H.B.U. - Syllabus

Rocks & Minerals

Rocks

1. Granite
2. Basalt
3. Dolerite
4. Shale
5. Slate
6. Schist
7. Gneiss
8. Marble
9. Limestone
10. Phyllite
11. Sandstone
12. Conglomerate
13. Quartzite

Mineral

1. Laterite
2. Feldspar
3. Mica (Biotite & muscovite)
4. Talc
5. Graphite
6. Bauxite
7. Magnetite
8. Harmatite
9. chalcopyrite
10. calcite
11. Galena
12. Quartz

Q:- Define minerals? Elaborate identification characteristics?

Ans:- A mineral may be defined as a natural inorganic substance with a definite chemical composition and atomic structure.

The term definite chemical composition requires a little more ~~composition requires~~ elaboration because there are certain mineral species in which the composition of the end members is fixed and the intermediate minerals vary from one another in the proportion of the one or the other element. But such variations follow a definite order.

Minerals can be identified by their (a) chemical properties, (b) by their physical properties. Here we shall discuss about the important physical properties of the minerals.

Physical properties

(A) Form:- Sometimes in minerals definite geometrical forms called crystals can be recognised and these help much in their identification. For example, galena occurs in perfect cubes.

There are other forms which are not quite associated with crystal character but nonetheless they are helpful in the identification of the mineral.

(a) Acicular - fine needle like crystals eg. tourmaline.
(b) Amygdaloidal - almond shaped e.g. zeolites.
(c) Bladed - occuring in thin blades e.g. kyanite.
(d) Botryoidal - Spherodial aggregate, eg. chalcedony
(e) Columnar - columns eg. beryl.
(f) Nodular - rounded or irregular nodules e.g. flint
(g) Dendritic - tree like or moss like form - manganese are deposited in crevices

(h) Fibrous - fine strands - asbestos.
(i) Foliaceous - thin seperable leaves - mica.
(j) Mammillated - large spherodial aggregates - malachite
(k) Reniform - kindly shaped - haematite.
(l) Wiry or fine form - rope-like form - native copper.

(B) Hardness :- The hardness of mineral may be determined with the help of a standard set of minerals known as Moh's scale of Hardness which is given in Table A. Of the gem minerals are excluded the scale need included Only of numbers. Substitutes may be used when the scale minerals are not available - (i) easily scratched by nail (ii) not so easily scratched, (iii) Can be scratched by a piece (a copper coin) and very easily scratched by a knife, (iv) Scratched readily by knife, (v) Can be scratched by knife with difficulty, (vi) Scratches by window-glass, (vii) window glass is scratched by the mineral.

Table - A

Hardness	Standard mineral
(i)	Tale
(ii)	Gypsum
(iii)	Calcite
(iv)	Flour-spar.
(v)	Apatite
(vi)	Orthoclase
(vii)	Quartz
(viii)	Topaz
(ix)	Corundum
(x)	Diamond.

(e) Fracture :- Freshly broken surfaces of minerals exhibit characteristics fracture surfaces. The following important types should be noted.

(i) Conchoidal — The fracture surfaces are curved with a concave or convex form e.g. quartz

(ii) Even — The fracture surfaces are nearly flat e.G. in cleavage.

(iii) Uneven — The fracture surface is formed of minute elevations and depressions, eg. most minerals.

(D) Cleavage :- Crystalline minerals are said to cleave or have cleavage when they break in definite directions along smooth surfaces. These are diagnostic of some minerals as follows —

(1) Octahedral → Diamond.
(2) Platy → Covellite, molybdenite
(3) Cubic → Galena, Halite
(4) Scaly → Graphite.
(5) Rhombic → Calcite, Dolomite, Siderite.
(6) Flaky → mica, chlorite.
(7) Diamond-shaped → Barite.
(8) Blocky → Anhydrite, Felspar.

(E) Colour :- When a body absorbs all the seven colours that compose the white light it appears black, and it reflects all the colours it appears white. Thus the colour of a body depends on the selective reflection and absorption of the different vibrations of white light.

1. Yellow → Sulphur
2. Pink → Felspar
3. Blue → Azurite
4. Green → Malachite
5. Brass → Chalcopyrite
6. Auburn → Apatite.
7. White → Kaolinite.

(f) Streak :- The colour of the powder of a mineral sometimes differs from the mineral in mass, e.g. pyrite. This can be observed from the streak of the mineral e.g. by rubbing the mineral on a hard plain surface to produce a colour line. Different specimens of the same mineral mineral shows some variation in colour, yet the streak is fairly constant.

1. Haematite → Indian-red.
2. Magnetite, Graphite → Black
3. Galena → Greenish
4. Chalcopyrite → Greenish-black
5. Chalcocite → Gray
6. Carnotite → yellow.

(g) Lustre :- The amount and type of reflection from the surface of a mineral determines its brightness. We can distinguish the following types of lustre.

(i) Metallic → The lustre of ordinary metals, e.g. Galena
(ii) Vitreous → The brightness of broken glass, e.g. Quartz
(iii) Resinous → The lustre resembling that of resin Topaz e.g. Sulphur
(iv) Silky → Gypsum
(v) Pearly → The lustre of pearl e.g. talc.

(h) Taste :- Some of the minerals which are soluble in water give distinctive taste but the character is not very useful in identification of minerals because there are only a few minerals which are soluble in water. e.g. Saline taste is common for Salt, alkali in case of Soda, potash

(i) Odour :- Only a few minerals have distinctive odour, such as the odour of garlic from arsenic compounds, sulphurous odours from pyrite.

(v) Feel :- minerals differ in the sensation they give by touch e.g. minerals are smooth, greasy or rough.

(k) Magnetism :- Generally ~~iron~~ minerals having iron composition are magnetic, but it is not necessarily applicable for all iron bearing minerals, such as monazite is slightly magnetic, electromagnetic character of mineral depends on varying magnetism of different minerals.

(l) Specific Gravity :- The ratio of the weight of a body to that of an equal volume of water is called the specific gravity of the body.

(i) Very heavy → Gold, Silver, pyromorphite.
(ii) Heavy → Galena, copper, Hematite, siderite, corundum,
(iii) Medium → chalcopyrite, pyrite, Haematite, magnesite, Gypsum, calcite, talc, Dolomite, Kaolinite, Quartz
(iv) Light → Graphite, Sulphur, Borax, Opal.

Selected minerals

(1) Feldspar — Feldspar is the name given to a group of minerals distinguished by the presence of alumina and silica (SiO_2) in their chemistry. This group includes aluminum silicates of soda, potassium or lime. It is single most abundant mineral group on Earth. They accounts for an estimated 60% of exposed rocks, as well as soil, clays and other unconsolidated sediments. The minerals included in this group are - Orthoclase, microcline etc.

crystal → Anicline, monoclinic.

mineral classification → Silicate.
chemical formula → $KAlSi_3O_8$
$NaAlSi_3O_8$
$CaAl_2Si_2O_8$

Streak → white

Mohs Hardness → 6-6.5
Colour → Pink, white, gray, brown
Lustre → vitreous
Fracture → conchoidal

② Mica (Biotite) $[K(Fe,Mg)_2(Si_3Al)O_{10}(OH)_2]$

Biotite (Potassium-magnesium-iron-aluminium silicate) is a type of mica and occurs as tabular prismatic crystals with scattered grains, scales and scaly masses.

Crystal → Monoclinic

Form → Scaly

Colour → Black, dark green or brown

Lustre → Generally glossy with white streaks and platy structure.

Opacity → Opaque to transparent

Cleavage → Perfectly 1-dimensional (splits into thin elastic sheets)

Hardness → 2.5 - 3.0

Specific gravity → 2.71 - 3.1

③ Muscovite $[KAl_2(Si_3Al)O_{10}(OH)_2]$

It is the commonest mica.

