LAB 2: ROCK IDENTIFICATION **DUE: Wednesday, October 3rd**

Directions

This lab constitutes four parts. In the first three sessions, you will familiarize yourselves with the characteristics of – and learn to describe, identify and interpret – the three main types of rock: igneous, sedimentary and metamorphic. In the fourth session, you will be given a selection of "unknown" specimens and asked to fully describe, identify and interpret them. The first three sessions will each make up 10% of the grade for this lab, with the final session constituting 70% of the grade.

Remember, you do not have a huge amount of time to work on these rocks. If you have questions, please ask. Particularly in the first three sessions, please do not feel that asking is giving up or cheating – these sessions are designed to teach, not test you, and they make up a comically small portion of your grade for the class.

You will receive a handout that will help you to describe rocks, and charts for each of the sessions, in which we would like you to give your answers.

For the first three sessions, each sample will be sitting on a numbered card, which indicates the rock number for that session. The rock "name" (e.g. I13-02) is written on the rock itself, usually on masking tape. If you turn over that card, you will find an abridged description of the rock. We recommend trying to identify as much as possible on your own before using the card. If you choose to use the card from the beginning, make sure you can identify all of the minerals and textures in the rock before moving on. If you can't, ask one of us to help.

When you've finished with a sample, put it back where you found it with its card underneath it, face down.

TERMINOLOGY FOR IDENTIFICATION

IGNEOUS GLOSSARY

WHERE THE ROCK COOLED

Intrusive – igneous rock that forced its way in a molten state into the earth's crust but never breached the surface	vs.	**Extrusive** – igneous rock derived from magma or lava poured out or ejected onto the earth's surface

MANY MG, FE MINERALS, OR FEW?

Felsic – containing a group of light-colored silicate minerals that are poor in Fe and Mg, such as feldspars and quartz	**Intermediate** – composition between felsic and mafic	**Mafic** – containing a group of dark-colored minerals rich in Mg and Fe (such as pyroxene, amphibole, and olivine)	**Ultramafic** – igneous rock composed entirely of Mg- and Fe-bearing minerals (*e.g.* dunite)

TEXTURE: relates to the size of the individual mineral grains in the final, solid rock, usually dependent on how quickly the magma cooled

Groundmass – fine-grained crystalline base of porphyritic rock in which larger crystals are embedded

Phaneritic – individual grains in an igneous rock are large enough to be identified without the aid of a microscope

Aphanitic – individual minerals are present in the igneous rock but in particles so small that they cannot be identified without a microscope

Porphyritic – igneous texture referring to relatively large isolated crystals in a mass of fine texture

Phenocryst – a large, crystal embedded in a finer matrix of an igneous rock

Xenocryst – a crystal foreign to the igneous rock in which it occurs

Pyroclastic – composed chiefly of rock fragments of volcanic origin

Amygdale – a small gas bubble in igneous, especially volcanic, rocks that is subsequently filled with secondary minerals such as zeolite, calcite, or quartz

ROCK NAMES

Defined by lower silica content (see charts)	*Defined by higher silica content (see charts)*	*Based on texture, not silica content*
Basalt – fine-grained, dark, mafic extrusive igneous rock composed of plag, pyroxene and olivine	**Rhyolite** – fine-grained extrusive volcanic rock, similar to granite in composition and usually exhibiting flow lines	**Obsidian** – usually black or banded, hard volcanic glass that displays shiny, curved surfaces when fractured (conchoidal fracture) and is formed by rapid cooling of lava
Gabbro – black, coarse-grained, intrusive igneous rock composed of calcic f-spars and pyroxene	**Diorite** – coarse-grained, dark, intrusive, intermediate igneous rock, rich in plagioclase and having little quartz	**Pumice** – A form of volcanic glass, usually felsic composition, filled with holes from the escape of gas during quenching and has a very low density
Andesite – fine-grained intermediate extrusive igneous rock, chiefly composed of plag and f-spar	**Granite** – felsic, coarse-grained, intrusive igneous rock composed of quartz, orthoclase f-spar, Na-rich plag and micas	**Tuff (welded)** – rock composed of compacted volcanic ash varying in size from fine sand to coarse gravel, also called tufa

