ACTIVITY

PALEO PLANTS PRESERVE THE PAST

A Deep-time Look at Alaska using Fossil Leaves

Fossil plants provide some of the best evidence for understanding just how different Earth was in the past. In this exercise, you will investigate a "flora" of fossil plants from the Alaskan Peninsula during the age of dinosaurs (the Late Cretaceous, about 69 to 78 million years ago) to see what the vegetation and climate was like. The fossils that you will use were collected from the Chignik Formation during explorations in the late 1800s and early 1900s, and were described by Dr. Charles Hollick in 1930. During this time, the Earth's climate was in a greenhouse state - it was overall warmer, the poles were not covered by ice sheets, and sea level was higher.



(left) Reconstruction of Earth 80 mya. (right) View of the North Pole and Alaska at 70 mya with the location of the Chignik fossils marked with a yellow dot. Maps from Colorado Plateau Geosystems, https://deeptimemaps.com, and from PLATES/UTIG.

Currently, the vegetation of the Alaskan Peninsula is considered Montane Taiga. It is mostly scrubby vegetation, and with seasonal flowering herbs (*below, left image*). The fossil flora contains very different plants - there are even ginkgo and redwood trees! (*below, right*)



BEST FOR

Grades

ACTIVITY

BEST FOR Grades 7-12

The BIG questions: What was the climate? And what was the vegetation like? Interpreting the past environment is key to providing the deep time history of the region and for understanding the past fauna's (dinosaurs!) habitats and lifestyle.

BACKGROUND RESEARCH

The first step in studying a fossil leaf flora (besides digging up the fossils!) is to sort the fossils into different species. Paleobotanists do this by comparing many traits of leaves, including their shape, features of the edges of leaves, and especially the patterns of the veins. Figuring out how many species are in a fossil flora is the most difficult and time-consuming part! Luckily, this has already been done for the Alaskan peninsula flora. You get to take over the investigation from there – using the fossil species to determine the climate and draw what the flora was like.

MISSION #1: ESTIMATE TEMPERATURE

Plants have close relationships with climate - especially temperature and water. Plants can be used to estimate the temperature of a place, using simple traits of their leaves. The most widely used method is called Leaf Margin Analysis. This uses the percentage of woody flowering plant species with smooth leaf margins (as opposed to toothed margins) in a flora to calculate the Average Annual Temperature (otherwise called the Mean Annual Temperature).

The graph below shows the relationship of temperature and leaf margins for a flora, based on studies of the modern floras. If you know the percentage of species in a flora that have smooth margins, you can determine the temperature, either using this graph, or the equation below.



The above figure is adapted from a classic work quantifying this relationship (Wolfe, 1979). The equation for the relationship is:

ACTIVITY

AVERAGE ANNUAL TEMPERATURE (CELSIUS) = (PERCENT SMOOTH MARGIN SPECIES) X 0.306 + 1.141

HOW TO ESTIMATE TEMPERATURE

Step 1 - Use the four pages of images of fossil leaf species (at the end of this document) to count how many species have leaves with smooth margins and how many have toothed margins. But be careful! Many of the leaves are not preserved perfectly, so you have to try to determine what the actual leaf margin is, instead of broken edges of the leaf (see below).



Step 2 - Calculate the percentage of species with smooth margins.

Total number of species = _____

Number of species with smooth margin = _____

(number of species with smooth margin) \oplus (total number of species) x 100 = _____

Step 3 - Use the graph above, or the equation, to determine the paleo temperature in Celsius and Fahrenheit.

The current average annual temperature for Chignik, Alaskan Peninsula = 38.5°F

The current average annual temperature for Dallas, Texas = 64.3°F

Questions: How does the average temperature for the Late Cretaceous of Alaska compare with today? What does the vegetation look like in places with similar temperature today?

Remember, this is the average across a year, so it will get hotter and colder! But from other evidence we know that it did not have longs periods of freezing.

BEST FOR

Grades

ACTIVITY

MISSION #2: RECREATE THE VEGETATION AND ENVIRONMENT

Use what you have learned about the climate, plus the images of the fossil flora and the clues below to sketch what you think the environment looked like on the Alaskan Peninsula in the Late Cretaceous!

Additional clues:

- 1) More plants! The plants used for temperature are only the flowering plants, but there were other groups of plants that were also important in the vegetation. Here are some of the most common ones:
 - a. Nilssonia serotina (a cycad-like shrub with large leaves)
 - b. Ginkgo minor (a tree)
 - c. Sequoia obovata (relative of modern redwood trees)
 - d. Ferns (herbs on ground)



- 2) Perot Museum paleontologist Dr. Tony Fiorillo and other scientists have found large fossil trunks of trees.
- 3) Some of the dinosaurs that lived there, based on fossil evidence, were: hadrosaurs, therizinosaurs, theropods, and ankylosaurs. Include them if you would like!

***SHOW US YOUR SKETCH AT @PEROTMUSEUM ON SOCIAL MEDIA!**

BEST FOR

Grades



PerotMuseum.org

J

f

Tag us @perotmuseum on social media

to show us how you Amaze your Brain!





Per St

PerotMuseum.org

0)

f

y

Tag us @perotmuseum on social media

to show us how you Amaze your Brain!







f0)

Tag us @perotmuseum on social media to show us how you Amaze your Brain!





ACTIVITY





(f) (J) Tag us @perotmuseum on social media to show us how you Amaze your Brain! PerotMuseum.org Per t