LV-2016-093

Landsvirkjun

Þeistareykir – Well ÞG-11

Phase 2: Drilling for Production Casing

from 304 m to 802 m Depth

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ÍSOR

ÍSLENSKAR ORKURANNSÓKNIR

ÍSOR-2016/042

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Key page

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Title: Þeistareykir – Well ÞG-11. Phase 2: Drilling for Production Casing from 304 m to 802 m Depth.

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Prepared for: Landsvirkjun

Co operators:

Abstract: Well ÞG-11 is a directionally drilled production well for the Þeistareykir power plant. It is sited on the same drill pad as well ÞG-9. The well is located approximately 600 m north of Mt. Bæjarfjall and the aim of the drilling was to penetrate purported fractures north of, and under, Mt. Bæjarfjall. This report addresses the drilling history and data acquisition of the 2nd phase. This includes subsurface mapping of the lithology and alteration in the well based on drill-cuttings, estimating sub-surface temperatures from key alteration minerals and relating drill-data and geophysical logs of lithology to constrain formation boundaries and identify potential aquifers. ÞG-11 was pre-drilled with a 21" drill bit for 18⅝" surface casing to 94.3 m and with 17½" drill bit for 13⅜" anchor casing down to 304 m. The 2nd phase was drilled with 12" bit for 9⅝" casing to 802 m. The stratigraphy of phases 0–2 in well ÞG-11 is composed of basaltic lava flows and hyaloclastite formations, including basaltic breccias, tuffs and pillow basalts. Intrusives become more common below 300 m. The grade of alteration is generally high. Epidote appears at 370 m. At 370–802 m the main alteration minerals are quartz, epidote, prehnite and clays. A loss zone was cut at 661 m depth, at a boundary between medium grained crystalline basalt above and a breccia below.

Keywords:

Þeistareykir, well ÞG-11, geothermal area, high temperature, wellbore, steam mining, geological strata, feed zones, wireline logging, Sleipnir, ÍSOR, Landsvirkjun

UWI (Unique Well Id): B60411

ISBN no.:

Approved by Landsvirkjun's project manager

Project manager's signature	Reviewed by
magnús Ólafsson	Sigvaldi Thordarson

Ágrip

Hola ÞG-11 er stefnuboruð vinnsluhola fyrir orkuverið á Þeystareykjum. Hún er staðsett á plani B, sama plani og hola ÞG-9, um 600 m norður af Bæjarfjalli. Tilgangur borunarinnar var að skera kortlagðar sprungur norður af Bæjarfjalli til að afla viðbótargufu fyrir virkjunina. Þessi skýrsla fjallar um borsögu og gagnaúrvinnslu 2. áfanga borunar. Með svarfskoðun á borstað er gerð grein fyrir jarðlögum og ummyndun bergs með tilliti til ummyndunarsteinda, sem gefa upplýsingar um berghita. Ennfremur er gefið yfirlit um borgögn úr sjálfvirku skráningarkerfi Sleipnis sem og borholumælingum sem gerðar voru á meðan á borverkinu stóð. Öll eru þessi gögn notuð til frekari túlkunar, m.a. til að greina jarðlagamót og hugsanlegar æðar í holunni. ÞG-11 var forboruð með 21" krónu og fóðruð með 18⅝" yfirborðsfóðringu niður á 94,3 m dýpi. 1. áfangi var boraður með 17½" krónu niður á 304 m dýpi fyrir 13⅝" öryggisfóðringu. 2. áfangi var svo boraður með 12" krónu niður í 802 m og fóðraður með 9⅝" vinnslufóðringu. Í forborun, 1. og 2. áfanga eru millikorna basalthraunlög ráðandi efst en þegar neðar dregur eru móbergsmyndanir, á borð við breksíu, bólstraberg og basalttúff, meira áberandi. Vart er töluverðra innskota neðan við 300 m. Ummyndun er alla jafna mikil og epidót finnst fyrst í svarfinu á 370 m dýpi. Aðalummyndunarsteindirnar frá 370–802 m eru epidót, kvars, prehnít og leir. Æð var skorin á 661 m dýpi þar sem 50 l/s af skolvökva tapaðist, á mótum meðalkorna basalts og breksíu fyrir neðan.

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1 Introduction

Drilling of well ÞG-11 in the Þeistareykir geothermal field was conducted by Iceland Drilling (Jarðboranir) for Landsvirkjun. ÞG-11 was drilled from the same well pad, i.e. well pad B, as the vertical, 2194 m deep well ÞG-9 (Figure 1). The wells are located approximately 600 m north of Bæjarfjall (Table 1), at 350 m a.s.l. (Mortensen, et al., 2013b). The planned depth of well ÞG-11 is 2000–2500 m. The well will be directionally drilled towards south, and the aim of drilling is to intersect the permeability and heat related to fractures north of Mt. Bæjarfjall (see Khodayar et al., 2016; Mortensen, 2012).

Table 1. *Geographical position of well ÞG-11. Coordinates are in ISNET93.*

Well name	Well ID	East (X) (m)	North (Y) (m)	Elevation (m a.s.l.)	Planned depth (m)
ÞG-11	60411	593436	599582	350	2500

The planned design of well ÞG-11 (Figure 2) is as follows:

- Phase 0: Pre-drilling for 18⅝" surface casing with 21" drill bit to approximately 100 m depth.
- Phase 1: Drilling for 13⅜" anchor casing with 17½" drill bit down to ~ 300 m depth.
- Phase 2: Drilling for 9⅝" production casing with 12" drill bit down to ~ 800 m depth.
- Phase 3: Drilling for 7" perforated liner with 8½" drill bit to 2000–2500 m depth.

To reach the target zones the direction of the well was set at 180 ±5° relative to true North with an inclination 40±3° from vertical within the depth range 320 m to 1600 m (MD). Below 1600 m (MD) greater deviations in direction and inclination are tolerated i.e. ±15° on direction and 40±12° on inclination (Figure 3). The kick-off was planned 20 m below the anchor casing, at 320 m depth. The angle build-up rate was planned to be 3°/30 m with the final inclination of 40° from vertical. The build-up should be completed before reaching 800 m (MD).

Phase 2 of ÞG-11 was drilled by the drill-rig Sleipnir and the plan is to use the rig (Óðinn) to drill the 3rd phase of the well. Drilling of phases 0 and 1 were described in a separate report (Guðjónsdóttir et al., 2016). Depths in this report refer to measured depth (MD) relative to Sleipnir´s rig floor, 5.72 m above ground level, except otherwise stated.

The drilling contractor, Iceland Drilling (Jarðboranir), carried out the drilling operations with Landsvirkjun supervising the work. Iceland GeoSurvey (ÍSOR) managed cutting inspection, well logging, gyro surveys and geothermal consulting.

This report presents the geological part of the drilling, including lithology, alteration and a list of feed points. Also, results of the well loggings carried out during phase 2 are presented. Appendix B contains the daily reports written by the on-site borehole geologist during drilling operations, presenting preliminary results.

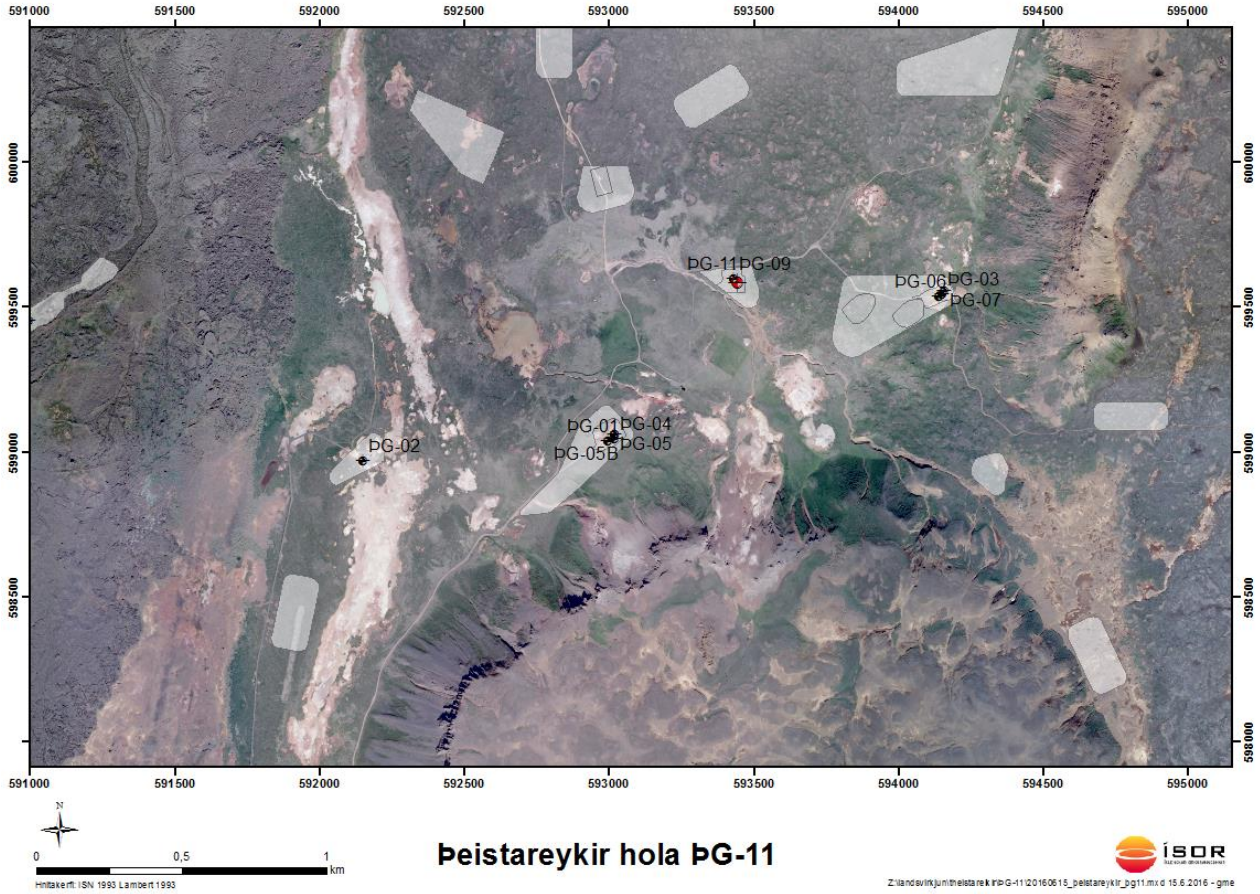


Figure 1. *Location of well ÞG-11 in Þeistareykir. The well pads are shown as light gray patches.*

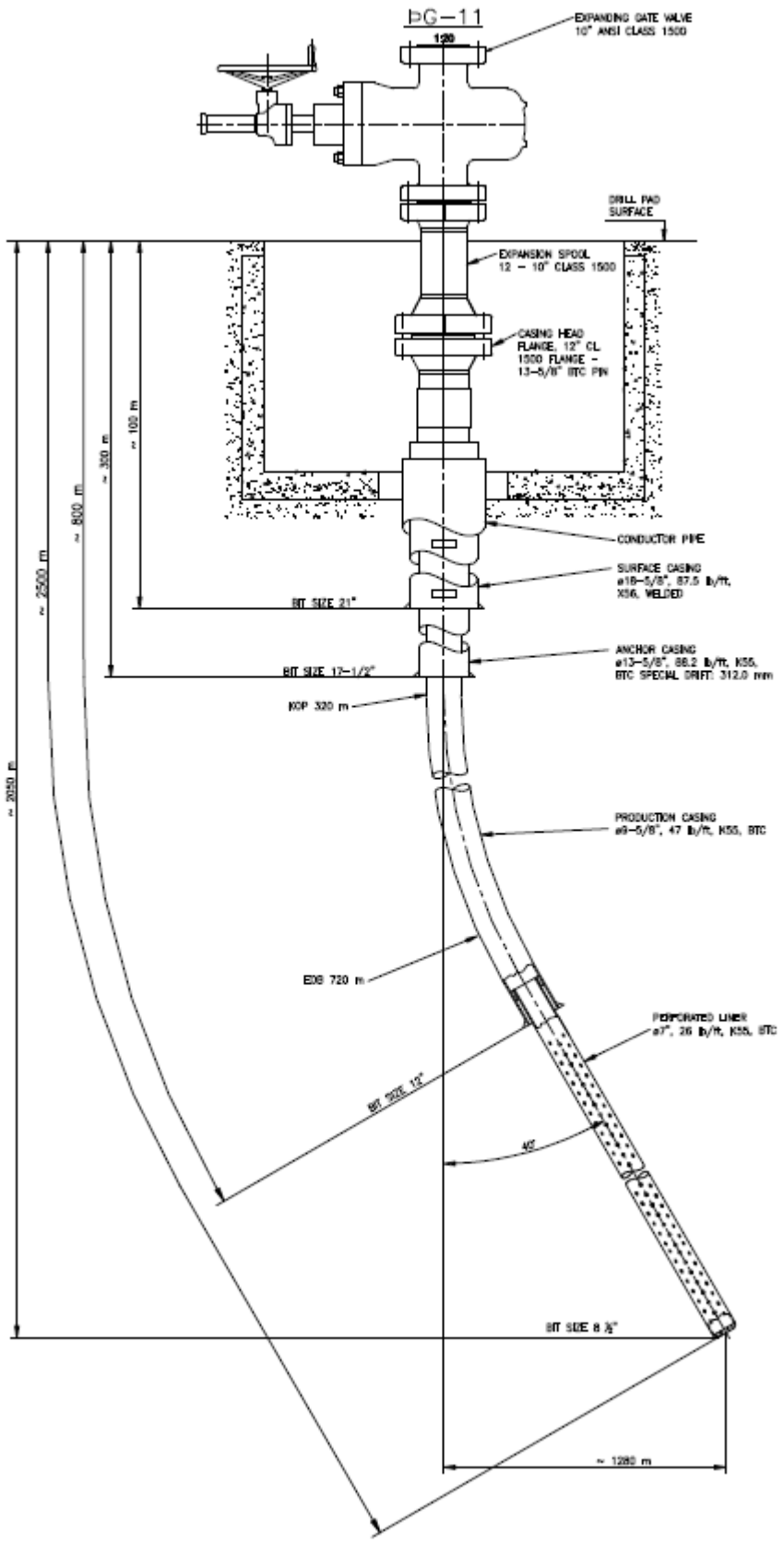


Figure 2. *Well design of ÞG-11.*

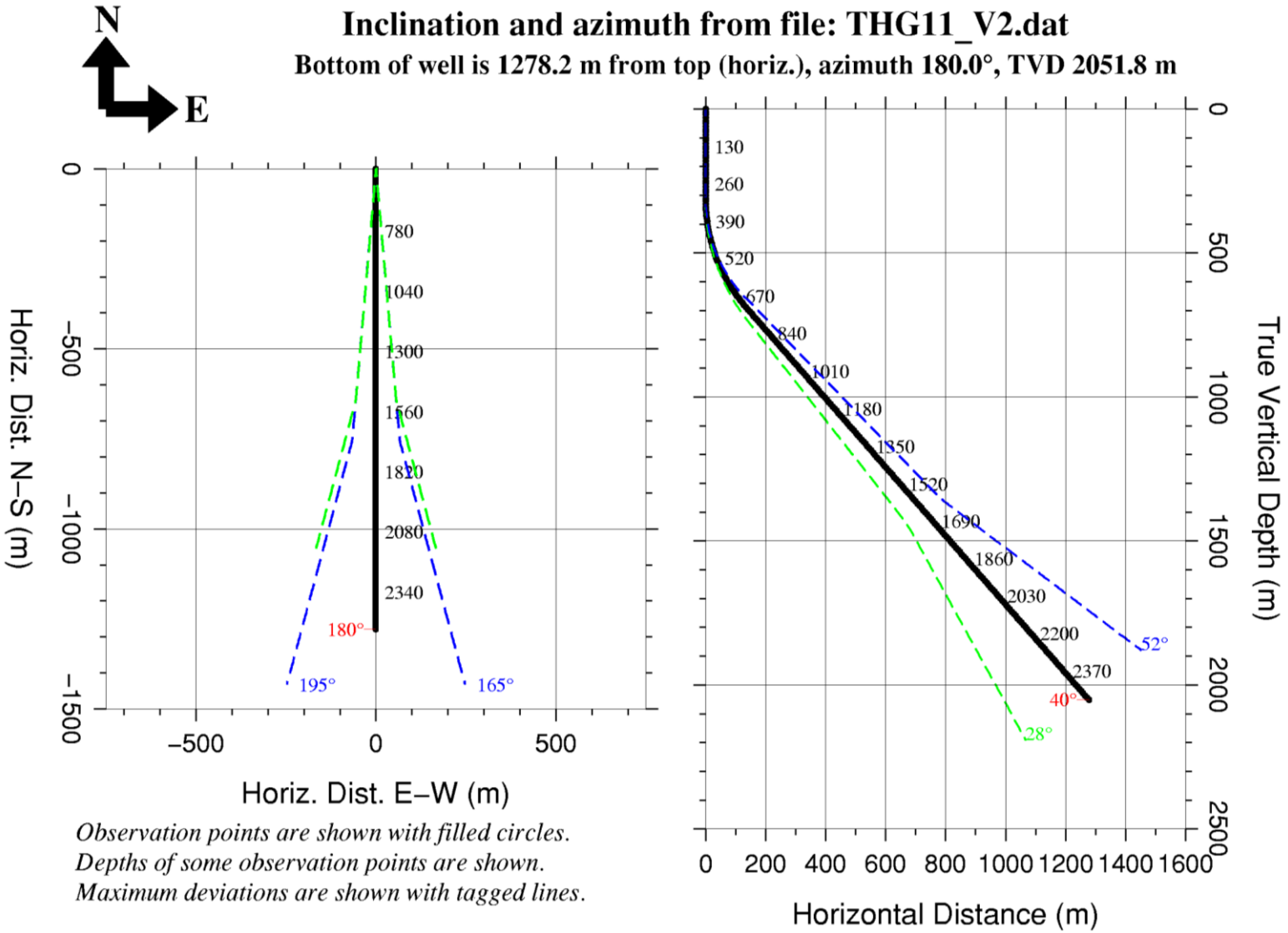


Figure 3. *Cross section and birds-eye-view of the planned trajectory of well ÞG-11 with allowable deviation indicated (Thordarson, 2016).*

2 Drilling operations

2.1 Overview

Preparations for the drilling of phase 2 started on the 3rd of June 2016, on workday 25, by setting up and testing the blow-out preventers (BOP´s). Drilling into formation with a 12" drill bit started at 304 m on the 5th of June. A total loss of circulation was observed at 661 m. A cement job was carried out on the 9th of June in order to seal the loss zone. No other major loss zones were intersected during drilling of phase 2. Drilling was terminated at 802 m on the 11th of June and the 9⅝" production casing was set at 801.7 m depth. On June 13th the production casing had been cemented and mobilization of the rig to another drill-pad started.

An overview of the drilling phases and details of the casing depths are shown in Table 2. Figure 4 and Table 3 show the drilling progress of well ÞG-11 during drilling of phases 0–2.

Table 2. *Drilling and casing depths of phases 0–2 in well ÞG-11.*

Drill-Rig	Phase	Drill bit	Depth (m)	Depth Reference	Casing width	Casing Depth
Sleipnir	0	21"	94.3	Sleipnir RF*	18⅝"	91.5
Sleipnir	1	17½"	304	Sleipnir RF*	13⅜"	302.5
Sleipnir	2	12"	802	Sleipnir RF*	9⅝"	801.7

* *RF = rig floor. Sleipnir´s rig floor is 5.72 m above ground level.*

2.2 Drilling for the production casing (9⅝") - Phase 2

Drilling operations of phase 2 started on June 3rd by mantling up and testing the blow-out preventers by applying a pressure of 30 bar for 15 min. The annular preventer passed the test after the stack had been centralized properly. Then the pipe ram was tested, following the same procedure as for the annular, but the pressure dropped for 2 bar. The pipe ram had to be dismantled and fixed. At 5 pm on the 4th of June, it finally passed the pressure test and preparations for running in the BHA started, including 12" bit, motor and MWD instrument.

At 8 am in the morning on the 5th of June the drill-bit tagged the top of cement at 274.3 m depth (top of floating collar). At 2:40 pm drilling in formation started at 304 m depth. A gyro survey was carried out when the well was 325 m deep giving an inclination of 2.44° and azimuth of 326.2° at 285 m depth. Drilling was stopped for few hours on the 6th of May due to failure in the mud pumps. Drilling resumed at lunch time with an average ROP of 7 m/hr. On the 8th of June a leakage was observed in the stand-pipe and the string was pulled out into the anchor casing. After the damaged part had been replaced the well was circulated clean for a gyro survey. No losses of circulation had been noted up to this point during drilling of phase 2 but at 2:45 pm on the 8th of June a total loss of circulation (50 l/s) occurred at 661 m depth. It was decided to drill two more singles, down to 677 m, before placing a cement plug in the well. The losses gradually decreased and measured 15 l/s when the drilling was stopped at 7 pm on the 8th of June. After a minor malfunction in the top drive

had been repaired (a leakage from the hydraulic system) preparations for pulling the string out started. Between 5 to 7 am the 9th of June, a temperature logging was carried out by ÍSOR´s loggers. The maximum logging depth was 670 m, and the log did not show the loss zone at 661 m as expected (see chapter 4). Next, preparation for the cement job commenced. Cementing started at 7 pm, the 9th of June, when a plug of 5.0 m^3 of cement slurry (density of 1.75 g/cm^3) was placed in the well. Then the string was pulled out to 494 m depth and the well circulated for half an hour before POOH. At midnight on June 9th the crew started to run a 12" drill bit and motor were run in hole. Drilling into cement, from 633.5–677 m, was complete around noon on June 10th and a drilling in formation started. Drilling was stopped at roughly 701 m. Circulation losses were ~5–8 l/s below the cement-plug. The well was circulated clean and polymer pills injected. In the afternoon ÍSOR´s loggers performed a gyro survey. The results showed an azimuth of 181.1° and inclination of 35.01° at 657 m depth. Drilling started again in the evening.

On the 11th of June the depth of the well reached 800 m, with circulation losses in range of 4–8 l/s. The ROP had been very high the last few meters but seemed to be decreasing at 800 m. Based on that it was decided to finish the single and drill 2 more meters before finish the drilling of phase 2. Then the well was circulated and cleaned with water and polymer pills. No bottom hole fill was found and the string was pulled out of the hole.

Between 3 am to 6 pm on June 11th the ÍSOR´s loggers carried out geophysical logging in the well, including temperature, caliper, resistivity, neutron-neutron (NN) and gamma. The temperature measurement reached down to 777 m where temperature was recorded around 150°C. The log showed an evidence of a small feeder at 670 m, at a similar depth as the total circulation loss was observed on the 8th of June.

The drill crew started running in the 9⅝" production casing at 9 pm on the 12th of June. The casing job was finished at 7 am on the 13th of June with the casing set at 801.7 m (Table 4).

A cement string was run in hole between 10:45 am to 3:00 pm on the 13th of June. The next three hours the well was cooled by pumping water through the string. The cementing job was finished at 10:30 pm. In total 52.5 m^3 of cement were used, almost two times more than had been calculated from the caliper log (Tables 5 and 6). The annular BOP was closed and in total 35.2 m^3 of cement were pumped down the string. No cement was retrieved at the surface. A displacement water of 6 m^3 was used. Then 17.3 m^3 were used for a fill up on top. After that, the cement did not subside in the annulus. WOC was next, and then ÍSOR´s logging engineers started temperature and CBL logging at midnight. The CBL log was carried out approximately 6 hours after cementing and revealed that cement was found everywhere behind the casing. The cement was very soft above 100 m. Between 100–450 m the cement was not fully cured. Below 450 m the bonding was almost complete.

The temperature log showed clear signs of cooling at the location of the feed zone at around 660–670 m and again at 750 m.

In the morning on the 14th of June the drill crew started to mobilize the drill rig to another pad, i.e. pad A, located some 2 km to the southwest.

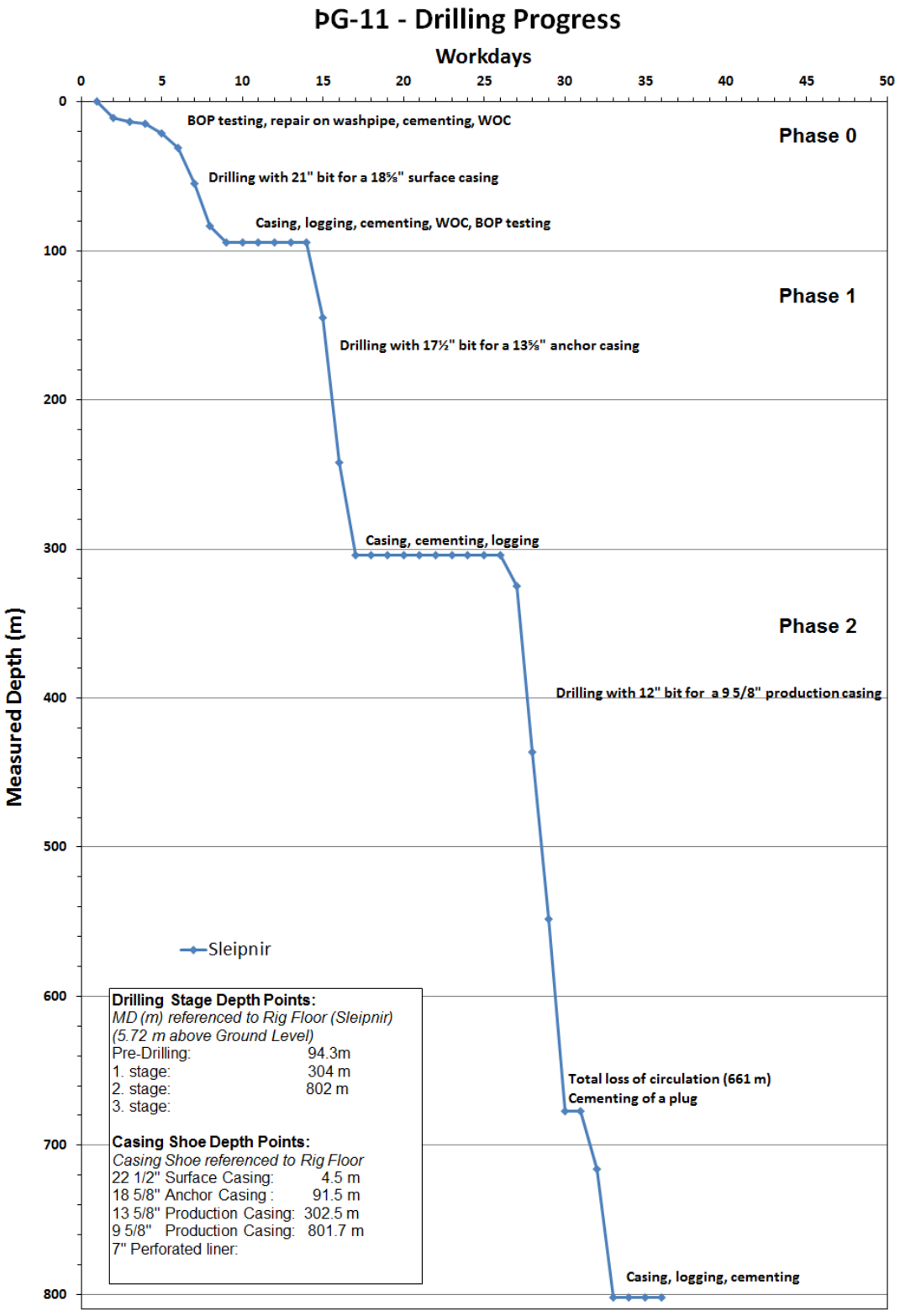


Figure 4. *Drilling progress of well ÞG-11 (phases 0–2).*

Table 3. *Drilling progress during drilling of phase 2 in ÞG-11.*

Day	Drilled Section (m)	Drill Time (h)	ROP (m/h)	Total Depth at 24:00 (m)
05.06.2016	21	7	3	325
06.06.2016	111	15	7.4	436
07.06.2016	112	14.5	7.7	304
08.06.2016	129	19	6.8	677
09.06.2016	-	-	-	677
10.06.2016	39	7.25	5.4	716
11.06.2016	86	10.75	8	802
Total	**498**	**73.5**	**6.4**	

Table 4. *Casing report for the 9⅝" production casing.*

ICELAND DRILLING

Casing Information Report
Rig: Sleipnir
Job No: 28176

Iceland Drilling
Rig No: 28000
Job Name: ÞG-11

Casing Information

Run Date/Time:	13-jún.-16 07:00		
		Leak Off Test (kg/cu m):	
Well Section:	INT2	**String Type:**	FULL
String Top MD (m):	7,1	**String Top TVD (m):**	
Casing Shoe MD (m):	801,7	**Casing Shoe TVD (m):**	
String Nominal OD (cm):	24,45	**String Nominal ID (cm):**	
Bit Diameter (cm):	30,48	**Avg. Open Hole Diam. (cm):**	
Centralizers: No:	49	**Manufacturer/Type:**	
Depths:			
Hanger Type:		**Manufacturer:**	
Comments:	Transferred from Casing Tally Detail on 22-jún.-16 01:34		

String Component Details

Joints	Item	Length (m)	OD(cm)	ID (cm)	Weight (kg)	Grade	Connection	Torque
1	SHOE	0,540	24,45			K-55	BUTT	
2	JOINT	22,680	24,45	22,05	69,9	K-55	BUTT	
1	FLOAT	0,520	24,45			K-55	BUTT	
67	JOINT	778,650	24,45	22,05	69,9	K-55	BUTT	
Totals: 71		802,390						

Table 5. *Cement report for the production casing.*

Rekstrarhandbók
Eyðublöð E-104
Útgáfa 1.0

Verkkaupi: Landsvirkjun
HOLA: ÞG -11
Steypu gerð: Fóðringarsteypa 9 5/8"
Dags:

JARÐBORANIR

Aðstæður í holunni:

Borað með 12 " krónu niður á 802 metra. Holan var var með umtalsverðum lekum og algjöru skoltapi í 661m. Mikill hiti er í holunni neðan við 660 metra.

Steypu aðferð:

Hefðbundin steyping gegnum streng. Tekið verður sýni á 10 m3 fresti. Eðlisþyngd steypu skal vera 1,7 kg/l. Fylgst verður með eðlisþyng með mælingum. Eftirdæling er 6 m3.

