

Unit 4:

Minerals and rocks



1. The Earth's layers

2. Minerals

2.1. Classification of minerals

2.2. Properties of minerals

3. Rocks

3.1. Magmatic rocks

3.2. Metamorphic rocks

3.3. Sedimentary rocks

3.4. The rock cycle

4. Uses of minerals and rocks

Think and answer?

- What is a rock? What is it composed by?
- Could you an example of a rock and other of a mineral?
- How are rocks classified? What criteria do we used to do it?
- What are minerals and rocks used for?

UNIT OBJECTIVES

In this unit you will learn:

- To distinguish between minerals and rocks
- To distinguish main types of minerals and rocks
- To identify the properties of minerals
- To classify rocks by their properties and origin
- To identify the processes of the rock cycle
- The uses of rock and minerals in our daily life.

1. The Earth's layers

We can distinguish four layers or "spheres" in the Earth. These "spheres" are interrelated. They are:

- **The geosphere.** It is the solid part of the Earth.
- **The atmosphere.** It is the gaseous part of the Earth.
- **The hydrosphere.** It is the liquid part of the Earth.
- **The biosphere.** It is the living part of the Earth.

1.1. The geosphere

The Earth's inside is divided into three concentric layers:

a) The crust

This is the outermost layer of the Earth. It is very thin, just only a few kilometers. It is solid and is composed by *silicates*. There are two types of crust:

- **Continental crust**
It makes up the continents.
It is thicker than the oceanic crust.
The most common rock on it is *granite*.
- **Oceanic crust**
It makes up the ocean floor.
It is thinner than the continental crust.
The most common rock on it is *basalt*.

b) The mantle

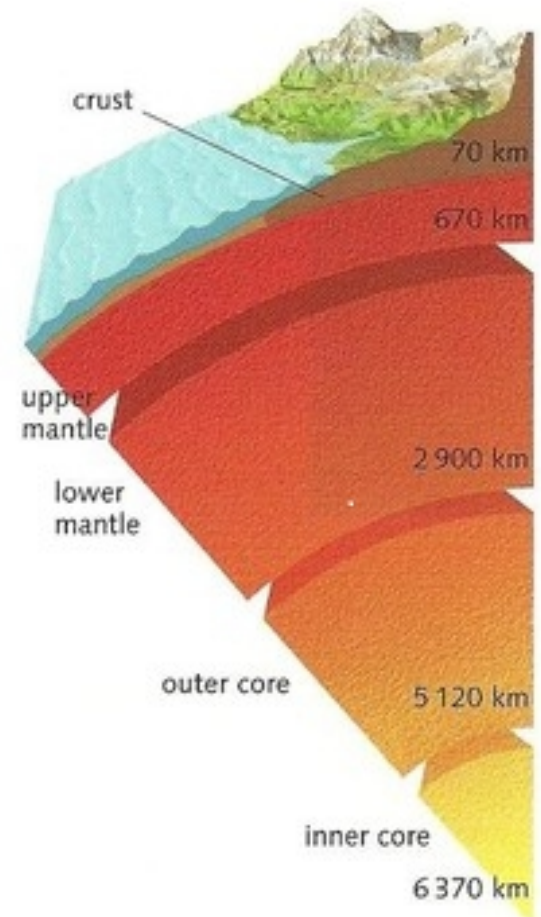
This is the middle layer. It is situated just below the crust. It is a very thick layer, about 2.900 km thick. It is composed by a rock called *peridotite*. It is a semi-solid layer and it is divided into two parts:

- **The upper mantle**
- **The lower mantle**

c) The core

This is the innermost layer. It is situated just below the lower mantle. It is the thickest layer, about 3.500 km thick. Its composition is mainly *iron*. It is divided into two concentric layers:

- **The outer core.** It is liquid.
- **The inner core.** It is solid



The crust and the upper part of the upper mantle form the **lithosphere**. This layer is divided into pieces called *tectonic plates*. Below the lithosphere is a layer of semifluid rock called **asthenosphere**, which forms part of the upper mantle.

5.2. The atmosphere

This is the layer of gases that surrounds the Earth. The mixture of gases that forms the atmosphere is called **air**.

