A Coaches Introduction to the 2017 R&M Event – Presentation A

Presenter: Linder Winter

DESCRIPTION

- Teams will demonstrate their knowledge of rocks and minerals.
- **A TEAM OF UP TO**: 2 **APPROX. TIME**: 40-50 Minutes

EVENT PARAMETERS

- Each **team** may bring one magnifying glass and one 3-ring binder (any size) containing pages of information in any form from any source.

THE COMPETITION

a. Emphasis will be placed upon task-oriented activities. Participants will move from station to station with the length of time at each station predetermined and announced by the event supervisor. Participants may not return to stations, but may change or add information to their original responses while at other stations.

THE COMPETITION

b. Written descriptions as to how a specimen might react were it to be tested with HCl may be provided. HCl will not be used or provided.

THE COMPETITION

c. Identification will be **limited to specimens** on the **Official Science Olympiad Rock and Minerals List** (see www.soinc. org), but other rocks and minerals may be used to illustrate key concepts.

THE COMPETITION

d. Tournament Directors may include up to five additional specimens important to their own state. **If additional specimens are to be included, all teams must be notified no later than three weeks prior to the competition.**

REPRESENTATIVE TOPICS

(may include, but are not limited to):

Minerals:

a. Identification
b. Properties: hardness, luster, streak, cleavage/fracture, density, etc.
c. Classification: see list

REPRESENTATIVE TOPICS

Minerals:

d. Chemical composition

e. Mineral habit (e.g. botryoidal, hexagonal, prismatic, bladed

f. Methods & environments of formation

REPRESENTATIVE TOPICS

- **g.** Economic importance (e.g., ores, industrial uses, jewelry)

REPRESENTATIVE TOPICS

Rocks:

h. Identification

i. Rock cycle

j. Classification: sedimentary, igneous, and metamorphic

REPRESENTATIVE TOPICS

Rocks:

k. Environments of formation

l. Texture and composition

m. Bowen's reaction series

n. Grade of metamorphism

REPRESENTATIVE STATION ACTIVITIES

a. Using the materials provided, fingernails included, determine the relative hardness of each of these six minerals. List the specimens, by name and number, in order of increasing hardness.

SCORING

Total scores will determine rankings in this event. Ties will be broken by the accuracy or quality of responses to preselected questions.

RECOMMENDED RESOURCES

- Mineral kits, individual mineral specimens, sample R&M exams, Rock Kit with Lessons and Specimens, R & M question cards (either on CD or pre-printed and cut) and other coaching aides may be ordered from Other Worlds Educational Enterprises, LLC at http://www.otherworlds-edu.net

Specimen Identification

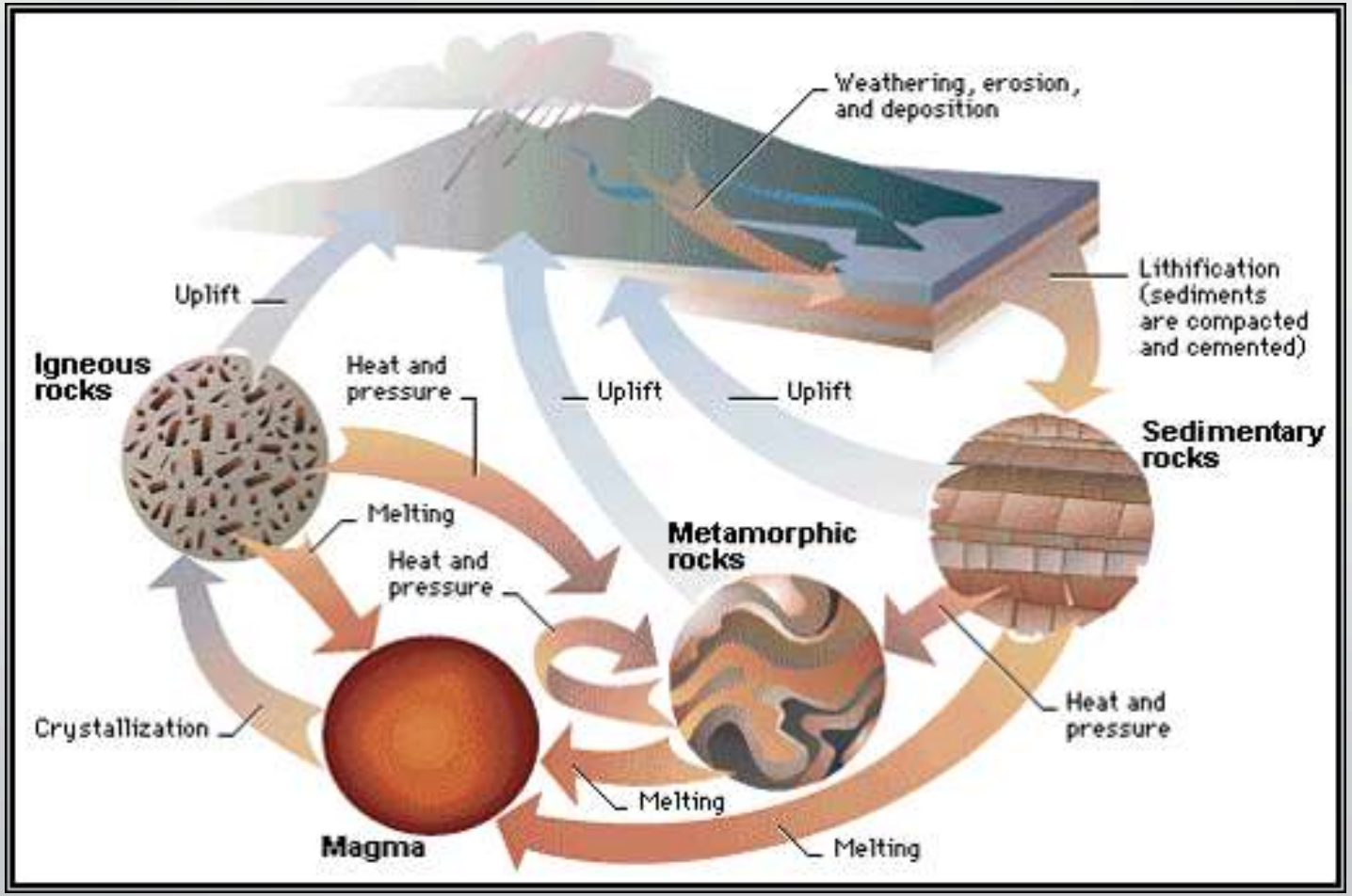
Minerals are defined as naturally occurring, inorganic, solids with a definite chemical composition and a regular, internal crystalline structure. The keys to this definition are the chemical composition and the crystalline structure.

