Cambridge Core Science Series: GeoBasics

ROCKS AND MINERALS

Cambridge Educational

Introduction

This Teacher's Guide provides information to help you get the most out of *Rocks and Minerals,* Part 3 of the *GeoBasics* series. The contents in this guide will allow you to prepare your students before they use the program, assist them as they navigate through the program, and present follow-up activities to reinforce the program's key learning points.

The *GeoBasics* series is intended to excite young people about science and teach them concepts that meet national educational standards for science literacy. Science, in its multiple disciplines, is inherently fascinating and helps explain the world around us. In addition to fulfilling our natural curiosity, studying science and learning critical thinking skills provides numerous practical benefits, including helping us make informed and reasoned decisions, solve problems, think creatively, and continue to learn.

This 23-minute video provides high school students grades 7 through 12 with an introduction to the various types of minerals and rocks on the planet, but the program is not limited to usage by this audience. Because science literacy is important for all people, the information presented in *Rocks and Minerals* could also be presented to vocational/technical schools or in adult education courses that focus on science.

Learning Objectives

After watching *Rocks and Minerals*, students will understand how to:

- Demonstrate an understanding of what minerals are and how they form.
- Explain the seven properties of minerals that help identify them.
- Identify the various classifications of minerals.
- Demonstrate an understanding of the criteria for classifying rocks and how to identify rocks.
- Identify the three major rock groups of igneous, sedimentary, and metamorphic, explain how each group forms, and provide examples of each group.
- Explain what gems are and where on Earth they are formed
- Demonstrate an understanding of what makes gems beautiful and why they are cut the way they are.

Educational Standards

The *Rocks and Minerals* video program correlates with the following Standards: the National Standards of the National Academy of Sciences National Science Education, International Society for Technology in Education (ISTE), National Educational Technology Standards (NETS), and National Council of Teachers of English; and the State Standards of Florida, Ohio, and Texas for Earth and Space Sciences, Processes that Shape the Earth; How Living Things Interact with Their Environment; and Listening, Viewing, and Speaking.

- Uses technology tools to enhance learning, increase productivity, and promote creativity; uses a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge; conducts research on issues and interests by generating ideas and questions, and by posing problems; gathers, evaluates, and synthesizes data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate discoveries in ways that suit the purpose and

audience. *(International Society for Technology in Education [ISTE] National Educational Technology Standards [NETS])*

- Recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth; understands the need for protection of the natural systems on Earth; understands the competitive, interdependent, cyclic nature of living things in the environment; understands the consequences of using limited natural resources; and uses viewing strategies effectively. *(Florida State Standards: Processes that Shape the Earth; How Living Things Interact with their Environment; Listening, Viewing, and Speaking)*

- Accesses, generates, processes, and transfers information using appropriate technologies; understands and applies scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognizes the historical development of ideas in science. *(New York State: Earth Science, Language for Information and Understanding, and Language for Social Interaction)*

- Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. *(California State: Earth Sciences)*

- Knows that interdependence and interactions occur within an ecosystem, knows the significance of plants in the environment, understands and interprets visual representations, and analyzes and critiques the significance of visual representations. *(Texas State: Biology; English I, II, III, and IV)*

- Demonstrates an understanding about how earth systems and processes interact in the geosphere resulting in the habitability of Earth; and understands historical perspectives, scientific approaches, and emerging scientific issues associated with Earth and space sciences. *(Ohio State: Earth and Space Science Standards)*

Program Overview

The *Cambridge Core Science* series is a 40-part series composed of subsets of programs addressing Life Science, Earth Science, Physical Science, Human Body Systems, and Space Science. The series is designed as a whole to give high school and some college students a basic scientific understanding of themselves and the world around them. The *GeoBasics* video program series consists of eight titles:

- Our Planet Earth
- Plate Tectonics
- Rocks and Minerals
- Oceans and Seas
- Geocycles
- Atmosphere, Climate, and Weather
- Energy and Resources
- Environmental Issues and Human Impact

The third title in the series, *Rocks and Minerals,* discusses the origins of minerals, what they are, and how they form, and explains the classification groups of minerals, their five conditions, and their seven properties. The program continues with an exploration of rocks, describing their relation to minerals, the criteria for classifying rocks, how to identify rocks, and the three major rock groups. The program concludes by focusing on the rock cycle as a dynamic representation of the Earth.

