Minnesota Minerals Education Workshop

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Mineral and Rock Identification

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Introduction to Rock Forming Minerals

All minerals meet these six criteria:

1. Naturally occurring (not man-made)
2. Inorganic (no plant matter)
3. Homogeneous (must be the same throughout)
4. Solid (no liquids)
5. Definite (but variable) chemical composition
6. Ordered internal arrangement of atoms

Identifying Minerals

- Many rock properties can be assessed very easily in a classroom
  - Color
  - Streak
  - Hardness
  - Specific Gravity

Note: Where applicable, image citations are listed in the presentation notes for each slide

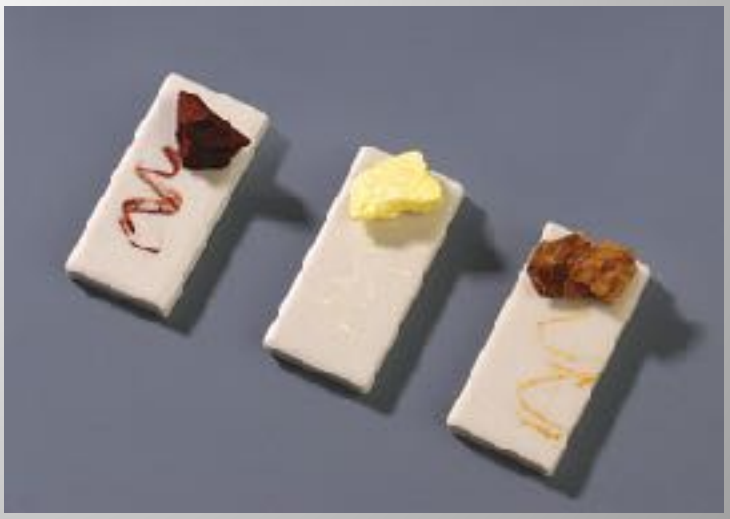
Mineral Properties: Color

- Color comes from the chemical composition of a mineral
- Easy to identify, but ***not always reliable***
  - Some minerals have an inherent color and are always the same
  - But some minerals come in a variety of colors based on presence of trace elements

Exhibit A: All fluorite!

Mineral Properties: Streak

- Streak is the color a mineral produces when ground to a fine powder
- ***Much more reliable than mineral color***, because each mineral has a diagnostic streak color, no matter the color of the mineral itself
- Note: ***many minerals do not produce a streak***
- Test streak by marking the mineral on a white porcelain streak plate – ***press firmly!***



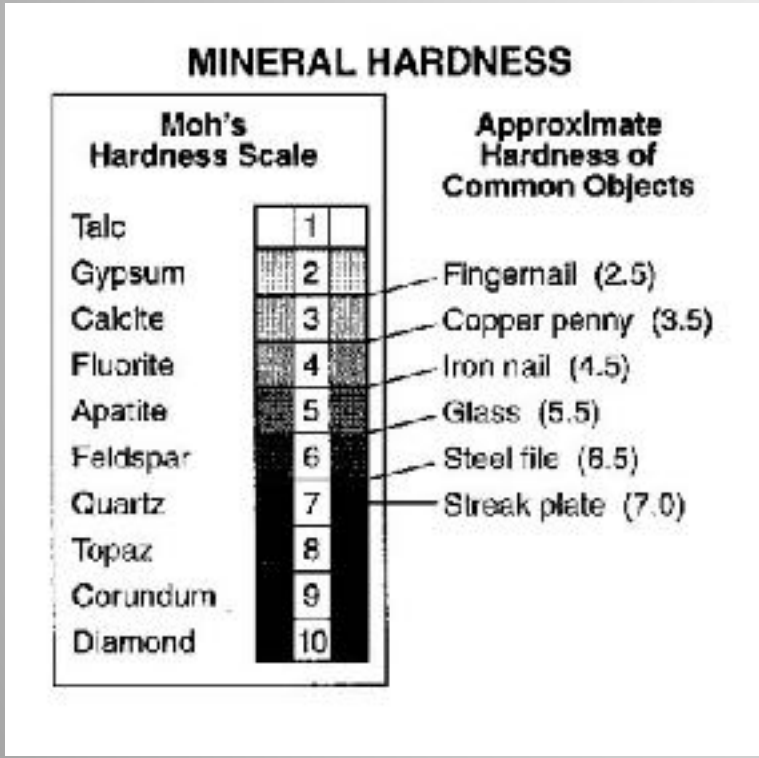
Mineral Properties: Hardness

- The hardness of a mineral is a factor of the strength of the chemical bonds within the mineral
- Hardness is shown by a mineral's ability to resist or inflict abrasion (a scratch) on or by another mineral
- Hardness is measured from ***1 (softest) through 10 (hardest)*** on the **Moh's Hardness Scale**
- Hardness is tested by scratching a mineral against various reference materials

Mineral	Mohs Hardness	Image
Talc	1	
Gypsum	2	
Calcite	3	
Fluorite	4	
Apatite	5	
Feldspar	6	
Quartz	7	
Topaz	8	
Corundum	9	
Diamond	10	

Hardness Test

- Use common classroom materials to test the hardness of minerals



- If a mineral can be scratched by your fingernail, its hardness is: Less than 2.5
- If a mineral scratches a streak plate, its hardness is: Greater than 7.0
- If a mineral can scratch glass but can be scratched by a steel file, its hardness must be: Between 5.5 and 6.5

Mineral Properties: Specific Gravity

- Specific gravity of a mineral is its density (ρ) relative to water
  - Specific gravity = $\frac{\rho_{mineral}}{\rho_{water}}$
- In a classroom, you can measure specific gravity by doing a density test or by a more subjective "heft test"
  - "**Heft test**": Does the mineral feel heavier, lighter, or about what you'd expect based on its size?
    - Heavier = high specific gravity
    - Lighter = low specific gravity
    - About what you'd expect = medium specific gravity

Mineral Properties: Magnetism

- Magnetism is the ability of some minerals to behave like magnets
- Magnetism is strongly related to iron content

Assess magnetism by holding a magnet up to a sample and feeling if there is a “pull” when you move the mineral farther away.