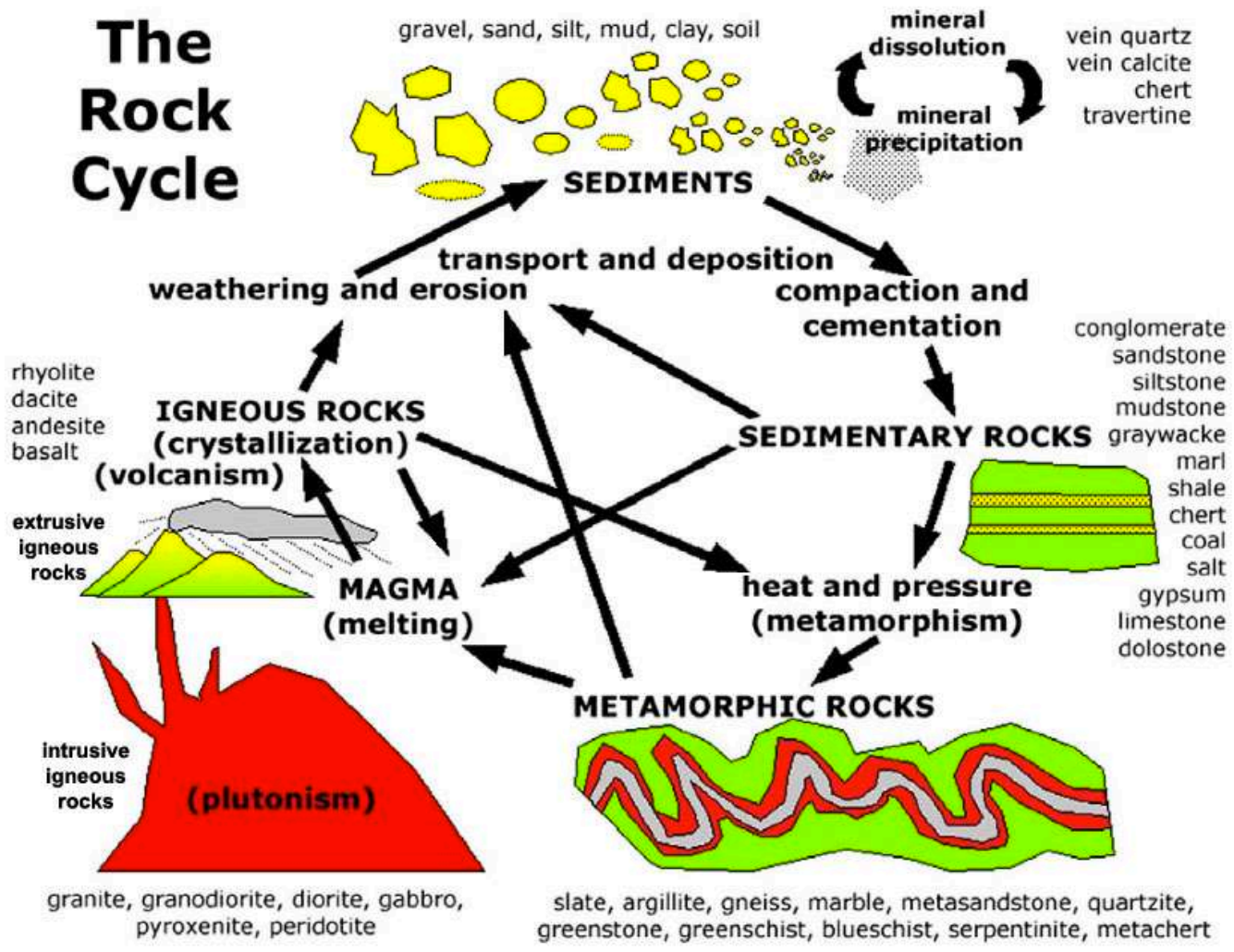
Rock Cycle

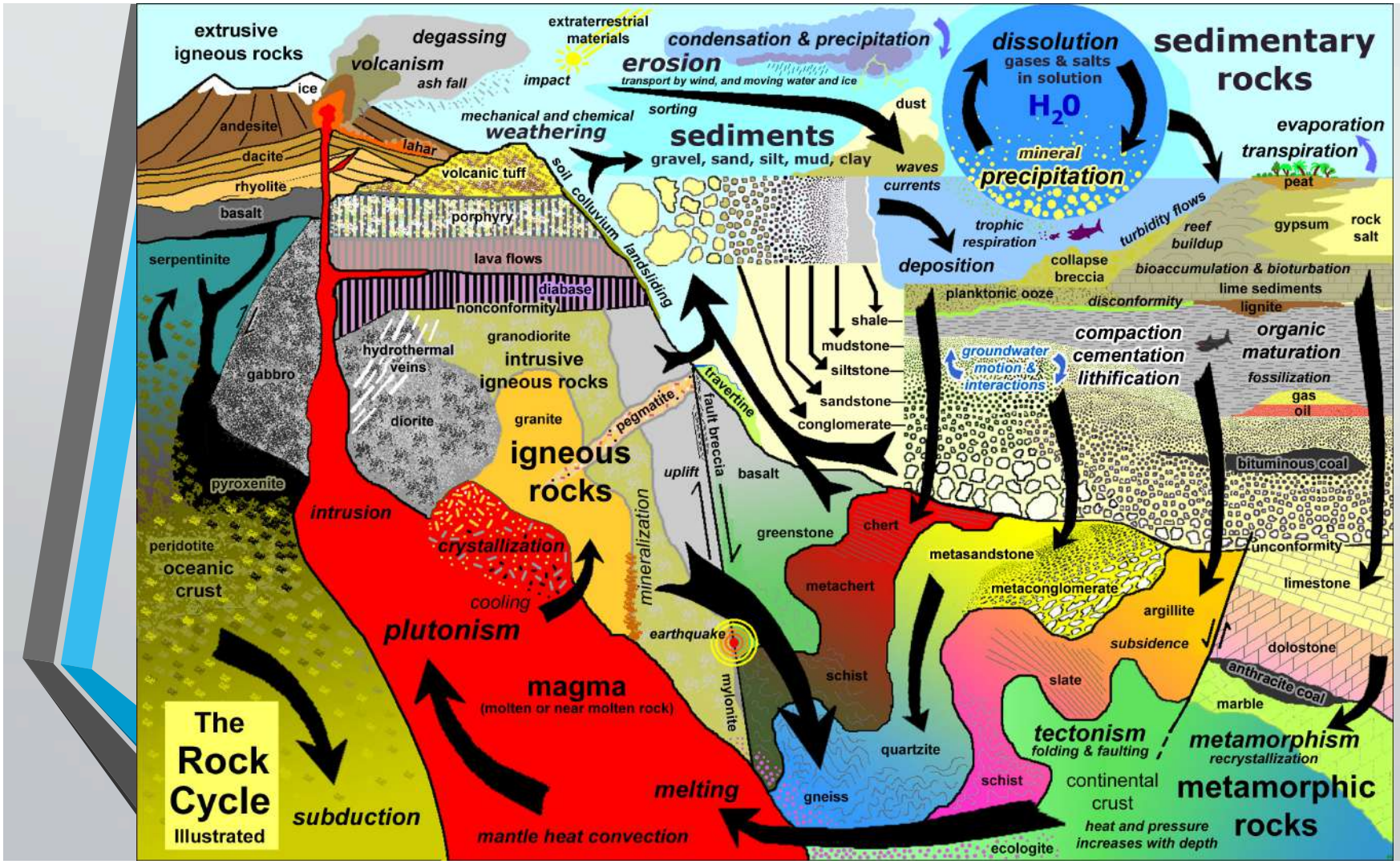
Rocks are classified into three main groups, according to how they were formed: (1) igneous rocks,
(2) sedimentary rocks and (3) metamorphic rocks. Rocks are never actually destroyed; they are broken down and "recycled" in the rock cycle.

Rock Cycle

Several rock cycle diagrams follow this slide. Participants should become familiar with different-appearing charts displaying similar information.


Weathering, erosion, and deposition
Lithification (sediments are compacted and cemented)
Uplift
Igneous rocks
Heat and pressure
Uplift
Uplift
Sedimentary rocks
Melting
Metamorphic rocks
Heat and pressure
Crystallization
Heat and pressure
Melting
Magma
Melting


The Rock Cycle
gravel, sand, silt, mud, clay, soil
mineral dissolution
mineral precipitation
vein quartz
vein calcite
chert
travertine
SEDIMENTS
transport and deposition
weathering and erosion
compaction and cementation
conglomerate
sandstone
siltstone
mudstone
graywacke
marl
shale
chert
coal
salt
gypsum
limestone
dolostone
rhyolite
dacite
andesite
basalt
IGNEOUS ROCKS
(crystallization)
(volcanism)
SEDIMENTARY ROCKS
extrusive igneous rocks
MAGMA
(melting)
heat and pressure
(metamorphism)
METAMORPHIC ROCKS
intrusive igneous rocks
(plutonism)
granite, granodiorite, diorite, gabbro, pyroxenite, peridotite
slate, argillite, gneiss, marble, metasandstone, quartzite, greenstone, greenschist, blueschist, serpentinite, metachert

