Introduction

- Geotechnical data provides information on **rock mass** and **structure characteristics** which will be relied upon for slope and underground design at the Back River deposits.
- It is important that the data collected be **accurate and precise**, so that SRK can assist to design a safe, but cost effective mine plan for Back River.
GEOTECHNICAL DESIGN STARTS WITH PROPER DATA COLLECTION

ROCK MASS RATING
- FIELD GEOTECH DATA
- PARAMETERS CALCULATION
- DATABASE

GEOMETRY (3D MODEL)
- STABILITY ANALYSIS & DESIGN

STRUCTURAL ANALYSIS
- FIELD STRUCT. DATA
- PARAMETERS CALCULATION
- STRUCTURAL ANALYSIS
LAUBSCHER’S RMR CLASSIFICATION SYSTEM

- INTACT ROCK STRENGTH
- FRACTURE FREQUENCY (Fractures per meter)
- JOINT CONDITIONS

"IN-SITU" PARAMETERS

ROCK MASS RATING - RMR (0-100)

ROCK MASS STRENGTH - RMS (MPa)

- WEATHERING
- ORIENTATION
- INDUCED STRESS
- BLASTING

MINING ADJUSTMENTS

MINING ROCK MASS RATING - MRMR (0-100)

DESIGN ROCK MASS STRENGTH - DRMS (MPa)

RMR (ROCK MASS RATING) 0 - 100

JOINT FREQUENCY (40 %)

IRS (20 %)

JOINT CONDITIONS (40 %)
## Contents

| A) Identifying fractures | 1) Fracture types: Joints, mechanical breaks, cemented joints, core handling breaks  
2) Core marking  
3) Rubble Zones |
|--------------------------|-----------------------------------------------------------------|
| B) Basic logging         | 1) Runs  
2) TCR  
3) RQD |
| C) Detailed logging      | 1) Open fracture count, joint count etc.  
2) Intact Rock Strength  
3) Micro Defects  
4) Describing joints  
5) Joint sets  
6) Major structures |
| D) Oriented Core logging | 1) Core orientation  
2) Alpha and Beta angles |
A) Identifying Fractures
In the core, indications of a naturally occurring, \textit{insitu} joint include:

- Freshness – Joints often are not fresh.
- Staining – Joints are often stained or have some type of coating or fill.
- No tensile strength – Joints separate solid (intact) core pieces and exhibit no tensile strength.
- Roughness of break – The edges of a joint usually do not match back together as seamlessly as a mechanical break.
- Angle of break – Low angle breaks are more likely to be joints than mechanical breaks.
Examples of Joints
Mechanical Breaks

- Mechanical breaks are artificial breaks in the core that have been created by the drilling process (i.e. fresh breaks).

- Indications of a mechanical break include:
  - Freshness – fresh looking surface could indicate artificial break
  - Angle of break – break perpendicular to the core axis could be an indication of an artificial break
  - Roughness – rough surface could indicate artificial break
  - Coating - no coating or fill could indicate artificial break
  - Spin marks from the drill.

- Mechanical breaks are often found near the end of the drilling run, or near the end of the box row, where the driller’s helper has hit the core to fit it in the box.

- If you are really unsure if something is a joint or a mechanical break, you should err on the side of caution and call it a joint.
Examples of Mechanical Breaks

Note high angle, very fresh break indicating drill damage.

Cluster of foliation sub-parallel fractures – roughness and angularity indicate mechanical damage.

Although sub-parallel to foliation, roughness and angularity of break indicate mechanical damage.

“Drill spin” is an obvious indication of mechanical damage.
Core Marking

Four sources of fractures can be found in the drill core, and are marked as follows:

- Artificial breaks induced by the core handling process should be marked with a yellow (X).
- Artificial breaks induced by the drilling process (mechanical breaks) are marked with a yellow line (—) across the break.
- Natural joints that are present in the rock mass are marked with a red (J) and a line along the joint.
- Microdefects are noted on the core with in blue (MD)

Write down all parameters and physically comment on core where possible.
Rubble Zones

- Rubble zones are sections of core that are broken, very jointed, sheared, or filled with gouge. Rubble zones may be associated with tightly spaced joints, highly altered or weak ground or fault zones.

