

This unit deals with

Minerals, elements, characteristics of minerals such as crystal form cleavage, fracture, lustre, colour, streak, transparency, structure, hardness specific gravity, important minerals such as feldspar, quartz, pyroxene, amphibole, mica, olivine and their characteristics classification of minerals, rocks, igneous, sedimentary, metamorphic rocks rock cycle

Minerals found in the crust are in solid form whereas in interior they are in liquid form 98% of the crust consist of eight elements

1. oxygen
2. Silicon
3. Aluminium
4. Iron
5. Calcium
6. Sodium
7. Potassium
8. Magnesium

the rest is constituted by titanium, hydrogen, phosphorous, manganese, sulphur carbon, nickel & other elements

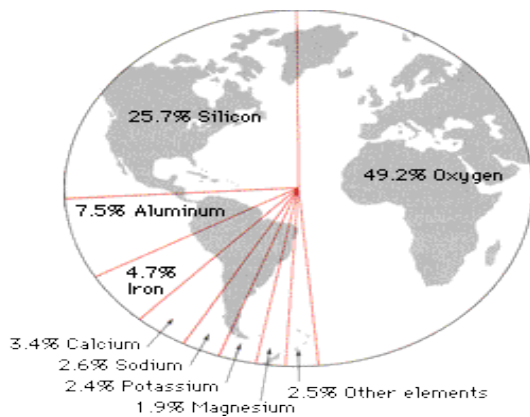


Table 5.1 : The Major Elements of the Earth's Crust

Sl. No.	Elements	By Weight(%)
1.	Oxygen	46.60
2.	Silicon	27.72
3.	Aluminium	8.13
4.	Iron	5.00
5.	Calcium	3.63
6.	Sodium	2.83
7.	Potassium	2.59
8.	Magnesium	2.09
9.	Others	1.41

Many elements found in combination with other elements. These substances are called minerals

Mineral: naturally occurring inorganic substance having an orderly atomic structure and a definite chemical composition and physical properties.

It is composed of two or three minerals /single element ex. S, Cu, Ag, Au, Graphite.

There are at least 2000 minerals in the crust. There are at least six mineral groups which form rocks in the crust.

The basic source of all minerals is the hot magma in the interior of the earth. Coal, petroleum and natural gas are organic minerals

PHYSICAL CHARACTERISTICS OF MINERALS

(I) **EXTERNAL CRYSTAL FORM:** Internal arrangement of molecules-cube, octahedrons, hexagonal, prisms.

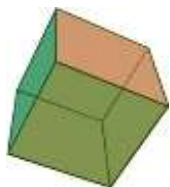


Figure 8 CUBE



Figure 9 HEXAGONAL

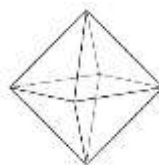


Figure OCTAHEDRONS

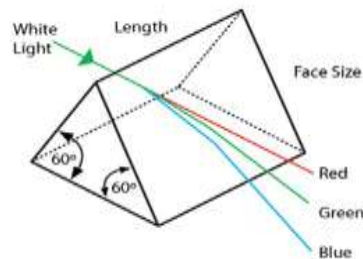
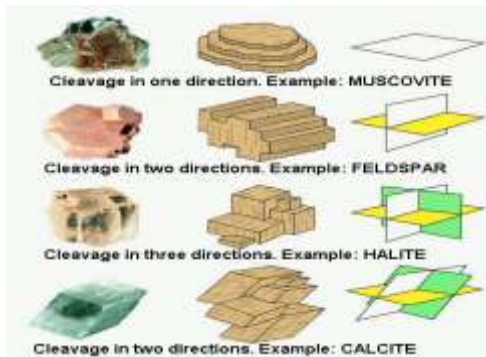


Figure 7 PRISM

(II) **CLEAVAGE:**



Tendency to break in given directions producing relatively plane surfaces, in any direction

**FRACTURE:** Conchoidal fracture



Obsidian

**Conchoidal fracture** is a curved breakage that resembles the concentric ripples of a mussel shell. It often occurs in amorphous or fine-grained minerals such as flint, opal or obsidian, but may also occur in crystalline minerals such as quartz. **Sub conchoidal fracture** is similar to conchoidal fracture, but not as curved. (Note that obsidian is an igneous rock, not a mineral, but it does illustrate conchoidal fracture well.)



**Earthy fracture**

Limonite

**Earthy fracture** is reminiscent of freshly broken soil. It is frequently seen in relatively soft, loosely bound minerals, such as limonite, kaolinite and aluminite.



