ENVIRONMENTAL FACTORS THAT CONTRIBUTE TO GLASS ALTERATION

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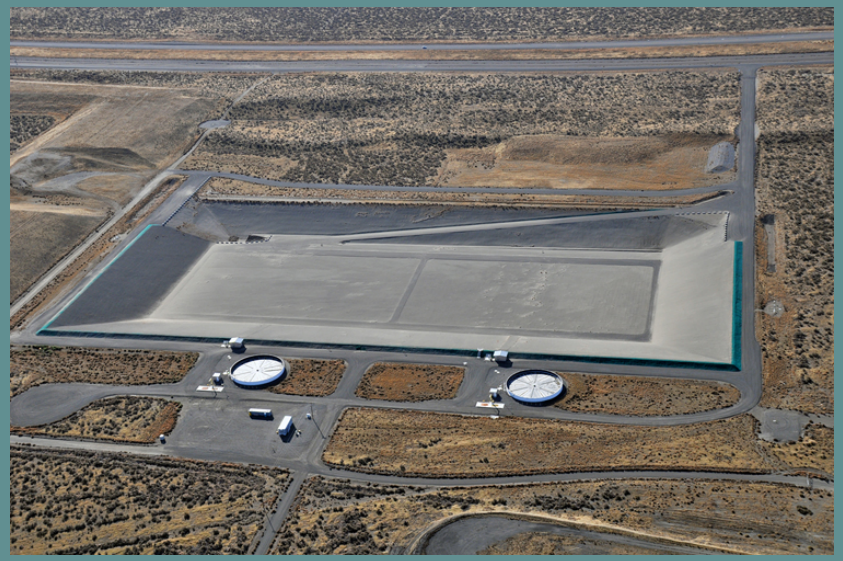
INTRODUCTION

- Various nuclear wastes
  - Vitrification
  - Slow alteration

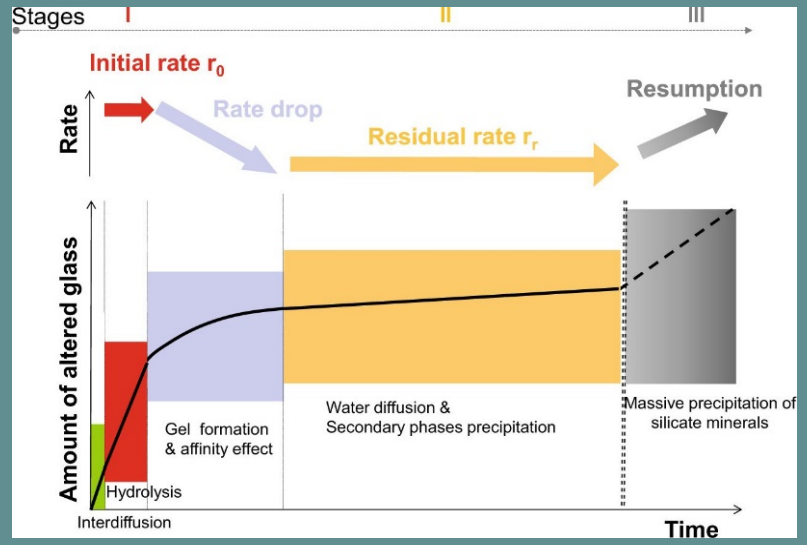
- There are still open questions about how to best model glass alteration in a natural setting over long periods of exposure time

Glass produced from a high level radioactive waste simulant
http://www.geologyin.com/2016/11/can-radioactive-waste-be-immobilized-in.html



Site where low activity nuclear waste will be stored. Richland, Washington State. Courtesy of DOE.

WHY IS ENVIRONMENTAL DATA NEEDED?



Model developed from lab tests

How well does the model predict natural alteration?

