DRAFT TANZANIA STANDARD

TBS/MMDC1(5633)/ P3 ***Rock core drilling and sampling of rock for site exploration – code of practice***

TANZANIA BUREAU OF STANDARD

First edition

0. Foreword

This draft Tanzania standard is being prepared by the Exploration Technical Committee (MMDC 1), under the supervision of the Mining and Minerals Standards Divisional Committee (MMDC).

Exploration involves various activities at different stages. In its later stages rock core drilling and sampling of rock is crucial to obtain a core of rock from the orebody. The petrologic, structural and mineralogical studies of the rock and analysis by chemical assay of the rock sample may be conducted to obtain the required information.

In preparation of this draft Tanzania standard main assistance was drawn from ASTM D2113 – 14 Standard practice for rock core drilling and sampling of rock for site exploration.

1. Scope

This draft Tanzania standard provides a summary of the guidelines, requirements, and procedures for core drilling, and sampling of rock for the purposes of site exploration and applies to surface drilling and drilling from adits and exploratory tunnels in soft and hard rock. The practice is described to obtain data used to probe the nature and contents of the ore deposits and other potential sites.

2. Terms and definition

For the purposes of this standard, the following terms and definitions shall apply:

2.1 Blind hole

Borehole that yields no fluid recovery of the drilling fluids.

2.2 Casing

Hollow tubes of steel used to support borehole walls or where fluid losses must be stopped.

2.3 Caving hole

Borehole whose walls or bottom are unstable and cave or collapse into the drilled borehole.

2.4 Core barrel

Hollow tube of steel used to collect cores of drilled rock.

2.5 Core bit

A drill bit that cuts cylindrical rock samples and consists of one of the following: a drill bit with surface set of diamonds or impregnated diamonds in a tungsten carbide mix of hardened steel, polycrystalline bit or tungsten carbide (TC) inserts mounted on a cylindrical bit that cuts out cylindrical rock samples.

2.6 Drill rig

Includes drilling power unit, mast or derrick, circulating pumps and mounting platform.

2.7 Drill rod

Hollow steel tubes that are connected to the drill bit or core barrel and to the rotary head of the drilling power unit.

2.8 Drill platform

A platform for drilling rig.

2.9 **Overshot**

A latching mechanism at the end of the hoisting line, specially designed to latch onto or release pilot bit or core barrel assemblies when using wireline drilling.

2.10 **Pilot bit assembly**

Designed to lock into the end section of drill rod for wireline drilling without sampling. The pilot bit can be either drag, roller cone, or diamond plug types. The bit can be set to protrude from the rod coring bit depending on the formation being drilled.

2.11 **Squeezing hole**

Borehole whose walls move into the drilled opening and squeeze on the drill rods.

2.12 **Wireline**

A cable made of steel strands connected to a drum hoist, used to raise and lower the core barrel, drill rods, or other equipment as needed in the drill hole.

2.13 **Wireline drilling**

A rotary drilling process using special enlarged inside diameter drilling rods with special latching pilot bits or core barrels raised or lowered inside the rods with a wireline and overshot latching mechanism.

2.14 **Core recovery-in rock drilling**

The ratio of length of core sample recovered, both weathered and unweathered, to the length drilled, and expressed as a percent.

2.15 **Core run**

In the most basic usage, the length of the interval measured from the depth at which drilling to obtain a core sample was started to the depth at which drilling stopped and the core barrel was retrieved to recover the cored sample.

2.16 **Drill break**

Any mechanical or man made break in the core that was not naturally occurring.

2.17 **Intact core**

Any segment of core between two open/unbounded, natural or mechanical discontinuities.

2.18 **Rock quality designation (RQD)**

A modified core recovery in which the ratio of length of core recovered to the total length drilled is modified such that only the length of the pieces of sound core that are equal to or greater than 100mm in length, as measured along the core axis, are counted towards the length of core recovered, and this ratio is expressed as a percent.

