Cambridge Core Science Series: GeoBasics

GEOCYCLES

Cambridge Educational

Teacher's Guide

Introduction

This Teacher's Guide provides information to help you get the most out of *Geocycles,* Part 5 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 20-minute video provides high school students, grades 7 through 12 with an overview of the Earth's geocycles—the carbon cycle, the hydrologic (water) cycle, and the nitrogen cycle. It also explains the various surface processes that change the characteristics of the Earth's surface. The program, however, is not limited to usage by this audience. Because science literacy is important for all people, the information presented in *Geocycles* could also be presented to vocational/technical schools or in adult education courses that focus on science and health.

Learning Objectives

After watching *Geocycles*, students will understand how to:

- Explain the two categories of the carbon cycle and the roles of photosynthesis and respiration in it.
- Demonstrate an understanding of the greenhouse effect and how humans impact the carbon cycle.
- Describe the five parts of the hydrologic cycle: condensation, precipitation, infiltration, runoff, and evaporation.
- List the five main processes of the nitrogen cycle.
- Demonstrate an understanding of the surface geologic processes that change the characteristics of the Earth's surface.

Educational Standards

The *Geocycles* 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, California, and Ohio for Earth and Space Sciences, Processes that Shape the Earth; How Living Things Interact with Their Environment; and Listening, Viewing, and Speaking.

- Develops an understanding of energy in the earth system, geochemical cycles, origin and evolution of the earth system, and origin and evolution of the universe. *(National Academy of Sciences National Science Education Standards)*

- 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 their discoveries in ways that suit their purpose and audience; 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. *(International Society for Technology in Education [ISTE] National Educational Technology Standards [NETS])*

- Uses spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information). *(National Council of Teachers of English Standards for the English Language Arts)*

- 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; and understands the consequences of using limited natural resources; uses listening strategies effectively; and uses viewing strategies effectively. *(Florida State Standards: Processes that Shape the Earth; How Living Things Interact with their Environment; Listening, Viewing, and Speaking)*

- Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. Climate is the long-term average of a region's weather and depends on many factors. *(California State Earth Sciences Standards)*

- Demonstrates an understanding about how earth systems and processes interact in the geosphere resulting in the habitability of Earth. This includes demonstrating an understanding of the composition of the universe, the solar system, and Earth. In addition, it includes understanding the properties and the interconnected nature of Earth's systems, process that shape Earth and Earth's history. *(Ohio State Earth and Space Science Standards)*

- Demonstrates an understanding of how concepts and principles of energy, matter, motion, and forces explains Earth systems, the solar system, and the universe. *(Ohio State Earth and Space Science Standards)*

- Defines and investigates self-selected or assigned issues, topics and problems; locates, selects and makes use of relevant information from a variety of media, reference and technological sources; uses an appropriate form to communicate their findings. *(Ohio State Earth and Space Science Standards)*

- Knows that interdependence and interactions occur within an ecosystem; knows the significance of plants in the environment; understands and interprets visual representations; analyzes and critiques the significance of visual representations; listens attentively for a variety of purposes; recognizes/interprets visual representations as they apply to visual media. *(Texas State Biology and English I, II, III, and IV Standards)*

- Understands and applies scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science. *(New York State Earth Science, Language for Information and Understanding, and Language for Social Interaction Standards)*

- Understands the fundamental concepts, principles, and interconnections of the life physical, and earth/space sciences; listens and speaks effectively in a variety of situations. *(Illinois State Concepts and Principles, Listening and Speaking 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 fifth title in the series, *Geocycles*, provides an overview of the Earth's geocycles—the carbon cycle, the hydrologic (water) cycle, and the nitrogen cycle—and explains the various surface processes that change the characteristics of the Earth's surface.

Main Topics

Topic 1: Introduction
The program begins by defining geocycles, including how they help keep our planet Earth in balance. It then introduces Earth's four fundamental systems—hydrosphere, lithosphere, biosphere, and atmosphere.

Topic 2: The Carbon Cycle
The program continues with the complexities of the carbon cycle, focusing on its two major categories—short term (biological) and long term (geological). The dangers of carbon cycle disruptions are discussed in relation to the harmful effects they would have on Earth.

Topic 3: The Hydrologic Cycle (a.k.a. The Water Cycle)
Considered the most important cycle, the hydrologic cycle (also known as the water cycle) is explored. Experts highlight the planet's ratio of salt water to fresh water and then take the student through the various stages of the cycle.

Topic 3: The Nitrogen Cycle
This section of the program takes an informative look at how igneous, sedimentary, and metamorphic rocks are created, destroyed, and changed by the many processes of the nitrogen cycle.

Topic 4: Surface Processes
Presenting breathtaking clips of our planet's majestic scenery, this section explores the surface processes that move sediment—including weathering, mass-wasting, and erosion. Weathering types and products, the importance of soil to our existence, the results of mass-wasting and erosion in carving the Earth's landscape, and examples of the two kinds of glaciers are described in vivid detail.

Topic 5: Conclusion
Experts add concluding thoughts on the longterm effects of geocycles over the time span of millions of years.

