Paleobotanical Evidence for High Altitudes in Nevada During the Miocene

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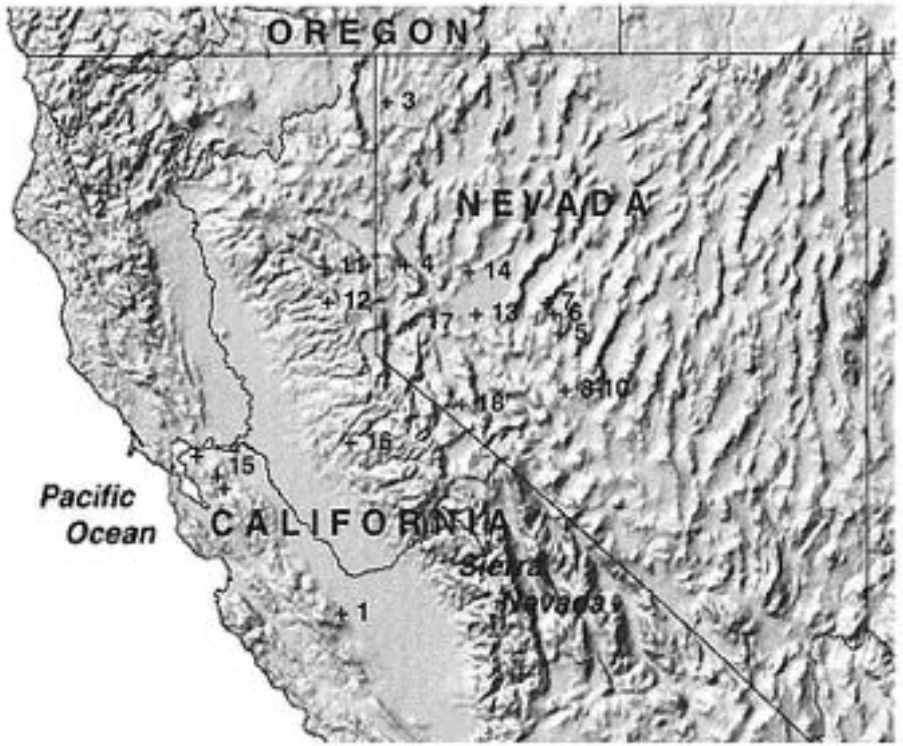
Presented by Angelica Rodriguez GEOL 730

Paleobotanical Methods

Nearest living relative method: Assumes that the environmental tolerances of a fossil species are the same as those of the nearest living relative

Implications: Data from this method suggest most of the Basin and Range Province was at low altitudes until <5 million years ago (Ma). In models, it is suggested that recent uplift helped initiate late Cenozoic glaciation.

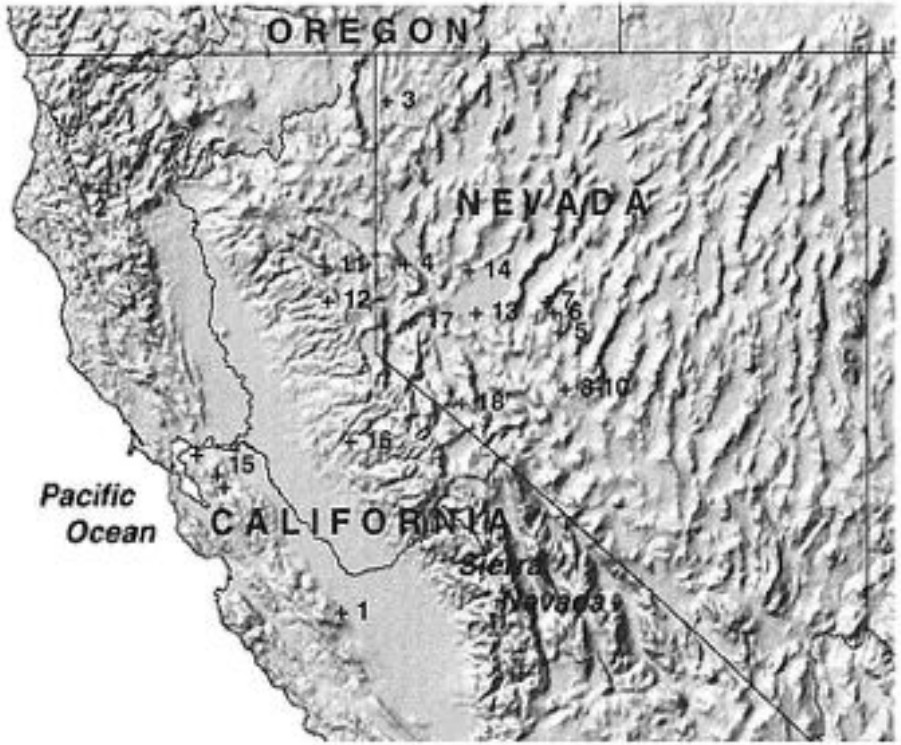


Wolfe, et al., 1997

Paleobotanical Methods

Physiognomy Method: Relates physiognomy (assessing character based off of outward appearance) of plants to the environment, this is based off of gross physical aspects of leaves that are observed to change in present day environmental gradients.