Mineral Properties: Luster

- Luster refers to how a mineral reflects light
- Mineral luster is classified generally as "metallic" or "non-metallic"
  - ***Metallic***: looks like a metal
  - ***Non-metallic***: does **NOT** look like a metal
    - ***Caution: can still be shiny!***
    - Glassy, shiny, greasy, waxy, dull, earthy

Luster (continued)

- Metallic

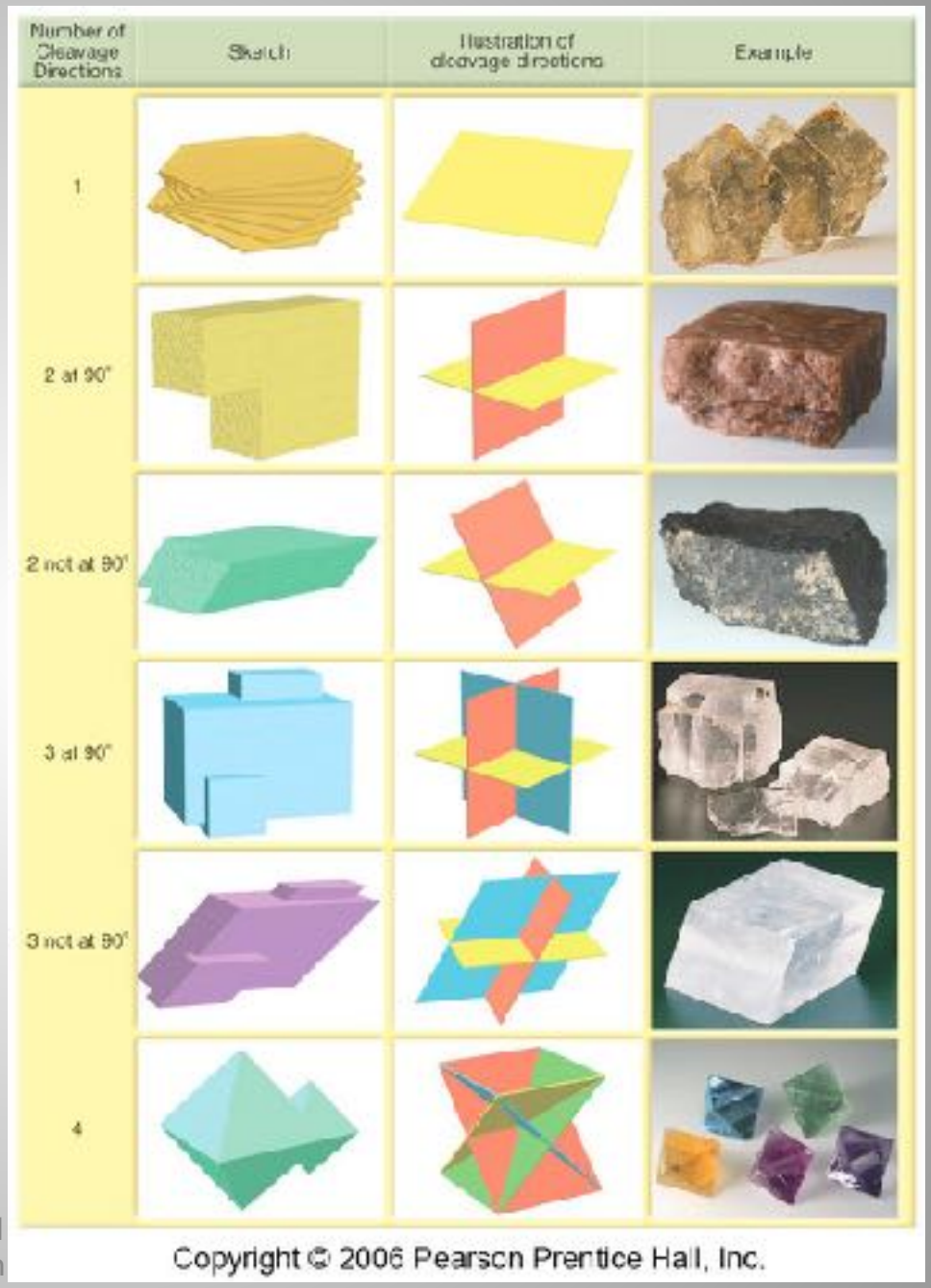
- Non-metallic

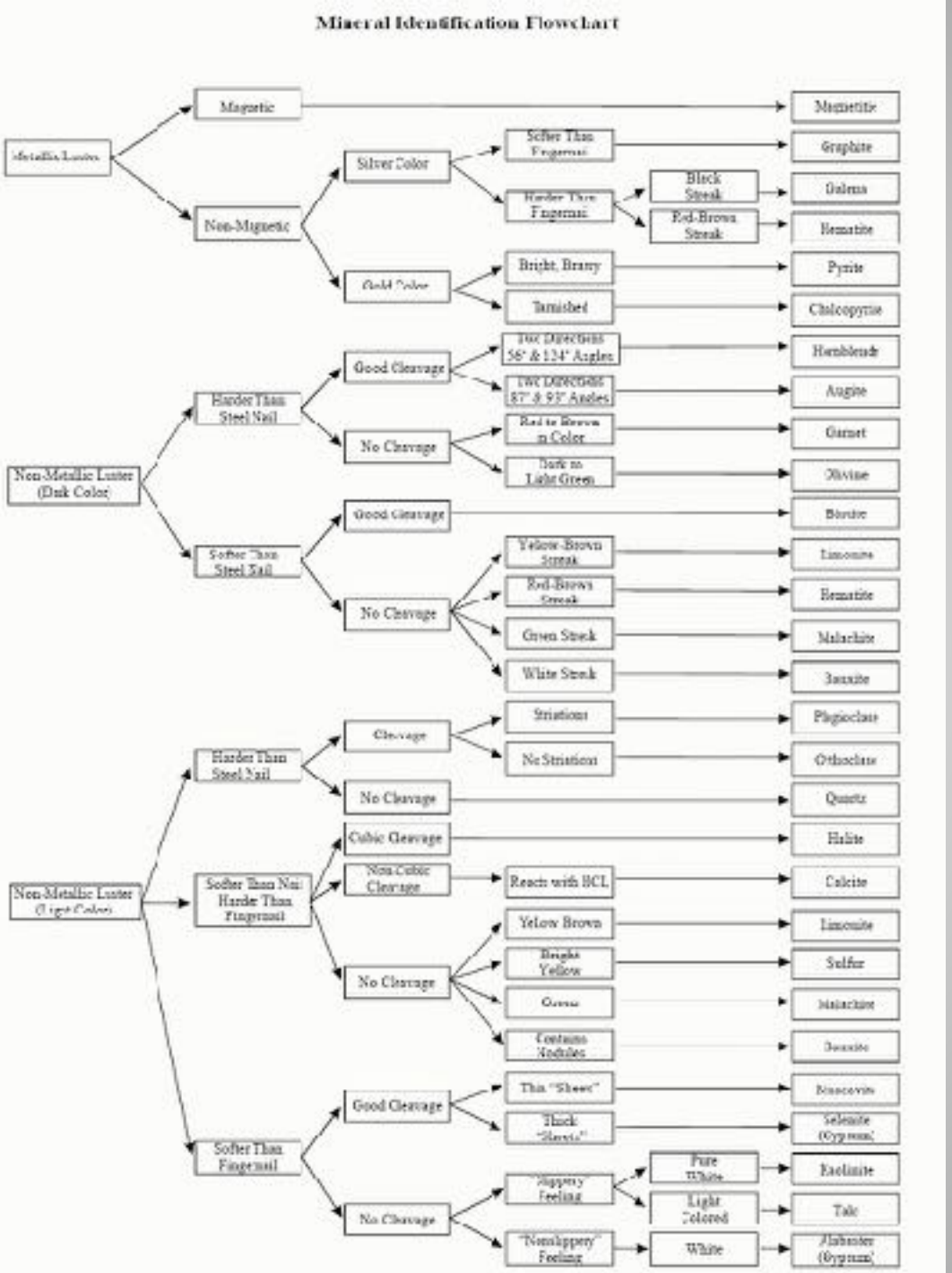
Mineral Properties: Cleavage

- Cleavage describes **the way a mineral breaks (cleaves) along planes of weakness in its atomic structure**
- ***Caution: Not all minerals have cleavage.*** Some minerals break or fracture in irregular ways
- Cleavage does form:
  - Flat, reflective surfaces
  - Angular corners
  - Defined edges
- Cleavage does NOT form:
  - Lumps & bumps
  - Irregular surfaces
  - Conchoidal fracture

Cleavage (continued)

- Minerals can have one, two, three, or even four different directions of cleavage depending on the strength or weakness of a mineral's atomic bonds.
- Multiple cleavage faces intersect each other at specific and predictable angles in certain minerals



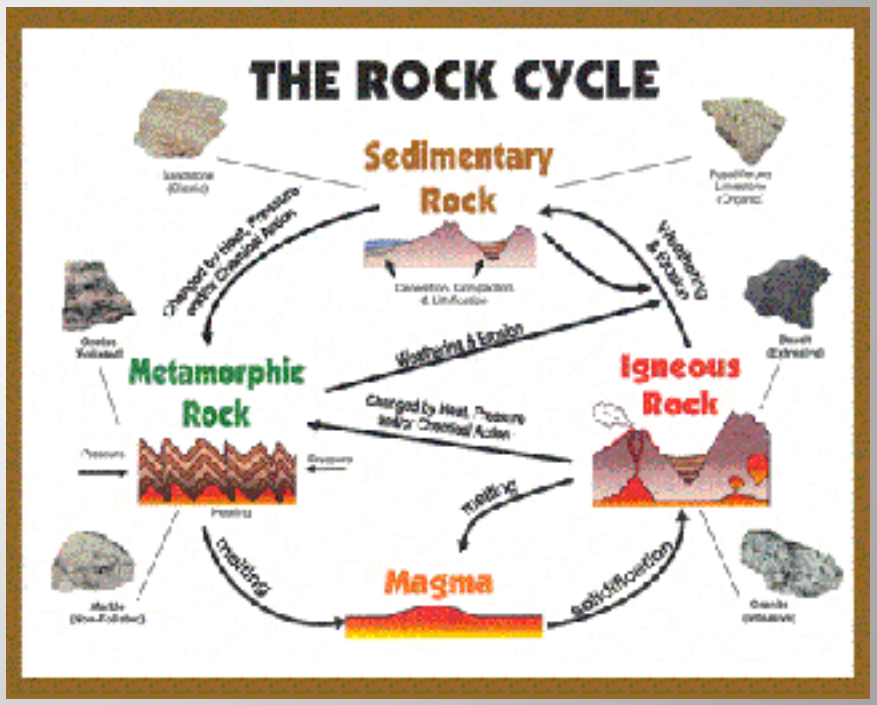

Mineral Identification Flowchart
Magnetic
Magnetite
Non-Magnetic
Silver Color
Softer Than Fingernail
Graphite
Harder Than Fingernail
Black Streak
Galena
Red-Brown Streak
Hematite
Bright, Brassy
Pyrite
Tarnished
Chalcopyrite
Good Cleavage
Two Directions 56° & 124° Angles
Hornblende
Two Directions 87° & 93° Angles
Augite
No Cleavage
