Petrophysical Report of the Dinantian Carbonates in the Dutch Subsurface

Report by Torbjörn Carlson

April 2019

Ministerie van Economische Zaken en Klimaat
ebn
TNO
Interreg North-West Europe DGE-ROLLOUT

Contents

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Dit rapport is een product van het SCAN-programma en wordt mogelijk gemaakt door het Ministerie van Economische Zaken en Klimaat

WELL DATA S05-01

Company Name : NAM

Well Name : S05-01

Field Name : Block S-5

Country : The Netherlands

Field Location : offshore

Geological targets : Dinantian - Devonian

Longitude : 51*47’33” N

Latitude :   03*33’47.8” E

Maximum Hole Deviation : 7.4 (deg)@2230m

Elevation of Kelly Bushing : 28.95m MSL

Elevation of Ground Floor :

Elevation of Derrick Floor : 28.65m

Permanent Datum :

Elevation of Permanent Datum :

Log Measured from : 87m to TD 2230m

Above Permanent Datum :

Drilling Measured From :

MRT Maximum recorded Temperature : 80 °C

TD : 2230m

Dinantian evaluation in S05-01 (1189-1996 m MD)

Log quality, edits and depth shifts

The GR-Sonic-Induction is the base log in all intervals and has not been shifted when creating the final logs.

The density-neutron logs have been shifted slightly in all intervals for the creation of the final logs. The 8 3/8" hole was logged twice with one intermediate to approximately 2000 m and one to TD. The intermediate density log is not in agreement with the TD log in the interval 1110-2000 m where they should be in close agreement. The deeper density log (to TD) indicate an average density almost 25 kg/m3 denser then the upper density log. A cross-plot density versus neutron indicate that the deep log covering the entire 8 3/8" hole is the better log and therefore this density is used for evaluation. The logs required some minor shifts.

Because the 8.5" hole has been logged in two separate intervals, the other logs required splicing and, in a few cases, depth shifting prior to splicing.

Log corrections

None of the curves have been environmentally corrected. The log quality across the Dinantian interval is good and no edits in this interval has been applied. A few very minor, sharp, washouts could cause lower quality, however, this is difficult to confirm. A quick check on the two neutron logs in the 8 3/8" resulted in a very small average difference of 0.0019, clearly within the limits of the calibration and tool accuracy.

Evaluation of Dinantian (1189-1996 m MD)

Porosity has been calculated from x-plot porosity of the Sonic and the Neutron curves and the Density-Neutron. The agreement between the two is very good in almost all intervals. The only major difference is observed in the interval 1438-1449 m where there is some rugose hole resulting in too low density being measured in some short intervals. The final porosity has therefore been chosen to be the sonic-neutron x-plot porosity

A clay indicator has been calculated based on the Potassium concentration from the spectral GR (0 % clay at Potassium concentration of 0.0004 and 100 % clay at Potassium conc. = 0.05 with the following equation resulting:

Clay Indicator = -0.008064+20.16*Potassium concentration in fractions

The proportions of Limestone and Dolomite is based on the calculated matrix slowness from sonic and calculated porosity. The Limestone proportion is calculated based on the following equation with a Limestone slowness of 160 µs/m and a Dolomite slowness of 145 µs/m:

Limestone proportion = -9.667+0.06667*Calculated Matrix Slowness (DTMapp)*(1-Clay Indicator)

Dolomite proportion = 1 – (Limestone + Clay Indicator)

Result

The result of the evaluation can be seen in the log evaluation plot. In the middle depth track are the cored intervals and the core recovery indicated in brown. In the evaluation track 11 is the Clay Indicator displayed. In track 12 is the calculated porosity and core porosity, on a 0 to 10 % scale, and the test intervals indicated with varying colors for the different tests. In track 13 is the core permeability and in track 14 is the calculated lithology displayed.

The sums and averages for this well is provided in the table below with a Clay Indicator cut-off of 0.1

Gross	Net	Net/Gross	Average Porosity	Average Clay Indicator	Average Porosity times net	Normalized Average Porosity*Net	Porosity cut-off
MD	MD	MD					
m	m	fract	fract	fract	m	fract	fract
807,4	467,51	0,579	0,005	0,025	2,45	1,00	0,00
807,4	71,88	0,089	0,018	0,042	1,30	0,53	0,01
807,4	18,90	0,023	0,031	0,043	0,58	0,24	0,02
807,4	9,30	0,012	0,037	0,036	0,35	0,14	0,03
807,4	3,05	0,004	0,043	0,028	0,13	0,05	0,04
807,4	0,02	0,000	0,050	0,028	0,01	0,00	0,05
807,4	0,00	0,000			0,00	0,00	0,06

The second column from the right is a normalized product of average porosity and net (Average porosity*net/Average Porosity*net at no porosity cut off) to enable plotting in the same graph as the other parameters, see figure 1 below.

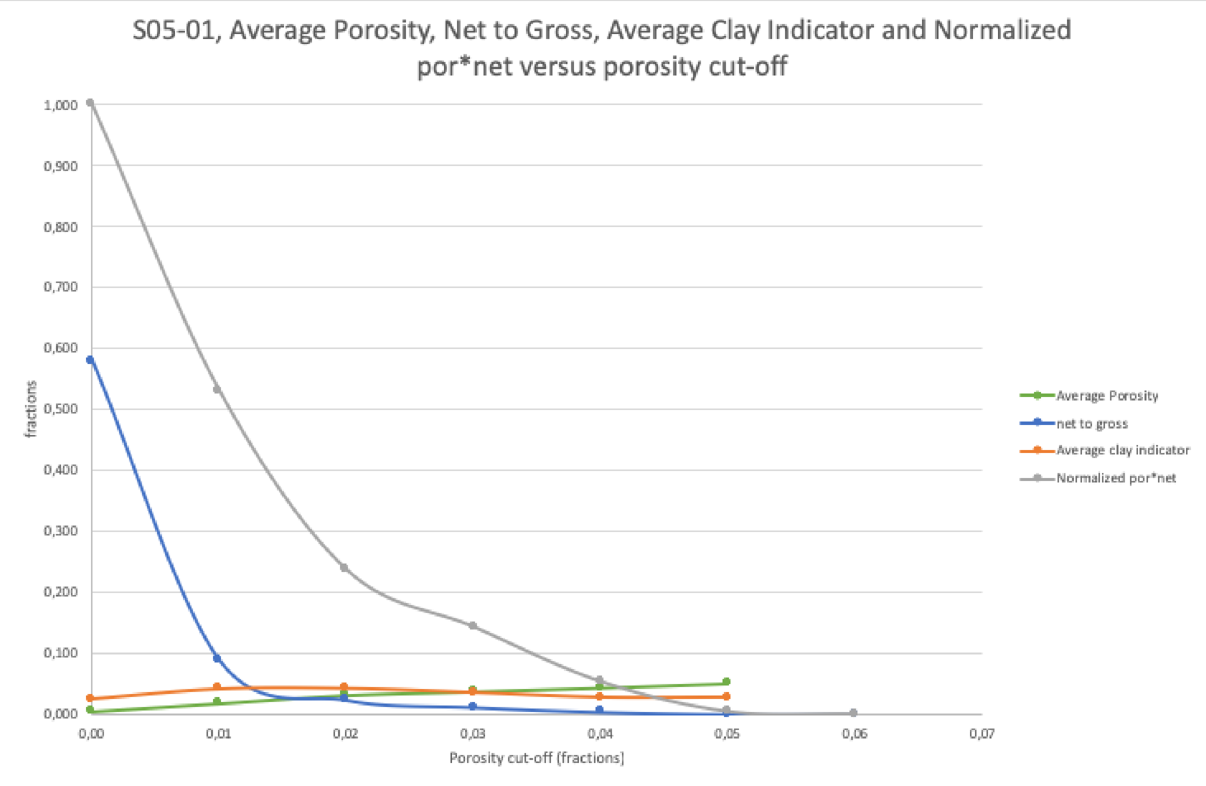


Figure 1. Average porosity, net-to-gross, clay indicator and normalized porosity*net thickness for increasing porosity cut-off

