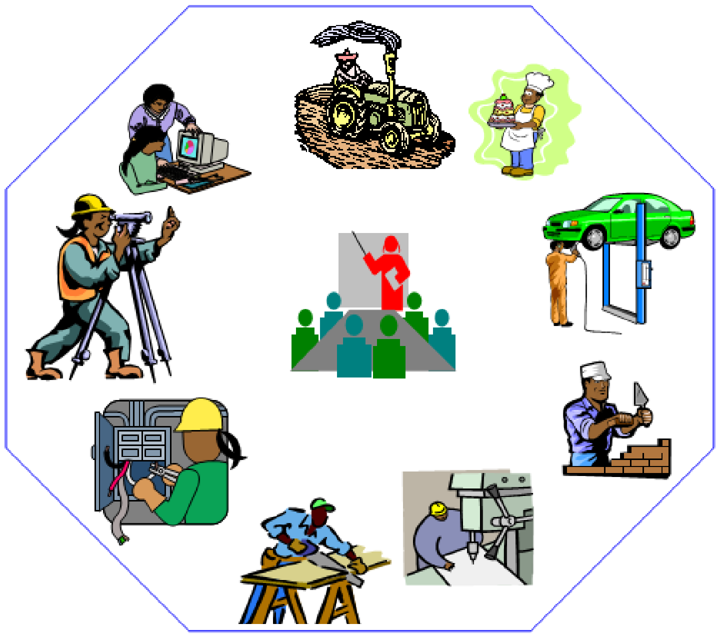
Surface mining

Level-II

Based on December 2018 Version 2,   OS and April, 2021, V1 Curriculum



Module Title: Supporting surface blast hole drilling operations

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Instruction Sheet	

This learning guide is also developed to provide you the necessary information regarding the following content coverage and topics –

- Applying relevant compliance documentation
- Obtaining work requirements and procedures
- Applying geological and survey data
- Preparing work area
- Identifying and reporting potential hazards and risks
- Resolving coordination requirements
- Selecting personal protective equipment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Apply relevant compliance documentation
- Obtain work requirements and procedures
- Apply geological and survey data
- Prepare work area
- Identify and report potential hazards and risks
- Resolve coordination requirements

- Select personal protective equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.

2. Follow the instructions described below.

3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 Sheet 4, Sheet 5, Sheet 6, and Sheet 7. Sheet 8 and Sheet 9.

4. Accomplish the “Self-check 1, Self-check 2, Self-check 3 Self-check 4, Self-check 5, Self-check 6, Self-check 7, Self-check 8 and Self-check 9” in page 6,10,16,23,36,44,50,56,and 61 respectively.

5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, and Operation Sheet 2” in page 37 and 50 respectively.

6. Do the “LAP test” in page – 38 (if you are ready).

Information Sheet-1	Apply relevant compliance documentation

1.1 Basic concept on Compliance documentation:-

Compliance documentation is the documents that must be completed in a job. These documents are required to show that the workplace is following the established laws, set practices and standards that must be in place.Compliance documents are documents that must be read and followed and in some cases completed by you. Failing to follow and work correctly with compliance documents may lead you to lose your job. In workplaces where there are inherent dangers around you, if you do not follow the rules you can expect to be looking for another line of work. Documentation in drilling operation management is essential. There are many types of project documents, which are also known as project artifacts. How do you decide on the documents to use for your projects? Your project management offices (PMOs) will provide you with guidance regarding the minimum required project documents to use on your projects. Your PMOs will not penalize you for using additional documents above the required documents; however, your PMOs will penalize you for failing to use the minimum required project documents.

The most common drilling operation documents, including formal and informal project documents:

1. **Project Schedule**:

Typically, project managers use project software to manage their projects' schedules, resources, dependencies, and project costs.

2. **Risk Management**:

A risk management document is used for the purpose of capturing risks by group and category, and it allows you to rank or prioritize your risks. Risks could convert to issues.

3. **Issues Log:**

Issues could block your project from moving forward or delay your implementation date. You need to use this document to track your issues to completion.

4. **Project Budget**:

It's imperative to track your project budget. This document allows you to track all costs associated with your project. Project costs include resources, hardware, software, and vendors.

5. **Communication Plan**:

This is a key project document because it proactively communicates to all of your stakeholders your communication media, frequency of communication, and communication content. You do not want your stakeholders guessing about your communication strategy.

6. **Project Status Report**:

You need to communicate your project status to your stakeholders and should report on progress and accomplishments, risks, issues, and next steps.

7. **Project Charter:**

This document captures the mutual agreement and initiation of a project. The charter contains a high-level schedule, high-level assumptions and constraints, and project requirements.

8. **Meeting Agenda/Minutes**:

Document your formal status meetings. Many organizations have existing meeting templates for you to create your meeting agenda. Meeting attendances tend to be higher when invitees can verify in advance that your meeting will be productive. You should recapture the meeting discussions using your meeting minutes document because it would help to provide clarity after the meeting and/or uncover discrepancies.

9. **Quality Assurance (QA) Test Plan**:

Reviewing and authorizing your projects' QA document could save time and money later during your project testing phase. The QA document contains the testing strategy, testing tools (automation), high-level duration, and a number of QA testers.

10. **Project Management Plan**:

The Project Management Institute (PMI) consolidated nine subsidiary plans, including:

- Scope management
- Scheduling management
- Resource management

1.2. Types of Compliance Documentation:

Compliance documentation in Drilling operation relevant to working safely and following WHS policies and procedures includes:

- Legislative Requirements.
- WHS Requirements / Regulations outline responsibilities of employers / such as providing first aid facilities and trained personnel / workers.
- Equal Employment Opportunity and Disability Discrimination Legislation.
- Employment and Workplace Relations Legislation.
- Regulations and Guidelines from authorized organizations or external personnel/workers
- Ethiopian Standards
- Codes of Practice.
- Duty of Care.
- Organizational Policies and Procedures.
- Management Plans.
- Sick Leave Requirements.

Some geotechnical data may be collected from trenches, test pits or surface observations; however, they comprise a small percentage of the data in comparison to the borehole data and are generally treated in the same manner as borehole data.

A borehole is any vertical, inclined, horizontal or curved hole drilled into the ground with the primary purpose of collecting information and samples on soil layers and their properties.

Geotechnical boreholes are made in order to collect information on type, thickness, lateral distribution and geotechnical and geo environmental properties of subsurface soil and rock material.

They also provide information on groundwater conditions.

In addition to direct observation of soil and rock cuttings/cores from the borehole, in-situ measurements are typically performed in the borings, and soil and rock samples are collected for laboratory testing.

Geotechnical data are collected from three major sources:

a) boreholes, trenches and test pits,
b) In-situ tests including geophysical tests, and
c) Laboratory tests performed on samples collected from the boreholes.

1.3 Drilling operation:-

During drilling operations: is standard practice to record slow circulation rates and pressures (SCRP) on each shift. This is less likely to occur during work over operations, since the pipe is not normally on the bottom for an extended duration. However, where possible, circulation rates and pressures should be recorded, documenting your chosen control measures helps show you have met your legal obligations. Keep records to track what has been done and what is planned; effective record-keeping can save time and money. The level of documentation should be appropriate for the level of risk and control measures. Documenting drilling operation activity is one of the essential elements of the quality system to maximize mining production. A major goal of keeping documents is to find information whenever it is needed. The documents needed in the drilling work process must be accessible to all staff.

Drilling operation Policies give broad and general direction to the drilling quality system.

They:

- tell “what to do”, in a broad and general way;
- include a statement of the organizational mission, goals, and purpose;
- Serve as the framework for the drilling quality system, and should always be specified in the quality drill machine manual.

Geotechnical data are one of the most prevalent data types in mining industry projects. Considering the widespread collection and usage of geotechnical data in various disciplines, one might expect that data are readily available for most developed areas. However, unlike other types of spatial data that are

Available in spatial data infrastructures (SDI), geotechnical data is often managed using traditional and ineffective methods.

Drilling operation consideration:

- Types and amounts of drilling fluids.
- Rock hardness, drill machine capacity
- Borehole depths typically used.
- performance of drill operater
- Borehole diameters typically used. ,
- Seals typically used.
- The fraction of boreholes sealed by humans today. ,
- The source(s) of the above information.

Self-Check -3	Written Test

Directions: Choose the correct answer from the given choose. Use the Answer sheet provided in the next page:

1. Which one of the following is not drilling operation consideration? (2pts)
   A) Rock hardness B) Bore hole diameter C) Typically used seals D) Risk management.
2. Which one of the following is a type of compliance document?(2pts)
   A) Legislative requirements B) Project management plan C) Meeting Agenda D) Status report

3.______________ is any vertical, inclined, horizontal or curved hole drilled into the ground? (2pts)

A) **Borehole B) Well C) Fisher D) Caldera**

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Obtaining work requirement and Procedures

2.1 Drilling requirements and procedures;

After a work piece is laid out and properly mounted, the drilling process can begin. The drilling process, or complete operation, involves selecting the proper twist drill or cutter for the job, properly installing the drill into the machine spindle, setting the speed and feed, starting the hole on center, and drilling the hole to specifications within the prescribed tolerance. After the drill has been aligned and the hole started, then insert the proper size drill and continue drilling into the work piece, while applying cutting fluid. The cutting fluid to use will depend on what material is being machined. Drilling parameters play a large role in helping drillers achieve a good ROP (rate of penetration), superior drilling performance and long bit life. They are basic recommendations that help guide a driller avoid burning bits or damaging other drilling equipment.

- Drilling requirements and procedures**:-**
- ✓ Blast hole drilling is essentially carried out in order to break up rock and hard minerals in order to make it easier for the mining crew to get to the resources being mined. A technique used in mining whereby a hole is drilled into the surface of the rock, packed with explosive material, and detonated.
- ✓ The aim of this technique is to reduce cracks in the inner geology of the surrounding rock, in order to facilitate further drilling and associated mining activity. The overall sequence of activities in modern mining is often compared with the five stages in the life of a mine: prospecting, exploration, development, exploitation, and reclamation.

- **Most boreholes drilled for mine production are blast holes for explosives.**
- The initial hole into which the explosives are packed is known as the "blast hole".
- Blast hole drilling is one of the primary surface drilling techniques employed in mining operations today.
- Blast hole drilling is traditionally used wherever the mining company wants to explore the mineral composition or potential mineral yield of the area demarcated for their mining interests.
- Blast holes are thus a fundamental step in the exploratory mining process, and can be employed in both surface mining operations and underground mining operations to varying degrees with varying effects or results.
- Blast hole drilling can also be employed in quarrying endeavors.

Fig: 2 Rotary blast hole drill rig

2.3 Providing information on drilling machinery:

Drilling machinery, equipment used to drill holes in the ground for such activities as prospecting, well sinking (petroleum, natural gas, water, and salt), and scientific explorations. Drilling holes in rock to receive blasting charges is an operation in tunneling, mining, and other excavating. Most modern drilling machines are either percussive (chipping rock or ground intermittently by impact) or rotary (involving a cutting or grinding action). A combined rotary-percussive drill uses both types of action when the hardness of the stratum warrants it.Employers must give staff this information in a way workers can easily understand it – be aware of language and literacy issues.

Employers may also need to give information to others who enter the workplace, including cleaners, visitors and contract staff.

This could be a machinery instruction handbook or other written instructions that include:

- a publication date and revision details (if the information has been redrafted or updated)
- any transport, handling or storage requirements, including the machine's dimensions, weight and lifting points
- Information about installation and connecting to a power source, including any assembly information and power supply requirements.
- Specific information about an individual machine should include:
- a detailed description of the machine (including any fittings, guards or protective safety devices)
- reference to any machinery safety standards used in its design, including any mandatory requirements (eg conformance declaration, verification of design)

- Details of any emissions (eg noise, fumes, dust) the machine makes when running.

Written information for the driller user should include:

- the machine's intended use
- a description of the machine's controls (especially emergency stops)
- operating instructions, including start-up preparations, process change-over and shutting down
- common faults and any reset instructions the user may need
- any guards or protective safety devices for particular hazards
- safety sign descriptions and details
- any prohibited uses or likely misuse
- any hazards the manufacturer could not eliminate
- any personal protective equipment that needs to be used
- Any training that is needed.

A wide range of information sources can be used to help identify hazards, including:

- ✓ employee and health and safety representative participation and involving those working with the machinery
- ✓ manufacturer's instructions and advice
- ✓ maintenance logs of machinery
- ✓ documentation of safe work practices and their effectiveness
- ✓ injury or incident information and hazard alerts
- ✓ relevant reports from occupational health and safety agencies, unions, employer and professional bodies

- ✓ articles from health and safety journals
- ✓ Safety information from safety authorities on the Internet.

Monitoring and reviewing effectiveness of control measures

Once control measures are in place, they must be regularly monitored and reviewed. To do this, it is useful to ask the following questions.

- Have control measures been implemented as planned?
- If control measures have not been implemented, why not, and what is happening in the meantime?
- Are the control measures being used correctly?
- Are the control measures working?
- Have the control measures isolated or minimized the risk from the hazard as intended?
- Have the control measures made any new hazards?
- Have the control measures made any existing hazards worse?

In order to answer these questions, you may need to:

- talk with workers, supervisors and any health and safety representatives
- measure levels of exposure (eg take noise measurements where a noise source was identified)
- refer to manufacturers' instructions
- monitor incident reports
- Contact industry associations, unions, government bodies or health and safety consultants.

When deciding when to monitor and review control measures, consider:

- the level of risk – high risk hazards need more frequent assessments

- the type of work practices or machinery involved
- whether new methods, tasks, equipment, hazards, operations, procedures, rosters or schedules have been introduced
- whether the environment has changed
- Any indication that risks are not being controlled.

Self-Check -2	**Written Test**

Directions: Fill the blank space. Use the Answer sheet provided in the next page:

1. _________is an equipment used to drill holes into the ground for prospecting petroleum, natural gas and water.(3pts)

2. _________is a surface drilling technique employed in mining operations today.(3pts)

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	**Applying geological and survey data**

3.1 Geological data

Geology is the most important factor that determines the nature, form and cost of a drilling. For example, the route, design and mineral sampling are largely dependent on geological considerations.

Geology is the study of the earth. It describes the origins and formation of the rock types under the surface of the earth. The original material or "building blocks" of the earth are the hard rocks such as granites and volcanic formations, formed when molten material cooled beneath or at the surface of the earth. These are known as the igneous rocks ("made by fire"). It is from these rocks that sedimentary layers have been formed. Geology survey is an essential engineering discipline that is important for the extraction of minerals and hydrocarbons. It includes topographic mapping that is performed by numerous surveying companies by using modern surveying instruments.

3.1.1Rock types:-

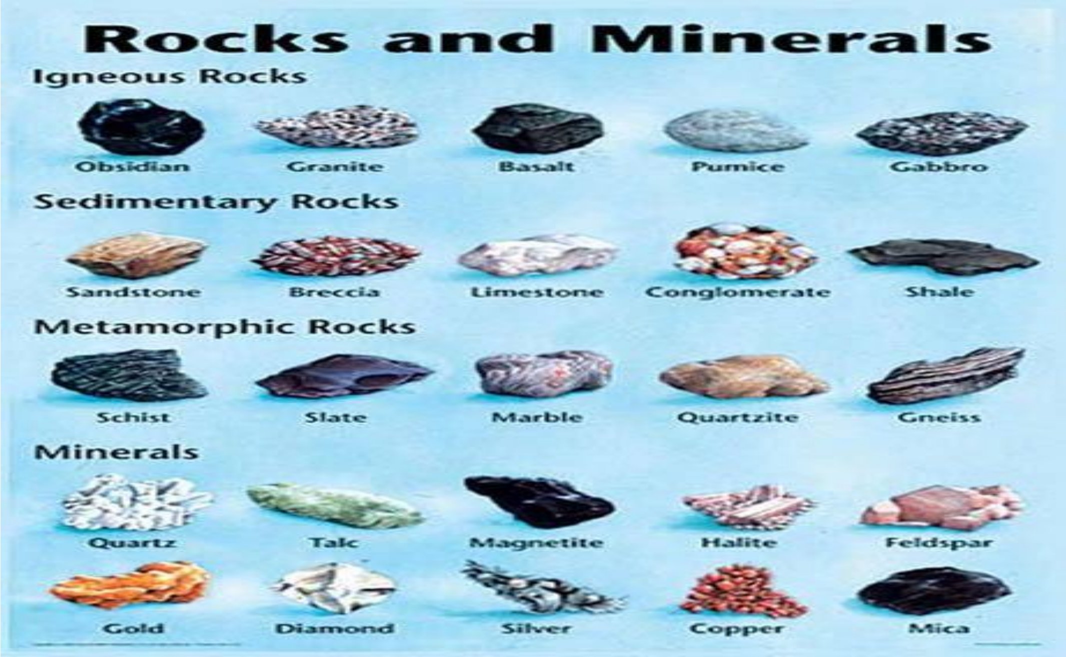


Fig: 1 rock and minerals.

Rocks are classified into three main groups on the basis of their origin and the way in which they were formed:

1. **Igneous or magmatic rocks** (formed from solidified lava or "magma").

Igneous rocks are formed when a magma solidifies deep down in the earth's crust (plutonic rock), or as it rises towards the surface (dyke rock) or on the surface (volcanic rock). Igneous rocks such as granite or lava are tough, frozen melts with little texture or layering. Rocks like these contain mostly black, white and/or gray minerals. Sedimentary rocks such as limestone or shale are hardened sediment with sandy or clay-like layers (strata).

The most important constituents (minerals) are quartz and silicates of various composition, chiefly feldspars.

A) Intrusive (plutonic):

Plutonic rocks solidify slowly and are therefore coarse-grained.

Granite, Diorite, Granodiorite, Gabbro

B) **Extrusive (volcanic**) Basalt, Dacite, Rhyolite, Andesite;

Volcanic rocks solidify quickly and become fine grained.

Fig: 2 igneous rocks

2. **Sedimentary rocks*:-***

- Formed by deposition of broken material or by chemical precipitation.
- Are formed by the deposition of material by mechanical or chemical action and a consolidation of this material under the pressure of overlying layers.
- It frequently occurs that the rock formation is broken down by mechanical action (weathering), carried away by running water and deposited in still water. Thus the original rock will determine the characteristics of the sedimentary rock.

A) **Clastic**; Conglomerate, Sandstone, Siltstone, Breccia, Mudstone, shale

B) **Chemical**; Limestone, dolostone, Evaporaties

C) **Biological;** Coal, chert

Figure:- 3 Sedimentary rocks

3. Metamorphic rocks:-

Metamorphic rocks are formed by the transformation of igneous or sedimentary rocks, in most cases by an increase in pressure and heat). The effects of chemical action or increased pressure and/or temperature on a rock formation can sometimes be so great that it produces a transformation, which the geologist calls metamorphism.

Fig 4: Metamorphic rock structure

For example, pressure and temperature might increase under the influence of up-welling magma, or because the formation has sunk down deeper into the earth's crust. This results in the recrystallization of the mineral grains or the formation of new minerals.

A characteristic of the metamorphic rocks is that they are formed without any complete melting. They are also frequently hard or very hard, and also compact and fine-grained, and are therefore often difficult to drill. The result is deformation in one way or another, and in nature we may therefore observe, for example, pronounced folding, crushed zones, faults and other phenomena that can have a telling effect on drilling.

- **A) Foliated** slate,schist,gneisis
- **B) Non Foliated** quortizite,marble


FOLIATED
NON-FOLIATED

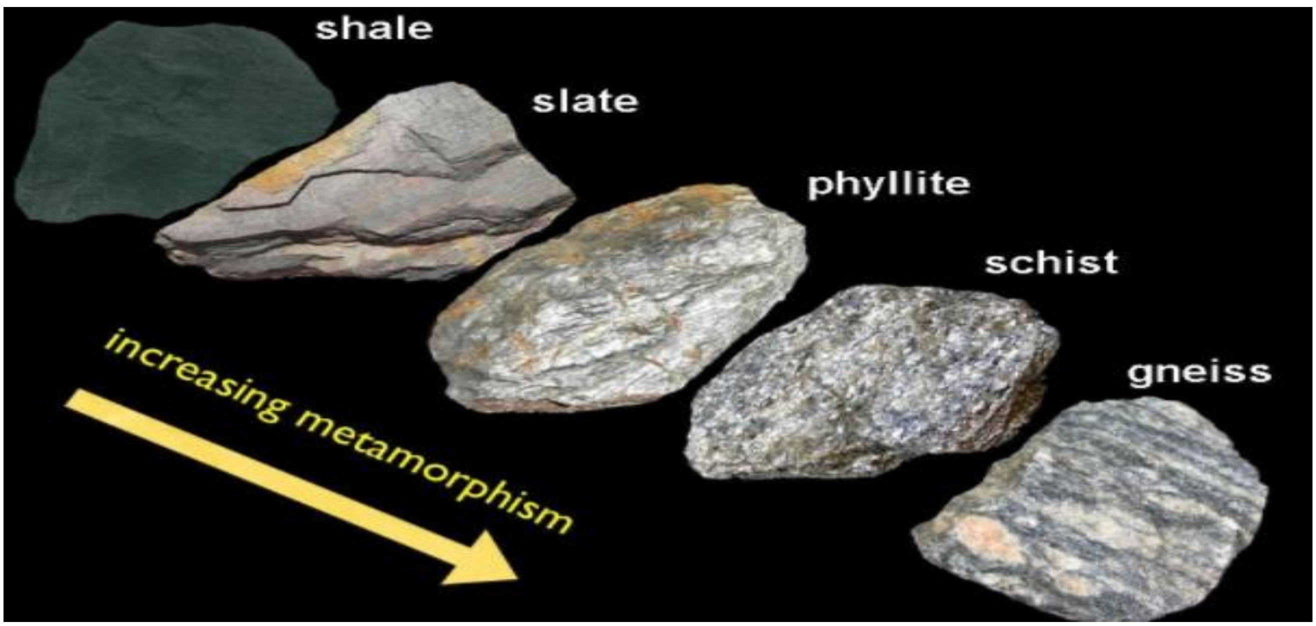

shale
slate
phyllite
schist
gneiss
increasing metamorphism

Figure 5: foliated and non-foliated metamorphic rocks

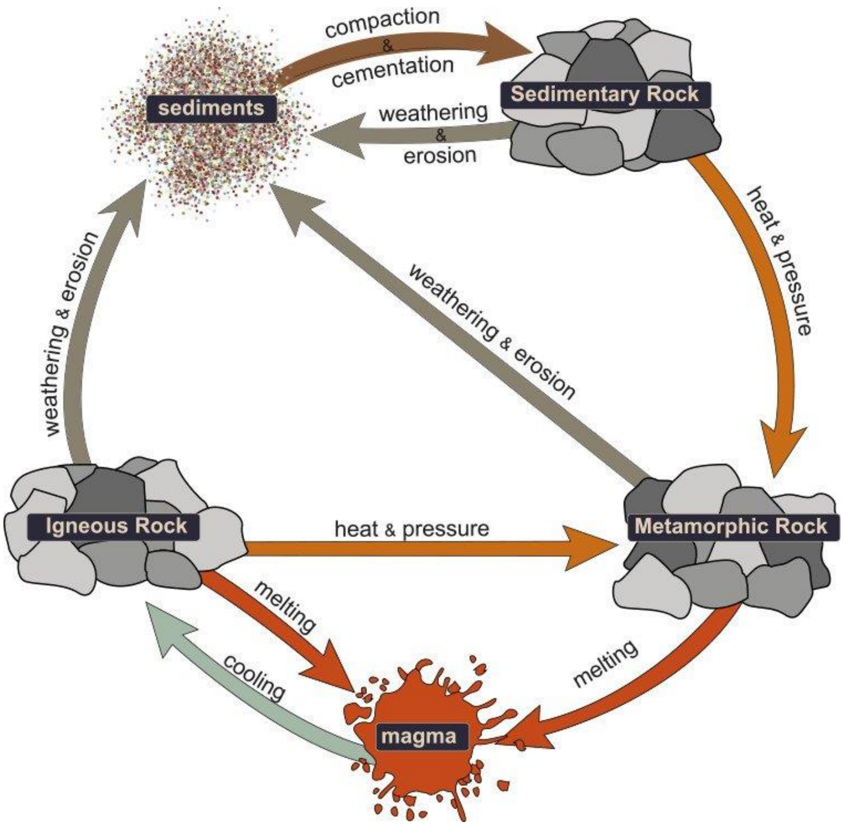


Figure 6: Rock cycle

5.2 Survey data:-

Surveying is the science and art of making the measurements necessary to determine the relative positions of points above, on, or beneath the surface of the earth or to establish such points.

The quality of a survey is determined by comparing the actual measured borehole uncertainties against the theoretical uncertainties of the survey tool.

What Is Geological Surveying?

Geology is the study of the liquid and solid substances that form the earth. The discipline of geology includes the examination of the composition, properties, and history of the earth materials. The technique of their formation, movement, and changes involved are also studied. Geology survey is an essential engineering discipline that is important for the extraction of minerals and hydrocarbons. It includes topographic mapping that is performed by numerous surveying companies by using modern surveying instruments. Geological information can be obtained by land survey techniques to assist in mitigating damage due to natural disasters. A geological survey is concerned with the methodical study of the subsurface for creation of geological maps. Several geological techniques are used for this purpose, including the conventional visual survey, studying of landforms, hand and machine driven bore holes, remote sensing systems like satellite imagery and aerial photography. Geological surveying has advanced due to the modern concepts evolved in all disciplines of engineering. Some of the modern techniques used for the geological survey are as under:

- Robotic laser devices that observe and record data
- Distances measured electronically by light beams
- Use of GPS that is a satellite positioning technology

- Guidance to construction machined by laser beams and satellites
- Laser scanners for the creation of 3-D models

Geological Surveying Techniques

Numerous surveying techniques are used for geological surveys like laboratory test results, and modeling approaches to understand the characteristics of the earth. In the usual geological surveying, the primary information is concerning the study of rocks, their location, and the deformation and examination of the sedimentary layers. In addition, the soils, landscapes, rivers, and glaciers are examined. Usually the surveying tasks include:

- Geological mapping

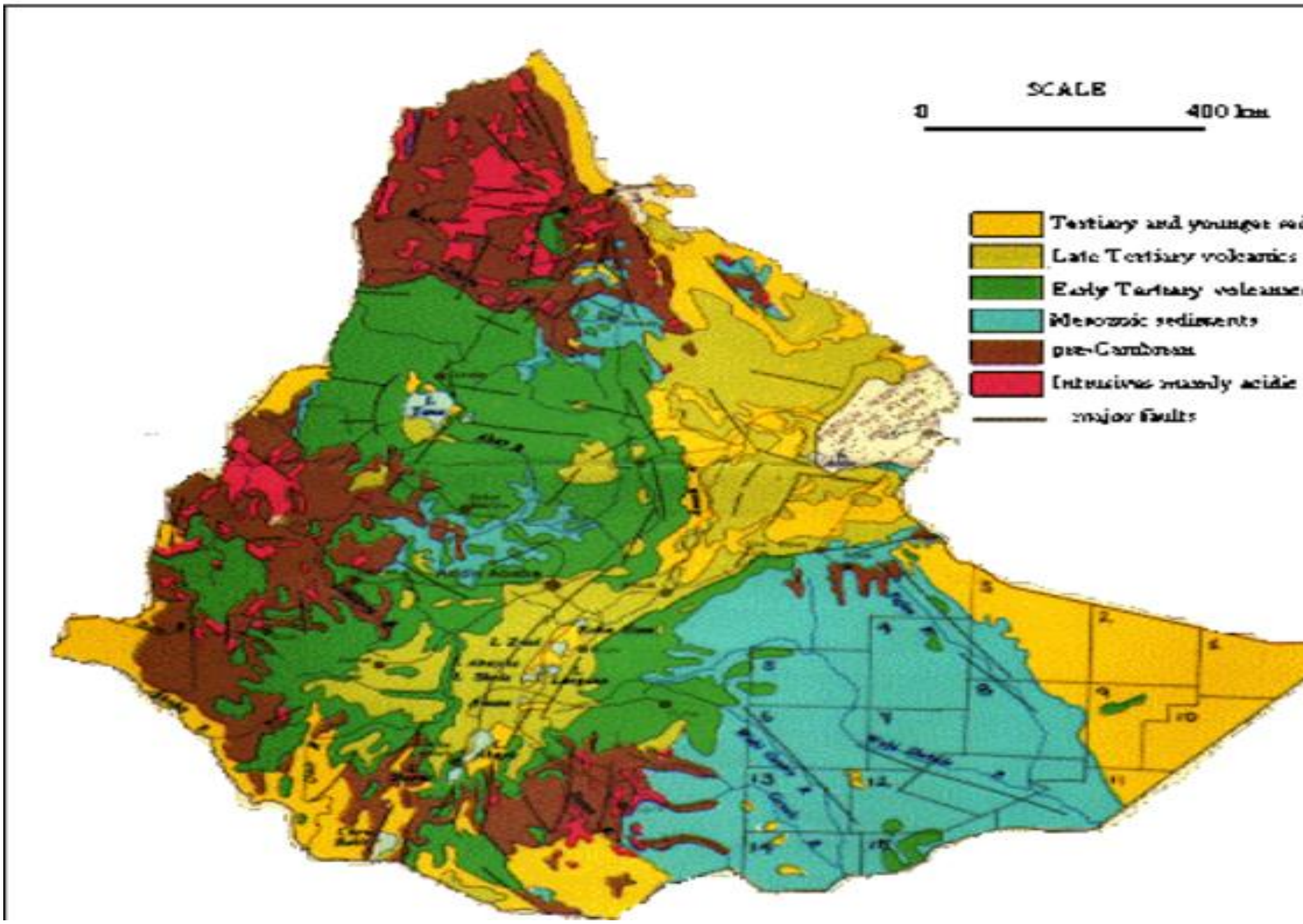


Fig 7: Geological mapping of Ethiopia

- Structural mapping to indicate the location of the main rocks and the faults due to which they were placed there
- Surficial mapping for the location of soils
- Survey of topographic features

- Formation of topographic maps
- Survey to identify changes in landscapes, erosion patterns, and river channels
- Subsurface mapping by seismic surveys, ground penetrating radar, and electrical tomography.

