High-Latitude Continental Response to Cenozoic Climate Change in Southern Alaska Based on Volcanic Glass Hydrogen Isotope Composition

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Objectives

1) How did high-latitude continental climate respond to Cenozoic climate change?
2) Can we infer Cenozoic paleotopography in southern Alaska using volcanic glass δD values?

Samples

1) 21 rhyolitic volcanic ash samples from fluvial Sterling Formation on the west side of the Kenai Peninsula. Elevations of sampling sites are ~200 m.
2) 3 volcanic ash samples from the West Foreland Formation on the Talkeetna and Tordrillos Mountains. Elevations of sampling sites are ~800 m.

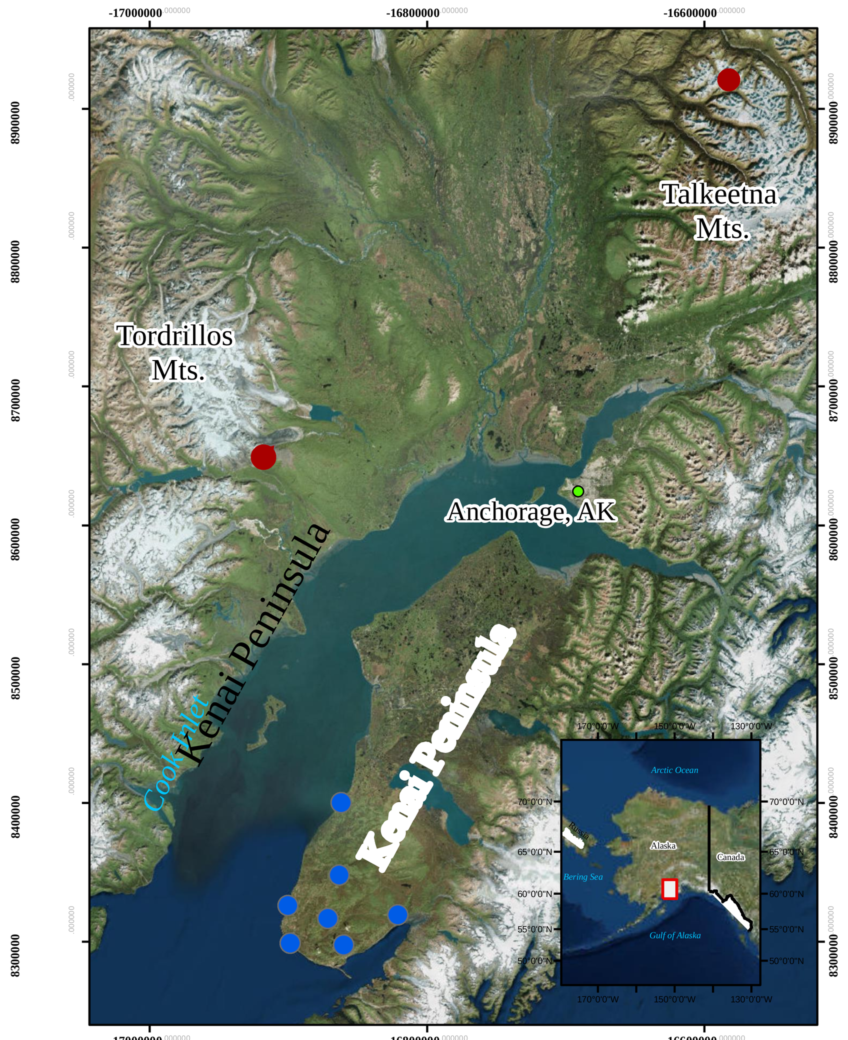
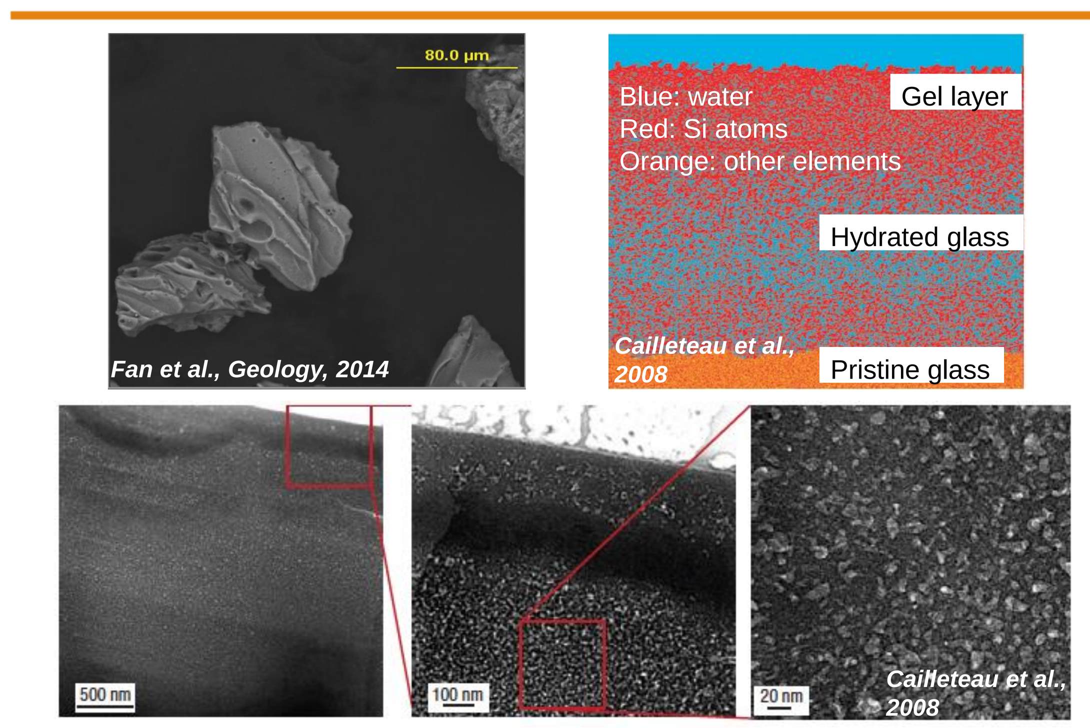


