Glencoe Science

Chapter Resources

Clues to Earth's Past

Includes:

Reproducible Student Pages

ASSESSMENT

- ✔ Chapter Tests
- ✔ Chapter Review

HANDS-ON ACTIVITIES

- ✔ Lab Worksheets for each Student Edition Activity
- ✔ Laboratory Activities
- ✔ Foldables–Reading and Study Skills activity sheet

MEETING INDIVIDUAL NEEDS

- ✔ Directed Reading for Content Mastery
- ✔ Directed Reading for Content Mastery in Spanish
- ✔ Reinforcement
- ✔ Enrichment
- ✔ Note-taking Worksheets

TRANSPARENCY ACTIVITIES

- ✔ Section Focus Transparency Activities
- ✔ Teaching Transparency Activity
- ✔ Assessment Transparency Activity

Teacher Support and Planning

- ✔ Content Outline for Teaching
- ✔ Spanish Resources
- ✔ Teacher Guide and Answers

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Reproducible Student Pages

Reproducible Student Pages

Hands-On Activities

Name Date Class

Predicting Fossil Preservation

Procedure

1. Take a brief walk outside and observe your neighborhood.
2. Look around and notice what kinds of plants and animals live nearby.

Analysis

1. Predict what remains from your time might be preserved far into the future.

2. Explain what conditions would need to exist for these remains to be fossilized.

Mini LAB

Modeling Carbon-14 Dating

Procedure

1. Count out 80 **red jelly beans.**
2. Remove half the red jelly beans and replace them with **green jelly beans.**
3. Continue replacing half the red jelly beans with green jelly beans until only 5 red jelly beans remain. Count the number of times you replace half the red jelly beans.

Analysis

1. How did this lab model the decay of carbon-14 atoms?

2. How many half lives of carbon-14 did you model during this lab?

3. If the atoms in a bone experienced the same number of half lives as your jelly beans, how old would the bone be?

Relative Ages

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. To find out the relative ages of rocks, do you need to know their exact ages? Explain.

2. State the principle of superposition.

Which of your two friends is older? To answer this question, you'd need to know their relative ages. You wouldn't need to know the exact age of either of your friends—just who was born first. The same is sometimes true for rock layers.

Real-World Question

Can you determine the relative ages of rock layers?

Materials

paper
pencil

Goals

- **Interpret** illustrations of rock layers and other geological structures and determine the relative order of events.

Procedure

1. **Analyze Figures A** and **B** on the next page.
2. On **Figure A,** identify the relative age of each rock layer, igneous intrusion, fault, and unconformity. For example, the shale layer is the oldest, so mark it with a 1. Mark the next-oldest feature with a 2, and so on.
3. Repeat step 2 for **Figure B.**

LAB (continued)

Figure A

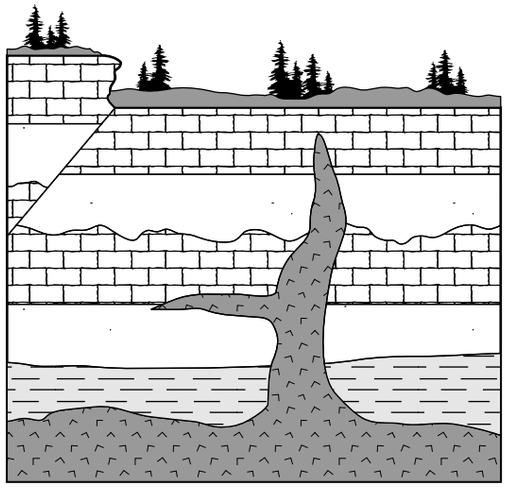
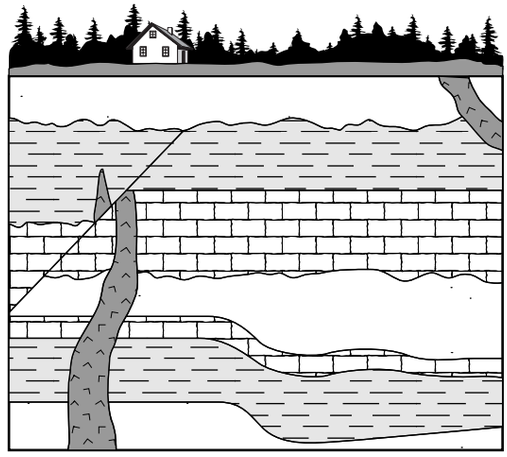


Figure B



Granite Limestone Sandstone Shale

Conclude and Apply

Figure A

1. **Identify** the type of unconformity shown. Is it possible that there were originally more layers of rock than are shown?

2. **Describe** how the rocks above the fault moved in relation to rocks below the fault.

3. **Hypothesize** how the hill on the left side of the figure formed.

Figure B

4. Is it possible to conclude if the igneous intrusion on the left is older or younger than the unconformity nearest the surface?

5. **Describe** the relative ages of the two igneous intrusions. How did you know?

6. **Hypothesize** which two layers of rock might have been much thicker in the past.

Communicating Your Data

Compare your results with other students' results. **For more help, refer to the Science Skill Handbook.**

Model and Invent

Trace Fossils

Lab Preview

Directions: *Answer these questions before you begin the Lab.*

1. What are trace fossils?

2. How will you simulate trace fossils?

Trace fossils can tell you a lot about the activities of organisms that left them. They can tell you how an organism fed or what kind of home it had.

Real-World Question

How can you model trace fossils that can provide information about the behavior of organisms?

Thinking Critically

What materials can you use to model trace fossils? What types of behavior could you show with your trace fossil model?

Goals

- **Construct** a model of trace fossils.
- **Describe** the information that you can learn from looking at your model.

Possible Materials

construction paper	wire
plastic (a fairly rigid type)	scissors
plaster of paris	toothpicks
sturdy cardboard	clay
pipe cleaners	glue

Safety Precautions

Make a Model

1. **Decide** how you are going to make your model. What materials will you need?
2. **Decide** what types of activities you will demonstrate with your model. Were the organisms feeding? Resting? Traveling? Were they predators? Prey? How will your model indicate the activities you chose?
3. What is the setting of your model? Are you modeling the organism's home? Feeding areas? Is your model on land or water? How can the setting affect the way you build your model?
4. Will you only show trace fossils from a single species or multiple species? If you include more than one species, how will you provide evidence of any interaction between the species?

Check the Model Plans

1. Compare your plans with those of others in your class. Did other groups mention details that you had forgotten to think about? Are there any changes you would like to make to your plan before you continue?
2. Make sure your teacher approves your plan before you continue.

Test Your Model

1. Following your plan, construct your model of trace fossils.
2. Have you included evidence of all the behaviors you intended to model?

(continued)

Analyze Your Data

1. **Evaluate** Now that your model is complete, do you think that it adequately shows the behaviors you planned to demonstrate? Is there anything that you think you might want to do differently if you were going to make the model again?

2. **Describe** how using different kinds of materials might have affected your model. Can you think of other materials that would have allowed you to show more detail than you did?

Conclude and Apply

1. **Compare and contrast** your model of trace fossils with trace fossils left by real organisms. Is one more easily interpreted than the other? Explain.

2. **List** behaviors that might not leave any trace fossils. Explain.

Communicating Your Data

Ask other students in your class or another class to look at your model and describe what information they can learn from the trace fossils. Did their interpretations agree with what you intended to show?

LAB 1 Laboratory Activity

Principle of Superposition

The principle of superposition states that beds in a series are laid down with the oldest at the bottom and successively younger layers on top. Beds may be exposed at the surface as a result of folding and uplifting or because of faulting. If part, or all, of a layer is removed by erosion and this surface is covered by a new deposit, the contact is called an unconformity. In some areas, river erosion will cut deeply enough to expose a number of layers, such as in the Grand Canyon.

Strategy

You will construct a map legend.
You will construct a block diagram of an area.
You will write the geologic history of the area.

