CLIMATE ANALYSIS USING PLANKTONIC FORAMINIFERA, A CLASSROOM ACTIVITY INTEGRATING SCIENCE AND MATHEMATICS

Credit: https://ucmp.berkeley.edu/fosrec/Olson2.html

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INTRODUCTION

Age Level: This activity is appropriate for middle school students in seventh or eighth grade. It may be adapted for use with high school biology students.

Prerequisites: Students should have an understanding of planktonic foraminifera. They should have a concept that our planet's climate has not always been as it is today. A review of the use of *Neogloboquadrina pachyderma* coiling ratios as a proxy for paleoclimate would be useful. *Neogloboquadrina pachyderma* is an excellent recorder of climatic temperatures through geologic time. When the earth experiences periods of relatively cold temperatures, ocean waters are cooler and *Neogloboquadrina pachyderma* forms its test (shell) such that it coils to the left. Alternatively, during periods of relatively warm temperatures when ocean waters are warmer, *Neogloboquadrina pachyderma* constructs its test with a coiling direction to the right. Students should be able to perform simple arithmetic procedures, namely, adding and formulation of percentage data. An answer key to the data chart is provided for you in Table 2. In addition, the students should know how to plot scientific data on graph paper. A graph of the data is given in Figure 1.

Objective: This exercise allows students to manipulate scientific data, plot the data and then interpret their results. You might query the students as to what is the "cause" and what is the "effect" in this scientific problem. The fact that our planet's climate has changed drastically throughout geologic time will be emphasized. Students should recognize that the climate will likely continue to change in the future.

Follow-Up: You might want to follow this activity with a discussion of the causes for climate change, past, present and future. This exercise can foster discussions on current climate change. The class could discuss current evidence for climate change and what might be the potential causes, both natural and man-made, for this change.

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Instructions: Follow the instructions given below and those of your teacher to complete this activity.

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1) You have been given a series of samples containing planktonic foraminifera representing time from the present to 160,000 years ago. After your analysis of the material, you decide to look at the climatic signal from these samples. You are aware that a particular species of foraminifera, *Neogloboquadrina pachyderma*, is an excellent recorder of water temperature through geologic

time. When the earth experiences periods of relatively cold temperatures, ocean waters are cooler and *Neogloboquadrina pachyderma* forms its test (shell) such that it coils to the left. Alternatively, during periods of relatively warm temperatures when ocean waters are warmer, *Neogloboquadrina pachyderma* constructs its test with a coiling direction to the right. Therefore, you have separated out the specimens of *Neogloboquadrina pachyderma* from your samples. For each sample you have counted how many of this species coil to the left and how many coil to the right. Your data is recorded in Table 1. Your next step is to calculate the percentage data for each sample. You must calculate percentage data so that your information is not biased by the total amount of foraminifera present in the sample. Complete the worksheet in Table 1 by calculating the total number of *Neogloboquadrina pachyderma* for each sample and the percentages of right- and left-coiling forms of the species. The first sample is done for you on the worksheet.

2) Next, use graph paper to plot your results. On the vertical axis you should plot the age of the samples with "0" at the top and "-160,000" at the bottom. On the horizontal axis, plot the percentage of right-coiling *Neogloboquadrina pachyderma* with "0%" on the left side and "100%" on the right side. You should now have a graph representing the climatic signal derived from the coiling ratios of *Neogloboquadrina pachyderma*.

3) Analyze your graph and make an interpretation of the climatic history on our planet during the last 160,000 years. Describe this history below and provide evidence for this interpretation.

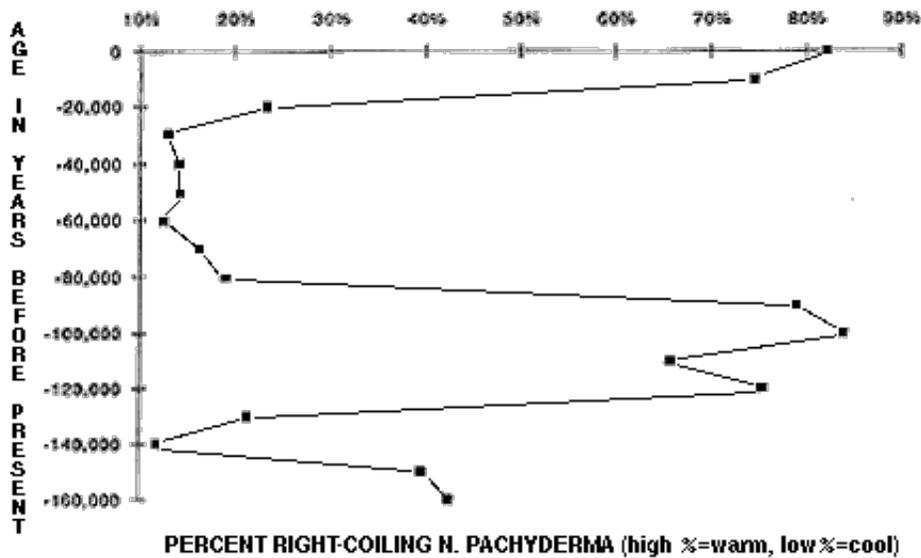**Table 1.** *Neogloboquadrina pachyderma* coiling rations worksheet

Age (years ago)	Right coiling *Neogloboquadrina pachyderma*	Left coiling *Neogloboquadrina pachyderma*	Total number *Neogloboquadrina pachyderma*	% Right coiling *Neogloboquadrina pachyderma*	% Left coiling *Neogloboquadrina pachyderma*
0	230	50	280	82%	18%
10,000	220	75			
20,000	70	230			
30,000	45	300			
40,000	50	302			
50,000	65	389			
60,000	20	140			
70,000	56	287			
80,000	63	267			
90,000	212	56			
100,000	120	23			
110,000	87	45			
120,000	203	66			
130,000	56	205			
140,000	45	332			
150,000	89	135			
160,000	123	166			

Table 2. Answers to *Neogloboquadrina pachyderma* coiling rations worksheet

Age (years ago)	Right coiling *Neogloboquadrina pachyderma*	Left coiling *Neogloboquadrina pachyderma*	Total number *Neogloboquadrina pachyderma*	% Right coiling *Neogloboquadrina pachyderma*	% Left coiling *Neogloboquadrina pachyderma*
0	230	50	280	82%	18%
10,000	220	75	295	75%	25%
20,000	70	230	300	23%	77%
30,000	45	300	345	13%	87%
40,000	50	302	352	14%	86%
50,000	65	389	454	14%	86%
60,000	20	140	160	13%	88%
70,000	56	287	343	16%	84%
80,000	63	267	330	19%	81%
90,000	212	56	268	79%	21%
100,000	120	23	143	84%	16%
110,000	87	45	132	66%	34%
120,000	203	66	269	75%	25%
130,000	56	205	261	21%	79%
140,000	45	332	377	12%	88%
150,000	89	135	224	40%	60%
160,000	123	166	289	43%	57%

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Figure 1. Climatic signal derived from coiling ratios of *Neogloboquadrina pachyderma*.

PERCENT RIGHT-COILING N. PACHYDERMA (high %=warm, low %=cool)

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