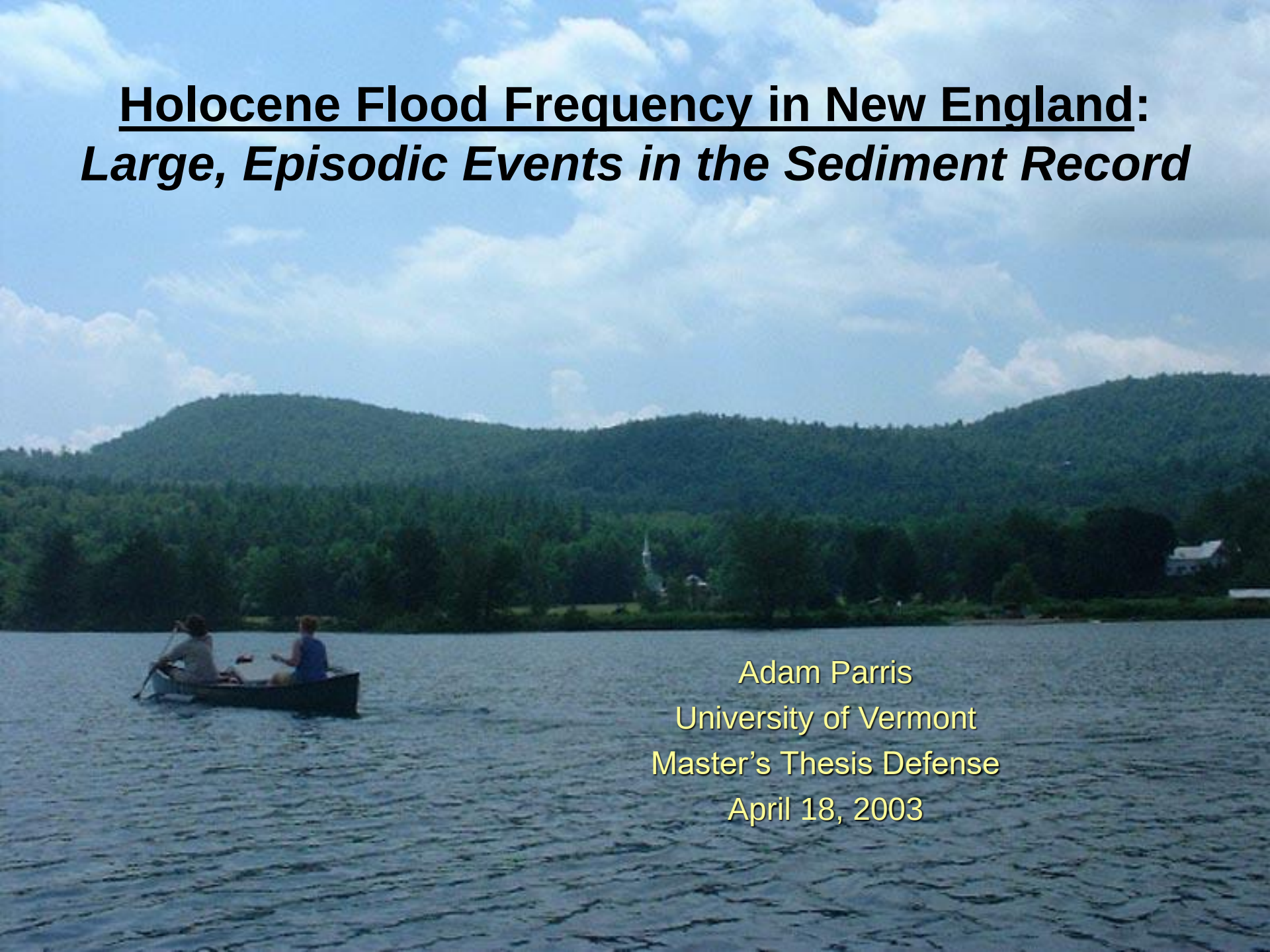
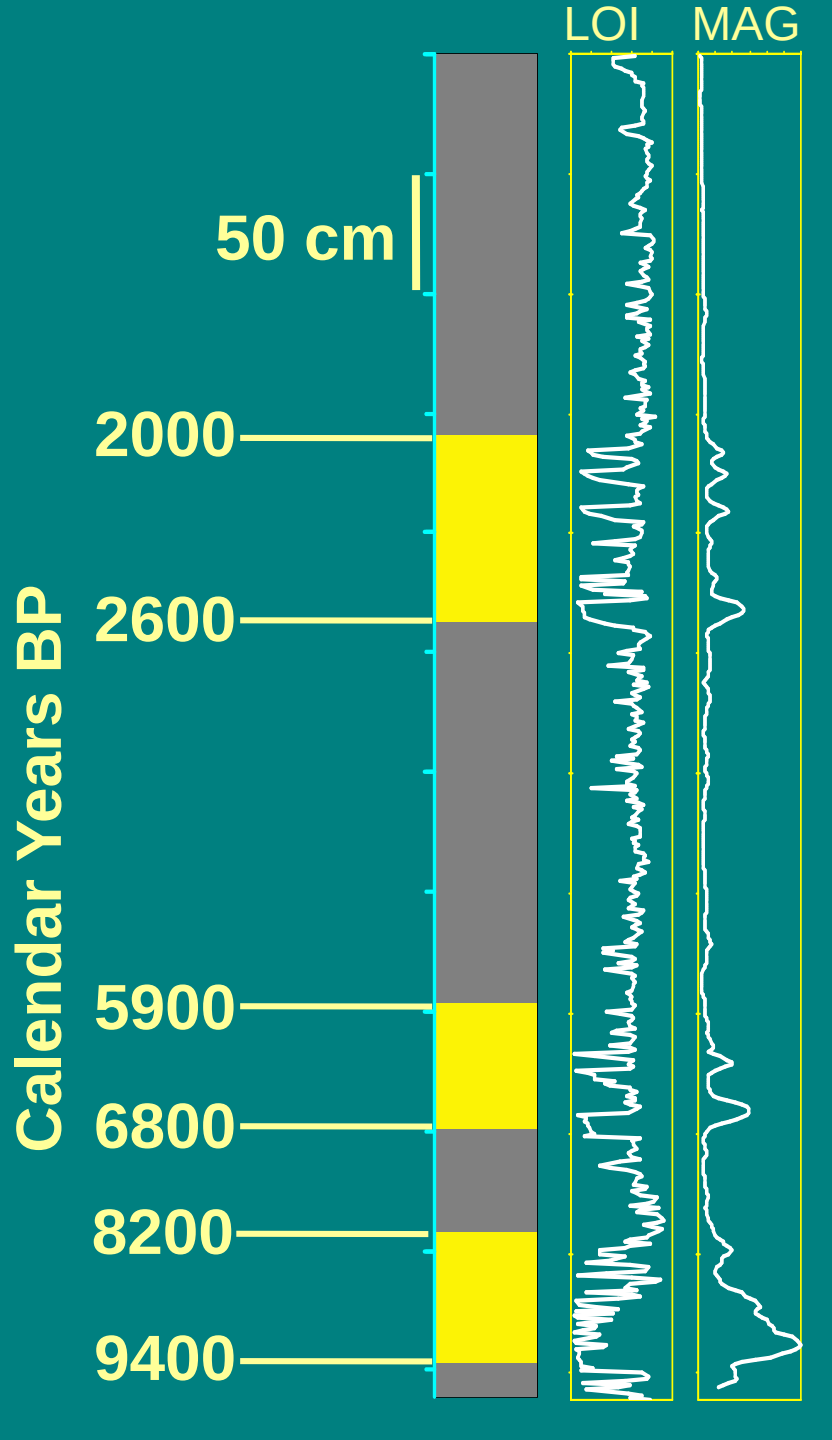
Holocene Flood Frequency in New England:
Large, Episodic Events in the Sediment Record



Adam Parris
University of Vermont
Master's Thesis Defense
April 18, 2003

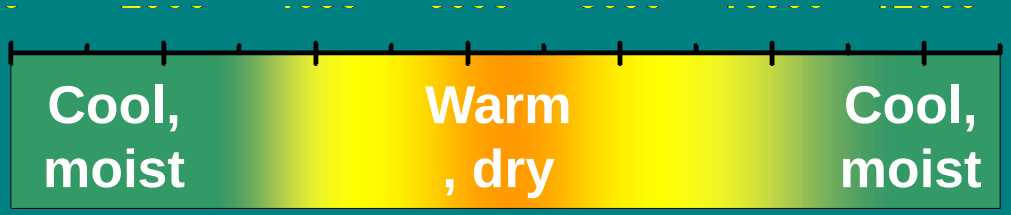

WHY?
RICHFORD, VT.
NOV. 4th. 1927.

Brown et al., *Geology*, 2000

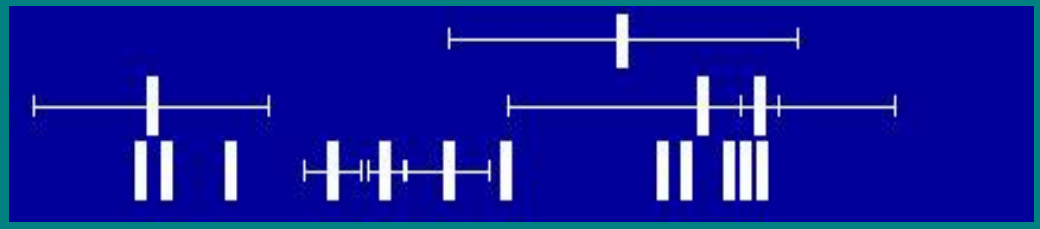


New England Climate

Avg.

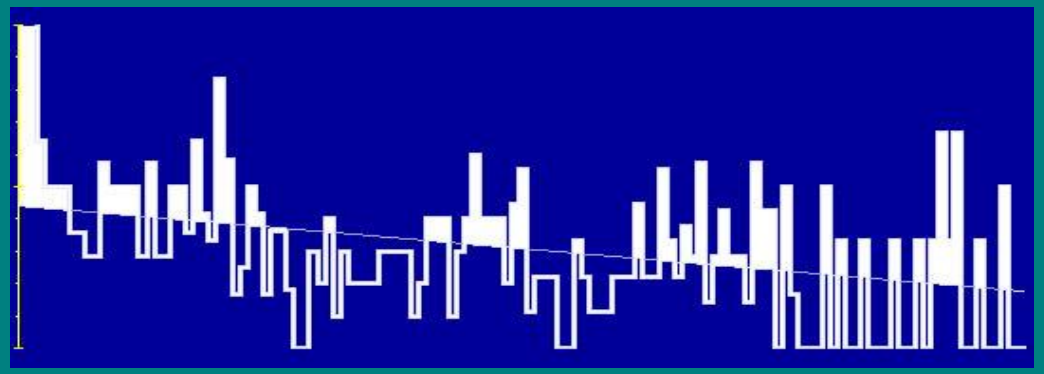


Fans



Jennings et al., *GSA Bulletin,* 2003

Storms



Noren et al., *Nature,* 2002

0 2 4 6 8 10 12

Calendar ky BP

Questions

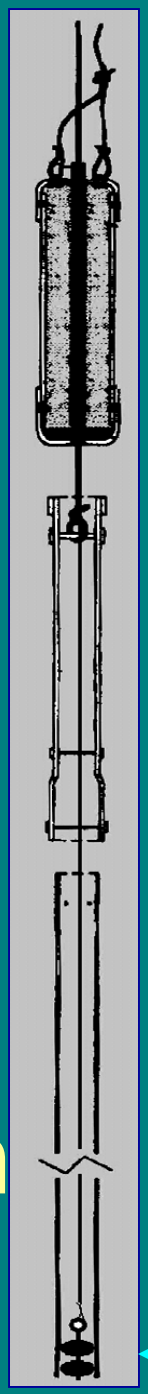
Does particle size anlaysis of lake sediment cores offer a higher resolution record of storminess?