Figure 1. Sampling locations around the Cook Inlet. Red dots represent samples >38 Ma. Blue dots represent samples <12 Ma.

Hydrated Volcanic Glass



Dense gel layer acts like a diffusion barrier and locks water molecules within the hydrated glass.

Volcanic Glass in Alaska

Volcanic glass collected showed characteristic traits of:

- Optically isotropic
- Refractive Index of ~1.50
- Thin walled with or without circular to suboval vesicles
- Angular shape
- Tabular

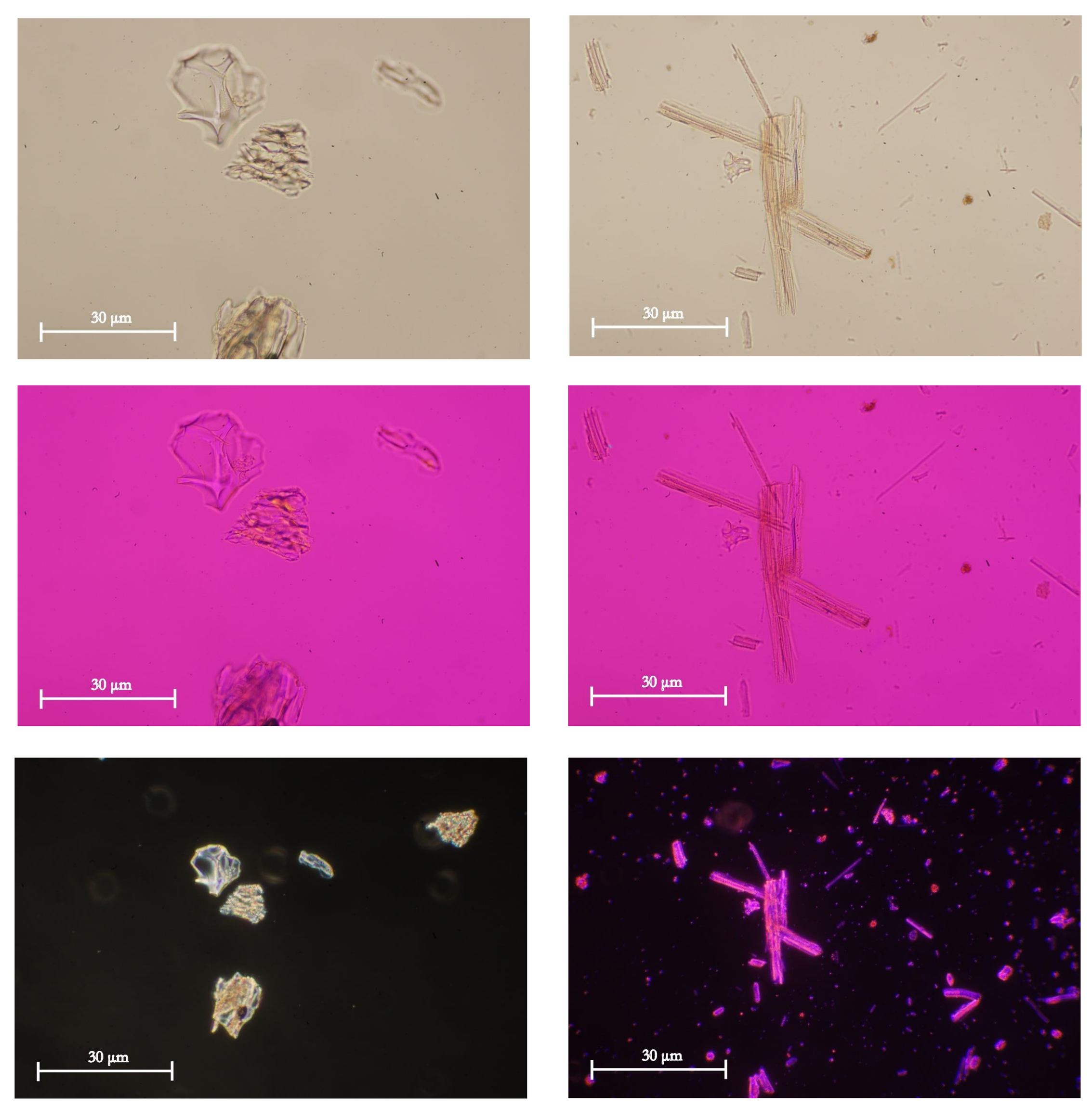


Figure 2. Left column: vesicular thin-walled volcanic glass. Right column: tabular thin-walled volcanic glass. From top to bottom plane polarized light, crossed polarized light with gypsum plate inserted, and dispersion staining objective.

