OPEN PIT SLOPE DESIGN
PREFEASIBILITY STUDY
MATAWINIE PROJECT - TONY BLOCK (GRAPHITE)
SAINT- MICHEL-DES-SAINTS, QUEBEC

Report No. L-17-1980

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NMG

NOUVEAU MONDE GRAPHITE

Foster the Future, Drive Innovation

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Executive Summary

This report covers the preliminary design recommendations for an open pit mine in the Matawinie Regional County located about 6 km southwest of the community of Saint-Michel-des-Saints in Lanaudière, Quebec which is planned to be excavated for Nouveau Monde Graphite. The project involves the open pit excavation of a north-south trending ore body within the Tony Block property. The proposed open pit will be about 2200 m long and have a maximum width of about 200 m and a maximum depth of 140 m. The ore body is composed of a southeast dipping graphitic zone of various graphite bands and lenses contained within a massive paragneiss host rock which will be exposed in the long east and west pit walls.

The structural geology surrounding the ore body was studied by logging the cores of ten (10) oriented boreholes and by reviewing previous exploration borehole logs drilled in 2015 and 2016 as well as information recorded in the literature. The pit wall design is primarily controlled by the massive paragneiss host rock. The surrounding rock formation is expected to generally have excellent rock quality designation (RQD) values, except in shallow local thin zones at the interface between the overburden and the rock or where faults are located. The bedding varies around the deposit, but it generally dips steeply to the south-east making the west pit wall the most susceptible to local rock failures.

Based on all the information obtained and analyzed for the host rock of the Tony Block deposit, for dry conditions, an overall slope of 55° is considered acceptable for the West Wall (Hanging wall) oriented from 30° (NE) to 210° (SW) and an overall slope of 60° is considered acceptable for the East Wall (Footwall) oriented from 210° (SW) to 30° (NE).

The recommended pit slopes are outlined in the following table.

Ultimate Slope Design Recommendations

Wall	Wall Azimuth	Maximum Vertical Bench Separation (m)	Bench Face Angle (°)	Inter-Ramp Angle (°)	Catch Bench (m)	Overall Pit Slope (°)
West Wall (Hanging wall)	30° (NE) to 210° (SW)	20	75	60	7	55
East Wall (Footwall)	210° (SW) to 30° (NE)	20	75	69	6.2	60

As mentioned, the pit wall stability is dependent on dry pit slopes which can be achieved by depressing the water table. Any seepage zones into the pit walls must be treated by installing long drainage holes laid out in a fan-like array to dewater the longest wall slope section possible (with one set-up of drainage holes).

Blasting a free face perpendicular to the pit wall is preferable to avoid back-break and widening of the joint systems parallel to the pit slope. Pre-shearing techniques and scaling will reduce risks of local failures.

Continuous geologic mapping of the structural discontinuities of the pit slopes as the pit deepens is imperative to identify any major steeply dipping (unfavourable) discontinuities or low shear strength discontinuities (e.g. graphite joints) that could increase the risk of slope instability.

1 INTRODUCTION

Met Chem Inc. mandated Journeaux Assoc., a division of LAB JOURNEAUX INC., to assist with the pit slope design for the Matawinie Project owned by Nouveau Monde Graphite. This report covers the preliminary geotechnical investigation for a proposed open pit (TONY BLOCK) to be excavated on the west side of Lac Aux Pierres situated 6 km southwest of the community of Saint-Michel-des-Saints in Lanaudière, Quebec, Canada. Tony block property is centered at 46.63°N and 73.96° W and covers 71.8 km^2. Figure 1-1 presents the mine site location.

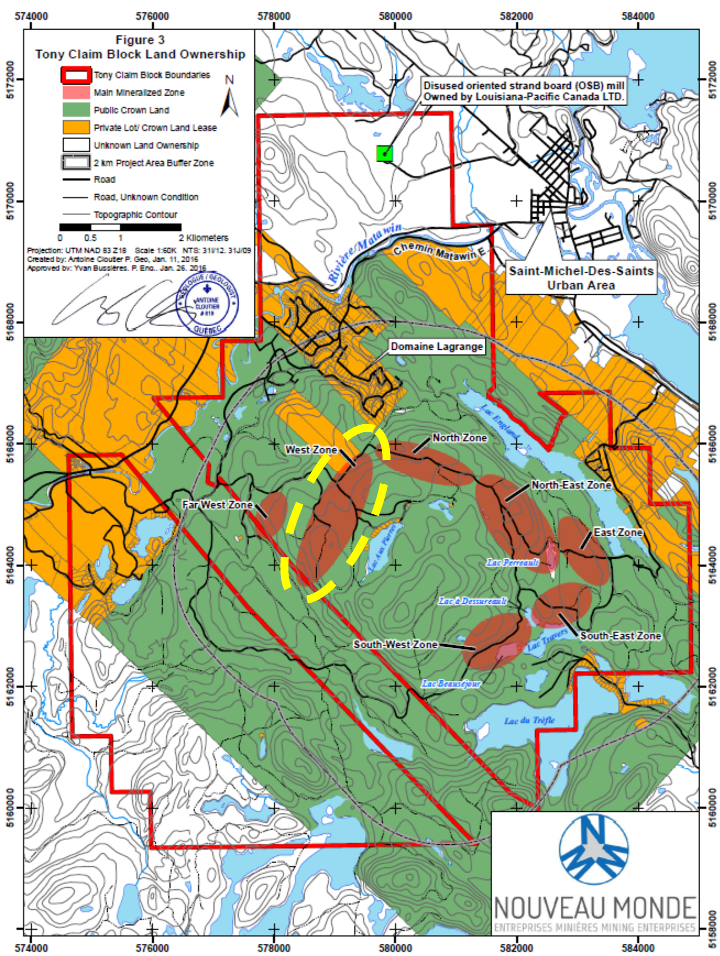


Figure 1-1: Map showing site location

Mining the graphite deposit involves the excavation of a generally north-south trending open pit to a depth of about 140 m over a maximum 200 m wide by about 2200 m long zone to recover rich graphite bands and lenses (Figure 1-2) within a hosting paragneiss rock formation.

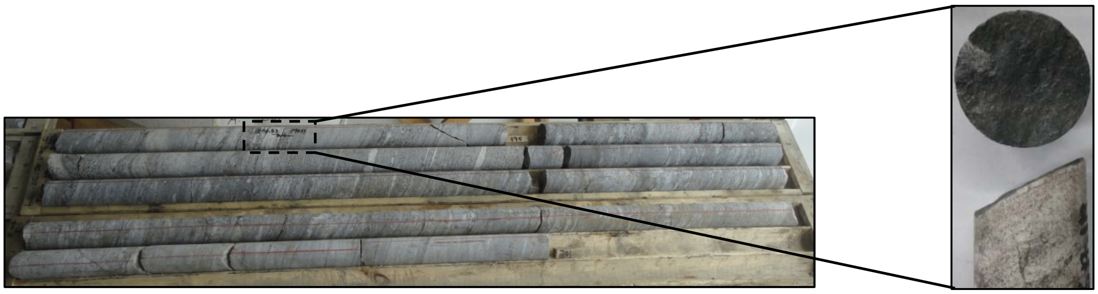


Figure 1-2: Typical graphite core samples from Tony Block deposit (Borehole – TO-17-119).

The proposed open pit shape is oval following the standard practice for open pit mines. Its width is irregular with the south end being narrower than the north end. Due to the nature of the ore body being concentrated in bands and lenses, the irregular width of the pit reduces costs by avoiding unnecessary waste rock excavation.

2 OBJECTIVES

The main objective of the study is to assess the structural geologic features of the rock formation that will affect the stability of the ultimate pit walls of Tony Block Graphite Deposit in order to recommend stable and economical pit slopes.

3 METHOD OF WORK

Sixty-eight (68) exploration boreholes were drilled at the proposed open pit area in 2015 and 2016 (shown on Figure 3-1).

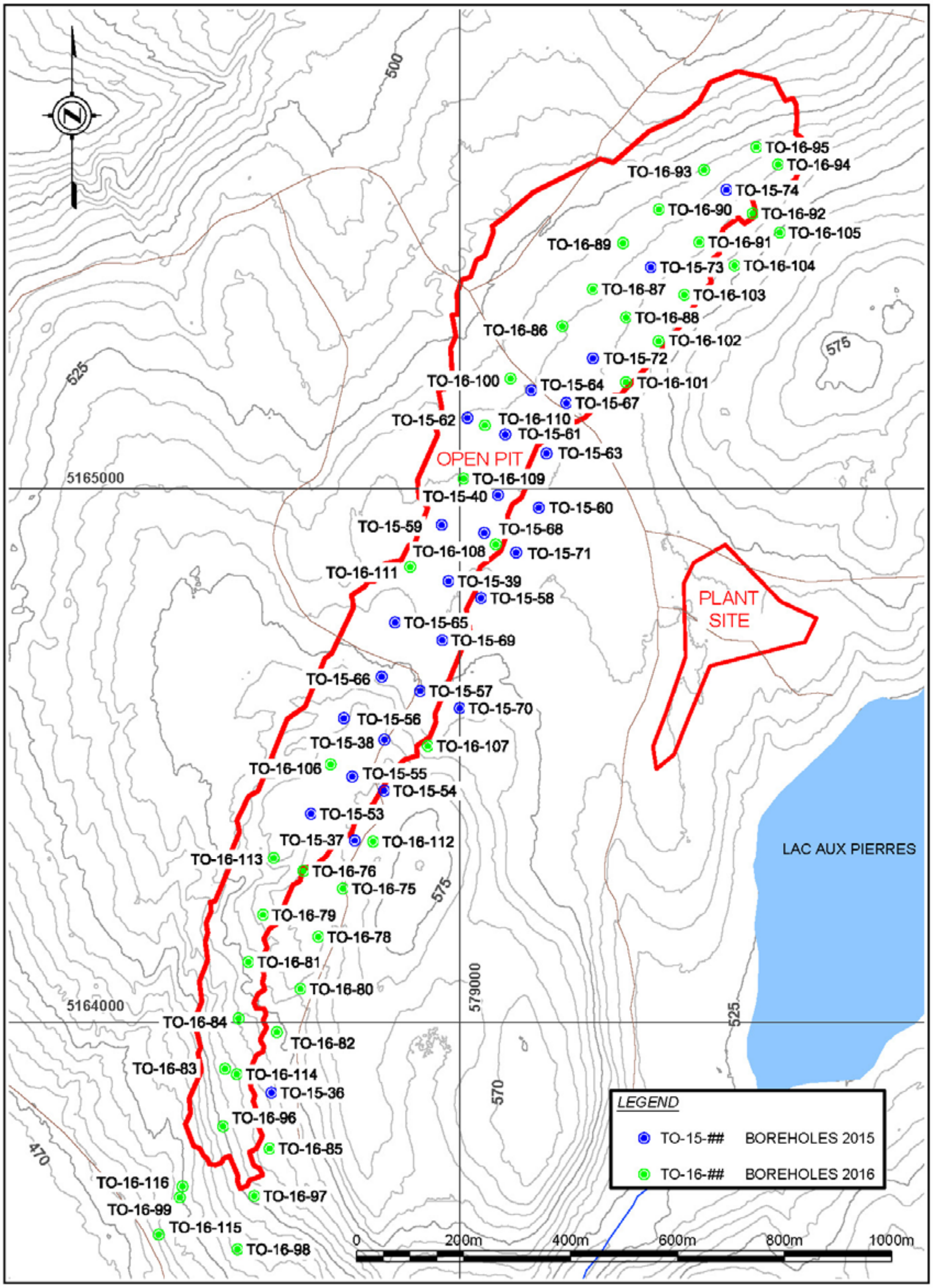


Figure 3-1: 2015 and 2016 exploration boreholes.

Most of the exploration boreholes were inclined at 45° with no orientation identified on the cores recovered. The data received from the exploration boreholes were analyzed by inspecting the photos of the boxes of the rock cores and reviewing the percentage of recovery and RQD. Rock core samples were selected by the personnel of Journeaux Assoc. from the rock shed located in the storage yard at Saint-Michel-des-Saints. The rock cores obtained from the 2015 and 2016 exploration boreholes by Nouveau Monde were stored outside and froze during the winter time. Table 3-1 lists the 2015 and 2016 exploration borehole sections from which samples were selected by Journeaux Assoc. for laboratory testing.

Table 3-1 : List of sections from the 2015-2016 exploration boreholes from which samples were selected for preliminary laboratory testing.

Borehole ID	Box ID number Inspected	Core Size	Depth along Borehole (m)	Dip (°)	Azimuth (°)	Location along Pit
TO-16-84	26	NQ	118	45.0	290.0	South *
TO-16-82	54	NQ	232	46.0	292.0	South
TO-15-37	40	BTW	174	45.5	293.0	South
TO-15-65	21	BTW	94	45.4	293.0	Middle
TO-15-71	41	NQ	177	45.3	297.8	Middle
TO-15-39	24&34	BTW	116 & 159	44.8	293.0	North **
TO-15-69	28	NQ	130	44.3	283.3	North

* Shallow Overburden
** Deep Overburden

In May 2017, an additional ten (10) geotechnical core-oriented boreholes (TO-17-117 to TO-17-126) were drilled under the supervision of Journeaux Assoc. (Appendix A). These boreholes were located along the exterior perimeter of the pit walls in order to assess the structural geologic characteristics of the rock formation controlling the pit slopes. Geotechnical core logging, including logging of the known dips and orientations of the structural geologic features was carried out. Rock cores were selected for additional laboratory testing.

4 BACKGROUND

4.1 General

The Tony Block property overlies a graphite-rich deposit located approximately 6 km southwest of the town of Saint-Michel-des-Saints within Lanaudière Administrative Region, Province of Quebec, Canada, which is about a 120 km drive north of the city of Montreal. The Tony Block property is accessible by a 4x4 or all-terrain vehicle (ATV) along a logging road accessible from the town of Saint-Michel Des Saints.

4.2 Topography

The proposed graphite pit will be excavated over a hilly terrain (see Figure 4-1). The elevation, within the proposed pit limits, generally varies between 505 m and 565 m. The ground surface in the center zone of the pit is at a higher elevation, i.e. 565 m, and slopes towards the north and south extremities which are at elevation 505 m and 510 m, respectively.

4.3 Seismic Environment

According to Natural Resources Canada / Earthquake Hazard (NBC 2015), the peak ground acceleration (PGA) in the zone where the pit is to be excavated is 0.122 g. This value represents a 2% probability of exceedance in 50 years. This value serves to define the horizontal acceleration in the slope stability analysis models considering seismic loading conditions.

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

July 03, 2017

Site: 46.6688 N, 73.9572 W   User File Reference: Saint Michel Des Saints

Requested by: ,

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	**Sa(0.2)**	Sa(0.3)	**Sa(0.5)**	**Sa(1.0)**	**Sa(2.0)**	**Sa(5.0)**	**Sa(10.0)**	**PGA (g)**	**PGV (m/s)**
0.162	0.212	**0.198**	0.165	**0.133**	**0.079**	**0.042**	**0.012**	**0.0045**	**0.122**	**0.117**

Notes. Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s²). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. ***These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.***

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.030	0.073	0.107
Sa(0.1)	0.043	0.101	0.144
Sa(0.2)	0.043	0.098	0.137
Sa(0.3)	0.036	0.083	0.115
Sa(0.5)	0.028	0.066	0.092
Sa(1.0)	0.015	0.038	0.054
Sa(2.0)	0.0061	0.019	0.028
Sa(5.0)	0.0013	0.0044	0.0070
Sa(10.0)	0.0007	0.0019	0.0030
PGA	0.024	0.057	0.082
PGV	0.019	0.051	0.076

References

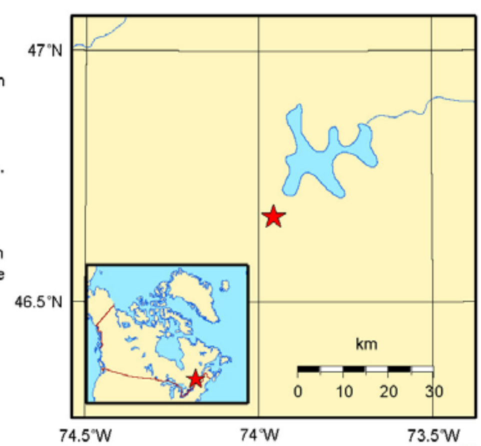
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites *www.EarthquakesCanada.ca* and *www.nationalcodes.ca* for more information

Aussi disponible en français



Natural Resources Canada   Ressources naturelles Canada

Canada

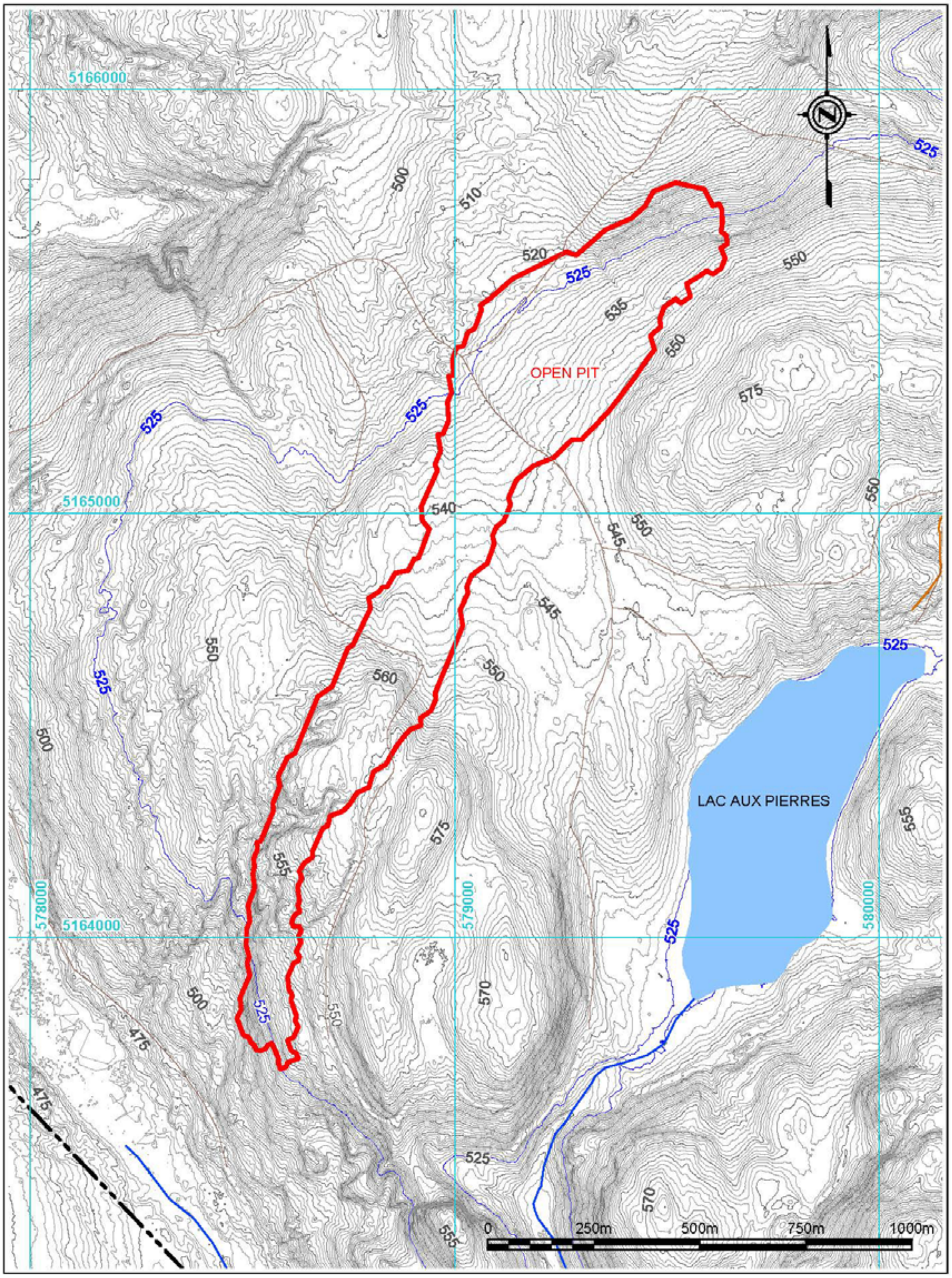


Figure 4-1: Topographic map showing the elevation contours in the proposed open pit zone.

5 HYDROGEOLOGY

The north-south trending Tony Block deposit is located west of Lake Aux Pierres at an elevation of approximately 25 m above the lake water level near the center zone of the proposed open pit and at approximately the same elevation with the lake on the north and south zones of the proposed open pit (Figure 4-1). The topography surrounding the deposit indicates that the surface water drains from east towards west towards the open pit as on the east side of the proposed pit the ground slopes north-west and south-west from the two hills located between Lake Aux Pierres and the Tony Block deposit.

Based on exploration drilling findings, the overburden in the north zone of the proposed open pit is generally deep, reaching up to 35 meters, while in the south zone the rock is encountered at a few meters below the ground surface.

To prevent surface water drainage from entering the open pit, low berms can be used to redirect drainage water away from the pit (Figure 5-1).

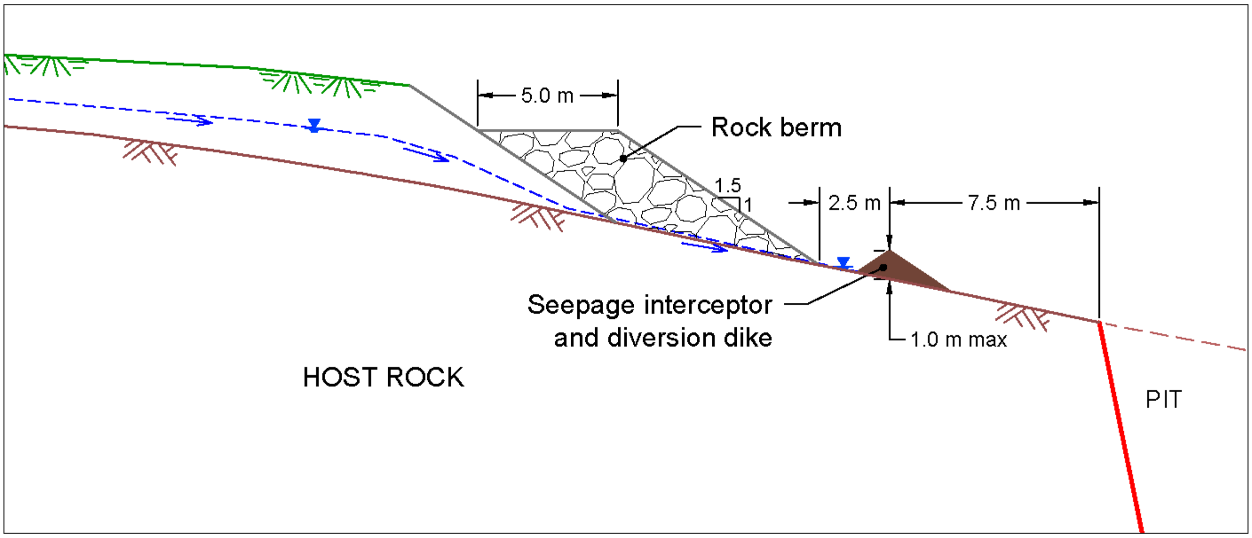


Figure 5-1: Typical cross-section showing a berm for diverting water.

As the pit is deepened and the bottom pit elevation falls below the Lake Aux Pierres, the groundwater must be properly managed. Permeable zones, such as fault zones, will be critical locations for water flow. A discussion on site dewatering is presented in Section 10.4. The pit slope design, presented in this report, is based on dry bedrock conditions (dry pit walls).

Figure 5-2 presents a contour map of the bedrock elevations within the proposed pit zone (prepared using the available exploration borehole data). Much of the water is expected to flow with gravity along the low permeable bedrock surface.

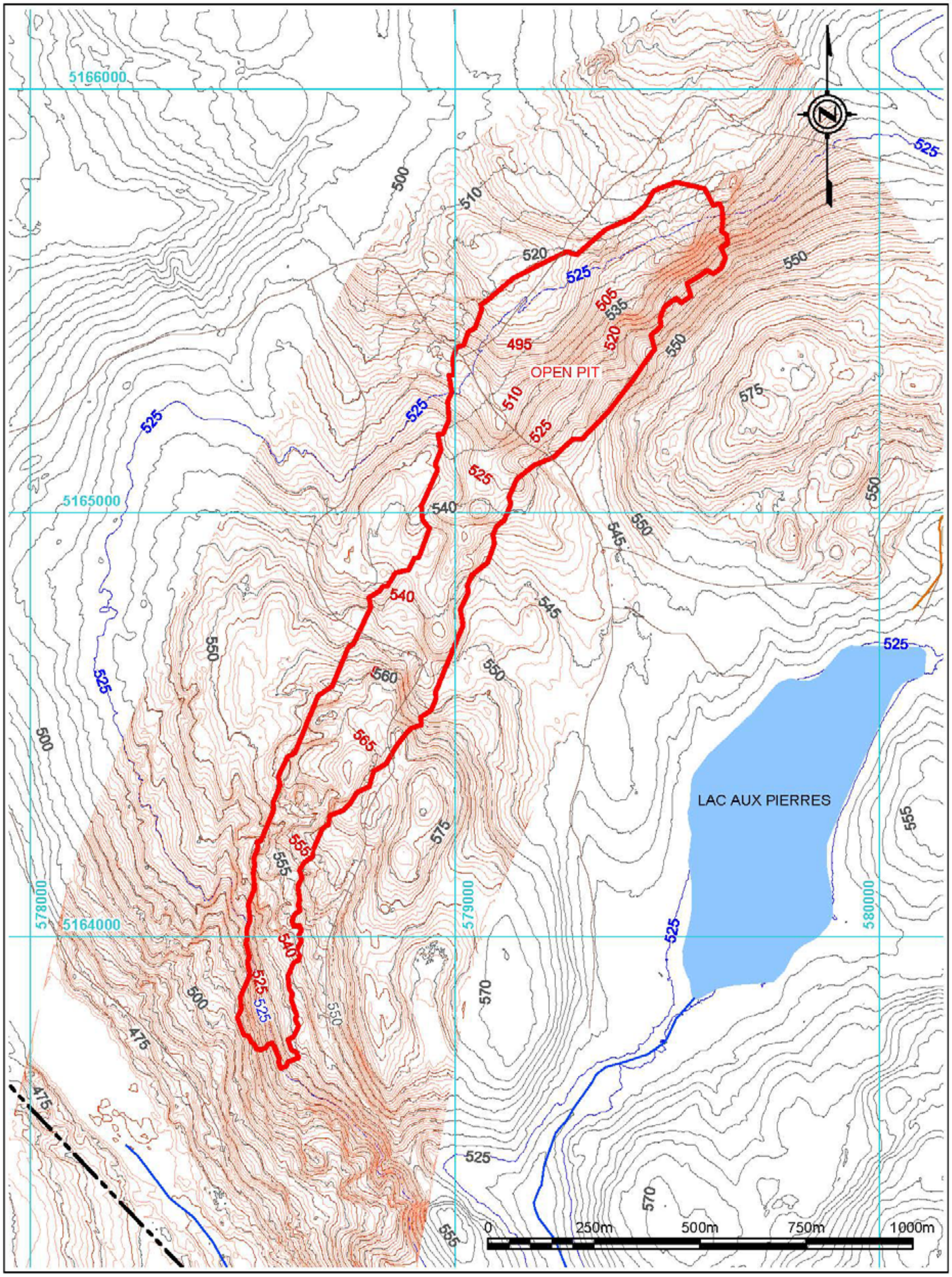


Figure 5-2: Bedrock elevations contours within the proposed open pit.

5.1 Ground water table measurements (SNC-LAVALIN)

Ground water table was measured by SNC-Lavalin on December 14 and 15, 2016. The elevations and depths of the ground water table in a number of boreholes are shown in Table 5-1.

Table 5-1 : Ground Water Table measurements by SNC-Lavalin, December 2016.

Borehole	Ground Elevation (m)	Water Elevation (m)	Water depth (m)
TO-15-37	571.000	553.20	17.80
TO-15-38	566.000	546.34	19.66
TO-15-54	571.000	568.11	2.89
TO-15-55	569.000	562.23	6.77
TO-15-56	563.000	556.71	6.29
TO-15-57	551.000	546.00	5.00
TO-15-58	546.000	545.51	0.49
TO-15-64	535.000	533.79	1.21
TO-15-65	547.000	546.06	0.94
TO-15-67	539.000	536.89	2.11
TO-15-72	539.000	534.99	4.01
TO-15-73	537.000	533.45	3.55
TO-15-74	536.000	529.26	6.74
TO-16-78	567.000	546.37	20.63
TO-16-84	542.000	515.26	26.74
TO-16-85	537.000	502.88	34.12
TO-16-86	535.000	533.41	1.59
TO-16-87	533.000	533.65	-0.65
TO-16-88	539.000	533.75	5.25
TO-16-91	538.000	534.80	3.20
TO-16-92	542.000	539.47	2.53
TO-16-93	531.000	523.51	7.49
TO-16-96	526.000	507.46	18.54
TO-16-86	534.783	533.96	0.82
TO-16-98	510.888	477.23	33.66
TO-16-101	542.310	539.36	2.95
TO-16-102	543.220	539.78	3.44
TO-16-103	542.040	538.40	3.64
TO-16-104	546.420	542.31	4.11
TO-16-107	556.570	546.98	9.59
TO-16-112	570.330	550.67	19.66

5.2 Hydraulic Conductivity (SNC-LAVALIN)

Slug tests were performed by SNC LAVALIN in 2016 in three boreholes (TO-16-86, TO-15-65, and TO-15-58). The hydraulic conductivity of the rock formation was estimated between 2.60E-07 m/sec and 2.10E-05 m/sec. Preliminary results from Packer tests done in boreholes TF-16-54 (depths 70 to 120 m) and TF-16-100 (depths 30 to 70 m), indicated hydraulic conductivities of approximately similar to one order lower (compared to the slug tests) ranging between 2.30E-08 and 3.70E-06 m/sec. Lower hydraulic conductivities were generally obtained at greater depth.

NMG has planned to carry additional in-situ testing (in 2017) of hydraulic conductivity of the rock formations as well as a pumping test to further examine its hydrological properties. The results of the 2017 planned hydrogeology program were not available at the time of issue of this report.

6 GEOLOGY

6.1 Regional Geology

The Tony Block property is located in the southwestern part of the Grenville geological province (

Figure **6-1**). Rivers et al. (1989) divided the Grenville into three tectonic belts (Autochthonous, Parautochthonous and Allochthonous). The Tony Block is located mainly within the Morin Terrane part of the Allochthonous monocyclic belt belonging to the Grenville Supergroup. On the west it is bounded by the Mont-Laurier Terrane that is separated from the Allochthonous monocyclic belt by a large inverse fault known as the Labelle- Kinonge Shear Zone (Figure 6-2).

The main host rock of the Tony Block property is a paragneiss rock, which is derived from the metamorphism and deformation of the original politic sedimentary rocks that took place during the Grenville Orogeny. During prospecting, some slivers of amphibolite were observed in the central part of the property. In the northwestern and southeastern parts, a charnockite orthogneiss wraps the main mineralized zones.