Are there periods and/or cycles of increased storminess in NH & ME, similar to VT & NY?

Is the regional storm record in NH & ME similar to other Atlantic records?

- **Climatic causes/controls?**

Reasoner Method



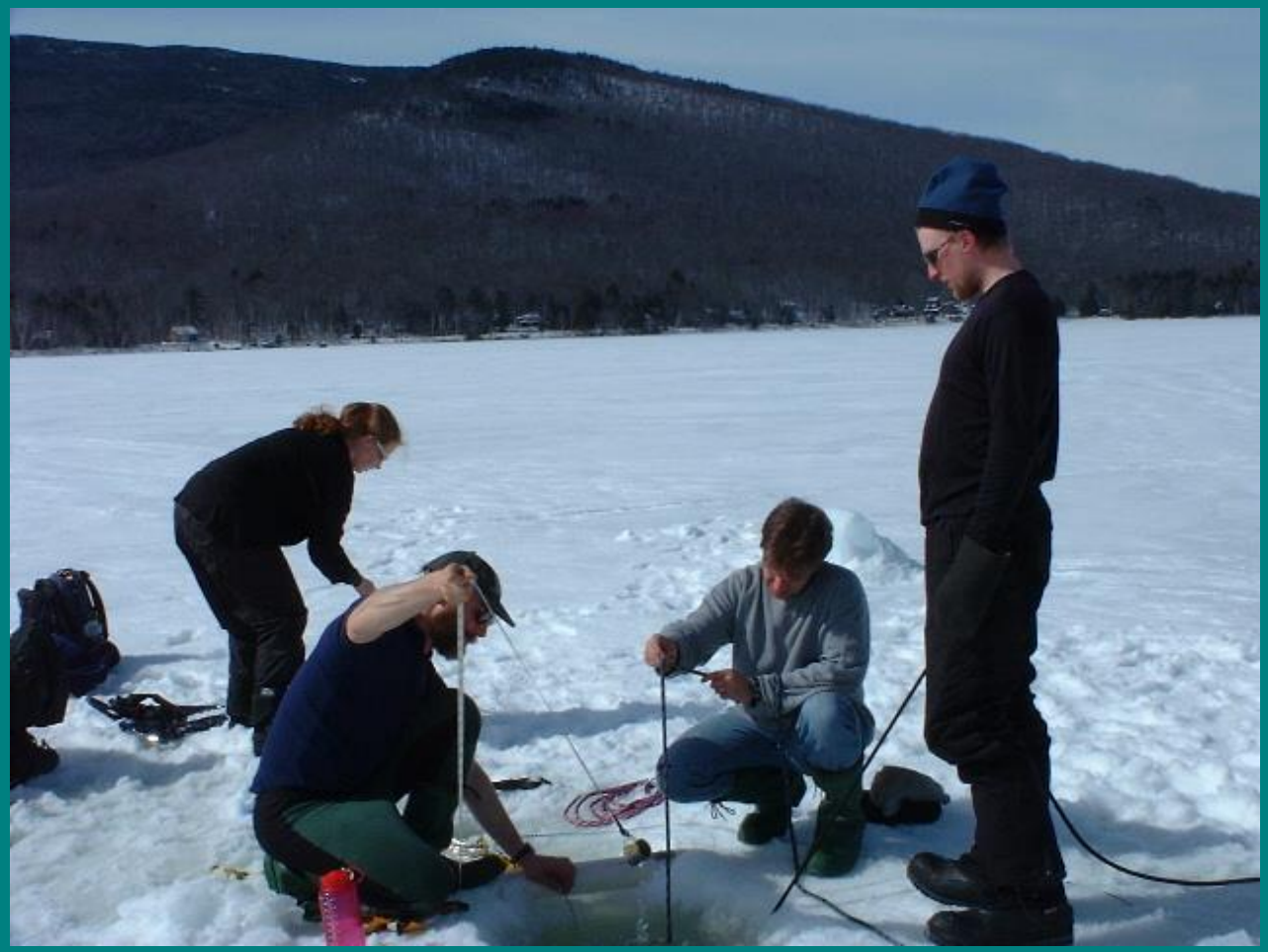
Driver

Head

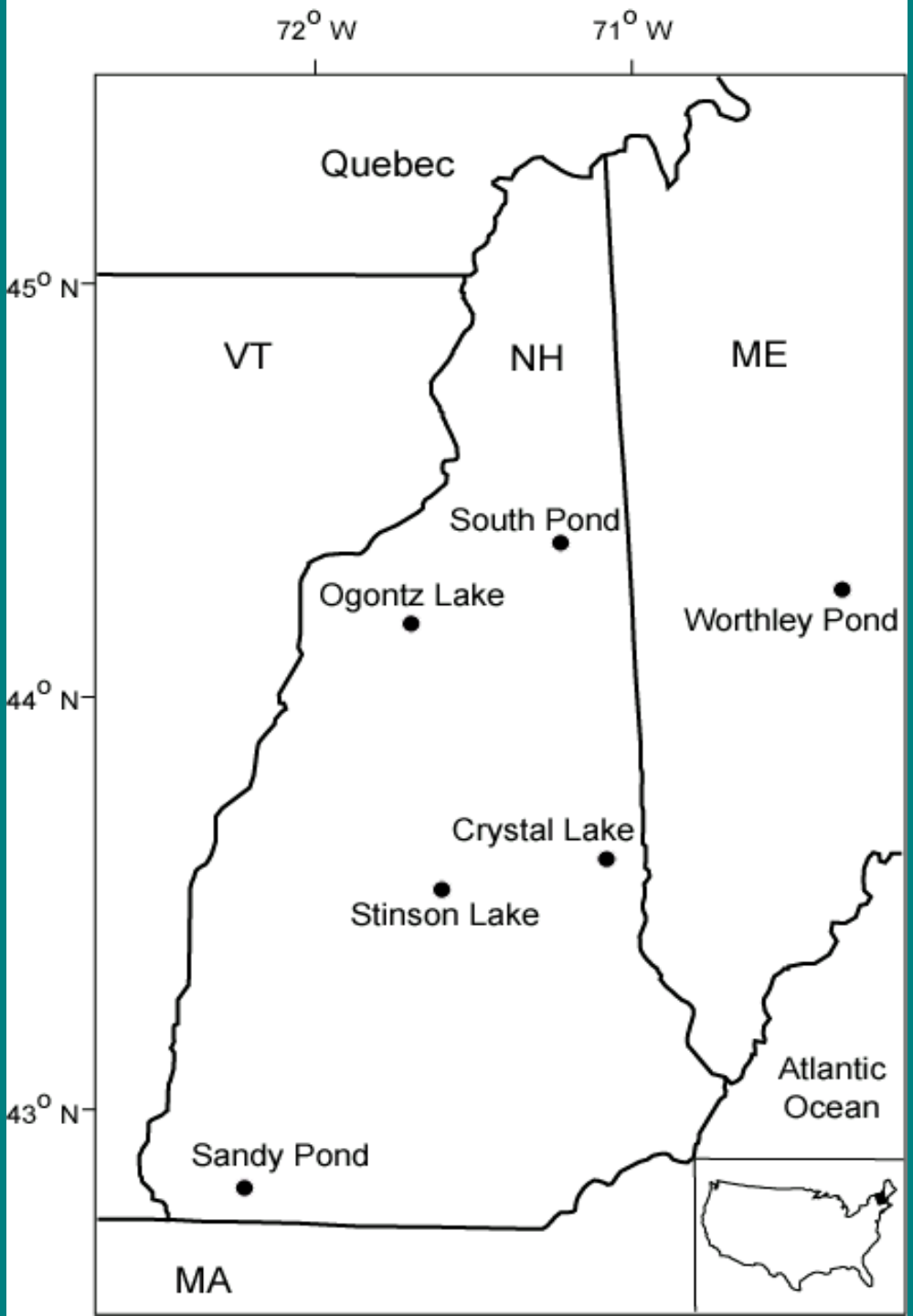
Barrel

6m

Piston



Lake Locations