The graph shows a rapid decrease in net to gross up to 1 % porosity cut-off and after that gradually a slowing decrease, up to 6 % porosity cut-off where net becomes 0. The product of average porosity and net (Normalized por*net) has a fast decrease up to a porosity cut-off of 2 % and then a slowing decrease up to a cut-off of 6 % where it becomes 0. The average porosity has a slowing increase with porosity cut-off. The Clay Indicator initially increases a bit and then falls back and the changes are small, indicating that there is little coupling between porosity and clay content.

The average porosity at no porosity cut-off is 0.5 %, which is lower than many of the other Dinantian wells and could indicate that the porosity should be slightly higher (0.1-0.3 %).

Discussion

Most of the interval has very low porosity. Both the two porosities have many values below zero and it is possible that a very minor correction should be applied. However, the correction should probably not exceed 0.001, an almost insignificant value and has therefore not been applied. The result is that the porosity calculated in many intervals hovers around zero porosity. The core porosity is in good agreement with the calculated porosity. There are a few high porosities in the core data that are clearly higher than the calculated porosity but this is an issue of very different resolution between logs and core data, where a core plug (only 1 inch in diameter) is compared to logging tools resolution of 0.3-1 m.

There are only a few intervals with porosity above 2 %, 1374 m, 1439-1448 m, 1482 m, 1838 m, 1886-1889 m, 1922 m, 1940.5 m, 1968-1987 m and 1990.5-1992.5 m. The intervals indicated by a single depth are very short, less than a 1 m thick. The interval 1886-1889 m has an elevated clay content and the interval is tight.

The interval 1439-1448 m is the only thicker, more porous, interval in the upper part of the Dinantian. It has several small sharp wash-outs, indicating that it could be fractured and at the base, a distinct small clay layer according to the spectral GR. It is therefore likely that it is a karsted interval with some clay infill and fractures.

The two short intervals at 1374 m and 1482 m (only successful pressure point) in the upper part has no indication that could point to origin of the porosity.

The best porosity (2-6 % porosity) interval 1968-1987 m is Dolomite and has some short intervals with increased clay content, often associated with the most porous parts but often slightly above the porosity peaks. Only one very small perturbation on the caliper could indicate fracturing. The porosity is related to secondary processes and it is relatively likely that karsting has played a role.

The lowermost interval 1990.5-1992.5 m is a clean Dolomite and it is likely that the porosity is related to the dolomitizing of this interval. The reason that this interval is separated from that just above is that it has a much lower resistivity than the interval 1968-1987 m and therefore must be treated separately, see discussion on resistivity below.

The resistivity profile in this well is anomalous, showing much lower resistivity down to approx. 1875 m. In this section, 1189-1875 m, a Rw of approximately 0.035 ohmm is derived from a Picket plot (porosity>0.02), see figure 2, below. When this is compared with the Picket plot for the interval at the bottom of the Dinantian from 1875-1996.5 m, see figure 3 (porosity>0.02, same axis as in figure 2), the Rw differs by approximately a factor of 10. In figure 3 some 5 points fall well below and are more similar to the resistivity of the upper interval and are from the porosity peak around 1992 m, while those around the peak at 1990.5 m are within the overall cluster of 1875-1996.5 m.

Both the data above 1875 and those below 1875 m indicate a typical water response on the Picket plot and it can therefore with a relatively high confidence be concluded that the water seen by the deep laterolog is different for these two intervals with a much fresher water at the base, possibly as low as 10000 ppm NaCl and with a much more saline water at the top, probably with a salinity of approximately 100000 ppm. The best explanation of the difference is that the low resistivity indicated in the upper part is caused by extremely deep invasion into all the more porous intervals because the salinity of 100000 ppm corresponds to the filtrate resistivity of 67000 ppm Cl-. This would be consistent with the quite large losses seen in the well of 664 m3 down to approximately 1800 m. This consistent deep invasion over long intervals is unusual and can probably be explained by the limited number of more porous intervals taking all the losses. Other explanations are unlikely.

The primary explanations to where the losses decreased is that the mud density was gradually decreased from 1220 kg/m3 at the top of Dinantian and reached 1080 kg/m3 at approximately 1724 m and then was kept in the range 1070-1090 kg/m3. The losses decreased below 1724 m and did stop, according to the records, at approximately 1800 m. However, it is highly likely that losses explain the lowermost anomalous resistivity at 1992 m, although none were recorded.

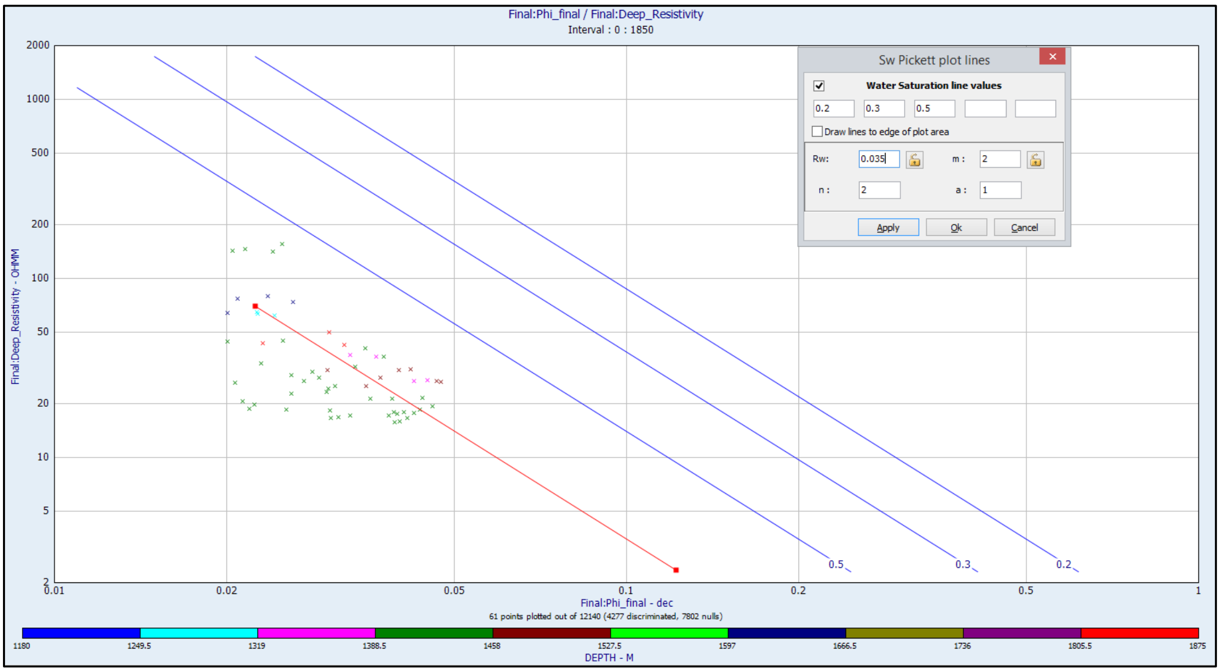


Figure 1. Picket plot for interval 1189-1875 m, Rw is approx. 0.035 ohmm (m=n=2)