Red to Brown in Color
Garnet
Dark to Light Green
Olivine
Harder Than Steel Nail
Softer Than Steel Nail
Good Cleavage
Biotite
No Cleavage
Yellow-Brown Streak
Limonite
Red-Brown Streak
Hematite
Green Streak
Malachite
White Streak
Bauxite
Striations
Plagioclase
No Striations
Orthoclase
Cleavage
No Cleavage
Quartz
Cubic Cleavage
Halite
Non-Cubic Cleavage
Reacts with HCL
Calcite
Softer Than Nail Harder Than Fingernail
Yellow Brown
Limonite
Bright Yellow
Sulfur
Green
Malachite
Contains Nodules
Bauxite
Thin "Sheets"
Muscovite
Thick "Sheets"
Selenite (Gypsum)
Good Cleavage
Softer Than Fingernail
"Slippery" Feeling
Pure White
Kaolinite
Light Colored
Talc
No Cleavage
"Nonslippery" Feeling
White
Alabaster (Gypsum)

So, how many minerals should students be familiar with?

- Important rock-forming minerals
  - Quartz
  - Plagioclase
  - Orthoclase
  - Hornblende
- Minerals with recognizable and diagnostic properties
  - Sulfur
  - Pyroxene
  - Pyrite
  - Olivine
  - Galena
  - Biotite
  - Magnetite
  - Muscovite
  - Hematite

Minerals to Rocks

- ***All rocks are made up of minerals***
- ***Most rocks are composed of numerous minerals***
- Three types of rocks
  - Sedimentary
  - Igneous
  - Metamorphic
- These three rock types are interconnected through the rock cycle. Erosion & weathering, heat, and pressure can transform any rock types into another, given enough time



Sedimentary Rocks

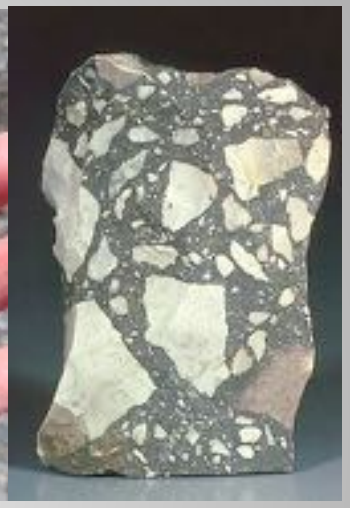
Sedimentary rocks form by deposition of sediment or precipitation of minerals at or near Earth's surface.

