TOPIC #9
INTRODUCTION TO TREE RINGS & DENDROCHRONOLOGY

CLASS NOTES p 51

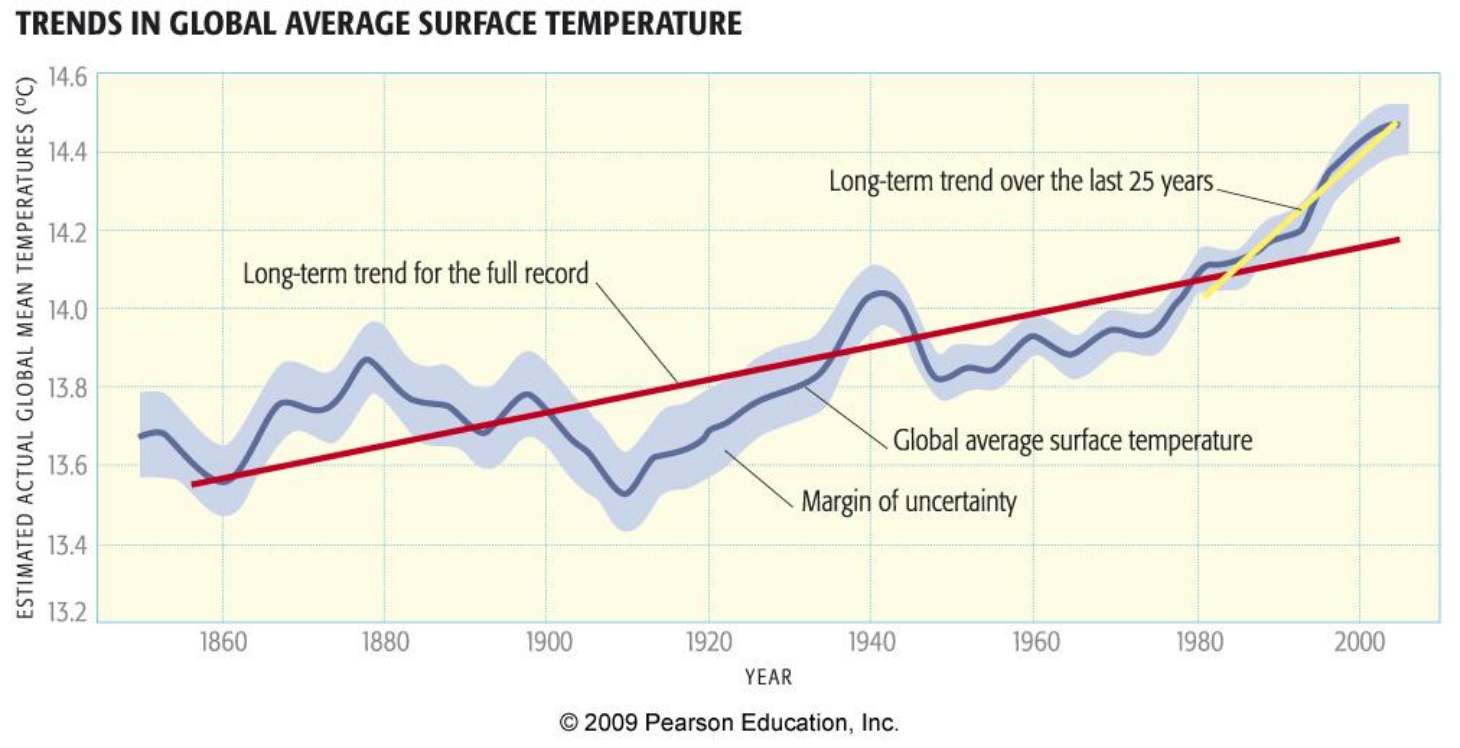
Global Change Tools

TREE RINGS & NATURAL ARCHIVES

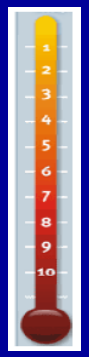
DETECTING GLOBAL WARMING:

In the recent past, we use the "INSTRUMENTAL RECORD" based on actual Thermometer readings from around the globe

Temperature Trends →



From **Dire Predictions, p 36**



We looked at some of these during this Indicator Interlude . . . Remember these time series "anomaly" plots?

INDICATOR INTERLUDE . . .

But what about what happened long before the Industrial Revolution?

Don't we really need to look at temperatures from a LONG time ago to assess the severity of the recent temperature observations of warming?

These temperature records and graphs are available online at the National Climatic Data Center (NCDC) of NOAA (The National Oceanic & Atmospheric Administration): http://www.ncdc.noaa.gov/cmb-faq/anomalies.php

To make an incontrovertible case about the role that humans play in global warming, what do scientists need?

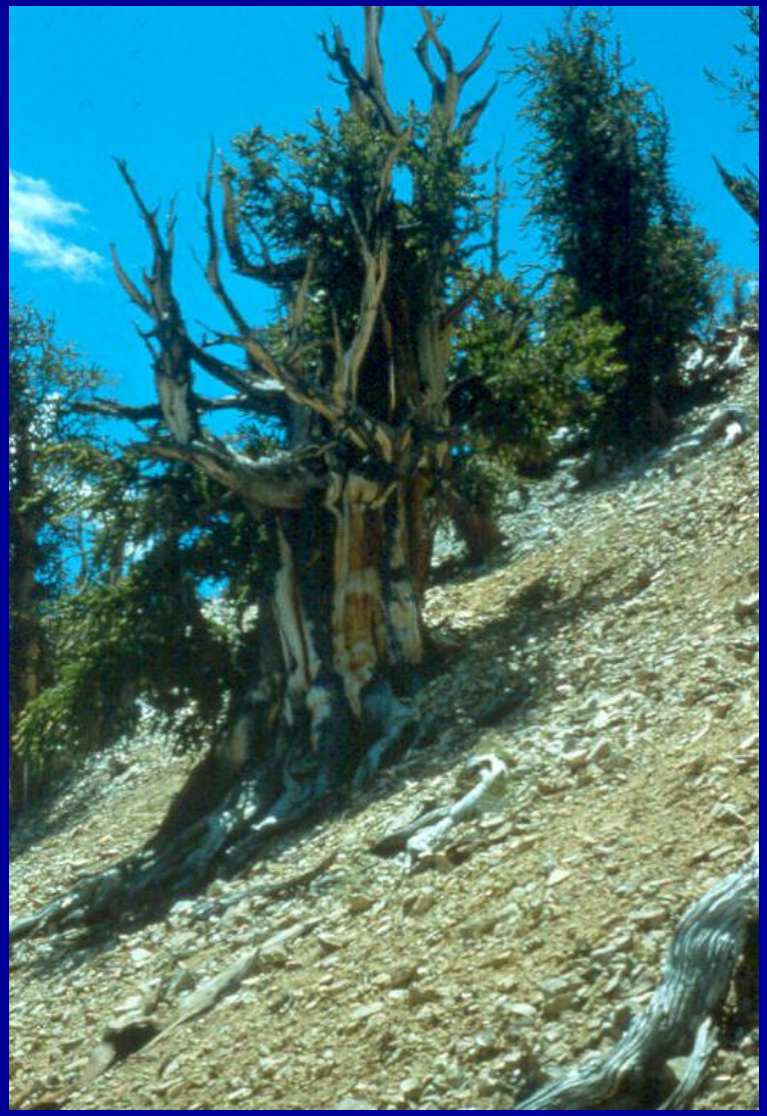
1) a long-term temperature record, i.e., centuries
2) over a large part of the globe
3) To be able to say . . . . .

"What's the average been for several hundred years, & is this a significant departure from that?"

"And that's very difficult to do."

(James Trefil, physicist)

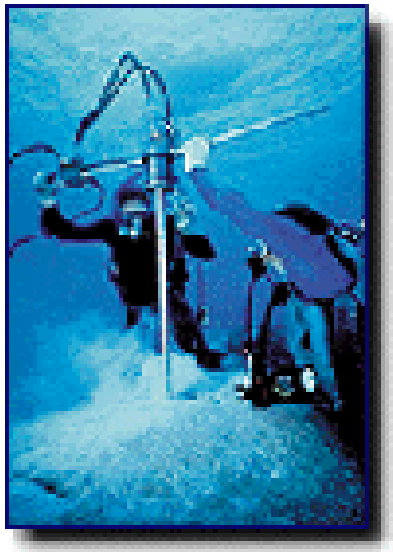
Review: p 17



Trees and stones will teach you that which you can never learn from masters.