Materials

block diagram, Figure 1
glue or paste
cardboard, thin
pencils (colored)
scissors
tape (clear)

Procedure

1. Set up a legend for your diagram and select a color for each layer. Record the legend in Table 1.
2. Glue Figure 1 on the cardboard. Color the map according to your legend.
3. Cut out, fold, and tape the block diagram as instructed on Figure 1.

Data and Observations

Table 1

	Color
Layer A	
Layer B	
Layer C	
Layer D	

Questions and Conclusions

1. Which layer is oldest? Explain.

2. What kind of structure do the layers have?

Laboratory Activity 1 (continued)

3. Why is the glacial till not folded?

4. What does the presence of the peat and soil layer in the glacial till tell you?

5. Was this a mountainous area prior to glaciation? Explain.

6. How many advances of the ice occurred here?

7. Write the geologic history of the area illustrated in the block diagram.

Strategy Check

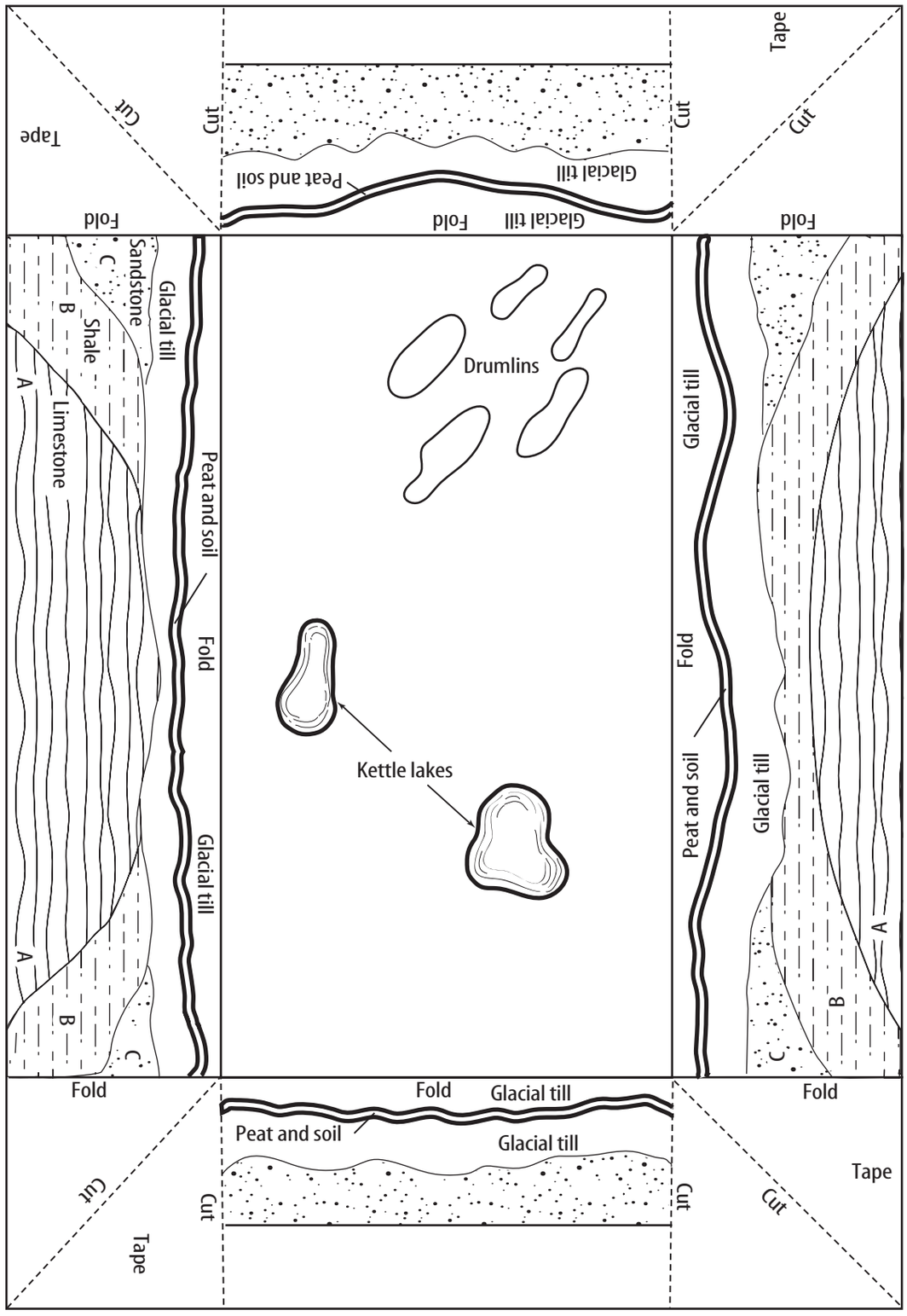
_____ Can you set up a map legend?

_____ Can you construct a block diagram?

_____ Can you write the geologic history of the area illustrated by a block diagram?

Laboratory Activity 1 (continued)

Figure 1



LAB 2 Laboratory Activity

Index Fossils

Fossils found in the deepest layer of undisturbed rocks in an area represent the oldest forms of life in that particular rock formation. When reading Earth history, these layers would be "read" from bottom to top, or oldest to most recent. If a specific fossil is typically found only in a particular type of rock and is found in many places worldwide, the fossil might be useful as index fossil. The index fossil can be useful in determining the age of layers of rock or soil. By comparing this type of information from rock formations in various parts of the world, scientists have been able to establish the geologic time scale.

Strategy

You will make trace fossils from several objects.
You will distinguish between index fossils and other fossils.

Materials

newspaper
objects to use in making trace fossils (3)
clay
container, at least 25 cm × 20 cm × 15 cm (or approximately shoe-box size)
varieties of "soil" (3)
**sand*
**potting soil*
**pea gravel*
**mulch*
**shredded dried leaves*
**fresh grass cuttings*
small shovel
**scoop*
**Alternate materials*

Procedure

1. Cover your desk or table with several layers of newspaper. Select three objects to use to make your trace fossils. Label these objects *A, B,* and *C.*
2. Make trace fossils of the three objects by pressing clay onto each of them. Carefully remove the clay from the objects. Label your trace fossils *A, B,* and *C,* and set your fossils aside. Make a second trace fossil from objects A and C. Label these.
3. Choose three different types of soil. You can have different amounts of each type of soil, but together the three soils should almost fill your container.
4. Layer one type of soil into your container. Bury one trace fossil A in this layer of soil. Sketch this layer in Figure 1 in the Data and Observations section. Be sure to note the location of the fossil.
5. Repeat step 4 twice using a different type of soil for each layer. In the second layer, bury trace fossils A, B, and C. Place only trace fossil C in the third layer. Fossil B is your index fossil.

Laboratory Activity 2 (continued)

6. Choose a time period that each of your soil layers represents, and add this information to Figure 1. Consider the distribution of fossils in the layers of soil when you select the time span for each object. Also, because fossil B is your index fossil, it must represent a unique time period. Be sure that the time period you select for the middle layer does not overlap with the other time spans.
7. Exchange containers with another group. Tell the group when object B, your index fossil, existed.
8. Carefully excavate your new container. Sketch each layer in Figure 2 as you proceed with the excavation. Carefully note where each fossil is found. Compare your sketches with the sketches made by the group who made the container.
9. Based on the age of the index fossil, determine what you can know about a time line for the second container. Add details on what you can tell about the time line to Figure 2.

Data and Observations

Figure 1—First Container

Layer	Bottom	Middle	Top
Time period			
Sketch			

Figure 2—Excavated Container

Layer	Bottom	Middle	Top
Time period			
Sketch			

Laboratory Activity 2 (continued)

Questions and Conclusions

1. Explain why an index fossil must represent a unique time period.

2. Are the three fossils in the middle layer from the same time period?

3. Is fossil A in the deepest layer from the same type of organism as fossil A in the middle layer?

4. Are the two fossils from object A from the same time period? What do you know about the duration of organism A in the geologic time line?