Steypu niðurstaða:

Steypt var 35,2 m3 í gegnum streng. Skift yfir í eftirdælingu eftir að hætti að koma upp, var dælt 6m3. Síðan var dælt vatni á killine voru 12 m3 og síðan skipt yfir í steypu og dældum 13 m3. við 42 bör. Beðið í tvær klst og steypt 4,3 m3 ofan á. Heildarmagn var 52,5 m3

Seinni steypa:

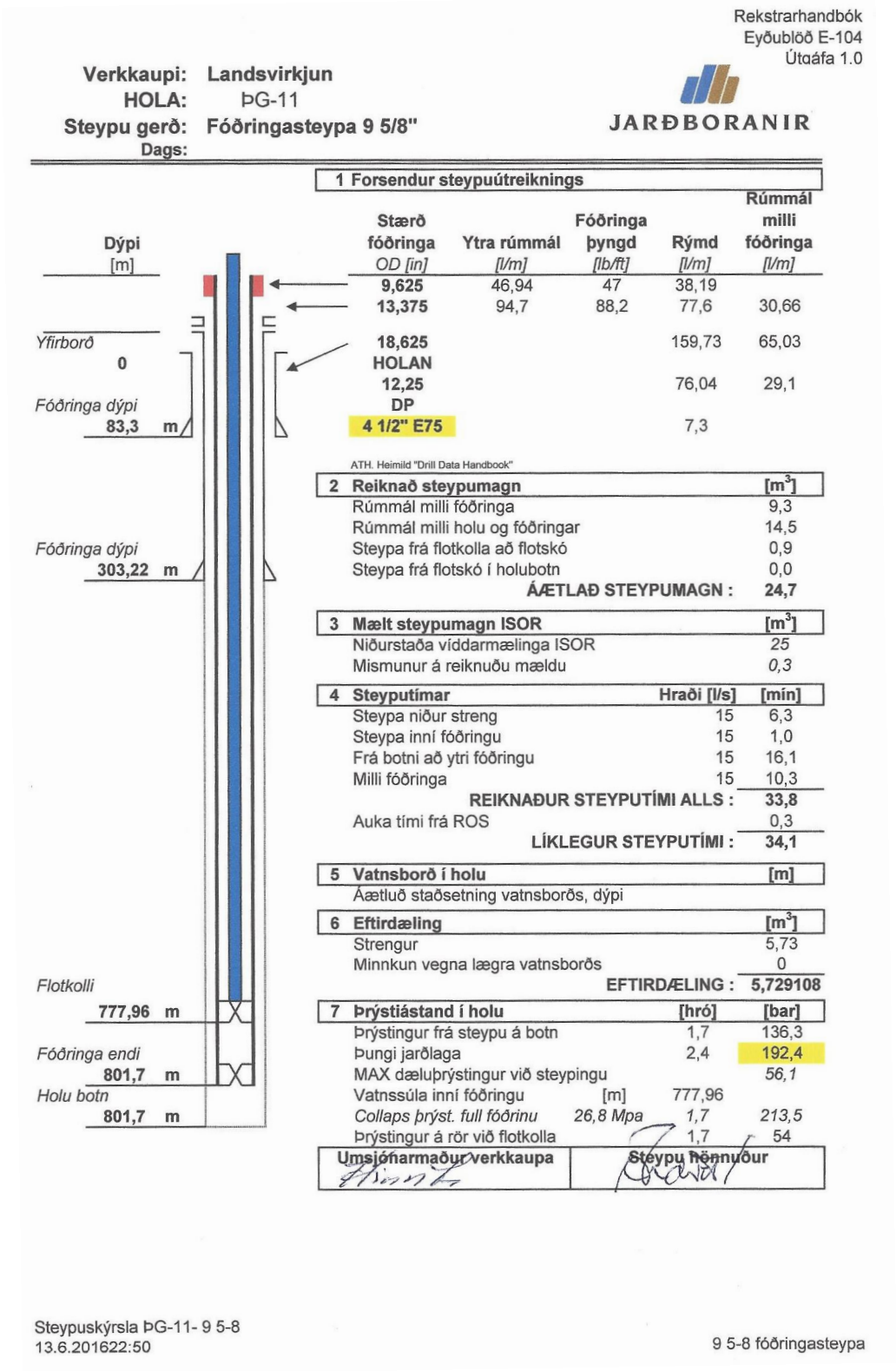
Sjá að ofan.

Umsjónarmaður verkkaupa	Steypu höfundur

teypuskýrsla ÞG-11- 9 5-8
3.6.201622:49

9 5-8 steypulýsing

Table 6. *Cement report for the production casing.*



Rekstrarhandbók
Eyðublöð E-104
Útgáfa 1.0

Verkkaupi: Landsvirkjun
HOLA: ÞG-11
Steypu gerð: Fóðringasteypa 9 5/8"
Dags:

JARÐBORANIR

1 Forsendur steypuútreiknings

Dýpi [m]	Stærð fóðringa OD [in]	Ytra rúmmál [l/m]	Fóðringa þyngd [lb/ft]	Rýmd [l/m]	Rúmmál milli fóðringa [l/m]
	9,625	46,94	47	38,19	
	13,375	94,7	88,2	77,6	30,66
Yfirborð 0	18,625 HOLAN			159,73	65,03
Fóðringa dýpi 83,3 m	12,25 DP			76,04	29,1
	4 1/2" E75			7,3	

ATH. Heimild "Drill Data Handbook"

2 Reiknað steypumagn	[m³]
Rúmmál milli fóðringa	9,3
Rúmmál milli holu og fóðringar	14,5
Steypa frá flotkolla að flotskó	0,9
Steypa frá flotskó í holubotn	0,0
ÁÆTLAÐ STEYPUMAGN :	24,7

3 Mælt steypumagn ISOR	[m³]
Niðurstaða víddarmælinga ISOR	25
Mismunur á reiknuðu mældu	0,3

4 Steyputímar	Hraði [l/s]	[mín]
Steypa niður streng	15	6,3
Steypa inní fóðringu	15	1,0
Frá botni að ytri fóðringu	15	16,1
Milli fóðringa	15	10,3
REIKNAÐUR STEYPUTÍMI ALLS :		33,8
Auka tími frá ROS		0,3
LÍKLEGUR STEYPUTÍMI :		34,1

5 Vatnsborð í holu	[m]
Áætluð staðsetning vatnsborðs, dýpi	

6 Eftirdæling	[m³]
Strengur	5,73
Minnkun vegna lægra vatnsborðs	0
EFTIRDÆLING :	5,729108

7 Þrýstiástand í holu		[hró]	[bar]
Þrýstingur frá steypu á botn		1,7	136,3
Þungi jarðlaga		2,4	192,4
MAX dæluþrýstingur við steypingu			56,1
Vatnssúla inní fóðringu	[m]	777,96	
Collaps þrýst. full fóðrinu	26,8 Mpa	1,7	213,5
Þrýstingur á rör við flotkolla		1,7	54

Flotkolli 777,96 m
Fóðringa endi 801,7 m
Holu botn 801,7 m

Umsjónarmaður verkkaupa	Steypu hönnuður

Steypuskýrsla ÞG-11- 9 5-8
13.6.201622:50

9 5-8 fóðringasteypa

3 Lithology, alteration, intrusions and circulation losses

During drilling of the 2nd phase of ÞG-11 the drillers collected cutting samples at two meters interval. Depth values of the samples refer to the rig floor of Sleipnir (5.72 m above ground level). The samples were collected in 150 ml plastic containers. ÍSOR's borehole geologists analysed the cutting samples on site during drilling and determined the lithology and the alteration mineral assemblages with the aid of a binocular microscope. Additionally, the main drilling parameters from the automatic data acquisition system of Sleipnir were collected.

Figure 3 shows the drilling data from the drill rig Sleipnir and lithology of well ÞG-11 from top to bottom (0–802 m). From the figure we can see how the ROP is generally higher during drilling of hyaloclastite formations like breccia and tuff, and lower during drilling of basaltic lava units or intrusive rock. The exception from this rule is the bottommost ~150 m where the drill bit penetrates hyaloclastite, basaltic lava units and intrusions and the ROP shows no clear correlation (high/low) with the formations.

3.1 Lithology of phase 2

The lithology of phase 2 in well ÞG-11 corresponds well to what was seen in the top 300 m in well ÞG-9 (Mortensen et al., 2013a). Both wells are drilled from well pad B, so strong similarities were expected. A detailed lithological log for well ÞG-11 from surface to 804 m depth is compiled in Figures 13–15, where different lithological units are described. In Figure 12 the lithologies of wells ÞG-9 and ÞG-11 are shown.

The results of the drill-cutting inspection from 304–802 m in ÞG-11 are shown below:

306–310 m: MEDIUM-COARSE GRAINED BASALT.

Medium grained gray-greenish crystalline basalt. Feldspar porphyritic. Micro-crystalline rock is common at its lower boundary. Intrusive rock.

310–318 m: GLASSY BASALT.

The rock becomes more altered than above. Crystalline rock admixed with dark green glass fragments. At 314 m the cuttings become whitish. Pyrite is very abundant.

318–320 m: BASALTIC BRECCIA.

Fractures filled with calcite, pyrite and quartz are seen.

320–328 m: NO CUTTINGS

328–332 m: BASALTIC BRECCIA.

A mixture of whitish and gray-greenish fragments, mostly from crystalline basalt. Non-porphyritic as before.

332–358 m: GLASSY BASALT.

A mixture of various types of crystalline rock and green glass fragments. The degree of alteration is high. Most possibly a pillow lava breccia. The rock is considerably fractured. The formation becomes more uniform at 346–350 m. But seem to be very brecciated at intervals.

358–366 m: FINE-MEDIUM GRAINED BASALT.

Fine grained crystalline basalt, non-porphyritic but vesicular with abundant dark green clay in vesicles. Gray-greenish in color. Possibly comprising a lava flow.

366–382 m: BASALTIC BRECCIA.

Mixed cuttings mostly composed of crystalline basalt but admixed with some few fragments of tuff. The rock is highly altered. Anhydrite might be present. Fracture fillings of pyrite and quarts are seen. At the lower boundary some rather fresh fragments of fine crystalline basalt are seen possibly representing an intrusive rock.

382–388 m: BASALTIC TUFF.

The cuttings are mostly composed of green fine-medium grained tuff, highly altered. Traces of epidote might be present at 386 m. Pieces of rock crystals are common.

388–398 m: GLASSY BASALT.

Reddish brown feldspar porphyritic crystalline basalt, with clay in pores. Considerably oxidized. Some dark green fragments of glass are admixed in the cuttings.

398–402 m: BASALTIC TUFF.

A thin layer of whitish-greenish tuff, very altered.

402–436 m: BASALTIC BRECCIA.

Very mixed cuttings, mostly green tuff and glass but some amount of crystalline basalt is also present. Most likely pillow lava breccia. At 414 m the amount of crystalline basalt increases. Some minor epidote seems to be present. The formation is considerably fractured with quartz, pyrite and calcite as fracture fillings.

436–452 m: BASALTIC BRECCIA.

A breccia with abundant crystalline fragments but admixed with some green glass fragments. Pillow lava breccia. At 438–440 m there is a dark gray feldspar porphyritic basalt that might represent an intrusive rock. Coarse grained clay is common in pores.

452–458 m: FINE-MEDIUM GRAINED BASALT.

Dark gray fine crystalline basalt, feldspar porphyritic. Somewhat porous, with coarse grained clay in pores. This might represent an intrusive rock.

458–462 m: BASALTIC BRECCIA.

Mixed cuttings, breccia.

462–470 m: BASALTIC TUFF.

Mostly composed of green fragments of tuff and glass. Crystalline fragments are sporadic in the cuttings.

470–492 m: GLASSY BASALT

Very altered whitish rock, a mixture of crystalline basalt and blue-green glass fragments. Most probably pillow lava. Coarse grained clay, quartz and pyrite are common in pores. The rock is rather porous.

492–498 m: BASALTIC BRECCIA.

Somewhat more mixed than above.

498–526 m: GLASSY BASALT.

Porous light gray crystalline basalt. Highly altered. With coarse grained clay in pores. Non-porphyritic. Rather homogenous formation. The glass fragments are gray and green in color.

498–526 m: GLASSY BASALT.

Porous light gray crystalline basalt. Highly altered. With coarse grained clay in pores. Non-porphyritic. Rather homogenous formation. The glass fragments are gray and green in color.

526–528 m: NO CUTTINGS.

528–544 m: BASALTIC BRECCIA.

Contains a lot of dark brown fine crystalline basalt, feldspar porphyritic. There are also some highly altered whitish fragments in the cuttings. Could be pillow lava breccia. Some intrusive rock might be present at the upper and lower boundaries.

544–550 m: NO CUTTINGS

550–558 m: FINE-MEDIUM GRAINED BASALT.

Mostly dark brown fine-glassy crystalline basalt. Sparsely feldspar and pyroxene porphyritic. Non-porous. Green clay is abundant. Might represent an intrusion. Alteration is moderate.

558–584 m: GLASSY BASALT.

A sharp upper boundary. The cuttings are almost white in color, highly altered. Most probably this is a glassy basalt as both crystalline rock and glass fragments are seen. The glass fragments are light gray in color but the crystalline basalt almost creamy colored. Epidote becomes rather common below 570 m depth.

584–600 m: BASALTIC BRECCIA.

At 584–588 m calcite is very abundant. The same applies to pyrite. White precipitations are common. The rock is highly altered. Epidote and prehnite are seen. In the lowermost part fragments of brownish medium grained basalt is seen.

600–658 m: MEDIUM-COARSE GRAINED BASALT/INTRUSIVE ROCK.

Medium to coarse grained basalt. Composed of large feldspar and pyroxene minerals and some minor amounts of Fe-Ti oxides. Resembles dolerite. Glass is a minor component. White precipitations are common. Could be intrusive rock? Seems to be a rather homogeneous formation. Grade of alteration is moderate to high. At intervals the formation is considerably fractured. Epidote and prehnite are common. At 661 m a total loss of circulation occurred. Could be at the lower

boundary of this unit. It is worth mentioning that in well ÞG-9 the only LOC (5 l/s) that occurred while drilling the 2nd phase occurred at 660 m, at a boundary between glassy basalt and a breccia below. The glassy basalt was described as medium grained and highly feldspar and pyroxene porphyritic.

658–664 m: NO CUTTINGS. Loss of circulation.

664–670 m: BASALTIC BRECCIA.

Mixed cuttings. Composed of medium grained basalt, green glass and white precipitations.

670–680 m: NO CUTTINGS.

680–690 m: BASALTIC BRECCIA.

Highly cement mixed. Mixed cuttings of dark crystalline basaltic grains and green totally altered grains. Very fine grained cuttings.

690–694 m: GLASSY BASALT.

More of crystallized grains with few noticeable plagioclase crystals in groundmass, due to high alteration. Still cement mixed.

694–710 m: FINE-MEDIUM GRAINED BASALT.

Most likely fine to medium grained crystalline basalt. The cuttings are very fine grained. A slight increase in epidote and decrease in calcite is noticed. The grades of alteration are highly variable. Some fragments of cement are seen at intervals. In the lower part of the unit, dark coloured plagioclase porphyritic basalt is common. Grains of green and white tuff are mixed in.

710–714 m: BASALTIC BRECCIA.

The cuttings become much finer grained and more mixed with cement, green tuff and crystalline basalt.

714–734 m: BASALTIC TUFF.

Pyrite rich and white tuff. Occasionally tuff grains with fine fractures are seen.

734–756 m: BASALTIC BRECCIA.

White and green tuff grains mixed with dark crystalline basalt. In the lower part of the unit the amounts tuff increase and also epidote becomes more abundant.

756–764 m: FINE-MEDIUM GRAINED BASALT.

Mostly fine grained and light colored basalt, but admixed with some tuff grains.

764–780 m: BASALTIC BRECCIA.

Highly altered tuff grains mixed with less altered light grey fine grained basalt.

780–782 m: BASALTIC TUFF.

Highly altered white and greenish tuff. Very fine cuttings. Some glassy and partly crystalline basaltic grains mixed in.

782–796 m: BASALTIC BRECCIA.

Coarser cuttings than above. A mixture of tuff and crystalline basalt. Fragments of fine grained moderately altered and dense crystalline basalt are common. The tuff is generally highly altered. Epidote is abundant.

796–802 m: FINE-MEDIUM GRAINED BASALT.

Mostly light gray crystalline basalt admixed with some tuff. The crystalline fragments are rich in plagioclase and pyroxene. Epidote is abundant. At 802 m (final depth of phase 2) some tuff is mixed in.

Figure 6 shows the comparison of well ÞG-11 and ÞG-9 from 0–802 m. The agreement between the two wells is good in the top 300 m and below 300 m it is quite good, but with some deviations. Hyaloclastite formations, which characterise the lithology of the uppermost 802 m of the formation, are characterized by a limited areal extent and steep slopes. Therefore, considerable changes in lithology may be observed over just short distances. At 802 m depth the distance between ÞG-11 and ÞG-9 should be about 200 m.

