Topic 11 – Rocks and Minerals

Vocabulary

Cleavage – the way a mineral breaks along a plane of weakness

Contact metamorphism – the hanging of older rock by the intrusion of magma, burns existing rock

Extrusive igneous rock – igneous rock formed on the surface of the Earth from cooling lava

Foliation – the alignment of minerals in a metamorphic rock

Fracture – the irregular breaking of a mineral

Hardness – the ability of a mineral to scratch another mineral, soft minerals can't scratch harder minerals

Igneous rock – rock from melted material in Earth

Intrusive igneous rock – igneous rocks formed underground from cooling magma

Lava – liquid rock material on Earth's surface

Luster – the way a mineral shines reflected light, metallic or non-metallic is one example

Magma – liquid melted rock material beneath Earth's surface

Metamorphic rock – rack that forms by altering previously existing rock

Mineral – naturally occurring crystalline solid having definite chemical composition with specific identifying properties

Precipitation (mineral) – dissolved minerals come out of solution to form solids

Regional metamorphism – process of forming metamorphic rock over a large region, such as a mountain range4 from heat and pressure

Rock cycle – a model to show relationships of rock formation

Sedimentary rocks – rocks that form directly from sediments

Streak – the color of the powered form of a mineral scratched on a porcelain plate

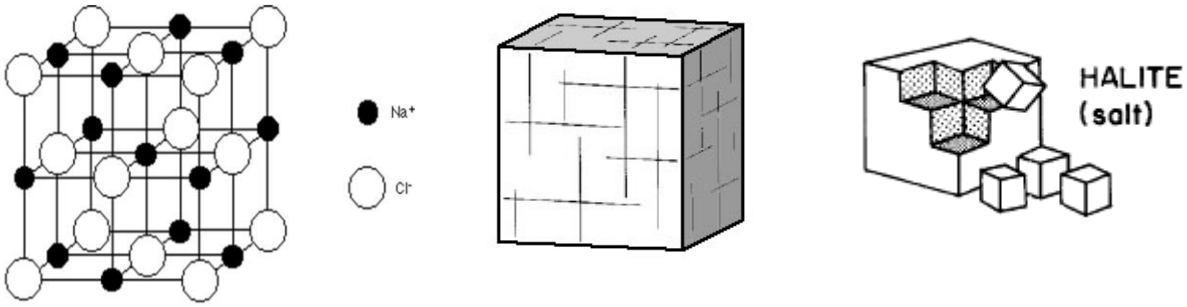
Texture – size shape and arrangement of mineral crystal and the sediments that make up a rock

Overview of Topic

I. Minerals
   a. Occur naturally
   b. Crystal structure

      The crystal structure give a mineral its distinct properties. Each mineral type has its own properties.

Atomic Structure | Crystal Shape | Cleavage Structure



   c. Minerals make rocks
      1. All rocks are made of minerals

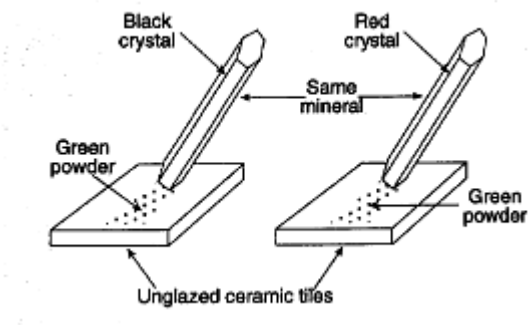
   d. Occur in Earth's Crust
      1. Page1 of the ESRT shows elements in Earth's crust
         - Oxygen (O) and Silicon (Si) are the most abundant elements by mass in the lithosphere
         - Silicates, the combination of SiO, is the most abundant mineral on Earth, see page 16 of the ESRT under the column "composition"
      2. 2000 + minerals on Earth

   e. Internal arrangement of atoms (crystal structure) determines the minerals properties
      - Very important to know this. Mineral identification is based on the arrangement of the atoms. Both diamond and graphite are made of the element carbon (C), because of the different way the atoms are arranged make diamond the hardest substance while graphite is one of the softest.

f. Mineral Identification - https://www.youtube.com/watch?v=c7wJP_K_sAQ

- There several properties used to identify minerals. The following you need to know. These are the best.

