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EXPLORATORY BOREHOLE PVGT-LT-1

(18.11.2006 – 26.07.2007)

LITOMĚŘICE

FINAL REPORT

CONCERNING THE CARRYING-OUT OF THE PVGT-LT 1 EXPLORATORY BOREHOLE

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PHOTOGRAPHIC DOCUMENTATION: Images in individual chapters

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INTRODUCTION

Based on an approved project for geological work with the purpose of verifying the temperature conditions and determining the types of rocks present to a depth of 2,500 m in Litoměřice, the exploratory phase – i.e. the carrying-out of the PVGT-LT 1 exploratory borehole was commenced in November 2006. The technical project was prepared for utilising full-profile rotary drilling technology with interval coring (twice at locations of changes of the rock environment, once at the final depth) using a system of narrow telescopic drilling with the requirement of a final diameter of 156 mm at the final depth of 2,500 m.

Subsequent to the establishment of a concrete foundation for the rig and the provision of power and water connections to the work-area, the drilling rig, together with the drilling accessories, was delivered to the location of the Jiřík Army Base, to the site delineated by the contractor for the geological task.

The drilling rig and the accessories were assembled at the workplace in accordance with the requirements predetermined for the implementation of the drilling. Prior to the commencement of the drilling a comprehensive inspection of the drilling rig and of the technical and auxiliary equipment was carried out.

The drilling crew had been familiarised with the nature of the technical work and trained by a qualified individual with competence in respect to work-safety and fire-protection, in accordance with the regulations of the CMA and the COSO in force in the Czech Republic.

1. Technological process of the carrying-out the PVGT-LT 1 exploratory borehole

1.1. The progress of the drilling work (28.11.2006 – 17.07.2007)

The drilling of the PVGT LT-1 exploratory borehole commenced on 28.11.2006 using a carriage drilling rig of German manufacture, the WIRTH B4-A (see Chapter 2.1.). The borehole was drilled, using an auger drill with a diameter of 393.7 mm, to a depth of 10.3 m for a Ø 357 mm RK casing and was subsequently cased and sealed with cement.

Drilling of the interval from 0 - to 252.5 m for the ÚK Ø 9 ⅝" casing was carried out in a rotary manner in the course of which three-roller boring bits with a diameter of 311.2 mm were utilised (the consumption of boring bits for the ÚK interval is shown in *Table 11*). The borehole was cased to a depth of 252.5 m and cemented up to the surface.

For drilling, using a rotary method, through the cement and the abutment of the ÚK casing and for further excavation of the TchK Ø 7" interval to a depth of 852.5 m, boring bits with a diameter of 215.9 mm were utilised (the consumption of boring bits for the TchK section is shown in *Table 11*). The TchK Ø 7" interval was cased and cemented up to the surface. Following drilling through the cement in the casing and the abutment of TchK, the borehole was deepened to 854 m and a core sample was taken at this depth.

Coring in the 854 to 857 m interval was carried out using the HQ double core barrel with a diamond core bit with a diameter of 96 mm. The yield was 3 m.

For excavating a non-cased ŤžK section (from 852.2 to 2,500 m) a rolling boring bit was utilised of the Ø 156 mm XR type and the section to the depth of 1,279 m was drilled in a rotary manner. At the depth interval between 1,279 - 1,282 m a 3 m core sample was again taken using the HQ double core barrel with a Ø 96 mm diamond core bit.

Because logging measurements indicated a significant deviation of the borehole from the vertical (by cca. 45°) in the 854 – 1,282 m section, which was not in compliance with the project documentation for the borehole, this section was cemented to a depth of 899 m.

Following the cementation rest drilling continued from the depth of 899 m to 1,114 m using a rotary method and utilising a boring bit with a diameter of 156 mm. Subsequent logging measurement showed a deviation of 12° at a depth of 1,063 m, on the basis of which the prior cementation step was repeated.

An amendment to the drilling process was approved. From the depth of 899 m the GEOBOR S double core barrel with a Ø 146 mm diamond core bit was utilised, together with ongoing coring.

When the depth of 1,003.8 m was reached the deviation of the borehole from the vertical had been reduced significantly, to 4.2°. At this depth of 1,003.8 m the diameter of the borehole was expanded to 156 mm, using a boring bit. During the continuation of the excavation of the borehole in a rotary manner, using a boring bit with a diameter of 156 mm, at the depth of 1,137 m the deviation of the borehole had increased to 7.3°.

From the depth of 1,137 m, the borehole was executed using a different drilling rig, the DIR 5519 SBS (see Chapter 2.2), and was drilled with the assistance of an external German service company, Directional Drilling Servis (see Chapter 2.3.), using a submersible motor together with the MWD system. In addition to the submersible motor and the MWD system, hydraulic-mechanical shanks were positioned in the base of the drilling assembly. High quality boring bits with a diameter of 152 mm made by the Smith Company were utilised.

Part of the borehole section was drilled using a combination technique, i.e. one section (of cca. 5 m) only with a submersible motor, without a rotary drilling assembly, and the other section (of cca. 4 m) together with a rotary drilling assembly in addition to the submersible motor. Using this method, however, the borehole, after a short section had been drilled, again adopted a significant deviation from the vertical (by as much as 9.8°).

Drilling was continued with the utilisation of the submersible motor to a depth of 2,053 m. In this manner, the deviation of the borehole from the vertical was maintained within the range of <1.5° - 5.8° >. During the drilling seizing-up of the drilling tools occurred in several sections of the borehole in the uncased sections (1,790 - 1,835 m and 1,993 - 2,024 m) that, on several occasions, resulted in the shaft breaking when the tool was released.

This technical downtime was used for logging measurements by two expert independent companies, Aquatest a.s. Praha and Geo-Log Kft. from Budapest. The resulting downtime caused the borehole to be passable only to the depth of 1,824 m. From this depth the borehole had to be re-drilled several times by a boring bit with a diameter of 152 mm, using a rotary method.

The depth of 2,111.2 m, achieved using the rotary manner was considered to be the furthest depth of the PVGT-LT 1 exploratory borehole, due to the frequent seizing-up of the drilling tools and concerns about the risk of an accident in the event of additional drilling efforts.

Based on the core sampling required for the project at the final depth, the drilling assembly was constructed using the GEOBOR S double core barrel with a diamond core bit with a Ø of 146 mm, which was sunk to a depth of 1,824 m, from which point, even after attempts lasting several hours, the core barrel would not go any deeper. The borehole was terminated prematurely, at a depth of 2,111.2 m, on 17th July 2007, without a core sample having been taken.

1.2. Drilling at complicated intervals

(Tectonic disturbances, caving-in, swelling, tightening of the borehole)

During the drilling of the PVGT - LT 1 exploratory borehole (after successful completion of the casing and the cementing of the TchK section) several complex geological sections were encountered in the uncased section of the borehole, which adversely affected the drilling process.

I. ***Section (852.5 – 1,282 m)*** *– with significant natural faulting – tectonically distorted rocks.* This section has been disturbed by a system of tectonic faults inclined at almost a 45° angle. These faults were manifested in the rapid drilling process (1 m in 8 min). The boring bit was slipping over the foliation surfaces of the rock (on the mica schists) above the tectonic faults.

SOLUTION 1: Construction of a special (re-stabilised) Bottom Hole Assembly of a drilling rig for rotary drilling

Subsequent to cementing the inclined section to a depth of 899 m (in accordance with the geologists that had been invited this fault zone should be approximately 50 m thick), the drilling assembly was established, consisting mainly of thick-walled pipes in the belief that this special drilling assembly (with a total length of 107.55 metres) would, by its own weight, maintain the vertical direction of the borehole. The Bottom Hole Assembly used in the section of 899 – 1,114 m is specified in *Table 1*.

RESULT 1:

This method using the "re-stabilised" drilling assembly, however, could not overcome the strong natural distortion. Logging results in the case of this method of drilling also showed a deviation of 12° from the vertical. The borehole was therefore affected by the same deviation as in the first instance, when it was inclined at cca. 45°; this time however in a different direction (azimuth).

The locations of the sharper distortion in the borehole in 2 cases even resulted in the breaking of the drilling tool just above the weight (in the thread where it was joined). This phenomenon was associated with material fatigue during repetitive bending of the drill pipe. Using a tap catcher (a conical reamer) the broken tool was successfully pulled out of the borehole.