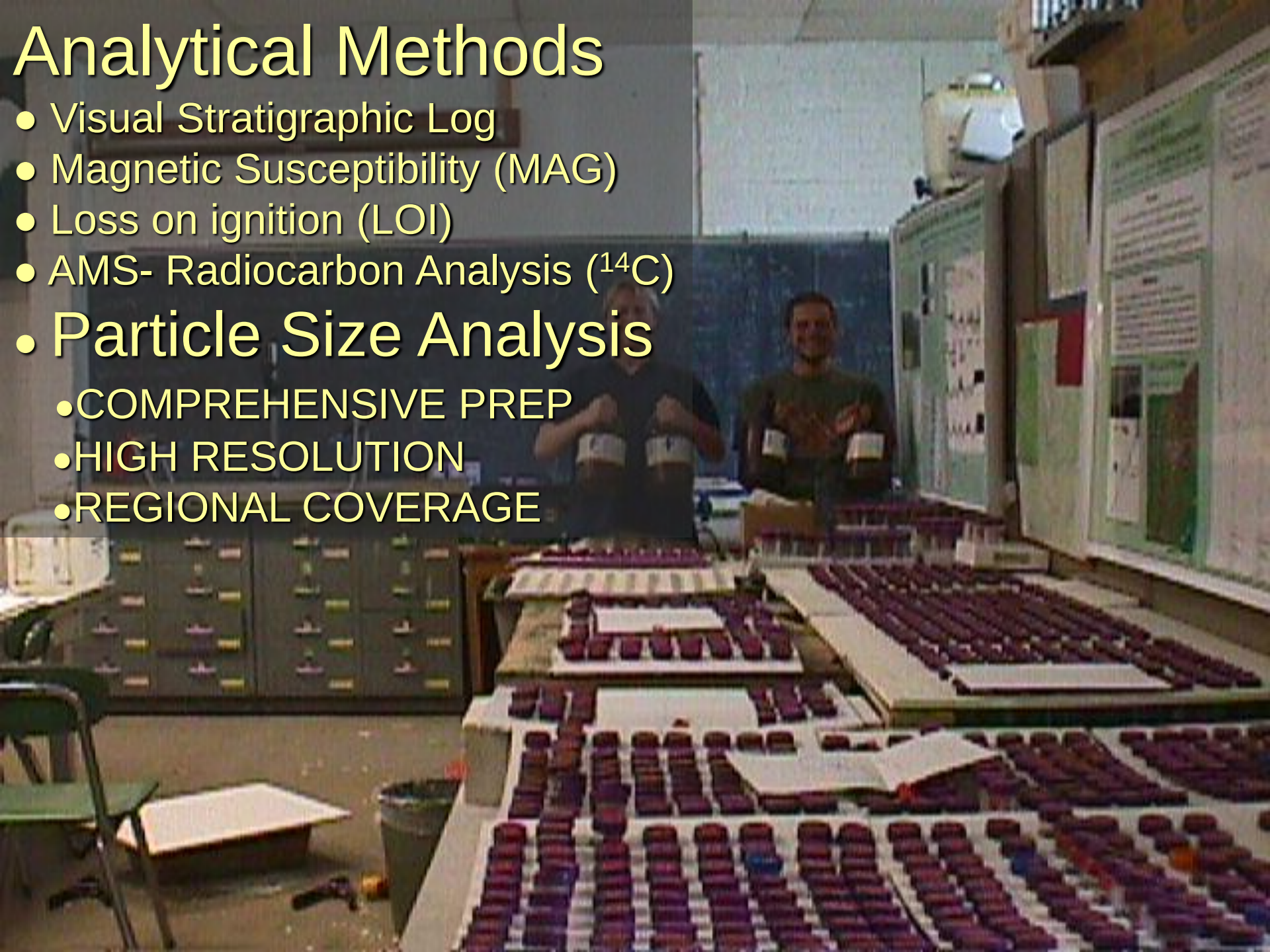


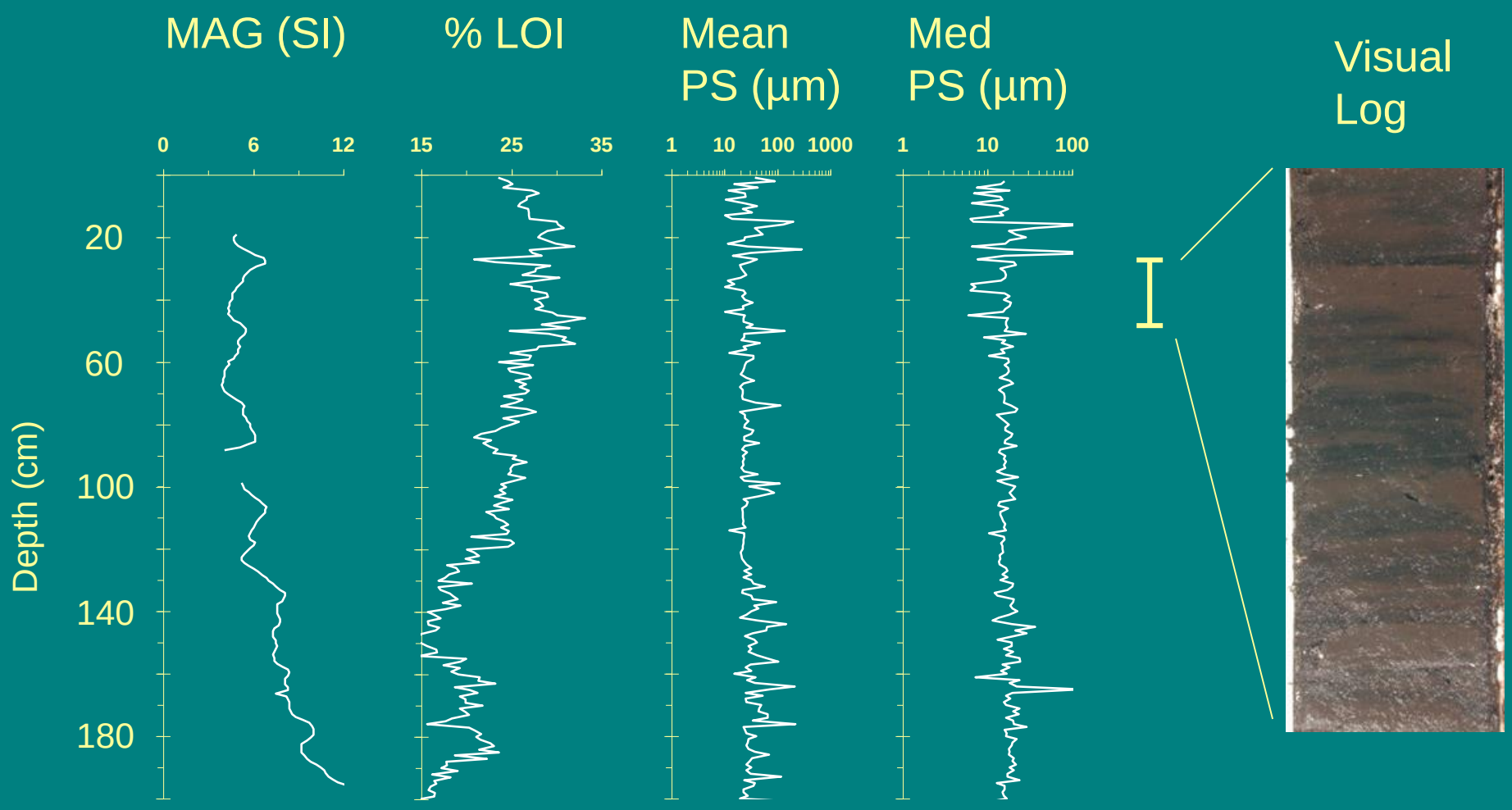
DEEP ↘ STEEP ↙

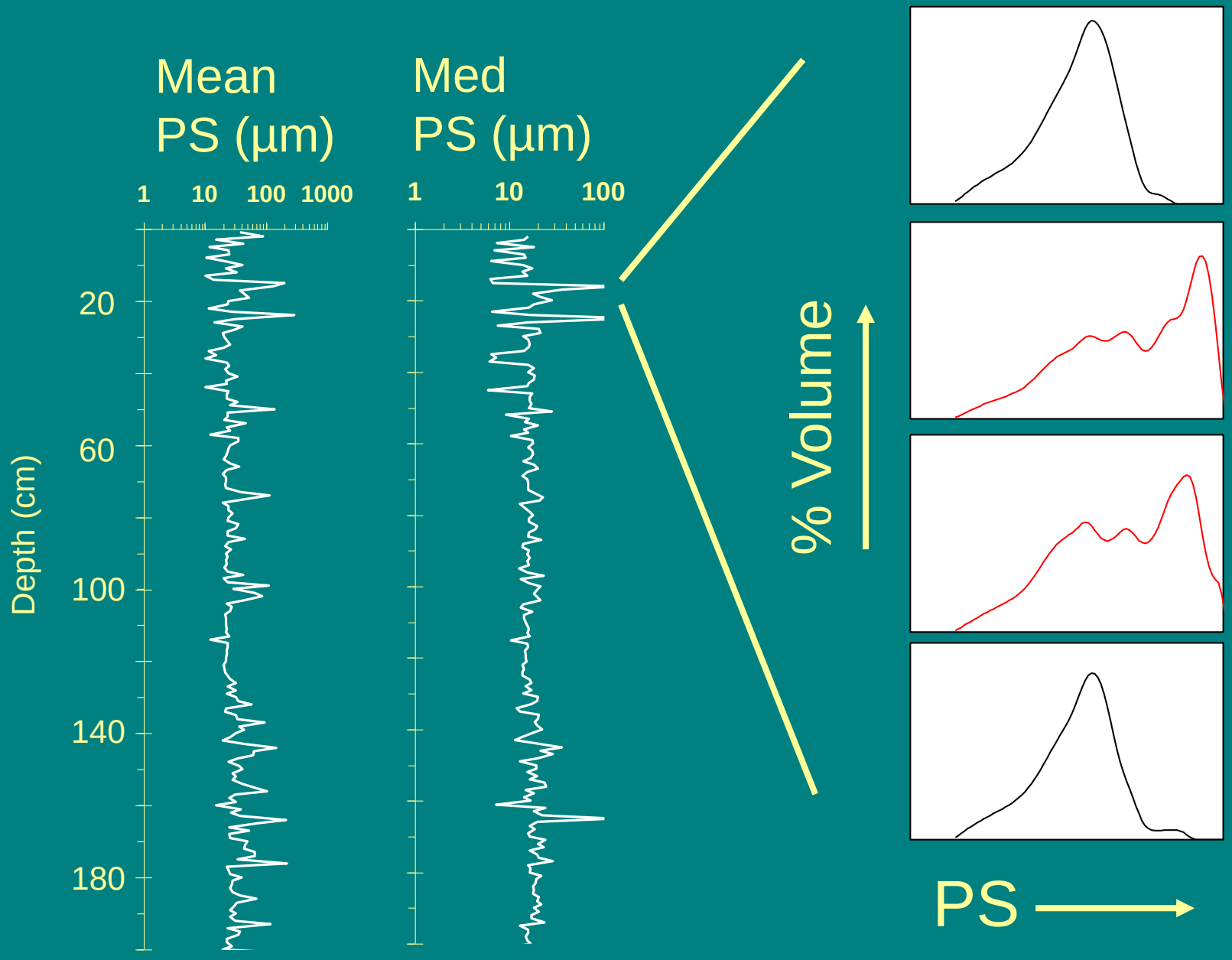
Lake Name	Surface Area (km^2)	Max Depth (m)	Basin Relief (m)
Worthley Pond (ME)	1.43	15	344
Crystal Lake (NH)	0.4	18	353
South Pond (NH)	0.7	27.9	427
Ogontz Lake (NH)	0.303	22	408
Stinson Lake (NH)	1.4	22	655
Sandy Pond (NH)	0.11	12	226

