Virginia Fossils & Paleontology

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I

Introduction & Kit Inventory

Introduction

This kit focuses on the paleontology of Virginia and contains all the materials and information necessary for four groups to perform up to nine different activities. The skills and concepts utilized in these activities are directed mainly towards the ninth grade level, but the activities “Is It a Fossil? Can It Become a Fossil?” and “Molds & Casts: Replicate a Fossil” can also be done with students at a fifth grade level. Each activity is intended to facilitate objective questioning and reasoning as well as integrate scientific observation by using procedures and asking questions critical to student-centered learning. Additionally, the activities of this kit correspond to and support various Virginia standards of learning, as outlined in section II. The kit may be used within a variety of circumstances, such as standard in-class teaching, 4H meetings, Girl and Boy Scout meetings, and other outreach programs.

Kit Inventory

<u>Total Kit Contents</u>

1 kit guide
5 tall cups with lids
13 short cups
1 bag containing ~850 milliliters fine sand
1 bag containing ~650 milliliters gravel
4 rocks
4 various extant shells
4 extant bivalve shells
4 rock pencils
4 feathers
4 crystals
4 pinecones
8 *Rafinesquina* fossils
4 gastropod fossils
4 rugose coral fossils
12 brachiopod fossils
4 trilobite fossils
4 rounded pebbles
1 mesh
1 rubber band
1 cardboard tray
1 measuring cup
4 funnels
400(+) Skittles

4 canisters of play doh
4 trilobite molds
4 Outcrop posters
4 Solite Lake posters
4 phytosaur cards
4 *Fraxinopsis* seed cards
4 *Atreipus* cards
4 *Tanytrachelos* cards
4 *Pannulika triassica* cards
4 *Semionotus* cards
4 Triassic beetle cards
4 *Architipula youngi* cards
4 *Mecistotrachelos apeoros* cards
4 *Turseodus* cards
4 calculators
1 baby powder
1 *The Audobon Field Guide to North American Fossils*
2 *Golden Guide: Fossils*
4 *Chesapecten jeffersonius* specimen A
4 *Chesapecten jeffersonius* specimen B
4 *Chesapecten jeffersonius* specimen C
4 regular pencils
4 wood discs
4 pieces of graphite
4 pieces of anthracite coal
4 pieces of bituminous coal
4 pieces of peat
4 "The Transformations of Plant Material" mats

Inventory for Each Activity

Is it a Fossil? Can It Become a Fossil? (bagged)
4 rocks
4 extant shells
4 rock pencils
4 feathers
4 crystals
4 *Rafinesquina* fossils
4 pinecones

Molds & Casts: Replicate a Fossil (bagged)
4 trilobite fossils
4 trilobite molds
4 brachiopod fossils
4 extant bivalve shells
4 canisters of play doh

Learning about Fossils by Examining *Chesapecten jeffersonius*
4 *Chesapecten jeffersonius* specimen A
4 *Chesapecten jeffersonius* specimen B
4 *Chesapecten jeffersonius* specimen C
4 brachiopod fossils

Reconstructing a Triassic Scene
4 Solite Lake Posters
Fossil Cards: 4 phytosaur cards
4 *Fraxinopsis* seed cards
4 *Atreipus* cards
4 *Tanytrachelos* cards
4 *Pannulika triassica* cards
4 *Semionotus* cards
4 Triassic beetle cards
4 *Architipula youngi* cards
4 *Mecistotrachelos apeoros* cards
4 *Turseodus* cards

The Appalachian Plateau: An Abundance of Coal
4 wood discs
4 pieces of graphite
4 pieces of anthracite coal
4 pieces of bituminous coal
4 pieces of peat
4 "The Transformations of Plant Material" mats

Relative Dating Exercise:
1 mesh
1 rubber band
1 cardboard tray
1 measuring cup
1 bag containing~800 milliliters of fine sand sized sediment (~100 ml each sample cup)
1 bag containing~640 milliliters of gravel sized sediment (~160 ml each sample cup)
12 short cups for sediment samples
4 clear cups with lids
4 brachiopod fossils
4 rugose fossils
4 gastropod fossils
4 rounded pebbles
4 funnels

Absolute Dating Exercise
400 Skittles
4 short cups
4 calculators

The Scientific Method and Index Fossils
4 *Rafinesquina* fossils
4 outcrop maps

II

Virginia Standards of Learning

The activities and text within this kit correlate with and support several Science Standards of Learning of Virginia. These correlations are detailed below by individual standards.

