

Paleolimnology: first principles and nuances

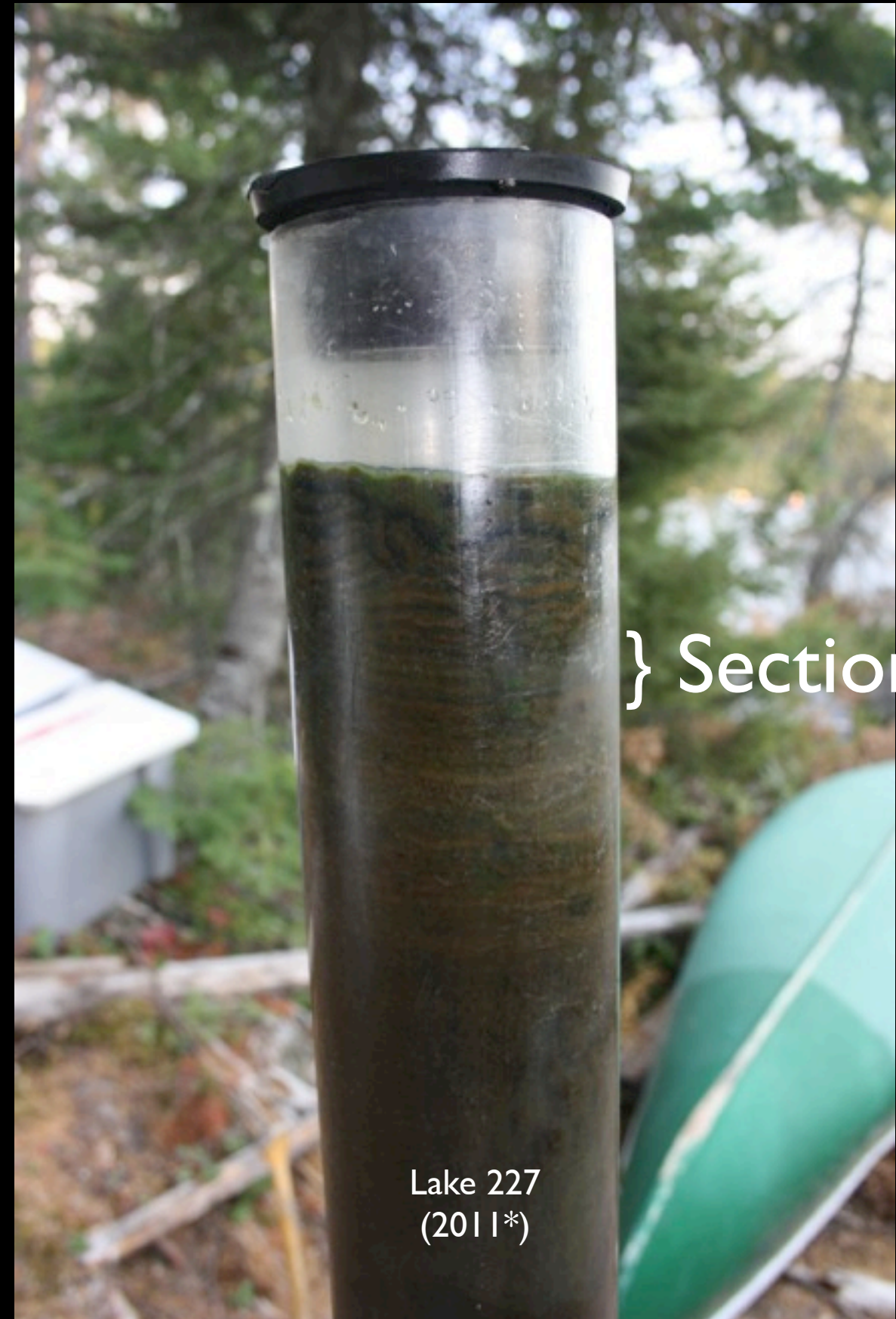
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What is paleolimnology?

Paleolimnology is a tool used to circumvent the limitations of short-term datasets; it proceeds via the study of the stratigraphic record preserved in lake sediments.

How does paleolimnology work?

- Collect cores from the lake bottom
- Section the core vertically into samples
- Freeze dry
- Potential analyses:
 - sediment
 - organic matter
 - fossils therein
 - Mineral content
 - Porewater