A geological map illustrates geological features. Rock units are identified by color, while the structural features like faults and folds are indicated by symbols. A geological map is considered to be one of the major tools to communicate or decode information relating to the surface of the earth. Geological maps are mainly used for the interpretation of the structure, mineralogy, stratigraphy, and paleontology of the earth crust. Geological maps are also valuable in locating energy resources like petroleum, coal, natural gas, and geothermal resources. They are also used for the exploration of mineral deposits like gold, copper, iron, and construction aggregate. Geological maps also identify potential hazards, for which necessary precautions can be taken. They are a basic source for engineering applications.

OBJECTIVES OF SURVEY

Mine surveying is a branch of mining science and technology. It includes all measurements, calculations and mapping which serve the purpose of ascertaining and documenting information at all stages from prospecting to exploitation and utilizing mineral deposits both by surface and underground working.

- Collect and record data of points on the surface of the earth
- Compute areas and volumes
- Prepare plans and maps
- Lay out engineering works using survey data
- Check the accuracy of laid out works

Fig 7; **Surveying**

Surveying work is an integral and important part of mining. Surveying works include:

- spatial and geometric measurements of underground structures and mining, determining their location, parameters, and their compliance with project documentation;
- monitoring the state of mining allotments and justifying their boundaries;
- justification and accounting of the volume of mining;
- identification of hazardous areas and measures for the protection of mining, buildings, structures and natural objects from the effects of work related to the use of subsoil;
- Surveying measurements of the volumes of mined minerals and mining operations;
- accounting of the state and movement of reserves, losses and dilution (debris) of mineral resources (geological surveying of reserves), accounting of incidentally mined, temporarily not used minerals, overburden and enclosing rocks and the resulting production wastes containing useful components;
- justification of mineral loss standards and extraction coefficients during their extraction;
- surveying control over compliance with the approved measures for the safe conduct of mining operations in the vicinity of and within the dangerous zones and the prevention of unauthorized construction of mineral deposits;
- timely creation of geodetic surveying support and surveying networks, carrying out the design parameters of various facilities in nature, assigning directions to mining and exploration workings, conducting instrumental observations of the displacement of rocks, deformations of the earth's surface, buildings, structures, stability of mine workings, calculation and drawing on mountain graphic

documentation of safety and barrier pillars and boundaries of safe mining operations and hazardous areas;

- Maintenance of mining graphic documentation.

Types of Surveying Equipment & Their Uses

- Chains and Tapes. Taking accurate measurements is one of the most important tasks a land surveyor must complete.
- Compasses and Clinometers.

Transits and Theodolites.

The main **surveying instruments** in use around the world are the Theodolites, measuring tape, total station, 3D scanners, GPS/GNSS, level and rod. Most instruments screw onto a tripod when in use. Tape measures are often used for measurement of smaller distances.

- Levels.
- Safety Gear.
- Prisms and Reflectors.
- Magnetic Locators.
- Poles, Tripods, and Mounts.

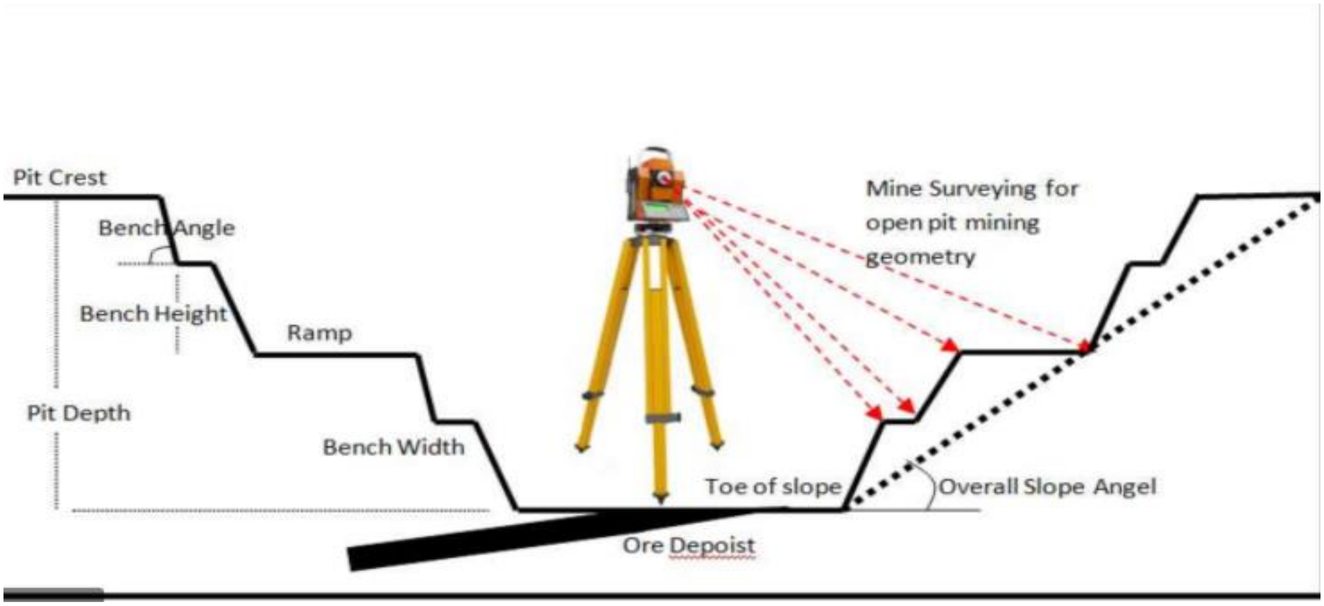


Fig 8: mine surveying

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Differentiate sedimentary rock from igneous rock.(2pts)
2. What do we mean by rock cycle? (2pts)
3. Define what mean geology.(2pts)
4. Define what mean survey.(2pts)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Quest

Information Sheet-4	**Preparing work area**

4.1 Introduction to drilling:

Drilling is a process whereby a hole is bored using a drill bit to create a well for oil and natural gas production. Planning for drilling operations, Start planning well in advance of the anticipated date for moving equipment onto site. It is best if one experienced person is designated to be responsible for evaluations of mineral thickness either by contracting profiling specialists or using appropriate equipment. During drilling operations, dynamic loading occurs when additional forces beyond the weight of the drill and support equipment are transferred to the surface. Maximum dynamic loading takes place when extracting stuck rods. To extract the rods, a pullback force is applied by alternately pushing and pulling against the drill string until the drill string is freed.

It is also important to consider pre- and post-drilling activities, which include:

- Mapping, sampling and surveying
- Camp preparation, infrastructure work,
- Gridline preparation
- Work site preparation, rock/soil test
- Drill pad preparation, drilling equipment selection
- Down hole surveying.
- Demobilization and rehabilitation plans.
- Well design drilling operation

There are numerous incidents where personnel have died or been seriously injured through inadequate recognition of exploration hazards and risks. Thorough planning and preparation are critical elements for effective management of the hazards associated with these activities,

Some specific considerations when preparing camps, work sites and drill pads.

Drilling is a relatively well-understood technological process but no two wells are the same and therefore risk management is important. The largest mainstream concern with drilling is the risk of blowouts, which is the uncontrolled release of oil and natural gas from a well due to issues with pressure management. With modern technology blowouts are preventable. However a high level of diligence is required by operators and regulators to ensure this does not happen. In addition to this, there are a wide array of drilling activities that can cause adverse environmental impacts .There are various kinds of oil wells with different functions:

- Exploration wells (or wildcat wells) are drilled for exploration purposes in new areas. The location of the exploration well is determined by geologist.
- Appraisal wells are those drilled to assess the characteristics of a proven petroleum reserve such as flow rate. Development or production wells are drilled for the production of oil or gas in fields of proven economic and recoverable oil or gas reserves.
- Relief wells are drilled to stop the flow from a reservoir when a production well has experienced a blowout. An injection well is drilled to enable petroleum engineers to inject steam, carbon dioxide and other substances into an oil producing unit so as to maintain reservoir pressure or to lower the viscosity of the oil, allowing it to flow into a nearby well.

The process of drilling involves several important steps.

a.Boring - a drill bit and pipe are used to create a hole vertically into the ground. Sometimes, drilling operations cannot be completed directly above an oil or gas reservoir, for example, when reserves are situated under residential areas. Fortunately, a process called directional drilling can be done to bore a well at an angle. This process is done by boring a vertical well and then angling it towards the reservoir.

b. Circulation: drilling mud is circulated into the hole and back to the surface for various functions including the removal of rock cuttings from the hole and the maintenance of working temperatures and pressures.

c. Casing - once the hole is at the desired depth, the well requires a cement casing to prevent collapse

Completion - after a well has been cased, it needs to be readied for production. Small holes called perforations are made in the portion of the casing which passed through the production zone, to provide a path for the oil or gas to flow. Production - this is the phase of the well's life where it actually produces oil and/or gas.

d. Abandonment - when a well has reached the end of its useful life (this is usually determined by economics), it is plugged and abandoned to protect the surrounding environment.

For example, ground clearing can have adverse effects on the ecological surroundings. Air quality and waste management from mining and during drilling can be an issue. The increase and vehicle and pedestrian traffic also creates an impact on the local environment.

4.2 Work area preparation for Drilling:-

Once the site has been selected, scientists survey the area to determine its boundaries, and conduct environmental impact studies if necessary. The company may need lease agreements, titles and right-of way accesses before drilling the land. For off-shore sites, legal jurisdiction must be determined.

After the legal issues are settled, the crew goes about preparing the land:

1. The land must be cleared and leveled, and access roads may be built.
2. Because water is used in drilling, there must be a source of water nearby. If there is no natural source, the crew drills water well.
3. The crew digs a reserve pit, which is used to dispose of rock cuttings and drilling mud during the drilling process, and lines it with plastic to protect the environment. If the site is an ecologically sensitive area, such as a marsh or wilderness, then the cuttings and mud must be disposed of offsite -- trucked away instead of placed in a pit.

Once the land has been prepared, the crew digs several holes to make way for the rig and the main hole. A rectangular pit called a **cellar** is dug around the location of the actual drilling hole. The cellar provides a work space around the hole for the workers and drilling accessories. The crew then begins drilling the main hole, often with a small drill truck rather than the main rig. The first part of the hole is larger and shallower than the main portion, and is lined with a large-diameter conductor pipe. The crew digs additional holes off to the side to temporarily store equipment -- when these holes are finished, the rig equipment can be brought in and set up.

Depending upon the remoteness of the drill site and its access, it may be necessary to bring in equipment by truck, helicopter or barge. Some rigs are built on ships or barges for work on inland water where there is no foundation to support a rig (as in marshes or lakes).

Preparation and planning are important before all drill moves. Verify that the location is adequate (e.g., slope, clearance, free of obstructions and dangerous branches). Complete site preparations before the move commences. The exploration company representative should show the foreman/senior driller the next site prior to completion of the current hole so arrangements can proceed for the move. Inspect the drill transport conveyance (skidder, truck/flatbed etc.) to make sure it is in good working order.

Preparing the machine and your working environment

- Drillers produce toxic exhaust fumes as soon as the engine starts running.
- Check the floor of your workplace.
- If anyone else is nearby, especially children, keep them at a safe distance. ...
- Check that the machine is in correct working order.

Be attentive while the drill move is underway.

- The exploration area has been surveyed, and hazardous ground conditions delineated (e.g. old workings) or addressed (e.g. previously capped drill holes).
- Overhead power lines or overhanging vegetation, underground services and other obstructions have been clearly identified.

- The camp is located to reduce exposure to natural hazards (e.g. fuel load, flood plains).
- The maintenance and storage facilities, and eating and ablution amenities are located to reduce exposure to drilling hazards and ensure hygienic conditions are maintained.
- Tracks to the camp and work sites are suitable for drilling, support and emergency vehicle access.
- There is a traffic management system for the camp and work sites, including designated parking areas and escape routes.
- Safety and warning signs at the camp and work sites are clear, legible and appropriately located.
- The drilling sites should be assessed by the exploration company project manager with the drilling contractor well in advance of the initial drill rig set up or moves.
- It is difficult to predict all problems that may occur during drilling fieldwork activities. Completing pre field work preparations will help to ensure that the project proceeds on schedule and in a safe manner.

Mine work plan should include:

- Maps and figures showing underground and aboveground mine equipment, piping, utilities and/or any surface or subsurface hazards,
- Historic site information (maps, photos, files),
- Site as-built drawings,
- Easement maps,
- Historic plot plans,
- Previous mine site investigations,
- Fire insurance plans,

- Tank dip charts, and
- Elevations and coordinates maps.

Self-Check -6	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is work area preparation for drilling? (2pts)
2. What do we mean by casing? (2pts)
3. List some of the Mine work plan. (2pts)

Note: **Satisfactory rating – 4 points** **Unsatisfactory - below 4 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: ________________________ Date: _______________

Short Answer Questions

Information sheet-5	Identifying and reporting potential hazards and risks

5.1 Potential hazards and risks in drilling operation:

Hazard Identification: This is the process of examining each work area and work task for the purpose of identifying all the hazards which are "inherent in the job".

Risk: The likelihood, or possibility, that harms (injury, illness, death, damage etc.) may occur from exposure to a hazard.

Risk Assessment: Is defined as the process of assessing the risks associated with each of the hazards identified so the nature of the risk can be understood.

Risk Control: Taking actions to eliminate health and safety risks so far as is reasonably practicable. **Hazard identification, risk assessment and control is** an on-going.

Hazard; Anything (e.g. condition, situation, practice, behavior) that has the potential to cause harm, including

- Geological Faults and Structures. Faults can act as conduits for high pressure oil, gas, or water from depth.
- Pipe Sticking and Drill Pipe Failures.
- Lost Circulation.
- Borehole Instability.
- Contamination of Producing Formations and Aquifers.
- Shallow Gas.
- Hydraulic Fracturing.
- Buried Valleys.
- the strength or weakness of the rock being dug,
- the nature of the rock on which structures are built or material placed,
- the influence of water at the surface or underground,
- injury, disease,
- death, environmental,
- Property and equipment damage.
- A hazard can be a thing or a situation.
- Climatic extremes (heat, cold, high and low humidity, altitude, and hyperbaric conditions) increase the possibility of relatively minor medical conditions becoming major impediments to health, safety, and productivity and pose challenges to even the fittest individuals. Remote locations also bring psychological stresses that may manifest in the form of alcohol and substance abuse. With a global shortage of skills in the mining industry it is likely that the work force will be a mixture of local and expatriate employees. Health problems may range from endemic diseases such as malaria to the psychological stress of isolation and continuous shift systems that can lead to wellness issues as well as alcohol and substance abuse. Prevention of medical and health problems in mining operations (from exploration to production environments) starts with

anticipation and recognition of the potential issues and proceeds with a thorough risk-assessment process inclusive of projected frequency and severity of incidents, development of risk-control measures, and allocation of adequate resources to implement the controls to manage the risk.

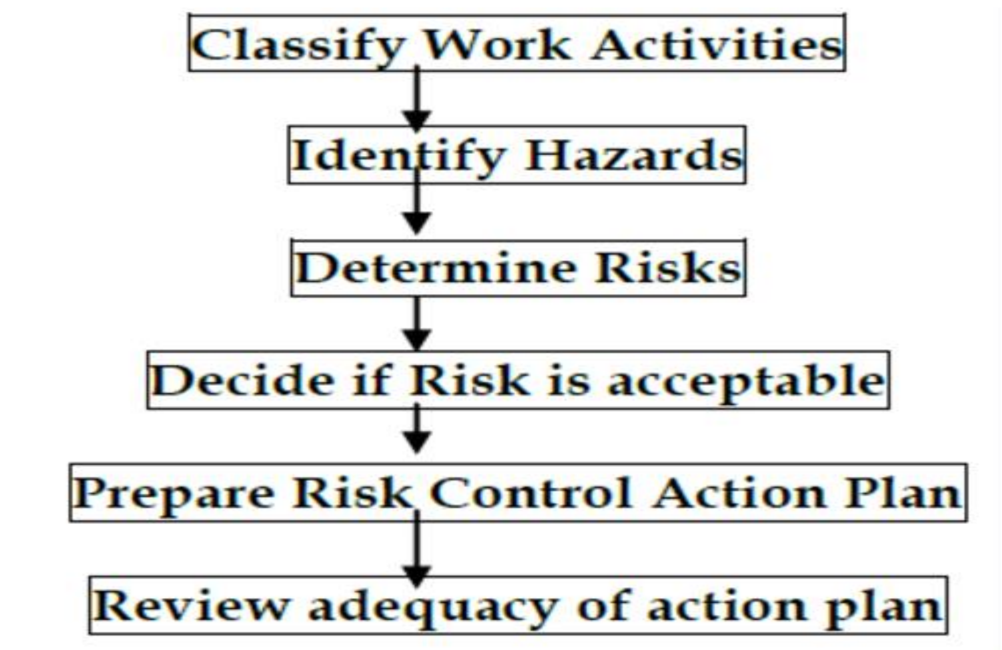


Fig1: procedures for hazard identification, risk assessment.

5.1.1 Hazard management

Before a safe system of work can be put in place, employers must identify and assess all hazards, such as:

- the work environment (eg layout, lighting, ventilation)
- human factors (eg people's capabilities, shift work, fatigue)
- The use and maintenance of personal protective equipment.
- Then they must develop a way to control each hazard, such as:

- safe operating procedures
- job or task safety analysis
- effective and safe maintenance
- cleaning and blockages procedures
- Procedures for unexpected events, like power outages.

5.1.2 Eliminate hazards at the design process

The best time to eliminate hazards is at the machinery design stage. This section covers some of the common hazards that can be eliminated through design. The section also outlines the principles of including health and safety in the design process.

The design process usually begins with:

- the buyer or employer wanting a piece of machinery to meet business needs and/or modifications
- a manufacturer seeing an opportunity to meet an industry need
- a supplier seeing a gap in the market
- a supplier looking for other products to promote.
- At this point, the designer should get advice from safety experts, people who might use it and engineers to help design a safe machine. Machinery must be designed that does not hurt anyone at any point in the process of its manufacture, installation, use, maintenance or repair.
- Designers must consider how the machinery can injure people working with it. Injuries include:
- amputation and crush injuries
- workplace stress and fatigue
- manual handling injuries
- Occupational illness from fumes, dust, noise, radiation.

Common hazards that can be eliminated through design include:

- **Mechanical hazards:** Hazards made by the shape, relative location, mass and stability, movement and strength of machine parts.
- **Electrical hazards:** Contact with or distance from live parts, suitability of insulation, static electricity, heat radiation and results of overloads or short circuits.
- **Heat hazards:** Contact with high- temperature objects or materials.
- **Noise and vibration hazards**
- **Radiation hazards:** Both ionizing, for example x-rays and gamma rays, and non-ionizing, for example electric and magnetic fields, radio waves, microwaves, infrared, and ultraviolet radiation.
- **Materials and substances hazards:** Hazards made, used or released by machinery or from the construction materials.
- **Ergonomic hazards:** Poor machine set-up leading to injuries and operational errors.
- **Maintenance hazards:** When guarding is removed or switched off for cleaning, maintenance or access to the area around a machine.
- **Slips, trips and falls hazards:** Flooring surface and access.
- **Work environment hazards:** Environmental conditions,

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the difference between hazard and risk?
2. Define what mean fatigue.
3. List down the procedure of Risk assessment.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-6	Resolving coordination requirements

6.1 Duties of the mine operator

The mine operator should:

- Notify the mining authority before starting operations at any mine and before discontinuing or abandoning any existing mining activity.
- Provide all the equipment, apparatus, facilities and finance to ensure, as far as reasonably practicable, good mining practice and an appropriate standard of occupational safety and health at the mine.
- Make sure everyone understands their safety and health responsibilities.
- Appoint, depending upon the number of mineworkers employed and the nature and extent of mining operations, one or more competent persons — supervisor — to supervise and control the operations at the mine.
- Encourage the workforce to be actively involved in safety and health.

Mining authority: means a government institution that is responsible for all or any part of occupational safety and health in mining.

Mine operator: means any individual or organization who operates, controls or supervises a mine, as an owner or lessee.

Competent person means a person who, in the opinion of the mine operator and the mining authority, has adequate qualifications, such as suitable training and sufficient knowledge and skill, for the design, organization, supervision and safe performance of the duties for which he or she is appointed.

If there is a good management or coordination among drill operators and other mine workers:-

- ✓ It maximize the mine production,
- ✓ To save working hours.
- ✓ To share experience,skill,knowledge
- ✓ It is easy to create a new technology
- ✓ To meet the required daily production safely, effectively

6.2 Requirements for employment in surface mines:

Drilling is a very hazardous activity. Safety of the workers on site is absolutely vital. Responsibilities for ensuring safety should be clearly set out in the contract. The Supervisor must be constantly vigilant to prevent accidents, and to minimize injuries.

Work in a surface mine often has to be performed in a hostile and dangerous environment. It can be made safe and productive by continual human effort. Such efforts cannot succeed unless all workers have certain skills and a good knowledge of possible hazards and risks. It is therefore vital to have competent and experienced persons who should be constantly on the site of the mine to supervise and control the operations and carry out regular inspections. Supervisors should have immediate charge of all persons employed within the mine area of operation and should be responsible for the safety, health and welfare of all persons assigned to them. Each newly recruited mineworker should receive instructions, guidance and supervision in their respective work from the supervisor and adequate on-the-job training before being starting work.

This instruction should include:

- Introduction to the working environment.

- Health and safety aspects of the task to be assigned.
- Hazard recognition and avoidance.
- Hazards relating to explosives.
- Ground control and working in areas of high walls.
- Hazards of machinery and equipment.
- Basic knowledge of first aid.

Drilling in any environment is potentially hazardous but mineral exploration in remote locations it is written to be used by anyone involved in drilling operations, from the driller's offsider to the managing director, and addresses hazards associated with the drilling methods. The drill & blast method is still the most typical method for medium to hard rock conditions. It can be applied to a wide range of rock conditions. Some of its features include versatile equipment, fast startup and relatively low capital cost tied to the equipment.

6.3 Drilling Operations requirements;-

Drilling safety rules:-

- Follow directions andinstructions
- Use equipment correctly
- Do not participate in 'horse play'
- Know your emergency procedures and equipment
- Stay alert
- Aware mining rule and regulation
- Understandyour responsibilities

- Conduct regular safety checks
- Follow mining sign
- Keep yourself fit and healthy
- Look out for others
- Treat all high risk environments with respect
- Be familiar with the site and equipment
- Wear personal protective equipment and clothing

6.3.1 Participation and consultation

For the safe system of work to be robust, anyone who could come in contact with the machine should be consulted. This includes:

- operators
- supervisors
- health and safety representatives
- maintenance staff
- in-house engineers
- Any health and safety experts.

Competency of operators and supervisors

Any operator using a safe system of work must be competent to do the job and be supervised by a competent person. Employers must have a training programme in place that works for:

- new employees
- existing employees
- Employees on leave when the safe system of work was introduced.

Reviewing

Every safe system of work needs regular reviewing to take into account:

- advances in technology
- incidents or accidents
- any new hazards identified
- new industry standards and guidance
- whether the hazards are still controlled
- Monitoring of the environment and/or health of operators.

Any proposed changes should involve anyone previously consulted on the safe system of work. The system and any changes need testing before they are included in the safe working system and approved by the duty holder.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least five Drilling safety rules.
2. How can you control potentially hazardous problems in any environment during Drilling operation?
3. **What is the importance of** good management or coordination among drill operators?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ____________

Rating: _____________

Name: ________________________ Date: _______________

Short Answer Questions

Information Sheet-7	Selecting personal protective equipment

7.1 Personal protective equipment

The purpose of Personal Protective Equipment is to protect employees from the hazards associated with using hand or powered tools at work area. PPE or Personal Protective Equipment is any clothing, equipment or substance designed to protect a person from risks of injury or illness. Employees may need personal protective equipment when working with machinery that makes heat, fumes, noise or other hazards.

FIRST AID: Every workplace should have first aiders and first aid supplies. Employers should put first aid provisions in place based on the types of accidents, injuries and illnesses that could occur in the workplace. For more information, see Work Safe's First Aid for Workplaces: A Good Practice Guide.

7.2 Common Protection Equipment

1. **Foot Protection:**

The mining work boot may be of either leather or rubber construction, depending on whether the mine is dry or wet. Minimum protective requirements for the boot include a full puncture-proof sole with a composite outer layer to prevent slipping

Figure: safety boot.

2. **Earmuffs** are used to protect the ears from too much noise in the workplace. The designed is to fully cover the ears.

Figure 2. Earmuffs

3. **Earplugs** are used to protect the ears from too much noise in the workplace. The designed is to fully cover the ears.

Figure 3. Earplugs

Eye and Face Protection

4. **Face shield** is best for general protection of the face. Commonly worn under a welding helmet.

Figure 4. Face Shield

5. **Safety Goggles** are used to protect the eyes from dust and particles.

Figure 5. Safety goggles

6. **Lung Protection**

Respirators filter dust and other particles from the air. The most commonly needed respiratory protection in mining operations is dust protection.

Coal dust as well as most other ambient dusts can be effectively filtered using an inexpensive quarter face piece dust mask. Welding, flame cutting, use of solvents, handling of fuels, blasting and other operations can produce air-borne contaminants. Twin cartridge respirators use to remove combinations of dust, mists, fumes, organic vapors and acid gases which are produced from the above.

Figure 6. Respirators

7. Hand Protection

Gloves are the most common type of PPE used. It can protect the hands from heat, spatter, dirt or radiations. Properly fitting gloves reduce hand injuries, which are one of the most common lost time injuries at drill sites. Wear appropriate gloves to handle core trays and chemicals etc. Drillers should wear close-fitting gloves

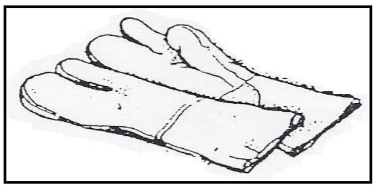


Figure 7. Gloves

8. Foot Protection

- **Safety shoes** are made of leather designed purposively to protect the toe … jects.