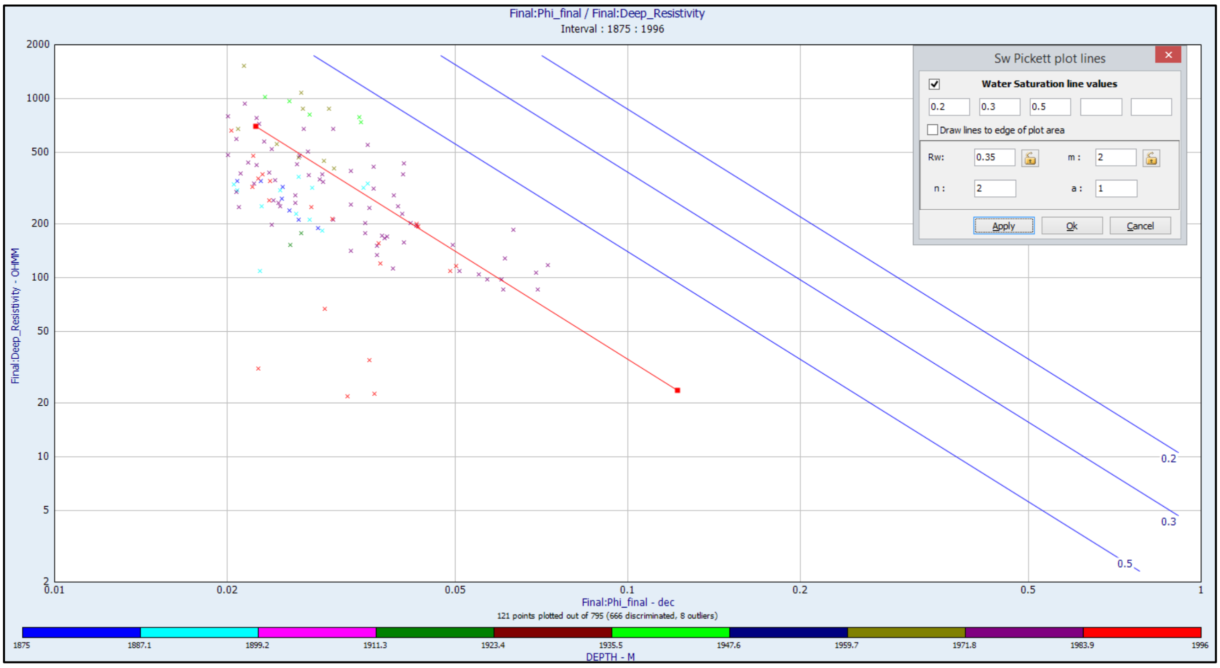


Figure 2. Picket plot for interval 1875-1996.5 m, Rw is approx. 0.35 ohmm (m=n=2)

Core data

The well was cored in the following intervals:

1190-1199 m (recovered 1190-1192 m, 22 %), 1199-1210 m (recovered 100 %), 1210-1228 m (recovered 100 %), 1228-1240 m (100 % recovery), 1349-1360 m (100 % recovery), 1668-1682 m (100 % recovery), 1784-1802 m (100 % recovery), 1904-1906 m (100 % recovery), 1906-1913 m (100 % recovery), 2015-2029 m (100 % recovery), 2130-2148 m (100 % recovery).

All cores had porosity and grain density analysis performed. Only very few plugs had permeability measurements. The reason for this is not known, possible explanations are poor plug quality and more likely that they either were too tight or it was decided that they should not be analyzed based on the porosity measurement information.

In the depth plot, all the core data has been shifted down by 1.25 m based on a porosity peak at 1230 m. No other shifts could be performed due to no anomalies to match. The core data indicate a very low porosity with only the odd plug showing a porosity above 2 %.

Flow potential

Tests

3 tests were performed in the Dinantian:

13/7/1981: 1911-1943 m (perfs: 1911.0-1921.3 (35 shots), 1921.3-1931.7 (35 shots), 1931.7-1943. 0 (38 shots):

After perforating the interval was acidized with 30 m^3 acid (max. injection pressure 157 bar). Produced 47.4 m^3 of water to surface, mostly with Nitrogen lift. No H_2S recorded. Took 3 downhole samples. Abandoned test 1.

18/7/1981: 1430-1491 m (perfs: 1430.0-1440.5 (35 shots), 1440.5-1451.0 (35 shots), 1480.0-1491.0 (37 shots):

After perforation, acidized the perforated intervals with a maximum pressure of 330 bar (acid-fracture, volume acid not provided). Produced a total 70.7 m^3 with Nitrogen lift. No H_2S recorded during the test. Abandoned test 2.

19/7/1981: 1189-1236 m (perfs: 1189.0-1200.0 (37 shots), 1225.0-1236.0 (37 shots):

Perforated and acidized with 22 m^3 acid (surface pressure not recorded). Produced a total of 245 m^3 with Nitrogen lift, less than 1 % mud contamination at end of test. No H_2S recorded during entire test. Abandoned test 3.

The three tests show that flow can be attained from all zones perforated and acidized using artificial lift. It is unlikely that the well would flow without Nitrogen lift due to the normal pressure in the reservoir. Fluid levels during shut in were around 168-212 m. No H_2S was recorded during any of the test and multiple recordings were made. This show that H_2S probably is not an issue in the area around S05-01.

Wireline formation tester (RFT)

RFT run1, 4 July 1981, max recorded temperature; 80 deg C. Time stopped circulation 21:00 3 Jul., Time Logger on bottom; 00:00 5 July.