- It is known that the following parameters affect glass alteration
  - Temperature
  - Humidity
  - Pressure
  - Biological Interaction
- When trying to predict the alteration of a glass in a natural environment one needs to know these parameters
- Project Goal: to compile these natural parameters as they relate to glass alteration

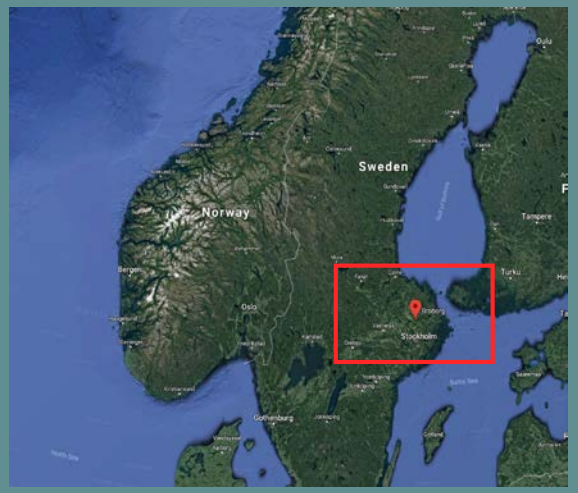
METHODOLOGY

METHODOLOGY

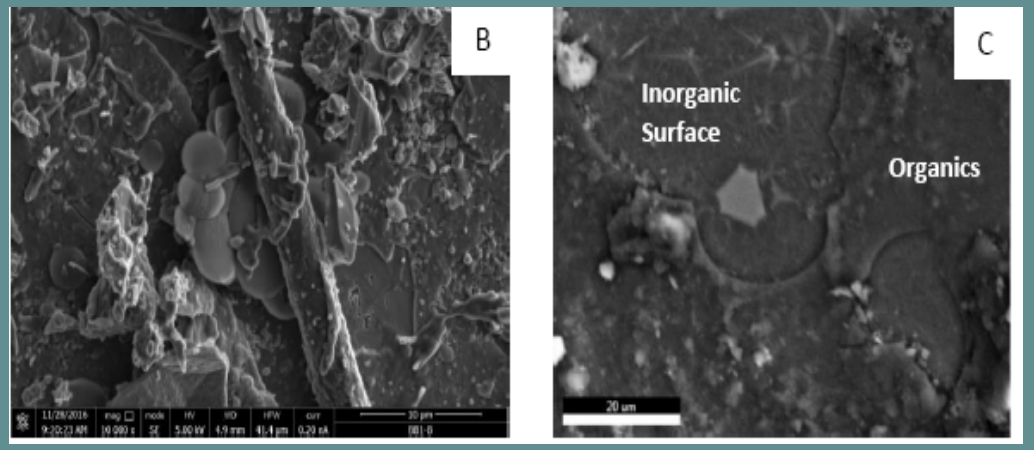
- Literature review
  - Climatic and environmental factors:
    - Temperature
    - Background Biology
- 1,500 year old Swedish hillfort glass found

Swedish Glass
Weaver et al., Microscopic Identification of Micro-organisms on Pre-Viking Swedish Hillfort Glass

Swedish Hillfort
Weaver et al., Microscopic Identification of Micro-organisms on Pre-Viking Swedish Hillfort Glass



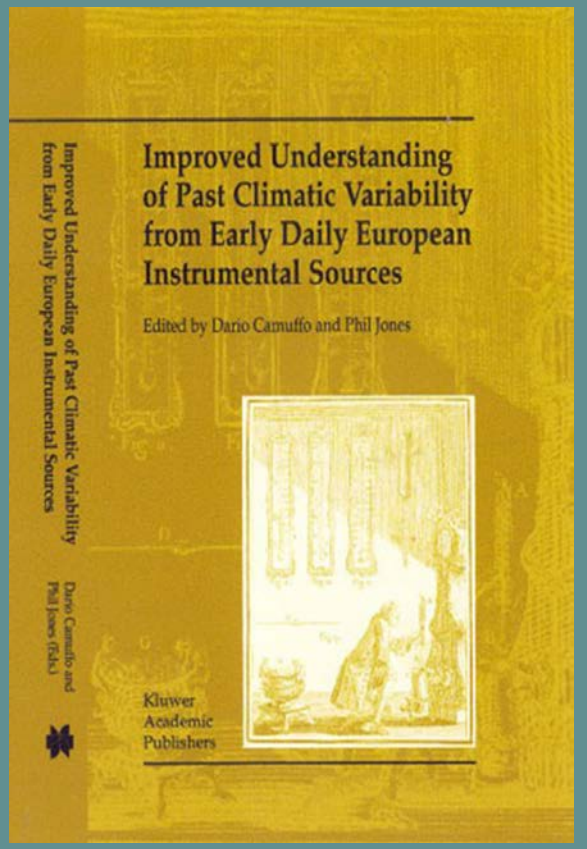
Areal view of Broborg and surrounding region (from Google Maps)

