Name

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Course

Date

1. **Describe the rock cycle; be sure to define each rock type (igneous, sedimentary and metamorphic) and briefly describe the processes that lead to the formation of each;**

The rock cycle is a continuous process that describes how rocks on Earth are formed, changed, and reformed over time. It involves three main types of rocks: igneous, sedimentary, and metamorphic.

**Igneous Rocks**: Igneous rocks are formed from the solidification of molten magma or lava. When magma cools and solidifies beneath the Earth's surface, intrusive igneous rocks are formed. These rocks have a coarse-grained texture due to slow cooling. Examples include granite and gabbro. When lava erupts onto the Earth's surface and rapidly cools, extrusive igneous rocks are formed. These rocks have a fine-grained texture. Examples include basalt and obsidian.

**Sedimentary Rocks**: Sedimentary rocks are formed from the accumulation and lithification (compaction and cementation) of sediments. Sediments are particles of rock, mineral fragments, organic matter, or chemical precipitates that are transported and deposited by wind, water, ice, or gravity. Over time, these sediments are compacted by the weight of overlying layers and cemented by minerals, forming sedimentary rocks. Examples include sandstone, limestone, shale, and conglomerate.

**Metamorphic Rocks:** Metamorphic rocks are formed from the transformation of existing rocks due to changes in temperature, pressure, and the presence of fluids. These changes occur deep within the Earth's crust, typically in regions of high heat and pressure, such as near tectonic plate boundaries or during mountain-building processes. The original rock, known as the protolith, undergoes recrystallization and reorganization of its minerals, resulting in the formation of new minerals and a change in texture and structure. Examples of metamorphic rocks include marble, slate, gneiss, and schist.

1. **Igneous rocks are classified based on their TEXTURE and COMPOSITION. Define texture and composition**

***Texture:***

Texture refers to the size, shape, and arrangement of the mineral grains or crystals within an igneous rock. It provides information about the cooling history and rate of the molten rock (magma or lava) from which the rock formed.

***Composition:***

Composition refers to the overall chemical makeup of an igneous rock, specifically the types and proportions of minerals present. It depends on the original composition of the magma or lava from which the rock formed.

1. **Define the following igneous rock textures: aphanitic, porphyritic, vesicular, glassy and** **pegmatitic.**

**Aphanitic:** Aphanitic texture refers to a fine-grained texture in igneous rocks where individual mineral grains are too small to be individually visible to the naked eye. The term "aphanitic" comes from the Greek word "aphanes," meaning "invisible." This texture indicates rapid cooling of lava on the Earth's surface, which leads to quick crystal formation. The small mineral grains in aphanitic rocks are typically not distinguishable without the use of a microscope. Examples of aphanitic igneous rocks include basalt and rhyolite.

**Porphyritic**: Porphyritic texture refers to a mixed texture in igneous rocks that consists of larger mineral grains (phenocrysts) embedded within a finer-grained matrix (groundmass). This texture indicates two stages of cooling: initial slow cooling beneath the surface, allowing larger crystals to form (phenocrysts), followed by a rapid cooling on the surface, resulting in the fine-grained groundmass. The phenocrysts are often larger and more visible compared to the surrounding matrix. Porphyritic rocks can exhibit a range of compositions and are commonly found in volcanic or plutonic environments. Examples include andesite and porphyry.

**Vesicular:** Vesicular texture refers to a texture in igneous rocks that is characterized by the presence of numerous small cavities or vesicles within the rock. These cavities are formed when gas bubbles are trapped in the molten rock during solidification. The rapid release of gas during volcanic eruptions creates these voids. Vesicular rocks have a spongy appearance and are often lightweight. Pumice is a well-known example of a vesicular igneous rock.

**Glassy:** Glassy texture refers to a non-crystalline texture found in some igneous rocks where the rock lacks any visible mineral grains. It occurs when lava cools so rapidly that mineral crystals do not have time to form. The resulting rock has a glass-like appearance and can be translucent or transparent. Obsidian is a prime example of a glassy igneous rock and is formed from the rapid cooling of felsic lava.

**Pegmatitic:** Pegmatitic texture refers to a coarse-grained texture found in certain igneous rocks, characterized by exceptionally large crystals. These crystals are often several centimetres to meters in size and can be much larger than those found in typical igneous rocks. Pegmatitic rocks form under specific conditions, such as the presence of water-rich fluids and slow cooling rates, which allow for the growth of large crystals. These rocks are commonly found in the late stages of magma cooling and are known for their diverse mineral compositions. Pegmatite is an example of a pegmatitic igneous rock.