SEDIMENTARY GLOSSARY

DESCRIPTIVE TERMS	*NAMES OF ROCKS*
Bedding – characteristic of sedimentary rocks in which parallel planar surfaces separate layers of different grain sizes or compositions deposited at different times	**Mudstone** – fine-grained, dark gray sedimentary rock, formed from silt and clay and similar to shale but without laminations
Stratification – characteristic layering or bedding of sedimentary rocks	**Shale** – fissile rock composed of layers of claylike, fine-grained sediments
Crossbedding – inclined beds in a sedimentary rock that were formed at the time of deposition of currents of wind or water in the direction in which the bed slopes downward	**Sandstone** – a sedimentary rock formed by the consolidation and compaction of sand and held together by a natural cement, such as silica
Matrix – the mass of rock fragments, crystals, or minerals that surrounds the larger clasts	**Conglomerate** – sedimentary rock, a significant fraction of which is composed of rounded pebbles, cobbles, and boulders (a.k.a clasts)
Clast – a rock fragment or grain resulting from the breakdown of larger rock and can be incorporated into a new rock (ex. Conglomerate)	**Limestone** – common sedimentary rock consisting mostly of calcium carbonate, $CaCO_3$, fizzes in HCl
Sorting – measure of the homogeneity of the sizes of particles in a sedimentary rock	**Dolostone** – magnesia-rich (primarily dolomite) sedimentary rock resembling limestone, only fizzes in HCl when scratched
	Chert – sedimentary rock made up of chemically or biochemically precipitated silica
	Coal – natural dark brown to black graphite like material formed from the metamorphic product of fossilized plants and consisting of amorphous carbon with various organic and some inorganic compounds
	Breccia – rock composed of sharp-angled fragments embedded in a fine-grained matrix, similar to a conglomerate

METAMORPHIC GLOSSARY

DESCRIPTIVE TERMS	*NAMES OF ROCKS*
Grade – Term used to designated the extent to which a rock has been metamorphosed	**Slate** – a fine-grained metamorphic rock that splits into thin, smooth-surfaced layers (a.k.a slaty cleavage), formed by low grade metamorphism of shale
Protolith – The unmetamorphosed rock from which a metamorphic rock was formed	**Phyllite** – metamorphic rock intermediate between slate and schist often having a wavy surface and a distinctive micaceous luster, commonly formed from shale or tuff
Pelite – General term for a protolith of sedimentary origins (generally a mudstone or shale; clay-rich bulk composition	**Schist** – Metamorphic rock composed of laminated, often flaky parallel layers of chiefly micaceous minerals forming strong foliation
Foliation – Layering of metamorphic rocks caused by the parallel alignment of minerals	**Gneiss** – A coarse-grained, strongly banded metamorphic rock, usually derived from granite
Porphyroblast – A large crystal in a finer grained matrix in a metamorphic rock	**Amphibolite** – A mostly nonfoliated metamorphic rock composed chiefly of amphibole with minor plagioclase and little quartz
	Quartzite – A nonfoliated metamorphic rock formed from sandstones rich in quartz sand grains and quartz cement
	Marble – A metamorphic rock formed by alteration of limestone or dolomite, often irregularly colored by impurities

METHODOLOGY FOR IDENTIFICATION:

When we classify rocks we are trying to force them to fit into discrete categories, even though the properties and characteristics of rocks form a natural continuum. Rock classification is important to be able to clearly and precisely communicate, but it can never replace observations and interpretations of why and how a rock is what it is.

There are MANY more specific subdivisions for naming igneous, sedimentary and metamorphic rocks than are described in this class. Instead of learning them, you need to be able to accurately observe and describe the rocks' characteristics.

IGNEOUS:

Start with OBSERVATIONS:

- Texture: (phaneritic, aphanitic, porphyritic)
  - Do you see discrete grains?
    - What sizes?
    - Are they interlocking?
    - Is there a fine-grained groundmass?
    - Are there vesicles?
  - Composition: What minerals? (Use your hand lens)
    - Quartz?
    - Feldspar? Which feldspar?
    - Micas?
    - Pyroxene?
    - Olivine?
    - What else???
  - Other observations?

