

Overview mining activities Q3 2018

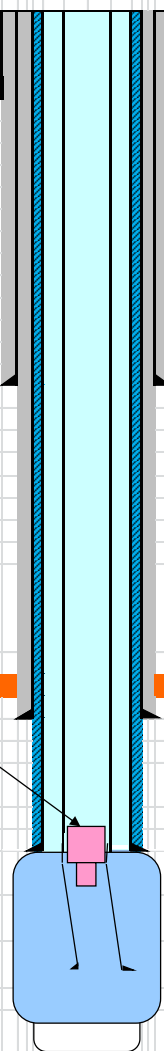
Quarterly meeting
Frisia Zout B.V. -SODM
10 October 2018

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5. Update Havenmond
6. AOB

BAS-1

Item Description	Wellhead and Xmastree BAS 1 140527		Depth	Depth	Pipe	Collar	Pipe ID
			m tvd	m ah	in	in	in
36" stove pipe			40	40	28,000		
24" x 1/2" casing			494	494	24,000		
Top cement in 18 5/8" x 13 3/8" annulus							
18 5/8" casing			1175	1175	18,625	20,000	17,688
13.3/8" Annulus filled with diesel/brine solution as of January 2013.							
Straddle Jan 2010; Top at; 2584md Minimum ID: 3.34" Bottom at; 2589 md							
Base of Carnalite			2522	2522			
13 3/8" casing			2543	2543	13,375	14,375	12,895
Roof height from March 2011 neck echo measurement			2567	2567			
7" Leak at ~2586 m 10 3/4" outer leaching string, internally coated			2587	2587	10,75	11,75	9,76
7" inner leaching string, internally coated			2787	2787	7,000	7,375	6,276
Sump Dec 2004			2832	2832			
Total Depth Cavern			2882	2882			



- Freshwater
- Water/Diesel Solution
- 1.20s.g. brine
- Casing cement
- Carnalite

* All depths are from ground level

Status

- Maintain max pressure 10 3/4" at 232bar
- Bleed-off pressure every 4 weeks
- 13 3/8" contains water, however at higher pressure then 10 3/4"

Planned

- Review and finalization of concept design abandonment

July 2018

9, 10, 23, 24	Pressure bleed-offs
11, 16, 25, 27	Repressurization of 13-3/8" annulus
25	Electricity black-out

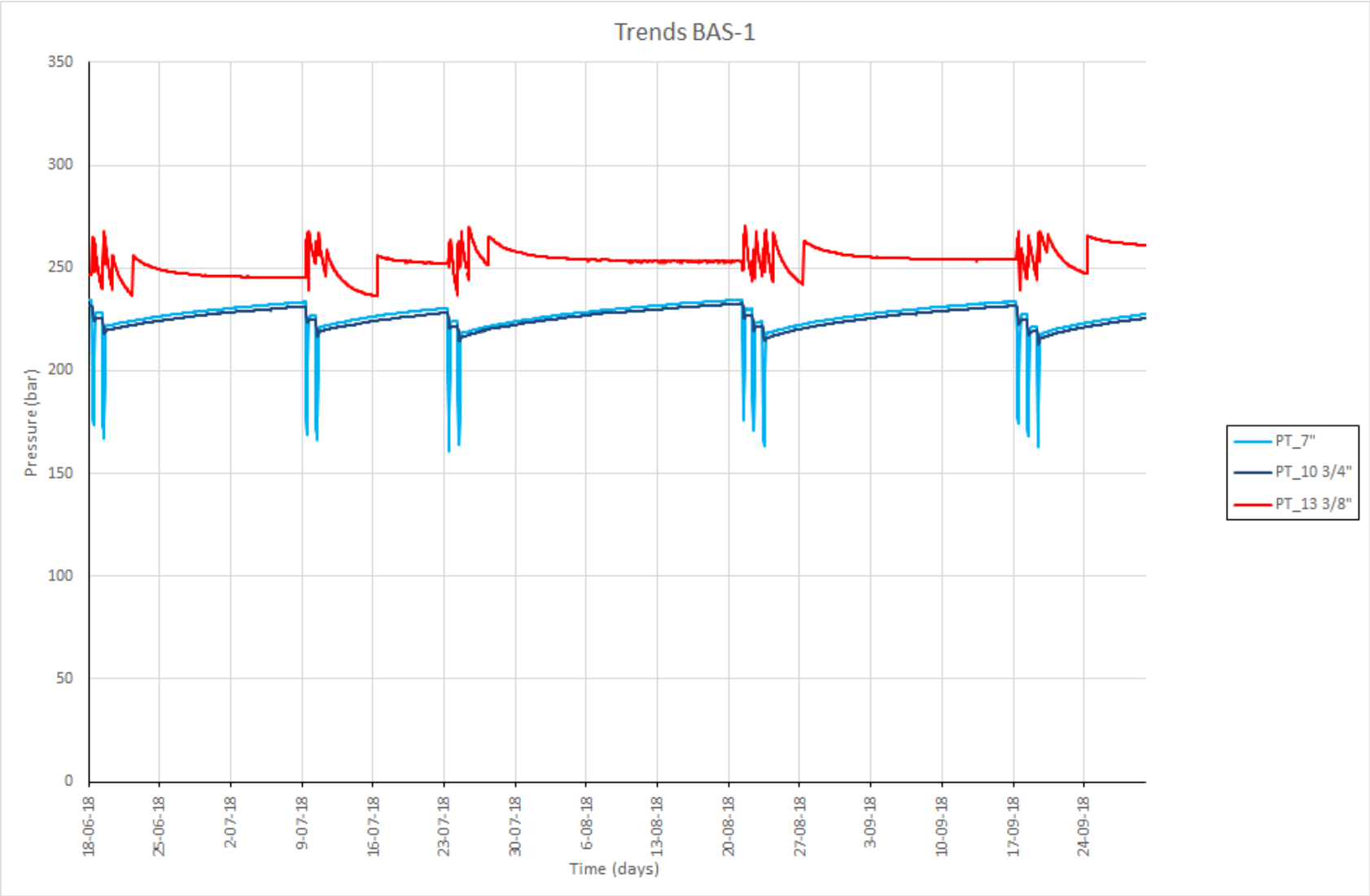
August 2018

21 - 23	Pressure bleed-offs
24, 27	Repressurization of 13-3/8" annulus

September 2018

17 - 19	Pressure bleed-offs.
20, 24	Repressurization of 13-3/8" annulus.