5.7: Earth Patterns, Cycles, and Change

A. the rock cycle including identification of rock types
- supported by the sections "Where Are Fossils Found?", "How Do Scientists Find Fossils?", and "The Physiographic and Geologic Provinces of Virginia"

B. Earth history and fossil evidence
- correlated to the second chapter, "Fossils in Virginia"
- supported by the "Relative Dating" section

E. weathering and erosion
- supported by the "How Do Scientists Find Fossils" section and the "Fossil Excavation and Preparation" activity

ES.2: The student will demonstrate scientific reasoning and logic by

A. analyzing how science explains and predicts the interactions and dynamics of complex Earth systems
- correlated to the sections "Absolute Dating" and :The Valley & Ridge Province: Fossil Assemblages and What They Say about Past Environments"

B. recognizing that evidence is required to evaluate hypotheses and explanations
- correlated to "The Scientific Method and Index Fossils" activity

C. comparing different scientific explanations for a set of observations about the Earth
- correlated to the fossil formation flowchart in the "How Are Fossils Formed?" section
- supported by "The Scientific Method and Index Fossils" activity

D. explaining that observation and logic are essential for reaching a conclusion
- correlated to "The Scientific Method and Index Fossils" activity

E. evaluating scientific evidence for scientific theories
- correlated to the sections "How Are These Skills and Concepts Applied to the Study of Ancient Life?", "The Scientific Method: A How-To", and "Data, Hypotheses, and Theories: How to Avoid Confusion"

ES.3: The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include

A. maps (bathymetric, geologic, topographic, and weather) and star charts;
- supported by "The Scientific Method and Index Fossils" activity

ES.10: The student will investigate and understand that many aspects of the history and evolution of the Earth and life can be inferred by studying rocks and fossils. Key concepts include

A. traces and remains of ancient, often extinct, life are preserved by various means in many sedimentary rocks
    - correlated to the "What Types of Fossils Are There?" and "How Are Fossils Formed?" sections and the "Is It a Fossil?" activity

B. superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock
    - correlated to the sections "Finding the Relative and Absolute Ages of Rocks and Fossils", "Relative Dating", and "Absolute Dating" and the activities "Relative Dating Exercise", "Absolute Dating Exercise", "Integrating Relative and Absolute Dating", and "The Scientific Method and Index Fossils"

C. absolute and relative dating have different applications but can be used together to determine the age of rocks and structures
    - correlated to the sections "Finding the Relative and Absolute Ages of Rocks and Fossils", "Relative Dating", and "Absolute Dating" and the activities "Relative Dating Exercise", "Absolute Dating Exercise", "Integrating Relative and Absolute Dating", and "The Scientific Method and Index Fossils"

D. rocks and fossils from many different geologic periods and epochs are found in Virginia
    - correlated to the second chapter, "Fossils in Virginia"

LS.1: The student will plan and conduct investigations in which

A. data are organized into tables showing repeated trials and means
    - correlated to the sections "How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?" and "The Scientific Method: A How-To", and to the activities "The Scientific Method and Index Fossils" and the "Absolute Dating Exercise"

B. variables are defined
    - correlated to the sections "How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?" and "The Scientific Method: A How-To", and to "The Scientific Method and Index Fossils" activity

C. metric units (SI-International System of Units) are used
    - correlated to the sections "How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?" and "The Scientific Method: A How-To", and to "The Scientific Method and Index Fossils" activity

D. models are constructed to illustrate and explain phenomena
    - correlated to the sections "How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?" and "The Scientific Method: A How-To", and to the activities "The Scientific Method and Index Fossils", "Absolute Dating Exercise", and "Relative Dating Exercise"

G. variables are controlled to test hypotheses, and trials are repeated
    - correlated to the sections "How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?" and "The Scientific Method: A How-To", and to "The Scientific Method and Index Fossils" activity

I. interpretations from a set of data are evaluated and defended
- correlated to the sections “How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?” and “The Scientific Method: A How-To”, and to “The Scientific Method and Index Fossils” activity

