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## Additional Assessment Resources available with Glencoe Science:

- ExamView® Pro Testmaker
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at msscience.com
- Interactive Chalkboard
- The Glencoe Science Web site at: msscience.com
- An interactive version of this textbook along with assessment resources are available online at: mhln.com
To the Teacher

This chapter-based booklet contains all of the resource materials to help you teach this chapter more effectively. Within you will find:

Reproducible pages for
■ Student Assessment
■ Hands-on Activities
■ Meeting Individual Needs (Extension and Intervention)
■ Transparency Activities

A teacher support and planning section including
■ Content Outline of the chapter
■ Spanish Resources
■ Answers and teacher notes for the worksheets

Hands-On Activities

MiniLAB and Lab Worksheets: Each of these worksheets is an expanded version of each lab and MiniLAB found in the Student Edition. The materials lists, procedures, and questions are repeated so that students do not need their texts open during the lab. Write-on rules are included for any questions. Tables/charts/graphs are often included for students to record their observations. Additional lab preparation information is provided in the Teacher Guide and Answers section.

Laboratory Activities: These activities do not require elaborate supplies or extensive pre-lab preparations. These student-oriented labs are designed to explore science through a stimulating yet simple and relaxed approach to each topic. Helpful comments, suggestions, and answers to all questions are provided in the Teacher Guide and Answers section.

Foldables: At the beginning of each chapter there is a Foldables: Reading & Study Skills activity written by renowned educator, Dinah Zike, that provides students with a tool that they can make themselves to organize some of the information in the chapter. Students may make an organizational study fold, a cause and effect study fold, or a compare and contrast study fold, to name a few. The accompanying Foldables worksheet found in this resource booklet provides an additional resource to help students demonstrate their grasp of the concepts. The worksheet may contain titles, subtitles, text, or graphics students need to complete the study fold.

Meeting Individual Needs (Extension and Intervention)

Directed Reading for Content Mastery: These worksheets are designed to provide students with learning difficulties with an aid to learning and understanding the vocabulary and major concepts of each chapter. The Content Mastery worksheets contain a variety of formats to engage students as they master the basics of the chapter. Answers are provided in the Teacher Guide and Answers section.
Directed Reading for Content Mastery (in Spanish): A Spanish version of the Directed Reading for Content Mastery is provided for those Spanish-speaking students who are learning English.

Reinforcement: These worksheets provide an additional resource for reviewing the concepts of the chapter. There is one worksheet for each section, or lesson, of the chapter. The Reinforcement worksheets are designed to focus primarily on science content and less on vocabulary, although knowledge of the section vocabulary supports understanding of the content. The worksheets are designed for the full range of students; however, they will be more challenging for your lower-ability students. Answers are provided in the Teacher Guide and Answers section.

Enrichment: These worksheets are directed toward above-average students and allow them to explore further the information and concepts introduced in the section. A variety of formats are used for these worksheets: readings to analyze; problems to solve; diagrams to examine and analyze; or a simple activity or lab which students can complete in the classroom or at home. Answers are provided in the Teacher Guide and Answers section.

Note-taking Worksheet: The Note-taking Worksheet mirrors the content contained in the teacher version—Content Outline for Teaching. They can be used to allow students to take notes during class, as an additional review of the material in the chapter, or as study notes for students who have been absent.

Assessment

Chapter Review: These worksheets prepare students for the chapter test. The Chapter Review worksheets cover all major vocabulary, concepts, and objectives of the chapter. The first part is a vocabulary review and the second part is a concept review. Answers and objective correlations are provided in the Teacher Guide and Answers section.

Chapter Test: The Chapter Test requires students to use process skills and understand content. Although all questions involve memory to some degree, you will find that your students will need to discover relationships among facts and concepts in some questions, and to use higher levels of critical thinking to apply concepts in other questions. Each chapter test normally consists of four parts: Testing Concepts measures recall and recognition of vocabulary and facts in the chapter; Understanding Concepts requires interpreting information and more comprehension than recognition and recall—students will interpret basic information and demonstrate their ability to determine relationships among facts, generalizations, definitions, and skills; Applying Concepts calls for the highest level of comprehension and inference; Writing Skills requires students to define or describe concepts in multiple sentence answers. Answers and objective correlations are provided in the Teacher Guide and Answers section.

Transparency Activities

Section Focus Transparencies: These transparencies are designed to generate interest and focus students’ attention on the topics presented in the sections and/or to assess prior knowledge. There is a transparency for each section, or lesson, in the Student Edition. The reproducible student masters are located in the Transparency Activities section. The teacher material, located in the Teacher Guide and Answers section, includes Transparency Teaching Tips, a Content Background section, and Answers for each transparency.
**Teaching Transparencies:** These transparencies relate to major concepts that will benefit from an extra visual learning aid. Most of these transparencies contain diagrams/photos from the Student Edition. There is one Teaching Transparency for each chapter. The Teaching Transparency Activity includes a black-and-white reproducible master of the transparency accompanied by a student worksheet that reviews the concept shown in the transparency. These masters are found in the Transparency Activities section. The teacher material includes Transparency Teaching Tips, a Reteaching Suggestion, Extensions, and Answers to Student Worksheet. This teacher material is located in the Teacher Guide and Answers section.

**Assessment Transparencies:** An Assessment Transparency extends the chapter content and gives students the opportunity to practice interpreting and analyzing data presented in charts, graphs, and tables. Test-taking tips that help prepare students for success on standardized tests and answers to questions on the transparencies are provided in the Teacher Guide and Answers section.

**Teacher Support and Planning**

**Content Outline for Teaching:** These pages provide a synopsis of the chapter by section, including suggested discussion questions. Also included are the terms that fill in the blanks in the students’ Note-taking Worksheets.

