And now . . .

G-4 DOING SCIENCE with TREE-RINGS:

The Amazing Bristlecone Pine Trees!

For G-4 turn to

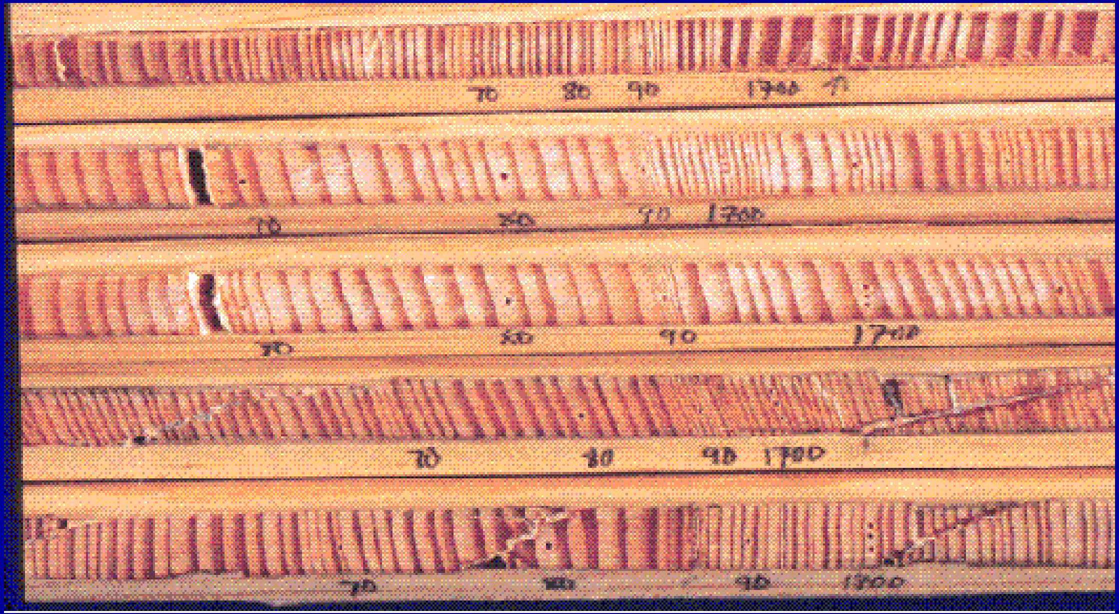
pp 125 – 128

in the CLASS NOTES APPENDIX

OK, so we extract the tree-ring cores with an increment borer . . . .

THEN WHAT?

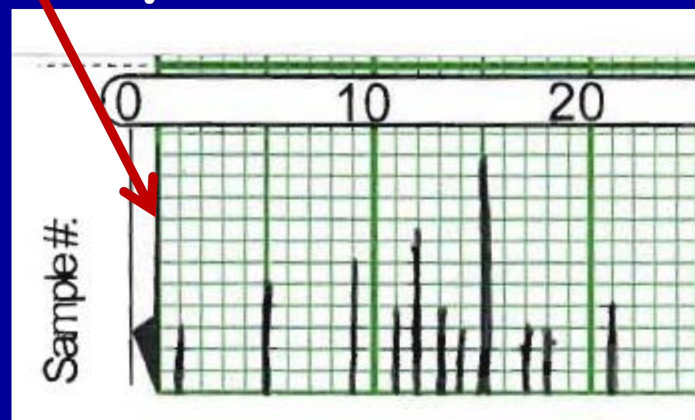
We compare one core to another and **MATCH THE PATTERNS** by lining up the rings of the really stressful years.



To do this we use a special kind of graph . . .

INTRODUCING: THE SKELETON PLOT!

= a graph-paper plot of the tree's **most stressful years** plotted for a sampled core:



= The LONGEST LINES represent the most NARROW RINGS in the core!

(only the narrow rings are plotted!)

Any fledgling Dendrochronologists in the class?

IF YOU WANT TO LEARN HOW to SKELETON PLOT . . .
see pp 123 -124 in CLASS NOTES

(this is NOT a course assignment – it's just included for fun!)

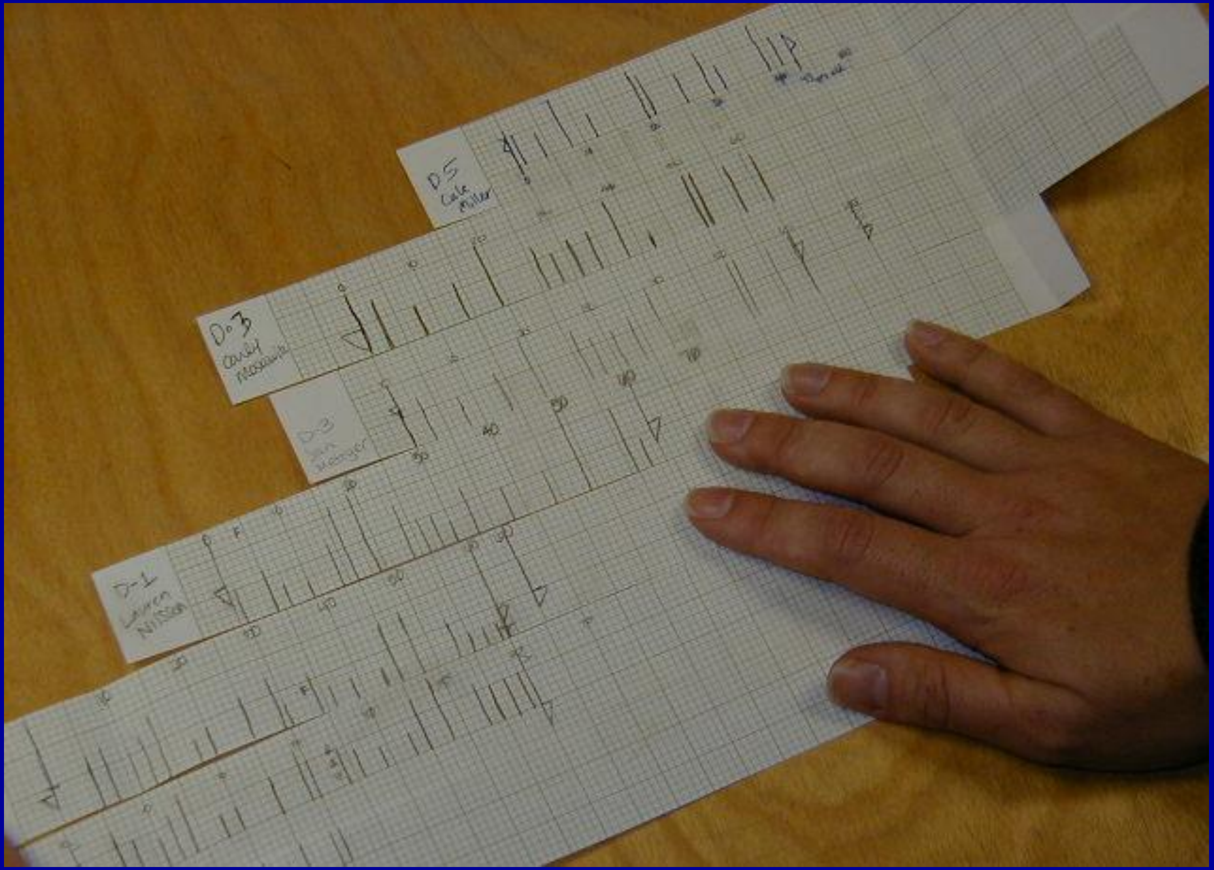
Pattern Matching:

Narrow rings on skeleton plots can be **MATCHED** from one core to another:

Skeleton Plot of Tree-Core A-3

Skeleton Plot of Plot of Tree-Core A-1

Multiple skeleton plots can then be combined to make a COMPOSITE PLOT of all cores from a site:

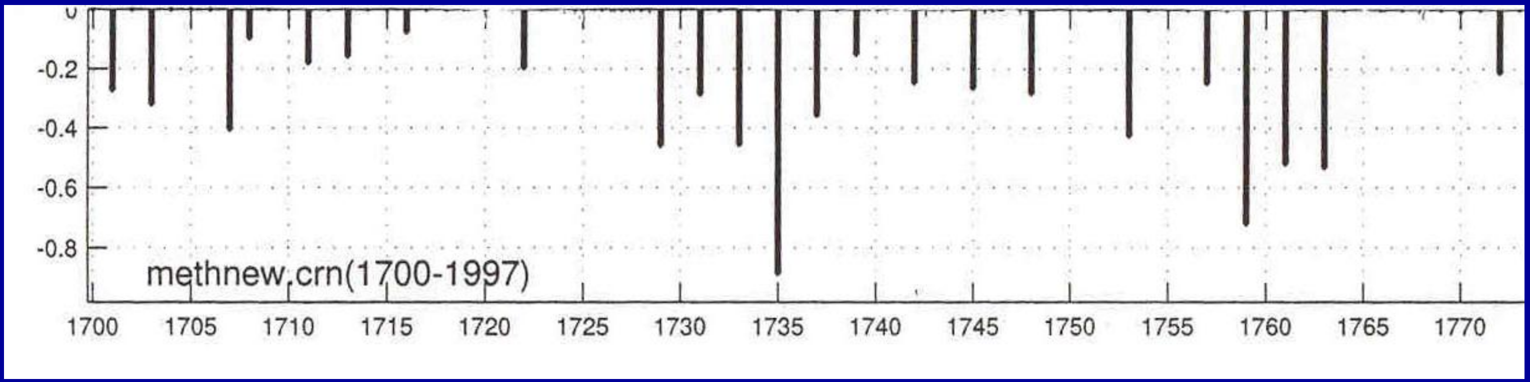


By doing this we can make a MASTER SKELETON PLOT for a site or region and add calendar dates →