- Two types of sedimentary rocks
  - **Clastic:** form by cementing together fragments or grains of pre-existing rocks
  - **Chemical:** form when minerals precipitate out of water solutions at the earth's surface

Common Sedimentary Rocks

Clastic

Sandstone



Conglomerate/Breccia

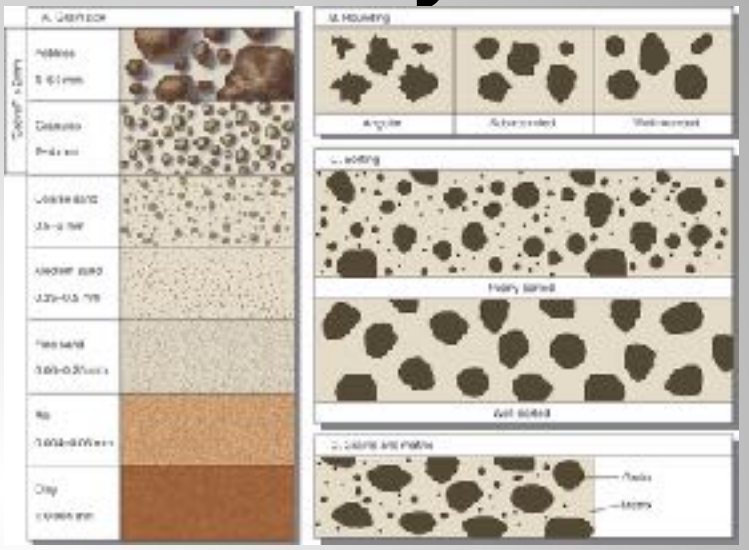
Chemical

Limestone

MMEW Rock & Mineral Identification - Amy Radakovich - Minnesota Geological Survey

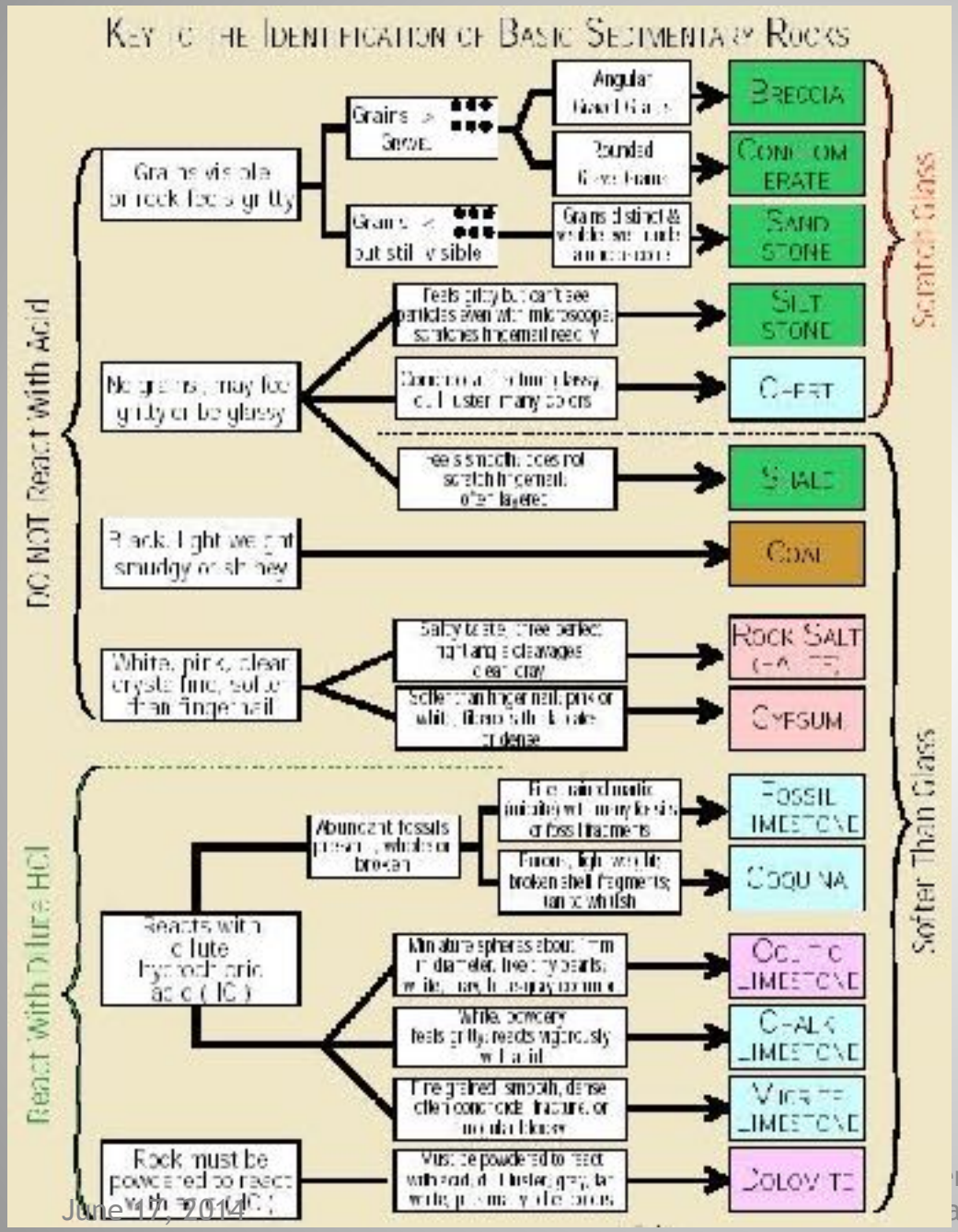
Identifying Sedimentary Rocks

- Grain Size
  - Fine, medium, or coarse-grained
- Grain Sorting
  - Well or poorly sorted
- Grain shape
  - Rounded or angular



- Reaction with dilute HCl (Hydrochloric acid)
  - Fizzes readily, fizzes after being powdered, or does not fizz