5.3. The hydrosphere

This is the discontinuous layer of **water** that covers the Earth. This water can be as liquid water, as ice and as water vapour.

5.4. The biosphere

This is the layer formed by all **living beings** in the Earth. It constantly interacts with the lithosphere, the atmosphere and the hydrosphere.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

1.1. Relate the following characteristics with the correspondent layer of the Earth:

- It is just below the crust and made up of peridotite.
- It contains all the water on the Earth.
- It is the thinnest Earth's layer. It is only a few kilometres.
- It is composed of a mixture of gases called air.
- It is divided into two layers, the outer one of them is liquid.

1.2. Explain which is the main differences between:

- the inner core and the outer core
- the upper mantle and the lower mantle
- the continental crust and the oceanic crust

1.3. Correct the following sentences:

- The lithosphere is the flexible outermost part of the Earth.
- The crust and some of the core make up the lithosphere.
- Tectonic plates are large pieces that form the asthenosphere.
- The lithosphere is a layer of semifluid rocks.
- The atmosphere and the hydrosphere are solid layers.
- The biosphere is composed of all living beings in the Universe.

1.4. Listen and indicate what layer of the Earth is described:

- Atmosphere
- Hydrosphere
- Geosphere
- Biosphere

2. MINERALS

The terrestrial crust is formed by different materials.

The most important ones are **minerals** and **rocks**.

- **Minerals:** They are substances that have to be:
 - *Solid* at room temperature, that is to say, they cannot be liquids or gases.
 - *Inorganic*, that is to say, they cannot be formed by living beings.
 - *Defined chemical composition*, that is to say, they are formed by one or more elements in a certain proportion that we can express with a chemical formula.
 - *Natural origin*, that is to say, they are not made up by humans.
- **Rocks:** They are solid substances formed by the combination of minerals.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

2.1. Look at the chart and indicate why these substances cannot be considered minerals.

Substance	State (at room temperature)	Inorganic	Chemical composition	Natural origin
Water	Liquid	Yes	H ₂ O	Yes
Mercury	Liquid	Yes	Hg	Yes
Bone	Solid	No	Ca ₃ (PO ₄) ₂	Yes
Plastic	Solid	Yes	Undefined	No

2.2. What is the difference between a mineral and a rock?

2.3. Listen and indicate what characteristic of minerals is described:

- a. Solid
- b. Inorganic
- c. Defined chemical composition
- d. Natural origin

2.1. COMPOSITION OF MINERALS

The main chemical elements that form the composition of minerals are: oxygen (O), silicon (Si), aluminium (Al), iron (Fe), calcium (Ca), sodium (Na), potassium (K) and magnesium (Mg).

Other elements exist in very small proportion: carbon, gold, copper, uranium, etc.

Minerals can be classified by their chemical composition in two main groups:

- **Silicates:** they are formed by the most frequent elements: oxygen and silicon. They are the most abundant minerals on the Earth. For example: *quartz, feldspar, mica, olivine*, etc.
- **Non-silicates:** they are formed by other compounds and do not contain silicon. It can be distinguish several groups:
 - **Native elements:** they are made up of a single element. For example, *gold*.
 - **Oxides:** They are made up of oxygen and other element. For example, *oligiste*.
 - **Sulphides:** They are made by sulphur and a metal. For example, *galena*.
 - **Carbonates:** They are made up of carbon, oxygen and a metal. For example, *calcite*.
 - **Halides:** They are made up of a metal and chloride or fluoride. For example, *halite*

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

2.4 What is the difference between silicates and non-silicates?

2.5. Match each term with its composition:

- | | |
|--------------|-------------------------------|
| a. Oxide | 1. Metal + chloride/ fluoride |
| b. Sulphide | 2. Oxygen + another element |
| c. Carbonate | 3. Sulphur + metal |
| d. Halide | 4. Carbon + oxygen + metal |

2.6. Diamonds are 100% carbon. Which group of minerals do they belong to? Why?

2.2. PROPERTIES OF MINERALS

They are physical characteristics that can be observed and determined in a simple way. The chemical composition and the disposition of the atoms influence many physical properties:

- **Density:** It is the relationship that exists between the mass of the mineral and its volume.
- **Hardness:** It is the resistance that the mineral has to being scratched. To define the hardness of a mineral we use the *Moss scale of hardness*.
 - If it can be scratched with your fingernail it is soft (low hardness)
 - if it does not scratch glass it is hard (half hardness)
 - if it scratches glass it is very hard (high hardness).



