Petrophysical Report of the Dinantian Carbonates in the Dutch Subsurface

Report by SCAN

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Ministerie van Economische Zaken en Klimaat
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Contents

WELL DATA UHM-02 3
Dinantian evaluation in UHM-02 (4682-5344 m MD) 4
Log quality, edits and depth shifts 4
Log corrections 4
Evaluation of Dinantian (4682-5344 m MD) 4
Result 5
Discussion 6
Core data 7
Flow Potential 7
Well test 7
Wireline formation tester (MDT and RFT) 7
Formation temperature 8
Evaluation plot 11
Pressure and Temperature plot 12
Well logging summary UHM-02 13
Appendix : Water analysis of formation water from the Dinantian in UHM-02 (sampled with MDT at 5154.5 m) 14
Appendix: Gas analysis of small amount of gas from water sample at 5154.5 m in in UHM-02. 17
Appendix: Analysis of the gas phase 18
Appendix: Horner plots 21

Report by Torbjörn Carlson

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

WELL DATA UHM-02

Company Name: NAM

Well Name: UHM-02

Field Name: Uithuizermeeden

Country: The Netherlands

Field Location: onshore

Geological targets: Dinantian

Longitude: 06*48’28.975” E

Latitude: 53*26’59.339”

Maximum Hole Deviation: 274 (deg) log header

Elevation of Kelly Bushing: 11.57m NAP

Elevation of Ground Level: top cellar 1.95m

Elevation of Derrick Floor RT: 11.57m NAP

Permanent Datum: in m NAP

Elevation of Permanent Datum: Ground level

Log Measured from: 2746 m to TD

Spud date: 27-Nov-2001

Abandoning date: 16-JUN-2002

Maximum recorded Temperature: 208 deg C

TD: 5435mAH

Dinantian evaluation in UHM-02 (4682-5344 m MD)

Log quality, edits and depth shifts

The logs in the 8 ½" hole are of high quality thanks to very good hole conditions.

The GR and Neutron from the composite logs (from NLOG) have been used as they are. The density and the sonic from the composite have been edited to fill gaps between runs. The density has been edited some sections above the Dinantian with poor data due to rugose borehole.

The other logs, not included in the composite log set (Induction resistivity, Spectral GR, Caliper etc.) have been shifted to match the composite logs and spliced together from the two runs made in the 8 ½" hole.

Log corrections

The neutron curve (APLC) in the carbonate interval (Dinantian) has a slightly too low mode of -0.005 and the mode should be slightly positive and therefore a correction of 0.007 has been added to the neutron curve. A slightly higher value could be argued but considering that most of the limestone is tight, also based on the other logs, it is natural that there are many slightly negative neutron (APLC) values

Evaluation of Dinantian (4682-5344 m MD)

Porosity has been calculated primarily from x-plot porosity of the density and the corrected neutron (APLC) curve. Alternative x-plot porosity from sonic and corrected neutron has been calculated as well as porosity from the sonic (dtma=160 us/m and dtfl=620 us/m) and density using a matrix density of 2710 kg/m3 (Limestone) and a fluid density of 1190 kg/m3 based on the water analysis, see Appendix 2. The different porosities agree closely except where the rock is more dolomitic. The final porosity is the density-neutron x-plot porosity. Due to whole mud invasion in the most porous sections, 5163-5165 m and 5247-5252 m, the porosity evaluation is more uncertain in these sections, and the actual porosity may be higher or lower than calculated.

Limestone and Dolomite proportions have been based on the apparent matrix density from the density-neutron (APLC) cross plot with the following densities of Limestone and Dolomite corrected for Clay Indicator:

Limestone: Rhoma = 2710 kg/m3

Dolomite: Rhoma = 2850 kg/m3

This result in the following equation:

Limestone proportion = 20.36 – 0.007143 * Rhoma_apparent (Rhoma_app)*(1-Clay_Indicator)

Dolomite proportion = 1 – (Limestone proportion+Clay_Indicator)

A calculation of Limestone and Dolomite proportions were also made with the apparent matrix slowness (Dtma_app), with a similar result.

A clay indicator has been calculated based on the Potassium curve from the spectral GR with no clay corresponding to a value of 0.0005 and 100 % clay 0.05 (5 %), resulting in the following equation:

Clay Indicator = -0.0101 + 20.2 * Potassium concentration

Based on the Clay Indicator, a shale cut off of 0.1 has been used for cutting off porosity (porosity = 0 when clay indicator exceeds 0.1)

Result

The result of the evaluation can be seen in the log evaluation plot. In the evaluation track 11 is the Clay Indicator, in track 12 the porosity on a 0 to 30 % scale and in track 13 the porosity on a 0 to 10 % scale. In track 14 is the core permeability and in track 15 is the calculated lithology described in this report 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 Porosity*Net	Porosity cut-off
MD	MD	MD					
m	m	fract	fract	fract	m	fract	fract
662,0	650,90	0,983	0,008	0,011	5,24	1,00	0,00
662,0	96,32	0,145	0,034	0,012	3,32	0,63	0,01
662,0	35,81	0,054	0,071	0,012	2,53	0,48	0,02
662,0	25,45	0,038	0,089	0,012	2,27	0,43	0,03
662,0	20,42	0,031	0,103	0,013	2,10	0,40	0,04
662,0	16,61	0,025	0,116	0,013	1,93	0,37	0,05
662,0	13,41	0,020	0,131	0,015	1,75	0,33	0,06
662,0	10,82	0,016	0,146	0,016	1,58	0,30	0,07
662,0	9,75	0,015	0,154	0,017	1,51	0,29	0,08
662,0	8,38	0,013	0,166	0,018	1,39	0,27	0,09
662,0	7,62	0,012	0,173	0,018	1,32	0,25	0,10
662,0	6,71	0,010	0,182	0,019	1,22	0,23	0,11
662,0	5,94	0,009	0,191	0,020	1,13	0,22	0,12
662,0	5,64	0,009	0,194	0,020	1,09	0,21	0,13
662,0	4,57	0,007	0,208	0,021	0,95	0,18	0,14
662,0	3,96	0,006	0,217	0,023	0,86	0,16	0,15
662,0	3,51	0,005	0,226	0,024	0,79	0,15	0,16
662,0	3,35	0,005	0,228	0,024	0,77	0,15	0,17
662,0	2,74	0,004	0,240	0,024	0,66	0,13	0,18
662,0	2,44	0,004	0,247	0,024	0,60	0,11	0,19
662,0	1,83	0,003	0,263	0,028	0,48	0,09	0,20
662,0	1,52	0,002	0,274	0,032	0,42	0,08	0,21
662,0	1,52	0,002	0,274	0,032	0,42	0,08	0,22
662,0	1,52	0,002	0,274	0,032	0,42	0,08	0,23
662,0	1,52	0,002	0,274	0,032	0,42	0,08	0,24
662,0	1,52	0,002	0,274	0,032	0,42	0,08	0,25
662,0	0,91	0,001	0,287	0,033	0,26	0,05	0,26
662,0	0,76	0,001	0,290	0,032	0,22	0,04	0,27
662,0	0,61	0,001	0,295	0,032	0,18	0,03	0,28
662,0	0,30	0,000	0,305	0,037	0,09	0,02	0,29
662,0	0,30	0,000	0,305	0,037	0,09	0,02	0,30
662,0	0,00	0,000			0,00	0,00	0,31

