**Technical Report**

**Title:** ***Oriented Core Logging of DGR-5 and DGR-6***

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**Authors:** **Steve Gaines, Kenneth Raven and Michael Melaney**

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**DGR Site Characterization Document**
**Geofirma Engineering Project 08-200**

Geofirma Engineering Ltd

| **Geofirma Engineering DGR Site Characterization Document** | | |
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# 1 Introduction

Geofirma Engineering Ltd. (formerly Intera Engineering Ltd.) has been contracted by the Nuclear Waste Management Organization (NWMO), on behalf of Ontario Power Generation, to implement the Geoscientific Site Characterization Plan (GSCP) for the Bruce nuclear site located near Tiverton, Ontario. The purpose of this site characterization work is to assess the suitability of the Bruce nuclear site to construct a Deep Geologic Repository (DGR) to store low-level and intermediate-level radioactive waste. The GSCP is described by Intera Engineering Ltd. (2006, 2008).

This Technical Report summarizes and presents the results of oriented core logging completed at two deep inclined bedrock boreholes (DGR-5 and DGR-6) as part of Phase 2B of the GSCP.

Work described in this Technical Report was completed in accordance with Test Plan TP-08-20 – DGR-5 and DGR-6 Drilling and Casing Installation (Intera Engineering Ltd., 2010a), Test Plan TP-09-01 – DGR-5 and DGR-6 Core Photography and Logging (Intera Engineering Ltd., 2009a), and Test Plan TP-09-11 – DGR-5 and DGR-6 Borehole Geophysical Logging (Intera Engineering Ltd., 2010b).

Work described in this Technical Report was completed following the general requirements of the DGR Project Quality Plan (Intera Engineering Ltd., 2009b).

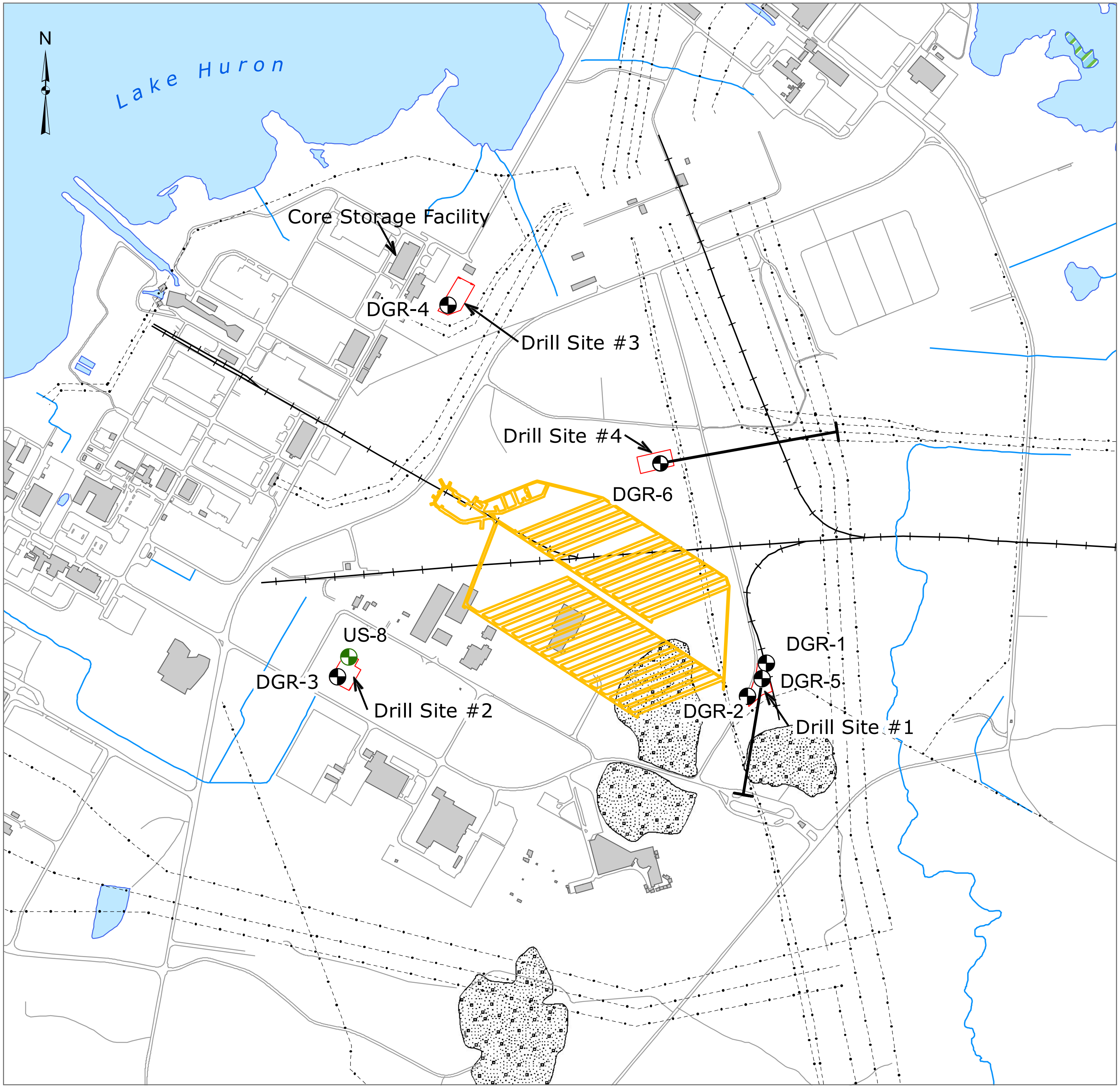
# 2 Background

The GSCP comprises three phases of borehole drilling and investigations. The Phase 1 GSCP is described by Intera Engineering Ltd. (2006) and included the drilling, logging and testing of two deep vertical 159 mm diameter boreholes (DGR-1 and DGR-2) to total depths of 462.9 and 862.3 metres below ground surface (mBGS) respectively, and the drilling and testing of one shallow borehole, US-8, to a total depth of 200 mBGS. Both of these deep boreholes were drilled at one location (Drill Site # 1), approximately 40 metres apart from each other. The shallow borehole (US-8) was drilled at a second location (Drill Site # 2); both drill sites are located at the Bruce nuclear site as shown on Figure 1. Phase 1 drilling and testing was completed between December 2006 and December 2007.

The Phase 2 GSCP is described by Intera Engineering Ltd. (2008). Phase 2 is divided into two sub-phases, 2A and 2B. Phase 2A consisted of drilling, logging and testing of two deep vertical 143 mm diameter boreholes, DGR-3 (Drill Site #2) and DGR-4 (Drill Site #3) to total depths of 869.2 and 857.0 mBGS, respectively. Phase 2A was completed between March 2008 and September 2009. Phase 2B comprised the drilling, logging and testing of two deep inclined 143 mm diameter boreholes, DGR-5 (Drill Site #1) and DGR-6 (Drill Site #4). The Phase 2B drilling and core logging activities are described below. Phase 2B work was completed between December 2008 and June 2010.

The purpose of drilling DGR-5 and DGR-6 was to:

- complement the information that was collected from DGR-1 to DGR-4,
- confirm the predictability of the strike/dip of strata around and below the proposed DGR location,
- provide information on inclined or sub-vertical fracture networks (fracture orientation, spacing, roughness and infilling characteristics), and
- to further investigate specific areas identified during the 2-D seismic study (TR-07-15, Intera Engineering Ltd., 2009c) showing seismic anomalies.




LEGEND

- DGR Boreholes
- US Well
- Proposed Repository Outline
- Drilling Direction
- Transmission Line
- Roads
- Stream or Drainage
- Railways
- Drill Sites
- Buildings
- Waterbody
- Wetland Area, Permanent
- Pits or Landfills

**Figure 1**
**Location of DGR Boreholes and US-8 at the Bruce Nuclear Site**

Scale 1:15,000

0 100 200 400 600 800
Meters

PROJECTION: UTM NAD 83 Zone 17N
SOURCE: NRVIS/OBM, MNR, OPG, NWMO

PROJECT No. 08-200 TR-09-09

PROJECT NWMO DGR Site Characterization Project

DESIGN: NMP
CAD/GIS: NMP
CHECK: GDB
REV: 0

DATE: 08/04/2011

Geofirma Engineering Ltd

P:\QMS_DGR\TR_WorkingFiles\TR-09-09_Oriented Fracture Logging of DGR-5 and DGR-6 Core\Figures\TR-09-09_SiteLocationDGR1-6_R0.mxd

Therefore, similar to Phase 1 and Phase 2A, drilling at DGR-5 and DGR-6 provided additional information on bedrock stratigraphy, core for additional laboratory, geological, geomechanical, hydrogeological and geochemical testing, and access for borehole geophysical testing and borehole hydraulic testing and possible future multi-level sampling, monitoring and testing. The information gathered from DGR-5 and DGR-6 will assist with developing descriptive geosphere models of the Bruce nuclear site.

# 3 Drilling and Core Logging Overview

The Phase 2B drilling program took into account the geological and hydrogeological conditions encountered during Phase 1 and Phase 2A drilling of DGR-1 through DGR-4. DGR-5 and DGR-6 were designed to provide two separate boreholes on either side of the proposed DGR with open bedrock intervals from Silurian dolostones and shales through the deeper Ordovician shales and limestones. The borehole stratigraphy, based on DGR-5 and DGR-6, is presented in Figure 2.

This section provides an overview of the drilling program at DGR-5 and DGR-6 and includes core logging and processing methodology, as well as a summary of borehole orientation data used. A detailed summary of all aspects of the DGR-5 and DGR-6 drilling program is provided in Technical Report, TR-09-01 – Drilling, Logging and Sampling of DGR-5 and DGR-6 (Geofirma Engineering Ltd., 2011a).

## 3.1 Field Core Logging and Processing

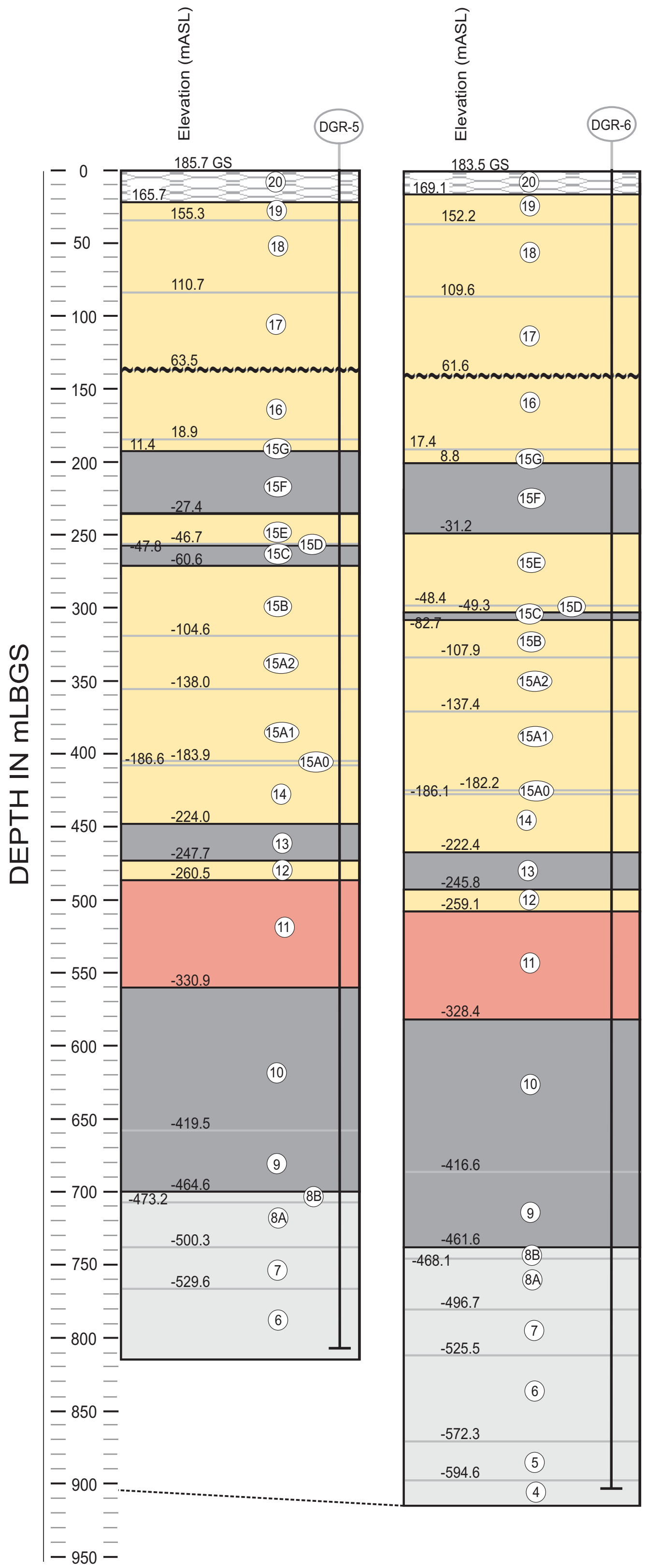
Core logging and processing was completed in accordance with the procedures outlined in Test Plan TP-09-01 – DGR-5 and DGR-6 Core Photography and Logging and is further summarized in TR-09-01 (Geofirma Engineering Ltd., 2011a). Core logging included descriptions of rock lithology, stratigraphy, sedimentological features, structural and discontinuity characteristics as well as any additional relevant observations made by the site geologist.

The primary focus of this Technical Report is to present the structural and discontinuity characteristics, which includes the following information:

- Depth of all natural fractures, which was recorded as metres length along borehole from ground surface (mLBGS);
- Borehole orientation parameters (azimuth and plunge) along the length of each DGR borehole;
- Measurement of apparent dip angle (alpha) and apparent dip direction (beta), with corresponding true dip and true dip directions; and
- Assessment of joint roughness and infilling/staining characteristics.

In the field, the apparent dip angle, alpha, was measured as the angle between the core axis and the maximum dip of the core discontinuity. The apparent dip direction angle, beta, was the angle measured clockwise from the black core reference line to the bottom of the core discontinuity ellipse while looking down the core axis. The black core reference line is the line drawn along the lowest point of the core based on core orientation measurements or alternatively along the top of the bedding plane ellipse (TR-09-01, Geofirma Engineering Ltd, 2011a). The black core reference line is used to define the orientation of the core. The measurements collected for core orientation are illustrated in Figure 3.