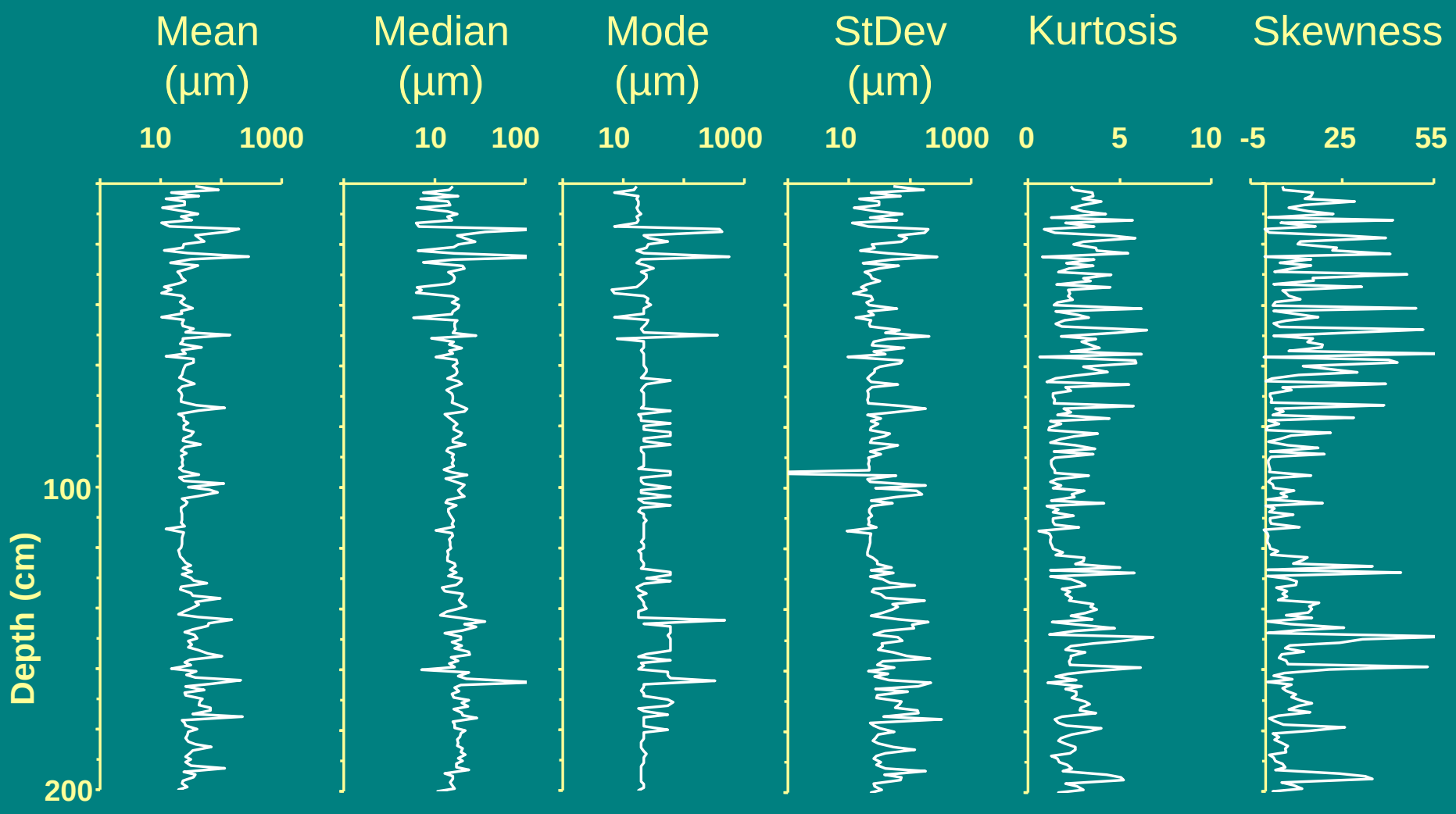
Analytical Methods

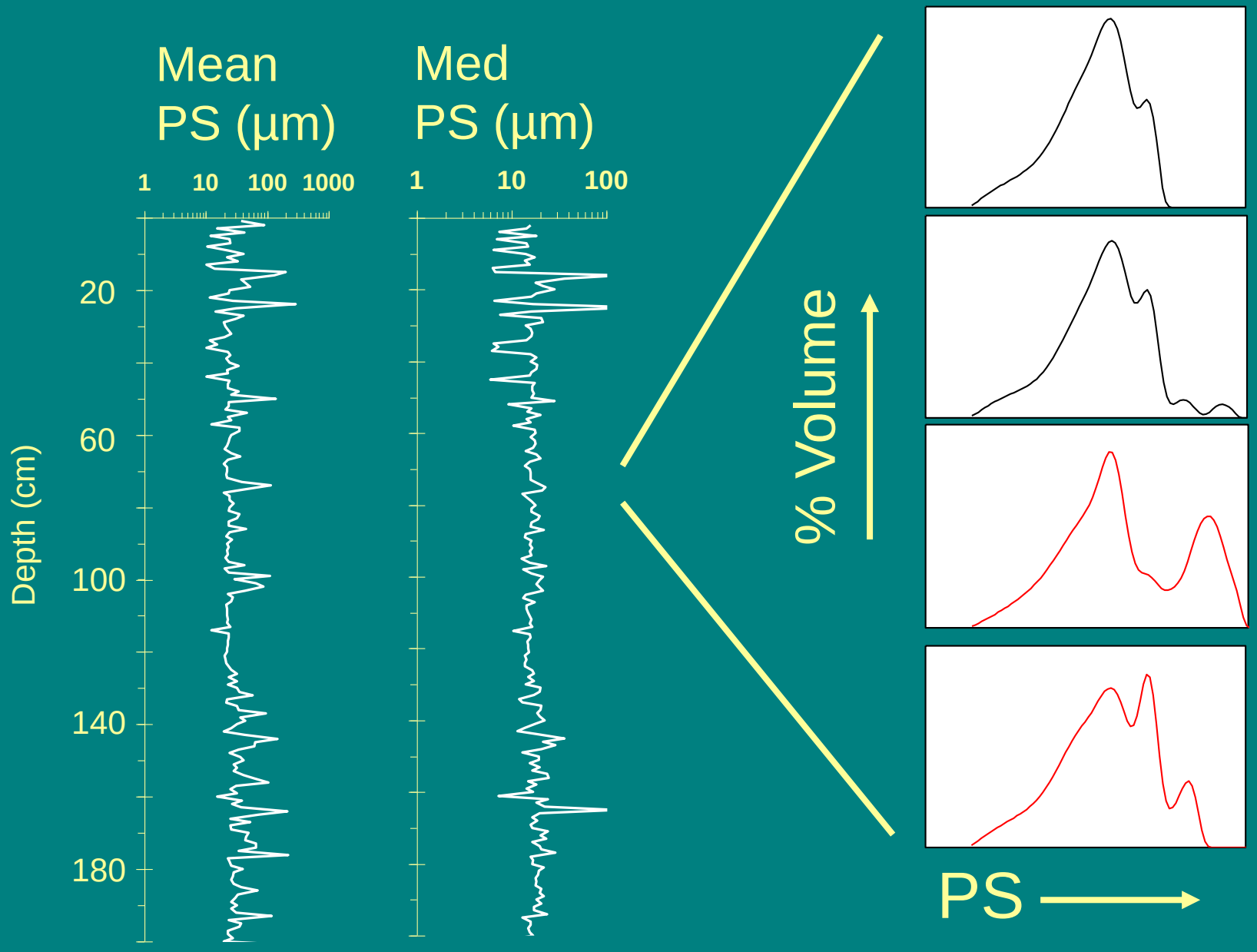
- Visual Stratigraphic Log
- Magnetic Susceptibility (MAG)
- Loss on ignition (LOI)
- AMS- Radiocarbon Analysis (^{14}C)
- Particle Size Analysis
  - COMPREHENSIVE PREP
  - HIGH RESOLUTION
  - REGIONAL COVERAGE



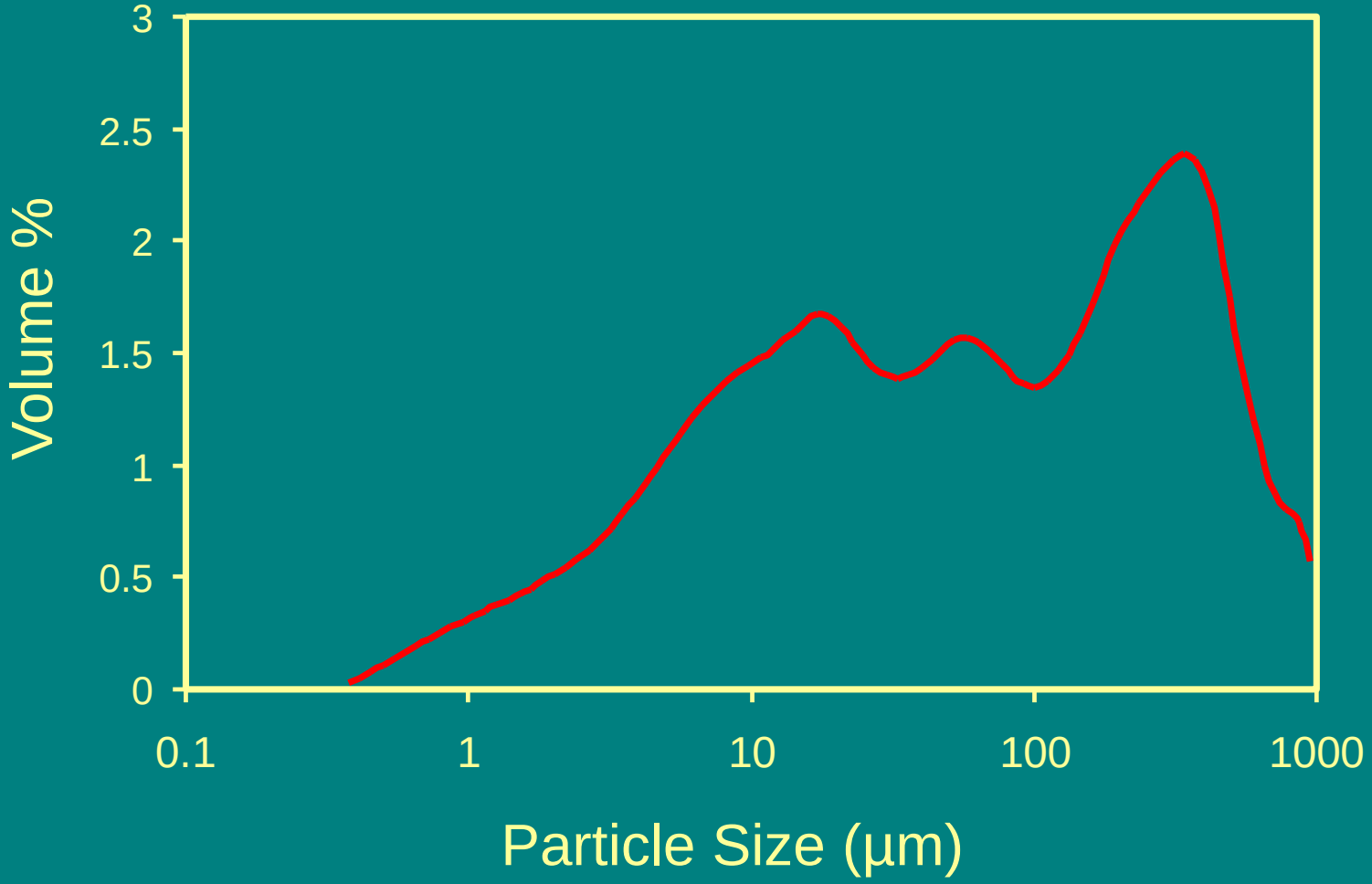

MAG (SI)
% LOI
Mean PS (µm)
Med PS (µm)
Visual Log
0
6
12
15
25
35
1
10
100
1000
1
10
100
Depth (cm)
20
60
100
140
180


Mean
PS (µm)
1
10
100
1000
Med
PS (µm)
1
10
100
Depth (cm)
20
60
100
140
180
% Volume
PS

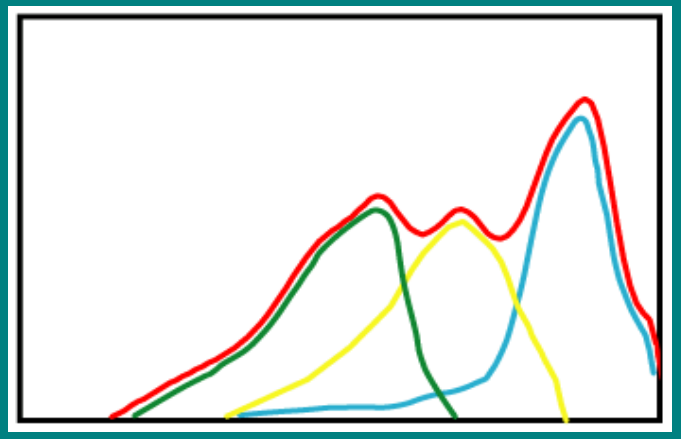

Mean (µm)
Median (µm)
Mode (µm)
StDev (µm)
Kurtosis
Skewness
10
1000
10
100
10
1000
10
1000
0
5
10
-5
25
55
Depth (cm)
100
200

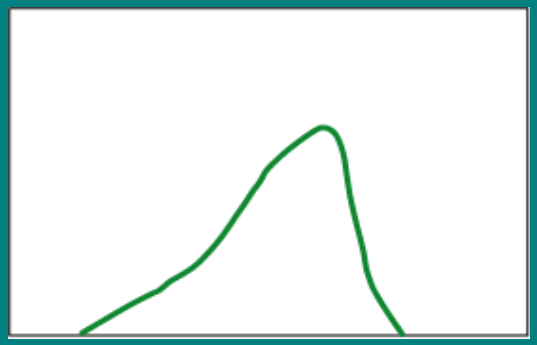

Mean
PS (µm)
1
10
100
1000
Med
PS (µm)
1
10
100
Depth (cm)
20
60
100
140
180
% Volume
PS

