LAB 9: METAMORPHIC ROCKS IN HAND SAMPLE

Knotty staurolite-garnet schist, Picuris Range, New Mexico

**Purpose:** This week you will be learning how to identify and name metamorphic rocks in hand sample. For each rock, you need to identify the minerals present (if visible), identify the rock's textural features, and give the rock a name. In the space provided, identify any textures or fabrics that you observe, then give as complete a rock name as possible, including metamorphic minerals and a textural or compositional name. Refer to the metamorphic textural classification handout as a guide. There will also be a set of reference metamorphic rock samples to help you become familiar with the various types of metamorphic rocks.

The nomenclature for metamorphic rocks is archaic! Rock names are inherited from all manner of early descriptive terms, some referring to minerals, some to texture, and some to composition or color, and they are difficult to remember. But, in simplest terms, metamorphic rock names are assigned as follows:

1. Basis of metamorphic classification is on —
   a. **fabric or texture** (e.g., schist, gneiss, mylonite, hornfels, etc.)
   b. **minerals** (e.g., amphibolite, etc.)
   c. unusual **composition** (e.g., quartzite, marble, serpentinite, eclogite, etc.)
   d. **color** (e.g., blueschist, greenstone/greenschist, whiteschist, etc.)

2. Rock names should be given as "mineral(s) + texture" (hence, *muscovite-garnet schist*) —
   a. list minerals in **increasing order of abundance** (e.g., muscovite-garnet)
   b. provide a textural name (e.g., schist, gneiss, etc.)

3. Common textures and fabrics —

   **foliation** — planar fabric formed by layers or minerals
   a. slaty cleavage
   b. phyllitic cleavage
   c. schistosity
   d. gneissic layering or banding
   e. shear foliation

   **lineation** — linear fabric formed mostly by minerals
   a. mineral alignment
   b. cleavage intersection
   c. fold axis

   **other rock textures, not associated with deformation** —
   a. massive
   b. granular
   c. hornfelsic
There is a reference set of common metamorphic rocks in the back of the lab. Use these rocks to understand the use of the classification scheme and refer to them as needed when working on the main lab assignment.

**Naming metamorphic rocks** is not as straightforward as with igneous or sedimentary rocks. Metamorphic rocks are given a name on the basis of their texture, mineralogy, or unusual composition. First, give the rock a name on the basis of its dominant texture (see brief list below), then add modifiers based on mineralogy or other textural terms. For example, you might have a "porphyroblastic garnet-muscovite-biotite schist". In cases of special composition, substitute an appropriate name in place of the texture (e.g., "sillimanite-orthopyroxene granulite").

**Strategies:**

Develop a classification “tree” that works for you. A good place to start is to first determine the overall texture (massive, foliated, lineated, etc.), then work on minerals. For metamorphic rocks, we do not need to determine mineral modes! Hooray for metamorphic rocks! It’s important to identify all the major minerals, but focus on those minerals that help us understand the metamorphic conditions (chlorite, garnet, staurolite, glaucophane, omphacite, etc.). Also identify any ‘framework’ minerals (quartz or feldspar). Be sure to note any special textures of minerals (porphyroblasts, augen, etc.).

**Trends:**

In general, grain size increases with metamorphic temperature (grade). As a first step, stick to the slate-phyllite-schist-gneiss progression. Some minerals typically form as porphyroblasts (garnet, staurolite, chloritoid). These are only “rules of thumb” for which there are many exceptions, but it’s a good place to start.

**Assignment:**

1. **Classify** each of the metamorphic rocks in the trays using the attached classification guides. In the worksheet provided, be as specific as you can, using proper terms that describe texture, mineralogy, and rock name.

2. On a separate page, draw neat, scaled **sketches** of any **two** of the larger samples provided. Take care to accurately draw what you see, show any fabrics or structures, and label the minerals or mineral zones present. Focus your attention on textures, in order to illustrate features related to the rock’s formation.

3. In words, provide a **complete description** of sample ___. Include color, texture and mineralogy, as well as a sketch of its texture and a complete rock name. The goal here is to provide with words a vivid picture of the sample’s characteristics and appearance that someone else can imagine.
TEXTURES REFERRING TO PLANAR AND LINEAR FABRICS

Preferred orientation: parallel arrangement of planar or linear elements in a rock; in metamorphic rocks includes grain-shape preferred orientation, due to alignment of inequant minerals, and lattice preferred orientation, due to parallelism of mineral crystal lattices

Foliation: parallel planar arrangement of minerals or compositional banding in a rock; a general term for a planar texture that includes slaty cleavage, schistosity, and gneissic layering

Lineation: parallel linear arrangement of minerals or structures in a rock; general term that includes alignment of prismatic or needle-like grains, linear aggregates of grains, axes of microfolds, or the intersection of two planar elements (e.g., foliations)

Slaty cleavage: foliation of very fine-grained micas, as in a slate, in which individual minerals are not distinguishable by eye; gives rock a high planar fissility or cleavability, but a dull finish