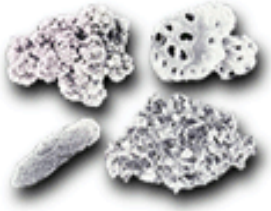
~ St. Bernard of Clairvaux

"PROXY" DATA or NATURAL ARCHIVES of CLIMATE

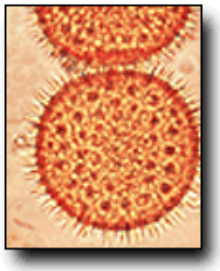


Corals

Ice cores



Lake, bog & ocean sediments



Pollen

TOPIC #9
INTRODUCTION TO TREE RINGS & DENDROCHRONOLOGY

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Dendrochronology is the dating and study of annual rings in trees:

- ***dendros***: from trees, or more specifically the growth rings of trees
- ***chronos***: time, or more specifically events in past time
- ***ology***: the study of . . .

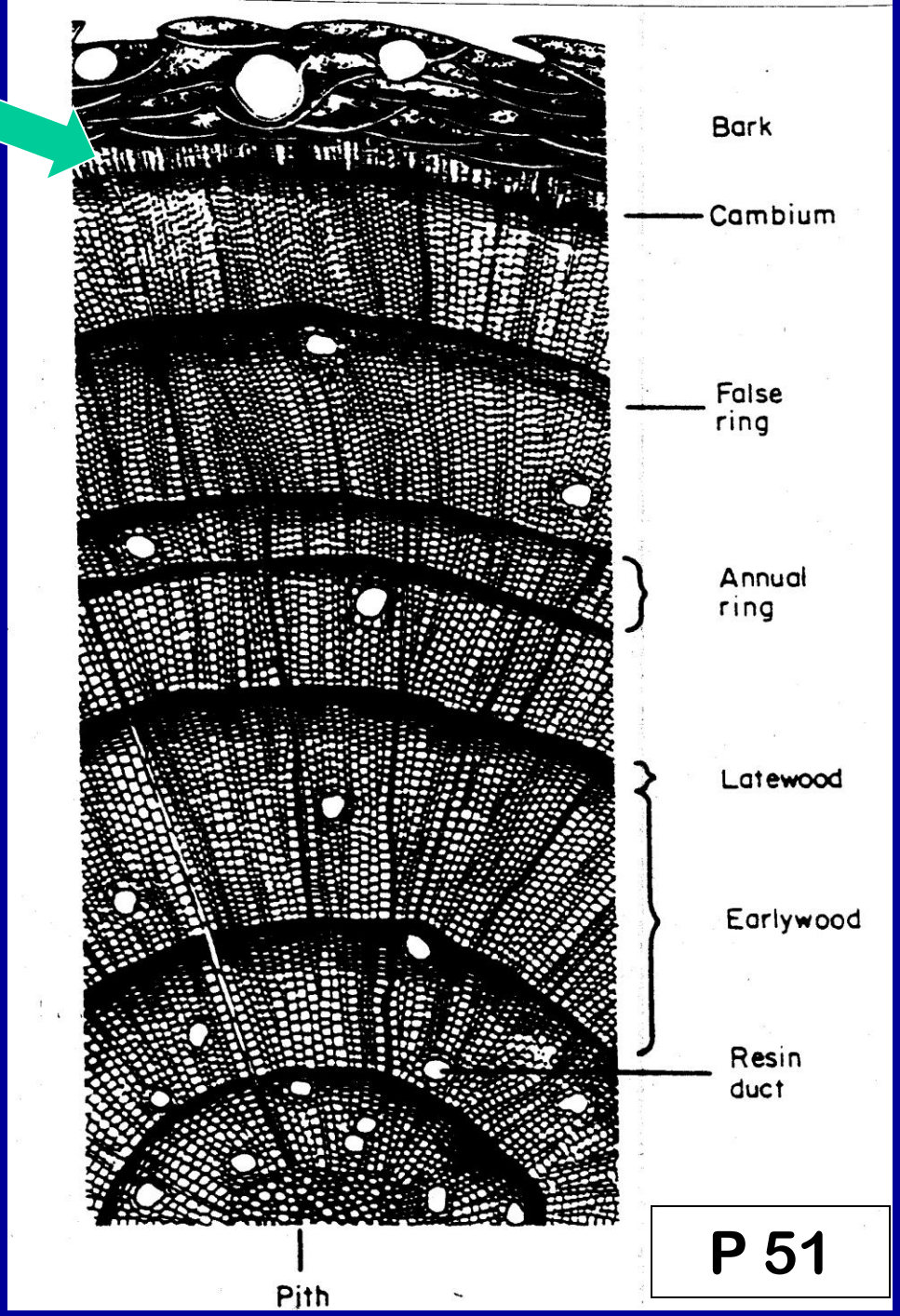
The current year's actively growing cells are just underneath the bark

Partial cross-section of a coniferous tree

How old is it? (in complete years) count 'em!

7 years old

(now in 8th year of growth)

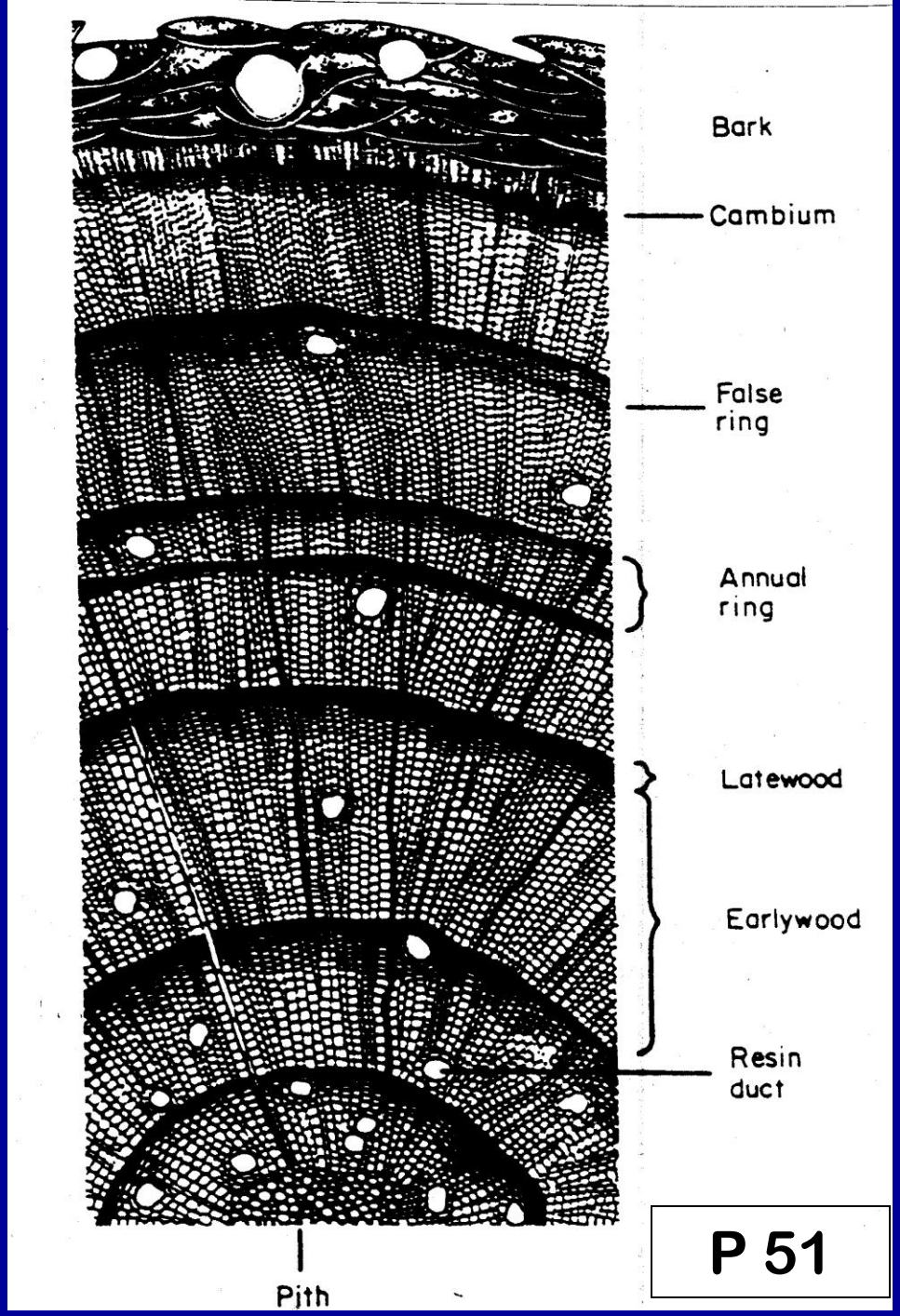


P 51

With 7 rings in the cross-section,

Is this the tree's age?