Figure 8. Safety Shoes

9. Body Protection

- **Leather apron** is made of chrome leather and provides a welder with complete protection from sparks and hot metal from his d… lf.

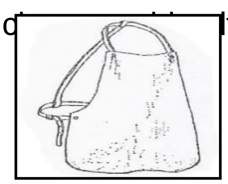


Figure 9. Leather Apron

10. Skin Protection

- Certain mining operations may cause skin irritation.
- Work gloves are worn whenever possible in such operations and barrier creams are provided for additional protection, particularly when the gloves cannot be worn.

Self-Check -9	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down some of personal protective equipment that we use in drilling operation?
2. Define what mean a Glove?
3. **What is the importance of** personal protective equipment in drilling operation?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Operation sheet _1	Rock type identification

Procedures (Steps) to identify rock types:

Step #1 Equipment selections (Geological hammer, hand lens, streak plate, GPS, topographical map, digital camera, sample bag…..)

Steps #2 locate a point using GPS.

Step #3 Then Rock type descriptions

"If the rock formed from solidified lava or "magma", If there is dyke rock, vein rock, we can concluded that it is ***Igneous or magmatic rock. (Granite***, basalt, obsidian***)"***

"If the rock is formed by deposition of broken material or by chemical precipitation). Or if there is friable soil, transported material, and if there is bedded structure or layer we can concluded that it is

Sedimentaryrock.(silt,sand,clay,limestone,friablesoil,pebbles,cobels,Conglomerate,Sandstone,Siltstone,Breccia,Mudstone,shale,coal,salt)"

"If the rock is foliated (spot line) or non-foliated***,*** they are also frequently hard or very hard, and also compact and fine-grained, and are therefore often difficult to drill. (Formed by the transformation of igneous or sedimentary rocks, in most cases by an increase in pressure and heat). we can concluded that it is ***Metamorphic rocks(*** slate, schist, gneiss ,quartzite, marble,serpentinite.)"

Step #4 After data collection related with three rock types then we can concluded that whether the rock is igneous ,metamorphic, and sedimentary rock.

Step #5 Naming of rock type.

Step # 6 Identify by color, grain size, shape, hardness, and density of rock.

Operation sheet_2	Risk assessment procedure

Step 1 Identify Hazards

- In general, hazards are likely to be found in the following;
- Physical work environment,
- Equipment, materials or substances used,
- Work tasks and how they are performed,
- Work design and management

Step 2: Assess Risks

- Risk assessment involves considering the possible results of someone being exposed to a hazard and the likelihood of this occurring. A risk assessment assists in determining:
- How severe a risk is
- Whether existing control measures are effective
- What action should be taken to control a risk
- How urgently action needs to be taken.

Step 3:- Risk Control:

Taking actions to eliminate health and safety risks so far as is reasonably practicable

Step 4: Monitor and Review: this involves ongoing monitoring of the hazards identified, risks assessed and risk control processes and reviewing them to make sure they are working effectively.

LAP Test	Practical Demonstration

Name: _____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, Geological tools and materials you are required to perform the following tasks in the field within 2-4 hours.

Task 1: Identify the rock type and describe it (color, grain size and shape, hardness, density)

LG #25	LO #2- Mark out drill pattern

Instruction Sheet	

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Placing indicators on drill pattern

- Marking drill patterns and ensuring visibility of drill holes
- Protecting pre-existing drill holes

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Place indicators on drill pattern
- Mark drill patterns and ensuring visibility of drill holes
- Protect pre-existing drill holes

Learning Instructions:

1. Read the specific objectives of this Learning Guide.

2. Follow the instructions described below.

3. Read the information written in the information “Sheet 1, Sheet 2, , and Sheet 3.

4. Accomplish the “Self-check 1, Self-check 2, and Self-check 3” in page 8 ,13 and 16 respectively.

5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, in page 17.

6. Do the “LAP test” in page – 18 (if you are ready).

Information Sheet-1	**Placing indicators on drill pattern**

1.1 Drilling patteren

Pattern drilling is a technique that is used when a sequence of holes must be drilled within a very tight locational tolerance or array, often involving a variety of sizes, depths and dimensional orientations. Drilling is performed in order to blast the overburden, ore deposit etc. so that the power requirement for excavators to extract the materials becomes less. This also reduces the wear and tear of the excavators, increases their life, reduces clearing time of materials, and decreases operation cost. Hole array is the arrangement of blast holes (both in plan and section). The basic blast hole arrays are single-row, square, or rectangular and staggered arrays. Irregular arrays are also used to take in irregular areas at the edge of a regular array. The term SPACING denotes the lateral distance on centers between holes in a row. The BURDEN is the distance from a single row to the face of the excavation, or between rows in the usual case where rows are fired in sequence. Delay patterns, and varying the hole array to fit natural excavation topography, allow for more efficient use of the explosive energy in the blast. Benches may be designed and carried forth with more than one face so that simple blasting patterns can be used to remove the rock

1.2 DRILLING PATTERN DESIGN:

Various drilling patterns have been developed for approaching the blasting of drifts which are described in the following sub-sections. These patterns refer to the pattern of the initial cuts which are then blasted into from surrounding holes. The selection of the optimum type of drilling pattern to be used when exploring for elliptical shaped targets is examined. The rhombic pattern is optimal when the targets are known to have a preferred orientation. Situations can also be found where a rectangular pattern is as efficient as the rhombic pattern. A triangular or square drilling pattern should be used when the orientations of the targets are unknown. The way in which the optimum hole spacing varies as a function of

(1) The cost of drilling,

(2) The value of the targets,

(3) The shape of the targets,

(4) The target occurrence probabilities was determined for several examples. Bayes' rule was used to show how target occurrence probabilities can be revised within a multistage pattern drilling scheme. Drilling the blast-holes in a staggered pattern results in a better distribution of the explosive energy into the rock mass, which delivers better fragmentation. The pattern allows for better overlap of the shock waves from each blast-hole. The staggered pattern may result in stepped edges of the new highwall; to eliminate this, additional blast-holes may be needed. Drilling the holes in this pattern may present difficulties for the drilling rig to manoeuvre on the bench.

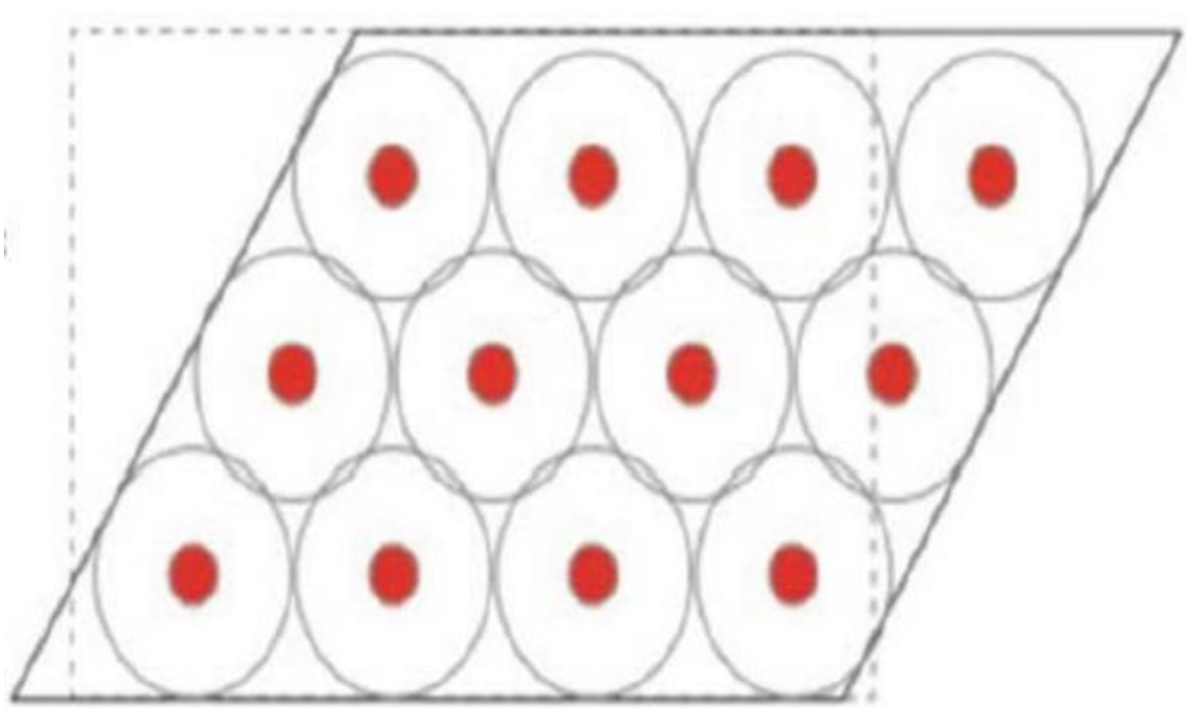


Figure 2: blast holes drilled in a staggered patteren

The blast-holes can be drilled either vertically or at an angle. If the face that is to be blasted lies with a dip and the blast-holes are drilled vertically there will some variation in the burden. The hole might be moved closer to the crest of the bench to prevent the toes from being overburdened but this will mean that at the top of the blast-holes the burden will be too small. This will result in high levels of air-blast, noise, and fly rock. Drilling the holes at the inclination of the dip of the bench face will overcome the tough toe conditions. The burden will then have a more uniform distance throughout the blast-hole length. The inclined holes will result in a more effective use of the explosive energy. This gives improved fragmentation and reduces the amount of rock in the stemming region of the blast-hole, where boulders are often formed.

There are three mainly drilling patterns;

1. Square pattern has drilled spacing's that are equal to drilled burdens.

Blast-holes are laid out on a bench in a sequential pattern in relation to the face of the bench. The hole can be drilled in a square pattern. A square pattern will provide straight edges on the newly formed highwall. The pattern allows for easier drilling conditions as the drill rig moves in straight parallel lines. The shock wave from each blast-hole will overlap in between the rows but there will be less coverage in the centre of every group of four holes.

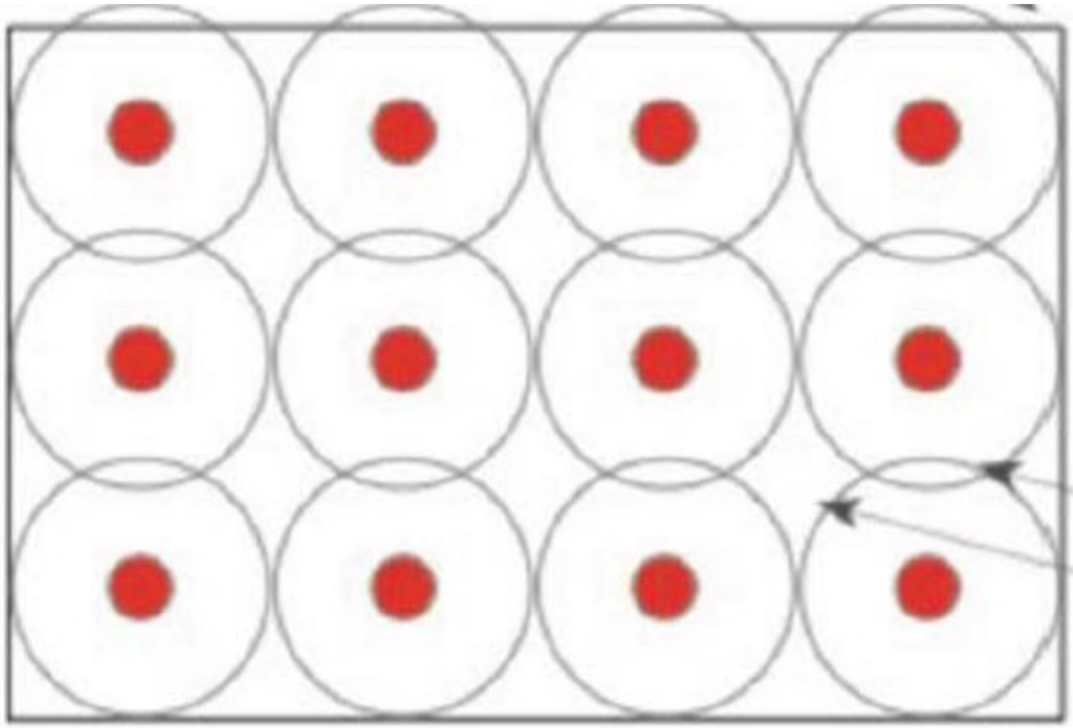
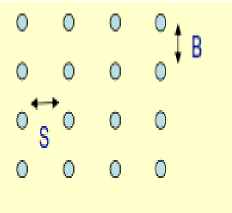


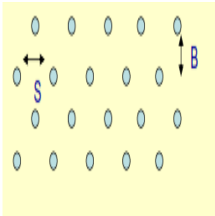
Fig 3: blast holes arranged in square pattern

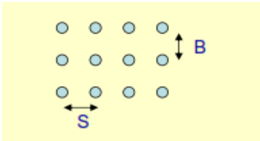
2. Rectangular pattern has drilled spacing's that are larger than drilled burdens. S>B

3. Staggered pattern, the drilled spacing's of each row are offset such that the holes in one row are positioned in the middle of the spacing's of the holes in the preceding row. In addition, the drilled spacing's are larger than the drilled burdens.

A staggered pattern is used for row firing, where the holes in one row are fired before the holes in the row immediately behind them.







1. Rectangular 2. Staggered 3.Square

Fig 3: Pattern design

The square and rectangular patterns;

- Are used for firing "V" (chevron) or echelon rounds.
- A **"**V"-pattern, or chevron, firing round is appropriate for most square or rectangular blast patterns; it is not as practical for staggered-pattern loading.
- Under any square or rectangular blast scenario that uses a "V"-pattern, actual burden and spacing (both of them dependent upon the timing of the shot) will be different from drilled, or apparent, burden and spacing.
- When a "V" pattern firing round is used under a square-pattern loading scenario, the rock movement is 45 degrees to the open face.
- "V"-pattern firing rounds are quite common at surface coal mines that use larger diameter blast holes.

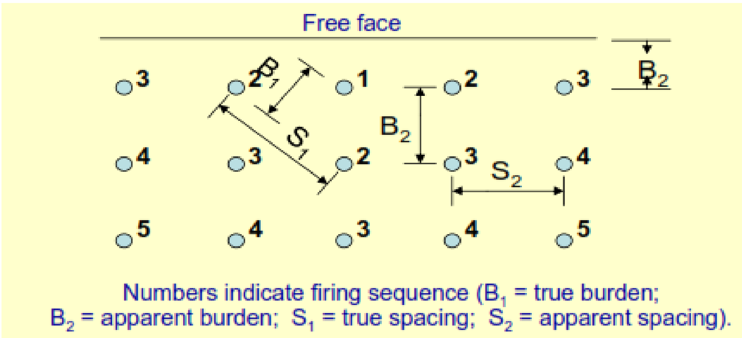


Fig 4: burden and spacing

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down the three types of drilling pattern.
2. Define what mean a v pattern.
3. What is the difference between square and rectangular patterns?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: ________________________ Date: ______________

Short Answer Questions

Information Sheet-2	Marking drill patterns and ensuring visibility of drill holes

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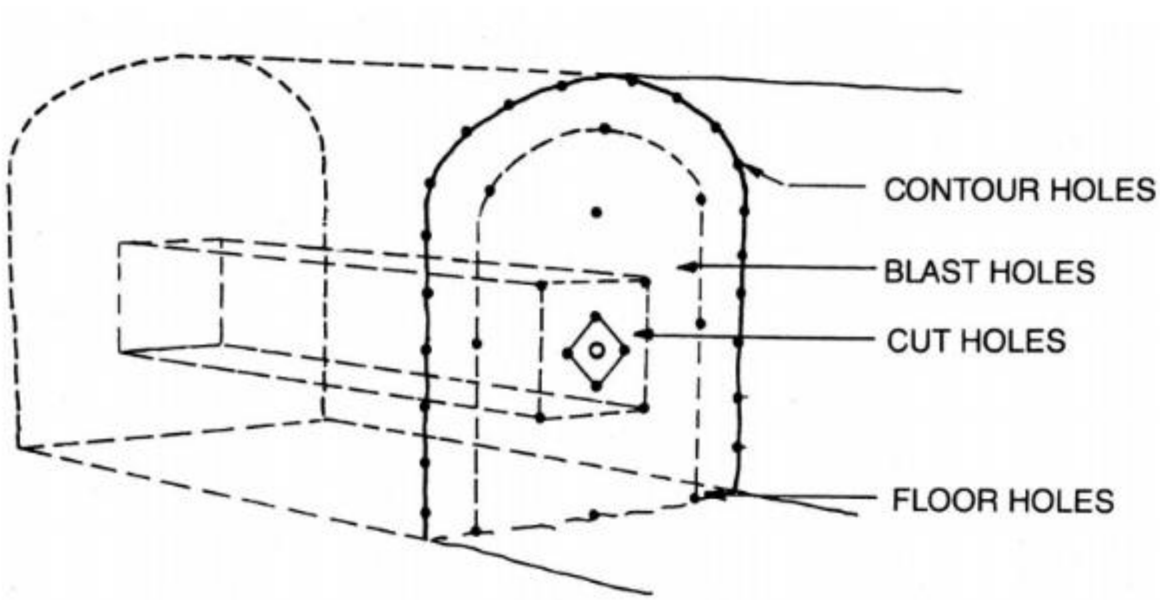
2.1 Marking drill patterns

Pattern drilling is a technique that is used when a sequence of holes must be drilled within a very tight locational tolerance or array, often involving a variety of sizes, depths and dimensional orientations. Complex variations in drill angle, hole depth and shape make these projects difficult, if not impossible, for many companies, but Dearborn has experience pattern drilling a wide variety of materials and metal alloys. We handle these complex challenges every day and approach each project knowing that no matter how complex the pattern or design array needs to be, Dearborn can maintain precision through an entire pattern drilled part with our industry-leading bore centric process. The drilling pattern ensures the distribution of the explosive in the rock and desired blasting result. Several factors must be taken into account when designing the drilling pattern: rock drill ability and blast ability, the type of explosives, blast vibration restrictions and accuracy requirements of the blasted wall etc. The basic drilling & blasting factors, and drilling pattern design are discussed below. Since every mining and construction site has its own characteristics, the given drilling patterns should be considered merely as guidelines. Many mines and excavation sites still plan their drilling patterns manually, but advanced computer programs are available and widely used. Computer programs make it easier to modify the patterns and fairly accurately predict the effects of changes in drilling, charging, loading and production. Computer programs are based on the same design information used in preparing patterns manually.



Drilling pattern design in tunneling and drifting is based on the following factors:

- Tunnel dimensions
- Tunnel geometry
- Hole size
- Final quality requirements
- Geological and rock mechanical conditions
- Explosives availability and means of detonation

- Expected water leaks
- Vibration restrictions
- Drilling equipment
- rock drill ability and blast ability,
- the type of explosives,
- Blast vibration restrictions and accuracy requirements of the blasted wall etc.
- Selection of drilling pattern varies with
- the type and size of the drill's used,
- depth of hole,
- kind of rock,
- quantity and rapidity of the explosive
- Amount of stemining.

Depending on site conditions, all or some of the above factors are considered important enough to determine the drilling pattern. Mine sites typically have several variations of drilling patterns to take into account the changing conditions in each tunnel. Drifting in mines is carried out with 5 to 10 drilling patterns for different tunnel sizes (production drifters, haulage drifters, draw points, ramps etc.) The pattern is finalized at the drilling site. Tunnel blasting differs from bench blasting in that tunnels have only one free surface available when blasting starts. This restricts round length, and the volume of rock that can be blasted at one time. Similarly, it means that specific drilling and charging increases as the tunnel face area decreases. When designing a drilling pattern in tunneling, the main goal is to ensure the optimum number of correctly placed and accurately drilled holes. This helps to ensure successful charging and blasting, as well as produce accurate and smooth tunnel walls, roof and floor. A drilling pattern optimized in this way is also the most economical and efficient for the given conditions.

Drilling Patterns

1. **Wedge, plough or V-cut.**

In this drill pattern, holes are first drilled at an angle to the face in a uniform **wedge** formation for the initial **cut** of the blast sequence. They are aligned so that the axis of symmetry is at the center line of the face.

- Pyramid or Diamond Cut.
- Drag and fan cuts.
- Breast Cut or Slashing.
- Burn or parallel-hole cuts.

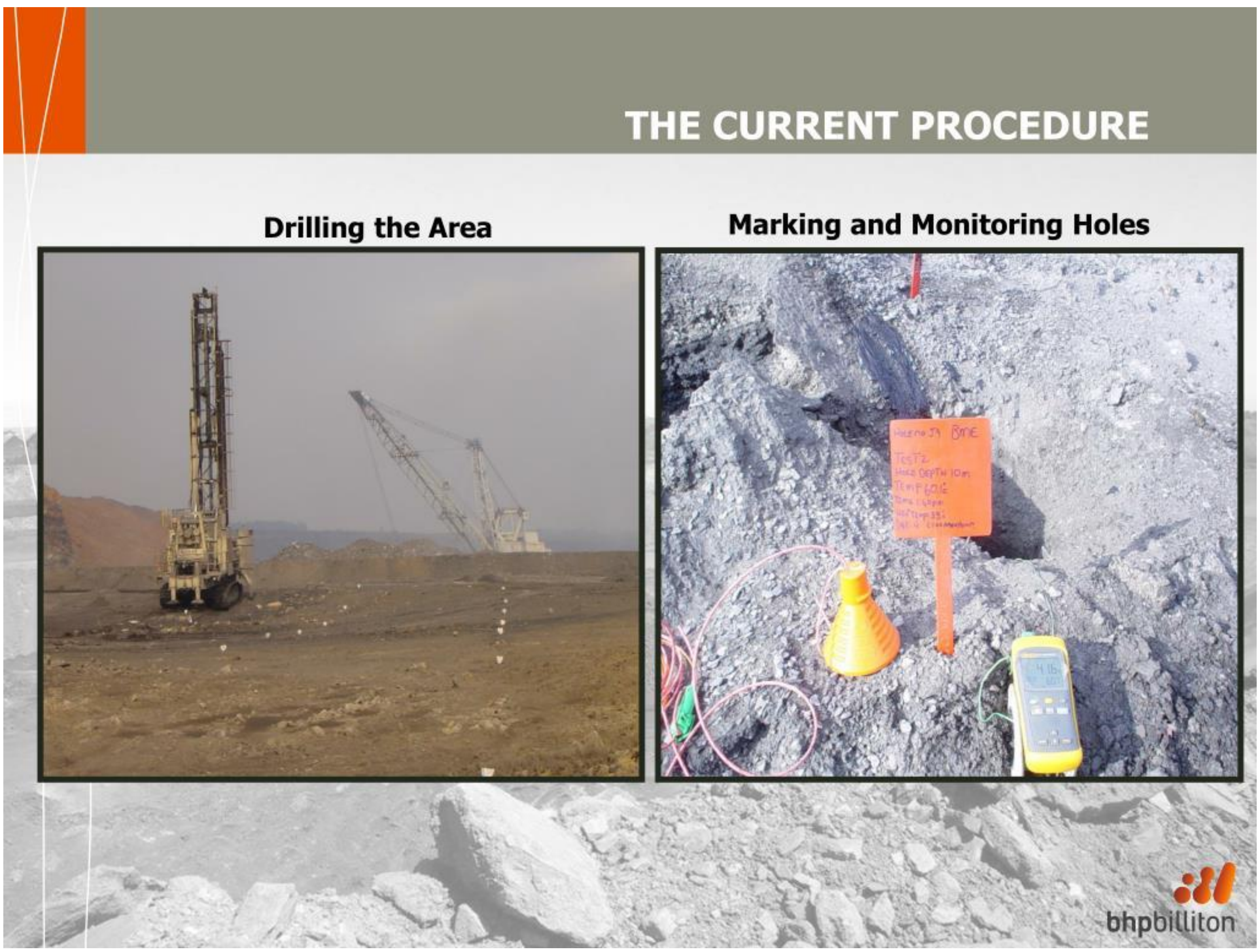


Figure 2: Drilling the area, Marking and monitoring blast holes.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two factors that must be taken into account when designing the drilling pattern:
2. What is the importance of marking a drilling pattern?
3. What is Drilling mean?

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: ___________________________ Date: ________________

Short Answer Questions

Information -3	Protecting pre-existing drill holes

3.1 Protecting pre-existing drill holes:

The key for a safe and smooth drilling startup is to organize the work area prior to commencing drilling operations:

- Do not attempt to commence drilling before everything is unloaded and organized.
- Suitable drilling storage locations should be provided for all tools, materials, and supplies
- Drilling will progress smoothly and accidents will be less likely if the driller takes the time to properly set up and organize first.
- The first requirement for safe field operation is that everyone understands and fulfills the responsibility for maintenance and housekeeping on and around the drill rig.
- Store items so that the work can proceed in an orderly fashion, with sufficient room in the work area to move about without tripping over supplies or equipment.

- Do not store equipment in places that would interfere with escape routes in an emergency.
- Establish a suitable location for storage of tools, equipment and supplies so those items can be safely and conveniently stored and located when needed. Keep all tools supplies and equipment in their proper places.
- Penetration or other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.
- Work areas, platforms, walkways, scaffolding, and other access-ways should be kept free of materials, debris, and obstructions and substances such as ice, grease, or oil that could cause surfaces to become slick or otherwise hazardous.
- Clear observed rocky area.
- Get confirmation for the same from supervision staff and record.
- For the purpose of preparing drilling & blasting hole pattern, make surveying and prepare cross section/template drawing at every 2.5m interval.
- Based on data from template determine drill hole depth, spacing and diameter
- Location of each hole with depth to be drilled must be located properly by surveying team
- Drilling of holes must be performed as per the data stacked on the ground by surveyor or as per the data recorded on drilling log
- Keep the hole from rock fragment, soil or any other materials falling in to it
- Execute drilling operation by blasting technician

Following appropriate procedures, load explosive in holes that are drilled in a specific pattern, which are chosen to produce the most economical and satisfactory breakage of rock ,and carry out blasting operation by authorized blasting technician

3.1 Drill safety:

- Don’t operate before understanding mechanism and how to stop
- Always were approved safety glasses

- Never attempt to hold work by hand
- Keep head back from revolving parts.
- As drill begins to break through work, case up on drill pressure.

Fig 1: Warning signs

➢ .

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down Emergencies at drilling operations**.**
2. Define what mean Emergency.
3. What is the importance of Protecting pre-existing drill holes?

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Operation sheet-1	Drilling pattern design

Procedures of drilling patteren design

Step#1 Equipment selection:

Step#2 Selection of drilling pattern

Step#3 layout of area (Topographical map or geological map)

Step £3.1**:** Locate a point by using GPS,

Step#4 Measures the area with tape or other modern instrument to know the spacing and burden.

Step#5 Marking and monitoring the hole using any instrument

Step#6 drilling the area

Step#7 Then calculate the, Area**= *spacing burden***

Step#8 lastly volume=Area x drilled depth in cubic meter.

LAP Test	Practical Demonstration

Name: _____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2-4 hours.

Task 1; Perform drilling pattern design

LG #27	LO #3 operate the drill system

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Carrying out pre-start, start-up, park-up and shutdown procedures
- OHS Requirements and procedures
- Completing work
- Adhering emergency procedures

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to

- Carry out pre-start, start-up, park-up and shutdown procedures in drilling
- OHS Requirements and procedures
- Complete work
- Adhere emergency procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.

2. Follow the instructions described below.

3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 Sheet 4, Sheet 5, Sheet 6, and Sheet 7.

4. Accomplish the "Self-check 1 up to Self-check 11.

5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet 1, Operation Sheet 2 ,and Operation Sheet 3" in page 16,23,and 49.