Site composites that have DATES assigned are referred to as "MASTERS"

Skeleton Plot "Master" for a site

(dates are marked & narrowest rings are indicated by long lines)

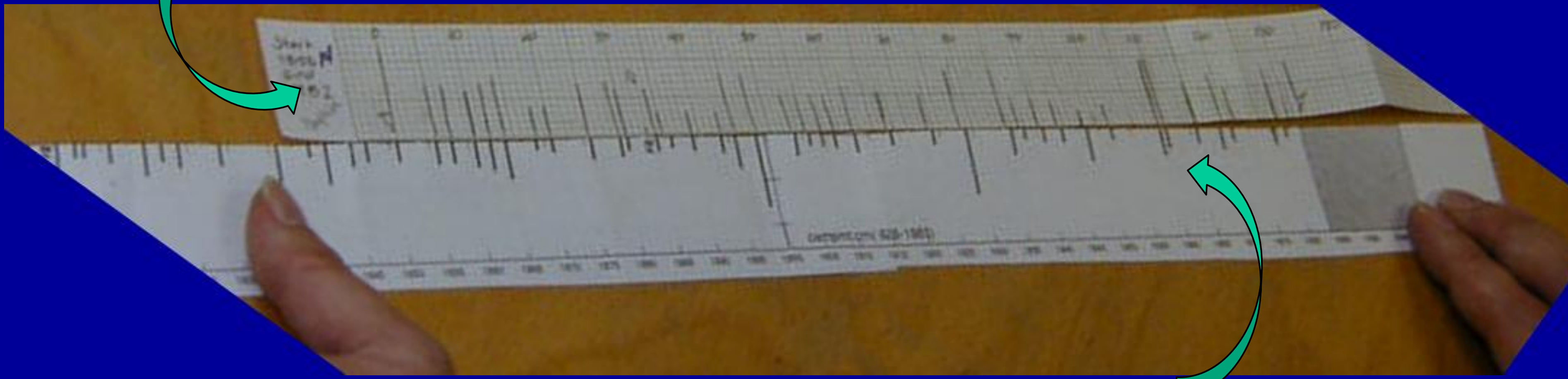


On a MASTER we know the ACTUAL CALENDAR DATES for all the years with really narrow rings

➔ In today's assignment you will work with Skeleton Plot Masters

A site or region's
<u>Master Skeleton Plot</u>
is used to assign dates to newly collected and undated tree-ring samples

Skeleton Plot of undated core



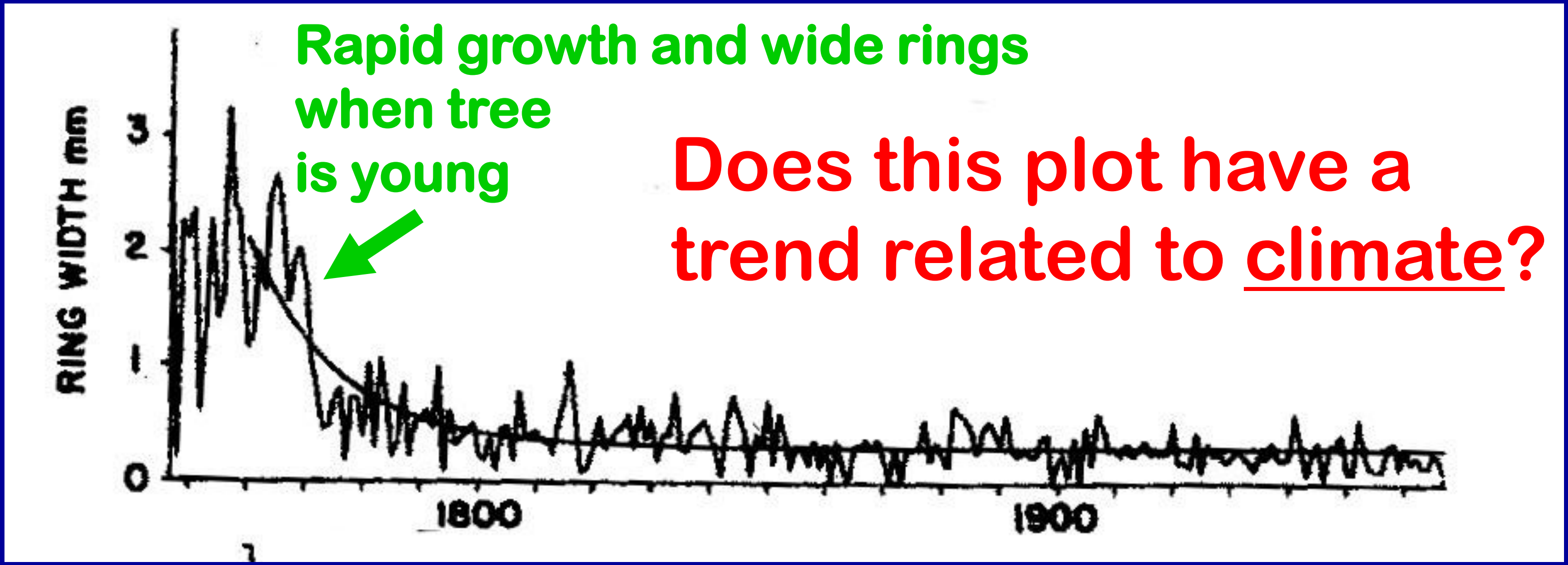
Master Chronology Skeleton Plot

➔ Today you will also work with <u>another</u> kind of graph:

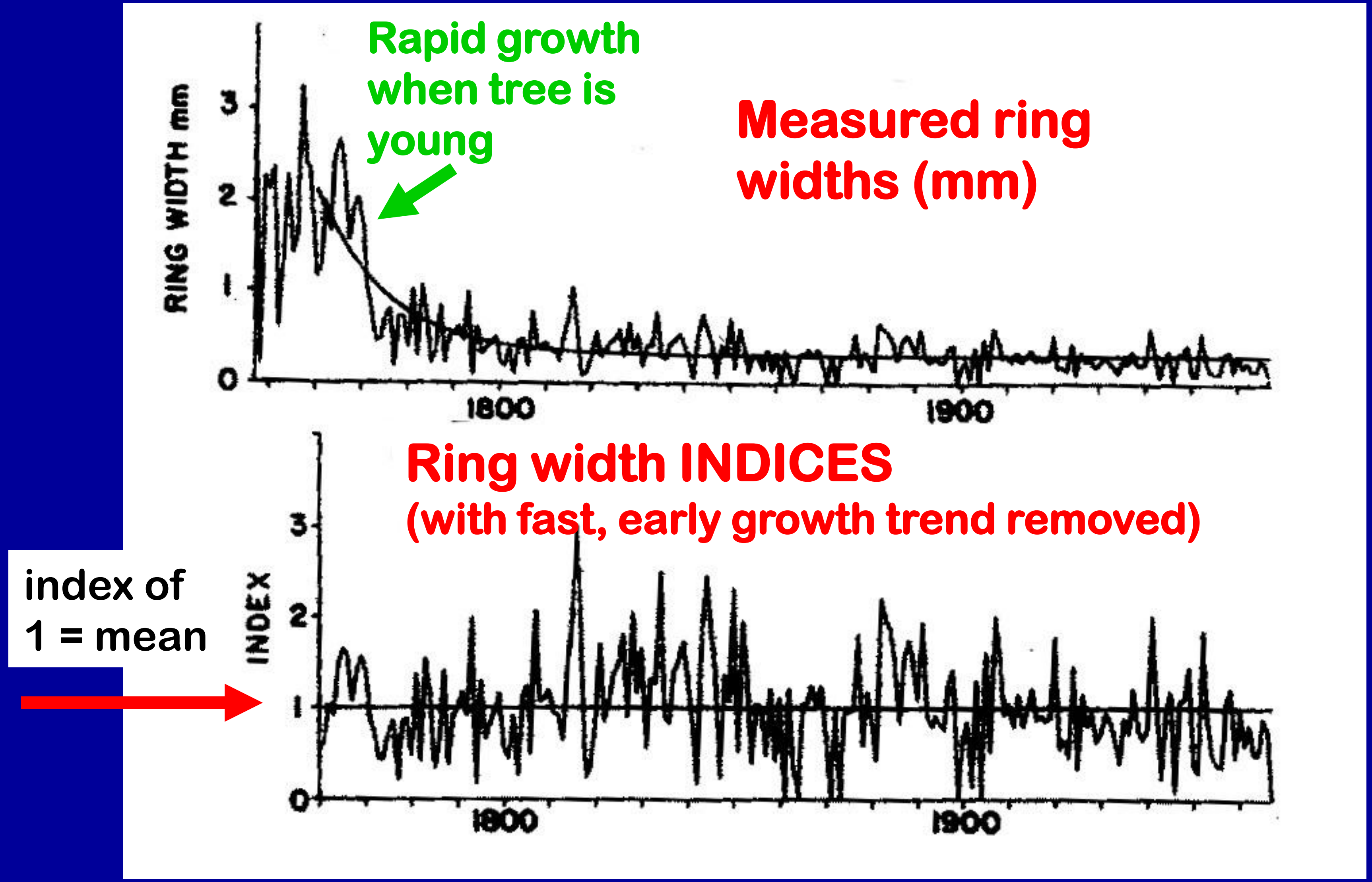
a TREE-RING WIDTH PLOT . . .