BAS-1



July 2018

1 - 31	Blocked cavern neck annulus
1 – 6	Pressure surges in blocked cavern neck annulus
5	Additional backpressure cavern to minimize amplitude of pressure surges
11	Regular blanket measurement
13	Production stop
25	Electricity black-out

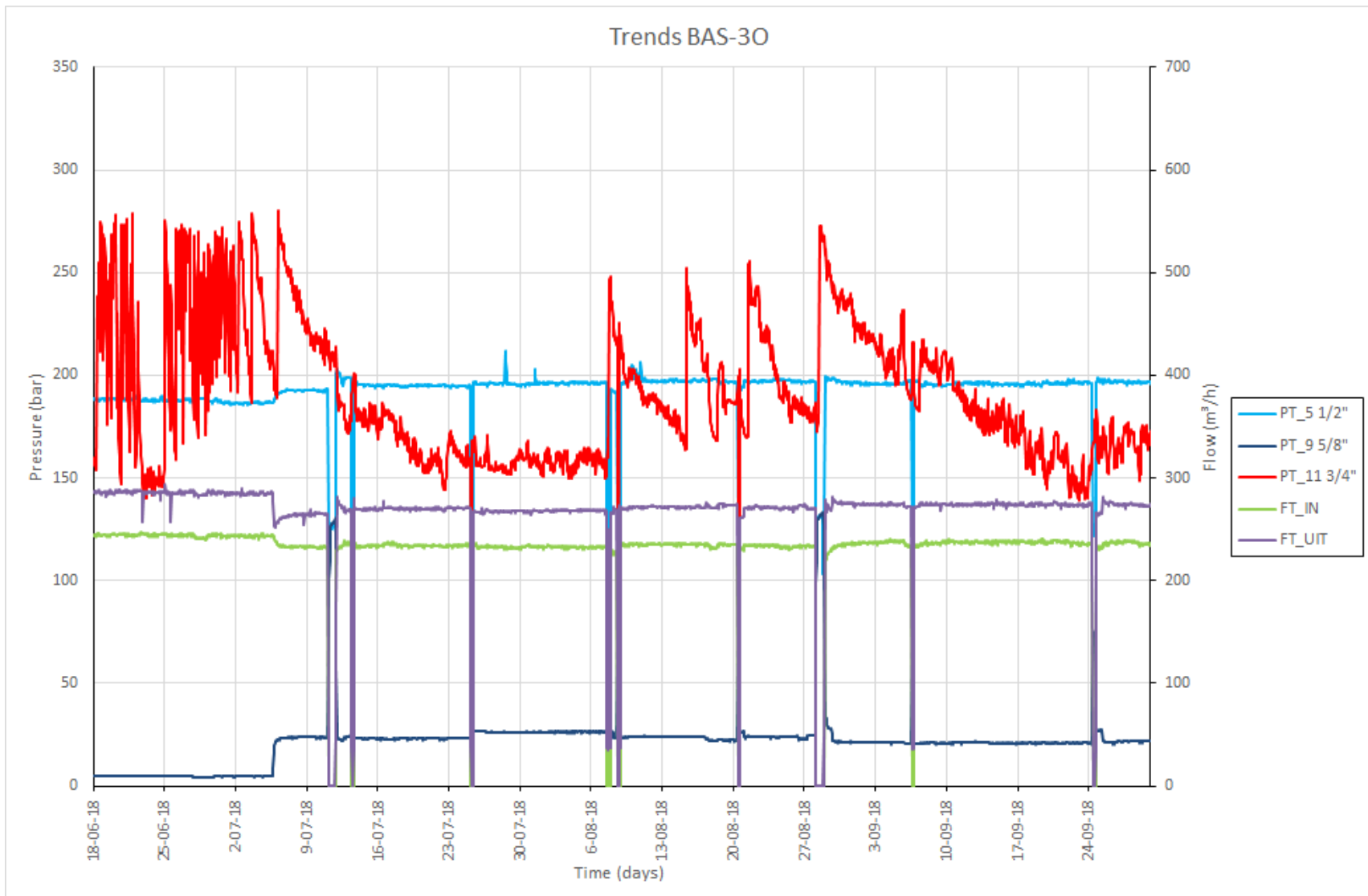
August 2018

1 - 31	Blocked cavern neck annulus, pressure fluctuations due to injection water temperature changes.
7, 15, 21	Diesel injection into 11-3/4" annulus
7, 8, 20	Production stop
28	Pressure surge in blocked cavern neck annulus
28	Regular blanket measurement

