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The Past is the Key to the Present: Reconstructing Changes in Seasonal Precipitation Triggered by Ancient Climate Change

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Reconstructing Changes in Seasonal Precipitation Triggered by Ancient Climate Change

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Ancient Climate Change

During the boundary between the Paleocene and Eocene epochs (~56 Mya), environmental instability led to a short-lived global warming event (known as the PETM). In less than 10,000 years, global temperatures rose by 5˚ - 8˚ C. There is evidence to suggest that these changes had lasting impacts on the hydrologic cycle, causing global increases in precipitation.

Artist rendition of the Eocene Epoch
Image by Kim Thompson

Landscape today in Bighorn Basin, WY
Photo by William B. Ward

Evidence for Global Warming

- Carbonate minerals in rocks from the PETM indicate atmospheric CO_2 was much higher than today.

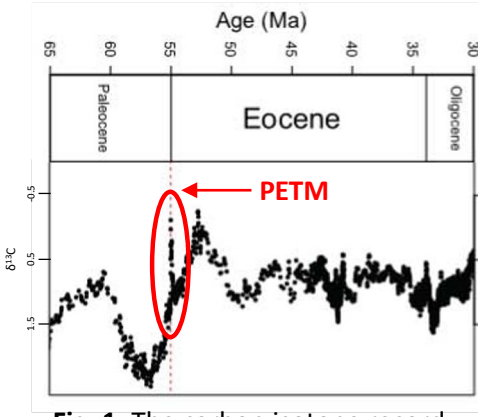


Fig. 1. The carbon isotope record of the Paleocene-Eocene Thermal Maximum (PETM; 56Mya) (modified from Zachos et al., 2001)

Evidence for Rainfall Variability

- Chemical composition (H isotopes) of plant molecules can record changes in precipitation at the time the plant was growing

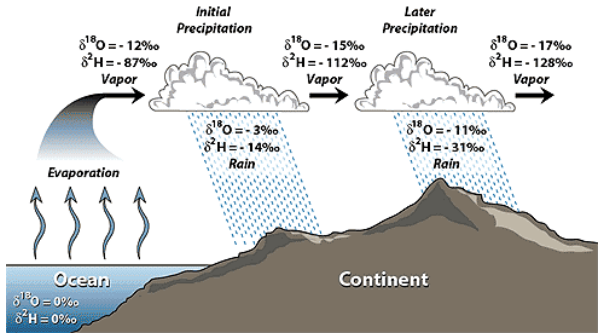


Fig. 2. Rainout effect on H isotopes (δ^2H) of water. The more it rains at one location, the lower the δ^2H value of the precipitation. (http://web.sahra.arizona.edu/programs/isotopes/oxygen.html)

Research Objectives

- Extracting ancient plant leaf waxes preserved in PETM rocks
- Measuring changes in the hydrogen composition of these waxes
- Reconstructing changes in rainfall during this global warming event.

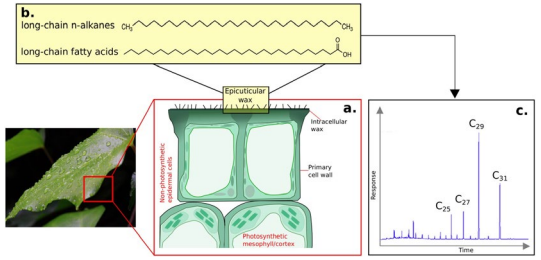
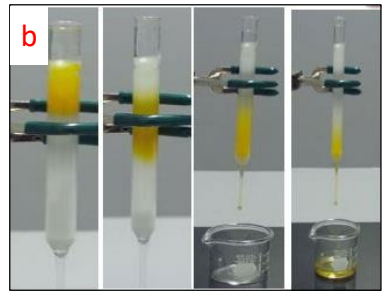
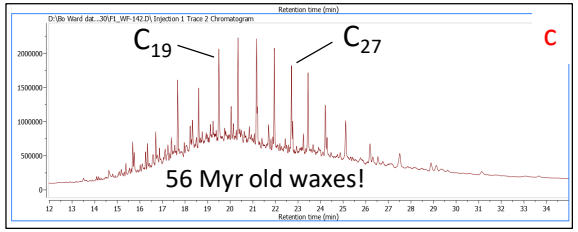


Fig. 3. Plant waxes protect the leaf from desiccation. Composed of C and H, they can be identified by gas chromatography. (modified from Eley & Hren, 2018).

Methods for Tracking Rainfall

- Sohxlet solvent extraction **(Panel a)**
- Column chromatography **(Panel b)**
- Gas chromatography **(Panel c)**





Summary & Implications

I successfully extracted and isolated plant waxes preserved in 56 myr-old rocks. Forthcoming isotopic analyses will inform on precipitation changes caused by the PETM, a global warming event. Since the PETM is an analog for anthropogenic climate change, our results can improve our understanding of future climate scenarios.