1. Streak – The color of the mineral scratched on a porcelain tile



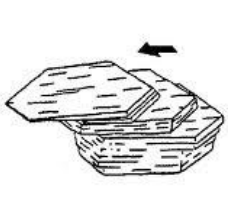
The streak is the true color. The color, appearance of the mineral can be many colors, the streak is the same color due to the arrangement of the atoms.

2. Hardness – The ability for a mineral to scratch another. Based on a scale of 1 – 10 (Mohs hardness scale).

Moh's Mineral Hardness Scale		Approximate Hardness of Common Objects
Talc	1	
Gypsum	2	Fingernail (2.5)
Calcite	3	Copper penny (3.5)
Fluorite	4	
Apatite	5	Iron nail (4.5)
Feldspar	6	
Quartz	7	Glass (5.5)
Topaz	8	
Corundum	9	Steel file (6.5)
Diamond	10	Streak plate (7.0)

Hardness of minerals is based on common objects. Glass is one of the most useful to determine hardness. This is due to the arrangement of atoms.

3. Cleavage – The way a mineral breaks evenly along planes of weakness. The broken pieces look identical to the original piece.



Cleavage can occur in several directions, notice the break is clean. Due to the internal arrangement of atoms.

4. Fracture – The way a mineral breaks that is not even. The pieces are random and look jagged. Think of broken glass.

Fracture is random breaking. Notice it is not a clean break, but jagged. Due to arrangement of atoms.

5. Luster – The mineral looks like metal. Page 16 breaks up into metal and non-metal in the left column

6. Effervesces – Bubbles with hydrochloric acid (HCl)

   Calcite ($CaCO_3$) easily bubbles with acid. Calcite is the major mineral that makes the sedimentary rock limestone and the metamorphic rock marble. They will bubble with acid.

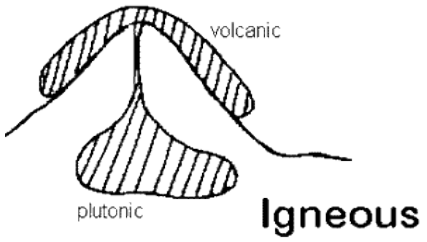
*** Mineral identification is tested in Part D the lab practical as well as the written examination.**

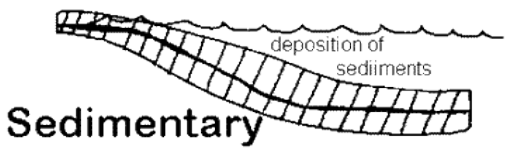
II. Rock Types

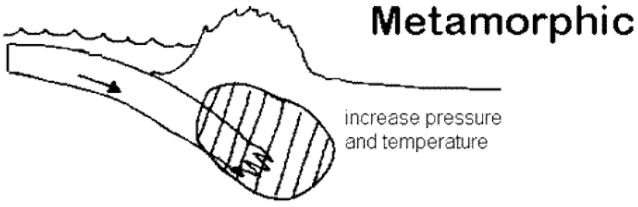
- All rocks are made of minerals

- Polymineralic – made of many minerals (most rocks)
- Monomineralic – made of one mineral (very few rocks)

- 3 types of rock
  - Igneous
  - Metamorphic
  - Sedimentary







a. Igneous - https://www.youtube.com/watch?v=aCnAF1Opt8M

- Page 6 ESRT – Scheme for Igneous Rock Identification
- All igneous rocks have interlocking crystals

1. Made from melted material
   - Magma – rock material solidifies underground
   - Lava – rock material solidifies on the surface

2. Environment of formation
   - Extrusive (volcanic) – formed on the surface due to fast cooling, crystals are small (less than a millimeter to microscopic)
     - Characterized by minerals as fine, glassy and / or vesicular (gas pockets)
     - contain one the following characteristics:
       - Glassy
       - Glassy vesicular
       - Fine texture
       - Fine texture vesicular