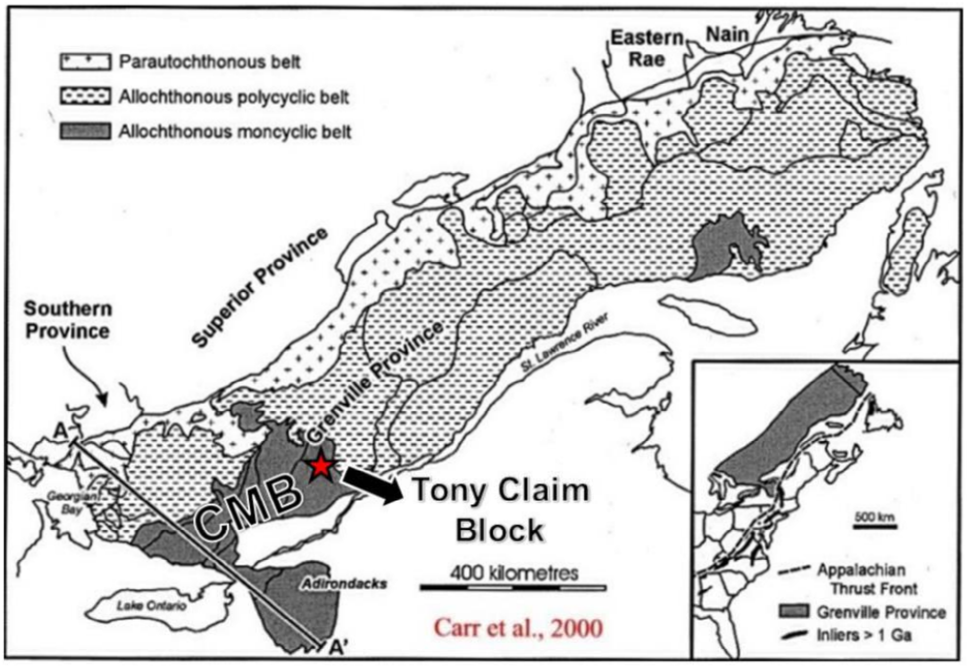


Figure 6-1: Geological province location

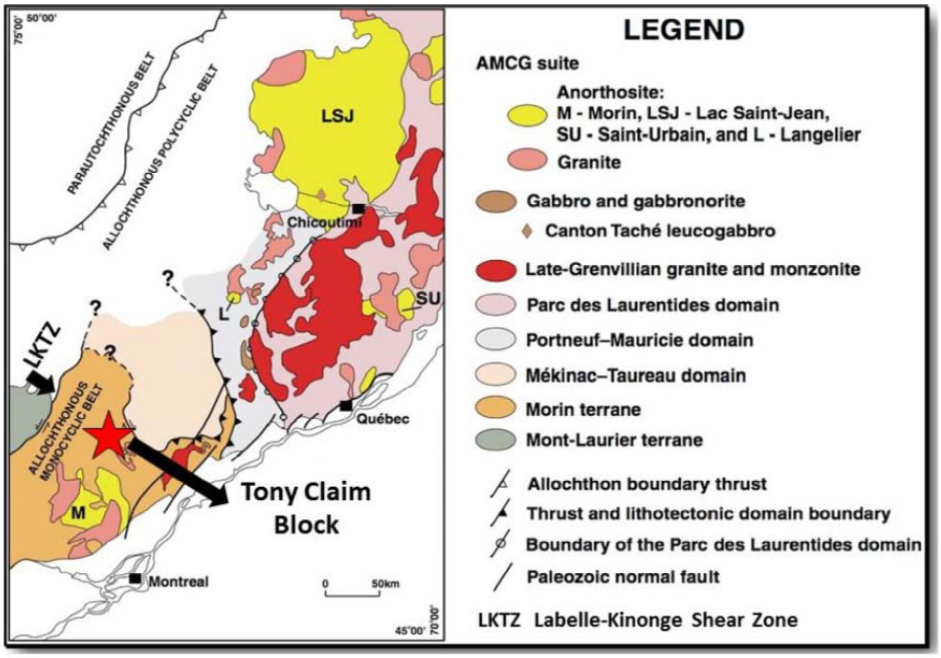


Figure 6-2: Close up view of the Tony Block within the Grenville Province

6.2 Local Geology

6.2.1 Overburden

The overburden covering the ore body varies between 2 m and 48 m in depth along the 2.4 km long pit. Therefore the pit can be distinguished by the shallow overburden zone situated in the south and the deep overburden zone situated in the north.

In the south, the shallow overburden depth varies between 2 m and 18 m with a dominant median depth of about 6 m that covers the first 1.4 km of the pit. In the north, the deep overburden depth varies between 2 m and 48 m with an average depth of about 25 m that extends over the last 1.0 km of the pit.

Figure 6-3 presents the depths of the overburden soil layer as encountered in the exploration and geotechnical boreholes drilled in 2015, 2016 and 2017 at the Block Tony property.

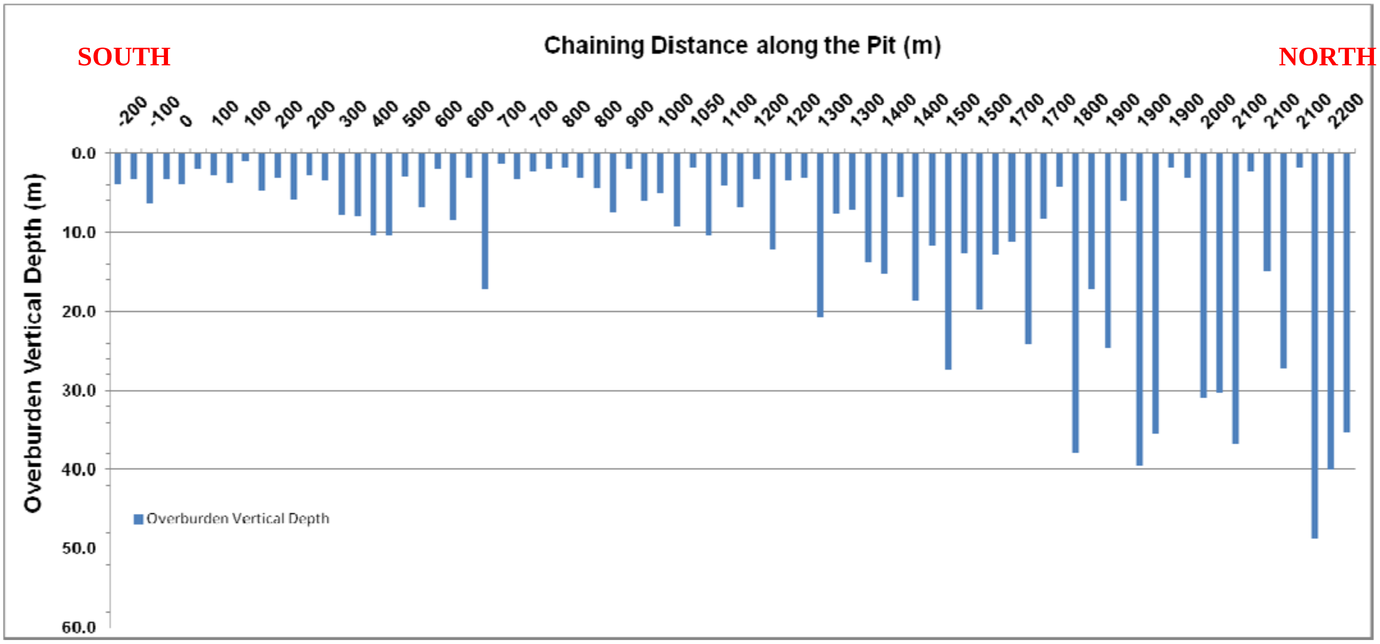


Figure 6-3: Depth to bedrock horizon based on Block Tony boreholes drilled in 2015, 2016 and 2017.

The overburden observed on the site is primarily composed of silty/gravelly sand with cobbles and boulders (glacial till) becoming siltier near water bodies (see Figure 6-4).

Figure 6-4: Overburden Encountered on Tony Block Site

During the pit excavation, the locations of high overburden cut slopes may be a source of risk and instability. To enhance the stability of such localised regions, a rock berm can be placed in front of the overburden cut. The rock berm should be 10 m wide up to half the overburden height with an overall slope of 26.6° (2H: 1V).

6.2.2 Bedrock

The principle area of interest of graphite ore covered by Tony Block claim includes large graphite bands trending north-south over a span of about 2.4 km and are surrounded mostly by a massive paragneiss formation. The local geology is also described in the preliminary economic assessment report (2016).

The paragneiss host rock varies in mineralogy over the open pit region but generally contains varying amounts of quartz, plagioclase, and potassic feldspars (orthoclase, microcline). The most common mafic mineral found in the paragneiss is biotite with other minerals such as graphite, garnet, sillimanite, cordierite, pyrite, and pyrrhotite. Marble and Calc-Silicate rocks are also encountered and are generally medium to coarse grained containing carbonate minerals. Few bands of Metagabbro were also observed and are characterized by their dark green color and mineral assemblage.

6.2.3 Structural Geology within the Tony Block

The proposed pit walls follow the general orientation outline of the N-S trending graphite ore body. The deposit consists of two distinct zones the south part where the overburden is shallow and the north part where the overburden is deep. The bedding planes in the open pit area are quite consistent and spaced every 5 cm to 20 cm. These beds are oriented towards the south east and dipping between 40° and 90°. Dominant repeatable bedding dipping at 45° was observed in most rock cores recovered from the geotechnical oriented boreholes. Figure 6-5 presents typical rock cores recovered where the bedding is shown.

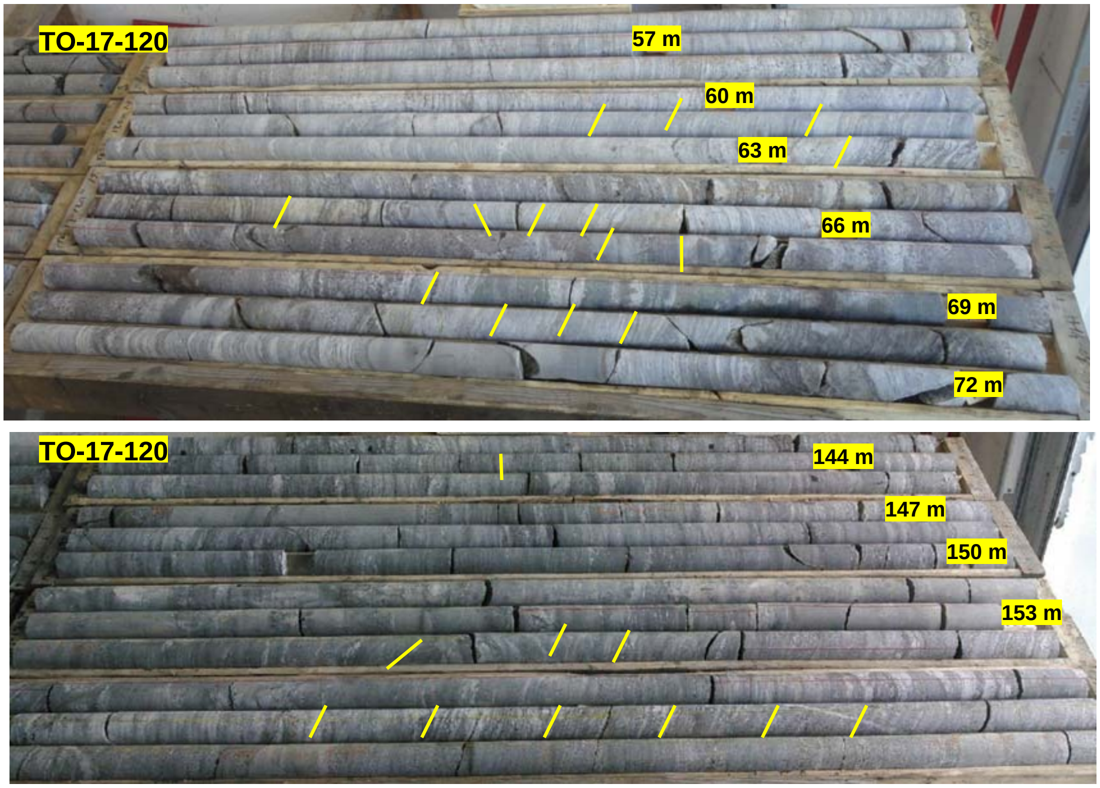


Figure 6-5 : Example of bedding orientation (boreholes TO-17-120 and TO-17-121)

The majority of joints follow the natural bedding, with other joint families present. Joints are found to occasionally cross-cut the bedding. Since the bedding is dipping mainly toward the south east, several joints appear to intersect the bedding planes at around 90°, therefore dipping moderately to the North West (see Figure 6-6).

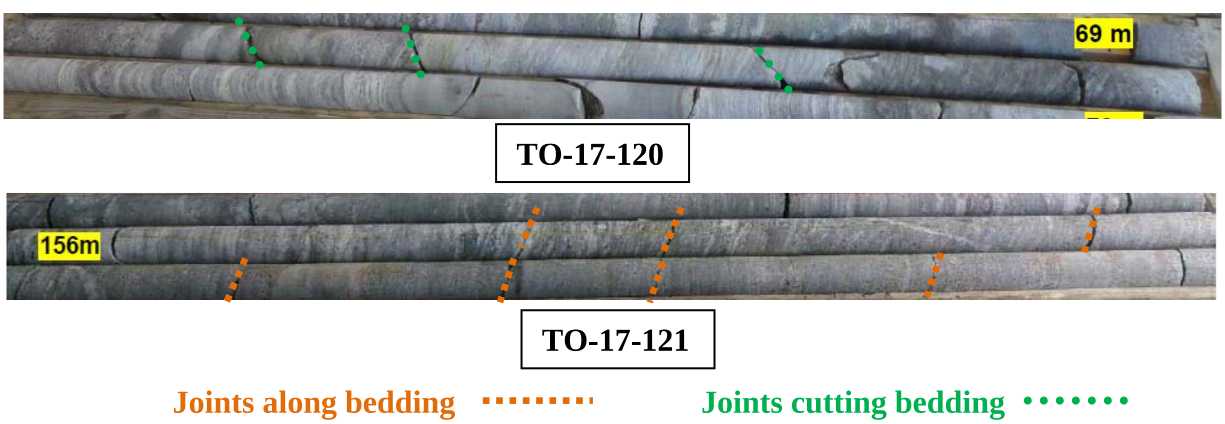


Figure 6-6: Examples of cross-cutting joints encountered in geotechnical boreholes.

The data collected in the ten (10) oriented boreholes drilled in 2017 (TO-17-117- TO-17-126) allowed for the development of a structural geologic model. The joints logged in the oriented boreholes can be grouped in four (4) families as given in Table 6-1 . The most common joint family follows the main bedding dipping southeast. Another common joint perpendicular to the bedding planes is a northwest dipping joint family that is encountered in the ten (10) boreholes. Two other joints dipping northeast and southwest are encountered in 7 boreholes and 9 boreholes, respectively. **Figure 6-7** below presents stereonets showing the structural geology models observed in the ten (10) geotechnical boreholes (TO-17-117 – TO-17-126). From these structural geologic model features, the West wall is expected to be the most prone for failures as bedding planes and major joint families are dipping parallel to the wall.

Table 6-1: Joint families encountered in the oriented boreholes (TO-17-117 to TO-17-126)

JOINT FAMILY	COMMENTS	DIP ANGLE AND DIRECTION	BOREHOLE NUMBER								
			TO-17-117	TO-17-118	TO-17-119	TO-17-120	TO-17-121	TO-17-122	TO-17-123	TO-17-124	TO-17-125
J1	major first joint parallel to the bedding planes	25°- 62° SE	✓	✓	✓	✓	✓	✓	✓	✓	✓
J2	major second joint cross cutting the bedding planes	07° - 33° NW	✓	✓	✓	✓	✓	✓	✓	✓	✓
J3	minor first joint dipping south to south west	26°- 56° S-SW		✓	✓	✓	✓	✓	✓	✓	✓
J4	minor second joint dipping north east	18° - 48° NE	✓	✓	✓			✓	✓		✓

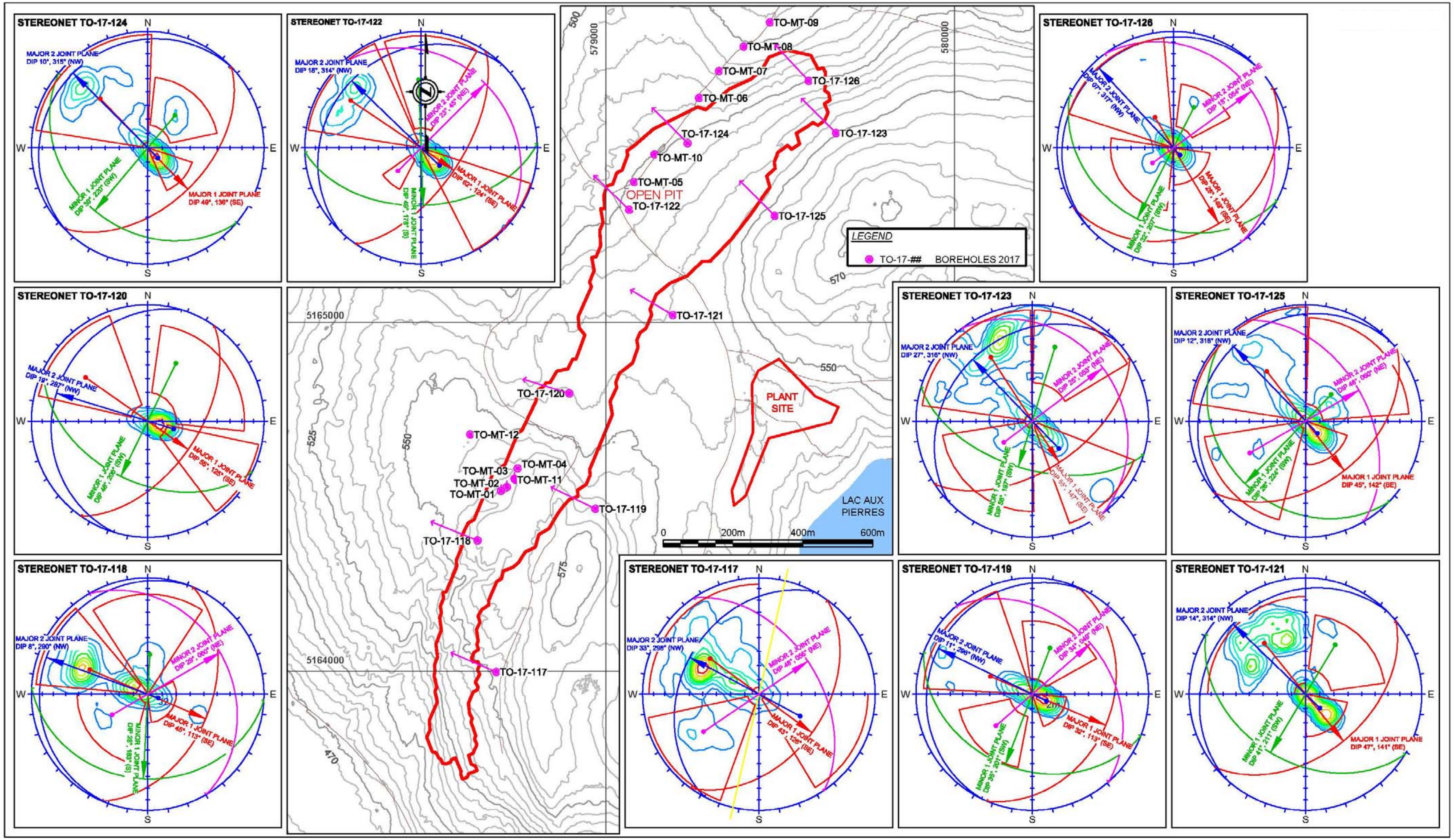
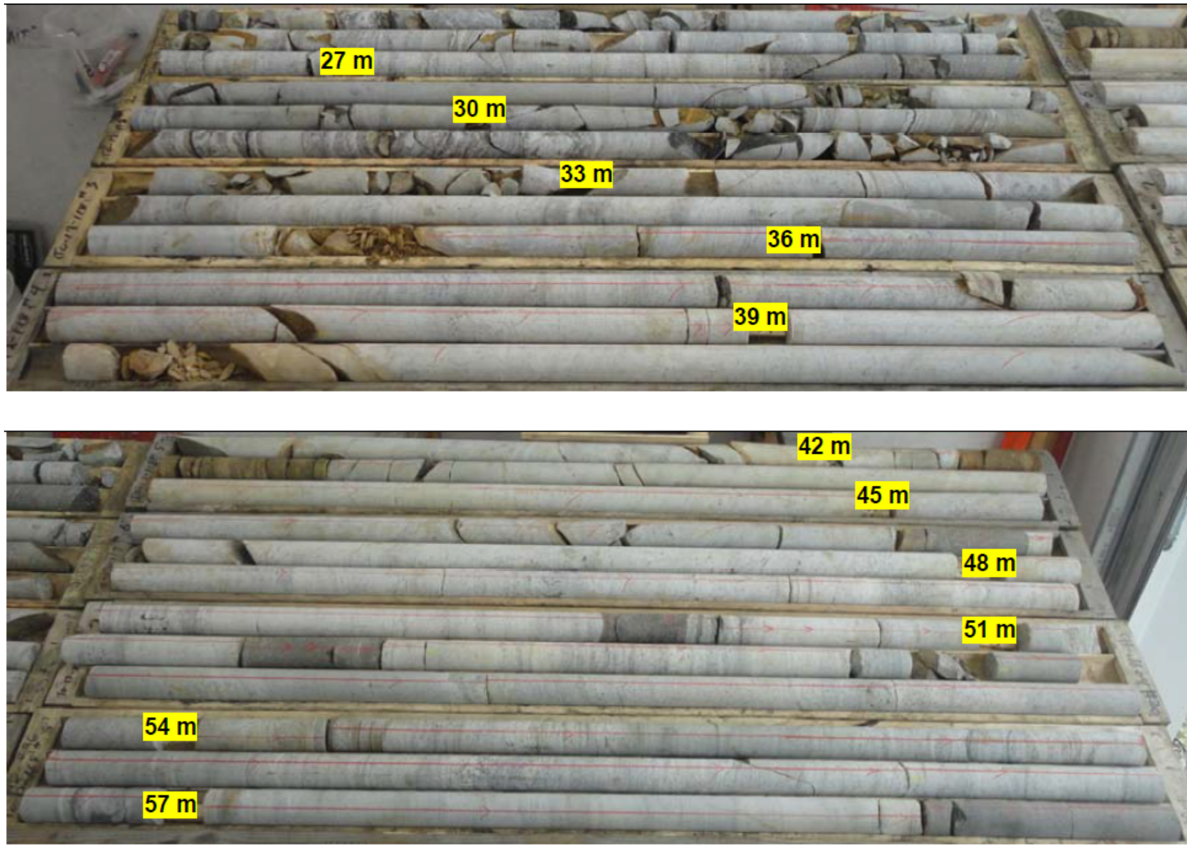


Figure 6-7: Stereonets of the structural geology models TO-17-117- TO-17-126

7 BEDROCK QUALITY

7.1 Recovery and Rock Quality Designation (RQD)

The rock in the area of the open pit is generally sound and of good quality. The review of the 2015-2016 exploration boreholes data and logging of the ten (10) oriented 2017 geotechnical boreholes indicated that recovery is mostly 100 %. Most RQDs are higher than 90% designating rock of excellent quality. Low RQD values, less than 50% indicating poor rock quality, are generally encountered in the rock cores recovered at shallow depth within the first 30 m of true vertical depth and over short local deep zones. Photos of the recovered rock cores of the ten (10) oriented 2017 geotechnical boreholes (TO-17-117 – TO-17-126) with recovery and RQD shown besides each run are presented in Appendix B. Figure 7-1 presents an example of rock core photographs with associated recovery and RQD values.



24-27 m; Recovery = 100%; RQD = 35.4%

27-30 m; Recovery = 100%; RQD = 68.7%

30-33m; Recovery = 100%; RQD = 28.3%

33-36m; Recovery = 100%; RQD = 96.7%

36-39m; Recovery = 100%; RQD = 94.7%

39-42 m; Recovery = 100%; RQD = 89%

42-45 m; Recovery = 100%; RQD = 70.9%

45-48 m; Recovery = 100%; RQD = 93.2%

48-51 m; Recovery = 100%; RQD = 100%

51-54 m; Recovery = 100%; RQD = 85.5%

54-57 m; Recovery = 100%; RQD = 100%

57-60 m; Recovery = 100%; RQD = 84.5%

Figure 7-1: Example of rock core photos with recovery and RQD measurements (borehole TO-17-118).

7.2 Rock Mass Classification

The rock mass rating (RMR) of the host rock controlling the pit walls is around 50, classifying the rock as fair (41 to 60). The RMR takes into account six (6) parameters (UCS Uniaxial Compressive Strength, RQD, joint spacing, conditions of the discontinuities, groundwater conditions and orientations of the discontinuities). The main weaknesses of a host rock for open pit slopes are the steeply dipping joints, the common slightly weathered joints as well as the rare in-filled joints (particularly in fault zones) and finally the presence of mica (biotite) within the paragneiss host rock which greatly reduces its strength.

8 LABORATORY TESTING

8.1 General

Within open pits, the intact rock mass strength controls the overall slope stability analysis for non-daylighting failure mechanisms. Shear strength properties along failure planes dominate the sliding failures. To establish the strength parameters of the bedrock formation, a series of laboratory tests was conducted on the bedrock formations affecting the pit walls.

Several samples of the paragneiss host rock, which varies in mineralogy around the open pit, were selected for strength testing. Samples rich in graphite were also tested to evaluate the strength characteristics of the graphite rich rock.

8.2 Strength Tests

Representative samples were selected from the 2015-2016 exploration campaign boreholes and the ten (10) oriented 2017 geotechnical boreholes of BTW (42.0 mm) and NQ (47.6 mm) core size barrels. Laboratory rock testing was performed at Journeaux Assoc.'s laboratory in Dorval. The laboratory testing included:

- 13 Unconfined compressive strength (UCS) tests (Section 8.2.1)
- 6 Direct Shear tests on joint Planes (Section 8.2.2)

8.2.1 Unconfined Compressive Strength (UCS)

A series of thirteen (13) rock core samples was selected for unconfined compressive strength testing. The testing procedure followed ASTM D 7012. The Unconfined Compression strength, density and water absorption for the rock core samples tested are given in Table 8-1 and Figures 8-1 to 8-4. Figure 8-1 to 8-4 present the rock cores tested and the corresponding UCS obtained.

The paragneiss has fairly low strength characteristics in comparison to strengths typically reported in literature for gneiss rock (typical UCS =170 MPa), with a minimum UCS of 29.2 MPa and a maximum UCS of 136.8 MPa. The average UCS for the paragneiss rock is 68.8 MPa which classifies it as a hard rock on the average (UCS for hard rock = 50 – 100 MPa; moderately hard rock = 12.5 – 50 MPa).

The lower strength characteristics, in comparison to typical gneiss rock formations, are likely attributed to the garnet/biotite/silicate/graphite content within the rock. The high variability in the strength results is likely due to wide variations in mineralogy. In general, the cores split parallel to the axis of the sample tested.

Table 8-1: Unconfined Compression Strength (UCS), Density and % Absorption of selected rock cores

BOREHOLE	SAMPLE CODE	DEPTH (meters)	DENSITY (kg/m^3)	ABSORPTION AFTER 24HRS (%)	UCS (Mpa)
TO-15-37	UCS-1-1	174.83 - 175.00	2690	0.10	81.4
TO-15-37	UCS-1-2	175.25 - 175.40	2720	0.11	48.3
TO-15-37	UCS-1-3	176.66 - 176.76	2820	0.10	44.1
TO-15-39	UCS-2-1	115.27 - 115.37	2690	0.33	136.8
TO-15-39	UCS-2-2	115.57 - 115.67	2820	0.08	29.2
TO-15-39	UCS-2-3	116.09 - 116.19	2790	0.08	41.4
TO-15-39	UCS-2-4	119.10 - 119.20	2840	0.44	64.0
TO-15-71	UCS-4-1	177.27 - 177.38	2660	0.36	67.7
TO-15-71	UCS-4-2	178.07 - 178.18	3700	0.23	113.9
TO-16-82	UCS-5-1	233.89 - 234.00	2990	0.25	49.7
TO-16-82	UCS-5-2	234.25 - 234.36	2760	0.35	77.7
TO-16-82	UCS-5-3	235.69 - 235.80	2660	0.25	85.4
TO-16-84	UCS-6-1	121.13 - 121.24	2820	0.26	54.3

SAMPLE ID	UCS 1-1	UCS 1-2	UCS 1-3	UCS 2-1
BOREHOLE	TO-15-37	TO-15-37	TO-15-37	TO-15-39
DEPTH (m)	174.8-175.0	175.3-175.4	176.7-176.8	115.3-115.4
UCS (MPa)	**81.4**	**48.3**	**44.1**	**136.8**

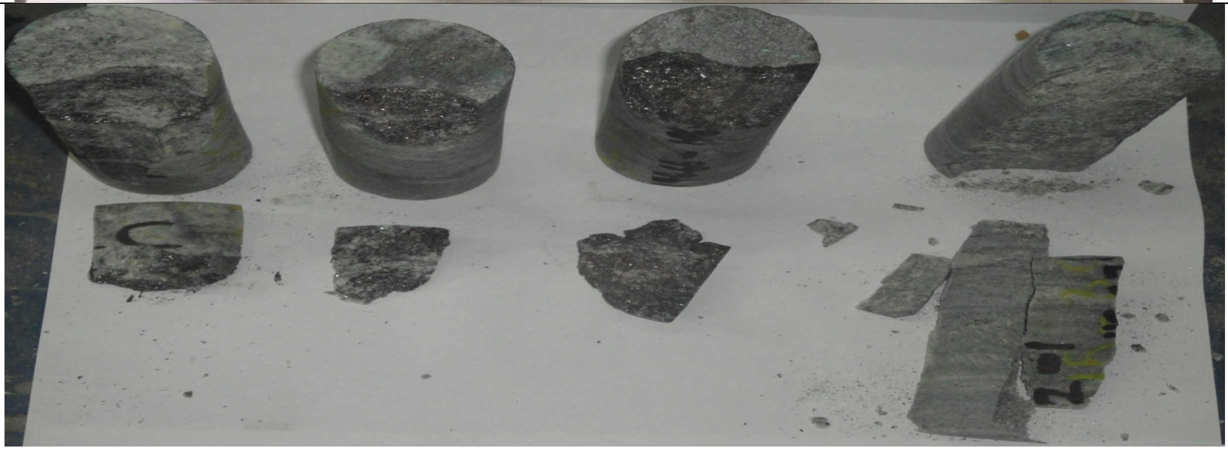


Figure 8-1: UCS samples before and after testing showing the general tensile splitting of cores.

SAMPLE ID	UCS 2-2	UCS 2-3	UCS 2-4
BOREHOLE	TO-15-39	TO-15-39	TO-15-39
DEPTH (m)	115.6-115.7	116.1-116.2	119.1-119.2
UCS (MPa)	**29.2**	**41.4**	**64.0**

Figure 8-2: UCS samples before and after testing showing the general tensile splitting of cores.

SAMPLE ID	UCS 4-1	UCS 4-2	UCS 5-1
BOREHOLE	TO-15-71	TO-15-71	TO-16-82
DEPTH (m)	177.3-177.4	178.1-178.2	233.9-234
UCS (MPa)	**67.7**	**113.9**	**49.7**

Figure 8-3: UCS samples before and after testing showing the general tensile splitting of cores.

SAMPLE ID	UCS 5-2	UCS 5-3	UCS 6-1
BOREHOLE	TO-16-82	TO-16-82	TO-16-84
DEPTH (m)	234.3-234.4	235.7-235.8	121.1-121.2
UCS (MPa)	**77.7**	**85.4**	**54.3**

Figure 8-4: UCS samples before and after testing showing the general tensile splitting of cores.

8.2.2 Shear Strength of Rock Joints

Prior to performing direct shear tests, the joints systems encountered were classified using common means of assessing joint shear strengths. The following methods were used to help define the joint systems:

- Barton's (1973, 1974) system of describing joint roughness and alteration.
- Barton and Choubey's (1977) method of providing a joint roughness profile (JRC).

Finally, Barton's equation (eq. 1) for determining the shear strength of joint planes was fitted to the direct shear tests results.

$$\tau = \sigma_n tan\left[JRC \log_{10}\frac{\mathrm{JCS}}{\sigma_n} + \Phi_b\right] \qquad \text{(eq. 1)}$$

where, τ is the peak shear strength, σ_n is the effective normal stress, JCS is the joint wall compressive strength and Φ_b is the basic angle of friction.

Most of the joints observed in the geotechnical boreholes within the host rock are clean staining (~80%) and are of a rough roughness profile resulting in high shear strength properties. The remaining 20% that are not rough and wavy fall into the categories of "smooth and planar", "smooth and wavy" or "smooth, planar". These will generally exhibit lower shear strengths. Slightly altered joints within the host formation (~34%) are commonly encountered at locations of water circulation veins.

8.2.2.1 Paragneiss and Paragneiss with Graphite Joint

The predominant joint system controlling the pit walls is located within the massive Paragneiss host rock. The joints within the Paragneiss formation typically occur along the south east dipping bedding planes.

The JRC values for the paragneiss joint system typically ranged between 8 and 16, averaging about 12. Figure 8-5 shows a typical rough, clean staining Paragneiss joint with graphite.

Figure 8-5: Typical 'clean staining' joints encountered within the host paragneiss rock formation.