The apparent dip and dip directions measured in the field were corrected by incorporating average borehole trend and plunge orientation collected during borehole geophysics or gyro surveys completed by Geofirma staff concurrent with drilling. The true dip and dip direction for a given fracture was determined by entering borehole orientation data into the Rocscience DIPS (Version 5.107) software package, which converts apparent measurements to true fracture orientations.




## LEGEND - BRUCE SITE STRATIGRAPHY

PLEISTOCENE
- 20 SURFICIAL DEPOSITS

MIDDLE DEVONIAN
- 19 LUCAS FORMATION - DOLOSTONE
- 18 AMHERSTBURG FORMATION - DOLOSTONE

LOWER DEVONIAN
- 17 BOIS BLANC FORMATION - CHERTY DOLOSTONE
- ~~~~~~ SILURIAN / DEVONIAN DISCONTINUITY

UPPER SILURIAN
- 16 BASS ISLANDS FORMATION - DOLOSTONE
- 15 SALINA FORMATION
- 15G G UNIT - ARGILLACEOUS DOLOSTONE
- 15F F UNIT - DOLOMITIC SHALE
- 15E E UNIT - BRECCIATED DOLOSTONE AND DOLOMITIC SHALE
- 15D D UNIT - ANHYDRITIC DOLOSTONE
- 15C C UNIT - DOLOMITIC SHALE AND SHALE
- 15B B UNIT - ARGILLACEOUS DOLOSTONE AND ANHYDRITE
- 15A2 A2 UNIT - DOLOSTONE AND ANHYDRITIC DOLOSTONE
- 15A1 A1 UNIT - ARGILLACEOUS DOLOSTONE AND ANHYDRITIC DOLOSTONE
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MIDDLE ORDOVICIAN
- 8 COBOURG FORMATION
- 8B COLLINGWOOD MEMBER - BLACK CALCAREOUS SHALE AND ARGILLACEOUS LIMESTONE
- 8A LOWER MEMBER - ARGILLACEOUS LIMESTONE
- 7 SHERMAN FALL FORMATION - ARGILLACEOUS LIMESTONE
- 6 KIRKFIELD FORMATION - ARGILLACEOUS LIMESTONE
- 5 COBOCONK FORMATION - BIOTURBATED LIMESTONE
- 4 GULL RIVER FORMATION - LITHOGRAPHIC LIMESTONE
- 3 SHADOW LAKE FORMATION - SILTSTONE AND SANDSTONE

CAMBRIAN
- 2 CAMBRIAN SANDSTONE

NOTE:
1. SUBSURFACE STRATIGRAPHIC NOMENCLATURE AFTER ARMSTRONG AND CARTER (2006)

| | | |
|---|---|---|
| **Interpreted Bedrock Stratigraphy at Bruce Site from DGR-5 and DGR-6 Data**<br>**TR-09-09 Oriented Core Logging of DGR-5 and DGR-6** | | Prepared by: NMP<br>Reviewed by: GDB<br>Date: Apr 7, 2011 |
| **FIGURE 2** | Doc. No.: TR-09-09_Figure 2_R1.cdr | |

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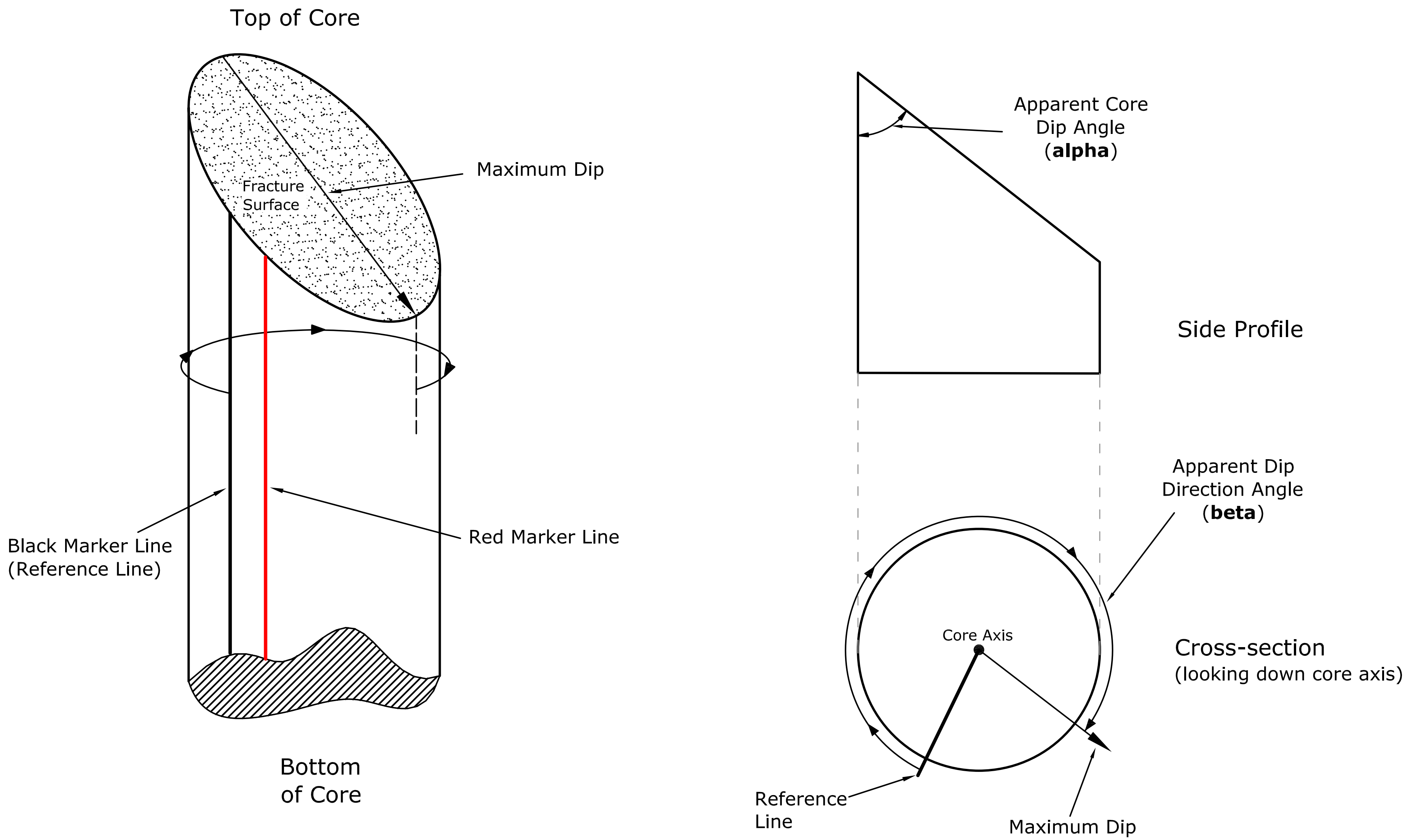


**Note:** The black marker line (reference line) was drawn along the bottom of the core based on core orientation measurements and the red marker line was drawn to the right of the black line if looking from the bottom of the core towards the top.

| **Borehole Fracture Orientation Parameters** | | Prepared by: SNG<br>Reviewed by: SNS<br>Date: 8-Apr-11 |
|---|---|---|
| **FIGURE 3** | Doc. No.: TR-09-09_Figure3_Oriented Core_R0.dwg | |

Reference: Modified from Rocscience website: online help - *borehole orientation data pairs*, www.rocscience.com

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## 3.2 Borehole Orientation

Borehole orientation information was collected at regular intervals to continually monitor borehole azimuth and plunge during drilling operations. In order to convert apparent dip and dip direction into a true dip and dip direction, the borehole orientation parameters collected using the acoustic televiewer and gyroscope were averaged on a per core run basis. Additional description of the instruments used to record borehole azimuth and plunge, as well as the results of the borehole orientation monitoring can be found in TR-09-03 – Borehole Geophysical Logging in DGR-5 and DGR-6 (Geofirma Engineering Ltd., 2011b).

# 4 Results and Conclusions

Results of the field core logging program are summarized in Tables A.1 and A.2, Appendix A. Information presented in Tables A.1 and A.2, for DGR-5 and DGR-6, respectively include fracture depth, alpha and beta angles measured in the field, average borehole attitude, processed dip and dip direction, as well as qualitative notes regarding joint roughness and infilling characteristics.

The results of oriented core logging and processing have been divided into mechano-stratigraphic (MS) units for the purposes of presenting data and determining average joint set orientation and spacing. Presentation and interpretation based on MS units is an appropriate approach to describing the geomechanical characteristics of the subsurface, that is in accordance with the grouping of formation geomechanical data followed in the Descriptive Geosphere Site Model. The MS units are described detail in the Descriptive Geosphere Site Model (Intera Engineering Ltd., 2011) and presented in Figure 4. The following is a brief description of the MS units, relative depths in DGR-5 and DGR-6, and corresponding horizontal sampling distances:

MS Unit 1: Comprising principally dolostones, this MS unit includes Devonian formations encountered at the Bruce nuclear site, as well as the Upper Silurian Bass Islands Formation and the Salina G Unit dolostone. Since the boreholes were drilled and cased into the Salina F Unit, this MS unit was not cored in DGR-5 or DGR-6.

MS Unit 2: Comprising the sequence of interbedded shales, dolostones and anhydrites, this MS unit includes the Silurian strata from the top of the Salina F Unit to the base of the Fossil Hill Formation. MS-2 lies from 192.5 to 447.8 mLBGS and 203.0 to 467.9 mLBGS in DGR-5 and DGR-6, respectively. The total horizontal sampling distance is 99.8 m in DGR-5, and 128.4 m in DGR-6.

MS Unit 3: Comprising principally the sequence of shales that overlie the repository horizon, this MS unit includes the strata from the top of the Lower Silurian Cabot Head Formation, through all of the Upper Ordovician strata, to the base of the Middle Ordovician Collingwood Member. MS-3 lies from 447.8 to 708.7 mLBGS and 467.9 to 746.1 mLBGS in DGR-5 and DGR-6, respectively. The total horizontal sampling distance is 76.3 m in DGR-5, and 130.6 m in DGR-6.

MS Unit 4: Includes the repository horizon and comprises the Middle Ordovician Cobourg Formation argillaceous limestone. This unit lies between 708.7 to 736.5 mLBGS and 746.1 to 780.2 mLBGS in DGR-5 and DGR-6, respectively. The total horizontal sampling distance is 6.3 m in DGR-5, and 18.6 m in DGR-6.

MS Unit 5: This MS unit consists of all units below the Cobourg Formation, from the Sherman Fall Formation to the Precambrian unit. In DGR-5, this MS unit lies between 736.5 mLBGS to the end of the borehole at 807.2 mLBGS, in the Sherman Fall Formation. In DGR-6, MS-5 ranges from 780.2 mLBGS to 903.2 mLBGS, in the Kirkfield Formation. The total horizontal sampling distance is 15.9 m in DGR-5, and 67.0 m in DGR-6.

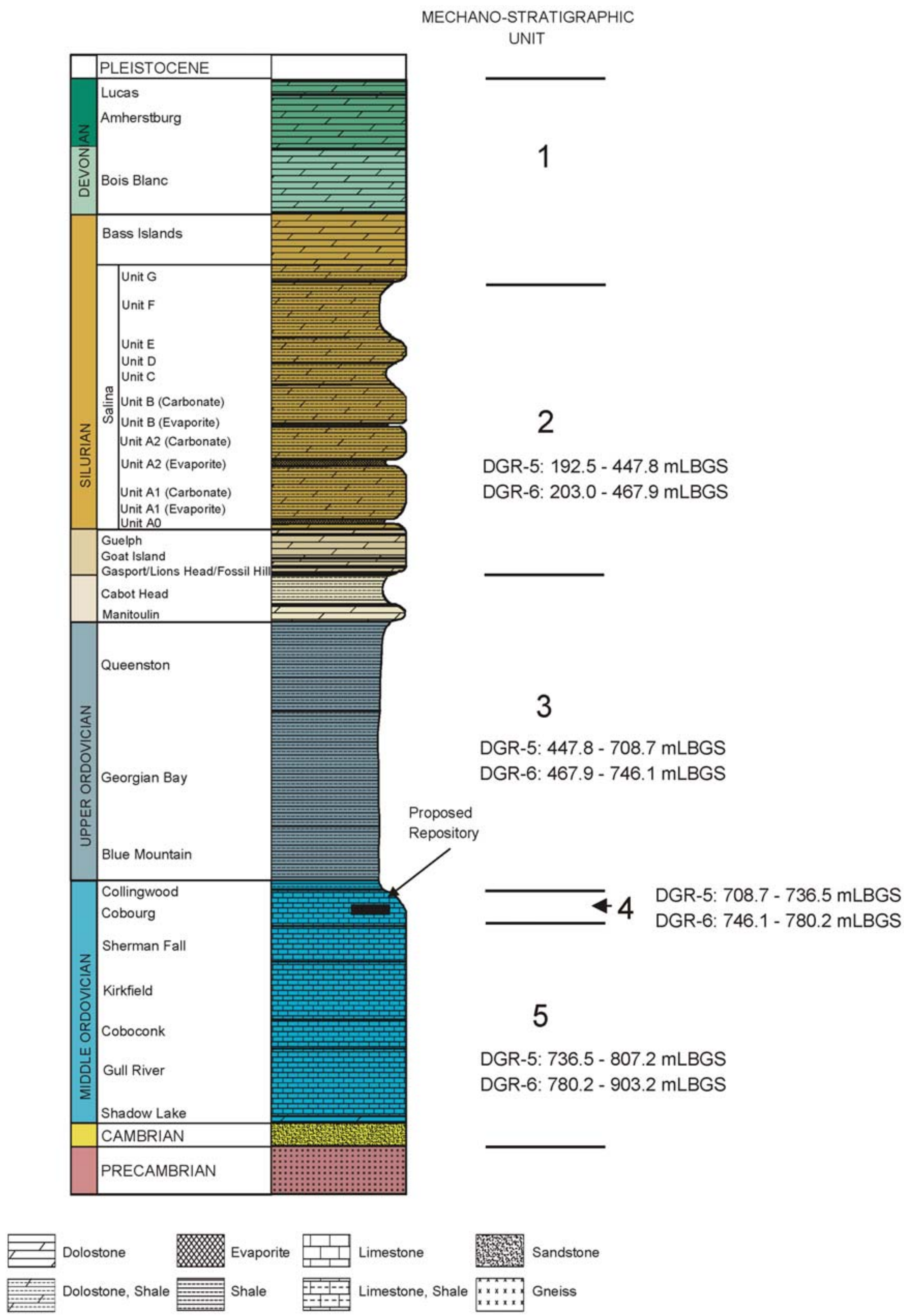


**Figure 4 Reference Stratigraphic Column Showing Mechano-Stratigraphic Units at the Bruce Nuclear Site.**

## 4.1 Field Core Logging

In total, 153 natural fractures in DGR-5 and 181 natural fractures in DGR-6 were identified based on field core logging. Of these fractures, the majority constitute bedding plane fractures, with the remaining fractures considered to be inclined joints. For the purposes of this report, and in accordance with the approach followed in the Descriptive Geosphere Site Model report, fractures with a true dip of greater than 35 degrees are considered to be inclined fractures. Table 1 summarizes the total number of fractures and number of inclined features recorded during core logging in DGR-5 and DGR-6. Sample photographs of bedding plane fractures and inclined fractures are presented in Figures 5 and 6, respectively. Additional representative fracture photographs are included in Appendix B.

**Table 1 Summary of Natural Fractures in DGR-5 and DGR-6 Based on Core Logging**

| *Mechano-Stratigraphic Unit* | *DGR-5* | | *DGR-6* | |
|---|---|---|---|---|
| | ***Total # of Fractures*** | ***Inclined Fractures [1]*** | ***Total # of Fractures*** | ***Inclined Fractures [1]*** |
| MS-2 – Upper and Middle Silurian Shales, Dolostones and Anhydrites | 90 | 34 | 126 | 39 |