6. Do the "LAP test" in page – 17, 24, and 50 (if you are ready).

Information Sheet-1	Carry out pre-start, start-up, park-up and shutdown procedures

1.1 Carry out pre-start operation:-

Drilling is the process of making a hole into a hard surface where the length of the hole is very large compared to the diameter. In the context of mining engineering drilling refers to making holes into a rock mass. To estimate the costs of drilling and blasting, engineers can gather a great deal of information from just a powder factor. Such a factor (which is most often reported in terms of kilograms of explosive per metric ton blasted) of course differs from one project to the next and is typically determined through experimentation, observation, and adjustment over time at an active operation

Surface mining requires drilling for different purposes that include:

a. Production drilling i.e. for making holes for placement of explosives for blasting. The objective of drilling and blasting is to prepare well-fragmented loose rock amenable to excavation with better productivity from the excavation machinery.

b. Exploration drilling for sample collections to estimate the quality and quantity of a mineral reserve. The samples are collected as core and the drilling for such purposes are referred as Core drilling. As diamond bits are used for such drilling, core drilling is often called diamond drilling. Exploration drilling Purpose: - to explore ore bodies to a depth, - to study internal structure of the ore bodies and rocks, - to study the continuity of mineralization, - to determine the thickness of the ore bodies, -data's are used in reserve calculation.

c. Technical drilling during development of a mine for drainage, slope stability and foundation testing purposes.

2.2 Selection Procedure for Drilling Method:

The selection of a particular machine for production drilling in a surface mine is the most critical kind of drill evaluation that the pit engineer is called upon to make. It is a true engineering design problem, requiring value judgments, generally, the procedure follows these steps.

- Determine and specify the conditions under which the machine will be used, such as the job factors (labor, site, weather, etc.,), with safety the ultimate consideration.
- State the objectives for the rock-breakage phases of the production cycle of operations-considering excavation and haulage restrictions, pit-slope stability, crushing capacity, production quota, pit geometry-in terms of tonnage, fragmentation, throw, vibrations, etc.,
- Based on blasting requirements, design the drill hole pattern (hole size and depth, inclination, burden, spacing, etc.,),
- Determine the drill ability factors, and, for the kind of rock anticipated, identify the drilling-method candidates that appear feasible (manufacturers can perform rock drill ability tests and recommend drills and bits),
- Specify the operating variables for each system under consideration, including drill, rod, bit, and circulation fluid factors,
- Estimate performance parameters, including machine availability and costs, and compare. Consider the power source and select specifications. Major cost items are bits, drill depreciation, labor, maintenance, power, and fluids. Bit wear and costs are critical but difficult to project.

Select the drilling system that, in best satisfying all requirements, has the lowest overall cost, commensurate with safe operation.

Historical information about previous holes includes:

- Depth
- Average rate of penetration
- Drilling time

Information about shifts includes:

- Total holes started during the shift.
- Average depth of all holes drilled or partially drilled during the shift.
- Total depth drilled during the shift.
- Average time to drill a hole, in minutes and seconds.
- Total time drilling during the shift.
- Average ROP during the drilling.

Production information about a time period you define includes the same statistics as shift information, except for the total time

Hands-on Performance Evaluation

In a safe area with adequate supervision, have each participant complete a hands-on performance evaluation while operating a tractor (including attachments, if appropriate). The evaluation may include:

- Pre-Operation Inspection
- Attaching implements
- Safe start-up
- Driving the tractor to perform
- safe task
- Removal of implements

- Safe shut-down

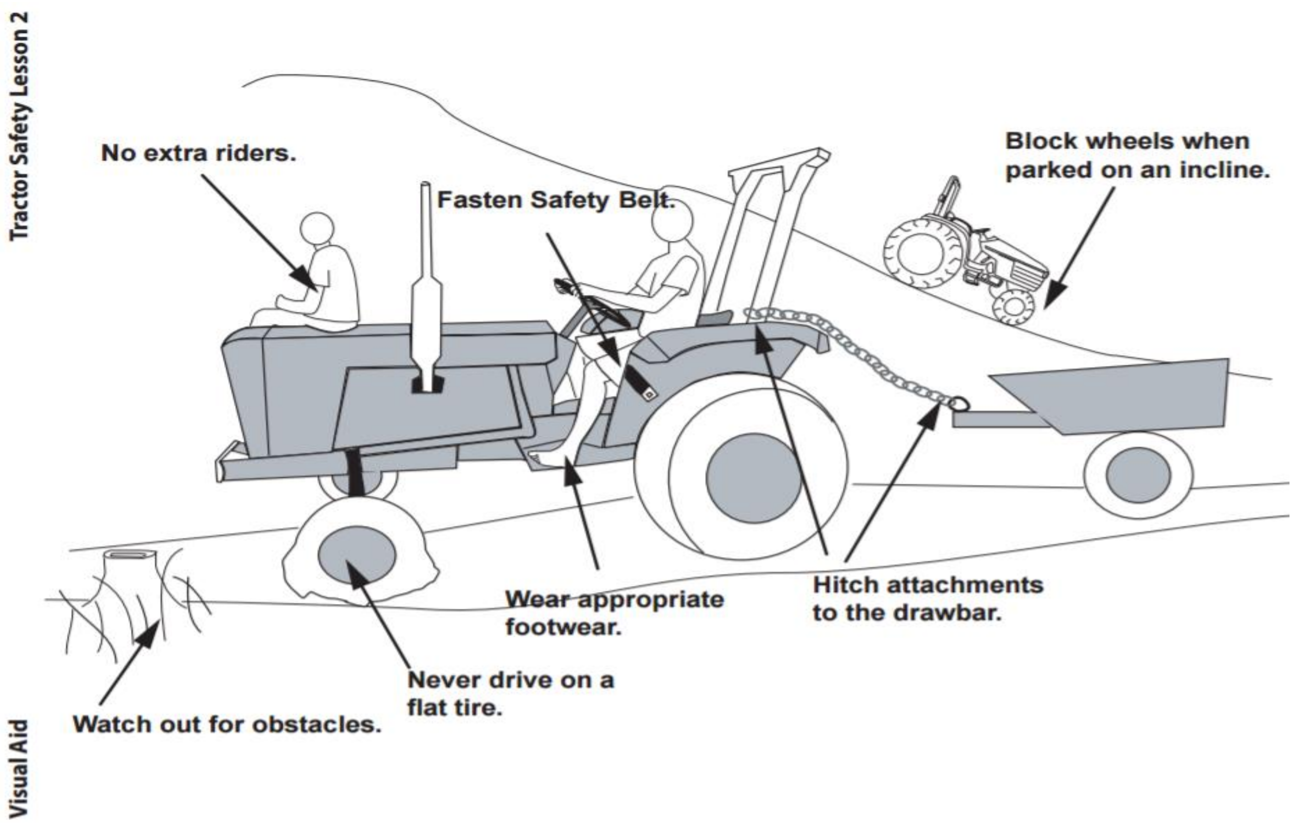


Fig 1. Safety procedure

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least three Selection Procedure for Drilling Method.
2. Define what mean Surface mining?
3. **What is** the purpose **of** drilling in Surface mining?

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Occupational, Health and Safety requirements and procedures

2.1 site safety plan

A site safety plan is a documented procedure that is designed to cover the hazards with a high chance of occurrence. Safety plans are custom made documents that can be amended and changed keeping in view the hazards of the work place. For example, in a workplace where there is a stacking of flammable liquids, the site safety plan will specifically cover the fire safety procedures. Drilling machines are one of the most dangerous hand operated pieces of equipment in the shop area. Following safety procedures during drilling operations will help eliminate accidents, loss of time, and materials. On a mine site, the site safety plan will include the procedures of Personal Protective Equipment, the fencing procedures, procedures regarding working at heights, etc.

The mine site safety also acts as a step by step guide to ensure you meet all parts of your obligations under the new Legislation to record the following:

- Identifying and managing hazards
- Reporting accidents and incidents
- Training or supervising employees
- Preparing for emergencies – first aid and rescue plans
- Providing opportunities for employees to be involved in safety procedures
- protecting workers from workplace hazards and preventing or reducing work-related injuries and diseases, ill health and dangerous occurrences;

- assisting and facilitating the improved management of OSH issues at each workplace;
- promoting effective consultation and cooperation between governments, employers, workers and their organizations in the improvement of OSH
- improved safety and health in the context of sustainable development; and
- The health and safety of local communities.

2.2 Safety Precautions on Drilling Machines;

Planning for drilling operations, Start planning well in advance of the anticipated date for moving equipment onto site. It is best if one experienced person is designated to be responsible for evaluations of mineral thickness either by contracting profiling specialists or using appropriate equipment. During drilling operations, dynamic loading occurs when additional forces beyond the weight of the drill and support equipment are transferred to the surface. Maximum dynamic loading takes place when extracting stuck rods. To extract the rods, a pullback force is applied by alternately pushing and pulling against the drill string until the drill string is freed.

Listed below are safety procedures common to most types of drilling machines.

- Remove all chuck keys and wrenches before operating.
- Ease up on the feed as the drill breaks through the work to avoid damaged tools or workplaces.
- Keep all guards in place while operating.
- Do not support the workplaces by hand. Use a holding device to prevent the work piece from being tom from the operator's hand.
- Never make any adjustments while the machine is operating.
- Never clean away chips with your hand. Use a brush.
- Keep all loose clothing away from turning tools.
- Make sure that the cutting tools are running straight before starting the operation

- Never place tools or equipment on the drilling place.

Fig 1: Safety signage

The OHS risks shall be identified through Cross Functional Team (CFT) and the following points shall be considered:

- Adverse conditions – routine / non-routine / emergency
- Past, present and future situations.
- Maintenance, purchasing activities.

- Human factors such as fatigue, stress, abnormal
- Working postures, ergonomics, etc.
- Housekeeping
- Material handling
- Working on different premises
- Working in a hazardous area having chemical fire/explosion hazards.
- Risks on account of statutory/legal requirement.

Importances of Occupational, Health and Safety (OHS) in Mining Industry:

- Creating safe working environment **t**o keep Safety and health of mine workers
- Safe and Efficient Extraction and Processing is one of the major goal of a mining companies.
- The dangers associated with the mining operations are more since they have to operate on remote and less hospitable regions.
- In order to know the severity we need to imagine the life of mine worker who risks their lives for achieving the company's objective
- So it becomes company's responsibility to have a proper safety system in place which ensures the Safe work environment in mines. From the corporate point of view, mounting safety incidents do more than affecting corporate reputation.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

4. Mention at least two importance's of OHS.
5. Define what mean a Occupational, Health and Safety (OHS).
6. List some of the safety procedures common to most types of drilling machines found in the machine shop.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Completing work

3.1 Drilling process in Mining:-

Blast hole drilling is a technique used in mining whereby a hole is drilled into the surface of the rock, packed with explosive material, and detonated. The aim of this technique is to induce cracks in the inner geology of the surrounding rock, in order to facilitate further drilling and associated mining activity.

Fig 1. Drilling process in mining

3.2 Standard Operating Procedure (SOP)

- Know the location of start and stop switches or buttons and keep the drill press table free of tools and other materials.
- Use only properly sharpened drill bits, sockets and chucks in good condition. Remove dull drill bits, battered tangs, or sockets from service.
- Do not remove by hand metal or wood chips from the table or stock. Use brushes or other tools to properly remove chips.

- Do not attempt to oil the machine or make adjustments to the work while the drill press is in motion.
- Do not insert a drill chuck key into the chuck until the power is shut off and the machine has come to a complete stop.
- All belts and pulleys must be guarded; if frayed belts or pulleys are observed, the drill press must be taken out of service and the belts or pulleys must be replaced.
- All stock must be properly secured with a vise or clamps prior to a machining process.
- If the stock slips in the vise or clamp, the operator must not attempt to hold the work with his/her hand or try to tighten the vise/clamp while the machine is in motion. Shutdown the power to the machine prior to re-tightening the loose stock.
- Use the correct speed and drill for the type of stock being machined.
- Use the appropriate bit for the stock being machined. Bits with feed screw or extremely long bits should not be used.
- The drill bit should be mounted the full depth and in the center of the chuck.
- Position the table and adjust the feed stroke eliminating the possibility of the bit striking the table.
- Feed the bit smoothly into the work. If the hole being drilled is deep, withdraw the bit frequently to remove shaving on the bit.
- Never attempt to remove a broken drill with a center punch or hammer.
- When an operator has finished working on the drill press, and before leaving the drill press for any reason, the power must be shut off and the machine must come to a complete stop.
- When an operator observes an unsafe condition on the drill press, or stock that is being worked on, they must report it immediately to the Supervisor and the press will be taken out of service until the problem has been corrected.

3.3 Risk Assessment

The Management of Health and Safety at Work Regulations requires every employer to undertake risk assessments for the purpose of identifying the measures he needs to take to comply with the requirements and prohibitions imposed on him by or under the relevant statutory provision. Assessing risks is important in order to identify their relative importance and to obtain information on their nature and extent. This will help both to prioritize risks and determine where to place the most effort in prevention and control, and to make decisions on the adequacy of existing control measures.

The main stages of the fire and explosion assessment process are to:

- Identify the hazards - the potential sources of ignition and materials that would cause a fire or explosion to spread;
- Consider the precautions already in place for the prevention and mitigation of each fire and explosion hazard;
- Evaluate the likelihood of a fire or explosion occurring due to a particular hazard;
- Consider the consequences of a fire or explosion, and decide who might be harmed and how;
- Determine what further measures are necessary to prevent, control or mitigate a fire or explosion;
- Record significant findings; these should be included within the fire protection plan and the explosion protection plan required by regulation
- Review the risk assessment periodically, or when you think that a change in circumstances will significantly affect the risks to which people are exposed (e.g. moving from a non-gassy to a gassy seam). While fire hazards are likely to be present at nearly all mines, if there are no explosion hazards present then there will be no risk to people from an explosion and therefore no need to introduce any explosion prevention and control measures. Anything that can burn is potential fuel for a fire or, in some cases, an explosion. Some of the most common fuels found in mines are:

- ✓ Firedamp (a naturally occurring mixture of hydrocarbon gases)
- ✓ Coal/coal dust;
- ✓ Wood;
- ✓ Diesel;
- ✓ Tyres and plastic materials;
- ✓ Mineral oils and grease;
- ✓ Rubbish and other waste material;
- ✓ Paper and plastics;
- ✓ Bottled gases e.g. acetylene, propane;
- ✓ Some explosives.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define what mean a Standard Operating Procedure (SOP).
2. **What is** the importance of Standard Operating Procedure (SOP)?
3. Define what mean a Blast hole Drilling.

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-4	Adhering emergency procedures

4.1 Introduction to emergency procedures

An emergency procedure is a plan of actions to be conducted in a certain order or manner, in response to a specific class of reasonably foreseeable emergency, a situation that poses an immediate risk to health, life, property, or the environment. Fire drills help prepare employees to respond quickly, calmly, and safely. Fire drills play a very important role in workplace fire safety. ... Include outside resources such as fire and police departments when possible. After each drill, gather management and employees to evaluate the effectiveness of the drill. A fire drill is a method of practicing how a building would be evacuated in the event of a fire or other emergency. Usually, the building's existing fire alarm system is activated and the building is evacuated as if the emergency had occurred.

4.2 Develop an emergency plan

Most event emergency plans should address the same basic requirements, to:

- get people away from immediate danger
- summon and assist emergency services
- handle casualties
- deal with those who have been displaced but not injured (eg at a festival with camping)
- liaise with the emergency services and other authorities and, where the situation is serious, hand over responsibility for the incident/emergency
- protect property

a. **Emergency procedures**

Procedures for staff and volunteers to follow in an emergency should include:

- raising the alarm and informing the public
- onsite emergency response, ie use of fire extinguishers
- summoning the emergency services and continuing to liaise with them
- crowd management, including where necessary
- evacuation of people with disabilities
- traffic management, including emergency vehicles
- incident control
- providing first aid and medical assistance

b. Have clear emergency roles and responsibilities

You should appoint people to implement your procedures if there is an incident or emergency. Make sure that all relevant staff members, whatever their normal role, understand what they should do in an emergency, for example:

- the location of exits
- how to use emergency equipment
- how to raise the alarm
- who they should receive instructions from

c. Evacuation

Emergencies can develop very rapidly. Make sure you are equipped to move the audience to a total or relative place of safety without delay. The following actions will help.

d. Escape routes and exits

- Plan escape routes and make sure they remain available and unobstructed
- Make sure all doors and gates leading to final exits, as well as site exits themselves, are available for immediate use at all times. Check they:
  - are unlocked - if security is an issue they should be staffed not locked

- are free from obstructions
- open outwards in the direction of escape

e. Signs and lighting to help evacuations

- Consider signs for people unfamiliar with escape routes
- Light all escape routes sufficiently for people to use them safely in an emergency
- Emergency lighting should comply with the requirements of British Standard . Use an independent power source, eg a generator, in case the mains electricity supply fails
- If using floodlighting, lighting towers etc as temporary lighting make sure it does not shine in people's faces along the escape route, making it more difficult for them. As an alternative, 'festoon lighting' along an escape route prevents glare

4.2.1 Steps for Using Fire Extinguishers

There are four basic steps for using modern portable fire extinguisher. The acronym **PASS** is used to describe these four basic steps.

A. Pull (Pin)

Pull pin at the top of the extinguisher, breaking the seal. When in place, the pin keeps the handle from being pressed and accidentally operating the extinguisher. Immediately test the extinguisher. (Aiming away from the operator) This is to ensure the extinguisher works and also shows the operator how far the stream travels

B. Aim

Approach the fire standing at a safe distance. Aim the nozzle or outlet towards the base of the fire.

C. Squeeze

Squeeze the handles together to discharge the extinguishing agent inside. To stop discharge, release the handles.

D. Sweep

Sweep the nozzle from side to side as you approach the fire, directing the extinguishing agent at the base of the flames. After an A Class fire is extinguished, probe for smouldering hot spots that could reignite the fuel.

Operation Sheet 3	Applying Fire Fighting Techniques

1. Steps of Extinguisher Operation

Step #1- Pull/remove the locking clip

Step# 2- Aim the nozzle at the base of the fire

Step #3-Press the knob down

Step # 4-Starting from the edge of the fire sweep the nozzle from side to side advancing ahead

LAP Test 3	Practical Demonstration

Name: _____________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3- 4 hour.

Task # 1 Apply Fire Fighting Techniques for fire extinguisher in your mine work site?

LG #28	LO #4- relocate drill

Instruction Sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Completing work area preparation
- Resolving coordination issues
- Relocating drill rigs

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Complete work area preparation
- Resolve coordination issues
- Relocate drill rigs

Learning Instructions:

1. Read the specific objectives of this Learning Guide.

2. Follow the instructions described below.

3. Read the information written in the information "Sheet 1, Sheet 2, and Sheet 3

4. Accomplish the "Self-check 1, Self-check 2, and Self-check 3

5. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheet

6. Do the "LAP test"

Information Sheet-1	Completing work area preparation

During drilling operations, it is standard practice to record slow circulation rates and pressures (SCRP) on each shift. This is less likely to occur during work over operations, since the pipe is not normally on the bottom for an extended duration. However, where possible, circulation rates and pressures should be recorded.

The following is a list of for site preparations:

- clearing of trees and vegetation
- Complete Development of location sites, reserve pits and access roads
- Pit Closures/Drilling Site Cleanups
- Soil Cementing and Permanent Rock locations
- Well Head Plumbing, Production Hook-Up Services and Lease Maintenance services
- Hydro seeding, site reclamation and erosion control services
- Crane and pile driving services.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List down the Basic Blast hole Drilling Process.
2. Why drilling is the most expensive method for making of holes **for different purpose?**
3. **What is the importance of** Plan drilling patterns

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Resolving coordination issues

2.1. Drilling coordination issues:

Drilling rigs can be massive structures housing equipment used to drill water wells, oil wells, or natural gas extraction wells, or they can be small enough to be moved manually by one person and such are called augers. Driller (Rig Operator) the employee of the drilling company directly in charge of a drilling rig and crew. Their main duty is operation of the drilling rig and hoisting equipment, but they are also responsible for the down-hole condition of the well, operation of down-hole tools, and pipe measurements.

Ministry of Mines and Petroleum

Figure 1: drilling rigs

A drilling rig is an integrated system that drills wells, such as oil or water wells, in the earths subsurface. Drilling rigs can be massive structures housing equipment used to drill water wells, oil wells, or natural gas extraction wells, or they can be small enough to be moved manually by one person and such are called augers. Drilling rigs can sample subsurface mineral deposits, test rock, soil and groundwater physical properties, and also can be used to install sub-surface fabrications.

When equipment, including a drilling rig, is located in a blasting area, sufficient precautions, including ensuring adequate traction and stability, shall be taken to prevent toppling, sliding or other unplanned movement of the equipment. Drill holes shall be of sufficient size to admit the free insertion to the bottom of the hole of explosives without ramming, pounding or undue pressure. No drilling shall be done in a previously blasted area until the surface to be drilled is carefully examined for remnants of explosives or holes containing explosive materials. Where a remnant of a hole containing explosives is found, this explosive shall be dealt with as a misfire before drilling commences. No drilling shall be done closer to any part of a hole containing an explosive.

Depending on the geological structure of the Earth's crust, mining companies can choose between different drill types. I have summarized the most common drilling rigs in the following table:

Drill Methods		
Drilling Rig	**Maximum Depth**	**Costs**
Auger Drilling	Roughly up to 25 meters	Lowest
Percussion Rotary Air Blast Drilling (RAB)	Roughly up to 150 meters	Low
Reverse Circulation Drilling (RC)	Roughly up to 500 meters	Medium
Diamond Drilling	Roughly up to 1800 meters	Highest

1. **Auger Drilling:**

Auger drilling is done with a helical screw which is driven into the ground with rotation; the earth is lifted up the borehole by the blade of the screw. **Hollow stem auger drilling** is used for softer ground such as swamps where the hole will not stay open by itself for environmental drilling, geotechnical drilling, soil engineering and geochemistry reconnaissance work in exploration for mineral deposits. **Solid flight augers / bucket augers** are used in harder ground construction drilling. In some cases, mine shafts are dug with auger drills. Small augers can be mounted on the back of a utility truck, with large augers used for sinking piles for bridge foundations.

Auger drilling is restricted to generally soft unconsolidated material or weak weathered rock. It is cheap and fast.

Fig 2: Auger drilling machine

2. Percussion Rotary Air Blast Drilling (RAB)

The rotary drilling rig uses a pneumatic reciprocating piston-driven "**hammer**" to energetically drive a heavy drill bit into the rock. The rotary drill bit is hollow, solid steel and has ~20 mm thick tungsten rods protruding from the steel matrix as "buttons". The tungsten buttons are the cutting face of the bit. The cuttings are blown up the outside of the rods and collected at surface. Air or a combination of air and foam lift the cuttings. *(***This drilling rig is also known as the Down-the-Hole drill.***)* Rotary-percussion air drilling is the simplest and most economical solution for taking the first steps in mining exploration. Performed using a triblade or down-the-hole hammer of varying diameters between 3 and 6.0 inches, samples exit along the borehole walls. This technique is used to get an overall idea of the mining potential for low-cost sites. However, in order to obtain contamination-free samples, we must rely on reverse circulation or diamond core drilling techniques.

3. Reverse Circulation Drilling (RC)

The drilling mechanism is a pneumatic reciprocating piston, also known as a “**hammer**“, driving a tungsten-steel drill bit. RC drilling utilizes much larger rigs and machinery and depths of up to 500 meters are routinely achieved. RC drilling ideally produces dry rock chips, as large air compressors dry the rock out ahead of the advancing drill bit. RC drilling is slower and costlier but achieves better penetration than RAB drilling; it is cheaper than diamond drilling and is thus preferred for most mineral exploration work. Reverse circulation drilling, or RC drilling, is more expensive than rotary air blasting. It also requires more equipment and greater driving skills. However, RC drilling results in greater sample accuracy, making it a more popular form of mining exploration. It is the most common drilling technique used for mining exploration, particularly in South America and Australia.RC drilling is a form of percussion drilling, by which the rock is made to fail through the use of a piston that delivers rapid impacts to the drill stem, transferring energy to the drill bit. These blows to the rock are delivered by the bit, while a rotational device makes sure that the bit hits a new rock surface with each blow. A feed force is applied to maintain rock/bit contact, and compressed air is used to remove or flush the drill cutting from the hole, advancing the hole depth efficiently. The piston can be mounted out of the hole or down the hole for quiet and efficient drilling. With RC drilling, a dual wall drill pipe is utilized. Air is injected between the two tubes using a “side inlet swivel.” The air exits the drill string behind the bit, which can be a hammer or a tricone. The air and cuttings are forced across the face of the bit and back up inside of the “inner tube.” From there, the air and cuttings travel back to the surface out to the top of the rotary head through a deflector elbow, along a discharge hose to the cyclone.

At the face of the bit, the air is prevented from rising up the annulus with a collar or shroud that is 1/8 inch smaller than the bit. Generally, hammers are used more often in RC drilling. In softer material, or where the hammer will no longer function due to a head of water entering the hole, a trigon may be used.

Fig 3: Reverse Circulation Drilling (RC)

4. Diamond Drilling

Diamond drilling utilizes an annular ***diamond-impregnated drill bit*** attached to the end of hollow drill rods to cut a **cylindrical core of solid rock**. The diamonds used are fine to micro fine industrial grade diamonds. They are set within a matrix of varying hardness, from brass to high-grade steel. Matrix hardness, diamond size and dosing can be varied according to the rock which must be cut. Holes within the bit allow water to be delivered to the cutting face. This provides ***three essential functions****:* lubrication, cooling, and removal of drill cuttings from the hole.

Diamond drilling is much slower than reverse circulation (RC) drilling due to the hardness of the ground being drilled. Drilling of 1200 to 1800 meters is common and at these depths, ground is mainly hard rock. Diamond drilling rigs need to drill slowly to lengthen the life of drill bits and rods, which are very expensive. Diamond core drilling is used in the mining industry to probe the contents of known deposits and potential mining sites. By removing a small diameter of rock from the deposit, geologists can analyze the core through chemical dosage and use the rock for petrographic, structural, and mineralogical studies.

Fig 4: Diamond Drilling

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two characteristics of drill rig.
2. Define what do mean a **drilling *rig***?
3. Is that possible to use drilling in soft rock?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Relocating drill rigs

Drilling Production drill rigs are usually truck- or crawler-mounted and are powered either by a diesel engine or an electric drive. Pull-down and hoist forces are applied by either hydraulic or chain-hoist systems. A range of systems is available for monitoring machine health and the drilling process. Production drill rigs are divided into rotary, top hammer, and down-the-hole (DTH) hammer drill rigs. Rotary drill rigs rely on a pull-down force transmitted through a rotating drill string usually with a tricone bit for the cutting action. Rotary drill rigs are generally most efficient in medium to hard rock and in holes with a diameter larger than approximately 170 mm. Hole depths can extend to more than 80 m in extreme cases.

Top hammer drill rigs transmit the hammering force from the drill rig through the drill string down the

Muck Pile.

3.1 Drilling Rig

A drilling rig is an integrated system that drills wells, such as oil or water wells, in the earths subsurface. Drilling rigs can be massive structures housing equipment used to drill water wells, oil wells, or natural gas extraction wells, or they can be small enough to be moved manually by one person and such are called augers. Drilling rigs can sample subsurface mineral deposits, test rock, soil and groundwater physical properties, and also can be used to install sub-surface fabrications, such as underground utilities, instrumentation, tunnels or wells. Drilling rigs can be mobile equipment mounted on trucks, tracks or trailers, or more permanent land or marine-based structures (such as oil platforms, commonly called 'offshore oil rigs' even if they don't contain a drilling rig). The term "rig" therefore generally refers to the complex equipment that is used to penetrate the surface of the Earth's crust.

