Emerging palaeoecological methods for charcoal analysis

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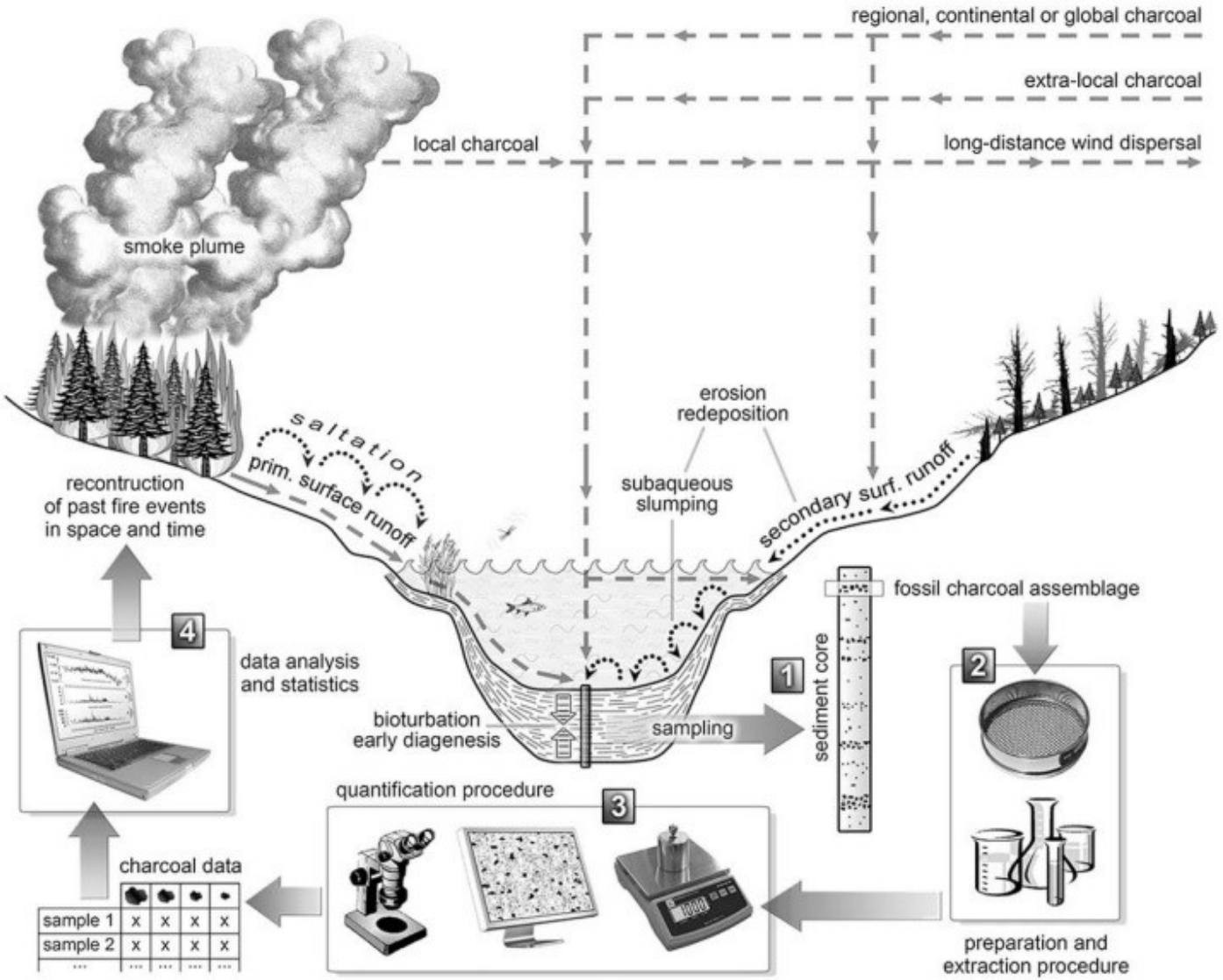
Charcoal deposits in sediments

- Many depositional environments (lakes, marine, ice, soil)
- Used to interpret changes in fire activity on landscapes
- Used in conjunction with other proxies:
  - Pollen, plant macrofossils
  - sedimentology

