**FIELD: EARTH SCIENCE, GEOLOGY.**

**TASK ONE**

The main aim of undertaking this task is to have an understanding of what a rock cycle is. It will also explore what forces are driving the occurrence of this process and the steps that rocks go through to form and sometimes disintegrate and reform. Lastly, this task shall endeavour to explore the resulting types of rocks that arise from this cycle.

**THE ROCK CYCLE**

A rock cycle is a concept in geology that describes the transitions of rocks through geologic time among the three main rock types of sedimentary, metamorphic, and ingenious, with alterations taking place when each type of rock is forced out of its equilibrium conditions.

It can also be defined as a web of processes that outline how each of the three major types of rocks form and break down based on the different applications of heat and pressure.

According to BCCampus open education, the rock cycle is driven by two main forces, that is:

* The heat engine that moves materials around the core and the mantle leading to slow but very significant changes within the earth’s crust
* The hydrological cycle which is basically the movement of water, ice and air at the surface. It is powered by the sun.

Rock Cycle Steps

**Weathering**

Weathering is a process where rocks are broken down into smaller particles without any transporting agents at play. The main role is played by temperature extremities, biological involvements of nature and water.

It can be broken down into chemical, physical and biological influencing agents.

Physical

change of temperature rapidly or at extreme levels causes weathering. This happens when rocks freeze and thaw. Similarly, it takes place when tectonic plates pressure changes suddenly causing fissures, many a times occurring in rocky or mountainous places.

Chemical

This mainly occurs when rain water tries to react with the rock minerals and create other minerals or chemical compounds. It happens in damp and warm places where reactions take place at higher temperatures. There are three main chemical reactions that take place during this process. These are:

* Hydrolysis which is an acidic reaction through which soluble salts and clay are formed.
* Oxidation that involves formation of rocks rich in iron in the presence of oxygen
* Solution where carbon dioxide dissolves limestones in the presence of water to give new stones

Biological

Biological processes contribute to the rock breakdowns in the following ways:

* Boring through rocks for protection
* Cracking of rocks under pressure while growing
* Breaking down of rocks for purposes of building houses
* The releasing of acids into the rocks so as to extract nutrients necessary for survival

**Erosion and transport:**

Erosion is a natural process that involves breaking down bigger sized rocks into sans like particles in the presence of water or wind. The water in this process not only acts as a factor of reaction but as an agent of transportation as well. Activities like attrition, abrasion and solution as well as wind transportation gives rise to caves, new tributaries and cracks in large rocks while wind transportation gives rise to thinned down rocks.

**Deposition and sedimentation:**

Sedimentation is that constant settling down of small particles of sand, pebbles and other rock items that has been broken down from rocks. This is catalysed by:

Wind and water: river waters and glaciers from mountains gradually erode sand particles creating layers of sediments.

Biological influence: living things like plants and animals die and get sedimented due to great pressure from rocks.

Evaporation: chemicals like calcium carbonate and sodium chloride are sedimented in troughs and sea shores to create limestones and rock salts in that order.

**Burial and compaction:**

Once the sand particles are sedimented, they create layers which are soon covered by subsequent layers of new sediments and the process cycles on. This gives rise to pressure on the sedimented layers below. During this process, the minerals in the water act as a slow cohesive agent between the particles. Hence, the soft layers turn into solid rocks with minerals inside.

**Crystallization of Magma**

Magma, which is the liquid form of rocks under great pressure and temperature due to heat from the earth core, is both sticky or less viscous. Factors such as temperature and amount of dissolved gasses determine the crystallization process, with the less viscous form erupting and forming porous rocks. The more viscous ones form solid rocks with distorted grains

**Melting**

This is basically a reverse of the crystallization process. This happens as soon as the rocks reach the bottom of the earth. The more the temperature rises, so does the pressure. This causes them to melt and give rise to melted rocks called lava. The lava is then erupted where it cools down at the surface to form rocks. However, some rocks do not erupt and are thus forced to change characteristics giving rise to new forms of rock.

**Uplift**

This is the process of forming a crust of earth upwards due to natural forces causing movements in the tectonic plates. This explains how mountains rise higher while new islands come up in the middle of the oceans.