**Spanish Resources:** A Spanish version of the following chapter features are included in this section: objectives, vocabulary words and definitions, a chapter purpose, the chapter Activities, and content overviews for each section of the chapter.
Reproducible Student Pages

Reproducible Student Pages

- **Hands-On Activities**
  - MiniLAB: Try at Home *Predicting Fossil Preservation* ............ 3
  - MiniLAB: *Modeling Carbon-14 Dating* .......................... 4
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Hands-On Activities
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.
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?
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

dpaper
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.
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.
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
- plastic (a fairly rigid type)
- plaster of paris
- sturdy cardboard
- pipe cleaners
- wire
- scissors
- toothpicks
- clay
- 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?
Lab (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?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
**Data and Observations**

### Table 1

<table>
<thead>
<tr>
<th>Layer</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer A</td>
<td></td>
</tr>
<tr>
<td>Layer B</td>
<td></td>
</tr>
<tr>
<td>Layer C</td>
<td></td>
</tr>
<tr>
<td>Layer D</td>
<td></td>
</tr>
</tbody>
</table>

### Questions and Conclusions

1. Which layer is oldest? Explain.

2. What kind of structure do the layers have?
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

[Diagram showing Earth's geological layers and features such as Glacial till, Peat and soil, Sandstone, Shale, Limestone, Drumlins, and Kettle lakes.]
Hands-On Activities

**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 timeline for the second container. Add details on what you can tell about the timeline to Figure 2.

Data and Observations

Figure 1—First Container

<table>
<thead>
<tr>
<th>Layer</th>
<th>Bottom</th>
<th>Middle</th>
<th>Top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sketch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2—Excavated Container

<table>
<thead>
<tr>
<th>Layer</th>
<th>Bottom</th>
<th>Middle</th>
<th>Top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sketch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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?
Directions: Use this page to label your Foldable at the beginning of the chapter.

Determining Age

Absolute or Relative
Meeting Individual Needs
Overview
Clues to Earth’s Past

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

absolute age        superposition        radiometric dating
younger            based on

Geologists
determine a rock’s

relative age
based on

1.

in which older rocks lie under

2.

3.

which is based

4.

5.

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).
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.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. fossil</td>
<td>a. fossil from a species that existed on Earth for a short period of time</td>
</tr>
<tr>
<td>3. cast</td>
<td>b. fossil made from a thin film of carbon atoms and molecules</td>
</tr>
<tr>
<td>4. mold</td>
<td>c. remains imprint, or trace of a once-living organism</td>
</tr>
<tr>
<td>5. index fossil</td>
<td>d. hard and rocklike fossil</td>
</tr>
<tr>
<td>6. carbonaceous film</td>
<td>e. cavity left in rock by a decayed organism</td>
</tr>
<tr>
<td>7. permineralized remains</td>
<td>f. produced when a cavity is filled in with solid matter</td>
</tr>
</tbody>
</table>
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
**Key Terms**

**Clues to Earth’s Past**

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

<table>
<thead>
<tr>
<th>absolute age</th>
<th>carbonaceous film</th>
<th>superposition</th>
<th>cast</th>
</tr>
</thead>
<tbody>
<tr>
<td>mold</td>
<td>unconformity</td>
<td>half-life</td>
<td>index</td>
</tr>
<tr>
<td>remains</td>
<td>relative</td>
<td>decay</td>
<td>dating</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>uniformitarianism</td>
</tr>
</tbody>
</table>

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.
**Sinopsis**

Pistas sobre el pasado de la Tierra

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

<table>
<thead>
<tr>
<th>edad absoluta</th>
<th>superposición</th>
<th>datación radiométrica</th>
</tr>
</thead>
<tbody>
<tr>
<td>más recientes</td>
<td></td>
<td>media vida</td>
</tr>
</tbody>
</table>

Los geólogos determinan la edad de las rocas basándose en el principio de

- 1. de las rocas basándose en el proceso de
- 2. en el cual las rocas más antiguas yacen debajo de rocas
- 3. que se basa en la
- 4. de un isótopo

**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).
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.

<table>
<thead>
<tr>
<th>Columna I</th>
<th>Columna II</th>
</tr>
</thead>
<tbody>
<tr>
<td>______ 2. fósil</td>
<td>a. fósil de una especie que existió en la Tierra durante un corto período de tiempo</td>
</tr>
<tr>
<td>______ 3. vaciado</td>
<td>b. fósil formado por una lámina fina de átomos y moléculas de carbono</td>
</tr>
<tr>
<td>______ 4. molde</td>
<td>c. restos impresos o como huellas de un organismo que vivió una vez sobre la Tierra</td>
</tr>
<tr>
<td>______ 5. fósil guía</td>
<td>d. duro y como roca</td>
</tr>
<tr>
<td>______ 6. película carbonácea</td>
<td>e. cavidad que queda en la roca de un organismo que se descompuso</td>
</tr>
<tr>
<td>______ 7. restos petrificados</td>
<td>f. producido cuando una cavidad se llena con material sólido</td>
</tr>
</tbody>
</table>

Pistas sobre el pasado de la Tierra
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
**Instrucciones:** Aparea el término con su definición. Escribe el término a la izquierda. No usarás todos los términos.