It depends on the height of the sample



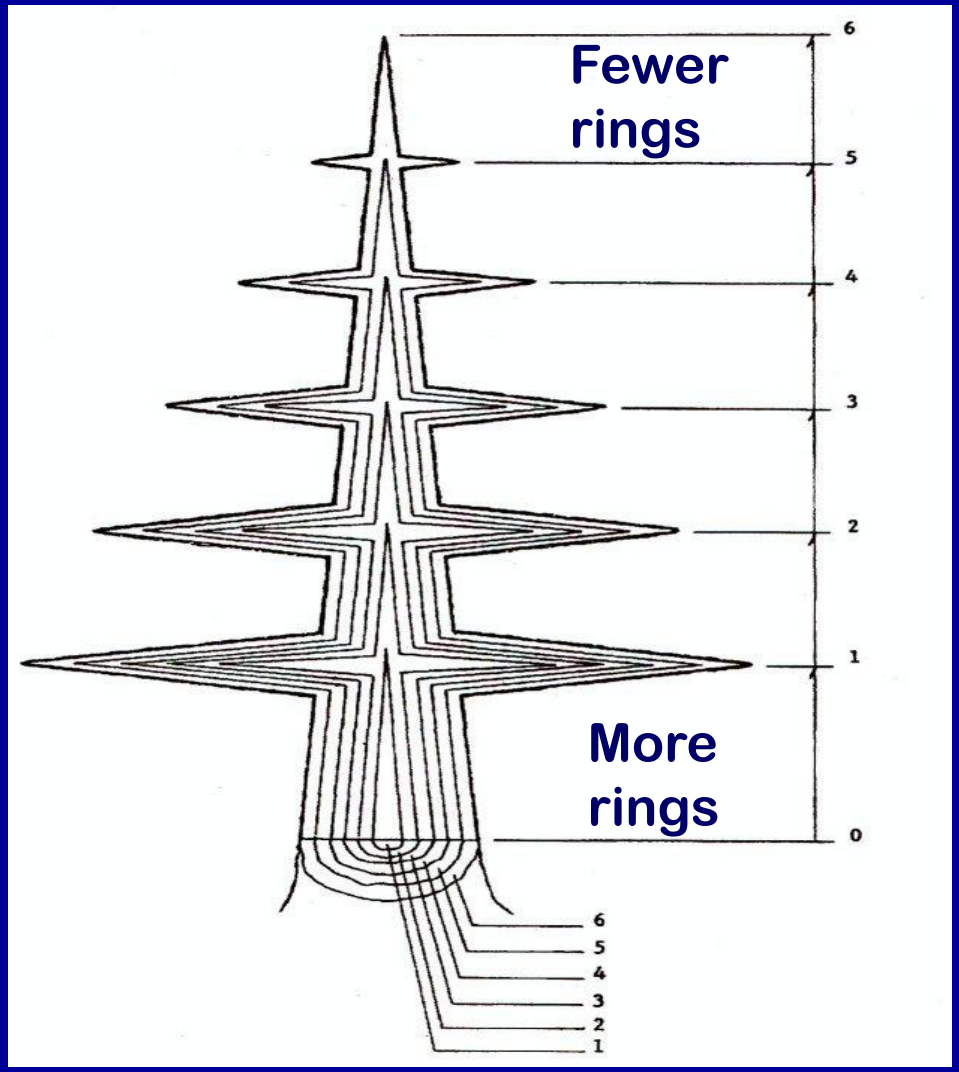
P 51

With 7 rings in the cross-section,

Is this the tree's age?

It depends on the height of the sample

Trees grow from the top



http://www.jefpat.org/Wood&CharcoalIdentification/Wood&Charcoal_Part2.htm

Clicker Question:

Given what you just learned about how trees grow, what is wrong with this picture?

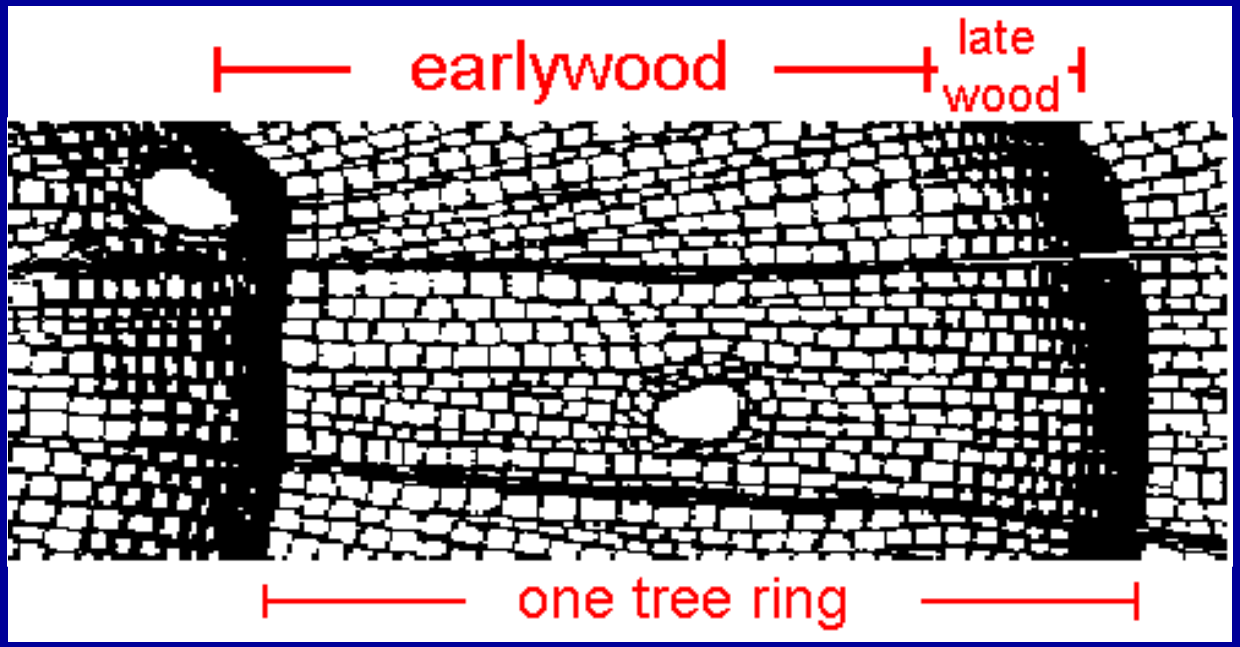
A. Trees grow up, not out, so this is clearly a photo shopped image.