Fast Facts

- Carbon (C) is the fourth most abundant element in the universe, after hydrogen (H), helium (He), and oxygen (O). Carbon is the building block of life; not only is it found in all living things, but it is present in the atmosphere, in the layers of limestone sediment on the ocean floor, and in fossil fuels such as coal.

- By 2025 it is estimated that over one-third of the world's freshwater will be gone. Already, 26 countries are considered to be "water-scarce." In addition, much of the drinking water in water-scarce countries is contaminated; only one in five Haitians has access to water that is safe to drink.

- Distilled water is actually a purer form of water than rainwater. Rainwater contains small amounts of dissolved minerals that have been blown into the air by winds, including tiny particles of dust and dissolved gases, which result in acid rain.

- Sulfur dioxide and nitrogen oxides are the primary causes of acid rain. In the US, most of these gases come from electric power generation that relies on burning fossil fuels like coal. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. The result is a mild solution of sulfuric acid and nitric acid.

- Of the world's total water supply of about 332.5 million cubic miles of water, over 96% is saline. Of the total freshwater, over 68% is locked up in ice and glaciers and 30% is in the ground. Fresh surface-water sources, such as rivers and lakes, only constitute about 22,300 cubic miles, which is about 1/700th of one percent of total water. Yet, rivers and lakes are the sources of most of the water people use every day.

- The concentration of carbon dioxide in the atmosphere has changed in the past hundred years. Before the Industrial Revolution (prior to the 19th century), carbon dioxide levels stayed nearly stable for thousands of years. Since human beings developed a dependence on fossil fuels, the amount of atmospheric carbon dioxide has increased dramatically.

- Algae produce over half of the oxygen that we breathe. The first plants on earth, they developed in the sea 3,500 million years ago. Like other plants, they give off oxygen as they produce food. Over time, algae produced enough oxygen to provide an atmosphere in which animals could survive.

- Plants take in carbon dioxide (CO_2) from the atmosphere during photosynthesis, and release CO_2 back into the atmosphere during respiration.

- Five main processes cycle nitrogen through the biosphere, atmosphere, and geosphere: nitrogen fixation, nitrogen uptake (organismal growth), nitrogen mineralization (decay), nitrification, and denitrification.

- Soil is material capable of supporting plant life. It can be divided into two general layers, or strata: topsoil, the topmost layer, where most plant roots, microorganisms, and other animal life are located; and subsoil, which is deeper and often more dense and which contains less organic matter.

Vocabulary Terms

alpine glacier: A glacier that moves down from a high valley.

atmosphere: The gaseous mass or envelope surrounding the Earth and retained by the Earth's gravitational field.

biota: The combined flora and fauna of a region.

biosphere: The part of the Earth and its atmosphere in which living organisms exist or which is capable of supporting life.

carbon: A naturally abundant nonmetallic element that occurs in many inorganic and in all organic compounds. It exists freely as graphite and diamond and as a constituent of coal, limestone, and petroleum, and is capable of chemical self-bonding to form an enormous number of chemically, biologically, and commercially important molecules.

carbon cycle: The combined processes of photosynthesis, decomposition, and respiration, by which carbon "cycles" among its major reservoirs—the atmosphere, oceans, and living organisms. Also called *carbon dioxide cycle*.

climate: The meteorological conditions, including temperature, precipitation, and wind, that characteristically prevail in a particular region.

conduction: The process by which heat energy is transmitted through contact with neighboring molecules.

continental glacier: A broad ice sheet resting on a plain or plateau and spreading outward from a central mass of ice or region of accumulation.

convection: The process that transmits heat by transporting groups of molecules from place to place within a substance. It occurs in fluids such as water and air, which move freely.

crude oil: Unrefined petroleum consisting mainly of hydrocarbons.

environmental impact: Human environmental health impact, risk to ecological health, and changes to the ways in which nature benefits humans—sometimes referred to as "nature's services"—caused by an activity.

erosion: The group of natural processes, including weathering, dissolution, abrasion, corrosion, and transportation, by which material is worn away from the Earth's surface.

flood: An overflowing of water onto land that is normally dry.

fold: A bend in a stratum of rock.

fossil fuel: Fuel consisting of the remains of organisms preserved in rocks in the Earth's crust with high carbon and hydrogen content.

geocycle: Process on Earth that moves and recycles matter.

geology: The scientific study of the origin, history, and structure of the Earth.

geothermal energy: A form of energy obtained from within the earth, originating in its core; also, energy produced by extracting the Earth's internal heat.

glacier: A large, long-lasting river of ice that is formed on land and moves in response to gravity. A glacier is formed by multi-year ice accretion in sloping terrain.

global warming: An increase in the average temperature of Earth's atmosphere, especially a sustained increase sufficient to cause climatic change.

hydrologic cycle (a.k.a. the water cycle): The cycle of evaporation and condensation that controls the distribution of Earth's water as it evaporates from bodies of water, condenses, precipitates, and returns to those bodies of water.

hydrosphere: The watery layer of the Earth's surface; includes water vapor.

