

Classification of Metamorphic Rocks

Reading: Winter Chapter 22:

Classification of Metamorphic Rocks

- Metamorphic rocks are classified on the basis of *texture* and *composition* (either mineralogical or chemical)
- Unlike igneous rocks, which have been plagued by a proliferation of local and specific names, metamorphic rock names are surprisingly simple and flexible
- May choose some prefix-type modifiers to attach to names if care to stress some important or unusual textural or mineralogical aspects

Foliated Metamorphic Rocks

- Foliation: and planar fabric element
- Lineation: any linear fabric elements
 - They have no genetic connotations
 - Some high-strain rocks may be foliated, but they are treated separately

Foliated Metamorphic Rocks

Cleavage

- Traditionally: the property of a rock to split along a regular set of sub-parallel, closely-spaced planes
- A more general concept adopted by some geologists is to consider cleavage to be any type of foliation in which the aligned platy phyllosilicates are too fine grained to see individually with the unaided eye

Foliated Metamorphic Rocks

Schistosity

- A preferred orientation of inequiant mineral grains or grain aggregates produced by metamorphic processes
- Aligned minerals are coarse grained enough to see with the unaided eye
- The orientation is generally planar, but linear orientations are not excluded

Foliated Metamorphic Rocks

Gneissose structure

- Either a poorly-developed schistosity or segregated into layers by metamorphic processes
- Gneissose rocks are generally coarse grained

Foliated Metamorphic Rocks

Slate: compact, very fine-grained, metamorphic rock with a well-developed cleavage. Freshly cleaved surfaces are dull

Phyllite: a rock with a schistosity in which very fine phyllosilicates (sericite/phengite and/or chlorite), although rarely coarse enough to see unaided, impart a silky sheen to the foliation surface. Phyllites with both a foliation and lineation are very common.



Figure 22-1. Examples of foliated metamorphic rocks. a. Slate. b. Phyllite. Note the difference in reflectance on the foliation surfaces between a and b: phyllite is characterized by a satiny sheen. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Foliated Metamorphic Rocks

Schist: a metamorphic rock exhibiting a schistosity. By this definition schist is a broad term, and slates and phyllites are also types of schists. In common usage, schists are restricted to those metamorphic rocks in which the foliated minerals are coarse enough to see easily in hand specimen.

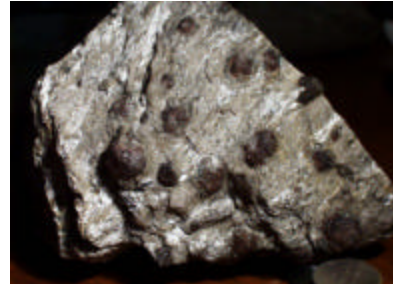


Figure 22-1c. Garnet muscovite schist. Muscovite crystals are visible and silvery, garnets occur as large dark porphyroblasts. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Foliated Metamorphic Rocks

Gneiss: a metamorphic rock displaying gneissose structure. Gneisses are typically layered (also called banded), generally with alternating felsic and darker mineral layers. Gneisses may also be lineated, but must also show segregations of felsic-mineral-rich and dark-mineral-rich concentrations.



Figure 22-1d. Quartzo-feldspathic gneiss with obvious layering. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Non-Foliated Metamorphic Rocks

Simpler than for foliated rocks

Again, this discussion and classification applies only to rocks that are not produced by high-strain metamorphism

Granofels: a comprehensive term for any isotropic rock (a rock with no preferred orientation)

Hornfels is a type of granofels that is typically very fine-grained and compact, and occurs in contact aureoles. Hornfelses are tough, and tend to splinter when broken.

Specific Metamorphic Rock Types

Marble: a metamorphic rock composed predominantly of calcite or dolomite. The protolith is typically limestone or dolostone.

Quartzite: a metamorphic rock composed predominantly of quartz. The protolith is typically sandstone. Some confusion may result from the use of this term in sedimentary petrology for a pure quartz sandstone.

Specific Metamorphic Rock Types

Greenschist/Greenstone: a low-grade metamorphic rock that typically contains chlorite, actinolite, epidote, and albite. Note that the first three minerals are green, which imparts the color to the rock. Such a rock is called greenschist if foliated, and greenstone if not. The protolith is either a mafic igneous rock or graywacke.

Amphibolite: a metamorphic rock dominated by hornblende + plagioclase. Amphibolites may be foliated or non-foliated. The protolith is

Specific Metamorphic Rock Types

Serpentinite: an ultramafic rock metamorphosed at low grade, so that it contains mostly serpentine.

Blueschist: a blue amphibole-bearing metamorphosed mafic igneous rock or mafic graywacke. This term is so commonly applied to such rocks that it is even applied to non-schistose rocks.