Table 1: The Bottom Hole Assembly utilised during the rotary drilling of PVGT-LT 1 (899 – 1,114 m) – using the WIRTH – B4 A drilling rig

Section	Number of items	Ø O.D. (mm)	Length of the section (m)
Boring bit 6 1/8"	1	156.00	0.18
Stabiliser	1	153.00	1.00
Weights 3 1/2"	1	146.00	2.71
Stabiliser 3 1/2"	1	156.00	1.48
Connecting link 3 1/2<4"	1	146.00	0.23
Weights 4"	2	140.00	7.39
Connecting link 4> 3 1/2"	1	146.00	0.25
Stabiliser 3 1/2"	1	156.00	1.55
Weights 3 1/2"	1	124.00	8.41
Stabiliser 3 1/2"	1	156.00	1.16
Weights 3 1/2"	1	124.00	6.93
Stabiliser 3 1/2"	1	141.00	1.07
Weights 3 1/2"	1	124.00	8.72
Stabiliser 3 1/2"	1	152.00	1.02
Weights 3 1/2"	1	124.00	5.55
Stabiliser 3 1/2"	1	152.00	1.07

Section	Number of items	Ø O.D. (mm)	Length of the section (m)
Weights 3 1/2"	9	124.00	58.58
Connecting link 3 1/2>2 7/8	1	125.00	0.25
Total length (m)			**107.55**

At a depth of 1,114 m, this method of drilling was terminated and SOLUTION 2 was adopted.

SOLUTION 2: The Bottom Hole Assembly for the rotary core drilling GEOBOR S

After re-cementing of a distorted section to a depth of 899 m the drilling assembly was established, consisting of a double core barrel with a diamond core bit (diameter 146 mm) for core drilling, in the belief that this solid drilling rig (with a total length of 32.15 metres) would maintain the straight direction of the 7" TchK cemented interval. The bottom part of the drilling assembly used in the 899 – 1,003.8 m section is specified in *Table 2*.

RESULT 2:

Much better results were achieved using the GEOBOR S core drilling system (Figure 5). The deviation was reduced to 4.2° at a depth of 1003.8. However, this method of drilling was very time consuming (in a month only 89 m of core samples were taken). Initially only cement was excavated. At a depth of 942 m first crescents started to appear (cement + rock) that gradually passed to the full core of a cylindrical shape.

Table 2: The Bottom Hole Assembly utilised during the rotary drilling of PVGT-LT 1 with the GEOBOR S double core bit at the interval of 899 – 1,003.8 m – using the WIRTH – B4 A drilling rig

Section	Number of items	Ø O.D. (mm)	Length of the section (m)
Diamond core bit	1	146.00	0.18
Double core barrel	1	146.00	9.36
Connecting link 4 3/4> 31/2"	1	146.00	0.14
Stabiliser 3 1/2"	1	152.00	1.48
Weights 4 3/4"	1	120.00	5.47
Stabiliser 3 1/2"	1	156.00	1.41
Weights 4 3/4"	2	120.00	12.45
Stabiliser 3 1/2"	1	156.00	1.41
Connecting link 3 1/2>2 7/8	1	125.00	0.25
Total length (m)			**32.15**

In some sections the core runs were very short and the core yield was less than 100%. Problems in core drilling were caused by the jamming of the core barrel in the borehole in the rock debris falling from above (from the soft rock) between the core barrel and the wall of the borehole. Fragments of rock from unstable areas were also falling into the actual borehole and when sinking the core barrel with a diamond core bit into the borehole the sections containing fallen rocks had to be re-drilled.

In the event of the filling or the jamming of the core barrel, or because of the need to replace a worn core bit, it was necessary to suspend drilling and to pull out the drilling assembly. This manipulation required the most time. When using the WIRT B4-A drilling rig, the manipulation, lifting and of the core barrel from and sinking it to such a depth took at least 10 hours.

For this reason INGEO Žilina, the contractor for the exploratory borehole, decided to replace the drilling rig. The DIR 5519 SBS drilling rig (in comparison with the WIRTH) permitted the simultaneous manipulation of 2 connected (screwed together) drilling rods with a total length of 20 m. Downtime in this case was decreased by a half.

Also the flushing of this drilling rig permitted smoother drilling due to the pumping of sufficient irrigation, providing an effective strong flush pump, which was a necessity for the continuation of drilling using the new technology – i.e. a submersible motor system.

Although following the deployment of the submersible motor with the MWD system in a relatively short time (in cca. 1 month) 916 m of rock was drilled, complications also occurred in the case of this method of drilling.

II. ***Section (1,790 – 2,024 m)*** – *associated with faulted, loose rocks of a swelling nature (graphitic shale).*The first time this problem occurred was when drilling was carried out through two layers of rock of a "muddy" character with a significant odour. Later, these sections caused jamming of the drilling assembly during deepening of the borehole. The cause of the jamming of the drilling tools was the narrowing of the borehole due to swelling of the walls in these sections of the borehole. The indication of a collapse in the borehole was the increased performance of the motor while pulling out the drilling tools, several times resulting in the breaking of the winding drum shaft.

SOLUTION: Preparation of bentonite – polymer flushing fluid

The polymer irrigation mixture containing CMC that had been used until then, for the purpose of strengthening the borehole wall in the problematic section, was complemented by bentonite. The optimum composition was prepared of a bentonite - polymer mixture of highly concentrated bentonite and an effective polymer that reduced filterability and increased the inhibition effect of the flushing fluid on the rock.

RESULT:

Even multiple pumping of the bentonite - polymer flushing fluid did not improve the situation. Upon reaching the already drilled floor of the borehole, at a depth of 2,053 m, due to logging measurements, the section had to be repeatedly re-drilled to a depth of 1,825 m. During the re-drilling of these problematic sections a larger quantity of drilling debris again appeared on the surface and also the viscosity of the flushing fluid increased.

Finally, re-drilling and constant irrigation of the borehole in order to collect core samples from a depth of 2,111.2 m resulted in the swelling of the graphite shale material and pressure in this area caused the failure of the stability of the walls so that the borehole was completely buried from the depth of 1,825 m down to the final drilled depth.

1.3. Isolation of layers

Guide casing string – RK ∅ 357/8 mm

The guide string was designed so that its abutment was established in quaternary rock, in order to protect the mouth of the borehole from flushing fluid circulating during the drilling of the conductor string.

The RK interval made of welded pipes with a diameter of 357 mm was cased and fixed by the cementation of the mouth to a depth of 10.3 m.

Portland-type cement with a 325 strength category was used for the cementation of this interval. Using the pumping unit of the drilling rig, grout was pushed straight through the cementation head to the annular ring of the cased borehole.

Conductor casing string – ÚK ∅ 9 $^{5}/_{8}$”

The conductor string was designed so that its abutment was established in the solid rock, and thereby covered the sandy horizons in the upper part of the geological profile from 10.3 to 252.5 m. The mouth of the borehole was equipped with a base flange to ensure anti-eruption protection during drilling in other parts of the borehole.

ÚK (∅ 244.48 / 8.94 mm) was cased and cemented to a depth of 252.5 m.

Technical casing string - TchK ∅ 7”

The technical string was designed in order to isolate the rock of the Cretaceous complex in the interval from 252.5 to 852.5 m and took over the function of ÚK for the emergency closure of a borehole in the case of the occurrence of gas.

TK (Ø 177.8 / 8.05 mm) was cased and cemented to a depth of 852.5 m.

1.3.1. ÚK and TchK Casing

The ÚK and TchK casing (Figure 2) met the utmost demanding requirements for quality, i.e. the J55 standard. It consisted of (hot-rolled) seamless steel tubes, in accordance with the API Spec. 5CT standard, bearing the name STC. The lengths of the casing tubes corresponded to those of the RANGE II type (7.62 to 10.36 m).

Subsequent to their re-moulding and prior to being sunk into a borehole, casing tubes, equipped with special tools (listed in *Table 3*), were requisite for cementation. These tools were:

- *An abutment for the casing tubes, with a check valve,* installed on the first casing tube at the bottom part of the drilling assembly. The simple rounded shape of the casing abutment, made from easily drillable material, guided the casing tube on the borehole trajectory, while the check valve prevented the entry of flushing fluid to the string during the installation of the casing tubes into the borehole.
- *An impact plate with an opening,* located 10 m above the abutment
- *Centralisers,* composed of leaf springs, were mounted to the body of the casing tube for centering the casing string. Their location, after each 50 m, maintained the required distance between the string and the borehole walls in order to ensure a continuous flow of cement along the entire circumference of the annular space.

Used casing tubes were joined together by coupling sleeves. Thereby they created a casing string, which was sunk and fitted in the defined depth to protect the borehole walls against caving in.

Table 3: Structure of the lower parts of casing strings

INTERVAL [m]	STRUCTURE
0 – 252.5	A CASING TUBE equipped with: - an abutment with a check valve - an impact plate with an opening 10 m above the abutment - centralisers, each 50 m

INTERVAL [m]	STRUCTURE
0 – 852.5	A CASING TUBE equipped with: - an abutment with a check valve - an impact plate with an opening 10 m above the abutment - centralisers, each 50 m

1.3.2. ÚK and TchK cementation (pressure cementation of casings)

Portland-type cement CEM I – 42.5 R transported from the nearby Holcim cement plant in Lovosice was used for the ÚK and TchK cementation. The content of the cementation mixture from the mixer of the cement plant was pressed into the cementation mixer from where it was delivered by the cementation unit (Figure 3) to the cementation head.

Cementation was carried out through the abutment with a check valve. A 15 m column of cement was left in the abutment; the annulus ring was cemented to the surface.

Prior to cementation the borehole was flushed through the flushing head, with rinsing fluid used to clear the borehole walls.

