mühendislik & sondaj

Well completion report for wells B-1 & B-2

Karkar, Armenia

03.04.2017

Contents

Executive summary

The Armenian Renewable Resources and Energy Efficiency Fund (R2E2) is exploring the Karkar Geothermal Field to assess the geothermal energy potential of the site. G&M Engineering & Qarazart LLC served as the Technical Supervision and Support Consultant (TSSC) for Phase I of the project, drilling of two slim-hole wells. The role of TSSC includes providing technical supervision of the drilling operation; review of the results and findings of well logging, mud logging, flow testing, and chemical analyses of cuttings, onsite geology; as well as provision of other technical advice and support related to the assignment.

This report summarizes the activities during drilling operation and analyses the resource data collected from wells B-1 and B-2. Furthermore, it integrates the newly acquired results into the previous conceptual model for the Karkar Geothermal Field as a whole. Additional conclusions and recommendations are offered for future consideration.

The Phase I of the project completed with the drilling of two exploratory wells. The first exploration well, B-1, was completed at 1500 m and tested in September 2016. The second well, B-2, was completed at 1684 and tested in November 2016.

During the drilling process continuous tests and mud logging performed, which recorded the drilling parameters as well as the lithological data. Pressure and temperature data recorded for both of the wells.

After the completion of two slim exploratory wells, B-1 and B-2, the data gathered supported the high temperature gradients and elevated temperatures of the Karkar Geothermal Field first discovered in well B-4. Wells B-1 and B-2, with no additional drilling or alterations, will produce low enthalpy geothermal fluid, around 75°C. The elevated conductive gradient at the bottom of B-1 and B-2 has proven temperatures >110°C at less than 1500 m, and projected temperatures as high as 160°C at depths of 2000 m, or >200°C at 3000 m. At these depths similar temperatures and permeability are encountered in similar basement rocks underlying commercially successful geothermal energy developments in western Anatolia and in the Basin and Range Province of the western United States.

Recommendations for next steps includes the drilling of new wells to at least 2000 m at Karkar in order to prove higher temperatures and permeability associated with a possible up flow at the intersection of the dominant fault trends. Temperatures in B-1 and B-2 should be re-surveyed at a later date to evaluate the stabilized temperature and confirm temperature gradients. The cuttings accumulated at the bottom of well B-2 could be cleaned with a rig or coiled tubing unit and the total loss zone at ~1660 m could be tested. Also wells B-1 and B-2 could be deepened. Alternatively a new well could be drilled to the depths of 2500 m or 3000 m to search for a deeper and higher temperature reservoir as in the cases of Western Anatolia(*Exploration and Discovery of the Gümüşköy Geothermal Reservoir in Aydın, Turkey*) and Western United States(*Reservoir Testing and Modeling of the Patua Geothermal Field, Nevada, USA*).

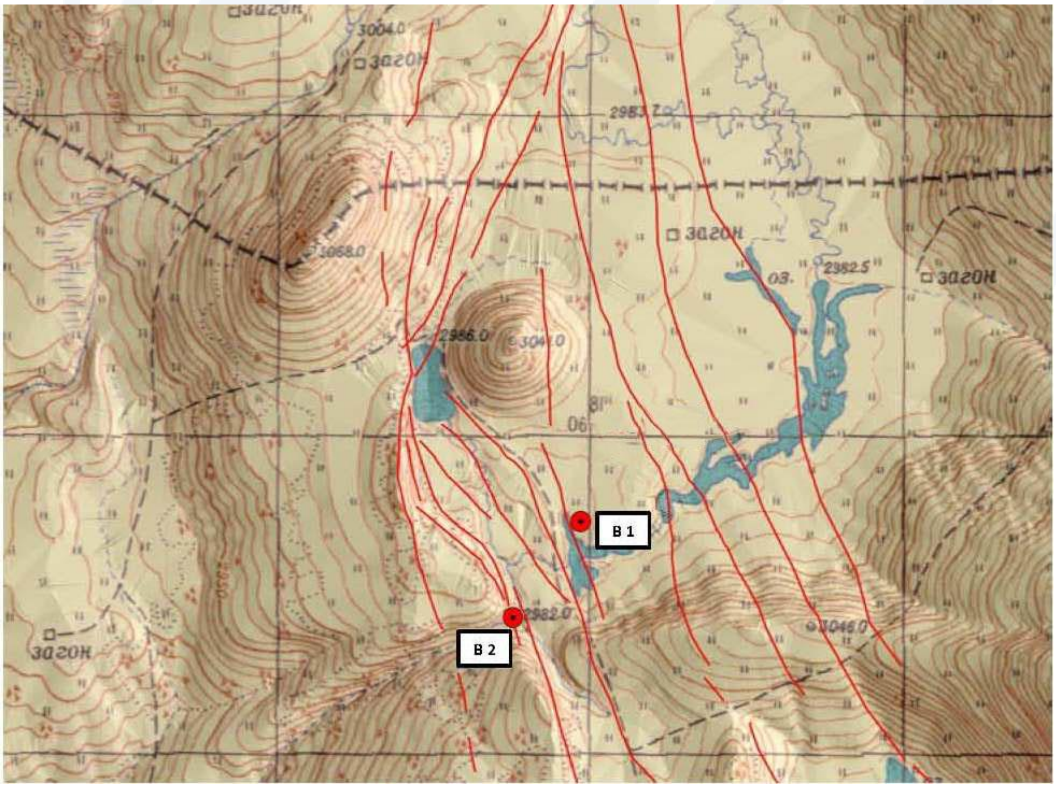
Introduction

Armenia is located in a zone of high tectonic activity and recent volcanism, which is frequently the source of geothermal energy resources. Several preliminary assessments carried out in the 1990s and 2000s which confirmed the existence of geothermal resources in various parts of the country and identified potential areas where resources could be suitable for power generation.

The Global Environmental Facility financed Geofund 2: Armenia Geothermal Project provided financing to carry out comprehensive field investigation studies of the most promising geothermal sites, Gridzor and Karkar, in order to assess the feasibility of exploratory drilling at the site with the highest potential. Studies included geological field scouting, magneto-telluric sounding surveys for both sites and interpretation of their results, and a 3D MT survey and interpretation of its results for the Karkar site, which was deemed to have the highest geothermal potential. This Karkar site has been selected for exploratory geothermal resource test drilling to confirm the quality and quantity of the local resource.

The comprehensive surface exploration work carried out at Karkar before the drilling of exploratory wells did not provide conclusive evidence on the type of geothermal resource and its potential for power generation. Although the results seemed to be indicating the geothermal system is more likely to hold medium or low temperature resources rather than high temperature ones, there were low resistivity readings which possibly indicated the regions with higher temperatures.

In these circumstances, the only way to confirm the nature of the resource and assess its commercial potential for power generation was to drill in order to enter the faults at depth (1,500- 1,800 m) and increase the chances of reaching into the main up-flow zone, where it would be most representative of the resource.



Geological map of Karkar Field (Procurement documents of Drilling of two slim wells. Nov. 30 . 2015)

Drilling Progress

Both of the exploratory wells in Karkar region, B-1 and B-2, drilled by the contractor Sisian Fpat under the supervision of TSSC Team, G&M Engineering & Qarazart LLC, serving the operator R2E2 Fund. The drilling rig was Gefco 185K. Well testing company JRG and mud logging company Geolog collected the data to help the drilling process and to increase the knowledge about the Karkar region in general. Collected data and graphs generated from them could be found on related sections of this report.

The coordinates of the well B-1 was 39.781N, 45.944E and located at an elevation of 3000m. Drilling operations started at B-1 on 7/15/2016 and the well was completed on 9/29/2016. B-1 drilled to the depth of 1500m in 70 days including 9 days spent on rig repairs and 11 days on stuck pipe problems.

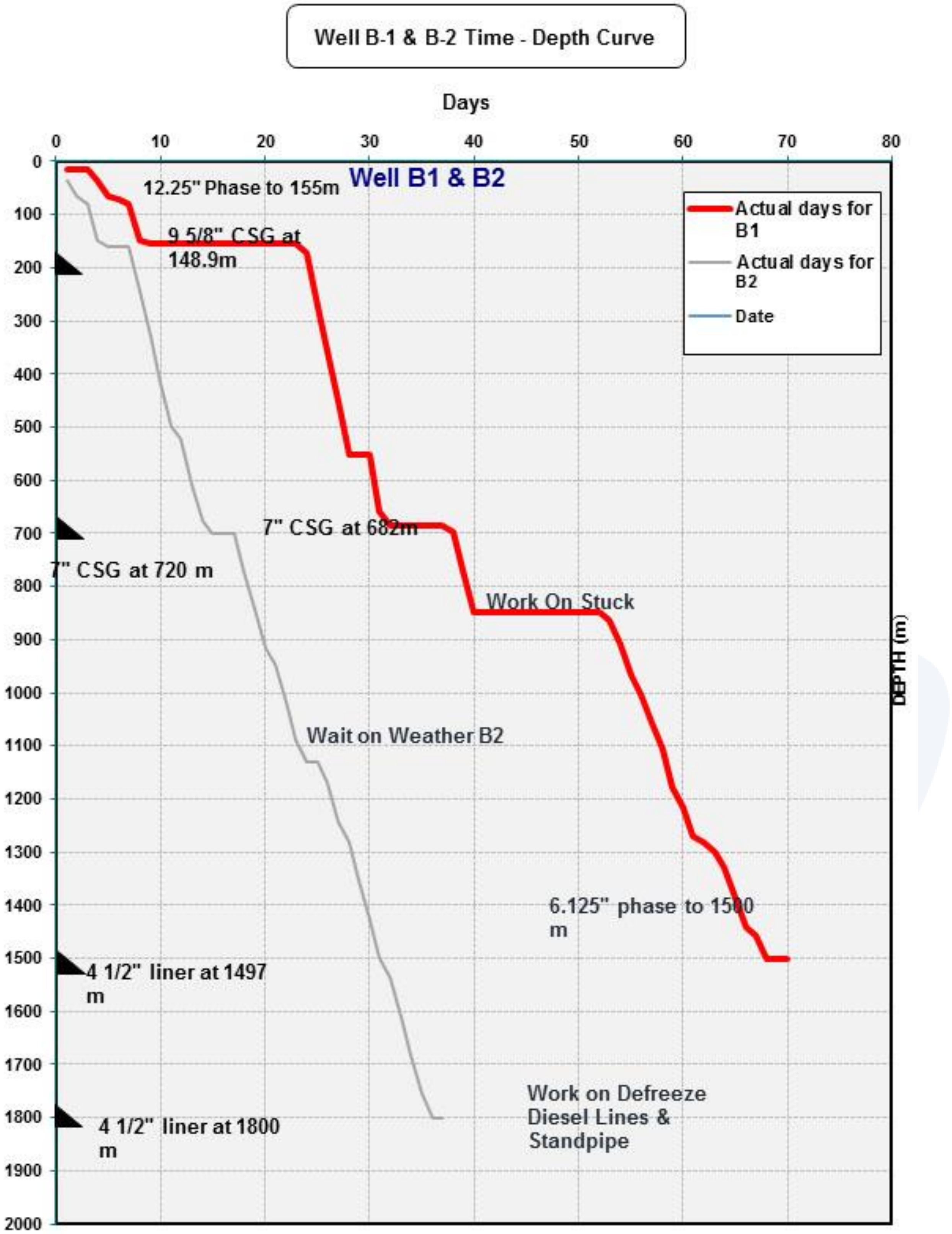
The coordinates of the second exploratory well B-2, was N 39° 46.678’, E 045° 56.486’ and located at an elevation 2989 m. Drilling operations started on 10/8/2016 and the well was completed on 12/1/2016. B-2 drilled to the depth of 1684 m in 52 days including 10 days spent on waiting for weather and de-freezing of the lines.

Stuck pipe problems on B-1 occurred during tripping out of the hole to change the drill bit. At 805 m string got over pulled and stuck completely at 772 m, no rotation, up or down movement, full circulation and shakers were clean of cuttings. Since the circulation was still free to flow, main suspect was differential sticking.

The main reason of the problem was the expanding and sloughing of the reactive tuff formation encompassing 682 to 825 m. Usage of water instead of low fluid loss drilling mud might have worsen the swelling. Also the predetermined bit by contract was designed to cut harder formations and was not optimum to drill the tuffs. After using several methods, including heavy circulation, over pulling, back reaming and changing the additives in drilling mud, the team successfully retrieved the drill string.

In order to prevent similar problems occurring in future one must take into account the nature of the tuff formation being drilled. Especially around reactive tuff sections it is better to use polymer muds with better fluid loss control instead of lignosulphonate mud. If polymer must be limited then the lignosulphonate mud must be kept in low fluid loss levels with additives. This would also keep the damage to the reservoir at minimum. Since the pipe sticking was due to the differential sticking around reactive tuffs, it is imperative to keep the drill string in motion as much as possible. Increasing the frequency of the short trips, in every 100m drilled or 24hr drilling time, would help mitigating the problem. Also to keep the rate of penetration higher and reduce the tripping times, using better suited bits is important. On these zones 4-1-7 or 4-3-7 IADC code bits performed better with less bit balling problems.

During the production and pressure, temperature testing of the well B-2, it is found out that the debris filled the bottom section of the well. The reason of the filling is the reactive tuffs expanding, sloughing and eventually collapsing into the well. 4 ½” perforated (2,35mm slits) liner section encompasses 688m to 1682m of well B-2. To prevent similar debris filling satiations on other wells the 7” production casings should be set on deeper sections to keep the reactive tuff behind the casing and isolate production zones as much as possible.


Well B-1 & B-2 Time - Depth Curve
Days
Well B1 & B2
12.25" Phase to 155m
9 5/8" CSG at 148.9m
7" CSG at 682m
7" CSG at 720 m
Work On Stuck
Wait on Weather B2
6.125" phase to 1500 m
4 1/2" liner at 1497 m
4 1/2" liner at 1800 m
Work on Defreeze Diesel Lines & Standpipe
Actual days for B1
Actual days for B2
Date
DEPTH (m)

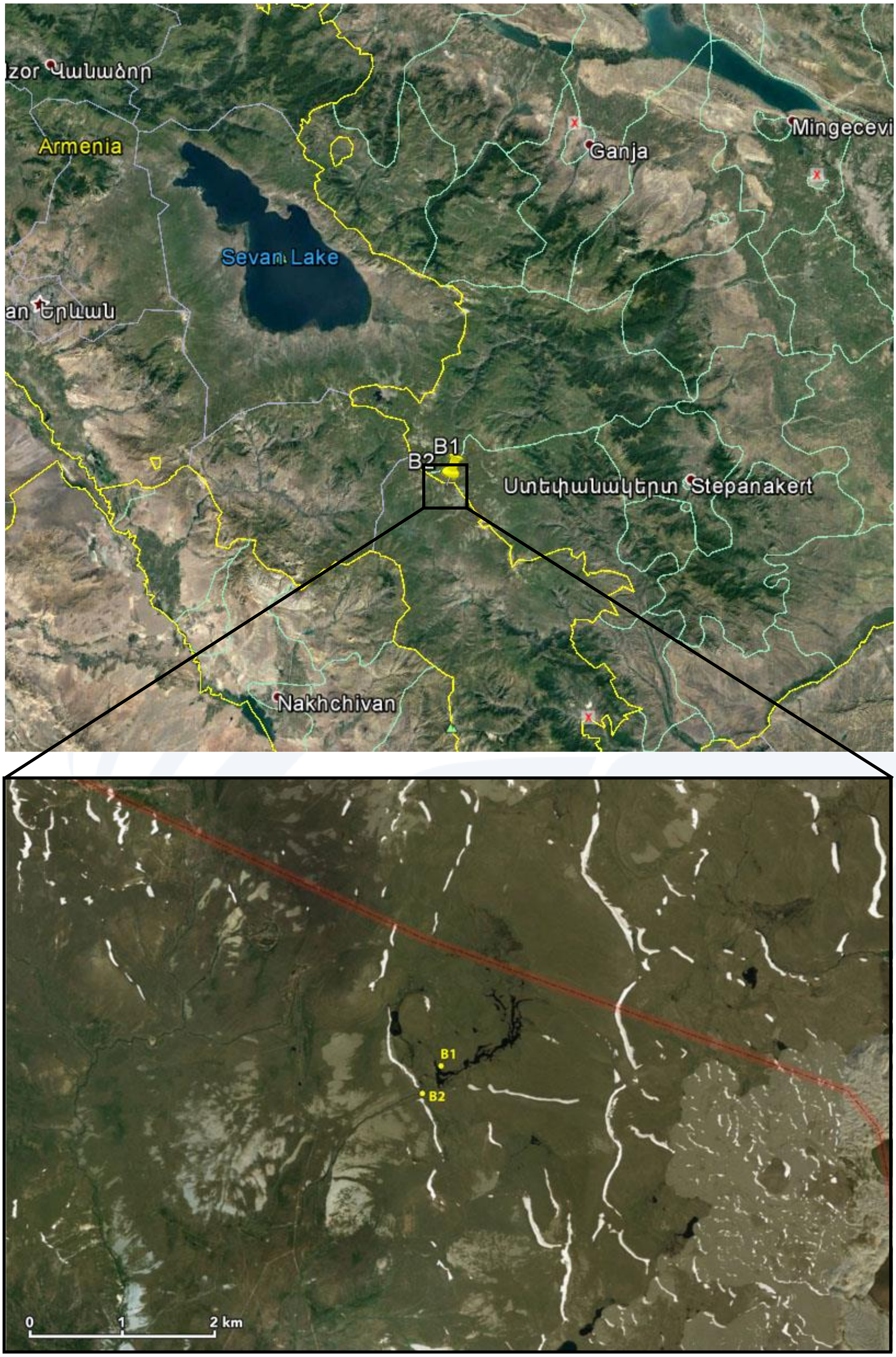


Figure 1 Location Map of Karkar Geothermal Field - Google Earth & Apple Maps

Description of the wells as-built

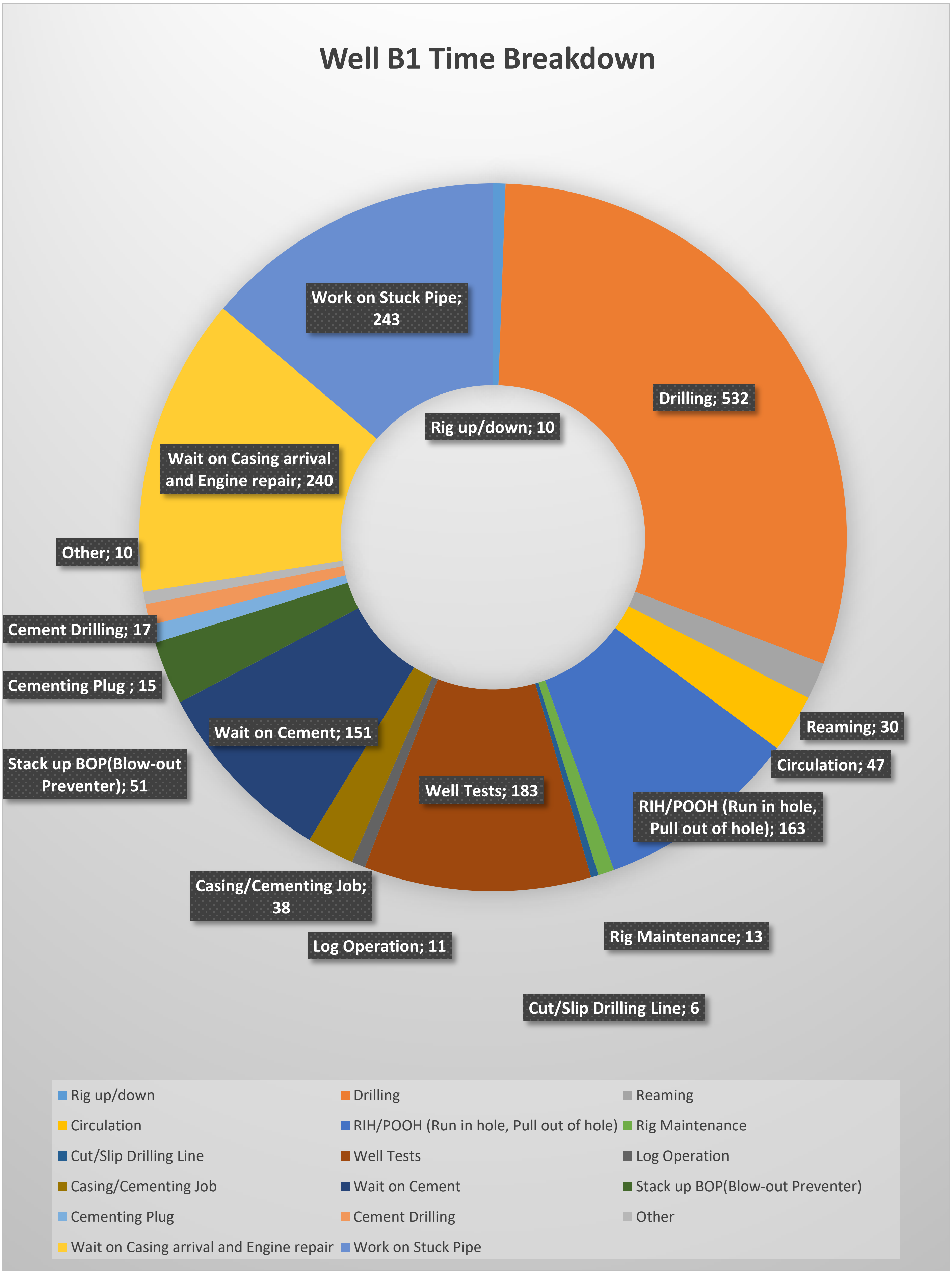
At the start of the project some changes had to be made in the well planning. The reasons for the revision were mainly giving better opportunities to the well test team to perform the tests. First of all the well test engineers recommended bigger production hole to limit the pressure loss and give better production capacity estimation. Secondly the original logging program was very complicated and in order to achieve the goals of the program larger diameter logging tools must be used to protect the probes from high temperatures. Because of increase in dimensions of the tools, losing the tools in hole due to sticking becomes a real risk. It is also know that reputable logging companies prefer and recommend bigger hole dimensions to be on the safe side. Lastly, due to the dense massive volcanic nature of the formation one would need 7000 lb.ft torsional torque to drill below production zones. In order to drill 4 ¼" hole the team needed 2 3/8" drill pipes which would not have the required torsional yield and drill string failures might have occurred or the drilling would not be continued.

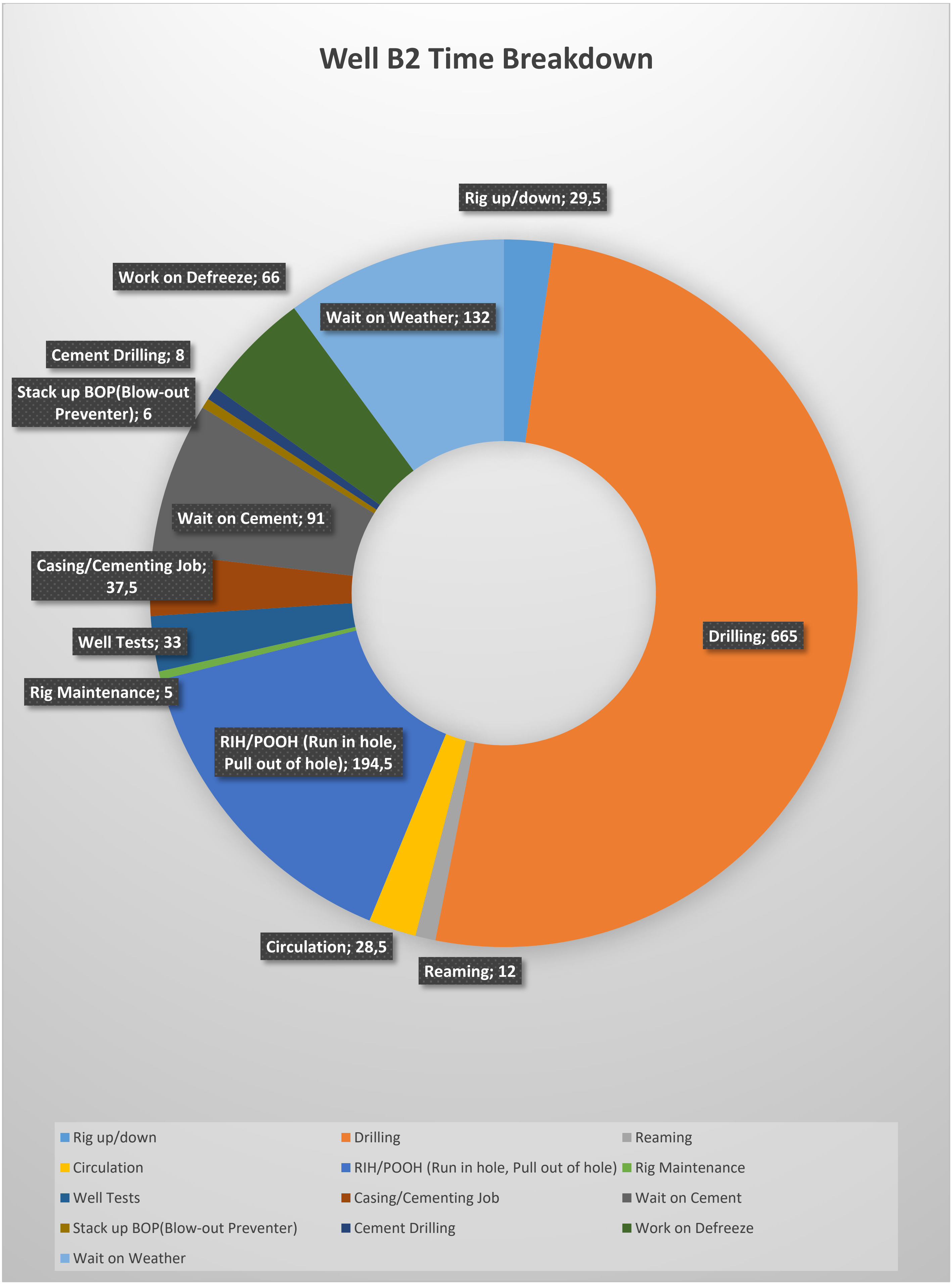
Because of the reasons explained, the new plan was built upon four sections instead of five. By removing the 4 ¼" section the distance distributed to other three sections. 12 ¼" sections extended from 75 m to 155m, 8 ½"section extended from 255m to 687m on B-1 and 725m on B-2, finally 6 1/8" section extended from 655m to 1500 on B-1 and 1684m on B-2. The 4 ½" perforated liner with 2,35mm is used in both wells.