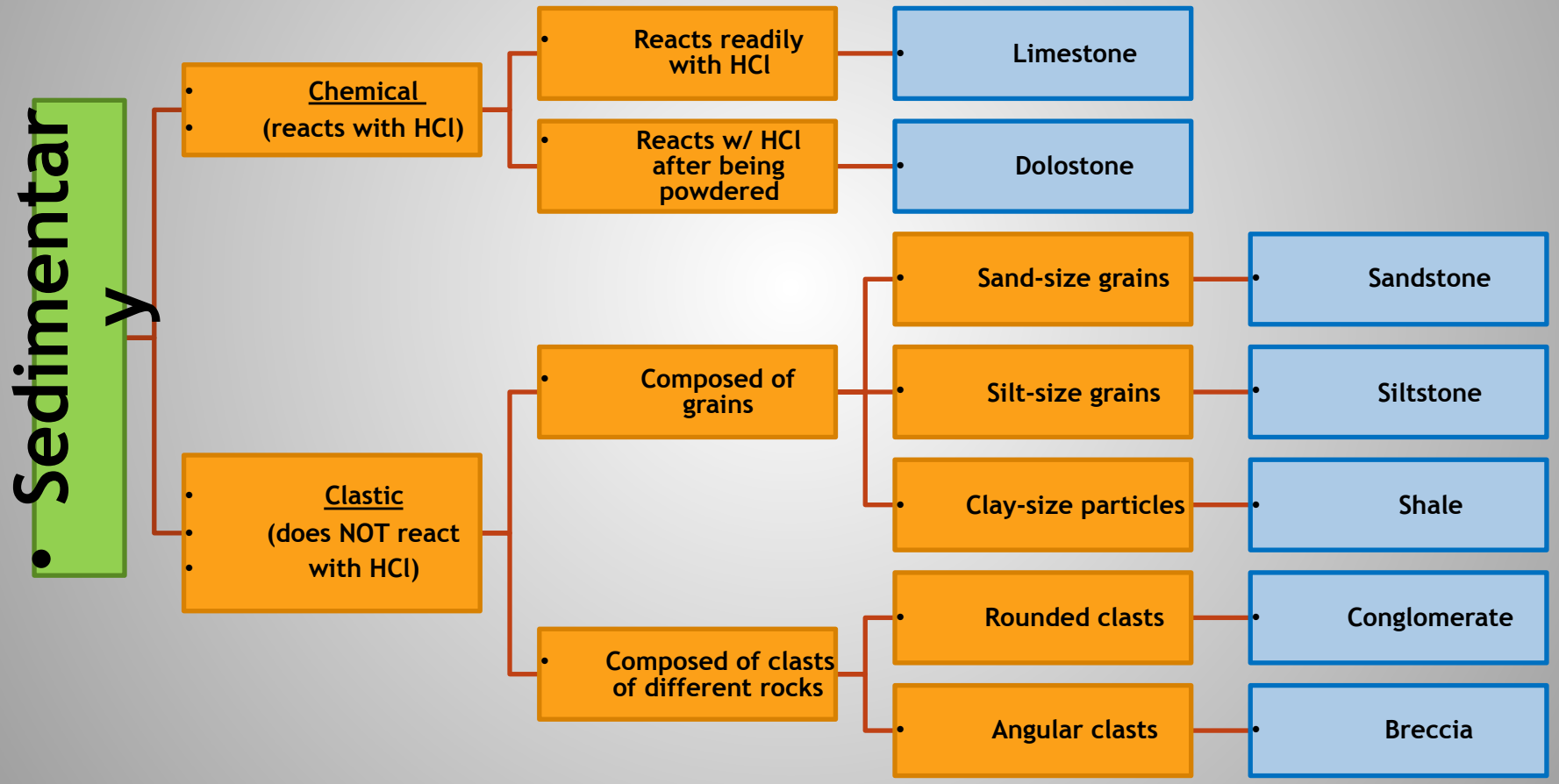
- Other “dead-giveaway” characteristics
  - Fossils
  - Layering



Flow Chart for Sedimentary Rock Identification

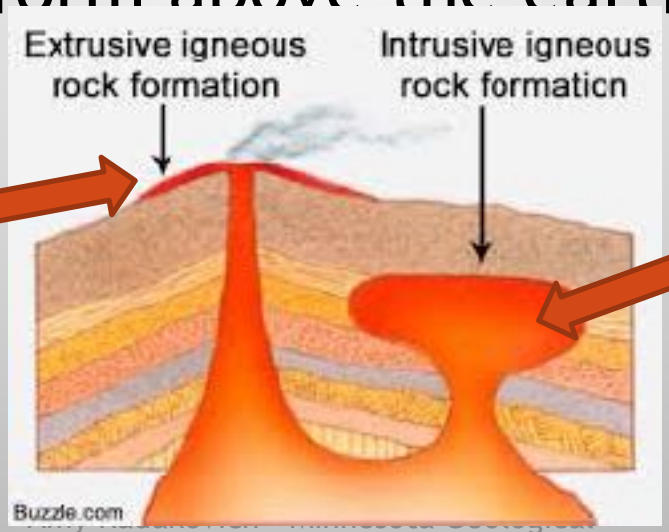
- This is a very comprehensive chart, but is probably a bit to detailed for elementary and middle school Earth science
- The next slide is a much more simplified chart I made that might be a bit more appropriate with rock ID at this grade level

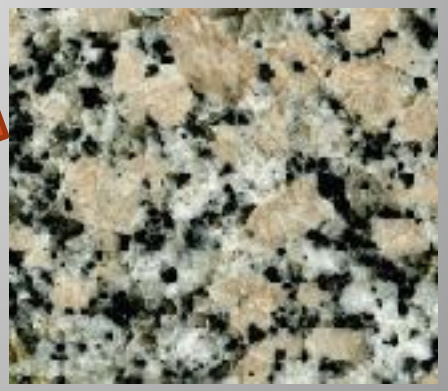
Simplified Flow-chart for Identifying Sedimentary Rocks



Igneous Rocks

- Rocks that solidified from a molten (or partially molten) material (magma or lava)
- 2 kinds of igneous rocks
  - **Intrusive** (form below the earth's surface)
  - **Extrusive** (form above the earth's surface)





Igneous Rock Formation

- How does magma/lava turn into a rock?
- Think about ice forming from water
  - Cools!
  - Solidifies!
    - How does a rock "solidify"???
      - Grows crystals/minerals

Minerals in Igneous Rocks

- Mineral size is a factor of TIME
  - The more time a rock has to crystallize, the bigger the minerals can grow!
    - Extrusive (Volcanic) = quick cooling, fine-grained
      - ***No visible crystals - aphanitic***
    - Intrusive (Plutonic) = slow cooling, coarse-grained
      - ***Crystals visible with the naked eye - phaneritic***

Fine-grained

Coarse-grained

Identifying Igneous Rocks

- Grain size: Fine-, medium-, coarse-grained, or a co

fine

medium

coarse

combination – porphyritic)

- Color & Composition: determined by minerals present

(felsic)

– (mafic)

(intermediate)

dark

Identifying Igneous Rocks (continued)

- Other features
  - Vesicles/Amygdule

  - Glassiness

Identifying Igneous Rocks (continued)