1. **List the common igneous rock-forming minerals (there are eight or nine) and give their formulas**.

* Quartz: SiO2
* Feldspar (Orthoclase, Plagioclase):
* Orthoclase Feldspar: KAlSi3O8
* Plagioclase Feldspar: (NaAlSi3O8 - CaAl2Si2O8)
* Mica (Biotite, Muscovite):
* Biotite: K (Fe, Mg)3AlSi3O10(OH)2
* Muscovite: KAl2(AlSi3O10) (OH)2
* Amphibole (Hornblende): Ca2(Mg, Fe)4Al (Si7Al) O22(OH)2
* Pyroxene (Augite): (Ca, Na) (Mg, Fe, Al) (Al, Si)2O6
* Olivine: (Mg, Fe)2SiO4
* Plagioclase feldspar: (NaAlSi3O8 - CaAl2Si2O8)
* Magnetite: Fe3O4

1. **Define ULTRAMAFIC, MAFIC, INTERMEDIATE, and FELSIC**

ULTRAMAFIC, MAFIC, INTERMEDIATE, and FELSIC are terms used to describe the composition of igneous rocks based on their silica (SiO2) content. These terms are commonly used in geology to categorize igneous rocks according to their chemical composition and mineral content. Let's define each of these terms:

**Ultramafic**: Ultramafic rocks have the lowest silica content (less than 45%) among the four categories. They are primarily composed of mafic minerals, such as olivine and pyroxene, with little to no feldspar or quartz present. Ultramafic rocks are typically dark green to black in colour and are rich in iron (Fe) and magnesium (Mg). Examples of ultramafic rocks include peridotite and komatiite. Ultramafic rocks are commonly associated with mantle-derived magmas and are often found in areas of tectonic activity, such as mid-oceanic ridges or within the Earth's mantle.

**Mafic**: Mafic rocks have a moderate silica content (45-52%) and are composed predominantly of dark-coloured minerals, such as pyroxene and olivine, along with some calcium-rich plagioclase feldspar. Mafic rocks are typically dark in colour, ranging from dark Gray to black, and are relatively rich in iron (Fe) and magnesium (Mg). Basalt, gabbro, and diabase are examples of mafic rocks. Mafic rocks are commonly associated with volcanic activity, such as oceanic crust formation or basaltic lava flows.

**Intermediate:** Intermediate rocks have a higher silica content (52-66%) compared to mafic rocks but lower than felsic rocks. They are characterized by a combination of dark-coloured minerals, such as amphibole and pyroxene, and light-coloured minerals, such as plagioclase feldspar. Intermediate rocks often display a mix of dark and light colours and have a balanced composition between mafic and felsic components. Diorite and andesite are examples of intermediate rocks. Intermediate rocks commonly form in subduction zones or as intermediate products of magma differentiation.

**Felsic**: Felsic rocks have the highest silica content (above 66%) among the four categories. They are primarily composed of light-coloured minerals, such as quartz, feldspar (orthoclase and plagioclase), and muscovite. Felsic rocks are typically light in colour, ranging from white to pink or grey. Granite and rhyolite are examples of felsic rocks. Felsic rocks are commonly associated with continental crust and are often found in areas with ancient orogenic activity, such as mountain ranges.

1. **For each of the following igneous rocks state if it is extrusive or intrusive and whether it is ultramafic, mafic, intermediate, or felsic. Peridotite Basalt Gabbro Andesite Diorite Rhyolite Granite**

**Peridotite:** Peridotite is an intrusive igneous rock. It is primarily composed of ultramafic minerals, such as olivine and pyroxene. Peridotite is found deep within the Earth's mantle and is associated with the formation of oceanic lithosphere.

**Basalt:** Basalt is an extrusive igneous rock. It is mafic in composition, containing minerals such as pyroxene and plagioclase feldspar. Basalt is commonly found in volcanic regions and forms from the rapid cooling of lava on the Earth's surface.

**Gabbro:** Gabbro is an intrusive igneous rock. It is mafic in composition and composed mainly of minerals such as pyroxene and plagioclase feldspar. Gabbro forms deep beneath the Earth's surface through slow cooling and crystallization.

