THINKING IN TIME SCALES

Background Information

Students have a difficult time comprehending how short the span of human history is in relation to Earth's geological history. In the next activity, *Reports from the Galápagos*, students will learn about the role the Galápagos Islands have played in recent human history. There, they will work with time scales ranging from the earliest written descriptions of the islands to the present. This activity will help students visualize these varying scales of time, and create a mental picture of time in terms of millions and billions of years. The immense span of time allows geologic forces to "set the stage" for the ecological development of an area. On this stage plays the development, survival, and evolution of species that live there. This activity relies on basic mathematics skills, and students will need to switch between thinking about thousands of years to thinking about billions of years, so you may wish to review mathematics concepts before you begin.

Ask the students to tell you what they mean when they say that something happened "a long time ago." (Answers will range from a few months to centuries and beyond.) Ask them to list events that occurred a long time ago. Record these events without comment. Emphasize that scientists seek proof of how long ago events occurred by studying things that record the passage of long periods of time, such as the layers in rocks (strata) and index fossils. A large number of strata indicates a long time period of deposition. The presence of index fossils—fossils of species that existed only during specific time periods—provide an index to the age of rocks. Radiometric dating techniques can also reveal how long ago rocks were formed. The dating of events that occurred a long time ago and the sequence in which they occurred are among the puzzles scientists must solve. We are constantly adding to our knowledge of Earth's history.

Procedure

Obtain 12 reams of standard-size paper and stack them on the floor or on a desk where they will be visible to all the students. Unwrap only the top ream.

Objectives

- To develop a mental picture of the time period of their own lives, the period of human history, and the age of Earth and events in Earth history.

- To connect mathematics, geology, and recent human history by working with changing time scales.

Materials

- Student handouts:

  2,000 Dots

  Twenty Centuries

  Selected Events in Human History & Geologic Time Scale

  Earth History Events (one per class, cut into strips along the dotted lines)

- Twelve, 500-sheet reams of 8½" x 11" paper

- Pencils

ACTIVITY 2: THINKING IN TIME SCALES

TEACHER SECTION

On each of the lower reams, tear a strip 7- to 10-cm wide from the side of each wrapper so the paper shows through. The result should be a column of exposed paper edges (to show the stratification, or layers, of paper). Stack the unwrapped twelfth ream neatly on top (see illustration at left). Inform students that every page in the stack stands for the same period of time, and the stack is 12 reams high.

12 reams of paper, top ream unwrapped

2,000 Dots worksheet on top

tears in each ream wrapper, exposing layers of paper

Before class you should cut into strips the *Earth History Events* worksheet. Put the strips into a box and let each student blindly choose one. There are 24 events, so you will need to budget the strips based on the number of students in your class. Then distribute the rest of the student handouts, one per student, and have students answer the questions on the *Twenty Centuries* worksheet. This worksheet will help them visualize different time scales, one for recent history, one for geological events. An extended discussion of the *Geologic Time Scale* may be appropriate.
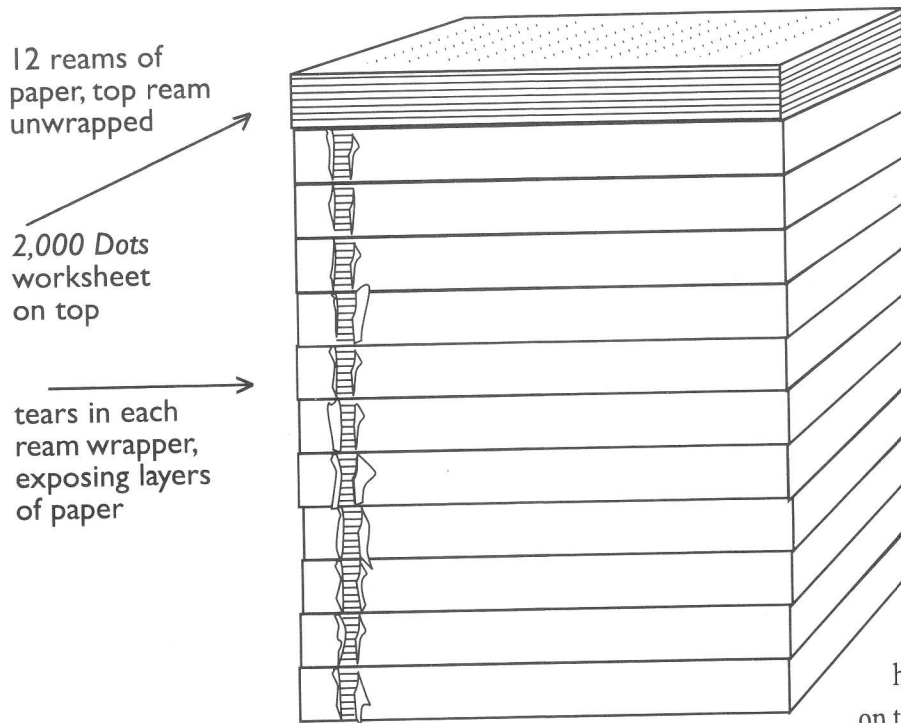
Answers to student questions:

1. At the top of the 2,000 Dots *sheet, write the words "Twenty Centuries." This sheet has 2,000 dots; each dot = 1 year. Show how 2,000 years equals 20 centuries.*

2,000 years divided by 100 years in a century = 20 centuries.

Steps 2. and 3. are procedural and do not require answers.

4. Look at the Geologic Time Scale. *Where do these events, and even the oldest dot on the worksheet, fit on this chart?*

They do not because the scale is too large to fit these events.

TEACHER SECTION

5. At the front of the room is a stack of 12 reams of paper, each of which has 500 sheets. If each sheet has 2,000 dots (each representing 1 year), how many years are represented by the entire stack of paper?

2,000 dots per page at 1 year per dot x 500 sheets of paper per ream x 12 reams of paper = 12,000,000 years (12 million years, with each sheet of paper representing 2,000 years)

6. Now, cross out the words "Twenty Centuries" at the top of the page, and write "Two Thousand Centuries." Instead of each dot = 1 year, now each dot = 100 years (one century). Look at the stack of 12 reams of paper again. If each sheet has 2,000 dots (each representing 100 years), how many years are now represented by the entire stack of paper?

2,000 dots per page at 100 years per dot x 500 sheets of paper per ream x 12 reams of paper = 1,200,000,000 years (1.2 billion years, with each sheet of paper representing 200,000 years)
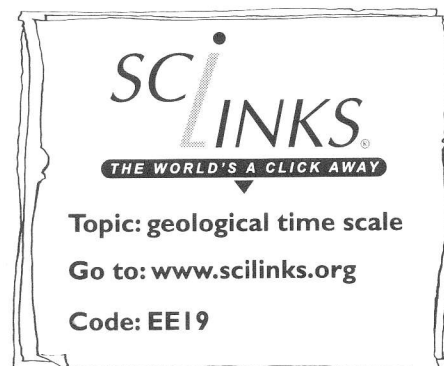
7. Look at your strip of paper with a geologic event written on it, and mark on the Geologic Time Scale when the event occurred. Will this event fit within the span of years represented by the stack of paper? If so, calculate how far down in the paper stack to place your individual marker, then come forward to place it at the correct depth. If not, use the mathematics you have already done to calculate how much more paper would be needed, and share your results with the class.

The entire stack represents 1,200,000,000 (1.2 billion) years. Some of the events on the strips of paper will fit within the reams (e.g., 1 million years ago will be 5 sheets from the top, .5 billion years will be 5 reams from the top). Some of the events are older than 1.2 billion years, so students will need to do additional calculations to figure out the number of reams of paper needed. You may want to have these students write their answers on the board, because they were not able to put their strip in the stack of papers at the front of the class.