The cementation head was assembled with chambers for two cementation caps - bottom and top - and three valves on its side arm. A liquid separator was pushed through the first bottom valve, as a separating column between the flush and the cement mixture. The first valve was closed and the arrester of the bottom (separation) membrane cap was released, the second valve was opened and the required amount of cementation mixture was applied (the amount is given in *Table 4*). The top cap was released and the required volume of flushing fluid (water) was applied as stated in *Table 4*.

Table 4: Consumption of the cementation mixture and of water for the individual sections of the borehole

INTERVAL [m]	CEMENTATION	SECTIONS	CEMENT	CONCENTRATION [kg.m^{-3}]	VOLUME [m^3] Cement mixture	water
RK	Up to the mouth	0 – 10.3	SPC - 325	1.80 – 1.82	4	-
ÚK	Through the abutment up to the mouth	0 – 252.5	CEM I – 42.5 R	1.81 – 1.83	6	3.6
TchK	Through the abutment up to the mouth	0 – 852.5	CEM I – 42.5 R	1.81	21	16.5

During each cementation the cement was sampled to perform control tests in regard to the strength of the cement stone.

Subsequent to cementation of the individual string and the cementation rest (5 days) leak tightness tests were carried out using a pressure method in the ÚK and the TchK sections. Cemented horizons were considered as hermetically sealed, when no pressure drop occurred during a one hour period.

The quality of the cement column behind the casing was investigated by the Aquatest a.s. Praha Company using thermo-logging measurement and was found to be flawless.

1.3.3. Flushing system

Sections of the casing strings (CL and TchK) and intervals to a depth of 1,790 m were drilled with the aid of a polymeric flushing fluid (CMC – Carboxymethyl cellulose)

The CMC polymer (Carboxymethyl cellulose) is a mixture of highly efficient powder polymers, intended primarily for the preparation of clay-less drilling fluids that have a multiple function in flushing. They in fact act as:

- regulators of rheological properties
- regulators of filterability
- shale stabilisers

Macromolecules of this polymer create a thin film on a surface of drilled rock that, to a significant extent, slows down the actual hydration and swelling of the rock. It is biologically easily degradable.

The polymer has the ability to reduce hydraulic losses in the annular ring of the borehole, which affects the course of drilling, particularly in an increased cleansing effect on the bottom of the borehole and the drifting effect on the rock drilled.

Polymer flushes are also widely used in the core drilling, with very positive results.

During the drilling from the depth of 1,790 m, for the problematic sections a bentonite – polymer flush was utilised.

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The properties of the flushing fluid used are defined in the following Table 5.

Table 5: Flushing fluid used for specific sections of the borehole

INTERVAL (m)	FLUSHING FLUID	CONCENTRATION ($kg.m^{-3}$)	VISCOSITY MARCH	FILTRATION API	SAND %	pH
< 10.3 – 252.5>	Polymer	1,010 – 1,090	40 - 45	5 - 7	2	9 - 10
< 252.5 – 852.5>	Polymer	1,010 – 1,090	40 - 45	5 - 7	2	9 - 10
< 852.5 – 1,790>	Polymer	1,010 – 1,050	30 - 40	4 - 5	2	9 - 10
< 1,790 – 2,111.2>	Bentonite -polymer	1,060	35 - 50	Max. 4	3	9 - 11

2. The drilling rigs utilised for carrying out the PVGT – LT 1 borehole

2.1. Drilling the PVGT - LT 1 exploratory borehole utilising the WIRTH B4-A drilling rig

WIRTH B4 - A DRILLING RIG (Fig. 1) - Technical Specifications

The modern, multi-purpose, fully hydraulic carriage drilling rig, WIRTH B4-A, of German production, with a 600 kN bearing capacity, is mounted on a truck chassis with its own hydraulic unit. It is equipped with a hydraulic rotary drilling head, which moves on a carriage of a drilling rig with a height of 17.31 m.

Its modular design permits the exchange and adjustment of the drilling head; it is therefore a universal device for its exploratory core and full-profile drilling. It is also equipped with an additional casing device, allowing for the casing of a borehole in loose rocks. During its operation the rig is stabilised by retaining hydraulic cylinders. The control housing with a control panel is located at the service platform.

The drive of the rig is procured by the BF 10L513 diesel motor with the performance of 218 kW and rated speed 1,800 rpm.min^{-1}.

The hydraulic system (hydraulic motor with axial pistons) provides a rotation drive of the head, as well as other functions of the rig.

The basic rig consists of the TPK 5"x5"/115 HD flush pump (1,208 l.min^{-1} at 3.8 MPa), the TPK 5"x5"/70 ND flush pump (1,208 l.min^{-1} at 2.24 MPa), the NB 3 120/40 flush pump (120 l.min^{-1} at 4.1 MPa). The flushing system creates an enclosed circuit, which is equipped with an appropriate cleaning technology.

The rotating head allows for 22.46 kNm torque and rotations up to 500 per minute.

The WIRTH B4-A drilling rig was used for drilling works utilising a rotary method in the interval 0 to 1284 m, casing and cementation of RK (0 to 10.3 m), ÚK (0 to 252.5 m) and TchK (0 - 852.5 m) and core sampling in sections 854-857 m and 1,279-1,282 m.

For drilling of individual sections of the borehole sections were used the following drilling tools mounted in the bottom part of the drilling assembly (listed in *Table 6*) and drill rods (listed in *Table 7*).

Table 6: Common Bottom Part Assembly of the drilling rig used in rotary drilling:

The Bottom Hole Assembly during the drilling of PVGT-LT 1 (10.3 – 1,279 m)

Section	Number of items	Ø O.D. (mm)	Length of the section (m)
Core drill 6 1/8"	1	156.00	0.25
Core drill stabiliser	1	152.00	1.00
Weights 4 3/4"	6	120.50	43.70
Stabiliser 3 ½”	1	154.00	1.65
Connecting link	1	146.00	0.22
Weights 4 3/4"	1	120.50	1.91
Connecting link 4 3/4">3 ½”	1	146.00	0.18
Stabiliser 3 ½”	1	156.00	1.51
Connecting link 3 ½”">4 3/4	1	146.00	0.18
Weights 4 3/4"	5	120.50	36.50
Connecting link 4 3/4">3 ½”	1	146.00	0.14
Stabiliser 3 ½”	1	156.00	1.21
Connecting link 3 ½” > 2 7/8”	1	125.00	0.25
Total length (m)			**88.70**

Table 7: Drilling rods utilised during the drilling of individual intervals of the borehole using the DIR 5519 SBS drilling rig

Interval in accordance with the measured depth	Drilling rods (")	Diameter of rods (mm)	Length of rods (m)	Quality level	Type of screw link
10.3 – 852.5	3 1/2"	9.35	9	D	3 1/2" IF
852.5 – 1,279	2 7/8"	9.19	9	D	2 7/8” IF

2.1.1. Interval coring

A drill core, periodically extracted to the surface still serves best for geological evaluation. So far it is the most plausible material for assessing the geological structure of the area of interest (determination of the extent and thickness of the deposits, their depositing condition and their quality).

Interval coring in the PVGT LT-1 borehole was carried out only in two sections of the borehole. These were sections 254-257 m and 1,279-1,282 m. In both cases, the core sampling was undertaken using a HQ double core barrel with a diamond core bit with a diameter of 96 mm. The assembly of the bottom part of the drill rig used for coring is defined in *Table 8*.

The yield of the core sampling was 100% and the core was 3 m long (Figure 4). An attempt to take a third core sample in the final core depth of 2,111.2 m failed due to the inconvenience.

The rock on the bottom of the borehole is disintegrated with a drilling core bit with a core barrel, i.e. a coring tool. During the rotation of the coring tool the rock, in the shape of a cylinder, gets inside the double core barrel. After the completion of a core run, the core is broken by a sample splitting device, which is located between the drilling core bot and the core barrel. The sample splitting device also serves to hold the core in the core barrel while pulling it from the borehole.

Table 8: The Bottom Part Assembly of the drilling rig, utilised during the core drilling of PVGT-LT 1, using the HQ double core barrel in the sections 854 – 857 m and 1,279 – 1,282 m

Section	Number of items	Ø O.D. (mm)	Length of the section (m)
HQ diamond core bit	1	96.00	0.11
Double core barrel	1	96.00	4.03
Connecting link 2 7/8"	1	125.00	0.22
Total length (m)			**4.36**

2.2. Drilling the PVGT - LT 1 exploratory borehole utilising the DIR 5519 SBS drilling rig

DIR 5519 SBS DRILLING RIG (Figure 6) - Technical Specifications

The U.S. made DIR 5519 SBS drilling rig, with a bearing capacity of 1000kN, is designed for full-profile drilling, with direct flushing, to a depth of 2,500 m with a final diameter of 146.1 mm. It is well adapted for rotary core drilling, i.e. interval coring.

This is a medium-size rig with the transmission of torque to the drill tool through the drill table. Transmission of torque from the drill table to the drilling rig is provided by a square drifting bar.