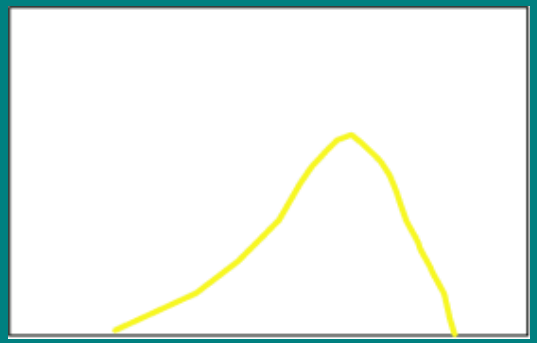
Size Frequency Distributions

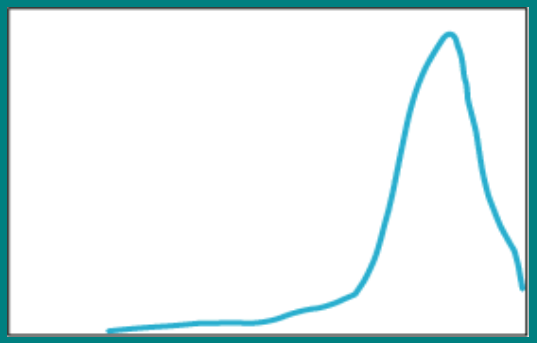


End Member Modeling:
Unraveling the size distribution







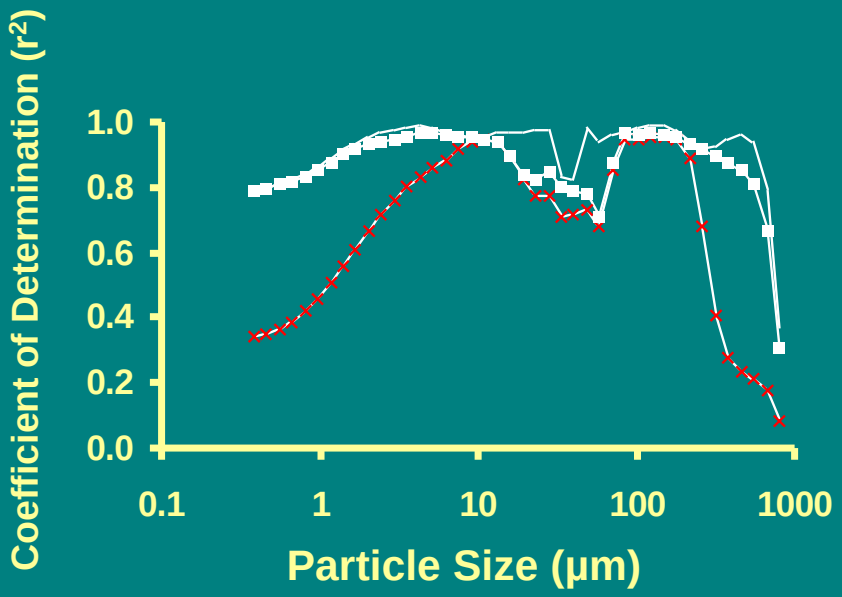


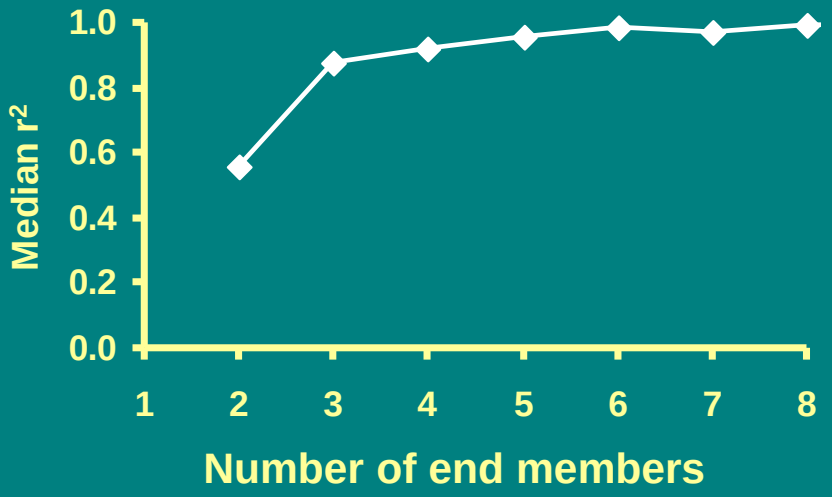
60 %

20 %

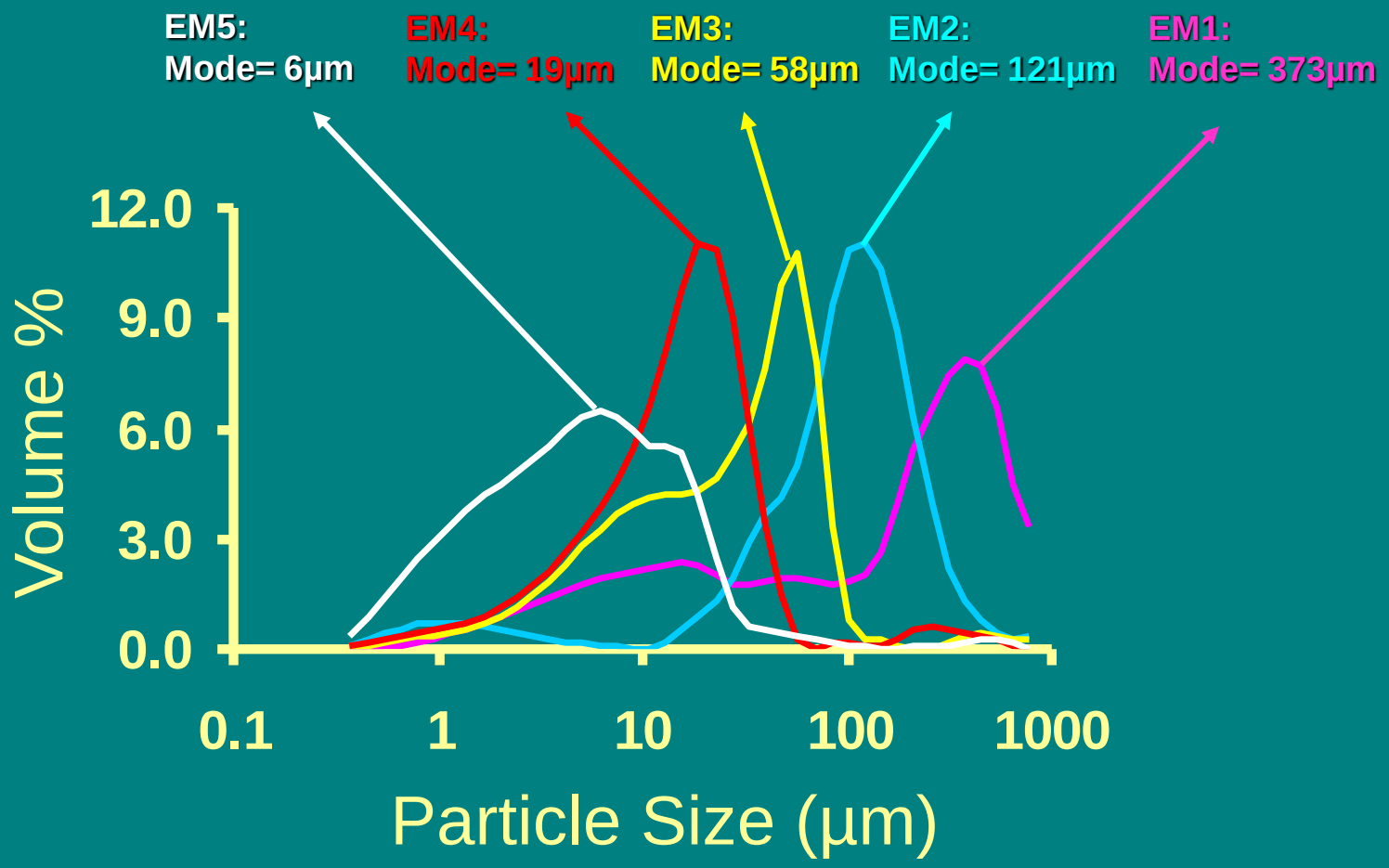
20 %

Estimation of End Members

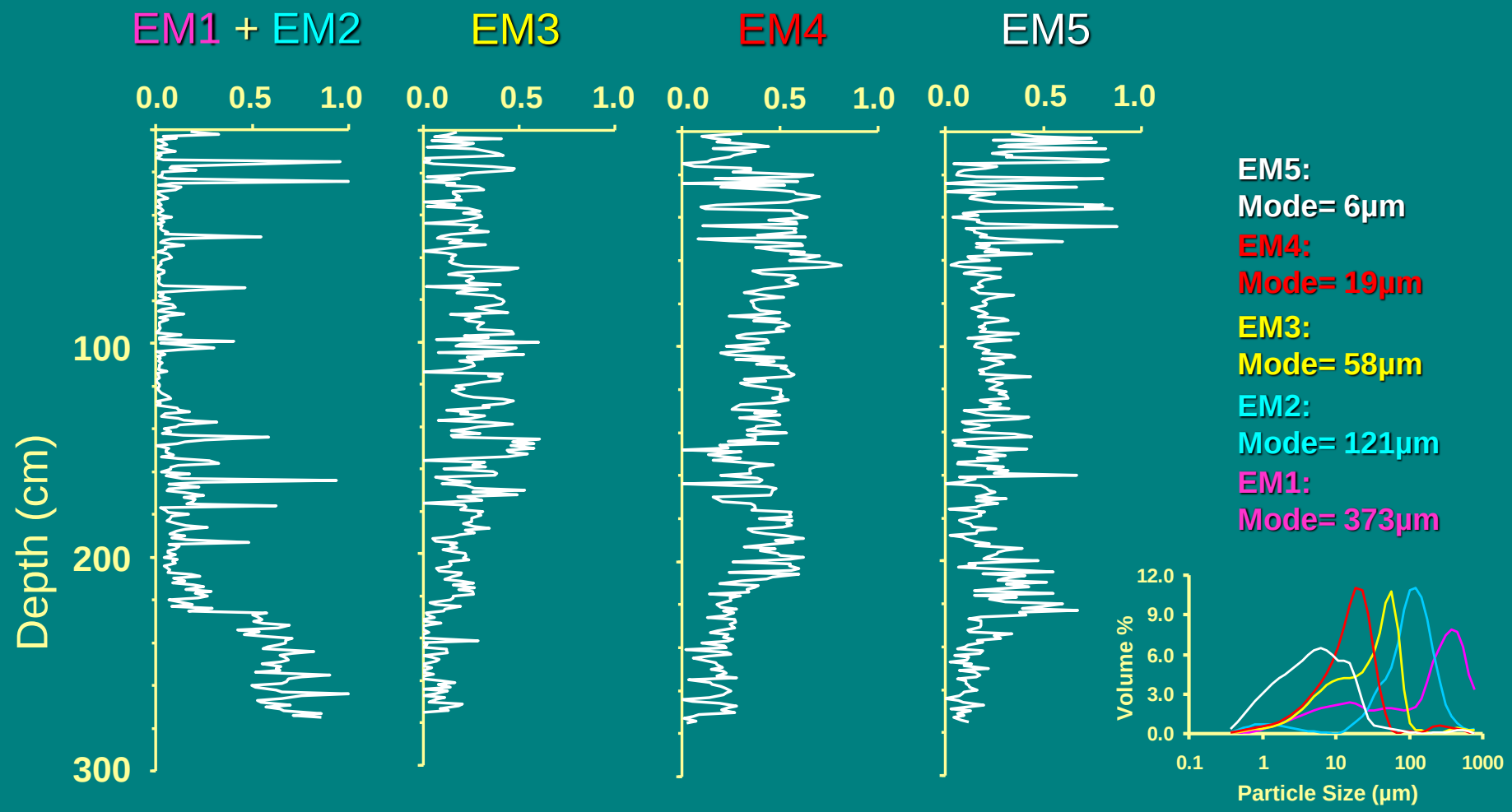




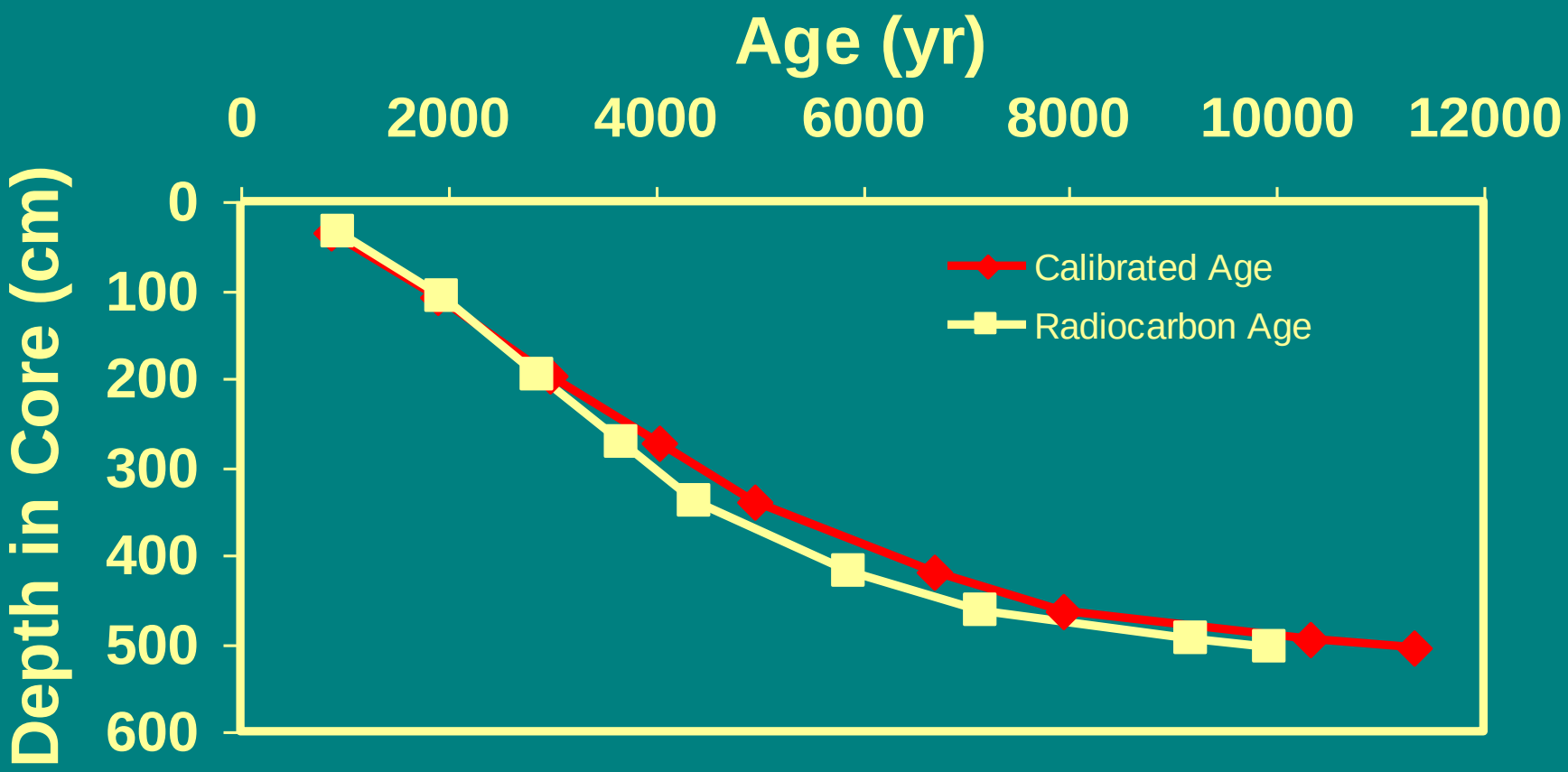