Stratigraphy

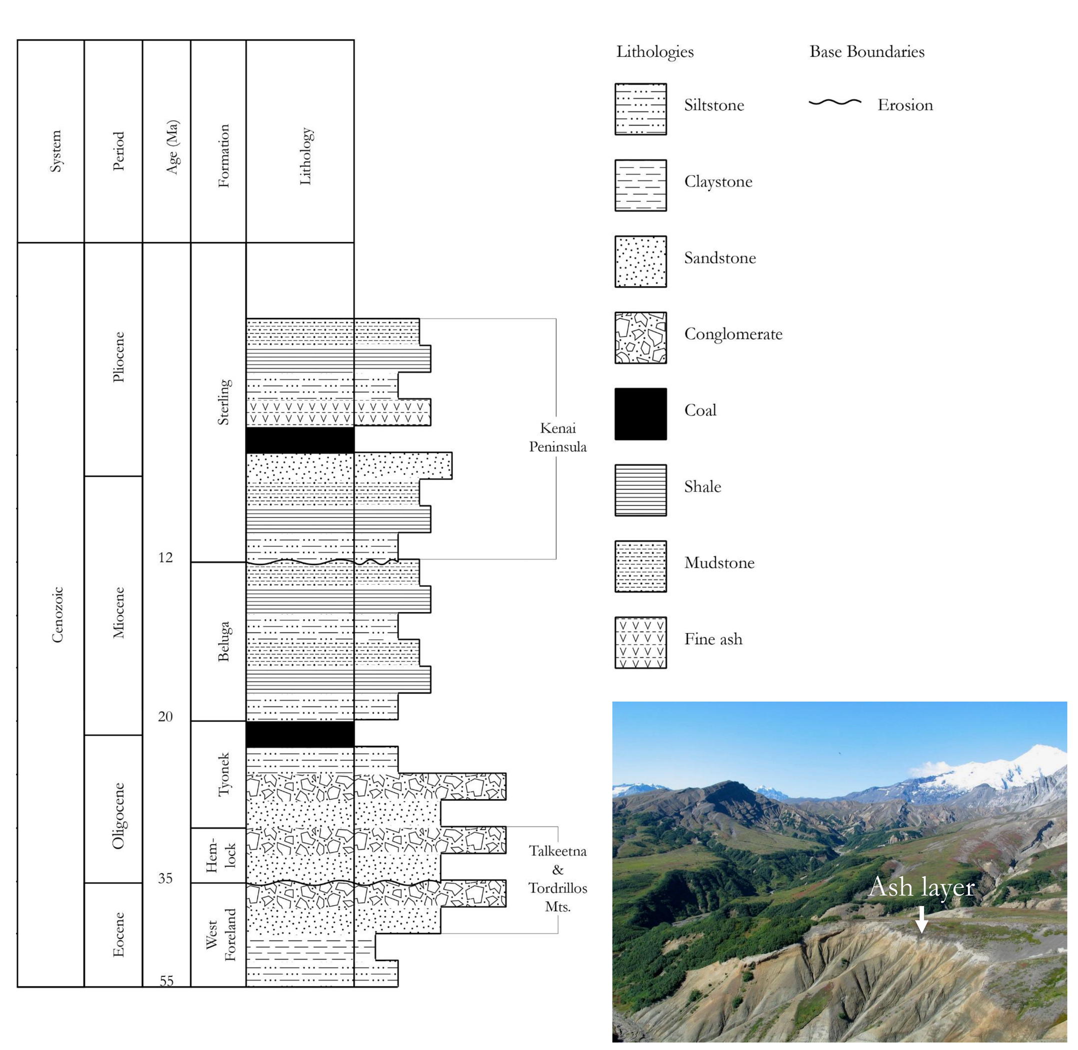


Figure 3. Generalized stratigraphic column in the study area and field picture of an ash layer in the Tordrillos Mountains.

Results and Interpretation

- 21 samples from the fluvial Sterling Formation on the Kenai Peninsula, dated to be younger than 12 Ma, have δD values ranging from -181‰ to -97‰ (VSMOW). The derived paleometeoric water δD values range from -153‰ to -66‰ (VSMOW). These values have larger variation than modern river water δD values at ~200 m on the Kenai Peninsula.
- The high paleometeoric water δD values most likely reflect evaporation of surface water on the floodplain.
- The low paleometeoric water δD values, occurred at 8-6 Ma, most likely reflect river water charged by high-elevation precipitation.
- Mountains on the Kenai Peninsula were at least ~1 km above sea level during the last 10 Ma.

