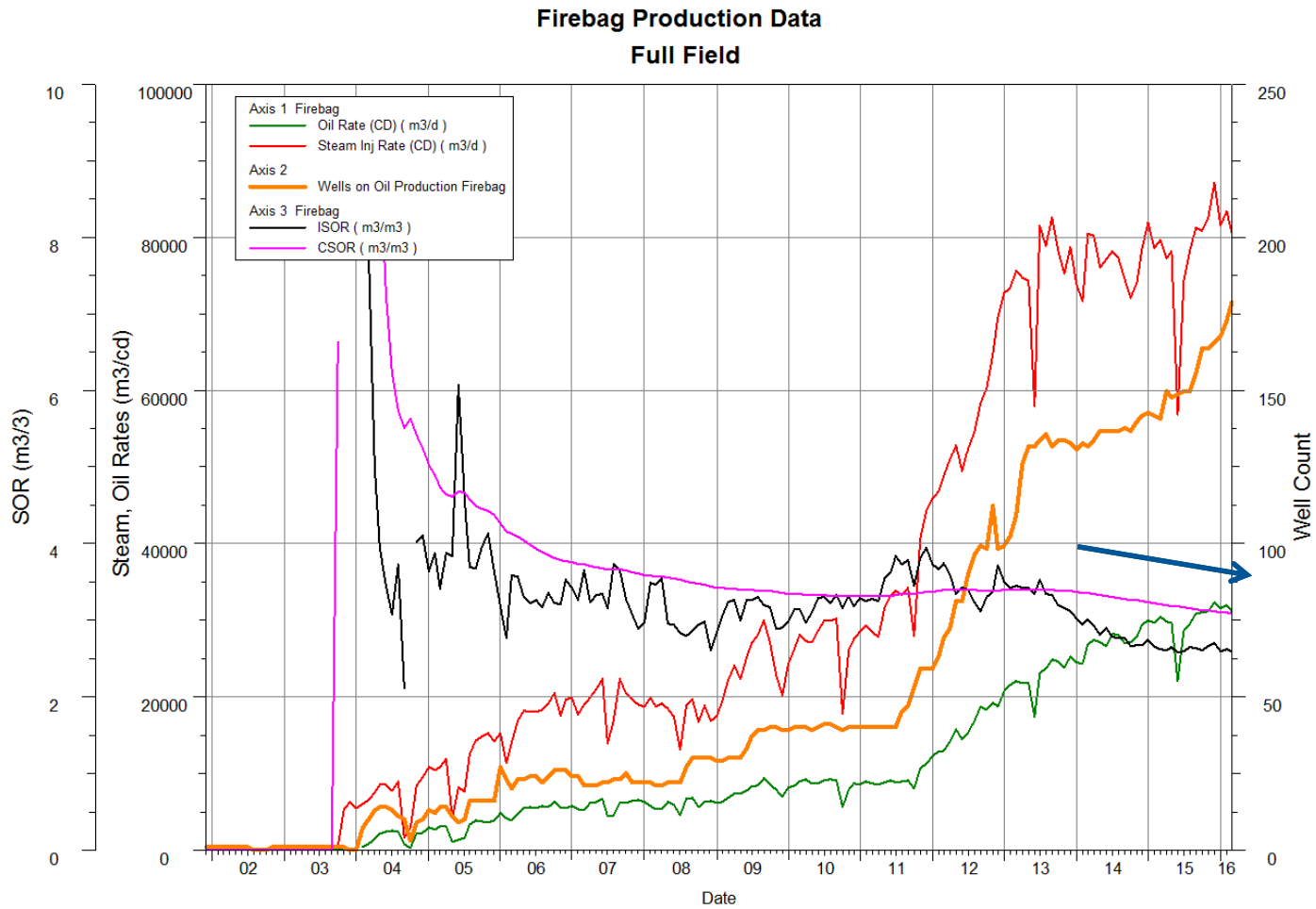
Summary of Key Learnings

- Pad 104 North Chemical Co-injection Test
  - First chemical co-injection initiative at Firebag
  - Chemical co-injection started in Q3 2015, ended in Q1 2016
  - No additive spills and no safety incidents reported during the co-injection phase. No additive release to the environment
  - The pilot was safely executed and the data is currently under statistical analysis for final recommendation
  - Suncor continues to monitor additive returns to surface and CPF, and perform water analysis and other studies in the surveillance plan
    - No additive observed at CPF confirming dilution factor for Firebag. To be considered in future chemical co-injection initiatives



Summary of Key Learnings

- Advanced reservoir management for improved energy efficiency



Summary of Key Learnings

- Advanced reservoir management for improved energy efficiency
  - Steam prioritized to be directed towards younger pads to ensure stable steam chamber development
  - Optimize leak-off from edge well pairs to avoid losing energy to virgin reservoir
  - Balance steam chamber pressures between pads for optimization and also heat efficiency
    - Avoid energy lost 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
    - Total field steam injection is not increased while increasing production by steaming more pads
    - Chamber pressure in the mature pads is gradually reduced as a result

Summary of Key Learnings

- Operating Strategy and Sub-cool Management
  - Operate SAGD well pairs with target of 20°C reservoir sub-cool
  - Temperature measured in all producers at the ESP intake
    - Some pads use 6 point thermocouples or fibre temperature data to assess sub-cool along the horizontal wellbore
  - Low rate steam tests measure reservoir pressure monthly
  - Adjust pump speeds regularly to maintain sub-cool target
    - Manage reservoir fluid levels below injectors to avoid flooding
    - Reduces risk of steam coning
    - Improved pump reliability
  - Infill wells operated at different sub-cool targets in some cases to manage interaction with base well pairs

Table of Contents

- Safety Moment – Daniela Montanez
- Introduction – Doug Castellino
- Geoscience – Christina Enns
- Surface Heave and Caprock Integrity – Kathy Cheung
- Drilling and Completions – Jeremy D'Mello
- Artificial Lift – Jeremy D'Mello
- Instrumentation in Wells – Jeremy D'Mello
- 4D Seismic – Jeremy D'Mello
- Scheme Performance – Kathy Cheung
- **Future Plans – Daniela Montanez**

Future Plans – Regulatory Applications

- Filed Applications

Directive 78 Amendments	Description	Date Submitted	Date Approved	Approval
Downhole Electrical Heater	Pad 109	3-Feb-15	13-Mar-15	8870HHH
Lean Zone Testing	OB 212	28-Sep-15	12-Nov-15	8870III
Non-Condensable Gas (NCG) Co-injection Expansion		24-Feb-16	2-Jun-16	8870JJJ

- Future Applications
  - Geoscience and Reservoir Development teams are continuing work to determine optimum depletion plans for next sustaining pads
  - Continuing work on NCG co-injection next phase development and chemical co-injection pilots

Future Plans - Drilling Activities

- Completed Drilling
  - Pad 118 finished drilling Q3 2015
- There were no re-entries or re-drills during the reporting period
- No drilling is currently in progress
- Future Drilling
  - Coreholes/observation wells will be drilled as necessary to:
    - Adequately delineate the resource
    - Monitor SAGD operations
    - Further caprock integrity analysis
    - Hydrogeology analysis
    - Water disposal analysis
    - Land retention

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Future Plans – Testing

- Pad 104 North Chemical Co-Injection Test
  - Execution started in Q3 2015, under evaluation
- Electrical Pre-heat in Pad 109
  - Canceled on Pad 109
  - Evaluating other suitable pads for test
- Lean Zone Testing in OB 212
  - Executed in Q1 2016
  - Test to understand the feasibility of de-watering the future top lean zone areas to help improve SAGD performance

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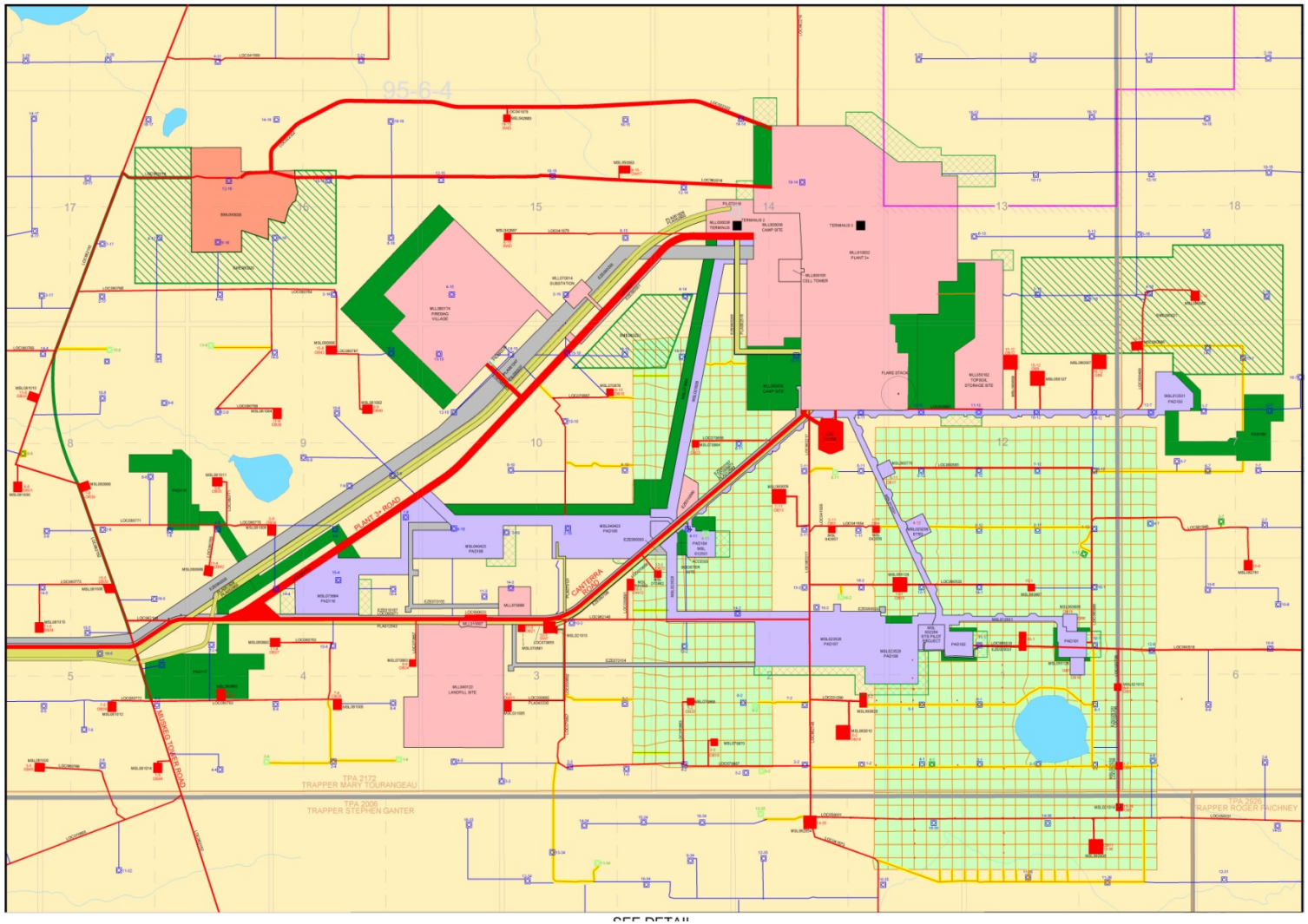
Section 3.1.2 – Surface Operations, Compliance and Issues Not Related to Resource Evaluation and Recovery

Table of Contents

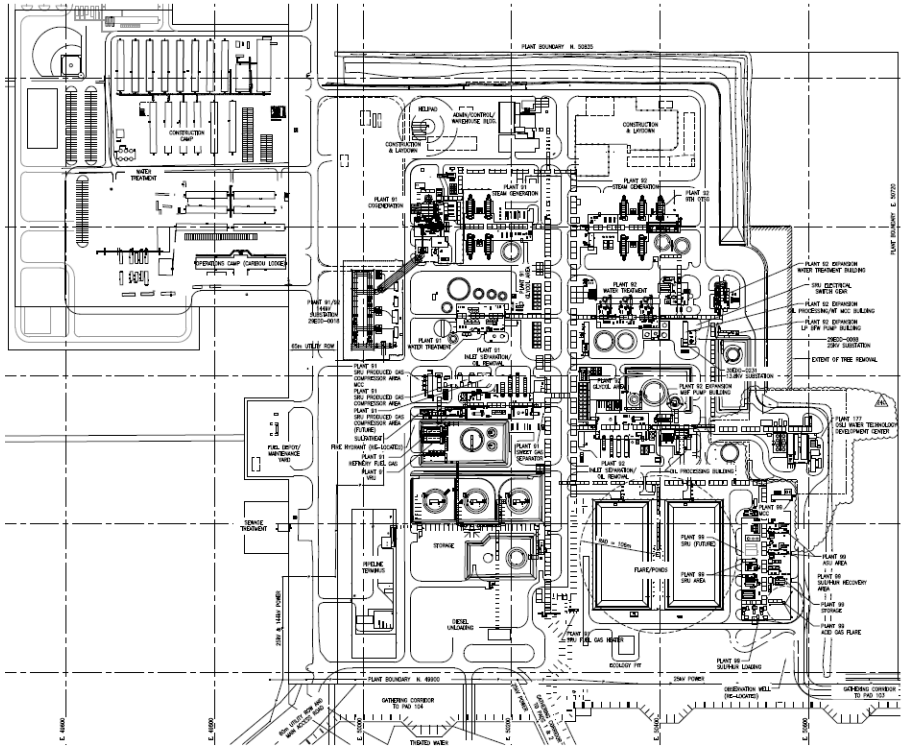
- **Operations and Facility Performance – Glen Myck**
- Measurement and Reporting – Jayanto Ghoshal, Jeremy D'Mello, Mike Robley
- Water Production, Injection and Usage – Jayanto Ghoshal, Jeremy D'Mello
- Sulphur Production – Doug Castellino
- Environmental Performance – Doug Castellino
- Future Plans – Glen Myck

Site Survey Plan

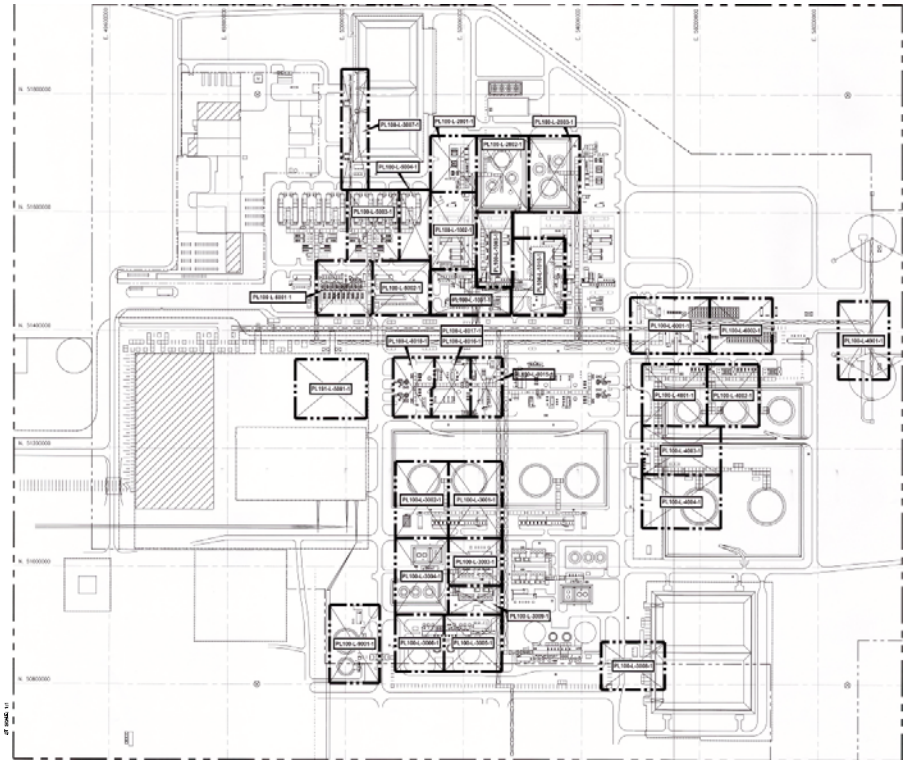


Firebag Site Layout

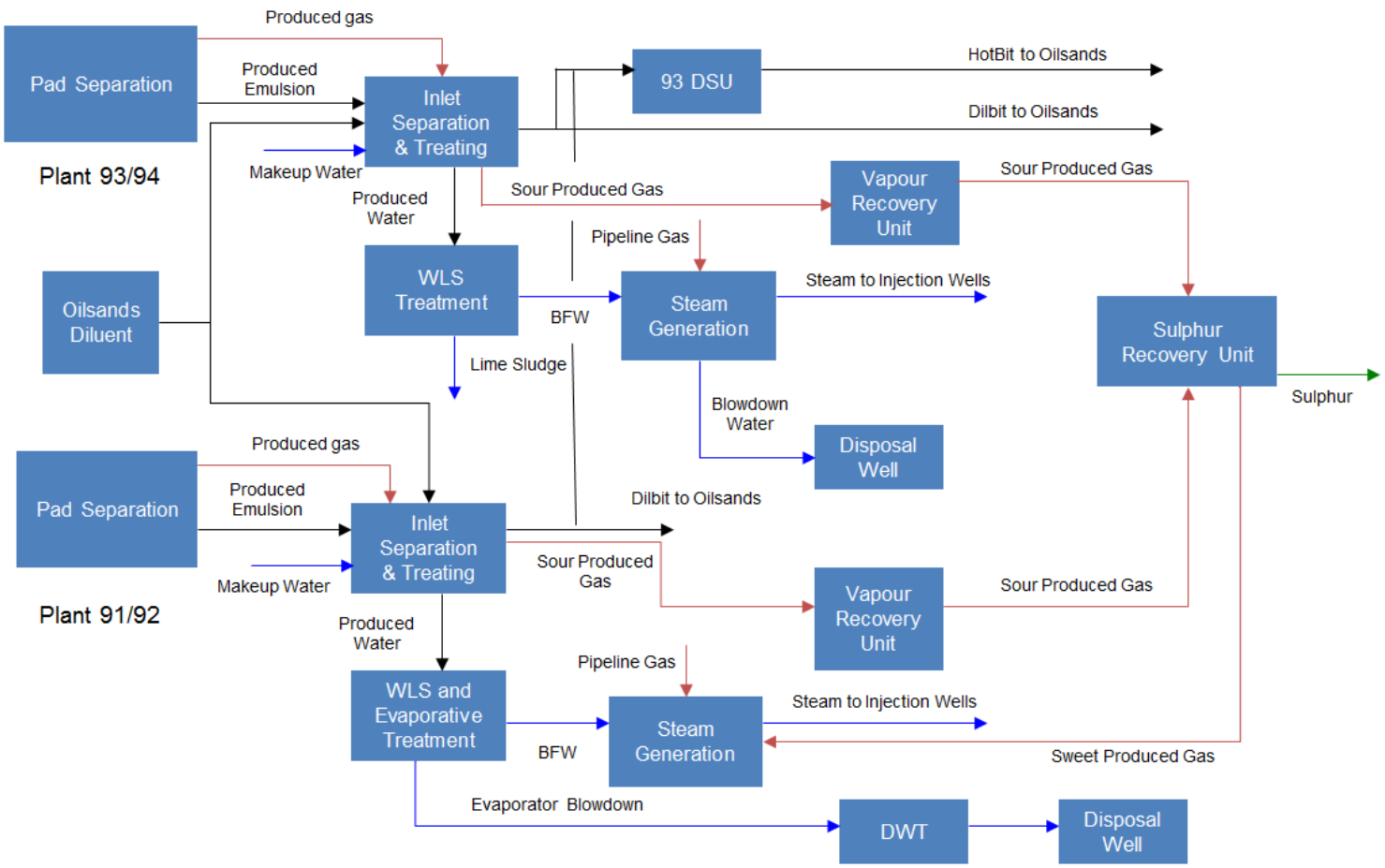
Plant 91/92



Plant 93/94



Firebag Simplified Process Block Diagram



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
  - Chemical Usage Optimization
    - Trial of chemical injection directly to the Treaters to attempt to improve Dilbit and Produced Water quality
  - Ongoing operation improvement to reduce venting incidents
  - Ongoing treatment of utility water system to prevent corrosion
    - Biological corrosion is no longer a significant issue and has been addressed. Ongoing active corrosion monitoring
  - Debottlenecking opportunities via handling of the Produced Water.
    - Re-route Expansion Treater Dumps to Plant 92 Skim Tank to improve Expansion MBF performance and potentially increase Expansion throughput
  - Continuous improvement in the operation and maintenance of the ORF's

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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
  - Chemical Optimization

- 92 – Evaporator Improvement Trials
  - Success with internal mechanical changes
  - Targeting extended run times between chemical cleanings and vessel entries for mechanical cleaning

- 93/94 – WLS Performance
  - Improve chemical system reliability
  - Chemical reduction and optimization
  - Reduction of off-spec occurrences

Steam Generation Risks and Opportunities

- Optimization of steam generation capacity during steam long situations
- Trialing new tube temperature monitoring equipment to help understand impact of water quality excursions
- Improved pigging frequency and use to maximize steam generator usage
- Improved reliability of 93/94 Once Through Steam Generators (OTSGs) due to erosion/corrosion issues

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 compressor throughput, in order to help excess PG handling result in increase in production
- Improve plant reliability by reducing foaming upset condition through continues skimming
- Reduction of gas to the SRC by optimization of the blanket gas and additional cooling in plants 93/94/DSU

Pads/Gathering Technologies

- Currently: 12 Pads and 189 Producing Wells
- New Pads: Pad 109, Pad 110, Pad 104 infill
- Future Pads: 117,114, 112, 118 and 111 (Firebag development program)
- Produced emulsion from Pads 101 to 104 and 109 is transferred to Plant-91/92
- Booster pumps to transfer some of the emulsion from Pads 101-104 and Pad 109 to Plant-93/94
- Produced emulsion from Pads 105, 106, 107, 108, 116, 110, 115 is transferred to Plant-93/94

Produced Water (PW) Quality

PW Quality (averages)			
	Plant 91	Plant 92	Plant 93 & 94
pH (pH units)	9.1	10.6	7.1
Turbidity (NTU)	26.4	17.8	99.5
Reactive Silica (mg/L)	248	273	263
Bitumen in Water (ppm)	1.8	3.0	1.9
Dissolved Ca (mg/L)	5.4	2.4	1.9
Dissolved Mg (mg/L)	1.1	0.6	1.0
Dissolved Hardness CaCO3 (mg/L)	18.0	8.2	9.0

Boiler Feed Water (BFW) Quality

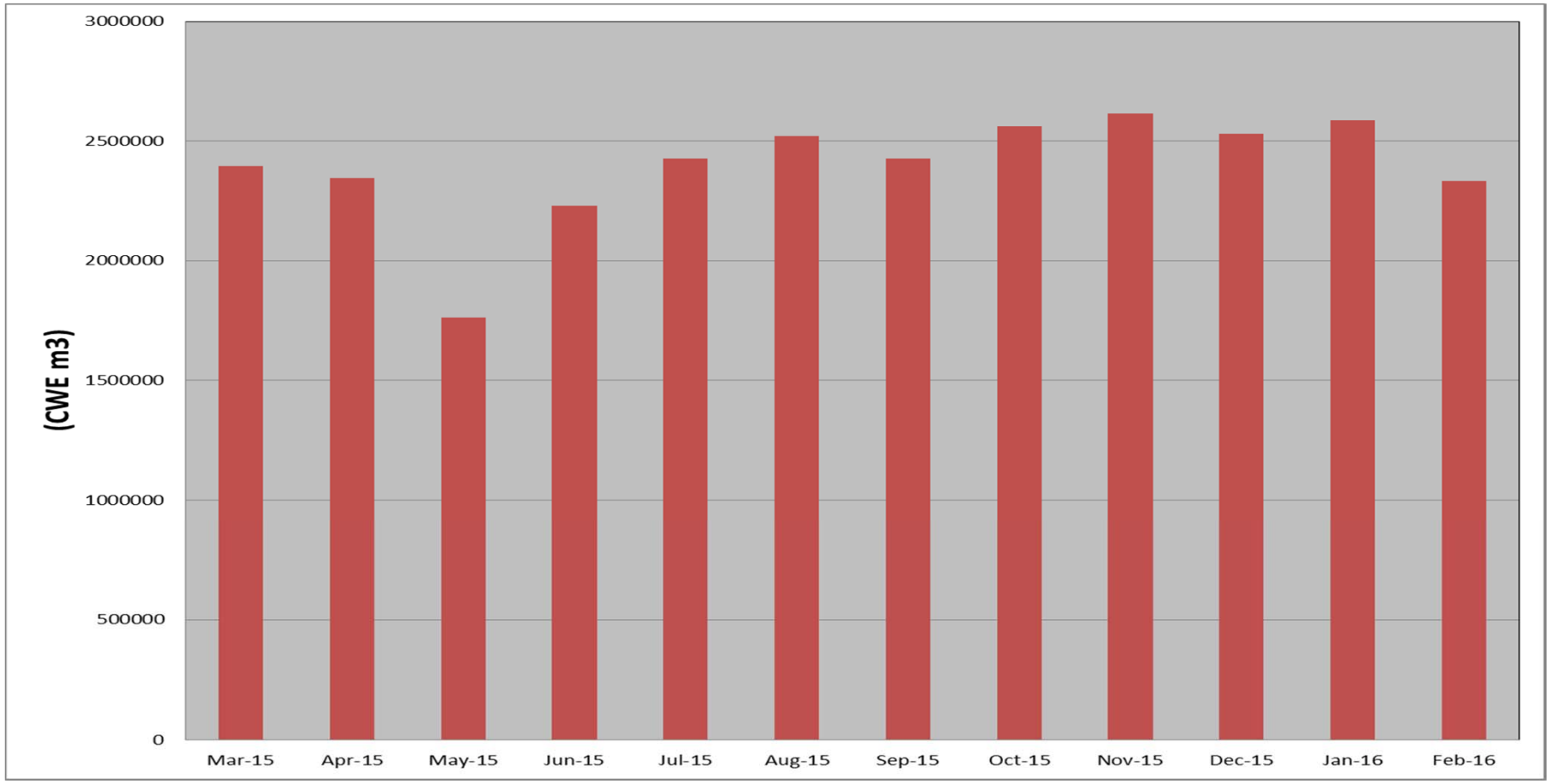
	Plant 91	Plant 92	Cogen (HRSG)	Plant 93/94
Total Dissolved Solids (mg/L)	1200	230	520	2900
Reactive Silica (mg/L)	45.0	7.0	22.0	42.0
Dissolved Chloride (mg/L)	180	24	75	570
Dissolved Sodium (mg/L)	478	84.4	210	1140
Dissolved Potassium (mg/L)	22.2	2.5	9.0	94
Alkalinity (mg/L)	457	133	236	814
pH (pH units)	10.1	10.0	9.6	9.9

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
- Improvement in Produced water cooler run time after switching to a different REB mix
- Increased throughput of Plant 93/94 by installing additional produced water coolers and optimizing of MBF
- Optimized steam generation capacity to maximize energy efficiency by operating in their most efficient combustion zones
- Chemical cleaning and demister reliability program on 92 Evaporators to extend time between manned vessel entries
- Disciplined adherence to the new steam generator water quality operating guidelines to improve reliability
- Reduced the foaming issue in Amine unit significantly by automated skimming of water from stripper column reflux drum.
- Reduction in SOR contributed to higher Bitumen production

Steam Injected

From March 2015 to February 2016, Firebag injected on average 78,498 m^3/day of steam into the wells

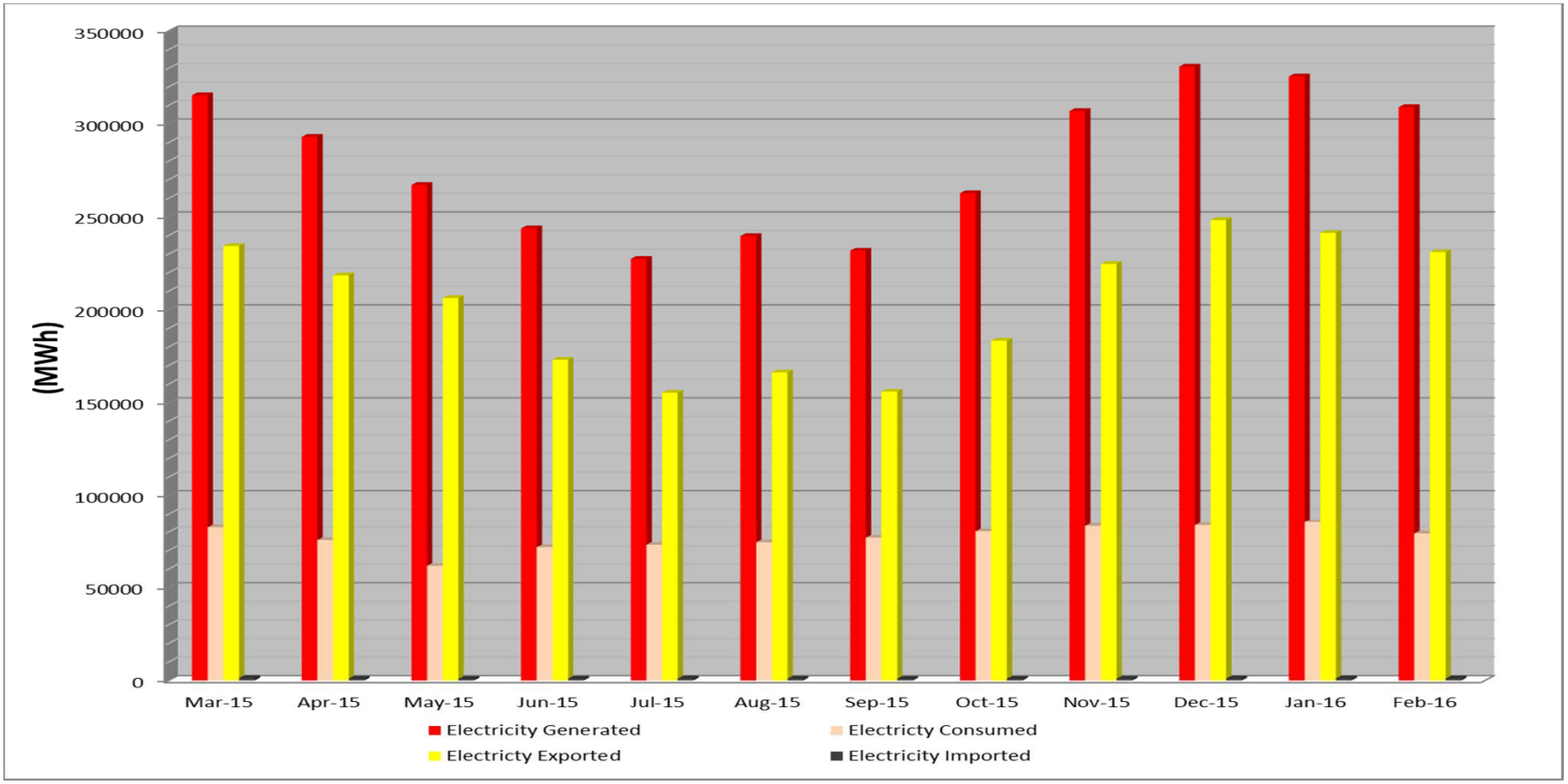


Steam Qualities

	Pland 91 OTSGs	Plant 92 OTSGs	Plant 91 Cogen	Plant 93 OTSGs	Plant 93 Cogens	Plant 94 OTSGs	Plant 94 Cogens
Mar-15	74.1	77.7	78.6	71.1	72.7	70.2	72.7
Apr-15	74.0	78.5	76.2	69.8	71.6	70.6	74.2
May-15	74.4	78.7	78.8	70.8	73.7	72.4	73.0
Jun-15	75.3	79.6	77.2	70.5	74.7	71.8	72.7
Jul-15	73.3	79.0	78.8	69.8	74.9	71.1	75.0
Aug-15	74.6	80.4	74.1	73.2	75.3	71.4	75.6
Sep-15	76.0	79.7	75.7	73.0	74.7	72.1	74.5
Oct-15	75.6	79.4	76.5	72.5	73.7	73.3	74.5
Nov-15	76.2	78.3	76.8	72.1	72.9	72.9	73.0
Dec-15	75.6	77.5	76.6	71.7	73.4	73.1	73.3
Jan-16	75.7	78.1	75.1	71.1	73.9	73.7	73.7
Feb-16	75.3	77.9	76.0	73.0	73.6	75.8	73.1
Average:	**75.0**	**78.7**	**76.7**	**71.6**	**73.8**	**72.4**	**73.8**

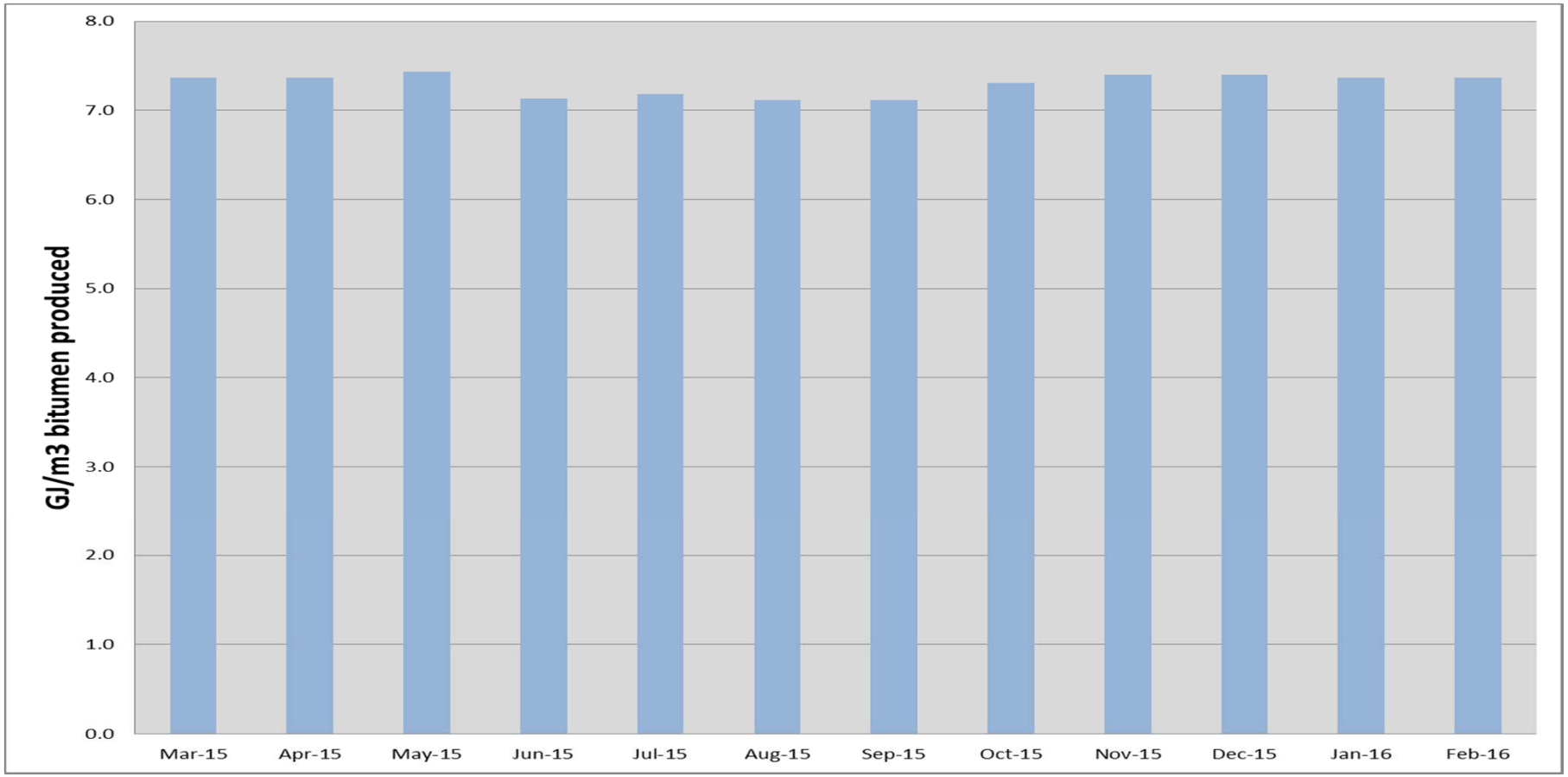
Electricity Generation/Consumption

From March 2015 to February 2016, Firebag generated 3,353 GW-hours of electricity, with 2,438 GW-hours being exported for sale



Energy Intensity

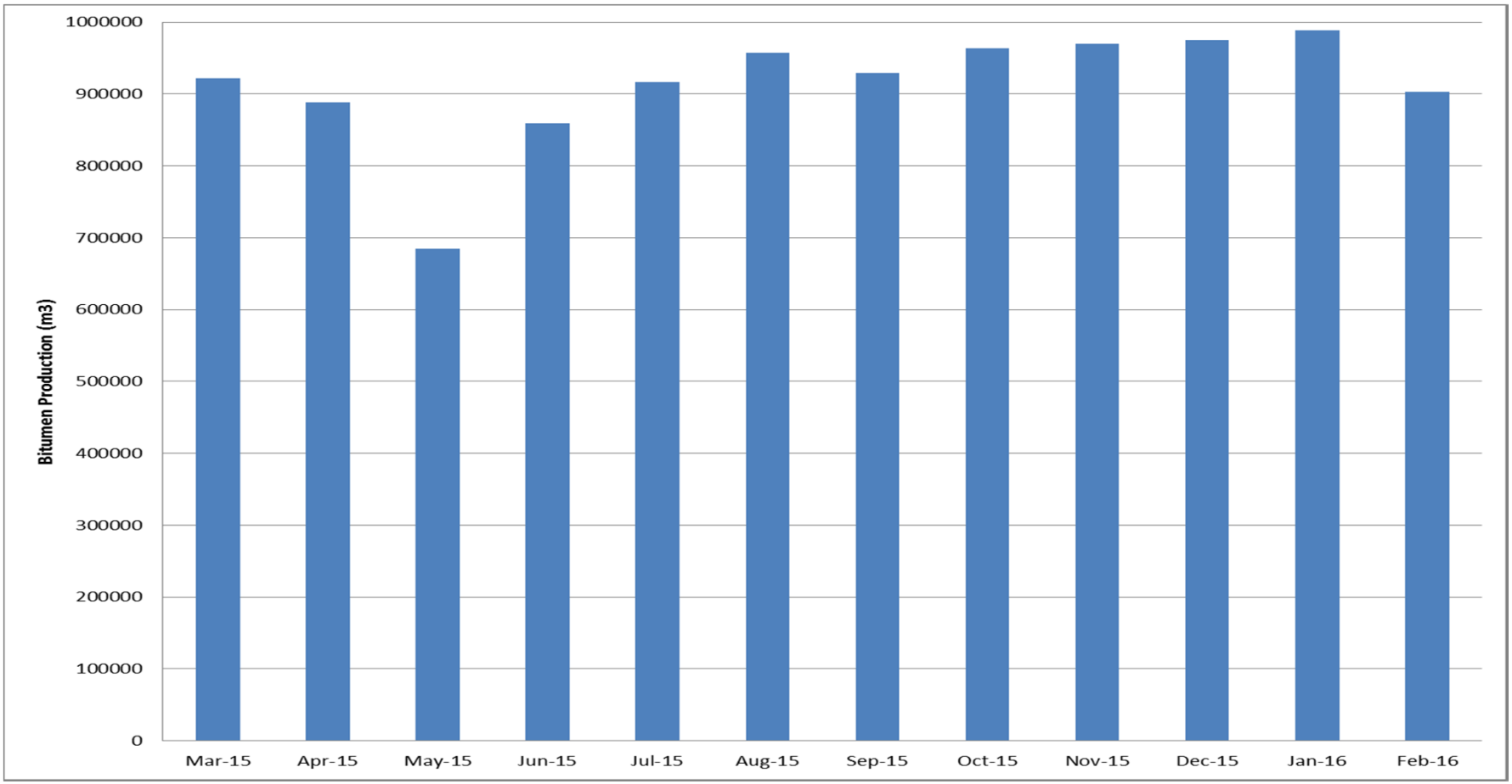
Firebag's average energy intensity was 7.3 GJ per m^3 of production, from March 2015 to February 2016



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

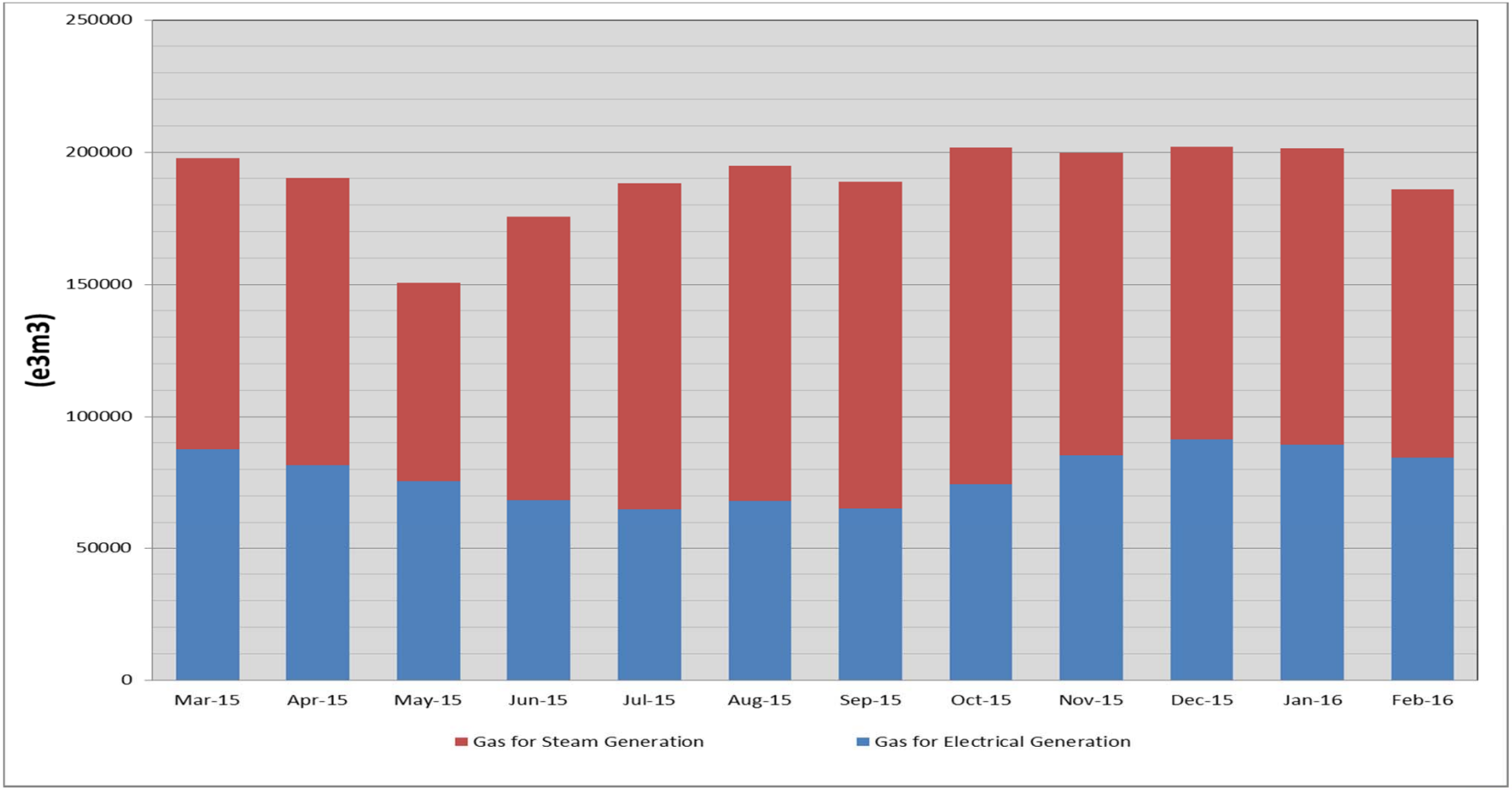
Monthly Bitumen Production

Firebag averaged 29,937 m^3/day (188,295 BPD) of production from March 2015 to February 2016



Purchased Gas Usage

Firebag used on average 6,612 e^3m^3 of natural gas per day, from March 2015 to February 2016



Facility Environmental Performance

Emissions Parameter	Mar 2015 - Feb 2016
Solution Gas Produced (e^3m^3)	15,661.7
Solution Gas Flared (e^3m^3)	426.6
Solution Gas Vented[1] (e^3m^3)	20.0
Solution Gas Recovery	97.1%
Total Gas Flared (e^3m^3)	785.4
Total Gas Vented[3] (e^3m^3)	56.2
H_2S Emissions[2] (kg)	2244.6

[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 2015 – Dec 2015
2015 GHG Emissions (tonnes CO_2e) Calendar Year	4,991,293.8
2015 GHG Emission Intensity (tonnes CO_2e/m^3) Calendar Year	0.33

❖CO_2e is based on AENV SGER Reporting for the 2015 calendar year

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- Future Plans – Glen Myck

Measurement, Accounting and Reporting Plan (MARP)

- Firebag MARP approved June 2010
- Sixth MARP update submitted to the AER in March 2016
- MARP details all the requirements in Directive 42
- Firebag formed an Enhanced Production Audit Program (EPAP) and MARP team in January 2013
  - Team made up of representatives from each discipline who have tasks associated with MARP and EPAP
  - Team meets bi-monthly (once every two months) to ensure tasks are being completed to remediate the deficiencies from the EPAP audit, and other measurement deficiencies identified through the monthly meetings

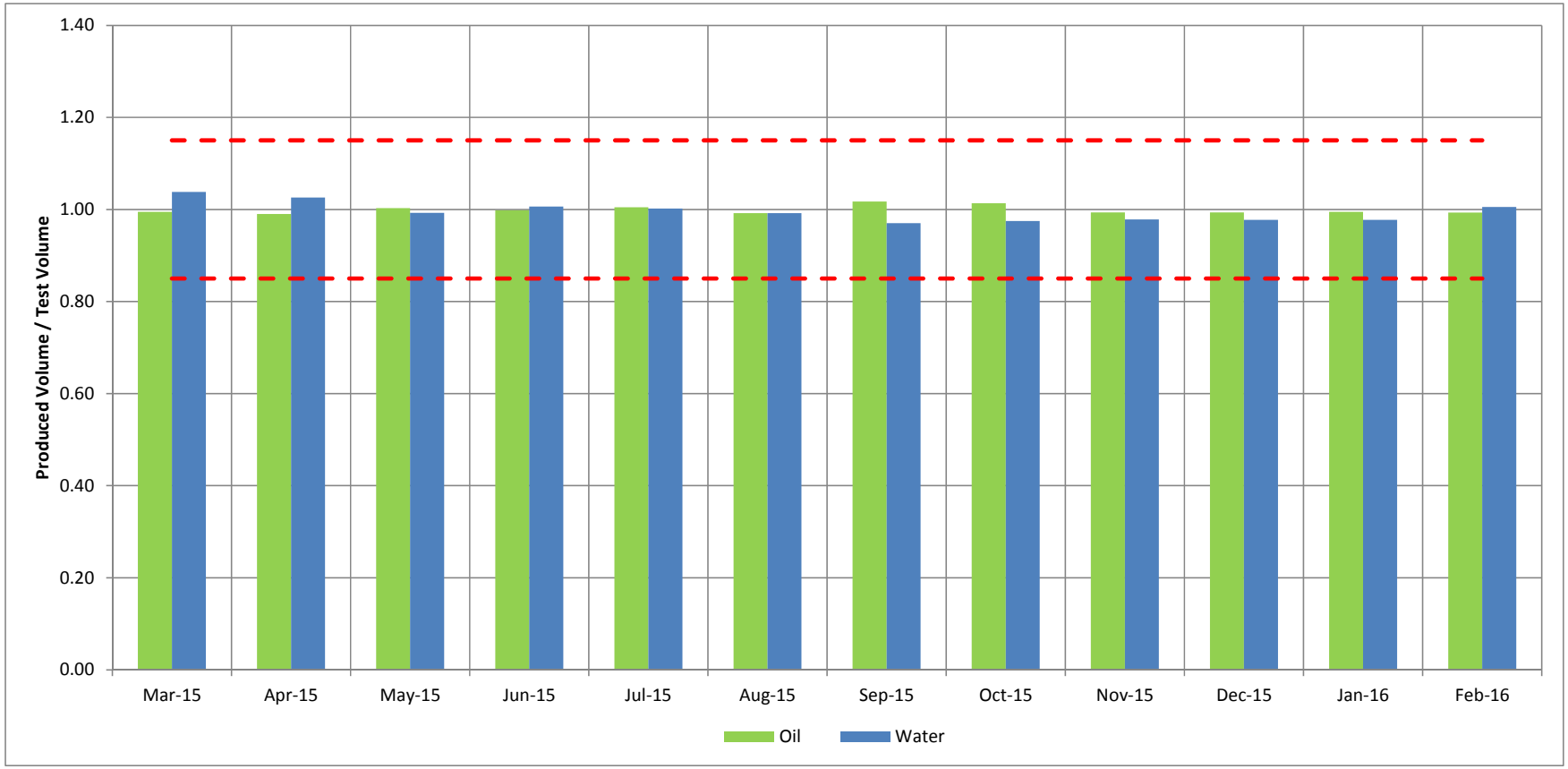
Estimating Well Production & Steam Injection Volumes

- 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

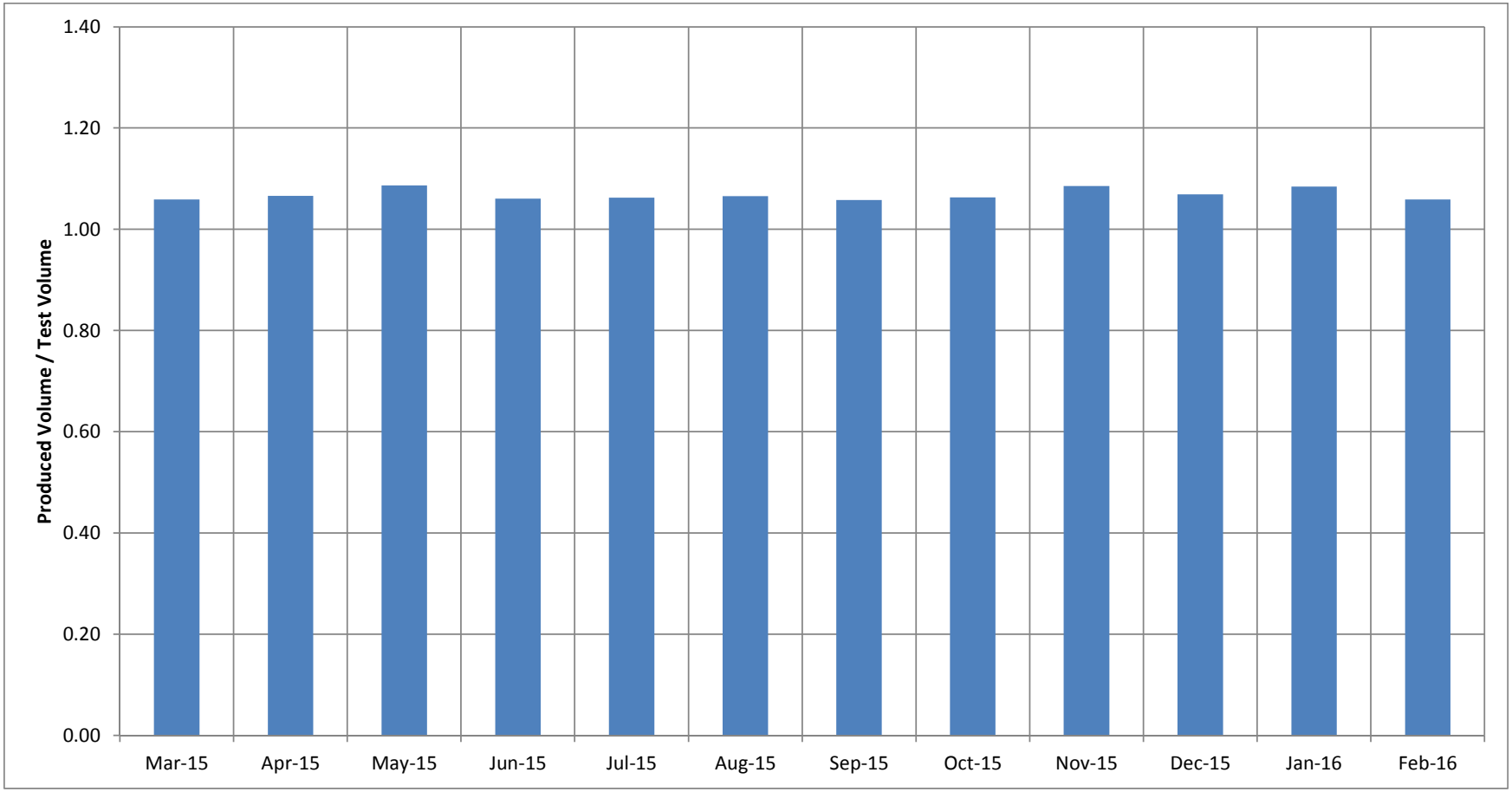
- Dec. 16, 2011 received approval for Multiphase Flow Meter (MPFM) on Pad 105 and future developments
- Fit for purpose Well Production Test software (WPT)
- MPFM now present on Pads 101 infills, 102 infills, 103 infills, 104 infills, 105, 106, 108 North, 115, 116

Oil and Water Proration Values



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

Steam Proration Values



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Water Sources

- Primary makeup water source for process operations is two wastewater streams from Oil Sands Base Plant:
  - Reverse Osmosis (RO) Water: The total volume of RO water used from March 2015 to February 2016 was 55,662 m^3 (2015 calendar year usage was 55,662 m^3)
  - Pond Effluent Water (PEW): The total volume of PEW used from March 2015 to February 2016 was 142,560 m^3 (2015 calendar year usage was 130,274 m^3)

Water Usage

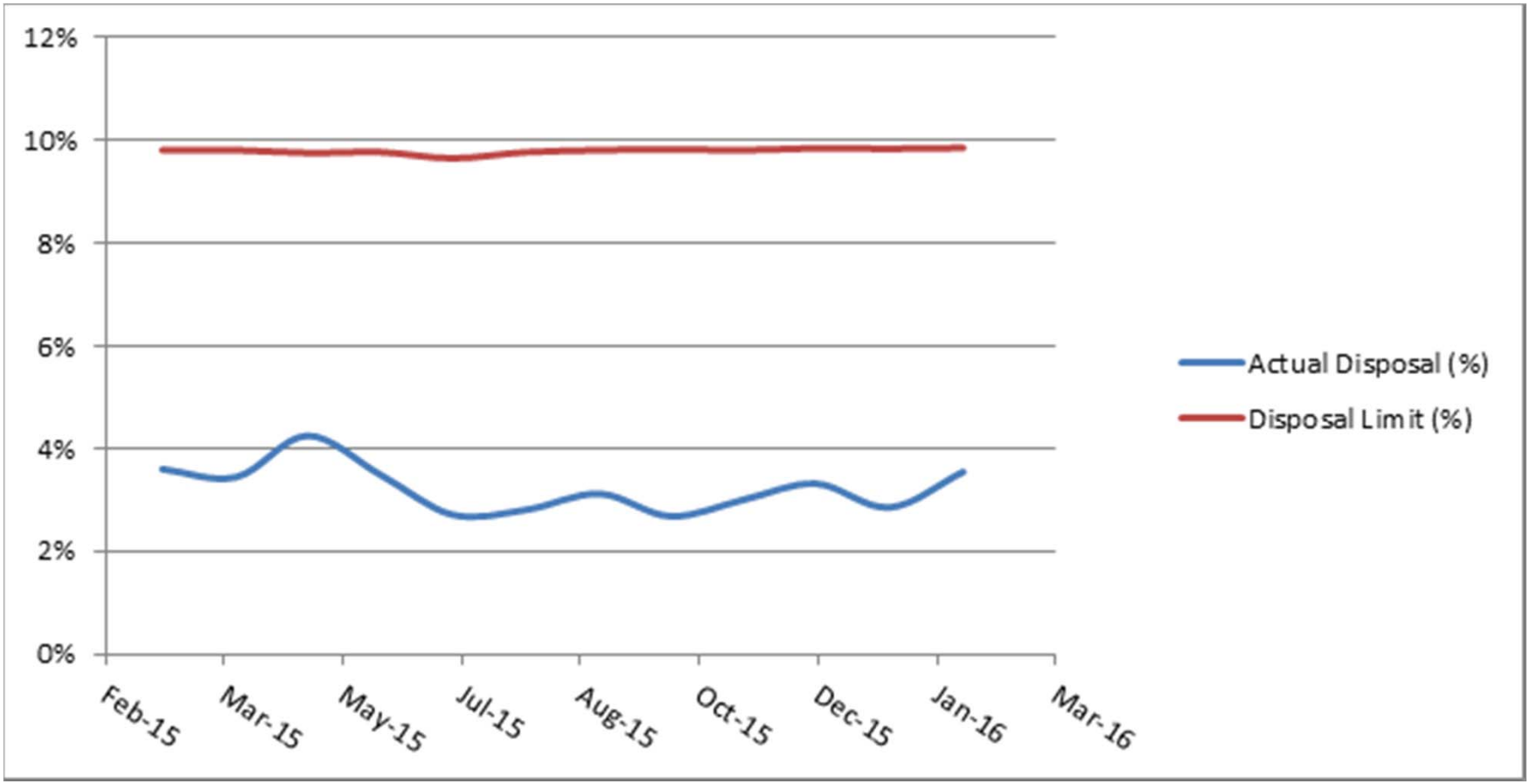
- Site runoff water (rainfall and snow melt) is routed to the site process ponds and reused in the process

- A total of 96,381 m^3 of storm water runoff water was diverted for process use from March 2015 to February 2016 (for the 2015 calendar year, usage was 97,730 m^3; 36,861 m^3 for the Stages 1/2 area and 60,869 m^3 for the Stages 3/4 area)

  - 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 Wells 03-05 & CPF –PW 11-14 as SAGD supply and utility water for up to 620,500 m^3 annually. A total of 573,397 m^3 of well water was diverted for process use (utility water and firewater make-up) from March 2015 to February 2016

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*

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
- All disposal wells approved for use as per Approval Class 1b Approval No. 9487G (February 12, 2016)

Injection Facility Water Balance

	Fresh Water			Steam	Produced Water				Disposal	Imbalance
	FW1	FW4	FW5	INT	PW1	PW8	PW4	PW5	DIT	Injection
	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	Facility
Mar-15	70,275	24,123	24,284	2,394,998	2,628,673	103,846	196,767	194,845	93,449	3.7%
Apr-15	69,851	24,284	23,836	2,346,053	2,526,113	103,507	194,845	114,743	88,517	4.9%
May-15	65,373	23,836	23,606	1,763,494	1,948,469	100,941	114,743	144,476	79,968	1.8%
Jun-15	78,864	23,606	24,034	2,228,679	2,404,205	102,469	144,476	127,649	83,464	3.2%
Jul-15	127,137	24,034	23,965	2,427,305	2,543,315	103,111	127,649	145,708	69,145	1.9%
Aug-15	87,201	23,965	23,816	2,521,690	2,716,231	106,536	145,708	155,349	75,401	3.0%
Sep-15	69,679	23,816	24,005	2,425,471	2,602,820	99,881	155,349	170,510	79,747	1.8%
Oct-15	67,243	24,005	23,616	2,561,129	2,720,055	111,432	170,510	152,063	72,230	2.1%
Nov-15	59,645	23,616	23,738	2,613,990	2,712,092	111,508	152,063	141,133	80,370	-0.8%
Dec-15	57,936	23,738	23,709	2,529,385	2,710,652	114,381	141,133	131,066	88,332	1.6%
Jan-16	62,326	23,709	24,000	2,586,149	2,758,758	114,970	131,066	168,534	76,083	0.2%
Feb-16	52,470	24,000	24,056	2,332,083	2,563,340	102,347	168,534	185,232	88,515	2.7%

Waste Management – Disposal

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

(data shown is averaged across the month)

Month	Injection Rate (Sm^3/day)	Wellhead Pressure (kPa-g)	Downhole Pressure (kPa-g)	Injection Temperature (^oC)
March-2015	669	1068	4760	52
April-2015	668	1128	4821	50
May-2015	552	666	4450	48
June-2015	642	919	4663	52
July-2015	579	497	4236	51
August-2015	516	655	4396	57
September-2015	548	803	4476	55
October-2015	507	748	4407	52
November-2015	580	773	4533	50
December-2015	613	1086	4744	50
January-2016	519	680	4398	49
February-2016	651	1497	5046	50

Waste Management – Disposal

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

(data shown is averaged across the month)

Month	Injection Rate (Sm^3/day)	Wellhead Pressure (kPa-g)	Downhole Pressure (kPa-g)	Injection Temperature (^oC)
March-2015	454	889	4796	51
April-2015	454	946	4855	49
May-2015	391	556	4489	47
June-2015	360	732	4721	51
July-2015	289	427	4322	50
August-2015	339	536	4496	56
September-2015	358	660	4596	54
October-2015	293	610	4513	51
November-2015	426	702	4674	49
December-2015	439	952	4893	49
January-2016	333	593	4536	48
February-2016	391	1316	5197	49

Waste Management – Disposal

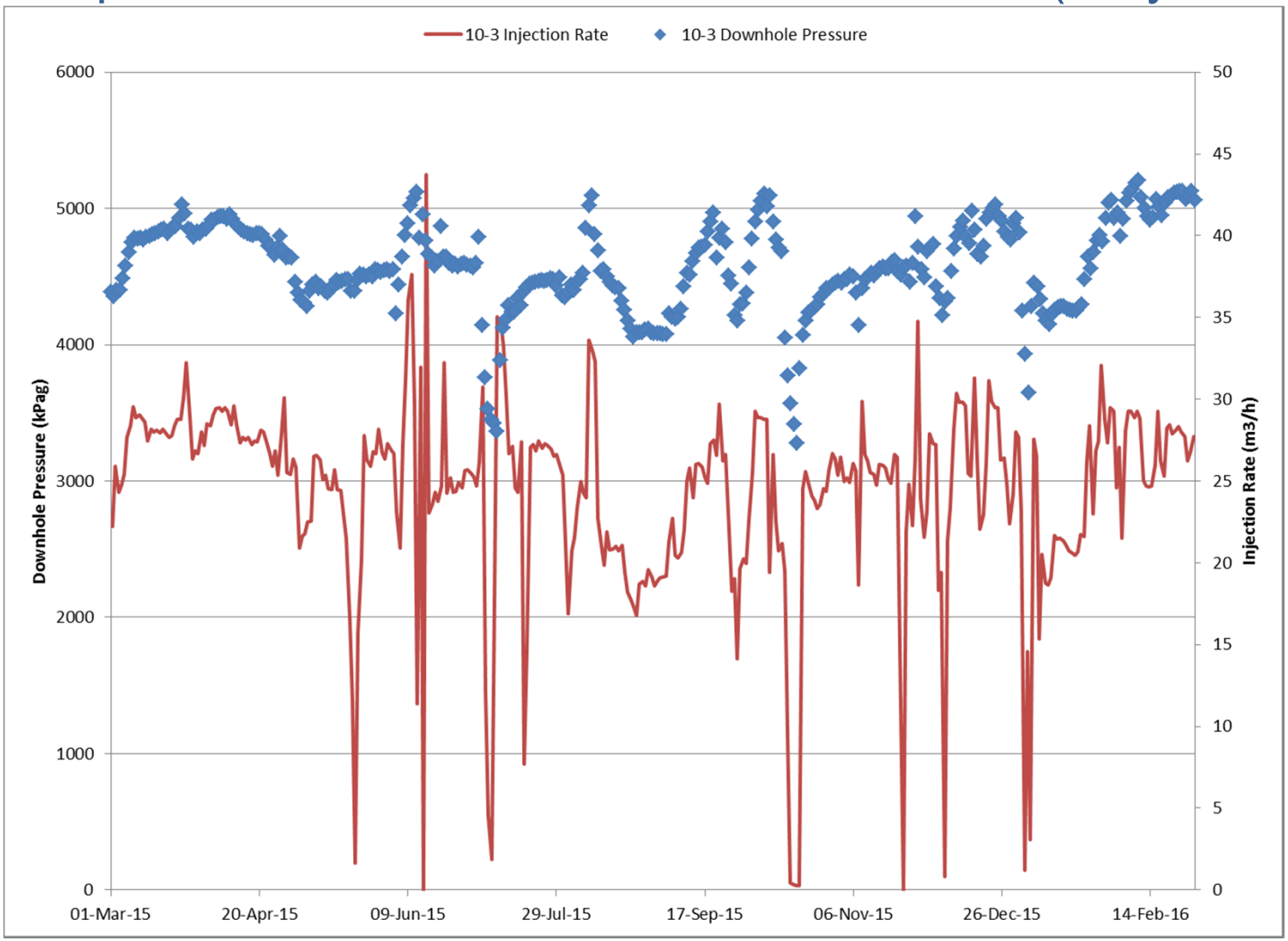
Disposal Information – 100/02-10-095-06W4

(data shown is averaged across the month)

Month	Injection Rate (Sm^3/day)	Wellhead Pressure (kPa-g)	Downhole Pressure (kPa-g)	Injection Temperature (^oC)
March-2015	1872	1077	5161	52
April-2015	1858	1134	5227	50
May-2015	1633	704	4845	48
June-2015	1849	957	5071	52
July-2015	1377	544	4623	51
August-2015	1576	673	4794	57
September-2015	1733	789	4880	55
October-2015	1525	750	4810	52
November-2015	1665	816	4944	50
December-2015	1808	1124	5139	50
January-2016	1571	657	4803	49
February-2016	2028	1479	5471	50

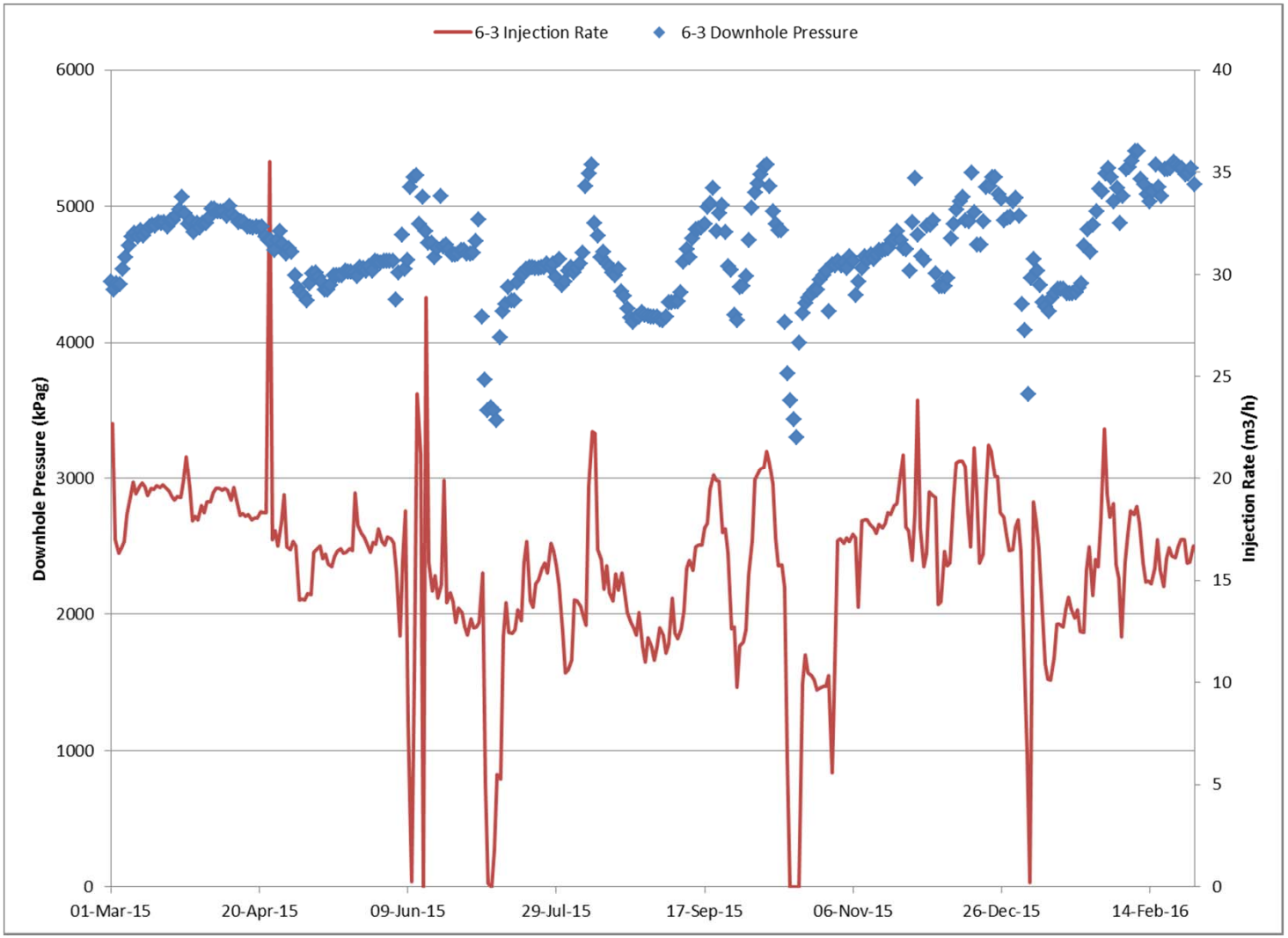
Waste Management – Disposal

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



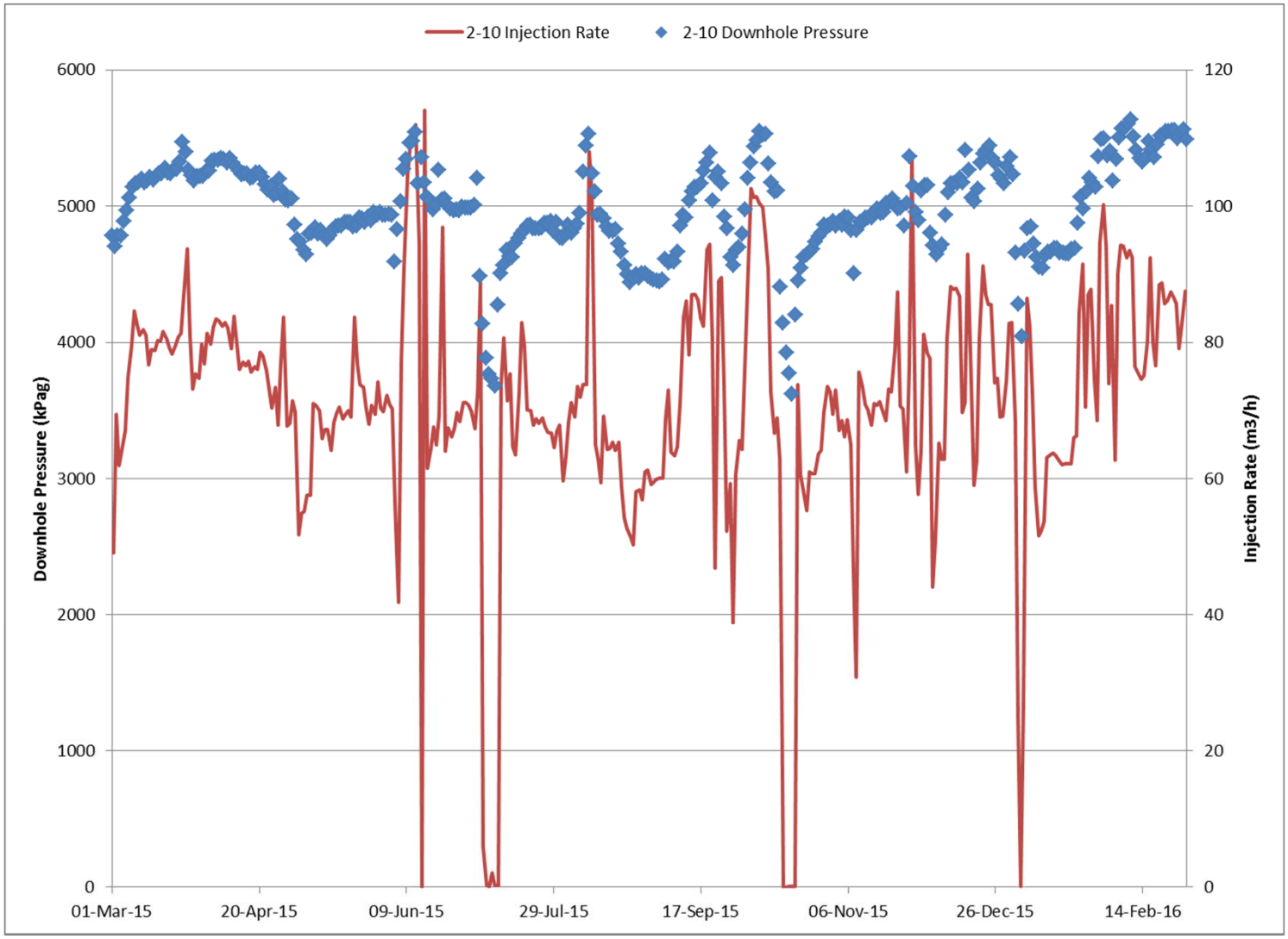
Waste Management – Disposal

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)*
  - *102/12-06-095-06W4/00 (DS2)*
  - *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)*
  - *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:
  - Re-sampled chemistry at DS1, DS2, DS3, DS4, DS5, DS6, DS7, DS8 and PP7
  - Performed injectivity test on PP7 and re-completed it back to a monitoring well
  - 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
  - Future drilling locations and testing programs will be based on learnings from the data acquired
- Numerical modeling, based on all data acquired to date, is ongoing

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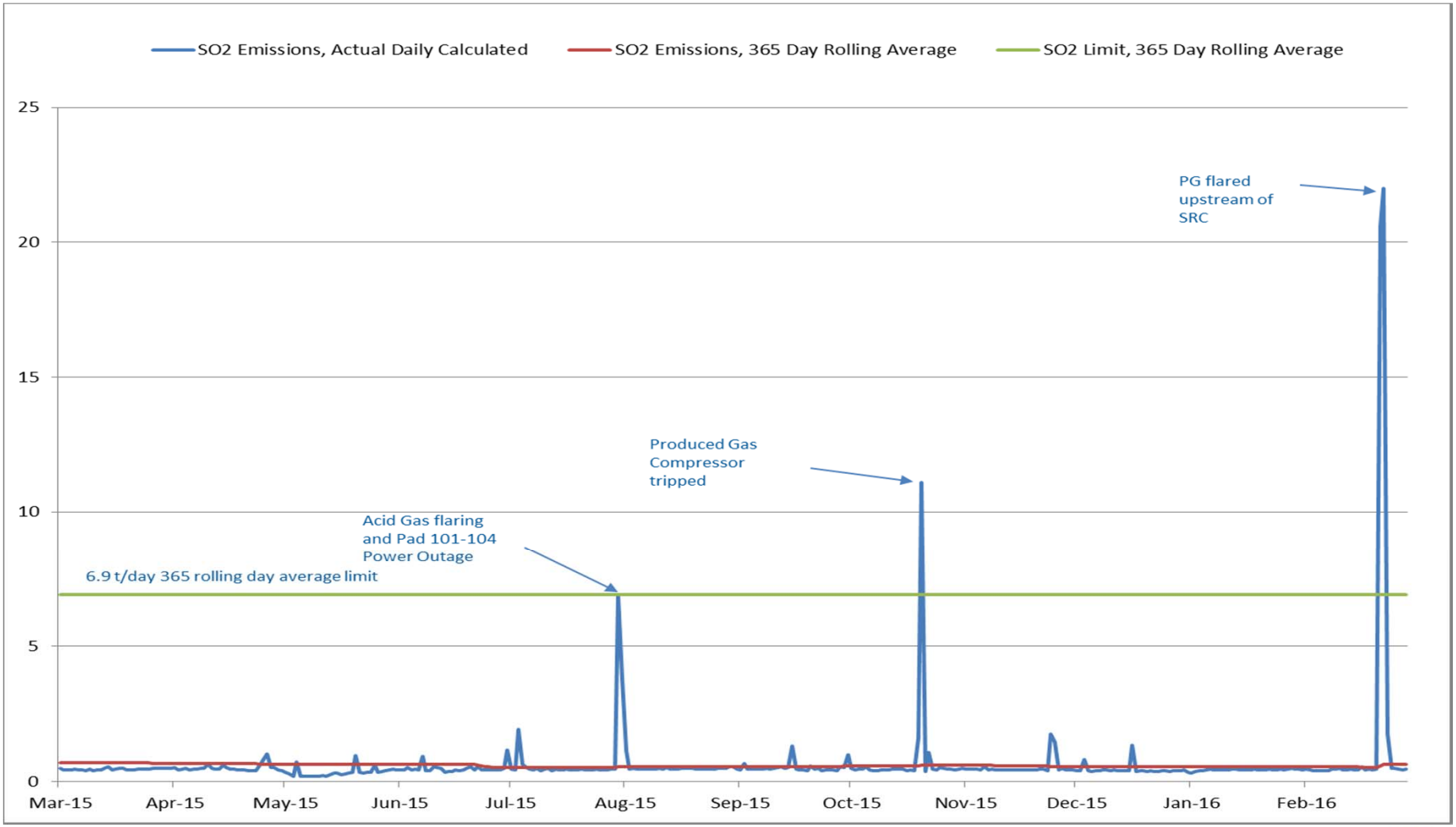
Sulphur Recovery

	Average Inlet Sulphur (tonnes/day)	Sulphur recovery (%)	Sulphur Balance (%)	Acid Gas Flared (e3m3)	Sulphur Flared (tonnes)
Q2 2015	10.0	97.8%	0.1%	753.5	1.7
Q3 2015	11.4	97.3%	2.8%	37.5	1.9
Q4 2015	11.6	97.5%	1.6%	129.0	8.4
Q1 2016	12.0	96.2%	1.9%	294.9	21.5

- Regulatory requirement of > 95.9% sulphur recovery per calendar quarter for inlet rates > 10-50 tonnes/day
- Sulphur recovery rates in 2015 and 2016 year-to-date have consistently been above these requirements
- Sulfur Recovery for Q1 2016 was lower due to leak on the SRU inlet filter (99Y-1400/1500) nozzle and the standby filter was offline due to planned maintenance which lead to Produced Gas flaring.

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 = 0.64 tonnes/day
- SO_2 Total = 234.2 tonnes
- Average Inlet H_2S Concentration = 5.2%

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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 – AER Compliance Items

	Number of Occurrences	Reference Number(s)	Date(s) of Occurrence	Details of Occurrence	Suncor Actions
SRU Stack Top Exceedance	1	302516	August 21, 2015	Stack top temperature (STT) exceeded the limits as outlined in Section 3 (Table 3.1) of the EPEA approval one time (5 consecutive hourly averages) during this reporting period.	Suncor has implemented corrective actions reflective of each of the root causes. Procedures have been reviewed and updated to include instructions for the Control Room Operator (CRO), prior to lining up sweep air or tail gas vents and to enable the stack top violation alarming in the DCS. An operations procedure has been developed for preparing and isolating the sweep air flame arrestors for servicing. Other actions completed include additional training for SRU regulatory requirements and CEMS functions for the CRO on each shift.
NOx CEMS Exceedance	2	299212, 301562	June 4, 2015 and July 23, 2015	There were two events where NOx limits were exceeded on the cogeneration units (91F-5710 and 193F-5000).	Suncor has addressed both of the NOx exceedance issues by implementing corrective actions for each root cause. 299212 - a vendor was engaged to assist with making a revision to the peak load control software for 91F-5710. 301562 - Island Management System testing has been reviewed with Power Engineering team to optimize timing of IMS initiation to prevent extended testing durations and impacts to NOx emissions.
SO2 Exceedance	4	297522, 300318, 301667, 308562	April 26, 2015, July 3, 2015, July 30, 2015, and February 23, 2016	There were four instances where SO2 exceeded the EPEA approval limits (133 kg/h) for a one hour average.	Suncor continues to address each of the SO2 exceedance events on a case by case basis and implement corrective actions accordingly. Recurring issues with losing power due to ravens striking electrical lines have been mitigated with the initial capping of the domestic waste cell.
Industrial Runoff Releases	3	295941, 296456, 300768	March 14, 2015, March 28, 2015 and July 12, 2015	Suncor had three events of uncontrolled releases of surface water to the environment. All three incidents were tested and met pump-off parameter requirements for pH, chlorides and oily sheen.	Suncor retained a third part survey company to conduct surveys of the berm areas within the CPF, operational well pads and the Village developed area. These surveys were used to perform runoff system enhancements on the northwest corner of the Village developed area as well as the east side of the CPF area where issues have been noted in the past. The survey results will be utilized by the Suncor Roads and Grounds department to assist with addressing other potential areas of concern within the CPF, well pads and Village developed areas.

Regulatory – AER Compliance Items

	Number of Occurrences	Reference Number(s)	Date(s) of Occurrence	Details of Occurrence	Suncor Actions
Venting	52	DDS, 801500 (298964)		There have been 52 venting incidents reported to the AER during the reporting period via the CIC and the DDS system as well as issues with the Plant 91 91D-2500 Skim Tank and 91D-2600 Skimmed Oil Tank.	Suncor continues to work on reducing the number and duration of venting incidents. Reliability engineering is currently working on an engineering assessment to re-rate the 91D-2500 tank. Successful re-rating of the Skim Tank will allow for the purchase of new valves with heavier pallets. These new valves with the heavier pallets will be the proposed engineered solution to address the fugitive emissions issue with the Plant 91 Skim Tank. The new valves will be purchased once the engineering assessment on the tank re-rating is complete. Suncor will then determine an opportune time to complete the replacement.
Missed Water Well Measurements	3	298893, 301647, 302232		There were several daily instances where the well level measurements were missed in the production wells as part of licence 233808 during the months of April, June, July and August.	Suncor initiated a series of crew stand-downs with each of the Firebag operations teams to review the compliance requirements of licence 233808 and the environmental and regulatory significance of the Water Act licence contraventions. Effective August 19, 2015 an automated notification was programmed to generate an email to Firebag management and EH&S personnel if well level readings have not been entered into Suncor's sample manager for a daily measurement by 11:30 am.
233808 Volume Exceedance (daily maximum)	1	299208	May 27, 2015	There was one event where the daily volume limit was exceeded for licence 233808 - production well 03-05.	Suncor's mitigation to prevent future incidents from exceeding the daily diversion rate by clamping the output of the water well valve (91FC-3000) at 75%, only allowing 66 m3/hr of flow at the current discharge pressure.
233808 PW03-05 Well Level Measurements - Incorrect Well	1	308617	February 24, 2016	It was determined that the well level measurements had been taken from a nearby observation well approximately 17 feet East of PW03-05 in the Plant 91-3000 area rather than PW03-05 as part of licence 233808 Section 4.2.	Suncor has installed a data logger to capture continuous water well level readings from PW03-05 and the associated observation well OW03-05 (March 29, 2016). Both wells are now equipped with the ability to obtain daily manual well level measurements.

Regulatory – AER Compliance Items

	Number of Occurrences	Reference Number(s)	Date(s) of Occurrence	Details of Occurrence	Suncor Actions
15P7 MOP Exceedance	1	VSD	July 2, 2015	Well P115P7 (UWI 105/08-09-095-06W4/0) temporarily exceeded the Alberta Energy Regulatory (AER) approval surface Maximum Operating Pressure (MOP) during the steam injection phase. A pressure sensor located at the pump intake on the P115P7 well indicated that the pressure reached a maximum of 4082 kPag at heel and that the pressure decreased immediately after the control valve was able to respond to the changes in header flow.	Learnings from the investigation to be shared with reservoir, production and operations personnel. Suncor has automated the low rate steam test process with smooth ramping of valves to limit pressure spikes in the medium pressure steam header. The low rate steam tests on Pad 115 were postponed until P115P7 is no longer injecting at these higher pressures. Trips to steam injection based on production BHP measurements while steaming past the ESP have been implemented.
Pad 108 and 115 VX meter	1	VSD	February 28, 2015	115P2, 115P4 115P6: Improperly designed insulation on the Pad 115 Vx meter caused the meter to overheat and go offline. 108P11: The higher relative flow rate on 8P11 through the system is causing multiphase flow through the Coriolis meter and this resulted in invalid tests.	Suncor has resolved both metering issues.
191D-5060 and 193D-5060 VSD	1	VSD	October 31, 2015	The 191D-5060 and the 193D-5060 cogeneration building drain tanks had been in operation since 2012 without written record of tank inspection on file.	Suncor has undertaken measures to address and amend the situation that lead to the non-compliance of not having record of leak detection monitoring results for both tanks include: both tanks have been added to the annual inventory review of the storage and containment devices and monthly inspection forms have been added to monthly tank and trench inspection program. These will be recorded in the Regulatory Compliance tool on a monthly basis.
Landfill Unapproved Waste Disposal		VSD	February 22, 2016	Liquid warm lime softener sludge waste was disposed of into the industrial landfill cell in contravention of Section 8 (d) of the Firebag WMF approval - WM095.	Suncor has undertaken measures to address and amend the situations that lead to the noncompliance of disposing liquid sludge waste into the Firebag oilfield waste cell, including the review and revision of work procedures to include a three time visual inspection prior to disposal into the landfill cell. In addition to a paint filter test being administered in the field if there is any indication the sludge properties are not indicative of the intended water stream for a Class II oilfield waste cell.

Regulatory Compliance Summary

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

Table of Contents

- Operations and Facility Performance – Glen Myck
- Measurement and Reporting – Jayanto Ghoshal, Jeremy D' Mello
- Water Production, Injection and Usage – Jayanto Ghoshal, Jeremy D' Mello
- Sulphur Production – Doug Castellino
- Environmental Performance – Doug Castellino
- **Future Plans – Glen Myck**

Future Plans

- Suncor is continually investigating opportunities to improve process efficiency
- Firebag Debottleneck project
- Well Pads 121-123 are under development

Firebag Debottleneck – Summary

- Objective: Incrementally increase the net Plant 93/94 steam capacity from 90.5k Sm^3/d to either 109k Sm^3/d by debottlenecking several operating areas of Plant 93/94 including the Diluent Stripping Unit:
  - No changes to Oil Logistics scope including cooling, blending & tankage.
- The scope of the Firebag debottleneck program includes CPF (Plants 93 & 94), development of associated pads and gathering system.
- The Firebag Debottleneck project is not requesting approval for new incremental volumes but advancing the already approved volume for Stage 5/6 (both EPEA and AER Oil Sands scheme)
- Tie In work is planned for 2017 during Firebag Turnaround to secure opportunities for future planned expansion work

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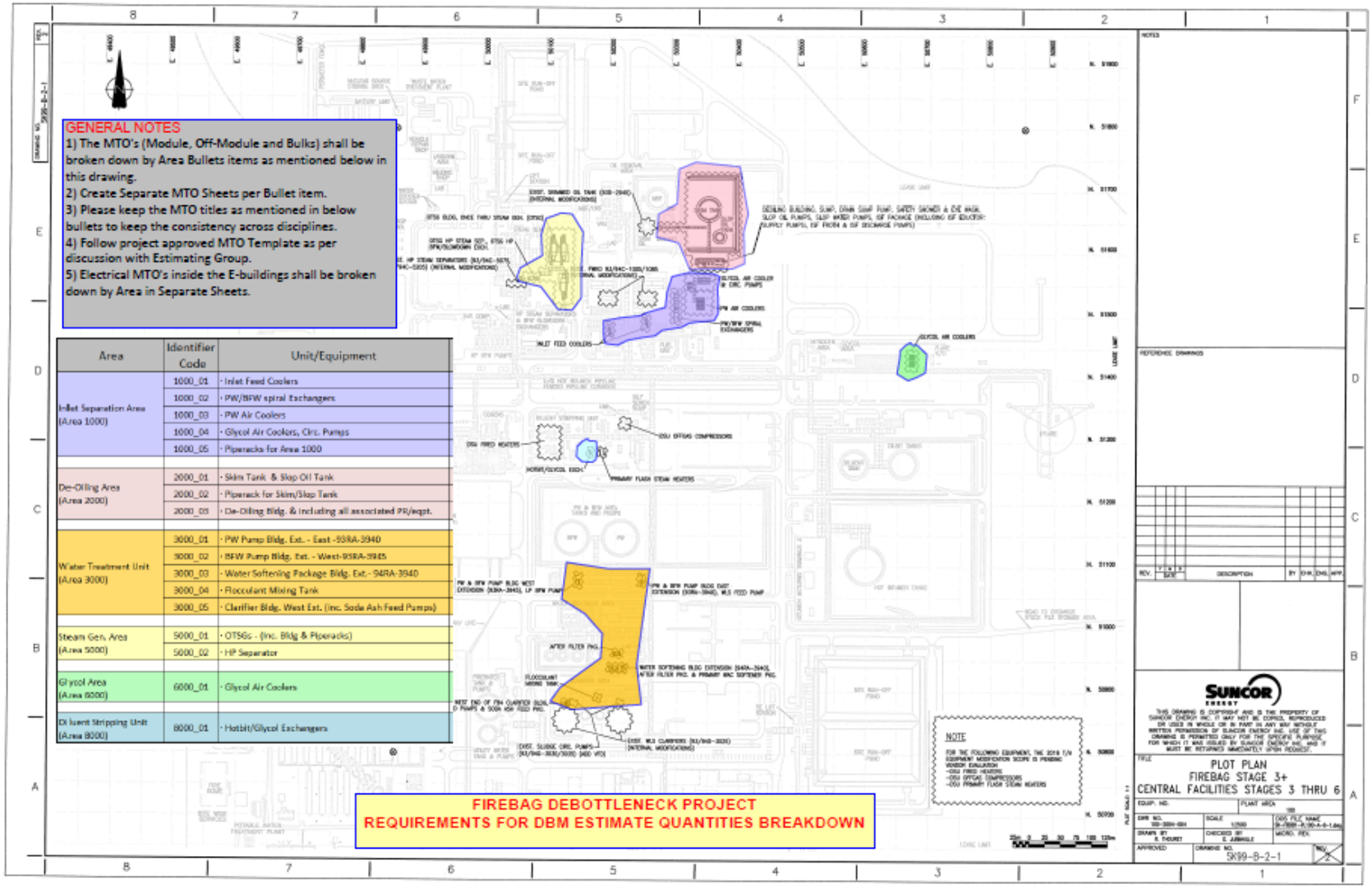
Firebag Debottleneck – Preferred Option being developed in Stage 2

Steam Generation Capacity Increase from 90.5k Sm^3/d to 109k Sm^3/d

- Highlights of Equipment Installed/Areas Affected
  - Additional one double stacked OTSGs (417m3/hr @ 85-90% quality)
  - scope expected to maximize utilization of existing available capacities in various areas of CPF.
  - equipment modifications & additions in Area 1000, 2000, 3000, 5000, 6000, 8000 in Plant 93/94
  - The air emissions are within already approved EPEA limits

Plot Plan



Area	Identifier Code	Unit/Equipment
Inlet Separation Area (Area 1000)	1000_01	· Inlet Feed Coolers
	1000_02	· PW/BFW spiral Exchangers
	1000_03	· PW Air Coolers
	1000_04	· Glycol Air Coolers, Circ. Pumps
	1000_05	· Piperacks for Area 1000
De-Oiling Area (Area 2000)	2000_01	· Skim Tank & Slop Oil Tank
	2000_02	· Piperack for Skim/Slop Tank
	2000_03	· De-Oiling Bldg. & including all associated PR/eqpt.
Water Treatment Unit (Area 3000)	3000_01	· PW Pump Bldg. Ext. - East -95RA-3940
	3000_02	· BFW Pump Bldg. Ext. - West-95RA-3945
	3000_03	· Water Softening Package Bldg. Ext.- 94RA-3940
	3000_04	· Flocculant Mixing Tank
	3000_05	· Clarifier Bldg. West Ext. (inc. Soda Ash Feed Pumps)
Steam Gen. Area (Area 5000)	5000_01	· OTSGs - (inc. Bldg & Piperacks)
	5000_02	· HP Separator
Glycol Area (Area 6000)	6000_01	· Glycol Air Coolers
Diluent Stripping Unit (Area 8000)	8000_01	· Hotbit/Glycol Exchangers

Equipment Summary

Area	Type of equipment	Qty
1000	Exchangers	16
	Aerial Cooler	2
	Pump	2
	Inj. Package	2
1000 Total		22
2000	F.E. Tank	1
	Tank	1
	ISF Package	1
	Pump	11
	Blowcase	2
2000 Total		16
3000	Package	3
	Softener	1
	Pump	10
	Tank	1
	Safety Shower	1
	Mixer	1
3000 Total		17
5000	OTSG	1
	Separator	1
5000 Total		2
6000	Exchanger	2
6000 Total		2
8000	Aerial Cooler	0
	Exchanger	2
8000 Total		2
DWT	Pump impeller	1
DWT Total		1
Grand Total		62

Firebag Debottleneck Tie-Ins

Scope	# of Tie-ins
Piping Tie-ins	100
Equipment Mods	3
Electrical Tie-ins	
4160V	0 MCCs 1 Section 5 Buckets / Contactors
600V	14 Sections 93 Buckets / Contactors
480V	10 Sections 16 Buckets / Contactors
I&C Tie-ins	
Control Valves	12 + 1 solenoid on existing CV
PSVs / PVRV	2 / 1
Level Transmitters	1 new & 1 replace
Thermowells / Temp. Trans	34 / 4
Flowmeters	0
On/Off Valves	3

Appendix - Surface

Injection 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).
- REC (FW2): Receipt Stream into the Injection Facility. Fresh Water Transfer from the oil battery (AB BT 0078417) to the Injection Facility within the scheme.
- DISP (FW3): Freshwater transferred to the oil battery (AB BT 0078417), in the deoiling unit for cooling purposes. This water is received back into the injection facility along with the produced water from the wells.
- 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 oil battery (AB BT 0078417). This includes produced water from the wells, plus (PW8) the water that was sent from the injection facility to the oil battery for utility and cooling purposes.
- 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).

Overall Facility Water Balance

	Fresh Water			Steam	Produced Water				Disposal	Imbalance
	FW1	FW4	FW5	INT	PW1	PW8	PW4	PW5	DIT	Scheme
	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	(m3)	
Mar-15	70,685	24,123	24,284	2,394,998	2,576,065	43,923	196,767	194,845	100,763	3.8%
Apr-15	70,225	24,284	23,836	2,346,053	2,474,191	42,979	194,845	114,743	97,123	5.0%
May-15	65,653	23,836	23,606	1,763,494	1,903,502	41,949	114,743	144,476	93,991	1.9%
Jun-15	79,243	23,606	24,034	2,228,679	2,353,435	43,323	144,476	127,649	91,840	3.3%
Jul-15	127,524	24,034	23,965	2,427,305	2,493,057	44,704	127,649	145,708	77,294	1.9%
Aug-15	87,560	23,965	23,816	2,521,690	2,665,426	47,840	145,708	155,349	83,293	3.1%
Sep-15	70,024	23,816	23,816	2,425,471	2,555,572	45,855	155,349	170,510	86,525	1.9%
Oct-15	67,598	24,005	23,616	2,561,129	2,665,413	51,263	170,510	152,063	77,758	2.1%
Nov-15	60,025	23,616	23,738	2,613,990	2,656,131	50,560	152,063	141,133	85,357	-0.8%
Dec-15	58,335	23,738	23,709	2,529,385	2,653,784	51,725	141,133	131,066	94,119	1.6%
Jan-16	62,722	23,709	24,000	2,586,149	2,700,059	51,215	131,066	168,534	81,140	0.2%
Feb-16	52,874	24,000	24,056	2,332,083	2,512,055	45,927	168,534	185,232	93,649	2.8%

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.

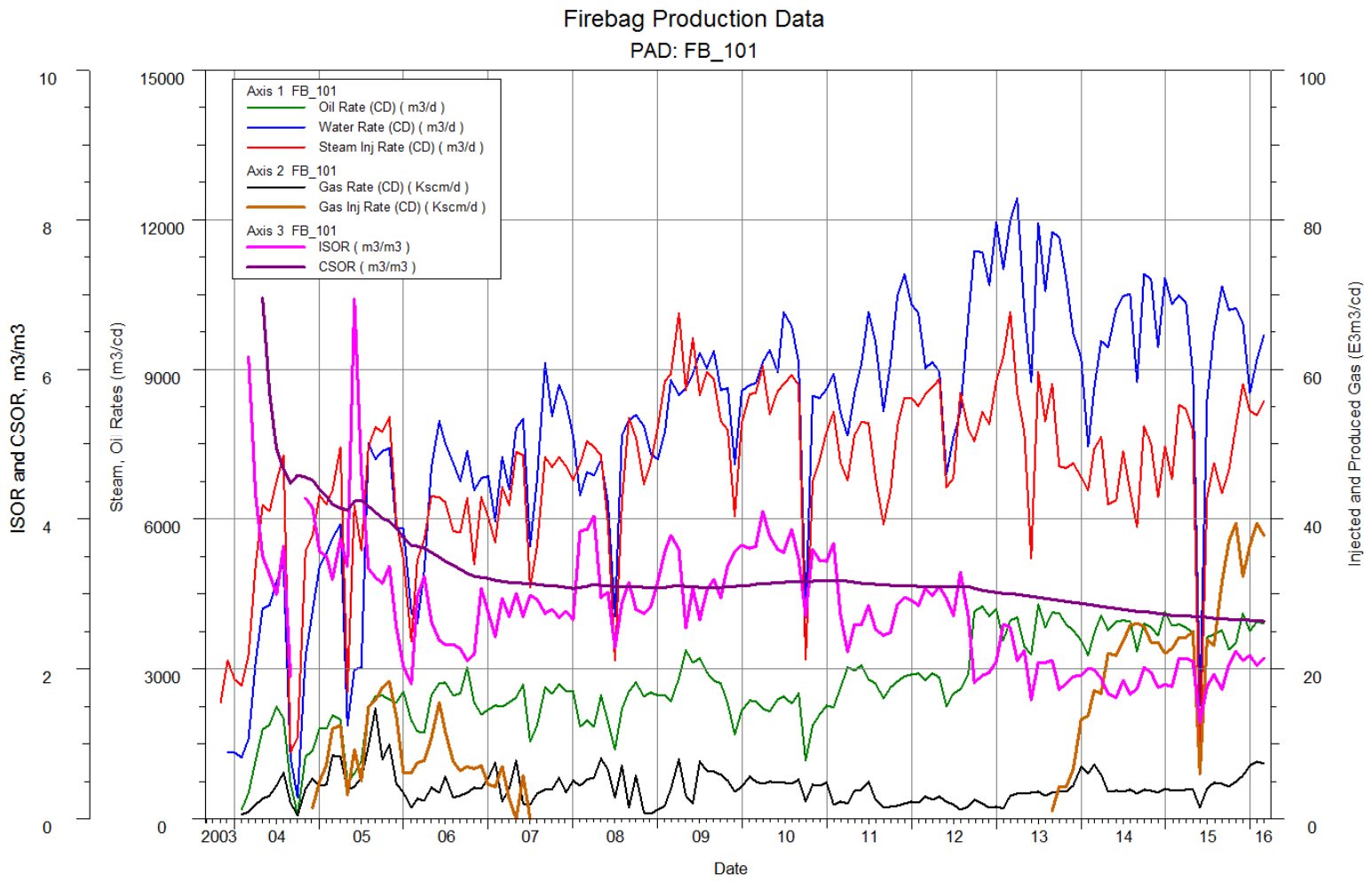
Water

- 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).

Appendix
2016 Appendix to AER Subsurface Presentation

May 10, 2016
Reporting Period: March 1, 2015 to February 29, 2016

Pad Produced & Injected Fluids Plots



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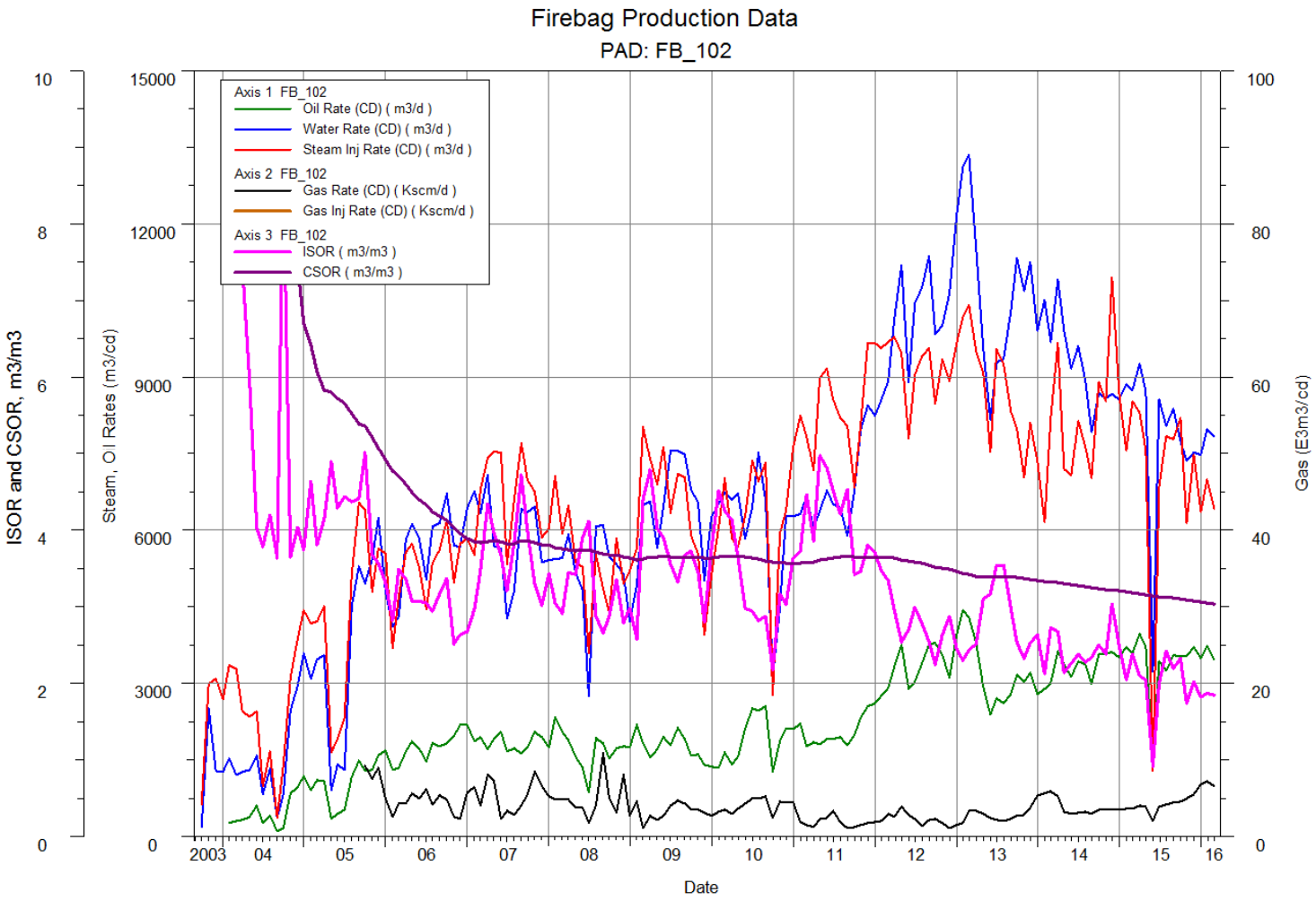

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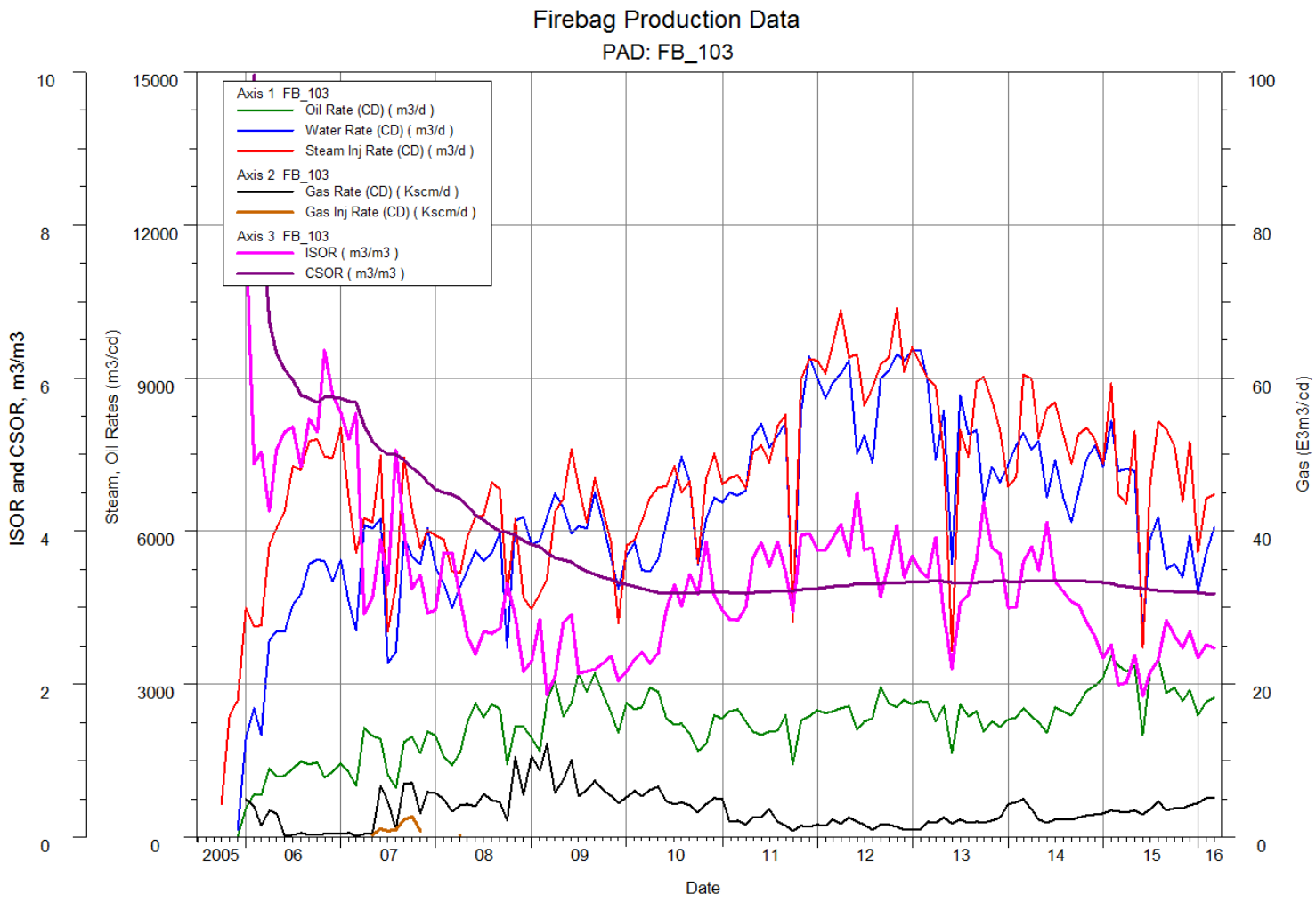

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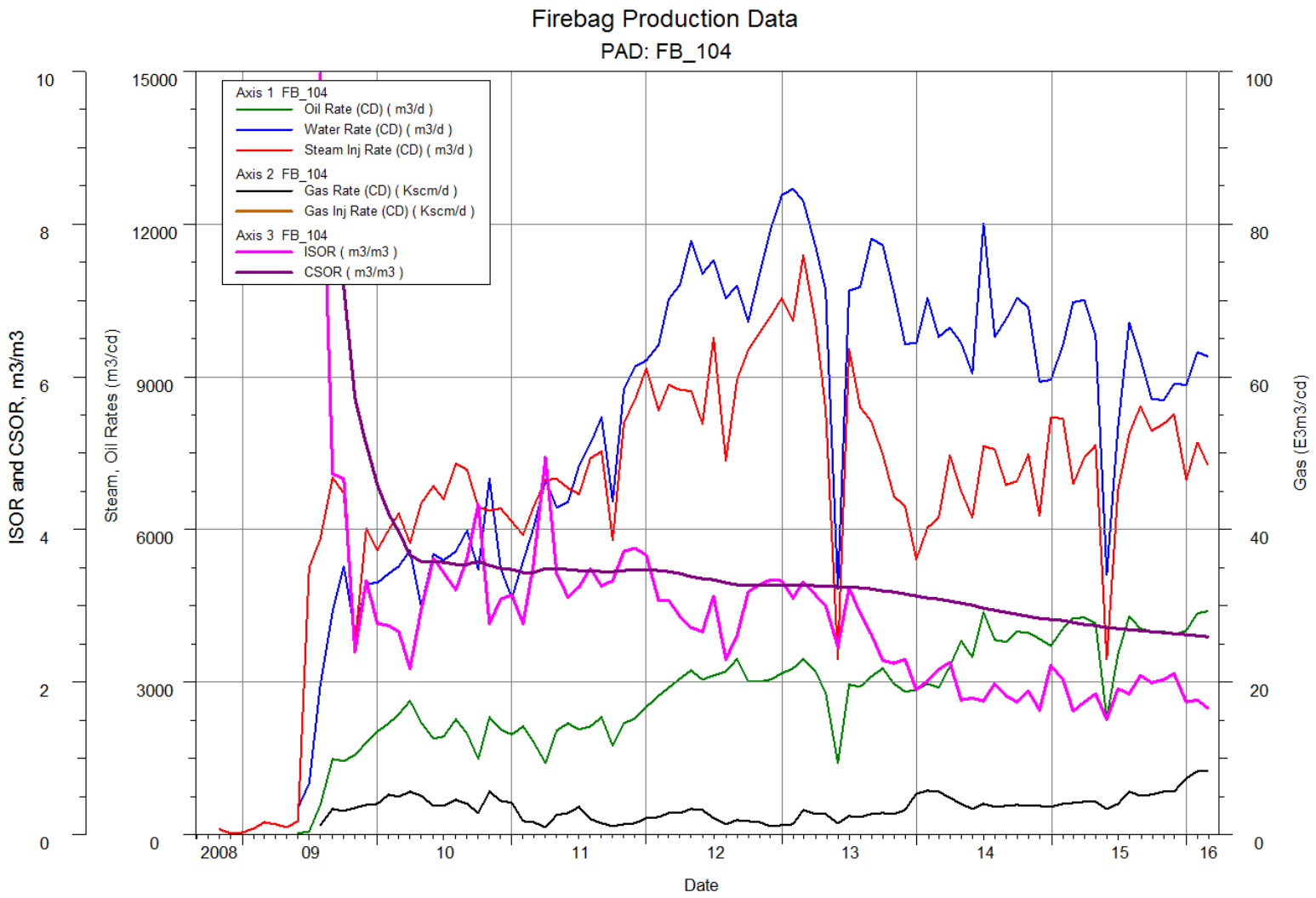

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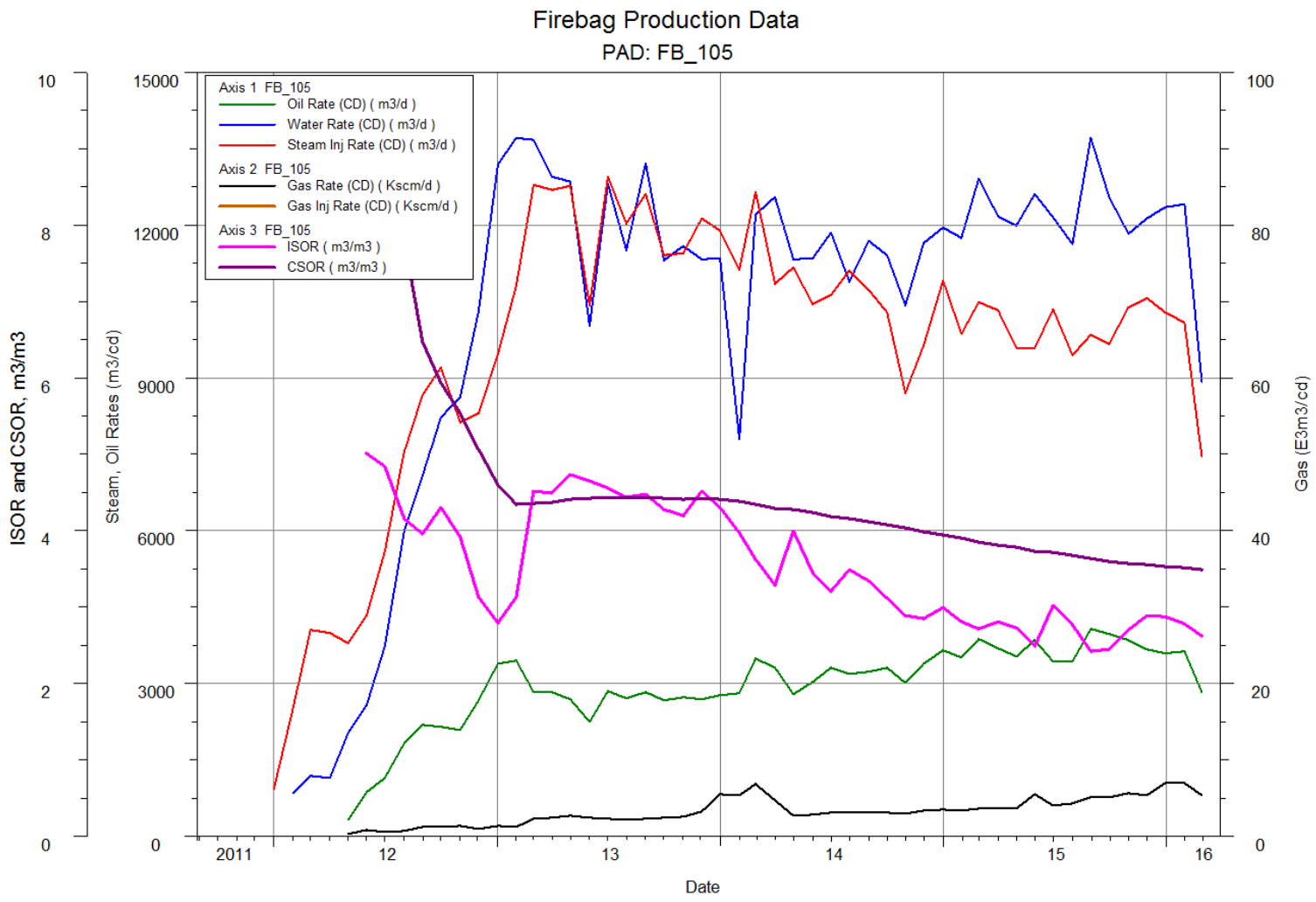

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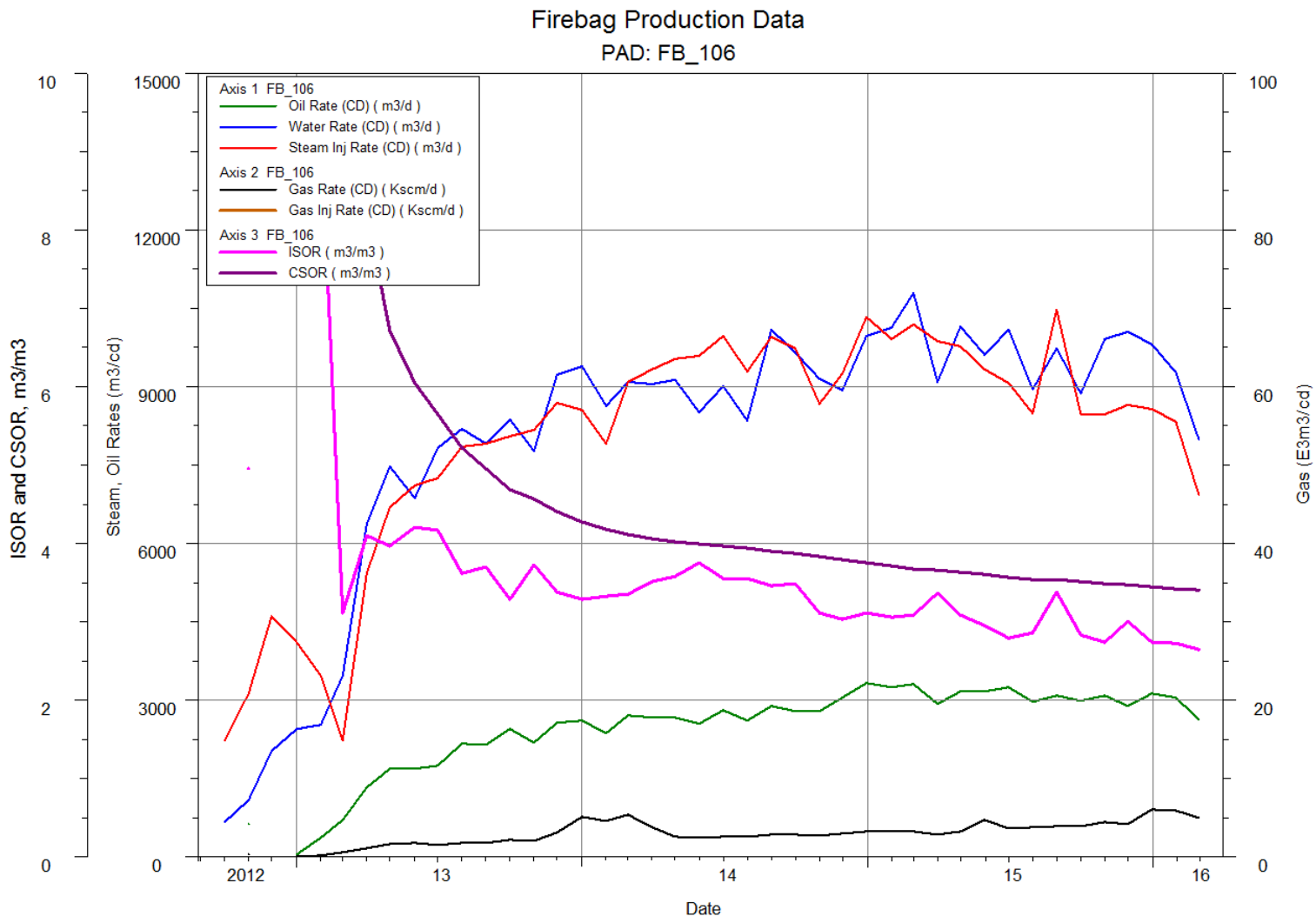

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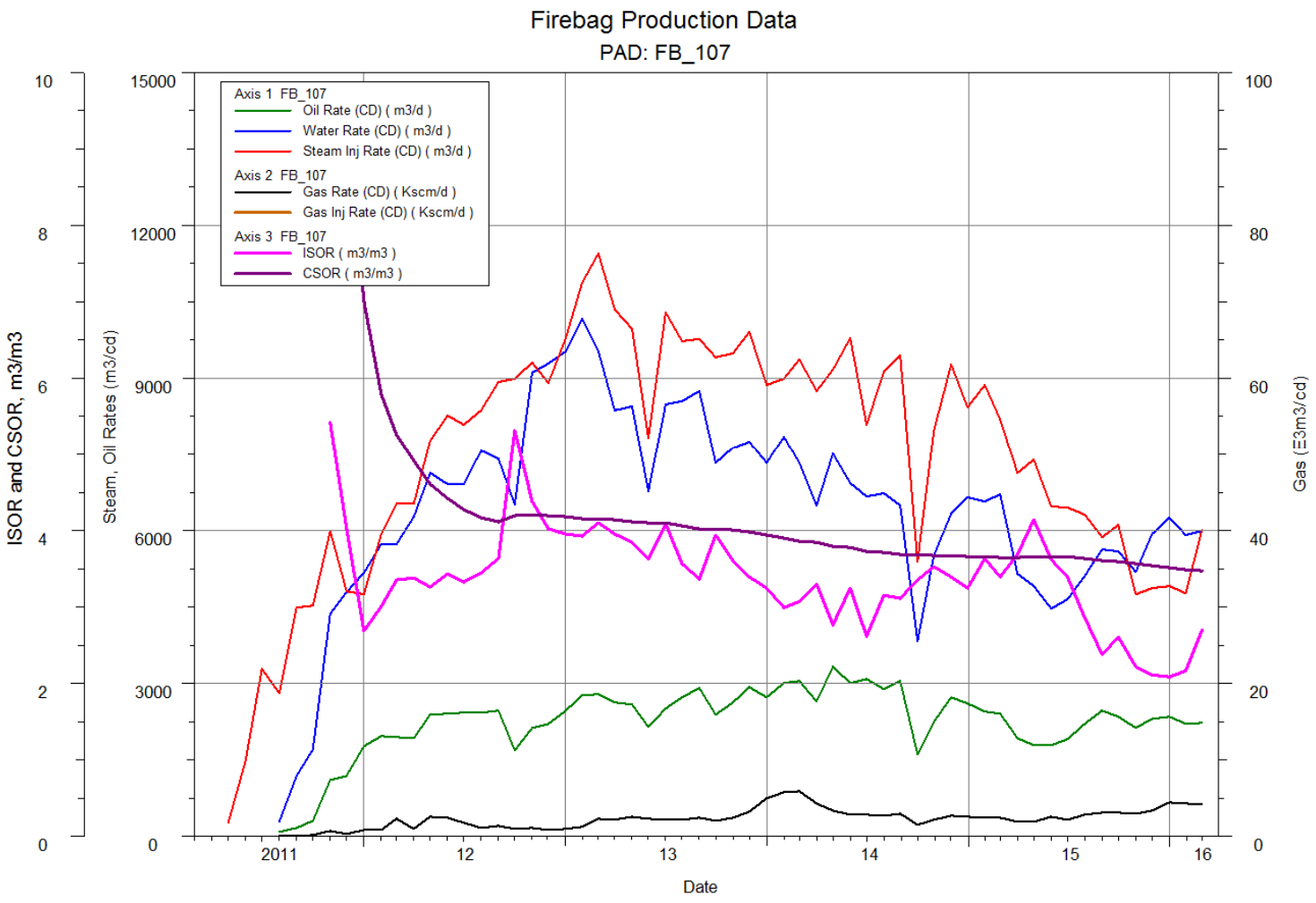