- **Colour:** It depends on the light that is absorbed or reflected by the mineral. Some mineral have always the same color, but others can be different colors because small differences in their chemical composition, such as quartz.
- **Streak:** It is the colour of the mineral in powder form. This is constant in each one.
- **Shine:** It is the aspect that the surface offers when reflecting light. It can have:
 - metallic shine (as metals)
 - adamantine (as diamond)
 - pearly (as mother-of-pearl)
 - fatty (as oil)
 - silky (as silk)
 - vitreous (as glass), etc.
- **Exfoliation (or cleavage):** It is the ability of a mineral to break easily in parallel sheets.
- **Diaphaneity:** It is the grade of transparency of the mineral. It can be:
 - opaque (if it doesn't allow light to pass)
 - translucent (if it allows light to pass, but not images)
 - transparent (if it allows light and images to pass).

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

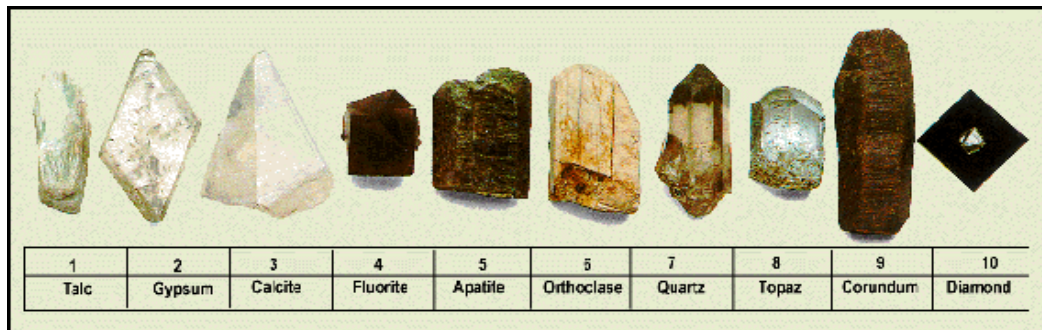
2.7. Identify the property that is talking about in each sentence and cross out the italics incorrect option:

- It is the resistance to be scratched. To measure it we use the *Mohs scale / Grade of transparency*.
- The minerals can be *metallic / vitreous* or non-metallic. If they don't have this property we say it is *dull / transparent*.
- This property refers to the ability of a mineral to break along *fragments / planes* of weakness.
- This property *is /is not* constant in each mineral and it refers to the colour of the mineral in powder.
- Minerals can be transparent, translucent or *dull / opaque*.

2.8. Read the following description of the galena and identify the properties it is talking about:

"Galena is formed from lead sulfide (PbS) (1). It is soft and easily breaks along the planes of a cube (2). It doesn't let light pass through it (3) and it is a deep shiny metal colour (4) and leaves a dark grey powder (5)."

2.9. Look at the Mohs scale and answer the questions:



- What minerals can be scratched with a fingernail?
- What minerals can scratch glass?
- Which of the minerals is the hardest one? Can it scratch the rest of them?
- What minerals are softer than *Orthoclase*? What minerals are harder?
- What number has *Orthoclase* in the *Mohs scale*? And the rest of minerals?

2.10. Listen and indicate what mineral property is described:

- Density
- Hardness
- Colour
- Strike
- Shine (or lustre)
- Exfoliation (or cleavage)
- Diaphaneity

3. ROCKS

The solid part of the Earth is made up of rocks. Rocks are any natural, inorganic material made up of minerals.

Most part of them is compounded by several minerals and is solid. But some rocks are made of a single substance and others can be found in liquid form, for example, oil.

According to their origin rocks can be classified as:

● Sedimentary rocks:

They are formed by the accumulation and compaction of sediment.