Crystal → Monoclinic

Form → Platy forms common

Colour → From brown-green to black in thick plates and blood-red brownish green in thin laminate.

Streak → White

Lustre → Glassy or pearly

Opacity → Opaque to translucent, transparent when thin sheets.

Cleavage → Perfectly 1 directional splitting into sheets that tear with hackly edges but are elastic and strong.

Hardness → 2 - 2.5

Specific Gravity → 2.76 - 3

④ Talc [$Mg_3Si_4O_{10}(OH)_2$]

Talc (hydrous magnesium silicate) occurs as foliated, radiating and compact masses. It has a three layer sheet structure. Two silica tetrahedral layers enclose an octahedral layer in which all octahedral position are filled with magnesium. Sheet bondage is very weak that is why it is lubricant.

Forms → Tabular or granular massive forms.
Colour → Silky white, rarely shades of green,
Streak → white.
Lustre → Pearly
Cleavage → Perfect
Feel → greasy to touch
Hardness → 1
Specific gravity → 2.58 - 2.83
Opacity → Translucent to transparent.

⑤ Graphite [C]

Like diamond, graphite consists solely of crystallized Carbon but differs extraordinarily in colour, hardness, conductivity and crystallisation. It is often fibrous with sectiles. It can mark paper. It is a good conductor and is the most stable form of carbon.

Form → Columnar or scale form,
Colour → Steel grey colour, black
Streak → black
Lustre → Metallic
Feel → Soft and cold
Hardness → 1.5-2
Specific gravity → 2.15.

⑥ Bauxite [mixture of diaspores AlO(OH), gibbsite, boehmite etc.]

Bauxite is the primary ore of aluminium. Bauxite does not have a specific composition. It is a mixture of hydrous aluminium oxides, aluminium hydroxides, clay minerals, and insoluble materials such as quartz, hematite, magnetite, siderite and goethite.

Crystal → N/a
Colour → white, grey, sometimes stained yellow, orange, red, pink, or brown by iron.
Streak → usually white, but iron stain can discolour.
Lustre → Dull, earthy
Cleavage → none.
Hardness → 1 - 3
Specific gravity → 2 - 2.5

⑦ magnetite [Fe_3O_4]

It contains both Fe^{++} (ferrous) and Fe^{+++} (ferric) ions. It is the most valuable iron ore.

Crystals → Octahedral crystal common
Forms → massive and granular
Colour → Iron black
Streak → black
Lustre → Sub metallic
Hardness → 5.5 - 6.5.
Specific gravity → 5.19

⑧ Haematite [Fe_2O_3]

It is the major ore of iron

Crystals → Tabular, semiform fibrous, foliated or in disseminated small flakes
Colour → Grey to black, red in earthy forms.
Streak → Violeet red.
Lustre → metallic, earthy forms dull
Hardness → 5.5 - 6.5.
Specific gravity → 4.9 - 5.3
Acid reaction → Soluble in hydrochloric acid.
magnetic → It is magnetic and sometimes it can itself lift iron filings.

(9) Chalcopyrite [$CuFeS_2$]

It is the most important copper mineral and ore of copper.

Crystals → massive also elongated crystals or spheroidal

Forms → Granular and compact masses.

Colour → Brass yellow.

Streak → Greenish black

Lustre → Metallic

Hardness → 3.5 – 4

Specific gravity → 4.1 – 4.3

Distinguished from pyrite by lower hardness & deeper colour.

* Define Rocks? Describe details about identification characteristics of different rocks.

Rocks

Rocks are the units of the earth's crust and are composed of minerals. A rock may be formed of only one mineral or it may be composed of several minerals. In popular conception the term rock is associated with something hard and heavy but in scientific usage a soft clay is as much a rock as the hard granite.

Genetically the rocks may be classified into three major groups viz. (i) Igneous (ii) Sedimentary, and (iii) Metamorphic.

(i) Igneous Rocks

These have solidified from a molten state and thus also known as primary rocks. Almost 95% of the earth's crust is composed of igneous rocks which are the most important group rocks which are the most important group amongst the rocks. The igneous rocks have been classified in various ways according to the purpose in view -

(a) mineralogical classification — based on the mineral composition of the rock which can be determined with the help of a microscope.

(b) Chemical classification — can be prepared based on chemical analysis of the various igneous rocks

(c) Megascopic classification — depends on characters which can be determined from the observation of a hand specimen. For this purpose one does not acquires any elaborate equipment excepting perhaps a pocket pen knife and say, a few drops of hydrochloric acid.

Granite

Specific gravity - 2.63 - 2.75

characteristics - These are most commonly ~~massive~~ massive rocks without showing any tendency of foliation or banding when metamorphosed they are banded or foliated and are properly called granite-gneiss. The granites are a completely crystalline rock without any glassy matter and the texture varies from fine to coarse. Mineralogically they are composed chiefly of quartz, felspars and accessories like biotite, muscovite, and other ferromagnesian minerals and iron oxides. These rocks are named according to the most prominent accessories as biotite-granite, hornblende-granite etc.

On hand specimen the quartz, felspar and the chief accessories can be distinguished with the help of a pocket lens. On colour granites are commonly of shade of gray but pink or red varieties also occour freequently. The colour of the rocks depends on the proportion of the felspars to the ferromagnesian minerals and also the colour of the felspar itself.

Basalt

Specific gravity - 2.9 - 3.1

Characteristics - The Basalts are very common volcanic rocks and the term covers many varieties. These are basic lavas in which plagioclase felspars and the ferromagnesian minerals occurs in almost equal proportion. ~~These~~ There may be a little quartz and alkali felspar also. The ferromagnesian mineral is either augite or olvine and iron oxide. Sometimes hypersthene, hornblende or biotite also occur

on colour the basalts vary from grey black to black and rather dull in appearance.

Cellular and amygdaloidal structures are common and less frequently the rock is porphyritic showing large crystals of plagioclase in a fine ground mass.

Dolerite

Specific Gravity - 2.64 - 3.12

characteristics - It is dark, heavy, finely crystalline dyke rock. Typically it is composed of labradorite, augite and iron oxides.

(B) Sedimentary rocks

These rocks have been formed by the denudation of pre-existing rocks and the deposition and consolidation of the denuded material in water or air. The sedimentary rocks are characterised by stratification.

Shale

These are finely stratified rocks and are compacted muds, clays, or silts. Sometimes the shales are so finely stratified that each laminate is no thicker than a sheet of paper. Apart from clay which is chiefly kaolin the shales contain varying proportions of sand and also calcareous matter and with the increase in the proportion of sand degrade into fine grained sandstone and with increase of calcareous matter they pass into limestone. Most

Shales are soft and disintegrate into small fragments. These occour in various shades of colour - gray, buff, yellow red, brown, purple, green or black.

Sandstone -

made up chiefly of sand grains held together by some cementing material like silica, iron oxide or lime. Some sandstones contain little cementing substance and their tenacity is due to the pressure during the time of consolization. Apart from sand the minor constituents are felspar, mica, garnet, magnetite, etc.

The size of the grains varies very widely. In the fine grained types the sand particles are generally angular but in the coarser varieties the sand particles are well rounded. Bedded or cross-bedded structures are well marked.

The colour varies widely from gray, white buff, brown to red depending primarily on the colour of the cementing material.