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.

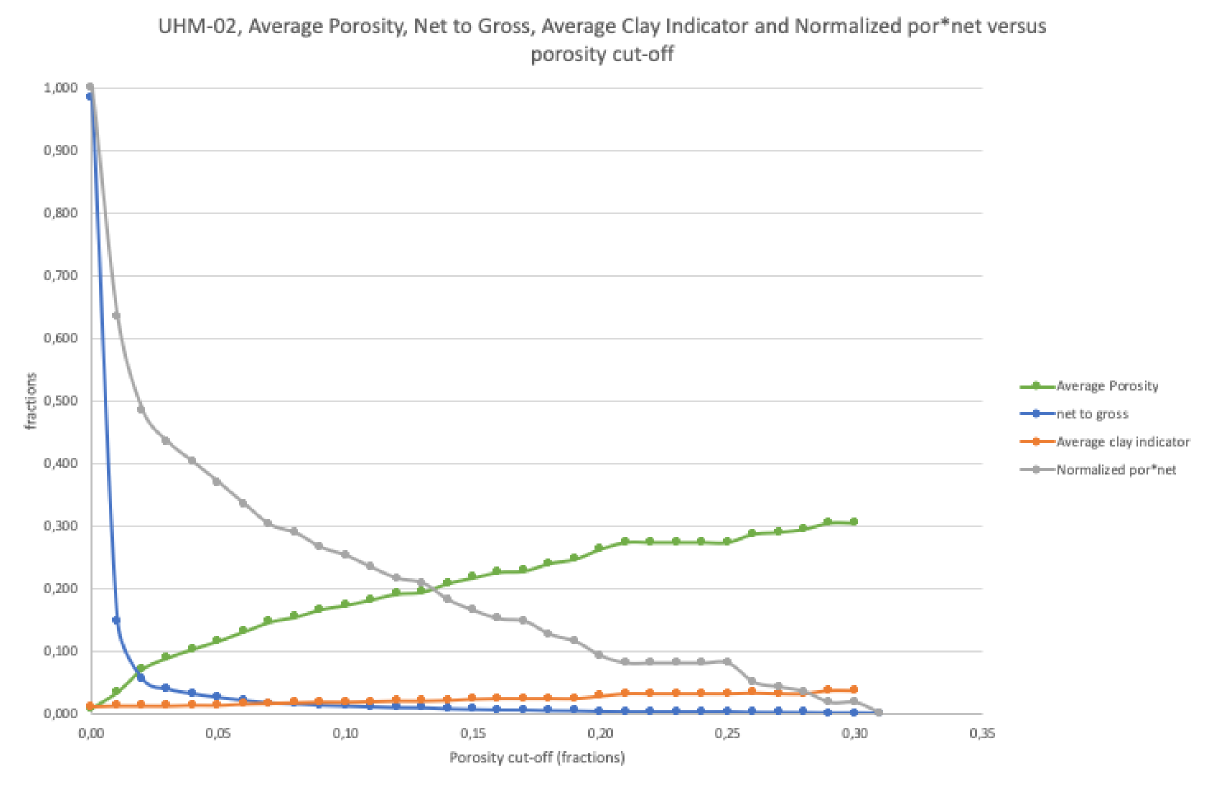


Figure 1. Average porosity, net-to-gross, clay indicator and normalized porosity*net thickness for increasing porosity cut-off

The graph illustrates the rapid decrease in net to gross, while the product of average porosity and net (Normalized por*net) initially drops rapidly and then declines more gradually with increasing porosity cut-off. The reason for the product of average porosity and net declines more gradually is that the average porosity increases rapidly initially up to a porosity cut-off of 0.02 and thereafter more gradually. The high porosity intervals have a large impact on the shape of the product of net*gross and creates a long tail above 20 % porosity.

The average porosity with no porosity cut-off is low in this well with a value of 0.8 %. The shale cut-off is relatively stable in this well with only a slow increase with porosity cut-off. The increase in shale with the higher porosity is an indication that there is a bit more clay in the high-end porosity. This may be an indication of clay associated with karsting but there could be other reasons.

Discussion

Overall the porosity is very low and in many intervals the rock has no porosity.

In the upper part of the Dinantian, at 4729 m and at 4757 m, there are two prominent shales. The lower one is confirmed by the core, which has a blackish shale at the top. These shales have high Thorium and high Potassium, as well as high Uranium. The interpretation is that these are shales, either of tuffaceous or anoxic origin (the origin will be determined by analysis by the geologists). There are some more, minor shales, in the upper part with elevated Thorium and Potassium content. However, these are not as prominent, probably because they are thinner.

Further down in the Dinantian there are high GR intervals, but these are almost exclusively caused by high Uranium concentrations, except the last few meters where there seem to be a mixed lithology of limestone and shale. The base appears to be a transgression from shale/silt into carbonate and the base of the Dinantian could be deeper than presently determined (5344 m). The acoustic impedance contrast is however at 5343-5344 m, corresponding to the present base of the Dinantian.