<table>
<thead>
<tr>
<th>término</th>
<th>definición</th>
</tr>
</thead>
<tbody>
<tr>
<td>edad absoluta</td>
<td>la edad, en años, de una roca u otro objeto</td>
</tr>
<tr>
<td>película carbonácea</td>
<td>mineralizados son fósiles en los cuales los espacios internos se llenaron con minerales del agua subterránea.</td>
</tr>
<tr>
<td>superposición</td>
<td>tiempo que debe transcurrir para que la mitad de los átomos de un isótopo se desintegren</td>
</tr>
<tr>
<td>impresión fósil</td>
<td>es la desintegración de algunos isótopos en otros isótopos y partículas.</td>
</tr>
<tr>
<td>molde</td>
<td>principio que dice que si las rocas no han sido alteradas, las rocas más antiguas yacen debajo de las más recientes</td>
</tr>
<tr>
<td>discordancia</td>
<td>principio que establece que los procesos que ocurren hoy en día en la Tierra son similares a los que ocurrieron en el pasado</td>
</tr>
<tr>
<td>media vida</td>
<td>fósil creado cuando el sedimento llena un molde y se endurece</td>
</tr>
<tr>
<td>guía</td>
<td>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.</td>
</tr>
<tr>
<td>fósiles</td>
<td></td>
</tr>
<tr>
<td>restos</td>
<td></td>
</tr>
<tr>
<td>relativa</td>
<td></td>
</tr>
<tr>
<td>desintegración</td>
<td></td>
</tr>
<tr>
<td>datación</td>
<td></td>
</tr>
<tr>
<td>uniformitarianismo</td>
<td></td>
</tr>
</tbody>
</table>
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?
**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
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) ____________.
### 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.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. absolute dating</td>
<td>a. time it takes for half of the atoms in an isotope to decay</td>
</tr>
<tr>
<td>2. half-life</td>
<td>b. breaking down of a neutron into a proton and an electron</td>
</tr>
<tr>
<td>3. radioactive decay</td>
<td>c. principle that Earth processes occurring today are similar to those that occurred in the past</td>
</tr>
<tr>
<td>4. radiometric dating</td>
<td>d. process that uses the properties of atoms in rocks and other objects to determine their ages</td>
</tr>
<tr>
<td>5. uniformitarianism</td>
<td>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</td>
</tr>
</tbody>
</table>

**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? 
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.
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.

1. __________
2. __________
3. __________
4. __________
5. __________

6. sill

________________________________________________________

7. laccolith

________________________________________________________

8. batholith

________________________________________________________
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.

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

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?
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.
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
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
**Part B. Concept Review**

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

<table>
<thead>
<tr>
<th>Type of fossil</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Permineralized remains</td>
<td></td>
</tr>
<tr>
<td>2. Carbonaceous film</td>
<td></td>
</tr>
<tr>
<td>3. Mold</td>
<td></td>
</tr>
<tr>
<td>4. Cast</td>
<td></td>
</tr>
<tr>
<td>5. Trace fossils</td>
<td></td>
</tr>
<tr>
<td>6. Index fossils</td>
<td></td>
</tr>
</tbody>
</table>

**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.
## I. Testing Concepts

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

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. cast</td>
<td>a. produced when sediments fill in a cavity made when an object decayed</td>
</tr>
<tr>
<td>2. carbonaceous film</td>
<td>b. cavity in rock made when an organism decayed</td>
</tr>
<tr>
<td>3. index fossils</td>
<td>c. principle that Earth’s processes occurring today are similar to those that occurred in the past</td>
</tr>
<tr>
<td>4. fossil</td>
<td>d. process that uses the properties of atoms in rocks and other objects to determine their ages</td>
</tr>
<tr>
<td>5. half-life</td>
<td>e. states that in a sequence of undisturbed rocks, the oldest rocks are on the bottom and the rocks become progressively younger toward the top</td>
</tr>
<tr>
<td>6. principle of superposition</td>
<td>f. gaps in rock records made when agents of erosion remove existing rock layers</td>
</tr>
<tr>
<td>7. absolute dating</td>
<td>g. method by which a geologist can calculate the absolute age of the rock by knowing the half-life of an isotope</td>
</tr>
<tr>
<td>8. mold</td>
<td>h. time it takes for half of an isotope’s atoms to decay</td>
</tr>
<tr>
<td>9. radioactive decay</td>
<td>i. fossil of thin layer of carbon atoms and molecules</td>
</tr>
<tr>
<td>10. relative dating</td>
<td>j. formed when original materials in skeletal remains are replaced by minerals</td>
</tr>
<tr>
<td>11. unconformities</td>
<td>k. method by which order of events or age of rocks is determined by examining the position of rocks in a layer</td>
</tr>
<tr>
<td>12. radiometric dating</td>
<td>l. remains, imprints, or traces of once-living organisms</td>
</tr>
<tr>
<td>13. uniformitarianism</td>
<td>m. process that occurs when the number of protons in an atom is changed and a new element is formed</td>
</tr>
<tr>
<td>14. permineralized remains</td>
<td>n. fossils of species that existed for short periods and were widespread</td>
</tr>
</tbody>
</table>
Chapter Test (continued)

Directions: Determine whether each of the following statements is true or false. Write true or false in the blank. Rewrite each false statement to make it true.

15. A fossil may tell a geologist when, where, and how an organism lived.  

16. A permineralized bone is composed of calcium.  

17. The soft parts of organisms are most likely to become fossils.  

18. Preserved animal tracks are trace fossils.  

19. Only a radioactive isotope will have a half-life.  

20. Any fossil can be dated by the amount of carbon-14 it contains.

II. Understanding Concepts

Skill: Concept Mapping

Directions: Complete the concept map below by writing the conditions for fossil formation and the types of fossils in the circles.

Assessment

- Quick burial
- Provide the conditions to create carbonaceous fossils
- Fossils
- Original remains
- Mold
- Preserved animal tracks
- Trace fossils
- Carbonaceous fossils
- Mold
- Original remains
- Fossils
6. What is the difference between relative and absolute dating?

Skill: Interpreting Data

Directions: Study the figure of the rock record. Then answer the questions on the lines provided.

7. List events A–F in the order they occurred, beginning with the oldest event.

8. When did the fault occur?

Skill: Using Tables

9. Complete the table below to show the amounts of parent and daughter materials left of a radioactive element after three half-lives if the original parent had a mass of 80 g.

<table>
<thead>
<tr>
<th>Number of half-lives</th>
<th>Parent material</th>
<th>Daughter product</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

III. Applying Concepts

Writing Skills

Directions: Answer the following questions using complete sentences.

