Canon Paleo Curriculum
Lesson Plan 9
Unit: 2

<u>**CLIMATE ACTIVITY**</u>

Important Information:
If you can have access to PowerPoint equipment then download the "Exploring Ecosystems for Paleontology" presentation on the Main page. If you do not have access to PowerPoint, download the "Exploring Ecosystems for Paleontology" PDF (for Adobe Acrobat) for your overhead machine. The information in both of these files is critical for the activities and forming hypotheses.

Materials:
• Investigating Paleoclimates
• Climate Descriptions
• Climate Work Sheet
• Paleoclimate and Paleoelevation

Skills:
• Using observation to make an inference
• Categorizing

Directions: Have students complete **Leaf Idendification** and **Fossil Identification** activity first. Then show them **Part 1** of the Powerpoint or overheads – **Explore Ecosystems for Paleontology.**

After completing **Part 1**, take the fossils identified in the **Fossil Identification Activity,** project the **Investigation Paleoclimates** list on an overhead and put a score mark for each student's fossil (genus) on the overhead into all the climates that applies to that fossil.

After scoring all of the fossils from the students. Tell them that they have just completed what scientists call the "Floristic Method", identifying climate through plant species.

Show the class **Part 2** of the powerpoint program on plate tectonics, life zones, and climate indicators or show overheads from the PDF file.

Again have the class break out into group of 4-5, hand out the **Climate Descriptions,** have them look at the fossil list in terms of climate, and then have them answer the questions on the **Climate Work Sheet**.

After they finish the **Climate Work Sheet** and the answers have been discussed, have them break out into groups again to speculate and form some hypotheses. List the hypotheses on the board and then show **Part 3** of the powerpoint presentation or

overheads explaining all of the current hypotheses.

Key to Investigation Paleoclimates Activity:
Most of the student's plants will fall in Subtropical and Warm Temperate
Hint: List the percentage of plants that are found in each climate; 100% being the total
plants listed

Key to Climate Descriptions Activity:
Question 1:

- Floristic and Physiognomic

Question 2:
- That most of the genre falls into Subtropical and Warm Temperate, only a small
percent fall into aCool Temperate climate.

Question 3:
- List the 3 characteristics for the three climates from the **Climate Descriptions**
page. Such annual mean temperature, annual mean rainfall, and coldest and warmest
temperatures.

Question 4:
- That it was wetter 34-35 million years ago.
- That it was warmer 34-35 million years ago.

Question 5:
- That it was wetter 34-35 million years ago.
- That it was warmer 34-35 million years ago.
- That most of the plants may have been in a subtropical to warm temperate climate.

Hypotheses

- That Florissant Fossil Beds National Monument site was at a lower elevation 34-35
  million years ago.
- That Florissant Fossil Beds National Monument site was closer to the equator.

- That the planet was just warmer 34-35 million years ago.

Name_____

Investigating Paleoclimate

On the list below circle each of the plant genera that you identified in Activity One. If the name appears more than once, circle it everywhere that it occurs.

Climatic environments of extant plant genera.
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Subtropical	**Warm Temperate**	**Cool Temperate**
Dryopteris fern	*Pinus* pine	*Pinus* pine
Sequoia redwood	*Sequoia* redwood	*Cercocarpus* mountain mahogany
Vanquelinia Rose	*Bursea* aromatic	*Populus* poplar
Zizyphus lotus	*Crataegus* hawthorn	*Chamaecyparis* white cedar
Cardiospermum soapberry	*Carya*	*Acer* maple
Rhus anacard	hickory	Salix willow
Salix Willow	*Fagopsis* beech	*Quercus* oak
	Acer maple	*Rosa* Rose
	Cercocarpus	*Ulmus* elm
	mountain mahogany	
	Chamaecyparis white cedar	
	Cedrelospermum elm	
	Paracarpinus beech	
	Typha cattail	
	Quercus oak	
	Ulmus elm	
	Rosa Rose	

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The plants you circled are the closest living relatives of genera typically found in the Florissant Fossil Beds.

Climate Work Sheet

1. List two methods that help scientists determine paleoelevation.

2. What are some observation about the plant list and their genre?

3. What are the characteristics of a Subtropical Climate? Warm Temperate? Cool Temperate?

4. What would you infer about the past climate at Florissant based on the plants genre you circled?

5. What would you infer about the past climate at Florissant based on the plant characteristics you describe in the "Pieces-Parts of Leaves" exercise?

Climate Descriptions

Tropical: Within five degrees of the equator there is little seasonal variation, it being hot and wet year round. Between five and fifteen degrees from the equator wet and dry seasons are common.
- The coolest month is above 18 degrees C.
- The annual mean temperature approaches 27 degrees C.
- Average rainfall between 100 and 200 cm per year.

Examples: **Brazilian Lowlands, Philippine Islands**

Subtropical: More noticeable seasonal variation in temperature, as well as distinct wet and dry seasons.
- Coldest month above 6 degrees C but below 18 degrees C.
- Annual mean temperature approximately 20 degrees C.
- Average annual rainfall between 50 and 100 cm.

