Rocks and minerals

Minerals

Mineral is a structually homogeneous solid of definite chemical composition, formed by inorganic process of nature.

This definition includes ice as a mineral but excludes coal, natural gas and oil. The only exception to the rule that the mineral must be solid is native mercury, which is liquid.

”Definite chemical composition” doesn’t mean ”fixed or constant composition”. Many minerals have compositions which are variable between certain limits. The variation of composition should not markedly alter fundamental properties.

”Structurally homogeneous” implies that the fundamental atomic structure is continuous and constant through the mineral unit.

There are more than 3500 minerals in the nature, 400 of them are widely distributed in the Earth crust and 50-60 are main of the rock forming minerals.

Origin of the minerals

Endogenetic – which originate within the Earth (crystallization of magma or lava)

Magma is molten fluid formed within the Earth crust or in the upper mantle which after consolidation forms the igneous rocks. This material is a solution of molten silicates, water and gases.

Lava is a material extracted by a volcano which consists of molten or part-molten silicate material.

Exogenetic – which originate at or very near the surface of the Earth (weathering, erosion).

Metamorphic – a result of different kind of metamorphism.

Cleavage – type of plane after breakage.

Many minerals will, when broken, display a flat plane of breakage which is parallel to a possible crystal face. The mineral is then said to possess a cleavage parallel to “hkl”. Cleavage planes are developed along planes of weakness in the atomic lattice and the perfection of the cleavage parallel to 001, amphiboles have cleavage parallel to 100 and galena has three cleavages parallel to the cube face – 100, 010, 001.

Luster – the character reflected by the minerals.

This is a useful diagnostic property of the minerals. The luster should be described from fresh, unweathered and unoxidised surfaces especially freshly cleaved surfaces. The luster of single crystals may differ from crystal aggregates, e.g. single crystals of gypsum have a vitreous luster, while fibrous gypsum has a silky luster.

The most commonly used desctriptive terms are: Adamantine (diamond-like), Metallic, Pearly, Silky, Splendid or specular (mirror reflection), Vitreous (glass-like), Waxy, Ideally.

Hardness – a property of the minerals which is determined by reference to an empirical scale of standard minerals.

Mineral hardness is a “scratch” hardness, as opposite to engineers’ identitation hardness.

The scale in general use by mineralogists is due to Mohs and is as follows:

1. Text
2. Gypsum

    Fingernail

3. Calcite
4. Fluorite

    Teeth, copper coin

5. Apatite

    Window glass

6. Orthoclase
7. Quartz
8. Topaz
9. Corondum
10. Diamond

The steps between various minerals are not equal, e.g. diamond is about ten times as hard as corundum, whereas corundum is only about 10% harder than topaz. It should also be appreciated then that hardness of non-cubic minerals varies with the direction. It is doubtful if measurement of hardness defines a single property; it probably involves an integration of several properties, which it is almost impossible to measure separately. Despite this, it is one of the most important tests available to the mineralogists.

Specific gravity – express the mass of the mineral in a unit volume.

$$\rho_s = \frac{M_d}{V_d}, g / cm^3, where$$

M_d is the mass of the mineral;

V_d is the volume

The specific gravity of the minerals may vary from 0.8 till 22.66 g/cm^3 (platinum), usually 2.5 - 3.5 g/cm^3. In general the light coloured minerals have smaller specific gravity. In the practice the minerals may be divided into light$(\rho_s \le 2.5 \ g / cm)^3$, medium and heavy$(\rho_s \le 4.0 \ g / cm)^3$.

MINERALS						
NAME	**COMPOSITION**	**COLOUR**	**HARDNESS, SPECIFIC GRAVITY**	**LUSTER**	**CLEAVAGE**	**REMARKS**
plagioclase *feldspars*	silicate	white	6 2,7	Vit.	Perfect (001) Good (010)	scratches glass, reddish black plate
orthoclase *feldspars*	silicate	white to pink	6 2,56	Vit. to p-ly	Perfect (001) Good (010)	scratches glass
Muscovite *mica*	silicate	colourless or pale brown	2,5 2,85	Vit. to p-ly	Perfect (001)	table
Biotite *mica*	silicate	black, dark green	2,5 3	Vit. to p-ly	Perfect (001)	
Hornblende (amphiboles)	silicate	black, greenish black	5,5 3,2	Vit.	Perfect (110)	black and white
Kaolinite (layer lattice mineral)	silicate	white, greyish	2 2,6	Earth luster	Perfect (001) when detecrable	
Quartz (silica)	SiO2	colourless , white	7 2,65	Vit.	None	scratches glass
Hermatite (oxides)	Fe2O3	red to black	5,5 5,2	Met.	None	
Limonite (oxides)	FeOxnH2O	yellow	3-5,5 4	Earthy	Non-perfect	
Calcite (carbonates)	CaCO3	white	3 2,71	Vit.	Perfect (1011)	
Gypsum (sulphates)	CaSO4xn2H2O	white	2 2,3	Vit. to p-ly	Perfect (010)	
Galena	PbS	lead-grey	2,5 7,5	Met.	Perfect (100)	
Pyrite	Fe2S	brass-yellow	6,5 5	Met.	Poor (001)	goldy
Halite	NaCl	white	2,5 2,16	Vit.	Perfect (100)	
Fluorite	CaF2	light violet, greenish	4 3,18	Vit.	Perfect (111)	