Only employees will operate the drilling rig or handle equipment associated with drilling operations, including winches, augers, drive rods, ropes, and cables. Technicians, field personnel and any visitors must be aware of the location of the emergency shut-down/kill switches and operation of these devices, and the devices must be in safe working condition prior to the start of the project and thereafter. The Technician should never leave the controls of the drilling rig while the tools are rotating unless all employees are clear of rotating equipment. During drilling operations the Well Technician at the controls must be aware of the Assistant Technicians position and actions at all times. Operation of the winches and or rotary actions should only occur once the Well Technician has visually or verbally confirmed that the Assistant Technician is all clear. During assembly operations (auger attachment or Roding connection) no mechanical operations should occur until body position or hand placement is confirmed to be in a non-pinch or crush position. Only employees necessary to run the rig are allowed in close proximity, except during essential sampling and other activities.

Technicians will not reach into or near pinch points, the borehole, or the rotating equipment, unless the drilling rig has been shut down

A drilling rig is the most visible part of the drilling operation however what is important is underground activity and the main consideration in the selection of a rig are

1) Noise, which can be minimized by using electric rig

2) Dust if air drilling is used, control of air and cutting is required30 appearance most rigs for un conventional well rigs are from 50 ft to over 100 ft tall, which is usually undesirable and take more time to set up a drilling.

Drilling rigs can be massive structures housing equipment used to drill water wells, oil wells, or natural gas extraction wells, or they can be small enough to be moved manually by one person and such are called augers. **Drilling rigs** drill new wells and work over rigs service the wells; however the number of target well sites is almost always more than the number of available rigs. Rig operations are costly and they are bounded with many factors. Hence numerous possible combinations and financial significance lead to challenging work over and drilling rig scheduling.

Fig 1: Mobile drilling rig mounted on a truck

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two environment impacts of mining activity.
2. Is that possible to mine or drill at historical place?
3. **What is the importance of** Keeping site environmental and heritage requirements?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

LG #28	LO #5- preparing for sampling

Instruction Sheet 1

This learning guide is also developed to provide you the necessary information regarding the following **content coverage** and topics –

- Accessing, interpreting and applying compliance documentation
- Confirming the purpose, priority and scope of the sample request or plan
- Liaising samples for arranging site access
- Identifying site hazards
- Using and documenting procedures to ensure representative sampling
- Confirming quantity, location, frequency of sampling and types of samples
- Assembling required sampling tools and equipment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Access, interpret and apply compliance documentation
- Confirm the purpose, priority and scope of the sample request or plan
- Liaise samples for arranging site access
- Identify site hazards
- Use and document procedures to ensure representative sampling
- Confirm quantity, location, frequency of sampling and types of samples
- Assemble required sampling tools and equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.

2. Follow the instructions described below.

3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 Sheet 4, Sheet 5, Sheet 6, Sheet 7, and Sheet 8.

4. Accomplish the “Self-check 1, up to 8..

5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet

6. Do the “LAP test”

Information Sheet - 1	Accessing, interpreting and applying compliance documentation

Mineral Sample Preparation is a vital stage in the process of minerals analytical testing. The purpose of sample preparation is generally the production of a homogeneous sub-sample, representative of the material submitted to the laboratory. Correct preparation is critical to obtaining meaningful analytical results. **Sampling** is a process used in statistical analysis in which a predetermined number of observations are taken from a larger mineralized area. Or Sampling is defined as taking a small portion of a whole mass that accurately represents the whole mass. Very simple to define, however obtaining a representative sample is anything but simple. However, this rarely represents what one would sample in "the real world" of mining and mineral processing. Mineral Sample Preparation is a vital stage in the process of minerals analytical testing. The purpose of sample preparation is generally the production of a homogeneous sub-sample, representative of the material submitted to the laboratory. Correct preparation is critical to obtaining meaningful analytical results

1.2 Handle **compliance documentation***:*

Drilling data from sample assays, alteration studies and geological-mineralogical logging accumulates rapidly when good drilling progress is made. The number of drills operating on a project must not exceed, but should, at least, match the capability of the staff to effectively study, record, and interpret information acquired in a timely manner the availability of drill sample data controls the effectiveness of the drill program, and allows timely decisions. Drill Sample Collection The use of rotary and percussion drills in testing the disseminated metal deposits has resulted in better sampling in most instances than with diamond drill equipment. The cost of such drilling is often less than one-half that of diamond drilling. Samples from rotary-percussion drilling are two to six times as large as with drill core and sample recoveries are often more complete. Weighing samples can detect losses or caving in the hole that would otherwise go undetected. Screen analyses on samples will indicate the presence of coarse gold and the distribution of values. Losses of fines in rotary-percussion drilling can result in upgrading or downgrading of metal content in samples.

1.3 Hardness of mineral:-

The earth's crust consists of a variety of rocks, formed under different circumstances. Rocks consist of one or more composite minerals or Rocks are an aggregate of minerals but the reverse is not true. All ores are rocks but the reverse is not true.

A mineral is a substance formed by nature. A mineral should homogenous, crystalline, inorganic, definite chemical composition and solid. A mineral may be an element or may consist of chemical compounds containing several elements. There are more than 3,000 different minerals, of 103 known elements; oxygen is by far the most common, making up about 50 per cent of the earth's crust. Silicon, about 25 per cent, Aluminum, iron, calcium, sodium, potassium, magnesium and titanium.

Some of the characteristics of the minerals are hardness, density, color, streak, luster, fracture, cleavage and crystalline form.

Hardness can be graded according to the Moh's 10-point scale (all are nonmetallic). (Example followed by test)

1. ***Talc*** - Easily scratched with the fingernail

2. Gypsum - Just barely scratched with the fingernail

3. Calcite - Very easily scratched with a knife

4. Fluorite - Easily scratched with a knife

5. **Apatite** - Can be scratched with a knife
6. **Orthoclase** - Hard to scratch with a knife, can be scratched with quartz
7. **Quartz** - Scratches glass, can be scratched with a hardened file
8. **Topaz** - Scratches glass, can be scratched with emery
9. **Corundum** - Scratches glass, can be scratched with a diamond
10. **Diamond** - Scratches glass

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. **What is** sampling? (Pts)
2. Mention at least two characteristics of rock. (2pts)
3. Define what mean a mineral. (pts)

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

Information Sheet - 2	**Confirming the purpose, priority and scope of the sample request or plan**

2.1 The priority during sampling:

The sampling of metalliferous and industrial mineral deposits is undertaken for a variety of reasons and at various stages in their evaluation and exploitation. During the exploration phase, the sampling is largely confined to the analysis of drill cuttings, or cores, and is aimed at the evaluation of individual, often well-spaced, intersections of the deposit. It thus gives the ***in situ*** grade and thickness of an intersection but provides little evidence of the continuity of potentially economic mineralization and generally takes little account of mining constraints.

Many accidents and incidents on mine sites have a causal factor in the rules and regulations that supposedly are in place to prevent the incident from occurring. The causes involve a lack of awareness or understanding, ignorance, or deliberate violations. It aimed to seek the opinions of the mining workforce on safety rules and regulations generally, as well as how they apply to their specific jobs on a mine site. It also aimed to investigate:

(a) the level of awareness and understanding of mine rules and procedures such as manager's rules and safe work procedures (SWPs);

(b) The level of awareness and understanding of mine safety regulations and legislation;

(c) The extent of communication of and commitment to rules and regulations;

(d) The extent of compliance with rules and regulations; and

(e) Attitudes regarding errors, risk-taking, and accidents and their interaction with rules and regulations. The sample consisted of a random selection of underground and open pit mines, extracting coal, metals, or industrial minerals.

The following steps, in order of priority:

- Eliminating the risk.
- Controlling the risk at source.
- Minimizing the risk.
- Using personal protective equipment.

2.1.1 Logging While Drilling

- Provides real-time information on formation characteristics.

– Allows us to determine where the bit is relative to the formation we are drilling.

– Helps define well placement and predict drilling hazards.

Sample acquisition is crucial because of the risk of contamination during drilling. Operations mining unconsolidated material often employ a continuous trencher (commonly referred to as a ditch witch) to produce samples. Best results are obtained by trenching at right angles to the predicted ore-body orientation. Sample results should be used to model grade distributions in planning or geostatistical software, while taking into account the minimum selective mining unit of an excavator. On the basis of the produced models, a clear demarcation of ore and barren rock in active operating areas can be provided, often done using colored flags or pegs. Hanging colored ribbons down the face can further aid excavator operators in discerning ore and barren rock. The next step in grade control is the selective mining of material.

Take detailed field notes for each undisturbed sample. They should include the following items as appropriate:

- Hole number and location

- Complete log of hole above and below samples
- Method of drilling and size of hole
- Type and size of test pit
- Casing (type and size) or drilling mud mixture used
- Groundwater elevation and date and time measured
- Length of drive and length of sample recovered, or percent recovery
- Size of sample (diameter)
- Elevations or depths between which sample was taken
- Method of cleaning hole before sampling
- Other items, such as difficulties in obtaining sample

2.2 Scope of the sample request or plan:

Sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a mineral or rock for the purpose of determining parameters or characteristics of the whole mineralized area.

- To obtain more information on the rocks type, boundary and degree of weathering,
- To have stored laboratorial information and for further information about the drill hole.
- To supplement information on orientation and character of weak zones
- To provide samples for laboratory analysis
- Hydrological and/or geophysical tests

The geologist and miners must determine what materials should be sampled and what tests are needed. The character of the material and the tests to be performed govern the size and kind of sample required.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is scope of the sample request or plan?
2. Write down the Importance of The drilling operation.
3. **What is *the objective of mining exploration*?**

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ____________
Rating: _____________

Name: ___________________________ Date: ________________

Short Answer Questions

Information Sheet - 3	**Liaising samples for arranging site access**

3.1 Introduction to liaising

Liaising is the process of working with others and establishing a connection. When you are in the process of working out your differences with other group, this is an example of a situation where you are liaising.

Sampling is a vital component during all stages of the

Mine Value Chain. It includes the sampling of in-situ

Material and broken rock for geological, metallurgical

And geoenvironmental purposes

3.2 Site access for samples:

Sub sampling Laboratories routinely receive larger samples than required for analysis. The challenge then becomes to prepare a sample that is representative and large enough for analysis, but not so large as to cause needless work in its final preparation. Generally, a raw sample first is crushed to a reasonable particle size and a portion of the crushed material is taken for analysis. This step may be repeated with intermittent sieving of the material until an appropriate sample size is obtained. Then, this final portion is crushed to a size that minimizes sampling error and is fine enough for the dissolution method. Operators and employees need safe access into, on and around machinery. Workers need a stable work platform that is right for the work they need to do. The operator should be able to keep good posture while working. The platform must give a sure footing, a safe working environment and prevents falls it is at height.
When designing safe access to machinery, think about who, what, where, when and how.

- Who will be working on or around the machinery?
- Do people need to work in enclosed areas where the atmosphere could be harmful (such as pits, tanks or storage vessels)?
- What equipment or materials need to be carried to do the job?
- Where and when is access needed to use, maintain and clean the machine?
- How will people get safe access (such as from a walkway, gantry, elevated work platform, ladder)?
- What work will be carried out with the machine?

- Will people be near or exposed to any mechanical or non-mechanical hazards when they access the machine?
- Has consultation occurred with employees or contractors about how they intend to gain access,

3.2.1 The aims of liaising with a community

The ultimate goal of community liaison is to place the needs and priorities of mine- and affected communities at the center of the planning, implementation and monitoring of mine action and other sectors.

The following are some of the key objectives of liaising with a community

- To address its mine
- To obtain relevant background information on the community itself (e.g. population size and movements, main livelihoods or sources of income and other socio-economic concerns); Š
- To obtain information about the background to the mine/ problem in a specific community (history of local battles/conflicts); Š
- To identify specific at-risk groups in the community and understand the extent and underlying reasons for ongoing risk-taking in mined
- To provide accurate information on the location or types of mines and to clearance and marking teams, which is necessary to direct mine action operations effectively; Š
- To ensure that community representatives are consulted on and involved in prioritizing mine action interventions; and Š
- To support community development

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define what mean a liaising? (3pts)
2. **What is** the aim of liaising with a community? (3pts)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet - 4	Identifying site hazards

4.1 Site hazards Monitoring before sampling:

Identify the hazard by carrying out a workplace risk assessment; determine how employees might be at risk; evaluate the risks; record and review hazards at least annually, or earlier if something changes.

Making sure hazards do not cause harm or injury is the basis of health and safety in any workplace. This section covers the basics of hazard management and the common hazards that are found when working with or near machinery. In areas of potential contamination, it is important to understand what potential physical or chemical hazards the site may pose in addition to the chemical hazards of the materials and preservatives being brought onsite for the purpose of sampling. Historical land use, waste manifests, environmental site assessments, surveys, as built drawings or any other historical documentation may be used to help provide site information. Once a site is ready to be sampled or drilled, the real or potential dangers from fire, explosion, airborne contaminants, radiation, or oxygen deficient atmospheres may need to be monitored.

4.1.1 Hazard management

Planning a safe approach to a job can help identify the hazards of working with machinery. The hazard management process includes:

- hazard identification
- hazard assessment – decide if the identified hazards are significant
- hazard control – either by eliminating, isolating or minimizing the hazard

- a safety plan or hazard register documenting this information
- hazard monitoring, including workplace exposure monitoring or health monitoring of workers
- a schedule to update the safety plan.

Identify hazards

The first step in the hazard management process is to identify hazards – anything that could injure or harm someone.

Do a workplace inspection to identify all machinery used. Include common items that may not normally be thought of as 'machines'. Also consider how other workplace items such as chairs and heaters can affect the use of machinery.

Organizational hazards

For machine guarding to work well, employers must:

- understand how materials move through the site
- understand all safe operating procedures for the machinery
- develop instructions on how to use machinery safely, including maintenance and cleaning
- Train workers to work safely.
- New technology, new machinery or changes to machinery can introduce new hazards. At these times, always complete a hazard assessment and consult with workers.

The following details hazards and the equipment used to identify those hazards:-

1. Combustible Gases -- The atmosphere in any location capable of containing or generating a combustible concentration of gases should be monitored with a combustible gas meter. Actions should be taken in response of the meter reaching a defined percentage of the lower explosive limit (LEL); 25% is often used to cause an immediate evacuation of the site.

2. Oxygen Deficiency -- A location capable of containing or generating an oxygen deficiency either by depletion or displacement should be monitored with an oxygen meter. Any reading less than 19.5% oxygen will result in the use of self-contained breathing apparatus (SCBA).

3. Organic Vapors and Gases -- The atmosphere can be monitored with either a photo ionization detector (PID) or a flame ionization detector (FID). When appropriate, cyanide gas and halogenated vapors will also be monitored. Any response above background concentrations may trigger an upgrade in PPE and respiratory protection. In addition, chemical specific Draeger tubes can also be used to identify presence of specific chemicals.

4. Inorganic Vapors and Gases -- There are only a few direct reading instruments with the capability to detect and quantify non-specific inorganic vapors and gases. PIDs have a very limited capability in this area. If specific in organics are known or suspected of being present, an attempt should be made to provide appropriate monitoring if possible. In the absence of a monitoring capability always assume a worst case scenario and upgrade the level of protection to a level that gives respiratory and skin protection that is appropriate to a worse case assumption.

5. **Radiation** - When radiation may be encountered at a site, a Geiger-Mueller detector for beta and gamma radiation should be used to monitor airborne levels. Hazards

6. Explosions from methane gas produced by the decay of organic materials in sanitary landfills. An explosion potential also exists in monitoring work involving hydrocarbon recovery.

7. Toxic substances used in manufacturing pesticides, herbicides, solvents, paints, and other common products. Sometimes certain nontoxic chemicals placed in a disposal site will react with other chemicals to produce highly toxic chemicals.

8. Biologic wastes from hospitals or medical laboratories at universities that contain bacteria and viruses.

9. Chemical wastes that are corrosive, highly reactive, flammable, or explosive.

10. Radioactive wastes from hospitals and industrial and university laboratories.

Before attempting to conduct monitoring work at a waste site, the drilling contractor should learn exactly what types of wastes were handled there, provide the necessary protective clothing and training for personnel, and stress that any physical changes in a worker's health may be caused by contact with the waste. Always be prepared for worst case conditions.

Self-Check -4	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. How Monitoring Work Area Before sampling?
2. Define what mean an Explosions.

3. List some of the most significant hazards identified when sampling.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet - 5	Using and documenting procedures to ensure representative sampling

5.1 Procedures for sampling:-

The process in which a portion (sample of ore) is selected in such a way, that its composition will represent the average composition of the entire bulk of ore. Such a selected portion is a sample, and the art of properly selecting such a sample is called sampling.

- Do not collect rocks in national parks and monuments or in State parks; it is illegal. Similar rocks commonly crop out on land nearby.
- Effective collection of representative samples of any rock mass can only result from a carefully planned sampling program.
- There is always a tendency to favor the easily-chipped rock outcrop either on the surface or underground.
- Description of individual samples in a sample book will often aid early recognition of mineralized rock types by comparing assay results.
- Before sampling is begun, competent assay companies must be contacted and evaluated. Accurate sample preparation and assaying procedures are not to be taken for granted.
- Many mining companies now prepare their samples through the assay pulp stage to assure proper protection against salting and inaccurate size reduction procedure.

- Assay procedures are not usually difficult, but good housekeeping in commercial and private laboratories is an essential practice not always observed.
- Considering the critical nature of samples taken at the surface or from drill core and cuttings, it is imperative that the exploration manager assures himself that the most effective procedures are being followed.

•

5.2 **Methods of sampling**:

In any Methods of sampling, the records kept are as important as in the field practice it is used. Here, type of sample, size of sample, true thickness of vein, intervals between sample location, naming of sample date and other relevant data are to be recorded, experience in sampling profession provides for deciding the proper spacing and number of samples to be taken and selection of methods.

1. Grab sampling:

As term indicates that grab sampling is not true sampling. A specimen picked up from ore or a mineral deposits or a portion of mineralized rock, which taken out of an ore body are called grab samples. The samples are taken and analyzed to obtain a preliminary idea about the nature and grade of whole deposit, to know appreciate metal content. When development and production is in progress, grab sampling is done at every level. Such samples are collected in stope face after blasting.

2. Chip or point sampling:

The method is less laborious and used as a regular method of known samples, is used for hard or uniform ores where it is difficult to cut channels. In this method the samples are collected by taking a small series of chips of rocks on a regular grid pattern from the working face in regular intervals. The blasted, broken materials are sampled. The shape of the grid is adapted to the morphology and structure of the deposit. The main advantage of this sampling is its high productivity.

3. Face or muck or lump sampling:

The term face sampling covers sampling of exposed faces of ore and waste, this methods taking of samples may be referred to the group of point sampling. One of three lumps of rocks are gathered in the face are taken from a pile of broken material with the purpose of of finding deforming mineral and also the chemical composition. it is very simple, quick and cheap procedure but the accuracy of this method is very low.

4. Bulk sampling:

This type sampling method is used in checking of the reliability of other types of samples and sometimes may be taken to determine a correlation factor for use in a estimate based on samples of others types. The samples are taken by blasting down drift blocks or sections in a stope or otherwise obtaining a sample of several tons to several hundreds or even thousands of tons, either from trench, pit, and channel or from the run of mine, where the entire lot is milled separately.

5. Channel sampling:

Before cutting the sample, the surface is thoroughly washed with water or with air under pressure the surface is then trimmed to level it and the channel marked on it, the channel is marked perpendicular to the strike of the ore body to get true width of ore zones. This sampling is carried out on the walls, in the crosscut and on the roof of back in the drives.

6. Muck sampling:

After blasting the muck is scattered over the area, so an approximate grid is made over much heap and samples from various blasted fragments are taken in the weight proportion to give good representation to the samples. These are required to half kilogram by coning and quartering at the sampling shed in the mine itself.

7. Dump sampling:

This is done to check the run off mine grade. In the dump a grid is made and samples are taken from the center and boundary and sent for assay.

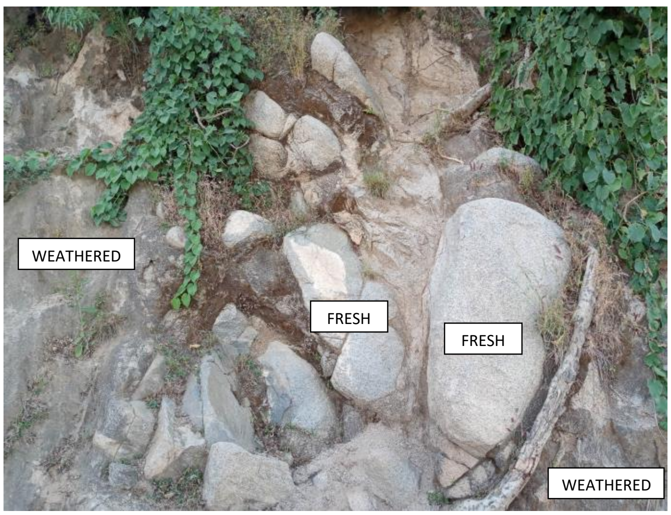
8. Production grade sampling:

The sample is taken from the conveyor belt or other ore transported machineries just after the ore is transported from the mine.

9. Box hole sampling:

In this method the samples are taken from the base, middle, and top of the dump in the box hole to check the grade of the ore in stope and sent for assay.

10. **Stream Sediment Sampling;**



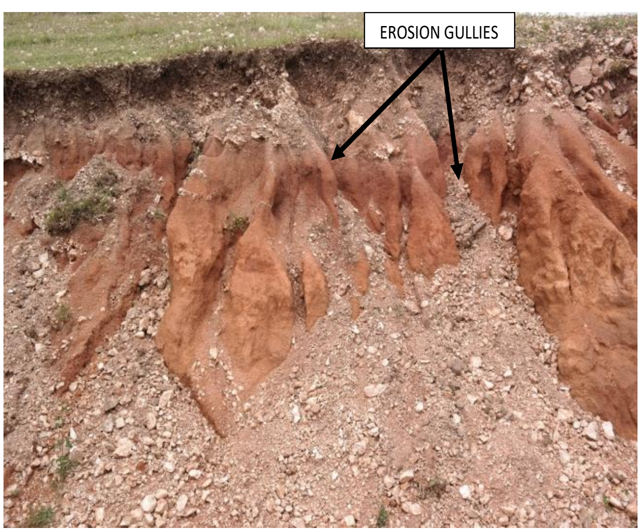


Figure 1: weathered and fresh Granite **Figure 2; Erosion**

Weathering is the process by which climatic factors transform hard rocks and minerals into softer rocks and minerals which are then subjected to erosion.

11. **Drill hole sampling;**

This hole is more convenient for the determination of the deposits boundaries. Here samples consist of the cuttings from drill holes. The samples are usually collected beyond the walls of underground working with a constant cross section.

Drill hole sampling methods:

The methods are classified based on the type of equipment employed.

Drive pipe method, churn drilling, rotary drilling**,** percussion rock drilling(test hole drilling),etc…

Planar sampling: this method is relatively rare procedure employed on deposits having a very low content of useful mineral. Example:pt,Au,cassiterite etc…

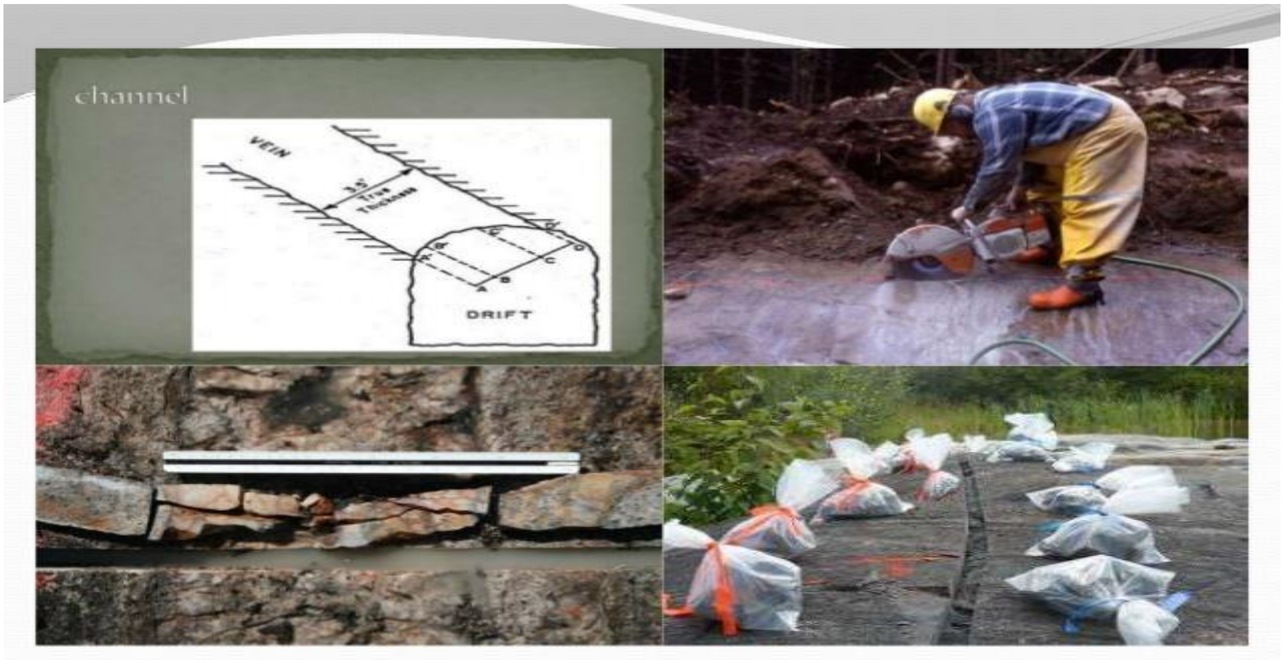


Figure 3: sampling methods.

Self-Check -6	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least three characteristics of representative sampling.
2. Define what mean a muck sampling?
3. **List down the** procedures to ensure representative sampling.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

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Ministry of Mines and Petroleum

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet – 6	**Confirming quantity, location, frequency of sampling and types of samples**

6.1 Rock/mineral sampling:-

When we want to know the location of mineral or rock samples, this first thing to know and record about the core is its location. When recording a hole location with a GPS, make sure to note the coordinate system (Projection, Datum) as well as error – otherwise great error can be introduced from future work. Knowing where your hole starts is important, but just as important are the direction its going (azimuth), what angle it's being drilled at (dip) and its projected length (EOH).All drill records will have an azimuth, dip and length recorded – these are values needed to actually drill the hole. The azimuth is just a direction to turn the rig. Someone will set-up foresights or back sights (or both) so the driller can line up the drill rig to. They then elevate the drill head so that the drill is angled at the correct "Dip". This is the angle down from the surface the drill is drilling. The length of hole can change dynamically as the hole is drilled.

6.1.1 Location:-

Location is used to identify a point or an area on the Earth's surface or elsewhere. The term location generally implies a higher degree of certainty than place, the latter often indicating an entity with an ambiguous boundary, relying more on human or social attributes of place identity and sense of place than on geometry.

Two types of location:

A. Relative location:

A relative location, or situation, is described as a displacement from another site.

An example is "3 miles northwest of mendi".

B. Absolute location:

An absolute location is designated using a specific pairing of latitude and longitude in a Cartesian coordinate grid — for example, a Spherical coordinate system or an ellipsoid-based system such as the World Geodetic System. GPS (Global positioning system) is used to know absolute location of an area.

6.3 Sampling procedures:

A. Soil sampling - site characterization for investigation purposes

1. Minimize the possibility of cross-contamination by using disposable sampling equipment that is certified as clean for each sample collected. If disposable sampling tools are not available, specify the cleaning procedures used. Wear clean sampling gloves at each sampling point. When using a split-spoon or similar sampler, wash it with a detergent solution (e.g., Liquinox or equivalent), and rinse before each use.

2. When sampling excavation sidewalls or floors, remove at least one foot of exposed soil prior to collecting the sample to ensure collection of a fresh sample.

3. Collect samples in the field. Collect samples as soon as possible after the surface of the soil has been exposed to the atmosphere. Do not collect analytical samples from soil cores that have been exposed for more than a few minutes. After the sampling interval has been determined, the analytical sample may be collected from the undisturbed bagged core sample. Sample containerization and preservation must be completed within two hours of retrieving the core from the subsurface. Document the procedure in the Investigation Report.