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

landslide: The downward sliding of a relatively dry mass of earth and rock.

lithosphere: The solid outermost shell of the Earth, which includes the crust and the uppermost layer of the mantle.

magma: The molten rock material under the Earth's crust, from which igneous rock is formed by cooling.

mass-wasting: The movement of rock under the influence of gravity.

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.

mudslide: A mudflow, especially a slow-moving one. A landslide of mud.

nitrogen cycle: The circulation of nitrogen in nature, consisting of a cycle of chemical reactions in which atmospheric nitrogen is compounded, dissolved in rain, and deposited in the soil. There it is assimilated and metabolized by bacteria and plants, eventually returning to the atmosphere by bacterial decomposition of organic matter.

photosynthesis: The uptake of carbon by plants, resulting in the production of oxygen and sugars.

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.

soil: The top layer of the Earth's surface, consisting of rock and mineral particles mixed with organic matter.

uplift: A rise of land to a higher elevation (as in the process of mountain building).

water table: The level below which the ground is completely saturated with water. Also called *water level.*

weathering: Any of the chemical or mechanical processes by which rocks exposed to the weather undergo changes in character and break down.

Pre-Program Discussion Questions

1. How much do you know about the four fundamental systems of our planet Earth? Name the systems and depict them in a drawing.

2. Name the geocycles and describe how they affect our planet.

3. Earth can be considered the "Water Planet." What percentage of it is covered by water? How much of that is water is potable? Name as many sources of water as you can.

4. What examples of weathering can you see around your home or school or en route between the two?

Post-Program Discussion Questions

1. Now that you have learned about the two types of weathering, which type do you think has had a greater effect on your local area?

2. What is the greenhouse effect? Have you, your family, or your schoolmates positively or negatively impacted it? Do you know of any organizations or political groups that are making a positive or negative difference?

3. Name, compare, and contrast the two major categories of the carbon cycle.

4. Describe the nitrogen cycle and discuss its importance to the planet.

Internet Activities

- How have humans affected the carbon cycle? Citing specific evidence from various sources, your students should create a timeline (of whatever time period they choose) demonstrating how humans have affected the carbon cycle. In addition, have them research current initiatives by environmental organizations and government agencies and create a timeline for what they think could occur in the next 1,000 years.

- Using the Internet as the primary research tool, have each student research and report his findings on examples of the following surface processes in the creation, destruction, or mutation of the continent's landscape: mass-wasting, landslides, mudslides, floods, continental glacier movement, alpine glacier movement, mechanical weathering, and chemical weathering. Have each student show the pictures, videos, and animations he finds to the class.

Group Activities

- Divide the class into three groups and assign each group a geocycle. Have each group research why its geocycle should or should not be considered the most important geocycle in relation to the proper balance of the Earth and the welfare of its inhabitants. Have each group present its findings, including visual aids to support claims made.

Individual Student Projects

- Ask each student to create a project that details the four regions of the atmosphere and how they work together. Students should feel free to express their findings through any of the following: a research paper; a large, detailed, and labeled poster; or a PowerPoint or interactive multimedia presentation.

- What would happen if the water cycle were to stop functioning properly, e.g., if it rained for three years straight, if there were no rain whatsoever for three years, or if all the polar ice caps melted? Have each student write a paper depicting not only what he believes would happen (being specific about the impact on humans and the biota), but also what changes would need to occur for the planet to survive.

Assessment Questions

Q1: What are the two types of weathering and how do they work together?
A: Chemical and physical weathering often work hand in hand. Cracks in rocks exploited by mechanical weathering increase the surface area that can be exposed to chemical action. Conversely, the chemical action of minerals in the cracks can aid the mechanical process of disintegrating the rock.

Q2: What are geocycles?
A: Geocycles are processes on Earth that move and recycle matter. They include the carbon cycle, the water cycle, and the nitrogen cycle.

Q3: What are Earth's four fundamental systems?
A: The hydrosphere contains water; the lithosphere is Earth's rocky outer shell; the biosphere contains the living matter on the planet; and the atmosphere contains the air we breathe.

Q4: The carbon cycle has two major categories. What are they?
A: The shortterm (biological) carbon cycle, which occurs over a period of days to thousands of years, and the longterm (geological) carbon cycle, which occurs over millions of years.

Q5: What is the process of the carbon cycle in which plants take in carbon to produce oxygen and sugars?
A: Photosynthesis.

Q6: What two changes on Earth can an increase of carbon dioxide cause?
A: An increase can cause rising sea levels and changing weather patterns.

Q7: Of the 100% total of water found on Earth, what is the breakdown of salt and fresh water?
A: Most of the water (97%) on the planet is salt water. Three percent is fresh water, of which two thirds is locked up in glacial ice.

Q8: Describe how rocks are created and destroyed by the nitrogen cycle.
A: Magma cools beneath the surface to create igneous rock. Through the process of uplift, it becomes sediment, which is transported by water, ice, and wind, then compacted and cemented together over time to make sedimentary rock. High pressures and temperatures change it into metamorphic rock, which can then be heated and crystallized to return to a rock formation of igneous rock.

Q9: What are three surface processes that move sediment?
A: Weathering, mass-wasting, and erosion.

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 a primordial ocean 4 billion years ago, this eight-part 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 the latest 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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