Gross physical aspects: Specifically looking at leaf outlines, shapes, and sizes on fossilized leaves.

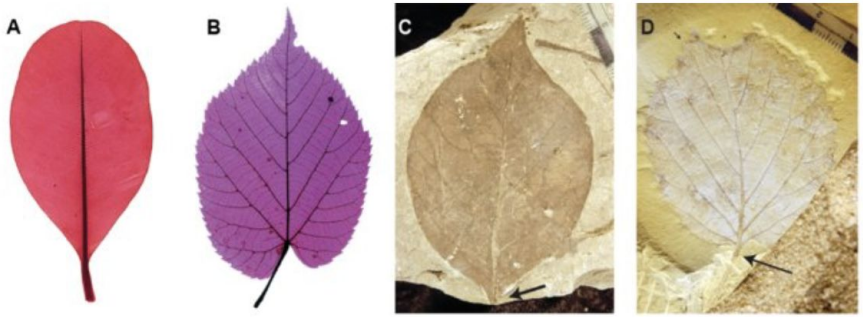


Wolfe, et al., 1997

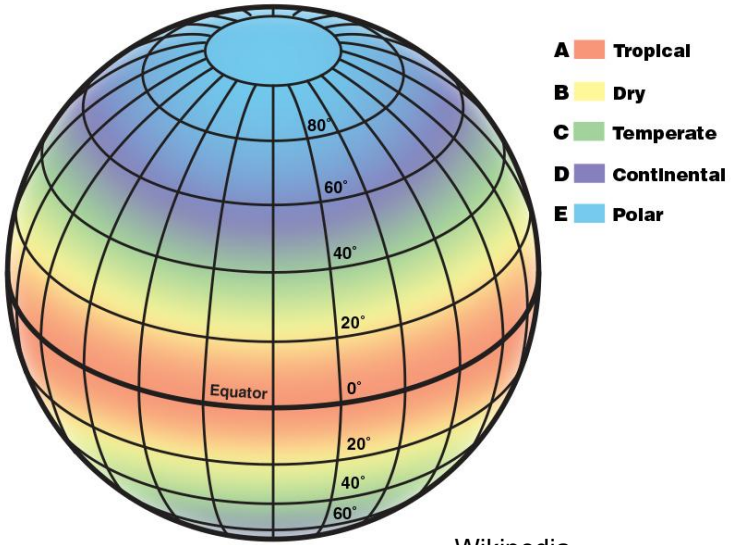
Calibration

In order to calibrate the physiognomy of leaves with climate 20 species of woody dicotyledons were collected across a range of latitudes (18°N to 62°N) and climates.

Physiognomic character is analyzed in a multivariable context using the Climate-Leaf Analysis Multivariate Program (CLAMP). CLAMP estimates: absolute temperature (T) and enthalpy (H).

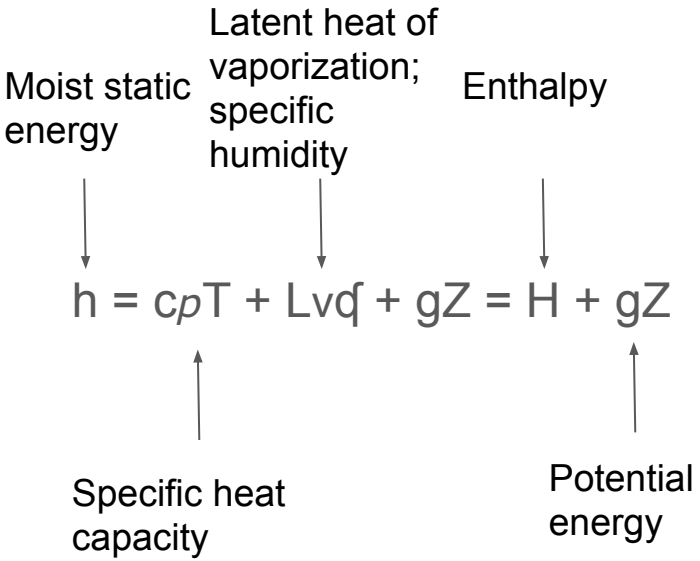


Peppe et al., 2018



Wikipedia

Enthalpy and Potential Energy Calculation



Assuming that the moist static energy is zonally invariant, the difference between two estimates of mean annual enthalpy for sites at similar paleo latitudes should yield an estimate of their difference in potential energy