File No	Depth	Hydr. Press. Before	Hydr. Press. Before	Hydr. Press. After	Hydr. Press. After	Stabilized Pressure during test	Stabilized Pressure during test	Remark
	m	psig	bar	psig	bar	psig	bar	
1	1230.0	1883	130.8	1884	130.9	8	1.6	Dry test
2	1229.7	1883	130.8	1884	130.9	0	1.0	Dry test
3	1230.3	1885	131.0	1886	131.0	2	1.2	Dry test
4	1374.5	2110	146.5	2111	146.6	4	1.3	Dry test
5	1374.2	2107	146.3	2103	146.0	10	1.7	Dry test
6	1374.8	2102	145.9	2099	145.7	12	1.8	Dry test
7	1431.0	2186	151.7	2188	151.9	13	1.9	Dry test
8	1430.7	2187	151.8	2187	151.8	-	-	Seal Failure
9	1431.3	2187	151.8	2186	151.7	12	1.8	Dry test
10	1439.5	2199	152.6	2199	152.6	-	-	Seal Failure
11	1439.2	2198	152.6	2197	152.5	-	-	Seal Failure
12	1439.8	2198	152.6	2197	152.5	-	-	Seal Failure
13	1481.5	2261	156.9	2262	157.0	14	2.0	Dry test
14	1481.2	2256	156.6	2259	156.8	2127	147.7	Stable, segregated sample 2.75+1 gallon after pretest. Pressure at end of sampling 1 gallon was 2127 psi (147.7 bar) reasonable perm.
15	1490.0	2273	157.7	2273	157.7	14	2.0	Dry test
16	1489.7	2271	157.6	2271	157.6	10	1.7	Dry test
17	1490.3	2270	157.5	2272	157.7	12	1.8	Dry test
18	1617	2465	171.0	2463	170.8	13	1.9	Dry test
19	1616.7	2461	170.7	2460	170.6	14	2.0	Dry test
20	1617.3	2460	170.6	2460	170.6	13	1.9	Dry test
21	1623.5	2469	171.2	2497	173.2	13	1.9	Dry test
22	1623.2	2499	173.3	2501	173.5	12	1.8	Dry test
23	1623.8	2502	173.5	2501	173.5	12	1.8	Dry test
24	1632.5	2514	174.3	2514	174.3	13	1.9	Dry test
25	1632.2	2514	174.3	2514	174.3	11	1.8	Dry test
26	1632.8	2516	174.5	2516	174.5	12	1.8	Dry test
27	1825	2814	195.0	2813	195.0	11	1.8	Dry test
28	1824.7	2811	194.8	2811	194.8	15	2.0	Dry test
29	1825.3	2811	194.8	2811	194.8	16	2.1	Dry test
30	1887	2909	201.6	2909	201.6	11	1.8	Dry test
31	1886.7	2907	201.4	2907	201.4	13	1.9	Dry test
32	1887.3	2907	201.4	2907	201.4	12	1.8	Dry test
33	1990	3067	212.5	3067	212.5	-	-	Seal Failure
34	1989.7	3064	212.3	3063	212.2	15	2.0	Dry test
35	1990.3	3063	212.2	3063	212.2	-	-	Seal Failure

Of the 35 RFT pressure tests only one point at 1481.2 m showed flow and resulted in a valid pressure and a segregated sample was taken. The sample was classified as filtrate/water with a Cl content of 67000 ppm (110000 ppm NaCl). This is in line with the resistivity of the filtrate, 0,075 ohmm at 15 °C.

The good test at 1482 m (1452 m TVDss) has a pressure of 147.7 bar, see plot with pressures below. This result in a pressure gradient from the sea surface to 1452 m TVDss of 0.1010 bar/m, corresponding to a density of 1030 kg/m^3. This corresponds to a Cl- content of approximately 28000 ppm (total salinity if assumed NaCl would be approximately 46000 ppm). It is also possible that the pressure gradient in the Dinantian is lower and that there is a very minor overpressure. This is something that cannot be determined with a single valid pressure!

There are 28 dry tests (so called because they show absolutely no flow) and 6 seal failures in addition to the successful test.

One warning on the RFT tests and other formation tester pressure tests, are that they are made with a probe where the sampled area is very small, normally in the range of a few square cm up to maybe 10 cm2, depending on probe. In a very heterogenous formation like the Dinantian there is a very large chance that if a few attempts are made in a porous layer the permeable place is missed. This is almost certainly one of the explanations to the very high proportion of dry tests (no flow from formation at all) and tight tests (very limited inflow) seen in the Dinantian wells.

Losses

A total of 664 m3 losses were taken in the interval 1240-1800 m, see pressure plot below. The losses are proof of permeability, although the permeability is probably low and only the few more porous intervals take the bulk of the losses. It should be noted that in the upper part of the Dinantian the overbalance was in the order of 20-25 bar, a bit too high in a formation that may have open fractures. The density of the mud at the top of the section was 1220 kg/m3 and this was gradually decreased during drilling and at 1724 m, it had been reduced to 1080 kg/m3. At which depth this occur cannot be determined with accuracy because one weekly drilling report is missing. At 1410 m the density of the mud was still 1170 kg/m3 and between this depth and 1724 m the mud density was reduced considerably to minimize the losses.

Formation temperature

Table showing the maximum temperatures from the logging runs in S05-01 at TD, 2230 m.

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(°C)
Dual Laterolog	≈2220	30/6/1981	5	73
GR/FDC/CNL	≈2220	4/7/1981	9.5	76.5
GR/BHC/ISF	≈2220	4/7/1981	14	78
NGT	≈2220	4/7/1981	18.5	80
Dipmeter	≈2220	4/7/1981	24	80

Table showing the maximum temperatures from the logging runs in S05-01 at 2030 m.

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(°C)
Dual Laterolog	≈2015	30/6/1981	9.5	66.5
GR/FDC/CNL	≈2020	30/6/1981	13	71
GR/BHC/ISF	≈2015	30/6/1981	17	72.5
Dipmeter	≈2020	30/6/1981	21	73.5

Table showing the maximum temperatures from the logging runs in S05-01 at 1100 m.

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(°C)
GR/BHC/ISF	≈1085	7/6/1981	4.5	49
GR/FDC/CNL	≈1090	7/6/1981	10	50

Table showing the maximum temperatures from the logging runs in S05-01 at 852 m.

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(deg C)
GR/BHC/ISF	≈840	3/6/1981	5.5	40
GR/FDC/CNL	≈840	7/6/1981	7.25	40

On this log suite both runs have recorded 39, 39 and 40 C on the maximum thermometers. This is probably only recorded on the first run and then copied to the following run and cannot therefore be used for a Horner extrapolation of temperature to formation temperature.

For the shallowest run, the maximum temperatures measured, 26.3, 26.3 and 25.8 C measured at approximately 290 m are not valid, as they would result in a far too high temperature at a depth of approximately 261 m TVDss considering that the temperature at the sea bottom is approximately 8 C (water depth is 22 m). The reason for these erroneous maximum temperatures recorded is that the thermometers reflect the temperature in the room where they were read off and not the formation temperature, which definitely is lower.

Horner Extrapolated temperatures

Depth	TVDss	Extrapolated all data	Extrapolated limited data	Gradient (all data)(from sea bottom)	Gradient (limited data) (from sea bottom)
m	m	deg C	deg C	deg C/km	deg C/km
55.7 (sea bottom)	22.0	8			
840	811.1	>40			
1085	1056	51	51	41.6	41.6
2015	1985.8	80.5	78	31.7 (36.9)	29.0 (35.6)
2215	2185.2	82.5	82.5	10.0 (34.4)	22.6 (34.4)

In the table above, a different temperature for the logging with the thermometers at approximately 2015 m includes a lower temperature based on the three last maximum temperatures because the extrapolation with all temperatures appear to be too high related to the temperature at approximately 2215 m. However, it should be realized that there is a clear error bar in the temperatures read off and how each individual run was logged can affect the temperatures recorded. Therefore, the gradient can be somewhat different. However, it is unlikely that any extrapolated temperature would be more than 3-4 degrees different from those tabled above. The final formation temperature gradient is becoming lower with depth and based on the above data, including all data the following equations have been derived and used:

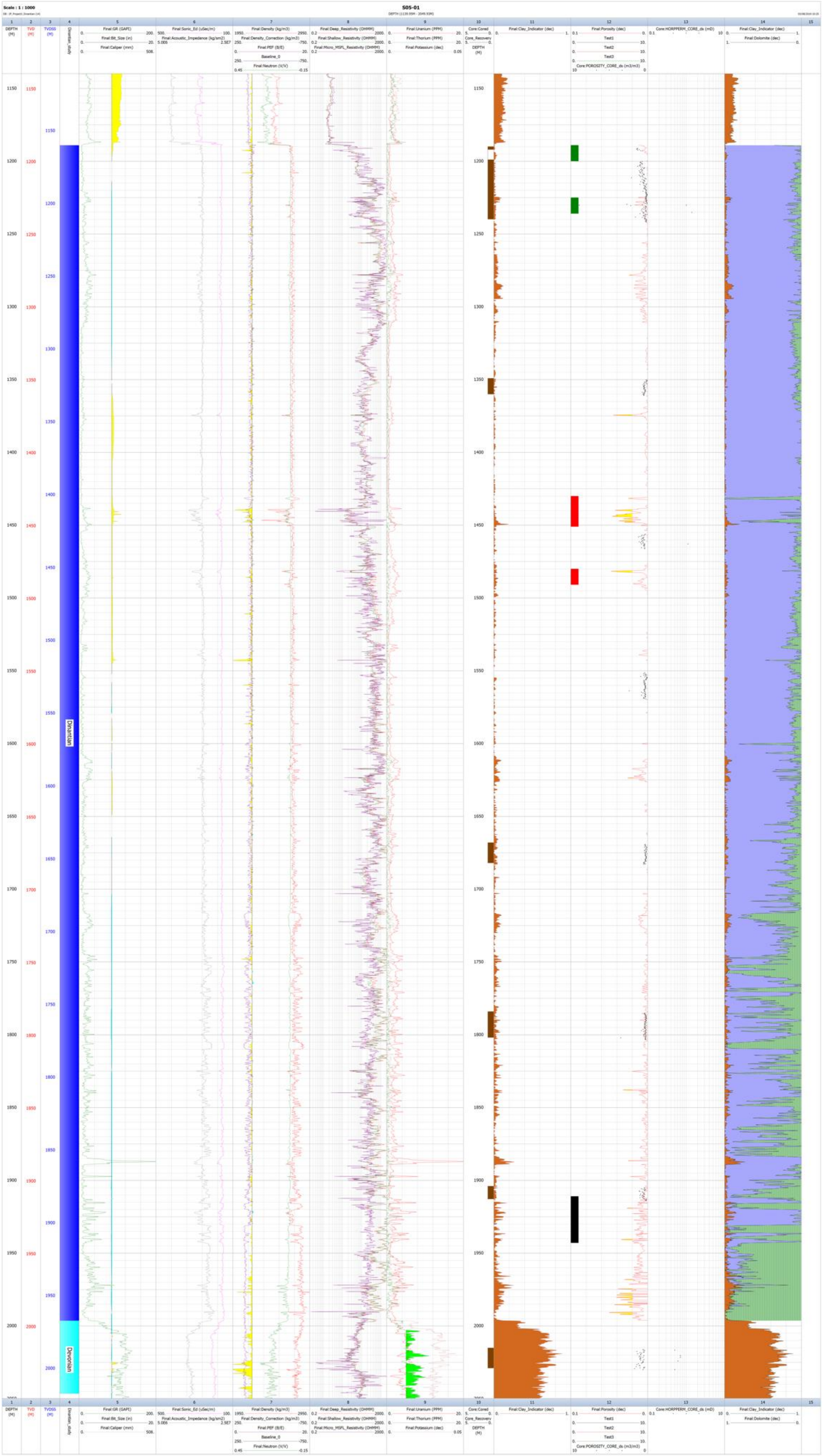
0-1085 m: Formtemp = 7.09+0.04123*TVDss (deg C)

1085-2015 m: Formtemp = 15.47+0.03275*TVDss (deg C)

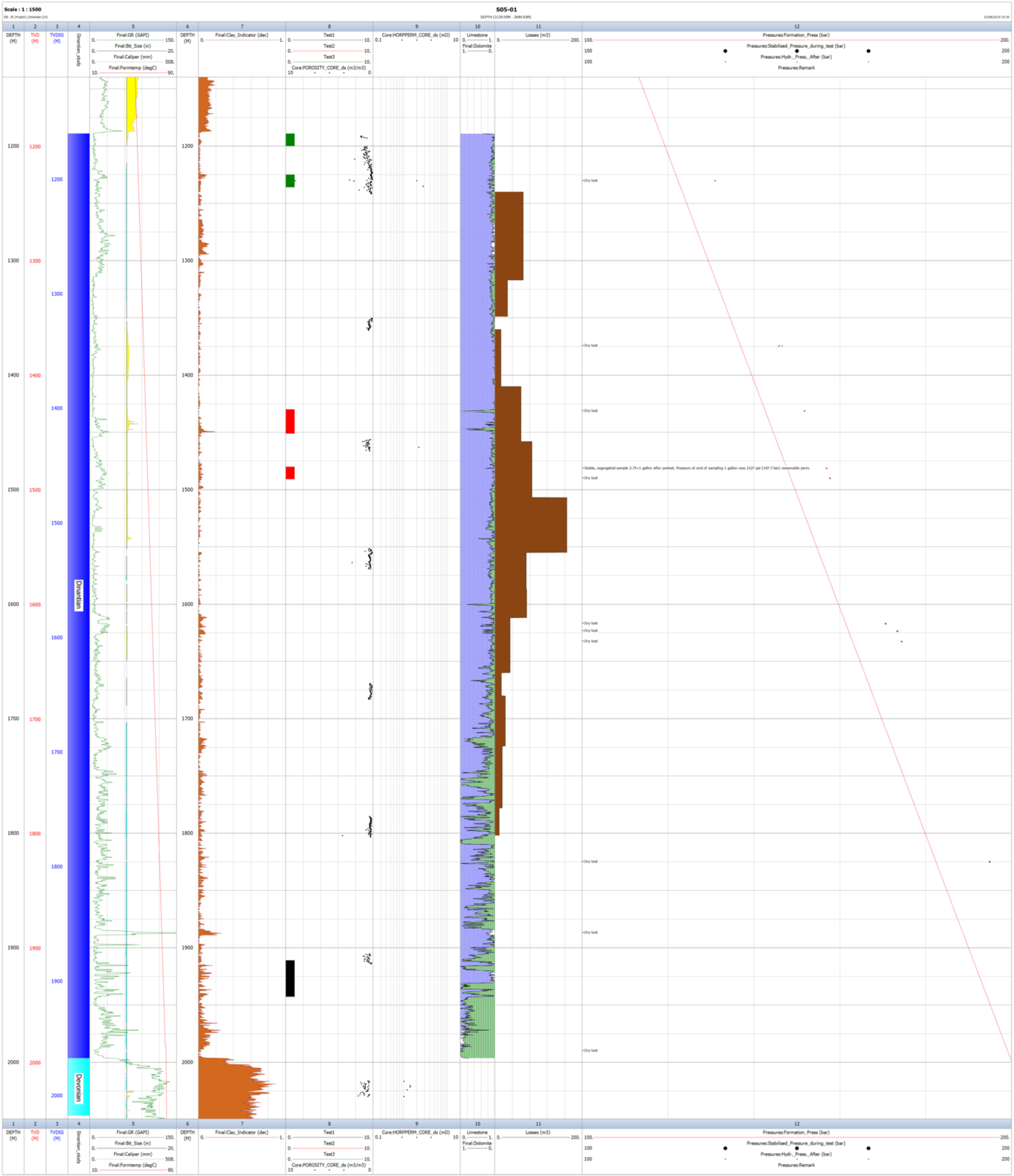
2015-2215 m: Formtemp = 60.58+0.01003*TVDss (deg C)