**Hackly fracture**

Native copper

**Hackly fracture** (also known as **jagged fracture**) is jagged, sharp and uneven. It occurs when metals are torn, and so is often encountered in native metals such as copper and silver.



**Splintery fracture**

Chrysotile

**Splintery fracture** comprises sharp elongated points. It is particularly seen in fibrous minerals such as chrysotile, but may also occur in non-fibrous minerals such as kyanite.

**Uneven fracture**



Magnetite

**Uneven fracture** is self descriptive. It occurs in a wide range of minerals including arsenopyrite, pyrite and magnetite. The crystal breaks in an irregular manner not along the planes

## LUSTURE : Adamantine lustre



Cut [diamonds](#)

**Adamantine** minerals possess a superlative lustre, which is most notably seen in [diamond](#).<sup>[1]</sup> Such minerals are transparent or translucent, and have a high [refractive index](#) (of 1.9 or more).<sup>[2]</sup> Minerals with a true adamantine lustre are uncommon, with examples being [cerussite](#) and [zircon](#).<sup>[2]</sup>

Minerals with a lesser (but still relatively high) degree of luster are referred to as **subadamantine**, with some examples being [garnet](#) and [corundum](#)

### Dull lustre

#### [Kaolinite](#)



**Dull** (or **earthy**) minerals exhibit little to no luster, due to coarse granulations which scatter light in all directions, approximating a [Lambertian reflector](#). An example is [kaolinite](#).<sup>[3]</sup> A distinction is sometimes drawn between dull minerals and earthy minerals,<sup>[4]</sup> with the latter being coarser, and having even less lustre.

### Greasy lustre



Moss [opal](#)

**Greasy** minerals resemble fat or grease. A greasy lustre often occurs in minerals containing a great abundance of microscopic inclusions, with examples including [opal](#) and [cordierite](#).<sup>[2]</sup> Many minerals with a greasy lustre also feel greasy to the touch.<sup>[5]</sup>

### Metallic lustre



[Pyrite](#)

**Metallic** (or **splendant**) minerals have the lustre of polished metal, and with ideal surfaces will work as a [reflective surface](#). Examples include [galena](#),<sup>[6]</sup> [pyrite](#)<sup>[7]</sup> and [magnetite](#).<sup>[8]</sup>

### Pearly lustre



[Muscovite](#)

**Pearly** minerals consist of thin transparent co-planar sheets. Light reflecting from these layers give them a lustre reminiscent of [pearls](#).<sup>[9]</sup> Such minerals possess perfect [cleavage](#), with examples including [muscovite](#) and [stilbite](#).<sup>[2]</sup>

### Resinous lustre



#### [Amber](#)

Resinous minerals have the appearance of [resin](#), [chewing gum](#) or (smooth surfaced) plastic. A principal example is [amber](#), which is a form of fossilized resin.<sup>[10]</sup>

### Silky lustre

#### [Satin spar](#) variety of [gypsum](#)



Silky minerals have a parallel arrangement of extremely fine fibres,<sup>[2]</sup> giving them a lustre reminiscent of [silk](#). Examples include [asbestos](#), [ulexite](#) and the [satin spar](#) variety of [gypsum](#). A fibrous lustre is similar, but has a coarser texture.

### Submetallic lustre



[Sphalerite](#) Submetallic minerals have similar lustre to metal, but are duller and less reflective. A submetallic lustre often occurs in near-opaque minerals with very high refractive indices,<sup>[2]</sup> such as [sphalerite](#), [cinnabar](#) and [cuprite](#).

### Vitreous lustre



#### [Quartz](#)

Vitreous minerals have the lustre of [glass](#). (The term is derived from the Latin for glass, *vitrum*.) This type of lustre is one of the most commonly seen,<sup>[9]</sup> and occurs in transparent or translucent minerals with relatively low refractive indices.<sup>[2]</sup> Common examples include [calcite](#), [quartz](#), [topaz](#), [beryl](#), [tourmaline](#) and [fluorite](#), among others.



## Waxy lustre



### [Jade](#)

Waxy minerals have a lustre resembling [wax](#). Examples include [jade](#)<sup>[11]</sup> and [chalcedony](#).<sup>[12]</sup>

## Optical phenomena

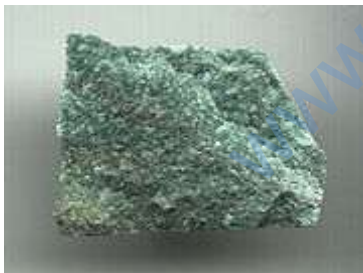
### Asterism



Sapphire [cabochon](#)

**Asterism** is the display of a star-shaped luminous area. It is seen in some [sapphires](#) and [rubies](#), where it is caused by impurities of [rutile](#).<sup>[12][13]</sup> It can also occur in [garnet](#), [diopside](#) and [spinel](#).