5. What is important to note while you are excavating?

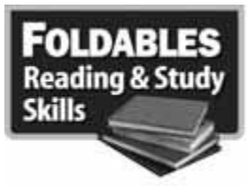
6. Compare your sketch of the container you excavated with the sketch made by the makers of that container? Explain any important differences.

7. Explain how an index fossil is used to determine the age of surrounding fossils.

Strategy Check

_____ Can you make trace fossils from a variety of objects?

_____ Can you determine the index fossil in the excavation?



Clues to Earth's Past

Directions: *Use this page to label your Foldable at the beginning of the chapter.*

Determining Age

Absolute or Relative

Meeting Individual Needs

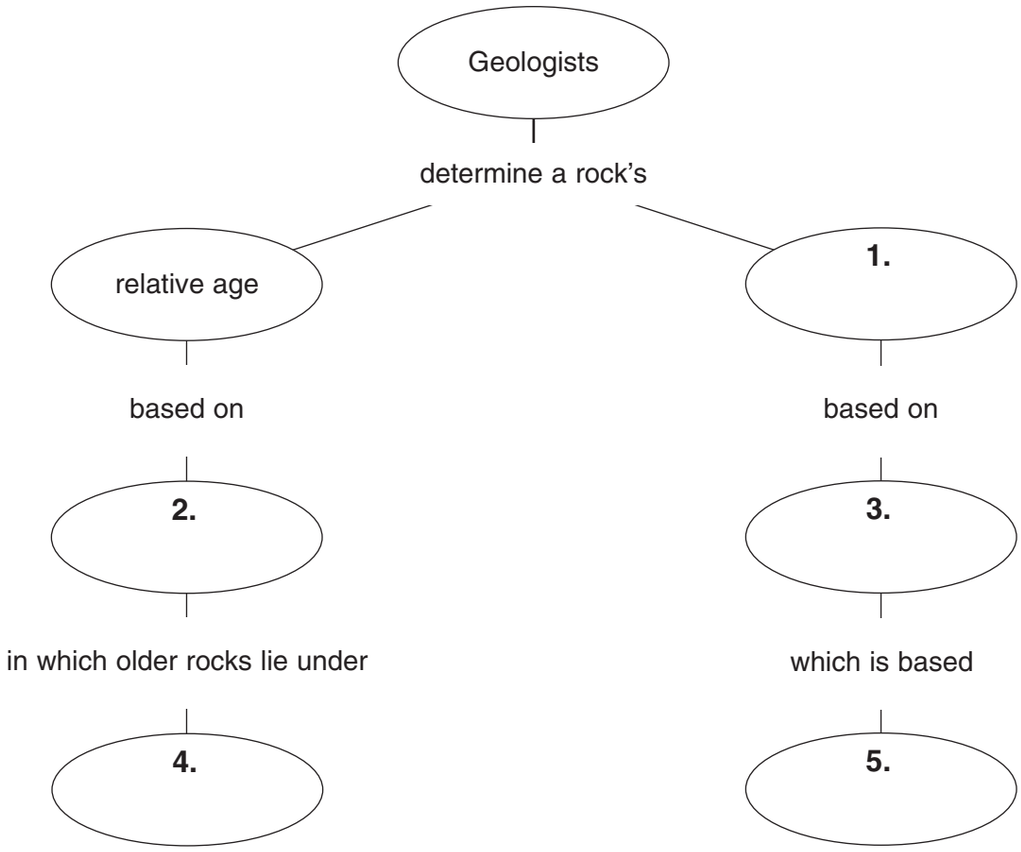
Name Date Class

Directed Reading for Content Mastery

Overview
Clues to Earth's Past

Directions: *Use the following terms to complete the concept map below.*

absolute age **superposition** **radiometric dating**
younger **half-life**



Directions: *Circle the terms in parentheses that best complete the sentences.*

6. (Permineralized remains, Carbon films) are fossils in which the spaces inside are filled with mineralized groundwater.

7. An insect trapped in amber is an example of (a trace fossil, original remains).

Meeting Individual Needs

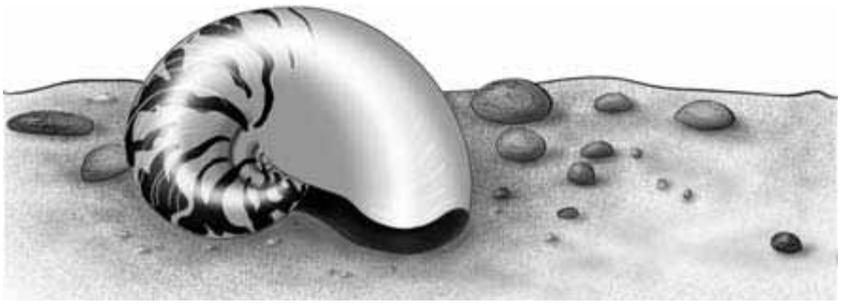
Name Date Class

Directed Reading for Content Mastery

Section 1 ▪ Fossils

Directions: *Complete the following sequencing activity.*

1. Put the events below in the correct sequence on the lines provided.



_____ **a.** The sediment is squeezed and cemented together into rock.

_____ **b.** The seashell becomes buried in sediment.

_____ **c.** Other sediments fill the hollow place and harden into rock.

_____ **d.** A seashell falls into the mud.

_____ **e.** Someone finds the fossil of a seashell buried in sediment and rock.

_____ **f.** Holes in the rock let water and air reach the seashell and dissolve it, leaving behind a hollow place in the rock.

Directions: *Match the terms in Column I with their descriptions in Column II. Write the letter of the correct phrase in the blank at the left.*

Column I

_____ **2.** fossil

_____ **3.** cast

_____ **4.** mold

_____ **5.** index fossil

_____ **6.** carbonaceous film

_____ **7.** permineralized remains

Column II

a. fossil from a species that existed on Earth for a short period of time

b. fossil made from a thin film of carbon atoms and molecules

c. remains imprint, or trace of a once-living organism

d. hard and rocklike fossil

e. cavity left in rock by a decayed organism

f. produced when a cavity is filled in with solid matter

Meeting Individual Needs

Name Date Class

Directed Reading for Content Mastery

Section 2 ▪ Relative Ages of Rocks
Section 3 ▪ Absolute Ages of Rocks

Directions: *In the blank at the left, write the letter of the term or phrase that best completes each statement.*

_____ **1.** In layers of undisturbed sedimentary rock, the oldest rocks are on the _____.

a. top **b.** bottom

_____ **2.** The statement that old rocks are on the bottom in layers of undisturbed rock is called the _____.

a. principle of superposition **b.** tectonic theory

_____ **3.** Sometimes layers of rock are overturned by forces generated by _____.

a. superposition **b.** mountain building

_____ **4.** Determining the age of rocks by examining their position in a layer is called _____.

a. relative dating **b.** faulting

_____ **5.** Gaps in rock layers are called _____.

a. faults **b.** unconformities

_____ **6.** The type of unconformity in which an erosional surface exists in one of several horizontal layers is called a(n) _____.

a. angular unconformity **b.** disconformity

_____ **7.** Matching of rock layers in two different areas is called _____ the layers.

a. concluding **b.** correlating

_____ **8.** One way to match rock layers that are apart is to see if the same type of _____ are found in both places.

a. fossils **b.** water

_____ **9.** In absolute dating, geologists determine the age of rock by reading its _____ decay.

a. organic **b.** radioactive

_____ **10.** When an isotope in the rock decays, a new _____ is formed.

a. element **b.** proton

Meeting Individual Needs

Name Date Class

Directed Reading for Content Mastery

Key Terms
Clues to Earth's Past

Directions: *Match the following terms with the definitions below. Write the terms on the lines provided.*

absolute age	**carbonaceous film**	**superposition**	**cast**	
mold	**unconformity**	**half-life**	**index**	**fossils**
remains	**relative**	**decay**	**dating**	**uniformitarianism**