ROCKS

These compose mineral aggregates, loose or consolidated hence soils are regarded as belonging to this category by geologists although engineers tend to distinguish between soils and rock in actual practice. The essential material contents, usually marking up over 95% of the total volume, are of the greatest importance, determining the type and characteristics of the rock concerned. The special arrangements of the minerals in a rock constitutes the texture, a classification feature. The usual classification of rocks by geologist is genetic, relating to their modes of origin, and includes the following groups:

(a) ***Igneous rocks*** formed ascending hot liquid material arising deep in the Earth called magma which crystallizes into the solid state as the temperature falls.

(b) ***Sedimentary rocks*** formed as a result of accumulation and compaction of:

(i) pre-existing rock fragments disintegrated throughout erosive processes;

(ii) organic debris such as shells;

(iii) materials dissolved in surface of groundwater and later precipitated in conditions of oversaturation;

(c) ***Metamorphic rocks*** formed from any pre-existing rock subjected to increases in pressure or temperature or both.

IGNEOUS ROCKS

These include a wide variety of minerals of which only eight are considered to be essential, namely quartz, orthoclase, plagioclase, muscovite, biotite, hornblende, augite and olivine. High quartz content igneous rocks are termed ***acid*** as opposite to those with low quartz content which are termed ***basic***. As well as these two subdivisions, there are intermediate and ultra-basic ones shown in ***Table***.

ACID ROCKS contain more than 60% silica.

The term “acid rocks” arise from the concept of silica as an acid oxide, i.e. in theory together with water it can form a range silicic acids, and thus regarded as salt of these acids.

BASIC ROCKS – A quartz igneous rock containing feldspars which are generally more classic then sodic. Rocks formerly defined in terms of silica percentage, **contain between 45 and 55% of silica.** Pyroxene and olivine are the common ferromagnesian although hornblende and biotite may occur in small quantities.

The term was used originally as the antithesis of acid rock, and does not imply the presence of free basis of chemical sense.

“Basic” is not synonymous with “alkaline”. *Basic rocks* grade into *intermediate rocks* by the increase in the *sodium content of the feldspars* and into *ultrabasic rocks* by decrease in the amount of *feldspar.* For typical basic rocks – Basalt, Dolerite, Gabbro.

MINERALS IN IGNEOUS ROCKS		
Composition	**Quantitey of silica**	**Essential minerals**
Acid (late crystalization from the magma at relatively low temperatures)	>65%	Quaryz, orthoclase, sodium-plagioclase, muscovite, biotite and sometimes hornblende
Intermediate	55-65%	Quaryz, orthoclase, plagioclase, biotite,hornblende and sometimes augite
Basic	45-55%	Calcium-plagioclase, augite and sometimes olivine and hornblende
Ultrabasic (early crystallization from the magma at relatively high temperatures)	<45%	Calcium-plagioclase, olivine and sometimes augite

Depending on their origin igneous rocks have different fabric.

Fabric – the fabric of the rock is the total of the features “structure” and “texture” ranging from the orientation of the individual grains to a regional joint or cleavage system.

Structure – a relationship between different parts of the rock. Examples of structures are: flow, amygdaloidal, bedding, jointing, cleavage.

Texture – the relationship between the grains of minerals forming a rock. Texture depends on four factors:

- grain size;
- grain shape;
- degree of crystallinity;
- contact relationships of the grains.

These factors are interrelated. According to that the texture of igneous rocks is:

- coarse grained;
- medium grained;

- fine grained.

There are:

- grains displaying a fully developed crystal form;
- grains showing some trace of crystal form;
- grains showing no development of their crystal form.

Besides the textures already indicated, igneous rocks may exhibit others, such as:

Glassy – due to the very rapid cooling

Porphyritic – in which both large and small crystals are associated

Vesicular and amygdaloidal – the commonest among extrusive rocks

Optic – resulting from the simultaneous crystallization of two minerals to produce a felted arrangement of interlocking crystals

Pegmatitic – produced in case when water and other fluxes sometime occur in the final stage of magmatic cooling

Igneous rocks are very varied reflecting the wide spectrum of possible physicochemical conditions of ***origin***. Most igneous rocks are composed of interlocking crystals, some of perfect crystalline form and hence are described as crystalline.