The drilling rig consists of a group of machines mounted on a 6-axle TATRA 815 mobile chassis, on which is located a drive unit with accessories, a gear box (a five-speed gearbox of the ALISON - CLBT 5861 type), a drilling reel, the system for raising and lowering the rig, the actual telescopic rig, control equipment, measurement devices and a hoist with a hook.

The other equipment, consisting of the actual structure, such as the drill table, the flushing head (SBS 1L - 120), the operating platform belonging to the table, the pump with a generating set, a flushing system, water tanks and the diesel unit are transported separately.

The drilling rig of tubular construction and the model of the mast type, with outer anchorage of the KM 103 - 212 GH type, consists of two telescopic sections. The upper section is inserted into the bottom one using a hydraulic cylinder. The height of the rig in the working position is 32 m.

Lifting and rotating devices consist of the H37 ED double-drum drilling reel with the maximum power of 323 kW and maximum tensile strength of the rope 171.47 kN, the IR - 175 IDEC (17 ½") drill table and the combined WDS -110 hoist.

The flushing system consists of the A3PN - 700 triplex mud pump (Q = 2562 - 1140 $l.min^{-1}$, p = 11.3 - 25.5 MPa) with its own diesel engine, three mud tanks (30 m^3) fitted with vibrating sieves (SVU-60) and mixer units and hydrocyclones (D- Sonder (GANZ) desander and D-Sitter declayer (GANZ)), piping and hydraulic flushing mixer.

This drilling rig enables a maximum thrust of 56-65 kN and a speed ranging from 70 to 120 rpm.

On 15th May 2007, an exchange of drilling rigs took place in order to overcome a complex geological situation and finally to complete the drilling of the defined final depth of the exploratory borehole. This replacement of the WIRTH B4 A drilling rig with the DIR 5519 SBS drilling rig was requisite.

2.3. Utilisation of the submersible motors and the MWD system during the exploratory drilling of PVGT - LT1

2.3.1. Bottom Hole Assembly - BHA

The problematic section with a very marked natural distortion was drilled using the submersible motor in the presence of the above-mentioned German service company, Directional Drilling Service. Using this method, the rotary motion of the drilling bit caused by fluid pressure during the flushing circulation is induced by a submersible motor positioned above the drilling bit, while the continuous communication between the borehole bottom and the surface is provided by the MWD system.

The service company supplied a special bottom hole assembly (Figure 7) consisting of a submersible motor (4 ¾" Bico P 150 XL Motor 1.83°), an oblong reducer and the MWD system (referred to in *Table 9*). Other elements in the assembly of the drilling rig such as drilling rods (*Table 10*), stabilisers and weights were original and were used in rotary drilling.

Currently, drilling with the submersible motor can be considered as a progressive method, used primarily for the "intentional" rectification of boreholes (i.e. directed drilling, horizontal drilling, multilateral drilling).

The foremost important role in the Bottom Hole Assembly is played by an auxiliary diverting tool – the oblong reducer - which is located above or below the submersible motor. It induces the diverting strength on the drilling bit which is oriented in the desired direction, which therefore means that the oblong reducer is used for the precise angling of the drilling rig in the specified direction.

In our case this was an attempt to reduce the deviation of 7.3° from the vertical at a depth of 1,110 m to the minimum possible deviation and to maintain it to the final depth of the borehole. This goal was achieved. In the uncased section of the borehole (852.5 to 2,111.2 m) the deviation varied within the limits of 1.5° to 5.8°.

2.3.2. Ongoing measurement in the borehole during drilling – the MWD system

The MWD system (Measurement While Drilling), included in the Bottom Hole Assembly, due to the measuring apparatus it contains (consisting of the actual measuring part, allows, the receiver of measured values, section for the transfer of data to the surface and to the surface recording device), to monitor the geometry of the borehole (the deviation and the direction of the borehole) and the tool-face (the orientation of the oblong reducer in the borehole) and additionally allows the transmission of data concerning the status of to the surface the borehole in real time (on the monitor of the computer on the drilling site).

This method of transmitting information (using impulses) from the borehole to the surface is implemented by pressure pulse telemetry, i.e. by a flushing stream. Impulses are generated by placing an adjustable barrier in the route of a flushing stream (in our case the drilling bit nozzle), which regulates the flow of flushing from the drilling rig to the annular ring.

Measured data are recorded to the memory of the device and transmitted to the surface in the form of resistance curves from different depths and subsequently evaluated by technicians (Figure 8).

Table 9 Utilisation of the Bottom Hole Assembly during the drilling of PVGT-LT 1 in the 1,137 – 2,053 m section

Section	Type	Number of items	Ø O.D. (mm)	Length of the section (m)
Drilling bit 6"	Smith Bit	1	152.00	0.20
Submersible motor 4 3/4"	Bico P 150	1	120.50	5.46
Connecting link 4 3/4"	Restrictor sub	1	120.50	0.39
Weights 4 3/4"	NM HWDP	1	120.50	9.13

Connecting link 4 3/4"	Pin x Pin Sub	1	120.50	0.40
MWD 4 3/4"	Pulser - Sub	1	120.50	1.91
Weights 4 3/4"	Drill Collar	6	120.50	48.56
Sheers 4 3/4"	Mech-Hydraulik Jar	1	120.50	4.01
Weights 4 3/4"	Drill Collar	4	120.50	33.72
Total lengths				**103.78**

Table 10: Drilling rods utilised during the drilling of individual intervals of the borehole using the DIR 5519 SBS drilling rig

Interval in accordance with the measured depth	Drilling rods (")	Diameter of rods (mm)	Length of rods (m)	Quality level	Type of a screw link
1,137 – 1,852.6	3 1/2"	9.35	9	D	3 1/2" IF
1,852.6 – 2,111.2	2 7/8"	9.19	9	D	2 7/8" IF

The German service company, DDS, after the completion of the drilling works using the submersible motor, submitted to the contractor, INGEO a.s. Žilina, a final report in the English language concerning the course of the drilling of the PVGT - LT 1 exploratory borehole. This report will be attached to the technical section of this Final Report.

3. Special requirements (organisational, work safety, environmental; reclamation and recultivation) for the implementation of the PVGT - LT 1 borehole

3.1. Wear and tear on drilling tools

The level of wear and tear on drilling tools (i.e. drilling bits and diamond core bits) was inspected following the removal of each tool from the borehole in accordance with the IADC methodology (Figure 9).

In the case of rotary drilling three-roller drilling bits (with diameters of 12 ¼", 8 ½", 6 1/8" and 6") were utilised for the disintegration of the rock.

In the case of core drilling (both interval coring and the drilling of complex sections using GEOBOR S) diamond core bits, with diameters of 96 mm and 146 mm, were utilised.

The quantities of drilling tools used during the entire drilling are shown in *Tables 11* and *12.*

Table 11: Drilling tools used - WIRTH B4A

Drilling tools used with the WIRTH-B4A drilling rig

Section	Drilling tool	Ø (mm)	Number of units	Types
(10.3 m - 252.5 m)	Drilling bit	311	3	12 1/4" FM-37 Vunar 058 - USA
(252.5 m - 854 m)	Drilling bit	215.9	12	F2-37 8 1/2" ST - USA, 8 1/2" DGT-France, 8 1/2" EHP 43J- France
(854 m - 857 m)	HQ diamond core bit	96	1	
(852.5 m – 1,279 m)	Drilling bit	156	1	6 1/8" XR 15 TPS- USA
(1,279 m – 1,282 m)	HQ diamond core bit	96	1	
(899 m – 1,114 m)	Drilling bit	156	1	6 1/8" XR 15 T- USA
(915 m – 1,003. 8 m)	Geobor S diamond core bit	146	7	
(1,003. 8 m – 1,137 m)	Drilling bit	156	2	6 1/8" XR 40 PS- USA, 6 1/8" XR 15 T- USA

Table 12: Drilling tools used - DIR 55 SBS

Drilling tools used with the DIR 55 19 SBS drilling rig

Section	Drilling tool	Ø (mm)	Number of units	Types
(1,139.69m – 2,053 m)	Drilling bit	152	6	XR 15 PS, XR 20 TPS PF, XR 15T, XR 20T, XR 30 TPS PF, XR 20
(1,139.69m – 2,053 m)	Submersible motor	4 3/4"	6	BICO P 150 XL Motor
(1,147.67 m – 2,111.2 m)	Drilling bit	152	2	XR 20, XR 15 PG 0171

3.2. Rock sampling

Sampling of drill cuttings was carried out by the drilling crew on an ongoing basis at every 5 m during the drilling, from the initiation of the borehole to its final depth of 2,111.2 m. The final rock sample was taken at a depth of 2,110 m.

Drill cuttings (in a quantity of cca. 5 kg) were stored in high-density polyethylene bags, which were labelled with information concerning the location (Litoměřice) and the identification of the borehole (PVGT LT-1) and in regard to the depth at which the sampling of the drill cuttings was conducted (Figure 10).

Finally, all the samples collected of the drill cuttings and of the core were stored for archival purposes in the room determined by the client (Figure 11).