Well Casing & Hole Section Depths of Wells B-1 and B-2

	13 3/8" Casing		**9 5/8" Casing**		**7" Casing**		**4 1/2" Perforated Liner (2,35mm slits)**	
	from (m)	to (m)	from (m)	to (m)	from (m)	to (m)	from (m)	to (m)
Well B1	0	12	0	149	0	682	649	1497
Well B2	0	12	0	149	0	721	688	1682

	17 1/2" Hole		**12 1/4" Hole**		**8 1/2" Hole**		**6 1/8" Hole**	
	from (m)	to (m)	from (m)	to (m)	from (m)	to (m)	from (m)	to (m)
Well B1	0	12	12	154	154	687	687	1500
Well B2	0	16	16	155	155	725	725	1684


Well B1 Time Breakdown
Work on Stuck Pipe; 243
Drilling; 532
Rig up/down; 10
Wait on Casing arrival and Engine repair; 240
Other; 10
Cement Drilling; 17
Cementing Plug ; 15
Wait on Cement; 151
Reaming; 30
Circulation; 47
Stack up BOP(Blow-out Preventer); 51
Well Tests; 183
RIH/POOH (Run in hole, Pull out of hole); 163
Casing/Cementing Job; 38
Log Operation; 11
Rig Maintenance; 13
Cut/Slip Drilling Line; 6
Rig up/down
Drilling
Reaming
Circulation
RIH/POOH (Run in hole, Pull out of hole)
Rig Maintenance
Cut/Slip Drilling Line
Well Tests
Log Operation
Casing/Cementing Job
Wait on Cement
Stack up BOP(Blow-out Preventer)
Cementing Plug
Cement Drilling
Other
Wait on Casing arrival and Engine repair
Work on Stuck Pipe


Well B2 Time Breakdown
Rig up/down; 29,5
Work on Defreeze; 66
Wait on Weather; 132
Cement Drilling; 8
Stack up BOP(Blow-out Preventer); 6
Wait on Cement; 91
Casing/Cementing Job; 37,5
Well Tests; 33
Rig Maintenance; 5
RIH/POOH (Run in hole, Pull out of hole); 194,5
Drilling; 665
Circulation; 28,5
Reaming; 12
Rig up/down
Drilling
Reaming
Circulation
RIH/POOH (Run in hole, Pull out of hole)
Rig Maintenance
Well Tests
Casing/Cementing Job
Wait on Cement
Stack up BOP(Blow-out Preventer)
Cement Drilling
Work on Defreeze
Wait on Weather

Daily Drilling summary of Well B-1

Date	Actual days for B1	M N depth(m)	Progress (m)	Operation
15.07.2016	1	15	15	Drilling 17 1/2"
16.07.2016	2	15	0	Run 13 3/8" Casing
17.07.2016	3	15	0	Cement & WOC
18.07.2016	4	35	20	Drilling 12 1/4"
19.07.2016	5	65	30	Drilling & Pump LCM Pill
20.07.2016	6	72	7	Drilling & Cement Plug
21.07.2016	7	80	8	Drilling & Cement Plug
22.07.2016	8	150	70	Drilling
23.07.2016	9	155	5	Drilling & Total Loss & Pump Cement
24.07.2016	10	155	0	WOC
25.07.2016	11	155	0	WOC
26.07.2016	12	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
27.07.2016	13	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
28.07.2016	14	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
29.07.2016	15	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
30.07.2016	16	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
31.07.2016	17	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
1.08.2016	18	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
2.08.2016	19	155	0	Wait on Extra 9 5/8" Casing & Engine Problem
3.08.2016	20	155	0	Engine Problem
4.08.2016	21	155	0	RIH 9 5/8" Casing
5.08.2016	22	155	0	Cementing & WOC & Nipple Up BOP
6.08.2016	23	155	0	Nipple up BOP
7.08.2016	24	172	17	Drilling
8.08.2016	25	273	101	Drilling
9.08.2016	26	356	83	Drilling
10.08.2016	27	450	94	Drilling
11.08.2016	28	553	103	Drilling
12.08.2016	29	553	0	Cement Plug & WOC
13.08.2016	30	553	0	WOC
14.08.2016	31	660	107	Drilling
15.08.2016	32	687	27	Drilling & Wiper Trip
16.08.2016	33	687	0	Temperature Log & Wiper Trip
17.08.2016	34	687	0	RIH Casing
18.08.2016	35	687	0	Cementing & WOC
19.08.2016	36	687	0	WOC & Nipple Up BOP
20.08.2016	37	687	0	Nipple Up BOP
21.08.2016	38	697	10	Drilling
22.08.2016	39	779	82	Drilling
23.08.2016	40	850	71	Drilling
24.08.2016	41	850	0	Work on stuck
25.08.2016	42	850	0	Work on stuck
26.08.2016	43	850	0	Work on stuck
27.08.2016	44	850	0	Work on stuck
28.08.2016	45	850	0	Work on stuck
29.08.2016	46	850	0	Work on stuck

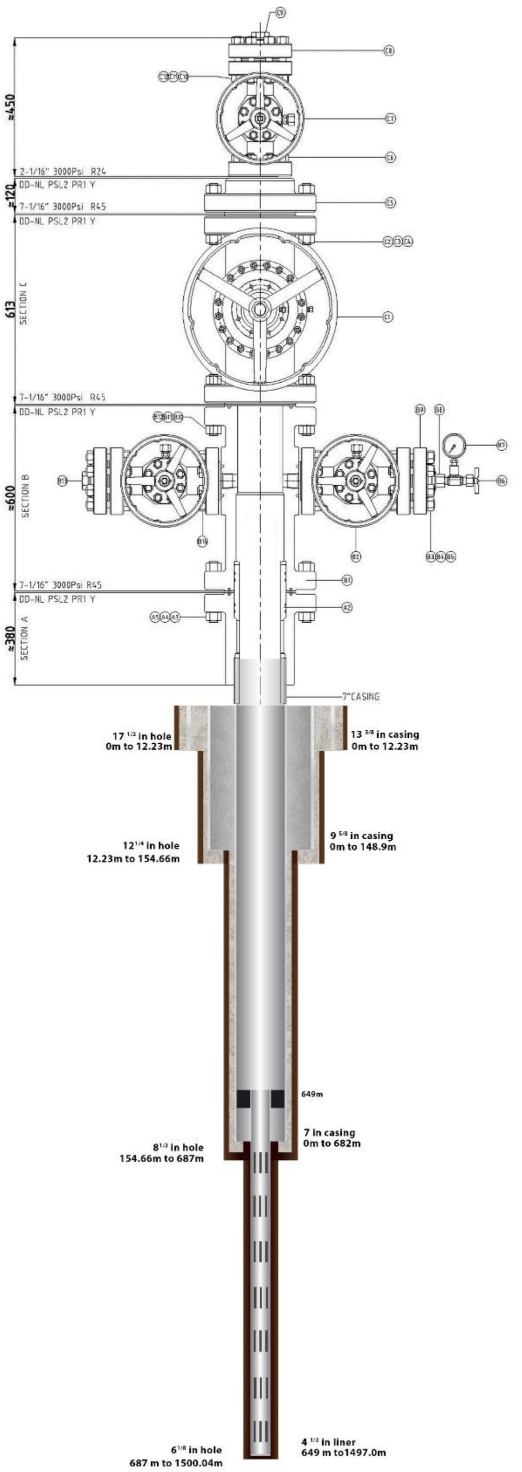
30.08.2016	**47**	**850**	**0**	Work on stuck
31.08.2016	**48**	**850**	**0**	Work on stuck
1.09.2016	**49**	**850**	**0**	Work on stuck
2.09.2016	**50**	**850**	**0**	Work on stuck
3.09.2016	**51**	**850**	**0**	Work on stuck
4.09.2016	**52**	**850**	**0**	Work on stuck & Round Trip
5.09.2016	**53**	**863**	**13**	Drilling
6.09.2016	**54**	**908**	**45**	Drilling
7.09.2016	**55**	**967**	**59**	Drilling
8.09.2016	**56**	**1003**	**36**	Drilling & Trip
9.09.2016	**57**	**1057**	**54**	Drilling
10.09.2016	**58**	**1106**	**49**	Drilling Total Loss Trip
11.09.2016	**59**	**1178**	**72**	Drilling
12.09.2016	**60**	**1218**	**40**	Drilling
13.09.2016	**61**	**1271**	**53**	Drilling
14.09.2016	**62**	**1281**	**10**	Drilling & Trip
15.09.2016	**63**	**1299**	**18**	Drilling & Trip
16.09.2016	**64**	**1330**	**31**	Drilling
17.09.2016	**65**	**1387**	**57**	Drilling
18.09.2016	**66**	**1443**	**56**	Drilling
19.09.2016	**67**	**1458**	**15**	Drilling & Trip
20.09.2016	**68**	**1500**	**42**	Drilling
21.09.2016	**69**	**1500**	**0**	Trip
22.09.2016	**70**	**1500**	**0**	RIH 4 1/2" Casing

Daily Drilling summary of Well B-2

Date	**Depth (m)**	**Progress (m)**	**Operation**
8.10.2016	**17**	**17**	Drilling 12 1/4" & Cement Plug
9.10.2016	**66**	**49**	Drilling 12 1/4"
10.10.2016	**74**	**8**	Drilling 12 1/4" & Cement Plug
11.10.2016	**140**	**66**	Drilling 12 1/4"
12.10.2016	**155**	**15**	Drilling 12 1/4" & Wiper Trip & RIH Casing
13.10.2016	**155**	**0**	WOC & N/U Conductor
14.10.2016	**242**	**87**	Drilling 8 1/2" Section
15.10.2016	**352**	**110**	Drilling 8 1/2" Section
16.10.2016	**534**	**182**	Drilling 8 1/2" Section
17.10.2016	**609**	**75**	Drilling 8 1/2" & Change Bit POOH
18.10.2016	**715**	**106**	Drilling 8 1/2"
19.10.2016	**725**	**10**	Drilling 8 1/2" & Wiper Trip & RIH Casing
20.10.2016	**725**	**0**	Cementing & WOC
21.10.2016	**725**	**0**	WOC
22.10.2016	**738**	**13**	Top Job Nipple up BOP & Drilling
23.10.2016	**822**	**84**	Drilling 6 1/8" Section
24.10.2016	**898**	**76**	Drilling 6 1/8" Section
25.10.2016	**938**	**40**	Drilling 6 1/8" Section & Trip for Bit
26.10.2016	**983**	**45**	Drilling 6 1/8" Section

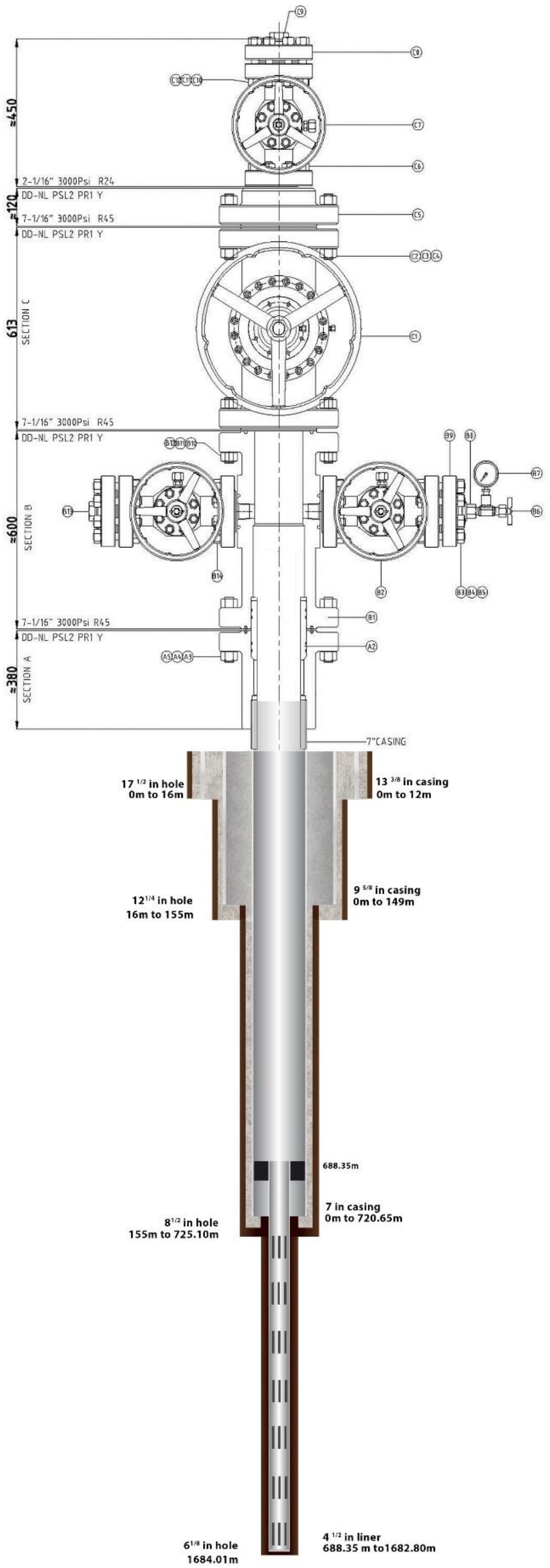
27.10.2016	**1031**	**48**	Drilling 6 1/8" Section
28.10.2016	**1040**	**9**	Drilling 6 1/8" Section & Trip for Bit
29.10.2016	**1086**	**46**	Drilling 6 1/8" Section
30.10.2016	**1102**	**16**	Drilling & Wait on Weather
31.10.2016	**1102**	**0**	Wait on Weather
1.11.2016	**1102**	**0**	Wait on Weather
2.11.2016	**1102**	**0**	Wait on Weather
3.11.2016	**1102**	**0**	Wait on Weather
4.11.2016	**1102**	**0**	Wait on Weather
5.11.2016	**1124**	**22**	Wait on Weather & Drilling
6.11.2016	**1179**	**55**	Drilling 6 1/8" Section
7.11.2016	**1220**	**41**	Drilling 6 1/8" Section
8.11.2016	**1253**	**33**	Drilling 6 1/8" Section
9.11.2016	**1272**	**19**	Drilling 6 1/8" Section & Trip for Bit
10.11.2016	**1307**	**35**	Drilling 6 1/8" Section
11.11.2016	**1336**	**29**	Drilling 6 1/8" Section
12.11.2016	**1373**	**37**	Drilling 6 1/8" Section
13.11.2016	**1389**	**16**	Drilling 6 1/8" Section & Trip for Bit
14.11.2016	**1416**	**27**	Drilling 6 1/8" Section
15.11.2016	**1464**	**48**	Drilling 6 1/8" Section
16.11.2016	**1492**	**28**	Drilling 6 1/8" Section & Trip for Bit
17.11.2016	**1531**	**39**	Drilling 6 1/8" Section
18.11.2016	**1558**	**27**	Drilling 6 1/8" Section & Trip for Bit
19.11.2016	**1590**	**32**	Drilling 6 1/8" Section
20.11.2016	**1655**	**65**	Drilling 6 1/8" Section
21.11.2016	**1674**	**19**	Work on Defreeze Diesel Lines
22.11.2016	**1674**	**0**	Work on Defreeze Diesel Lines
23.11.2016	**1674**	**0**	Work on Defreeze Stand pipe
24.11.2016	**1674**	**0**	Work on Defreeze Stand pipe
25.11.2016	**1674**	**0**	Trip & Plug Nozzle
26.11.2016	**1674**	**0**	Trip & Reaming
27.11.2016	**1684**	**10**	Drilling 6 1/8" Section
28.11.2016	**1684**	**0**	RIH 4 1/2" Casing

As-Built Schema of well B1



C12	NUT 7/8-9UNC
C11	BOLT 7/8-9UNC×6.10"
C10	R24 RING GASKET
C9	PLUG 2"LP
C8	2-1/16" 3000Psi 2"LP COMPANION FLANGE
C7	2-1/16" 3000Psi EXPANDING VALVE
C6	BOLT 7/8-9UNC×4.33"
C5	7-1/16" 3000Psi 2-1/16"3000Psi ADAPTOR FLANGE
C4	NUT 1-1/8-8UN
C3	BOLT 1-1/8-8UN×8.07"
C2	R45 RING GASKET
C1	7-1/16" 3000Psi EXPANDING VALVE
SECTION C	
B14	BOLT 7/8-9UNC×4.33"
B13	PLUG 2"LP
B12	NUT 1-1/8-8UN
B11	BOLT 1-1/8-8UN×8.07"
B10	R45 RING GASKET
B9	2-1/16" 3000Psi 2"LP COMPANION FLANGE
B8	PLUG 2"LP-1/2"NPT
B7	PRESSURE GAUGE 0-3000Psi,1/2"NPT(MALE)
B6	NEEDLE VALVE 1/2"NPT(FEMALE)-1/2"NPT(MALE) 5000Psi
B5	NUT 7/8-9UNC
B4	BOLT 7/8-9UNC×6.10"
B3	R24 RING GASKET
B2	2-1/16" 3000Psi EXPANDING VALVE
B1	EXPANDING SPOOL 7-1/16"3000Psi BTM,7-1/16"3000PsiTOP,WITH 1.9"VR THD
SECTION B	
A5	NUT 1-1/8-8UN
A4	BOLT 1-1/8-8UN×8.07"
A3	R45 RING GASKET
A2	CENTRALIZER 4-1/2"
A1	CASING HEAD 7-1/16" 3000Psi TOP FLANGE,BTM 7"SOW

As-Built Schema of well B2



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C6	BOLT 7/8-9UNC×4.33"
C5	7-1/16" 3000Psi 2-1/16"3000Psi ADAPTOR FLANGE
C4	NUT 1-1/8-8UN
C3	BOLT 1-1/8-8UN×8.07"
C2	R45 RING GASKET
C1	7-1/16" 3000Psi EXPANDING VALVE
SECTION C	
B14	BOLT 7/8-9UNC×4.33"
B13	PLUG 2"LP
B12	NUT 1-1/8-8UN
B11	BOLT 1-1/8-8UN×8.07"
B10	R45 RING GASKET
B9	2-1/16" 3000Psi 2"LP COMPANION FLANGE
B8	PLUG 2"LP-1/2"NPT
B7	PRESSURE GAUGE 0-3000Psi,1/2"NPT(MALE)
B6	NEEDLE VALVE 1/2"NPT(FEMALE)-1/2"NPT(MALE) 5000Psi
B5	NUT 7/8-9UNC
B4	BOLT 7/8-9UNC×6.10"
B3	R24 RING GASKET
B2	2-1/16" 3000Psi EXPANDING VALVE
B1	EXPANDING SPOOL 7-1/16"3000Psi BTM,7-1/16"3000PsiTOP,WITH 1.9"VR THD
SECTION B	
A5	NUT 1-1/8-8UN
A4	BOLT 1-1/8-8UN×8.07"
A3	R45 RING GASKET
A2	CENTRALIZER 4-1/2"
A1	CASING HEAD 7-1/16" 3000Psi TOP FLANGE,BTM 7"SDW

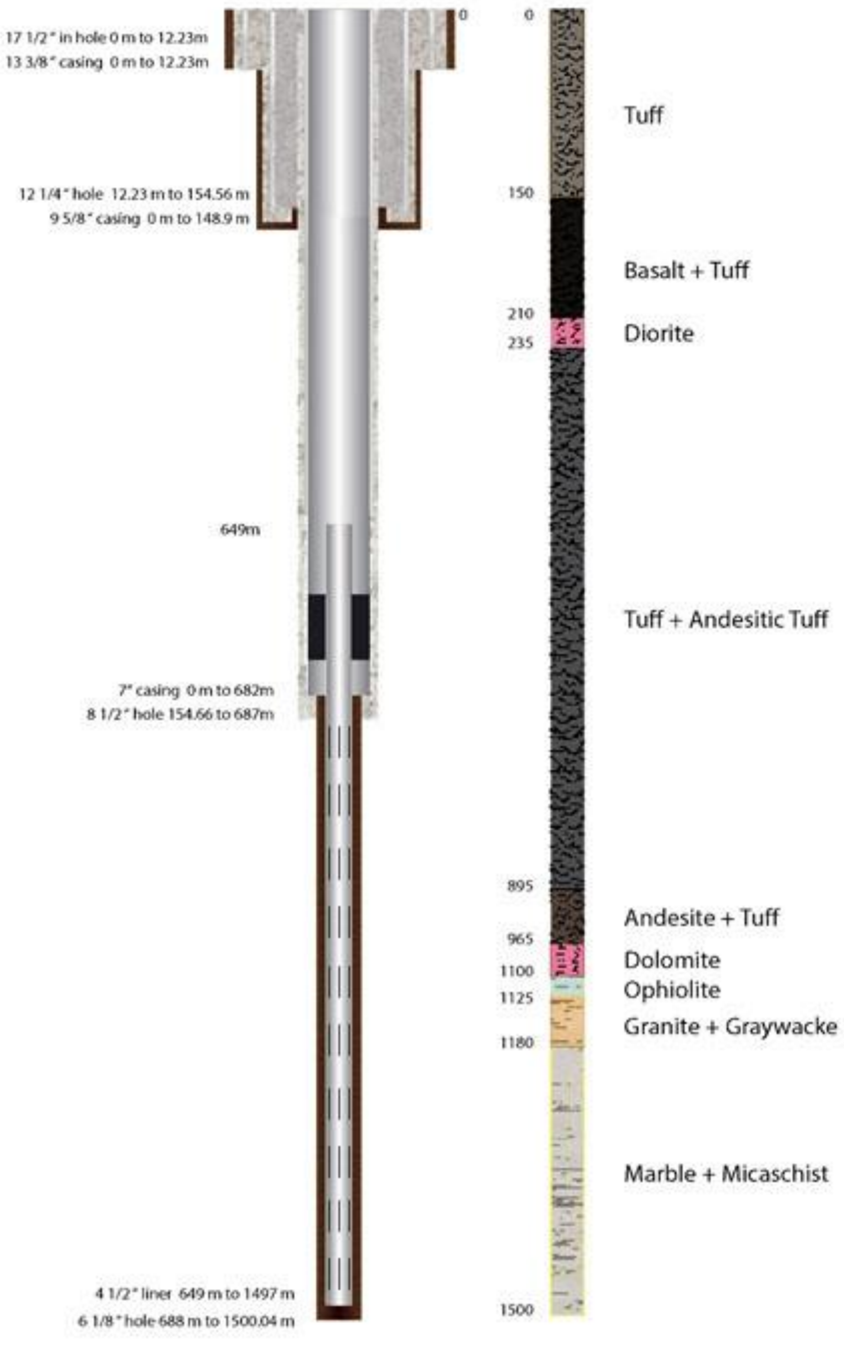
Drilling parameters collected during drilling

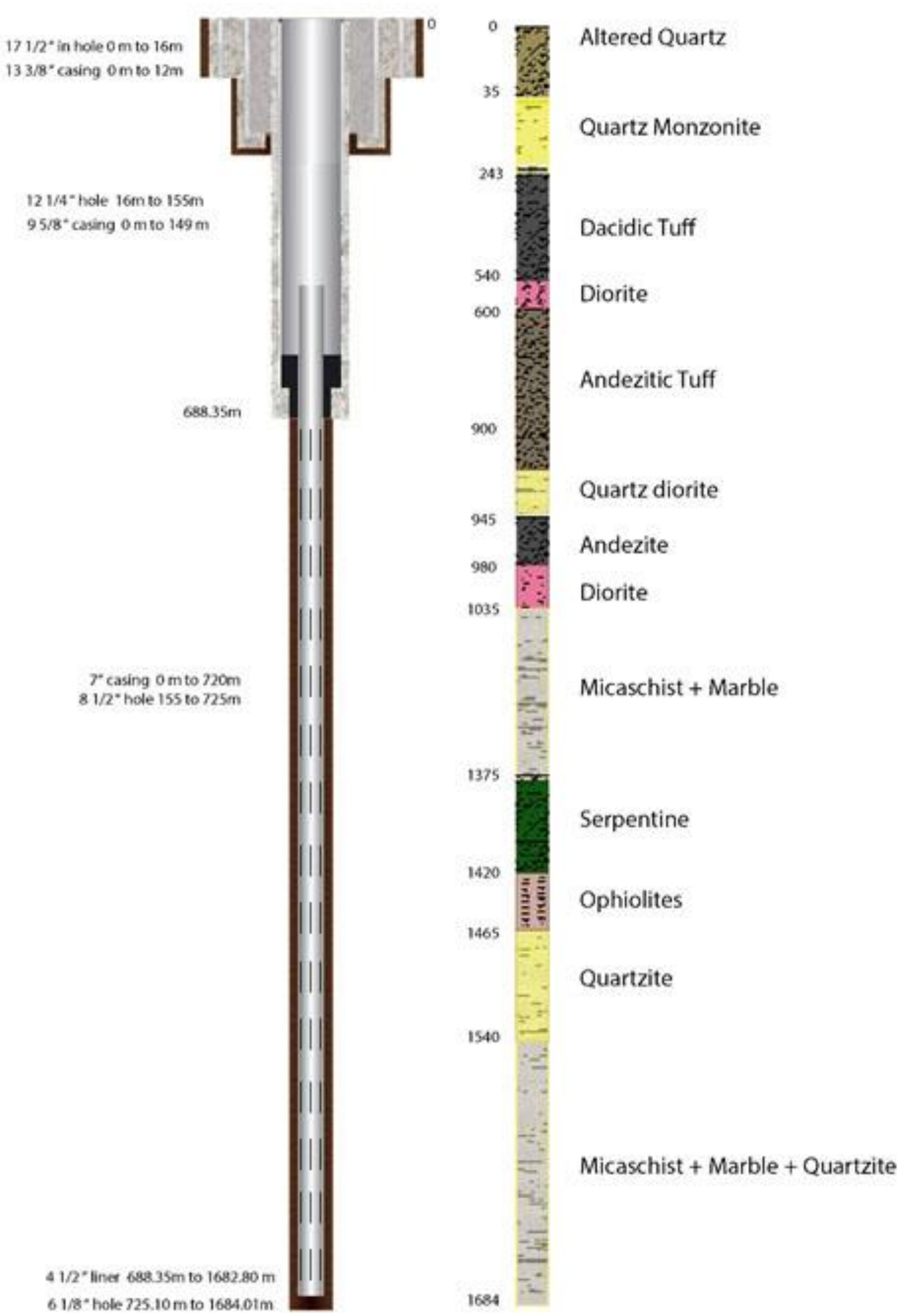
Weight on bit(WOB), rate of penetration(ROP), revolutions per minute(RPM), torque and drilling mud flow rate were the main parameters that has been kept during drilling. The combination of these parameters and the response of the formation being cut, are the main resources of information for the team. These parameters are generally dependent of each other. By increasing the WOB one might see better ROP, but also might face too much torque and the risk of damaging the drilling pipes. The flow rate of the mud effects not only the cleaning of the cuttings from the hole but also the impact of the hydraulic force applied on the formation is related to it. Fine tuning of the flow rate would ensure the highest amount of cleaning and maximum hydraulic force on the bit while keeping the total working pressure between safety limits.

Since these parameters have been closely watched and tuned according to the formation being drilled, they are the main sources of information about the well. The feed zones where the main flow generated usually happens in fractured formations. These formations might lead to the total or partial losses of mud flow. Another indication of the fracture is the sudden increase in ROP and decrease of WOB on the record sheets. This fractures might happen between the formation transition zones or naturally high porosity formations. On well B-2 total losses observed at 1660 meters. The loss of flow happened during transition from marble to quartzite. The sudden decrease of WOB and increase in ROP also indicate this as a feed zone. Partial losses between 1570 to 1590 meters also indicate a potential fracture and a feed zone. Same pattern also observed on B-1 around 1100 meters during transition zones.

The collection of said parameters depend on the logging team's vigilance. Geolog supplied the equipment and the manpower to collect the mud logging data. Most of the information during drilling provided by them and that information helped guiding the process. The condensed version of their mud logging efforts is included in this section. The more detailed mud logging data could be found on appendix.

Condensed Lithology of B1




17 1/2" in hole 0 m to 16m
13 3/8" casing 0 m to 12m
12 1/4" hole 16m to 155m
9 5/8" casing 0 m to 149 m
688.35m
7" casing 0 m to 720m
8 1/2" hole 155 to 725m
4 1/2" liner 688.35m to 1682.80 m
6 1/8" hole 725.10 m to 1684.01m
0
0
Altered Quartz
35
Quartz Monzonite
243
Dacidic Tuff
540
Diorite
600
Andezitic Tuff
900
Quartz diorite
945
Andezite
980
Diorite
1035
Micaschist + Marble
1375
Serpentine
1420
Ophiolites
1465
Quartzite
1540
Micaschist + Marble + Quartzite
1684

Summary of well testing results

Well test services provided by JRG. Even though the tests could not be completed on B-2 they increased our knowledge about the region and would be invaluable for the future steps. According to the report of JRG the well B-1 supports the high temperature gradients and elevated temperatures of the Karkar Geothermal Field first discovered in well B-4. While the precise location of B-4 is unconfirmed (to within several hundred meters), well B-1 extends the area of this heat anomaly at least ~1.5 km east from the reported location of B-4 into the pull-apart basin and well B-2 extends the area south into. The elevated conductive gradient at the bottom of B-1 has proven temperatures >110°C at less than 2000 m, and possibly as high as 160°C at depths of 2000 m, or >200°C at 3000 m.

Data from well B-2 supports the high temperature gradients and elevated temperatures of the Karkar Geothermal Field first discovered in well N-4. While the precise location of N-4 is unconfirmed (to within several hundred meters). The elevated conductive gradient at the bottom of B-2 has proven temperatures >120°C at less than 2000 m. By analogy to commercial geothermal fields in similar basement rocks in western Anatolia, temperature gradients could decrease near intermediate aquifers and then increase again with greater depth. Therefore deeper drilling could possibly encounter commercial permeability and temperatures at depths up to 3500 m.

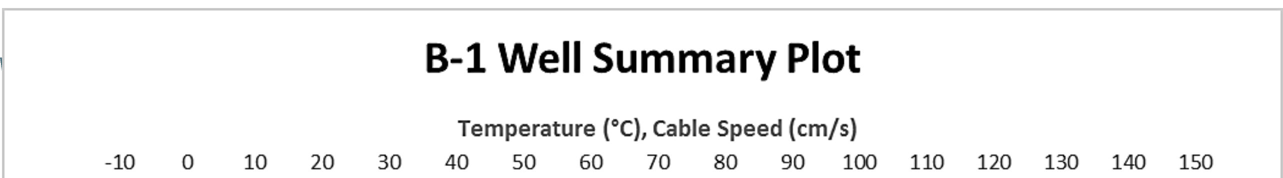
The main feed zone of well B-1 has a temperature <100°C. Therefore, it is not the zone of interest for commercial geothermal energy production. However, it may be useful for a direct use/district heating project. While the bottom of well B-1 is >110°C, however there are no definitive feed zones at this temperature and therefore, cannot be utilized in B-1 production. If B-1 were deepened to 2000-3000 m, it may encounter permeable zones at higher temperature within the basement rocks. The basement contact of B-1 is permeable. But it contains a mixture of hot outflowing and cold down flowing waters. It is not the zone of interest for geothermal production but could be useful for injection or direct use.

