ROCK IDENTIFICATION

ROCKS

Rocks are made of minerals. Rocks can be a mixture of different kinds of minerals, a mixture of many grains of the same kind of mineral, or a mixture of different grains of rocks. When you split a rock into very small pieces, the pieces are different from each other. For example, when you break granite apart, you get small pieces of quartz (clear), feldspar (pink or white), and mica (black). When you split a mineral into pieces, you still have pieces of the same mineral. If you break a big chunk of quartz into smaller pieces, you still have pieces of quartz.

There are three basic rock types: igneous, sedimentary, and metamorphic.

IGNEOUS ROCKS (fiery rocks) are made when molten material inside or outside the earth cools and becomes solid. This melted rock is called magma when it is inside the earth. When magma finds its way to the surface through cracks or volcanoes, it is called lava. When lava cools on top of the earth's surface, it forms **extrusive or volcanic** igneous rock because it was extruded or pushed out onto the surface. Because it cools quickly, it only has time to make very tiny crystals. Extrusive or volcanic igneous rocks look dull and do not sparkle much because they are fine grained.

If the magma stays inside the earth and takes thousands of years to cool, it has time to make big crystals. These crystals make a coarse-grained igneous rock called **plutonic or intrusive** igneous rock because the magma was intruded into cracks deep under the earth's surface. These coarse-grained crystals make the rock look sugary as the flat crystal faces reflect the light in hundreds of little sparkles. The name of the igneous rock depends on what minerals are present. If there are lots of light colored minerals and the rock is coarse grained, it is granite. If there are mostly dark colored minerals and the rock if fine grained, it is basalt.

SEDIMENTARY ROCKS (layered rocks) are made by the deposition of particles carried in air or water and by the precipitation of chemicals dissolved in water. These particles and chemicals come from the weathering (breaking apart in place) and erosion (carrying away and breaking apart while moving) of rocks on the earth's surface. boulders, rocks, gravel, sand, silt, clay, and mud are carried by water currents in streams, rivers, lakes, and oceans. These particles are deposited in stream beds, shores, lake and ocean bottoms, and deltas where rivers empty into lakes and oceans. These particles are cemented together and hardened to form the sedimentary rocks called conglomerate, sandstone, siltstone, shale or claystone, and mudstone.

Chemicals that are leached or dissolved from other rocks are carried invisibly in streams and oceans. When these invisible chemicals reach a lake or ocean, and the water evaporates, the chemicals are left behind in evaporite deposits. Salt around salt lakes and limestone from sea bottoms are examples of these chemical sedimentary rocks. Plants and animals are sometimes buried and preserved in the finer grained sedimentary rocks, such as shale or limestone.

METAMORPHIC ROCKS (changed rocks) are made when existing rocks are subjected to high temperatures and high pressures for long periods of time. metamorphism (meta = change, morph = form) happens when molten rock intrudes other rocks and bakes the contact zone where the molten rock touches the preexisting rock. Metamorphism also happens when rocks are buried deeply during the process of mountain building. The kind of metamorphic rock made depends on the kind of original rock; for example, sandstone is turned to quartzite, shale is turned to slate, and limestone is turned to marble. Other kinds of metamorphic rock are named for the kinds of minerals present, the size of the grains and other textures. For example, mica schist has very thin layers of mica, and garnet gneiss (pronounced like nice) has garnet crystals in thick layers of quartz and feldspar. The amount of time, amount of pressure, and highness of temperature determine what type of metamorphic rocks are made.

IGNEOUS ROCKS

Igneous rocks are formed when molten material (magma) cools. The word is derived from the Latin word igneous for fire and is related to words such as ignite.

Igneous rocks are subdivided into two main categories according to the crystal size - coarse or intrusive and fine or extrusive (volcanic).

INTRUSIVE IGNEOUS ROCKS

How formed:

1. While molten, they intrude (push into) other rocks.
2. They cool below the earth's surface generally deep.
3. They cool gradually and slowly.
4. Individual crystals have time and space to grow large.
5. Feldspar (pink to white blocky mineral) crystallizes at high temperatures, early in the cooling process and thus has straight crystal sides.
6. Quartz (clear, glassy mineral) crystallizes later and fills spaces.