| MS-3 – Lower Silurian and Upper Ordovician Shales and Dolostones | 50 | 30 | 51 | 32 |
| MS-4 – Middle Ordovician Cobourg Formation | 7 | 0 | 0 | 0 |
| MS-5 – Middle Ordovician Sherman Fall and Deeper Formations | 6 | 0 | 4 | 1 |

**Notes**: 1 - inclined fractures are considered to have a true dip of greater than 35 degrees.

**Figure 5 Bedding Fracture in DGR-6 at 504.93 mLBGS with Halite Infilling (MS Unit 3, Manitoulin Formation)**


**Figure 6 Inclined Fracture in DGR-5 at 676.18 mLBGS (MS Unit 3, Blue Mountain Formation). Note the Apparent Offset Along the Fracture is Not True and is Due to Misalignment of the Core Pieces**

In DGR-5, 64 of 153 fractures are inclined and in DGR-6, 72 of 181 natural fractures logged have a true dip of greater than 35 degrees. The majority of inclined features were identified in MS Unit 2 and MS Unit 3, from the Salina Formation F Unit to the bottom Collingwood Member of the Cobourg Formation. The shales overlying the repository horizon (MS Unit 3) contained the highest inclined to total fracture ratio. It should be noted that no inclined fractures were recorded in the Cobourg Formation in either DGR-5 or DGR-6. Only one inclined feature, which was a healed fracture in DGR-6, was recorded below the Cobourg Formation. The remaining fractures noted in the Cobourg Formation and below (MS Unit 4 and MS Unit 5) are relatively horizontal and assumed to be fractures along bedding planes or other sedimentological features.

## 4.2 Acoustic Televiewer Fracture Logging

Analysis of acoustic televiewer (ATV) images of borehole walls provides an additional source of information on occurrence and orientation of fractures in DGR-5 and DGR-6. Structural ATV logging (Geofirma Engineering Ltd., 2011b) included all minor, major, continuous and filled fractures - the results are summarized in Table 2.

**Table 2 Summary of Natural Fractures in DGR-5 and DGR-6 Based on ATV Fracture Logging**

| *Mechano-Stratigraphic Unit* | *DGR-5* | | *DGR-6* | |
|---|---|---|---|---|
| | *Total # of Fractures* [1] | *Inclined Fractures* [2] | *Total # of Fractures* [1] | *Inclined Fractures* [2] |
| MS-2 – Upper and Middle Silurian Shales, Dolostones and Anhydrites | 258 | 4 | 174 | 21 |
| MS-3 – Lower Silurian and Upper Ordovician Shales and Dolostones | 58 | 10 | 30 | 11 |
| MS-4 – Middle Ordovician Cobourg Formation | 0 | 0 | 1 | 0 |
| MS-5 – Middle Ordovician Sherman Fall and Deeper Formations | 0 | 0 | 0 | 0 |

**Notes**: 1 - fractures include; minor, major, continuous and filled fractures, as identified on the ATV logs
2 - inclined fractures are considered to have a true dip of greater than 35 degrees.

In total, 14 of 316 fractures in DGR-5 are inclined features, compared to 32 of 205 fractures in DGR-6. The variation in number of fractures identified in DGR-5 versus DGR-6 in MS Unit 2 may be attributed to the presence of numerous gypsum and anhydrite veins and the relatively poor quality of the borehole walls in Upper Silurian strata and subsequent difficulty identifying distinct fracture features on the borehole wall. Overall, ATV fracture identification is similar to the results of core logging, especially in the rock with smoother borehole walls (MS Unit 3, MS Unit 4 and MS Unit 5). Most notable is the lack of inclined features within MS Unit 4 and MS Unit 5, which represent the Cobourg Formation and underlying Ordovician limestone formations.

ATV fracture logging results versus core logging results is further discussed in Section 5 - Data Quality and Use.

## 4.3 Fracture Analysis

Fracture analysis provides important rock mass quality parameters including the orientation of major joint sets, discontinuity spacing, as well as the evaluation of the fracture qualities such as roughness and infilling characteristics. This section provides an overview of the major joint sets identified based on the results of DGR-5 and DGR-6 core logging and provides estimation of the joint set attitude and spacing. Qualitative fracture characteristics are included with the summary tables in Appendix A.

Fracture orientation measurements collected from core logging are presented on contoured, lower hemisphere polar plots, in order to identify significant joint sets. The plots were produced using DIPS Version 5.107 software with Terzaghi (1965) correction applied to account for sampling bias. The pole cluster boundaries given in red represent the area for which all poles are used in calculating the weighted average joint set orientation and discontinuity spacing. In addition to representative contoured plots provided in this section, un-weighted polar plots presenting individual poles for DGR-5 and DGR-6 are included in Appendix C.

### 4.3.1 MS Unit 2: Upper and Middle Silurian Shales, Dolostones and Anhydrites

A total of 216 fractures from the Upper and Middle Silurian shales, dolostones and anhydrite units of DGR-5 and DGR-6 are presented in Figure 7.

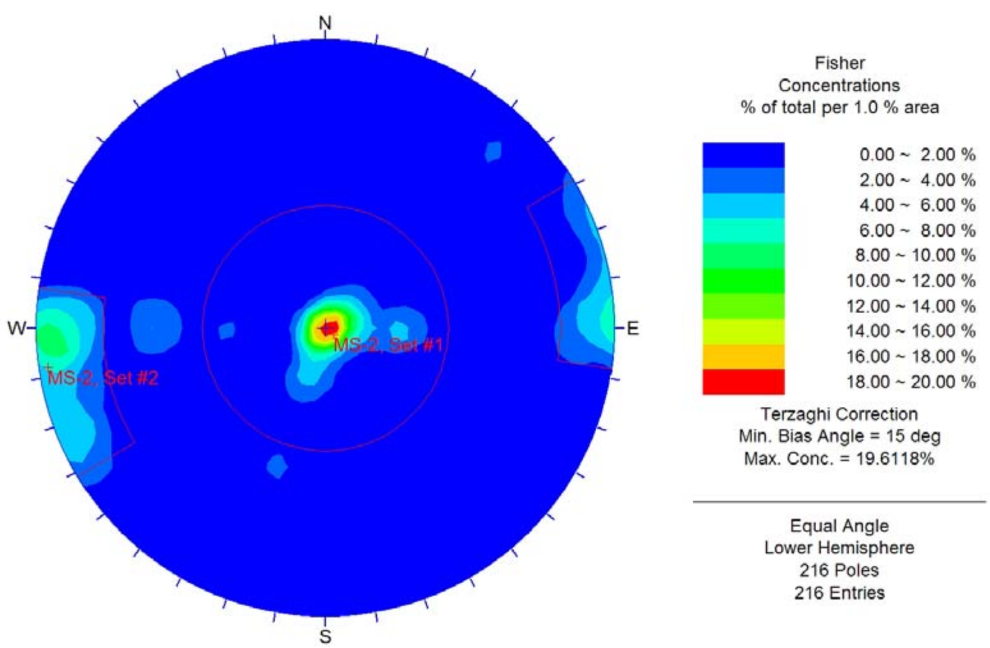


**Figure 7 Contoured Equal Area Polar Plot of All Natural Fractures from DGR-5 and DGR-6 in MS Unit 2.**

The polar plot suggests the presence of two major fracture sets. The first, and most pronounced, is the horizontal fracture set representative of bedding joints. The other set, MS Unit 2, Set #2 is representative of a near vertical set of fractures, striking north-south. The arithmetic average weighted fracture set orientation, including number of occurrences and average discontinuity spacing is presented in Table 3.

**Table 3 Natural Fracture Set Orientations in MS Unit 2**

| | ***Number of Occurrences*** | ***Dip (Degrees)*** | ***Dip Direction (Degrees)*** | ***Average Discontinuity Spacing (m)*** |
|---|---|---|---|---|
| MS Unit 2, Set #1 | 155 | 4 | 305 | 2.8 |
| MS Unit 2, Set #2 | 24 | 88 | 82 | 6.8 |
| Miscellaneous | 37 | -- | -- | -- |

### 4.3.2 MS Unit 3: Lower Silurian and Upper Ordovician Shales and Dolostones

A total of 101 fractures from the Lower Silurian and Upper Ordovician shales were logged in DGR-5 and DGR-6 and are presented in Figure 8. The polar plot suggests the presence of two major fracture sets, with a third minor fracture set. The two major fracture sets include a near horizontal bedding plane set and an east-west trending near vertical set. Fracture set #3 is sub-vertical and has a northeast-southwest strike. The average weighted fracture set orientations, including number of occurrences and average discontinuity spacing is presented in Table 4.

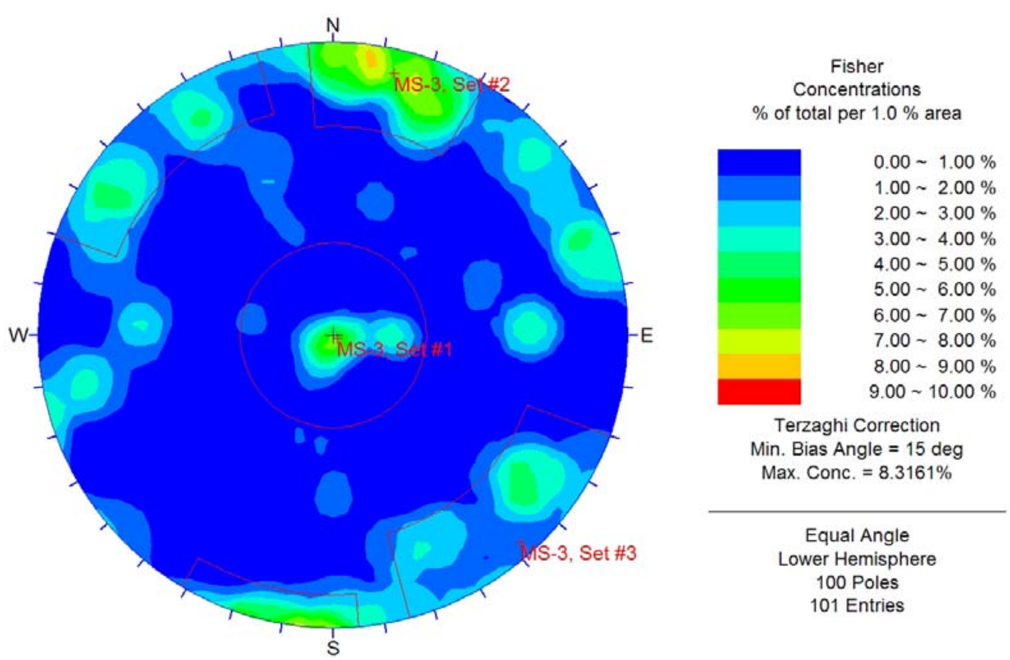


**Figure 8 Contoured Equal Area Polar Plot of All Natural Fractures from DGR-5 and DGR-6 in MS Unit 3.**

**Table 4 Natural Fracture Set Orientations in MS Unit 3**

| | *Number of Occurrences* | *Dip (Degrees)* | *Dip Direction (Degrees)* | *Average Discontinuity Spacing (m)* |
|---|---|---|---|---|
| MS Unit 3, Set #1 | 39 | 2 | 309 | 9.6 |
| MS Unit 3, Set #2 | 15 | 85 | 193 | 11.5 |
| MS Unit 3, Set #3 | 16 | 87 | 317 | 6.8 |
| Miscellaneous | 31 | -- | -- | -- |

### 4.3.3 MS Unit 4: Middle Ordovician Cobourg Formation

A total of seven fractures were noted in the Cobourg Formation, all from DGR-5, and are presented in Figure 9. No natural fractures were recorded in the Cobourg Formation in DGR-6. The only fracture set present is approximately horizontal and likely represents the discontinuities along the bedding plane. The average weighted fracture set orientation, including number of occurrences and average discontinuity spacing is presented in Table 5.

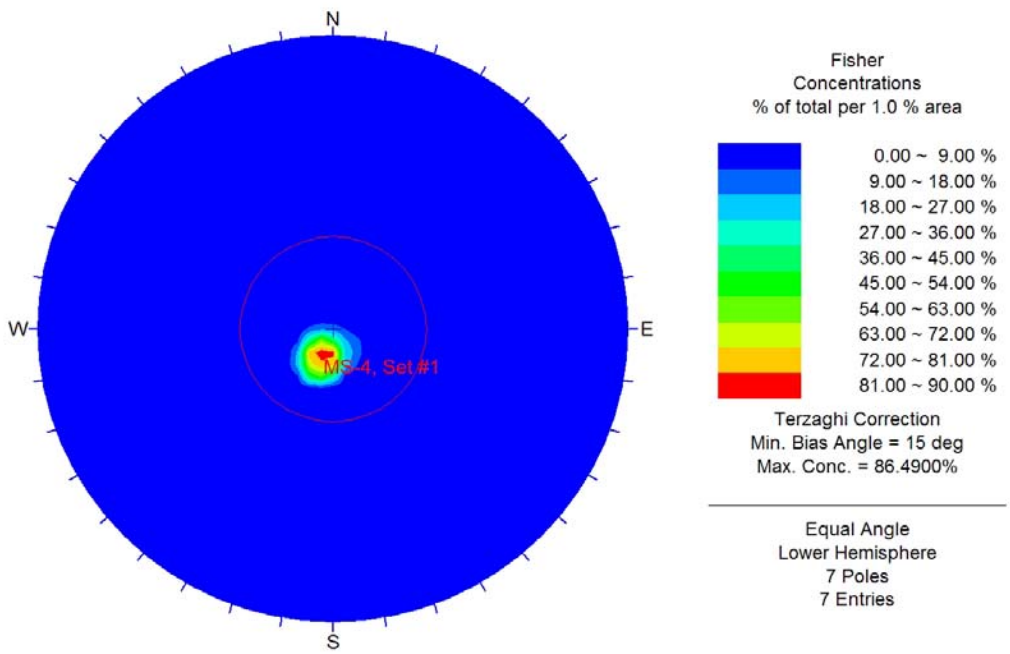


**Figure 9 Contoured Equal Area Polar Plot of All Natural Fractures from DGR-5 and DGR-6 in MS Unit 4.**

**Table 5 Natural Fracture Set Orientations in MS Unit 4**

| | *Number of Occurrences* | *Dip (Degrees)* | *Dip Direction (Degrees)* | *Average Discontinuity Spacing (m)* |
|---|---|---|---|---|