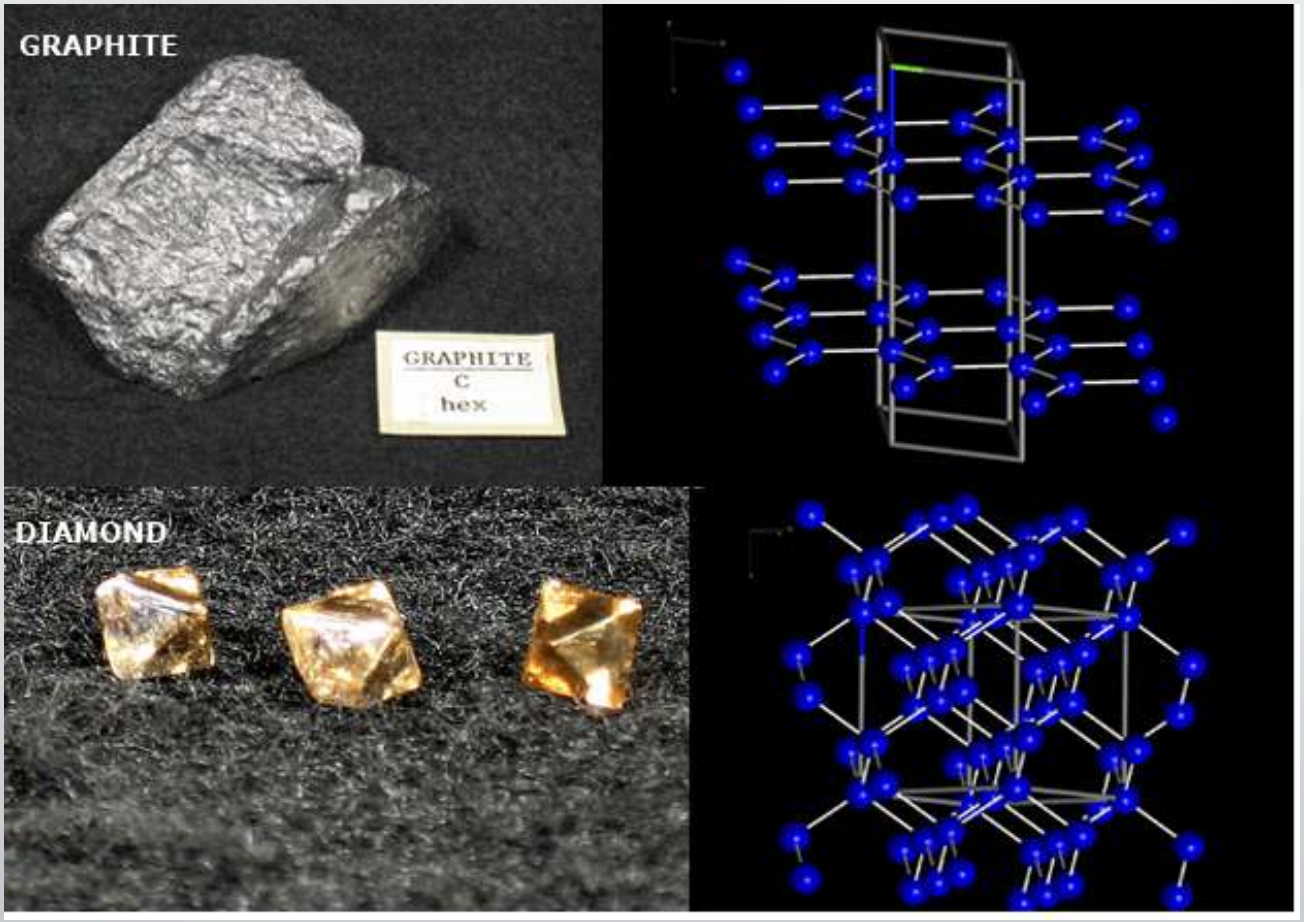

The Rock Cycle Illustrated
extrusive igneous rocks
degassing
volcanism
ash fall
extraterrestrial materials
impact
condensation & precipitation
erosion
transport by wind, and moving water and ice
dissolution
gases & salts in solution
H_2O
sedimentary rocks
evaporation
transpiration
ice
andesite
dacite
rhyolite
basalt
lahar
volcanic tuff
porphyry
mechanical and chemical weathering
sorting
sediments
gravel, sand, silt, mud, clay
dust
waves
currents
mineral precipitation
peat
soil
colluvium
landsliding
trophic respiration
turbidity flows
reef buildup
gypsum
rock salt
serpentinite
lava flows
diabase
nonconformity
deposition
collapse breccia
bioaccumulation & bioturbation
planktonic ooze
disconformity
lime sediments
lignite
shale
mudstone
siltstone
sandstone
conglomerate
compaction
cementation
lithification
groundwater motion & interactions
organic maturation
fossilization
gas
oil
hydrothermal veins
granodiorite
intrusive igneous rocks
gabbro
diorite
granite
pegmatite
travertine
fault breccia
uplift
basalt
igneous rocks
bituminous coal
pyroxenite
intrusion
crystallization
cooling
plutonism
mineralization
greenstone
chert
metasandstone
unconformity
peridotite
oceanic crust
metachert
metaconglomerate
limestone
argillite
subsidence
earthquake
dolostone
anthracite coal
schist
slate
marble
magma
(molten or near molten rock)
mylonite
tectonism
folding & faulting
metamorphism
recrystallization
quartzite
schist
continental crust
metamorphic rocks
gneiss
melting
subduction
mantle heat convection
heat and pressure increases with depth
ecologite

Properties of Minerals: Crystalline Structure

A crystal structure is composed of a unit cell, a set of atoms arranged in a particular way; which is periodically repeated in three dimensions on a lattice.

Properties of Minerals: Crystalline Structure

A excellent example of the importance of crystal structure is the difference between two minerals: graphite and diamond. Both are composed of a single element, carbon. The reason that graphite and diamond are so different from each other is due to the carbon atoms being stacked together into totally different crystal structures (see next slide).


GRAPHITE
GRAPHITE
C
hex
DIAMOND

Properties of Minerals: Crystal Habit

- In nature perfect crystals are rare. The faces that develop on a crystal depend on the space available for the crystals to grow. If crystals grow into one another or in a restricted environment, it is possible that no well-formed crystal faces will be developed.

Properties of Minerals: Crystal Habit

- Crystals sometimes develop certain forms more commonly than others, although the symmetry may not be readily apparent from these common forms. The term used to describe general shape of a crystal is ***habit.***

Properties of Minerals: Crystal Habit

- *Individual Crystals*
- *Cubic - cube shapes*
- *Octahedral - shaped like octahedrons*
- *Tabular - rectangular shape*
- *Equant - minerals that have all of their boundaries of ~ equal length*
- *Acicular - long, slender crystals*
- *Prismatic - abundance of prism faces*
- *Bladed - like a wedge or knife blade*

Properties of Minerals: Luster

- Luster refers to how light is reflected from the surface of a mineral. The two main types of luster are metallic and nonmetallic.
- Minerals exhibiting metallic luster look like metal, such as a silvery appearance or that of a flat piece of steel.

Properties of Minerals: Non-Metallic Luster

- ***vitreous*** - looks glassy - examples: clear quartz, tourmaline
- ***resinous*** - looks resinous - examples: sphalerite, sulfur
- **pearly** - iridescent pearl-like - example:
- ***greasy*** - appears to be covered with a thin layer of oil - example:
- ***silky*** - looks fibrous. - examples - some gypsum, malachite
- **a*damantine*** - brilliant luster like diamond

Properties of Minerals: Color

For some minerals, color is directly related to one of the major elements and can be characteristic, thus serving as a means of identification. Malachite is always green; azurite is always blue; and rhodonite is always red or pink.

Properties of Minerals: Color

The color of a mineral is the first thing most people notice, but it can also be the least useful in identifying a mineral. Most minerals occur in more than one color. Fluorite can be clear, white, yellow, blue, purple, or green. The other properties, such as hardness, cleavage, and luster, must be used instead.

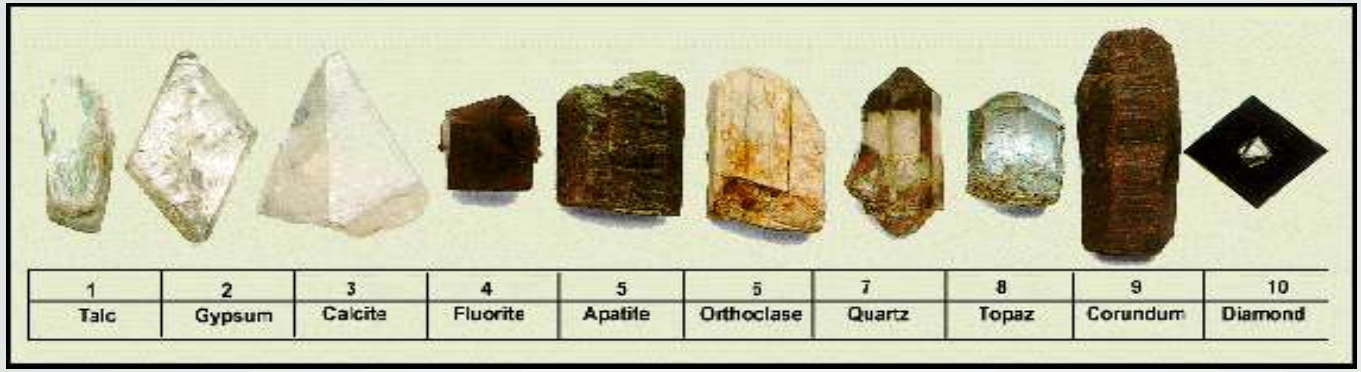
Does anyone know which mineral has the most colors?

Properties of Minerals: Streak

The streak of a mineral is the color of the powder left on a piece of unglazed porcelain (streak plate) when the mineral is scraped across it. The streak plate has a hardness of glass, so minerals with a Mohs Hardness >7 will scratch the streak plate and won't powder the mineral.

Properties of Minerals: Streak

Streak can be useful for identifying metallic and earthy minerals. Nonmetallic minerals usually give a white streak because they are very light-colored. Other minerals may have very distinctive streaks. Hematite, for example, always gives a reddish-brown streak no matter what type of luster it displays.



The hardness of a mineral is its ability to resist scratching. The Mohs Hardness Scale ranks the order of hardness of minerals and some common objects. The hardness of a mineral is very diagnostic.

*FYI: Although copper pennies are no longer composed of pure copper and glass now comes in a wider range of hardness, they have not been replaced on tools recommended for use in tests of hardness.

Properties of Minerals: FYI

Because frequent testing of a specimen's hardness and streak will damage the specimen, many event supervisors will not permit participants to test their personal specimens for hardness.

Properties of Minerals: Cleavage

Crystals often contain planes of atoms along which the bonding between the atoms is weaker than along other planes. In such a case, if the mineral is struck with a hard object, it will tend to break along these planes. This property of breaking along specific planes is termed cleavage.

Properties of Minerals: Fracture

- If the mineral contains no planes of weakness, it will break along random directions called fracture. Several different kinds of fracture patterns are observed.
- Conchoidal fracture - breaks along smooth curved surfaces.
- Fibrous and splintery - similar to the way wood breaks.
- Hackly - jagged fractures with sharp edges.
- Uneven or Irregular - rough irregular surfaces.

Properties of Minerals: Specific Gravity

Specific gravity is a unitless measure, and it is the ratio of the mass of a substance to the mass of an equal volume of water. Most rock-forming minerals have a specific gravity between two and three; for example, quartz has a specific gravity of 2.65. Metallic minerals are far more dense; for example, galena has a specific gravity of 7.5, and platinum has a specific gravity around 22.

Properties of Minerals: Specific Gravity

Specific gravity can usually be qualitatively measured by the heft of a mineral, in other words those with high specific gravities usually feel heavier. Most common silicate minerals have a specific gravity between about 2.5 and 3.0. These would feel light compared to minerals with high specific gravities.

Properties of Minerals: Striations

Plagioclase feldspar commonly shows very small, parallel lines on some of the cleavage planes. These lines are called striations. In some cases, these striations are the only way to distinguish plagioclase feldspar from orthoclase feldspar. A quartz crystal has very fine striations on one of its six sides. These striations are perpendicular to its sides.

Properties of Minerals: Feel

Graphite has a greasy feel. After touching it, your fingers may feel gritty since graphite has a hardness of "1." Because it is so very soft, it will leave a mark on paper when rubbed across it.

Properties of Minerals: Smell

Sulfur is a native mineral with a chemical formula of "S." It smells like rotten eggs when rubbed against a streak plate. Although sulfur specimens are generally yellow in color, its more common color is gray.