Additional discussion suggestions:

Earth is approximately 4.6 billion years old. How many reams of paper like the ones in the front of the classroom would it take to represent that many years?

Forty-six reams, almost four times as much as is presently there.

SCI LINKS

THE WORLD'S A CLICK AWAY

Topic: geological time scale

Go to: www.scilinks.org

Code: EE19

TEACHER SECTION

Now that you have an idea of the age of Earth, would you describe the Galápagos Islands as young or old?

They are relatively young, less than five million years for the oldest islands. As volcanic eruptions presently occur, the islands are still forming.

Compare these answers with the students' earlier guesses. Emphasize that terms like *young and old*, *long ago*, and *recent* can have very different meanings in different contexts (e.g., our lifetime, written history, human history, geologic time).

Standards

The material promoted in this activity enhances and supports student understanding of the following *National Science Education Standards* for grades 5–8:

Structure of Earth System (Earth and Space Science)

The solid Earth is layered with a lithosphere; hot, convecting mantle; and dense, metallic core.

Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

Some changes in the solid Earth can be described as the *rock cycle*. Old rocks at Earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.

Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.

Earth's History (Earth and Space Science)

The Earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.

Fossils provide important evidence of how life and environmental conditions have changed.

Assessment

Activity	Exemplary	Emergent	Deficient
	Students are able to accurately place their "event" into the stack of paper. They can calculate how much paper is needed to accurately model the age of Earth. Students accurately describe the age of the Galápagos Islands and explain that dinosaurs came before humans.	Students can find the correct location of their event, but have some difficulty calculating how much paper is necessary to represent the age of Earth. Students have a good idea of the age of the Galápagos Islands and know that dinosaurs preceded humans.	Students have a difficult time finding where their event should be placed in the stack of paper. Students cannot calculate how much paper is needed to show Earth's age. The age of the Galápagos is also not understood. They may know that dinosaurs preceded humans.