3.3. Staffing

The crew of the WIRTH B4-A drilling rig consisted of 4 employees per shift. From the commencement of the drilling the work was carried out on a 2-shift cycle (minimum 10 days of drilling followed by 5 days of rest for the drilling crew). These rest days, however, were frequently associated with the cementation rest, which was required for the cementation process. The longest time gap was over the Christmas holidays (18 days).

After the arrival of the DIR 5519 SBS drilling rig and the representatives of the German DDS service company, drilling work was carried out as a continuous operation (in 3-shift cycles) until the completion of the drilling. The operation of the DIR SBS 5519 drilling rig required 5 employees per shift. The DDS Company was represented by three technicians, of whom 1 or 2 were always present at the drilling site.

3.4. Documentation

All the documentation listed was available at the drilling site:

- regarding the *exploratory borehole* [Project of geological works, Technological Procedures and Technical Documentation of the Borehole, the Protocol instigating the borehole (Permission of the CBA, the Environmental Department of the Municipal Office and the Regional Office in Ústí nad Labem for carrying out the PVGT LT-1 exploratory borehole), the Protocol on the completion of the borehole (the Acceptance Protocol signed by the client and the contractor)

- regarding the *drilling rig* [Operation and maintenance manual for the WIRTH B4 (then later the DIR 5519 SBS) drilling rigs, Machine Logs, Inspection Log for the Electrical Equipment)

- regarding *all inspections carried out at the drilling site* (Inspection reports concerning electrical equipment, Protocols from the unannounced inspection by the Mining Office in Most, Minutes from the Inspection Days).

Records were kept in the Drilling Log indicating the progress of the work from the time of the arrival of the drilling rig and its assembly until its dismantling and removal. Concise records were kept concerning technical, technological, organisational and time data; the responsibility for their accuracy lay with the supervisor of the drilling rig.

3.5. Precautions in regard to environmental protection

Flushing fluids containing drill cuttings were deposited at landfills. Hazardous waste materials, such as used oil and oil-contaminated clothes (stored in the defined containers) were transported to the nearest vehicle centre in Bohušovice.

Operation of the drilling rig and its accessories was conducted using diesel fuel delivered to the drilling site by a tanker vehicle belonging to the Řepa Company at regular intervals (cca. 3,000 l, 3 x per week). The diesel was stored in the above-ground fuel tank (refuelling station), which held the machinery and the electrical equipment for the filling, storing and dispensing of fuel and was in compliance with the health and safety regulations and standards.

Fire extinguishers were always available at the specified locations at the workplace, i.e. by the drilling rig, in the fuel store and in the residential premises, together with fire-extinguishing means in accordance with the Fire Regulations issued for fieldwork sites. Collection tanks were placed in all locations where there was a possibility of oil leakage, i.e. under the drilling rig, the pumps and the propulsion units. "Perlite" and "Vapex" spreading was utilised for the prevention of soil and groundwater pollution.

3.6. Reclamation and recultivation work

Subsequent to the departure of the drilling rig, the concreted surface at the site of the PVGT - LT1 exploratory borehole was retained for the purpose of other required measurement activities (e.g. pumping tests). The remaining panel surfaces were dismantled and returned to their owner. The mud settling pond for the storage of flushing fluid and also the surrounding terrain were remodelled to their original state.

4. Rigging the PVGT – LT 1 borehole

4.1. The above-ground and underground parts of the rig at the PVGT - LT1 borehole

After the completion of the drilling works, the final section of the borehole (852.5 m – 2,111.2 m) remained uncased and uncemented (OPEN HOLE). Its long-term stability and access were ensured by the subsequent rigging of the borehole.

The PVGT - LT 1 borehole was fitted in its underground uncased section with a production casing and in its above-ground section with a borehole outset.

Production casing consisting of a string of steel 2 7/8" (casing) pipes was sunk into the borehole in the following sequence (from the bottom upwards):

- 0.30 m of guide rods with conical ends
- 100.69 m of full-pipe string
- 97.25 m of perforated pipe string
- 1,602.26 m of full-pipe string

To avoid the clogging of the filter holes by dirt and drilling debris, centralisers were placed at every 50 m on the exterior of the drilling string. The armoured logging cables (with a diameter of 9 mm) connected to the two thermal sensors were also attached to the outside of the pipes. Thermal sensors were located at depths of 850 m and 1,075 m. The production casing was fitted 25 m above the bottom of the borehole and was attached by a hinge to the borehole outset. The casing string terminated at a depth of 1,800.5 m.

The perforated section of the string called the FILTER is the most important item of the drilling equipment and is designed to ensure the circulation of the pumped water free of sand.

The most widely used filters are made from casing pipes by making longitudinal holes in them using an oxyacetylene burner. The perforated casing pipes with a diameter of 73 mm and a total length of 97.25 m that were sunk in the PVGT - LT1 borehole were made in the workshop of the same company that provided the rigging for the borehole.

The tubular filter with milled longitudinal perforation (Figure 12) was made in accordance with the specific requirements of the customer in regard to the length and the width of the perforations (the holes had a width of 3 mm and a length of 50 mm).

The outset of the borehole

Subsequent to the sinking of the production casing the mouth of the borehole was fitted with an outset (see Figure 13). It is a basic flange with a hinge, comprising:

- a 3" upright valve, enabling the connection of a hose for the water intake to the borehole
- a 3" side valve, enabling the connection of a hose as a water outlet from the borehole
- 2 x 10 mm holes, specially made for the exiting of the logging cables from the thermal sensors located on the outside of the borehole casing.

Subsequent to the overall outfitting of the borehole the flushing fluid was replaced with water and multiple rinsing (10 $l.s^{-1}$) was carried out through washing holes in the bottom area of the perforated casing, using direct circulation (water was pumped in through drilling rods and out through the annular ring), but there was also an indirect manner of circulation (in the opposite direction from the regular circulation). After this exchange had taken place the pressurised borehole was left to settle.

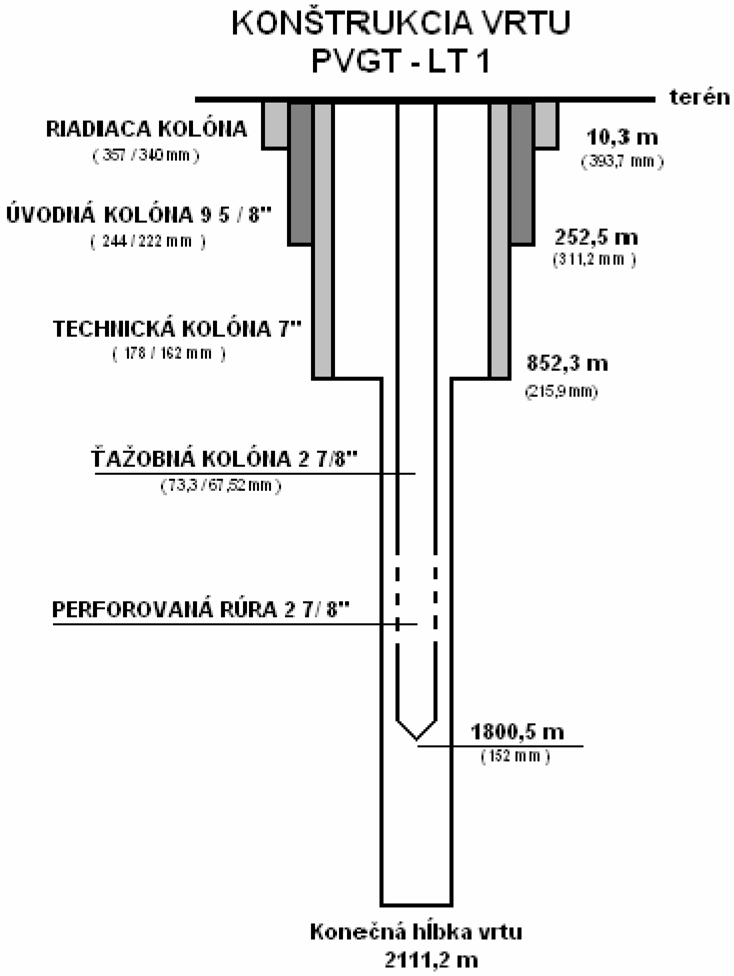
4.2. The structure of the PVGT - LT 1 exploratory borehole as of the 26th July 2007

The structure of the borehole, inclusive of the complex of information and of the following data:

- the diameters of the borehole at the individual depth intervals
- the diameters and the depth of recessing of the individual casing strings
- the final diameter and depth of the borehole
- the diameter of the cased production string and the depth of its fitting

are shown in the picture below and listed in *Table 13*.

The PVGT - LT 1 exploratory borehole of the structure shown below following the completion of drilling works and the removal of the drilling rig was subsequently sold on 26.7.2007 to the client – Geomedia s.r.o. in Litoměřice as a complete finished work.