B. In 99 years of tree growth, the bicycle would be much higher up in the tree.

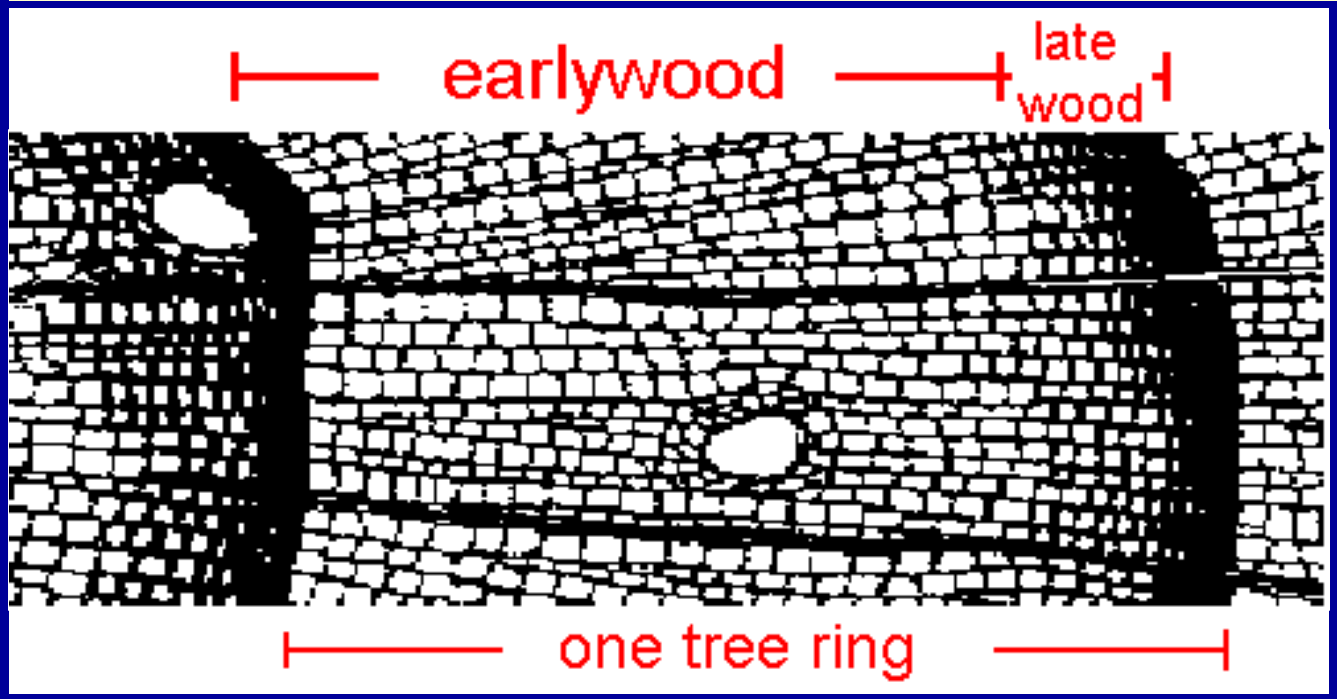
C. In 99 years of tree growth, the bicycle would still be on the ground, but the tree would have started to grow around it.

Why we can see the rings: cell size & thickness changes during the growing season

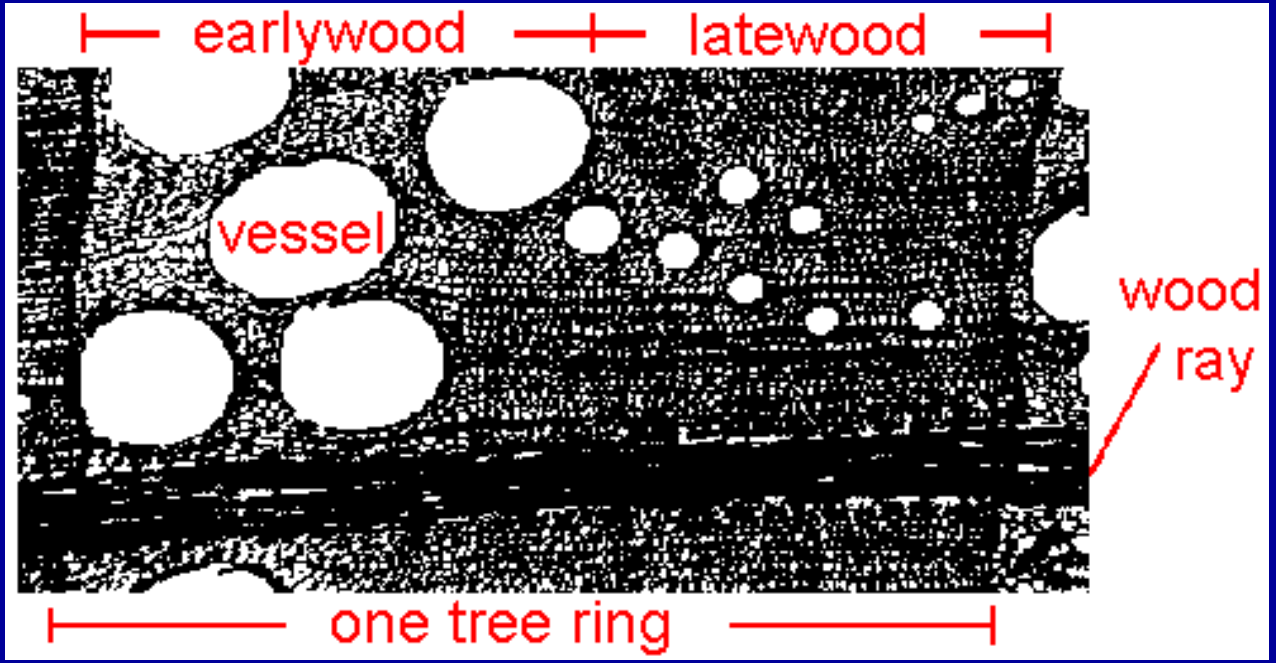
Conifer Tree Ring (cross-section view)



- Earlywood:
  - Cells: thin walls, large diameter
  - Appears light in color
- Latewood:
  - Cells: thick walls, small diameter
  - Appears dark in color



Ring Porous Angiosperm Tree Ring (cross-section, view)



- Earlywood:
  - Cells: large diameter vessels
- Latewood:
  - Cells: small diameter vessels

But not all trees have rings!

The image below shows a conifer tree-ring sample with about thirty rings (every tenth ring is marked) – growing from left to right.

The rings display much variation:

Tree growth (adding new cells) is this way

← Pith
(center of tree)

Bark →
(outside of tree)

☺

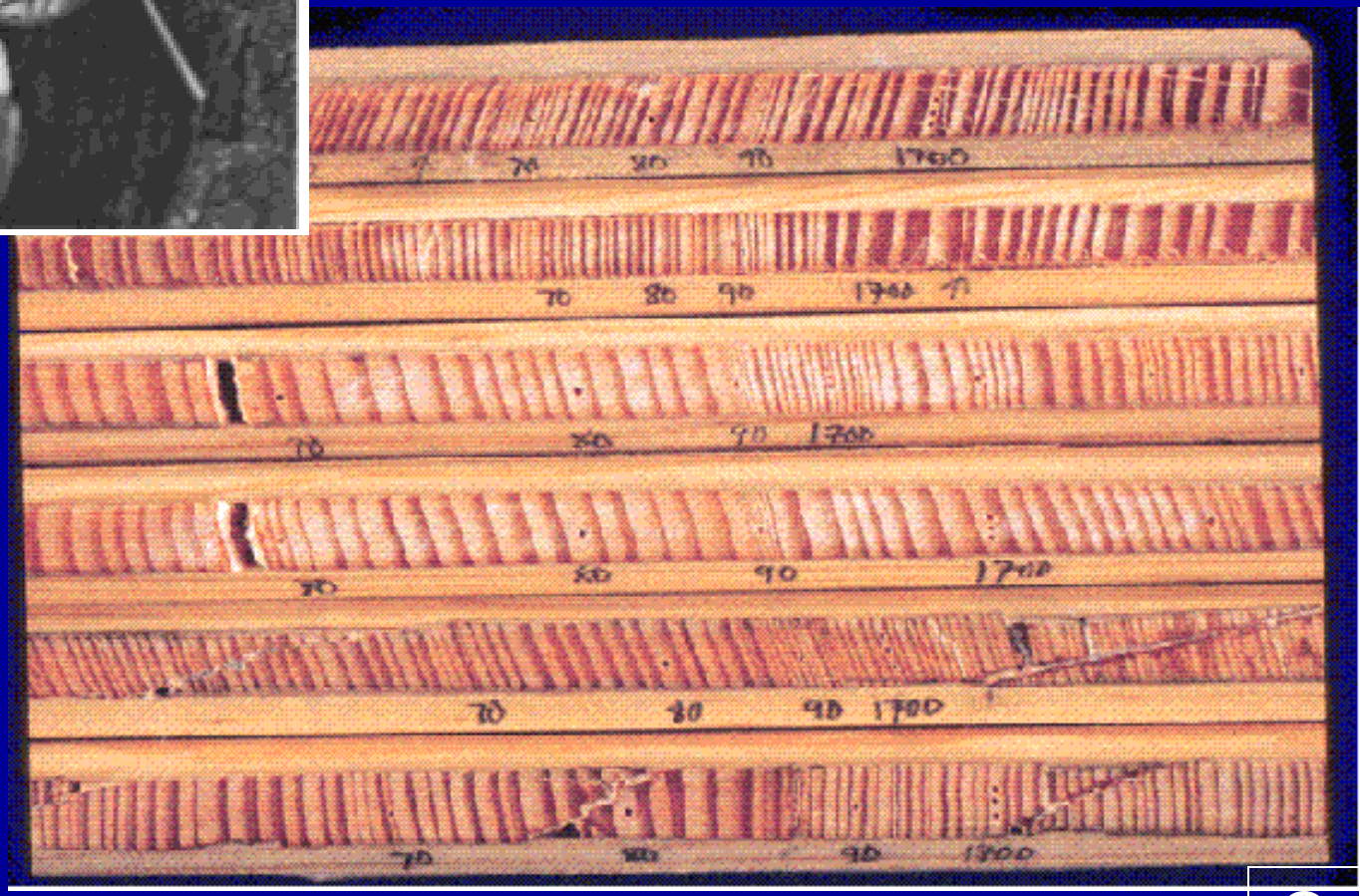
Variation in tree rings is due to variation in environmental conditions when they were formed.