Characteristics:

1. Coarse-grained = the grains or crystals are big enough to tell what mineral each one is. The crystals are usually larger than 1 millimeter (larger than the point of a pen or pencil). They are commonly 1/8 to 1 inch long.
2. The edges of the crystals interlock. The crystals are shiny, flat surfaces which fit together like jigsaw puzzle pieces, with straight edges on some crystals.
3. The minerals are very hard and will scratch glass. If the rock has been weathered by the elements, it may be crumbly.
4. The texture is generally uniform (the same in all directions).

EXTRUSIVE (Volcanic) IGNEOUS ROCKS

How formed:

1. While molten, they flow out onto the surface or flow into cracks near the Earth's surface.
2. They cool quickly with no time for large crystals to grow.
3. They are thus very fine grained.
4. Mineral composition can only be identified with a microscope unless phenocrysts are present (see below).
5. Field identification of hand specimens is based on light or dark color, unless phenocrysts are present.

Characteristics:

1. Fine grained (too fine to identify the minerals without a microscope).
2. Some fine-grained igneous rocks have rectangular crystals in them.
3. Very hard! It will scratch glass, although it will be crumbly if it has been out in the weather for a long time.
4. Some volcanic rocks have vesicles, which are holes caused by gas bubbles when the lava was molten.

Porphyritic igneous rocks have coarse crystals in a fine background.

Matrix or ground mass is the fine-grained background.

Phenocrysts are the crystals surrounded by the matrix; these arc usually large, straight-sided, and glassy minerals unless they have been weathered.

Porphyritic is used as an adjective to modify the name of any fine grained igneous rock that has less than 50% phenocrysts in it. Ex. - porphyritic basalt, porphyritic andesite.

Porphyry is used as a noun after the rock name if more than 50% of the rock is made of phenocrysts. Ex .- basalt porphyry.

Vesicular volcanic rocks - vesicular is the adjective used to modify the name of any fine-grained igneous (volcanic) rock which has vesicles (holes from gas bubbles). Ex. vesicular basalt.

Scoria - basalt with over 50% vesicles; it looks like cinders. It is irregularly porous with rough surfaces and sharp edges and is often red brown.

VOLCANIC GLASS

How formed:

Formed by sudden cooling, with no time to form even tiny crystals. This rapid crystallization produces glass with a random arrangement of atoms; therefore these rocks are slightly less dense. The glasses are usually from a more viscous (harder to flow) lava of rhyolite chemical composition.

VITROPHYRE is a glassy rock containing crystals (phenocrysts).

OBSIDIAN is a black glass with conchoidal (circular) fracture.

PUMICE is a light gray, glass froth with many, many holes from gas bubbles. If there are enough holes that are not connected, pumice will float. It is very light because of all the holes.

VOLCANIC FRAGMENTAL ROCKS

How formed:

Formed by explosive eruptions of solid fragments and ash.

TUFF = A light colored volcanic ash, sometimes with glass and pumice fragments in it. Some tuffs are light in weight if they weren't compacted. Some are welded tuffs and look like rhyolite.

AGGLOMERATE = Contains volcanic fragments larger than 2 centimeters (about 1 inch in diameter) that were blown out of a volcanic vent. They are larger than ash particles, but have the same origin.

SEDIMENTARY ROCKS

Sedimentary rocks are derived from pre-existing rocks by weathering and erosion. The resulting particles settle out of water or air (clastic rocks such as sandstone and mudstone) or the resulting chemicals precipitate from concentrated solutions (non-clastic rocks such as limestone and salt).

CLASTIC SEDIMENTARY ROCKS

How formed:

1. Pre-existing rock undergoes chemical and mechanical weathering by roots, acid rainwater, gravity, wind, and water.
2. The broken particles are carried through water or air until they settle out in a lower area when the current wasn't fast enough to carry the particles.
3. Quartz is the most stable and has the greatest resistance to the mechanical and chemical abrasion during erosion, so most sand size grains are quartz.
4. Feldspar alters to clay with chemical weathering and erosion, so arkose, which is sandstone with more than 25% feldspar, indicates the sediment was deposited close to the source rock and wasn't in transport long.
5. Grain size and shape and composition can indicate the composition, distance, and height of the source rock.
6. Textures & structures (ripple marks, cross-bedding, sorting, etc.) and size, shape, and composition can indicate the environment of deposition.