TREE-RING WIDTH PLOT

= a time series plot of the ring widths in a tree for each year



Time Series Plot of Measured Ring Widths for each year's growth



RING WIDTH CHRONOLOGY in "INDEX" format

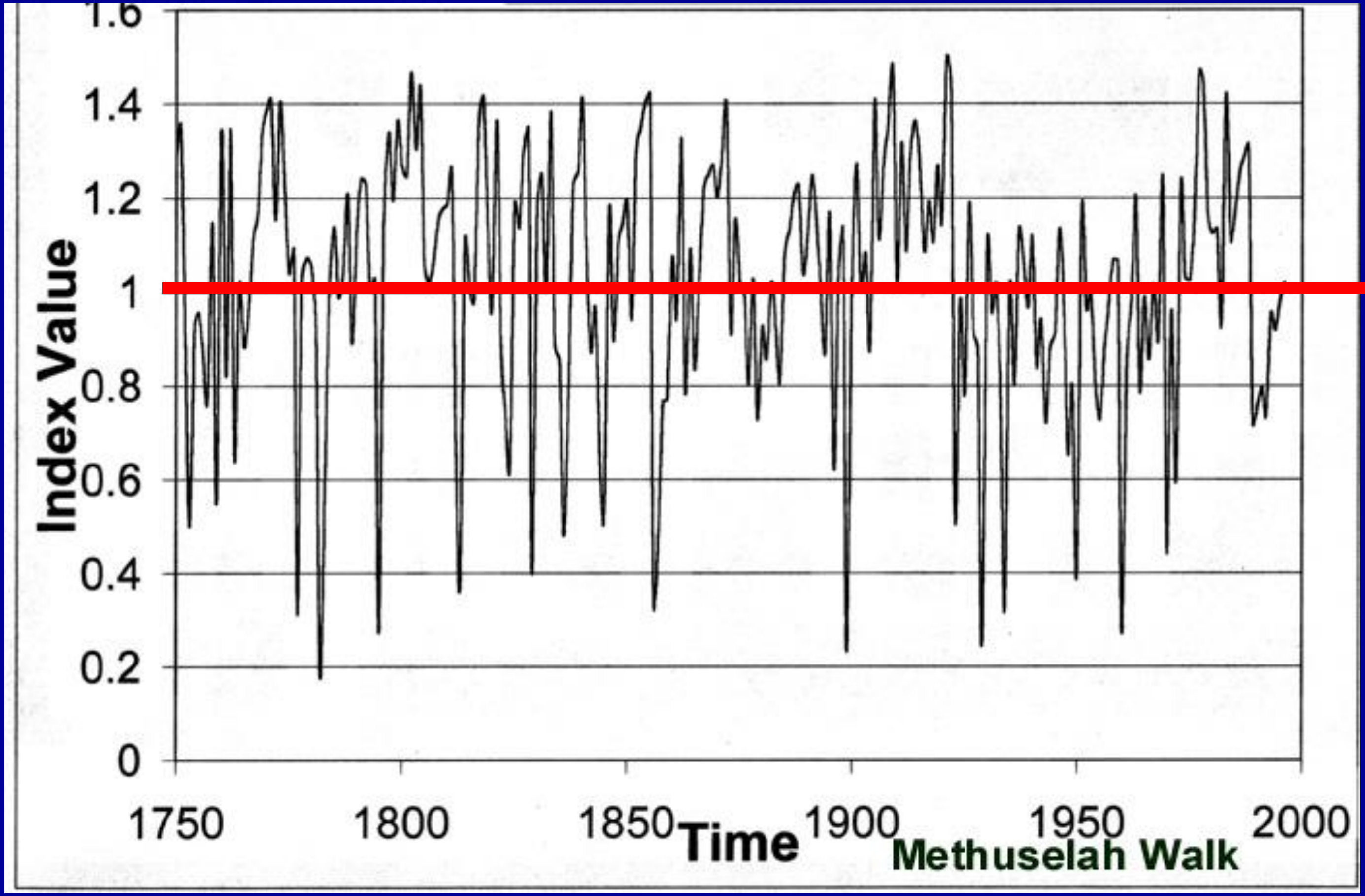
index of 1.0 = chronology's mean width

Ring-Width Indices

for each site

A Ring Width Index = a departure of growth for any one year compared to average growth.

Index of 1.0 = average or normal growth.