_____ **1.** any gap in a rock record

_____ **2.** the remains, imprints, or traces of prehistoric organisms

_____ **3.** the thin film of carbon that shows the outline of an organism

_____ **4.** Permineralized _____are fossils in which the spaces inside are filled with minerals from ground water.

_____ **5.** the age, in years, of a rock or other object

_____ **6.** A _____ age is something's age in comparison to something else.

_____ **7.** the time it takes for half of the atoms in an isotope to decay

_____ **8.** Radioactive _____ is the breaking down of some isotopes into other isotopes and particles.

_____ **9.** principle that says if rocks are undisturbed, older layers are under younger layers

_____ **10.** Radiometric _____ is a method used to calculate the absolute age of a rock.

_____ **11.** cavity in rock from which an organism has decayed.

_____ **12.** the principle that Earth processes occurring today are similar to those that occurred in the past

_____ **13.** fossil created when a sediment fills a mold and hardens

_____ **14.** A(n) _____ fossil is the remains of an organism that lived during a specific time that is used to define the age of a particular rock layer.

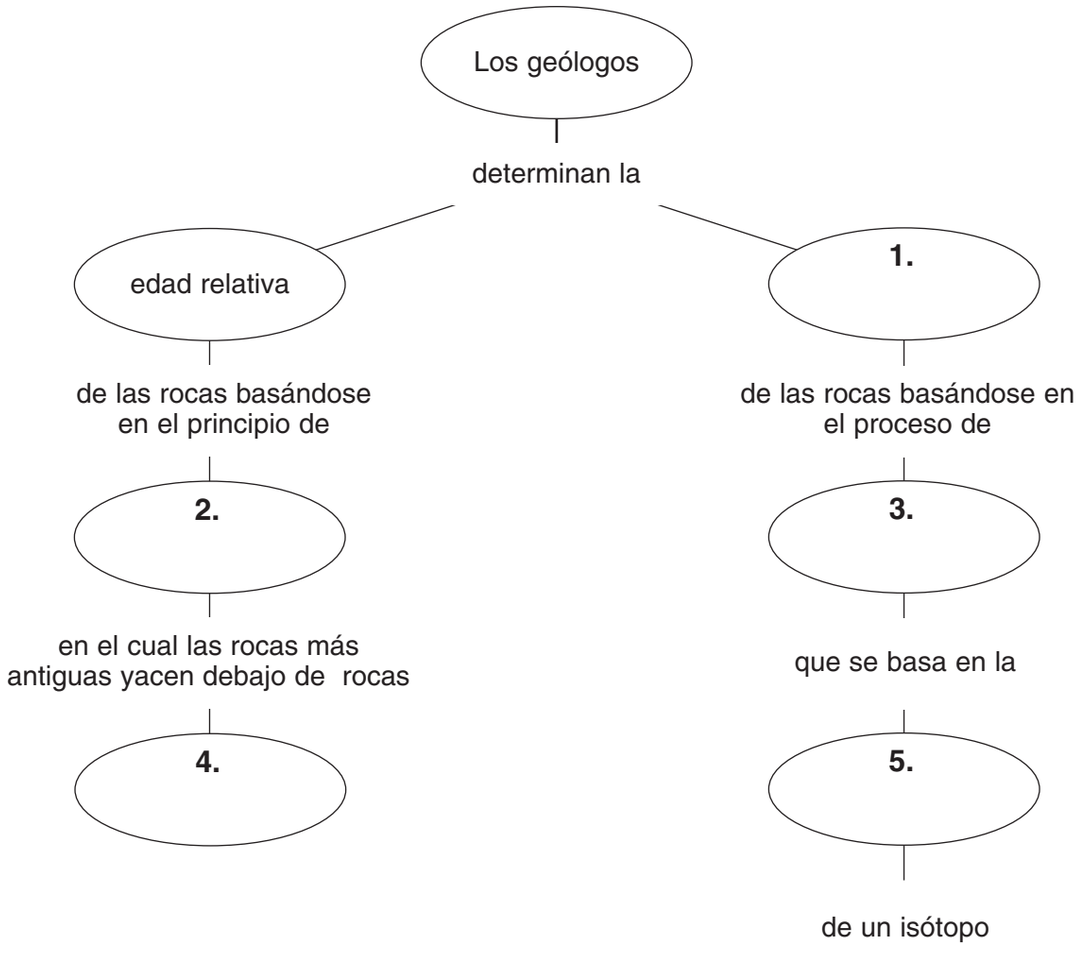
Meeting Individual Needs

Lectura dirigida para Dominio del contenido

Sinopsis
Pistas sobre el pasado de la Tierra

Instrucciones: *Usa los siguientes términos para completar el mapa de conceptos.*

edad absoluta **superposición** **datación radiométrica**
más recientes **media vida**



Instrucciones: *Haz un círculo alrededor de la palabra en paréntesis que mejor complete la oración.*

6. Los(Las) (restos permineralizados, películas carbonáceas) son fósiles en los cuales los espacios internos se han llenado con agua subterránea mineralizada.

7. Un insecto atrapado en ámber es un ejemplo de (una huella fósil, restos originales).

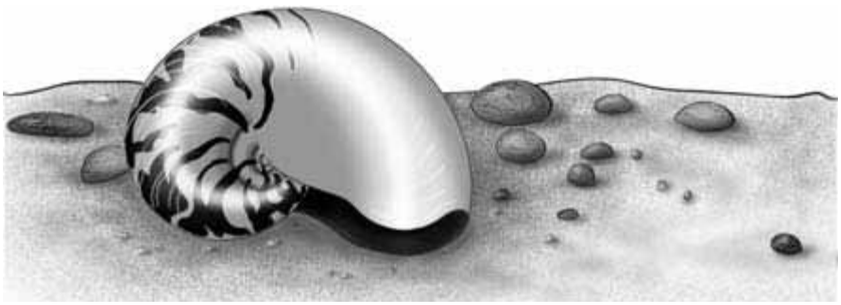
Meeting Individual Needs

Lectura dirigida para Dominio del contenido

Sección 1 ▪ Fósiles

Instrucciones: *Completa la siguiente actividad de secuencias.*

1. Coloca los siguientes eventos en la secuencia correcta, en las líneas dadas.



_____ **a.** El sedimento es comprimido y cementado formando roca.

_____ **b.** El sedimento entierra la concha.

_____ **c.** Otros sedimentos llenan el espacio hueco y se endurecen formando roca.

_____ **d.** Una concha cae al lodo.

_____ **e.** Se encuentra el fósil de una concha enterrada en el sedimento y la roca.

_____ **f.** Los hoyos en la roca permiten que el agua y el aire lleguen a la roca y la disuelvan, dejando solamente un espacio vacío en la roca.