A mineral, by definition, must satisfy five criteria: (1 of 5)

It must be naturally occurring. This means that the mineral may not be manufactured. There are some minerals that occur naturally but may now be manufactured artificially, like diamonds.

A mineral, by definition, must satisfy five criteria: (2 of 5)

It must be composed of inorganic compounds. Anything made of plant material does not qualify as a mineral. Coal, which is made from dead plants, is not classified as a mineral.

A mineral, by definition, must satisfy five criteria: (3 of 5)

It must be a solid element or compound. All minerals are solids at normal temperatures and pressures that exist on the surface of the Earth. Mercury, which is a liquid at room temperature, is not classified as a mineral. Liquid water is not a mineral. Its solid form, ice, is a mineral.

A mineral, by definition, must satisfy five criteria: (4 of 5)

It must possess a regular internal crystalline structure. The atoms that make up a mineral are arranged in a regular, repeating, orderly pattern. Solids that lack a regular internal structure, such as glass, are not classified as minerals because their atoms are not arranged in a regular pattern.

A mineral, by definition, must satisfy five criteria: (5 of 5)

It must have a definite chemical composition. Sometimes the composition of a mineral is composed of a single element such as gold. More minerals, however, are made of many elements called compounds.

Economic Importance

In economic terms a mineral is any substance obtained by mining, including but not limited to:

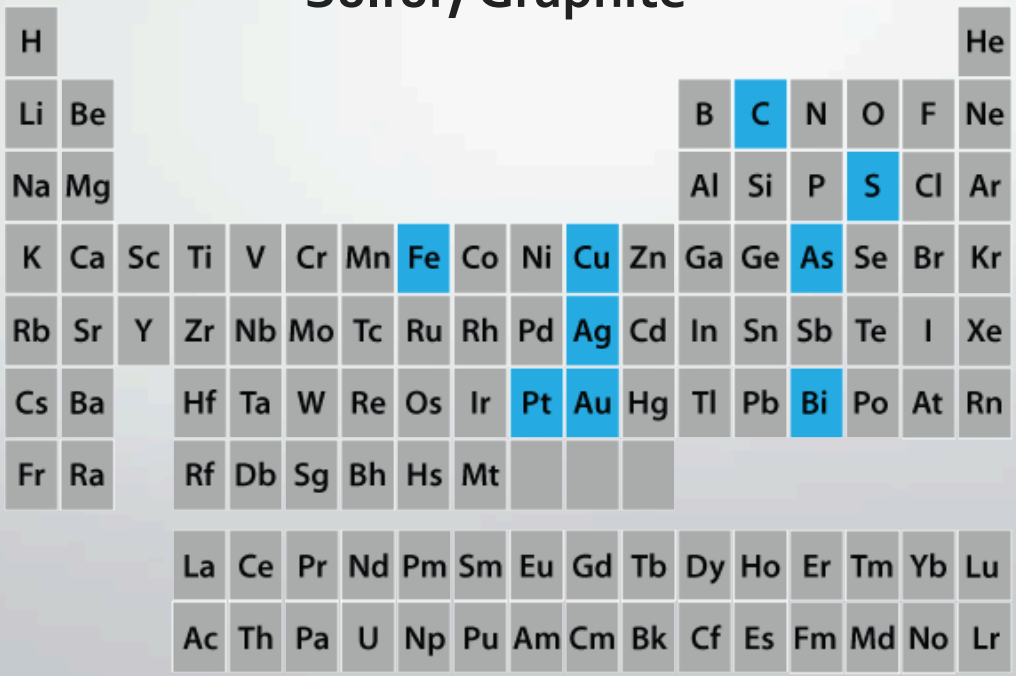
- Precious metals, other metals, and gemstones
- Industrial minerals: non-metallic minerals
- Construction minerals: for aggregates and building stone

Mineral Groups

- Minerals are classified according to chemical composition. There are seven major chemical groups. There are also several minor groups.
- Several representatives of mineral specimens included on the NSO list have been included in each slide.

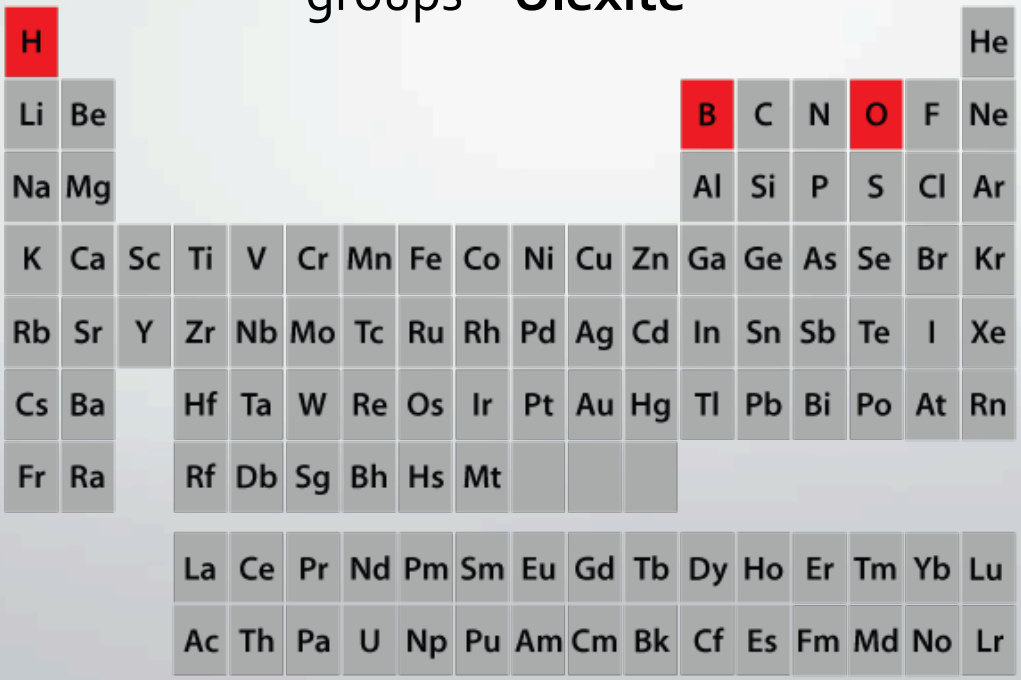
Mineral Groups: Native Elements

Minerals that are composed of atoms from a single element are referred to as **native elements – Copper, Gold, Silver, Diamond, Sulfur, Graphite**



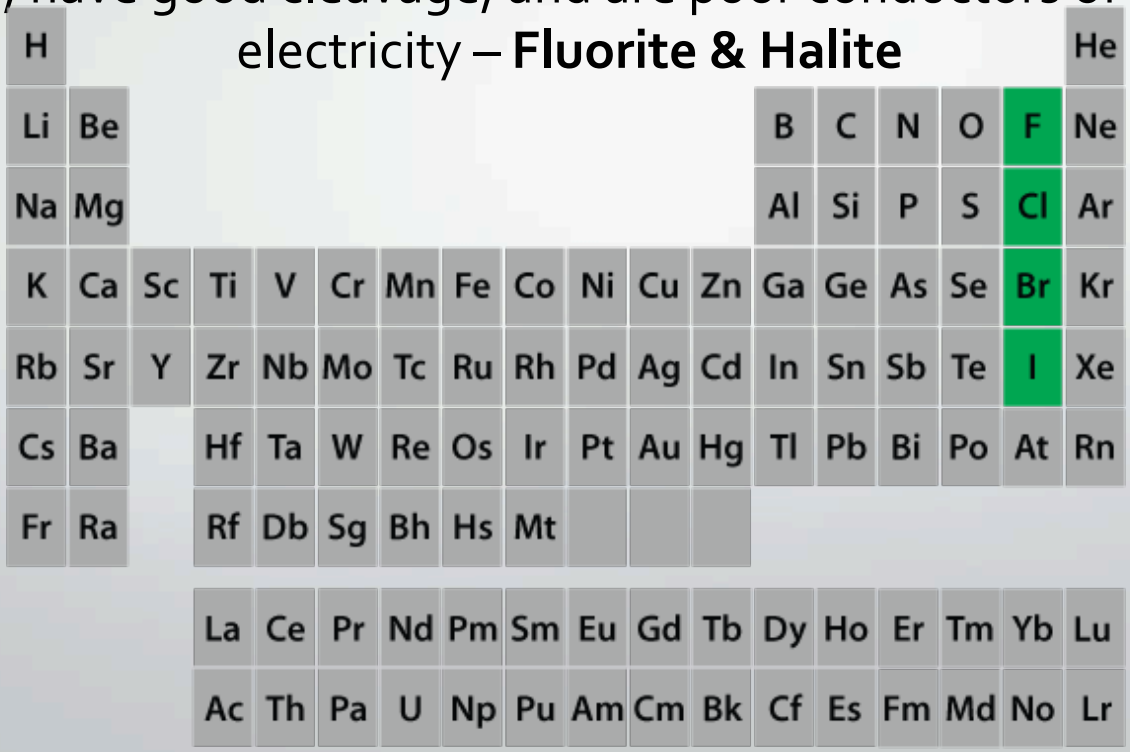
Mineral Groups: Borates

These minerals have a structure to the silicon-oxygen tetrahedron (BO_3). They are capable of forming chains, sheets, or isolated groups – **Ulexite**