Phyllitic: foliation of fine-grained micas in which individual minerals are not readily visible, but the rock (phyllite) has a pronounced sheen or silky appearance; often foliation is uneven

Schistose: foliation of inequant minerals (micas, amphiboles, etc.), as in a schist, in which individual minerals are plainly visible; often foliation is rumply

Gneissic: foliation in which rock contains bands of alternating composition, often as dark or light layers; minerals are often coarser than in a schist, but include fewer micas; can be designated as orthogneiss for igneous protoliths and paragneiss for sedimentary protoliths

ROCK NAMES BASED ON TEXTURE

<table>
<thead>
<tr>
<th>Texture</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slate</td>
<td>slaty rock</td>
</tr>
<tr>
<td>Phyllite</td>
<td>phyllitic rock</td>
</tr>
<tr>
<td>Schist</td>
<td>schistose rock</td>
</tr>
<tr>
<td>Gneiss</td>
<td>gneissic rock</td>
</tr>
<tr>
<td>Hornfels</td>
<td>hornfelsic rock</td>
</tr>
<tr>
<td>Mylonite</td>
<td>mylonitic rock</td>
</tr>
</tbody>
</table>

ROCK NAMES BASED ON COMPOSITION, COLOR, MINERALOGY, AND THE PROTOLITH

Amphibolite: mafic rock composed predominantly of hornblende and plagioclase; indicates medium- to high-grade metamorphism; often black from predominant hornblende

Blueschist: mafic rock containing lilac- or blue-colored amphibole such as glaucophane; may also contain mica, epidote or lawsonite; indicates high-pressure of metamorphism

Calc-silicate schist or gneiss: calcareous rock containing abundant calc-silicate minerals (diopside, plagioclase, epidote, grossularite, scapolite, etc.) in addition to calcite or dolomite; a skarn is a type of calc-silicate rock that exhibits compositional banding concordant to contacts with plutonic rocks

Eclogite: mafic rock containing garnet and pyroxene; strictly, pyroxene is omphacitic (solid solution of diopside and jadeite) and garnet is Mg-rich pyrope; generally forms under high pressures
Granulite: granoblastic rock containing dominantly equant minerals such as quartz, feldspar, pyroxene or garnet; may exhibit compositional layering; generally forms at high temperatures

Greenstone: fine-grained granoblastic rock of low-grade regional metamorphism and mafic composition; chiefly contains chlorite, epidote, and actinolite; also **greenschist** if schistose

Marble: calcareous rock composed chiefly of calcite or dolomite; usually of granoblastic texture

Migmatite: a *mixed rock* composed of dark schistose or gneissic parts that are intimately intermingled with lighter-colored igneous looking parts

Pelite: siliceous rock containing abundant micas (esp. muscovite and biotite); strictly, should contain an Al-silicate mineral (andalusite, kyanite, or sillimanite) to demonstrate Al-rich composition equivalent to that of shale (i.e., it is *pelitic*

Quartzite: rock composed dominantly of quartz; distinguished from sandstone in that fractures propogate through quartz grains

Serpentinite: rock of ultramafic composition composed chiefly of serpentine; may also contain talc, chlorite, and carbonate, as well as relict pyroxene or olivine

**COMMON METAMORPHIC TEXTURES**

Augen texture: from the German for "eye"; refers to elliptical or eye-shaped coarse crystals of a mineral (usually feldspar) seen in some gneisses and schists

Corona or reaction rim: grains of one mineral that are surrounded by grains of another, indicating a reaction between the interior mineral and the surrounding matrix

Granoblastic: mosaic of equigranular, anhedral grains, *commonly showing 120° crystal junctions*

Helicitic: refers to a porphyroblastic mineral that preserves an earlier fabric; often are S-shaped curved trains of inclusions, suggesting progressive entrapment of inclusions during rotational growth of the porphyroblast

Hornfelsic: fine-grained texture in which the minerals are not oriented, often giving the rock a granular or ceramic-like appearance

Mylonitic: fine-grained rock having a texture in which matrix minerals (often quartz and mica) appear to flow around strong, rigid grains (such as feldspar); may give the rock a banded, flinty or streaky appearance; forms as a result of intense ductile shear deformation in which mineral recrystallization (function of shear-stress) predominates over mineral growth (function of temperature)

Poikiloblast: a porphyroblast with many inclusions of another mineral that were trapped during growth; also referred to as **sieve texture**; often seen in garnet, staurolite, and andalusite; a rock containing poikiloblasts is referred to as poikiloblastic

Porphyroblast: mineral in a rock that has grown with markedly coarser grainsize than the minerals in the matrix; often seen in garnet, staurolite, chloritoid, etc.; analogous to phenocryst in igneous rocks; a rock containing porphyroblasts is referred to as porphyroblastic
Porphyroclast: coarse mineral in a rock that is relict from a coarser grainsize, often showing effects of strain or breakage due to deformation (i.e., a fragment); often seen in strong minerals such as feldspar or garnet