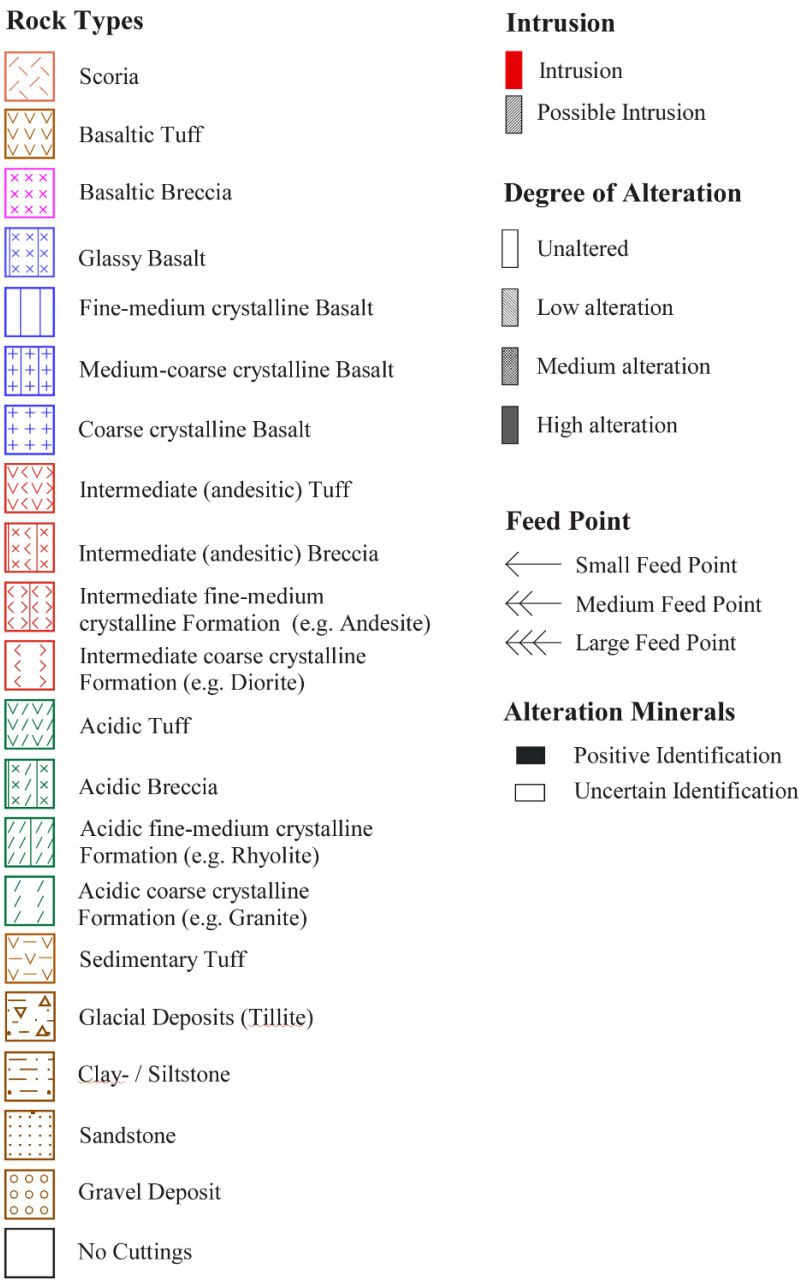


Figure 5. *Lithology legend for Figures 6–9.*

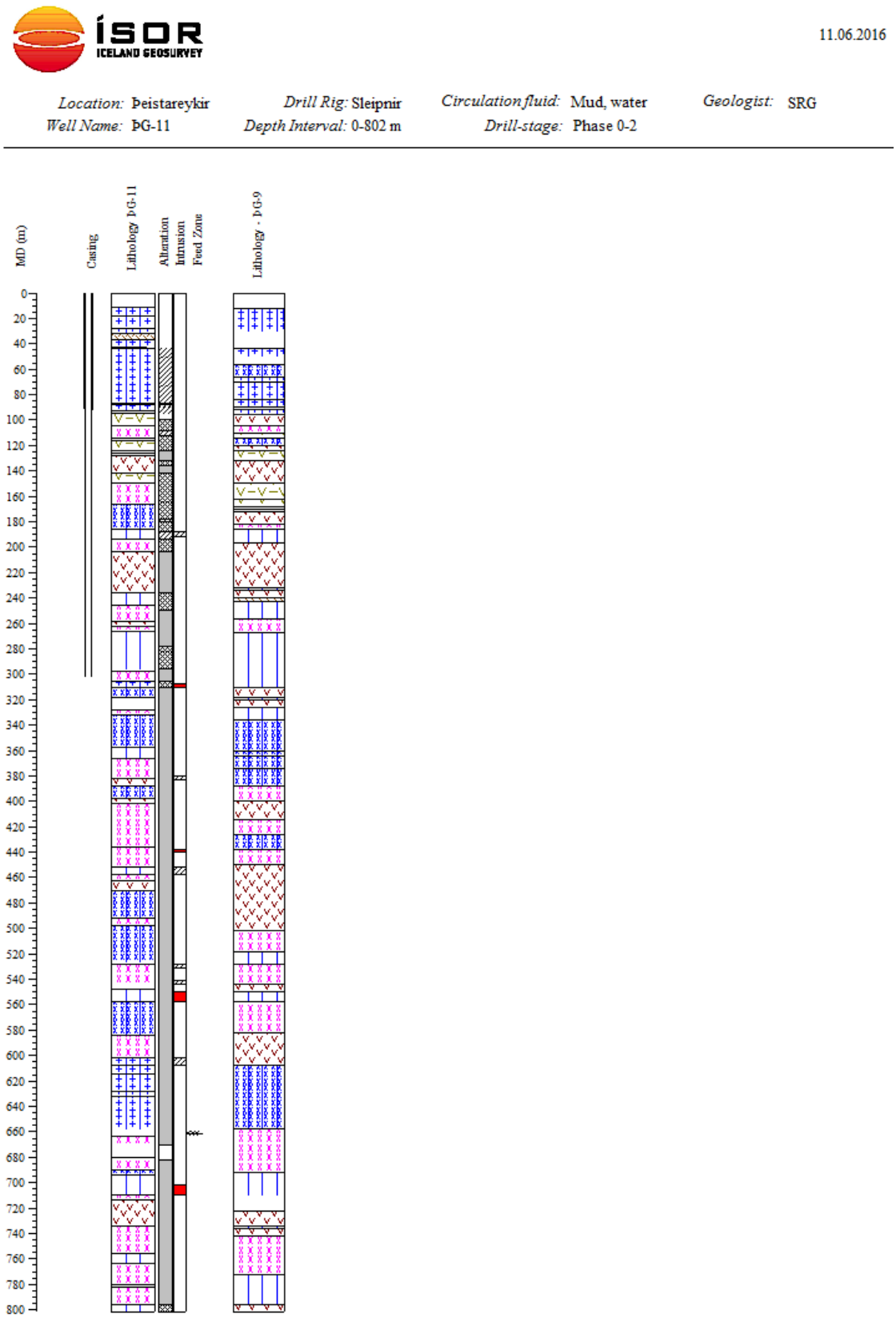


Figure 6. *Comparison of the lithology in wells ÞG-11 and ÞG-9, from 304–802 m.*

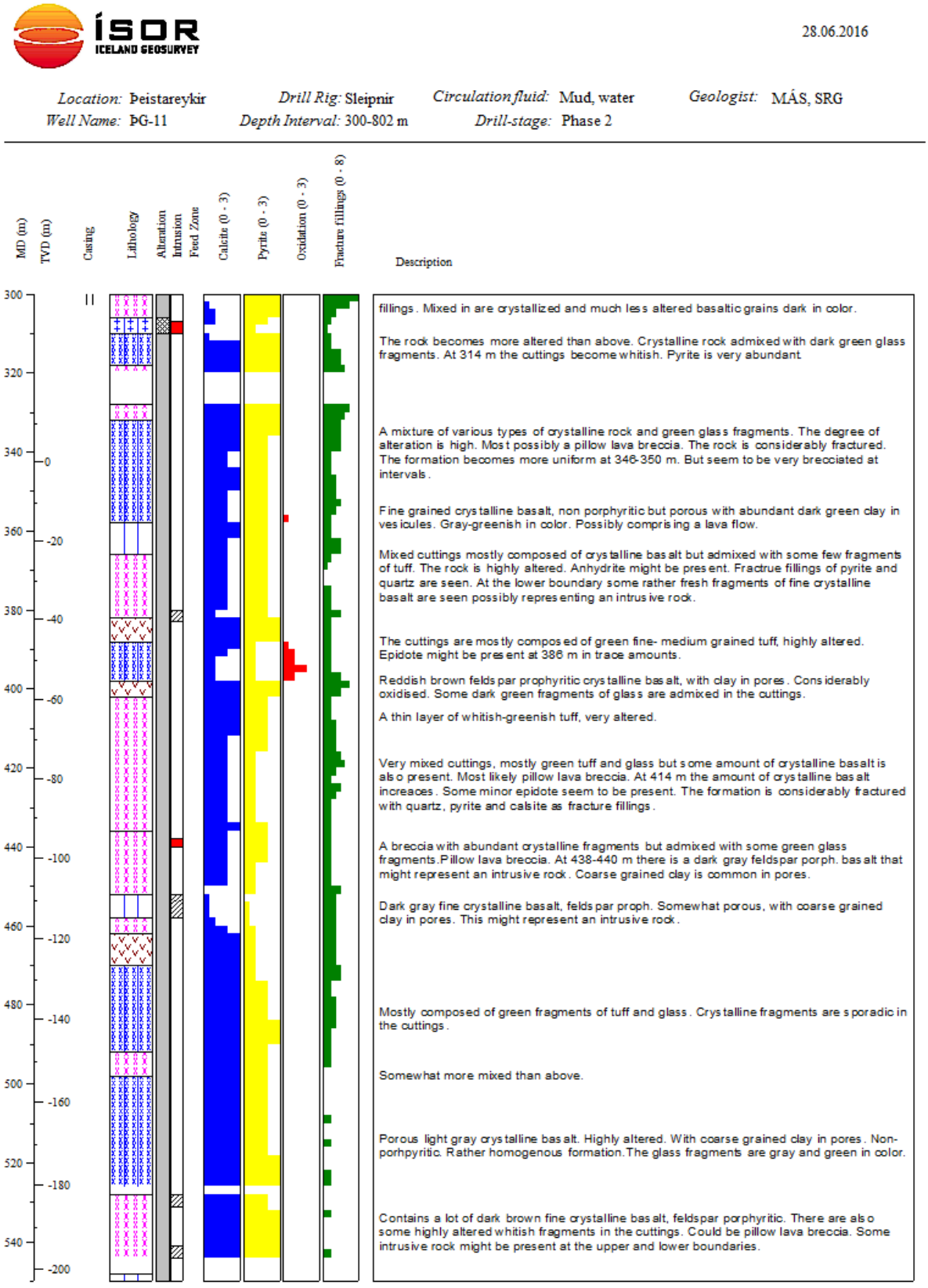


Figure 7. *Lithology and lithology descriptions at 300–550 m in ÞG-11.*

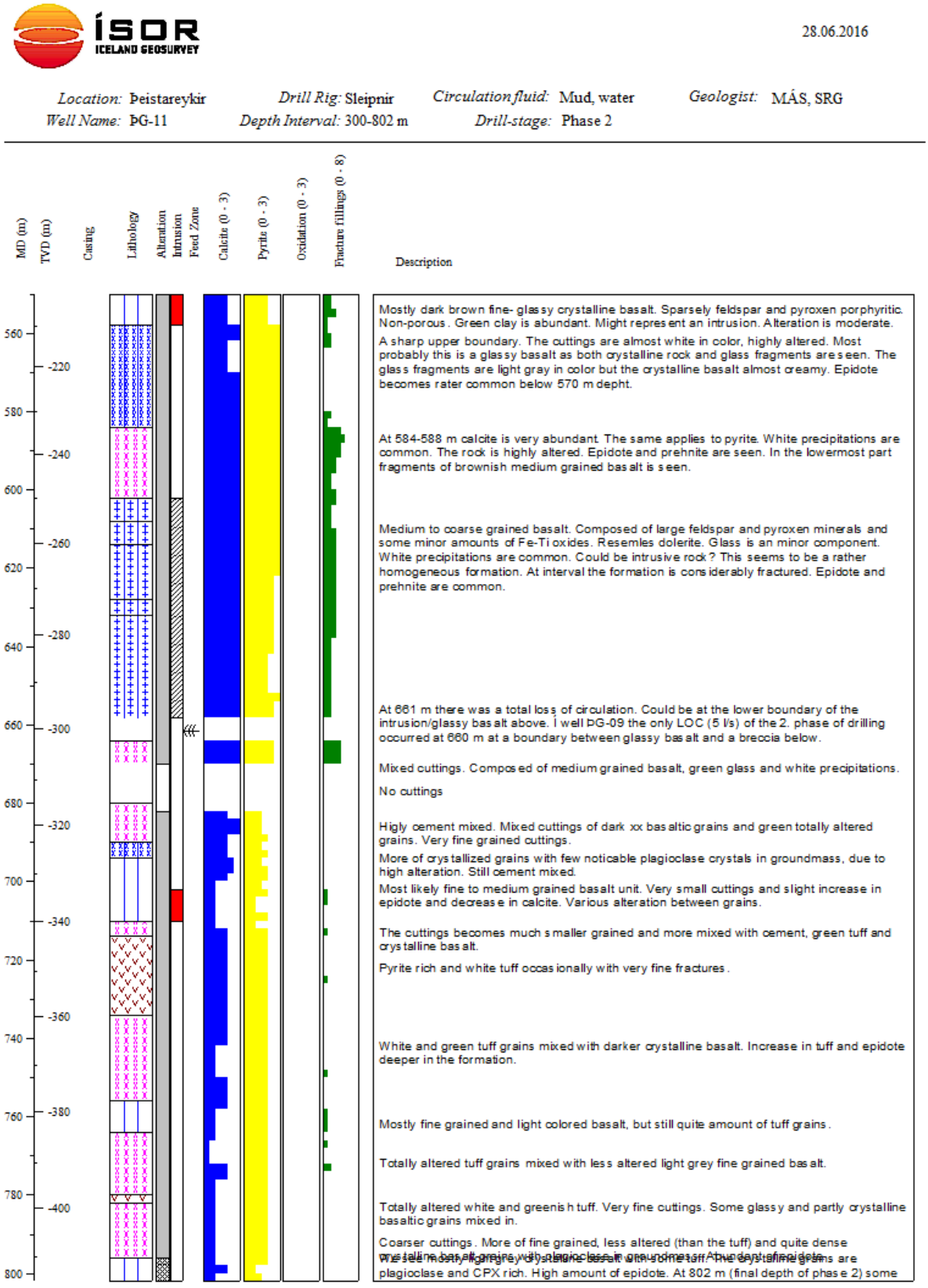


Figure 8. *Lithology and lithology descriptions at 550–802 m in well ÞG-11.*

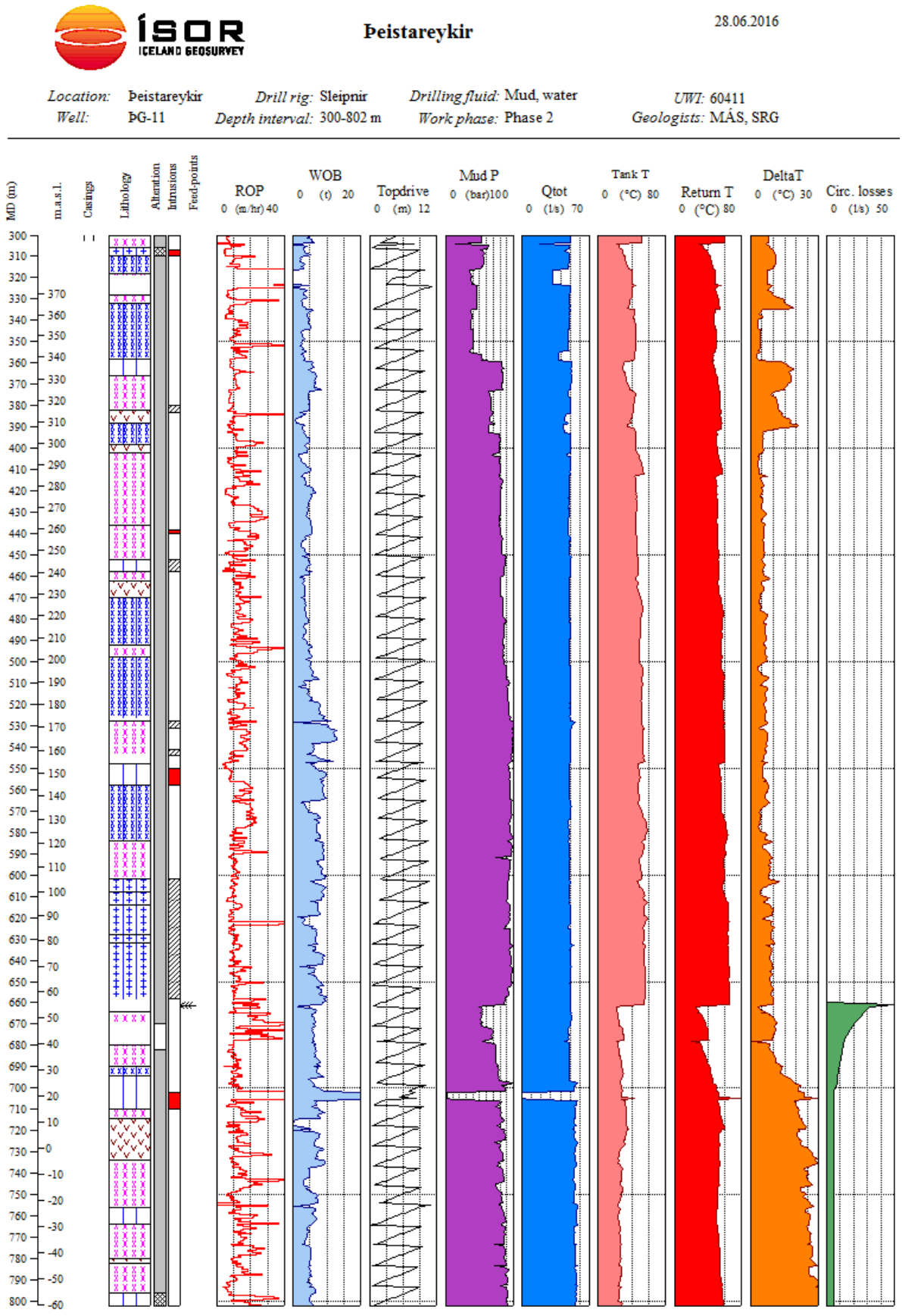


Figure 9. *Comparison of lithology and drilling data from 300–802 m in ÞG-11.*

3.2 Intrusions

Spikes in resistivity and NN together indicate the presence of dense formations, with low porosity. This is noticed at 308, 440 and 552 meters, where intrusions are being penetrated. The same is seen at around 530, 550, and between 600–661 m, where possible intrusions might be present. A large spike in NN and resistivity is also observed around 360 m, interpreted as a basaltic lava unit. At 600–661 m the well might have intersected a thick dike. For comparison, in well ÞG-9 a thick unit of medium grained glassy basalt was found at 608–658 m (Harðarson et al., 2013). Based on lithology descriptions, this formation/intrusion might have been intersected in both the wells. In well ÞG-9 this unit was identified as a glassy basalt or even a pile of lavas. To solve this, a petrographic study is needed.

3.3 Alteration

Figure 10 shows the main alteration mineral distribution in well ÞG-11 from 304–802 m depth. In general, the grade of alteration is high. In the uppermost part, from 304 m to ca. 400 m the main alteration minerals are clays and quartz, which appeared at around 200 m depth. At 386 m the first appearance of epidote was noticed. In the neighbouring well ÞG-9, epidote was first noted at 324 m, but did not become common until below 420 m (Harðarson et al., 2013). In ÞG-11 epidote becomes rather common in the cuttings below ca. 450 m. At around 400 m depth, prehnite appears. At similar depth the clays become more coarsely crystallized than above. These minerals are found down to 802 m. A white precipitation that resembles anhydrite might be present below ca. 350 m. But a thin section study is needed to support that contention. Calcite and pyrite are generally common below 300 m depth with only few exceptions.

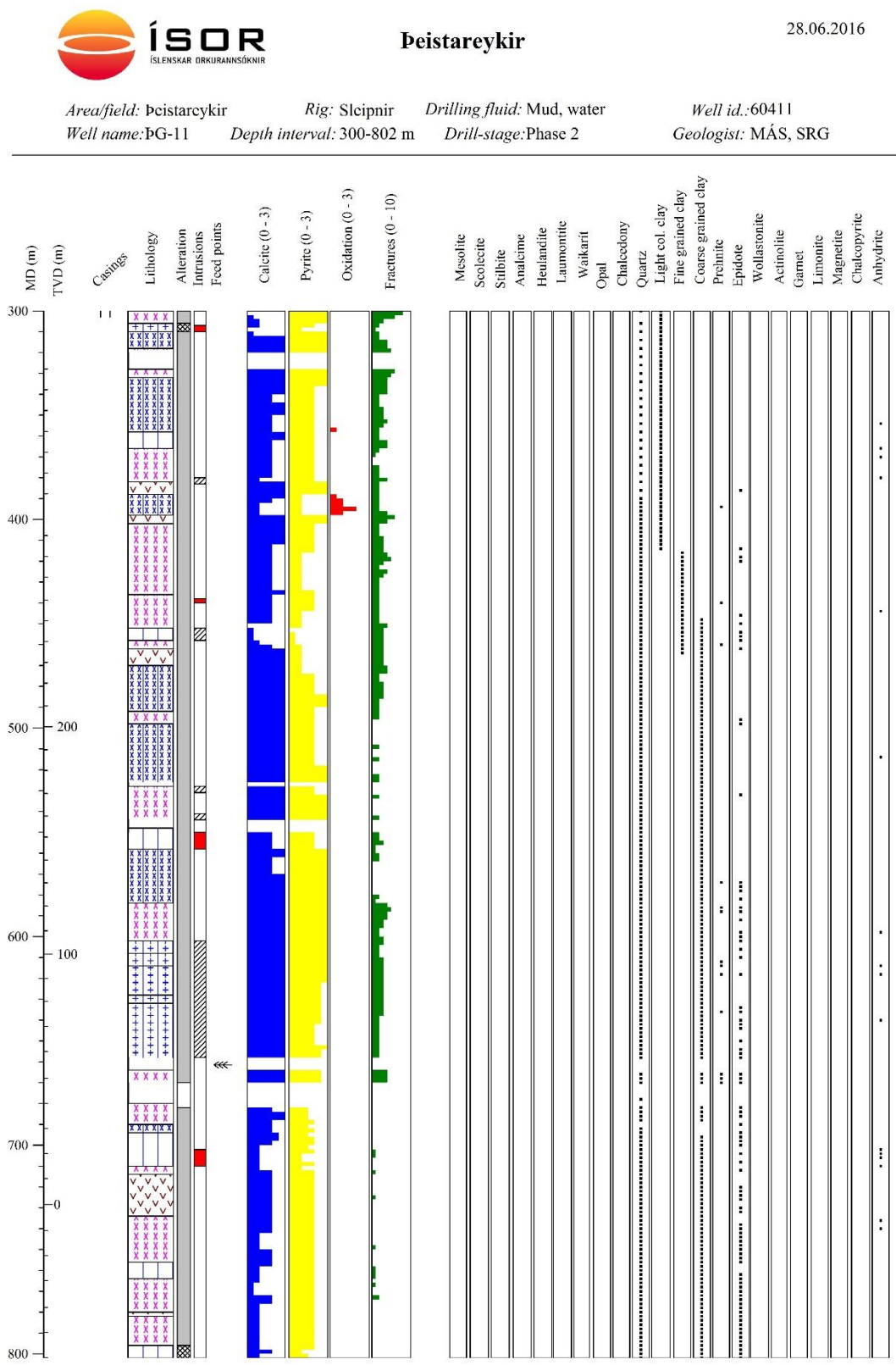


Figure 10. *Lithology and alteration minerals in well ÞG-11 at 300–802 m depth.*

3.4 Circulation losses during drilling of phase 2

Circulation losses (LOC) were monitored during drilling of phase 2 in ÞG-11. No losses were encountered during drilling except at 661 m were a total loss of circulation occurred. A cement plug was placed in the well in order to seal it. Based on cutting inspections the loss seems to have occurred at a lithological boundary between a thick unit of medium grained crystalline basalt (above) and a basaltic breccia below. In well ÞG-9 no losses were observed during drilling of the second phase, but after drilling, a minor loss of 5 L/s appeared (Harðarson et al., 2013). Based on temperature logging, a minor feed point was detected at ca. 660 m in well ÞG-11.

After drilling through the cement plug, with its bottom at 667 m, a loss of 4–8 L/s was measured until reaching the final depth of phase 2 at 802 m.

Table 7. *Circulation losses during drilling of phase 2 of ÞG-11.*

Date	Depth (m)	LOC (L/s)	Remarks
08.06.2016	661	50	5 m^3 of cement slurry were used to seal off the loss zone. On the formation boundary of a medium-grained basalt above, possibly an intrusion (dike), and a basaltic breccia below
08.06.2016	677	15	Losses gradually decrease
10.06.2016	698	8	
11.06.2016	736-755	4-6	
11.06.2016	764-799	8	Drilling of phase 2 terminated at 802 m

4 Wireline logging

Wireline logging in phase 2 of well ÞG-11 can be divided into 5 types.

- Gyro surveys to measure inclination and azimuth with depth in order to monitor the directional drilling (angle build-up and direction) and to determine the trajectory of the well when the drilling is completed.
- Temperature log prior to cementing in order to check the warm-up rate inside the well and to locate loss zones if they occur.
- Lithological logs including neutron-neutron, natural gamma radiation, resistivity, self-potential, and acoustic televiewer. Besides this, a caliper-log is run in order to obtain information on the width of the well and to locate cavities (wash out zones).
- Caliper-log prior to cementing in order to map the well's diameter, i.e. cavities and possible obstacles inside the well that require further reaming. In addition, the caliper log gives the minimum volume behind the casing needed to be filled with cement.
- Temperature log and CBL-log after cementing in order to check the hardening- and the binding process of the cement that is exergic and heats up the stagnant water inside the casing.

In this chapter the logging activity and the logging results for the drilling of well ÞG-11 for the 9⅝" production casing (drilling of phase 2) are introduced and discussed but the analysis and the results of the televiewer logging will be given in a separate report. Overview of the wireline loggings is shown in Table 9.

Table 8. *Geophysical logs in phase 2 of ÞG-11.*

Date	Time	Log type	Depth (m)	Purpose	Q [l/s]	Remarks
5.6.2016	22:45-23:31	Gyro	50-289	Motor-tool face	0	Survey depths: 50, 100, 150, 200, 250 and 285 m.
6.6.2016	20:20-20:39	Gyro	285-370	Incl. & azimuth	0	Survey depths: 285, 320, 350 and 370 m.
7.6.2016	22:20-22:57	Gyro	370-513	Incl. & azimuth	0	Survey depths: 370, 400, 430, 460, 490 and 513 m.
9.6.2016	05:26-06:07	Temperature	5-670	Temp / feed point location	≈ 10	Pumpflow through kill line 18 L/s
10.6.2016	20:38-21:09	Gyro	490-657	Incl. & azimuth	8	Survey depths: 490, 520, 550, 580, 610, 640 and 657 m
12.6.2016	03:47-04:19	Temperature	10-777	Temp / feed point location	7,5	Stopped at 777 m depth because of high temperature 150°C
12.6.2016	04:26-04:55	Temperature	750	Heat-up	7,5	
12.6.2016	06:10-06:46	XY-Caliper	250-730	Well diameter	7,5	Stopped at 730 m depth because of high temperature
12.6.2016	08:00-09:14	Neutron-Neutron	15-680	Lithology	7,5	Stopped at 680 m depth because of high temperature
12.6.2016	08:00-09:14	Gamma	15-680	Lithology	7,5	Stopped at 680 m depth because of high temperature
12.6.2016	10:20-10:42	Resistivity	280-755	Lithology	7,5	Stopped at 755 m depth because of high temperature
12.6.2016	14:35-17:25	Televiewer	290-669	Lithology	7,5	Tool stagnates at 669 m.
14.6.2016	00:33-01:14	Temperature	0-777	Temperature	0	Logged before Cement bond. Spikes in log
14.6.2016	03:13-04:00	CBL	0-774	Cement Bond	0	About 6 hours after last cementing.
14.6.2016	04:14-04:48	Temperature	0-777	Temperature	0	CCL removed from logging stack, no spikes
14.6.2016	13:15-13:47	Temperature	0-773	Temperature	0	Logged before Cement bond
14.6.2016	15:12-15:54	CBL	4-700	Cement Bond	0	About 18 hours after last cementing. Stopped at 700 m because of high temperature

The drilling of phase 2 started early morning June 5th with drilling in the cement float collar at 279 m depth. The first Gyro log for motor orientation was run when drilling depth was 325 m, which is the kick-off point (KOP). A total of four Gyro runs were performed in phase 2. One temperature log was performed while drilling phase 2 to locate feed points for cementing. Production casing (9⅝") depth was reached at 802 m on Saturday, June 11th and geophysical logging started right after the bottom hole assembly (BHA) had been pulled out of hole (POOH). The logging program consisted of the following measurements: Temperature, XY-caliper, electric properties, including normal resistivity and spontaneous potential, neutron-neutron response (back scattering of thermal neutrons), natural gamma radiation from the formation and acoustic televiewer. Cement bond log was performed after cementing of the casing production. Table 8 shows an overview of all logs performed during phase 2 in well ÞG-11.

Gyro surveys

Table 9 shows the design parameters for the directional drilling of well ÞG-11 including kick-off-point (KOP), angle build-up (AB), inclination and azimuth. Logging engineers from ÍSOR carried out four gyro surveys in phase 2 of well ÞG-11 and the corresponding depth intervals are listed in Table 10. The resulting surveys, together with derived well path parameters are given in Table 11 and Figure 11 shows the measured inclination and azimuth. The first Gyro survey was conducted on June 5th for the depth interval down to 289 m when the motor "tool face" was logged. The second gyro survey was conducted for depths 285 m–370 m. As seen from the gyro data, the well started to slant considerably already after 250 m in direction of about 320–330° but that was corrected successfully over a distance of only 80 m (Figure 11). For the reminder of the drilling job, two more gyro surveys were run in phase 2 to measure the inclination and the azimuth of the well. The last gyro survey in phase 2 was run on June 10th when drilled depth was 701 m and the well was logged down to 657 m depth. Figure 12 shows the calculated well path from the measured inclination and azimuth data together with the designed well path and corresponding deviation limits. There it can be seen that the actual well path has reached within the well path criteria from 610 m depth.

The first two surveys were performed with a SPT-1414 gyro tool and the latter two were performed with a SPT-45 gyro tool to confirm the reliability of the other tool. The results show that the inclination at 657 m depth is 35° and the azimuth 181°.

Table 9. *Target for inclination and azimuth in well ÞG-11.*

Azimuth	KOP	AB	Inclination	Target
180°	325 m	3°/30 m	40°	2000–2500 m (MD)

Table 10. *Gyro surveys carried out in phase 2 of well ÞG-11.*

Date	Depth interval (m)	Tool
5.16.2016	50-289	SPT 1414
6.16.2016	285-370	SPT 1414
7.16.2016	370-513	SPT 45
10.16.2016	490-657	SPT 45

Table 11. *Inclination, azimuth and derived parameters for well ÞG-11.*

Measured Depth [m]	Inclination [°]	Azimuth [°]	Horizontal displacement [m]	TVD [m]	ISNET93 Coordinates		
					East [m]	North [m]	Elevation [m]
0	0.00	0.0	0	0	593436.0	599582.0	350
50	0.18	340.4	0	50	593436.0	599582.1	300
100	0.23	319.6	0	100	593435.9	599582.2	250
150	0.41	334.3	1	150	593435.7	599582.5	200
200	1.02	327.0	1	200	593435.4	599583.0	150
250	1.66	329.2	2	250	593434.8	599584.0	100
285	2.17	328.7	4	285	593434.2	599585.0	65
320	2.35	321.7	5	320	593433.4	599586.1	30
350	1.52	228.9	5	350	593432.7	599586.3	0
370	3.48	183.3	5	370	593432.5	599585.6	-20
400	5.95	181.7	4	400	593432.4	599583.1	-50
430	8.37	180.7	5	430	593432.3	599579.4	-80
460	11.14	183.0	9	459	593432.2	599574.3	-109
490	14.49	180.9	15	488	593431.9	599567.6	-138
520	18.44	182.1	23	517	593431.7	599559.1	-167
550	22.24	180.4	34	545	593431.5	599548.7	-195
580	25.74	184.0	46	573	593431.0	599536.6	-223
610	29.30	181.5	60	599	593430.3	599522.7	-249
640	32.95	180.2	75	625	593430.1	599507.2	-275
657	35.01	181.1	85	639	593430.0	599497.7	-289

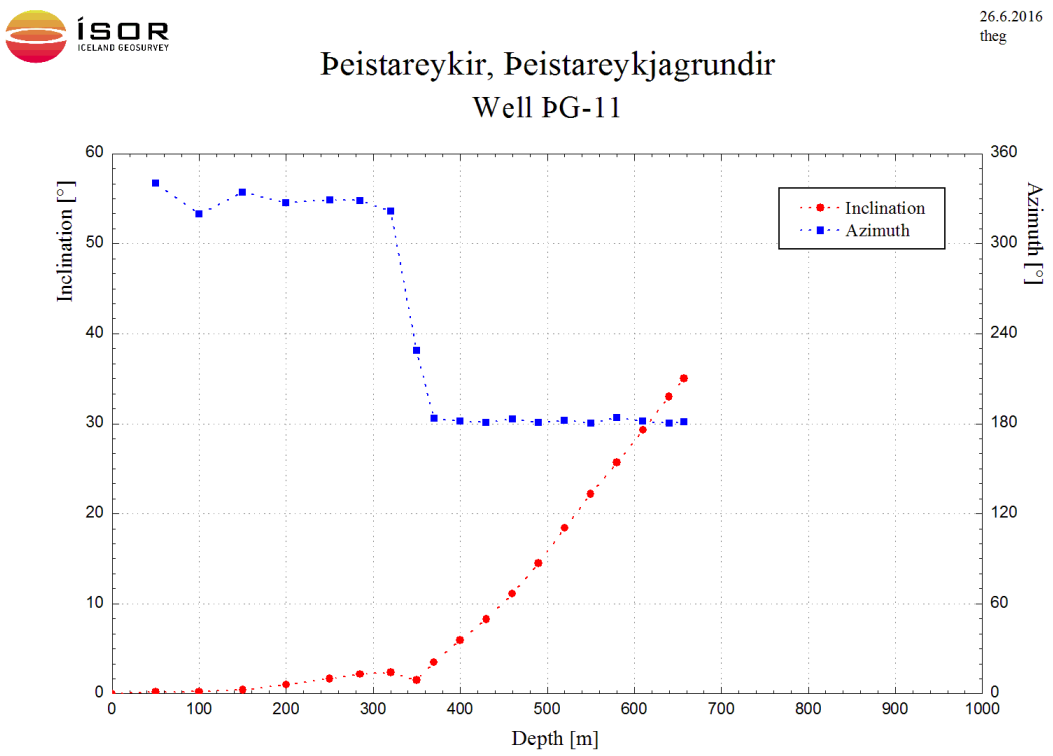


Figure 11. *Measured inclination and azimuth during the angle build-up phase in well ÞG-11 as listed in Table 11.*

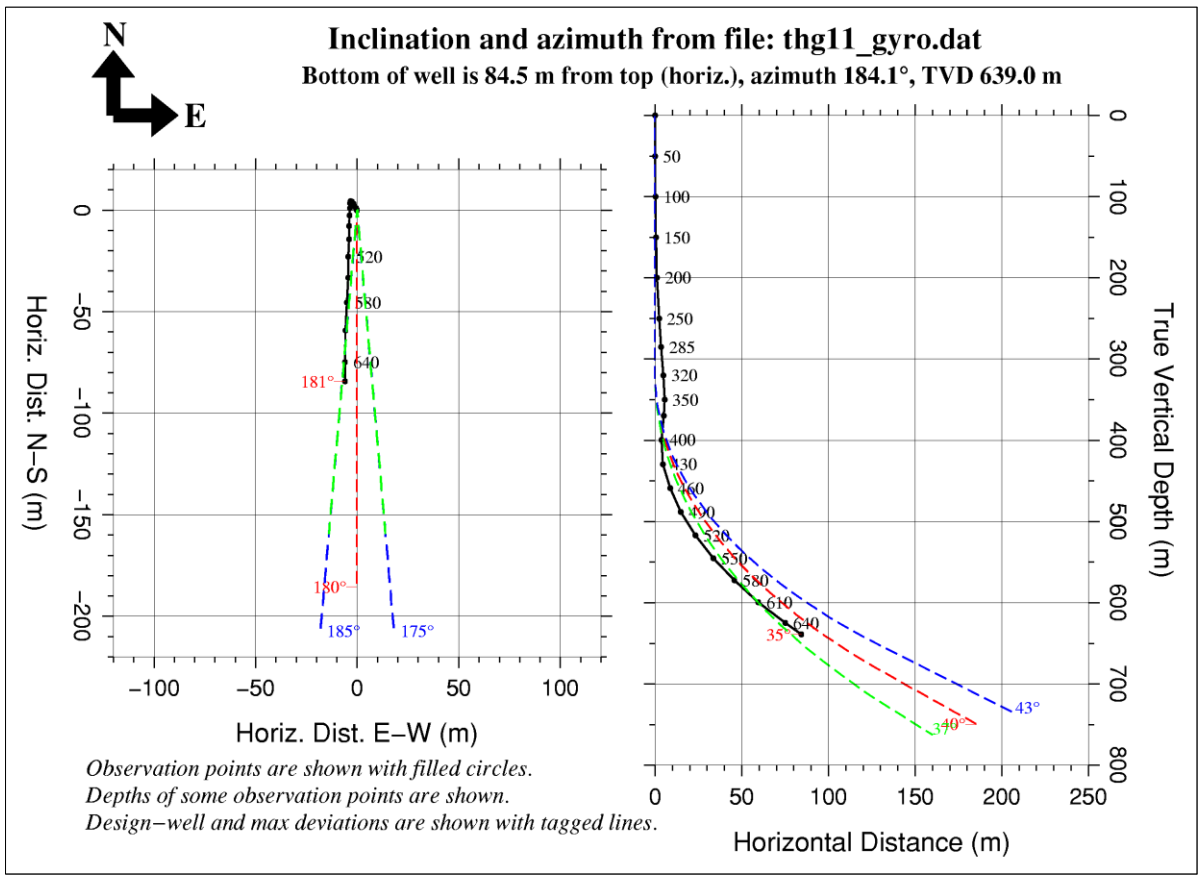


Figure 12. *Calculated well path from measured inclination and azimuth as listed in Table 11.*

Temperature, XY-caliper and geophysical logs.

Total circulation loss occurred at 661 m depth and when the depth reached 677 m, it was decided to plug the loss zone. The circulation loss decreased and was measured 15 l/s when the drilling finished. After the bottom hole assembly (BHA) had been pulled out of hole (POOH) the circulation loss was estimated about 10 l/s. A temperature log was run prior to the cement job in order to accurately locate the leakage zone, see Figure 13. As mentioned above, only minor LOC were observed after drilling through the cement (from ~4 to ~8 l/s see table 4) during the remainder of drilling this section.

When the target depth for the production casing was reached at 802 m on Saturday, June 11th, geophysical logging started right after the bottom hole assembly was out of hole. Then, the circulation loss in the well was estimated about 7.5 l/s. The program started with a temperature log on June 12th at 03:47 in the morning. The temperature log was stopped at 777 m depth due to high temperature that exceeded the temperature tool's tolerance of 150°C. The temperature profile is shown in blue on Figure 13. This log shows the evidence for a feed-zone at 670 m where almost all the circulation loss occurs. Very little flow is beyond this point, which is at a similar location as the feed zone that was plugged earlier, i.e. on the 8th of June. The cooling spot at 750 m while the well was heating up after the cement job on June 14th indicates a very small loss zone there during the drilling, but as mentioned above, very little flow passed below 670 m.

After the temperature log was finished, the 4-arm XY-caliper tool was used to log the well's diameter. The results are shown in Figures 14 and 15 where the caliper log shows no obstacles and no major cavities. The traditional cement washout right below the anchor casing is there, but besides that there are four minor caliper anomalies at 400, 670, 690 and 710 m depths, with one at 670 m where the most active loss zone was located. In Figure 15 it can be seen that the well is slightly elliptical, especially below 470 m depth. In Figure 14 the accumulated space between the 9⅝" production casing and the annulus is shown. The volume builds up to 29 m^3, which is the estimated slurry volume to fill this space and cement the production casing to the formation and the anchor casing.

In general, the resistivity is low, and the back scattering neutron response shows no large anomalies although it still reflects intrusions. The natural gamma log shows clear indications of silicic formations. The analysis of the lithological logs described below is based on Figure 15.

315–376 m: Neutron response anomaly with considerably low natural gamma radiation indicates basaltic intrusion.

420 m: Peaks in resistivity, neutron response and a small natural gamma anomaly indicates a silicic intrusion.

434 m: Small anomalies in resistivity, neutron response and a bit faded peak in natural gamma, indicates a silicic intrusion.

447–456 m: Broad anomalies in resistivity and neutron response. Right below, at 460 m, there is a relatively high peak in natural gamma. This indicates basaltic intrusion above a silicic horizon, probably pyroclastic.

485 m: Anomaly in natural gamma indicates silicic horizon, probably pyroclastic.

523–528 m: Anomaly in natural gamma at 523 m, right above an anomaly in neutron response at 528 m, indicates basaltic intrusion above a silicic horizon. The resistivity at these locations is uniform.

541–556 m: The lithological logs indicate signs of a complex geological structure. Sharp peak in natural gamma at 541 m, right above a broad anomaly in neutron response and a single peak in natural gamma at 549 m. This indicates a silicic horizon above intrusive rock where both basaltic and silicic nature occur.

556–563 m: A low neutron response with a ~7 m broad anomaly in natural gamma indicates silicic pyroclastic layer (tuff?). Uniform, relatively low resistivity.

578–609 m: Increasing neutron response and a natural gamma activity with uniform resistivity. A single peak in natural gamma at 595 m. Indicates complex formation moving towards denser rock with increased silicic content.

609–641 m: High neutron response with variety in natural gamma but no remarkable peaks. Dense formation of uniform resistivity.

641–660 m: Increasing activity in natural gamma and decreasing neutron response down to 650 m. The peak in natural gamma at 660 m is just below a small anomaly in neutron response and refers most likely to a silicic pyroclastic horizon in connection with a permeable zone at this depth.

660–752 m: Decreased resistivity and more irregularities in caliper. There is no measure of neutron response and natural gamma below 680 m (Table 8).

Cement bond logs

The cementing of the 9⅝" production casing was finished June 13th at 22:30. In total, 52.5 m^3 of cement were used. ÍSOR´s logging engineers started temperature and CBL logging at midnight June 14th. The temperature log was performed first and the results can be seen in Figure 13 (green curve). The highest temperature measured was 107 °C, at the bottom of the well. According to the figure, there were clear signs of cooling at the location of the feed zone at around 660–670 m and also at 750 m.

The first CBL log was carried out approximately 6 hours after cementing and revealed that cement was behind the casing at all depths. The cement was very soft above 100 m. Between 100–450 m the cement was bonding, but not fully hardened, and below 450 m the hardening of the cement already seemed at final phase, see Figure 16. Another CBL log was carried out 18 hours after the cementing had finished, see Figure 17. Again, the bonding and/or hardening of the cement above 100 m has not completed. Also, improvements of the cement bonding/hardening were not clear at the 100–450 m depth interval, but below 450 m the casing is strongly bonded to the formation.