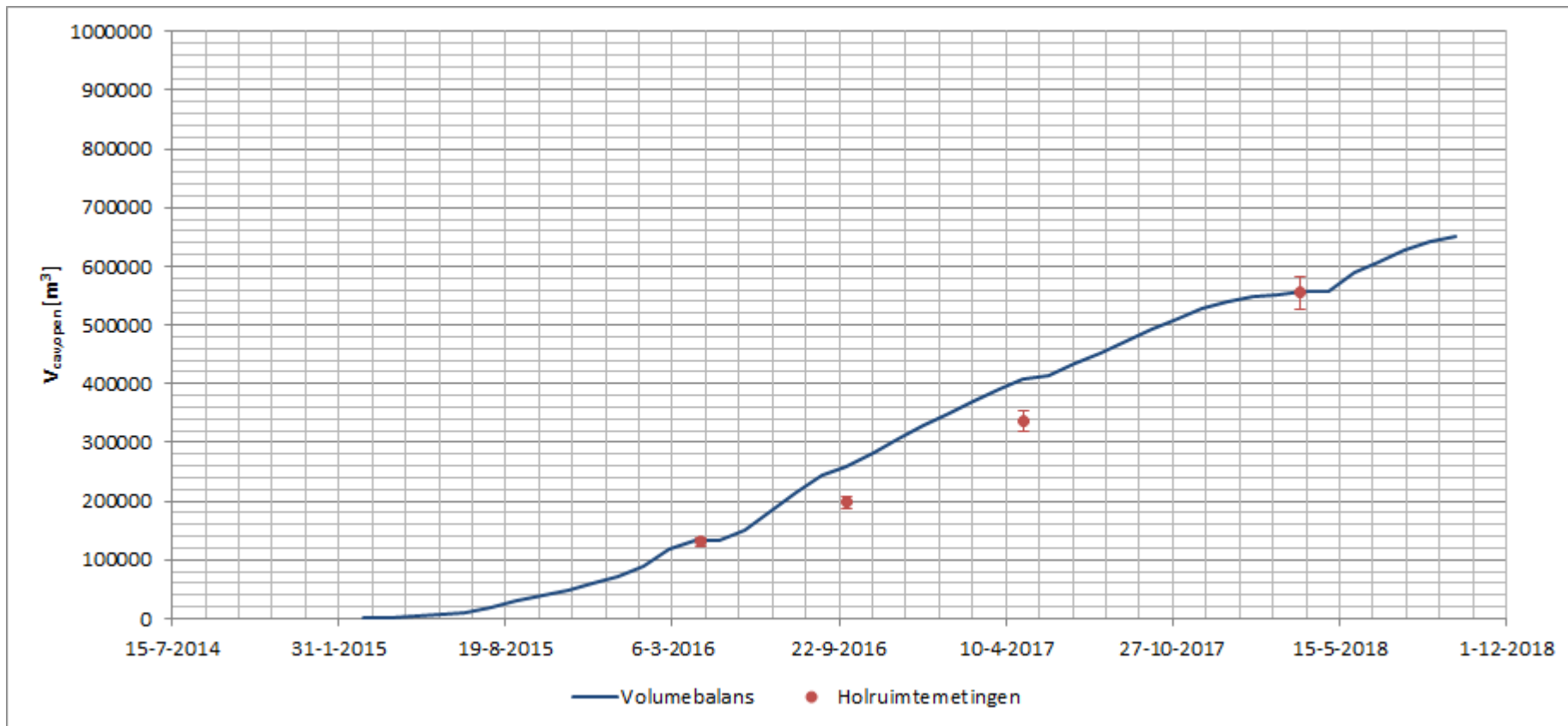
September 2018

1 - 30	Blocked cavern neck annulus, pressure fluctuations due to injection water temperature changes.
6	Production stop.
24	Production stop.

BAS-30

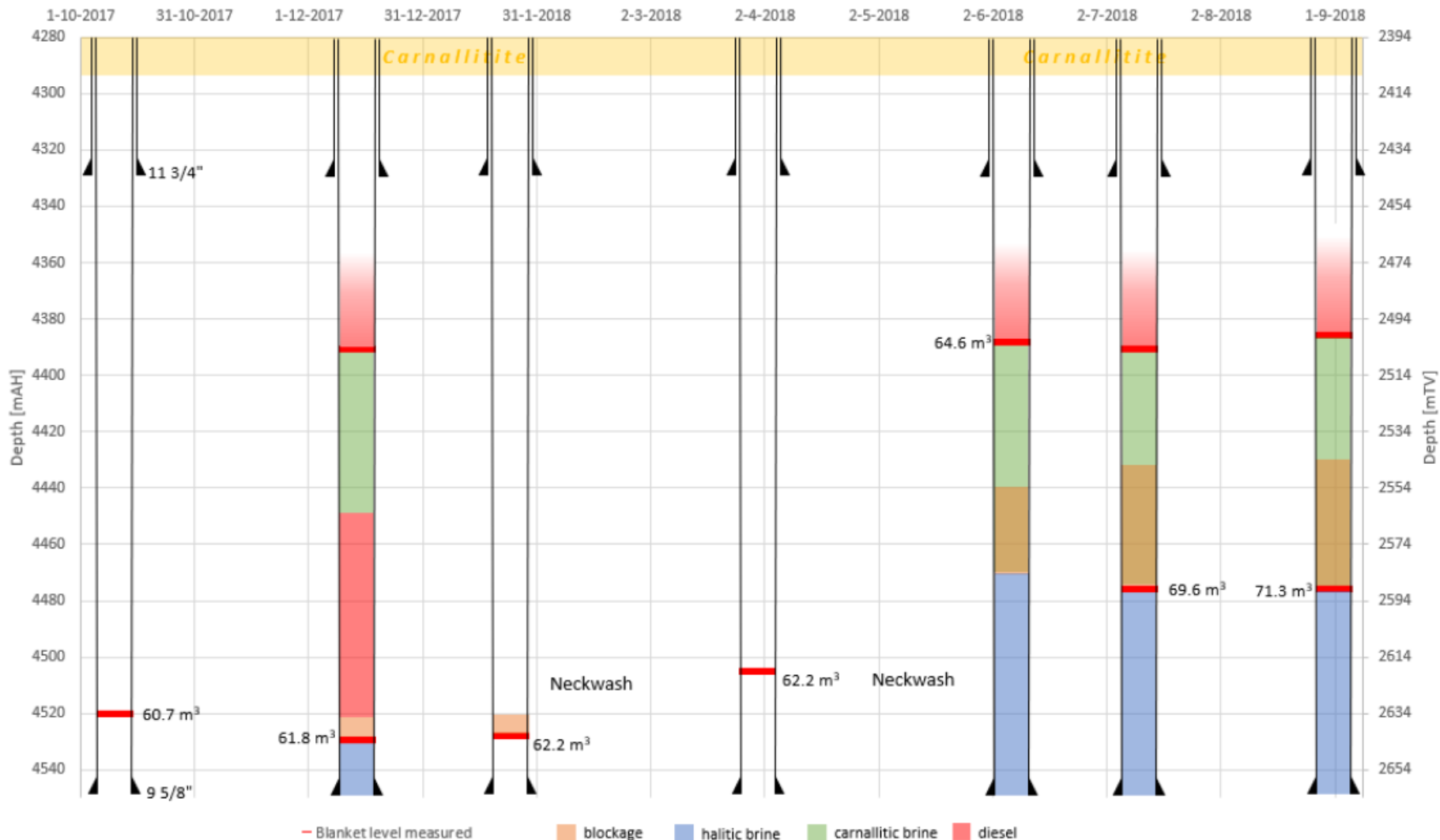


Volume balans BAS-30



BAS-30 blocked

Blanket measurements performed on BAS-30



BAS-3O blocked blanket annulus

Current thoughts:

- Blockage due to potassium and sodium chlorides crystallization (lab test performed)
- Minimum stress at BAS-3O cavern can get upto 30bar lower
- Influx:
 - Potassium rich brine, carnalitic.
 - Influx volume 700-1000ltr, pressure increases from 150bar to 280bar
 - Pressure of influx is ~35bar sub-lithostatic (limited volume or restricted flow)
 - BAS-3 cavern seems source
 - Potentially connection via lateral micro-fracturing through the Carnalite (2-10bar over minimum stress)
 - And vertical/lateral via Halite (20-30bar over minimum stress)
- No fracturing conditions through 80m overlaying Anhydrite (45bar over minimum stress)
- No change in stress Z3 Salt 155m

BAS-3O blocked blanket annulus

Immediate actions

- Reduce amplitude cyclic stress, increase pressure cavern - **done, 10bar additional cavern pressure, since pressure increase one pressure spike**
- No blockage removal operations, pending studies
- Diesel injections via injection string
 - Increased frequency blanket measurements, control on level