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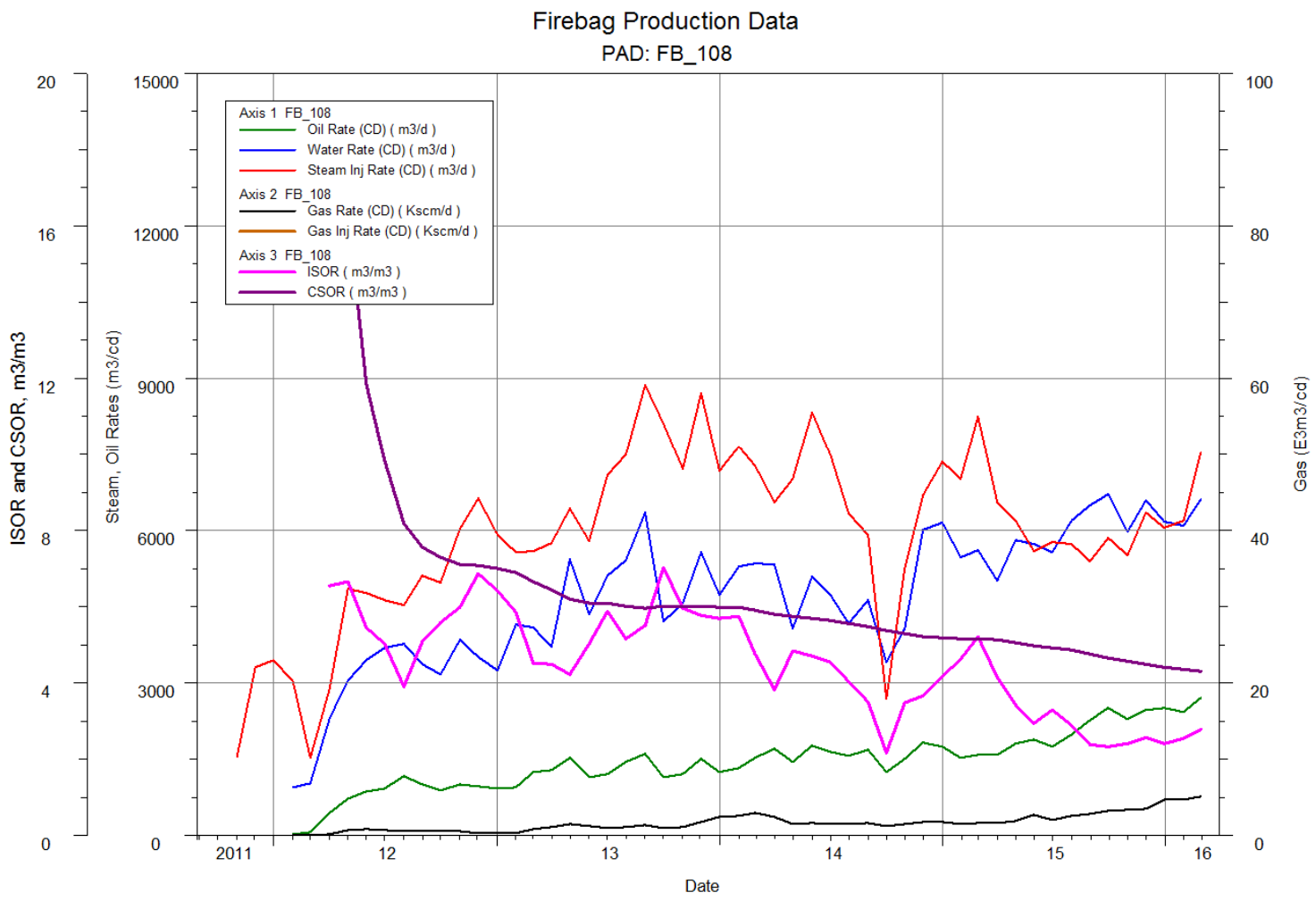

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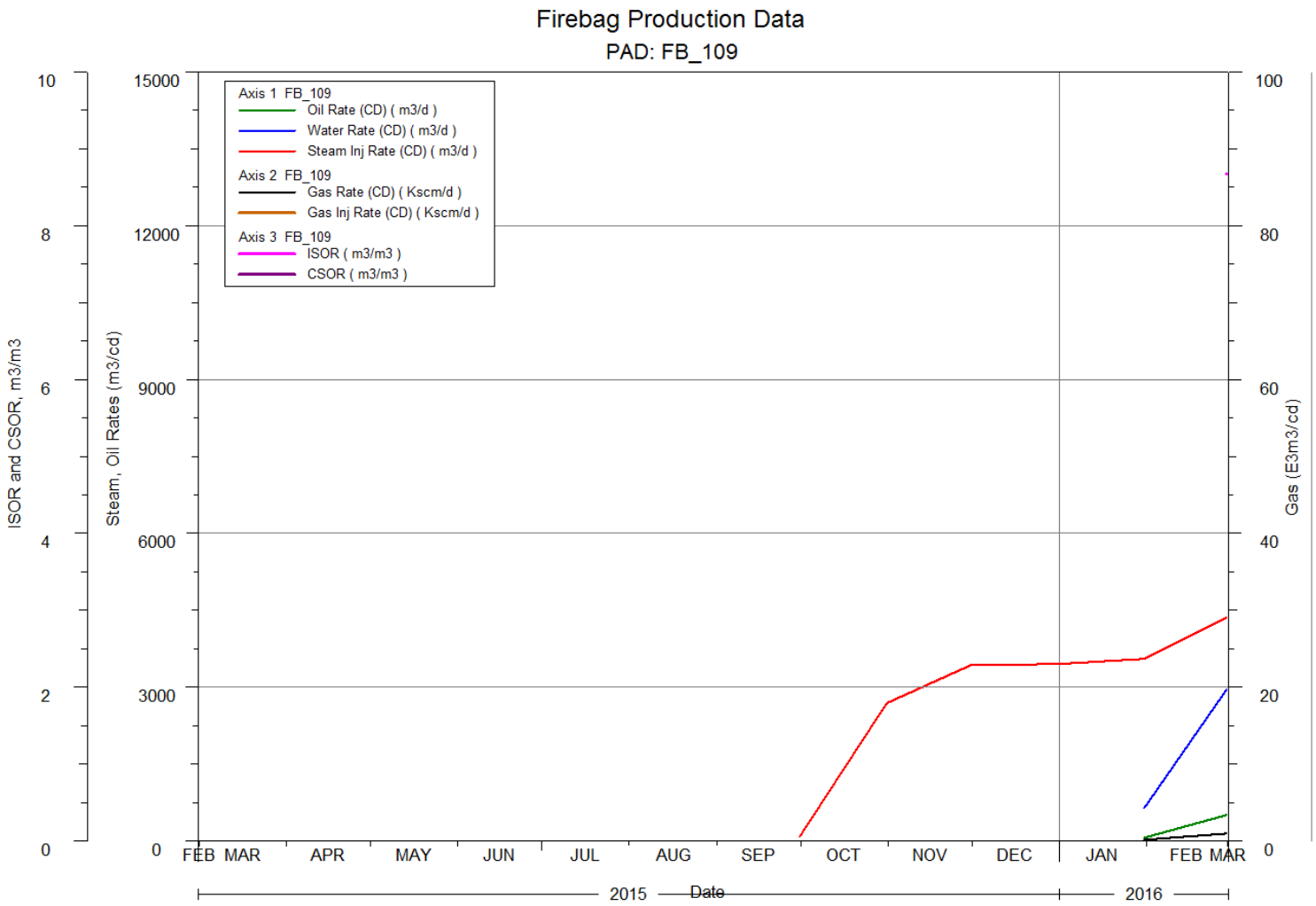

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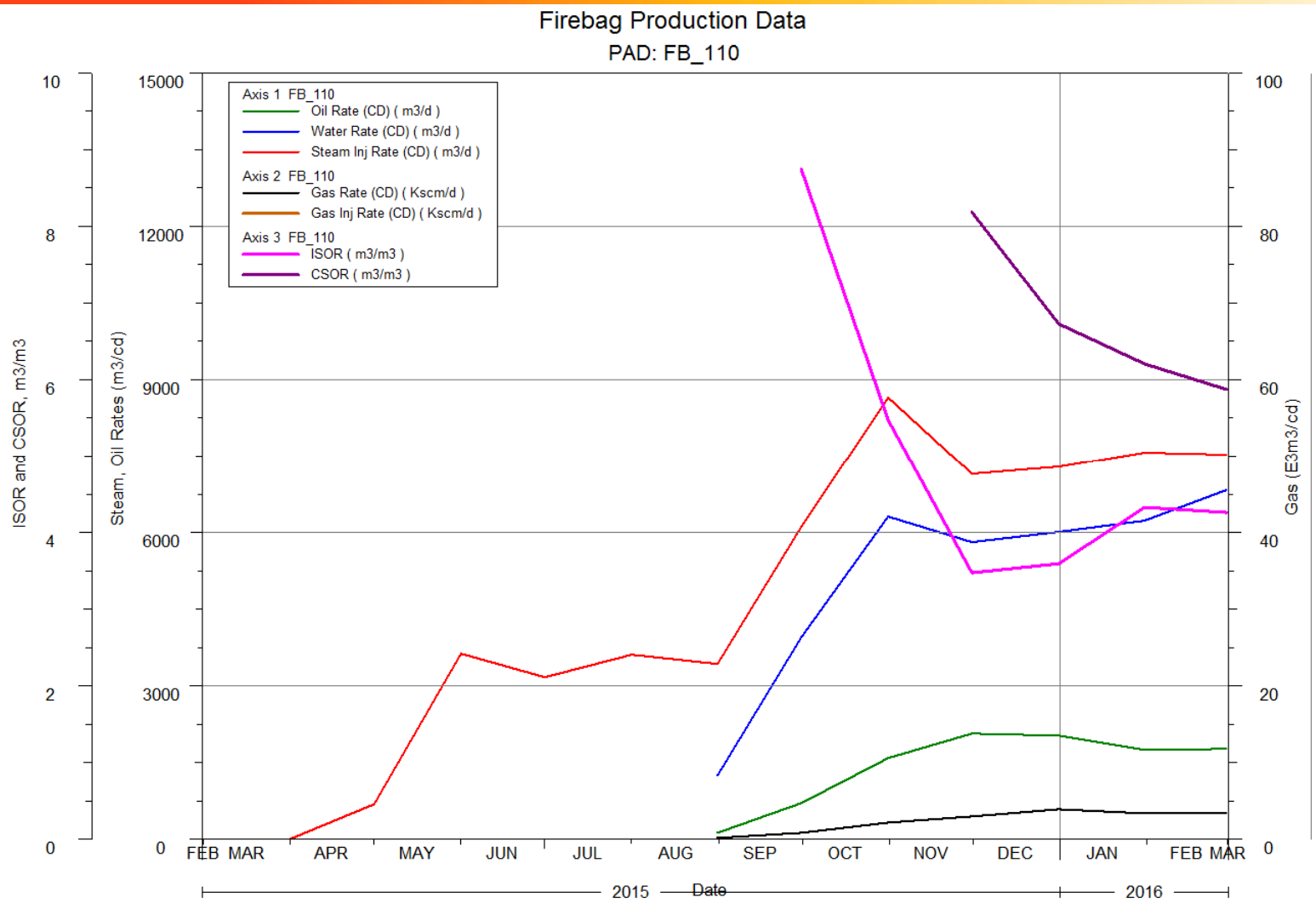

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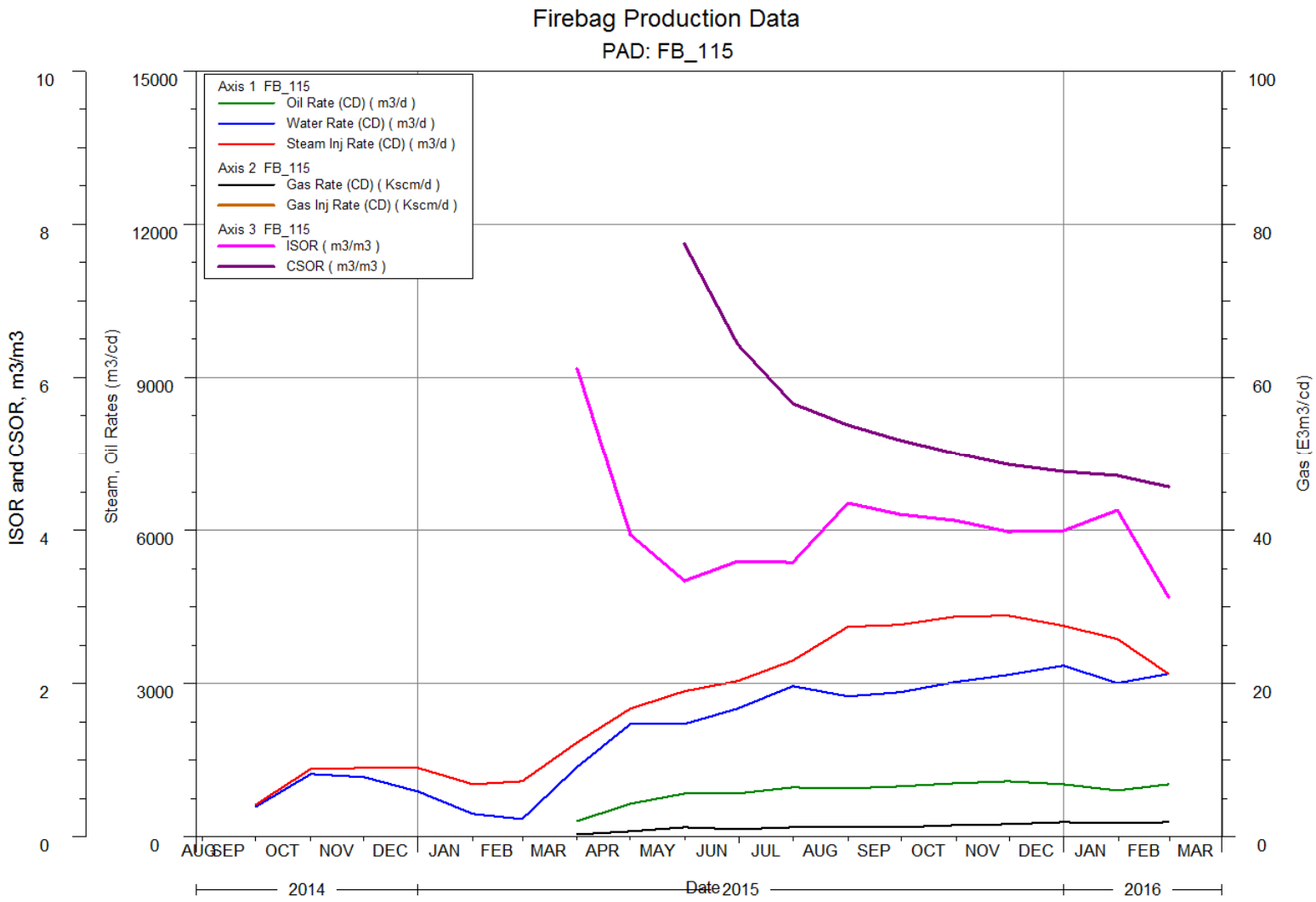

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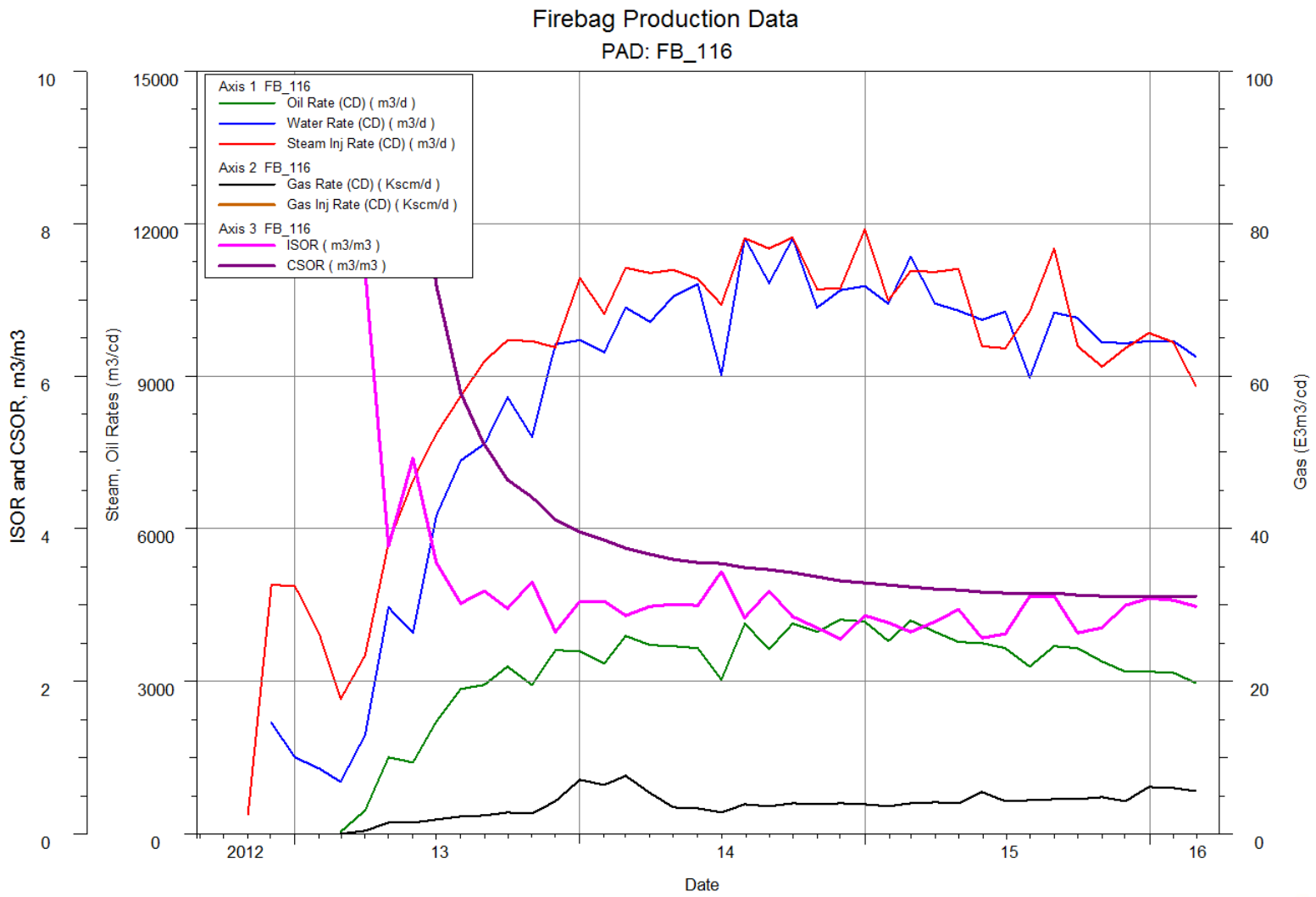


SAGD Observation Well Positioning

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
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 OB1	02/10-01-095-06W4/0	P8P1 P8P2	69.5 m S 32.6 m N	311.5m MD 315.9m MD
ETS OB3	00/01-11-095-06W4/0	P8P13B P814B	57.6m E 35.9m W	315.0m MD 316.0m MD
ETS OB4	02/01-11-095-06W4/0	P7S6 P7P7	24.8 m E 79.5 m W	323.0m MD 315.0m MD
OB DW12	00/16-03-095-06W4/0	P5P12	14 m W	320.9
OB DW4	1AA/12-30-095-05W4/0	P9P15	3525 m N	288.6
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

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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
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	P16P11	2025 m SW of build	307.5m MD
OB110	00/15-33-094-06W4/0	P6P16	835.5 m SW of toe	308.5m 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
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

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB122	00/09-02-095-06W4/0	P7NP10_planned	1.0 m S	315.4 m MD
		P8P9	50.1 m S	315.4 m MD
		P8P8	49.4 m N	315.4 m MD
OB123	02/15-02-095-06W4/0	P7P3	47.0 m E	323.7 m MD
		P7P4	42.9 m W	326.0 m MD
		P8P10	135.8 m N	319.1 m MD
OB124	04/04-01-095-06W4/0	P8P5	56.6 m E	313.9 m MD
		P8P4	50.1 m W	313.3 m MD
OB125	00/02-02-095-06W4/0	P7P12	43.8 m E	325.6 m MD
		P7P11	47.4 m W	324.3 m MD
OB126	00/07-02-095-06W4/0	P7P12	42.2 m E	325.8 m MD
		P7P11	45.1 m W	325.1 m MD
OB127	04/08-02-095-06W4/0	P8P6	45.5 m E	312.9 m MD
		P8P5	46.0 m W	315.3 m MD
OB128	05/08-02-095-06W4/0	P7P9	96.3 m E	327.2 m MD
		P8P6	155.6 m W	314.0 m MD
		P8P7	200.6 m S	315.9 m MD
OB129	10/11-02-095-06W4/0	P4P7	77.4 m E	319.1 m MD
		P4P6	82.9 m W	326.1 m MD
OB13	10/07-11-095-06W4/0	P7S2	16.8 m W	322.66m MD
		P7P2	14.9 m W	322.7m MD
		P7P1	74.2 m E	318.5m MD
OB130	02/09-03-095-06W4/0	P5P14	78.7m E	324.7 m MD
		P5P13	58.8 m W	324.8 m MD
OB131	10/01-10-095-06W4/0	P5P8	95.2 m S	311.3 m MD
		P5P10	5.0 m N	311.3 m MD

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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
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	P10P7 P10P8	66.8 m S 24.8 m N	320.5 m MD 323.5 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
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	P12P10_planned P17P8	104 m SW 82 m NW	289.9 289.4
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

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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
OB182	03/01-09-095-06W4/0	P15P8 P16P1	5 m S 127 m N	285.5 305.0
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
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
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
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
OB27	00/05-04-095-06W4/0	P16P12	559 m S of horizontal	296.2m MD
OB28	00/07-04-095-06W4/0	P16P11	400m SW of ICP	315.75m MD
OB29	00/07-05-095-06W4/0	P16P12	643.7 m SW of toe	293m 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

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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
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	P16P12 P16P10	218 m SE of ICP 585 m SW of ICP	294.3m MD 306.2m 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	02/01-01-095-06 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	P16P12	1065 m S of horizontal	296.4m MD
OB45	00/03-05-095-06W4/0	P16P12	1191 m SW of toe	285.6m 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

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
OB5	00/15-36-094-06W4/0	P1S6 P1P6	1.3 m E 0.9 m W	310.21 m MD 316.71 m MD
OB51	00/03-18-095-05W4/0	P3P10	725 m NE of ICP	307.7m MD
OB54	00/13-07-095-05W4/0	P3S10	53m NE of heel	299.67 m MD 302.91 m MD
OB56	00/15-06-095-05W4/0	P3S1 P3P1	108.64 m E of horizontal 110.92 m E of horizontal	306.67 m MD 314.85 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

SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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
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
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

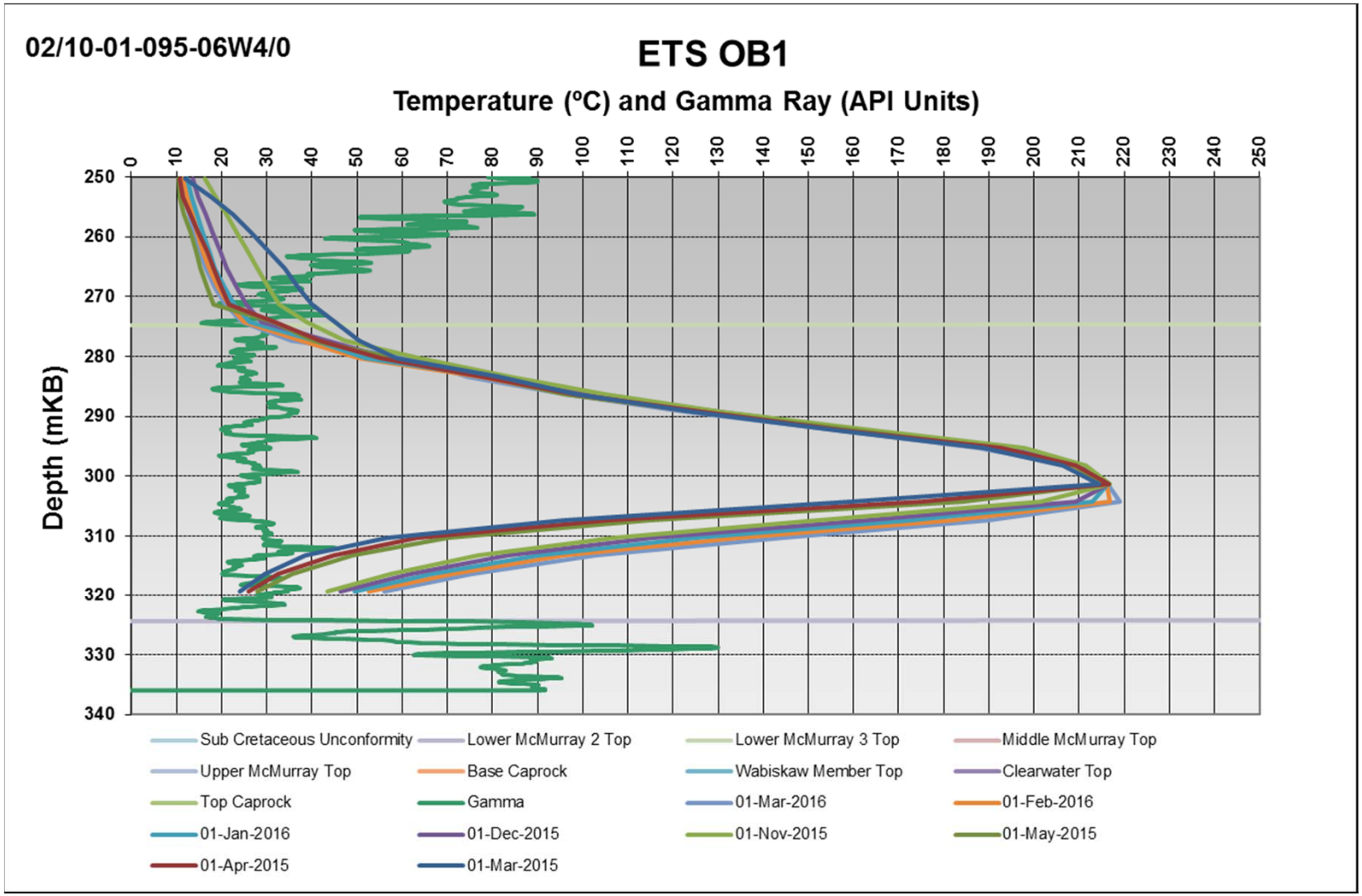
SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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	P3S1	790 m NE of horizontal	279m MD
OB91	00/09-07-095-05W4/0	P3S1	862.2 m NE of horizontal	296m 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
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

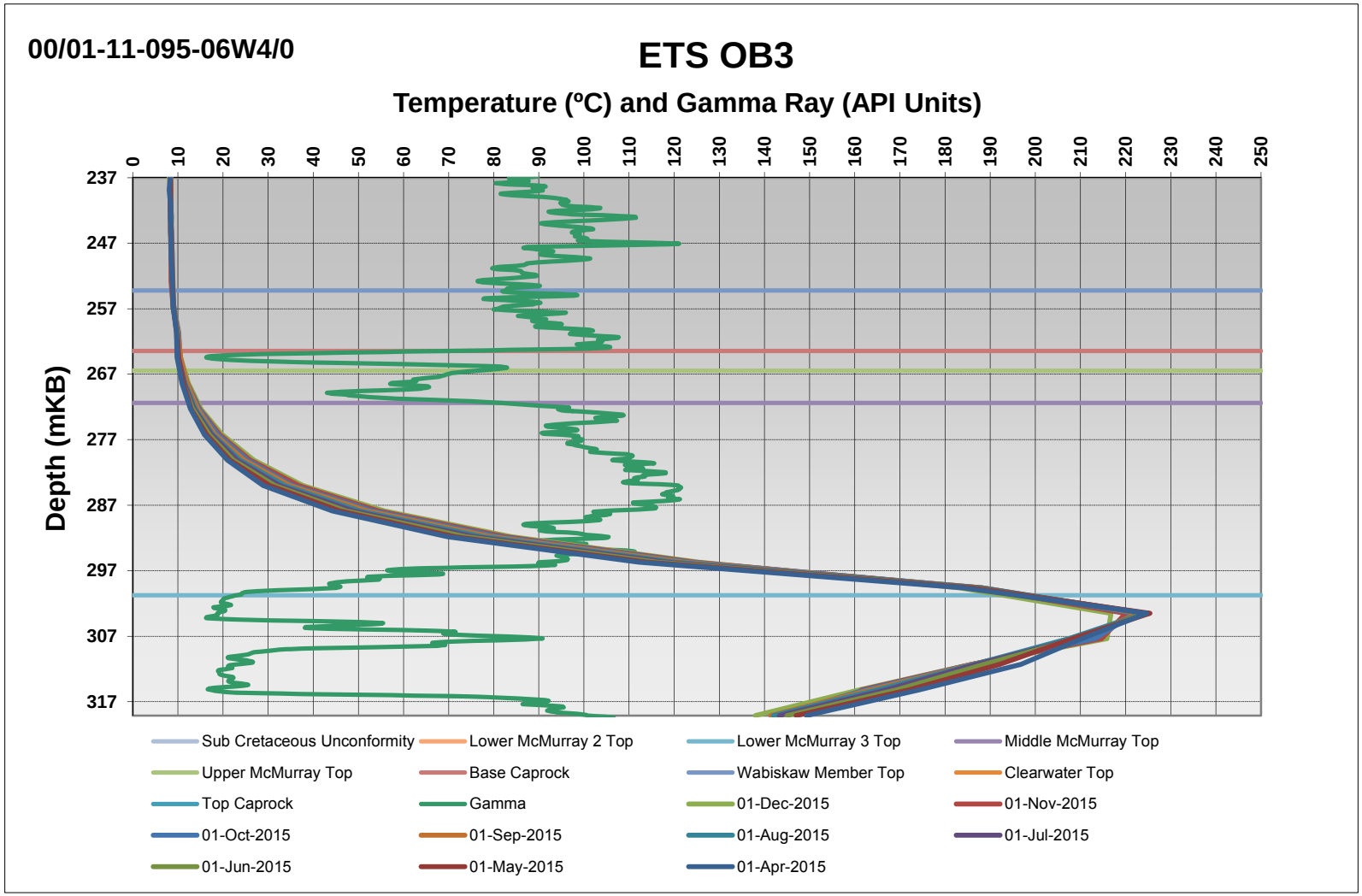
SAGD Observation Well Positioning

Well Name	UWI	Proximity Relative to	Lateral Proximity To	Vertical Proximity To
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

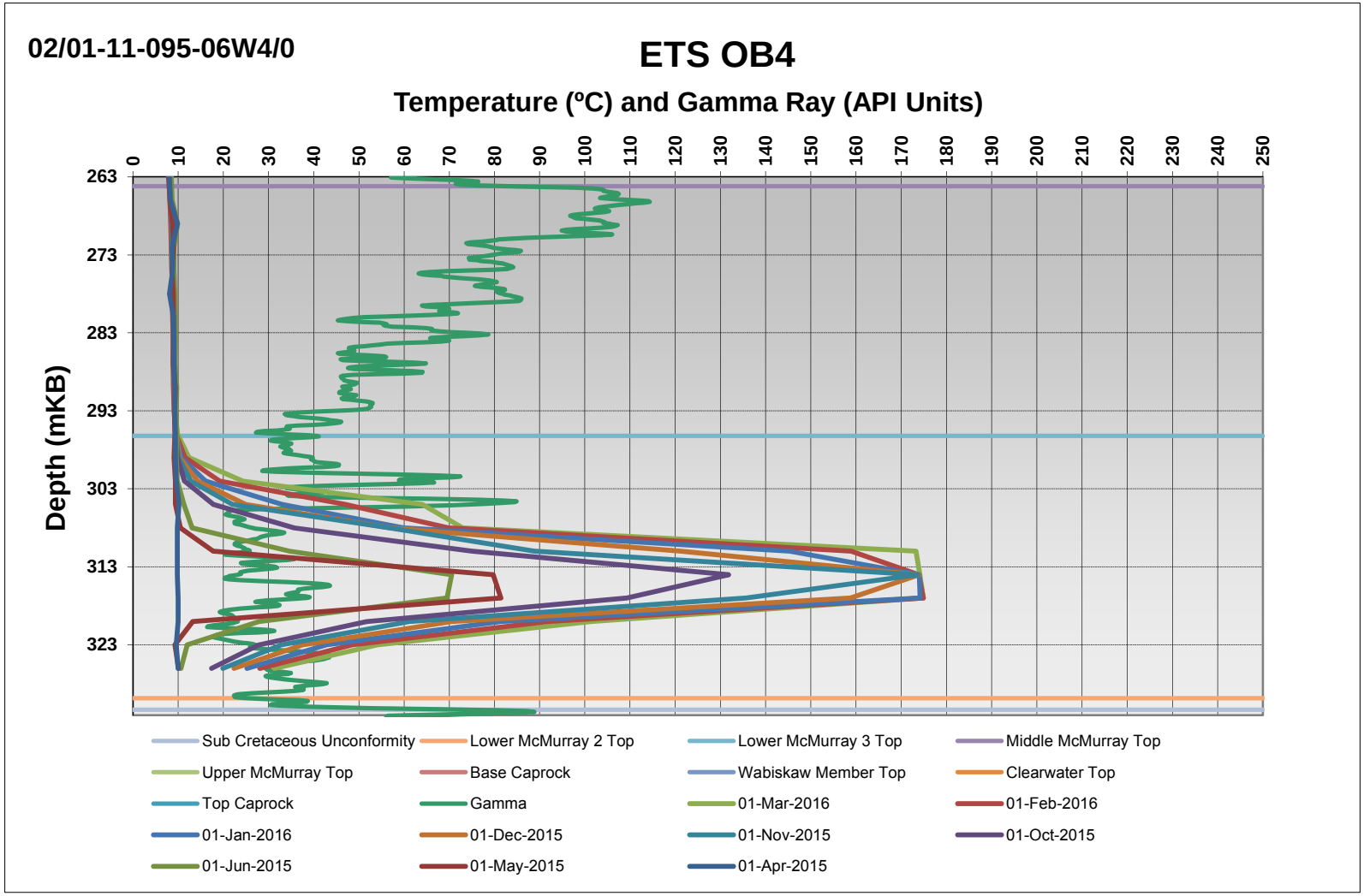
Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



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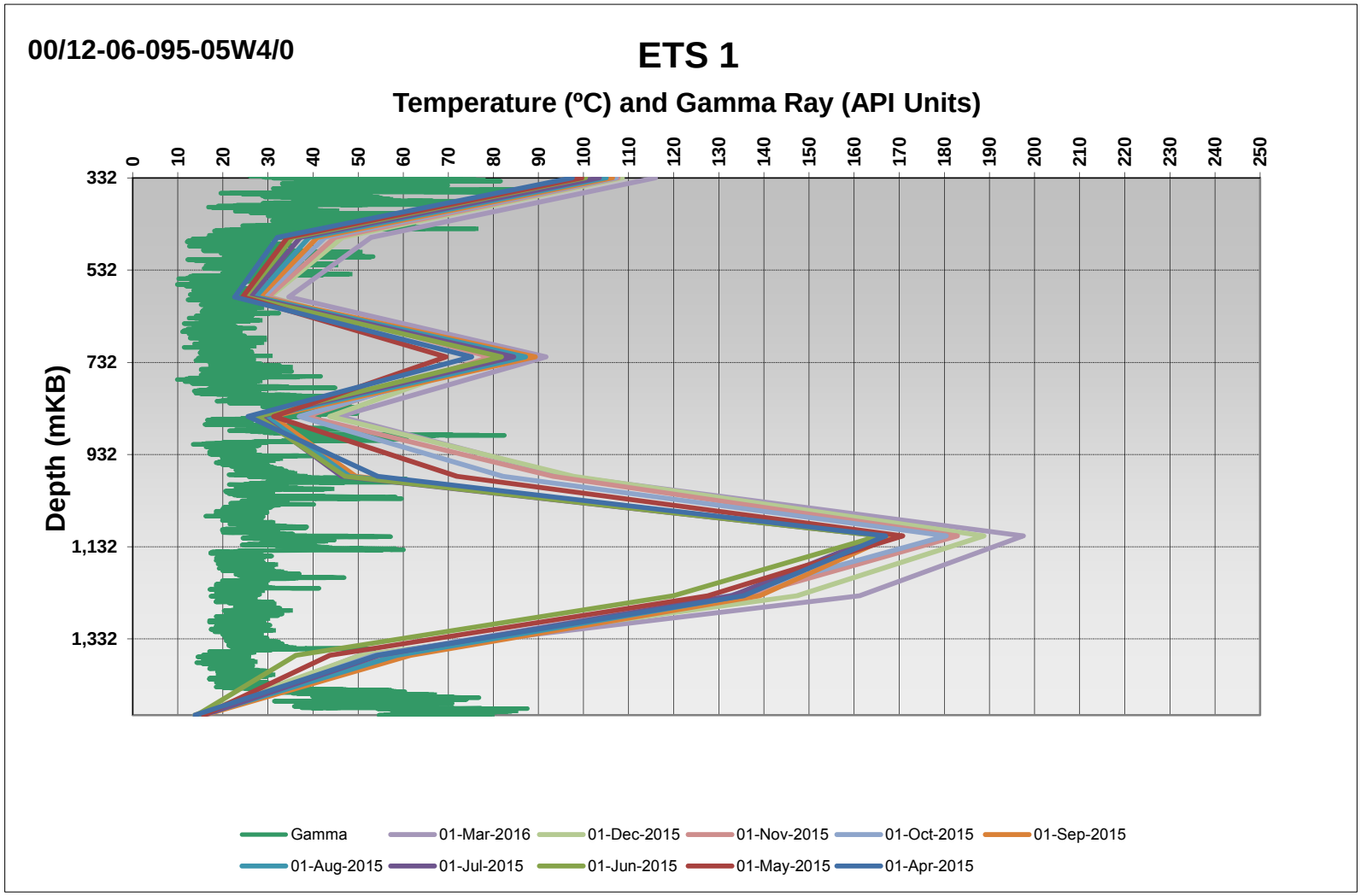
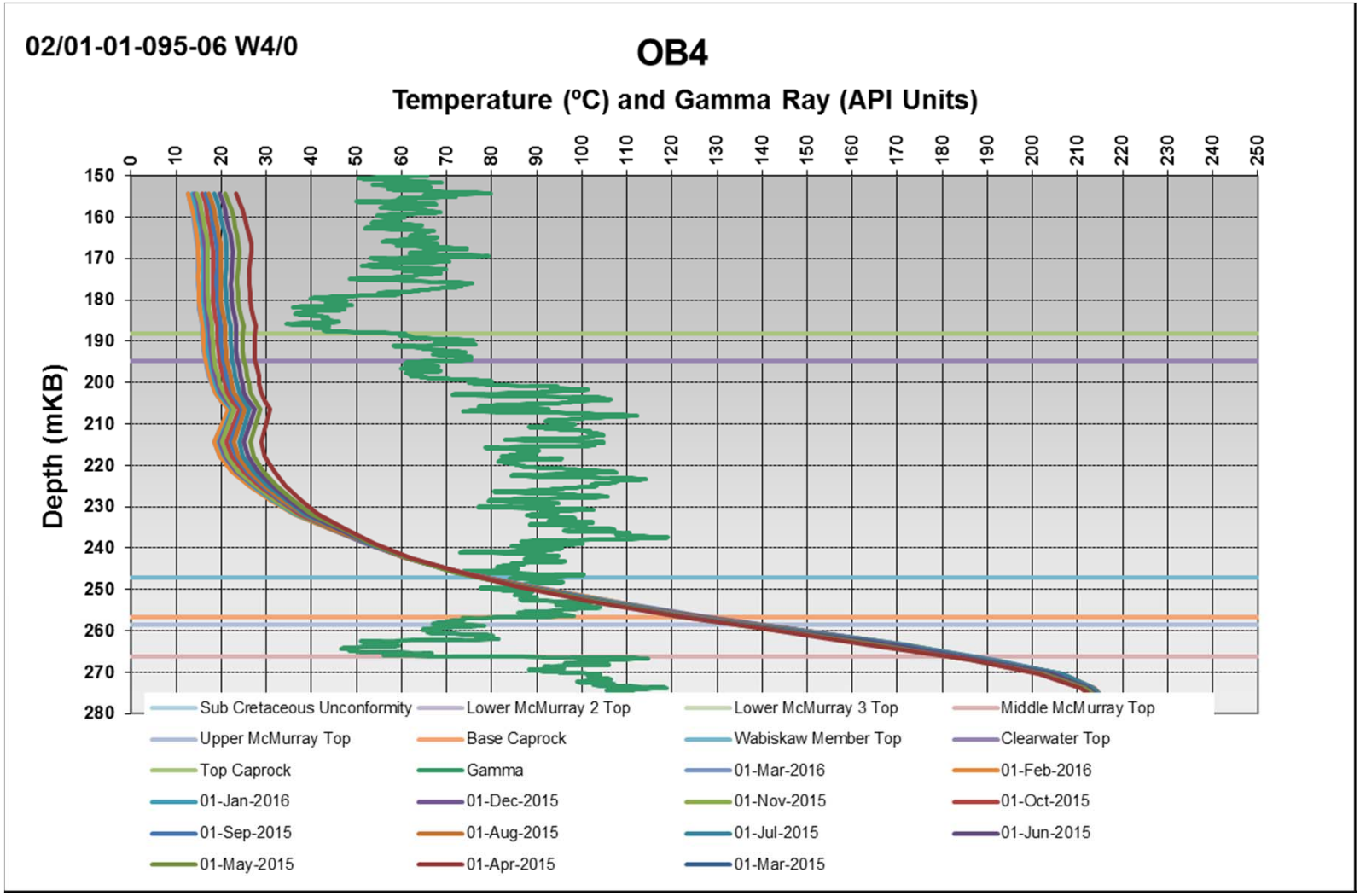
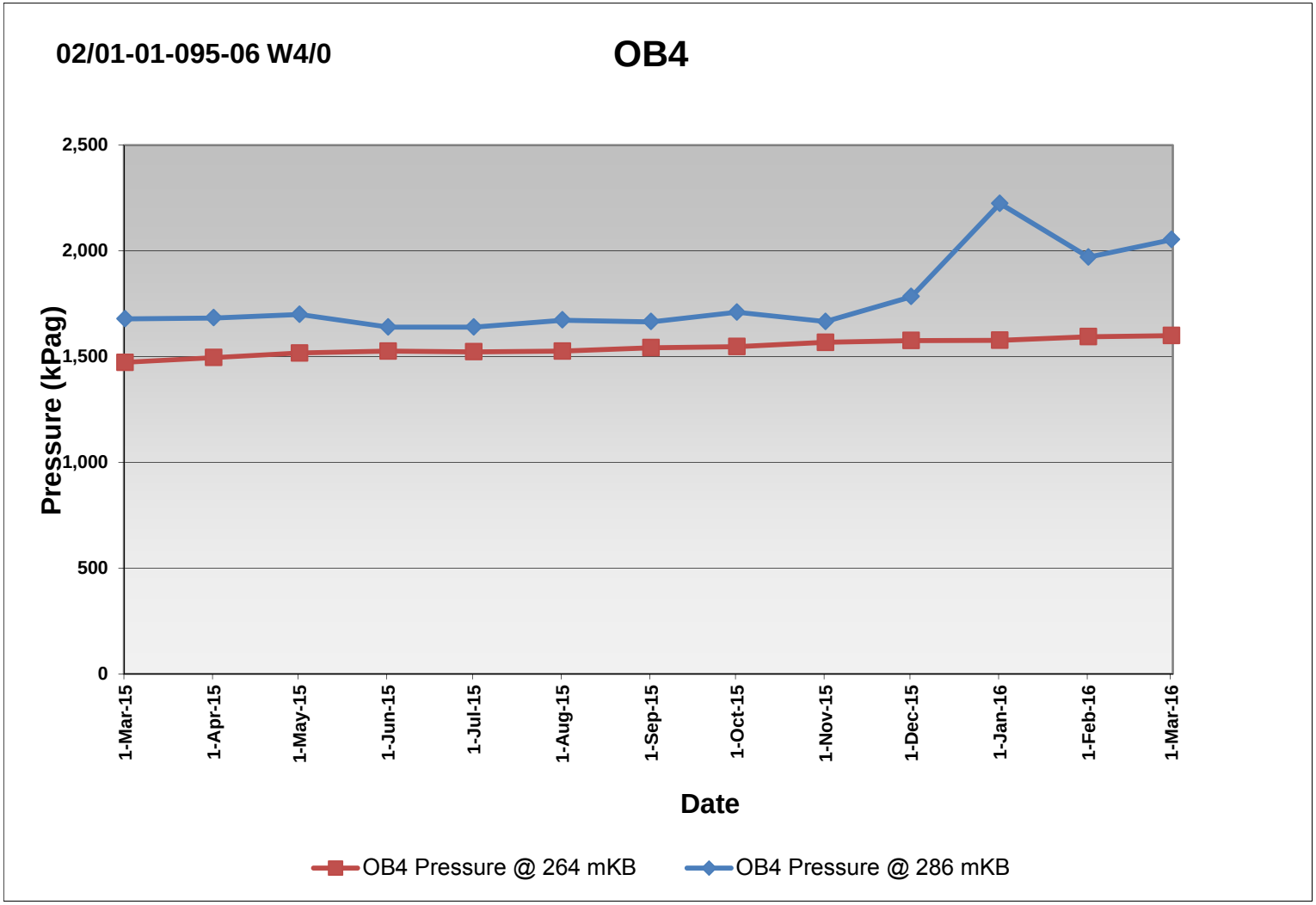


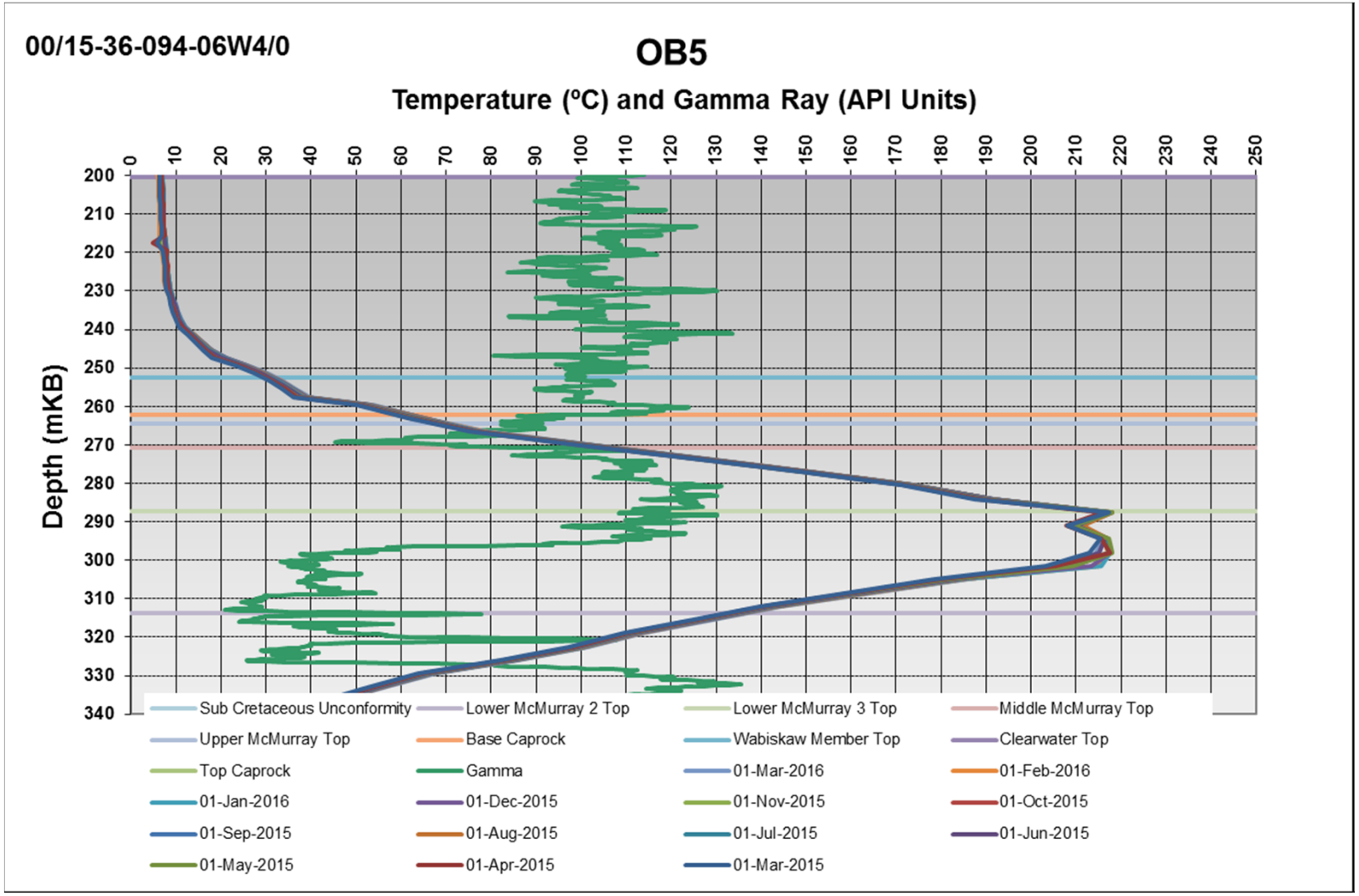
Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



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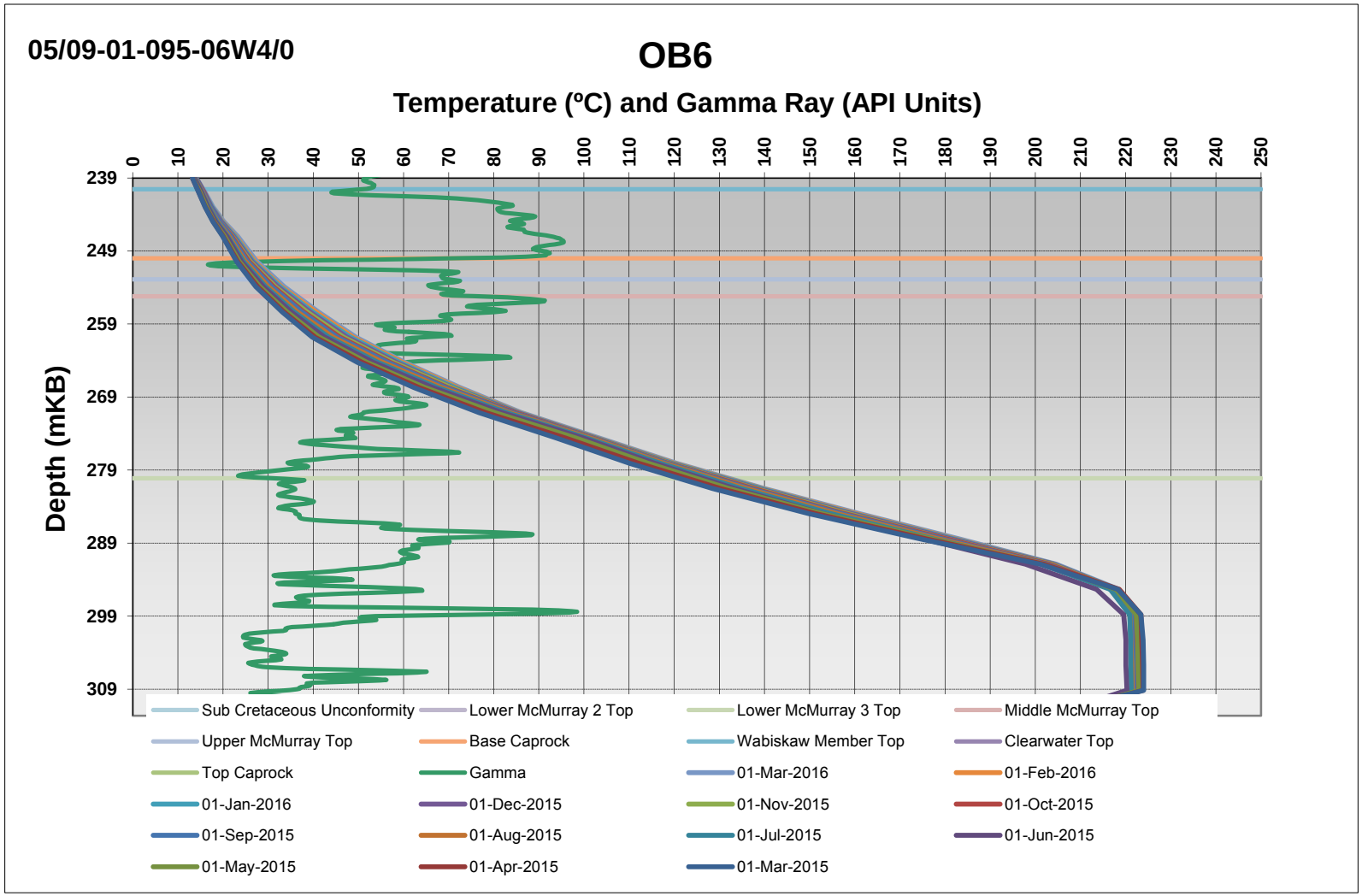
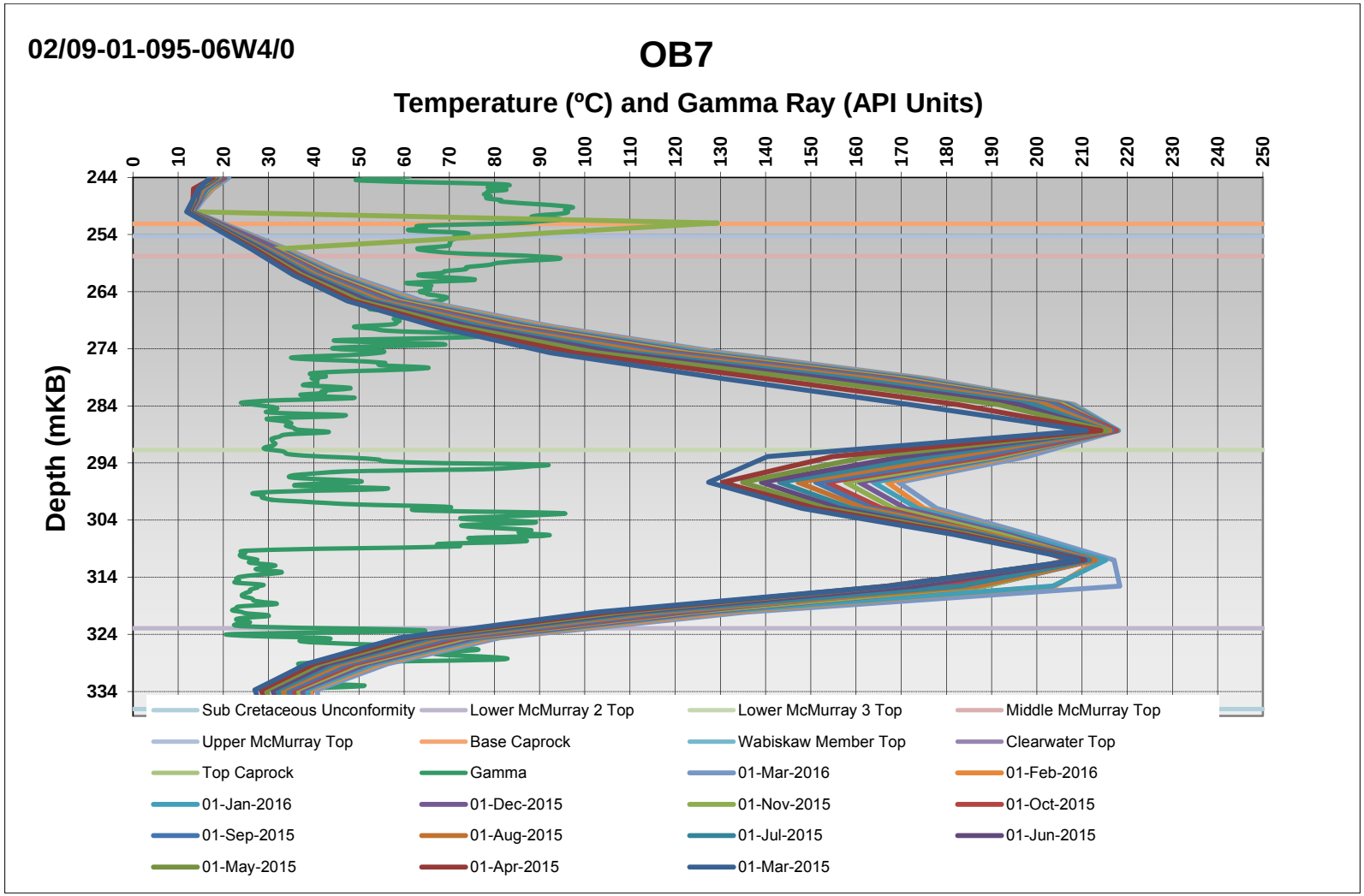
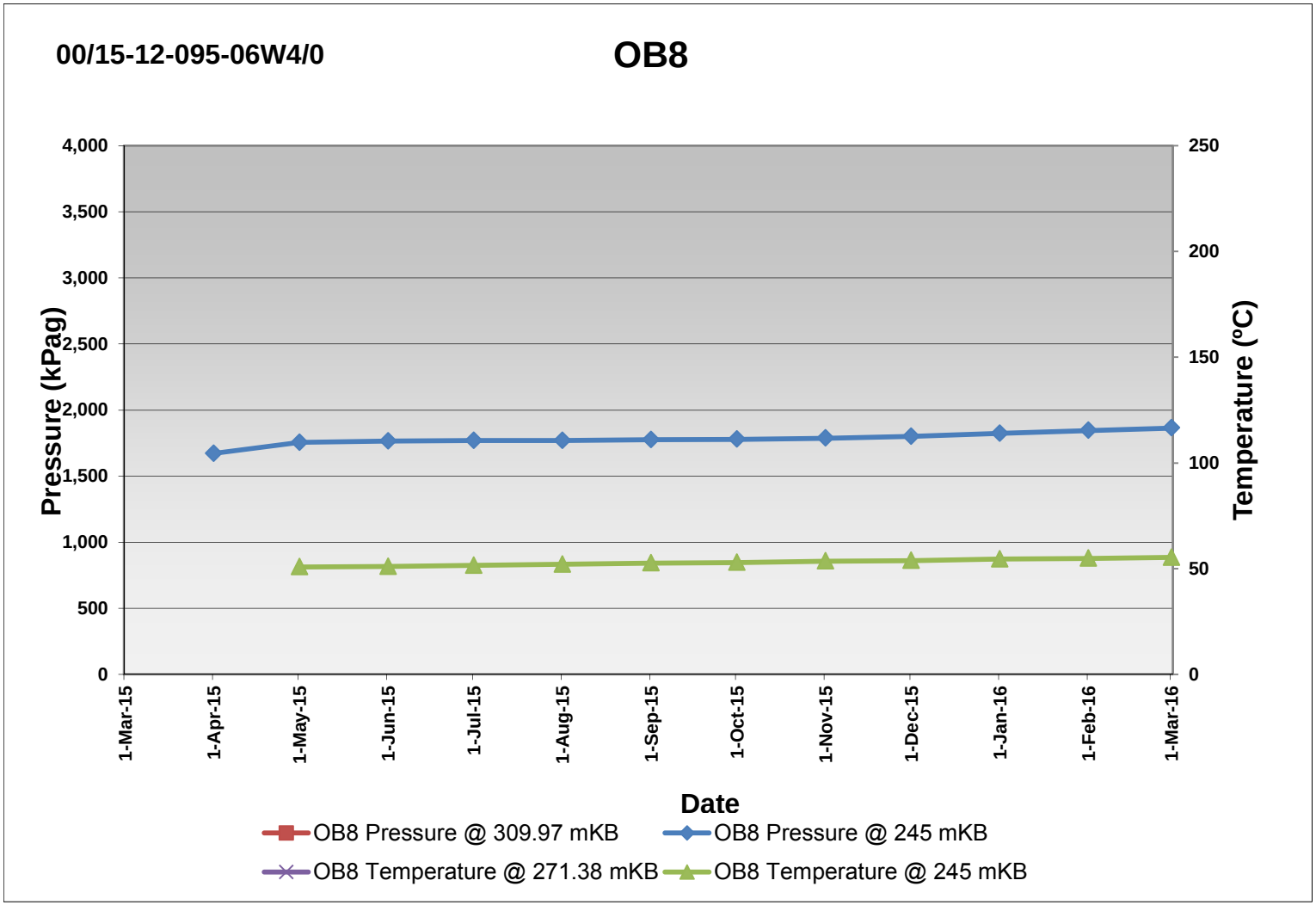


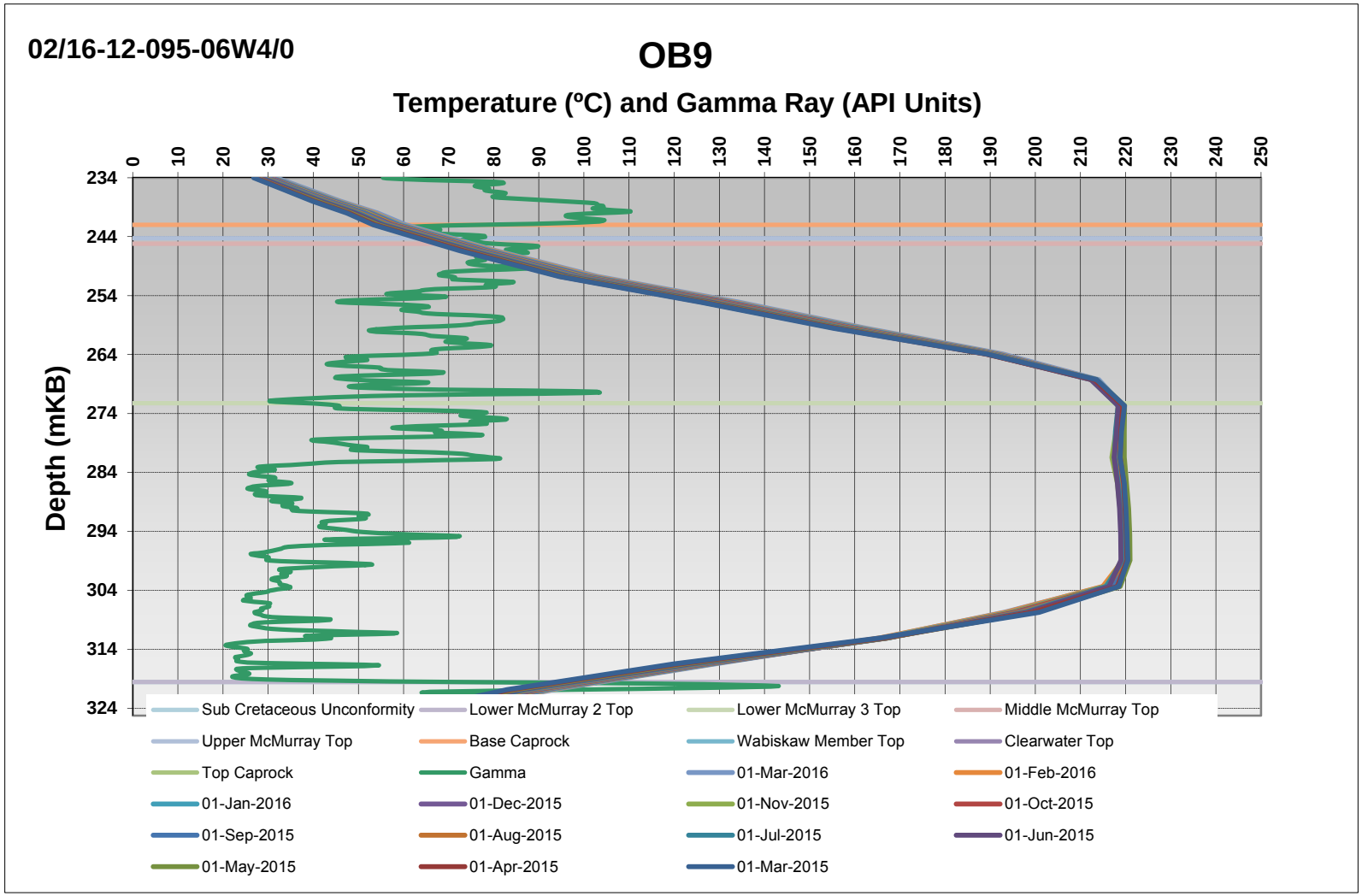
Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



Piezometer Plots & Temperature vs Depth Plots



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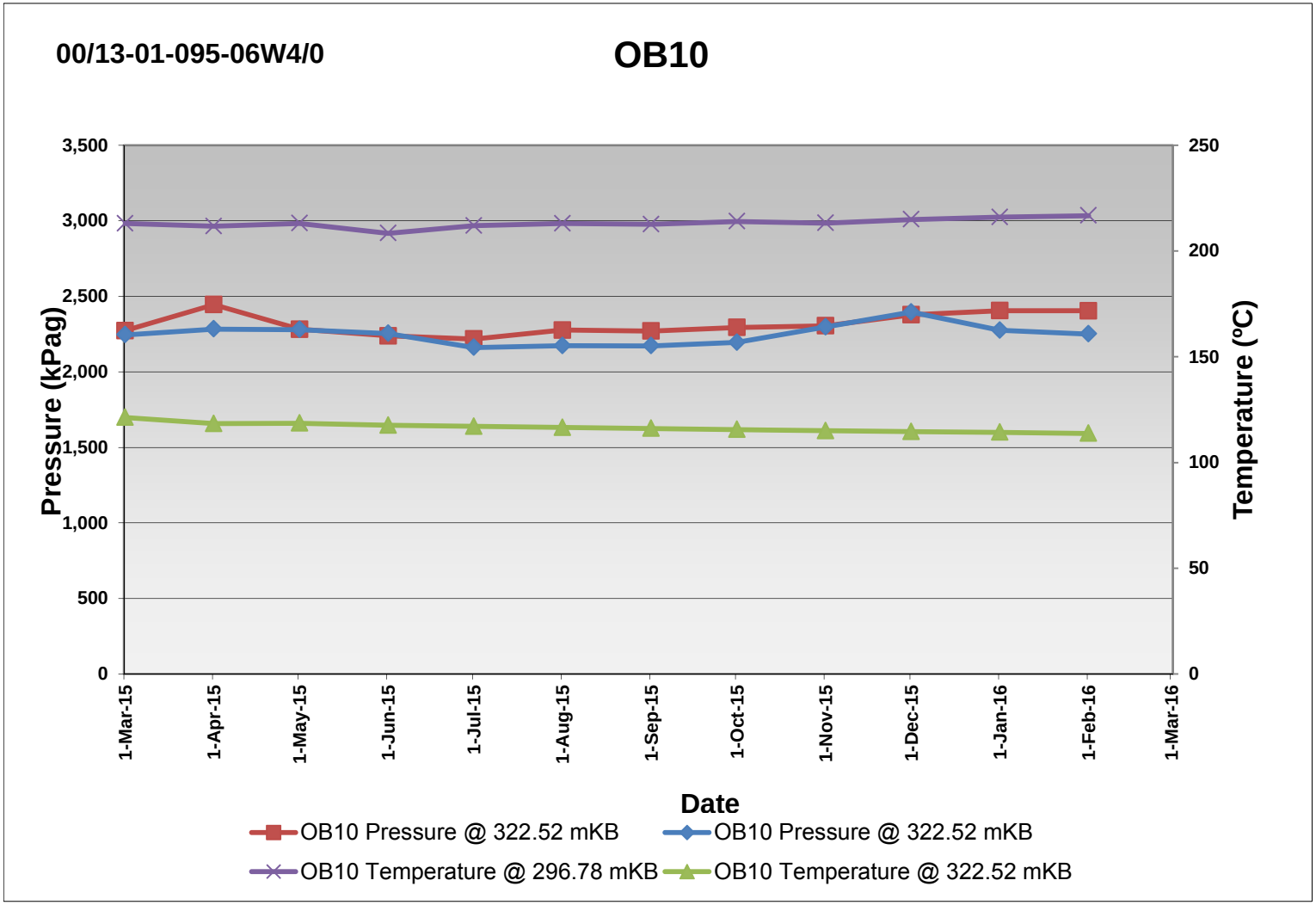

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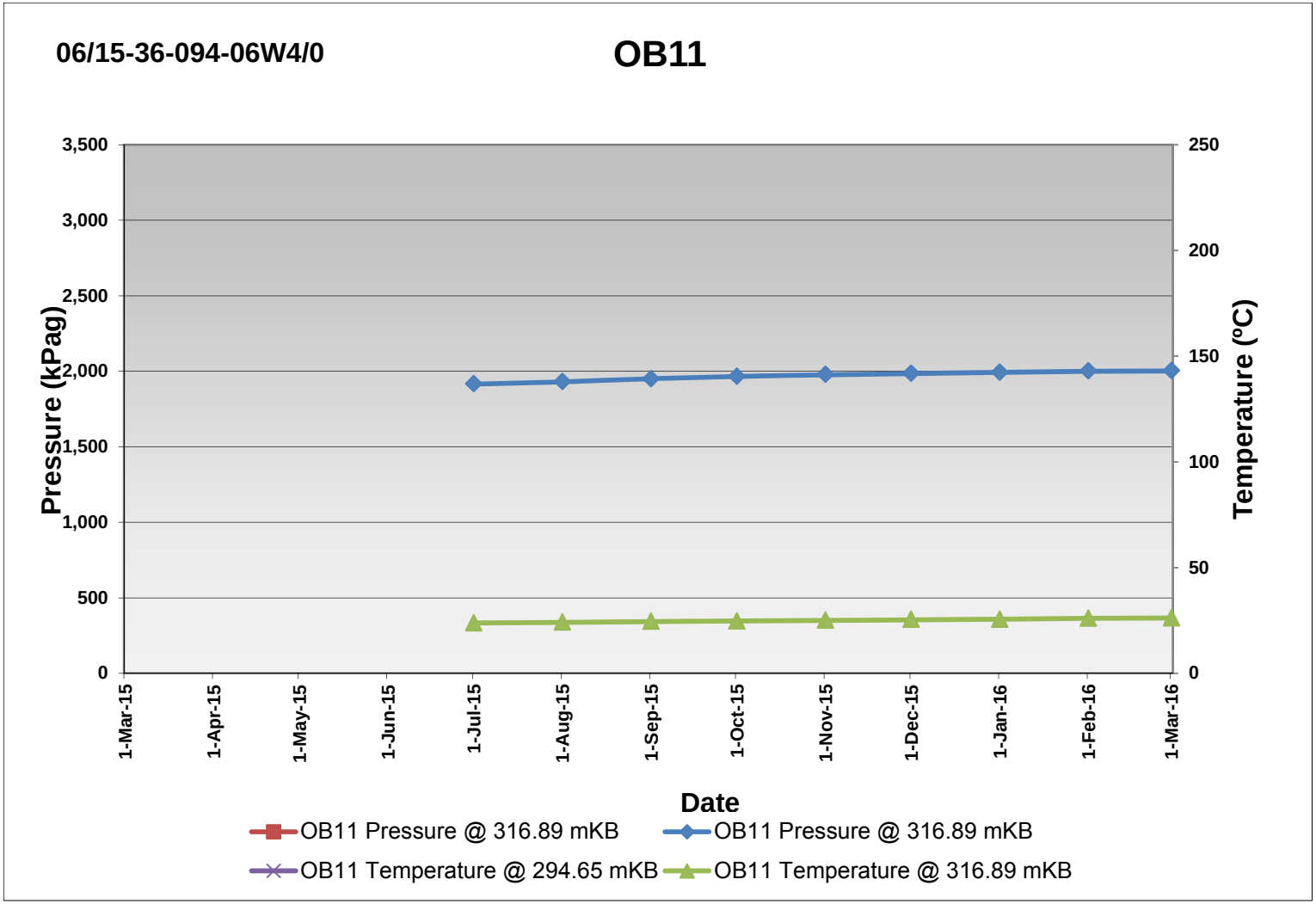

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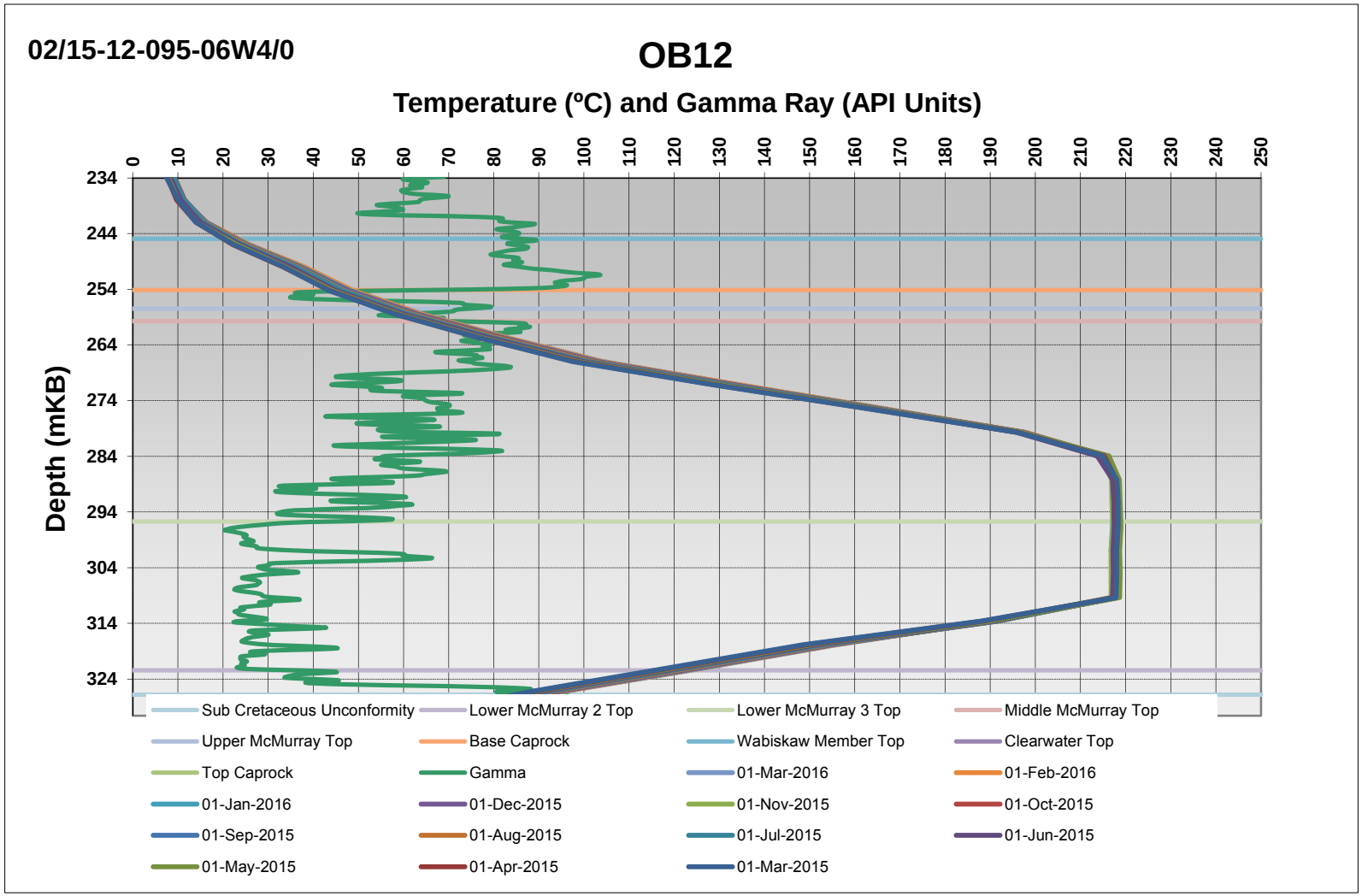
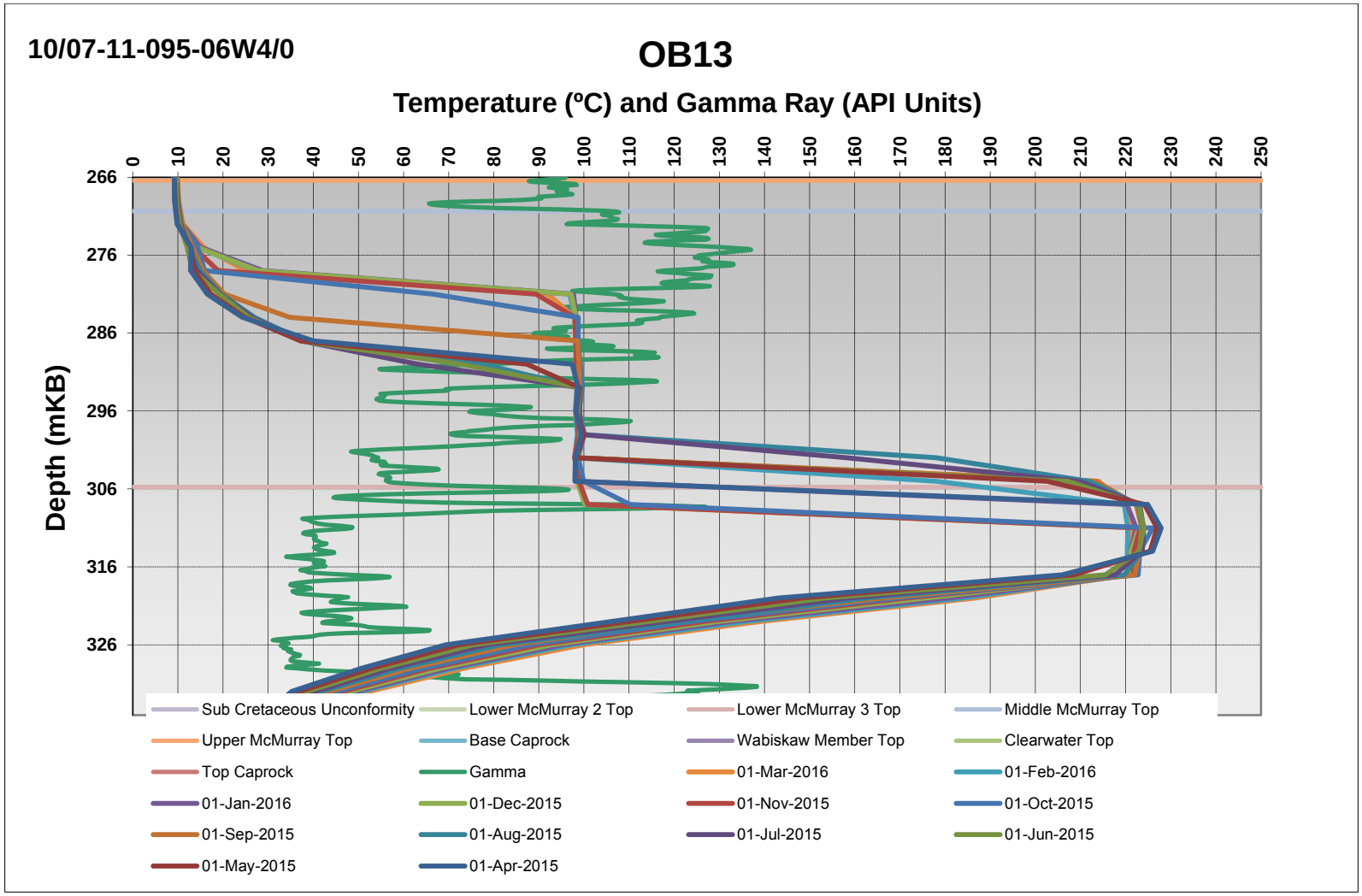


Piezometer Plots & Temperature vs Depth Plots



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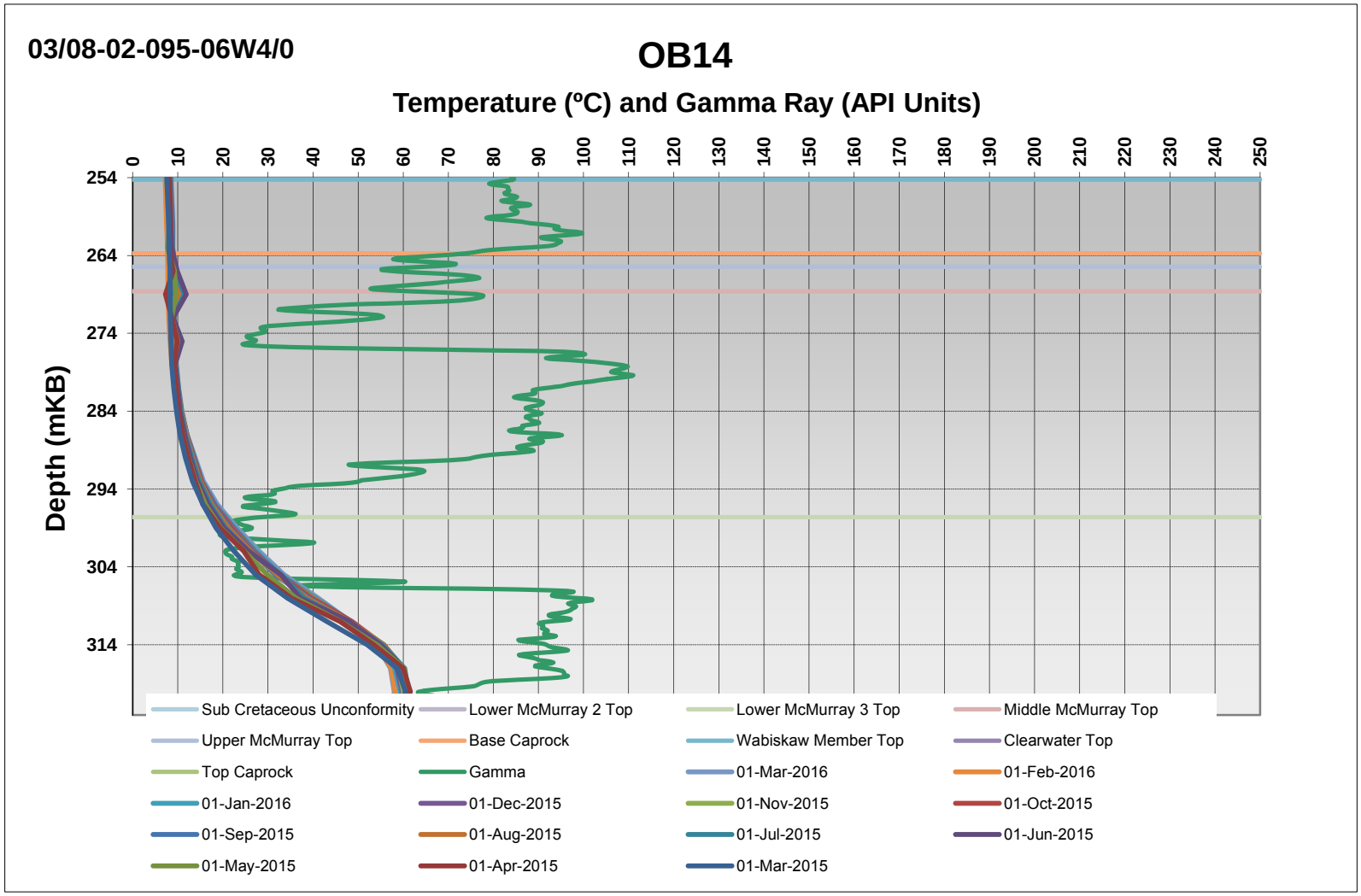

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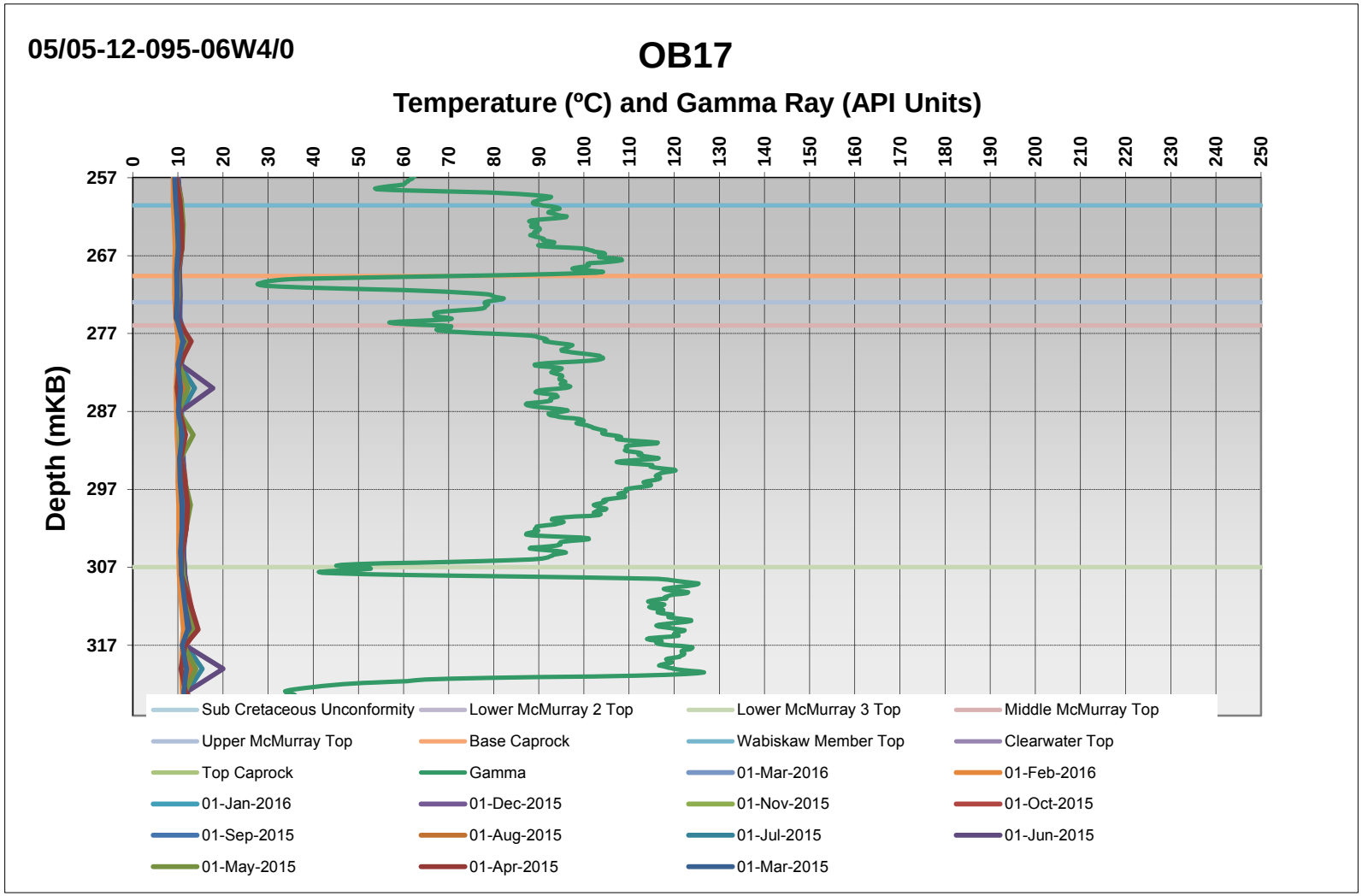

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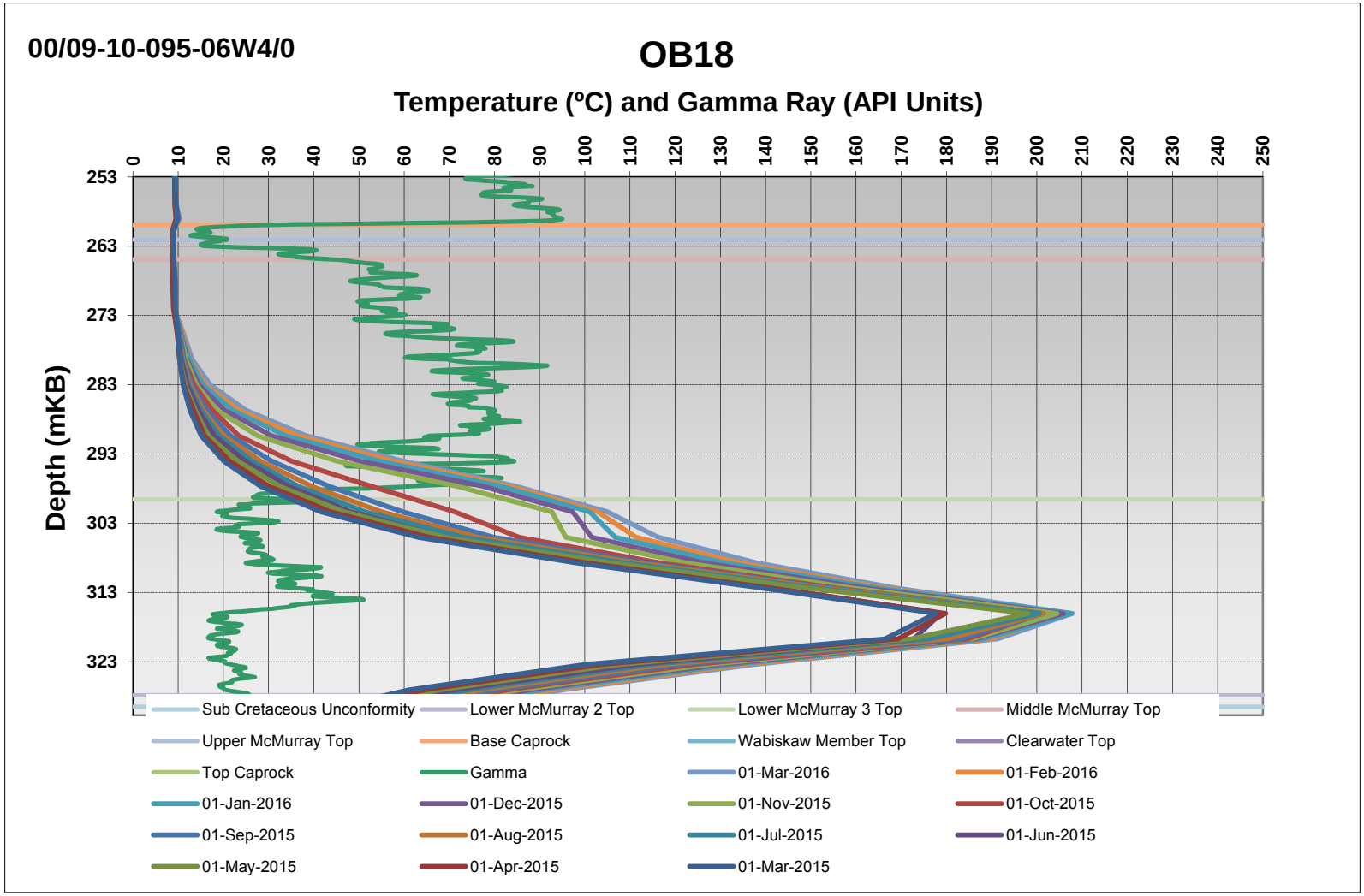

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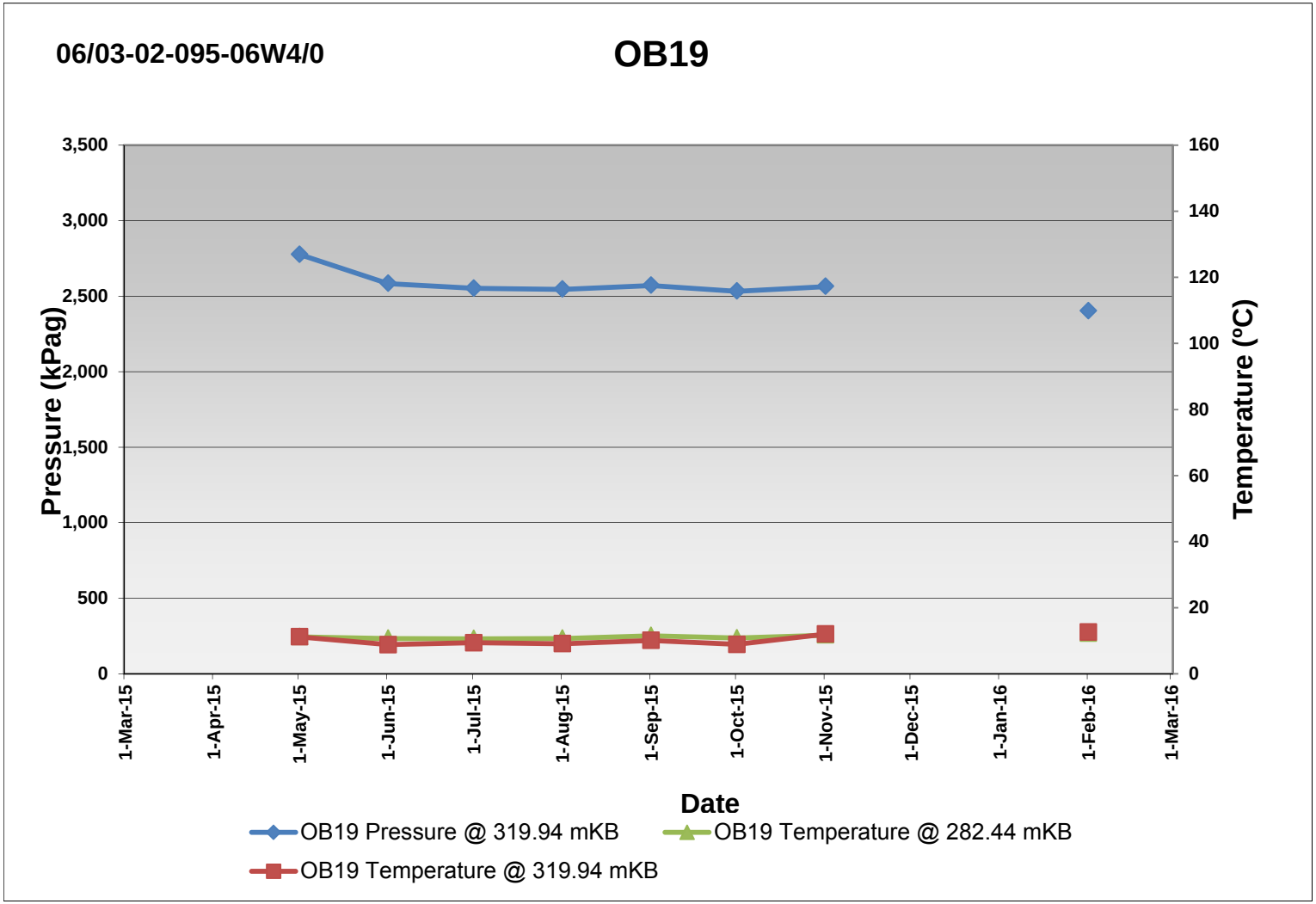

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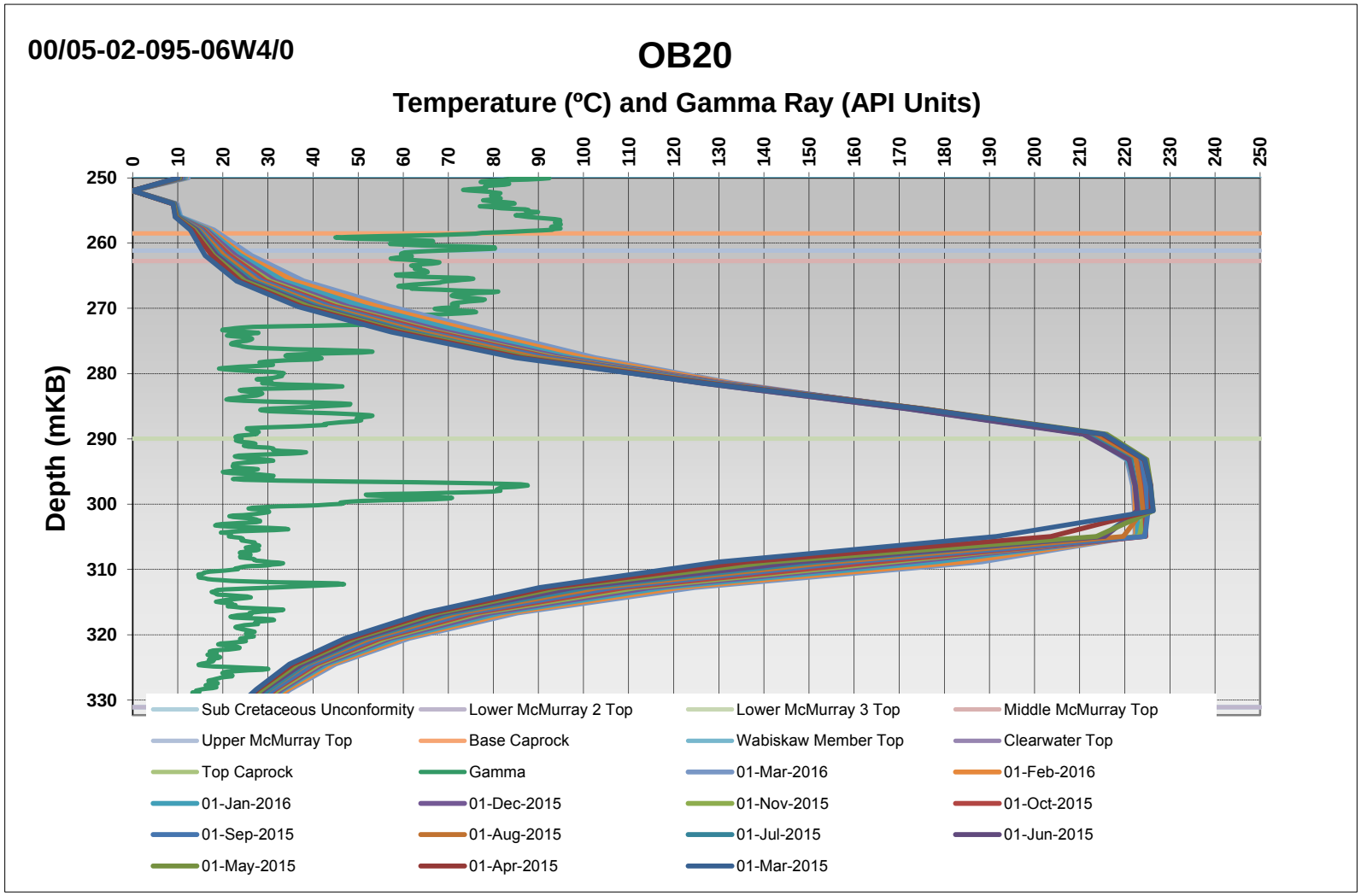

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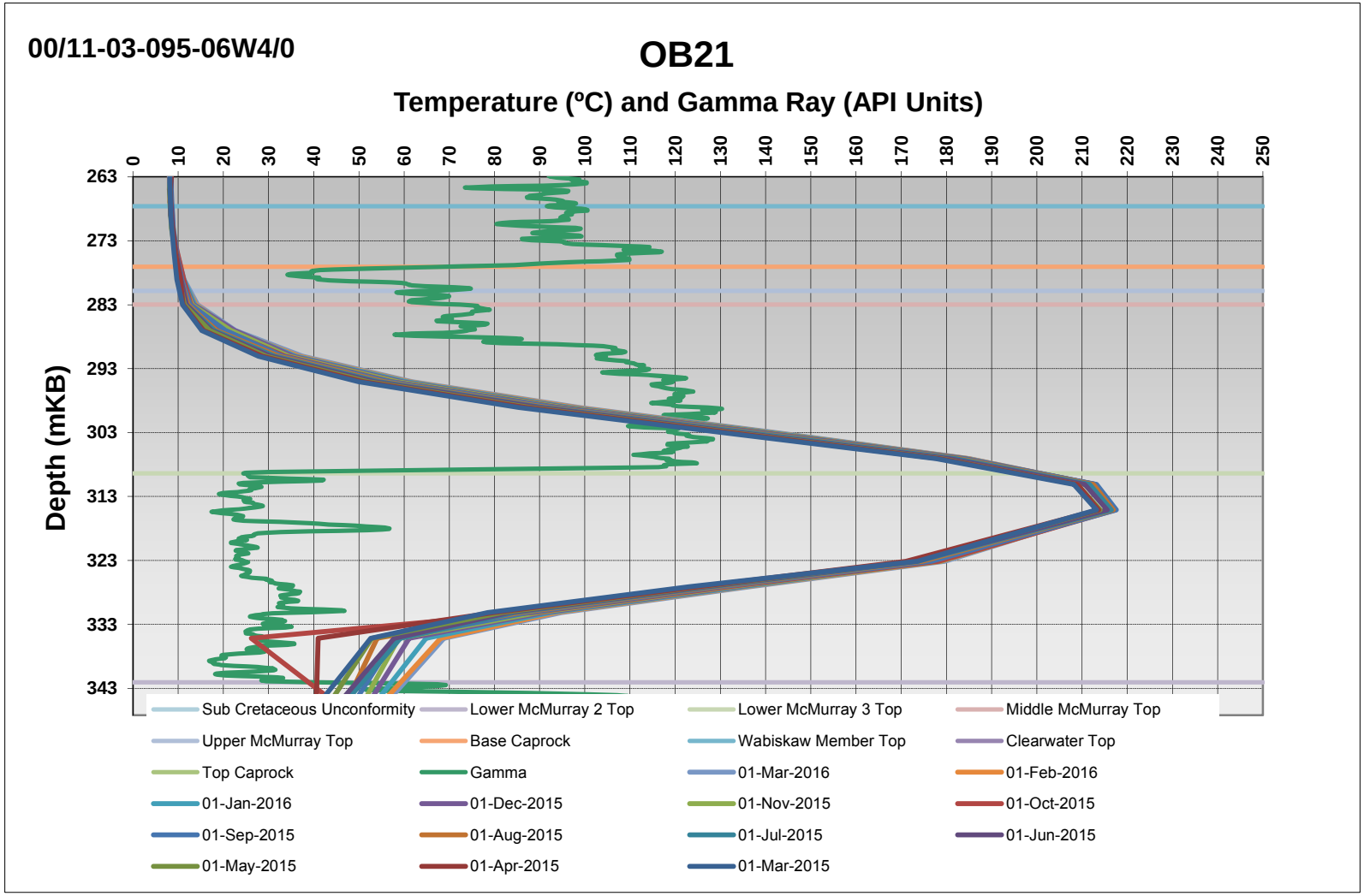

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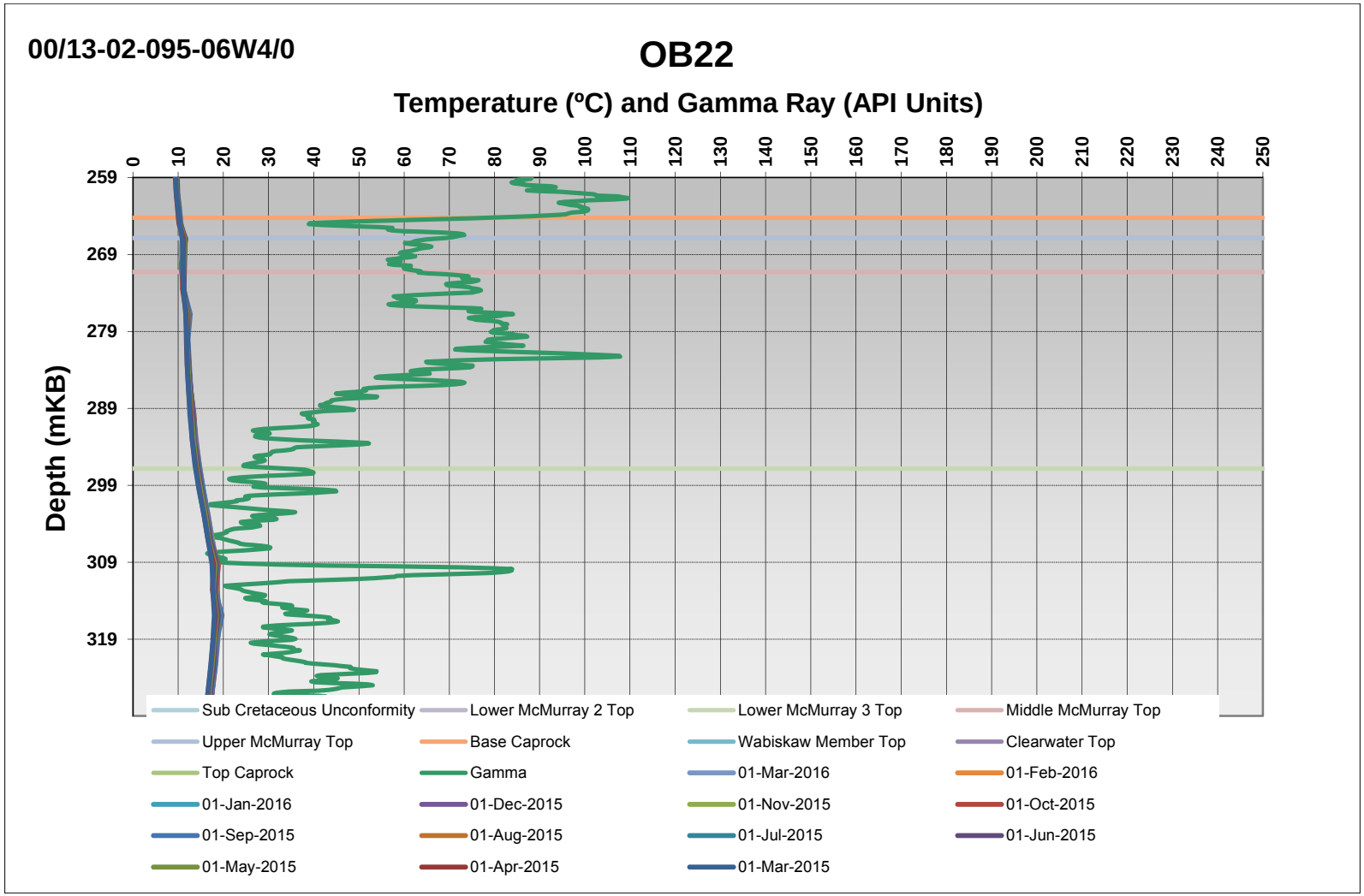

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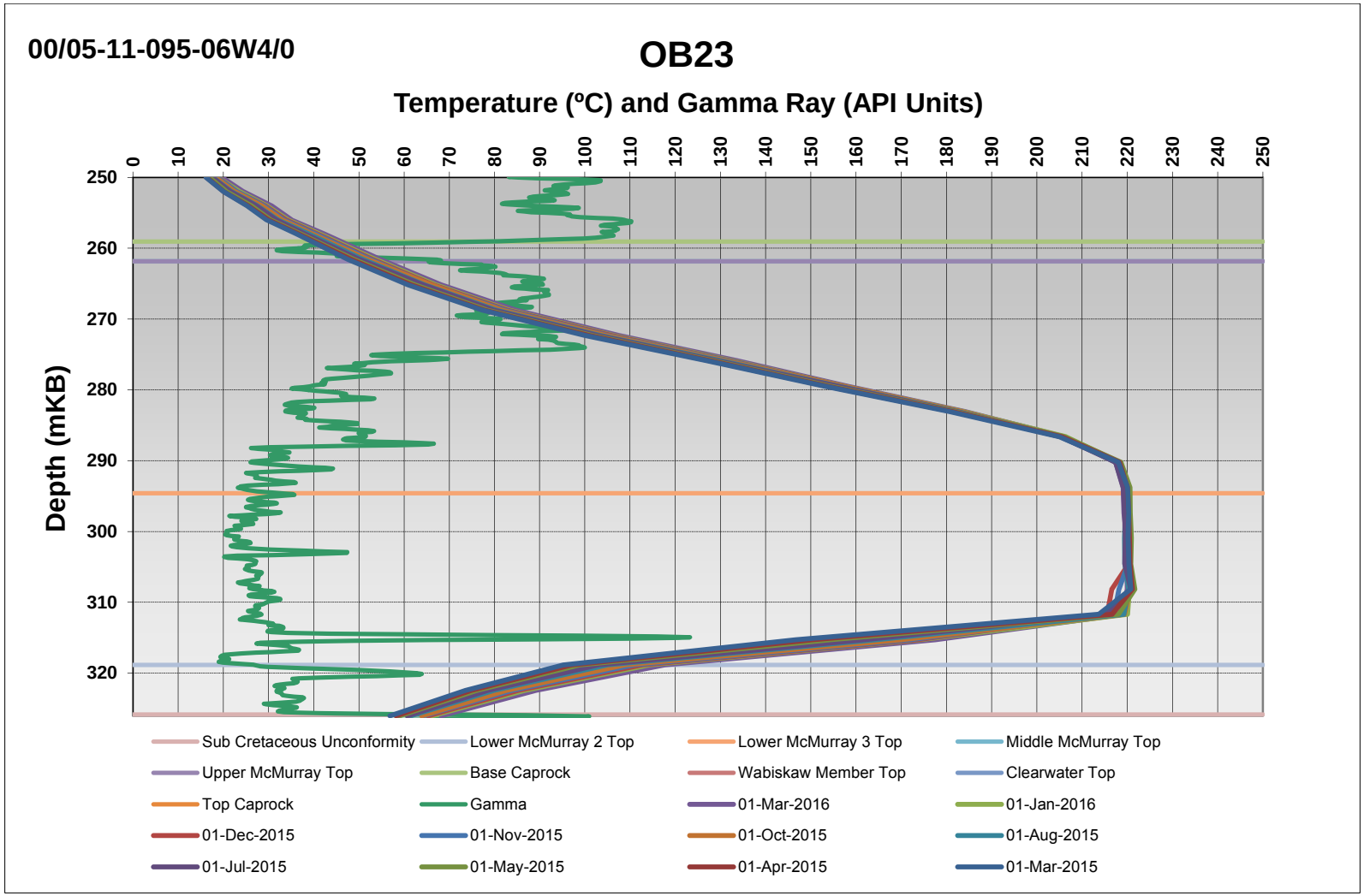

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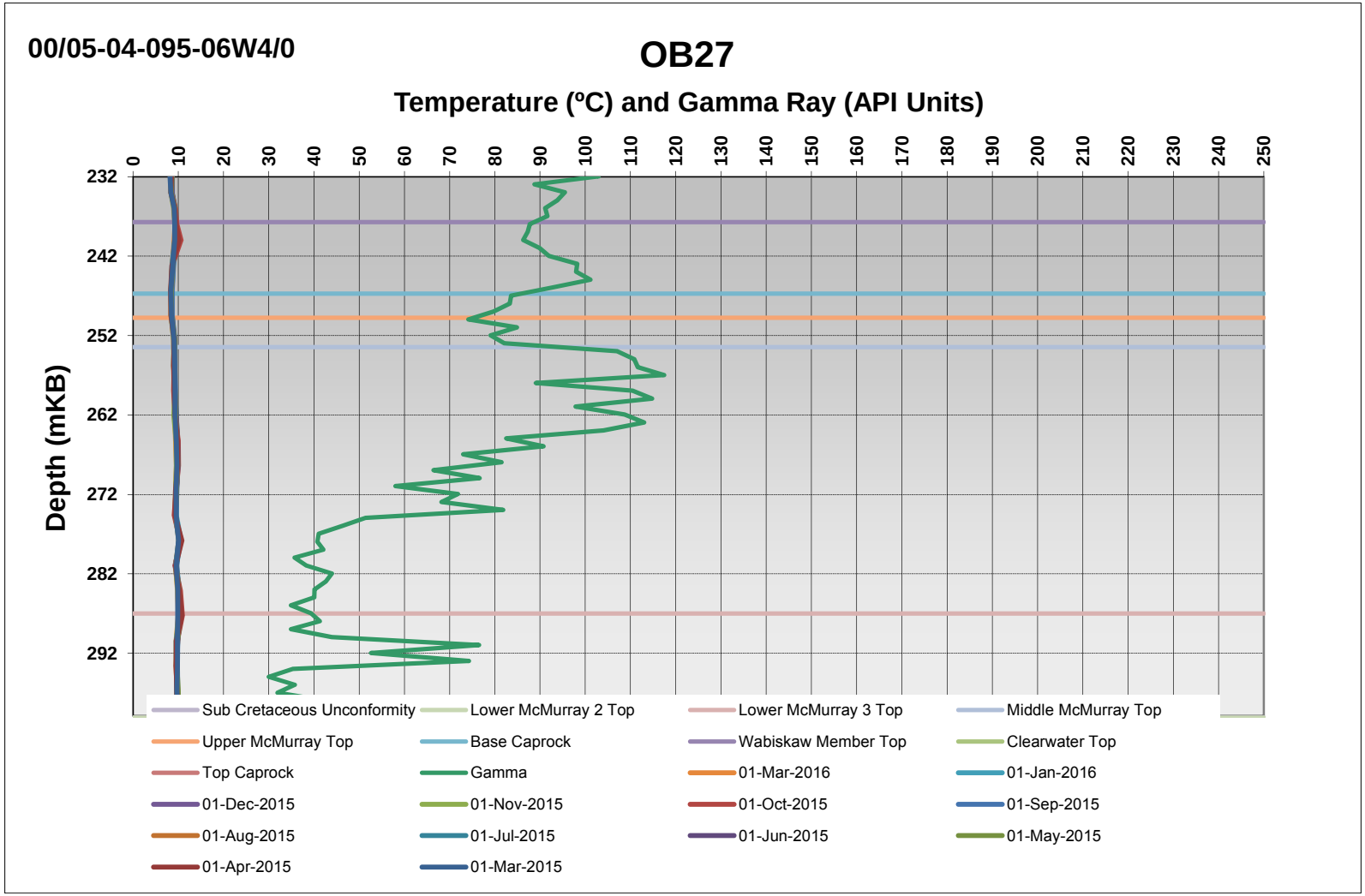

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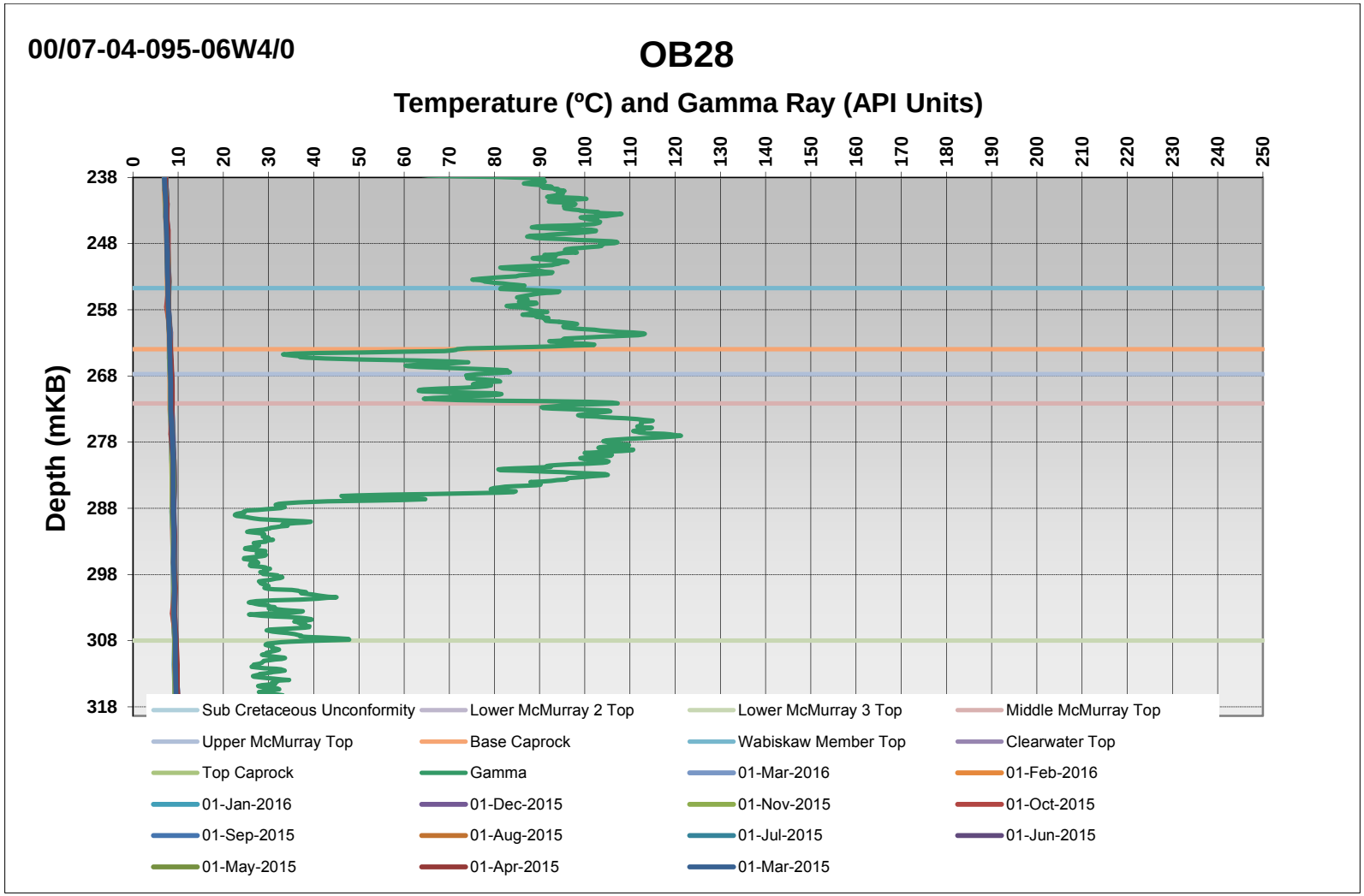

