FREQUENTLY ASKED QUESTIONS – LOP PRACTITIONER'S GUIDELINES FOR SAMPLING AND LABORATORY TESTING FOR OPEN PIT OPERATIONS: ISRM R3 TO R6

Sampling

Is there any guidance on practices like covering core with a damp cloth at the rig to preserve moisture content? Any other suggestions for preservation of moisture content?

Covering core with a damp cloth is an effective measure to preserve moisture content. This prevents evaporation and drying out, maintaining the sample integrity.

In addition, it is recommended to wrap samples as soon as they are retrieved from the core barrel to preserve moisture content. This can be done by wrapping the core samples in plastic wrap, coating them in wax, or sealing them in airtight or vacuum containers (ASTM 2017).

Could you provide guidance on wrapping direct shear samples for filled faults? Can you wrap the samples as two separate pieces?

When possible, it is recommended to wrap direct shear samples for filled discontinuities together, keeping the discontinuity intact and maintaining the integrity of the infill material (ASTM 2016). For filled faults, when wrapping the sample, ensure the sample remains intact and the fault fill material is not displaced or altered (MacDonald et al. 2023). If it is not possible to wrap the sample with the discontinuity intact, wrap each side of the sample separately with care to maintain the integrity of the discontinuity. If the sample must be wrapped as two separate pieces, clearly label each piece with the downhole direction, top and bottom depths, and other identification information for proper re-assembly (ASTM 2016). In addition, handling should be minimized, and samples should be transported in a rigid container with padding to protect the samples.

In the case of discontinuities with no infill, the two pieces of the sample should be wrapped separately. If both sides of an unfilled discontinuity are wrapped together, there is potential for the surfaces to rub against each other during shipping, which can damage the asperities.

Can you elaborate on how temperature affects samples during storage and transportation? How do freezing, freeze-thaw, and heat impact the sample?

Extreme temperatures and temperature changes can degrade the sample strength during storage and transportation. Freezing or freeze-thaw of the sample expands any pore water in the rock mass, creating internal stresses that may lead to cracking or fracturing of the rock (Tomás 2023). The cracking or fracturing of rock from freezing or freeze-thaw can happen at a micro-scale, undetectable prior to testing. This process is referred to as mechanical weathering and can reduce the strength of the rock (Bureau of Reclamation 2021).

Heating of a sample can cause thermal expansion, dehydration, and phase changes. When heated, different minerals react differently, expanding at different rates. This can create internal stresses and lead to cracking and degradation of strength. Heat can also dehydrate certain minerals, resulting in a phase change which may alter the rock's chemical properties.

To prevent this, it is recommended that samples be stored and transported in refrigerated or temperature-controlled environments to maintain their integrity; if not available, samples should be stored in an insulated container. In addition, samples should not be stored in direct sunlight (Martin and Stacey 2018).

Could you provide guidance on lump sampling or bulk sampling? Can you take surface samples in lieu of core samples?

Lump or bulk sampling are useful when the rock mass is heterogeneous and a representative sample is needed to understand the overall composition and properties of the rock mass. Lump sampling refers to collecting large, discrete pieces of rock from a site, typically from loose material or from exposed benches. The most important aspect to consider when collecting lump samples is that the sample size collected is large enough to represent the rock mass and its heterogeneity.

When considering lump (surface) samples versus core samples, there are advantages and disadvantages to both. The selected sampling method will be dependent on the goals of the investigation. Surface samples are easier and less costly to collect than core samples; however, they may not be representative of subsurface conditions. Surface samples are limited to areas where rock is exposed at surface and may have experienced degradation due to weathering.

Core samples are more representative of the subsurface conditions of the rock mass. However, core samples are typically collected during drilling investigations, making them more costly and time consuming to collect. The general guidance is to select samples that are representative of the intact and undisturbed rock mass, making core samples preferable to surface samples, when available.

Could you provide guidance on sampling of weak material for strength testing?

Detailed guidance for sampling of weak material will be provided in the forthcoming webinar guidelines sponsored by the LOP in the *LOP Practitioner's Guidelines for Weak Rock Sampling and Laboratory Testing for Open Pit Design – Core Logging and Sampling Guideline.* This guideline will focus on guidance for sampling weak rocks (R1 to R2) including sample packaging, preserving water content, block sampling, and using wax to protect weak samples.

If a direct shear sample is chipped at the tip of the feature (not fully intact), is that acceptable for testing?

A chipped sample can affect the shear strength measurements collected during testing by altering the distribution of stresses and leading to lower strength values (MacDonald et al. 2023). If a chipped sample is used for testing, this should be noted and considered during interpretation.

Per the ASTM guidelines (ASTM 2016), where possible, samples should be undisturbed. Minor imperfections are acceptable; however, significant damage like chipping should be carefully evaluated and the potential impact on results properly understood.