1. If horizontal layers of sedimentary rock have a vertical fault running through them, how might a geologist use relative dating to determine when the fault occurred?
2. Explain how a trace fossil can provide information on how an organism lived.

3. Explain what is meant by correlating rock layers.

4. Do all rocks contain fossils? Describe the conditions necessary for fossils to form.

5. Explain what the term *half-life* means and how knowing the half-life of an isotope can help a geologist establish the age of a rock or fossil.
Transparency Activities
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.
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?
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?
Index Fossils

Clues to Earth's Past

Transparency Activities

Activity

Illaenus Rhipidomella Euomphalus

Fossil Range Chart

Millions of Years Ago

286 3.20 360 408 438 505

Eumorphus Ildenus Rhipidomella
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?
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
Teacher Support and Planning

Teacher Support and Planning
Content Outline for Teaching ......................... T2
Spanish Resources ...................................... T5
Teacher Guide and Answers ....................... T9
Clues to the Earth’s Past

Section 1  Fossils

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

B. **Fossils**—remains, imprints, or traces of prehistoric organisms
   1. Fossils can form if the organism is quickly buried by sediments.
   2. Organisms with **hard parts** are more likely to become fossils than organisms with soft parts.

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

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

E. Fossils can reveal information about past land forms and **climate**.

**DISCUSSION QUESTION:**
Why are original remains seldom found? *Because the conditions necessary for the preservation of original remains are very rare. For original remains to be preserved, an organism must be surrounded and protected by a substance like amber, ice, or tar.*
Section 2  Relative Ages of Rocks

A. Principle of superposition—process of reading undisturbed rock layers
   1. oldest rocks in the bottom layer
   2. younger rocks in the top layers

B. How old something is in comparison with something else is its relative age.
   1. The age of undisturbed rocks can be determined by examining layer sequences.
   2. The age of disturbed rocks may have to be determined by fossils or other clues

C. Unconformities—gaps in rock layers
   1. Angular 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 disconformity.
   3. Nonconformity—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 correlate those rock layers.

DISCUSSION QUESTION:
What is the difference between a disconformity and a nonconformity? Disconformity—horizontal sedimentary rock layers are exposed, eroded, and then covered with younger sedimentary rock. A nonconformity develops when sedimentary rock forms over metamorphic or igneous rock.
Content Outline for Teaching (continued)

Section 3 Absolute Ages of Rocks

A. Absolute age—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 radioactive decay.
   1. Beta decay—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. Alpha decay—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 half-life.

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 dating.
   1. Potassium-argon dating is used to date ancient rocks millions of years old.
   2. Carbon-14 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 3.96 billion years old.

D. Uniformitarianism—Earth processes occurring today are similar to those which occurred in the past

DISCUSSION QUESTION:
To determine the age of ancient rock, is it better to use potassium-argon dating or carbon-14 dating? Why? Potassium-argon dating is better because the parent isotope has a longer half-life.
Pistas sobre el pasado de la Tierra

**Fósiles**

Lo que aprenderás
- enumerar las condiciones necesarias para la formación de fósiles.
- A describir varios procesos en la formación de fósiles.
- A explicar cómo se usa la correlación entre fósiles para determinar la edad de las rocas.
- A determinar cómo se pueden usar los fósiles para explicar cambios en la superficie terrestre, formas de vida y medio ambientes.

Vocabulario
- fossils / fósiles: restos, impresiones o trazas de organismos prehistóricos que pueden indicar cuándo y dónde los organismos vivieron y cómo vivieron.
- permineralized remains / restos permineralizados: fósiles cuyos espacios interiores están llenos de minerales los cuales provienen de aguas subterráneas.
- carbon film / película carbonácea: fina película de residuo carbonoso preservada como fósil.
- mold / molde: tipo de fósil corporal que se forma en la roca cuando un organismo con partes duras se entierra, se descompone o se disuelve y deja una cavidad en la roca.
- cast / impresión fósil: tipo de fósil corporal que se forma cuando los cristales llenan un molde o cuando los sedimentos se asientan en un molde y se endurecen convirtiéndose en roca.
- index fossils / fósiles guía: restos de especies que existieron en la Tierra durante un período relativamente corto de tiempo, fueron abundantes y se extendieron geográficamente; los geólogos pueden usar estos fósiles para determinar las edades de las capas rocosas.

Por qué es importante
Los fósiles ayudan a los científicos a encontrar petróleo y otros recursos energéticos que la sociedad necesita.

**Edad relativa de las rocas**

Lo que aprenderás
- A describir los métodos que se usan para asignar la edad relativa a las capas rocosas.
- A interpretar las brechas en el registro de las rocas.
- A dar un ejemplo de cómo las capas rocosas pueden correlacionarse con otras capas rocosas.

Vocabulario
- principle of superposition / principio de sobreposición: establece que en capas rocosas inalteradas, las rocas más antiguas se encuentran en el fondo y las rocas más recientes se hallan en la parte superior.
- relative age / edad relativa: la edad de algo comparada con otras cosas.
- unconformity / discordancia: brecha en una capa rocosa provocada por la erosión o por periodos cuando no hubo depositación.

Por qué es importante
El poder determinar la edad de las capas rocosas es importante para tratar de comprender la historia de la Tierra.

**Laboratorio Edades relativas**

¿Cuál de tus dos amigos es el mayor? Para contestar esta pregunta, necesitarías saber sus edades relativas. No necesitarías saber la edad exacta de ninguno de tus dos amigos, solamente quién nació primero. A veces sucede lo mismo con las rocas.

Preguntas del mundo real
¿Cómo puedes determinar la edad relativa de dos capas rocosas?

Materiales
- papel
- lápiz
Pistas sobre el pasado de la Tierra

Metas
■ Interpretar ilustraciones de capas rocosas y otras estructuras geológicas y determinar el orden relativo de los sucesos.