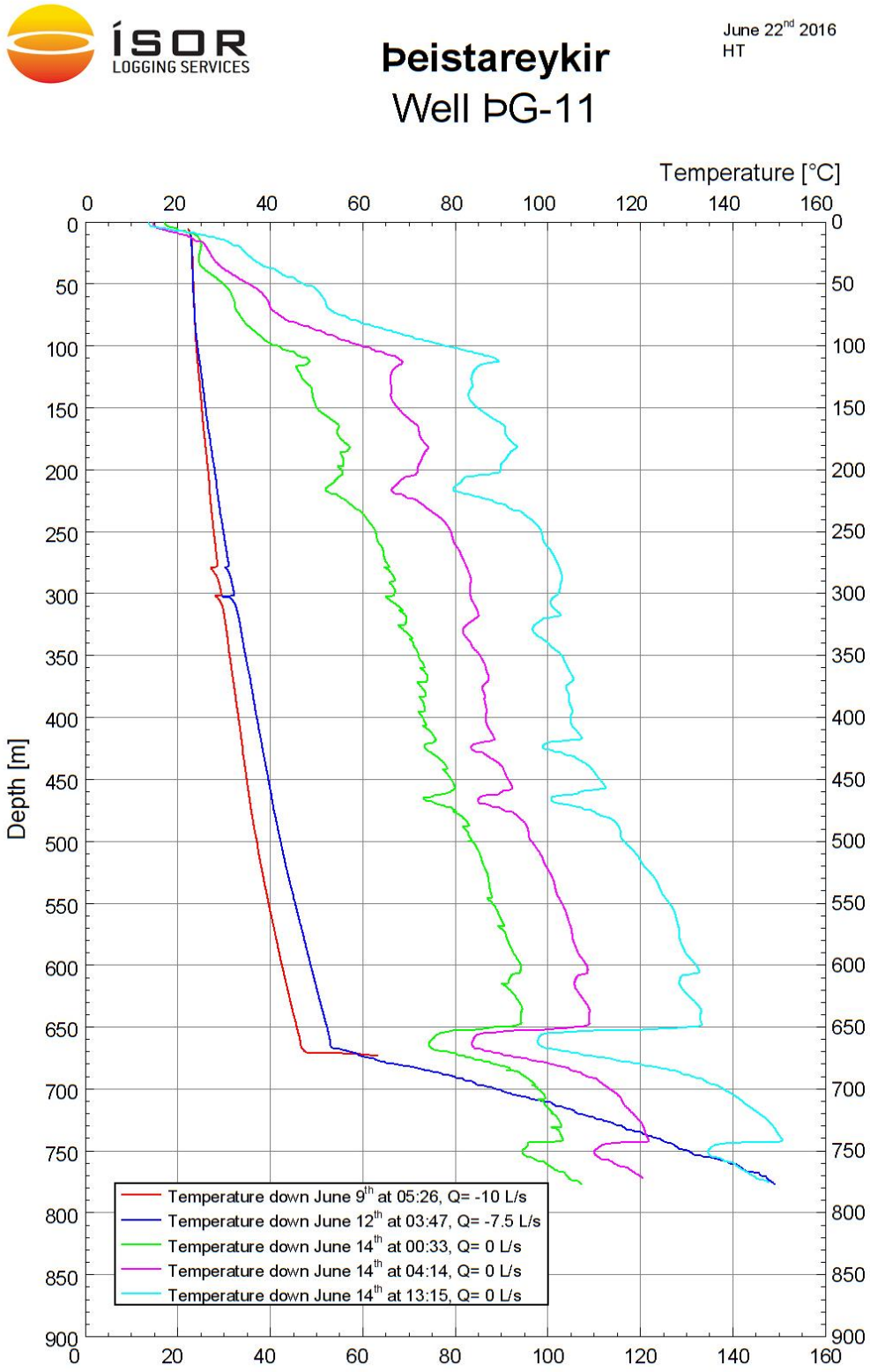


Figure 13. *Temperature logs in well ÞG-11 at drilling phase 2.*

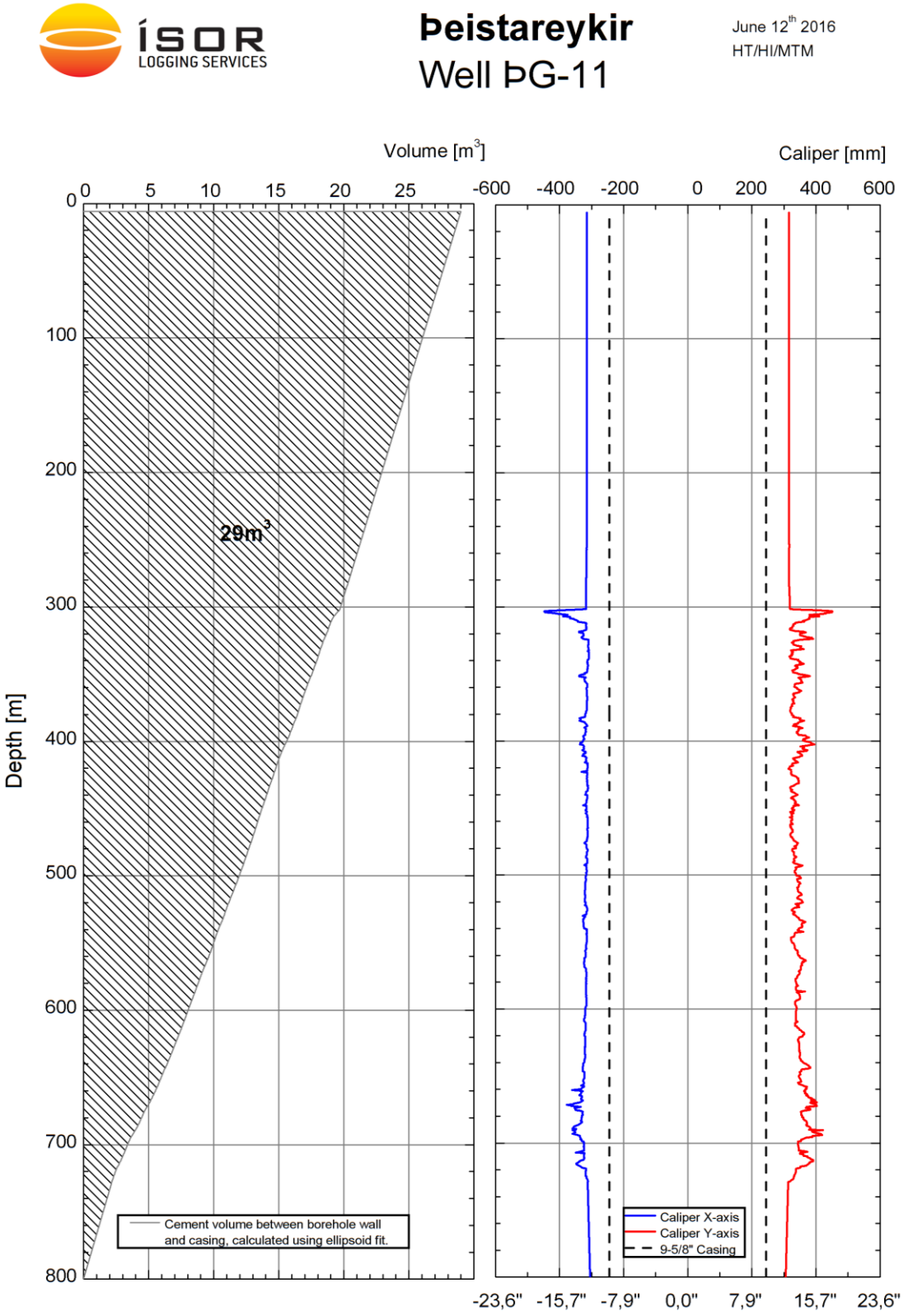


Figure 14. *Caliper log and an estimated amount of cement for the production casing in ÞG-11.*

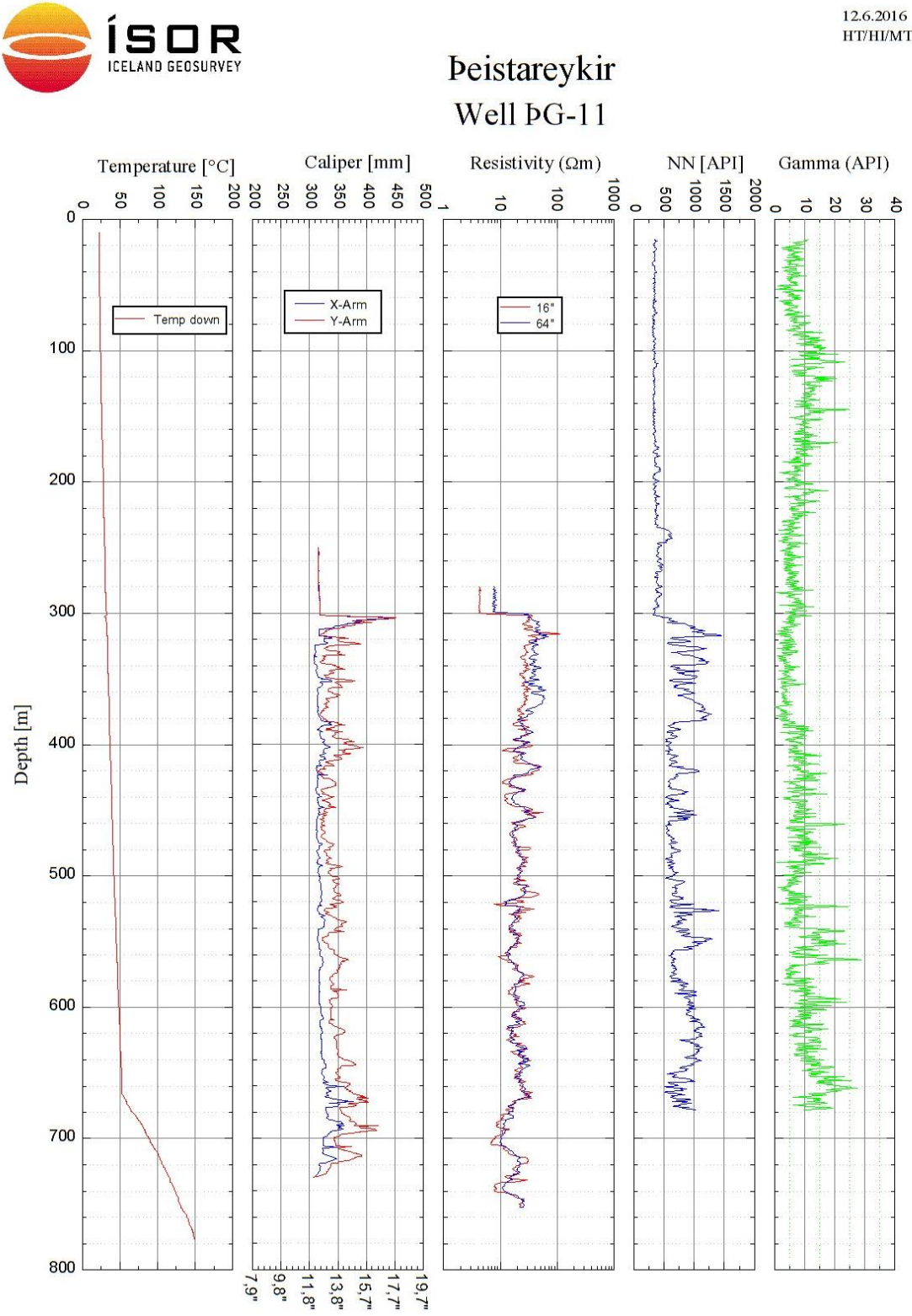


Figure 15. *Geophysical logs after phase 2 of the drilling of well ÞG-11.*

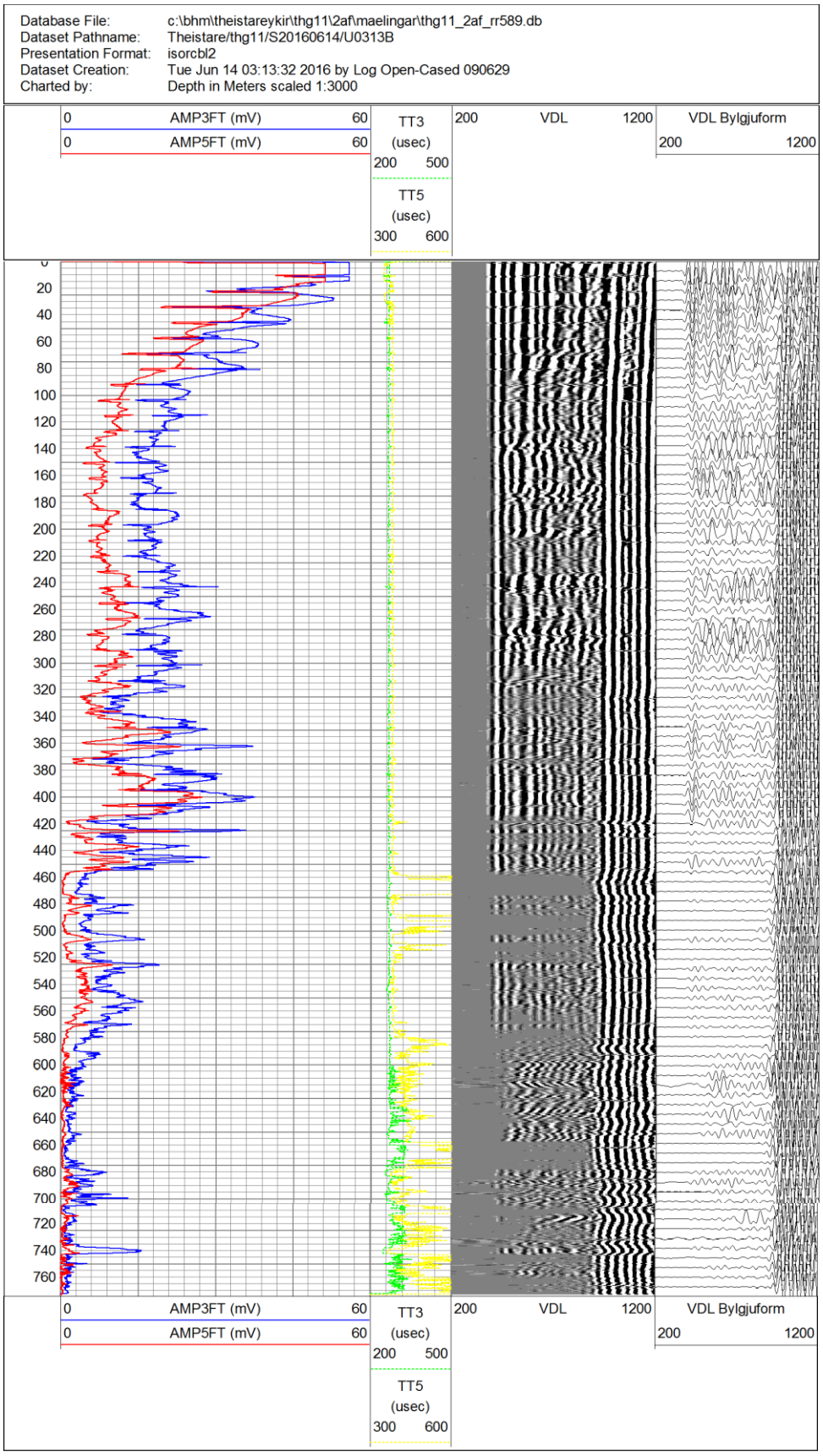


Figure 16. *Cement Bond Log – Production casing, ~6 hours after cementing.*

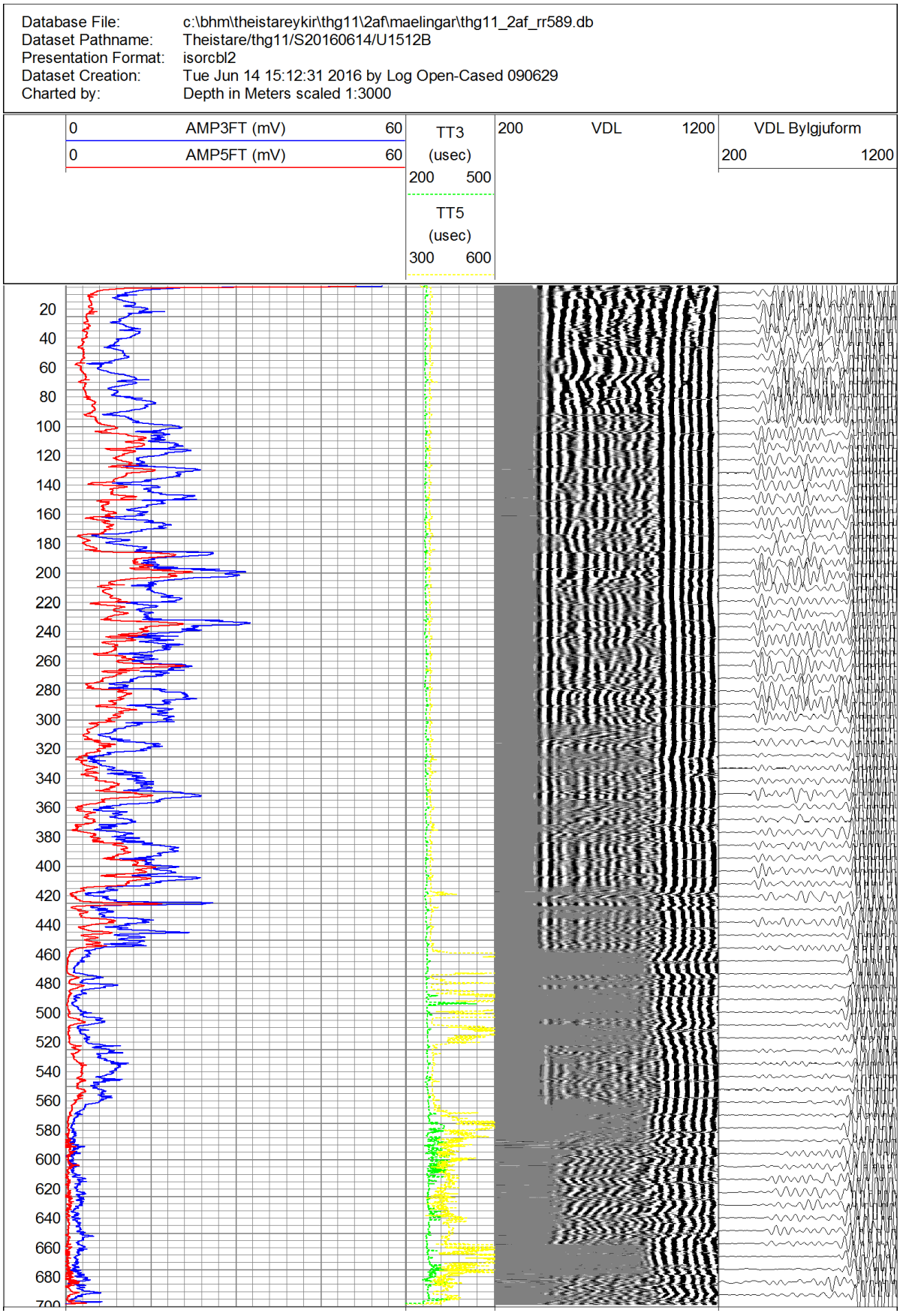


Figure 17. *Cement Bond Log – Production casing, ~18 hours after cementing.*

5 References

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Appendix A: 9⅝" production casing report

ICELAND DRILLING

Casing Tally Run Report — **Jarðboranir**

Rig: Sleipnir — **Rig No: 28000**

Job No: 28176 — Job Name: ÞG-11

String Nominal OD (cm): 24,45 **String Type: FULL**

Items Run:	**71**	**Length Run:**	**802,390**	**Top Depth:**	**7,100**
Items Excluded:	**0**	**Length Excluded:**	**0,000**	**Bottom Depth:**	**801,700**
Items Tallied:	**71**	**Length All Items:**	**802,390**	**Cut Off Length:**	**7,790**

Run No.	Joint No	Item	Length	Top	Bottom	Description	Comments	Cnt	Scr
1		SHOE	0,540	801,160	801,700	24,45 x 0,00 K-55 BUTT	Order no:3586-01/Seq-5		
2	69	JOINT	11,070	790,090	801,160	24,45 x 22,05 K-55 BUTT	16600850/1602410482W07 17	1	
3	68	JOINT	11,610	778,480	790,090	24,45 x 22,05 K-55 BUTT	16600854/1602410483W05 64	1	
4		FLOAT	0,520	777,960	778,480	24,45 x 0,00 K-55 BUTT	Order no:3559/Seq-4		
5	67	JOINT	11,640	766,320	777,960	24,45 x 22,05 K-55 BUTT	16600850/1602410482W07 16	1	
6	66	JOINT	11,630	754,690	766,320	24,45 x 22,05 K-55 BUTT	16700658/1602410489W06 65	1	
7	65	JOINT	11,690	743,000	754,690	24,45 x 22,05 K-55 BUTT	16600854/1602410483W05 63	1	
8	64	JOINT	11,670	731,330	743,000	24,45 x 22,05 K-55 BUTT	16600853/1602410484W04 92	1	
9	63	JOINT	11,630	719,700	731,330	24,45 x 22,05 K-55 BUTT	16700658/1602410489W06 64	1	
10	62	JOINT	11,530	708,170	719,700	24,45 x 22,05 K-55 BUTT	16700658/1602410489W06 66	1	
11	61	JOINT	11,650	696,520	708,170	24,45 x 22,05 K-55 BUTT	16700659	1	
12	60	JOINT	11,660	684,860	696,520	24,45 x 22,05 K-55 BUTT	16600853/1602410484W04 90	1	
13	59	JOINT	11,630	673,230	684,860	24,45 x 22,05 K-55 BUTT	16600853/1602410484W04 91	1	
14	58	JOINT	11,650	661,580	673,230	24,45 x 22,05 K-55 BUTT	16700659/1602410488W03 73	1	
15	57	JOINT	11,630	649,950	661,580	24,45 x 22,05 K-55 BUTT	16700659/1602410488W04 14	1	
16	56	JOINT	11,680	638,270	649,950	24,45 x 22,05 K-55 BUTT	16700659/1602410488W04 13	1	
17	55	JOINT	11,620	626,650	638,270	24,45 x 22,05 K-55 BUTT	16700661/1602410486W00 17	1	
18	54	JOINT	11,630	615,020	626,650	24,45 x 22,05 K-55 BUTT	16700659/1602410488W03 74	1	
19	53	JOINT	11,090	603,930	615,020	24,45 x 22,05 K-55 BUTT	16700659/1602410488W03 75	1	
20	52	JOINT	11,680	592,250	603,930	24,45 x 22,05 K-55 BUTT	16600853/1602410484W05 18	1	
21	51	JOINT	11,640	580,610	592,250	24,45 x 22,05 K-55 BUTT	16700661/1602410486W00 18	1	
22	50	JOINT	11,640	568,970	580,610	24,45 x 22,05 K-55 BUTT	16700661/1602410486W00 16	1	
23	49	JOINT	11,640	557,330	568,970	24,45 x 22,05 K-55 BUTT	16700658/1602410489W06 92	1	
24	48	JOINT	11,670	545,660	557,330	24,45 x 22,05 K-55 BUTT	16600853/1602410484W05 17	1	
25	47	JOINT	11,040	534,620	545,660	24,45 x 22,05 K-55 BUTT	16600853/1602410484W05 19	1	
26	46	JOINT	11,650	522,970	534,620	24,45 x 22,05 K-55 BUTT	16400658/1602410489W06 91	1	
27	45	JOINT	11,650	511,320	522,970	24,45 x 22,05 K-55 BUTT	16700658/1602410489W06 93	1	

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ICELAND DRILLING

Casing Tally Run Report

Rig: Sleipnir
Job No: 28176

Jarðboranir
Rig No: 28000
Job Name: ÞG-11

String Nominal OD (cm): 24,45 **String Type: FULL**

Run No.	Joint No	Item	Length	Top	Bottom	Description	Comments	Cnt	Scr
28	44	JOINT	11,660	499,660	511,320	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0681	1	
29	43	JOINT	11,670	487,990	499,660	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0671	1	
30	42	JOINT	11,510	476,480	487,990	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0886	1	
31	41	JOINT	11,630	464,850	476,480	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0655	1	
32	40	JOINT	11,670	453,180	464,850	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0657	1	
33	39	JOINT	11,630	441,550	453,180	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0656	1	
34	38	JOINT	11,650	429,900	441,550	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0683	1	
35	37	JOINT	11,660	418,240	429,900	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0684	1	
36	36	JOINT	11,660	406,580	418,240	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0682	1	
37	35	JOINT	11,630	394,950	406,580	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0455	1	
38	34	JOINT	11,600	383,350	394,950	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0690	1	
39	33	JOINT	11,670	371,680	383,350	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0688	1	
40	32	JOINT	11,650	360,030	371,680	24,45 x 22,05 K-55 BUTT	16600853/1602410489W0654	1	
41	31	JOINT	11,660	348,370	360,030	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0456	1	
42	30	JOINT	11,650	336,720	348,370	24,45 x 22,05 K-55 BUTT	16600850/1602410482W0707	1	
43	29	JOINT	11,650	325,070	336,720	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0673		
44	28	JOINT	11,510	313,560	325,070	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0675		
45	27	JOINT	11,650	301,910	313,560	24,45 x 22,05 K-55 BUTT	16600850/1602410482W0706	1	
46	26	JOINT	11,660	290,250	301,910	24,45 x 22,05 K-55 BUTT	16600850/1602410482W0708		
47	25	JOINT	11,660	278,590	290,250	24,45 x 22,05 K-55 BUTT			
48	24	JOINT	11,660	266,930	278,590	24,45 x 22,05 K-55 BUTT		1	
49	23	JOINT	11,670	255,260	266,930	24,45 x 22,05 K-55 BUTT	16600854/1602410483W0562		
50	22	JOINT	11,680	243,580	255,260	24,45 x 22,05 K-55 BUTT	16700655/1602410489W0653		
51	21	JOINT	11,660	231,920	243,580	24,45 x 22,05 K-55 BUTT	16700658/1602410489W0652	1	
52	20	JOINT	11,670	220,250	231,920	24,45 x 22,05 K-55 BUTT	16700658/1662410489W0654		
53	19	JOINT	11,640	208,610	220,250	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0446		
54	18	JOINT	11,630	196,980	208,610	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0447	1	
55	17	JOINT	11,630	185,350	196,980	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0445		
56	16	JOINT	11,660	173,690	185,350	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0402		

ICELAND DRILLING

Casing Tally Run Report

Rig: Sleipnir
Job No: 28176

Jarðboranir
Rig No: 28000
Job Name: ÞG-11

String Nominal OD (cm): 24,45 **String Type: FULL**

Run No.	Joint No	Item	Length	Top	Bottom	Description	Comments	Cnt	Scr
57	15	JOINT	11,670	162,020	173,690	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0400	1	
58	14	JOINT	11,650	150,370	162,020	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0401		
59	13	JOINT	11,600	138,770	150,370	24,45 x 22,05 K-55 BUTT	16600850/1602410482W0715		
60	12	JOINT	11,650	127,120	138,770	24,45 x 22,05 K-55 BUTT	16000854/1602410483W0560	1	
61	11	JOINT	11,640	115,480	127,120	24,45 x 22,05 K-55 BUTT	16600854/1602410483W0561		
62	10	JOINT	11,650	103,830	115,480	24,45 x 22,05 K-55 BUTT	16600854/1602410483W0559		
63	9	JOINT	11,650	92,180	103,830	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0520	1	
64	8	JOINT	11,630	80,550	92,180	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0522		
65	7	JOINT	11,640	68,910	80,550	24,45 x 22,05 K-55 BUTT	16600853/1602410484W0521		
66	6	JOINT	11,480	57,430	68,910	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0422	1	
67	5	JOINT	11,660	45,770	57,430	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0423		
68	4	JOINT	11,670	34,100	45,770	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0421		
69	3	JOINT	11,620	22,480	34,100	24,45 x 22,05 K-55 BUTT	16700659/1602410488W0569	1	
70	2	JOINT	11,570	10,910	22,480	24,45 x 22,05 K-55 BUTT	1660854/1602410483W0568		
71	1	JOINT	11,600	-0,690	10,910	24,45 x 22,05 K-55 BUTT	1660854/1602410483W0570		

Appendix B

Daily reports

ÍSOR ICELAND GEOSURVEY	**ÞG-11**	**Sunday** **5th of June 2016** Workday #27

Þeistareykir	**Report #23** **Preliminary results**	**Phase 2** **(9 ⅝" production casing)**

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**MÁS** **(E-mail: mas@isor.is)**

Last casing size:	**13 ⅝"** **(surface casing)**	**Depth at 24 hrs.**	**304 m**	**Hole made last 24 hrs. :**	**0 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**304 m**	**Drilling time:**	**0 hrs.**
Drilling fluid:	**Water**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**m/hr**

Drilling operation

Yesterday morning the installation of the BOP stack finished. At 3:30 am the annular blowout preventer was pressure tested by applying a pressure of 30 bar for 15 min. The annular passed the test after the stack had been centralized properly. Then the pipe ram was tested following the same procedure as for the annular, but the pressure dropped for 2 bar, which is not acceptable. Then the pipe ram had to be dismantled and fixed. In the afternoon at 4:30 pm it finally passed the pressure test. Then preparations for running the BHA in hole started.

In the next section (phase 2) ÞG-11 is going to be directionally drilled towards south (i.e. 180°±5°) in direction to Bæjarfjall. The KOP will be at 320 m; the build-up of inclination will be 3°/30 m until an inclination of 40° is reached. Which should be close to 720 m. For phase 2 a 12" bit, a mud motor and a MWD will be used.

According to the lithology of the neighbor well, ÞG-9, the formation from 304-800 m should mostly be composed of hyaloclastite, i.e. basaltic tuff, breccia and glassy basalt intersected by few intrusive dikes.

Early this morning drilling in cement started. At 2:40 pm drilling in formation started. Now at 3:30 pm one of the pumps needs some maintenance and also a drilling mud is being mixed. Drilling in formation should begin late in the afternoon.