- Intrusive (plutonic) – formed underground due to slow cooling, crystal are large (1 millimeter and larger)
    - Characterized by minerals as coarse and very coarse
    - contain one the following characteristics:
        - coarse crystals 1 – 10 mm
        - very coarse crystals > 10 mm
        - crystals can easily be seen with your eye

EXTRUSIVE (VOLCANIC)

Glassy

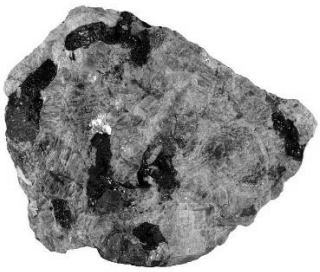
Gas pockets

Fine

INTRUSIVE (PLUTONIC)

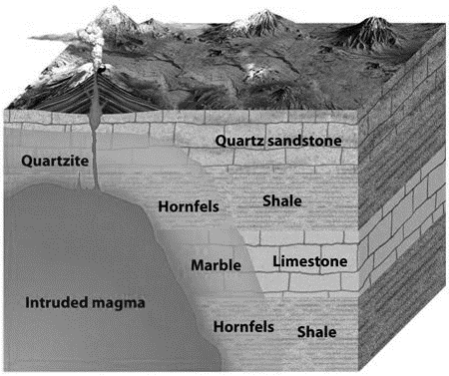
Coarse

Very coarse



b. Metamorphic – changed rock - https://www.youtube.com/watch?v=1oQ1J0w3x0o

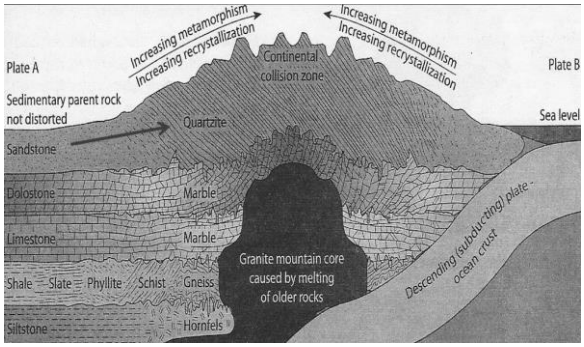
- Page 7 ESRT – Scheme for Metamorphic Rock Identification
    1. Formation
        i. Contact metamorphism
            - When magma or lava burns already existing rock



As the intruded magma burns the surrounding rock material it is altered. Notice that the existing rock type is altered into a different metamorphic rock type.

The area is localized and the altered rock is due to heat.

        ii. Regional metamorphism
            - When plates collide pressure increase, which increase the temperature which alters the bedrock



As plates squeeze together it alters rock with pressure and heat. The more intense the pressure and heat, the more altered the rock.

Shale is metamorphosed from least intense to most intense.

Least ⟶ Most

Shale → slate →phyllite → schist → gneiss

- 2 textures
    - Foliated
        - Mineral alignment
            - Minerals line up in a common direction due to heating

- Look like scales in a fish, they line up
- Often shiny and may contain garnet crystals
- Least intense form of foliation

- Banding
  - Minerals line up in a common direction and by similar mineral type
  - Look stripped
  - Most intense form of foliation

- Non-foliated
  - Minerals look like melted sugar, or snow crystals that begin to melt; not liquid
  - Hard to identity
  - Marble and quartzite are examples

c. Sedimentary – make from sediment, layers - https://www.youtube.com/watch?v=Etu9BWbuDlY

- Page 7 ESRT
- Easy to identify

1. Formation – almost always in water
    - Cementation of particles such as sand, silt, clay and cobbles react with dissolved materials in the water to form cement.
    - Compaction of the material from more layers on top "squeeze" the layers on the bottom making the particle contact each other.
    - Chemical action. Water contains dissolved minerals. As the water evaporates minerals are left behind (evaporates). In some cases the dissolved minerals precipitate, drop out of solution, to form a layer (precipitates).
    - Organic processes. When minerals are removed from water by living organisms, such as clams, oysters, coral and plants are needed to build structures the process is considered organic. When these organisms due the remains are cemented together to form rock.