J. an understanding of the nature of science is developed and reinforced
- correlated to the sections “How Are These Skills and Concepts Integrated and Applied to the Study of Ancient Life?” and “The Scientific Method: A How-To”, and to “The Scientific Method and Index Fossils” activity

LS.9: The student will investigate and understand interactions among populations in a biological community. Key concepts include

B. the relationship between predators and prey
- supported by the activities “Reconstructing a Triassic Scene” and “Learning about Fossils by Examining *Chesapecten jeffersonius*”

E. niches
- supported by the “Reconstructing a Triassic Scene” activity

LS.10: The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include

B. characteristics of land, marine, and freshwater ecosystems
- supported by the “Reconstructing a Triassic Scene” activity

C. adaptations that enable organisms to survive within a specific ecosystem
- supported by the “Reconstructing a Triassic Scene” activity

LS.14: The student will investigate and understand that organisms change over time. Key concepts include

B. evidence of evolution of different species in the fossil record
- supported by the activities “Learning about Fossils by Examining *Chesapecten jeffersonius*” and “What Environment Was the Valley & Ridge Province?”

C. how environmental influences, as well as genetic variation, can lead to a diversity of organisms
- supported by “The Piedmont and Blue Ridge Province: Extraordinary Fossils of the Triassic Rift Basins” section and the “Reconstructing a Triassic Scene” activity

BIO.7: The student will investigate and understand bases for modern classification systems. Key concepts include

A. structural similarities among organisms
- correlated to the “Learning about Fossils by Examining *Chesapecten jeffersonius*” and “What Environment Was the Valley & Ridge Province?” activities

B. fossil record interpretation
- correlated to the “Reconstructing a Triassic Scene” and “What Environment Was the Valley & Ridge Province?” activities

C. comparison of developmental stages in different organisms
- supported by the “Learning about Fossils by Examining *Chesapecten jeffersonius*” activity

Chapter 2: Fossils in Virginia

The Physiographic and Geologic Provinces of Virginia: An Overview

Virginia is divided into five main provinces of differing geology and ages. The Coastal Plain province, which is located at Virginia's shore, is a mainly flat area containing siltstones and sandstones that are between Jurassic and Holocene in age. This is the province that yields a high quantity of the state fossil *Chesapecten jeffersonius*. The province to the west of the Coastal Plain province is the Piedmont province, and further west is the Blue Ridge province. The rocks found in these provinces are very old, dating back to the Precambrian and lower Paleozoic, and are predominately metamorphic. Because fossils are not found in metamorphic rock, the only fossils that come from these provinces are found within the Triassic rift basins they contain. West of the Blue Ridge province is the Valley and Ridge province, which consists of limestones and dolostones that were created between the Cambrian and Devonian periods. These rocks contain a variety of invertebrate and some vertebrate fossils that are evidence of the depositional environment of this province during these periods. Lastly, the Appalachian Plateau lies on the very far west side of the state, and consists of Mississippian to Pennsylvanian age limestones, siltstones, and coal. The abundance of coal in this province is a reservoir of ancient plant fossils. A reference map is supplied in the back of this manual to describe the provinces in a little more detail.