At 5165 m there is a very high porosity interval, up to 30 %, with very low resistivity and at 5250 m there is thicker high porosity interval. Both these intervals show high PEF and a slightly anomalous density correction indicating that there is an aggregation of baryte from the mud. However, there is no caliper indication that there is a mudcake build up and it is therefore likely that these anomalies are caused by whole mud entering the rock and that the mud cake is inside the rock. This would then most likely be explained by a karsted interval or an interval with large to very large vugs. However, it cannot be excluded that the high PEF is caused by Baryte in the actual rock, so the explanation with Baryte from the mud causing the anomalies could be wrong. Another relative high porosity interval is found at 5155 m. The high porosity intervals are associated with dolomite.

Indications are that the high porosity intervals are permeable and the permeability may even be very high (more than 100 mD, possibly more than 1 D).

A strange feature is that there are some long intervals with surprisingly low resistivity, although the porosity is very low. The first such interval is 4836-5007 m, the second 5119-5144, the third 5264-5333 m. The low resistivity is associated with elevated Uranium content and in some places with many Uranium spikes. This could indicate fractures and another possibility is dispersed conductive minerals, something that has a prominent influence on induction tools.

Core data

The interval 4751-4758 m was cored with a core recovery of 98 %. The core has been shifted down by 5.9 m based on the shale at the top of the core and the core porosity signature below the shale fits relatively well to the log porosity. All permeabilities measured are below 1 mD and if corrected to in situ conditions it is likely that all permeabilities would be reduced by a factor of 10.

Flow Potential

Well test

No well test was performed in this well.

Wireline formation tester (MDT and RFT)

SRFT pressure tests on 8 April 2002 in 5 7/8” hole down to 4848 m. Max recorded temperature 195 C.

File No	Depth	Hydr. Press. Before	Hydr. Press. After	Stabilized Pressure during test	Remark
	m	bar	bar	bar	
296	4699.7	676.7	676.9		Dry test
297	4699.0	676.8	677.2		Dry test
298	4699.5	677.0	677.2		Dry test
299	4704.8	677.9	678.2		Dry test
300	4705.0	677.9	678.2		Dry test
301	4704.5	677.8	678.0		Seal Failure
302	4739.6	683.0	683.4		Seal Failure
303	4740.0	683.1	683.2		Seal Failure
308	4704.9	679.6	679.4		Dry test
310	4739.6	683.2	683.3		Seal Failure
315	4758.9	685.3	685.5		Dry test
316	4758.5	685.1	685.4		Seal Failure
317	4759.5	685.7	684.4		Seal Failure
318	4760.5	686.1	686.6		Seal Failure
319	4758.9	686.1	686.3		Dry test
320	4761.0	686.7	687.0		Dry test

321	4762.0	686.8	686.9		Seal Failure
322	4774.5	688.6	688.9		Dry test
325	4826.4	696.6	696.7		Seal Failure
326	4826.9	696.5	696.6		Seal Failure
327	4826.0	696.6	695.3		Seal Failure

All tests are either dry (no flow at all) or seal failures.

MDT pressure test on 10 May 2002 in 5 7/8” hole at 5154.5 m. Max recorded temperature 205 C. After the pressure test a sample was taken at this point into a 2 ¾ gallon chamber.

File No	Depth	Hydr. Press. Before	Hydr. Press. After	Stabilized Pressure during test	Mobility	Remark
	m	bar	bar	bar	mD/cP	
487	5154.5	729.2		706.9	77.3	Almost stable

This is the only valid formation pressure recorded in the Dinantian section of UHM-02. The mobility is good, and the pressure stabilized quickly. The pressure was recorded with a strain gauge due to the high temperature and the accuracy is not as high as for quartz gauges.

The pressure taken at 5154.5 m (5141.9 m TVDss) of 706.9 bar result in a pressure gradient of 0.1373 bar/m corresponding to a density of 1400 kg/m3. The overpressure using a normal gradient of 0.1010 bar/m, corresponding to sea water with a density of 1030 kg/m3, the overpressure is 178 bar. With higher fluid density the overpressure would be reduced and if the extreme density of the fluid in the reservoir, 1197 kg/m3 (0.1174 bar/m), is used to calculate the overpressure, it would be 103 bar.

The fluid and gas sample analysis are attached to this report, Appendix 1 and 2. The analyses show that the formation water is a salt-saturated brine and that it has a very high content of metals, where the most important ones are Zink and Lead. It has also high concentrations of Cadmium and Barium, both very troublesome elements. It is highly likely that these elements would cause very large problems in any production of the water (scaling etc.) and from an environmental point of view, the waters would have to be either re-injected as is or that some of the elements would have to be removed before the formation water would be re-injected.

The MDT fluid sample analysis does not indicate the presence of H_2S. However, during drilling minor indications of H_2S were reported near TD. Therefore, the H_2S presence in the UHM-02 well remains unclear.

It is recommended that a specialist reviews the sample analysis and that the review includes an assessment on production issues with this composition.

Formation temperature

Table showing the maximum temperatures from the TD logging run in UHM-02. (5 7/8” hole).

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(deg C)
GR/BHC	5425	28/5/2002	17.25	208
GR/HIT	5420	29/5/2002	22.25	208
HLDS/HNGS	5420	29/5/2002	28	208
CNL/XAPS/GR	5415	29/5/2002	35	208

It is quite certain that in this suite of logs, only the maximum temperatures have been recorded on the first run and that this temperature has been copied in to the other log runs. All three thermometers have a temperature of 208 C recorded on all runs.

On an MDT sampling run on 10/5/2002 with sampling at 5154.5 m and a temperature of 205 C was measured 23 hrs after circulation. One advantage this measurement has is that it was at the sampling depth for some time, probably 1 hr or so, while most of the other runs probably were on bottom a minimal amount of time, to safeguard against tool failures.

Table showing the maximum temperatures from the intermediate logging run in UHM-02 at 5338 m (5 7/8" hole).

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(deg C)
HIT/HSLT/HTGC	5315	24/4/2002	14.75	206
CNL/HLDS/XAPS/HNGS	5305	24/4/2002	22	207

Horner extrapolation of this data result in a formation temperature of 209,2 deg C.

Table showing the maximum temperatures from the intermediate logging runs at 5226 m in UHM-02 (5 7/8" hole).