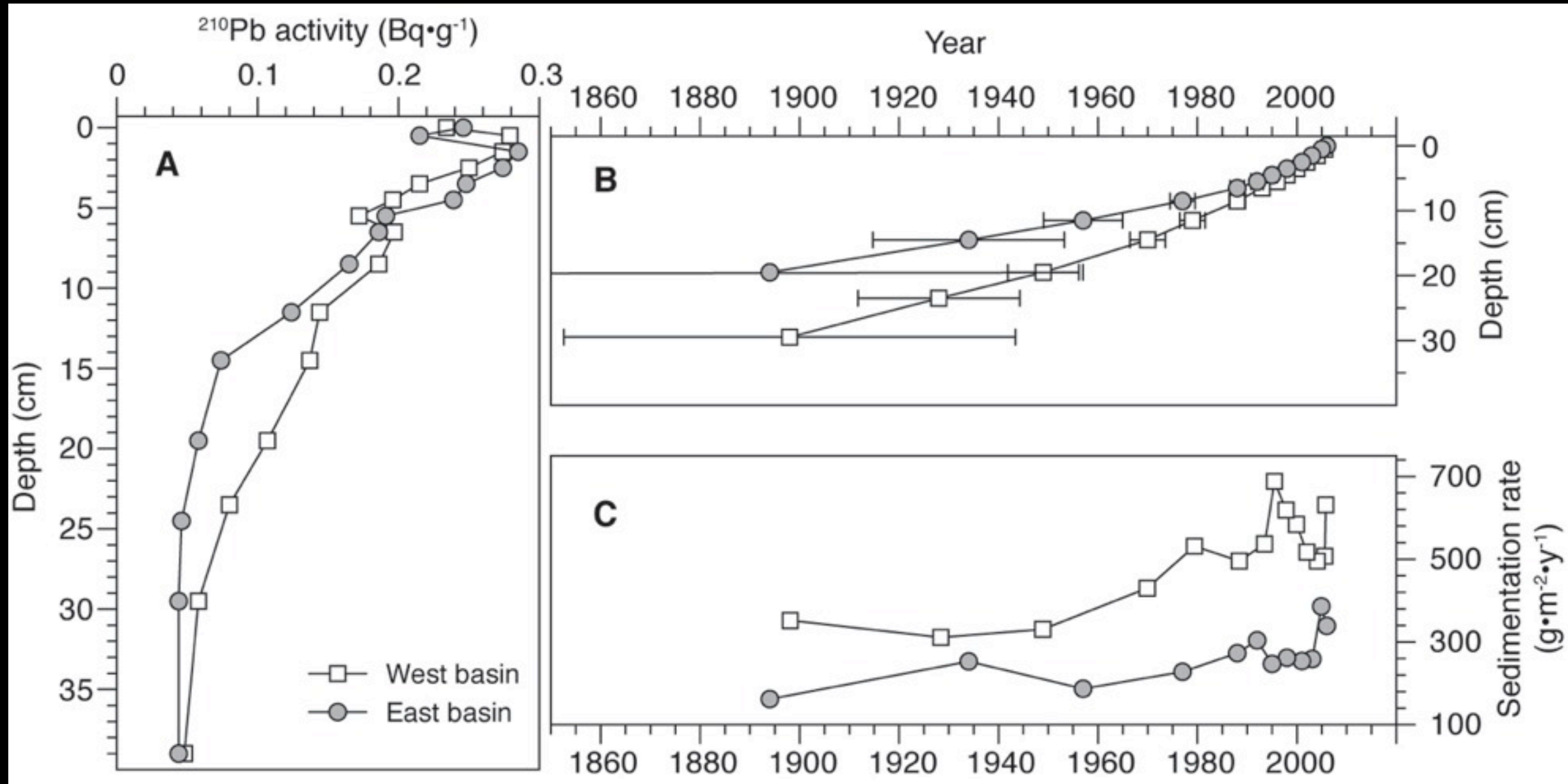
} Section

Lake 227
(2011*)

* core date

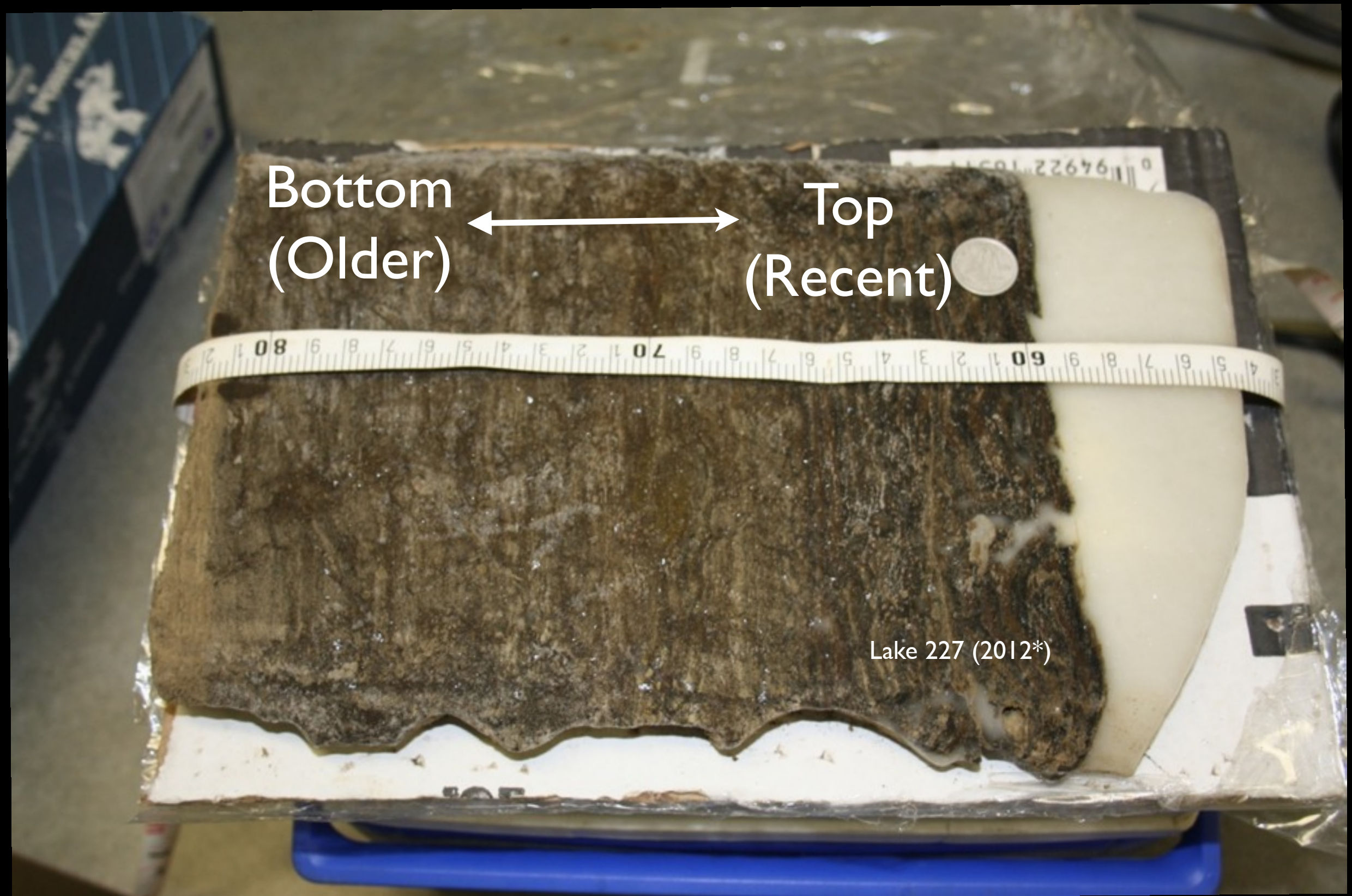
Radiogenic isotopes

Hazewinkel & Cooke, unpublished



^{210}Pb profiles, Slave Lake (2007*)