ÍSOR ICELAND GEOSURVEY

ÞG-11

Monday
6th of June 2016
Workday #28

Þeistareykir

Report #24
Preliminary results

Phase 2
(9 ⅝" production casing)

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**MÁS/HT, HOS, SSy** (E-mail: mas@isor.is)

Last casing size:	**13 ⅝"** (surface casing)	**Depth at 24 hrs.**	**325 m**	**Hole made last 24 hrs. :**	**21 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**359 m**	**Drilling time:**	**7 hrs.**
Drilling fluid:	**Water**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**3 m/hr**

Drilling operation

Early last morning a BHA with a 12" bit, motor and a MWD instrument was run into the hole. At 8 am the top of the float collar was tagged at 274.3 m, then during the day there was a drilling in cement. At 1:30 pm 304 m depth was reached, the final depth of the last section (phase 1). Then the crew began to mix drilling mud. Also one of the pump needed some maintenance. At 6 pm drilling in formation started. A gyro survey was carried out at 9:30 pm to midnight. At that point the depth of the well was 325 m (the KOP of the well). The results are shown in the table below. According to the survey the build-up of inclination has started.

MD, m	Inclination, °	Azimuth, °
50	0.18	340.4
100	0.23	319.6
150	0.41	334.3
200	1.02	327.0
250	1.66	329.2
285	2.44	326.2

During last night drilling in formation continued. At present (at 359 m) one of the mud pumps in being repaired. Drilling should resume before lunch-time. Figure 1 shows the drilling progress of ÞG-11 so far.

Geology

Cuttings from 306-358 m are being inspected at present. Preliminary analysis indicates that at 304-306 m there is a basaltic breccia but at 306-310 m the cuttings are composed almost entirely of crystalline fine- medium grained basalt. The rock is not much altered. Most likely this unit represents an intrusive rock, an intrusive dike. At 310 m there is a sharp boundary. Below it the formation is composed of highly altered glassy basalt, light grayish to whitish in color. Quartz, fine grained green clay, calcite and pyrite are generally abundant in the cuttings (except at 306-310 m). A more detailed description of the lithology will be given in the daily report tomorrow.

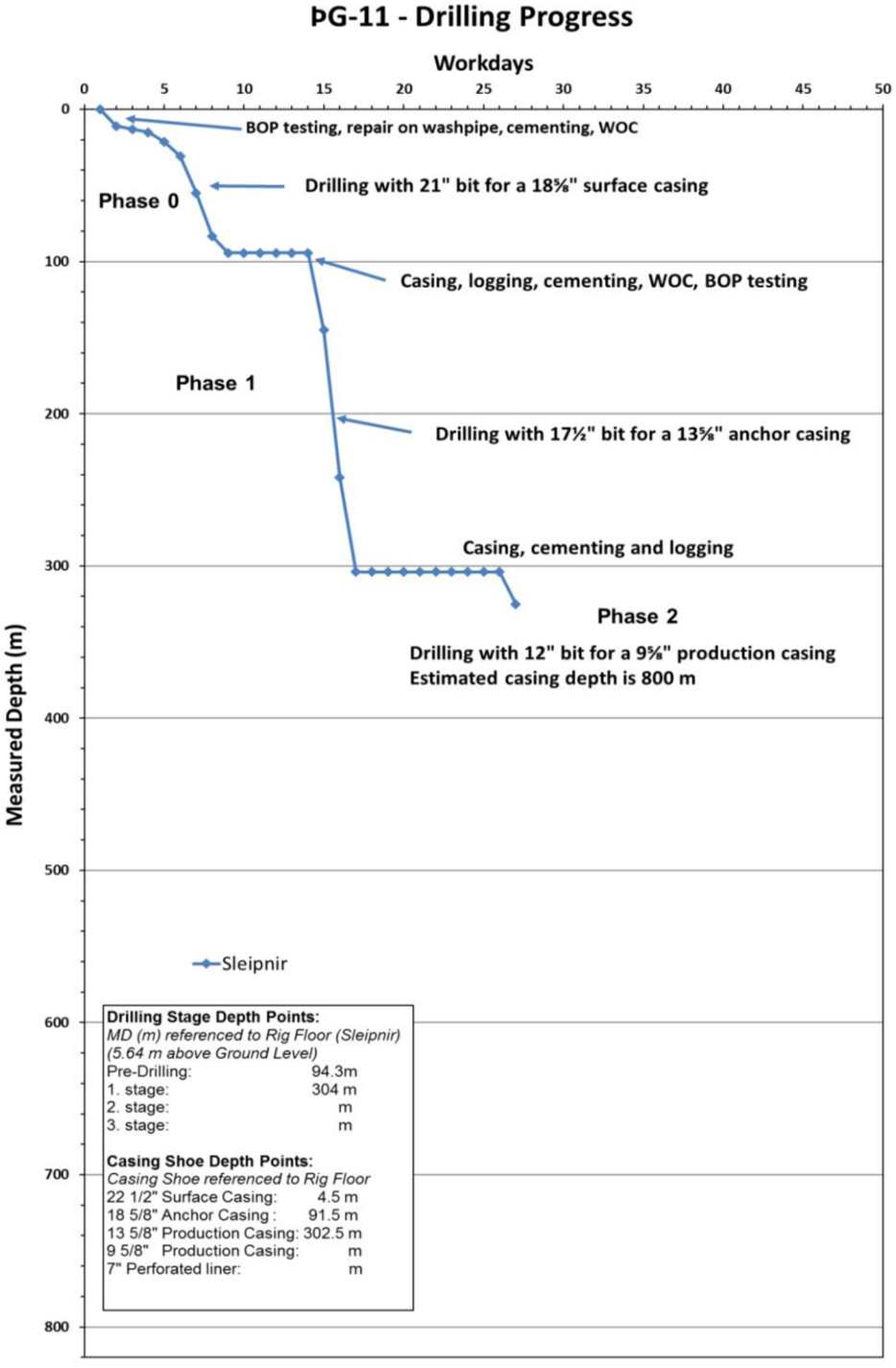


Figure 1. *Drilling progress of ÞG-11 until present.*

Þeistareykir

Report #25
Preliminary results

Phase 2
(9 ⅝" production casing)

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**MÁS/HT, HOS, SSy** (E-mail: mas@isor.is)

Last casing size:	**13 ⅝"** (surface casing)	**Depth at 24 hrs.**	**436 m**	**Hole made last 24 hrs. :**	**111 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**505 m**	**Drilling time:**	**16 hrs.**
Drilling fluid:	**Water/mud**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**6,9 m/hr**

Drilling operation

Yesterday morning, at 5 to 11 am, both of the mud pumps needed maintenance and repairing. Drilling resumed at lunch-time and after that it has been going fine without much delays. ROP has been about 7 m/hr on average. A gyro survey was carried out between 8 and 9 pm last night (with well depth of 412 m). The results are shown in the table below.

MD, m	Inclination, °	Azimuth, °
285	2.17	328.7
320	2.35	321.7
350	1.52	228.9
370	2.90	186.3

Geology

Cuttings from 390-505 m are being inspected this morning. Preliminary analysis indicates that at 494-498 m there we are still drilling in hyaloclastite, most likely basaltic breccia. The cuttings are composed of crystalline fine- medium grained basalt and fragments greenish of glass and tuff. The grade of alteration is high.

Lithology descriptions from 306 to 388 m are listed below:

306-310 m: MEDIUM-COARSE GRAINED BASALT. Medium grained gray greenish crystalline basalt. Feldspar porphyritic. Microcrystalline rock is common at its lower boundary. Intrusive rock

310-318 m: GLASSY BASALT. The rock becomes more altered than above. Crystalline rock admixed with dark green glass fragments. At 314 m the cuttings become whitish. Pyrite is very abundant.

318-320 m: BASALTIC BRECCIA. Fractures filled with calcite, pyrite and quartz are seen.

320-328 m: NO CUTTINGS

328-332 m: BASALTIC BRECCIA. A mixture of whitish and gray-greenish fragments, mostly from crystalline basalt. Non-porphyritic as before.

332-358 m: GLASSY BASALT. A mixture of various types of crystalline rock and green glass fragments. The degree of alteration is high. Most possibly a pillow lava breccia. The rock is considerably fractured. The formation becomes more uniform at 346-350 m. But seem to be very brecciated at intervals.

358-366 m: FINE-MEDIUM GRAINED BASALT. Fine grained crystalline basalt, non-porphyritic but vesicular with abundant dark green clay in vesicles. Gray-greenish in color. Possibly comprising a lava flow.

366-382 m: BASALTIC BRECCIA. Mixed cuttings mostly composed of crystalline basalt but admixed with some few fragments of tuff. The rock is highly altered. Anhydrite might be present. Fracture fillings of pyrite and quarts are seen. At the lower boundary some rather fresh fragments of fine crystalline basalt are seen possibly representing an intrusive rock.

382-388 m: BASALTIC TUFF. The cuttings are mostly composed of green fine- medium grained tuff, highly altered. Traces of epidote might be present at 386 m. Pieces of rock crystals are common.

The lithology of ÞG-11 from 90-388 m is depicted in figure 1. Also a comparison with ÞG-09 is given.

ÍSOR ICELAND GEOSURVEY

Þeistareykir

07.06.2016

Location:	Þeistareykir	*Drill rig:*	Sleipnir	*Drilling fluid:*	Mud, water	*UWI:*	60411
Well:	ÞG-11	*Depth interval:*	90-388 m	*Work phase:*	Phases 1-2	*Geologists:*	MÁS/SÁ/SRG

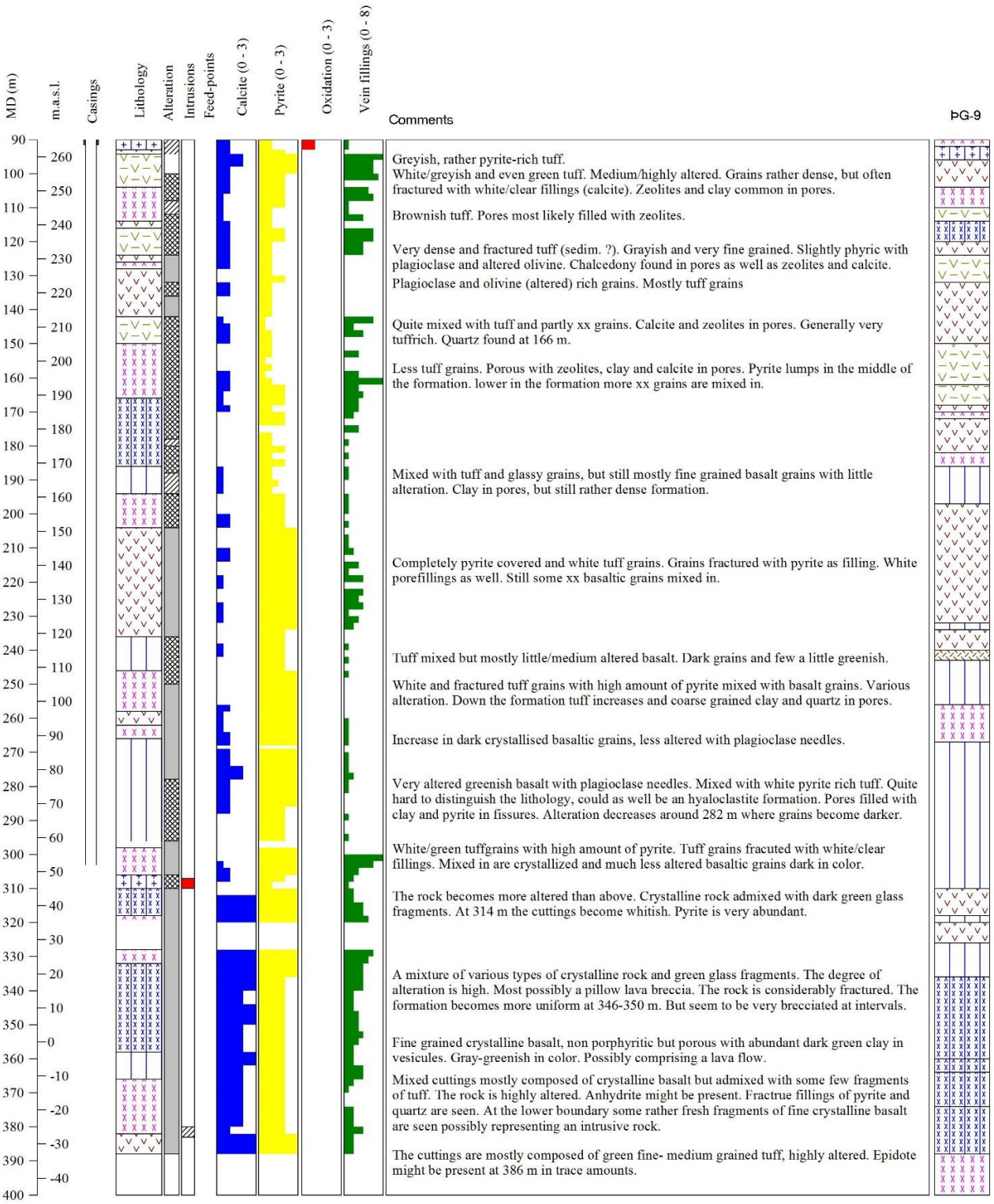


Figure 1. *Lithology of ÞG-11 from 90-388 m depth. A comparison with ÞG-09 is shown.*

ÍSOR ICELAND GEOSURVEY

ÞG-11

Wednesday
8th of June 2016
Workday #30

Þeistareykir

Report #26
Preliminary results

Phase 2
(9 ⅝" production casing)

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**MÁS/HT, HOS, SSy** (E-mail: mas@isor.is)

Last casing size:	**13 ⅝"** (surface casing)	**Depth at 24 hrs.**	**548 m**	**Hole made last 24 hrs. :**	**112 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**608 m**	**Drilling time:**	**14,5 hrs.**
Drilling fluid:	**Water/mud**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**7.7 m/hr**

Drilling operation

Yesterday drilling was going fine until 2 pm when a leakage appeared in the stand-pipe. Then the string was POOH into the anchor casing. At 6 pm the damaged part had been replaced and drilling could resume. The string was RIH and the well cleaned before a gyro survey. A gyro survey was carried out between 10 and 11 pm last night (with well depth of 548 m). The results are shown in the table below. As may be seen the inclination is gradually building-up and the azimuth is as planned, towards South.

No loss of circulation has been noticed so far.

MD, m	Inclination, °	Azimuth, °
513	17.80	180.0
490	14.70	180.5
460	11.14	183.0
430	8.37	180.5
430	8.37	180.7
400	5.95	181.7
370	3.48	183.3

The main drilling parameters have been as follows:

ROP: 7-12 m/hour

Pumping rate: 50 L/s

Wellhead pressure: 93 bar

Diff. temperature: 4-6 °C

WOB: 6-11 ton

Geology

Cuttings down to 500 m have been inspected at present. Preliminary analysis indicates that at around 600 m we are still drilling in hyaloclastite, most likely glassy basalt. The grade of alteration is high. Some minor epidote is present. The formation is considerably fractured.

Lithology descriptions from 306 to 500 m are listed below:

306-310 m: MEDIUM-COARSE GRAINED BASALT. Medium grained gray greenish crystalline basalt. Feldspar porphyritic. Microcrystalline rock is common at its lower boundary. Intrusive rock

310-318 m: GLASSY BASALT. The rock becomes more altered than above. Crystalline rock admixed with dark green glass fragments. At 314 m the cuttings become whitish. Pyrite is very abundant.

318-320 m: BASALTIC BRECCIA. Fractures filled with calcite, pyrite and quartz are seen.

320-328 m: NO CUTTINGS

328-332 m: BASALTIC BRECCIA. A mixture of whitish and gray-greenish fragments, mostly from crystalline basalt. Non-porphyritic as before.

332-358 m: GLASSY BASALT. A mixture of various types of crystalline rock and green glass fragments. The degree of alteration is high. Most possibly a pillow lava breccia. The rock is considerably fractured. The formation becomes more uniform at 346-350 m. But seem to be very brecciated at intervals.

358-366 m: FINE-MEDIUM GRAINED BASALT. Fine grained crystalline basalt, non-porphyritic but vesicular with abundant dark green clay in vesicles. Gray-greenish in color. Possibly comprising a lava flow.

366-382 m: BASALTIC BRECCIA. Mixed cuttings mostly composed of crystalline basalt but admixed with some few fragments of tuff. The rock is highly altered. Anhydrite might be present. Fracture fillings of pyrite and quarts are seen. At the lower boundary some rather fresh fragments of fine crystalline basalt are seen possibly representing an intrusive rock.

382-388 m: BASALTIC TUFF. The cuttings are mostly composed of green fine- medium grained tuff, highly altered. Traces of epidote might be present at 386 m. Pieces of rock crystals are common.

388-398 m: GLASSY BASALT. Reddish brown feldspar porphyritic crystalline basalt, with clay in pores. Considerably oxidized. Some dark green fragments of glass are admixed in the cuttings.

398-402 m: BASALTIC TUFF. A thin layer of whitish-greenish tuff, very altered.

402-436 m: BASALTIC BRECCIA. Very mixed cuttings, mostly green tuff and glass but some amount of crystalline basalt is also present. Most likely pillow lava breccia. At 414 m the amount of crystalline basalt increases. Some minor epidote seems to be present. The formation is considerably fractured with quartz, pyrite and calcite as fracture fillings.

436-452 m: BASALTIC BRECCIA. A breccia with abundant crystalline fragments but admixed with some green glass fragments. Pillow lava breccia. At 438-440 m there is a dark gray feldspar porph. basalt that might represent an intrusive rock. Coarse grained clay is common in pores.

452-458 m: FINE-MEDIUM GRAINED BASALT. Dark gray fine crystalline basalt, feldspar proph. Somewhat porous, with coarse grained clay in pores. This might represent an intrusive rock.

458-462 m: BASALTIC BRECCIA. Mixed cuttings, breccia.

462-470 m: BASALTIC TUFF . Mostly composed of green fragments of tuff and glass. Crystalline fragments are found sporadic in the cuttings.

470-492 m: GLASSY BASALT. Very altered whitish rock, a mixture of crystalline basalt and blue-green glass fragments. Most probably pillow lava. Coarse grained clay, quartz and pyrite are common in pores. The rock is rater porous.

492-498 m: BASALTIC BRECCIA. Somewhat more mixed than above.

498-500 m: GLASSY BASALT. Porous light gray crystalline basalt, very altered. Coarse grained clay is common, and some minor amount of epidote is seen.

The lithology of ÞG-11 from 300-500 m is depicted in figure 1. Also a comparison with ÞG-09 is given.

ÍSOR ICELAND GEOSURVEY

Þeistareykir

08.06.2016

Location:	Þeistareykir	*Drill rig:*	Sleipnir	*Drilling fluid:*	Mud, water	*UWI:*	60411
Well:	ÞG-11	*Depth interval:*	300-500 m	*Work phase:*	Phases 1-2	*Geologists:*	MÁS/SÁ/SRG

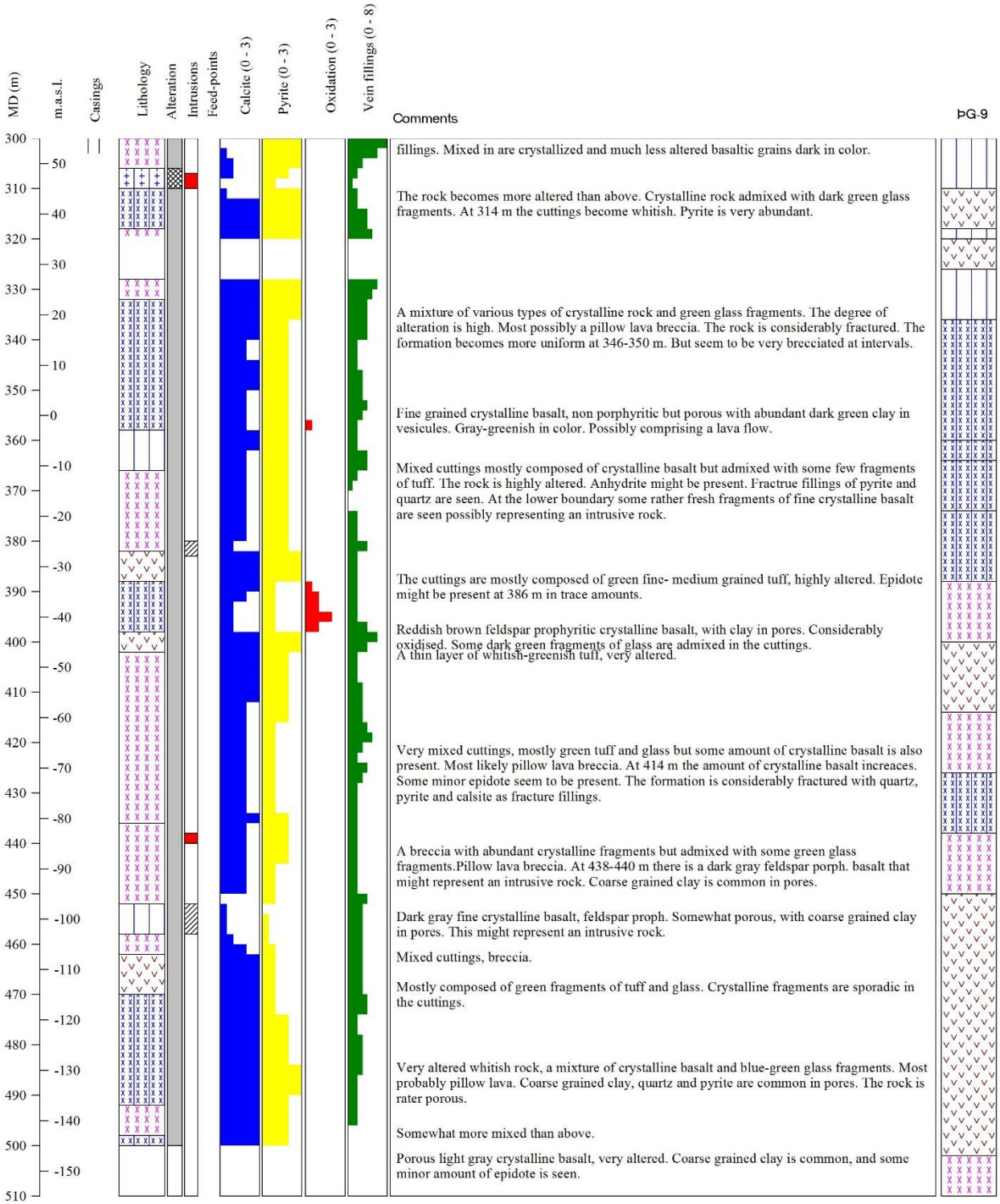


Figure 1. *Lithology of ÞG-11 from 300-500 m depth. A comparison with ÞG-09 is shown.*

ÍSOR ICELAND GEOSURVEY	**ÞG-11**	**Thursday** **9th of June 2016** Workday #31

Þeistareykir	**Report #27** **Preliminary results**	**Phase 2** **(9 ⅝" production casing)**

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**MÁS/HT, SSy** **(E-mail: mas@isor.is)**

Last casing size:	**13 ⅝"** **(surface casing)**	**Depth at 24 hrs.**	**677 m**	**Hole made last 24 hrs. :**	**129 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**677 m**	**Drilling time:**	**19 hrs.**
Drilling fluid:	**Water/mud**	**Circulation losses at 8 hrs.**	**c. 10 l/s**	**Average ROP:**	**6.8 m/hr**

Drilling operation

Yesterday drilling was going fine until 3 pm when a total loss occurred at 661 m depth. The pumping rated had been about 50 l/s. After that two more singles were drilled, down to 677 m. The losses decreased and measured 15 l/s when the drilling finished at 7 pm. After a minor malfunction in the top drive had been repaired (a leakage from hydraulic system) preparations for POOH started. The POOH finished early this morning. Between 5 to 7 am a temperature logging was carried out by the ISOR loggers. The results are shown in figure 1. The maximum logging depth was 670 m. The log does not show the loss zone at 661 m as expected.

At present cementing of a plug in the loss zone is underway. Some equipment is needed from Reykjavík that is expected to be on the drill site at around 10-11 am. Cementing will probably be carried out in the afternoon. While waiting, some 19 l/s of circulation fluid is being pumped into the well.

Figure 2 shows the main drilling parameters from 300-677 m collected by Sleipnir.

Geology

Cuttings down to 610 m have been inspected this morning (see figure 3). Preliminary analysis indicates that at around 670 m we are still drilling in hyaloclastite, most likely glassy basalt. The grade of alteration is high. Some sporadic epidote is present. No samples were obtained from 660-664 m, around the loss zone.

Lithology descriptions from 500 to 610 m are listed below:

498-526 m: GLASSY BASALT. Porous light gray crystalline basalt. Highly altered. With coarse grained clay in pores. Non-porphyritic. Rather homogenous formation. The glass fragments are gray and green in color.

526-528 m: NO CUTTINGS

528-544 m: BASALTIC BRECCIA. Contains a lot of dark brown fine crystalline basalt, feldspar porphyritic. There are also some highly altered whitish fragments in the cuttings. Could be pillow lava breccia. Some intrusive rock might be present at the upper and lower boundaries.

544-550 m: NO CUTTINGS

550-558 m: FINE-MEDIUM GRAINED BASALT. Mostly dark brown fine- glassy crystalline basalt. Sparsely feldspar and pyroxen porphyritic. Non-porous. Green clay is abundant. Might represent an intrusion. Alteration is moderate.

558-584 m: GLASSY BASALT. A sharp upper boundary. The cuttings are almost white in color, highly altered. Most probably this is a glassy basalt as both crystalline rock and glass fragments are seen. The glass fragments are light gray in color but the crystalline basalt almost creamy colored. Epidote becomes rather common below 570 m depth.

584-602 m: BASALTIC BRECCIA. At 584-588 m calcite is very abundant. The same applies to pyrite. White precipitations are common. The rock is highly altered. Epidote and prehnite are seen. In the lowermost part fragments of brownish medium grained basalt is seen.

602-610 m MEDIUM-COARSE GRAINED BASALT/GLASSY BASALT. Mostly coarse grained crystalline basalt. Some greenish fragments of glass are in the cuttings. Possibly this unit represents an intrusive dyke. Epidote is noted and possibly prehnite also.

The lithology of ÞG-11 from 300-610 m is depicted in figure 3. Also a comparison with ÞG-09 is given.