Direct shear tests were performed on two (2) paragneiss (DS-2-6 and DS-17-120-155.87) and three (3) paragneiss with graphite (DS-1-3, DS-17-119-194.53 and DS-17-119-102.25) rock joints. The full test results are presented in Appendix C.

A friction angle varying between 40° and 73° was obtained from the direct shear tests. A lower value of 27° was obtained in one test (DS-17-119-194.53), performed on a smooth paragneiss with graphite joint.

The results obtained on fresh joint surfaces collected from the 2017 geotechnical boreholes are higher when compared to values obtained on samples from boreholes drilled in 2015 and 2016 (tests DS-1-3 and DS-2-6, 37° to 63°). This is due to exposure of freeze-thaw cycles of the 2015-2016 rock cores as they were stored outside in a non heated shed.

The high friction angles for Paragneiss were obtained in tests performed by shearing the samples perpendicular to the rough joints of the high strength Paragneiss host rock. An average friction angle of about 70° was obtained.

Most low friction angles were observed on smooth joints rich in the soft graphite. Tests on paragneiss with graphite joints resulted into an average friction angle of about 45° ; higher than expected for typical graphite joints due to the undulating nature of the joints surface.

8.2.2.2 Graphite Joints

One test (DS-17-119-169) was conducted on a high rich Graphite joint (see Figure 8-6).

Figure 8-6: Typical smooth high rich graphite joint

Generally pure graphite joints are known for their slippery nature. The properties of the coating material may dominate the shear strength of the joint surface, especially weak and slippery coatings of graphite when wet.

The JRC of the graphitic joint tested is 4 indicating a smooth joint. The full test results are presented in Appendix C. The angle of friction obtained in this test was 14° ; such a low value is due to the smooth planar surface and the weak graphite joint properties.

In the design of pit walls, it is important to consider the graphite joint properties. However, as most of the graphite ore body will be mined, the final pit walls stability will be actually controlled by the dip and orientation of the host bedrock formation which is hard quartz rich in paragneiss.

9 PIT WALL STABILITY ANALYSIS

The major discontinuity planes dip towards either southeast or northwest within the rock formation of the Tony Block project. The bedding planes dip towards southeast. This structural geologic feature is a key component in the slope design of the open pit.

The main failure mode expected will be due to discontinuities daylighting into the pit, which could lead to local bench failures.

In general, there are three (3) typical failure mechanisms for high rock slopes:

1. Planar shear failure (local or deep)
2. Wedge failure
3. Circular (rock mass) shear failure

9.1 Planar Shear Failure

Local planar failure will occur when a continuous discontinuity daylights/intersects the bench face, creating a relatively thin knife-edged triangular block of rock that may slide if, as a rule of thumb, the inclination of the major geologic defect is steeper than the peak friction angle of the shear plane. Usually with seasonal freeze-thaw conditions these planes of weakness can deteriorate and lead to block-sliding. Figure 9-1 shows a typical planar failure. The predominance of steeply dipping joints may cause local failures to occur when a joint plane daylights into the pit face even if the average shear strength of common joint planes obtained in the laboratory was $\Phi_p \sim 70°$.

Figure 9-1: Planar failure in a rock wall.

Larger deep planar failures involving many benches of the high slope are not expected for dry pit wall conditions due to the fact that a major continuous discontinuity feature must be located deep behind the pit slope and well beyond the maximum depth of frost penetration. In addition, any major discontinuities are expected to follow the steeply dipping bedding trend within the formation; therefore, the plane would not intersect the flatter pit slope.

9.2 Wedge Failure

Local wedge failures will occur when two (2) opposing dipping joints meet on a steeply inclined intersection line. In this case, a local rock wedge can slide along the two joint surfaces if they intersect at an angle steeper than the peak friction angle. Figure 9-2 shows a schematic depicting wedge failure where two intersecting joints form a wedge along a sloping face. Figure 9-3 shows a typical wedge failure.

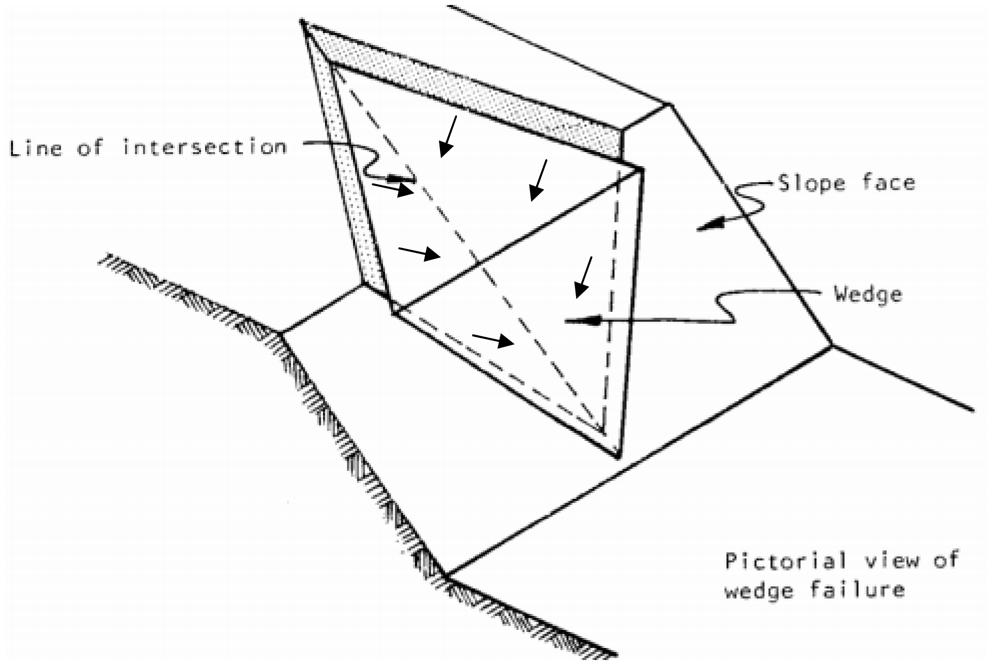


Figure 9-2: Schematic of two intersecting joints causing wedge failure.

Figure 9-3: Wedge failure within pre-shear blasted rock face.

Within the rock formation surrounding the Tony Block Deposit, weakness plane dips and orientations may exist; therefore, a variety of wedges may occur within the pit walls. Careful monitoring for such features is necessary to prevent slides. Because the major structural geology indicates two planes west and east, the plane with the steepest dip will define the pit wall most prone to wedge failure which in the present case is the west pit wall.

9.3 Circular (rock mass) Shear Failure

Deep circular shear failures are not expected to occur within the massive, very resistant, solid host rock formation because of the limited depth of the pit (about 150 m). As is shown in Figure 9-4, these failure mechanisms can occur in highly jointed/foliated rock or weak rock. Since the host rock surrounding the pit rarely contains steep continuous joints and is a relatively solid rock mass, these failure mechanisms do not apply.

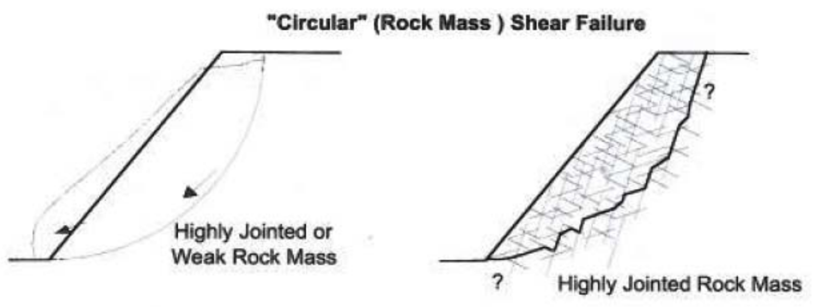


Figure 9-4: Circular (rock mass) failure mode (Hustrulid et. al., 2001).

9.4 Summary of Pit Slope Analysis

Planar shear failures and wedge failures are the two failure mechanisms that are expected to occur locally within the Tony Block deposit open pit. Both planar and wedge failures are controlled by the shear strength properties of the joint planes, which were noted to be usually rough and wavy in the rock cores. Common joint planes within the paragneiss host rock formations will control most of the planar and wedge failures at the pit wall interface. Shear strengths within the paragneiss joint planes are estimated to be in the range of 70°. The majority of joints are dipping southeast or northwest and some may daylight within the west pit wall. In fact, with the variation in bedding plane orientation due to the intense deformations that have taken place in the past, joint planes will locally daylight throughout the open pit. Joints in the surface zone within the frost depth can slide, particularly if the pit walls are not dry. Weaker joint planes such as graphite are at risk of sliding if the joint planes daylight in the pre-sheared excavation slope at even low angles.

9.5 Pit Slope Design Recommendations

As most of the graphite ore body will be mined, the final pit walls will be mostly parallel to the formation dip and orientation of the bedrock which is the hard quartz rich in paragneiss. It is recommended that initially the footwall of the pit (East wall), where the southeast oriented bedding dips at about 45° into the wall, is designed using a slope of 60° and this for a depth up to 50 m. Based on the performance of the slope during the summer and winter periods of the initial years of operation, this slope can be adjusted as the pit deepens.

For the hanging wall (west wall), where the southeast dipping bedding daylights into the pit at about 45°, the slopes should be designed for an overall pit slope of 55° over the first 50 m depth of the pit. As the pit gets deeper beyond 50 m, those slopes can be modified by considering pushing back the top benches or flattening the bottom benches to reduce the slopes, if needed. A simplified stereonet and typical common blocs forming as a result of the major joint planes are presented for the hanging wall and the footwall in Figure 9-5.

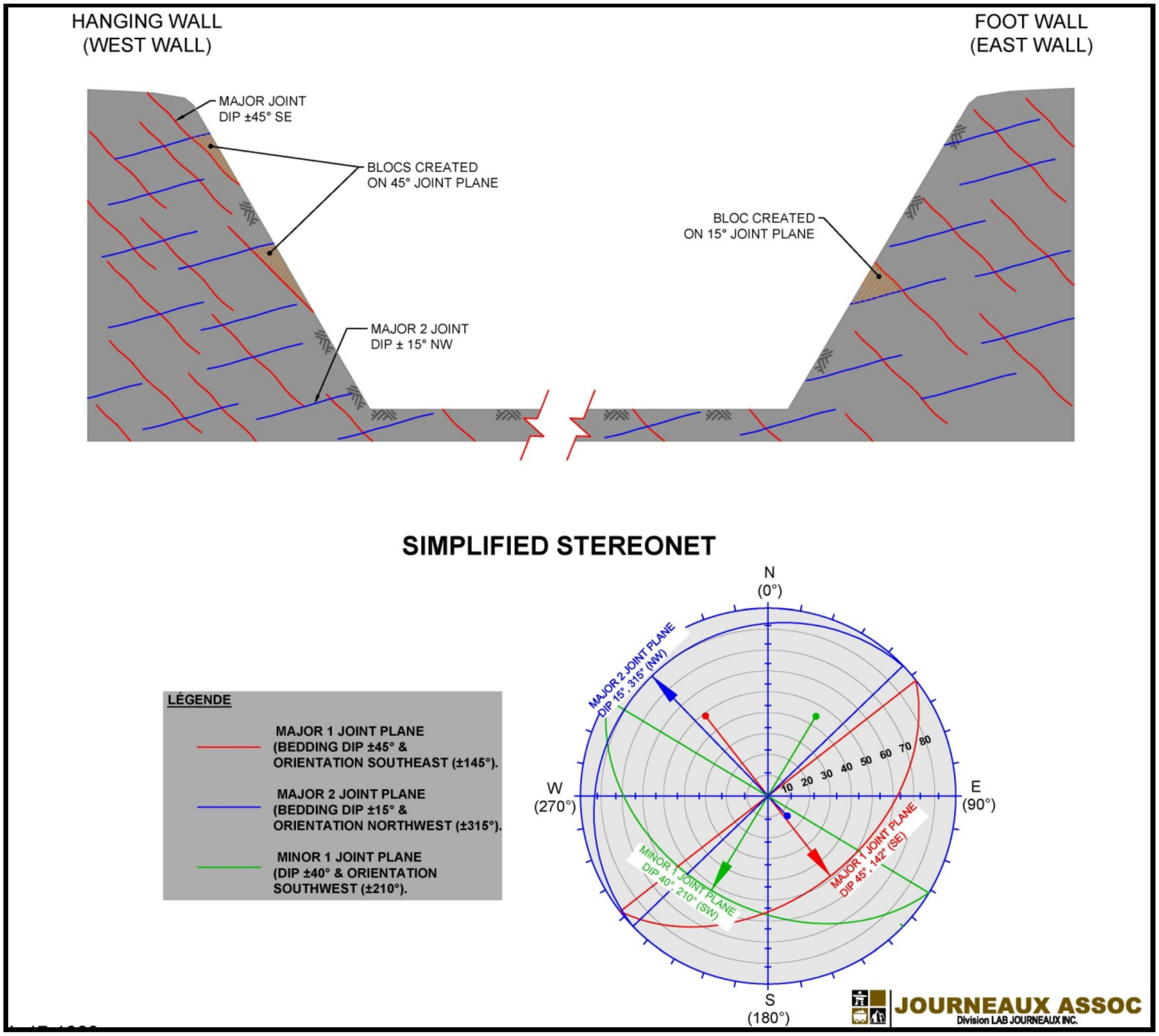


Figure 9-5: Simplified stereonet and common blocs formed due to major joint planes.

Table 9-1 and Figure 9-6 present the ultimate pit slope design recommendations; the bench face angle (BFA) of 75° and inter-ramp angles (IRA) of 60° to 69° are considered to be safe.

To determine whether steeper slopes can be used for the ultimate pit slope, it will be necessary to inspect and review the structural geology of the bedrock on both sides of the excavation body as the pit is deepened. These inspections should be done once the pit reaches 50 m depth. Depending on the conditions of the pit walls, the stability analysis can be repeated for the deepest part of the pit with any new structural information, and the ultimate pit slopes can be adjusted as required.

Table 9-1 : Ultimate Slope Design Recommendations.

Wall	Wall Azimuth	Maximum Vertical Bench Separation (m)	Bench Face Angle (°)	Inter-Ramp Angle (°)	Catch Bench (m)	Overall Pit Slope (°)
West Wall (Hanging wall)	30° (NE) to 210° (SW)	20	75	60	7	55
East Wall (Footwall)	210° (SW) to 30° (NE)	20	75	69	6.2	60

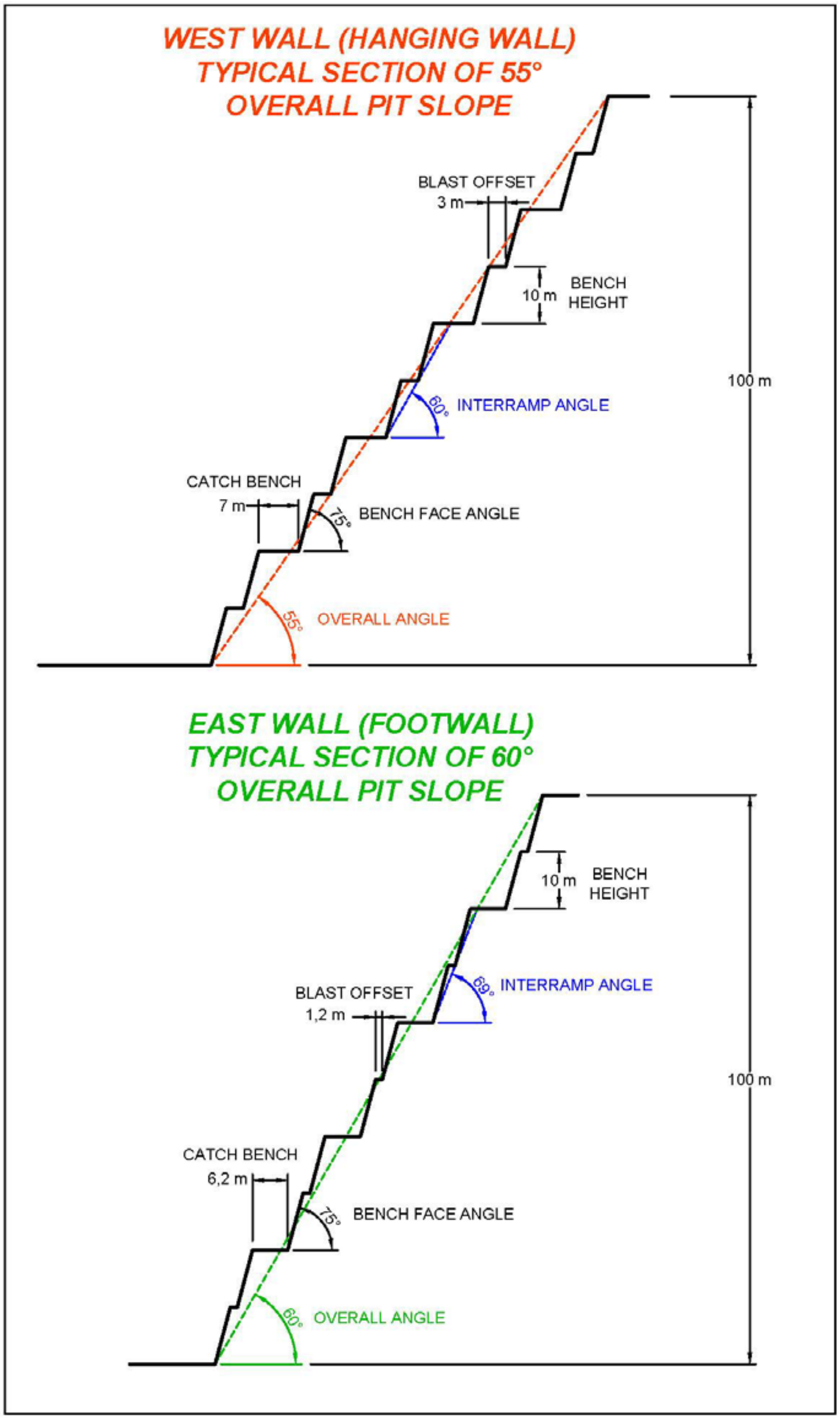


Figure 9-6: Wall sections of proposed Tony Block pit walls.

9.6 Overburden Design Recommendations

For stability of the pit overburden, a 10 m catch bench (berm) at the overburden/bedrock contact and a 26.6 degree slope (2H:1V) is recommended. This geometry may be presently incorporated in the pit design for all areas, regardless of the thickness of overburden, and adjusted during operations as more information will be available relative to soil type, condition and overburden height as well as ground water level and drainage.

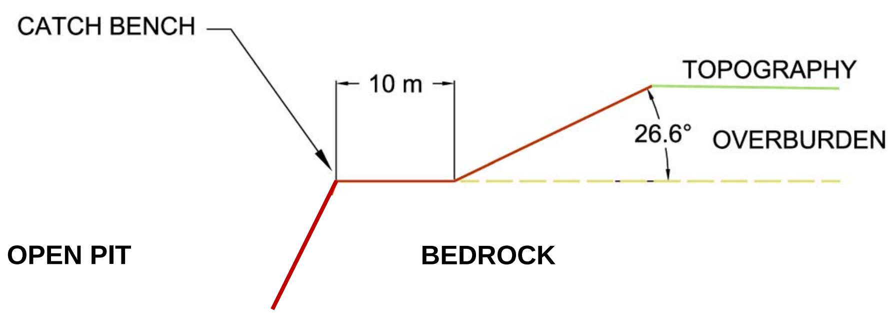


Figure 9-7: Typical overburden bench geometry

10 DISCUSSION

10.1 Structural Geology and Pit Design

The dominant structural geology of the bedrock formation is controlled by a solid, massive paragneissic host rock which contains the ore body, trending in a general north-east to south-west orientation. This trending feature, with predominant southeast dipping joints defines the principal structural weakness in the formation and will control the main instability planes affecting mainly the west wall.

10.1.1 Effect of Main Structural Features on the Pit Wall Stability

The risks of instability are greatest in the west pit wall because of the dominant southeast dipping joint systems, which are at risk of daylighting in the bench faces. If joints daylight at angles above 50^{o}, the stability becomes critical, particularly if blocks or local sections of the wall are defined by two (2) joint planes dipping towards each other and intersecting at steep angles. These form a wedge which can slide onto the berm especially if the surfaces are smooth or covered with soft minerals. If the joint systems are closely spaced, the wedge blocks are rarely large and are usually confined to the bench height or the preceding bench. However, if the discontinuities are widely spaced, then unstable wedge blocks can be quite large and involve multiple benches in the pit wall.

Pre-shearing techniques are recommended since mass-excavation with large powder factors lead to considerable back-break resulting in the opening of joint planes and other discontinuities, ultimately leading to unstable rock sections along the wall. In addition, detonation of charges in the nearest rows parallel to the pit walls is preferable since a detonation towards the open pit area will damage the structural geology of the pit wall face.

Flatter dipping intersecting joint systems isolate large rock volumes resting on low sloping sliding surfaces which control the risk of instability and rock falls. This instability depends on the surface roughness of the joint surface and the relative strength or hardness of the material covering the sliding surfaces. Naturally, water seeping from a high water level behind the pit wall weakens the contact material and increases the risk of wedge instability.

The presence of these unfavourable structural conditions must be searched for and identified as the pit is deepened, and their destabilising effects minimized by appropriate and strategic drilling of horizontal relief and drainage holes.

During the open pit excavation faults, if any, should be identified and brought to the attention of the designer for stability consideration. Naturally, if the fault is cutting the wall perpendicularly to the pit face, the fault will not cause serious slope failure issues, unless the fault adversely affects the water conditions of the rock wall. Faults oriented parallel or near parallel to the pit and dipping towards the pit can cause significant planar or wedge failures.

10.1.2 Degradation of Host Rock

Certain rock types are prone to degradation when exposed to air and/or water, as well as freezing and thawing cycles or changes in confining stress. Generally, the paragneiss host rock is not expected to be very sensitive to the elements. However, in order to assess the degradation potential of the host rock or sections of the rock, a practical and effective method is to leave the core samples exposed to the site conditions.

10.2 Minimizing Slope Instability by Pre-Shearing Blasting

Mining of the ore body should be carried out using pre-shearing techniques following generally acceptable MTQ procedures. This involves closely spaced (~1 m) inclined pre-shear holes drilled parallel to the bench face angle 10V: 1H and taken at about 1 or 1.5 meters below the bench level. Blast holes on bench levels should be no longer than 12 meters if deviation of the drill hole is to be minimized.

In addition, the protection of the bench shoulder should be a serious objective, and blasting in holes within 1.5 meters on each side of the shoulder must be avoided. A continuous production hole should be drilled parallel to the bench face to minimize damage due to back break and opening of discontinuities or predominant joints.

To avoid isolated rock falls rebounding onto lower parts of the slope, the horizontal berm should have a 3% slope towards the pit wall. During removal of the blast rock, the pre-sheared rock face must be carefully scaled and all wedge zones removed if considered being at risk to slide. At this time, the finished bench surface should be properly sloped downwards (10%) towards the preshearing blast holes. Initially, this will minimized falling boulders from bouncing from the ledge and falling to lower benches. Figure 10-1 shows a photograph of a pre-sheared rock face over three 15 m high benches.

Figure 10-1: Pre-shearing blast over three 15 m high benches.

10.3 Excavation Control and Scaling

During the excavation of the pit wall, careful removal of loose blocks or potentially unstable material should be done along the final face of the slopes using shovels (see Figure 10-2). This will reduce future clean-up costs and reduce rockfall hazards for roadways. Scaling is usually an effective technique for stabilizing slopes for periods between two (2) and ten (10) years, depending on site condition. It is not a permanent solution, but it is relatively inexpensive and may be used as a short-term strategy for the beginning of the mine life.

Figure 10-2: Scaling methods; (left) using excavator (right) using a lift and steel bars to pry loose rocks off.

10.4 Drainage/Dewatering

The stability of the pit wall is greatly reduced if water pressures build behind the face. In the event that surface seepage conditions develop in the pit wall, horizontal drainage holes can be used to relieve any hydrostatic pressures in such zones. The drawdown of the water table occurs in most pits during the gradual deepening of the mining operation. In this case, dry wall conditions can exist for several benches, and this reduces the risk of instability.

Serious seepage infiltration is very possible once the pit descends below the level of the surrounding water bodies, particularly Lac Aux Pierres to the south-east. Where these conditions are encountered, long horizontal drainage holes, set up in a fan-shaped array (see Figure 10-3 and Figure 10-4), are required to accelerate the drawdown and re-establish dry conditions behind the wall. In highly fractured fault zones where infiltrations can be large, the injection of cement grout may be considered.

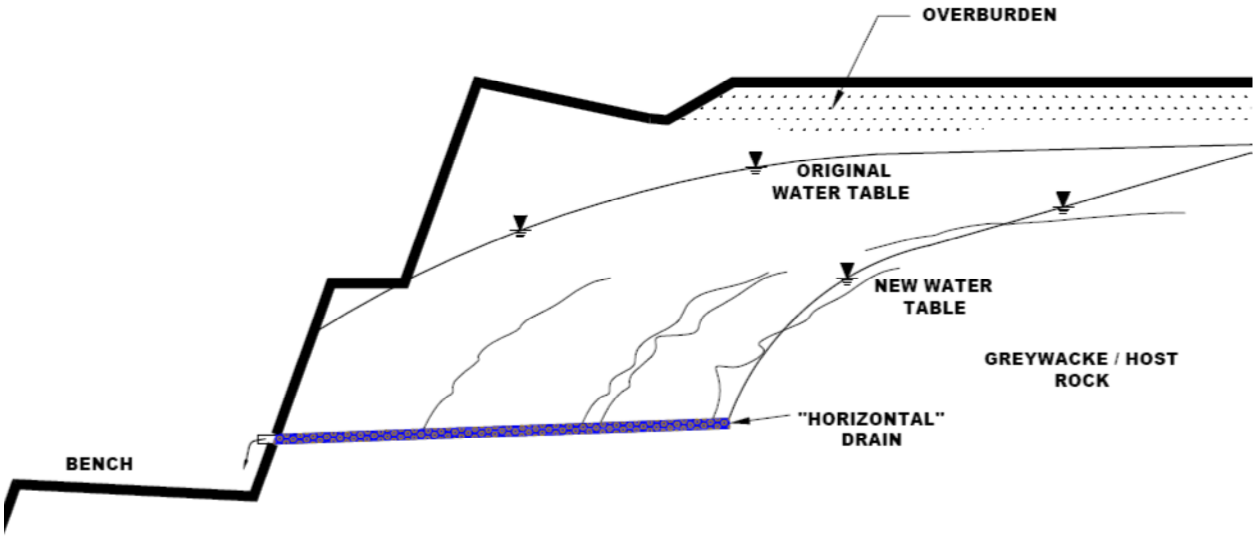


Figure 10-3: Cross-sectional view of horizontal drain.

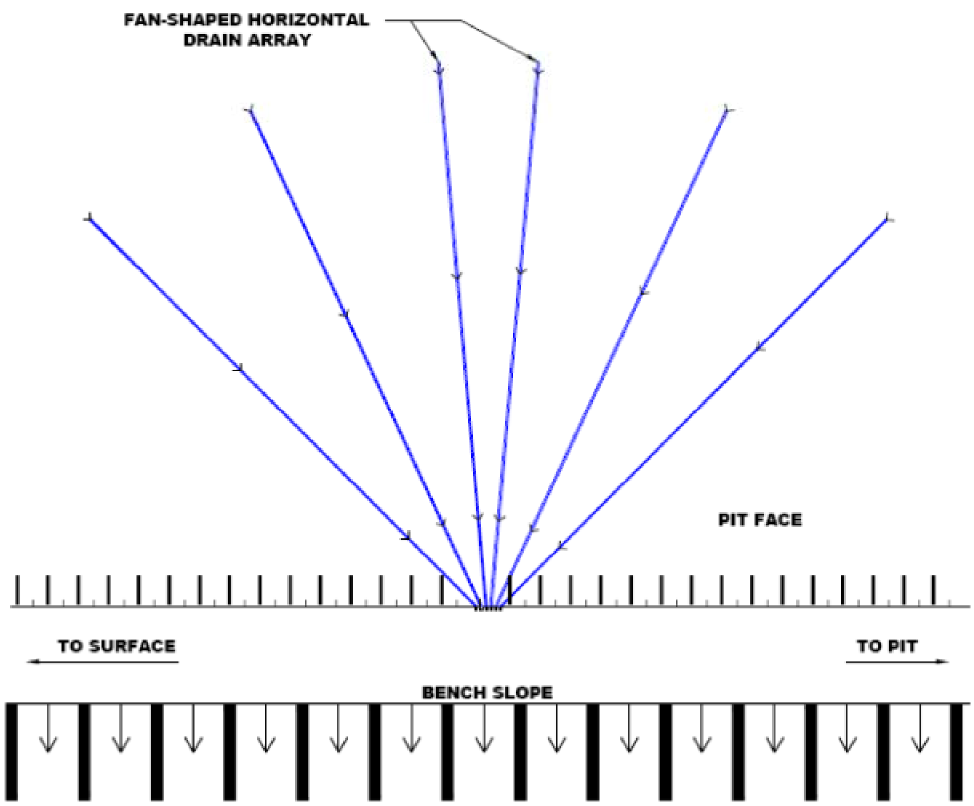


Figure 10-4: Plan view of fan-shaped horizontal drain array.

10.5 Detailed Pit Slope Inspections and Slope Monitoring

The bedrock along the walls of the Tony Block open pit will be subject to seasonal freezing and thawing cycles and could also be subject to some local lateral displacement of the rock face, particularly in areas where seepage waters appear on the face. Such movements could indicate some signs of slope instability. To help identify any movements, it is prudent to install some lateral movement detection devices along the haul road. These should be at a regular spacing of 200 meters at both the 50-meter and 150-meter pit levels. Regular monitoring of well-secured and anchored pins, installed a minimum of 10 meters into the pit walls, will establish whether lateral movements are occurring. These movement measurements will help in identifying what stabilization measures may be required. Detailed mapping of the structural geology should be done at every three (3) excavation levels, and from these observations the location of the lateral displacement monitor can be positioned, as well as any horizontal drainage holes in seepage zones.

11 CONCLUSIONS AND RECOMMENDATIONS

The examination of the bedrock from the geotechnical and exploration boreholes and the related structural geology described in literature leads to the following conclusions:

- The Tony Block deposit is oriented north-south and is bounded within a massive paragneiss host rock which is mainly composed of quartz, feldspar and biotite.
- The dominant joint system dips between 15° and 45° from north-west to south-east via south-west.

- Except for local fault zones, the analysis of rock cores indicates excellent rock quality with RQD values between 90% and 100%, and generally a recovery of 100% (particularly at depth).
- Pre-splitting or pre-shearing techniques should be used for shaping the bench faces of the permanent ultimate pit slopes.
- The preliminary stability analysis indicates stable slopes for a 100 m deep pit with an overall pit slope (OPS) of 55° (east wall) and 55°(west wall) and inter-ramp angles (IRA's) of 60° to 69° with 6.2 m and 7 m wide catch benches with face angles (BFA's) of 75° over 20-meter high benches. The pit slope design parameters provided are based on dry pit wall conditions.
- Horizontal drainage holes should be installed at all seepage zones encountered in the pit wall to drawdown the water table.
- Based on proposed design conditions and the limited depth of the open pit (100 meters), large scale slip circle are not expected.
- Local plane and wedge shear failures are expected to occur locally around the pit, particularly where steeply dipping discontinuities intersect the bench faces at obtuse or oblique angles to the slopes. These can be safely controlled by properly scaling and monitoring the pit walls as the excavation is deepened.
- Regular inspections of the structural geology along the pit wall are required once the pit reaches the 50 meter depth to validate the structural model deduced from the cores.
- Monitoring of movements in the pit walls is required at widely spaced intervals on at least two (2) pit levels (50 and 75-meter levels).

- The east wall of the pit is more exposed to wedge sliding while the west wall of the pit is more exposed to planar sliding given that the major bedding and joints sets dip to north-west and south-east, respectively.

