



TANZANIA STANDARD

MMDC 1 (3830) DTZS Rock core drilling and sampling of rock for site exploration — Code of practice

FOR PUBLIC COMMENTS

TANZANIA BUREAU OF STANDARDS

TZS 2363:2019

This Tanzania Standard was published under the authority of the Board of Directors of Tanzania Bureau of Standards on 2018-11-08.

Tanzania Bureau of Standards (TBS) is the statutory national standards body for Tanzania established under the Standards Act No. 3 of 1975 which was repealed and replaced by the Standards Act No. 2 of 2009.

The Mining and Minerals Divisional Standards Committee, under whose supervision this Tanzania Standard was prepared, consists of representatives from the following organizations:

- *University of Dar es Salaam (College of Natural and Applied Sciences – CoNAS)
- *Tanzania Chamber of Mines (TCM)
- *Occupational Safety and Health Authority (OSHA)
- *Geological Survey of Tanzania (GST)
- Mining Commission
- *National Environment Management Council (NEMC)
- Rural Water Supply and Sanitation Agency (RUWASA)
- Ministry of Energy (MoE)
- Ministry of Minerals (MoM)
- *State Mining Cooperation (STAMICO)
- *Federation of Miners Association of Tanzania (FEMATA)
- Tanzania Women Miners Association (TAWOMA)

The organizations marked with an asterisk (*) in the above list, together with the following, were directly represented on the Technical Committee entrusted with the preparation of this Tanzania Standard:

Ministry of Minerals (MoM)

Tanzania Bureau of Standards
P O Box 9524
Dar es Salaam
Tel: +255 (22) 2450206/2450949/2450298
Fax: +255 22 2450298
E-mail: info@tbs.go.tz

Rock core drilling and sampling of rock for site exploration — Code of practice

0 Foreword

This Tanzania Standard was prepared by the Exploration Technical Committee under the supervision of the Mining and Minerals Divisional Standards Committee.

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 Tanzania Standard, main assistance was drawn from ASTM D2113 – 14 *Standard practice for rock core drilling and sampling of rock for site exploration*, published by ASTM International.

1 Scope

This 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 audits 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 definitions

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 or polyvinyl chloride (PVC) 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

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

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

platform for drilling rig.

2.9 overshot

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

facility 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

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

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

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, 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

mechanical or manmade break in the core that was not naturally occurring.

2.17 intact core

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

2.18 rock quality designation (RQD)

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 100 mm 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

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

2.20 drill rods

cylindrical steel pipes used in drilling operations, BQ, NQ, HQ, PQ sizes for Diamond drilling, RC drill rods for reverse circulation drilling.

2.21 stop ring

metal ring fitted on the core barrel inner tube assembly.

2.22 core lifter

hardened steel spring-like component used in the core barrel assembly to grip and retain the rock core inside the inner tube during drilling.

2.23 locking coupling

short, heavy-duty connector used in the outer tube assembly (drill string) to join two drill rods or outer tubes securely and prevent them from loosening during drilling operations.

2.24 adapter coupling

connector used to join drill rods, outer tubes, or core barrels of different types or sizes, allowing the drill string to function smoothly despite differences in components.

2.25 drill bit

cutting/ crushing tool attached at the end of the drill string that penetrates rock formations to create a borehole or recover core samples.

2.26 front reamer

rotary tool attached in front of the core barrel to enlarge the borehole diameter slightly ahead of the core barrel and guide it smoothly through the rock formation.

2.27 back reamer

component attached behind the core barrel to stabilize the drill string and enlarge the borehole diameter after the core has passed through.

2.28 outer tube

hollow cylindrical steel pipe that forms the main body of the core barrel assembly and provides structural support for the inner tube and core recovery components.

2.29 inner tube

hollow steel cylinder that sits inside the outer tube and is the primary component responsible for collecting the rock core during drilling.

2.30 overshot assey

wireline device used to retrieve the inner tube from the borehole without having to remove the entire drill string.

2.31 backend

rear or bottom end of the drill string assembly, often associated with the portion of the core barrel or outer tube assembly that supports and stabilizes the drilling operation.

2.32 rod recovery tap

tool or mechanism used to safely remove or recover drill rods from the drill string, especially if they become stuck in the borehole or need to be disconnected during maintenance.

2.33 water swivel

component used to supply water (or drilling fluid) to the drill bit while allowing the drill string to rotate freely.

2.34 winch cable

a winch cable is a strong steel wire rope used in wireline drilling systems to raise and lower the inner tube or core barrel without having to pull the entire drill string out of the hole.

2.35 wire line

system used to retrieve the inner tube (core barrel) from the borehole without removing the entire drill string.

2.36 pipe wrench

hand tool used to grip and turn drill rods, outer tubes, or couplings to assemble or disassemble the drill string.

2.37 hammer

drilling tool used to crush and penetrate the rock formation at the bottom of the borehole. This is usually part of a top hammer or down-the-hole (DTH) system, depending on the RC method.

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), Carboxymethylcellulose powder (CMC), Potassium chloride (muriated potash), Polyacrylamide, Guar gum, Barium sulfate and Attapulgit.

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, Protection of air, water and soil pollution; conservation natural resources (like water, forests and soil); protection ecosystems and promotion of sustainable practices (use of clean energy, waste reduction/re-use/recycling, treatment and disposal.

4.3 Evaluate applicable methods for safety and traffic regulation during core drilling.

4.4 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.

4.5 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.

4.6 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.

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

4.8 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.

4.9 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.

4.10 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.

4.11 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.

4.12 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.

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

4.14 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.

4.15 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.

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

4.17 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.

4.18 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** to **4.17**.

4.19 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".

4.20 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.

4.21 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.

4.22 Perform downhole survey to conduct in situ data gathering down the drilling hole that measures the deviation of a borehole from the planned to actual depth and collect all other associated information.

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:

5.6.1 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.

5.6.2 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.

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

5.6.4 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.

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

5.8 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.

5.9 In-situ testing:

5.9.1 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.

5.9.2 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.

5.10 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.

5.11 Boring logs – Boring logs should be completed and some information that the boring log should include is:

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

5.11.2 Elevation coordinates of the top of the borehole.

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

5.11.4 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.

5.11.5 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.

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

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

5.11.8 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.

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

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

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

5.11.12 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 A).

Annex A **(normative)**

Calculation of RQD

A.1 Procedure

A.1.1 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.

A.1.2 Measure all core piece lengths that are intact and greater than 100 mm to the nearest 1 mm and record on an RQD data sheet (Figure 1). Measure such pieces along the centerline of the core as illustrated in Figure 1.

A.1.3 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.

A.1.4 Record the top and bottom depths of each core run.

A.1.5 Sketch core features such as natural fractures, drilling breaks, lost core, highly weathered pieces, and so forth.

A.1.6 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.

A.1.7 Record the sum of intact core pieces longer than 100 mm long and calculate the RQD value for the core run evaluated.

A.1.8 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:

S/N	RQD (Rock Quality Designation)	Description of rock quality
1	0-25%	Very poor
2	25-50%	Poor
3	50-75%	Fair
4	75-90%	Good
5	90-100%	Excellent

PROJECT:			
RQD DATA SHEET		DATE:	
Recorder _____			
Core diameter _____			
Depth (m)	Sketch of core	Length of intact pieces > 100 mm	Remarks
Σ of intact pieces > 100mm = $RQD(\%) = \frac{[\sum \text{length of core pieces} > 100\text{mm}]}{\text{Total length of core run}} \times 100\%$ RQD (%) =			

Figure 1 — RQD data sheet

FOR PUBLIC COMMENTS