10

Identification of Minerals and Rocks

HIGHLIGHTS

- 7 Keys to Recognising Minerals
- Selected Specimens of Minerals
- 4 Keys to Recognising Rocks
- Selected Specimens of Rocks

Over 99% of the earth's crust is made up of the eight major elements—oxygen (46.7%), silicon (27.69%), aluminium (8.07%), iron (5.05%), calcium (3.65%), sodium (2.75%), potassium (2.58%), and magnesium (2.08%). Some elements naturally make minerals by themselves (e.g. gold, platinum, copper, sulphur and carbon), but in most cases two or more elements chemically combine to form rocks and minerals. To a geologist the term 'mineral' is restricted to (a) a substance of inorganic origin, (b) a substance having a definite chemical composition, and (c) a substance possessing a definite physical property. A mineral may, therefore, be defined

Fig. 10.1 (igneous Activity)

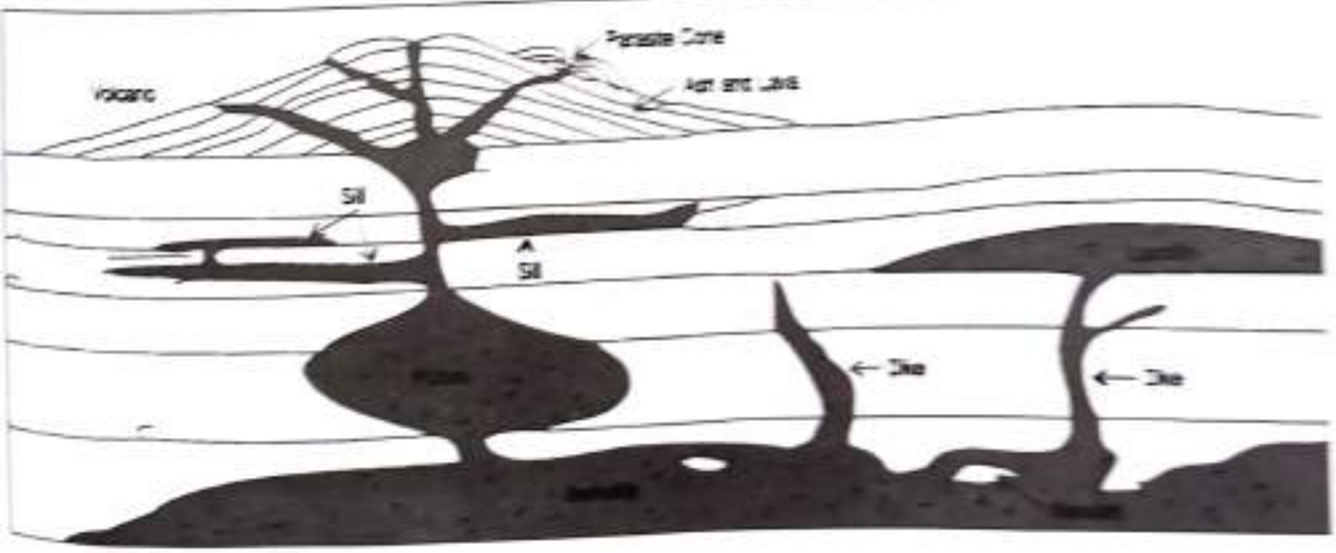
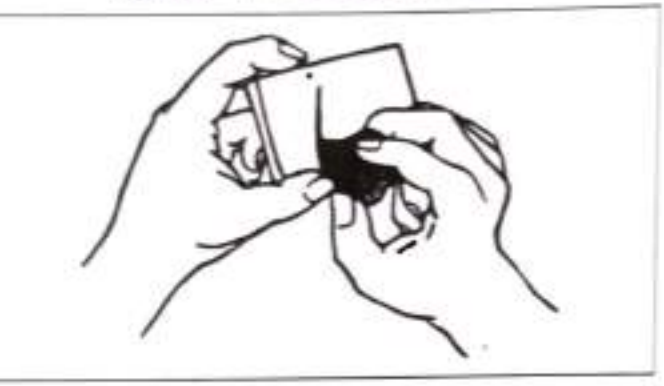


Fig. 10.4 Testing Streaks of Minerals



eaction. The diagnostic characteristics of hand pecimens of some common minerals and ocks are described in the following paragraphs.

KEYS TO RECOGNISING MINERALS

Key No. 1: Lustre

Every mineral has either a metallic or a non-metallic lustre (i.e., reflection of light from the mineral surface). A metallic lustre is typical of a metal, e.g., gold, silver, copper, aluminum, etc. Such minerals are opaque and when crushed they yield a powder which is black or darker in colour than the mineral itself. Minerals having a non-metallic lustre become transparent on a thin edge, and when crushed they yield a powder which is white or lighter than the mineral itself. The common ones are—

1.	Vitreous	Quartz, Malachite, Azurite, Barite, Halite, Topaz
2.	Pearly	Mica, Chlorite, Gypsum, Calcite, Talc, Dolomite
3.	Adamantine	Diamond, Lead, Rutile, Cinnabar, Corundum
4.	Resinous	Sphalerite, Wolframite, Sulphur, Sphene
5.	Silky	Gypsum
6.	Earthy	Carnotite, Kaolinite, Bauxite
7.	Greasy	Cryolite, Serpentine, Scheelite
8.	Waxy	Turquoise

Key No. 2: Hardness

Hardness is described by Mohs scale. He placed talc, the softest of all minerals as No. 1 in the series and diamond, the hardest of all known minerals as No. 10, as follows—

10	Diamond	5	Apatite
9	Corundum	4	Fluorite
8	Topaz	3	Calcite
7	Quartz	2	Gypsum
6	Feldspar	1	Talc

The scale does not indicate the exact hardness; it only means that any mineral can scratch all those beneath it. Some familiar objects we can use in the field to test are—

6.5 Steel File
5.5 Knife Blade, Window Glass
3.0 Copper Coin
2.5 Fingernail

Minerals under 2.5 will leave a mark on paper; those under 5.5 can be scratched by a knife; and those over 5.5 will scratch glass.

Key No. 3: Colour

There are minerals that are reasonably constant in their colour and are diagnostic of them, as follows—

1.	Yellow	Sulphur
2.	Pink	Feldspar
3.	Blue	Azurite
4.	Green	Malachite
5.	Brass	Chalcopyrite
6.	Auburn	Apatite
7.	Bronze	Pyrrhotite
8.	Black	Pitchblende
9.	White	Kaolinite

Key No. 4: Streak

The colour of a powdered mineral, called streak is obtained by rubbing it against a piece of unglazed porcelain, called streak plate. It is diagnostic of some minerals, as follows—

1.	Indian-red	Haematite
2.	Black	Magnetite, Graphite

3. Greenish	Galena
4. Greenish-black	Chalcopyrite
5. Gray	Chalcocite
6. Pale Green	Malachite
7. Light Blue	Azurite
8. Scarlet	Cinnabar
9. Orange	Realgar
10. Yellow	Carnotite

Key No. 5: Cleavage

Crystalline minerals are said to cleave or have cleavage when they break in definite directions along smooth surfaces. These are diagnostic of some minerals as follows—

1. Octahedral	Diamond
2. Platy	Covellite, Molybdenite
3. Cubic	Galena, Halite
4. Scaly	Graphite
5. Rhombic	Calcite, Dolomite, Siderite, Magnesite
6. Flaky	Mica, Chlorite
7. Diamond-shaped	Barite
8. Blocky	Anhydrite, Feldspar

Key No. 6: Fracture

Minerals that break in irregular directions are said to fracture. These are also typical of some minerals—

1. Conchoidal	Quartz, Malachite, Azurite, Magnesite, Opal, Tourmaline, Beryl
2. Hackly	Gold, Copper

Key No. 7: Specific Gravity

It implies how heavy it is with respect to equal volume of water and can be diagnostic of some minerals as follows—