The size of the crystals is a basis for classification and relates to the mode of cooling of the original magma. Thus igneous rocks vary from ***fine grained*** to ***coarse grained*** with crystals ranging from as small as 1 mm across on the former to 3 mm or more across in the later.

Igneous rocks are divisible into three groups according to their ***emplacements***, namely:

I. ***Plutonic***, which form by slow cooling at depth of enormous masses of magma; the depth of formation may extend down many kilometers; as heat dissipates very slowly from such vast bodies of material, the crystallization process is slow and the rocks cool into coarse-grained texture.
II. ***Hypabyssal***, which form as small bodies of rock called dykes and sills; the bodies are termed concordant because they are injected along such layering; even though the cooling process is more rapid than with plutonic rocks, their crystals are still reasonably large so that they assume a medium-grained texture.
III. ***Volcanic***, which form at the planetary surface and originate as lavas emitted throughout volcanic activity and as these cool relatively rapidly, attain a fine-grained texture.

I and II comprise *intrusive rocks* that are intruded into a crust of the Earth, while III comprises *extrusive rocks,* which are rocks extruded on to the Earth surface. (Table)

Forms plutonic rocks are:

Batholith – large intrusive mass of igneous rock *(almost always granite in its widest sense).* They have a large area of outcrop and have no observable bottom.

Cupola – a small dome-like protuberance projecting from the main body of a larger igneous sediments.

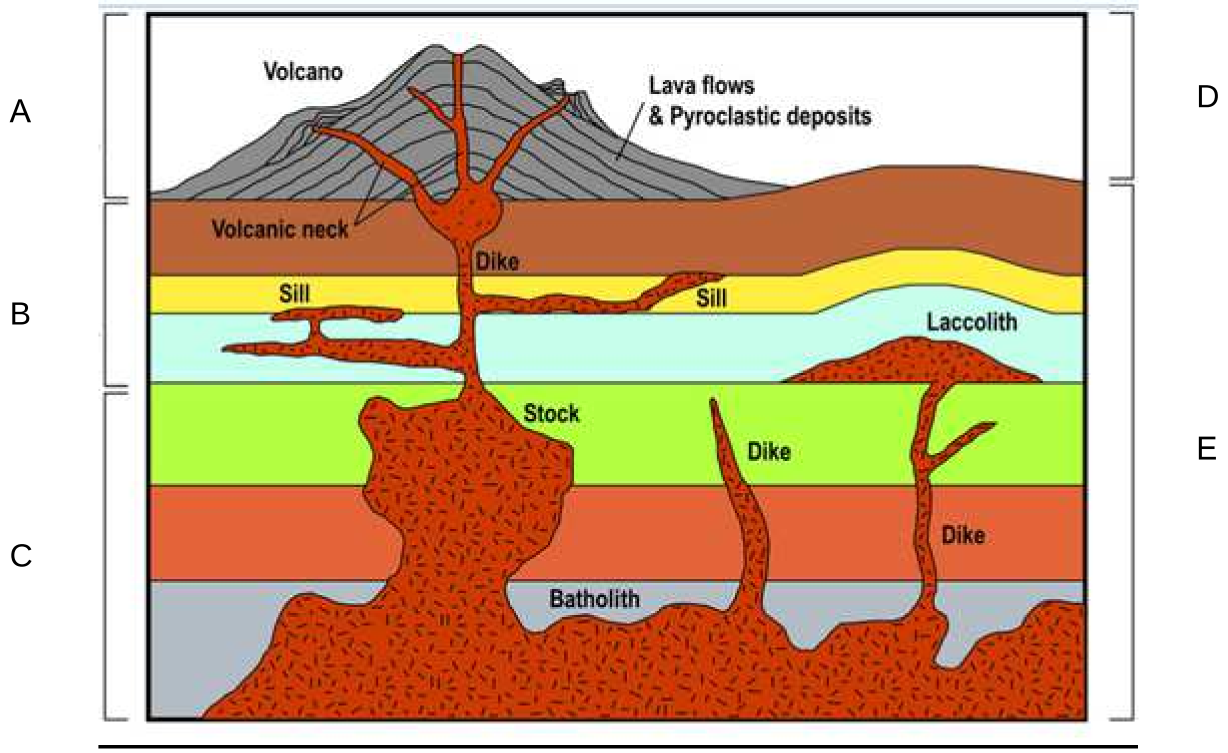
Laccolith – A saucer-shaped igneous intrusion which is concave upwards.

Dyke – a sheet-like body of igneous rock, which is discordant.