These sediments can be:

- **fragments** of the rocks are carried to where they are then deposited.
For example: *conglomerate*, *sandstone*, etc
- accumulated **chemical substances** in the bottom of seas, lakes, etc.
For example: *gypsum*.

● Metamorphic rocks:

Forces inside the Earth cause that a rock change into another type, without melting.

They are formed from other rocks by the effects of high **temperature** and **pressure**.

- due to the high pressure.
For example: *slate*.
- due to the high temperature
For example: *marble*.

● Magmatic (or igneous) rocks:

They are formed from cooled magma.

Magma is molten rocky material below the Earth's surface.

When the magma cools down:

- slowly, inside the terrestrial crust, for example: *granite*.
- quickly, when it surfaces from volcanoes, for example: *basalt*.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

3.1. Answer these questions:

- a. What is a rock?
- b. We can classify them in three types, which are they?
- c. What criteria do we used to do it?

3.2. Match these columns:

- | | |
|----------------------|--|
| a. Sedimentary rocks | 1. They formed when magma cools down |
| b. Metamorphic rocks | 2. They form because temperature and pressure |
| c. Magmatic rocks | 3. They can form inside the crust or on surface |
| | 4. Some of them came from fragments of other rocks |
| | 5. They form when a sediment become a rock |
| | 6. They form without melt. |

3.3. Listen and identify what type of rock is described:

- | | | |
|------------------|---------------------|---------------------|
| a. Magmatic rock | b. Metamorphic rock | c. Sedimentary rock |
|------------------|---------------------|---------------------|

3.1. Magmatic rocks

Magmatic rocks are formed as a result of the cooling and solidification of magma. **Magma** is the melted, rocky material formed below the Earth's crust or mantle.

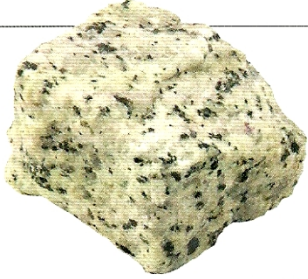



There are two types of igneous rocks:

- Plutonic (intrusive) rocks

They form as magma cools slowly under the ground over thousands of years. As a result, the mineral crystals are large and well done.

- Volcanic (extrusive) rocks

They form as lava cools rapidly on the surface of the Earth. As a result, the mineral crystals are tiny.

COMMON IGNEOUS ROCKS Formed by the solidification of magma	Plutonic rocks: slow cooling, large crystals.	Granite	<ul style="list-style-type: none"> • Made up of quartz, feldspars and small quantities of mica and other minerals • Large, visible crystals • The most common rock in the continental crust • Many colours – pink to grey and black • Very hard and strong 	
	Volcanic rocks: quick cooling, tiny crystals, vitreous. As a result, the crystals are not visible.	Basalt	<ul style="list-style-type: none"> • Dark or black colour • Heavy and hard • It may contain olivine crystals • It may have a few bubble holes • The most common rock on the ocean floors 	
		Pumice	<ul style="list-style-type: none"> • Mostly light colours • Light weight and floats in water • Spongy texture from bubble holes 	
		Obsidian	<ul style="list-style-type: none"> • Black and smooth • Looks like black glass • The edges can cut 	

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

3.4. What is the difference between:

- plutonic or intrusive rocks and volcanic or extrusive rocks
- magma and lava


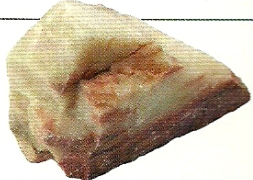
3.5. In which type of magmatic rock can you see minerals most clearly? Why?

3.2. Metamorphic rocks

Metamorphism is a slow process which occurs deep in the Earth.

Metamorphic rocks are formed deep within the Earth by the effects of intense heat and pressure on sedimentary, igneous or other metamorphic rocks.

These rocks do not melt, but the minerals inside them are changed by heat and pressure. The rocks become hard and compact. Metamorphic rocks rarely have fossils.