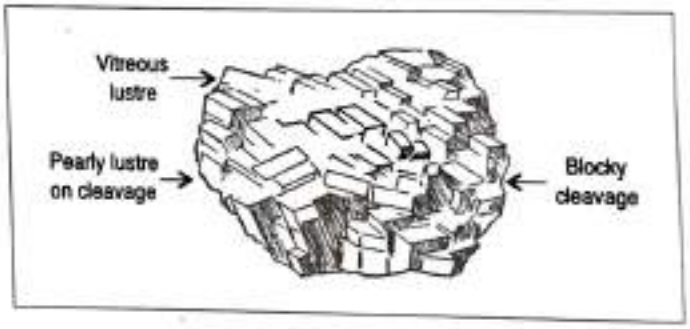
1. Very Heavy	Gold, Silver, Cinnabar, Pyromorphite, Wulfenite
2. Heavy	Galena, Copper, Pitchblende, Wolframite, Malachite, Azurite, Siderite, Corundum, Zircon, Garnet
3. Medium	Chalcopyrite, Cuprite, Pyrite, Haematite, Magnesite, Gypsum, Calcite, Talc, Dolomite, Kyanite, Bauxite, Kaolinite, Quartz
4. Light	Graphite, Halite, Stilbite, Natrolite, Sulphur, Borax, Opal

SELECTED SPECIMENS OF MINERALS

Anhydrite [$CaSO_4$]

Its composition is calcium sulphate but does not contain water like gypsum. It is found in veins, cavities (as crystals) and also as evaporate deposits (Fig. 10.5).

Fig. 10.5 Anhydrite

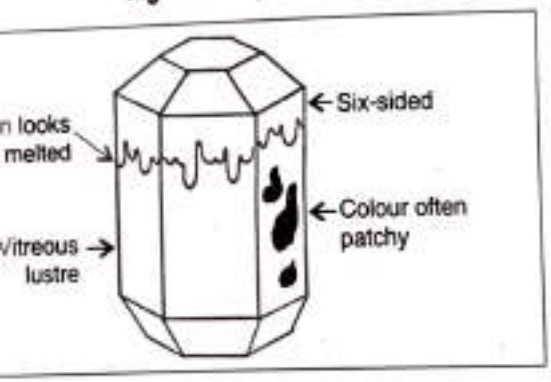


Lustre	Vitreous; Pearly (on cleavage)
Cleavage	Blocky
Colour	White
Streak	White
Hardness	can be scratched by copper coin
Specific	Gravity 2.9 –3.0

Apatite [$Ca_5(PO_4)_3(OH,F,Cl)$]

It is the common phosphate (calcium phosphate with hydroxyl, flourine and chlorine) that occurs as accessory minerals in rocks. It is known as *hydroxyapatite* when rich in hydroxyl, *flourapatite* when rich in flourine and *chlorapatite* when rich in chlorine. Apatite occurs either as transparent, glassy, prismatic or tabular crystals or as dull, fibrous or granular aggregates (Fig 10.6).

Fig. 10.6 Apatite



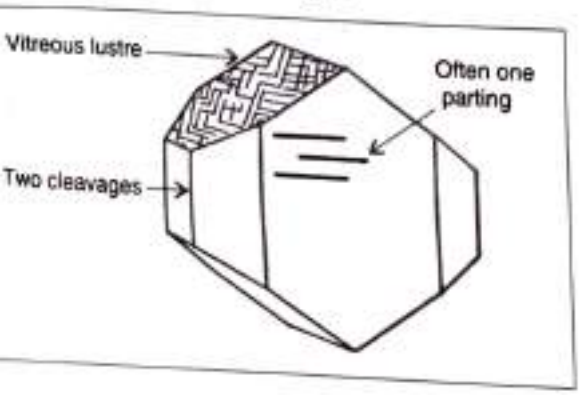
al	hexagonal
ur	white (if pure) but more often green, brown, yellow or blue
k	White
vage	Poor
ure	Conchoidal
ness	5
fic gravity	3.1–3.4

ite [$(Ca, Mg, Fe, Ti, Al)_2 (Si, Al)_2O_6$]

he most common igneous pyroxene. It occurs attered crystals evenly distributed throughout sic igneous rock, notably gabbro and basaltic Augite crystallises in the monoclinic system. ccurs as prismatic crystals (often twined) and anular masses (Fig. 10.7).

our	Brown, green or black
ak	Colourless
tre	Glassy
acity	Translucent to opaque
avage	Good (2-dimensional at 87°)
cture	Uneven

Fig. 10.7 Augite

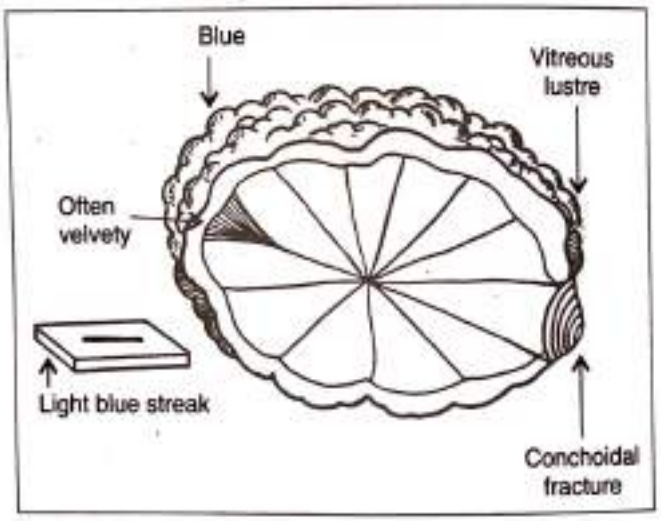


Hardness	5.5–6.0
Specific gravity	3.23–3.52

Azurite [$Cu_3(CO_3)_2 (OH)_2$]

It is the basic copper carbonate with distinctive azure blue shades. It occurs only in the oxidized portions of copper ore veins. Azurite commonly occurs as an earthy material. The crystal system is monoclinic with tabular or equidimensional habit (Fig. 10.8).

Fig. 10.8 Azurite



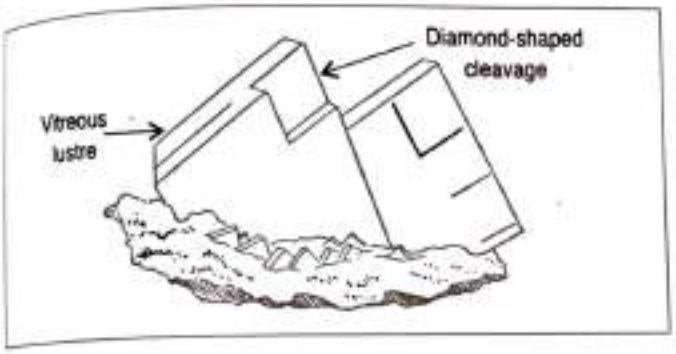
Crystal	Transparent
Colour	Azure blue
Streak	Light blue
Lustre	Brilliant (vitreous to adamantine)
Cleavage	Complex
Fracture	Conchoidal
Hardness	3.5–4.0 (it is very soft and can easily be broken to form gemstones)
Specific gravity	3.77–3.89

Barite [$BaSO_4$]

It is the most common mineral containing barium and one of the most common sulphate minerals. It is heavy and often found as crystals of enchanting blue colour (Fig. 10.9).