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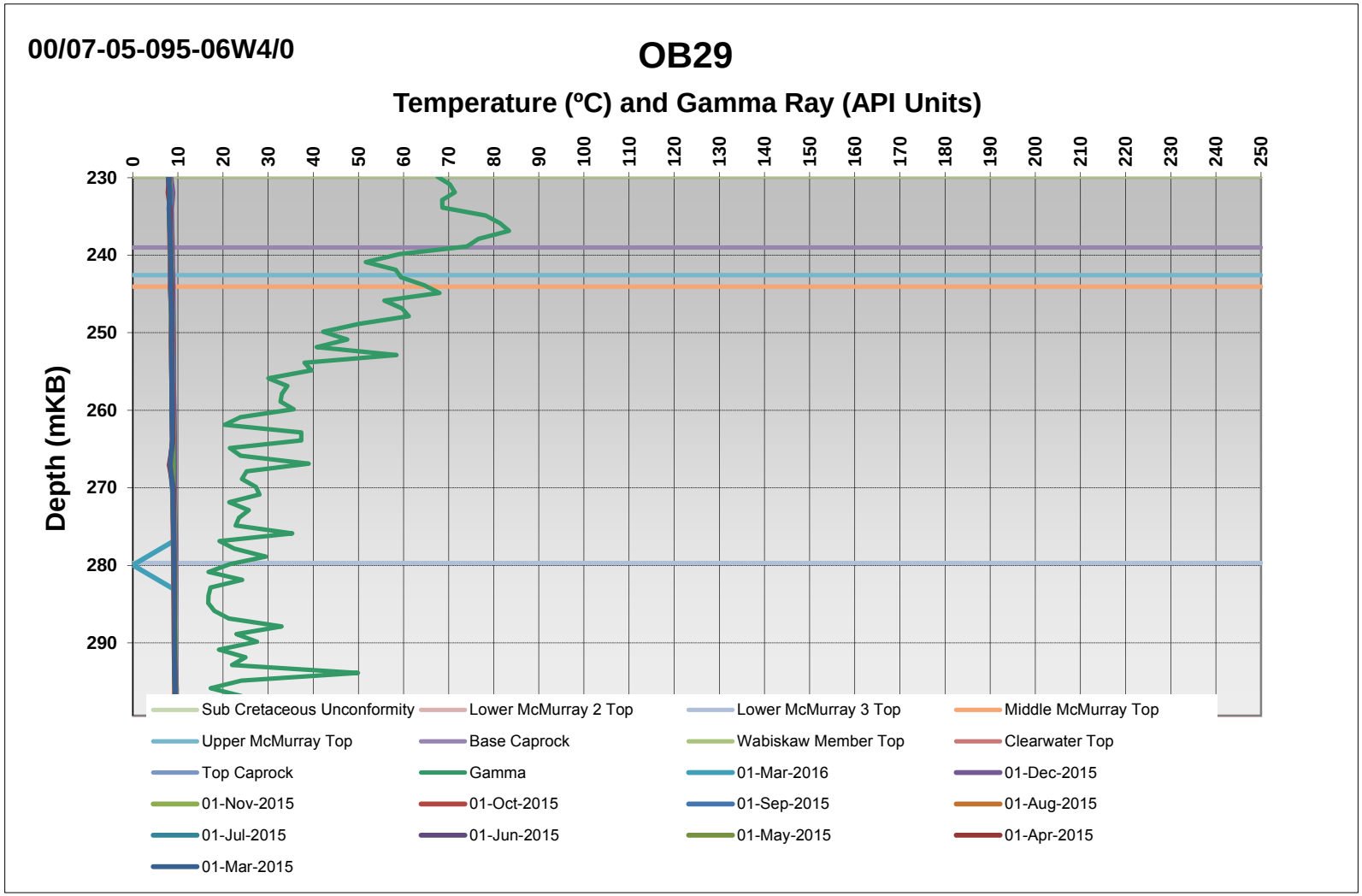

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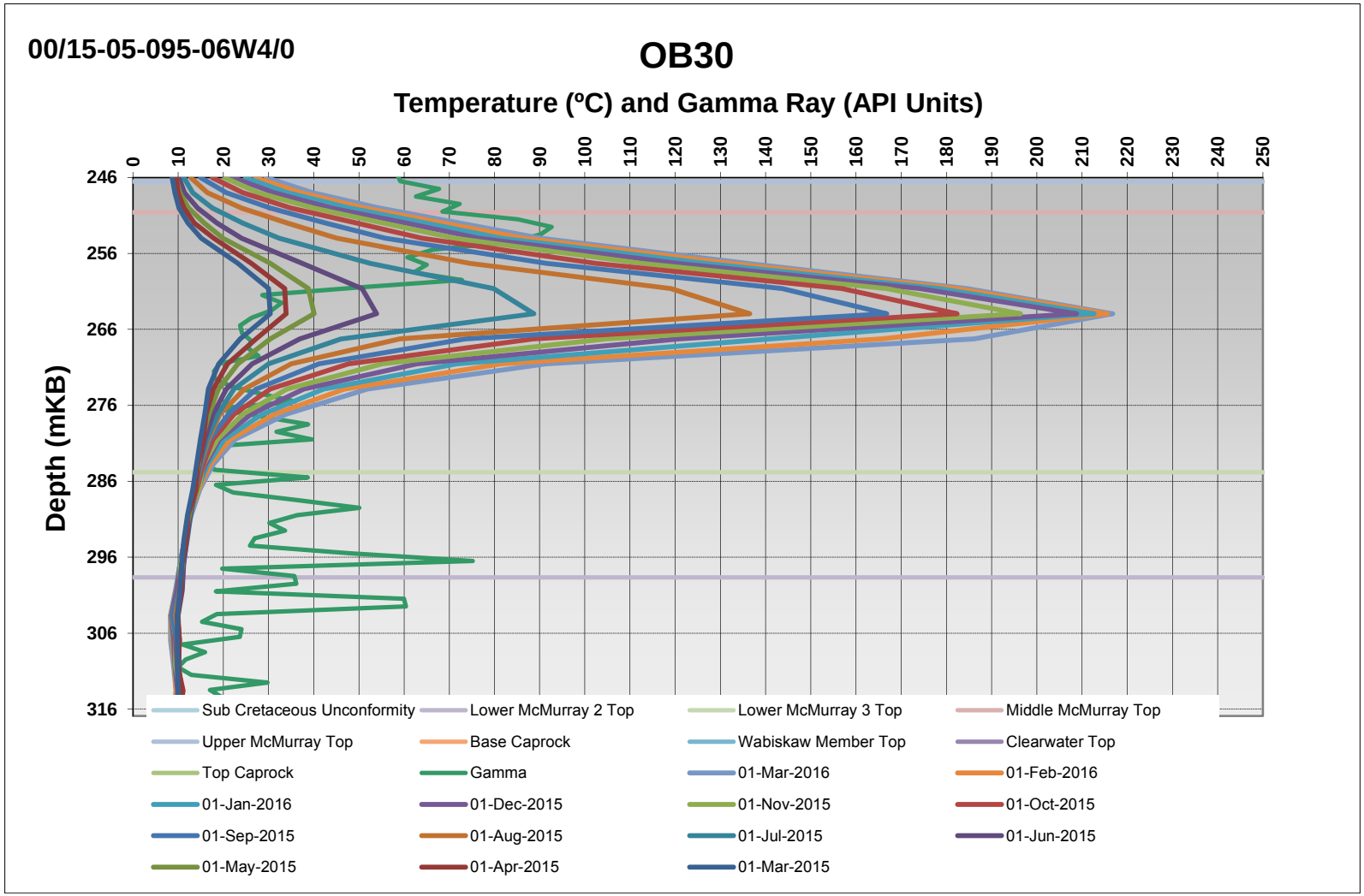

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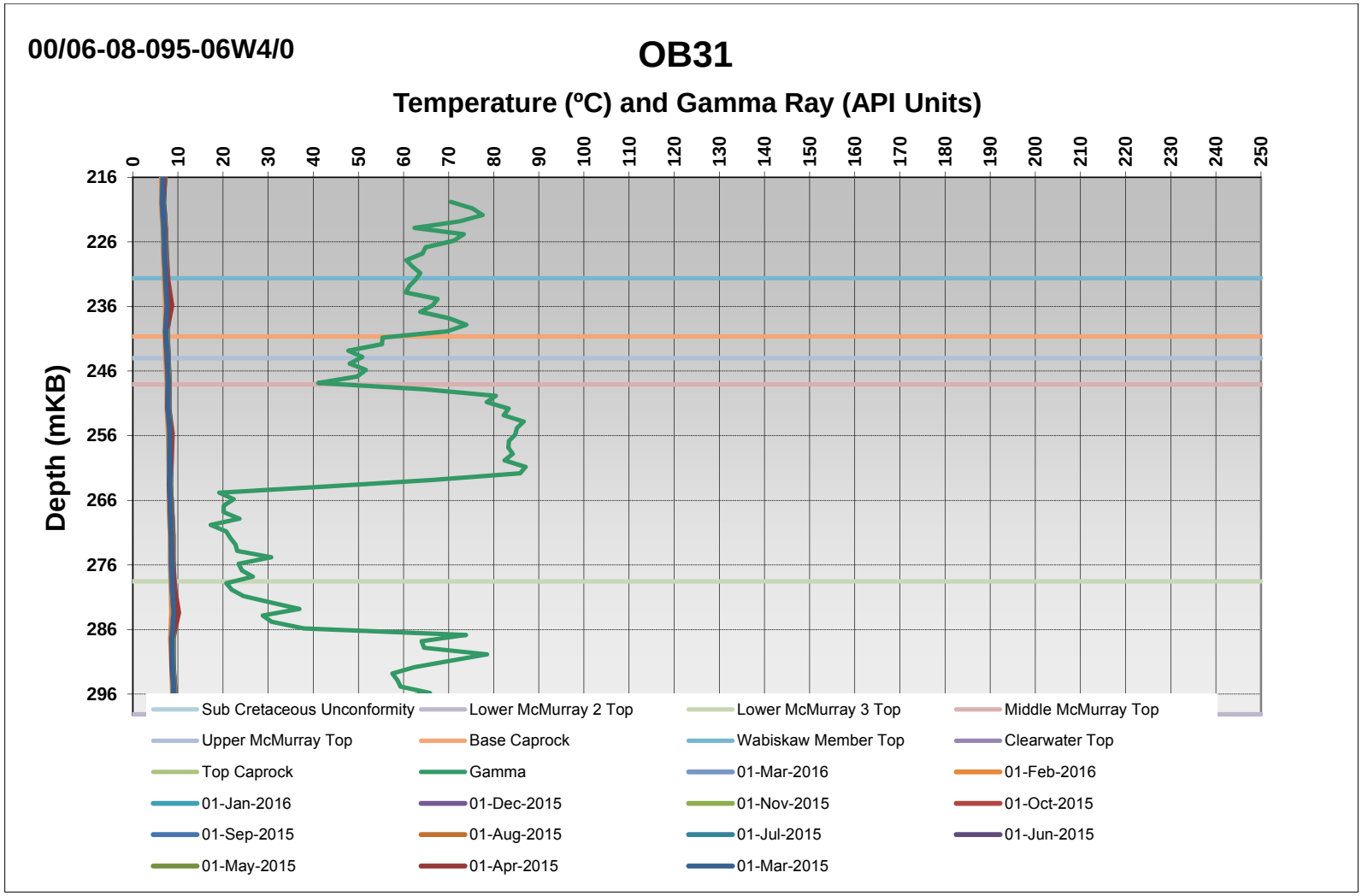

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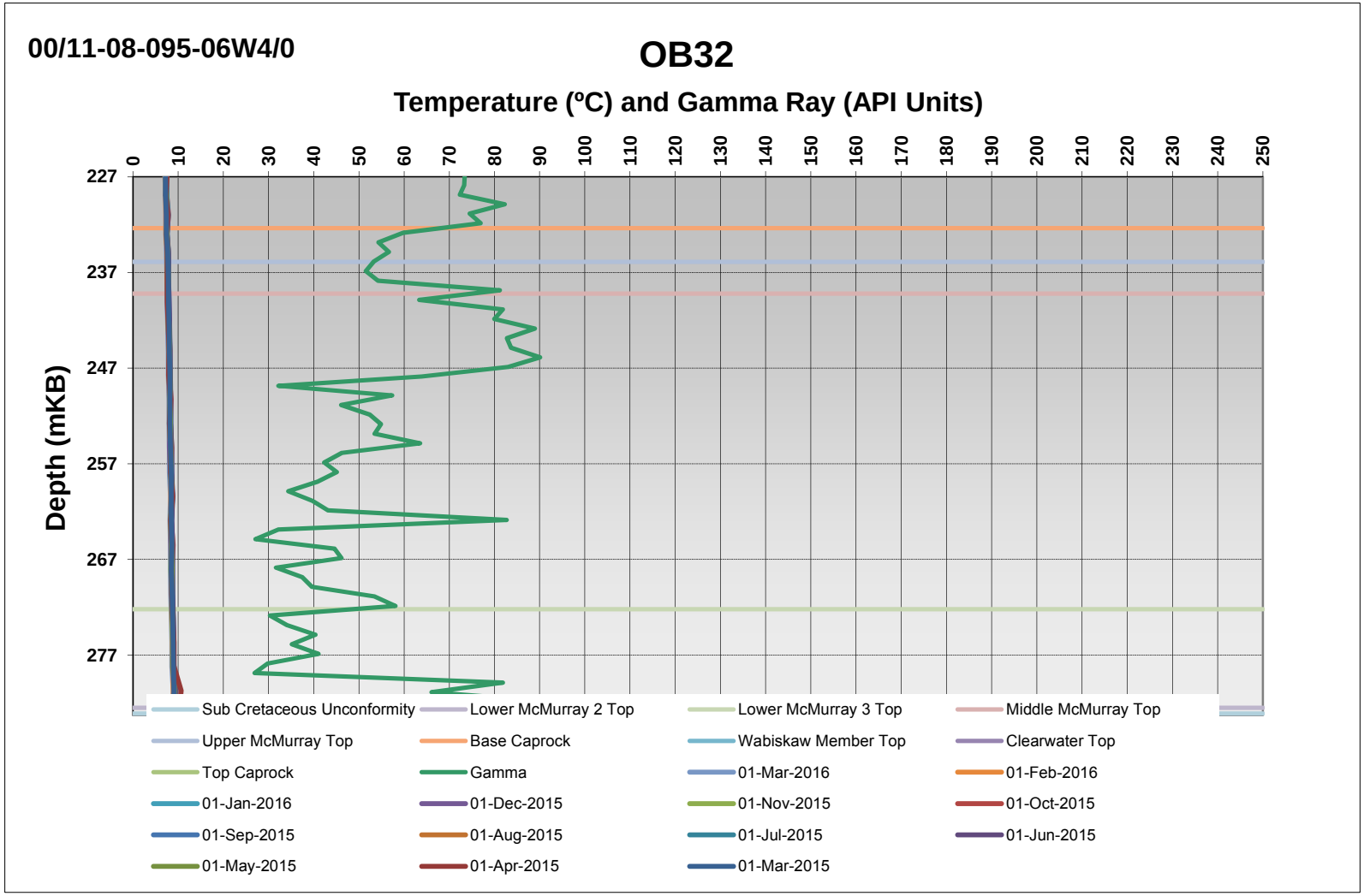

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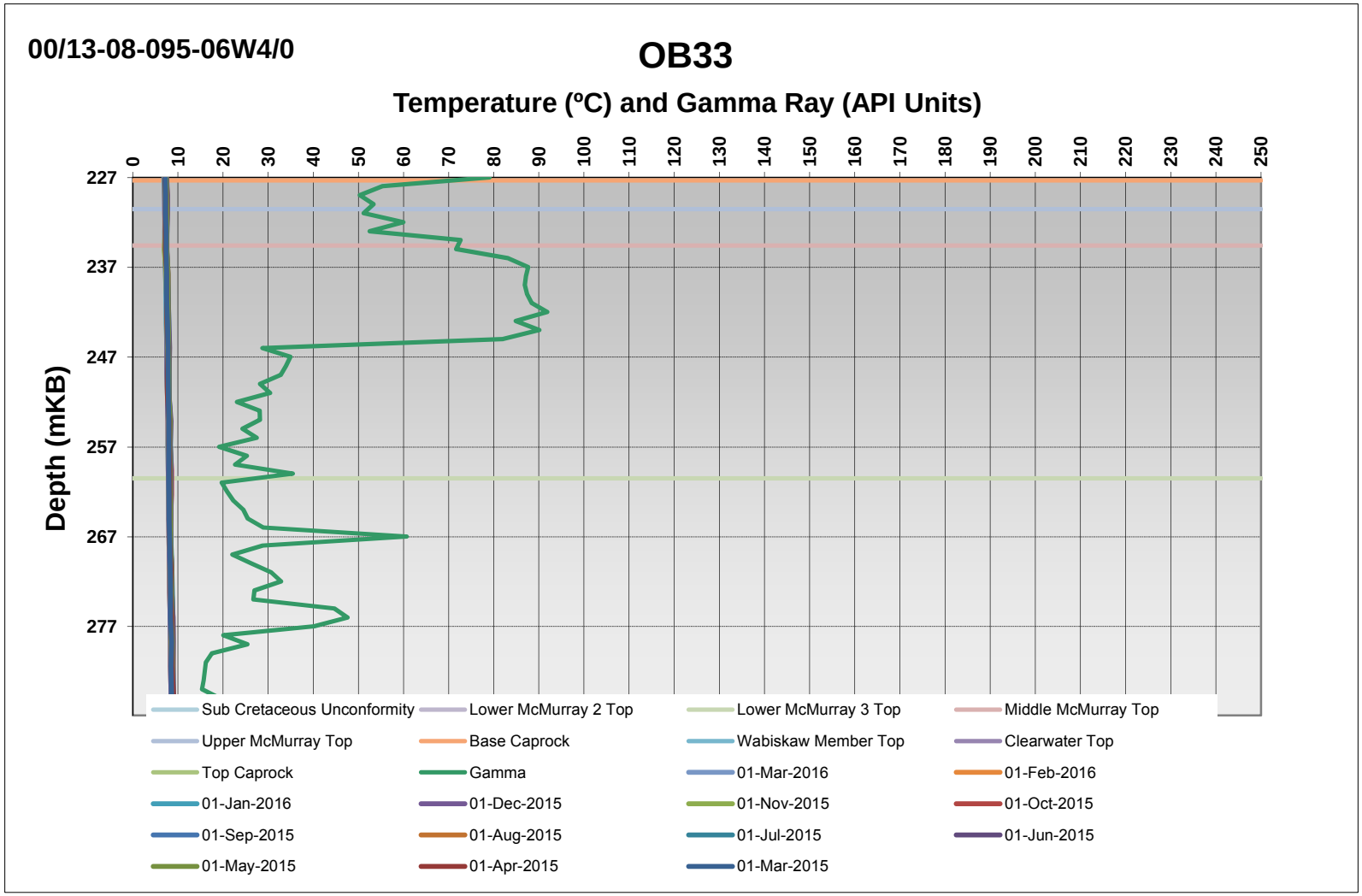

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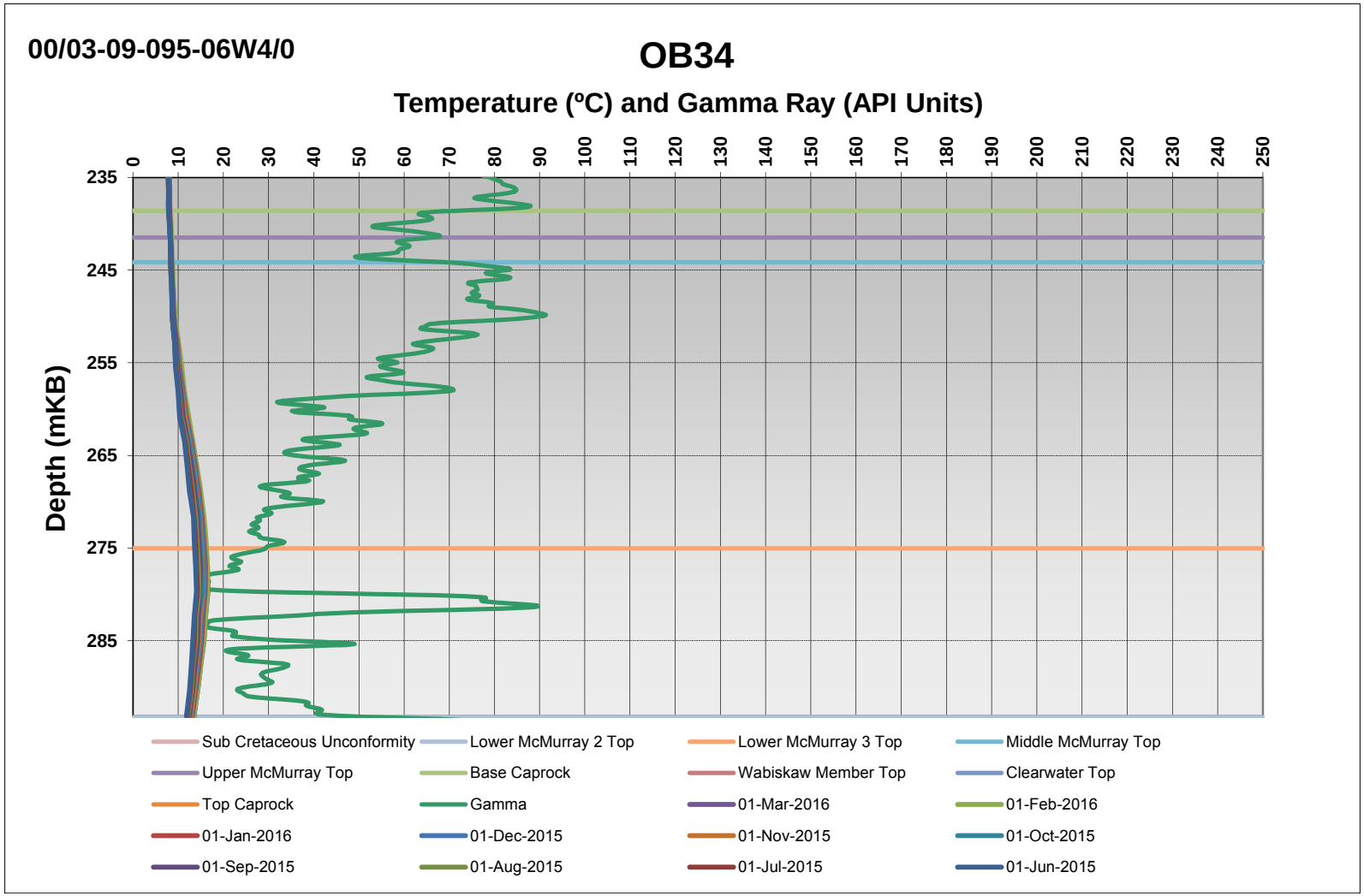

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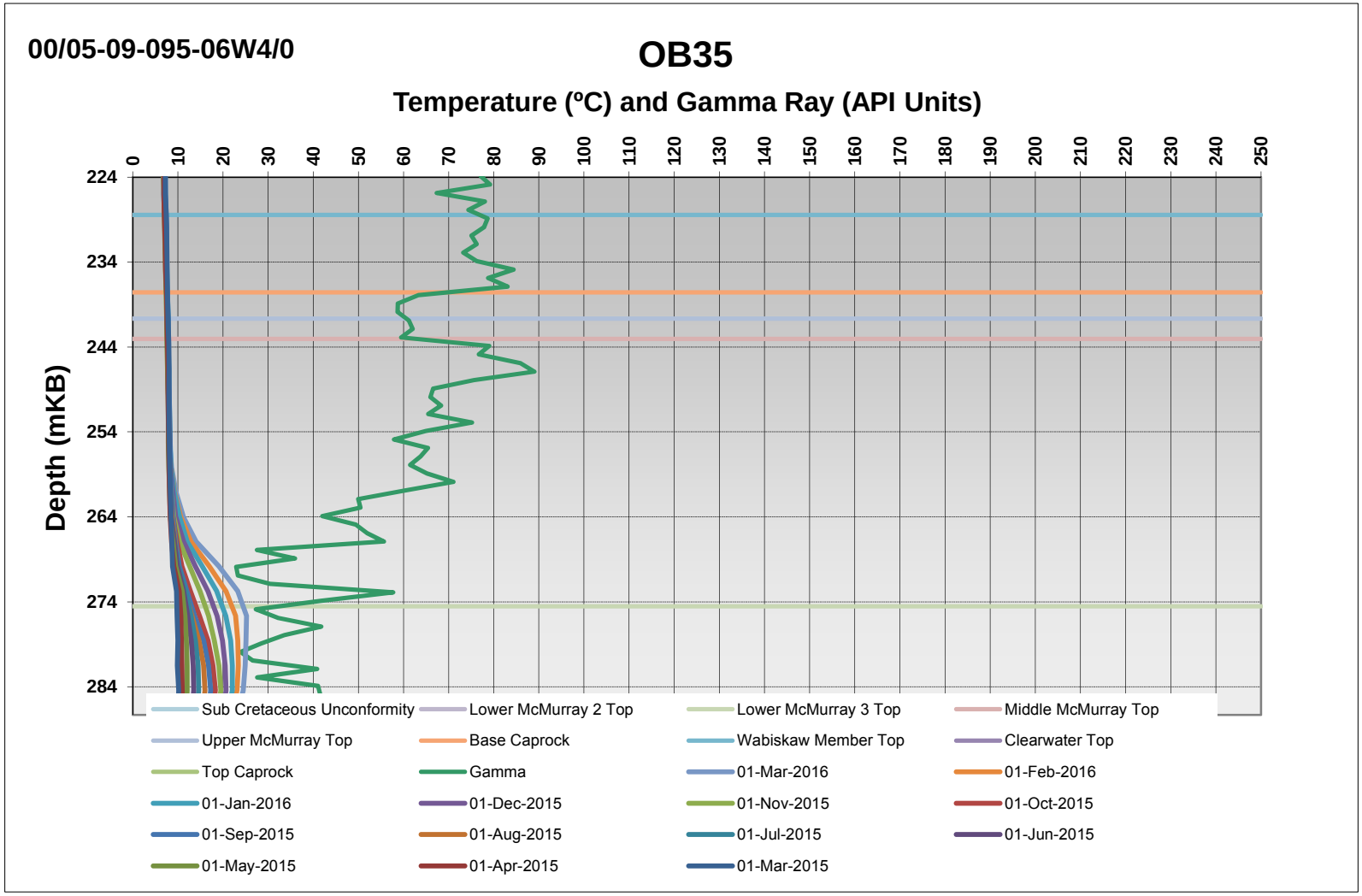

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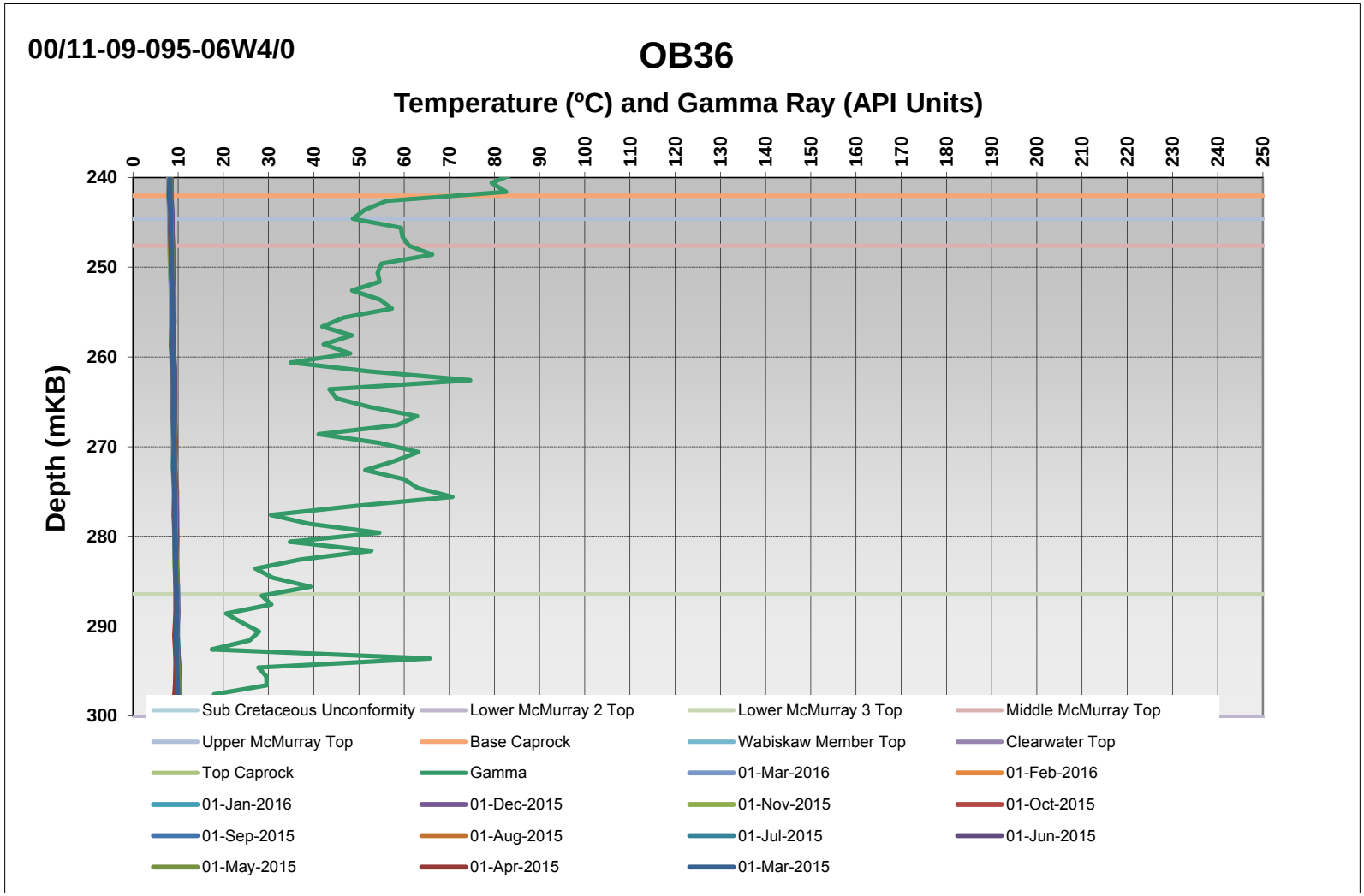

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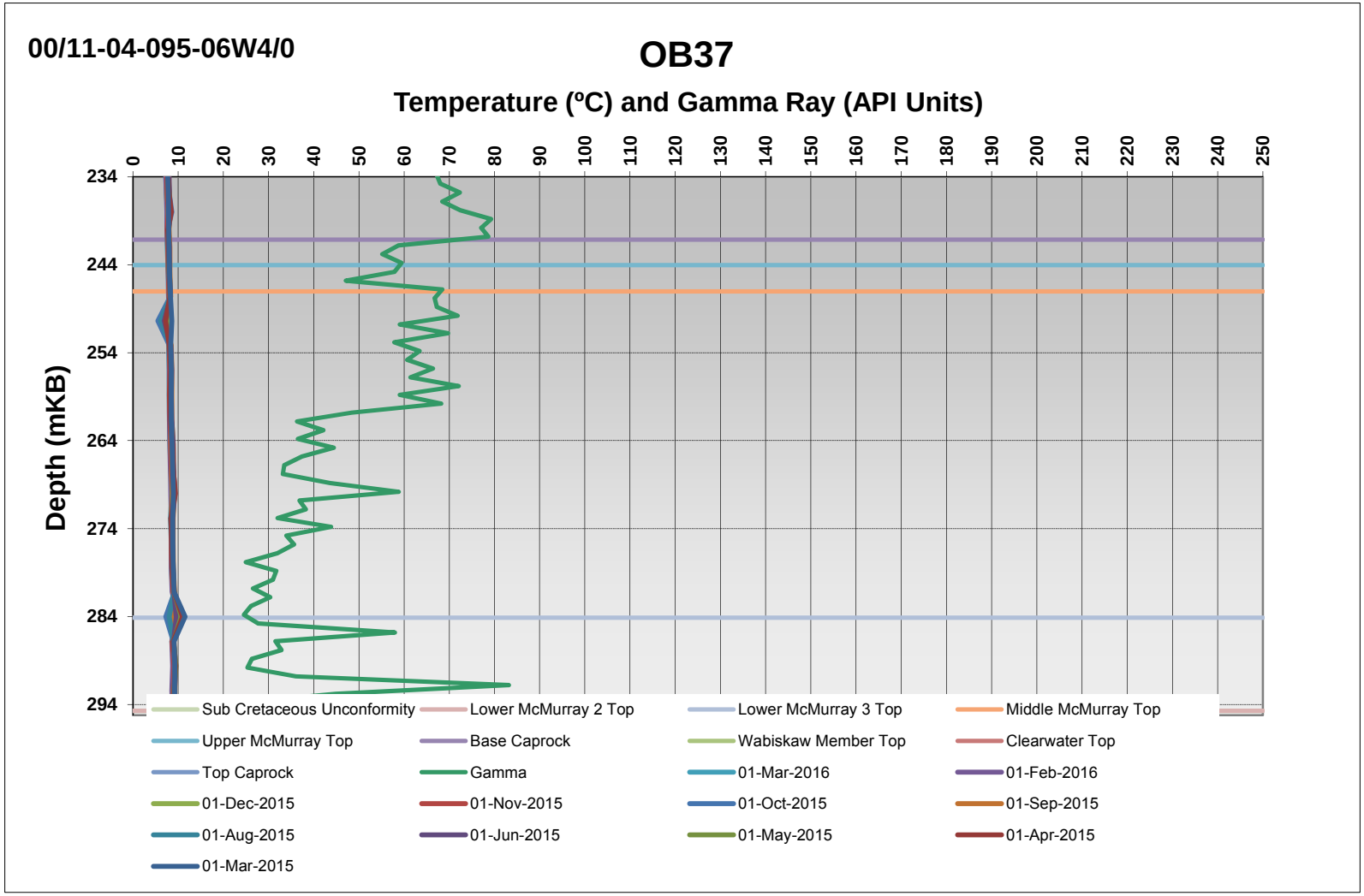

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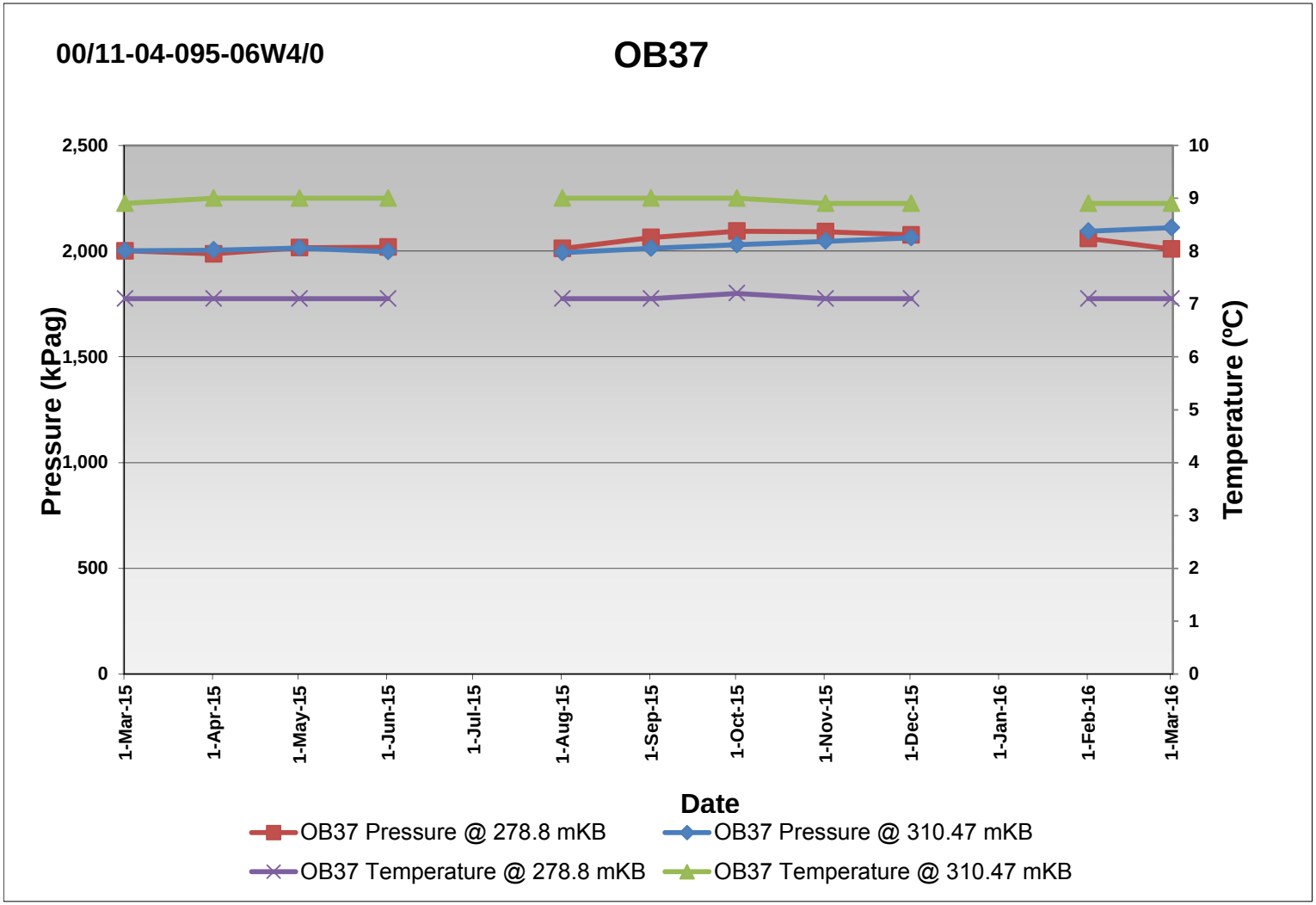

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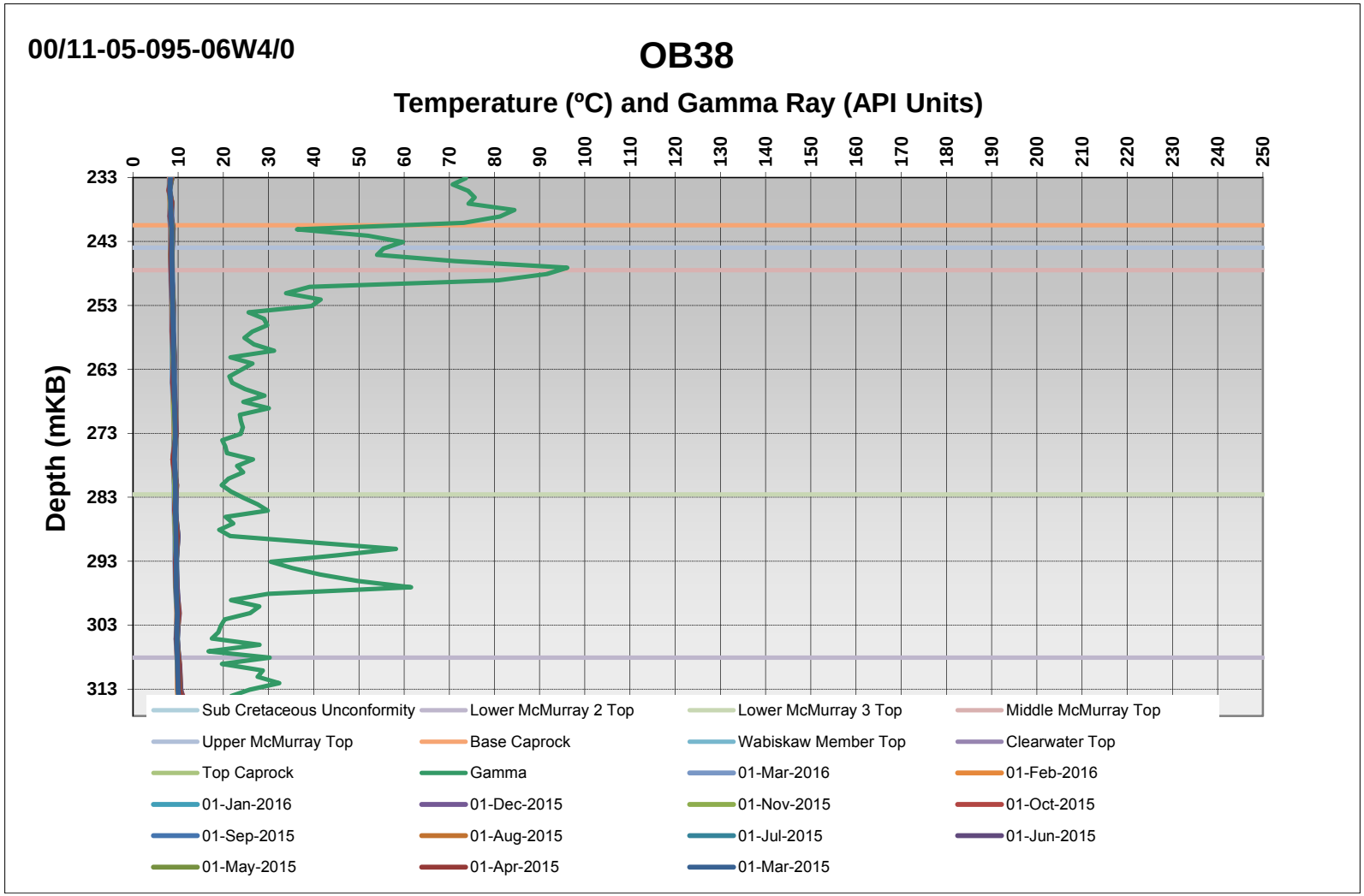

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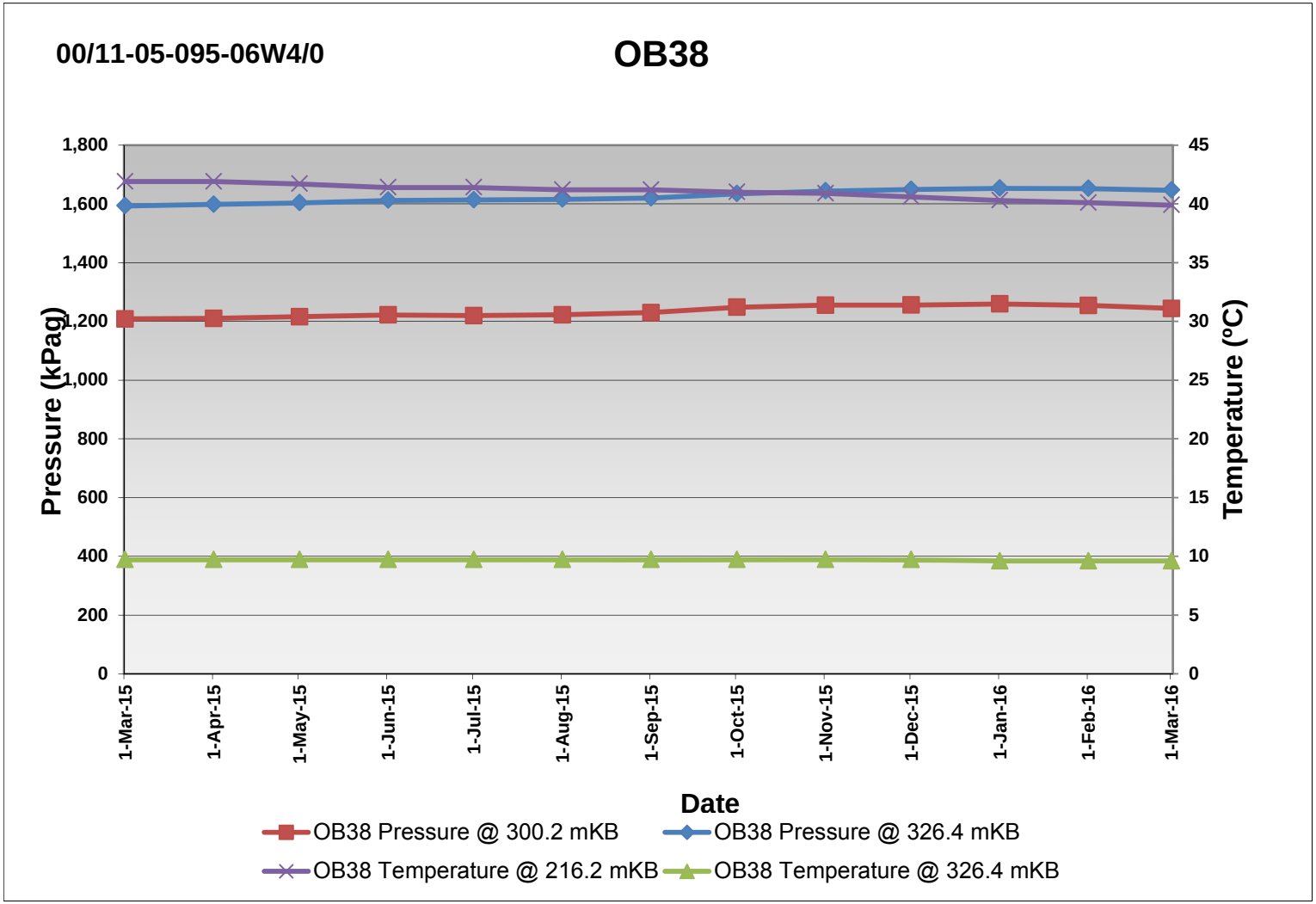

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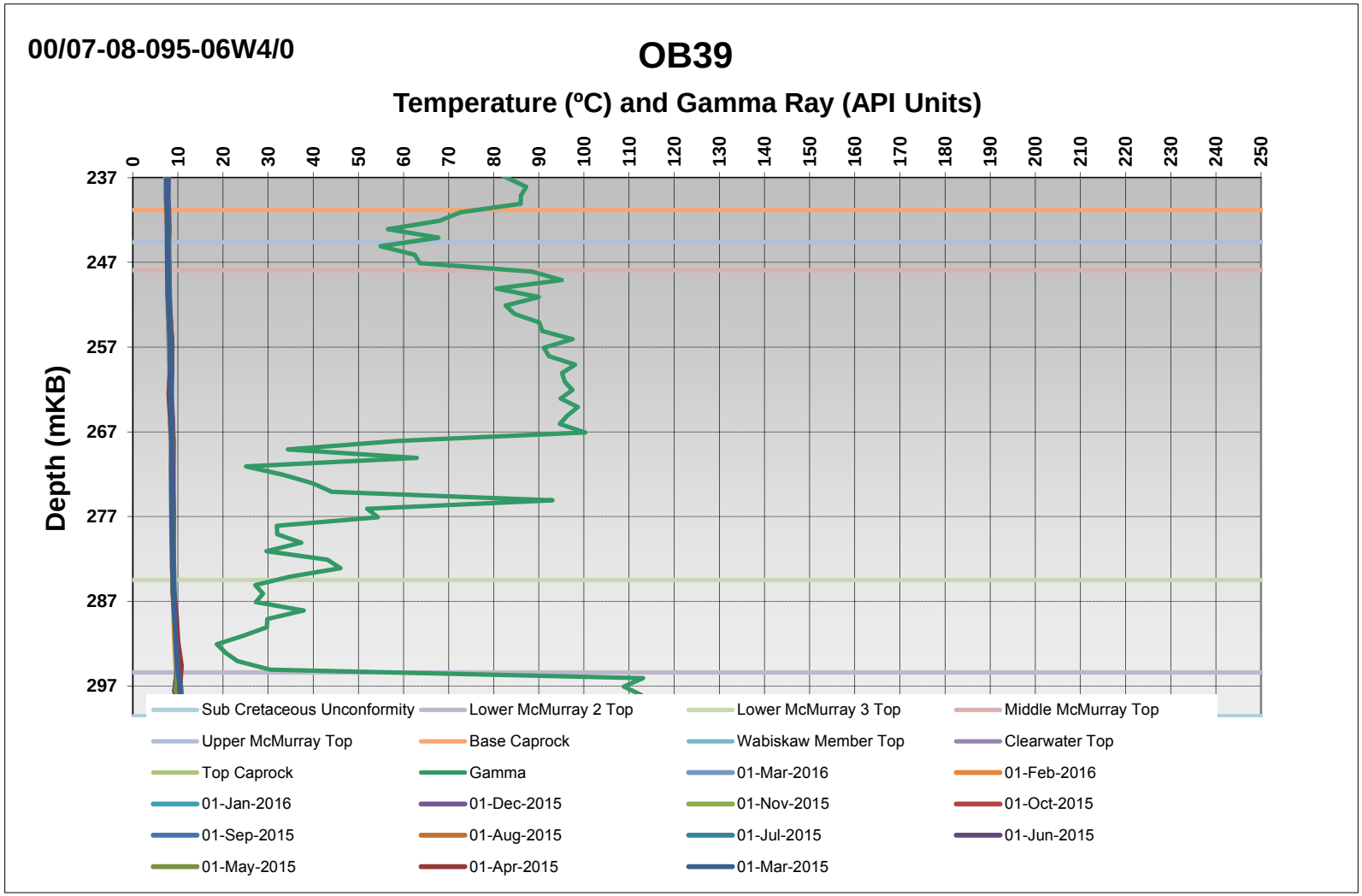

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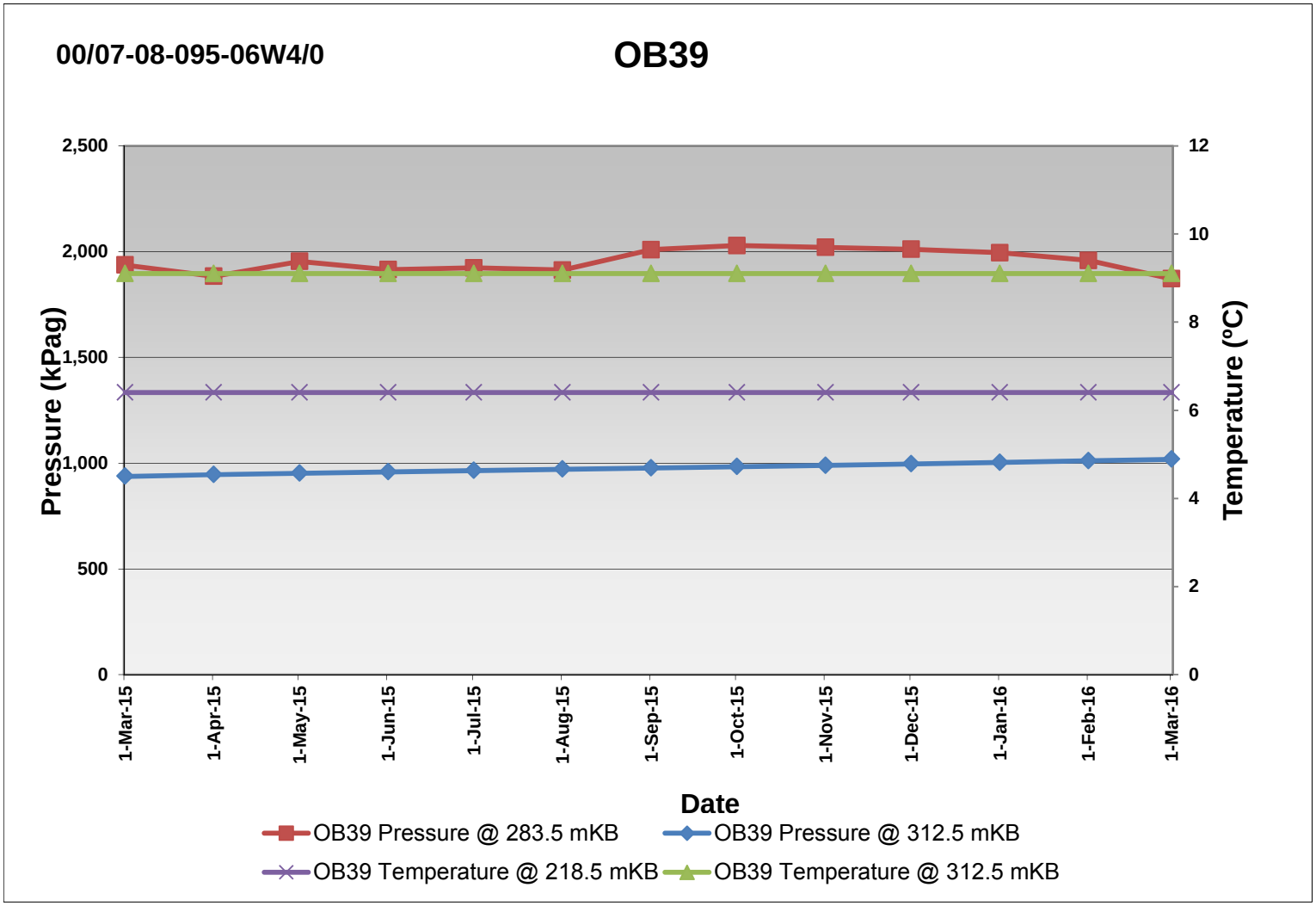

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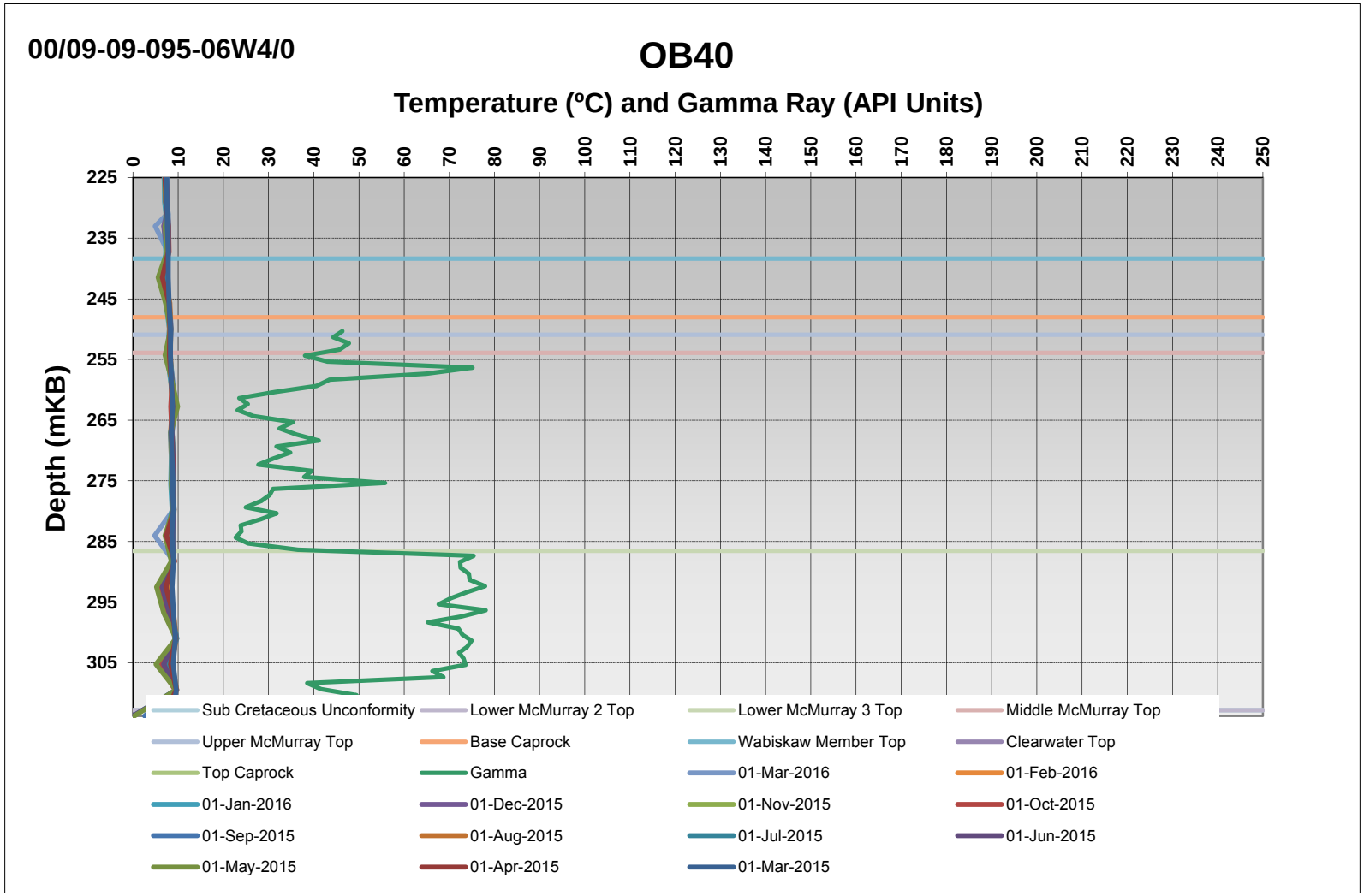

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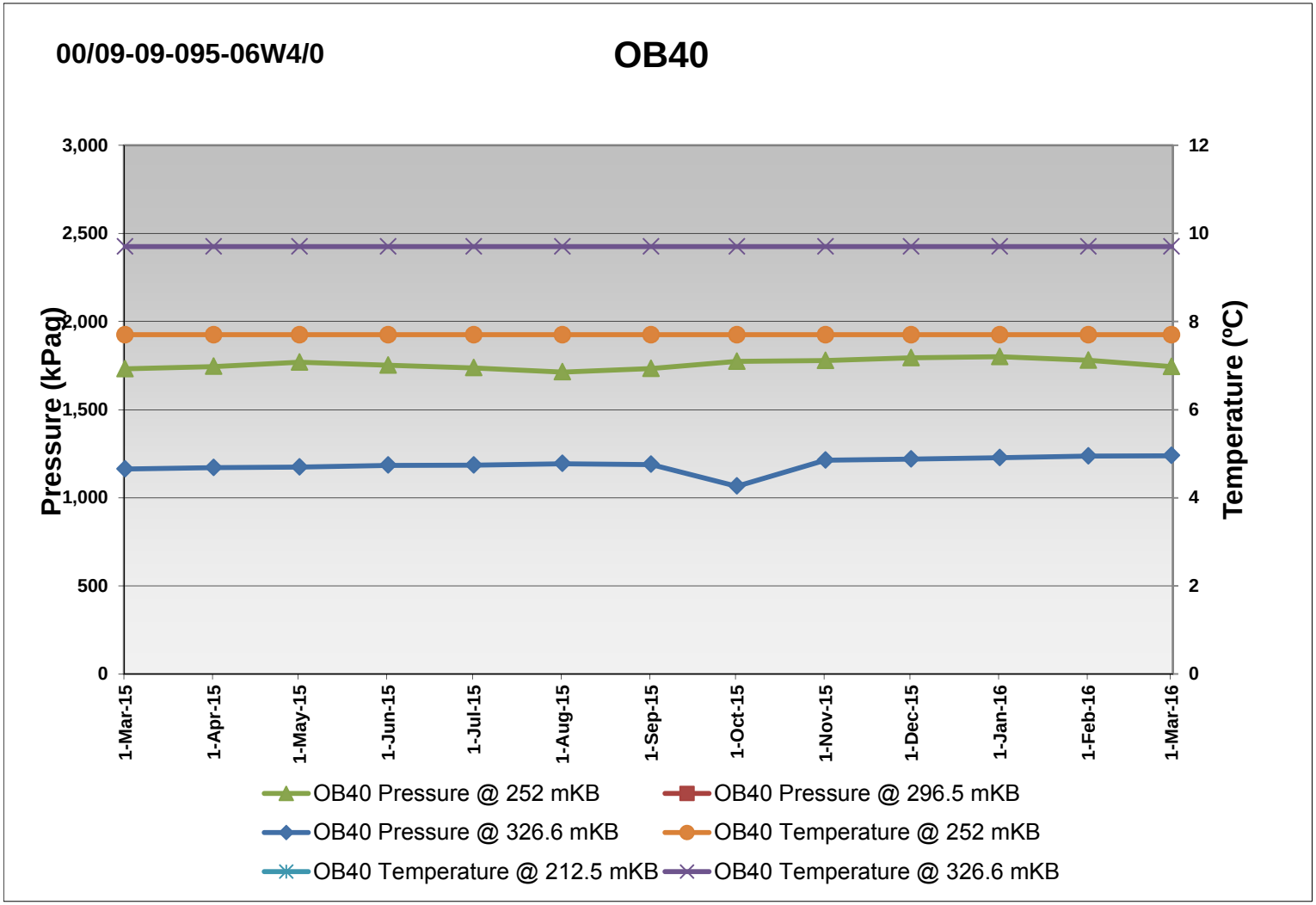

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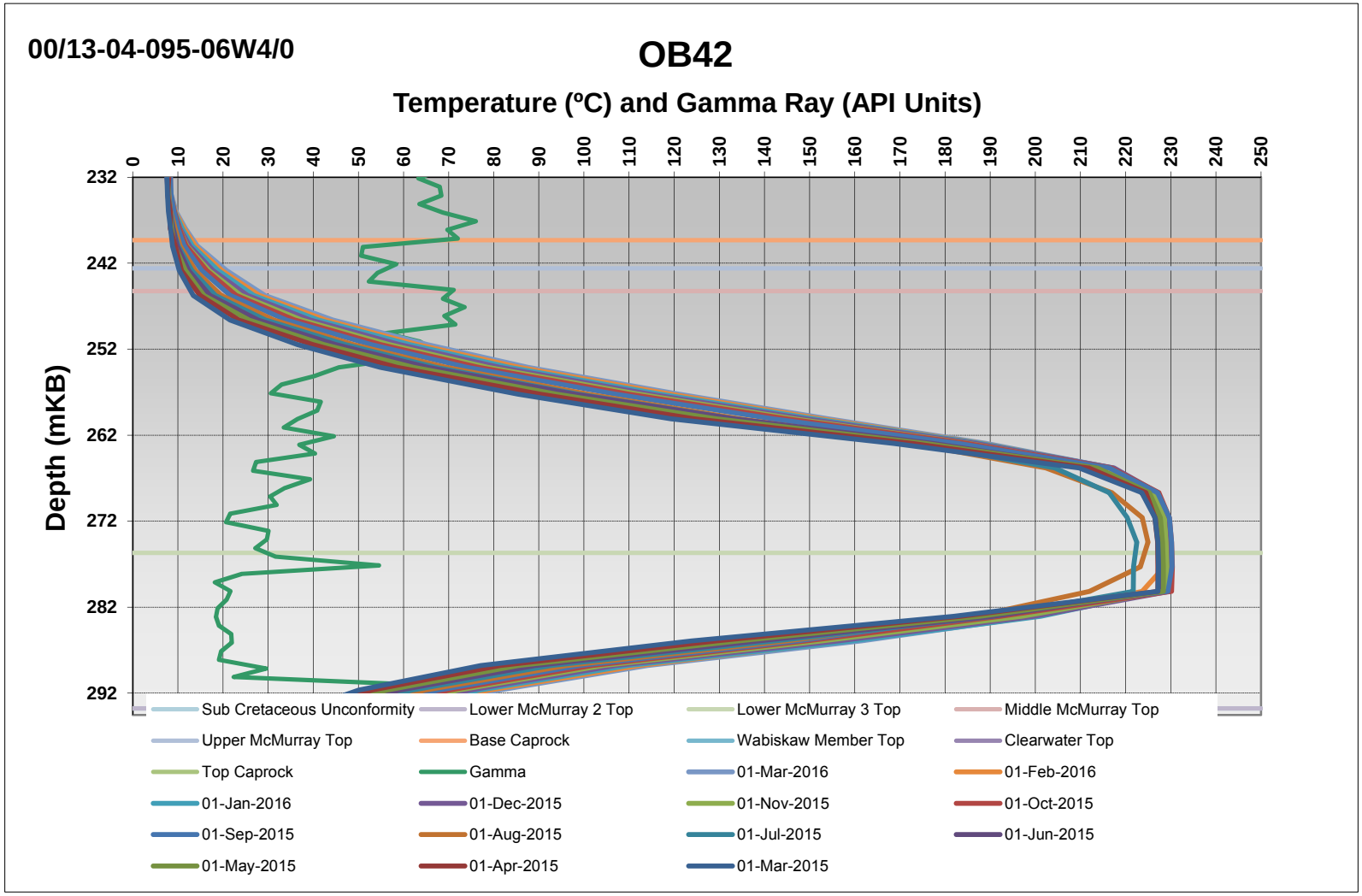

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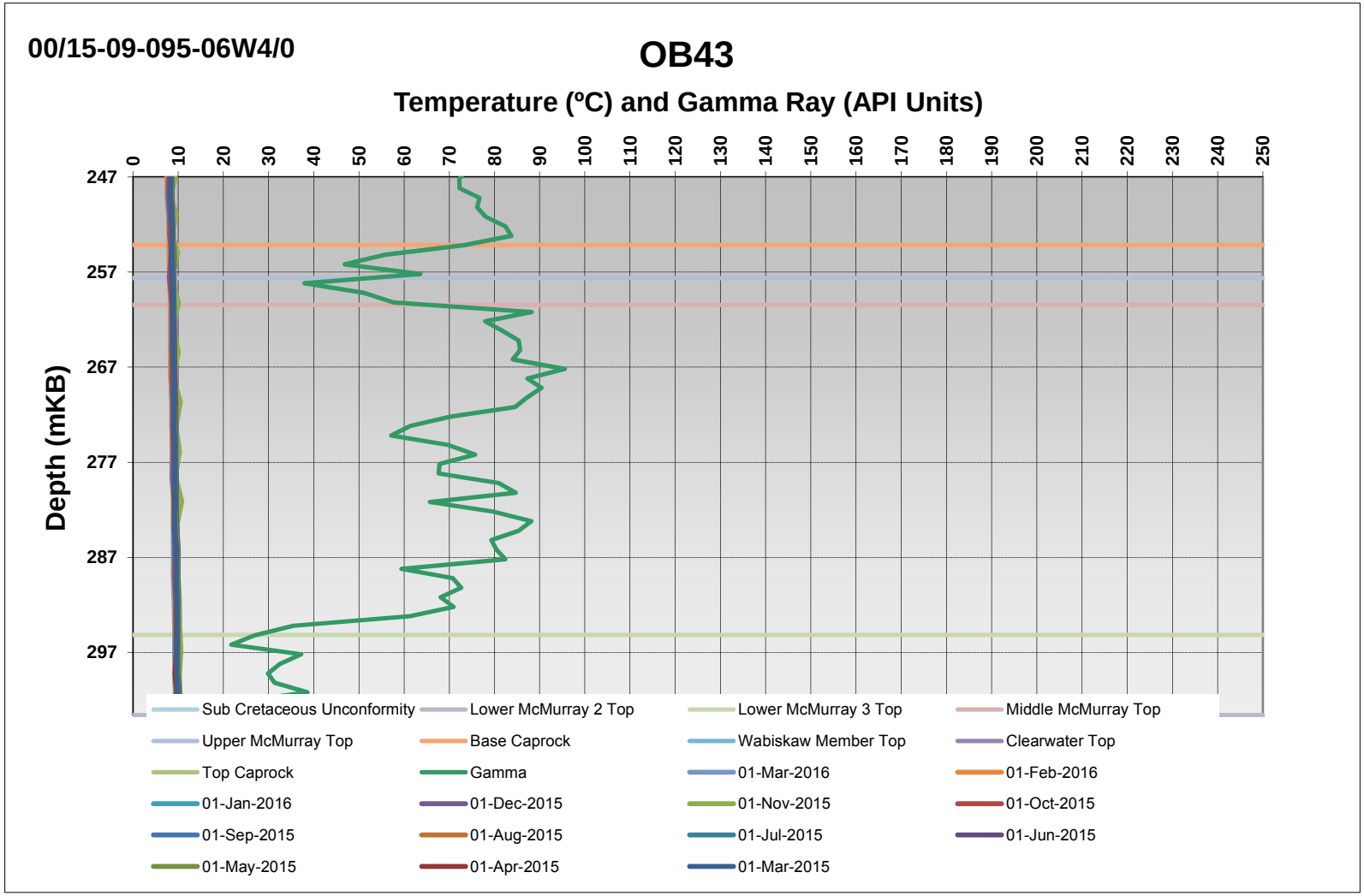

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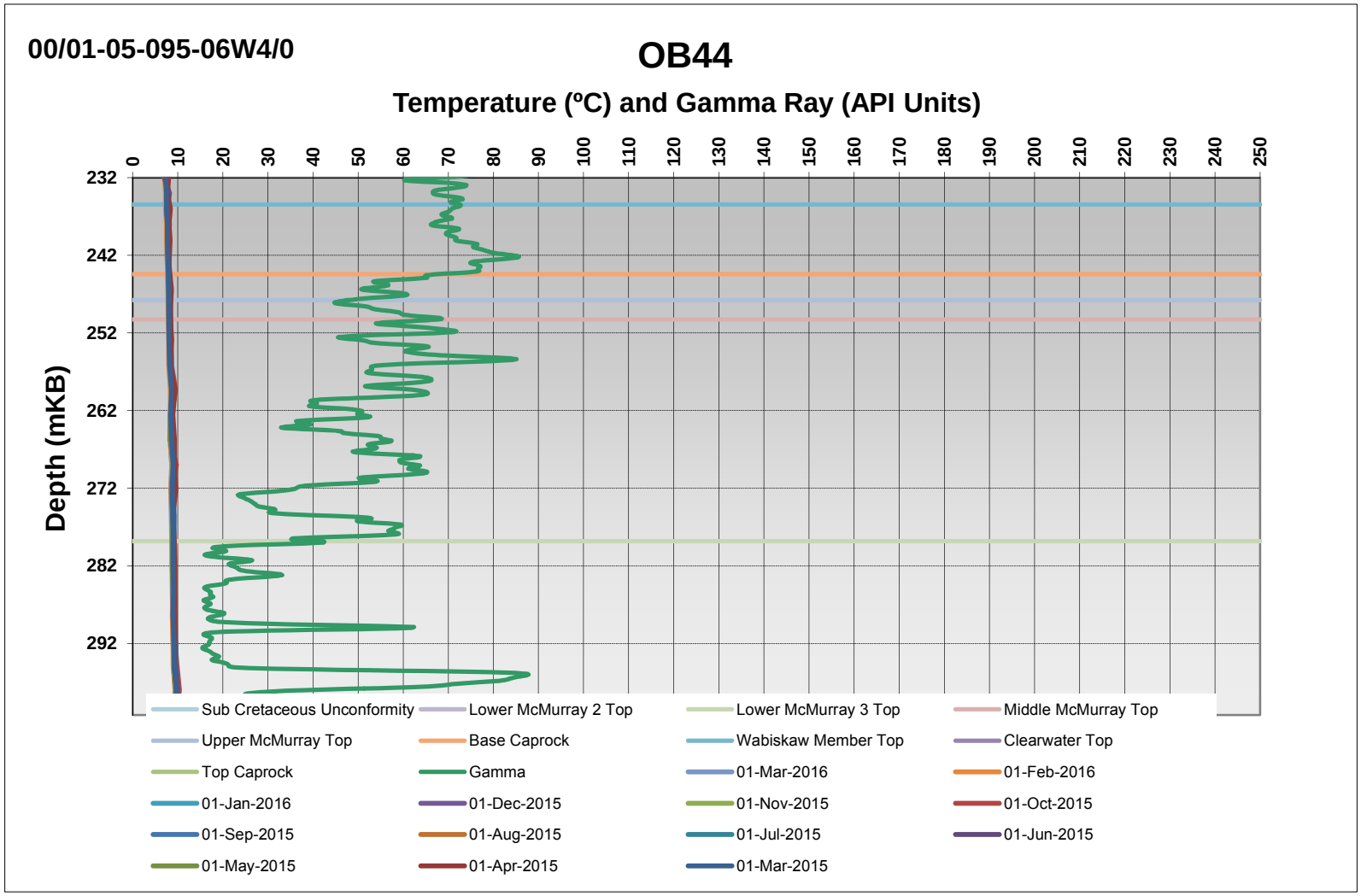

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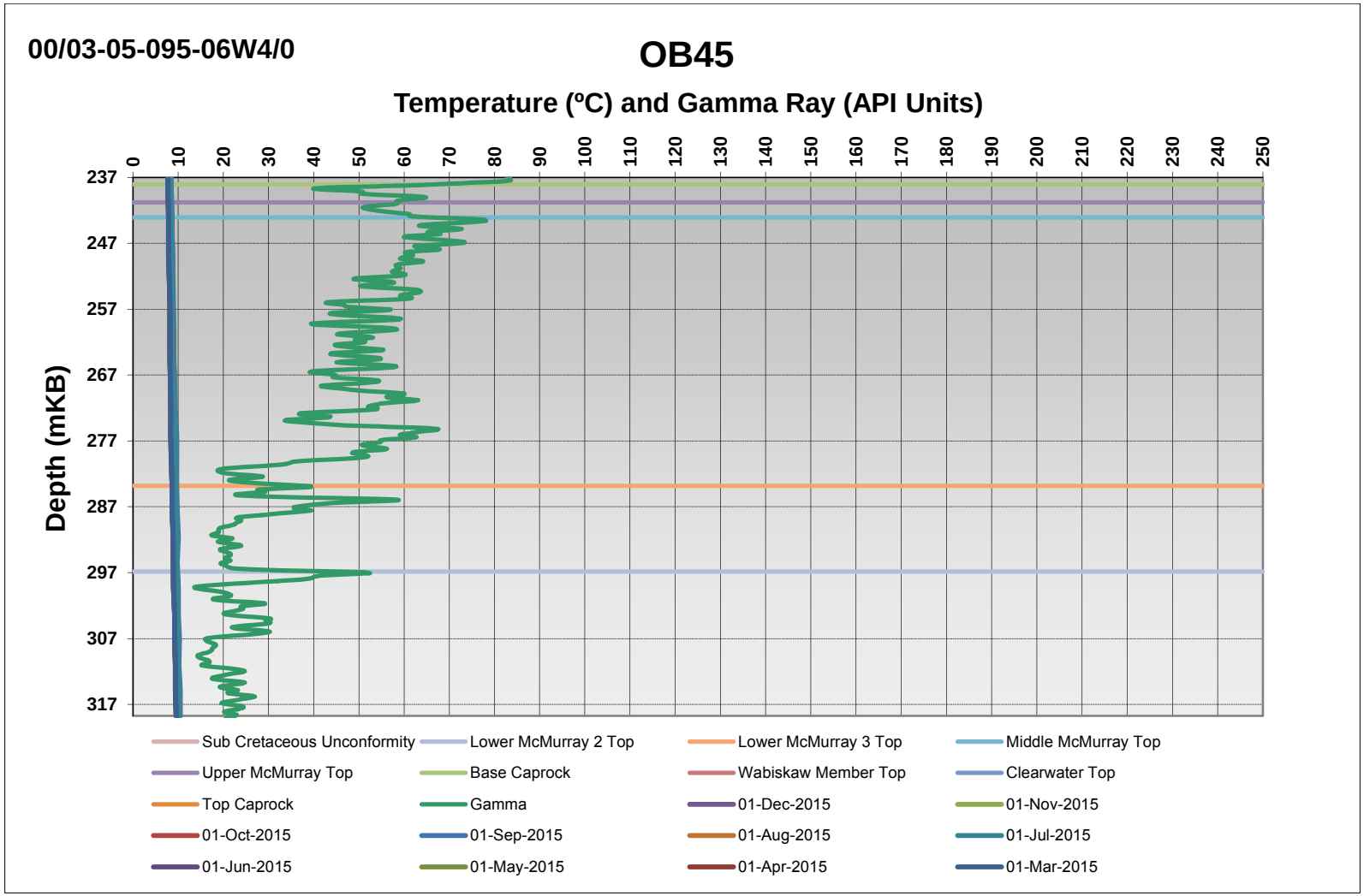

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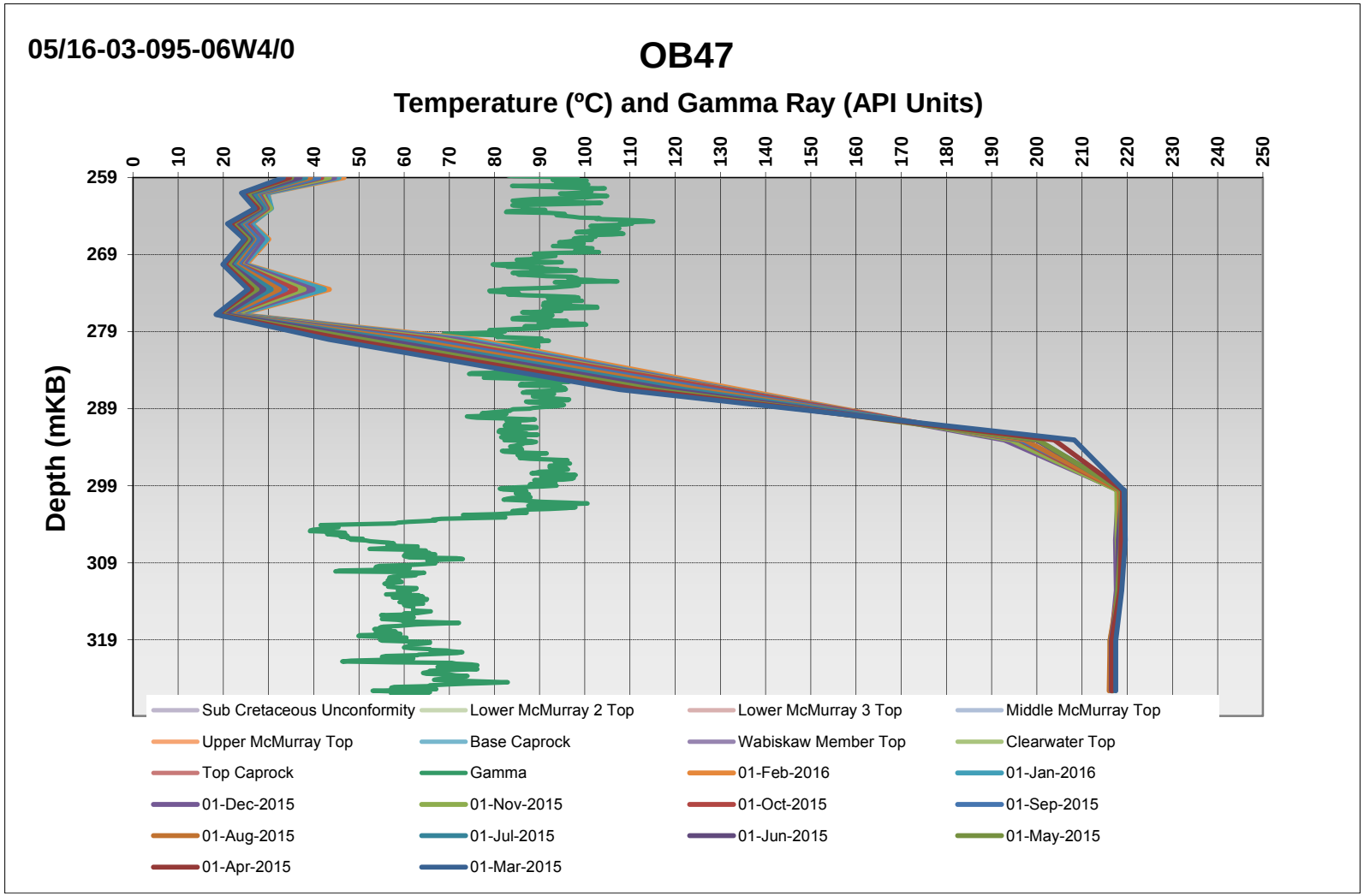

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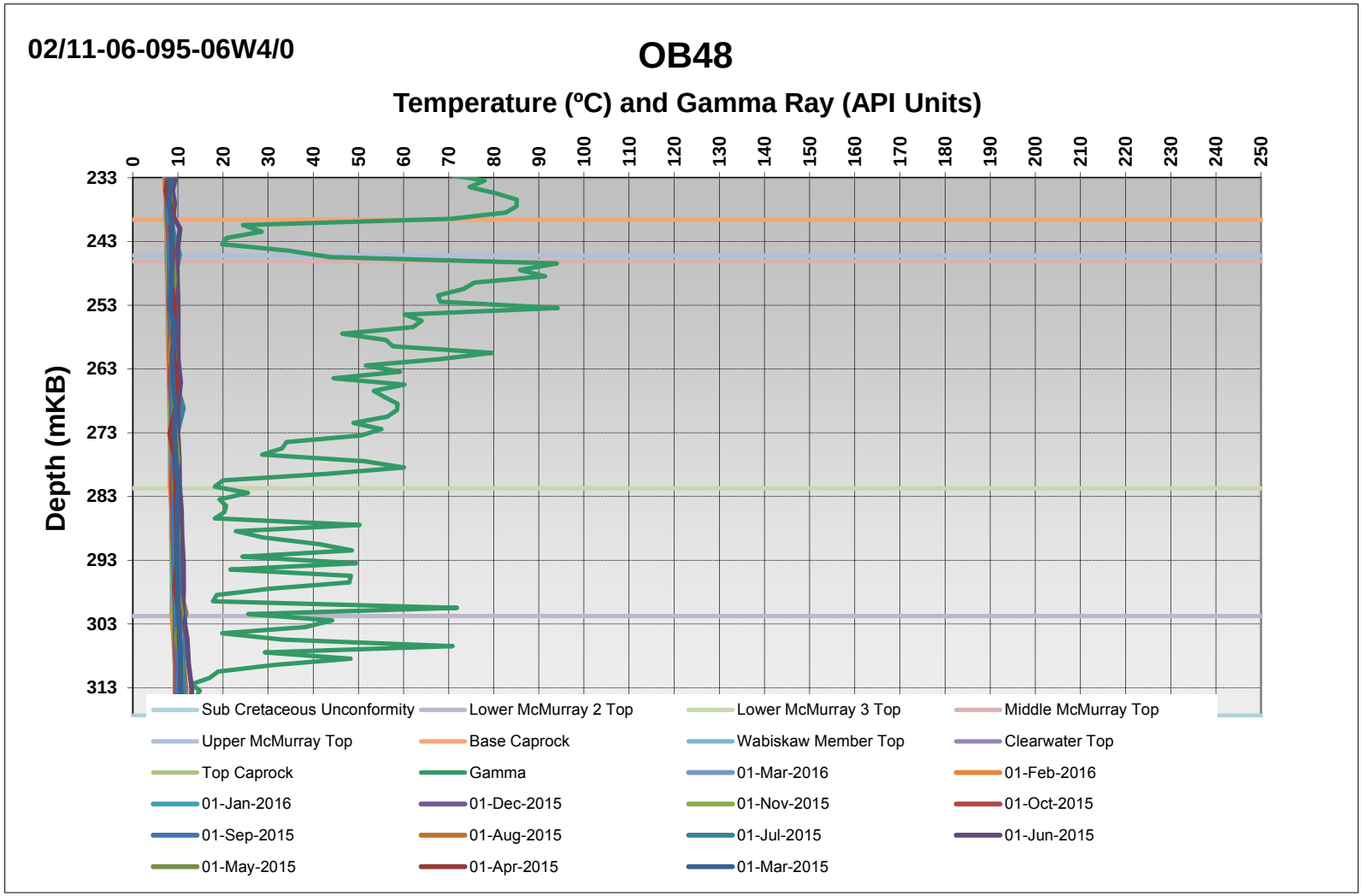

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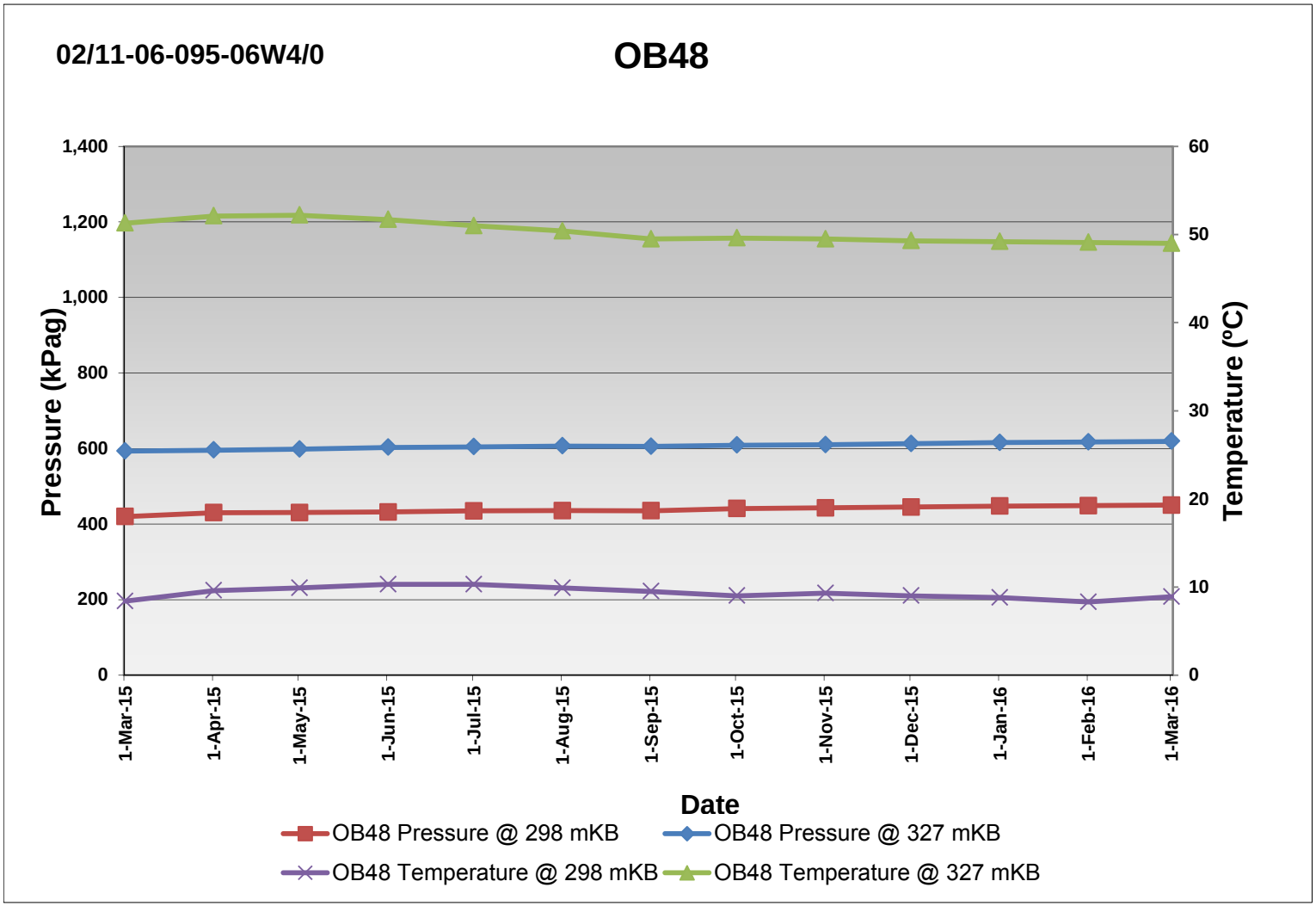

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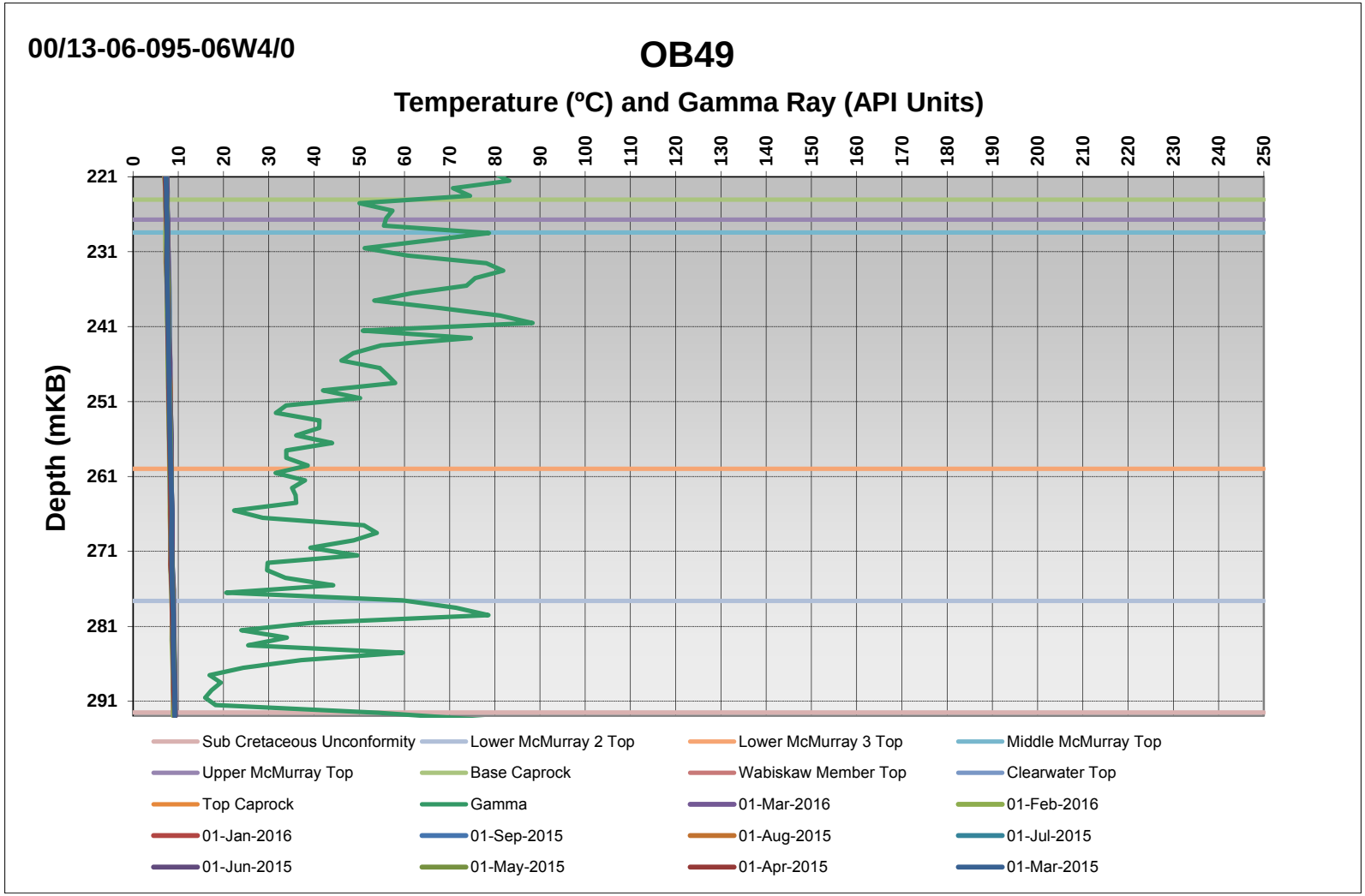

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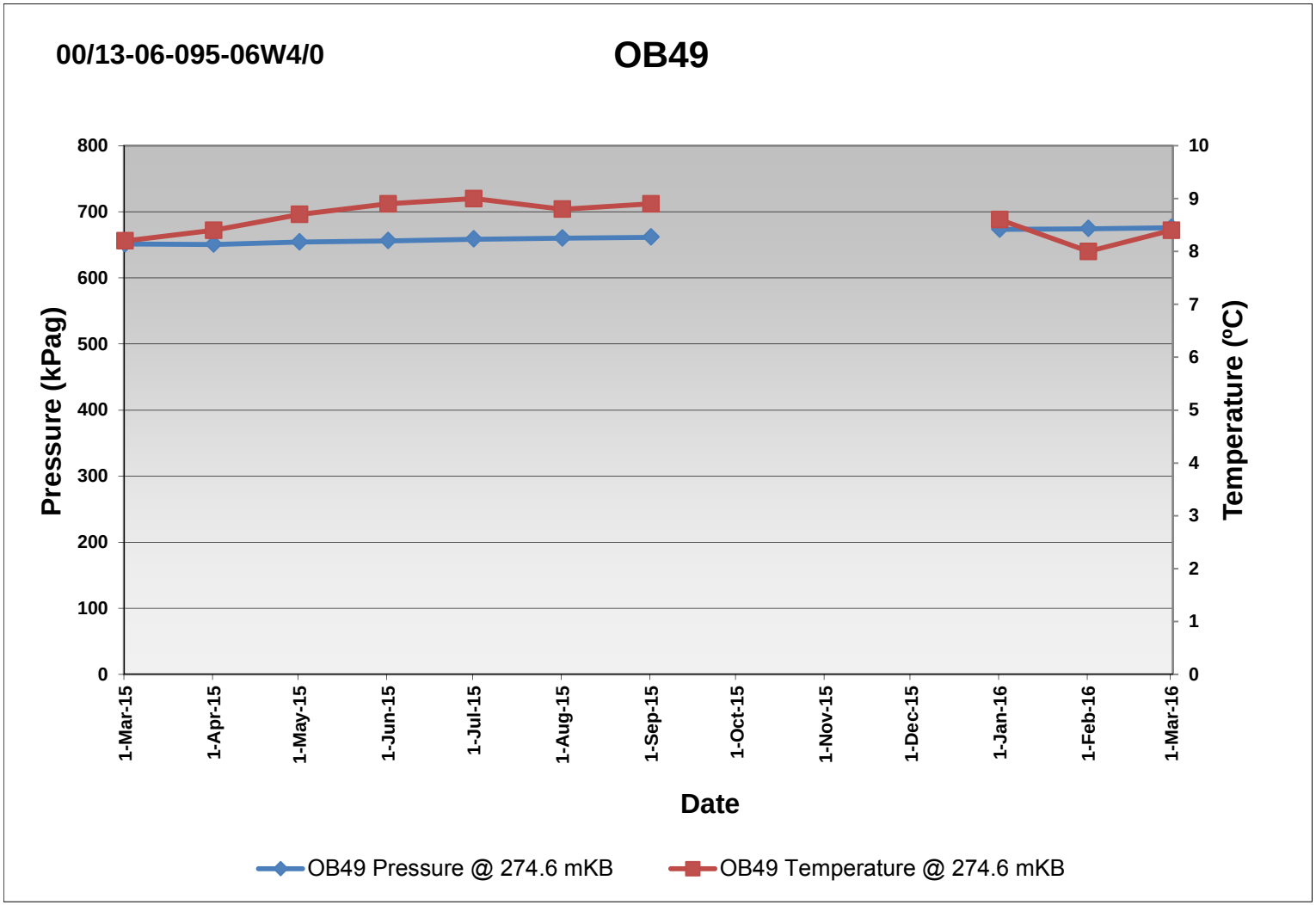

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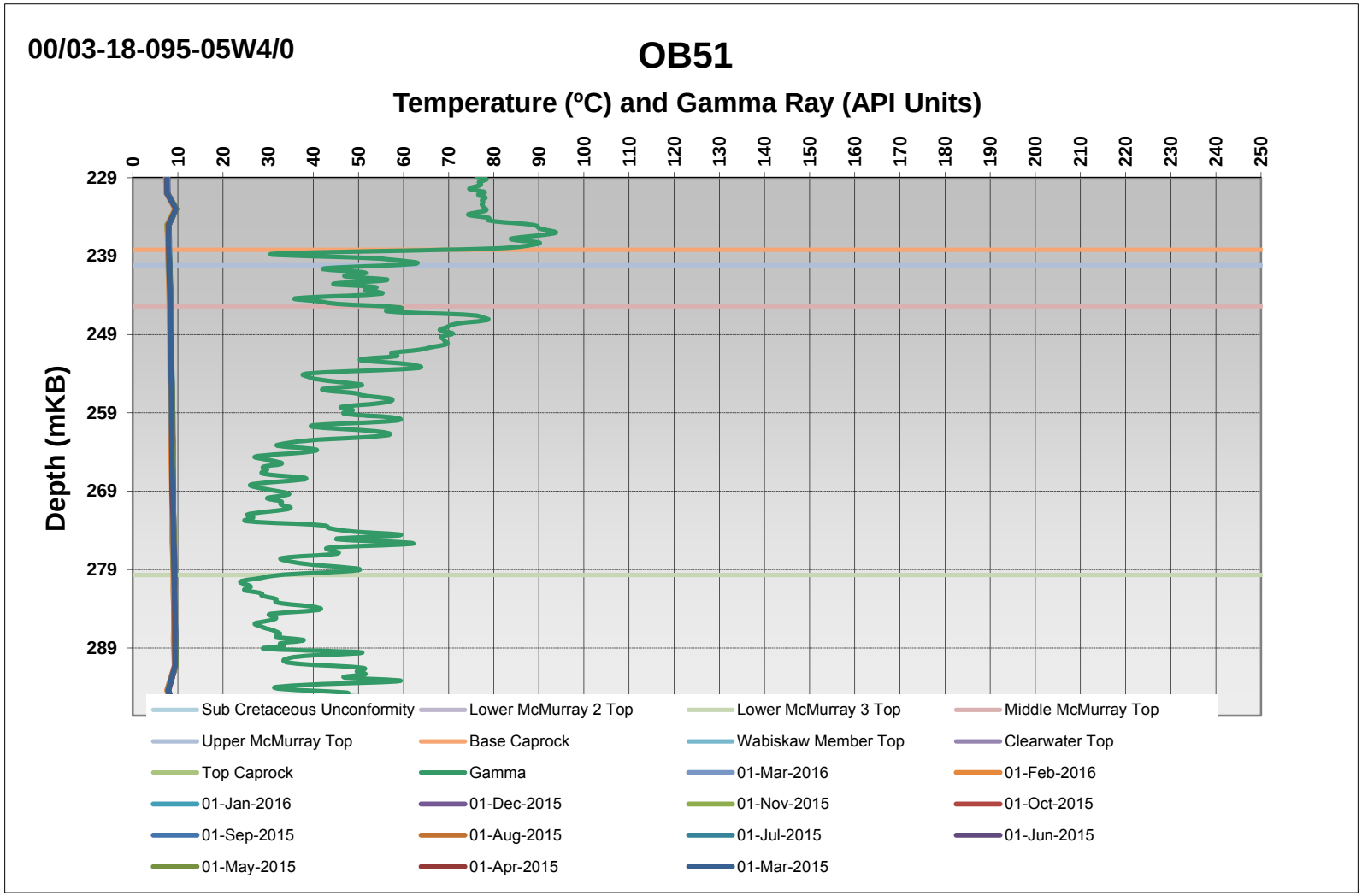

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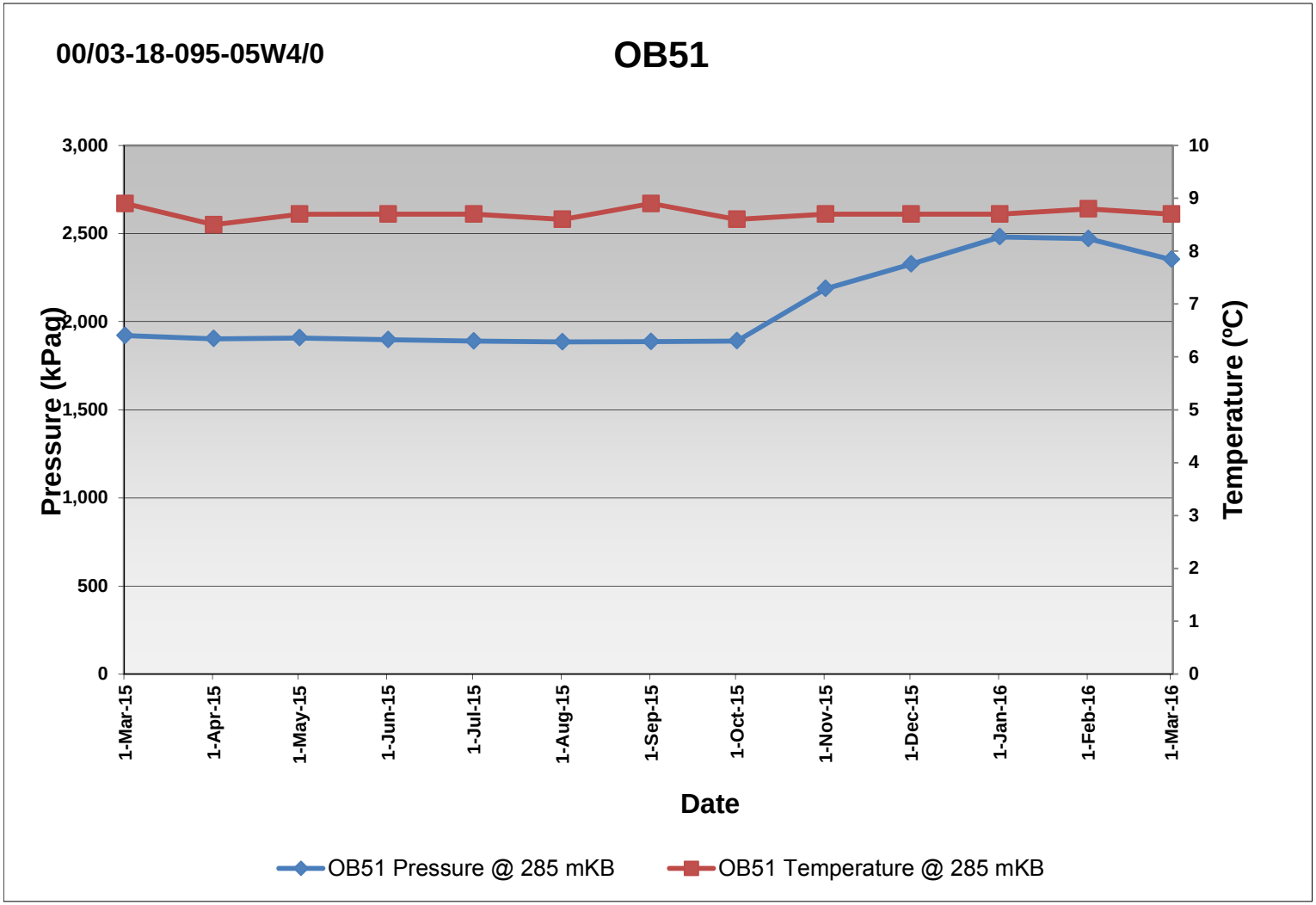

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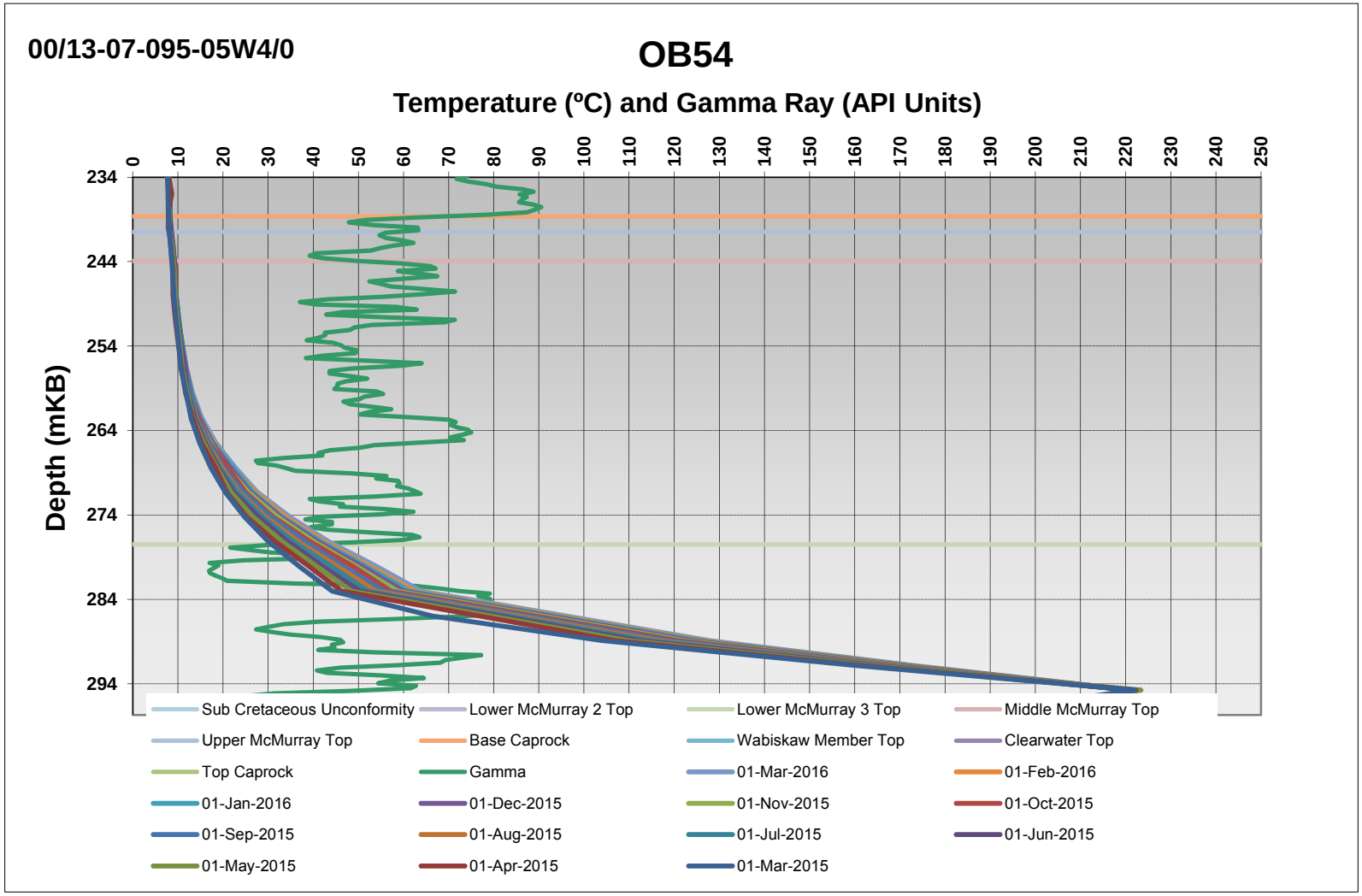

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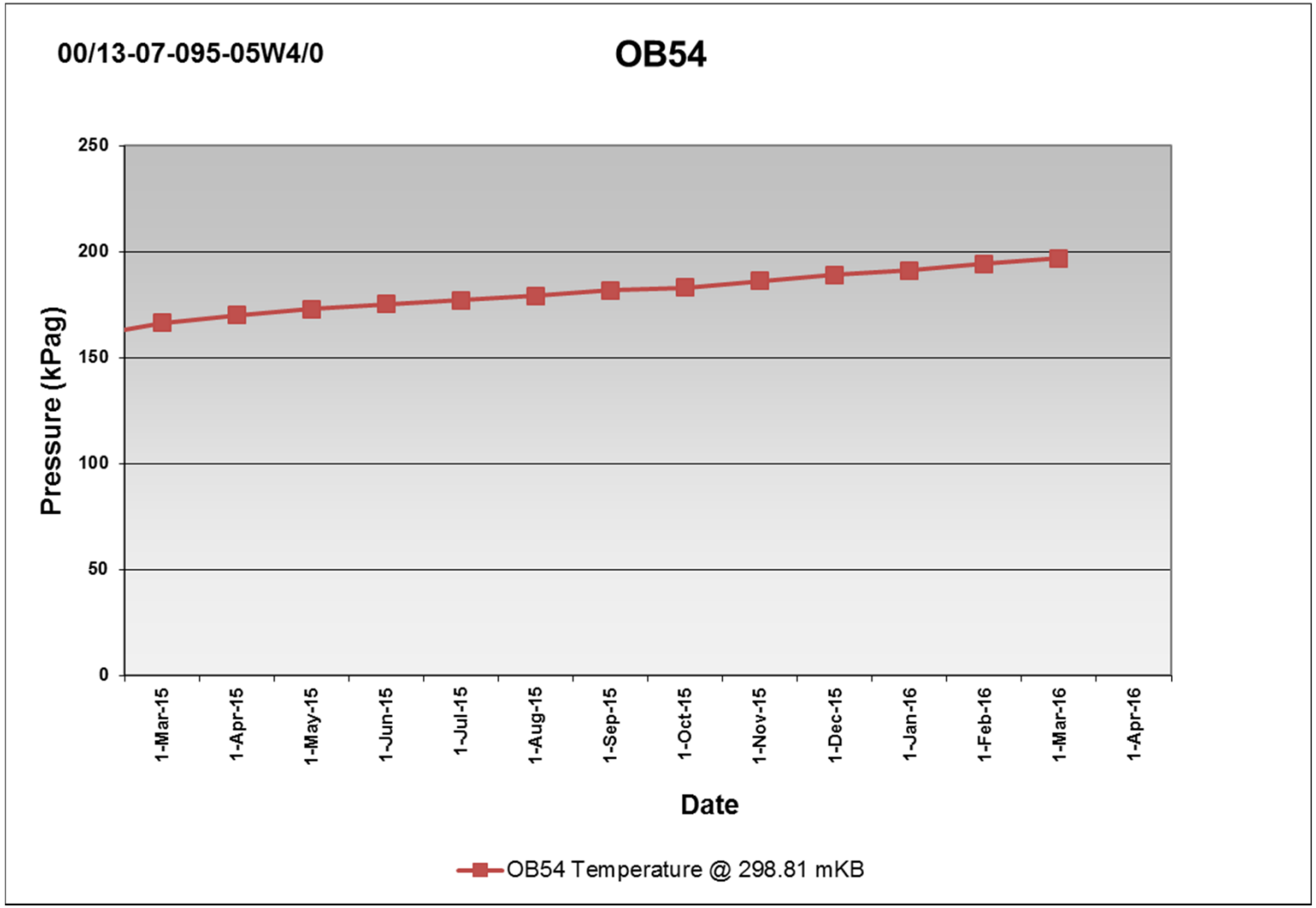

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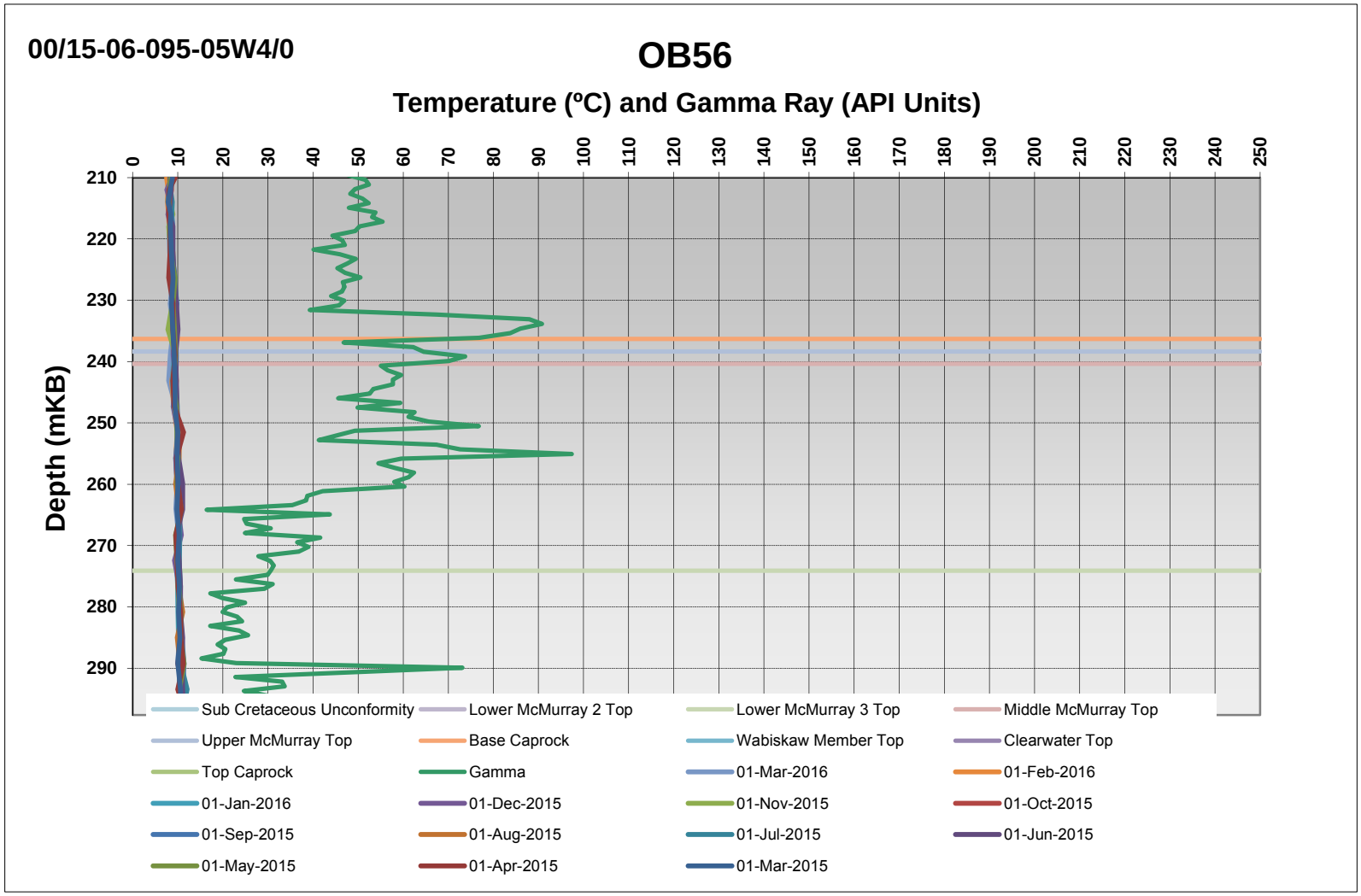

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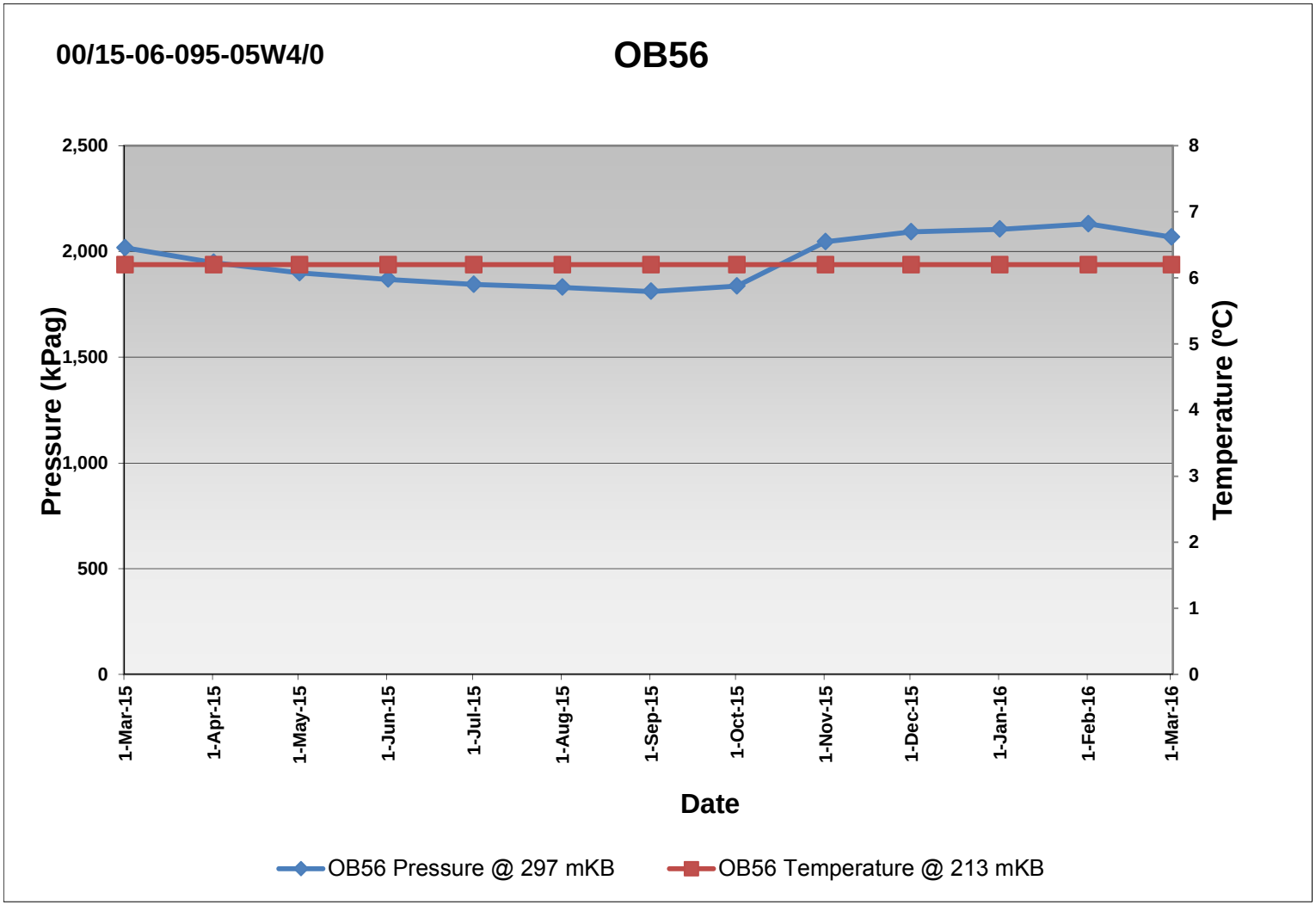

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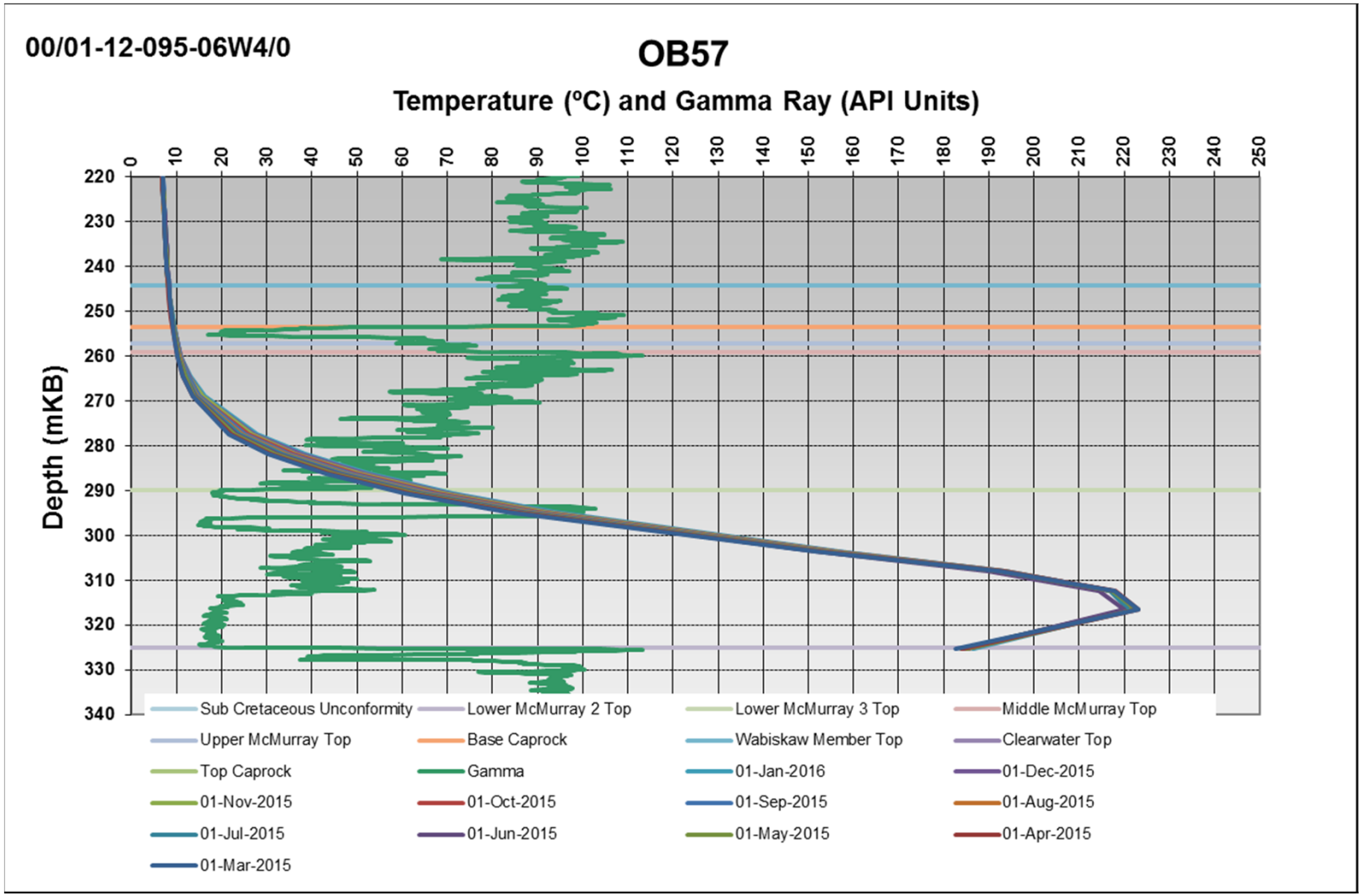