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(deg C)
OBDT/GR/BHC	5200	17/4/2002	23.25	205
CNL/HLDS/XAPS/HNGS	5200	18/4/2002	31.5	205
GR/HIT	5210	18/4/2002	40.5	206

Horner extrapolation of this data result in a formation temperature of 207 deg C.

Table showing the maximum temperatures from the intermediate logging runs at 4856 m in UHM-02 (5 7/8" hole).

Log	Depth	Log date	Time since circ.	Max Temp
	(m)		(hrs)	(deg C)
AIT/DSI/CAL/GR	4810	8/4/2002	28	185
CNL/HLDS/XAPS/HNGS	4830	8/4/2002	37	192
SRFT	4825	9/4/2002	42.5	195

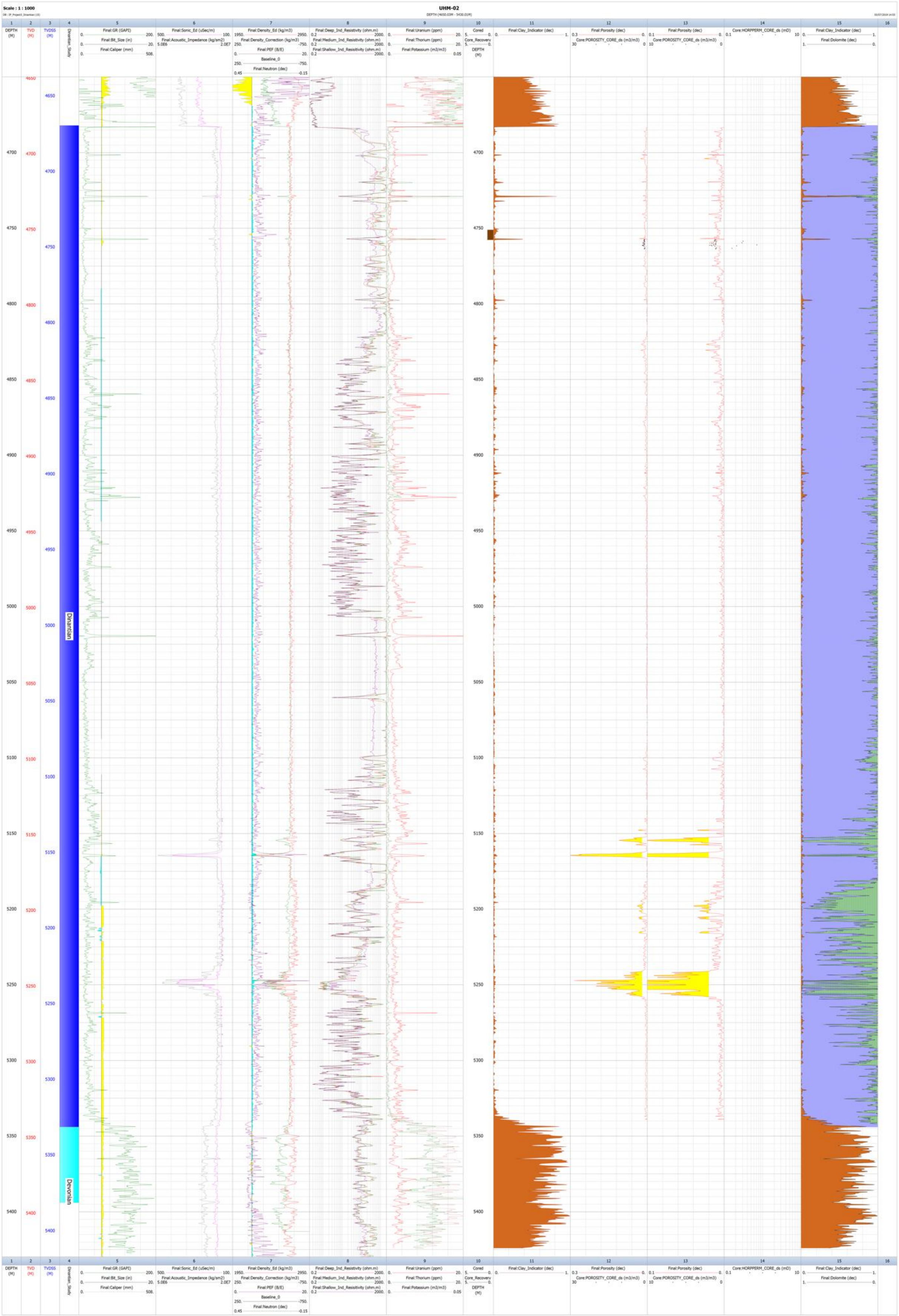
This set of data is not believable because the temperature increases too much between logging runs and the extrapolated Horner temperature is too high for this depth, when compared to the other temperature measurements in the well. In a 5 7/8" hole, the circulation rates are low and the cooling effect limited. Therefore, the borehole temperature will be close to the formation temperature relatively fast (1-2 days). The resulting Horner extrapolated formation temperature is 215 deg C, much too high compared to the deeper recordings. Another odd thing is that the recorded temperatures line up too well on the Horner plot to be correct, it looks as if they were constructed.

For the logging of the 8.5" hole, at approximate 4610 m on 5 March 2002, a temperature of 172 C was recorded on the print for all runs. It is probably the same as for the TD runs, that the temperatures where copied from one run to the next. In an 8 ½" hole, the circulation rates are high and the cooling is efficient and therefore clear temperature differences between runs are expected. This temperature is therefore much lower than the formation temperature at this depth.