WIDE RINGS > 1.0

NARROW RINGS < 1.0

Prometheus

Wheeler Peak, Snake Mts. NV

Donald Currey
Summer 1963

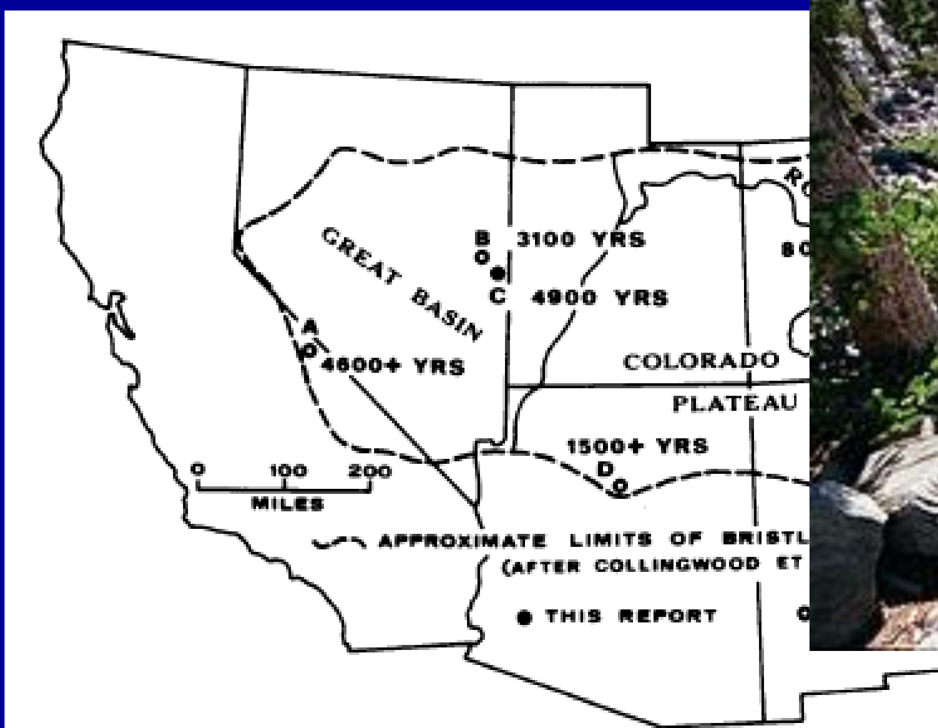
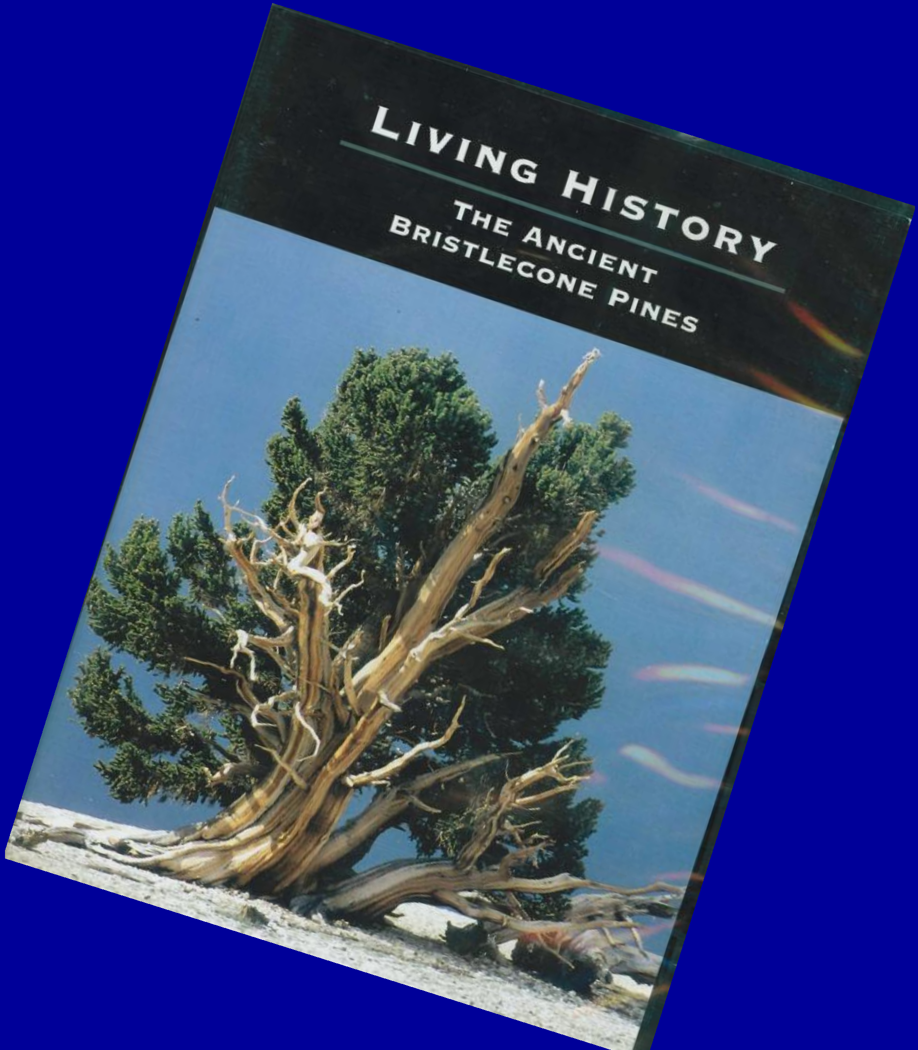
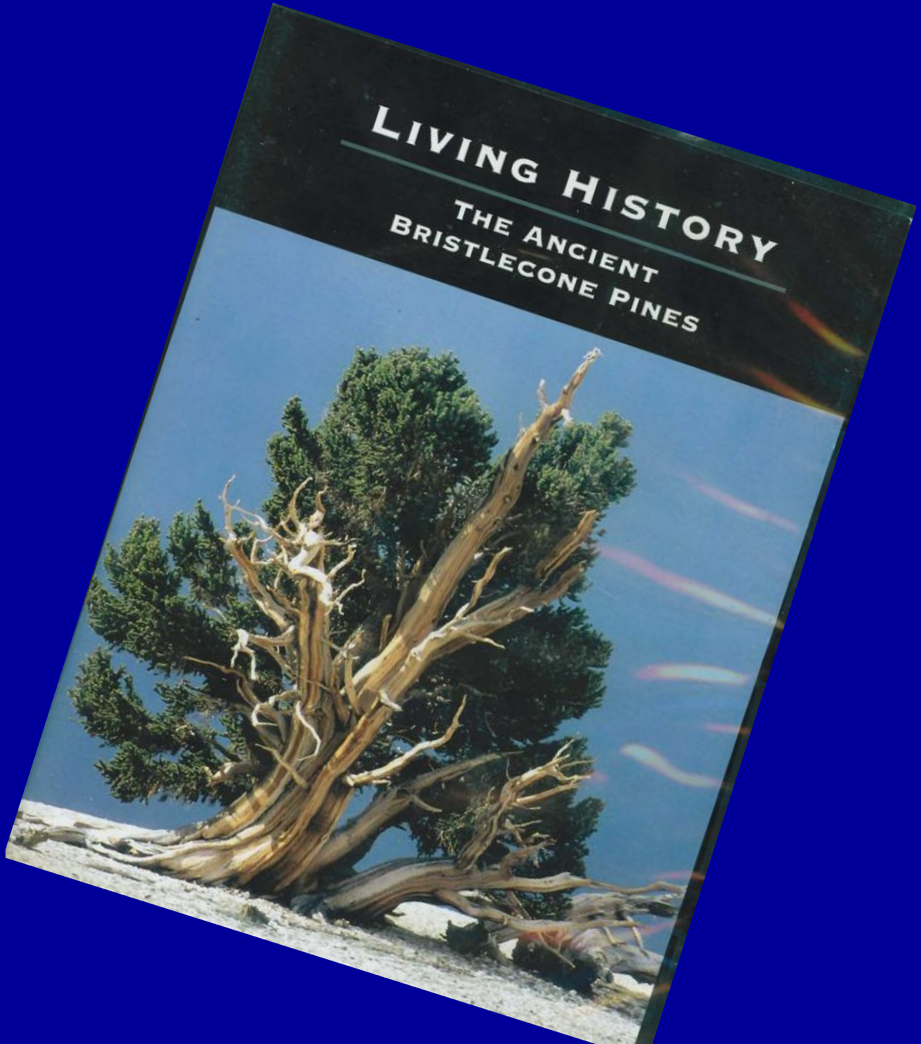


FIG. 2. Northeast face of Wheeler Peak. Forested area is upper half of the bristlecone pine stand. WPN-114 site is circled. U. S. Forest Service photo.

VIDEO BREAK:



G-4 Bristlecone Pine Assignment:
Doing Science with Tree Rings



Doing Science with Tree Rings . . .

1. FORMULATE A QUESTION

- Review Background Information (previous studies)

- Initial Field Observations & Questions

Doing Science with Tree Rings . . .

2. DEVELOP HYPOTHESES

- Must be answerable ("testable") with . . .

available data
or
data that can be collected

Doing Science with Tree Rings . . .

3. COLLECT DATA

Design the study

- Develop formal, systematic data collection plan
- Collect data
- Process it
- Compile it; Organize it
- Analyze it

Doing Science with Tree Rings . . .

4. TEST HYPOTHESES

- Be open-minded
  but skeptical

- Test one or "multiple working" hypotheses

- Decide if evidence supports the hypothesis

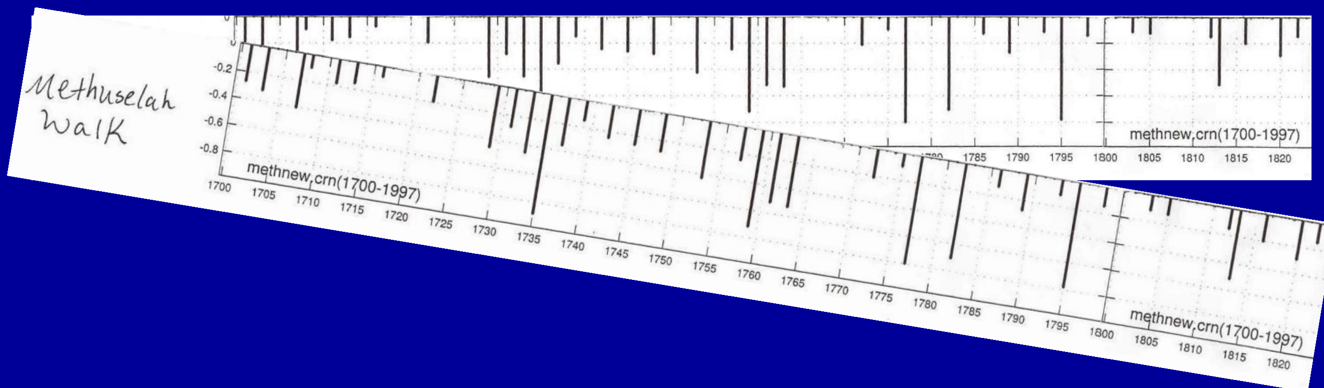
5. DRAW CONCLUSIONS

So here we go . . . .

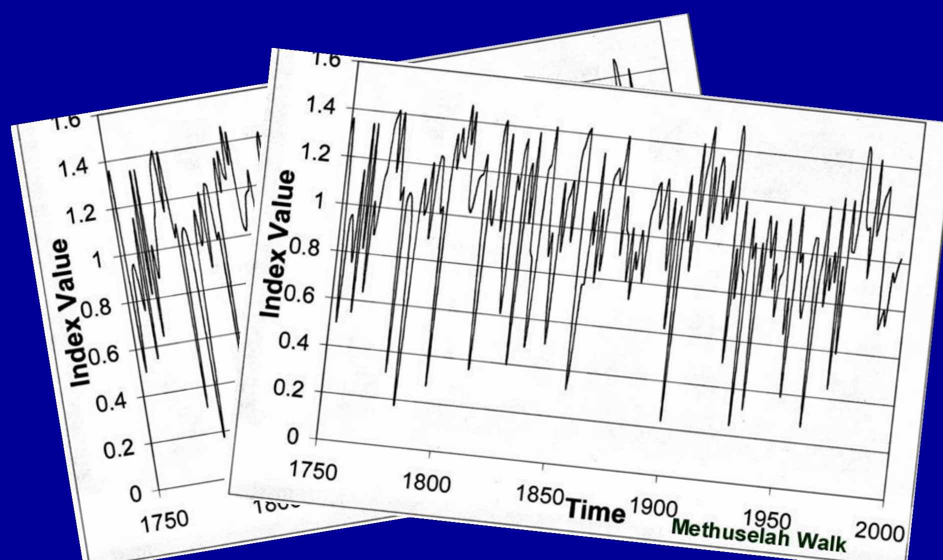
First, we'll visit the data collection sites.