Characteristics:

1. Soft, compared to igneous rocks.
2. Occur in layers or beds from a few millimeters thick to 100 feet thick, most commonly 1-5 ft. thick.
3. Granular and gritty if composed of sand and silt-sized particles; sand is often rounded, sometimes angular.
4. Sedimentary structures (cross-bedding, mud cracks, ripple marks, worm trails and burrows, fossil shells) are not usually visible in hand specimens, but are noticeable in outcrops.
5. Color is not usually significant, because as little as 3% hematite (iron oxide) gives a rich red color. Some pinkish sandstones get their color from feldspar.
6. Fossils are more common in shales than sandstones, because of the higher current activity in sandstones.

NON-CLASTIC SEDIMENTARY ROCKS

How formed:
Formed by chemical precipitation from a concentrated solution in water as salt, gypsum, or limestone.

Characteristics:
l. Soft, because they are composed of soft minerals such as halite, gypsum, calcite. They can easily be scratched with steel or a copper penny.
2. Commonly fine-grained and homogeneous.
3. Fossils are common in limestone.
4. Limestone fizzes in dilute hydrochloric (HCl) acid, because it is composed of the mineral calcite, CaC03.
5. Some limestone contains chert, which is very, very hard silica (like flint). It typically weathers to brown on the surface and occurs in nodules and occasionally replaces fossil shells.

METAMORPHIC ROCKS

Metamorphic rocks are formed when pre-existing rocks are changed by heat and pressure.

How formed:
1. Pressure from the weight of overlying rocks or from stresses of mountain building rearranges the minerals in rocks into bands or rearranges the atoms of the minerals into new minerals.
2. Heat from the intrusion of a large igneous mass can metamorphose a large area.
3. Heat from the intrusion of a dike or sill or flow can bake the adjoining rocks in a contact metamorphic zone.

1. **Texture** - The term *texture* refers to the size, shape, and boundary relationships of the minerals, particles, and other substances that make up a rock. There are two major textural groups in metamorphic rocks:

FOLIATED (BANDED) METAMORPHIC ROCKS

a. **Foliated** - In this texture the mineral crystals in the rock are aligned with each other. This alignment may be displayed as parallel planes along which the rock splits, by overlapping sheets of platy minerals such as micas, by the parallel alignment of elongate minerals such as amphiboles, or by alternating layers of light and dark minerals. Foliated texture is further subdivided based on the presence or absence of pronounced color banding in the rock. Rocks without distinct alternating bands of light and dark minerals are described a *nonlayered,* whereas rocks with alternating bands of dark and light minerals are described as *layered.* Layered is also referred to as gneissic foliation. Foliated textures are further described on the basis of the grain (crystal) size in the rock. Examples of complete descriptions of foliated metamorphic rocks include: foliated, nonlayered, very fine grained for slate, foliated, layered, coarse grained for gneiss, and foliated, nonlayered, fine grained for phyllite. Foliated textures produced by shearing and breaking, such as in a fault zone or a meteor impact crater, are referred to as *mylonitic.*

NON-FOLIATED METAMORPHIC ROCKS

b. **Nonfoliated** - In this texture the mineral crystals in the rock have grown in many directions and do not show alignment. As a result, nonfoliated rocks commonly appear massive and structureless, with only a few lines of impurities through the rock. These rocks may break across, rather than around, mineral grains to produce a scaly surface on the specimen. Nonfoliated textures are further described on the basis of the grain (crystal) size in the rock. Examples of complete descriptions of nonfoliated metarnorphic rocks include nonfoliated, medium grained for quartzite, or nonfoliated, coarse grained for marble.

2. **Composition** - Indicate the mineral composition of the rock based on observations with a hand lens and if needed, physical or chemical tests. At minimum, identify and list all visible minerals present in the rock.

Note that the rock may contain minerals other than those shown in the classification chart (Fig. 5.3) in your lab manual.

3. **Rock Name** - Use the metamorphic rock classification chart on page 60 (Fig. 5.3) of your lab manual to determine the name for each of the rocks. For schists include the dominant or distinctive mineral or the color in the rock name. Examples of some of the names given to schists include greenshist, garnet schist, biotite schist, and muscovite schist.