Charcoal analysis

Environmental processes

Methodology



Coring

Photo: Z. Gedalof

Coring and Geochronology

Photo: Z. Gedalof

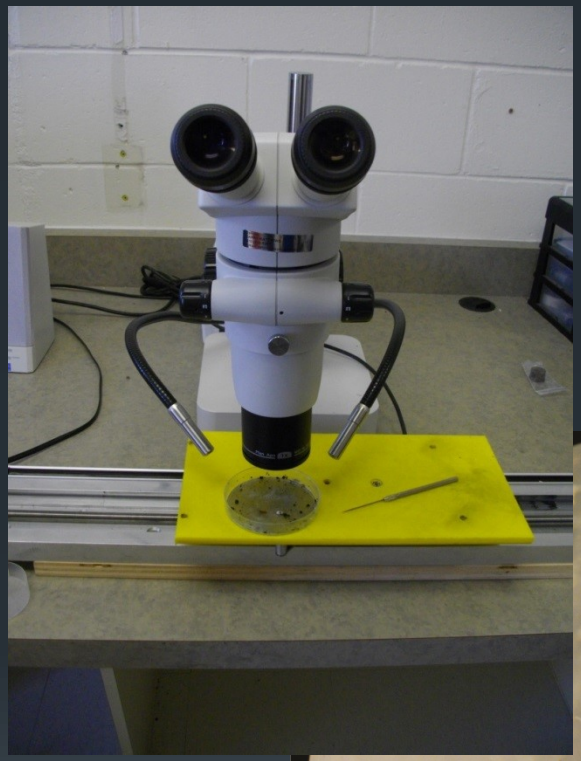
^{210}Pb

^{14}C

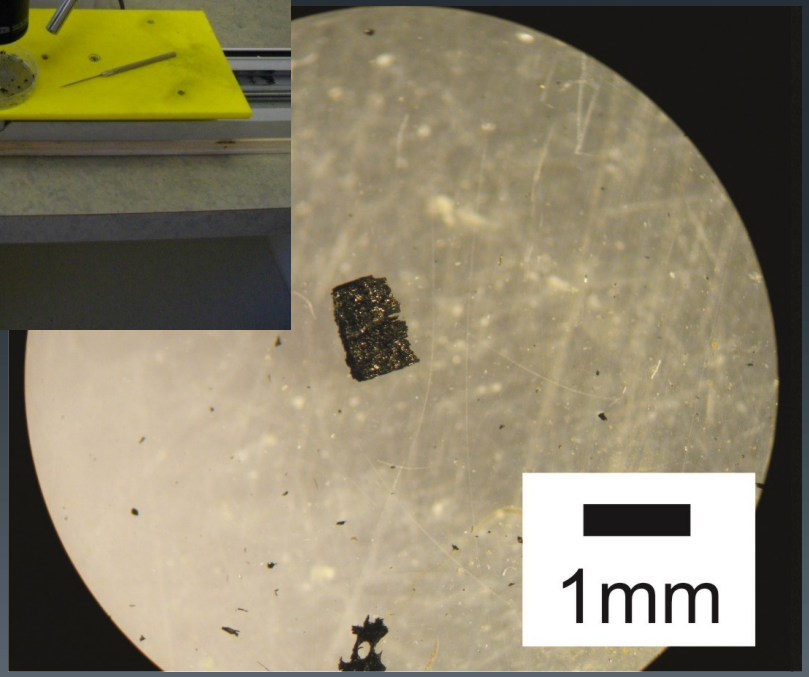
Volcanic ash

Proxy for past wildfires

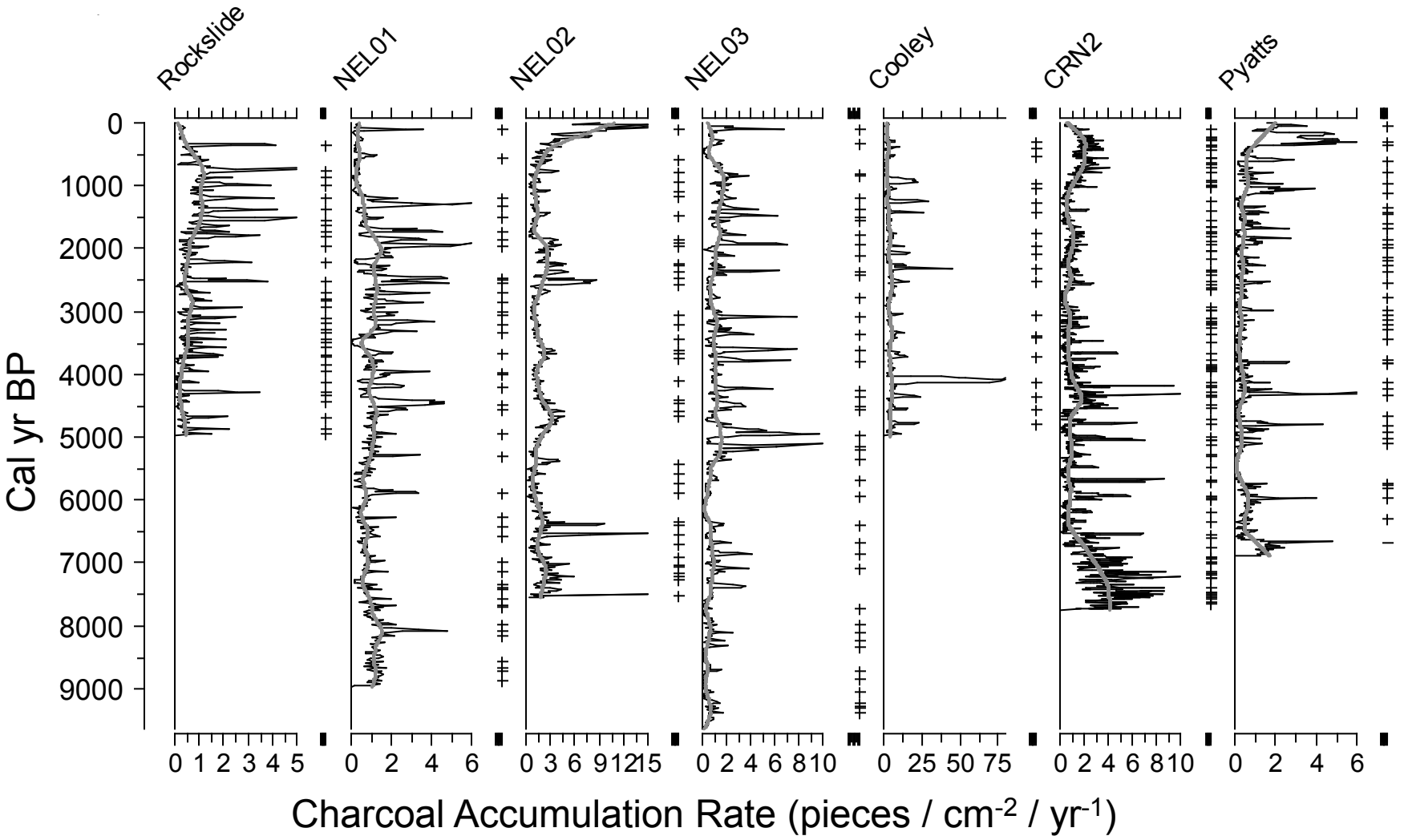
http://www.real-project.eu/macroscopic-charcoal-analysis-of-sediments/



Macroscopic Charcoal



Charcoal Records



Fire frequency reconstructions

- Decompose charcoal time series into peaks and background
- To understand role of fire frequency in evolution of ecosystems, anthropogenic changes, compare over large scales

Fire activity at regional-global scales

- Global charcoal database (GCD)
- http://www.paleofire.org/
- Used to study past patterns of fire activity

- NEW! Modern global charcoal database
- To examine relationships between burning and ecosystem processes
- CO_2 emissions, satellite products

New techniques

Article

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A classification for macroscopic charcoal morphologies found in Holocene lacustrine sediments

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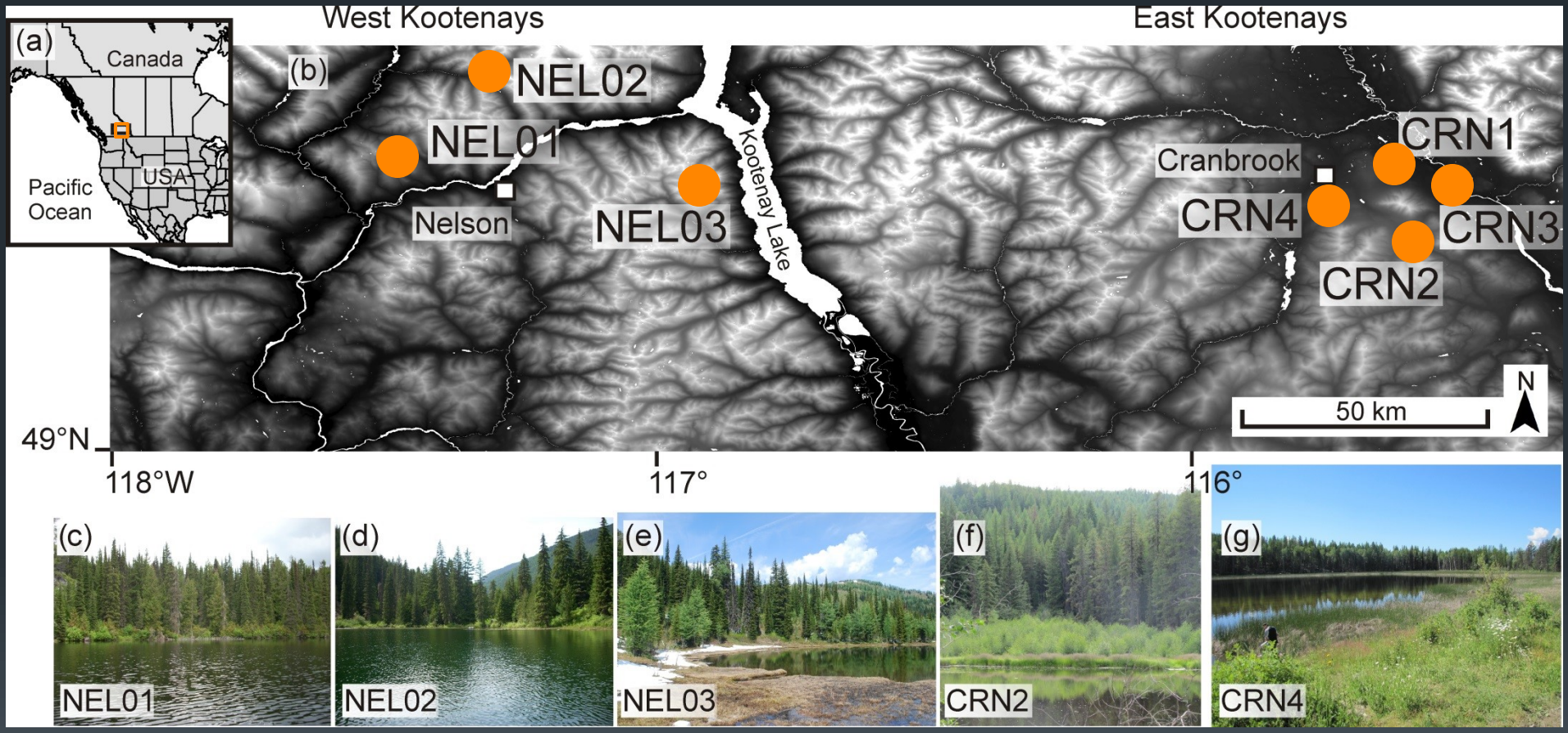
Michael F.J. Pisaric
Brock University, Canada