Procedimiento
1. Analiza las Figuras A y B.
2. Haz un diagrama de la Figura A. Identifica la edad relativa de cada una de las capas rocosas, intrusiones ígneas, fallas y discordancias. Por ejemplo, la capa de esquisto es más antigua, entonces márcala con un 1. Marca la capa siguiente en edad, de mayor a menor, como 2 y así sucesivamente.
3. Repite el Paso 2 con la Figura B.

Concluye y aplica
Figura A
1. Identifica el tipo de discordancia que se muestra. ¿Es posible que hubiera originalmente más capas rocosas de las que se muestran?
2. Describe cómo las rocas a la izquierda de la falla se movieron en relación con las rocas de la derecha.
3. Formula una hipótesis sobre cómo se formó la colina de la izquierda de la figura.

Figura B
4. ¿Es acaso posible concluir que la intrusión ígnea de la izquierda es más antigua o más reciente que la discordancia que está cerca de la superficie?
5. Describe las edades relativas de las dos intrusiones ígneas. ¿Cómo lo sabes?
6. Formula una hipótesis sobre cuál par de capas rocosas pudieron haber sido mucho más gruesas en el pasado.

Comunica tus datos
Compara tus resultados con los de otros estudiantes. Para más ayuda consulta el Science Skill Handbook.

Edad absoluta de las rocas
Lo que aprenderás
■ A identificar cómo la edad absoluta difiere de la edad relativa.
■ A describir cómo puede usarse la media vida de los isótopos para determinar la edad de las rocas.

Vocabulario
absolute age / edad absoluta: edad, expresada en años, de una roca u otro material; se puede determinar usando las propiedades de los átomos que componen tales materiales.
radioactive decay / desintegración radiactiva: proceso mediante el cual algunos isótopos se desintegran formando otros isótopos y liberan energía y partículas nucleares.
half-life / media vida: tiempo que se demora la mitad de la masa de una muestra de isótopo radiactivo para desintegrarse.
radiometric dating / datación radiométrica: proceso que se usa para calcular la edad absoluta de las rocas midiendo la razón del isótopo original al producto descendiente en un mineral y conociendo la vida media del isótopo original.
uniformitarianism / uniformitarismo: principio que establece que los procesos terrestres que suceden en la actualidad son semejantes a aquellos que ocurrieron en el pasado.

Por qué es importante
Podemos entender mejor los sucesos de la historia de la Tierra si conocemos sus edades absolutas.

Modela e inventa Fósiles de huellas
Los fósiles de huellas te pueden decir mucho sobre las actividades de los organismos que los dejaron. Pueden indicarte cómo se alimentaba el organismo o qué tipo de hogar tenía. ¿Qué más puedes aprender de los fósiles de huellas?

Preguntas del mundo real
¿Cómo puedes hacer un modelo de un fósil de huellas que te dé información sobre el comportamiento del organismo?
Piensa críticamente
¿Qué puedes usar para hacer un modelo de un fósil de huellas? ¿Qué tipos de comportamiento podrías mostrar con tu modelo de un fósil de huellas?

Metas
■ Construir un modelo de un fósil de huellas.
■ Describir lo que aprendas al estudiar tu modelo.

Medidas de seguridad

Posibles Materiales
cartulina
plástico bastante duro
yeso
cartulina gruesa
limapiapipas
alambre
tijeras
palillos de dientes
arcilla
goma

Diseña un modelo
1. Decide cómo vas a hacer tu modelo. ¿Qué materiales necesitarás?
2. Decide los tipos de actividades que mostrarás en tu modelo. ¿Se estaban alimentando los organismos? ¿Viajaban? ¿Eran depredadores? ¿Cuál era la presa? ¿De qué forma podrá indicar tu modelo las actividades que escojas?
3. ¿En qué ambiente está tu modelo? ¿Estás modelando su hogar? ¿Sus áreas de alimentación? ¿Es tu modelo terrestre o acuático? ¿Cómo puede el ambiente afectar la forma en que construyes tu modelo?
4. ¿Mostrarás fósiles de huellas de una sola especie o de varias? Si incluyes más de una especie, ¿cómo mostrarás la interacción entre las especies?

Verifica los planes para tu modelo
1. Compara tus planes con los de otros en tu clase. ¿Mencionaron otros grupos detalles que tú olvidaste? ¿Quieres hacer cambios en tus planes antes de proseguir?
2. Asegúrate de que tu maestro(a) apruebe tus planes antes de continuar.

Verifica tu modelo
1. Sigue tus planes y construye tu modelo de un fósil de huellas.
2. ¿Has incluido pruebas de todos los comportamientos que querías modelar?

Analiza tus datos
1. Evalúa Ahora que completaste tu modelo, ¿crees que muestra adecuadamente los comportamientos que querías mostrar? ¿Qué crees que te gustaría cambiar si hicieras de nuevo el modelo?
2. Describe cómo el uso de diferentes materiales podría haber afectado tu modelo. ¿Puedes pensar en otros materiales que te hubieran permitido mostrar más detalles?

Concluye y apla
1. Compara y contrasta tu modelo de un fósil de huellas con fósiles de huellas dejados por organismos reales. ¿Es alguno de los dos más fácil de interpretar? Explica.
2. Enumera comportamientos que no dejen fósiles de huellas. Explica.

Comunica tus datos
Pídele a otros estudiantes de tu clase o de otra clase que vean tu modelo y describe qué información pueden aprender de los fósiles de huellas. ¿Concuerdan sus interpretaciones con lo que intentaste demostrar?

Guía de estudio

Sección 1 Fósiles
1. Los fósiles se forman con más facilidad a partir de las partes duras de organismos muertos que son enterrados rápidamente.
2. Algunos fósiles se forman cuando los minerales sustituyen el material original que componía el organismo. Otros fósiles se forman cuando los restos se ven expuestos al calor y a la presión, lo que sólo deja una
pequeña película carbonácea. Algunos fósiles son las huellas o trazas que dejaron los organismos. ¿Qué tipo de fósil se muestra a la derecha?