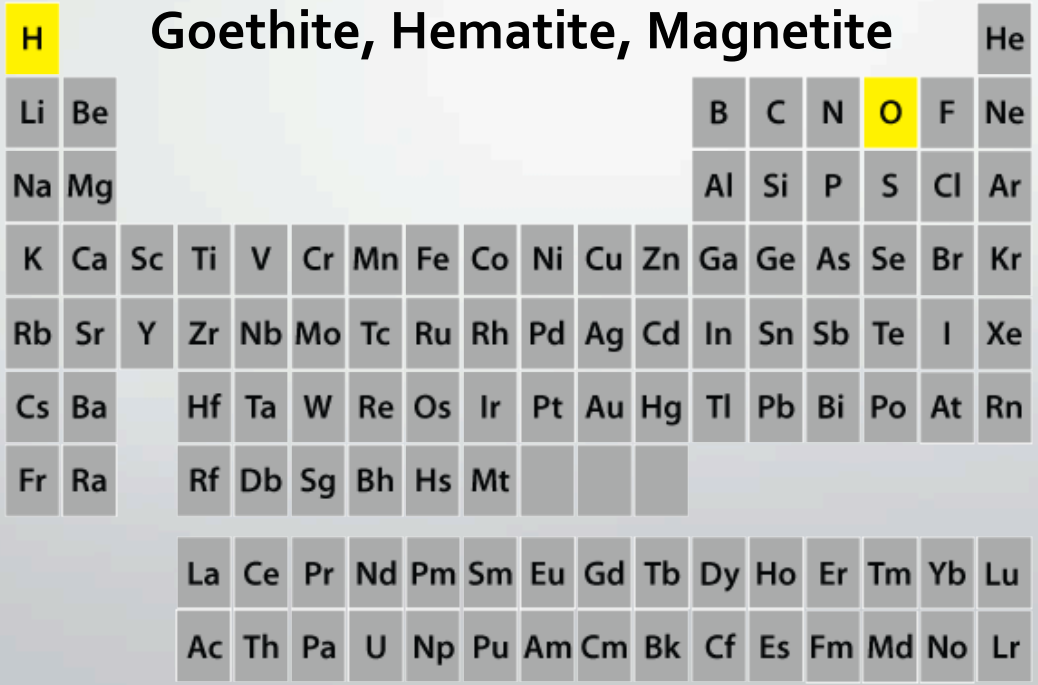
Mineral Groups: Halites

Have relatively low hardness, can be transparent, have low specific gravities, have good cleavage, and are poor conductors of heat and electricity – **Fluorite & Halite**



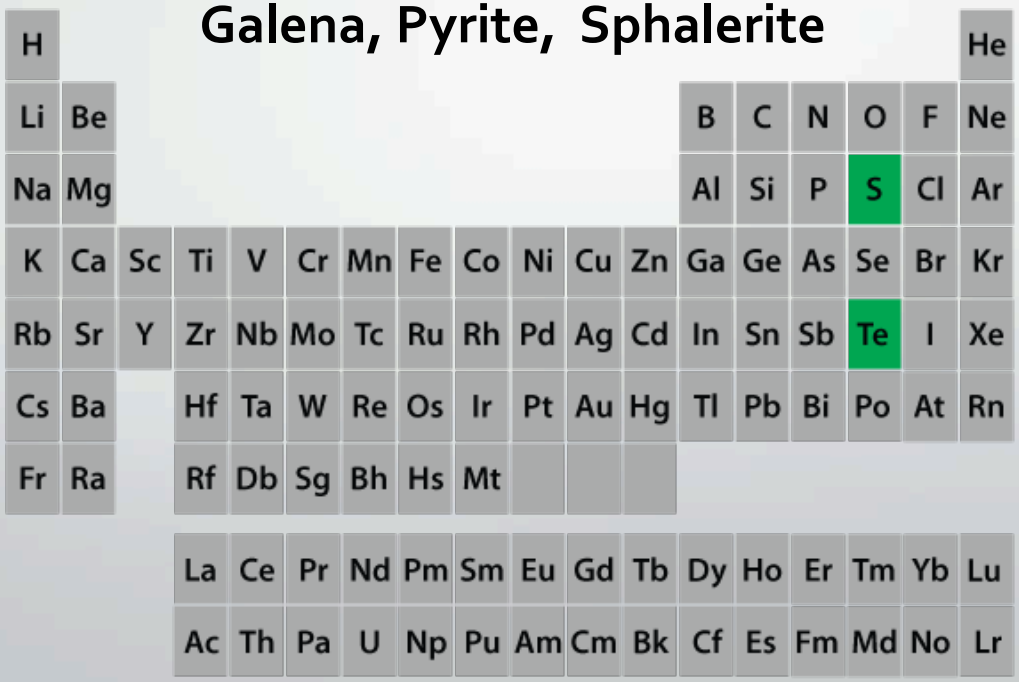
Mineral Groups: Oxides

The minerals that make up the oxide class include those in which oxygen is combined with one or more metals – **Corundum, Goethite, Hematite, Magnetite**



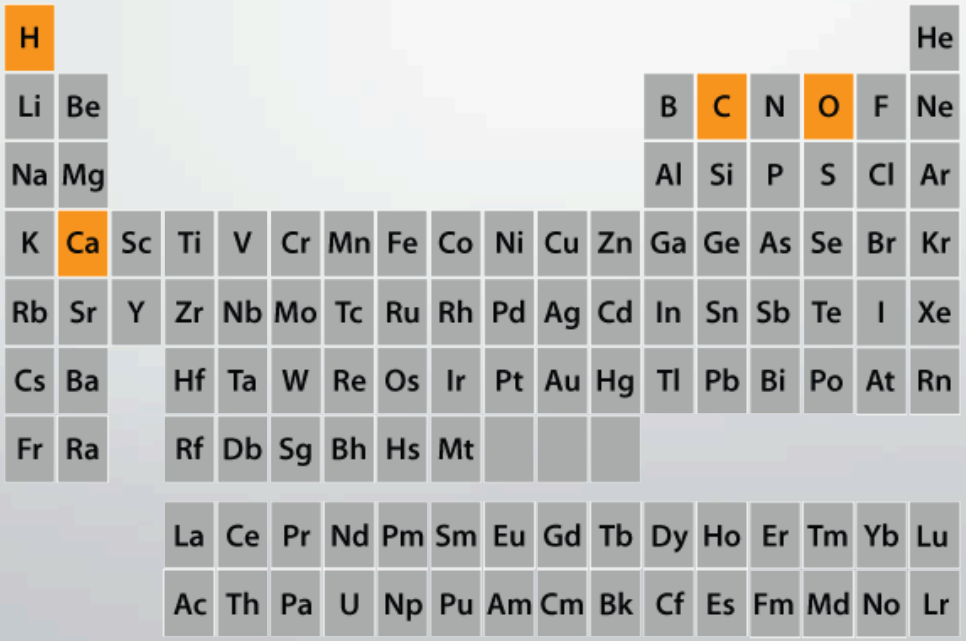
Mineral Groups: Sulfides

The minerals that make up the sulfide class are composed of metal cations (+2 charge) combined with sulfur – **Bornite, Chalcopyrite, Galena, Pyrite, Sphalerite**



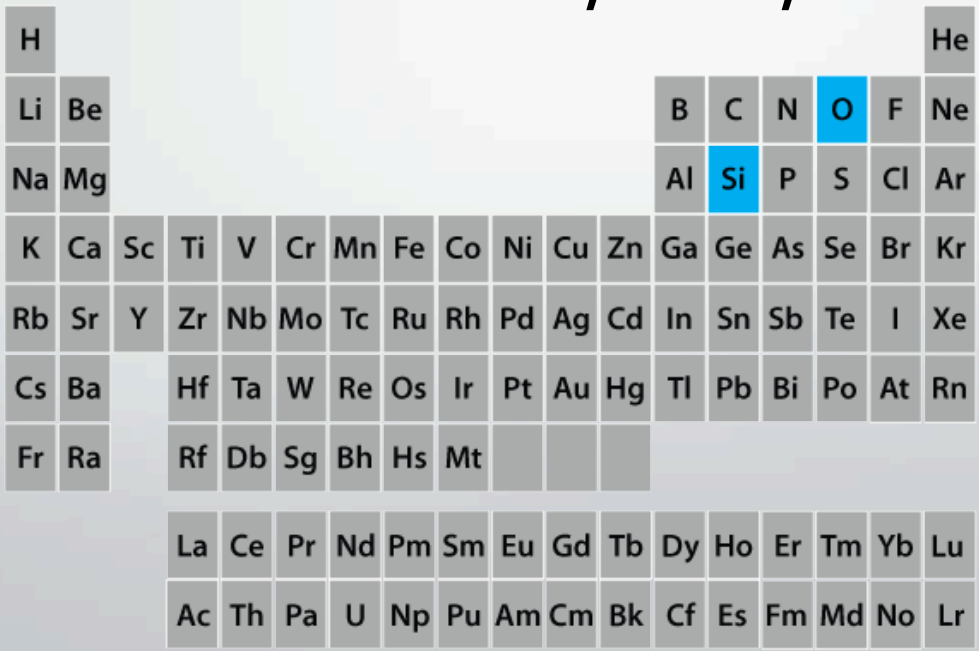
Mineral Groups: Carbonates

In nature, carbon atoms join with oxygen to form the carbonate ion, CO_3. These ions combine with metal cations to form carbonate minerals – **Azurite, Calcite, Dolomite, Malachite**



Mineral Groups: Silicates

The class is considered to be the most important of all the mineral classes. About 25% of the known minerals and nearly 40% of the common ones are silicates – **Garnet, Olivine, Staurolite, Topaz**



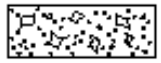
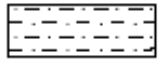
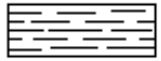
Formation and properties of igneous, sedimentary and metamorphic rocks

Minerals combine with each other to form rocks. For example, granite consists of the minerals feldspar, quartz, mica, and amphibole in varying ratios. Rocks are thus distinguished from minerals by their heterogeneous composition.