Increasing Fe and Mg →

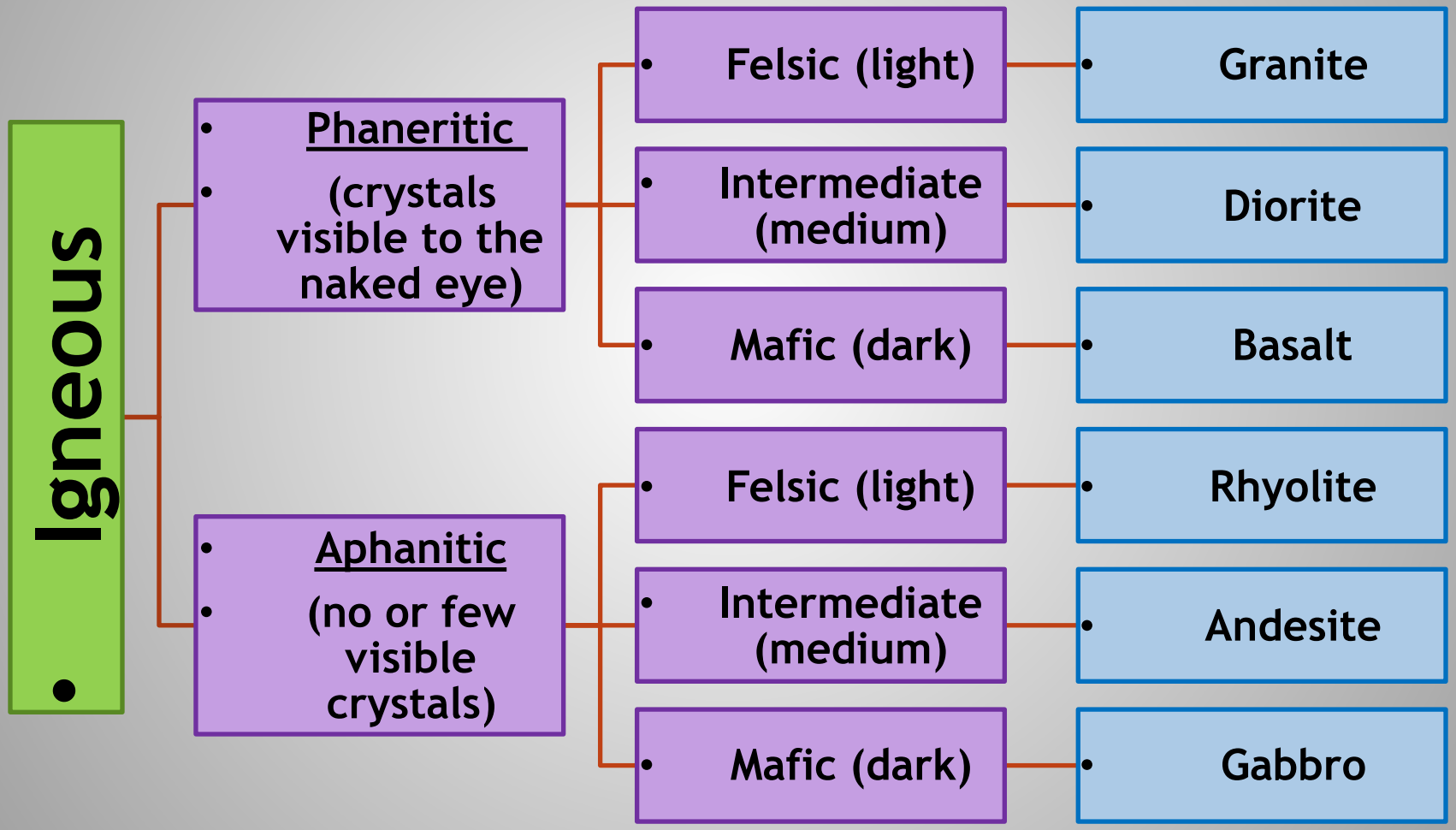
Increasing silica content ←

Igneous Rock Classification		Felsic/ Silicic light colored high in SiO_2	Intermediate	Mafic dark colored low in SiO_2
Phaneritic	Plutonic (magma)	Granite	Diorite	Gabbro
(coarse grained)	Intrusive			
Aphanitic	Volcanic (lava)	Rhyolite	Andesite	Basalt
(fine grained)	Extrusive			

This table can be VERY useful to help understand the similarities and differences of igneous rocks.

However, a simplified flow chart like I created on the next slide often proves MUCH more helpful in the process of identifying igneous rocks.

Simplified Flow-chart for Identifying Igneous Rocks



Metamorphic Rocks

- Metamorphic rocks form when a rock is exposed to elevated temperature and pressure
- Involves a change in texture or mineralogy in the solid state (***in other words, the rock can't re-melt***)
- Can form from an igneous rock, a sedimentary rock, or another metamorphic rock

Common metamorphic rocks

- The more heat and pressure you add, the more the rock changes
- The most common structure developed in metamorphic rocks is ***foliaton***, when minerals are aligned parallel to one another by deformation

slate

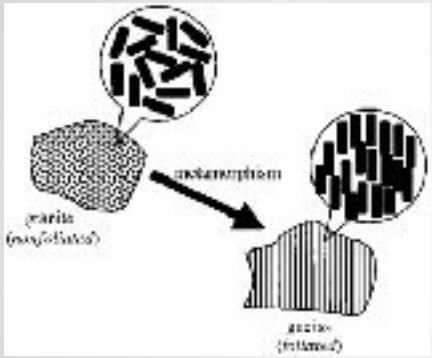
schist

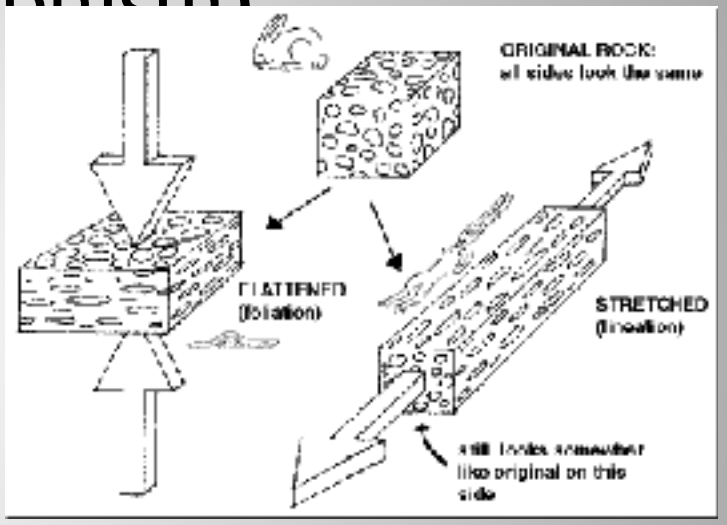
phyllite

gneiss

Identifying Metamorphic Rocks

- Grain size (grain size usually increases with increasing metamorphism)
- Foliation