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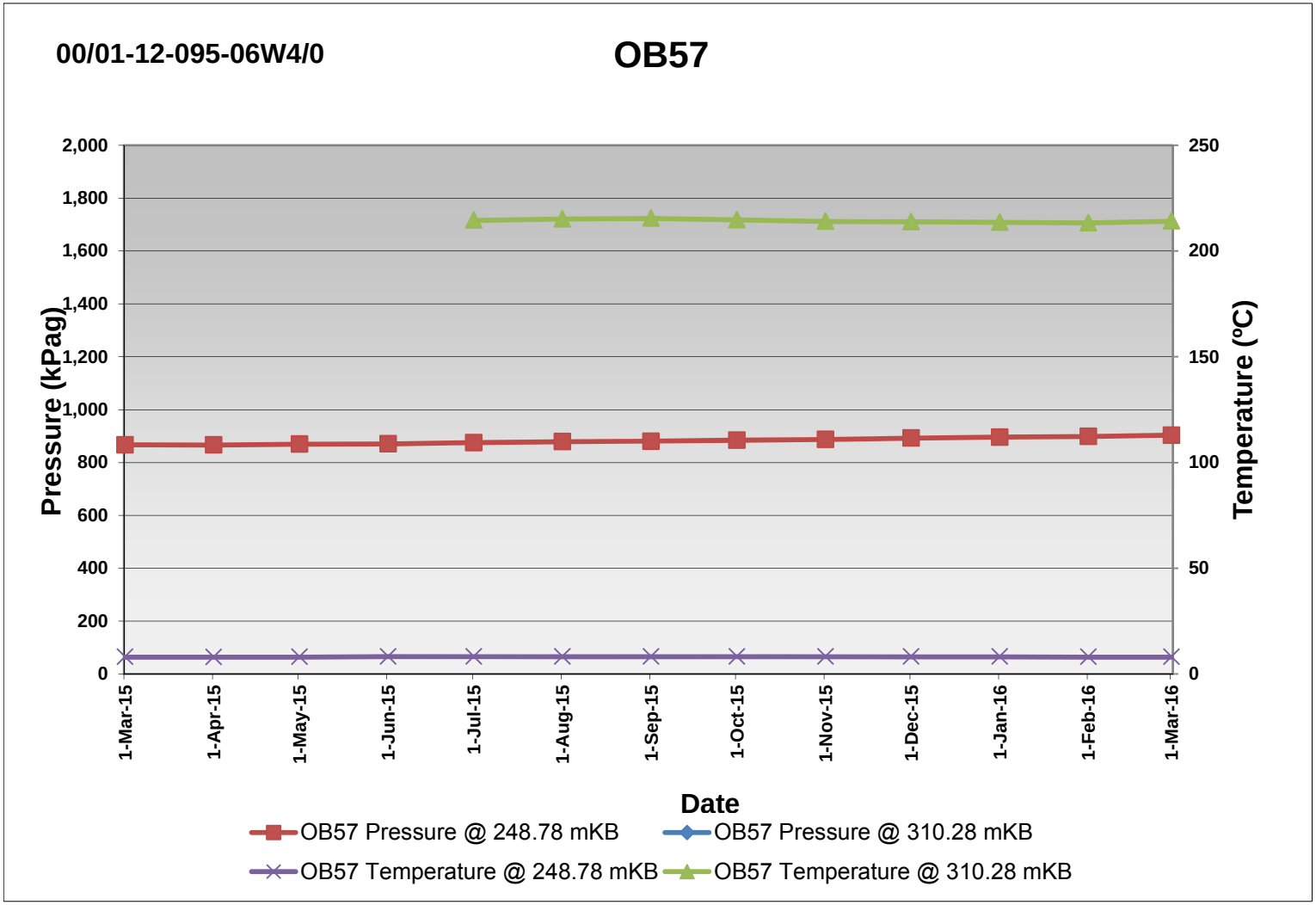

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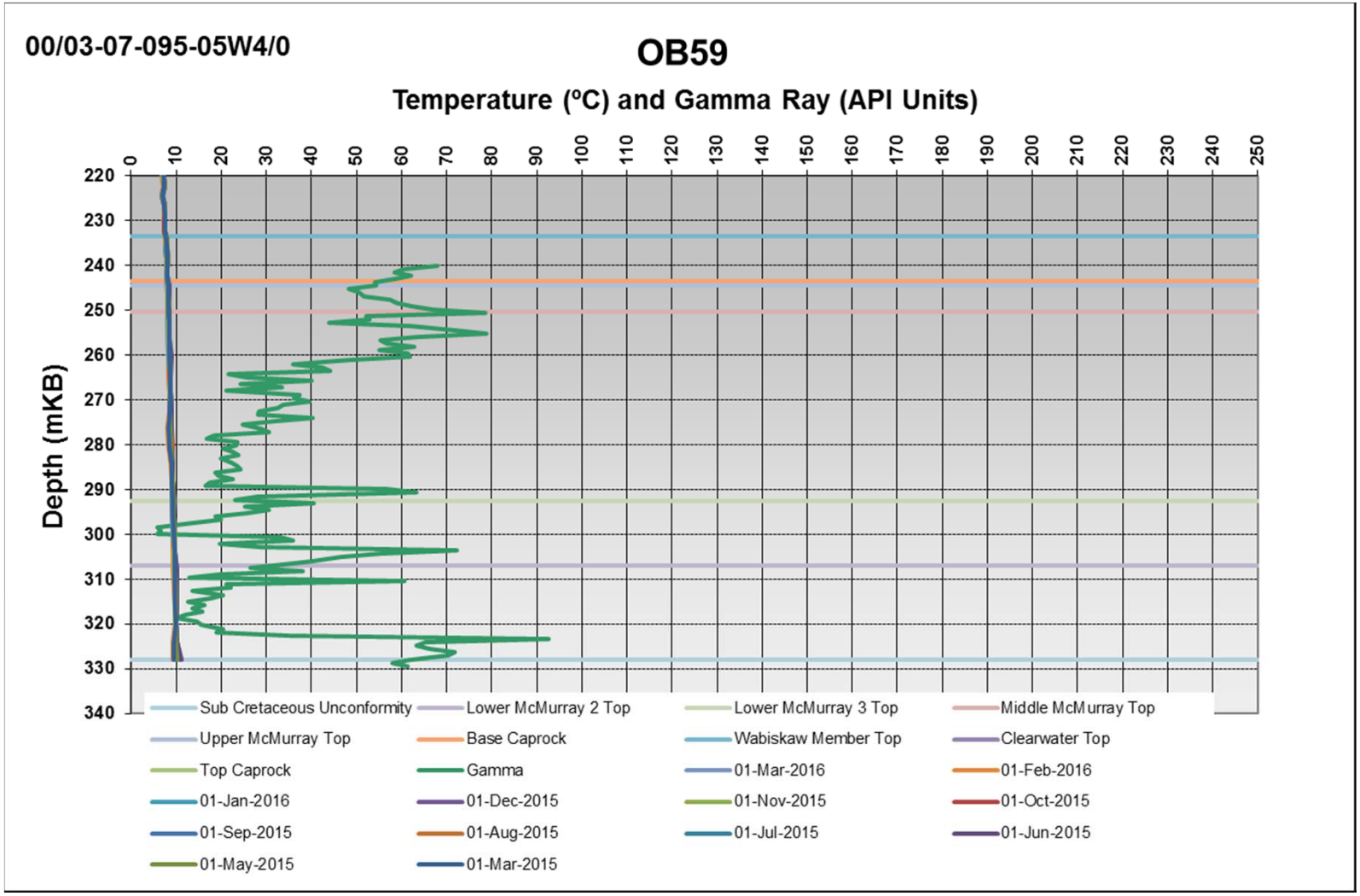

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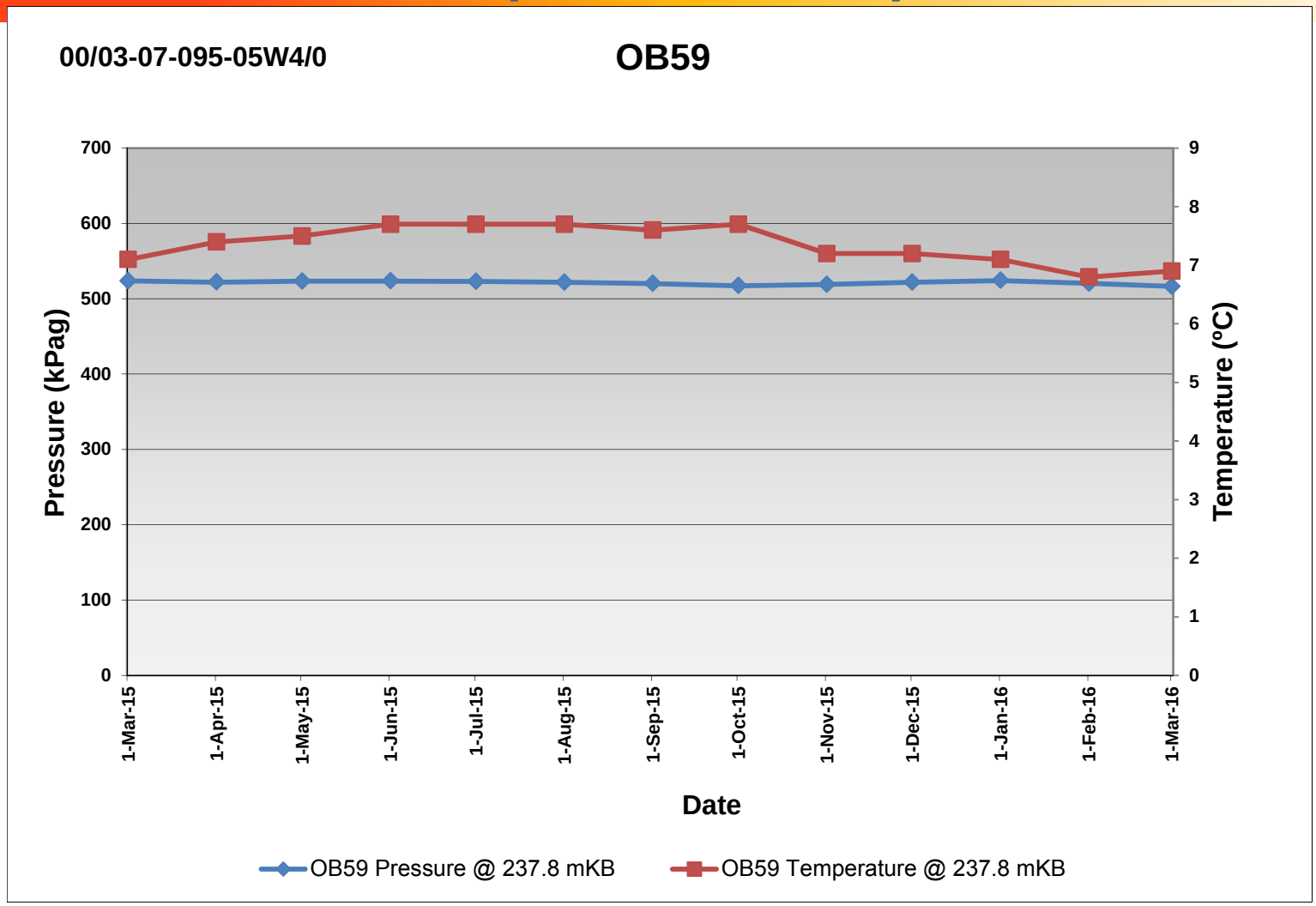

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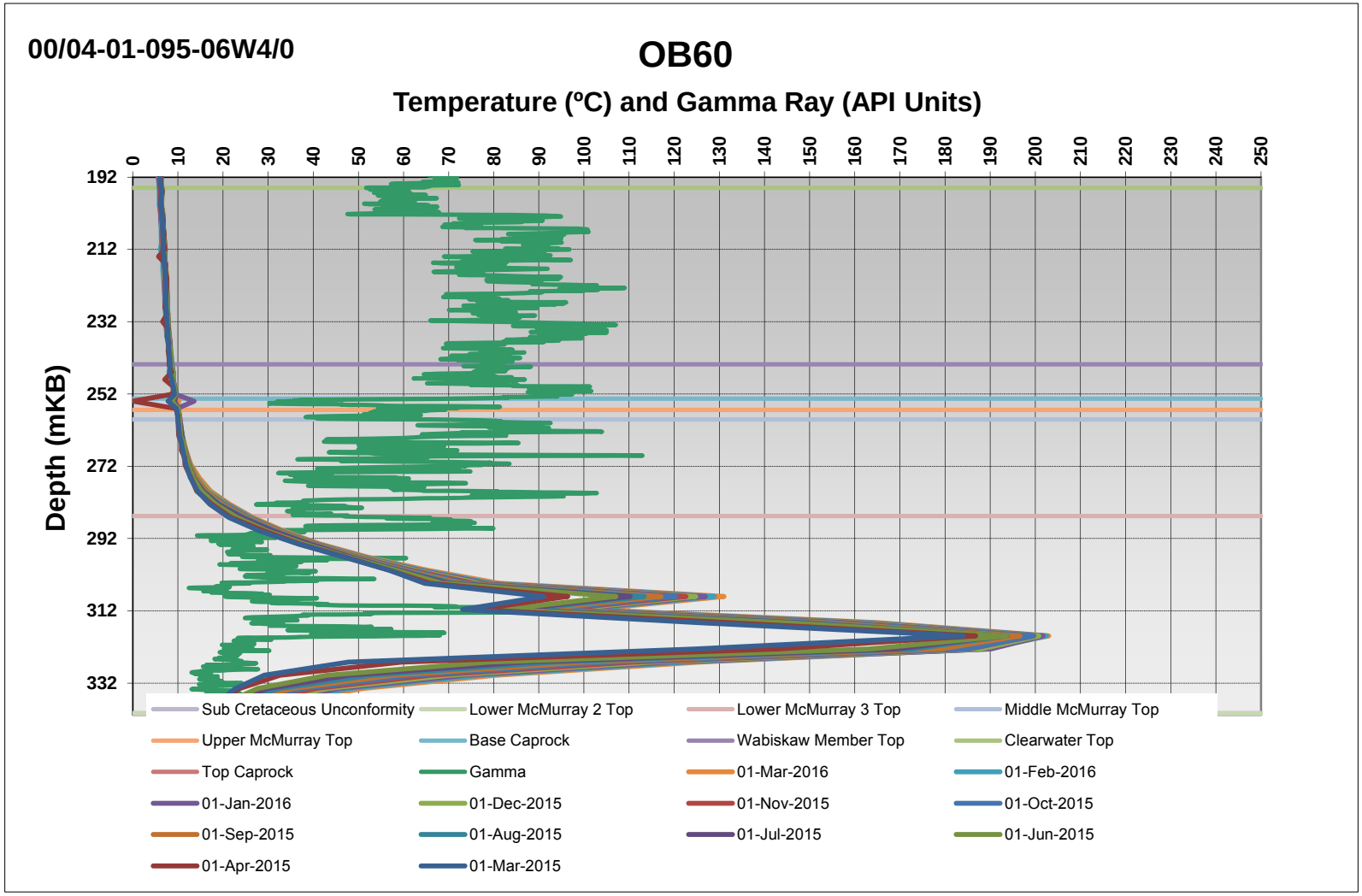

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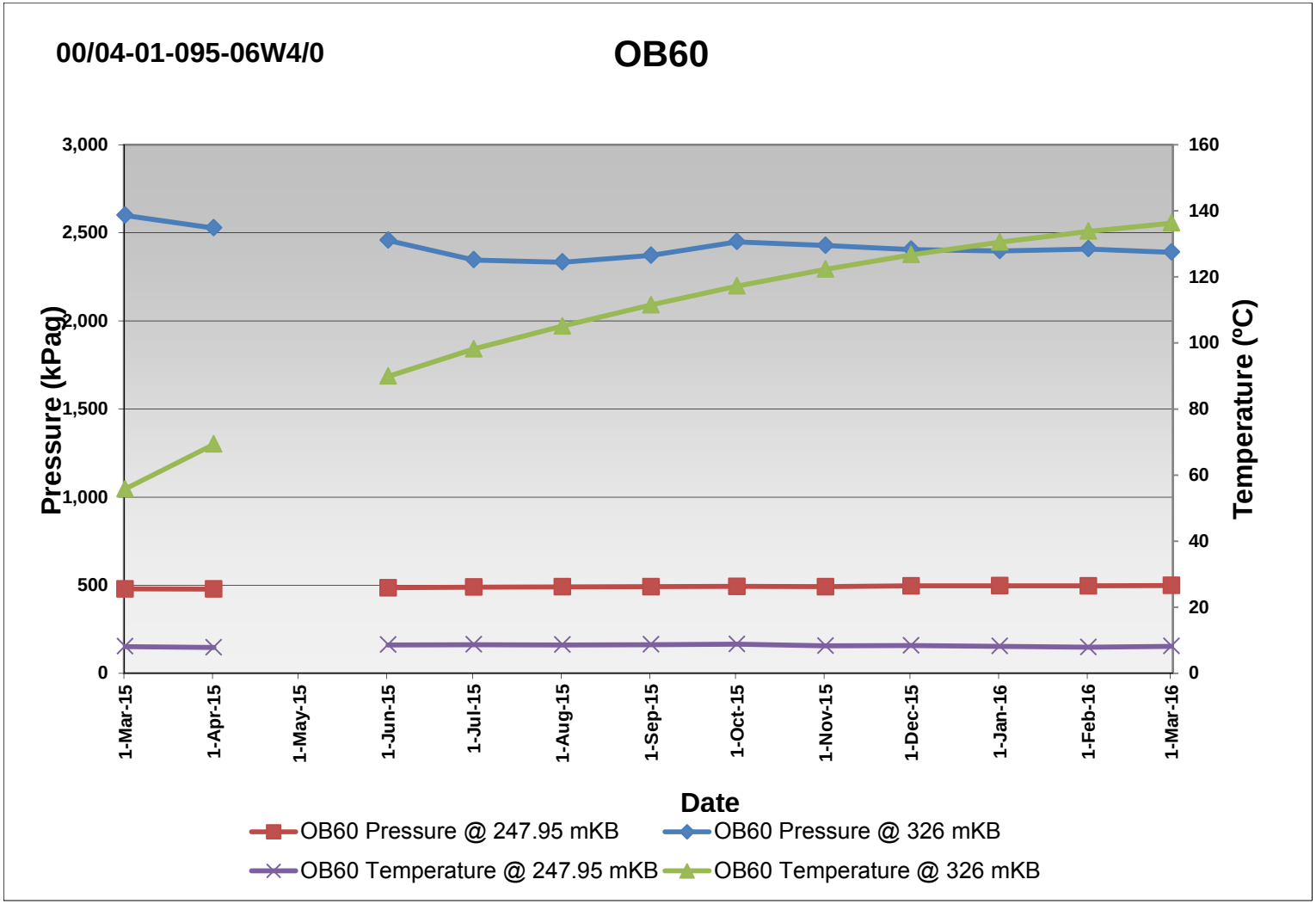

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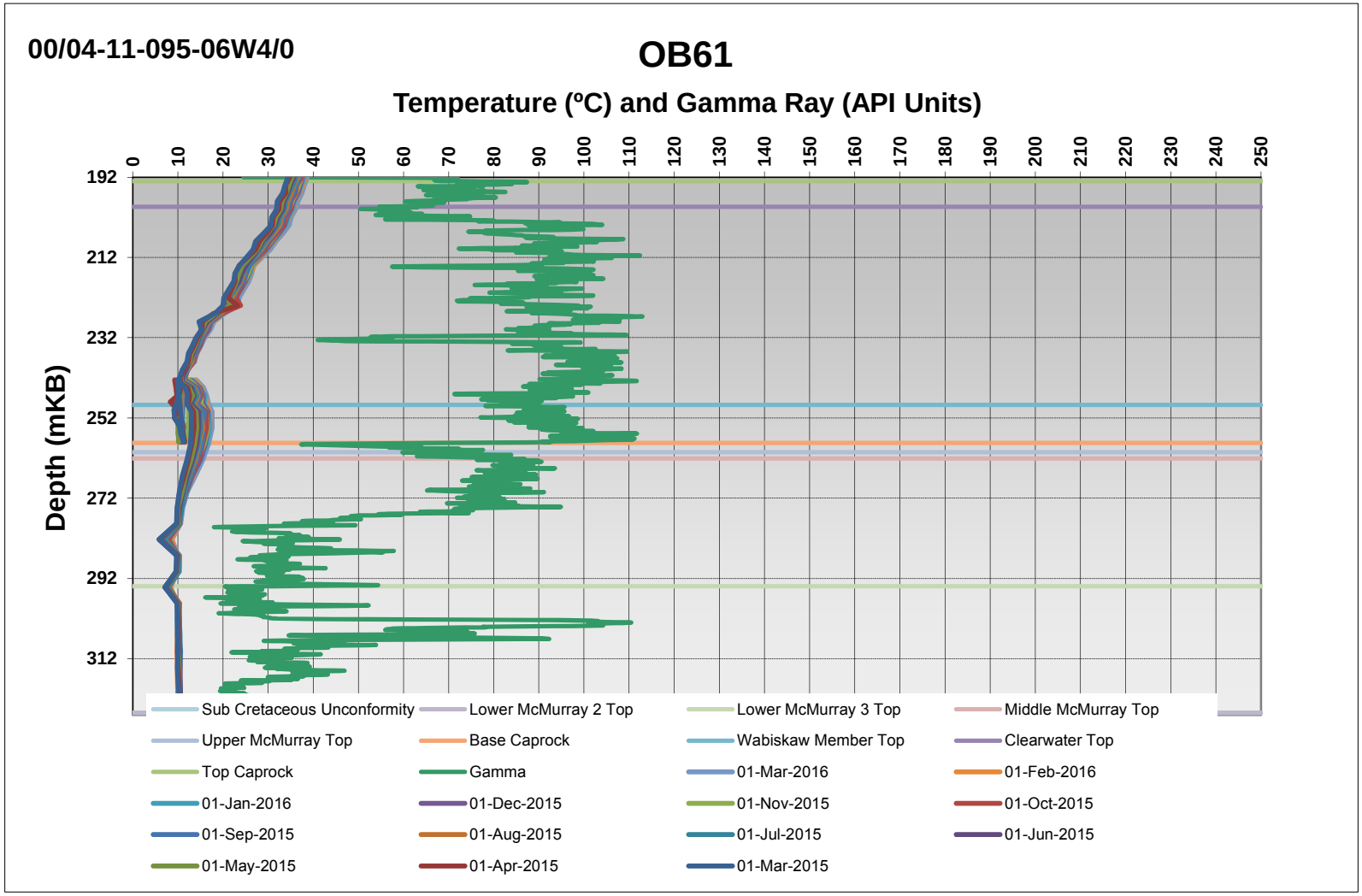

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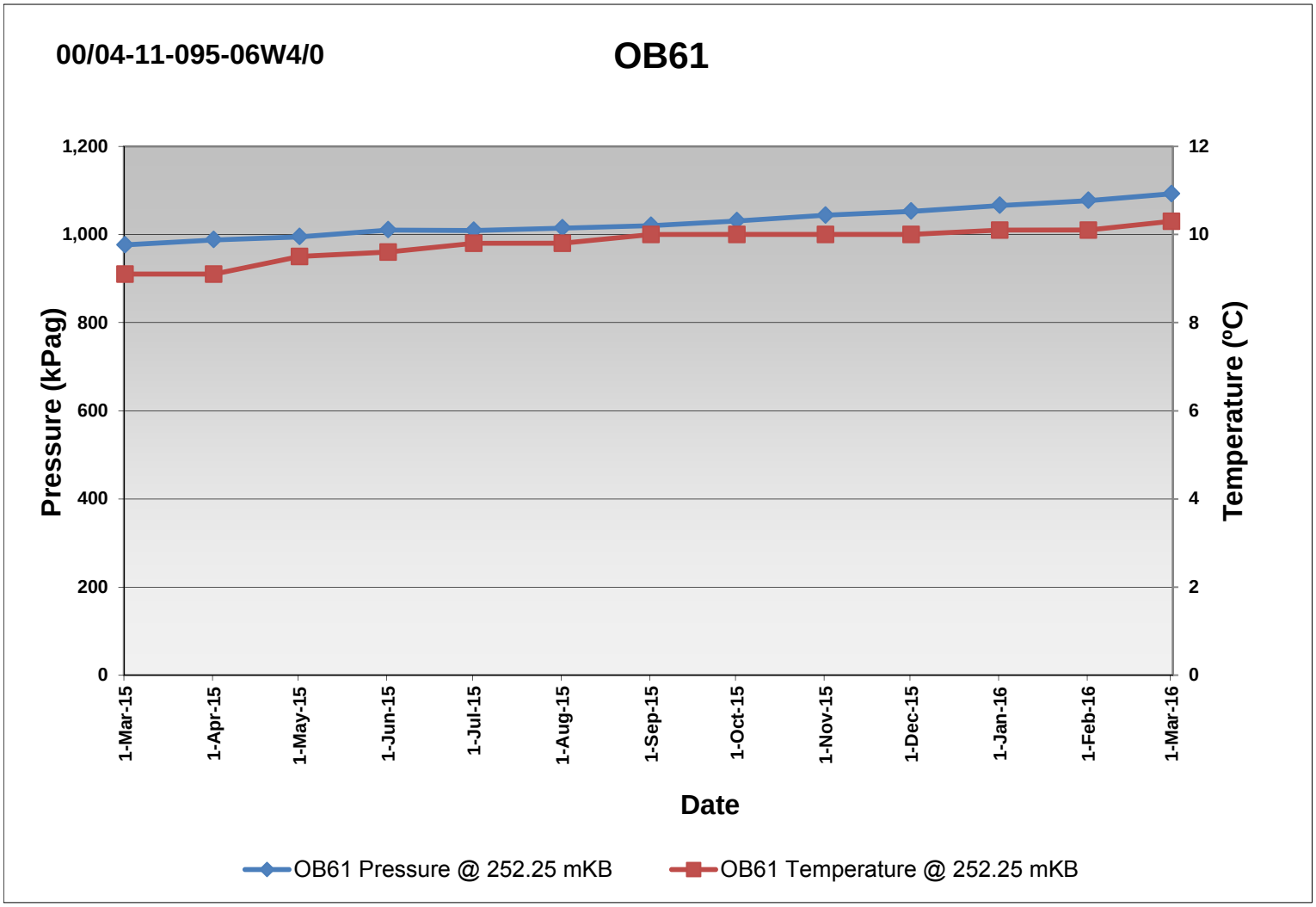

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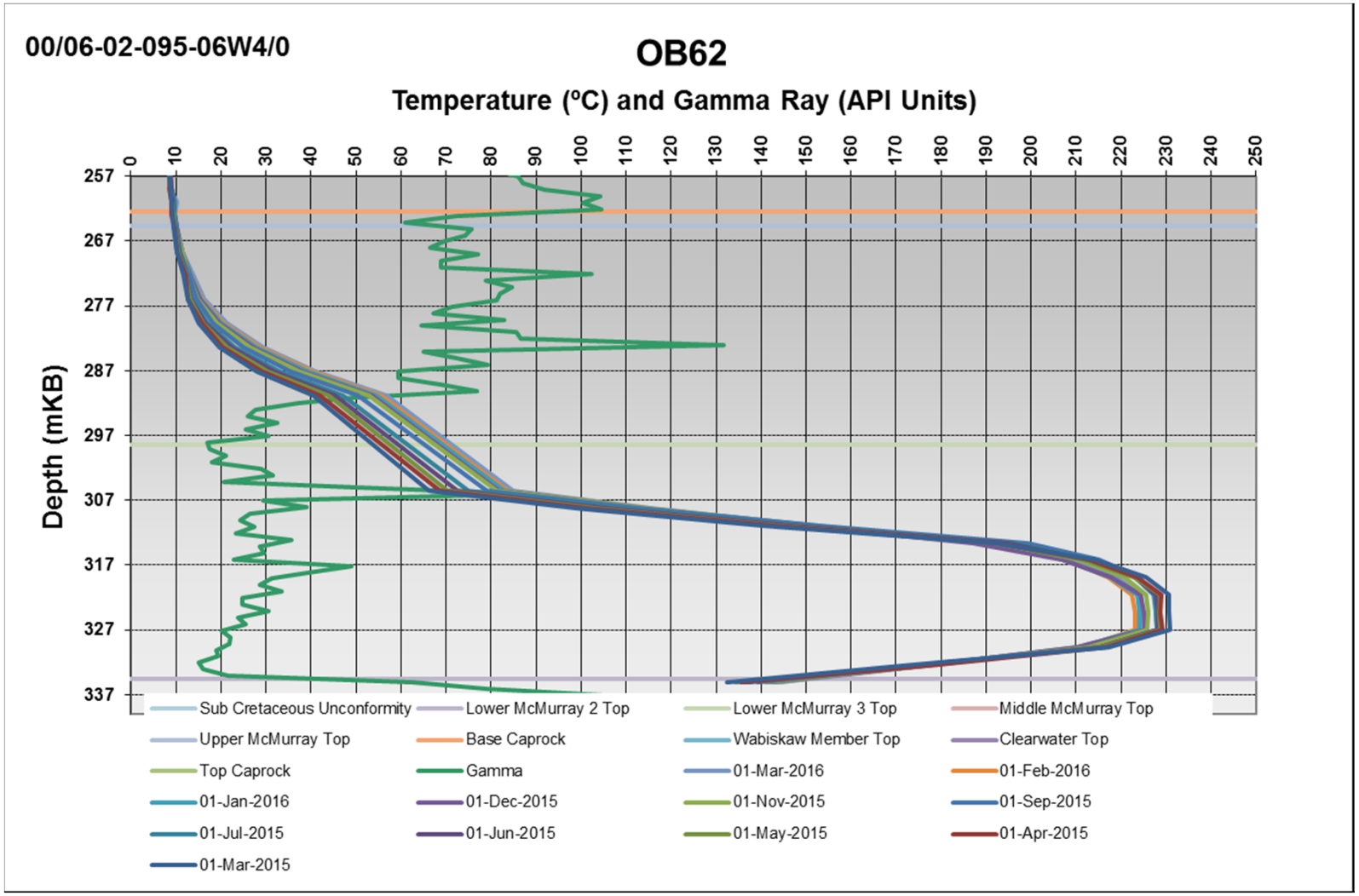
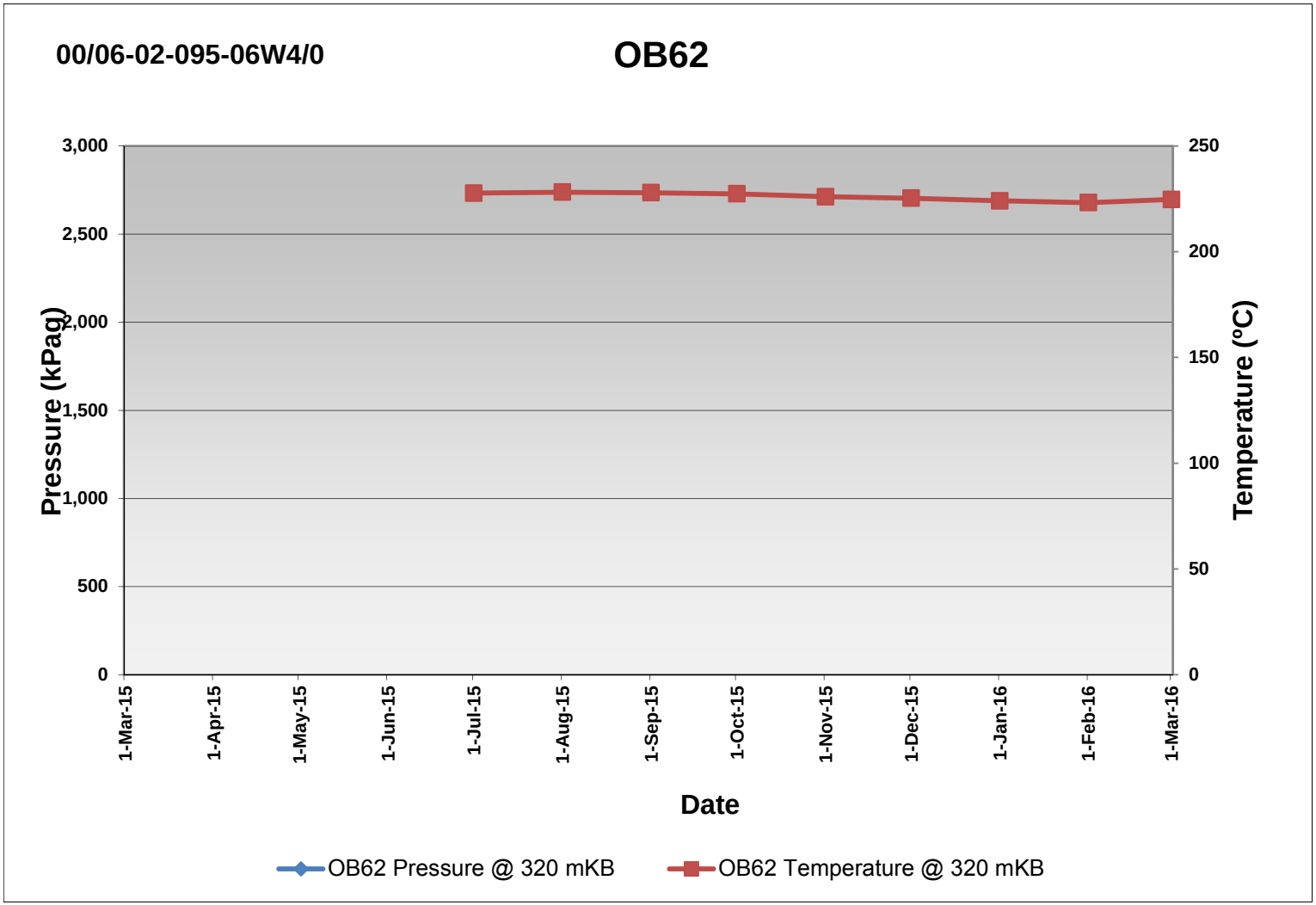


Piezometer Plots & Temperature vs Depth Plots



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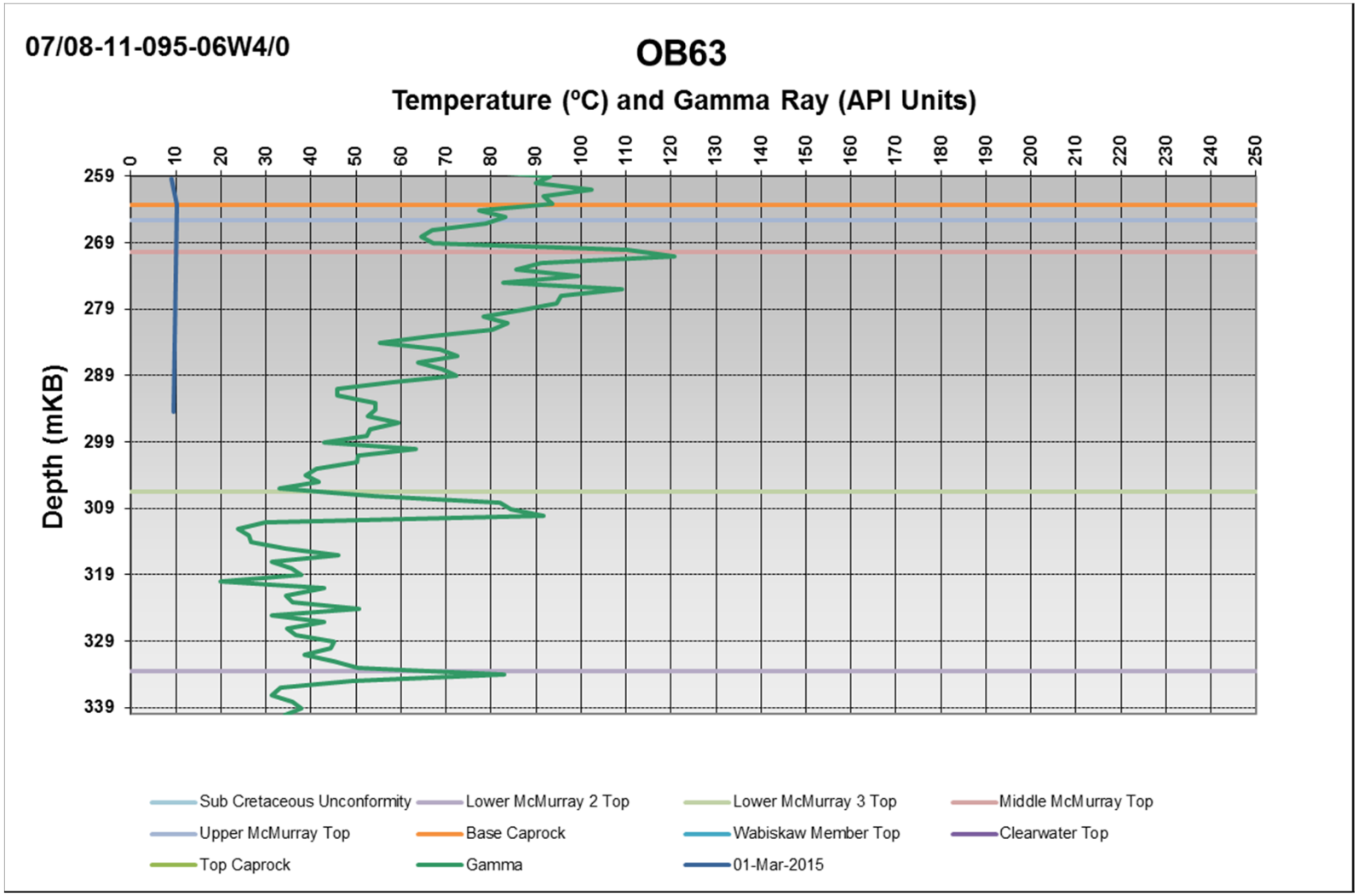

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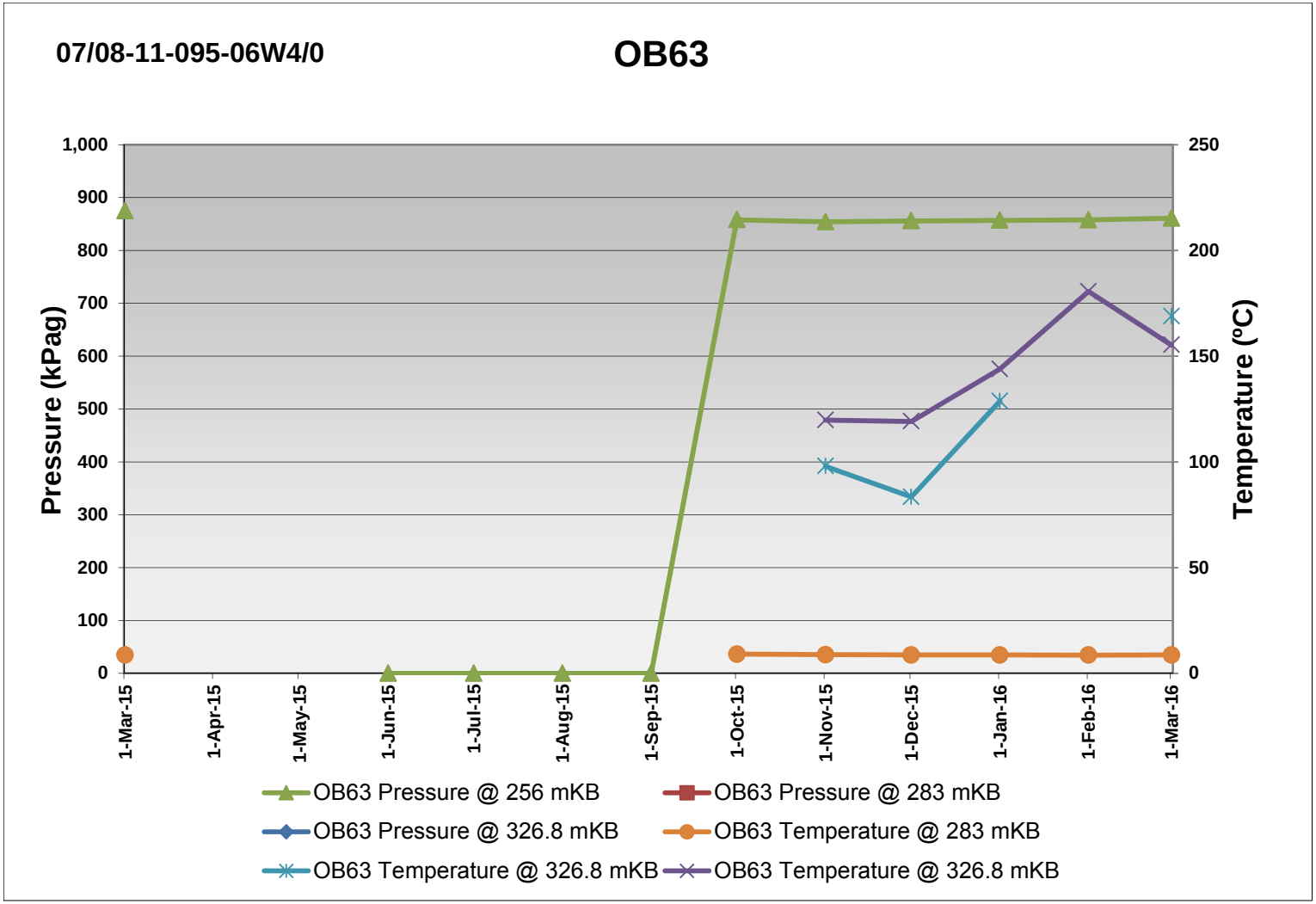

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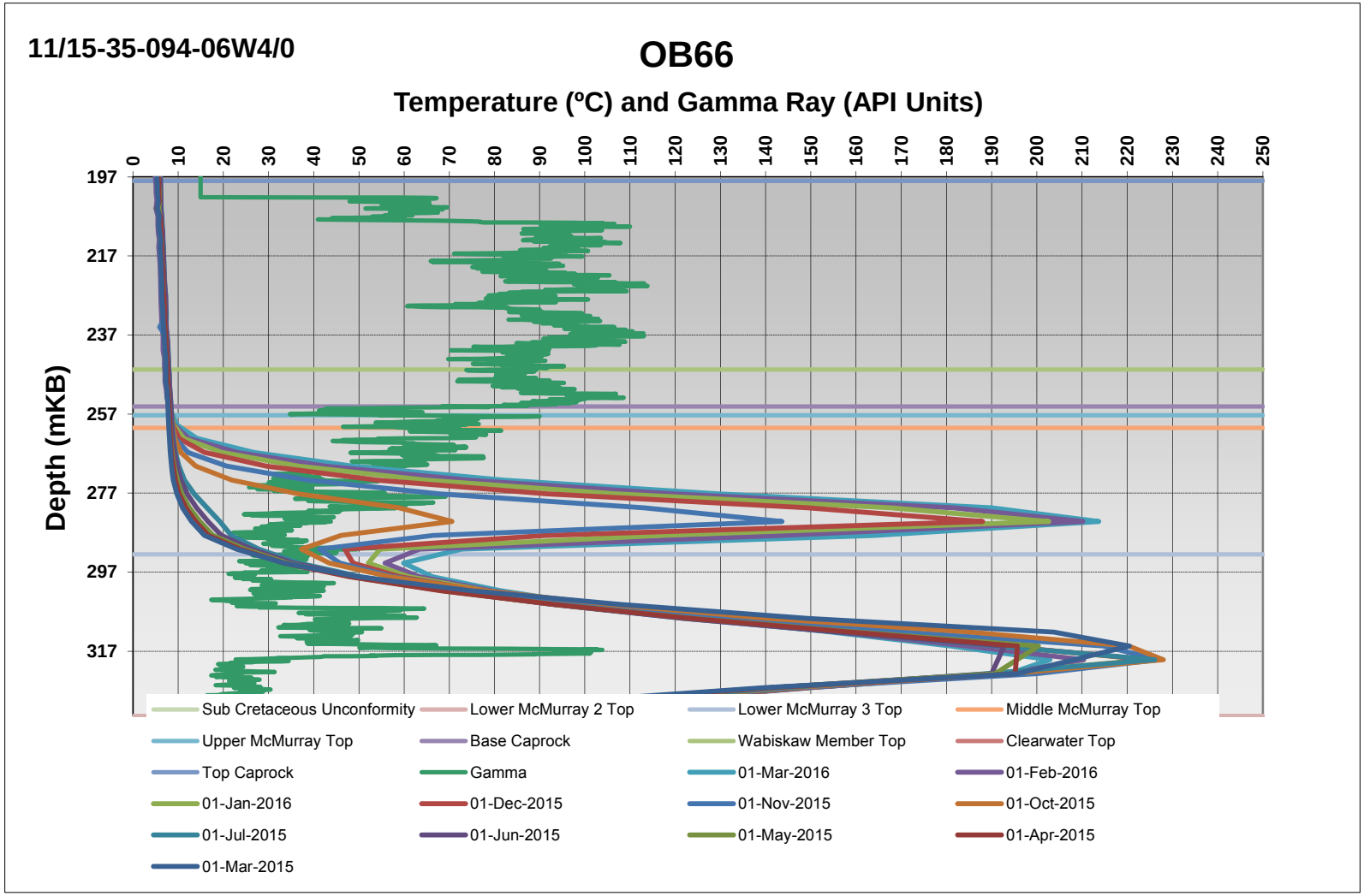

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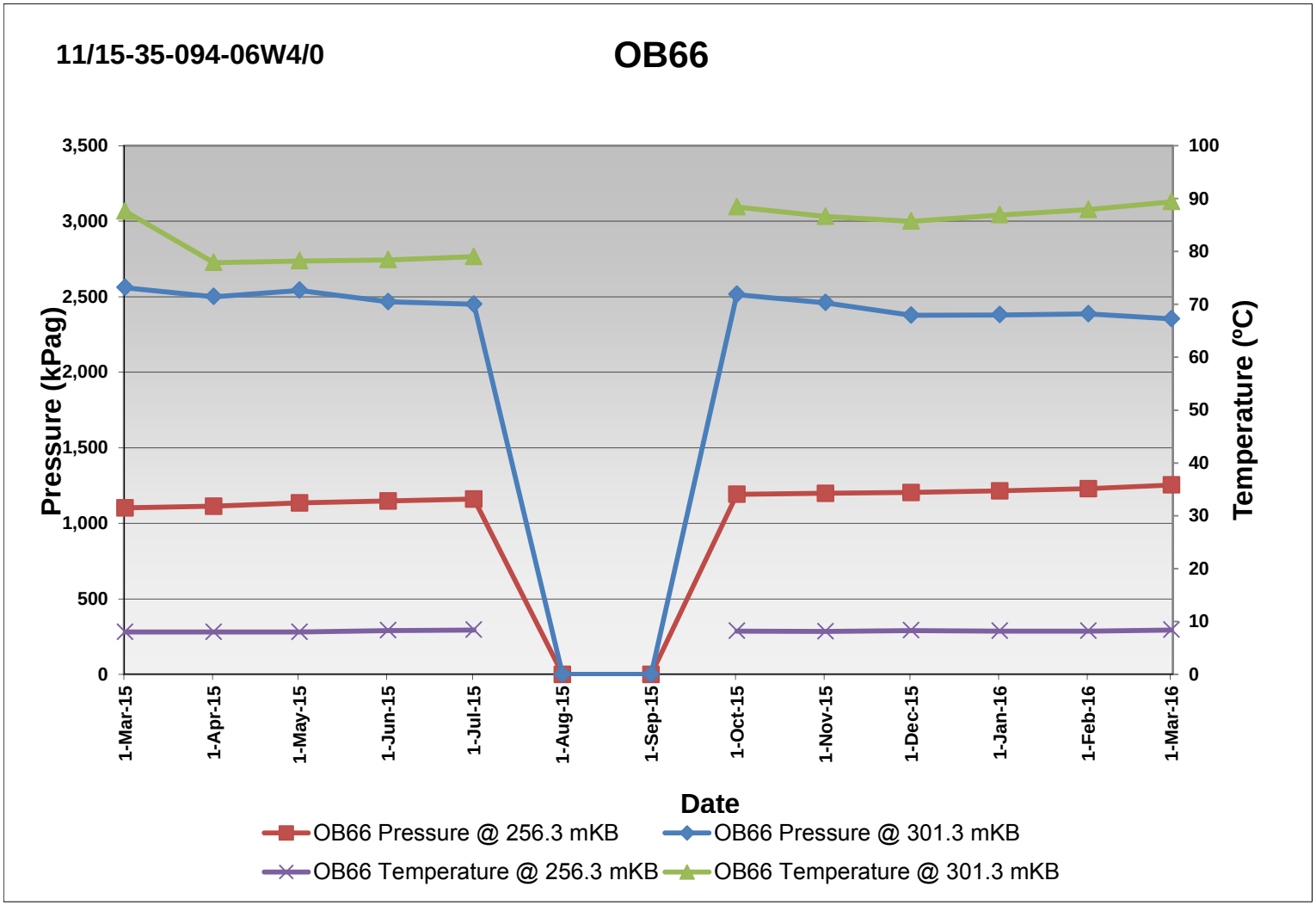

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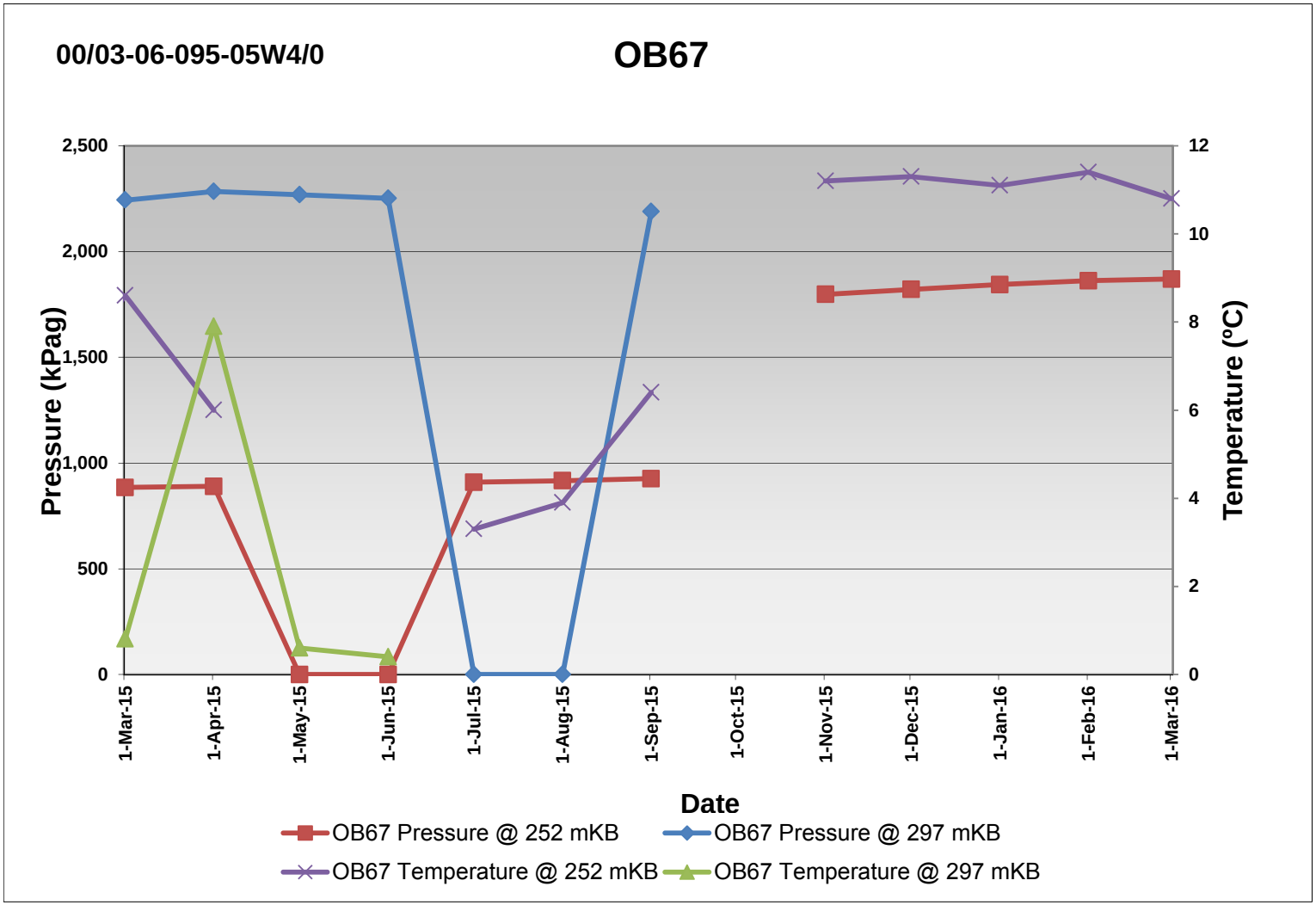

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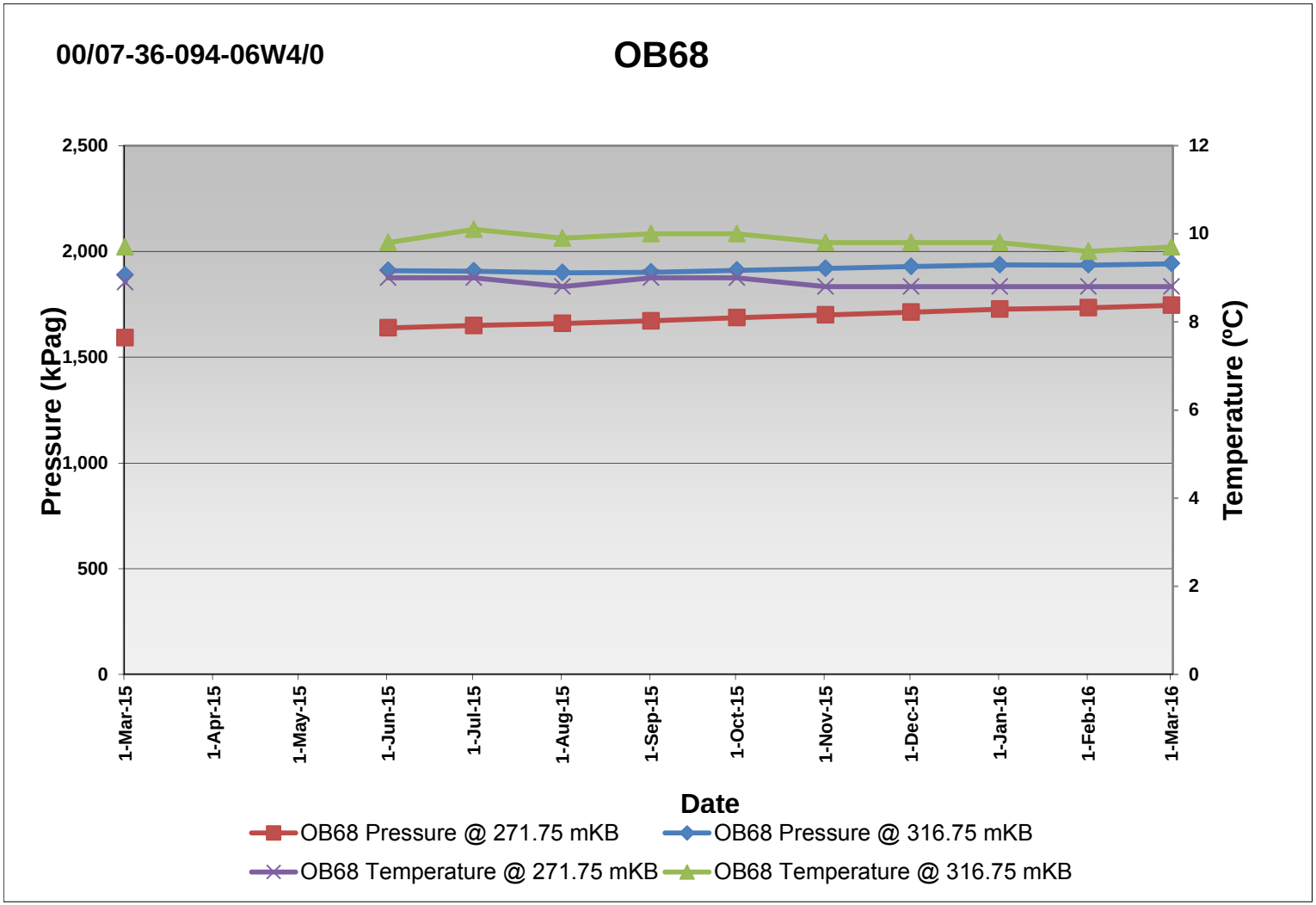

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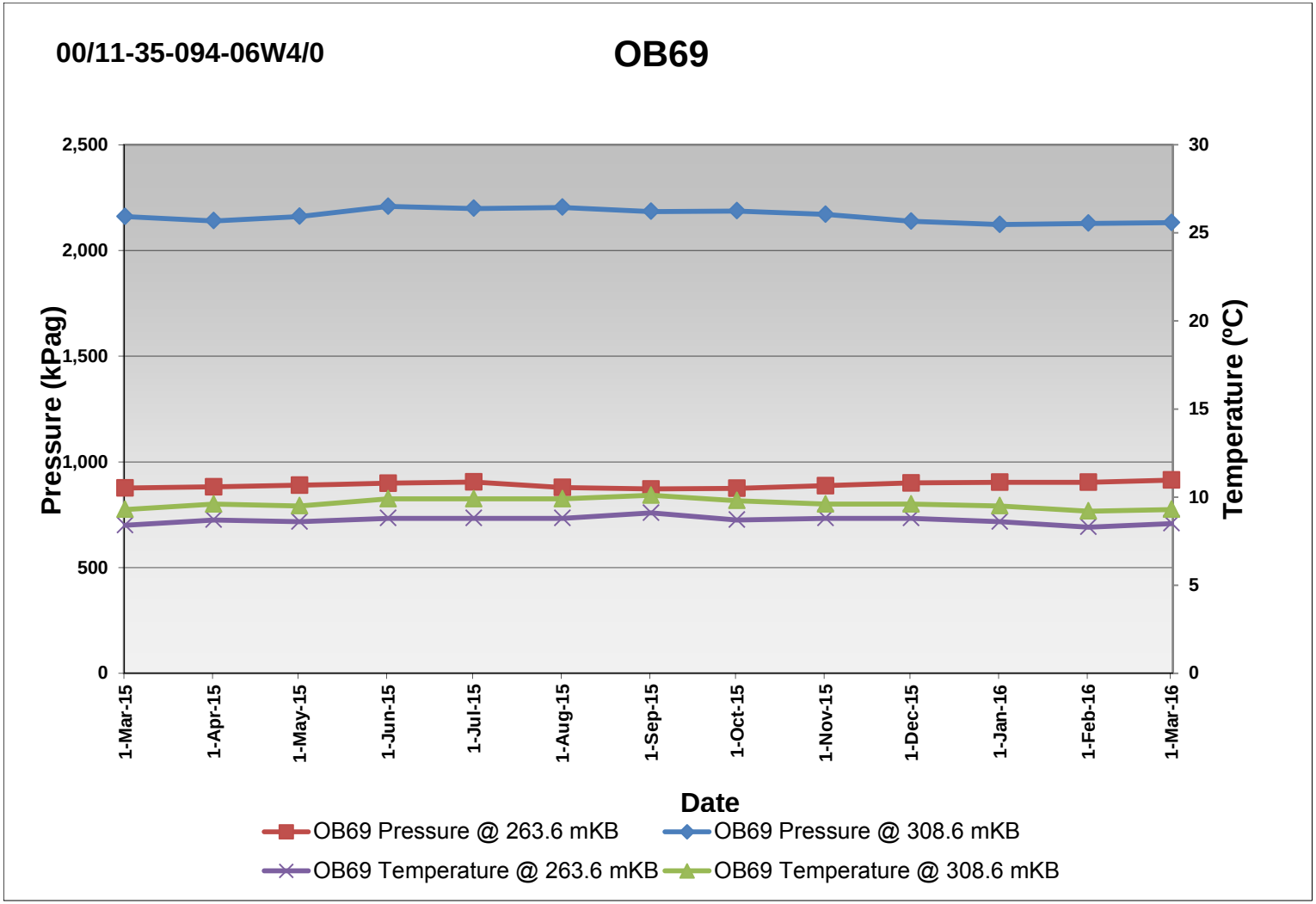

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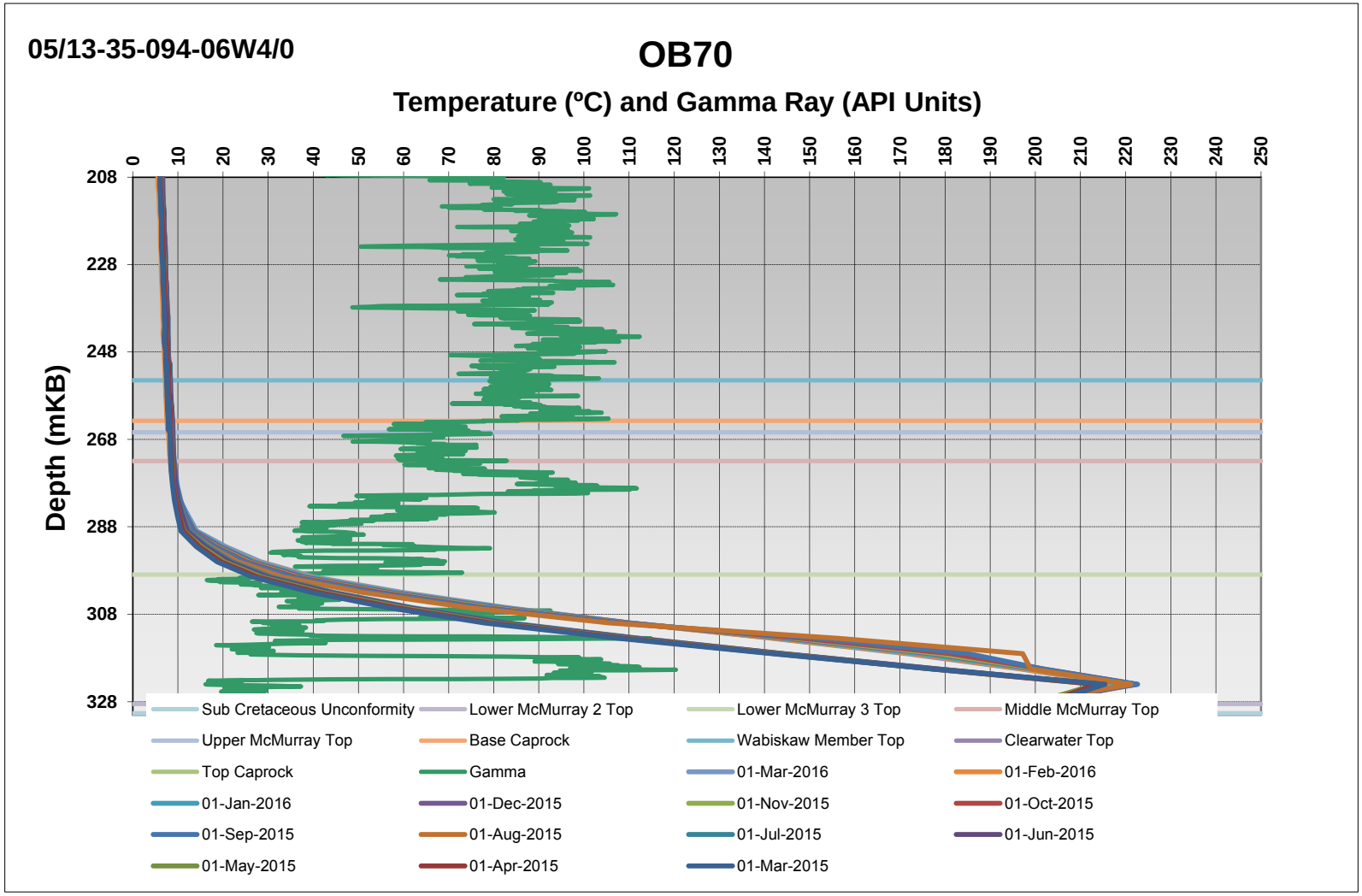

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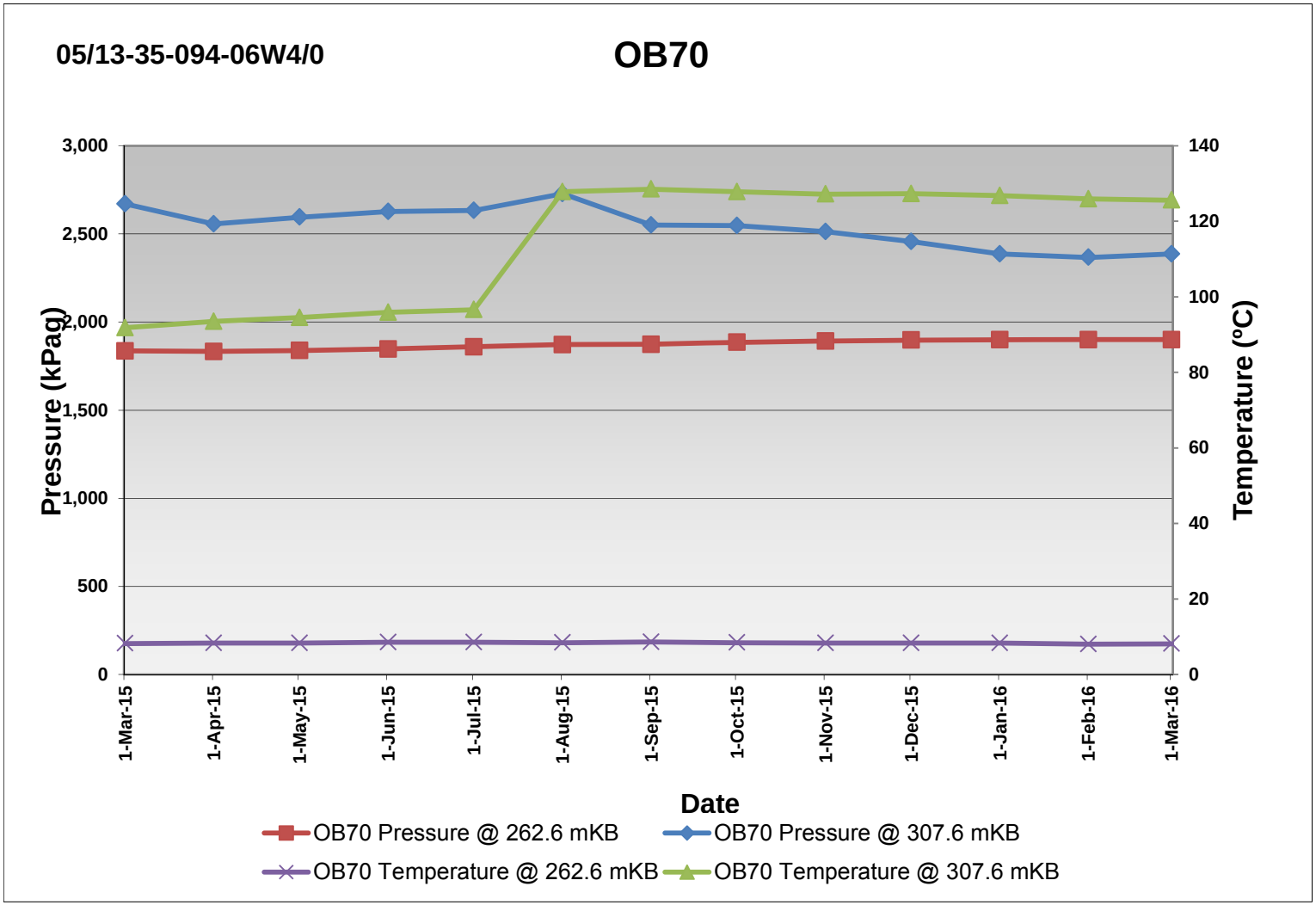

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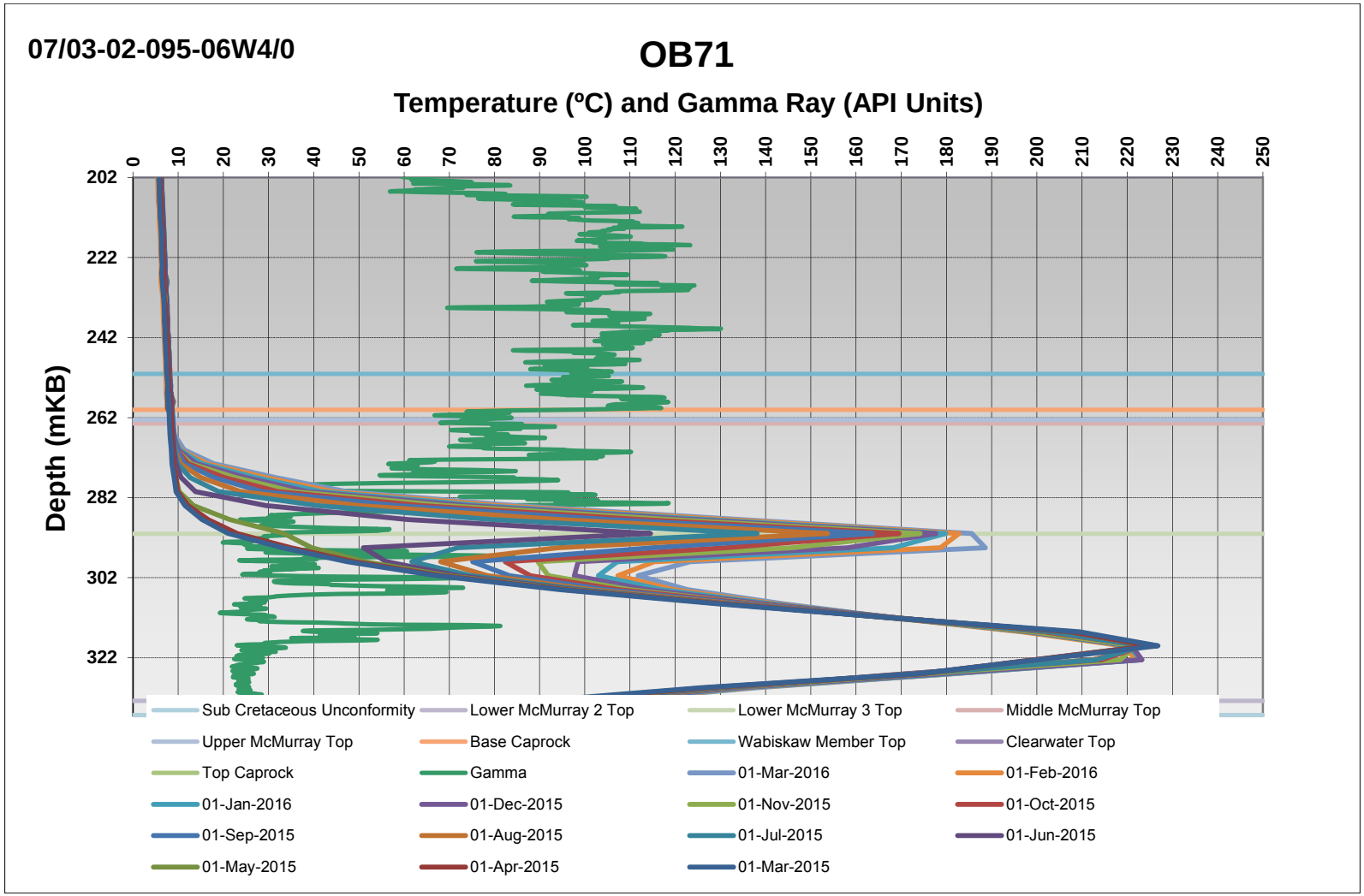

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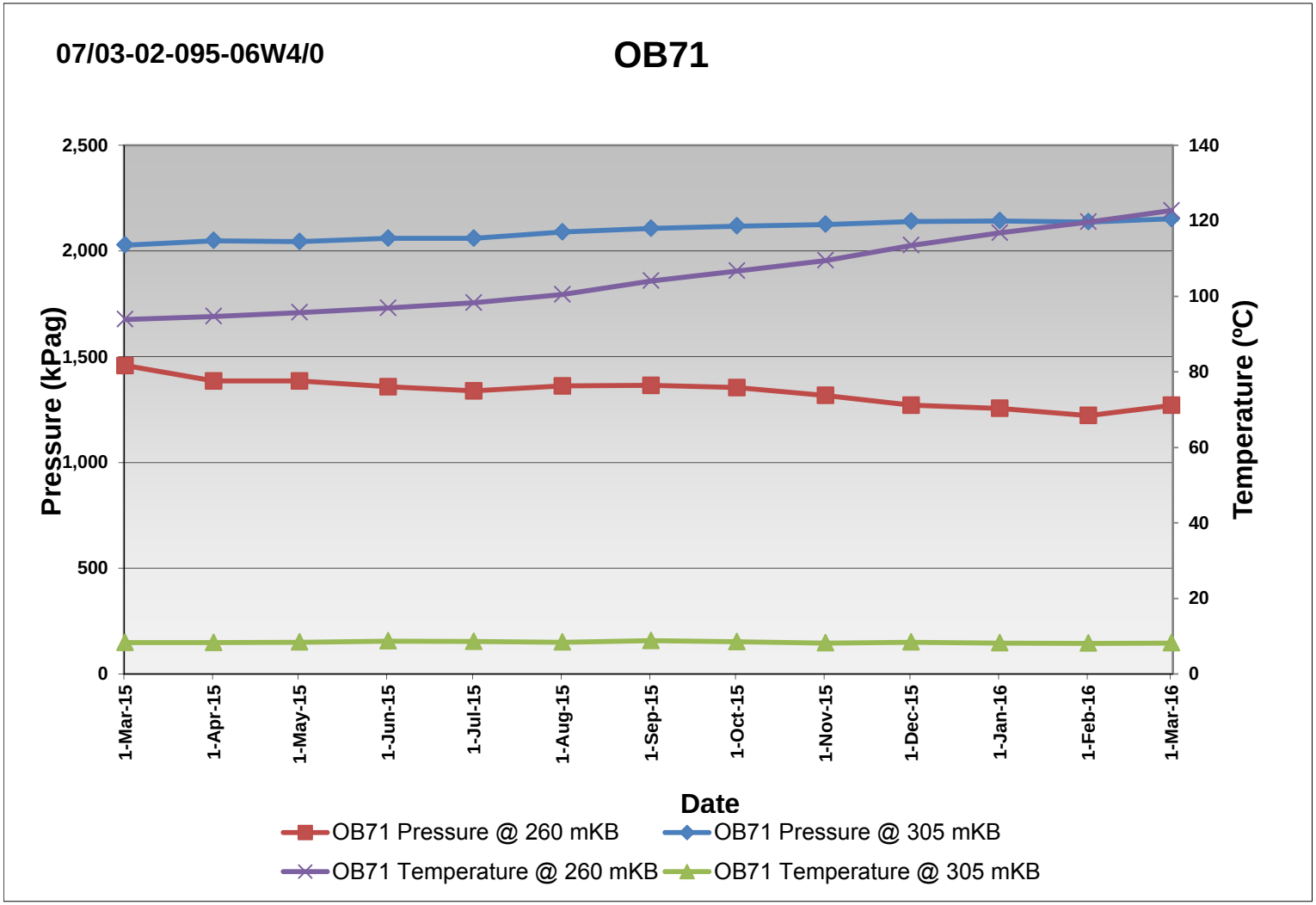

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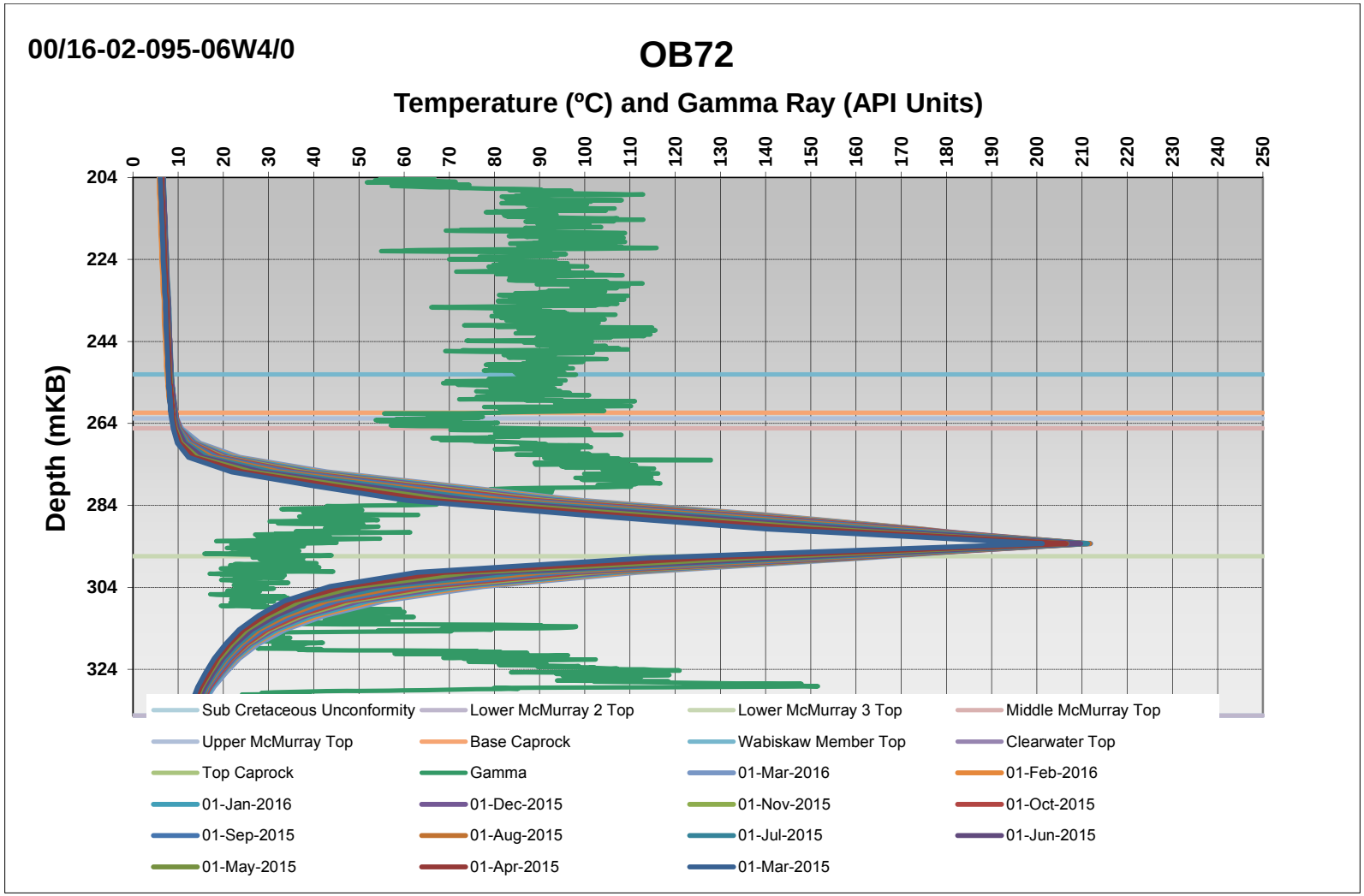

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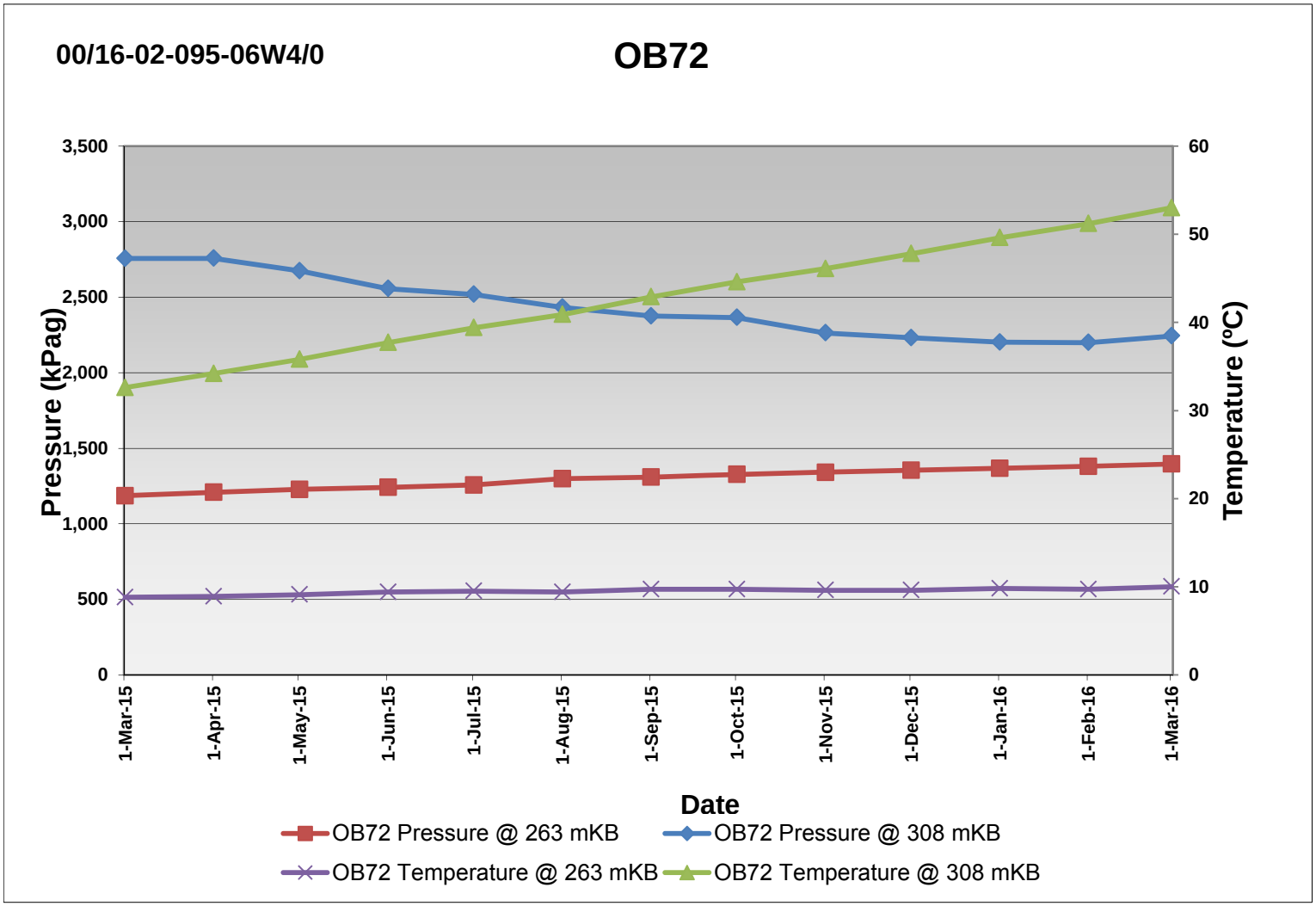

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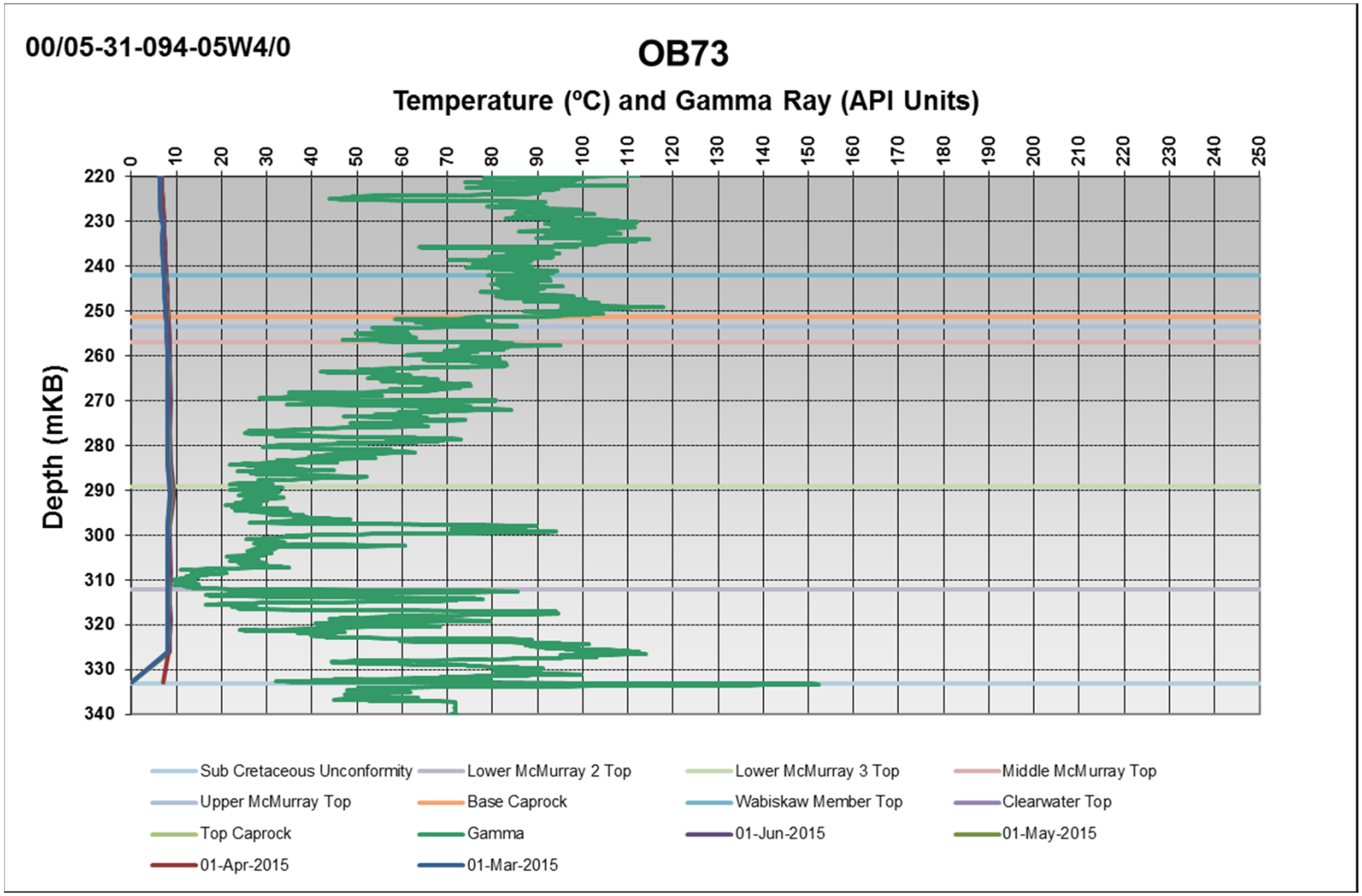

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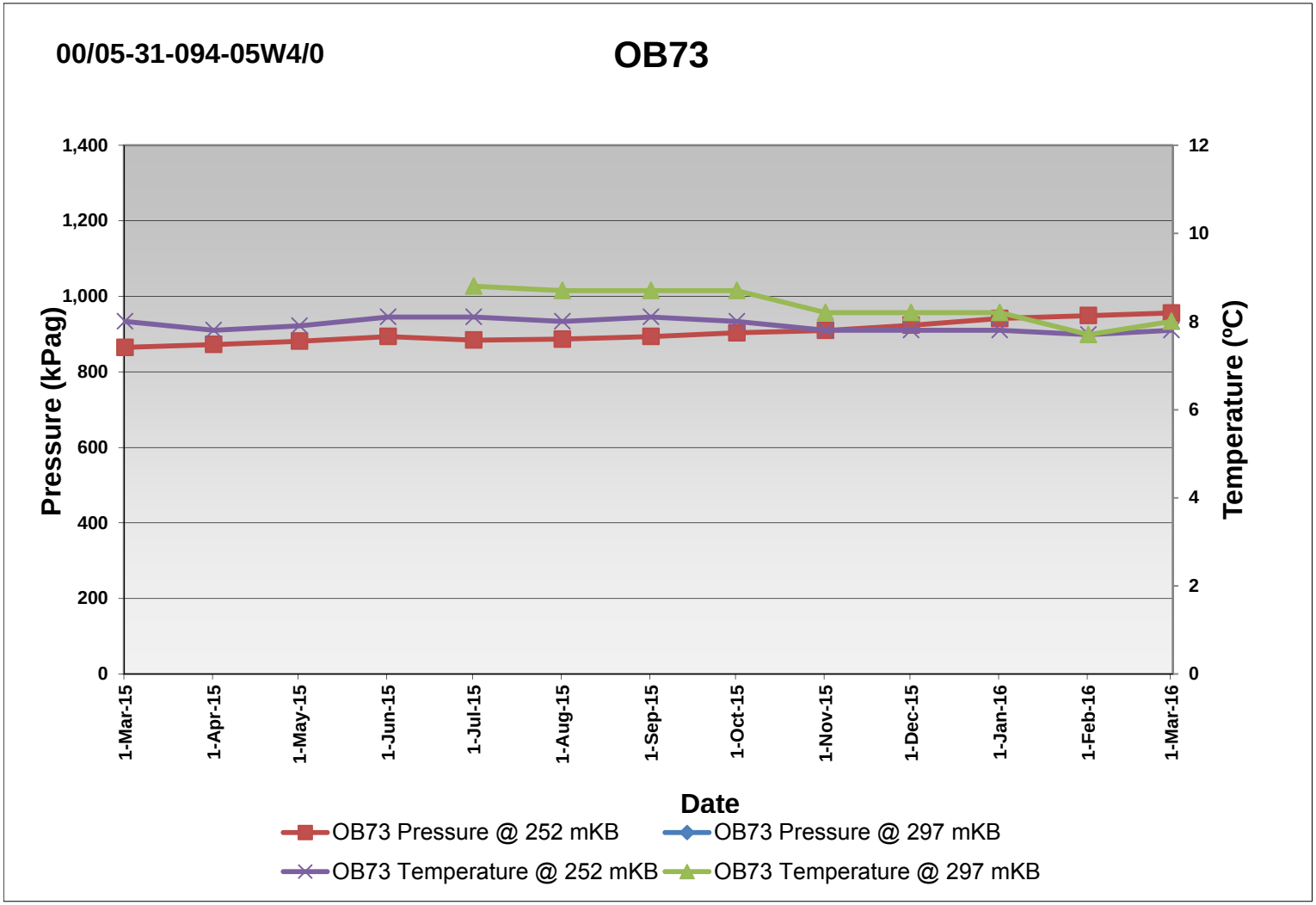

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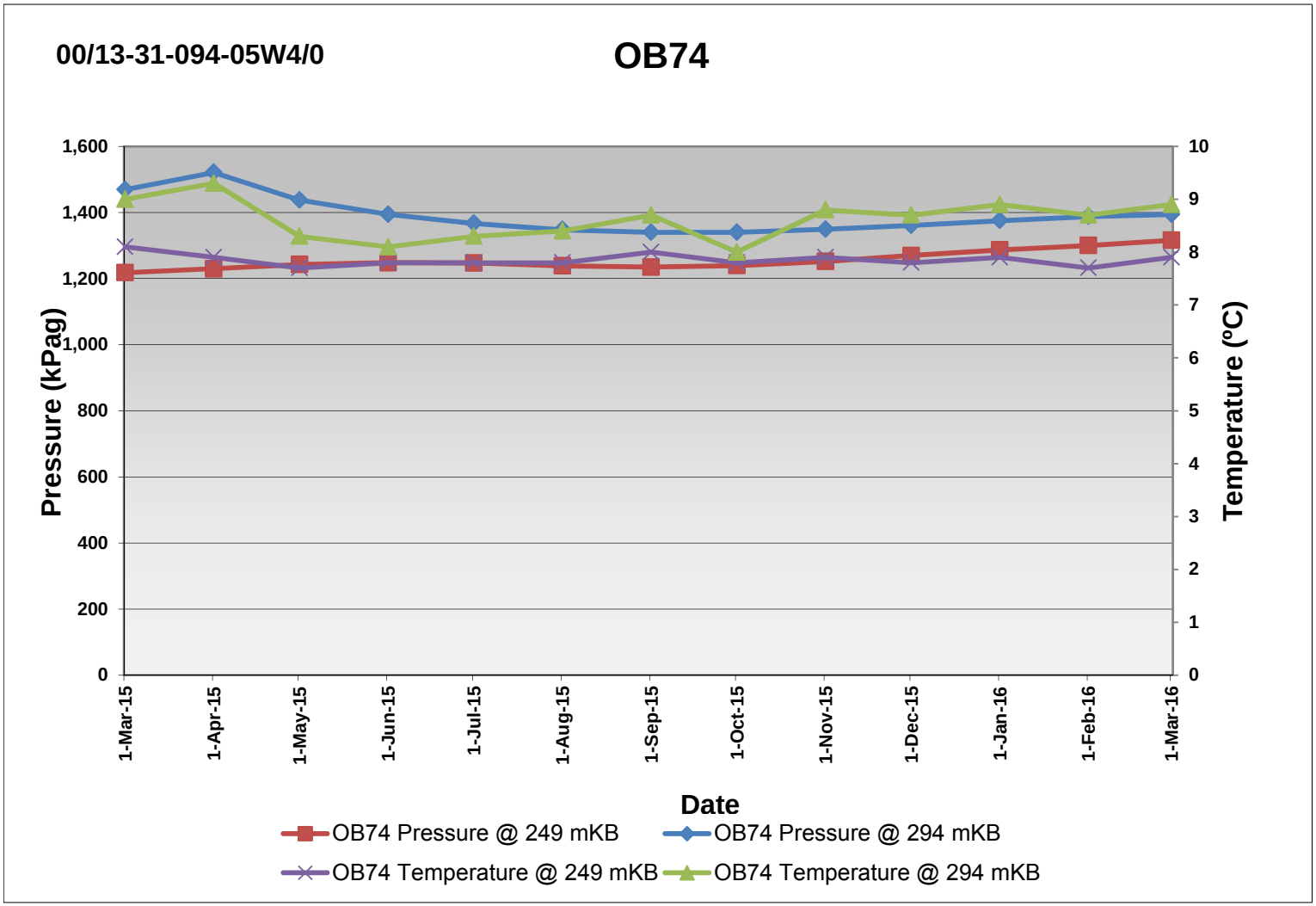

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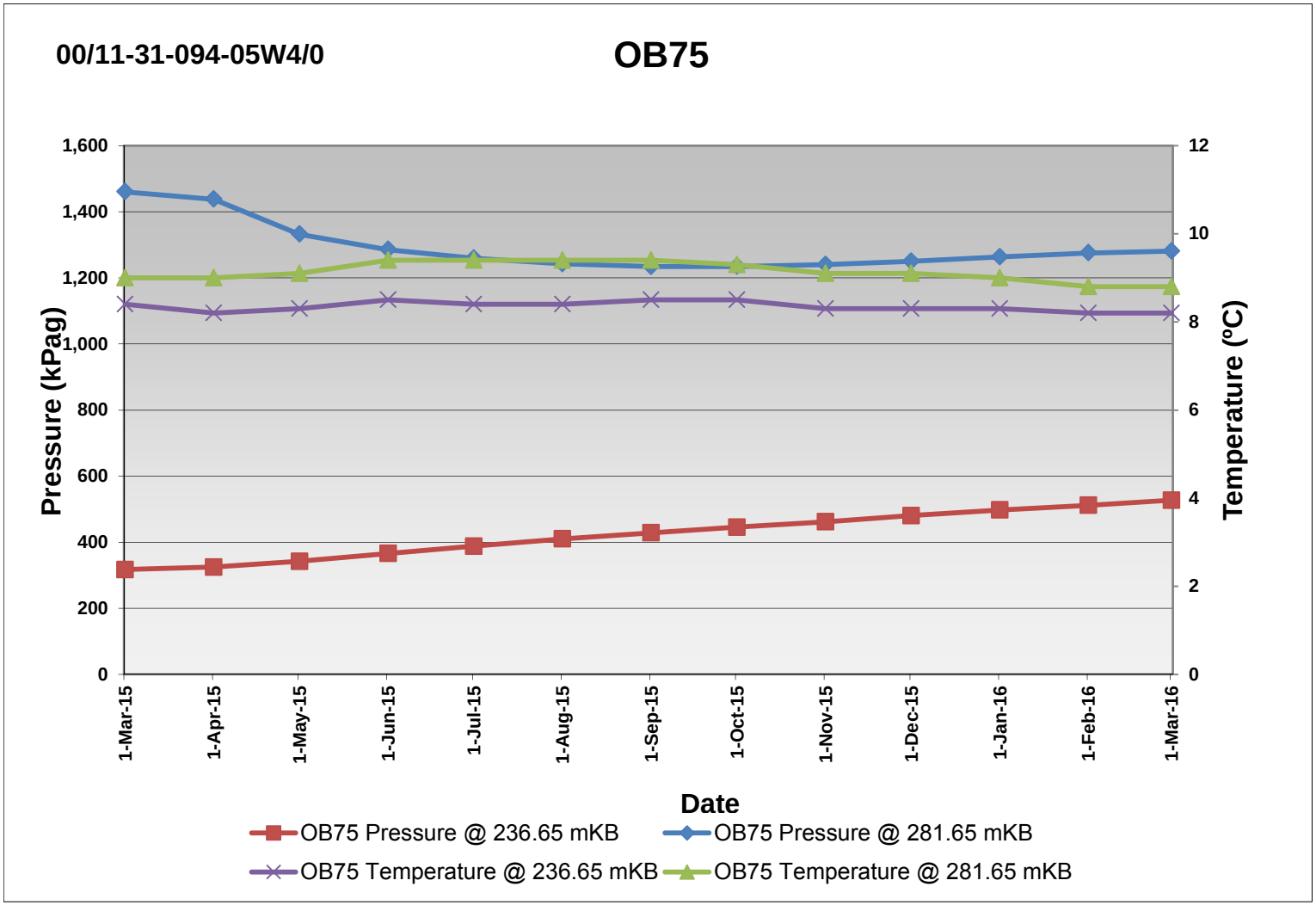

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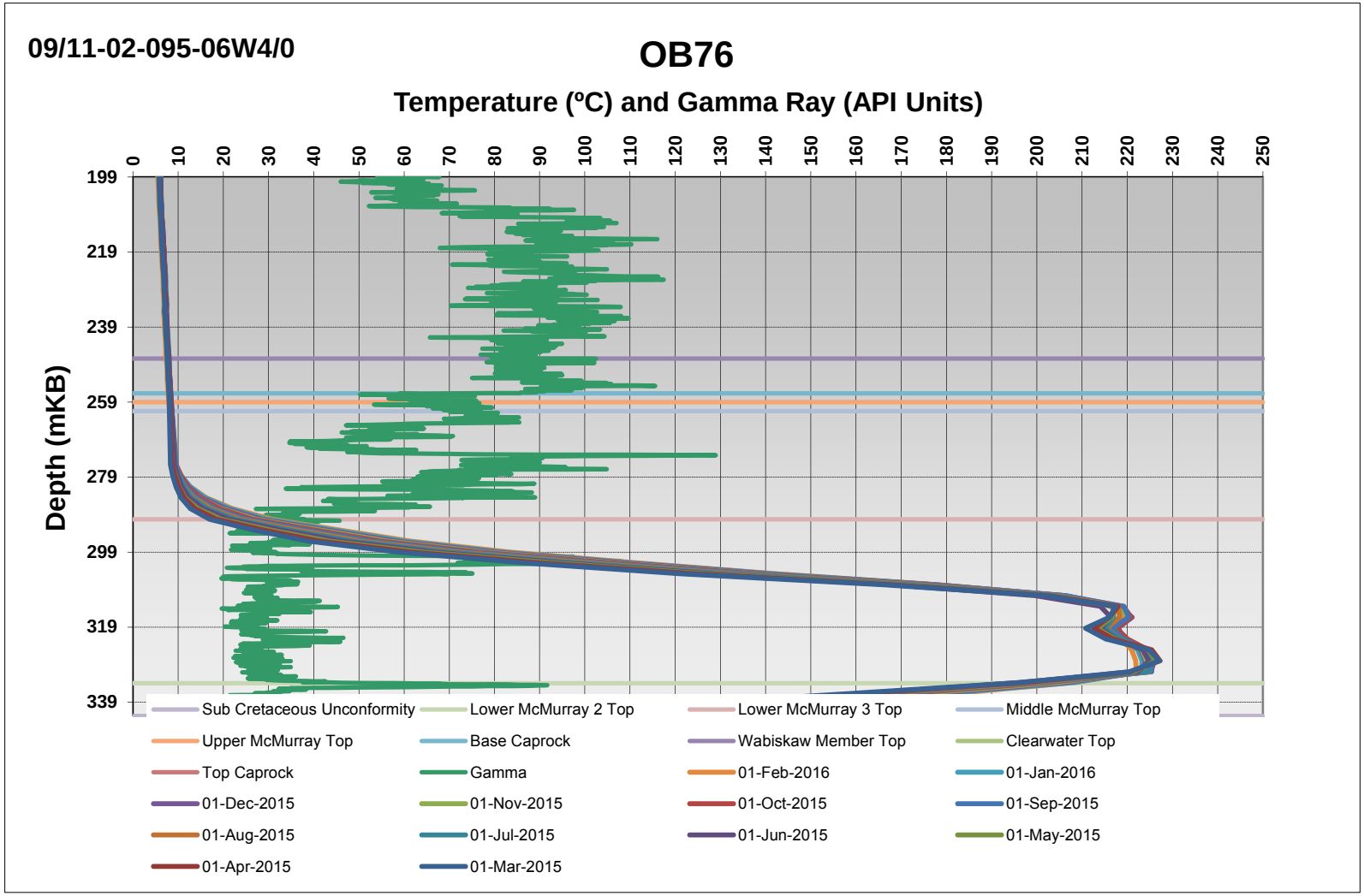

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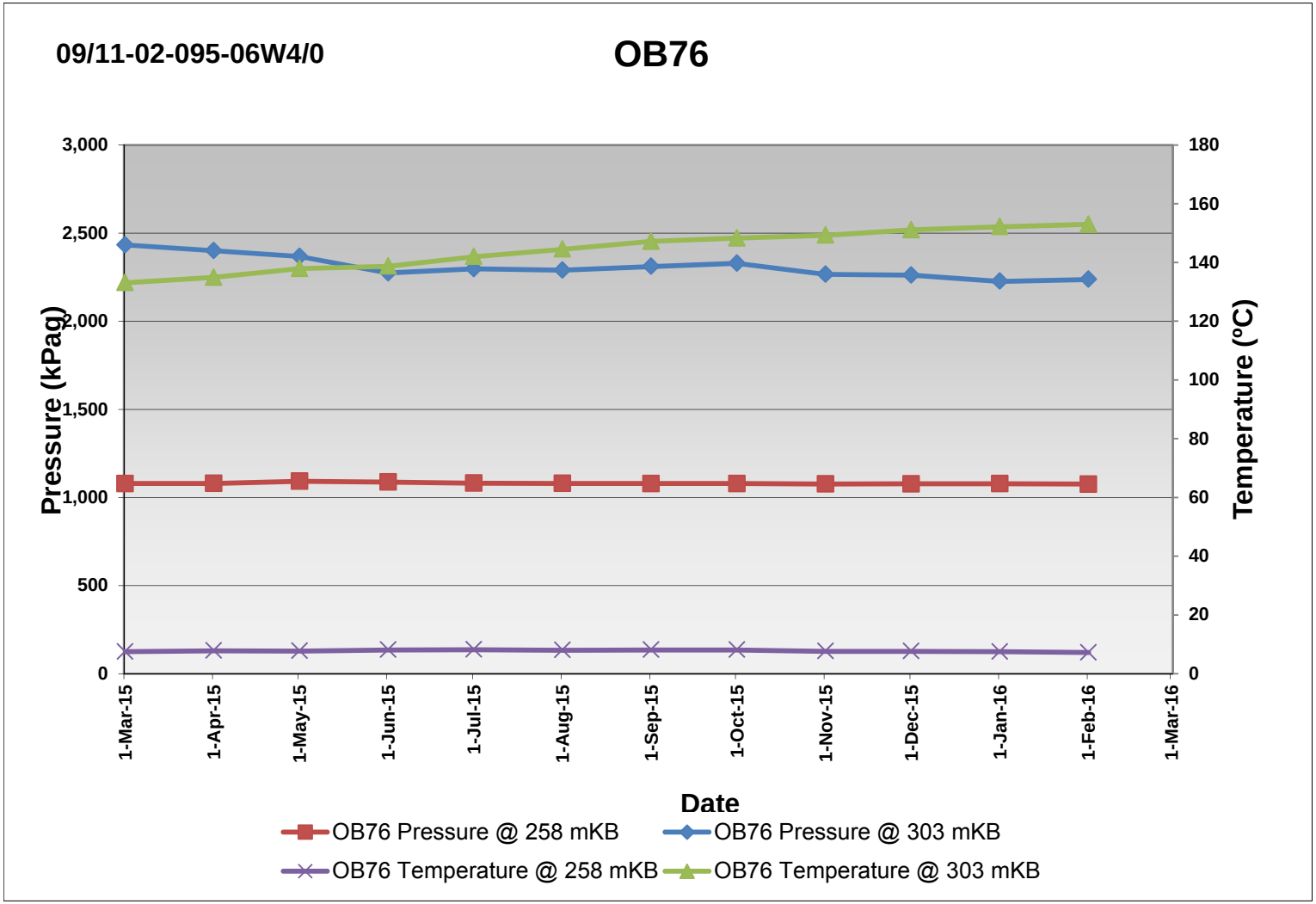

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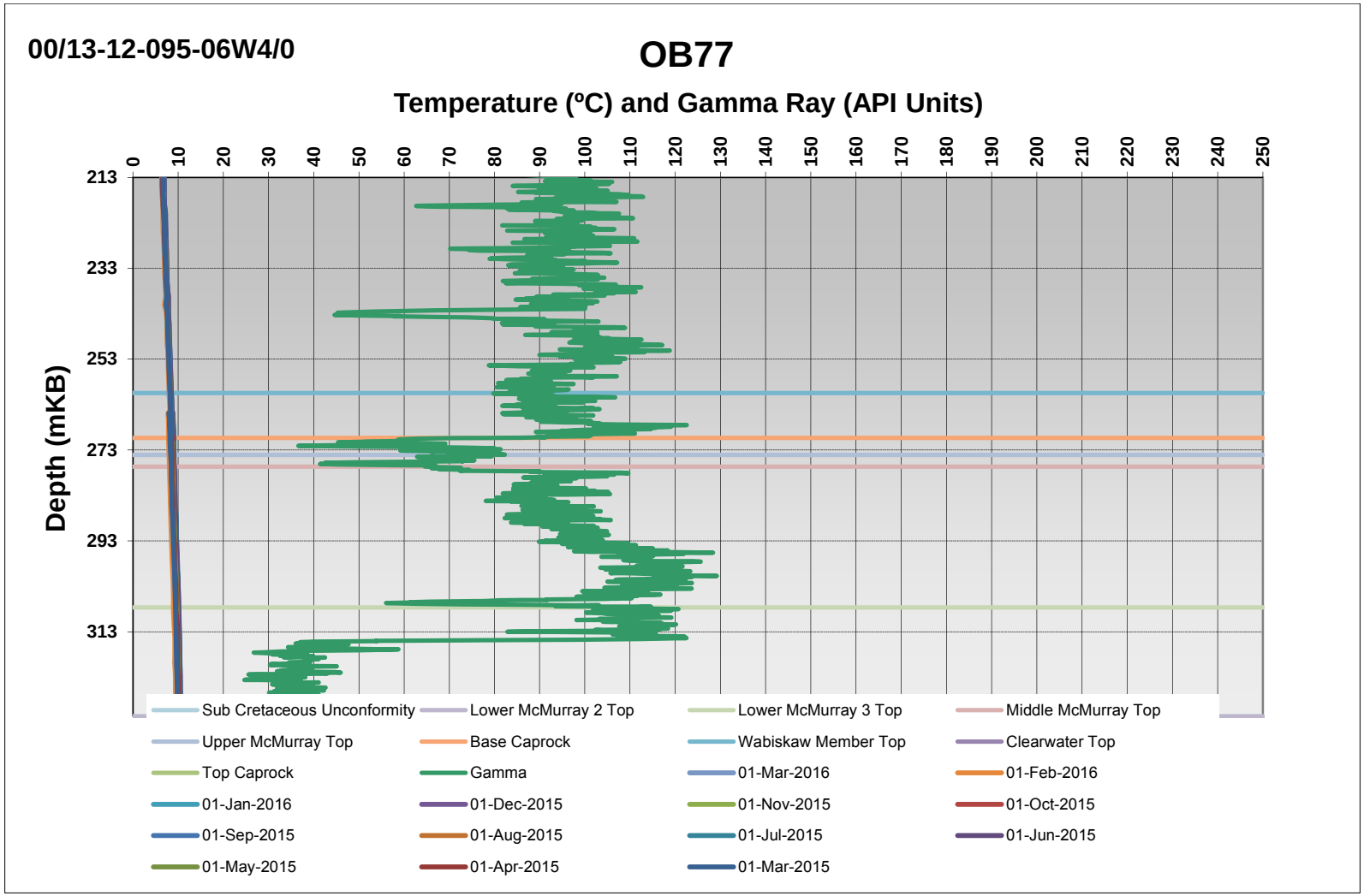

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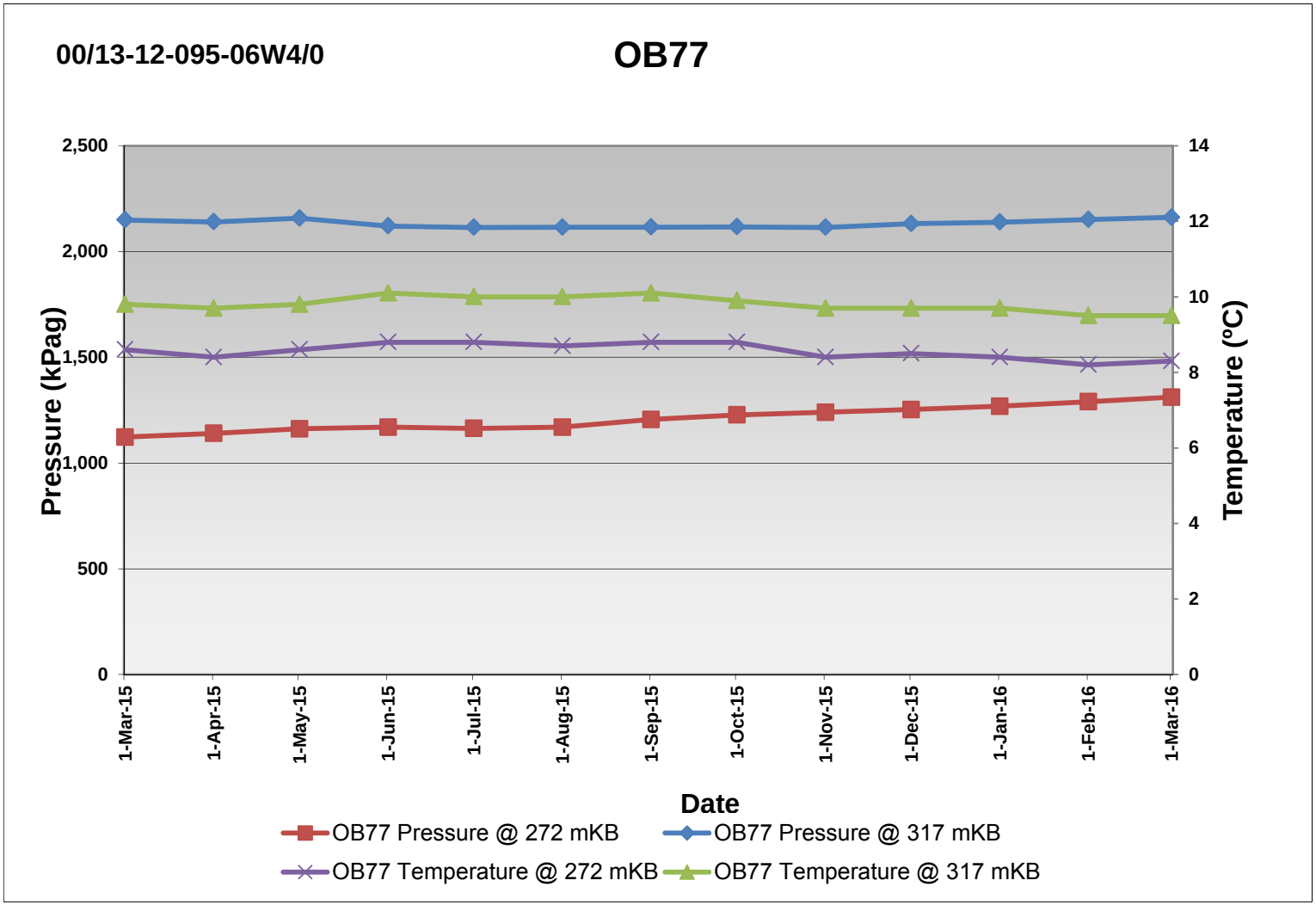

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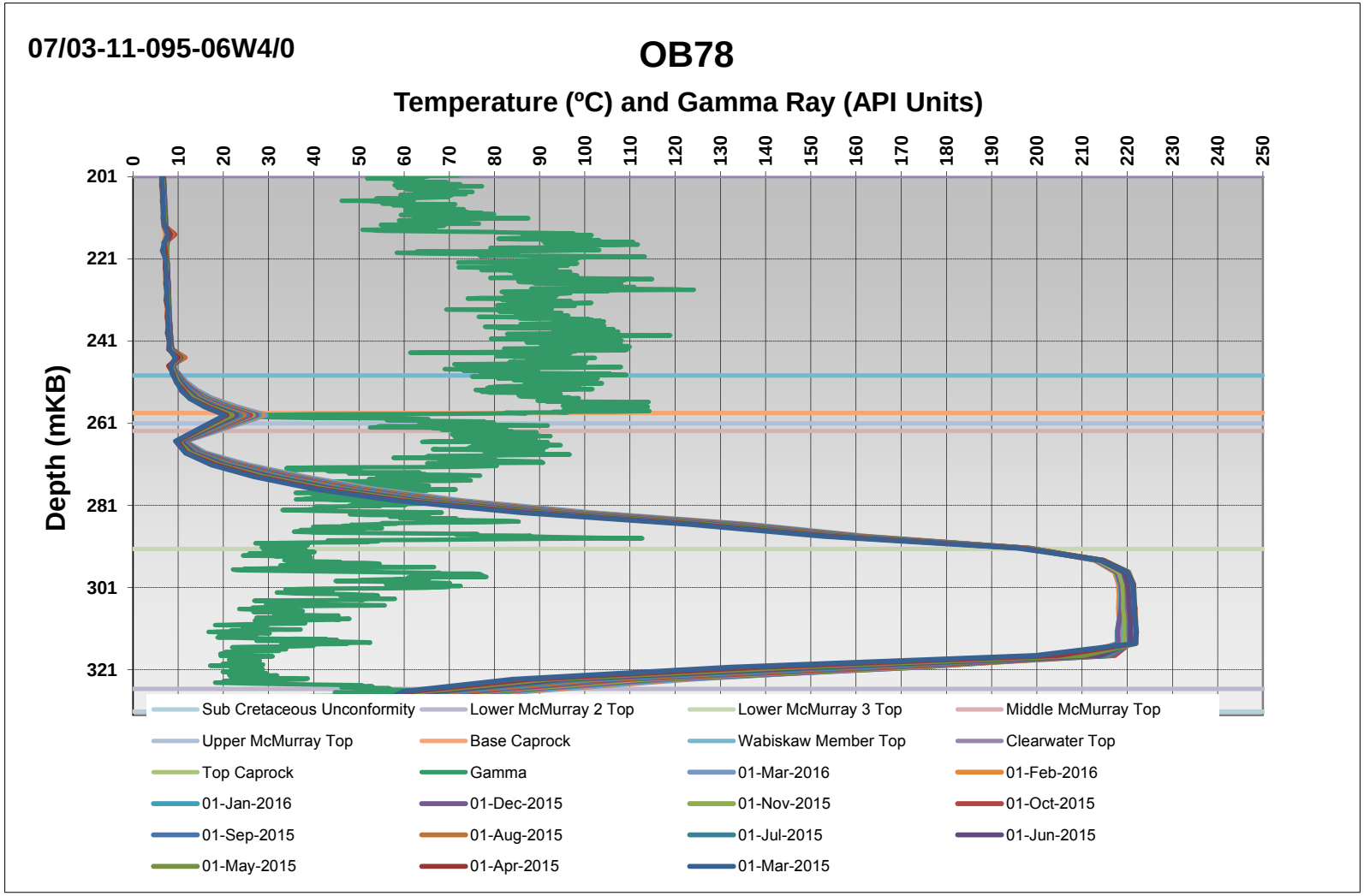

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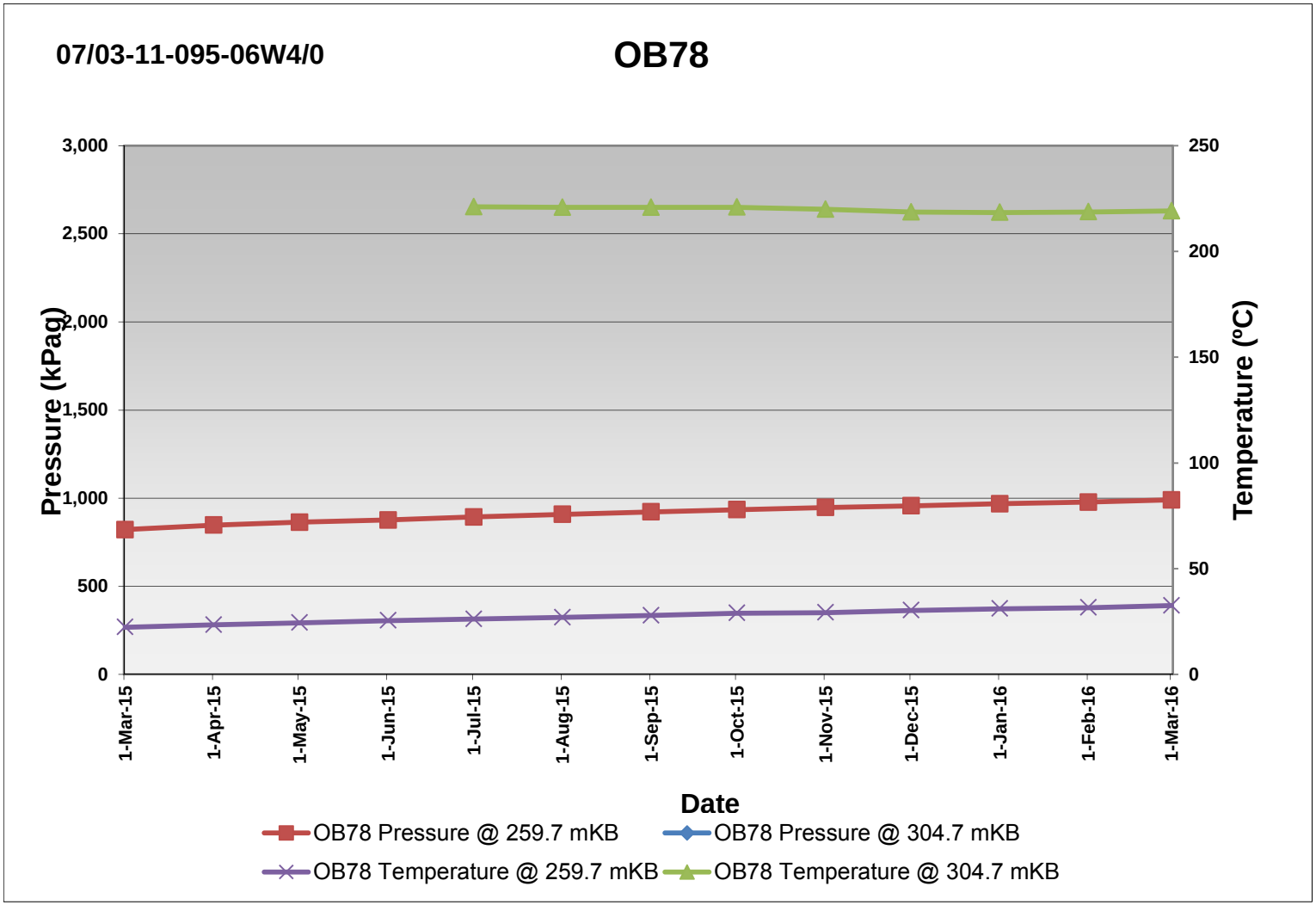