| MS Unit 4, Set #1 | 7* | 11 | 19 | 2.5 |
| Miscellaneous | 0 | -- | -- | -- |

**Note**: * = all fracture occurrences in DGR-5

### 4.3.4 MS Unit 5: Middle Ordovician Sherman Fall and Deeper Formations

Ten fractures were noted below the Cobourg Formation and the results are presented in Figure 10. Similar to the results of MS Unit 4, the only fracture set present is approximately horizontal and likely represents the discontinuities along the bedding plane. The average weighted fracture set orientation, including number of occurrences and average discontinuity spacing is presented in Table 6.

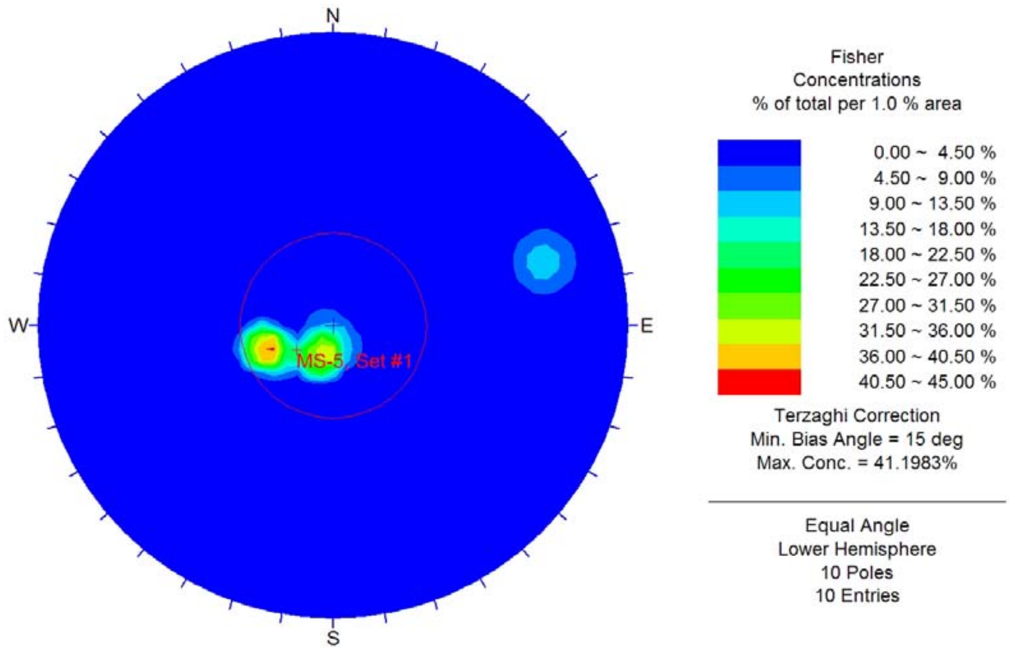


**Figure 10 Contoured Equal Area Polar Plot of All Natural Fractures from DGR-5 and DGR-6 in MS Unit 5.**

**Table 6 Natural Fracture Set Orientations in MS Unit 5**

| | ***Number of Occurrences*** | ***Dip (Degrees)*** | ***Dip Direction (Degrees)*** | ***Average Discontinuity Spacing (m)*** |
|---|---|---|---|---|
| MS Unit 5, Set #1 | 9 | 17 | 56 | 7.6 |
| Miscellaneous | 1 | -- | -- | -- |

## 5 Data Quality and Use

Results of oriented core logging of DGR-5 and DGR-6 core described in this Technical Report are based on data collected following the general requirements of the Intera DGR Project Quality Plan and TP-09-01. The results presented in this Technical Report are suitable for assessing general trends with respect to fracture set orientation in the vicinity of the Bruce DGR site and will assist in the development of regional- and site-scale geological and geomechanical models of the site.

There is inherent uncertainty with data obtained from core logging. This includes identification of the reference line on the core, field measurements of alpha and beta angles, as well as measurement of borehole trend and plunge. The reference line was identified by a combination of using the bedding plane ellipsoid as well as the

Reflex ACT Core Orientation Instrument as outlined in TP-09-01. In general, it was observed that the reference line obtained by identifying the upper edge of the bedding ellipse was comparable to the result of the core orientation instrument, thus providing some degree of confidence in the orientation reference. Human error is introduced with respect to the collection alpha and beta measurements, although this is considered relatively minor. Error associated with the borehole orientation is also considered to be minor; however there may have been some magnetic interference due to nearby power lines, grounding grids (railroad tracks), and inherent in-situ rock properties.

To evaluate the degree of uncertainty in calculated true dip and true dip direction results and estimation of fracture set orientation, the core logging data presented in this Technical Report were compared to the independent results of on-site core logging completed by Hatch Mott MacDonald (HMM, 2010) as well as the structural results assembled from borehole acoustic televiewer (ATV) logging.

## 5.1 Comparison with Hatch Mott MacDonald On-Site Core Logging

Table 7 presents the results of Geofirma core logging compared to corresponding Hatch Mott MacDonald (HMM) on-site core logging. The majority of fractures correspond well with HMM data. True dip measurements correlate especially well, with less than 5 degrees difference associated with most orientation measurements. The true dip direction measurements were slightly more variable, with differences of 10-30 degrees noted in most cases.

**Table 7 On-Site Core Logging Comparison**

| | ***Geofirma Fracture Orientation*** | | ***Corresponding HMM Orientation [1]*** | |
|---|---|---|---|---|
| ***Formation*** | ***Depth (mLBGS)*** | ***True Dip / Dip Direction (Degrees)*** | ***Depth (mLBGS) [2]*** | ***True Dip / Dip Direction (Degrees)*** |
| ***DGR-5*** | | | | |
| Georgian Bay | 657.75 | 85/183 | 657.80 | 89/220 |
| Georgian Bay | 659.62 | 87/193 | 659.60 | 85/210 |
| Georgian Bay | 660.02 | 85/183 | 660.00 | 89/210 |
| Georgian Bay | 661.05 | 5/202 | 661.06 | 13/20 |
| Blue Mountain | 676.18 | 85/202 | 676.19 | 86/200 |
| Blue Mountain | 677.30 | 89/297 | 677.50 | 88/296 |
| Blue Mountain | 685.25 | 83/233 | 685.29 | 80/231 |
| Blue Mountain | 692.35 | 82/223 | 692.35 | 85/200 |
| Blue Mountain | 699.45 | 74/203 | 699.90 | 77/200 |
| Collingwood | 700.44 | 86/151 | 700.48 | 87/150 |
| ***DGR-6*** | | | | |
| Blue Mountain | 693.82 | 41/223 | 693.72 | 37/221 |
| Blue Mountain | 694.86 | 84/145 | 694.24 | 86/342 |
| Blue Mountain | 695.91 | 76/312 | 695.65 | 84/293 |
| Blue Mountain | 697.41 | 84/317 | 697.30 | 73/334 |
| Blue Mountain | 697.42 | 74/333 | 697.55 | 77/337 |
| Blue Mountain | 703.11 | 54/154 | 703.07 | 73/176 |
| Blue Mountain | 703.19 | 76/197 | 703.23 | 73/176 |

**Notes**: 1 - Hatch Mott MacDonald, 2010. Deep Geologic Repository Project – Technical Memorandum, *Trip Reports from DGR-5 and DGR-6 Borehole Investigations*, Rev.00, March.

2 - Presented HMM DGR-6 depths are corrected by -3 metres from HMM reported depths to account for depth adjustments made following drilling completion.

## 5.2 Comparison with ATV Logging

Results of acoustic televiewer logging from DGR-5 and DGR-6 are presented on Figures 11 and 12 for MS Unit 2 and MS Unit 3, respectively. Terzaghi correction has been applied to each polar plot to account for sampling biases. Figure 11 presents only inclined fractures (greater than 35 degrees) because the large number near horizontal features overshadow any steeply dipping fracture sets. Only one fracture was identified in DGR-5 and DGR-6 by ATV logging from MS Unit 4 and 5 (see Table 2), therefore polar plots are not presented.

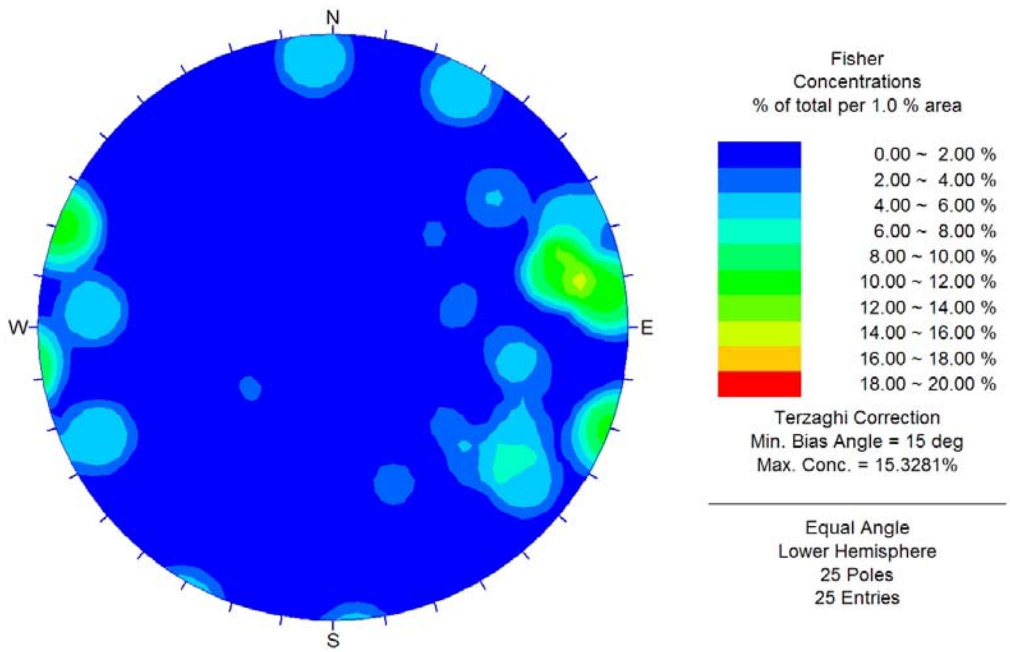


**Figure 11 Contoured Equal Area Polar Plot of Inclined Fractures Identified in ATV Structural Logging from DGR-5 and DGR-6 in MS Unit 2.**

The results of ATV data from MS Unit 2 suggest the presence of one or two sets of steeply dipping fracture sets, striking roughly north-south, in addition to a set of near horizontal fractures (not plotted) that represent bedding partings and/or sedimentological features. Polar plots produced using core logging data (see Figure 7, Section 4.3.1) showed a similar trend, with one set of dominant fractures that is horizontal and another set striking north-south and sub-vertical. Figure 12, which presents ATV structural data for MS Unit, clearly shows that there is one dominant horizontal set (bedding related) with two sub-vertical sets striking east-west. Only one fracture (horizontal) was observed on the ATV logs in the Cobourg Formation and below (MS Units 4 and 5), which is consistent with field core logging.

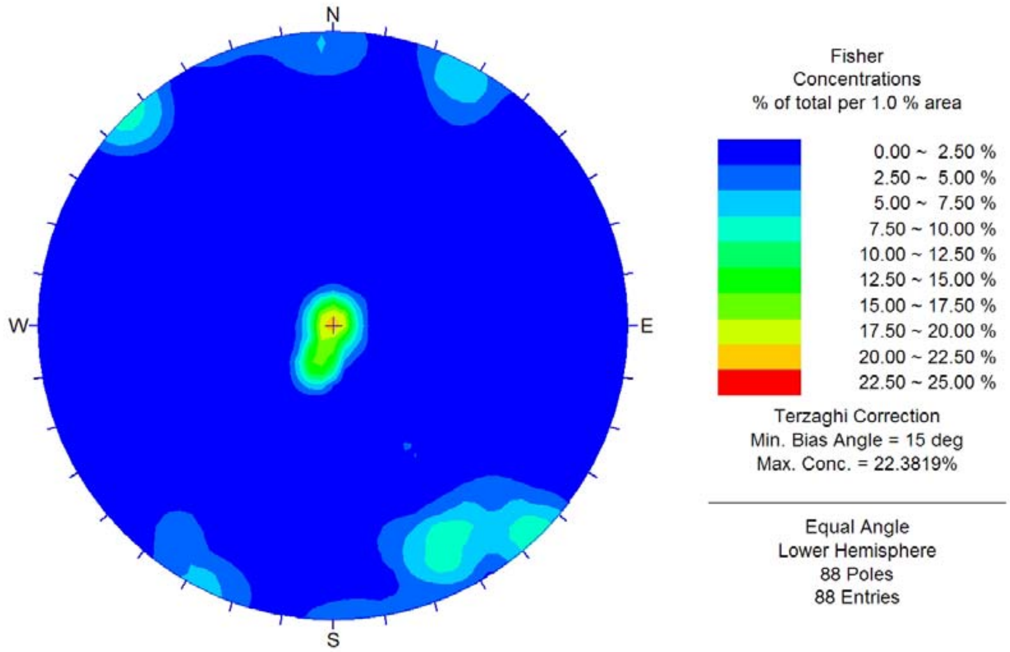


**Figure 12 Contoured Equal Area Polar Plot of Fractures Identified in ATV Structural Logging from DGR-5 and DGR-6 in MS Unit 3.**

## 6 Conclusions

Oriented core logging identified 153 natural fractures in DGR-5 and 181 natural fractures in DGR-6. The majority of the fractures were recorded in the Upper and Middle Silurian shales, dolostones and anhydrites (MS Unit 2) and the Lower Silurian and Upper Ordovician shales and dolostones (MS Unit 3). There were very few natural fractures identified in the Cobourg Formation (MS Unit 4), and none had a true dip of greater than 35 degrees. The rock quality below the proposed DGR host formation (i.e., MS Unit 5) was similar, with only ten bedding fractures observed and only one healed inclined fracture logged.

Fracture analysis completed using the results of oriented core logging from DGR-5 and DGR-6 provide a meaningful data set to approximate the orientation of significant fracture sets at the Bruce nuclear site. It is clear that near horizontal fracture sets, which are representative of bedding partings or other sedimentological features, are dominant in every mechano-stratigraphic unit. The analysis suggests the presence of sub-vertical fracture sets in MS Unit 2 (striking north-south) and two sets in MS Unit 3, which strike east-west and northeast-southwest. There is no evidence of any significant sub-vertical fracture sets in the Cobourg Formation and below (MS Unit 4 and 5, respectively).