- dry or moist soil conditions
- cold or warm temperatures
- frost rings from tissue damage

- even insect outbreaks, fires, and other non-climatic factors

Studying this variation gives us information about past environmental conditions and is the basis for many research applications of dendrochronology.

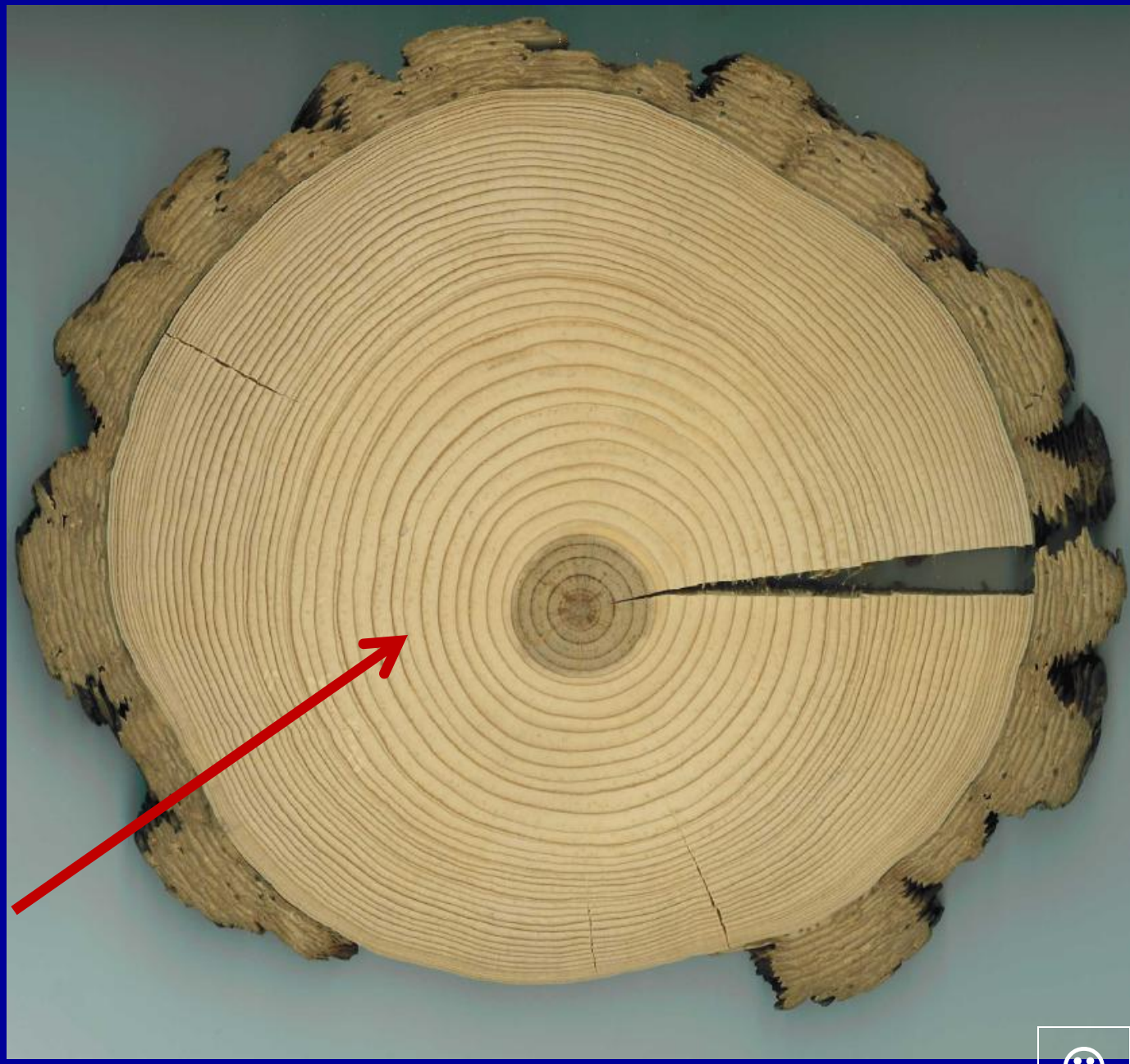
How do we get the tree rings without killing the trees!



Extract cores with an increment borer

If the tree is already dead or cut down, we can take cross-sections from the tree or its stump ➔

Notice how wide the rings in the center are – this was when the tree was young and growing faster!



KEY PRINCIPLES OF DENDROCHRONOLOGY

UNIFORMITARIANISM –

"The present is the key to the past"

(this is a key principle for many other natural archives used in the geological sciences as well)

LIMITING FACTORS –

growth can occur only as fast as allowed by the factor that is most limiting, e.g.

- "too dry" – the amount rainfall is the limiting factor
- "too cold" or "too hot" – the temperature is the limiting factor
- NOTE: the limiting factor can vary from site to site, even in the same species of tree!

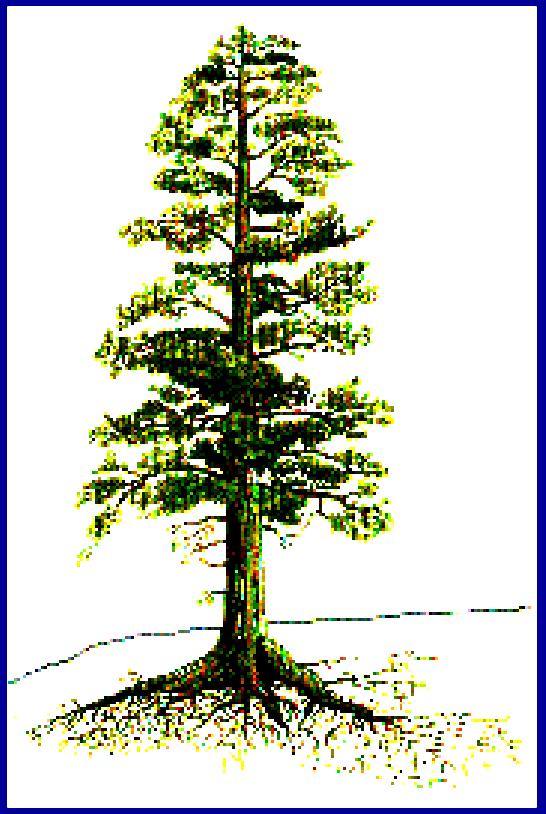
Key Principles p 51

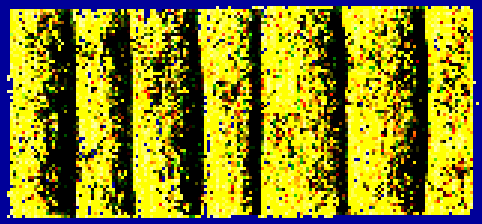
SITE SELECTION --

sites are selected based on criteria of tree-ring sensitivity to an environmental variable