### Aventurescence



Aventurine **Aventurescence** (or **aventurization**) is a reflectance effect like that of [glitter](#). It arises from minute, preferentially oriented mineral platelets within the material. These platelets are so numerous that they also influence the material's body colour. In [aventurine quartz](#), chrome-bearing [fuchsite](#) makes for a green stone and various [iron oxides](#) make for a red stone.<sup>[12]</sup>

### Chatoyancy



### [Tiger's eye](#)

**Chatoyant** minerals display luminous bands, which appear to move as the specimen is rotated. Such minerals are composed of parallel fibers (or contain fibrous voids or inclusions), which reflect light into a direction perpendicular to their orientation, thus forming narrow bands of light. The most famous examples are [tiger's eye](#) and [cymophane](#), but the effect may also occur in other minerals such as [aquamarine](#), [moonstone](#) and [tourmaline](#).

## Colour change



### Alexandrite

**Color change** is most commonly found in Alexandrite, a variety of [chrysoberyl](#) gemstones. Other gems also occur in color-change varieties, including (but not limited to) [sapphire](#), [garnet](#), [spinel](#).

Alexandrite displays a color change dependent upon light, along with strong [pleochroism](#). The gem results from small scale replacement of aluminum by chromium oxide, which is responsible for alexandrite's characteristic green to red color change. Alexandrite from the [Ural Mountains](#) in Russia is green by daylight and red by incandescent light. Other varieties of alexandrite may be yellowish or pink in daylight and a columbine or raspberry red by incandescent light. The optimum or "ideal" color change would be fine emerald green to fine purplish red, but this is exceedingly rare.

### Schiller[Labradorite](#)



**Schiller**, from German for "twinkle", is a term used to describe the metallic iridescence originating from below the surface of a stone, that occurs when light is reflected between layers of minerals. It is seen in [moonstone](#) and [labradorite](#) and is very similar to [adularescence](#) and [aventurescence](#).<sup>[14]</sup>

appearance of material without regard to colour-metallic silky

glossy



**COLOUR** : some colours determined by molecular structure ex. malachite, azurite, chalcopryrite some because of impurities found the crystal.

**STREAK** : colour of the ground powder of any mineral Ex. Malachit -green, fluorite - purple/white



**TRANSPARENCY:** Transparency **Definition:** Transparency refers to the degree to which light can pass through a mineral.

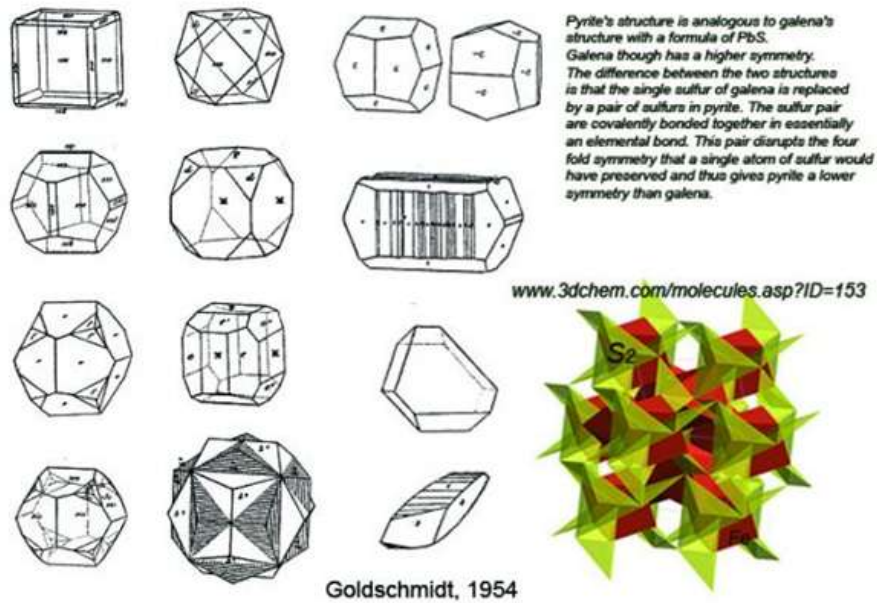
**Terminology:** *Opaque* - no light can pass through the mineral;

*Translucent* - light can pass through the mineral but is diffused so that images cannot be seen clearly;

*Transparent*- light can pass through the mineral and images can be seen clearly.







1. Transparency -light rays pass through 2.translucent-light pass through but diffused 3.opaque-light doesnot pass through.