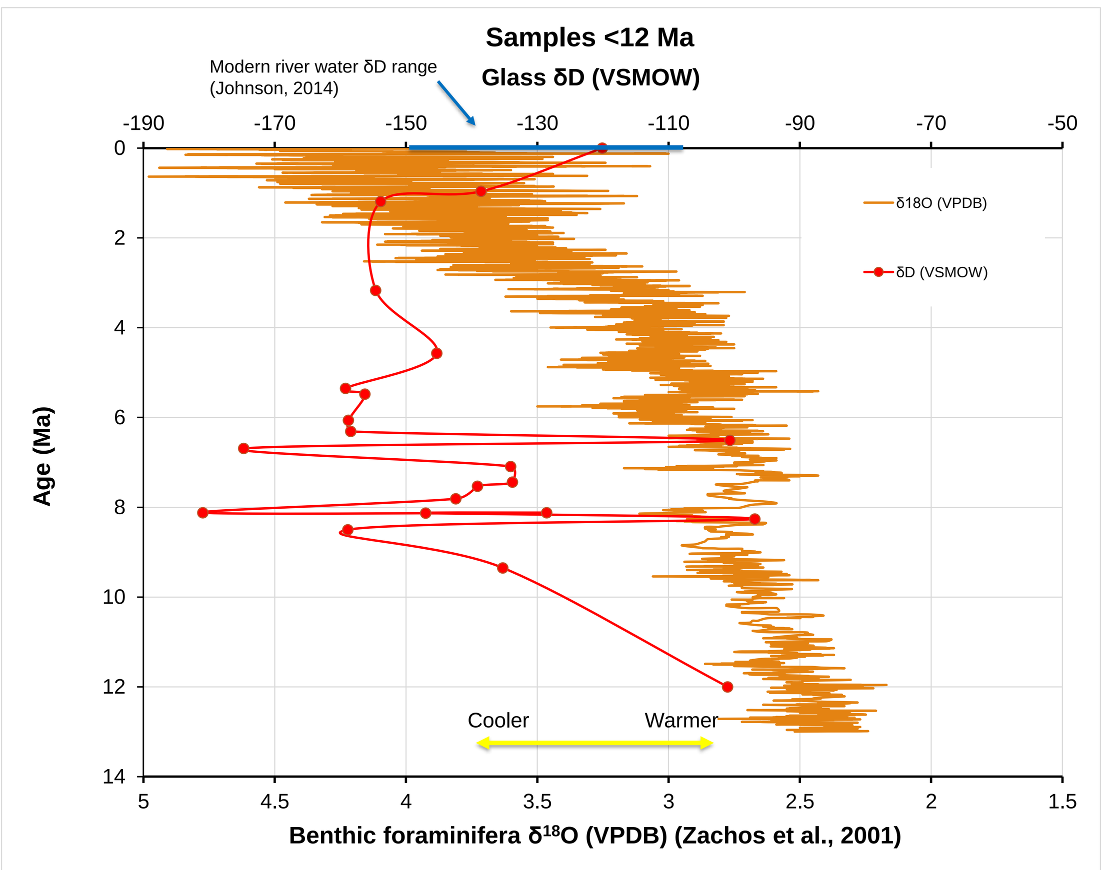


Figure 4. 21 samples from the Kenai Peninsula.

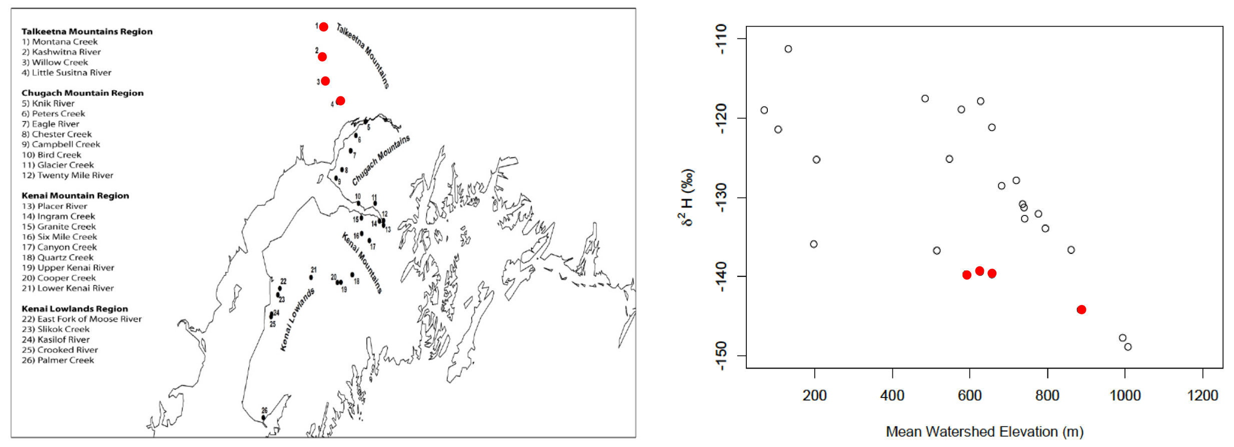


Figure 5. River water δD values in southern Alaska (Johnson, 2014).