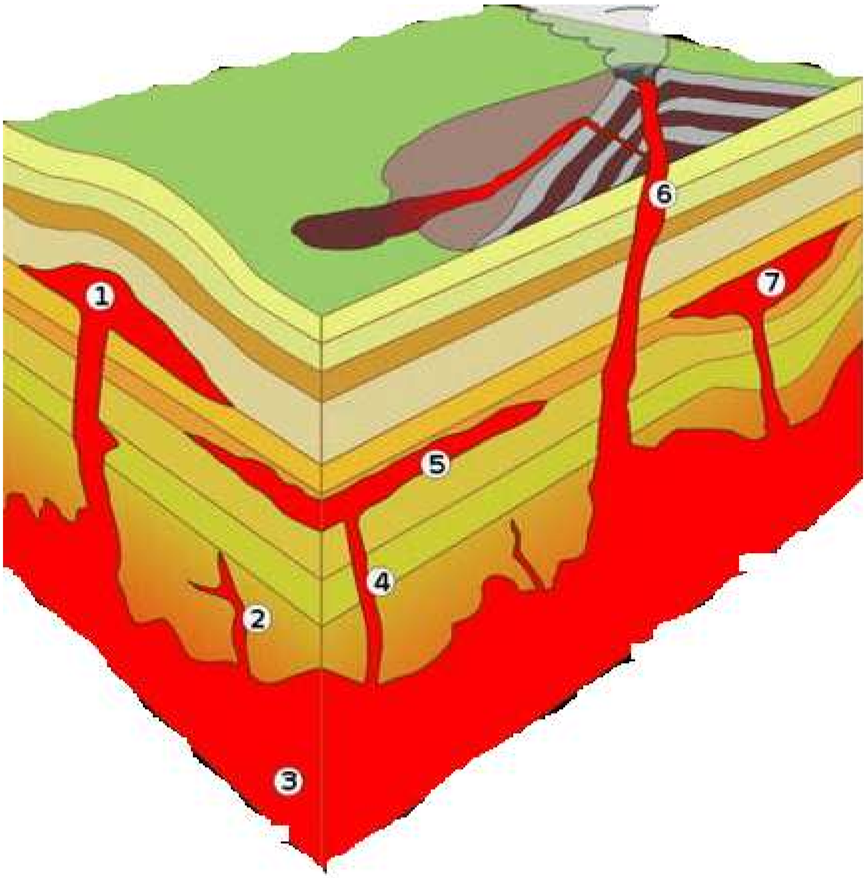
Sill – a sheet-like body of igneous rock, which conforms to bedding or other structural planes.

Extrusive rocks are a result of ***lava*** cooling.
LAVA is a material extrude by a volcano, which is consists of molten or partly molten silicate material. A single outputting of lava, called ***lava flow***, may arise from a central type vent or a fissure.
Lavas which are extruded under water commonly take the form of distorted globular masses, the characteristics of the so-called ***pillow-shape.***

Basic types of intrusions



A) – Rapid cooling rates; fine crystal sizes;
B) – Moderate cooling rates; medium crystal sizes;
C) – Slow cooling rates; large crystal sizes;
D) – Extrusive (volcanic) rocks;
E) – Intrusive (plutonic) rocks.



1 – Laccolith;

2 – Small dyke;

3 – Batholith

4 – Dyke;

5 – Sill;

6 – Volcanic neck/Pipe

7 – Lopolith

Most common igneous rocks

Granite - a *coarse grained* igneous rock consisting essentially *of quartz (20-40%), alkali feldspar*, and very commonly a *mica biotite and/or muscovite.* A number of accessory minerals may be included – *apatite, zircon and magnetite.* A small amount of *calcium bearing plagioclase* may occur in forms transitional to *granodiorite.* Granites characteristically contain a high proportion of *silica, often more than 70%,* and relatively high soda and potash percentage. (Na2O+K2O ranges from 5 to 12%).
Granites occur exclusively as intrusive bodies and may occur in almost any form (dykes, sills, plugs, bosses, ring complexes etc.) ***The largest masses of granite, however are batholiths.***
Granite is a plutonic equivalent of volcanic rhyolite, while adamellite is the plutonic equivalent of volcanic rhyodacite.

Rhyolite – *fine grained* to glassy acid volcanic rock. Mineralogically, they are *similar to granites*, although chemically, they appear *somewhat richer in Si2O.* Ferromagnesian minerals are less obvious than in the corresponding plutonic rocks.
The volcanic equivalent of granodiorite is dacite.
Many rhyolites show *well-marked flow textures* and structures.
Rhyolite lava is notably very viscous.