The results of the oriented core logging program provide a preliminary estimate of the orientation of major fracture sets in the strata underlying the Bruce nuclear site. The results compare reasonably well with independent on-site core logging as well as structural geophysical analysis using borehole wall images.

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# APPENDIX A

## Natural Fracture Logging

**Table A.1 – Summary of Natural Fractures in DGR-5**

**Table A.2 – Summary of Natural Fractures in DGR-6**

# Table A.1 - Summary of Natural Fractures in DGR-5

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| **Lucas Formation (22.2-33.8 mLBGS)** | | | | | | | | | | |
| **Amherstburg Formation (33.8-83.2 mLBGS)** | | | | | | | | | | |
| **Bois Blanc Formation (83.2-134.8 mLBGS)** | | | | | | | | | | |
| **Bass Islands Formation (134.8-184.0 mLBGS)** | | | | | | | | | | |
| **Salina Formation - G Unit (184.0-192.5 mLBGS)** | | | | | | | | | | |
| **Salina Formation - F Unit (192.5-235.2 mLBGS)** | | | | | | | | | | |
| DGR-5 | 1 | 207.98 | 80 | 160 | 206 | 65 | 16 | 38 | Smooth | Anhydrite |
| DGR-5 | 1 | 208.29 | 80 | 230 | 206 | 65 | 20 | 3 | Smooth | -- |
| DGR-5 | 1 | 208.96 | 80 | 200 | 206 | 65 | 16 | 13 | Smooth | Anhydrite |
| DGR-5 | 1 | 209.26 | 70 | 180 | 206 | 65 | 6 | 25 | Smooth | -- |
| DGR-5 | 1 | 209.49 | 85 | 180 | 206 | 65 | 21 | 26 | Smooth | Anhydrite |
| DGR-5 | 3 | 214.01 | 90 | 0 | 201 | 65 | 25 | 21 | Undulating | -- |
| DGR-5 | 6 | 223.12 | 60 | 200 | 199 | 66 | 11 | 264 | Smooth | -- |
| DGR-5 | 6 | 223.80 | 60 | 190 | 199 | 66 | 8 | 240 | Smooth | -- |
| DGR-5 | 6 | 223.86 | 60 | 190 | 199 | 66 | 8 | 240 | Smooth | -- |
| DGR-5 | 6 | 224.03 | 60 | 190 | 199 | 66 | 8 | 240 | Smooth | -- |
| DGR-5 | 6 | 224.17 | 60 | 200 | 199 | 66 | 11 | 264 | Smooth | -- |
| DGR-5 | 6 | 224.21 | 60 | 200 | 199 | 66 | 11 | 264 | Smooth | -- |
| DGR-5 | 6 | 224.48 | 60 | 200 | 199 | 66 | 11 | 264 | Rough | -- |
| DGR-5 | 6 | 224.99 | 60 | 200 | 199 | 66 | 11 | 264 | Smooth | -- |
| DGR-5 | 7 | 228.69 | 70 | 200 | 199 | 66 | 9 | 326 | Smooth | -- |
| DGR-5 | 8 | 228.90 | 15 | 270 | 199 | 66 | 77 | 295 | Healed | -- |
| DGR-5 | 8 | 229.02 | 70 | 180 | 199 | 66 | 5 | 18 | Rough | -- |
| DGR-5 | 8 | 229.89 | 14 | 50 | 199 | 66 | 89 | 247 | Smooth | -- |
| DGR-5 | 8 | 229.96 | 70 | 180 | 199 | 66 | 5 | 18 | Smooth | -- |
| DGR-5 | 8 | 230.12 | 25 | 350 | 199 | 66 | 89 | 9 | Smooth | -- |
| DGR-5 | 8 | 230.16 | 80 | 180 | 199 | 66 | 15 | 18 | Smooth | -- |
| DGR-5 | 8 | 230.34 | 70 | 180 | 199 | 66 | 5 | 18 | Smooth | -- |
| DGR-5 | 8 | 230.83 | 10 | 300 | 199 | 66 | 88 | 140 | Rough | -- |
| DGR-5 | 9 | 232.95 | 60 | 180 | 199 | 66 | 7 | 199 | Smooth | -- |
| DGR-5 | 9 | 233.33 | 60 | 0 | 199 | 66 | 54 | 19 | Rough | -- |
| DGR-5 | 9 | 233.62 | 60 | 0 | 199 | 66 | 54 | 19 | Rough | -- |
| DGR-5 | 9 | 233.73 | 60 | 0 | 199 | 66 | 54 | 19 | Rough | -- |
| DGR-5 | 9 | 233.85 | 60 | 0 | 199 | 66 | 54 | 19 | Rough | -- |
| DGR-5 | 9 | 234.25 | 60 | 0 | 199 | 66 | 54 | 19 | Smooth | -- |
| DGR-5 | 9 | 234.40 | 60 | 0 | 199 | 66 | 54 | 19 | Smooth | Anhydrite |

## Table A.1 - Summary of Natural Fractures in DGR-5

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-5 | 10 | 235.13 | 50 | 180 | 199 | 67 | 17 | 199 | Smooth | Anhydrite |
| **Salina Formation - E Unit (235.2-256.2 mLBGS)** | | | | | | | | | | |
| DGR-5 | 10 | 235.66 | 60 | 180 | 199 | 67 | 7 | 199 | Rough | -- |
| DGR-5 | 10 | 236.21 | 60 | 180 | 199 | 67 | 7 | 199 | Rough | -- |
| DGR-5 | 10 | 236.71 | 75 | 180 | 199 | 67 | 9 | 18 | Rough | -- |
| DGR-5 | 10 | 236.85 | 75 | 180 | 199 | 67 | 9 | 18 | Rough | -- |
| DGR-5 | 10 | 236.93 | 75 | 180 | 199 | 67 | 9 | 18 | Rough | Anhydrite |
| DGR-5 | 10 | 237.27 | 60 | 180 | 199 | 67 | 7 | 199 | Smooth | Anhydrite |
| DGR-5 | 11 | 238.40 | 10 | 20 | 199 | 67 | 79 | 219 | Rough | -- |
| DGR-5 | 11 | 238.72 | 60 | 180 | 199 | 67 | 7 | 199 | Rough | -- |
| DGR-5 | 11 | 238.96 | 55 | 180 | 199 | 67 | 12 | 199 | Smooth | -- |
| DGR-5 | 11 | 239.65 | 90 | 0 | 199 | 67 | 23 | 19 | Rough | -- |
| DGR-5 | 11 | 239.87 | 90 | 0 | 199 | 67 | 23 | 19 | Smooth | -- |
| DGR-5 | 11 | 240.04 | 90 | 0 | 199 | 67 | 23 | 19 | Rough | -- |
| DGR-5 | 11 | 240.69 | 10 | 30 | 199 | 67 | 81 | 228 | Smooth | -- |
| DGR-5 | 12 | 241.30 | 30 | 90 | 199 | 67 | 63 | 96 | Rough | -- |
| DGR-5 | 12 | 242.12 | 90 | 0 | 199 | 67 | 23 | 19 | Rough | -- |
| DGR-5 | 13 | 246.35 | 90 | 270 | 199 | 67 | 24 | 19 | Smooth | -- |
| DGR-5 | 13 | 246.49 | 90 | 270 | 199 | 67 | 24 | 19 | Smooth | -- |
| DGR-5 | 14 | 247.96 | 65 | 190 | 200 | 67 | 5 | 268 | Smooth | -- |
| DGR-5 | 14 | 248.27 | 65 | 190 | 200 | 67 | 5 | 268 | Smooth | -- |
| DGR-5 | 14 | 248.75 | 65 | 180 | 200 | 67 | 2 | 200 | Smooth | -- |
| DGR-5 | 14 | 249.62 | 70 | 180 | 200 | 67 | 4 | 19 | Smooth | -- |
| DGR-5 | 14 | 249.75 | 70 | 180 | 200 | 67 | 4 | 19 | Smooth | -- |
| DGR-5 | 15 | 250.82 | 90 | 0 | 200 | 68 | 23 | 20 | Smooth | -- |
| DGR-5 | 16 | 254.43 | 60 | 90 | 200 | 68 | 37 | 77 | Smooth | -- |
| **Salina Formation - D Unit (256.2-257.3 mLBGS)** | | | | | | | | | | |
| **Salina Formation - C Unit (257.3-271.2 mLBGS)** | | | | | | | | | | |
| **Salina Formation - B Unit (271.2-319.0 mLBGS)** | | | | | | | | | | |
| DGR-5 | 38 | 315.81 | 60 | 270 | 201 | 66 | 38 | 326 | Smooth | -- |
| DGR-5 | 39 | 318.86 | 70 | 180 | 202 | 66 | 5 | 21 | Smooth | Anhydrite |
| **Salina Formation - A Unit (319.0-408.0 mLBGS)** | | | | | | | | | | |
| DGR-5 | 41 | 326.27 | 65 | 180 | 202 | 67 | 2 | 202 | Gouge | -- |
| DGR-5 | 46 | 340.42 | 20 | 55 | 203 | 67 | 85 | 73 | Healed | -- |
| DGR-5 | 46 | 340.48 | 20 | 60 | 203 | 67 | 83 | 78 | Healed | -- |
| DGR-5 | 52 | 358.59 | 15 | 70 | 203 | 67 | 84 | 88 | Rough | -- |
| DGR-5 | 53 | 361.50 | 40 | 355 | 204 | 67 | 73 | 19 | Rough | -- |

## Table A.1 - Summary of Natural Fractures in DGR-5

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-5 | 53 | 361.98 | 80 | 10 | 204 | 67 | 33 | 27 | Partially healed | -- |
| DGR-5 | 55 | 367.70 | 75 | 180 | 204 | 67 | 9 | 23 | Rough | Anhydrite |
| DGR-5 | 55 | 368.32 | 80 | 160 | 204 | 67 | 15 | 38 | Rough | Anhydrite |
| DGR-5 | 55 | 368.38 | 20 | 45 | 204 | 67 | 87 | 65 | Healed | Anhydrite |
| DGR-5 | 55 | 368.56 | 20 | 45 | 204 | 67 | 87 | 65 | Healed | Anhydrite |
| DGR-5 | 55 | 369.49 | 65 | 190 | 204 | 67 | 5 | 272 | Smooth | Anhydrite |
| DGR-5 | 57 | 374.91 | 85 | 175 | 204 | 67 | 19 | 25 | Rough | -- |
| DGR-5 | 59 | 379.52 | 75 | 190 | 204 | 67 | 9 | 6 | Smooth | -- |
| DGR-5 | 59 | 380.66 | 5 | 140 | 204 | 67 | 68 | 160 | Rough | Anhydrite |
| DGR-5 | 59 | 381.21 | 30 | 305 | 204 | 67 | 75 | 336 | Smooth | Anhydrite |
| DGR-5 | 59 | 381.29 | 60 | 200 | 204 | 67 | 12 | 265 | Rough | -- |
| DGR-5 | 63 | 389.31 | 15 | 60 | 204 | 68 | 87 | 80 | Healed | Anhydrite, Hydrocarbons |
| DGR-5 | 64 | 391.97 | 10 | 60 | 204 | 69 | 90 | 262 | Healed | Anhydrite |
| DGR-5 | 65 | 395.58 | 75 | 170 | 204 | 69 | 7 | 46 | Rough | -- |
| DGR-5 | 65 | 395.75 | 75 | 170 | 204 | 69 | 7 | 46 | Rough | Anhydrite, Hydrocarbons |
| DGR-5 | 65 | 397.17 | 65 | 35 | 204 | 69 | 44 | 44 | Healed | Anhydrite |
| **Guelph Formation (408.0-413.7 mLBGS)** | | | | | | | | | | |
| DGR-5 | 69 | 409.17 | 20 | 50 | 204 | 69 | 85 | 70 | Healed | Anhydrite |
| DGR-5 | 70 | 411.92 | 45 | 50 | 204 | 69 | 61 | 62 | Rough | Calcite, pyrite |
| DGR-5 | 70 | 412.26 | 70 | 0 | 204 | 69 | 42 | 24 | Rough | -- |
| DGR-5 | 70 | 412.28 | 40 | 0 | 204 | 69 | 71 | 24 | Rough | -- |