- Rubble zones are either:
  - **Natural Rubble Zones** (RZ), which are created by a fault or series of joints in close succession; or
  - **Mechanical Rubble Zones** (MRZ), which are created artificially by the drilling process, and are essentially a series of mechanical breaks in close succession.

- Natural Rubble Zones often have staining or fill, and look weathered. Mechanical Rubble Zones are often jagged and fresh looking, with no staining or fill.

- If you are unsure whether a rubble zone is natural or mechanical, classify as a natural rubble zone.
Examples of Rubble Zones
Rubble Zones – How to Allocate Fractures?

- It is not possible to actually count the joints natural rubble zones, therefore we log the rubble zones as follows:
  - Natural Rubble Zones (RZ) are assumed to have 4 joints per 10cm of rubble zone.
  - Mechanical Rubble Zones (MRZ) are noted on the core but not counted.

- Often rubble zones are interspersed with short sections of competent core, or competent core with a few joints. If the competent sections between the rubble are less than approximately 30cm long, mark it as one rubble zone.

- For natural rubble zones, ensure to include the interval in the major structures log. Place all “allocated” joints in JOINT SET 1 (discussed later).

- You should use your judgment to determine an appropriate joint count for these rubble zones – i.e. do not apply the 4J/10cm rule across sections of competent rock between rubble - see example on next page.
Example of how to count...

The above rubble zone is 110cm long, but the actual rubble makes up 25cm + 24cm + 21cm = 70cm, so we use our judgement in applying the 4J/10cm rule, and give the rubble zone 28 joints for the run.
Rubble Zones Summary

**Natural Rubble Zone (RZ)**
- Include all Natural Rubble Zones as well as those you are unsure of.
- 4 counts are added to the open fractures count and the joint count (discussed later).
- Natural Rubble Zones must be marked in the Major Structures Tab (discussed later).
- Natural Rubble Zones are taken out of RQD measurements (discussed later).

**Mechanical Rubble Zone (MRZ)**
- Mechanical Rubble Zones are induced by the drilling process. Consider a rubble zone mechanical only if you are 100% sure it was caused by drilling!
- Nothing is added to the joint count.
- **Mechanical** rubble zones are not marked in the Major Structures Tab or taken out of RQD measurements.
B) Basic Logging
Runs

- Basic logging is conducted for every run.

- The drilling run is considered to be the length of rod that was drilled into the ground before recovering the core inner-tube.

- At the end of every drilling run, the driller brings the core inner-tube to the surface to empty. A “full” drilling run should be 3.0m±10%.

- The driller’s helper will mark the end of each run by putting a wooden block in the core box, indicating the depth of the run end.
Total Core Recovery

- Total Core Recovery (TCR) is the sum of **all measurable core recovered in one drill run.**
- TCR is measured for each run length drilled.
- To measure TCR:
  - **Fit the core together** as best as possible;
  - For the broken zones, **push the broken pieces together** so that it approximately resembles a core volume;
  - **Measure** the total length of core recovered, including the solid and broken zones.
- The actual distance of the run is also recorded, and is obtained from the driller, using the rod measurements.
- The TCR ratio (the ratio of core recovered to run length) is very important in the weaker rock types, where core loss can be expected (mainly fault zones at Back River).
Total Core Recovery Example

- In the example above, Run B (highlighted in yellow) is indicated by the drillers block marks to be 3m long.
- To calculate the TCR, you would measure the actual core recovered, by measuring where the orange arrows indicate.
- The TCR of interval B is approximately 2.4m, while the indicated drill run is 3.0m.
- If core is lost and fault zones are present, assume the missing material is both the weakest and most fractured of what is observed in the run and enter this “allocated” strength in the database.
Rock Quality Designation

- Rock Quality Designation (RQD) is an indication of how jointed and weak the rock is, measured as the total length of core pieces that are longer than 10 cm.