### Magnetite

(III) **STRUCTURE** : particular arrangement of the individual crystals - fine medium, or coarse, coarse grained fibrous, separable divergent radiating

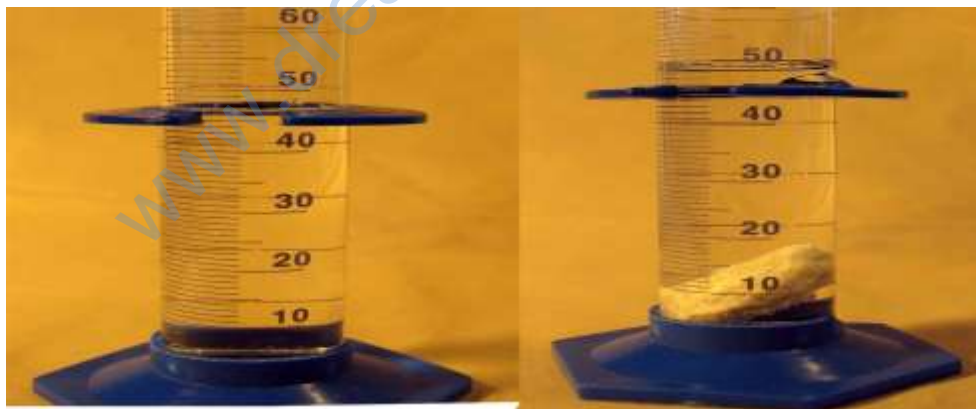
**HARDNESS**: as corundum. The table below shows comparison with absolute hardness measured by a sclerometer, with pictorial examples. <sup>[7][8]</sup>

Mohs hardness	Mineral	Chemical formula	Absolute hardness	Image
1	<u>Talc</u>	$Mg_3Si_4O_{10}(OH)_2$	1	
2	<u>Gypsum</u>	$CaSO_4 \cdot 2H_2O$	3	
3	<u>Calcite</u>	$CaCO_3$	9	
4	<u>Fluorite</u>	$CaF_2$	21	
5	<u>Apatite</u>	$Ca_5(PO_4)_3(OH, Cl, F)$	48	

Mohs hardness	Mineral	Chemical formula	Absolute hardness	Image
6	<a href="#">Orthoclase Feldspar</a>	$KAlSi_3O_8$	72	
7	<a href="#">Quartz</a>	$SiO_2$	100	
8	<a href="#">Topaz</a>	$Al_2SiO_4(OH^-, F^-)_2$	200	
9	<a href="#">Corundum</a>	$Al_2O_3$	400	
10	<a href="#">Diamond</a>	$C$	1600	

(IV) Relative resistance being scratched ten minerals are selected to measure the degree of hardness from 1 to 10

1. Talc 2. gypsum 3. calcite 4. fluorite 5. apatite 6. feldspar 7. quartz 8. topaz 9. corundum 10. diamond. ex. fingre nail has 2.5 hardness knife has 5.5 hardness



(V) **SPECIFIC GRAVITY** : The ratio between the weight of a given object and the weight of an equal volume of water ; object weighed in air and then weighed in water and divide weight in air by the difference of the two weights.



## IMPORTANT MINERALS OF THE EARTH CRUST



**FELDSPAR:** Silicon & Oxygen Are Common Elements, Sodium, Potassium Calcium Aluminium Are Found In Specific Variety. ½ The Earth Crust Consists Of Feldspar. Light Cream To Salmon Pink Colour Used In Ceramics And Glass Making.



**QUARTZ:** important component of sand granite. consists of silica, hard mineral, insoluble in water it is white or colorless used IN RADO OR RADOR



**YROXENE** : consists of calcium aluminum magnesium iron silica, it forms 10% of earth crust, found in meteorites, green or black in colour



**OLIVINE:** Magnesium, Iron, Silica are major elements, used in jewellery, greenish crystal, found in basaltic rock

**AMPHIBOLE:** major elements, used in asbestos



aluminium, calcium silica, iron magnesium are They form 7% of earth crust, green or black colour industry, hornblende is a; another form of amphibole



**MICA:** consists of potassium, aluminium, magnesium iron silica . Form 4% Of the earth crust. Found in basaltic rock

**IGNEOUS ROCKS;** 1. They are primary rocks 2. formed due to cooling of lava 3. They are two types intrusive & extrusive rocks

Extrusive rocks have small grains because of sudden cooling intrusive rocks have bigger grains due to slow cooling 4. they are hard 5. Do not contain fossils 6. Do not allow water to percolate through them 7. No layers

**SEDIMENTARY ROCKS:** 1. Formed Due To Sedimentation 2. Consists Of Layers 3. Contain Fossils 4. The Process Of Sedimentary Rock Formation Is Called Lithification 5. They Are Three Types . A. Mechanically Formed B. Chemically Formed 3. Organically Formed.