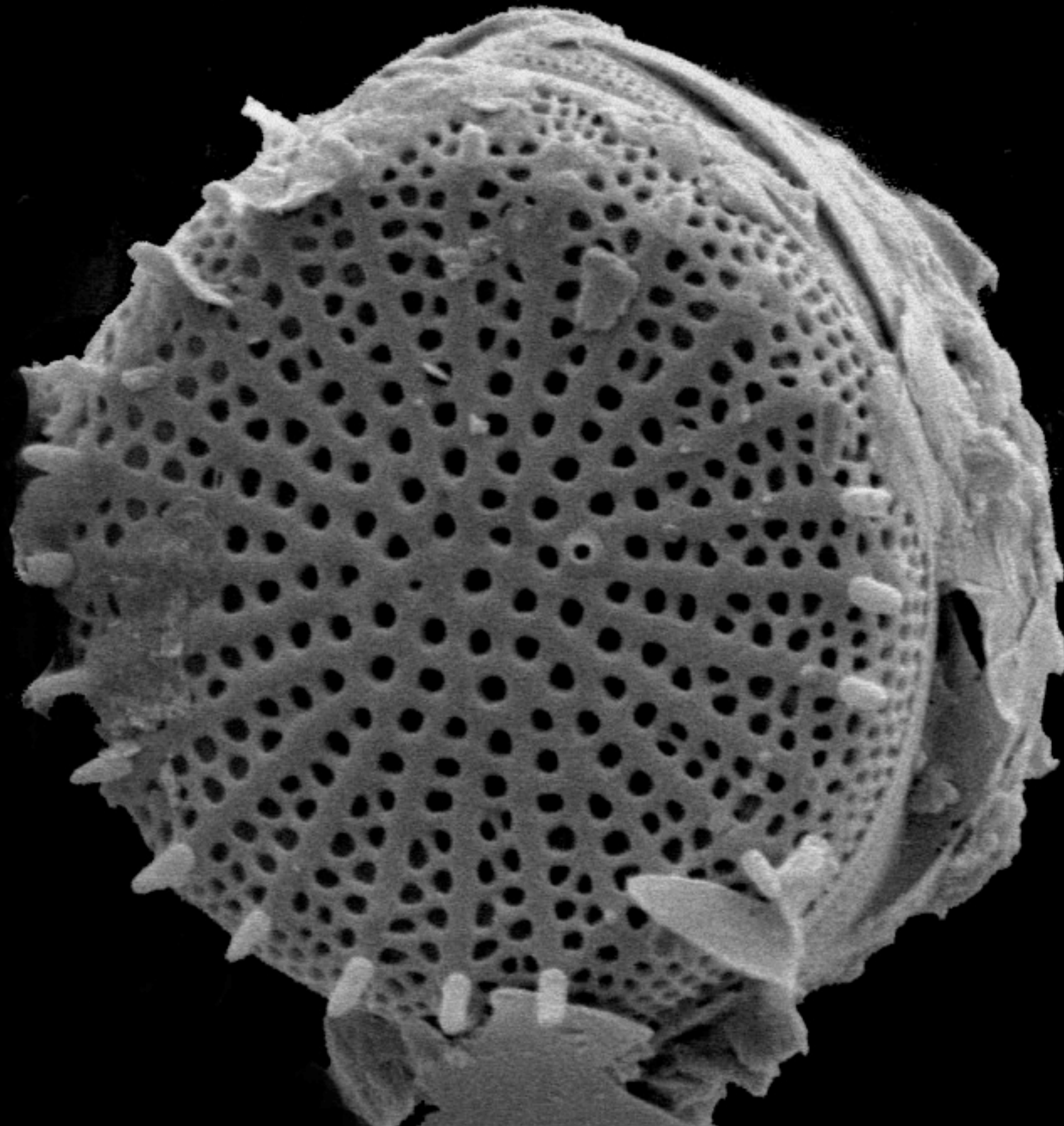
- First principle of superposition: younger sediments are deposited on top of older sediments



- First principle:
- Sediments remain representative of conditions in the lake and/or the catchment at the time they were deposited.

Lake 227 (2011*)