Study Area: the Kootenays

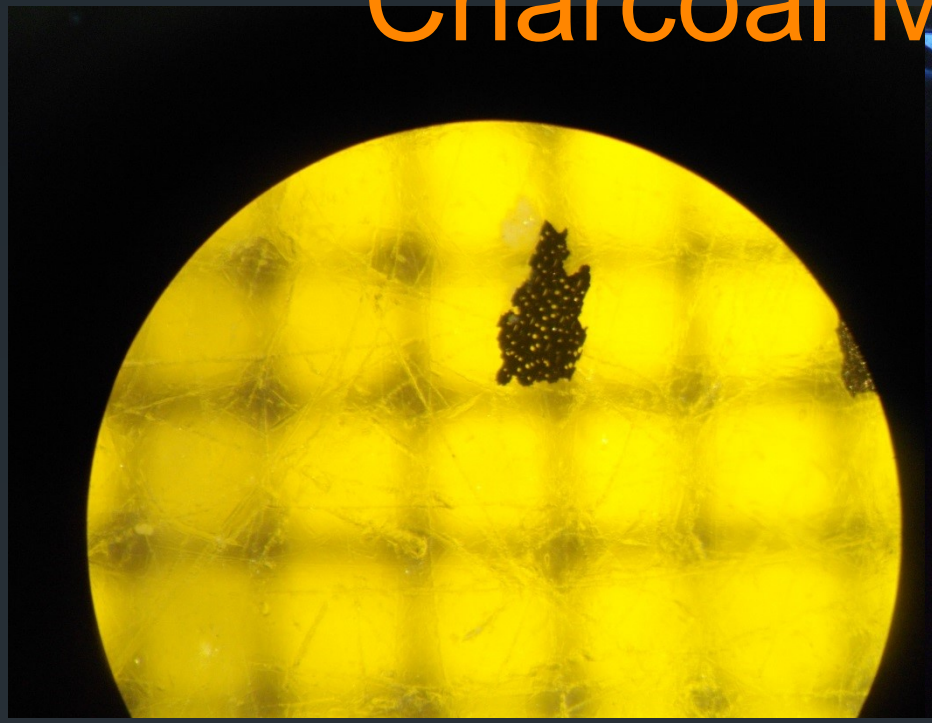
7 lake sites

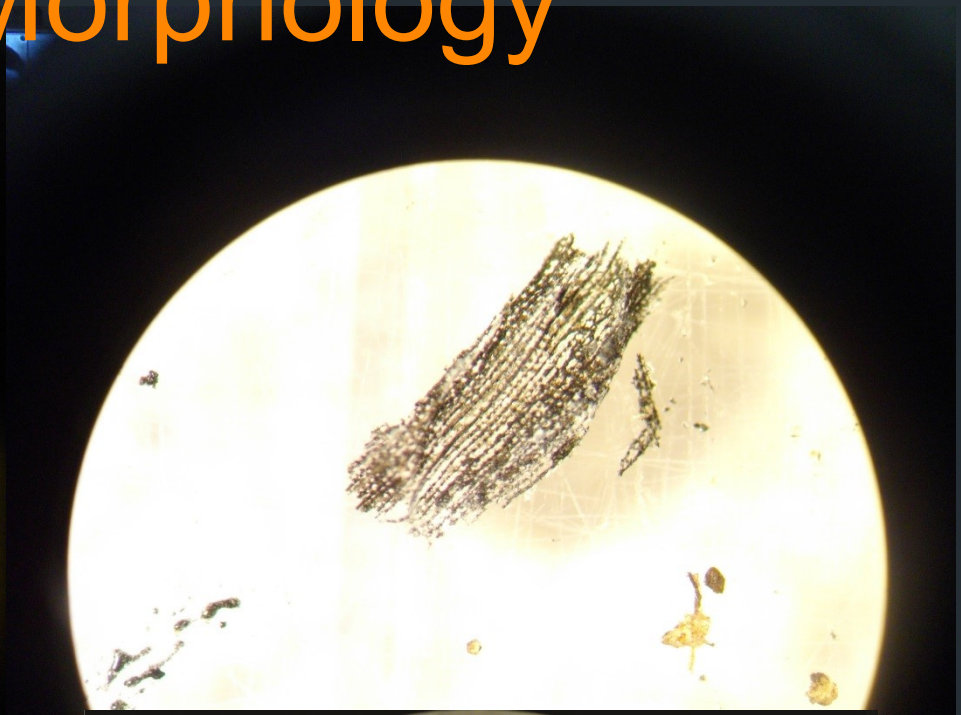

(a)
Canada
USA
Pacific Ocean
West Kootenays
East Kootenays
(b)
NEL02
NEL01
NEL03
Nelson
Kootenay Lake
Cranbrook
CRN1
CRN4
CRN3
CRN2
N
50 km
49°N
118°W
117°
116°
(c)
NEL01
(d)
NEL02
(e)
NEL03
(f)
CRN2
(g)
CRN4

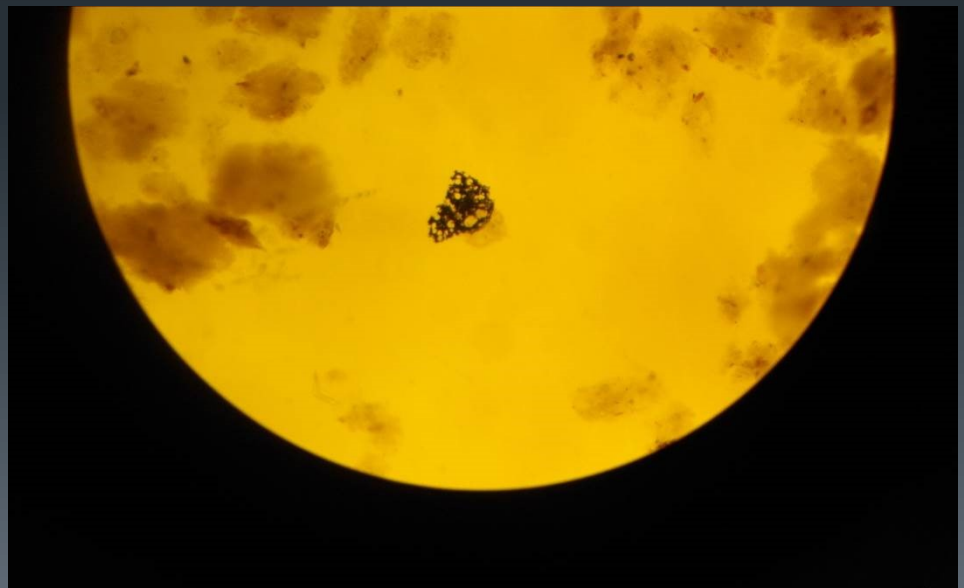
Charcoal Analysis

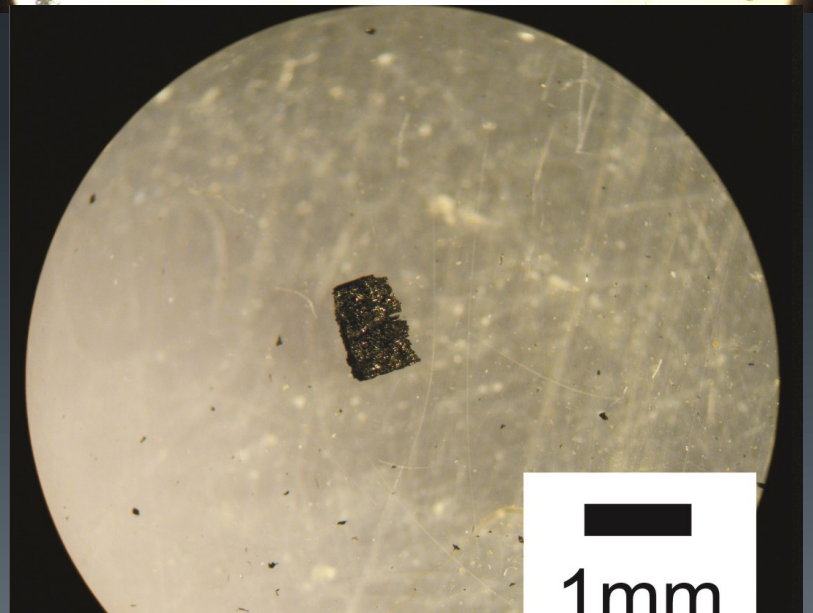
- Interpretations limited to fire frequency
- Is there more potential for more information?
- Such as Fire Type, Fuel sources, Biomass abundance