THE AVAILBLE DATA:

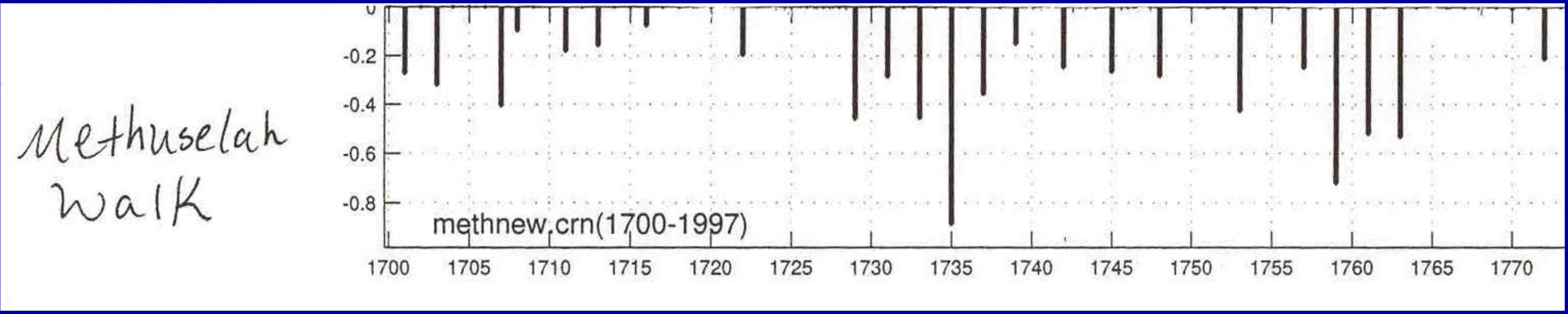
1) SKELETON PLOTS MASTER of each site



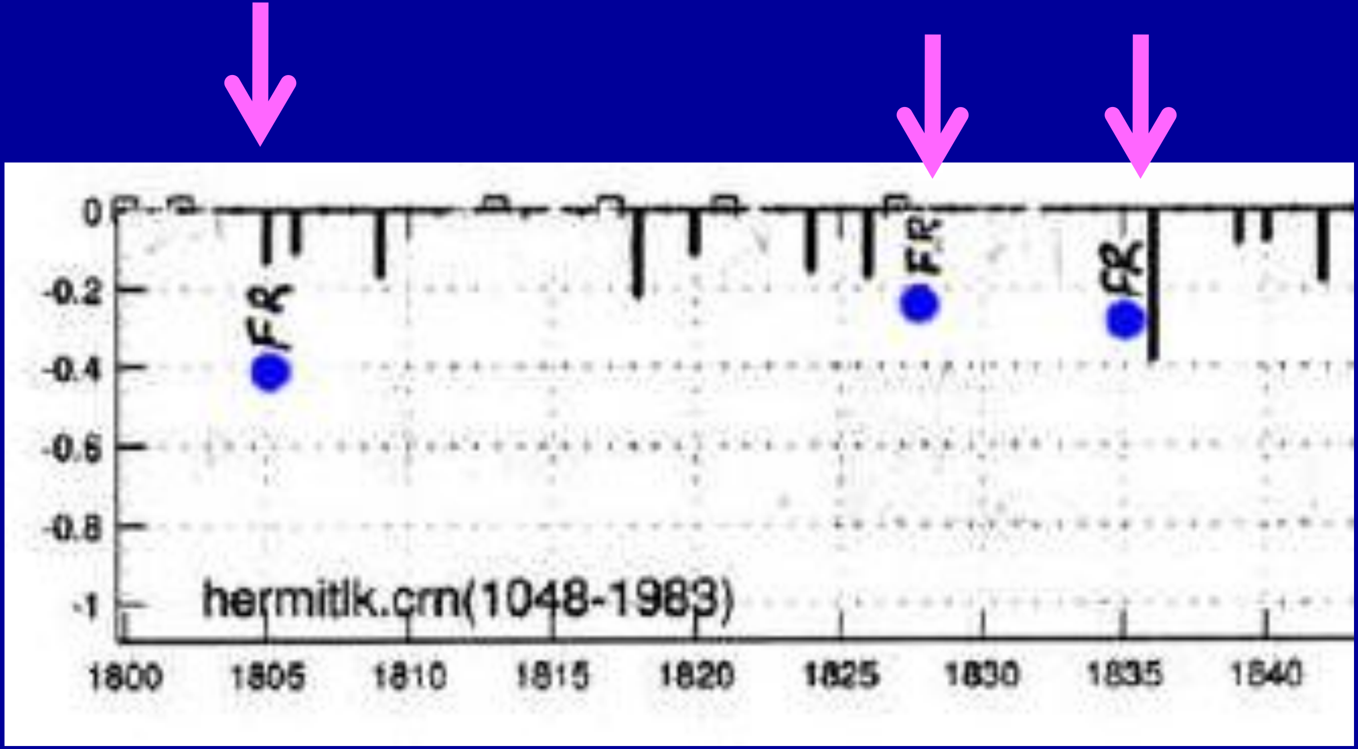
2) Ring Width “INDEX” PLOTS of each site



Site Skeleton Plot Masters (with dates marked & narrowest rings shown by long lines)



also on the Skeleton Plot Masters you will find "FROST RING YEARS" marked!



FR = frost ring year

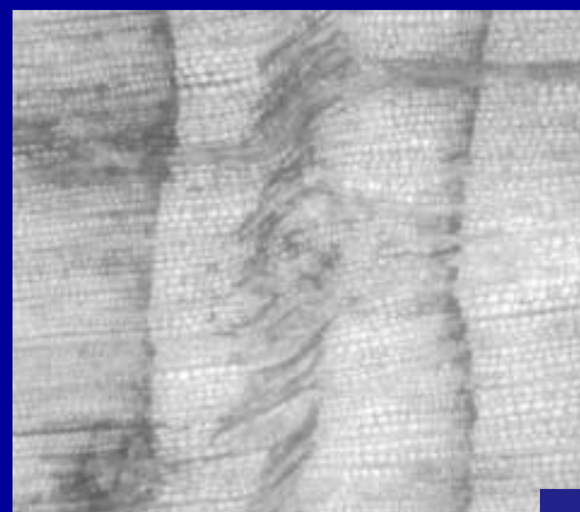
WHAT DO YOU NEED TO KNOW TO COMPLETE THE ASSIGNMENT?

To answer Q's about possible causes for variations in the BCP ring widths . . .
Need to know the following:

- Possible causes for FROST RINGS in BCP
- What the graph of global Northern Hemisphere temperature variations looks like
- What else besides climate might enhance or suppress growth in the trees

WHAT CAUSES FROST RINGS?

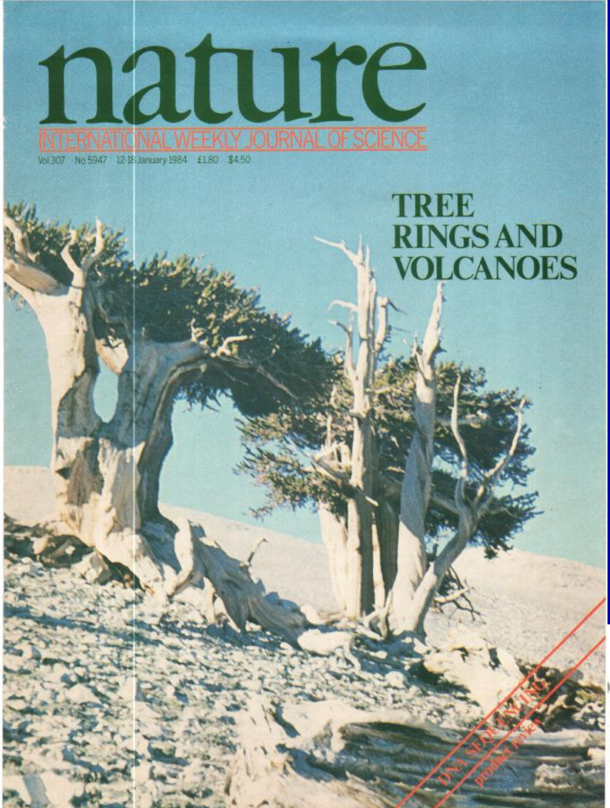
Permanent wood damage in cells, due to freezing & expansion of intercelluar water, can be useful for pattern matching & crossdating!