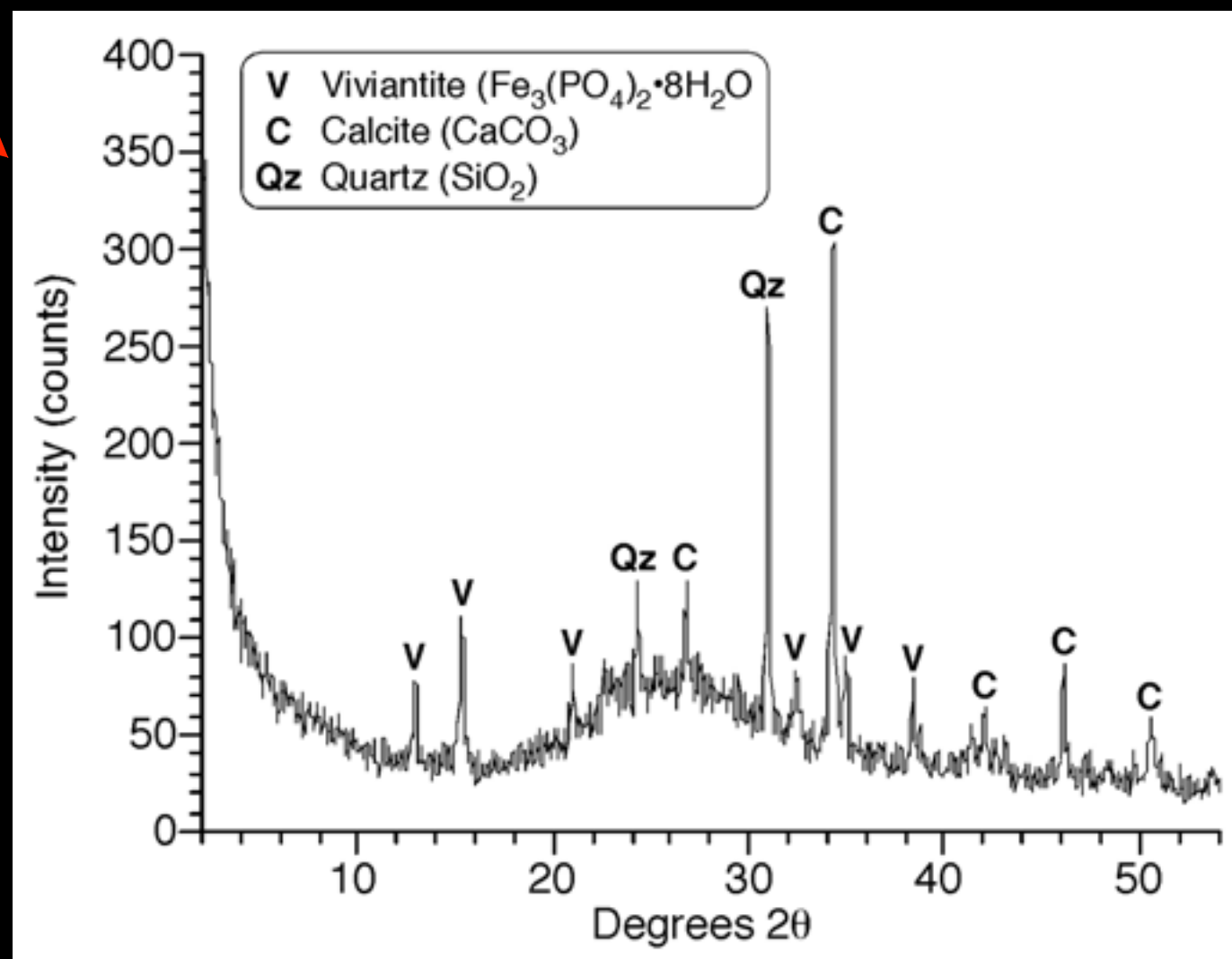
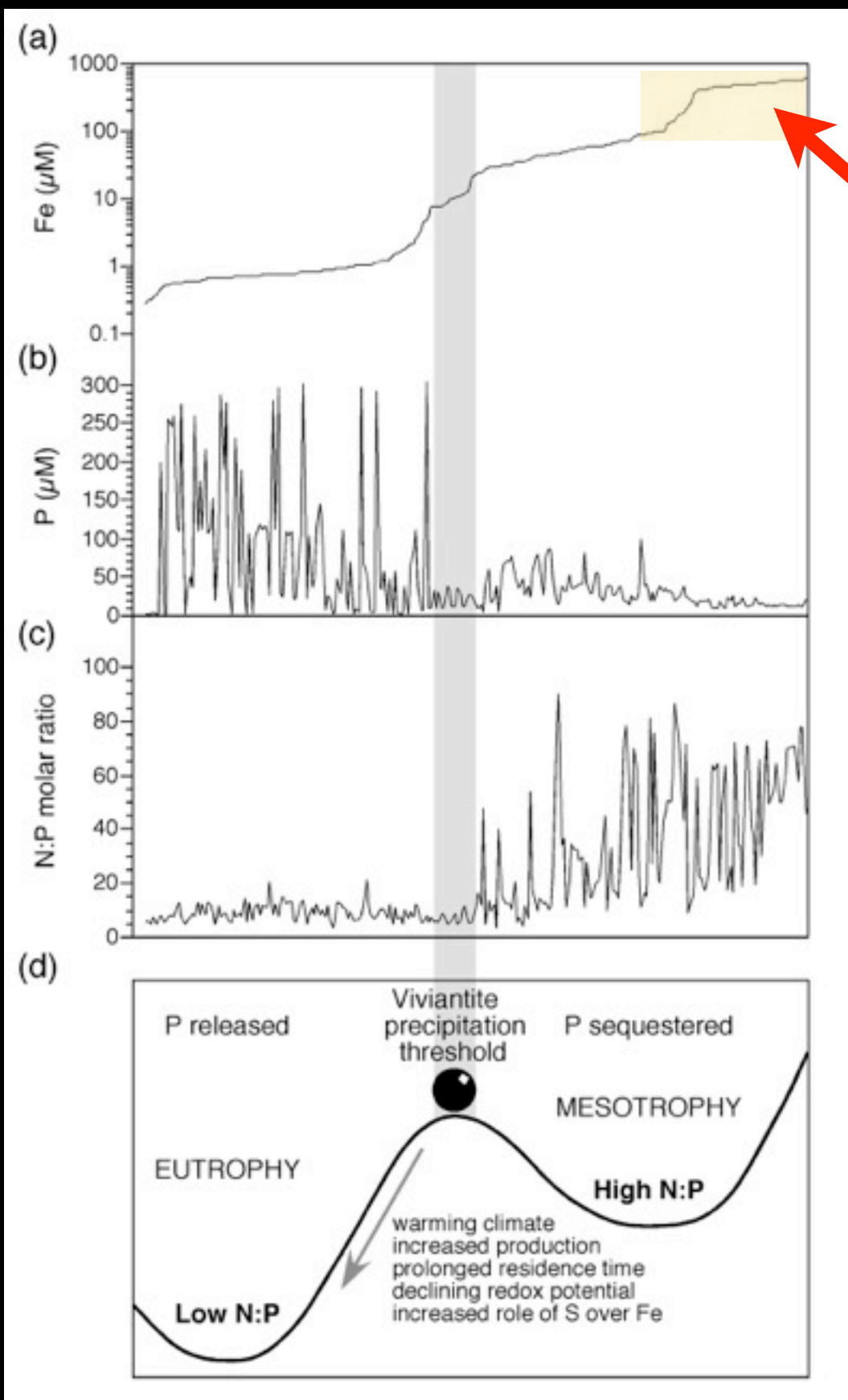