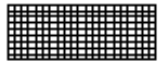
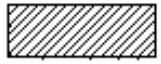
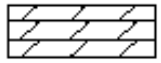
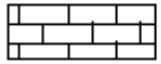
Formation and properties of igneous, sedimentary and metamorphic rocks

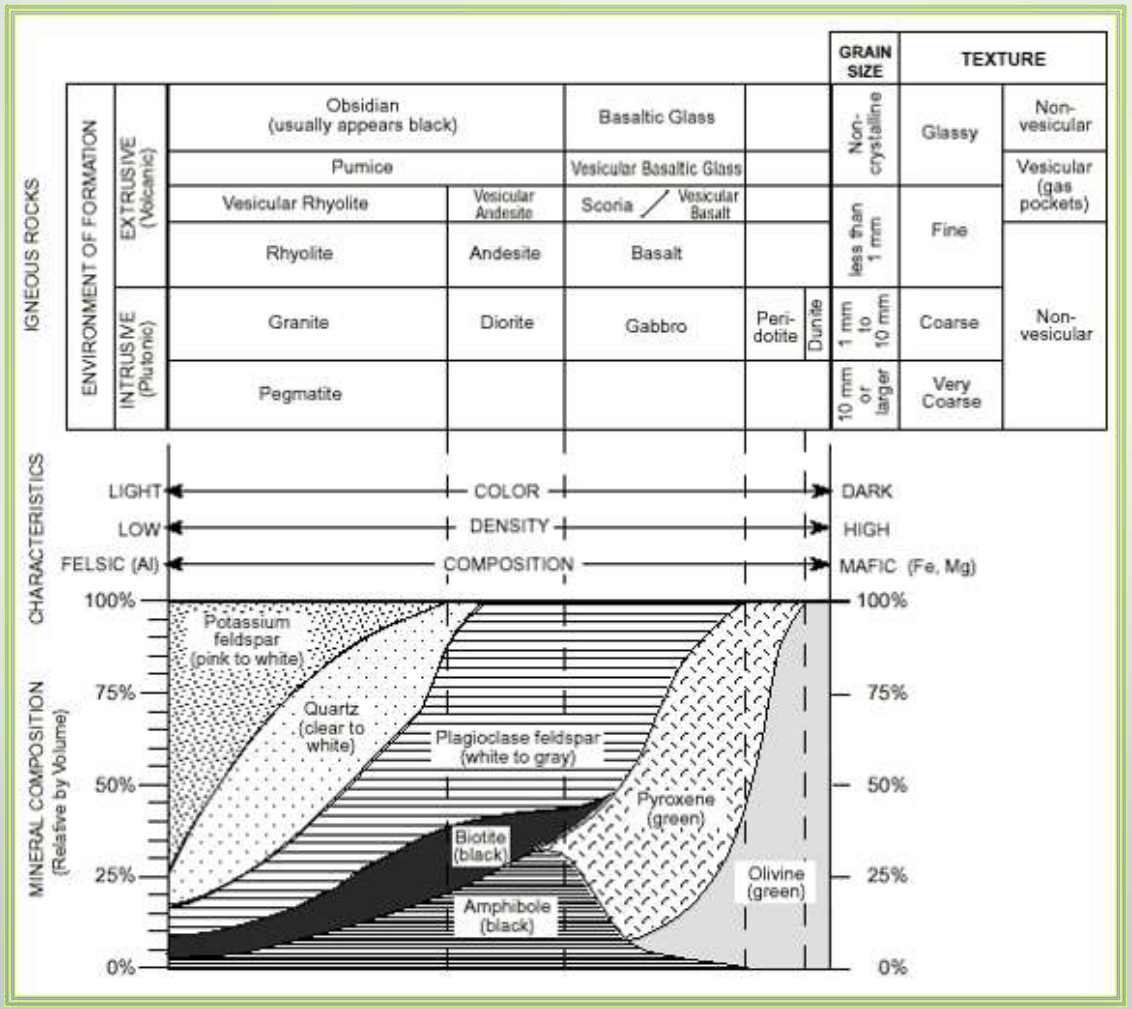
Copies of the following charts should be included in the appendix of Participant Resource Notebooks. It's crucial that participants be totally familiar and knowledgeable with the contents of each of these three charts. Several instructional PowerPoints are referenced at the end of this presentation.

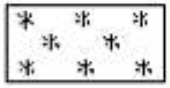
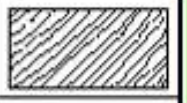
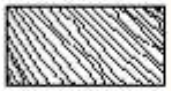
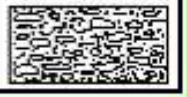
INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

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	


IGNEOUS ROCKS
ENVIRONMENT OF FORMATION
EXTRUSIVE (Volcanic)
INTRUSIVE (Plutonic)
Obsidian (usually appears black)
Basaltic Glass
Pumice
Vesicular Basaltic Glass
Vesicular Rhyolite
Vesicular Andesite
Scoria
Vesicular Basalt
Rhyolite
Andesite
Basalt
Granite
Diorite
Gabbro
Peri-dotite
Dunite
Pegmatite
GRAIN SIZE
TEXTURE
Non-crystalline
Glassy
Non-vesicular
Vesicular (gas pockets)
less than 1 mm
Fine
1 mm to 10 mm
Coarse
Non-vesicular
10 mm or larger
Very Coarse
CHARACTERISTICS
LIGHT
COLOR
DARK
LOW
DENSITY
HIGH
FELSIC (Al)
COMPOSITION
MAFIC (Fe, Mg)
MINERAL COMPOSITION (Relative by Volume)
100%
75%
50%
25%
0%
Potassium feldspar (pink to white)
Quartz (clear to white)
Plagioclase feldspar (white to gray)
Pyroxene (green)
Biotite (black)
Olivine (green)
Amphibole (black)

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	

Clues to Past Environments

Igneous rocks contain mineral crystals formed due to the cooling of molten rock from Earth's interior. They provide information about the chemical composition of Earth and temperatures beneath Earth’s surface.

Igneous Rock Environment

Coarse particle size indicates slow cooling at depth in the Earth's crust (say, a few miles deep). It is not volcanic. Granite is shown.

Igneous Rock Environment

The size of its crystals tell us how quickly it cooled. Fast cooling corresponds to cooling at or near the Earth's surface. Rhyolite is shown.

Clues to Past Environments

Metamorphic rocks are composed of a variety of minerals formed or introduced by processes occurring within Earth, so they tell us about physical and chemical conditions within Earth.

Metamorphic Environment

In general, high temperature and pressure reflect deep burial, such as in the roots of a growing mountain range, or exposure to an extra-hot place such as near a magma intrusion. Quartzite is shown.

Clues to Past Environments

Sedimentary rocks tend to form at or near Earth's surface, so they often contain information about natural environments that existed on Earth over the past several billion years.

Sedimentary Environment

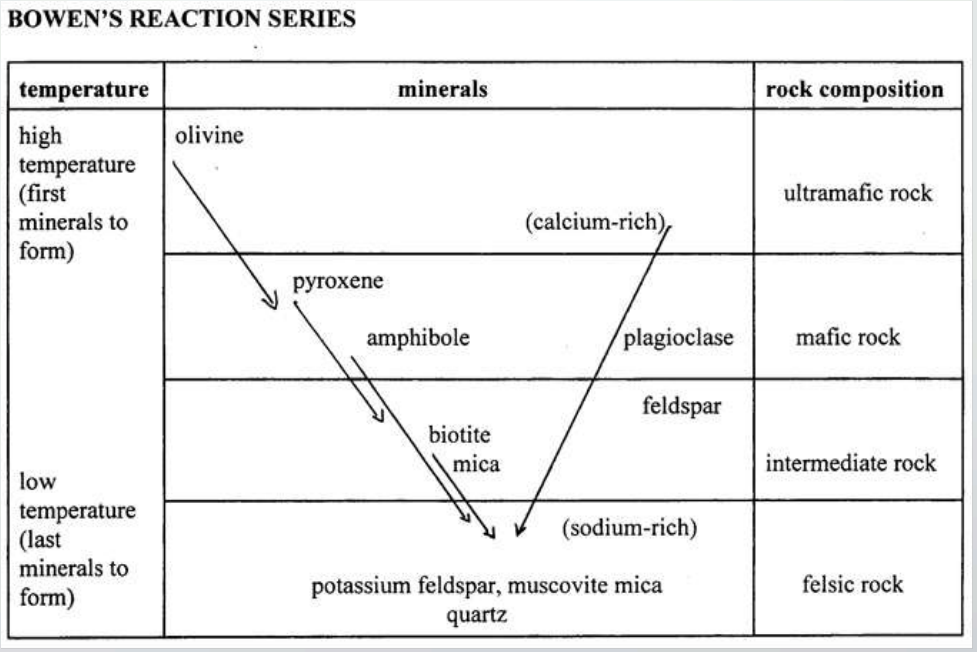
This image shows a fossiliferous limestone rich in recrystallized gastropod fossils.

Sedimentary Environment

The specimen is a fossiliferous limestone. Its dominant fossils are brachiopod valves that have been recrystallized.