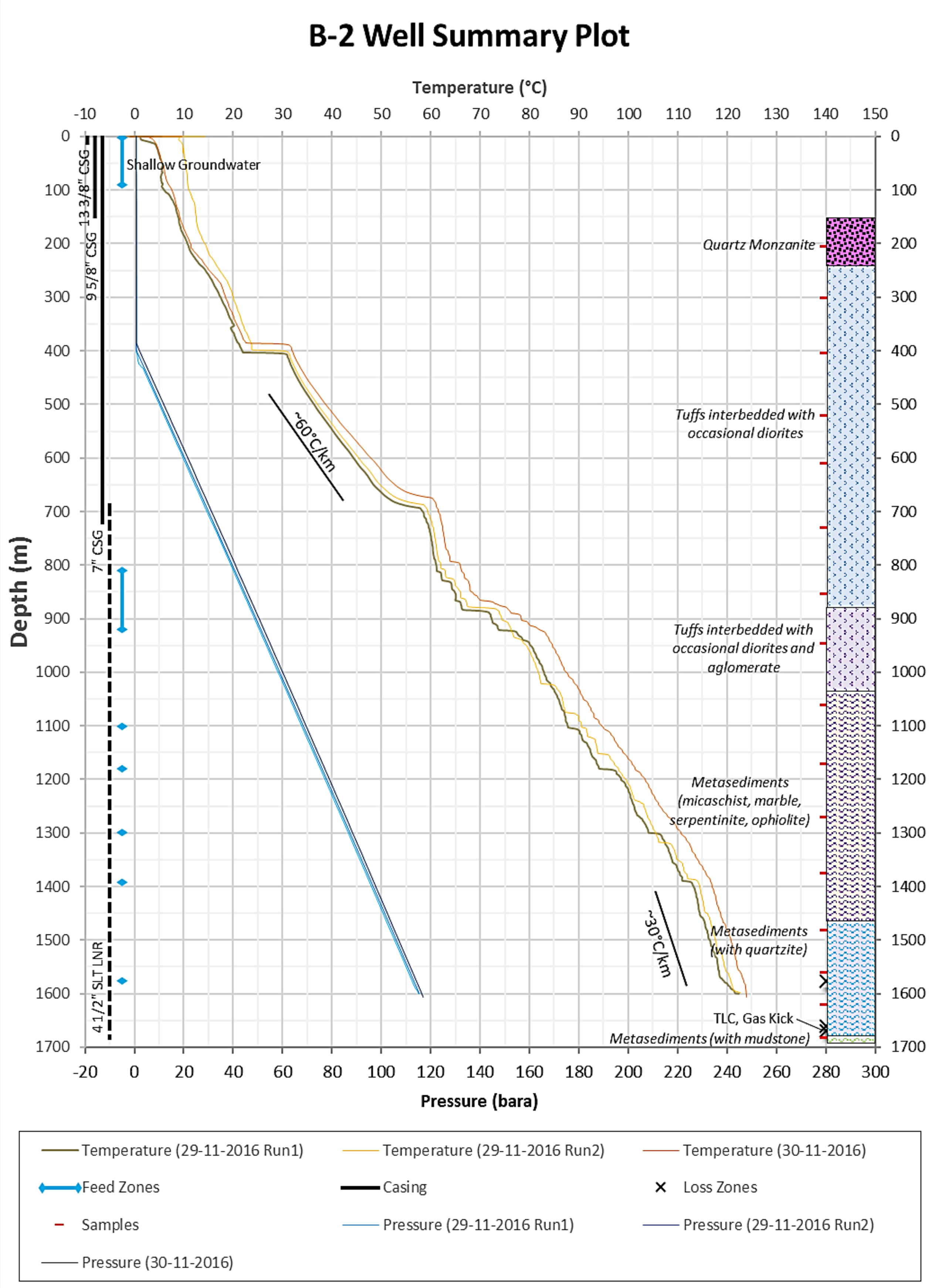
The low-resistivity anomaly is possibly the product of previously higher temperatures within the basin but is not currently associated with in situ high-temperature fluid. However, it’s geometry may still inform well targeting.

No significant feed zones were able to be tested in well B-2. A zone of total lost circulation was encountered at ~1660 m but was covered in sloughing cuttings before it could be tested. If this zone could be tested it may have a temperature >130°C.

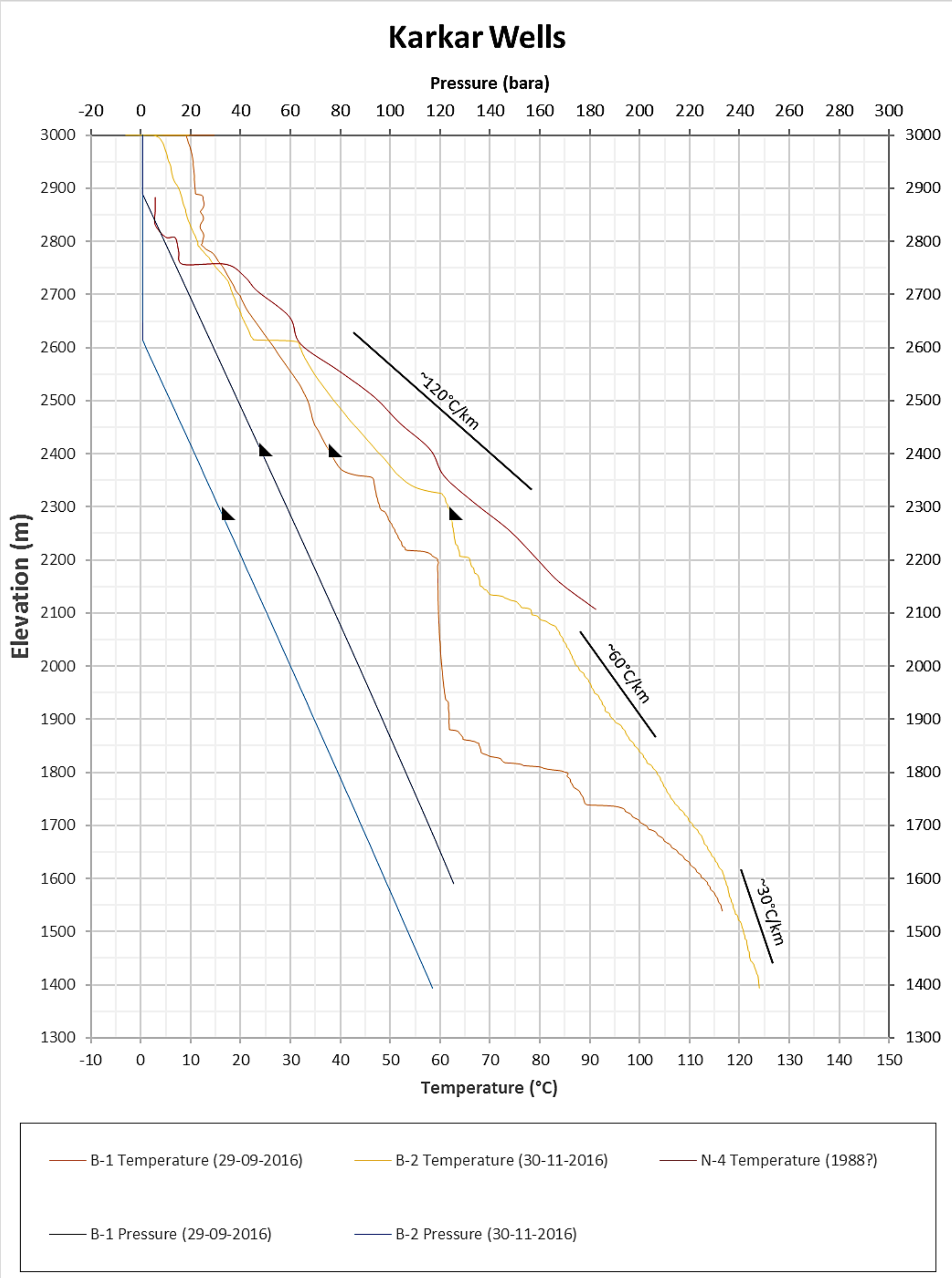
Unlike well B-1, the basement contact in well B-2 is not permeable. As evidenced by the large difference in static water levels between wells B-1 and B-2, the two wells are not in good hydraulic communication. This may be due to B-2 crossing a hydrological barrier such as impermeable fault.

The lateral extent of the Karkar Geothermal Field is unbounded in all directions. Deep temperatures in the basement rocks may fall of rapidly to the east of well B-1. B-2 may be the hottest well in the field after it fully heats up, but the up flow may also be located elsewhere.





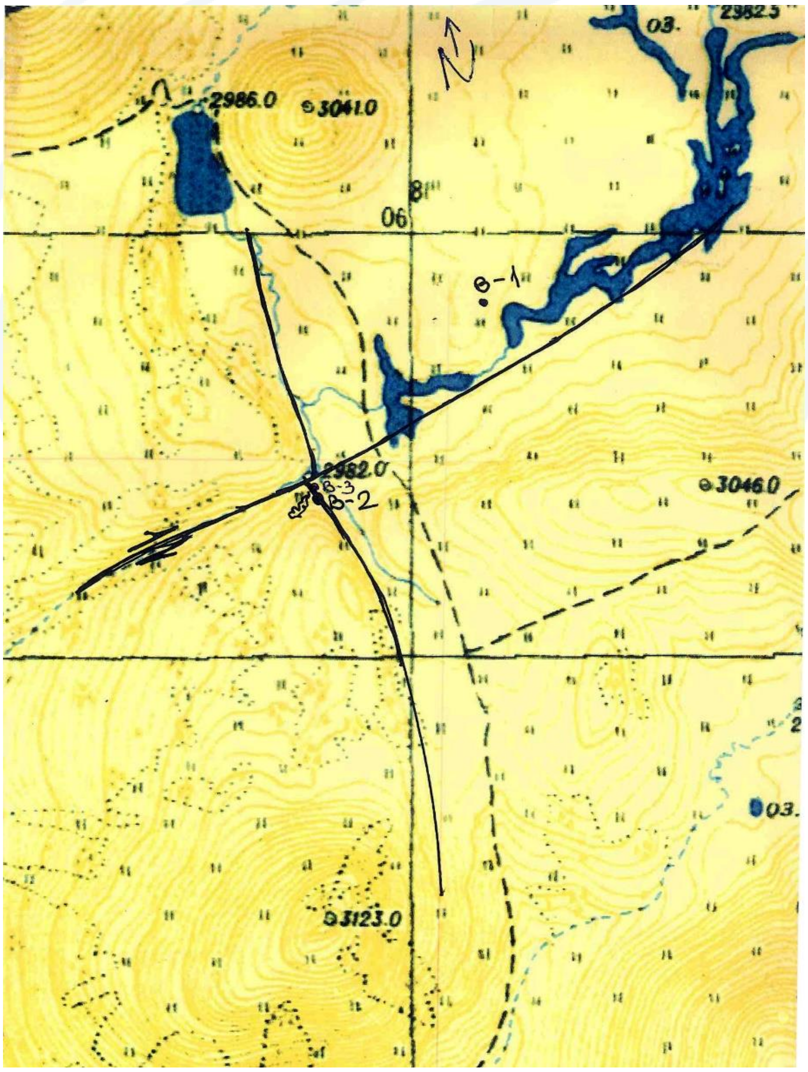
JRG Energy - Well Test Summary Plot B2



JRG Energy - Temperature and Pressure vs Elevation profiles of the three Karkar wells.

Integrated interpretation of the data collected through the drilling and testing of the wells

Karkar geothermal field is the top of 3300m, situated in Southern Armenia. Karkar, close to the border with Nagorno-Karabakh, in the SW of Armenia, in the Eastern Turkey-Iranian High Plateau and Caucasus is one of the best examples of an active continental collision zone in the world. It comprises one of the high plateaus of the Alpine-Himalaya mountain belt. A pull-apart zone and of Armenian high temperature geothermal area. A variety of extrusive, intrusive end metamorphic rocks are found on the surface of Armenian territory, ranging in a composition of tuffs. The range in composition of the rocks was produced by quartz monzonite, andesitic tuff, dacitic tuff, diorite. Many of the extrusive and intrusive rocks are fresh, and some of the quartz monzonites may be as young as a few hundred years old. The oldest possible age of the occurrence of the collision of area volcanic assemblage is defined by that of the collision crust of in Alp-Himalaya belt.



Tectonic model of Karkar Geothermal Field

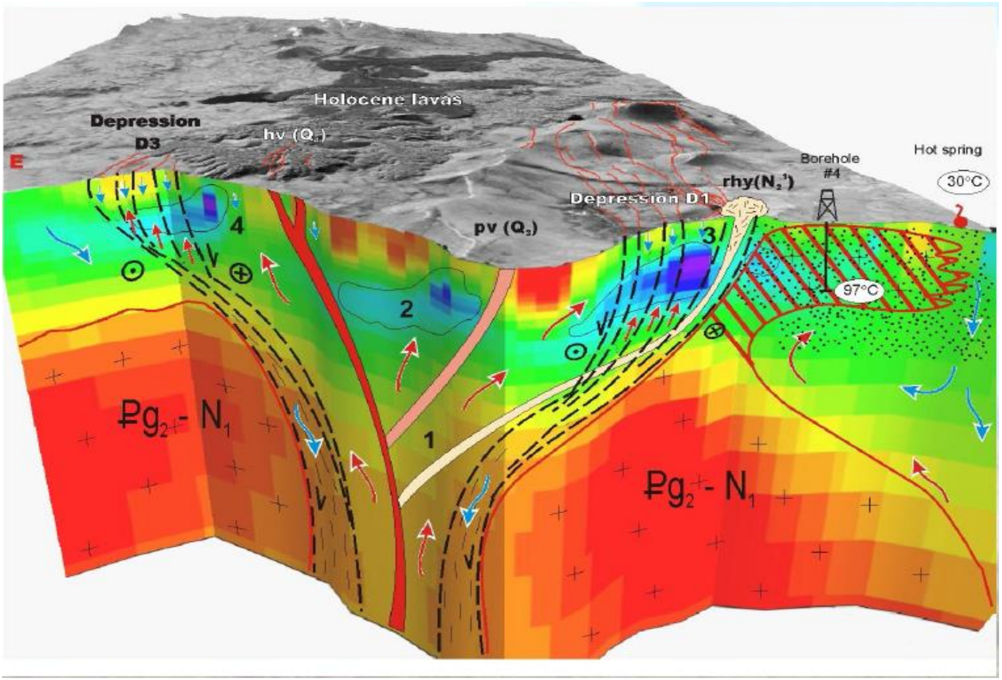
Quartz monzonite lavas are much more extensive at Karkar Mountain than other parts of Armenia, overlaid by marbles/ophiolites. Although N-S and E-W trending faults predominate in the Karkar Geothermal area, several NE/SW striking lineaments and SE/NW postulated faults also cut the geothermal area. The simplified geological section of the well shows the succession to be totally composed of pyroclastic rocks of two types of cover rocks and metamorphic basement rocks, are marble/mica schist and ophiolites (See Lithologies of B1 and B2).

All around Syunic area base metamorphic rocks represented by non-outcropped mica schists, marbles and ophiolites encountered at well B-1 between 1071-1500m. In geothermal area, surface volcanic rocks here are dominantly quartz monzonite, also quartz diorite, andesitic tuff, dacitic tuff and obsidian is encountered. The most dominant intrusive rock is quartz diorite, found between 545-570m, 630-660m, 900-965m, at the upper zones of wells. The basement/reservoir rocks are ophiolites.

The conceptual model of the Karkar Geothermal Field, originally presented in a resource assessment report by Georisk (2012) and revised by ISOR (2012), has been revised and updated based on review of the available resource reports, original re-interpretation of the data sets, and integration of data acquired from B-1 and B-2.

The previous conceptual model was based on the surveys, measurements and studies listed below;

1. Structural-geological and volcanological studies carried out jointly by GEORISK Scientific Research CJS and The South Florida University in 2009.
2. Geochemical investigations carried out by GEORISK Scientific Research CJS and the South Florida University in 2009.
3. 2D MT and TEM surveys carried out by GEORISK Scientific Research CJS and the South Florida University in 2009.
4. Interpretations of the 2D MT and TEM surveys of 2009 are conducted independently by the "Nord-West" Company (Russian Federation), and jointly by GEORISK CJS and the University of South Florida.
5. 3D MT and gravimetric surveys, as well as CO_2 gas surveys conducted by WesternGeco (Italy) in 2011.
6. Interpretations of the 3D MT and gravimetric surveys of 2011, realized independently by the Western Geco Company (Italy), and by GEORISK CJS in cooperation with the University of South Florida.



Conceptual Model Before B-1 & B-2

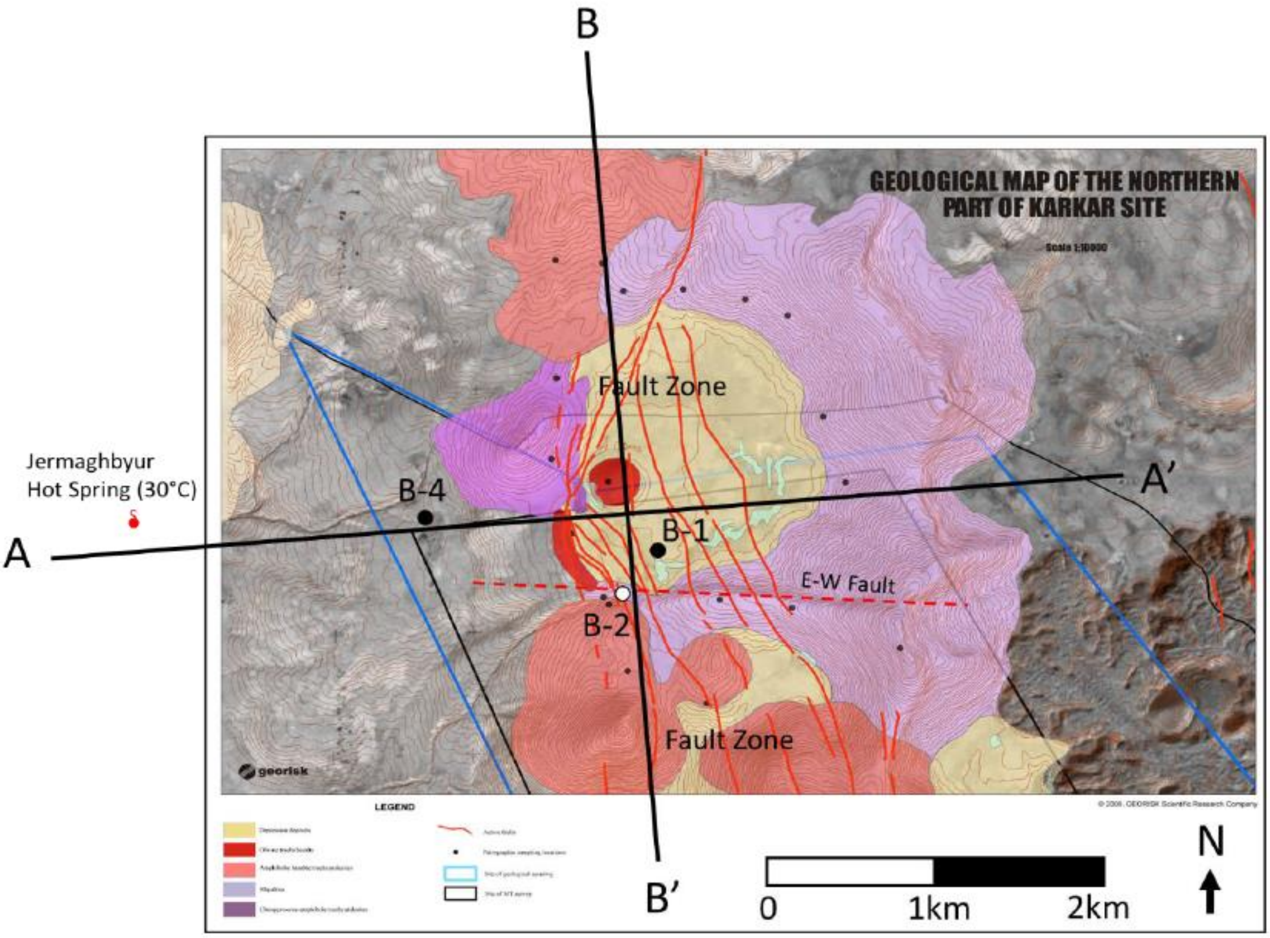
(Georisk/USF) The Geothermal Energy Project Armenıa,2014

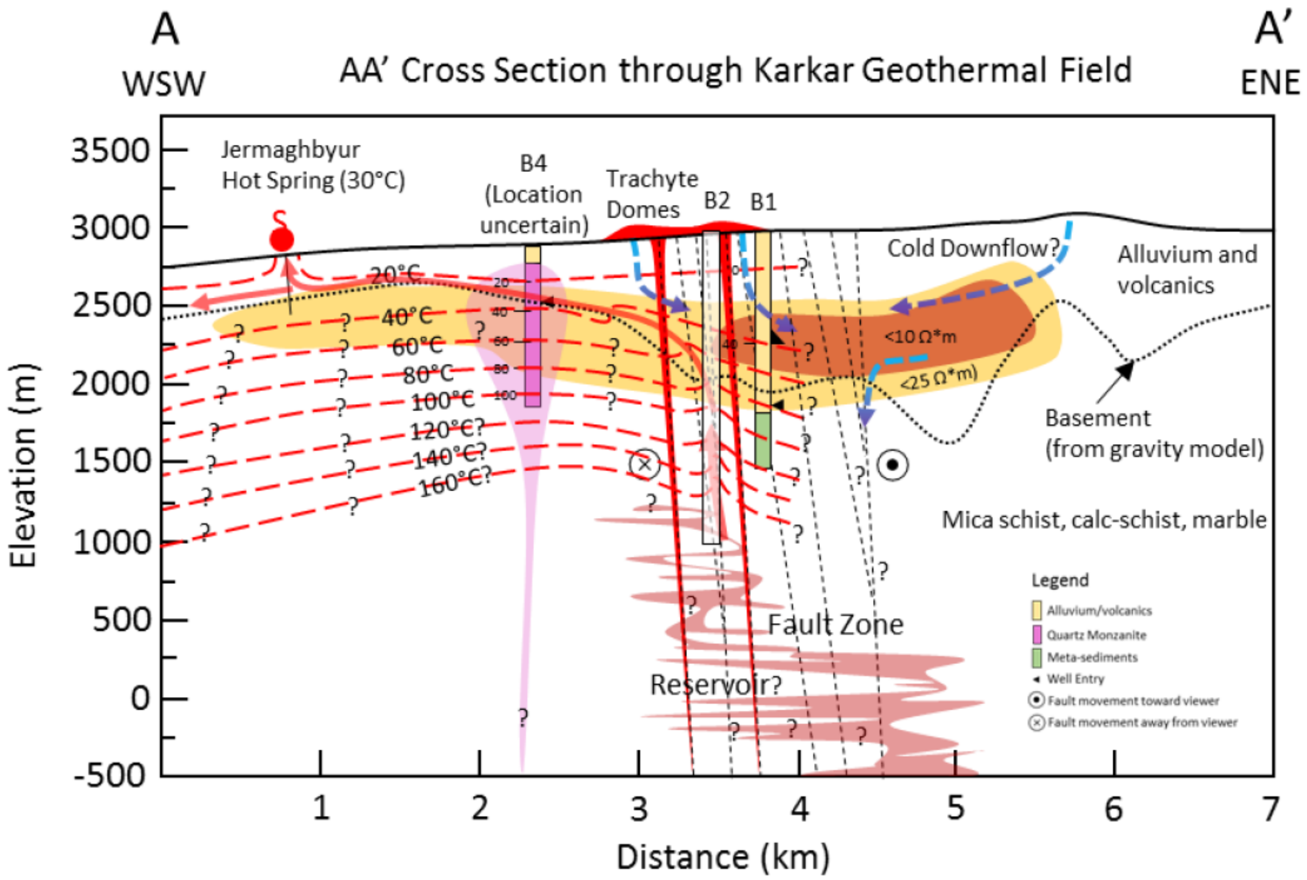
Cross-sections illustrating the conceptual model have been prepared and are presented below. Cross Section AA’ runs WSW to ENE approximately perpendicular to the mapped N-S extensional fault zone and includes the Jermaghbyur Hot Spring, well N-4, and the basin containing wells B-1 and B-2. Cross Section BB’ runs from NNW to SSE approximately parallel to the mapped N-S extensional fault zone, through the volcanic domes on either side of the basin and wells B-1 and B-2, and approximately perpendicular to the E-W strike slip fault interpreted by Erdogan Olmez (personal communication).

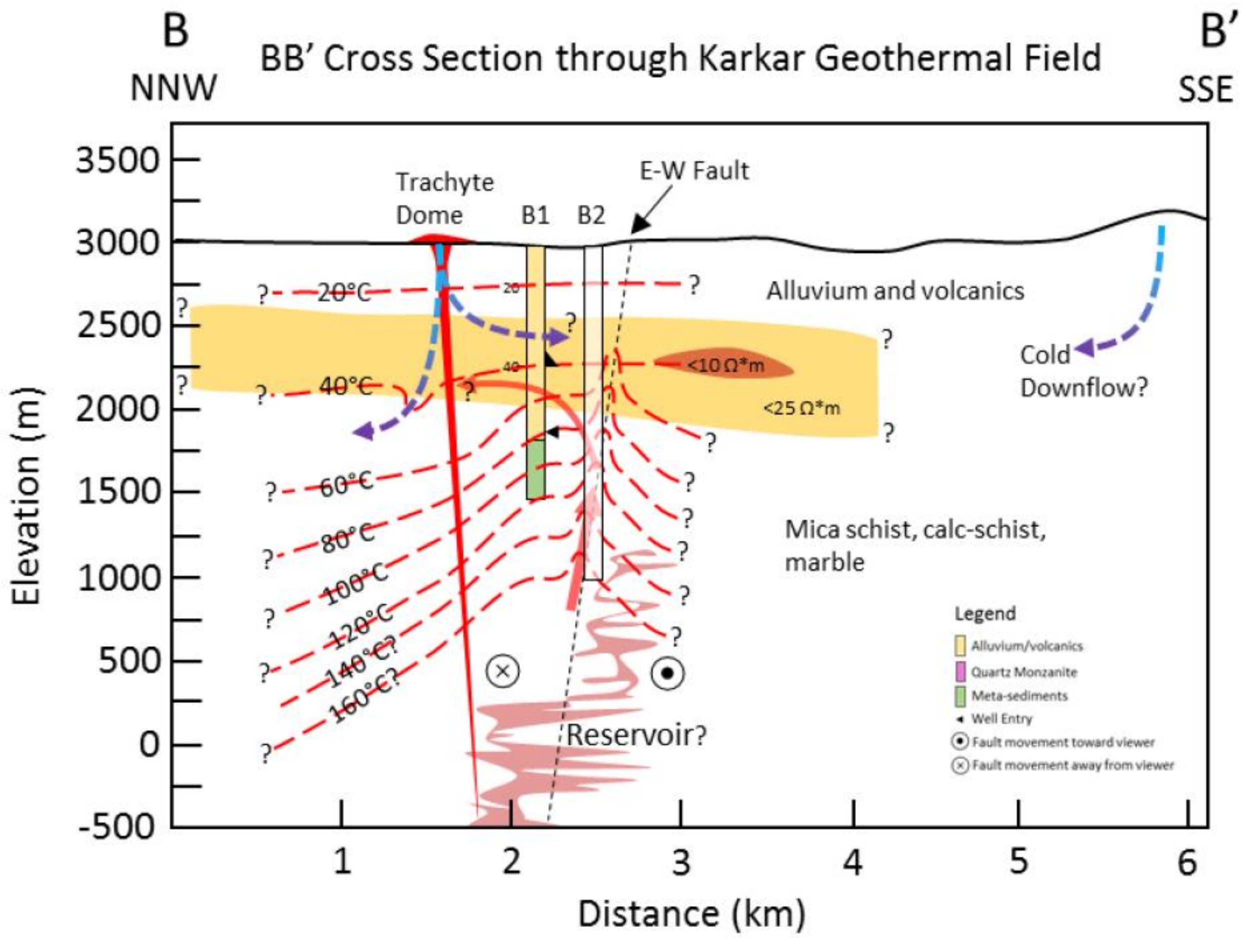
The preferred conceptual model involves a heat source at unknown depth related to volcanic intrusives and/or high regional heat flow. Hot buoyant fluids ascending from depth along the extensional faults utilize permeable marble zones in the basement rocks, fault complexities such as the intersection of the E-W and N-S extensional faults, and fracture networks between the faults to circulate forming a geothermal reservoir at depths of approximately 2000-3000 m and at temperatures between 150-160°C. The intersection of the fault trends allows an up flow of geothermal fluid to reach the permeable contact between the Paleozoic basement rocks and the overlying fractured Quaternary volcanic rocks. Geothermal fluid outflows along the basement contact in all directions at temperatures less than 100°C and mixes with cold meteoric groundwater which down flows along the fractured throats of the volcanic domes and within the fractured basin.

Meteoric water within the pull-apart basin recharges the reservoir along extensional faults on the margins of the basin.

An outflow at >30°C flows west along the basement contact and surfaces along a minor N-S fault at the Jermaghybur Hot Spring, along with CO_2 derived from buried organic and/or deep crustal sources.




A
WSW
AA' Cross Section through Karkar Geothermal Field
A'
ENE
Jermaghbyur
Hot Spring (30°C)
B4
(Location
uncertain)
Trachyte
Domes
B2
B1
Cold Downflow?
Alluvium and
volcanics
20°C
40°C
60°C
80°C
100°C
120°C?
140°C?
160°C?
<10 Ω*m
<25 Ω*m)
Basement
(from gravity model)
Mica schist, calc-schist, marble
Fault Zone
Reservoir?
Legend
Alluvium/volcanics
Quartz Monzanite
Meta-sediments
Well Entry
Fault movement toward viewer
Fault movement away from viewer
Elevation (m)
Distance (km)


B
NNW
BB' Cross Section through Karkar Geothermal Field
B'
SSE
Trachyte
Dome
B1
B2
E-W Fault
20°C
40°C
60°C
80°C
100°C
120°C
140°C?
160°C?
Alluvium and volcanics
<10 Ω*m
<25 Ω*m
Cold
Downflow?
Mica schist, calc-schist,
marble
Reservoir?
Legend
Alluvium/volcanics
Quartz Monzanite
Meta-sediments
Well Entry
Fault movement toward viewer
Fault movement away from viewer
Elevation (m)
Distance (km)

Recommendations for next steps

Further wells should be drilled to at least 2000 m at Karkar in order to prove higher temperatures and permeability associated with a possible upflow at the intersection of the dominant fault trends. Alternately, wells B-1 and B-2 could be deepened to 2500 meters.