Follow up actions

- Additional cyclic stress calculations – **no feedback manufacturer casing, SN curves required for analyses**
- Study possibility BAS-3 cavern as source and identify migration/leaching path (Carnalite/Polyhalite) – **in progress (see previous slide current thoughts), if fracturing Carnalite, why towards BAS-3O**
- FEM calculation stress in Z3 (154m Salt and 90m Anhydrite) – **in progress (see previous slide current thoughts)**
- Impact potassium/magnesium influx on production
- Impact on subsidence, production and abandonment

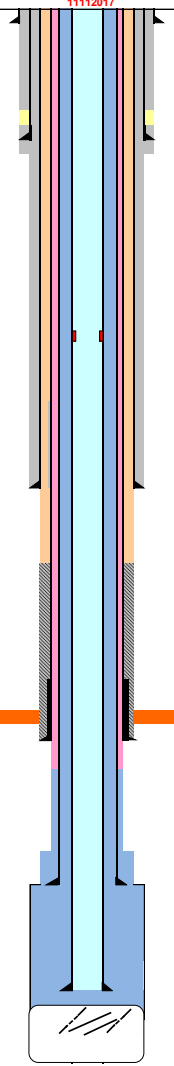
BAS-4

Status

- Production to fit factory requirements
- Issues with pump, cavitation and vibration giving much noise. Noise nuisance complaint from neighbour. Stop production at night.
- Attempted sonar measurement (5sep), HUD in well.
- Wijziging instemmingsbesluit
 - Awaiting EZK, negative advise SODM

Planned

- Continue bottom injection mode
- Blanket measurement (every 6 months)

Item Description	Wellhead and Xmastree BAS 4	Depth	Depth	Hole ID	Pipe	Collar	Pipe ID	
		GL	GL		OD	OD	ID	
		m	m	in	in	in	in	
		td	ah					
28" x 1" X 52E conductor shoe		15	15	driven	28,000	welded	28,000	
7" 29 ppf N80 VAM TOP inner leaching string, internally coated		319	319					
7" 26 ppf L80/N80Q VAM TOP inner leaching string, internally coated		366	366					
24" x 1/2" WT 35 ksi conductor, welded		279	279	26,00	24,000	welded	23,000	
7" 29 ppf N80 VAM TOP inner leaching string, internally coated		319	319					
7" 26 ppf L80/N80Q VAM TOP inner leaching string, internally coated		366	366					
7" 29 ppf N80 VAM TOP inner leaching string, internally coated		577	577					
7" 23 ppf N80 VAM TOP inner leaching string, internally coated		591	591					
7" 29 ppf N80 VAM TOP inner leaching string, internally coated		604	604					
7" wireline profile 5.75" Otis 'RPT'		966	966					5,75
Top cement in 18 5/8" x 13 3/8" annulus	916	916						
18 5/8" 87.5 ppf K55 Big Omega casing	1126	1126	22,00	18,625	20,000	17,688		
13 3/8" 68 ppf P110 VAM-TOP casing	1980	1980	16,00	13,375	14,375	12,415		
14" heavy wall VAM TOP 106 ppf N80	2382	2382	16,00	14,000	14,000	12,500		
Base of Camalite	2410	2410						
BM 23-10-2017	2470,6	2470,6						
EM (Oct 2015, Roof = 2478m) Mar 2012, Not possible to inject more diesel below 2496m -> indicating leak at that point in 11 3/4" connection.								
11 3/4" 65 ppf VM 80HC, VAM FJL outer leaching string, internally coated	2506	2506	26	11,750	11,965	10,682		
	2509	2509						
	2530	2530						
7" 26 ppf N80 VAM TOP inner leaching string, internally coated. Explosive cut.	2628	2628	17 1/2"	7,000	7,375	6,276		
Sump level Oct 2017 (EM)	2639	2639						
Total Depth Cavern	2810	2810						

* All depths are from ground level

July 2018

7, 8, 11-13, 16, 26, 29, 30	Production stop
10	Regular blanket measurement
25	Electricity black-out