End Members


EM5:
Mode= 6µm
EM4:
Mode= 19µm
EM3:
Mode= 58µm
EM2:
Mode= 121µm
EM1:
Mode= 373µm
12.0
9.0
6.0
3.0
0.0
Volume %
0.1
1
10
100
1000
Particle Size (µm)

Proportion of the End Members



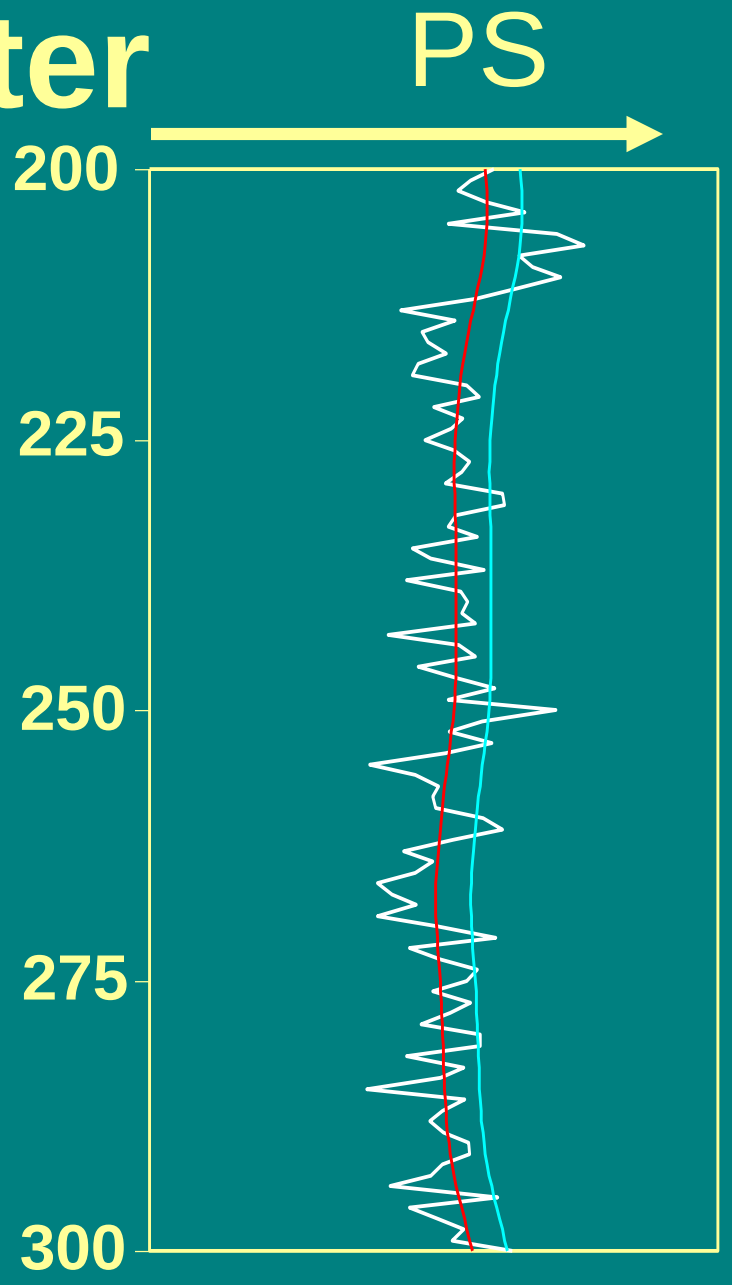
Stinson Lake Core 2 Age Model

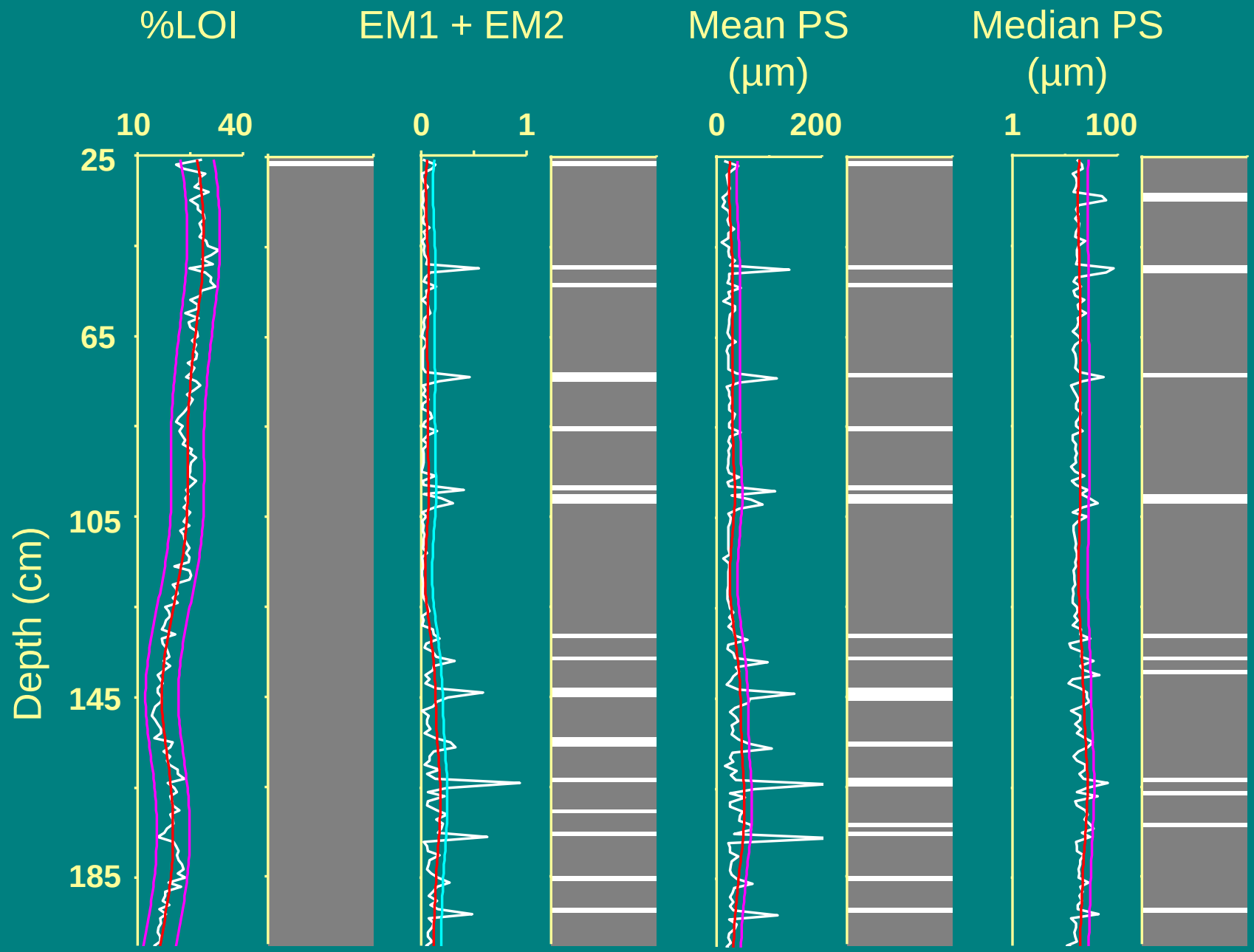


- 80 dates
- John Southon, Tom Guilderson
  Lawrence Livermore National Laboratory