		Common metamorphic rocks	Appearance	Properties	
Classification of metamorphic rocks	Foliated	Slate	Usually black, slightly shiny because of the presence of mica	Hard, but can be separated into thin layers or sheets (foliation)	
	Non-foliated	Marble	Many different colours. Often with veins	Does not separate into layers. Marble reacts with acids, such as vinegar or hydrochloric acid, producing CO ₂ bubbles	

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.




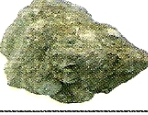




3.6. Indicate the main difference between a metamorphic rock and a magmatic rock.

3.3. Sedimentary rocks

a) Types of sedimentary rocks

Sedimentary rocks are classified into three groups: detrital, chemical and organic.

- **Detrital rocks** are made up of fragments of other rocks that are stuck together.
- **Chemical sedimentary rocks** are made of mineral crystals from oceans, lakes and groundwater that have dissolved in water.
- **Organic sedimentary rocks** are made of plant and animal remains which have been transformed into minerals.

		Common sedimentary rocks	Formed by	Properties	
Classification of Sedimentary Rocks	Detrital	Conglomerate	Fragments of rock and some sand	Round or angular fragments	
		Sandstone	Small grains of sand	Grains break off if scratched	
		Clay	Very small grains	Different colours. Smells like wet earth when wet	
	Chemical	Limestone (Many types)	Chemical reactions. All contain calcium carbonate.	Reacts to acids by producing bubbles	
		Gypsum	Evaporation of the water in deposits	Very soft. Can be scratched with a fingernail	
		Rock salt		Tastes salty	
	Organic	Coal	Remains of land vegetation	Soft, black. Burns easily	
		Oil	Remains of marine plants and animals	Thick, black liquid	

b) Formation of sedimentary rocks

It begins with the accumulation and consolidation of sediment or of rock fragments.

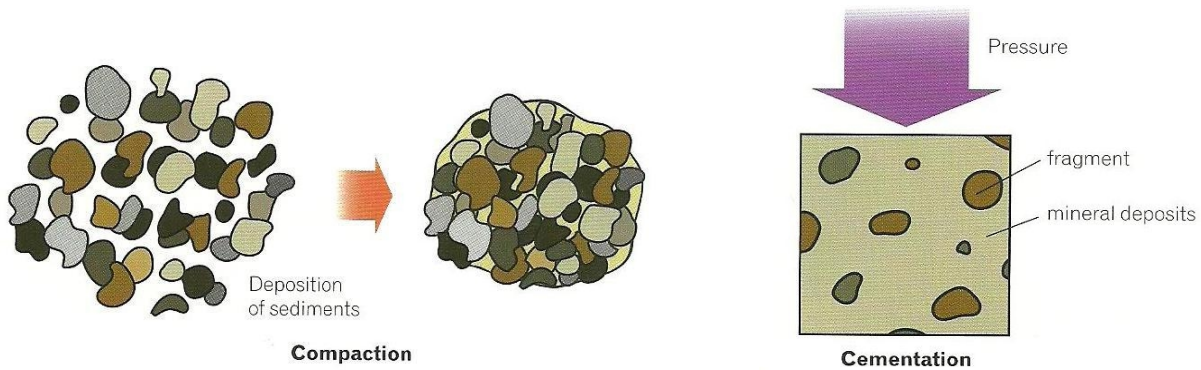
Rocks are fragmented by:

- **Weathering.** Rocks at the surface of the Earth are broken up by the action of atmospheric phenomena (changes in temperature, rain, etc), or by the activities of plants and animals.
- **Erosion.** These broken fragments of rocks are swept away by running water, glaciers, waves or wind.

The deposition of sediments in layers, in lakes or seas, takes place over millions of years.

The deposited sediments are transformed into compact, cohesive rocks by two processes:

- **Compaction.** The weight of successive layers of sediment compacts the sediments. This pressure reduces the spaces between the fragments and squeezes out the water. As a result, salt crystals are formed.
- **Cementation.** The rock fragments are stuck together with the salt crystal which formed when the water was eliminated.



Each layer of sediments is transformed into a layer of sedimentary rock, called a **stratum**.