The maximum temperature measured at approximately 840 m was 40 C and with the above equation for the interval 0-1085 m a temperature of 40.5 C is calculated and this is probably slightly on the low side but fully acceptable and much better than what is calculated if a straight-line equation is done between TD and surface, which would result in a calculated temperature at this depth of 35.1 C, clearly too low. In many of the other Dinantian wells, there is often only a formation temperature calculated for TD, due to lack of intermediate data, and therefore a single gradient from surface to TD. This probably results in an underestimation of the temperature at intermediate depths in those wells.

Evaluation plot



Pressure plot S05-01



Well logging summary S05-01

WELL LOGGING SUMMARY

OPERATOR:	NAM- Netherlands
WELL:	SO5-01
WELL BORE:	SO5-01
FIELD:	SO5
PLATFORM:	offshore
COUNTRY:	NETHERLANDS
DRILL PERMIT #:	
WELL STATUS:	P and A

Hole section:	File name:	Main Service:	Generic Logs	Service Company:	Mode:	Run #:	Sub file:	Run Type	Pass Direction (Up/Down)	Date:	Interval Top (m):	Interval Bot (m):	Remarks:
8 3/8"	SL 1	GR-ISF-LSSL	GR-IND-Long Spaced Sonic Log	SCHLUMBERGER	EWL	1	1	Main	Up	27-MAY-1981	87.5	302.7	
8 3/8"	FDC 1	GR-FDC-CNL	GR-DEN-NEU	SCHLUMBERGER	EWL	1	2	Main	Up	27-MAY-1981	87	304	
17 1/2"	SL 2	GR-ISF-LSSL	GR-IND-Long Spaced Sonic Log	SCHLUMBERGER	EWL	2	3	Main	Up	03-JUN-1981	299	850.5	
17 1/2"	FDC 2	GR-FDC	GR-DEN	SCHLUMBERGER	EWL	2	4	Main	Up	03-JUN-1981	299	846	
12 1/4"	SL 3	GR-ISF-LSSL	GR-IND-Long Spaced Sonic Log	SCHLUMBERGER	EWL	3	5	Main	Up	07-JUN-1981	849.5	1317.6	
12 1/4"	SL WFT 1	GR-SWF-VDL	GR-Sonic Wave Forms-Variable Density Log	SCHLUMBERGER	EWL	3	6	Main	Up	07-JUN-1981	849.5	1094.5	
12 1/4"	FDC 3	GR-FDC-CNL	GR-DEN-NEU	SCHLUMBERGER	EWL	3	7	Main	Up	07-JUN-1981	849.5	1099	
8 3/8"	LL 1	GR-DLL-MSFL	GR-Dual Laterolog-MSFL	SCHLUMBERGER	EWL	4	8	Main	Up	30-JUN-1981	1097	2028.5	
8 3/8"	FDC 4	GR-LDT-CNL	GR-DEN-NEU	SCHLUMBERGER	EWL	4	9	Main	Up	30-JUN-1981	1097	2028,0	
8 3/8"	SL 4	GR-ISF-LSSL	GR-IND-Long Spaced Sonic Log	SCHLUMBERGER	EWL	4	10	Main	Up	30-JUN-1981	1097	2026,0	
8 3/8"	HDT 1	GR-4 arm Diplog	GR-DIP Log	SCHLUMBERGER	EWL	4	11	Main	Up	30-JUN-1981	1097	2027.5	
8 3/8"	HDT FIL 1	Fracture identification log from Dip Log	Diplog	SCHLUMBERGER	EWL	4	12	Main	Up	30-JUN-1981	1097	2027.5	
8 3/8"	LL 2	GR-DLL-MSFL	GR-Dual Laterolog-MSFL	SCHLUMBERGER	EWL	4	13	Main	Up	30-JUN-1981	1096	2027.5	
8 3/8"	FDC 5	GR-LDT-CNL	GR-DEN-NEU	SCHLUMBERGER	EWL	4	14	Main	Up	30-JUN-1981	1097	2229.5	
8 3/8"	SL 5	GR-ISF-LSSL	GR-IND-Long Spaced Sonic Log	SCHLUMBERGER	EWL	4	15	Main	Up	30-JUN-1981	1990	2227,0	
8 3/8"	SL WFT 2	GR-SWF-VDL	GR-Sonic Wave Forms-Variable Density Log	SCHLUMBERGER	EWL	4	16	Main	Up	30-JUN-1981	1175	1600,0	
8 3/8"	NGT 1	GR Spectral	GR-Spectral	SCHLUMBERGER	EWL	4	17	Main	Up	30-JUN-1981	1097	2227,0	
8 3/8"	HDT 2	GR-4 arm Diplog	GR-DIP Log	SCHLUMBERGER	EWL	4	18	Main	Up	30-JUN-1981	1992	2228.5	

