ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

PRACTICE ADVISORY

DIAMOND DRILL CORE LOGGING: STRUCTURE

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This Practice Advisory has been issued for professional registrants of Engineers and Geoscientists BC to establish the expectations of professional practice related to logging of geological structures as observed in diamond drill core for mineral exploration, mining projects, and related geotechnical engineering studies.

Data inputs derived from diamond drill core logging are used to create subsurface geological and geomechanical models that inform mineral exploration, mining projects, and geotechnical engineering studies. Therefore, for purposes of public safety and environmental protection, it is essential that data are collected in an accurate, reliable, and consistent manner between professional registrants.

Informed by current industry standards, this Practice Advisory describes the expectations of professional registrants engaged in:

a) recording of diamond drill hole collars, surveys, drill depths, core orientations, and;

b) logging geological structures in diamond drill core,

to support mineral exploration, mining projects, and geotechnical engineering studies. This Practice Advisory should be used in conjunction with the Mineral Exploration Best Practice Guidelines (Canadian Institute of Mining, Metallurgy and Petroleum 2018), the *Mines Act*, and the Health, Safety and Reclamation Code for Mines in British Columbia.

BACKGROUND

Structural logging of diamond drill core describes the orientation and characteristics of geological structures within the Earth's crust (such as sedimentary bedding, faults, joints, folds, and shear zones) in relation to the Earth's surface. Identification, measurement, and documentation of such structures in diamond drill core by professional registrants is a fundamental practice. It informs subsurface geological modelling of mineral exploration and mining projects and related geotechnical engineering studies.

Geological structures often create planes of weakness in the subsurface, which can control both the geomechanical and hydraulic behaviour of a rock mass, and the spatial distribution and characteristics of ore bodies. Therefore, it is important that professional registrants accurately

report diamond drill hole collars, surveys, drill depths, and core orientations, and log geological structures in a consistent manner.

For mineral exploration and mining projects, it is critical that orientations and characteristics of significant geological structures are accurately reported to enable precise targeting and drilling of predicted ore bodies. Furthermore, for purposes of environmental protection, precision modelling of geological structures could lead to safer extraction of ore and decrease the amount of waste rock produced and processed during exploration and/or mining activities.

For geotechnical engineering applications, it is critical that orientations and characteristics of geological structures are accurately reported to support studies that impact site safety and environmental protection. This includes, but is not limited to, the development of project sites and infrastructure such as hydrogeological dewatering or contaminant transport models, tailings dams, leach pads, underground workings, open pits, or camps.

ROLES AND RESPONSIBILITIES

Professional registrants are responsible for meeting the expectations of professional practice listed in the following sections of this Practice Advisory. Professional registrants must be aware of Engineers and Geoscientists BC's Bylaws, which describe Standards of Conduct and Competence, including Quality Management Standards.

It is acceptable for professional registrants to delegate work outlined in this advisory to others, provided delegation is done in compliance with the standard for delegation and direct supervision as outlined in Section 7.3.8 of the Bylaws and further discussed in the *Guide to the Standard for Direct Supervision* (Engineers and Geoscientists BC 2023a).

Delegation and direct supervision do not release the professional registrant of responsibility for meeting the other quality management standards such as for documented field reviews (Engineers and Geoscientists BC 2023b) and documented checks (Engineers and Geoscientists BC 2023c), which must be completed throughout the drilling and logging program in a manner that is appropriate to the project's risk level. The risk level of a project must be determined and monitored based on documented risk assessment(s) throughout the life of a project. Documented risk assessment templates can be found in *Appendix C* of Engineers and Geoscientist's *Guide to the Standard for Documented Independent Review of High-Risk Professional Activities or Work* (Engineers and Geoscientists BC 2023d).

PROFESSIONAL PRACTICE

The following sections outline the professional practice considerations for various components of the diamond drill core logging process, with a particular emphasis on the procedures professional registrants should follow to promote accurate and consistent data collection of geological structures.

EQUIPMENT CALIBRATION

Professional registrants are responsible for confirming that all geolocation and core orientation tools, including but not limited to: global positioning systems (GPS), downhole orientation tools, and core orientation tools are reliable and consistently calibrated for use with the project's geodetic system. Consideration must be given to the project area's magnetic declination, which changes over time, as well as any offset between grid north and true north, which changes with latitude.

COLLAR LOCATION RECORDING

When a drill hole collar location has been finalized, the collar location should be reported by the professional registrant using the following parameters:

- consistent reporting of collar location using a geodetic system applicable to the geographic location of the project. In BC, a commonly used system is NAD83 CSRS with UTM Zone indicated;
- consistent reporting of collar elevation, typically in metres above sea level (mASL);
- results and depths of downhole orientation surveys, noting the orientation tool used and marking conventions (i.e., either the top or bottom of the core);
- reporting of the instrument used to determine the collar location and elevation, and its accuracy, typically in metres (e.g. hand-held GPS, differential GPS, or other formal survey); and
- magnetic declination applied, where applicable.