Instrucciones: *Coordina los términos de la Columna I con las definiciones de la Columna II. Escribe la letra de la frase correcta en los espacios a la izquierda.*

Columna I

_____ **2.** fósil

_____ **3.** vaciado

_____ **4.** molde

_____ **5.** fósil guía

_____ **6.** película carbonácea

_____ **7.** restos petrificados

Columna II

a. fósil de una especie que existió en la Tierra durante un corto período de tiempo

b. fósil formado por una lámina fina de átomos y moléculas de carbono

c. restos impresos o como huellas de un organismo que vivió una vez sobre la Tierra

d. duro y como roca

e. cavidad que queda en la roca de un organismo que se descompuso

f. producido cuando una cavidad se llena con material sólido

Meeting Individual Needs

Nombre Fecha Clase

Lectura dirigida para Dominio del contenido

Sección 2 ▪ Edad relativa de las rocas
Sección 3 ▪ Edad absoluta de las rocas

Instrucciones: *Escribe en el espacio a la izquierda la letra del término que complete mejor cada oración.*

_____ **1.** En las capas de roca sin alterar, las rocas más antiguas están en _____.
a. la parte superior **b.** el fondo

_____ **2.** El enunciado que dice que en áreas no alteradas las capas de roca más antiguas están en el fondo, se llama _____.
a. principio de superposición **b.** teoría tectónica

_____ **3.** A veces las capas de roca son invertidas por fuerzas generadas por _____.
a. superposición **b.** actividad tectónica

_____ **4.** La determinación de la edad de las rocas examinando su posición en una capa se llama _____.
a. datación relativa **b.** afallamiento

_____ **5.** Las brechas en las capas rocosas se llaman _____.
a. fallas **b.** discordancias

_____ **6.** El tipo de discordancia en la cual existe una superficie erosiva en una de las capas horizontales se llama un(a) _____.
a. discordancia angular **b.** disconformidad

_____ **7.** Aparear dos rocas en dos áreas diferentes se llama _____ las capas.
a. concluir **b.** correlacionar

_____ **8.** Una manera de correlacionar capas rocosas separadas es ver si el mismo tipo de _____ se encuentra en ambos lugares.
a. fósiles **b.** agua

_____ **9.** En la datación absoluta, los geólogos determinan la edad de una roca leyendo su desintegración _____.
a. orgánica **b.** radioactiva

_____ **10.** Cuando se desintegra un isótopo en las rocas, se forma un(a) _____.
a. elemento **b.** protón

Meeting Individual Needs

Nombre Fecha Clase

Lectura dirigida para Dominio del contenido

Palabras claves
Claves del pasado de la Tierra

Instrucciones: *Aparea el término con su definición. Escribe el término a la izquierda. No usarás todos los términos.*

edad absoluta **película carbonácea** **superposición** **impresión fósil**
molde **discordancia** **media vida** **guía** **fósiles**
restos **relativa** **desintegración** **datación** **uniformitarianismo**

_____ **1.** cualquier brecha en el registro fósil

_____ **2.** restos, impresiones o huellas de organismos prehistóricos

_____ **3.** película de carbono que muestra la forma de un organismo

_____ **4.** _____mineralizados son fósiles en los cuales los espacios internos se llenaron con minerales del agua subterránea.

_____ **5.** la edad, en años, de una roca u otro objeto

_____ **6.** La edad _____ es la edad de algo comparada con algo.

_____ **7.** tiempo que debe transcurrir para que la mitad de los átomos de un isótopo se desintegren

_____ **8.** _____ es la desintegración de algunos isótopos en otros isótopos y partículas.

_____ **9.** principio que dice que si las rocas no han sido alteradas, las rocas más antiguas yacen debajo de las más recientes

_____ **10.** La(El) _____ radiométrica(o) es un método que se usa para calcular la edad absoluta de una roca.

_____ **11.** cavidad en una roca en donde se ha descompuesto un organismo

_____ **12.** principio que establece que los procesos que ocurren hoy en día en la Tierra son similares a los que ocurrieron en el pasado

_____ **13.** fósil creado cuando el sedimento llena un molde y se endurece

_____ **14.** Un fósil _____ son los restos de un organismo que vivió durante un tiempo específico y el cual se usa para definir la edad de una capa rocosa particular.

Meeting Individual Needs

Name _____ Date _____ Class _____

SECTION 1 Reinforcement

Fossils

Directions: *Write* **fossil** *if the statement describes a fossil. Write the word* **no** *in front of statements that do not describe a fossil. After each fossil description, name the type described.*

_____	**1.** oil formed from sea animals of long ago	_____
_____	**2.** bird tracks in snow	_____
_____	**3.** shell-shaped mineral found in rock cavity	_____
_____	**4.** insect in amber from a pine tree	_____
_____	**5.** dinosaur tracks in rocks	_____
_____	**6.** sandstone showing ripple marks from water	_____
_____	**7.** rocklike parts of a species of fish that lived a short time in parts of the world	_____
_____	**8.** arrowhead made thousands of years ago	_____
_____	**9.** dinosaur leg bone containing quartz instead of calcium	_____
_____	**10.** flesh, fur, and bones of a wooly mammoth preserved in frozen ground	_____
_____	**11.** thin cavity in a rock showing where a shell has decayed	_____
_____	**12.** burrows of worms that lived millions of years ago	_____
_____	**13.** living pine tree more than 4000 years old	_____
_____	**14.** thin layer of carbon from the remains of a plant that lived thousands of years ago	_____

Directions: *Answer the following questions on the lines provided.*

15. What must happen to a dead organism if a fossil is to form?

_____

_____

16. What do you know about a rock layer found on a mountain if you find a seashell fossil in the layer?

_____

17. What three kinds of information can geologists gather from a study of fossils?

_____

_____

Meeting Individual Needs

Name Date Class

SECTION 2 Reinforcement

Relative Ages of Rocks

Directions: *In the blank at the left, write the term that completes each statement.*

_____ **1.** Natural laws govern the way geologists determine the age of rock deposits. This technique is called _____.

_____ **2.** The principle of _____ states that an older rock layer and things buried in it occur beneath younger layers unless the layers have been disturbed.

_____ **3.** Some rock layers are incomplete. The gaps are called _____.

_____ **4.** A common cause of gaps in rock layers is _____.

Directions: *Look at the cross-sectional view of the rock layers shown in Figure 1. For each question, decide which of the two named materials is older. Assume the layers have not been overturned. Write the name of the older material on the line provided.*

_____ **5.** tan sandstone and brown sandstone

_____ **6.** brown sandstone and gray limestone

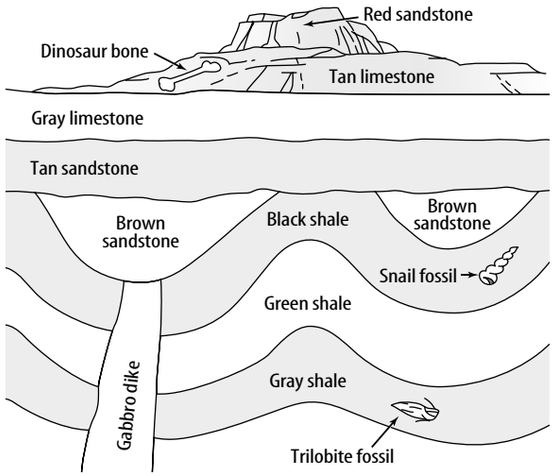
_____ **7.** gabbro dike and brown sandstone

_____ **8.** gabbro dike and gray shale

_____ **9.** snail fossil and trilobite fossil

_____ **10.** snail fossil and dinosaur bone

Figure 1



_____ **11.** snail fossil and green shale

_____ **12.** dinosaur bone and red sandstone

_____ **13.** red sandstone and gray limestone

_____ **14.** tan limestone and tan sandstone

_____ **15.** tan limestone and gray limestone

_____ **16.** The type of unconformity shown in Figure 1 is a(n) _____.

Meeting Individual Needs

Name Date Class

SECTION 3 Reinforcement

Absolute Ages of Rocks

Directions: *Match the terms in Column I with their definitions in Column II. Write the letter of the correct phrase in the blank at the left.*

Column I

_____ **1.** absolute dating

_____ **2.** half-life

_____ **3.** radioactive decay

_____ **4.** radiometric dating

_____ **5.** uniformitarianism

Column II

a. time it takes for half of the atoms in an isotope to decay

b. breaking down of a neutron into a proton and an electron

c. principle that Earth processes occurring today are similar to those that occurred in the past

d. process that uses the properties of atoms in rocks and other objects to determine their ages

e. calculating the absolute age of a rock by measuring the amounts of parent and daughter materials in a rock and by knowing the half-life of the parent material

Directions: *Follow the steps below to demonstrate the radioactive decay of carbon-14. Then answer the questions.*

1. Cut a strip of paper 8 cm long. Think of the paper as all of the carbon-14 in an animal when it died.

2. The idea is to show how you find the age of a rock that contains an animal fossil by using the half-lives of isotopes. Cut the strip of paper in half.

