

Quadrant II – Transcript and Related Materials (Notes)

Programme	: Bachelor of Science (Third Year)
Subject	: Geology
Paper Code	: GEC 109
Paper Title	: Metamorphic Petrology
Unit	: 3
Module Name	: Anisotropic fabric
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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.
- 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)

Anisotropic fabric (imposed) foliation

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.

Foliation is the term for any planar textural element in a rock.

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.

Types of foliations

- a. Compositional layering (in Gneiss)
- b. Preferred orientation of platy minerals (like in Schists)
- c. Shape of deformed grains
- d. Grain size variation
- e. Preferred orientation of platy minerals in a matrix without preferred orientation
- f. Preferred orientation of lenticular mineral aggregates
- g. Preferred orientation of fractures
- h. Combinations of the above

Anisotropic fabric (imposed) foliation:

Slaty cleavage

- **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.
- Slates are usually aphanitic (very fine grained, individual minerals hard to see with naked eye) and have a dull lustre on the well-developed slaty cleavage.

- The cleavage planes may lie parallel to the original bedding or across it depending on the direction of applied non-hydrostatic stress.

Schistosity

- **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. The term schist is derived from the Greek schistos - to split.
- 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.
- Slates/Phyllites and Schists are strongly foliated and formed under low grade metamorphism due to abundance of platy phyllosilicates minerals as compared to higher grade rocks.

Gneissic banding

- A weakly foliated rock is defined by weak parallelism of in-equant 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.

It may be defined by:

- Alignment of the long axes of elongate mineral grains (= *mineral lineation*)
- Alignment of elongate mineral aggregates
- Parallelism of hinge lines or small scale folds (= *crenulation lineation*)
- Intersection of two foliations
- Slickenside striations or fibres.
- Lineations may become curved or distorted.
- A pure lineation without associated foliation may be expressed by preferred orientation of columnar or acicular mineral grains, such as amphibole, or by linear segregations of contrasting grain aggregates.
- But rock bodies with only a linear fabric are rare and most lineated rocks are also foliated. E.g. Linear streaks of micaceous aggregates, also define a foliation because the basal planes of the mica grains are more or less parallel.

High Strain metamorphic textures (Fault/Shear Zones)

Shear stresses are important in development of textures and structures in a metamorphic rock. Shear and recrystallization 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 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.

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**.

Augen fabric

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:

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 megacrysts that have survived deformation lie in a finer mylonitic matrix. The megacryst/porphyroclast fragments have similar composition to the minerals in the matrix.