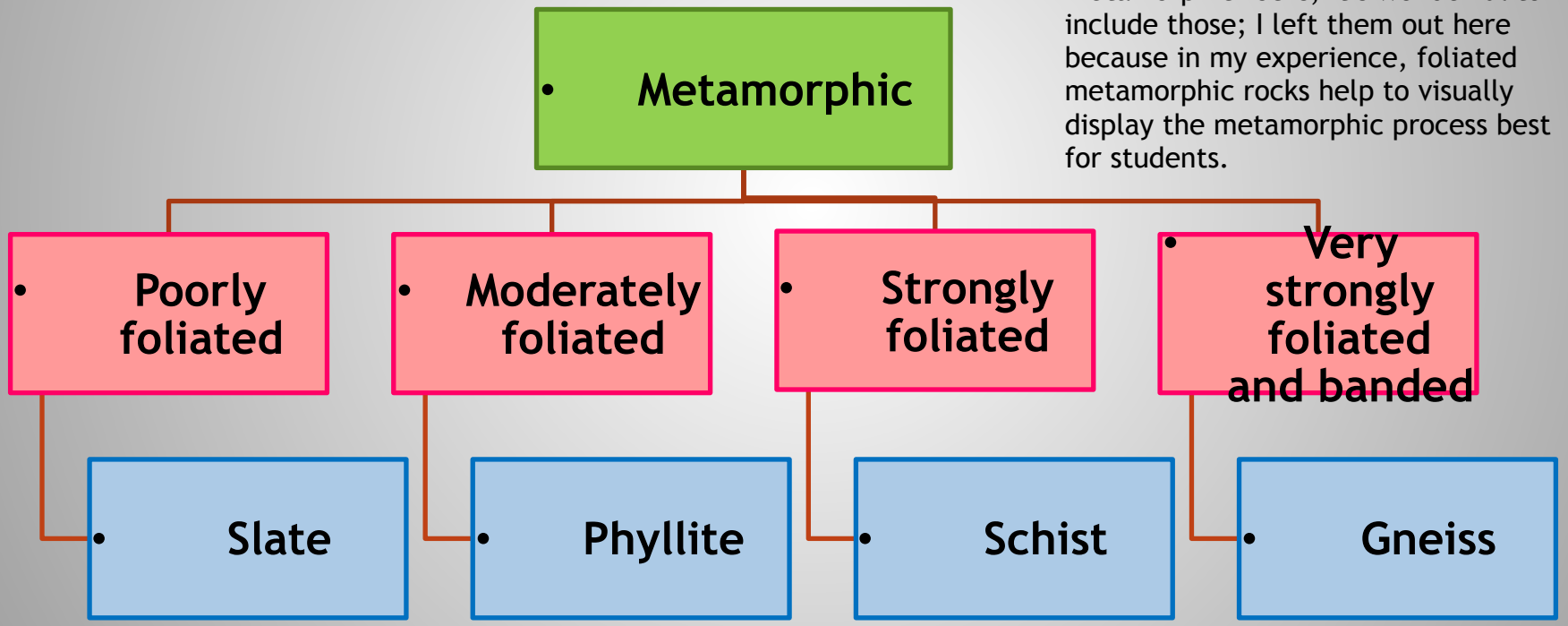


- Other features
  - Folding

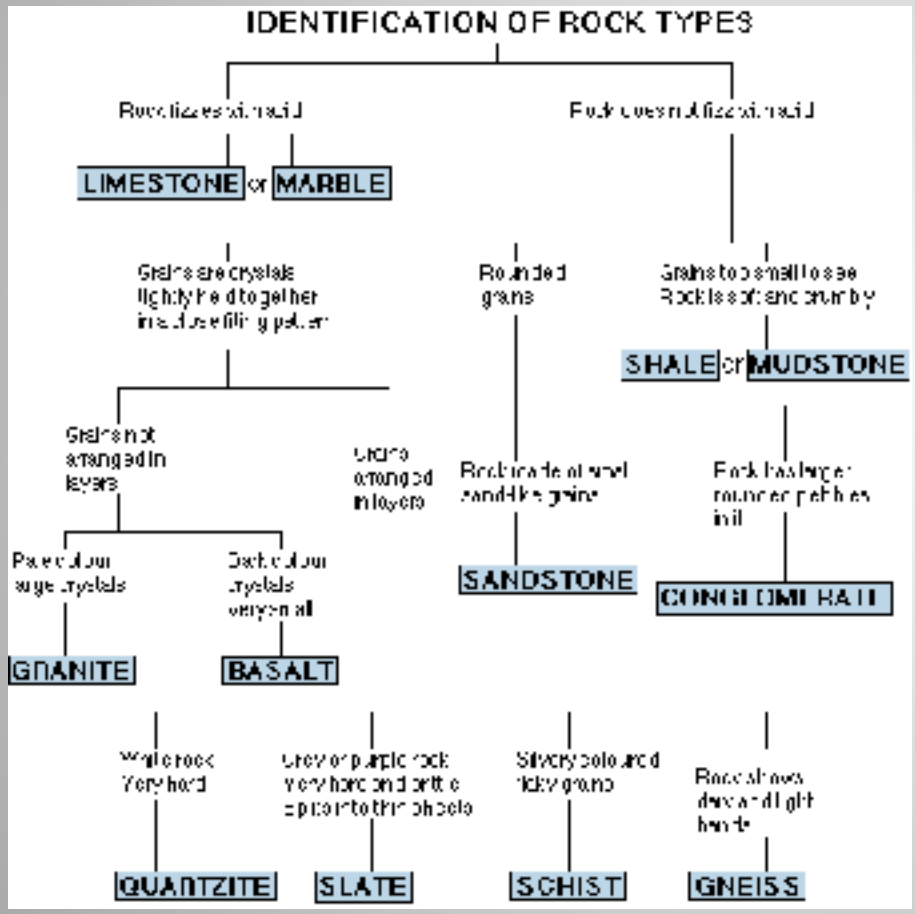
"Squished" appearance

Simplified Flow-chart for Identifying *Foliated* Metamorphic Rocks

NOTE: Remember, there are non-foliated metamorphic rocks such as quartzite and marble as well. If you have a lot of time to spend on metamorphic rocks, it's wonderful to include those; I left them out here because in my experience, foliated metamorphic rocks help to visually display the metamorphic process best for students.