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NOUVEAU MONDE GRAPHITE

OPEN PIT SLOPE DESIGN
PREFEASIBILITY STUDY
MATAWINIE PROJECT - TONY BLOCK (GRAPHITE)

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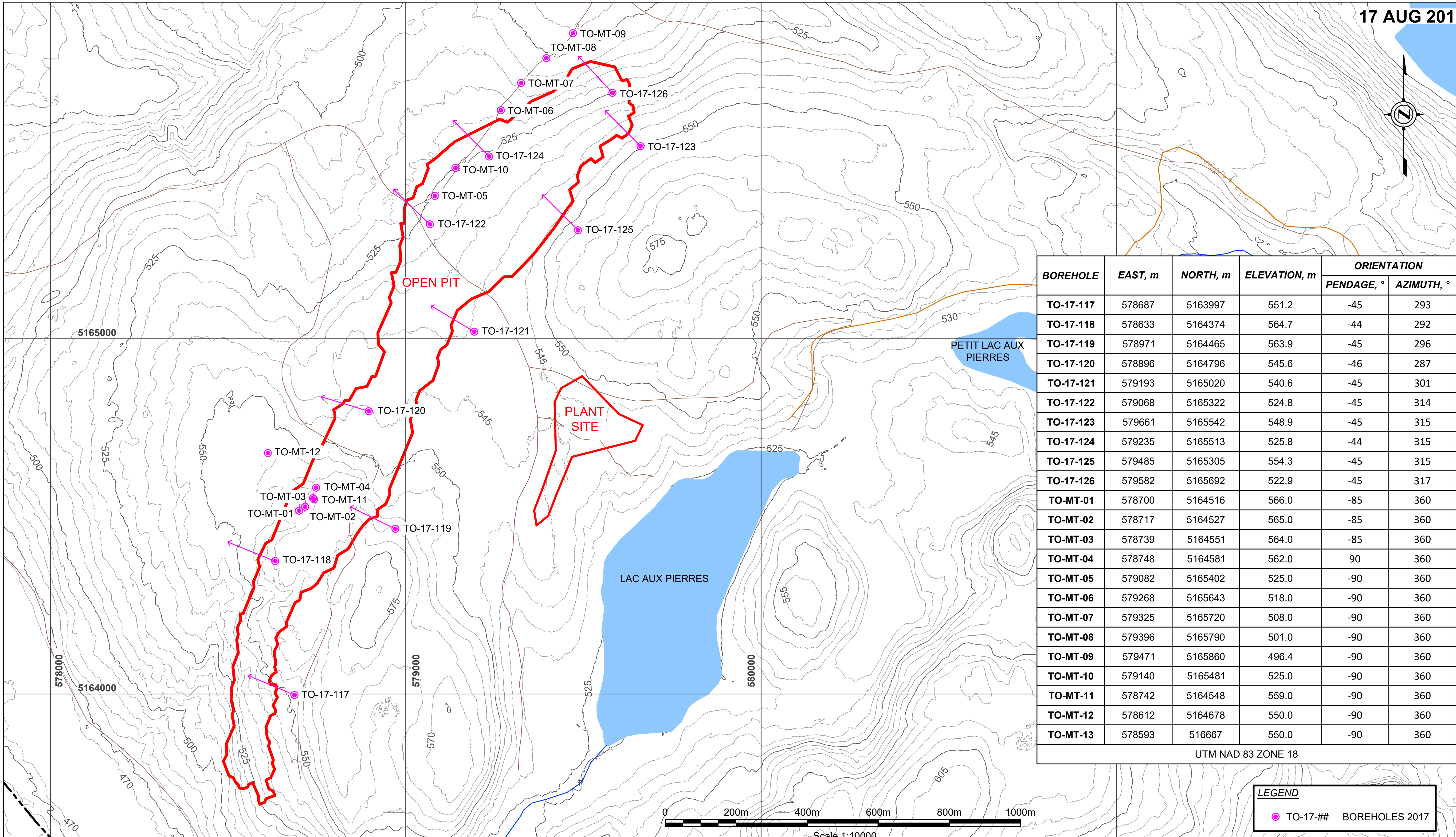
APPENDIX A

Drawings



BOREHOLE	EAST, m	NORTH, m	ELEVATION, m	ORIENTATION	
				PENDAGE, °	AZIMUTH, °
TO-17-117	578687	5163997	551.2	-45	293
TO-17-118	578633	5164374	564.7	-44	292
TO-17-119	578971	5164465	563.9	-45	296
TO-17-120	578896	5164796	545.6	-46	287
TO-17-121	579193	5165020	540.6	-45	301
TO-17-122	579068	5165322	524.8	-45	314
TO-17-123	579661	5165542	548.9	-45	315
TO-17-124	579235	5165513	525.8	-44	315
TO-17-125	579485	5165305	554.3	-45	315
TO-17-126	579582	5165692	522.9	-45	317
TO-MT-01	578700	5164516	566.0	-85	360
TO-MT-02	578717	5164527	565.0	-85	360
TO-MT-03	578739	5164551	564.0	-85	360
TO-MT-04	578748	5164581	562.0	90	360
TO-MT-05	579082	5165402	525.0	-90	360
TO-MT-06	579268	5165643	518.0	-90	360
TO-MT-07	579325	5165720	508.0	-90	360
TO-MT-08	579396	5165790	501.0	-90	360
TO-MT-09	579471	5165860	496.4	-90	360
TO-MT-10	579140	5165481	525.0	-90	360
TO-MT-11	578742	5164548	559.0	-90	360
TO-MT-12	578612	5164678	550.0	-90	360
TO-MT-13	578593	516667	550.0	-90	360

UTM NAD 83 ZONE 18

NOTE: UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN METERS.

CLIENT : DRA / NOUVEAU MONDE GRAPHITE — Foster the Future, Drive Innovation

DATE : 17-08-2017
PROJECT No. : L-17-1980

GENERAL LOCATION PLAN OF GEOTECHNICAL ORIENTED BOREHOLES 2017
OPEN PIT
MATAWINIE PROJECT
SAINT-MICHEL-DES-SAINTS
QUEBEC

SCALE : 1:10000
DRAWN BY : S.E.
PROJECTED BY : S.K.
APPROVED BY : N.J.

JOURNEAUX ASSOC
Division LAB JOURNEAUX INC.
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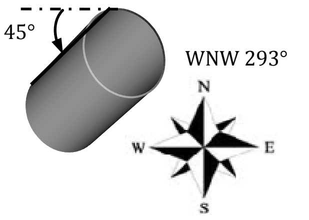
DRAWING No. : B-IO1790-0725-GT
FIGURE No. : - - - -
REV. : A

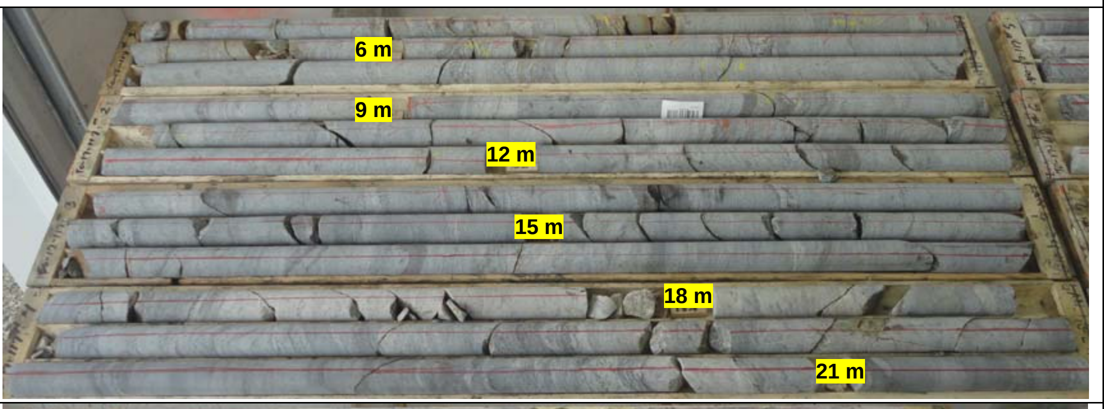
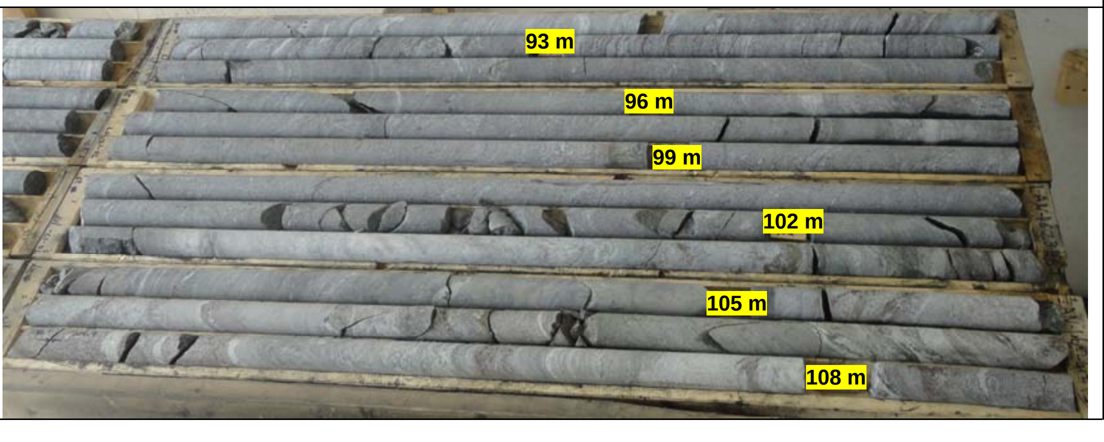
PRINTED DATE: 20170817112550

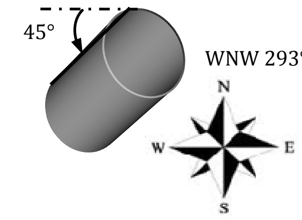
S:\1-LAB\2-Projects\1950\L-17-1980 - DRA GLOBAL - Études Géotechnique et Résidus, mine Matawinie\2. OPEN PIT\Dessins\CAD\L SERIES\B-I01790-0724,0725-GT.dwg

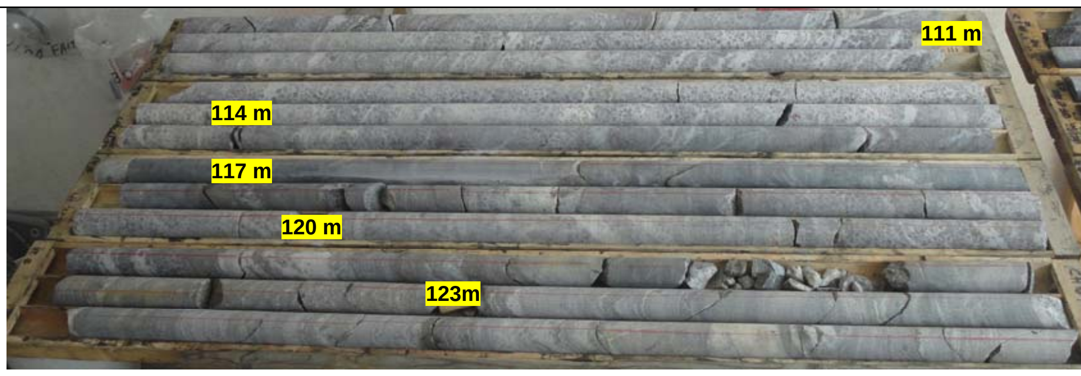
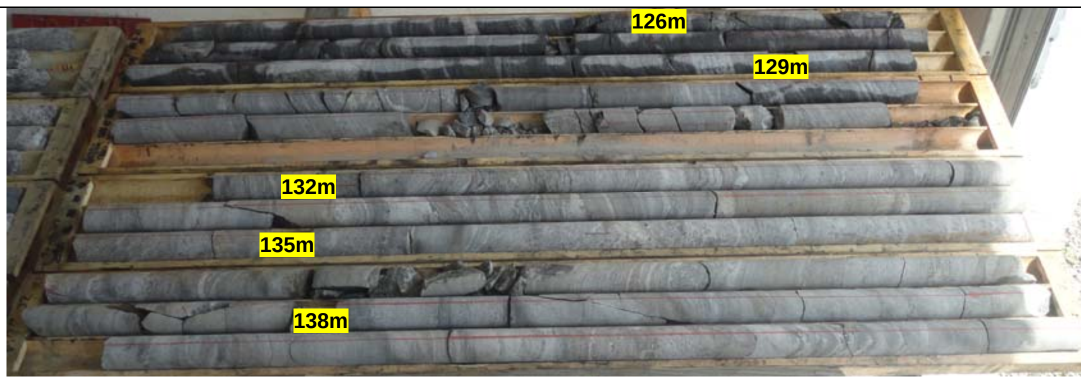
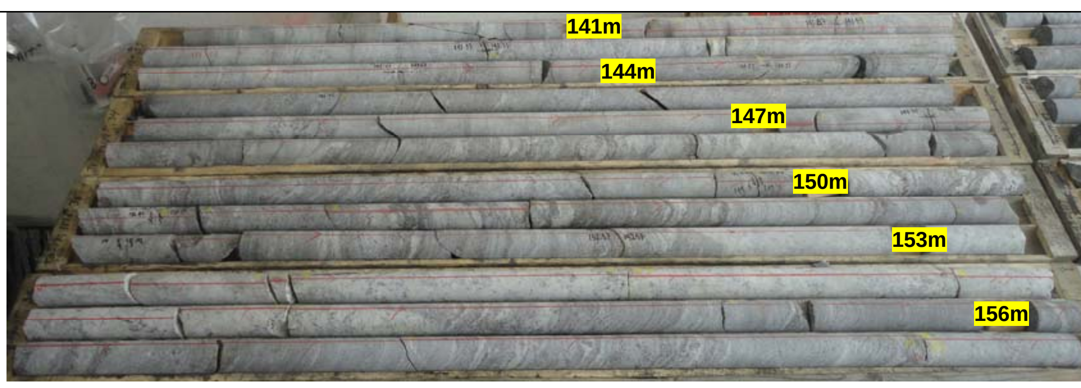
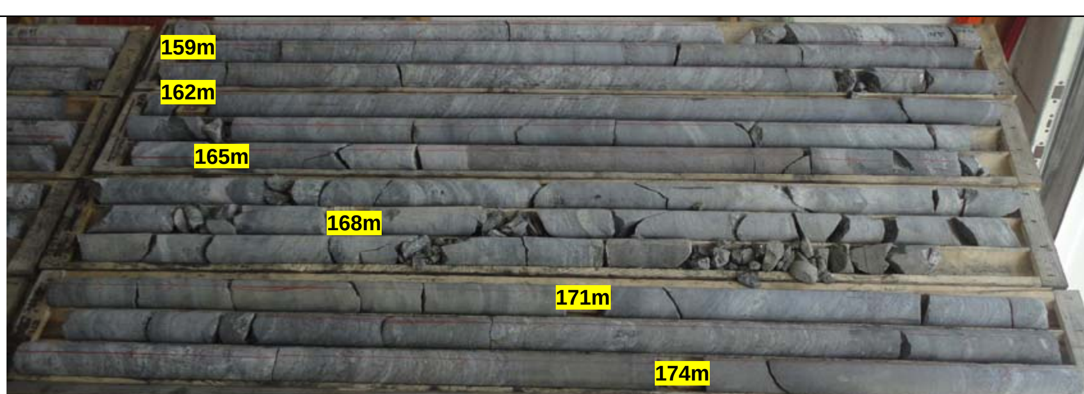
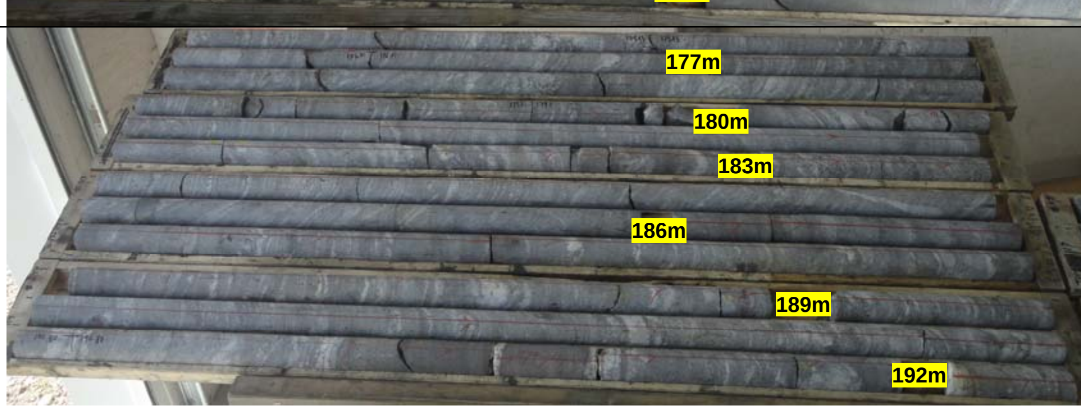
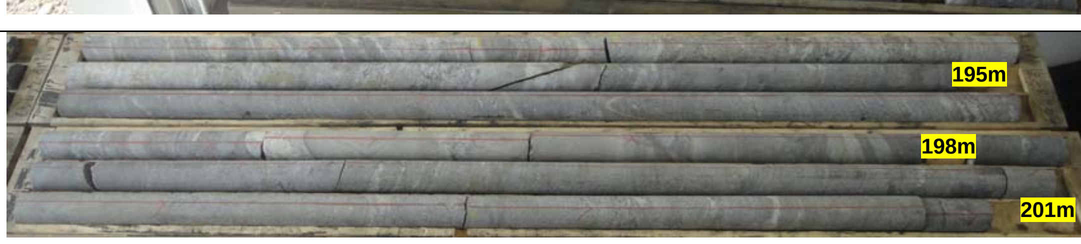
APPENDIX B

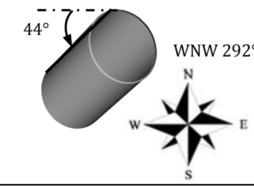
Oriented Boreholes Rock Core Photographs
2017 geotechnical investigation program

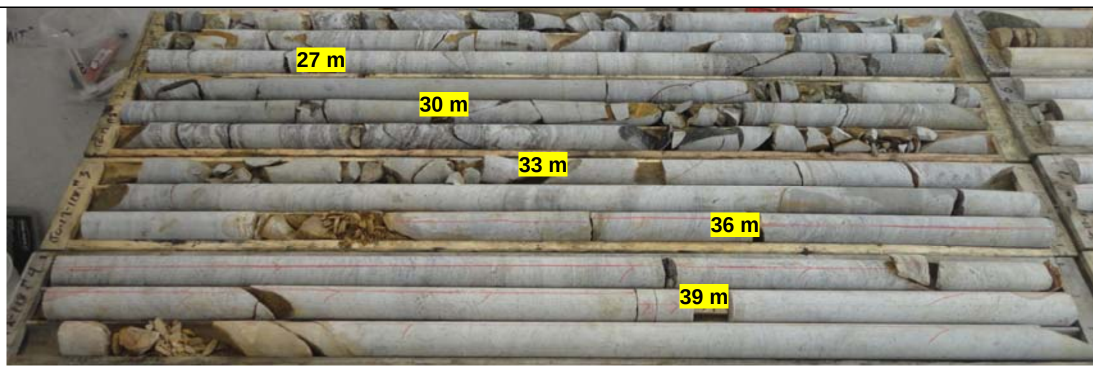
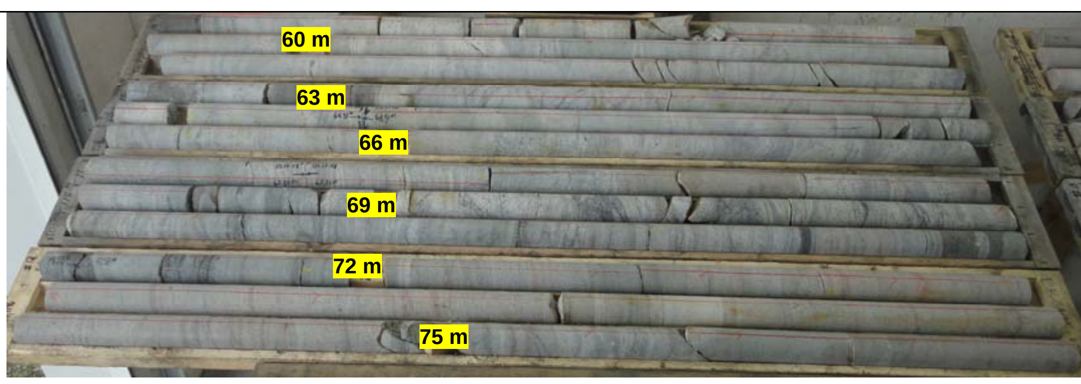
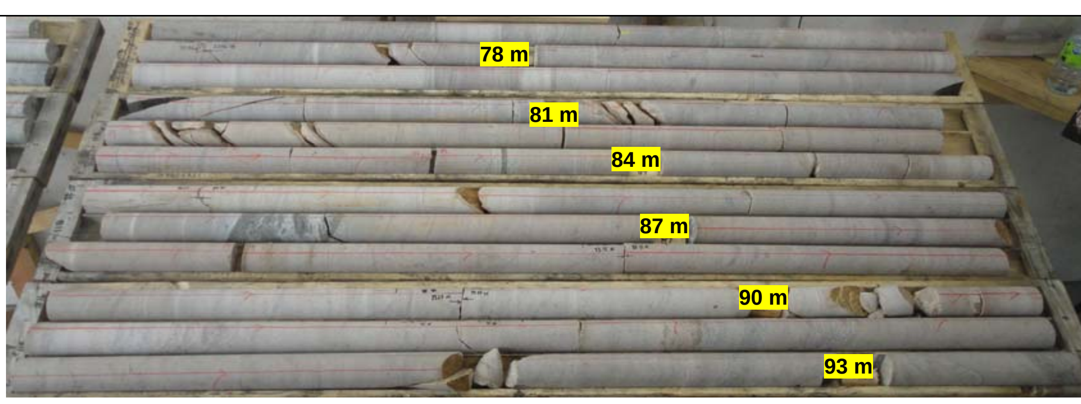
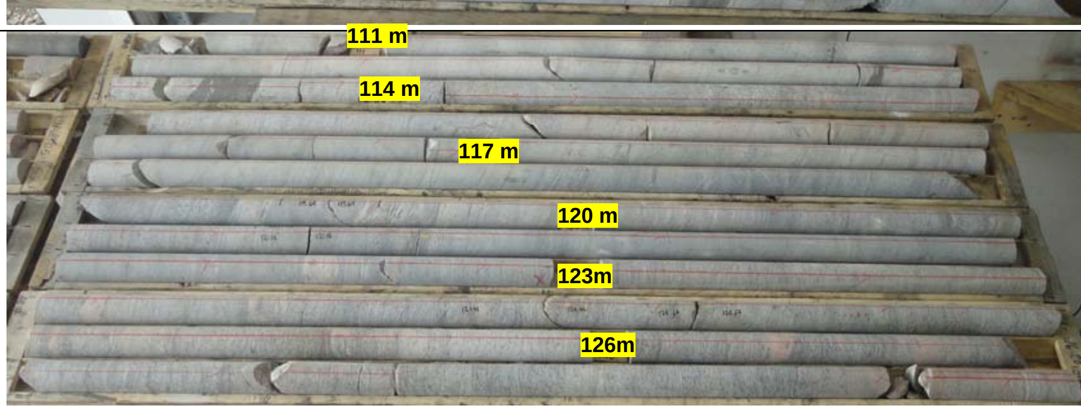


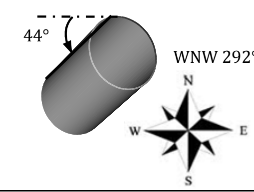
BOX #	L-17-1980-Geotechnical Hole TO-17-117 Oriented NQ Core EL. 551.2 m (South East of Pit)	Comments
1-4		4.1-6 m; Recovery = 100%; RQD = 78.7% 6-9 m; Recovery = 100%; RQD = 94.5% 9-12m; Recovery= 100%; RQD = 92.2% 12-15m; Recovery = 100%; RQD = 94.6% 15-18 m; Recovery = 100%; RQD = 70.3% 18-21 m; Recovery = 100%; RQD = 83%
5-8		21-24 m; Recovery = 100%; RQD = 89.3% 24-27 m; Recovery = 100%; RQD = 100% 27-30 m; Recovery = 100%; RQD = 92.4% 30-33m; Recovery = 100%; RQD = 100% 33-36m; Recovery = 100%; RQD = 88.7% 36-39m; Recovery = 100%; RQD = 95.7%
9-12		39-42 m; Recovery = 100%; RQD = 95.7% 42-45 m; Recovery = 100%; RQD = 78.5% 45-48 m; Recovery = 100%; RQD = 88.9% 48-51 m; Recovery = 100%; RQD = 97.6% 51-54 m; Recovery = 100%; RQD = 97.3% 54-57 m; Recovery = 96.03%; RQD = 96%
13-16		57-60 m; Recovery = 100%; RQD = 93.1% 60-63 m; Recovery = 100%; RQD = 80.6% 63-66m; Recovery = 100%; RQD = 91% 66-69 m; Recovery = 100%; RQD = 98.4% 69-72 m; Recovery = 100%; RQD = 88%
17-20		72-75 m; Recovery = 100%; RQD = 89% 75-78 m; Recovery = 100%; RQD = 100% 78-81 m; Recovery = 100%; RQD = 97.3% 81-84 m; Recovery = 100%; RQD = 83.4% 84-87 m; Recovery = 100%; RQD = 100% 87-90 m; Recovery = 100%; RQD = 100%
21-24		90-93 m; Recovery = 100%; RQD = 100% 93-96 m; Recovery = 100%; RQD = 84.3% 96-99 m; Recovery = 100%; RQD = 100% 99-102 m; Recovery = 100%; RQD = 76.7% 102-105 m; Recovery = 100%; RQD = 89.1% 105-108 m; Recovery = 100%; RQD = 78.2%

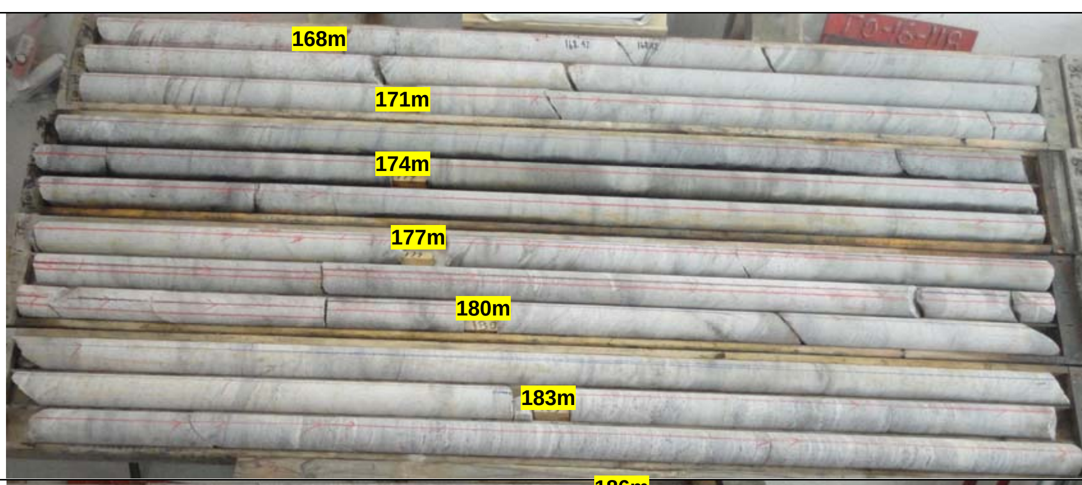
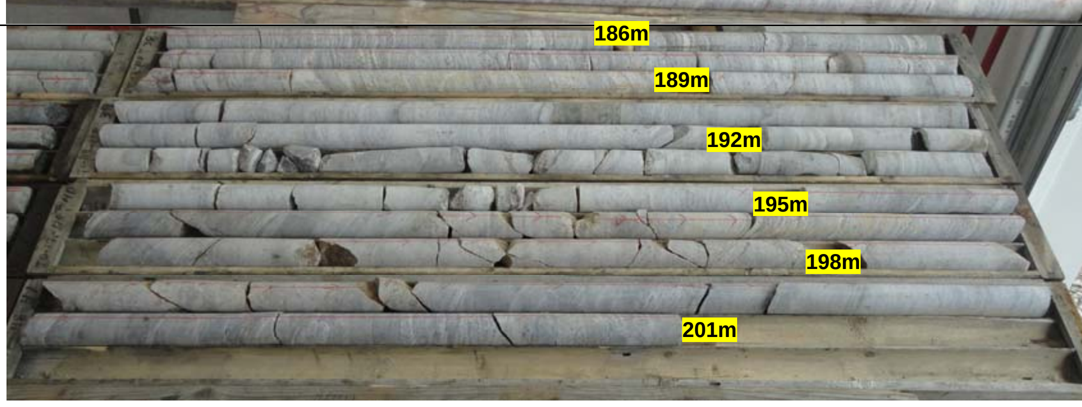


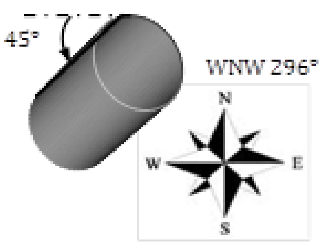
BOX #	L-17-1980-Geotechnical Hole TO-17-117 Oriented NQ Core EL. 551.2 m (South East of Pit)	Comments
25-28		108-111 m; Recovery = 100%; RQD = 100% 111-114 m; Recovery = 100%; RQD = 100% 114-117 m; Recovery = 100%; RQD = 100% 117-120 m; Recovery = 100%; RQD = 96.7% 120-123 m; Recovery = 100%; RQD = 93.3% 123-126 m; Recovery = 100%; RQD = 82.3%
29-32		126-129 m; Recovery = 100%; RQD = 66.7% 129-132 m; Recovery = 100%; RQD = 66.7% 132-135 m; Recovery = 100%; RQD = 91.2% 135-138m; Recovery = 100%; RQD = 78.3% 138-141m; Recovery = 100%; RQD = 90.1%
33-36		141-144m; Recovery = 100%; RQD = 96.1% 144-147m; Recovery = 100%; RQD = 97.4% 147-150m; Recovery = 100%; RQD = 80.7% 150-153m; Recovery = 100%; RQD = 86% 153-156m; Recovery = 100%; RQD = 98.7% 156-159m; Recovery = 100%; RQD = 93.2%
37-40		159-162m; Recovery = 100%; RQD = 93.2% 162-165m; Recovery = 100%; RQD = 93.8% 165-168m; Recovery = 100%; RQD = 59.4% 168-171m; Recovery = 100%; RQD = 46.5% 171-174m; Recovery = 100%; RQD = 87.7%
41-44		174-177m; Recovery = 100%; RQD = 94.7% 177-180m; Recovery = 100%; RQD = 93.3% 180-183m; Recovery = 100%; RQD = 97.7% 183-186m; Recovery = 100%; RQD = 100% 186-189m; Recovery = 100%; RQD = 97.7% 189-192m; Recovery = 100%; RQD = 100%
45-48		192-195m; Recovery = 100%; RQD = 97.4% 195-198m; Recovery = 100%; RQD = 100% 198-201m; Recovery = 100%; RQD = 96.7%