3. Discard one half of the paper. This represents the decayed material. Record the cut in Item 6 below with an X.

4. Continue by cutting the second half of the paper in half. Record the cut below with an X.

5. Continue Steps 3 and 4 until the paper is so small you cannot make another cut. Record each cut you make with an X.

6. Number of cuts: _____

7. What is the total number of times you were able (practically) to cut the sample in half?

_____

8. Each cut represents the half-life of carbon-14. What is the total amount of time represented by each cut?

_____

9. Multiply the number of cuts by the half-life of carbon-14. What is the total amount of time represented by the cuts?

_____

10. Could using the half-life of carbon-14 determine when dinosaurs died? Explain.

_____

Meeting Individual Needs

Name Date Class

SECTION 1 Enrichment

The Hermit Trail Fossil Tracks

Even if you've never been to the Grand Canyon in northwestern Arizona, you've probably read or heard about its size, beauty, and colorful rock formations. But the canyon is also rich with permineralized remains and other fossils. Fossils of sponges, crinoids, bryozoans, brachiopods, mollusks, and plants have all been found there.

An Old, Cold Trail

Of particular interest are the fossilized reptile tracks found on the Hermit Trail. The Hermit Trail is an old Native American route that was originally called Horsethief Trail, but was later renamed for a small camp, Hermit Camp, built at the end of the trail near Hermit Creek. From the late 1800s until the 1930s, Hermit Trail was a bustling place, serving as an entrance to the canyon. Today, tourists visit Hermit Trail, looking at the scenery, rock formations, and the fossilized footprints of several reptile species.

The reptile tracks were found in the Coconino sandstone formations along the Hermit Trail. Coconino sandstone is a cream-colored rock that probably formed from desert-like sand dunes that existed some 270 million years ago. Geologists believe the grains of sand were compressed and, with the addition of bubbling, mineralized groundwater became cemented into the rock we find there today.

Walking the Dunes

Several different-sized reptiles made the tracks, probably by walking in the sand dunes after a rainfall. Just by examining the pattern of the tracks, geologists believe that one of the reptiles pushed back loose sand as it climbed up the dune. They also believe that an animal roughly the size of a cow made the largest of the tracks.

The tracks are examples of trace fossils, the only kind found in the Coconino sandstone. Trace fossils are not fossils in the traditional sense. Instead, they are fossils of something other than the animal or plant's form, like an animal track or burrow, that tells us an animal has been there.

1. What would happen to the trace fossils on the Hermit Trail if tourists walked on them?

2. What is the difference between a fossil of a plant or organism and a trace fossil of an animal?

3. What do the fossilized tracks tell you about the reptiles that once lived in the canyon? Support your answer with evidence from the passage above.

Meeting Individual Needs

Name Date Class

SECTION 2 Enrichment

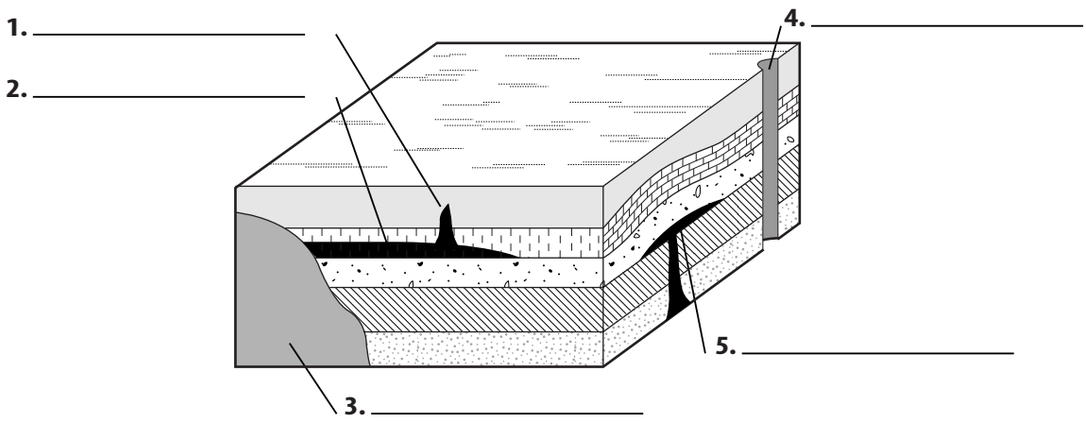
Igneous Intrusions

Do you remember your last birthday? What about the last time you went on a class field trip or had pizza for dinner? Which of these three events happened first? Which two followed and in what order? Placing these events in the order they happened is called relative order.

Geologists use the principles of relative order to help them understand sedimentary rock formations. One type of formation they look for is an igneous intrusion. To intrude is to enter by force. So, an igneous intrusion is when hot magma forces its way into cracks beneath Earth's surface, forming a mass of igneous rock within the sedimentary layers. Using relative order, geologists know that a rock formation with an igneous intrusion means the intrusion occurred after the layering was formed.

Geologists easily recognize igneous intrusions because they have certain identifying features. These features include a vertical, cylindrical structure called a volcanic pipe, as well as a dike, which is the part of the igneous rock that cuts diagonally across the existing rock.

Directions: *Examine the diagram below and, using resources in your library, label the following igneous intrusions:* **volcanic pipe**, **dike**, **sill**, **laccolith**, *and* **batholith**. *Then define the terms in questions 6 through 8 using complete sentences.*



6. sill

7. laccolith

8. batholith

Meeting Individual Needs

Name Date Class

SECTION 3 Enrichment

Calculating Half-Lives

Directions: *You learned in the chapter about the half lives of carbon-14 and radium. Here is a table of some other isotopes and their half-lives. Use the table to answer the questions that follow.*

Isotope	Half-life
Plutonium-238	86 years
Americium-241	433 years
Curium-242	163 days
Berkelium-249	314 days
Californium-249	360 days
Einsteinium-253	20 days
Nobelium-259	1 1/2 hours
Lawrencium-260	180 seconds
Element 103-262	40 seconds

1. If you had a 100-gram sample of plutonium, how much would still remain in 43 years?

2. What happened to the part of the plutonium that is no longer there?

3. If you had a 5-gram sample of Lawrencium, how much would still remain in 30 minutes?

4. If you had a 100-gram sample of Einsteinium, how much would you have left after 40 days?

5. A rock sample contains 7.5 grams of Californium-249 and 52.5 grams of the product into which the Californium has changed. How old is the rock?

Meeting Individual Needs

Name Date Class

Note-taking Worksheet

Clues to Earth's Past

Section 1 Fossils

A. _____ study fossils and reconstruct the appearance of animals.

B. _____—remains, imprints, or traces of prehistoric organisms

1. Fossils can form if the organism is quickly _____ by sediments.
2. Organisms with _____ are more likely to become fossils than organisms with soft parts.

C. Types of _____

1. Fossils in which spaces inside are filled with minerals from groundwater are called _____ **remains**.
2. _____ results when a thin film or carbon residue forms a silhouette of the original organism; carbonized plant material becomes _____.
3. _____—cavity in rock left when the hard parts of an organism decay
4. If sediments wash into a mold, they can form a _____ of the original organism.
5. Occasionally _____ remains are preserved in a material such as amber, ice, or tar.
6. _____—evidence of an organism's activities
   - **a.** Can be _____ left in mud or sand that became stone
   - **b.** Can be trails or _____ made by worms and other animals

D. _____—abundant, geographically widespread organisms that existed for relatively short periods of time

E. Fossils can reveal information about past land forms and _____.

Section 2 Relative Ages of Rocks

A. Principle of _____—process of reading undisturbed rock layers

1. _____ rocks in the bottom layer
2. _____ rocks in the top layers

B. How old something is in comparison with something else is its _____.

1. The age of _____ rocks can be determined by examining layer sequences.
2. The age of disturbed rocks may have to be determined by _____ or other clues.