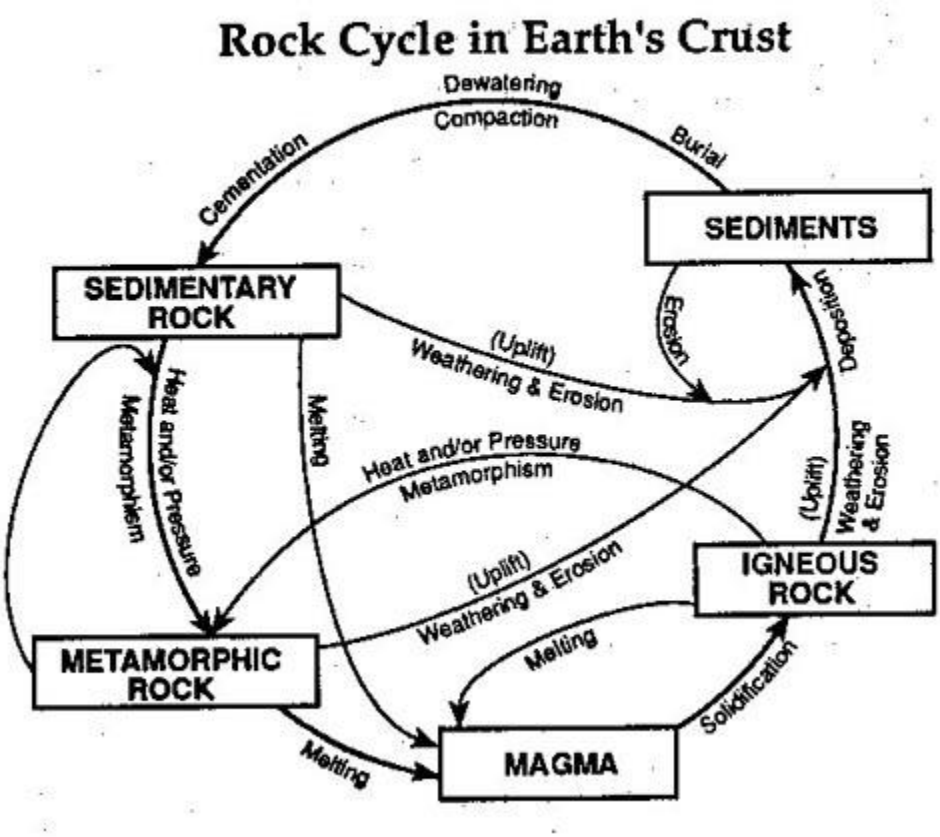
2. Characteristics
    - Clastic – rocks made from particles of other rock or sediment
    - Bioclastic – rocks made from remains of shells or plants
    - Crystalline – evaporates and precipitates, they don't have grains, but crystals that formed together

3. Identification
    - Page 7 ESRT – Scheme for Sedimentary Rock Identification
    - Look at the rains and determine size
    - Sedimentary rocks are boring in appearance, dull
    - Some sedimentary rocks contain fossils
    - Fossils are only found in sedimentary rocks

***NOTE: You must be able to identify rocks on Part D the lab practical.**

III. Rock Cycle

- Page 6 ESRT



- General overview of how rocks are formed on Earth.
- Rock formation is cycled between on type of rock to another via Earth processes.

Earth Science Reference Table – (ESRT)

Pages from ESRT used in Topic 11.

Page 1, 6, 7 and 16

Page 1

AKA – Lithosphere

Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

- What is necessary to know is the crust (lithosphere) is broken in to two columns: percent by mass and percent by volume.
- These represent the most abundant mineral forming elements in the crust

Page 6 and 7

Scheme for Igneous Rock Identification

https://www.youtube.com/watch?v=RGQeJL1izBE

Classifying igneous rocks

Either **intrusive** or **extrusive** (ESRT pg 6)

Ask a series of questions using pg 6.