Lustre	Vitreous
Cleavage	Diamond-shaped
Colour	Blue, White, also colourless

Fig. 10.9 Barite

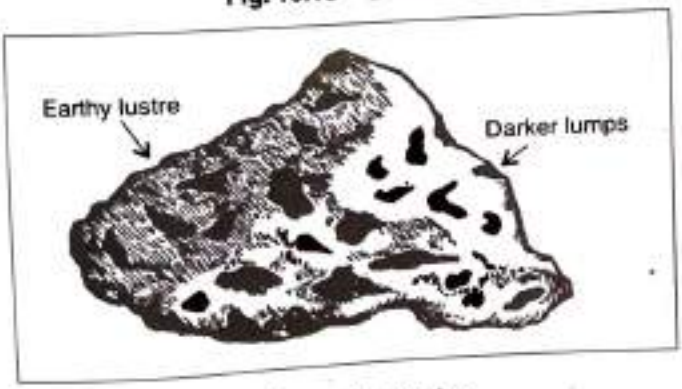


Streak	White
Hardness	can be scratched by copper coin
Specific	Gravity 4.5

Bauxite [Principal Ore of Aluminium]

It is a mixture of diaspores [AlO(OH)], gibbsite, boehmite and other materials. Within this non-crystalline colloidal precipitates, clay, limonite and partly weathered silicates may be present (Fig. 10.10).

Fig. 10.10 Bauxite

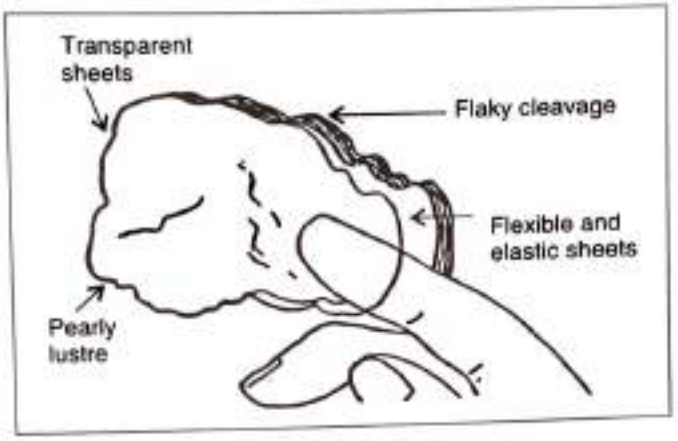


Occurrence	Earthy and massive
Structure	Nobby
Colour	Generally grey and white with reddish brown iron stains
Streak	White

Biotite [$K(Fe,Mg)_2(Si_3Al)O_{10}(OH)_2$]

Biotite (potassium-magnesium-iron-aluminium-silicate) is a type of mica and occurs as tabular prismatic crystals with scattered grains, scales and scaly masses (Fig. 10.11).

Fig. 10.11 Biotite



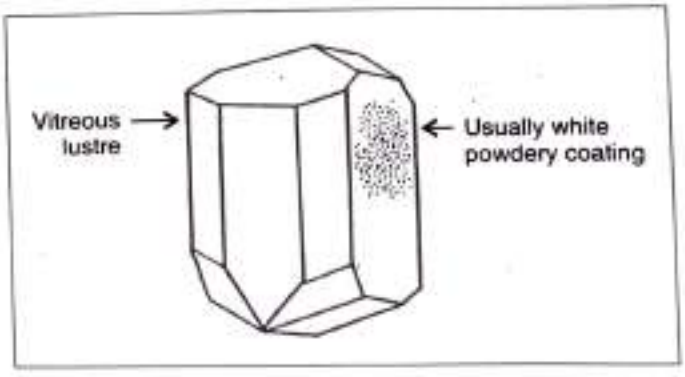
Crystal	Monoclinic
Form	Scaly
Colour	Black, dark green or brown
Lustre	Generally glossy with white streaks and platy structures
Opacity	Opaque to transparent
Cleavage	Perfectly 1-dimensional (splits into thin elastic sheets)
Hardness	2.5–3.0

Borax [$Na_2B_4O_7,10H_2O$]

It is the most widespread borate (hydrous sodium borate). It occurs in large deposits in the dry beds of salt lakes in arid and semi arid regions. Borax occurs as prismatic crystals, crusts and porous masses (Fig. 10.12).

Crystal	Monoclinic
Colour	Usually colourless, white or tinted
Streak	White

Fig. 10.12 Borax

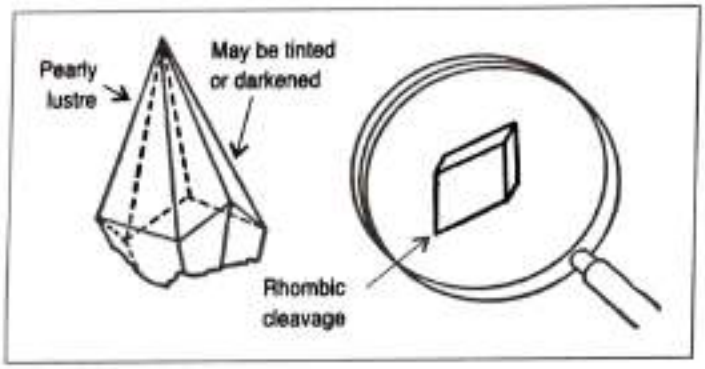


Lustre	Glassy or resinous
Opacity	Translucent to opaque
Solubility	Soluble in water producing a sweet alkaline taste
Hardness	2–2.5
Specific gravity	1.7

Calcite [$CaCO_3$]

It is the most common mineral and the main constituent of limestone (Fig. 10.13).

Fig. 10.13 Calcite



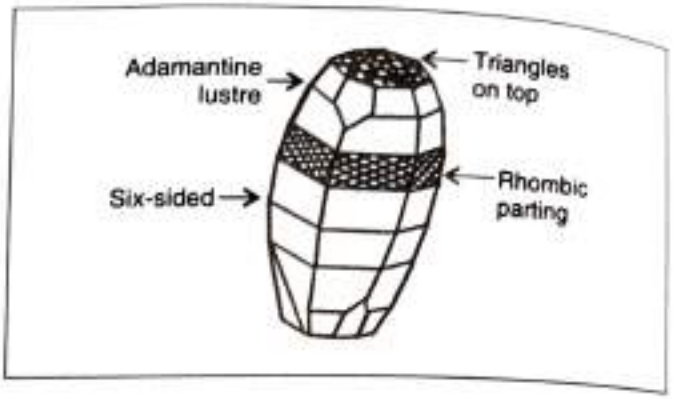
Occurrence	Dog-tooth spar crystals
Crystal	Rhombohedral
Colour	White or grey but sometimes colourless or tinted yellow, blue, green and pink
Acid reaction	Quick effervescence with hydrochloric acid
Streak	White
Lustre	Vitreous to earthy
Cleavage	Perfectly 3-dimensional
Hardness	3

Corundum [Al_2O_3]

It is a common mineral important as an abrasive and also as gemstone (Fig. 10.14).

Occurrence	As pyramids, prisms (often rounded into barrel shapes) and granular masses
Crystal	Rhombohedral
Colour	Usually colourless brown, red, blue, white, black, green and grey
Streak	Colourless

Fig. 10.14 Corundum



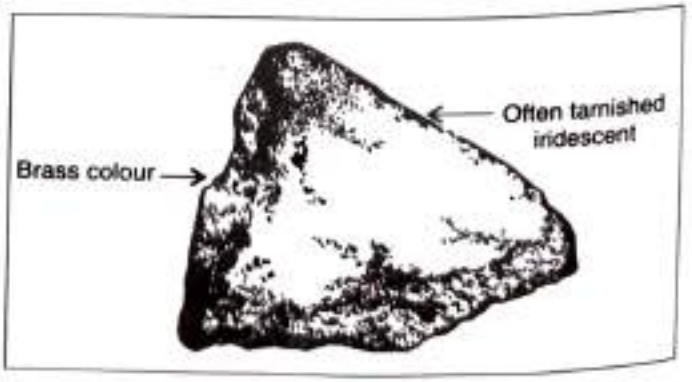
Lustre	Brilliant to glossy
Fracture	Conchoidal
Hardness	9
Specific gravity	4.0

Chalcopyrite [$CuFeS_2$]

It is the most important copper mineral and ore of copper. Chalcopyrite (copper iron sulphide) occurs as tetrahedral or spheroidal crystals (often twined) and as granular and compact masses (Fig. 10.15).