Main Topics

Topic 1: Introduction
The program begins with an explanation of the incredible story rocks tell of the planet's history over the last several billion years. It discusses both the Earth's composition and why geologists study rocks to learn about the world we live in.

Topic 2: Minerals
The second section details the difference between rocks and minerals, what minerals are and how they form, and what the various types of minerals are (i.e., silicates, non-silicates, carbonates, halides, oxides, sulfides, and native elements).

Topic 3: Mineral Conditions and Properties
Continuing on the subject of minerals, the third section delves into the five conditions and seven properties of minerals, highlighting various minerals on the Mohs Scale of Hardness. It also touches upon gems and how they differ from minerals.

Topic 3: Rock Classifications
The three rock classifications of igneous, sedimentary, and metamorphic rocks are broken down in this section, with emphasis on the varieties, sub-groups, and examples of each classification type.

Topic 4: Conclusion—The Rock Cycle
The program concludes with the rock cycle, discussing why the rocks on the Earth are younger than the Earth itself.

Fast Facts

- A rock is a solid mineral deposit. It may be formed of one or more minerals, and may also include organic remains. All rocks are minerals, but not all minerals are rocks.
- A mineral is an inorganic, naturally-occurring homogeneous substance that is solid and has a crystalline structure. Minerals span the range from pure elements and simple salts to very complex silicates with thousands of known forms.
- The science of mineralogy is the study of the physics and chemistry of natural, solid, crystalline materials.
- About 3,000 different minerals have been identified in the Earth's crust.
- While basalt is the most common rock on Earth, quartz (silicon dioxide) is the most common mineral; quartz is found in nearly every geological environment and is at least a component of almost every rock type.
- Silicates account for 80% of minerals near the Earth's surface. Based on silicate structures, silicates are classified further into these sub-groups: nesosilicate, sorosilicate, cyclosilicate, inosilicate, phyllosilicate, and tectosilicate.
- The automobile industry uses 17% of the more than 90 million tons of steel produced in the U.S. each year; the average 3,000-pound car contains 240 pounds of aluminum, 42 pounds of copper, 22 pounds of zinc, 250 pounds of plastics, and 140 pounds of rubber; platinum is used

in catalytic converters and in the synthesis of a gasoline additive to replace lead and reduce automobile carbon monoxide emissions; and more than 30 million automobiles are equipped with air bag systems that have gold-coated electrical contacts.

- A telephone contains over 40 different mineral materials, while a television set has about 35.
- The average American will use approximately 800 pounds of lead in the course of a lifetime, in the form of batteries and as shields against dental and medical X-rays and TV radiation.
- Of the 193,000 metric tons of gold discovered to date, 62% is found in just four countries on earth. South Africa, the US, Australia, and Canada are the top gold-producing countries.
- The karat mark on gold jewelry designates the number of parts in twenty-four that are gold (e.g., 24 karat gold is pure gold, while 12 karat is half gold and half other metals).
- Platinum is so rare that two million pounds of ore may contain only one pound of metal; white gold was originally developed to imitate platinum, and is usually an alloy containing 25% nickel and zinc; and sterling silver contains 92.5% silver and 7.5% copper.
- The Taj Mahal, built between 1632 and 1654 in India, is made entirely out of marble.
- The first recorded use of turquoise dates back over 7,000 years ago, when Mesopotamians used it to make beads.

Vocabulary Terms

calcium carbonate: A colorless or white crystalline compound, $CaCO_3$, occurring naturally as chalk, limestone, marble, and other forms and used in a wide variety of manufactured products including commercial chalk, medicines, and dentifrices. Examples are stalagmites and stalactites.

cleavage: In a crystallized substance, the splitting or tendency to split along definite crystalline planes, yielding smooth surfaces.

conglomerate: A rock made up of loosely cemented heterogeneous material.

covalent bond: A chemical bond formed by the sharing of one or more electrons, especially pairs of electrons, between atoms.

crust: The outer layer of the Earth.

detritus: Loose fragments or grains that have been worn away from rock.

element: A substance that cannot be reduced to simpler substances by normal chemical means and that is composed of atoms having an identical number of protons in each nucleus.

extrusive: Derived from magma poured out or ejected at the Earth's surface.

foliated: Of or relating to rock that exhibits a layered structure.

fracture: The characteristic manner in which a mineral breaks.

gem: A mineral with commercial value. A crystalline rock that can be cut and polished for jewelry.