1) What kind of texture does it have? (7 types)
2) What is the grain size? (4 sizes)
3) What is the color, light or dark? (obsidian is light)
4) Environments of Formation
5) What rock is it?

5 **2** **1**

Scheme for Igneous Rock Identification

4

IGNEOUS ROCKS: ENVIRONMENT OF FORMATION							GRAIN SIZE	TEXTURE	
EXTRUSIVE (Volcanic)	Obsidian (usually appears black)		Basaltic Glass			Non-crystalline	Glassy	Non-vesicular
	Pumice		Vesicular Basaltic Glass					Vesicular (gas pockets)
	Vesicular Rhyolite	Vesicular Andesite	Scoria / Vesicular Basalt			less than 1 mm	Fine	
	Rhyolite	Andesite	Basalt					
INTRUSIVE (Plutonic)	Granite	Diorite	Gabbro	Peridotite	Dunite	1 mm to 10 mm	Coarse	Non-vesicular
	Pegmatite					10 mm or larger	Very Coarse	

CHARACTERISTICS			
LIGHT	COLOR	DARK	**3**
LOW	DENSITY	HIGH	
FELSIC (Al)	COMPOSITION	MAFIC (Fe, Mg)	

Scheme for Sedimentary Rock Identification

https://www.youtube.com/watch?v=NWQLmGu8fSg

This order is a general overview of how to identify based on a set of criteria given.

Identify by asking questions

1) What is the texture?
2) What is the Grain size
3) Comments?
4) Identify rock!

1 2 3 4

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	Conglomerate	
			Angular fragments	Breccia	
	Sand (0.2 to 0.006 cm)		Fine to coarse	Sandstone	
	Silt (0.006 to 0.0004 cm)		Very fine grain	Siltstone	
	Clay (less than 0.0004 cm)		Compact; may split easily	Shale	
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Varied	Halite	Crystals from chemical precipitates and evaporites	Rock Salt	
	Varied	Gypsum		Rock Gypsum	
	Varied	Dolomite		Dolostone	
Bioclastic	Microscopic to coarse	Calcite	Cemented shell fragments or precipitates of biologic origin	Limestone	
	Varied	Carbon	From plant remains	Coal	