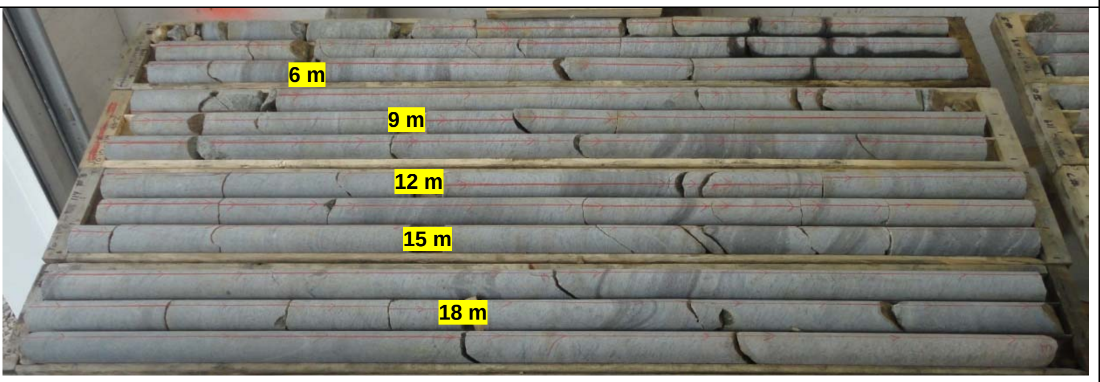
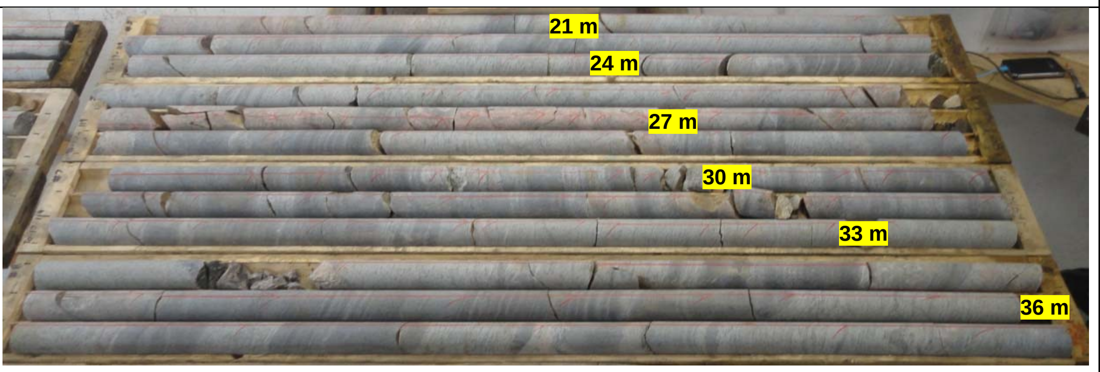
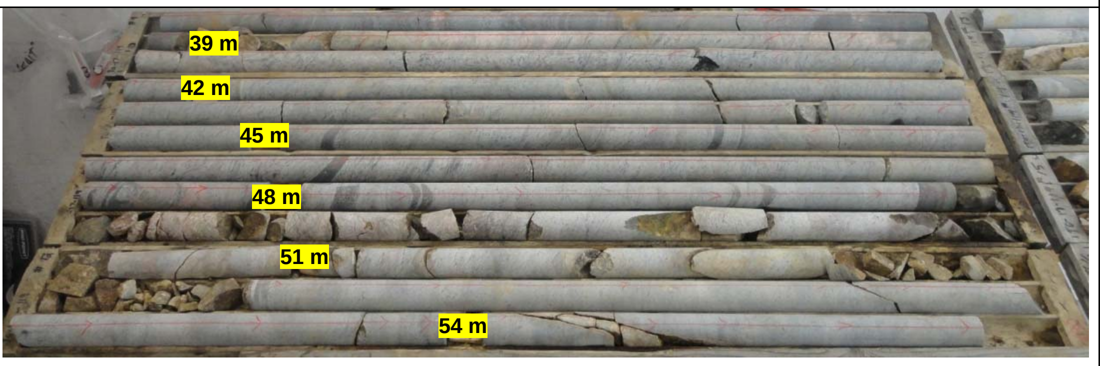
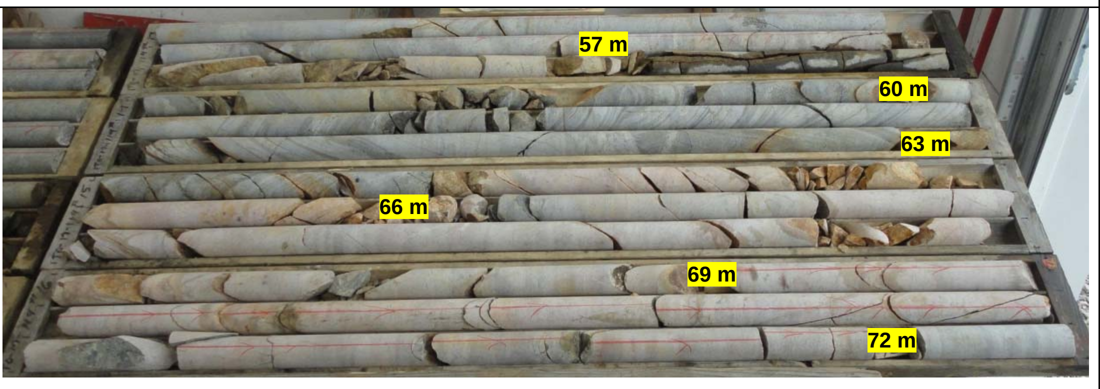
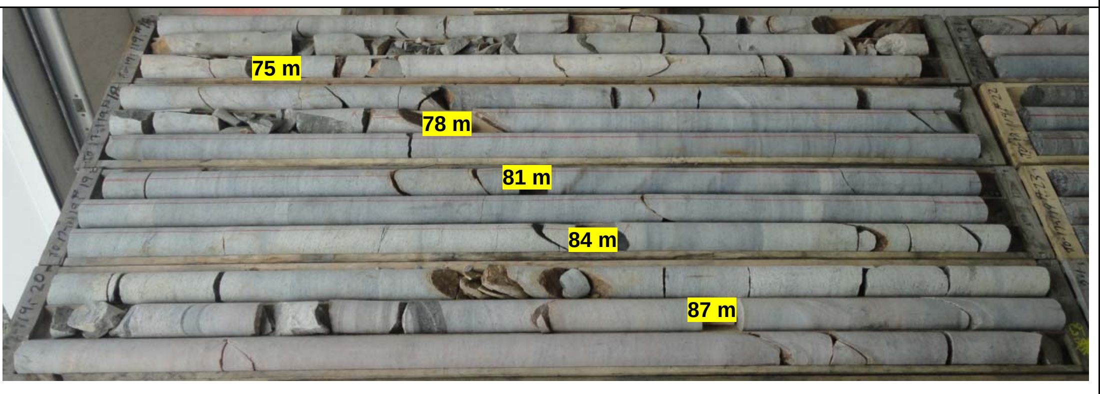


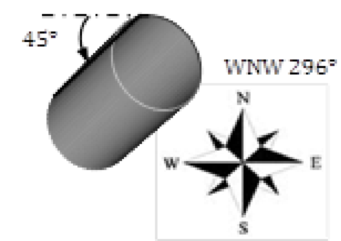
BOX #	L-17-1980-Geotechnical Hole TO-17-118 Oriented NQ Core EL.564.7 m (South West of Pit)	Comments
1-4		24-27 m; Recovery = 100%; RQD = 35.4% 27-30 m; Recovery = 100%; RQD = 68.7% 30-33m; Recovery = 100%; RQD = 28.3% 33-36m; Recovery = 100%; RQD = 96.7% 36-39m; Recovery = 100%; RQD = 94.7% 39-42 m; Recovery = 100%; RQD = 89%
5-8		42-45 m; Recovery = 100%; RQD = 70.9% 45-48 m; Recovery = 100%; RQD = 93.2% 48-51 m; Recovery = 100%; RQD = 100% 51-54 m; Recovery = 100%; RQD = 85.5% 54-57 m; Recovery = 100%; RQD = 100% 57-60 m; Recovery = 100%; RQD = 84.5%
9-12		60-63 m; Recovery = 100%; RQD = 91.2% 63-66m; Recovery = 100%; RQD = 91.5% 66-69 m; Recovery = 100%; RQD = 94.2% 69-72 m; Recovery = 100%; RQD = 93.2% 72-75 m; Recovery = 100%; RQD = 97.4%
13-16		75-78 m; Recovery = 100%; RQD = 98.4% 78-81 m; Recovery = 100%; RQD = 91.7% 81-84 m; Recovery = 100%; RQD = 84.9% 84-87 m; Recovery = 100%; RQD = 100% 87-90 m; Recovery = 100%; RQD = 100% 90-93 m; Recovery = 100%; RQD = 81.1%
17-20		93-96 m; Recovery = 100%; RQD = 84.9% 96-99 m; Recovery = 100%; RQD = 89.6% 99-102 m; Recovery = 100%; RQD = 88.3% 102-105 m; Recovery = 100%; RQD = 100% 105-108 m; Recovery = 100%; RQD = 91.2% 108-111 m; Recovery = 100%; RQD = 95.6%
21-24		111-114 m; Recovery = 100%; RQD = 100% 114-117 m; Recovery = 100%; RQD = 95.5% 117-120 m; Recovery = 100%; RQD = 100% 120-123 m; Recovery = 100%; RQD = 100% 123-126 m; Recovery = 100%; RQD = 100% 126-129 m; Recovery = 100%; RQD = 97.1%

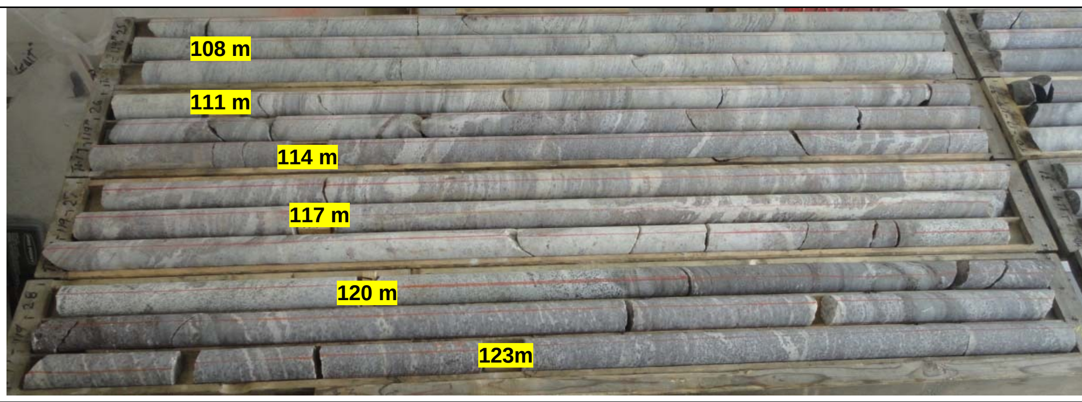
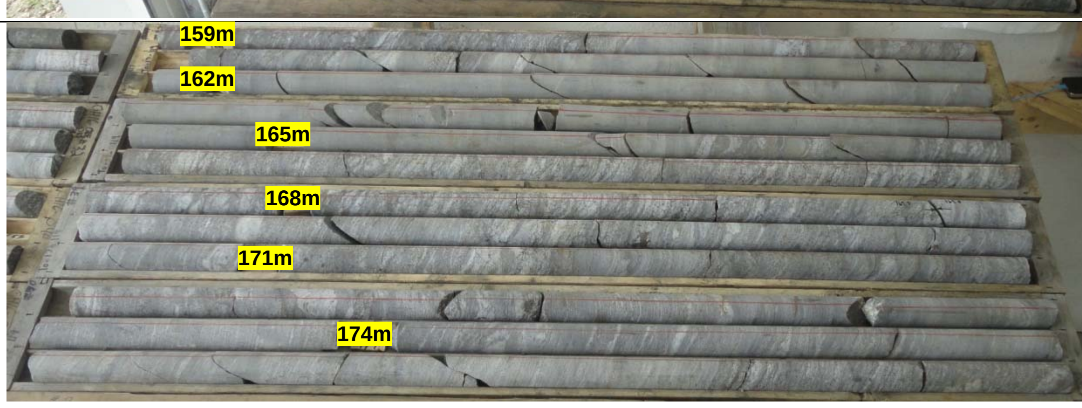
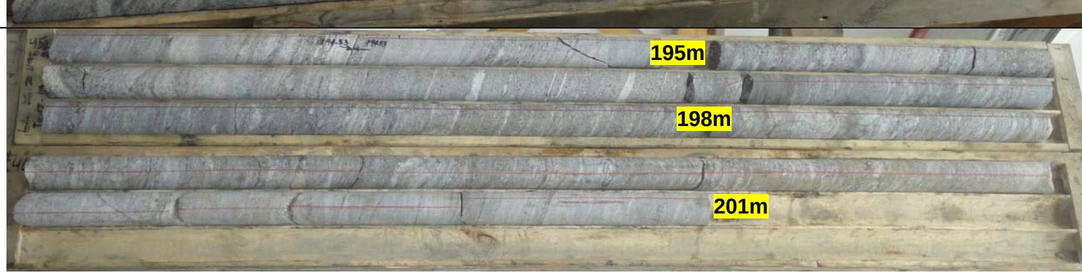


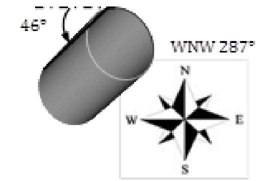
BOX #	L-17-1980-Geotechnical Hole TO-17-118 Oriented NQ Core EL.564.7 m (South West of Pit)	Comments
25-28		129-132 m; Recovery = 100%; RQD = 100% 132-135 m; Recovery = 100%; RQD = 96.6% 135-138m; Recovery = 100%; RQD = 98.3% 138-141m; Recovery = 100%; RQD = 93.9% 141-144m; Recovery = 100%; RQD = 100% 144-147m; Recovery = 100%; RQD = 100%
29-32		147-150m; Recovery = 100%; RQD = 100% 150-153m; Recovery = 100%; RQD = 100% 153-156m; Recovery = 100%; RQD = 100% 156-159m; Recovery = 100%; RQD = 100% 159-162m; Recovery = 100%; RQD = 100%
33		162-165m; Recovery = 100%; RQD = 100% 165-168m; Recovery = 100%; RQD = 100%
34-37		168-171m; Recovery = 100%; RQD = 100% 171-174m; Recovery = 100%; RQD = 100% 174-177m; Recovery = 100%; RQD = 100% 177-180m; Recovery = 100%; RQD = 96.7% 180-183m; Recovery = 100%; RQD = 100% 183-186m; Recovery = 100%; RQD = 100%
38-41		186-189m; Recovery = 100%; RQD = 94.4% 189-192m; Recovery = 100%; RQD = 94.1% 192-195m; Recovery = 100%; RQD = 63.6% 195-198m; Recovery = 100%; RQD = 77.2% 198-201m; Recovery = 100%; RQD = 95.9%

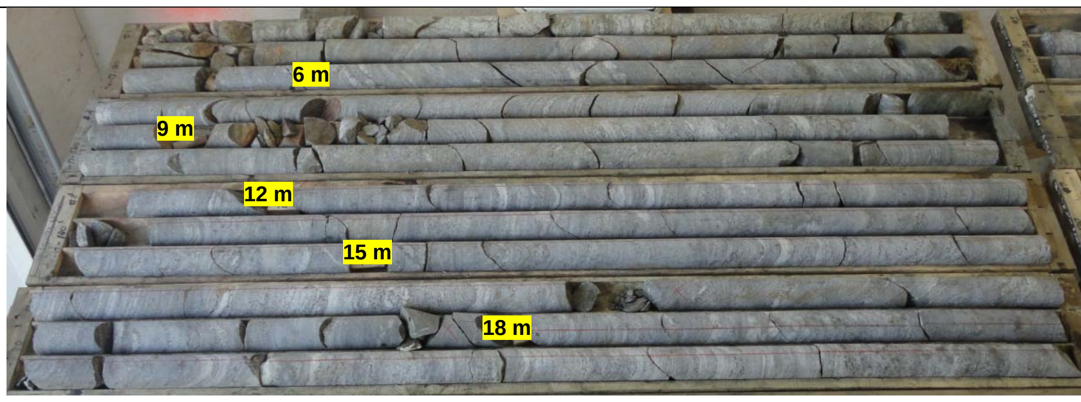
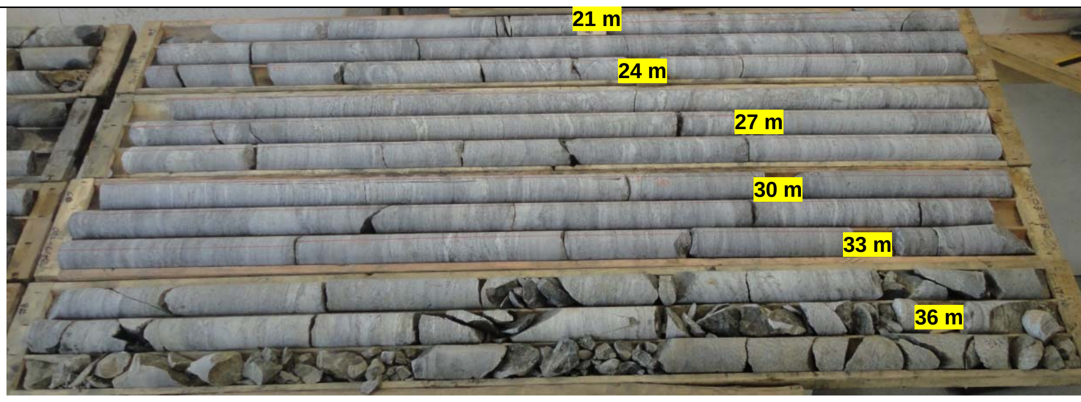
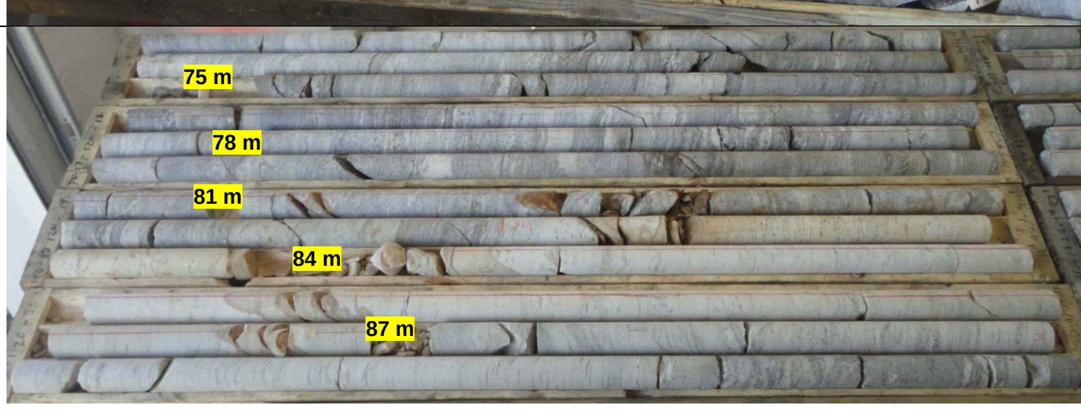
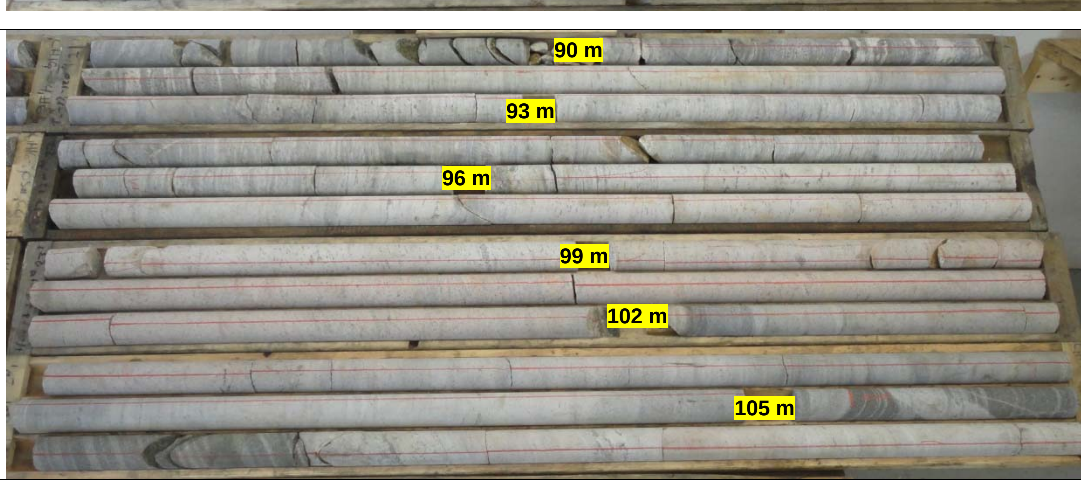


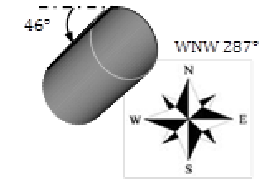
BOX #	L-17-1980-Geotechnical Hole TO-17-119 Oriented NQ Core EL.563.9 m (South East of Pit)	Comments
1-4		3-6 m; Recovery = 100%; RQD = 84.7% 6-9 m; Recovery = 100%; RQD = 90.7% 9-12m; Recovery= 100%; RQD = 100% 12-15m; Recovery = 100%; RQD = 98.3% 15-18 m; Recovery = 100%; RQD = 98% 18-21 m; Recovery = 100%; RQD = 96.8%
5-8		21-24 m; Recovery = 100%; RQD = 91.9% 24-27 m; Recovery = 100%; RQD = 61.5% 27-30 m; Recovery = 100%; RQD = 89.2% 30-33m; Recovery = 100%; RQD = 85.4% 33-36m; Recovery = 100%; RQD = 91.1% 36-39m; Recovery = 100%; RQD = 97.7%
9-12		39-42 m; Recovery = 100%; RQD = 84.7% 42-45 m; Recovery = 100%; RQD = 98.4% 45-48 m; Recovery = 100%; RQD = 100% 48-51 m; Recovery = 100%; RQD = 68.4% 51-54 m; Recovery = 100%; RQD = 76%
13-16		54-57 m; Recovery = 100%; RQD = 85.8% 57-60 m; Recovery = 100%; RQD = 31.1% 60-63 m; Recovery = 100%; RQD = 88.3% 63-66m; Recovery = 85%; RQD = 33.3% 66-69 m; Recovery = 100%; RQD = 83.6% 69-72 m; Recovery = 100%; RQD = 68.3%
17-20		72-75 m; Recovery = 100%; RQD = 57.6% 75-78 m; Recovery = 100%; RQD = 68.9% 78-81 m; Recovery = 100%; RQD = 96% 81-84 m; Recovery = 100%; RQD = 100% 84-87 m; Recovery = 100%; RQD = 68.7% 87-90 m; Recovery = 100%; RQD = 79%
21-24		90-93 m; Recovery = 100%; RQD = 92.5% 93-96 m; Recovery = 100%; RQD = 100% 96-99 m; Recovery = 100%; RQD = 100% 99-102 m; Recovery = 100%; RQD = 98% 102-105 m; Recovery = 100%; RQD = 100% 105-108 m; Recovery = 100%; RQD = 89.2%

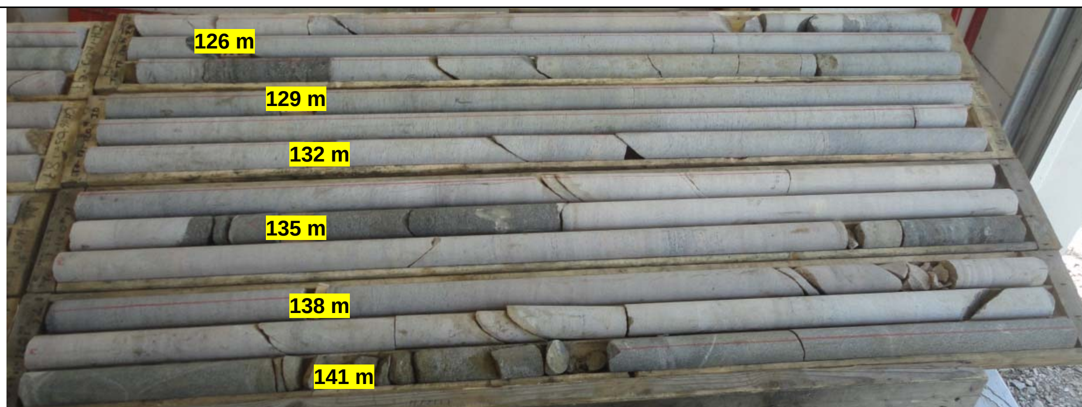
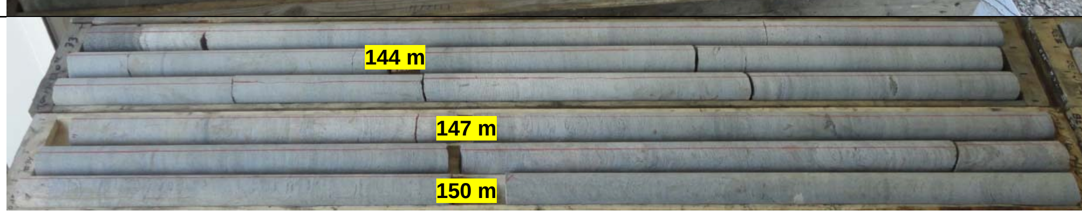
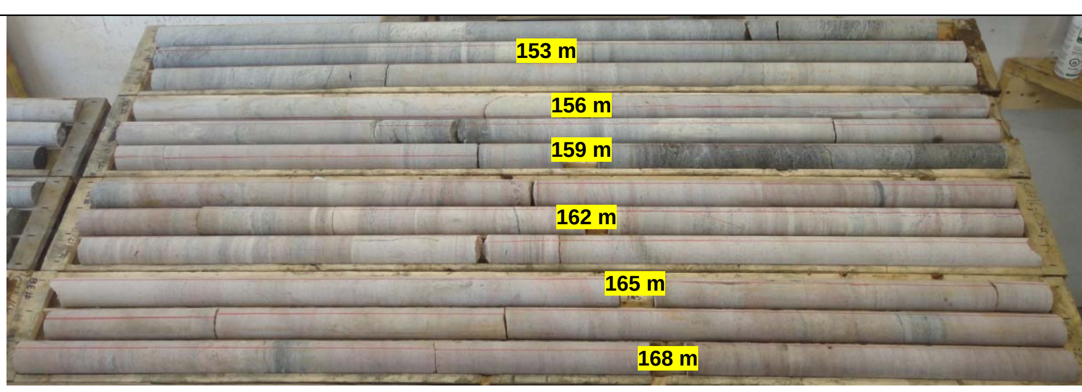
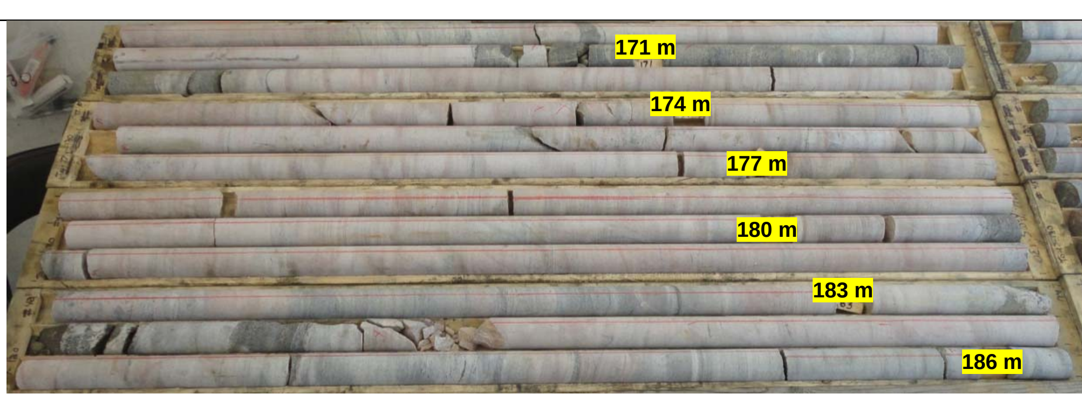


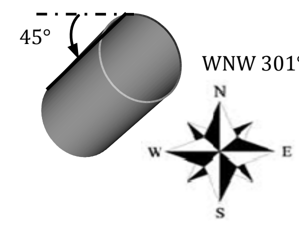
BOX #	L-17-1980-Geotechnical Hole TO-17-119 Oriented NQ Core EL.563.9 m (South East of Pit)	Comments
25-28		108-111 m; Recovery = 100%; RQD = 100% 111-114 m; Recovery = 100%; RQD = 89.6% 114-117 m; Recovery = 100%; RQD = 100% 117-120 m; Recovery = 100%; RQD = 98.7% 120-123 m; Recovery = 100%; RQD = 93%
29-32		123-126 m; Recovery = 100%; RQD = 95.3% 126-129 m; Recovery = 100%; RQD = 85.4% 129-132 m; Recovery = 100%; RQD = 100% 132-135 m; Recovery = 100%; RQD = 100% 135-138m; Recovery = 100%; RQD = 94.4% 138-141m; Recovery = 100%; RQD = 95%
33-36		141-144m; Recovery = 100%; RQD = 78% 144-147m; Recovery = 100%; RQD = 100% 147-150m; Recovery = 100%; RQD = 87.9% 150-153m; Recovery = 100%; RQD = 100% 153-156m; Recovery = 100%; RQD = 100% 156-159m; Recovery = 100%; RQD = 100%
37-40		159-162m; Recovery = 100%; RQD = 91.1% 162-165m; Recovery = 100%; RQD = 100% 165-168m; Recovery = 100%; RQD = 100% 168-171m; Recovery = 100%; RQD = 100% 171-174m; Recovery = 100%; RQD = 100% 174-177m; Recovery = 100%; RQD = 95.3%
41-44		177-180m; Recovery = 100%; RQD = 100% 180-183m; Recovery = 100%; RQD = 100% 183-186m; Recovery = 100%; RQD = 100% 186-189m; Recovery = 100%; RQD = 100% 189-192m; Recovery = 100%; RQD = 100% 192-195m; Recovery = 100%; RQD = 100%
45-48		195-198m; Recovery = 100%; RQD = 100% 198-201m; Recovery = 100%; RQD = 100%

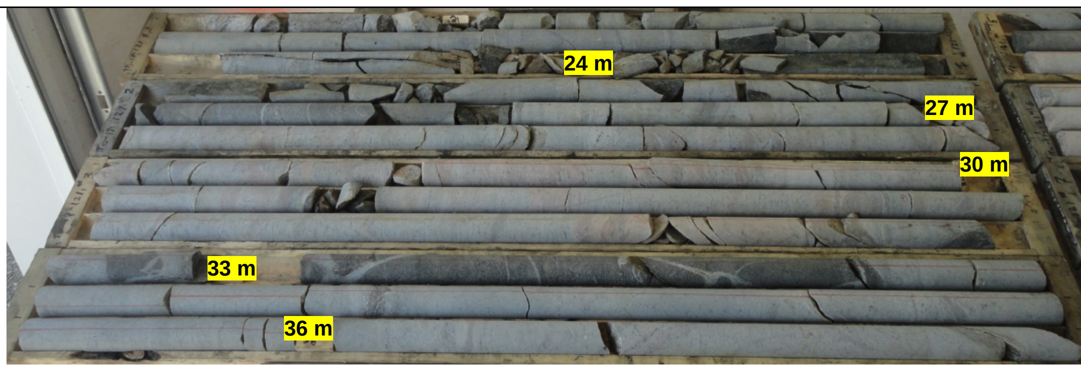
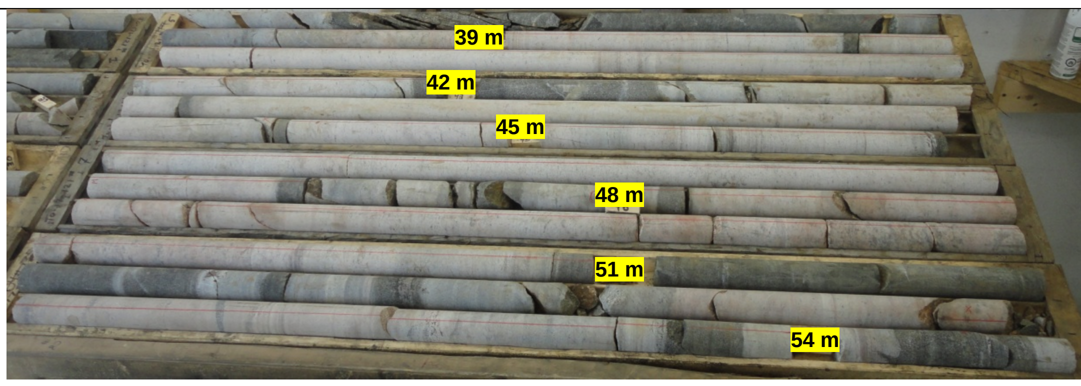
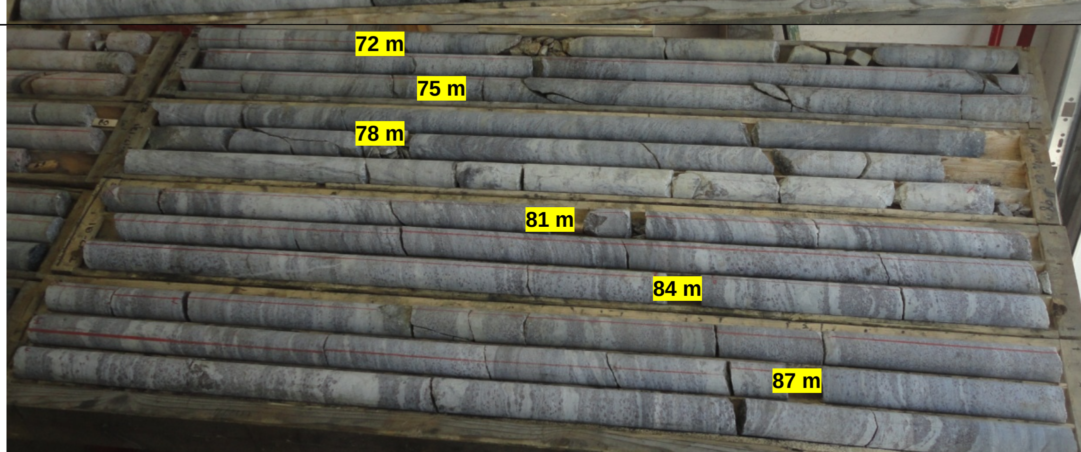
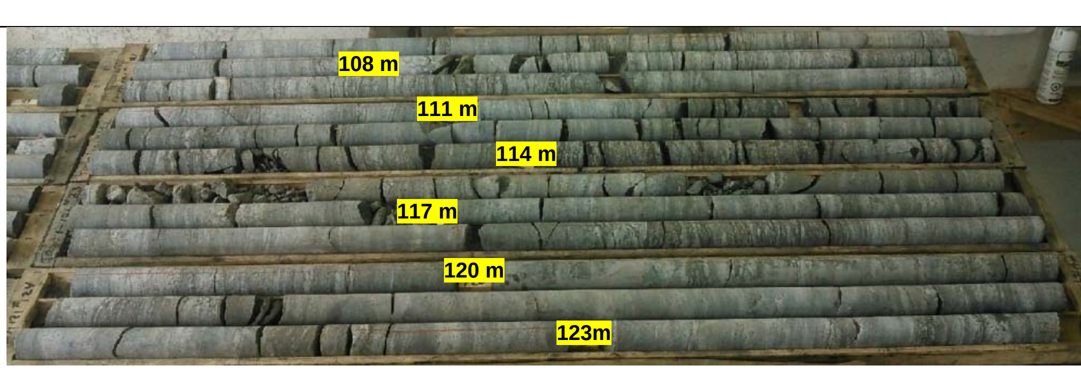