Stephanodiscus hantzschii,
Nakamun Lake (2007*)

1 μ m

- Uniformitarianism: modern processes operate the same way today as they have in the past
 - Applies to interpretations of:
 - Thermodynamics
 - Response of organisms to various stimuli
 - Decay of radiogenic isotopes
 - Fractionation mechanisms of stable isotopes
 - etc.
- Caveat: process outcomes are often context specific; misinterpretation can lead to circular reasoning.

Porewaters from sediment of 7 Alberta lakes
 ~249 Anoxic samples
 ~ 7 Oxidic samples



Narrow Lake sediment (2007*)

(Ballard & Wolfe, unpublished)

Influences to constrain

- **Catchment**

- Erosion/deposition
 - water
 - wind
 - mass movements
 - terrestrial organics

- **Sediment column**

- Erosion/deposition
- Disturbance
- Decomposition
- Respiration
- mineral precipitation

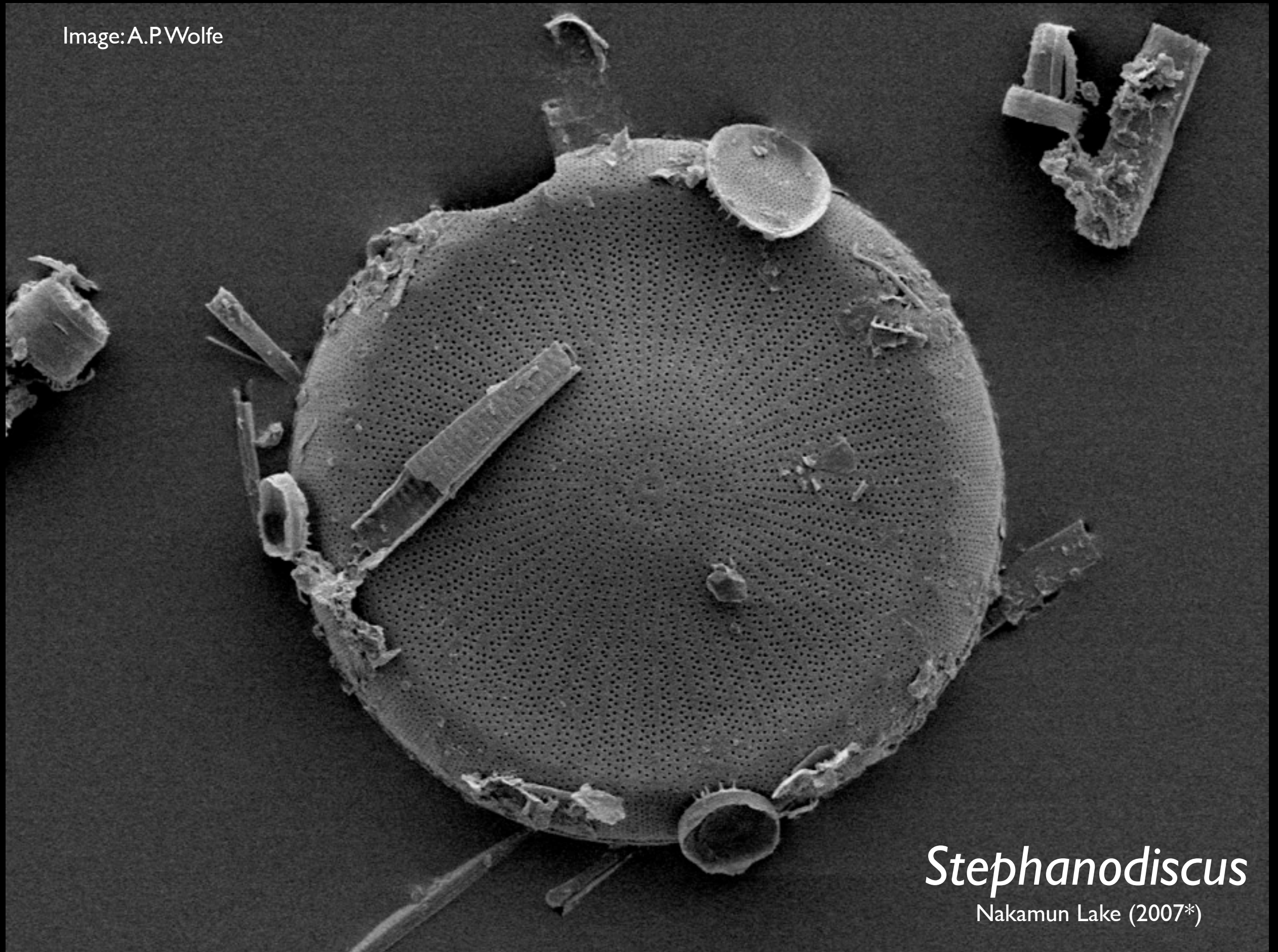
- **Water column**

- Erosion/deposition
 - mineral precipitation/dissolution
 - mineral transport and deposition
- Decomposition
- Productivity

- **Atmosphere**

- Temperature
- Precipitation
- Gasses

Image: A.P. Wolfe



Stephanodiscus

Nakamun Lake (2007*)