Scheme for Identifying Metamorphic Rocks

https://www.youtube.com/watch?v=G2U5TUux-cQ

How to identify
Ask questions

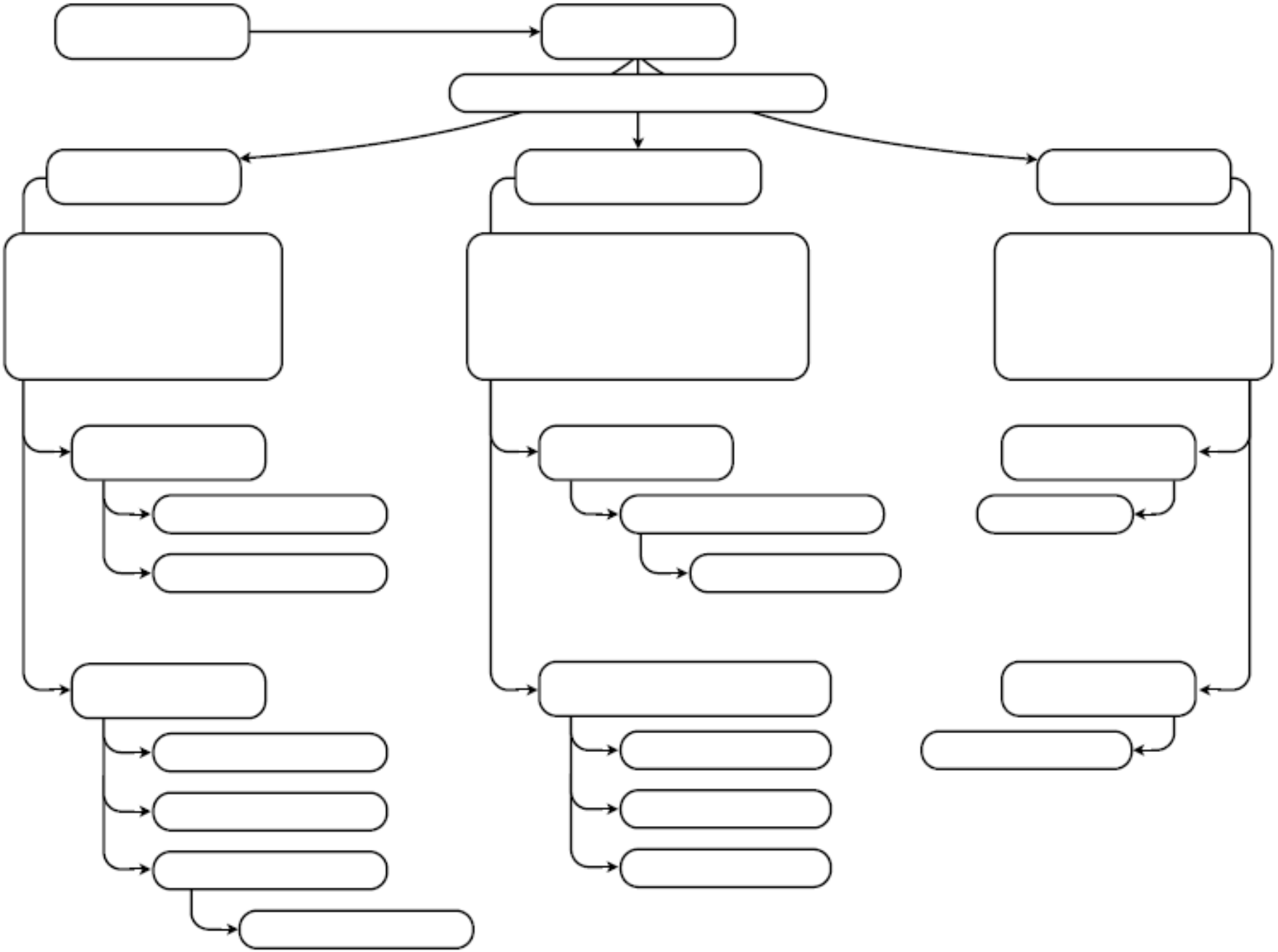
1) What is the texture?
2) What is the grain size?
3) Comments?
4) Identify the rock

Non foliated metamorphic rocks look very similar to other rocks and some minerals. Be careful when identifying.

1 2 3 4

Scheme for Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	MINERAL ALIGNMENT	Fine	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional (Heat and pressure increase with depth)	Low-grade metamorphism of shale	Slate	
		Fine to medium			Foliation surfaces shiny from microscopic mica crystals	Phyllite	
					Platy mica crystals visible from metamorphism of clay or feldspars	Schist	
	BAND-ING	Medium to coarse			High-grade metamorphism; some mica changed to feldspar; segregated by mineral type into bands	Gneiss	
NONFOLIATED		Fine	Variable	Contact (Heat)	Various rocks changed by heat from nearby magma/lava	Hornfels	
		Fine to coarse	Quartz	Regional or Contact	Metamorphism of quartz sandstone	Quartzite	
			Calcite and/or dolomite		Metamorphism of limestone or dolostone	Marble	
		Coarse	Various minerals in particles and matrix		Pebbles may be distorted or stretched	Metaconglomerate	



Page 16 Properties of Common Minerals

https://www.youtube.com/watch?v=BlsG2C5ttJc

This is not the best chart to use to identify minerals. It is good for finding properties about minerals.

To use it for Identification start at the left column and ask a series of questions:

1) LUSTER metallic or non metallic?

2) HARDNESS – here it has a range. I like reference glass which is about 5.5 hardness. Does the mineral scrath glass?

3) CLEAVAGE or FRACTURE how does it break

4) DISTIGUISHING CHARACTERISTICS what is something that is easy identifiable in the mineral.

We will use another chart for the lab practical of the exam which is much more relable and esier to identify minerlas with.