Structure of the PVGT-LT 1 borehole

Table 13: Structure of the casing strings

Casing strings:

String	Diameter (")	Diameter (mm)	Depth measured (m)	Interval in accordance with the depth measured (m)	Material	Wall thickness (mm)	Type of thread	Weight (t)
RK		357	10.3	0 - 10.3		8		1.03
ÚK	9 5/8"	244.48	252.5	0 - 252.5	J - 55	8.94	API, 5CT, STC	14.64
TchK	7"	178.8	852.5	0 - 852.5	J - 55	8.05	API, 5CT, STC	28.66
ŤžK	2 7/8"	73	1,800.2	0 – 1,800.2	J - 55	6.05	API	17.12

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK

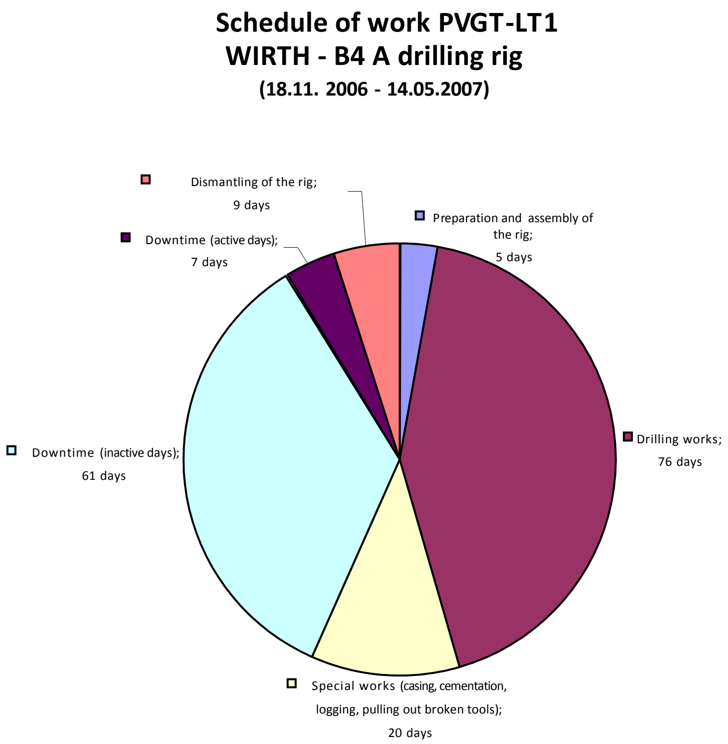
Through the implementation of the exploratory work at the PVGT - LT1 borehole the geological profile of the borehole was clarified and data was obtained concerning the temperature conditions to a depth of 2,111.2 m. In this respect, the borehole fulfilled the established goals and objectives.

The geological conditions cannot be altered; however it is possible to prevent needles problems in the borehole, using suitably chosen technical methods. Therefore for further work during the second stage (while drilling the 5 km boreholes) it will be necessary to carefully consider:

- the construction of the borehole (the establishment of I.TchK at a depth of cca. 1500 m; a final diameter for the borehole of at least 8 ½" in order that there should be a an option of altering the current borehole diameter of 6 1/8" in the event of any complications)
- the drilling mode (to ensure continuous measurement during drilling in any circumstances; to continuously monitor the trajectory of the borehole by using submersible motors and the MWD measurement systems attached to the Bottom Hole Assembly).
- the flushing system in complex sections of the borehole (subsequent to the classification of the shale in terms of its swelling, an appropriate flushing fluid should be selected with a sufficiently high density value).

Acceptance of the work: GEOMEDIA s.r.o (the client) and INGEO a.s. Žilina (the contractor) on 26.7.2007 in Litoměřice.

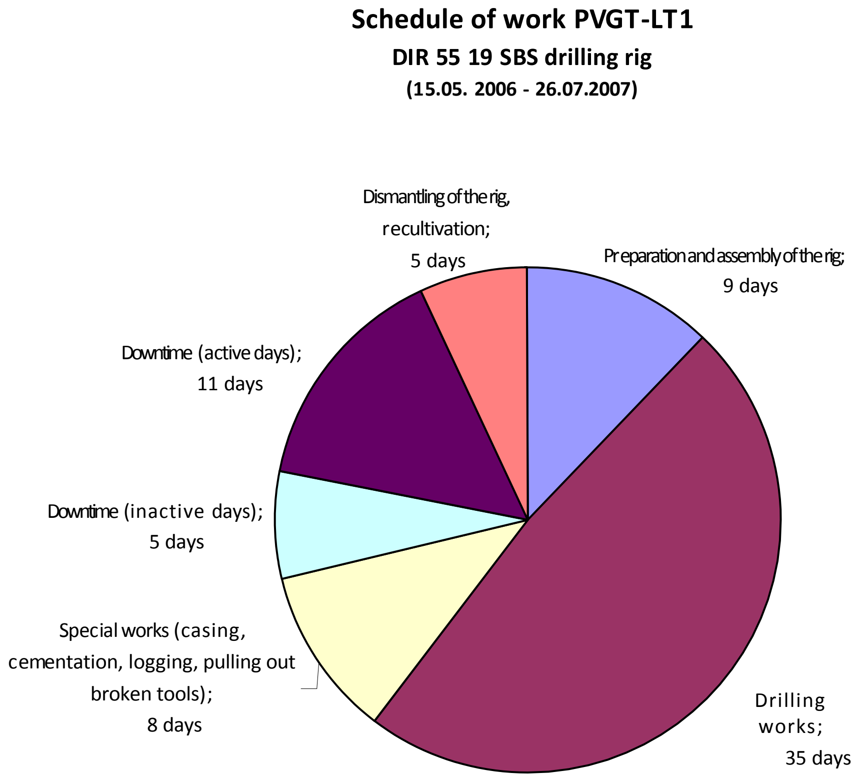
Appendix 1: Schedule of work on the PVGT - LT1 borehole using the WIRTH-B4A drilling rig



WIRTH B4A drilling rig

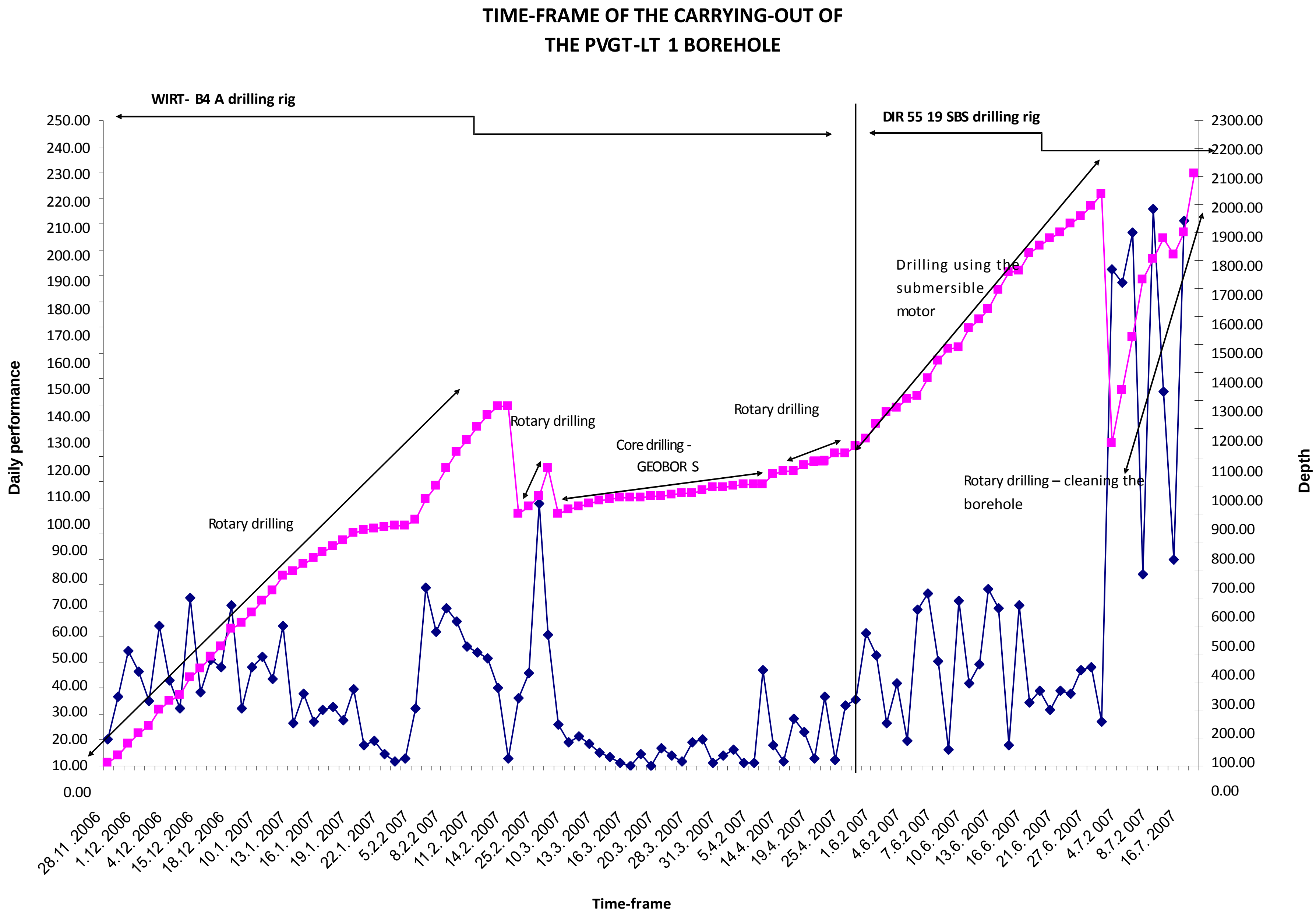
Schedule of works:	**Days**
Preparation and assembly of the rig	5
Drilling works	76
Special works (casing, cementation, logging, pulling out broken tools	20
Downtime (inactive days)	61
Downtime (active days)	7
Dismantling of the rig	9
Total:	**178**