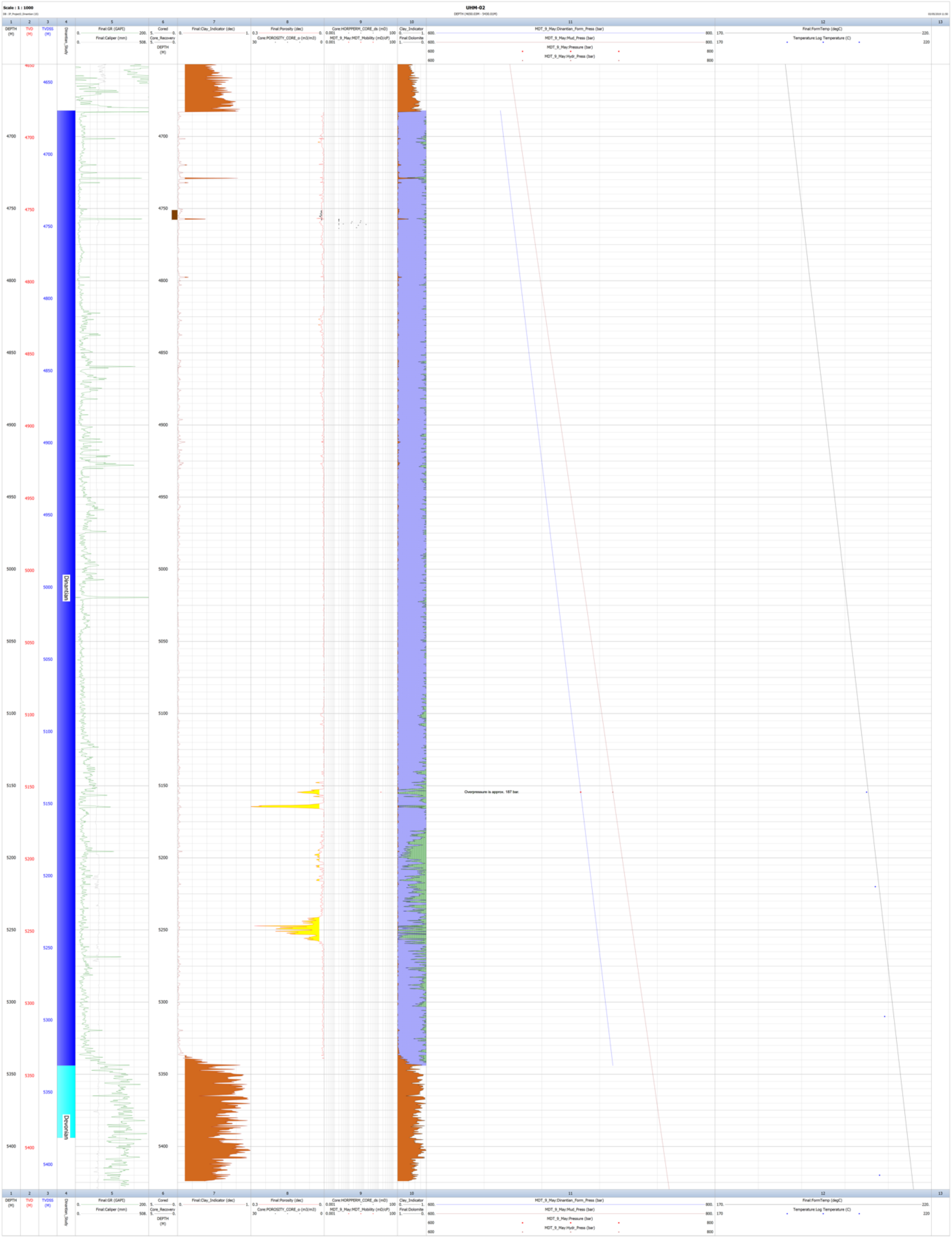
On the two logging runs in the 8.5” hole on 25 Feb 2002 at 4505 m, a temperature of 163 C was recorded on both runs with a high likelihood that the maximum temperatures were recorded on the first run and then copied to the second run.

Based on the temperature measured with the MDT pressure testing and sampling at 5154.5 m (205 deg C) and the extrapolated temperatures at 5220 m (207 deg C) and 5310 m (209.2 deg C) a temperature gradient of 0.038 deg C/m with a 10 deg C surface temperature fits these 3 points well. The other temperature measurements are clearly too low.

Evaluation plot



Pressure and Temperature plot



Well logging summary UHM-02

OPERATOR:	NAM- Netherlands
WELL:	UITHUIZERMEEDEN-2
WELL BORE:	UHM-02
FIELD:	UITHUIZERMEEDEN
PLATFORM:	onshore
COUNTRY:	NETHERLANDS
DRILL PERMIT #:	
WELL STATUS:	P and A