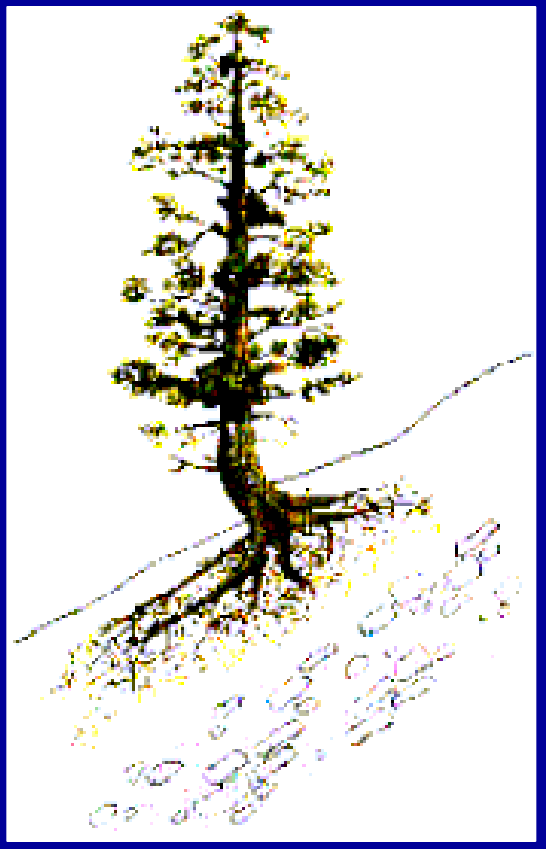
(temperature, precipitation, etc.)