Cuttings from B-1 and B-2 should be analysed at an appropriate laboratory for petrographic mineral identification, alteration clays by shortwave infrared (SWIR) and/or x-ray diffraction (XRD), and possibly fluid inclusion temperature analysis. Appropriate laboratories include ISOR in Iceland and GNS Science in New Zealand. The data and conclusions from these analysis should be made available to technical overseers and included in the conceptual models.

Temperatures in B-1 and B-2 should be re-surveyed at a later date to evaluate the stabilized temperature and confirm temperature gradients. This would help minimize the introduced error in the horner temperature plot and lead to higher accuracy in the conceptual model.

Well B-2 should have the cuttings on bottom cleaned out with a rig or coiled tubing unit and air compressor/Nitrogen unit. The total loss zone at ~1660 m should be tested once this is complete. Both well intervention methods are capable of clearing the cuttings from the bottom of the well, however the best course of action for this particular case is a drilling rig. The main advantage of using a rig in this instance is that the existing lining can be pulled and drilling may continue. If this course is chosen, the initial planned TD of 2000 m should be targeted to provide more conclusive data of existing models and improve the likelihood of viable production. The size and capabilities of the unit should be larger than that used to drill B1 and B2.

An area thermography map should be created to re-evaluate existing surface geothermal features and identify the location of the N4 wellbore. Consider using ROAV’s or drone capabilities with radiometric IR cameras to complete this task in a cost effective manner. The results can be used to improve the accuracy of the existing conceptual model and improve the accuracy of subsequent well placements.

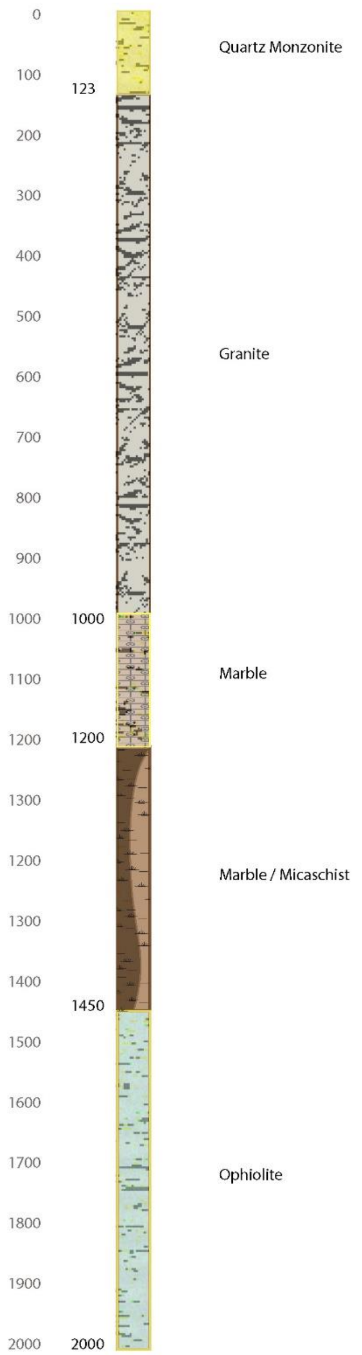
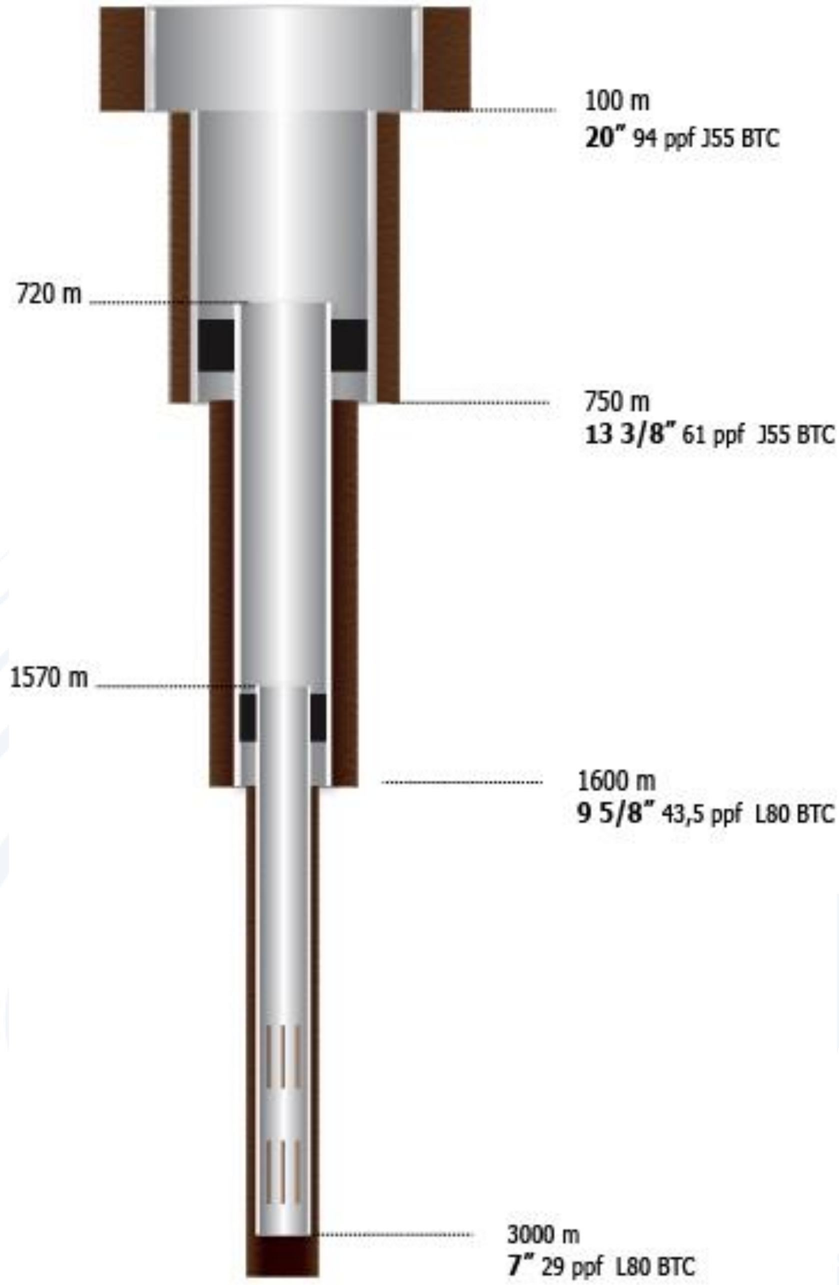


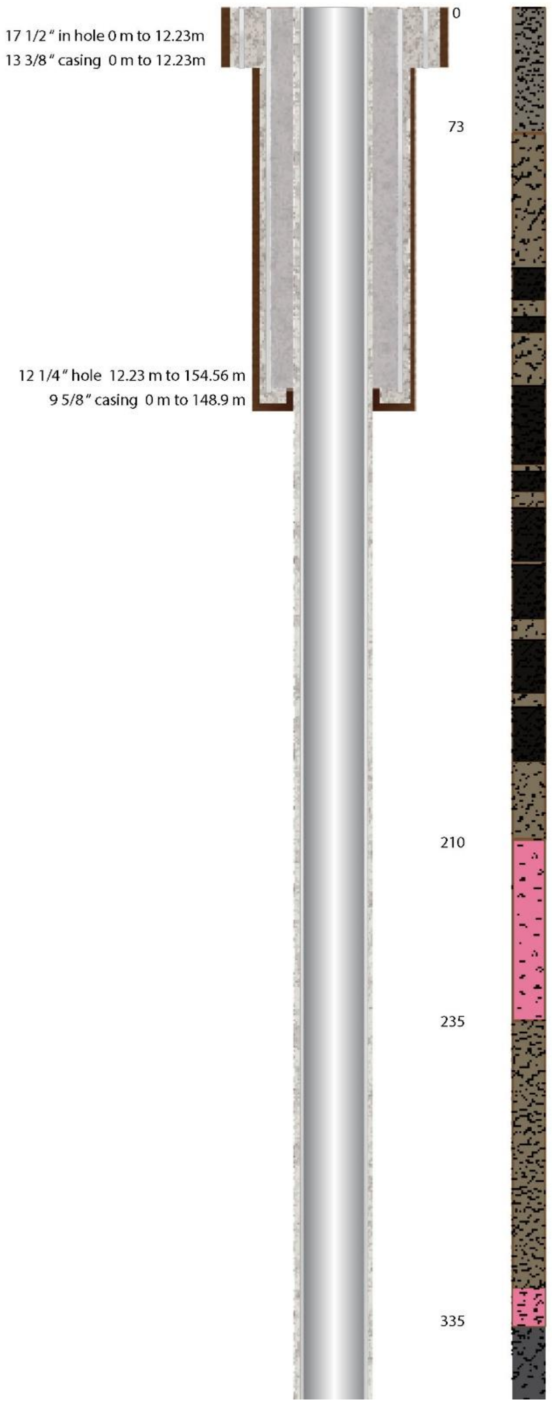
Figure 2 Uncertainity log of well B-5



Well Plan for proposed wells B3 and B5

APPENDIX

Lithology of B-1



Tuff: White in color, medium hard, rounded

Tuff: Yellowish brown to brown, beige, dark gray, black ; firm to hard ; micaceous transparent, green, shiney, glittering mica flakes (olivine,muscovite,plagioclase) ; occassionally verysmall obsidian grains ; trace pyrite.

Basalt : Black, firm to hard, fine grain size, micaceous, pxroxene and amphibole accessories.

Tuff(Andesitic): Beige, gray, firm to hard, earthy, fine grain size, micaceous, coarse pyroxene, feldspar and quartz accessories.

Basalt : Black,dark gray, firm to hard, fine grain size, micaceous, olivine, pyroxene and amphiboleaccessories.

Tuff: Pinkish red, brown, beige, dark gray; firm to hard; micaceous, transparent, green, shiney, glittering micaflakes (muscovite,plagioclase); occassionally very small obsidian grains.

Diorite: Gray to dark gray; firm to hard; earthy, fine to coarse grained, micaceous, transparent, black, shiney, glittering mica flakes (hornblend, plagioclase, biotite); quartz accessories, occassionally light gray tuff grains, trace of andesite.

Tuff: Yellowish brown to brown, white, gray to dark gray, beige ; soft to firm; micaceous, transparent, shiny, fibrous, glittering muscovite and biotite flakes; high percentage of white, translucent, sub-euhedral plagioclase grains.

Tuff: White, translucent, transparent, amorphous to chalky texture, soft to moderately hard, sub-euhedral to euhedral, vitreous.

Diorite: Gray to dark gray; firm to hard; earthy, fine to coarse grained, micaceous, black, shiny, hexagonal, glittering mica flakes (hornblend, biotite).

Tuff(Andesitic): Beige, gray, firm to hard, earthy, fine grain size, micaceous, coarse pyroxene, feldspar accessories, occassionally chalcopyrite.

Diorite: Pale red with white to light gray point, white, beige; firm to hard; earthy, coarse grained, euhedral, micaceous.

Tuff(Andesitic): White, beige, gray, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene accessories, grading to diorite.

Diorite: White to light gray point, rarely pale red, white, beige; firm to hard; earthy, coarse grained, euhedral, micaceous, high percentage of chalcopyrite.

Tuff(Andesitic): White, beige, gray, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar and quartz accessories, abundance of chalcopyrite.

Tuff: White, translucent, amorphous to chalky texture, soft to moderately hard, sub-euhedral to euhedral, occassionally pyrite.

Tuff(Andesitic): Light gray to dark gray, beige, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar and quartz accessories.

Tuff: White, translucent, amorphous to chalky texture, soft to moderately hard, sub-euhedral to euhedral, occasionally pyrite

Total Loss

Tuff(Andesitic): Gray to dark gray, beige, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar and quartz accessories, abundance of pyrite, tuff traces.

Tuff(Andesitic): Gray to dark gray, rarely light gray, beige, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar accessories, abundance of pyrite.

Tuff(Andesitic): Dark gray, rarely gray, hard, earthy, fine grain size, euhedral, micaceous, coarse feldspar accessories, abundance of pyrite.

Tuff(Andesitic): Lightgray to dark gray, hard, earthy, fine grain size, euhedral, micaceous, coarse feldspar accessories, abundance of pyrite; rarely altered soft grains, trace ofgypsum/anhydrite.

Tuff: White, amorphous to chalky texture, soft to hard, sub-euhedral to euhedral.

Tuff(Andesitic): Light gray to dark gray, hard, earthy, fine grain size, euhedral, micaceous, coarse feldspar accessories, abundance of pyrite; occassionally white, yellow colored, altered soft grains, trace of gypsum/anhydrite.

Tuff(Andesitic): Gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally whit e, yellow colored, altered soft grains.

Tuff(Andesitic): Light gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, beige colored, altered soft grains.

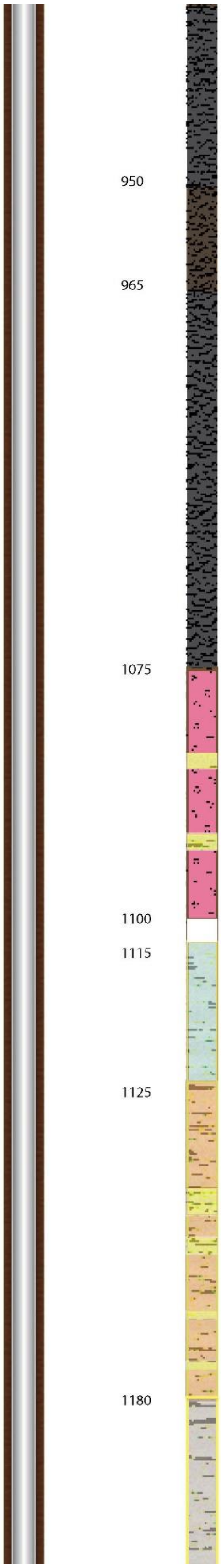
Tuff(Andesitic): Light gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, beige colored, altered soft grains.

Tuff: White, light gray to dark gray, soft to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occasionally beige colored, altered soft grains.

Tuff(Andesitic): Light gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, beige colored, altered soft grains.

Tuff (Andesitic) (Dacidic): Black, andesines converted to clay, black, soft, alterated, biotite and some hornblends.

Andesite: Black, gray, andesines partly altered cemented hard tuff in gray color, full sulphur, fracture fill, cement welded.
Andesite: Black, grey, andesines partly altered cemented hard tuff in grey, full sulphur, hornblend, iron, pyrite, opalin, hornblend, fracture fill, cement welded.



Tuff (Andesitic): Brown, pyrite, iron, layered, fine grained.

Tuff (Andesitic): Grey, andesine altered, soft, non consolidated, colapsable, pyrite, tuff cemented.

950

Andesite: Grey to dark grey, soft to moderately hard, altered andesine, feldspar cement, fine grained, sulphur and pyrite.

Andesite: Grey to dark grey, soft to moderately hard, altered andesine, feldspar cement, fine grained, sulphur, smectite and pyrite.

965

Tuff (Dacidic): Black, white, fine grained, pyrite, sticky.

Tuff (Dacidic): Black, white, fine grained, pyrite, sticky, smectite, calcopyrite, biotite.

1075

Dolomitic Marble: white, chalcopyrite, quartzite, feldspar, alterated rock/iron, listvenite.

Grayywacke: Brown, hard, sand size, rounded, well sorted, abundance of pyrite, quartzite fracture fills.

Grayywacke: Brown, hard, sand size, rounded, well sorted, abundance of pyrite, quartzite fracture fills.

1100

1115

Ophiolite: White, light grey, soft to hard, coarse grained, coarse feldspar pyroxene, quartzite, feldspar, calcopyrite, pyrite, smectite, cement matrix tuff, carbonate, clay.

1125

Granite: White, hard, coarse grained, quartzite, feldspar, mica, smectite. biotite, pyrite, chalcopyrite, fracture porosity.

Grayywacke: Brown, hard, sand size, rounded, well sorted, abundance of pyrite, quartzite fracture fills.

Grayywacke: Brown, hard, sand size, rounded, well sorted, abundance of pyrite, quartzite fracture fills.

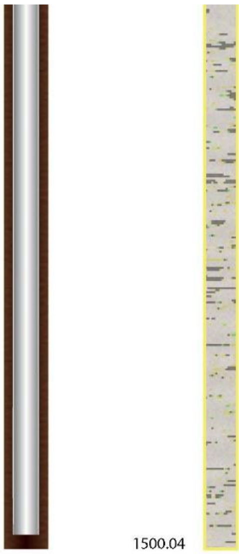
1180

Mica schist: Black, thin layered, medium hardness, fine grained, fracture file calcite green, cement matrix welded clay.

Marble: White, hard, fine grained, cement CaCo3, welded.

Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.

Marble: White, sand size carbonated, cement carbonate, pyrite, smectite.



4 1/2" liner 649 m to 1497 m

6 1/8" hole 687 m to 1500.04 m

1500.04

Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.

Marble: White, sand size carbonated, cement carbonate, pyrite, smectite.

Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.

Marble: White, sand size carbonated, cement carbonate, pyrite, smectite, iron.

Mica schist: Black, hard, medium hardness, fine grained, clastics rounded, black clay cementing material, accessory minerals, serizites, pyrite, sulphur, smectite.

Mica schist: Black, hard, medium hardness, fine grained, clastics rounded, black clay cementing material, accessory minerals, serizites, pyrite, sulphur, smectite.

Marble: White, sand size carbonated, cement carbonate, pyrite, smectite, iron oxide.

Mica schist: Black, hard, fine grained, rounded sand size, clay cemented

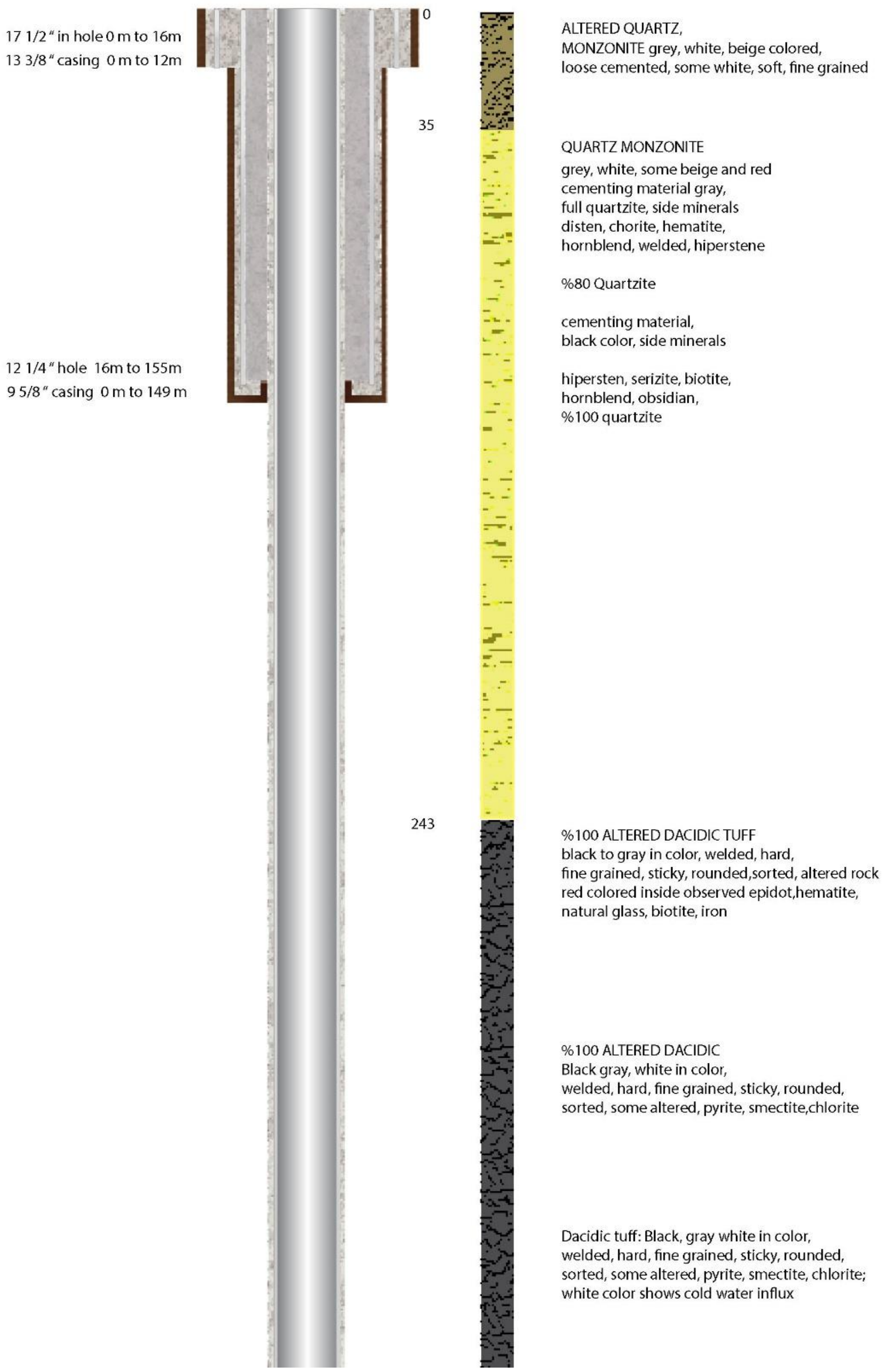
Marble: White, sand size carbonated, cement carbonate, sulphur crystal, pyrite, smectite, iron.

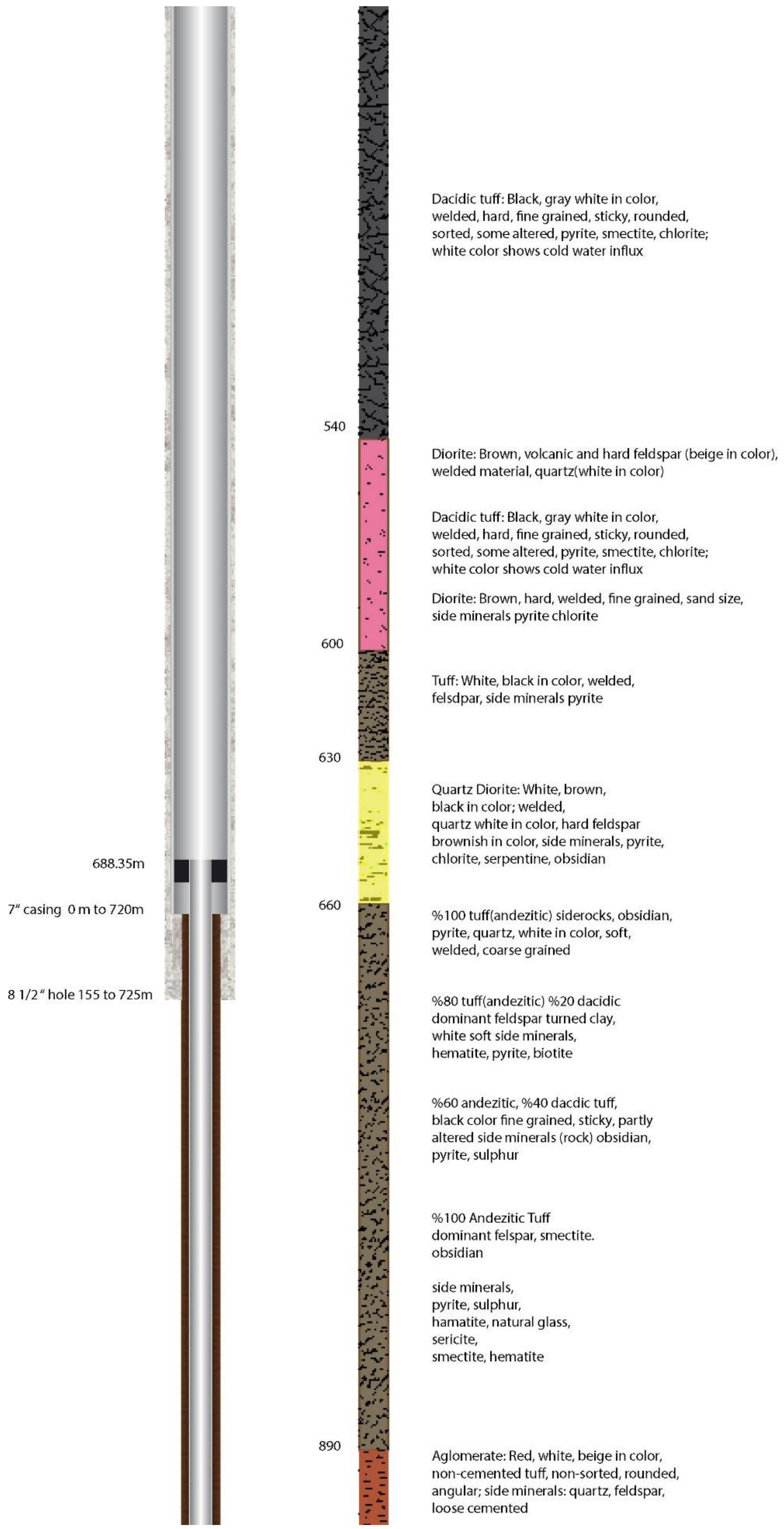
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented, sulphur, serizit schist, green schist.

Mica schist: Black, hard, fine grained, rounded sand size, clay cemented, sulphur, serizit schist, green schist, pyrite, smectite.

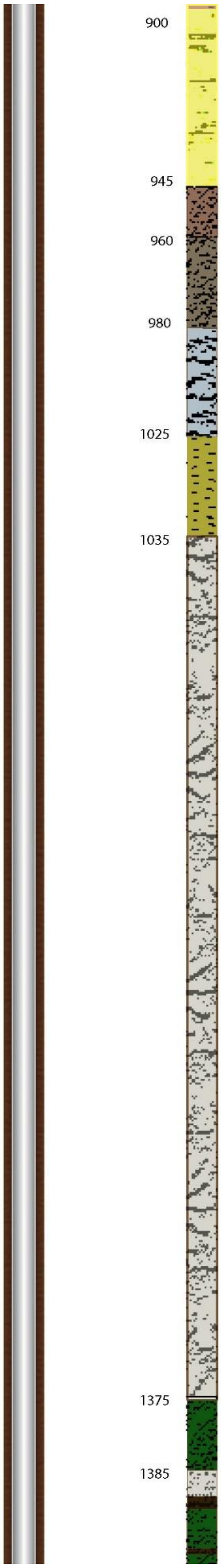
Marble: White, sand size carbonated, cement carbonate, sulphur crystal, pyrite, smectite, iron.

Lithology of B2





688.35m
7″ casing 0 m to 720m
8 1/2″ hole 155 to 725m
540
600
630
660
890
Dacidic tuff: Black, gray white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite, smectite, chlorite; white color shows cold water influx
Diorite: Brown, volcanic and hard feldspar (beige in color), welded material, quartz(white in color)
Dacidic tuff: Black, gray white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite, smectite, chlorite; white color shows cold water influx
Diorite: Brown, hard, welded, fine grained, sand size, side minerals pyrite chlorite
Tuff: White, black in color, welded, felsdpar, side minerals pyrite
Quartz Diorite: White, brown, black in color; welded, quartz white in color, hard feldspar brownish in color, side minerals, pyrite, chlorite, serpentine, obsidian
%100 tuff(andezitic) siderocks, obsidian, pyrite, quartz, white in color, soft, welded, coarse grained
%80 tuff(andezitic) %20 dacidic dominant feldspar turned clay, white soft side minerals, hematite, pyrite, biotite
%60 andezitic, %40 dacdic tuff, black color fine grained, sticky, partly altered side minerals (rock) obsidian, pyrite, sulphur
%100 Andezitic Tuff dominant felspar, smectite. obsidian
side minerals, pyrite, sulphur, hamatite, natural glass, sericite, smectite, hematite
Aglomerate: Red, white, beige in color, non-cemented tuff, non-sorted, rounded, angular; side minerals: quartz, feldspar, loose cemented



Quartz diorite: Altered, brown,red in color,
hard, coarse grained; side minerals: serizite,
kaoline, pyrite, hematite, natural glass, sulphur,
epidote, serpentine, obsidian,
alterated mineral: smectite

Andezite : Brown, red in color,feldspar dominant, angular side,
welded; side mienrals: hematite,altered mineral: smectite

Andezitic Tuff: White color, soft, too loose cemented,
coarse grained, non-sorted, feldspars, turned clay,
side minerals: obsidian,alterated mineral: smectite

Diorite: White color, hard, welded,
fine grained, side minerals: feldspar, serizite,
hornblend, alteration mineral: smectite

Basal Conglomerate
White, black color, hard, loose welded,
cobble marble, tuff, obsidian, shale, cobbles,
cementing materials: calcite

White in color, hard, welded fine grained,
side marks, side minerals: calcite

Mica schist: Black in color, hard, welded, rine grained;
side minerals: hematite, calcite, smectite

%70 Mica schist. %30 marble black color, hard welded fine grained
side minerals, hematite,calcite, smectite

%70 marble, %30 mica-schist
Marble: White in color, hard, welded, fine grained.
Mica schist: black/ white in color, hard, laminated,
impermeable, welded, fine grained;
alteration mineral: smectite

%100 marble,white color, hard

1205
%90 marble, %10 mica-schist
blackin color, hard welded, smectite

1220
%70 mica-schist, %30 marble
blackin color, hard welded, fine grained
marble, white, beige hard calcilitic
alteration minerals, smectite

%60 mica-schist, %40 marble

%70 mica-schist, %30 marble

%80 mica-schist, %30 marble
side minerals, pyrite, smectite

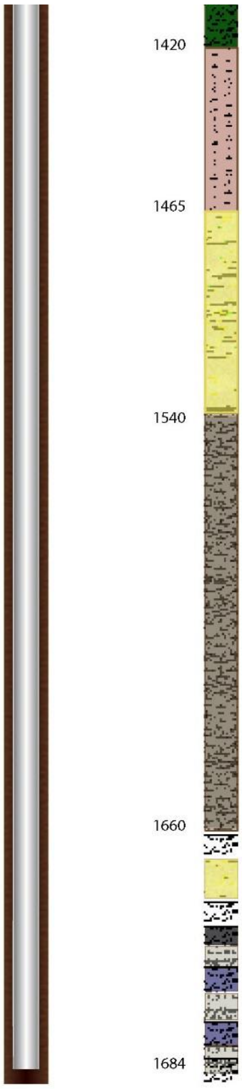
%80 marble (calsificated) %10 mica-schist, %10 biotite
Marble: White, beige, black in color, medium to hard, cemented,
fine grained, calcite fill; alteration mineral: smectite;
side mineral:hematite, biotite.
Mica schist: Black brown in color, hard welded, fine grained.