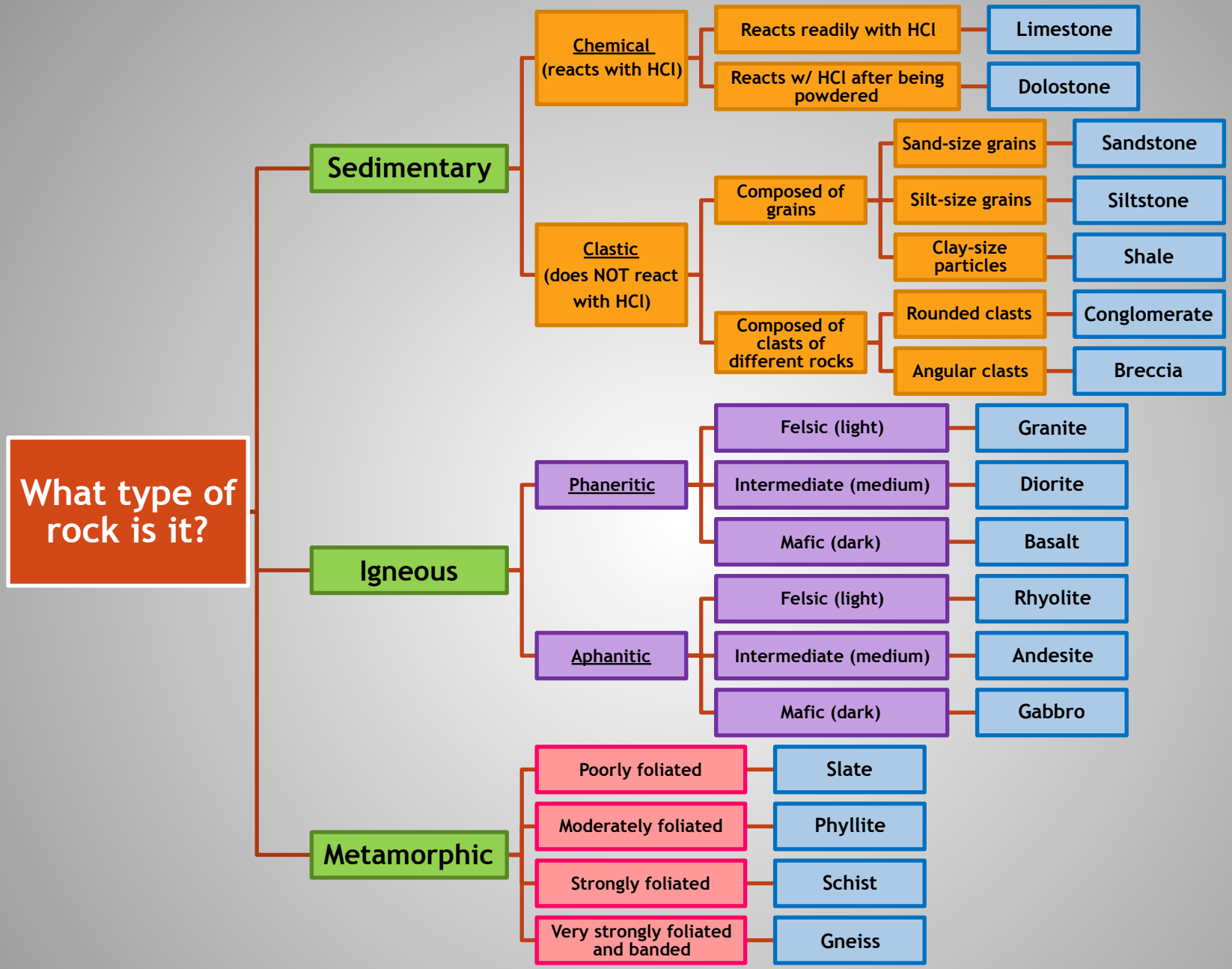


General Rock Identification



Many rock identification charts like this are available on the Internet, but I found it most helpful to create my own chart that helps students arrive at a rock name by eliminating possibilities in manageable steps (see next slide) … Hopefully this will help you in your classroom as well!

This rock ID chart is a combination of the three shown previously for the three different rock types.


What type of rock is it?
Sedimentary
Chemical (reacts with HCl)
Reacts readily with HCl
Limestone
Reacts w/ HCl after being powdered
Dolostone
Clastic (does NOT react with HCl)
Composed of grains
Sand-size grains
Sandstone
Silt-size grains
Siltstone
Clay-size particles
Shale
Composed of clasts of different rocks
Rounded clasts
Conglomerate
Angular clasts
Breccia
Igneous
Phaneritic
Felsic (light)
Granite
Intermediate (medium)
Diorite
Mafic (dark)
Basalt
Aphanitic
Felsic (light)
Rhyolite
Intermediate (medium)
Andesite
Mafic (dark)
Gabbro
Metamorphic
Poorly foliated
Slate
Moderately foliated
Phyllite
Strongly foliated
Schist
Very strongly foliated and banded
Gneiss

Questions?

LAB TIME!!!

#	Color	Streak	Hardness	Specific Gravity	Mag	Luster	Cleavage	Mineral Name
0	Grey	Grey	1-1.5	Low	N	Non-metallic	1	graphite
1	Silver	Dk. Grey	2.5-2.75	high		metallic	Cubic (3 @ 90)	Galena
2	Gold	Black/grey	6-6.5	High	weak	Metallic	Cubic (3 @ 90)	Pyrite
3	Dk grey/silver	Dk grey	5.5-6.5	High	y	Metallic	none	Magnetite
4	Red or silver	Red to dk brown	4.5	High	weak	Metallic to non-metallic	none	Hematite
5	Orange to yellow	Orange to yellow	4-5.5	Med-high	N	Non-metallic	none	limonite
6	Clear	white	2-2.5	med	N	Vitreous	2 @ 90	Halite
7	Clear to white	white	1.5-2	High	N	Vitreous, pearly	2 @ 90	Gypsum
8	Clear to yellow	white	3	med	N	Vitreous to pearly	3 not @ 90	Calcite
9	Green	none	6.5-7	high	N	vitreous	none	Olivine
10	Dk green to black	White	5-6	Med	N	Vitreous/shiny to dull	2 @ 90	Pyroxene
11	Dk green to black	white	5-6	Med	N	Vitreous/shiny to dull	2 @60	Hornblende
12	black	White/ none	2.5-3	Low	N	shiny	1	Biotite
13	Clear/tan	White/ none	2.5-3	Low	N	shiny	1	Muscovite
14	White, tan, grey	None	6	med	N	Non-metallic	2 @ 90	Plagioclase
15	Pink to white	None	6	Med	N	Non-metallic	2 @ 90	Orthoclase