

Rocks and Minerals - Who Cares?

Some Exercises and Discussions using the Boxes of Rocks and Minerals - High School Level

1. Examine the stones in the two boxes (one of minerals^a and one of rocks^b). Using the physical and chemical properties that you can easily determine in your classroom, invent new methods for classifying minerals and rocks. Determine (measure or estimate) these properties on individual samples relative to other samples (15 minutes).
 - What properties allow you to distinguish one mineral from another?
 - What properties allow you to distinguish one rock from another?
 - Why do you even care whether you can tell one rock or mineral from another?
2. Discuss uses of the minerals and rocks in the boxes (15 minutes).
 - What properties make these and other individual minerals useful in society?
 - What properties make rocks (in addition to the individual minerals in the rocks) useful in society?
 - What factors influence the value of a rock or mineral that you might find on land in Nevada?
 - How important is technology (tools, machines, etc.) in determining the value of a rock or mineral?
 - Why might knowing how a rock formed help you determine whether you have a valuable mineral deposit?
3. Slide Show on the Geology, History, and Resources of Nevada (30 to 40 minutes).
4. Examine the "unknown" rocks or minerals given to you. Determine the properties of these "unknowns" and classify them according to the scheme you invented earlier under Part 1 (5 minutes).
 - Are there any likely uses for these rocks?
5. Discuss how to use the mineral and rock boxes to meet the Nevada Science Education Standards^c.
 - Why might classifying rocks with the terms "igneous," "sedimentary," and "metamorphic" not be a good approach for students trying to discover for themselves how rocks form. (10 minutes).
 - How does the science of geology differ from the sciences of physics, chemistry, and biology? (detective work - determining what happened; multiple working hypotheses; deep time)

FOOTNOTES

- ^a The standard definition of a mineral (American Geological Institute's Glossary of Geology, 1987) is "a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties."
- ^b The standard definition of a rock (also from AGI's Glossary of Geology) is "an aggregate of one or more minerals, e.g. granite, shale, marble; or a body of undifferentiated mineral matter, e.g. obsidian, or of solid organic material, e.g. coal."
- ^c Numbers in parentheses are references to the Nevada Science Standards available on line at the Nevada Department of Education's Web site [<http://www.nde.state.nv.us/>]. A few of the standards are copied on the next page.

Examples of Nevada Science Education Standards 2005 that are relevant to these exercises. See also the summary of Nevada Science Education Standards prepared for the NMA teachers conference, and the Nevada Department of Education website:
<http://www.doe.nv.gov/standards/standscience.html>

Physical Science Underlying Concept A: Matter has various states with unique properties that can be used as a basis for organization. The relationship between the properties of matter and its structure is an essential component of study in the physical sciences. The understanding of matter and its properties leads to practical applications, such as the capability to liberate elements from ore, create new drugs, manipulate the structure of genes, and synthesize polymers.

Content Standard P.12.A: Structure and Properties of Matter—*Students know atomic structure explains the properties and behavior of matter.*

By the end of **Grade 12**, students know and are able to do everything required in earlier grades and:

[P.12.A.1] Students know that different molecular arrangements and motions account for the different physical properties of solids, liquids, and gases.

[P.12.A.3] Students know that identifiable properties can be used to separate mixtures.

Types of properties:

Intrinsic Property – A characteristic of a sample of material related only to the quality of the material itself and not on the amount of material present; examples include density, color, odor, and hardness.

Extrinsic Property – A property of material that depends on the amount of material present, for example, mass, length, and volume.

Earth and Space Sciences Unifying Concept C: Earth is composed of materials that move through the biogeochemical cycles. Earth's features are shaped by ongoing and dynamic processes. These processes can be constructive or destructive and occur over geologic time scales.

Content Standard E.12.C: Students understand evidence for processes that take place on a geologic time scale.

By the end of **Grade 12**, students know and are able to do everything required in earlier grades and:

[E.5.C.4] Students know that rock is composed of different combinations of minerals.

[E.8.C.2] Students know that rocks at Earth's surface weather, forming sediments that are buried, then compacted, heated and often recrystallized into new rock.

[E.8.C.5] Students know how geologic processes account for state and regional topography.

[E.8.C.6] Students know that minerals have different abundances and have different properties.