Time Series Filter

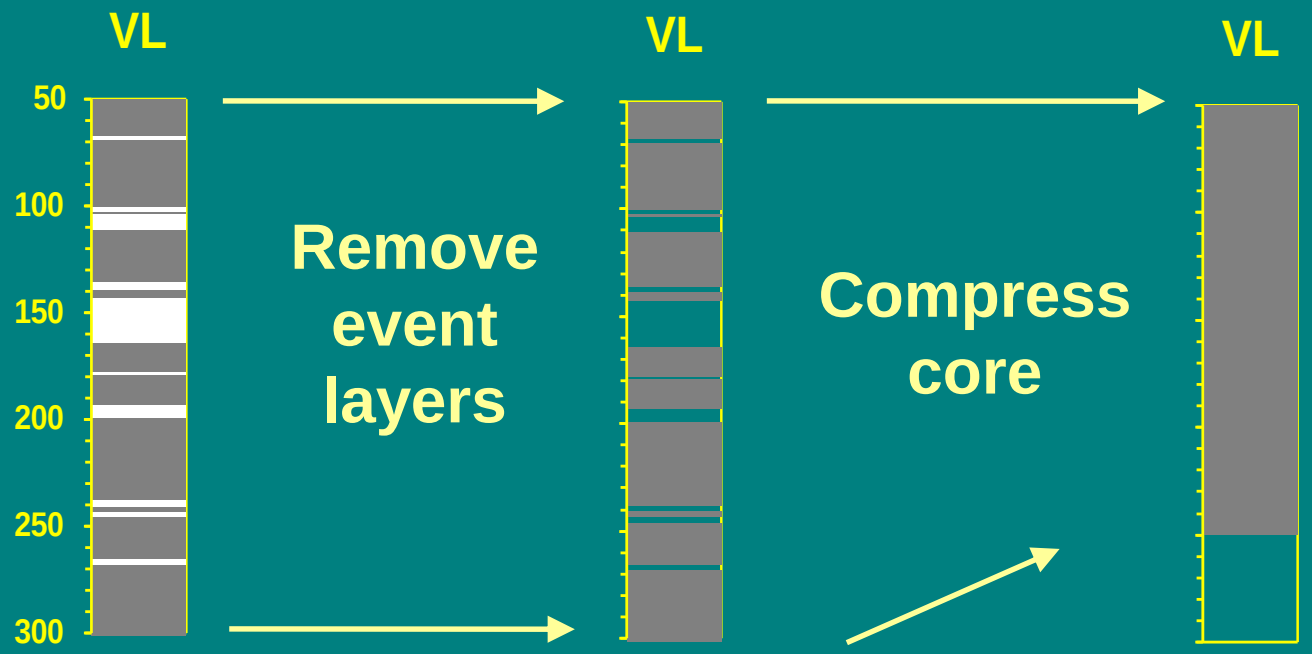
- SSA construction of raw data series
- Remove linear trend of data
- Peaks > 1σ from reconstruction = SIGNIFICANT EVENT LAYER

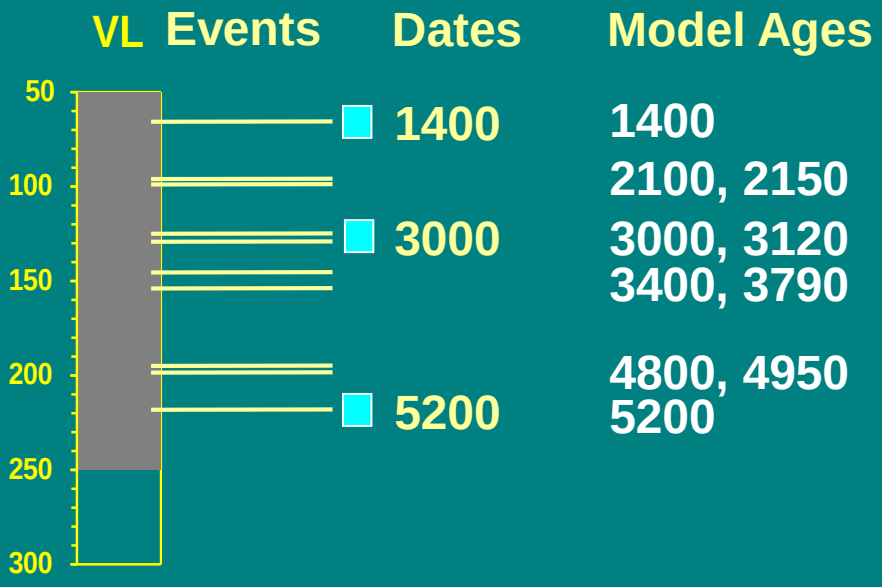



%LOI
EM1 + EM2
Mean PS (µm)
Median PS (µm)
10
40
0
1
0
200
1
100
25
65
105
145
185
Depth (cm)

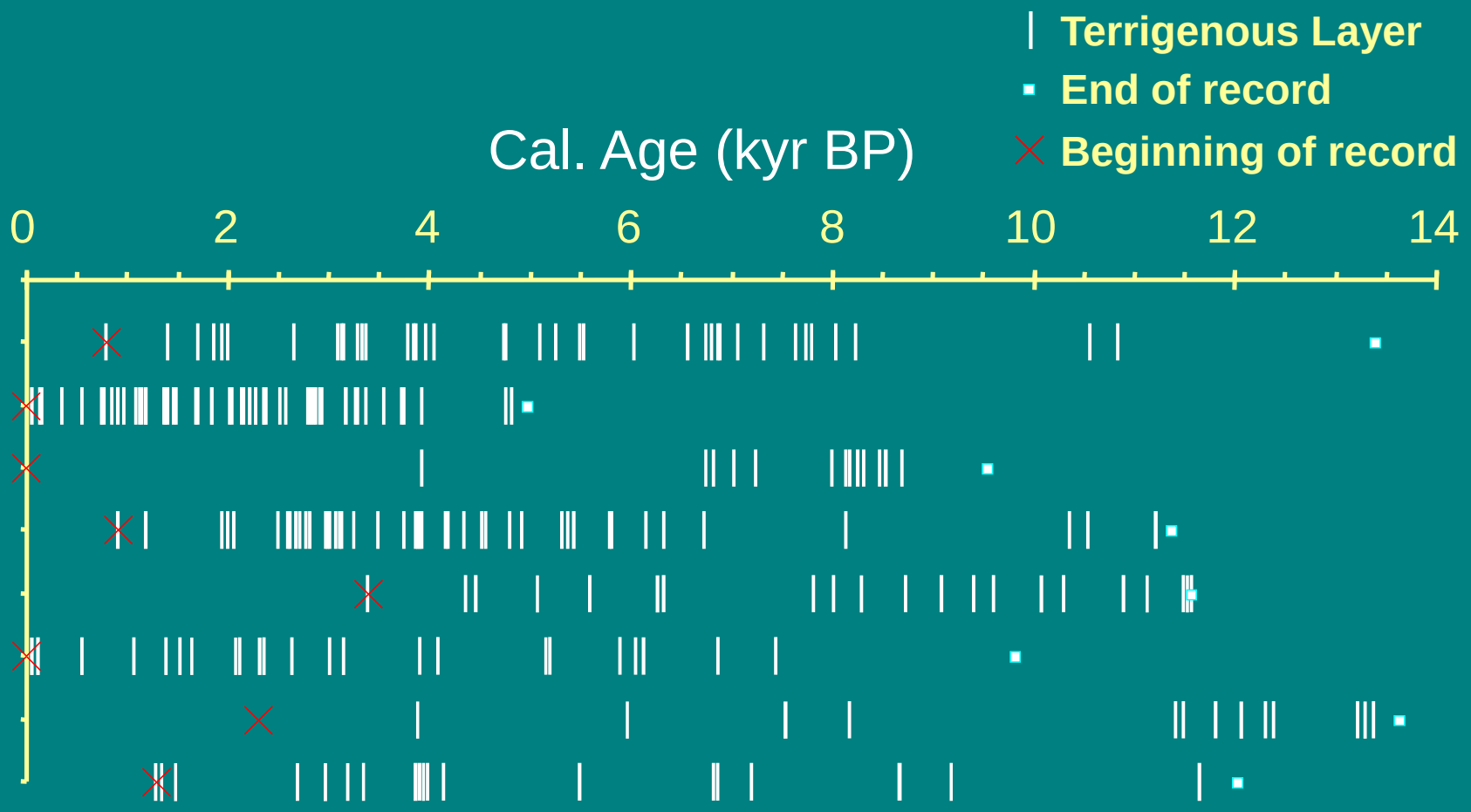
Event Detection Comparison

	Mean	Median	Min	Max
LOI 1σ	31	28	15	70
LOI 2 σ	8	4	2	32
Mean PS 1 σ	39	33	11	81
Mean PS 2 σ	20	18	7	45
Median PS 1 σ	37	32	12	88
Median PS 2 σ	18	15	6	52
Coarse EMs 1 σ	29	22	14	57
Coarse EMs 2 σ	15	12	7	31