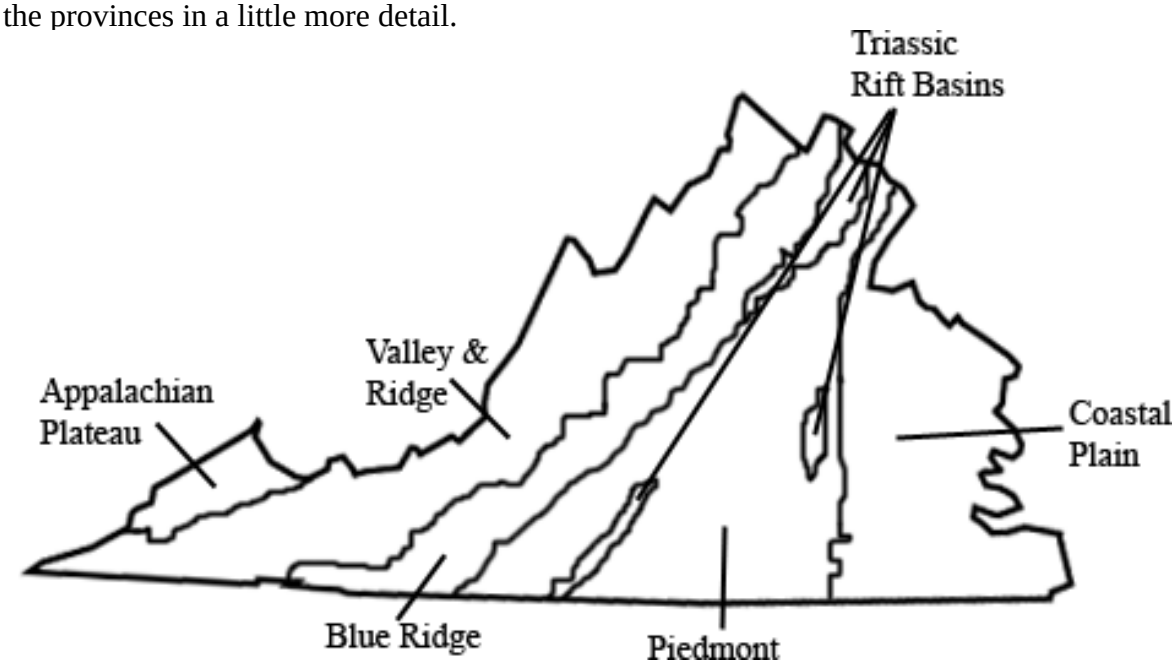

Figure 2: Diagram showing the locations of the five geologic provinces of Virginia, as well as the Triassic rift basins located within the Piedmont and Blue Ridge Provinces.

The Coastal Plain Province: Virginia's State Fossil, *Chesapecten jeffersonius*

The state fossil of Virginia, *Chesapecten jeffersonius*, was the very first fossil ever described in North America. It lived during the Early Pliocene Epoch, between 4.3 and 4.5 million years ago, and its fossils are found in the Lower Yorktown Formation. These fossils are so abundant that to this day they continue to be found. Their abundance

and restriction between 4.5 and 4.3 million years ago allow for *Chesapecten jeffersonius* to be used as an index fossil for the Lower Yorktown Formation.

ACTIVITY: Learning about Fossils by Examining *Chesapecten jeffersonius*

The Piedmont Province and Blue Ridge Province: Extraordinary Fossils of the Triassic Rift Basins

The Piedmont and Blue Ridge provinces consist mainly of metamorphic rock, and thus no fossils can be found within this rock (although the state rock, unakite, is found in the Blue Ridge province). However, these two provinces contain over eight rift basins, which are basins that formed by the pulling apart of the surrounding land, and each basin contains Triassic rocks and fossils. One particularly impressive site within a Triassic rift basin is the Solite quarry, which is located near the southern border of Virginia. The Solite quarry is a lagerstatten, which is a small location of rare fossils that are either in high abundance, demonstrate extraordinary preservation quality (details such as feathers and skin outlines can be seen), or have both characteristics. The Solite quarry has yielded high numbers of excellently preserved fossil organisms, including (but not limited to) several species of fish, many different types of insects, a species of gliding reptile, several carnivorous aquatic reptiles, various plants, trackways of terrestrial vertebrates, and hundreds of specimens of an aquatic lepidosaur (relative to snakes and lizards) called *Tanytrachelos*. The insects, plant fossils, and ***Tanytrachelos*** are especially well preserved, as these fossils often show traces of the soft parts such as insect wings, leaves, and skin outlines that are rarely preserved in the fossil record. The reason for such excellent preservation and high abundance of fossils in the Solite quarry is that its sediments were deposited in a quiet lake setting.

ACTIVITY: Reconstructing a Triassic Scene

The Valley & Ridge Province: Fossil Assemblages and What They Say about Past Environments

A variety of invertebrate fossils and some vertebrate fossils are found within the strata of the Valley & Ridge province. Such a variety is helpful to scientists because by comparing the living habits and habitats of the existing relatives of these various organisms, some light can be shed on the type of environment in which these fossils were preserved. This is important because the environment in any one location is constantly changing through time. Thus, what may be a grassy field today may have been a desert, a beach, or a forest in the past, depending on the rock types and fossils deposited in that location.