**Andesite:** Andesite can be both extrusive and intrusive, depending on its formation. It is an intermediate igneous rock with a composition between mafic and felsic. Andesite typically contains minerals such as plagioclase feldspar and amphibole. Extrusive andesite forms from volcanic eruptions, while intrusive andesite forms through the slow cooling of magma beneath the surface.

**Diorite:** Diorite is an intrusive igneous rock. It is intermediate in composition and consists of minerals such as plagioclase feldspar and amphibole. Diorite forms through the slow cooling and crystallization of magma deep within the Earth's crust.

**Rhyolite:** Rhyolite is an extrusive igneous rock. It is felsic in composition and rich in minerals like quartz, feldspar, and biotite. Rhyolite forms from the rapid cooling of lava on the Earth's surface, often associated with explosive volcanic activity.

**Granite**: Granite is an intrusive igneous rock. It is felsic in composition and composed mainly of minerals such as quartz, feldspar, and biotite. Granite forms deep within the Earth's crust through slow cooling and crystallization.

***To summarize:***

Peridotite: Intrusive, Ultramafic

Basalt: Extrusive, Mafic

Gabbro: Intrusive, Mafic

Andesite: Both extrusive and intrusive, Intermediate

Diorite: Intrusive, Intermediate

Rhyolite: Extrusive, Felsic

Granite: Intrusive, Felsic

1. **List and define the three types of volcanos**

The three main types of volcanoes are shield volcanoes, stratovolcanoes (composite volcanoes), and cinder cone volcanoes

***Shield volcanoes****:*

A shield volcano is a type of volcano characterized by its low-profile, gently sloping shape resembling a warrior's shield or a flattened dome. Shield volcanoes are typically formed by the eruption of fluid basaltic lava, which flows easily and covers large areas.

Shield volcanoes provide a fascinating glimpse into the processes of volcanic activity and the behavior of basaltic lava flows. Their relatively calm eruptions and widespread lava flows contribute to the formation of unique landscapes and can have significant impacts on the surrounding environment.

Here are more descriptions about the shield volcanoes

**1. Shape and Size:**

Shield volcanoes have a broad, rounded shape with gentle slopes. They can be massive in size, covering extensive areas. Unlike other volcano types, shield volcanoes have a relatively low height compared to their width. This is due to the relatively fluid lava flows that spread out over large distances, allowing the volcano to grow outward rather than building up in height.

**2. Lava Composition:**

Shield volcanoes are primarily composed of basaltic lava, which is low in silica content and has low viscosity (ability to flow). The low viscosity of the lava allows it to travel long distances from the central vent before solidifying. Basaltic lava is typically dark in color and rich in iron and magnesium.

**3. Eruption Style:**

Shield volcanoes are associated with effusive eruptions, characterized by the relatively quiet and steady flow of lava from the central vent. The eruptions are generally non-explosive, with the lava flowing out in streams or channels rather than erupting violently. This is due to the low viscosity of the lava, which allows it to flow easily.

**4. Lava Flows:**

The primary mechanism of growth for shield volcanoes is the continuous eruption and gradual accumulation of basaltic lava flows. The lava spreads out in all directions from the central vent, creating broad, flat layers. The lava flows tend to be relatively thin, which contributes to the gentle slopes of the volcano.

**5. Volcanic Features:**

Shield volcanoes often have a central vent or a summit caldera, which is the point where the lava is erupted. They may also have secondary vents or fissures along the flanks, through which additional lava can be released. These secondary vents can form long, linear features known as rift zones.

**6. Example Locations:**

Some of the most well-known shield volcanoes are found in the Hawaiian Islands, including Mauna Loa and Kilauea. These shield volcanoes are notable for their large size, extensive lava flows, and ongoing volcanic activity. Other examples of shield volcanoes can be found in Iceland, the Galapagos Islands, and the Canary Islands.

***Composite volcanos***

A composite volcano, also known as a stratovolcano, is a tall and steep-sided cone-shaped volcano composed of alternating layers of solidified lava flows, volcanic ash, and pyroclastic deposits. Composite volcanoes are characterized by their explosive eruptions and are known for their hazardous nature.

Composite volcanoes provide a dramatic and hazardous display of volcanic activity. Their explosive eruptions and accumulation of pyroclastic materials make them significant geological features, and studying them is crucial for understanding volcanic processes and mitigating volcanic hazards.

Here are more descriptions about the shield volcanoes

**1. Shape and Size:**

Composite volcanoes have a distinct conical shape with steep sides. They are tall and can reach great heights, often towering over the surrounding landscape. The steep slopes are a result of the accumulation of alternating layers of lava, ash, and pyroclastic materials.