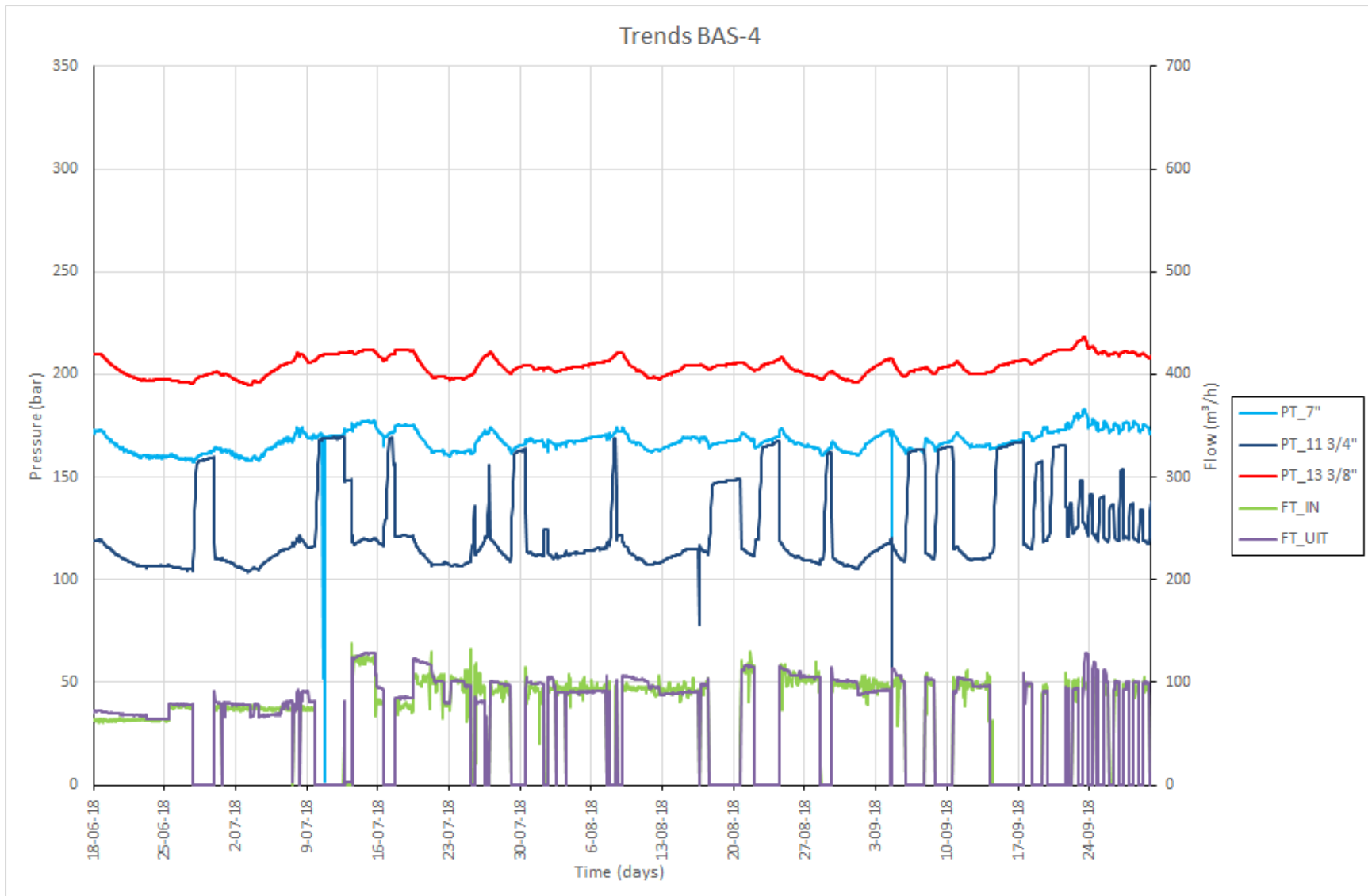
August 2018

1, 2, 3, 7, 8, 16, 17, 22, 28	Production stop
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September 2018

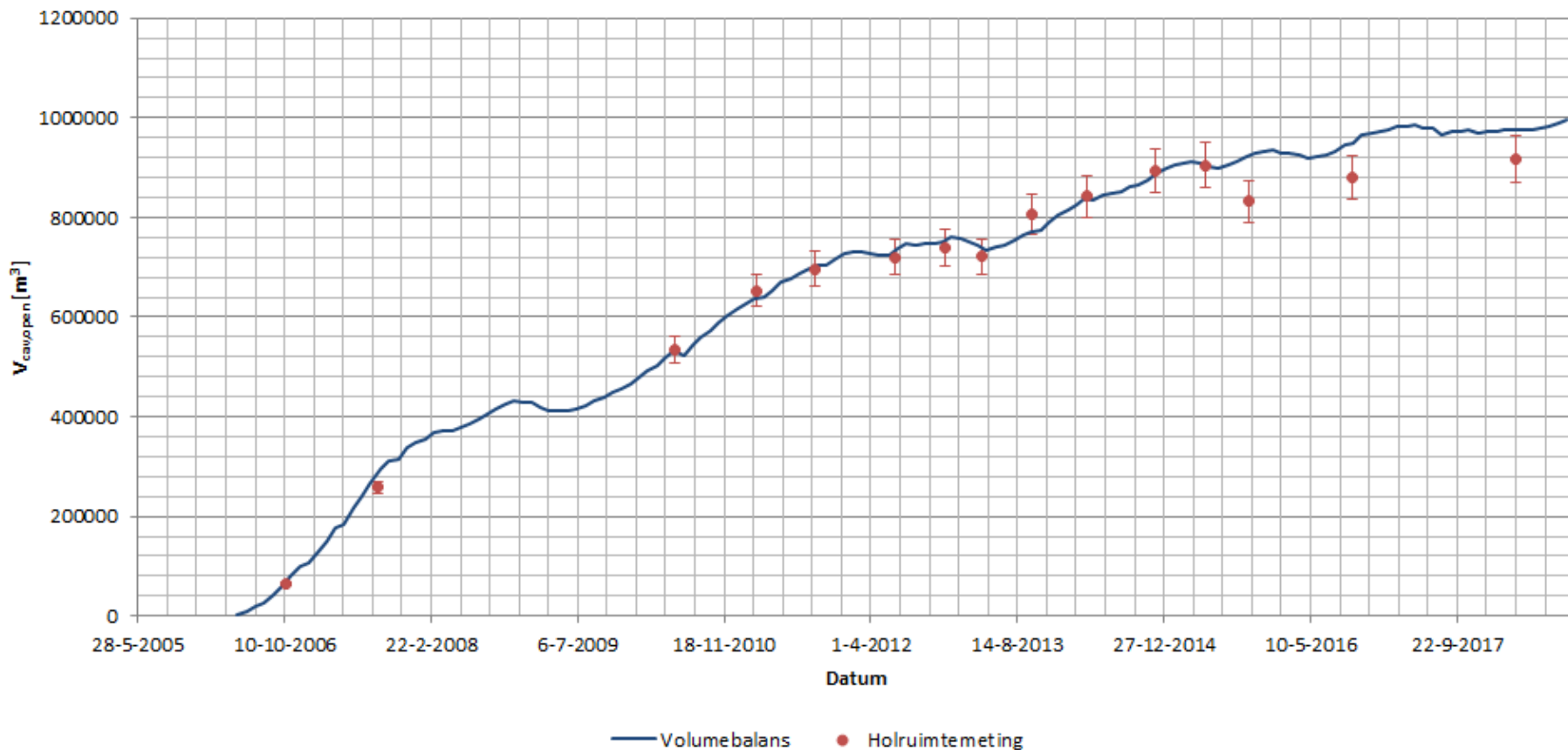
4, 5, 6, 7, 8, 14, 18, 19	Production stop.
21 – 30	Production stop during night time after sound nuisance complaint.

BAS-4



Volume balance BAS-4

Open caverne volume BAS-4



BAS-4 Reserves

- Reserves:
 - Remaining production from the 1st of December 2017 onwards: 300.000 tons (within current winningsplan)
 - Produced 1dec17 to 30sep18; 137,502 tons (2.0sg)
 - Independed study reserves BAS-4 Deltaris
 - Density Halite 2.16sg (cores BAS 1-2-4)
 - Evaluation Gausion-Kriging
 - Sonar measurement

Waterpassing

M&R 2017

- Measurements were performed November/December 2017 by ANTEA and analyzed
- Modeling contour Gaussian in progress, draft report end October

➤ Subsidence winningsplan:

- Winningsplan (Barradeel II):
- Current GPS (8-Oct-2018):
- Subsidence deepest point**:

BAS-3/30

300 mm
171 mm
191 mm

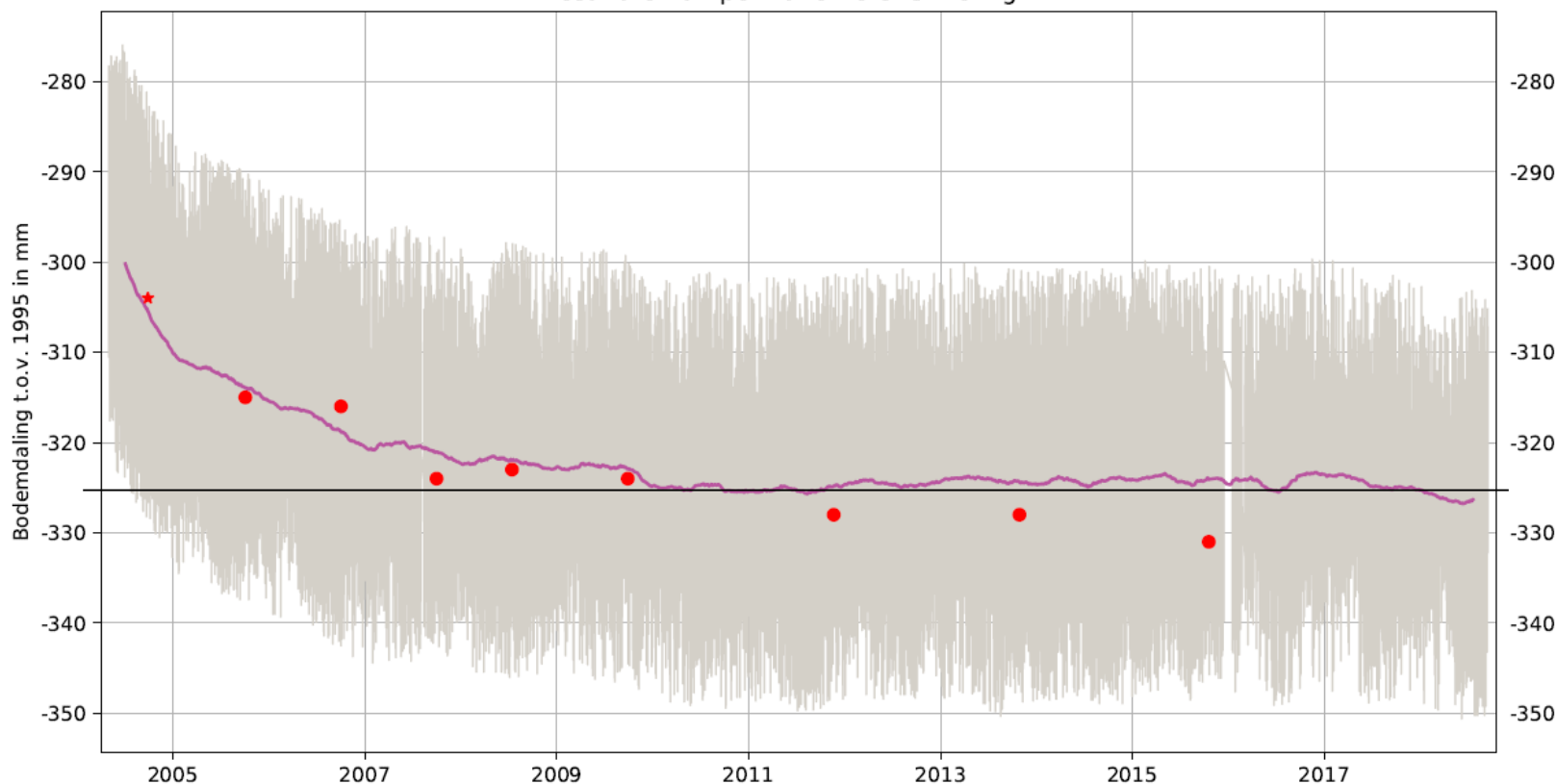
BAS-4

300 mm
279 mm
282 mm

** *Based on M&R 2015*

GPS BAS 1/2

Bodemdaling GPS station Barradeel*
Resultaten uit permanente GPS meting***

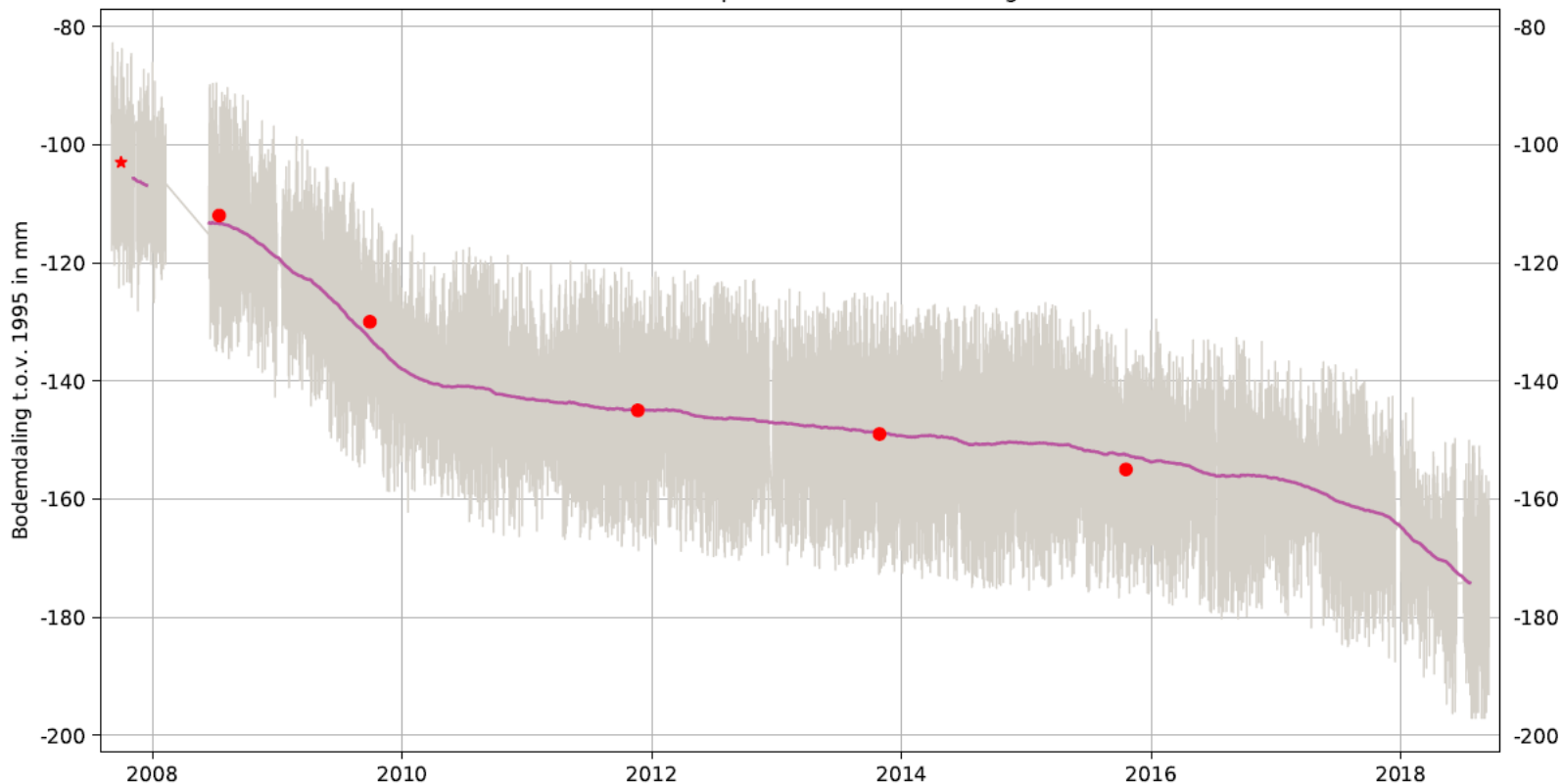


- GNSS observaties
- Moving Average 16 weken
- ★ week 40 2004 = -30.4cm**
- week 40 2005 = -31.5cm**
- week 40 2006 = -31.6cm**
- week 40 2007 = -32.4cm**
- week 29 2008 = -32.3cm**
- week 40 2009 = -32.4cm**
- week 47 2011 = -32.8cm**
- week 44 2013 = -32.8cm**
- week 43 2015 = -33.1cm**

* Op basis van WEB analyse WP 2015 bedraagt in 2015 de daling van diepste punt in de winningsvergunning Barradeel 1,65 cm meer dan daling van GPS-station Barradeel.
** Daling GPS station berekend uit "best fit" dalingskommen. (ref. WP 2015 Zweins, glijdende PM, 3 kommen v1.2- Dkrit 13 mm, gamma 4,3)
*** GPS is een relatieve meting tussen station Barradeel en het station Zweins. De relatieve GPS meting is gekoppeld aan de absolute datering vastgesteld in WP 2004 (rode ster).

GPS BAS 3/30