4. Collect soil samples using coring devices put the "cored" soil directly into containers provided by the analytical laboratory (verify that the laboratory has pre-weighed these containers) The correct volume of soil to use in the coring device is established by weighing a similar soil sample before coring the analytical sample.

Label all samples, place in a covered container and transport to the laboratory for analysis.

The labels should indicate:

a) Type of analysis

b) Name of facility

c) Monitoring point identification

d) Name of person collecting sample

e) Time and date the sample was collected

f) Name of preservative added, if applicable

6. Samples must be collected, transported.

Soil classification and determination

An essential quality of a professional driller is his ability to recognize and describe different types of soil (formation material) encountered during drilling. For the construction of a good quality well it is essential to know the characteristics of different soils and their influence on the yield (water discharge), water quality and performance of the well. In fact, knowing the characteristics of the soil is even more important than to name different soils exactly itself. First of all it is very important to know whether the types of soil drilled are permeable or impermeable.

Permeability

Permeability is a measure of the ability of a soil (or formation) type to transmit water through it. In other words;

fig 1 blue is water, white is soil

When coarse sand or gravel is put into a bucket of which the bottom is perforated and a cup of water is added on top of it, the water moves easily through the sand to the bottom of the bucket. The water flows easily through the pores (open space) between the grains. Conclusion; water easily flows through sand and gravel. Sand and gravel are thus very permeable.

Clay and loam

The opposite is seen with clay and loam. When wet clay is put in a bucket (compressed as in a layer of soil) and a cup of water is added, the water will remain on top.

Clay particles are very small (and 'sticky') as are the pore spaces between the particles. Conclusion; Water does NOT easily flow through clay. Clay is therefore described as not permeable or impermeable. If a well-screen is placed in a clay layer, the water flow into the well will be very low.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. How can we differentiate relative location from absolute location? (2pts)
2. What is the advantage of GPS (Global positioning system) in mining? (2pts)
3. **List down the** types of location.(2pts)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet – 7	Assembling required sampling tools and equipment

There are different types of sampling tools and equipment used for sampling. Sampling tools and equipment is necessary in mine point of view and it should be done by hand tools based on the area of the land or depth of excavation.

7.2 Sampling equipment:

As we know for successful sampling procedure the following pieces of equipment are necessary. The equipment are depends on which method we apply for sampling. The selection of equipment and the method of obtaining samples are controlled by site conditions, character of the material, depth of sampling, and the size. Drill rods, jack hammer, drills. Right machine type among the options for the intended application. Right machine size from the series of standard machines. In some cases a purpose built machines may be design for the specific application. Machine that would operate in its most efficient.

Some of the Surveying sampling equipment are:-

- Pencil/pen, Aluminum sheet holder,
- Shovel ,pick, hoe,
- Field bag, Digital camera
- Sampling bag, brushes, large boxes with locks
- Magnetic penicillin ,pan, sieves,
- Rock/soil/mineral test machine
- Gold detector machine
- PPE equipment
- Sampler wrench
- Split core sampler Geological hammers

- Hand lens
- Hand magnet
- Scribe or other hardness testing items
- Acid bottles to test for carbonate minerals
- Streak and glass plates
- GPS units
- Geological and topographic maps
- Air Photos and stereoscopes
- Rock and mineral samples
- Safety glasses, gloves and ear protection
- Traffic cones and first aid kits Optional Items General items:
- Shovels to collect soil and till samples
- Stainless steel sieves to sort sediment samples (soil, sand and gravel)
- Gold pan (to separate heavy minerals)
- Moh's scale hardness sets
- Bottle roll equipment for gold-cyanide dissolution tests
- Lab size ball/rod mill equipment for grinding tests
- Sieve analysis. Particle size distribution (Can be used in conjunction with the geomechanical lab)
- Rock crusher/Grinder
- Waterproof pH, Temperature and conductivity meter.
- Filed note book, pocket compass, measuring tape ,
-

Basic Field Equipments

The following are field equipments that we need to have when we think of sampling:-

✓ **C**

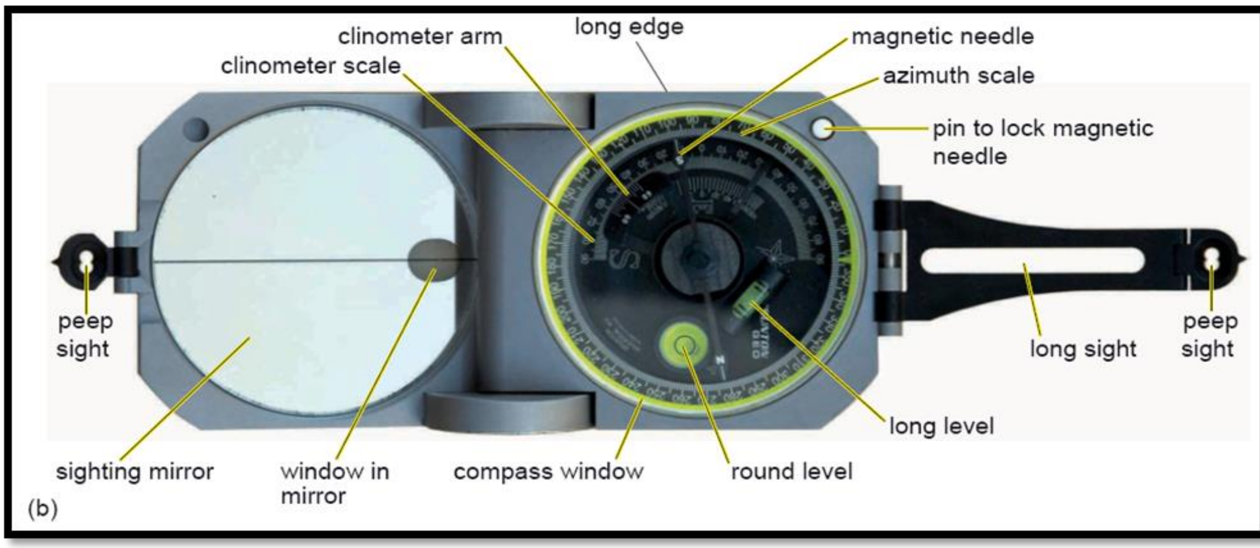
ling film/shrink wrap: This is very useful for fragile specimens such as fossils and mudstones. As well as the obvious advantage of helping to hold the specimen together the film also retains the moisture in the sample, allowing it to be dried out under controlled conditions.

- **Paper**: This is useful to help protect delicate specimens and for packing. It should not be used in direct contact with the rocks if the samples are also to be used for geochemical analysis, particularly organic carbon analyses.
- **Polythene sample bags**: It is good practice to put each sample into a new bag to avoid cross - contamination. Most bags come with write - on labels available from a variety of suppliers. Check for rocks with sharp edges because they tend to split the bag. If the rock has sharp edges either round them by gently tapping them using the square end of your hammer or carefully place the rock in a bag and wrap over this with paper.
- **Aluminum foil**: This is useful for holding together very fragile specimens such as mudstones. Wrap the foil around the specimen immediately after extraction in a systematic manner so that you are able to remove it sequentially in the laboratory. Aluminum foil is best avoided if the samples will be stored for any length of time as salts from the rock tend to corrode the foil.
- **Glue**: Strong glue suitable for metal or wood can be used for sticking samples together. If you need to protect fragile specimens such as shelly material within mudstone or vertebrate teeth before shipping or transporting them back, soak the sample for several hours in a 50:50 mixture of PVA glue and water. Then allow the specimen to dry.
- **Marker pens**: Permanent marker pens provide a distinct label. Note that wet, dusty or fine - grained dark colored rocks can be difficult to mark. It is worth carrying several markers into the field because they tend to wear out quickly.

✓ **The hand lens and binoculars**:

The hand lens is an essential piece of equipment for the detailed observation of all rock types and fossil material. Most have a lens with 10 × magnification and some contain both a 10 × and a 15 × or 20 × lens. If your eyesight is poor, a better quality lens will often help, especially a larger lens. It is also possible to obtain lenses with built - in lights, which can enhance the image considerably.

✓ **The compass - clinometers**: The compass - clinometers is used to measure: (1) the orientation of geological planes and lineation with respect to north; and (2) the angle of dip of geological features with respect to the horizontal. This allows an accurate record of the geometry of the features to be constructed. The compass - clinometers can also be used in conjunction with a topographic map to accurately determine location.



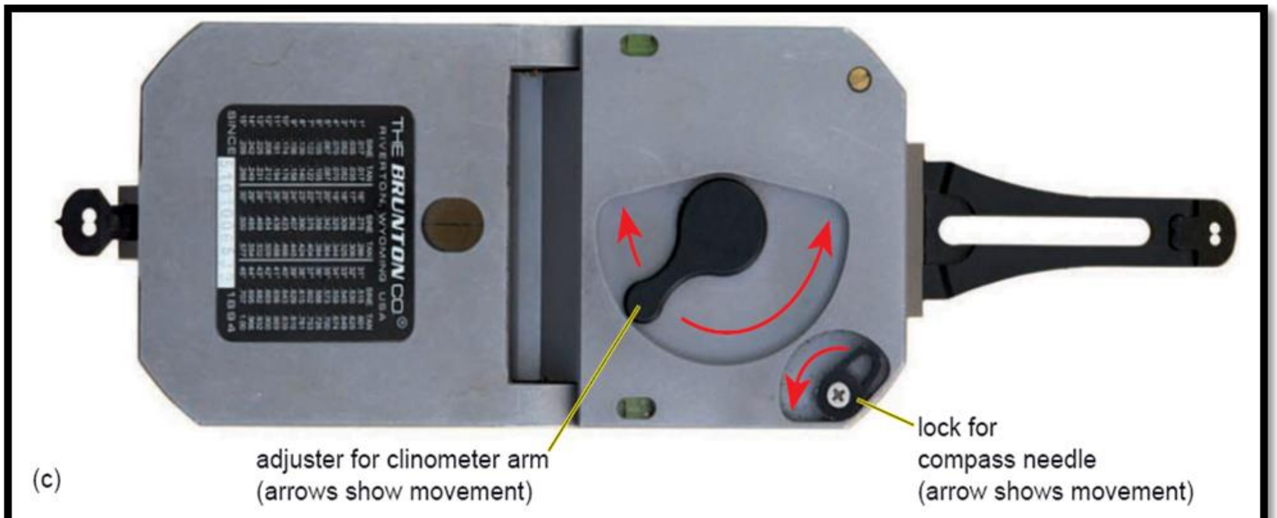


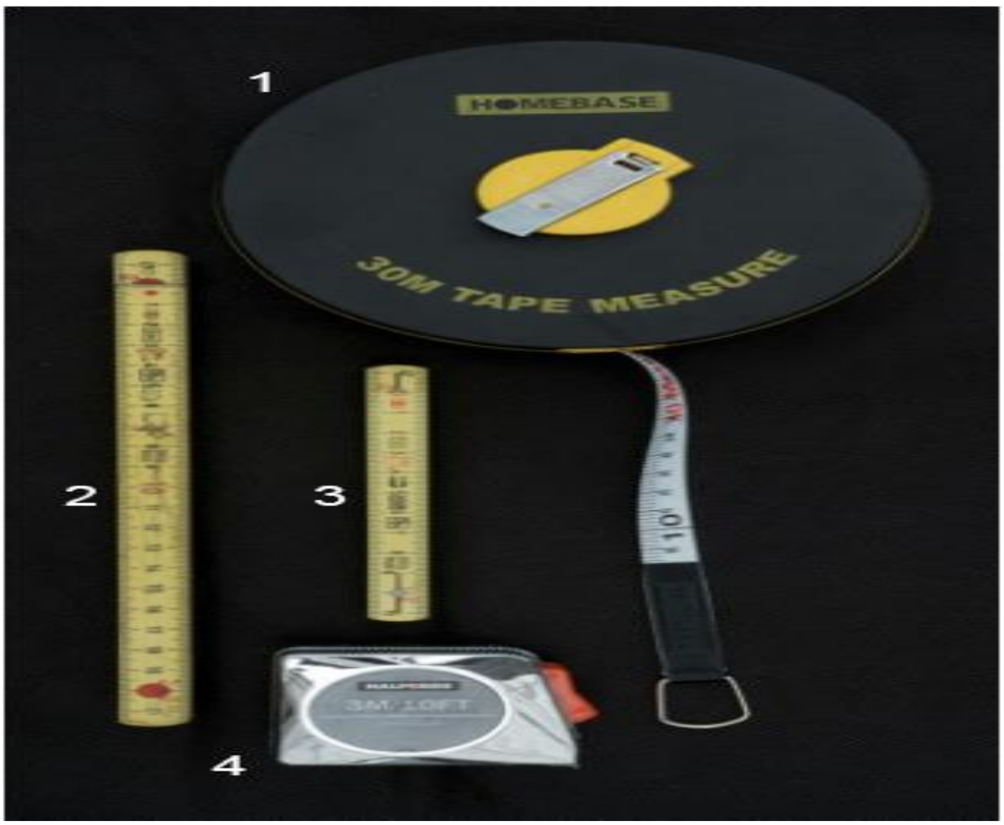
Figure 2.3 Labelled photographs of the parts of two of the most commonly used types of compass-clinometer. These terms are referred to in the text and in other figures. (a)–(c) The Brunton-type compass-clinometer: in this case the Brunton Geo. Views: (a) side; (b) top; (c) bottom.

✓

Global positioning systems and altimeters: Global positioning systems (GPS) use ultra high - frequency radio wave signals from satellites to trigonometrically derive your position to within a few meters laterally. A wide range of GPS systems are available on the market and the reader should refer to specialist reviews and literature for more information. Increasingly, mobile phones contain a GPS unit. Global positioning systems units do not work in deep ravines and on some coastal sections; they are also not particularly accurate for altitude. The GPS can be set up for the particular grid system that you are working with or for a global reference that is based on latitude and longitude. The global reference World Geodetic System 1984 (WGS84) is the most commonly used. Instructions on how to set up your GPS will be in the manufacturer's manual. After setting it up or modifying any settings, for instance when you go to a new country, it is a good idea to test it out at a known location. The unit may take some time to locate the satellites if the GPS has been moved hundreds of kilometers.

✓

Measuring distance and thickness (tape) : Thickness and distance are two of the most basic measurements that need to be made for many geological tasks. For most of them a tape measure or folding ruler will sufficient but when working on slopes a Jacob staff and compass clinometers can be useful

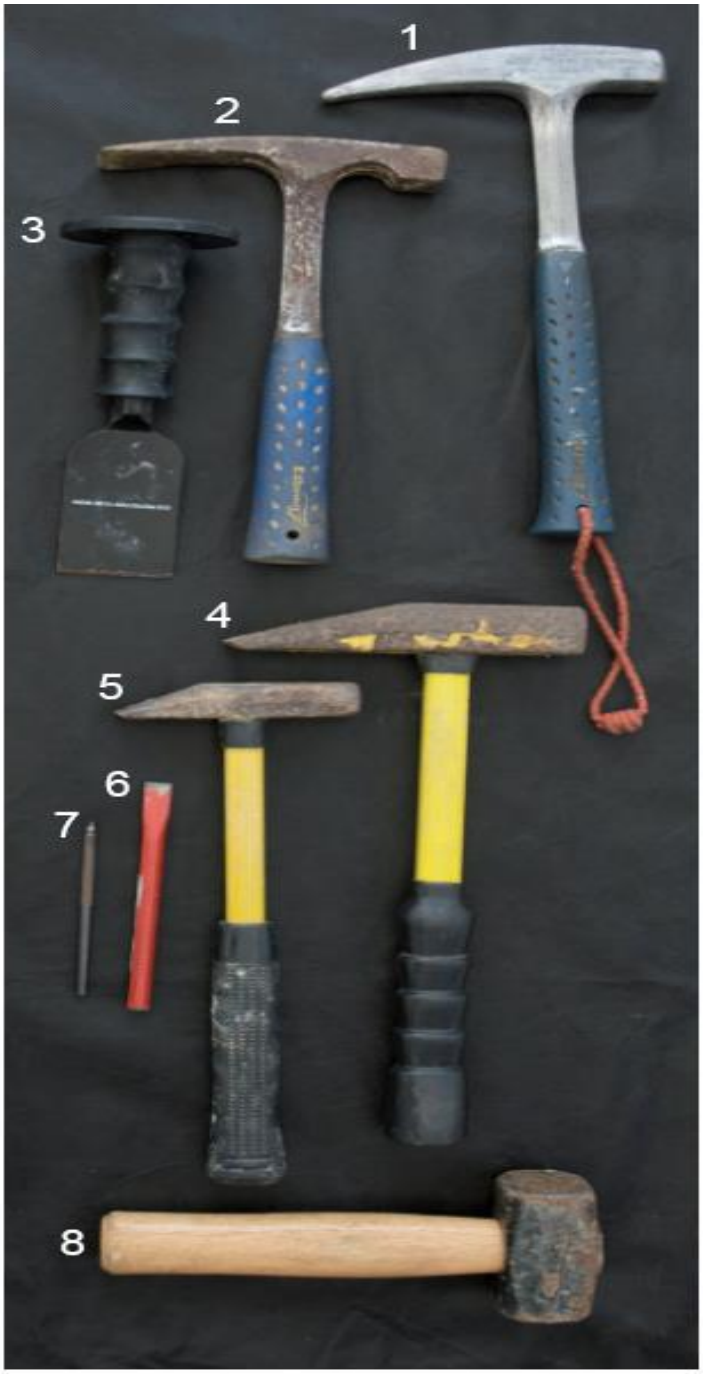


✓ C

lassification and color charts: Various well - established comparison charts can be used to provide a semi - quantitative description of the rock and any changes in it. These include grain - size charts and rock classification diagrams. Charts such as those for grain size and texture can also be purchased for use in the field. The grain size chart should be used by placing the edge of the card on top of a clean fresh surface of rock and comparing the grain size on the chart to that of the rock until a match is found for the average grain size and if appropriate the maximum and minimum size. If the grain size is small it might also be necessary to use a hand lens on the card and rock. If the rock is poorly consolidated, scatter a few representative grains across the grain - size images to determine the average size.

✓

Hammer, chisels and other hardware: A geological hammer is necessary for most geological fieldwork, both for the collection of samples and, where necessary, to create fresh surfaces so that the rock and the minerals within it can be described. Having said this it is perfectly possible to do a lot of geological fieldwork without a hammer provided samples are not required. Rocks that are exposed in sea - cliffs and along foreshores, in new trenches or in road cuts often do not need hammering and indeed the slightly weathered or wave washed surface is often as good as, if not better than, a hammered surface. For sedimentary rocks a 1 lb (0.5 kg) hammer is often sufficient. For igneous, metamorphic and hard or well - cemented sedimentary rocks a 2 lb (1 kg) or even a sledge - hammer may be necessary if good quality and/or large samples are required. However, a good chisel or pick hammer can be used to exploit planes of weakness (joints, bedding planes, foliation, and vein margins) and extract samples from tougher rock types. Matters of conservation should always be considered.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- ✓ **The hard copy field notebook**: Except for safety equipment, provisions and suitable clothing, the hardcopy or electronic field notebook is probably the most essential piece of field kit. There is a wide range of hardcopy notebooks suitable for fieldwork available on the market and the choice is a matter of identifying something suitable for the particular task that is to be undertaken and personal preference.
- ✓ **Maps and relevant literature**: Geological and topographical maps, field maps, photographs, published papers, etc., can form an essential part of your field tools. A topographic map for locating your position is fairly essential; aerial photographs are also useful for this

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention some of the sampling equipment**. (2pts)**
2. Define what mean a geological hammer? (2pts)
3. **What is clinometer**? (2pts)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Operation Sheet-1	Confirming location and specifications of the intended sampling area

Procedures how to use GPS

Follow the following procedures to use GPS

Step1. Turn on the GPS

Before you turn on your GPS, go outside where you have a clear view of the sky. Because the GPS determines your location by receiving signals from satellites, it won't work indoors. On the right side of your GPS, press and hold the Power button. The GPS will start, and it will show you the Satellites page. You should see something like the image below.

Step2. Looking Your GPS for satellite signals. When it has connected to three or more satellites, it will have your location.

Fig 1.1. GPS screen after power is on

Step 3.See the main menu once your location is determined, the Satellite screen will disappear

Fig 1.2. GPS screen showing main menu of GPS

- The GPS has different screens and menus that allow you to do different things.

  Step 4. Switch between screens, press the button marked "X", just above the power button on the right side of the device. This button also serves to go back. If you press something by mistake and would like to cancel or go back, press the "X" button.

  Step 5. Press the X button; you should be able to flip through different screens.

- If you return to the Satellites page, you can see that you are connected to three or more satellites. In the upper left corner are your coordinates, your latitude and longitude.

LAP Test	**Practical Demonstration**

Name: ______________________________ Date: ________________

Time started: ________________________ Time finished: ________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3- 4 hour.

Task # 1 Perform procedures how to use GPS

LG #29	LO #6- Conduct sample collection

Instruction Sheet	**Learning Guide # 29**

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Collecting samples as specified in sample request or plan
- Preserving sample integrity throughout collection
- Placing samples in suitable containers
- Storing and transporting samples
- Identifying and recording characteristics of sampling environment particularly any non-standard aspects
- Maintaining sampling equipment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Collect samples as specified in sample request or plan
- Preserve sample integrity throughout collection
- Place samples in suitable containers
- Use measuring instrument
- Label samples
- Store and transport samples
- Identify and record characteristics of sampling environment particularly any non-standard aspects
- Maintain sampling equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish from "Self-check 1 up to Self-check 8
5. Ask your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check).
6. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheets
7. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Collecting samples as specified in sample request or plan

1.1 Introduction to sample collection

Sample Preparation is a complete treatment of the theory and methodology of sampling in all physical phases and the theory of sample preparation for all major extraction techniques.

Samples are collected as specified in sample request or plan;

- Surveying of drill hole collar locations and down hole surveys,
- Sampling of drilling chips and sampling and logging of drill core,
- Sampling for rock density,
- Drilling of core or non – core drill holes,
- Storage and transport for rock density,
- sample preparation in the field and in the laboratory,
- use of duplicate samples,
- validation and storage of assay results and geological data in a computer database,
- basic environmental considerations, and
- handling of potentially hazardous materials

1.2 Sample *Collection plan:*

Sampling plan are designed to determine the metal content and the feasibility of economically recovering that metal from a volume of material being investigated. The problem of sampling arises in the initial stages of an investigation when setting up the most efficient means of achieving the main objective of the experimental program, and it crops up again at various stages throughout the experiment in attaining required levels of precision *of estimates from different* measuring techniques. Because of its fundamental role in experimentation, the sampling pattern should be decided upon at the same time as the overall strategy of the program, i.e., at the beginning; generally in sedimentary petrography it is resolved as the experimenter becomes aware of it, a certainly inefficient and, possibly, disastrous practice." Sampling plan is a major step in the discovery of a mineral deposit, and in the early exploration stage must receive close supervision by professional geologists. Sampling a mineral deposit after it has been identified is a critical step. Poor sampling procedure is common .Careless sampling might not be damaging if there are no mineralogic characteristics that reduce metal recovery and no shortage of metal reserve.

Personal Requirements:

- analytical mind
- aptitude for scientific inquiry
- responsible and neat
- systematic and precise
- interest in metallurgy, mining and/or geology
- good interpersonal skills

1.2.1 Exploration drilling for Sample collection:-

Sample collections to estimate the quality and quantity of a mineral reserve. The samples are collected as core and the drilling for such purposes are referred as Core drilling. As diamond bits are used for such drilling, core drilling is often called diamond drilling.

Exploration drilling Purpose:

- Sampling data's are used in reserve calculation
- To explore ore bodies to a depth,

- To study internal structure of the ore bodies and rocks,
- To study the continuity of mineralization,
- To determine the thickness of the ore bodies.

Fig 1; sample collection in the field

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

4. Mention at least three Exploration drilling Purpose.
5. What are the Personal Requirements during sample preparation?
6. What is the importance of sample collection plan?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet - 2	Preserving sample integrity throughout collection

2.1. Definitions:

The geological sample is a representative unit of soil, rock, ore, fluid, or gas that is selected from a larger mass or volume to serve as an example of that larger body or to reflect some specific feature or variation within it. Systematic rock sampling can be used to characterize a geothermal reservoir. The physical and chemical properties of rock samples provide important information for determining whether a power generation or heat utilization facility can be developed.

2.2 Sample integrity:-

Sample integrity is critical to the safety of mineral sample laboratory services. If there is a problem with the sample, then test results are meaningless. Each time there is a problem with sample integrity, to minimize the potential for volatilization between sampling and analysis, Samples requiring preservation should be preserved as soon as possible after collection to maintain the integrity of the sample. Lab test failures contribute to delayed or wrong diagnoses and unnecessary costs and care. The basic purpose of sampling is to collect a manageable mass of material which is representative of the total mass of material from which it was collected. This manageable mass of material, called a “sample”, is subject to certain preparation procedures, which render it suitable for either physical testing, or lab Analysis

2.2.1 The basic purpose of Preserving sample throughout collection:-

Is to collect a manageable mass of material which is representative of the total mass of material from which it was collected. This manageable mass of material, called a “sample”, is subject to certain preparation procedures, which render it suitable for either physical testing, or lab.The method by which samples are collected, the frequency of collecting samples and the accuracy of the samples collected, that is, how closely they represent the true characteristics of the total mass. A totally homogeneous material will require the collection of only a single sample in order to determine its characteristics accurately, whereas a lumpy heterogeneous material will require the collection of many small samples, or increments, which, when combined, will represent the total mass, or lot, with an acceptable degree of accuracy. These increments should be collected from all parts of the lot, with the number required to be collected being dependent on the variability of the material constituting the lot. Sample collection and preservation will vary, depending on the test and the type of sample to be collected. The laboratory must carefully define a sample collection process for all tests it performs.

The following should be considered when preparing sampling instructions:

- Sample preparation
- Sample identification
- Type of sample required
- Type of container
- Sample labeling
- Special handling

2.3 Trenching and test pitting:

Trenching and test pitting are simple methods of shallow exploration of easily excavated rock or soil materials. Visual inspection of a wide section of strata is of great value in logging profiles and selecting samples. If bedrock is anticipated at a shallow depth, trenches and test pits should be located on the centerline of the proposed structure and dug parallel with it. If bedrock is not at shallow depths, deep trenches or test pits should be offset from the centerline to avoid damaging the foundation of the structure. Shallow trenches or test pits may be dug adjacent to the centerline for correlation purposes. Where pits or trenches penetrate or pass through foundation materials, trenches are backfilled and compacted to the density of the original in-place material. It is recognized that certain limitations exist in the use of trenching and test-pit excavating equipment for compacting fill material. However, every practical effort should be made to reestablish the in-place densities of foundation materials. Trenches—Trenches are long, narrow excavations. They are advantageous for studying earth materials on steep slopes and in exposed faces. Trenches made by power equipment, such as backhoes, power shovels, and bulldozers, may require hand trimming of the sides and bottom to reach relatively undisturbed material. The method is of particular value in delineating the rock surface beneath the principal spillway and in abutments and in exploring auxiliary spillway materials. Trenching may be the most feasible method of investigation in materials containing cobbles or boulders. Trenches may yield valuable information on potential rock excavation and core trench depth along the centerline of the structure, depending on its design.

Test pits—Test pits are large enough to accommodate a person with sampling equipment. They may be excavated by hand or by power equipment such as a clamshell or orange-peel bucket. Power equipment should be used only for rough excavation and with extreme caution when approaching the depths at which undisturbed samples are to be taken.