Colour	Brass yellow
Acid reaction	Soluble in nitric acid
Streak	Greenish-black
Lustre	Metallic
Opacity	Opaque
Cleavage	Poor
Fracture	Uneven
Hardness	3.5–4.0
Specific gravity	4.28

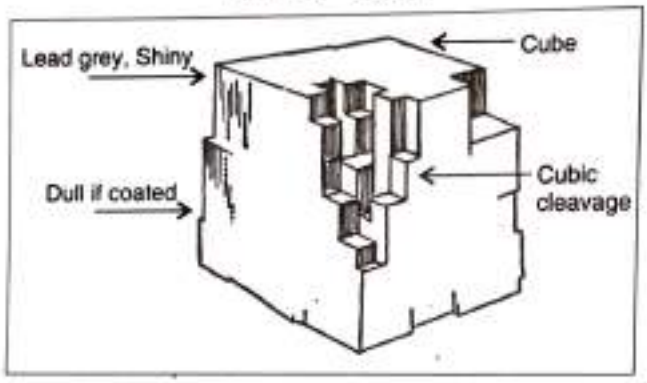
Fig. 10.15 Chalcopyrite



Galena [PbS]

It is the chief ore of lead. Galena (lead sulphide) occurs as crystals (twin) and granular masses (Fig. 10.19).

Fig. 10.19 Galena



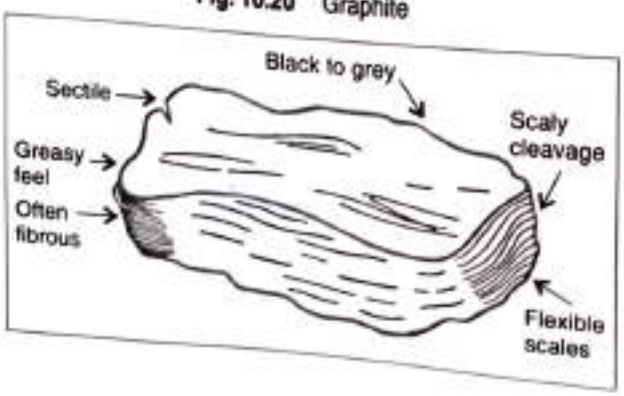
Colour	Lead grey
Lustre	Metallic
Cleavage	Perfectly cubic and
Streak	Grey
Specific gravity	7.57 (very heavy)

Graphite [C]

Like diamond, graphite consists solely of crystallized carbon but differs extraordinarily in colour, hardness, conductivity and crystallisation. It is often fibrous with sectiles. It can mark paper. It is a good conductor and is the most stable form of carbon (Fig. 10.20).

Colour	Grey or black
Streak	black
Lustre	Metallic
Feel	Greasy

Fig. 10.20 Graphite

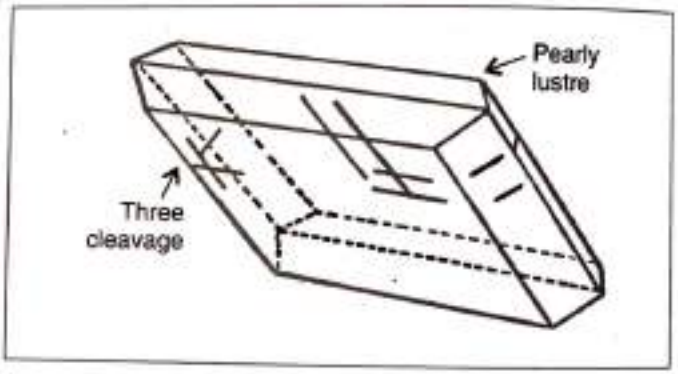


Cleavage	1-directional scaly (flexible scales)
Specific gravity	2.1–2.2

Gypsum [$CaSO_4$, $2H_2O$]

It is the most common sulphate. Gypsum (hydrous calcium sulphate) is of three varieties with distinctive habits—*alabaster* (massive), *selenite* (transparent and foliated) and *satinspar* (fibrous with silky or pearly lustre). It occurs as prismatic and bladed crystals and as fibrous vein fillings, radiating aggregates, clusters on cave walls and massive rock forming beds (Fig. 10.21).

Fig. 10.21 Gypsum



Colour	White or grey but may be colourless (in large crystals), pink (in alabaster) or brown and yellow (in massive beds)
Lustre	Silky or earthy
Cleavage	Distinct
Hardness	2
Specific gravity	2.3

Haematite [Fe_2O_3]

It is the major ore of iron. Spectacular haematites occur as brilliant black tabular crystals, commonly foliated. Generally three varieties are recognized—*red haematite* (as columnar or radiating masses and fibrous clusters), *kidney ore* (as kidney shaped masses) and *earthy* or *ocherous haematite* (as dull yellowish, or in oolitic, earthy form) (Fig. 10.22).

Crystal	Rhombohedral
Acid reaction	Soluble in concentrated hydro chloric acid

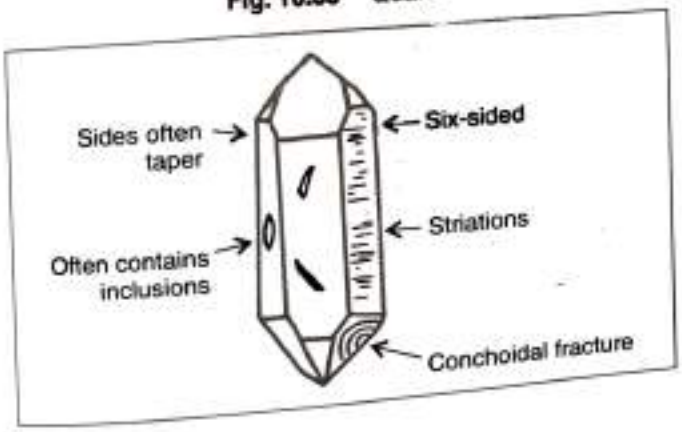
Hardness 6–6.5
Specific gravity 5.01

Quartz [SiO_2]

It is the principal constituent of glass and occurs as irregular grains intergrown with other minerals or as rounded grains or as microscopically grained specimens or as prismatic crystals (often twined) (Fig. 10.35).

Crystal Hexagonal
Colour Colourless, if pure, and any colour, if not pure
Opacity Normally transparent
Fracture Conchoidal
Hardness 7
Specific gravity 2.65

Fig. 10.35 Quartz

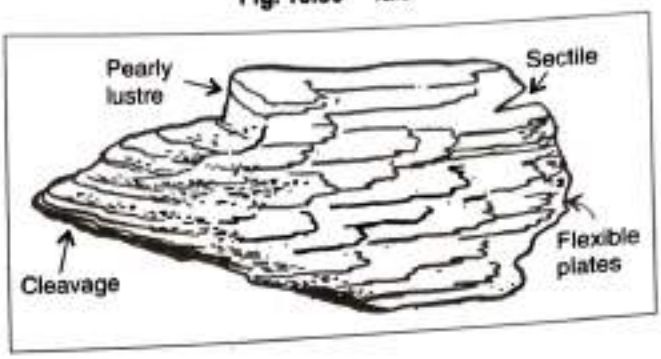


Talc [$Mg_3Si_4O_{10}(OH)_2$]

Talc (hydrous magnesium silicate) occurs as foliated, radiating and compact masses. It has a 3-layer sheet structure. Two silica tetrahedral layers enclose an octohedral layer in which all octahedral positions are filled with magnesium ions. Because of weaker sheet-bondage, talc is a better lubricant and feels greasier (Fig. 10.36).