PRIOR TO LOGGING

Prior to logging diamond drill core, professional registrants should:

- check that block markers are appropriately placed and labelled to accurately represent the depth drilled (typically in metres), and account for any core loss noted during drilling;
- make an effort to re-assemble the core to reflect its original in-ground condition; and
- take mitigative measures such as taking clear photographs of drill core, with block markers labelled and visible prior to transportation, or logging core at the drill if there is concern that structural properties of the drill core could be compromised during transport from the drill to the logging area.

If the core is oriented, it should be reassembled with respect to the drill team's orientation marks by:

- checking that orientation marks consistently and accurately mark the core top or bottom;
- extending the orientation mark up-hole using a straight edge without flex, unless the orientation mark cannot be extended up-hole due to the condition of the core, in which case it can be extended down-hole from a previous run; and
- where possible, measuring and marking the offset angle (lock angle) from the previous orientation mark using an appropriate measurement tool.

After the core has been appropriately reassembled and the orientation line has been drawn (if applicable), professional registrants should:

- mark the downhole direction on the core;
- identify and exclude mechanical breaks from further interpretation or measurements described in the following sections. In other words, core that is mechanically fractured shall be treated as a continuous piece. If a break cannot be confidently classified as mechanical or natural, it shall be treated as a natural break; and
- record minimum geotechnical data and measure representative geological structures.

OBTAINING AND RECORDING MINIMUM GEOTECHNICAL DATA

There is a wide range of geotechnical data that can be collected on diamond drilling programs, and at a minimum, professional registrants should ensure the collection and recording of Total Core Recovery (TCR) and Rock Quality Designation (RQD) at the earliest stages of a project.

For geotechnical scopes of work, a more sophisticated method than TCR to characterize or classify the rock mass, such as the Q-system or the RMR system (Barton et al., 1974; Bieniawski, 1976; Bieniawski, 1989) should be considered. This should be decided based on the project requirements. The level of effort and type of geotechnical data collection must be decided on and clearly communicated by the professional registrant by considering:

- the data and data resolution required for the program's design; and
- the practical limitations of the field program schedule.

The following sections provide a framework for collecting and recording TCR and RQD.

Total Core Recovery (TCR)

Total Core Recovery (TCR) is defined as the proportion of core recovered to the total reported length of the drilled run. It is important since it is used to extrapolate the true depth drilled and assess the proportion of any core lost during drilling. Professional registrants should be vigilant in monitoring core recovery within mineralized zones that could compromise interpreted grades and/or ore body size.

There are three possible outcomes in determining the TCR: (1) the core recovery is less than 100% (core loss), (2) the core recovery is 100%, or (3) the recovery is greater than 100% (core gain). Generally, core losses or gains of less than 5% may be ignored and excluded from consideration,

as they are as likely to be due to errors in measurement as actual loss or gain (Valentine & Norbury 2011).

Professional registrants must use their judgement, with consideration for the project's unique geological features (i.e., karst or voids), to determine how core losses or gains will be accounted and corrected for. Best efforts must be made to report true drill depths as accurately as reasonably achievable.

Rock Quality Designation (RQD)

Rock Quality Designation (RQD) is a type of modified core recovery measurement. Drill core must consist of "hard and sound" rock to be considered for RQD, meaning that mechanical fractures, extremely weathered rock or rock that is altered to a soil-like material should not be included in the RQD calculation.

To obtain the RQD value, all intervals of core pieces greater than 0.10m (10cm) are summed and divided by the drill run interval (Figure 1).