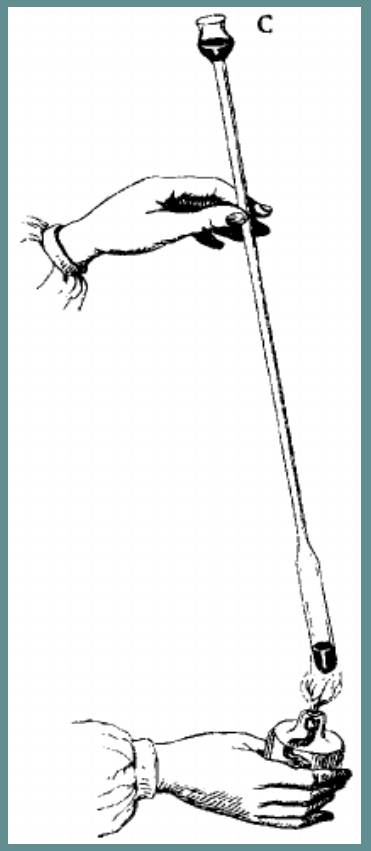


Microscopic view of glass
Weaver et al., Correlating Aging and Durability of Pre-Viking Hillfort Glasses from the Broborg Hillfort Site, Sweden, to Predicted Long Term Performance of Vitrified Waste

TEMPERATURE

- Anthropogenic temperature data
  - Short-term data sets (couple hundred years)
  - Data has been taken in variety of ways
    - Data taken by older instruments subject to method error
    - Corrections needed for accurate data