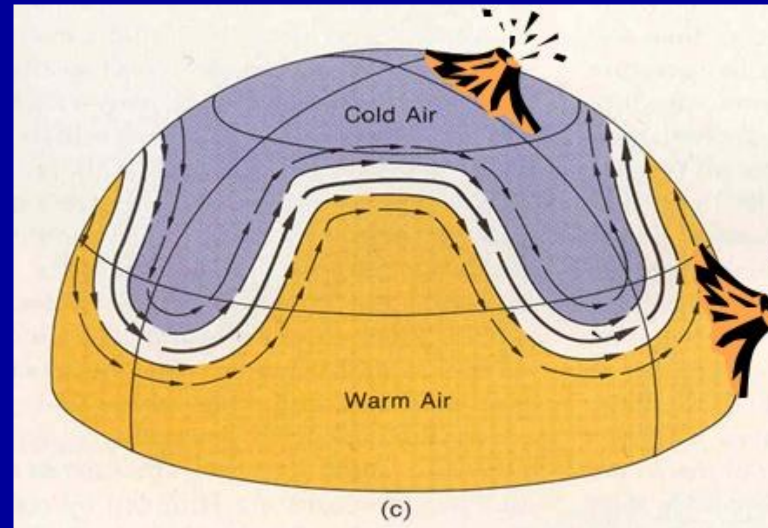


Produced by a severe freeze occurring DURING the tree's growing season :

2 nights < - 5° C
intervening day 0° C

Have been linked to global cooling after major volcanic eruptions !!





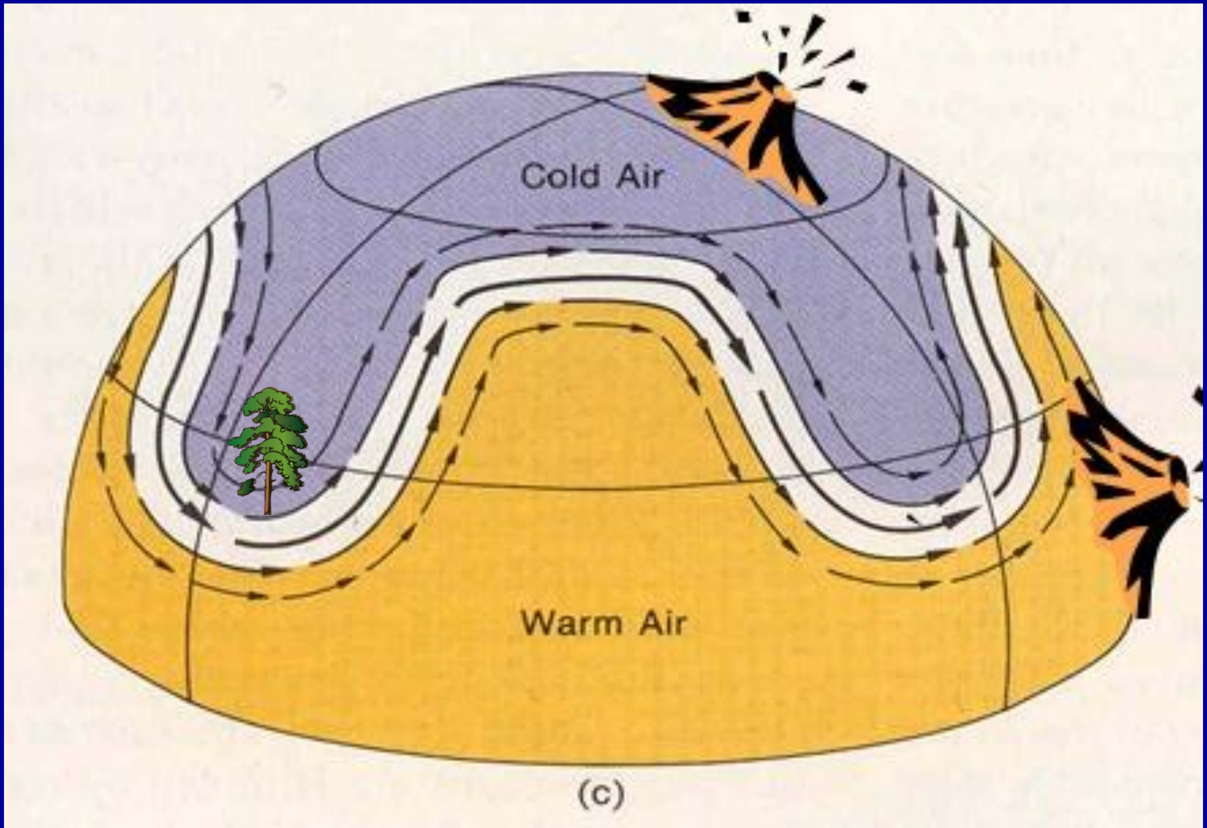
…rinted from Nature, Vol. 307, No. 5946, pp. 121-126, 12 January, 1984

Frost rings in trees as records of major volcanic eruptions

Valmore C. LaMarche Jr[*] & Katherine K. Hirschboeck[†]

[*] Laboratory of Tree-Ring Research and [†] Department of Geosciences, University of Arizona, Tucson, Arizona 85721, USA

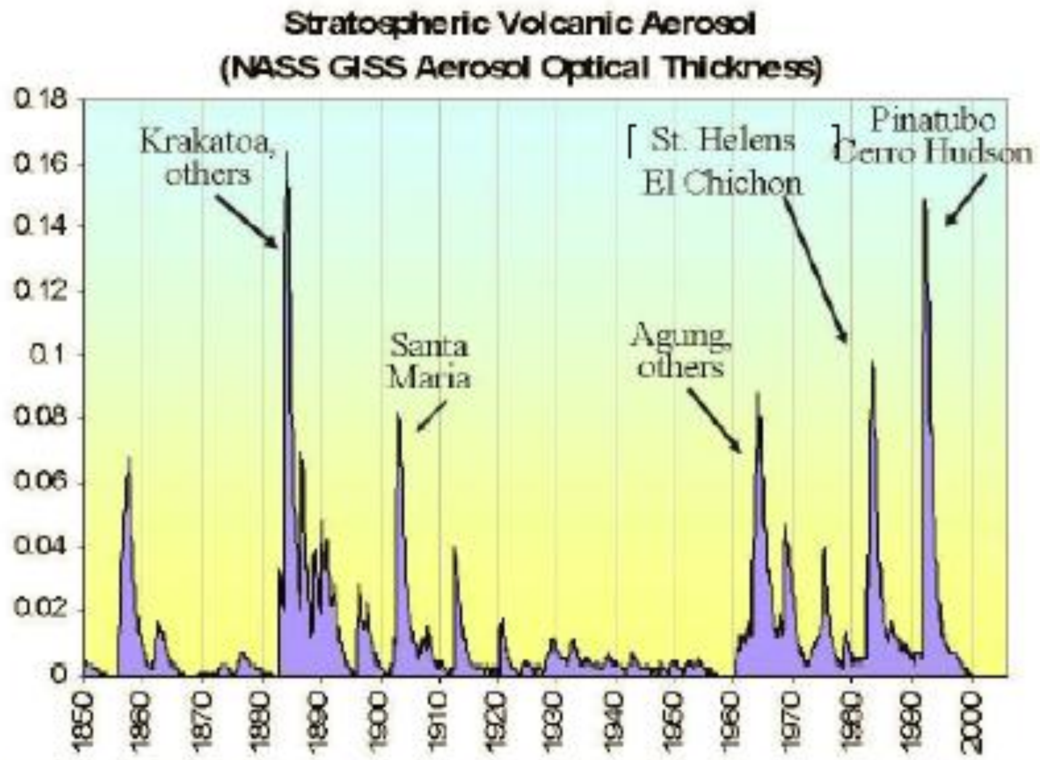
New data about climatically-effective volcanic eruptions during the past several thousand years may be contained in frost-damage zones in the annual rings of trees. There is good agreement in the timing of frost events and recent eruptions, and the damage can be plausibly linked to climatic effects of stratospheric aerosol veils on hemispheric and global scales. The cataclysmic proto-historic eruption of Santorini (Thera), in the Aegean, is tentatively dated to 1628–26 BC *from frost-ring evidence.*



Atmospheric Circulation Patterns determine warm and cold weather patterns around the globe – including cold polar outbreaks!