- 3 samples from the West Foreland Formation on the Talkeetna and Tordrillos Mountains, dated to be 44-38 Ma, have δD values ranging from -167‰ to -128‰ (VSMOW). The derived paleometeoric water δD values range from -139‰ to -98‰ (VSMOW). These values are comparable to modern river water δD values in the study area. Given that late Eocene was warmer than today, these comparable δD values may suggest that the study area was higher during the late Eocene than today.

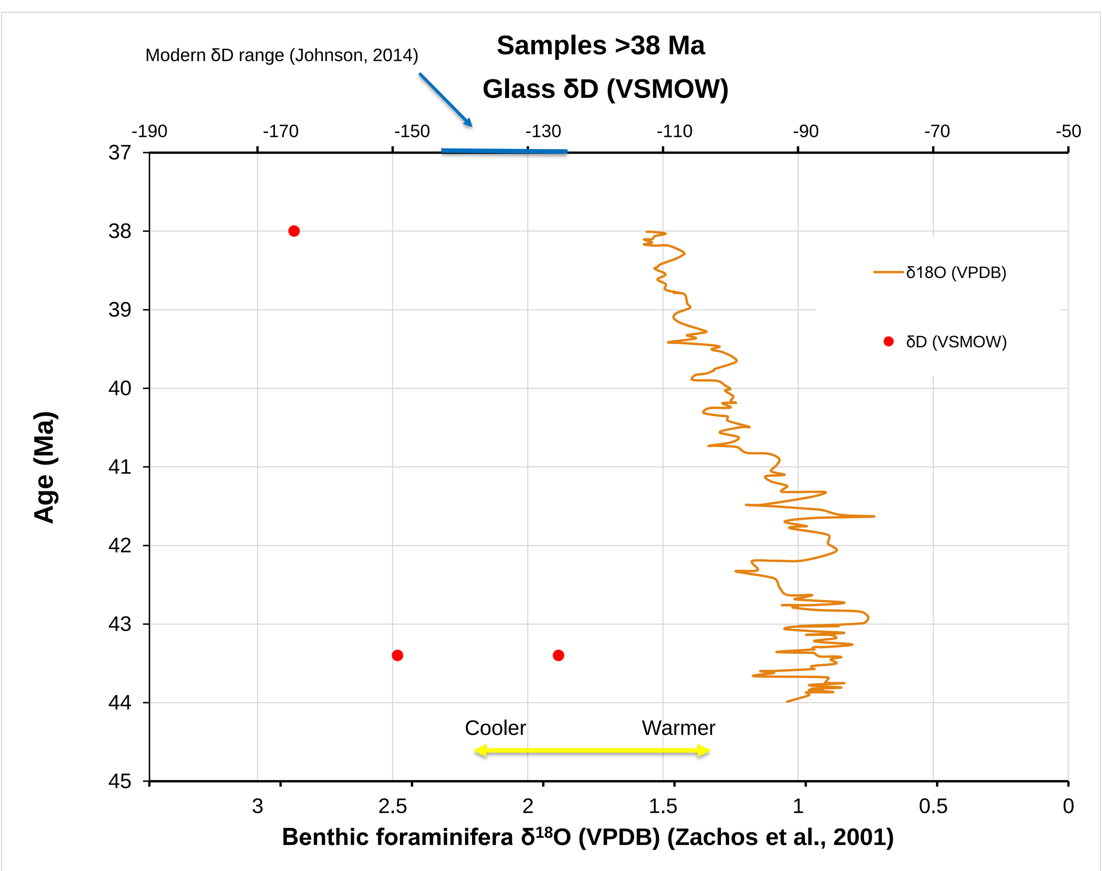


Figure 6. 3 samples from the Talkeetna and Tordrillos Mts.

Conclusions

- Cenozoic paleometeoric water δD values in south Alaska do not follow the trend of deep-sea temperature.
- The Kenai mountain belt in the Kenai Peninsula was at least 1 km above sea level during the last 10 Ma.
- The Talkeetna and Tordrillos Mountains were higher during the late Eocene than today.

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