- To determine RQD for each run, you should measure the length of core recovered, EXCLUDING:
  - Sections where there are joints closer than 10 cm together
  - Natural rubble zones
  - Soft core, with a strength rating of R0 or R1 (discussed later)

- Notes:
  - Machine breaks and core handling breaks should be considered solid core, i.e. they are included in the RQD measurement
  - Joints along the core axis should be considered solid core, i.e. included in the RQD measurement.
The RQD of interval B in the example is approximately 1.5m (1.5 / 3.0 x 100 = 50%).

Areas not counted are circled.

Areas that are measured are indicated with orange arrows.
In the example provided above, the yellow boxes are zones removed from RQD while the red circles are not (as they are bounded by mechanical breaks which do not affect RQD).
C) Detailed Logging
Remember:

Domain changes correspond to changes in structure, intact rock strength (IRS), lithology and alteration.

Change in domain at 967.00m

SAMPLE DRILL RUN: B = 965.50 – 968.50m
ROCK TYPE 1: Gabbro, Intact Rock Strength =R3, rubble zones
ROCK TYPE 2: Pillow basalt, Intact Rock Strength =R5, increased joints and cemented joints, solid core.

The changes in geotechnical qualities of run B are significant enough that the run must be split into two separate domains. The resulting changes will be reflected in the ‘Detailed Geotech Form’ by defining a new domain. The ‘General Geotech Form’ will also have the new domain change i.e. RQD and TCR are assessed for each domain.

NOTE: Realistically, the need for a domain change at Back River will likely be limited to major structures (fault zones) greater than 50cm in length. Otherwise, run-based intervals are usually short enough in length to achieve the required resolution.
Fracture Counts Per Run

- The following items are **counted** during core logging:
  - **Joints**: a total count of all joints in the domain.
  - **Foliation breaks**: a total count of all **open** breaks along foliation.

- The count for each run is written on the core in that order: J/FOL

- **Natural rubble zone** (RZ) ‘allocated’ joints are added to the **joints** count (assuming ~4 joints/10cm).

- Breaks caused by someone hitting the core with a hammer, i.e. core that is purposely broken to fit it into the core boxes, or to test strength are not included in any counts.
Intact Rock Strength

- As part of the detailed geotechnical log, you need to rate the intact rock strength (IRS). Tests are conducted several times per run, or whenever a difference in rock strength is suspected. In broken rock, you are evaluating the strength of the individual pieces.
Intact Rock Strength (IRS)

- We are estimating rock strength using a rock hammer.
- A good test will break through intact rock. If the rock breaks along a cemented feature, vein, or microdefect this is not testing the intact rock strength. For broken rock estimate the strength of the rock pieces.
- Up to two values for IRS are given for each run. The ‘**strong rock strength**’, and the ‘**weak rock strength**’ values are entered, as well as a ‘**percentage weak**’ to indicate how much of the rock is represented by the ‘weak’ rock strength value.

In the example above, 80% of the rock is rated as R0, and 20% is rated as R3, and this is entered like this:

<table>
<thead>
<tr>
<th>IRS</th>
<th>Strong</th>
<th>Weak</th>
<th>% Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>R3</td>
<td>R0</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>
Intact Rock Strength

ISRM STANDARD - FIELD ESTIMATE OF ROCK STRENGTH

<table>
<thead>
<tr>
<th>Index</th>
<th>Abbr.</th>
<th>Description</th>
<th>Field Test</th>
<th>Approximate Range Uniaxial Compressive Strength (MPa)</th>
<th>R0 Extremely Weak</th>
<th>R1 Very Weak</th>
<th>R2 Weak</th>
<th>R3 Medium Strong</th>
<th>R4 Strong</th>
<th>R5 Very Strong</th>
<th>R6 Extremely Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>S1</td>
<td>Very Soft Clay</td>
<td>Easily penetrated several inches by fist</td>
<td>&lt; 0.025</td>
<td>Indented by Thumbnail</td>
<td></td>
<td>Crumbles under firm blow of geologic hammer pick, peeled by pocket knife</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>S2</td>
<td>Soft Clay</td>
<td>Easily penetrated several inches by thumb</td>
<td>0.025 - 0.05</td>
<td></td>
<td></td>
<td>Shallow indentation under firm blow of pick end of geologic hammer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3</td>
<td>S3</td>
<td>Firm Clay</td>
<td>Penetrated several inches by thumb with mod. effort</td>
<td>0.05 - 0.10</td>
<td></td>
<td></td>
<td>Fractured with single firm blow of geologic hammer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td>S4</td>
<td>Stiff Clay</td>
<td>Indented with thumb, but penetrated with great effort</td>
<td>0.10 - 0.25</td>
<td></td>
<td></td>
<td>Requires more than one blow of hammer to fracture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5</td>
<td>S5</td>
<td>Very Stiff Clay</td>
<td>Readily indented with thumbnail</td>
<td>0.25 - 0.50</td>
<td></td>
<td></td>
<td>Requires many blows of hammer to fracture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6</td>
<td>S6</td>
<td>Hard Clay</td>
<td>Indented with difficulty with thumbnail</td>
<td>&gt; 0.50</td>
<td></td>
<td></td>
<td>Can only be chipped with strong blows of hammer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*International Society for Rock Mechanics