Organic sedimentary rocks are formed because the rests of vegetation and microscopic marine animals and plants was covered quickly by sediments, avoiding the putrefaction. In this environment, of high pressure and temperature and without air, some kind of bacteria changes the organic matter into coal or oil.

c) Fossils

Sedimentary rocks sometimes contain remains of living things that lived millions of years ago. These remains are called **fossils**. Fossils become part of the rocks, during the processes of compaction and cementation of sediments. Fossils provide invaluable information about the history of life on Earth.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

3.7. Name some examples of:

- a. Detrital sedimentary rocks
- b. Chemical sedimentary rocks
- c. Organic sedimentary rocks

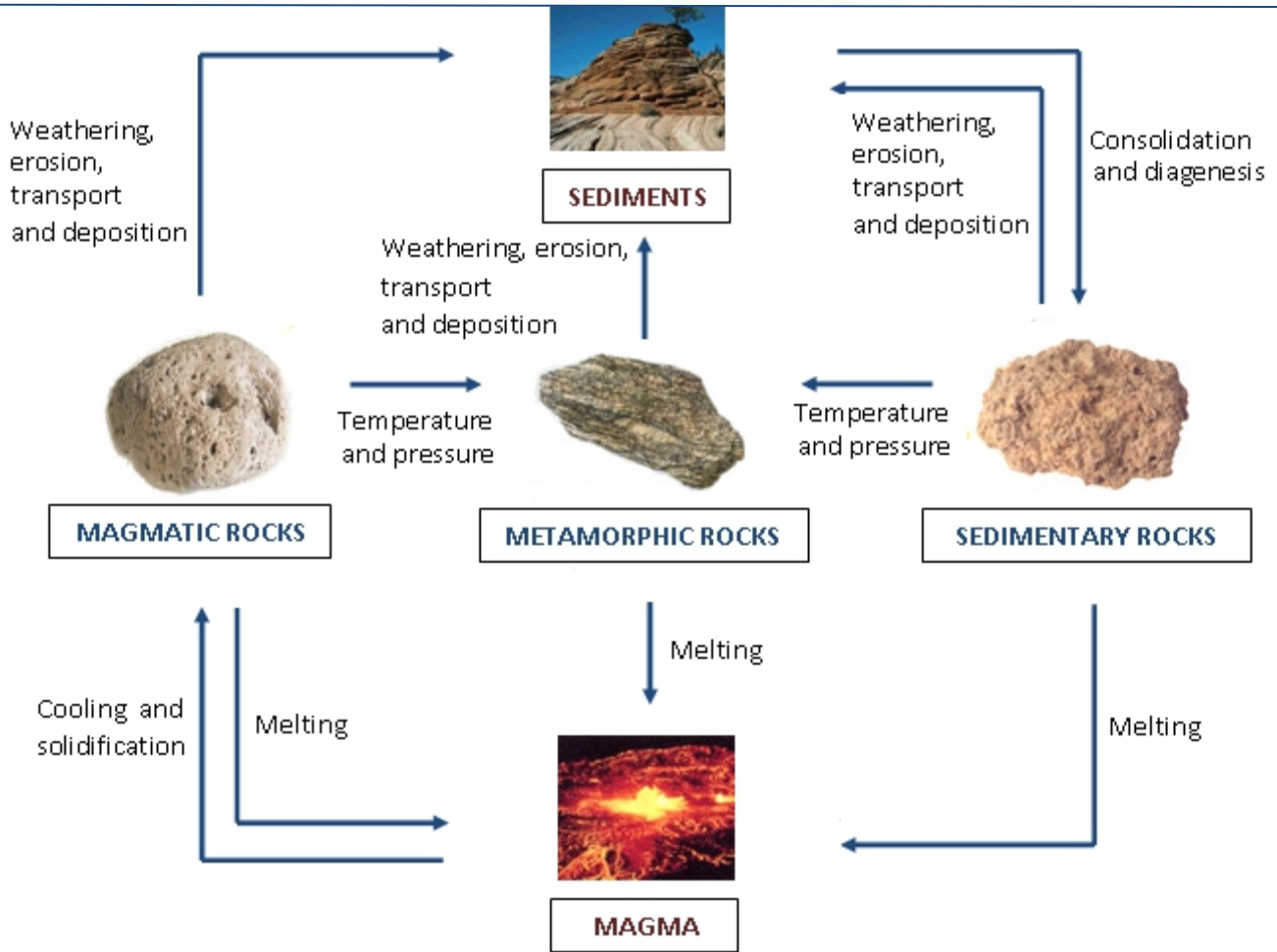
3.8. Define:

- a. Compaction
- b. Fossil
- c. Stratum

3.4. The rock cycle

The **rock cycle** is a set of processes which form, change and recycle rocks over time. These processes can take thousands or even millions of years.