U of A

SEI

5.0kV

X1,200

10µm

WD 7.0mm

INORGANIC CARBON ACQUISITION BY CHRYSOPHYTES¹

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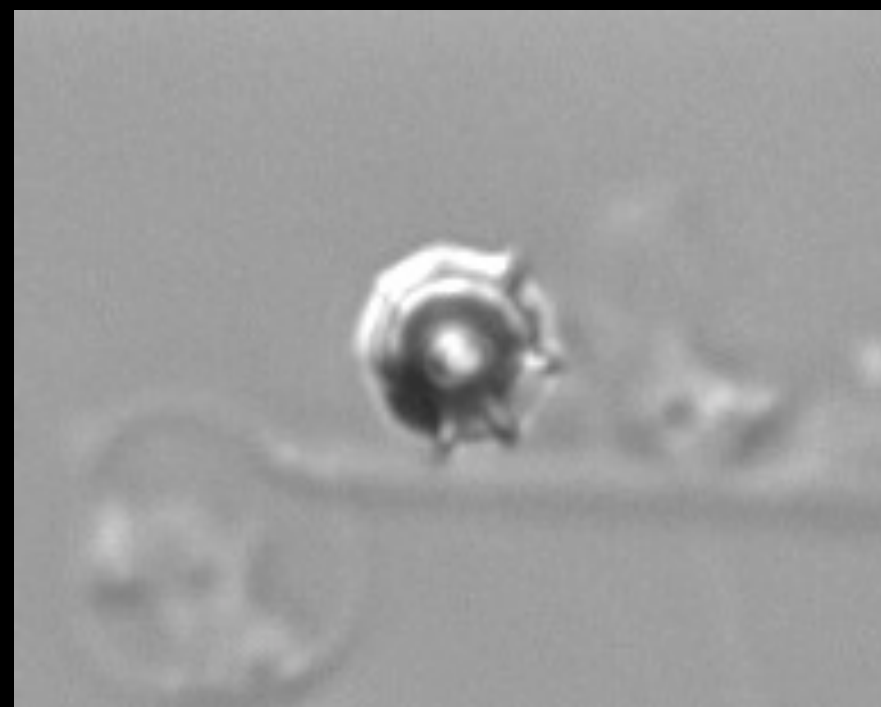
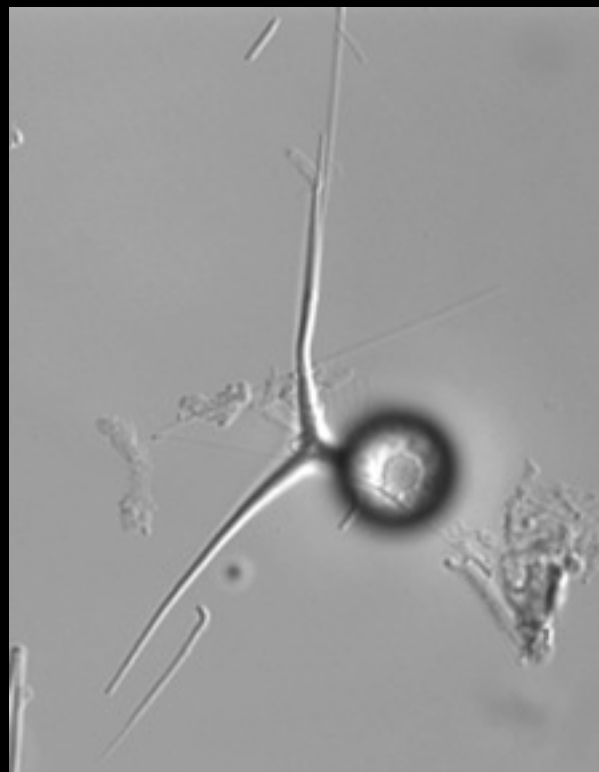
The Freshwater Biological Association, The Ferry Landing, Far Sawrey, Ambleside, Cumbria, LA22 0LP, UK

John A. Raven

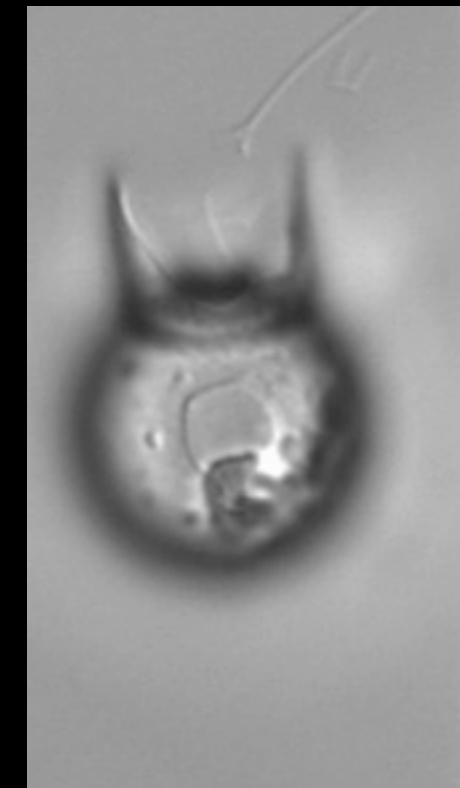
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Lake 227 (2011*)



Pigment profiles, Slave Lake

(2007*)