Volcanic aerosols in stratosphere from sulfur dioxide gases in eruption can REFLECT back incoming solar radiation → global cooling

Graph is on p 79 in Class Notes



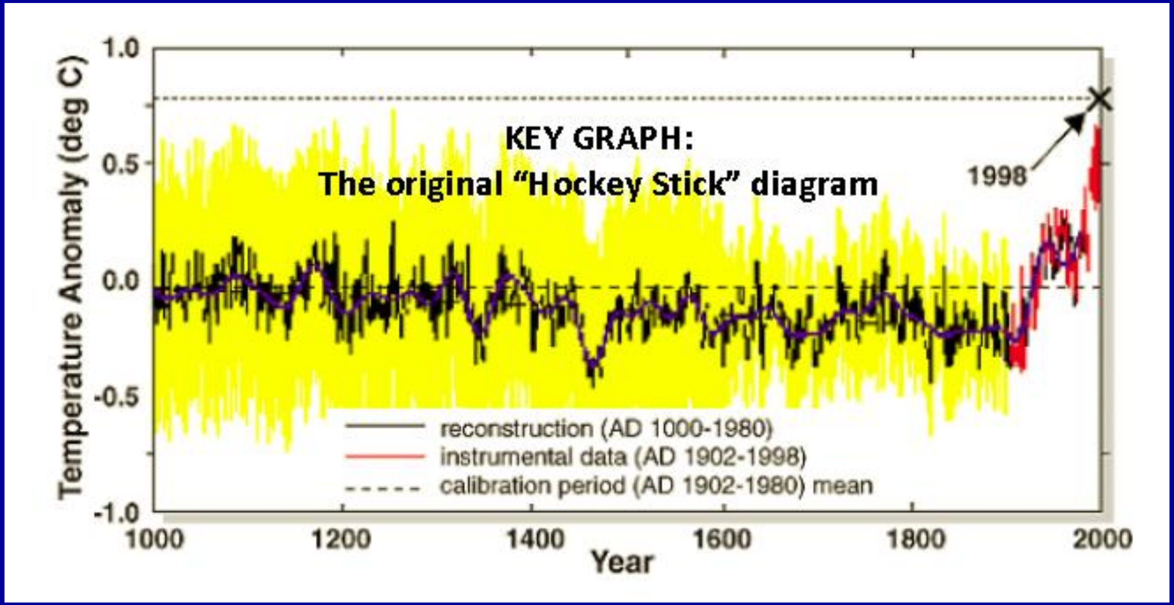
Volcanic aerosols in the high atmosphere block solar radiation and increase cloud cover leading to widespread cooling, especially significant in summer

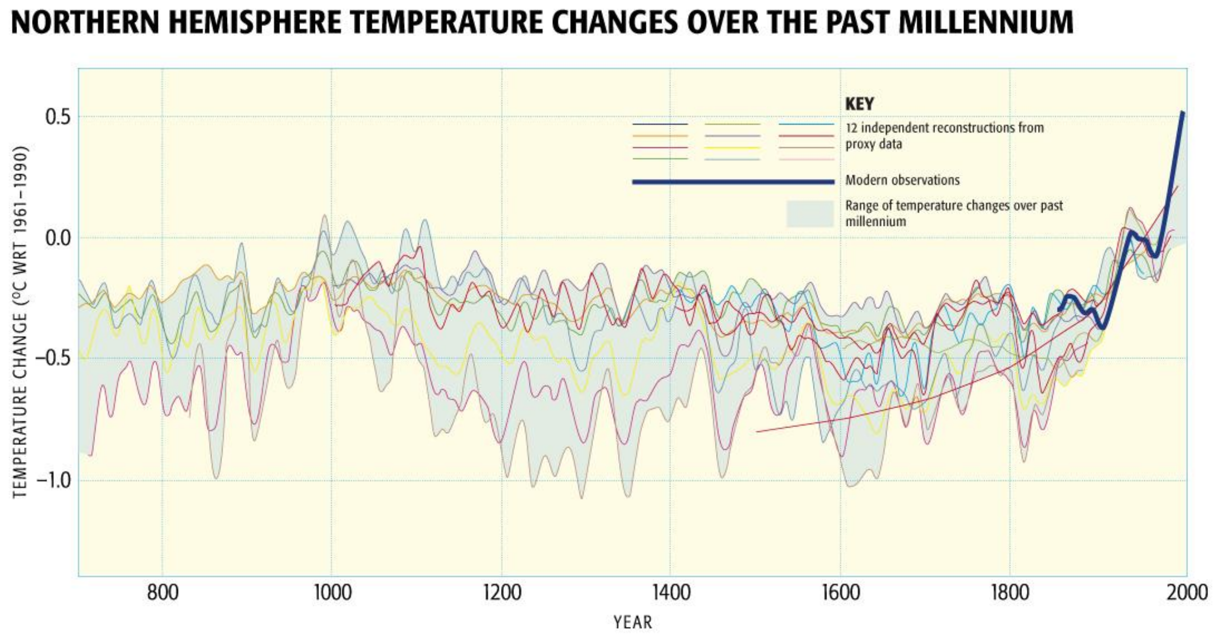
SOME MAJOR VOLCANIC ERUPTIONS OF THE PAST 250 YEARS:

Laki (Iceland)	1783
El Chichon? (Mexico)	1809
Tambora (Indonesia)	1815
Cosiguina (Nicaragua)	1835
Krakatau (Indonesia)	1883
Agung (Indonesia)	1963
El Chichon (Mexico)	1982
Mt Pinatubo (Philippines)	1991

Global cooling can occur for up to 3 years after the eruption!

PAST NORTHERN HEMISPHERE TEMPERATURE VARIATIONS





Graph is on p 91 in CLASS NOTES & in color on p 47 of Dire Predictions

And . . .

THE ROLE OF CO_2 IN TREE GROWTH!

Photosynthesis: (Primary Production)

$$CO_2 + H_2O \longrightarrow CH_2O + O_2.$$

CO_2	+	H_2O	$\longrightarrow$ CH_2O	+ O_2.
carbon dioxide		water	carbohydrate	oxygen gas

See p 87 in Class Notes

Tour of the 5 Bristlecone Pine Sites

Map is on p 125

➔ Key info is already filled in on the Table on p 126

OBSERVATION TABLE (p 126 of Class Notes)

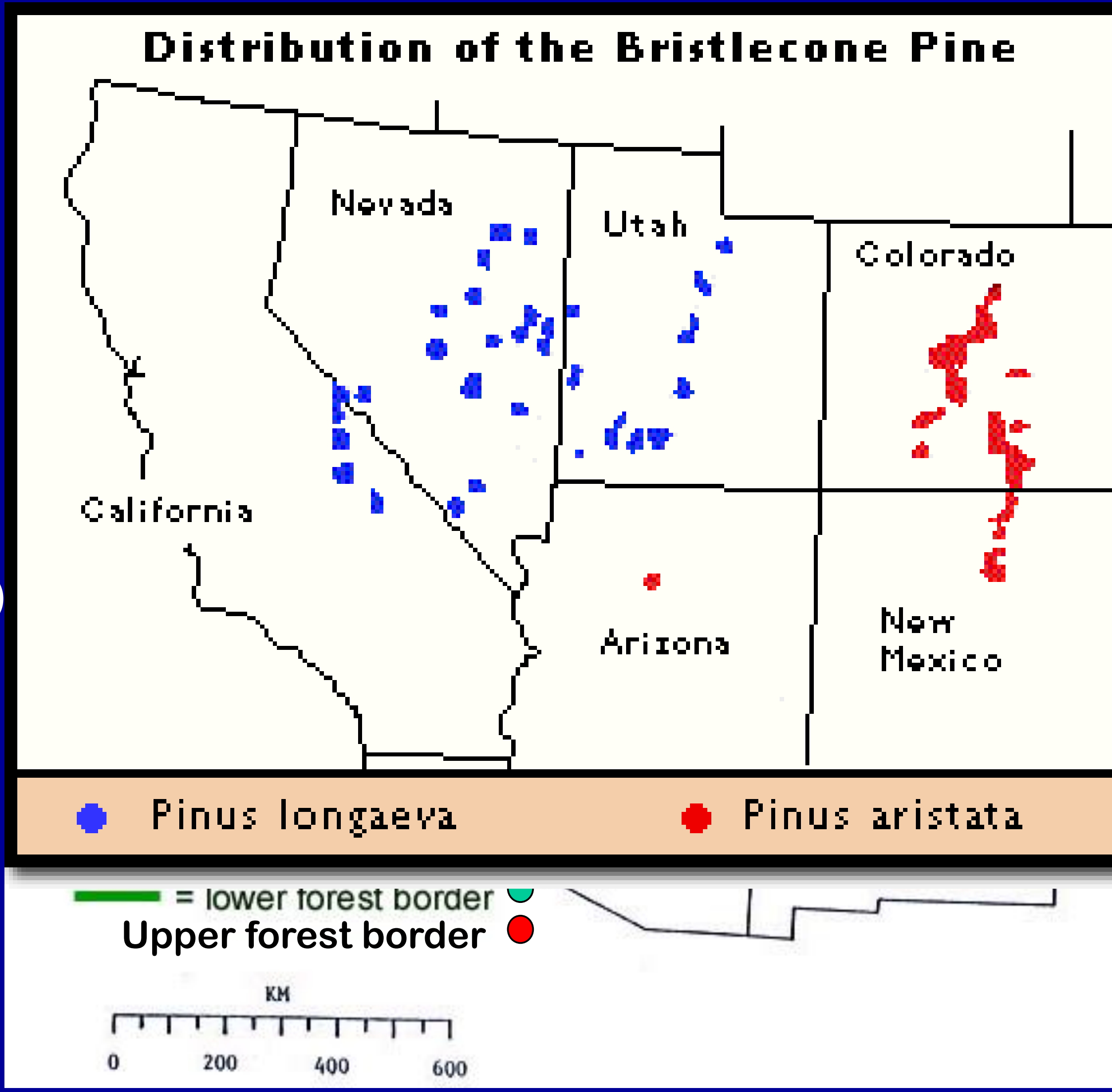
VARIABLES (NOTE: A variable is something that varies from site to site or from time to time at one or more sites)	SITE-to-SITE COMPARISON TABLE				
	Sheep Mt Core ID = C	Campito Mt Core ID = D	Methuselah Walk Core ID = B	Almagre Mt Core ID = E	Hermit Lake Core ID = A
Geographic Location	White Mountains near Bishop, California	White Mountains near Bishop, California	White Mountains near Bishop, California	Front Range of the Colorado Rockies	Front Range of the Colorado Rockies
Elevation	3475 m (~11,500 ft)	3400 m (~11,000 ft)	2805 m (~ 9200 ft)	3536 m (~11,600 ft)	3657 m (~ 12,000 ft)
Upper or Lower Forest Border?	upper	upper	lower	upper	upper
Moisture- or Temperature- sensitive?	temperature	temperature	moisture	temperature	temperature
Rock / soil type	dolomite	sandstone	dolomite	granite	sandstone
	Complete the rest of the site-to-site observations (below) based on our in-class discussion				
# of frost rings in entire record:					
Any differences in # of frost rings over time?					
Describe any trends in the time series of the ring width indices:					
Describe any pre- & post 1900 differences:					
Describe any other interesting things you noticed about any of the sites:					