Sección 2 Edad relativa de las rocas
1. El principio de sobreposición establece que las rocas más antiguas están debajo de las rocas más recientes en áreas donde no ha habido alteraciones. Las fallas y las intrusiones ígneas son siempre más recientes que las rocas que atraviesan. ¿Cuál de las siguientes capas rocas es la más reciente?
2. Las discordancias o brechas en el registro rocoso se deben a la erosión o a periodos durante los cuales no ocurrió depositación.
3. Las capas rocosas pueden correlacionarse usando el tipo de roca y los fósiles.

Sección 3 Edad absoluta de las rocas
1. A diferencia de la datación relativa, la datación absoluta de rocas y minerales proporciona la edad de la roca en años.
2. La media vida de un isótopo radiactivo es el tiempo que demora la mitad de los átomos del isótopo en desintegrarse y formar otro isótopo. ¿Cuál isótopo usarías para calcular la edad del siguiente árbol enterrado?
Hands-On Activities

MiniLAB: Try at Home (page 3)
1. The objects named must be the remains of living things or evidence of their activities, such as footprints or burrows. Possible answers: leaves, sticks, bones, shells
2. To best be preserved, the remains should have hard parts and be buried quickly.

MiniLAB (page 4)
1. As in carbon-14, each half-life resulted in half of the remaining jelly beans being removed.
2. 4
3. 22,920 years old

Lab (page 5)
Lab Preview
1. No; a relative age indicates only whether one rock is older than another.
2. In an undisturbed layer of rock, the oldest rocks are on the bottom, and the rocks become progressively younger toward the top.

Conclude and Apply
1. Disconformity; yes, other rock layers could have been eroded.
2. The rocks moved upward.
3. as the result of a fault
4. A fault cuts through the intrusion but stops at the unconformity. Thus the fault occurred after the intrusion but while erosion was occurring. Therefore, the intrusion is older.
5. The one on the left is older than the one on the right. The one on the right intrudes the sandstone and is therefore younger. The one offset by the fault is older than the sandstone.
6. The sandstone and the upper shale may have been thicker. They exhibit erosional disconformities at their upper surfaces.

Lab: Model and Invent (page 7)
Lab Preview
1. fossilized tracks and other evidence of the activities of organisms
2. Answers will vary, but students should have an understanding of how trace fossils are formed.

Analyze Your Data
1. Answers will be individualized and based on the students’ opinions of their research. Look for depth and quality of research performed.
2. Answers will vary depending on what materials students used. Clay would show three-dimensional fossils, whereas paper or fabric would be only two-dimensional.

Conclude and Apply
1. The models may be easier to interpret because they will not have any extraneous features and were not subject to weather or other factors that could damage them.
2. Answers will vary. Look for behaviors like mating rituals or communication that wouldn’t necessarily leave any marks on sediments for later fossilization.

Laboratory Activity 1 (page 9)
Questions and Conclusions
1. Layer A; It is on the bottom and, by the principle of superposition, is the oldest.
2. The beds have been folded upward into an anticline.
3. The folding predated the glaciation and subsequent deposition of the glacial till.
4. The glacier withdrew and vegetation was able to grow. Then a second advance occurred.
5. As the mountainous area would have had valley glaciers; hanging valleys, horns, and steep walled valleys would be left.
6. two
7. Beds A, B, and C were deposited and then uplifted and folded into an anticline. Erosion removed bed C and part of Bed B from the top of the anticline. The area then was covered by a continental glacier that deposited a layer of till as it withdrew. During a period of warming and weathering, peat and soil were formed on the till. Another advance of the ice was followed by a retreat, and the second layer of till was deposited.

Laboratory Activity 2 (page 13)
Data and Observations
Students’ sketches will vary with the objects they choose.
Questions and Conclusions
1. If a fossil appears in soils and rocks from many time periods, it does not isolate and identify when the organism existed.
2. Yes
3. Yes, both fossils are from the same type of organism
4. No, the soil in the bottom layer was laid down first. The fossils in the bottom layer are older than the fossils in the middle layer. A lived during both time periods.
5. what fossils are located in which layers of soil
6. Answers will vary Results should be similar. If the containers were disturbed during excavation, the fossils could have shifted. Results would be invalid
7. It is important to note that index fossils are found only during a specific time period. Fossils that are found nearby are close in age. If another like fossil is found from a different time, you can infer that
the second plant or animal lived longer than the index fossil object. Whether the second fossil is found above or below or below the index fossil helps to determine time spans when that organism existed.

Meeting Individual Needs

Directed Reading for Content Mastery (page 19)

Overview (page 19)
1. absolute age
2. superposition
3. radiometric dating
4. younger
5. half-life
6. Permineralized remains
7. original remains

Section 1 (page 20)
1. a. 3
   b. 2
   c. 5
   d. 1
   e. 6
   f. 4
2. c
3. f
4. e
5. a
6. b
7. d

Sections 2 and 3 (page 21)
1. b
2. a
3. a
4. a
5. b
6. b
7. b
8. a
9. b
10. a

Key Terms (page 22)
1. unconformity
2. fossils
3. carbonaceous film
4. remains
5. absolute age
6. relative
7. half-life
8. decay
9. superposition
10. dating
11. mold
12. uniformitarianism
13. cast
14. index

Lectura dirigida para Dominio del contenido (pág. 23)

Sinopsis (pág. 23)
1. edad absoluta
2. superposición
3. datación radiométrica
4. más recientes
5. media rida
6. restos permineralizados
7. restos originales

Sección 1 (pág. 24)
1. a. 3
   b. 2
   c. 5
   d. 1
   e. 6
   f. 4
2. c
3. f
4. e
5. a
6. b
7. d

