2. Each of the climate proxies discussed in the reading yields information about climate in a particular area of Earth—land or sea, tropical, temperate, or arctic areas. Why would it be important to have data from all these different areas?
3. Some climate records, such as tree rings, give more detailed and continuous information about past climate, but only date back hundreds or thousands of years. Other climate records, such as those in continental rocks, go back much farther but are less complete or detailed. How might scientists use each of these types of information to learn about how Earth's climate system works?

ACTIVITY 2
Using Climate Proxies

Setting the Stage: Using Forams as Clues to Ocean Temperature

As you learned in the reading *Evidence of Earth's Past,* scientists are able to use various clues preserved in ocean sediment to learn about Earth's climate history. The microscopic foraminifera *Neogloboquadrina pachyderma* (*N. pachyderma)* serves as a particularly useful indicator of ocean temperature. These foraminifera (Figure 6.10) are found in two forms. When the ocean water is relatively warm, this organism tends to grow into a right-coiling form. When the water is relatively cold, *N. pachyderma* grows into a left-coiling form. When these organisms die, they settle to the ocean bottom and their skeletons are incorporated into the accumulating layers of sediment, preserving a record of the ocean temperature at the time each organism was alive.

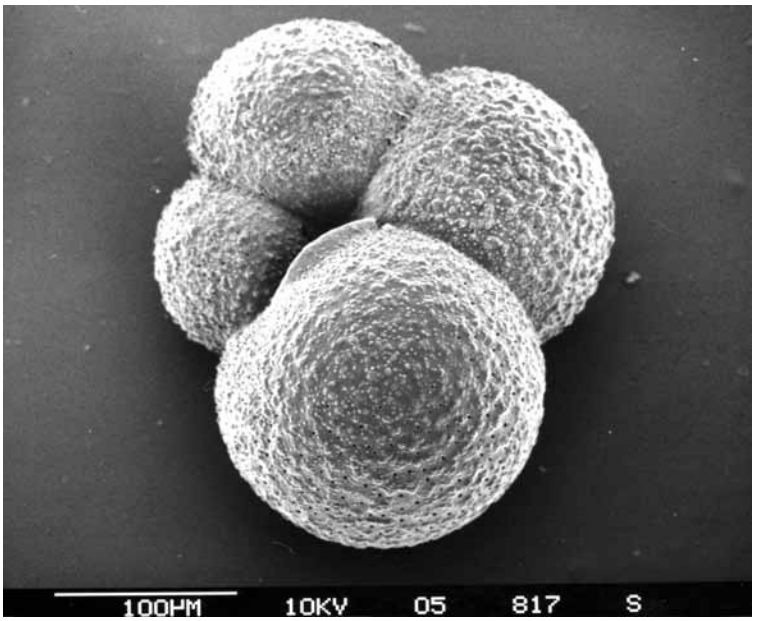

FIGURE 6.10
Neogloboquadrina pachyderma *is a microscopic organism that provides valuable clues about past ocean temperature.*

Scientists study the record preserved in the sediment layers by drilling into the ocean bottom using a variety of coring devices. They obtain undisturbed sediment cores using hollow tubes, such as the one shown in Figure 6.11. The sediment cores are then brought to the surface and analyzed. The age of the layers is determined using radioisotopic dating techniques, and each layer is carefully studied.

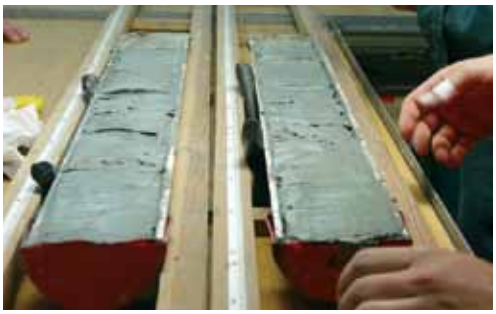

FIGURE 6.11
These sediment cores from the ocean floor contain microscopic organisms, such as foraminifera, that can be used to determine past ocean temperatures.

In this activity, you will simulate counting and analyzing the number of right-coiling versus left-coiling *N. pachyderma* in the layers of a sediment core. You will use these data to determine past ocean temperatures.

Procedure

Record all observations and answers in your notebook as you work.

1. Carefully pour the contents of your core onto your desk or lab bench, being careful not to lose any pieces (this could cause errors in your measurements). Notice that there are three different fossil foraminifera (forams) as shown in Figure 6.12 below: left-coiling *N. pachyderma,* right-coiling *N. pachyderma,* and *Globigerinoides sacculifer (G. sacculifer):*[3]

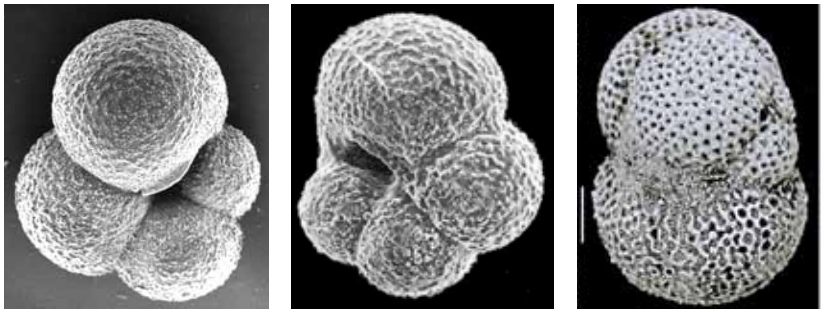

FIGURE 6.12
(left to right) Left-coiling N. pachyderma, *Right-coiling* N. pachyderma, G. sacculifer

2. Count and record the number of each of the different types of forams found in your sediment core.
3. Note the age of your core sample (printed on your core tube) then record the number of right-coiling and left-coiling *N. pachyderma* in the row of the class chart that corresponds to the age of your core.
4. Make a table in your notebook similar to Table 6.2. Copy the class data into it.

Materials

FOR EACH TEAM OF STUDENTS

- 1 "sediment core" containing "forams"
- 1 tray
- 1 calculator

FOR EACH STUDENT

- ruler (optional)
- graph paper

5. For each time period in the chart, calculate the total number of *N. Pachyderma* and the percent of right-coiling *N. Pachyderma*. Record your results in Table 6.2.

Table 6.2

AGE (years ago)	RIGHT-COILING *N. PACHYDERMA*	LEFT-COILING *N. PACHYDERMA*	TOTAL NUMBER OF *N. PACHYDERMA*	% RIGHT COILING (WARM WATER)
0				
30,000				
60,000				
90,000				
120,000				
150,000				
180,000				
210,000				

6. Create a labeled line graph that shows the percent of right-coiling organisms versus time.
7. Since a higher percentage of right-coiling *N. Pachyderma* corresponds to warmer temperatures, label the warm and cool periods on your graph.
8. Write answers to the Analysis questions and be prepared to discuss them with the class.

Analysis

With your group, complete the following questions and record your answers in your notebook. Be prepared to share your answers with the rest of the class.

1. Describe your results:
   a. During what time periods was the ocean water relatively warm according to the simulated foraminifera data?
   b. During what time periods was the ocean water relatively cold according to the simulated foraminifera data?
2. Relate the ocean-water temperature recorded in these sediment samples to past global climate. What does it tell you? What does it not tell you about global climate at the time these layers formed?
3. Aside from the fact that you didn't use real organisms, describe your initial ideas about how this activity might be similar to and different from the real processes scientists follow to analyze sediment cores.

Now that you have a better idea of how scientists study past climate, you will look at what they've learned about what has caused climate to change in the past. The first mechanism you'll study is change in Earth's orbit.