2.19 **Sound core**

Any core that is unweathered to moderately weathered and has sufficient strength to resist hand breakage.

3. Equipment, reagents and materials

3.1 **Drill rig**

The drill rig is a machine that provides the rotary power and downward (or advance) force or hold-back force on the core barrel to core the rock. The drill rig includes drilling power unit, mast or derrick, circulating pumps and mounting platform.

3.2 **Fluid circulating system**

The circulating system includes air or water as the drilling media. The drilling media functions to remove drill cuttings, stabilize the borehole, cool and lubricate the bit, control fluid loss and drop cuttings into a settling pit.

Water-based fluids is the predominant type in the circulating systems effective in a wide range of conditions both above and below the water table. Air drilling is selected when water-sensitive soils such as swelling clays or low density collapsible soils are encountered. Air drilling may also be required above the water table if special testing is required in the unsaturated zone.

The four main classes of water-based drilling fluids are: (1) clean, fresh water, (2) water with clay (bentonite) additives, (3) water with polymeric additives, and (4) water with both clay and polymer additives.

The commonly used additives for water-based drilling fluids include beneficiated and unbeneficiated bentonite, sodium carbonate powder (soda ash), Carboxylmethylcellulose powder (CMC), Potassium chloride (muriated potash), Polyacrylamide, Guar gum, Barium sulfate and Attapulgite.

3.3 **Reaming shells**

The reaming shell is a subassembly of a row or strip of material placed on the outside of the core barrel for some distance behind the core bit. It is designed to ream and enlarge the hole to a final diameter and must allow for adequate fluid circulation to the surface. The shell also acts as a collar or centralizer for the barrel.

3.4 **Core boxes**

These are durable waxed cardboard, metal, plastic, or wooden boxes with partitioned compartments for storing and transporting the core samples.

4. Procedure

4.1 Perform site inspections to determine locations of boreholes, and to select disposal sites for waste products during drilling.

4.2 Evaluate applicable methods for environmental protection, safety and traffic regulation during core drilling.

4.3 Determine site accessibility and availability of water for core drilling operation. Check around the drill site for overhead obstructions or hazards, such as power lines, before raising the mast. A survey of underground and all other utilities is required before drilling to evaluate hazards.

4.4 Fabricate and assemble the drill mounting platform. The type of platform will depend on the terrain encountered, the stipulated depth of the borehole, and the accessibility of the drill site. Specialized mountings such as a barge or stilts or specially constructed towers are necessary to mount platforms for drilling over water.

4.5 For water-based fluid drilling operation, a mud pit is positioned to collect and filter fluid return flow. An initial quantity of drilling fluid is mixed, usually using the mud pit as the primary mixing reservoir.

4.6 For air-based circulation systems, the dust collector or cyclone separator is positioned and “sealed” to the ground surface.

4.7 Case any interval of the borehole that penetrates the overburden. This will prevent collapsing of loose materials into the borehole or loss of drill fluid. The casing should extend through the overburden and extend at least 1.5 m into the rock. Casing may be omitted if the borehole will stand open without caving. Deeper casing(s) or nested casing(s) may be required to facilitate adequate drill hole fluid circulation and hole control. Records of casing(s) lengths and depth intervals installed should be maintained and documented.

4.8 A datum for measuring drill hole depth should be established and documented. This datum normally consists of a stake driven into stable ground surface, the top of the surface casing, or the drilling deck. If there is possibility for movement of the surface casing, it should not be used as a datum. If the hole is to be later surveyed for elevation, record and report the height of the datum to the ground surface.

4.9 The core barrel is assembled following manufacturers’ instructions. Keep core barrels cleaned and lubricated and free from damage, dents, or other defects that might affect core quality. Inspect barrels for wear, clearances, dents, or galls. Check condition of core lifters, fluid passages, relief holes, ball checks, valve rubbers, and inner barrel stabilizers, if present. Assemble and disassemble core barrels with the correct tools for the job.