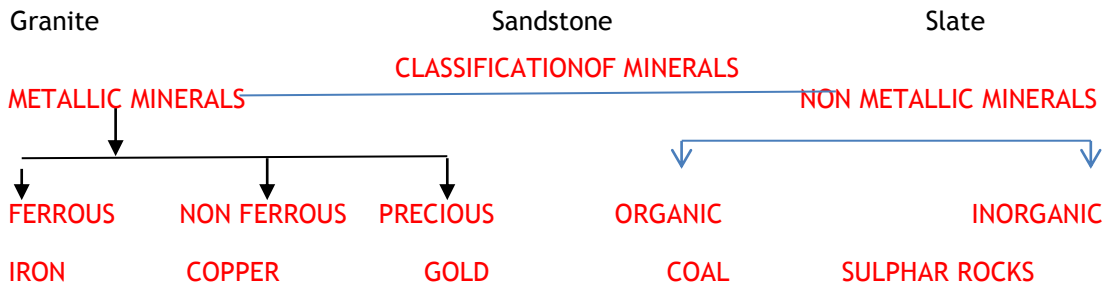
**METAMORPHIC ROCKS:** 1. Formed Due To Recrystallization 2. Formed Due To Pressure And Temperature 3. Very Smooth

4. Consists of layers some times very precious stones

### Type of rock

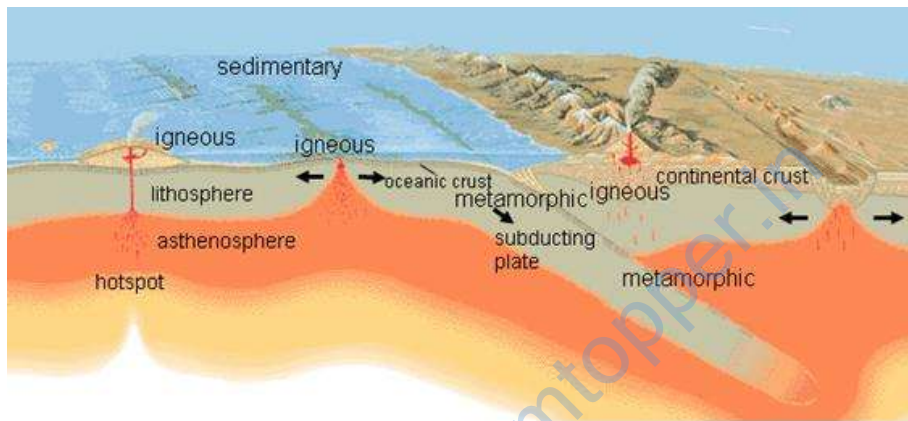
Igneous rock      Sedimentary rock      Metamorphic rock



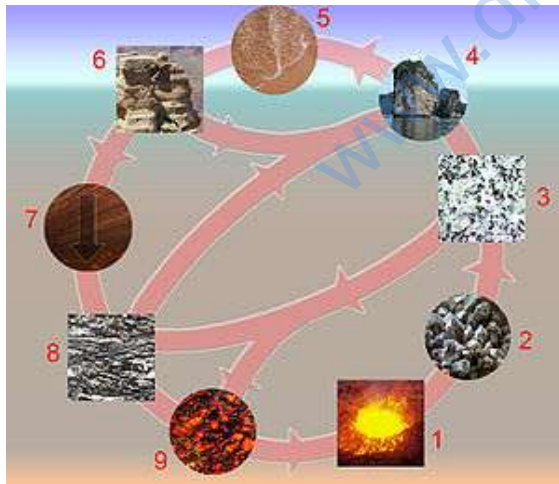


Rocks are aggregate of one or more minerals, they may be hard or soft in varied colours, they do not have definite chemical composition.

Petrology is the science of rocks. Petrologist who studies the scientific methods of rocks.



### ROCK CYCLE



A diagram of the rock cycle. Legend: 1 = [magma](#); 2 = [crystallization](#) (freezing of rock); 3 = [igneous rocks](#); 4 = [erosion](#); 5 = [sedimentation](#); 6 = [sediments&sedimentary rocks](#); 7 = [tectonic burial and metamorphism](#); 8 = [metamorphic rocks](#); 9 = [melting](#).

Rock cycle is a continuous process through which old rocks are converted into new rocks. Igneous rocks are changed into metamorphic or sedimentary rocks. Metamorphic rocks a further change into magma