Secciones 2 y 3 (pág. 25)
1. b
2. a
3. b
4. a
5. b
6. b
7. a
8. b
9. b
10. a

Términos claves (pág. 26)
1. discordancia
2. fósiles
3. película carbonácea
4. restos
5. edad absoluta
6. relativa
7. media vida
8. desintegración
9. superposición
10. datación
11. molde
12. uniformitarianismo
13. impresión fósil
14. guía

Reinforcement (page 27)

Section 1 (page 27)
1. no
2. no
3. fossil; cast
4. fossil; original remains
5. fossil; trace fossil
6. no
7. fossil; index fossil
8. no
9. fossil; permineralized remains
10. fossil; original remains
11. fossil; mold
12. fossil; trace fossil
13. no
14. fossil; carbonaceous film
15. It must be covered rapidly to keep it from scavengers and bacteria, and it must have hard body parts.
16. The rock was once under water.
17. Fossils tell when, where, and how organisms once lived.

Section 2 (page 28)
1. relative dating
2. superposition
3. unconformities
4. erosion
5. brown sandstone
6. brown sandstone
7. gabbro dike
8. gray shale
9. trilobite fossil
10. snail fossil
11. green shale
12. dinosaur bone
13. gray limestone
14. tan sandstone
15. gray limestone
16. angular unconformity

Section 3 (page 29)
1. d
2. a
3. b
4. e
5. c
6. 9, possibly 10
7. Most students will find it practical to make nine or ten cuts.
8. 5,730 years
9. time = number of cuts x 5,730
10. No; dinosaurs died so long ago that no carbon-14 would be left in the remains.

Enrichment (page 30)
Section 1 (page 30)
1. The trace fossils would easily erode if tourists walked on them.
2. Fossils are the preserved remains of organisms or plants; trace fossils are evidence of an animal’s activity, such as a track or burrow, that proves the animal once existed.
3. Answers will vary. Sample answer: Since the fossilized tracks were from different-sized reptiles, the reptiles were either the same species traveling together or were different species that co-existed peacefully.

Section 2 (page 31)
1. dike
2. sill
3. batholith
4. volcanic pipe
5. laccolith

6. A sill is a flat surface of igneous rock.
7. A laccolith is the part of an igneous intrusion that produces a dome-shaped bulge of the overlying layers.
8. A batholith is a large mass of igneous rock that stopped rising well below the surface.

Section 3 (page 32)
1. 75 grams
2. It changed into another substance.
3. an insignificant amount
4. 25 grams
5. 1,080 days

Note-taking Worksheet (page 33)
Refer to Teacher Outline, student answers are underlined.

Assessment

Chapter Review (page 37)
Part A. Vocabulary Review (page 37)

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1. (5/2)
2. (8/3)
3. (1/1)
4. (8/3)
5. (9/3)
6. (9/3)
7. (8/3)
8. (2/1)
9. (8/3)
10. (1/1)

Part B. Concept Review (page 38)
1. hard, rocklike fossil in which original materials were replaced by minerals (2/1)
2. thin layer of carbon atoms left when organism is subjected to heat and pressure (2/1)
3. cavity left when organism decays (2/1)
4. sediments that fill a mold and harden (2/1)
5. tracks or other evidence of organism activity (2/1)
6. fossils of species that existed on Earth for a short time over a wide geographic area (3/1)
7. Processes occurring today are similar to those that occurred in the past. Erosion, transportation of sediments, and deposition of sediments have been occurring slowly for a long time. (9/3)

8. Scientists use index fossils to determine the age of rock layers. Finding a layer containing the fossils of an organism known to have lived in a certain period helps them date the rock. (3/1, 6/2)

9. The organism must be protected from scavengers and bacteria by a covering of sediment. The sediment in which it is embedded eventually solidifies, and the organism becomes a part of the rock. (1, 2/1)

Chapter Test (page 39)

1. Testing Concepts (page 39)
   1. a (2/1)
   2. i (2/1)
   3. n (3/1)
   4. l (1/1)
   5. h (8/3)
   6. e (5/2)
   7. d (8/3)
   8. b (2/1)
   9. m (8/3)
  10. k (5/2)
  11. f (6/2)
  12. g (8/3)
  13. c (9/3)
  14. j (2/1)
  15. true (4/1)
  16. false; a permineralized bone is composed of a mineral, such as quartz, that has replaced the calcium (2/1)
  17. false; the hard parts of an organism are most likely to become fossils (1/1)
  18. true (2/1)
  19. true (9/3)
  20. false; only fossils up to 75,000 years old can be dated by carbon-14 (8/3)

II. Understanding Concepts (page 40)

1. hard parts (2/1)
2–5 can be in any order.
3. permineralized (2/1)
4. index fossils (2/1)
5. trace fossils (2/1)
6. Relative dating compares layers of rocks; ages are stated relative to other layers. Absolute dating involves half-lives and can tell in which geologic period a rock was formed. (8/3)

7. E, D, F, C, B, A (5/2)
8. between B and A (5/2)
9. 1—40g, 40g (9/3)
   2—20g, 60g (9/3)
   3—10g, 70g (9/3)

III. Applying Concepts (page 41)

Writing Skills

1. The layers had to be there before the fault could form if the fault ran through the horizontal layers. The relative age of the rocks is older than the relative age of the fault. (5/2)
2. Footprints may indicate how it walked; the rock type it is found in will indicate water or land; some traces may show how it rested or ate. (4/1)
3. Correlating rock layers means matching exposed layers of rock in places that are apart from each other. You try to identify layers of rock in both places, matching the sequence of the layers of rock and any fossils in them. If the rock layers correlate, it means they are from the same rock formation and rock between the two locations has eroded. (7/2)
4. Not all rocks contain fossils. Dead organic matter is usually destroyed by scavengers or bacteria. Only when the organism was quickly covered could it be preserved. Hard parts of organisms were less apt to be consumed or eroded by weather. (1/1)
5. Half-life is the time it takes for half of the atoms in a radioactive isotope to decay. A geologist can measure the parent and daughter materials and, using the half-life of the parent material, calculate the length of time that has elapsed since the rock or fossil formed. (9/3)

Transparency Activities

Section Focus Transparency 1 (page 44)

Guess Again

Transparency Teaching Tips

- This is an introduction to permineralization, how the process occurs, and how scientists use fossils to study Earth's past. Ask the students for clues to the identify of the object in the photo.
- Inform them that few trees are changed this way. Ask them to make conjectures as to how such a change takes place and why finding such specimens is rare.