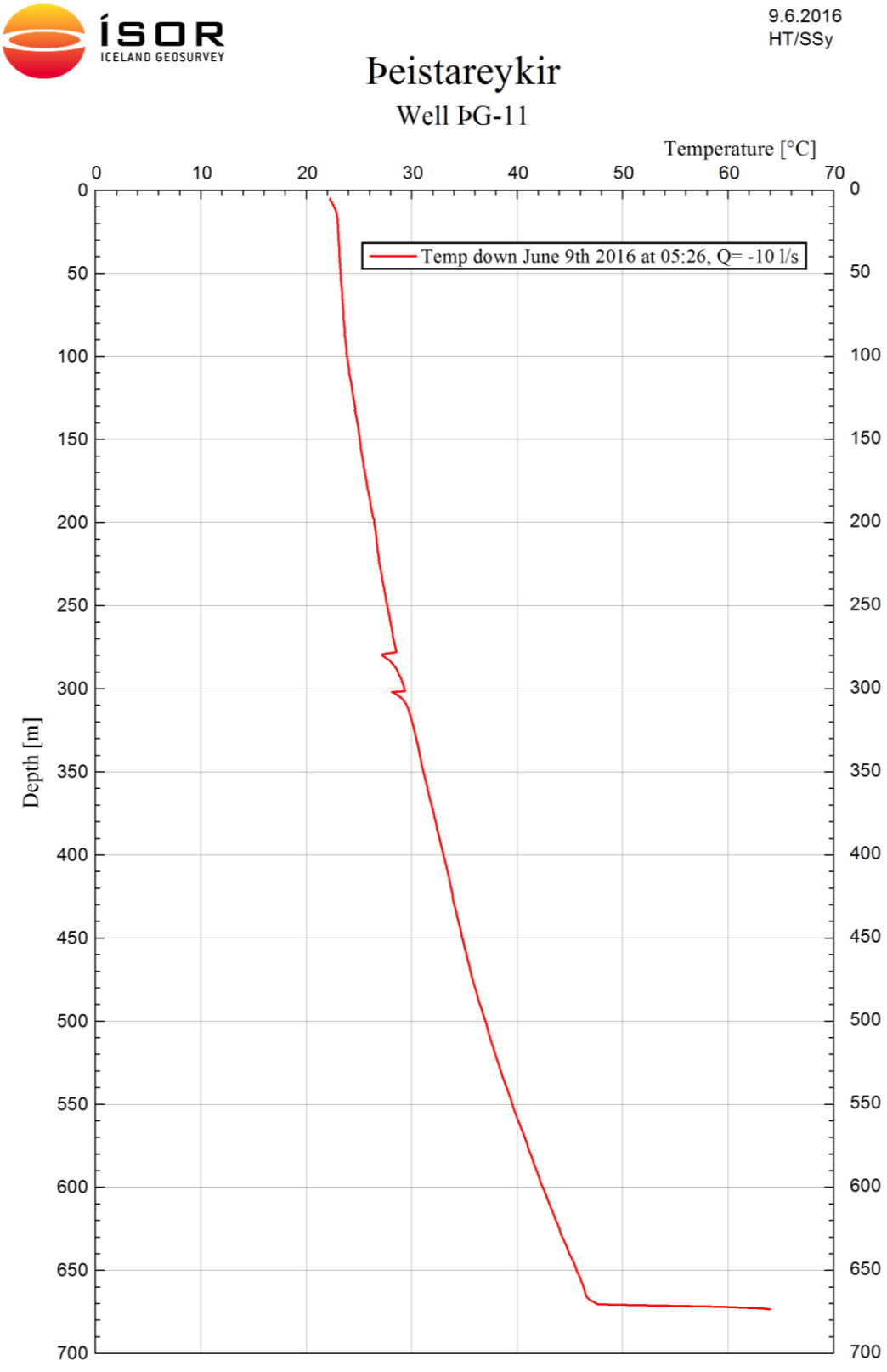


Figure 1. *Temperature logging from ÞG-11 this morning. The maximum logging depth was 670.3 m. The cooling fluid seems to reach to the bottom of the well. A pump rate of 18 l/s on kill-line was applied during logging.*

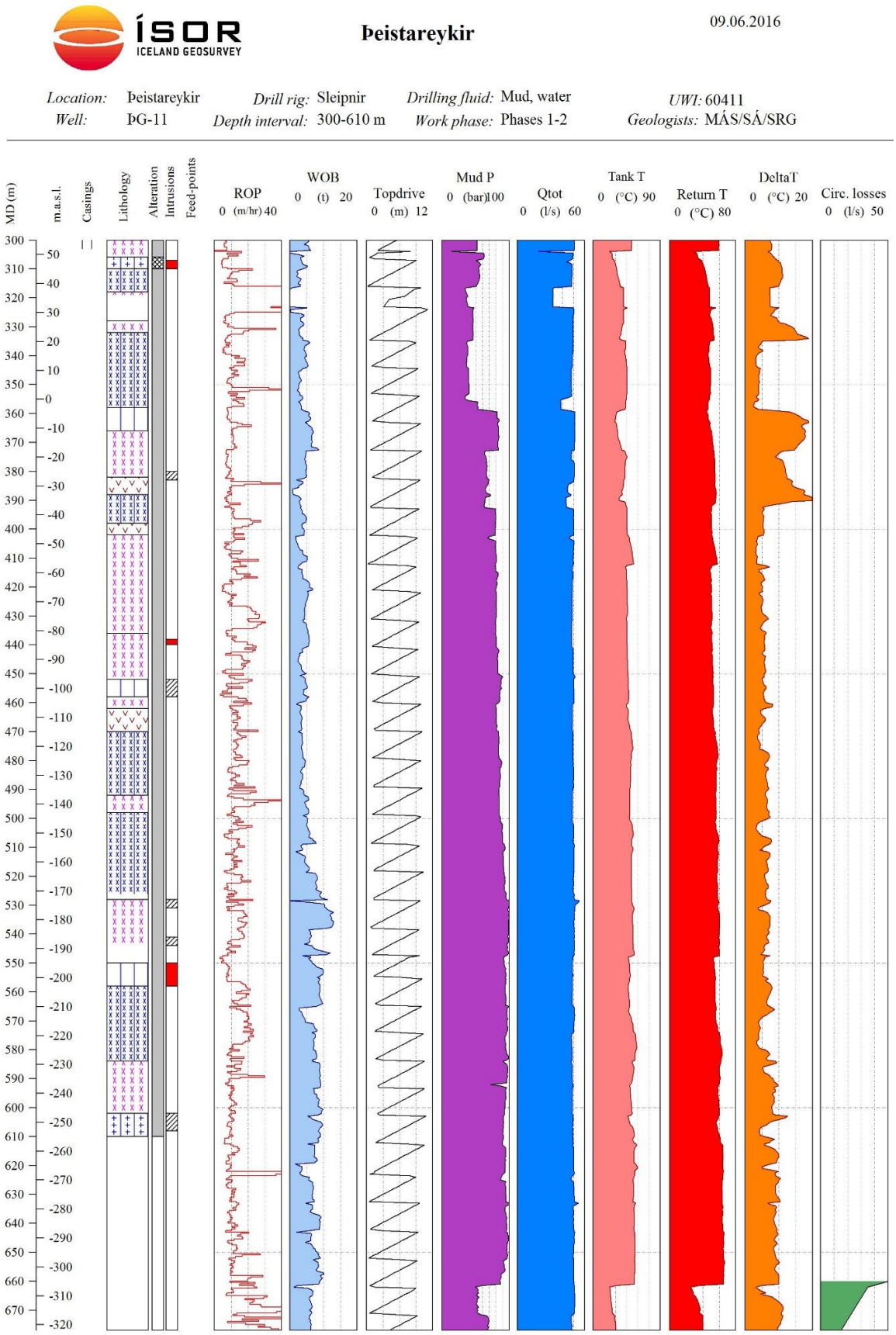


Figure 2. *Drilling data from Sleipnir, from 300-677 m. A total LOC occurred at 661 m. A sudden drop in mud pressure and diff. temperature of circulation fluid at that depth is clear.*

ÍSOR ICELAND GEOSURVEY

Þeistareykir

09.06.2016

Location:	Þeistareykir	*Drill rig:*	Sleipnir	*Drilling fluid:*	Mud, water	*UWI:*	60411
Well:	ÞG-11	*Depth interval:*	300-610 m	*Work phase:*	Phases 1-2	*Geologists:*	MÁS/SÁ/SRG

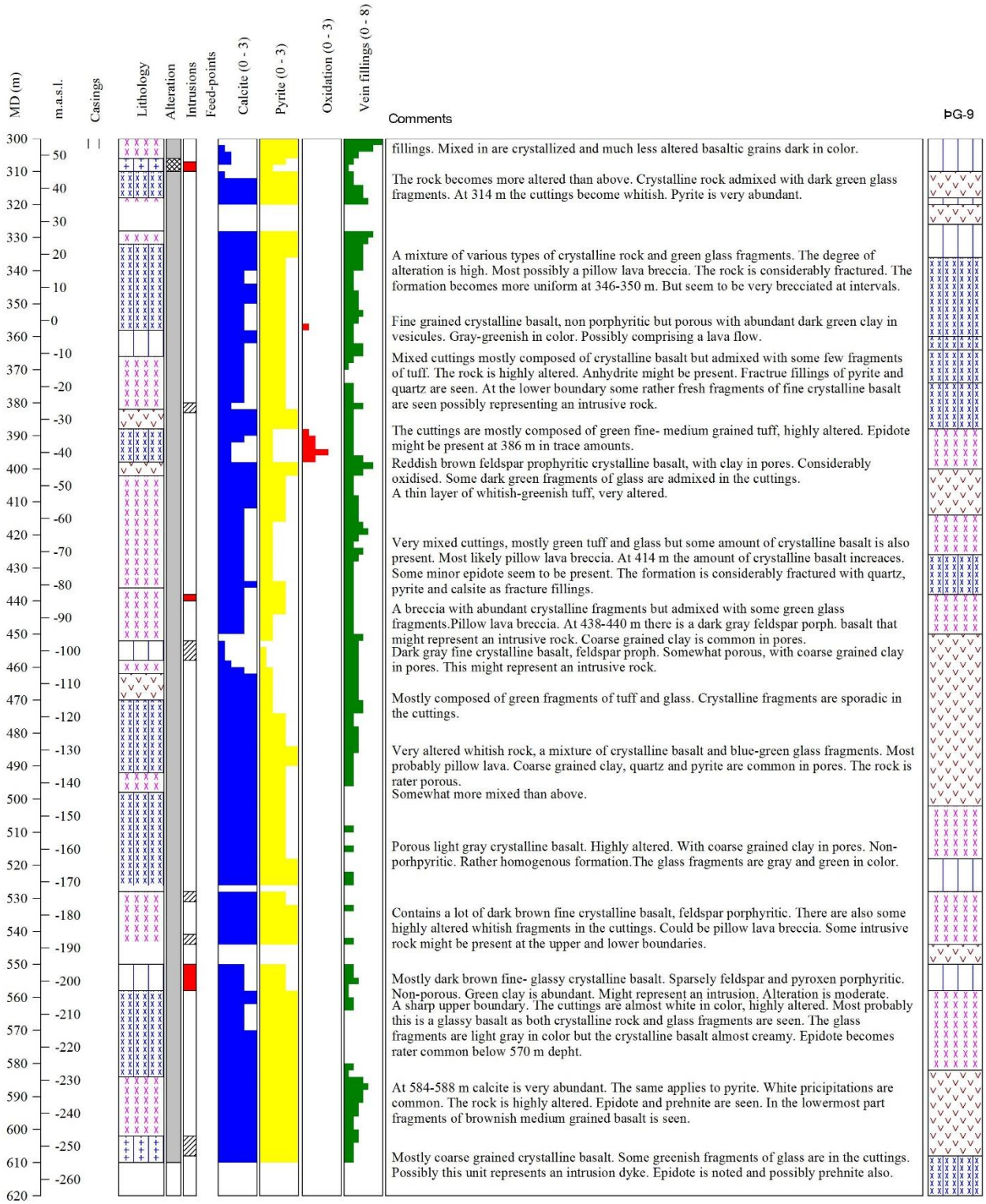


Figure 3. *Lithology of ÞG-11 from 300-610 m depth. A comparison with ÞG-09 is shown.*

ÍSOR ICELAND GEOSURVEY

ÞG-11

Friday
10th of June 2016
Workday #32

Þeistareykir

Report #28
Preliminary results

Phase 2
(9 ⅝" production casing)

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**MÁS, SRG/HHT, SSy** (E-mail: mas@isor.is)

Last casing size:	**13 ⅝"** (surface casing)	**Depth at 24 hrs.**	**677 m**	**Hole made last 24 hrs. :**	**0 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**677 m**	**Drilling time:**	**0 hrs.**
Drilling fluid:	**Water/mud**	**Circulation losses at 8 hrs.**	**c. 0 l/s**	**Average ROP:**	**0 m/hr**

Drilling operation

Yesterday morning the crew waited for equipment needed for the cementing operation, i.e. an X-over and an elevator for the fiber rods that were going to be used. At noon everything was ready and the cementing string was RIH. The string is composed of four fiber rods (3½") and then the drillpipes. At 5:30 the cementing string was at 667 m depth and the well was cooled for 1.5 hours before cementing. At 7-7:30 pm a plug of 8.8 m^3 in total (density of 1.75 g/cm^3) of cement was placed in the well. Then the string was pulled up to 494 m depth and the well circulated for a half an hour before POOH. The cementing string had been surfaced at midnight. Short after midnight a BHA with a 12″ bit was RIH. This morning at 9 am drilling in cement has started. Drilling in formation should start later this morning.

The drilling progress of ÞG-11 until now is shown on figure 1 below.

Geology

Cuttings down to 677 m have been inspected (see figure 2). Lithology descriptions from 500 to 610 m are listed below:

498-526 m: GLASSY BASALT. Porous light gray crystalline basalt. Highly altered. With coarse grained clay in pores. Non-porphyritic. Rather homogenous formation. The glass fragments are gray and green in color.

526-528 m: NO CUTTINGS

528-544 m: BASALTIC BRECCIA. Contains a lot of dark brown fine crystalline basalt, feldspar porphyritic. There are also some highly altered whitish fragments in the

cuttings. Could be pillow lava breccia. Some intrusive rock might be present at the upper and lower boundaries.

544-550 m: NO CUTTINGS

550-558 m: FINE-MEDIUM GRAINED BASALT. Mostly dark brown fine- glassy crystalline basalt. Sparsely feldspar and pyroxene porphyritic. Non-porous. Green clay is abundant. Might represent an intrusion. Alteration is moderate.

558-584 m: GLASSY BASALT. A sharp upper boundary. The cuttings are almost white in color, highly altered. Most probably this is a glassy basalt as both crystalline rock and glass fragments are seen. The glass fragments are light gray in color but the crystalline basalt almost creamy colored. Epidote becomes rather common below 570 m depth.

584-600 m: BASALTIC BRECCIA. At 584-588 m calcite is very abundant. The same applies to pyrite. White precipitations are common. The rock is highly altered. Epidote and prehnite are seen. In the lowermost part fragments of brownish medium grained basalt is seen.

600-658 m: MEDIUM-COARSE GRAINED BASALT/INTRUSIVE ROCK. Medium to coarse grained basalt. Composed of large feldspar and pyroxen minerals and some minor amounts of Fe-Ti oxides. Resembles dolerite. Glass is a minor component. White precipitations are common. Could be intrusive rock? Seems to be a rather homogeneous formation. Grade of alteration is moderate to high. At intervals the formation is considerably fractured. Epidote and prehnite are common. At 661 m a total loss of circulation occurred. Could be at the lower boundary of the this unit. It is worth mentioning that in well ÞG-09 the only LOC (5 l/s) that occurred while drilling the 2. phase occurred at 660 m, at a boundary between glassy basalt and a breccia below. The glassy basalt was described as medium grained an highly feldspar and pyroxene porphyritic.

658-664 m: NO CUTTINGS. Loss of circulation.

664-670 m: BASALTIC BRECCIA. Mixed cuttings. Composed of medium grained basalt, green glass and white precipitations.

670-677 m: NO CUTTINGS

The lithology of ÞG-11 from 300-677 m is depicted in figure 4. Also a comparison with ÞG-09 is given.

Úr skýrslu um ÞG-9. Á 608-658 m. Bólstraberg.

Meðalgróft, plagíóklas og pýroxen dílótt kristallað berg og grænt túff. Oxuð korn á stangli. All sprungið og oxun í sprungum, sem og pýrít og kvars. Nokkuð má sjá af setkenndum, ljósum kornum, alsett örfínum málmæðum. Er að öllum líkindum bólstraberg en gæti hugsanlega verið hraunlagasyrpa. Mikill borhraði gæti hafa valdið blöndun svarfsins. Mjög mikið kalsít og pýrít finnst í þessari myndun.

Ekkert skoltap kom fram við borun 2. áfanga ÞG-09. Hins vegar mældist 5 l/s skoltap fyrir steypingu. Á þessi leki líklega ættir að rekja til jarðlagamóta á um 660 m dýpi. Á 608-658 m dýpi er afar kalsít- og pýrít ríkt bólstraberg en á um 658 m kemur inn fínkorna breksía og þá fínkorna, sprunginn þóliít gangur, ríkur af pýríti. Þarna á lektin að líkindum uppruna sinn og hitamæling (mynd 7) bendir til þess sama

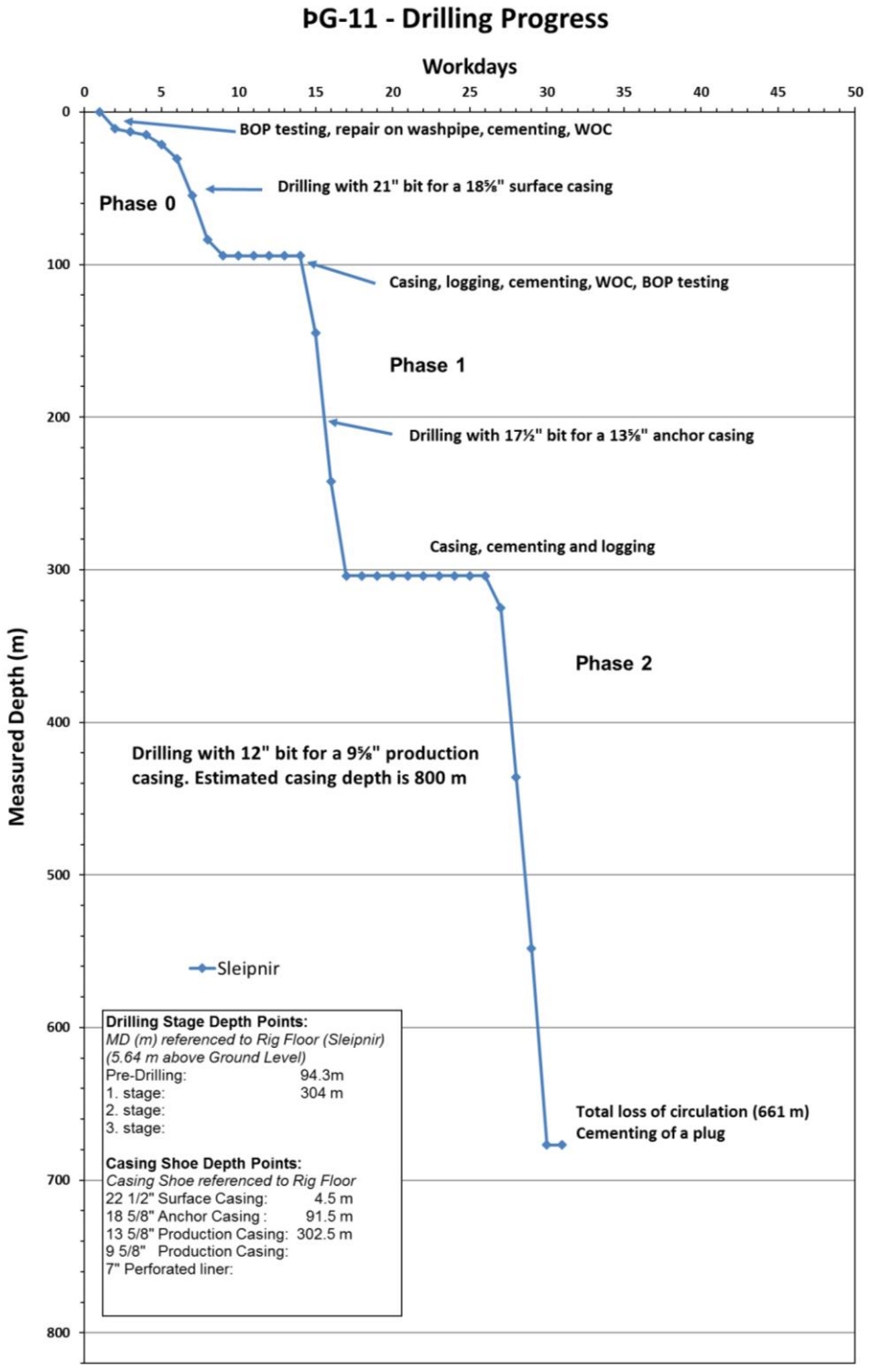


Figure 1. *Drilling progress of ÞG-11 until present.*

Location:	Þeistareykir	*Drill rig:*	Sleipnir	*Drilling fluid:*	Mud, water	*UWI:*	60411
Well:	ÞG-11	*Depth interval:*	300-677 m	*Work phase:*	Phases 1-2	*Geologists:*	MÁS/SÁ/SRG

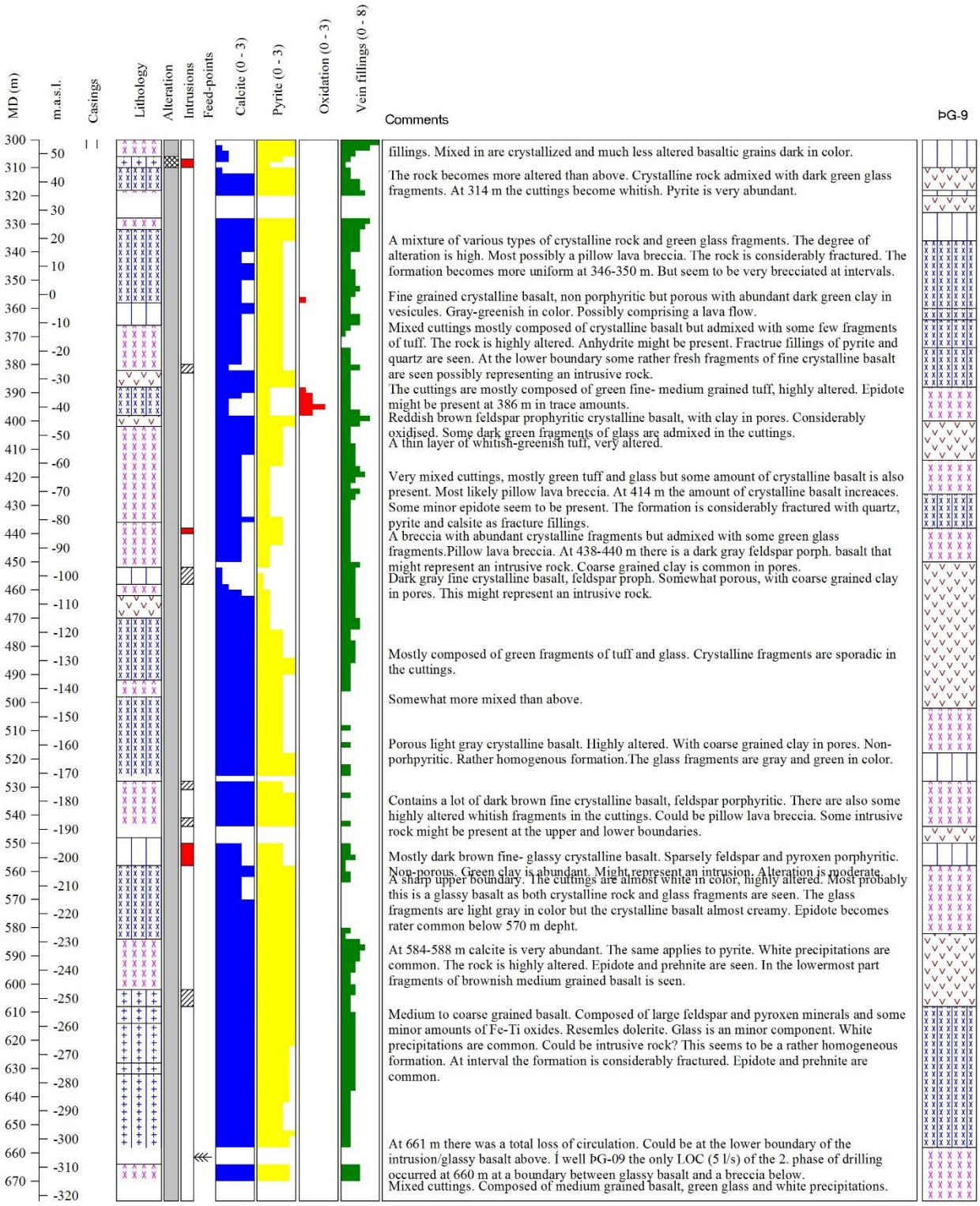


Figure 2. *Lithology of ÞG-11 from 300-677 m depth.*

ÍSOR ICELAND GEOSURVEY	**ÞG-11**	**Saturday** **11th of June 2016** Workday #33

Þeistareykir	**Report #29** **Preliminary results**	**Phase 2** **(9 ⅝" production casing)**

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**SRG/HI, MATM** **(E-mail: srg@isor.is)**

Last casing size:	**13 ⅝"** **(surface casing)**	**Depth at 24 hrs.**	**701.3 m**	**Hole made last 24 hrs. :**	**34.3 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**773.7 m**	**Drilling time:**	**5.25 hrs.**
Drilling fluid:	**Water/mud**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**6.5 m/hr**

Drilling operation

RIH with a 12" drill bit and motor was carried out from 0:00-08:00 the 10th of June. Drilling into cement from 633.5-677 was complete around noon, when drilling into a formation started. Drilling was stopped at 701.3 m, where circulation losses had been measured 5-8 l/s. The well was circulated clean and polymer pills injected. ÍSOR´s logging engineers prepared for a Gyro measurement. The Gyro was measured from 657-490 m with azimuth of 181.1° and inclination of 35.01°at 657 m. Drilling started again at 22:00. The results of the Gyro survey are shown in table 1.

Table 1. The results of the Gyro Survey carried out the 10th of June 2016 in well ÞG-11.

Time	MD (m)	Inclination	Azimuth
20:38	657	35.01	181.1
20:43	640	32.95	180.2
20:48	610	29.30	181.5
20:52	580	25.74	184.0
20:58	550	22.24	180.4
21:02	520	18.44	182.1
21:09	490	14.49	180.9

Geology

Cuttings down to 700 m have been analyzed (see figure 2). Lithology descriptions from 680 to 700 m are listed below:

680-690 m BASALTIC BRECCIA:

Higly cement mixed. Mixed cuttings of dark xx basaltic grains and green totally altered grains. Very fine grained cuttings.

690-694 m GLASSY BASALT:

More of crystallized grains with few noticeable plagioclase crystals in groundmass, due to high alteration. Still cement mixed.

694-700 m FINE-MEDIUM GRAINED BASALT:

Most likely fine to medium grained basalt unit. Very small cuttings and slight increase in epidote and decrease in calcite. Various alteration between grains.

Figure 1 shows the alteration mineral assembly from 0-700 m in ÞG-11. From the Figure it can be seen that the alteration mineral assembly indicates incresed degree of alteration down the well, where low temperature minerals like zeolites and fine grained clay are replaced by high temperature minerals like quartz, waikarite, epidote and phrenite at greater depths.

Area/field: Þeistareykir *Rig:* Sleipnir *Drilling fluid:* Mud, water *Well id.:* 60411
Well name: ÞG-11 *Depth interval:* 0-700 m *Drill-stage:* Phases 0-2 *Geologist:* MÁS/SÁ/SRG

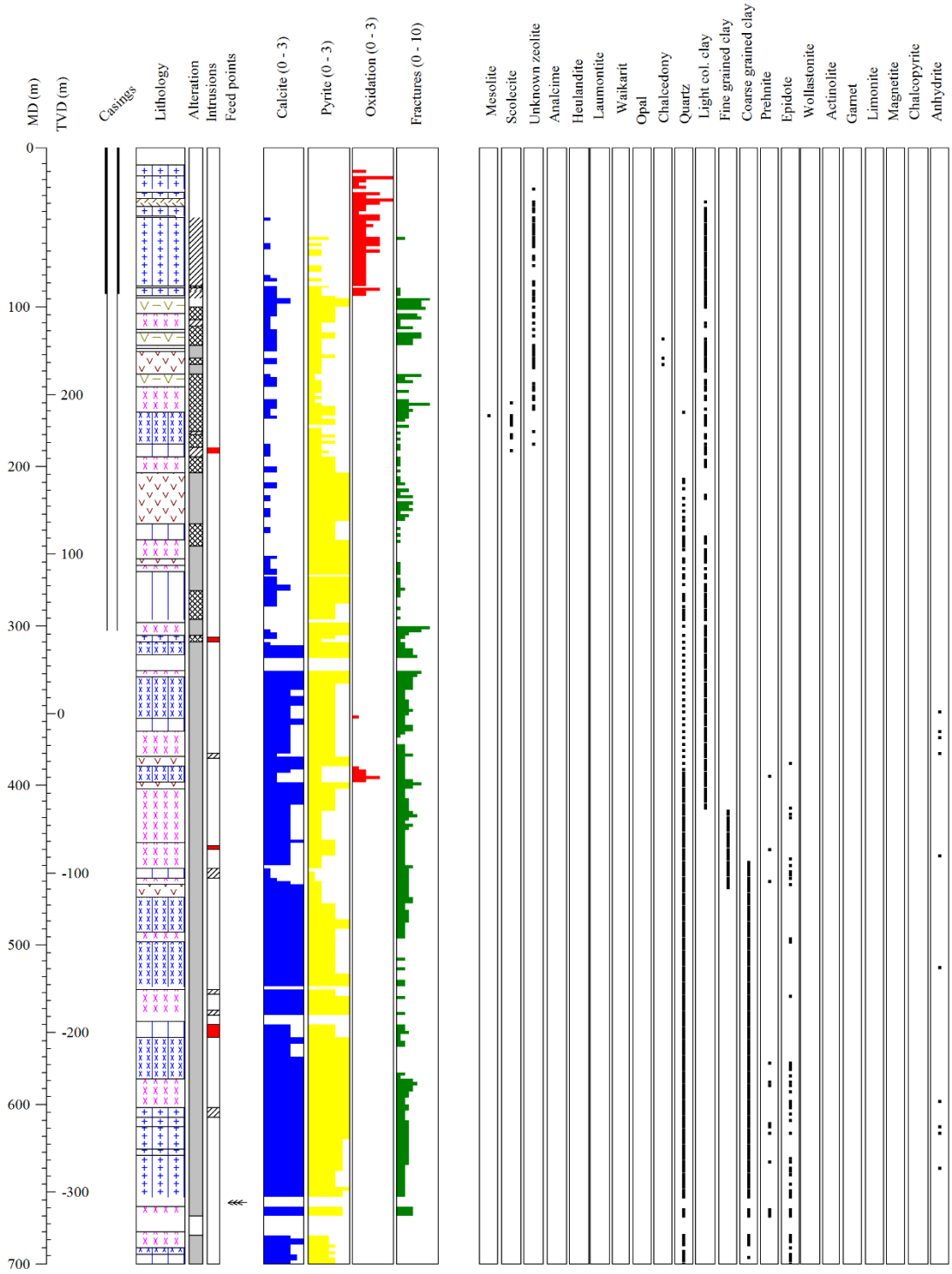


Figure 1. *Alteration and alteration minerals from 0-700 m in well ÞG-11.*

ÍSOR ICELAND GEOSURVEY	**ÞG-11**	**Sunday** **12th of June 2016** Workday #34

Þeistareykir	**Report #30** **Preliminary results**	**Phase 2** **(9 ⅝" production casing)**

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**SRG/HI, MATM** **(E-mail: srg@isor.is)**

Last casing size:	**13 ⅝"** **(surface casing)**	**Depth at 24 hrs.**	**802 m**	**Hole made last 24 hrs. :**	**86 m**
Last casing depth:	**302.5 m**	**Depth at 8 hrs.**	**802 m**	**Drilling time:**	**10.75 hrs.**
Drilling fluid:	**Water/mud**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**8 m/hr**

Drilling operation

Drilling was carried out from 716 m – 800 m with circulation losses from 4-8 l/s. The ROP had been very high the last meters but seemed to be decreasing just before depth of 800 m. Based on that it was decided to finish the single and drill 2 more meters. The ROP however, did not decrease and it was decided to terminate drilling at 802 m and circulate the well clean with water and polymer pills. No bottom hole deposit was found and POOH was started at 16:45. Currently, ÍSOR´s logging engineers are carrying out geophysical logging in the well (Figure 1). Figure 2 shows the temperature measurement down to 777 m where temperature was recorded around 150°C. The log shows an evidence of a small feeder at 670 m, a similar depth a total circulation loss was observed the 8th of June, and cement job was used to plug the loss zone. Figure 3 shows the caliper log down to 730 m. The amount of cement needed for cementing the production casing is yet to be calculated.