2,000 DOTS
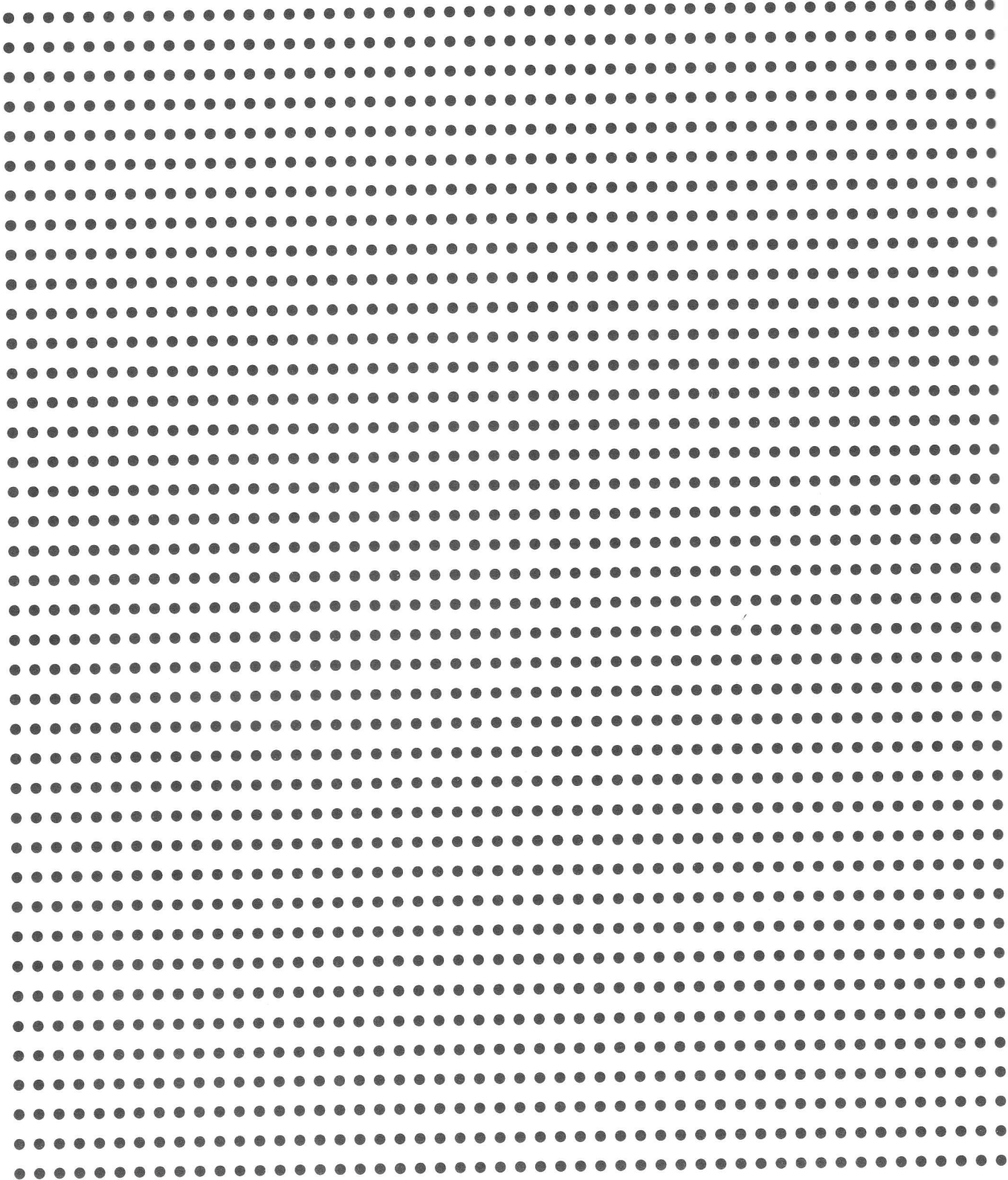
TWENTY CENTURIES

For this activity, you should have two handouts: *2,000 Dots* and *Selected Events in Human History* & *Geologic Time Scale*, and a strip of paper that has some geologic event written on it. Every dot on the *2,000 Dots* sheet represents one year, the last dot on the bottom line is this year, each dot before that one is a previous year. Follow the directions below and answer the questions on a separate sheet of paper.
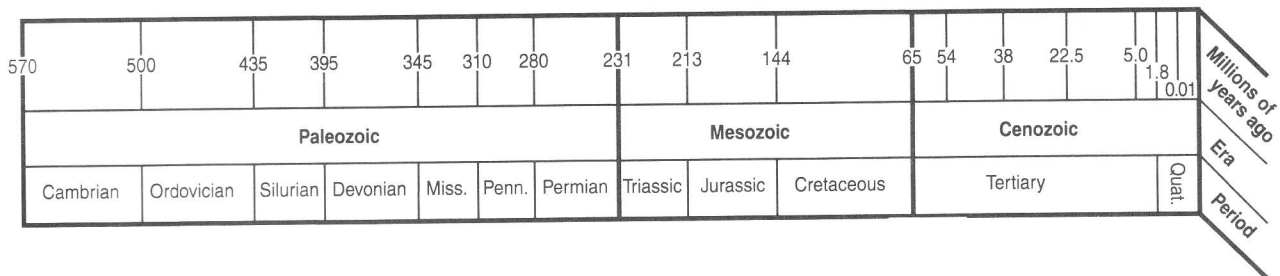
1. At the top of the *2,000 Dots* sheet, write the words "Twenty Centuries." This sheet has 2,000 dots; each dot = 1 year. Show how 2,000 years equals 20 centuries.

2. The first dot at the top of the line represents the year 2000; each dot after that is a previous year. Draw a circle around the year you were born, and write the year next to that dot. Now draw a circle around the year one of your parents was born. Then draw a circle around the year one of your grandparents was born (estimate if necessary). Write the years next to the dots. You've now placed the time frame for three generations of your family on the page.