**Deformation and Metamorphism**

The constant pressure and sudden movements put some sedimentary and igneous rocks under great pressure. Such forces can create folds or fissures among the rocks and among all these events, rocks deform to create metamorphic rocks. Deformation basically means folding and faulting of rocks caused by compression and tension.

THE THREE MAIN TYPES OF ROCKS

Igneous rocks:

These are defined as rocks formed through the cooling and solidification of magma or lava (hot, molten rocks). Thus, they are also referred to as magmatic rocks. The magma can be derived from the partial melts of existing rocks in the mantle or crust of the planet.

Metamorphic rocks:

By definition, these are rocks that form as a result of an alteration to the pre-existing rocks due to changes in environmental conditions such as temperature variations, changes in pressure or mechanical stress.

Equally, they are derived from the process of addition or subtraction of chemical components or a combination of all these four factors.

Sedimentary rocks:

These are a type of rock that are formed by the accumulation or deposition of, or organic particles on the earth’s surface. They often have distinctive layering or bedding. They are produced by the processes of cementing, compacting and solidifying pre-existing unconsolidated sediments.

**TASK TWO**

This task seeks to comprehensively discuss how igneous rocks are classified based on their texture as well as their chemical composition. It will also will help one to clearly understand different rock types arising from these two main classifications.

IGNEOUS ROCKS CLASSIFICATION

Igneous rocks are classified according to their texture and composition.

Texture: this is the physical feel of an igneous rock to touch. It can be coarse- grained, fine-grained or a mixture of fine and coarse grained. This classification gives rise to the following igneous rock texture types: aphanitic, phaneritic, porphyritic, vesicular, glassy, pegmatitic and pyroclastic.

Composition: this is a consideration of the kind of minerals contained in an igneous rock. The determination of their chemical composition gives rise to rocks such as felsic, mafic, intermediate and ultramafic rocks. The main minerals found in igneous rocks are Feldspars, quartz or feldspathoids, olivines, pyroxenes, amphiboles, and micas

**TASK THREE**

This task sets out to explore various igneous rock textures and bring out a clear understanding of their nature.

IGNEOUS ROCK TEXTURES.

Aphanitic:

This consists of igneous rocks whose mineral crystals are so fine or small that they cannot be seen by the naked eye or by use of hand lens.

The aphanitic texture is as a result of faster cooling and solidification of liquid magma.

Phaneritic:

This relates to an igneous rock whose individual minerals are so coarse that they can be seen even with the naked eye.

They are intrusive rocks that cooled slowly enough to allow significant crystal growth.

Porphyritic:

These are igneous rocks with a distinct difference in mineral crystals. The larger crystals are called phenocrysts.

Since both extrusive and intrusive rocks can be porphyritic, then it means all types of igneous rocks can display some degree of porphyritic texture.

 They develop when magma that has been cooling slowly and crystalizing within the earth’s crust suddenly erupts at the surface causing the remaining uncrystallized magma to cool rapidly.

This is the typical characteristic of most volcanic rocks.

Vesicular:

A vesicle is a small cavity in an aphanitic or glassy igneous rock formed by expansion of a bubble of gas or steam during solidification of the rock. A rock formed through this process is called vesicular rock.

Vesicles help geologists understand the cooling history of extrusive (volcanic) rocks because lava contains large amounts of dissolved gasses that are later released as the lava hardens.

Rock types that display a vesicular texture are pumice and scoria

Glassy:

They are also called vitreous rocks, meaning having a shiny surface. These rocks form when magma or lava cools extremely fast that no crystals form. Hence, the rock formed looks like a block of coloured glass.

The chemical composition of these rocks is also of vital importance. The high silica (SiO2) found in felsic rocks causes a rock to form a glass much more readily than it would happen in low silica rocks such as basalt. Thus, the cooling rate of a felsic and mafic lava flow could be same, but the former will form a glass since it is packed with silica.

Pegmatitic:

This type of rock texture is one in which the mineral grains are exceptionally large, with the largest ones more than about three centimetres long. This texture is found in intrusive rocks.

Most of them are composed of quartz, feldspar and mica, with a similar silic composition as granite.

The presence of large crystals may not automatically imply that the cooling process was extremely slow in their formation. Contrary, they are believed to have formed from the last part of a magma body to crystalize. This final fluid fraction is found to contain very high amounts of volatile and trace elements.