Diorite – a *coarse-grained* plutonic intermediate igneous rock consisting essentially of *intermediate plagioclase feldspar* (oligoclase and andesine), and one of the following ferromagnesian minerals – *biotite, hornblende, augite. Quartz* may be presented in small amounts, *up to 10%*. Alkali feldspars may also occur, up to one third of the total feldspar.
By increasing the content of *alkali feldspar*, diorites grade into *monzonites* by increasing a *quartz content – into granodiorited.* When the plagioclase becomes more basic than andesine, the rock becomes a gabbro.
Diorites are the plutonic equivalent of andesites.
They are rather uncommon rocks and are usually found either as rather small plugs or bosses *(rarely large dykes or sills)* or as marginal or satellite masses to granodiorites, gabbros or more rarely syenites.

Andesite – a *fine-grained intermediate* volcanic igneous rock characterized by the presence of *oligoclase or andesine.* Their chemistry and mineralogy are very similar to those of the diorites.
With increasing *silica content* and the development of *free quartz,* andesites pass into *dacites (rhyolite).*

Syenite – *coarse grained intermediate* igneous rocks characterized by the presence of *alkali feldspars and/or feldspatoids.* Typical ferromagnesian minerals are hornblende, biotite and augite.
Syenites are the plutonic equivalent of trachytes.
Separate bodies of syenite sometimes occur – *lopolthic forms and ring structures* have been found, also dykes and sills of microsyenites occur.

Basalt – a *fine-grained* sometimes glassy *basic* igneous rock. The essential minerals are a *calcic plagioclase and pyroxene* (usually augite) with or without *olivine. Magnetite* is important accessory, while *quartz, hornblende and hypersthene* are sometimes present in significant amounts.
Basalt are characterize by *low SiO_2 content (45-50%).* FeO, MgO and CaO content is generally *high,* while Na_2O and K_2O content is low especially in the olivine basalts.
With the decrease of *feldspar* content, basalts grade into *ultrabasic* types. With the increase of *soda plagioclase* and the development of *hornblende,* basalts turn into *andesites.*
Basalts are generally found in the form of *lava flow* which may be extensive and are often erupted from fissures and sometime from central type vents.
More than 90% of volcanic rocks are basalts and more than 90% of basic igneous rocks are basalt.
Basalts are fine-grained (volcanic) equivalent of the coarse-grained (plutonic) gabbros, and the medium-grained (hypabyssal) dolerites.

Diabase – pre-tertiary *medium-grained basic* igneous rock.

Peridotite – *ultra basic plutonic* rock consisting predominantly of *olivine* with or without other ferromagnesian minerals.

Gabbro – a *coarse-grained (plutonic) basic* igneous rock consisting of *basic plagioclase, pyroxene* (augite or hyperstone) and, *olivine* in substantial amounts. *Hornblende, biotite and quartz* occur in accessory amounts, and magnetite and ilmenite are common accessories.
Gabbros are coarse-grained equivalents of the volcanic basalts and hypabyssal dolerites.
Chemically, gabbros are *low in silica and high in Mg and Ca.* Na and K are very low, while Fe ranges from low values in the feldspathic types to exceedingly high ones in the Fe-rich ferrogabbros.
Some types of gabbro are:

Bojite – a gabbro containing primary amphibole;

Hyperite is a gabbro, containing hypersthene and augite;

Leucogabbro and leuconorite are feldspar-rich varieties;

Gabbros commonly occur in the form of either large lopoliths or layered complexes.

SEDIMENTARY ROCKS

Sedimentary rocks **are formed from a material derived from pre-existing rocks by the processes of denudation, together with a material with organic origin.**

Denudation – all processes tending to lower the surface of the land.

Weathering – mechanical break-up and/or chemical decomposition caused by agents like: frost, temperature change, chemicals in the atmosphere, precipitation and surface water.

Erosion – helps weathered products to be transported by rain, rivers, wind and gravity.

Materials can be deposited in *continental* areas, *marine* or *intermediate* depositional areas. Sedimentary rocks can be both *consolidated* and *unconsolidated* material. The process of conversion of unconsolidated sediments to coherent sedimentary rocks called *diagenesis.*

Sedimentary structures, classification:

External form of the bedding – bedding is described as thickness of the layers, variation of thickness, both in an absolute sense and in relation to variation of thickness of other lay.

Internal structures of bed – there are various types of bedding, including cross-bedding, graded bedding etc.

Sedimentary rocks are classified on the basis of the character of the material and the process which leads to their deposition:

- **terrigenous,** clastic or detrital formed from rock fragments;

- **organic,** derived from skeletal remains of plants and animals;
- **chemical,** formed by precipitation of dissolved salts, they are usually crystalline like chloride (rock salt), sulphate (gypsum);
- **calcareous,** limestones and dolomites containing over 50% calcium carbonate.