Meeting Individual Needs

Note-taking Worksheet (continued)

C. _____—gaps in rock layers

1. _____ unconformity—rock layers are tilted, and younger sediment layers are deposited horizontally on top of the eroded and tilted layers.
2. A layer of horizontal rock once exposed and eroded before younger rocks formed over it is called a _____.
3. _____—sedimentary rock forms over eroded metamorphic or igneous rock.

D. The same rock layers can be found in different locations; fossils can be used to _____ those rock layers.

Section 3 Absolute Ages of Rocks

A. _____—age, in years, of a rock or other object; determined by properties of atoms

B. Unstable isotopes break down into other isotopes and particles in the process of _____ **decay.**

1. _____—an isotope's neutron breaks down into a proton and an electron with the electron leaving the atom as a beta particle; a new element forms due to proton gain.
2. _____—an isotope gives off two protons and two neutrons as an alpha particle; a new element forms.
3. The time it takes for half the atoms in an isotope to decay is the isotope's _____.

C. Calculating the absolute age of a rock using the ratio of parent isotope to daughter product and the half-life of the parent is called **radiometric** _____.

1. _____ dating is used to date ancient rocks millions of years old.
2. _____ dating is used to date bones, wood, and charcoal up to 75,000 years old.
3. Earth is estimated to be about 4.5 billion years old; the oldest known rocks are about _____ years old.

D. _____—Earth processes occurring today are similar to those that occurred in the past.

Assessment

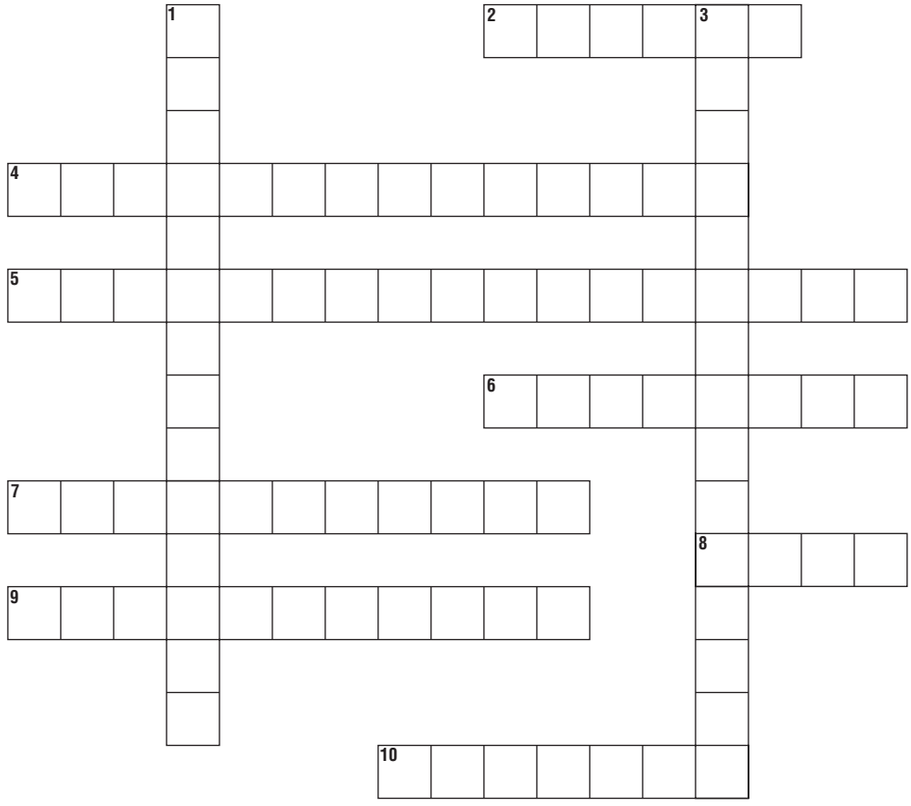
Name Date Class

Chapter Review

Clues to Earth's Past

Part A. Vocabulary Review

Directions: *Use the clues below to complete the crossword puzzle.*



Across

2. Element found in tissues of most organisms

4. Method using properties of atoms in rocks and other objects to determine their ages

5. Principle stating that Earth's processes occurring today are similar to those that occurred in the past

6. Time it takes for half of the atoms in a radioactive element to decay

7. Kind of decay that results in the formation of a different element

8. Cavity left in rock by a decayed organism

9. Method of dating rocks when the amounts of parent and daughter materials are measured

10. Remains, imprints, or traces of once-living organisms

Down

1. Gaps found in rock records

3. Actual organism or parts of organism protected from decay

Assessment

Chapter Review (continued)

Part B. Concept Review

Directions: *Complete the chart to describe different types of fossils.*

Type of fossil	Description
1. Permineralized remains	
2. Carbonaceous film	
3. Mold	
4. Cast	
5. Trace fossils	
6. Index fossils	

Directions: *Answer the questions on the lines provided.*

7. Explain what the concept of uniformitarianism means.

8. How do geologists use fossils to determine rock ages? What are these fossils called?

9. Explain how a dead organism may become a fossil.

Transparency Activities

Name Date Class

SECTION 1 Section Focus Transparency Activity

Guess Again

If you were asked to identify these objects, you'd probably say they were sections of tree trunks. Tree trunks are made of wood, right? Look again and you might come to a different conclusion.

1. **What did you decide these trunks are made of? Why?**
2. **What usually happens to a tree after it dies?**
3. **Name some ways that ancient organisms are sometimes preserved.**

Name Date Class

SECTION 2 Section Focus Transparency Activity

Older than the Hills

Some of the oldest exposed rock in North America is in the Canadian Shield. This picture was taken at Hudson Bay, which is a large bay in northeastern Canada.