2.3.1Procedures for obtaining undisturbed samples from exposed profiles:

Undisturbed hand-cut samples can be obtained from exposed profiles above the water table. Undisturbed samples may be obtained as box, cylinder, or chunk samples. Box samples are hand-cut and trimmed to cubical dimensions and placed in individual boxes for handling and shipping. They should have a minimum dimension of 6 inches. Cylinder samples from 4 to 8 inches in diameter and 6 to 12 inches long can also be hand-cut by sliding a cylinder over a column of soil, which is trimmed to approximate size in advance of the cylinder. Cylinder samples may also be obtained by jacking or otherwise pushing drive samples into exposed surfaces using a continuous steady pressure. Hydraulic power equipment may also be used to push Shelby tubes into exposed undisturbed soil to collect undisturbed samples, such as the sampler mounted on a backhoe. Chunk samples are of random size and shape and are broken away from the soil mass with or without trimming. They are difficult to package and ship but are simple to obtain.

Information gathered from soil samples

Soil samples help provide a general subsurface profile and can be used to measure engineering properties, including those properties indicating the presence of a restrictive soil layer. When a soil boring is performed to determine if a site is suitable for infiltration,

The following information should be requested from a soil boring company or geotechnical engineer.

- Boring name
- Project name/project number/client/nearest city or county
- Boring coordinates (location) and ground surface elevation (local reference to a fixed point on the site is acceptable)
- Start / End date and time
- Site conditions at time of sampling, including weather
- Type and depth of boring
- Type of drilling method
- Sampling method and sample type
- Sample recovery
- Soil Density or Consistency
- Soil Color (includes mottling or redoximorphic feature color, abundance, size and contrast)
- Grain size determined by Particle Size Distribution (PSD) lab test
- Particle shape

- Rock structure
- Layer boundaries and thickness (transition in color or between two different types of soil)
- Blow Counts
- Depth to bedrock, and/or refusal
- Depth to groundwater (indicated during drilling by wet or saturated soil moisture content and after drilling by recording the water level in an open borehole typically measured after 24 hours)
- Plasticity (plasticity of a soil is its ability to undergo deformation without cracking and is greatly influenced by the particle size, water content, and aging)
- Moisture
- Inclusion is used to describe the secondary mineral component in a soil sample
- Topsoil (A Horizon) thickness
- Photos

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1 Write the considerations when preparing instructions for preserving samples.

2 Mention at least two basic purpose of sampling?

3 What are the procedures Preserving sample integrity throughout collection?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet – 3	Placing samples in suitable containers

Container any bag, barrel, bottle, box, can, cylinder, drum, reaction vessel, storage tank, or the like that contains a hazardous chemical. For purposes of this section, pipes or piping systems, and engines, fuel tanks, or other operating systems in a vehicle, are not considered to be containers. And also placing samples in suitable containers in order to prevent sample loss and contamination.

3.2 Sampling Bags:-

Geological sample bags are a must have item, especially for exploration geologists, surveyors & field researchers where the collection of rock, fossil, mineral and geochemical soil samples are needed. With this comes a need to store samples and prevent contamination.

When you finish working, please make sure that Sample Storage:-

- the equipment is clean
- the work area is clean - including sampling area and floor
- dust filter in vacuum cleaner has been changed
- Samples have been labeled and stored; do not leave samples on lab tables, turn back to the original place after use.

3.2.1 Core logging

The systematic study of depth wise lithologic character and structural features of borehole cores and mineralogical characters for the purpose of construction of subsurface maps and determining the subsurface geological structures and ore body width is called core logging.

Records are presents in the form of a log.

The following information should be including in log:-

- Color fabric, grain size, texture
- Core loss
- Bore hole number, angle of inclination, data of drilling
- Length of core recovered and visual estimation of ore mineral.
- Structures present.

3.3 Choose an Appropriate Container:-

Samples that are volatile should be in a tightly sealed container, to prevent evaporation.

Choose the container most appropriate for the length of storage, long-term vs. short-term.

Some containers may deteriorate in presence of some chemicals and elevated temperatures, which will contaminate sample--choose inert containers and caps.

Samples sensitive to air, temperature, and/or moisture should be prepared and stored in the appropriate environment. The label needs to note the environment required.

Containers should incorporate the following features:

- ➢ Sample tubes are maintained in a vertical position from packing onsite to unpacking at the testing facility.
- ➢ For sensitive soils, design features and packing materials will cushion or isolate the tubes from the adverse effects of jarring or shocks while in transit.
- ➢ Internal packing and external marking should be provided to protect against freezing.

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two importance of container?
2. Define what mean a container?
3. What is Core logging?

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet – 4	**Storing and transporting samples**

4.1. Sample storing

Handle rock cores carefully and store them in boxes of dressed lumber or other suitable materials.

At the time the samples are sent to the laboratory, send copies of the various forms, logs, and the geologic report, including the supplement, to the State office.

4.2. Storing and transporting samples:

Sample handling is a key function in mining and mineral processing, which may account for 30–60% of the total delivered price of raw materials. It covers the processes of transportation, storage, feeding, and washing of the ore ***en route*** to, or during, the various stages of treatment in the mill. Use mineral cartons or strong boxes to hold your mineral specimens. May involve employee contact with hazardous materials, operations, and equipment. Samples may be subject to quarantine and statutory regulations, and these need to be determined in advance. It is also most important that appropriate safety and health practices are known and established before these procedures are used. Containers that may include radioactive material, toxic chemicals, or other hazardous materials must be clearly marked and described, and must be handled in accordance with specific instructions. Interstate transportation containment, storage, and disposal of soil samples obtained from certain areas these guidelines do not purport to address all of the safety problems associated with handling and transporting hazardous material. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. If you keep them more than one specimen in a box, make dividers to keep the specimens safely apart from each other. Keep them in plastic boxes or on a plastic base and any decomposition will not affect your shelf. Do not keep them in the same cabinet as carbonate minerals such as calcite, any acid fumes released could damage them.

Avoid sample cross contamination by:

- Decontaminating or disposing of sampling equipment between sampling locations.
- Double-checking sample labels to ensure accuracy and adhesion to containers.

- Split barrel samplers should be inspected daily for excessive wear to threads or bowing of split-tube halves.
- Keep the ball check free of debris to ensure proper operation.
- Do not hold on to the sampling rods while operating the hammer
- Do not use hands to manipulate the own hole hammer when transferring it to vertical use.
- Inspect inner workings of the automatic hammer regularly and lubricate lifting mechanism(s) often.
- Keep the ball check free of debris to ensure proper operation.
- Pull, do not push, the pipe wrench while turning the sampling rods to break the sample free while down hole.
- Do not use the machine to turn the rods.
- Keep hands away from the bottom of the sampler when removing it from, or inserting it into, the casing or augers.
- When removing a tube from the head, do not suspend the sampling rods from a slip ring.

6.2.1Measures to Store mineral samples:

- ✓ Use of minerals in a planned and sustainable manner.
- ✓ Recycling of metals.
- ✓ Use of alternative renewable substitutes.
- ✓ Technology should be improved to use the low grade ores profitably.
- ✓ Be aware of the electrical hazards associated with using groundwater-sampling pumps.
- ✓ Be aware of biological hazards when revisiting wells for sampling.
- ✓ Request MSDSs for sample preservatives as well as site constituents.
- ✓ Wear appropriate chemical gloves when handling samples

It's best to stick to a dry, well-ventilated area because moisture can ruin your minerals. Specimens should be kept out of direct sunlight, which can cause colors to fade. If your collection is valuable, security should also be a consideration, which may include locked cases, locked doors, and an alarm system

6.3 Documentation of rock core samples:

Photographic documentation of core samples is a vital part of the investigation reporting process and should be accomplished in a precise and systematic fashion. As a matter of practice, core samples are periodically disposed of, at which time the photographs become the primary visual record of subsurface rock conditions. High resolution digital images are preferred, although color prints are also acceptable. **The advantages of core photography include:**

- provides a permanent visual record of the rock condition, including in situ color weathering condition and void filling
- provides a graphic record of structural features exposed in the rock core, from which angular and spatial relationships can be measured
- provides convenient graphic illustration for geologic reports and presentations during design, construction, and operation
- May be enlarged to provide examination of mineral and microstructure characteristics in place of actual core samples. These enlargements can also be cut and pasted on the master drill logs. To be effective, the photographic documentation must be accomplished in accordance with the following minimum standards:
- Core boxes should be photographed under natural light conditions and oriented so that shadows are eliminated.
- The axis of the camera lens should be perpendicular to the core box floor to minimize distortion of core and linear features.

- A measuring scale should be affixed to the edge of each core box as a size reference.
- A color proof strip (multicolor chart obtainable from photo shops) should be included in the documentation to ensure true color reproduction.
- Index information should include: – Reference data such as project name, hole and box number, date, core internal, and hole location. These data would usually be printed on the box lid and end. Identification and scaling data such as project name, hole number, box number, core run depth, reference scale in inches and tenths, hole completion date, and color index strip. These data are provided in or along the edge of the core box. The lettering on the core box should not be less than one inch in height.

6.3.1 Disposition of rock cores:

Store samples of easily weathered rock cores, such as shale, indoors. If they are left outdoors and allowed to weather, they may give prospective contractors an erroneous impression of their original hardness. Handle rock cores carefully and store them in boxes of dressed lumber or other suitable materials. The core boxes should be about 4 feet long, with no more than four cores stored in each box. The cores should be separated by longitudinal partitions. Use separation blocks wherever a core is lost. Embossed metal tape or other acceptable materials can be securely fastened in the box to indicate by elevation the beginning and end of each reach of core in proper sequence as taken from boring. Place cores first in the top compartment next to the hinged cover and proceed toward the front of the box in the order the cores were taken from the drill hole, filling each compartment from left to right in turn. The elevations on separation blocks for those sections in which a core could not be obtained. Photograph the cores after they are boxed. On the inside of the cover stencil the box number, project name, site number, and hole number. Stencil the same information on the outside of both ends of the box.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two Measures to Store mineral samples
2. What are the importance of Handle rock cores carefully and store them in suitable materials?
3. How can Avoid sample cross contamination?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet – 5	Identifying and recording characteristics of sampling environment particularly any non-standard aspects

5.1 Introduction to sampling environment:

Mining is a complex long term activity. The basic elements of environmental risk at mining sites has not changed: mines have large pits and generate large amounts of tailings and waste rock.

Modern mining often resembles a complex chemical plant rather than a quarry due to the reliance on acids and cyanides. Environmental management of mining requires attention from the very beginning of mine design throughout the life of the mine until closure. Environmental compliance requires a robust monitoring program which provides data to the public on a regular basis. Mineral exploration and development are investigative activities prior to mining. The rewards of successful exploration and development can be large, if a mineral deposit is discovered, evaluated, and developed into a mine. For a mining company, successful exploration and development lead to increased profits. For a local community or nation, successful mineral exploration and development can lead to jobs—often well paying— that otherwise would not exist; to new infrastructure, such as roads and electric power supplies, that are catalysts for broader, regional economic development; and to increased government revenues that, in turn, can be invested in social priorities such as education, health care, and poverty alleviation.

5.2 Characteristics of sampling environment:

Mining is one of the best areas of investment for over all socio economic development in Ethiopia. In our daily activity we are going to use mining products. For

- jewelry,
- construction purpose,

- computer spare parts
- vehicle spare parts
- Any use full product that extracted from the earth.

Environmental drilling can be performed safely with proper pre-fieldwork planning and proactive adjustment of planned safe work procedures to actual conditions in the field.

Ground control -the ability to predict and influence the behavior of rock in a mining environment, having due regard for the safety of the workforce and the required serviceability and design life of the openings

Monitoring and Review: This involves ongoing monitoring of the hazards identified, risks assessed and risk control processes and reviewing them to make sure they are working effectively.

As every experienced driller and environmental professional knows, it is very difficult to predict all hazards that may be encountered during drilling fieldwork. The pre-field work preparations suggested here are applicable to mechanical drilling and push probe where portable drill rigs are used for soil boring advancement, subsurface soil and water sample collection, or groundwater monitoring well installation. If these pre-fieldwork preparations are diligently completed, the job can proceed safely and smoothly with less down time.

To achieve the mining regulation, the Government of Ethiopia will:

- ✓ Ensure that the regulatory framework addresses the management of the social and physical environments.
- ✓ Ensure that the objectives of sustainable development.
- ✓ Promotes gender equality.
- ✓ Ensure that the international obligations are addressed.
- ✓ Promote industrial growth and the development of the service sectors

- ✓ Establish an institutional capacity to cooperate with investors to facilitate compliance with the overall National Regulatory

Mining is a useful economic activity but it also has negative impacts. Reclamation and closure planning begin at the start of mining and are refined throughout the life of the mine. Environmental modeling of mine waters is extremely complex. The reliability of modeling is at best questionable. Modeling must be confirmed with life of mine monitoring.

Environmental impacts may not become apparent until years after closure and may occur despite the best designs. Mines should be required to obtain financial assurance to cover the costs of remediation by a third party.

Negative environmental health and safety impacts of mining.

Such impacts include:

- Loss of grazing and arable land
- Destruction of landscape, with possible impact on tourism
- Increased erosion
- Water filled open excavations pose a risk of drowning for cattle and children, and become a breeding ground for mosquitoes
- Pollution and interference with community's water resources (wells, streams
- Excessive erosion,
- Slope instability,
- Quarries can result in ponds, ragged topography, etc,
- Change in stream flow rate patterns,
- Increase turbidity of streams and lakes
- Stream sedimentation;

- Degradation of stream and river beds resulting from road building and drainage change;
- Obstruction of fish reproduction;
- Dust problems,
- Habitat fragmentation i.e. roads disrupt:
- Calving/rearing grounds,
- Key forage areas,
- Movement and migratory routes
- Increased wildlife mortality;
- Collision between vehicles and wildlife;
- Uncontrolled hunting, poaching;
- Pollutants in pristine areas;
- Chemicalization of soil:
- Gas, oil, drill-core slurry, ground core assay chemicals;
- Abandoned structures;
- Garbage and noise;
- leaks of poisonous gases such as
  - ✓ hydrogen sulfide or explosive natural gases,
  - ✓ firedamp or methane,
  - ✓ dust explosions,
- collapsing of mine stopes,

➢ mining-induced seismicity,

➢ flooding,

➢ General mechanical errors from improperly used or malfunctioning mining equipment (such as safety lamps or electrical equipment).

➢ Use of improper explosives underground can also cause methane and coal dust explosions

More importantly, any negative impact of the mining activity affecting the local community creates a negative feeling against the miners, and this many prevent further mining activity. It is always important for the miners to ensure a good relationship with the local community, administration, and with other land users in particular. Maintaining such a good relationship helps ensuring that future mining activity will be well accepted.

Rehabilitation is very important in this respect.

Figure: A **sapphire** mining site

Large surfaces of land have been rendered useless for grazing due to the presence of deep holes where cows can fall and had to be fenced off. As a result, the local Fulani herders have not allowed the miners to continue their activity on nearby sites.

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least five Negative environmental health and safety impacts of mining.
2. Define what mean a sampling.
3. What are the causes of Mining accidents?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet - 6	Maintaining sampling equipment

6.1 Sampling equipment

Sampling is defined as taking a small portion of a whole mass that accurately represents the whole mass, since this site is primarily concerned with mining and mining issues, the sampling discussed here will be relative to mining, sampling of ores and processed products from mills, processing plants and mines. The selection of the right tool for a given application is a function of several parameters, including rock strength and Abrasivity, machine type and size, and accessibility of the face. It must be stressed that using the right tool can influence the overall success and the economics of using mechanized excavation in an operation. Traditional mining is a mining method involving the use of simple manual tools, such as shovels, pickaxes, hammers, chisels and pans. It is done in both surface and underground environments. in traditional surface and underground mining, hammers and chisels with pickaxes and shovels are used. Mine carts are used to move ore and other materials in the process of mining. Pans are used for placer mining operations, such as gold panning. In order to avoid cross-contamination, grinders, sieves, mixers and other equipment should be cleaned before using them for a new sample. Additional cleaning of equipment prior to use is only necessary if the equipment has not been used for some time. The procedure can be as simple or as complicated as the analytical objectives warrant as illustrated .In some applications, simply wiping down the equipment with ethanol may suffice. Another practical approach is to brush out the container, and briefly process an expendable portion of the next sample and discard it. For more thorough cleaning, one may process one or more batches of pure quartz sand through the piece of solid processing equipment, and then wash it carefully. The efficacy of the decontamination is determined by monitoring this sand for radionuclide contamination.

An effective cleaning procedure for most grinding containers is to grind pure quartz sand together with hot water and detergent, then to rinse and dry the container. This approach incorporates a safety advantage in that it controls respirable airborne dusts. It is important to note that grinding containers become more difficult to clean with age because of progressive pitting and scratching of the grinding surface. Hardened steel containers can also rust, and therefore should be dried thoroughly after cleaning and stored in a plastic bag containing a desiccating agent. If rust does occur, the iron oxide coating can be removed by a warm dilute oxalic acid solution or by abrasive cleaning.

With a permanent marking device, label the sample container.

Record the following information on the label:

- watershed, site number, and location
- date
- hole number and sample number
- elevations or depths between which sample was taken
- top clearly identified
- Name of person who took the sample the placement of an aluminum tag with pertinent information in the storage container helps the laboratory when exterior labels are lost or damaged.

Additional core saw safety tips include:

- Core saw operators should be required to wear a full-face shield and hearing protection. As core saws use water to wet down the dust generated from the cutting procedures, a waterproof apron, gloves and steel toed rubber work boots may also be required. If core saws are operated in a confined area, enough silica dust may become airborne to create hazardous breathing conditions and require extraction ventilation equipment. It may be necessary to use a dust mask or a respirator.

- Before sawing rocks or splitting core, check the conditions of the saw/splitter, the ventilation and drainage of the overall workspace to prevent respiratory hazards, slips and falls, and possible electrocution. Replace the blade if there are broken teeth on the saw blade.

Self-Check -7	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least five Negative environmental health and safety impacts of mining.
2. Define what mean a sampling.
3. What are the causes of Mining accidents?

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ____________

Rating: _____________

Name: __________________________ Date: ________________

Short Answer Questions

Operation sheet -1	**Applying Sample collection**

Procedure sample collection:

Step #1 Equipment selection for sampling (Geological hammer, hand lens, pan, dola, American sluice box, GPS, compass, aerial photography…..)

Experience in sampling profession provides for deciding the proper spacing and number of samples to be taken and selection of methods.

Step #2 preparing traverse plans. Planning the field work to travel across the strike

Step #3 Collect samples

Step #4 After Collect samples, the records kept are as important as in the field practice it is used. Here, type of sample, size of sample, true thickness of vein, intervals between sample location, naming of sample date and other relevant data are to be recorded,

Step #5 Samples must be collected, transported

Step #6 placing samples in suitable containers

LAP Test	Practical Demonstration

Name: _______________________________ Date: _________________

Time started: __________________________ Time finished: _________________

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 2-4 hours.

Task 1: perform sample collection.

LG #30	LO #7- prepare samples

Instruction Sheet	

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Verifying and checking samples, documentation and required equipment
- Performing sample preparation
- Containing sample loss and Protecting sample against contamination
- Recovering and cleaning samples
- Storing or disposing residues and samples

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- Verifying sample, check documentation and required equipment
- Performing sample preparation
- Containing sample loss and Protect sample against contamination
- Recovery and clean samples
- Store or dispose residues and samples

Learning Instructions:

8. Read the specific objectives of this Learning Guide.
9. Follow the instructions described below.
10. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.

11. Accomplish from “Self-check 1 up to Self-check 8
12. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheets
13. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Verifying and checking samples, documentation and required equipment

1.1 Sampling equipment:

- Field Accessories.
- Ground Water Monitoring.
- Hammers, Picks and Chisels.
- Measuring Equipment.
- Meteorological Equipment.
- Microscopes.

The equipment required to adequately prepare mineral samples for analysis depends to some extent on the nature and quantity of the samples, and even on the climatic environment. In hot desert environments, samples can be adequately air dried under the sun, and a laboratory with only a handful of small rock samples to crush and pulverize per day could do an adequate job with a manual bucking board and muller.

Dryers Electric or gas-fired ovens are used to remove moisture from samples before crushing and pulverizing. Airflow is maintained through the oven to remove water vapor released from the samples. For routine assay purposes, oven temperatures are usually maintained from 104° to 140°C (220° to 285°F), the higher temperatures being used on clays, although the temperature should not exceed 37°C (100°F) if mercury is to be determined. The submission of larger and excessively wet drill-cutting samples to high-volume minerals laboratories has started a trend toward drying rooms or even buildings equipped to dry large quantities of samples.

Screens Soil and sediment samples should be screened through screens with both frame and screen as well as a pan made of stainless steel, the screen pressed or welded in, not soldered. Screen sizes typically are 10 mesh to remove coarse fragments and 80 mesh for the final product.

Gravity methods have a rather restricted application in the search for and evaluation of ore deposits. The successful use of gravity surveys requires a definite, measurable, density contrast between the ore body and country rock. It may give highly useful results on ore bodies with a strong remanent magnetization or on deposits that are essentially nonmagnetic. Since gravity measurements are directly related to rock density, gravity surveys can give, under favorable conditions, an approximate indication of the tonnage present in an ore body. **Example**: by using magnetic pencilla.

1.2 Geological sample preparation:-

Using sample preparation tools improve correlation with lab methods.

Analysis of prepared samples (powdered by mill or grinder) – Takes a few minutes to prepare each sample. Assay results are repeatable. Allowing a portion of the prepared sample to be sent to the lab for direct comparison of techniques.

Our geological sample preparation capabilities include:

- Core photographing and preparation
- Core Cutting
- Quarantine Services
- Core Logging

Core Logging is the recording of data concerning the materials and conditions in individual test holes, pits, trenches, or exposures. Logging must be accurate so that the results can be properly evaluated to provide a true concept of subsurface conditions. It is equally imperative that recorded data be concise, complete, and presented in descriptive terms that are understood and evaluated in the field, laboratory, and design office. Logging is the geologic description of the material between specified depths or elevations.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define what mean a crushing.
2. What is Core Logging?
3. Define what mean a grinding.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Performing sample preparation

2.1 Introduction sample preparation

Sample preparation may seem the most routine aspect of an analytical protocol. However, it is critical that analysts realize and remember that a measurement is only as good as the sample preparation that has preceded it. If an aliquant taken for analysis does not represent the original sample accurately, the results of this analysis are questionable. As a general rule, the error in sampling and the sample preparation portion of an analytical procedure is considerably higher than that in the methodology itself,

Sample preparation includes all of the steps taken in the laboratory to render a sample into a form that is suitable for chemical analysis. Correct sample preparation results in sub-samples that are representative of the total sample.

2.2 General Guidance for Sample Preparation:

Sample preparation is the process of converting samples of geologic materials from the larger sample collected in the field or mine into finely divided homogeneous powders suitable for chemical analysis or other testing. This is accomplished by the screening of soil or sediment samples or the mechanical reduction of pieces of rock to a smaller particle size in a stepwise sequence, alternating with the reduction of sample volume or mass by an unbiased splitting process. Error can be introduced in many ways during sample preparation. As a consequence, attention to detail and thorough cleaning of equipment between samples is necessary. The desired end result of sample preparation is a powder, or pulp, that contains the elements to be analyzed in the same concentrations and proportions as in the original sample received. The reduction in particle size will be affected by many factors, including particle shape, hardness, specific gravity, lubricity, malleability, residual moisture, and the quantity of clay minerals or organic matter present.

Some general considerations during sample preparation are to minimize sample losses and to prevent contamination. Possible mechanisms for sample loss during preparation steps are;

2.2.1, Potential Sample Losses during Preparation

Materials may be lost from a sample during laboratory preparation. the potential types of losses and the methods used to control them. The addition of tracers or carriers is encouraged at the earliest possible point and prior to any sample preparation step where there might be a loss of analyte. Such preparation steps may include homogenization or sample heating. The addition of tracers or carriers prior to these steps helps to account for any analyte loss during sample preparation.

2.2.2 Losses as Dust or Particulates

When a sample is dry ashed, a fine residue (ash) is often formed. The small particles in the residue are resuspended readily by any air flow over the sample. Air flows are generated by changes in temperature (e.g., opening the furnace while it is hot) or by passing a stream of gas over the sample during heating to assist in combustion. These losses are minimized by ashing samples at as low a temperature as possible, gradually increasing and decreasing the temperature during the ashing process, using a slow gas-flow rate, and never opening the door of a hot furnace .If single samples are heated in a tube furnace with a flow of gas over the sample, a plug of glass or quartz wool can be used to collect particulates or an absorption vessel can be used to collect volatile materials. At a minimum, all ash or finely ground samples should be covered before they are moved.

Solid samples are often ground to a fine particle size before they are fused or wet ashed to increase the surface area and speed up the reaction between the sample and the fluxing agent or acid. Since solid samples are frequently heterogeneous, a source of error arises from the difference in hardness among the sample components. The softer materials are converted to smaller particles more rapidly than the harder ones, and therefore, any loss in the form of dust during the grinding process will alter the composition of the sample. The finely ground particles are also susceptible to suspension. Samples may be moistened carefully with a small amount of water before adding other reagents. Reagents should be added slowly to prevent losses as spray due to reactions between the sample and the reagents.

2.2.3 Losses through Volatilization

Some radionuclides are volatile under specific conditions (e.g., heat, grinding, strong oxidizers), and care should be taken to identify samples requiring analysis for these radionuclides. Special preparation procedures should be used to prevent the volatilization of the radionuclide of interest.

The loss of volatile elements during heating is minimized by heating without exceeding the boiling point of the volatile compound. Ashing aids can reduce losses by converting the sample into less volatile compounds. These reduce losses but can contaminate samples. During the wet ashing process, losses of volatile elements can be minimized by using a reflux condenser. If the solution needs to be evaporated, the reflux solution can be collected separately. Volatilization losses can be prevented when reactions are carried out in a properly constructed sealed vessel. some commonly analyzed radioisotopes, their volatile chemical form, and the boiling point of that species at standard pressure. Note that the boiling point may vary depending upon solution, matrix, etc.

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least three General Guidance for Sample Preparation.
2. Define what mean a Volatilization**.**
3. Write the importance of Sample Preparation?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Containing sample loss and protecting sample against contamination

3.1 Sample Losses

Sample Losses Due to Reactions between Sample and Container and Specific elements may be lost from sample materials from interaction with a container. Such losses may be significant, especially for trace analyses used in radioanalytical work. Losses due to adsorption may be minimized by using pretreated glassware with an established hydrated layer. Increasing the amount of sample for dry ashing increases the amount of ash, minimizing the loss of the samples trace materials to the container surface.

The choice of sample container depends primarily on the the sample preparation process. When dry ashing or fusing, the sample container will usually be a platinum or porcelain crucible. Zirconium or nickel crucibles may also be used. If the sample will be dissolved using wet ashing techniques, the container may be borosilicate glass or a platinum crucible. Care should be taken to prevent ignition of samples in glass containers. Ignited samples may burn at temperatures high enough to cause damage to the container and loss of sample.

For many studies, the majority of the solid samples will be soil/sediment samples or samples that contain some soil. Size is used to distinguish between soils (consisting of sands, silts, and clays) and gravels. The procedures to be followed to process a raw soil sample to obtain a representative subsample for analysis depend, to some extent, upon the size of the sample, the amount of processing already undertaken in the field, and more importantly, the radionuclide of interest and the nature of the contamination. Global fallout is relatively homogeneous in particle size and distribution in the sample, and therefore, standard preparation procedures should be adequate for this application. However, when sampling accidental or operational releases, the standard procedures may be inadequate.

3.1.1 Liquid Samples:

Liquid samples are commonly classified as aqueous, nonaqueous, and mixtures. Aqueous liquids are most often surface water, groundwater, drinking water, precipitation, effluent, or runoff.