4.10 The inner tube of double tube core barrels must be positioned correctly for proper operation. For both conventional and wireline systems where fluid circulates between the bit and lifter case, check that the proper clearance is maintained for circulation. For wireline systems, this will require engaging the inner barrel while the outer barrel is held vertically. If clearances are not correct, they should be adjusted using the adjustment screw on top of the barrel assembly.

4.11 An initial assembly of lead drill rod and core barrel is attached to the drill mechanism through a spindle or below the drill head, and placed within the top of the surface casing. Hole depth is determined by keeping track of the length of the rod-bit assemblies and comparing its position relative to the established surface datum. Hole depth for increments of drilling, coring, and sampling is recorded on the drill log.

4.12 The drilling-fluid circulation pump or air compressor is activated, causing drilling fluid or air to circulate through the system.

4.13 Drilling fluid or air circulation is initiated and rotation and axial force are applied to the drill rod and bit until drilling progresses to a depth where: (1) when the core sample has fully entered the core barrel or blockage is apparent, (2) sampling or in-situ testing will be performed, or (3) the length of the drill-rod column limits further penetration.

4.14 Rotation is stopped, the advance or down force pressure is released, and circulation is continued for a short time until the drill cuttings are removed from the borehole annulus. Circulation is stopped and the barrel is rested on the hole bottom to determine hole depth.

4.15 Remove the core barrel and the core from the borehole. Disassemble the core barrel and remove the core.

4.16 Reassemble the core barrel and return it to the borehole. Check for proper barrel conditions as noted in 4.12. The use of two barrels can greatly speed coring operations; as one barrel is cleaned and reassembled the other is in use in coring.

4.17 Drilling depth is increased by attaching an additional drill-rod section(s) to the top of the previously advanced drill-rod column and resuming drilling operations in accordance with 4.13 – 4.17.

4.18 Rock core handling—Use of split inner barrel liners greatly increases the efficiency of handling of cores, especially in broken formations. Cores can be transferred into plastic half rounds for logging and sealing. Rock core samples should be properly placed in the core boxes prior to logging. During storage the core boxes are marked with catalog numbers, identifying names and numbers, basic locality information, and depths of core contained in the box. Maintain each core section in its relative position to all other sections, fasten each core section securely in the core box so it does not shift and strap the lid of the box firmly to avoid mixing cores. In cases where core samples are removed for analysis, Indicate the depth and positions of sections removed for analysis on the inside of the trays. All mechanical breaks, man or equipment related, of the core sample shall be recorded in the logs and by marking the cores in some consistent manner. Typically, this is by two parallel lines drawn perpendicular and crossing the mechanical break and labeled “MB”.

4.19 Rock core recovery—Rock core shall be recovered continuously in the borehole. If core recovery of the solid portion of the subsurface material drops a significant amount below 100 % **(see Annex),** modify the drilling procedure, that is, adjust the drilling rotation per minute (RPM), down feed pressure, the drilling fluid type and flow, or change the type and the size of core barrel or bit used, until core recovery is improved to a level acceptable to the project geologist or project engineer. Minimize mechanical breaks in the core during core drilling as much as possible.

4.20 If conditions prevent advance of the drill hole to the stipulated depth, the borehole shall be cemented and redrilled, or reamed and cased, and advanced with a smaller size drill bit and core barrel, or abandoned, as directed by the engineer or geologist.

5. Report

Report the following information:

5.1. Description of the site and any unusual circumstances.

5.2. Document all personnel at the site during the drilling process, including the driller, helpers, geologist or logger, engineer, and other monitors or visitors.

5.3. Weather conditions during drilling.

5.4. Working hours, operating times, break-down times, and sampling times. Report any long-term delays in the drilling and installation process.