Serpentine: Green in color, hard, welded, fine grained, harzburgit;
side mineral: quartz, pyrite, mica schist; alteration mineral: smectite

Marble(10%): Brown, beige in color, hard to medium hard,
cementing material: mud coarse grained, silisificated;
alteration mineral: smectite, diorite.
Mica schist(10%): Black, brown in color, hard welded, fine grained;
side minerals: greywacke, sandstone, limestone.

4 1/2" liner 688.35m to 1682.80 m

6 1/8" hole 725.10 m to 1684.01m



Serpentine: Green in color, hard, welded, fine grained, harzburgite,
side mineral: quartz, calcite; alteration mineral: chlorite, smectite.

Ophiolites:
Metasandstone, beige in color, hard, well cemented, sand side
quartize, cemented by slica, welded, fine grained;
greywacke - gray in color, hard welded, cemented material -
clay, sand size quartzite, coarse grained.

Qaurtzite
Gray, light beige in color, too hard, fine grained,
slica dominant; side minerals: mica schist, pyrite, mudstone;
alteration minerals: smectite, chlorite

%90 mica-schist %10 quartzite
Mica schist: Black, white in color, hard, fine grained; side rocks: marble;
alteration minerals: smectite.
Quartzite: Gray, light beige in color, hard, fine grained,
silica dominant; side rocks: mica schist, marble; alteration minerals: chlorite.

%40 marble , %30 Qaurtzite,%30 mica-schist
Marble: Brown, beige in color, hard to medium hard, cementing material CaCO3,
coarse grained.
Mica schist: Black, white in color, hard, fine grained,
cementing material methamorphic mud; side rocks: marble;
alteration minerals: smectite.

%10 serpentine, %80 quartzite, %10 marble
Serpentinite: Green in color, hard, welded, fine grained, harzburgite;
side mineral: quartz, calcite; alteration mineral: chlorite, smectite.
Marble: Brown, beige in color, hard to medium hard,
cementing material CaCO3, coarse grained.
Quartzite: Gray, light beige in color, hard, fine grained, silica dominant;
side rocks: mica schist, pyrite; alteration minerals: smectite, chlorite.

1660 - 1665 Total Loss

%90 Quartzite %10 metasandstone
white/ red in color, hard
1675-1680m Total Loss

%60 mudstone, %20 mica-schist,
%10 marble, %10 quartzite
red mudstone, white (quatrzite/marble)
black (micaschist) color, hard(quartzite/marble)
soft (mudstone), cementing material clay,(mudstone)
CaCO3(marble) slica (quartzite, fine grained)
alteration minera smectite, temperature inverse,
side minerals, pyrite, calcite.

Mud Log

GEOLOG SURFACE LOGGING

MASTER LOG

Well : B-1

Scale 1:500 | All Depth in : m

WELL DATA

Company Name: SISIAN FPAT
Well Name: B1
Well Code:
Country: Armenia
Lease / Concession:
Region / Zone: Sisian
Well Coordinates: N39°46'54" Latitude
E45°56'50" Longitude
RT - Ground: 3.15 m
Sea Depth: 0 m
Spud-in Date: 15/07/2016 13:00:00
TD Depth: 1500 m
TVD Depth: 1500 m
Drilling End Date: 21.09.2016
Drilling Contractor: SISIAN FPAT
Rig Name: GEFCO 185K

OPEN HOLE SIZE

17.5"	From 0 m
12.25"	From 12.23 m
8.5"	From 154.66 m
6.125"	From 687 m

CASING SIZE

13.375"	to 12.23 m
9.625"	to 148.9 m
7"	to 682 m

MUD

SPUD	from 0 m
	from m
	from m
	from m

ABBREVIATIONS

NB New Bit
DB Diamond Bit
DBC Diamond Core
CB Core Bit
RRB Re-run Bit
TB Turbodrilling
RPM Revol/Min
WOB Weight on Bit
FR Flow Rate
TFA Total Flow Area
NR No Return
LC Mud Losses
DS Survey
SPP Pump Pressure
D Mud Density
S Mud Salinity
V Funnel Viscosity
TG Trip Gas
STG Short Trip Gas
PCG Connection Gas
Sample
Succesful

LITHOLOGY SYMBOLS

Shale	Limestone	Dolomite
Conglomerate	Mudstone	Gypsum
Pebbles	Wackstone	Anhydrite
Sand	Packstone	Granite
Sandstone	Grainstone	Basalt
Silt	Boundstone	Methamorphic Rocks
Clay	Chalk	Pyrite
Silty Clay	Argillaceous Limestone	Glauconite
Claystone Sillicif.	Silicified Limestone	Tuff
Marl	Dolomitic Limestone	Andesite
Coal - Lignite	Calc. Dolomite	Chert

GEOLOGICAL SAMPLING

Depth: from 60 m to 1500 m
Date: from 19.07.2016 to 21.09.2016

Sampling Rate:	
1-2 m	From 60 m to 1500 m
m	From m to m
m	From m to m
m	From m to m

UNIT CREW

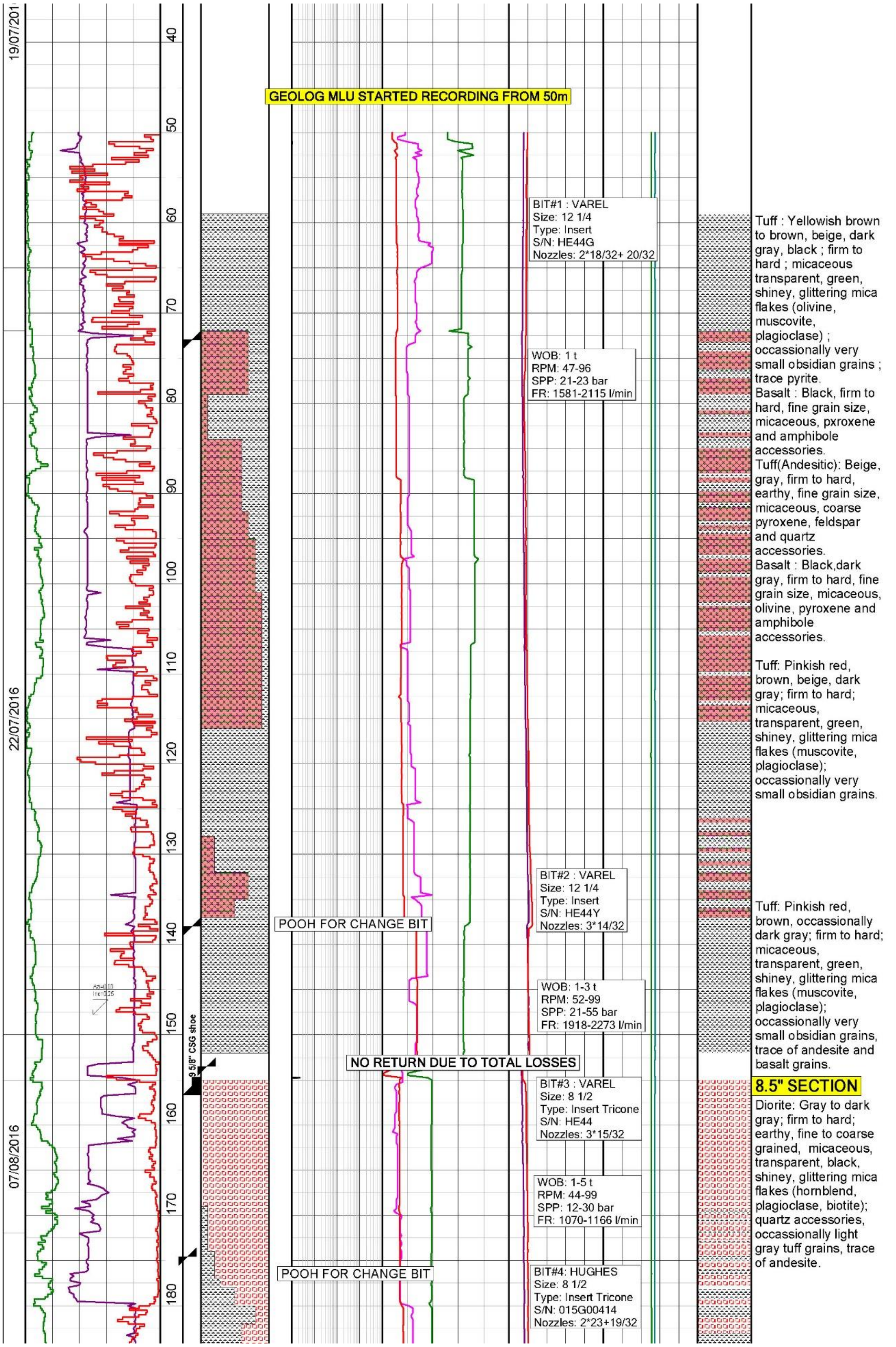
D.E: Alexandru Dabija, Kadir Kumtemur, Mehmet Ali Akman, Catalin Pop

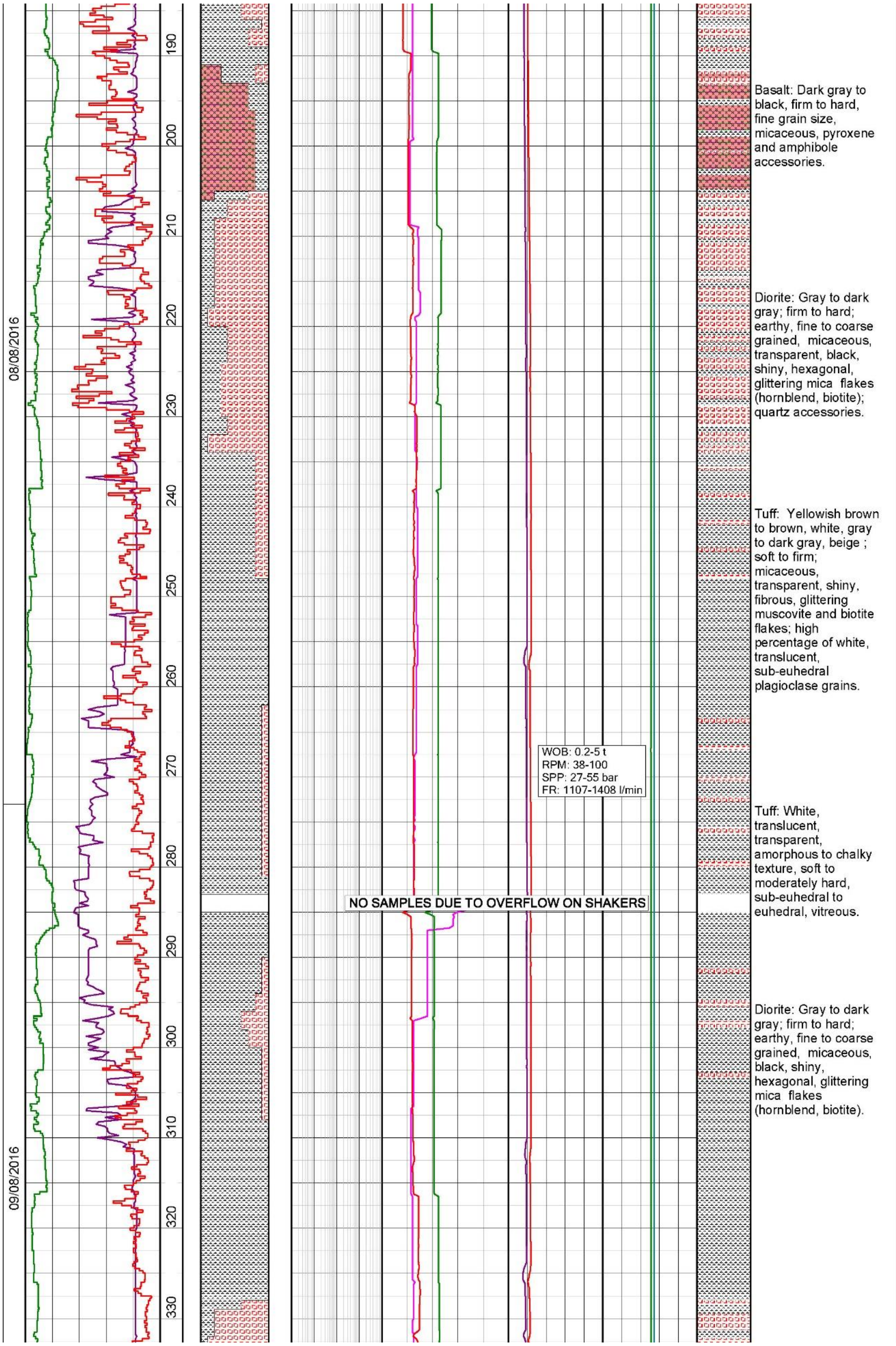
M.L:

SYMBOLS

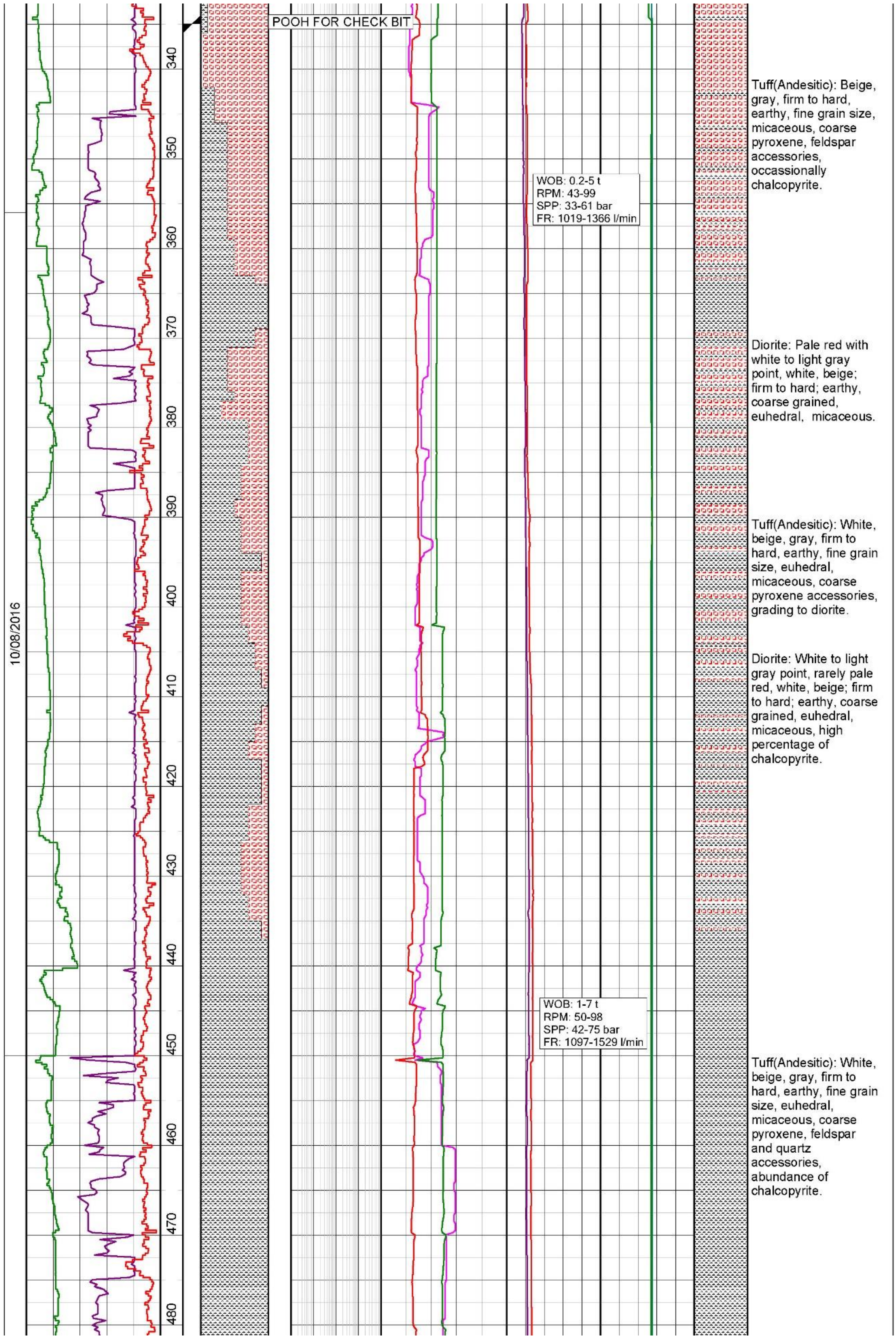
Heavy Oil	Gas and Water	Salty Water	Fresh Water
Casing Shoe	Top Liner	H2S Smell	CO2
Core Not Recovered	Recovery %	Sidewall Core	Core No.
	Deviation Survey	Fish	Cement

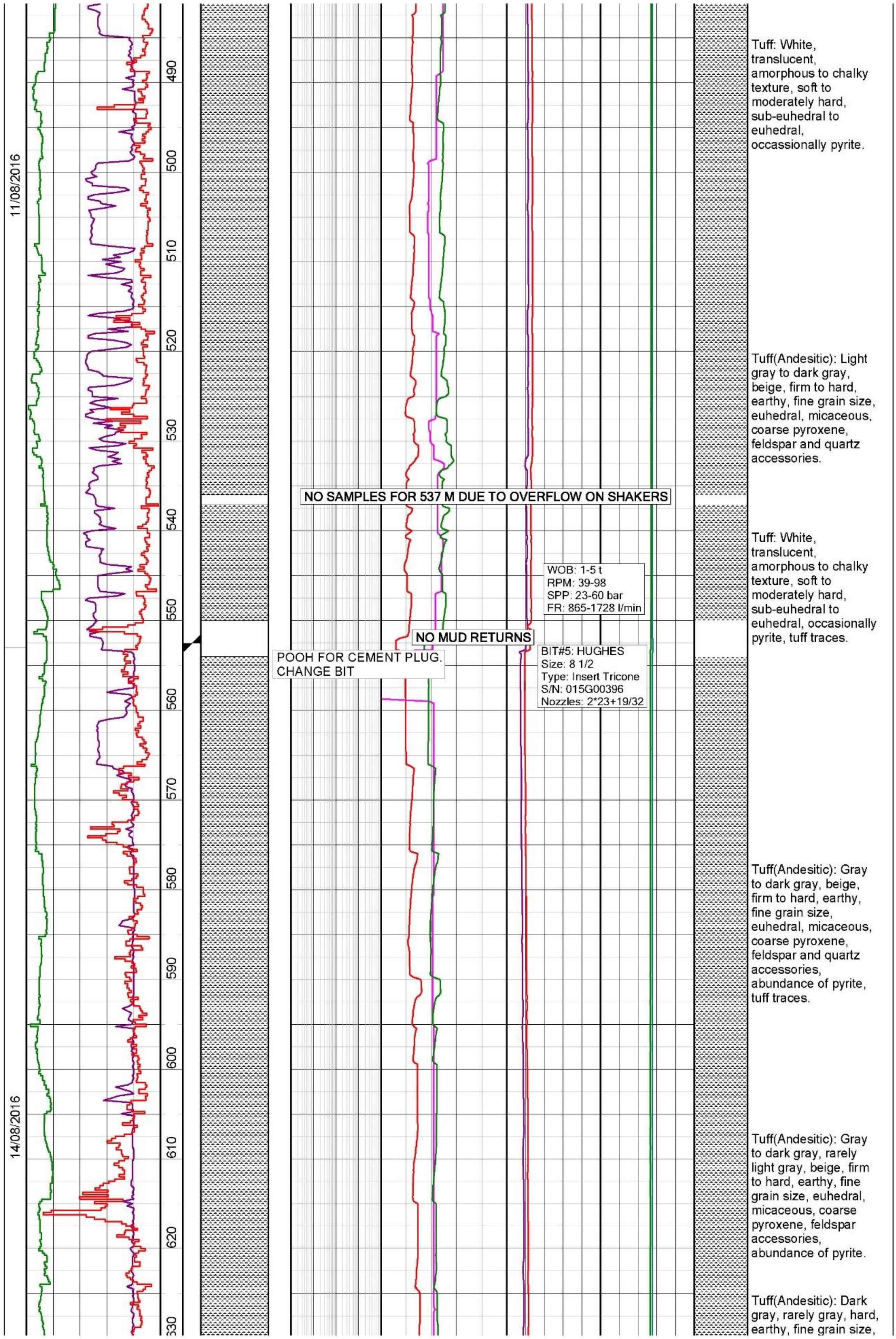
Date	ROP 50 m/h 0; WOB Avg 0 t_metric 20; RPM Avg 0 rpm 120	Depth (Mts)	Symbols	Cuttings	Core	TG (%) 0.01 % 100	Pressure: SPP Avg 0 bar 200; Flow IN (Pumps) Avg 0 l/min 3000; Flow Paddle 0 % 100	Temp. OUT 0 °C 150; Temp. IN 0 °C 150	Mud: MWI Avg 0 kg/l 2; Mud: MWO Avg 0 kg/l 2	Interpreted Lithology	Lithology / Remarks
15/07/2016		10	13 3/8" CSG shoe								12.25" SECTION
		20									
		30									

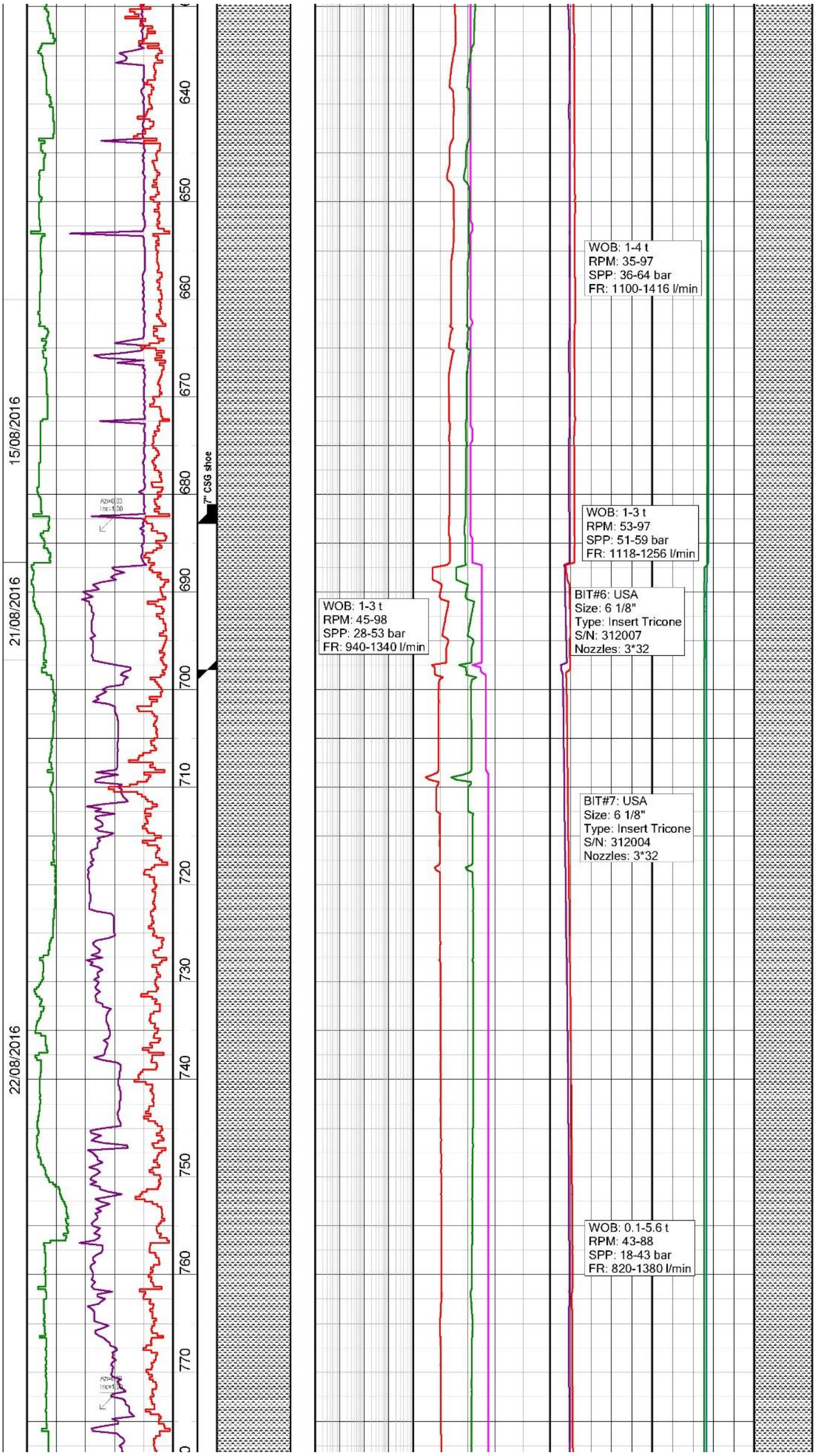

19/07/201
22/07/2016
07/08/2016
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
9 5/8" CSG shoe
GEOLOG MLU STARTED RECORDING FROM 50m
BIT#1 : VAREL
Size: 12 1/4
Type: Insert
S/N: HE44G
Nozzles: 2*18/32+ 20/32
WOB: 1 t
RPM: 47-96
SPP: 21-23 bar
FR: 1581-2115 l/min
BIT#2 : VAREL
Size: 12 1/4
Type: Insert
S/N: HE44Y
Nozzles: 3*14/32
POOH FOR CHANGE BIT
WOB: 1-3 t
RPM: 52-99
SPP: 21-55 bar
FR: 1918-2273 l/min
NO RETURN DUE TO TOTAL LOSSES
BIT#3 : VAREL
Size: 8 1/2
Type: Insert Tricone
S/N: HE44
Nozzles: 3*15/32
WOB: 1-5 t
RPM: 44-99
SPP: 12-30 bar
FR: 1070-1166 l/min
POOH FOR CHANGE BIT
BIT#4: HUGHES
Size: 8 1/2
Type: Insert Tricone
S/N: 015G00414
Nozzles: 2*23+19/32
Tuff : Yellowish brown to brown, beige, dark gray, black ; firm to hard ; micaceous transparent, green, shiney, glittering mica flakes (olivine, muscovite, plagioclase) ; occassionally very small obsidian grains ; trace pyrite.
Basalt : Black, firm to hard, fine grain size, micaceous, pxroxene and amphibole accessories.
Tuff(Andesitic): Beige, gray, firm to hard, earthy, fine grain size, micaceous, coarse pyroxene, feldspar and quartz accessories.
Basalt : Black,dark gray, firm to hard, fine grain size, micaceous, olivine, pyroxene and amphibole accessories.
Tuff: Pinkish red, brown, beige, dark gray; firm to hard; micaceous, transparent, green, shiney, glittering mica flakes (muscovite, plagioclase); occassionally very small obsidian grains.
Tuff: Pinkish red, brown, occassionally dark gray; firm to hard; micaceous, transparent, green, shiney, glittering mica flakes (muscovite, plagioclase); occassionally very small obsidian grains, trace of andesite and basalt grains.
8.5" SECTION
Diorite: Gray to dark gray; firm to hard; earthy, fine to coarse grained, micaceous, transparent, black, shiney, glittering mica flakes (hornblend, plagioclase, biotite); quartz accessories, occassionally light gray tuff grains, trace of andesite.



08/08/2016
09/08/2016
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
WOB: 0.2-5 t
RPM: 38-100
SPP: 27-55 bar
FR: 1107-1408 l/min
NO SAMPLES DUE TO OVERFLOW ON SHAKERS
Basalt: Dark gray to black, firm to hard, fine grain size, micaceous, pyroxene and amphibole accessories.
Diorite: Gray to dark gray; firm to hard; earthy, fine to coarse grained, micaceous, transparent, black, shiny, hexagonal, glittering mica flakes (hornblend, biotite); quartz accessories.
Tuff: Yellowish brown to brown, white, gray to dark gray, beige ; soft to firm; micaceous, transparent, shiny, fibrous, glittering muscovite and biotite flakes; high percentage of white, translucent, sub-euhedral plagioclase grains.
Tuff: White, translucent, transparent, amorphous to chalky texture, soft to moderately hard, sub-euhedral to euhedral, vitreous.
Diorite: Gray to dark gray; firm to hard; earthy, fine to coarse grained, micaceous, black, shiny, hexagonal, glittering mica flakes (hornblend, biotite).