[E.12.C.4] Students know processes of obtaining, using, and recycling of renewable and non-renewable resources.

Science Inquiry Nature of Science Unifying Concept A: Scientific inquiry is the process by which humans systematically examine the natural world. Scientific inquiry is a human endeavor and involves observation, reasoning, insight, energy, skill, and creativity. Scientific inquiry is used to formulate and test explanations of nature through observation, experiments, and theoretical or mathematical models. Scientific explanations and evidence are constantly reviewed and examined by others. Questioning, response to criticism, and open communication are integral to the process of science.

Content Standard N.12.A: Students understand that a variety of communication methods can be used to share scientific information.

By the end of **Grade 12**, students know and are able to do everything required in earlier grades and:

[N.5.A.3] Students know how to draw conclusions from scientific evidence.

[N.8.A.2] Students know how to critically evaluate information to distinguish between fact and opinion.

[N.8.A.3] Students know that different explanations can be given for the same evidence.

Science, Technology, and Society, Nature of Science Unifying Concept B: Technology defines a society or era. It can shape the environment in which people live, and it has increasingly become a larger part of people's lives. While many of technology's effects are regarded as desirable, other effects are seen as less desirable. Instruction in this area should not be solely in science or technology courses but should be shared by science, math, technology, social studies, and language arts. The development and use of technology affects society and the environment in which we live, and at the same time, society influences the development of technology and its impact on culture.

Content Standard N.12.B: Students understand the impacts of science and technology in terms of costs and benefits to society.

By the end of **Grade 12**, students know and are able to do everything required in earlier grades and:

[N.12.B.1] Students know that science, technology, and society influence one another in both positive and negative ways.

[N.12.B.2] Students know that consumption patterns, conservation efforts, and cultural or social practices in countries have varying environmental impacts.

[N.12.B.3] Students know the influence of ethics on scientific enterprise.

*Developed by Jonathan G. Price, Nevada Bureau of Mines and Geology, 1 April 2001, updated 15 March 2006.
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TO KEEP THE STUDENT ENGAGED AND ACTIVE, HAVE THEM

STAND UP IF YOU

1. ARE BREATHING.

KEEP STANDING IF YOU

2. KNOW WHAT THE MAJOR METAL BEING PRODUCED IN NEVADA IS TODAY, IN TERMS OF DOLLAR VALUE. (Au)
3. KNOW THREE COMMODITIES BEING MINED TODAY WITHIN 50 MILES OF FALLON. (diatomite, limestone, salt, sand and gravel, perlite, gypsum, gold, silver)
4. KNOW WHAT HAS TO BE MINED TO PRODUCE SILICON FOR COMPUTER APPLICATIONS. (quartz crystals)
5. KNOW WHAT THE MOST ABUNDANT ELEMENT IN STEEL IS. (Fe)
6. KNOW WHAT THE SECOND MOST ABUNDANT ELEMENT IN STEEL IS. (C)
7. KNOW WHAT HAS TO BE MINED TO MAKE HIGHWAYS, OR KNOW WHAT MAKES CONCRETE.
[aggregate + cement (limestone, shale, gypsum, iron ore)]
8. KNOW THREE USES FOR GOLD. (electronics – excellent conductor; air conditioning of buildings – excellent reflector of infrared; jewelry; bullion)

STAND UP IF YOU

1. LIVE IN NEVADA

KEEP STANDING IF YOU

2. HAVE EVER BEEN TO ELY, EUREKA, AUSTIN, OR FALLON
3. THINK YOU MIGHT EVER GO BACK TO ELY, EUREKA, AUSTIN, OR FALLON
4. KNOW WHAT THE MAIN METAL MINED IN THE ROBINSON DISTRICT NEAR ELY WAS. (Cu)
5. KNOW WHAT THE MAIN METAL MINED IN THE EUREKA DISTRICT WAS HISTORICALLY. (Pb)
6. KNOW WHAT THE MAIN METAL BEING MINED TODAY IN THE EUREKA DISTRICT IS. (Au)
7. KNOW WHAT EVIDENCE THERE IS THAT THERE WERE LAKES COVERING MUCH OF NORTHERN NEVADA VALLEYS 14,000 YEARS AGO? (wave-eroded shorelines; lake sediments deposited at levels above the valley bottoms)