If testing must be completed on a chipped sample, the extent and location of the chip must be documented. In addition, where possible, testing results from chipped samples should be compared to the results from intact samples to understand the variability introduced by the chipped samples.

Should you take additional tests when there are alteration changes in the rock?

Yes, additional samples should always be collected when there are alteration changes in the rock. Planning a sampling program should consider potential changes in alteration, and the field personnel should be aware that additional samples will be required if alteration (or other rock properties) change.

Alteration can lead to formation of new minerals or transformation of existing ones, affecting the rock's strength, permeability, and other physical properties. Alteration can either weaken or strengthen rock, depending on the mineral composition of the rock and type of alteration. Representative samples of the different types and degrees of alteration should be collected and tested to assess the impact of alteration on rock strength.

In addition to strength testing on different types of alteration, mineralogical and chemical analysis are important to understand the alteration type and intensity. This can include X-ray diffraction (XRD) or geochemical assays.

How do you address changes in core between homogeneous and heterogeneous rock when sampling?

Addressing changes in core between homogeneous rock and heterogeneous rock starts with detailed geotechnical core logging. Geotechnical core logs identify and document the transition between homogeneous and heterogeneous rock masses. When sampling, it is important to collect samples representative of the different rock types, avoiding bias towards homogeneous rock and collecting additional samples in transitional zones, where possible. To avoid bias, a regular sampling frequency should be established during a sampling campaign, increasing the frequency when a change in rock conditions is observed or an unexpected material is encountered.

In addition, techniques that provide a continuous measurement along the length of core such as downhole testing and core scanning can provide valuable data on the variability of rock properties and transition zones. If available, this data can be used to optimize the testing program to adequately capture the rock mass variability.

Can you provide guidance on selecting drillhole orientation when drilling in anisotropic rocks?

Adequately selecting drillhole orientation in anisotropic rocks is critical to obtain accurate and representative data. Anisotropic rock masses, such as stratified sedimentary rocks and foliated metamorphic rocks, exhibit directional differences in strength and other rock properties. Prior to conducting geotechnical drilling, available geological information should be reviewed to understand the orientation of the anisotropic features present at the site.

To best collect structural data, the drillhole should be oriented perpendicular to these features. The more parallel the drillhole is to the critical structures, the less likely the drillhole will intersect them. Due to the variability in ground conditions and the potential for multiple anisotropy orientations at a site, it is recommended to drill at a variety of angles to intersect structures or planes of weakness at different orientations to avoid blind zones in the data (Plinninger 2006).

Downhole geophysics and core orientation tools should be used to collect information on the anisotropy orientation downhole.

Is it best practice to take photographs of the core in the splits before boxing?

Yes, it is considered best practice to take photographs of the core in the splits before boxing. This is the best opportunity to collect a visual record of the core's condition and structure prior to disturbance from handling during geotechnical logging and sampling. Photographs serve as a visual backup of the core logging data collected and they provide a permanent record that can be easily referred to during data processing and quality control.

Core should be cleaned and labeled for photography. The photographs should be taken using a high-resolution camera and consistent lighting, and when possible, should be taken from a consistent location above the core. A scale bar, standard colour chart, and clear label with the project information should be included in every photograph. The image quality should be checked for every photograph to make sure the image is in focus and to confirm that the writing is clear and visible.

Does the presence of drilling mud in core change the properties of the rock or affect moisture content when sampling? Should you wash/remove drill mud before sampling core?

The presence of drilling mud on a core sample can affect the moisture content and rock properties. Drilling mud can impact the mechanical rock properties by infiltrating the pores and fractures, potentially weakening the rock structure (Wei et al. 2023). In addition, particularly in shales, drilling mud can affect the natural moisture content or permeability of a rock sample by entering or clogging the fractures and open joints of the rock sample (Fang et al. 2022).

For these reasons, it is recommended to wipe and remove drill mud from core samples prior to packaging and testing. This keeps the core sample as close to its natural state as possible for testing. Clean water should be used to gently wipe the core surface (USGS 2024). To preserve discontinuity infill or softer areas of the core, no high-pressure water should be applied to the surface of the core. Documentation of any changes after cleaning the core should be included when collecting geotechnical logging data.

Is there a standardized way to log micro-defect intensity in a sample log?

It is good practice to record the frequency, type, and strength of micro-defects when collecting geotechnical logging data. Read and Stacey (2009) recommend classifying the frequency, or intensity, of micro-defects as:

- none
- minor (spacing > 100 mm)
- moderate (spacing between 10 mm and 100 mm)
- heavy (spacing < 10 mm)

Micro-defect strength can be assessed using the ISRM-based system by striking the rock core along a micro-defect and recording the results with ISRM grades (R1, R2, etc.) (Brown 1981).

These values can be included in a sample log, where applicable, to identify possible correlations between micro-defect intensity and laboratory strength testing results.

References

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