Figure 1. *ÍSOR´s logging engineers preparing for geophysical logging in well ÞG-11.*

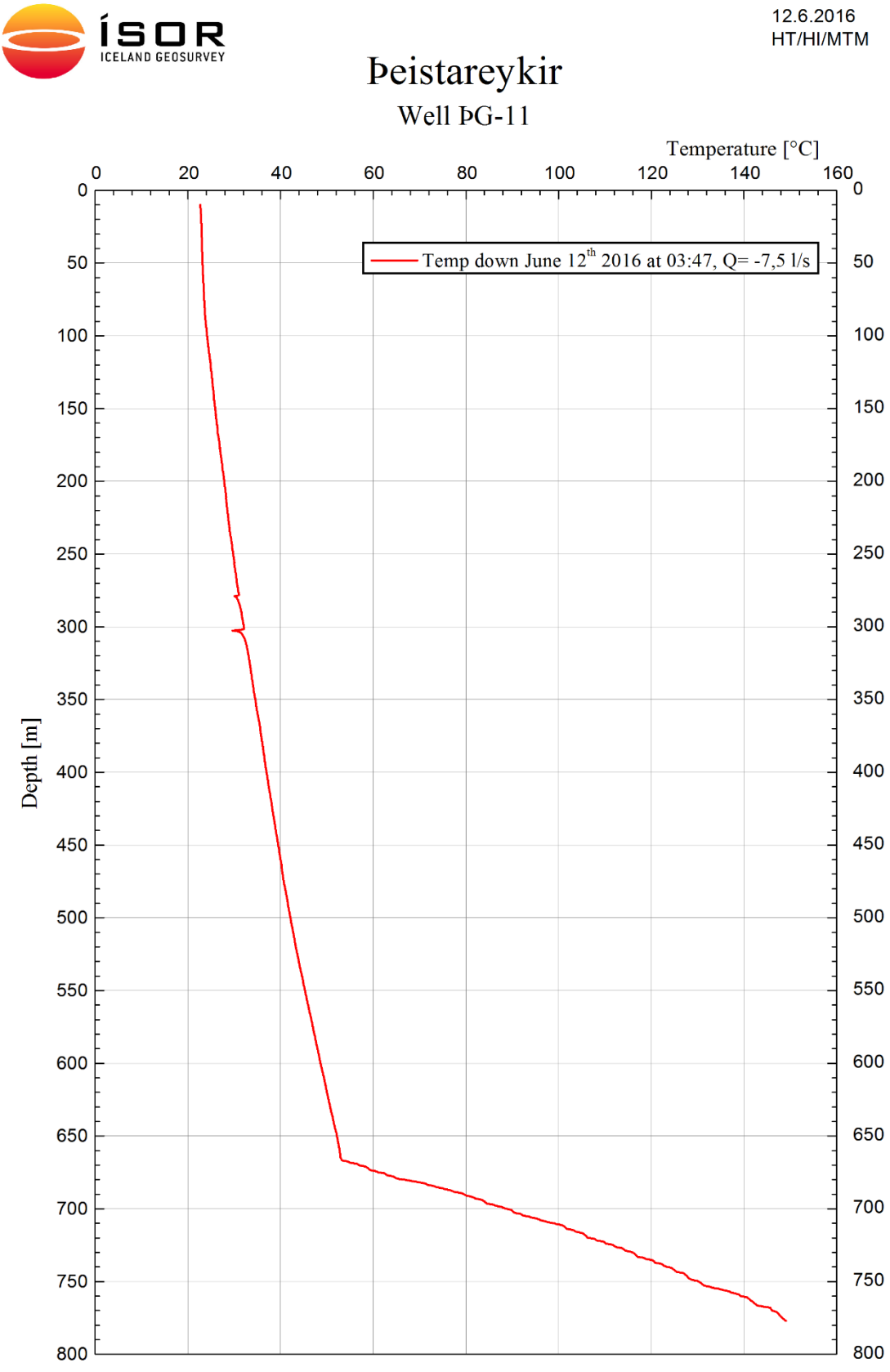


Figure 2. *The temperature log carried out the 12th of June in well ÞG-11 down to 777 m.*

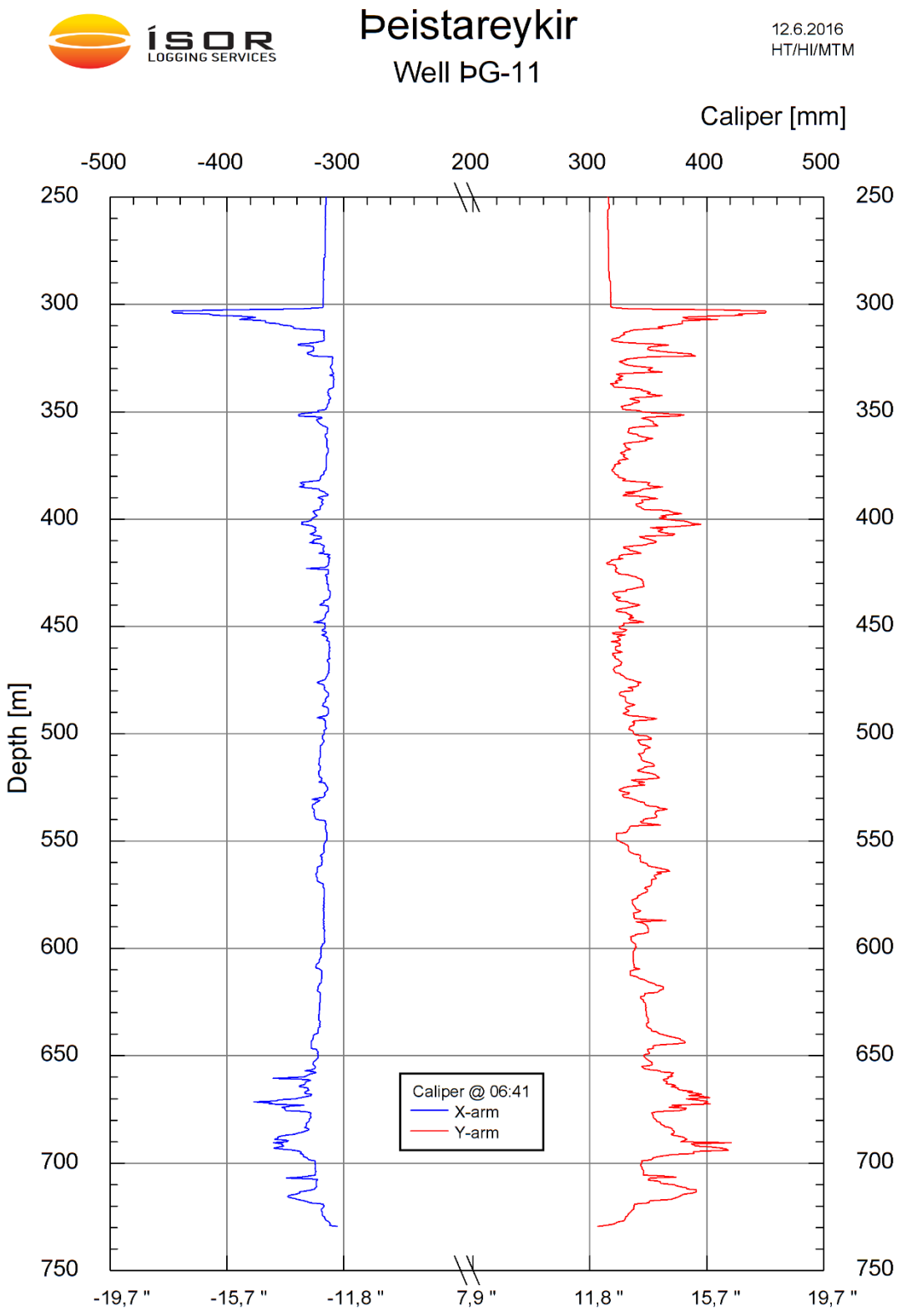


Figure 3. *The caliper log carried out the 12th of June in well ÞG-11 down to 730 m.*

Geology

Cuttings down to 802 m have been analyzed (see figure 2). Lithology descriptions from 710 to 802 m are listed below:

710-714 m BASALTIC BRECCIA

The cuttings become much smaller grained and more mixed with cement, green tuff and crystalline basalt.

714-734 m BASALTIC TUFF

Pyrite rich and white tuff occasionally with very fine fractures.

734-756 m BASALTIC BRECCIA

White and green tuff grains mixed with darker crystalline basalt. Increase in tuff and epidote deeper in the formation.

756-764 m FINE-MEDIUM GRAINED BASALT

Mostly fine grained and light colored basalt, but still quite amount of tuff grains.

764-780 m BASALTIC BRECCIA

Totally altered tuff grains mixed with less altered light grey and fine grained basalt.

780-782 m BASALTIC TUFF

Totally altered white and greenish tuff. Very fine cuttings. Some glassy and partly crystalline basaltic grains mixed in.

782-796 m BASALTIC BRECCIA

Coarser cuttings. More of fine grained, less altered (than the tuff) and quite dense crystalline basalt grains with plagioclase in groundmass. Abundant of epidote.

796-802 m FINE-MEDIUM GRAINED BASALT

We see mostly light grey crystalline basalt with some tuff. The crystalline grains are plagioclase and CPX rich. High amount of epidote. At 802 m (final depth of phase 2) some tuff is mixed in. The samples analyzed after cleaning the well by circulation for 0.5, 1 and 1.5 hrs, more tuff appears which could indicate formation boundaries or drilling into a tuff formation.

Figure 4 shows the description of lithology and alteration from 700-802 m in well ÞG-11, compared to the lithology from the same depth interval in well ÞG-09. Well ÞG-09 was a vertical well, but ÞG-11 is a directionally drilled well which explains the depth differences between each unit in the well. Overall, the agreement between the two wells is good where we see hyaloclastite formations (e.g. tuff and breccia) intersected by fine grained basalt units and basaltic intrusions.

Location:	Þeistareykir	*Drill rig:*	Sleipnir	*Drilling fluid:*	Water	*UWI:*	60411
Well:	ÞG-11	*Depth interval:*	700-802 m	*Work phase:*	Phase 2	*Geologists:*	SRG

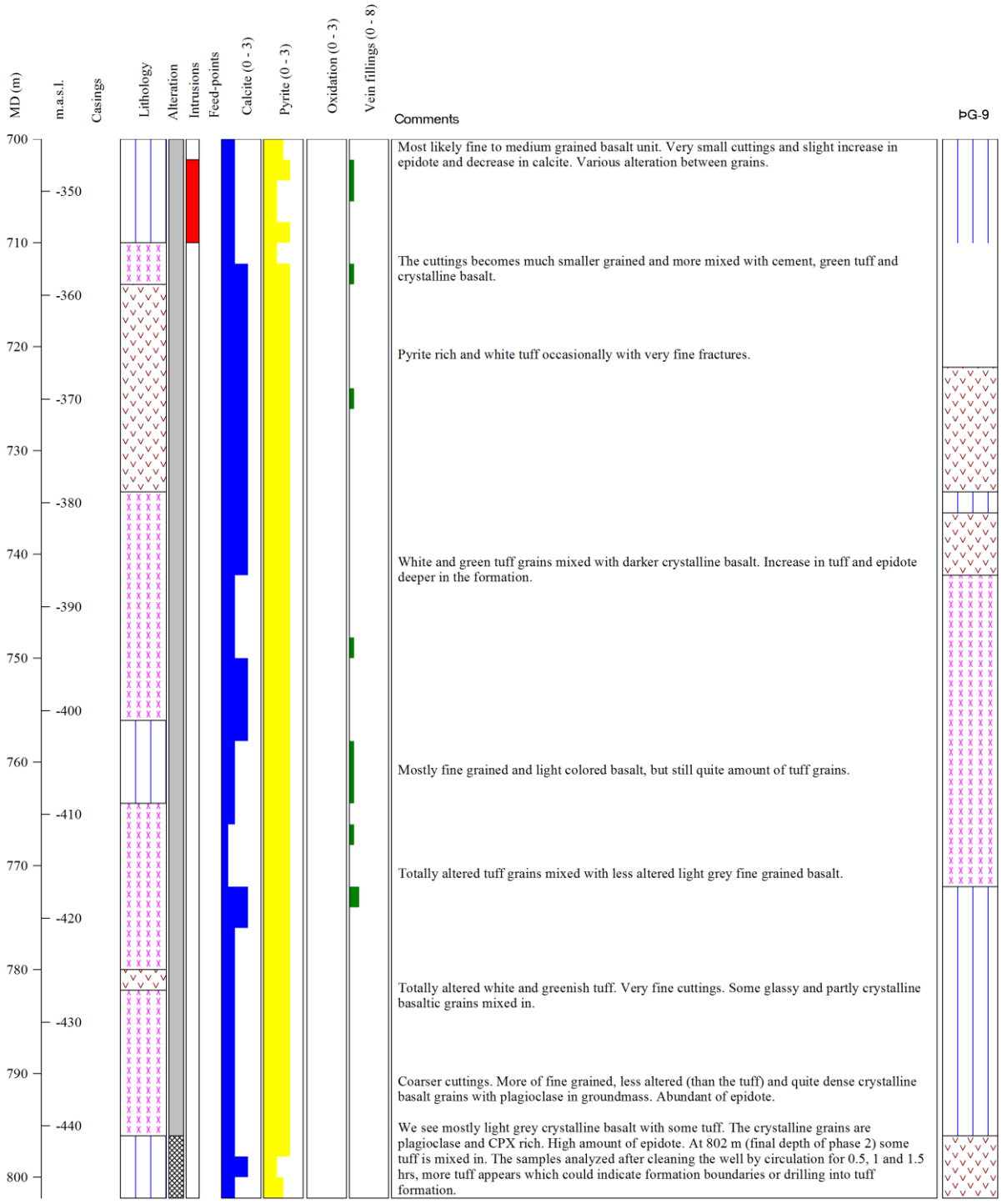


Figure 1. *Comparison of lithology from 700-802 m in wells ÞG-11 and ÞG-9.*

ÍSOR ICELAND GEOSURVEY

ÞG-11

Monday
13th of June 2016
Workday #34

Þeistareykir

Report #31
Preliminary results

Phase 2
(9 ⅝" production casing)

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**SRG/HI, MATM** (E-mail: srg@isor.is)

Last casing size:	**9 ⅝"** (production casing)	**Depth at 24 hrs.**	**802 m**	**Hole made last 24 hrs. :**	**- m**
Last casing depth:	**801.7 m**	**Depth at 8 hrs.**	**802 m**	**Drilling time:**	**- hrs.**
Drilling fluid:	**Water**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**- m/hr**

Drilling operation

Ísor´s logging engineers completed the geophysical measurements in the open well at 18:00 the 12th of June. Between 18:00 and 21:00 the drill crew was preparing the 9 5/8" production casing work, and started running in the casing at 21:00. The casing job was finished around 7 this morning, with no bottom hole deposit, where casing was set at 801.7 m. Currently the drill crew is preparing the cement job. Figure 1 shows the caliper log from yesterday and estimated volume of cement needed for cementing of the production casing, 29m^3. Figure 2 shows the temperature, caliper, NN-Gamma and resistivity measurements from yesterday.

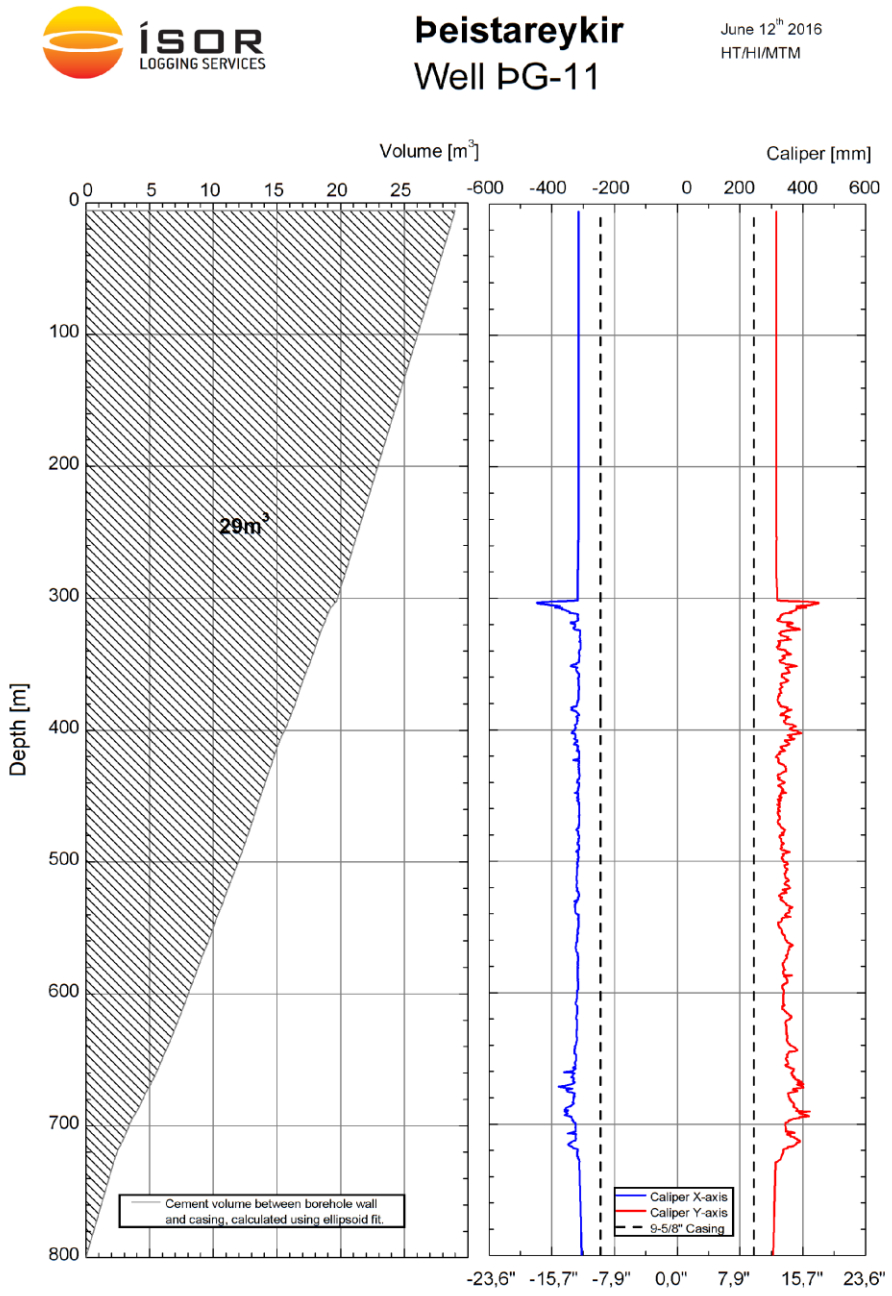


Figure 1. Caliper log and estimated volume of cement needed to cement the production casing.

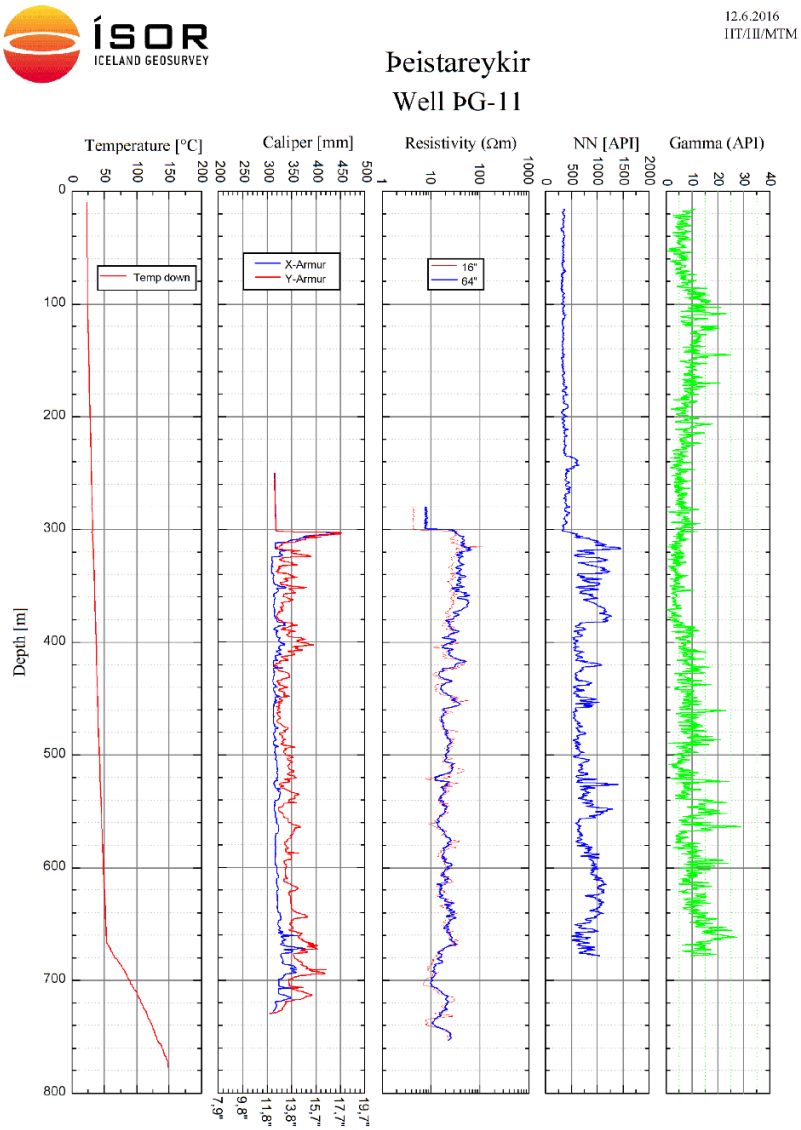


Figure 2. The Geophysical logging carried out the 12th of June.

Geology

Figure 3 shows the drilling data from the drill rig Sleipnir and lithology of well ÞG-11 from top to bottom (0-802 m). From the figure we can see how the ROP is generally higher during drilling of hyaloclastite formations like breccia and tuff, and lower during drilling of basaltic lava units. The exception from this rule is the bottom most ~150 m where the drill bit penetrates trough hyaloclastite, basaltic lava units and intrusions and the ROP shows no clear correlation (high/low) with the drilled formations.

Figure 4 shows the comparison of well ÞG-11 and ÞG-09 from 0-802 m. The agreement between the two wells is very good in the top 300 m. Below 300 m the agreement is quite good, but with some deviations between the two wells that could be explained by that well ÞG-09 is a vertical well, but ÞG-11 is not. Another factor is human error in the cutting analysis, where the alteration is very high at deeper levels and the drill cuttings are very fine grained. Based on that it is harder to distinguish between e.g. different hyaloclastite formations like glassy basalt and breccia.

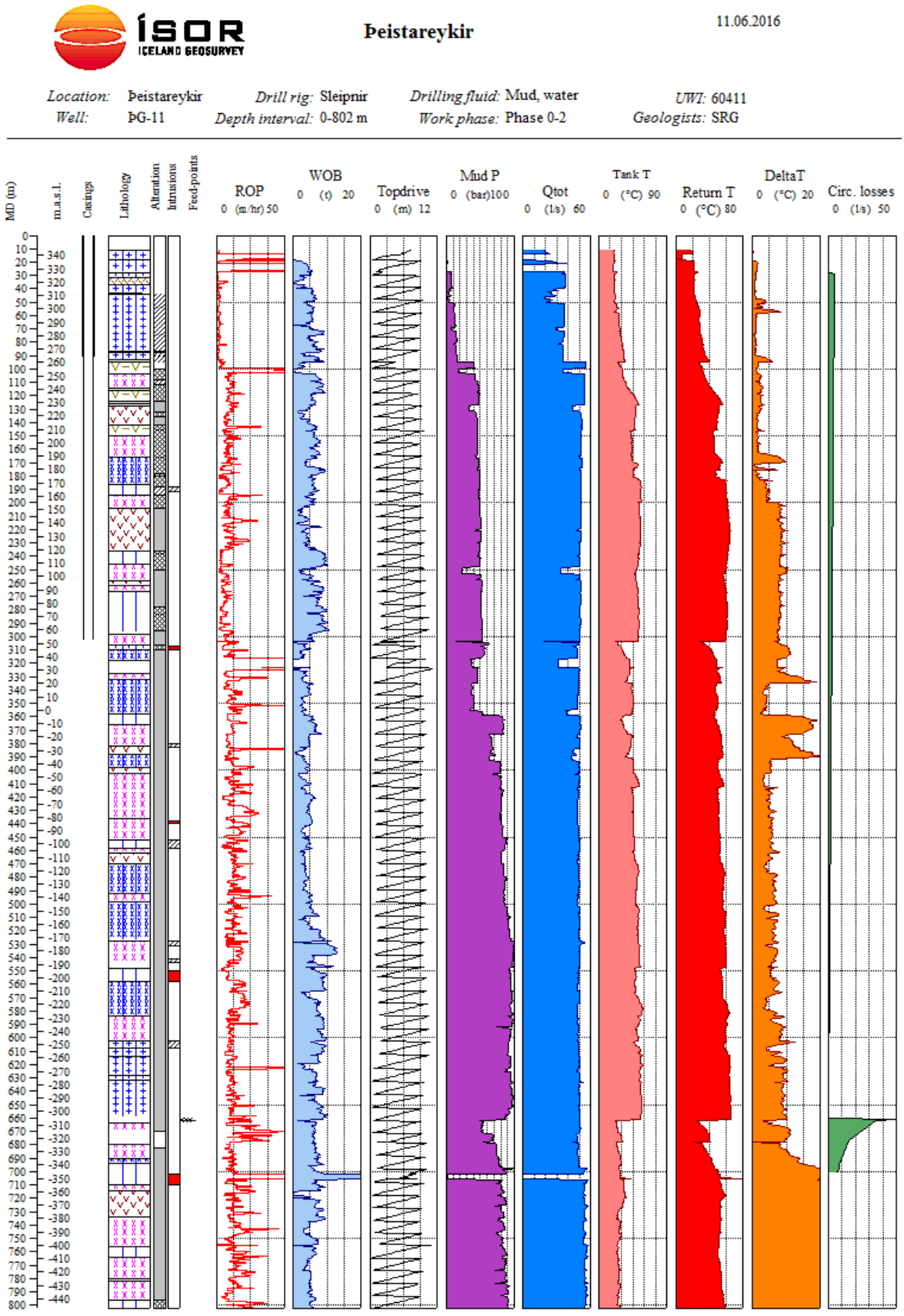


Figure 3. Drilling data and lithology in ÞG-11.

Location: Þeistareykir *Drill Rig:* Sleipnir *Circulation fluid:* Mud, water *Geologist:* SRG
Well Name: ÞG-11 *Depth Interval:* 0-802 m *Drill-stage:* Phase 0-2

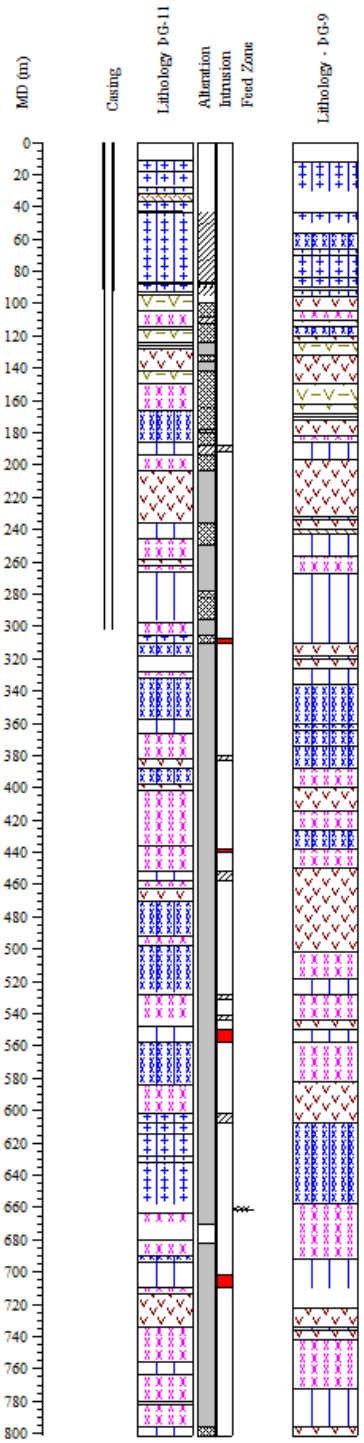


Figure 4. Comparison of lithology in well ÞG-11 and ÞG-09 from 0-802 m.

Figure 5 compares the geophysical logging and lithology in well ÞG-11. The NN log begins to rise rapidly below 300 m. Spikes in resisitivity and NN together indicate dense formations, with little porosity. That is noticed at 308, 440 and 552 meters, where intrusions are being penetated. The same story is seen at the possible intrusions around 530 and 550 m. A large spike in NN and resistivity is also observed around 360 m, in a basaltic lava unit. The Gamma log indicates generally higher alteration below 370 m, but still shows a spike between 85-190 m. The temperature log was discussed in daily report nr 30, but from figure 5 it can be seen that the feeder at ~667 m is located on a boundary between medium grained basalt unit and basaltic breccia below.

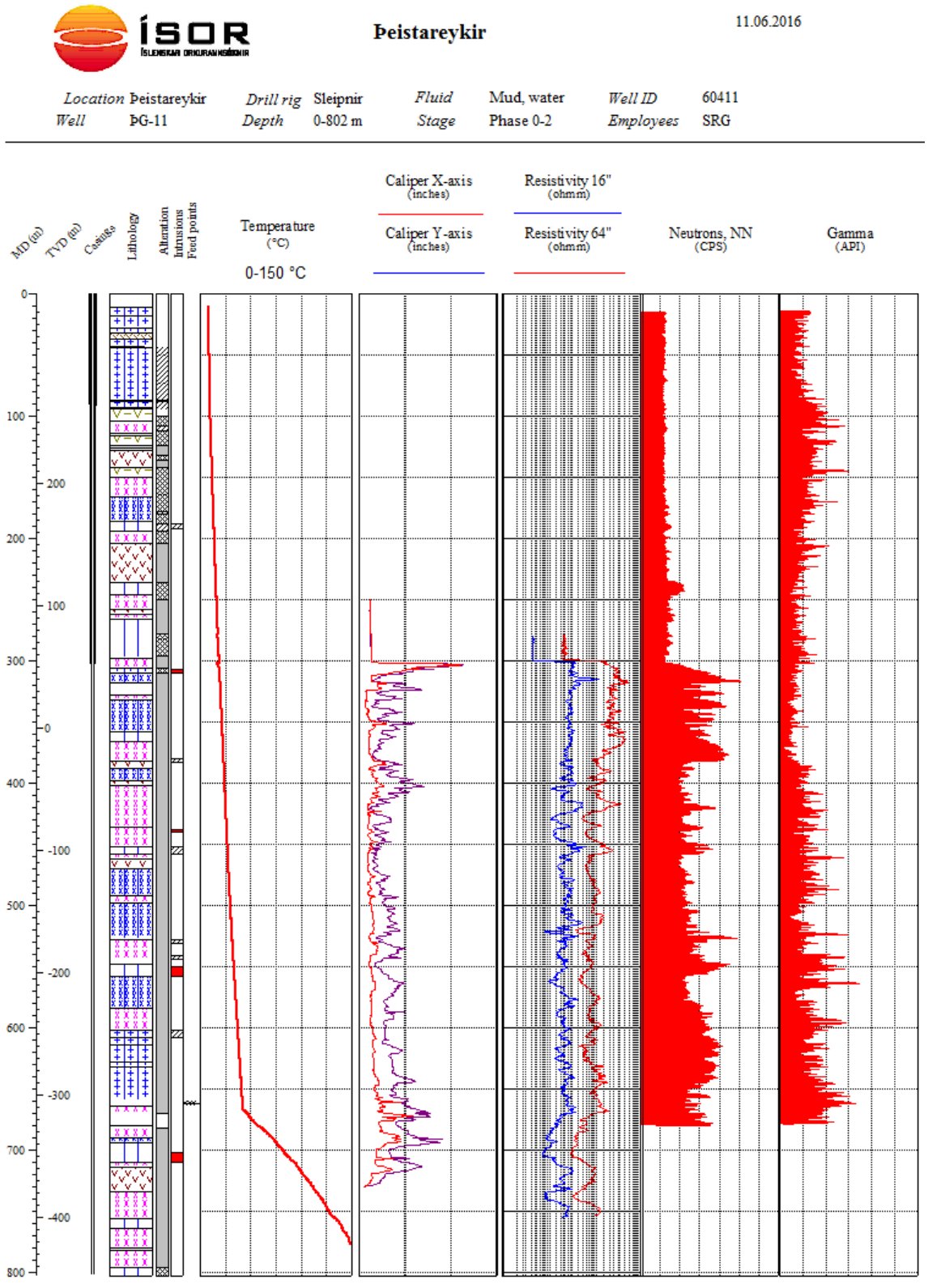


Figure 5. Geophysical logging in well ÞG-11.