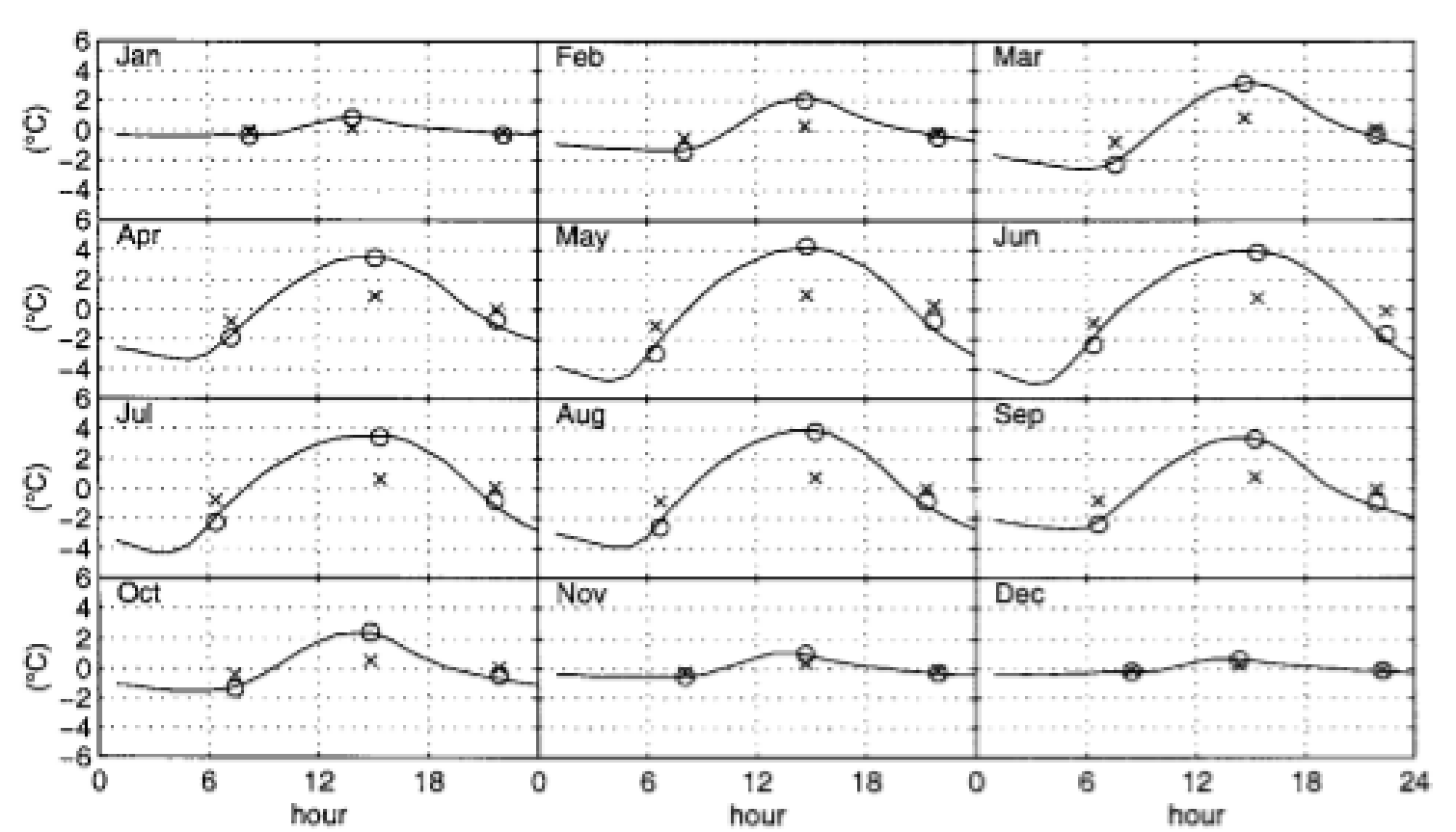




bulb was heated over a flame so that some of the bubbles of dilated air escaped from the capillary

Camuffo, Calibration and Instrumental Errors in Early Measurements of Air Temperature

DAILY AIR TEMPERATURE AND PRESSURE SERIES FOR UPPSALA (1722-1998)



Diurnal temperature cycles with reference to the monthly averages in Uppsala 1961-1990 (full line), and compared to the mean temperature readings 1722-1732 in the morning, in the afternoon, and in the evening .
HANS BERGSTRÖM and ANDERS MOBERG, DAILY AIR TEMPERATURE AND PRESSURE SERIES FOR UPPSALA (1722–1998)

