

In this particular module,
we will highlight what is
meant by metamorphic rocks,
and outline the factors that are
responsible for metamorphism.

By the end of this module will be able
to distinguish between metamorphic
rocks from the different type of rocks,
that is, the sedimentary and igneous
rocks. we will be able to define what is
metamorphic rocks and list the factors
that are responsible for metamorphism.

In the dynamic earth, changes in
geologic systems resulting from
transfers and transformation of
energies and from movement of rock,
magma, and fluids are continuously occurring.

This occurs mainly at the margins
of the lithospheric plates.

The state of thermodynamic
equilibrium are then perturbed,

causing the rock to seek new, lower energies which are most stable states, by the adjustment of their fabric as well as their composition.

Metamorphism is the sum of all the transformations which causes the rearrangement of elements of a rock at an atomic scale, leading to recrystallization and solid state.

With or without a fluid phase.

As a result of variation in temperature, pressure, or of composition.

This equilibrating adjustments that take place in solid state at elevated temperatures are considered to be metamorphic processes.

The broad ranges of condition between igneous crystallization and surficial weathering and diagenesis is the realm of metamorphism.

So let us take a look at what is the

definition that has been proposed by IUGS/SCMR.

Metamorphism is a process involving

Changes, in the mineral constituent/.

Composition and or

Microstructure of a rock, dominantly

in a solid state.

This process is mainly due to the

adjustment of the rock to the

physical conditions that differ from

those, which the rock originally

formed and that also differed from

the physical conditions normally

occurring at the surface of the

earth and in the zone of diagenesis.

The process make coexist also

with partial melting and may also

involve change the bulk chemical

composition of the rock.

We got to remember that this mostly

occurs in a solid state due to the

changes in the new set of conditions,

that is, temperature and pressure.

The term metamorphism comes from

the Greek word called meta,

meaning change and morph meaning form.

Metamorphism therefore refers

to a change in the rocks,

mineralogy, its texture and or composition

that occurs predominantly in solid state

under conditions of those that occur

at diagenesis and as well as those,

At large scale melting.

During metamorphism,

the rocks are hot enough to recrystallize

but not hot enough to melt.

By metamorphism, the constituent,

mineral of the rock are changed over

to others which are now most stable

under this new set of conditions.

And these may arrange themselves

with the production of structures,

which are likewise better suited

to the new set of environment.

Like magmatism,

metamorphism involves a

transfer of heat and mass.

There are significant contrasts between

magmatic and metamorphic systems.

Magmatic behavior is dominated by

a melt or a silicate liquid that

contains dissolved volatile and

interacts with the crystalline matter.

In contrast,

sub solidus metamorphic system lack a

melt but usually have volatile

fluids that interact chemically,

physically and thermally with

the crystalline aggregates.

And can have a catalyzing kinetic effect

on the metamorphic equilibration.

Thus,

hastening and facilitating changes

in the rock system.

Hence,

mineralogical disequilibrium and

relics of incomplete or printed

reactions are widespread,

which help us to unravel the

metamorphic history.

Metamorphic rocks commonly bear the imprint

of non- hydrostatic states of stress

and form of anisotropic fabrics that

are developed during the ductile flow,

such as that foliation and

lineation as seen in schists.

In contrast, those of magma,

those that have been crystallized from magma,

that as your igneous rocks,

these contain mostly isotropic fabric

and locally acquire anisotropic fabric.

So now let us think or understand

what is the real name of metamorphism

that is, the lowermost temperature

and the higher most temperature

at which metamorphism can occur.

The temperature at which recrystallization

or new minerals form take place

depends on the initial material.

That is the protolith.

For example,

you can have glass or volcanic

ash or evaporites.

In such cases,

these may alter at much lower temperatures

compared those to silicates and carbonates.

Zeolites are generated at very

low temperatures,

diagenetic environment as well as

rocks that are clearly recrystallized

by metamorphic standard.

Diagenesis is therefore the process

which changes unconsolidated

sediments into sedimentary rocks.

Diagenesis consists in large part

of reduction of the sedimentary

porosity through the process

of compaction and also to some

extent implies recrystallization.

Metamorphism generally takes place

at a higher temperature and pressure

conditions than that of diagenesis.

But, the intrinsic nature of physiochemical

mechanism is the same for both processes.

Metamorphism is generally related to

orogenic or pre-orogenic phenomena,

whereas, diagenesis is related to

the dynamics of sedimentary basins.

This distinction is extremely subtle

because sedimentary basins precede

follow or accompany orogenesis,

and their dynamics are therefore related.

Therefore,

there is a general consensus, that,

metamorphism begins in the range

of 100 to 150 degrees Centigrade.

For more unstable type of protolith

and can be marked by the formation

of minerals such as Laumonite,

heulandite, pargonite,

prehnite, pumpellyite, lawsonite,

glaucopegane or Stipnomelane.

Some Zeolites are considered diagenetic,

whereas others are considered metamorphic.

Also now let us discuss about

the higher temperature range at

which metamorphism can occur.

Crystallization and melting takes

place over a wide range of temperatures.

For example,

if you have granitic type of rocks,

this will be at 600 degrees Centigrade.

Depending on water content of the system.

When we heat a metamorphic rock till it melts,

we can say that the melted part is igneous,

but the solid portion still

remains metamorphic.

Therefore,

in certain domains of
high grade metamorphism,
the temperature is sufficiently
high to allow partial Fusion of the
material and the production of liquids
generally of granitic composition.

If these liquids remain enclosed
and crystallize within the rock
bodies from which they were derived.

They result in a mixed formation
or migmatites which belong
to the metamorphic domain.

Let us take a look at the few factors
that are responsible for metamorphism.

Equilibration process and the kinetic
factors that control the rates of
metamorphism vary, depending on the
fabric and composition of the parent rock,
the temperature,
the pressure, of the evolving rock system,
and the composition of the

chemically active fluids in it.

So this temperature or the heat may be coming from magmas or from the increase in temperature with depth within the surface of the Earth.

It also could be here that is generated from the decay of radioactive minerals.

Whereas pressure,

This is due to gravity and also can be that of hydrostatic and non hydrostatic kinds.

The main vehicle for alteration is the interstitial volatile or liquid matter that occupies the capillary pores or fissures.

Water is a chief fluid.

This can also be carbon dioxide,

Boric, hydrochloric acids which emanate from the igneous magmas.

That reaction can take place by partial or complete solution of the minerals.

These are the references.

Thank you.