Charcoal Morphology









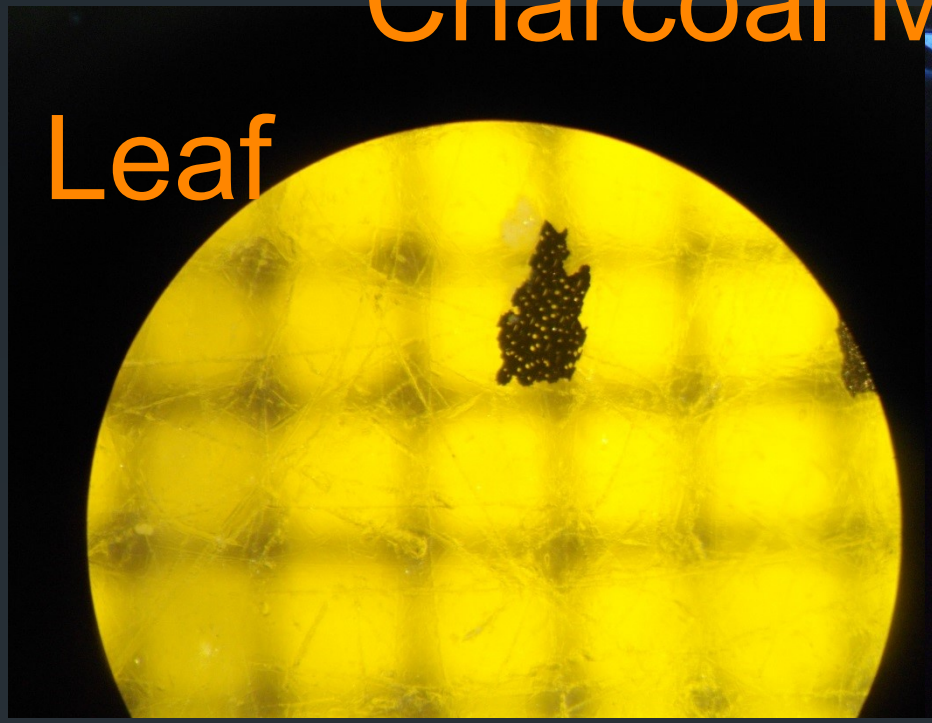
Charcoal morphology represents

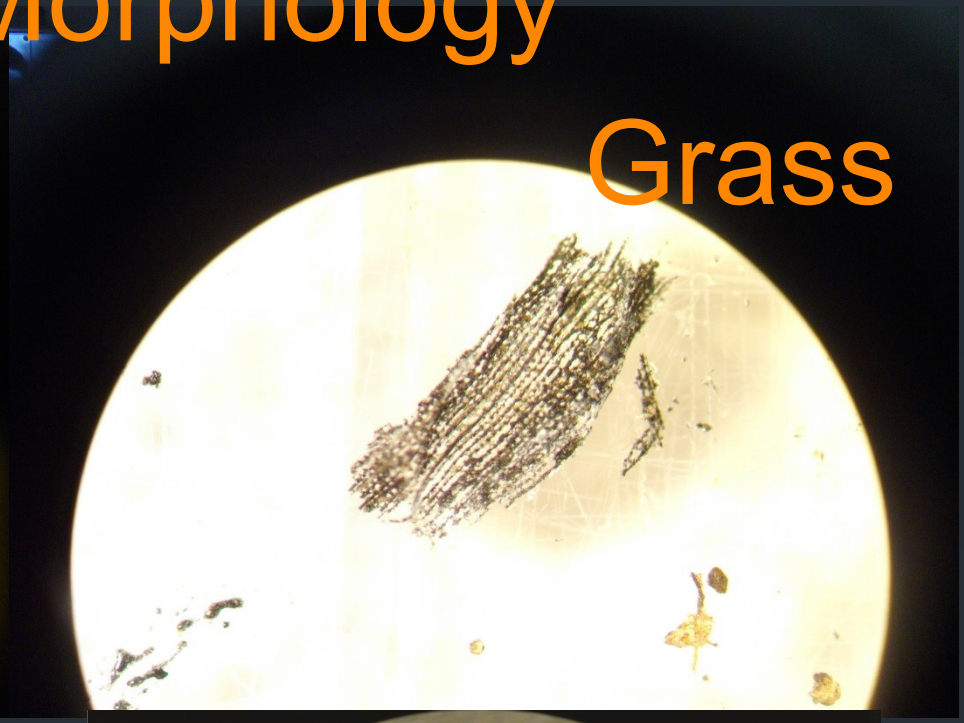
1) Fuel type (woody, herbaceous, leaves, roots, moss, etc)

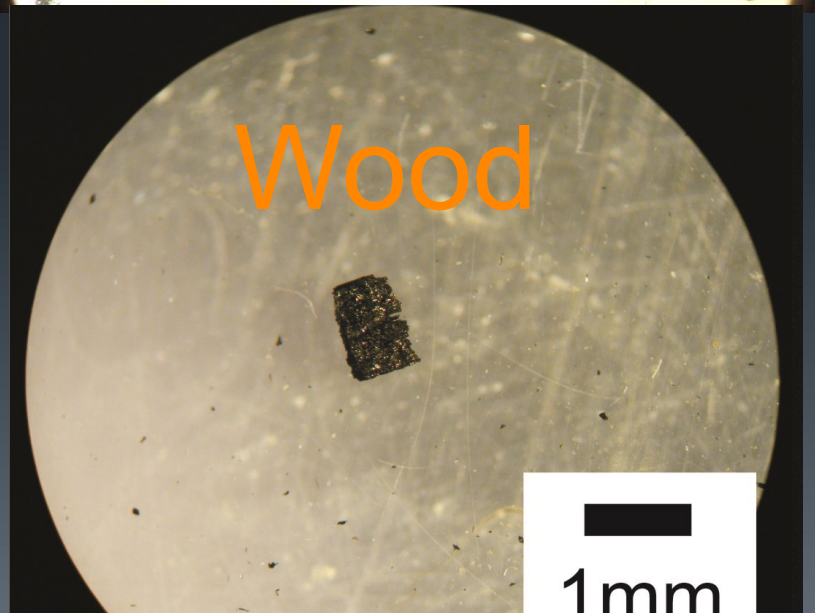
2) Fire type (low or high severity, ground fire, crown fire)

3) Taphonomic processes (transport to lake)