- Diurnal temperature- daily measurements
- 1722-1732
- Data corrected due to inconsistencies in how the readings were taken
- Use corrected data from Uppsala in experiments

TEMPERATURE

- Temperature from proxy sources
  - A proxy is a preserved environmental characteristic that can be used to track climate variability
    - Background biology

The temperature of Europe during the Holocene reconstructed from pollen data

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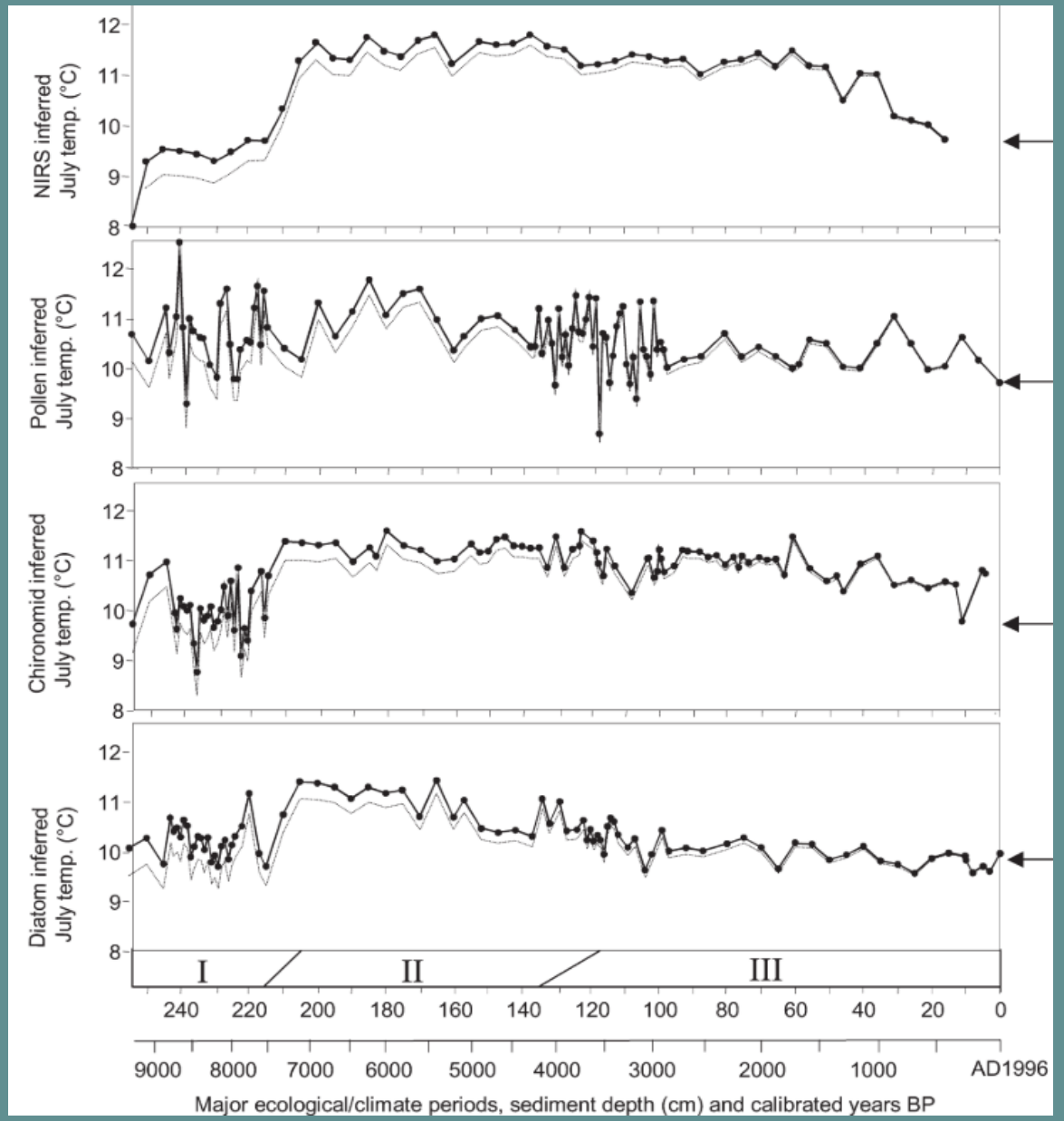