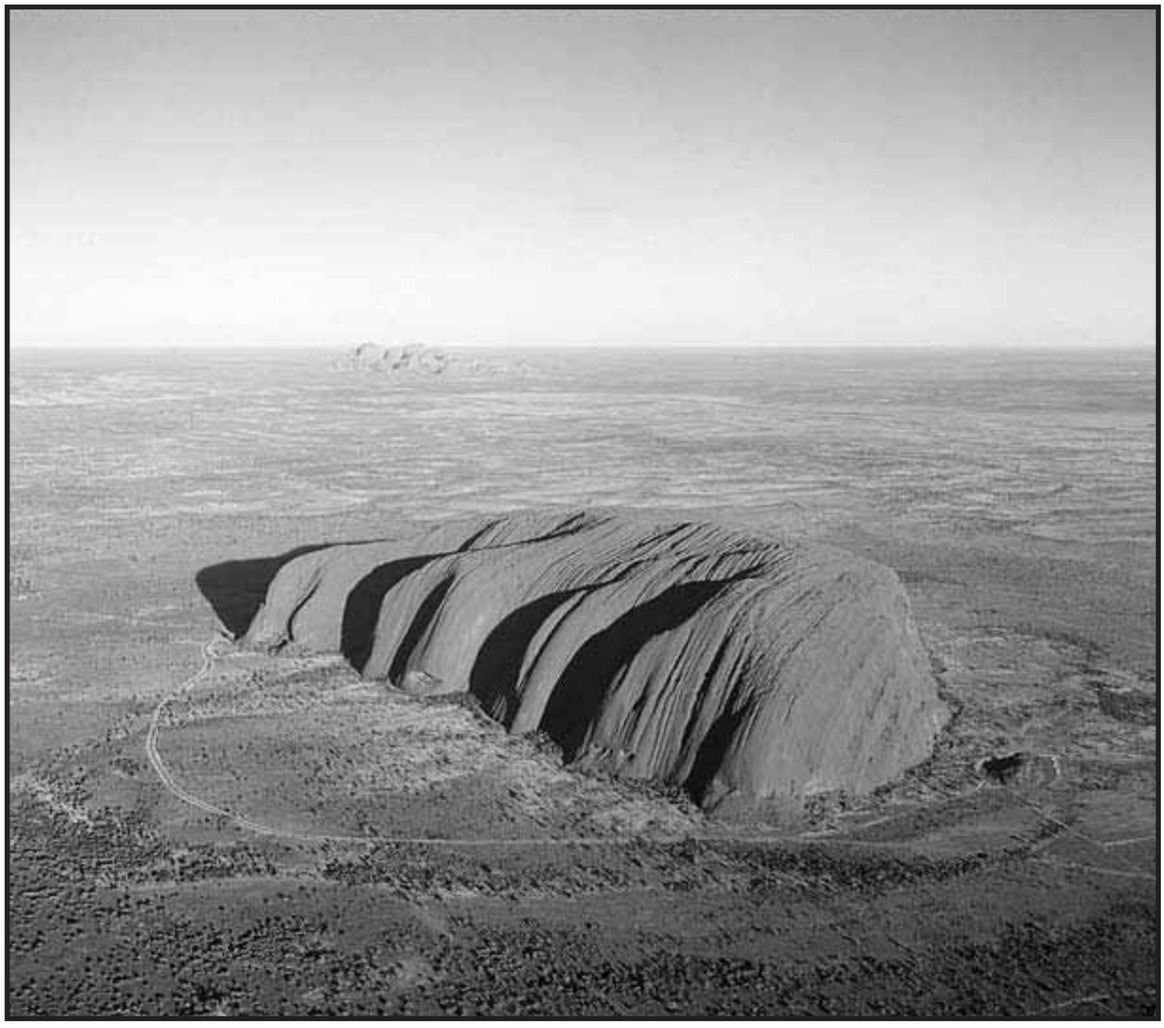
1. **Where do you think the layers of old rock should be, on top or on the bottom? Explain.**
2. **If the Canadian Shield is made of really old rock, what happened to the layers of young rock?**
3. **Why would it be difficult to grow anything here?**

Name Date Class

SECTION 3 Section Focus Transparency Activity

One Big Rock

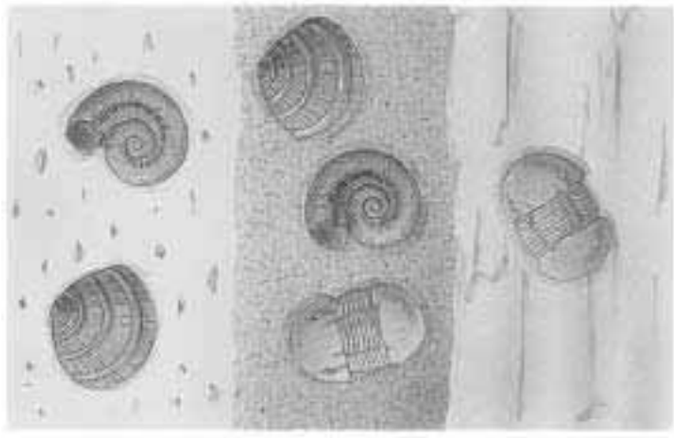
Uluru National Park in Australia's Northern Territory is the site of the world's largest monolith. Made of sandstone, the Uluru monolith has been shaped by erosion.

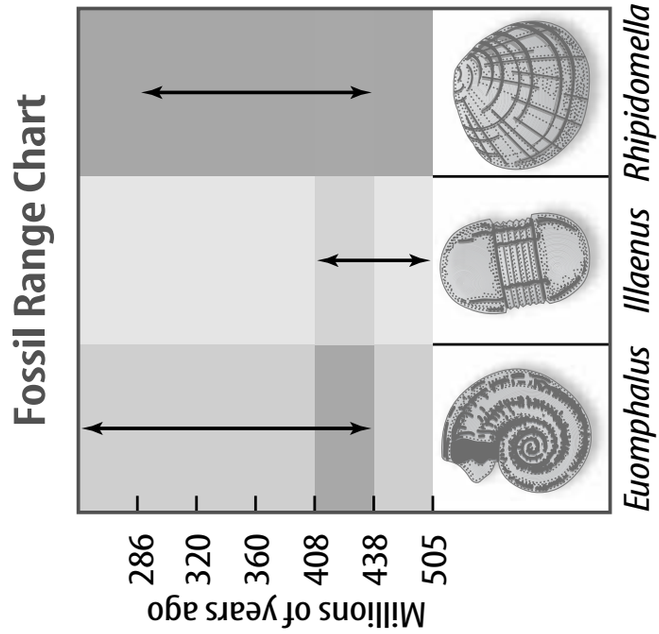


1. **Look at the terrain surrounding Uluru. What clues does it give you about how the monolith was formed?**
2. **If the process of shaping Uluru has taken hundreds of millions of years, what does that tell you about the age of Earth?**

SECTION 1 Teaching Transparency Activity

Index Fossils





Name Date Class

Teaching Transparency Activity (continued)

1. What are index fossils?

2. How do scientists use index fossils?

3. Which of the three fossil specimens existed over the longest span of time?

4. When did Illaenus live?

5. When did Rhipidomella live?

6. Which fossil shown is the index fossil? How do you know?

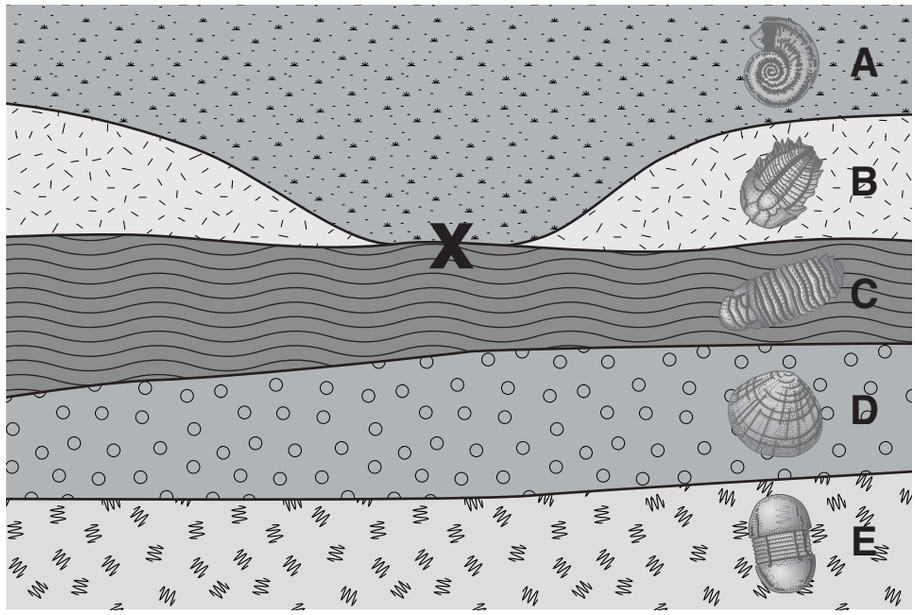
7. Look at the diagram on the right. During what time period was the middle layer of rock deposited? How do you know?

Name Date Class

Assessment Transparency Activity

Clues to Earth's Past

Directions: *Carefully review the diagram and answer the following questions.*



1. In which layer is the fossil most likely the oldest?

A layer B
B layer C
C layer D
D layer E

2. What type of feature is present at the letter X?

F trace fossil
G carbonaceous film
H unconformity
J carbon-14

3. Which of these processes most likely contributed to the formation of these layers of rock?

A sedimentation
B earthquakes
C tidal waves
D radioactive decay