WELL LOGGING SUMMARY

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 1/2"		GR-LDS-APS-DSI	GR-DEN-NEU-SON	SCHLUMBERGER	EWL	1	1	Main	Up	25-FEB-2002	3239	4504.5	HTHP
8 1/2"		IPLT-HGNS-LDS-AIT	GRSpec-NEU-DEN-IND	SCHLUMBERGER	EWL	2	1	Main	Up	05-MAR-2002	4536.4	4632.4	HTHP
8 1/2"		AIT-AS-GR	Array Induction-Sonic	SCHLUMBERGER	EWL	3	1	Main	Up	05-MAR-2002	2746.5	4643.4	HTHP-GR-SON up to 4537.7m
8 1/2"		MSCT-GR	Sidewall coring	SCHLUMBERGER	EWL	4	1	Main	Up	06-MAR-2002	4169.8	4703.6	HTHP
8 1/2"		MDT-GR	WFT-GR	SCHLUMBERGER	EWL	5	1	Main	Up	06-MAR-2002	3449	4527.5	HTHP
8 1/2"		MSCT-GR	Sidewall coring	SCHLUMBERGER	EWL	6	1	Main	Up	07-MAR-2002	3814.5	4620.0	HTHP
5 7/8"		GR-AIT-DSI-CAL	IND-SON	SCHLUMBERGER	EWL	7	1	Main	Up	08-APRIL-2002	4577.0	4850.0	HTHP
5 7/8"		CNL-LDS-APS-HNGS	NEUT-DEN-SPECGR	SCHLUMBERGER	EWL	8	1	Main	Up	08-APRIL-2002	4623.0	4850.0	HTHP
5 7/8"		SRFT-GR	Slimhole WFT-GR	SCHLUMBERGER	EWL	9	1	Main	Up	09-APRIL-2002	4699.0	4826.9	HTHP
5 7/8"		GR-XSLT-HOBDT	SON-OBM Imager	SCHLUMBERGER	EWL	10	1	Main	Up	17-April-2002	4622.5	5225.0	HTHP
5 7/8"		CNL-HLDS-XAPS-HNGS	NEU-DEN-SPECGR	SCHLUMBERGER	EWL	11	1	Main	Up	18-April-2002	4622.5	5227.0	HTHP
5 7/8"		HIT-GR	IND-GR	SCHLUMBERGER	EWL	12	1	Main	Up	18-April-2002	4622.5	5226.0	HTHP
5 7/8"		MDT-GR	WFT-GR	SCHLUMBERGER	EWL	13	1	Main	Up	19-April-2002		5140.5	HTHP
5 7/8"		CNL-HLDS-XAPS-HNGS	NEU-DEN-SPECGR	SCHLUMBERGER	EWL	14	1	Main	Up	24-April-2002	5034.8	5338.7	HTHP
5 7/8"		GR-XSLT-HIT	GR-SON-IND	SCHLUMBERGER	EWL	15	1	Main	Up	24-April-2002	4803.2	5340.7	HTHP
5 7/8"		MDT-GR	WFT-GR	SCHLUMBERGER	EWL	16	1	Main	Up	10-May-2002		5154.5	HTHP
5 7/8"		HOBDT-GR	GR-OBM Imager	SCHLUMBERGER	EWL	17	1	Main	Up	18-May-2002	5126.0	5268.0	HTHP
5 7/8"		MDT-GR	WFT-GR	SCHLUMBERGER	EWL	18	1	Main	Up	19-May-2002	4705.0	4835.0	HTHP
5 7/8"		MDT-GR	WFT-GR	SCHLUMBERGER	EWL	19	1	Main	Up	19-May-2002		4760.0	HTHP
5 7/8"		GR-XSLT	GR-SON	SCHLUMBERGER	EWL	20	1	Main	Up	28-May-2002	5191.3	5434.5	HTHP
5 7/8"		GR-HIT	GR-IND	SCHLUMBERGER	EWL	21	1	Main	Up	29-May-2002	5169.4	5434.5	HTHP
5 7/8"		LDS-HNGS	DEN-SpecGR	SCHLUMBERGER	EWL	22	1	Main	Up	29-May-2002	5157.5	5434.5	HTHP
5 7/8"		HNGS-CNTH-XAPS	SpecGR-NEU	SCHLUMBERGER	EWL	23	1	Main	Up	29-May-2002	5182.7	5434.5	HTHP
5 7/8"		GR-CST	GR-Core sample tool	SCHLUMBERGER	EWL	24	1	Main	Up	30-May-2002	5316.8	5416.3	HTHP
5 7/8"		GR-CST	GR-Core sample tool	SCHLUMBERGER	EWL	25	1	Main	Up	30-May-2002	5070.0	5386.0	HTHP
5 7/8"		GR-CST	GR-Core sample tool	SCHLUMBERGER	EWL	26	1	Main	Up	30-May-2002	4660.0	5364.0	HTHP

Appendix : Water analysis of formation water from the Dinantian in UHM-02 (sampled with MDT at 5154.5 m)

Request number	LR2002050035
File name	05-035A.DOC
Additional report	Additional analyses performed to acquire basic data

Sampling conditions:

Reservoir pressure and temp:	706.4 bar, 205 °C
Sample bottle number:	2 ¾ Gallon MDT sample chamber ex Schlumberger
Sampled well, at depth	UHM 2, at 5154.5 m AHORT
Date of sampling	10-05-2002

<u>Analysis of the water.</u>

Density	1.197	kg/l	at 22.6 °C
pH	6.4		
Resistivity	4.86	Ohm*cm	at 21.8 °C

Cl	176000	mg/l	W721
SO_4	<25	mg/l	W721
HCO_3	462	mg/l	W371
CO_3	0	mg/l	W371
OH	0	mg/l	W371
PO_4	<7.5	mg/l	W721
BO_3	290	mg/l	HASKONING
Br	900	mg/l	W721
Na	69000	mg/l	W331
K	6500	mg/l	W331
Ca	31000	mg/l	W231
Mg	600	mg/l	W231
Sr	2100	mg/l	W231
Ba	2300	mg/l	W231
Fet	25	mg/l	V081

Mn	164	mg/l	W168
Pb	222	mg/l	W174
Dissolved Si	12	mg/l	HASKONING
As	100	µg/l	HASKONING
Cd	1400	µg/l	HASKONING
Cu	1300	µg/l	HASKONING
Ni	370	µg/l	HASKONING
Zn	832	mg/l	W180
Hg	<5	µg/l	W361
Ag	1300	µg/l	HASKONING
Co	<10	µg/l	HASKONING
Cr	5	µg/l	HASKONING

Formic acid	13	mg/l *	W651
Acetic acid	64	mg/l *	
Propionic acid	13	mg/l *	
Butyric acid	<5	mg/l	
Valeric acid	<5	mg/l	

* Door storingen vanuit de monstermatrix kan het resultaat beïnvloed zijn.

The ion balance is correct

The following isotopes were measured in (the gas sample) by ISO lab

Ref no SIEP: GMC nr 1639, well name UHM 2, depth 5150 m

Isotope ratios (off-line)

$\delta^{15}N(N_2)$	2.3

Isotope ratios (CSIA)

Methane	-31.1
Ethane	-28
Propane	-23
i-C_4	(-28)
n-C_4	(-27)

Appendix: Gas analysis of small amount of gas from water sample at 5154.5 m in in UHM-02.

Request number	LR2002050035
File name	05-035.DOC

Sampling conditions:

Reservoir pressure and temp:	706.4 bar, 205 °C
Sample bottle number:	2 ¾ Gallon MDT sample chamber ex Schlumberger
Sampled well, at depth	UHM 2, at 5154.5 m AHORT
Date of sampling	10-05-2002

Conditions at opening the tool

The tool was at ambient temperature during opening

Top pressure	approx. 20 bar
Top pressure after releasing the air cushion below the piston	zero bar

An attempt was made to get a gas sample from the tool.

Therefore a 500 ml glass pipette, under vacuum conditions was used

Approx. 50 ml of gas could be retrieved from the tool together with mudfiltrate (in the glass pipette).

No signs of H_2S were present in the gas or liquid.

The gas in the pipette was analysed.

After taking a sample into the 500 ml pipette the rest of the sample was drawn into a 20 l vacuum bottle.
In order to establish the type of liquid in the 20 l bottle air was added to the bottle to get it at atmospheric conditions. A part of the liquid was drawn from the bottle on site, the rest in the laboratory.