Bodemdaling Barradeel II GPS station BAS-3* & BAS-3-O
Resultaten uit permanente GPS meting***

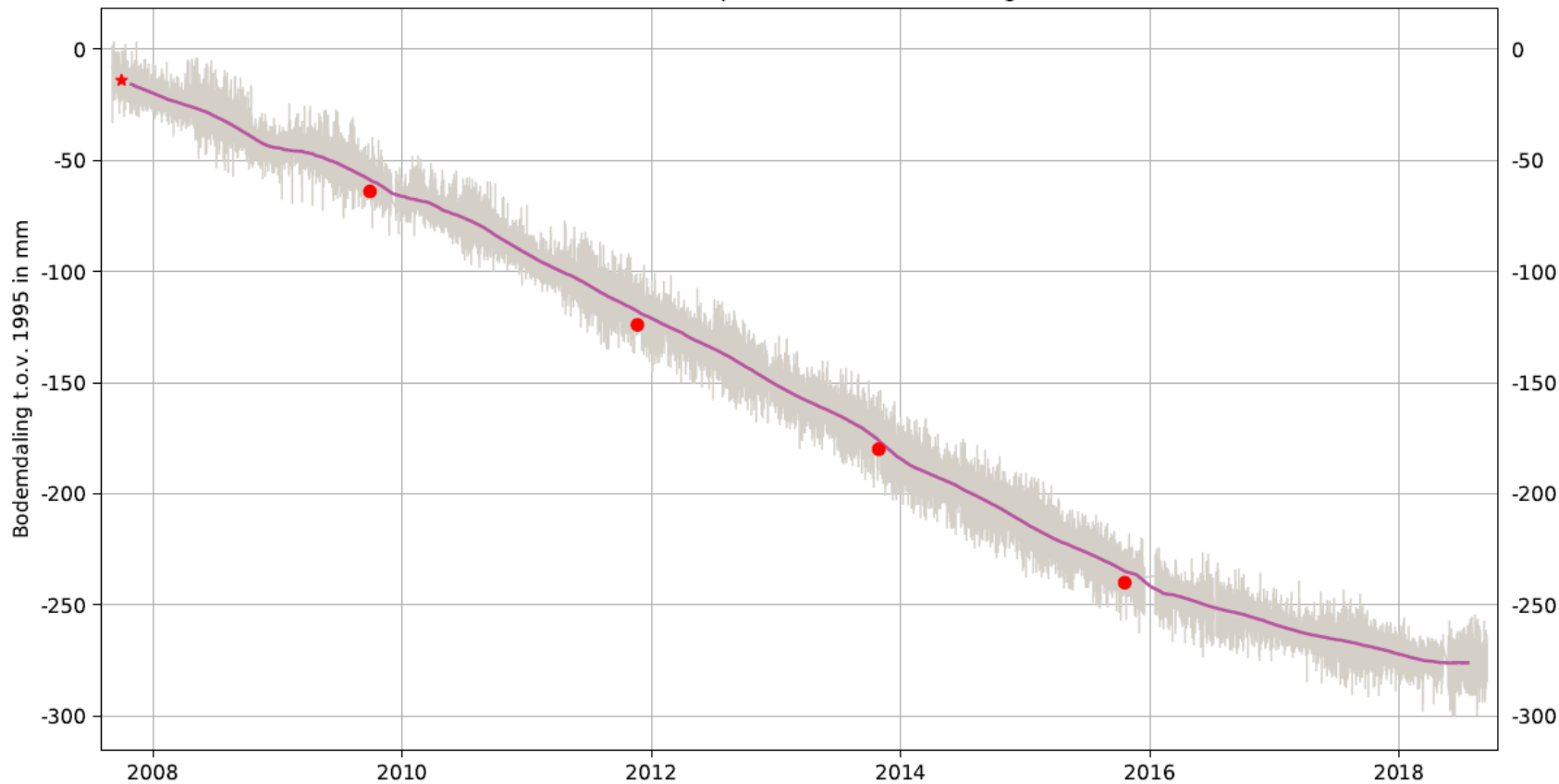


- GNSS observaties
- Moving Average 16 weken
- ★ week 40 2007 = -10.3cm**
- week 29 2008 = -11.2cm**
- week 40 2009 = -13.0cm**
- week 47 2011 = -14.5cm**
- week 44 2013 = -14.9cm**
- week 43 2015 = -15.5cm**

*Op basis van WEP analyse WP 2015 bedraagt in 2015 de bodemdaling boven caveerne BAS-3 1,95 meer dan de daling van GPS-station BAS-3.
 ** Daling GPS station berekend uit "best fit" dalingskommen. (ref. WP 2015 Zweins, glijdende PM, 3 kommen v1.2- Dkrit 13 mm, gamma 4,3)
 *** GPS is een relatieve meting tussen station BAS-3 en het station Zweins. De relatieve GPS meting is gekoppeld aan de absolute dating vastgesteld in WP 2007 (rode ster).