Hazewinkel & Cooke, unpublished

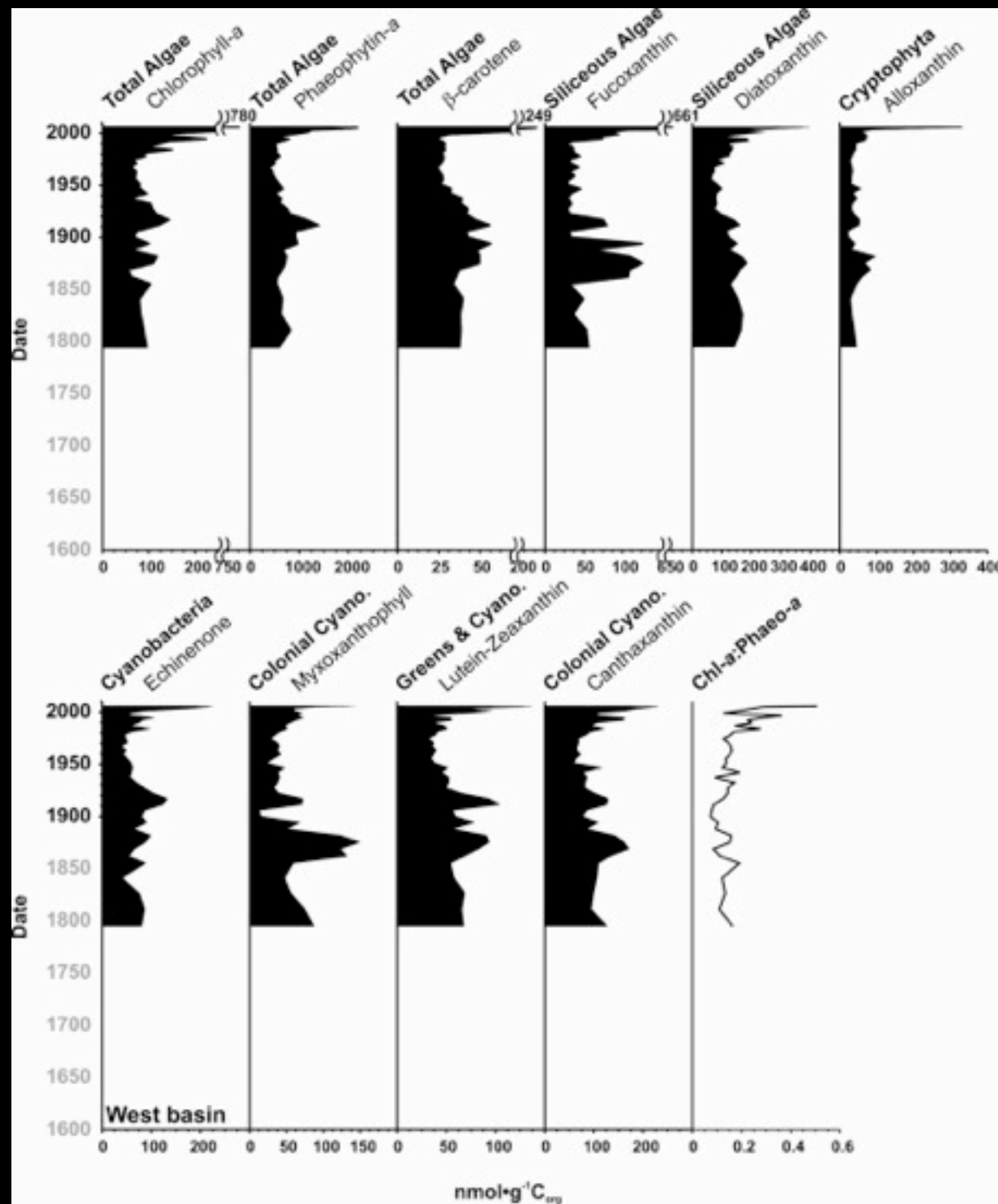


Figure 4a. Phytopigment concentrations ($\text{nmol}\cdot\text{g}^{-1}\text{C}_{\text{org}}$) in sediments from the west basin of Lesser Slave Lake. Dates inferred from the unsupported ^{210}Pb inventory; missing dates and dates prior to 1898 are interpolated/extrapolated from the ^{210}Pb age-depth curve.