Terrigenous rocks

Arenaceous rocks – a group of detrital sedimentary rocks, typically sandstones in which the *particles range in size from 0.06 mm to 2 mm.*

Arenaceous rocks may be either accumulated by wind action or deposited by water action, and in the latter case they may form in marine or fresh water enviroments. They may be subdivided according to the following criteria:

(1) Particle size is as an indication of *distance of transport.*

Very coarse	-	2-1 mm
Coarse	-	1-0.5 mm
Medium	-	0.5-0.25 mm
Fine	-	0.25-0.125 mm
Very fine	-	0.125-0.6 mm

(2) Sorting – well sorted if the particle size range is small and *poorly sorted* or poorly graded if the particle size range is large.

(3) Particle shape – angular to sub-angular are *grits rounded* to sub-rounded grains, are termed *sandstones.*

(4) Mineralogy of grains – in most arenaceous rocks the grains are predominantly *quartz* (quartz sandstone).

(5) Mineralogy of cement – the commonest types of cement are:

(a) Calcareous;

(b) Siliceous;

(c) Argillaceous.

Argillaceous rocks – are a group of *detrital* sedimentary rocks, commonly *clays, shales, mudstones, siltstones and marls.* Two grades of particle size are recognized:

- *slit grade* in which the particles range in size from *0.06 - 0.002 mm;*
- *clay grade* with particles of less than *0.002 mm;*

Argillaceous rocks are almost always laid down in water – fresh or marine.

<u>Clay is</u> a term generally reserved for material, which is plastic when wet and has no well-developed parting along the bedding planes.

<u>Shale has</u> a well-marked bedding plane fissility due to the orientation of the clay material particles parallel to the bedding planes. Shales do not form a plastic mass when wet but the may disintegrate in water.

<u>Mudstones are</u> rocks, similar to shales in their non-plasticity, cohesion and lower water content, but lack of bedding plane fissility.

<u>Siltstones are</u> similar to mudstones but consist a predominance of silt-grade material.

<u>Marl is</u> a calcareous mudstone.

<u>Rudaceous rocks</u> – a group of detrital sedimentary rocks where the particles range in size *from 2 mm upward*. This type of rocks can be deposited in either water or sub-aerially, and have generally not been transported far from their point of origin. Two main classes of rudaceous rocks are known: *<u>breccias and conglomerates.</u>*

<u>Till</u> – all glacial and fluvioglacial left after the retreat of glaciers and ice sheets. Fluvioglacial drift is water lain, which distinguishes it from the unstratified condition of direct glacial deposits. After diagenetic processes till becomes tillstone.

<u>Calcareous</u>

<u>Limestone</u> – the term limestone is applied to any sedimentary rock consisting *essentially of carbonates.* The two most important constituents are *dolomite* and *carbonite,* but small amount of *iron-bearing carbonates* may also occur. Limestones may be *fresh water or marine,* and usually indicate deposition in *warm, clear water environment.*

Limestones can be classified into three major groups:

- *<u>Organic limestones</u>* – many plants and animals secrete $CaCO_3$, and on the death of the organisms, their skeletons either completed or broken up, may in the absence of any other sedimentary material accumulate to a form of limestone.
- *<u>Chemically precipitated</u>* – the main types are:
  (a) limestones belonging to an evaporate sequence – dolomite and calcite;
  (b) oolithic limestones in which concentric layers of calcite have been deposited around nuclei of mineral grains so as to form small spheres. Millions of these cement together to produce the characteristic of oolithic structure;
- *<u>Clastic (detrital) limestones</u>* – they are mechanically deposited carbonite rocks.

<table>
<tr><th colspan="5"><u>SEDIMENTARY ROCKS</u></th></tr>
<tr><th colspan="2">ORIGIN</th><th colspan="2">UNCONSOLIDATED ROCKS</th><th>CONSOLIDATED ROCKS</th></tr>
<tr><td rowspan="5">Terrigenous</td><td rowspan="2">rudaceous</td><td rowspan="2">gravel</td><td>angular</td><td>breccia</td></tr>
<tr><td>rounded</td><td>conglomerat</td></tr>
<tr><td>arenaceous</td><td colspan="2">sand</td><td>sandstone</td></tr>
<tr><td rowspan="2">argillaceous</td><td colspan="2">silt</td><td>siltstone</td></tr>
<tr><td colspan="2">clay</td><td>mudstone, shale</td></tr>
<tr><td colspan="2">Intermediate</td><td colspan="2">calcareous clay</td><td>marl</td></tr>
<tr><td colspan="2" rowspan="4">Chemical, biochemical</td><td colspan="2">calcareous</td><td>dolomite, limestones</td></tr>
<tr><td colspan="2">sulphate</td><td>gypsum, anhydrite</td></tr>
<tr><td colspan="2">chloride</td><td>rock salt</td></tr>
<tr><td colspan="2">silica</td><td>flintstone (chalcedony)</td></tr>
</table>