**2. Lava Composition:**

Composite volcanoes are composed of a variety of volcanic materials, including andesite and rhyolite. These lavas have higher silica content compared to the basaltic lavas found in shield volcanoes. The higher silica content results in higher viscosity (thickness) of the lava, making it more resistant to flow and more prone to explosive eruptions.

**3. Eruption Style:**

Composite volcanoes are associated with explosive eruptions. The eruptions are characterized by the violent ejection of volcanic materials, such as ash, pyroclastic flows, and gas. These explosive eruptions are caused by the buildup of pressure within the volcano due to the high viscosity of the magma. The eruptions can release a combination of ash clouds, lava flows, and pyroclastic flows.

**4. Pyroclastic Deposits:**

One of the defining features of composite volcanoes is the accumulation of pyroclastic materials. These materials include volcanic ash, pumice, and rock fragments that are ejected during explosive eruptions. The pyroclastic deposits form layers around the volcano and contribute to its cone shape.

**5. Volcanic Hazards:**

Composite volcanoes are considered highly hazardous due to their explosive nature. The eruptions can release ash clouds that can travel long distances, affecting air quality and posing risks to aviation. Pyroclastic flows, which are fast-moving currents of hot ash, gas, and rock fragments, can be extremely destructive and pose a significant threat to nearby communities. Other hazards associated with composite volcanoes include lahars (mudflows), volcanic gases, and landslides triggered by volcanic activity.

**6. Example Locations:**

Some well-known examples of composite volcanoes include Mount Fuji in Japan, Mount Vesuvius in Italy, Mount St. Helens in the United States, and Mount Pinatubo in the Philippines. These volcanoes are known for their historical eruptions and their impact on surrounding areas.

***Cinder cones volcanos:***

A cinder cone volcano, also known as a scoria cone volcano, is a small, cone-shaped volcano that is primarily formed by the accumulation of pyroclastic materials around a central vent. Cinder cone volcanoes are the simplest and smallest type of volcanoes. While they may be relatively small in size compared to other volcano types, they still play an important role in the volcanic landscape.

Cinder cone volcanoes provide valuable insights into volcanic processes and eruption dynamics. While they may be smaller in size and have relatively short lifespans, their eruptions can still pose hazards to the surrounding areas. Understanding the formation and behavior of cinder cone volcanoes contributes to our overall understanding of volcanic activity and assists in assessing volcanic hazards.

Here is a full description of cinder cone volcanoes:

**1. Shape and Size:**

Cinder cone volcanoes have a characteristic cone-shaped appearance with steep sides. They are generally smaller in size compared to composite and shield volcanoes, typically ranging from tens to hundreds of meters in height. The slopes of cinder cones are steeper than those of shield volcanoes due to the accumulation of loose pyroclastic materials.

**2. Eruption Style:**

Cinder cone volcanoes are associated with explosive eruptions. The eruptions are characterized by the ejection of pyroclastic materials, such as volcanic ash, lapilli (small rock fragments), and scoria (cinder). These materials are ejected into the air and fall back to the ground, forming a cone-shaped pile around the vent.

**3. Pyroclastic Deposits:**

The main feature of cinder cone volcanoes is the accumulation of pyroclastic deposits around the vent. These deposits consist of fragmented volcanic material, which is typically dark and porous. Scoria, a type of basaltic rock with gas bubbles trapped within, is the most common type of material found in cinder cones. The accumulation of these pyroclastic materials gives the volcano its characteristic cone shape.

**4. Single Vent:**

Cinder cone volcanoes typically have a single vent from which the volcanic material is ejected. The vent is a central opening through which gases, ash, and other volcanic materials are expelled during eruptions. Unlike composite volcanoes with multiple vents, cinder cone volcanoes have a single focal point of eruption.

**5. Short Lifespan:**

Cinder cone volcanoes have relatively short lifespans compared to other types of volcanoes. They are often formed by a single eruptive event or a series of brief eruptions. Once the volcanic activity ceases, the cinder cone volcano is typically dormant and does not produce further eruptions.

**6. Example Locations:**

Cinder cone volcanoes can be found in various volcanic regions around the world. Examples include Paricutin in Mexico, Sunset Crater in the United States, and Cerro Negro in Nicaragua. These examples showcase the characteristic cone shape and the accumulation of pyroclastic materials around the central vent.