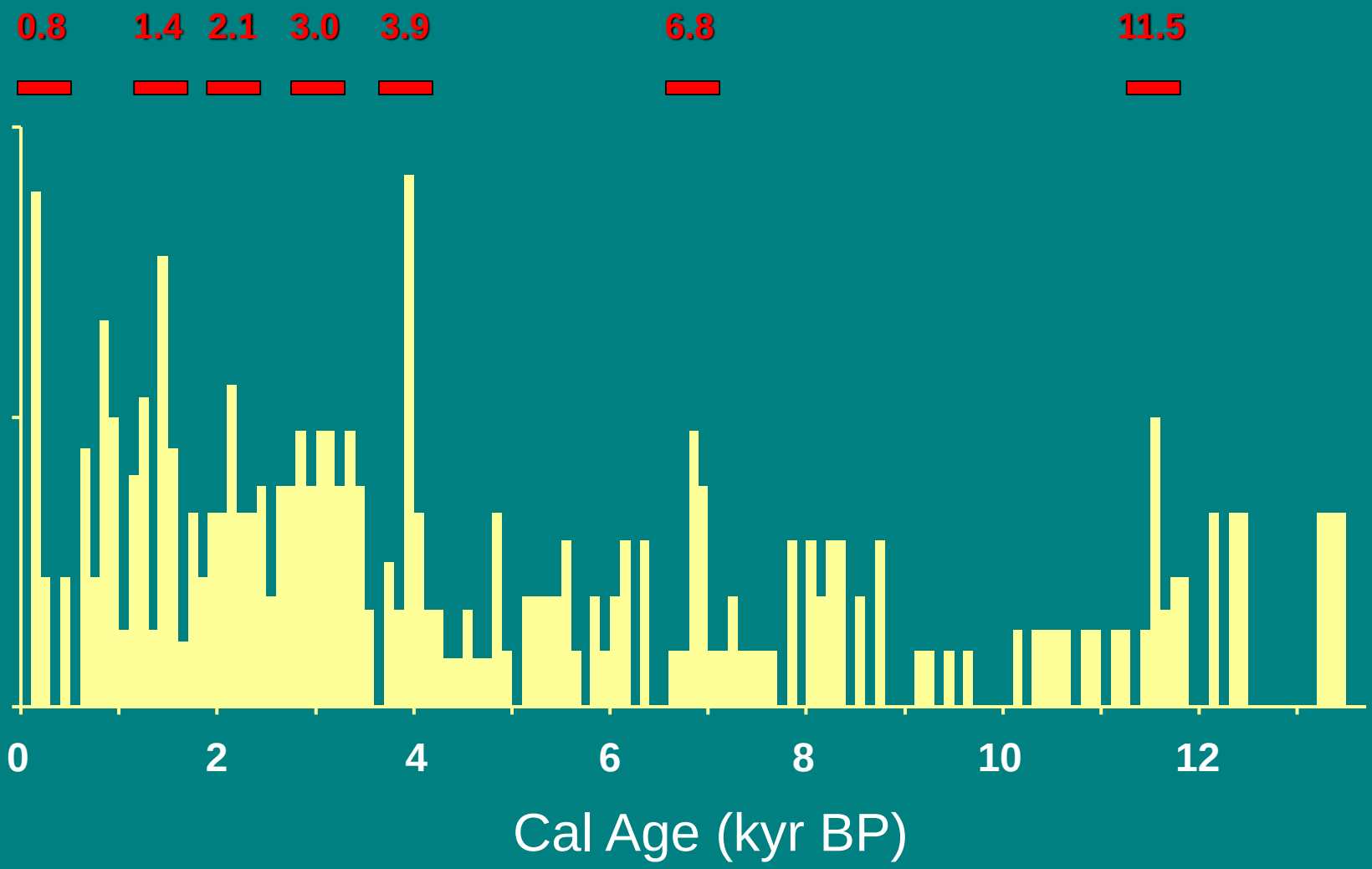

VL
VL
VL
50
100
150
200
250
300
Remove event layers
Compress core


VL
Events
Dates
Model Ages
50
100
150
200
250
300
1400
3000
5200
1400
2100, 2150
3000, 3120
3400, 3790
4800, 4950
5200

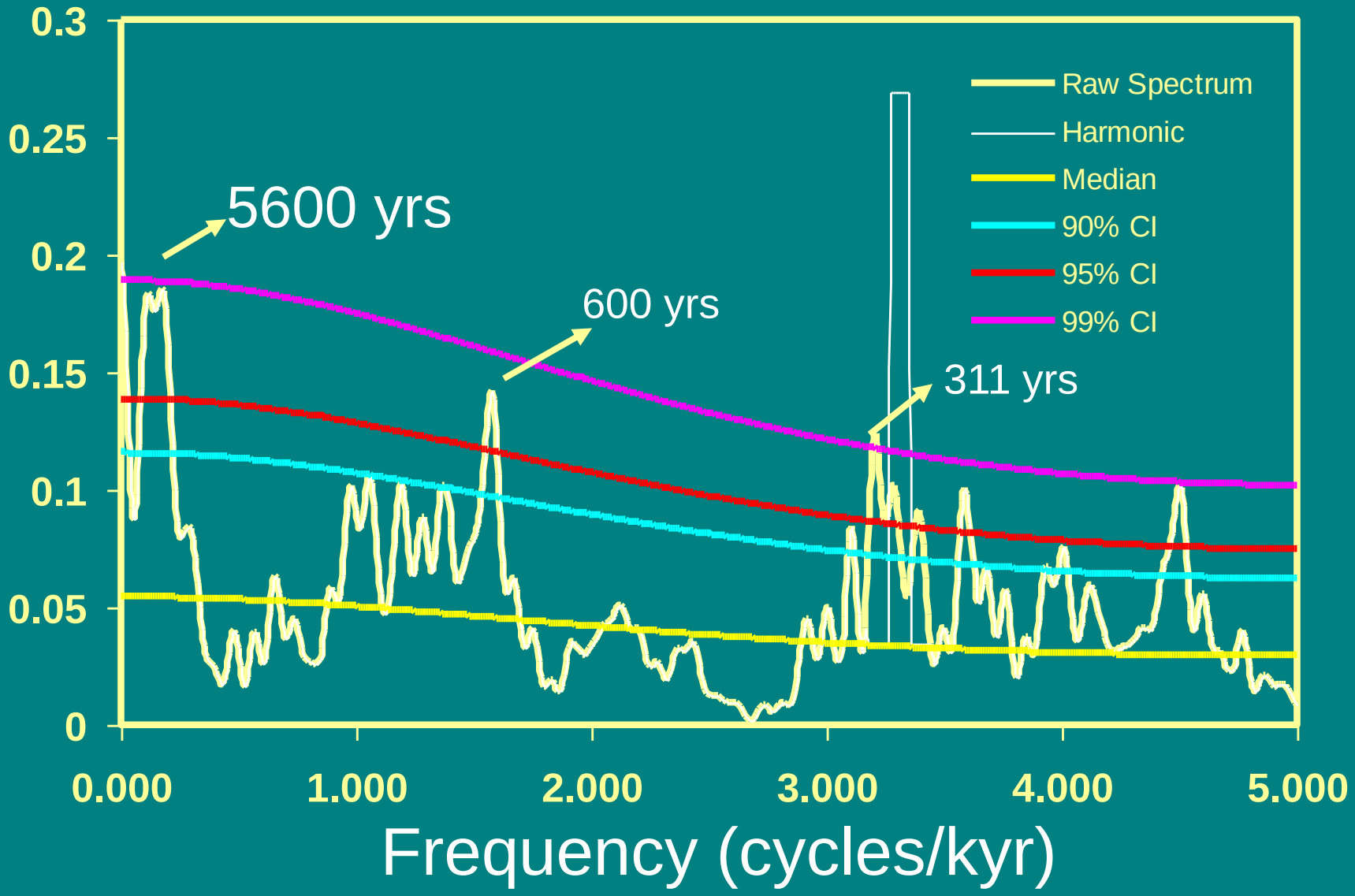
Storm Dates


Terrigenous Layer
End of record
Beginning of record
Cal. Age (kyr BP)
0
2
4
6
8
10
12
14

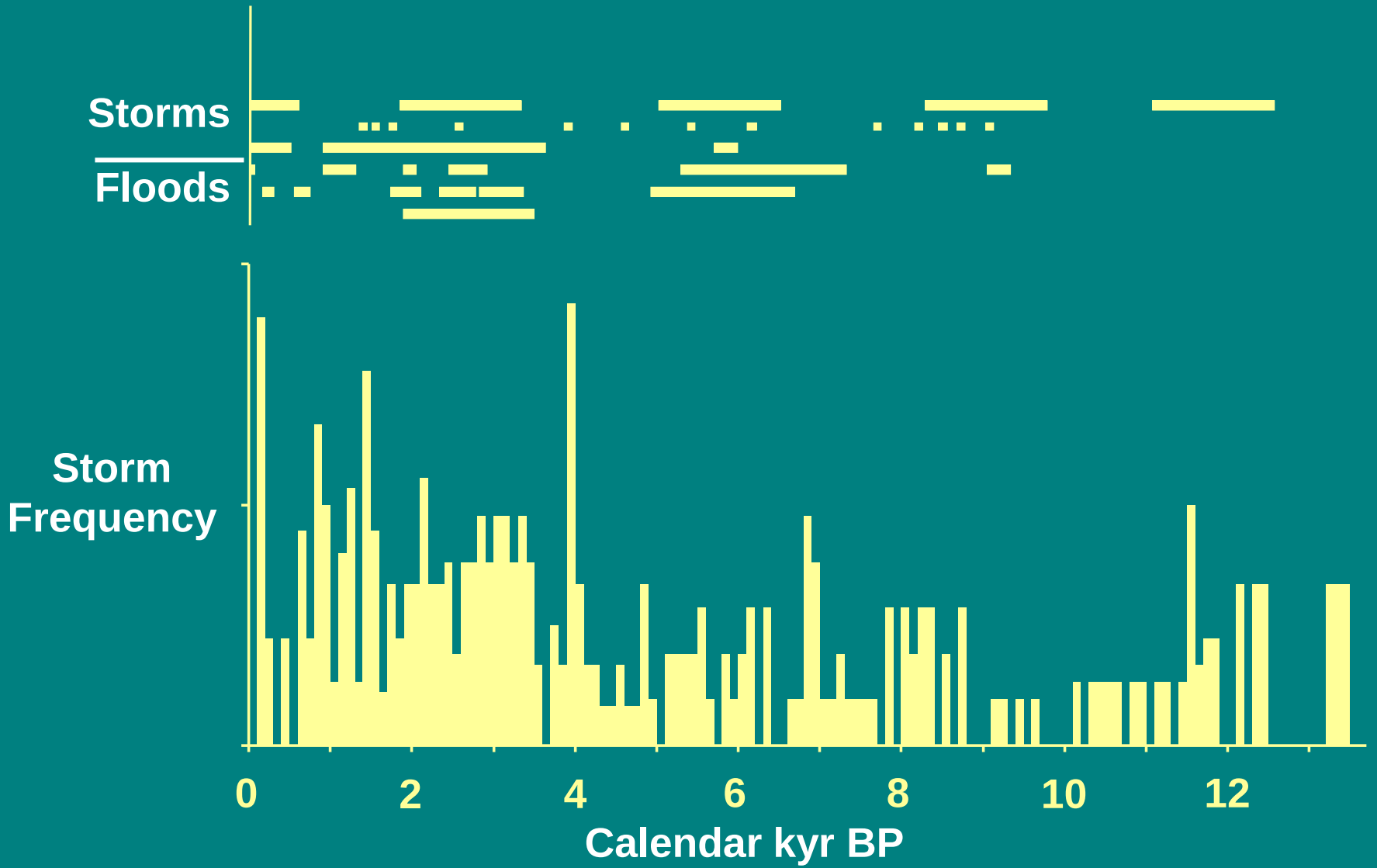
Storm Frequency



Storm Frequency- EMM



Climate in Northeastern USA



Hurricane Connection

- Increased storminess in New England = Increased hurricane frequency in Atlantic and Gulf Coast
- Increased storminess in New England = Increased flooding in Upper Mississippi Valley
- Modern record of hurricane-related precipitation and flooding

Discussion

- Differing landscape response to precipitation
- Storm size
  - More frequent events
  - Smaller cycles
  - Radiocarbon uncertainties

Discussion

- Geographic location of study area
- Proposed mechanisms for hurricane-related storms in New England

Conclusions

- **Grain size is an effective physical parameter which detects more frequent events**
- **End Member Modeling is a valuable tool for revealing processes reflected in grain size distributions**
- **Different patterns of storminess in NH & ME than VT & NY**
- **Patterns of storminess in NH & ME connected to hurricane related storms**

Acknowledgements

Without the financial support from NSF and the friendship, support, and collaboration of these people, this project would not be possible.

Paul Bierman
Peter Ryan
Charlotte Mehrtens
Angie Conlan
Sarah Brown
Kristen Benchley
Joseph Haun
Sarah Stopper
Anders Noren
Andrea Lini
Andi Lord
Maarten Prins
Wayne Parris
Kathy Parris
Krista Parris
Laura Mallard
Andy Bosley
Stephen Wright
Karen Jennings
John Southon
Tom Guilderson
Eric Steig
Craig Kochel