**Active Learning Exercise 23.1**

to accompany

*Vertebrate Life*, Tenth Edition

Pough • Janis

**How Do We Know What the Climate Was Like**

**Millions of Years Ago?**

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**Source:** Global Climate Change: <http://www.global-climate-change.org.uk/3-3.php>

**Level of Difficulty:** Medium

**Relevant Terminology:** climate change, data proxy, geologic uniformitarianism

**Introduction**

With the climate such an important focus of scientific research these days, this exercise focuses on climate research. The Cenozoic is known for dramatic shifts in climate. In fact, it is often trotted out as evidence that the climate always changes and the shifts we’re seeing now are nothing out of the ordinary. How do we know what the climate was doing millions of years ago?

**Activity**

1. Why do we care what the climate was doing millions of years ago? What does this information tell us or help us understand?

2. Instrumental records of climate span <10–7 years of Earth’s climatic history. Estimate how many years that is, and how many years make up the entirety of “Earth’s climatic history.”

Since we weren’t there to measure Earth’s early climate, and we want to know about it, we have to depend on climatic signals, or phenomena that are climate-dependent, that we can measure or figure out historically. They serve as proxies for direct climate measurement.

3. List as many climate signals as you can think of. What are some natural phenomena that are climate-dependent? (Depending how you state them, there are around two dozen of these!)

4. Of your list above, which ones could be used to look back in time at climate, potentially way back?

5. Consider two climate proxies that you may have listed: tree rings and ocean sediments.

a. What question might you ask that tree rings could answer but ocean sediment data could not?

b. What question might you ask that ocean sediments could answer and tree rings could not?

c. Given your answers, explain how the climate information provided by these two climate proxies differ.

One of the key books that Charles Darwin took along with him on his voyage on the hms *Beagle* was Sir Charles Lyell’s *Principles of Geology*. This book promoted the principle of “uniformitarianism” in geology.

6. What is that, and how does it relate to paleoclimatology? Explain this with an example using one of your climate proxies from Question 4 above.

Paleoclimates are reconstructed with observational data in stages. First, there is the proxy data collection and analysis. This is considered “primary data.” Then those data are compared with modern climate records, based on Lyell’s principle. Sometimes, though, the paleo-environmental conditions lack modern analogs, so while the comparison may be quantitative in nature, it may also have to be quite qualitative and subjective. These interpretations are “secondary data.” Finally, these data are statistically described and interpreted.

In addition to observational data, much climate research uses climate models. If the climate behaves in a particular way under particular physical circumstances, scientists can change the parameters and predict how the climate will change in response. You probably see this most commonly in storm forecasting. The forecasts are based on model predictions based on what past storms have done. Paleoclimate models work similarly, following patterns known in the climate now, and laws of physics.

7. Do model always get climate (and storms) right? Why or why not?

8. Given the preceding paragraphs, speculate on why paleoclimatologists might get into arguments over what was going on when.

9. Suppose you are a climate change denier. Based just on this exercise, justify your position in a few sentences.

10. You are a science major, so presumably you agree with the majority of scientists who say our climate is changing, in large part due to us humans. Broadly speaking, what is different between your view and that of the person in Question 9? What is that person in Question 9 misunderstanding?