4. **Probable Parent Rocks(s)** - All metamorphic rocks are derived by the action of heat and/or pressure on pre-existing igneous, sedimentary, or metamorphic rocks. The pre-existing rock is called either the parent rock or the protolith. Your textbook incorrectly uses the term Asource rocks@ for the pre-existing rock. The term source rock used in sedimentary deposits to describe the rock from which petroleum is derived, or the rock that erodes to produce sediment and later sedimentary rock. Read the descriptions in your lab manual or textbook for the source rock of each of the metamorphic rocks that you identify. Indicate in the name(s) of the probable parent rock(s) in the last column of the metamorphic rock identification form.

Igneous Rocks

Igneous - phaneritic or aphanitic

texture \/	**color >**	**light colored pink, white, gray green, lavender**	**medium to dark colored purple, greenish**	**dark gray to black**	**dark green to black**
	minerals>	10 - 30% K-feldspar 10 - 40% quartz 0-33% Na plag. 8-15% amphibole and biotite	55-70% plagio-clase feldspar 15-40% biot. & amphibole	25-70% Ca plagioclase 25-75% dark mafic minerals (pyroxene, amphibole, olivine)	0-5% Ca plag. 65-100% olivine 0-25% pyroxene 0-10% ore minerals (magnetite, ilmenite, chromite)
compo-sition		felsic sialic	intermediate	Mafic	ultramafic
fine = aphanitic	extrusive volcanic	**Rhyolite**	**Andesite**	**Basalt**	**Komatiite**
coarse = phaneritic	intrusive plutonic	**Granite**	**Diorite**	**Gabbro**	**Peridotite**
environ-ment		subduction zones	subduction zones	mid-ocean ridges, hot spots	mid-ocean ridges, mantle

descriptive terms used with above names:

. . . **porphyritic** = crystals 2 to 3 times size of matrix, and >10% of rock is crystals.

. . . . . porphyritic phaneritic = smaller crystals surrounds larger crystals (phenocrysts).

. . . . . porphyritic aphanitic = massive, structureless ground mass surrounds crystals (phenocrysts).

. . . **vesicular** = holes from gas bubbles escaping lava, making cinder-like or clinker-like appearance.

Characteristics of important minerals in igneous rocks:

Quartz = occurs as irregular, glassy grains, commonly clear to smoky, no cleavage.

Muscovite – brass- or clear gray-colored flakes associated with quartz or K-feldspar. Perfect cleavage in 1 direction (layers)

K-feldspar (Orthoclase) = porcelain luster; commonly colored pink, white, or gray. Cleavage in 2 directions at right angles may be detected by a reflection of light when specimen is rotated.

Plagioclase = Usually gray or white in granite, dark-bluish color in gabbro. Striations common. 2 cleavage directions at right angle may be detected.

Biotite = small black flakes; perfect cleavage in 1 direction (layers); reflects light.

Amphibole (hornblende) = long, black crystals in a light-colored matrix. Cleavage at 60 and 120 degrees.

Pyroxene (augite) = short, dull, greenish-black minerals in darker rocks. Cleavage in two directions at 90 degrees.

Olivine = glassy, light-green to dark green grains.

Igneous - glassy

texture	composition	characteristics	name
glassy	? not applicable	massive, black glass	**Obsidian**
glassy	? not applicable	frothy, grey glass of subparallel glass fibers with many squashed air bubbles - may float	**Pumice**
glassy	? not applicable	grey glass, rounded spherical structures	**Perlite**

Igneous - pyroclastic (fragmental)

texture	composition	characteristics	name
pyroclastic	volcanic ash, pumice fragments, some rock fragments or glass	light colored volcanic ash, sometimes with glass and pumice fragments	**tuff**
pyroclastic	volcanic ash, pumice fragments, some rock fragments or glass	fine grained or gritty, light in weight if not compacted; light color	**ash fall tuff**
pyroclastic	volcanic ash, pumice fragments, some rock fragments or glass	particles or grains are fused or welded, with flow lines	**ash flow tuff**
pyroclastic	round pebbles and bombs that were blown out of a volcanic vent, with ash	volcanic fragments larger than 2 centimeters (about 1 inch in diameter)	**agglomerate**
pyroclastic	volcanic bombs, pebbles, ash, pumice fragments, some rock fragments, or glass	sharp, angular volcanic fragments larger than 2 centimeters (1 inch diameter) mixed with others	**volcanic breccia**