Appendix: Analysis of the gas phase

Helium	1.5	mol%
Hydrogen	2.5	mol%
Nitrogen	84.5	mol% (*)
Methane	4.3	mol%
Ethane	0.02	mol%
Carbon dioxide	6.9	mol%
Carbon monoxide	0.08	mol%
C6 components	0.01	mol%
C7 components	0.03	mol%
C8 components	0.07	mol%
C9 components	0.05	mol%
C10 components	0.03	mol%
C11 components	0.01	mol%
C12 components	< 0.01	mol% (**)
C13 components	< 0.01	mol% (**)
C14 components	< 0.01	mol% (**)

(*) The sample contained Oxygen (1.4 mol%) analysis corrected for air (6.7mol%)
(**) components originated from the mudfiltrate

The gas composition was confirmed by two different methods
After analysis the gas sample was sent to Shell Rijswijk for isotope analysis

Liquid volumes in the 2 ¾ Gallon chamber:

Volume hydrocarbons (baseoil or mud filtrate)	6850	ml	
Volume water (with some mud residu's)		2250	ml
Total volume of liquid in the bottle W131	9100	ml	According to NAM

Analysis of the hydrocarbons:

Density	0.793	kg/l	
Measured at W101	22.0	°C	According to NAM
Water content O271	0.03	%v/v	According to NAM

A GC identification analysis of the hydrocarbons showed baseoil components (range from C12 till C20 and no gas components, however components in the range from C5 till C11 were present in the hydrocarbons (approx. 0.23 %m/m)

A comparison was made with mud from the active pit sampled at 19/4/02, 23.30 hr.

The oil from the mud is comparable to the hydrocarbons from the sample, the mud contains even more components (from C2 till C11) than the hydrocarbons sampled on 10/5/02 (amount of C2 till C11 fraction is approx. 1.44 %m/m)

See attached chromatograms for details (05-035.xls)
(the part of the chromatogram before 7.5 min's is the part till C11)

Analysis of the water.

Density	1.197	kg/l	at 22.6 °C
PH	6.4		
Resistivity	4.86	Ohm*cm	at 21.8 °C
Cl	176000	mg/l	
Na	69000	mg/l	
K	6500	mg/l	
Ca	31000	mg/l	

Mg	600	mg/l
Sr	2100	mg/l

A comparison was made with mud from the active pit sampled at 19/4/02, 23.30 hr.

Analysis of the mud (19/4/02, active pit) Based on the mud (not on the waterphase of the mud)

Cl	26200	mg/l
Na	6800	mg/l
K	2000	mg/l
Ca	8900	mg/l
Mg	< 100	mg/l
Sr	< 100	mg/l

Conclusion:
The water consists mainly of formation water.