STAND UP IF YOU

1. KNOW WHAT THE MOST ABUNDANT ROCK IN THE EARTH'S CRUST IS. (basalt)

KEEP STANDING IF YOU

2. KNOW WHAT THE MOST ABUNDANT MINERAL IN THE EARTH'S CRUST IS. (plagioclase feldspar)
3. KNOW WHAT THE MOST ABUNDANT ELEMENT IN THE EARTH'S CRUST IS. (O)
4. KNOW WHAT THE SECOND MOST ABUNDANT ELEMENT IN THE EARTH'S CRUST IS. (Si)
5. KNOW WHAT THE THIRD MOST ABUNDANT ELEMENT IN THE EARTH'S CRUST IS. (Al)
6. KNOW WHAT THE CHEMICAL FORMULA FOR QUARTZ IS. (SiO_2)
7. KNOW WHAT LIME IS. (CaO)
8. KNOW WHAT LIMESTONE IS. (sedimentary rock composed mostly of calcite, CaCO_3)
9. KNOW WHAT THE CHEMICAL FORMULA FOR CALCITE IS. (CaCO_3)
10. KNOW WHY CEMENT WORKS - WHY IT HARDENS TO FORM A ROCK-LIKE SOLID. (It forms minerals.)
11. KNOW WHAT THE CHEMICAL FORMULA FOR PLAGIOCLASE FELDSPAR IS. (Plagioclase is a solid solution of mostly $\text{CaAl}_2\text{Si}_2\text{O}_8$ and $\text{NaAl}_3\text{Si}_3\text{O}_8$ with lesser $\text{KAl}_3\text{Si}_3\text{O}_8$.)

STAND UP IF YOU

1. KNOW THE LOCATION OF THE LOWEST ELEVATION IN THE STATE OF NEVADA. (Colorado River at the southern tip of Nevada, south of Laughlin)

KEEP STANDING IF YOU

2. KNOW WHAT COUNTY YUCCA MOUNTAIN IS IN. (Nye)
3. KNOW WHAT THE GREAT BASIN IS. (Area of internal drainage centered on Nevada; water in this area does not flow to the ocean but into interior lakes and playas.)
4. KNOW WHAT THE LOCATION OF THE LOWEST ELEVATION IN THE U.S. IS. (Death Valley, California)
5. KNOW HOW MANY METERS BELOW SEA LEVEL THAT LOCATION IS. (86 meters)
6. KNOW WHAT THE TWO MAJOR SOURCES OF LAS VEGAS DRINKING WATER ARE, IN ORDER. (surface water from the Colorado River (Lake Mead) and ground water from Las Vegas Valley)

STAND UP IF YOU KNOW

1. What country produced the most gold last year? (South Africa)

KEEP STANDING IF YOU KNOW

2. What country was second in gold last year? (either Australia or the United States of America – final statistics are not yet in, but it looks as if Australia may have taken second place from the USA in 2005.)
3. What state in the USA produced the most gold last year? (Nevada)
4. What country produced the most copper last year? (Chile; USA was second in 2005.)
5. What state in the USA produced the most copper last year? (Arizona)
6. What country produced the most silica sand, used mostly for glass bottles, last year? (USA)
7. What country produced the most coal last year? (either China or USA)
8. What country was second in coal production last year? (either USA or China)

STAND UP IF YOU KNOW

1. Why does smelting of aluminum ore or alumina take the most amount of energy of any of the processes used to produce aluminum metal? (It takes a lot of energy to break the Al-O bonds in the ore minerals.)

KEEP STANDING IF YOU KNOW

2. What happens to an aluminum can if you toss it into a campfire? (It oxidizes, forming Al_2O_3 .)
3. What should you separate aluminum cans rather than burn them in an incinerator and recycle the aluminum from the incinerator ash? (It would take a lot more energy to recover the Al once it has been oxidized.)
4. What is the main chemical element in coal? (C)
5. Why don't we recycle carbon from the burning of coal? (Because of the laws of thermodynamics – the second law - it would take more energy to separate C from O in CO_2 than is generated when we burn C to make CO_2 .)
6. What mineral is sapphire and ruby? (corundum, Al_2O_3)
7. What is its hardness? (9 on the Mohs hardness scale)
8. Why is it so hard? (The Al-O bonds are strong.)