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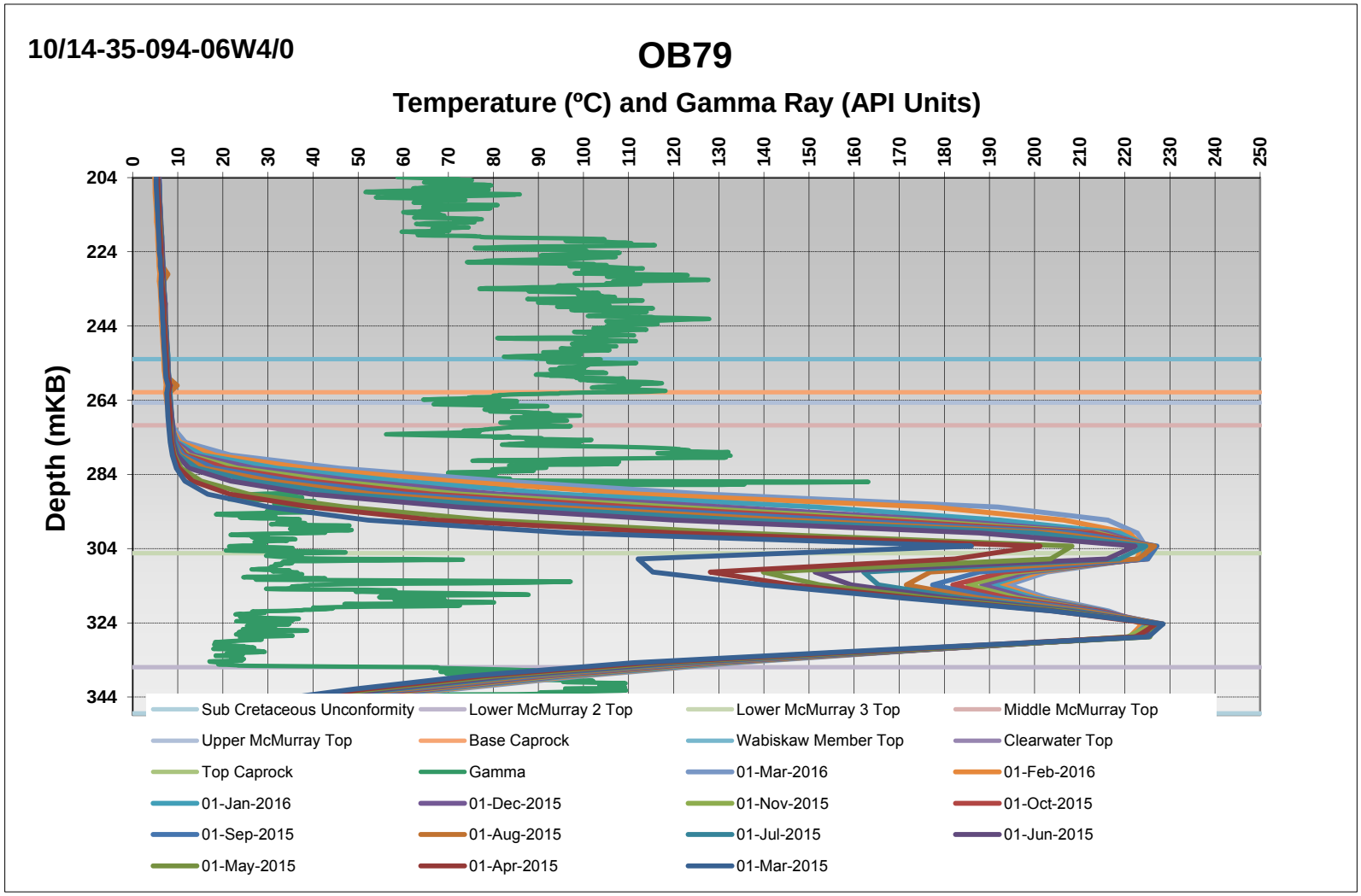

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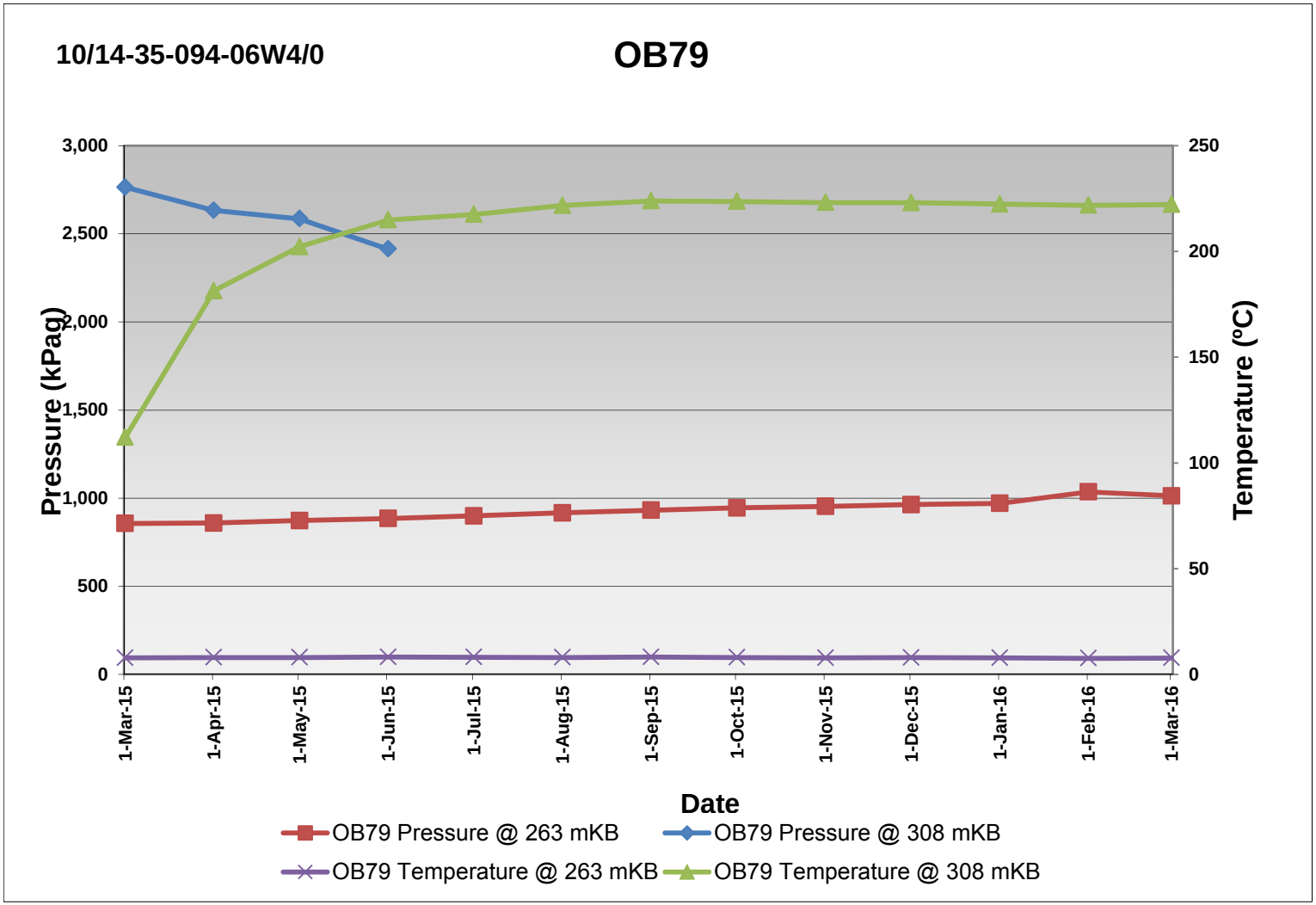

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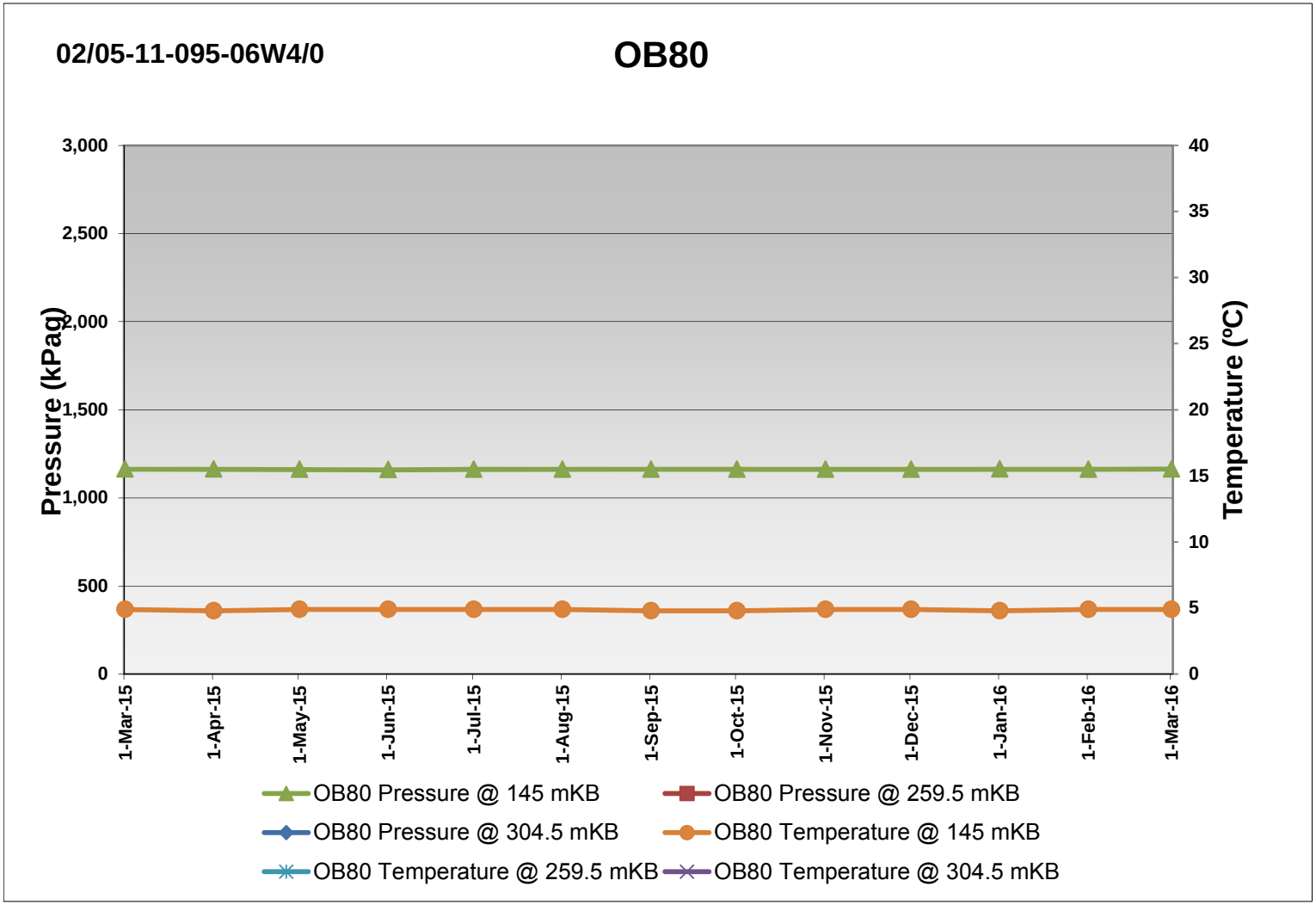

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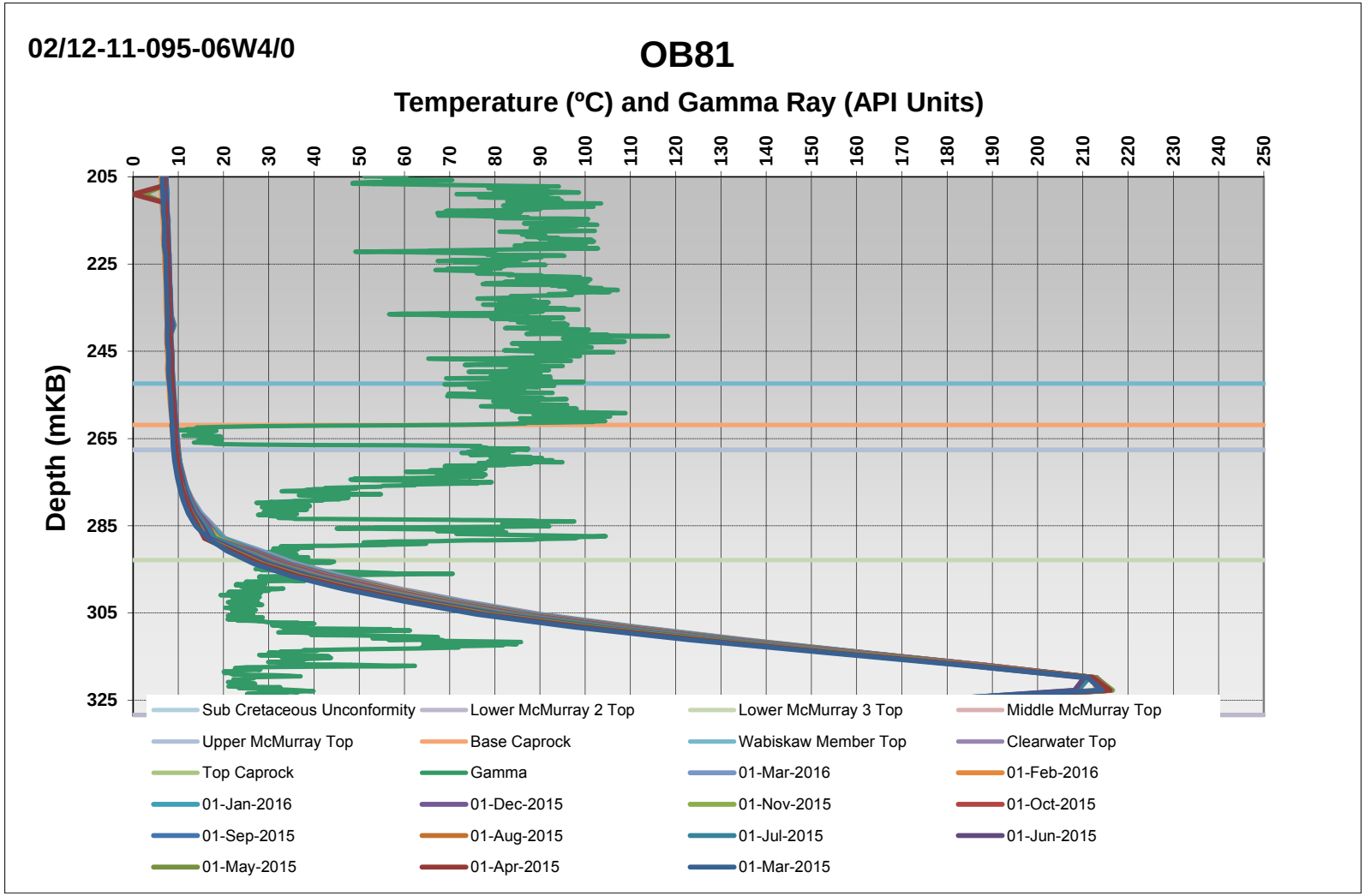

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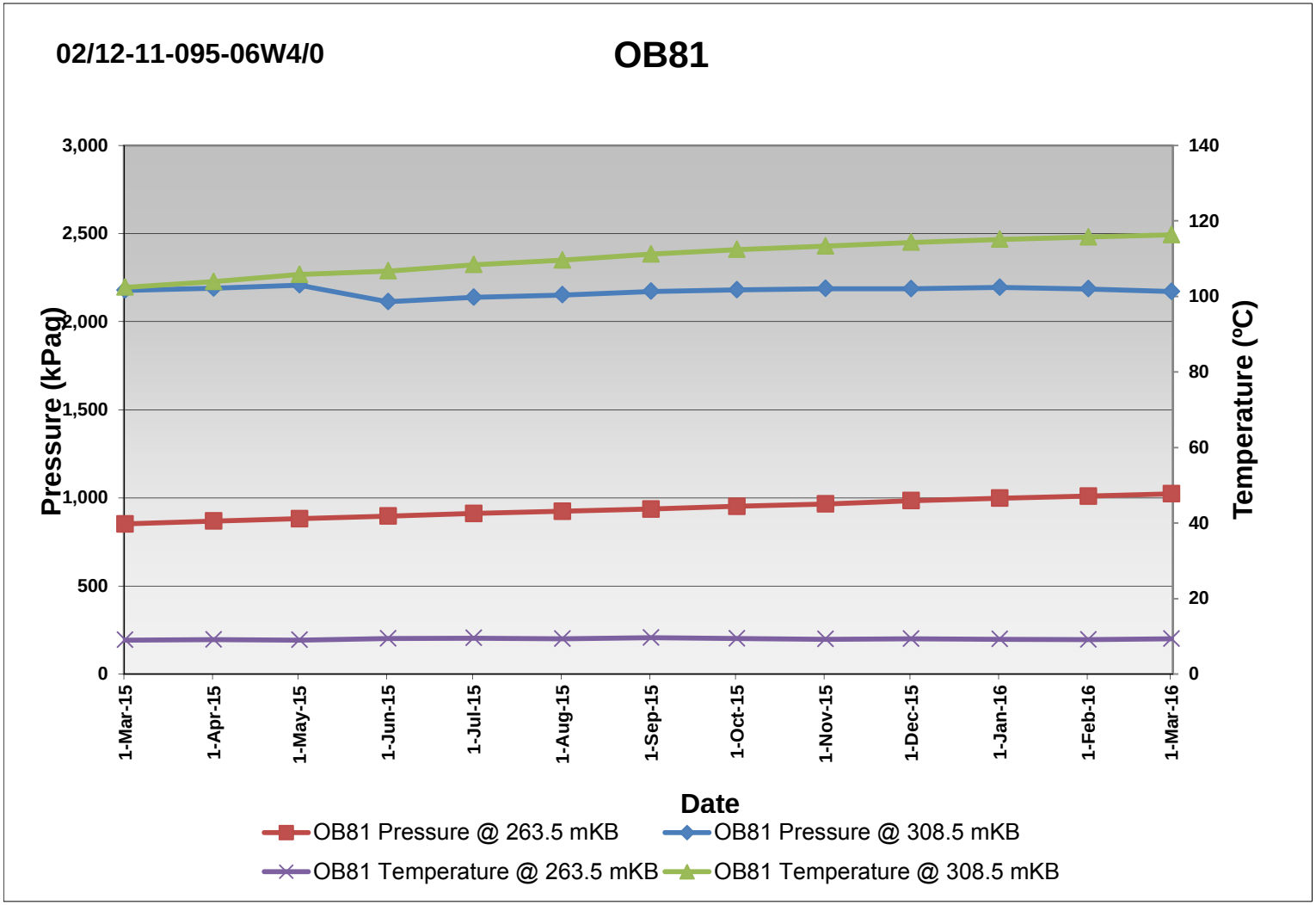

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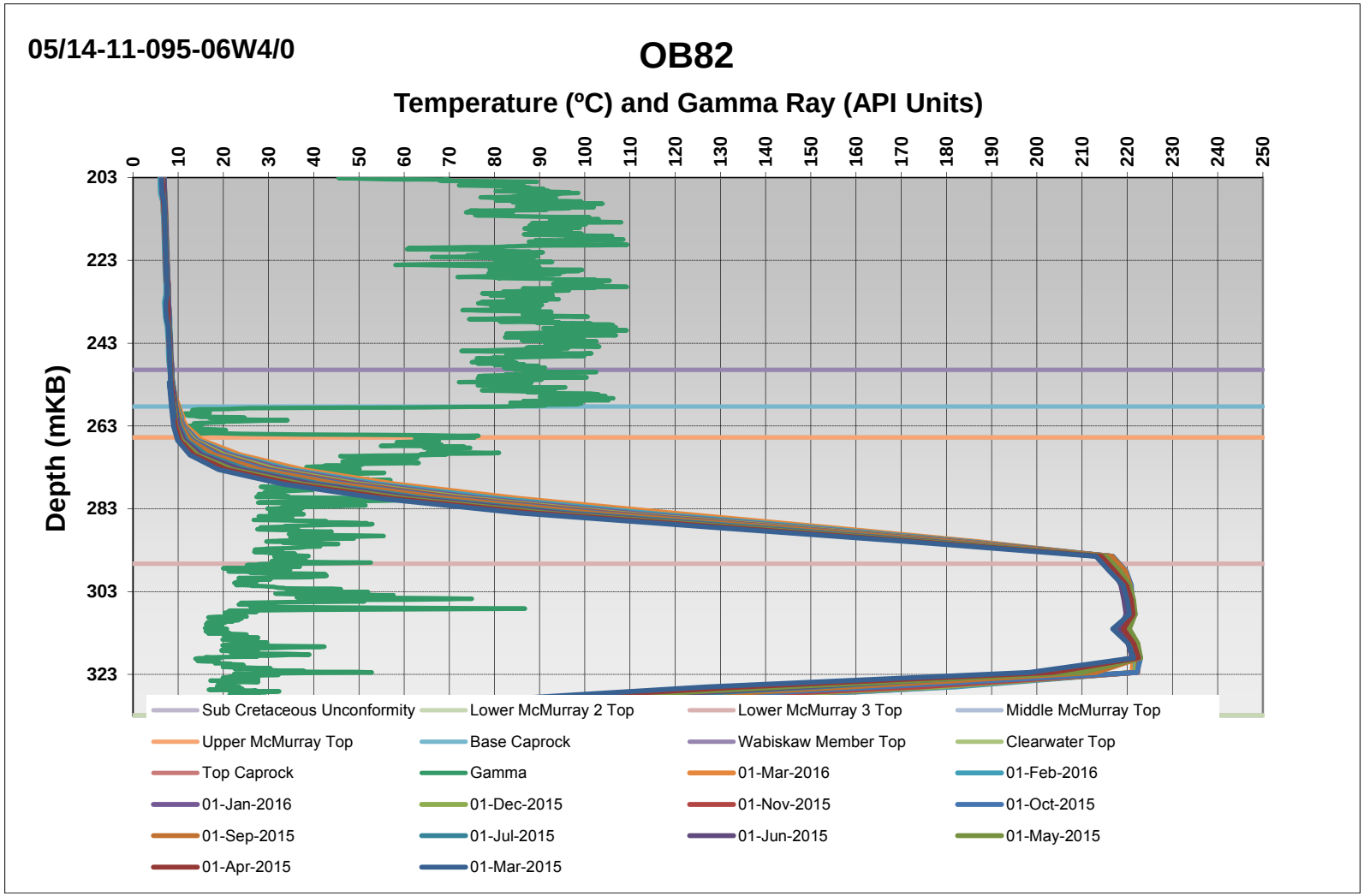

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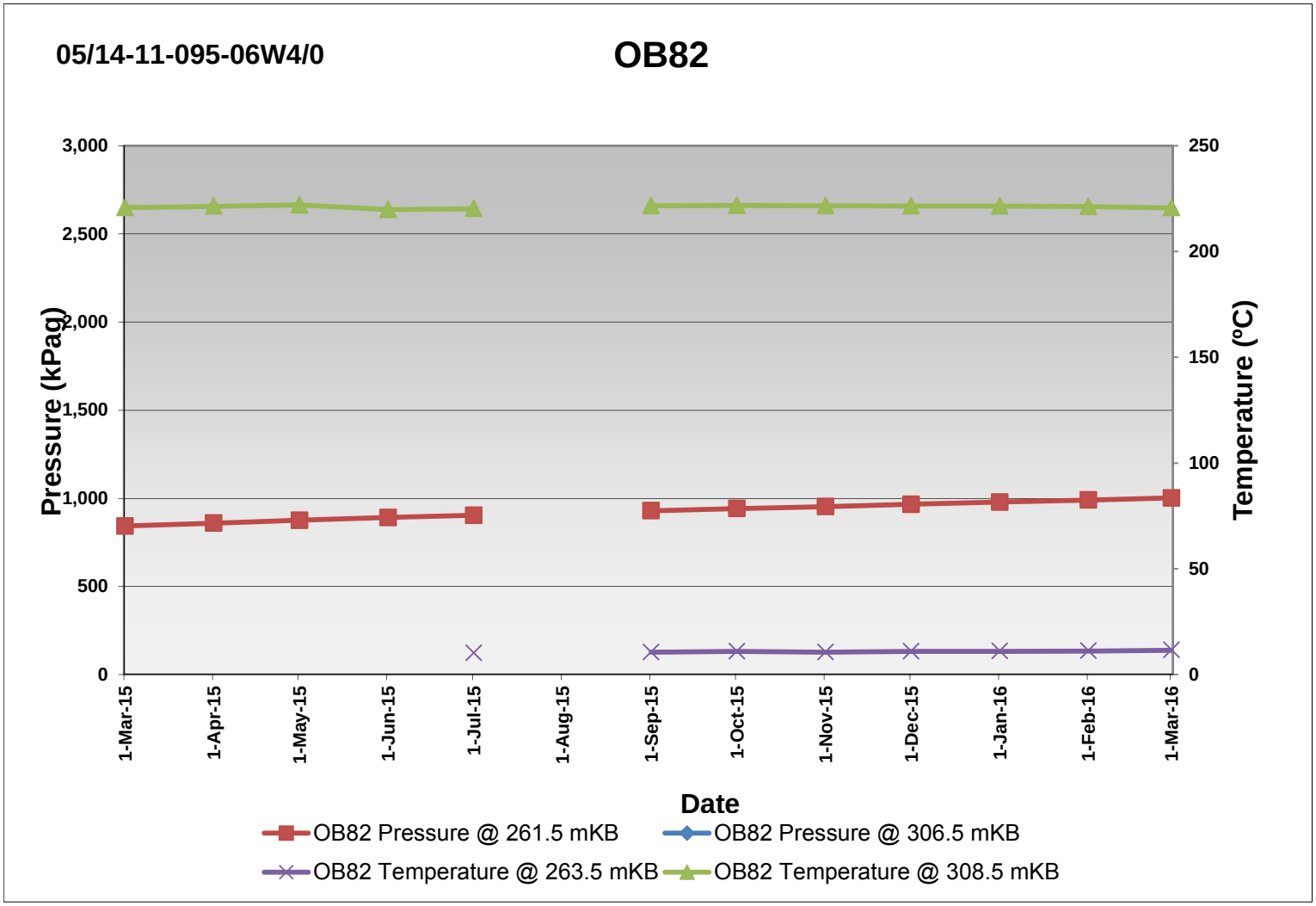

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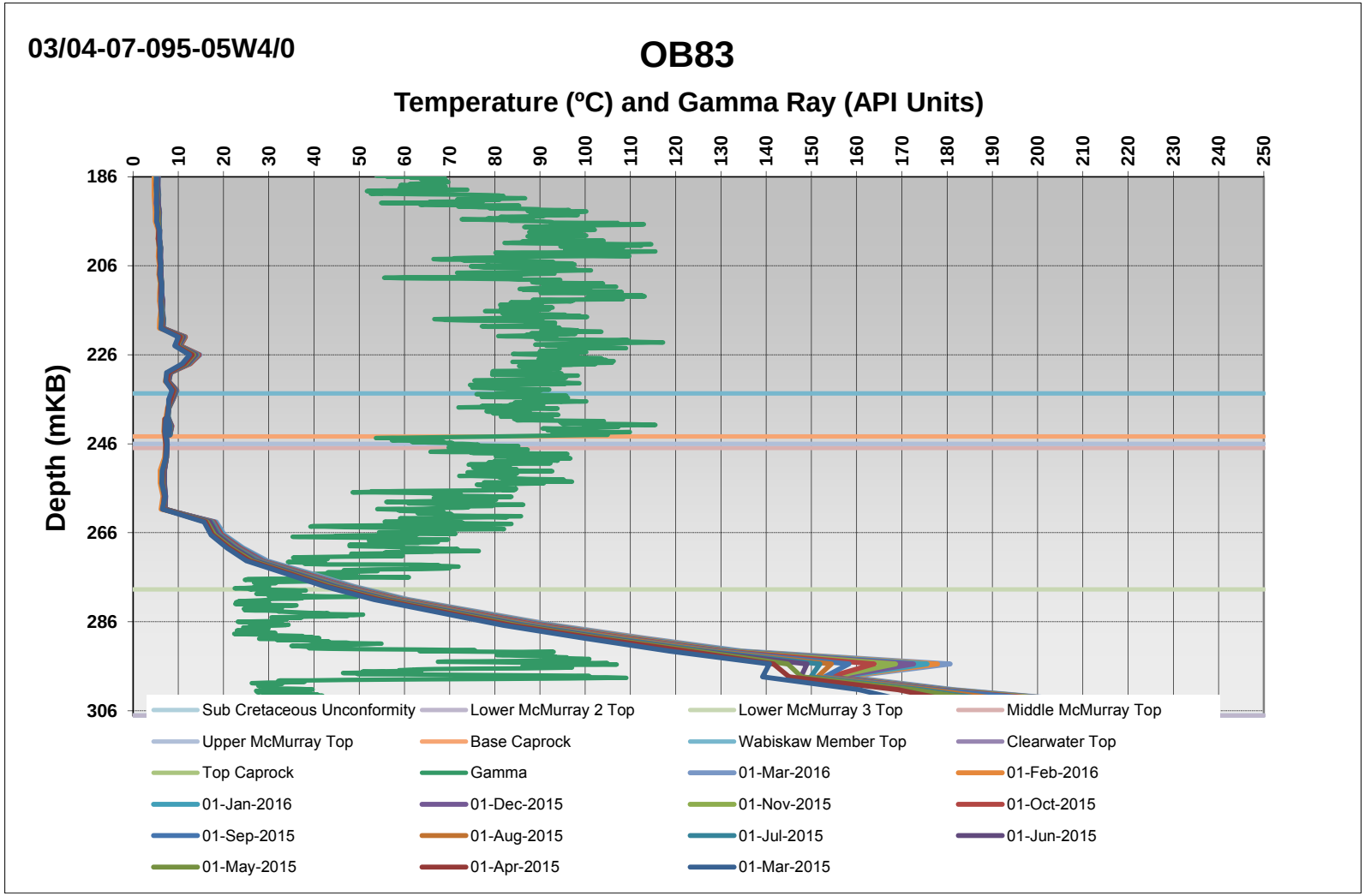

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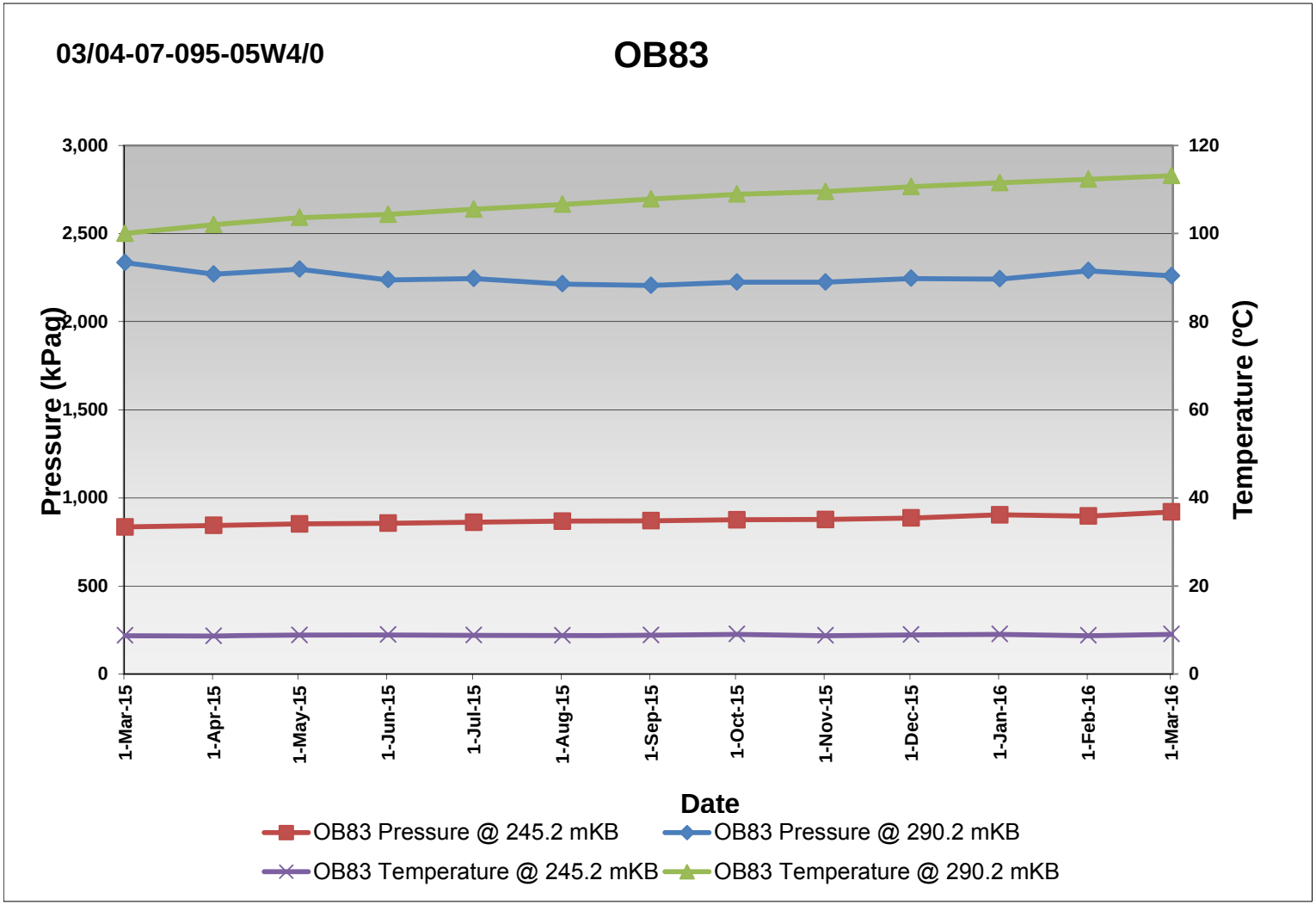

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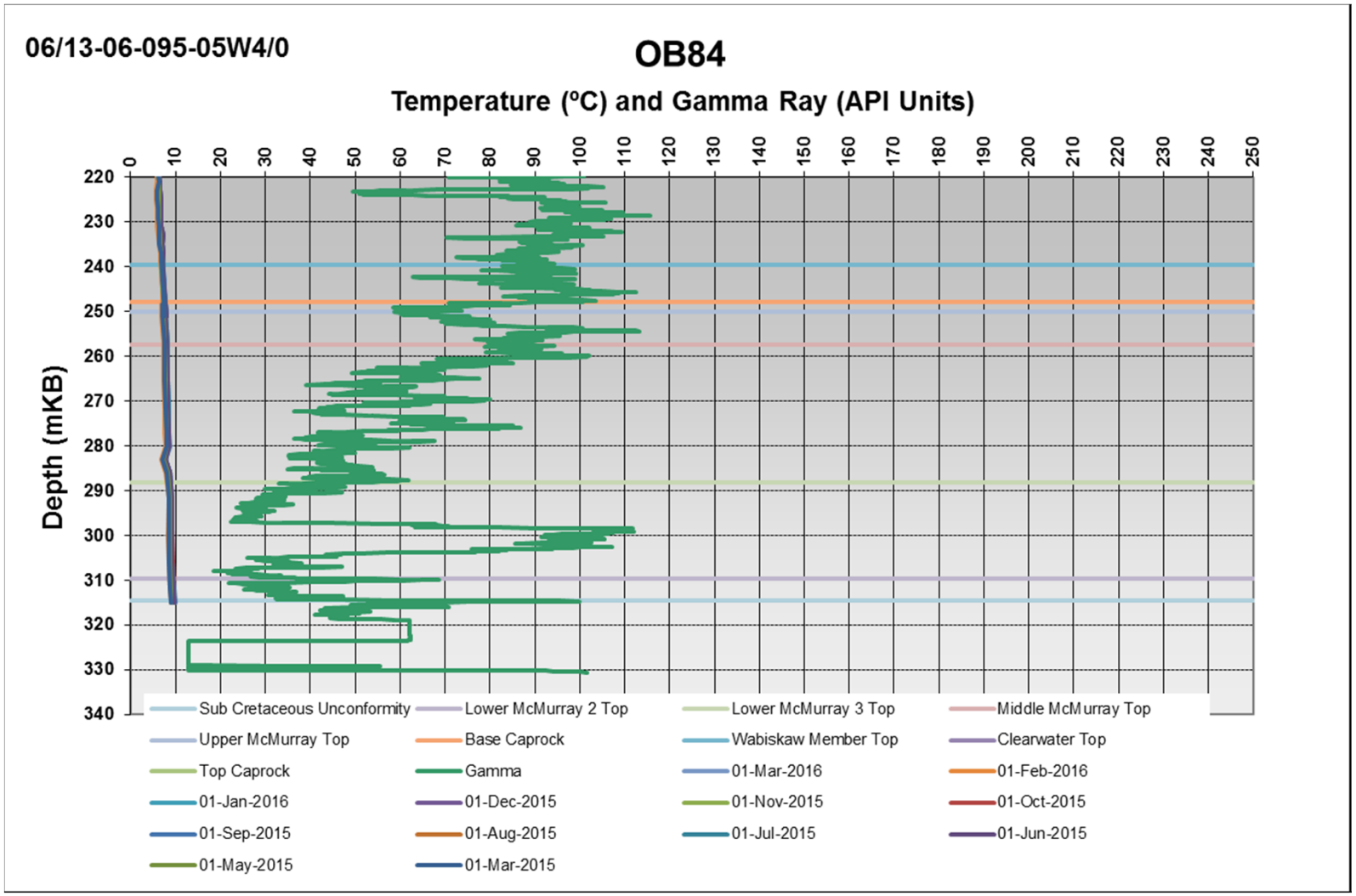

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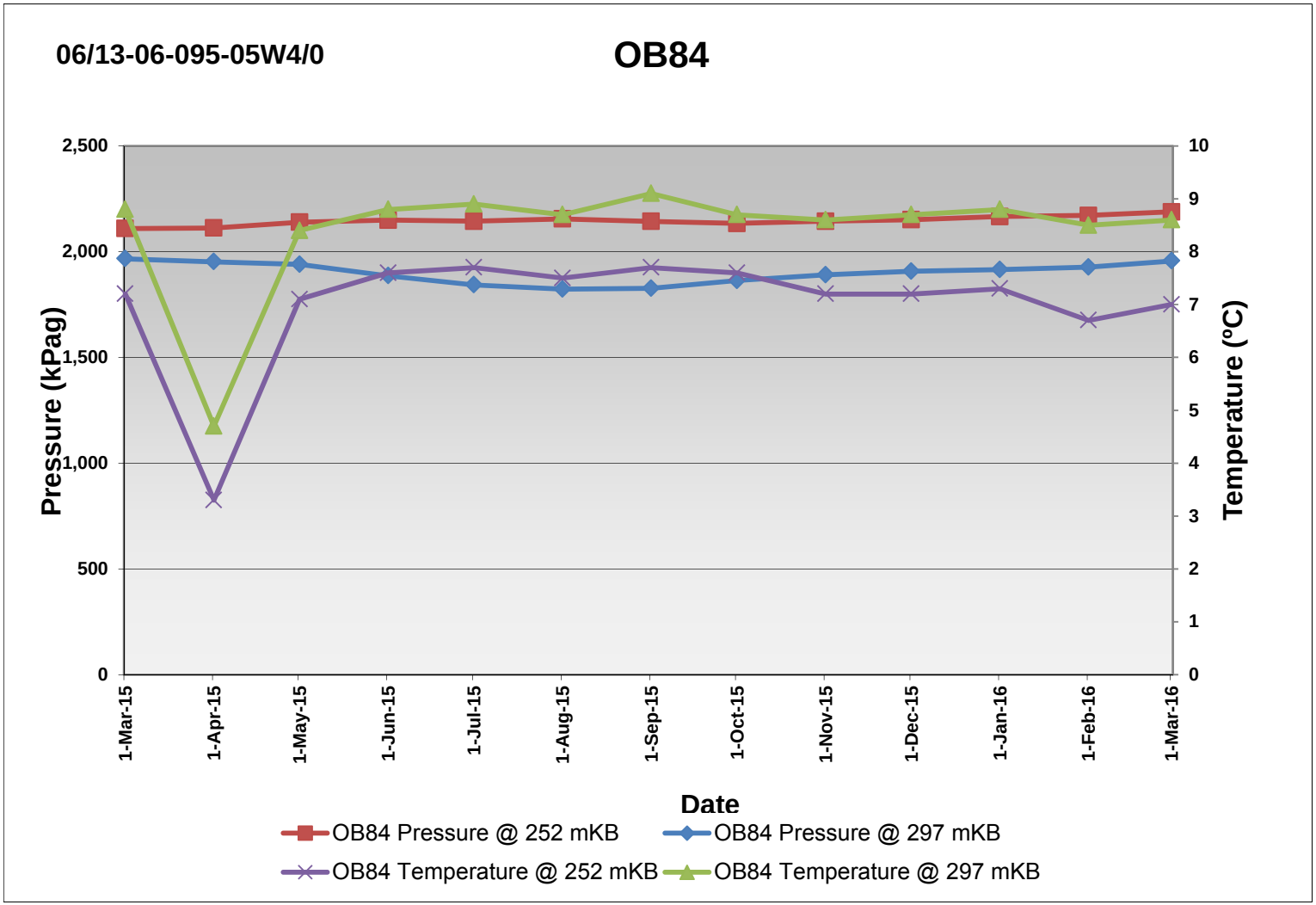

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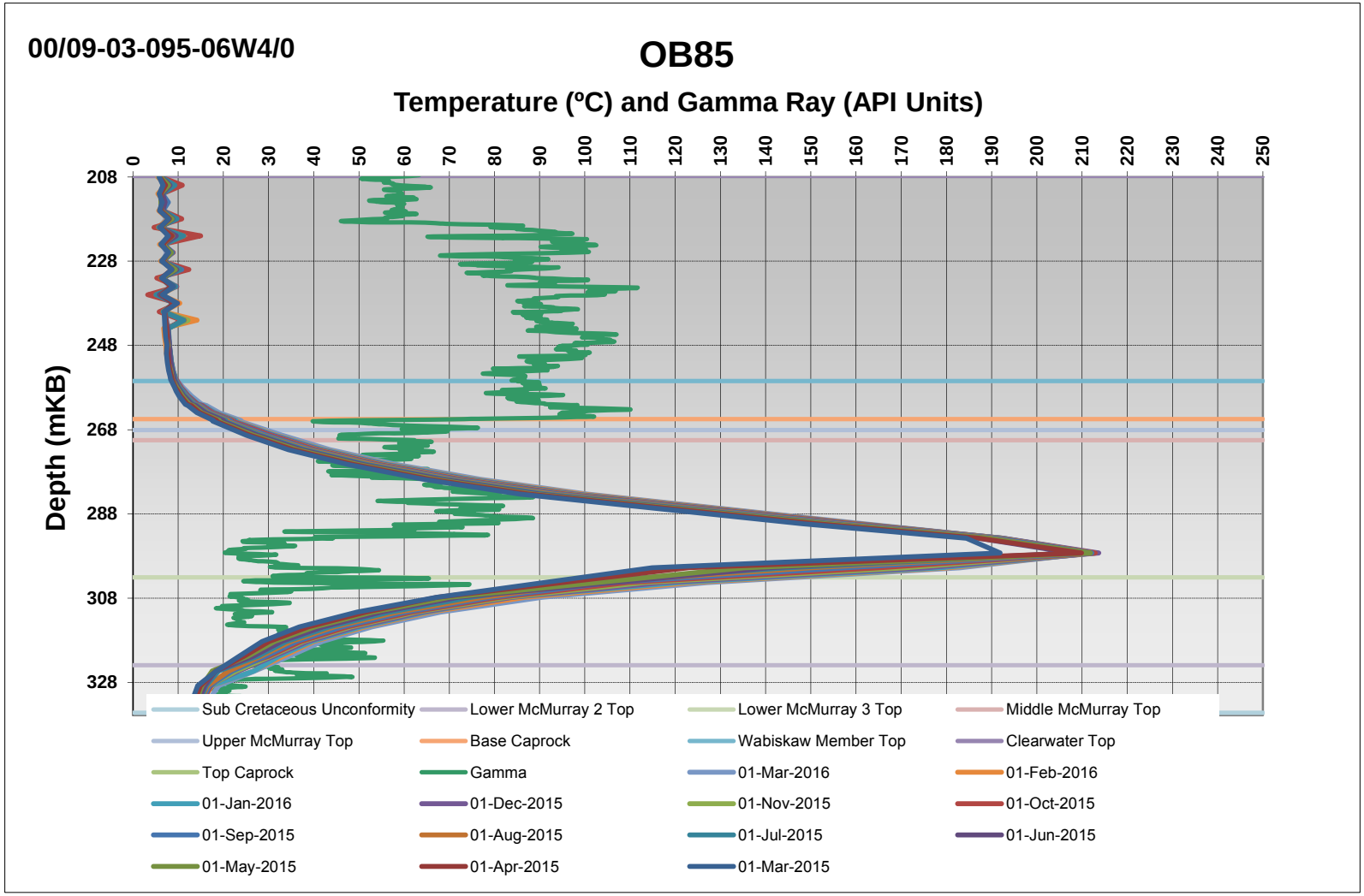

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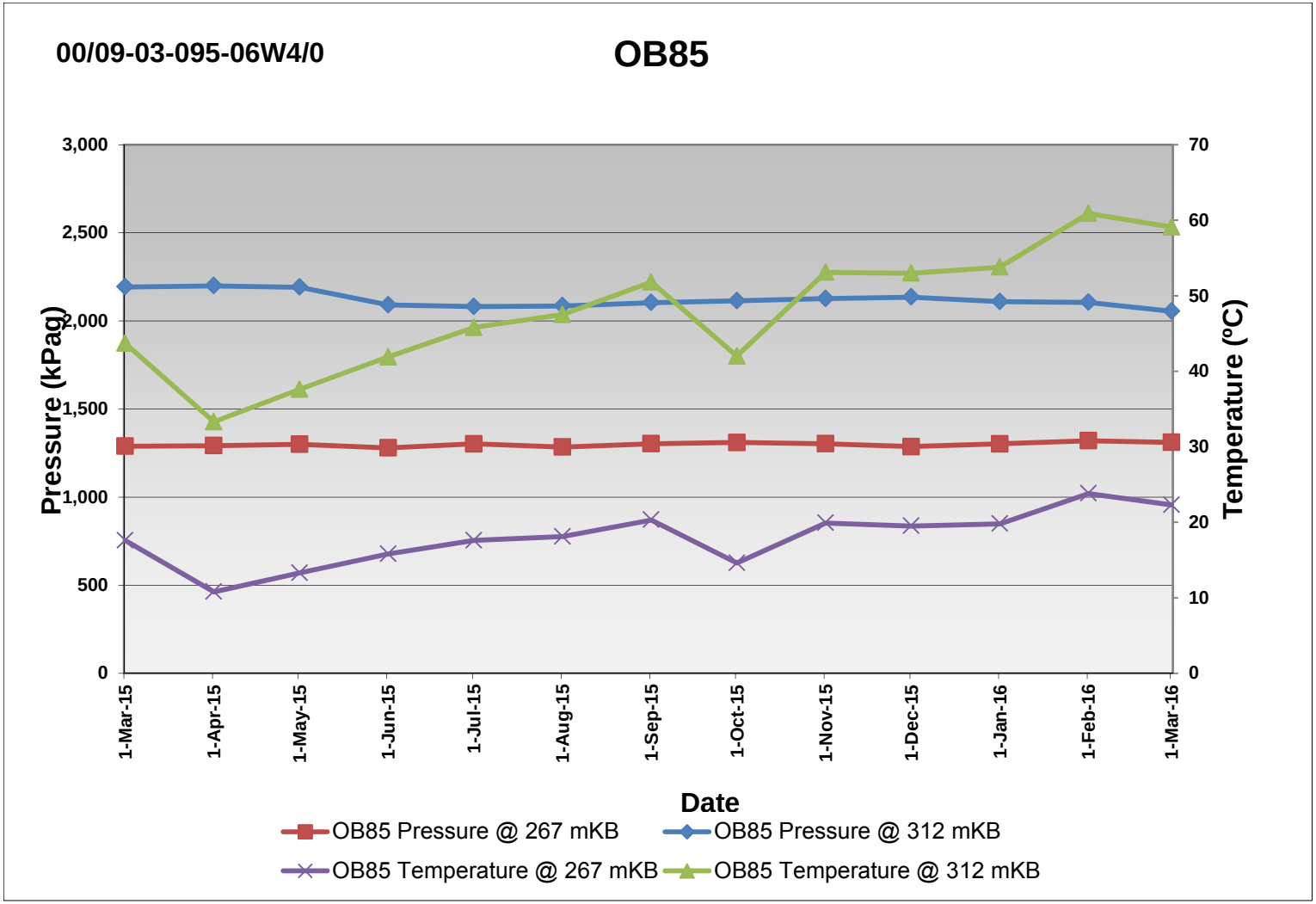

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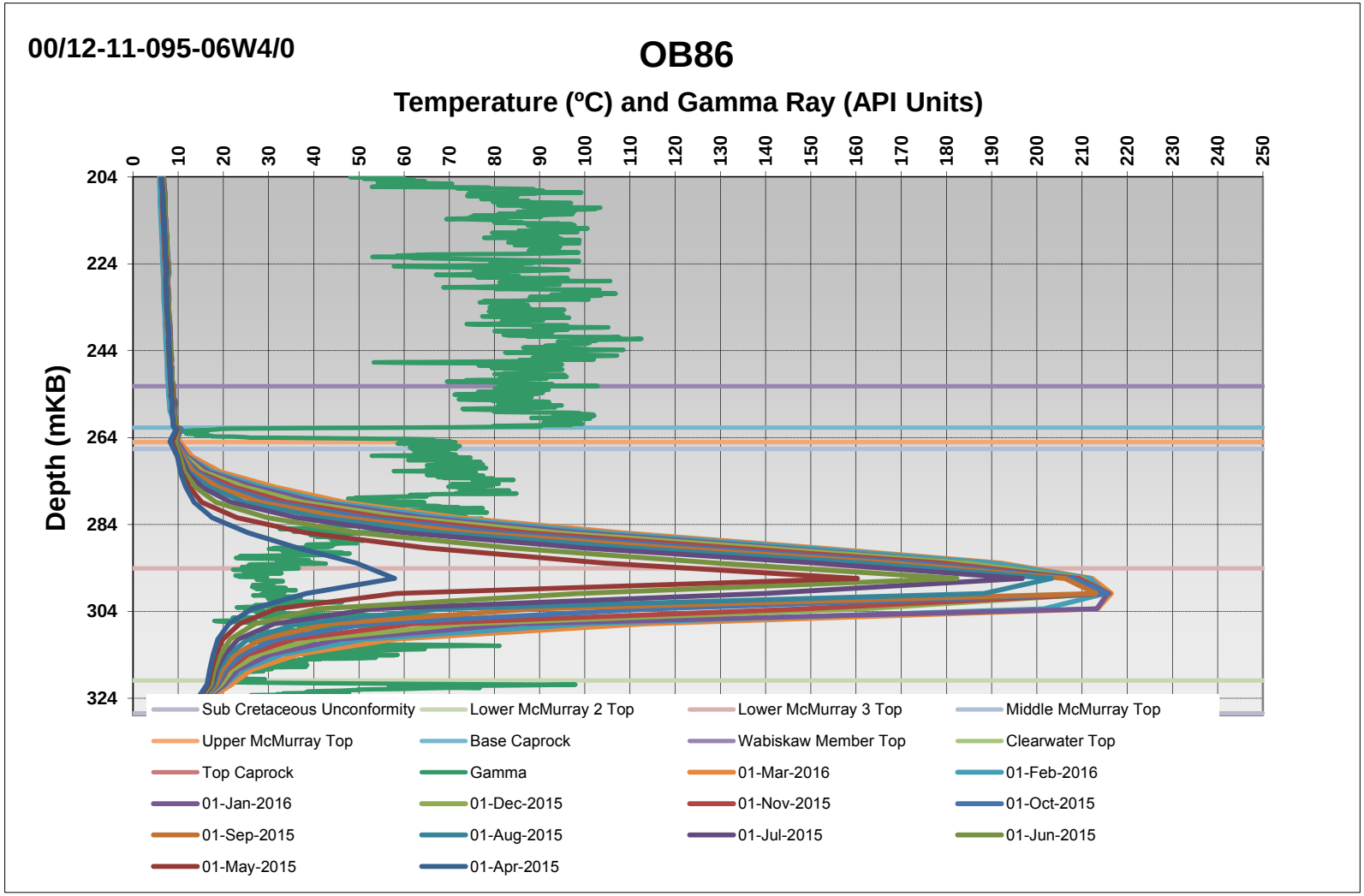

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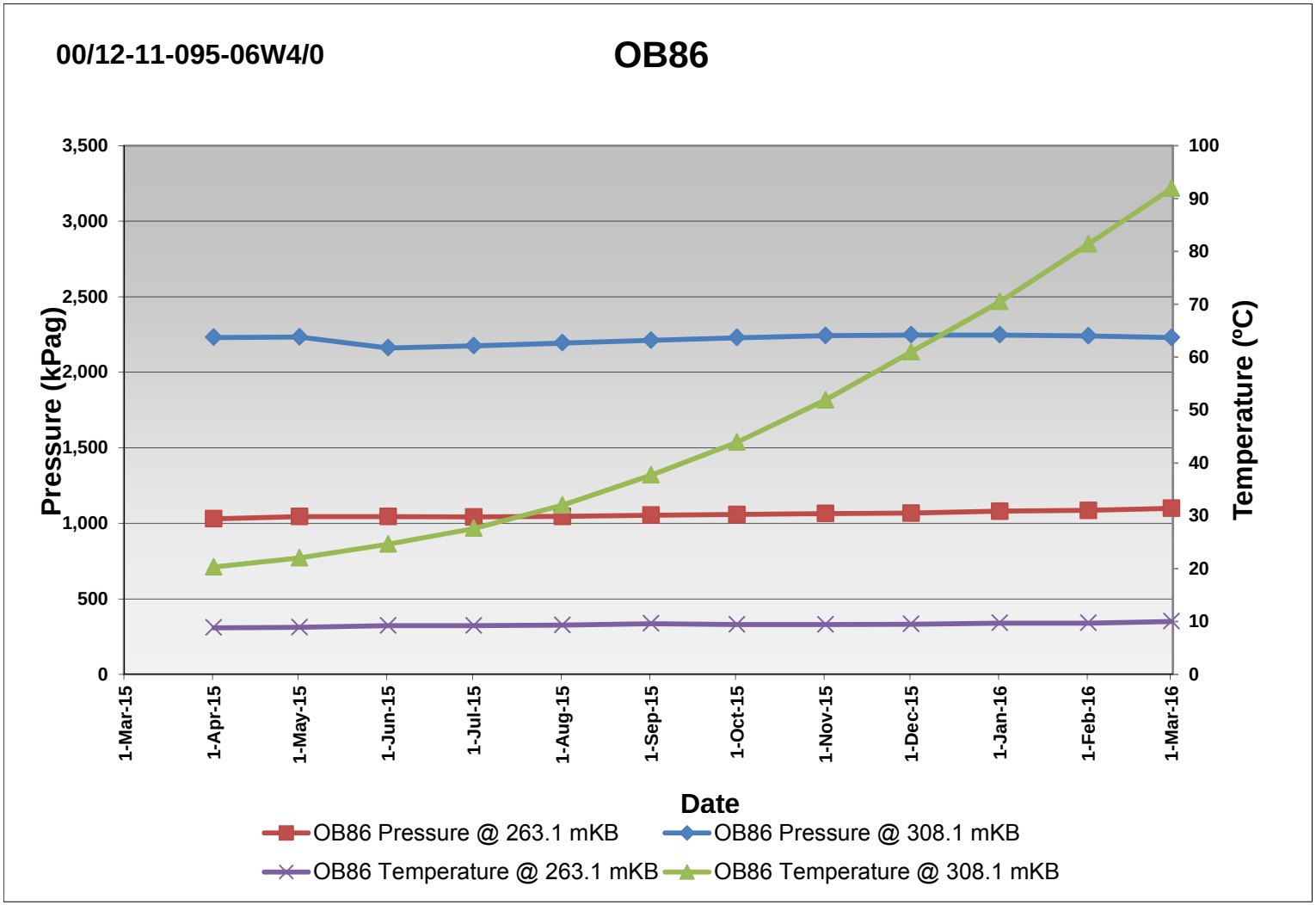

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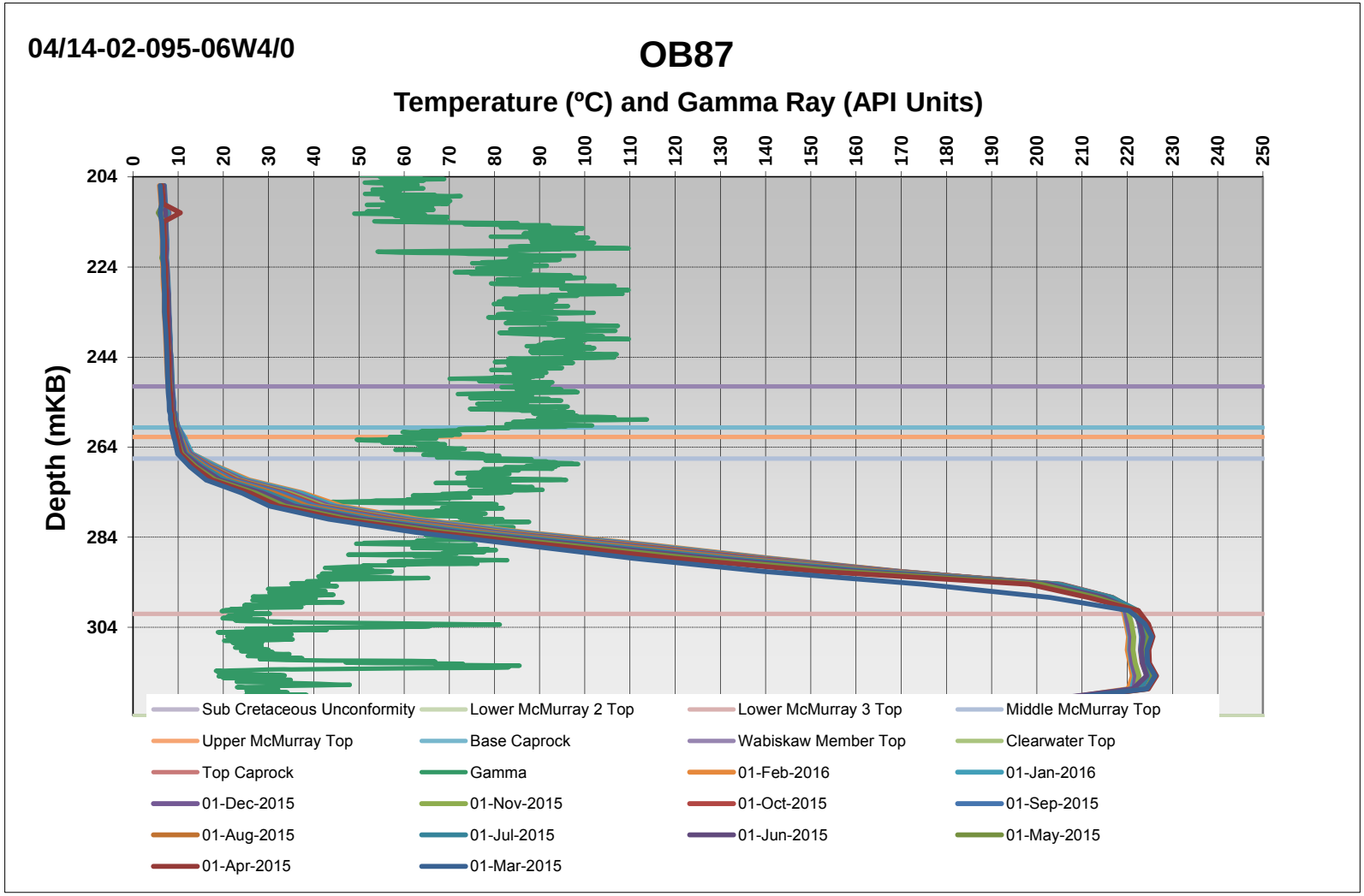

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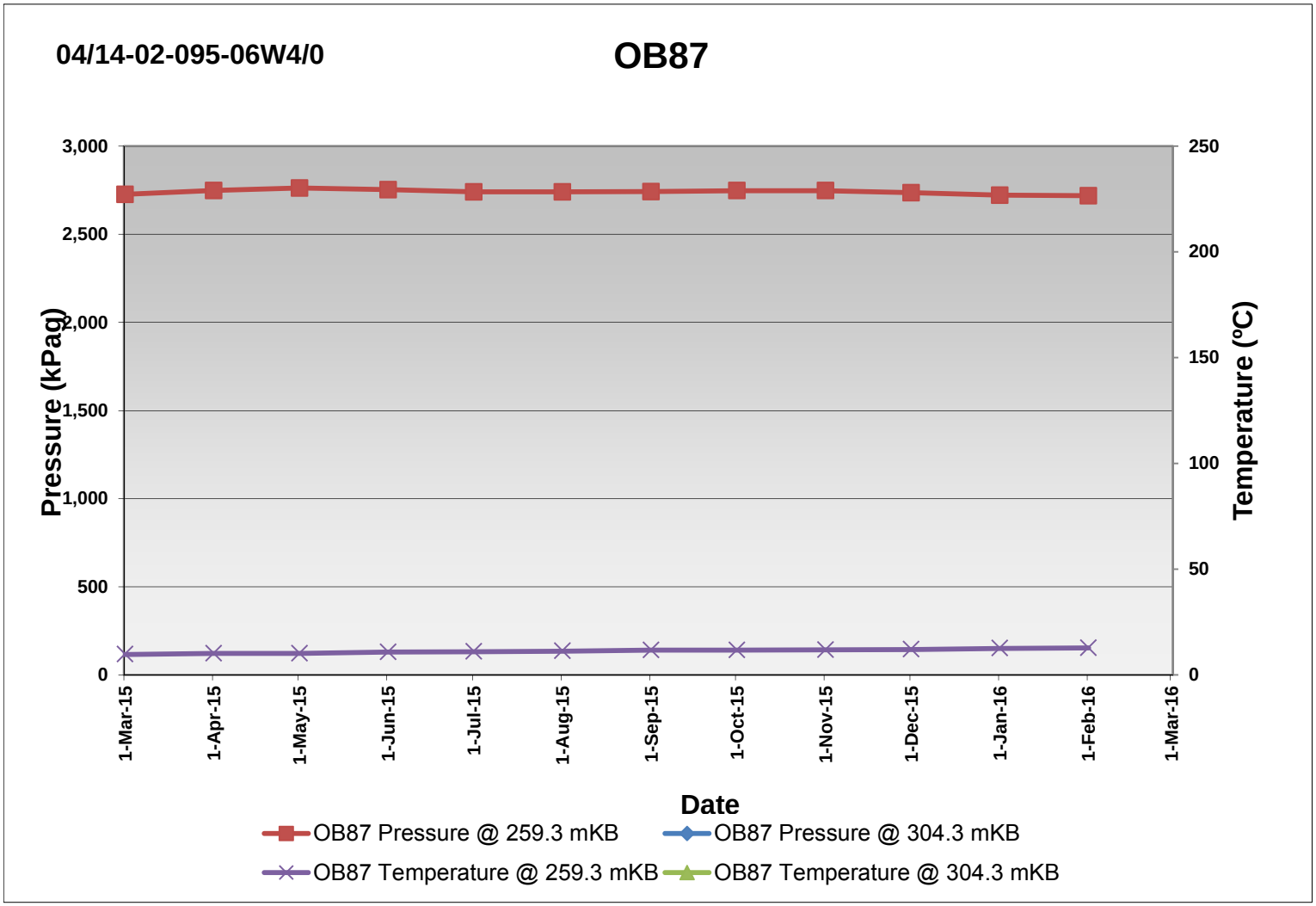

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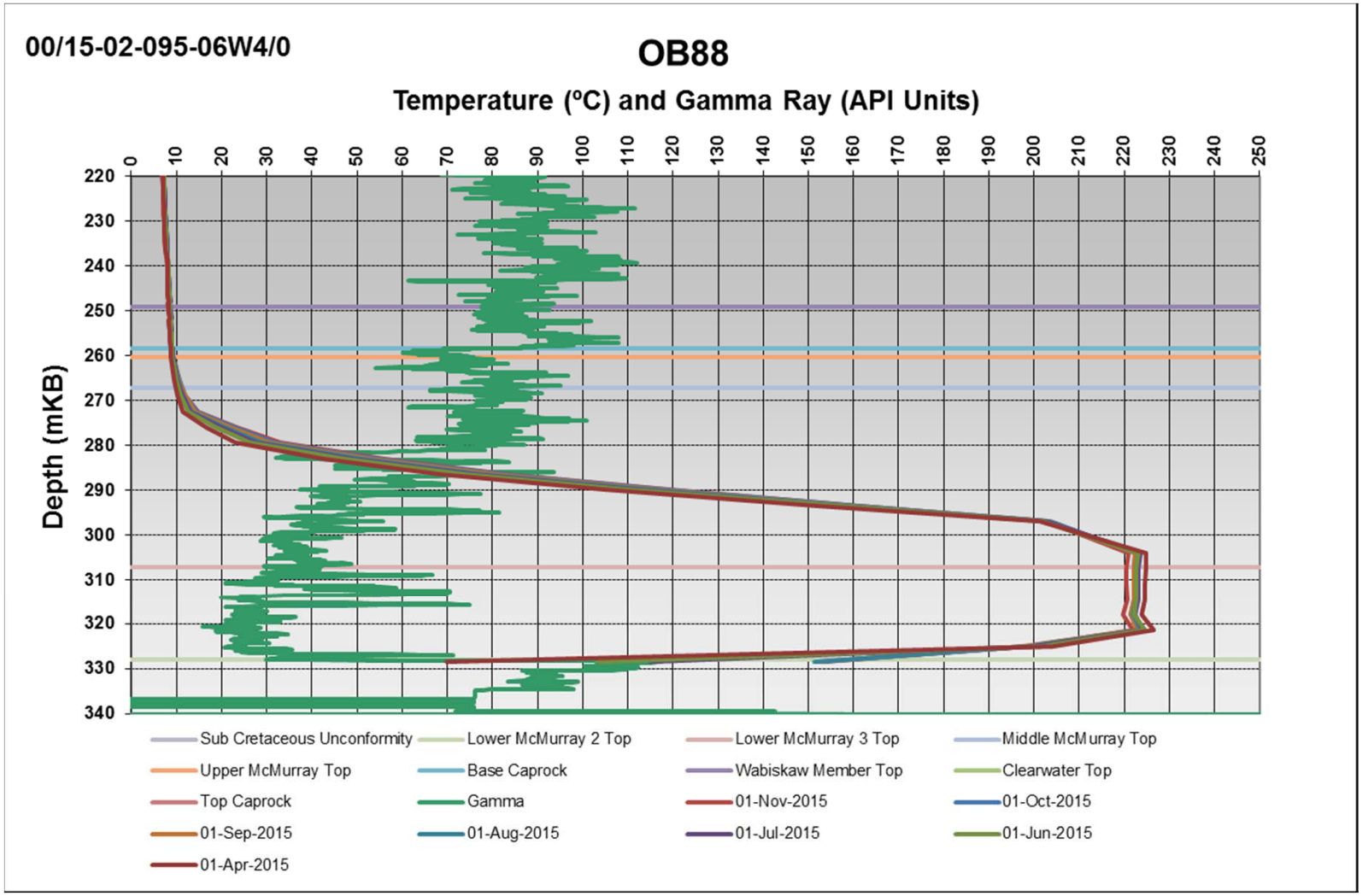

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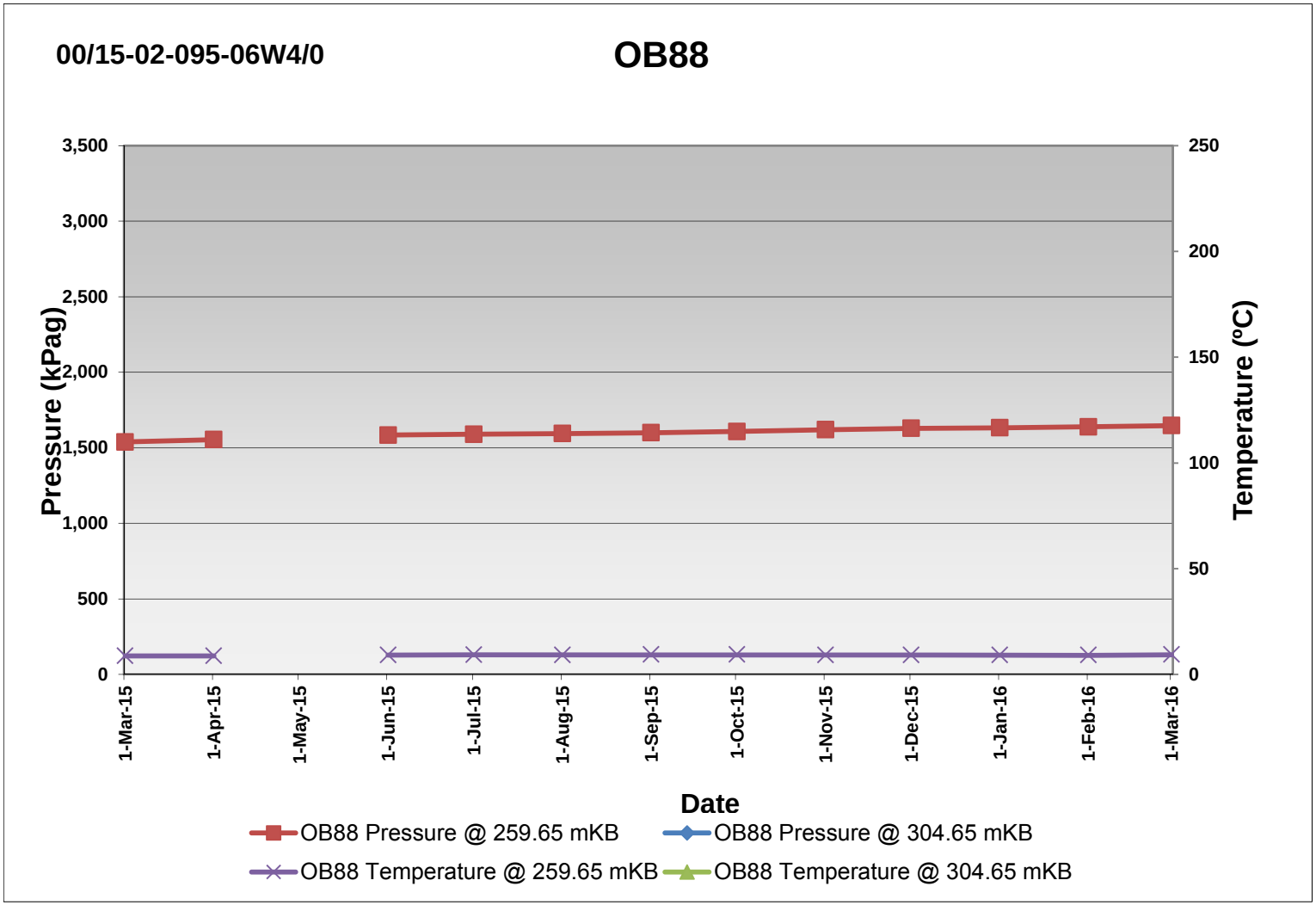

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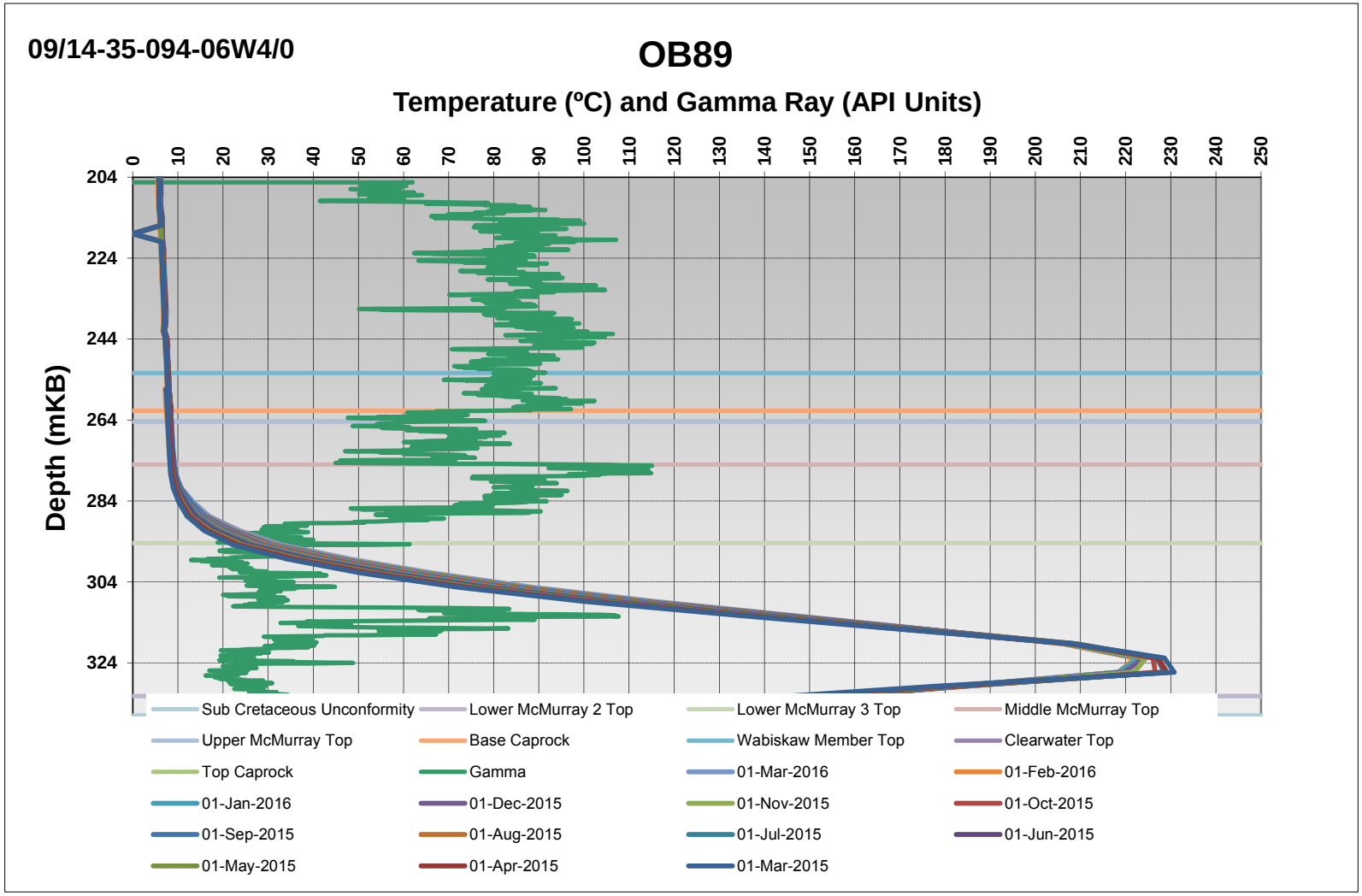

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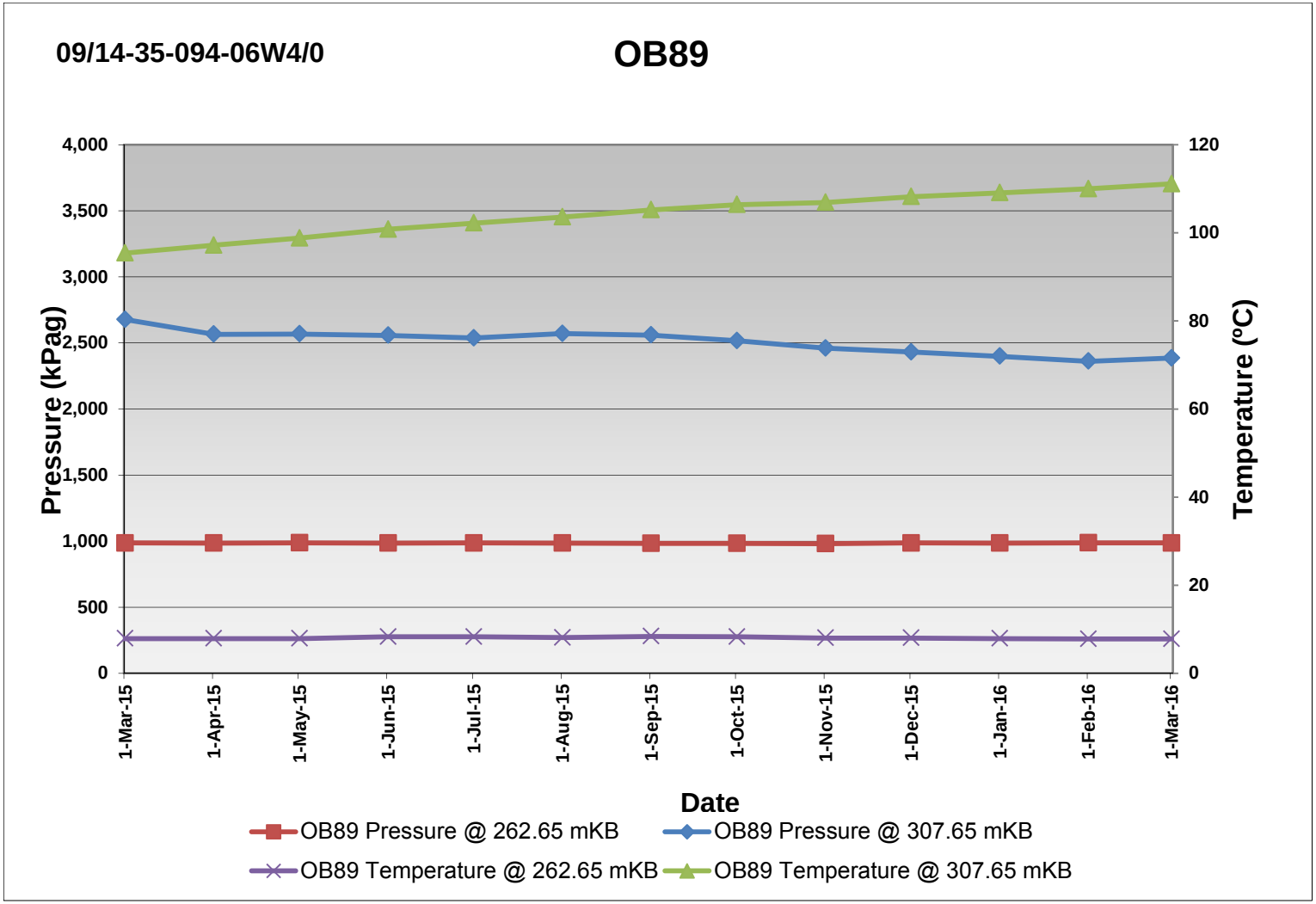

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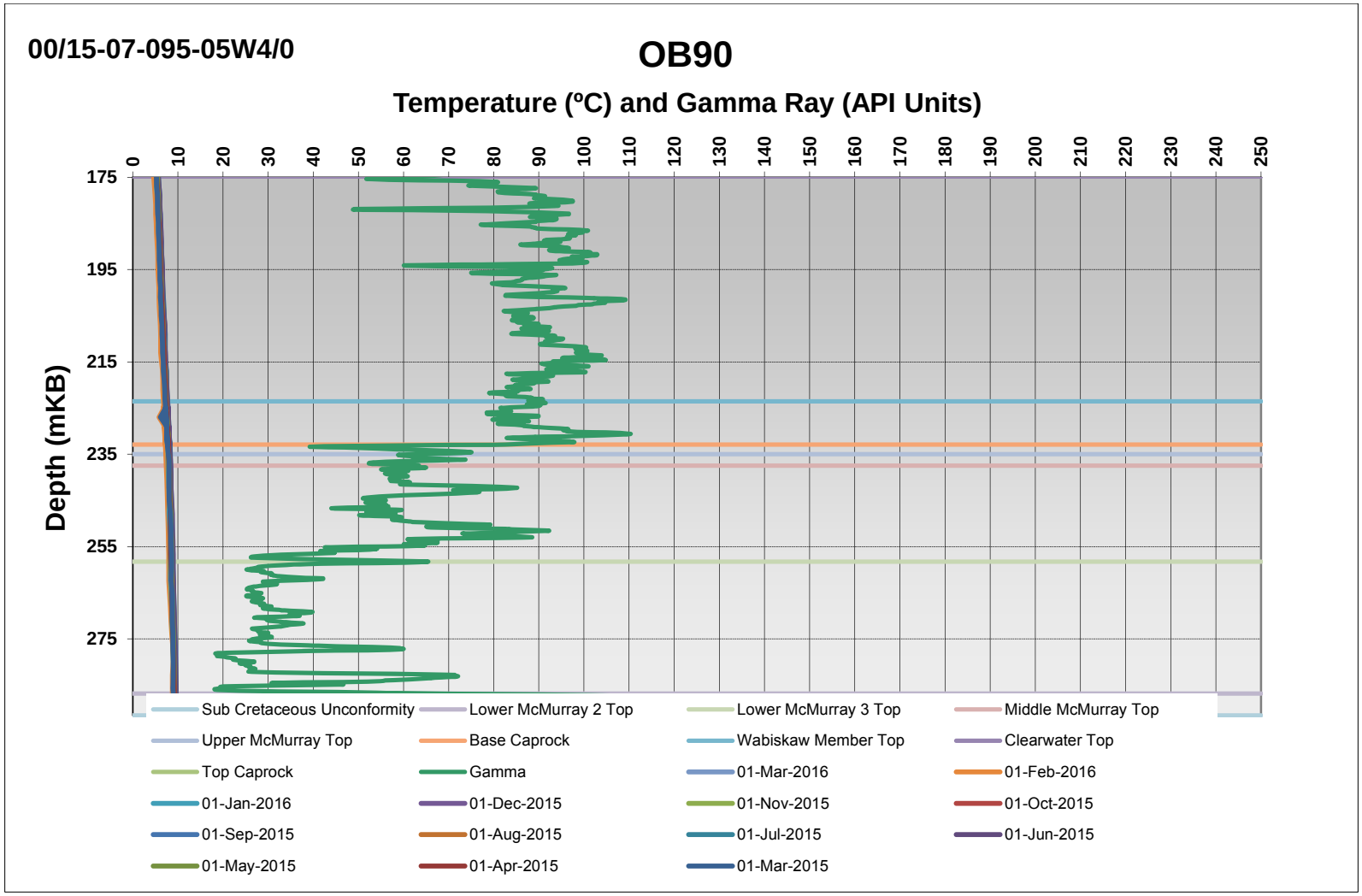

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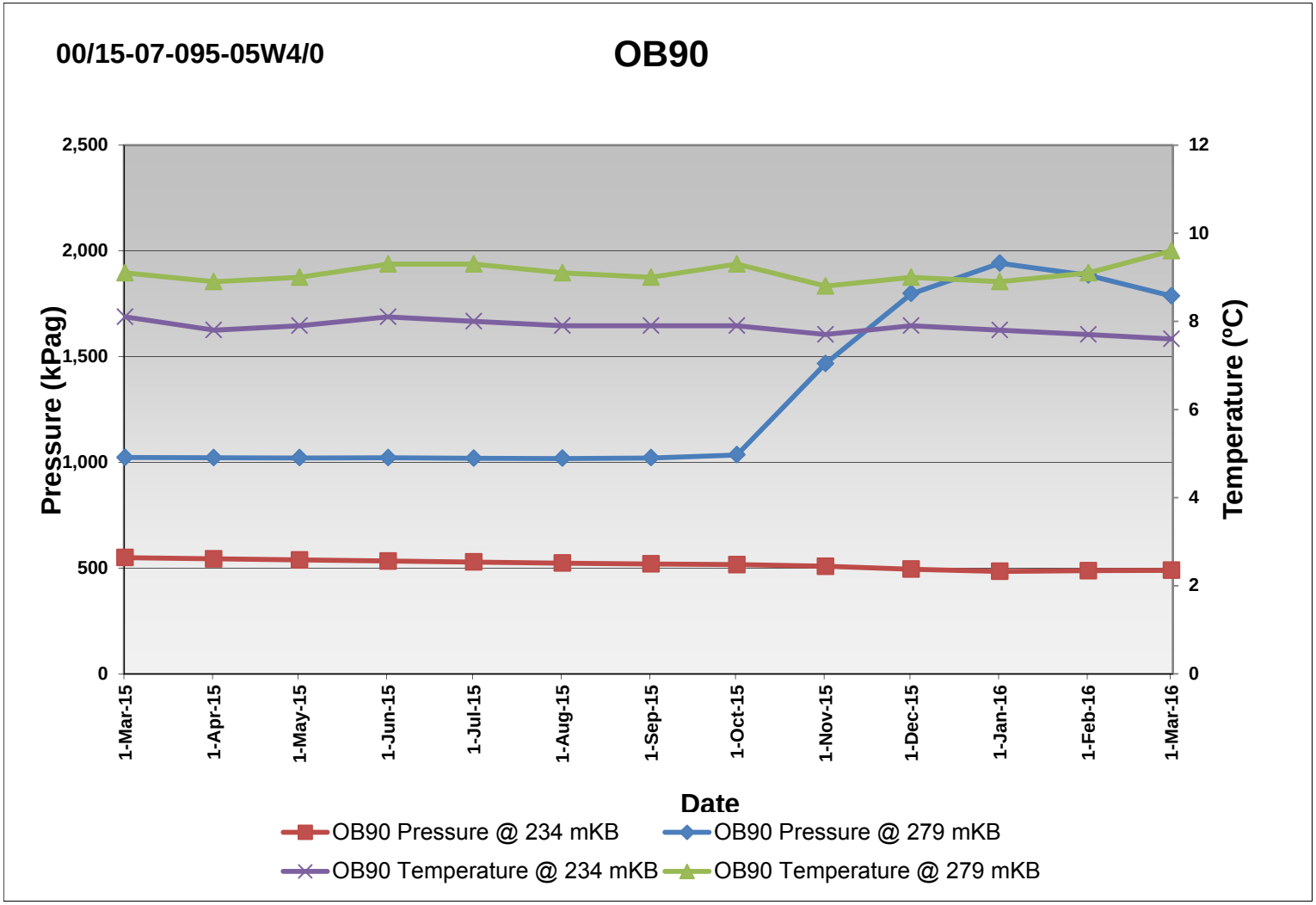

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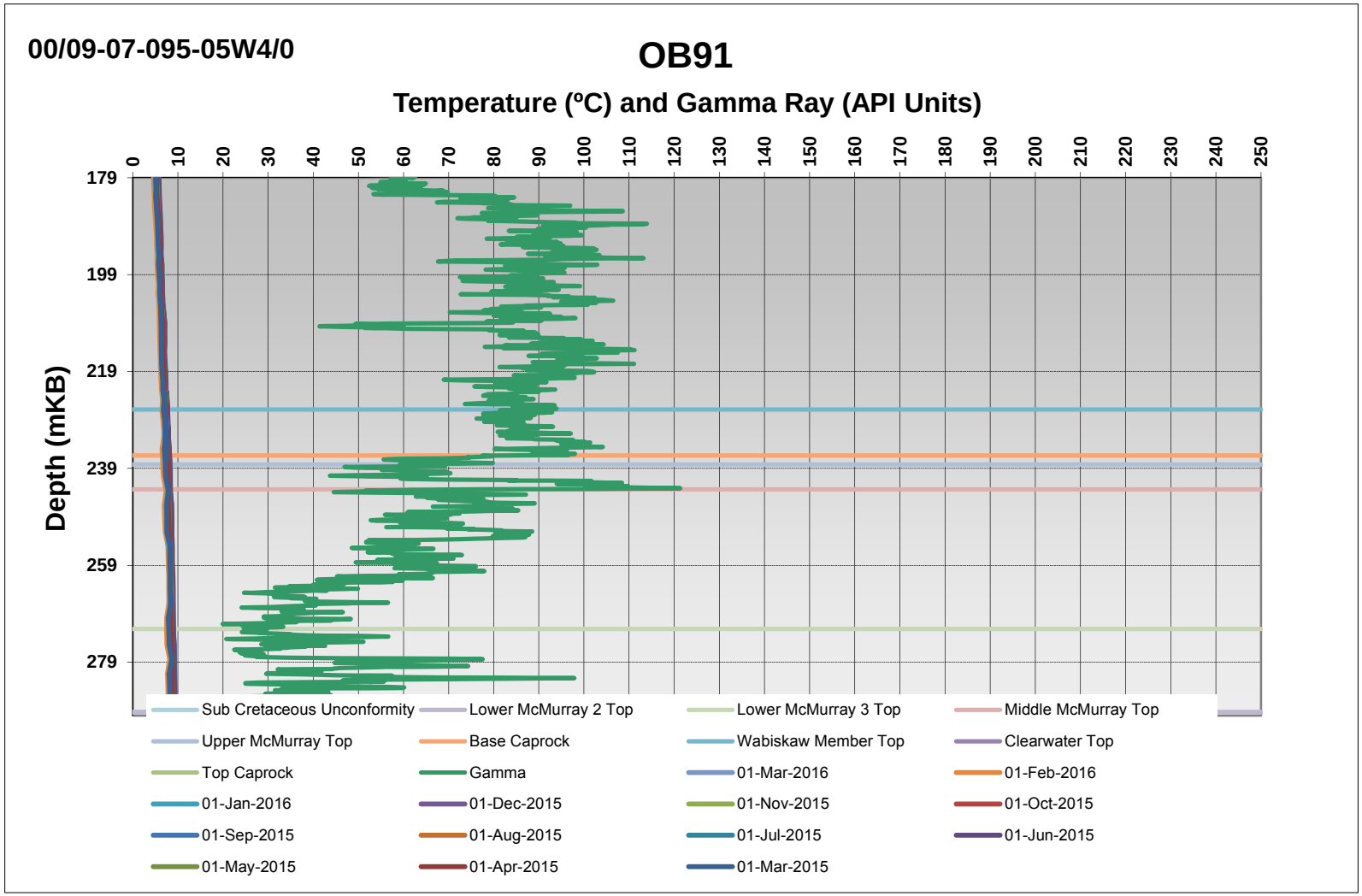

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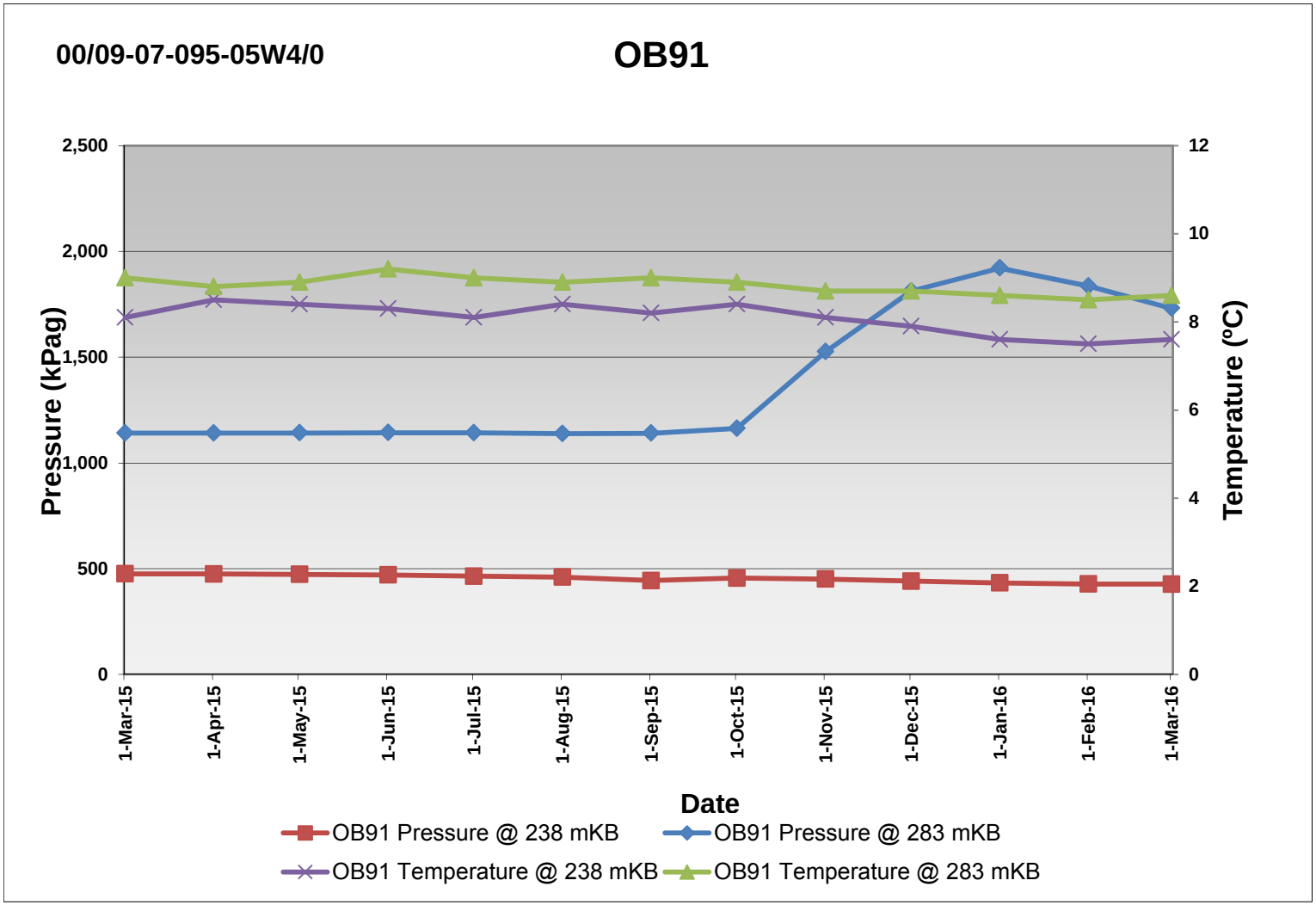

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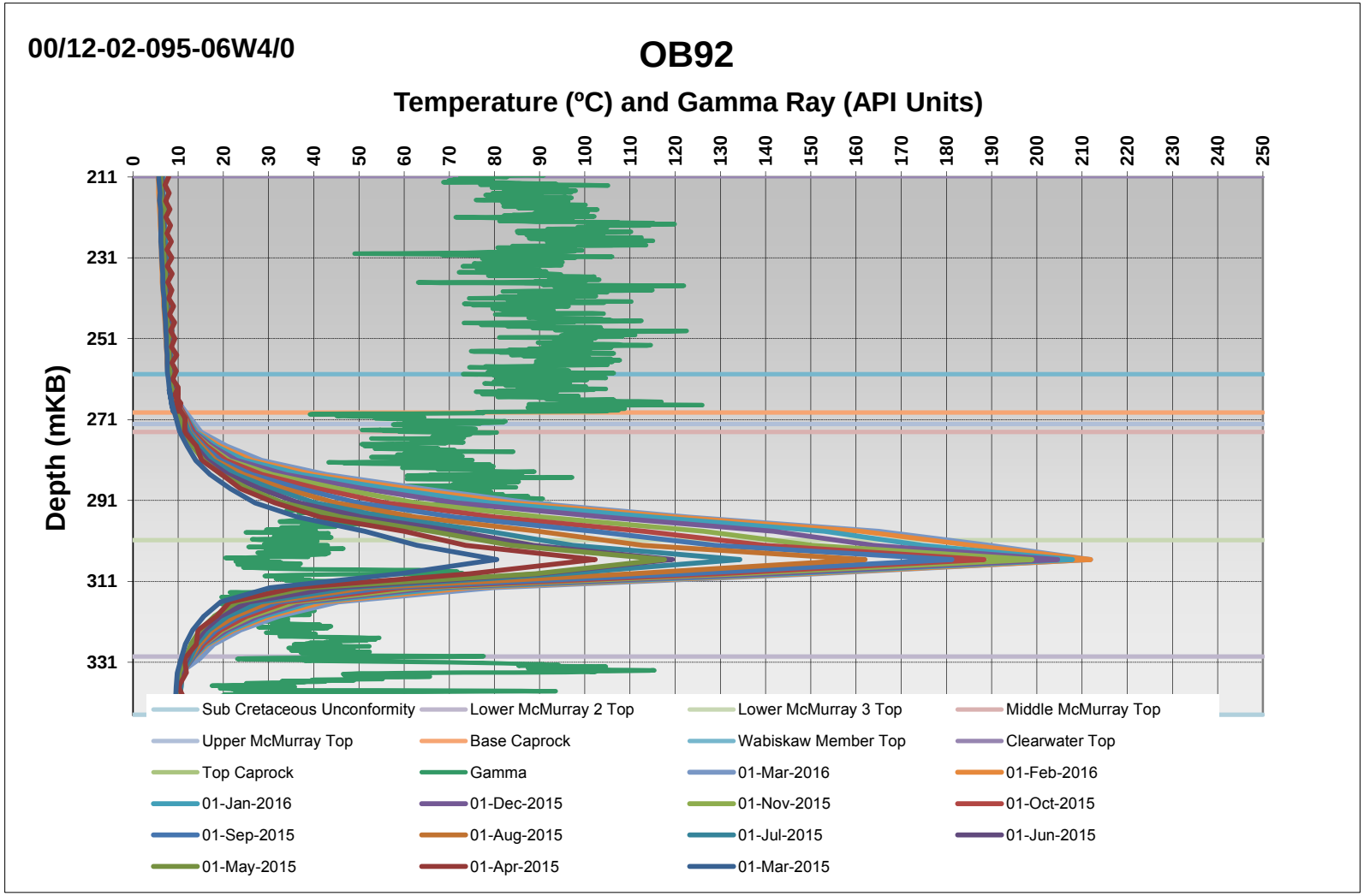

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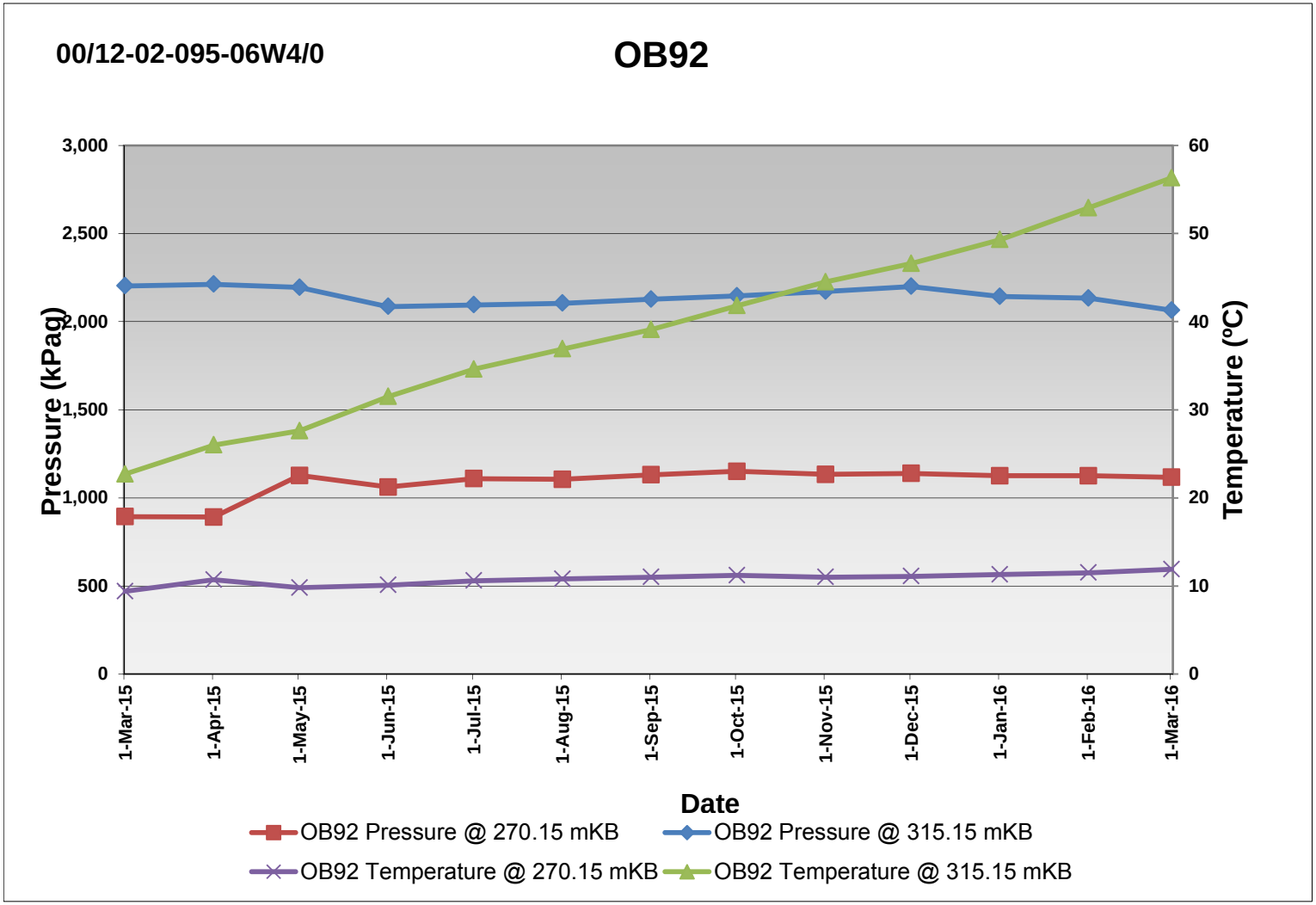
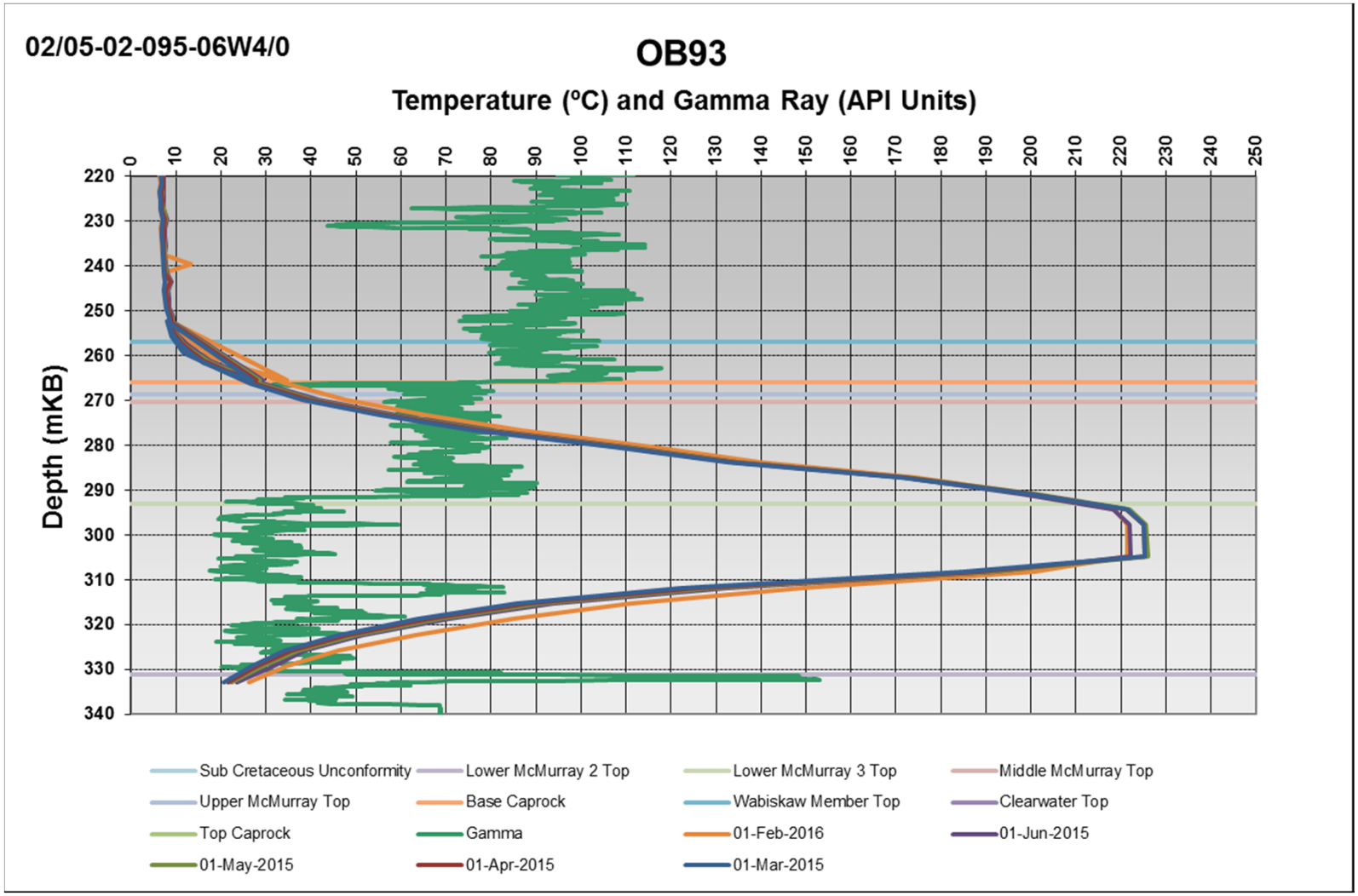


Piezometer Plots & Temperature vs Depth Plots



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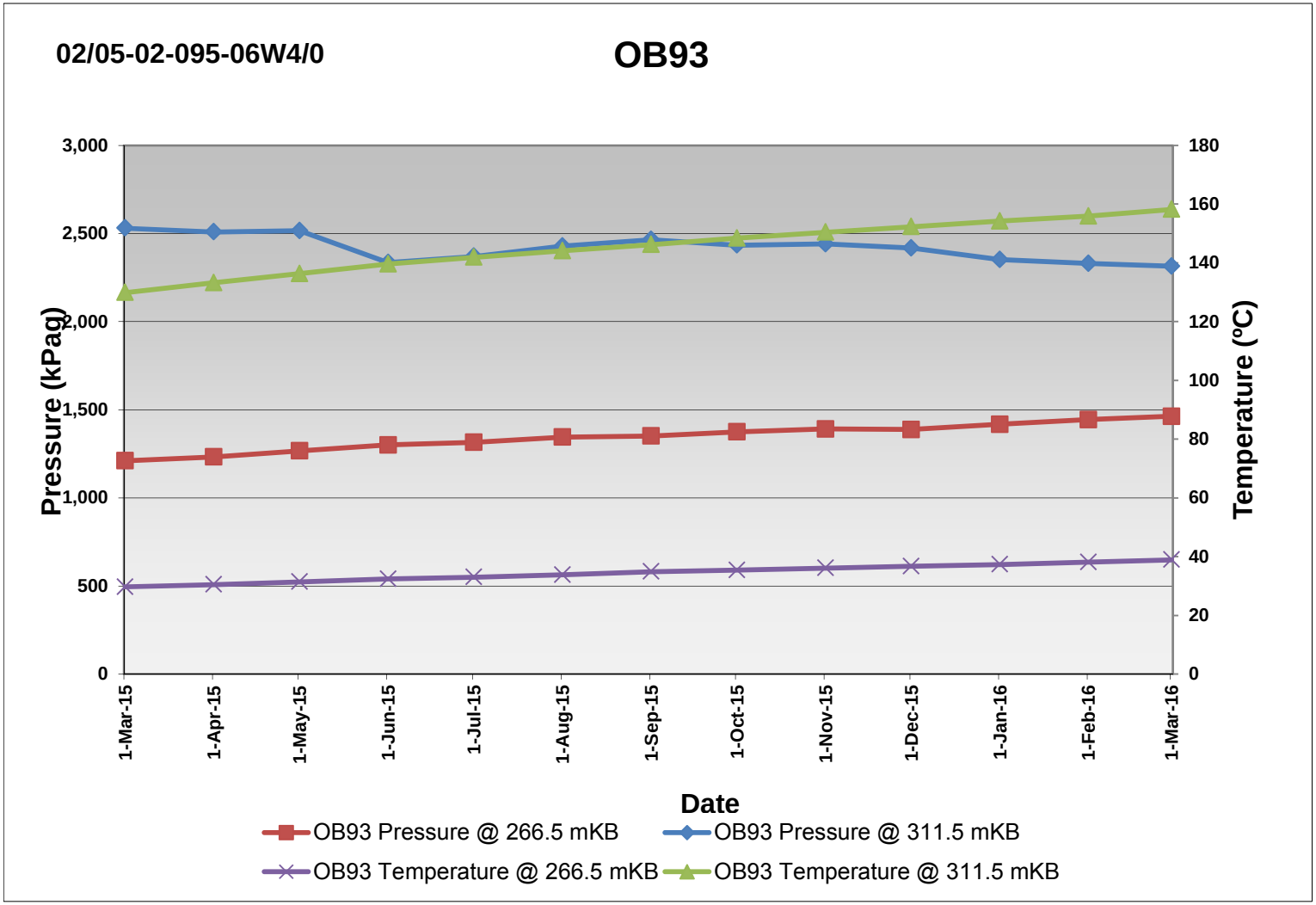

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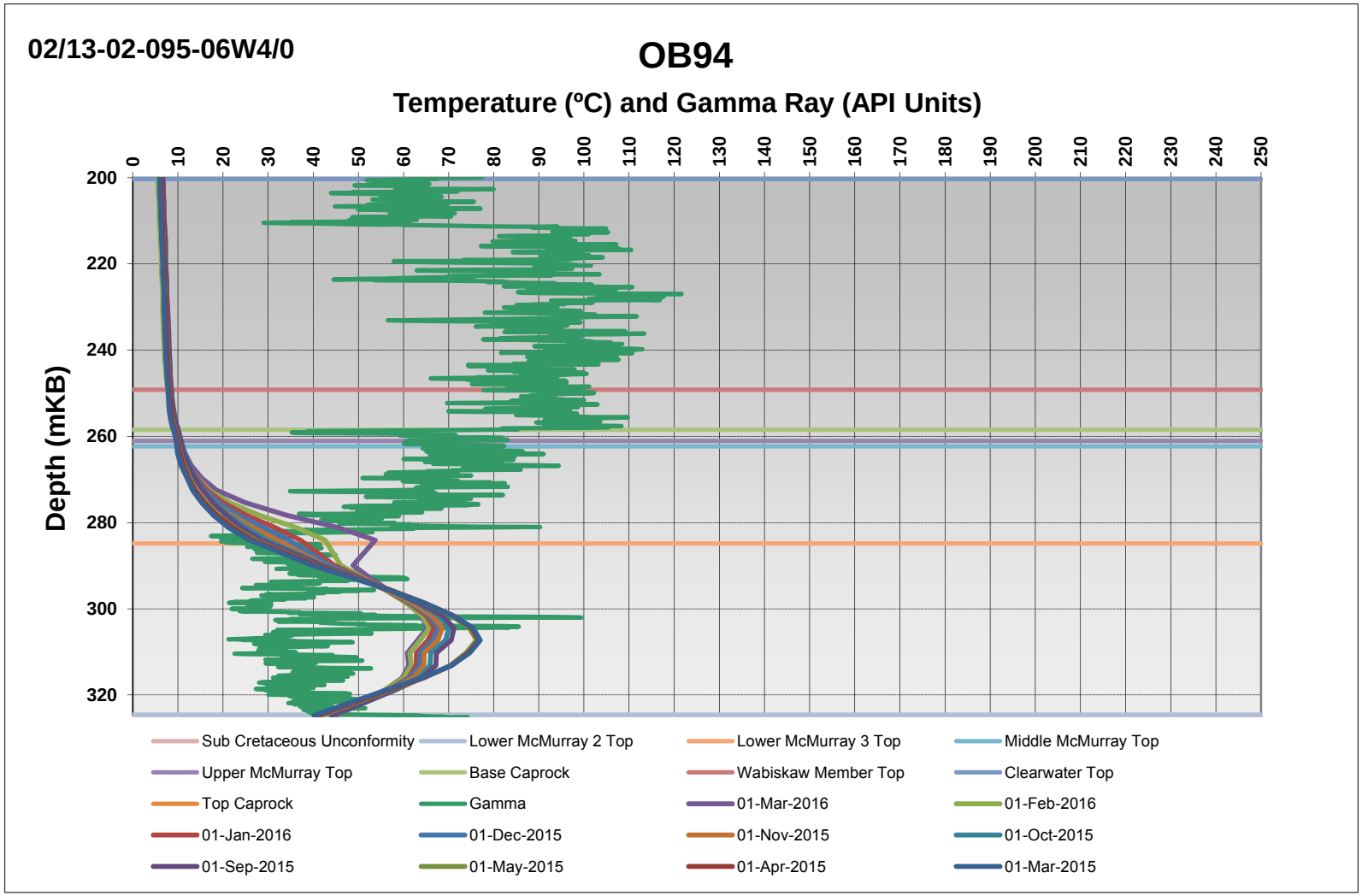

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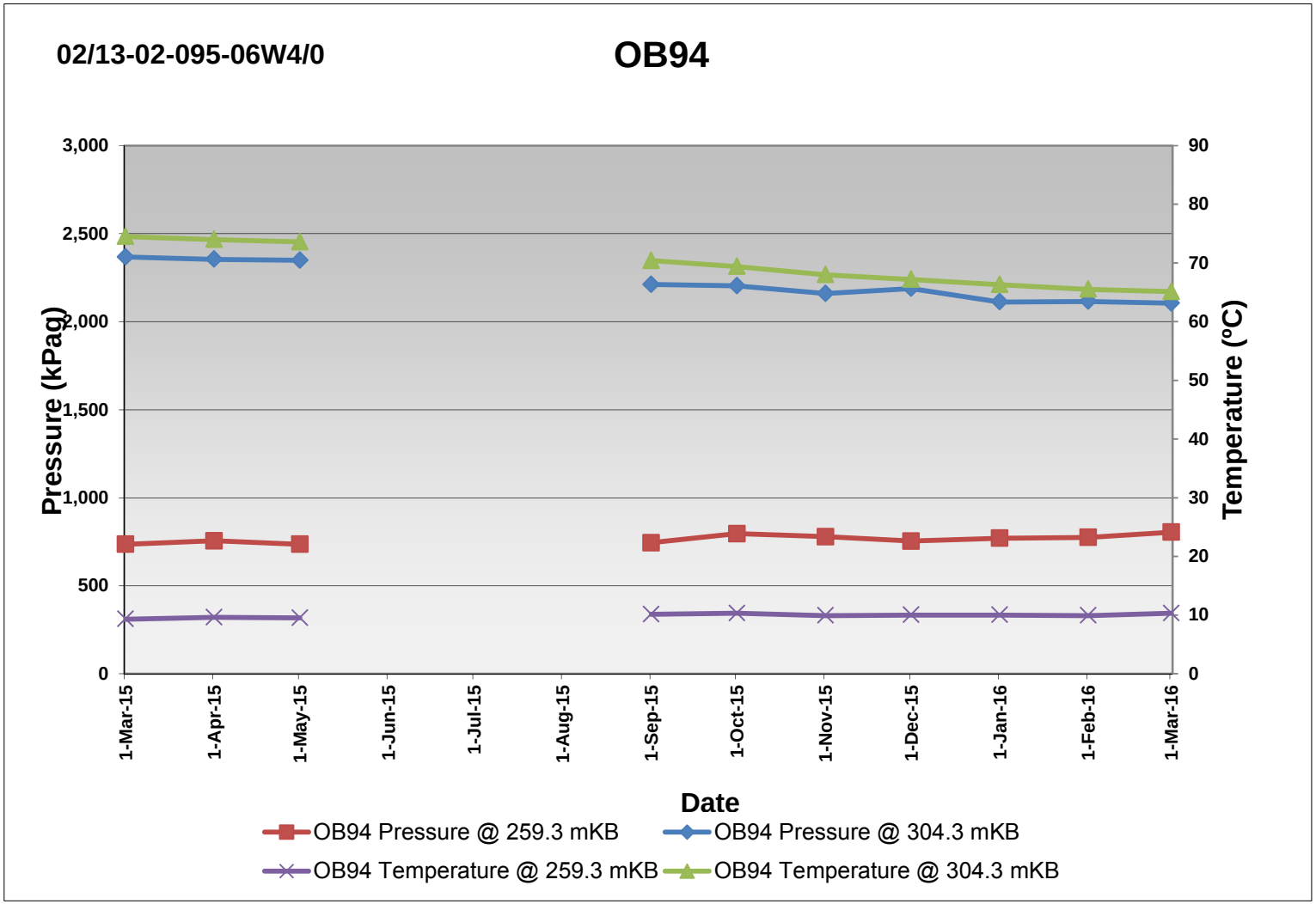

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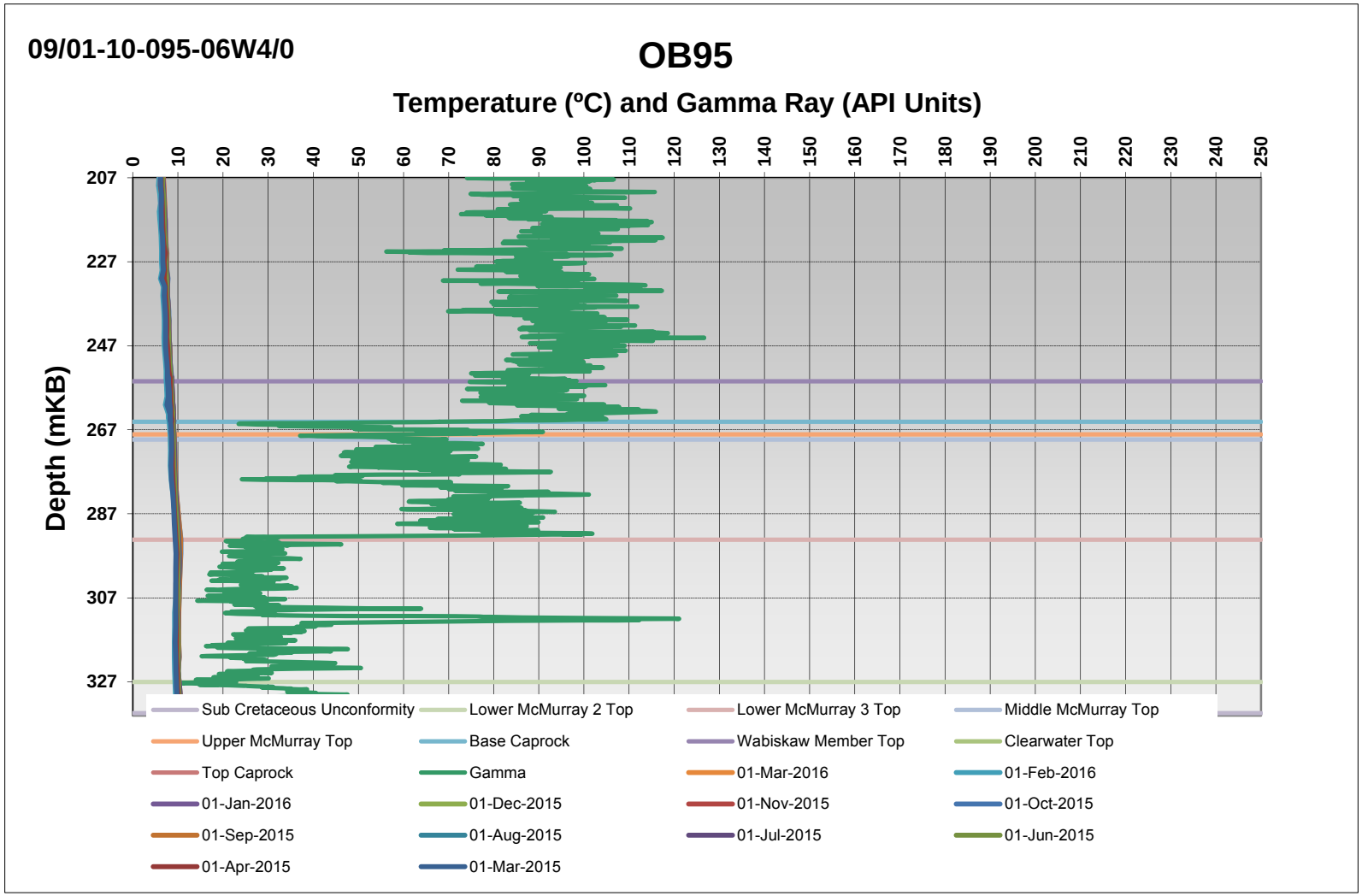