Charcoal Morphology

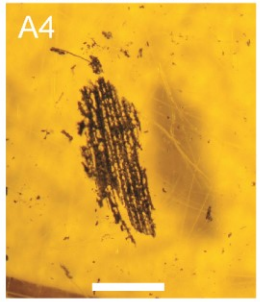




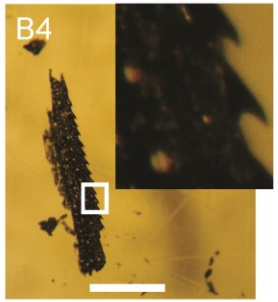


Poaceae leaves

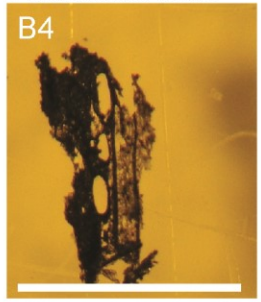
(a) Poaceae leaf



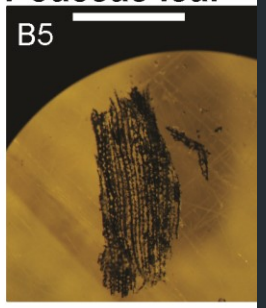
(b) Poaceae leaf



(c) Poaceae leaf



(d) Poaceae leaf

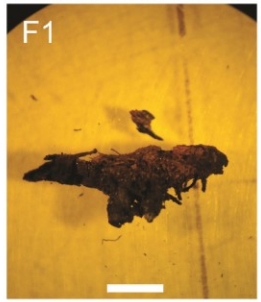


Poaceae roots

(e) Roots, stolons

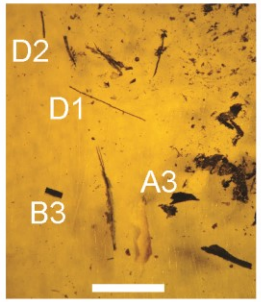
(f) Rootlets

(g) Roots and soil

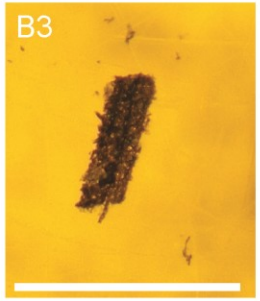


Other leaves

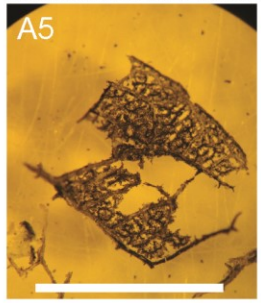
(h) Monocot leaf



(i) Monocot leaf



(j) Deciduous tree leaf

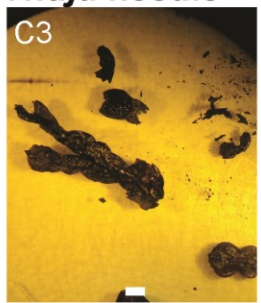


Needles and wood

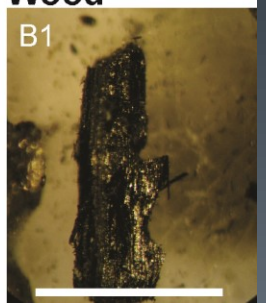
(k) *Picea* needles

(l) *Picea* needles

(m) *Thuja* needle



(n) Wood



Case Study: Pyatts Lake

- Small lake
- Rocky Mountain Trench, rich deglacial history
- High biodiversity, rare species
- First Nations environmental impact poorly known
- Heavily impacted by settlers over past 125 year

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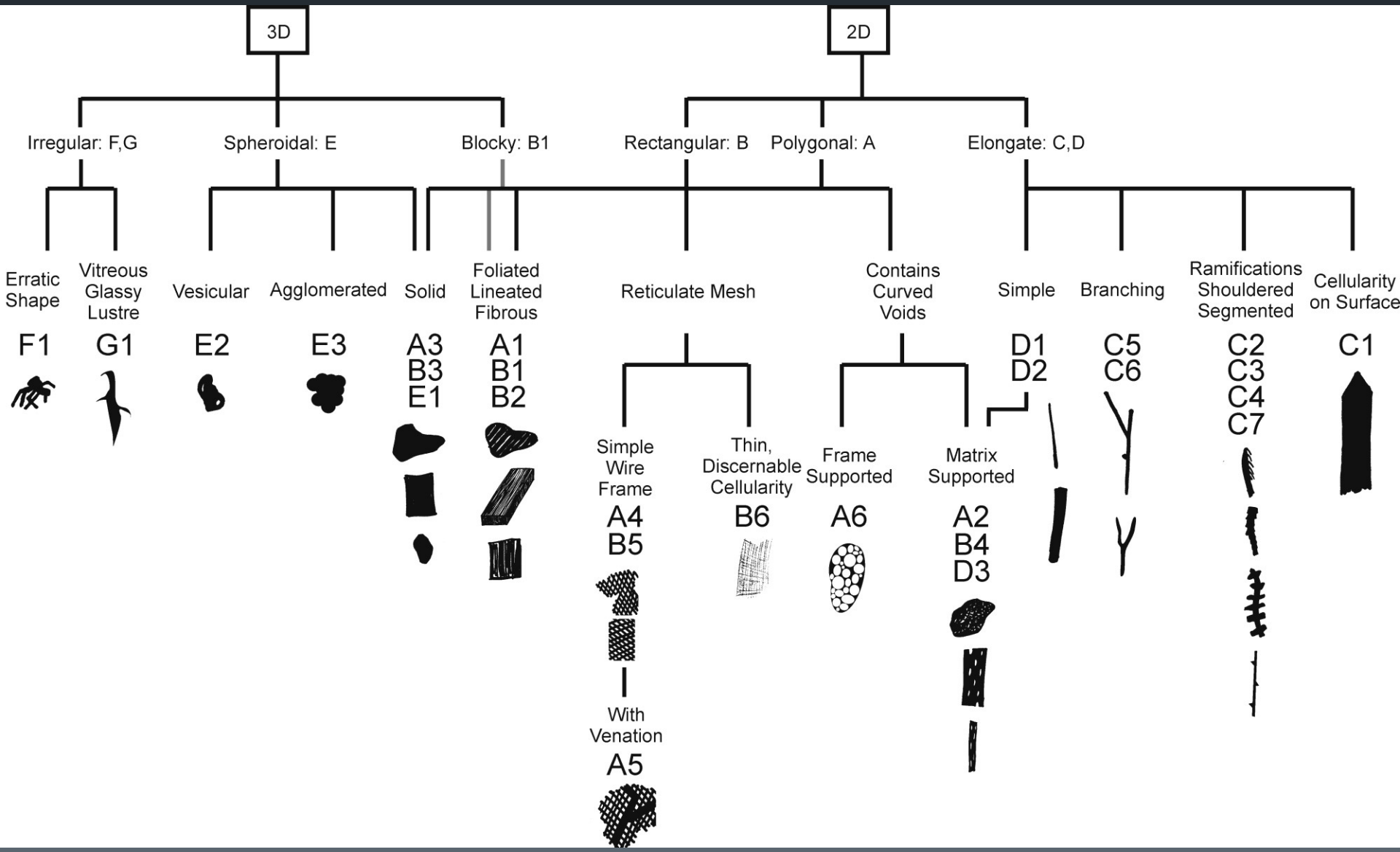
- Small lake
- Rocky Mountain Trench, rich deglacial history
- High biodiversity, rare species
- First Nations environmental impact poorly known
- Heavily impacted by settlers over past 125 year
  - Logging, defaunation, fragmentation, fire suppression