ÍSOR ICELAND GEOSURVEY	**ÞG-11**	**Tuesday** **14th of June 2016** Workday #35

Þeistareykir	**Report #32** **Preliminary results**	**Phase 2** **(9 ⅝" production casing)**

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**SRG/HI, MATM** **(E-mail: srg@isor.is)**

Last casing size:	**9 ⅝"** **(production casing)**	**Depth at 24 hrs.**	**802 m**	**Hole made last 24 hrs. :**	**- m**
Last casing depth:	**801.7 m**	**Depth at 8 hrs.**	**802 m**	**Drilling time:**	**- hrs.**
Drilling fluid:	**Water**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**- m/hr**

Drilling operation

RIH with a cement string was carried out between 10:45-15:00 the 13th of June. The next three hours the well was cooled by pumping water through the string, maximum temperature reached 38°C. The cementing job was in action from 18:00-22:30. In total 52.5 m^3 of cement were used. The annular BOP was closed and 15 m^3 of cement were pumped down the string to fill up the annulus. Shortly after, additional 20.2 m^3 were used. 17.3 m^s were used for a fill up on top and by that the well was full of cement and the cement did not sink. WOC was next, and then ÍSOR´s logging engineers started temperature and CBL logging at midnight. The CBL log was carried out approximately 6 hours after cementing and revealed that cement was found all the way behind the casing. The cement is very soft above 100 m. Between 100-450 m the cement is bonding, but is not fully hardened. Below 450 m the bonding is almost complete (Figure 1)

The temperature measurement is shown on Figure 2 and. According to the figure there are clear signs of cooling at the location of the feed zone at around 660-670 m and again at 750 m.

The casing and cement report are not ready and will be published in the tomorrow report. Currently at 09:00 the 14th of June, the drill crew is preparing to move the drill to the next drill pad. Figure 3 shows the drilling progress of well ÞG-11 during drilling of phases 0-2.

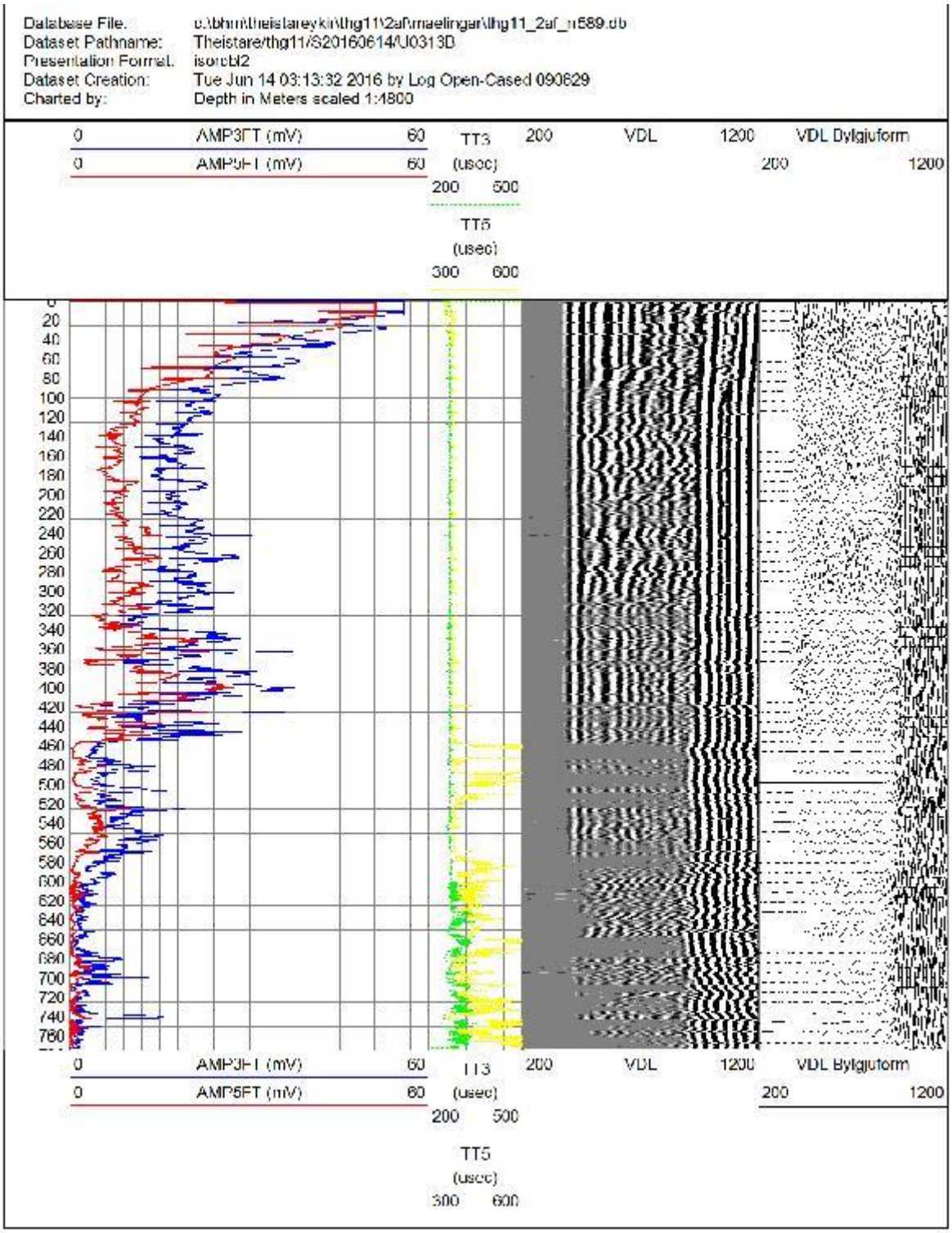


Figure 1. Cement bond logging (CLB) after 6 hours on WOC in well ÞG-11.

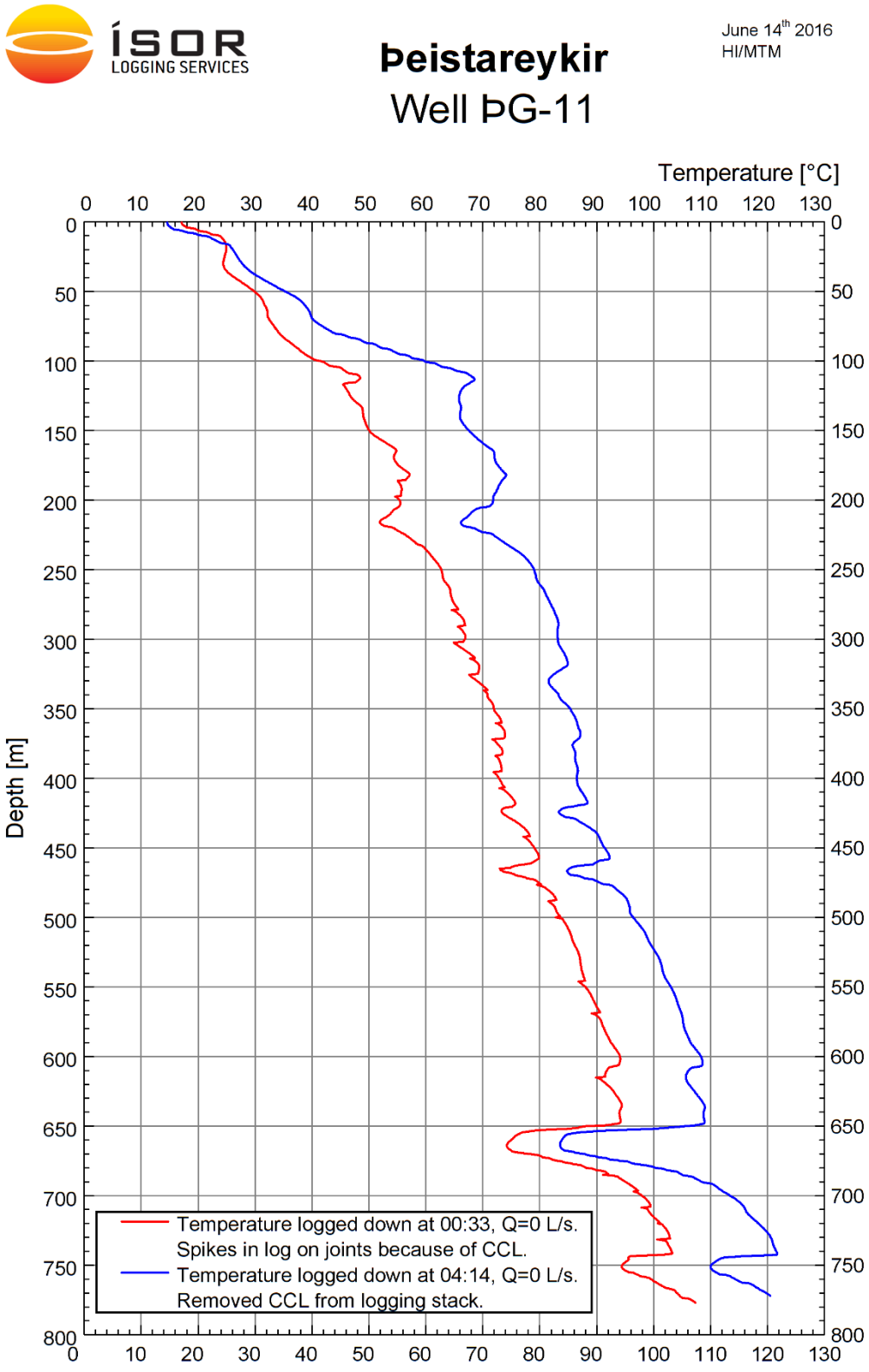


Figure 2. Temperature log performed before the CBL log.

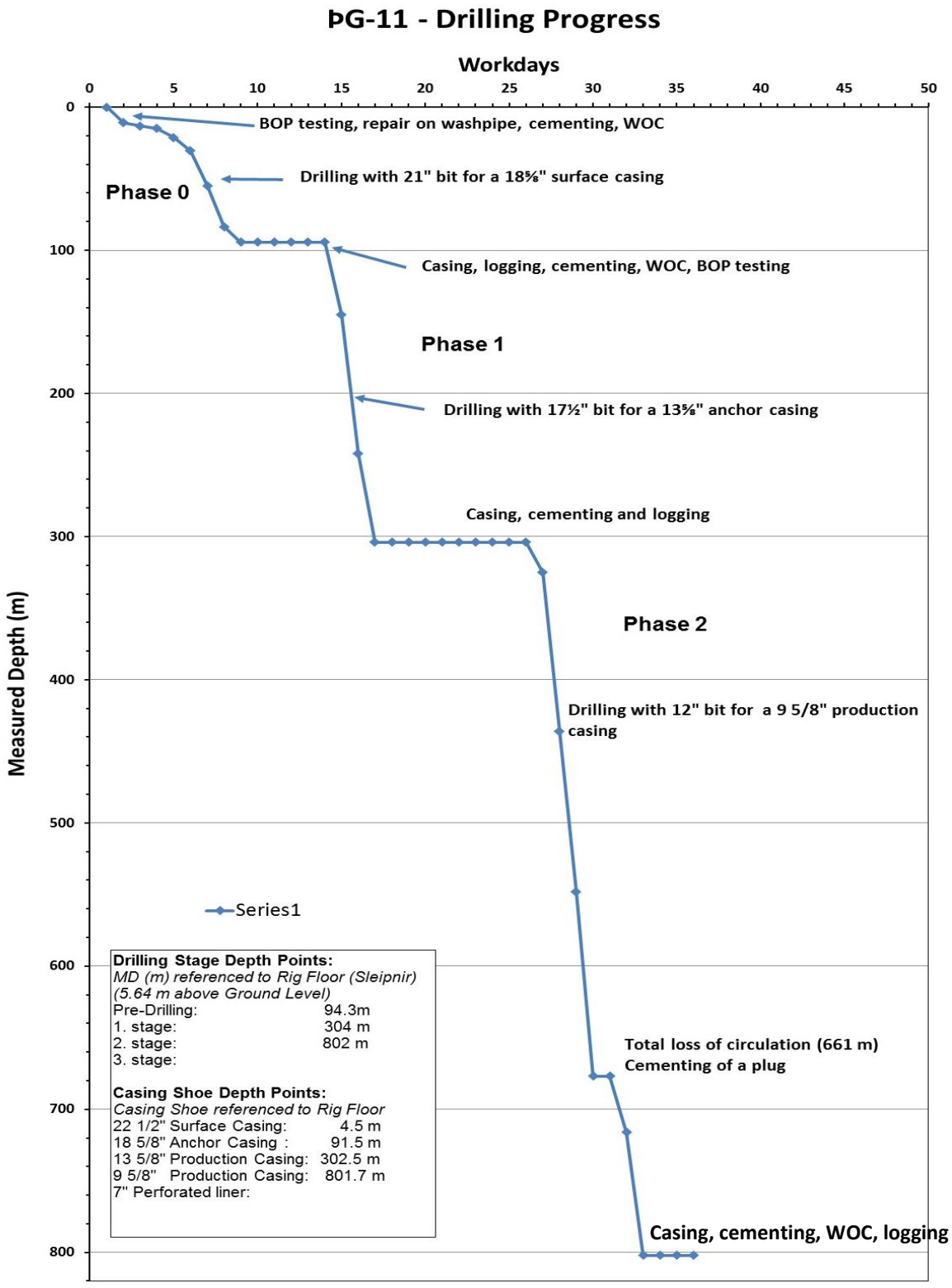


Figure 3. Drilling progress of phases 0-2 in well ÞG-11.

ÍSOR ICELAND GEOSURVEY	**ÞG-11**	**WednesdayWednesday** **15th of June 2016** Workday #36

Þeistareykir	**Report #33** **Preliminary results**	**Phase 2** **(9 ⅝" production casing)**

Operator:	**Landsvirkjun**	*Drilling Company:*	**Iceland Drilling Company**
Well Name:	**ÞG-11**	*Drill-Rig:*	**Sleipnir**
Well-Id:	**60411**	*Geologist/Geophysicist:*	**SRG/HI, MATM** **(E-mail: srg@isor.is)**

Last casing size:	**9 ⅝"** **(production casing)**	**Depth at 24 hrs.**	**802 m**	**Hole made last 24 hrs. :**	**- m**
Last casing depth:	**801.7 m**	**Depth at 8 hrs.**	**802 m**	**Drilling time:**	**- hrs.**
Drilling fluid:	**Water**	**Circulation losses at 8 hrs.**	**0 l/s**	**Average ROP:**	**- m/hr**

Drilling operation

WOC was until 13:15 the 14th of June, when the second CBL and temperature log was performed by Ísor´s logging engineers. The Temperature log still revealed cooling at several places, and the largest one at 660 m (Figure 1). The CBL log showed clear signs of bonding, but still the cement is not fully hardened from 0-300 m and at 600-660 m (approximately the depth of the largest feeder) (Figure 2). WOC was carried out until 19:00, when permission was granted to cut off the flange. The casing report for the 9 5/8" production casing is shown on Figure 3. Cement report is shown on Figure 4. A total of 52.5 m^3 of cement were used for the job.

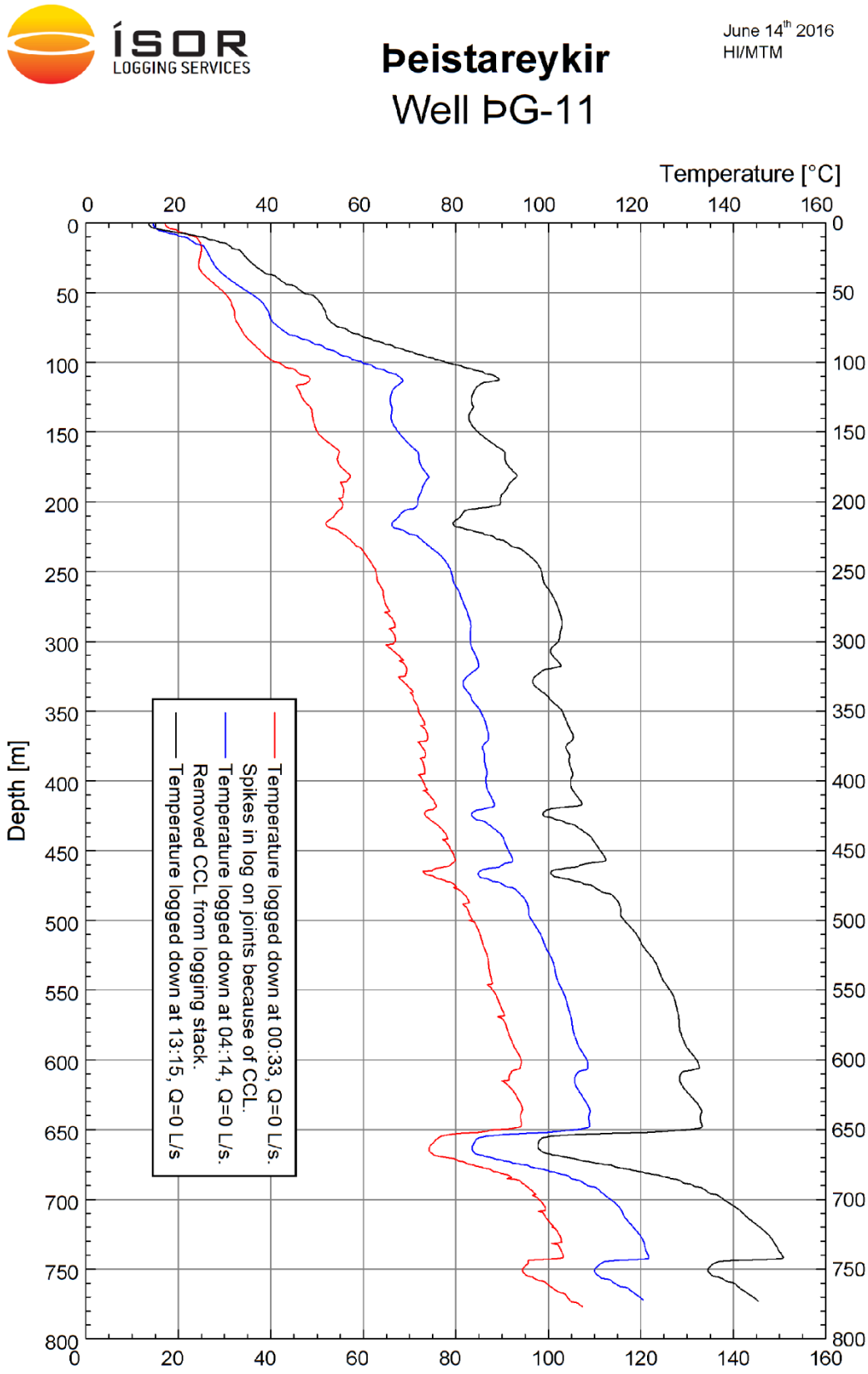


Figure 1. Temperature log performed before the second CBL log.

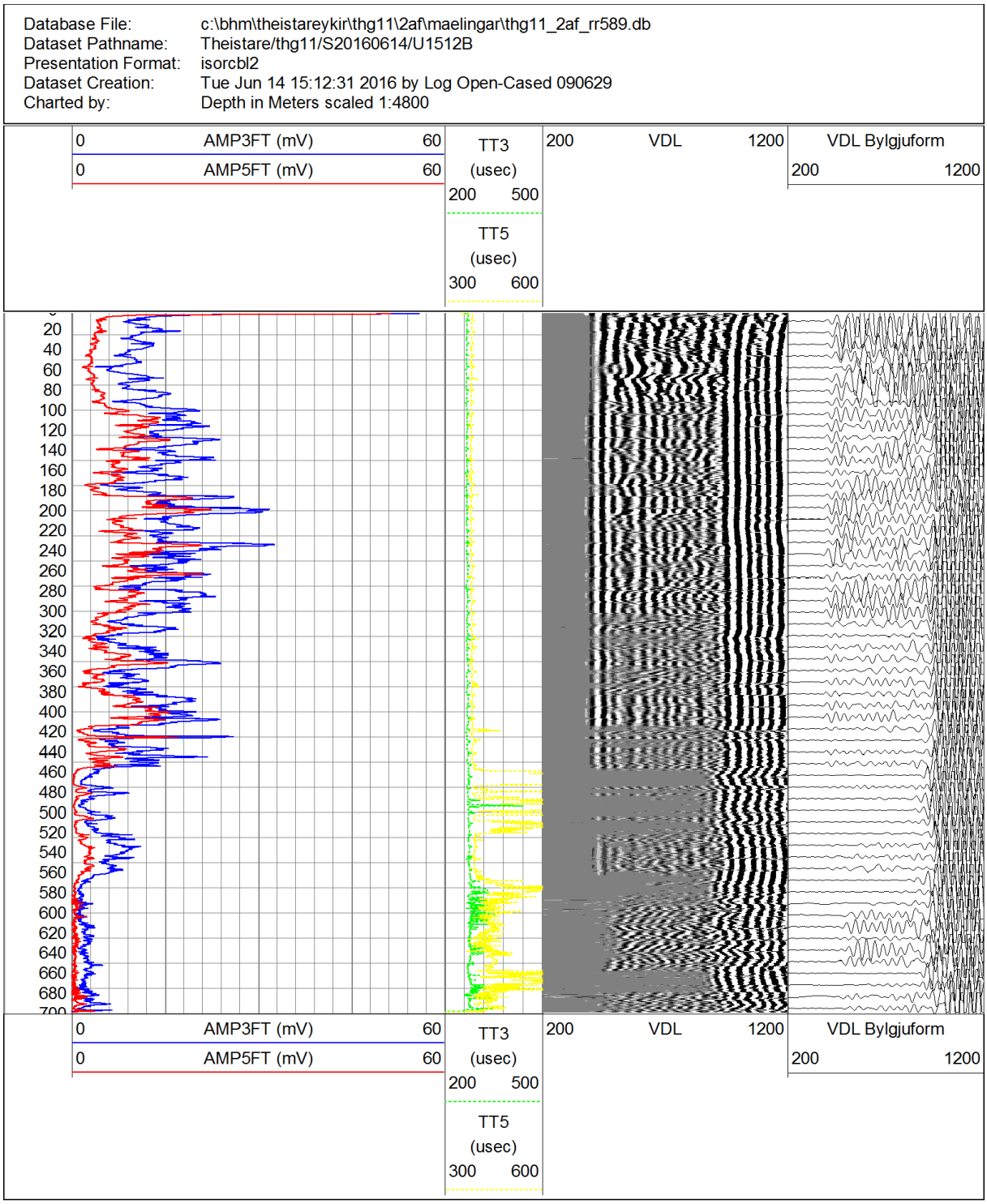
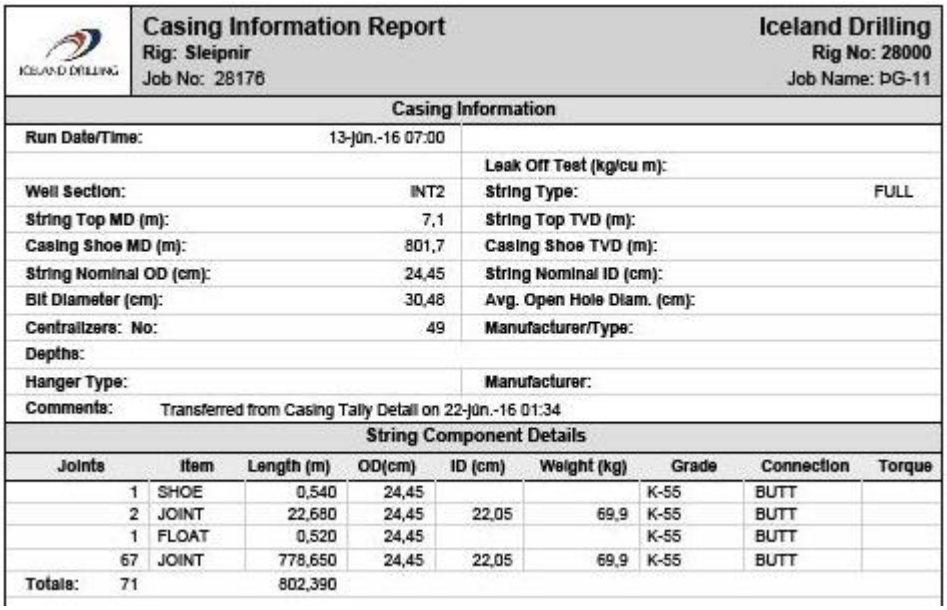


Figure 2. The second CBL log in well ÞG-11



Casing Information Report
Rig: Sleipnir
Job No: 28176

Iceland Drilling
Rig No: 28000
Job Name: ÞG-11

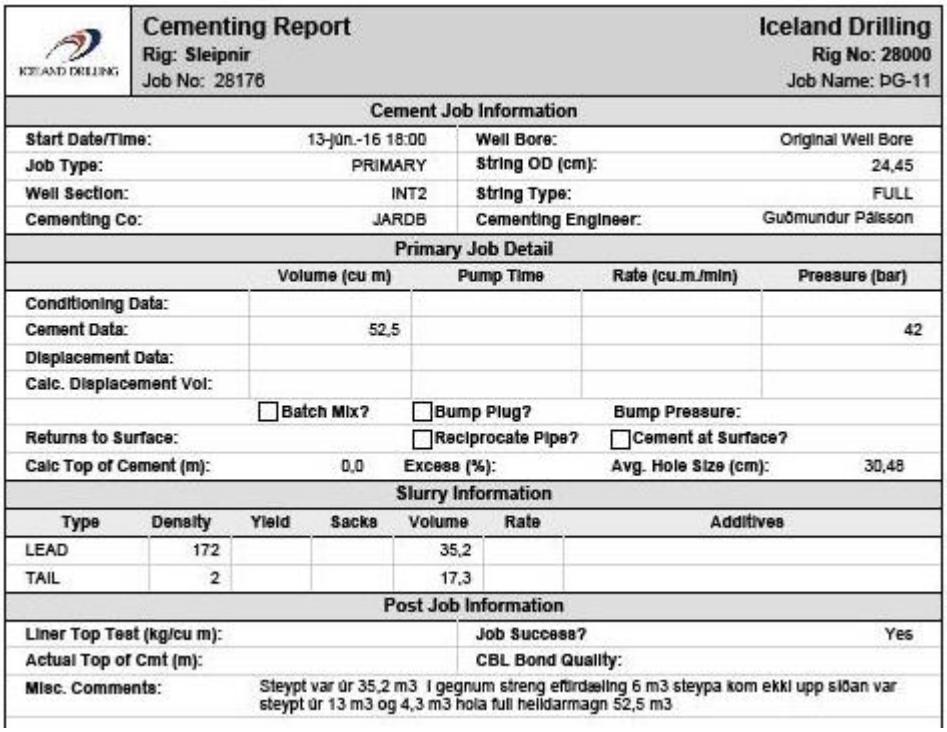
Casing Information

Run Date/Time:	13-jún.-16 07:00		
		Leak Off Test (kg/cu m):	
Well Section:	INT2	String Type:	FULL
String Top MD (m):	7,1	String Top TVD (m):	
Casing Shoe MD (m):	801,7	Casing Shoe TVD (m):	
String Nominal OD (cm):	24,45	String Nominal ID (cm):	
Bit Diameter (cm):	30,48	Avg. Open Hole Diam. (cm):	
Centralizers: No:	49	Manufacturer/Type:	
Depths:			
Hanger Type:		Manufacturer:	
Comments:	Transferred from Casing Tally Detail on 22-jún.-16 01:34		

String Component Details

Joints	Item	Length (m)	OD(cm)	ID (cm)	Weight (kg)	Grade	Connection	Torque
1	SHOE	0,540	24,45			K-55	BUTT	
2	JOINT	22,680	24,45	22,05	69,9	K-55	BUTT	
1	FLOAT	0,520	24,45			K-55	BUTT	
67	JOINT	778,650	24,45	22,05	69,9	K-55	BUTT	
Totals: 71		802,390						

Figure 3. Casing report for the 9 5/8″ production casing



Cementing Report
Rig: Sleipnir
Job No: 28176

Iceland Drilling
Rig No: 28000
Job Name: ÞG-11

Cement Job Information

Start Date/Time:	13-jún.-16 18:00	Well Bore:	Original Well Bore
Job Type:	PRIMARY	String OD (cm):	24,45
Well Section:	INT2	String Type:	FULL
Cementing Co:	JARDB	Cementing Engineer:	Guðmundur Pálsson

Primary Job Detail

	Volume (cu m)	Pump Time	Rate (cu.m./min)	Pressure (bar)
Conditioning Data:				
Cement Data:	52,5			42
Displacement Data:				
Calc. Displacement Vol:				

☐ Batch Mix?	☐ Bump Plug?	Bump Pressure:	
Returns to Surface:	☐ Reciprocate Pipe?	☐ Cement at Surface?	
Calc Top of Cement (m): 0,0	Excess (%):	Avg. Hole Size (cm):	30,48

Slurry Information

Type	Density	Yield	Sacks	Volume	Rate	Additives
LEAD	172			35,2		
TAIL	2			17,3		

Post Job Information

Liner Top Test (kg/cu m):		Job Success?	Yes
Actual Top of Cmt (m):		CBL Bond Quality:	
Misc. Comments:	Steypt var úr 35,2 m3 I gegnum streng eftirdæling 6 m3 steypa kom ekki upp síðan var steypt úr 13 m3 og 4,3 m3 hola full heildarmagn 52,5 m3		

Figure 4. Cement report for the cementing of the casing.

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Sími: 515 90 00

Prentað efni