The residual magma is said to undergo a phase separation into a melt phase and a hydrous phase that is saturated with silica, alkalis and other elements.

**TASK FOUR**

The main aim of this task is to clearly bring out an understanding of the various rock forming minerals and their chemical formula.

COMMON IGNEOUS ROCK-FORMING MINERALS

Some of the most common rock-forming minerals include:

**Quartz**(SiO2): It is the most abundant mineral on Earth and is a major component of many rocks, including granite, quartzite and sandstone. It is known for its hardness, resistance to weathering, and wide range of colours and crystal forms.

**Feldspars** (KAlSi3O8–NaAlSi3O8–CaAl2Si2O8): Feldspars are a group of rock-forming minerals that make up a significant portion of the Earth’s crust. The most common types of feldspars are orthoclase, plagioclase, and microcline

**Mica**: The general formula for minerals of the mica group is XY2–3Z4[O](https://www.britannica.com/science/oxygen)10(OH, F)2 with X = K, [Na](https://www.britannica.com/science/sodium), [Ba](https://www.britannica.com/science/barium), [Ca](https://www.britannica.com/science/calcium), Cs, (H3O), (NH4); Y = Al, [Mg](https://www.britannica.com/science/magnesium), [Fe](https://www.britannica.com/science/iron-chemical-element)2+, Li, [Cr](https://www.britannica.com/science/chromium), [Mn](https://www.britannica.com/science/manganese), V, Zn; and Z = [Si](https://www.britannica.com/science/silicon), Al, Fe3+, Be, [Ti](https://www.britannica.com/science/titanium).

**Amphibole**: amphiboles is R14[(OH)4 Si16O44]. In these formulas, R is Mg, Fe2+, or Ca

**Pyroxene**: Pyroxenes have the overall formula XY (Si, Al)2O6 where X depicts calcium, sodium, iron (II) or potassium and more commonly zinc, manganese or lithium, and Y includes ions of lower magnitude such as chromium, aluminium, iron (III), magnesium, cobalt, manganese, scandium, titanium, vanadium or even metal (II)

**Calcite**(CaCO3): Calcite is a common mineral that forms in sedimentary rocks, such as limestone and [marble](https://geologyscience.com/rocks/metamorphic-rocks/marble/). It is known for its rhombohedral crystal shape and effervescence in the presence of weak acids.

**Olivine**: Olivine in polarizing light. It provides its name to the set of associated minerals (the olivine group)—including tephroite (Mn2SiO4), monticellite (CaMgSiO4) and kirschsteinite (CaFeSiO4).

**Hematite**(Fe2O3) and magnetite (Fe3O4): These iron oxide minerals are common in many types of rocks and are important for their magnetic properties.

**Garnets:** [Garnets](https://www.geologypage.com/2014/03/garnet.html) are a set of minerals of silicate that have been used as gemstones and abrasives since the Bronze Age. They have the general chemical formula A 3B 2Si 3O 12, where A is a divalent cation (Fe 2+, Ca 2+, Mg 2+, Mn 2+) and B is a trivalent cation (Fe 3+, Al 3+, Cr 3+).

**Clay minerals:** Some clay minerals may be expressed using ideal chemical formulas as the following: 2SiO2·Al2O3·2H2O (kaolinite), 4SiO2·Al2O3·H2O (pyrophyllite), 4SiO2·3MgO·H2O (talc), and 3SiO2·Al2O3·5FeO·4H2O (chamosite).

**TASK FIVE**

The task seeks to bring an understanding of the various minerals and rocks that form under those various chemical formations.

MAFIC, ULTRAMAFIC, INTERMEDIATE AND FELSIC

Mafic:

This is a blend or a make- up of magnesium and ferric words to form the word mafic. This rock mineral is rich in magnesium and iron, with calcium also present. It also has a dark colour. Common rock forming mafic minerals are olivine, pyroxene, amphibole and biotite while common mafic rocks are basalt, diabase and gabbro.

Ultramafic:

These result from the metamorphism of mantle rocks and some oceanic crust. These contain mainly magnesium, silicon, and carbon dioxide. They also have small amounts of iron, calcium, and aluminium. They have a colour index of greater than 90. Here, the implication is that the percentage of mafic minerals like olivine and pyroxene are present in these rocks.