Appendix: Horner plots

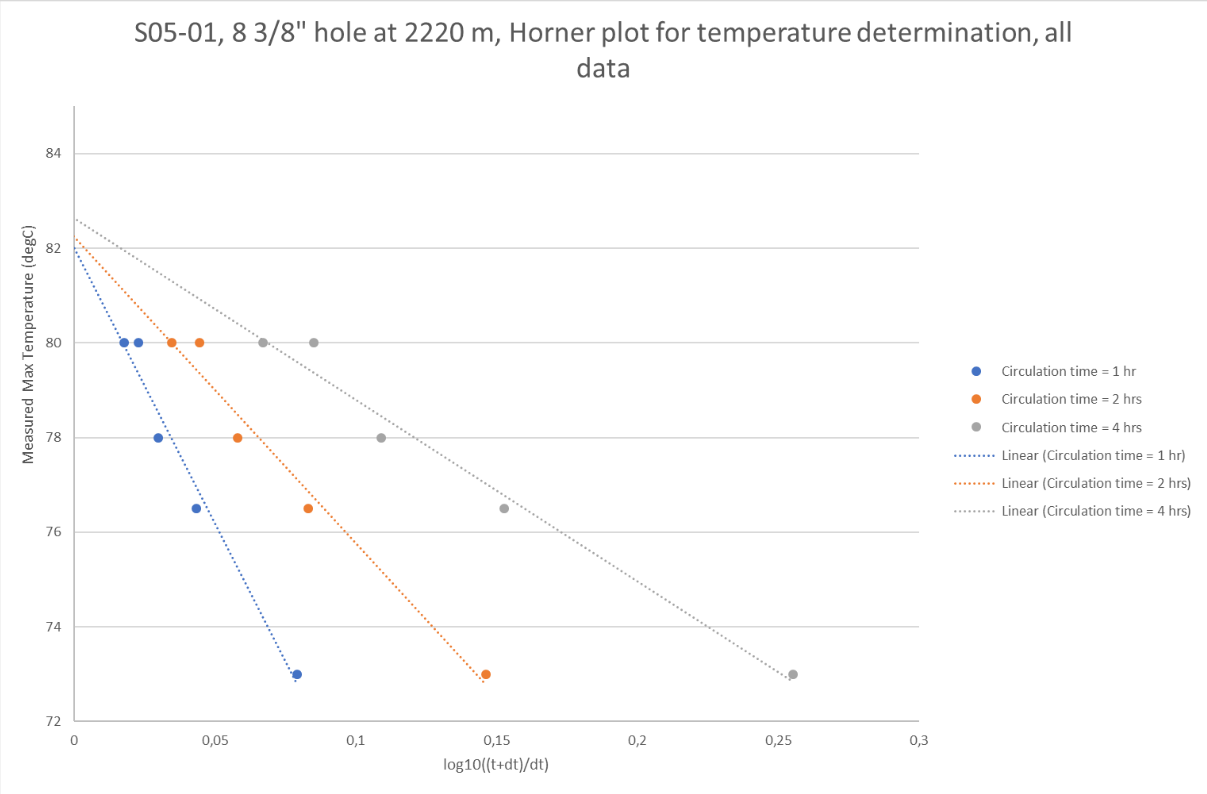


Figure 1. Horner plot at 2220m

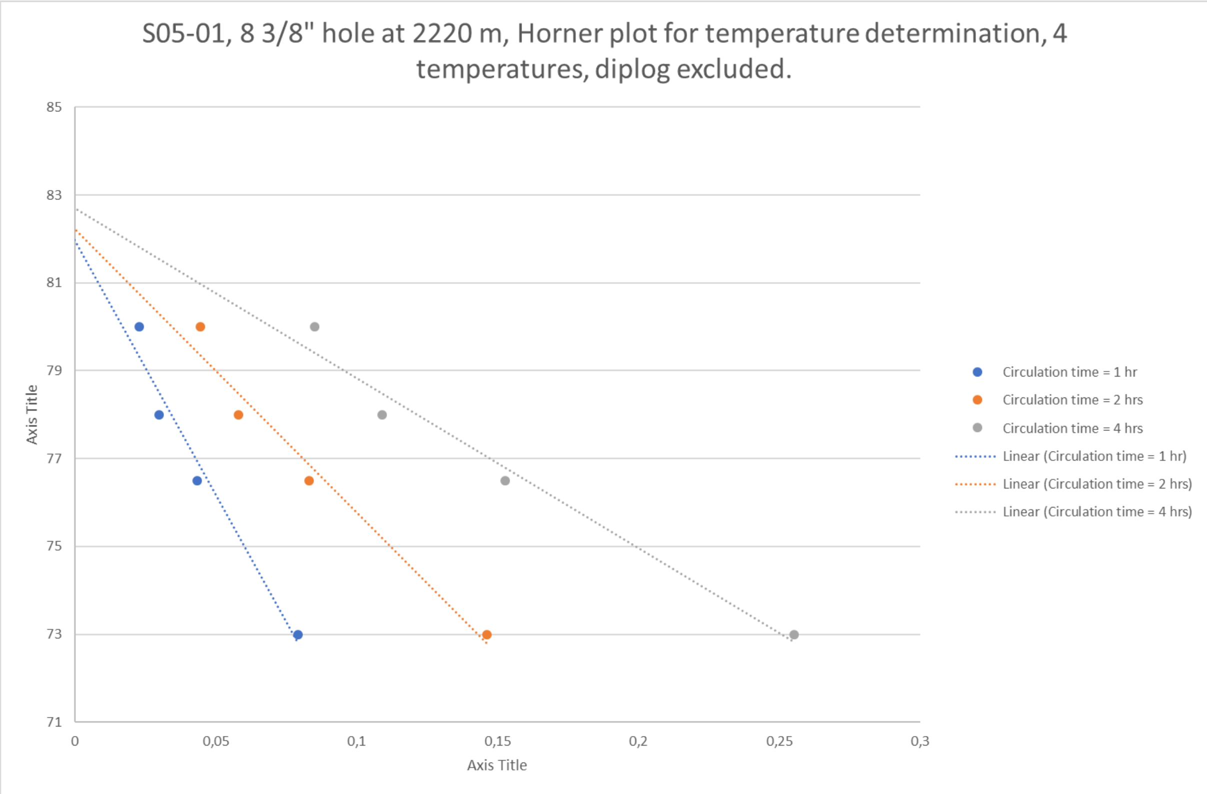


Figure 2. Horner plot at 2220m

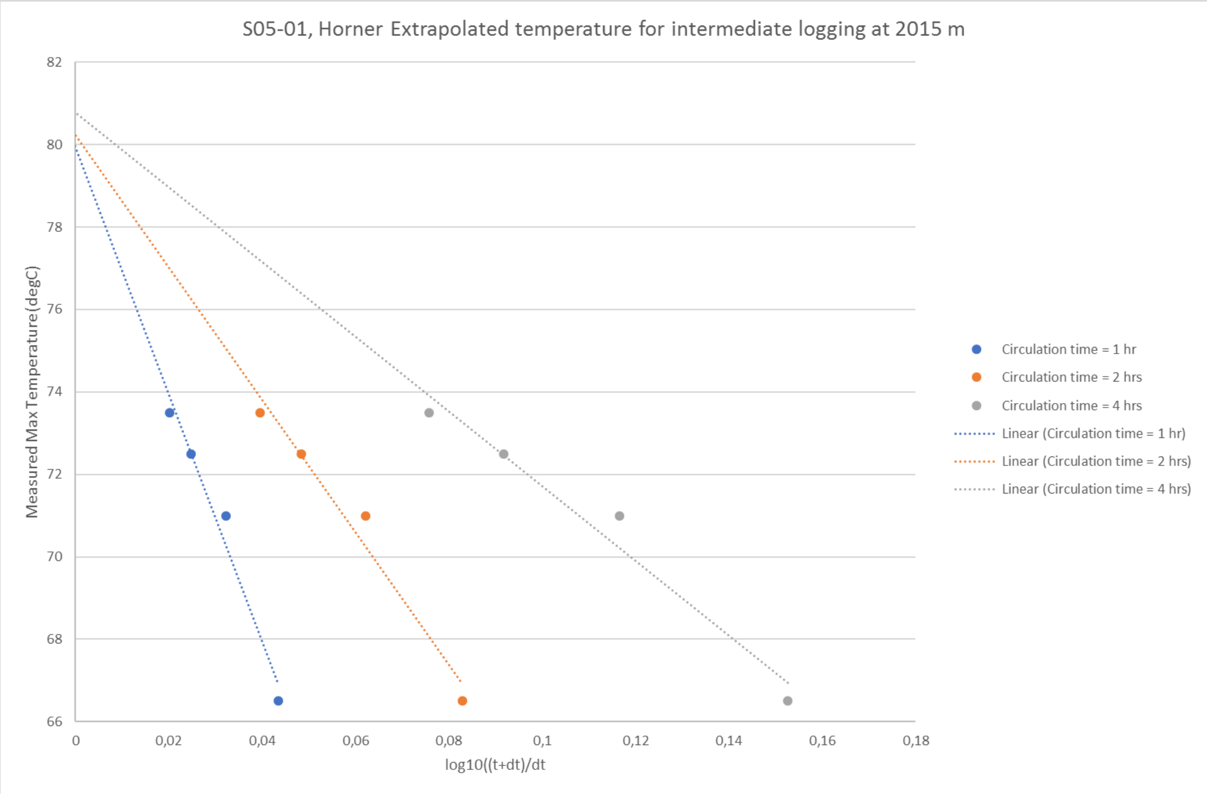