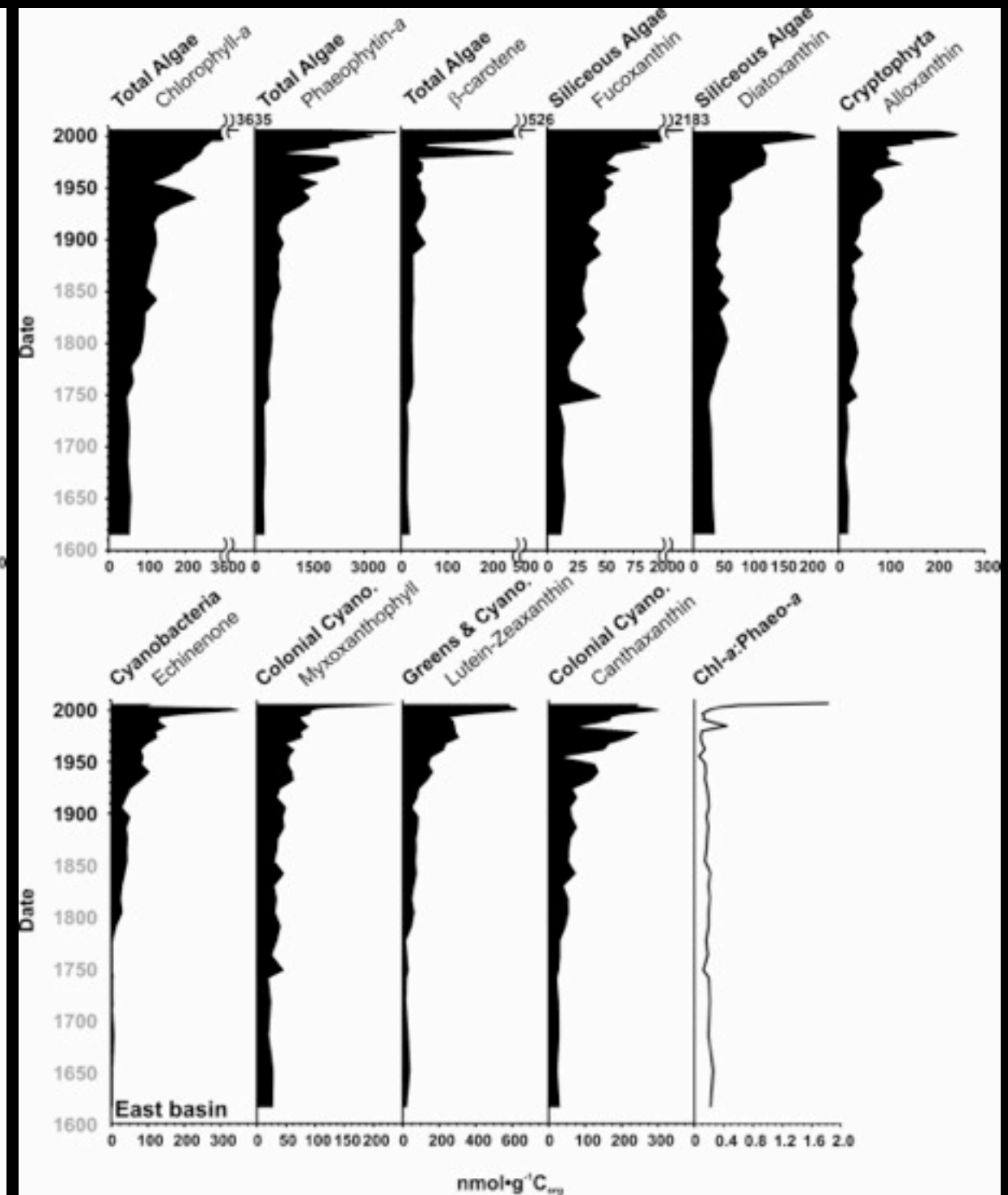
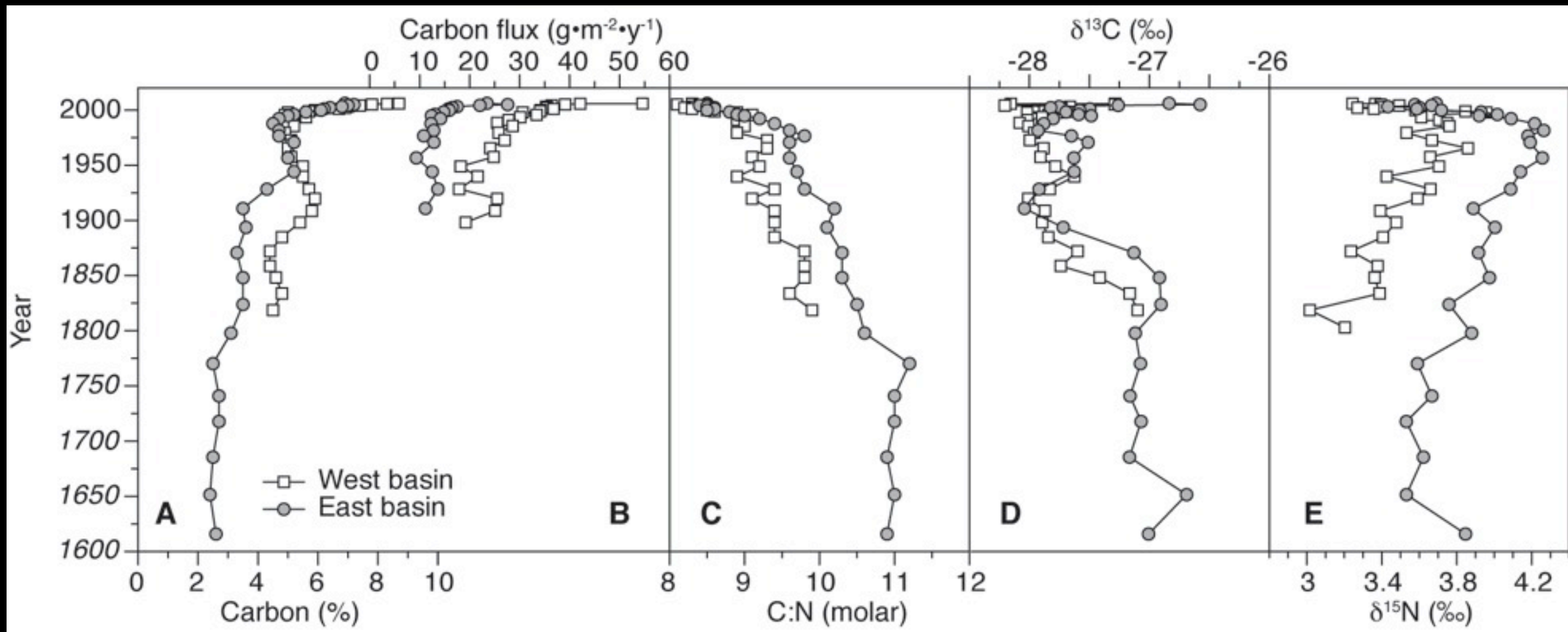


Figure 4b. Phytopigment concentrations ($\text{nmol}\cdot\text{g}^{-1}\text{C}_{\text{org}}$) in sediments from the east basin of Lesser Slave Lake. Dates inferred from the unsupported ^{210}Pb inventory; missing dates and dates prior to 1894 are interpolated/extrapolated from the ^{210}Pb age-depth curve.



Hazewinkel & Cooke, unpublished

Profiles: Slave Lake

(2007*)

- Carbon weight percent, flux
- C:N molar ratios
- Carbon stable isotopes
- Nitrogen stable isotopes

Common Analyses

- Sediment characterization

- Photographs
- Electron microscope
- X-ray diffraction
- Microscope analysis
- Grain sizes & orientations
- Magnetic susceptibility

- Sediment chemistry

- Isotopes
- Metals
- Nutrients
- Microsensor (O_2 , HS^- , pH)
- Contaminants
 - Dioxins
 - Furans

- Organic compounds and fossils

- diatoms
- pigments
- choronamids
- chrysophytes
- pollen
- hydrocarbons

- First principles
 - superposition
 - representative sediments
- Nuances
 - uniformitarian logic
 - often context specific
- Hypothesis
 - What do we want to find out?
- Questions?