- If you have weak rock in your domain, rated as **R0 or R1**, you also need to **further classify** it's characteristics **in the comments section**.
- Use the table above to further describe the weak rock as **S1 – S6**.
Microdefects

As part of the detailed log, you need to rate the strength of microdefects (MD) for each run (if present).

The strength of these features can be determined by gently hitting the feature with a rock hammer.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NONE</td>
<td>Strong (Never breaks)</td>
</tr>
<tr>
<td>1</td>
<td>MINOR</td>
<td>Moderate (Sometimes breaks)</td>
</tr>
<tr>
<td>2</td>
<td>MODERATE</td>
<td>Weak (Always breaks)</td>
</tr>
</tbody>
</table>

**Intensity**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NONE</td>
</tr>
<tr>
<td>1</td>
<td>MINOR</td>
</tr>
<tr>
<td>2</td>
<td>MODERATE</td>
</tr>
<tr>
<td>3</td>
<td>HEAVY</td>
</tr>
</tbody>
</table>

**Strength of Fill (Drop Test)**

- **Code**
  - 0: Weak (Always breaks)
  - 1: Moderate (Sometimes breaks)
  - 2: Weak (Always breaks)
Joint Roughness

To describe the conditions of the joint, we rate the **roughness**, **alteration** of joint walls, and **infill**.

The **roughness** is evaluated on a scale of 1 to 9 by using the chart on the right (the lines on the chart are 10cm long at full scale).
Joint Roughness Examples

- Stepped Slickensided
- Stepped Rough
- Undulating Rough
- Undulating Slickensided
- Planar Slickensided
- Planar Rough
Joint Wall Alteration

Joint wall alteration results from fluids moving along the joint and altering the surrounding rock composition.

Alteration of the rock on either side of the joint is evaluated as follows:

1 = The altered joint wall is the same strength as the rock around the joint.

2 = The altered joint wall is now stronger than the rock around the joint.

3 = The altered joint wall is now weaker than the rock around the joint.

At Back River the joint wall alteration is typically the same strength as the rock (1).
Joint Fill

Joint fill is also rated according to the scale on the right.

‘Softening’ refers to soft deposits that can be scratched with your finger.

‘Non-softening’ refers to harder deposits stuck onto the joint walls that need to be chipped off.

Fine, medium and coarse refer to the grain size within the fill.

Gouge is a clay-like joint filling.

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOUGE THICKNESS &gt; AMPLITUDE</td>
<td>1</td>
</tr>
<tr>
<td>GOUGE THICKNESS &lt; AMPLITUDE</td>
<td>2</td>
</tr>
<tr>
<td>SOFTENING - FINE</td>
<td>3</td>
</tr>
<tr>
<td>SOFTENING - MEDIUM</td>
<td>4</td>
</tr>
<tr>
<td>SOFTENING - COARSE</td>
<td>5</td>
</tr>
<tr>
<td>NON SOFTENING - FINE</td>
<td>6</td>
</tr>
<tr>
<td>NON SOFTENING - MEDIUM</td>
<td>7</td>
</tr>
<tr>
<td>NON SOFTENING - COARSE</td>
<td>8</td>
</tr>
<tr>
<td>STAINING ONLY</td>
<td>9</td>
</tr>
<tr>
<td>NONE</td>
<td>10</td>
</tr>
</tbody>
</table>