Sedimentary Rocks

Clastic Sedimentary Rocks

particles	size	minerals	character	general size	rock name
gravel	> 2 mm	rock fragments, quartz, feldspar	pebbles	coarse	**Conglom-erate**
sharp gravel	> 2 mm	rock fragments, quartz, feldspar	angular	coarse	Breccia
coarse gravel to fine clay	> 2 mm	any rock type	poorly sorted, nonstratified, angular	fine to coarse	Tillite
sand	2- 1/16 mm	quartz, feldspar	granular	sandy	**Sandstone**
silt	1/16-1/256	clay, quartz	gritty	gritty, fine grained	**Siltstone**
clay	<1/256 mm	clay	platy massive	smooth, very fine grained	**Shale, Claystone**
silt & clay	< 1/16 mm	clay, quartz	massive	smooth, very fine grained	**Mudstone**

Non-Clastic Sedimentary Rocks

mineral	chemical form	characteristics	rock name
calcite	$CaCO_3$	fizzes in HCl acid	**Limestone**
calcite	$CaCO_3$	medium to coarse grained, fizzes in acid	**Crystalline Limestone**
calcite	$CaCO_3$	microcrystalline, conchoidal fracture, fizzes in acid	**Micrite**
calcite	$CaCO_3$	aggregates of small round spheres, fizzes in acid	**Oolitic Limestone**
calcite	$CaCO_3$	fossils and fossil fragments loosely cemented, fizzes in acid	**Coquina**
calcite	$CaCO_3$	fossils in calcareous matrix, fizzes in acid	**Fossiliferous Limestone**
calcite	$CaCO_3$	shells of microscopic organisms and clay, soft, fizzes in acid	**Chalk**
calcite	$CaCO_3$	banded calcite - cave deposits, fizzes in acid	**Travertine**
halite	NaCl	tastes salty, fine to coarse crystalline	**Salt**
gypsum	$CaSO_4 \cdot 2H_2O$	fine to coarse crystalline, softer than fingernail, white, grainy	**Gypsum**
microscopic quartz chalcedony	SiO_2	crypotocrystalline, dense, conchoidal fracture, dull, very hard (scratches glass)	**Chert**
dolomite	$CaMg(CO_3)_2$	fizzes in acid only if scratched first	**Dolomite**
carbon	C	brownish plant material - soft, porous, fibrous	**Peat**
carbon	C	black, vitreous, crumbly	**Bituminous Coal**

Metamorphic Rocks

Foliated (banded) Metamorphic Rocks

characteristics	minerals	rock name
very thin layers, like blackboards very fine-grained smooth, flat surfaces, from slaty cleavage separate grains not visible dense, brittle, clinking sound	mica quartz clay (microscopic)	**Slate**
very, very thin, irregular layers of mica usually pale gray green satin sheen to rock rather than individual flakes fine to medium-grained uneven surfaces grains visible	mica quartz other minerals	**Phyllite**
thin, irregular layers of mica & platy minerals usually pale gray green medium-grained uneven surfaces grains visible	mica (muscovite, biotite) chlorite, talc; hornblende quartz, garnet; feldspar	**Schist**
thin, irregular layers of mica & platy minerals	bluish; mica, quartz	**Blueschist**
thin, irregular layers of mica & platy minerals	greenish color; mica, quartz, serpentine	**Greenschist**
thick bands, wavy, semi-continuous layers of white quartz, feldspar, and mica medium to coarse-grained banded, coarsely crystalline large, crystalline grains	feldspar quartz; mica or hornblende or garnet	**Gneiss**

Non-foliated Metamorphic Rocks

characteristics	former rock	rock name
very hard, smooth stretched and welded cobbles and pebbles = fractures through grains, not around them as in . . rougher conglomerate composed of rock fragments, quartz, chert	Conglomerate	**Metaconglomerate**
very hard, smooth welded sand grains - fractures through grains, not around them as in rougher sandstone composed mostly of quartz	Sandstone	**Quartzite**
fizzes in dilute acid medium to coarse grained sugary to crystalline composed of calcite ($CaCO_3$)	Limestone	**Marble**
very hard, flint-like fracture smooth, very fine-grained dark colored to black very dense, compact	Claystone, Slate, Mudstone, Shale	**Hornfels**
black to brown dense, highly altered plant remains Carbon, opaque, noncrystalline	peat	**Anthracite Coal**

Rock Identification Chart