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Geologic Materials

There are a handful of "fundamental" particles (so far), three basic building blocks (protons, electrons, and neutrons), over 100 elements, thousands of minerals, and hundreds of types of rocks! What do you need to know, and where should you begin? The following exercise introduces a minimum number of minerals, sediments, and rocks, and a minimum number of terms. All of these terms will reappear again and again throughout the semester.

Minerals

Minerals are important to Environmental Geology for several reasons:

- They may interact chemically with water to clean it (by scavenging heavy metals) or pollute it (e.g., sulfides),
- They may interact physically with surrounding materials to weaken (micas) or strengthen (quartz cement) them,
- They may serve as a valuable resource (e.g., feldspar in abrasive cleansers), and
- They may serve as ores for valuable elements.

Minerals are defined as:

- naturally-occurring (not man-made alloys, for example)
- solid (not mercury, for example)
- composed of one or more elements
- predictable chemical composition (e.g., NaCl - "halite" - table salt; some variability is allowed)
- predictable physical structure (not glasses - like obsidian - in which atomic arrangement is random)
- inorganic (not shells, coral, or coal)

Observation and Description

Properties of Minerals

Property	Definition	Example
Crystal form	External (unbroken) shape of samples	Hexagon, cube
Cleavage/fracture	Internal (broken) shape	Platy/fibrous
Hardness	Relative resistance to scratching	Harder than glass
Luster	Fresh surface appearance	Metallic, earthy
Color	Obvious (but often variable!)	Clear, black
Other	Properties specific to one mineral	reacts to weak acid

Diagnostic properties of common rock-forming minerals and mineral families

Mineral	Cleavage/ *Fracture*	Hardness	Luster	Color	Other
Calcite	3 at 75°	~penny	glassy	clear/white	**reacts w/acid**
Feldspars	2 at ~90°	~glass	glassy	clear/white	
"mafics"	variable	variable	often glassy	usually **black**	weathers red or yellow
micas	**1, perfect**	fingernail - penny	glassy	white, black, green	
ores	variable	variable	may be **metallic**	often dark	dense, rare; often sulfurous
Quartz	*curved*	>steel	glassy	clear, white, other	

NOTE: Crystal form is seldom seen, thus rarely diagnostic. **Boldfaced characteristics** are immediately diagnostic.

Exercise:

Examine the specimens in the tray. For each, **determine whether or not it is a mineral**. If it is, **identify the mineral** and discuss briefly how the characteristics of that mineral (from the table above, the link below, and your own observation) make it significant to the environment.

Sample	Mineral (Y/N;Name)	Significance
1		
2		
3		
4		
5		

You will find some assistance, especially with significance, at the USGS Minerals Page.

Now that you know the basics, spend a little time exploring minerals: Amethyst Galleries has a nice Minerals by Name page and a section on Mineral Properties.

Sediments

Sediments cover most of the world's land surface. As such, they are of paramount importance because:

- They hold, filter, and occasionally pollute much of the water we drink;
- They are a major economic resource (e.g., construction aggregate);
- They are the parent materials in which the soils which feed us form; and
- They provide the foundations upon which our structures - from roads to houses to great bridges - are built.

Common sediments are:

- mineral and/or organic
- solid (not water)
- transported and redeposited
- loose or unconsolidated

Properties of Sediments

Property	Definition	Example
Composition	Dominant and secondary materials	rock fragments, fossils
Particle Size	Dominant or average size of sediment	clay, silt, sand, gravel, boulders
Particle Sorting	Range of particle sizes present	clay to boulders = "poor"!
Particle Rounding	Sharpness of corners (of coarse particles)	angular to well rounded

Classification of Sediments - see Examples

Sediment	Part. Size	Part. Sorting	Part. Rounding
Clay	<1/256 mm (too fine to see)	good	(invisible)
Mud	mixture of clay and silt	poor	(invisible), poor
Silt	1/256 - 1/16 mm ("dust")	good	poor
Sand	1/16 - 2 mm	very good	usually well-rounded
Gravel	2 - 64 mm	very good	usually well-rounded
Cobble/Boulder	>64 mm	very good	usually well-rounded
Mixed (e.g., "glacial till")	Wide range	very poor	angular to moderately rounded

NOTE: There are materials which are termed "chemical sediments", like evaporated salt. However, these are rarely seen as sediments, and are more common (but still rare) as rocks.