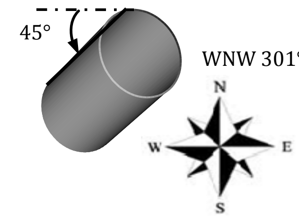
BOX #	L-17-1980-Geotechnical Hole TO-17-120 Oriented NQ Core EL.545.6 m (West of Pit)	Comments
1-4		3-6 m; Recovery = 100%; RQD = 72.2% 6-9 m; Recovery = 100%; RQD = 79.1% 9-12m; Recovery= 100%; RQD = 73.1% 12-15m; Recovery = 100%; RQD = 92.4% 15-18 m; Recovery = 100%; RQD = 87% 18-21 m; Recovery = 100%; RQD = 94.1%
5-8		21-24 m; Recovery = 100%; RQD = 100% 24-27 m; Recovery = 100%; RQD = 94.4% 27-30 m; Recovery = 100%; RQD = 100% 30-33m; Recovery = 100%; RQD = 100% 33-36m; Recovery = 100%; RQD = 25.7% 36-39m; Recovery = 100%; RQD = 20%
9-12		39-42 m; Recovery = 100%; RQD = 35.3% 42-45 m; Recovery = 100%; RQD = 88.3% 45-48 m; Recovery = 100%; RQD = 91.5% 48-51 m; Recovery = 100%; RQD = 95.2% 51-54 m; Recovery = 100%; RQD = 94.7%
13-16		54-57 m; Recovery = 100%; RQD = 100% 57-60 m; Recovery = 100%; RQD = 94.4% 60-63 m; Recovery = 100%; RQD = 97.7% 63-66m; Recovery = 100%; RQD = 100% 66-69 m; Recovery = 100%; RQD = 89% 69-72 m; Recovery = 100%; RQD = 100%
17-20		72-75 m; Recovery = 100%; RQD = 86.8% 75-78 m; Recovery = 100%; RQD = 89.9% 78-81 m; Recovery = 100%; RQD = 95.9% 81-84 m; Recovery = 100%; RQD = 91.7% 84-87 m; Recovery = 100%; RQD = 89.8% 87-90 m; Recovery = 100%; RQD = 70.2%
21-24		90-93 m; Recovery = 100%; RQD = 93.8% 93-96 m; Recovery = 100%; RQD = 96.7% 96-99 m; Recovery = 100%; RQD = 95.8% 99-102 m; Recovery = 100%; RQD = 94.4% 102-105 m; Recovery = 100%; RQD = 100% 105-108 m; Recovery = 100%; RQD = 97%

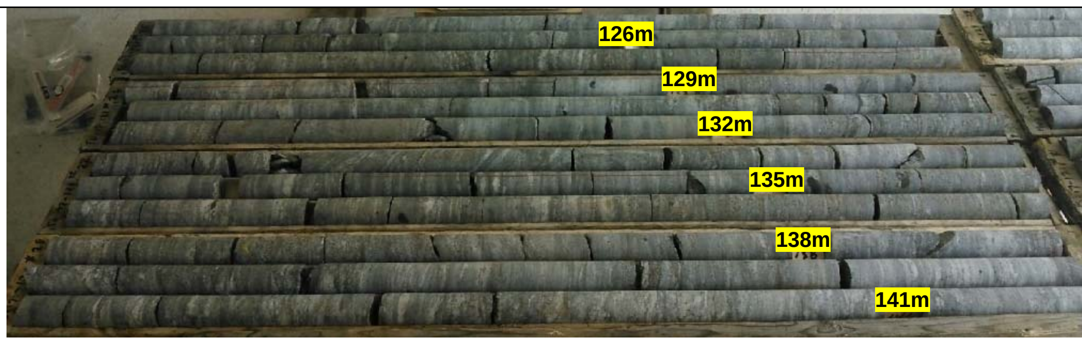
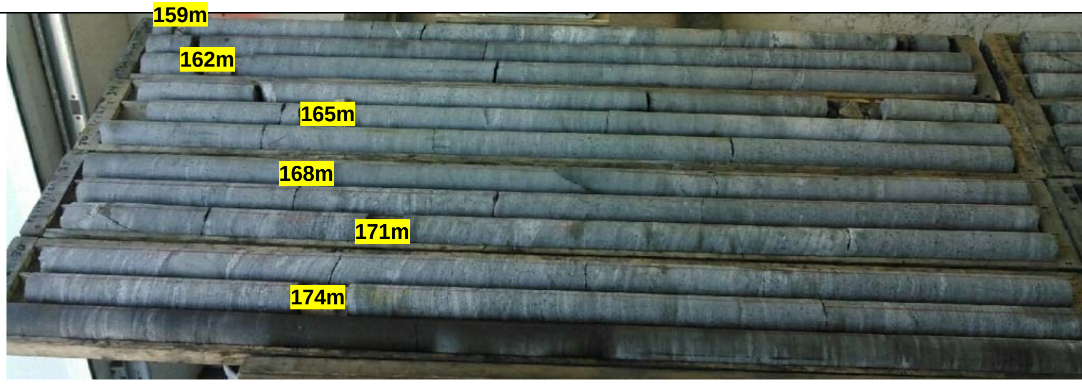
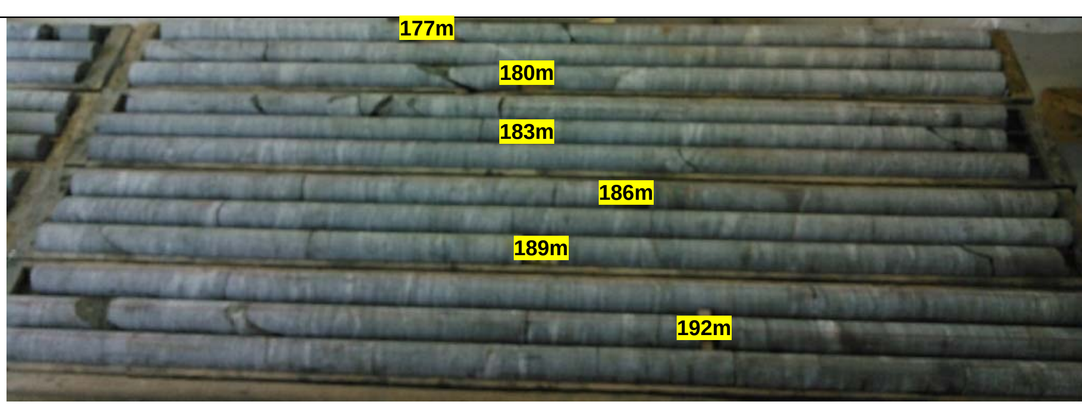
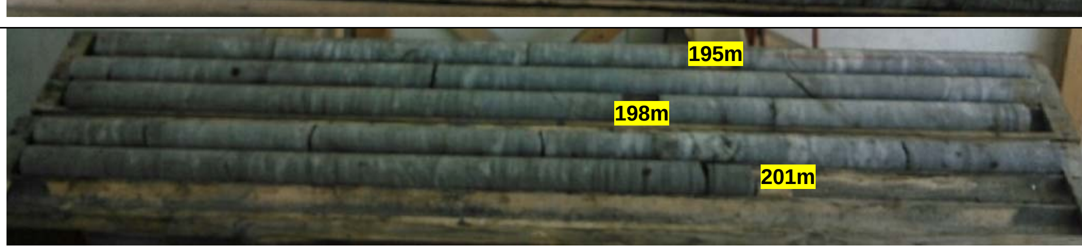


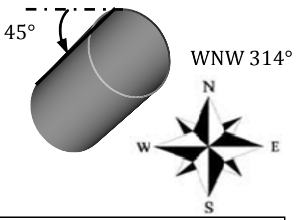
BOX #	L-17-1980-Geotechnical Hole TO-17-120 Oriented NQ Core EL.545.6 m (West of Pit)	Comments
25-28		108-111 m; Recovery = 100%; RQD = 98% 111-114 m; Recovery = 100%; RQD = 84.2% 114-117 m; Recovery = 100%; RQD = 77% 117-120 m; Recovery = 100%; RQD = 85.2% 120-123 m; Recovery = 100%; RQD = 94.3%
29-32		123-126 m; Recovery = 100%; RQD = 86% 126-129 m; Recovery = 100%; RQD = 100% 129-132 m; Recovery = 100%; RQD = 100% 132-135 m; Recovery = 100%; RQD = 96.6% 135-138m; Recovery = 100%; RQD = 97% 138-141m; Recovery = 100%; RQD = 90.6%
33-34		141-144m; Recovery = 100%; RQD = 81.3% 144-147m; Recovery = 100%; RQD = 100% 147-150m; Recovery = 100%; RQD = 100%
35-38		150-153m; Recovery = 100%; RQD = 100% 153-156m; Recovery = 100%; RQD = 100% 156-159m; Recovery = 100%; RQD = 100% 159-162m; Recovery = 100%; RQD = 100% 162-165m; Recovery = 100%; RQD = 100% 165-168m; Recovery = 100%; RQD = 100%
39-42		168-171m; Recovery = 100%; RQD = 94.6% 171-174m; Recovery = 100%; RQD = 94.6% 174-177m; Recovery = 100%; RQD = 100% 177-180m; Recovery = 100%; RQD = 100% 180-183m; Recovery = 100%; RQD = 100% 183-186m; Recovery = 100%; RQD = 91.1%
43-46		186-189m; Recovery = 100%; RQD = 100% 189-192m; Recovery = 100%; RQD = 100% 192-195m; Recovery = 100%; RQD = 96.9% 195-198m; Recovery = 100%; RQD = 93% 198-201m; Recovery = 100%; RQD = 87.9%

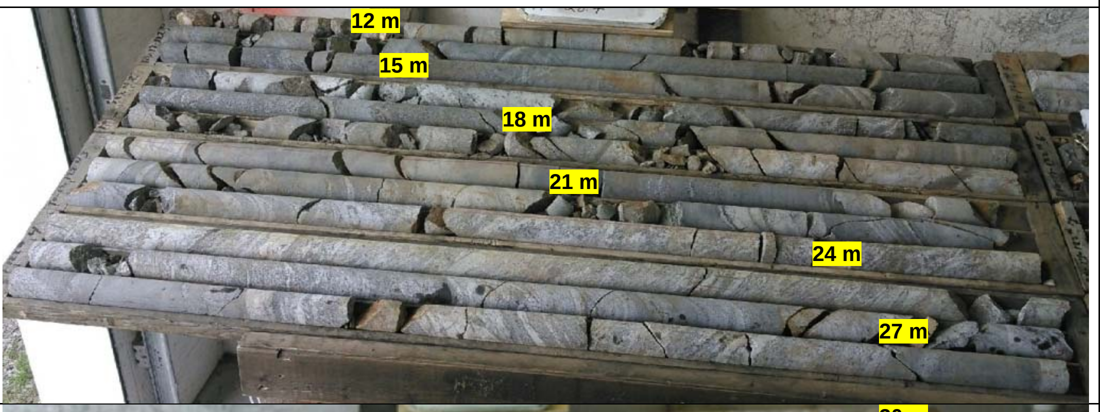
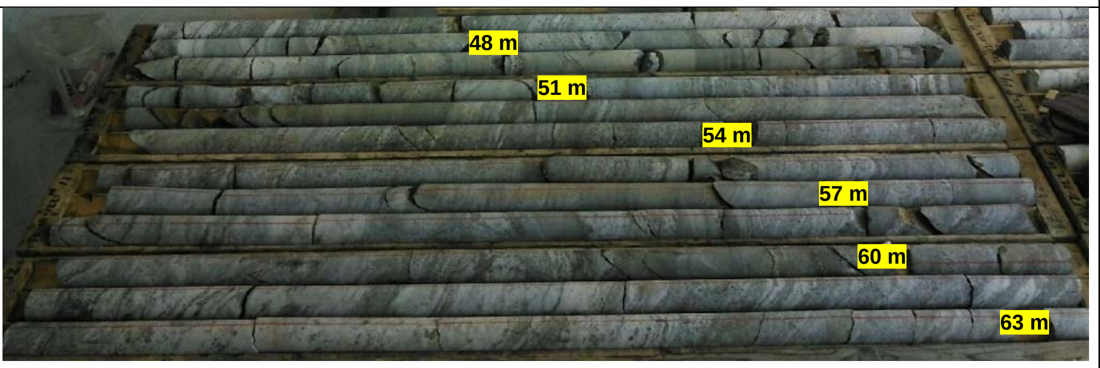
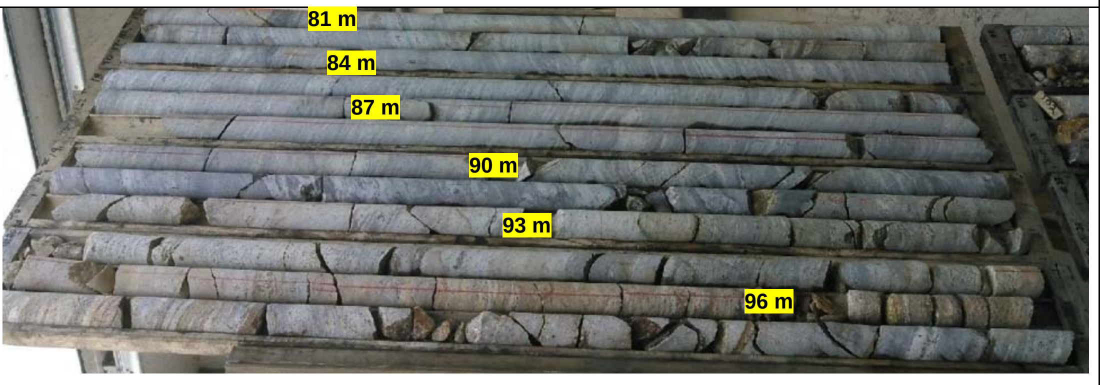


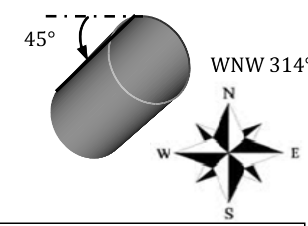
BOX #	L-17-1980-Geotechnical Hole TO-17-121 Oriented NQ Core EL.540.6 m (East of Pit)	Comments
1-4		21-24 m; Recovery = 100%; RQD = 80.5% 24-27 m; Recovery = 100%; RQD = 63.6% 27-30 m; Recovery = 100%; RQD = 86.7% 30-33m; Recovery = 100%; RQD = 92.6% 33-36m; Recovery = 100%; RQD = 97%
5-8		36-39m; Recovery = 100%; RQD = 89% 39-42 m; Recovery = 100%; RQD = 96.9% 42-45 m; Recovery = 100%; RQD = 95.7% 45-48 m; Recovery = 100%; RQD = 93.1% 48-51 m; Recovery = 100%; RQD = 95% 51-54 m; Recovery = 100%; RQD = 91.7%
9-12		54-57 m; Recovery = 100%; RQD = 81.8% 57-60 m; Recovery = 100%; RQD = 86.9% 60-63 m; Recovery = 100%; RQD = 100% 63-66m; Recovery = 100%; RQD = 92.6% 66-69 m; Recovery = 100%; RQD = 100% 69-72 m; Recovery = 100%; RQD = 86.4%
13-16		72-75 m; Recovery = 100%; RQD = 85.34% 75-78 m; Recovery = 100%; RQD = 94.1% 78-81 m; Recovery = 100%; RQD = 94.8% 81-84 m; Recovery = 100%; RQD = 96.4% 84-87 m; Recovery = 100%; RQD = 92.3% 87-90 m; Recovery = 100%; RQD = 96.8%
17-20		90-93 m; Recovery = 100%; RQD = 96.4% 93-96 m; Recovery = 100%; RQD = 87.3% 96-99 m; Recovery = 100%; RQD = 95.5% 99-102 m; Recovery = 100%; RQD = 81.5% 102-105 m; Recovery = 100%; RQD = 100%
21-24		105-108 m; Recovery = 100%; RQD = 94.37% 108-111 m; Recovery = 100%; RQD = 69.4% 111-114 m; Recovery = 100%; RQD = 34.9% 114-117 m; Recovery = 100%; RQD = 37.9% 117-120 m; Recovery = 100%; RQD = 96% 120-123 m; Recovery = 100%; RQD = 93.5%

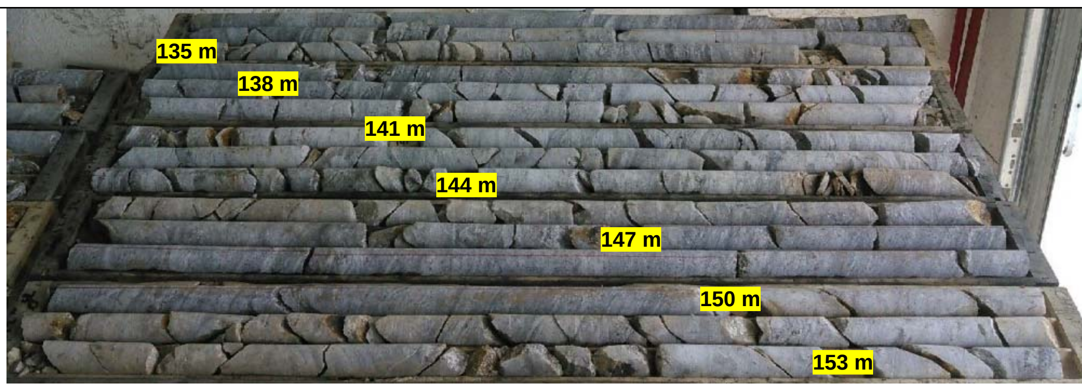
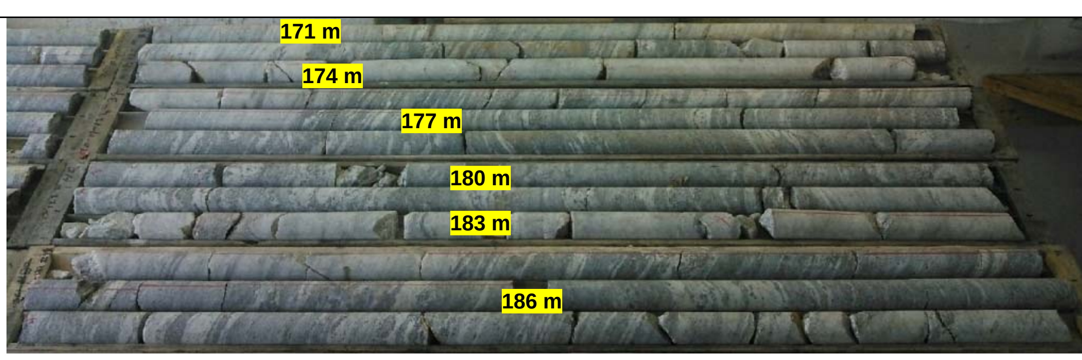
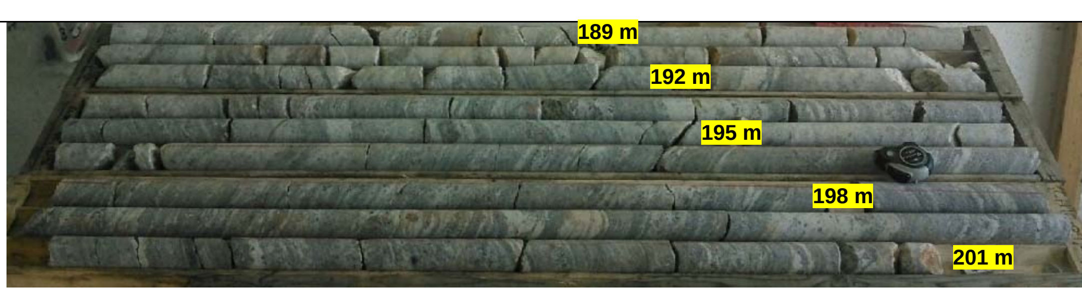


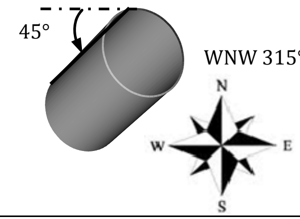
BOX #	L-17-1980-Geotechnical Hole TO-17-121 Oriented NQ Core EL.540.6 m (East of Pit)	Comments
25-28		123-126 m; Recovery = 100%; RQD = 95.4% 126-129 m; Recovery = 100%; RQD = 100% 129-132 m; Recovery = 100%; RQD = 97% 132-135 m; Recovery = 100%; RQD = 93.3% 135-138m; Recovery = 100%; RQD = 95.3% 138-141m; Recovery = 100%; RQD = 94.1%
29-32		141-144m; Recovery = 100%; RQD = 98.3% 144-147m; Recovery = 100%; RQD = 95.4% 147-150m; Recovery = 100%; RQD = 94.6% 150-153m; Recovery = 100%; RQD = 94.7% 153-156m; Recovery = 100%; RQD = 100% 156-159m; Recovery = 100%; RQD = 100%
33-36		159-162m; Recovery = 100%; RQD = 93.1% 162-165m; Recovery = 100%; RQD = 94.2% 165-168m; Recovery = 100%; RQD = 100% 168-171m; Recovery = 100%; RQD = 100% 171-174m; Recovery = 100%; RQD = 100% 174-177m; Recovery = 100%; RQD = 100%
37-40		177-180m; Recovery = 100%; RQD = 100% 180-183m; Recovery = 100%; RQD = 94% 183-186m; Recovery = 100%; RQD = 100% 186-189m; Recovery = 100%; RQD = 100% 189-192m; Recovery = 100%; RQD = 100% 192-195m; Recovery = 100%; RQD = 100%
41-44		195-198m; Recovery = 100%; RQD = 100% 198-201m; Recovery = 100%; RQD = 100%

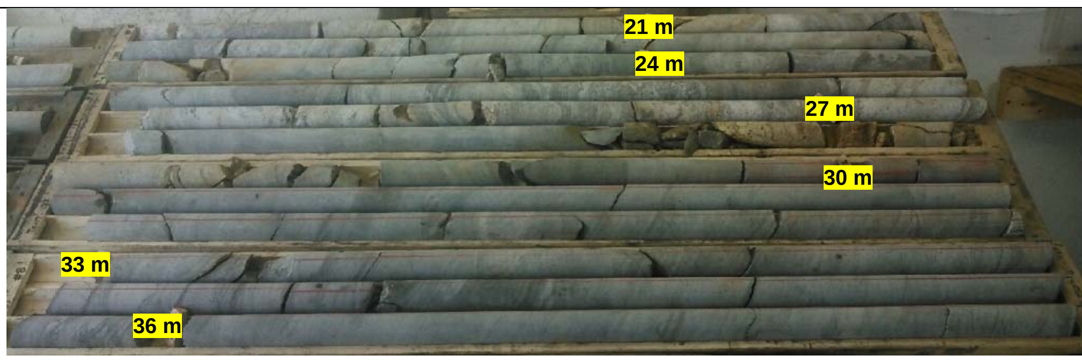
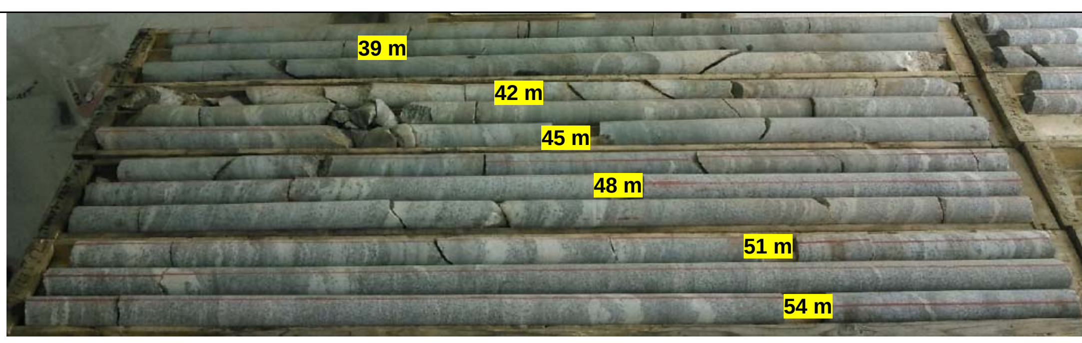
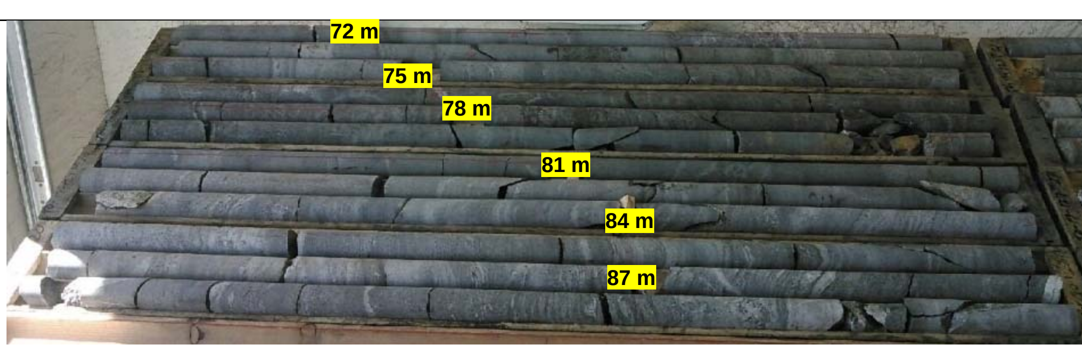
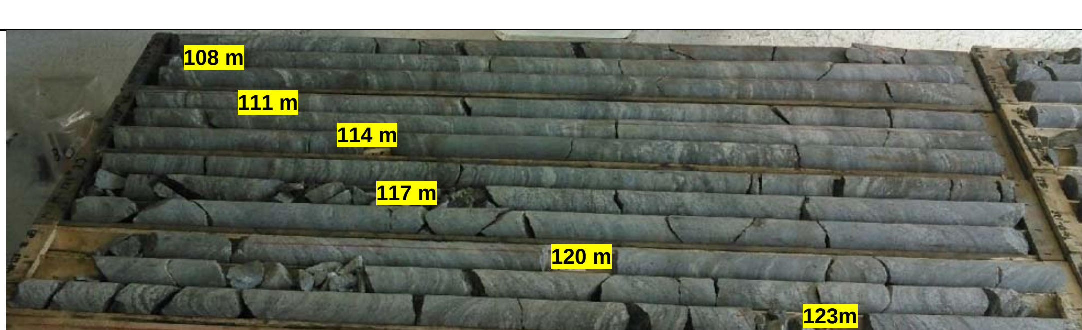


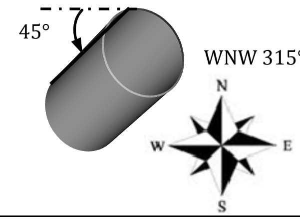
BOX #	L-17-1980-Geotechnical Hole TO-17-122 Oriented NQ Core EL.524.8 m (North West of Pit)	Comments
1-4		12-15m; Recovery = 100%; RQD = 89.1% 15-18 m; Recovery = 100%; RQD = 82.7% 18-21 m; Recovery = 100%; RQD = 58.9% 21-24 m; Recovery = 100%; RQD = 85.2% 24-27 m; Recovery = 100%; RQD = 92.2% 27-30 m; Recovery = 100%; RQD = 85.1%
5-8		30-33m; Recovery = 100%; RQD = 95% 33-36m; Recovery = 100%; RQD = 88.7% 36-39m; Recovery = 100%; RQD = 93.2% 39-42 m; Recovery = 100%; RQD = 91% 42-45 m; Recovery = 100%; RQD = 82.3%
9-12		45-48 m; Recovery = 100%; RQD = 95.3% 48-51 m; Recovery = 100%; RQD = 82.6% 51-54 m; Recovery = 100%; RQD = 90.4% 54-57 m; Recovery = 100%; RQD = 93.4% 57-60 m; Recovery = 100%; RQD = 91.2% 60-63 m; Recovery = 100%; RQD = 95.5%
13-16		63-66m; Recovery = 100%; RQD = 97.6% 66-69 m; Recovery = 100%; RQD = 100% 69-72 m; Recovery = 100%; RQD = 88.6% 72-75 m; Recovery = 100%; RQD = 89.6% 75-78 m; Recovery = 100%; RQD = 97.1% 78-81 m; Recovery = 100%; RQD = 98.3%
17-20		81-84 m; Recovery = 100%; RQD = 95.7% 84-87 m; Recovery = 100%; RQD = 96% 87-90 m; Recovery = 100%; RQD = 100% 90-93 m; Recovery = 100%; RQD = 80% 93-96 m; Recovery = 100%; RQD = 67.7% 96-99 m; Recovery = 100%; RQD = 56.9%
21-24		99-102 m; Recovery = 100%; RQD = 81.1% 102-105 m; Recovery = 100%; RQD = 83% 105-108 m; Recovery = 100%; RQD = 97.7% 108-111 m; Recovery = 100%; RQD = 96.4% 111-114 m; Recovery = 100%; RQD = 96%

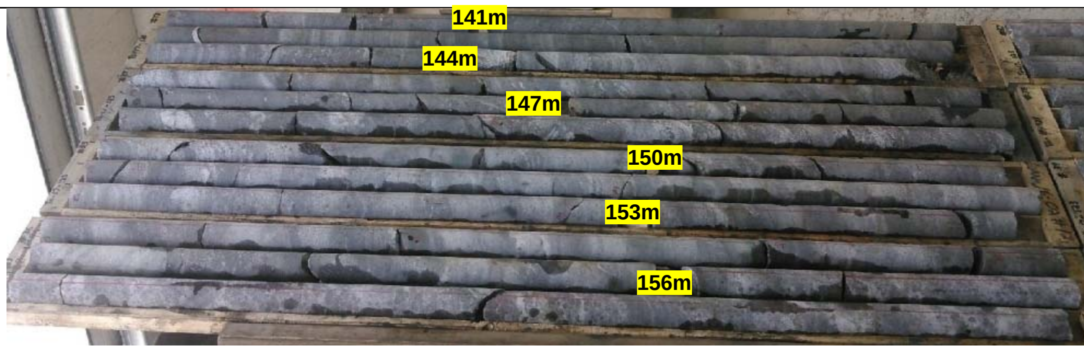
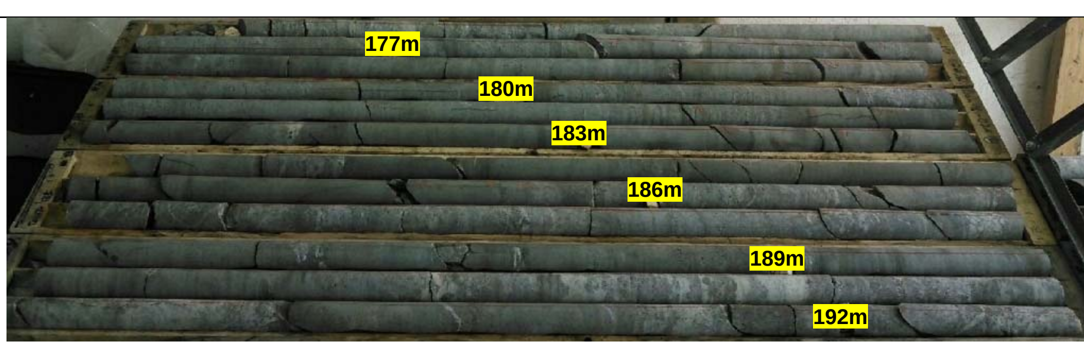