GPS BAS-4

Bodemdaling Barradeel II GPS station BAS-4*
Resultaten uit permanente GPS meting***



- GNSS observaties
- Moving Average 16 weken
- ★ week 40 2007 = -1.4cm**
- week 40 2009 = -6.3cm**
- week 47 2011 = -12.4cm**
- week 44 2013 = -18.0cm**
- week 43 2015 = -24.0cm**

* Op basis van WEP analyse WP 2015, bedraagt in 2015 de bodemdaling boven caveerne BAS-4 0,3 cm meer dan de daling van GPS-station BAS-4
 ** Daling GPS station berekend uit "best fit" dalingskommen (ref. WP 2015, glijdende PM, 3 kommen v1.2- Dkrit 13 mm, gamma 4,3)
 *** GPS is een relatieve meting tussen station BAS-4 en het station Zweins. De relatieve GPS meting is gekoppeld aan de absolute datering vastgesteld in WP 2007 (rode ster).

GPS logbook

15-05-2018 t/m 23-05-2018	BAS4	<i>Onderbreking data ontvangst van BAS4 van 15-05-2018 0:59 t/m 23-05-2018 13:59.</i>
7-06-2018 t/m 8-06-2018	BAS4	<i>Onderbreking data ontvangst van BAS4 van 7-06-2018 8:59 t/m 8-06-2018 6:59.</i>
3-07-2018 t/m 4-7-2018	BAS12/BAS4	<i>Onderbreking data ontvangst van BAS12 en BAS4 van 3-07-2018 7:59 t/m 4-07-2018 6:59.</i>
16-06-2018 t/m 2-07-2018	BAS3	<i>Onderbreking data ontvangst van BAS3 van 16-06-2018 0:00 t/m 2-07-2018 7:59.</i>
5-07-2018 t/m 6-07-2018	BAS3 / BAS4	<i>Onderbreking data ontvangst van BAS3 en BAS4 van 5-07-2018 12:59 t/m 6-07-2018 8:59.</i>
7-08-2018 t/m 9-08-2018	BAS3 / BAS4	<i>Onderbreking data ontvangst van BAS3 van 7-08-2018 10:59 t/m 9-08-2018 6:59.</i>
12-08-2018 t/m 16-08-2018	BAS 4	<i>Onderbreking data ontvangst van BAS4 van 12-08-2018 9.35 t/m 16-08-2018 12:59. 14-08 is contact geweest met Frisia om BAS4 te resetten,op 16-08 is station gereset.</i>

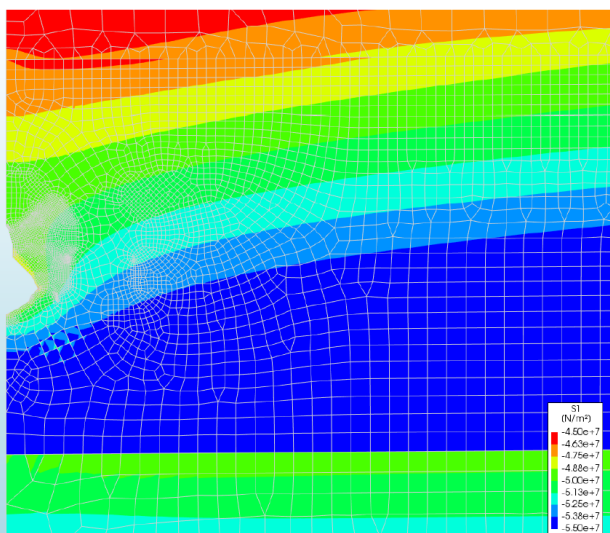
Havenmond

- Seperate meeting held with SODM on 13 September 2018.
- Update M&R, ready end October18
 - Zero measurements can start, Permanent poles installed, GPS to be installed.
- Update “Aanmeldnotitie MER”, submit Oct18
- Alternative blanket fluid study
 - Nitrogen impossible
- Finalized detailed design
- Omgevingsvergunning mid Nov18
- Start drilling summer 2019
- Winningsplan requirements:
 - Volume balance report
 - Review BAS-3 abandonment
 - Sluitingsplan before start production



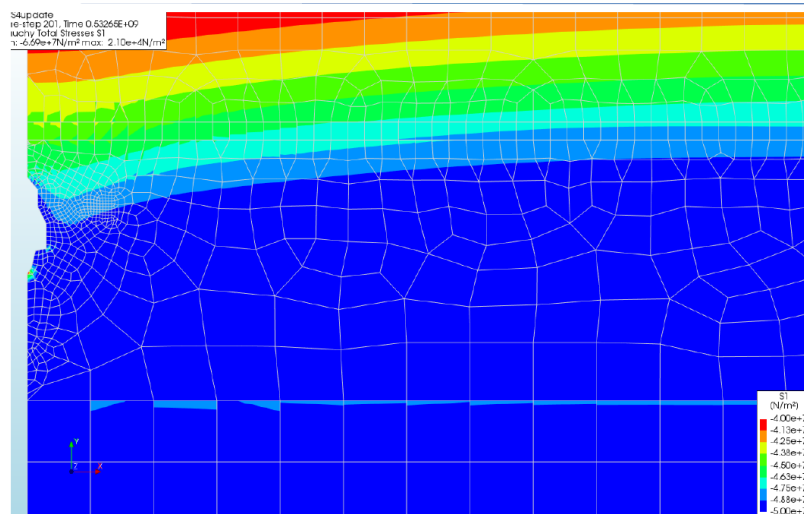
WVTTK

BAS30.G01.0
Time-step 220, Time 0.23332E+09
Cauchy Total Stresses S1
min: -6.78e+7N/m² max: 5.02e+3N/m²



Figuur 1 Minimum principal stress voor BAS-30 bij 20 cm bodemdaling. Kleurenranges van 45 tot 55 MPa.

S4update
ie-step 201, Time 0.53265E+09
Cauchy Total Stresses S1
min: -6.50e+7N/m² max: 2.10e+4N/m²



Figuur 2: Minimum spanningen rondom BAS4 bij 30 cm bodemdaling. Kleurenranges van 40 tot 50 MPa.

WVTTK

- Next quarterly meeting