halide: A salt of any halogen acid.

igneous: A rock type formed by solidification from a molten state.

inorganic: Of or relating to compounds not containing hydrocarbon groups.

intrusive: Of or relating to igneous rock that is forced while molten into cracks or between other layers of rock.

metamorphic: Changed in structure or composition as a result of metamorphism.

metamorphism: The process by which rocks are altered in composition, texture, or internal structure by extreme heat, pressure, and the introduction of new chemical substances.

mineral: A mineral is an inorganic, naturally-occurring homogeneous substance that is solid and has a crystalline structure. Minerals span the range from pure elements and simple salts to very complex silicates with thousands of known forms. Minerals can be identified by their color and hardness.

Mohs Scale of Hardness: A scale that characterizes the scratch resistance of various minerals through the ability of a harder material to scratch a softer. It was created in 1812 by the German mineralogist Friedrich Mohs and is one of several definitions of hardness in materials science.

oxide: A binary compound of an element or radical with oxygen.

plutonic: Of deep igneous or magmatic origin: plutonic rocks.

rock: A relatively hard, naturally formed mineral or petrified matter; stone.

rock cycle: The process by which rocks are formed, altered, destroyed, and reformed by geological processes and which is recurrent, returning to a starting point.

sedimentary: Of or relating to rocks formed by the deposition of sediment.

silicate: Any of a large group of minerals that consist of SiO_2 or SiO_4 groupings combined with one or more metals and sometimes hydrogen.

streak: A line, mark, smear, or band differentiated by color or texture from its surroundings.

subduction zones: Zones that exist at convergent plate boundaries and mark sites of convective downwelling of the Earth's lithosphere.

sulfate: A chemical compound containing the bivalent group SO_4.

sulfide: A compound of bivalent sulfur with an electropositive element or group, especially a binary compound of sulfur with a metal.

Pre-Program Discussion Questions

1. Which do you think is more important: a rock or a mineral? Why?

2. What do think is the most common mineral on the planet? How about the most common rock on the planet?

3. Do you think there are undiscovered rocks and minerals on the planet? If so, where might they be found? If not, why not?

4. Why are some minerals deemed more valuable than others? What property or condition makes one more valuable than another? Discuss.

5. How does a construction company or design firm know which materials are best suited for their needs? Why wouldn't, for example, a company use mica to construct wall interiors, or insist that marble be used for low-income housing?

Post-Program Discussion Questions

1. Which minerals do you consume every day?

2. Will we ever run out of minerals? Which ones do you think will be depleted first? Do you think it is possible to prevent a mineral from being depleted? If so, how would you accomplish the task?

3. If you were the head of a country, and some technological innovation or scientific discovery enabled you to make as much of one single mineral as you wished, which mineral would you choose and why? If you were a geologist or environmentalist, how would your answer change?

4. Now that it is possible to drill into the bottom of the Earth's crust, how do you think the minerals found there will differ from those on the Earth's surface? If it were possible to drill down to the core of the Earth, what rocks or minerals do you think would be found there, if any?

5. Have you ever visited a cavern such as Mammoth Cave in Kentucky, the Luray Caverns in Virginia, the Rock Bridge Memorial State Park in Missouri, or the Carlsbad Caverns in New Mexico? What minerals can be found there? If possible, show slides or video and discuss, pointing out such items as stalagmites, stalactites, "chandeliers," etc.

Internet Activities

Make a list of various common minerals, write each mineral on a slip of paper, and place it in a hat. Have each student choose a mineral. Then, using the Internet as their research tool, ask your students to research how the minerals are used in everyday life, providing supporting pictures for their findings.

Group Activities

Exploring your school's surrounding community, have each student bring in at least two different rocks or mineral samples. (If your school is in an urban neighborhood, bringing in building materials can suffice.) Discuss each rock's classification and minerals it contains. Are the samples mostly homogeneous or heterogeneous?

Bring in various items such a penny, a gemstone, a butter knife, a piece of glass, etc., that are used for reference by the Mohs Scale of Hardness. Have your students identify the hardness of the rock/mineral samples they brought in by scratching them with these items.

Individual Student Projects

- A house is not a home without minerals. Research what minerals are used in the construction of a house—from its foundation to its roof, and from its walls to the nails that hold everything together. Create a drawing of the house, labeling the house components and the associated minerals they are made of.