Classification scheme, based on overall composition and on intrusive or extrusive:

	FELSIC (HIGH SILICA)	INTERMEDIATE	MAFIC (LOW SILICA)	ULTRAMAFIC
INTRUSIVE	granite	diorite	gabbro	peridotite: pyroxenite dunite
EXTRUSIVE	rhyolite: obsidian pumice tuff	andesite	basalt	(komatiite)

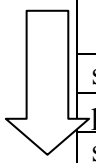
METAMORPHIC:

Start with OBSERVATIONS:

- Do you see foliation?
- Do you see discrete minerals?
  - What size?
    - Are there porphyroblasts?
  - What composition?
    - Mineralogy: Mica? Quartz? Feldspar? Garnet? Kyanite? Staurolite? Pyrite?
- Do you see any indication of the protolith?
  - *e.g.* remnant bedding

Classification scheme for metamorphic rocks:

1. FOLIATED rocks: mineral grains have clear preferred orientation



INCREASING METAMORPHISM	METAMORPHIC ROCK	PROTOLITH
	slate	shale/mudstone
	phyllite	varies; usually pelite
	schist	varies; often pelite
	gneiss	varies; sandstone or granite

2. NONFOLIATED rocks (granoblastic): little or no preferred mineral orientation

METAMORPHIC ROCK	PROTOLITH
quartzite	high-quartz sandstone
marble	limestone, dolostone
amphibolite	shale, basalt

SEDIMENTARY:

Start with OBSERVATIONS: (All apply to both carbonate and clastic rocks)

Do you see discrete grains?

What size?

What composition?

Rock fragments? Fossils? Carbonate?

Mineralogy: Quartz? Feldspar? Mica? Calcite? Dolomite?

Sorting?

Preferred grain orientations?

Are there sedimentary structures?

bedding?

cross bedding?

ripples?

graded bedding?

bioturbation/trace fossils?

Classification scheme for sedimentary rocks, based overall on composition:

1. CLASTIC rocks: made from physically transported rock fragments derived from the weathering of pre-existing rocks

   Sediment composition is primarily:
   Quartz, Feldspar, Rock fragments, Clays

SEDIMENT SIZE		ROCK CLASSIFICATION
Coarse (>2mm):	gravel	Conglomerate (rounded clasts) Breccia (very angular clasts)
Medium:	sand	Sandstone
Fine:	mud, silt, clay	Siltstone (contains mostly silt) Mudstone (contains silt and clay) Shale (good cleavage parallel to bedding)

2. CHEMICAL/BIOCHEMICAL Rocks
   a. Carbonates

      Carbonate sediment (calcite):

      Skeletons/shells: either microscopic or macroscopic
      e.g. foraminifera, brachiopods, reefs

      Ooids: spherical, concentric carbonate grains, sand-sized, form from (mostly) inorganic precipitation on particles in waves.

      Mud: carbonate mud is called micrite. Extremely fine-grained (usually < 4

microns), mostly formed by algae and inorganic precipitation.

Carbonate rock classifications:

LIMESTONE: Primarily calcium carbonate (calcite), formed from any of the carbonate sediments. examples: fossiliferous, micritic, or oolitic limestone

DOLOSTONE: Primarily calcium-magnesium carbonate (dolomite). Dolostone always forms as a secondary alteration (during diagenesis) of limestone! Therefore, it usually looks very similar to limestone.

b. Evaporites

Most commonly gypsum, halite. Often crystalline. Form from saturated/oversaturated seawater.

Special chemical sedimentary rock cases:

CHERT (flint): Microcrystalline SiO_2. Usually forms nodules. Can look a great deal like micritic (mud) limestone. Usually forms from biochemical precipitation of silica-based skeletal sediment (e.g. radiolarians). Chert nodules are often found in carbonates.

COAL: A biochemical sedimentary rock, composed mostly of organic carbon.

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