| **Goat Island Formation (413.7-433.0 mLBGS)** | | | | | | | | | | |
| DGR-5 | 72 | 417.29 | 57 | 190 | 204 | 70 | 14 | 227 | Rough | -- |
| DGR-5 | 72 | 418.79 | 86 | 120 | 204 | 70 | 19 | 35 | Rough | -- |
| **Gasport Formation (433.0-442.8 mLBGS)** | | | | | | | | | | |
| DGR-5 | 79 | 437.75 | 79 | 190 | 204 | 70 | 10 | 12 | Rough | -- |
| DGR-5 | 79 | 438.37 | 85 | 260 | 204 | 70 | 20 | 9 | Smooth | -- |
| DGR-5 | 80 | 442.42 | 5 | 320 | 204 | 70 | 80 | 163 | Rough | -- |
| **Lions Head Formation (442.8-445.3 mLBGS)** | | | | | | | | | | |
| DGR-5 | 80 | 443.03 | 20 | 85 | 204 | 70 | 73 | 102 | Healed | -- |
| DGR-5 | 80 | 443.42 | 30 | 20 | 204 | 70 | 79 | 41 | Rough | -- |
| **Fossil Hill Formation (445.3-447.8 mLBGS)** | | | | | | | | | | |
| DGR-5 | 82 | 447.78 | 15 | 70 | 204 | 70 | 83 | 90 | Healed | -- |
| **Cabot Head Formation (447.8-473.0 mLBGS)** | | | | | | | | | | |
| DGR-5 | 82 | 449.08 | 72 | 160 | 204 | 70 | 7 | 87 | Smooth | Halite |
| DGR-5 | 83 | 451.17 | 20 | 175 | 204 | 70 | 51 | 197 | Slickensides | -- |
| DGR-5 | 83 | 452.04 | 25 | 335 | 204 | 70 | 84 | 1 | Smooth | -- |

## Table A.1 - Summary of Natural Fractures in DGR-5

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| **Manitoulin Formation (473.0-486.6 mLBGS)** | | | | | | | | | | |
| **Queenston Formation (486.6-560.6 mLBGS)** | | | | | | | | | | |
| DGR-5 | 97 | 487.40 | 15 | 350 | 203 | 71 | 87 | 193 | Smooth | Halite |
| DGR-5 | 97 | 488.57 | 20 | 220 | 203 | 71 | 57 | 249 | Smooth | Halite |
| DGR-5 | 99 | 494.90 | 30 | 280 | 203 | 71 | 65 | 312 | Rough | -- |
| DGR-5 | 99 | 495.42 | 30 | 230 | 203 | 71 | 50 | 264 | Smooth | Halite |
| DGR-5 | 100 | 497.06 | 30 | 190 | 203 | 71 | 42 | 216 | Rough | Halite |
| DGR-5 | 101 | 501.85 | 20 | 350 | 203 | 71 | 89 | 13 | Healed | Halite |
| DGR-5 | 105 | 512.05 | 78 | 180 | 203 | 72 | 7 | 22 | Smooth | -- |
| DGR-5 | 105 | 512.75 | 15 | 240 | 203 | 72 | 67 | 268 | Smooth | Halite |
| DGR-5 | 109 | 524.04 | 73 | 200 | 203 | 72 | 7 | 311 | Smooth | Halite |
| DGR-5 | 115 | 542.40 | 15 | 240 | 203 | 72 | 67 | 268 | Smooth | -- |
| DGR-5 | 120 | 557.92 | 73 | 175 | 203 | 72 | 2 | 77 | Smooth | Halite |
| **Georgian Bay Formation (560.6-653.3 mLBGS)** | | | | | | | | | | |
| DGR-5 | 121 | 561.20 | 20 | 315 | 203 | 72 | 84 | 340 | Smooth | Halite |
| DGR-5 | 125 | 573.00 | 80 | 200 | 203 | 73 | 9 | 358 | Smooth | -- |
| DGR-5 | 128 | 582.00 | 15 | 60 | 203 | 73 | 84 | 80 | Smooth | Halite |
| DGR-5 | 128 | 583.10 | 5 | 50 | 203 | 73 | 85 | 253 | Smooth | Halite |
| DGR-5 | 128 | 583.32 | 90 | 180 | 203 | 73 | 18 | 23 | Rough | -- |
| DGR-5 | 129 | 586.46 | 5 | 0 | 203 | 73 | 79 | 203 | Smooth | -- |
| DGR-5 | 130 | 587.76 | 80 | 40 | 203 | 73 | 26 | 38 | Smooth | -- |
| DGR-5 | 130 | 589.39 | 65 | 10 | 203 | 73 | 42 | 29 | Smooth | -- |
| DGR-5 | 131 | 592.70 | 50 | 195 | 203 | 73 | 24 | 227 | Smooth | -- |
| DGR-5 | 135 | 603.66 | 15 | 280 | 203 | 73 | 79 | 306 | Smooth | Halite |
| DGR-5 | 135 | 605.30 | 5 | 40 | 203 | 73 | 82 | 243 | Smooth | Halite |
| DGR-5 | 135 | 605.46 | 15 | 280 | 203 | 73 | 79 | 306 | Smooth | Halite |
| DGR-5 | 135 | 605.53 | 5 | 50 | 203 | 73 | 85 | 253 | Smooth | Halite |
| DGR-5 | 138 | 614.14 | 60 | 325 | 202 | 73 | 45 | 358 | Smooth | Halite |
| DGR-5 | 138 | 614.58 | 60 | 210 | 202 | 73 | 18 | 259 | Closed | -- |
| DGR-5 | 140 | 619.39 | 70 | 190 | 202 | 73 | 5 | 253 | Smooth | Halite |
| DGR-5 | 148 | 645.20 | 80 | 140 | 202 | 74 | 11 | 59 | Smooth | -- |
| **Blue Mountain Formation (653.3-699.9 mLBGS)** | | | | | | | | | | |
| DGR-5 | 153 | 657.75 | 10 | 340 | 203 | 74 | 85 | 183 | Smooth | Halite |
| DGR-5 | 153 | 659.62 | 12 | 350 | 203 | 74 | 87 | 193 | Smooth | Halite |
| DGR-5 | 153 | 659.82 | 10 | 340 | 203 | 74 | 85 | 183 | Smooth | Halite |
| DGR-5 | 153 | 660.02 | 10 | 340 | 203 | 74 | 85 | 183 | Smooth | -- |
| DGR-5 | 154 | 661.05 | 70 | 180 | 202 | 75 | 5 | 202 | Smooth | -- |

## Table A.1 - Summary of Natural Fractures in DGR-5

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-5 | 159 | 676.18 | 10 | 0 | 202 | 75 | 85 | 202 | Smooth | Halite |
| DGR-5 | 159 | 677.30 | 3 | 275 | 202 | 75 | 89 | 297 | Smooth | Halite |
| DGR-5 | 162 | 685.25 | 5 | 30 | 203 | 76 | 83 | 233 | Smooth | -- |
| DGR-5 | 165 | 692.35 | 5 | 20 | 203 | 76 | 82 | 223 | Smooth | Calcite |
| DGR-5 | 167 | 699.45 | 3 | 180 | 203 | 77 | 74 | 203 | Smooth | -- |
| **Cobourg Formation - Collingwood Member (699.9-708-7 mLBGS)** | | | | | | | | | | |
| DGR-5 | 168 | 700.44 | 4 | 310 | 202 | 77 | 86 | 151 | Smooth | -- |
| DGR-5 | 168 | 701.09 | 80 | 180 | 202 | 77 | 4 | 21 | Rough | -- |
| DGR-5 | 168 | 703.34 | 78 | 210 | 202 | 77 | 7 | 315 | Rough | Calcite |
| DGR-5 | 169 | 703.76 | 82 | 200 | 203 | 77 | 7 | 356 | Rough | -- |
| DGR-5 | 169 | 704.07 | 80 | 180 | 203 | 77 | 4 | 22 | Rough | -- |
| DGR-5 | 169 | 704.48 | 90 | 0 | 203 | 77 | 13 | 23 | Healed | -- |
| DGR-5 | 169 | 704.94 | 90 | 0 | 203 | 77 | 13 | 23 | Healed | -- |
| DGR-5 | 169 | 705.25 | 82 | 130 | 203 | 77 | 10 | 61 | Smooth | -- |
| DGR-5 | 169 | 705.94 | 90 | 0 | 203 | 77 | 13 | 23 | Smooth | -- |
| **Cobourg Formation - Lower Member (708.7-736.5 mLBGS)** | | | | | | | | | | |
| DGR-5 | 174 | 721.49 | 90 | 0 | 203 | 77 | 13 | 23 | Rough | Calcite |
| DGR-5 | 175 | 722.04 | 90 | 0 | 203 | 77 | 13 | 23 | Smooth | -- |
| DGR-5 | 175 | 722.97 | 90 | 0 | 203 | 77 | 13 | 23 | Smooth | -- |
| DGR-5 | 177 | 728.6 | 90 | 0 | 203 | 77 | 13 | 23 | Smooth | -- |
| DGR-5 | 177 | 729.07 | 90 | 0 | 203 | 77 | 13 | 23 | Smooth | -- |
| DGR-5 | 179 | 735.16 | 80 | 220 | 203 | 77 | 9 | 332 | Rough | -- |
| DGR-5 | 179 | 736.48 | 83 | 165 | 203 | 77 | 7 | 39 | Rough | -- |
| **Sherman Fall Formation (736.5-766.5 mLBGS)** | | | | | | | | | | |
| DGR-5 | 180 | 737.10 | 80 | 220 | 203 | 77 | 9 | 332 | Smooth | -- |
| DGR-5 | 180 | 738.21 | 78 | 170 | 203 | 77 | 3 | 83 | Rough | -- |
| DGR-5 | 180 | 738.43 | 90 | 0 | 203 | 77 | 13 | 23 | Rough | -- |
| DGR-5 | 180 | 738.82 | 90 | 0 | 203 | 77 | 13 | 23 | Rough | Calcite |
| DGR-5 | 180 | 739.99 | 90 | 0 | 203 | 77 | 13 | 23 | Rough | -- |
| DGR-5 | 185 | 752.56 | 90 | 0 | 203 | 77 | 13 | 23 | Smooth | -- |
| **Kirkfield Formation (766.5- mLBGS)** | | | | | | | | | | |

## Table A.2 - Summary of Natural Fractures in DGR-6

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| **Lucas Formation (16.9-37.0 mLBGS)** | | | | | | | | | | |
| **Amherstburg Formation (37.0-87.1 mLBGS)** | | | | | | | | | | |
| **Bois Blanc Formation (87.1-145.3 mLBGS)** | | | | | | | | | | |
| **Bass Islands Formation (145.3-193.3 mLBGS)** | | | | | | | | | | |
| **Salina Formation - G Unit (193.0-203.0 mLBGS)** | | | | | | | | | | |
| **Salina Formation - F Unit (203.0-249.1 mLBGS)** | | | | | | | | | | |
| DGR-6 | 1 | 215.04 | 40 | 20 | 89 | 60 | 79 | 284 | Healed | Anhydrite |
| DGR-6 | 2 | 216.84 | 70 | 170 | 89 | 60 | 11 | 287 | Smooth | -- |
| DGR-6 | 3 | 218.90 | 60 | 95 | 90 | 60 | 40 | 321 | Smooth | -- |
| DGR-6 | 3 | 219.01 | 65 | 35 | 90 | 60 | 53 | 287 | Smooth | -- |
| DGR-6 | 3 | 219.15 | 65 | 35 | 90 | 60 | 53 | 287 | Smooth | -- |
| DGR-6 | 3 | 219.95 | 70 | 80 | 90 | 60 | 39 | 302 | Smooth | -- |
| DGR-6 | 3 | 220.15 | 80 | 255 | 90 | 60 | 29 | 249 | Smooth | Iron staining |
| DGR-6 | 3 | 220.68 | 50 | 80 | 90 | 60 | 53 | 322 | Smooth | Anhydrite |
| DGR-6 | 3 | 221.36 | 40 | 270 | 90 | 60 | 57 | 202 | Rough | -- |
| DGR-6 | 4 | 221.94 | 70 | 15 | 89 | 60 | 50 | 275 | Smooth | -- |
| DGR-6 | 4 | 222.55 | 80 | 130 | 89 | 60 | 25 | 287 | Undulating | -- |
| DGR-6 | 4 | 223.69 | 82 | 135 | 89 | 60 | 25 | 282 | Undulating | -- |
| DGR-6 | 7 | 227.47 | 80 | 110 | 89 | 60 | 29 | 289 | Rough | -- |
| DGR-6 | 7 | 228.25 | 85 | 140 | 89 | 60 | 27 | 276 | Rough | -- |
| DGR-6 | 9 | 232.44 | 65 | 130 | 89 | 60 | 23 | 325 | Smooth | -- |