Lower numbers on the scale represent softer, thicker fill, which reduces friction on joint surfaces, resulting in a lower rock mass strength.
Joint Fill Examples

- Gouge thickness > Amplitude
- Softening – Fine
- Softening – Fine
- Non-Softening – Fine
- Softening – Medium
- No Fill
Joint Aperture

- Joint aperture measures the openness of the joint.
- Estimated based on how tight the joint fits back together
Joint Sets

- For each run, joints are grouped together by alpha angles of 0-30° (Joint Set 1), 30-60° (Joint Set 2) and 60-90° (Joint Set 3).

- For each joint set, record the representative characteristics for each set — roughness, alteration, fill.

- For simplicity, all “allocated” joints should be added to Joint Set 1 when present — use 45-5-1-5-5 for alpha angle, roughness, alteration, fill and aperture respectively unless better estimates can be made on core fragments.
Major Structures

- Major structures are key weak areas of the core that we need to highlight in the log. It will be used as a reference during the detailed evaluation of the structural features.

- Major structures include rubble zones, faults, or fault zones (which may contain many rubble zones).

- For each major structure, you must describe:
  - the total **length** (m) of the major structure;
  - The **alpha** and **beta** angles of the structure, where possible.
  - the **type** of structure (described as either **jointed**, **broken**, **sheared** or **gouge**, with gouge being the most intensely deformed). These terms should be strictly structural in nature.
  - the **total allocated joints** in the major structure.
## Major Structures

<table>
<thead>
<tr>
<th>Site</th>
<th>Borehole</th>
<th>Depth</th>
<th>Length</th>
<th>Quality</th>
<th>Total Jnt</th>
<th>Remark</th>
<th>Categ.</th>
<th>Tr</th>
</tr>
</thead>
<tbody>
<tr>
<td>BACK RIVER</td>
<td>EXAMPLE</td>
<td>10.00</td>
<td>1.20</td>
<td>GOUGE</td>
<td>48</td>
<td>Mix gouge and rock fragments &lt;10mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BACK RIVER</td>
<td>EXAMPLE</td>
<td>20.25</td>
<td>0.50</td>
<td>SHEARED</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BACK RIVER</td>
<td>EXAMPLE</td>
<td>32.50</td>
<td>0.45</td>
<td>BROKEN</td>
<td>18</td>
<td>No fines, possible mechanical damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BACK RIVER</td>
<td>EXAMPLE</td>
<td>41.80</td>
<td>0.70</td>
<td>JOINTED</td>
<td>18</td>
<td>Some intact pieces of core &lt;50mm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Receive split tube from drill.
2. Fit the core together if loose in split.
3. Mark metres on core.
4. Clean core.
5. If core is orientated, continue the orientation line along the length of core.
6. Take a photo of the undisturbed core in the split tube.
7. Review core and determine potential geotechnical domains within the run.
8. Mark mechanical breaks, microdefects, and joints.
9. Review and comment on the drilling quality and notable features in the detailed log.
10. Conduct basic geotechnical logging, TCR and RQD.
11. Conduct orientation measurements and mark on drillcore; record offsets.
13. Take detailed photographs of specifics if required.
14. Label ends of core boxes to two decimal places.

Other: note the base of casing depth in the database.
**Microdefect and Joint Descriptions**

**Joint Roughness**

- **Rough**
- **Smooth**
- **Slickensided**

**Joint Wall Alteration**

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint wall = Rock Hardness</td>
<td>1</td>
</tr>
<tr>
<td>Joint wall is Stronger than IRS</td>
<td>2</td>
</tr>
<tr>
<td>Joint wall weaker than intact rock</td>
<td>3</td>
</tr>
</tbody>
</table>