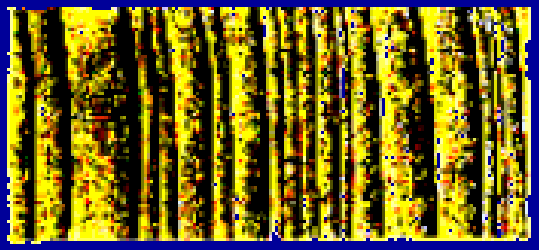
Key Principles p 51





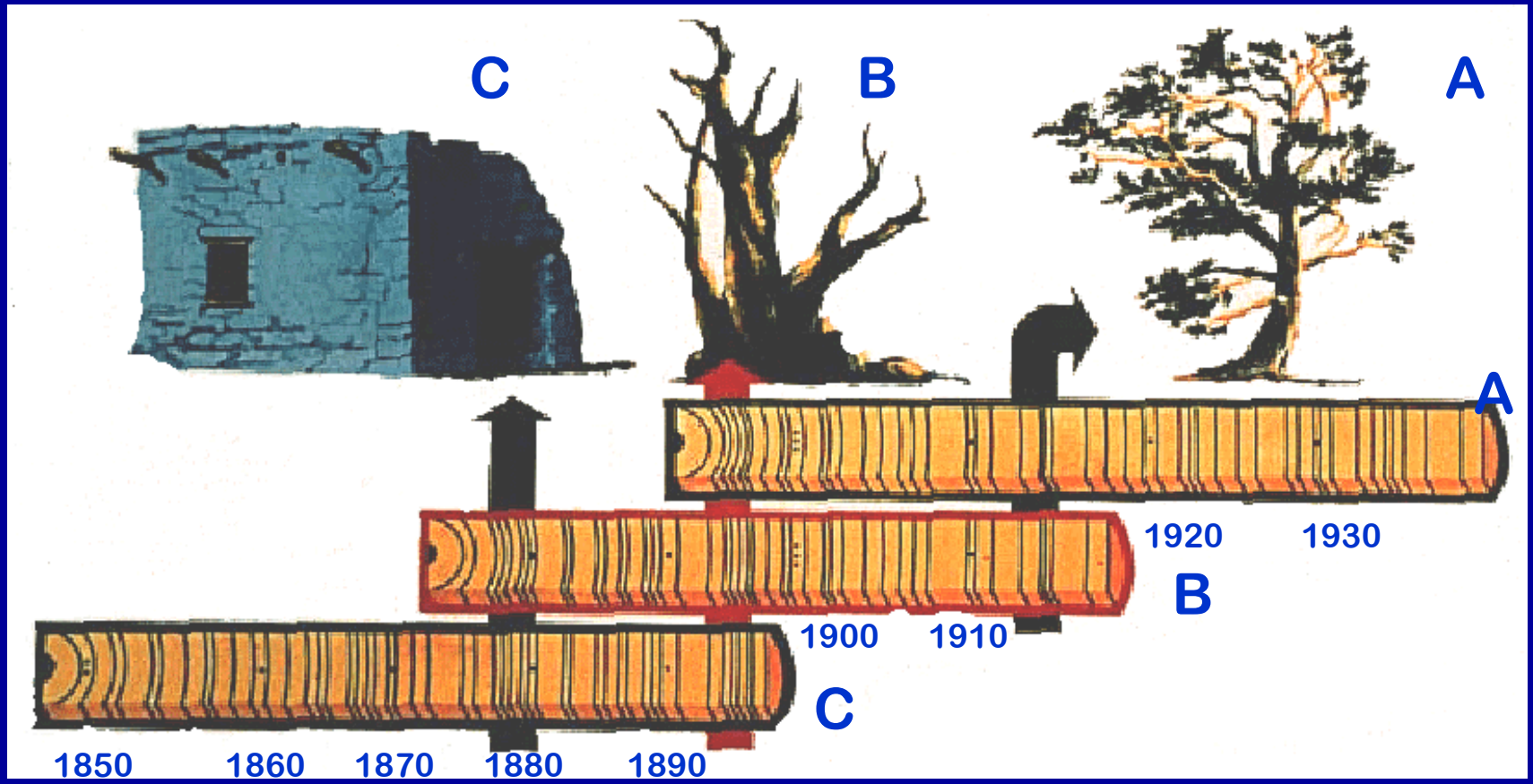
Complacent





Sensitive

Crossdating: The Central Premise of Dendrochronology

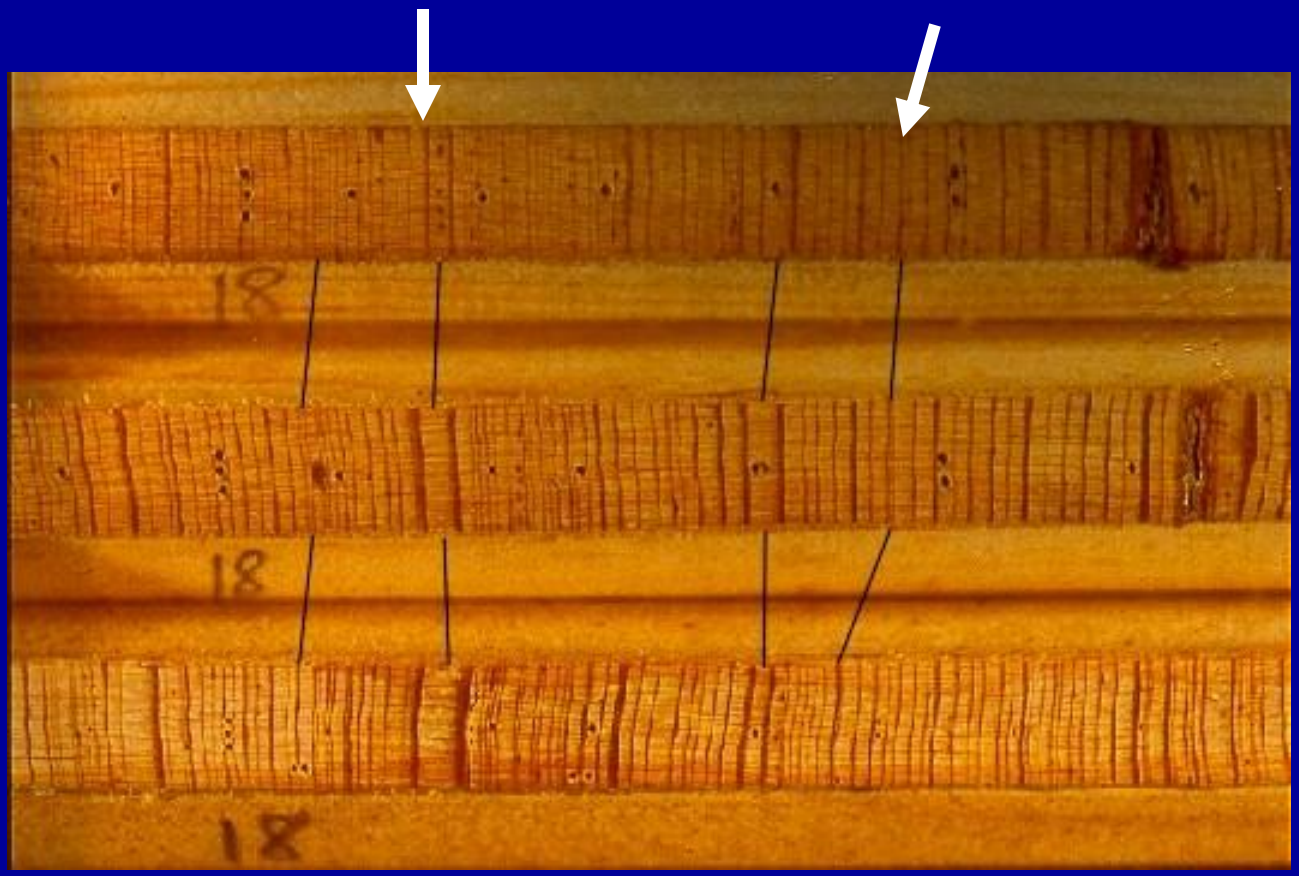


<<< "Bridging" the record back in time <<<

Key Principles p 51

CROSSDATING –

matching patterns in rings of several sensitive tree-ring series allows precise dating to exact year



To Crossdate you need a lot of rings to compare, usually **50 rings minimum** to be certain of dating

Key Principles p 51

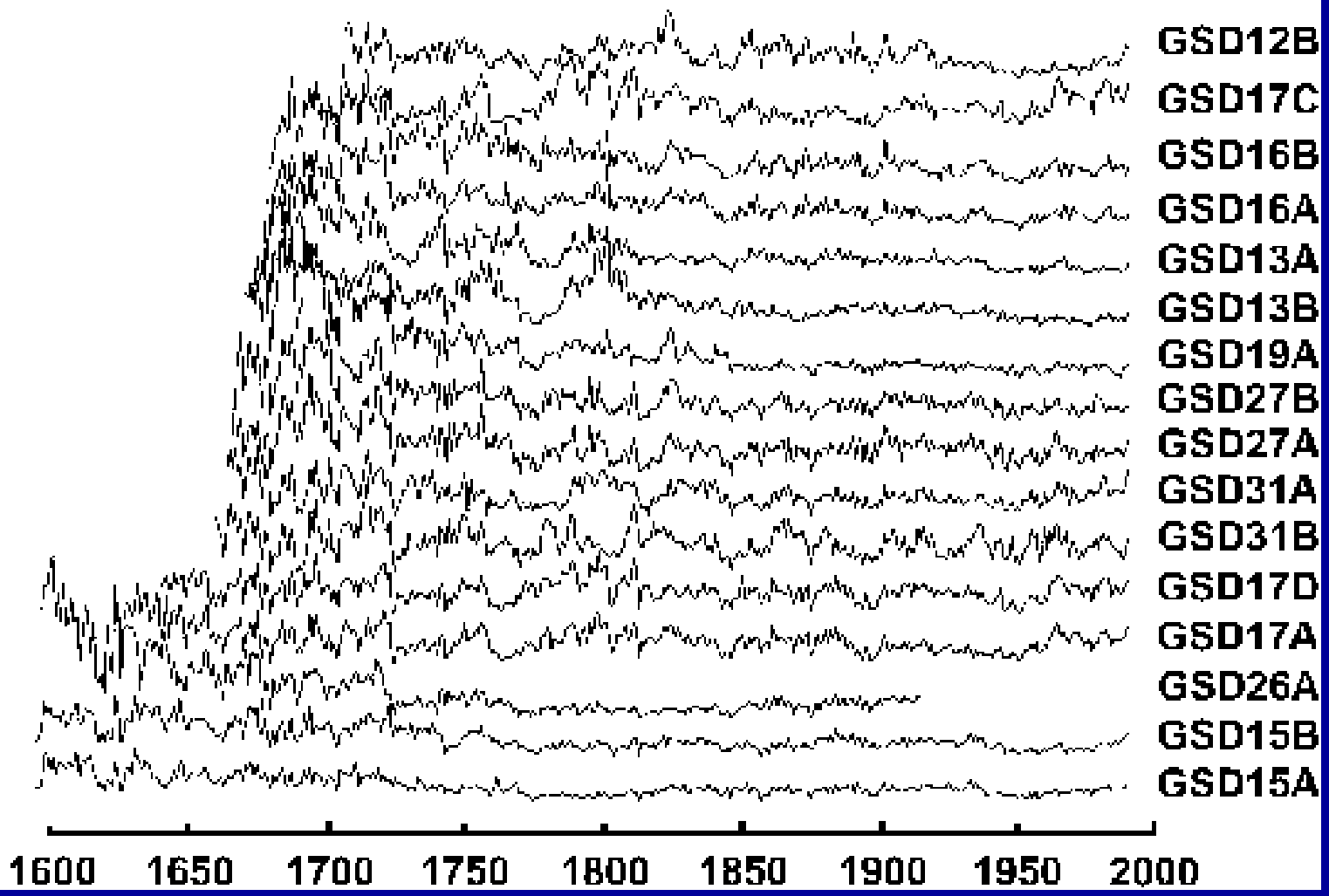
Now, back to the principles:

REPLICATION –

"noise" minimized by sampling many trees at a site + more than one core per tree

Key Principles p 51

Ring width measurements showing a similar pattern of growth



ECOLOGICAL AMPLITUDE –

trees are more sensitive to their environment at latitudinal and elevational limits of the tree species' range

