Quadrant II – Transcript and Related Materials (Notes)

Programme	**: Bachelor of Science (First Year)**
Subject	**: Geology**
Paper Code	**: GEC 102**
Paper Title	**: Introduction to Petrology**
Unit	**: 4**
Module Name	**: Structures & Textures of Metamorphic Rocks -3**
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Notes:

Anisotropic Fabric

Complex interactions between solid state recrystallization and ductile deformation that results from imposed non-hydrostatic stresses are widespread in metamorphic systems.

Structure is a term used for large- scale features that occur on the hand sample, outcrop or even regional scale.

Structure of a metamorphic rock depends on the interrelations of various textures within the same rock unit and are frequently dominated by the directive forces due to the unequal pressure.

These interactions are expressed in the penetrative **anisotropic fabrics of tectonites** that are seen mostly in **regional dynamothermal settings in orogens.** They are also seen in deep shear zones to strained contact aureoles.

Dynamothermal setting is where you have both **deformation and heat**

Imposed anisotropic fabrics reflect the pervasive solid-state flow of the rocks in response to **non-hydrostatic stresses.** Here the fabric has different aspects in different directions (e.g. like a deck of cards).

- Rocks that show such fabric include, slates, schists and gneisses.
- Elongated minerals here will show preferential orientations.
- The rock may have layers of contrasting mineral composition (Gneisses)

Tectonite is a deformed rock, with a texture that records the deformation by developing a preferred mineral orientation of some kind. The fabric of tectonite is a complete spatial and geometrical configuration of its textural and structural element.

Anisotropic fabric may be classified as:

a) **Planar**

b) **Linear**

c) **Planar-Linear**

Planar fabric is expressed by a set of closely spaced, sub-parallel faces within the rock body, that is referred to as **foliation**. The foliation may be irregular curved or even folded if deformed.

Primary foliation are (pre-deformational ones) such as bedding planes which survive.

Secondary foliation are the deformational ones created or imposed such as slaty cleavage in slates, schistosity of schists and the compositional layering of gneiss.

Slaty cleavage: A type of continuous cleavage in which the individual grains are too small to be seen by the unaided eye.

It is a fine penetrative foliation. It is defined by closely spaced planes along which a rock cleaves easily when hit with a hammer.

Phyllites have a slightly coarser continuous cleavage. They have a lustrous sheen on foliated surfaces as the grain size is slightly coarser than slates.

And where the individual aligned crystals become large enough to see with our naked eye, (medium to coarse) the foliation is termed as **Schistosity.** Is a coarser penetrative foliation.

It is characterized by more intensely metamorphosed rocks. Due to which the relict magmatic and sedimentary features are erased.

The rock here usually breaks irregularly along planes of schistosity.

These are also commonly lineated, expressed by long segregation of contrasting minerals due to metamorphic differentiation.

e.g. are Chlorite and Mica Schists.

Schistose: This structure is due to the predominance of flaky, lamellar, tabular, rod-like and highly cleavable minerals such as mica, chlorite, talc, which under dominant influence of directed pressure in dynamothermal metamorphism form layers and folia arranged in more or less parallel layers.

The folia may be plane, undulating or lenticular, where they wrap round porphyroblasts. Foliated rocks have the property of schistosity whereby they can be split along planes parallel to the plane of extension of the constituent minerals

Slates/Phyllites and Schists are strongly foliated and formed under low grade metamorphism due to abundance of platy phyllosillicates minerals as compared to higher grade rocks.

Gneissic banding

A weakly foliated rock is defined by weak parallelism of inequant mineral grains or due to mechanical compositional layering. The rocks here do not easily break along the foliation.

When the foliation consists of mm to cm scale layering in which mineral proportions, colours or textures may vary, and along which there is no particularly strong tendency to break, the fabric is called gneissic and the rock that shows such fabric is called as **Gneiss**.

These are poor in platy minerals and represent a higher grade of metamorphism

Gneiss is medium to coarse grained rock, granoblastic to lepidoblastic (**lepidoblastic** texture is a metamorphic texture in which platy (micas, talc, chlorites, graphites) are aligned preferentially to produce a planar fabric).Compositionally they are made up of dominantly quartz and feldspars and micas and hornblende.

Lineation:

Any repetitively occurring set of parallel to sub-parallel visible linear feature in a rock body.

It is a pervasive feature.

Orientation of grains in metamorphic rocks may result due to elongation of grains. An important mechanism which leads to purely crystallographic orientation is recrystallisation; it is best shown by recrystallised quartz & calcite which show orientation of c - axes.

Elongated mineral fragments produced by fracturing may show crystallographic as well as dimensional orientation.

High Strain metamorphic textures (Fault/Shear Zones)

Shear stresses are important in development of textures and structures in a metamorphic rock. Shear and recystallization causes elongated elements

Deformation tends to break minerals down to smaller grains and sub-grains, whereas heat of metamorphism tends to bring them up again.

In highly deformed rocks are elevated temperatures and pressures.

With either brittle or ductile granulation, larger initial grains (phenocryst) or more resistant mineral, may stand out in a pseudo-porphyritic manner (pseudo = false) and be left surrounded by finer crushed material .

The larger shear bounded grains are called as **porphyroclasts** and are commonly **lenticular or eye-shaped** (Augen- German) because of the branching of the micro-shears around them.

Many rocks are drawn out into parallel lenticles, streaks and bands of differential crushing, and sometimes of different composition, resulting in a structure similar to that of schists and gneisses due to recrystallisation.

If the porphyroclasts are surrounded by matrix of fine crushed material that is derived from them as they are rotated and grounded down this texture is called as **mortar texture.**

Cataclastic structure:

It is the structure of fragmented rocks developed by shearing stress upon hard, brittle materials in the upper zones of the earth's crust with little new minerals formation.

Soft rocks, like shales or tuffs, develop cleavage; harder rocks are shattered and finally crushed to powder with the formation of **crush breccia**.

Augen Gneiss.

Gneisses with ovoidal megacryst of feldspar are called as **Augen Gneiss.**

It is a type of porphyroclastic texture where the alkali feldspar or plagioclase occurs as clasts.

Mylonitic fabric

Mylonitic fabric: a very fine grained, usually aphanitic, hard, streaked, foliated, may contain presence of less deformed ovoidal relict grains (flaser fabric). It is an anisotropic fabric produced in intense deformation through **cohesive solid-state ductile flow under non-hydrostatic stresses** leading to tectonic reduction in grain size.

The grains under microscope will show intense strains like undulose extinction in quartz.

Flaser fabric:

It's a type of mylonitic fabric in which ovoidal megacrysta that have survived deformation lie in a finer mylonitic matrix. The megacryst/porphyroclast fragments have similar composition to the minerals in the matrix.

How do we relate texture structure and fabric in a rock?

e.g. Foliation is a planar, directional feature, produced by **penetrative deformation** in metamorphic rocks, which is observable at all scales, i.e. at outcrop or quarry scale, hand-specimen scale or under the microscope. Therefore, depending on at what scale a person made the observations he may use the words **foliated-fabric, foliated structure or foliated-texture**. Because foliation is a penetrative fabric it occurs both as a **structure and texture**.

A layered fabric may do the same depending on the scale of layering. If the layers are very thick one may observe that in outcrop but not under the microscope (unless one makes a slice containing marginal region of two layers).

Fabric incorporates both texture (called microstructure) and structure.

On the other hand, texture refers to small-scale features in a rock including grain size and shape, intergranular relations, and degree of crystallinity (amount of crystal and glass) generally observed at the scale of a hand specimen and using microscope. Many geologists also use fabric as a synonym for texture