POOH FOR CHECK BIT
10/08/2016
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
WOB: 0.2-5 t
RPM: 43-99
SPP: 33-61 bar
FR: 1019-1366 l/min
WOB: 1-7 t
RPM: 50-98
SPP: 42-75 bar
FR: 1097-1529 l/min
Tuff(Andesitic): Beige, gray, firm to hard, earthy, fine grain size, micaceous, coarse pyroxene, feldspar accessories, occassionally chalcopyrite.
Diorite: Pale red with white to light gray point, white, beige; firm to hard; earthy, coarse grained, euhedral, micaceous.
Tuff(Andesitic): White, beige, gray, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene accessories, grading to diorite.
Diorite: White to light gray point, rarely pale red, white, beige; firm to hard; earthy, coarse grained, euhedral, micaceous, high percentage of chalcopyrite.
Tuff(Andesitic): White, beige, gray, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar and quartz accessories, abundance of chalcopyrite.


11/08/2016
14/08/2016
490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
NO SAMPLES FOR 537 M DUE TO OVERFLOW ON SHAKERS
WOB: 1-5 t
RPM: 39-98
SPP: 23-60 bar
FR: 865-1728 l/min
NO MUD RETURNS
POOH FOR CEMENT PLUG.
CHANGE BIT
BIT#5: HUGHES
Size: 8 1/2
Type: Insert Tricone
S/N: 015G00396
Nozzles: 2*23+19/32
Tuff: White, translucent, amorphous to chalky texture, soft to moderately hard, sub-euhedral to euhedral, occassionally pyrite.
Tuff(Andesitic): Light gray to dark gray, beige, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar and quartz accessories.
Tuff: White, translucent, amorphous to chalky texture, soft to moderately hard, sub-euhedral to euhedral, occasionally pyrite, tuff traces.
Tuff(Andesitic): Gray to dark gray, beige, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar and quartz accessories, abundance of pyrite, tuff traces.
Tuff(Andesitic): Gray to dark gray, rarely light gray, beige, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse pyroxene, feldspar accessories, abundance of pyrite.
Tuff(Andesitic): Dark gray, rarely gray, hard, earthy, fine grain size,



euhedral, micaceous, coarse feldspar accessories, abundance of pyrite.

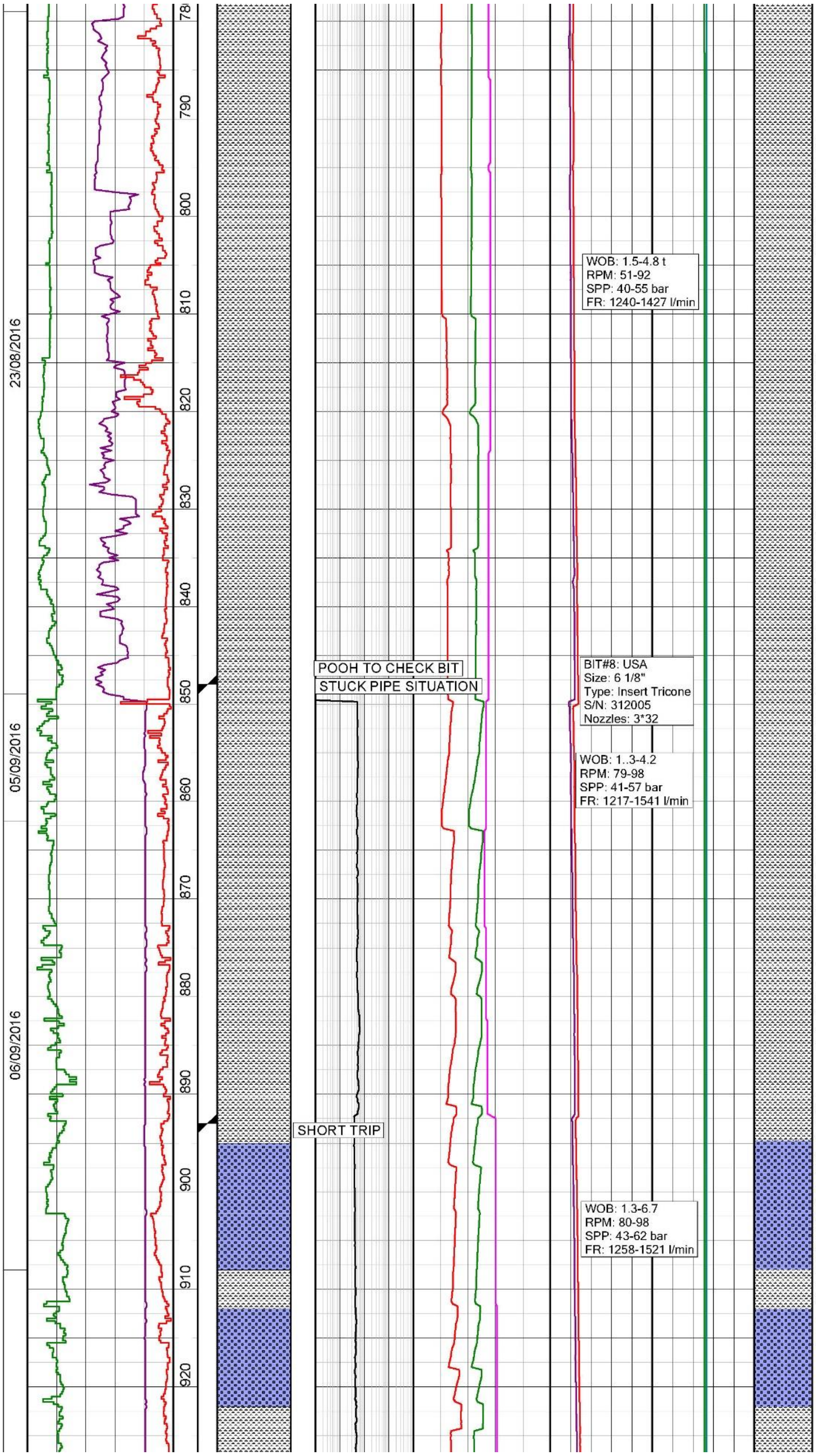
Tuff(Andesitic): Light gray to dark gray, hard, earthy, fine grain size, euhedral, micaceous, coarse feldspar accessories, abundance of pyrite; rarely altered soft grains, trace of gypsum/anhydrite.
Tuff: White, amorphous to chalky texture, soft to hard, sub-euhedral to euhedral.

Tuff(Andesitic): Light gray to dark gray, hard, earthy, fine grain size, euhedral, micaceous, coarse feldspar accessories, abundance of pyrite; occassionally white, yellow colored, altered soft grains, traces of gypsum/anhydrite.

6.125" SECTION

Tuff(Andesitic): Light gray to dark gray, firm to hard, earthy, fine grain size, euhedral, micaceous, coarse feldspar accessories, abundance of pyrite.

Tuff(Andesitic): Light gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, yellow colored, altered soft grains, traces of gypsum/anhydrite.



Tuff(Andesitic): Gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, yellow colored, altered soft grains.

Tuff(Andesitic): Light gray to gray, dark gray, white, firm to hard, altered soft grains, sticky, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite.

Tuff(Andesitic): Light gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, beige colored, altered soft grains.

Tuff(Andesitic): Gray to dark gray, firm to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occassionally white, beige colored, altered soft grains.

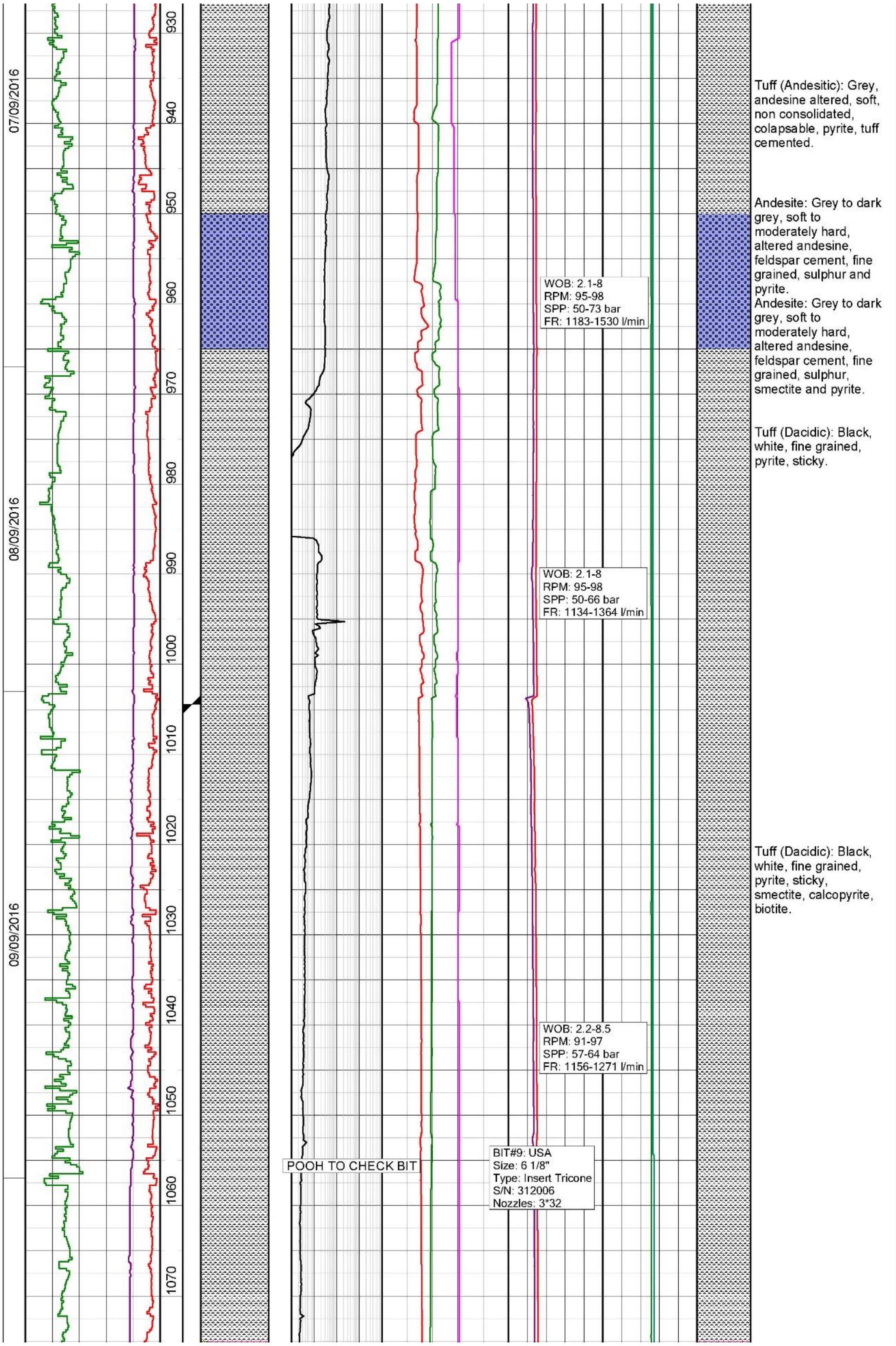
Tuff: White, light gray to dark gray, soft to hard, earthy, fine grain size, euhedral, coarse feldspar accessories, abundance of pyrite, occasionally beige colored, altered soft grains.

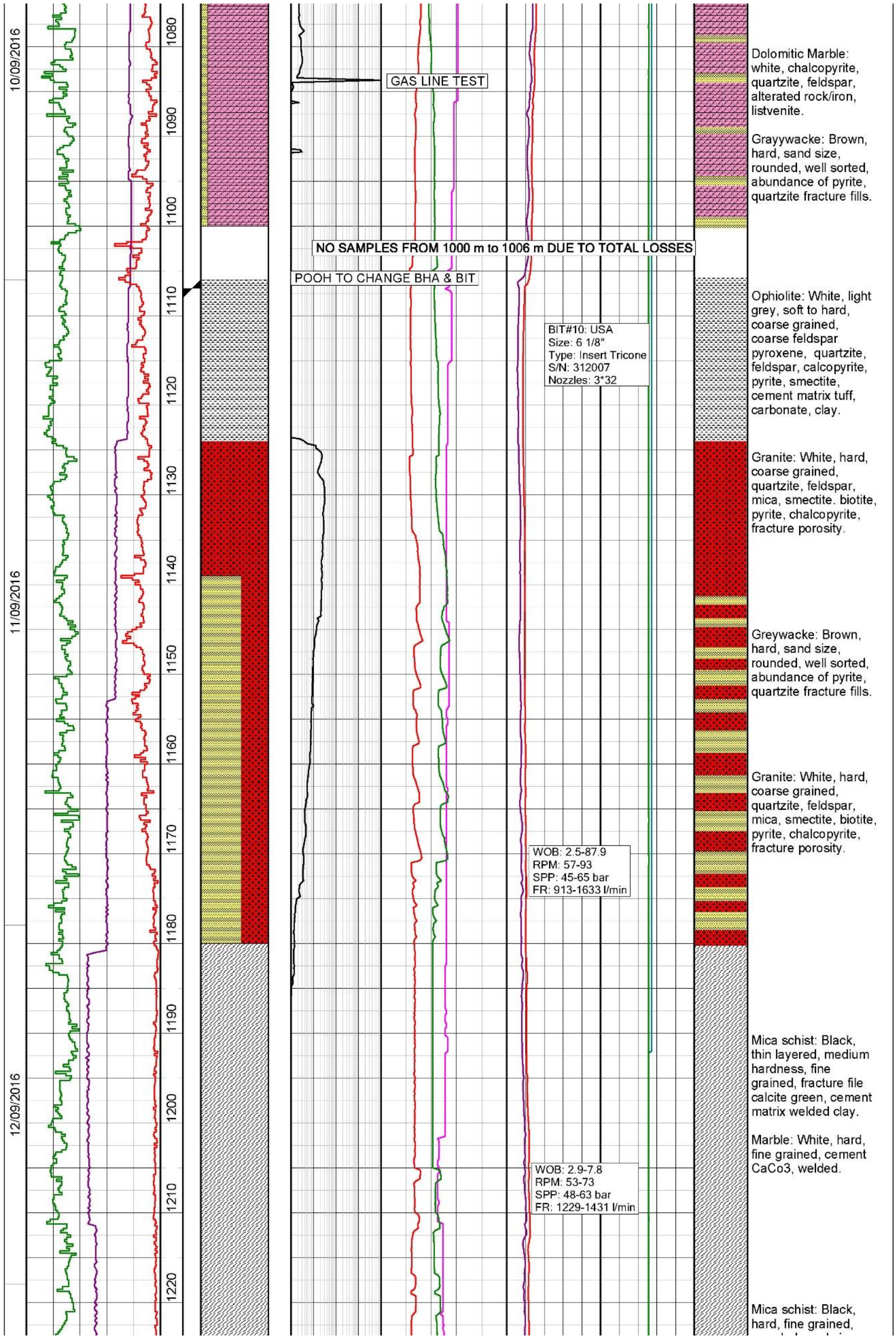
Tuff (Andesitic) _ (Dacidic): Black, andesines converted to clay, black, soft, alterated, biotite and some hornblends.

Andesite: Black, gray, andesines partly altered cemented hard tuff in gray color, full sulphur, fracture fill, cement welded.

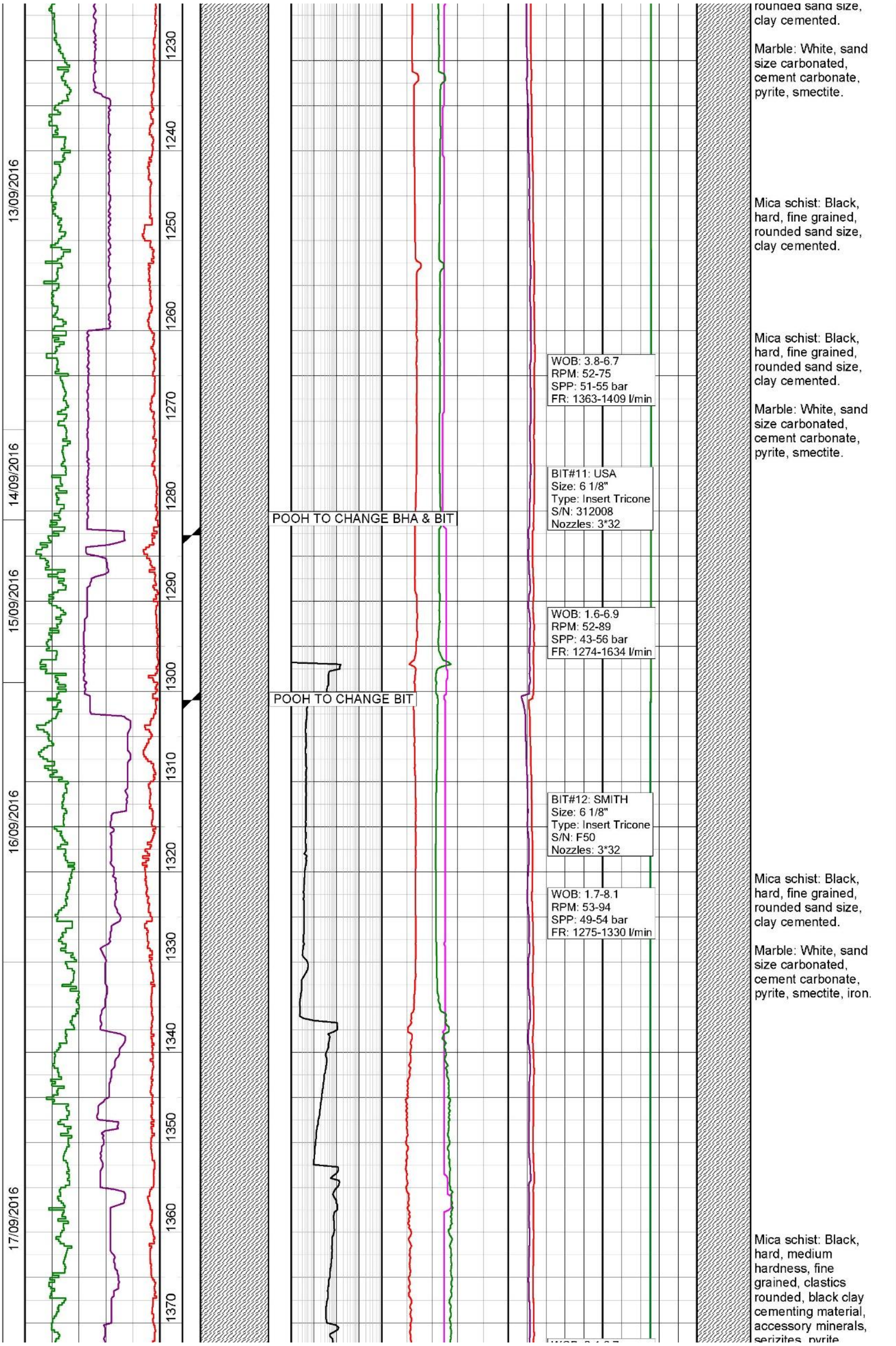
Andesite: Black, grey, andesines partly altered cemented hard tuff in grey, full sulphur, hornblend, iron, pyrite, opalin, hornblend, fracture fill, cement welded.

Tuff (Andesitic): Brown, pyrite, iron, layered, fine grained.

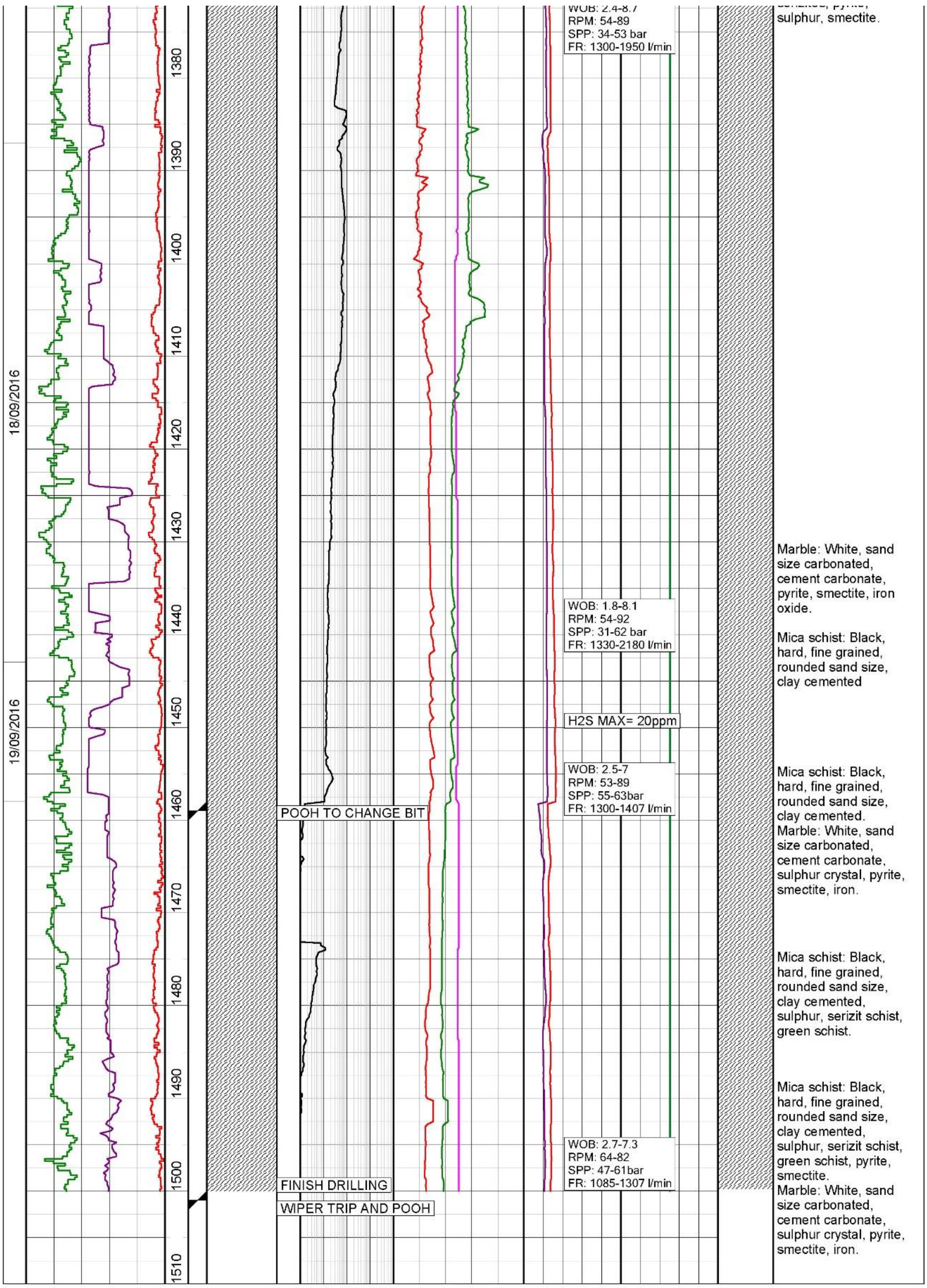

07/09/2016
08/09/2016
09/09/2016
930
940
950
960
970
980
990
1000
1010
1020
1030
1040
1050
1060
1070
WOB: 2.1-8
RPM: 95-98
SPP: 50-73 bar
FR: 1183-1530 l/min
WOB: 2.1-8
RPM: 95-98
SPP: 50-66 bar
FR: 1134-1364 l/min
WOB: 2.2-8.5
RPM: 91-97
SPP: 57-64 bar
FR: 1156-1271 l/min
POOH TO CHECK BIT
BIT#9: USA
Size: 6 1/8"
Type: Insert Tricone
S/N: 312006
Nozzles: 3*32
Tuff (Andesitic): Grey, andesine altered, soft, non consolidated, colapsable, pyrite, tuff cemented.
Andesite: Grey to dark grey, soft to moderately hard, altered andesine, feldspar cement, fine grained, sulphur and pyrite.
Andesite: Grey to dark grey, soft to moderately hard, altered andesine, feldspar cement, fine grained, sulphur, smectite and pyrite.
Tuff (Dacidic): Black, white, fine grained, pyrite, sticky.
Tuff (Dacidic): Black, white, fine grained, pyrite, sticky, smectite, calcopyrite, biotite.



10/09/2016
11/09/2016
12/09/2016
1080
1090
1100
1110
1120
1130
1140
1150
1160
1170
1180
1190
1200
1210
1220
GAS LINE TEST
NO SAMPLES FROM 1000 m to 1006 m DUE TO TOTAL LOSSES
POOH TO CHANGE BHA & BIT
BIT#10: USA
Size: 6 1/8"
Type: Insert Tricone
S/N: 312007
Nozzles: 3*32
WOB: 2.5-87.9
RPM: 57-93
SPP: 45-65 bar
FR: 913-1633 l/min
WOB: 2.9-7.8
RPM: 53-73
SPP: 48-63 bar
FR: 1229-1431 l/min
Dolomitic Marble: white, chalcopyrite, quartzite, feldspar, alterated rock/iron, listvenite.
Grayywacke: Brown, hard, sand size, rounded, well sorted, abundance of pyrite, quartzite fracture fills.
Ophiolite: White, light grey, soft to hard, coarse grained, coarse feldspar pyroxene, quartzite, feldspar, calcopyrite, pyrite, smectite, cement matrix tuff, carbonate, clay.
Granite: White, hard, coarse grained, quartzite, feldspar, mica, smectite. biotite, pyrite, chalcopyrite, fracture porosity.
Greywacke: Brown, hard, sand size, rounded, well sorted, abundance of pyrite, quartzite fracture fills.
Granite: White, hard, coarse grained, quartzite, feldspar, mica, smectite, biotite, pyrite, chalcopyrite, fracture porosity.
Mica schist: Black, thin layered, medium hardness, fine grained, fracture file calcite green, cement matrix welded clay.
Marble: White, hard, fine grained, cement CaCo3, welded.
Mica schist: Black, hard, fine grained,



13/09/2016
14/09/2016
15/09/2016
16/09/2016
17/09/2016
1230
1240
1250
1260
1270
1280
1290
1300
1310
1320
1330
1340
1350
1360
1370
POOH TO CHANGE BHA & BIT
POOH TO CHANGE BIT
WOB: 3.8-6.7
RPM: 52-75
SPP: 51-55 bar
FR: 1363-1409 l/min
BIT#11: USA
Size: 6 1/8"
Type: Insert Tricone
S/N: 312008
Nozzles: 3*32
WOB: 1.6-6.9
RPM: 52-89
SPP: 43-56 bar
FR: 1274-1634 l/min
BIT#12: SMITH
Size: 6 1/8"
Type: Insert Tricone
S/N: F50
Nozzles: 3*32
WOB: 1.7-8.1
RPM: 53-94
SPP: 49-54 bar
FR: 1275-1330 l/min
rounded sand size, clay cemented.
Marble: White, sand size carbonated, cement carbonate, pyrite, smectite.
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.
Marble: White, sand size carbonated, cement carbonate, pyrite, smectite.
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.
Marble: White, sand size carbonated, cement carbonate, pyrite, smectite, iron.
Mica schist: Black, hard, medium hardness, fine grained, clastics rounded, black clay cementing material, accessory minerals,



WOB: 2.4-8.7
RPM: 54-89
SPP: 34-53 bar
FR: 1300-1950 l/min
sulphur, smectite.
18/09/2016
19/09/2016
1380
1390
1400
1410
1420
1430
1440
1450
1460
1470
1480
1490
1500
1510
Marble: White, sand size carbonated, cement carbonate, pyrite, smectite, iron oxide.
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented
WOB: 1.8-8.1
RPM: 54-92
SPP: 31-62 bar
FR: 1330-2180 l/min
H2S MAX= 20ppm
WOB: 2.5-7
RPM: 53-89
SPP: 55-63bar
FR: 1300-1407 l/min
POOH TO CHANGE BIT
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented.
Marble: White, sand size carbonated, cement carbonate, sulphur crystal, pyrite, smectite, iron.
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented, sulphur, serizit schist, green schist.
Mica schist: Black, hard, fine grained, rounded sand size, clay cemented, sulphur, serizit schist, green schist, pyrite, smectite.
Marble: White, sand size carbonated, cement carbonate, sulphur crystal, pyrite, smectite, iron.
WOB: 2.7-7.3
RPM: 64-82
SPP: 47-61bar
FR: 1085-1307 l/min
FINISH DRILLING
WIPER TRIP AND POOH

GEOLOG SURFACE LOGGING

MASTER LOG

Well : B-2

Scale 1:500 | All Depth in : m

WELL DATA

Company Name: SISIAN FPAT
Well Name: B2
Well Code:
Country: ARMENIA
Lease / Concession:
Region / Zone: SISIAN
Well Coordinates: N Latitude
E Longitude
RT - Ground: 3.15 m
Sea Depth: 0 m
Spud-in Date: 13/10/2016 07:49:43
TD Depth: 1684 m
TVD Depth: 1684 m
Drilling End Date: 27.11.2016
Drilling Contractor:
Rig Name:

OPEN HOLE SIZE

16"	From 0 m
12.25"	From 15 m
8.5"	From 155 m
6.125"	From 725 m

CASING SIZE

13.375"	to 12 m
9.625"	to 149 m
7"	to 720.65 m
4.5"	to 1680 m

MUD

SPUD	from 0 m
	from m
	from m
	from m

ABBREVIATIONS

NB New Bit
DB Diamond Bit
DBC Diamond Core
CB Core Bit
RRB Re-run Bit
TB Turbodrilling
RPM Revol/Min
WOB Weight on Bit
FR Flow Rate
TFA Total Flow Area
NR No Return
LC Mud Losses
DS Survey
SPP Pump Pressure
D Mud Density
S Mud Salinity
V Funnel Viscosity
TG Trip Gas
STG Short Trip Gas
PCG Connection Gas
Sample
Succesful