Very old tree on Mt Graham, SE Arizona
inner ring date: A.D. 1101

Key Principles p 51

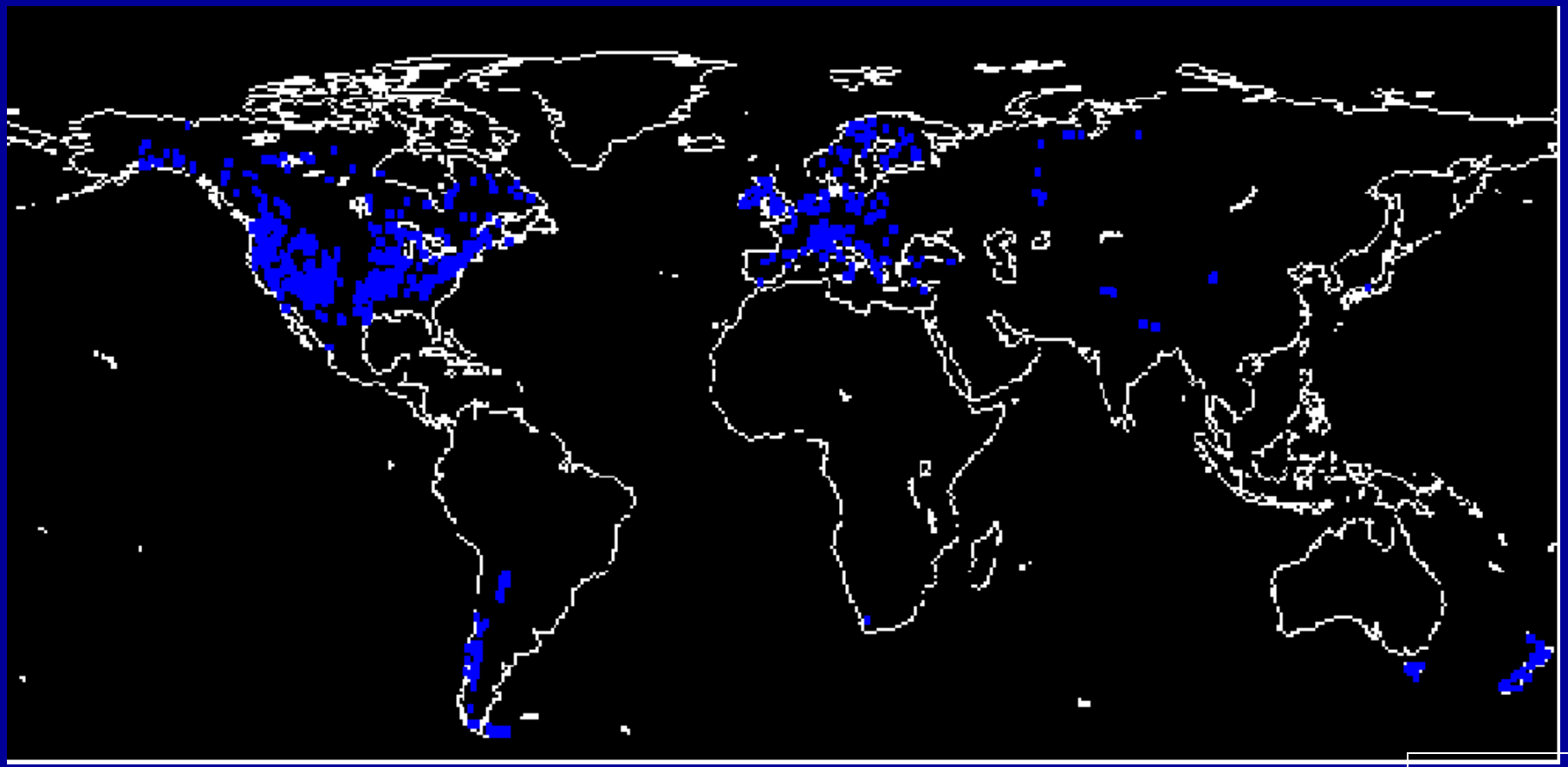
KEY SCIENTIFIC ISSUES

- **Missing rings & false rings** (to identify these, need a "master chronology")
- **Species limitations** (some trees have no rings, non-annual rings, or poorly defined rings)
- **Trees must crossdate!** (can't develop a chronology or link to climate without this)

Today's class activity

Top of p 52

- **Geographical limitations** tropics, deserts and other treeless areas, oceans, etc.)



- **Age limitations**

old trees hard to find

oldest living trees = Bristlecone Pines

~ 5,000 years old

why don't we know for certain?

Because sampling the base of a live tree is difficult

- **Value of precise dating**

(long chronologies, climate reconstructions, archaeology, radiocarbon dating)


Now on to the G-3
Tree-Ring “Wood Kit”
ASSIGNMENT!

Goals of Assignment G-3:

(1) To see "inside" different species of trees and woody shrubs

(2) To classify the wood samples in a "wood kit" into categories :

Trees that are:

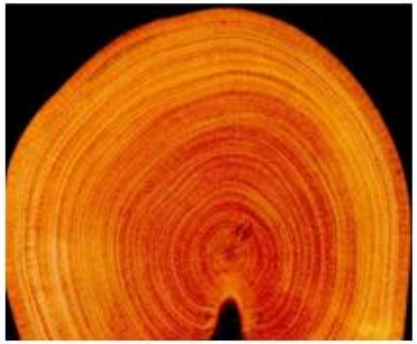
(1) **Suitable** or
(2) **Unsuitable**

. . . for crossdating and subsequent dendrochronological analysis.

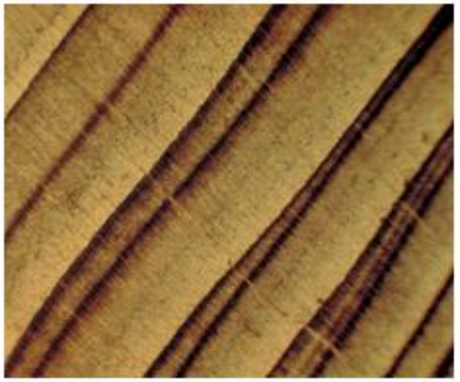
SUMMARY OF FEATURES THAT INDICATE SUITABILITY FOR DENDROCHRONOLOGY

1. Has Rings:

2. Distinct Ring Boundaries:

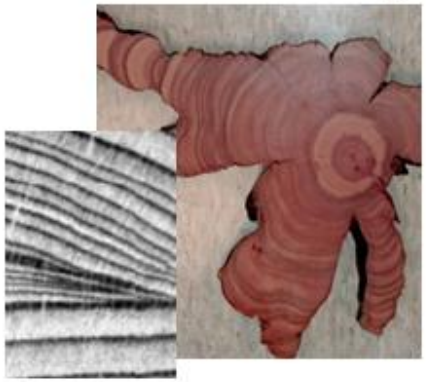


3. Rings are Annual:



4. Sensitive Growth:

5. Circuit Uniformity:



6. Long Ring Record:

See bottom of p 53 and pp 121 -122 in Class Notes

Tree species	Dendrochronological Criteria		Y/N
	Reasons FOR using	Reasons for NOT using	
Bristlecone pine (*Pinus longaeva*)			
Fan palm (*Washingtonia spp.*)			
Lodgepole pine (*Pinus contorta*)			
Mesquite (*Prosopis spp.*)			
Mulberry (*Morus spp.*)			
Saguaro (*Carnegiea gigantea*)			
Giant redwood (*Sequoiadendron giganteum*)			
Southwestern white pine (*Pinus strobiformis*)			

Then, for each specimen in your box, fill out reasons FOR using it and reasons for NOT using it in a dendrochronological study

Start by matching each wood specimen with a PHOTO, using LABELS on the wood to guide you

Example:
SEGI = Giant redwood

1) Match the wood specimens in your box with the right tree photo

2) Fill our the chart for the specimens in your box

3) SWAP boxes

4) REPEAT for second box

5) All who participated, sign the form & return the folder with your completed G-3 form inside

SUMMARY OF FEATURES THAT INDICATE SUITABILITY FOR DENDROCHRONOLOGY

1. Has Rings:

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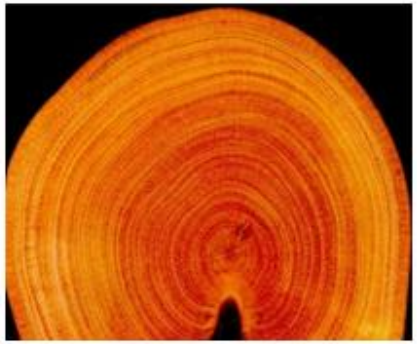

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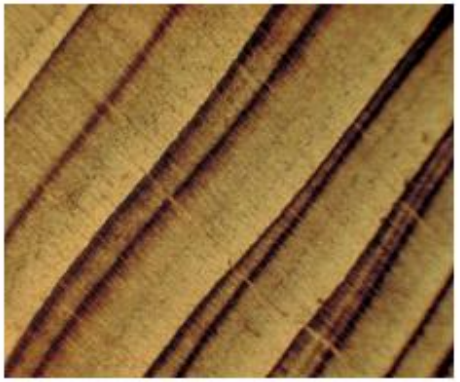

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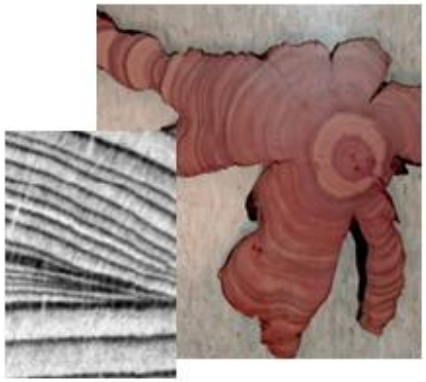

6. Long Ring Record:

See pp 121 -122 in Class Notes

TIME TO WRAP UP FOR TODAY

Please clean up your area and put chairs back in place