Rosén, P., Segerström, U., Eriksson, L., Renberg, I., & Birks, H. J. B. (2001). Holocene climatic change reconstructed from diatoms, chironomids, pollen and near-infrared spectroscopy at an alpine lake (Sjuodjijaure) in northern Sweden. *The Holocene, 11*(5), 551-562.

BACKGROUND BIOLOGY

- Pollen % used to infer past vegetation
- Can be found in lake sediments layers, sample cores give past information
- Biological
  - "Pollen analysis is a commonly accepted method for reconstructing past changes in vegetation and thus indirectly past climate change"

-Rosén, P., Segerström, U., Eriksson, L., Renberg, I., & Birks, H. J. B. (2001).

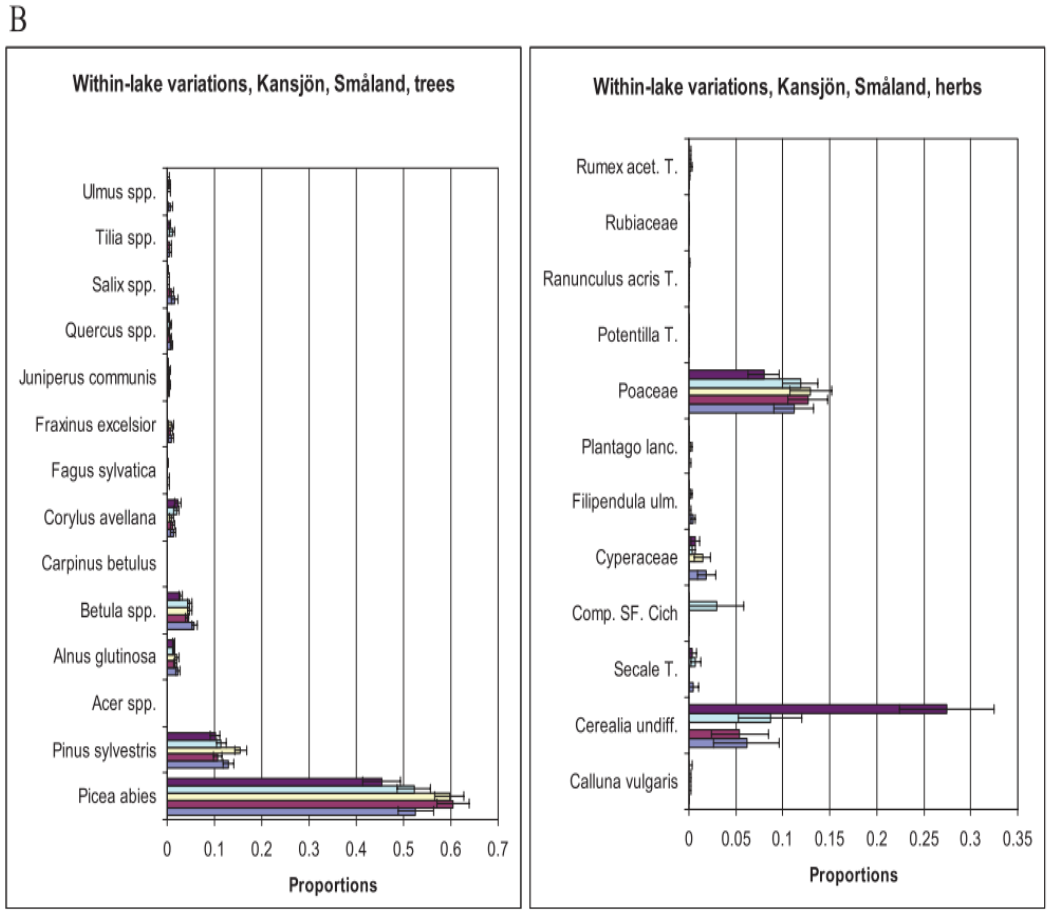

Figure 7 Examples of within-lake variation of the vegetation proportions predicted by REVEALS for five samples per lake, in one lake per region (randomly selected), with their related error estimates. (A). Skåne: lake Snogeholmssjön; (B). Småland: lake Kansjön

Hellman, S., Gaillard, M. J., Broström, A., & Sugita, S. (2008).

Background Biology

- Testate Amoebae found on glass
  - *Trinema enchelys*
  - Self secretes silica shell- cores can indicate climate change
  - Si reliant- how does this affect glass?

Increased aeolian activity during humidity shifts as recorded in a raised bog in south-west Sweden during the past 1700 years

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[2]Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden

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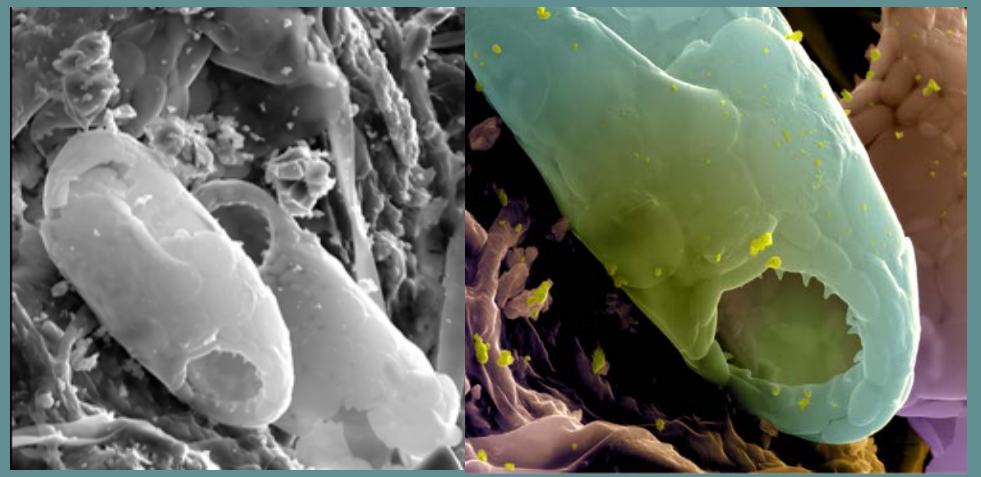
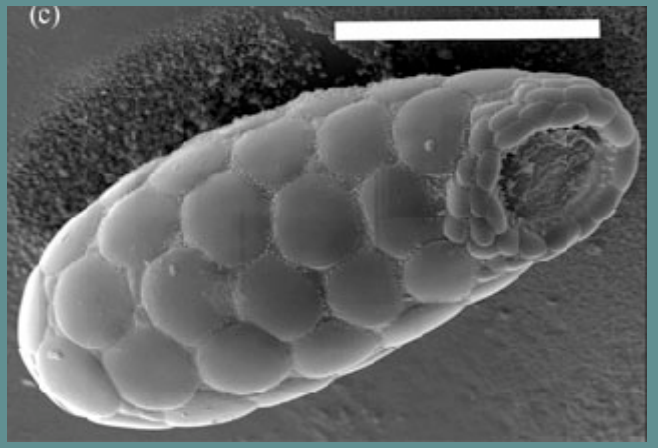
From Environmental Sequences to Morphology: Observation and Characterisation of a Paulinellid Testate Amoeba (*Micropyxidiella edaphonis gen. nov. sp. nov.* Euglyphida, Paulinellidae) from Soil using Fluorescent in situ Hybridization