Colour White, green, blue or brown
Streak White
Lustre pearly
Opacity Translucent to transparent
Cleavage Perfectly 1-directional
Fracture Irregular
Hardness 1
Specific gravity 2.58–2.83

Fig. 10.36 Talc

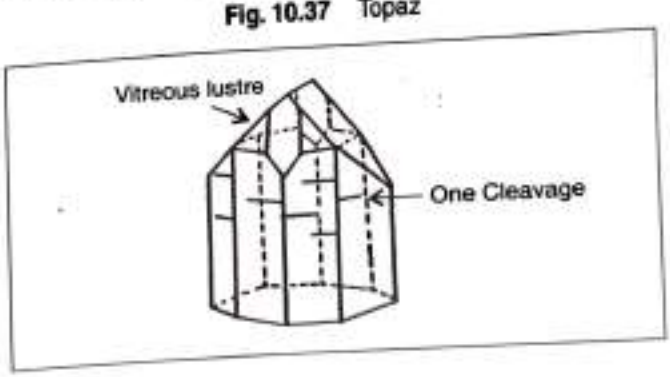


Topaz [$Al_2(SiO_4)(OH,F)_2$]

Topaz (aluminium fluro silicate) is often used as gemstones. It is highly durable and has a high index of refraction. It occurs as crystals (column prisms with striated faces) and as granular masses. It is colourless and brittle (Fig. 10.37).

Crystal Orthorhombic
Streak Pale
Lustre Glossy
Opacity Transparent
Cleavage Perfectly 1-directional
Hardness 8
Specific gravity 3.49

Fig. 10.37 Topaz



Tourmaline

Tourmaline is an aluminium silicate with a very complex chemical formula. It occurs in a wide variety of colours—rubellite, indicolite, achroite, dravite, etc. The colours are often zones either along the length or across the width of the unique rounded- triangular crystals. Watermelon tourmaline has a green exterior, surrounding first a white zone and then a red core. The jet black

SELECTED SPECIMENS OF ROCKS

Basalt

Basalts make up over 98% of all volcanic rocks. It is a very fine grained (cryptocrystalline) and dark coloured (melanocratic) mafic (44–52% silica content) igneous rock with typical volcanic texture, very high specific gravity (2.9–3.1) and high hardness (cannot be scratched by knife). It is very compact and is characterised by conchoidal fractures. Individual minerals cannot be identified by the naked eye. The characteristic minerals are calcic-plagioclase, pyroxene and iron ore with or without olivine. They may be vescicular or the vescicules may be filled with secondary minerals forming amygdales and thereby giving rise to *amygdaloidal structure*. The basaltic magma which erupted under water forms pillow-like masses giving rise to a basaltic pillow lava. The individual pillows have a glassy crust and a more or less crystalline interior which may show radiating contraction cracks. Two main types of basalts may be recognized—*tholeiitic basalt* (rich in clinopyroxenes and poor in calcium) and *alkali basalt* (rich in lime and olivine) (Fig. 10.42).

Coal

It is regarded as a sedimentary rock because it is found in layers or beds. It is lighter in weight, black in colour and often friable. It has banded structure (Fig. 10.43).

Fig. 10.42 Basalt

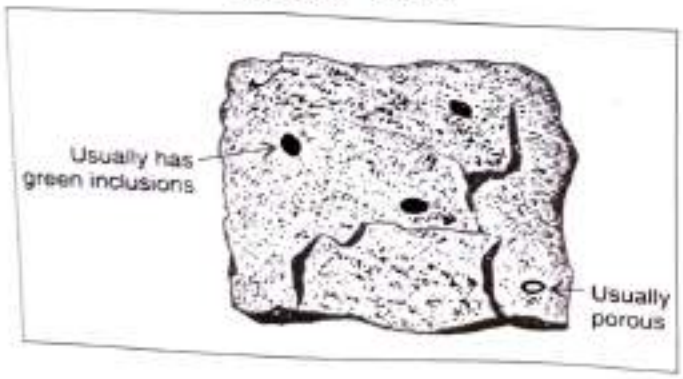
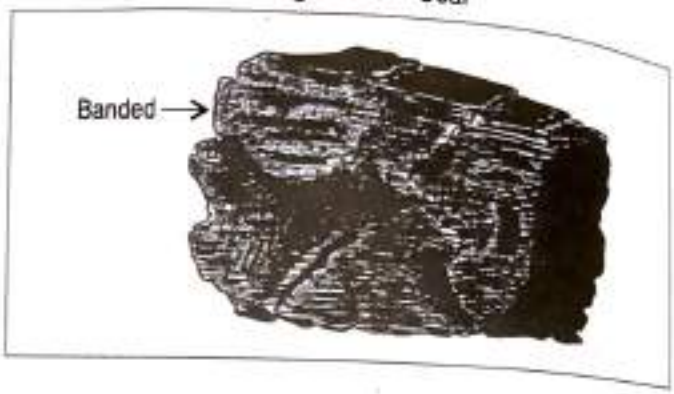


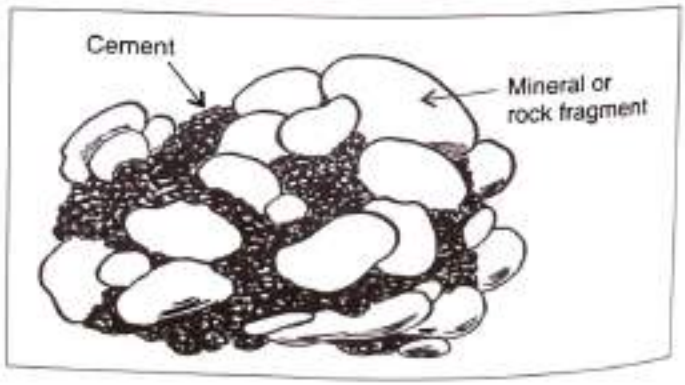
Fig. 10.43 Coal



Conglomerate

Conglomerates are clastic sedimentary rocks of rudaceous type. These are pebbly rocks of medium to fine in size (over 2 mm in diameter). These are variegated in colour with moderate to high specific gravity and moderate compactness. Being mostly of fluvial, glacial and shoreline origin, these consist of typical mud-free gravels or their lithified equivalents (i.e., grains of quartz, jasper, feldspar and rock fragments of various sizes, shapes and colours). The texture is typically clastic as lithic clasts are the essential constituents. The pebbles, cobbles, gravels, rock fragments and granules are cemented together in a *fine-grained matrix* or ground mass of *ferruginous* (reddish brown), *siliceous* (light colour) *argillaceous* (muddy odour) and *calcareous* (reaction with dilute hydrochloric acid) sediments (Fig. 10.44).