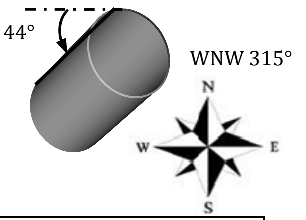
BOX #	L-17-1980-Geotechnical Hole TO-17-122 Oriented NQ Core EL.524.8 m (North West of Pit)	Comments
25-28		114-117 m; Recovery = 100%; RQD = 81% 117-120 m; Recovery = 100%; RQD = 73.5% 120-123 m; Recovery = 100%; RQD = 83.8% 123-126 m; Recovery = 100%; RQD = 81.3% 126-129 m; Recovery = 100%; RQD = 66.9% 129-132 m; Recovery = 100%; RQD = 75.5%
29-33		132-135 m; Recovery = 100%; RQD = 91.7% 135-138m; Recovery = 100%; RQD = 55.6% 138-141m; Recovery = 100%; RQD = 57.9% 141-144m; Recovery = 100%; RQD = 75.2% 144-147m; Recovery = 100%; RQD = 77.6% 147-150m; Recovery = 100%; RQD = 100% 150-153m; Recovery = 100%; RQD = 73.4%
34-37		153-156m; Recovery = 100%; RQD = 96% 156-159m; Recovery = 100%; RQD = 98% 159-162m; Recovery = 100%; RQD = 100% 162-165m; Recovery = 100%; RQD = 89.1% 165-168m; Recovery = 100%; RQD = 87.7% 168-171m; Recovery = 100%; RQD = 89 %
38-41		171-174m; Recovery = 100%; RQD = 91.3% 174-177m; Recovery = 100%; RQD = 97.7% 177-180m; Recovery = 100%; RQD = 96.1% 180-183m; Recovery = 100%; RQD = 83.2% 183-186m; Recovery = 100%; RQD = 95.6% 186-189m; Recovery = 100%; RQD = 85.9%
42-44		189-192m; Recovery = 100%; RQD = 84.6% 192-195m; Recovery = 100%; RQD = 95.8% 195-198m; Recovery = 100%; RQD = 97.4% 198-201m; Recovery = 100%; RQD = 94%

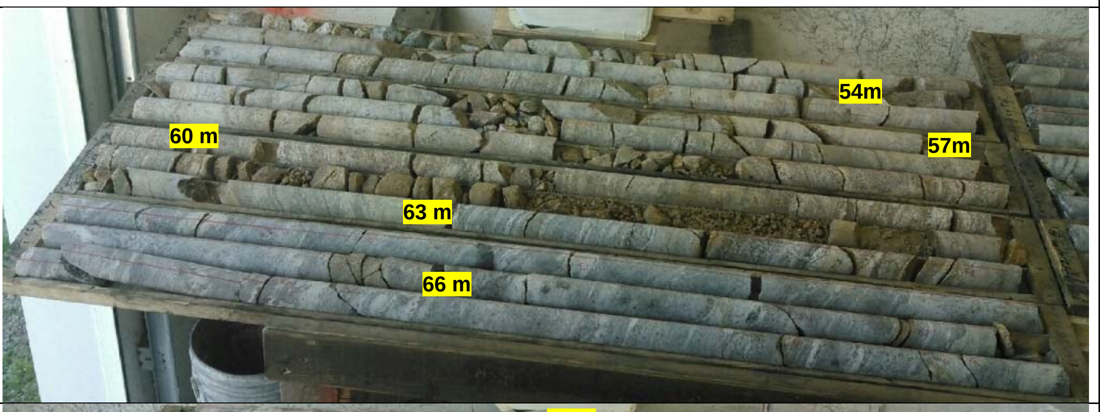
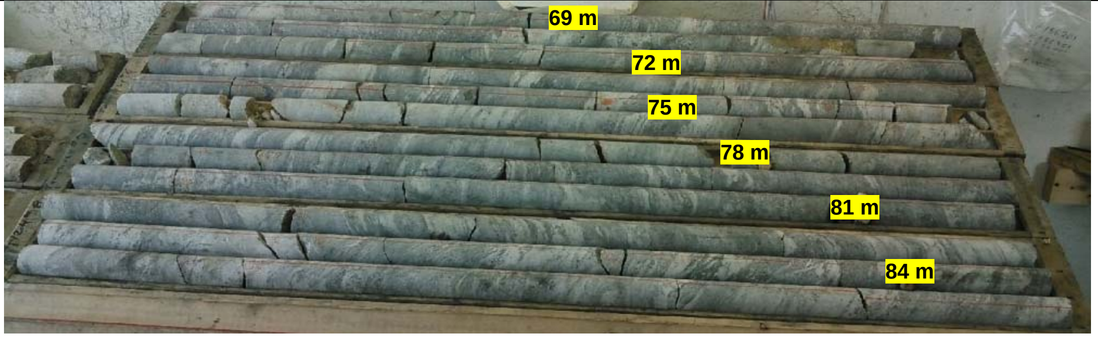
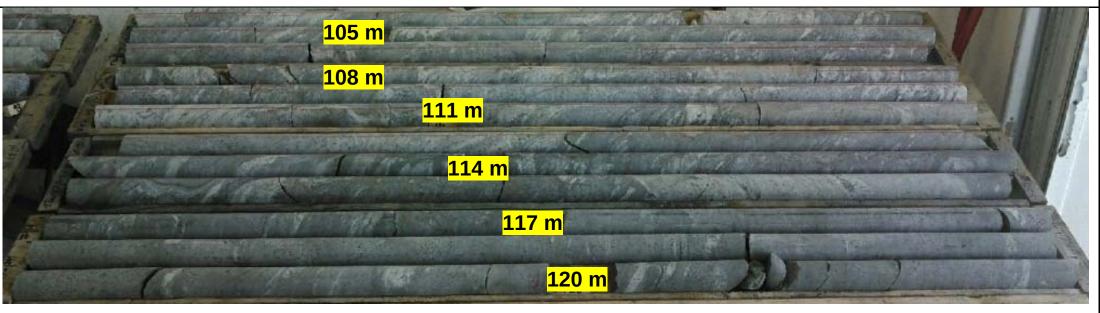
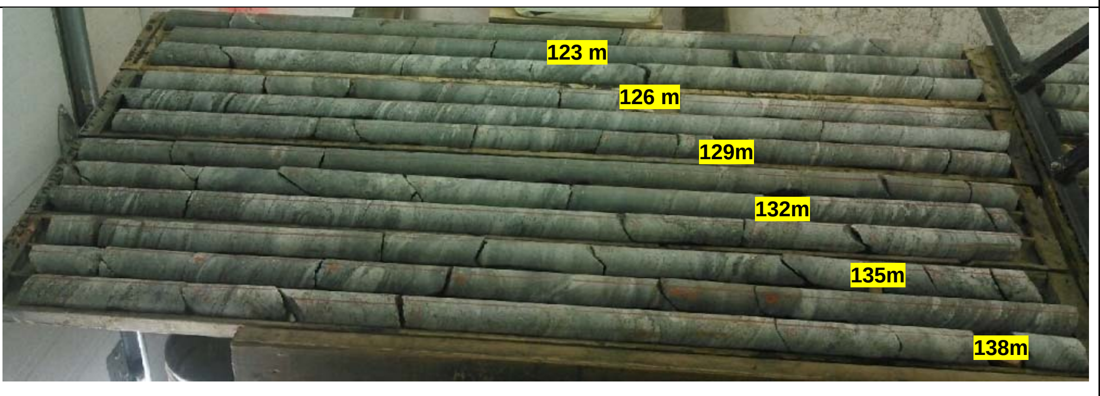


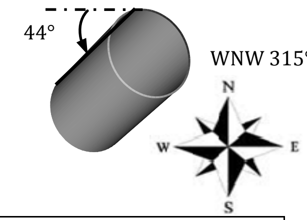
BOX #	L-17-1980-Geotechnical Hole TO-17-123 Oriented NQ Core EL. 548.9 m (North East of Pit)	Comments
1-4		3-6 m; Recovery = 100%; RQD = 70.2% 6-9 m; Recovery = 100%; RQD = 67.3% 9-12m; Recovery= 100%; RQD = 60.9% 12-15m; Recovery = 100%; RQD = 90.1% 15-18 m; Recovery = 100%; RQD = 74.7% 18-21 m; Recovery = 100%; RQD = 94.7%
5-8		21-24 m; Recovery = 100%; RQD = 96.3% 24-27 m; Recovery = 100%; RQD = 98.1% 27-30 m; Recovery = 100%; RQD = 72.9% 30-33m; Recovery = 100%; RQD = 96.1% 33-36m; Recovery = 100%; RQD = 97%
9-12		36-39m; Recovery = 100%; RQD = 97.4% 39-42 m; Recovery = 100%; RQD = 93.5% 42-45 m; Recovery = 100%; RQD = 91.3% 45-48 m; Recovery = 100%; RQD = 100% 48-51 m; Recovery = 100%; RQD = 100% 51-54 m; Recovery = 100%; RQD = 100%
13-16		54-57 m; Recovery = 100%; RQD = 100% 57-60 m; Recovery = 100%; RQD = 100% 60-63 m; Recovery = 100%; RQD = 93.9% 63-66m; Recovery = 100%; RQD = 92.6% 66-69 m; Recovery = 100%; RQD = 91.4% 69-72 m; Recovery = 100%; RQD = 86.7%
17-20		72-75 m; Recovery = 100%; RQD = 100% 75-78 m; Recovery = 100%; RQD = 97.3% 78-81 m; Recovery = 100%; RQD = 91.3% 81-84 m; Recovery = 100%; RQD = 100% 84-87 m; Recovery = 100%; RQD = 100% 87-90 m; Recovery = 100%; RQD = 92.3%
21-24		90-93 m; Recovery = 100%; RQD = 88.2% 93-96 m; Recovery = 100%; RQD = 100% 96-99 m; Recovery = 100%; RQD = 100% 99-102 m; Recovery = 100%; RQD = 97% 102-105 m; Recovery = 100%; RQD = 100%
25-28		105-108 m; Recovery = 100%; RQD = 94.3% 108-111 m; Recovery = 100%; RQD = 100% 111-114 m; Recovery = 100%; RQD = 100% 114-117 m; Recovery = 100%; RQD = 86.7% 117-120 m; Recovery = 100%; RQD = 90.3% 120-123 m; Recovery = 100%; RQD = 70.9%

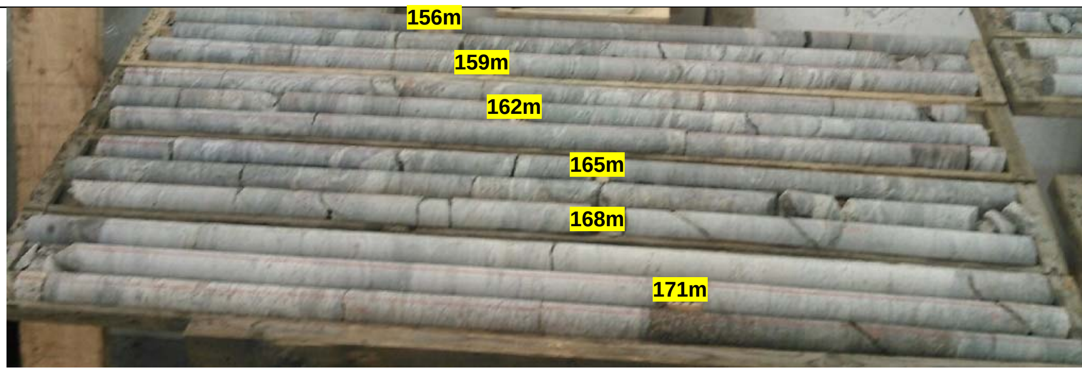


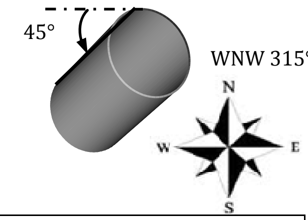
BOX #	L-17-1980-Geotechnical Hole TO-17-123 Oriented NQ Core EL. 548.9 m (North East of Pit)	Comments
29-33		123-126 m; Recovery = 100%; RQD = 77.7% 126-129 m; Recovery = 100%; RQD = 98% 129-132 m; Recovery = 100%; RQD = 100% 132-135 m; Recovery = 100%; RQD = 100% 135-138m; Recovery = 100%; RQD = 95.4% 138-141m; Recovery = 100%; RQD = 100%
34-37		141-144m; Recovery = 100%; RQD = 97.3% 144-147m; Recovery = 100%; RQD = 100% 147-150m; Recovery = 100%; RQD = 100% 150-153m; Recovery = 100%; RQD = 94.3% 153-156m; Recovery = 100%; RQD = 97.7% 156-159m; Recovery = 100%; RQD = 97.4%
38-41		159-162m; Recovery = 100%; RQD = 93.7% 162-165m; Recovery = 100%; RQD = 100% 165-168m; Recovery = 100%; RQD = 100% 168-171m; Recovery = 100%; RQD = 77.9% 171-174m; Recovery = 100%; RQD = 98%
42-44		174-177m; Recovery = 100%; RQD = 68.3% 177-180m; Recovery = 100%; RQD = 100% 180-183m; Recovery = 100%; RQD =97.4% 183-186m; Recovery = 100%; RQD = 87% 186-189m; Recovery = 100%; RQD = 95% 189-192m; Recovery = 100%; RQD = 93.7%
45-46		192-195m; Recovery = 100%; RQD = 94.1% 195-198m; Recovery = 100%; RQD = 98.4% 198-201m; Recovery = 100%; RQD = 97.7%

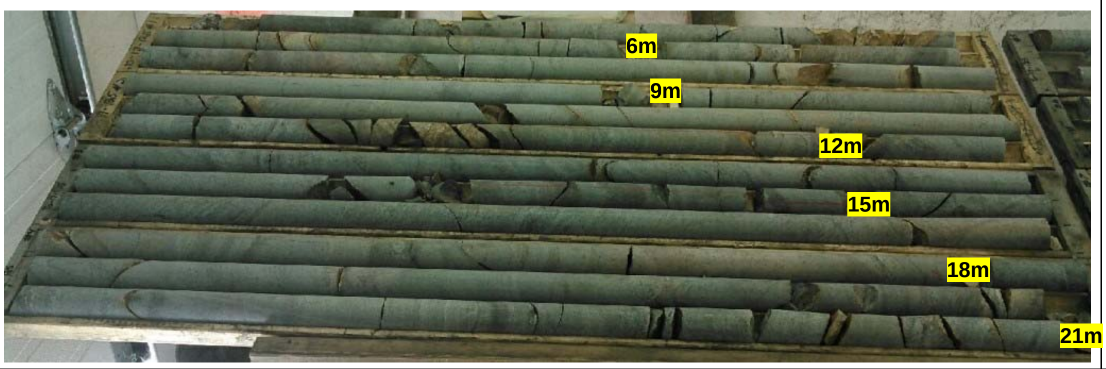
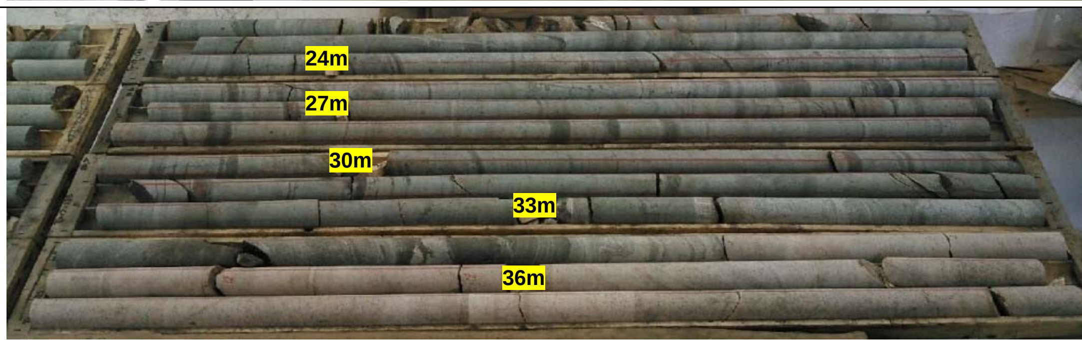
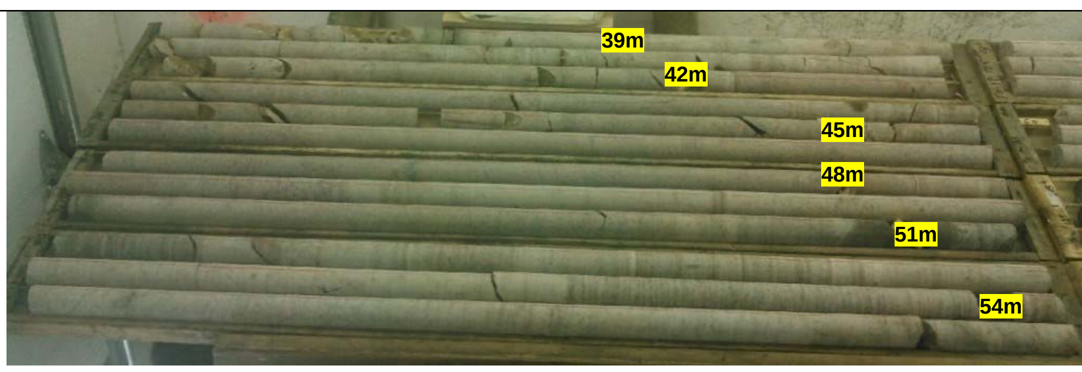
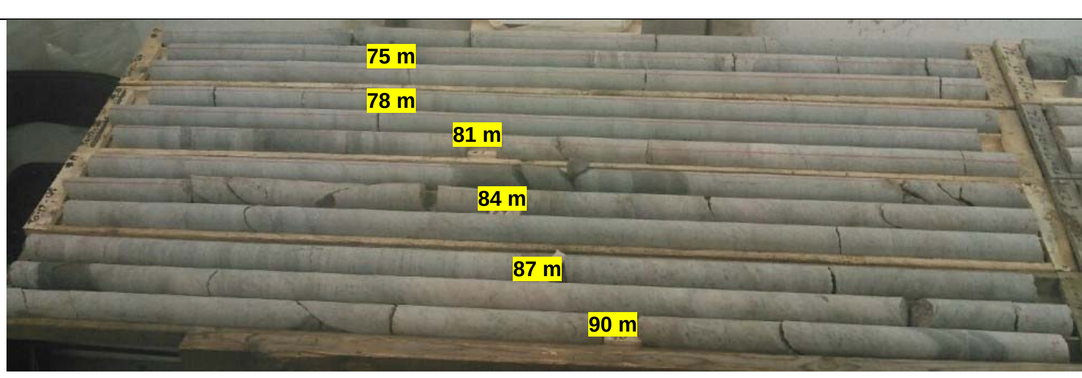


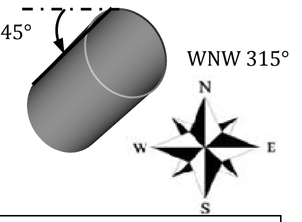
BOX #	L-17-1980-Geotechnical Hole TO-17-124 Oriented NQ Core EL.525.8 m (North West of Pit)	Comments
1-4		51-54 m; Recovery = 100%; RQD = 39.7% 54-57 m; Recovery = 100%; RQD = 66.6% 57-60 m; Recovery = 100%; RQD = 59.9% 60-63 m; Recovery = 100%; RQD = 49.8% 63-66m; Recovery = 85%; RQD = 90% 66-69 m; Recovery = 100%; RQD = 88.5%
5-8		69-72 m; Recovery = 100%; RQD = 100% 72-75 m; Recovery = 100%; RQD = 98% 75-78 m; Recovery = 100%; RQD = 83.8% 78-81 m; Recovery = 100%; RQD = 92.8% 81-84 m; Recovery = 100%; RQD = 91% 84-87 m; Recovery = 100%; RQD = 90%
9-12		87-90 m; Recovery = 100%; RQD = 100% 90-93 m; Recovery = 100%; RQD = 95.7% 93-96 m; Recovery = 100%; RQD = 96% 96-99 m; Recovery = 100%; RQD = 97.4% 99-102 m; Recovery = 100%; RQD = 98.7%
13-16		102-105 m; Recovery = 100%; RQD = 100% 105-108 m; Recovery = 100%; RQD = 98.6% 108-111 m; Recovery = 100%; RQD = 97.7% 111-114 m; Recovery = 100%; RQD = 100% 114-117 m; Recovery = 100%; RQD = 100% 117-120 m; Recovery = 100%; RQD = 94%
17-20		120-123 m; Recovery = 100%; RQD = 100% 123-126 m; Recovery = 100%; RQD = 97% 126-129 m; Recovery = 100%; RQD = 96.1% 129-132 m; Recovery = 100%; RQD = 97.7% 132-135 m; Recovery = 100%; RQD = 96% 135-138m; Recovery = 100%; RQD = 95%
21-24		138-141m; Recovery = 100%; RQD = 97% 141-144m; Recovery = 100%; RQD = 93.7% 144-147m; Recovery = 100%; RQD = 100% 147-150m; Recovery = 100%; RQD = 88.4% 150-153m; Recovery = 100%; RQD = 91.5% 153-156m; Recovery = 100%; RQD = 93.4%

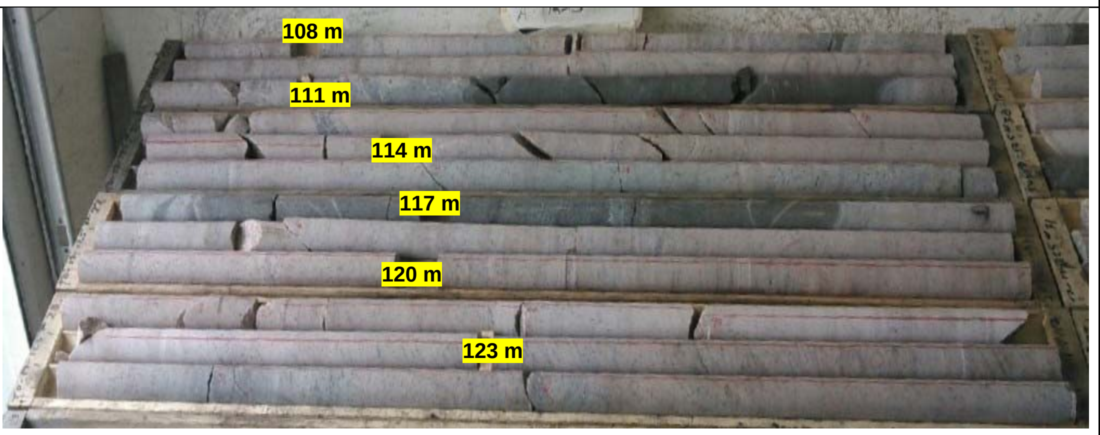
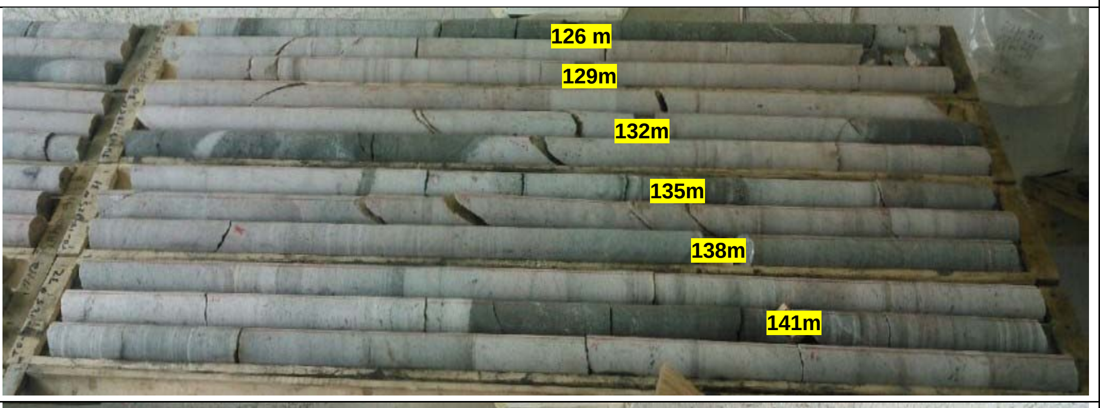
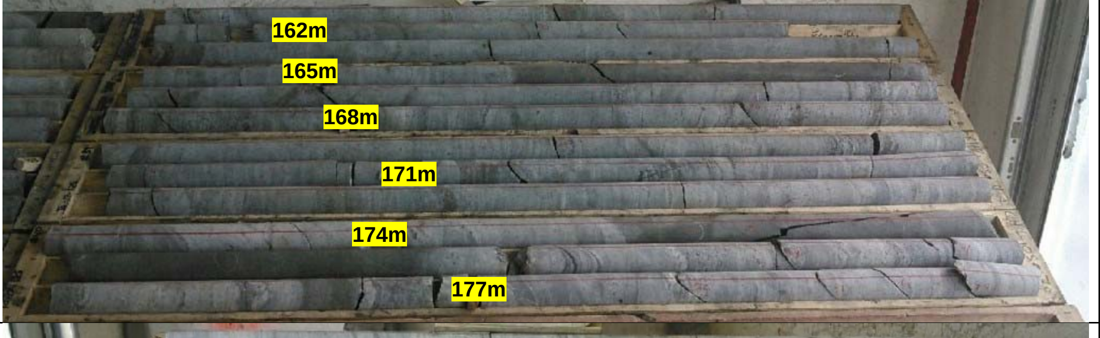


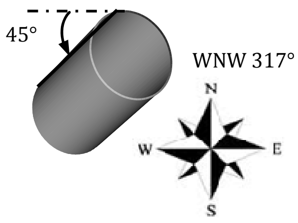
<table>
<tr><th>BOX #</th><th>L-17-1980-Geotechnical Hole TO-17-124
Oriented NQ Core EL.525.8 m (North West of Pit)</th><th>Comments</th></tr>
<tr><td>25-28</td><td></td><td>156-159m; Recovery = 100%; RQD = 90.7%
159-162m; Recovery = 100%; RQD = 96%
162-165m; Recovery = 100%; RQD = 95%
165-168m; Recovery = 100%; RQD = 92%
168-171m; Recovery = 100%; RQD = 98%
171-174m; Recovery = 100%; RQD = 88.9%</td></tr>
<tr><td>29-32</td><td></td><td>174-177m; Recovery = 100%; RQD = 90.4%
177-180m; Recovery = 100%; RQD = 100%
180-183m; Recovery = 100%; RQD = 100%
183-186m; Recovery = 100%; RQD = 98.3%
186-189m; Recovery = 100%; RQD = 95.3%
189-192m; Recovery = 100%; RQD = 100%</td></tr>
<tr><td>33-35</td><td></td><td>192-195m; Recovery = 100%; RQD = 96%
195-198m; Recovery = 100%; RQD = 100%
198-201m; Recovery = 100%; RQD = 97%</td></tr>
</table>

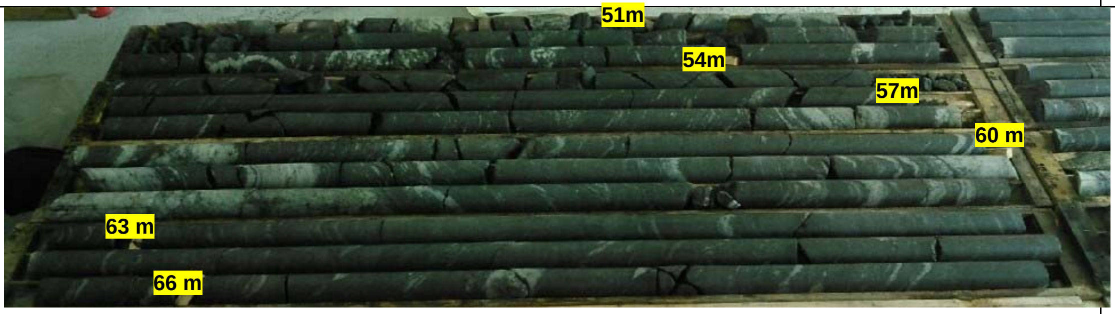
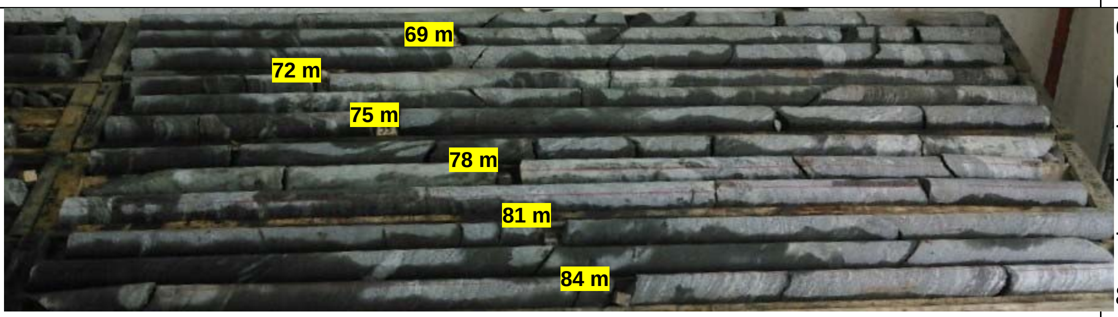
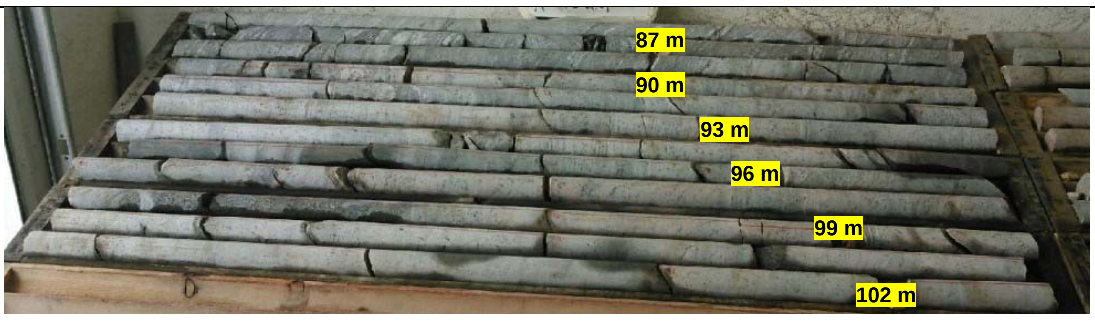
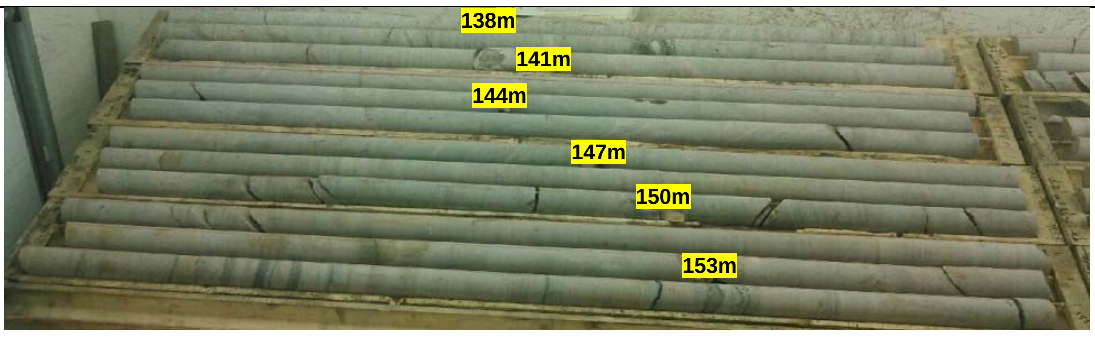