Exercise:

Examine the specimens in the tray. For each, **determine whether or not it is a sediment**. If it is, **identify the sediment**, describe its composition, sorting and rounding, explain its likely origin, and discuss briefly how the characteristics of that mineral (from the table above and from your observation) make it significant to the environment.

Sample	Sediment (Y/N;Name)	Description, explanation, and Significance
1		
2		
3		
4		

NOTE: The USGS Minerals link (above) will get you to commodities like crushed stone, sand, and gravel. They also have a regional (Colorado Front Range) detailed study of construction aggregates.

Rocks

Rocks are the solid material which appears at the surface as "outcrop" or lies beneath centimeters to kilometers of sediment. Their significance should be self-evident! They are described as:

- naturally-occurring
- solid
- combinations of one or more minerals or other materials
- possibly organic (coal, amber)
- may lack crystallinity (glass)

There are many ways to classify rocks. Below is a simple scheme which includes the most common rock types.

Observation and Description:

Properties of Common Rocks

Grain Character	Grain Size	Secondary Char.	Minor Char.	Notes	NAME	Type

Fragmental	Coarse	Rounded			Conglomerate	S
		Angular			Breccia ("broken")	S
	Medium				**Sandstone**	S
(Invisible)	Very fine	Soft	Black		**Shale**	S
			Dark to Light	reacts with acid	**Limestone**	S
		Hard			**Basalt**	I
Crystalline (intergrown)	Striped	Cleaves well			**Slate**	M
		Cleaves poorly			**Schist**	M
		No cleavage	Hard		**Gneiss**	M
	Uniform	Fine	Soft	reacts with acid	**Marble**	M
			Dark		**Basalt**	I
			Light		**Rhyolite**	I
		Coarse	Mixed		**Andesite**	I
			Dark		Gabbro	I
			Light		**Granite**	I

NOTES: Names not in boldface are rare; types are Sedimentary, Metamorphic, and Igneous.

Exercise:

Examine the specimens in the tray. For each, **determine whether or not it is a rock**. If it is, **identify the rock** and discuss briefly how the characteristics of that rock are determined by its mineral composition (from the table above and from your observation), and what makes it significant to the environment.

Sample	Rock (Y/N;Name)	Significance
1		
2		
3		
4		
5		

NOTE: I know of no specific "rocks" Web page. You might want to look for one (try Ixquick, Metacrawler or Google to search several Search Engines.) I'll bet you can find many rock classification schemes out there!

Practicum: ROCKS ACROSS SPACE

As you know, the distribution of rocks across space is shown by geologic maps at various scales. The largest-scale (smallest area) maps commonly available are at 1:24,000 (7.5' quads), but they are available only in selected areas. Using geologic maps available in this room (Montana) and far end of the hallway (Bozeman - Livingston area), identify which of the rocks in this tray came from which of the sites listed below. Also suggest where the remaining rocks might have come from!

Note: The small-scale (large area) maps of the Appalachian Orogen (2nd/3rd floor stairway), United States (second floor above water fountain), Gondwana (southern) continents (2nd/3rd floor stairway), and world (1st/2nd floor landing) show more generally the age than the rock type.

Draw a line connecting the location with the sample, or suggest a locality

SITE	SAMPLE	ROCK NAME	SAMPLE
A. Canyon Mountain, south of Livingston			1
B. Homestake Pass, between Whitehall and Butte			2
C. Rainbow Falls, at Great Falls			3
D. Beartooth Plateau			4
E. Green Mtn., East of Bridger Ck., Bridger Canyon			5
F.			6
G.			7
H.			8
I.			9

Example: Rainbow Falls is located on the lower Kootenai Formation, which is described on the map in the hallway as being characterized by a basal "chert pebble conglomerate". Thus, "C" connects to "2".

REFLECTION:

As a group, discuss what you have learned. Have you heard of these materials before - if so, in what context? In what contexts do you expect to hear about them again? What names did you expect that did not appear? Why did the map keys sound so foreign?