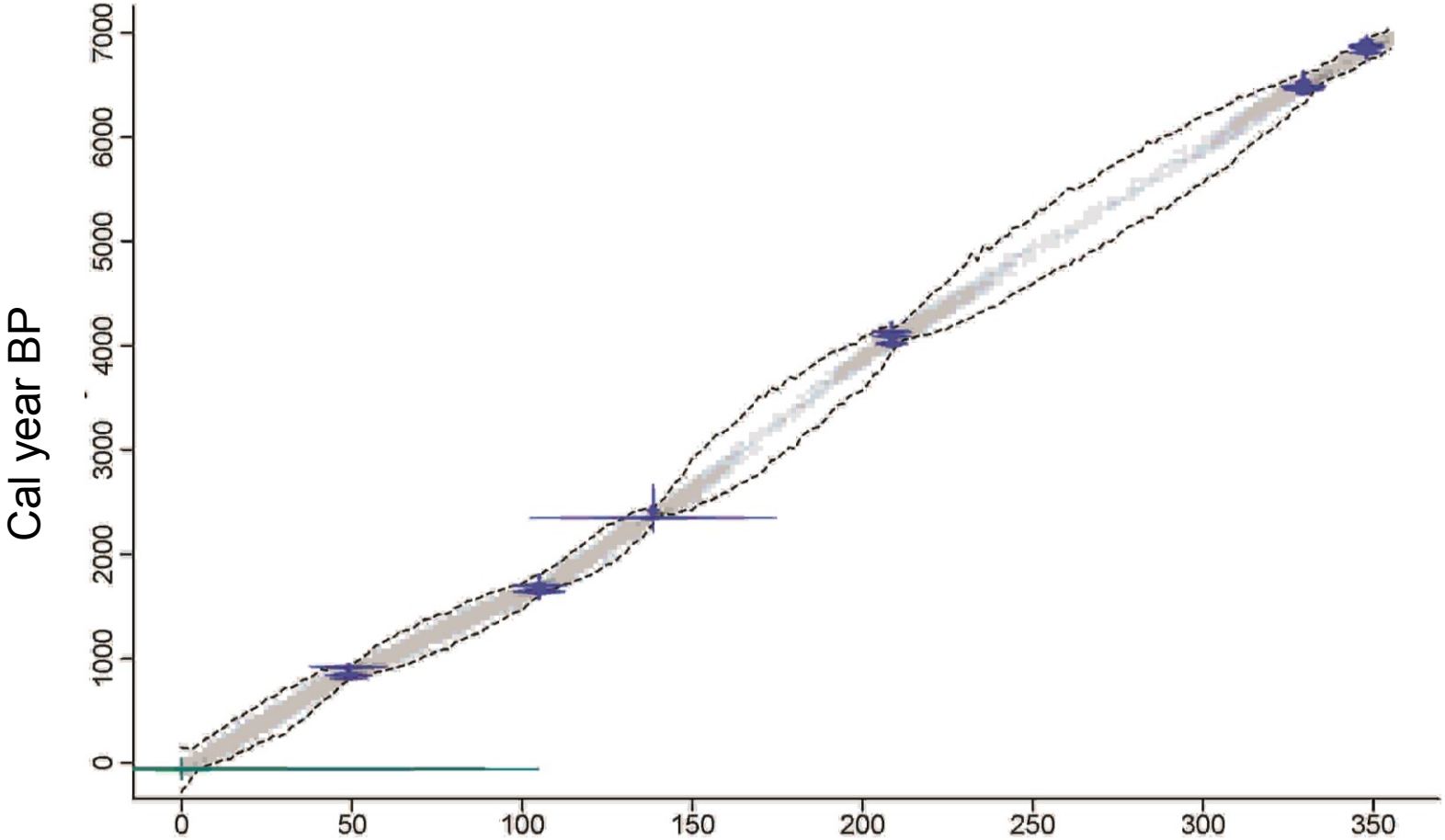
Case Study: Pyatts Lake

Study Site

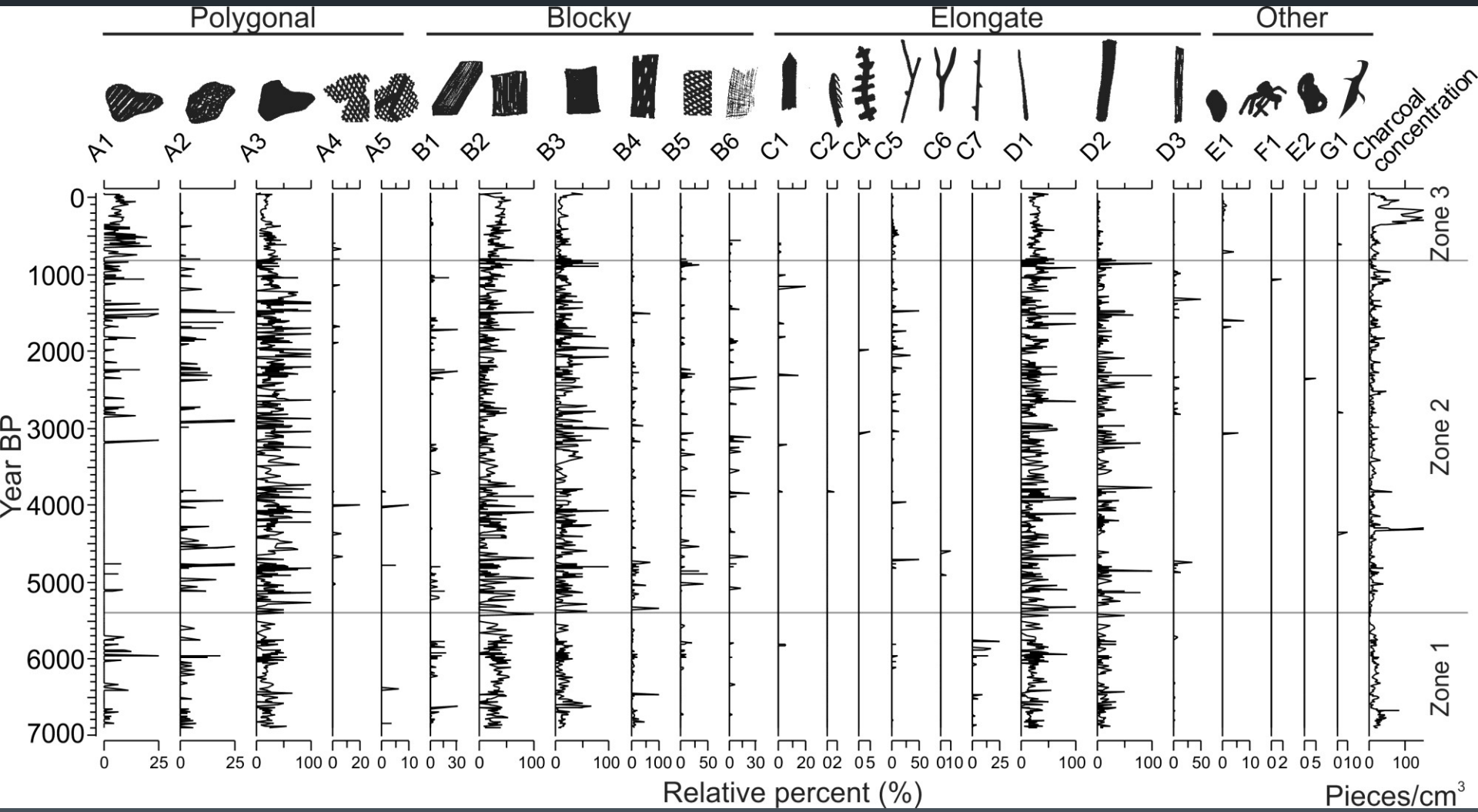
Charcoal Morphologies



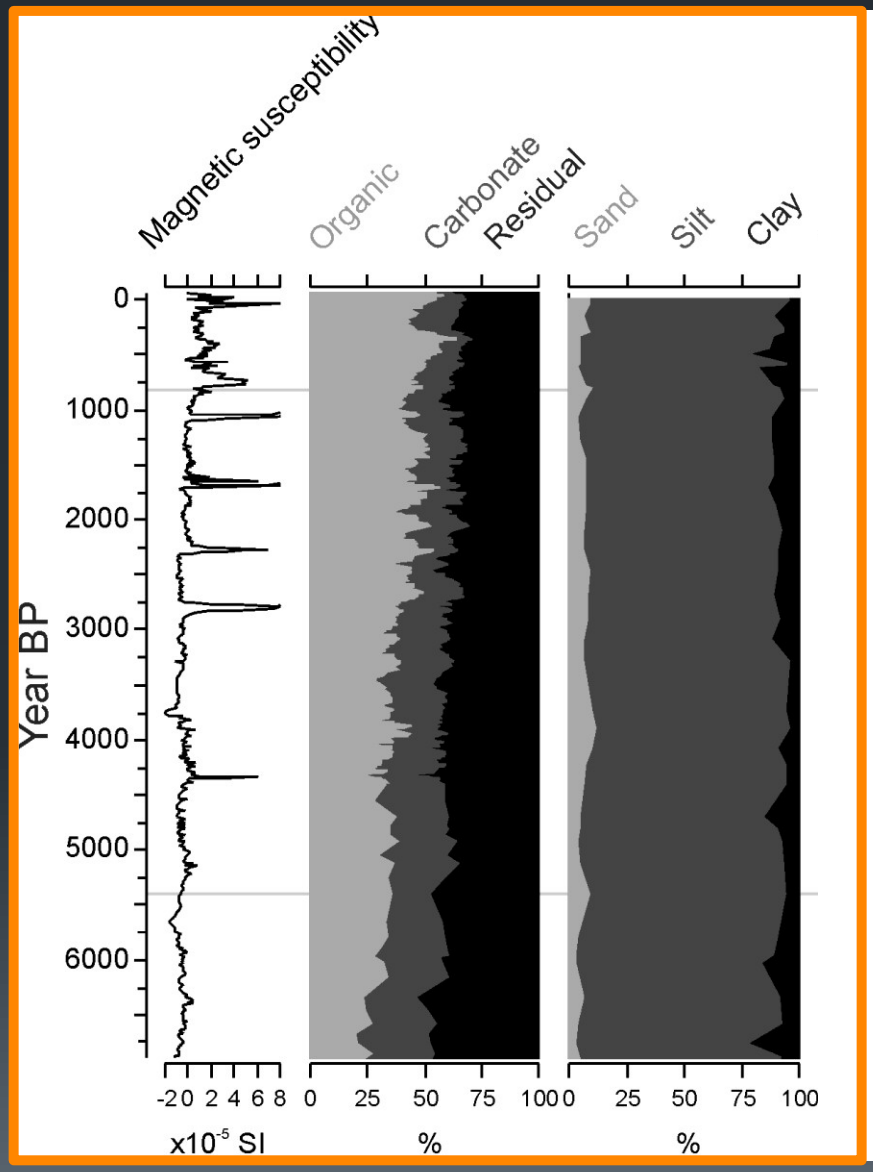