METAMORPHIC ROCKS

Metamorphic rocks are a result of the process of *metamorphism.* These rocks are a result from the subjection of pre-existing rocks to increases in *pressure and/or temperature* to a degree which promotes recrystallization so that a new rock is produced, one with a *new texture* and perhaps also with *new mineral composition.* Other agency of metamorphic process is *chemically active fluids.*

Five types of metamorphism can be recognised:

(a) – **<u>Thermal metamorphism</u>** – it involves *heat* alone, without significant pressure effect.

(b) – **<u>Dynamic metamorphism</u>** (dislocation metamorphism) – it involves intense localized *stress* which tend to break up the rocks.

(c) – **<u>Regional metamorphism</u>** (dynamothermal metamorphism) – it is the large-scale action of both *heat and pressure*, producing a wide range of new minerals and a widespread development of tectonites.

(d) – **<u>Retrograde metamorphism</u>** – any *reversal of metamorphism* which produces rocks of a lower metamorphic grade from one of a higher grade.

(e) – **<u>Autometamorphism</u>** – the process involves changes which occur during the cooling of an igneous mass as a result of the *activity of residual fluids* within the mass.

(f) – **<u>Polymetamorphism</u>** is applied to cases where two or more successive metamorphic episodes have left their traces in the rocks.

Gneiss – banded rocks form during high-grade regional metamorphism. Gneiss banding consists of more or less regular alternation of schistose and granulose bands. The schistose layers consists of micas and/ or amphiboles. The granulose band are essentially quartz-feldspathic and may or may not show prefer orientation. Gneisses are generally fairly coarse-grained rocks. In the group of gneisses there are many rock types heaving different origin, like paragneiss – from a sedimentary parent, orthogneiss – from igneous rocks etc.

Amphibolite – a metamorphic rock composed mainly of amphibolite, generally with an orientated fabric.

Hornblende schist – a rock consisting essentially of orientated crystals of hornblende, giving rise to the linear schistosity. Other minerals which may occur include plagioclase, quartz, epidote and biotite. Hornblende schist appears to be derived mainly from basic igneous rocks. Hornblende schist is regionally metamorphosed rocks.

Phyllite – a cleaved metamorphic rock having affinities with both slates and schists. The rocks are coarser grained and less perfectly cleaved than slates. They are however finer grained and better cleaved than mica schists. The common minerals are muscovite and chlorite. They have a phyllitic texture.
These rocks are a result of continuous stress acting on slates with some heat. They are formed by low-temperature regional metamorphism.

Schist – a regionally metamorphosed rock characterized by parallel arrangement of the bulk of the constituent minerals. The common minerals which give rise to schistosity are the micas in the case of platy and amphiboles give rise to linear. Schists are named according to their most prominent minerals. All these rocks have schistose structure.

Slates – the have slaty texture. The rocks are formed by low grade regionally metamorphosed argillaceous rocks which have developed a well-marked cleavage. It turns into phyllite when more stressed.

Talc schist – are low or medium grade metamorphosed basic or ultrabasic igneous rocks. In certain cases mineral talc constitutes the greater part of the rock.

Quartzite – a metamorphosed arenaceous rock with granulose texture. Predominantly composed of quartz. Quartzites are usually thought of as thermally metamorphosed rocks but regional metamorphism also produces them.