Error

σH = 4.2 kJ kg^-1
standard error for
predicted enthalpy

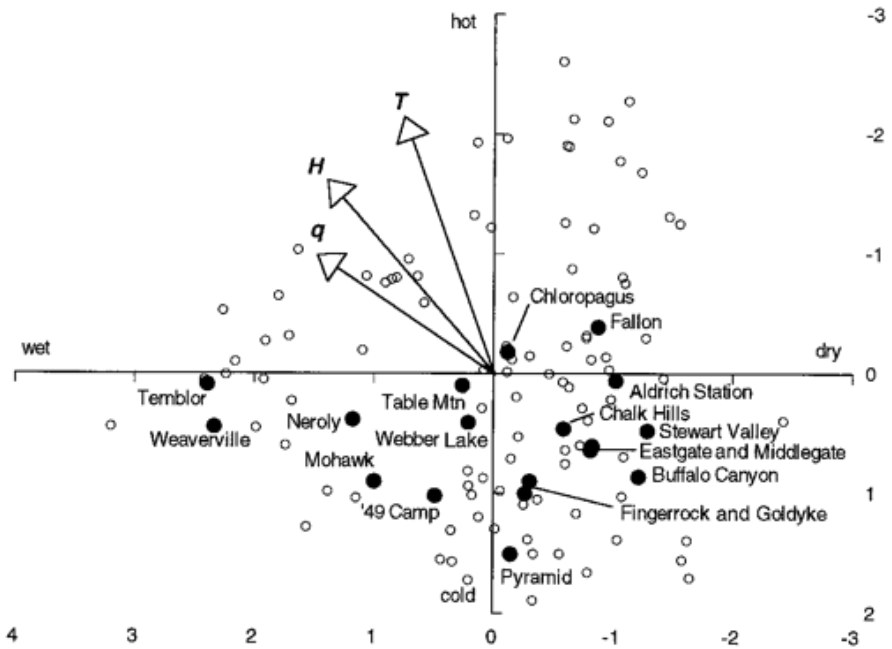
σh = 4.5 kJ kg^-1 error
from moist static energy
varying with longitude

σz = √((2σ^2н+σ^2h) /(g^2))
= 760m standard error for
predicting altitude

Variable Dependance

Canonical correspondence analysis findings:

1. H (enthalpy),T (temperature),q (specific humidity) can be estimated from leaf physiognomy
2. 50% of physiognomic variations on x axis are from temperature factors
3. 20% of the physiognomic variation on y axis from water stress
4. q is not linearly dependant on T as assumed in previous studies.



Modern samples (open circles)
Fossil leaf assemblage (closed circles)

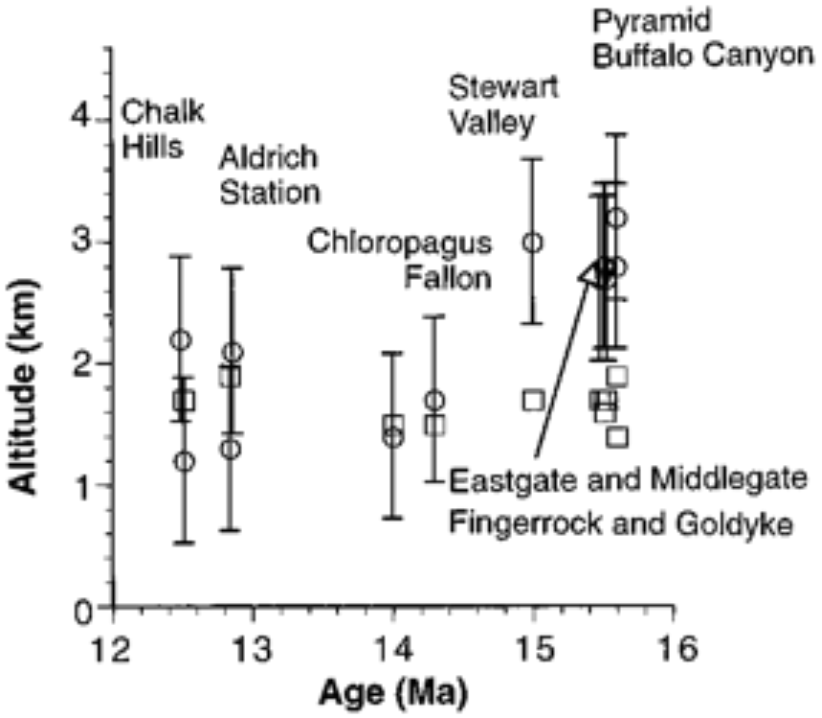
Wolfe, et al., 1997

Paleo Altitudinal Estimates

Overall, paleobotanical evidence supports the hypothesis that Mesozoic thrust faulting and crustal thickening built a high terrain in the basin and range.

Generally, altitudes decrease at about the same time basin and range faulting begins.

Authors argue that late Cenozoic uplift of mountain ranges and plateaus was not a trigger for the Ice Age.



Wolfe, et al., 1997

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Geologic Context

Onset of Extension and Magmatism in Western Basin and Range began in the Early Miocene.

Sierra Nevada acted as the Western Flank to the Nevada Altiplano; results corroborate findings for the Sierra Nevada uplift.

M.G. Best et al., 2009