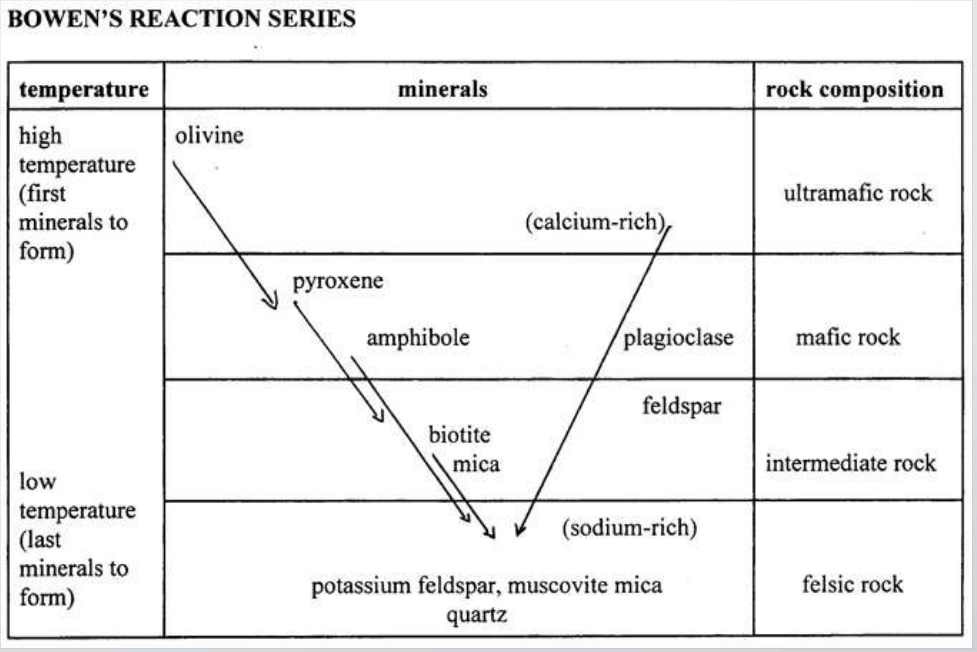
Bowen's Reaction Series

Bowen determined that specific minerals as magma cools form at specific temperatures.



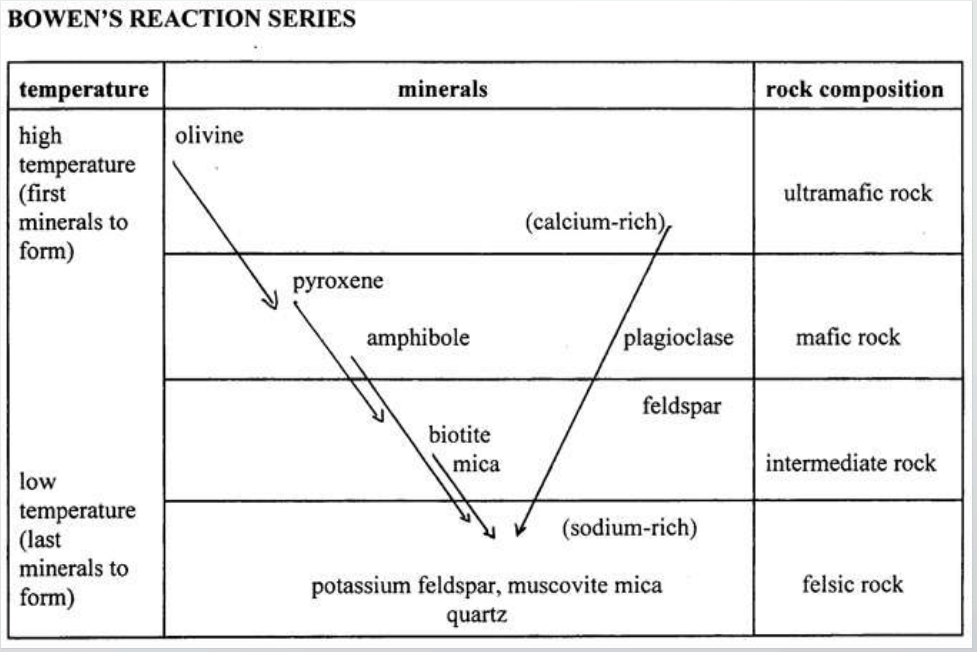
Bowen's Reaction Series

At the higher temperatures associated with mafic and intermediate magmas, the general progression may be separated into two branches.



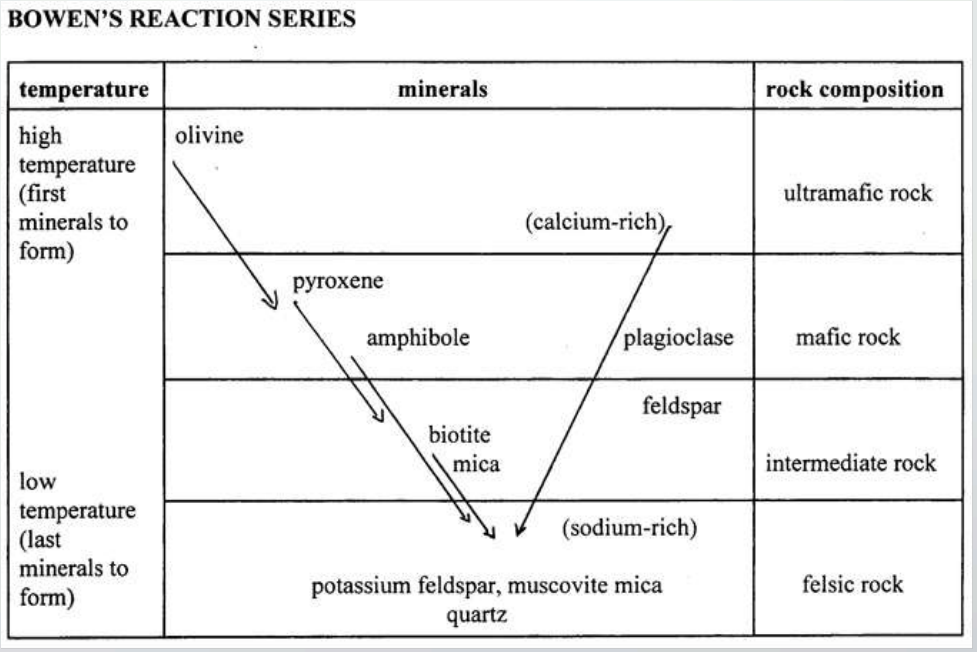
Bowen's Reaction Series

The <u>continuous branch</u> describes the evolution of the plagioclase feldspars as they evolve from being calcium-rich to more sodium rich.



Bowen's Reaction Series

The discontinuous branch describes the formation of the mafic minerals olivine, pyroxene, amphibole, and biotite mica.



Rocks and Minerals Event Coaching Strategies

- Selecting participants
- Seek out coaching assistants
- Resource Notebooks
- References
- Specimens
  - Labeling
  - Acquisition

Introductory Meeting

- Schedule and invite interested students
  - Ask teaching colleagues to help in identifying and encouraging students who have shown interest in rocks and minerals to attend the meeting
  - Prepare a basic informational questionnaire for students in attendance to complete while at the meeting. Include questions regarding their past and present interest in rocks and minerals, any experiences they have had with rocks and minerals, etc.
  - In addition to basic information about the Science Olympiad in general and the Rocks and Minerals Event it particular, provide an activity that will capture their interest.

Participant Selection

- Encourage as many students to sign-up and participate as possible
  - Anticipate a high drop-out rate
  - Be patient in making the final decision as to which candidates will make the team
  - Do not base your choice on which candidates appear the most knowledgeable as some students may have had prior instruction and experiences and may thus "outshine" others
  - Continued interest and enthusiasm are indicative of a willingness to work hard to succeed
  - Continue to encourage those students who work hard, display interest, attend meetings, etc. Tournament schedules are unpredictable, illness can present a problem, conflict with other events, both within the Science Olympiad and other school and outside activities, must be taken into consideration.

Participant Roles

- It's best to discuss and assign specific roles for the final two participants chosen for this event. It's also wise to have a second person to assist should one of the original members not be available.
- Determine the exact roles of each individual, i.e. which should be the recorder, which should be the "researcher," i.e. the person who searches the Resource Notebook for required information.
- It is highly recommended that you do not have a second person if that person's sole role is to fill a vacancy. In the long ago past, a second individual was added to broaden the knowledge and skills for the benefit of the team. Simply to have a second individual present to collect a possible medal is not in line with the spirit of the competition.

Assistant Coaches

- Although there may be few members within your community who possess a knowledge or interest in rocks and minerals along with a desire to work with students, attempt to seek them out. You may just luck out!
- There are at least two scientific fields in which "old timers" are thrilled to share their professional skills and knowledge with children – Astronomy and Mineralogy!

Assistant Coaches

- There are also parents who are willing to work with children and are willing to do whatever it takes to acquire knowledge of a subject such as rocks and minerals so they can effectively work with students. Many of these parents are even more willing to assist if their own children are directly involved. Should you identify such a parent, you must address the possibility that other children with whom they will be working might end up more qualified to represent the team than their own. Should you have such an individual, you must discuss this possibility prior to accepting him/her as a volunteer coach, and he/she must agree that they understand and are willing to accept this possibility.

Assistant Coaches

- And, finally, you may have a former Science Olympiad participant who would be thrilled to work with your team. They've gone through this experience and are often highly qualified and motivated to do so.

A Participant Resource Notebook: A Highly Recommended Design and Strategy

Obtain a three-ringed binder with transparent, plastic sleeves on both front and back covers.