Age Model: 6 C-14 dates



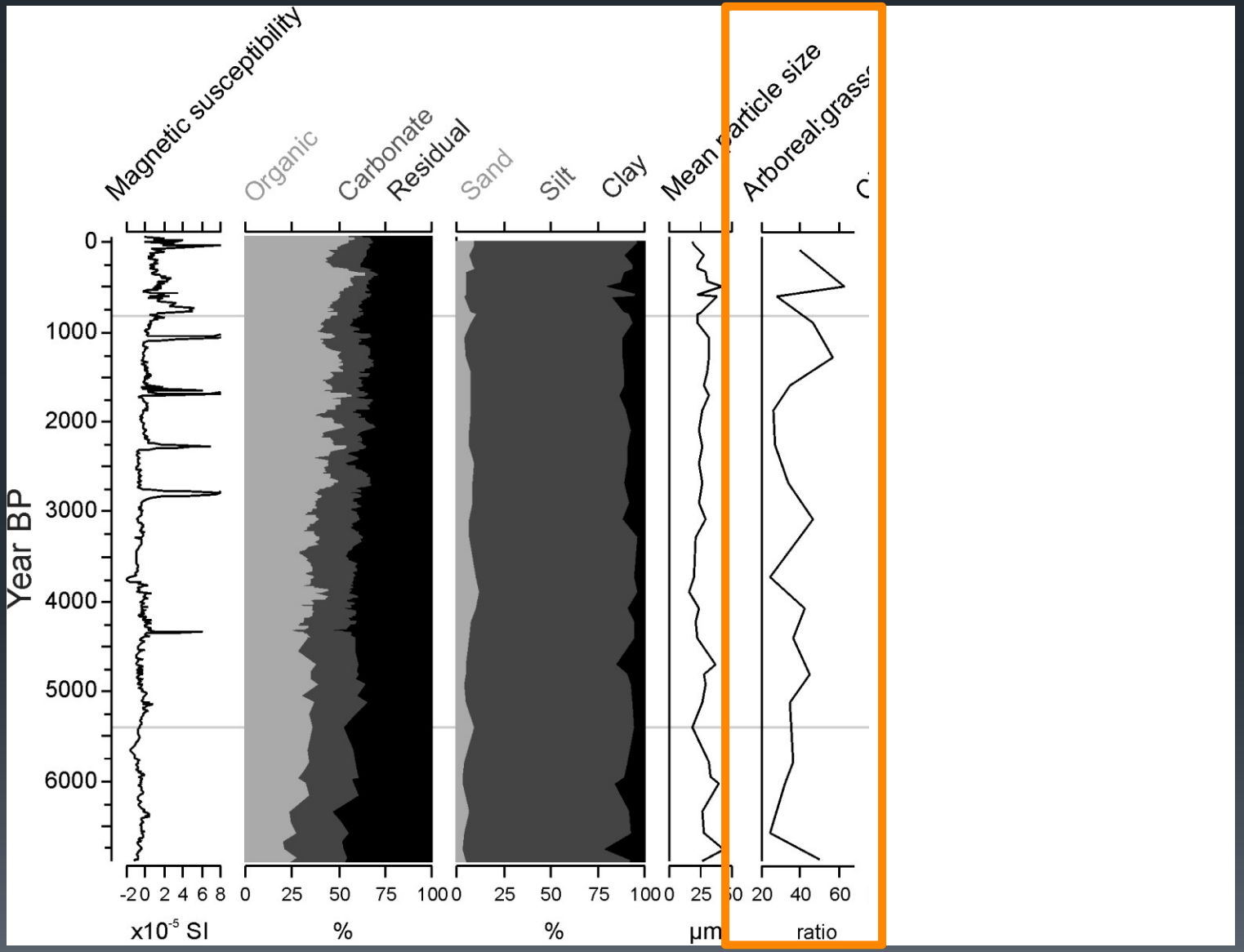
Charcoal Morphology Assemblage



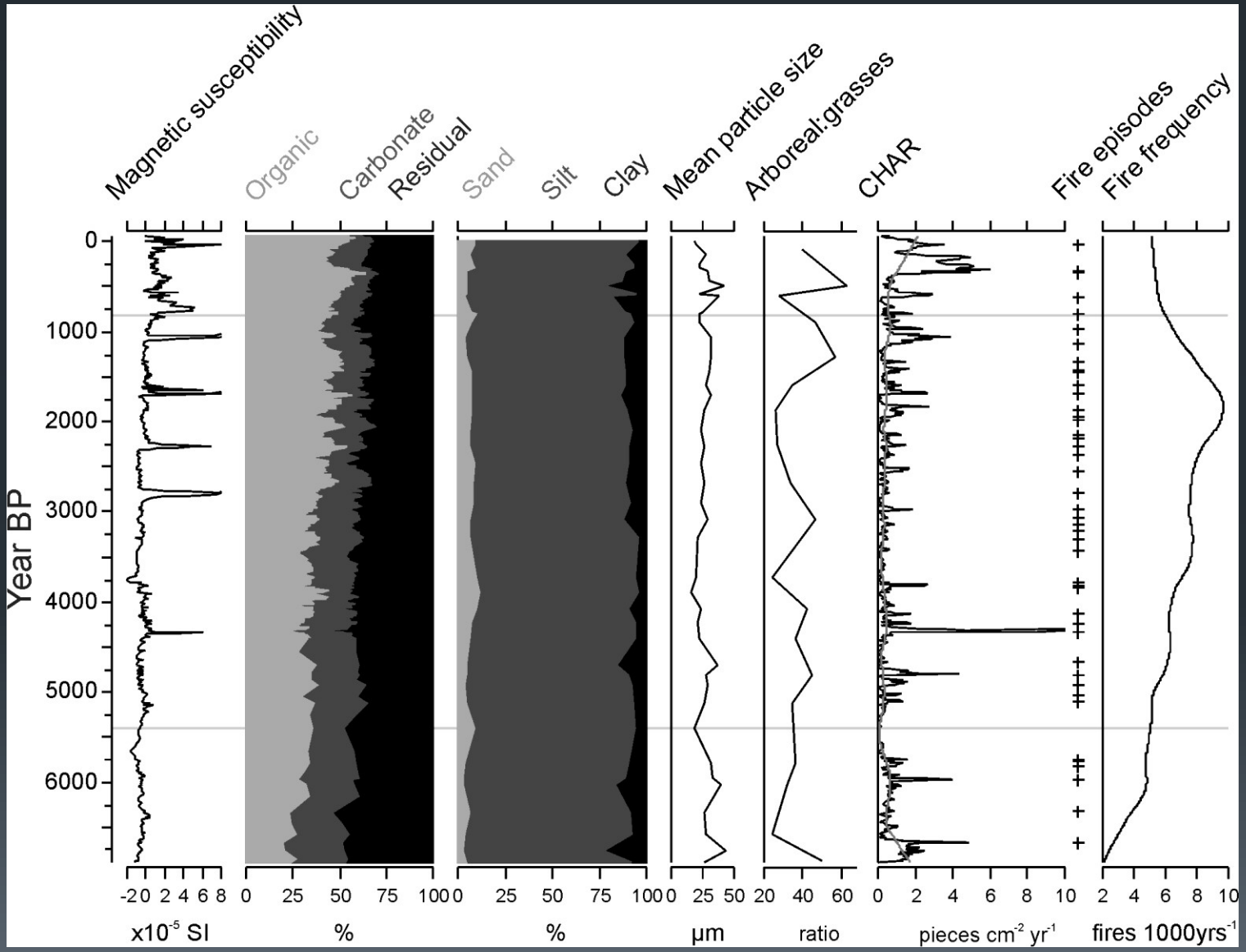
Driven by taphonomy?