Felsic:

Felsic is a word derived from the two words feldspar and silica, of quartz, hence these are rocks that mainly contain feldspar, feldspathoids and silica. The most common felsic rocks are granite and rhyolite.
Intermediate:

This refers to the chemical composition of a rock that has 52- 63 percentage weight of silica. They are usually grey in colour and contain equal amount of dark and light-coloured minerals. Some of the main intermediate rocks are the extrusive andesite rock and the intrusive diorite rock while some of the intermediate minerals in these intermediate rocks are a mixture of felsic minerals like plagioclase and mafic minerals like pyroxene and biotite.

**TASK SIX**

This task seeks to bring out the nature of different rocks and their particular location whether on the surface or deep into the earth’s crust.

|  |  |  |
| --- | --- | --- |
| **Rock** | **Intrusive/ Extrusive** | **Mafic/ Ultramafic/Intermediate/Felsic** |
| Peridotite  | Intrusive  | Ultramafic  |
| Basalt  | Extrusive  | Mafic |
| Gabbro  | Intrusive  | Mafic  |
| Andesite  | Extrusive  | Intermediate  |
| Diorite  | Intrusive  | Intermediate  |
| Rhyolite  | Extrusive  | Felsic  |
| Granite  | Intrusive  | Felsic  |

**TASK SEVEN**

This particular work aims at clearly bringing out the three main types of volcanoes and their distinctive characteristics.

THREE MAIN TYPES OF VOLCANOES

A volcano is an opening in the earth’s crust through which lava, volcanic ash and gasses escape from its interior.

Volcanoes are classified into three types. These are:

* Cinder cone volcanoes
* Composite volcanoes or stratovolcanoes
* Shield volcanoes

Cinder cone volcanoes:

They are also called pyroclastic cones or scoria cones.

They form as a steep conical hill consisting of loose pyroclastic fragments such as volcanic clinkers, volcanic ash or scoria that has been built around a volcanic vent.

They are formed when the gas charged lava is blown violently into the air and breaks into small pieces or fragments that fall as cinders, clinkers or scoria around the vent. The feature forming is symmetrical in shape with slopes of 30 – 40 degrees with a nearly circular ground plan.

They are the smallest, simplest and most common type of volcano.

Cinder cones are found in many parts of the world such as in Canada, Australia, Philippines, Peru, Russia Italy, Turkey, Unites States, New Zealand among others.

The main characteristics of this type of volcano can be summarised as:

* They are the smallest
* They are rarely more than 1,000 feet tall
* The form on the surface of larger volcanoes hence creating a very active surface.
* They do not erupt for very long.

Composite volcanoes:

These are large, cone shaped volcanoes built from many layers of lava, pumice, ash, and tephra.

 They are tall, symmetrically shaped with steep sides that sometimes rise to 10,000 feet high.

Famous composite volcanoes include Mount Fuji in Japan, and Mount Shasta and Mount Lassen in California

Some of the salient characteristic features of these volcanoes are:

* **Acidic lava** that is very viscous (sticky).
* Steep sides due to the fact that the lava doesn't flow very far before it solidifies.
* Alternate layers of ash and lava. This is the reason why they're also known as stratovolcanoes.
* Violent eruptions.
* Longer periods between eruptions.

Shield volcanoes:

This type of volcano derives its name from its low profile that resemble a warrior’s shield lying on the ground.

It is formed by the eruption of highly liquid lava that travels farther and forms thinner flows that cover large areas as compared to the more viscous lava that erupt from a stratovolcano.

They tend to erupt basalt lava which is of low viscosity, the reason why it flows long distance.

There are some shield volcanoes that are active. A good example is the Fernandina Island whose most recent eruption was in April 2009. We also have inactive shield volcanoes that have depressions since the magma chamber empties. Because of insufficient underground support, it collapses forming a caldera. An example of an inactive shield volcano with a caldera is Crater Lake in Oregon, USA.

* Shield volcanoes have the following characteristics:
* Consists of high temperature magma that is basaltic but very low in silica and gas content.
* It produces fluid lava with very little explosive activity
* It is very basic, generally non acidic and very low viscosity
* It forms gentle sides as the lava is able to flow for long distances before solidifying
* It has shorter periods between eruptions