Appendix 2: Schedule of work on the PVGT - LT1 borehole using the DIR 5519 SBS drilling rig



DIR 5519 SBS drilling rig

Schedule of works:	**Days**
Preparation and assembly of the rig	9
Drilling works	35
Special works (casing, cementation, logging, pulling out broken tools	8
Downtime (inactive days)	5
Downtime (active days)	11
Dismantling of the rig	5
Total:	**73**



Appendix 3: Time-frame of the carrying-out of the borehole - Chart

Appendix 4: Time-frame of the carrying-out of the borehole – Table

Date	Daily drilling performance (m)	Initial daily depth (m)	Final daily depth (m)	Diameter of the borehole (mm)	Drilling tool	Description of works
18.11.2006	**Arrival of the WIRTH B4A drilling rig**					
19.11.2006	Assembly of the rig					
20.11.2006						
21.11.2006						
22.11.2006						
23.11.2006	Rest time of the drilling crew					
24.11.2006						
25.11.2006						
26.11.2006						
27.11.2006						
COMMENCEMENT OF DRILLING WORKS						
28.11.2006	10.00	0.00	10.00	370.00	spiral	drilling
29.11.2006	26.60	10.00	36.60	311.00	Drilling bit 12 1/4"	Rotary drilling
30.11.2006	44.36	36.60	80.96			
1.12.2006	36.44	80.96	117.40			
2.12.2006	25.38	117.40	142.78			
3.12.2006	54.22	142.78	197.00			
4.12.2006	33.00	197.00	230.00			
5.12.2006	22.50	230.00	252.50			
6.12.2006	Logging in the 0 - 252 m section					
7.12.2006	casing + cementation (casing tubes 244/ 222), (cementation of the 0 – 252.5 m section, the volume of the cement mixture - 13 m3)					
8.12.2006	Cementation rest					
9.12.2006						
10.12.2006						
11.12.2006						
12.12.2006						
13.12.2006	Compression test					
14.12.2006	65.10	252.50	317.60	215.90	Drilling bit 8 1/2"	Rotary drilling
15.12.2006	28.40	317.60	346.00			
16.12.2006	41.00	346.00	387.00			
17.12.2006	38.00	387.00	425.00			
18.12.2006	62.00	425.00	487.00			
19.12.2006	22.38	487.00	509.38			
20.12.2006	Technical downtime (sealing the borehole)					
21.12.2006	Rest time of the drilling crew – Christmas holiday					
22.12.2006						
23.12.2006						
24.12.2006						
25.12.2006						

26.12.2006						
27.12.2006						
28.12.2006						
29.12.2006						
30.12.2006						
31.12.2006						
1.1.2007						
2.1.2007						
3.1.2007						
4.1.2007						
5.1.2007						
6.1.2007						
7.1.2007						
8.1.2007	Logging in the 0 - 509 m section					
9.1.2007	38.34	509.38	547.72	215.90	Drilling bit 8 1/2"	Rotary drilling
10.1.2007	42.28	547.72	590.00			
11.1.2007	33.48	590.00	623.48			
12.1.2007	54.02	623.48	677.50			
13.1.2007	16.50	677.50	694.00			
14.1.2007	28.00	694.00	722.00			
15.1.2007	17.00	722.00	739.00			
16.1.2007	21.60	739.00	760.60			
17.1.2007	22.90	760.60	783.50			
18.1.2007	17.50	783.50	801.00			
19.1.2007	29.40	801.00	830.40			
20.1.2007	7.80	830.40	838.20			
21.1.2007	9.80	838.20	848.00			
22.1.2007	4.50	848.00	852.50			
23.1.2007	casing (casing tubes 178/162)					
24.1.2007	Cementation of the 0 - 852 m section; the volume of the cement mixture - 21 m3					
25.1.2007						
26.1.2007	Cementation rest					
27.1.2007						
28.1.2007						
29.1.2007						
30.1.2007						
31.1.2007						
1.2.2007	Logging in the 0 - 852 m section					
2.2.2007	Technical downtime (repair of the defect)					
3.2.2007	1.50	852.50	854.00	156.00	Drilling bit 6 1/8	Rotary drilling
4.2.2007	3.00	854.00	857.00	96.00	HQ double core barrel	Core sampling using the HQ double core barrel
5.2.2007	22.00	857.00	879.00	156.00	Drilling bit 6 1/8"	Rotary drilling
6.2.2007	69.30	879.00	948.30			
7.2.2007	51.70	948.30	1000.00			
8.2.2007	61.00	1000.00	1061.00			
9.2.2007	56.00	1061.00	1117.00			
10.2.2007	46.00	1117.00	1163.00			
11.2.2007	44.00	1163.00	1207.00			
12.2.2007	41.50	1207.00	1248.5			

13.2.2007	30.50	1248.50	1279.00			
14.2.2007	3.00	1279.00	1282.00	96.00	HQ double core barrel	Core sampling using the HQ double core barrel
15.2.2007	Logging in the 0 - 1280 m section					
16.2.2007	Cementation of the 899 - 1103 m section; the volume of the cement mixture - 6 m3					
17.2.2007						
18.2.2007	Cementation rest					
19.2.2007						
20.2.2007						
21.2.2007						
22.2.2007	26.00	925.00	899.00	156.00	Drilling bit 6 1/8"	Rotary drilling
23.2.2007	36.15	961.15	925.00			
24.2.2007	Pulling out the broken tool (tap catcher)					
25.2.2007	101.85	1063.00	961.15	156.00	Drilling bit 6 1/8"	Rotary drilling
26.2.2007	51.00	1114.00	1063.00			
27.2.2007	Logging in the 0 - 1114 m section					
28.2.2007	Pulling out the broken tool (tap catcher)					
1.3.2007						
2.3.2007						
3.3.2007	Cementation of the 890 – 1048 m section; the volume of the cement mixture - 6 m3					
4.3.2007	Cementation rest					
5.3.2007						
6.3.2007						
7.3.2007						
8.3.2007						
9.3.2007	15.70	915.00	899.30	156.00	Drilling bit 6 1/8"	Rotary drilling
10.3.2007	9.30	924.30	915.00	146.00	Geobor S	Core drilling
11.3.2007	11.70	936.00	924.30	146 + 156	Geobor S + Drilling bit 6 1/8"	Drilling, reaming
12.3.2007	8.40	944.40	936.00	146.00	Geobor S	Core drilling
13.3.2007	5.40	949.80	944.40	146.00	Geobor S	Core drilling
14.3.2007	3.60	953.40	949.80	146.00	Geobor S	Core drilling
15.3.2007	1.00	954.40	953.40	146 + 156	Geobor S + Drilling bit 6 1/8"	Drilling, reaming
16.3.2007	0.15	954.55	954.40	146.00	Geobor S	Core drilling
17.3.2007	Technical downtime (replacement of the rope)					
18.3.2007	4.80	959.35	954.55	146.00	Geobor S	Core drilling
19.3.2007	0.25	959.60	959.35	146 + 156	Geobor S + Drilling bit 6 1/8"	Logging, drilling, reaming
20.3.2007	7.10	966.70	959.60	146.00	Geobor S	Core drilling
21.3.2007	4.00	970.70	966.70	146 + 156	Geobor S + Drilling bit 6 1/8"	Logging, drilling, reaming
22.3.2007	Rest time of the drilling crew					
23.3.2007						
24.3.2007						
25.3.2007						
26.3.2007						
27.3.2007	1.57	972.27	970.70	146 + 156	Geobor S + Drilling bit 6	Core drilling, reaming
28.3.2007	9.30	980.00	970.70	146.00	Geobor S	Core drilling
29.3.2007	10.20	990.20	980.00	146.00	Geobor S	Core drilling