Content Background

- Petrification takes place when the remains of a plant or animal become buried in sand, ash, or mud, which discourages the usual process of decomposition. Water seeping into the remains carries dissolved minerals, such as quartz, which slowly begin to replace the decaying cells. Over a long period of time the object becomes solid stone, the stone replacing and preserving the original structure.
- The most famous evidence of this process (in regards to trees) in the United States is found in the Petrified Forest National Park, in northern Arizona.
Section Focus Transparency 2 (page 45)

Older than the Hills

Transparency Teaching Tips
- This transparency is an introduction to rocks and their relative ages. Ask the students to envision the pile of dirty clothes in their room or (on rare occasions) in the dirty clothes hamper. Ask the students for the location, within this pile, of the most recently worn clothing (on top); ask the location of the clothes that were worn long past (on the bottom).
- Explain that this concept, called superposition also applies to rocks—the oldest rocks are on the bottom and the younger ones are toward the top. Geologists can determine the relative age of the rocks by their layered position.
- Point out that the movement of Earth’s plates creates various geological activities, like uplifting, folding, faulting, and earthquakes, that disrupt this horizontal layering. Wind, rain, and other eroding agents then wear away some of the exposed layers, creating sections of missing rock. The remaining sections will not conform in type or age to nearby layers. This process creates what are called unconformities.
- Ask the students to explain how the exposed rock shown in the transparency (some of the oldest rock formations in the world) came to be on top. Ask the students to hypothesize what eroding agent could have so uniformly removed the upper layers of younger rock (a glacier).

Content Background
- The rock of the Canadian Shield was exposed by glacial activity during the Pleistocene epoch (10,000 to 1,600,000 years ago). The glacier, moving toward the south, ground away all the overlying rock layers and deposited the rock well to the south and southwest.
- The exposed rock is between three and four billion years old.

Answers to Student Worksheet
1. The petrified wood is made of rock. The cells of the trees have been replaced by minerals. The cross-sections of the trees no longer appear to be made of wood.
2. Trees usually decay.
3. Answers will vary. Organisms are sometimes fossilized, encased in amber or resin, frozen in the ground, or imprinted on stone.

Section Focus Transparency 3 (page 46)

One Big Rock

Transparency Teaching Tips
- This transparency introduces absolute age and methods of dating rock. Explain that rocks can be dated using radiometric dating. Certain isotopes are radioactive and decay at a specific rate over time. By measuring the amount of a chosen isotope in a rock and comparing it to the original amount of the isotope, a rock’s age can be determined (as long as the isotope’s rate of decay, or half-life, is known).
- The Uluru monolith (formerly Ayers Rock) has been dated to approximately 550 million years ago. It is the largest, single rock dome in the world. Ask the students to hypothesize as to how such a singular formation was created. It was extruded during the process that created the mountain ranges of central Australia, then shaped by erosion over the past 500 million years.

Content Background
- Up to 70 million years ago, Uluru was an island in a large lake. Made of the soft rock, arkosic sandstone, the monolith was shaped by lake water and infrequent rainstorms. The course-grained sandstone is rich in feldspar and iron. The color of the rock is caused by the oxidation of iron, creating rusting flakes and the reddish-orange color.
- Approximately 348 m (1,142 feet) tall, the rock is dotted with caves and aboriginal rock paintings. The rock is central to many aboriginal legends, including their creation legend. The area that includes the Uluru rock is inscribed on the list of the World Heritage Committee as Uluru-Kata Tjuta National Park. The World Heritage Committee, a branch of UNESCO, is dedicated to identifying sites of cultural or natural significance. Uluru is a place name without meaning. Kata Tjuta, however, means “many heads,” a reference to Uluru and two other nearby tors.
- Earth is about 4.5 billion years old.
Answers to Student Worksheet
1. The entire area is flat, as if water action eroded everything away.
2. If it took that long to shape Uluru, then Earth must be very old.

Teaching Transparency (page 47)

Index Fossils

Section 1

Transparency Teaching Tips
- Explain that an index fossil is like a bookmark of sorts. It is used by scientists to help date specific rock layers. Only fossils that are abundant, existed as a species for a relatively short time, and are dispersed around the world are designated as index fossils.
- Point out to students that index fossils must be geographically widespread so that if the fossil is found in rocks in other locations, the age of the rocks in which it is found can be determined.
- Use the transparency to help students understand the time period during which index fossils lived.

Reteaching Suggestion
- Draw two different columns of rock layers on the board and draw imaginary index fossils in each. Ask students to identify which rock layers in each column were deposited at the same time by comparing the index fossils present in the layers.

Extensions
- Challenge: Ask students why they think free-swimming organisms that live in the ocean make good index fossils.
- Research: Ask students to find out how index fossils are used by geologists who work for oil companies.

Answers to Student Worksheet
1. Index fossils are fossils of species that lived on Earth for short periods of time, were abundant, and were widespread geographically.
2. to tell the age of rock layers
3. Euomphalus
4. between 505 and 408 million years ago
5. between 438 and 286 million years ago
6. Illaenus, because it lived for a short period of time
7. It was deposited between 438 and 408 million years ago. That is the time period during which all three organisms lived.