5.5. Report any unusual occurrences that may have happened during the exploration.

5.6. Drilling methods:

5.7. Description of the coring system including type, sizes, core barrels, fluid pump, fluid circulation, and discharge systems. Note intervals of equipment change or drilling method changes and reasons for change.

5.8. Type, quantities of additives added to the circulation media and drill hole locations. If changes to the circulating medium are made, such as addition of water or conversion to foam, the depth(s) or interval(s) of these changes should be documented.

5.9. Descriptions of circulation rates, cuttings return, including quantities, over intervals used. Note the quantity and locations of loss of circulation and probable cause.

5.10. Descriptions of drilling conditions related to drilling pressures, rotation rates, and general ease of drilling related to subsurface materials encountered. These descriptions can be very general, and should report how the sampling of different materials progressed.

5.11. Records of casing, type, amount and times of installation. Record water levels (dates and elevation) observed during drilling.

5.12. Sampling—When core sampling or intact sampling at the base of the boring separate from coring operations, report condition of the base of the boring before sampling and any slough or cuttings present in the recovered sample. Samples of fluid circulation cuttings can be collected for analysis of materials being penetrated. If cuttings samples are taken, the depth(s) and interval(s) should be documented.

5.13. In-situ testing:

5.14. For devices inserted below the base of the drill hole, report the depths below the base of the hole and any unusual conditions during testing.

5.15. For devices testing or seating at the drill hole wall, report any unusual conditions of the drill hole wall such as inability to seat pressure packers.

5.16. Installations—A description of completion materials and methods of placement, approximate volumes placed, intervals of placement, methods of confirming placement, and areas of difficulty or unusual occurrences.

5.17. Boring Logs—Boring logs should be completed and some information that the boring log should include is:

5.17.1. Project identification, boring number, location, orientation, date boring began; date boring completed, and drillers' name(s).

5.17.2. Elevation coordinates of the top of the borehole.

5.17.3. Elevation of, or depth to, groundwater surface, and any changes in water level, including the dates and times measured.

5.17.4. Elevations or depths at which the drilling fluid returns were lost and amount of return with depth. Report advance or down feed and hold-back pressures, rotation rates of drill rods, fluid/gas pressure, and circulations return during drilling. Report the penetration rate and drill cuttings as they relate to the geologic strata being penetrated. Document any significant abrupt changes and anomalies that occur during drilling.

5.17.5. Size, type, and design of core barrels used. Size, type, and set of core bits and reaming shells used. Size, type, and design and lengths of all casing used, and locations or elevations of casings used. Records of casing(s) lengths and depth intervals installed should be maintained and documented.

5.17.6. Length of each core run and the percentage of core recovery.

5.17.7. Driller's description of the core in each run, if no engineer or geologist was present.

5.17.8. Geologist's or engineer's description of the core recovered in each run. Subsurface description, including dip of strata, jointing, cavities, fissures, core loss, and any other observations made by the geologist, engineer, or the driller that could yield information about the formation encountered during drilling. Depth, thickness, and apparent nature of the filling of each soft seam or cavity encountered. Report the calculated RQD.

5.17.9. Any change in the character of the drilling fluid or drilling fluid return.

5.17.10. Reservoir, tidal, or current information, if the drilling is near or over a body of water.

*5.17.11***.** Drilling time in minutes per foot and down feed gauge pressure, when applicable, and the RPM of the drill rods.

5.17.12. Notations of character of drilling, that is, soft, slow, easy, smooth, and others.

6. Precision and bias

6.1. This practice does not produce numerical data; therefore, a precision and bias statement is not applicable.

6.2. The boring log reflects the subjective opinions of the engineer, the geologist, or the driller. Therefore, the designer must exercise proper prudence when interpreting the boring logs.