Examples: **Hawaiian Islands**

Warm Temperate: Thoroughly differentiated seasons. Warm Temperate is further divided based on the wet season. Many interior continental regions have warm wet summers and mild winters. Those regions that have mild wet winters and hot dry summers are termed *Mediterranean*.
- Coldest month above 0 degrees C.
- Annual mean of 12 degrees C.
- Average annual rainfall is between 25 and 75 cm.

Examples: **Milan, Italy; San Francisco, CA**

Cool Temperate: Thoroughly differentiated seasons. Cool Temperate is also divided into two categories: *Oceanic* and *Continental*. *Oceanic Cool Temperate* is mild and rainy year round, while *Continental* regions experience cold winters and warm summers.
- Coldest month below 0 degrees C.
- Annual mean of 6 degrees C.
- Average annual rainfall is 25 to 75 cm.

Examples: **Woodland Park, CO; Nova Scotia, Canada**

Cold: Cold climates are defined as regions that spend 6 to 9 months below 6 degrees C.
- Coldest month well below 0 degrees C.
- Average rainfall is often below 25 cm per year.

Examples: **Fairbanks, AK**

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Climate Information:
    http://www.fs.fed.us/colorimagemap/images/230.html
    Espenshade, E. B. and Morrison, J. L., 1974, *Goode's World Atlas*. Chicago, Rand McNally
 and Co. pp. 10-15.
    Pearce, E.A. and Smith, C.G., 1998, *Fodor's World Weather Guide*. New York, Random House. p. 11.
                NA, 1987, *Encyclopedia of Climatology, Volume XI*, New York.
[1] MacGinite, H.D., 1953, *Fossil Plants of the Florissant Beds, Colorado*: Baltimore, Lord Baltimore

<h1 style="text-align:center">PALEOCLIMATE AND PALEOELEVATION</h1>

<p style="text-align:center">(Past climate and Past Elevation)</p>

Comparing Research Methods

You have now completed activities on fossil identification and have made observations and inferences about the climates in which the may have exisited. Do you have any questions?

We purposely left many questions unanswered, because as you me have discovered, science is a process, and not a list of facts.

Take your own hypothesis for example. As a class you decided that the most likely reason that Florissant has cooled off considerably in the last 35 million years was due to regional uplift.

In the chart below you will find information about other hypotheses and methodoligies that have fueled debate on this very issue for almost 50 years.

began only 5 million years ago.   Studied sediment deposition in stream beds to calculate relative age of tilting and canyon cutting.

Woodland High School Classes (2000)*Hypothesized that the decrease in average temperature at Florissant since the Eocene could be caused by uplift.   "Warm Temperate"About 12 degrees C.   FloristicComparing fossil plants to closest living relative's habitat.   Lower than present elevation.Present elevation is 2600 meters. Propose to study landscape for evidence of Uplift. This would be* geomorphic *evidence.*

	Paleo-Temperature (Currently 4 C)	Technique for Temp.	Elevation (Currently 2600m)	Technique for Elev.
Harry MacGinitie (1953) By comparing fossil plants to the habitat of their closest living relatives, MacGinitie predicted a low paleo-elevation.	>18 degrees C	**Floristic** Closest living relative	305-915 meters	Qualitative analysis using closest living relatives and current habitat.
Dr. Herb Meyer (1986) Studied fossil leaf structures to predict past climate and elevation.	About 14 degrees C	**Physiognomic** First to apply plant features to the problem of paleo-elevation at Florissant.	2450 meters	Compared Florissant flora with co-eval sea level flora and calculated elevation using an inferred
Dr. Jack Wolfe (1992) Studied fossil leaves to calculate past temperature and elevation.	12 degrees C	**Physiognomic** Compared leaf structures at Florissant with current leaf structures to est. temp.	2700-2900 meters	lapse rate. Compared fossils from Florissant with sea level fossils and calculated elevation using lapse rate.
Dr. Kate Gregory (1994) Studied fossil leaves and sequoia stumps to calculate past temp, and believes Florissant has not been uplifted since Eocene	10.7 degrees C	**Physiognomic** Plant features and *sequoia affinis* tree ring comparison.	2300-3300 meters	Compared paleo temps at Florissant with *co-eval* (same age) temps from sea level and calculated using a lapse rate.
Dr. Emmett Evanoff (1997) Hypothesized that the Florissant region has been uplifted since the Eocene.		*Uplift* – due to plate tectonics	Lower than present elevation. Proposes that uplift began only 5 million years ago.	Studied sediment deposition in stream beds to calculate relative age of tilting and canyon cutting.
Woodland High School Classes (2000) Hypothesized that the decrease in average temperature at Florissant since the Eocene could be caused by uplift.	"Warm Temperate" About 12 degrees C.	**Floristic** Comparing fossil plants to closest living relative's habitat.	Lower than present elevation. Present elevation is 2600 meters.	Propose to study landscape for evidence of Uplift. This would be *geomorphic* evidence.