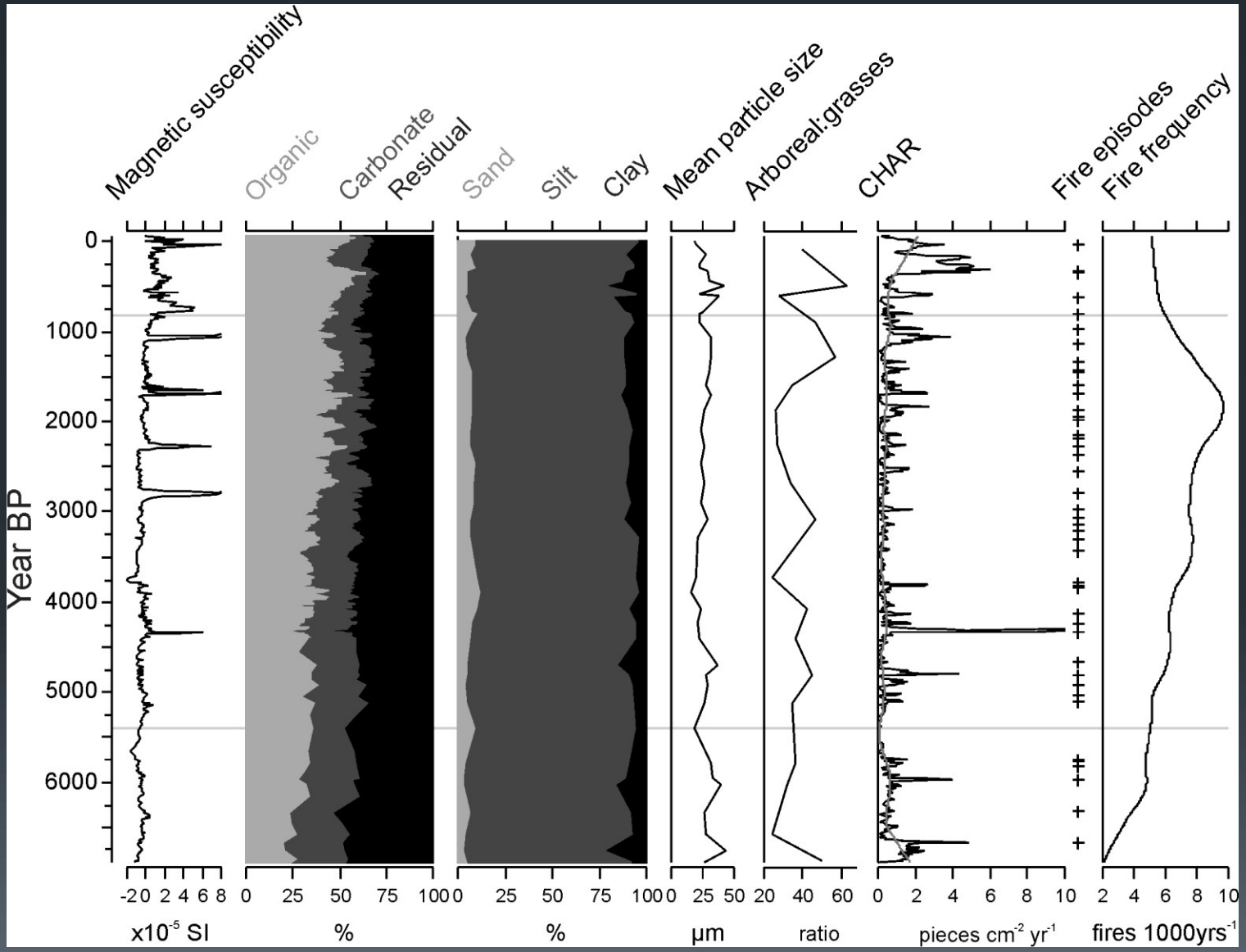
Driven by fuel types?



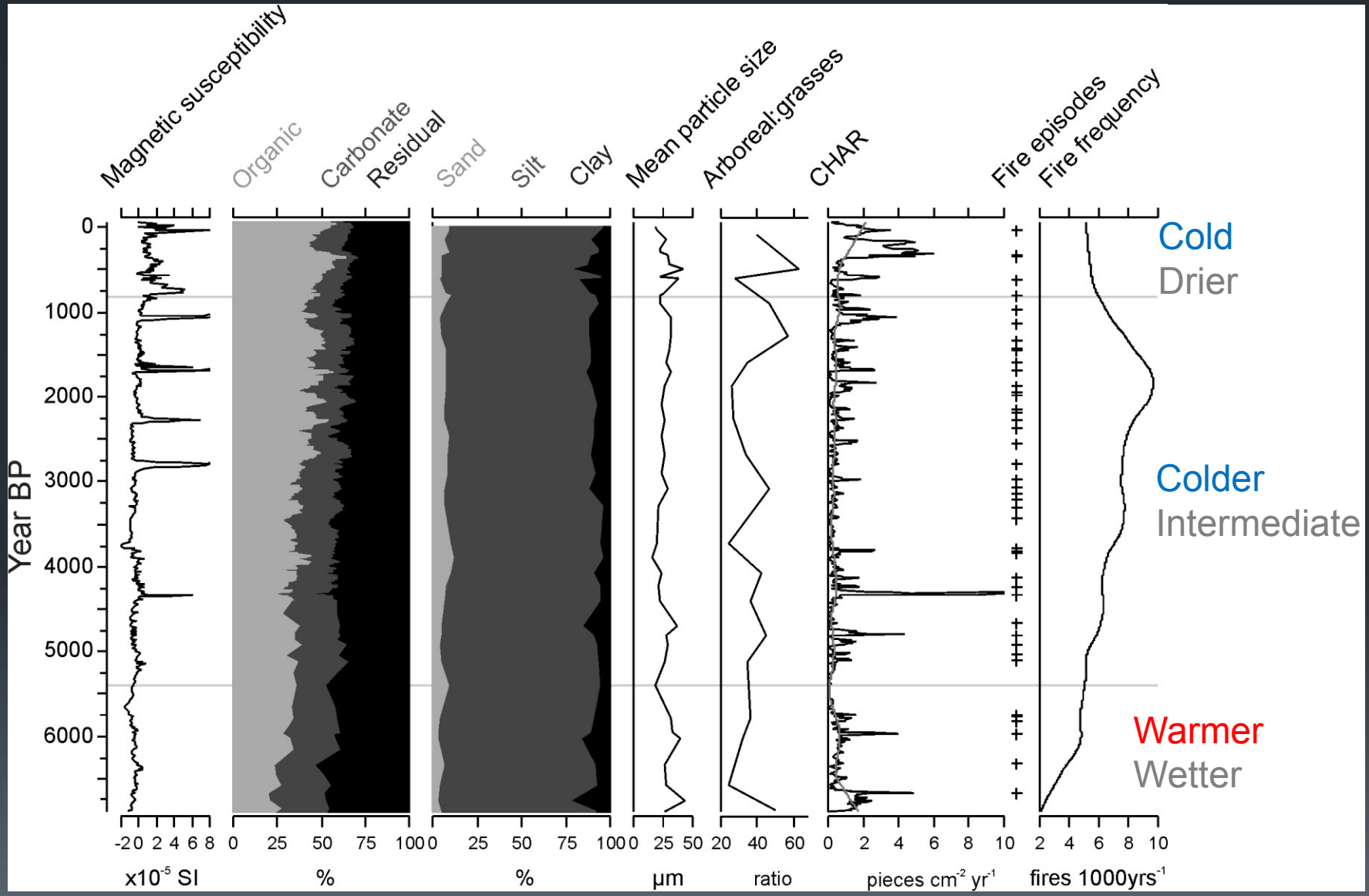
Driven by fire regime?



Driven by fire regime?



Driven by hydroclimate?



Conclusions:

- Morphology data can be useful for interpreting ecosystem changes
- Drivers of assembly changes may change over time
- First study to examine morphology assemblage rather than key morphotypes
- First high resolution morphology study
- New calibration studies, new ecosystems, mechanistic experiments

Tools:

- GCD
- PAGES paleofire working group

- CharAnalysis (Phil Higuera – U Montana)

- Paleofire R package