Eclogite: a green and red metamorphic rock that contains clinopyroxene and garnet (omphacite + pyrope). The protolith is typically

Specific Metamorphic Rock Types

Skarn: a contact metamorphosed and silica metasomatized carbonate rock containing calc-silicate minerals, such as grossular, epidote, tremolite, vesuvianite, etc. Tactite is a synonym.

Granulite: a high grade rock of pelitic, mafic, or quartzo-feldspathic parentage that is predominantly composed of OH-free minerals. Muscovite is absent and plagioclase and orthopyroxene are common.

Specific Metamorphic Rock Types

Migmatite: a composite silicate rock that is heterogeneous on the 1-10 cm scale, commonly having a dark gneissic matrix (*melanosome*) and lighter felsic portions (*leucosome*). Migmatites may appear layered, or the leucosomes may occur as pods or form a network of cross-cutting veins.

Metamorphic Rock Classification

Additional Modifying Terms:

Porphyroblastic means that a metamorphic rock has one or more metamorphic minerals that grew much larger than the others. Each individual crystal is a porphyroblast

Some porphyroblasts, particularly in low-grade contact metamorphism, occur as ovoid "spots"

If such spots occur in a hornfels or a phyllite (typically as a contact metamorphic overprint over a regionally developed phyllite), the terms spotted hornfels, or spotted phyllite would

Metamorphic Rock Classification

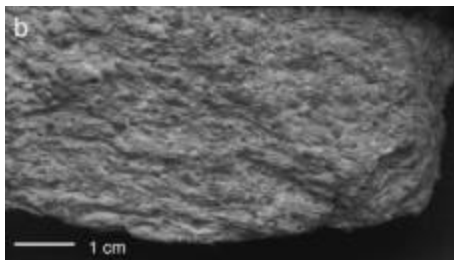


Figure 23-14b. Spotted Phyllite. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Metamorphic Rock Classification

Additional Modifying Terms:

Some gneisses have large eye-shaped grains (commonly feldspar) that are derived from pre-existing large crystals by shear. Individual grains of this sort are called *auge* (German for eye), and the (German) plural is *augen*. An *augen* gneiss is a gneiss with *augen* structure

Metamorphic Rock Classification



Figure 23-18. Augen Gneiss. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Metamorphic Rock Classification

Additional Modifying Terms:

Other modifying terms that we may want to add as a means of emphasizing some aspect of a rock may concern such features as grain-size, color, chemical aspects, (aluminous, calcareous, mafic, felsic, etc.). As a general rule we use these when the aspect is unusual. Obviously a *calcareous marble* or *mafic greenschist* is redundant, as is a *fine grained slate*.

Metamorphic Rock Classification

Additional Modifying Terms:

Ortho- a prefix indicating an igneous parent, and Para- a prefix indicating a sedimentary parent

The terms are used only when they serve to dissipate doubt. For example, many quartzo-feldspathic gneisses could easily be derived from either an impure arkose or a granitoid rock. If some mineralogical, chemical, or field-derived clue permits the distinction, terms such as *orthogneiss*, *paragneiss*, or *orthoamphibolite* may be useful.

High Strain Rocks

Table 22-1. Classification of High-Strain Fault Zone Rocks

% fine matrix	Rocks without primary cohesion	Rocks with primary cohesion		
		Non-foliated	Foliated	
50-	Fault breccia	Microbreccia	Protomylonite	Blotomylonite (if significantly recrystallized)
70-	Fault gouge	Cataclasite	Mylonite	
90-			Ultramylonite	Pseudotachylite

After Higgins (1971)

High Strain Rocks

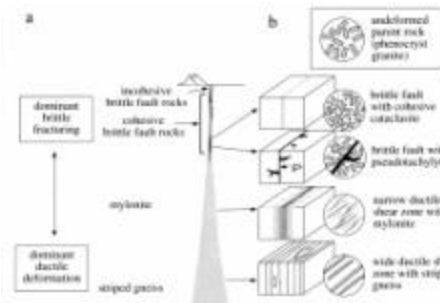


Figure 22-2. Schematic cross section through a shear zone, showing the vertical distribution of fault-related rock types, ranging from non-cohesive gouge and breccia near the surface through progressively more cohesive and foliated rocks. Note that the width of the shear zone increases with depth as the shear is distributed over a larger area and becomes more ductile. Circles on the right represent microscopic views or textures. From Passchier and Trouw (1996) *Microtectonics*. Springer-Verlag, Berlin.

High Strain Rocks



Figure 22-3. Terminology for high-strain shear-zone related rocks proposed by Wise et al. (1984) *Fault-related rocks: Suggestions for terminology. Geology*, 12, 391-394.

High Strain Rocks



Figure 22-4. Shatter cones in limestone from the Houghton Structure, Northwest Territories. Photograph courtesy Richard Grieve. © Natural Resources Canada.