3. For each event listed on the *Selected Events in Human History* worksheet, circle the appropriate dot on the *2,000 Dots* sheet, and write the year next to that dot.

4. Look at the *Geologic Time Scale*. Where do these events, and even the oldest dot on the worksheet, fit on this chart?

5. At the front of the room is a stack of 12 reams of paper, each of which has 500 sheets. If each sheet has 2,000 dots (each representing 1 year), how many years are represented by the entire stack of paper?

6. Now, cross out the words "Twenty Centuries" at the top of the page, and write "Two Thousand Centuries." Instead of each dot = 1 year, now each dot = 100 years (one century). Look at the stack of 12 reams of paper again. If each sheet has 2,000 dots (each representing 100 years), how many years are now represented by the entire stack of paper?

7. Look at your strip of paper with a geologic event written on it, and mark on the *Geologic Time Scale* when the event occurred. Will this event fit within the span of years represented by the stack of paper? If so, calculate how far down in the paper stack to place your individual marker, then come forward to place it at the correct depth. If not, use the mathematics you have already done to calculate how much more paper would be needed, and share your results with the class.

SELECTED EVENTS IN HUMAN HISTORY

1776 .... U.S. Congress adopts the Declaration of Independence.

1912 .... Wright Brothers launch their first successful flight.

1492 .... Columbus reaches the Americas.

1904 .... Henry Ford markets the automobile.

1835 .... Darwin visits the Galápagos.

1959 .... The Galápagos Islands are given National Park status, and the Darwin Foundation is formed.

_____ .... My great-grandmother is born. (Estimate.)

1200 .... The Incan Empire (later to include Ecuador) begins its rise.

1564 .... William Shakespeare is born.

1969 .... Humans first walk on the moon.

GEOLOGIC TIME SCALE

570	500	435	395	345	310	280	231	213	144	65	54	38	22.5	5.0 1.8 0.01	Millions of years ago
Paleozoic							Mesozoic			Cenozoic					Era
Cambrian	Ordovician	Silurian	Devonian	Miss.	Penn.	Permian	Triassic	Jurassic	Cretaceous	Tertiary				Quat.	Period

EARTH HISTORY EVENTS

Earth formed: 4,600,000,000 years ago

North and South America joined by the closing of the Panama Isthmus: 2,800,000 years ago

Earliest known hominid (human ancestor) fossils deposited: 4,400,000 years ago

Earliest known Galápagos rocks formed: 4,000,000 years ago

Earliest known animal fossils (jellyfish-like organisms) deposited: 1,200,000,000 years ago

Earliest known fish fossils deposited: 500,000,000 years ago

Earliest known reptile fossils deposited: 290,000,000 years ago

Earliest known bird fossils deposited: 160,000,000 years ago

Earliest known mammal fossils deposited: 200,000,000 years ago

Earliest known flowering plant fossils deposited: 135,000,000 years ago

Earliest known trilobite fossils deposited: 600,000,000 years ago

Appalachian Mountains formed: 250,000,000 years ago

Rocky Mountains formed: 70,000,000 years ago

Mass extinction of dinosaurs: 65,000,000 years ago

Breakup of Pangaea began: 180,000,000 years ago

Earliest known fossils of land animals deposited: 390,000,000 years ago

Last Ice Age ended: 10,000 years ago

Oldest known rock on Earth formed in southwest Greenland: 3,200,000,000 years ago

Alps and Himalayas begin forming as India joined Asian continent: 30,000,000 years ago

Formation of iron, copper, and nickel ores: 1,000,000,000 years ago

Much of continental land masses underwater: 330,000,000 years ago

Active volcanoes in New England: 210,000,000 years ago

Earliest microfossils formed in South African chert: 3,200,000,000 years ago

Algae deposited in Rhodesian limestones: 3,000,000,000 years ago

*All dates are approximate, and these events actually occurred over a range of time.