- Have students write a paper of 5-7 pages in length on one of the following topics: the five parts of the definition for a mineral; the seven properties of a mineral; or the chemical classifications of a mineral.

Assessment Questions

Q1: True or false: Rocks are the building blocks of minerals.
A: False. Minerals are the building blocks of rocks, like mineral "potatoes" in a "stew" of rocks.

Q2: When the Earth was formed, where did the lighter elements go, and where did the heavier elements go?
A: Heavier elements (iron and nickel) went to the Earth's center and lighter elements went to the crust.

Q3: What are the two most abundant elements in the Earth's crust?
A: The two most abundant elements in the Earth's crust are oxygen (about 47%) and silica (about 28%).

Q4: What are silicates?
A: "Silicate" is a classification of minerals. Roughly 90% of the Earth's crust is made up of silicates.

Q5: How many elements must there be in a mineral for it to be considered a mineral?
A: Minerals are usually a combination of two or more elements. A few, such as gold and silver, are made of only one element.

Q6: Gold and diamonds are examples of what kind of element?
A: Native, or "pure" elements (made of only 1 element).

Q7: Match salt, iron, and copper with their corresponding mineral group (Sulfides, Halides, or Oxides).

A: Halides: salt; Oxides: iron; Sulfides: ore of copper.
Q8: What are the five conditions an element must meet to be considered a mineral?
A: By definition, a mineral must be naturally occurring, inorganic, a solid element or compound, have a definite composition, and have a regular internal crystal structure.

Q9: What are various properties of minerals?
A: Minerals have specific crystal forms and shapes, levels of hardness, cleavage, parting, and fracture, color and streak, luster and transparency; in addition, some have a specific taste.

Q10: What are three rock classification groups, and how do the rocks in each group form?
A: Igneous, which are formed by solidification from a molten state; sedimentary, which are fragments of existing rocks, exposed to the elements; and metamorphic, which are rocks that have been changed by heat and pressure.

Additional Resources

USGS Education: Science for a Changing World
www.usgs.gov/education

Educypedia: The Educational Encyclopedia
http://users.pandora.be/educypedia/education/geology.htm

NASA's Science Mission Directorate Website
http://science.hq.nasa.gov

The Center for International Earth Science Information Network (CIESIN)
www.ciesin.org

The Earth Institute at Columbia University
www.earthinstitute.columbia.edu

The WWW Virtual Library: Earth Science
http://vlib.org/EarthScience

Earth Science Week
www.earthsciweek.org

National Earth Science Teachers Association
www.nestanet.org

Additional Resources at www.filmsmediagroup.com

Available from Films Media Group • www.filmsmediagroup.com • 1-800-257-5126

Earth Science I Video Library
- **VHS #30977**
- **VHS #30992—in Spanish**
- **DVD #30962**
- **Closed captioned**

• Correlates to National Science Education Standards
• Includes a User's Guide

Contains 18 video clips on the history of the Earth, fossils, paleontology, and mapping the Earth. Clips include *Introduction to Earth History, Thermal Features, Blue Hole, Extinction, Glaciers, Fossil Hunter, Fossil Voyage, Amber, Mammoth, Rhino Fossils, Fossil Tunnels, Early Maps, Remote Sensing, Global Positioning System, Mountains, Seafloor Maps, Measuring Latitude, Measuring Longitude*. A User's Guide is included, containing an overview; a numbered index of clips, with brief descriptions and lengths; time codes (VHS only); suggested instructional strategies; and a list of additional resources. A Discovery Channel/FFH&S Production. © 2003.

Earth Science II Video Library

• VHS #30978
• VHS #30993—in Spanish
• DVD #30963
• Closed captioned
• Correlates to National Science Education Standards
• Includes a User's Guide

The *Earth Science II Video Library* contains 24 video clips on volcanoes, earthquakes, oceans, seasons, weather, and climate. Clips include *Introduction to Volcanoes, Birth of a Volcano, Death and Destruction, Types of Volcanoes, Volcanology, Plate Tectonics, Earth in Motion, San Andreas Fault, Seismology, Earthquake-Proof, Earthquake Zone, Introduction to Oceans, Coral Reefs, Waves and Tides, Fish Harvesting, Currents, Introduction to Weather, Polar Weather, Man-Made Weather, Rain, Violent Weather, Heat and Weather, Weather Systems, Water Cycle*. A User's Guide is included, containing an overview; a numbered index of clips, with brief descriptions and lengths; time codes (VHS only); suggested instructional strategies; and a list of additional resources. A Discovery Channel/FFH&S Production. © 2003.