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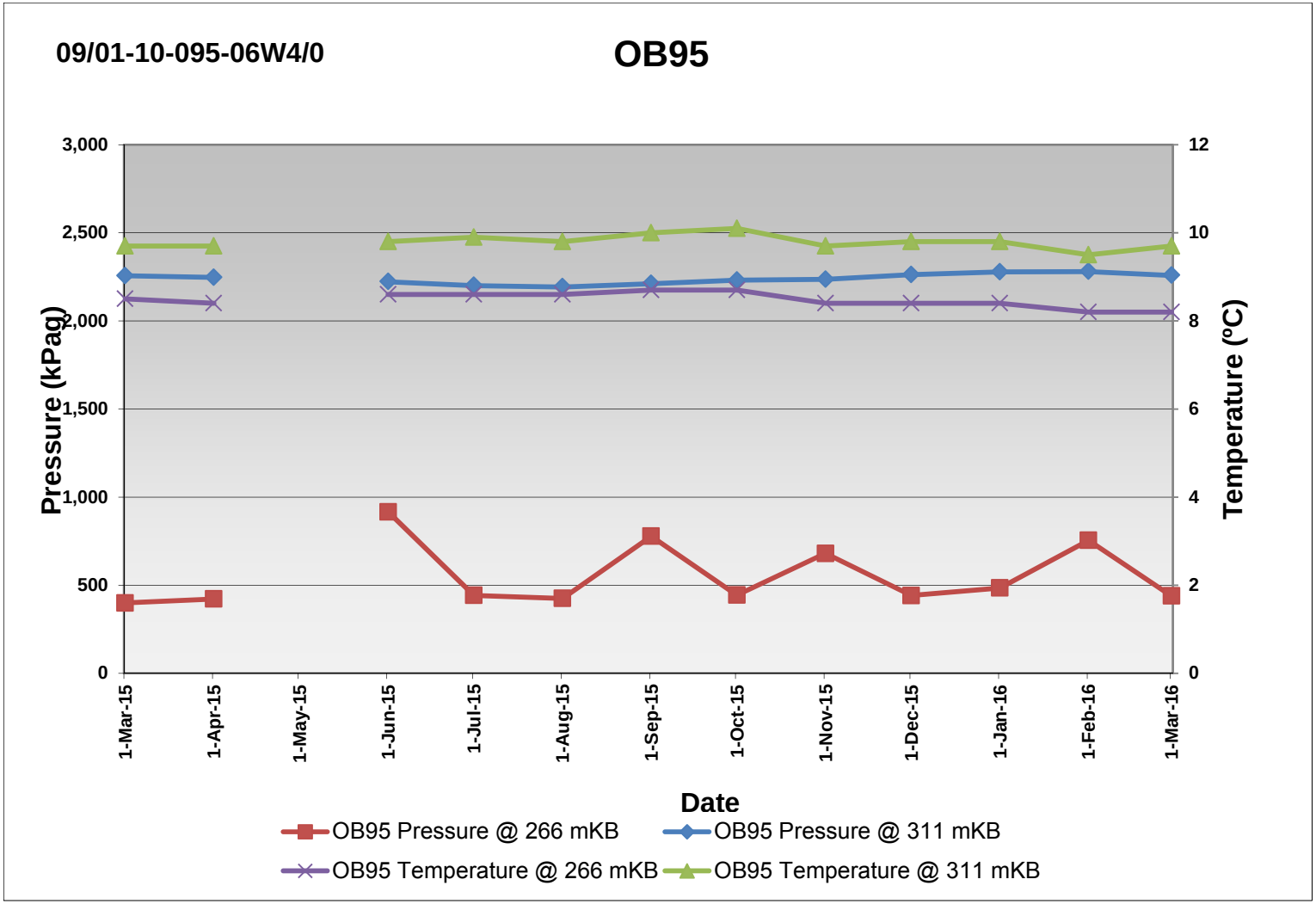

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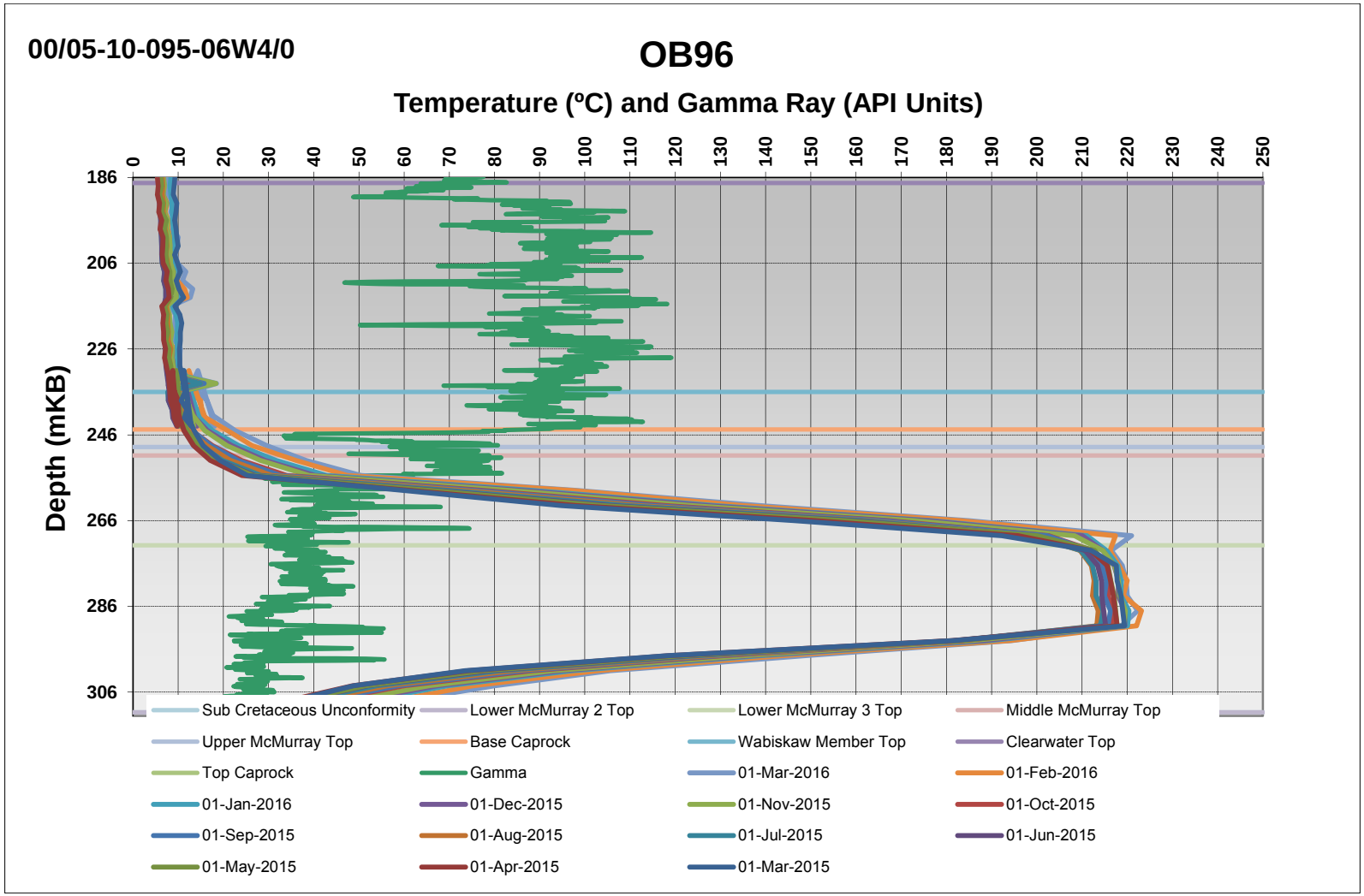

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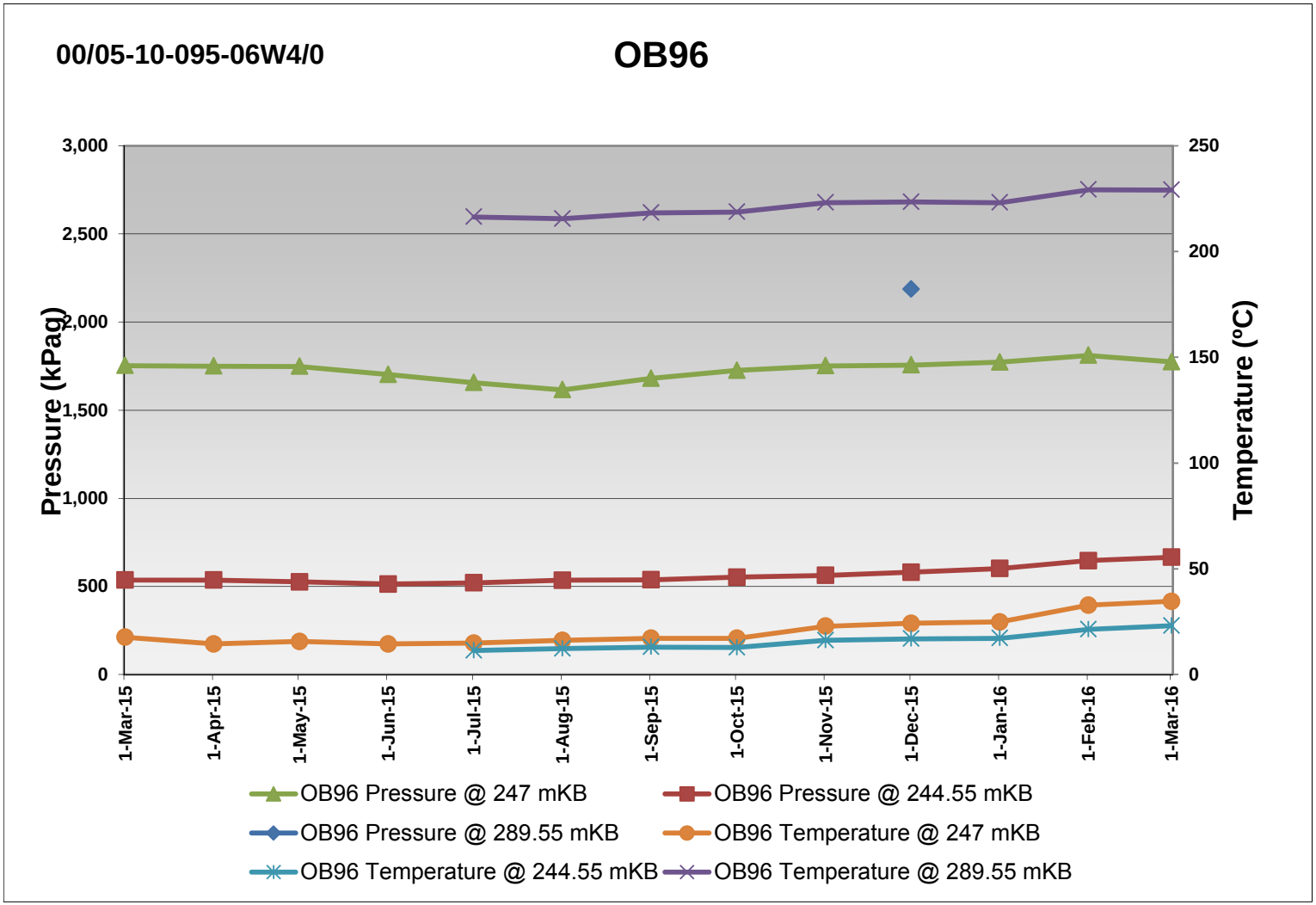

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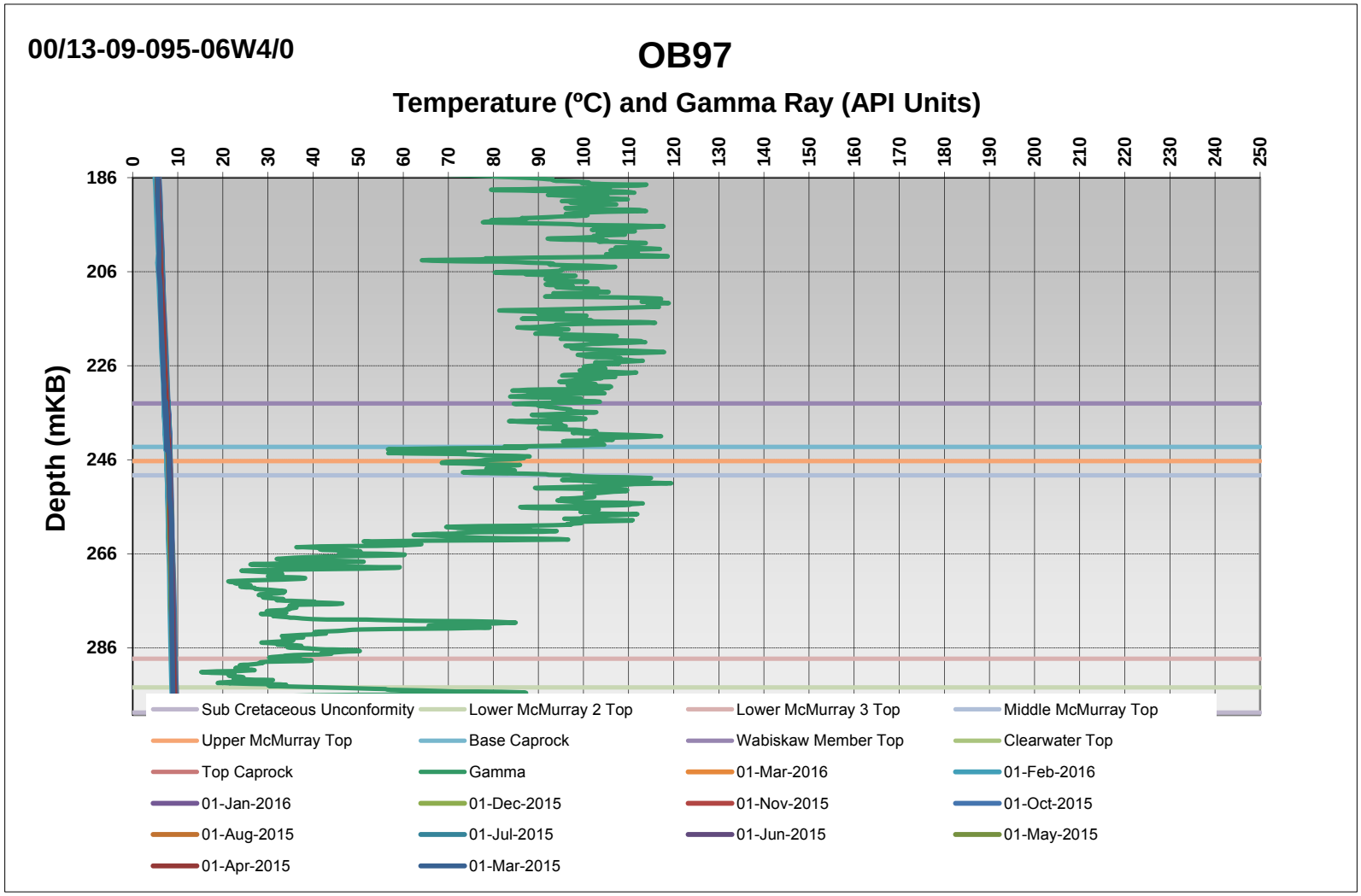

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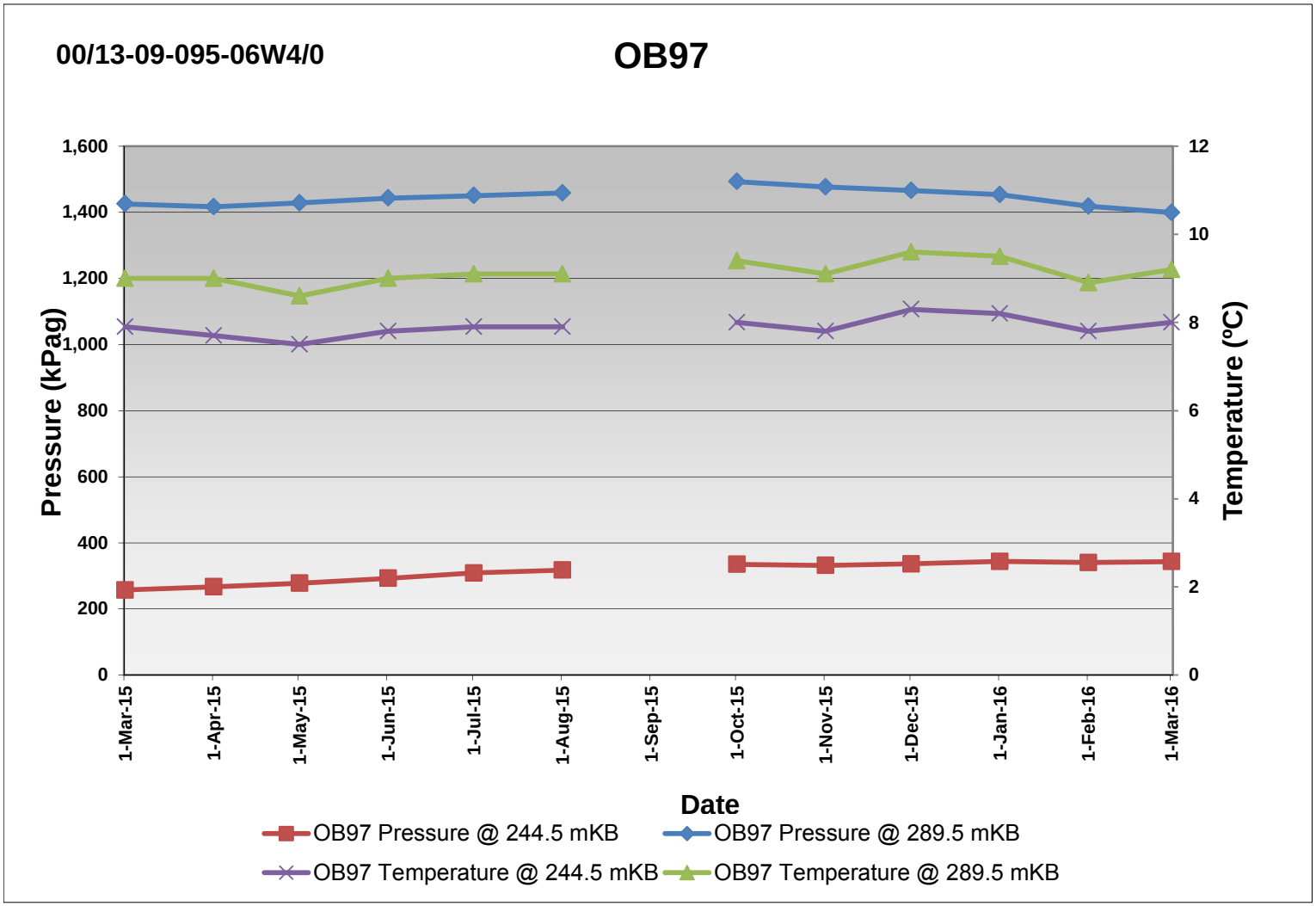

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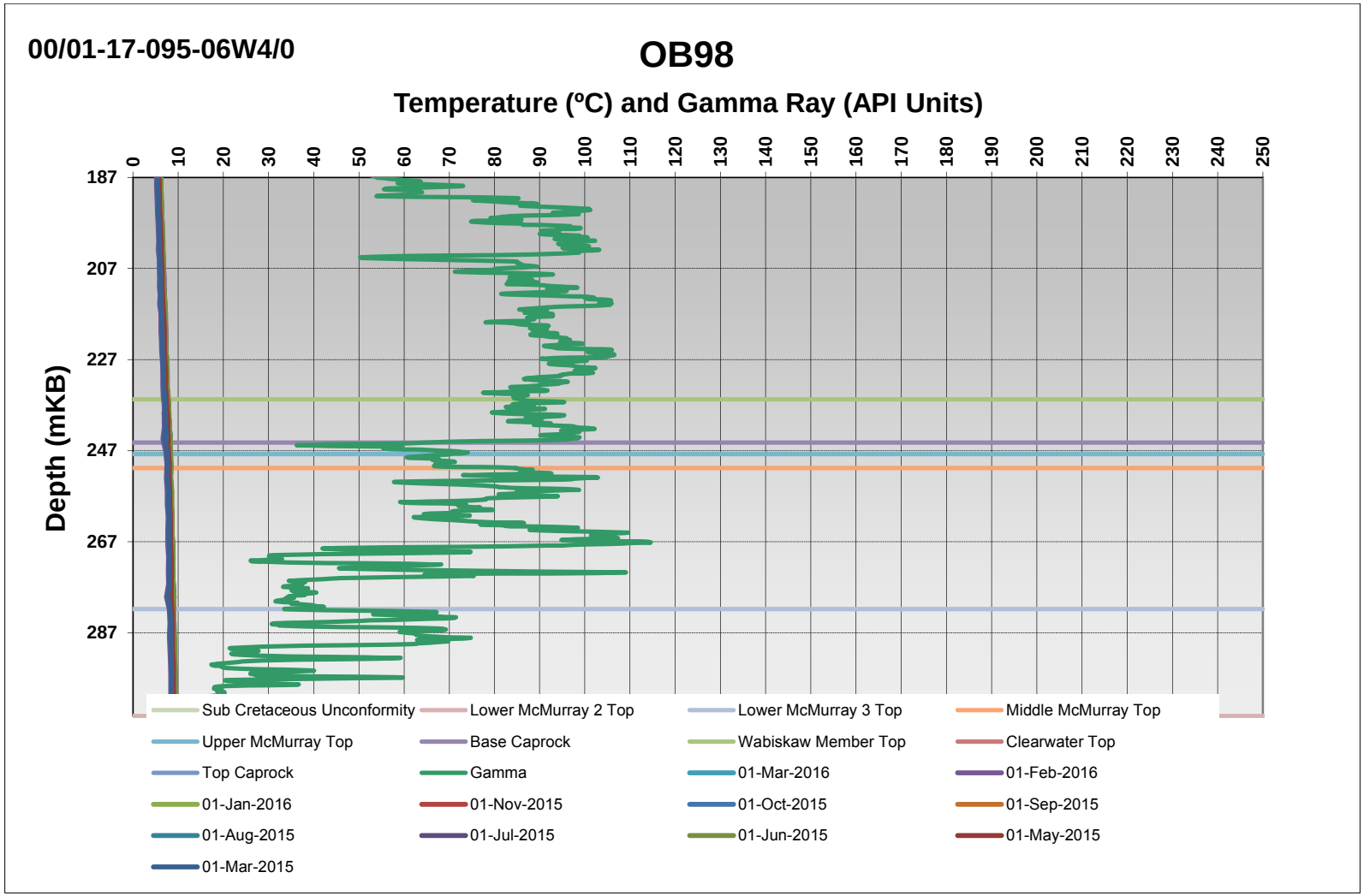

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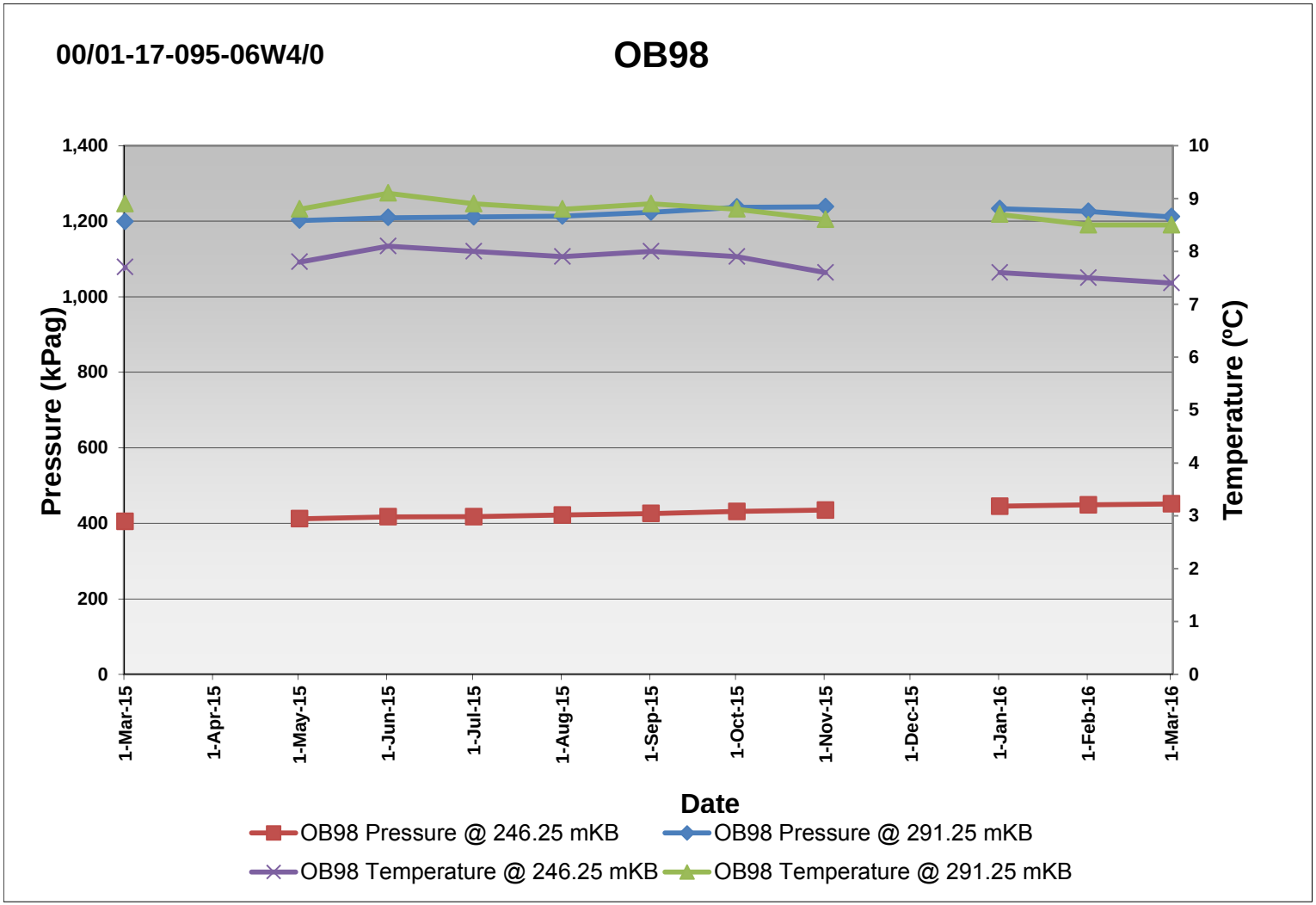

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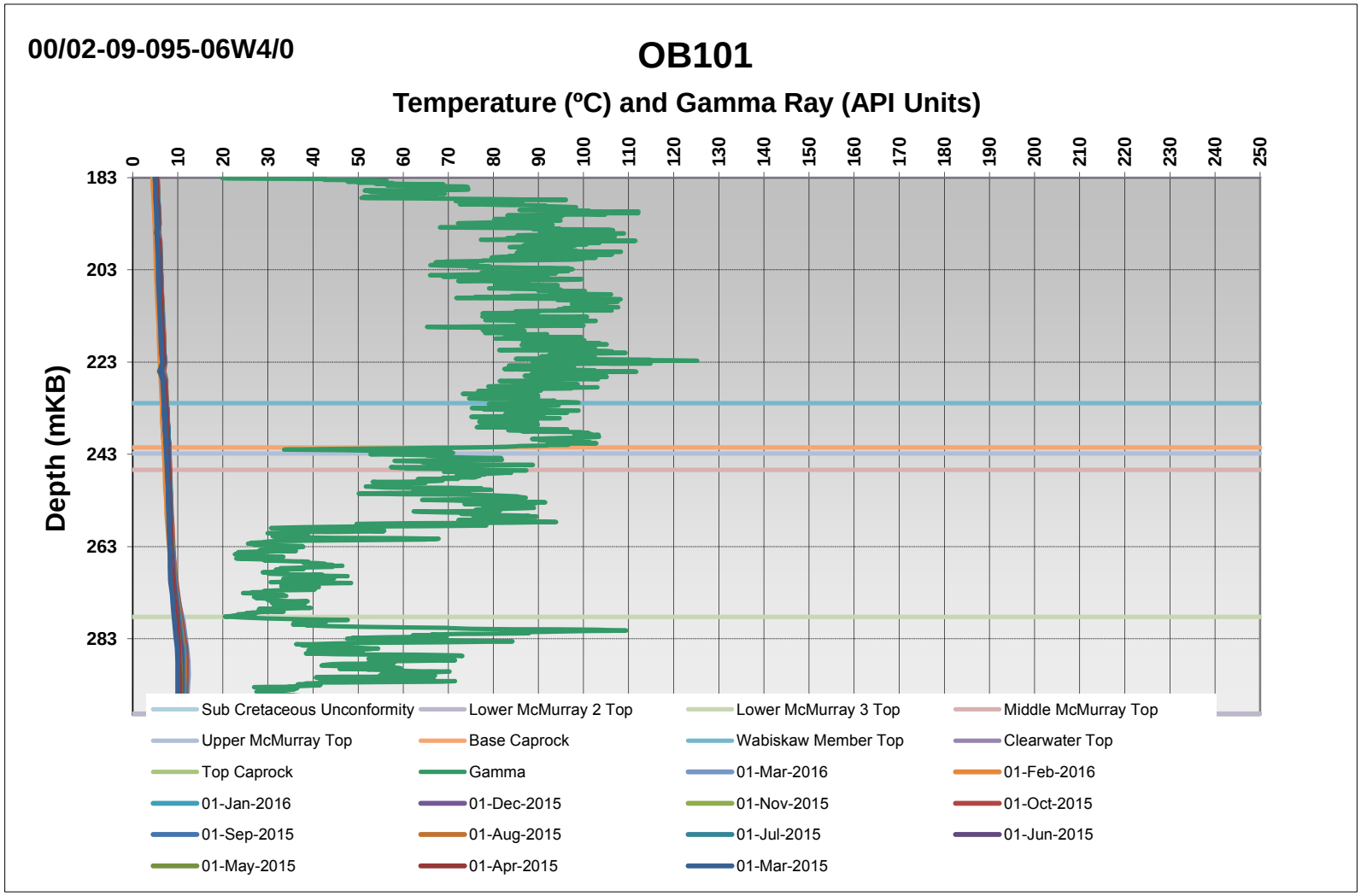

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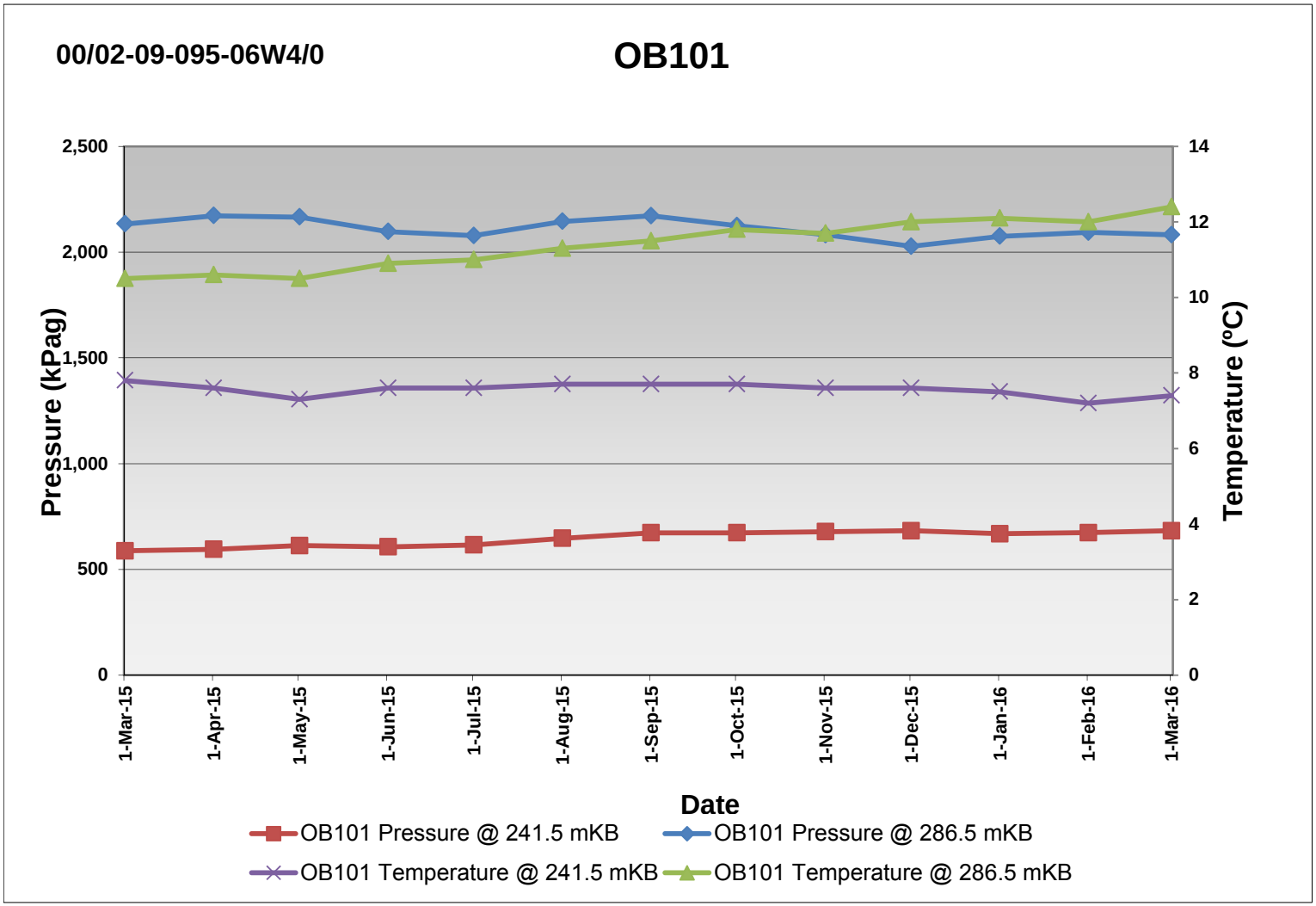

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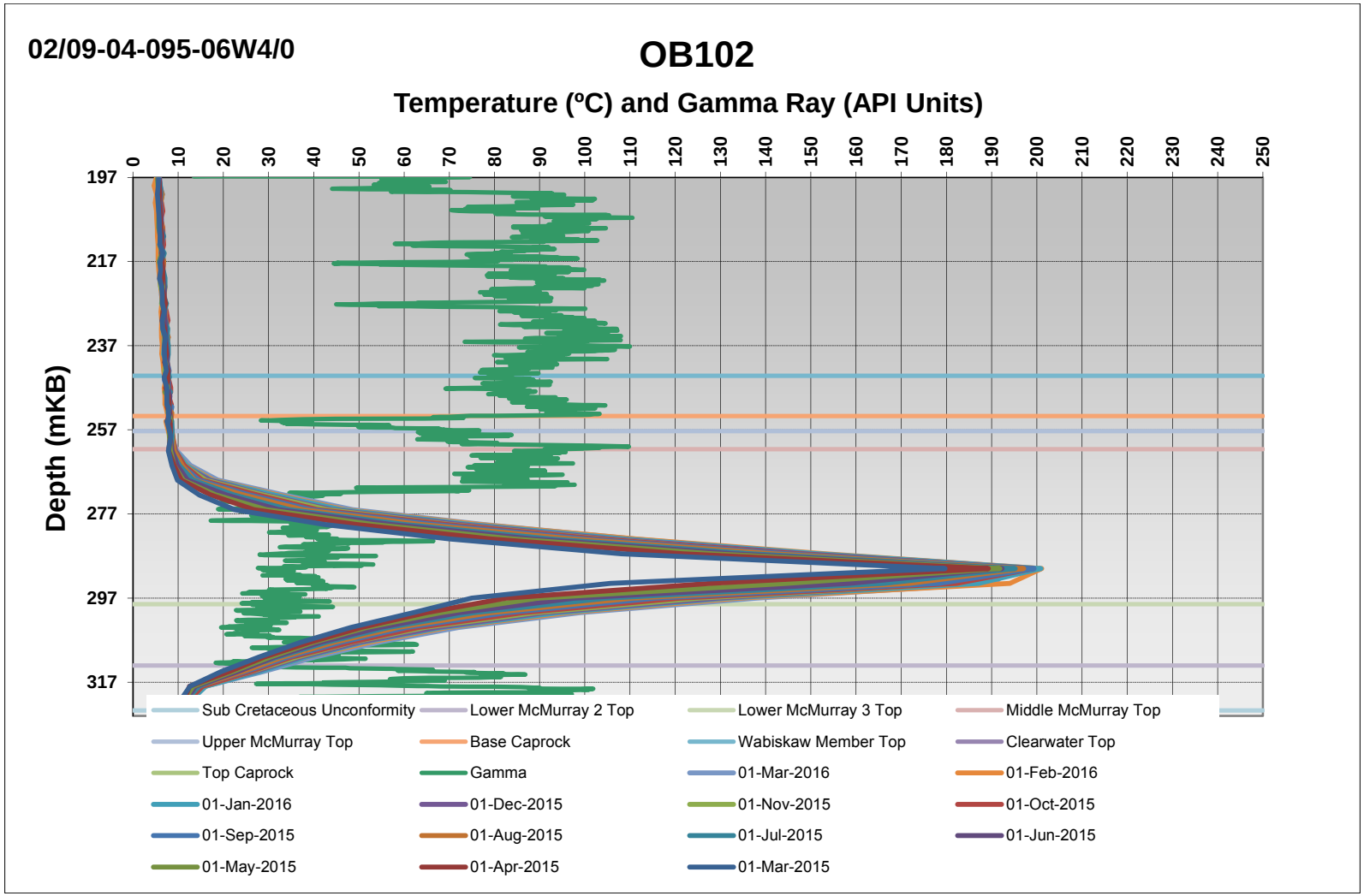

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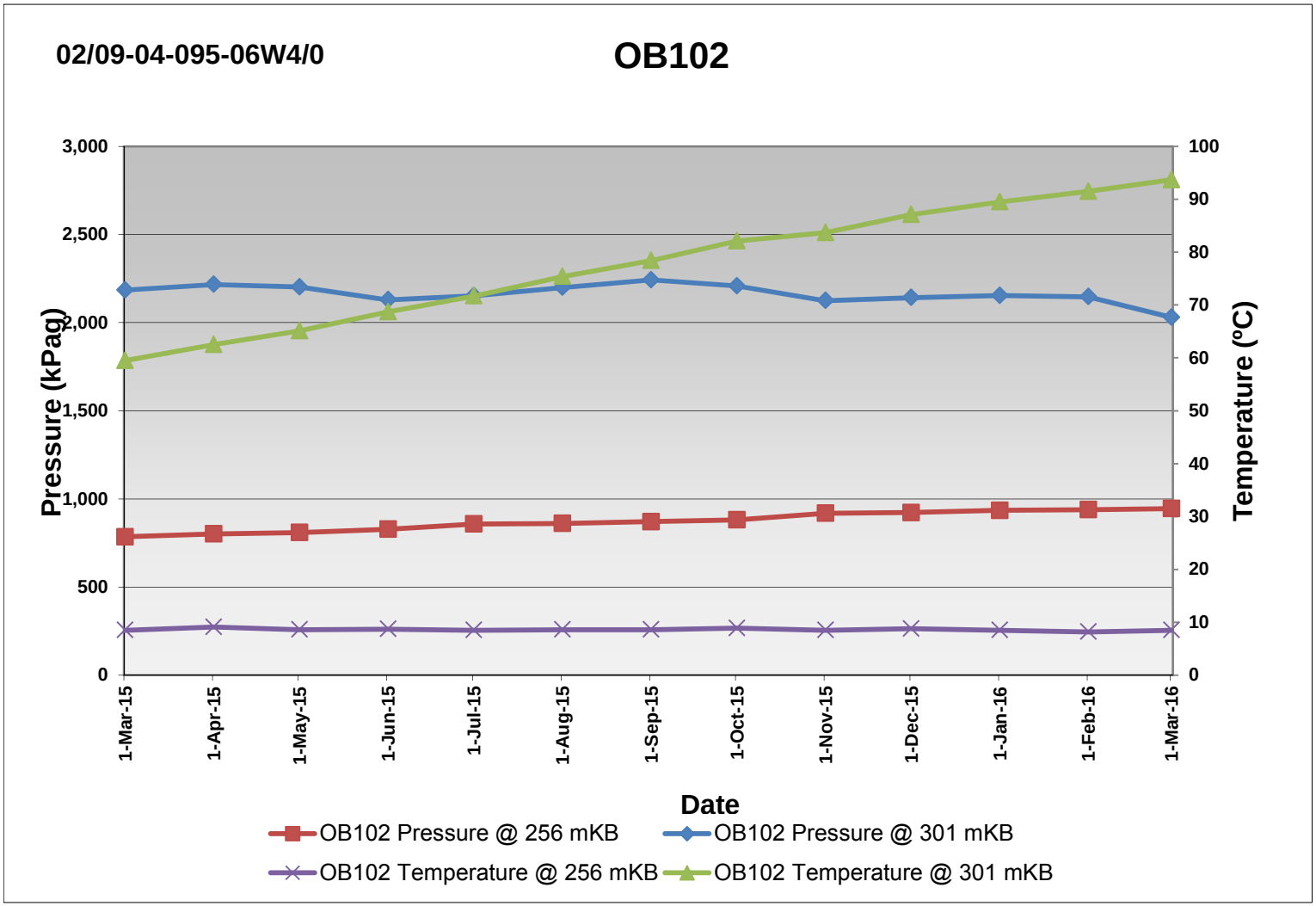

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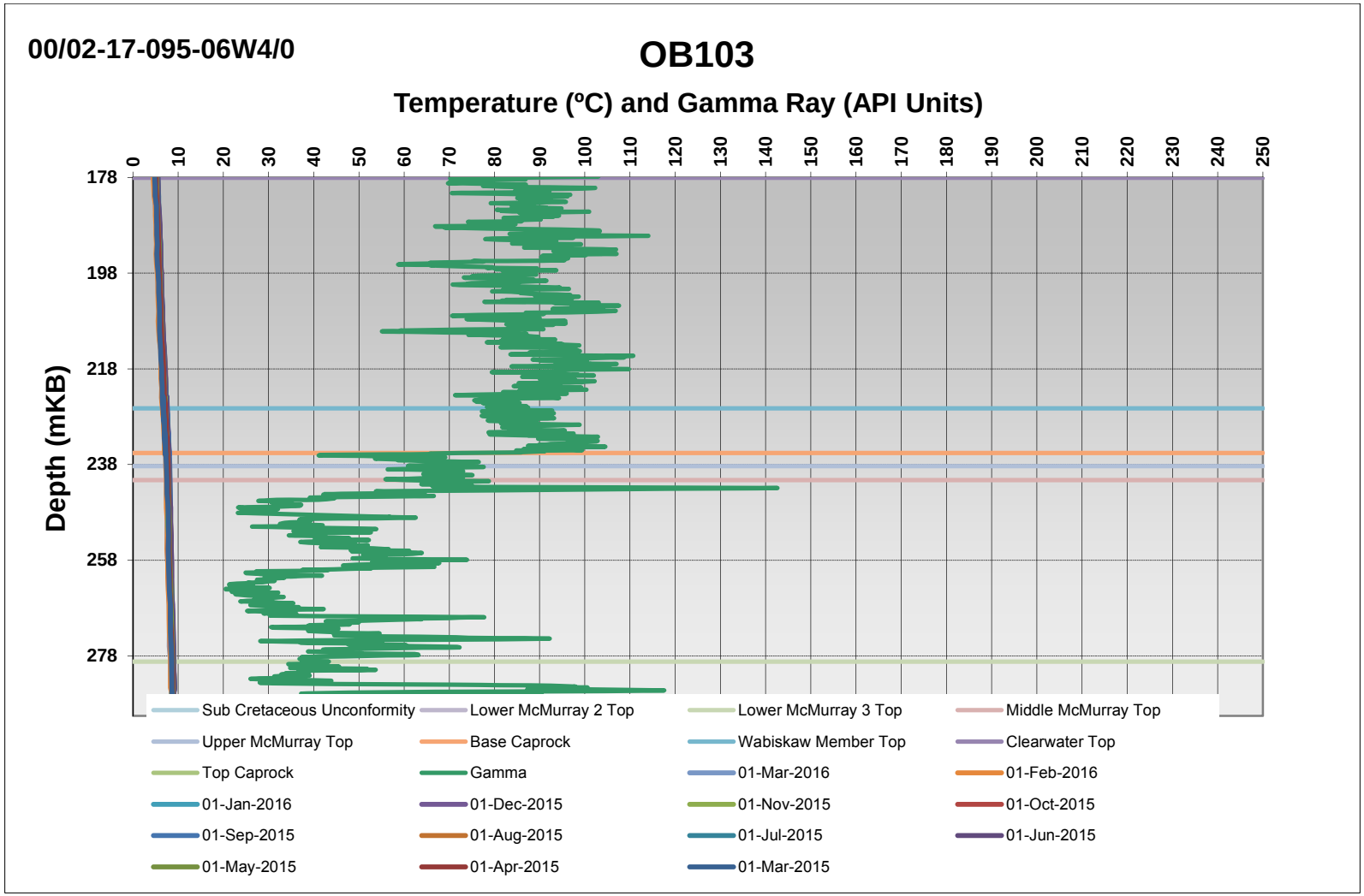

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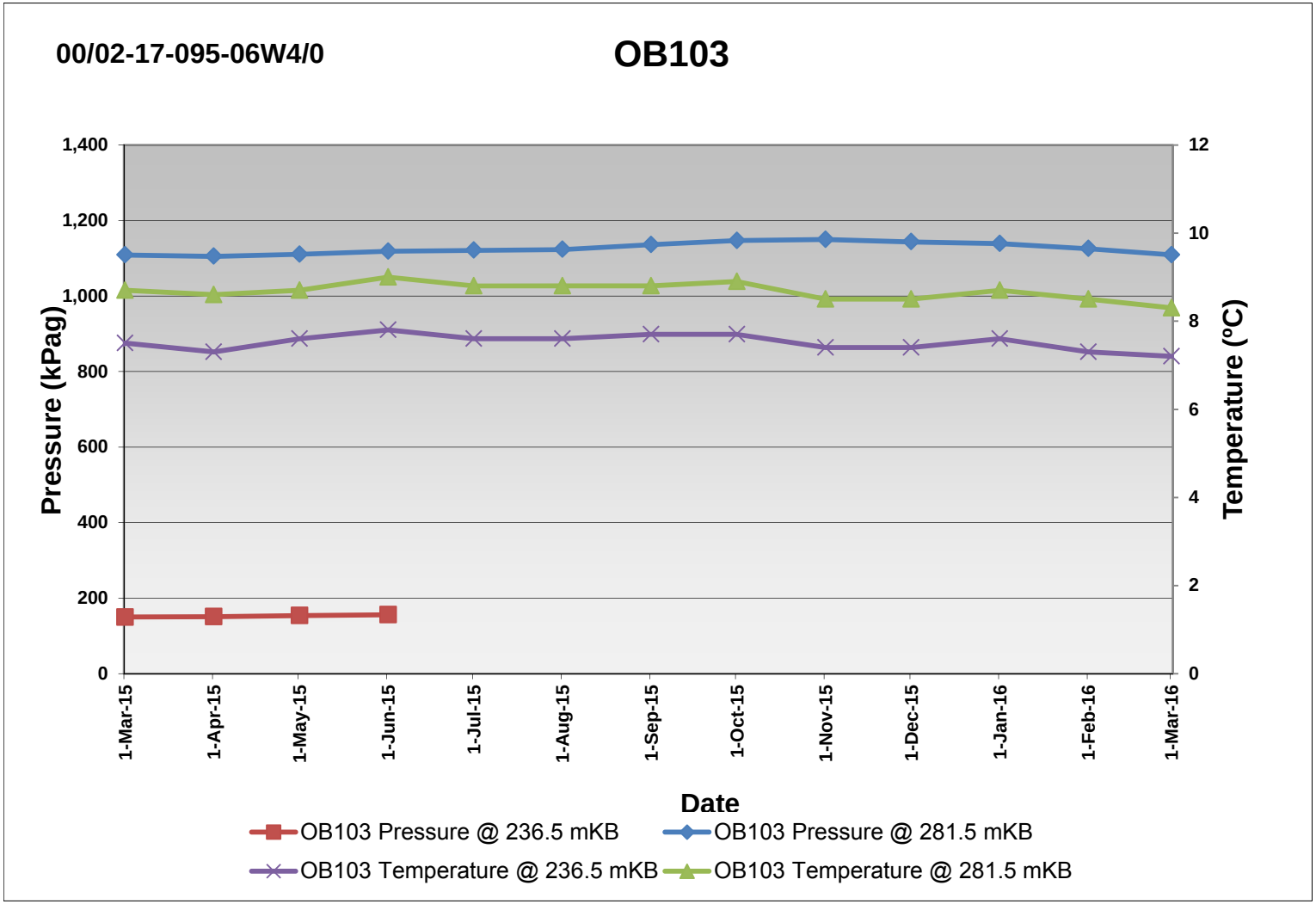

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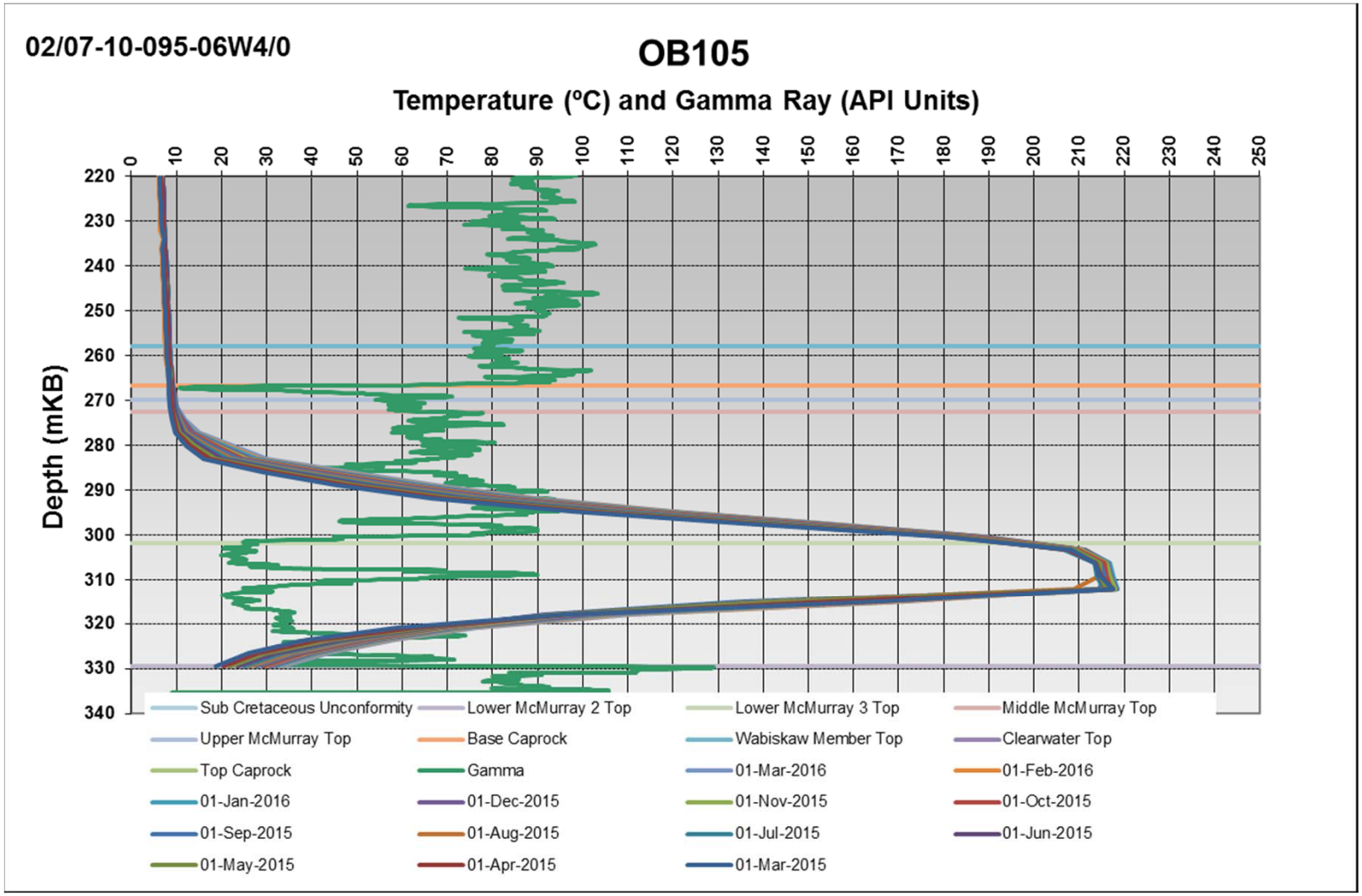

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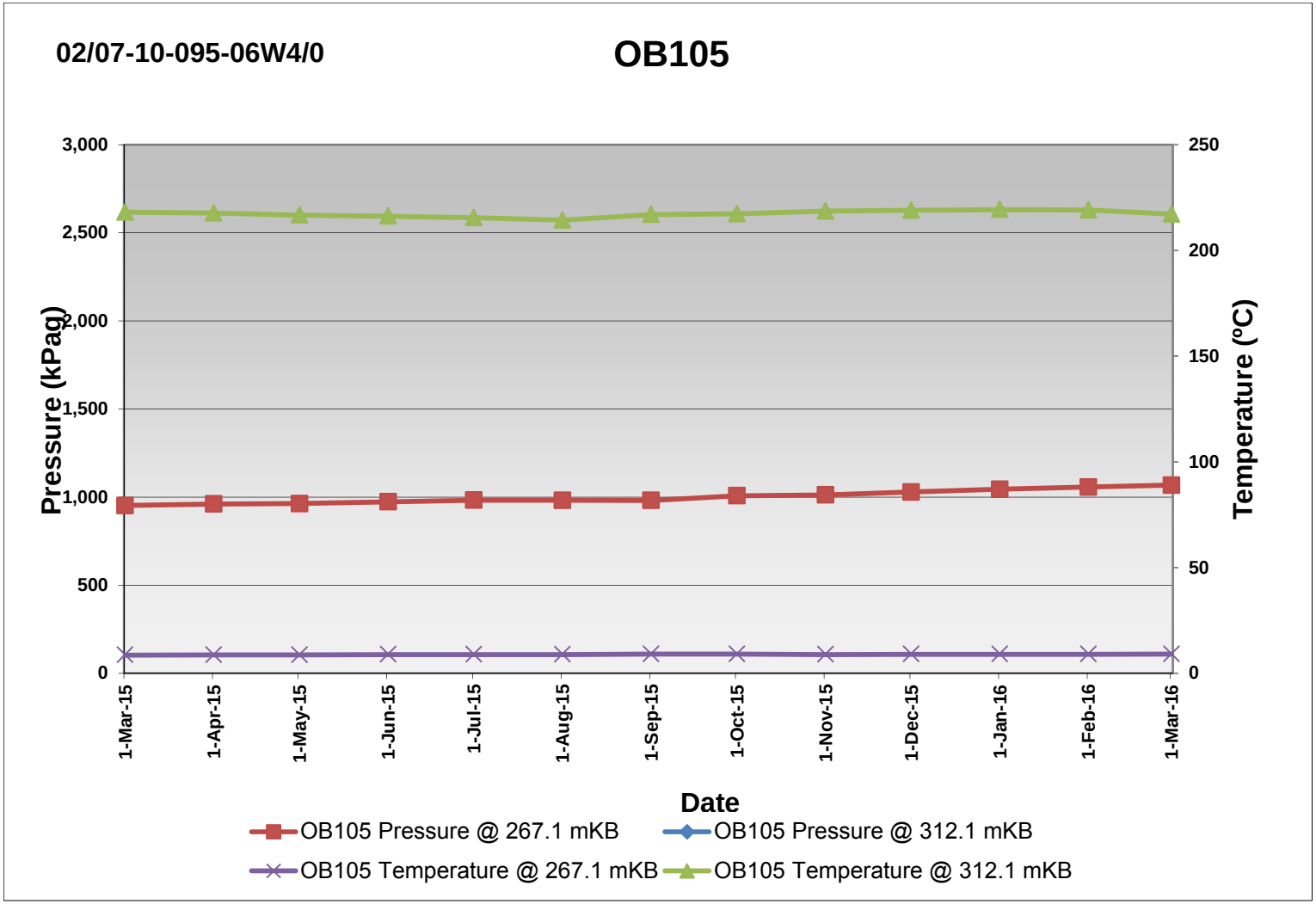

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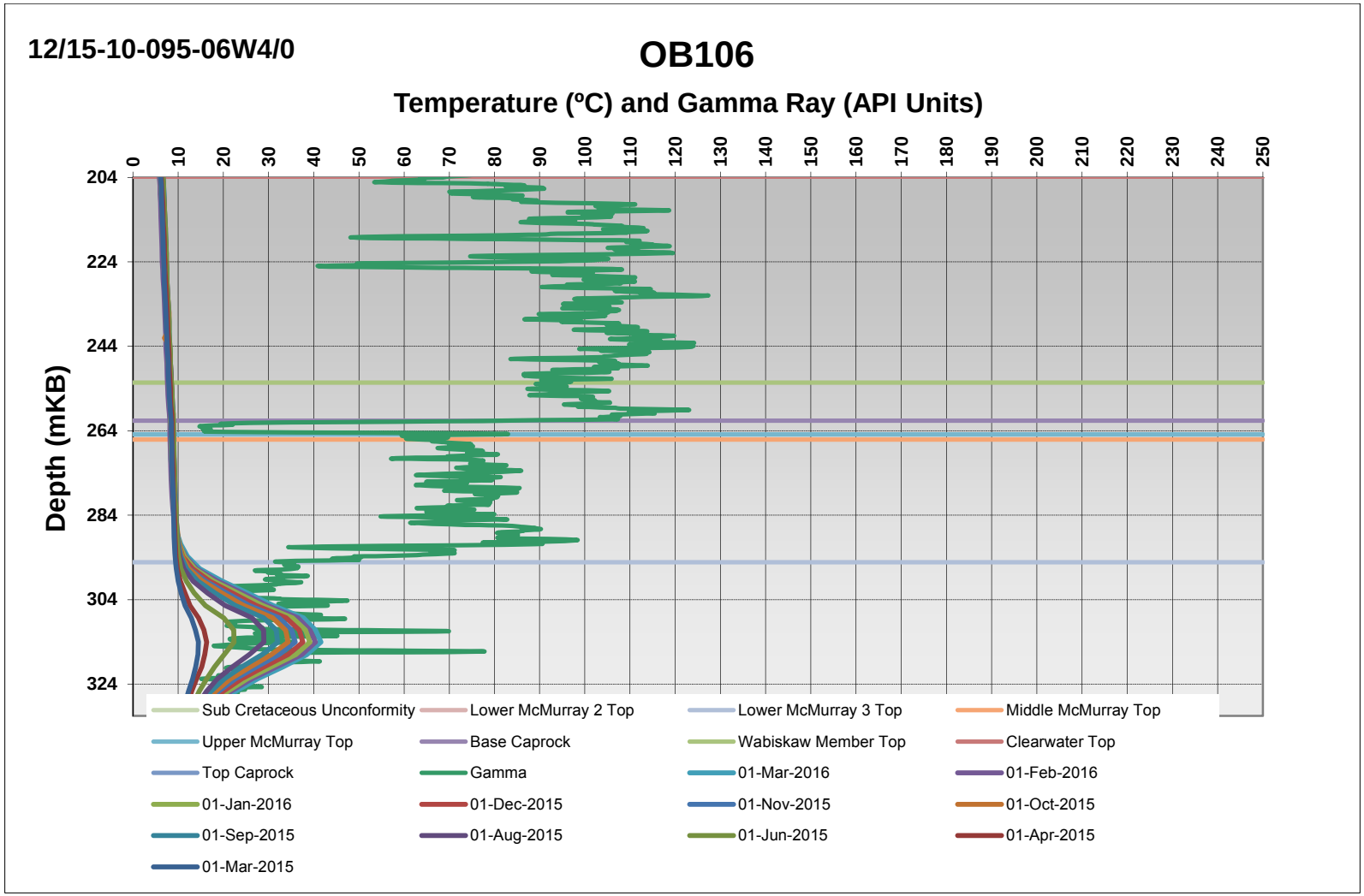

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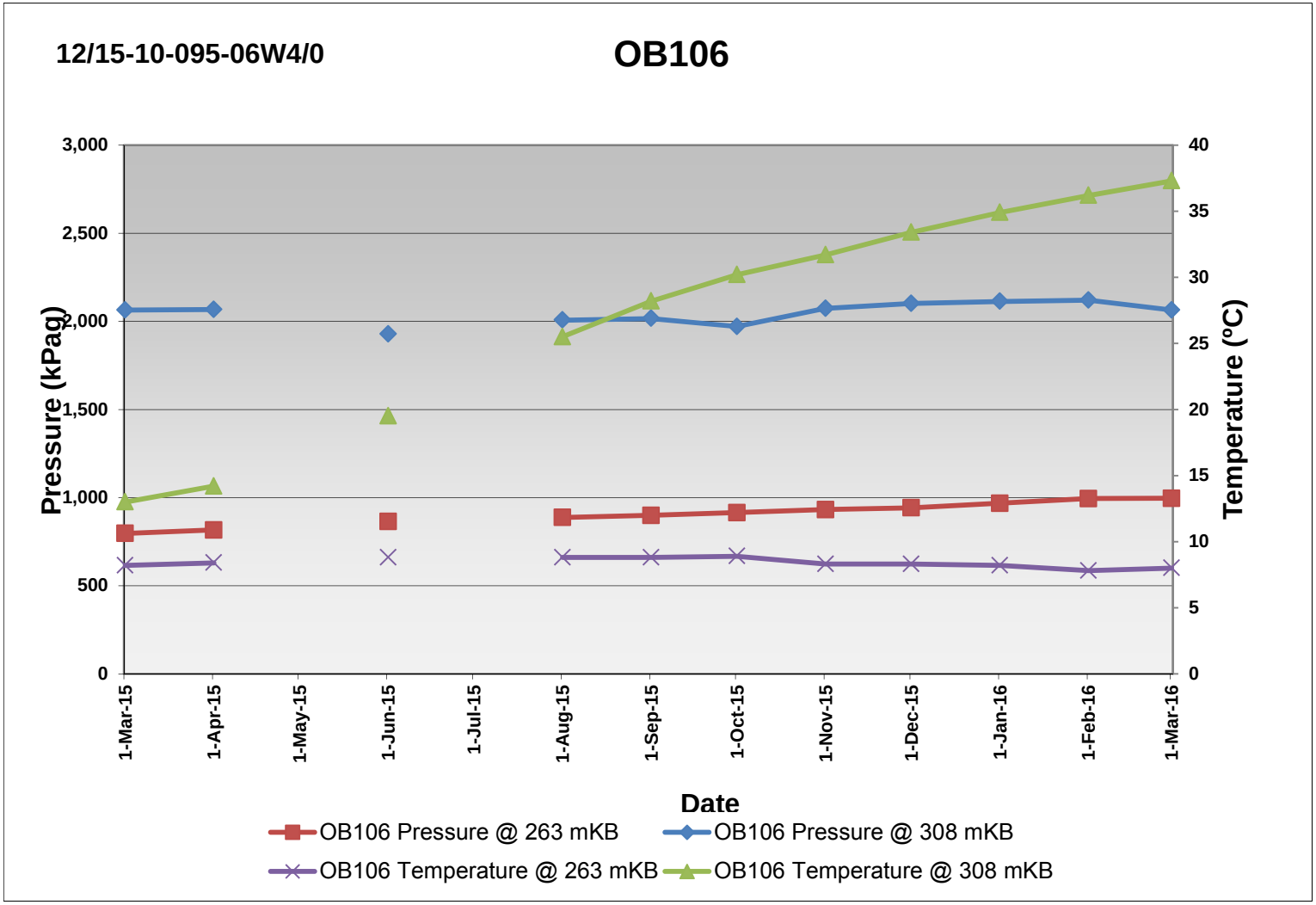

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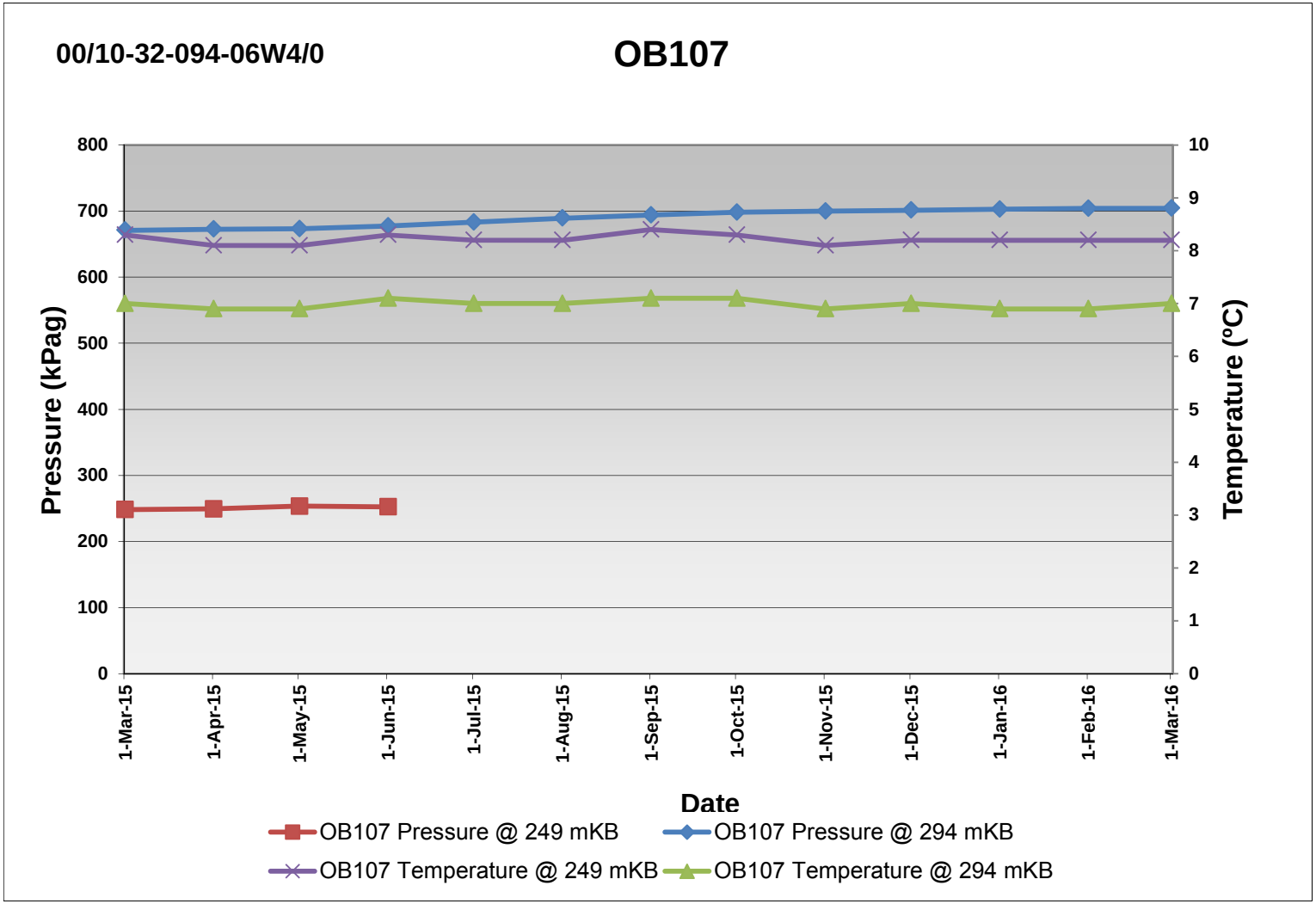

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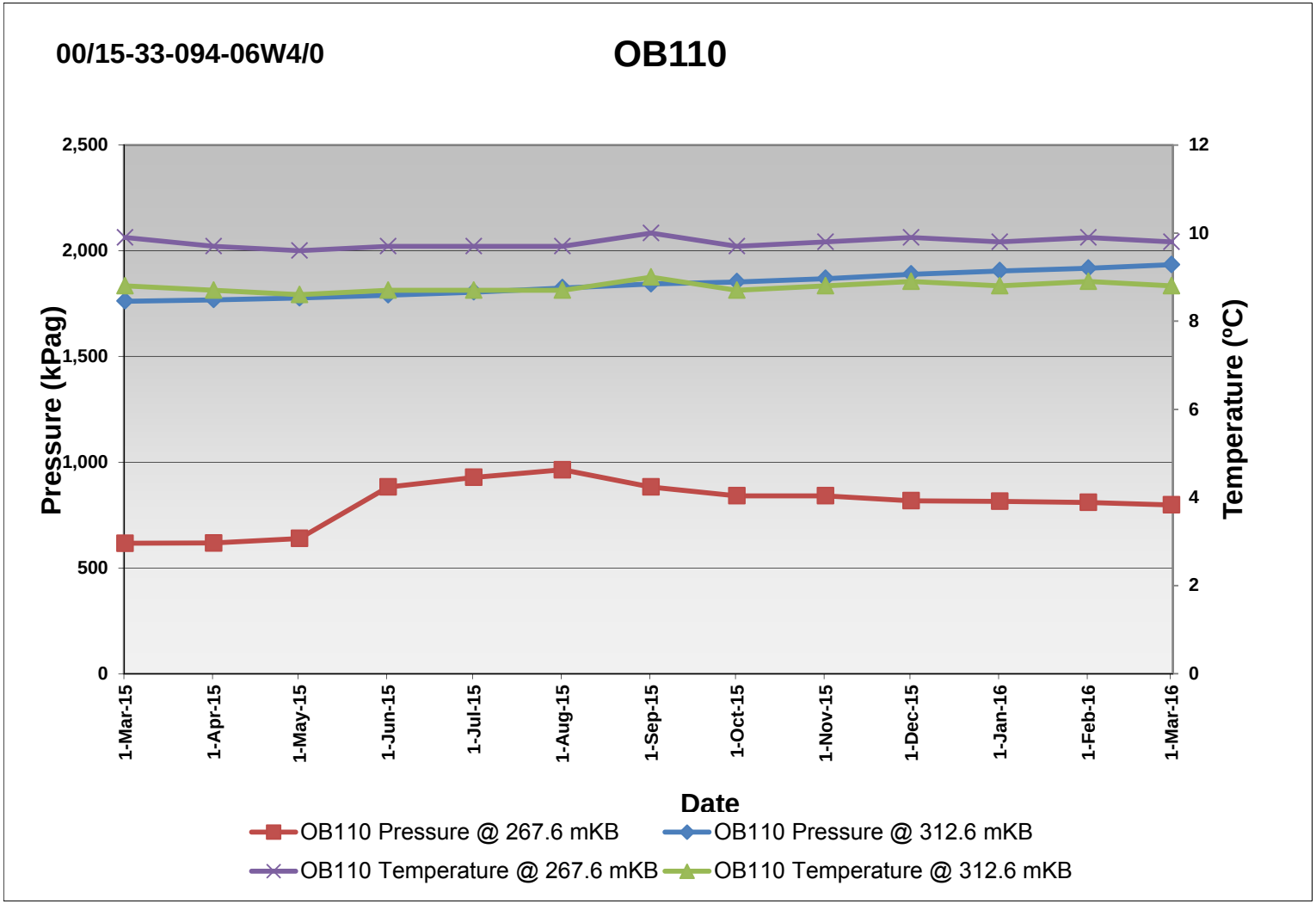

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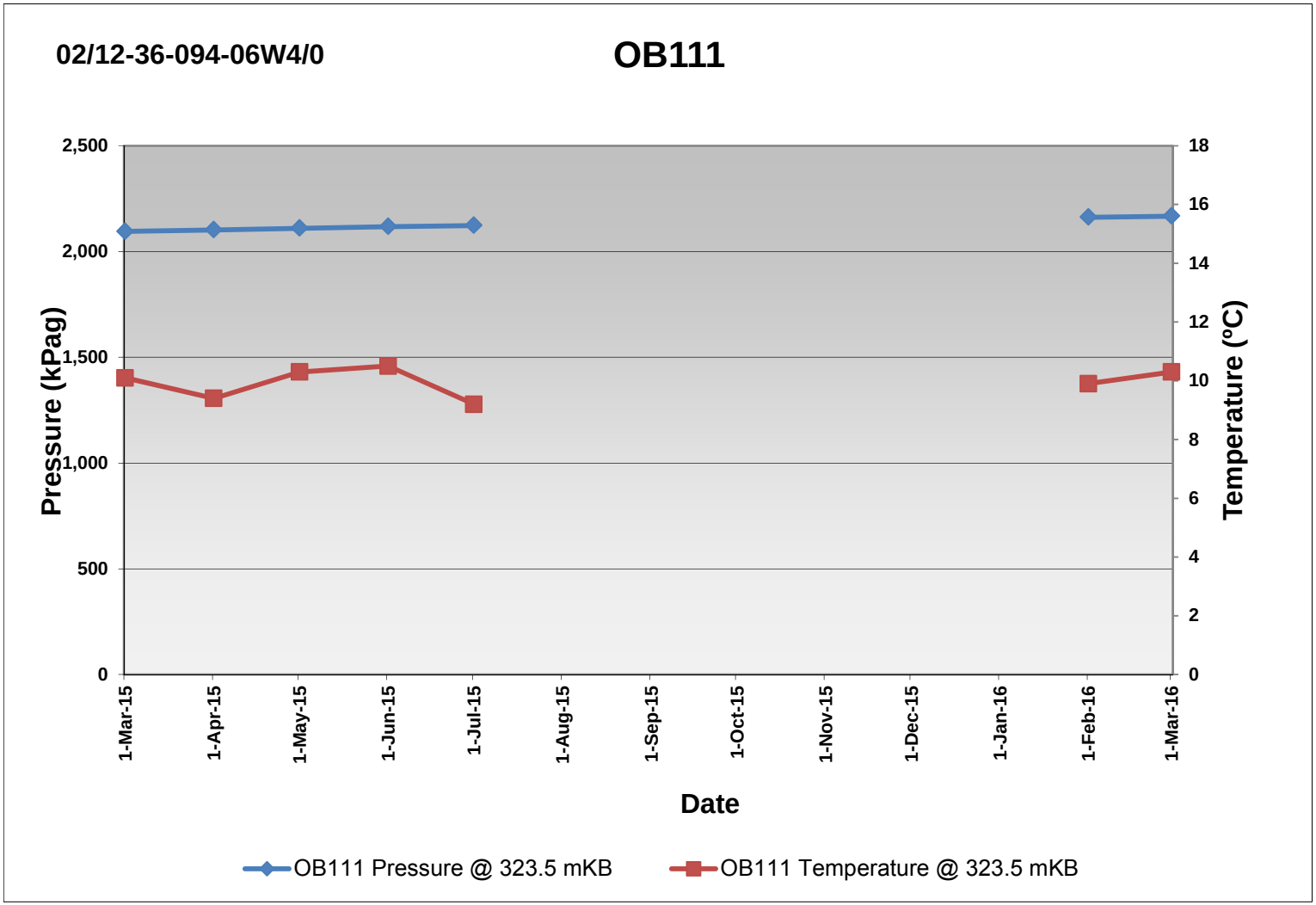

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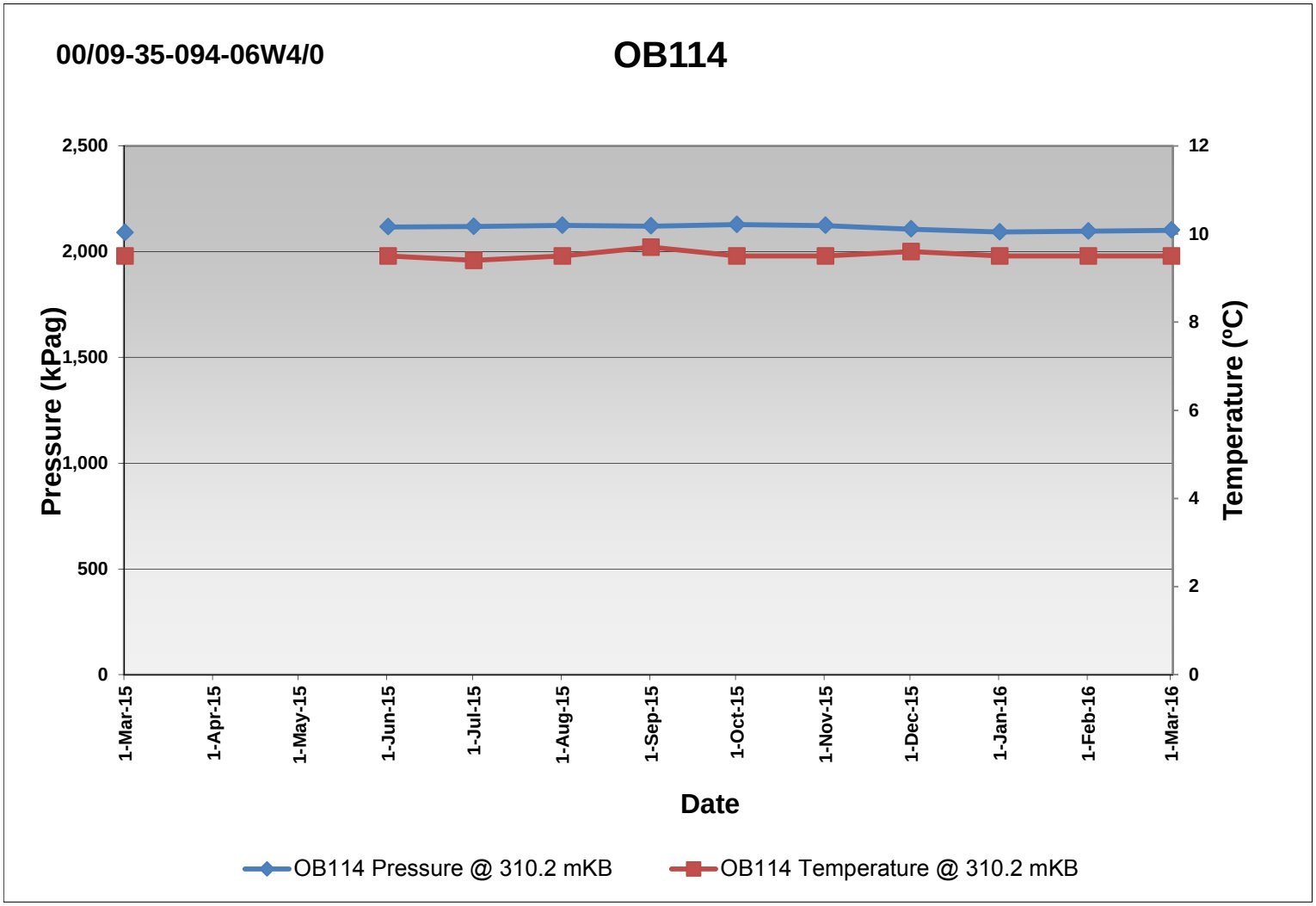

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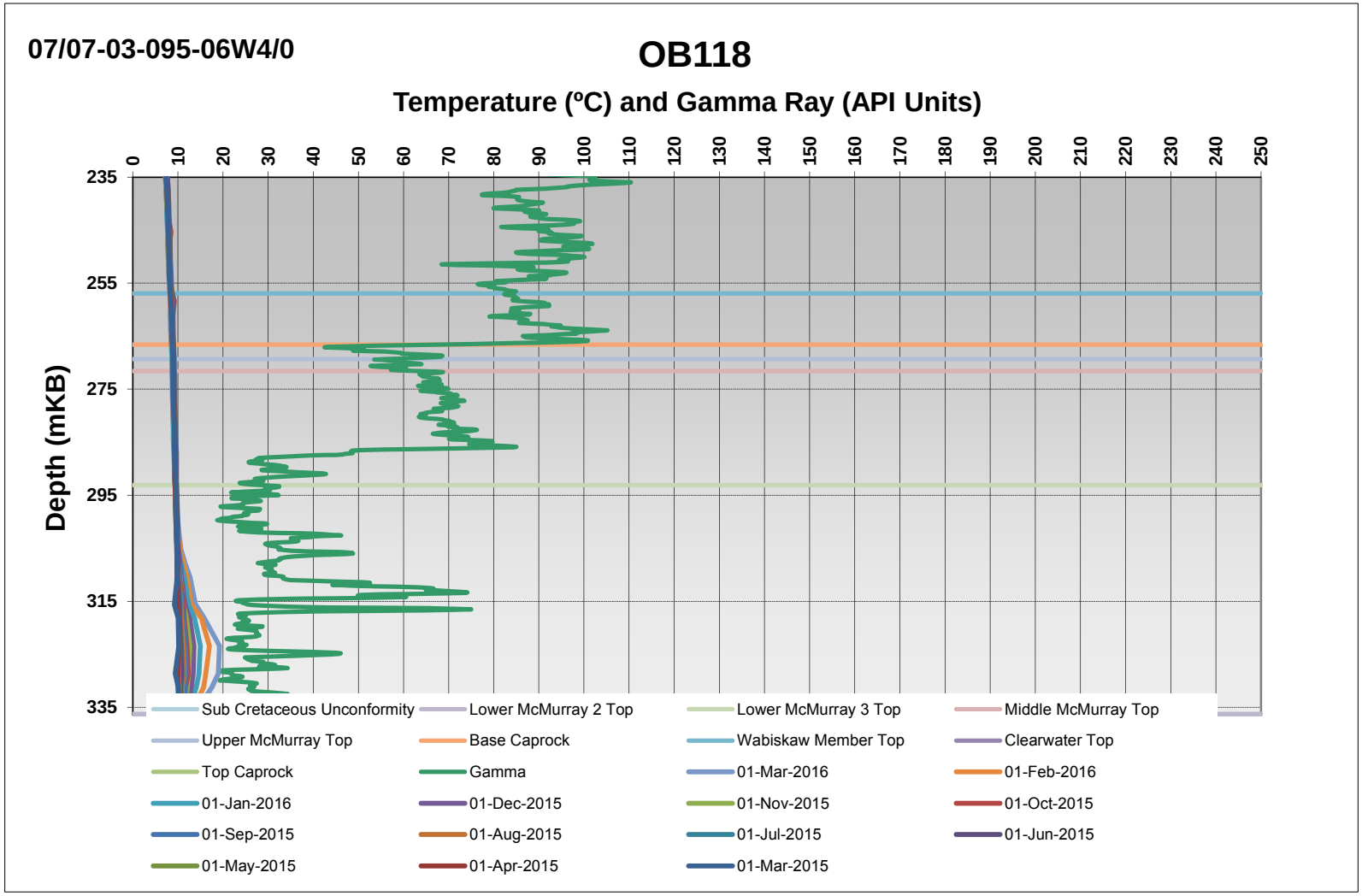

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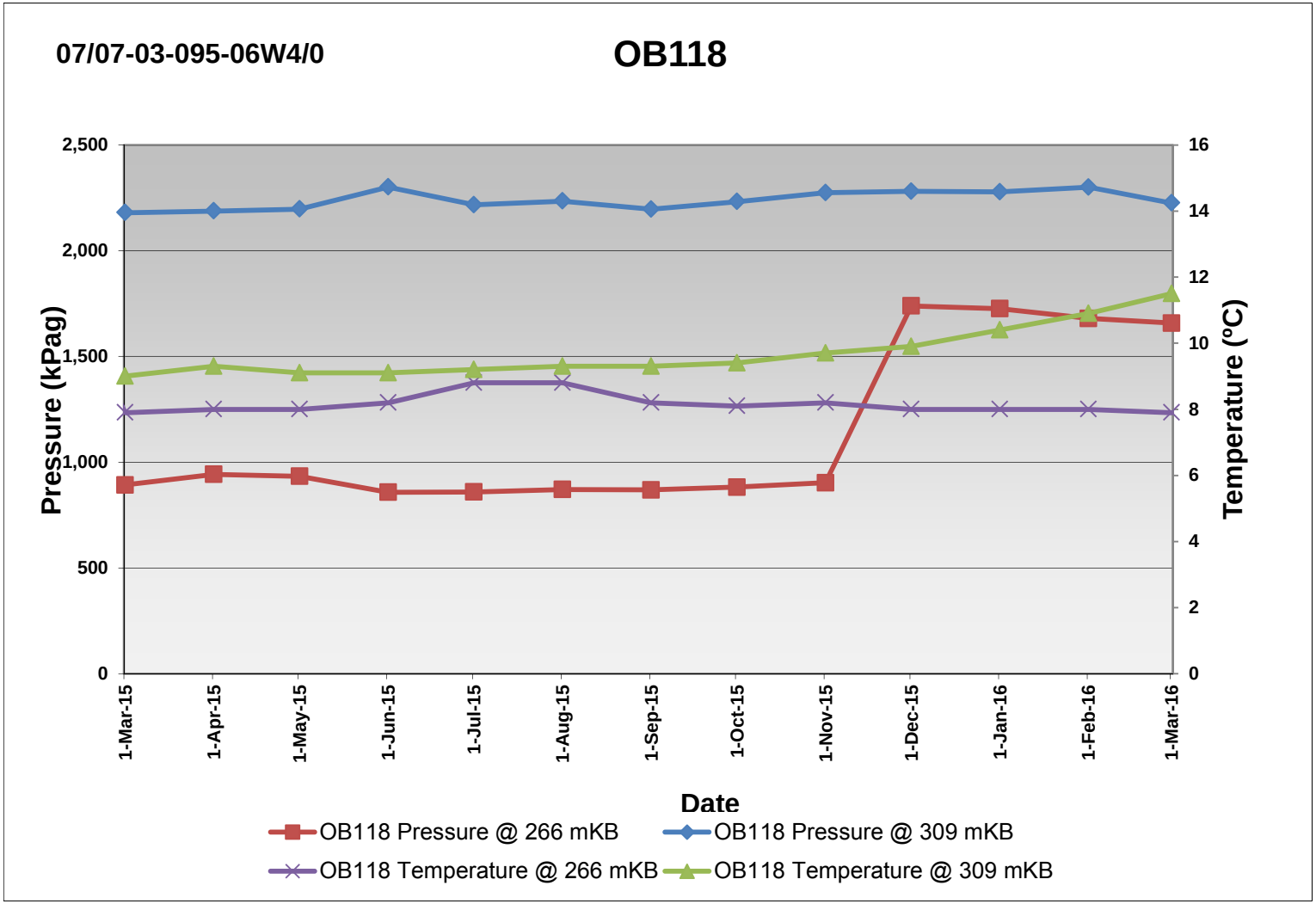

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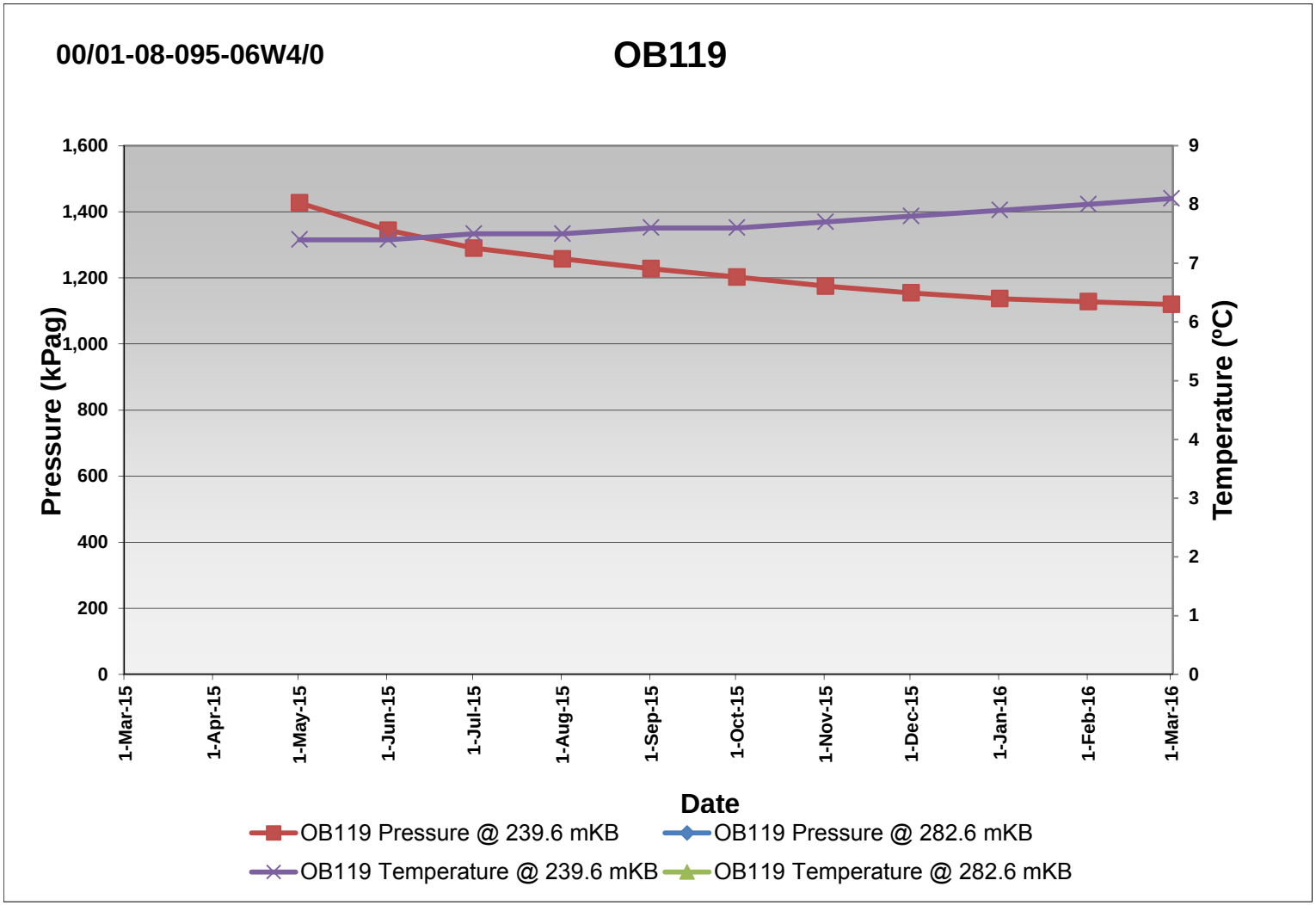

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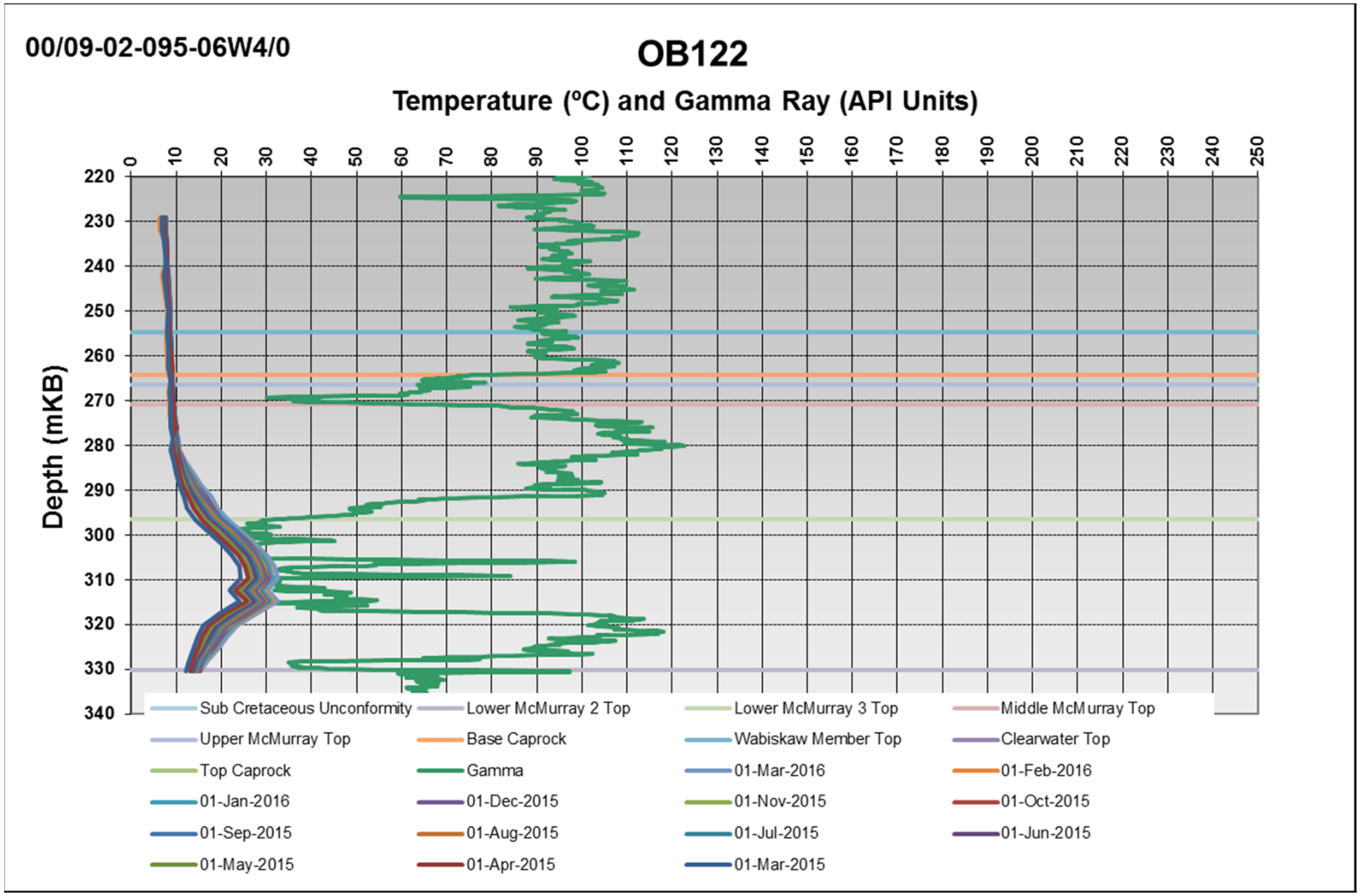

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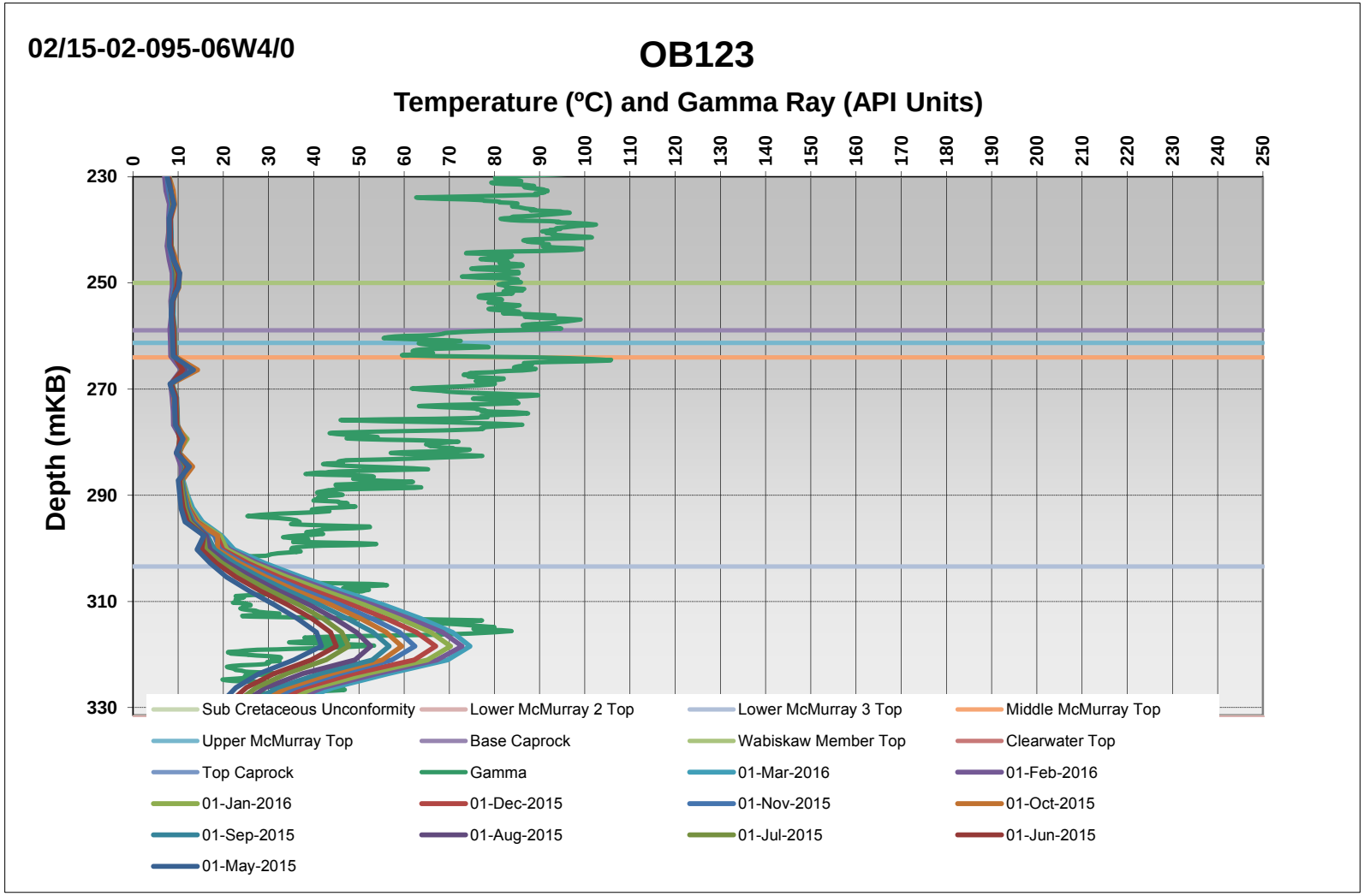

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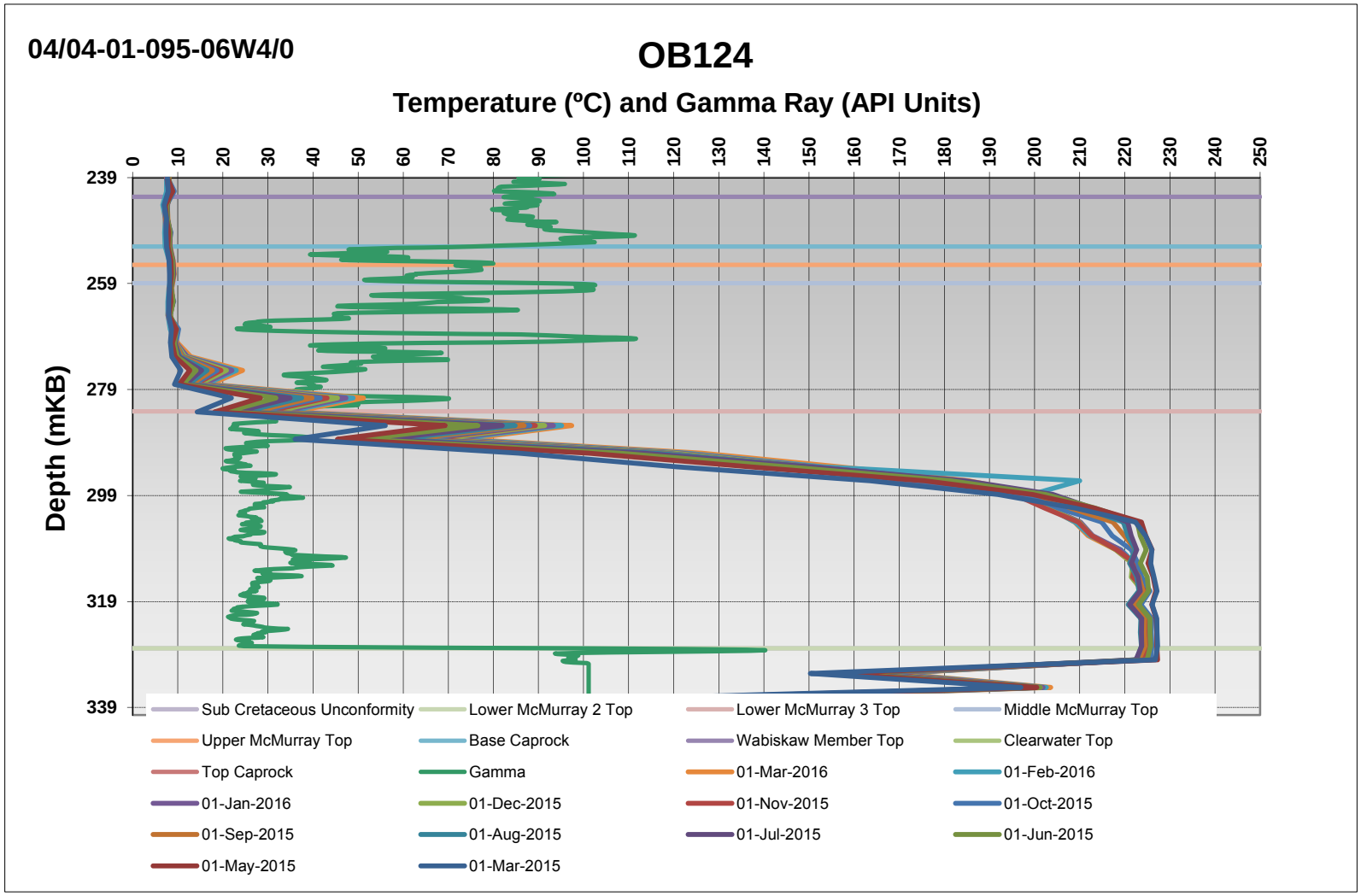

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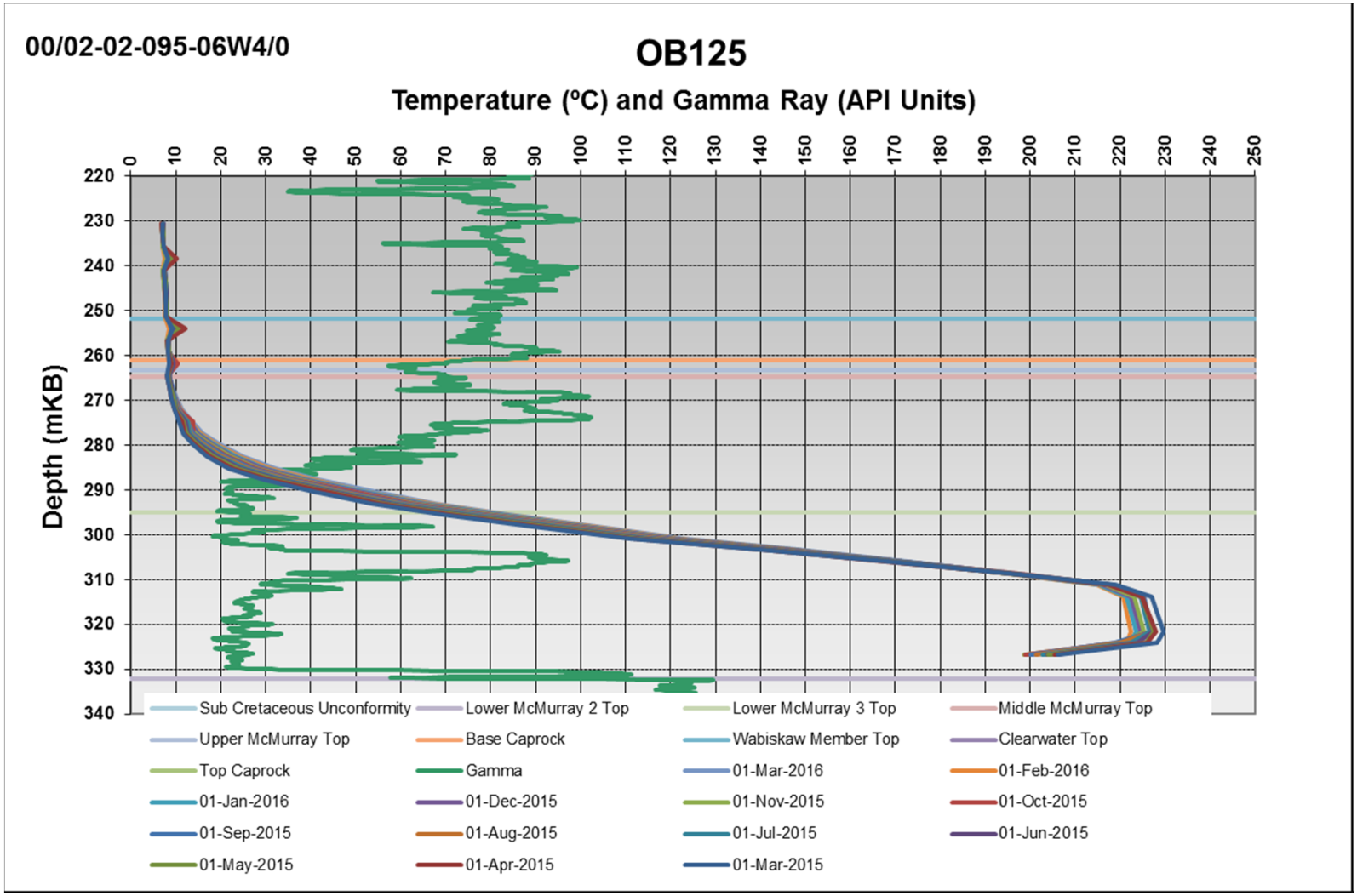

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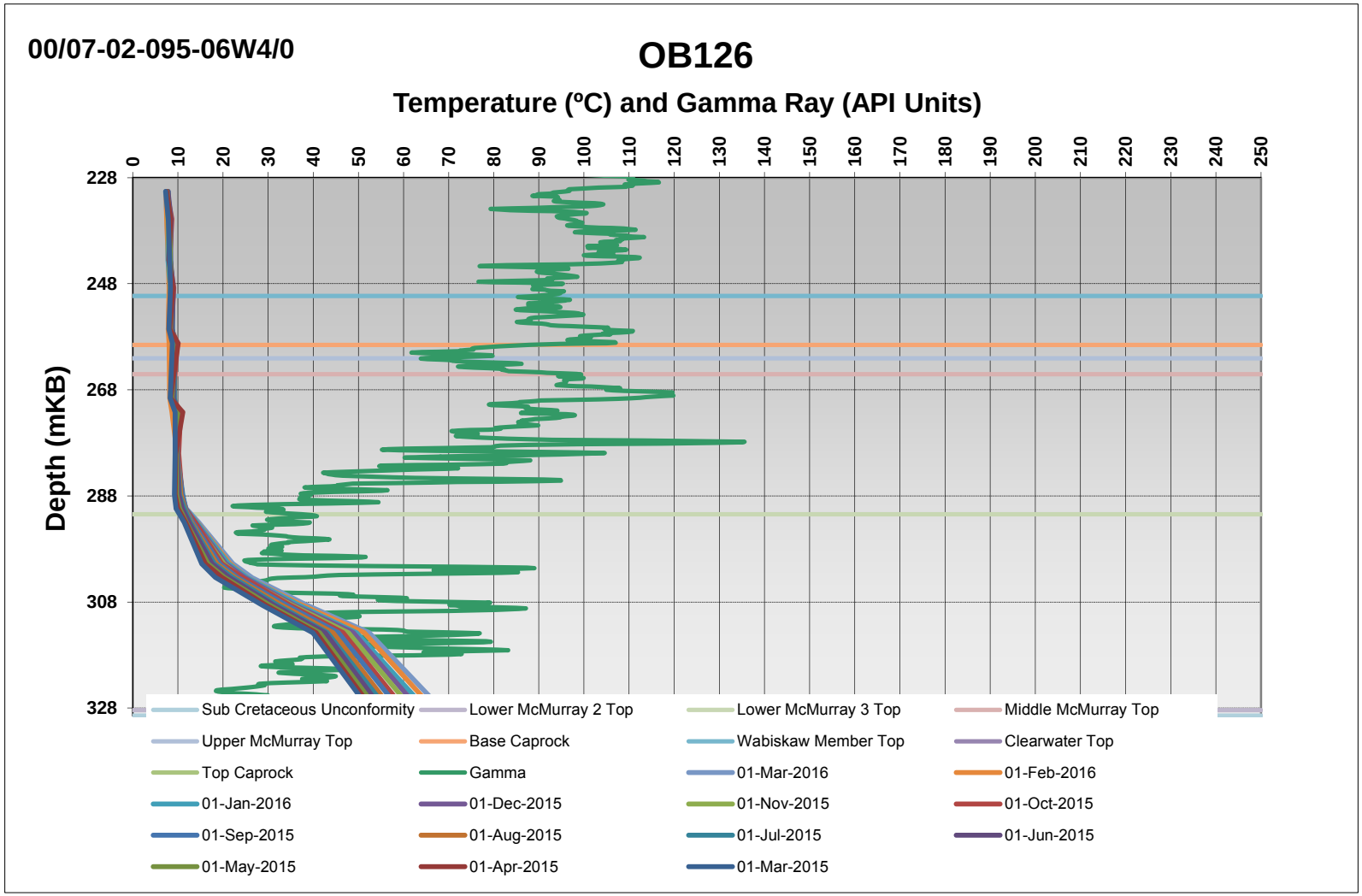

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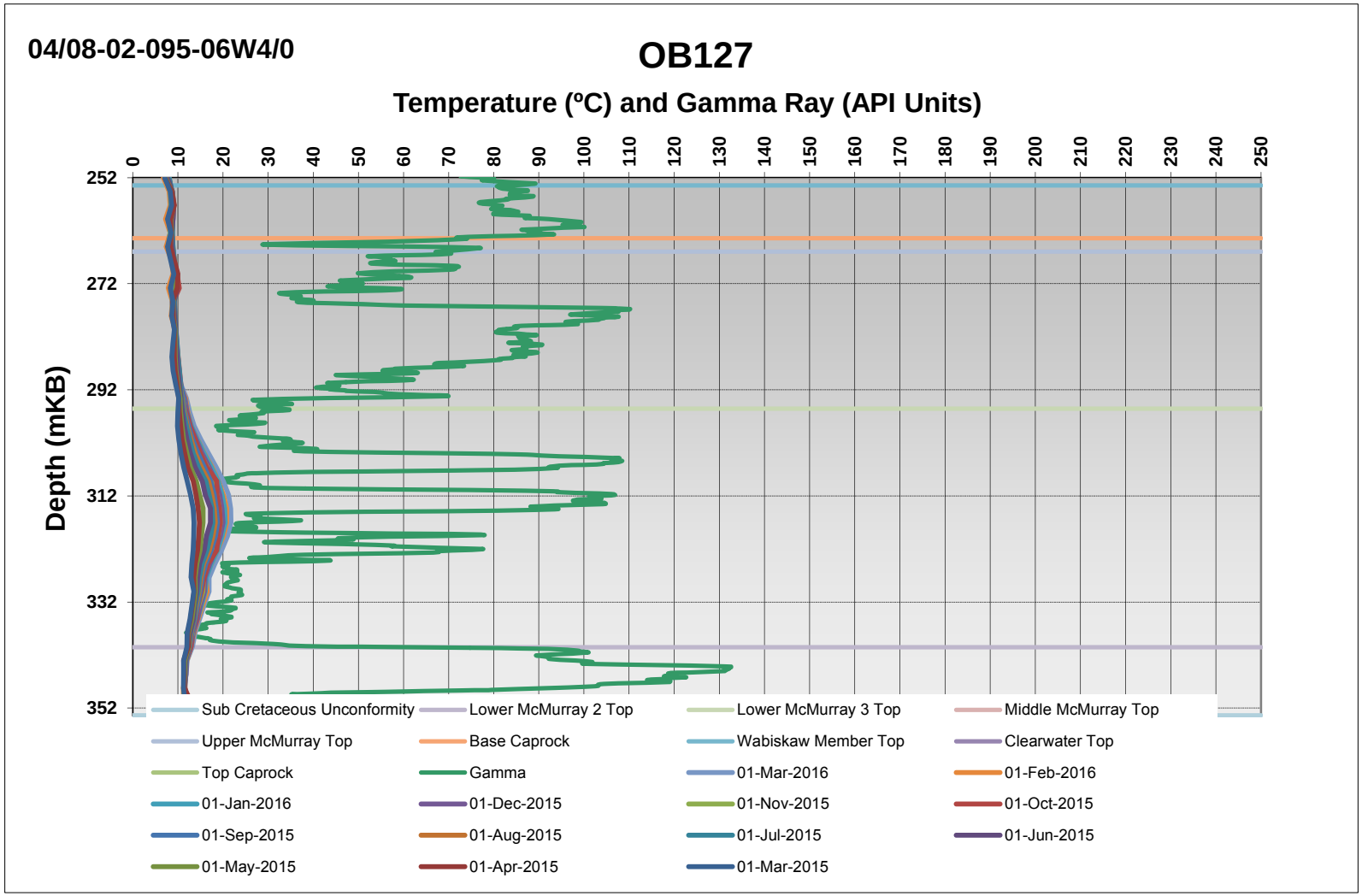

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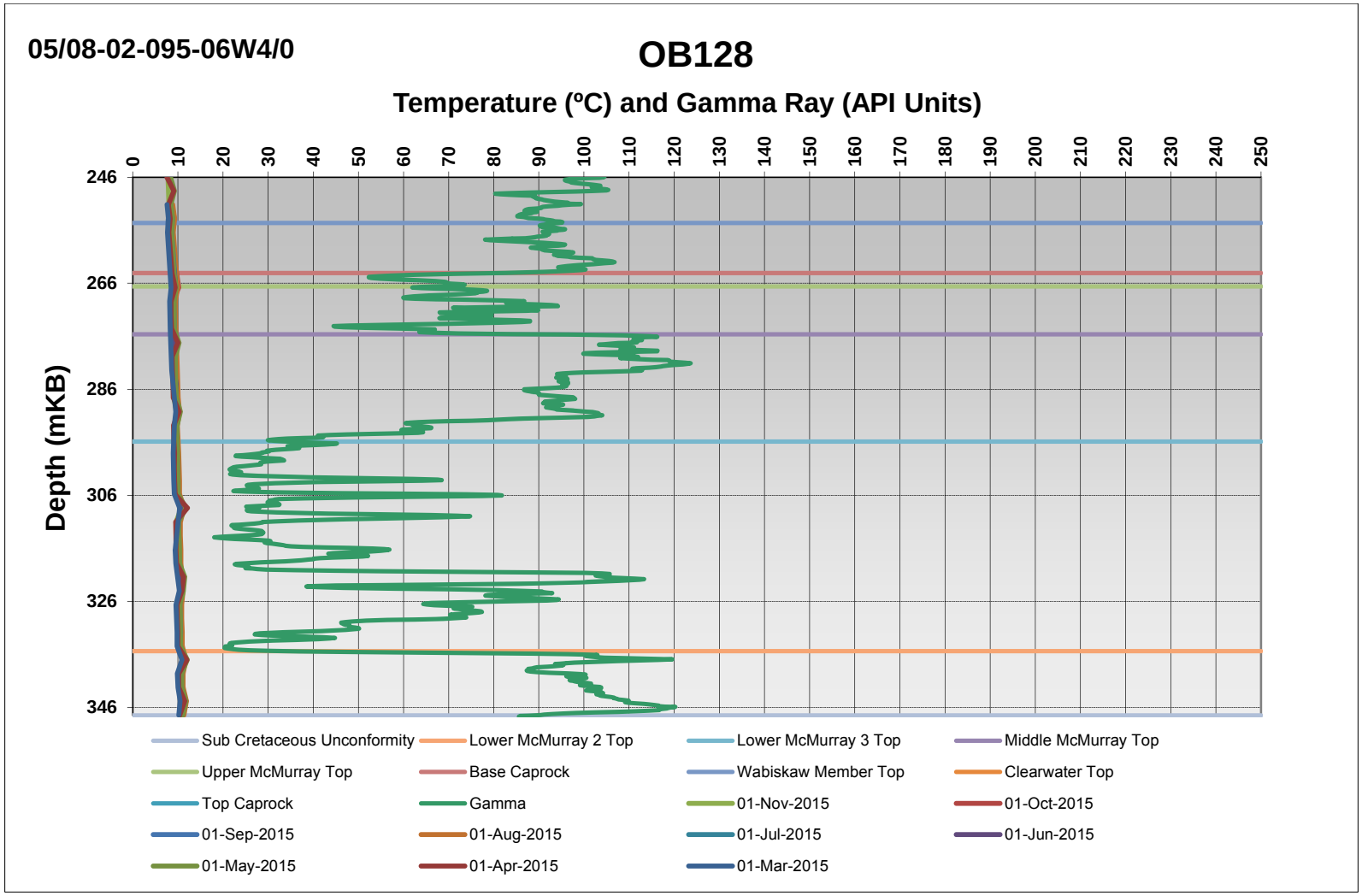

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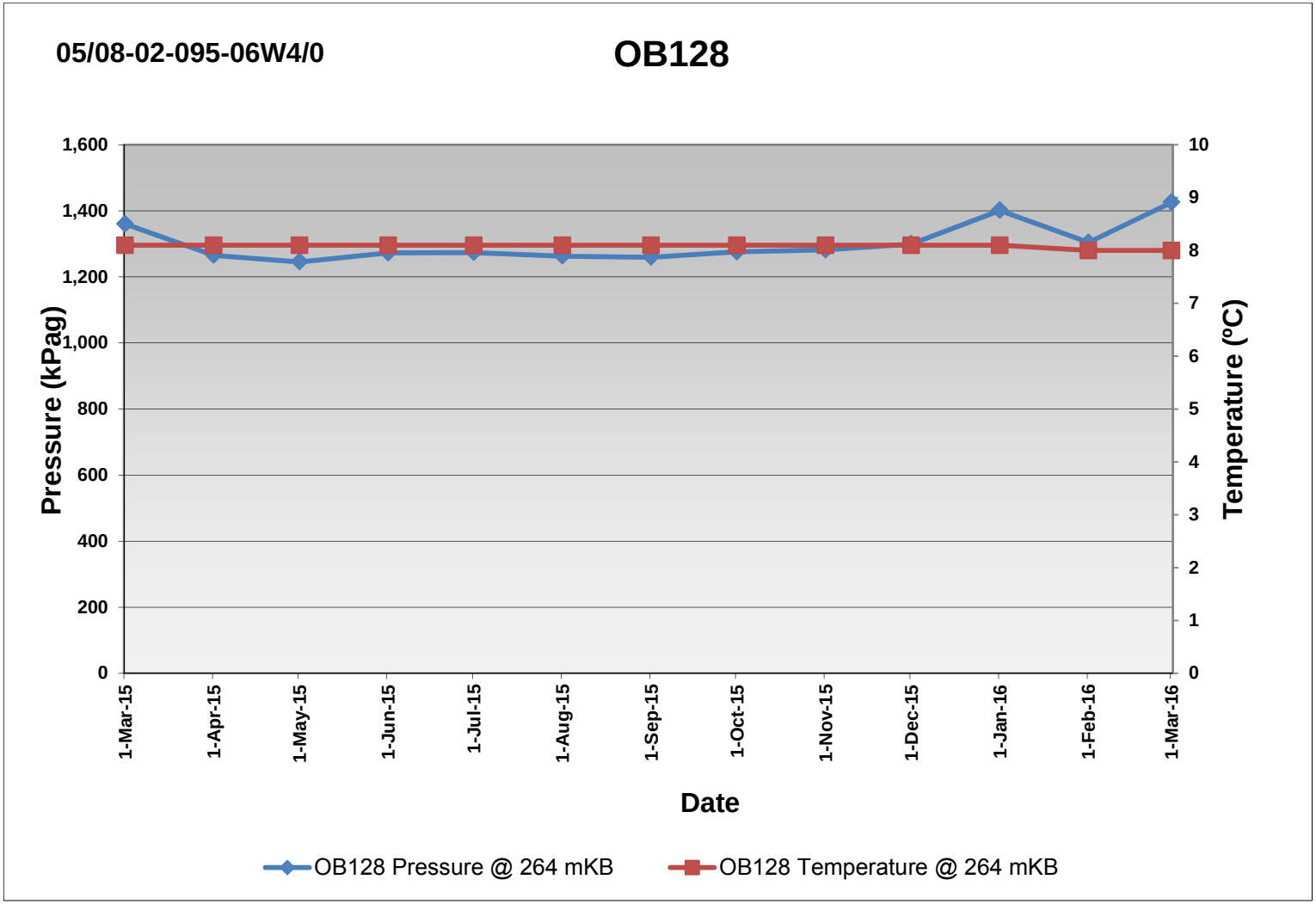