Figure 3. Horner plot at 2015m

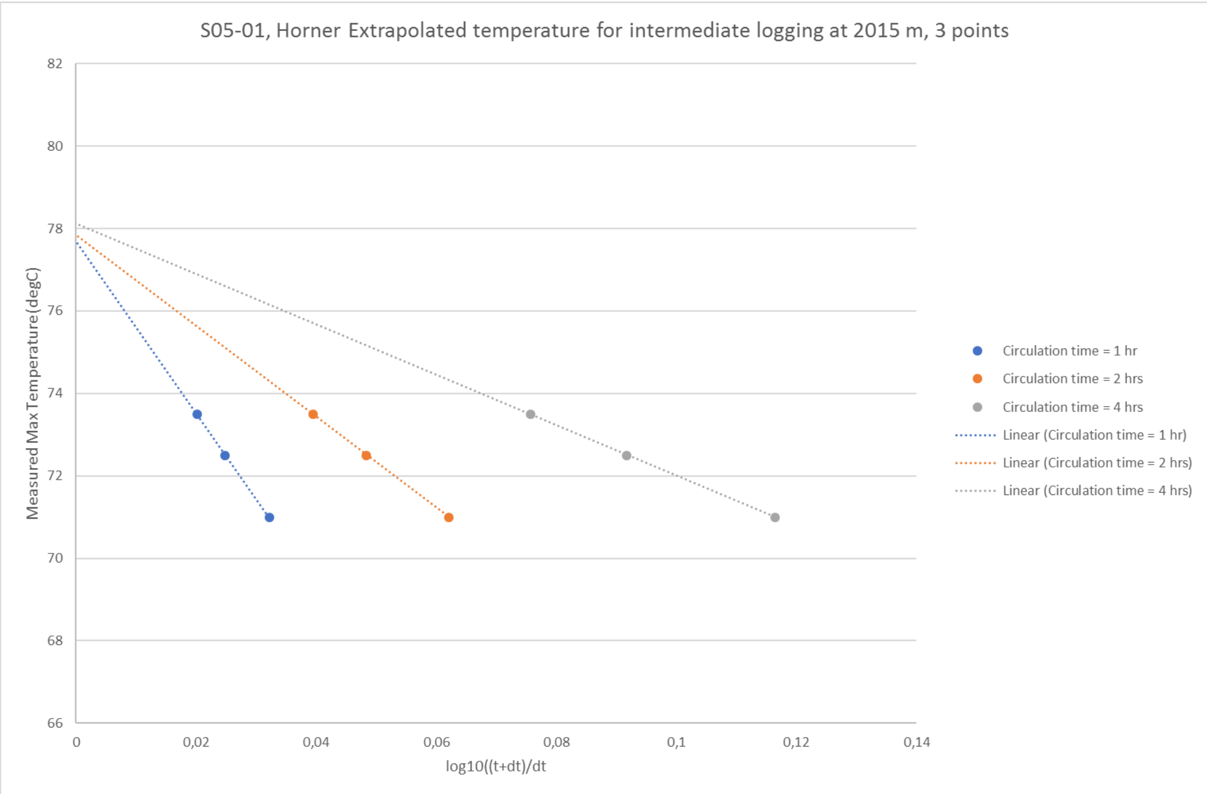


Figure 4. Horner plot at 2015m

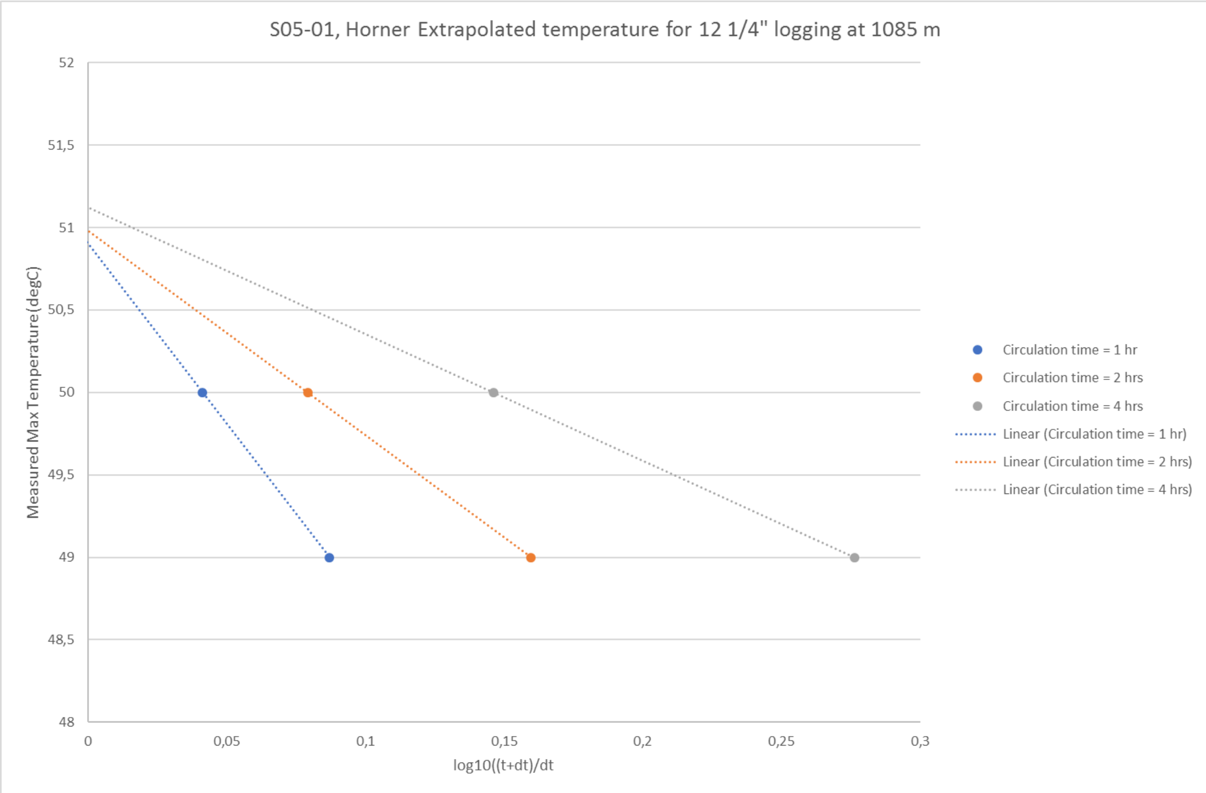


Figure 5. Horner plot at 1085m

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