| DGR-6 | 9 | 232.52 | 60 | 240 | 89 | 60 | 29 | 205 | Smooth | -- |
| DGR-6 | 9 | 233.18 | 70 | 210 | 89 | 60 | 16 | 230 | Smooth | -- |
| DGR-6 | 10 | 236.18 | 80 | 30 | 90 | 60 | 39 | 277 | Undulating | -- |
| DGR-6 | 10 | 237.23 | 90 | 0 | 90 | 60 | 30 | 270 | Smooth | -- |
| DGR-6 | 12 | 242.59 | 60 | 170 | 90 | 60 | 5 | 355 | Undulating | Anhydrite |
| DGR-6 | 12 | 243.04 | 60 | 130 | 90 | 60 | 25 | 338 | Undulating | Anhydrite |
| DGR-6 | 12 | 243.33 | 60 | 145 | 90 | 60 | 18 | 344 | Undulating | Anhydrite |
| DGR-6 | 12 | 243.43 | 60 | 180 | 90 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 13 | 244.63 | 60 | 180 | 90 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 13 | 244.73 | 70 | 220 | 90 | 60 | 20 | 227 | Undulating | -- |
| DGR-6 | 13 | 245.07 | 65 | 180 | 90 | 60 | 6 | 269 | Undulating | -- |
| DGR-6 | 13 | 245.12 | 62 | 170 | 90 | 60 | 6 | 333 | Undulating | -- |
| DGR-6 | 13 | 245.19 | 60 | 130 | 90 | 60 | 25 | 338 | Undulating | Anhydrite |
| DGR-6 | 13 | 245.25 | 70 | 170 | 90 | 60 | 11 | 288 | Smooth | Anhydrite |
| DGR-6 | 13 | 245.37 | 60 | 170 | 90 | 60 | 5 | 355 | Smooth | Anhydrite |
| DGR-6 | 13 | 245.59 | 65 | 200 | 90 | 60 | 11 | 217 | Smooth | Anhydrite |

## Table A.2 - Summary of Natural Fractures in DGR-6

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-6 | 13 | 245.75 | 60 | 180 | 90 | 60 | 1 | 180 | Undulating | Anhydrite |
| DGR-6 | 13 | 246.12 | 60 | 175 | 90 | 60 | 3 | 357 | Smooth | Anhydrite |
| DGR-6 | 13 | 246.4 | 70 | 200 | 90 | 60 | 13 | 238 | Smooth | Anhydrite |
| DGR-6 | 13 | 246.63 | 55 | 180 | 90 | 60 | 6 | 90 | Undulating | Anhydrite |
| DGR-6 | 13 | 246.72 | 55 | 180 | 90 | 60 | 6 | 90 | Undulating | Anhydrite |
| DGR-6 | 13 | 246.84 | 55 | 180 | 90 | 60 | 6 | 90 | Undulating | Anhydrite |
| DGR-6 | 13 | 246.96 | 55 | 180 | 90 | 60 | 6 | 90 | Undulating | Anhydrite |
| DGR-6 | 14 | 247.12 | 50 | 180 | 89 | 60 | 10 | 89 | Smooth | Anhydrite |
| DGR-6 | 14 | 247.13 | 55 | 0 | 89 | 60 | 65 | 269 | Smooth | Anhydrite |
| DGR-6 | 14 | 247.92 | 55 | 180 | 89 | 60 | 6 | 89 | Smooth | -- |
| DGR-6 | 14 | 248.28 | 50 | 210 | 89 | 60 | 20 | 161 | Smooth | -- |
| DGR-6 | 14 | 248.47 | 60 | 190 | 89 | 60 | 5 | 183 | Smooth | -- |
| **Salina Formation - E Unit (249.1-298.5 mLBGS)** | | | | | | | | | | |
| DGR-6 | 14 | 249.12 | 70 | 160 | 89 | 60 | 13 | 300 | Smooth | Anhydrite |
| DGR-6 | 15 | 252.23 | 75 | 210 | 90 | 60 | 19 | 245 | Smooth | -- |
| DGR-6 | 15 | 252.27 | 20 | 0 | 90 | 60 | 80 | 90 | Smooth | Pyrite |
| DGR-6 | 17 | 257.16 | 70 | 230 | 90 | 60 | 23 | 226 | Smooth | Anhydrite |
| DGR-6 | 17 | 258.26 | 82 | 180 | 90 | 60 | 23 | 269 | Undulating | -- |
| DGR-6 | 17 | 258.44 | 70 | 150 | 90 | 60 | 16 | 308 | Smooth | -- |
| DGR-6 | 18 | 260.68 | 70 | 180 | 90 | 60 | 11 | 269 | Smooth | -- |
| DGR-6 | 20 | 265.84 | 70 | 180 | 90 | 60 | 11 | 269 | Smooth | Anhydrite |
| DGR-6 | 20 | 265.93 | 70 | 180 | 90 | 60 | 11 | 269 | Smooth | -- |
| DGR-6 | 21 | 269.99 | 75 | 170 | 90 | 60 | 16 | 279 | Smooth | -- |
| DGR-6 | 22 | 271.51 | 60 | 180 | 90 | 60 | 1 | 180 | Undulating | -- |
| DGR-6 | 22 | 271.83 | 60 | 180 | 90 | 60 | 1 | 180 | Undulating | Anhydrite |
| DGR-6 | 22 | 272.46 | 60 | 180 | 90 | 60 | 1 | 180 | Smooth | Anhydrite |
| DGR-6 | 22 | 273.64 | 60 | 180 | 90 | 60 | 1 | 180 | Undulating | Anhydrite |
| DGR-6 | 23 | 274.96 | 0 | 0 | 89 | 60 | 60 | 89 | Smooth | -- |
| DGR-6 | 23 | 276.1 | 70 | 180 | 89 | 60 | 11 | 268 | Smooth | -- |
| DGR-6 | 23 | 276.95 | 10 | 350 | 89 | 60 | 71 | 78 | Smooth | -- |
| DGR-6 | 24 | 278.39 | 90 | 180 | 89 | 60 | 31 | 269 | Smooth | -- |
| DGR-6 | 24 | 278.41 | 50 | 180 | 89 | 60 | 10 | 89 | Smooth | -- |
| DGR-6 | 27 | 287.77 | 60 | 180 | 89 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 28 | 290.86 | 90 | 0 | 89 | 60 | 30 | 269 | Smooth | -- |
| DGR-6 | 28 | 291.31 | 60 | 310 | 89 | 60 | 54 | 240 | Smooth | -- |
| DGR-6 | 29 | 293.26 | 90 | 0 | 90 | 60 | 30 | 270 | Smooth | -- |
| DGR-6 | 29 | 293.53 | 90 | 0 | 90 | 60 | 30 | 270 | Smooth | -- |

## Table A.2 - Summary of Natural Fractures in DGR-6

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-6 | 29 | 294.16 | 80 | 0 | 90 | 60 | 41 | 270 | Smooth | -- |
| DGR-6 | 29 | 294.71 | 90 | 0 | 90 | 60 | 30 | 270 | Smooth | -- |
| DGR-6 | 29 | 295.08 | 80 | 260 | 90 | 60 | 30 | 249 | Smooth | -- |
| DGR-6 | 29 | 295.52 | 90 | 0 | 90 | 60 | 30 | 270 | Smooth | -- |
| DGR-6 | 30 | 298.15 | 80 | 0 | 90 | 60 | 41 | 270 | Smooth | -- |
| **Salina Formation - D Unit (298.5-299.5 mLBGS)** | | | | | | | | | | |
| **Salina Formation - C Unit (299.5-308.4 mLBGS)** | | | | | | | | | | |
| DGR-6 | 31 | 301.82 | 70 | 260 | 90 | 60 | 33 | 231 | Rough | Anhydrite |
| **Salina Formation - B Unit (308.4-337.7 mLBGS)** | | | | | | | | | | |
| DGR-6 | 35 | 312.62 | 20 | 180 | 90 | 60 | 40 | 90 | Rough | -- |
| DGR-6 | 37 | 318.71 | 85 | 0 | 90 | 60 | 36 | 270 | Smooth | -- |
| DGR-6 | 38 | 322.82 | 15 | 280 | 90 | 60 | 82 | 196 | Smooth | Anhydrite |
| DGR-6 | 41 | 329.75 | 65 | 195 | 91 | 60 | 9 | 223 | Smooth | -- |
| DGR-6 | 42 | 332.94 | 80 | 140 | 91 | 60 | 24 | 287 | Undulating | -- |
| DGR-6 | 42 | 334.46 | 60 | 175 | 91 | 60 | 3 | 358 | Smooth | -- |
| DGR-6 | 42 | 335.17 | 55 | 160 | 91 | 60 | 12 | 17 | Smooth | -- |
| DGR-6 | 42 | 335.37 | 0 | 180 | 91 | 60 | 60 | 91 | Rough | Clay |
| DGR-6 | 43 | 337.29 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| **Salina Formation - A Unit (337.7-427.3 mLBGS)** | | | | | | | | | | |
| DGR-6 | 45 | 341.04 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 45 | 341.35 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 45 | 341.50 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 45 | 341.83 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 45 | 341.95 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 45 | 342.03 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | Pyrite |
| DGR-6 | 45 | 342.12 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 45 | 341.87 | 20 | 330 | 91 | 60 | 84 | 62 | Healed | -- |
| DGR-6 | 45 | 342.22 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 46 | 343.94 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 46 | 344.14 | 0 | 90 | 91 | 60 | 90 | 1 | Smooth | Anhydrite |
| DGR-6 | 47 | 344.82 | 60 | 180 | 91 | 60 | 1 | 180 | Undulating | Clay |
| DGR-6 | 47 | 345.37 | 60 | 180 | 91 | 60 | 1 | 180 | Undulating | -- |
| DGR-6 | 47 | 346.12 | 0 | 0 | 91 | 60 | 60 | 91 | Healed | Anhydrite |
| DGR-6 | 47 | 346.58 | 60 | 180 | 91 | 60 | 1 | 180 | Undulating | -- |
| DGR-6 | 47 | 346.74 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | Clay |
| DGR-6 | 48 | 347.70 | 60 | 180 | 91 | 60 | 1 | 180 | Rough | Anhydrite |
| DGR-6 | 49 | 351.76 | 85 | 270 | 91 | 60 | 31 | 261 | Rough | Anhydrite |

## Table A.2 - Summary of Natural Fractures in DGR-6

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-6 | 52 | 358.21 | 60 | 180 | 91 | 60 | 1 | 180 | Rough | Anhydrite |
| DGR-6 | 52 | 359.65 | 60 | 180 | 91 | 60 | 1 | 180 | Rough | Anhydrite |
| DGR-6 | 53 | 361.50 | 40 | 0 | 91 | 60 | 80 | 271 | Healed | Anhydrite |
| DGR-6 | 53 | 361.56 | 40 | 0 | 91 | 60 | 80 | 271 | Healed | Anhydrite |
| DGR-6 | 53 | 361.73 | 40 | 0 | 91 | 60 | 80 | 271 | Healed | Anhydrite |
| DGR-6 | 53 | 361.76 | 40 | 0 | 91 | 60 | 80 | 271 | Healed | Anhydrite |
| DGR-6 | 57 | 372.45 | 60 | 180 | 91 | 60 | 1 | 180 | Smooth | -- |
| DGR-6 | 60 | 377.13 | 10 | 200 | 91 | 60 | 53 | 116 | Slickensides | |
| DGR-6 | 61 | 378.80 | 20 | 320 | 91 | 60 | 87 | 53 | Healed | Calcite, Pyrite |
| DGR-6 | 61 | 378.85 | 25 | 80 | 91 | 60 | 74 | 339 | Healed | -- |
| DGR-6 | 62 | 383.69 | 70 | 200 | 91 | 60 | 13 | 239 | Smooth | -- |
| DGR-6 | 62 | 384.03 | 70 | 200 | 91 | 60 | 13 | 239 | Smooth | -- |
| DGR-6 | 67 | 398.55 | 45 | 190 | 91 | 61 | 18 | 115 | Smooth | -- |