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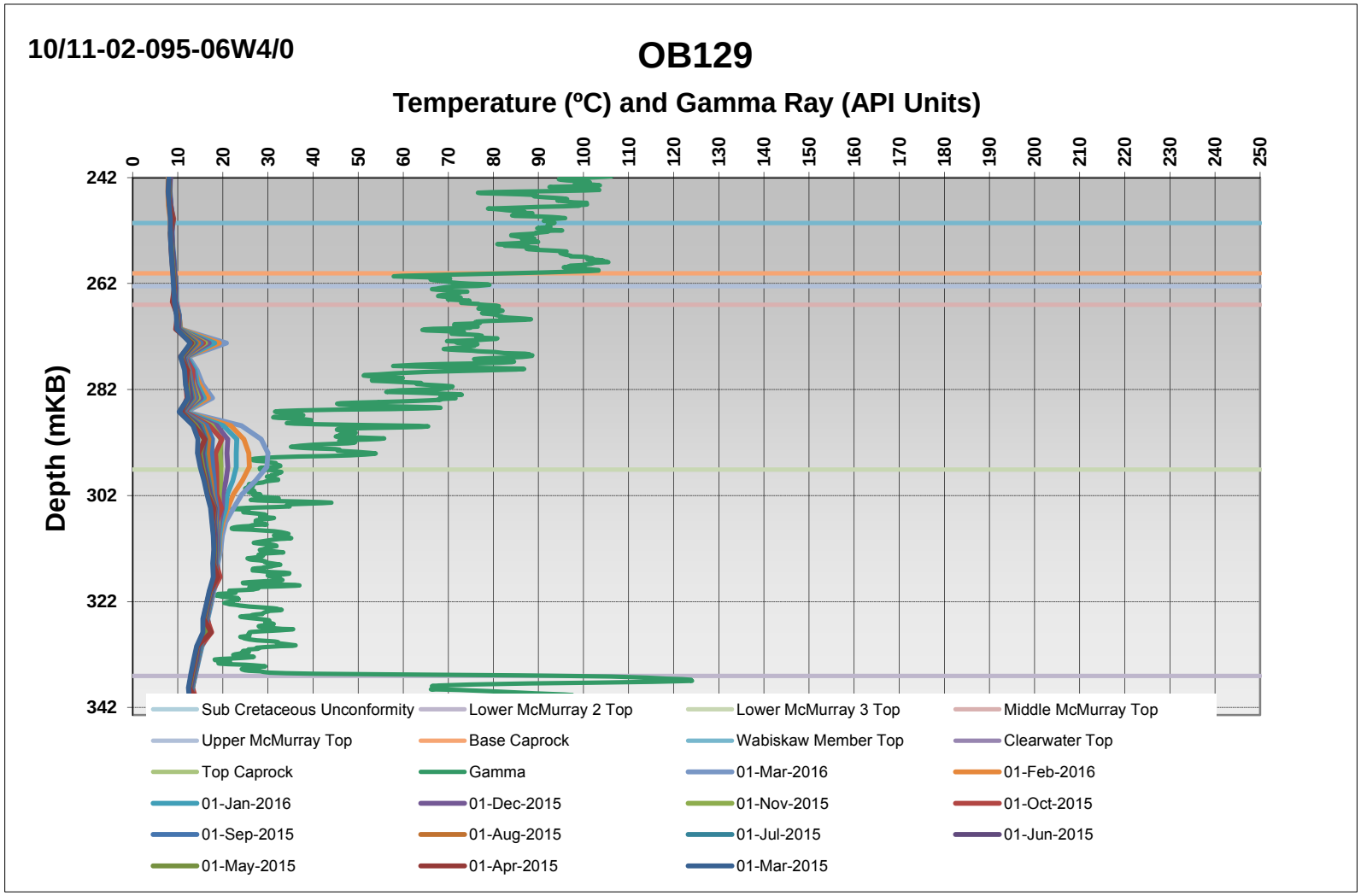

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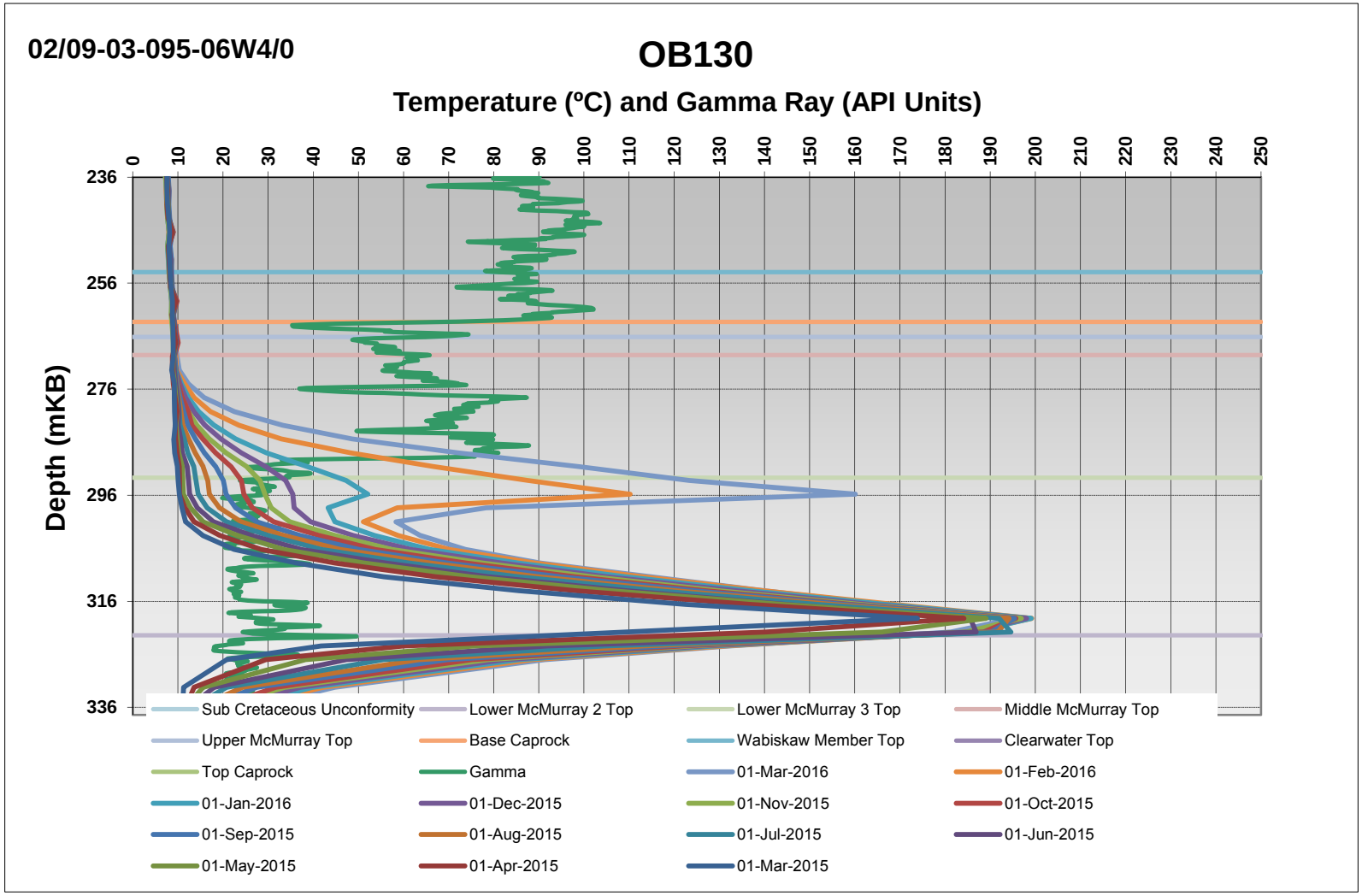

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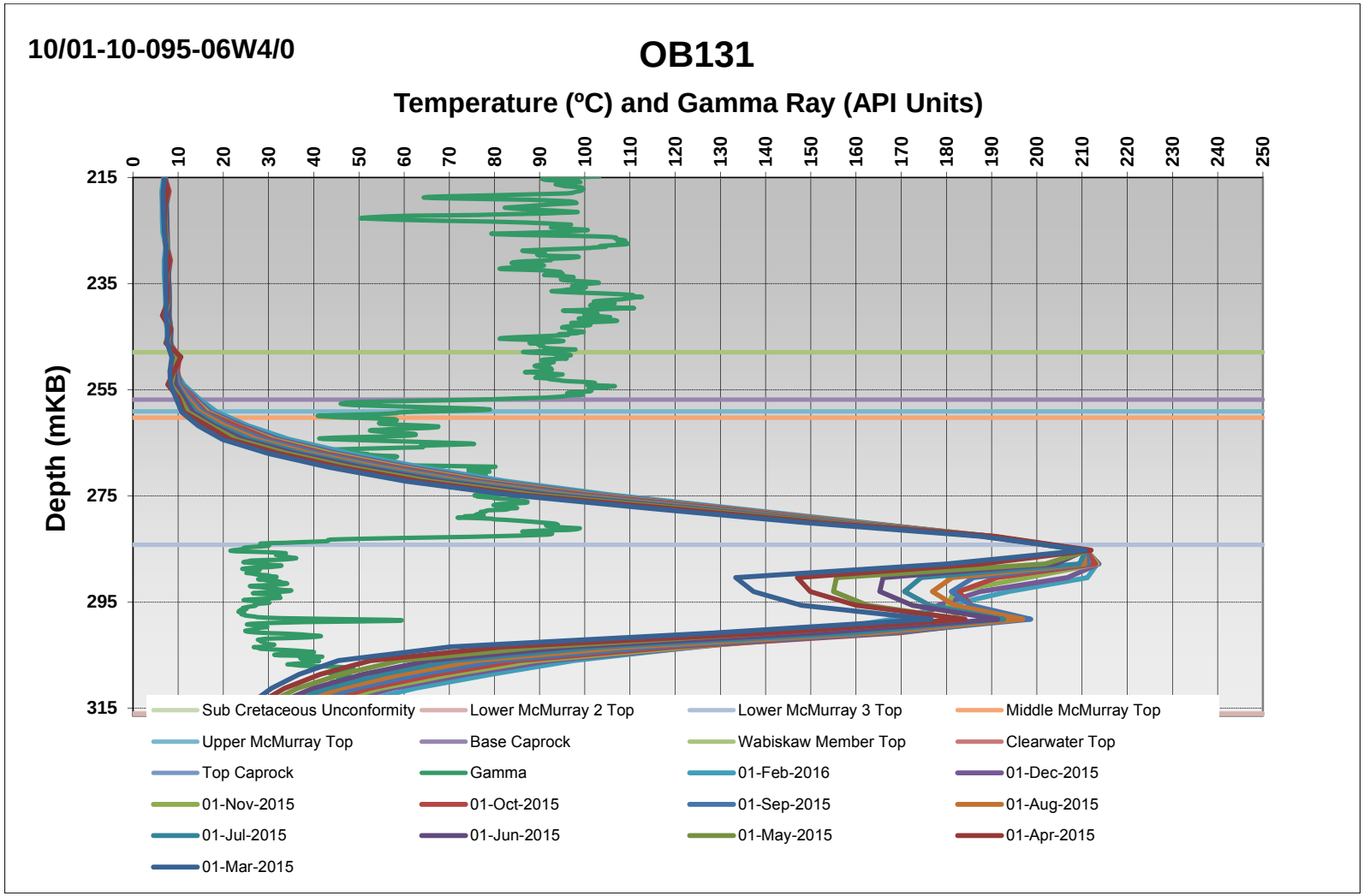

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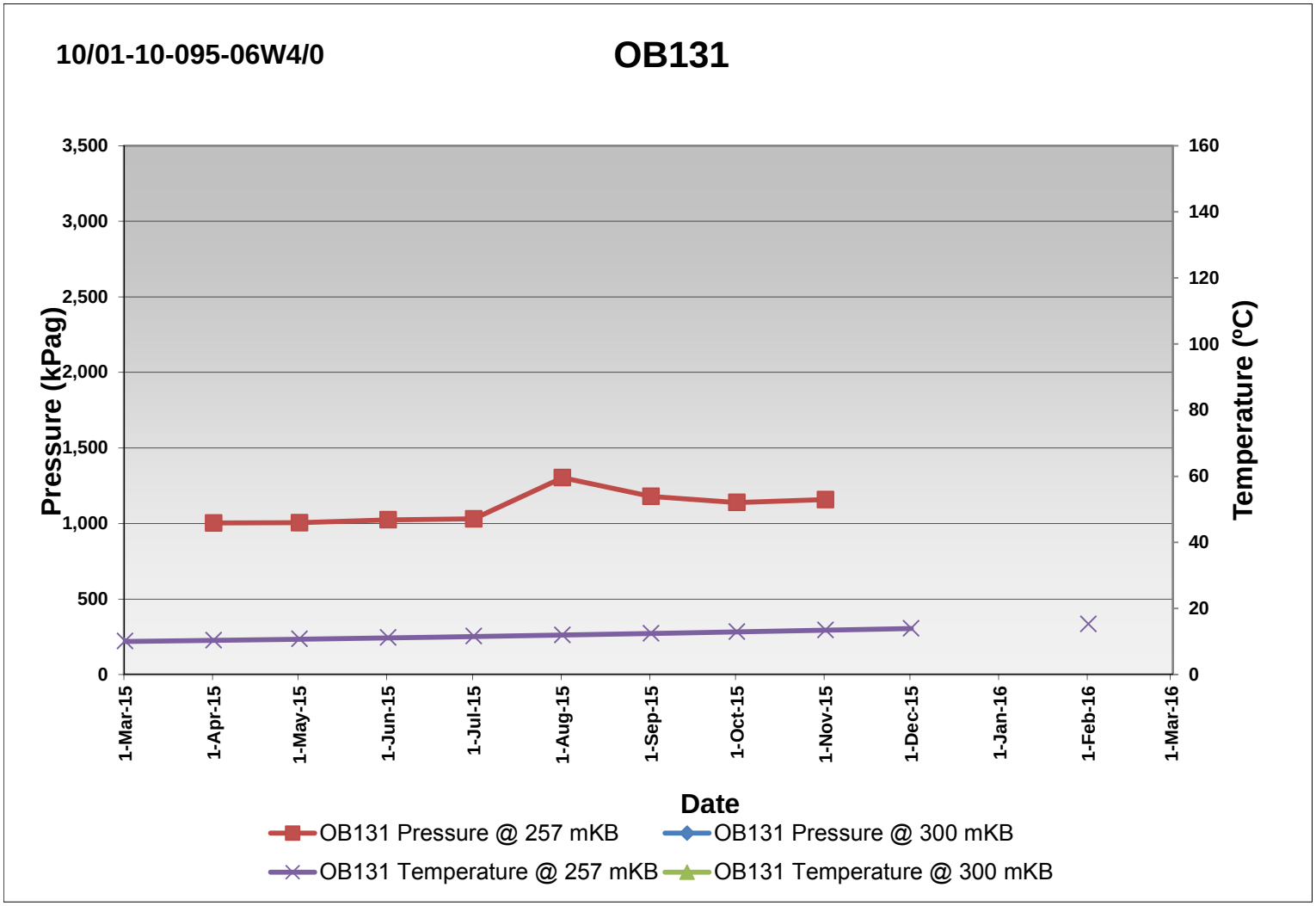

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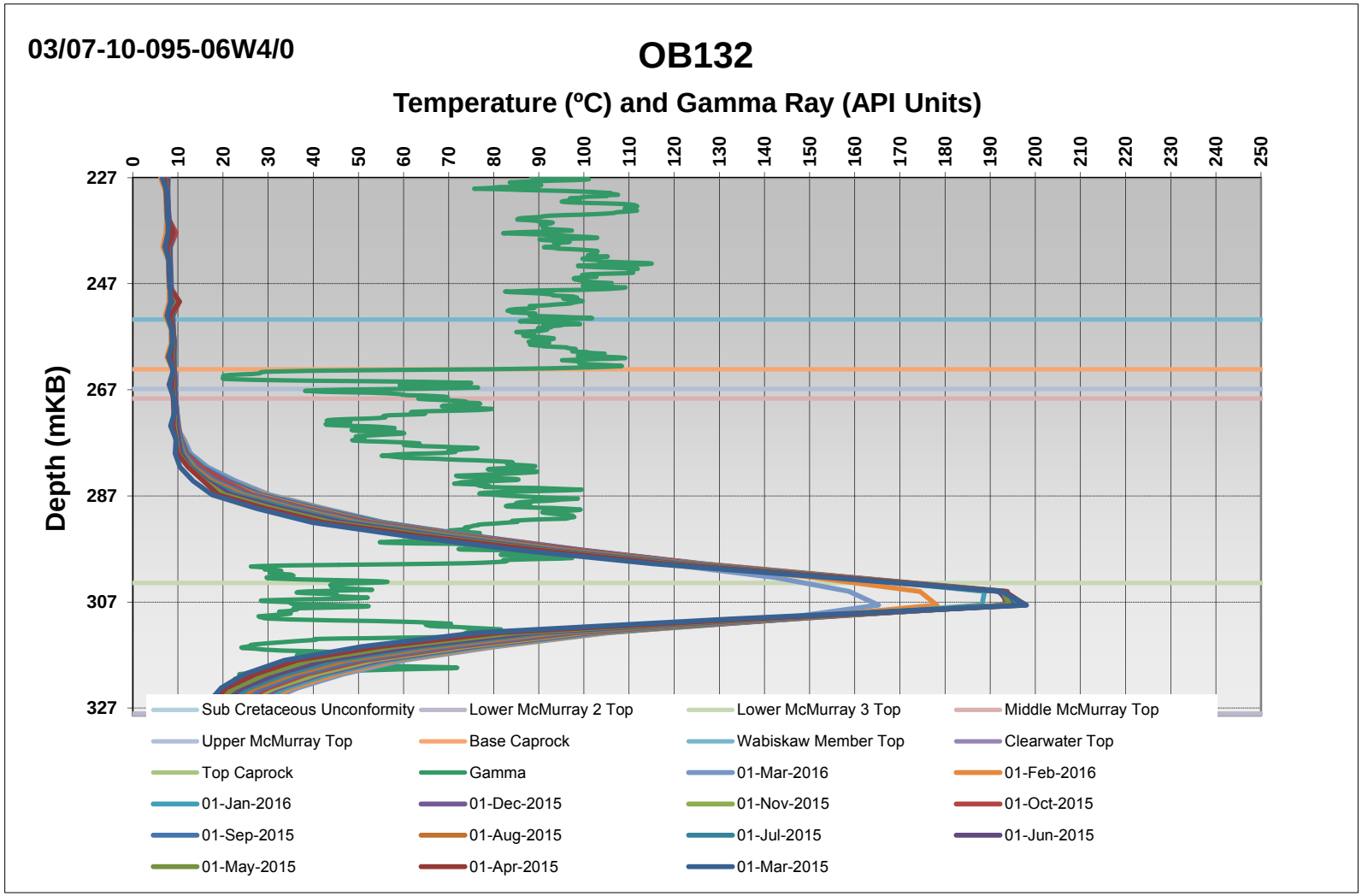

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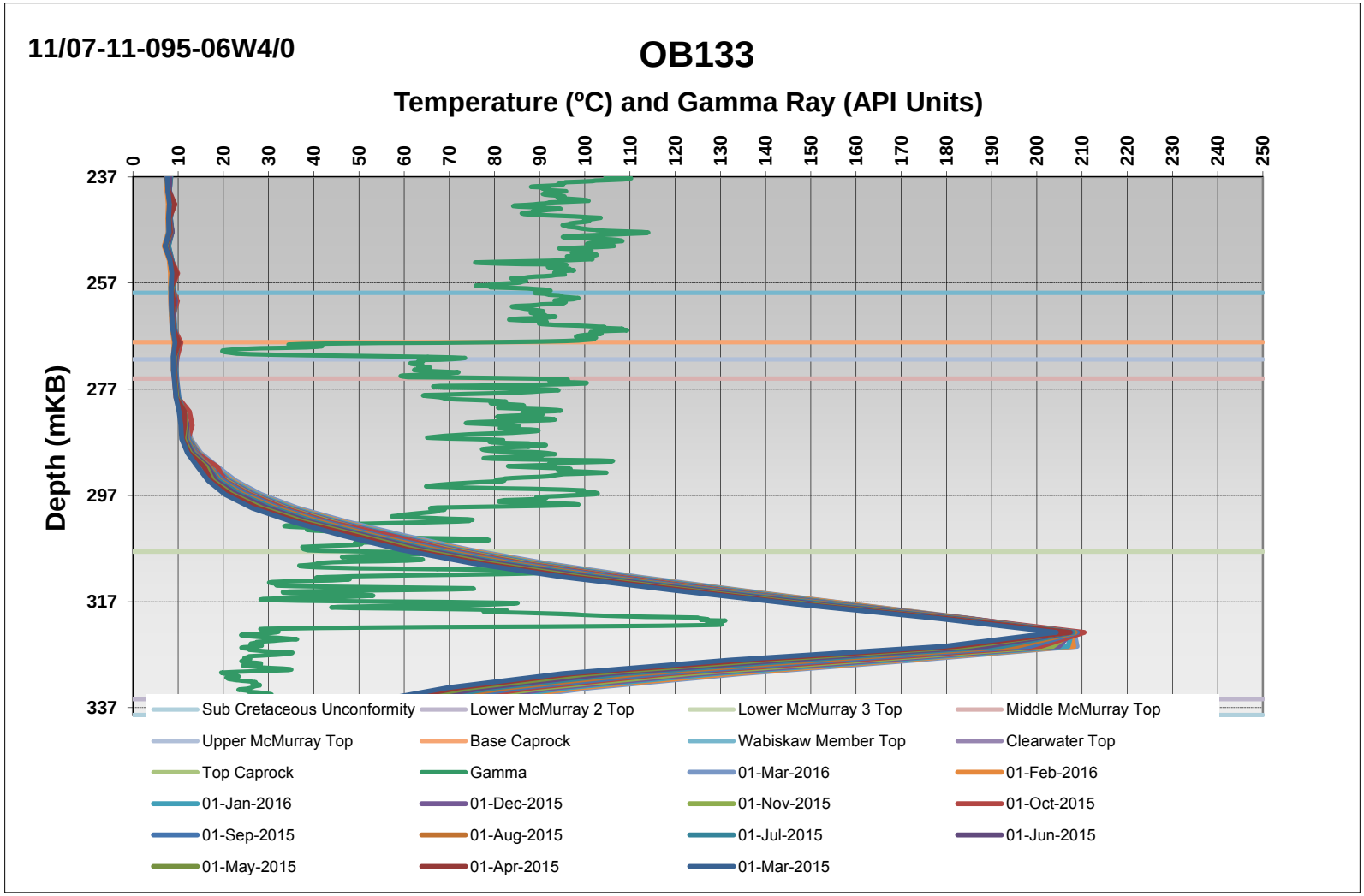

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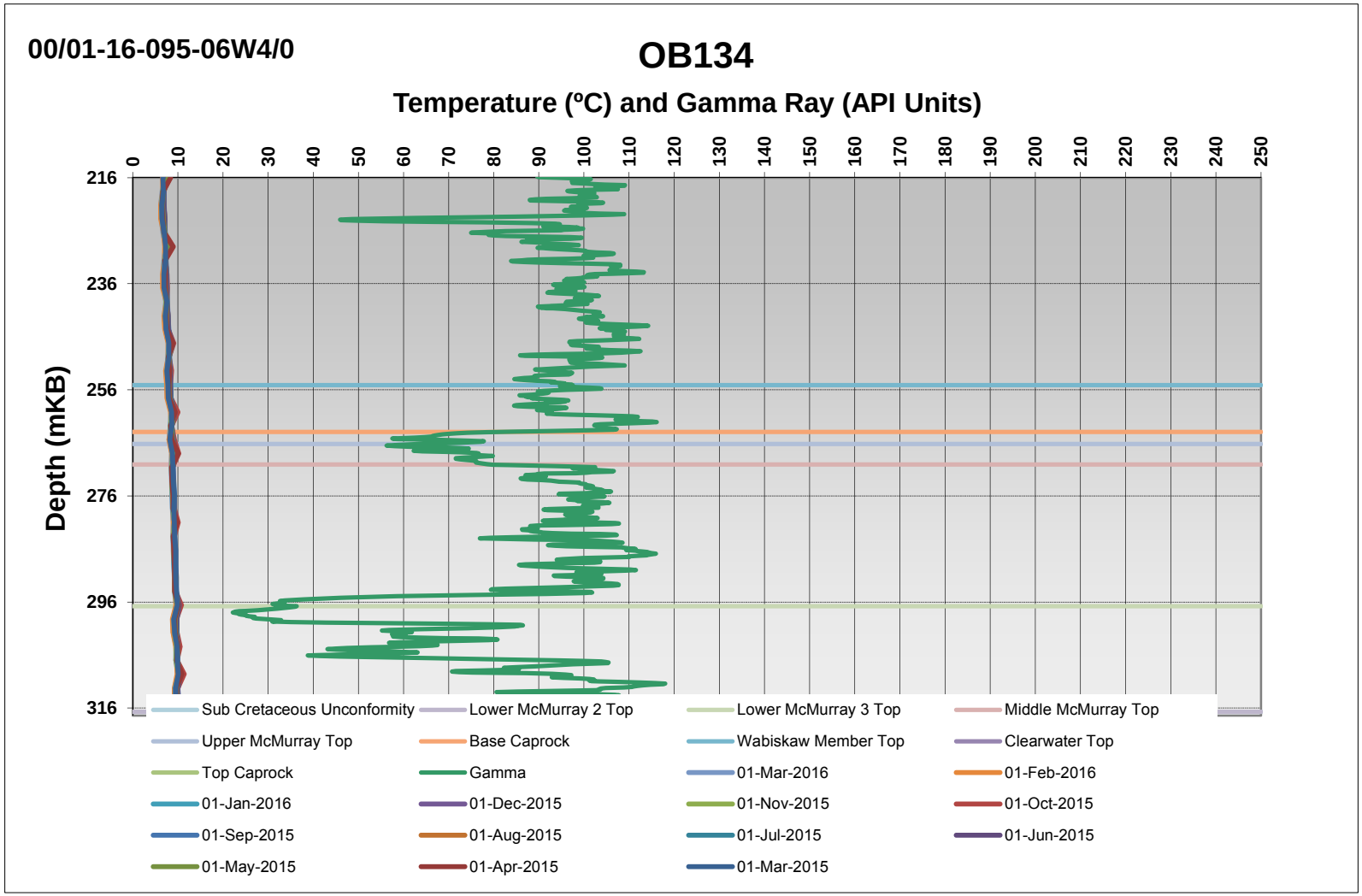

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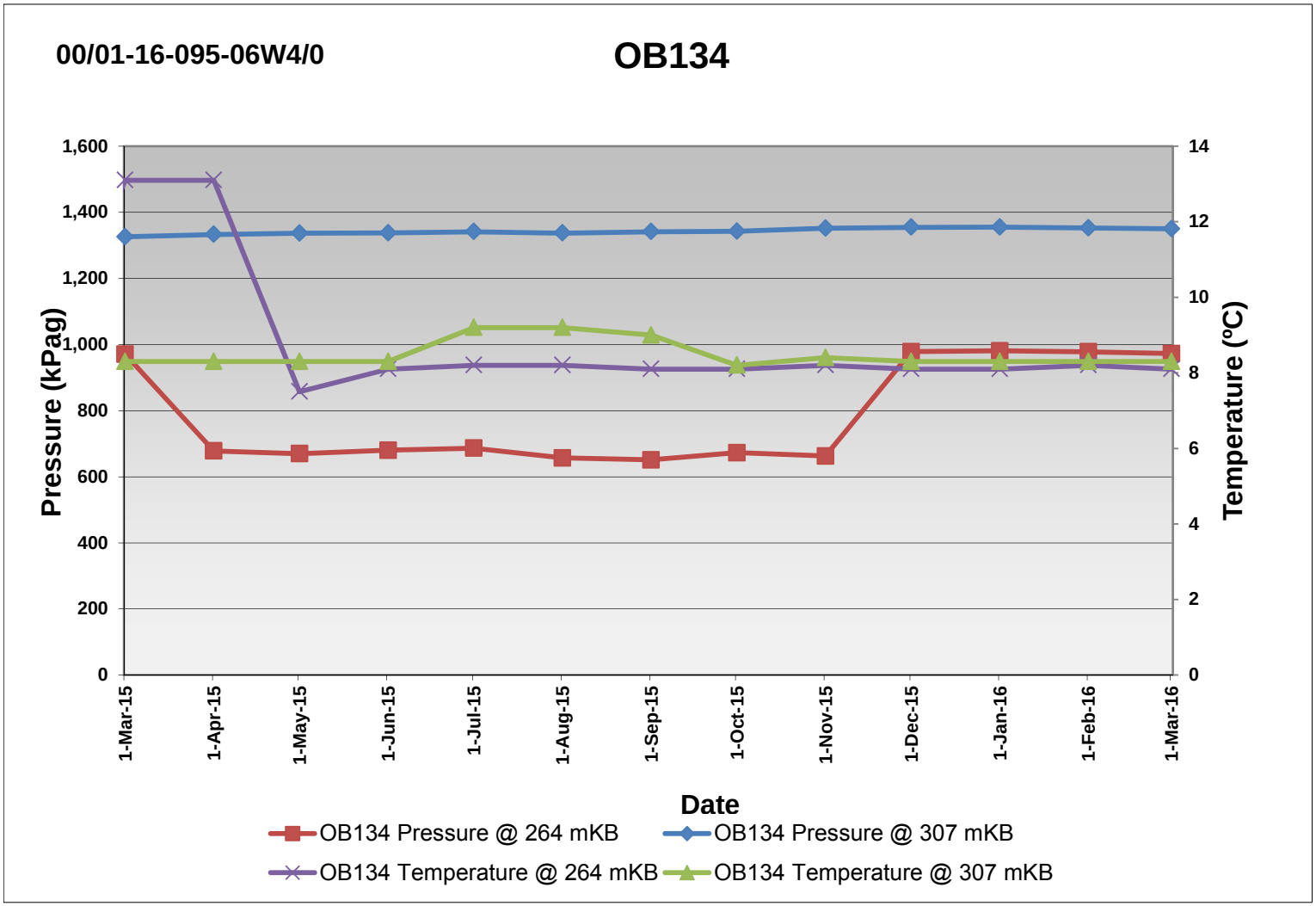

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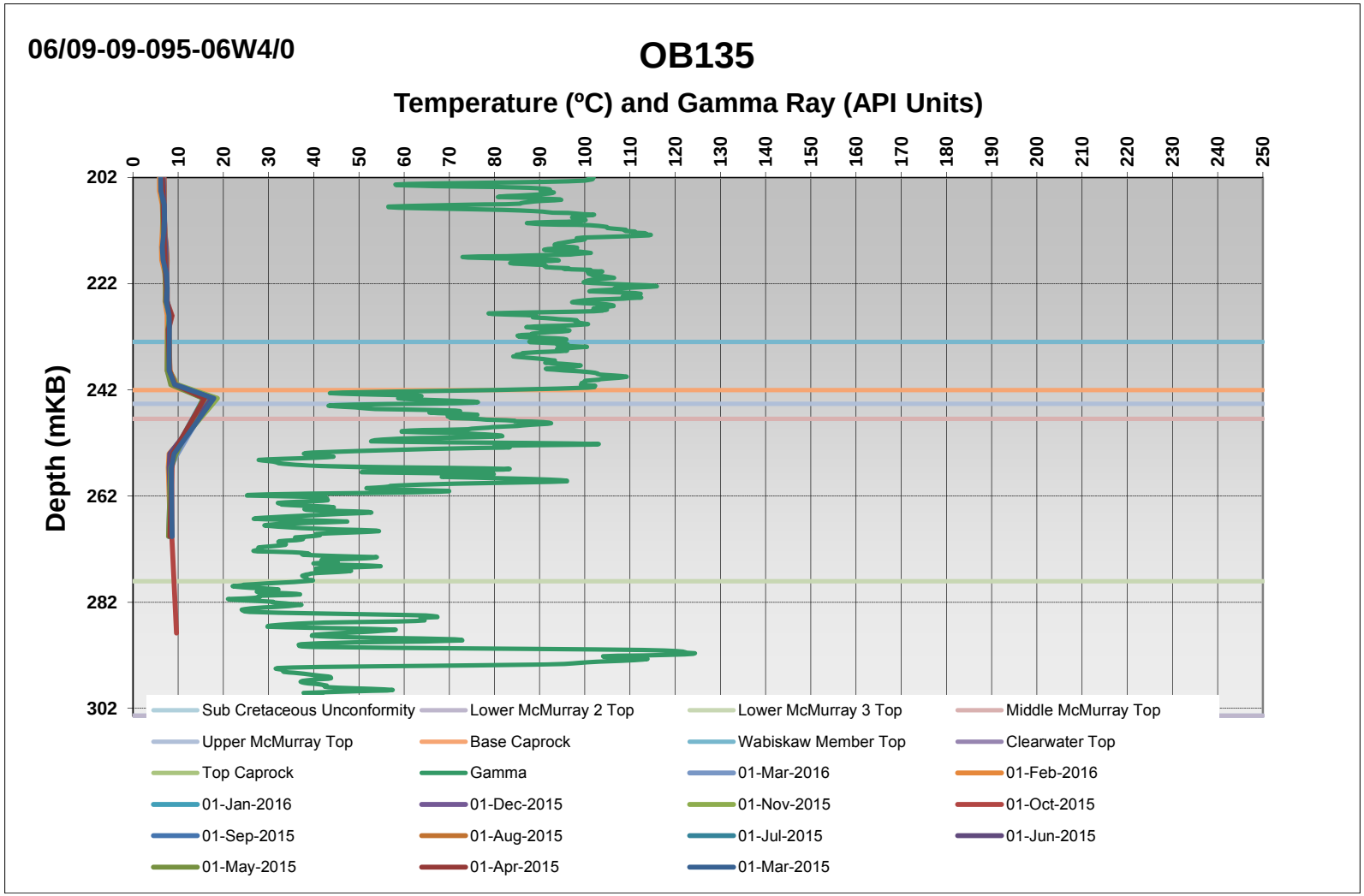

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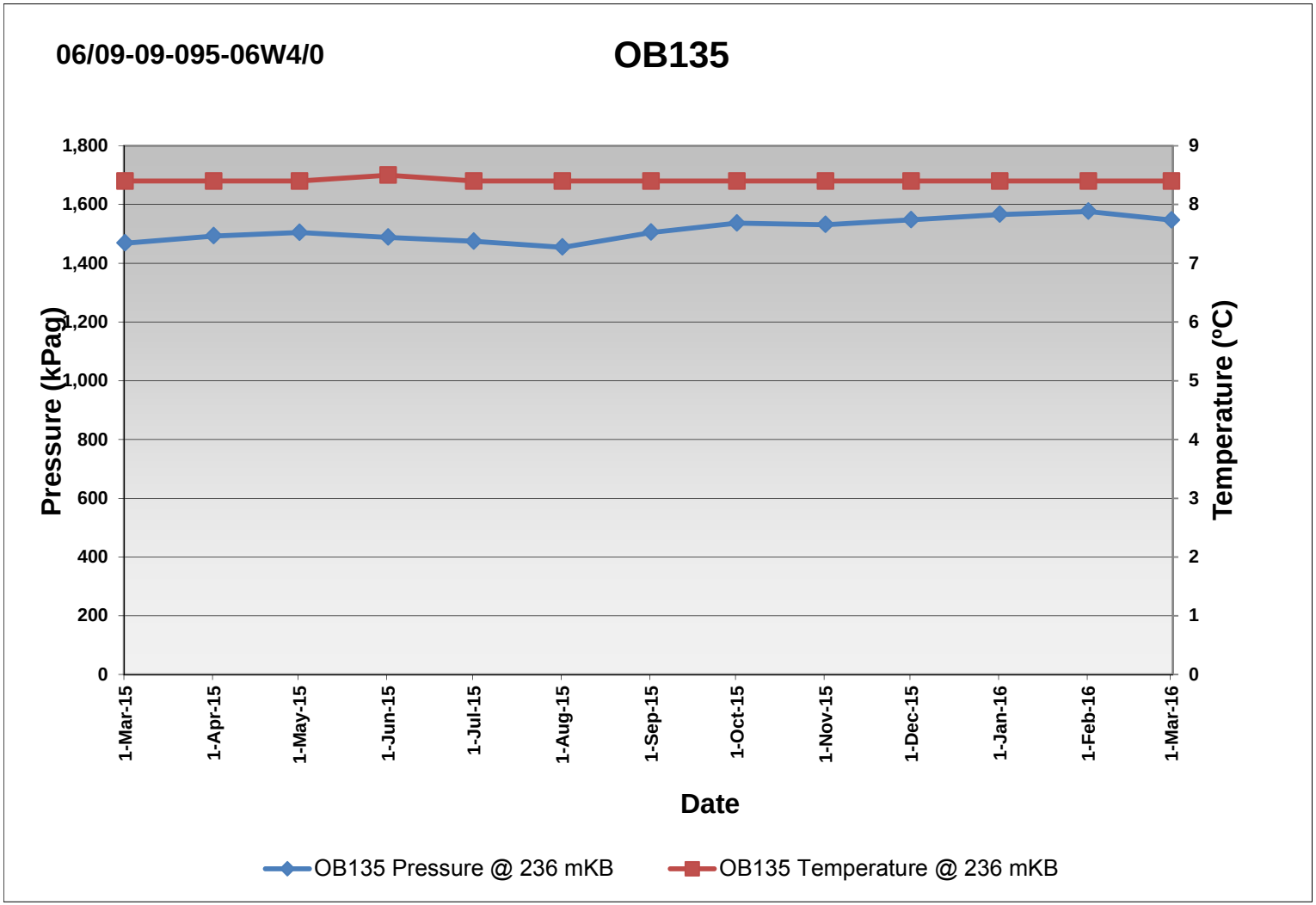

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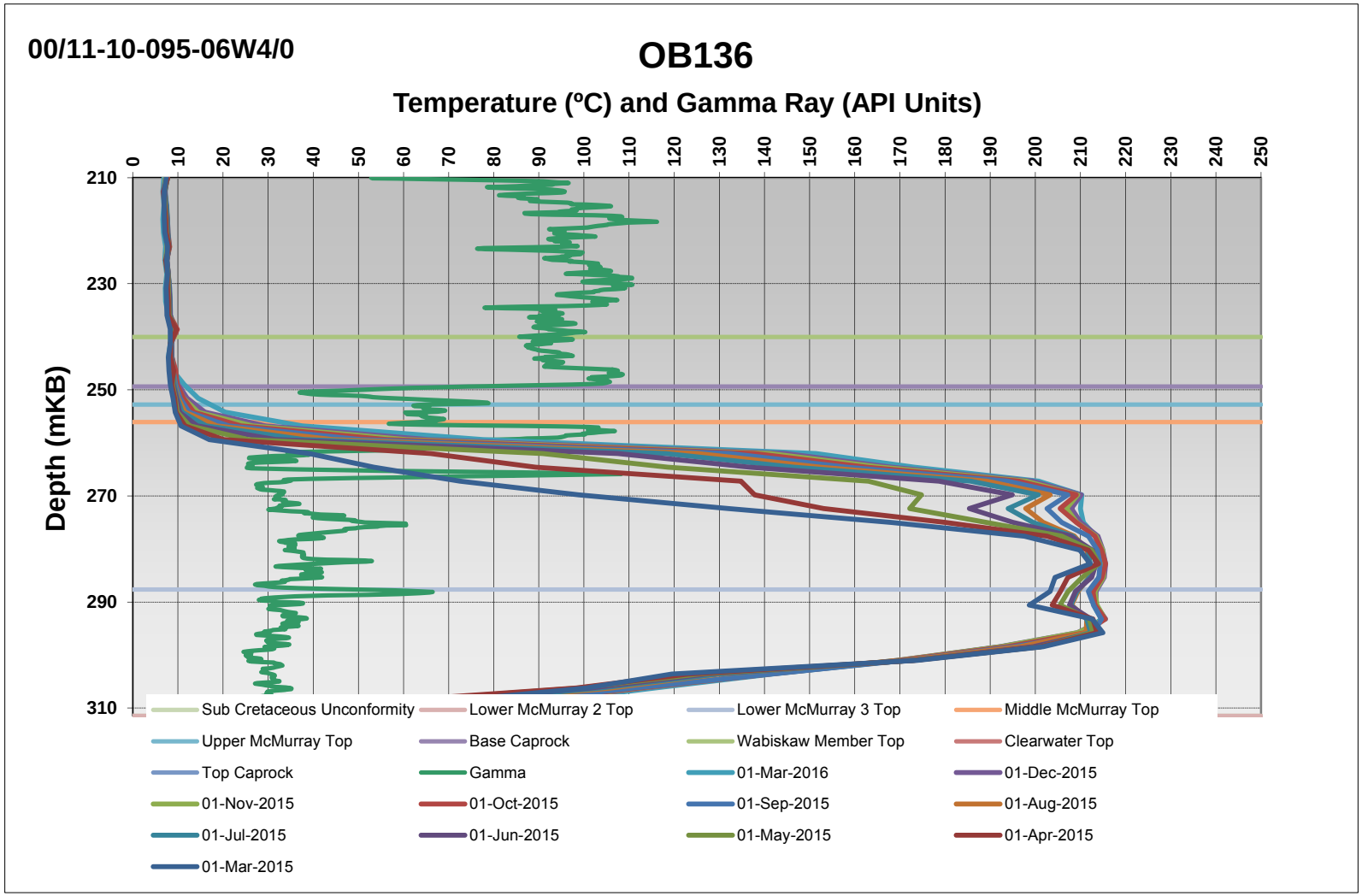

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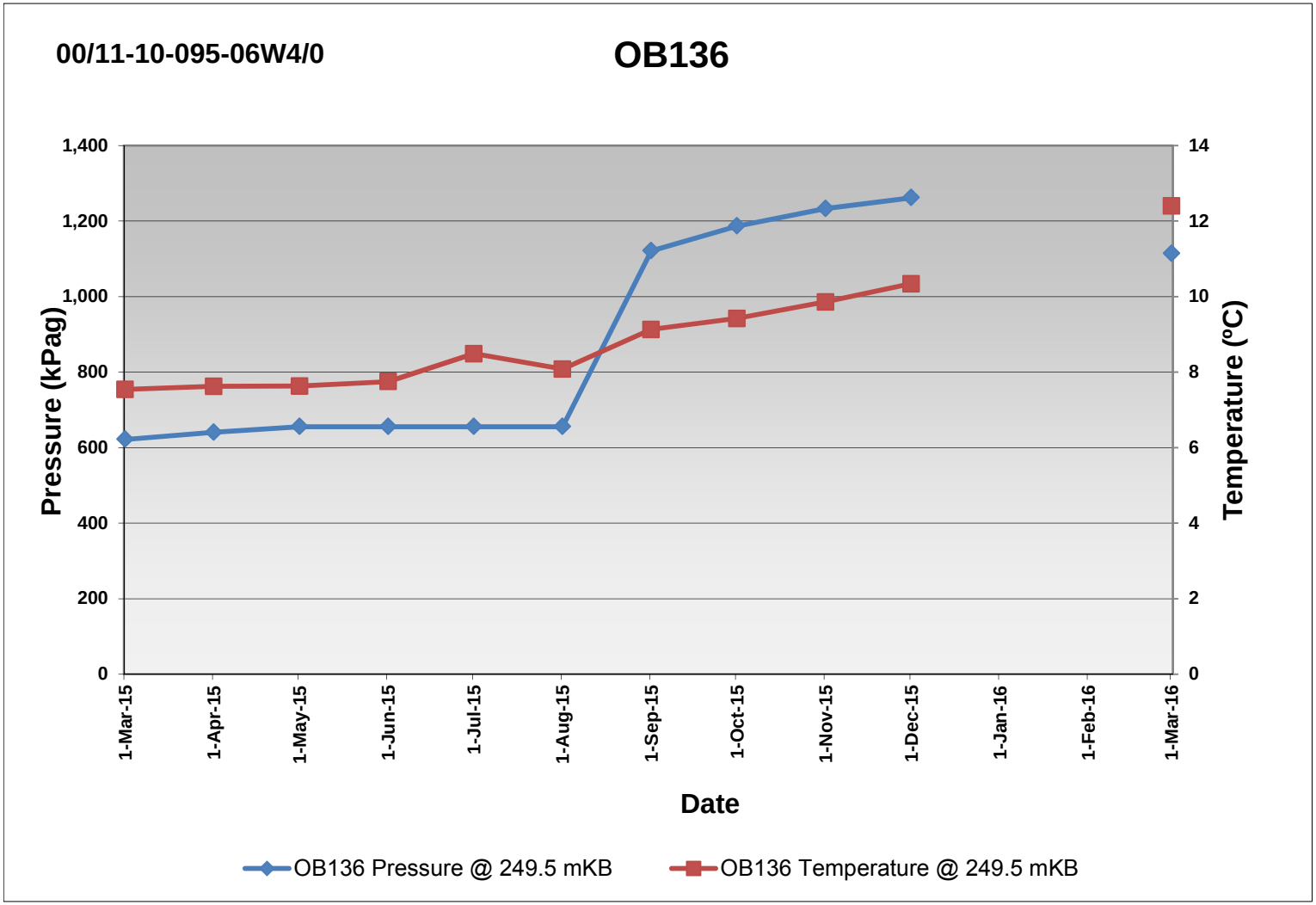

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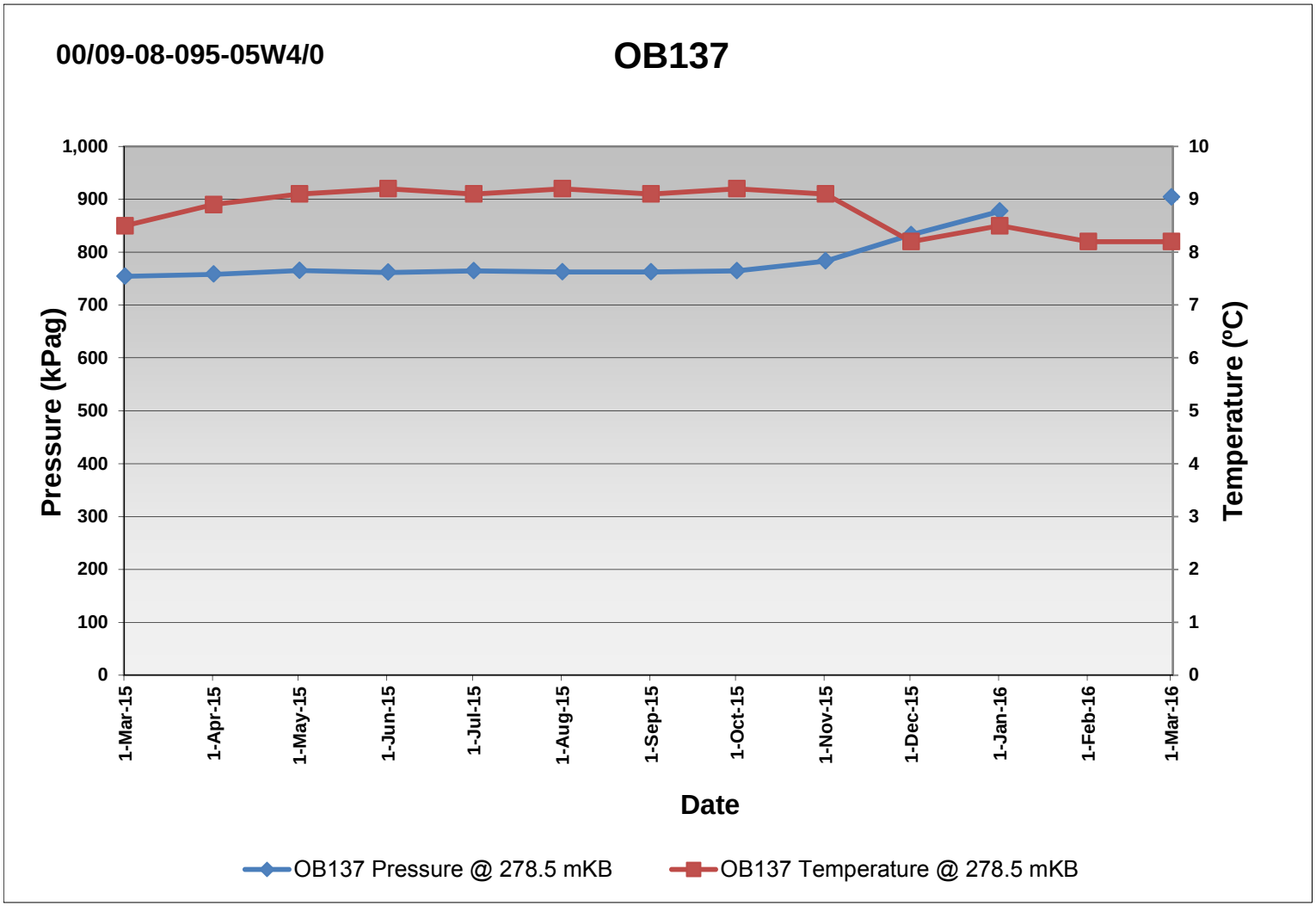

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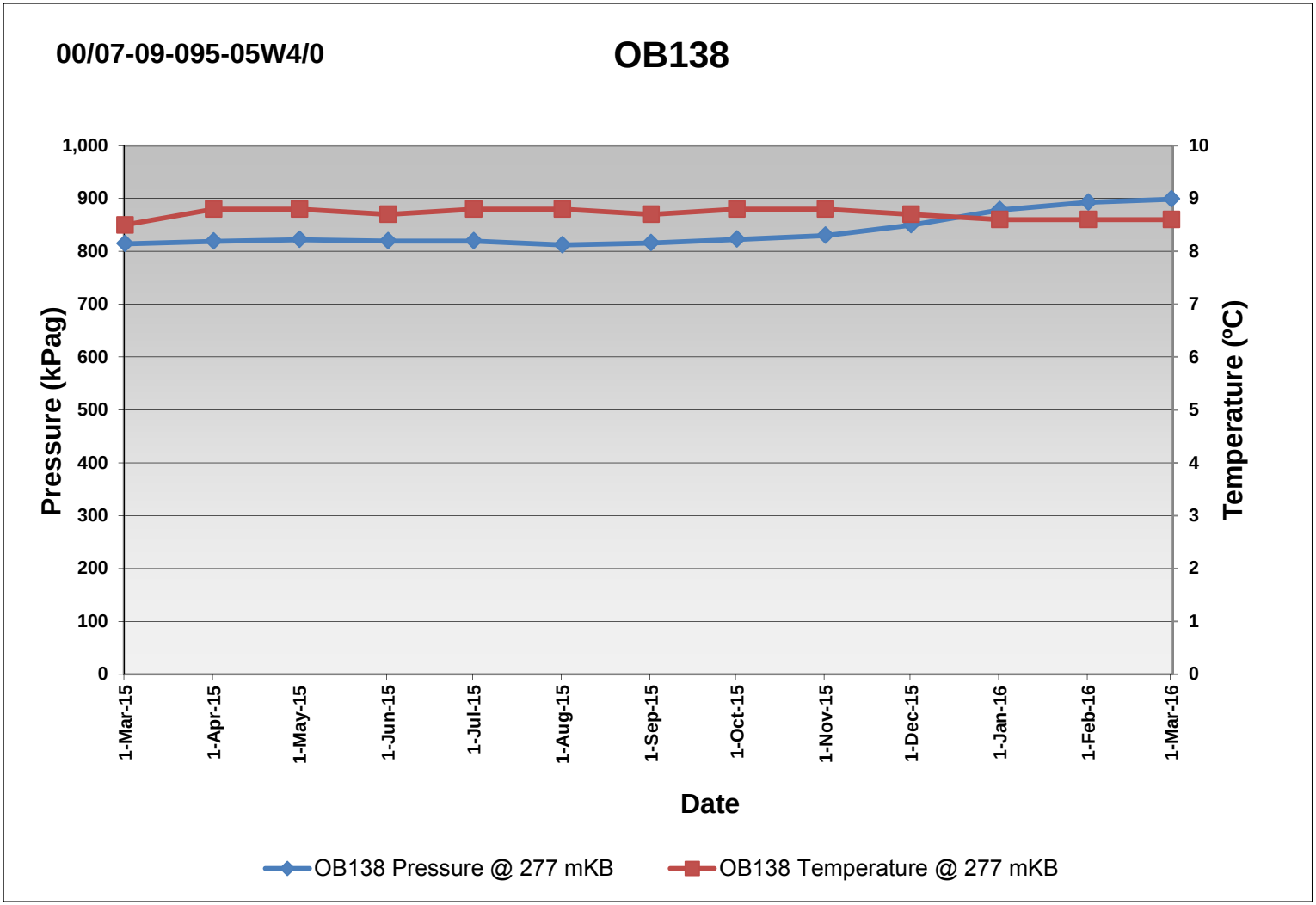
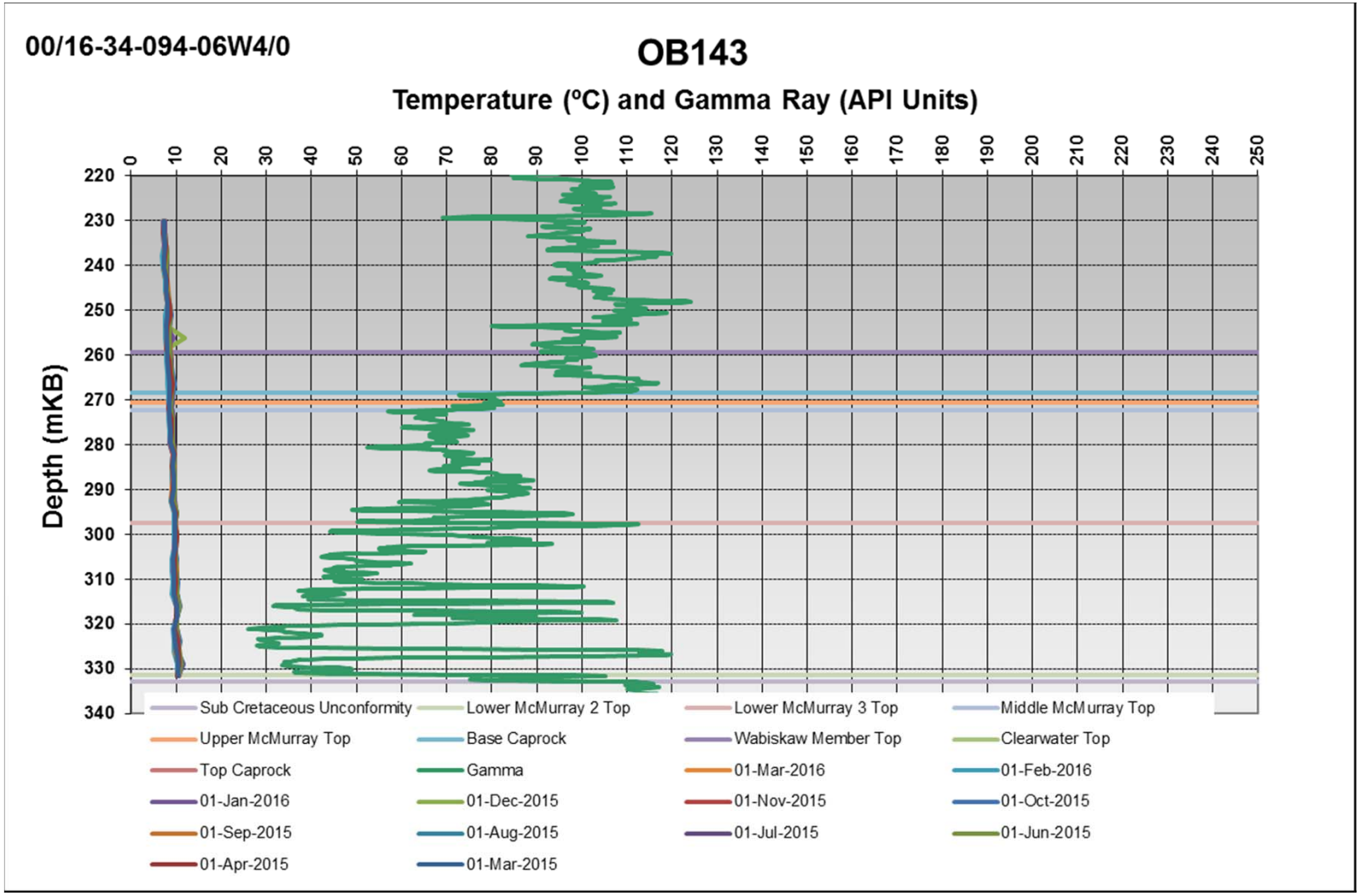
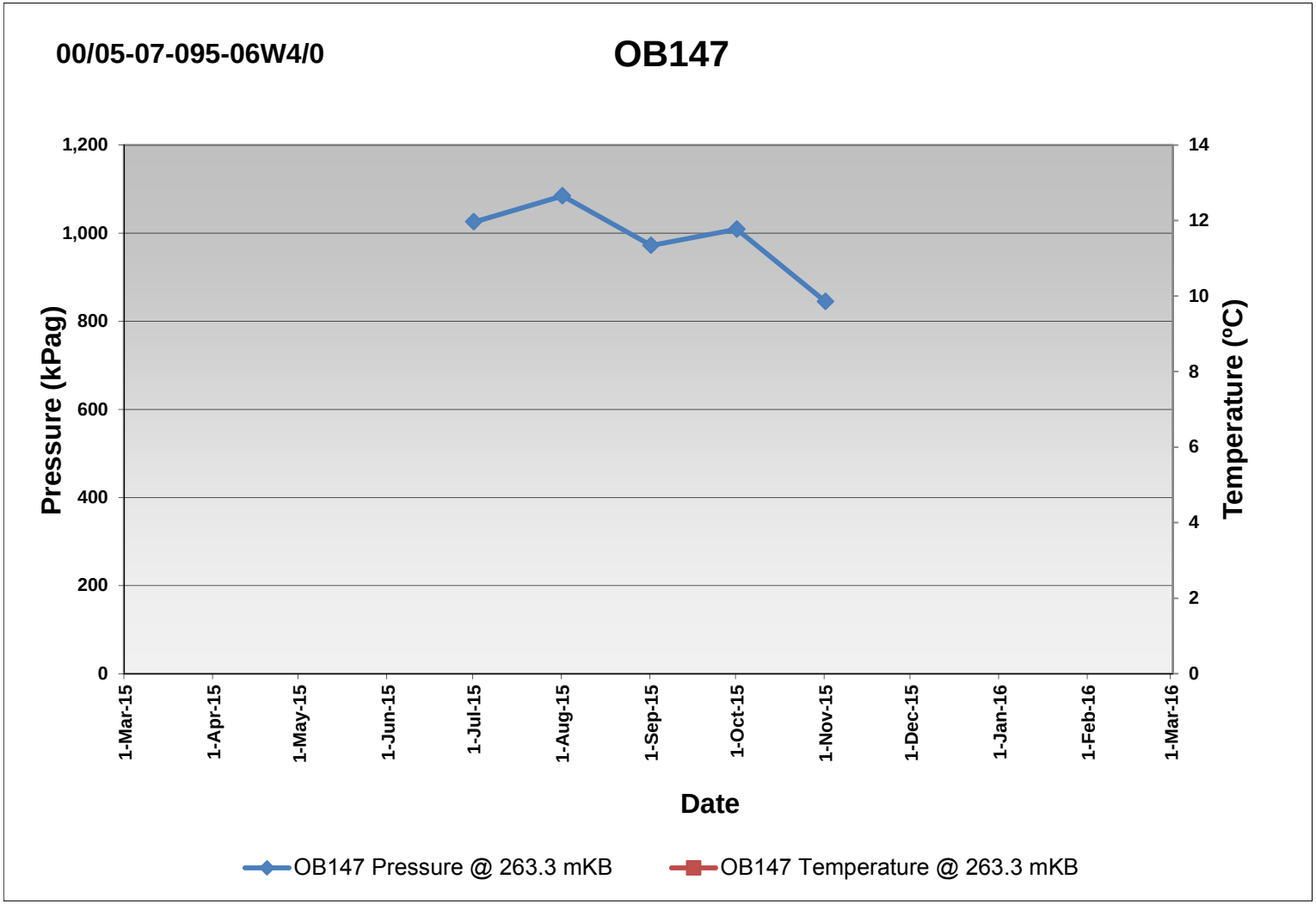


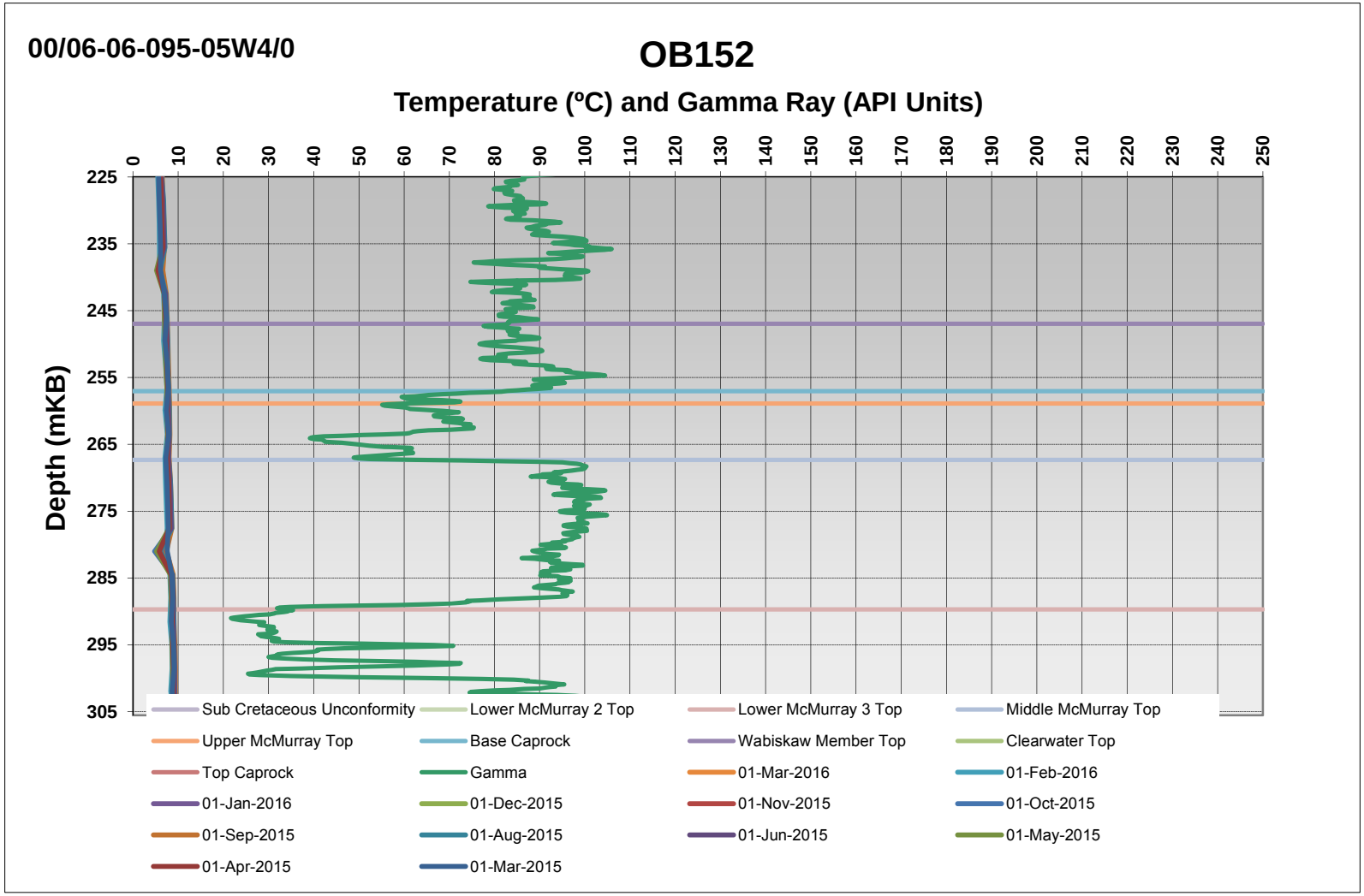
Piezometer Plots & Temperature vs Depth Plots



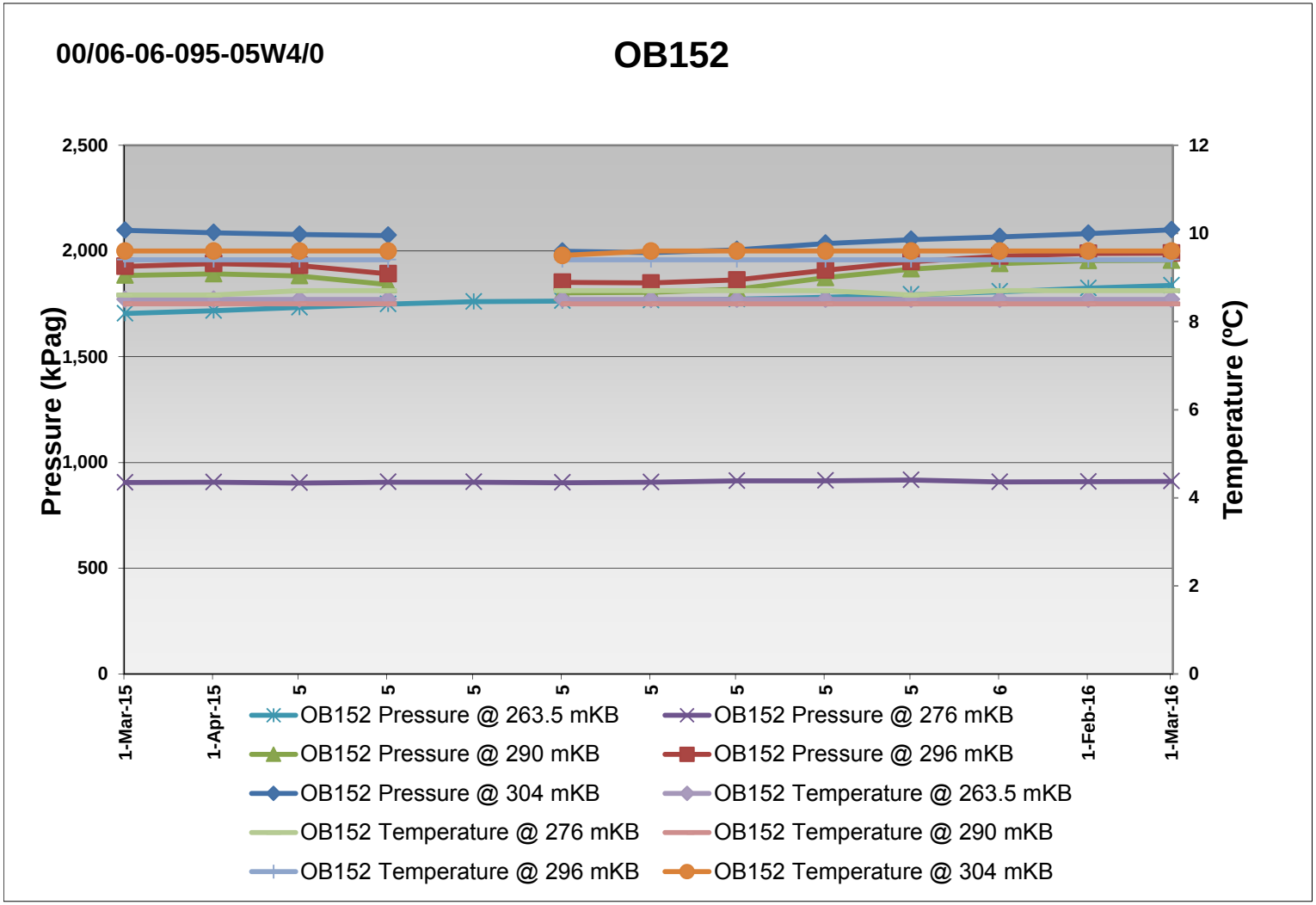
Piezometer Plots & Temperature vs Depth Plots



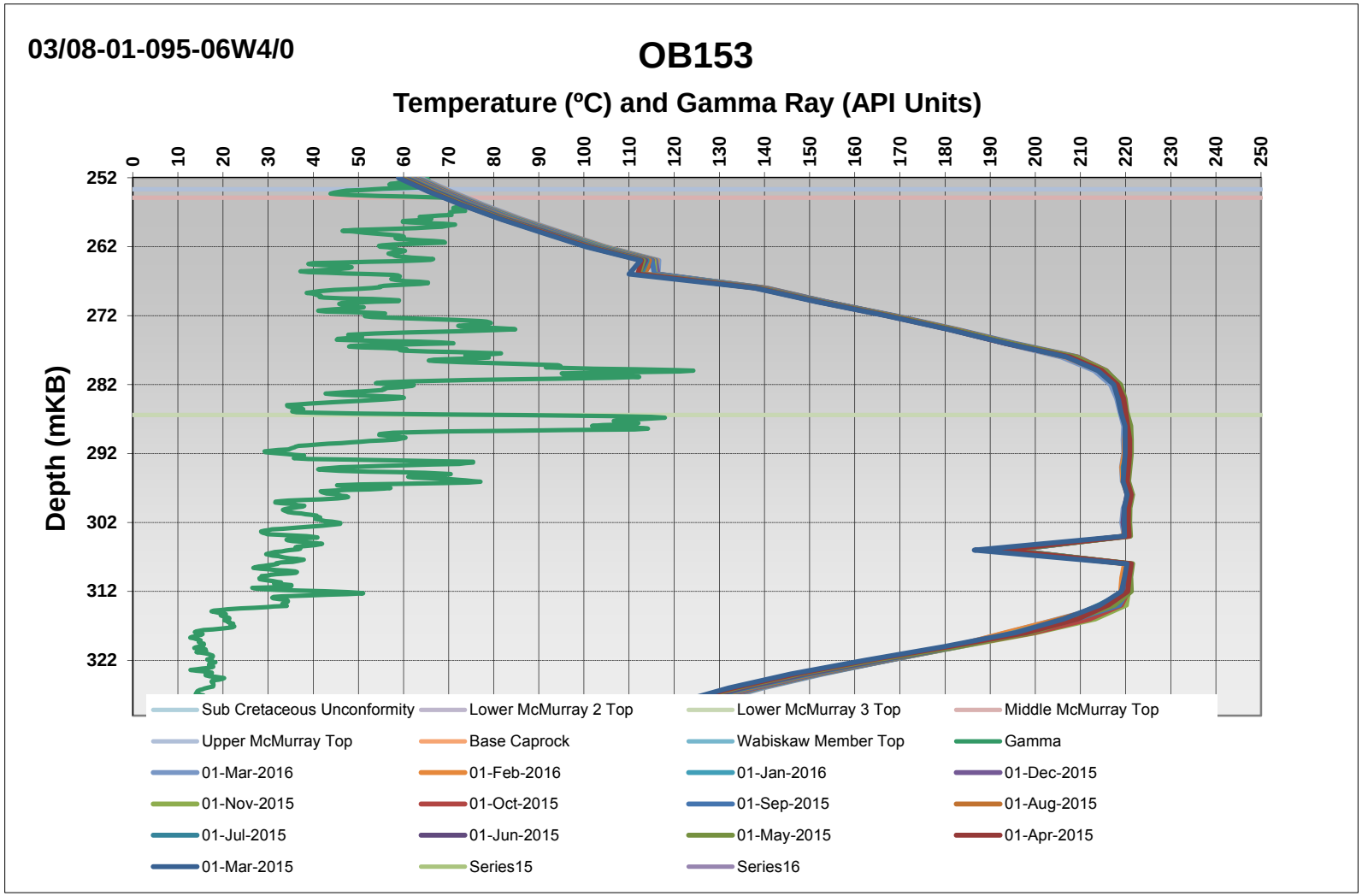
Piezometer Plots & Temperature vs Depth Plots



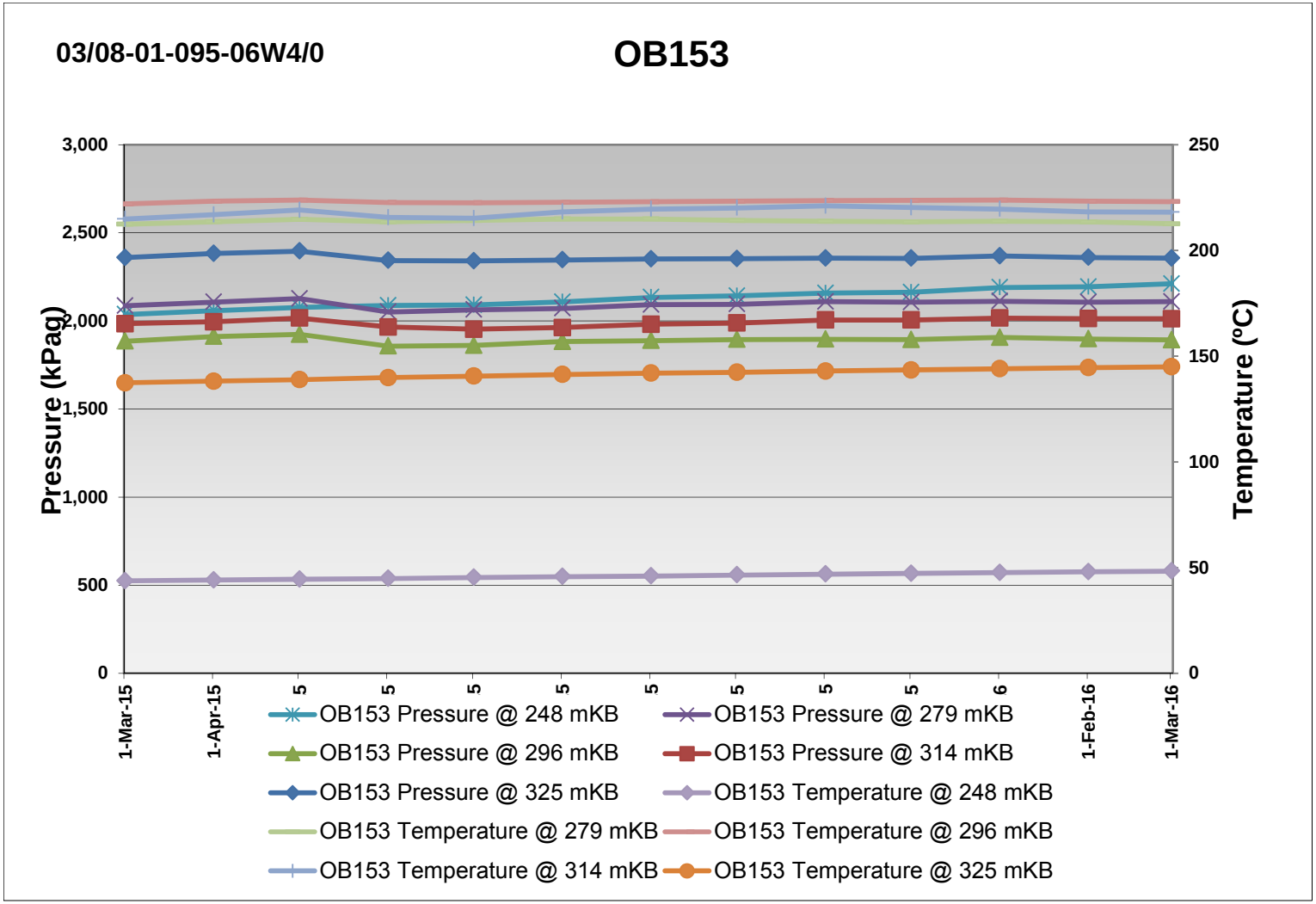
Piezometer Plots & Temperature vs Depth Plots



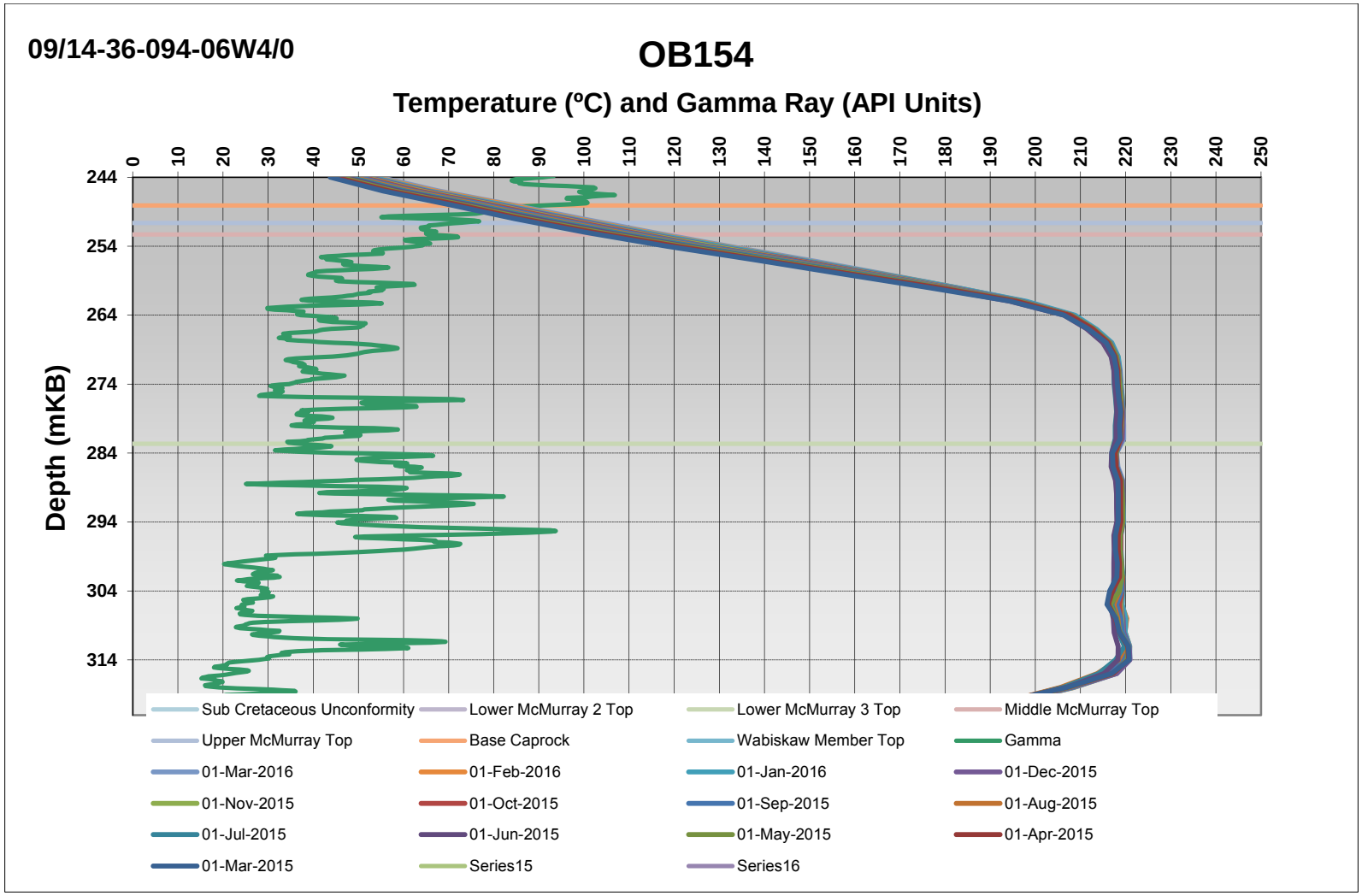
Piezometer Plots & Temperature vs Depth Plots



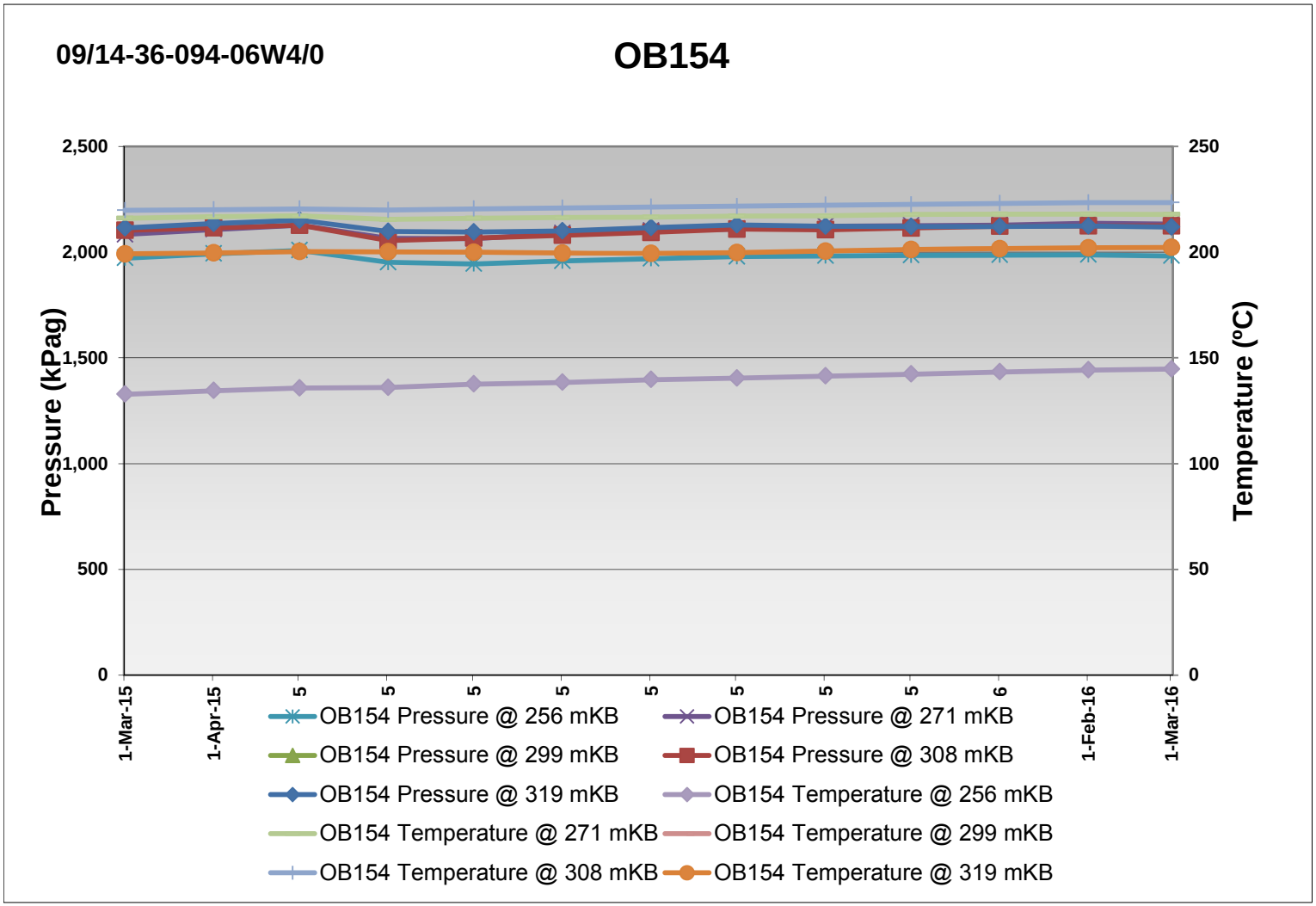
Piezometer Plots & Temperature vs Depth Plots



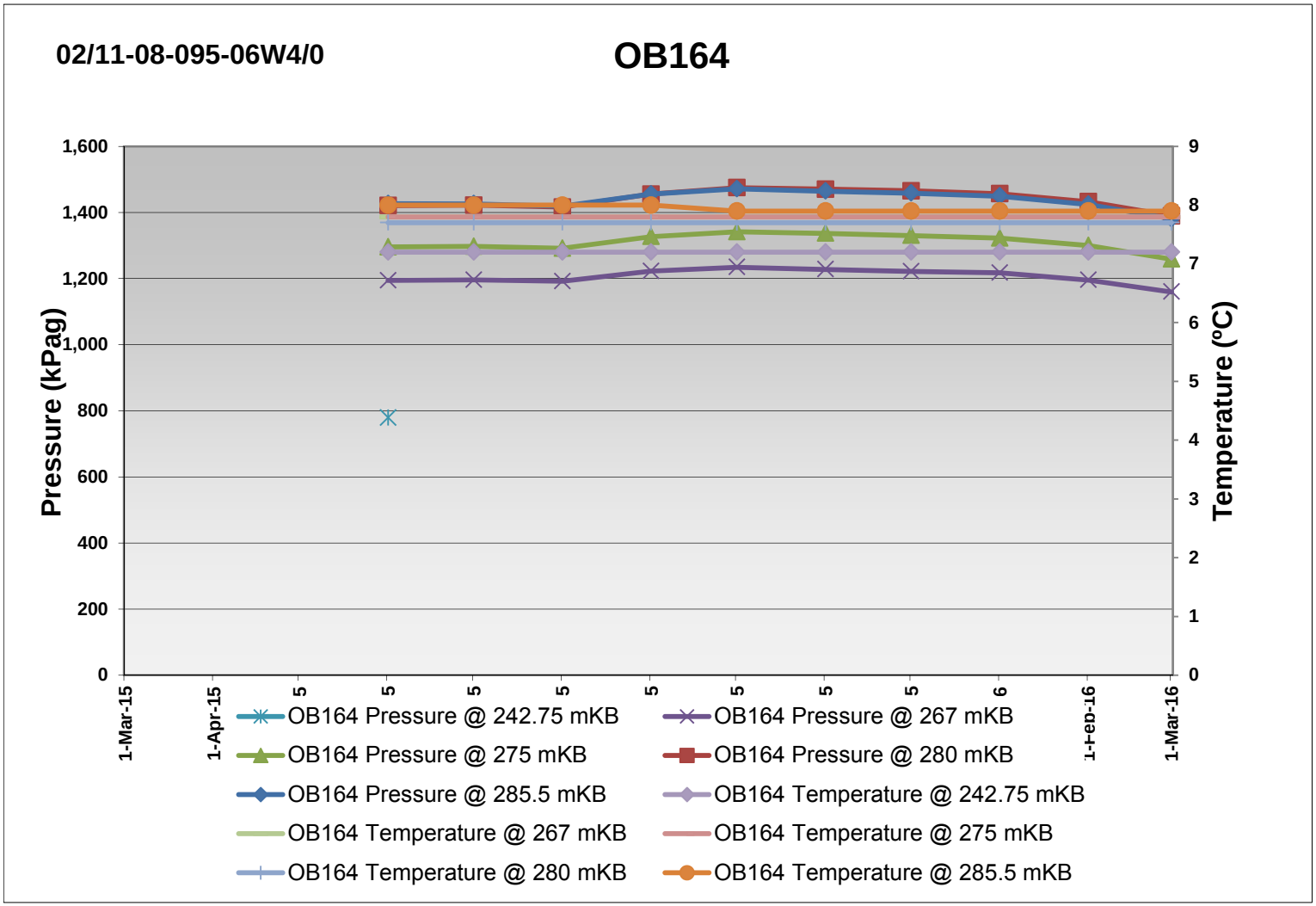
Piezometer Plots & Temperature vs Depth Plots



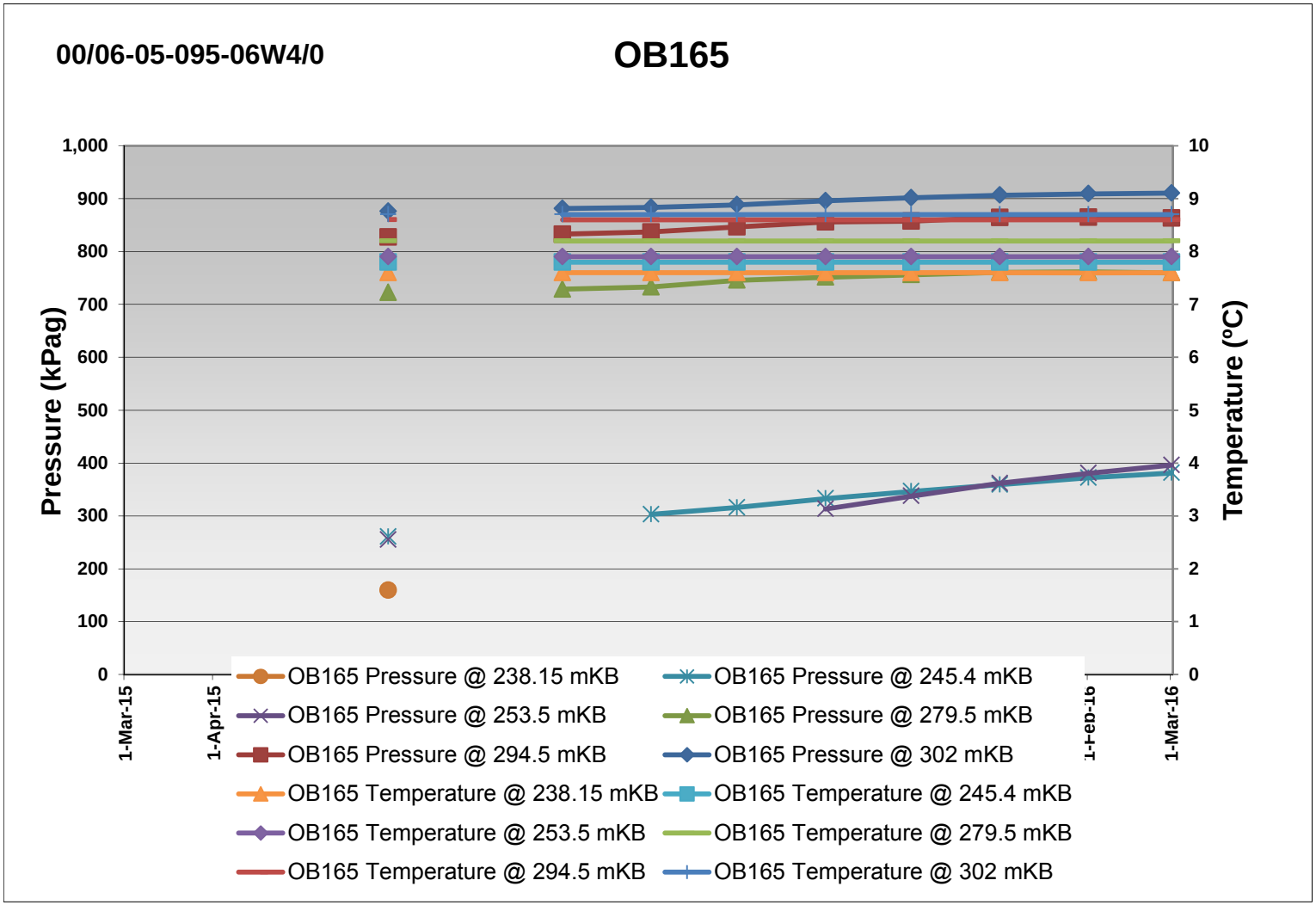
Piezometer Plots & Temperature vs Depth Plots



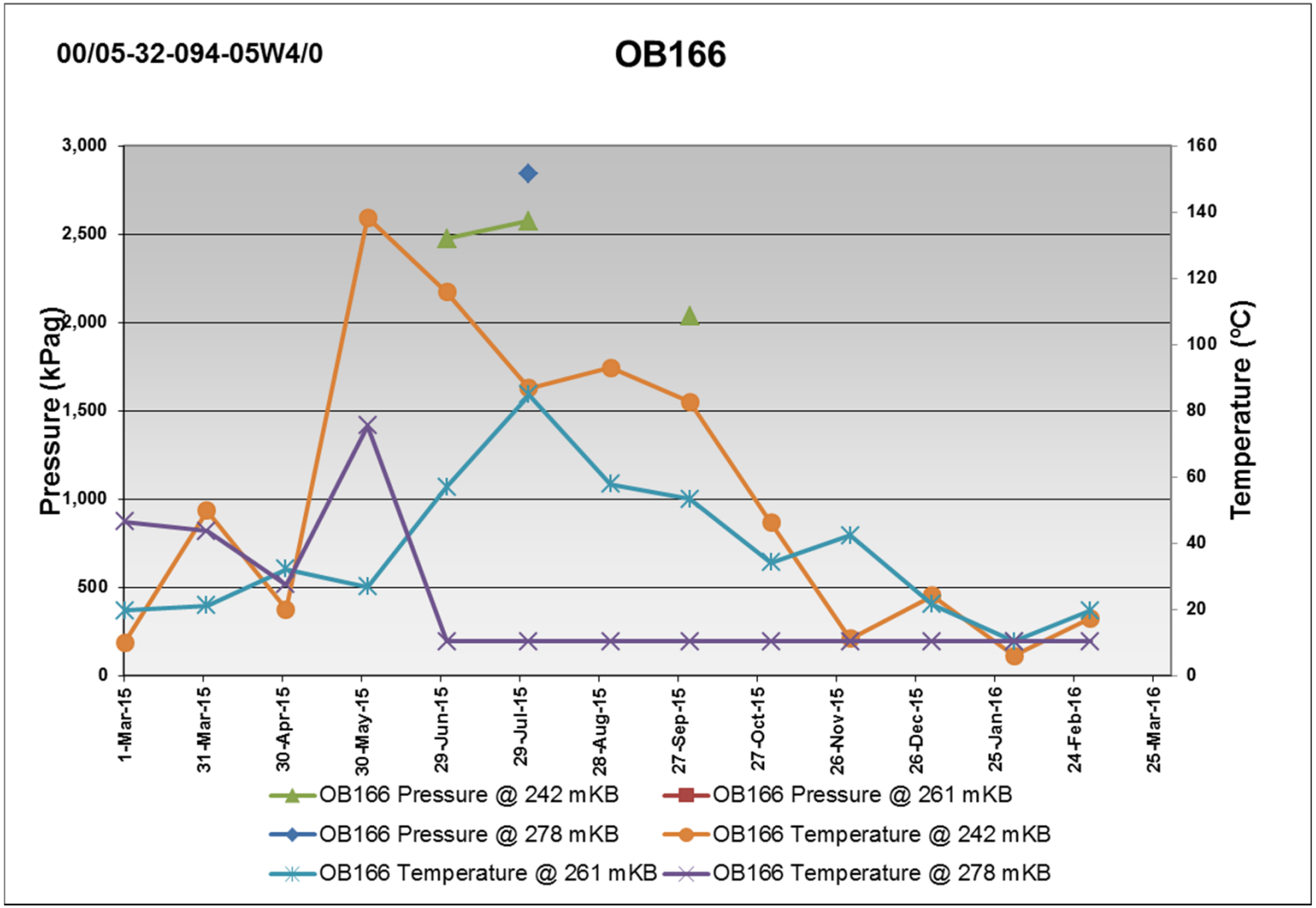
Piezometer Plots & Temperature vs Depth Plots



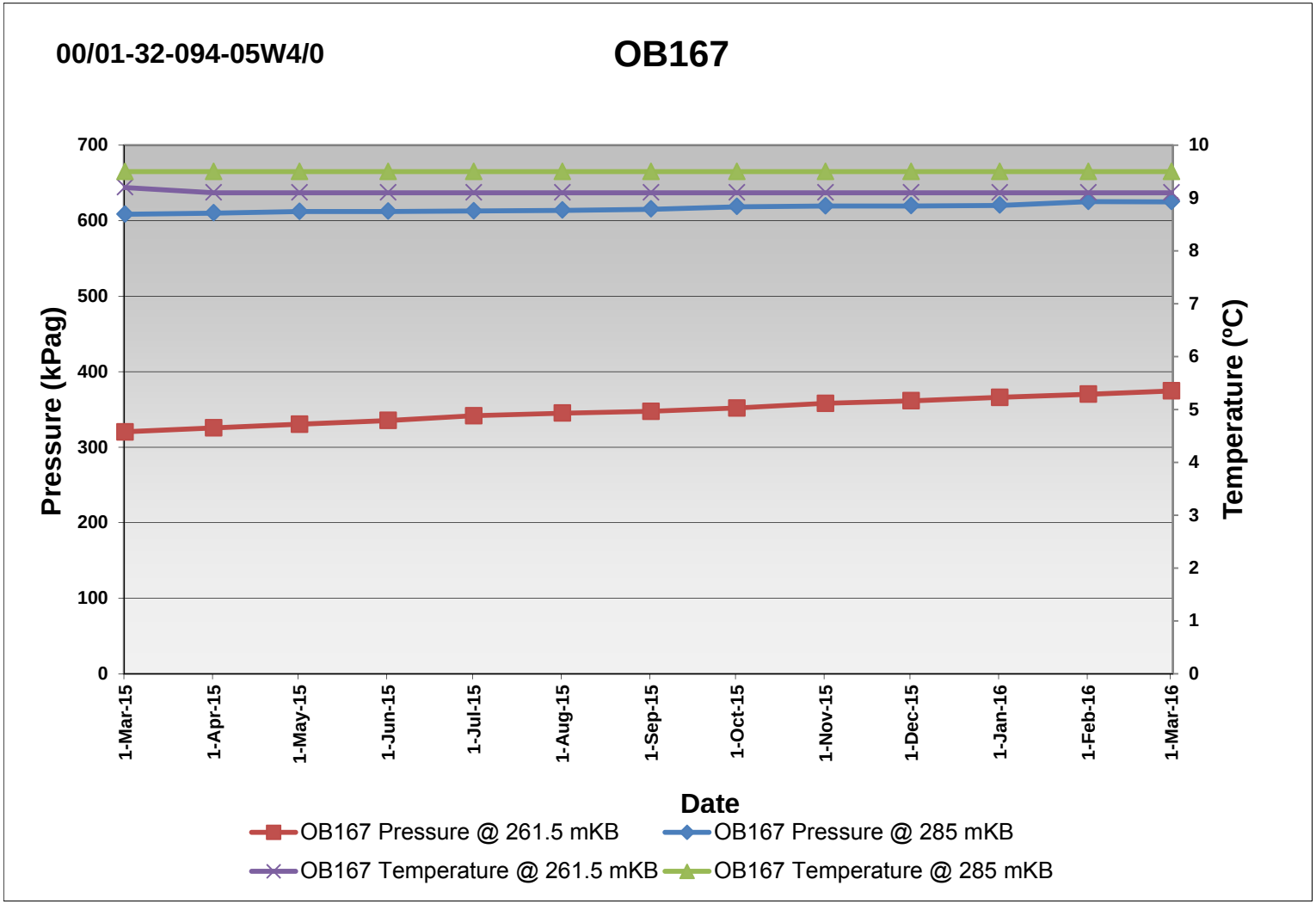
Piezometer Plots & Temperature vs Depth Plots



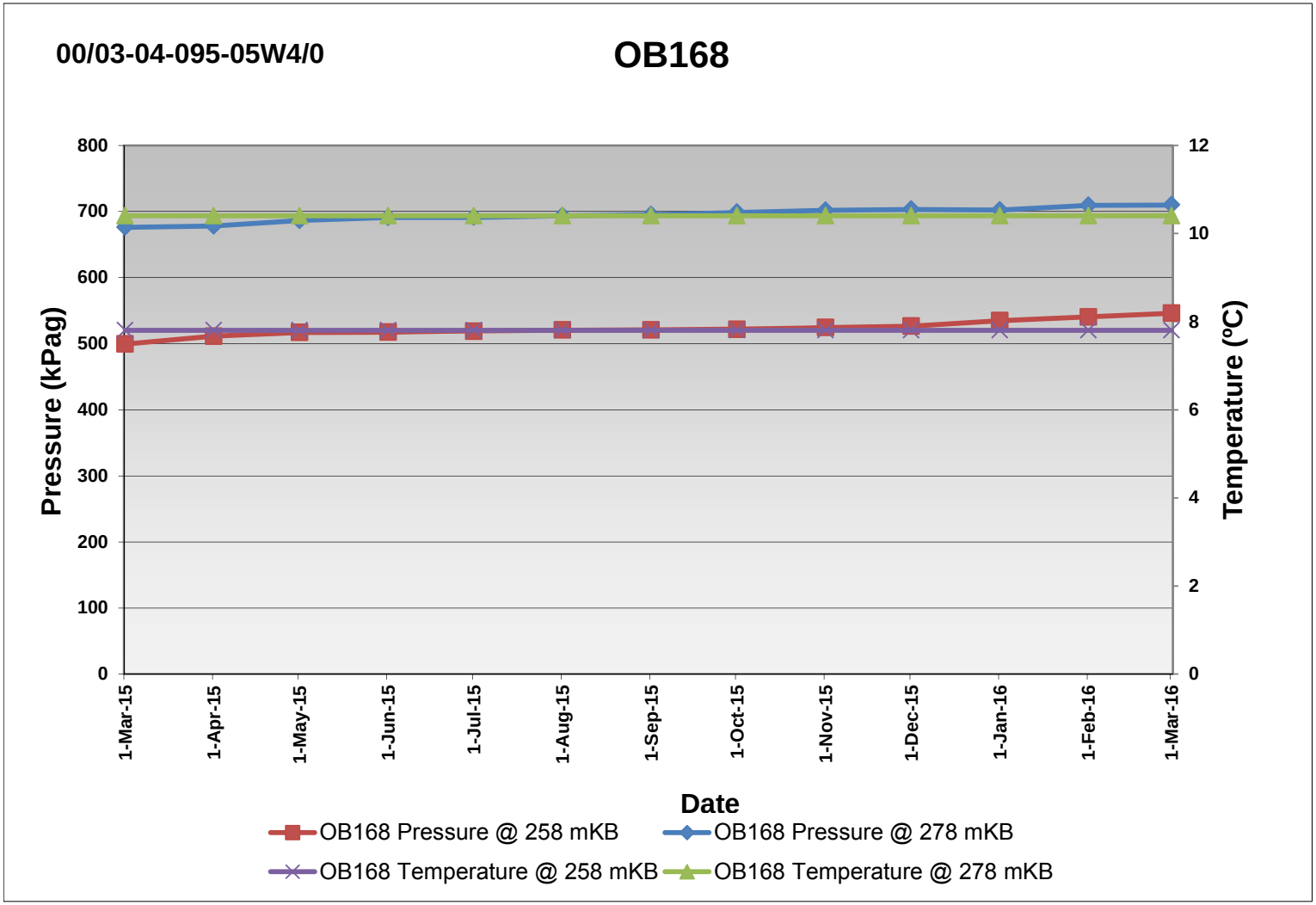
Piezometer Plots & Temperature vs Depth Plots



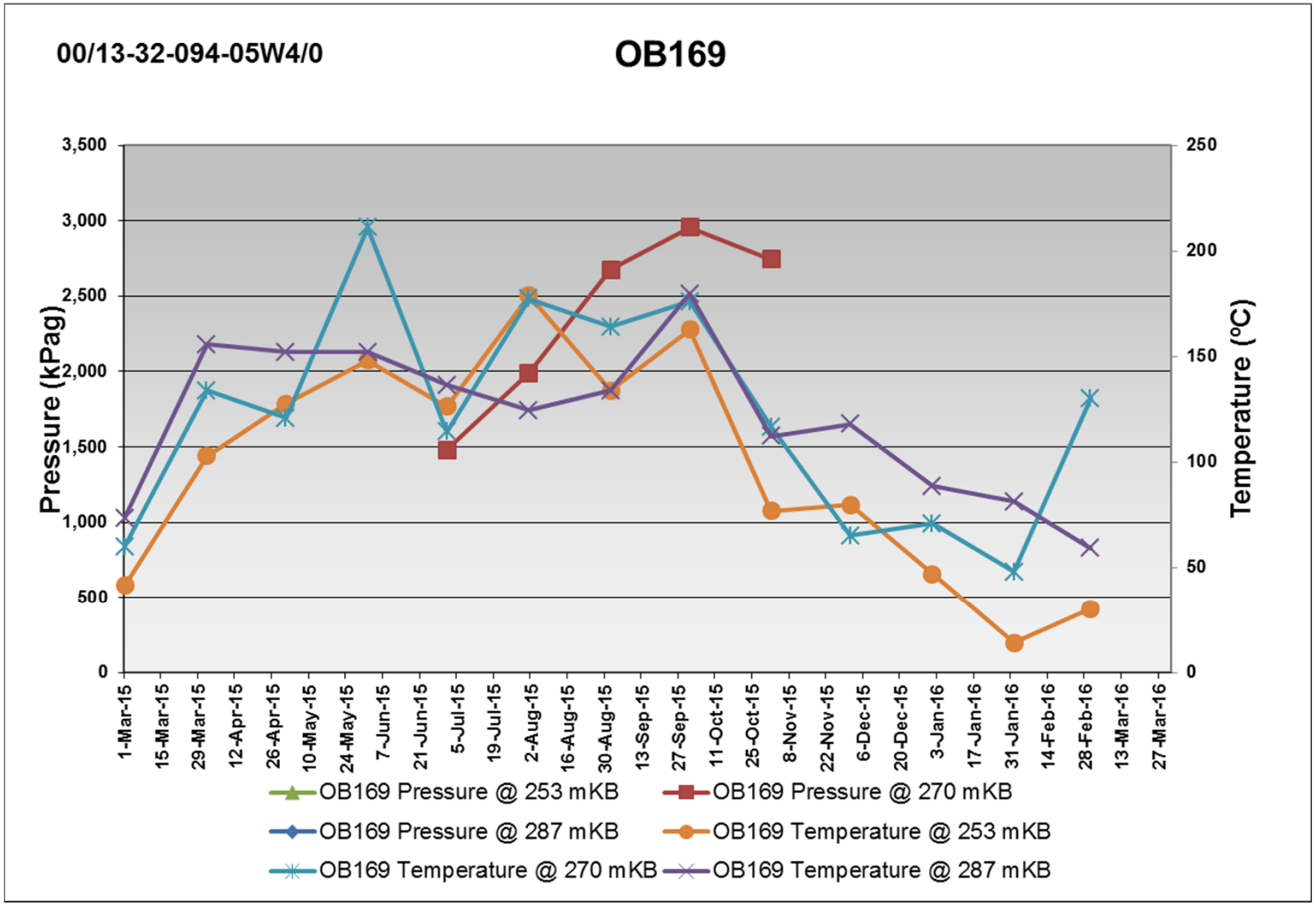
Piezometer Plots & Temperature vs Depth Plots



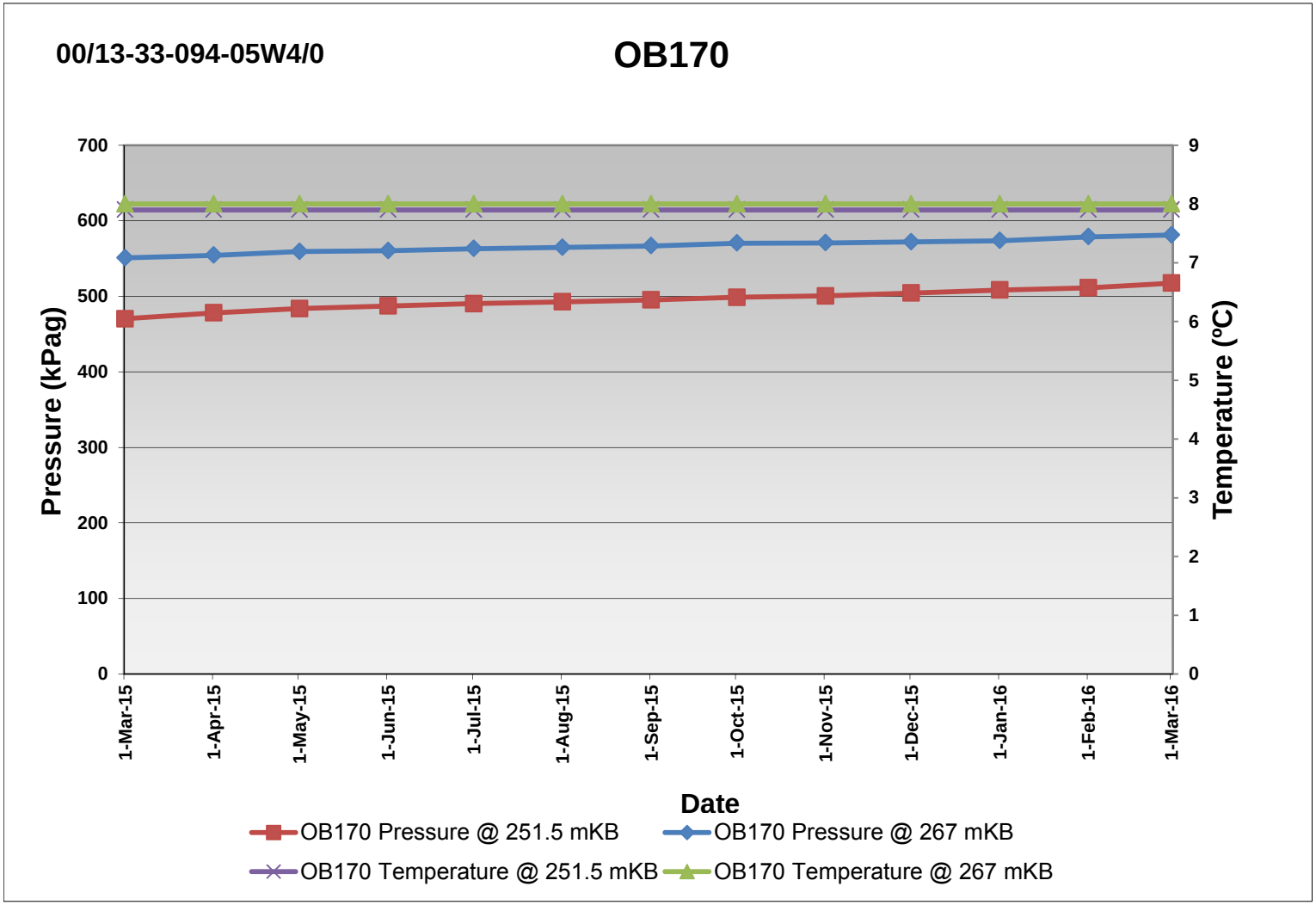
Piezometer Plots & Temperature vs Depth Plots



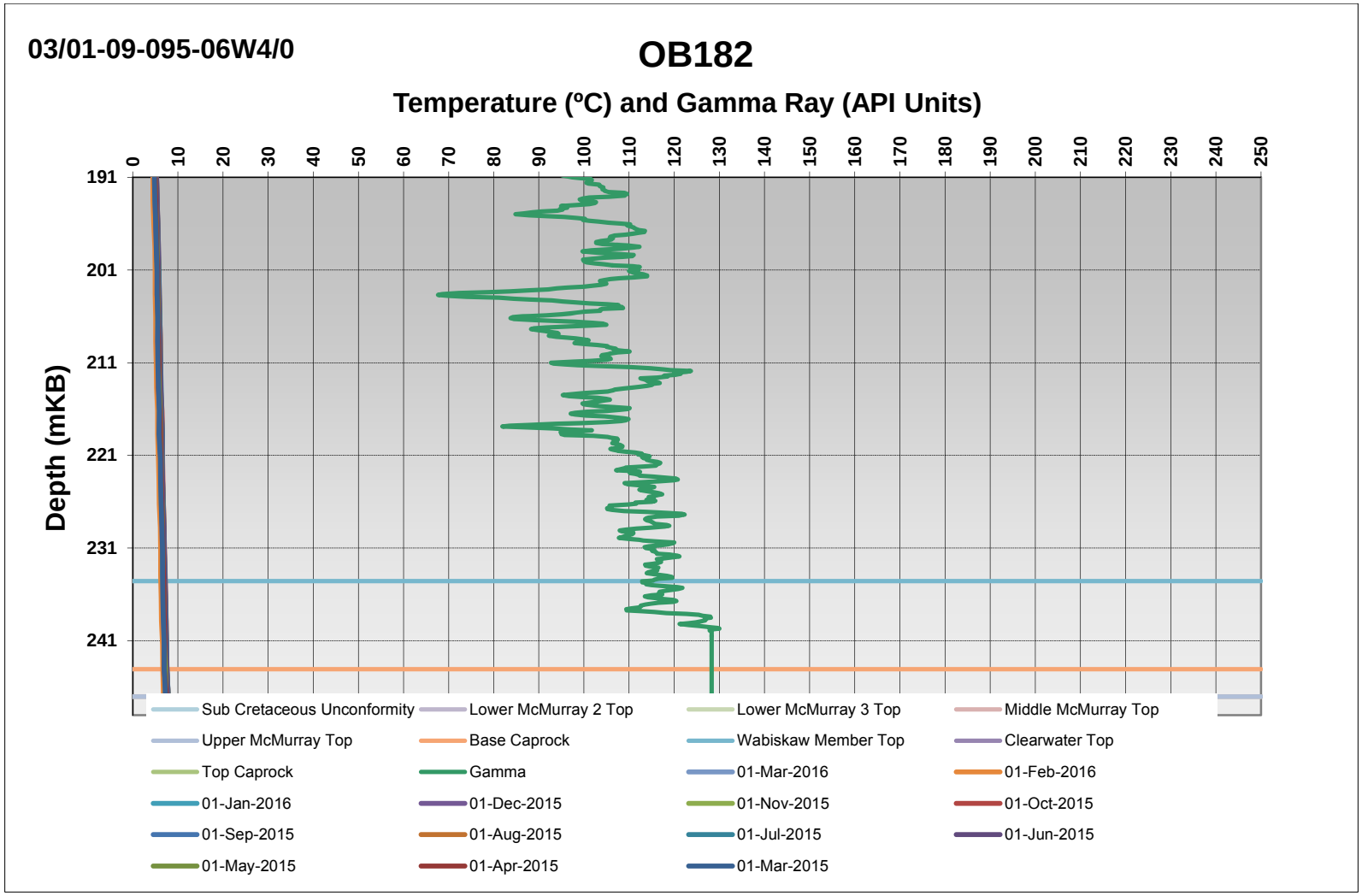
Piezometer Plots & Temperature vs Depth Plots



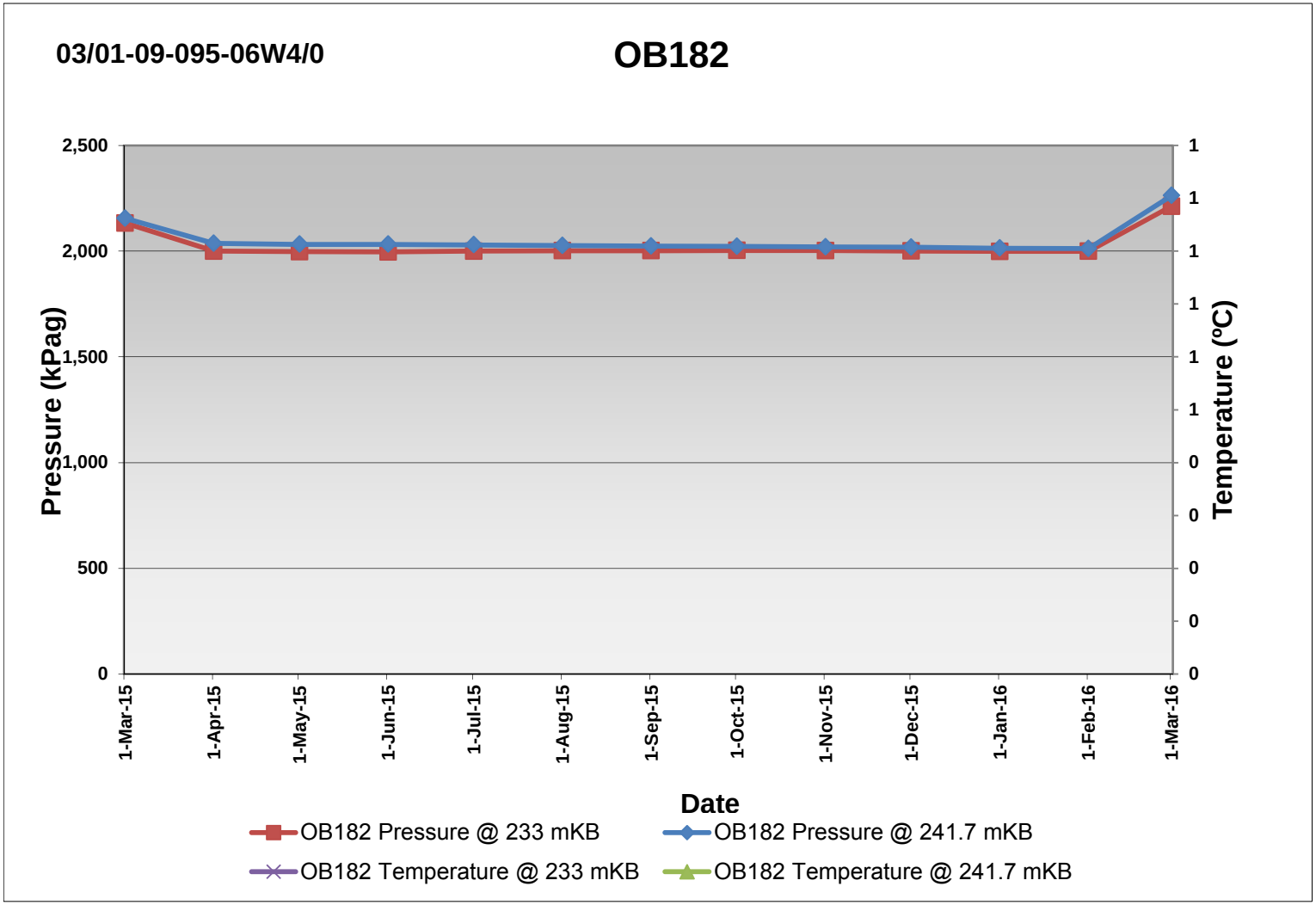
Piezometer Plots & Temperature vs Depth Plots



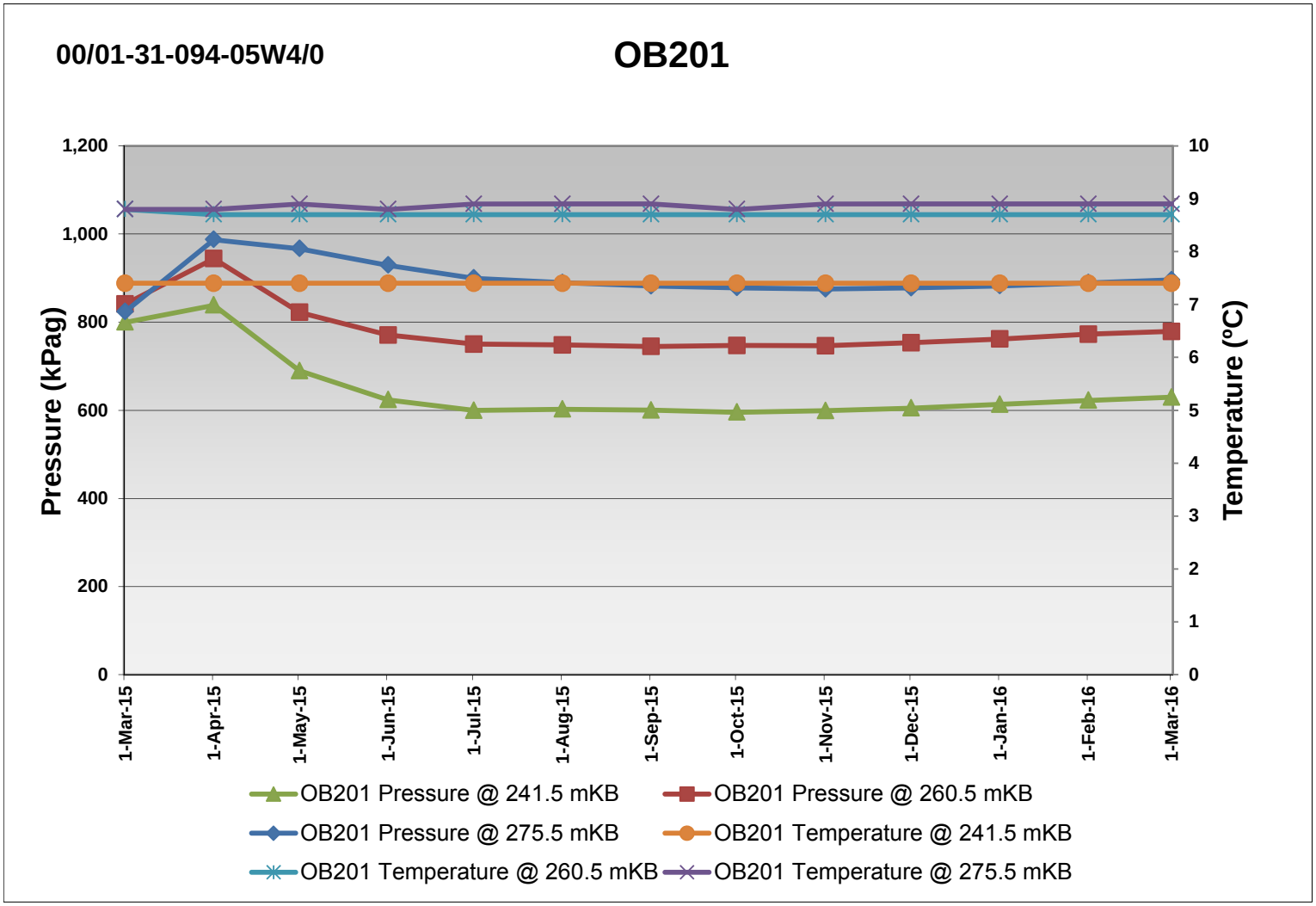
Piezometer Plots & Temperature vs Depth Plots