Earth Story

• 8-part series
• VHS/DVD-R #8503
• "Extremely well done!" —*Booklist*

Beginning with the first land formations that emerged from the ocean 4 billion years ago, this series explores how all geologic phenomena, from volcanoes to earthquakes, are intertwined. Journeying from the sea bottom to the highest peak in the Andes, the series presents theories on plate tectonics, earthquakes, volcanoes, land formations, and continental drift. An indispensable resource for teaching earth science and geology. A BBC Production. (50 minutes each)

The series includes *Dating the Earth, Journey to the Ocean Floor, Continental Drift: Legacy of Fire, Death of the Dinosaurs, Winds of Change, Noah's Children, Oxygen: The Poison Gas, The Earth and the Moon.*

Landforms

• CD-ROM #6978 (Windows only)

What causes volcanoes and earthquakes? Why do tsunamis and floods occur? How do river beds and coastlines change? And what challenges do the forces that shape the Earth pose for people? Using this highly interactive CD-ROM, students can freely explore the Geodome, a virtual laboratory of geologic landforms. Learning stations provide targeted opportunities to manipulate 3-D topographical models, conduct simulations of natural disasters, examine hundreds of slides, and watch video clips. Plus, info/quiz features offer additional background and test comprehension. Headline-making catastrophes and issues of geologic concern drive home the present-day relevance of earth science, geology, and physical geography. Plate tectonics and seismology, eruptions and erosion, landslides and sedimentation—this disc has it all.

The Life and Times of El Niño

- **VHS/DVD-R #34956**
- **Closed captioned**

It has been linked to famines, epidemics, even the fall of empires. This program follows El Niño's deadly path through human history and the progress science has made in understanding the once-mysterious phenomenon. The effects of El Niño are presented in detail, including an 1878 outbreak of yellow fever in Tennessee, a concurrent drought that ravaged much of China, and more recent calamities that have brought the true nature of this climatic occurrence to light. Focusing on high-tech advances in meteorology, the video outlines El Niño's significance in the global warming debate and illustrates the use of computer models that can predict its next appearance. A BBCW Production. (50 minutes) © 2005.

Man and the Biosphere

- **12-part series**
- **VHS/DVD-R #2333**
- ***Recommended by Science Books & Films***

Using an integrated interdisciplinary approach combining the natural and the social sciences, these videos look at the relationships between living beings and their environments. The work of botanists, biologists, geologists, and demographers is used to examine the realities of ecological concerns in the framework of political realities. From the tops of the Himalayas to the bottom of the sea, from empty deserts to overcrowded cities, these videos show life where it thrives and where it has died out. Based on UNESCO's ground-breaking Man and the Biosphere Program, they illustrate the problems and concerns of preserving life, including human life, on Earth, and demonstrate numerous environmental projects that have successfully met the needs of both humankind and nature. (28 minutes each)

The series includes *Life in Arid and Semi-Arid Lands; The Desert as Laboratory; Life at the Top*; *Equilibrium in a Mountain Habitat; The Tropical Rain Forest; Preserving the Rain Forest; Coastlines; Ecology of the Coral Reef; Lagoons; Wetlands and Pinelands; Urban Ecology; Toward a Livable City.*

BioBasics

- **8-part series**
- **VHS/DVD-R #33833**
- **Preview clip online at www.films.com (Search on 33833)**
- **Includes viewable/printable Teacher's Guide**
- **Correlates to National Academy of Sciences National Science Education Standards and the American Association for the Advancement of Science Benchmarks for Science Literacy**
- **"A welcome replacement for outdated life science programs."—*School Library Journal***

Use the comprehensive 8-part *BioBasics* series to excite your students about life science as you present the fundamental concepts they'll need for a firm foundation in biology. An engaging blend of computer graphics, interviews with scientists, and animations will hold their attention as they open their minds to a wide range of essential life science topics.

The series includes *Introduction to Life Science; Cells: The Building Blocks of Life;Genetics and Evolution; Organization and Diversity; Life Processes of Animals; Life Processes of Plants; Microorganisms; Interdependence of Life.* A Cambridge Educational Production. Viewable/printable teacher's guides are available at www.cambridgeeducational.com. (25 minutes each) © 2005.

For information on other programs

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www.cambridgeeducational.com

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