The Valley & Ridge province, which contains limestones and dolostones that were formed during the Cambrian and Devonian periods, contain a variety of mollusk fossils such as clams, snails and scallops, brachiopod fossils, crinoid fossils, trilobite fossils, as well as fossil shark teeth. Since all of these animals lived in the ocean, it can be surmised that the Valley & Ridge province was a marine environment during the Cambrian and Devonian, in contrast to the land environment present there today.

The Appalachian Plateau Province: An Abundance of Coal

The Appalachian Plateau province contains several types of rock, including limestone and siltstone, but this province is best known for its abundant coal deposits. The two most famous coal formations in the Appalachian Plateau province are the Merrimac, which was deposited during the Mississippian period, and the Pocahontas Formation, which was deposited during the Pennsylvanian period. These deposits are the remnants of ancient plants that had lived, died, and been preserved in a temperate, wet environment.

ACTIVITY: The Appalachian Plateau: An Abundance of Coal

The Appalachian Plateau: An Abundance of Coal

1. An abundance of coal was deposited in the Appalachian Plateau during the Mississippian and Pennsylvanian periods. This coal was formed by the preservation and compression of primitive ferns and trees in an extremely wet environment. On a separate piece of paper, draw a reconstruction of what this scene may have looked like (note: grass did not exist at this time).

2. Take a look at your drawing. What type of modern environment does it most closely resemble?

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3. The creation of coal from plant material is a stepwise process during which the material transforms progressively to a denser material. On the mat provided, arrange the five specimens in order of beginning material to end result by placing the specimens into the appropriate boxes according to the following hints:
    1. First, a plant dies.
    2. Secondly, the plant decomposes but is not yet heavily compressed.
    3. Third, the material is compressed and becomes very dark.
    4. Fourth, the material is compressed further and becomes smooth and glossy.
    5. Lastly, if an extremely high amount of pressure is applied, a mineral can be formed that is soft, metallic, and is used as pencil lead.

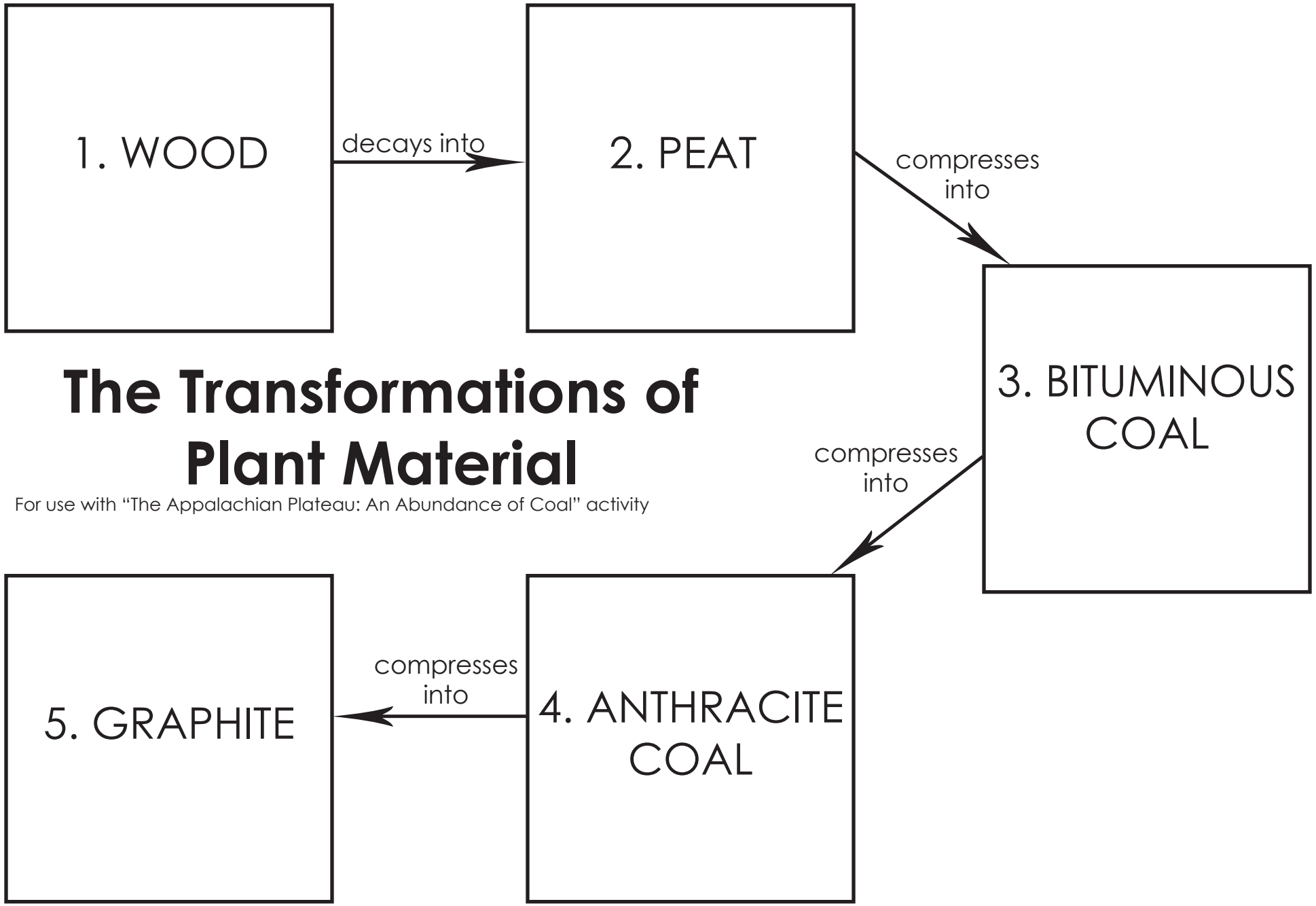
4. The environment of a single geographic location is constantly changing throughout time due to changes in factors such as sea levels and climate. For example, what is a forest today may have been a beach several million years ago. On a separate page is a diagram of an outcrop with is location marked within Virginia. This outcrop contains the two famous coal formations called the Merrimac, which was deposited during the Mississippian period, and the Pocahontas Formation, which was deposited during the early Pennsylvanian period.