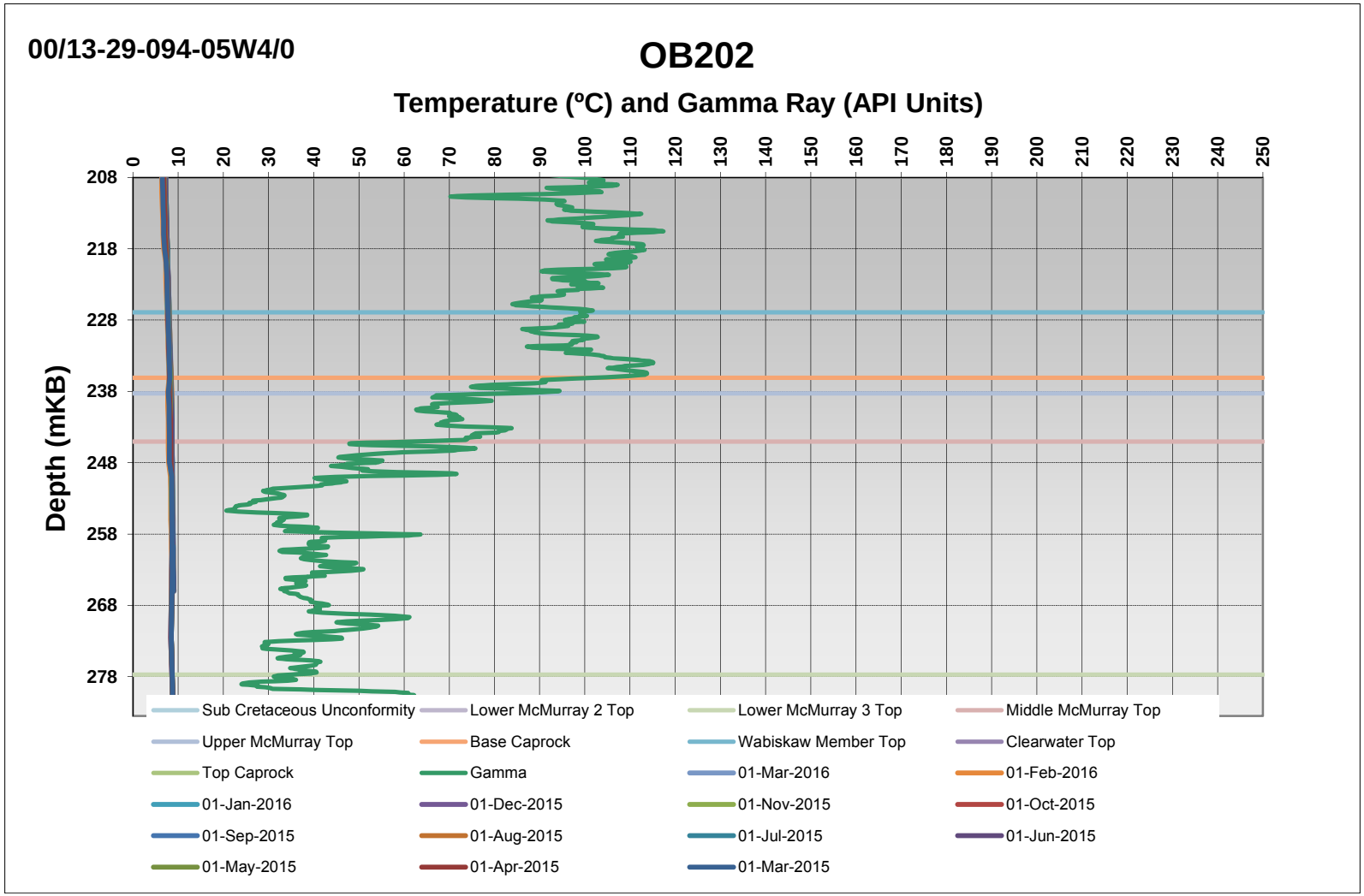
Piezometer Plots & Temperature vs Depth Plots



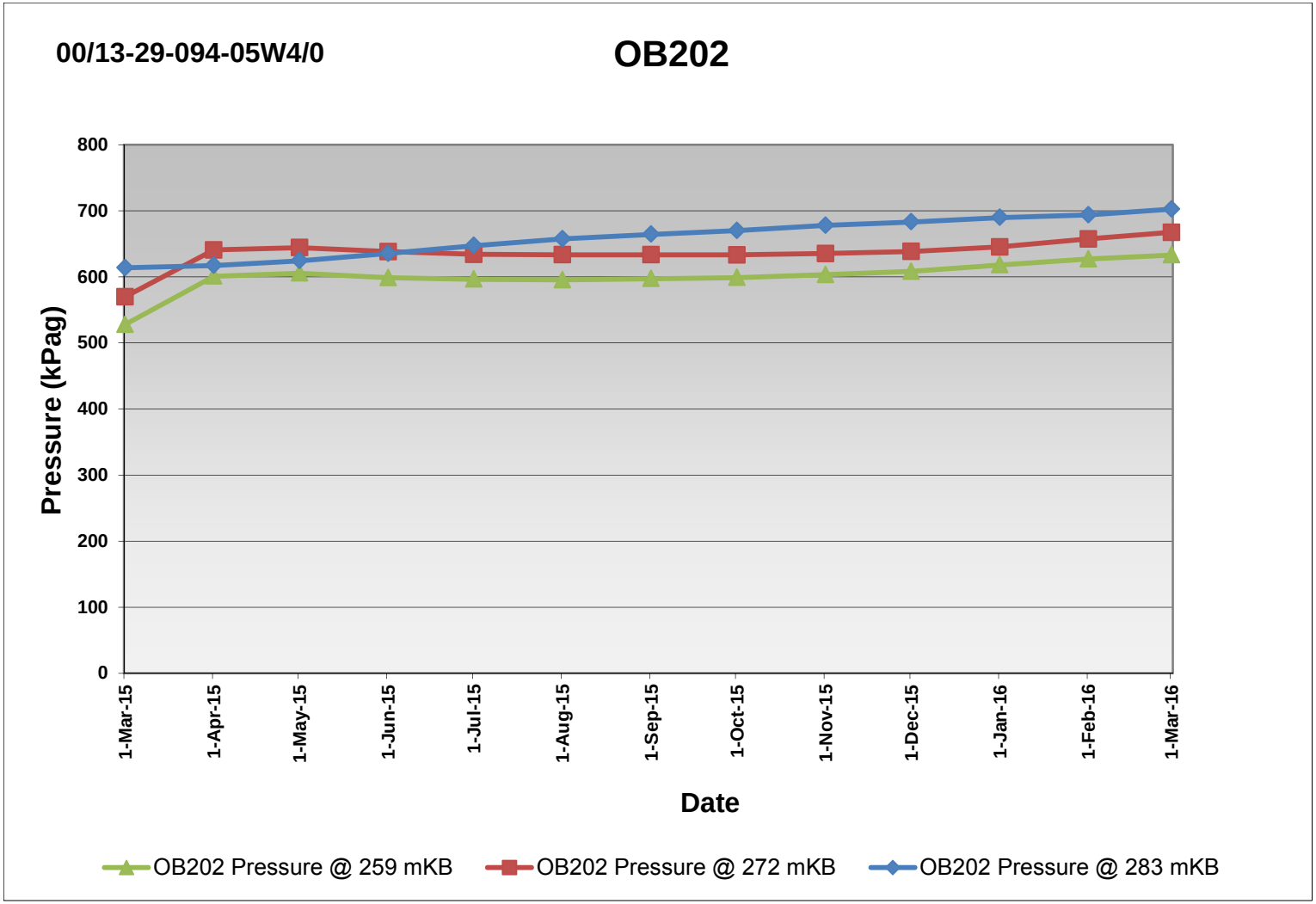
Piezometer Plots & Temperature vs Depth Plots



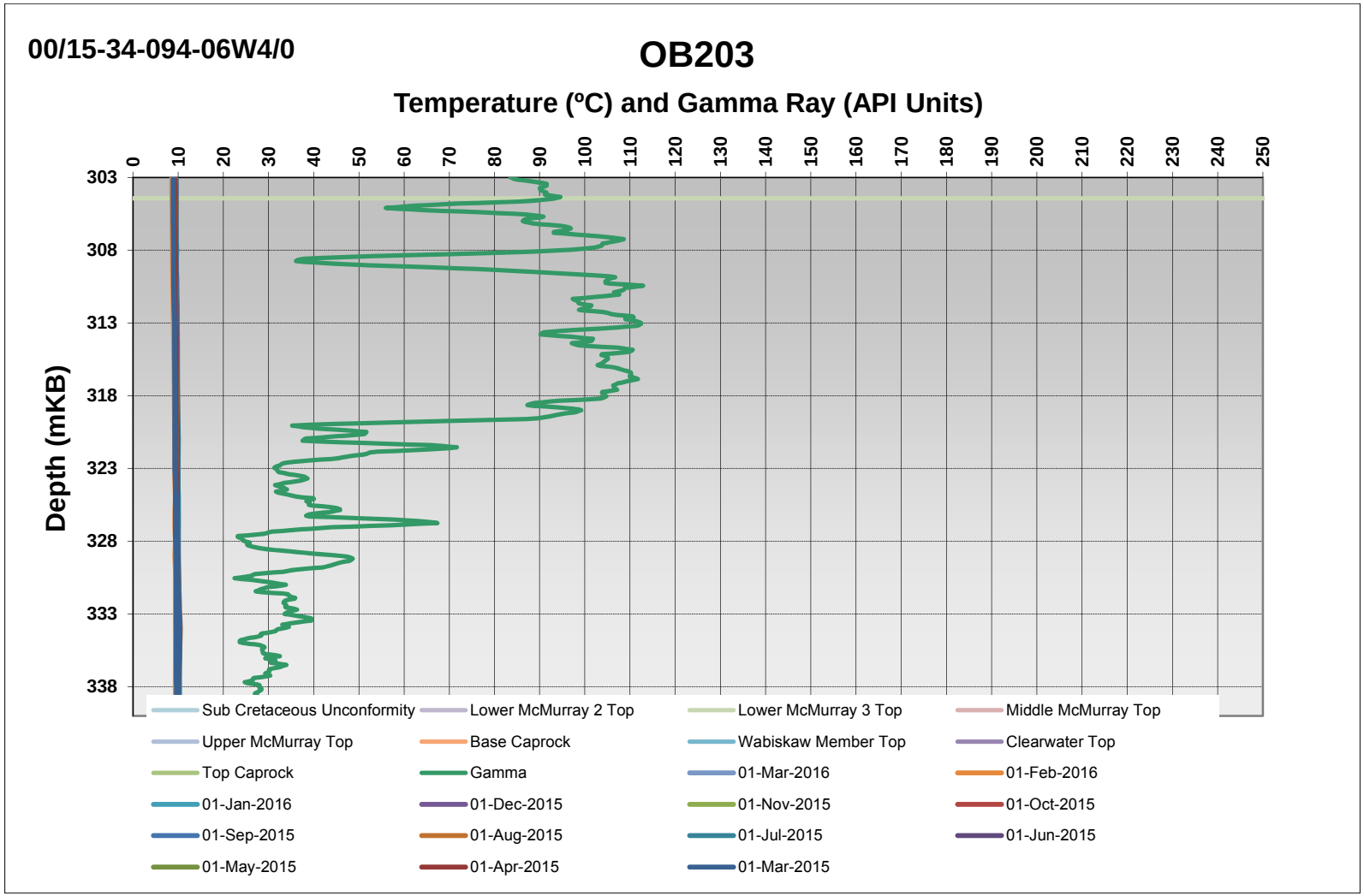
Piezometer Plots & Temperature vs Depth Plots



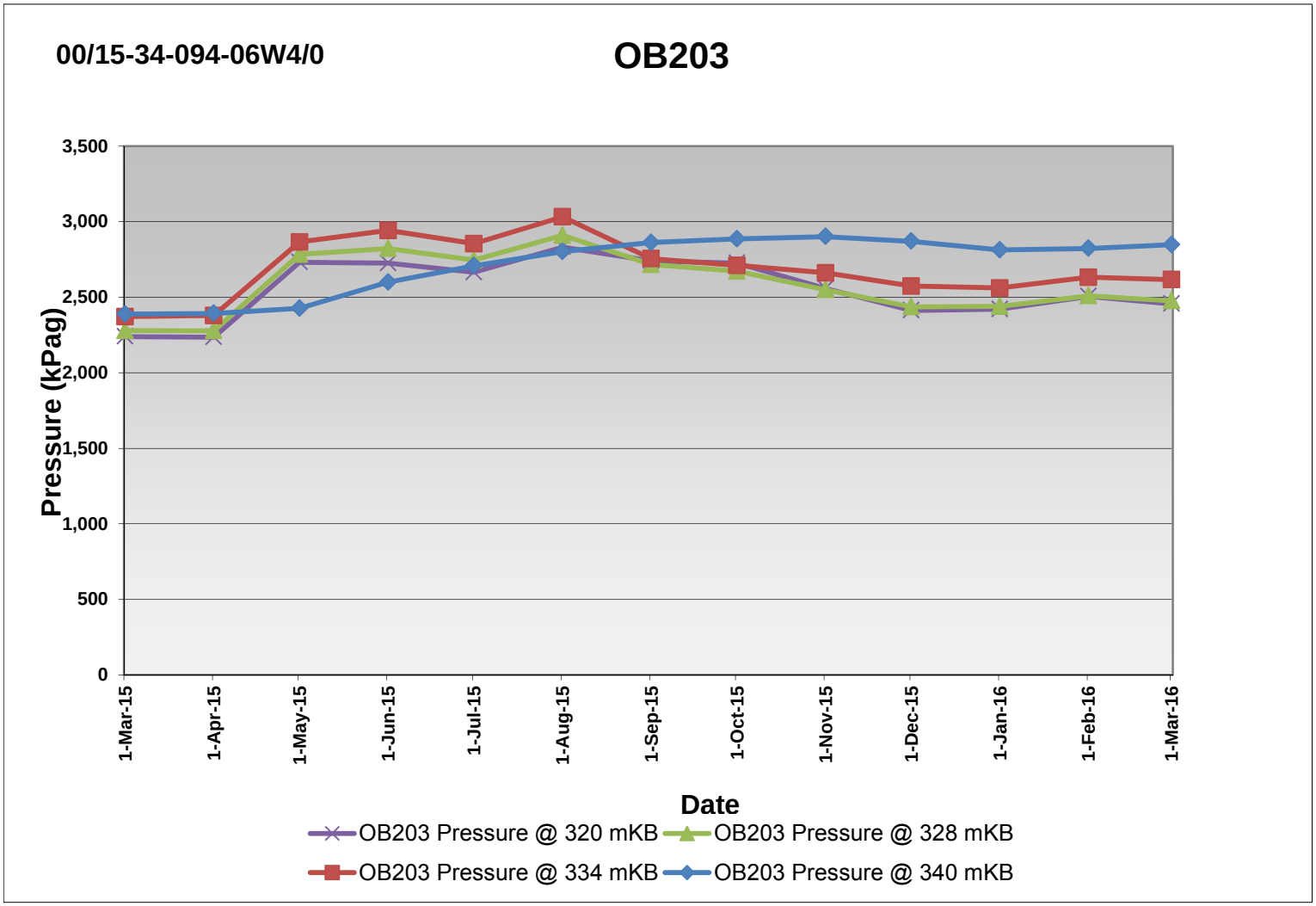
Piezometer Plots & Temperature vs Depth Plots



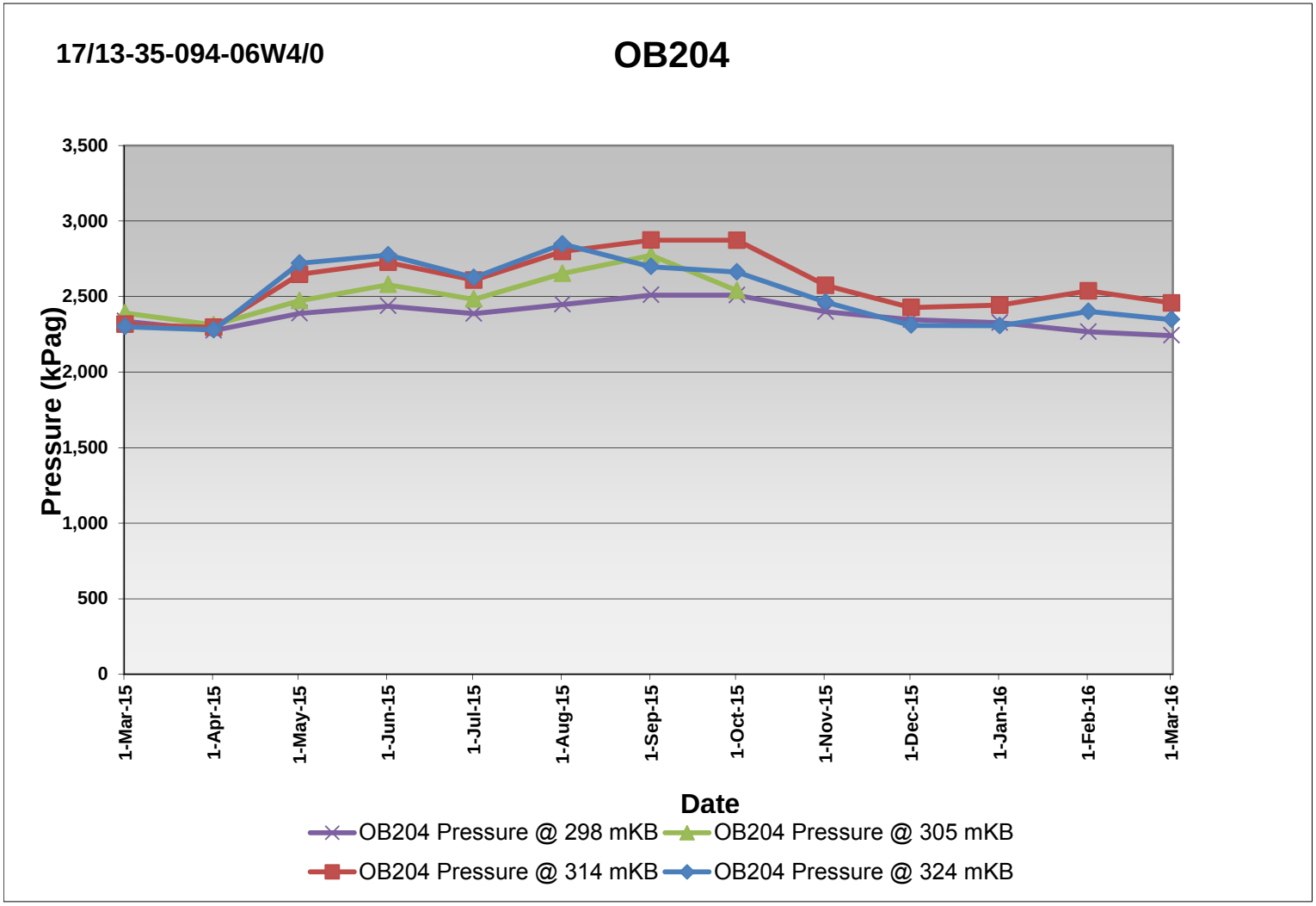
Piezometer Plots & Temperature vs Depth Plots



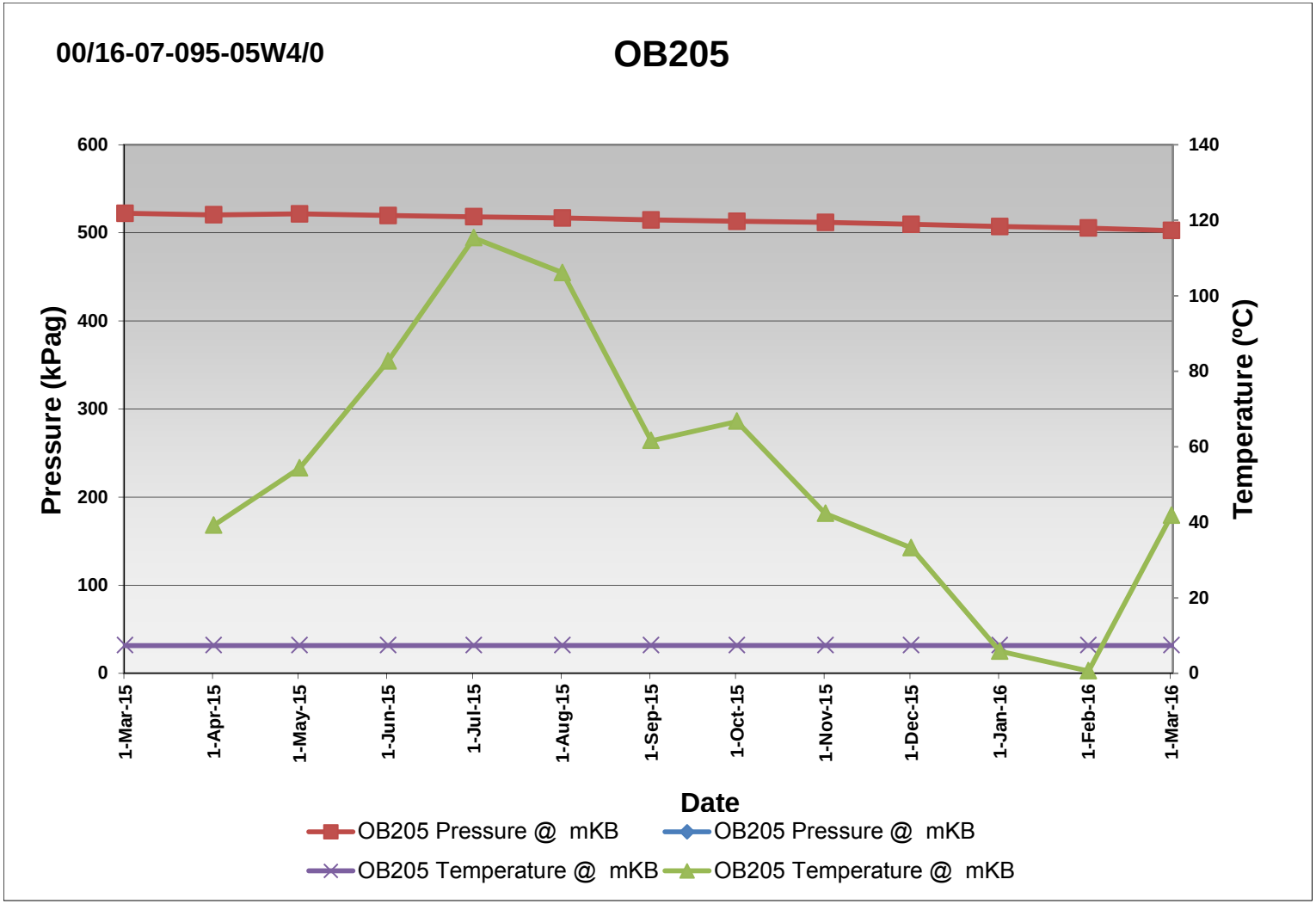
Piezometer Plots & Temperature vs Depth Plots



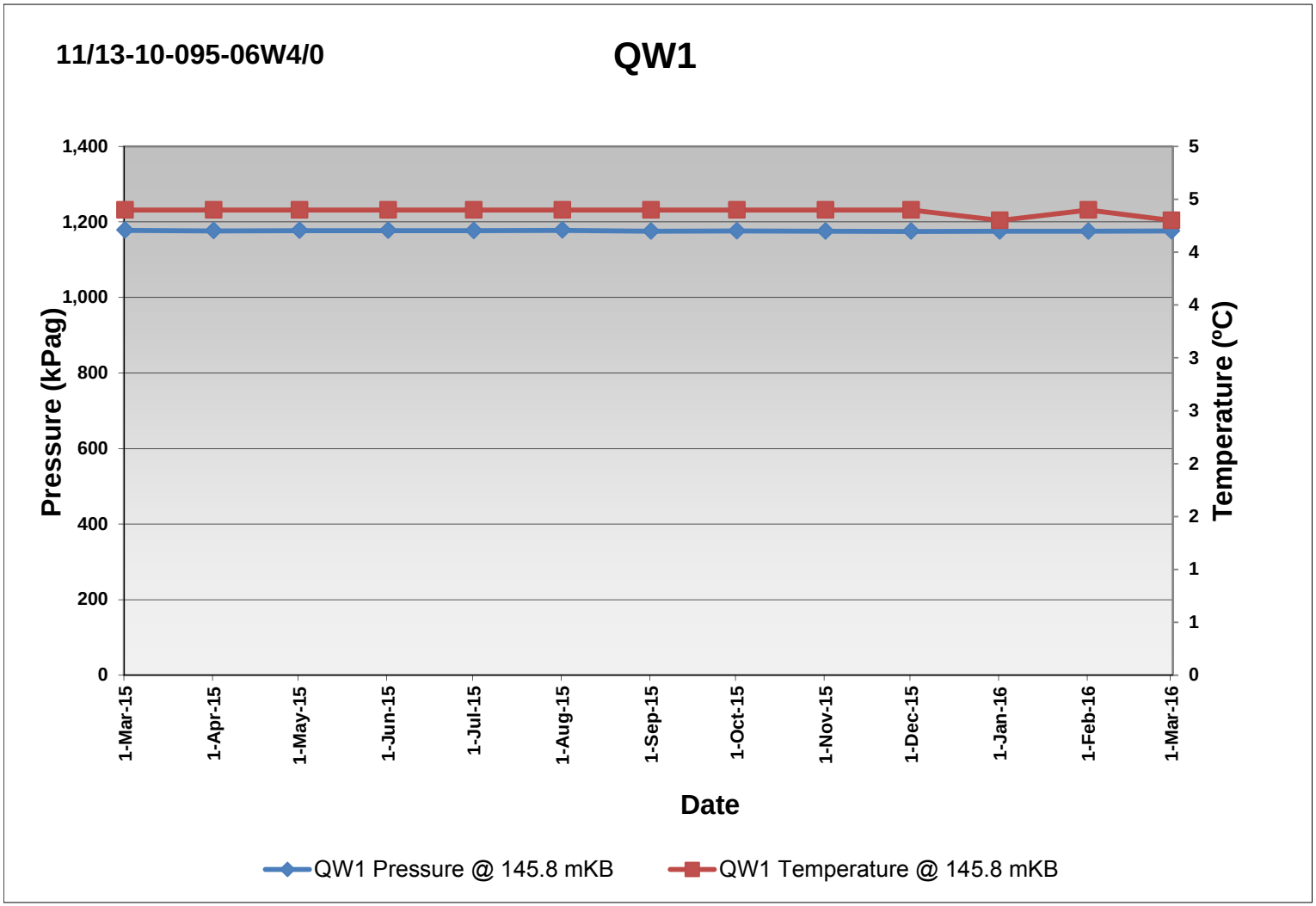
Piezometer Plots & Temperature vs Depth Plots



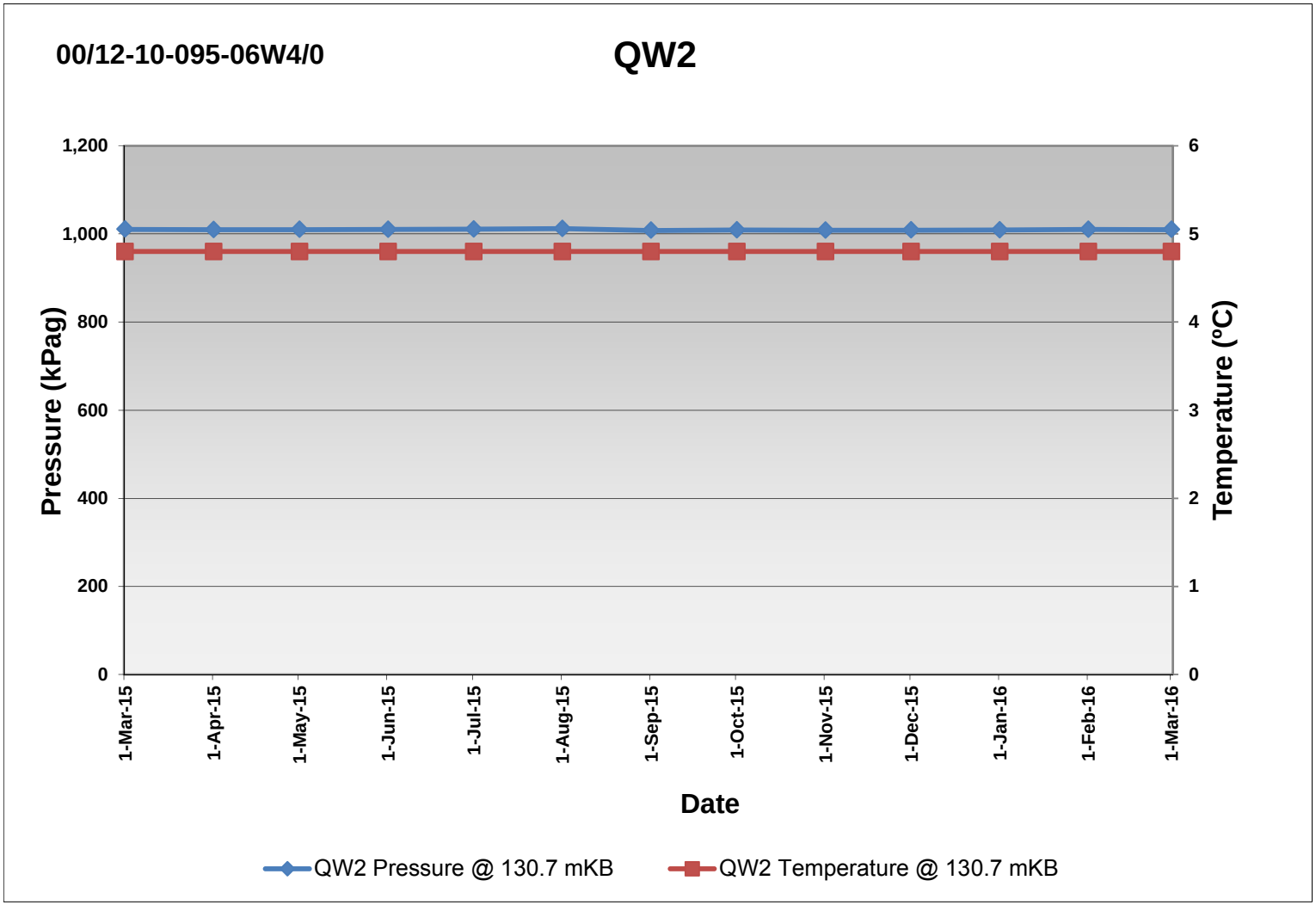
Piezometer Plots & Temperature vs Depth Plots



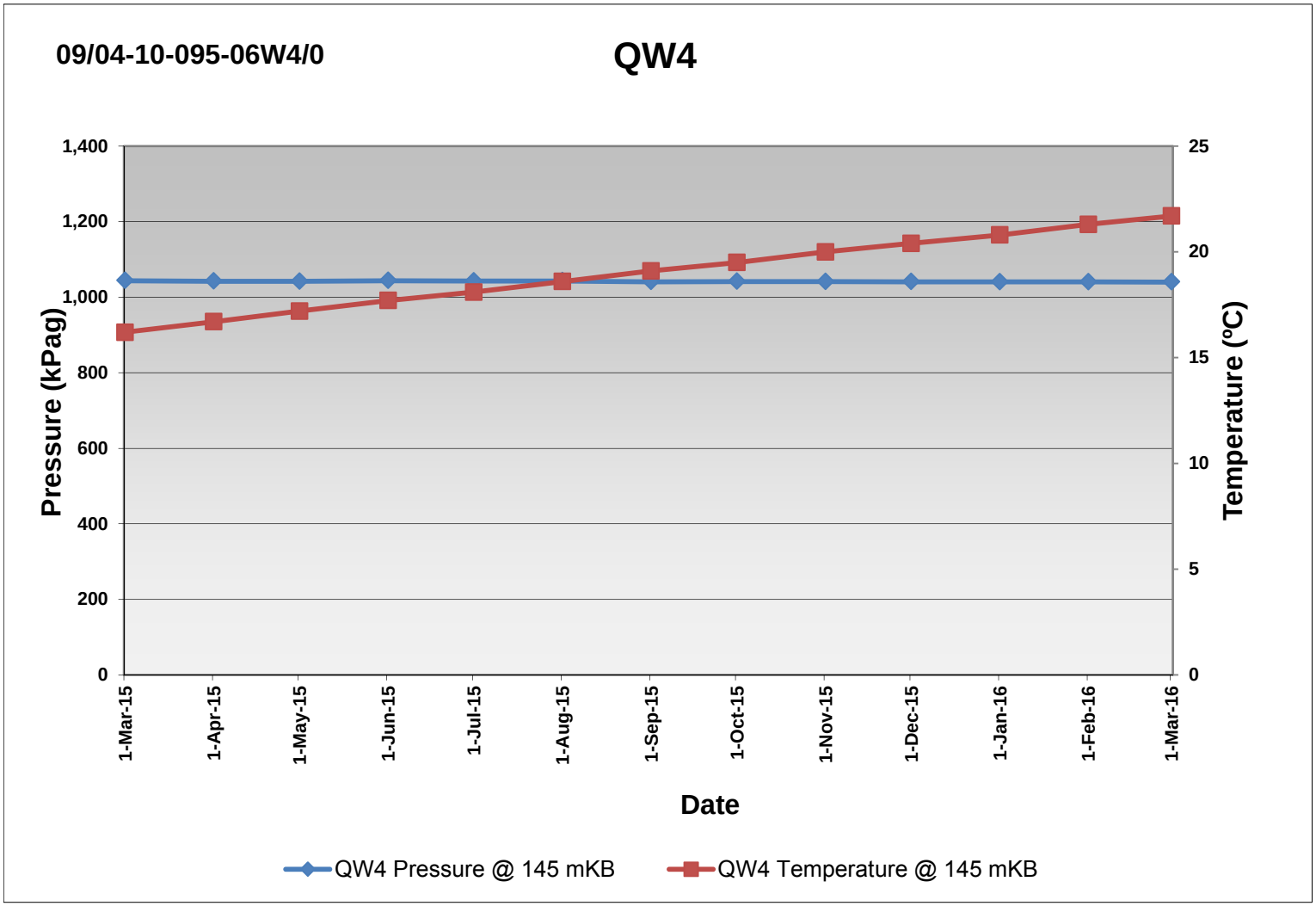
Piezometer Plots & Temperature vs Depth Plots



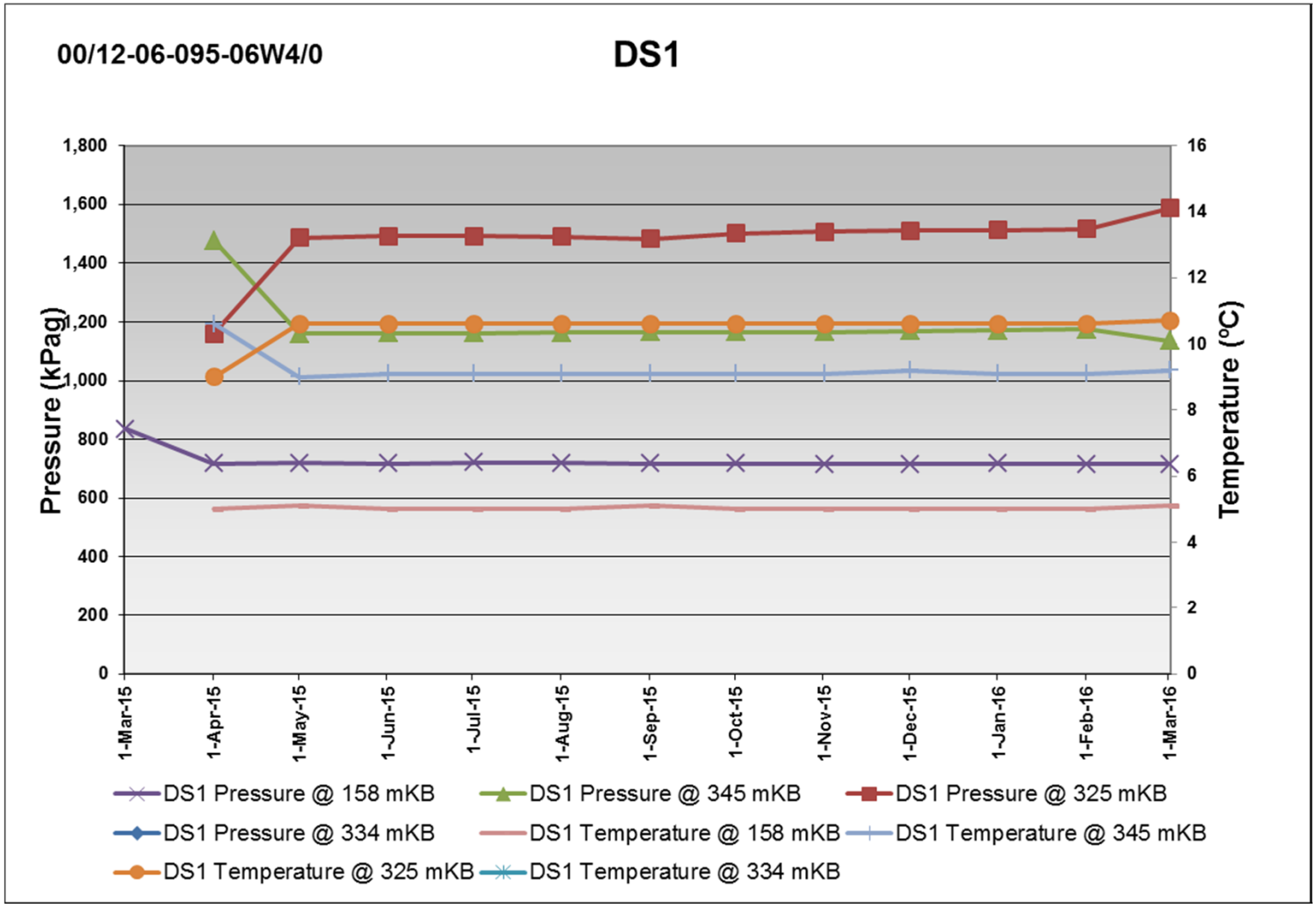
Piezometer Plots & Temperature vs Depth Plots



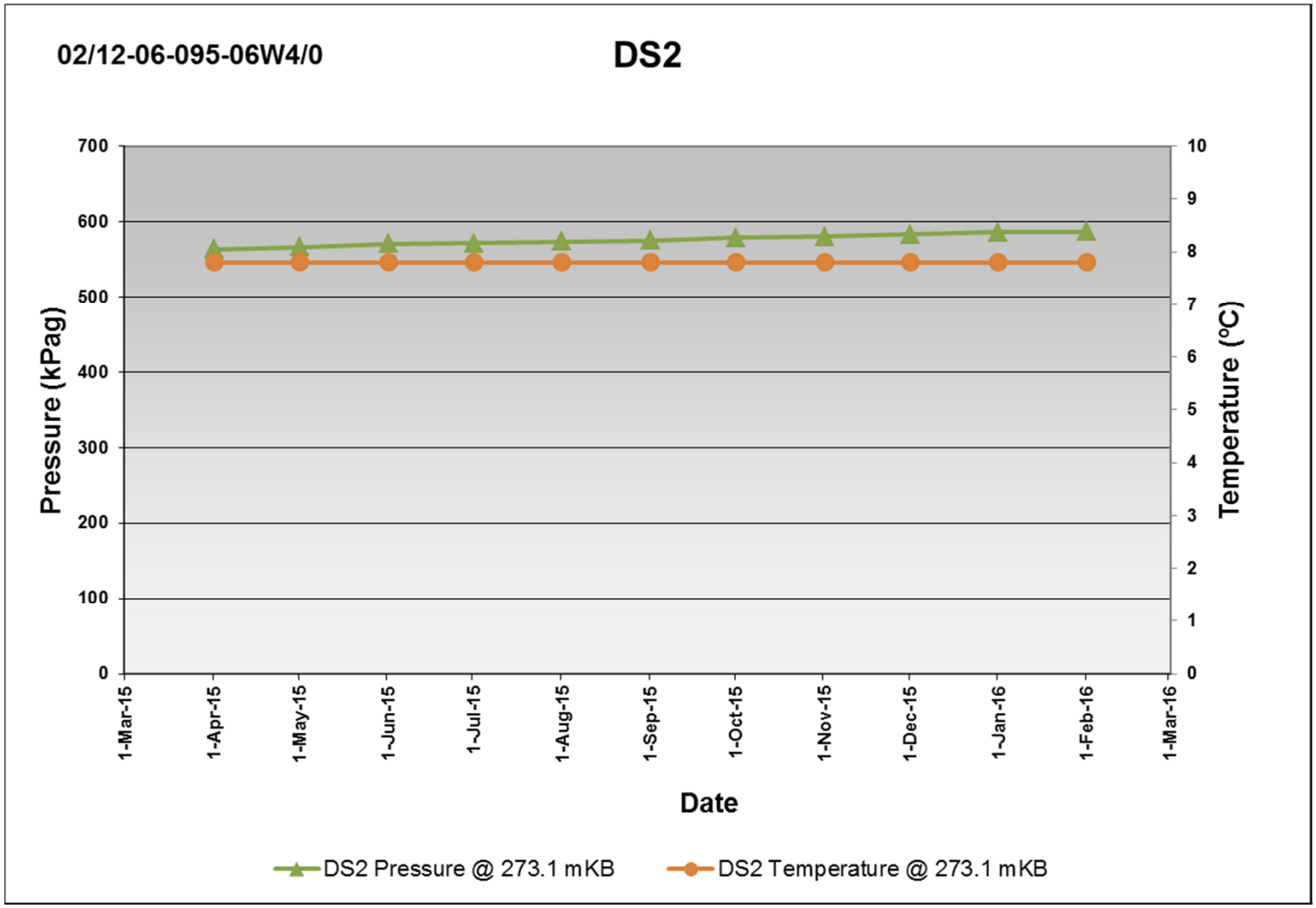
Piezometer Plots & Temperature vs Depth Plots



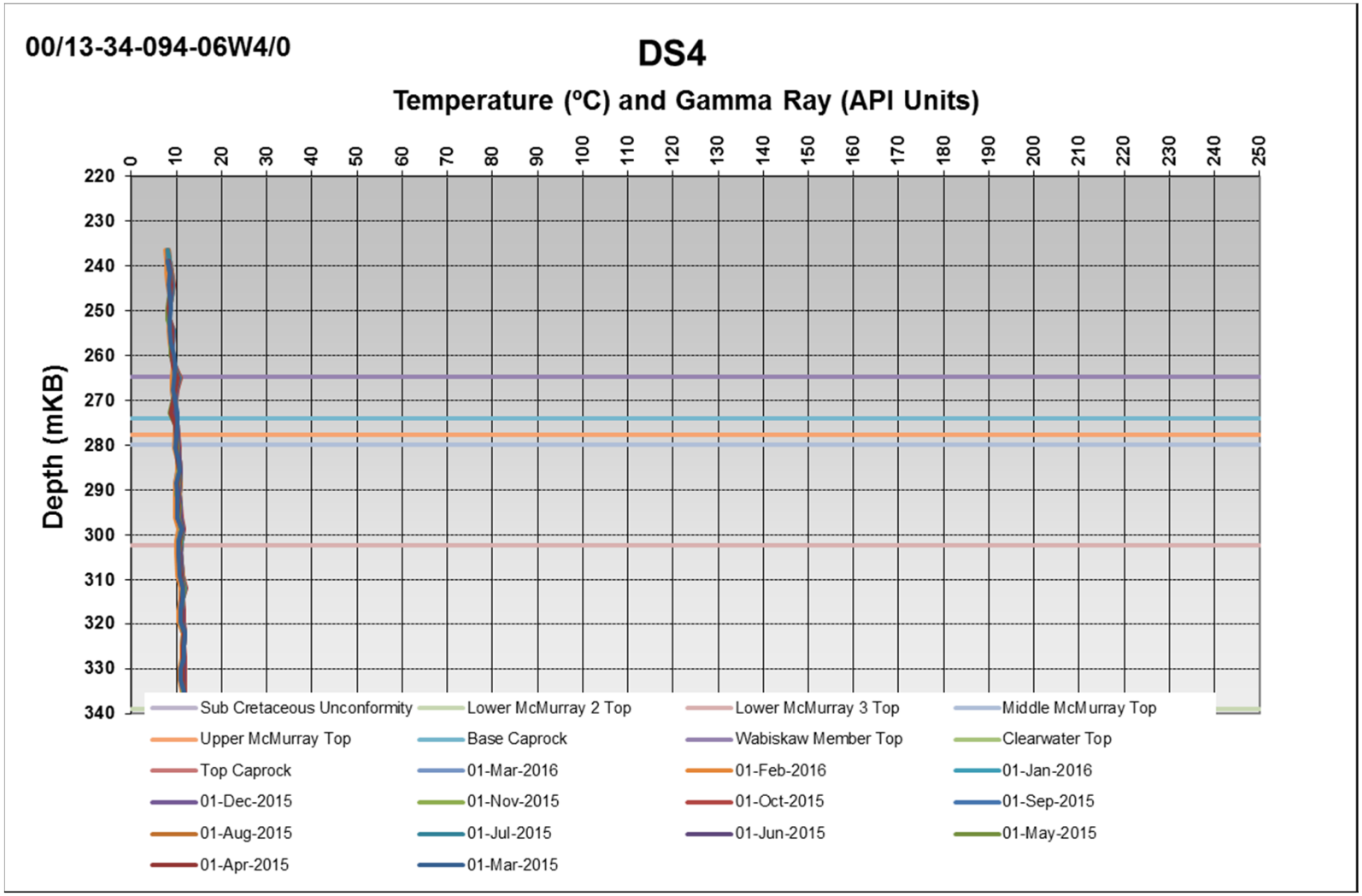
Piezometer Plots & Temperature vs Depth Plots



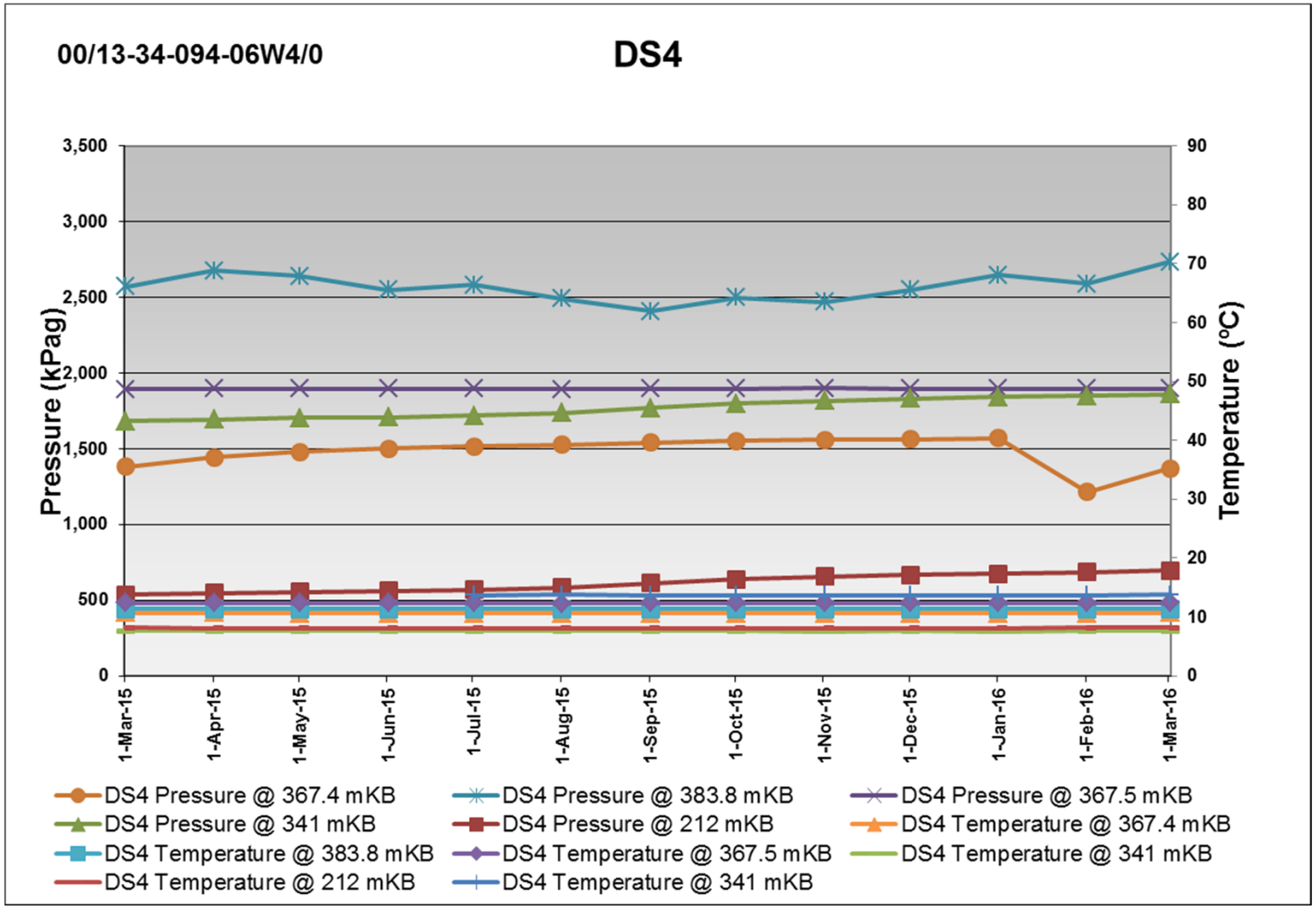
Piezometer Plots & Temperature vs Depth Plots



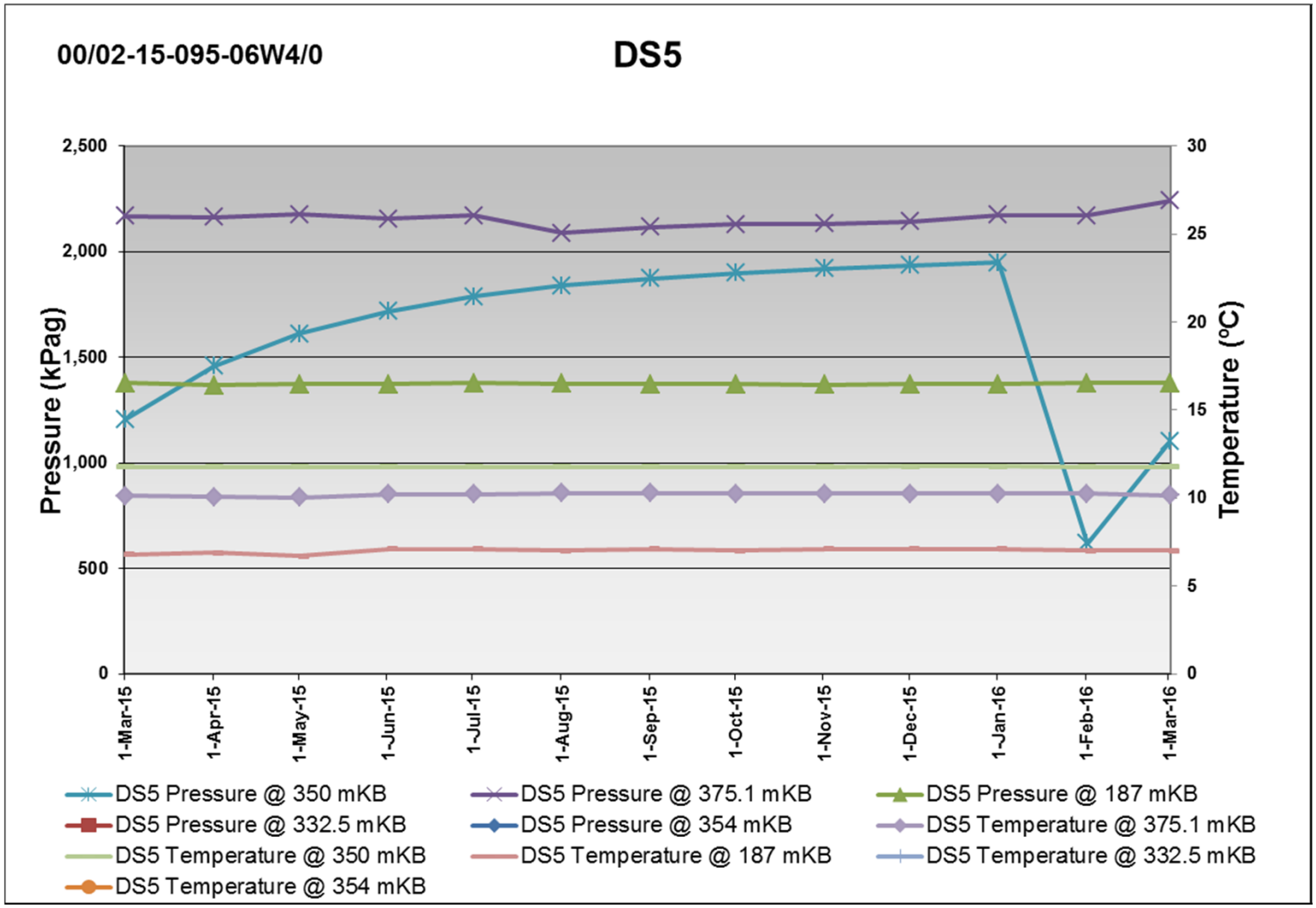
Piezometer Plots & Temperature vs Depth Plots



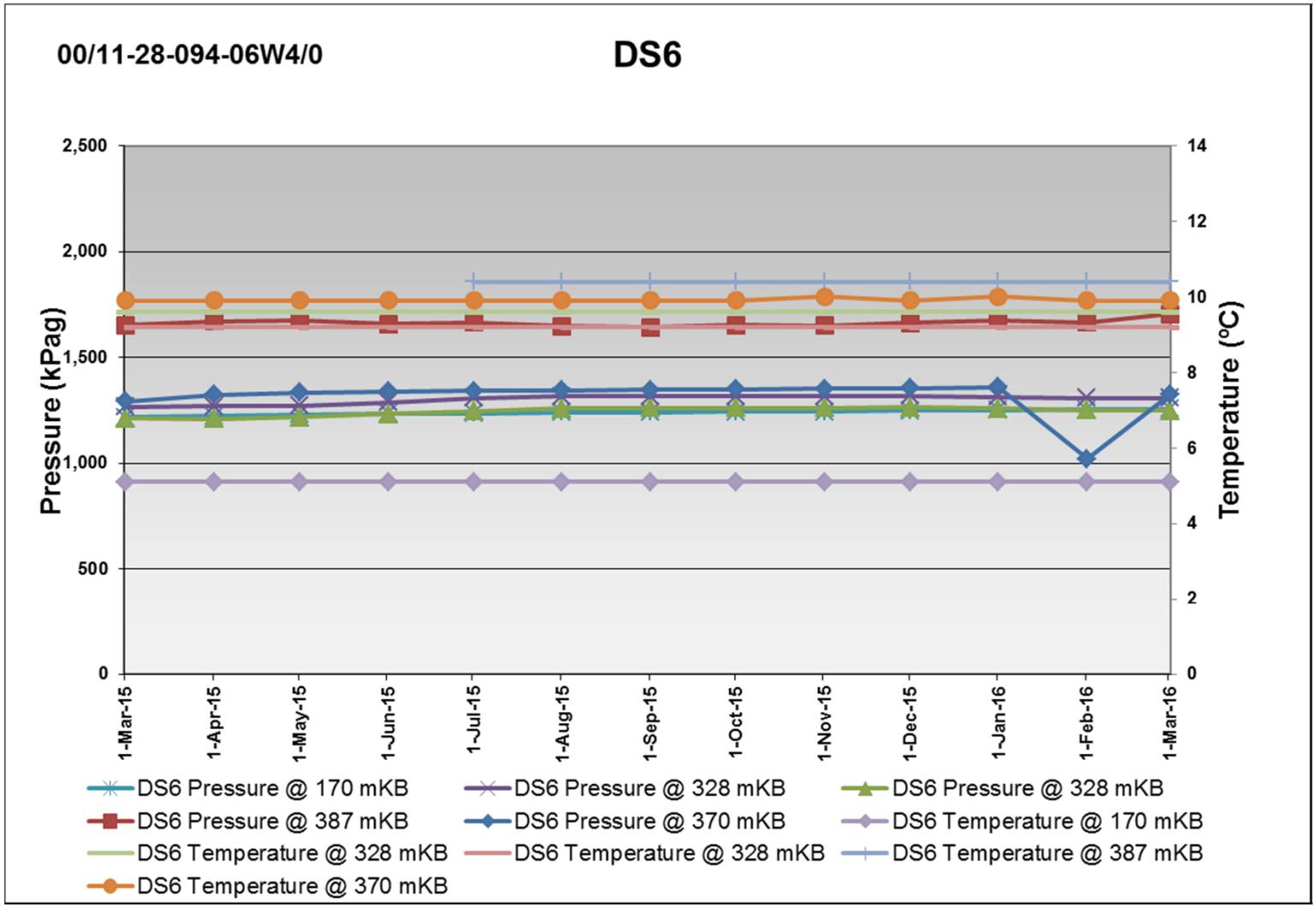
Piezometer Plots & Temperature vs Depth Plots



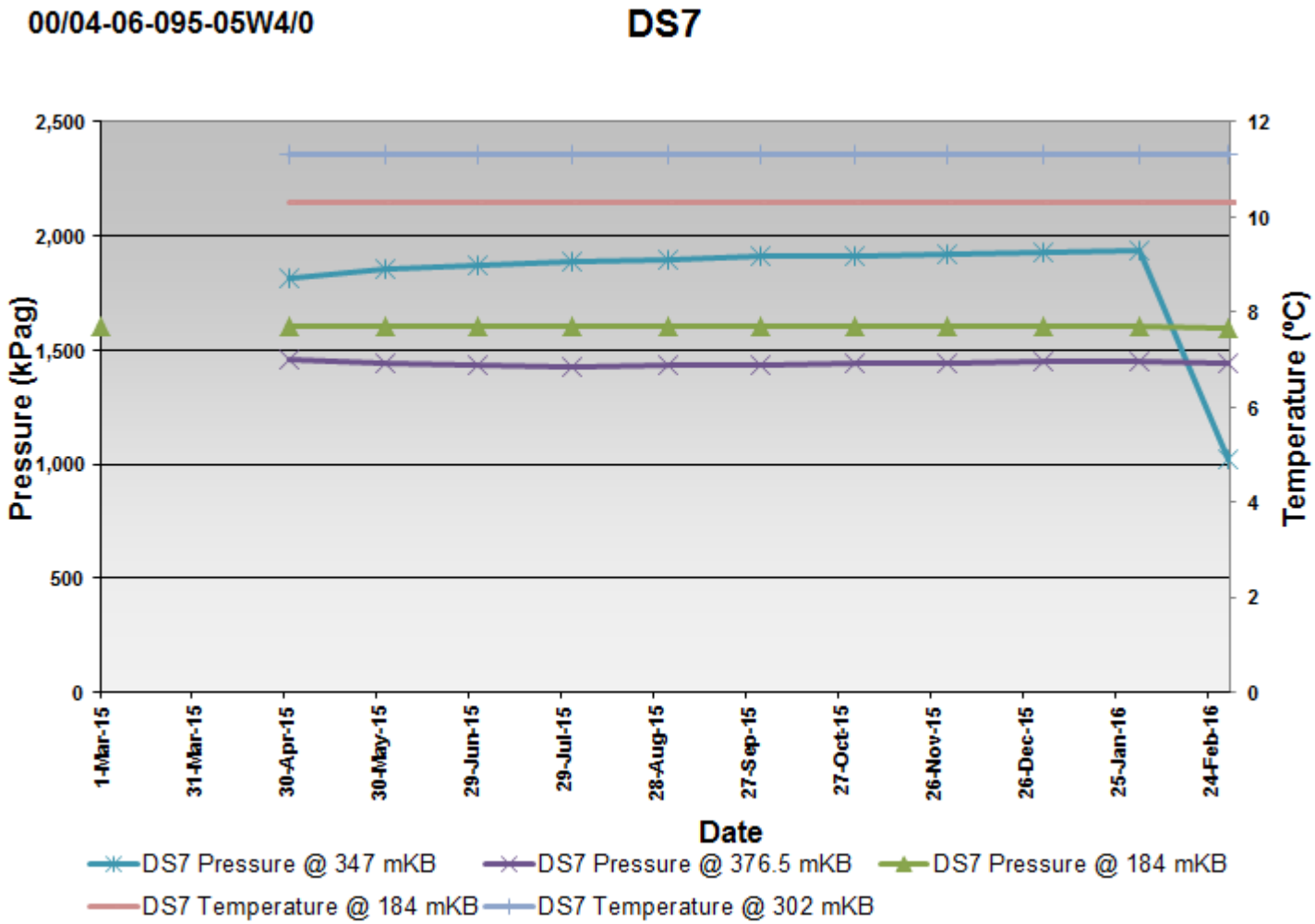
Piezometer Plots & Temperature vs Depth Plots



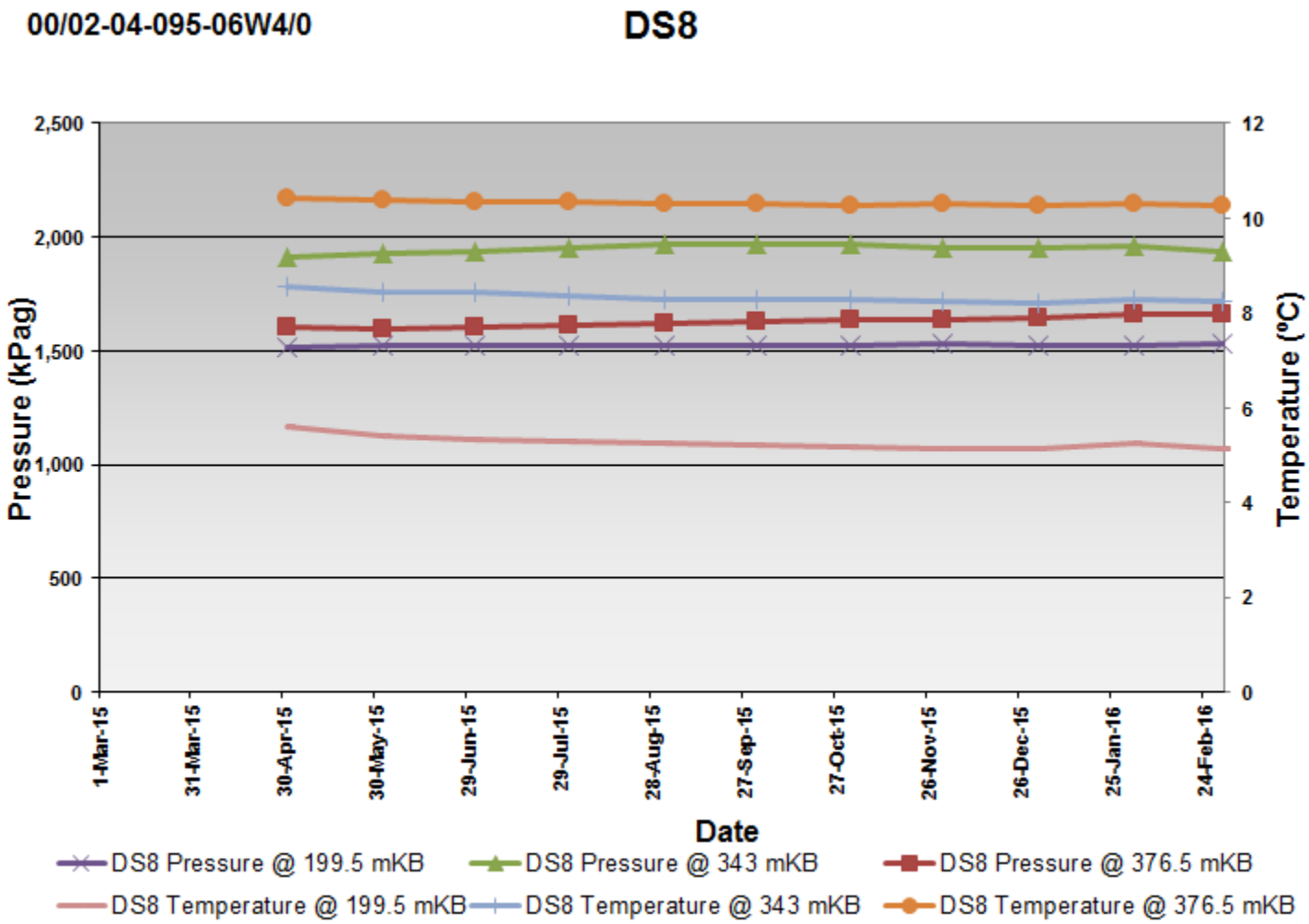
Piezometer Plots & Temperature vs Depth Plots



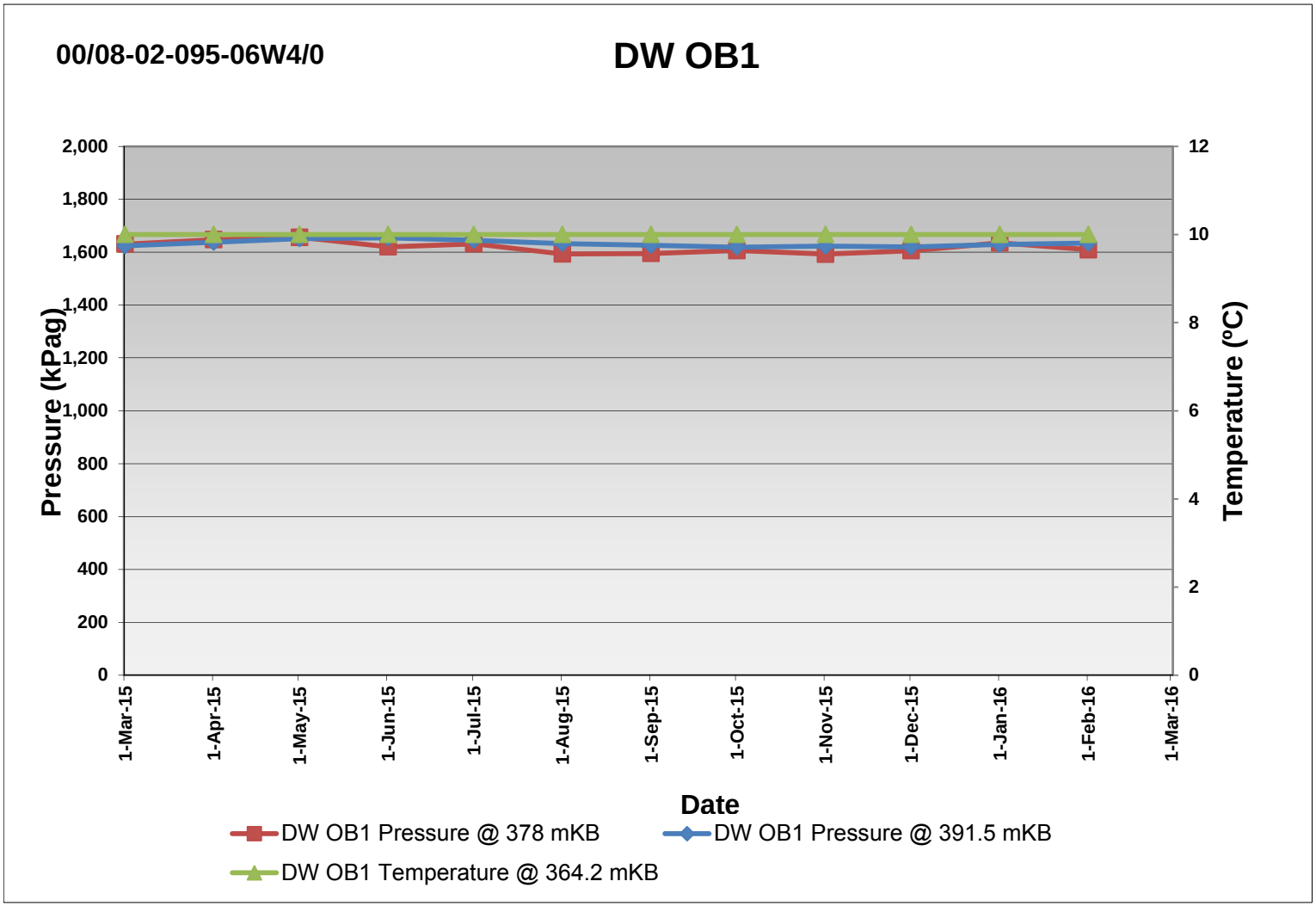
Piezometer Plots & Temperature vs Depth Plots



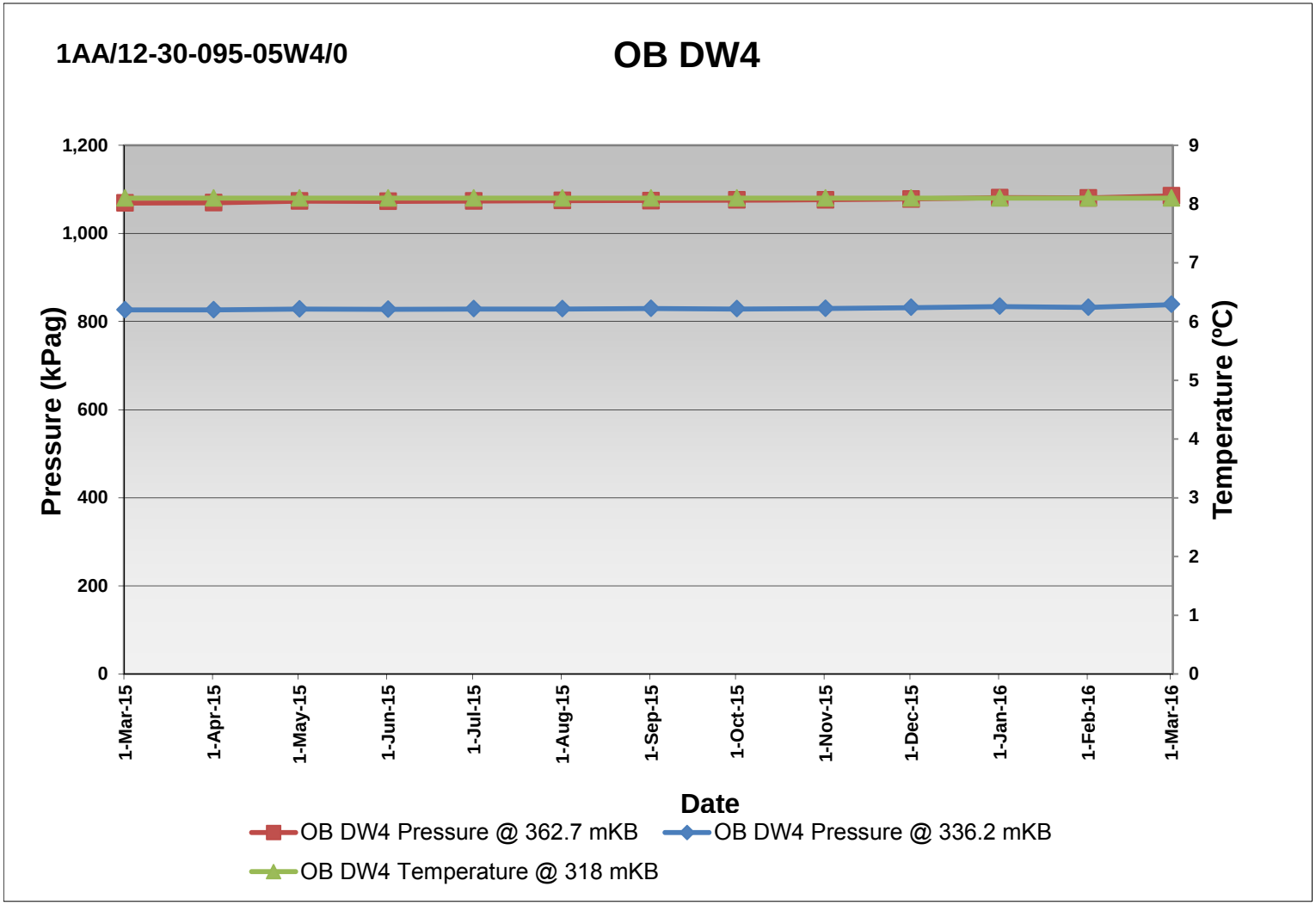
Piezometer Plots & Temperature vs Depth Plots



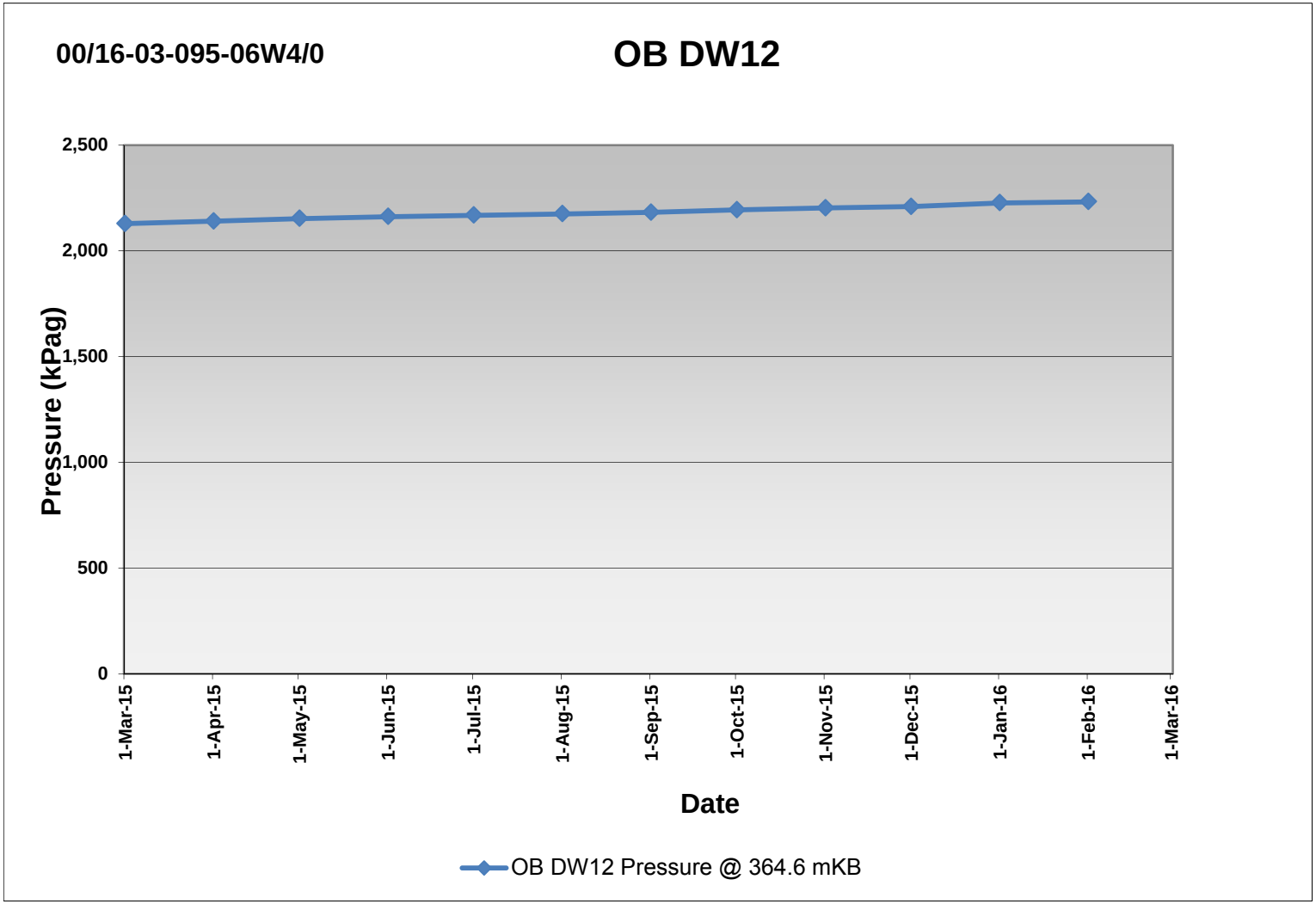
Piezometer Plots & Temperature vs Depth Plots



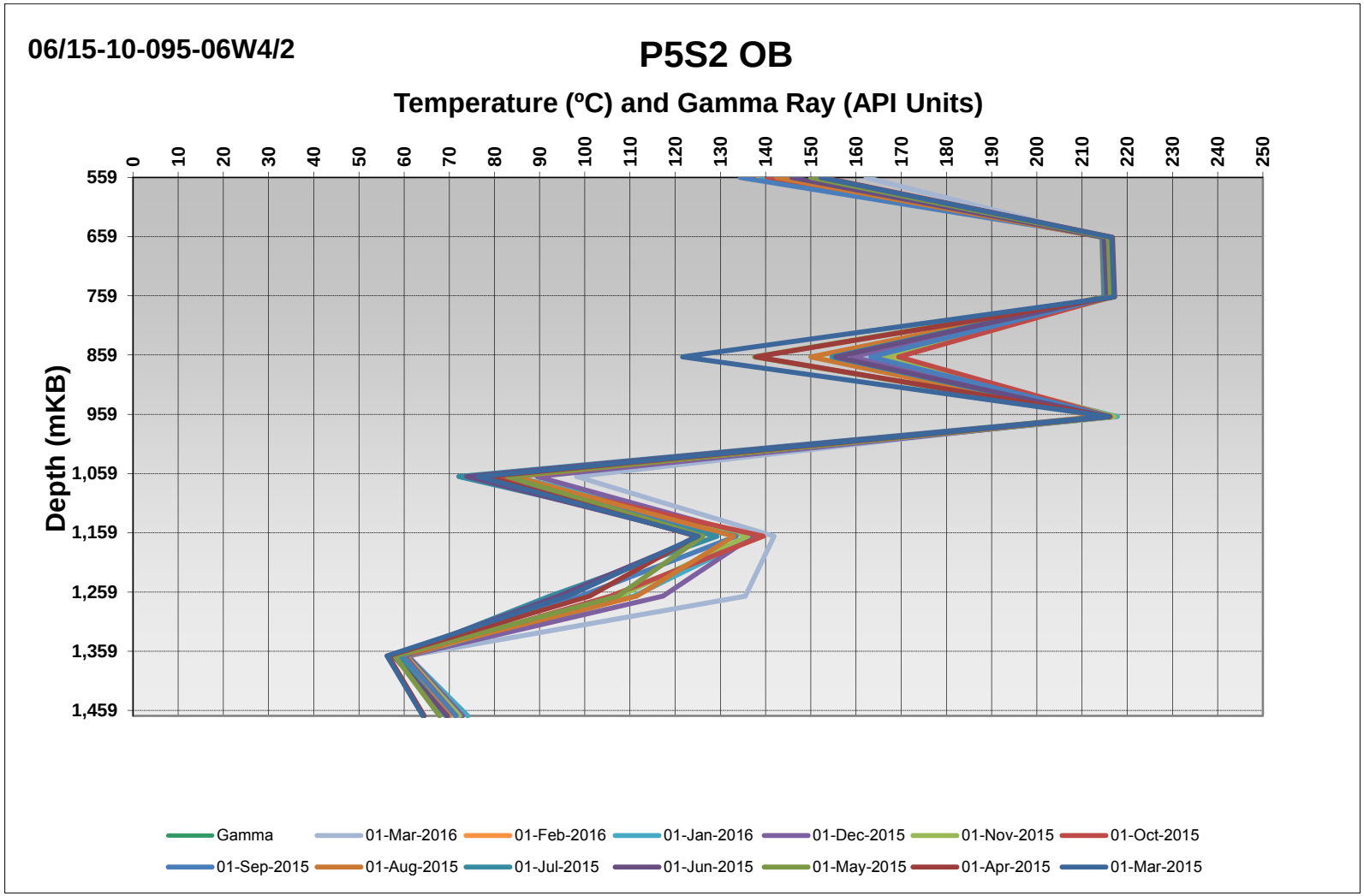
Piezometer Plots & Temperature vs Depth Plots



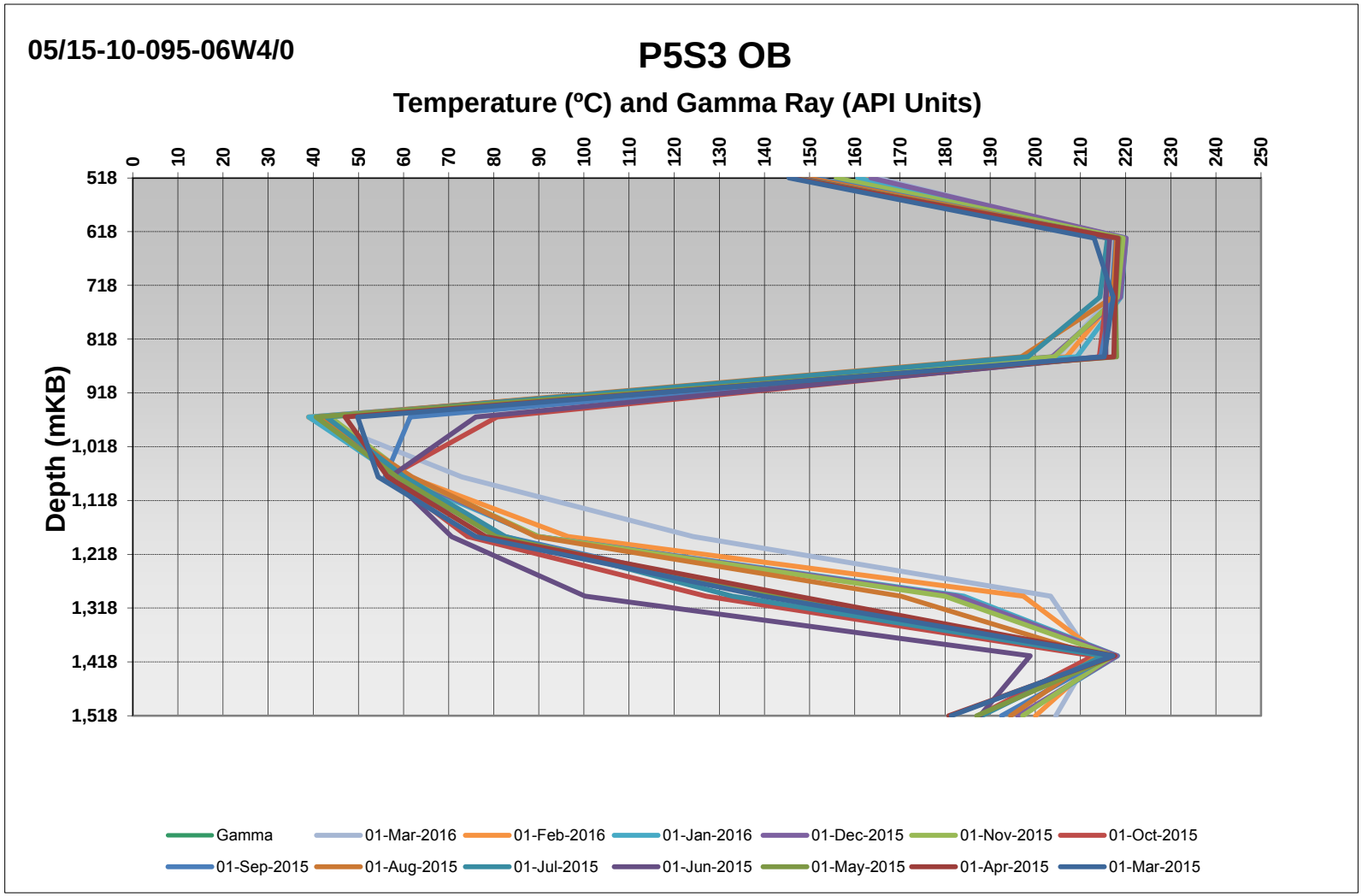
Piezometer Plots & Temperature vs Depth Plots



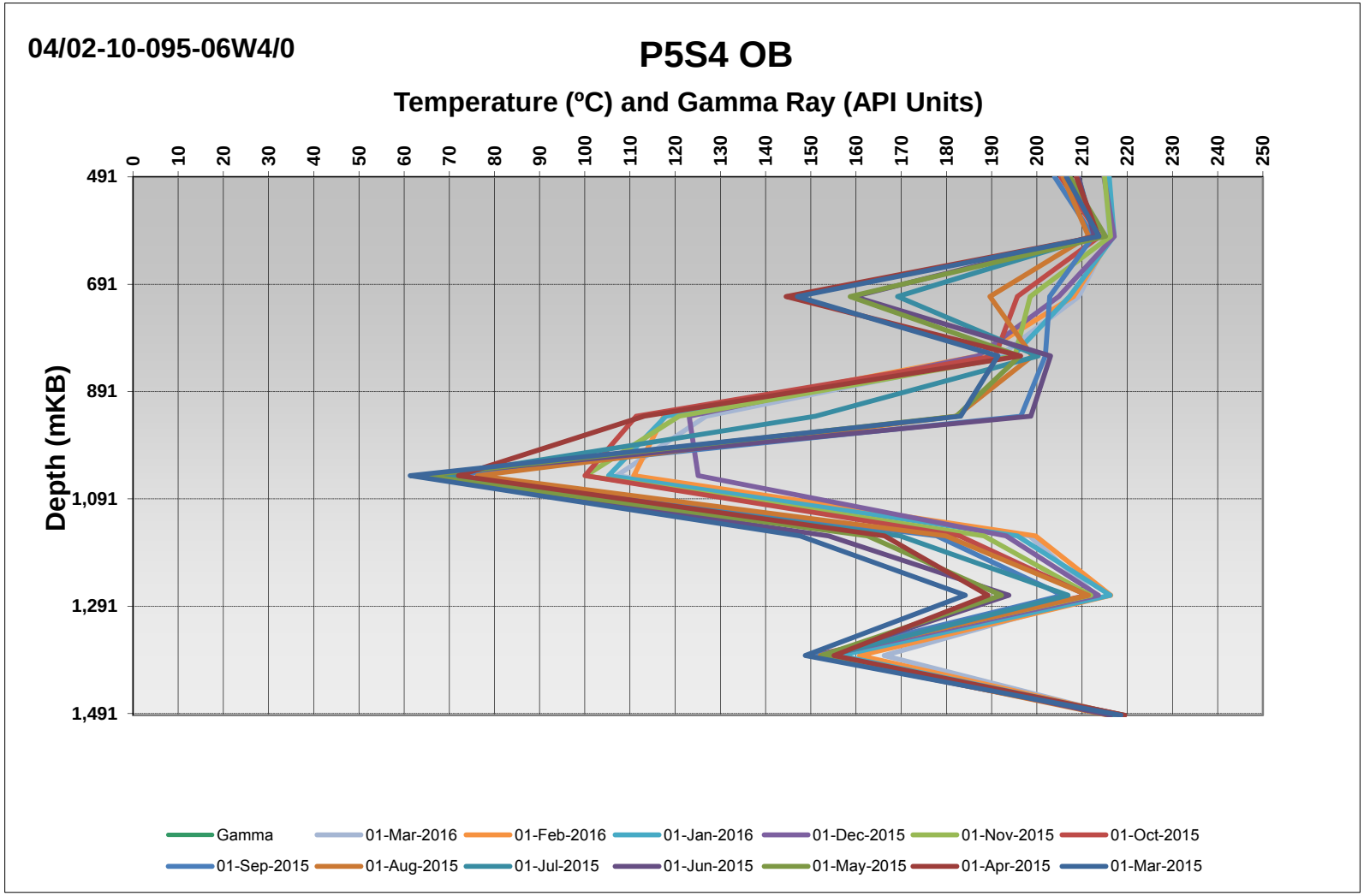
Piezometer Plots & Temperature vs Depth Plots



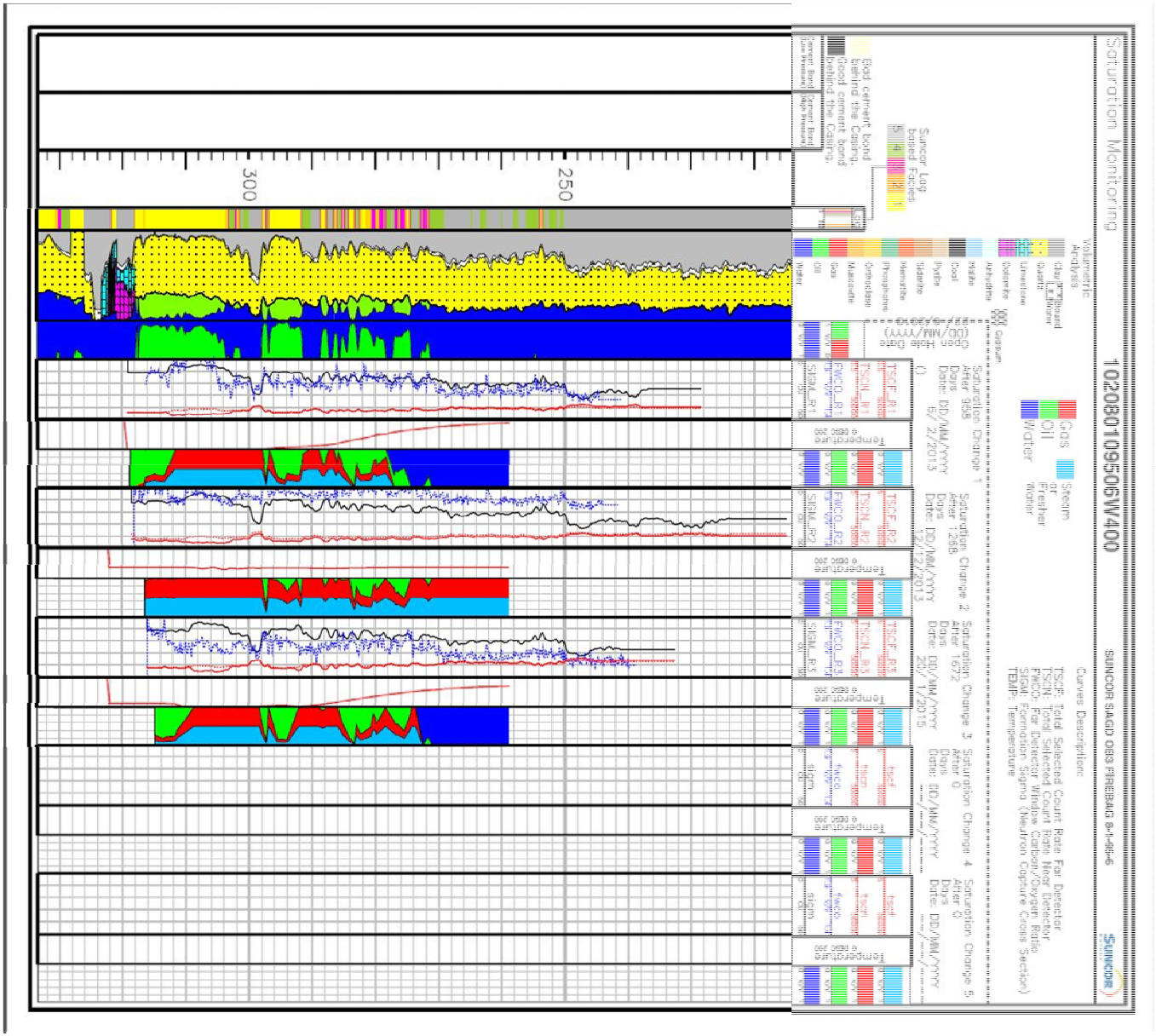
Piezometer Plots & Temperature vs Depth Plots



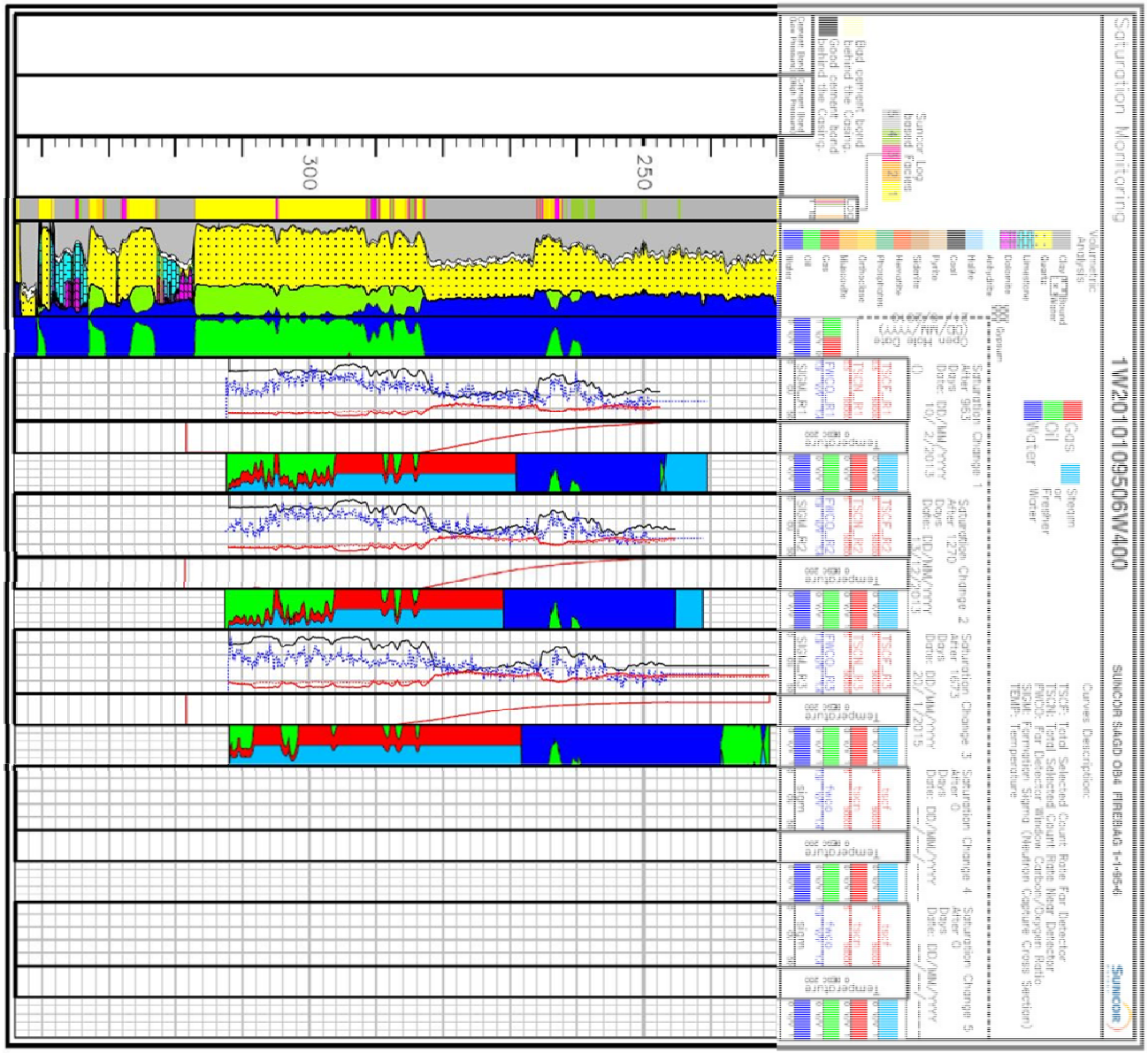
Piezometer Plots & Temperature vs Depth Plots



RST Logs


Saturation Monitoring
102080109506W400
SUNCOR SAGD OBS FIREBAG 8-1-95-6
Suncor
Volumetric Analysis
Clay
Quartz
Dolomite
Limestone
Anhydrite
Halite
Coal
Pyrite
Siderite
Hematite
Phosphorite
Orthoclase
Muscovite
Gypsum
Oil
Gas
Water
Sand
Shale
Coal
Oil
Gas
Steam
Air
Fresher Water
Curves Descriptions
TSCF: Total Selected Count Rate For Detector
TSCN: Total Selected Count Rate Near Detector
FWCO: Far Detector Window Carbon/Oxygen Ratio
SIGM: Formation Sigma (Neutron Capture Cross Section)
TEMP: Temperature
Saturation Change 1
After 958
Days
Date: DD/MM/YYYY
6/ 2/2013
Saturation Change 2
After 1268
Days
Date: DD/MM/YYYY
12/12/2013
Saturation Change 3
After 1672
Days
Date: DD/MM/YYYY
20/ 1/2015
Saturation Change 4
After 0
Days
Date: DD/MM/YYYY
Saturation Change 5
After 0
Days
Date: DD/MM/YYYY
Open Hole Date
(DD/MM/YYYY)
Suncor Log based Facies
Bad cement bond behind the Casing
Good cement bond behind the Casing
Cement Bond Low Pressure
Cement Bond High Pressure
300
250
TSCF_R1
TSCN_R1
FWCO_R1
SIGM_R1
TSCF_R2
TSCN_R2
FWCO_R2
SIGM_R2
TSCF_R3
TSCN_R3
FWCO_R3
SIGM_R3
Temperature
0 DEGC 200

RST Logs


Saturation Monitoring
1W2010109506W400
SUNCOR SAGD OB4 FIREBAG 1-1-65-4
Suncor
Volumetric Analysis
Clay
Quartz
Granite
Limestone
Dolomite
Anhydrite
Halite
Coal
Pyrite
Siderite
Hematite
Phosphorite
Orthoclase
Muscovite
Water
Oil
Gas
Steam
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Oil
Fresher Water
Curves Description:
TSCF: Total Selected Count Rate Far Detector
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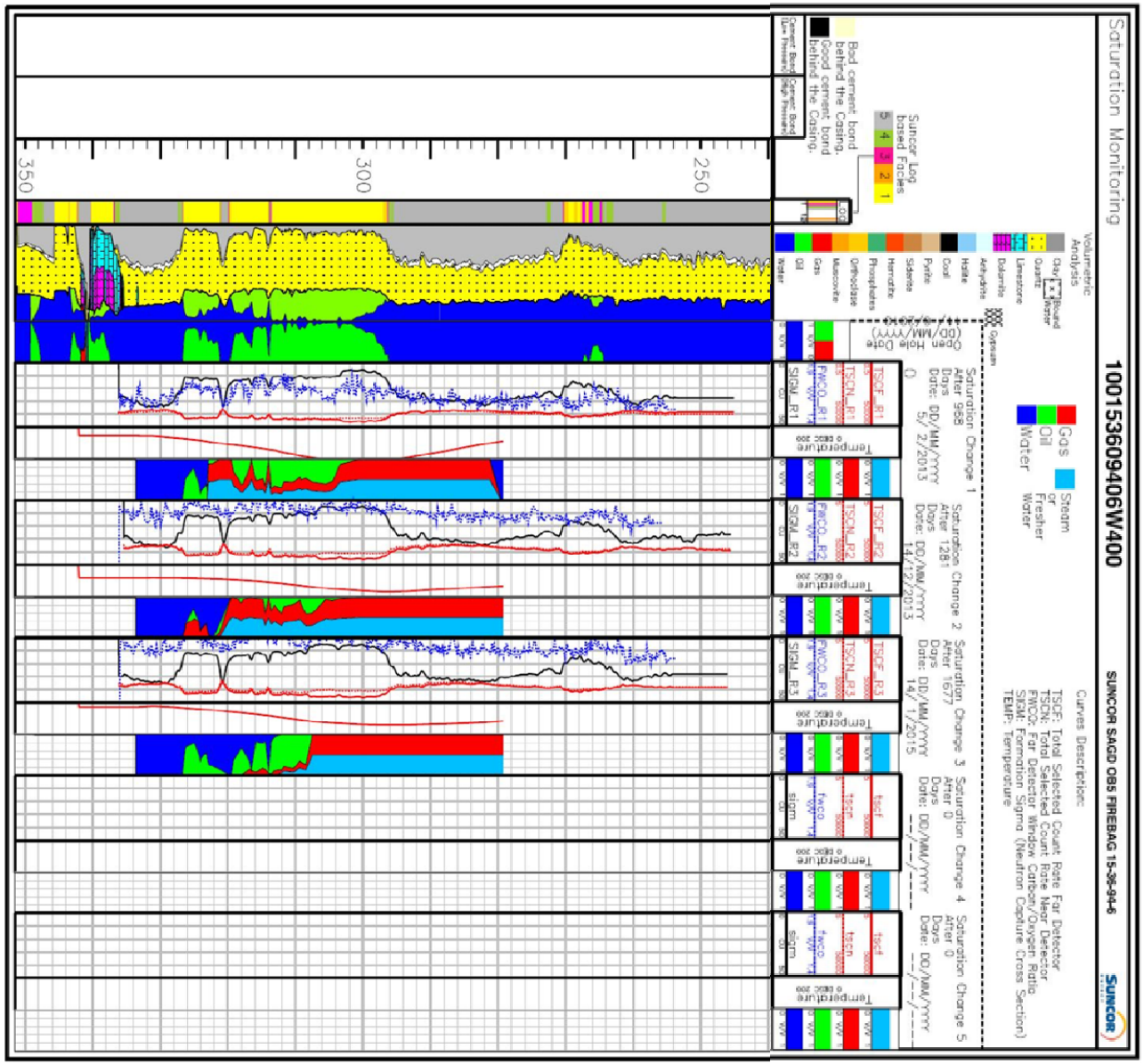
Suncor Log based Facies
Bad cement bond behind the Casing.
Good cement bond behind the Casing.
Cement Bond (Low Pressure)
Cement Bond (High Pressure)
Open hole Date (DD/MM/YYYY)
Saturation Change 1 After 963 Days Date: DD/MM/YYYY 10/ 2/2013
Saturation Change 2 After 1270 Days Date: DD/MM/YYYY 13/ 2/2013
Saturation Change 3 After 1675 Days Date: DD/MM/YYYY 20/ 1/2015
Saturation Change 4 After 0 Days Date: DD/MM/YYYY
Saturation Change 5 After 0 Days Date: DD/MM/YYYY
TSCF_R1
TSCN_R1
FWCO_R1
SIGM_R1
TSCF_R2
TSCN_R2
FWCO_R2
SIGM_R2
TSCF_R3
TSCN_R3
FWCO_R3
SIGM_R3
Temperature
300
250

RST Logs


Saturation Monitoring
100153609406W400
SUNCOR SAGD OBS FIREBAG 15-36-94-6
SUNCOR
Volumetric Analysis
Clay
Quartz
Limestone
Dolomite
Anhydrite
Gypsum
Halite
Coal
Pyrite
Siderite
Hematite
Phosphates
Orthoclase
Muscovite
Gas
Oil
Water
Steam
Gas
Oil
Fresher Water
Water
Curves Description
TSCF: Total Selected Count Rate Far Detector
TSCN: Total Selected Count Rate Near Detector
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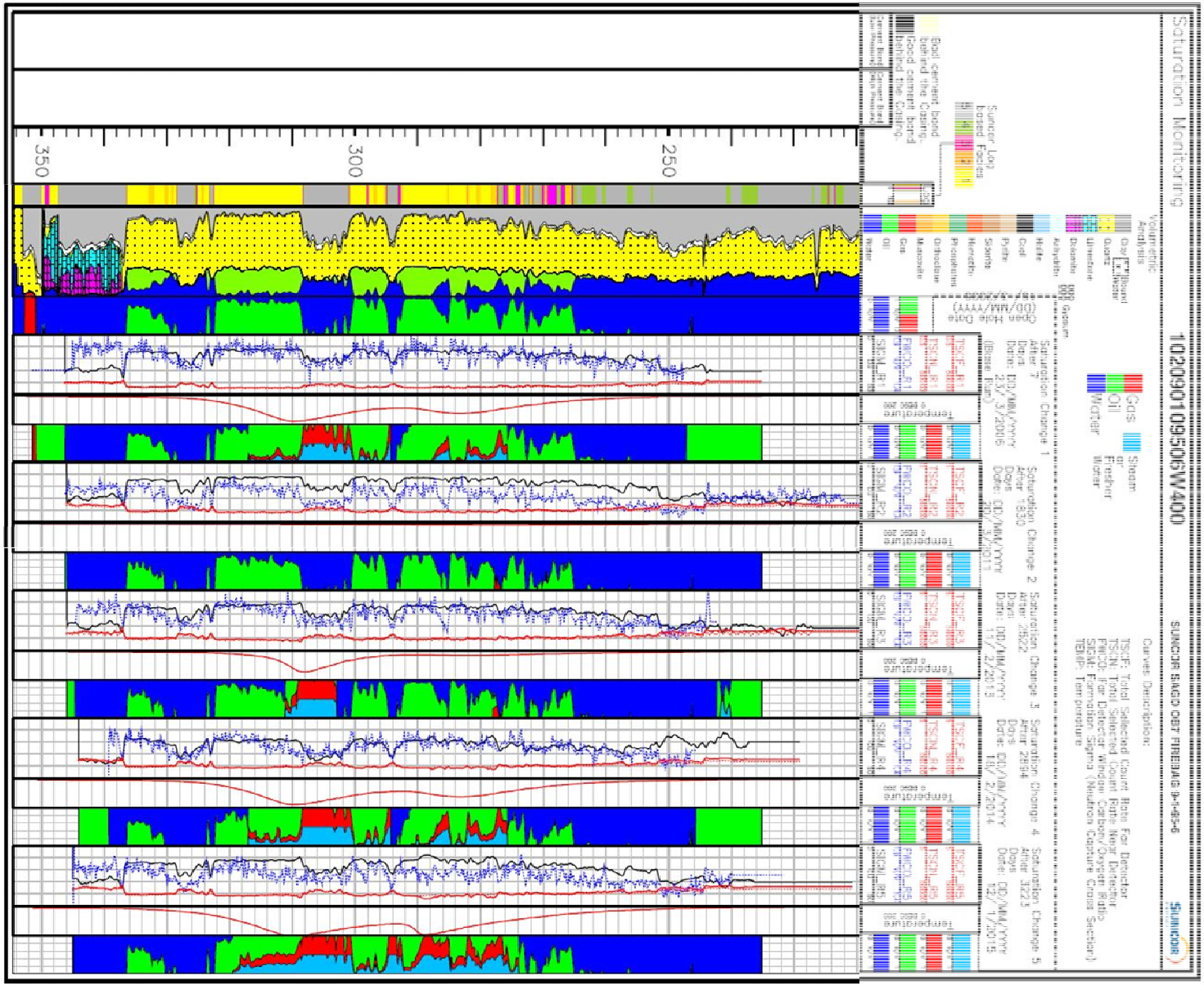
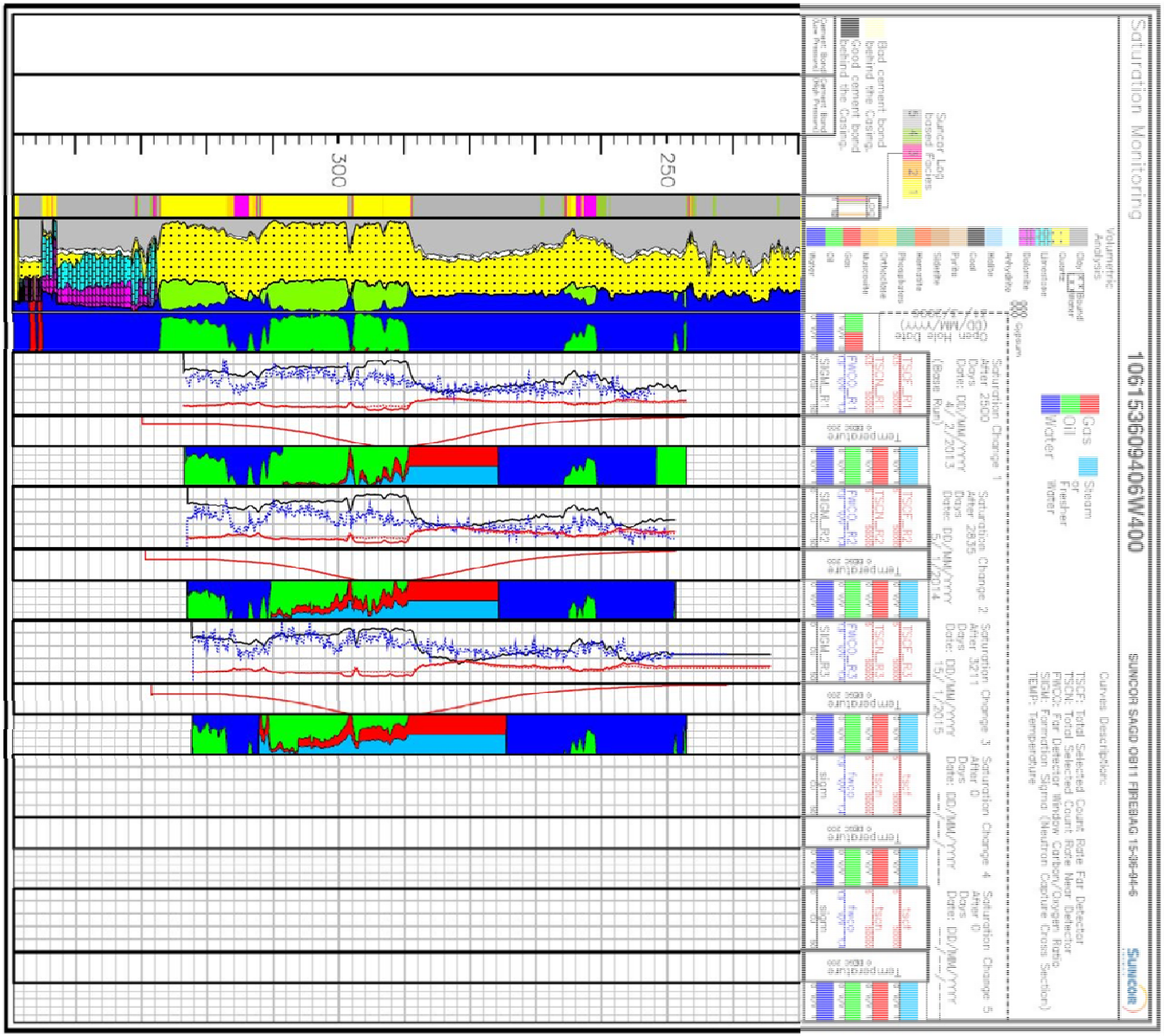
SIGM: Formation Sigma (Neutron Capture Cross Section)
TEMP: Temperature
Suncor Log based Facies
5
4
3
2
1
Bad cement bond behind the Casing.
Good cement bond behind the Casing.
Cement Bond (Low Pressure)
Cement Bond (High Pressure)
Saturation Change 1
After 968 Days
Date: DD/MM/YYYY 5/ 2/2013
Saturation Change 2
After 1281 Days
Date: DD/MM/YYYY 14/12/2013
Saturation Change 3
After 1677 Days
Date: DD/MM/YYYY 14/ 1/2015
Saturation Change 4
After 0 Days
Date: DD/MM/YYYY __/__/____
Saturation Change 5
After 0 Days
Date: DD/MM/YYYY __/__/____
Open Hole Date (DD/MM/YYYY)
TSCF_R1
TSCN_R1
FWCO_R1
SIGM_R1
TSCF_R2
TSCN_R2
FWCO_R2
SIGM_R2
TSCF_R3
TSCN_R3
FWCO_R3
SIGM_R3
tscf
tscn
fwco
sigm
Temperature
250
300
350

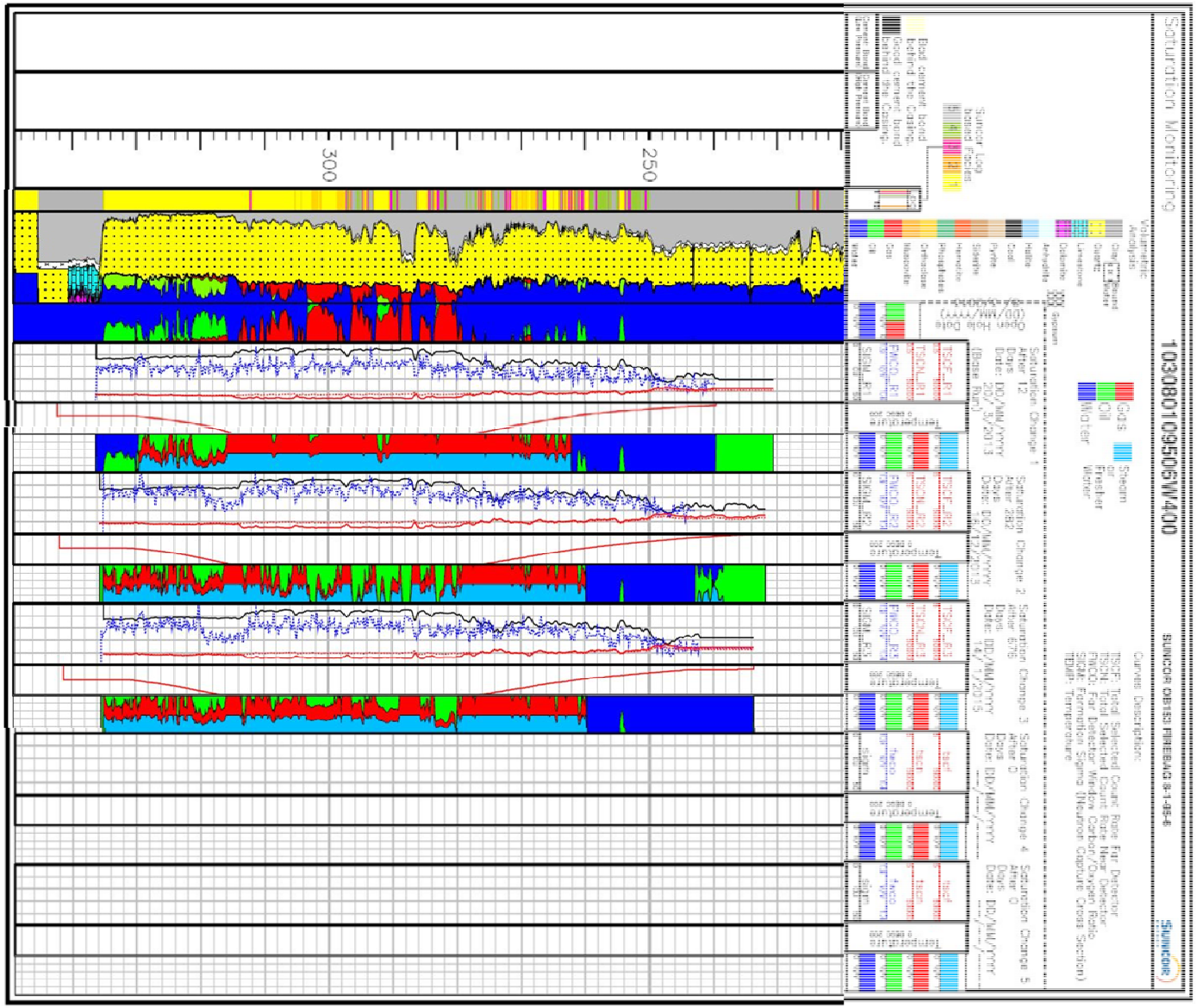
RST Logs


Saturation Monitoring
102090108506W400
Sensor Log
Bad Cement Band
Bad Cement Band
Good Cement Band
Good Cement Band
Bad Cement Band
Bad Cement Band
Gas
Oil
Water
Steam
Fresh
Water
Saturation Change 1
After 1
Date: DD/MM/YYYY
(Base Run)
Saturation Change 2
After 1630
Date: DD/MM/YYYY
Date: 23/3/2006
Saturation Change 3
After 2562
Date: DD/MM/YYYY
Date: 11/2/2013
Saturation Change 4
After 3623
Date: DD/MM/YYYY
Date: 11/2/2014
Saturation Change 5
After 4484
Date: DD/MM/YYYY
Date: 11/1/2015
Temperature
Temperature
Temperature
Temperature
Temperature
Temperature
Temperature
Temperature
350
300
250

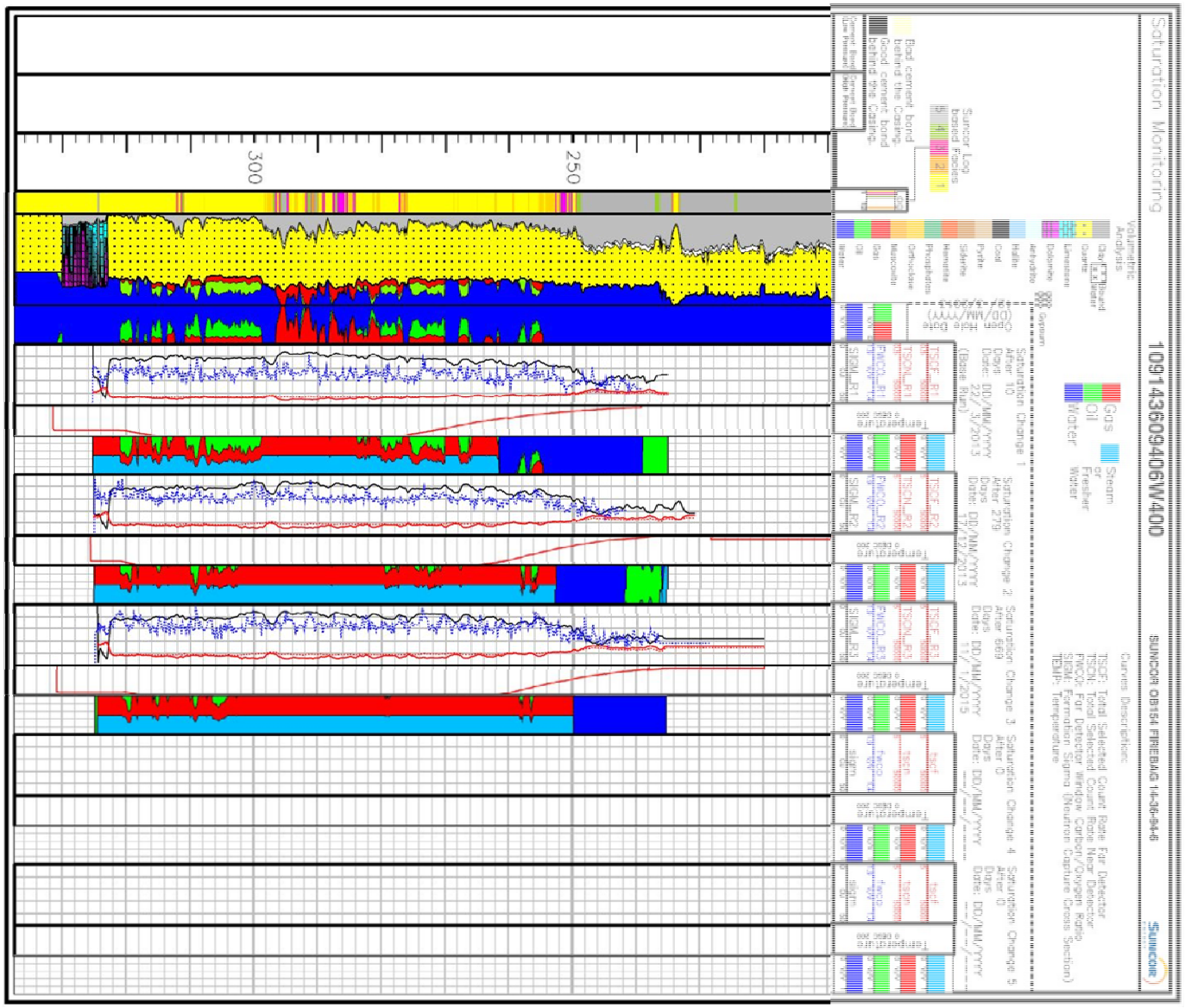
RST Logs


Saturation Monitoring
Volumetric Analysis
Dry
Quartz
Limestone
Dolomite
Anhydrite
Halite
Coal
Perlite
Siderite
Ankerite
Phosphatic
Orthoclase
Muscovite
Gas
Oil
Water
Sulphur
Bad cement bond behind the Casing
Good cement bond
Sulfur Layer
Bonded Pebbles
Gas
Oil
Water
Steam or Freshwater
Saturation Change 1
After 2500 Days
Date: DD/MM/YYYY
(Base Run)
4/ 2/2013
Saturation Change 2
After 2815 Days
Date: DD/MM/YYYY
5/ 1/2014
Saturation Change 3
After 3211 Days
Date: DD/MM/YYYY
15/ 1/2015
Saturation Change 4
After 0 Days
Date: DD/MM/YYYY
Saturation Change 5
After 0 Days
Date: DD/MM/YYYY
Open Hole Date (DD/MM/YYYY)
TSCF: R1
TSCN: R1
FBOR: R1
SGMN: R1
Temperature
TSCF: R2
TSCN: R2
FBOR: R2
SGMN: R2
TSCF: R3
TSCN: R3
FBOR: R3
SGMN: R3
Sigma
Porosity
Curves Description
TSCF: Total Selected Count Rate For Detector
TSCN: Total Selected Count Rate Near Detector
FBOR: For Detector Window Carbon/Oxygen Ratio
SGMN: Formation Sigma (Neutron Capture Cross Section)
TEMP: Temperature
SUNCOR SAGD OB11 FIREBAG 15-08-44-6
Suncor
300
250

RST Logs



RST Logs


Saturation Monitoring
1091436094061W400
SUNCOR OB 154 FIREBAG 14-36-94-6
Suncor
Volumetric Analysis
Clay (Shale)
Quartz
Anhydrite
Halite
Coal
Pyrite
Siderite
Hematite
Phosphates
Orthoclase
Muscovite
Gas
Oil
Water
Dolomite
Gypsum
Limestone
Water
Oil
Gas
Steam
Frontier
Curves Description
TSCF: Total Selected Count Rate For Detector
TSCN: Total Selected Count Rate Near Detector
FNCO: For Detector Window Corrected/Oxygen Ratio
SIGM: Formation Sigma (Neutron Capture Cross Section)
TEMP: Temperature
Bad cement bond behind the Casing
Good cement bond behind the Casing
Suncor Log bound Facies
Saturation Change 1
Saturation Change 2
Saturation Change 3
Saturation Change 4
Saturation Change 5
300
250