LITHOLOGY SYMBOLS

Shale, Conglomerate, Pebbles, Sand, Sandstone, Silt, Clay, Silty Clay, Claystone Sililicif., Marl, Coal - Lignite

Limestone, Mudstone, Wackstone, Packstone, Grainstone, Boundstone, Chalk, Argillaceous Limestone, Silicified Limestone, Dolomitic Limestone, Calc. Dolomite

Dolomite, Gypsum, Anhydrite, Granite, Basalt, Methamorphic Rocks, Pyrite, Glauconite, Tuff, Andesite, Chert

GEOLOGICAL SAMPLING

Depth: from 155 m to 1684 m
Date: from 13.10.2016 to 27.11.2016

Sampling Rate:	
1 m	From 155 m to 1684 m
m	From m to m
m	From m to m
m	From m to m

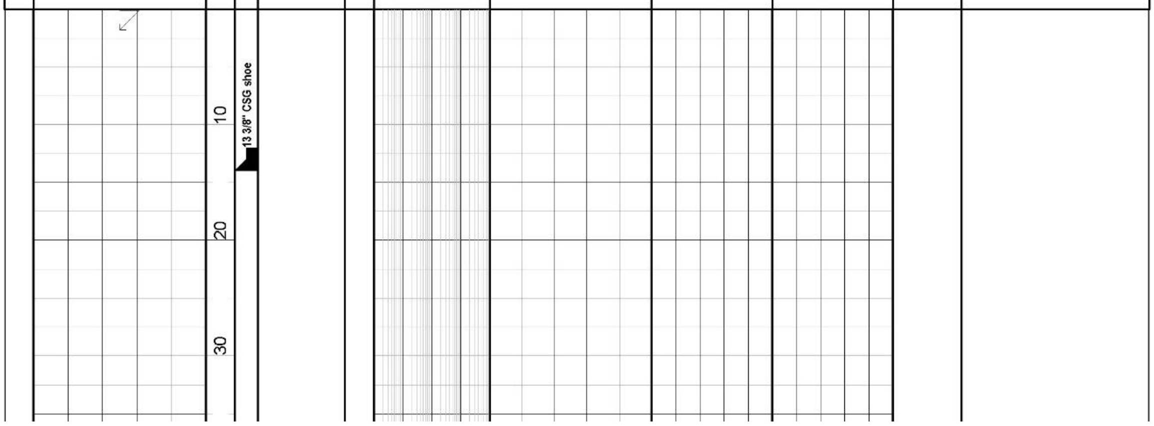
UNIT CREW

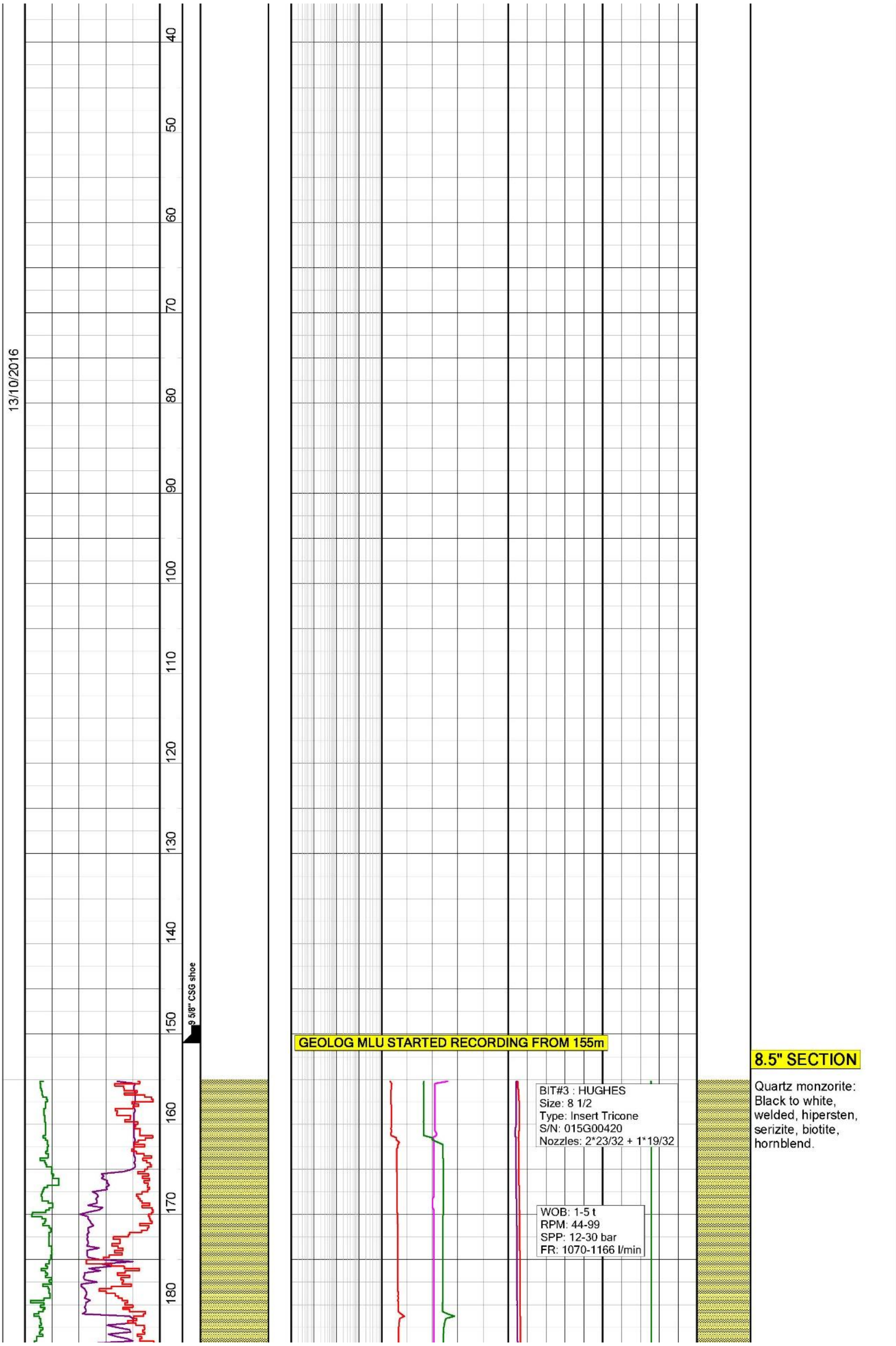
D.E: Alexandru Dabija, Mehmet Ali Akman
M.L:

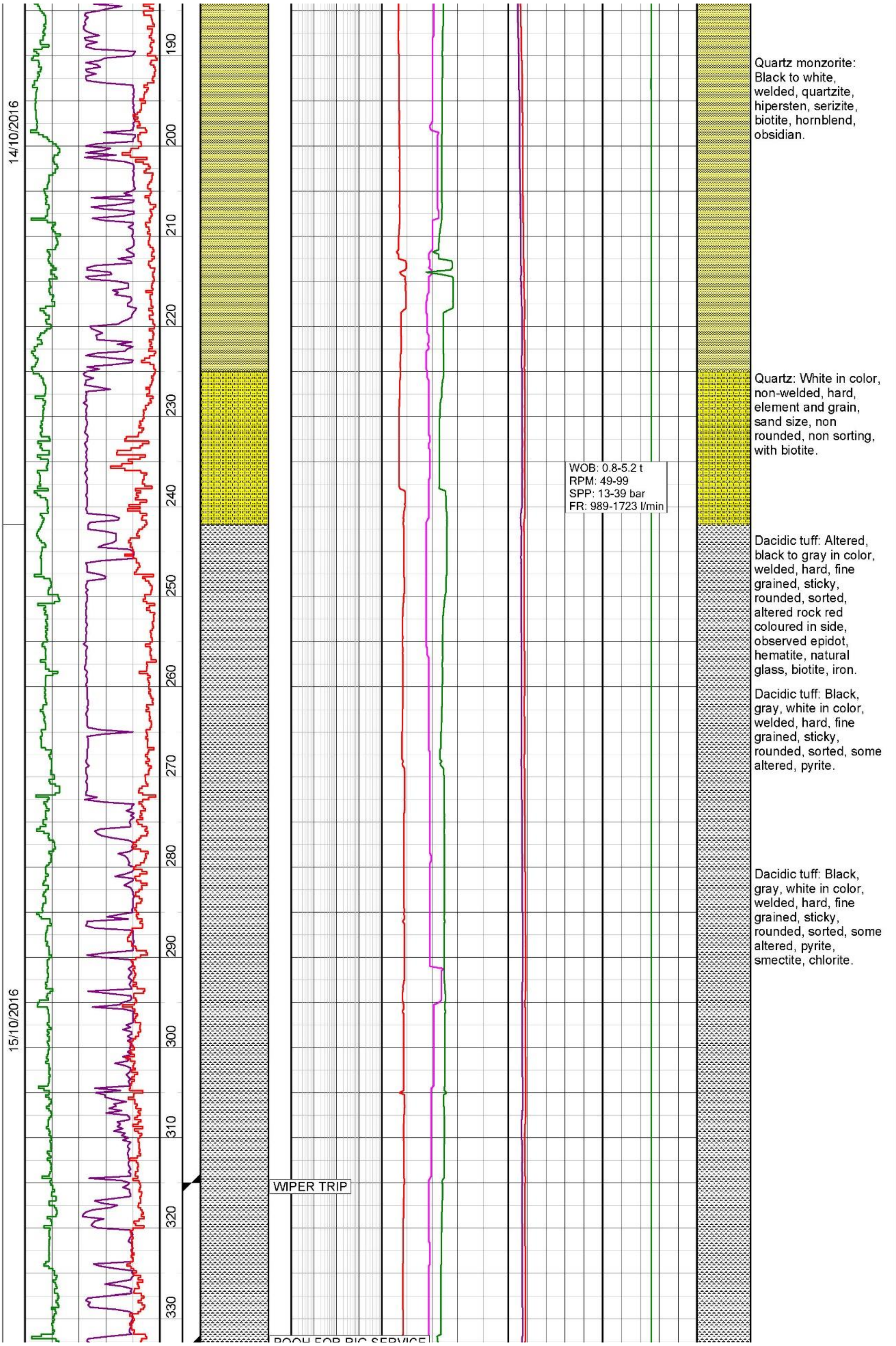
SYMBOLS

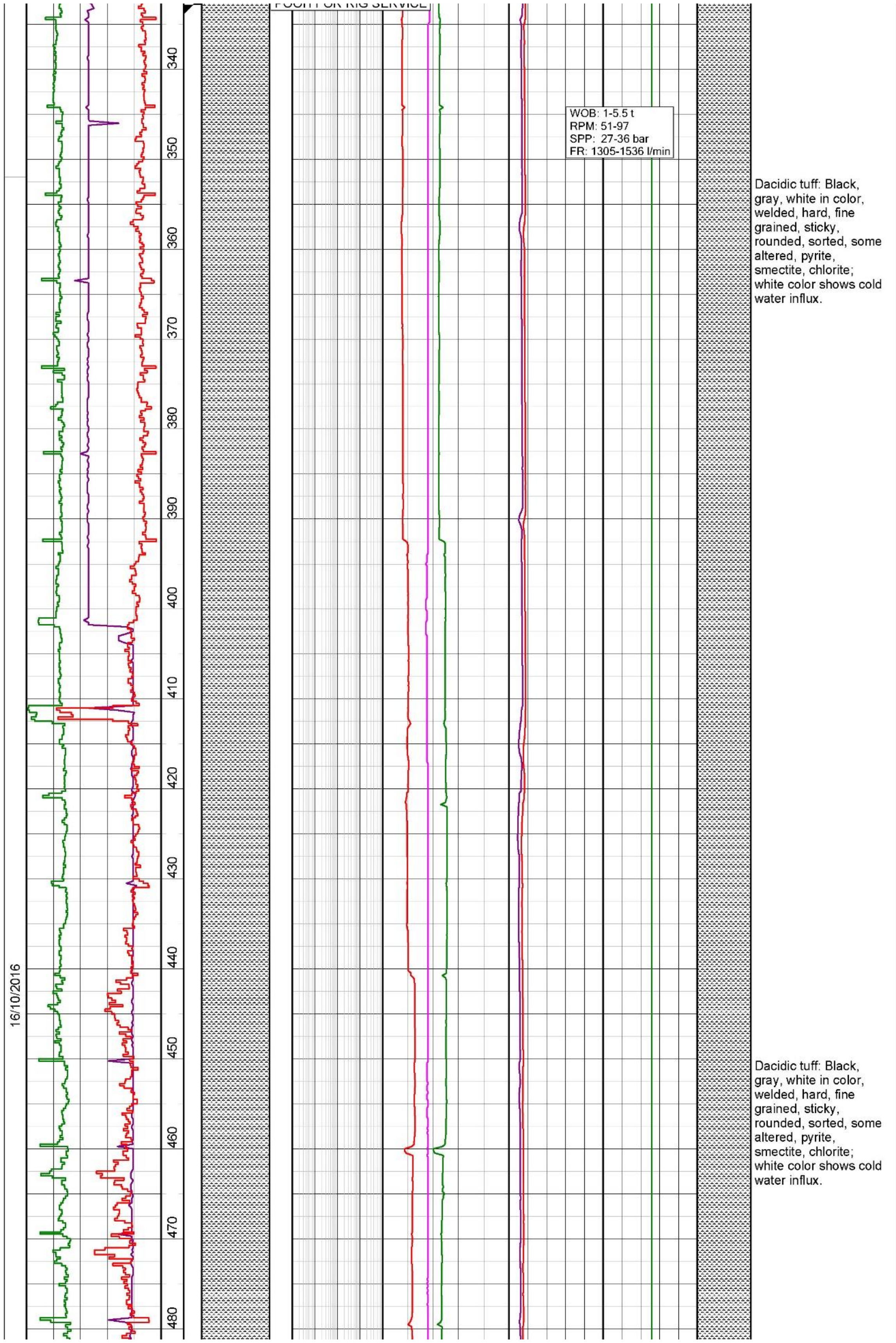
Heavy Oil, Casing Shoe, Core Not Recovered, Gas and Water, Top Liner, Recovery %, Deviation Survey, Salty Water, H2S Smell, Sidewall Core, Fish, Fresh Water, CO2, Core No., Cement

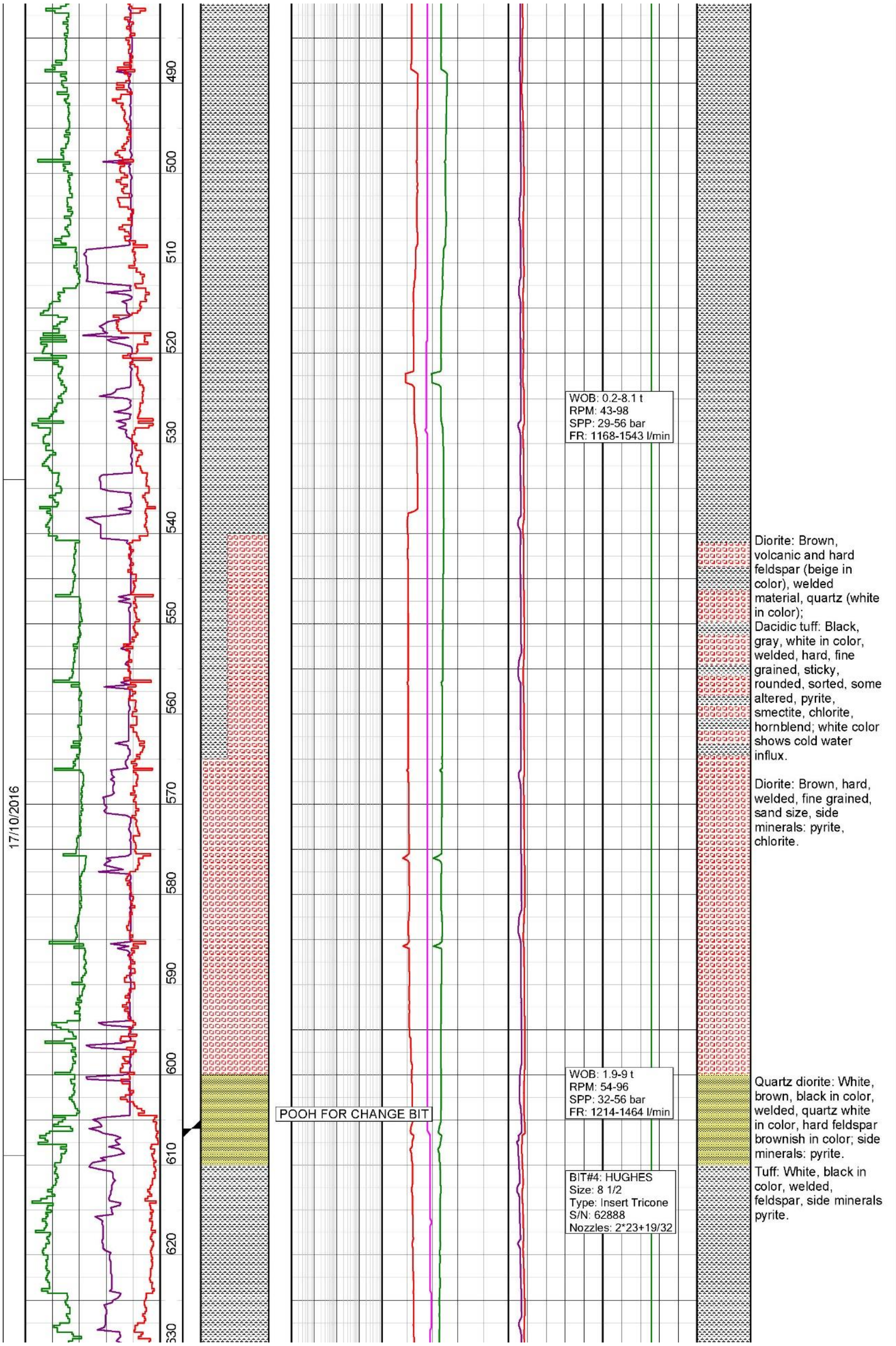
Date	ROP 50 m/h 0; WOB Avg 0 t_metric 20; RPM Avg 0 rpm 120	Depth (Mts)	Symbols	Cuttings	Core	TG (%) 0.01 % 100	Pressure: SPP Avg 0 bar 200; Flow IN (Pumps) Avg 0 l/min 3000; Flow Paddle 0 % 100	Temp. OUT 0 °C 150; Temp. IN 0 °C 150	Mud: MWI Avg 0 kg/l 2; Mud: MWO Avg 0 kg/l 2	Interpreted Lithology	Lithology / Remarks



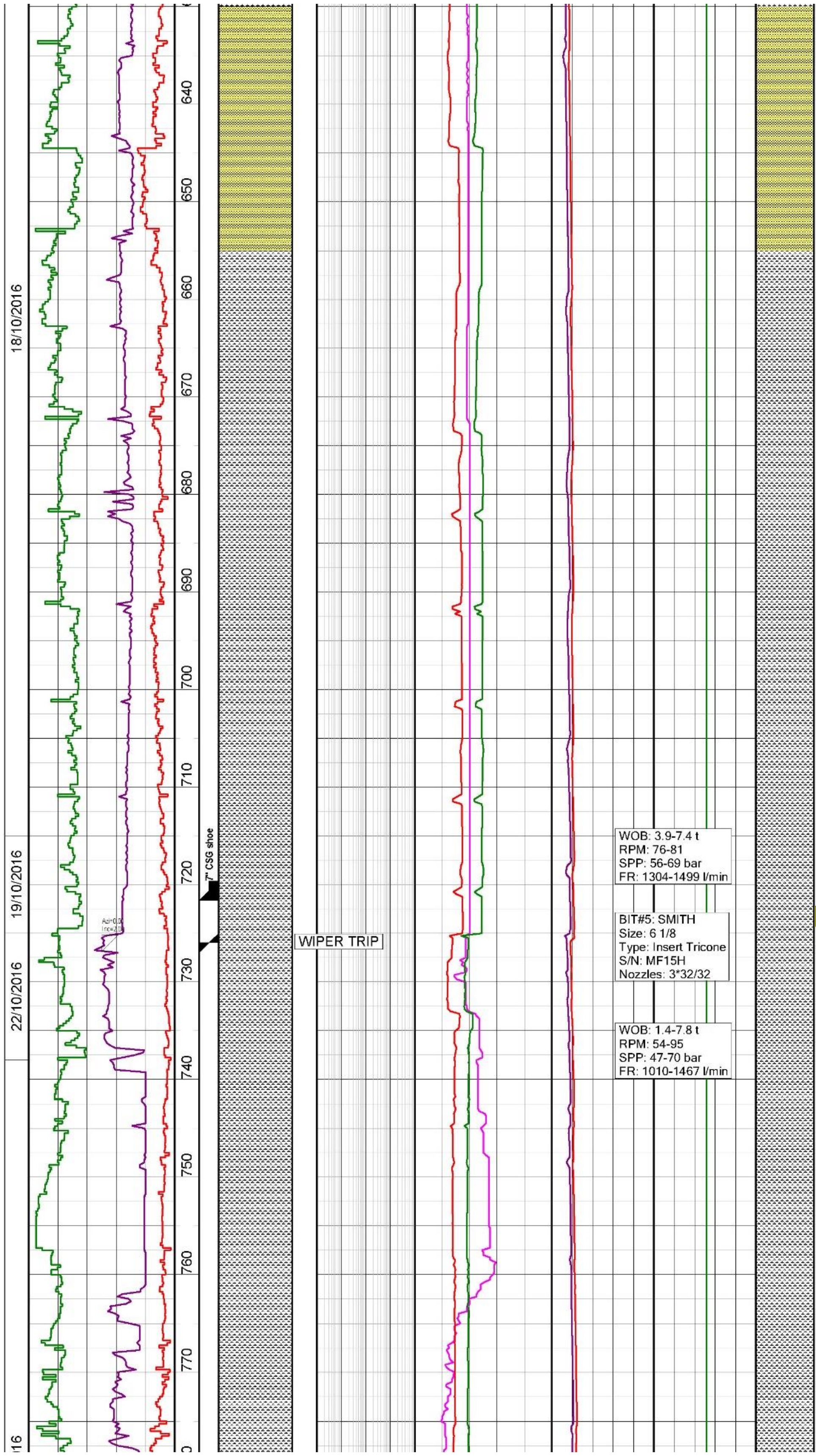

13/10/2016
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
9 5/8" CSG shoe
GEOLOG MLU STARTED RECORDING FROM 155m
BIT#3 : HUGHES
Size: 8 1/2
Type: Insert Tricone
S/N: 015G00420
Nozzles: 2*23/32 + 1*19/32
WOB: 1-5 t
RPM: 44-99
SPP: 12-30 bar
FR: 1070-1166 l/min
8.5" SECTION
Quartz monzorite:
Black to white,
welded, hipersten,
serizite, biotite,
hornblend.


14/10/2016
15/10/2016
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
WIPER TRIP
WOB: 0.8-5.2 t
RPM: 49-99
SPP: 13-39 bar
FR: 989-1723 l/min
Quartz monzorite: Black to white, welded, quartzite, hipersten, serizite, biotite, hornblend, obsidian.
Quartz: White in color, non-welded, hard, element and grain, sand size, non rounded, non sorting, with biotite.
Dacidic tuff: Altered, black to gray in color, welded, hard, fine grained, sticky, rounded, sorted, altered rock red coloured in side, observed epidot, hematite, natural glass, biotite, iron.
Dacidic tuff: Black, gray, white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite.
Dacidic tuff: Black, gray, white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite, smectite, chlorite.


340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
16/10/2016
WOB: 1-5.5 t
RPM: 51-97
SPP: 27-36 bar
FR: 1305-1536 l/min
Dacidic tuff: Black, gray, white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite, smectite, chlorite; white color shows cold water influx.
Dacidic tuff: Black, gray, white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite, smectite, chlorite; white color shows cold water influx.



17/10/2016
490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
POOH FOR CHANGE BIT
WOB: 0.2-8.1 t
RPM: 43-98
SPP: 29-56 bar
FR: 1168-1543 l/min
WOB: 1.9-9 t
RPM: 54-96
SPP: 32-56 bar
FR: 1214-1464 l/min
BIT#4: HUGHES
Size: 8 1/2
Type: Insert Tricone
S/N: 62888
Nozzles: 2*23+19/32
Diorite: Brown, volcanic and hard feldspar (beige in color), welded material, quartz (white in color);
Dacidic tuff: Black, gray, white in color, welded, hard, fine grained, sticky, rounded, sorted, some altered, pyrite, smectite, chlorite, hornblend; white color shows cold water influx.
Diorite: Brown, hard, welded, fine grained, sand size, side minerals: pyrite, chlorite.
Quartz diorite: White, brown, black in color, welded, quartz white in color, hard feldspar brownish in color; side minerals: pyrite.
Tuff: White, black in color, welded, feldspar, side minerals pyrite.



Quartz diorite: White, brown, black in color, welded, quartz white in color, hard, feldspar, side minerals pyrite, chlorite.

Tuff: White in color, soft, welded, coarse grained, side minerals: obsidian, feldspar, quartz, pyrite.

6.125" SECTION

Andezitic tuff : White in color, soft, welded, coarse grained; side minerals: obsidian (cement), dominant feldspar, turned clay.

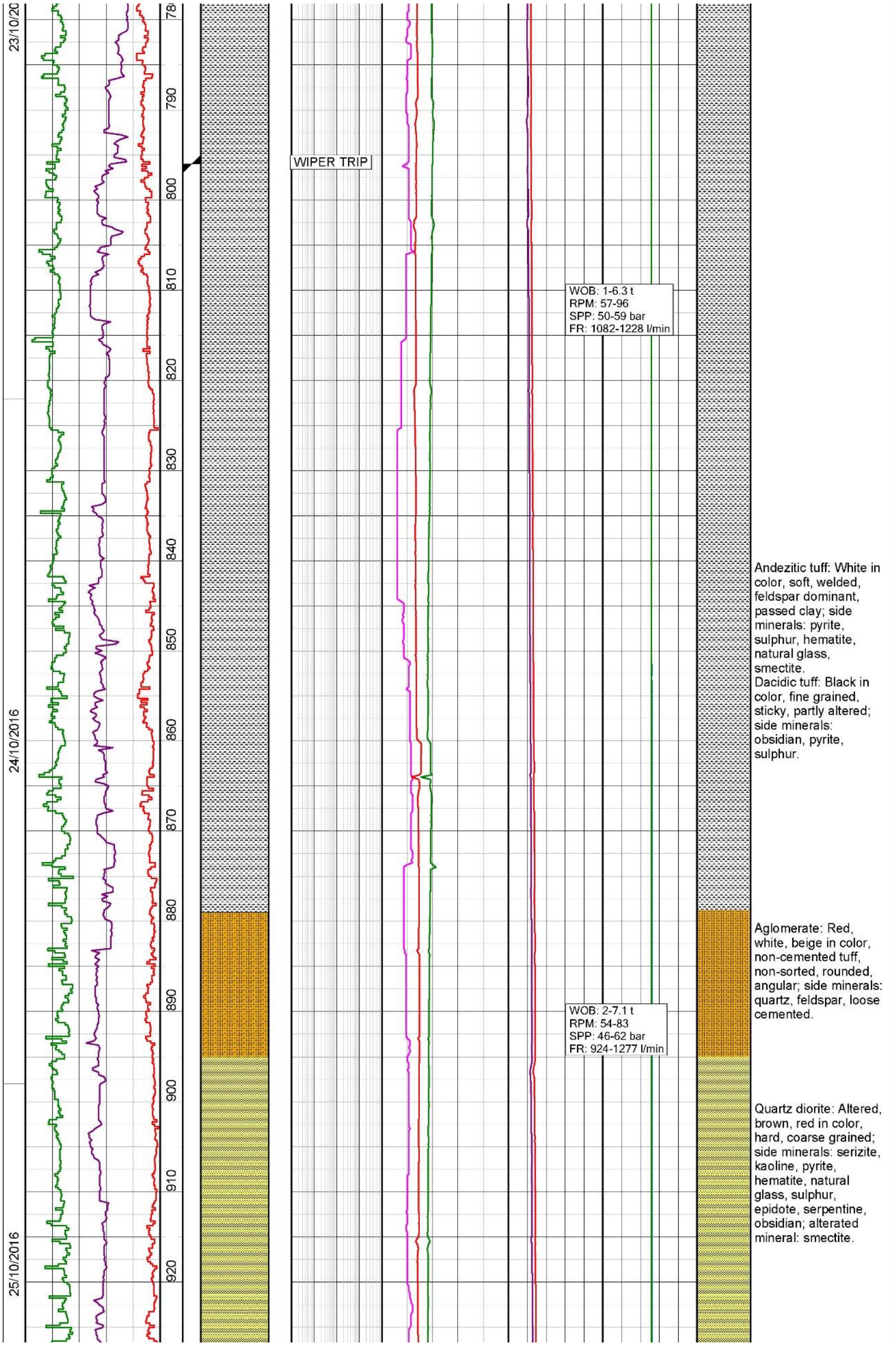
Andezitic tuff: White in color, soft, welded, feldspar dominant, passed clay.