    The environment in which a rock formation was deposited can be indicated by the types of fossils it contains. According to the

types of environments that are the habitats for the organisms in the symbol key and the type of environment that produces coal, label the type of environment present at the time of each line to the right of the stratigraphic column on the following page. Note that the oldest formation, the Price Formation, is on the bottom of the column, and that the formations within the outcrop are progressively younger upwards.

The Transformations of Plant Material

For use with "The Appalachian Plateau: An Abundance of Coal" activity



ENVIRONMENT

PENNSYLVANIAN PERIOD

MISSISSIPPIAN PERIOD

Pocahontas Formation

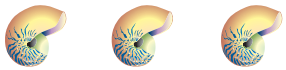
Bluestone Formation

Princeton Formation

Hinton Formation

Bluefield Formation

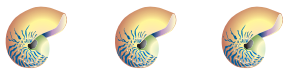
Greenbrier Limestone



MacCrady Shale

Merrimac

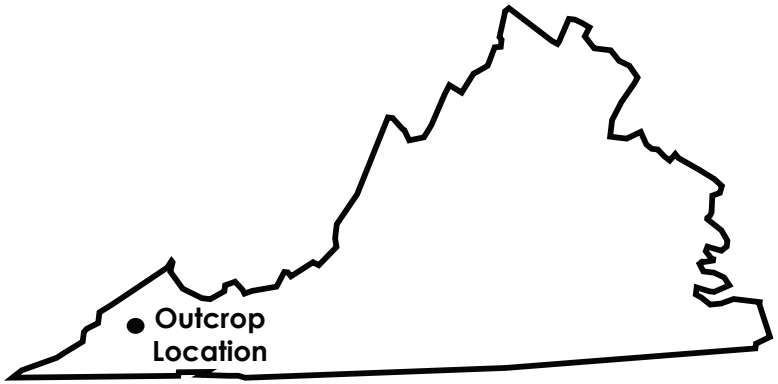
Price Formation



beach/ocean

Fossils and Coal as a Proxy of Changing Environments through Time

To the left is a diagram of a stratigraphic column (with key) found at the site indicated below. It consists of the entire Mississippian period and the first formation of the Pennsylvanian Period. Following the directions outlined in #4 of the previous page, write the depositional environment at the time on each horizontal line to the right of the fossils or coal. The oldest environment at the bottom has been started for you.



KEY

 Freshwater (lake) Fossils

 Marine (ocean) Fossils

 Land Plant Fossils

Coal