The binder may be of any thickness, but a two-inch binder is quite likely the ideal.

Obtain tabbed dividers for separating major sections within the binder.

The following slide illustrates the upper two rows of mineral images as they should appear on the front cover.

Participant Resource Notebook
Front Cover Design – 48 Minerals

Albite 1	Almandine 2	Amazonite 3	Apatite 4	Aragonite 5	Augite 6
Azurite 7	Bauxite 8	Barite 9	Beryl 10	Biotite 11	Bornite 12

Participant Resource Notebook: Outside Covers

- Step 1: Templates for both the front and back covers of your resource notebook are available as separate documents on the disk or thumb drive you have been given. The mineral *bornite* serves as a place holder in all squares on those templates. The squares have already been labeled with the names of the rocks and minerals specimens appearing on the Official NSO Rocks and Minerals List. Page numbers will be added as the binder is assembled and grow.
- Step 2: Use the search phrase "*specimen name* mineral image" to seek out images on the world wide web. Generally a wide range of image appears almost immediately.
- Step 3: Select an image that you believe best represents that mineral. It may be difficult to make this determination, but the images may be changed in the future. It's best to select images that appear within squares rather than rectangles since these are much easier to insert into the small squares on the front and back covers of your Resource Notebook
- As you develop your Resource Notebook, page numbers may be added to the subtitle following the name of each specimen.

Participant Resource Notebook: Specimen Pages

- 1. Create one page for each rock and mineral specimen included on the *Official NSO Rocks and Minerals List*.
- 2. Develop a similar format for the mineral specimens and a somewhat different format for the rock specimens. Templates for one mineral and one rock are provided as separate documents on the disk, thumb drive, or other source you have been given. The rocks and minerals pages your participants develop may be differ from the sample pages provided.

Why such a format for the Resource Notebook?

- The answer is simple. The more quickly a participant seeks out the required information, the more time is available to perform the task at hand. Efficiency in locating information is a definite advantage for those teams that achieve it!

Appendix: Suggested materials to include in the Resource Notebook

- Glossary of frequently used terms
- Rocks and Minerals Charts
- Sedimentary, igneous and metamorphic rock diagrams
- Bowen's Reaction Series
- Sketches and identification of general crystal types
- Rock Cycle Diagrams

… in addition to numerous others

Labeling Rocks and Minerals Specimens

- Step 1: In Microsoft Word, create a column of numbers on the left hand side of the screen, hitting the space key after each completed number. Choose a font size that will fit comfortably within a ¼ inch circle. Print this document onto white copy paper.
- Step 2: Using a ¼ inch handheld paper punch, center and punch out the first number.
- Step 3: Select a flat spot on the specimen large enough for the punched-out number to fit comfortably.
- Step 4: Place a drop of Elmer's clear glue on the flat spot selected.
- Step 5: Using a pair of tweezers, grasp and place the numbered dot directly onto the drop of glue.
- Step 6: Permit the glue to dry overnight.
- Step 7: Using the small brush provided in the bottle, coat the numbered dot with a layer of clear fingernail polish. Permit the glue to thoroughly dry.

Science Olympiad Coaching Aids available from Other Worlds Educational Enterprises, LLC

Please visit our website: http://www.otherworlds-edu.net

- Instructional Rock Kit with specimens, instructional lessons, practice labs
- High quality mineral specimen kits and individual specimens
- Rocks and Minerals Exam Packet with two complete exams on CD with lab stations, photos, student response sheets, and answer keys
- CDs from TASA Graphics – Wonders of Rocks and Minerals, Earth's Atmosphere and Its Seasons, The Wonders of Rocks and Minerals, Introduction to Topographic Maps, The Theory of Plate Tectonics
- Road Scholar units complete with scenarios, USGS Quads, US Highway maps, student response sheets and answer keys
- Earth, Ocean and Space Games

Recommended Websites

- The final section of this PowerPoint presentation lists many valuable and quality websites useful to both supervisors and participants. Participants should be encouraged to seek out others as well. As the internet goes, some of these sites may have been taken down.
- An attempt has been made to classify each website by topic.

Recommended Websites

- **Delaware Science Olympiad * R & M PowerPoint * Different approach from the PowerPoint you are presently studying but full of helpful information**

http://search.aol.com/aol/search?s_it=webmail-searchbox&q=rocks%20and%20minerals%20clues%20to%20past%20environments

- **Composition and Structure of Minerals**
  http://geology.csupomona.edu/mineral/minerals.htm

Recommended Websites

- **Economic Importance of Minerals**:
  http://quizlet.com/7104446/minerals-economic-importance-flash-cards /
- **Mineral Physical Properties and Identification**:
  http://facweb.bhc.edu/academics/science/harwoodr/geol101/labs/minerals/
  http://www.windows2universe.org/earth/geology/mineral_id1.html
  http://www.mineralogy4kids.org/mineral-properties
- **Introduction to Mineral Identification (lecture on mineral properties)**
  http://www.usouthal.edu/geology/haywick/GY111/111lab-1.pdf
- **Minerals A-Z – Filtered by Alphabet**:
  http://www.minerals.net/mineralmain.aspx

Recommended Websites

- **Economic Uses of Minerals**

  http://www.scienceviews.com/geology/minerals.html

- **Clues to Past Environments**

  http://suite101.com/a/rocks-and-minerals-hold-clues-to-the-past-a284426

- **Sedimentary Rocks Contain Clues to Ancient Environments**

  http://geology.campus.ad.csulb.edu/people/bperry/Sedimentary%20Rocks%20Tour/environmental_clues.htm

- **Environmental clues to past environments (igneous, metamorphic, sedimentary)**

  http://web.mnstate.edu/colson/est/est2a.html

  http://www.calstatela.edu/faculty/ahamane2/psci183/psci183.activities/psci183.act2.rocks.hand.htm

Recommended Websites

- **Introduction to sedimentary rocks**

  http://geology.campus.ad.csulb.edu/people/bperry/Sedimentary%20Rock s%20Tour/introduction_to_sedimentary_rocks.htm

- **Clues to ancient environments**

http://geology.campus.ad.csulb.edu/people/bperry/Sedimentary%20Rocks%20Tour/environmental_clues.htm

- **Mineral Clues to Past Climates**

  http://www.giss.nasa.gov/research/briefs/gornitz_08/

Recommended Websites

- **40 Common Minerals and Their Uses**

http://www.nma.org/index.php/minerals-publications/40-common- minerals-and-their-uses

- **Online Economic Mineral Databases**

  http://www.geologynet.com/dbasesecon.php3 **(enter the name of a mineral to acquire its basic uses and properties)**

- **40 Common Minerals and Their Uses (some give info directly, others provide links)**

  http://www.gold-traders.co.uk/gold-information/40-common-minerals.html

Recommended Websites

- **Uses of Rocks and Minerals (short, but helpful list that includes rocks)**

  http://library.thinkquest.org/J002289/uses.html

- **2007 Socially Rocks and Minerals PowerPoint**

  https://thorntonso.wikispaces.com/file/view/Rocks-and-Minerals-07.ppsm

- **Rock cycle – The first of these is an incredible diagram**

  http://www.geologycafe.com/images/rock_cycle_big.jpg

  http://www.geologycafe.com/images/rock_cycle.jpg

Recommended Websites

- **Mineral groups**
  http://www.mineralogy4kids.org/mineral-group
- **Physical properties of minerals**
  http://www.tulane.edu/~sanelson/eens211/physprop.htm
- **The Rock Cycle & Basic Geologic Principles**
  http://geologycafe.com/class/chapter2.html
- **Excellent site for all classes of rocks**
  http://geologycafe.com/index.html

Recommended Websites

- **Rocks**

  http://regentsprep.org/regents/earthsci/units/rocks/rocks.cfm

  http://www.discoverearthscience.com/regentses/regentses.html (PowerPoint)

- **Minerals**

  http://regentsprep.org/regents/earthsci/units/rocks/minerals.cfm

- **Rocks and Minerals Practice Exam**

http://www.regentsprep.org/Regents/core/questions/question.cfm?Course=ESCI&TopicCode=03&QNum=1&Wrong=0

Recommended Websites

- **Rocks Identification Chart (limited, but very informative)**

  http://geoscience.stevekluge.com/regentses/labs/rockcharacteristics.pdf

- **Rocks and Minerals Exam (Several questions refer to non-NSO specimens.)**

http://www.discoverearthscience.com/regentses/units/rocks/assessment/Geology_IgenousRxExamPreTest.pdf

- **Rock Exam**

  http://reviewearthscience.com/subjects/es/review/topic-spec/rocks.pdf

- **Answer Key for Above**

  http://reviewearthscience.com/subjects/es/review/topic-spec/rocksans.pdf

References: PowerPoint Rock Chart Instruction

- **How to Use the Igneous Rock ID Chart … Regents PowerPoint Presentation**
  http://view.officeapps.live.com/op/view.aspx?src=http%3A%2F%2Fregentsearth.com%2FPowerpoints%2FTutorials%2FHow%2520To%2520Use%2520The%2520Igneous%2520Rock%2520ID%2520Chart.ppt
- **Regents Earth Science Sedimentary Rock ID Lab**
  http://newyorkscienceteacher.com/sci/files/user-submitted/sedimentaryid.pdf
- **Regents Earth Science Metamorphic Rock ID Lab**
  http://newyorkscienceteacher.com/sci/files/user-submitted/metamorphicid.pdf
- **Regents Earth Science Igneous Rock ID Lab**
  http://newyorkscienceteacher.com/sci/files/user-submitted/igneousid.pdf