| DGR-6 | 68 | 399.82 | 30 | 180 | 91 | 61 | 31 | 91 | Healed | Anhydrite, Hydrocarbons |
| DGR-6 | 68 | 401.13 | 30 | 355 | 91 | 61 | 89 | 266 | Healed | Anhydrite, Hydrocarbons |
| DGR-6 | 68 | 401.16 | 30 | 355 | 91 | 61 | 89 | 266 | Healed | Anhydrite, Hydrocarbons |
| DGR-6 | 68 | 401.22 | 30 | 355 | 91 | 61 | 89 | 266 | Healed | Anhydrite, Hydrocarbons |
| DGR-6 | 71 | 410.55 | 20 | 180 | 91 | 62 | 42 | 91 | Healed | Anhydrite |
| DGR-6 | 72 | 413.87 | 20 | 0 | 91 | 62 | 83 | 91 | Rough | Anhydrite |
| DGR-6 | 73 | 417.05 | 30 | 0 | 91 | 63 | 87 | 271 | Healed | Anhydrite |
| DGR-6 | 73 | 417.13 | 30 | 0 | 91 | 63 | 87 | 271 | Healed | Anhydrite |
| **Guelph Formation (427.3-431.5 mLBGS)** | | | | | | | | | | |
| **Goat Island Formation (431.5-452.2 mLBGS)** | | | | | | | | | | |
| DGR-6 | 79 | 435.05 | 70 | 240 | 91 | 63 | 24 | 223 | Rough | -- |
| DGR-6 | 80 | 438.02 | 90 | 0 | 91 | 63 | 27 | 271 | Rough | -- |
| **Gasport Formation (452.2-461.0 mLBGS)** | | | | | | | | | | |
| DGR-6 | 86 | 456.10 | 20 | 0 | 92 | 64 | 85 | 92 | Healed | Calcite |
| DGR-6 | 86 | 456.25 | 20 | 0 | 92 | 64 | 85 | 92 | Healed | Calcite |
| **Lions Head Formation (461.0-465.0 mLBGS)** | | | | | | | | | | |
| DGR-6 | 89 | 464.99 | 90 | 180 | 93 | 64 | 27 | 273 | Smooth | -- |
| **Fossil Hill Formation (465.0-467.9 mLBGS)** | | | | | | | | | | |
| **Cabot Head Formation (467.9-493.6 mLBGS)** | | | | | | | | | | |
| DGR-6 | 90 | 468.09 | 14 | 240 | 92 | 64 | 65 | 160 | Smooth | Halite |
| DGR-6 | 90 | 468.24 | 90 | 180 | 92 | 64 | 27 | 272 | Smooth | -- |
| DGR-6 | 90 | 468.98 | 70 | 180 | 92 | 64 | 7 | 271 | Smooth | -- |
| DGR-6 | 92 | 473.26 | 60 | 220 | 92 | 65 | 19 | 185 | Smooth | Halite |
| DGR-6 | 95 | 481.09 | 70 | 180 | 92 | 65 | 6 | 271 | Rough | -- |

## Table A.2 - Summary of Natural Fractures in DGR-6

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-6 | 95 | 482.08 | 90 | 180 | 92 | 65 | 26 | 272 | Rough | -- |
| DGR-6 | 96 | 484.31 | 90 | 180 | 92 | 66 | 26 | 272 | Smooth | -- |
| DGR-6 | 97 | 486.04 | 90 | 180 | 92 | 66 | 25 | 272 | Rough | -- |
| DGR-6 | 99 | 490.43 | 70 | 180 | 93 | 67 | 4 | 272 | Smooth | -- |
| DGR-6 | 100 | 492.99 | 90 | 180 | 92 | 67 | 24 | 272 | Rough | -- |
| DGR-6 | 100 | 493.55 | 70 | 180 | 92 | 67 | 4 | 271 | Smooth | -- |
| **Manitoulin Formation (493.6-507.9 mLBGS)** | | | | | | | | | | |
| DGR-6 | 101 | 495.96 | 80 | 180 | 92 | 67 | 14 | 271 | Smooth | -- |
| DGR-6 | 102 | 498.36 | 90 | 0 | 92 | 68 | 23 | 272 | Smooth | -- |
| DGR-6 | 102 | 498.57 | 90 | 0 | 92 | 68 | 23 | 272 | Smooth | -- |
| DGR-6 | 103 | 501.69 | 80 | 180 | 91 | 68 | 13 | 270 | Smooth | -- |
| DGR-6 | 104 | 504.76 | 90 | 0 | 91 | 68 | 23 | 271 | Rough | -- |
| DGR-6 | 104 | 504.93 | 65 | 180 | 91 | 68 | 4 | 91 | Smooth | Halite |
| **Queenston Formation (507.9-583.1 mLBGS)** | | | | | | | | | | |
| DGR-6 | 111 | 522.96 | 65 | 180 | 89 | 68 | 4 | 89 | Smooth | -- |
| DGR-6 | 112 | 527.36 | 5 | 80 | 89 | 67 | 90 | 347 | Smooth | -- |
| DGR-6 | 112 | 528.61 | 10 | 40 | 89 | 67 | 83 | 128 | Smooth | -- |
| DGR-6 | 113 | 528.98 | 55 | 180 | 89 | 66 | 11 | 89 | Smooth, Slickensides | -- |
| DGR-6 | 117 | 538.69 | 10 | 350 | 88 | 67 | 78 | 78 | Healed | -- |
| DGR-6 | 117 | 538.84 | 0 | 0 | 88 | 67 | 67 | 89 | Smooth | -- |
| **Georgian Bay Formation (583.1-684.7 mLBGS)** | | | | | | | | | | |
| DGR-6 | 137 | 593.71 | 10 | 40 | 87 | 66 | 82 | 126 | Smooth | -- |
| DGR-6 | 137 | 594.84 | 10 | 20 | 87 | 66 | 78 | 107 | Smooth | Halite |
| DGR-6 | 137 | 595.03 | 10 | 30 | 87 | 66 | 80 | 117 | Smooth | -- |
| DGR-6 | 143 | 608.17 | 20 | 300 | 85 | 63 | 85 | 210 | Smooth | -- |
| DGR-6 | 143 | 608.37 | 20 | 320 | 85 | 63 | 89 | 47 | Smooth | -- |
| DGR-6 | 144 | 613.70 | 50 | 40 | 82 | 63 | 63 | 289 | Smooth | Halite |
| DGR-6 | 145 | 615.20 | 40 | 240 | 81 | 63 | 42 | 166 | Rough | Iron staining |
| DGR-6 | 149 | 626.59 | 55 | 300 | 77 | 60 | 56 | 219 | Rough | -- |
| DGR-6 | 151 | 633.47 | 20 | 120 | 75 | 59 | 58 | 360 | Smooth, Slickensides | -- |
| DGR-6 | 151 | 633.51 | 30 | 190 | 75 | 59 | 30 | 92 | Smooth, Slickensides | -- |
| DGR-6 | 151 | 633.63 | 30 | 200 | 75 | 59 | 33 | 108 | Smooth, Slickensides | -- |
| DGR-6 | 160 | 651.18 | 5 | 280 | 75 | 57 | 89 | 356 | Smooth | Halite |
| DGR-6 | 160 | 651.20 | 5 | 20 | 75 | 57 | 65 | 97 | Smooth | -- |
| DGR-6 | 160 | 652.08 | 45 | 110 | 75 | 57 | 44 | 329 | Smooth | Halite |
| DGR-6 | 161 | 654.56 | 20 | 85 | 75 | 57 | 76 | 329 | Smooth | Halite |
| DGR-6 | 161 | 655.16 | 5 | 250 | 75 | 57 | 76 | 150 | Smooth | Halite |

## Table A.2 - Summary of Natural Fractures in DGR-6

| Borehole | Core Run | Fracture Depth (mLBGS) | Alpha (degrees) | Beta (degrees) | Average Borehole Azimuth (degrees) | Average Borehole Plunge (degrees) | True Dip (degrees) | True Dip Direction (degrees) | Roughness | Infilling |
|---|---|---|---|---|---|---|---|---|---|---|
| DGR-6 | 161 | 655.81 | 15 | 100 | 75 | 57 | 73 | 344 | Smooth | Halite |
| DGR-6 | 170 | 680.28 | 40 | 60 | 75 | 57 | 71 | 299 | Smooth | Halite |
| **Blue Mountain Formation (684.7-738.3 mLBGS)** | | | | | | | | | | |
| DGR-6 | 175 | 693.82 | 75 | 290 | 75 | 57 | 41 | 232 | Smooth | Halite |
| DGR-6 | 175 | 694.86 | 5 | 70 | 75 | 57 | 84 | 145 | Smooth | Halite |
| DGR-6 | 175 | 695.56 | 30 | 140 | 75 | 57 | 39 | 12 | Smooth | Halite |
| DGR-6 | 175 | 695.91 | 30 | 70 | 75 | 57 | 76 | 312 | Smooth | Halite |
| DGR-6 | 176 | 697.41 | 20 | 70 | 75 | 57 | 84 | 317 | Smooth | Halite |
| DGR-6 | 176 | 697.51 | 20 | 90 | 75 | 57 | 74 | 333 | Smooth | Halite |
| DGR-6 | 178 | 703.11 | 25 | 240 | 75 | 57 | 54 | 154 | Smooth | -- |
| DGR-6 | 178 | 703.19 | 30 | 290 | 75 | 57 | 76 | 197 | Smooth | Iron staining |
| DGR-6 | 178 | 703.34 | 25 | 300 | 75 | 57 | 84 | 202 | Smooth | Iron staining |
| DGR-6 | 179 | 705.54 | 35 | 230 | 75 | 57 | 40 | 153 | Rough | Halite |
| **Cobourg Formation - Collingwood Member (738.3-746.1 mLBGS)** | | | | | | | | | | |
| **Cobourg Formation - Lower Member (746.1-780.2 mLBGS)** | | | | | | | | | | |
| **Sherman Fall Formation (780.2-814.7 mLBGS)** | | | | | | | | | | |
| DGR-6 | 212 | 807.02 | 35 | 175 | 73 | 57 | 23 | 62 | Rough | Halite |
| **Kirkfield Formation (814.7-870.5 mLBGS)** | | | | | | | | | | |
| DGR-6 | 218 | 823.04 | 30 | 180 | 73 | 57 | 28 | 73 | Smooth | -- |
| DGR-6 | 218 | 823.63 | 30 | 180 | 73 | 57 | 28 | 73 | Smooth | -- |
| DGR-6 | 229 | 857.30 | 50 | 0 | 73 | 58 | 73 | 253 | Healed | -- |
| **Coboconk Formation (870.5-897.2 mLBGS)** | | | | | | | | | | |
| **Gull River Formation (897.2- mLBGS)** | | | | | | | | | | |

# APPENDIX B

## Sample Fracture Photographs


DGR-5, Core Run 120, 557.92 mLBGS (Queenston Fm.)


DGR-5, Core Run 140, 619.39 mLBGS (Georgian Bay Fm.)


DGR-6, Core Run 57, 372.45 mLBGS (Salina A Unit)


DGR-6, Core Run 99, 490.49 mLBGS (Cabot Head Fm.)

**Figure B.1, TR-09-09: Sample Bedding Plane Fractures**

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DGR-5, Core Run 80, 442.42 mLBGS (Gasport Fm.)


DGR-5, Core Run 101, 501.85 mLBGS (Queenston Fm.)


DGR-6, Core Run 161, 655.16 mLBGS (Georgian Bay Fm.)

DGR-6, Core Run 175, 694.86 mLBGS (Blue Mountain Fm.)

**Figure B.2, TR-09-09: Sample Inclined Fractures**

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## APPENDIX C

### Polar Plots (Core Logging)

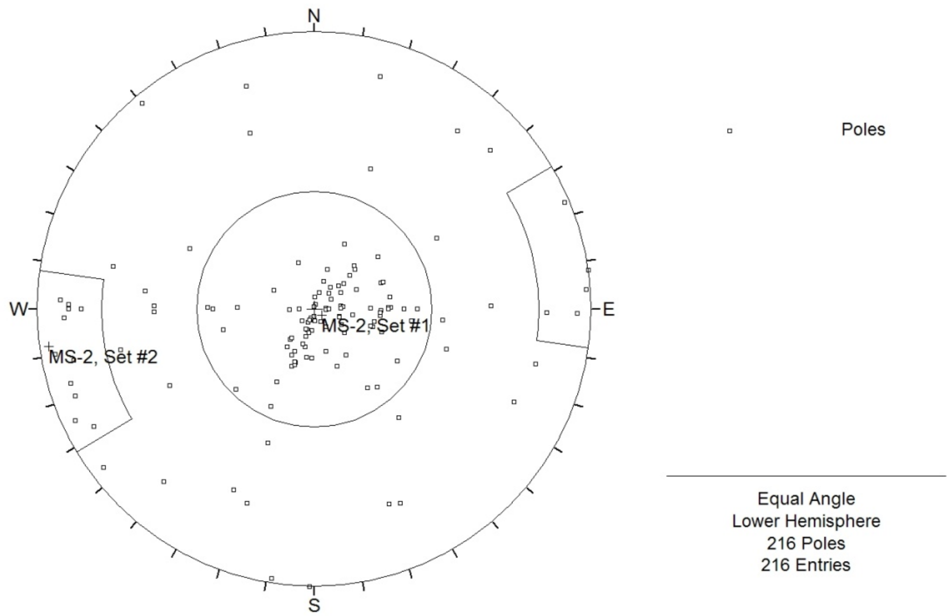


**Figure C.1 Equal area polar plot of all natural fractures from DGR-5 and DGR-6 in MS Unit 2.**

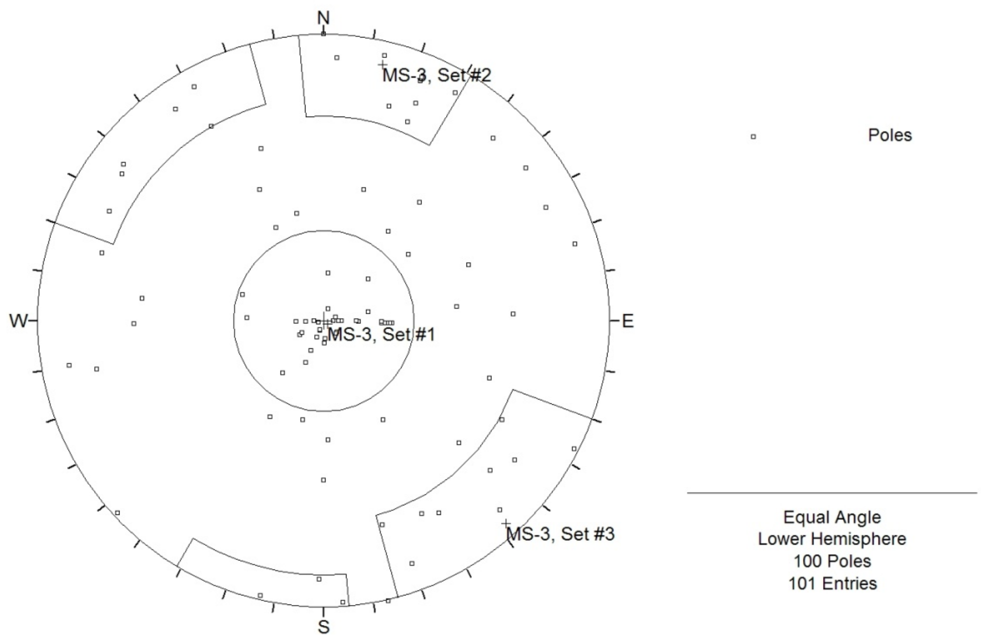


**Figure C.2 Equal area polar plot of all natural fractures from DGR-5 and DGR-6 in MS Unit 3.**

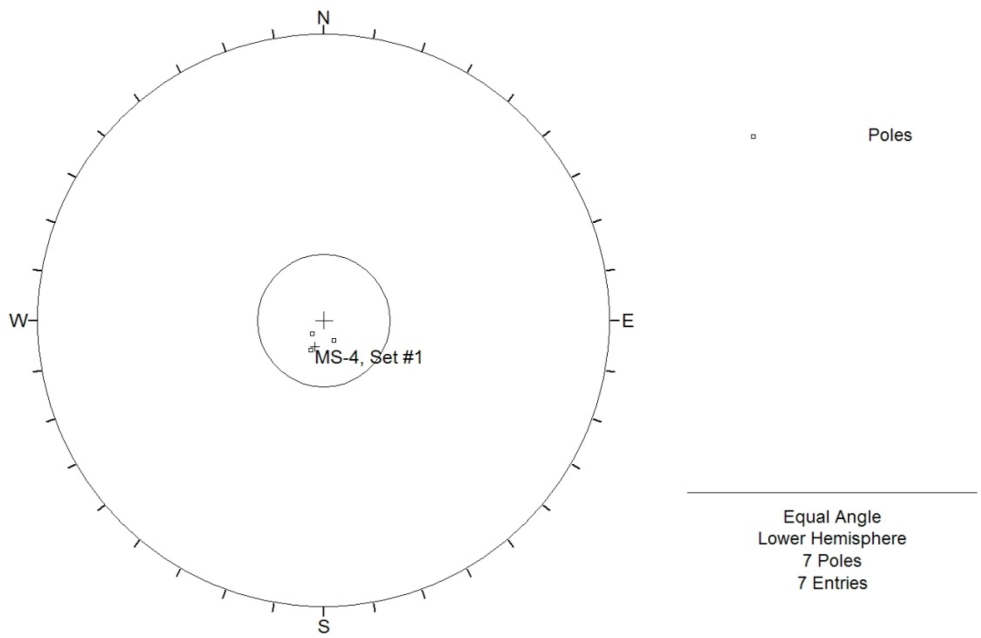


**Figure C.3 Equal area polar plot of all natural fractures from DGR-5 and DGR-6 in MS Unit 4.**

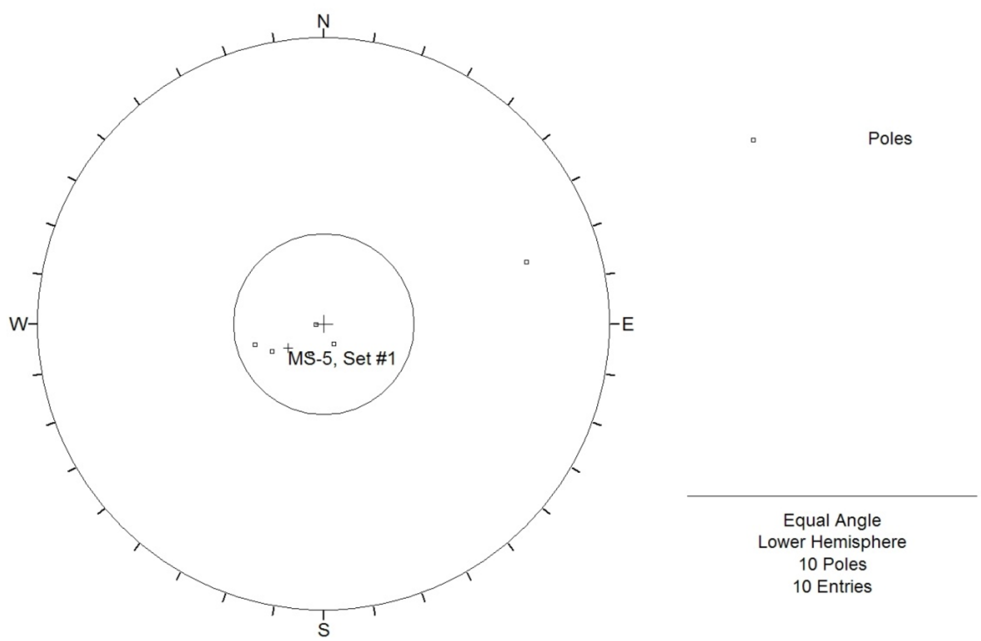


**Figure C.4 Equal area polar plot of all natural fractures from DGR-5 and DGR-6 in MS Unit 5.**