6.3 This procedure produces data on rock type and rock quality and recovery factors such as RQD that may reflect the biases of the persons collecting the data. **(see annex)**

ANNEX A; CALCULATION OF RQD

A.1 Procedure

i. Close visual examination of core pieces is required for assessing the type of fracture (that is, natural or drill break). Pieces of core that are moderately or intensely weathered, contain numerous pores, or are friable, or combination thereof, should not be included in the summation of pieces greater than 100 mm for the determination of the RQD. Any rejected piece of core is still included as part of the total length of core run and should be noted in the report.

i. Measure all core piece lengths that are intact and greater than 100 mm to the nearest 1 mm and record on a RQD data sheet (Fig.) Measure such pieces along the centerline of the core as illustrated in Fig. 1

i. Only those pieces of rock formed by natural fractures (that is, joints, shear zones, bedding planes, or cleavage planes that result in surfaces of separation) shall be considered for RQD purposes. The core pieces on either side of core breaks caused by the drilling process shall be fitted together and counted as one piece. Drilling breaks are usually evident by rough fresh surfaces. In some cases, it may be difficult to differentiate between natural fractures and drilling breaks. When in doubt, count a fracture as a natural fracture. If for some reason there is not 100% core recovery for a drill run, the length of core left in the borehole should be taken into account by adding it to the run in which it was cored rather than the run in which it was retrieved.

/. Record the top and bottom depths of each core run.

/. Sketch core features such as natural fractures, drilling breaks, lost core, highly weathered pieces, and so forth.

i. Include remarks concerning judgement decisions such as whether a break in a core is a natural fracture or a drilling break or why a piece of core longer than 100 mm was not considered to be intact.

i. Record the sum of intact core pieces longer than 100 mm long and calculate the RQD value for the core run evaluated.

i. Calculate as a percentage, the RQD of a core run as follows

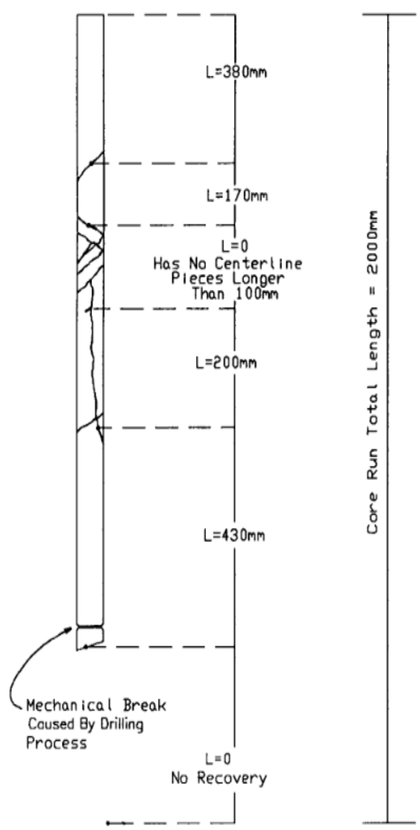
$$\text{RQD}=\frac{[\sum \text{length of intact core pieces} > 100\text{mm}]\times 100\ \%}{\text{total core run length}}$$

A.2 Rock Quality Description

Indicate the rock quality description for the core run using the rock quality table below.

RQD (Rock Quality Designation)	Description of Rock Quality
0-25%	Very poor
25-50%	Poor
50-75%	Fair
75-90%	Good
90-100%	Excellent

<table>
<tr><td colspan="4">PROJECT:</td></tr>
<tr><td colspan="2">RQD DATA SHEET</td><td colspan="2">DATE :</td></tr>
<tr><td colspan="2">Recorder ______

Core diameter
___</td><td colspan="2"></td></tr>
<tr><td>Depth (m)</td><td>Sketch of core</td><td>Length of intact pieces > 100mm</td><td>REMARKS</td></tr>
<tr><td></td><td>
</td><td></td><td></td></tr>
<tr><td colspan="4">∑ of intact pieces > 100mm =

$RQD(\%)=\frac{[\sum length\ of\ core\ pieces > 100mm]}{Total\ length\ of\ core\ run}=100\%$

RQD (%) =</td></tr>
</table>

 First edition