Nonaqueous liquids may include solvents, oils, or other organic liquids. Mixtures may be combinations of aqueous and nonaqueous liquids, but may include solid material mixed with aqueous or nonaqueous liquids or both. Preliminary sample measurements (e.g., conductivity, turbidity) may be performed to provide information about the sample and to confirm field processing these measurements are especially useful when there is no prior historical information available from the sample collection site. In addition, this information can also be helpful in the performance of certain radiochemical analyses. In many cases, the results of preliminary measurements can be used to determine the quantity of sample to be used for a specific analysis.These preliminary measurements typically require little or no sample preparation. However, they should be performed on a separate portion of the sample. This avoids any unexpected degradation of the sample parameters during transport and storage, and allows laboratory analysts to focus on radiochemical analyses. Using a separate aliquant also helps to prevent cross contamination of samples sent to the laboratory or loss of radionuclides through interaction with field-measuring equipment.

3.2 Sample contamination:

Contamination leads to biased data that misrepresent the concentration or presence of radionuclides in a specific sample. Therefore, laboratory personnel should take appropriate measures to prevent the contamination of samples. Such precautions are most important when multiple samples are processed together. Possible sources of contamination include:

- Airborne;
- Reagents;
- Glassware/equipment;
- Facilities; and Cross-contamination between high- and low-activity samples.

Contamination of samples can be controlled by adhering to established procedures for equipment preparation and decontamination before and after each sample is prepared. Additionally, the results of blank samples (e.g., sand), which are run as part of the internal quality assurance program, should be closely monitored, particularly following the processing of samples with elevated activity. “Cross-contamination” is the contamination of one sample by another sample that is being processed concurrently or that was processed prior to the current sample leaving a residue on the equipment being used. Simply keeping samples covered whenever practical is one technique to minimize cross-contamination. Another technique is to order the processing of samples beginning with the lowest contamination samples first. It is not always possible to know the exact rank of samples, but historical or field screening data may be useful.

Laboratory personnel should be wary of using the same equipment (gloves, tweezers for filters, contamination control mats, etc.) for multiple samples. Countertops and other preparation areas should be routinely monitored for contamination.

3.2.1 Airborne Contamination:

Airborne contamination is most likely to occur when grinding or pulverizing solid samples. Very small particles (~10 µm) may be produced, suspended in air, and transported in the air before settling onto a surface. Other sources of potential airborne contamination include samples that already consist of very small particles, volatile radionuclides (including tritium), or radionuclides that decay through a gaseous intermediate (i.e., 226Ra decays to 222Rn gas and eventually decays to 210Pb). Therefore, the grinding or pulverizing of solid samples or the handling of samples that could produce airborne contamination should be carried out under a laboratory hood or ventilated enclosure designed to prevent dispersal or deposition in the laboratory of contaminated air particulates. These particles easily can contaminate other samples stored in the area. To prevent such cross-contamination, other samples should be covered or removed from the area while potential sources of airborne contamination are being processed.

If contamination from the ambient progeny of 222Rn is a concern, it can be avoided by refraining from the use of suction filtration in chemical procedures, prefiltering of room air (Lucas, 1967), and use of radon traps (Lucas, 1963; Sedlet, 1966). The laboratory may have background levels of radon progeny from natural sources in soil or possibly in its construction materials.

3.2.2 Contamination of Reagents

Contamination from radiochemical impurities in reagents is especially troublesome in low-level work. Care must be taken in obtaining reagents with the lowest contamination possible. Due to the ubiquitous nature of uranium and thorium, they and their progeny are frequently encountered in analytical reagents. Other problematic reagents include the rare earths (especially cerium salts), cesium salts that may contain 40K or 87Rb, and potassium salts. Precipitating agents such as tetraphenyl borates and chloroplatinates may also suffer from contamination problems. In certain chemical procedures, it is necessary to replace stable carriers of the element of interest with isotopes of another element when it is difficult to obtain the stable carrier in a contamination-free condition. Has written an extensive review article on the radiochemical contamination of analytical reagents

3.2.3 Contamination of Glassware and Equipment

Other general considerations in sample preparation include the cleaning of glassware and equipment .Criteria established in the planning documents or laboratory SOPs should give guidance on proper care of glassware and equipment (i.e., scratched glassware increases the likelihood of sample contamination and losses due to larger surface area). Glassware should be routinely inspected for scratches, cracks, etc., and discarded if damaged. Blanks and screening should be used to monitor for contamination of glassware. Whenever possible, the use of new or disposable containers or labware is recommended.

For example, disposable weigh boats can be used to prevent contamination of a balance. Disposable plastic centrifuge tubes are often less expensive to use than glass tubes that require cleaning after every use. If non-disposable containers or labware are used, it may be necessary to use new materials for each new project to reduce the potential for contamination. Blanks can be used to detect cross-contamination. Periodic rinsing with a dilute solution of nitric acid can aid in maintaining clean glassware. However, could not easily remove nuclides sorbed onto the walls of plastic containers by washing with strong mineral acids. They report that nuclides can be wiped from the walls, showing the importance of the physical action of a brush to the cleaning process.

3.2.4 Contamination of Facilities

In order to avoid contamination of laboratory facilities and possible contamination of samples or personnel, good laboratory practices must be constantly followed, and the laboratory must be kept in clean condition. The laboratory should establish and maintain a Laboratory Contamination Control Program to avoid contamination of facilities and to deal with it expeditiously if it occurs. Such a program should address possible samples of varying activity or characteristics. This minimizes sample cross-contamination through laboratory processing equipment (e.g. filtering devices, glassware, ovens, etc.).

3.3 Protecting sample contamination:

The laboratory should establish a general program to prevent the contamination of mineral samples. Included in the program should be ways to detect contamination from any source during the sample preparation steps if contamination of samples occurs. The laboratory contamination control program should also provide the means to correct procedures to eliminate or reduce any source of contamination.

Some general aspects of a control program include:

- Appropriate engineering controls, such as ventilation, shielding, etc., should be in place.
- The laboratory should be kept clean and good laboratory practices should be followed. Personnel should be well-trained in the safe handling of radioactive materials.
- Counter tops and equipment should be cleaned and decontaminated following spills of liquids or dispersal of finely powdered solids. Plastic-backed absorbent benchtop coverings or trays help to contain spills.
- There should be an active health physics program that includes frequent monitoring of facilities and personnel.
- Wastes should be stored properly and not allowed to accumulate in the laboratory working area. Satellite accumulation areas should be monitored.
- Personnel should be mindful of the use of proper personnel protection equipment and practices (e.g., habitual use of lab coats, frequent glove changes, routine hand washing).
- Operations should be segregated according to activity level. Separate equipment and facilities should be used for elevated and low-level samples whenever possible.
- SOPs describing decontamination and monitoring of labware, glassware, and equipment should be available.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two possible sources of contamination.
2. Define what mean Decontamination.
3. How can Protect sample contamination?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________
Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-5	Recovering and cleaning samples

5.1 Introduction to assaying and sampling:

Assaying and sampling are the processes through which small samples of ore are systematically taken from the rock face and used to determine the nature, quality and quantity of the ore. The work of samplers is aimed at taking onsite samples, either in open-cast or underground workings of the mine. Collection of reliable data is the science of sampling. The collected samples are analyzed for some quality, metal content (assay), particle size, etc. and the data are used for process control and metallurgical accounting.

5.2 Cleaning samples:

It is very important to be aware general equipment cleaning steps that may be followed for general field sampling activities .Some labware is too expensive to be used only once (e.g., crucibles, beakers, reparatory funnels). Labware that will be used for more than one sample should be subjected to thorough cleaning between uses. A typical cleaning protocol includes a detergent wash, an acid soak (HCl, $HNO3$, or citric acid), and a rinse with deionized or distilled water. As noted scrubbing glassware with a brush aids in removing contaminants.

The sampler Technicians Ready practical advice on washing and cleaning samples:

- Always clean your apparatus immediately after use. It is much easier to clean the glassware before the residues become dry and hard. If dirty glassware cannot be washed immediately, it should be left in water to soak.
- Thoroughly rinse all soap or other cleaning agent residue after washing glassware to prevent possible contamination. If the surface is clean, the water will wet the surface uniformly; if the glassware is still soiled, the water will stand in droplets.
- Use brushes carefully and be certain that the brush has no exposed sharp metal points that can scratch the glass. Scratched glassware increases the likelihood of sample contamination and losses due to larger surface areas. Moreover, scratched glassware is more easily broken, especially when heated.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least three importance of cleaning samples.
2. Define what mean a Cleaning.
3. How can wash and clean samples:

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-6	Storing or disposing residues and samples

6.1 Introduction to sampling:

Sampling is defined as taking a small portion of a whole mass that accurately represents the whole mass. Since this site is primarily concerned with mining and mining issues, the sampling discussed here will be relative to mining, sampling of ores and processed products from mills, processing plants and mines.

6.2 Mineral Sampling:

Mostly residual waste is material that doesn't decompose or that can't be recycled. A primary example is most plastics although there are some that actually do break down over time. This is a very good reason not to throw trash on the ground or into the oceans or waterways. Creatures can become stuck in plastic rings such as those from drink cans. Certain chemicals don't break down or do so very slowly and can also cause severe damage to the environment. Glass, ceramics, many paints, oil, and a wide variety of industrial waste such as ash, contaminated soil, many electronic parts, etc.Proper sampling of tectonic deposits of minerals is essential to assess its economic viability of extraction. The sampling techniques used to attain this objective are described in this chapter for varying conditions such as incremental and continuous analysis for particles of different sizes, shapes, densities and for precious metals. Statistical approaches of analytical data are given to interpret results as accurately as possible. The forms in which metals are found in the crust of the earth and as seabed deposits depend on their reactivity with their environment, particularly with oxygen, sulfur, and carbon dioxide. Gold and platinum metals are found principally in the ***native*** or metallic form. Silver, copper, and mercury are found native as well as in the form of sulfides, carbonates, and chlorides. The more reactive metals are always in compound form, such as the oxides and sulfides of iron and the oxides and silicates of aluminum and beryllium. The naturally occurring compounds are known as ***minerals***, most of which have been given names according to their composition (e.g., galena—lead sulfide (PbS), cassiterite—(tin oxide, SnO_2).

6.3 Dispose of Samples:

- When samples cannot be re-used – Samples that were prepared for a one-time use as in the case for many instrumentation samples
- When samples have been contaminated – The integrity of the sample has been compromised, therefore results are unreliable
- When samples are broken, not well maintained,
- When samples are no longer needed, dispose of samples properly.
- Lab space is limited.

Keeping space free of unwanted samples provides an organized working environment, in addition to reducing risks of contamination and/or injury.

Rules and regulation during Storing or disposing residues and samples:

- Always check the proper storage location of samples
- Be sure samples are properly labeled and organized

- Submit an inventory of samples
- be sure to put the samples in a location that they can easily find
- Valuable samples should be in a location that are known to remaining group members
- Properly dispose of any samples that can be discarded

Follow sample labeling guidelines as ;

- Name, date, sample name (or structure), notebook code, collection site information (if applicable)
- Choose a label and storage container most appropriate for:
- Type and size of sample
- Length of storage – Location of storage
- Keep samples organized. Categorizing by project, type, researcher, etc.
- When samples are no longer needed, are contaminated, and/or degraded, dispose of them properly
- When leaving laboratory, be sure samples are in a loca2on that can be easily accessed by remaining group members and PI.

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least four Rules and regulation during Storing or disposing residues and samples.
2. What is the importance of Mineral Sampling?
3. What are the guidelines for sample labeling?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: ____________________________ Date: ________________

Short Answer Questions

LG #31	LO-#8 Carry out post operational procedures

Instruction Sheet	

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Carrying out Routine operator servicing, Maintenance and Housekeeping tasks
- Providing operator support during preparation and conduct of major maintenance
- Maintaining and processing records and reports

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Carry out Routine operator servicing, Maintenance and Housekeeping tasks
- Provide operator support during preparation and conduct of major maintenance
- Maintain and process records and reports

Learning Instructions:

14. Read the specific objectives of this Learning Guide.
15. Follow the instructions described below.
16. Read the information written in the "Information Sheets 1". Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
17. Accomplish from "Self-check 1 up to Self-check 3
18. Ask your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check).
19. If you earned a satisfactory evaluation from the "Self-check" proceed to "Operation Sheets.
20. Submit your accomplished Self-check. This will form part of your training portfolio.

Information Sheet-1	Carrying out Routine operator servicing, Maintenance and Housekeeping tasks

1.1 Routine operator servicing:

Proper care and servicing of drilling machines:-

- Test lubricant frequently.
- Check for signs of wear.
- Keep the machines clean.
- Sharpen important components.
- Check alignment specifications.
- Have maintenance and repair schedule, and keep good records.

a. Test lubricant frequently:

Lubricant reduces friction around any moving part. A schedule of good lubrication maintenance extends the life of the machines. You can also check for leak around the oil seals and ensure you have used the right lubricant. Getting a lubricant checked is a good way to diagnose problems with the machines. one of the largest manufacturers of water drilling rigs which offers Mud drilling; Air drilling; air foam drilling; top drive, recommends drill pipes joints and reducers to be lubricated with butter.

b. Check for signs of wear:

Vibration, shock, high temperature, friction and age all contribute to the breakdown of the parts in the machines

- Vibration can come from gears and belts that are out of alignment.
- Shock can come from accidents or from poor operator servicing.
- High temperature can come from extended use of friction, poor lubrication and worn out parts.

c. Keep the machines clean

There are many seals and filters in place of the machine to keep working parts clean and free of contamination. Seals should be inspected regularly to make sure they are in good condition.

Filters should be inspected and changed regularly. Breathers should be kept clean to avoid creating a vacuum in the cab which will suck contamination in the cab. Machines should be stored in the shed or other building if possible. Exposure to wind and weather can lead to rust, the machine should be run periodically if not in use. Machines in a friendly place and always check and replace the spare parts regularly.

Figure: water drilling machines

The modern day water drilling machines are the advanced forms of older manually operated water drilling machines that were hard to operate and required more labor and time to carry out the drilling tasks. Equipped with powerful motors these are quicker and highly efficient machinery designed for easy, consistent and precise drilling tasks. Efforts to apply drill to the work piece and carrying out drilling tasks are greatly reduced in today's user friendly and automated drill machines.

1.2 Maintenance of drilling machine:-

The drilling contractor should maintain logs, documenting all preventative maintenance performed on a given rig. Any maintenance determined to be necessary once the rig has arrived on location should be completed prior to drilling. Maintenance activities should never be performed while drilling.

Considerations when performing maintenance include the following:

- Never use gasoline or other flammables to perform cleaning duties around the rig.
- Place all transmissions, gearboxes, hydraulic valves, and hoist levers in neutral before initiating repairs.
- Have all preventative maintenance, or other scheduled maintenance, completed as recommended.
- Shut down the drill rig and remove the positive cable from the battery to clean, repair or lubricate fittings, unless the adjustment requires the rig to be running. The operator and lubricator must coordinate their efforts to successfully perform the maintenance safely.
- While performing maintenance, either remove or tag the key to prevent accidental starting of the rig.
- Apply grease and oil only through oil and grease inlets.

- Always chock wheels, lower leveling jacks, and set hand brakes prior to working under a drill rig.
- Whenever possible, reduce operating systems to a zero energy state, that is, release all pressure from hydraulic, drilling fluid and air pressure systems, prior to performing maintenance. Use extreme caution when opening drain plugs, pressure caps, valves, and removing hoses and hydraulic lines.
- Never weld or cut on or near a fuel tank.
- Replace all caps, plugs, clamps, cables and guards prior to returning the rig to service.
- Never modify any part of the mast without permission from the equipment shop.
- If it should become necessary to drain oil, fuel, hydraulic fluid or any other industrial fluid in the field, never allow the fluid to drain onto the ground.

1.3 **Housekeeping tasks**:-

Maintaining a clean and tidy site with well-organized operations, equipment and stores is an important part of a good housekeeping program. Poor housekeeping at a drilling operation, including the camp, can lead to injuries, fires and damage to health.

Performing emergency evacuation; and practicing good housekeeping in the workplace according to environmental plan, government legislation, company standards and manufacturer specifications. Performing emergency shutdown; working around mobile equipment; working around rotating, stationary and portable equipment; working from tower/elevated work platform; lifting and carrying materials and/or supplies manually; locking out and tagging mobile and fixed equipment.

Maintain good housekeeping practices, store sampling supplies, coolers, tools, and equipment orderly and out of the main traffic area to avoid unnecessary slip, trip, and fall hazards.

Good housekeeping is a proactive approach to keeping the job-site clean which in-turn reduces accidents and injuries. A clean work environment adds to drilling speed and efficiency. Customers like it when you keep and leave a work-site clean because it shows professionalism. Together, good housekeeping improves working conditions and safety practices. Every crewmember should inspect the work site upon his arrival to assure that equipment is in safe condition and the job site is in proper order. Return the job site to proper order prior to proceeding with work. Housekeeping means cleaning-up, which is an ongoing part of drilling, rather than an occasional activity.

Follow these suggestions to make your housekeeping efforts more efficient:

- Identify where to unload equipment and supplies
- Put materials in a convenient place where they can be safely handled without hitting or falling on anyone
- Find a safe place for tools you pick up, not on the edge of a truck bed
- Drill rods, casing, augers, and similar tools should be orderly stacked on racks to prevent sliding, rolling, spreading, or falling
- Place fire extinguishers and first aid kits in easily accessible locations
- Decide on a location for trash collection: All trash should be placed in bags and stored in areas outside of the immediate work area.
- Determine a steam cleaning site that reduces the mess
- Every crew member is responsible for site clean-up
- Good housekeeping can eliminate most trip hazards
- Suitable storage locations should be provided for all tools, materials, and supplies so that tools, materials, and supplies can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor, without creating tripping hazards, and without protruding at eye or head level.
- Avoid storing or transporting tools, materials, or supplies within or on the mast of the drill rig.

- Pipe, drill rods, casing, augers, and similar drilling tools should be stacked orderly on racks or sills to prevent spreading, rolling, or sliding.
- Penetration or other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.
- Keep all controls, control linkages, warning and operation lights, and lenses free of oil, grease, and ice.
- Do not store gasoline in any portable container other than a self-closing, non-sparking, red container with flame arrester in the fill spout and having the word gasoline clearly visible. The container must also comply with all other hazard communication requirements.
- Dirty or contaminated pipe, drill rods, augers, or sampling equipment, should be moved away from the work area to prevent possible exposure to non-protected personnel and also to prevent cross contamination of clean materials.
- Wastewater and drilling fluids must be properly contained and labeled and stored out of the operational area.
- The use of additional footing safeguards (mats) should be evaluated on a case-by-case basis.
- Remove and dispose of empty bags or other containers, which have held drilling mud, cement or other dust producing materials.
- Do not leave items such as hand tools, rakes, shovels, or other small equipment left lying on the ground to pose a trip hazard.
- Never use compressed air for cleaning clothes.
- All unattended boreholes must be adequately covered or otherwise protected to prevent personnel, site visitors, or animals from falling into the hole. All open boreholes should be covered, protected, or back filled adequately and according to local and state regulations or customer requirements upon completion of the drilling project.

- Walk around, not over, obstacles. Carefully choose a walking path to avoid ruts and steep slopes. Walk around freshly placed fill, gravel, or rip-rap. Keep your eyes on the path.
- Avoid storing or transporting tools, materials, or supplies within or on the mast of the drill rig.

Self-Check -1	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

7. Mention at least two Housekeeping tasks.
8. What is the importance of Proper care and servicing of drilling machines?
9. How can maintain a drilling machine.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-2	Provide operator support during preparation and conduct of major maintenance

2.1 Operator Consideration pre- and post-drilling activities

The detailed planning of sample collecting requires close supervision of sample helpers to avoid non-representative sampling. Inspection of sample book entries by the project geologist should be routine to help identify incorrect procedures used in sample collecting; drillers' reports should receive similar attention**.** The first requirement for safe field operation is that everyone understands and fulfills the responsibility for maintenance and housekeeping on and around the drill rig.

- mapping, sampling and surveying
- Camp preparation
- Gridline preparation
- Work site preparation
- Drill pad preparation
- Down hole surveying
- Demobilisation and rehabilitation.

There are numerous incidents where personnel have died or been seriously injured through inadequate recognition of exploration hazards and risks. Thorough planning and preparation are critical elements for effective management of the hazards associated with these activities.

2.2 Site preparation:-

- The exploration area has been surveyed, and hazardous ground conditions delineated (e.g. old workings) or addressed (e.g. previously capped drillholes).

- ❖ Overhead powerlines or overhanging vegetation, underground services and other obstructions have been clearly identified.
- ❖ The camp is located to reduce exposure to natural hazards (e.g. fuel load, flood plains).
- ❖ The maintenance and storage facilities, and eating and ablution amenities are located to reduce exposure to drilling hazards and ensure hygienic conditions are maintained.
- ❖ Tracks to the camp and work sites are suitable for drilling, support and emergency vehicle access.
- ❖ There is a traffic management system for the camp and work sites, including designated parking areas and escape routes.
- ❖ Safety and warning signs at the camp and work sites are clear, legible and appropriately located.

Technical capabilities and equipment

- ➢ Drillers
- ➢ Public and private utility locators
- ➢ Traffic control and security
- ➢ Laboratory services (including data validation)
- ➢ Waste transportation and disposal

Pre-qualification requirements to be considered

- ✓ Medical and substance abuse surveillance
- ✓ Training and experience of personnel
- ✓ Age and condition of required equipment Environmental Remediation Drilling Safety
- ✓ Proof of adequate insurance
- ✓ Licenses and registrations
- ✓ Safety performance

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two Operator Consideration pre- and post-drilling activities.
2. List down the Pre-qualification requirements for driller operater.
3. What is the importance of Site preparation?

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

Information Sheet-3	Maintain and process records and reports

3.1 Definition

- The first requirement for safe field operation is that everyone understands and fulfills the responsibility for **maintenance and housekeeping** on and around the drill rig.
- Standardized work practice is a tool for maintaining productivity, quality, and safety, at high levels.
- Standardized work practice is defined as work in which the sequence of job elements has been efficiently organized, and is repeatedly followed by workers.

3.2 Maintain and process records and reports in mine work site:-

- Provides a basis for employee training
- Establishes process stability
- Reveals clear stop and start points for each process
- Assists audit and problem solving
- Creates baseline for kaizen
- Enables effective employee involvement
- Maintains organizational knowledge

A dust collector includes a dust container; a centrifugal separator installed inside the dust container to separate dust from air; a filter unit installed at a discharge hole of the centrifugal separator and provided with a filter member; and a dust-removing device for dislodging dust from the filter unit. The dust-removing device includes a dust removal unit including a dust-removing member having dust-removing projections formed on an undersurface thereof, wherein the dust-removing projections move back and forth while contacting the filter unit to dislodge dust from the filter unit; and a drive unit for providing driving power to the dust removal unit.

3.3 DRILLING OPERATION

Designers must design machinery and plant that is safe to use. Some examples of designing machinery for safe operation:

- Consider the type of seating an operator may use and the ease of using the controls from the seat.
- If an operator needs to move around a large machine, provide a portable emergency stop button.
- Give easy and safe access to areas that need regular maintenance. Access will be needed for cleaning, lubrication and adjustment. Maintenance considerations include:
    - ✓ routine adjustments – people should be able to do these with the machine stopped but without needing to remove safeguards or take apart any of the machine
    - ✓ when frequent access is needed – use interlocked guards
    - ✓ when access is difficult – consider self- lubrication or central lubrication for parts
    - ✓ Positive lock-off devices to stop the machine restarting accidentally, particularly if a machine was shut down in error

3.3.1 Maintenance

Work procedures should identify any maintenance needed to keep control measures effective. Looking at maintenance of control measures is an important part of the implementation process.

So maintenance can be done safely, consider:

- the ease of accessing parts
- ensuring machinery parts are safe to maintain
- ease of handling
- Designing machinery to reduce the range of tools and equipment needed for maintenance.

Servicing and maintenance considerations

When designing guards, consider what safe procedures are needed for their removal for repair, clearing jams and breakdowns.

Servicing matters to consider include:

- following documented safe work procedures, including manufacturers' instructions
- proximity to hot or sharp parts
- cool-down or warm-up periods
- run down periods
- lock-out provisions or permission for guard removal
- enough room to do tasks without risk of injury or strain
- stored energy in the machine or materials being processed
- any additional hazards from maintenance procedures – such as testing while the machine is unguarded (a 'dry run' or 'trial run'), working at heights, use of solvents
- Maintaining or updating service records.

Maintenance considerations include:

- ➔ where servicing is needed

- how much servicing is needed
- what kind of servicing is needed
- how often servicing needs to be done.

3.3 Equipment Inspection:-

Hazard and risk assessment is a process to determine how significant a hazard is and what harm it could cause. Inspect equipment at the start of each shift (pre-op) and at the end of each shift (post-op). Correct all major defects and safety defects prior to the start of work. Environmental

General Inspection Routine;

- Inspect drilling equipment, cranes, winches, generators and compressors prior to use - correct any identified problem before proceeding with work
- Verify that the emergency shutoff switch works
- Verify that preventative maintenance has been conducted
- Wear proper PPE: Hardhat, safety glasses with side shields, and steel-toed boots as a minimum
- Conduct tailgate safety meetings and facilitate a safe work culture
- Pre-qualify drilling subcontractors
- Verify that Drillers and Helpers have proper training and experience
- Refer to company specific Drilling Safety Guidelines, Subcontractor Health and Safety Requirements, and Behavior Based Safety procedures

3.3.1 Operational hazards

Hazards associated with cleaning, maintenance and repair, along with irregular hazards.

To keep people safe during inspections, cleaning, repairs, maintenance and emergencies:

- use isolation procedures whenever people need to enter the danger area around machinery for maintenance and repair
- make sure workers understand cleaning, repair, maintenance and emergency procedures
- put in place a regular inspection regime to identify any problems with machinery and guards
- identify and assess any other hazards specific to inspections, cleaning, repair, maintenance and emergencies
- take special precautions when workers cannot be seen or where there are multiple operating switches
- if dangerous parts need to move while a guard is open (for example: setting, fault finding, or maintenance), use safe operating procedures (such as speed as slow as practical, and two-hand hold-to-run inching controls with pendant) to minimise hazards and the risk of injury.

Mine Regulation requires employers must make sure machinery is safe to clean, maintain and repair. Procedures must be put in place for these activities and workers trained to follow them.

Every identified hazard must be assessed to see if it is a significant hazard – something that could cause serious harm. If it is a significant hazard, it must be controlled using the hierarchy of controls. A significant hazard should be eliminated, if it can't then isolated, and if that isn't practicable, controls should be put in place to minimize the hazard. If it is not a significant hazard the employer must still take all practicable steps to ensure the equipment is safe for employees to use.

Risk assessment

The process to assess hazards, select controls and to assess whether these methods have reduced or eliminated the risk of harm occurring.

To manage risks effectively, an assessment of how likely a hazard is to cause harm must occur and, if it does, how badly someone can be hurt. This helps to prioritise which hazards need to be dealt with first.

Any risk assessment should cover:

- where, which and how many workers could be injured or harmed
- how often this is likely to occur
- How serious any injuries might be.

For example, with hazards from moving, rotating or reciprocating machinery, first assess how likely it is that a worker could get caught, entangled or nipped, and then determine how serious any injury might be.

Risk factors to consider during the risk assessment include:

- Visibility – how easy is it to see the hazard?
- Orientation (eg feed screw that is low and horizontal could entangle hair, ties and jewellery. A screw in a different place or angle would pose a different risk).
- Anticipated work practices, including less obvious ones such as:
- maintenance, inspection, repair and cleaning practices (eg a screw conveyor is behind closed panels, but when it jams, a worker may open the panel and stick their hand in)
- Infrequent or one-off tasks required on the machine.

When assessing the risk, take into consideration:

- whether the danger zone can be reached
- The likelihood of a worker putting fingers, hands, arms, feet or legs into places where they do not normally go when the machine is running.

Key for arrows:

Solid red arrows = where a part of the body could be drawn into a nip-point

Grey arrows = movement of machine parts

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Mention at least two process records and reports in mine work site.
2. What is the advantage of Standardized work practice?
3. List down the considerations for Servicing and maintenance equipment.

***Note:* Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = ___________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions

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This Teaching, Training and Learning Materials (TTLM) was developed on April 2017 at Adama, Dire International Hotel.

The trainers who developed the learning guide

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