30.3.2007	0.90	991.10	990.20	146.00	Geobor S	Core drilling
31.3.2007	4.20	995.30	991.10	146.00	Geobor S	Core drilling
1.4.2007	6.20	1001.50	995.30	146.00	Geobor S	Core drilling
2.4.2007	0.00	1001.50	1001.50	156.00	Drilling bit 6 1/8"	Rotary drilling
3.4.2007	0.00	1001.50	1001.50	156.00	Drilling bit 6 1/8"	Rotary drilling
4.4.2007	1.10	1002.60	1001.50	146.00	Geobor S	Core drilling
5.4.2007	1.20	1003.80	1002.60	146.00	Geobor S	Rotary drilling + logging
6.4.2007	Rest time of the drilling crew					
7.4.2007						
8.4.2007						
9.4.2007						
10.4.2007						
11.4.2007	Technical downtime (repair of the defect)					
12.4.2007	37.00	1040.80	1003.80	152.00	Drilling bit 6"	Rotary drilling
13.4.2007	8.00	1048.80	1040.80			
14.4.2007	1.70	1050.50	1048.80			
15.4.2007	18.20	1068.70	1050.50			
16.4.2007	Technical downtime (repair of the defect)					
17.4.2007	13.10	1081.80	1068.70	152.00	Drilling bit 6"	Rotary drilling
18.4.2007	Technical downtime (repair of the defect)					
19.4.2007	2.70	1084.50	1081.80	152.00	Drilling bit 6"	Rotary drilling
20.4.2007	26.90	1111.40	1084.50			
21.4.2007	0.00	1111.40	1111.40	156.00	Drilling bit 6 1/8"	Reaming
22.4.2007	2.20	1113.60	1111.40			Rotary drilling
23.4.2007	Pulling out the broken tool (tap catcher)					
24.4.2007						
25.4.2007	23.40	1137.00	1113.60	156.00	Drilling bit 6 1/8"	Rotary drilling
26.4.2007	Pulling out the broken tool (tap catcher)					
27.4.2007	Dismantling of the rig					
28.4.2007						
29.4.2007						
30.4.2007						
1.5.2007						
2.5.2007						
3.5.2007						
4.5.2007	Rest time of the drilling crew					
5.5.2007						
6.5.2007						
7.5.2007						
8.5.2007						
9.5.2007	Dismantling of the rig					
10.5.2007						
11.5.2007	**Departure of the WIRTH B4A drilling rig**					
12.5.2007	Rest time of the drilling crew					
13.5.2007						
14.5.2007						

Date	Daily drilling performance (m)	Initial daily depth (m)	Final daily depth (m)	Diameter of the borehole (mm)	Drilling tool	Description of works
15.5.2007	**Arrival of the DIR drilling rig**					
16.5.2007	Assembly of the rig					
17.5.2007						
18.5.2007						
19.5.2007						
20.5.2007						
21.5.2007						
22.5.2007						
23.5.2007						
24.5.2007	Rest time of the drilling crew					
25.5.2007						
26.5.2007						
27.5.2007						
28.5.2007						
29.5.2007	Flushing of the borehole					
30.5.2007	25.90	1165.59	1139.69	152.00	Drilling bit 6 “	Drilling using the submersible motor
31.5.2007	51.45	1217.04	1165.59			
1.6.2007	43.05	1260.09	1217.04			
2.6.2007	16.67	1276.76	1260.09			
3.6.2007	32.24	1309.00	1276.76			
4.6.2007	9.95	1318.95	1309.00			
5.6.2007	60.49	1379.44	1318.95			
6.6.2007	66.56	1446.00	1379.44			
7.6.2007	40.60	1486.60	1446.00			
8.6.2007	6.46	1493.06	1486.60			
9.6.2007	64.03	1557.09	1493.06			
10.6.2007	32.06	1589.15	1557.09			
11.6.2007	39.12	1628.27	1589.15			
12.6.2007	68.73	1697.00	1628.27			
13.6.2007	61.01	1758.01	1697.00			
14.6.2007	7.93	1765.94	1758.01			
15.6.2007	62.06	1828.00	1765.94			
16.6.2007	24.60	1852.60	1828.00			
17.6.2007	Technical downtime (replacement of drilling rods)					
18.6.2007	28.90	1881.50	1852.60	152.00	Drilling bit 6 "	Drilling using the submersible motor
19.6.2007	21.94	1903.44	1881.50			
20.6.2007	Technical downtime (broken shaft)					
21.6.2007	28.97	1932.41	1903.44	152.00	Drilling bit 6 "	Drilling using the submersible motor
22.6.2007	27.69	1960.10	1932.41			
23.6.2007	Technical downtime (broken shaft)					
24.6.2007						
25.6.2007						

26.6.2007	37.36	1997.46	1960.10	152.00	Drilling bit 6 "	Drilling using the submersible motor
27.6.2007	38.34	2035.80	1997.46			
28.6.2007	17.20	2053.00	2035.80			
29.6.2007	Technical downtime (broken shaft)					
30.6.2007						
1.7.2007						
2.7.2007						
3.7.2007	192.18	1339.85	1147.67	152.00	Drilling bit 6 "	Rotary drilling – cleaning the borehole
4.7.2007	187.37	1527.22	1339.85			
5.7.2007	206.89	1734.11	1527.22			
6.7.2007	74.43	1808.54	1734.11			
7.7.2007	Technical downtime (broken shaft)					
8.7.2007	215.77	2024.31	1808.54	152.00	Drilling bit 6 "	Rotary drilling - cleaning the borehole
9.7.2007	Technical downtime (repair of drilling equipment)					
10.7.2007						
11.7.2007	logging - Aquatest (0-1875 m)					
12.7.2007	logging - Geo Log (0-1820 m)					
13.7.2007	144.79	2026.79	1882.00	152.00	Drilling bit 6 "	Rotary drilling - cleaning the borehole
14.7.2007	logging - Geo Log (0- 2016 m)					
15.7.2007	80.00	1900.00	1820.00	152.00	Drilling bit 6 "	Rotary drilling - cleaning the borehole
16.7.2007	211.20	2111.20	1900.00	152.00	Drilling bit 6 "	Cleaning the borehole + rotary drilling
17.7.2007	0.00	1822.81	1822.81	146.00	Geobor S	Core drilling
COMPLETION OF DRILLING WORKS						
18.7.2007	Cleaning of the borehole (0 – 1825.72 m)					
19.7.2007	Rigging the borehole [casing the borehole using 2 7/8" tubing (0 – 1800.5 m)] and equipping the mouth of the borehole with a fitting					
20.7.2007						
21.7.2007	Replacement of the flushing fluid with a clean water					
22.7.2007	Dismantling of the rig					
23.7.2007						
24.7.2007						
25.7.2007	**Departure of the DIR drilling rig**					
26.7.2007	Acceptance of the work by the client					

Figure 1: The WIRTH B4-A drilling rig

Figure 2: 7" Tubes used for casing the PVGT – LT1borehole

Figure 3: Cementation unit for pumping the cement mixture

Figure 4: Core from the 1279 – 1282 m section

Figure 5: Core drilled using the GEOBOR S double core barrel

Figure 6: The DIR 5519 SBS drilling rig

Figure 7: Bottom Hole Assembly

Figure 8: Continuous measurement of any deviation in the direction of the borehole during drilling (the DDS Company)

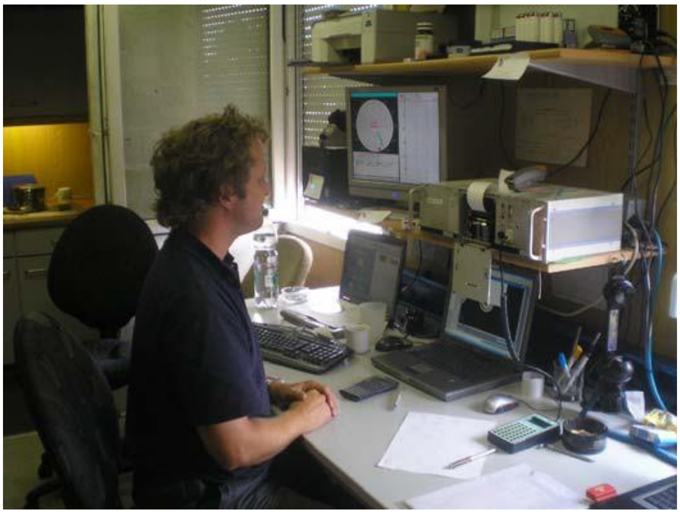


Figure 9: New and worn drilling bit

Figure 10: Rock sample from the depth of 2000 m

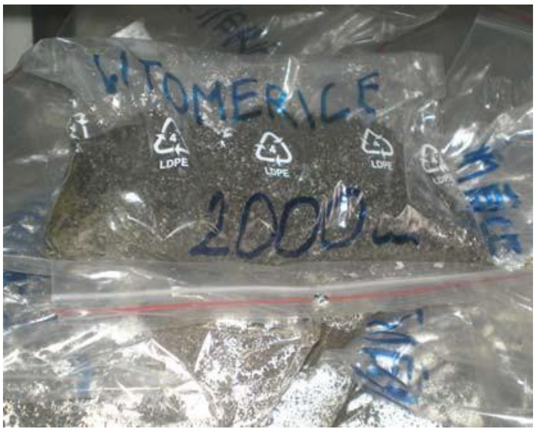


Figure 11: Documentation of the samples taken from the entire drilled section of the PVGT-LT1borehole

Figure 12: Filter – perforated casing tubes

Figure 13: Outset of the PVGT – LT1 borehole