Appendix: Horner plots

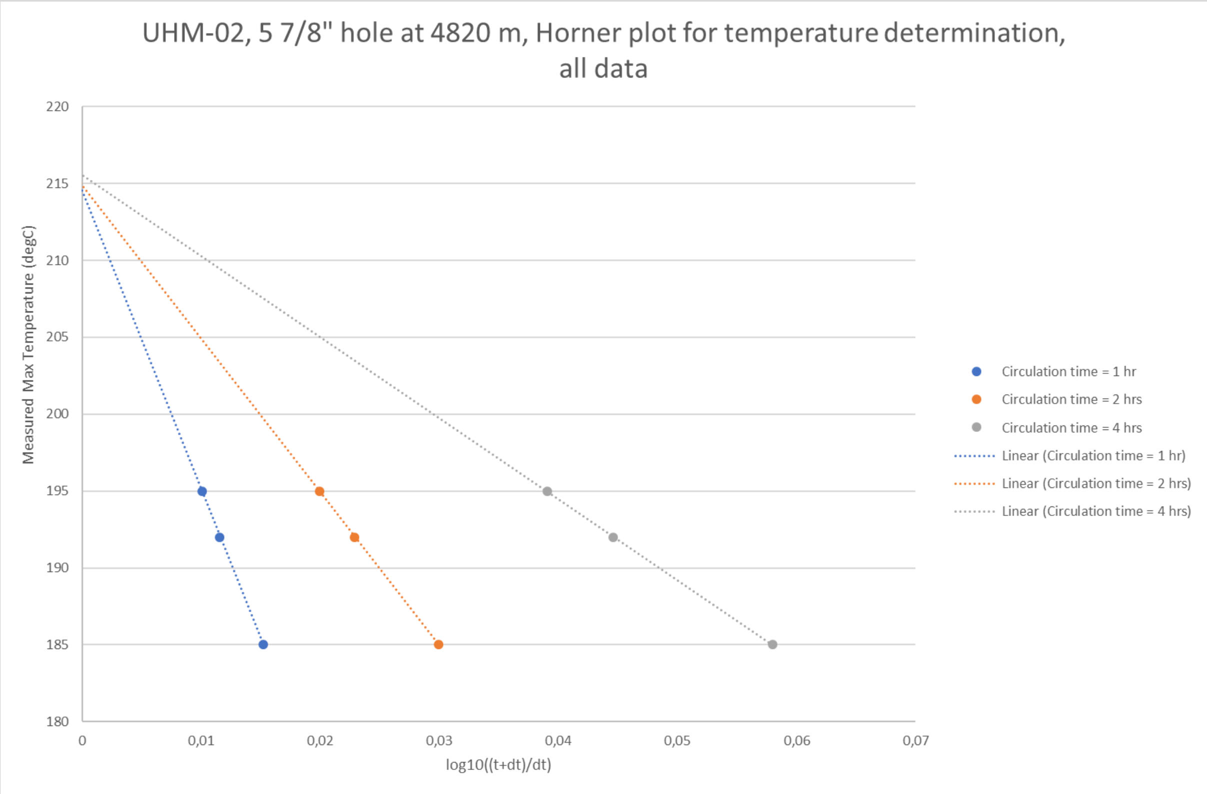


Figure 1. Horner plot at 4820m

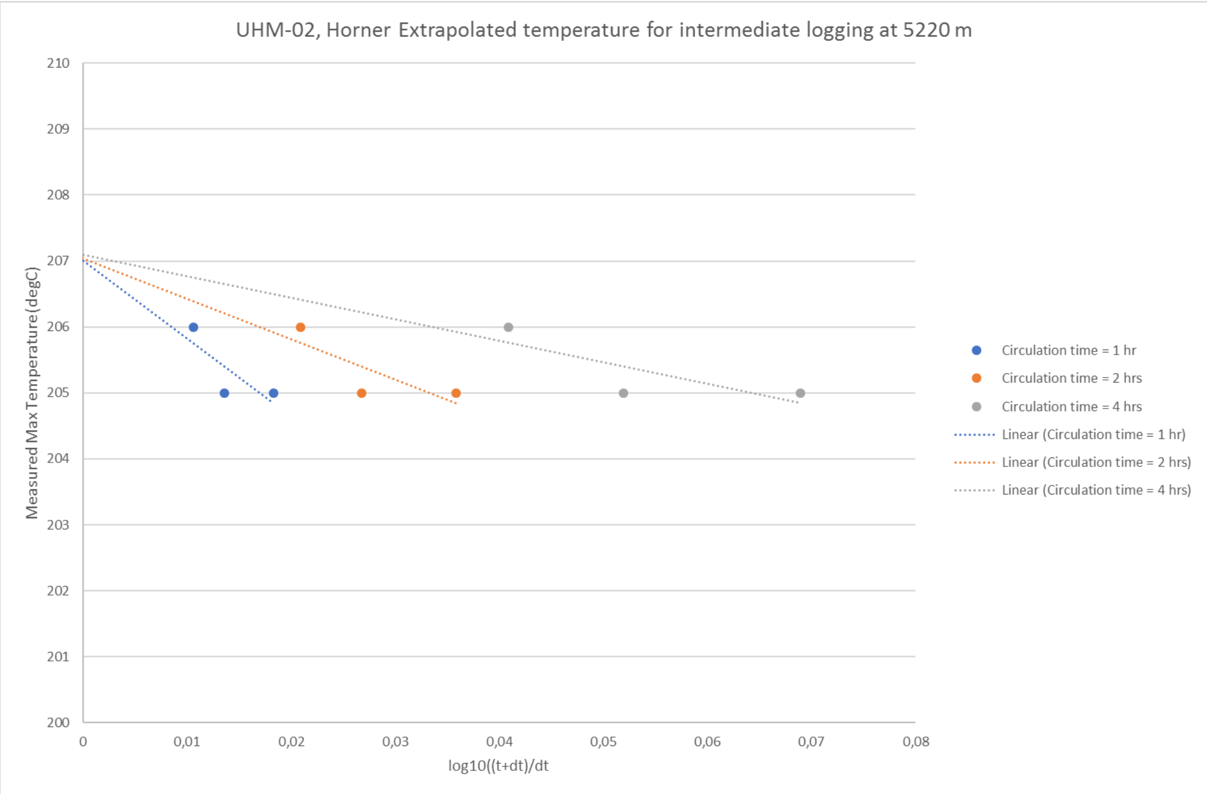


Figure 2. Horner plot at 5220m

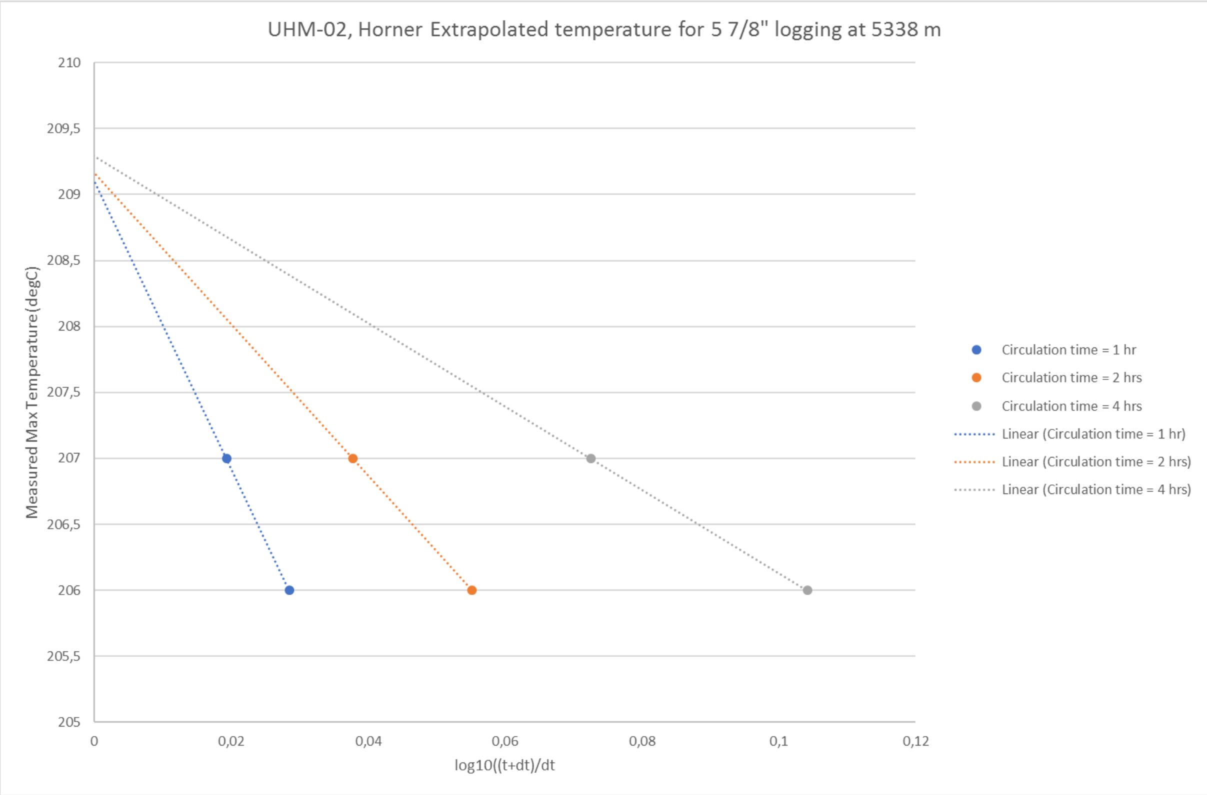


Figure 3. Horner plot at 5338m

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