TREE-RING SITE MAP

<u>All</u> are Bristlecone Pine sites

<u>SITE NAME (abv)</u>

Sheep Mt (SHP)
Campito Mt (CAM)
Methuselah Walk (MWK)
Almagre Mt (ALM)
Hermit Lake (HER)



Map is on p 125 in Class Notes

Upper & Lower Forest Border:

Temperature-sensitive and Precipitation-sensitive Trees

Take notes
p 126 Table

SITE 1 (SHP) SHEEP MT, Inyo Range, California

- In the White Mountains near Bishop, California
- Elevation - 3475 meters (~11,500 ft)
- Rock type - dolomite

see
p 126 Table

SHEEP MT

SHEEP MT

SITE 2 (CAM) CAMPITO Mt

- White Mts. Near Bishop California
- Elevation - 3400 meters (~11,000 ft)
- Rock type - sandstone

see
p 126 Table

CAMPITO MT

CAMPITO MT

SITE 3 (MWK) METHUSELAH WALK

- In White Mts near Bishop California
- Elevation - 2805 meters (~ 9,200 ft)
- Rock type - Dolomite

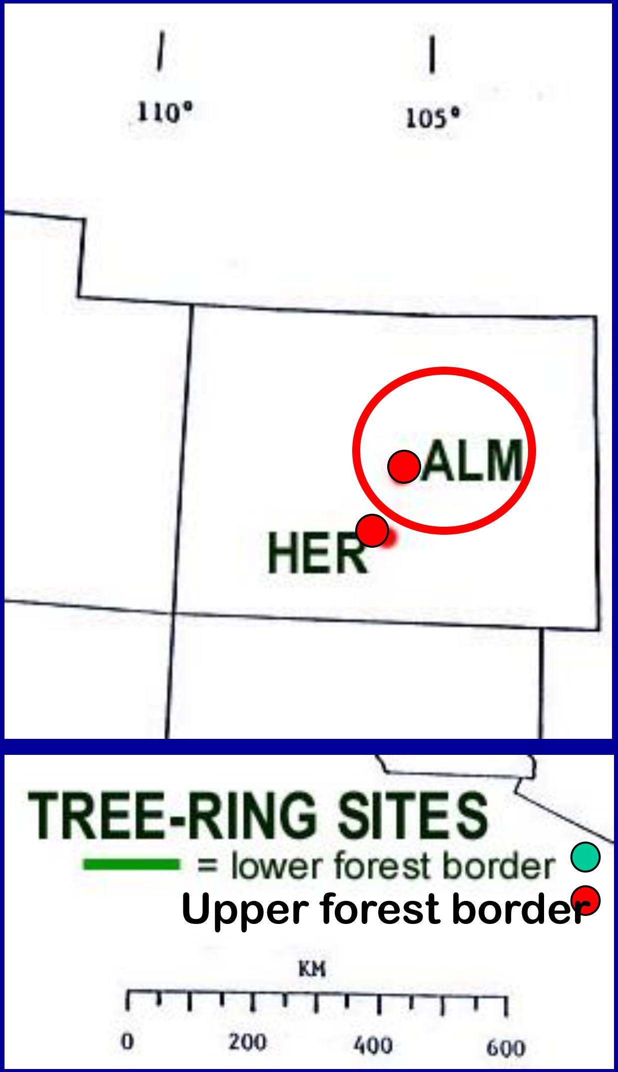
see p 126 Table

METHUSELAH WALK

METHUSELAH WALK

SITE 4 (ALM)
Almagre Mt

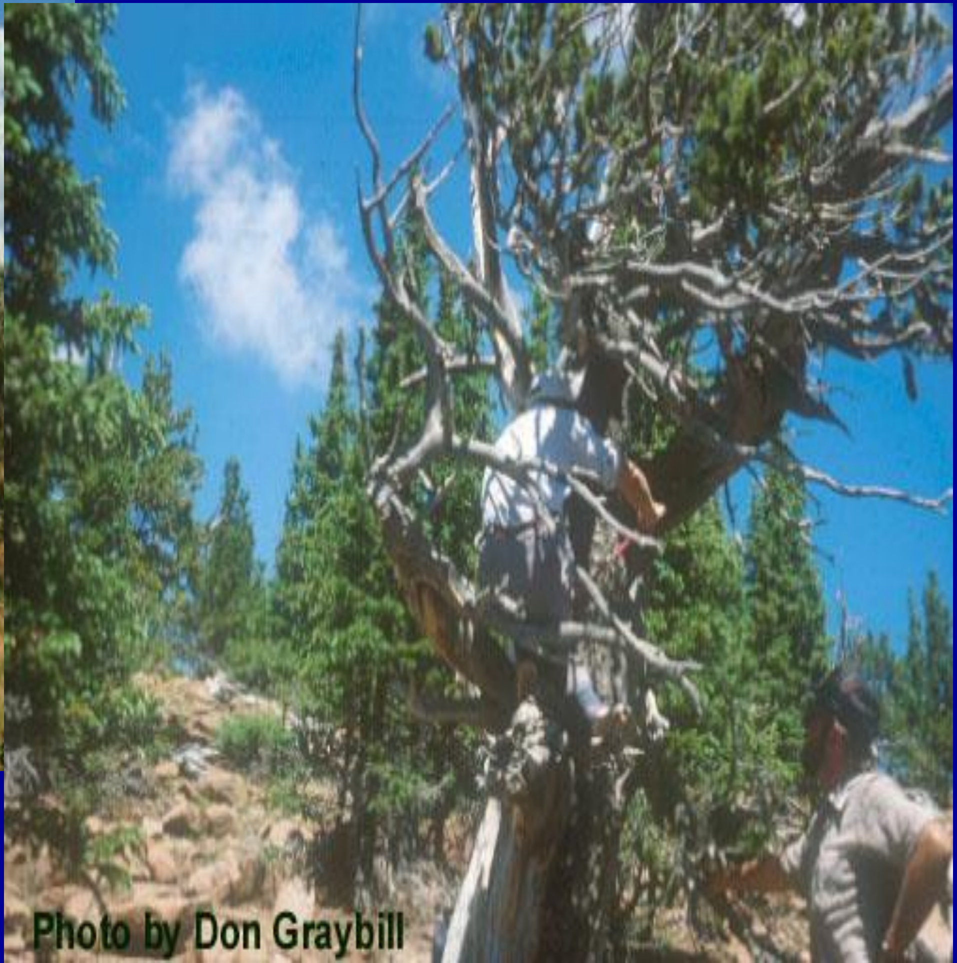
- located in the Front Range of the Colorado Rockies
- Elevation - 3536 meters (~11,600 ft)
- Rock type - granite



see
p 126 Table

ALMAGRE MT

ALMAGRE MT



SITE 5 (HER)
HERMIT LAKE

- located in the Front Range of the Colorado Rockies
- Elevation – 3657 meters (~ 12,000 ft)
- Rock type - sandstone

see
p 126 Table

HERMIT LAKE

HERMIT LAKE

Now get going on analyzing the data by carefully examining skeleton plots, masters, and tree-ring index plots . . . . .

Go to:

ANALYZING SITE-TO-SITE COMPARISONS (p127 - 128)