Fig. 10.44 Conglomerate



Dolerite

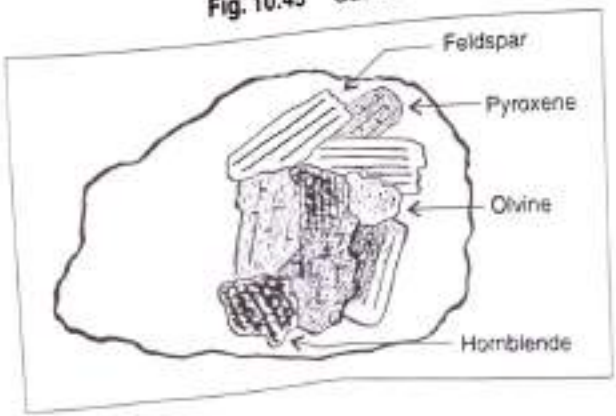
Dolerites are the hypabyssal representatives of the gabbros and basalts, finer grained than

the former but coarser grained than the latter. They occur mostly as dykes and sills and their texture is frequently ophitic or subophitic. They are dark coloured (melanocratic) mafic igneous rocks with high specific gravity (2.64–3.12), high hardness and high compactness. Feldspar laths are randomly oriented forming a criss-cross arrangement—the interspaces are filled up by ferro-magnesian minerals in which traces of cleavage can be seen. As it is prone to weathering, local patches of reddish brown tint can often be distinguished. Generally two types of dolerites are recognised—*tholeiitic* or *quartz dolerite* (rich in clino and ortho-pyroxene and calcicplagioclase) and *alkali dolerite* (rich in lime).

Gabbro

Gabbros are coarse or medium grained, melanocratic, mafic and plutonic igneous rocks with high specific gravity (2.9–3.2), high compactness and high hardness. The essential constituents are calcic plagioclase feldspar and one or more ferromagnesians like orthopyroxene, clinopyroxene, olivine, hornblende, etc. Some gabbros have a subhedral-granular texture while others have a poikilitic or a subophitic texture in which plates of pyroxene or amphibole partially enclose the crystals of plagioclase. Many gabbroic instrusions have well marked banded or layered structures while a few have orbicular structures (Fig. 10.45).

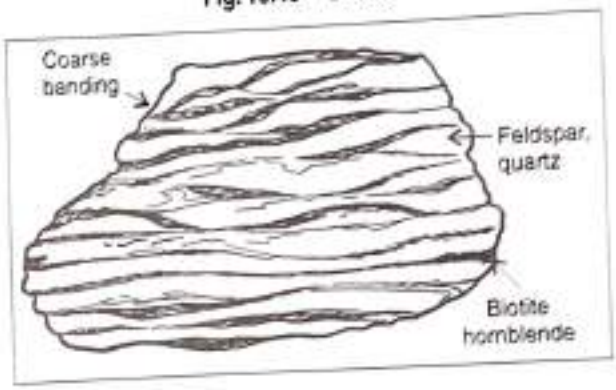
Fig. 10.45 Gabbro



Gneiss

Gneisses are medium coloured, moderately coarse grained, hard and compact metamorphic rocks of the highest grade with medium specific gravity. It is a coarsely crystalline rock of a granular texture. It is typically characterised by alternate bands of *light* and *dark* coloured minerals. The lighter bands are composed of quartz and feldspar with an equant granular habit while the *darker bands* are defined by the preferred orientation of flaky and platy ferro-magnesian minerals like mica, amphibole, hornblende, augite, etc. (Fig. 10.46).

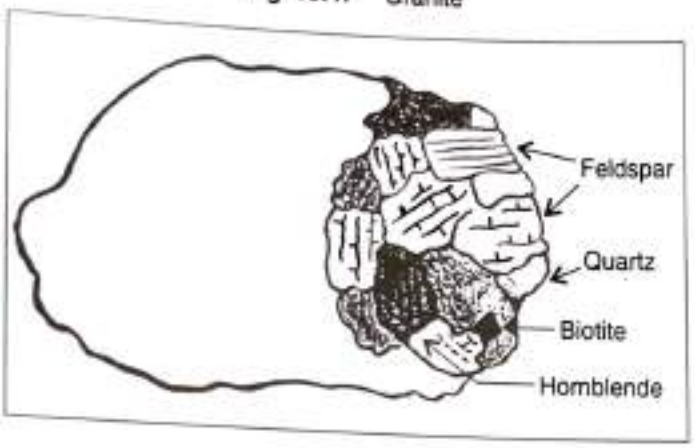
Fig. 10.46 Gneiss



Granite

Granites are coarse grained (*phaneritic*), light coloured (*leucocratic*), acidic (>66% silica content) and *holocrystalline plutonic* igneous rocks with medium specific gravity (2.63–2.75). They are hard and compact rocks composed essentially of quartz, feldspar and mica, usually with some ferro-magnesian minerals. Feldspar is identified by its lath shape in which cleavage may be present, while quartz is identified by its vitreous lustre and mica by its flaky habit. Both plagioclase and mafic minerals tend to form subhedral crystals while intergranular spaces are occupied by anhedral quartz. This typical interlocking of grains form the usual (subhedral-angular) texture. Sometimes micrographic intergrowth of quartz and feldspar is found. Some of these are *porphyritic*, commonly with phenocrysts of potash feldspar. A few develop *rapakivi* texture in which ovoids of potash feldspar are mantled by

Fig. 10.47 Granite



lime-bearing plagioclase. Regarding the larger scaled structures, some have a *banded* or layered structure. A few on the other hand show an *orbicular* structure while high level granitic rocks may develop a *drusy* structure (Fig. 10.47).

Limestone

Limestones are rocks whose primary constituents are composed dominantly of aragonite (orthorhombic $CaCO_3$) and calcite (rhombohedral $CaCO_3$). They are very fine grained, light coloured with moderate specific gravity (2.5–2.8) very compact but of low hardness (easily scartched by a knife or even fingernails). Texture is typically non-clastic—calcirudite (pebble-sized grain), *calcarenite* (sand-sized grain), *calcisiltite* (silt-sized grain) and *calcilutite* (clay-sized grain). It strongly reacts with cold and dilute hydrochloric acid. A salient feature is that most of the limestones are particulate and bimodal, i.e., they consist initially of relatively large carbonate particles mixed in various proportions with carbonate mud. Compositional layering characterised by different colour bands are often present (Fig. 10.48).

Marble

Marbles are coarse grained, light coloured rocks with high compactness, low hardness and medium specific gravity. They are produced by the metamorphism of limestones and hence are dominantly composed of calcite. They strongly effervesce with dilute hydrochloric acid. Generally, they show an even grained texture. Some show a crude foliation due to segregation of minor silicate constituents or in some cases a parallel alignment of lustrous flakes of graphite while some bear the imprint of stain in the form of lensoid outlines (Fig. 10.49).

Pegmatite

Pegmatites are very coarse grained, hard, moderately compact leucocratic igneous rocks with medium specific gravity. They occur as dykes or veins in the plutonic bodies or as marginal segments to such plutonic intrusions into the adjoining country rock. They are dominantly composed of quartz and feldspar and also contain minerals like tourmaline, fluorite, topaz, lepidolite, etc. They show a typical interlocking texture. Pegmatite minerals are oriented perpendicular to the walls of the dykes and some

Fig. 10.48 Limestone

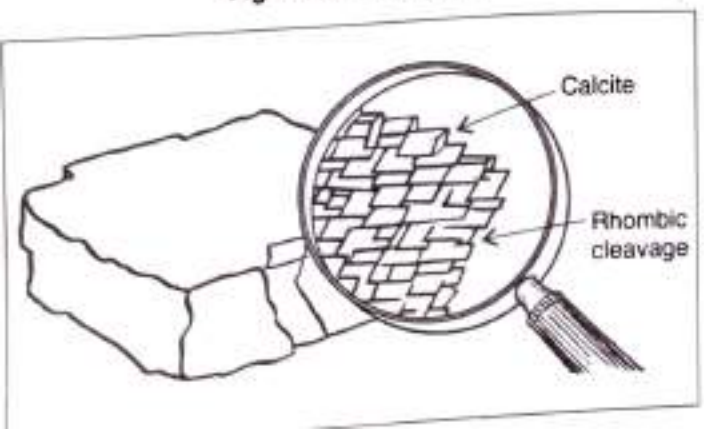


Fig. 10.49 Marble