Sonia-Estelle Tarnawski[a,b], and Enrique Lara[a,1]



Weaver et al. ,Microscopic Identification of Micro-Organisms on Pre-Viking Swedish Hillfort Glass

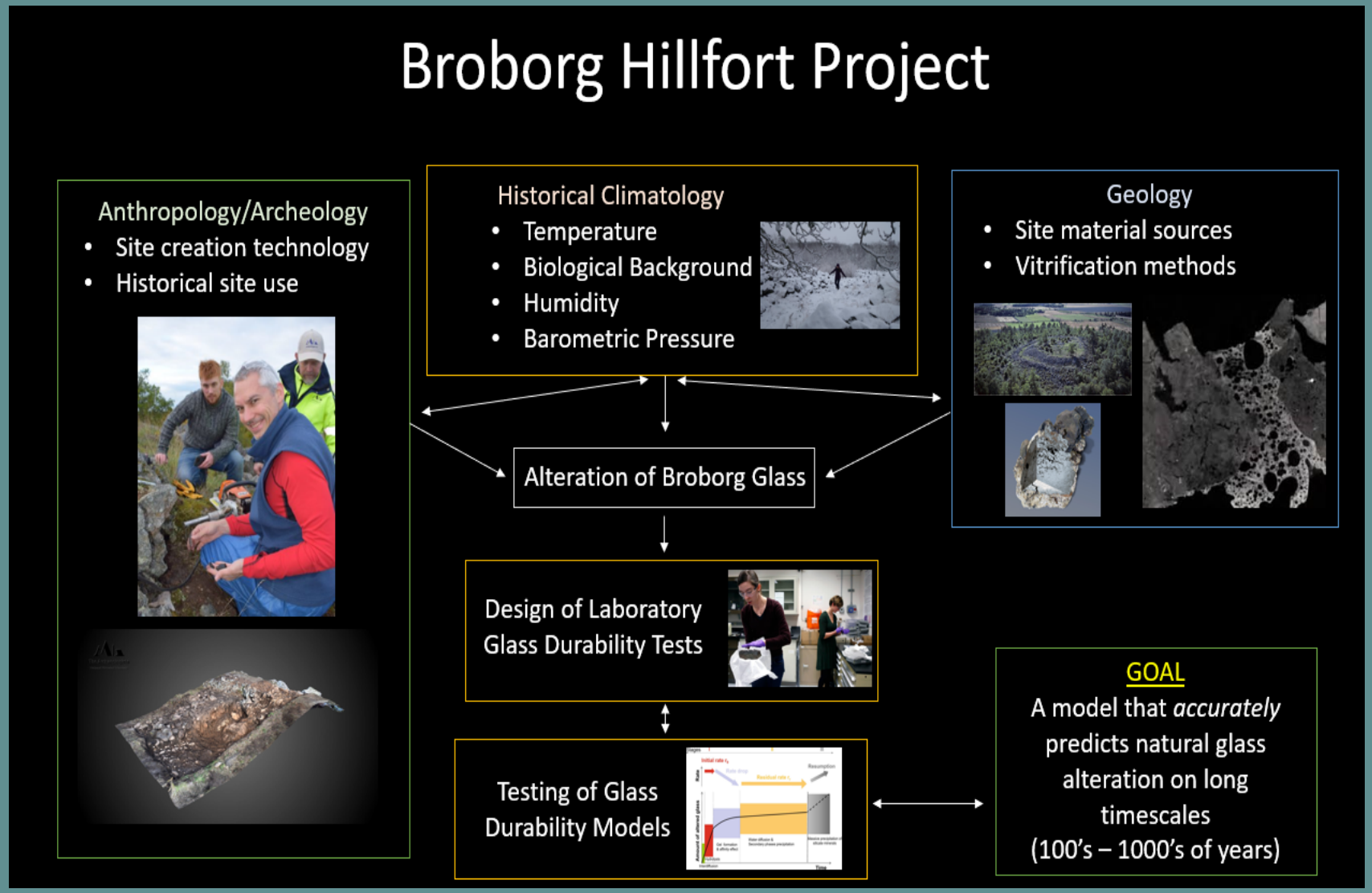
Trinema enchelys



Bobrov, Anatoly, et al., "Testate amoebae communities from some freshwater and soil habitats in China (Hubei and Shandong Provinces)." *Frontiers of Earth Science* 6.1 (2012): 1-9.

SUMMARY

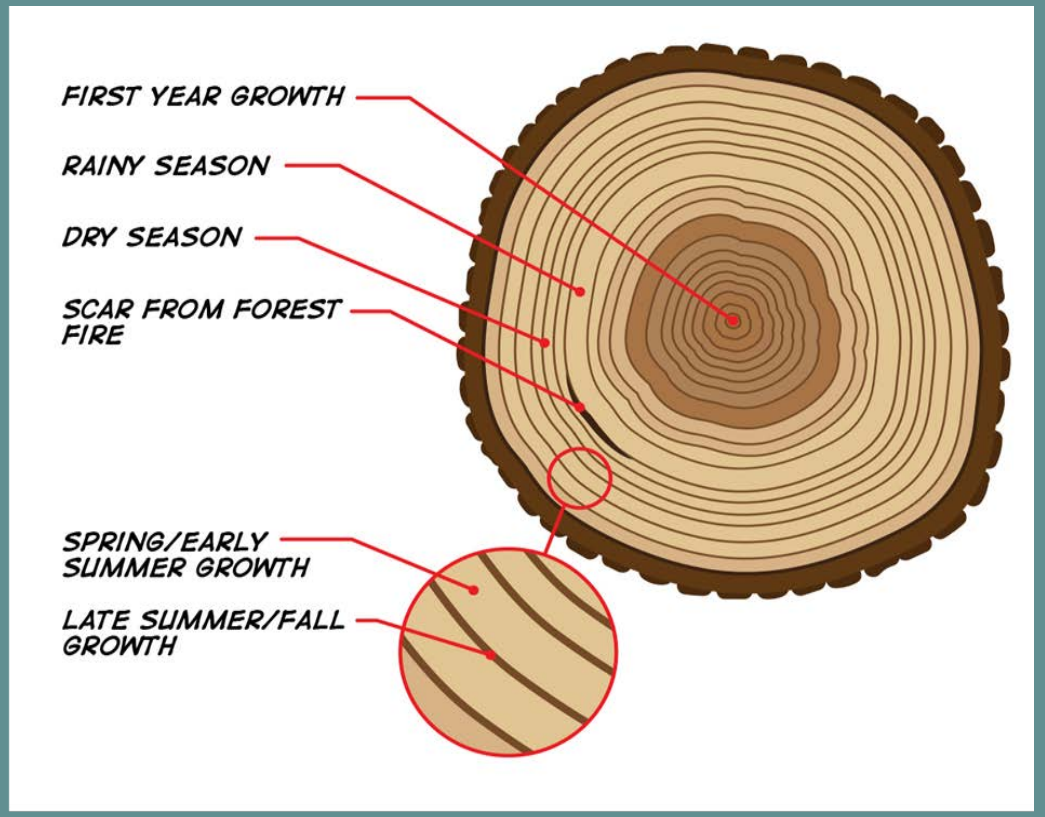
- Specific contributions
  - Uncovered yearly average temperatures that will be used to design more accurate lab experiments
  - Methodology from prior papers can be used for Uppsala data
- Findings will be included in a Smithsonian volume



Weaver et al. ,Microscopic Identification of Micro-Organisms on Pre-Viking Swedish Hillfort Glass

FUTURE WORK

- Further research into pollen data around Uppsala
- Research surrounding diatoms and fungus
- Tree rings, humidity, air pressure, pH



NASA. (2018). NASA Climate Kids :: What can trees tell us about climate change?

ACKNOWLEDGEMENTS

Thank you!
Any questions?