On the Earth's surface, weathering and erosion break down and transport rocks. Under the Earth's surface, rocks go through processes which change them. As a result, they become new rocks. The cycle is continuous.



READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

3.9. Indicate the factor that changes:

- A metamorphic rock into magma.....
- Magma into a magmatic rock.....
- A magmatic rock into a sediment.....
- Sediment into a sedimentary rock.....
- A sedimentary rock into a metamorphic rock.....

3.10. Complete the diagram about the rock cycle, putting in their place the following labels. Pay attention, you have to repeat some of them.

Weathering, erosion, transport and deposition

Magmatic rocks

Consolidation and diagenesis

Metamorphic rocks

Cooling and solidificatio

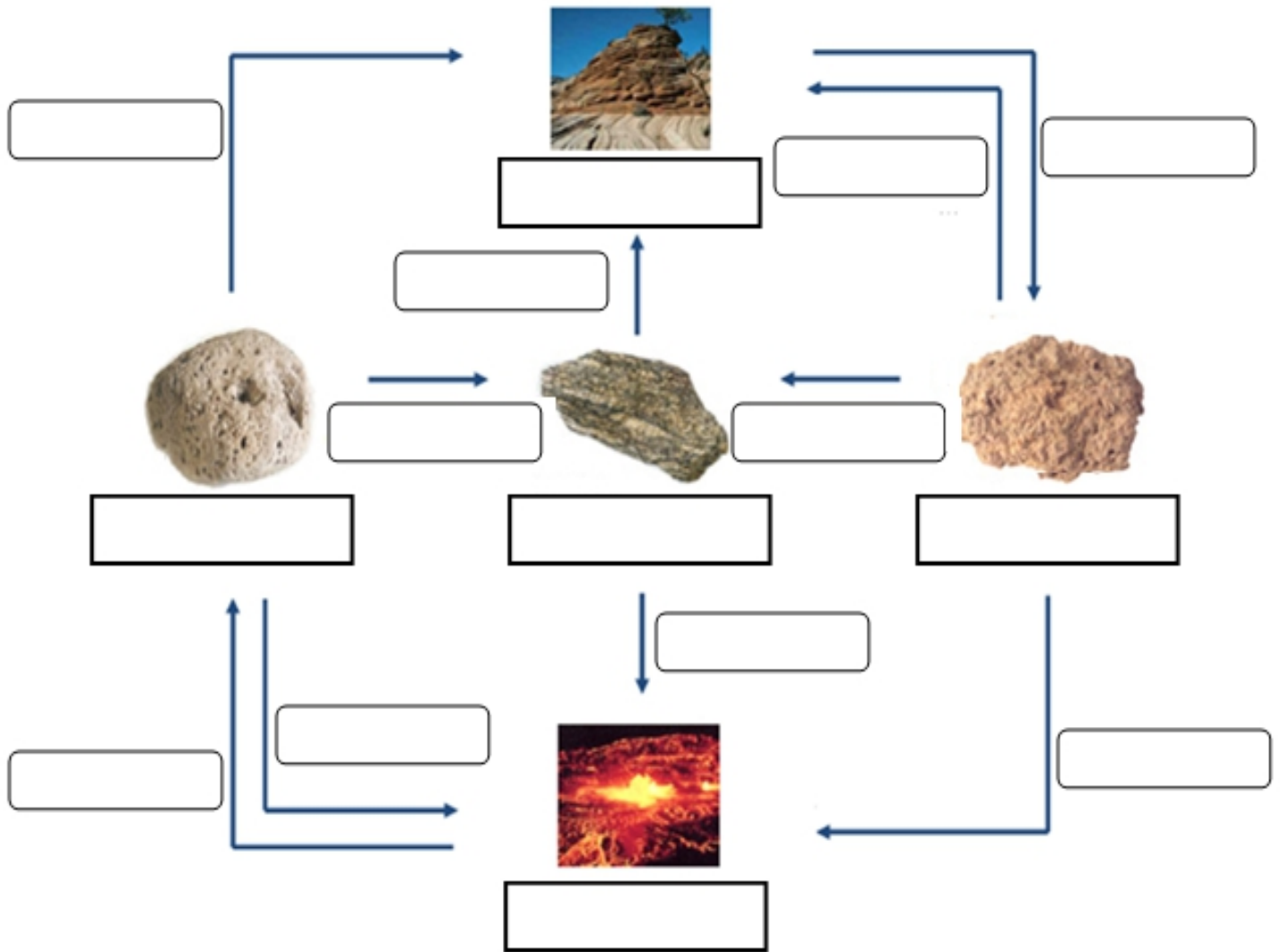
Sedimentary rocks

Melting

Sediments

Temperature and pressure

Magma



4. USES OF MINERALS AND ROCKS

a) Minerals

- **Ores:** They are the minerals that are useful to us. They are extracted from mines. They are profitable when the benefit is bigger than the expenses of exploitation.
- **Non ores:** are the minerals that are not profitable.
 - **Metal-bearing ore:** are those that provide us with metals.
 - *Iron (Fe):* is extracted from loadstone, hematite, etc.
 - *Copper (cu):* is extracted from chalcopyrite.
 - *Lead (Pb):* is extracted from galena.
 - *Aluminium (Al):* is extracted from bauxite.
 - **Non metal-bearing ore:** are the minerals that don't give metals.
 - *Construction materials:* such as talc, sulphur, graphite, gypsum, etc.
 - *Jewellery:* such as diamond, emerald, sapphire, ruby, etc. Receives the name of precious stones or gems. They are valuable because of their colour, rarity and beauty.

b) Rocks

In the past, stone was used to make buildings, bridges, city walls, aqueducts, roads, etc. Today, most modern constructions are not made of stone. However, they usually contain some form of rock.