**Joint Filling**

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gouge Thickness &gt; Amplitude</td>
<td>1</td>
</tr>
<tr>
<td>Gouge Thickness &lt; Amplitude</td>
<td>2</td>
</tr>
<tr>
<td>Softening - Fine</td>
<td>3</td>
</tr>
<tr>
<td>Softening - Medium</td>
<td>4</td>
</tr>
<tr>
<td>Softening - Coarse</td>
<td>5</td>
</tr>
<tr>
<td>Non Softening - Fine</td>
<td>6</td>
</tr>
<tr>
<td>Non Softening - Medium</td>
<td>7</td>
</tr>
<tr>
<td>Non Softening - Coarse</td>
<td>8</td>
</tr>
<tr>
<td>Staining Only</td>
<td>9</td>
</tr>
<tr>
<td>None</td>
<td>10</td>
</tr>
</tbody>
</table>

**Microdefect Quantity**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>Minor</td>
</tr>
<tr>
<td>2</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Heavy</td>
</tr>
</tbody>
</table>

**Microdefect Strength**

<table>
<thead>
<tr>
<th>Code</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Strong (Never Breaks)</td>
</tr>
<tr>
<td>1</td>
<td>Moderate (Sometimes Breaks)</td>
</tr>
<tr>
<td>2</td>
<td>Weak (Always Breaks)</td>
</tr>
</tbody>
</table>

10cm
D) Oriented Core Logging
Core Orientation

- For angled holes, the drillers use a reflex product called an ACT or “Ace Tool” to determine the bottom of the hole for each run.

- The driller will mark the bottom of the hole on the end of the core for that run. Sometimes they may mark the top, indicated by a ‘T’.

- The geotech will use this mark to draw the bottom of hole orientation line on the core. Step by step instructions for this are provided in the manual.

- From this information, we can measure the orientation of joint planes, called the ‘beta’ angles.
Orientation Line Offset

- If the orientation tool is being used correctly, and the geotech ensures that the rock is matched together when the orientation line is drawn, the bottom-of-hole orientation lines marked on each run should correspond from one run to the next.

- If the lines do not match, there is an ‘offset’, which is measured in degrees around the core, from the previous run’s line to the current run’s line, in a clockwise direction looking down the hole.

- The offset is recorded as a number between zero degrees and 360 degrees:
  - Offset = 0 would indicate a perfect match between two orientation lines
  - Offset = 10 would indicate that the new run is rotated clockwise by 10 degrees from the previous run
  - Offset = 350 would indicate that the run is rotated clockwise by 350 degrees (or anticlockwise by 10 degrees) from the previous run

- At Back River we are recording this information in the basic log comments. Please indicate if there is no ori line available or the offset could not be determined because of the following reasons:
  - Orientation line is marked on this run, but no offset could be measured because the run above did not have an orientation line.
  - Orientation line is marked on this run, but no offset could be measured because the core from the run above did not match well with this run.
  - No orientation line for this run.
Orientation Line Offset

The geotech should make a comment about the orientation line, including their confidence in the offset measured. For example, if a section of the run was broken and difficult to put together, the geotech would indicate low confidence in the orientation for that run.

Downhole direction

We measure two angles on a joint:

- **Alpha angles** measure the joint dip, and are measured on every joint.
- **Beta angles** measure the orientation of the joint plane, and are only measured on joints with an orientation line.

$\alpha$ is the maximum dip of the joint/feature, relative to the core axis.

$\beta$ is measured clockwise to the bottom of the ellipse. In this case it is $\approx 232^\circ$.
Measuring Alpha and Beta Angles

- Measuring the required orientation parameters is done using a graduated strip and a carpenter’s angle.

- **Alpha angle** (α): the carpenter angle is used to measure the maximum dip (α) of the feature relative to the core axis.

- **Beta angle** (β): The plastic calibrated strip is placed with the “0” on the orientation line of the same piece of core and the tape is wrapped clockwise around the core so that the 360° point returns to the orientation line. The angle (β) is then measured, clockwise, from the orientation line to the most down hole part of the ellipse.
Measuring Alpha and Beta Angles

Step 1

- Maximum dip (alpha) angle measured
- Orientation line (marked previously)

Step 2

- Beta angle is measured **clockwise** (in the downhole direction) around core from the orientation line

**Results:**
- Alpha = 42°
- Beta = 134°