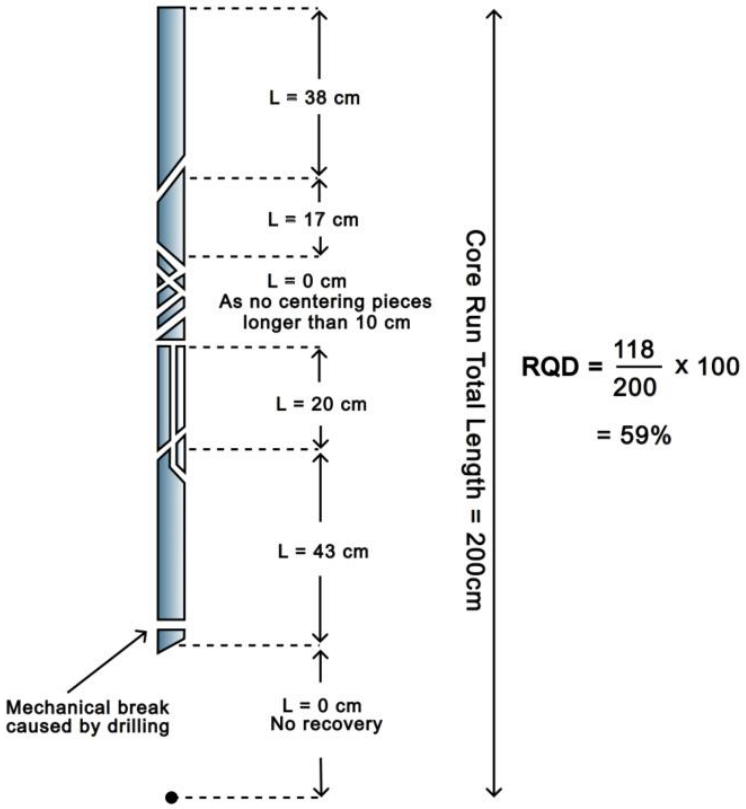

***Figure 1** - RQD calculation. Modified from Deere & Deere*

OBTAINING AND RECORDING GEOLOGICAL STRUCTURAL DATA

The level of effort and type of geological structural data collection should be decided on, and made clear, by a professional registrant by considering:

- the data type and data resolution required for the program's design; and
- the practical limitations of the field program schedule.

Geological structures in drill core should be measured using appropriate measurement tools. Each structural measurement must have an associated hole depth so that it represents a point in x-y-z space ("point data").

All reported point data drill hole depths should be measured with respect to the drill hole's collar with regard for any core depth adjustments that resulted from block marker checks and core recovery corrections. It is strongly recommended to report point data using the same measurement units as the geodetic grid.

Generally, when measuring geological structures in drill core, α angles should be obtained and interpreted from all drill core, whereas β and γ angles can only be obtained and interpreted in oriented drill core (Figure 2).

It is recommended to report final point orientation data in True North dip/dip-direction. Where possible, down-hole α, β, and γ angle measurements should be converted into True North dip/dip-direction.

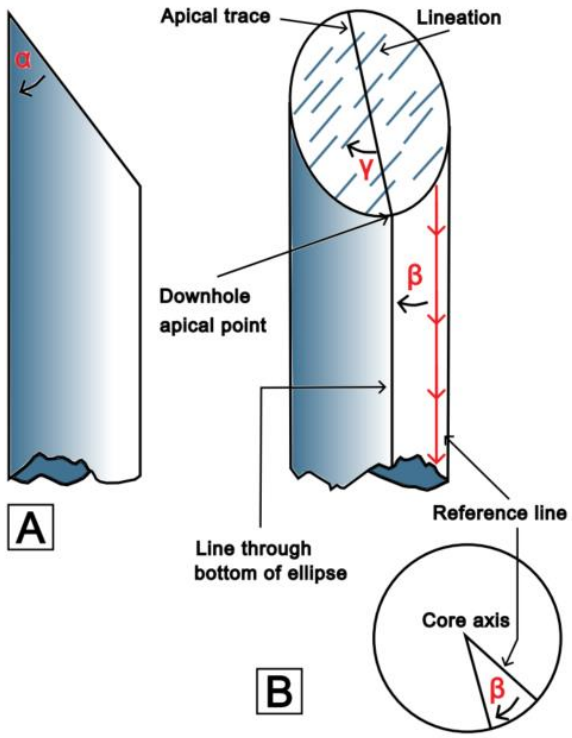

***Figure 2** – Alpha (α), beta (β), and gamma (γ) angle conventions in oriented core **(A)** and construction of apical trace for structures subparallel to the drill core **(B).** Modified from Kramer Bernhard et al. 2020.*

All point data should be reported in drill logs and accompanied by any appropriate geological observations, descriptions, and/or laboratory testing that is prescribed by the project requirements.

If present, professional registrants should document and describe any other geological features that would impact the knowledge of a project's structural geology, such as the presence of way-up indicators like graded bedding or fossils.

It is recommended that measurements be collected in fresh whole core prior to sampling. It is also recommended that measurements be checked at regular intervals during the core logging process, either using 3D software, or manually, to ensure consistency, validity and that the measurements make sense within the geological context. Preliminary quality assurance and control checks for geological structure logging should be based on any known structural trends in the study area, such as major faults or shear zones.

ADDITIONAL CONSIDERATIONS

The following section describes additional considerations that professional registrants should be aware of.

The use of acoustic (ATV) and optical televiewers (OTV), drill hole caliper tools, and downhole geophysical surveys can supplement observations made during logging of physical core by rapidly creating a record of geological structures present in a drill hole during or after drilling. In areas where core recovery is low, this data can be particularly useful. However, ATV and OTV data should not generally be considered a replacement for core logging.

As part of the overall core logging process, logged core should be consistently photographed prior to sampling or cutting. After drill core has been logged, it is recommended that photographs or scans clearly show any orientation reference lines and document the core when it is wet and dry. Due to the increase in the use of AI-assisted logging technologies, photographs should use consistent markers, colour pallets, box locations in photos, angles of photos, and metadata.

ACKNOWLEDGEMENTS

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LEGISLATION

Mines Act [RSBC 1996], Chapter 293.

Health, Safety and Reclamation Code for Mines in British Columbia

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VERSION HISTORY

VERSION NUMBER	PUBLISHED DATE	DESCRIPTION OF CHANGES
1.0	December 4, 2024	Initial version.