- **Construction materials.** Granite, limestone and slate are strong, decorative, and provide good insulation. They are used to make walls and roofs. They also serve as raw materials to manufacture other products.
 - **Cement** is made of limestone and clays. It is used to make concrete. Concrete is used for roads, bridges, dams and entire buildings.
 - **Plaster** is made of gypsum and other ingredients. It is used on interior walls.
 - **Ceramic materials** are made of clay. They are used for tiles, bricks, and bathroom pieces like sinks and toilets.
- **Decoration.** Granite and marble are the most popular. They are used for sculptures, floors, etc. They are easy to carve and polish to a smooth, shiny finish.
- **Containers.** Clay is used to make pottery and china. After the pieces are decorated, they are glazed and fired. This makes them much stronger.
- **Fuels.** Coal and oil are used in transportation, industry, heating and to produce electricity
- **Chemical industry.** Oil is used to make plastics, paints, fertilizers, synthetic fibres and many other products.

READING ACTIVITIES

After reading the text, copy and answer the following questions into your notebook:

Remember: you must make complete sentences.

4.1. What is the difference between ores or non-ores.

4.2. Put the verb in brackets into the correct form to complete the sentence.

- Gypsum (*to form*) a raw material used to make useful substances
- Paint and pigments (*to be*) made of minerals
- Precious stones (*to be*) very valuable but they (*not to be*) very common.
- People (*to use*) noble metals to make jewellery because they are easy to work with.
- Platinum is valuable because it (*not to change*) with time.

4.3. Label each photo with one of the uses of rocks.



A Stonehenge, in England, is made of sandstone.



B The Roman aqueduct in Segovia is made of granite.



C Many buildings are decorated with stone.



D Concrete, glass and metals are made from rock.



E Many statues and monuments are made of marble.



F Clay is used to make plates and pottery.



G Refineries process oil into fuel.



H Plastics are made from oil.