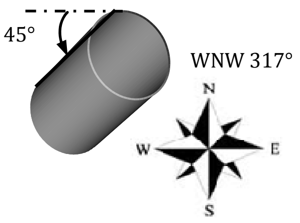
BOX #	L-17-1980-Geotechnical Hole TO-17-125 Oriented NQ Core EL.554.3 m (North East of Pit)	Comments
1-4		3.3-6 m; Recovery = 100%; RQD = 76.7% 6-9 m; Recovery = 100%; RQD = 90% 9-12 m; Recovery = 100%; RQD = 82.9% 12-15 m; Recovery = 100%; RQD = 95.7% 15-18 m; Recovery = 100%; RQD = 100% 18-21 m; Recovery = 100%; RQD = 80.7%
5-8		21-24 m; Recovery = 100%; RQD = 81% 24-27 m; Recovery = 100%; RQD = 97.3% 27-30 m; Recovery = 100%; RQD = 100% 30-33 m; Recovery = 100%; RQD = 93.5% 33-36 m; Recovery = 100%; RQD = 96.3% 36-39 m; Recovery = 100%; RQD = 95.5%
9-12		39-42 m; Recovery = 100%; RQD = 92% 42-45 m; Recovery = 100%; RQD = 97.1% 45-48 m; Recovery = 100%; RQD = 96.3% 48-51 m; Recovery = 100%; RQD = 100% 51-54 m; Recovery = 100%; RQD = 97% 54-57 m; Recovery = 100%; RQD = 94%
13-16		57-60 m; Recovery = 100%; RQD = 93.7% 60-63 m; Recovery = 100%; RQD = 97.3% 63-66m; Recovery = 100%; RQD = 93% 66-69 m; Recovery = 100%; RQD = 97% 69-72 m; Recovery = 100%; RQD = 100%
17-20		72-75 m; Recovery = 100%; RQD = 94.5% 75-78 m; Recovery = 100%; RQD = 97.3% 78-81 m; Recovery = 100%; RQD = 100% 81-84 m; Recovery = 100%; RQD = 86.7% 84-87 m; Recovery = 100%; RQD = 100% 87-90 m; Recovery = 100%; RQD = 100%
21-24		90-93 m; Recovery = 100%; RQD = 100% 93-96 m; Recovery = 100%; RQD = 96% 96-99 m; Recovery = 100%; RQD = 86.9% 99-102 m; Recovery = 100%; RQD = 100% 102-105 m; Recovery = 100%; RQD = 41.9% 105-108 m; Recovery = 100%; RQD = 95.7%

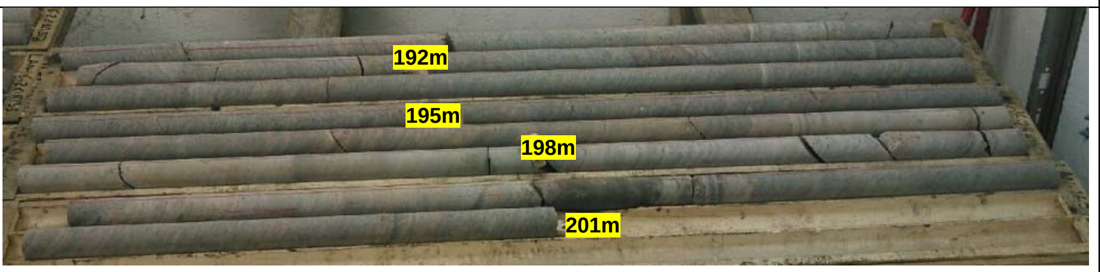


BOX #	L-17-1980-Geotechnical Hole TO-17-125 Oriented NQ Core EL.554.3 m (North East of Pit)	Comments
25-28		108-111 m; Recovery = 100%; RQD = 99% 111-114 m; Recovery = 100%; RQD = 93.5% 114-117 m; Recovery = 100%; RQD = 100% 117-120 m; Recovery = 100%; RQD = 97.7% 120-123 m; Recovery = 100%; RQD = 98.7% 123-126 m; Recovery = 100% ; RQD = 93.7%
29-32		126-129 m; Recovery = 100%; RQD = 93.7% 129-132 m; Recovery = 100%; RQD = 100% 132-135 m; Recovery = 100%; RQD = 97.3% 135-138m; Recovery = 100%; RQD = 94% 138-141m; Recovery = 100%; RQD = 97.3% 141-144m; Recovery = 100%; RQD = 100%
33-36		144-147m; Recovery = 100%; RQD = 95.7% 147-150m; Recovery = 100%; RQD = 97% 150-153m; Recovery = 100%; RQD = 100% 153-156m; Recovery = 100%; RQD = 100% 156-159m; Recovery = 100%; RQD = 100%
37-40		159-162m; Recovery = 100%; RQD = 94% 162-165m; Recovery = 100%; RQD = 100% 165-168m; Recovery = 100%; RQD = 100% 168-171m; Recovery = 100%; RQD = 94.7% 171-174m; Recovery = 100%; RQD = 100% 174-177m; Recovery = 100%; RQD = 98.3%
41-44		177-180m; Recovery = 100%; RQD = 100% 180-183m; Recovery = 100%; RQD = 96% 183-186m; Recovery = 100%; RQD = 100% 186-189m; Recovery = 100%; RQD = 100% 189-192m; Recovery = 100%; RQD = 100% 192-195m; Recovery = 100%; RQD = 56%
45-46		195-198m; Recovery = 100%; RQD = 94.3% 198-201m; Recovery = 100%; RQD = 91.3%



BOX #	L-17-1980-Geotechnical Hole TO-17-126 Oriented NQ Core EL.522.9 m (North of Pit)	Comments
1-4		50.07-51 m; Recovery = 100%; RQD = 66.7% 51-54 m; Recovery = 100%; RQD = 56.3% 54-57 m; Recovery = 100%; RQD = 57.8% 57-60 m; Recovery = 100%; RQD = 92.7% 60-63 m; Recovery = 100%; RQD = 91.4% 63-66 m; Recovery = 100%; RQD = 99.7%
5-8		66-69 m; Recovery = 100%; RQD = 92.5% 69-72 m; Recovery = 100%; RQD = 95% 72-75 m; Recovery = 100%; RQD = 95.3% 75-78 m; Recovery = 100%; RQD = 100% 78-81 m; Recovery = 100%; RQD = 96.3% 81-84 m; Recovery = 100%; RQD = 100%
9-12		84-87 m; Recovery = 100%; RQD = 89.6% 87-90 m; Recovery = 100%; RQD = 92.6% 90-93 m; Recovery = 100%; RQD = 96.4% 93-96 m; Recovery = 100%; RQD = 93% 96-99 m; Recovery = 100%; RQD = 100% 99-102 m; Recovery = 100%; RQD = 100%
13-16		102-105 m; Recovery = 100%; RQD = 97.3% 105-108 m; Recovery = 100%; RQD = 97% 108-111 m; Recovery = 100%; RQD = 88.7% 111-114 m; Recovery = 100%; RQD = 100% 114-117 m; Recovery = 100%; RQD = 100% 117-120 m; Recovery = 100%; RQD = 93.4%
17-20		120-123 m; Recovery = 100%; RQD = 97% 123-126 m; Recovery = 100%; RQD = 93.7% 126-129 m; Recovery = 100%; RQD = 100% 129-132 m; Recovery = 100%; RQD = 98% 132-135 m; Recovery = 100%; RQD = 100% 135-138m; Recovery = 100%; RQD = 100%
21-24		138-141m; Recovery = 100%; RQD = 100% 141-144m; Recovery = 100%; RQD = 100% 144-147m; Recovery = 100%; RQD = 100% 147-150m; Recovery = 100%; RQD = 99% 150-153m; Recovery = 100%; RQD = 98% 153-156m; Recovery = 100%; RQD = 100%
25-28		156-159m; Recovery = 100%; RQD = 93.7% 159-162m; Recovery = 100%; RQD = 97.3% 162-165m; Recovery = 100%; RQD = 97.3% 165-168m; Recovery = 100%; RQD = 100% 168-171m; Recovery = 100%; RQD = 100% 171-174m; Recovery = 100%; RQD = 88.3%
29-32		174-177m; Recovery = 100%; RQD = 92.7% 177-180m; Recovery = 100%; RQD = 98% 180-183m; Recovery = 100%; RQD = 97% 183-186m; Recovery = 100%; RQD = 100% 186-189m; Recovery = 100%; RQD = 100%



BOX #	L-17-1980-Geotechnical Hole TO-17-126 Oriented NQ Core EL.522.9 m (North of Pit)	Comments
33-35		189-192m; Recovery = 100%; RQD = 98% 192-195m; Recovery = 100%; RQD = 100% 195-198m; Recovery = 100%; RQD = 96.4% 198-201m; Recovery = 100%; RQD = 100%

APPENDIX C

Direct Shear Test Results on Rock Cores

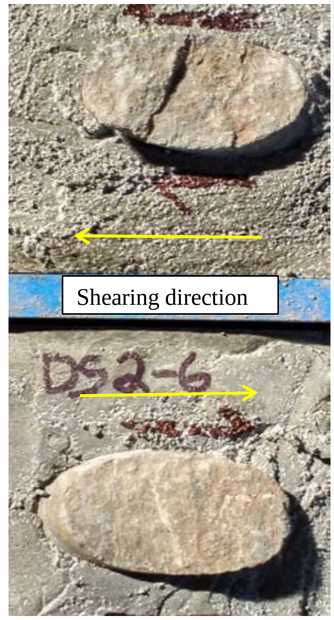
JOURNEAUX ASSOC Division LAB JOURNEAUX INC.	DIRECT SHEAR STRENGTH TEST ON ROCK JOINT	Project: Open Pit Study, DRA Global (mine Matawinie) Project No.: L-17-1980 Date: 07/06/2017

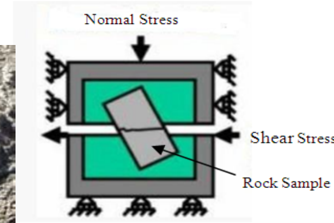
Test Number:	1

Sample ID:	DS-2-6
Borehole:	TO-15-39
Depth (m):	119.1
Rock Type:	Paragneiss
Joint Description:	Rough Joint
Joint Dip:	Unknown
Joint Orientation	Unknown
Joint Roughness Coefficient (JRC):	9
Moisture condition:	Dry
Other comments:	

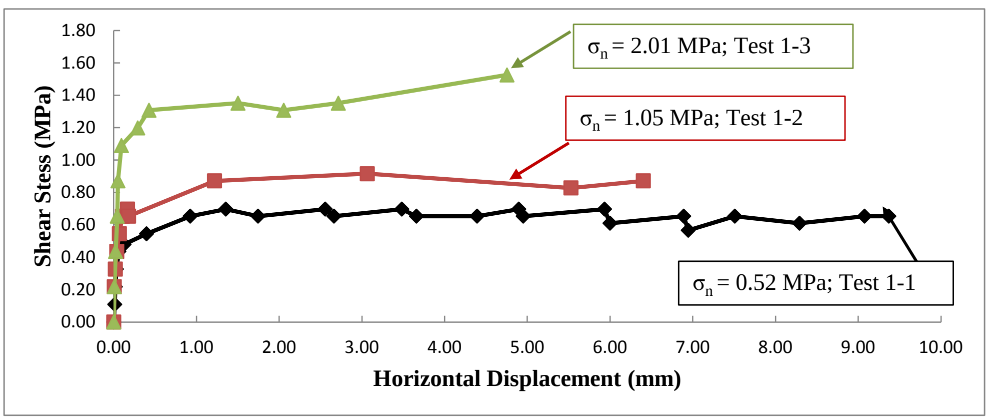
Apparatus:	Matest A129
Mortar:	Sika 212

Normal Load (MPa):	0.52, 1.05, 2.01

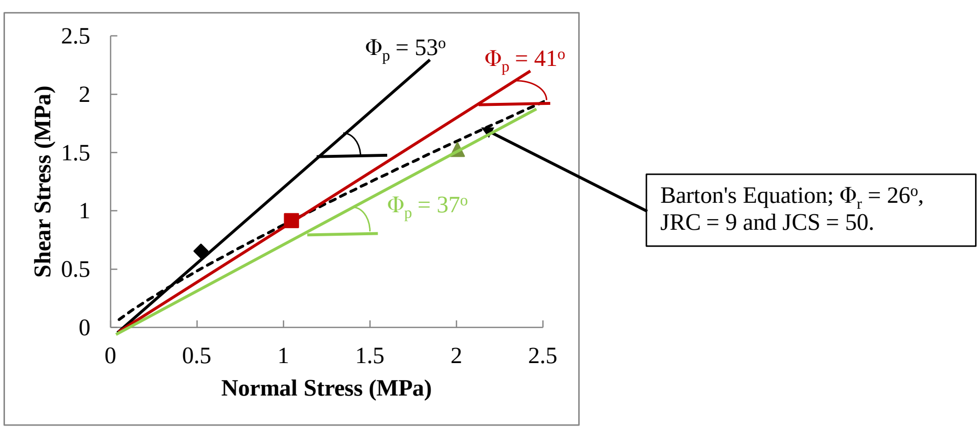




Direct Shear Test Set-up



Note: No significant damage to the joint faces were observed during testing.



Performed by: L. Jenner Date : 31/05/17 Analysed by : N. Journeaux Date : 22/06/17

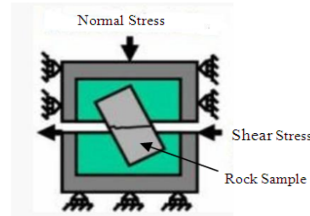
JOURNEAUX ASSOC Division LAB JOURNEAUX INC.	DIRECT SHEAR STRENGTH TEST ON ROCK JOINT	Project: Open Pit Study, DRA Global (mine Matawinie) Project No.: L-17-1980 Date: 14/06/2017

Test Number:	2

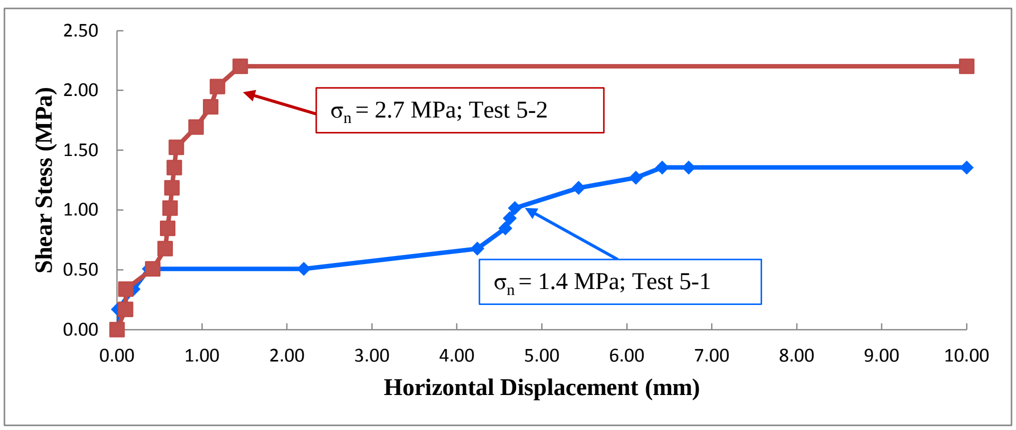
Sample ID:	DS-17-120-155.87
Borehole:	TO-17-120
Depth (m):	155.87
Rock Type:	Paragneiss
Joint Description:	Smooth Joint
Joint Dip:	19°
Joint Orientation	Major North West Joint
Joint Roughness Coefficient (JRC):	8
Moisture condition:	Dry
Other comments:	

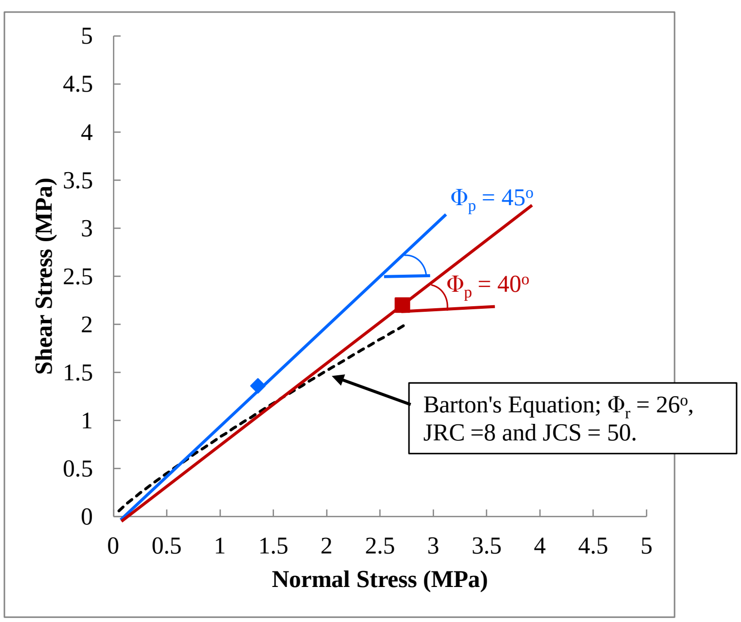
Apparatus:	Matest A129
Mortar:	Sika 212

Normal Load (MPa):	1.4; 2.7



Direct Shear Test Set-up





<u>Note</u>: Significant damage to the joint faces were observed during testing.

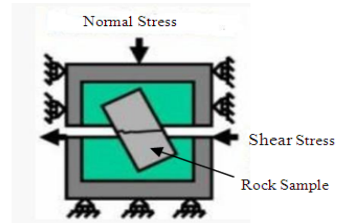
Test Number:	3

Sample ID:	DS-1-3
Borehole:	TO-15-37
Depth (m):	176.8
Rock Type:	Paragneiss with Graphite
Joint Description:	Rough and Wavy
Joint Dip:	Unknown
Joint Orientation	Unknown
Joint Roughness Coefficient (JRC):	16
Moisture condition:	Dry
Other comments:	

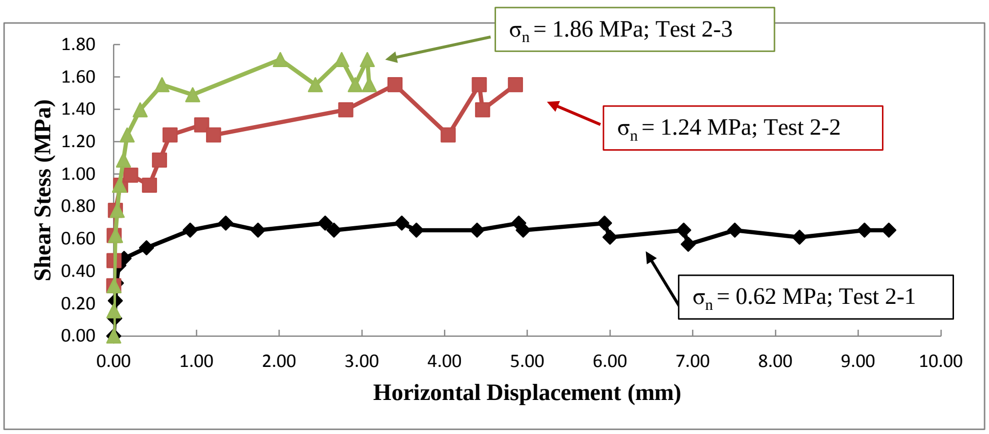
Apparatus:	Matest A129
Mortar:	Sika 212

Normal Load (MPa):	0.62, 1.24, 1.86

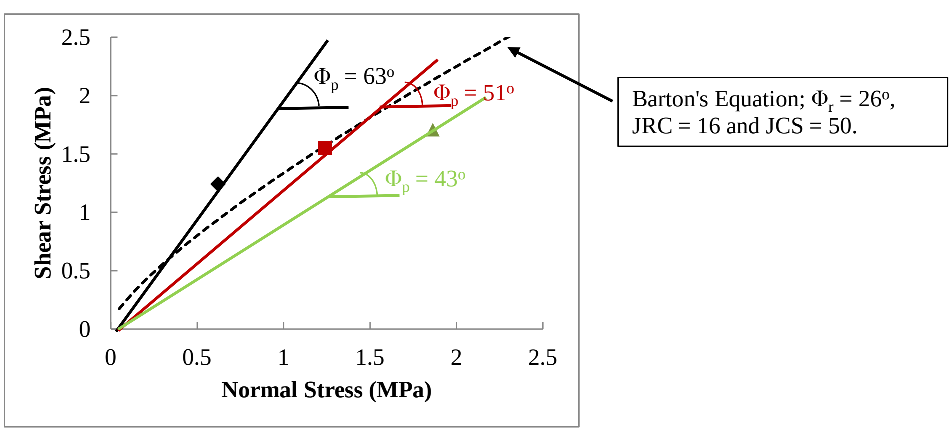
Shearing direction



Direct Shear Test Set-up



Note: No significant damage to the joint faces were observed during testing.



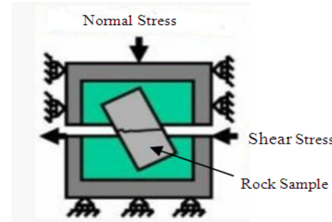
JOURNEAUX ASSOC Division LAB JOURNEAUX INC.	DIRECT SHEAR STRENGTH TEST ON ROCK JOINT	Project: Open Pit Study, DRA Global (mine Matawinie) Project No.: L-17-1980 Date: 14/06/2017

Test Number:	4

Sample ID:	DS-17-119-102.25
Borehole:	TO-17-119
Depth (m):	102.3
Rock Type:	Paragneiss with Graphite
Joint Description:	Rough Joint
Joint Dip:	11°
Joint Orientation	Major North-West Joint
Joint Roughness Coefficient (JRC):	18
Moisture condition:	Dry
Other comments:	

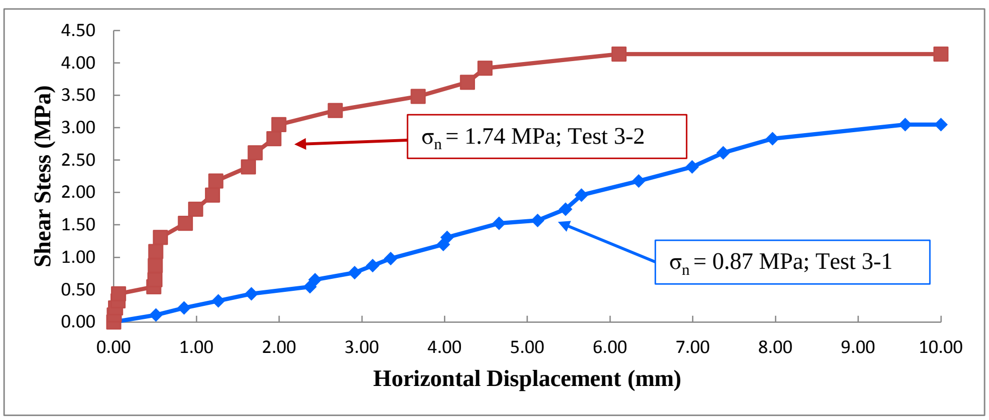
Apparatus:	Matest A129
Mortar:	Sika 212

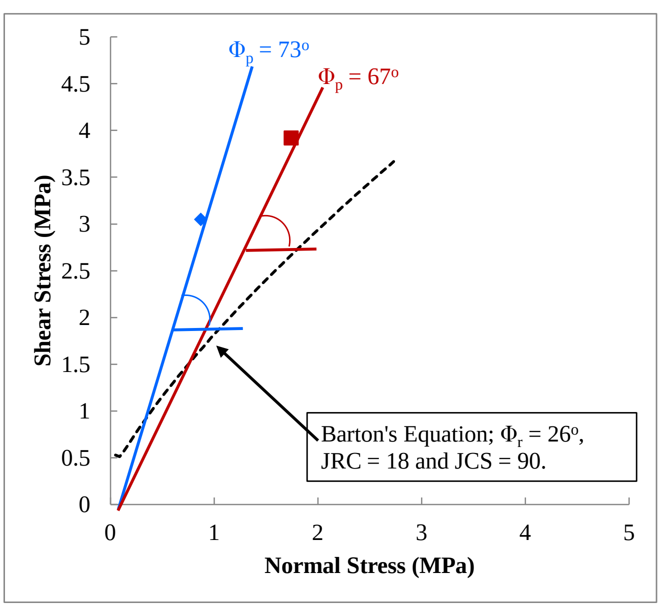
Normal Load (MPa):	0.87, 1.74



Direct Shear Test Set-up

Shearing direction





Note: Significant damage to the joint faces were observed during testing.

Performed by: S.Kamel Date : 14/06/17 Analysed by : N. Journeaux Date : 22/06/17

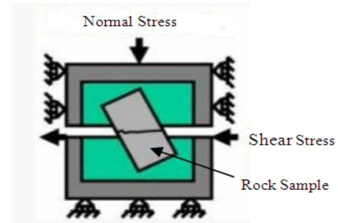
JOURNEAUX ASSOC Division LAB JOURNEAUX INC.	DIRECT SHEAR STRENGTH TEST ON ROCK JOINT	Project: Open Pit Study, DRA Global (mine Matawinie) Project No.: L-17-1980 Date: 14/06/2017

Test Number:	5

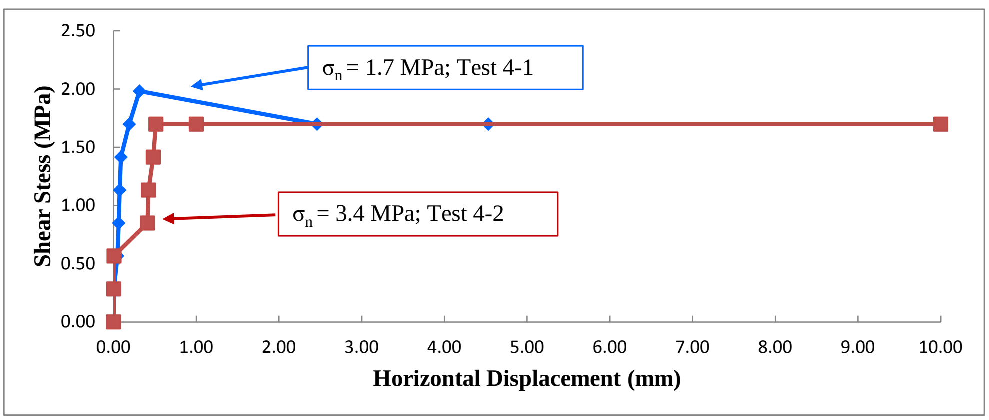
Sample ID:	DS-17-119-194.53
Borehole:	TO-17-119
Depth (m):	194.53
Rock Type:	Paragneiss with Graphite
Joint Description:	Smooth Joint
Joint Dip:	32°
Joint Orientation	Major South East Joint
Joint Roughness Coefficient (JRC):	8
Moisture condition:	Dry
Other comments:	

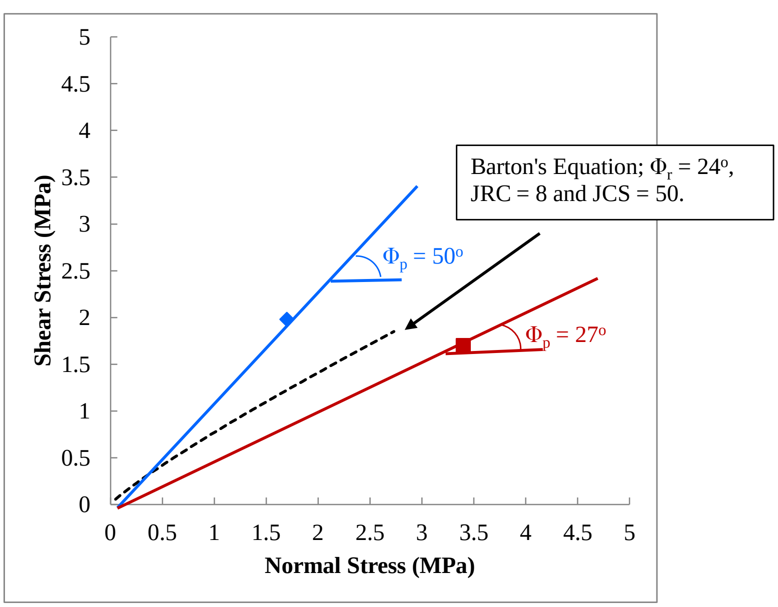
Apparatus:	Matest A129
Mortar:	Sika 212

Normal Load (MPa):	1.7; 3.4



Direct Shear Test Set-up





Note: Significant damage to the joint faces were observed during testing.

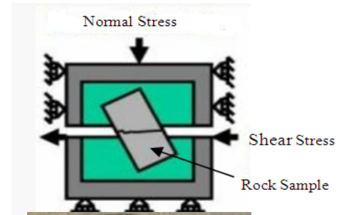
JOURNEAUX ASSOC Division LAB JOURNEAUX INC.	DIRECT SHEAR STRENGTH TEST ON ROCK JOINT	Project: Open Pit Study, DRA Global (mine Matawinie) Project No.: L-17-1980 Date: 14/06/2017

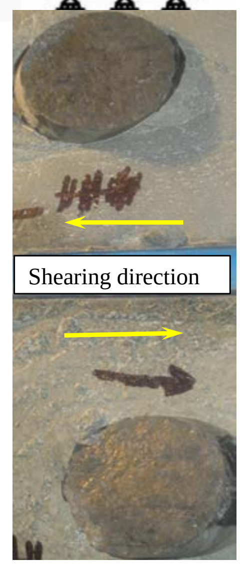
Test Number:	6

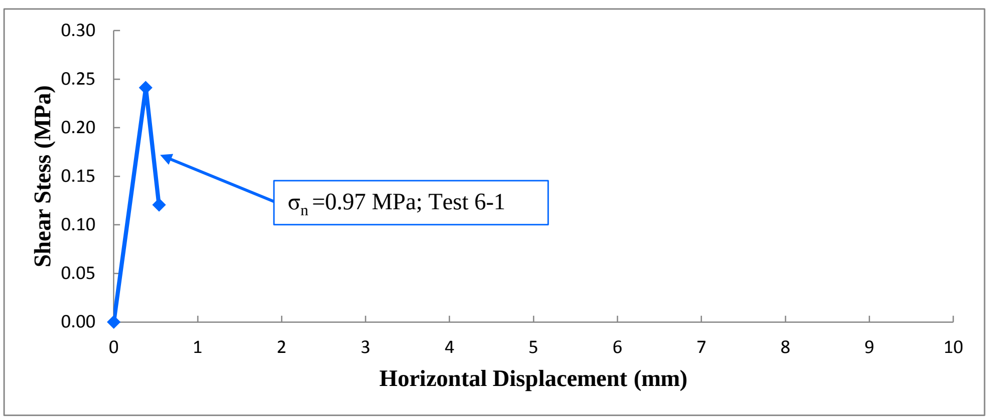
Sample ID:	DS-17-119-169
Borehole:	TO-17-119
Depth (m):	169
Rock Type:	Graphite
Joint Description:	Smooth Joint
Joint Dip:	32°
Joint Orientation	Major South East
Joint Roughness Coefficient (JRC):	4
Moisture condition:	Dry
Other comments:	

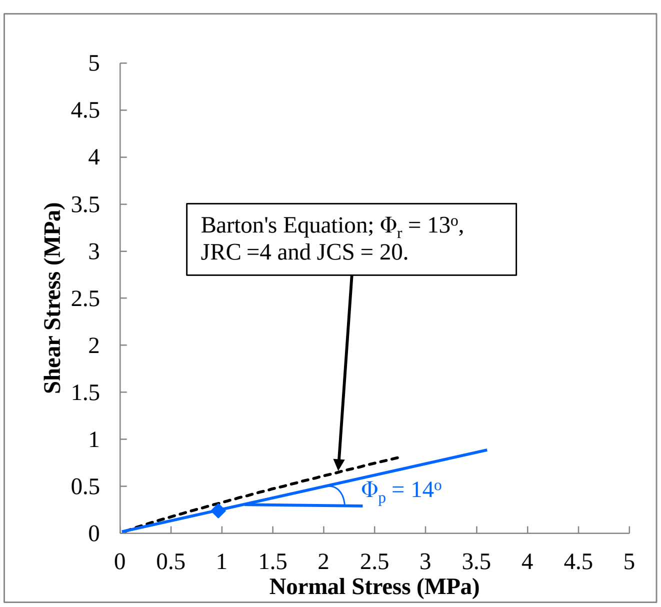
Apparatus:	Matest A129
Mortar:	Sika 212

Normal Load (MPa):	0.97









Performed by: S.Kamel Date : 20/06/17 Analysed by : N. Journeaux Date : 22/06/17

JOURNEAUX ASSOC

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