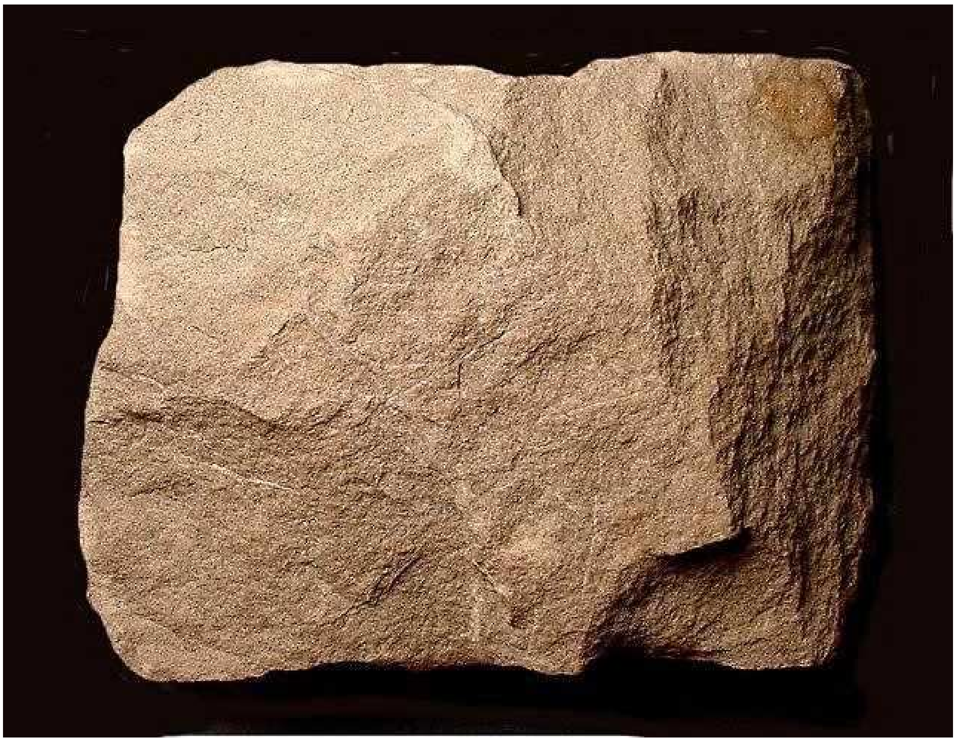
Marble – a metamorphosed limestone produced by recrystallization under conditions of thermal metamorphism. They have granulose texture. Marbles derived from pure limstones consists simply of recrystallized calcite.

METAMORPHIC ROCKS		
Rocks	**Mineral content**	**Parent rock**
Gneiss	quartz, feldspars, micas, hornblende	acid and intermediate igneous rocks, sedimentary rocks (sandstones, clays)
Mica schist	quartz, micas	argillaceous rocks, sandstones
Phyllite	quartz, chlorite, muskovite	argillaceous rocks, slates, schists
Amphibolite	plagioclase, hornblende	intermediate and basic igneous rocks, argillaceous rocks
Hornblende schist	hornblende	basic and ultra basic igneous rocks, argillaceous rocks
Talc schist	talc	basic and ultra basic igneous rocks
Quartzite	quartz	sandstone
Marble	calcite, dolomite	limestones

Some rocks look like this

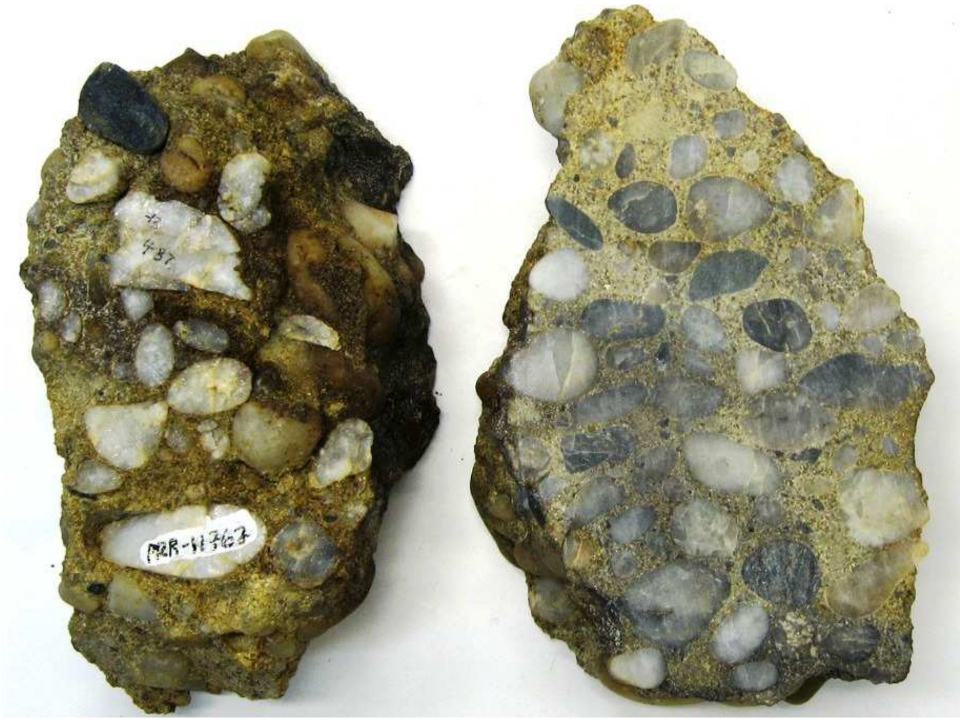
Black limestone

Breccia



Sandstone

Shelly limestone



Conglomerate

Gneiss

Phyllite

Schist

Quartzite

Quartzite

Marble

Granite

Diorite

Gabro

Rhyolite

Andesite

Basalt