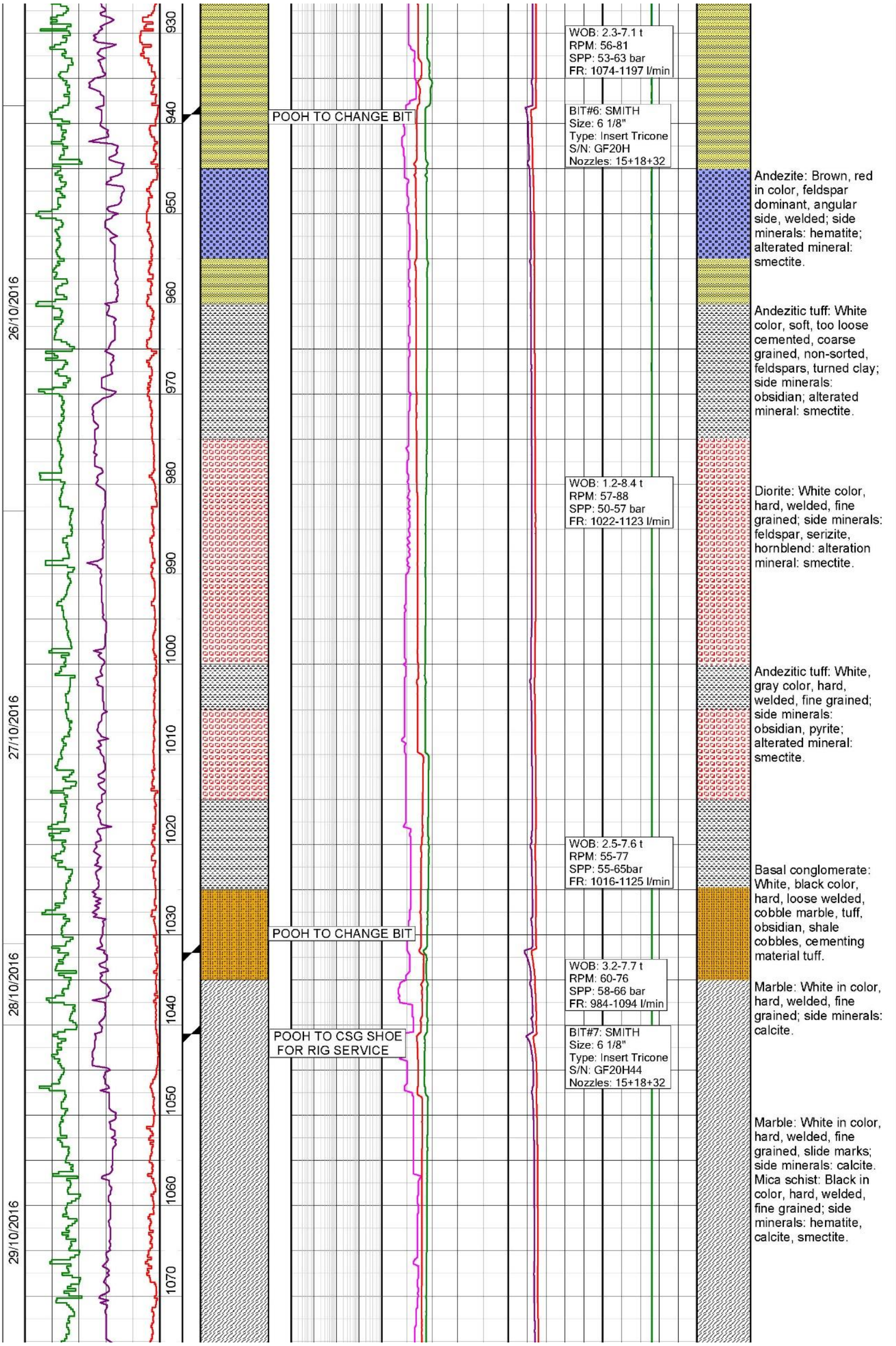
Dacidic tuff: Gray, black in color, hard, welded, fine grained; side minerals: hematite, pyrite, biotite.

Andezitic tuff: White in color, soft, welded, feldspar dominant, passed clay.

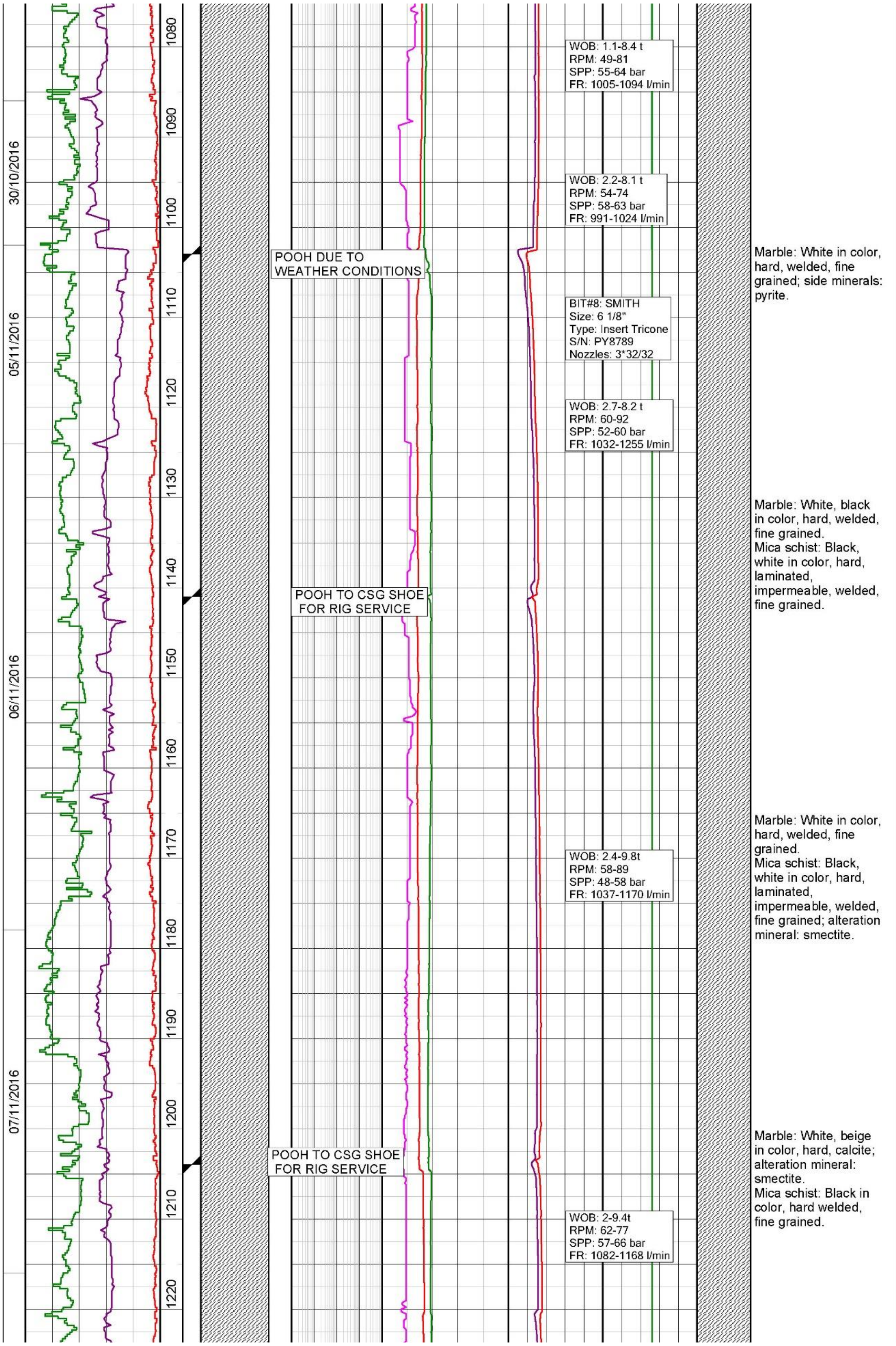
Dacidic tuff: Black in color, fine grained, sticky, partly altered; side minerals: obsidian, pyrite, sulphur.

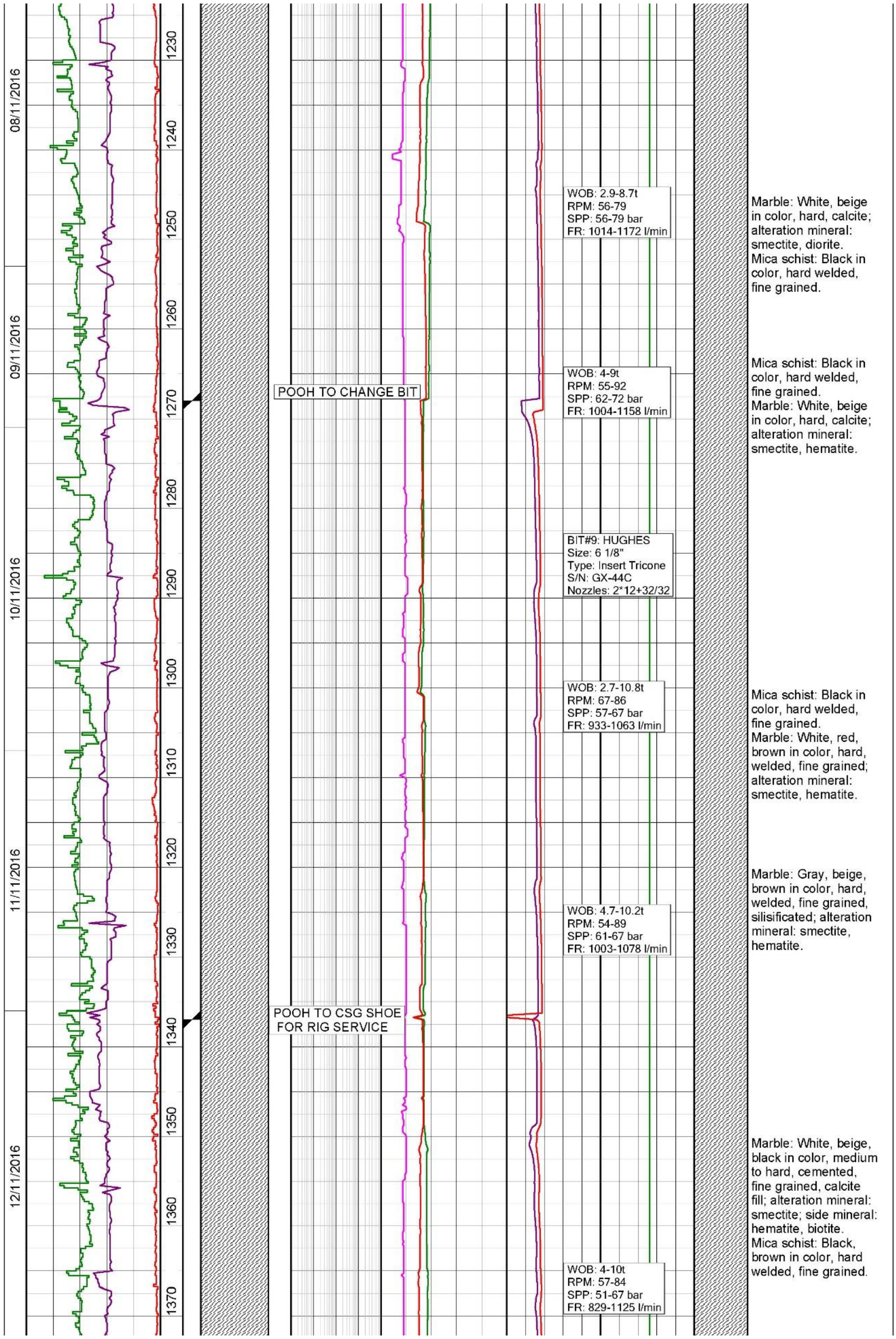
Andezitic tuff: White in color, soft, welded, feldspar dominant, passed clay; side minerals: smectite,


23/10/20
24/10/2016
25/10/2016
790
800
810
820
830
840
850
860
870
880
890
900
910
920
WIPER TRIP
WOB: 1-6.3 t
RPM: 57-96
SPP: 50-59 bar
FR: 1082-1228 l/min
WOB: 2-7.1 t
RPM: 54-83
SPP: 46-62 bar
FR: 924-1277 l/min
Andezitic tuff: White in color, soft, welded, feldspar dominant, passed clay; side minerals: pyrite, sulphur, hematite, natural glass, smectite.
Dacidic tuff: Black in color, fine grained, sticky, partly altered; side minerals: obsidian, pyrite, sulphur.
Aglomerate: Red, white, beige in color, non-cemented tuff, non-sorted, rounded, angular; side minerals: quartz, feldspar, loose cemented.
Quartz diorite: Altered, brown, red in color, hard, coarse grained; side minerals: serizite, kaoline, pyrite, hematite, natural glass, sulphur, epidote, serpentine, obsidian; alterated mineral: smectite.



930
940
950
960
970
980
990
1000
1010
1020
1030
1040
1050
1060
1070
26/10/2016
27/10/2016
28/10/2016
29/10/2016
POOH TO CHANGE BIT
POOH TO CHANGE BIT
POOH TO CSG SHOE FOR RIG SERVICE
WOB: 2.3-7.1 t
RPM: 56-81
SPP: 53-63 bar
FR: 1074-1197 l/min
BIT#6: SMITH
Size: 6 1/8"
Type: Insert Tricone
S/N: GF20H
Nozzles: 15+18+32
WOB: 1.2-8.4 t
RPM: 57-88
SPP: 50-57 bar
FR: 1022-1123 l/min
WOB: 2.5-7.6 t
RPM: 55-77
SPP: 55-65bar
FR: 1016-1125 l/min
WOB: 3.2-7.7 t
RPM: 60-76
SPP: 58-66 bar
FR: 984-1094 l/min
BIT#7: SMITH
Size: 6 1/8"
Type: Insert Tricone
S/N: GF20H44
Nozzles: 15+18+32
Andezite: Brown, red in color, feldspar dominant, angular side, welded; side minerals: hematite; alterated mineral: smectite.
Andezitic tuff: White color, soft, too loose cemented, coarse grained, non-sorted, feldspars, turned clay; side minerals: obsidian; alterated mineral: smectite.
Diorite: White color, hard, welded, fine grained; side minerals: feldspar, serizite, hornblend: alteration mineral: smectite.
Andezitic tuff: White, gray color, hard, welded, fine grained; side minerals: obsidian, pyrite; alterated mineral: smectite.
Basal conglomerate: White, black color, hard, loose welded, cobble marble, tuff, obsidian, shale cobbles, cementing material tuff.
Marble: White in color, hard, welded, fine grained; side minerals: calcite.
Marble: White in color, hard, welded, fine grained, slide marks; side minerals: calcite. Mica schist: Black in color, hard, welded, fine grained; side minerals: hematite, calcite, smectite.


30/10/2016
05/11/2016
06/11/2016
07/11/2016
1080
1090
1100
1110
1120
1130
1140
1150
1160
1170
1180
1190
1200
1210
1220
WOB: 1.1-8.4 t
RPM: 49-81
SPP: 55-64 bar
FR: 1005-1094 l/min
WOB: 2.2-8.1 t
RPM: 54-74
SPP: 58-63 bar
FR: 991-1024 l/min
POOH DUE TO
WEATHER CONDITIONS
Marble: White in color, hard, welded, fine grained; side minerals: pyrite.
BIT#8: SMITH
Size: 6 1/8"
Type: Insert Tricone
S/N: PY8789
Nozzles: 3*32/32
WOB: 2.7-8.2 t
RPM: 60-92
SPP: 52-60 bar
FR: 1032-1255 l/min
Marble: White, black in color, hard, welded, fine grained.
Mica schist: Black, white in color, hard, laminated, impermeable, welded, fine grained.
POOH TO CSG SHOE
FOR RIG SERVICE
Marble: White in color, hard, welded, fine grained.
Mica schist: Black, white in color, hard, laminated, impermeable, welded, fine grained; alteration mineral: smectite.
WOB: 2.4-9.8t
RPM: 58-89
SPP: 48-58 bar
FR: 1037-1170 l/min
Marble: White, beige in color, hard, calcite; alteration mineral: smectite.
Mica schist: Black in color, hard welded, fine grained.
POOH TO CSG SHOE
FOR RIG SERVICE
WOB: 2-9.4t
RPM: 62-77
SPP: 57-66 bar
FR: 1082-1168 l/min


08/11/2016
09/11/2016
10/11/2016
11/11/2016
12/11/2016
1230
1240
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1270
1280
1290
1300
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1330
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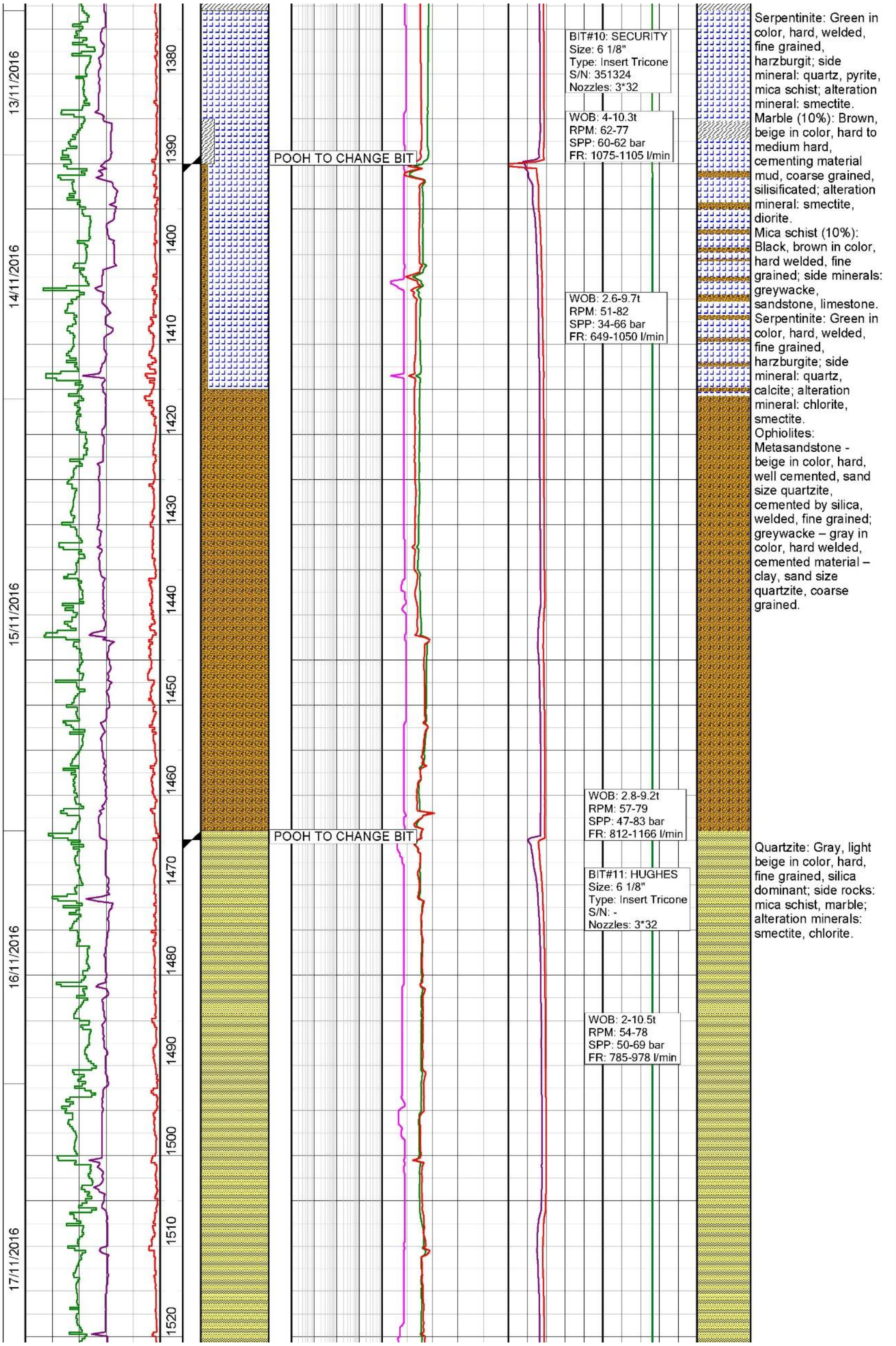
1350
1360
1370
POOH TO CHANGE BIT
POOH TO CSG SHOE FOR RIG SERVICE
WOB: 2.9-8.7t
RPM: 56-79
SPP: 56-79 bar
FR: 1014-1172 l/min
WOB: 4-9t
RPM: 55-92
SPP: 62-72 bar
FR: 1004-1158 l/min
BIT#9: HUGHES
Size: 6 1/8"
Type: Insert Tricone
S/N: GX-44C
Nozzles: 2*12+32/32
WOB: 2.7-10.8t
RPM: 67-86
SPP: 57-67 bar
FR: 933-1063 l/min
WOB: 4.7-10.2t
RPM: 54-89
SPP: 61-67 bar
FR: 1003-1078 l/min
WOB: 4-10t
RPM: 57-84
SPP: 51-67 bar
FR: 829-1125 l/min
Marble: White, beige in color, hard, calcite; alteration mineral: smectite, diorite. Mica schist: Black in color, hard welded, fine grained.
Mica schist: Black in color, hard welded, fine grained. Marble: White, beige in color, hard, calcite; alteration mineral: smectite, hematite.
Mica schist: Black in color, hard welded, fine grained. Marble: White, red, brown in color, hard, welded, fine grained; alteration mineral: smectite, hematite.
Marble: Gray, beige, brown in color, hard, welded, fine grained, silisificated; alteration mineral: smectite, hematite.
Marble: White, beige, black in color, medium to hard, cemented, fine grained, calcite fill; alteration mineral: smectite; side mineral: hematite, biotite. Mica schist: Black, brown in color, hard welded, fine grained.


13/11/2016
14/11/2016
15/11/2016
16/11/2016
17/11/2016
1380
1390
1400
1410
1420
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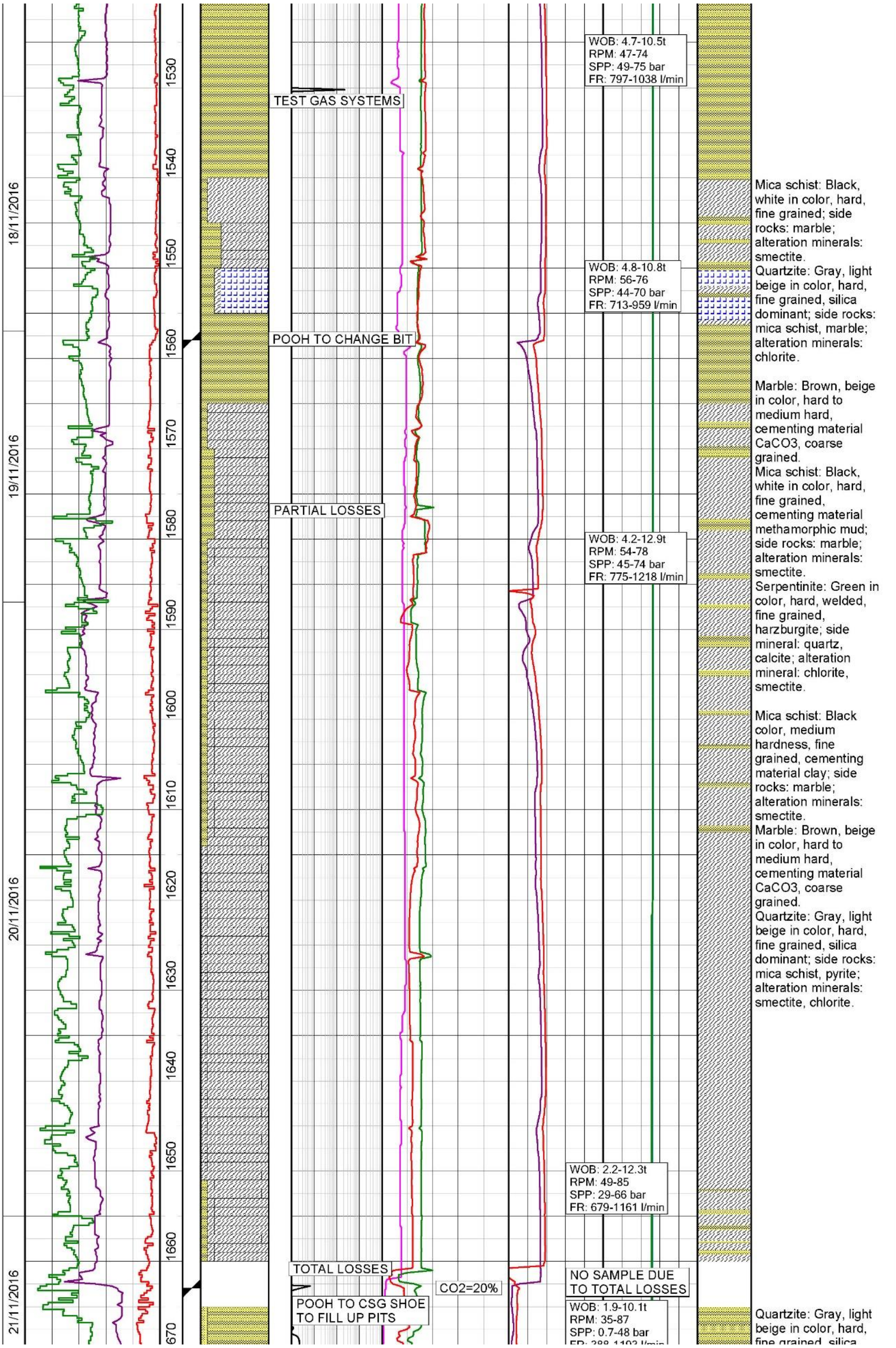
1440
1450
1460
1470
1480
1490
1500
1510
1520
POOH TO CHANGE BIT
POOH TO CHANGE BIT
BIT#10: SECURITY
Size: 6 1/8"
Type: Insert Tricone
S/N: 351324
Nozzles: 3*32
WOB: 4-10.3t
RPM: 62-77
SPP: 60-62 bar
FR: 1075-1105 l/min
WOB: 2.6-9.7t
RPM: 51-82
SPP: 34-66 bar
FR: 649-1050 l/min
WOB: 2.8-9.2t
RPM: 57-79
SPP: 47-83 bar
FR: 812-1166 l/min
BIT#11: HUGHES
Size: 6 1/8"
Type: Insert Tricone
S/N: -
Nozzles: 3*32
WOB: 2-10.5t
RPM: 54-78
SPP: 50-69 bar
FR: 785-978 l/min
Serpentinite: Green in color, hard, welded, fine grained, harzburgit; side mineral: quartz, pyrite, mica schist; alteration mineral: smectite.
Marble (10%): Brown, beige in color, hard to medium hard, cementing material mud, coarse grained, silisificated; alteration mineral: smectite, diorite.
Mica schist (10%): Black, brown in color, hard welded, fine grained; side minerals: greywacke, sandstone, limestone.
Serpentinite: Green in color, hard, welded, fine grained, harzburgite; side mineral: quartz, calcite; alteration mineral: chlorite, smectite.
Ophiolites: Metasandstone - beige in color, hard, well cemented, sand size quartzite, cemented by silica, welded, fine grained; greywacke – gray in color, hard welded, cemented material – clay, sand size quartzite, coarse grained.
Quartzite: Gray, light beige in color, hard, fine grained, silica dominant; side rocks: mica schist, marble; alteration minerals: smectite, chlorite.


18/11/2016
19/11/2016
20/11/2016
21/11/2016
1530
1540
1550
1560
1570
1580
1590
1600
1610
1620
1630
1640
1650
1660
1670
TEST GAS SYSTEMS
POOH TO CHANGE BIT
PARTIAL LOSSES
TOTAL LOSSES
CO2=20%
POOH TO CSG SHOE
TO FILL UP PITS
WOB: 4.7-10.5t
RPM: 47-74
SPP: 49-75 bar
FR: 797-1038 l/min
WOB: 4.8-10.8t
RPM: 56-76
SPP: 44-70 bar
FR: 713-959 l/min
WOB: 4.2-12.9t
RPM: 54-78
SPP: 45-74 bar
FR: 775-1218 l/min
WOB: 2.2-12.3t
RPM: 49-85
SPP: 29-66 bar
FR: 679-1161 l/min
NO SAMPLE DUE
TO TOTAL LOSSES
WOB: 1.9-10.1t
RPM: 35-87
SPP: 0.7-48 bar
Mica schist: Black, white in color, hard, fine grained; side rocks: marble; alteration minerals: smectite.
Quartzite: Gray, light beige in color, hard, fine grained, silica dominant; side rocks: mica schist, marble; alteration minerals: chlorite.
Marble: Brown, beige in color, hard to medium hard, cementing material CaCO3, coarse grained.
Mica schist: Black, white in color, hard, fine grained, cementing material methamorphic mud; side rocks: marble; alteration minerals: smectite.
Serpentinite: Green in color, hard, welded, fine grained, harzburgite; side mineral: quartz, calcite; alteration mineral: chlorite, smectite.
Mica schist: Black color, medium hardness, fine grained, cementing material clay; side rocks: marble; alteration minerals: smectite.
Marble: Brown, beige in color, hard to medium hard, cementing material CaCO3, coarse grained.
Quartzite: Gray, light beige in color, hard, fine grained, silica dominant; side rocks: mica schist, pyrite; alteration minerals: smectite, chlorite.
Quartzite: Gray, light beige in color, hard,