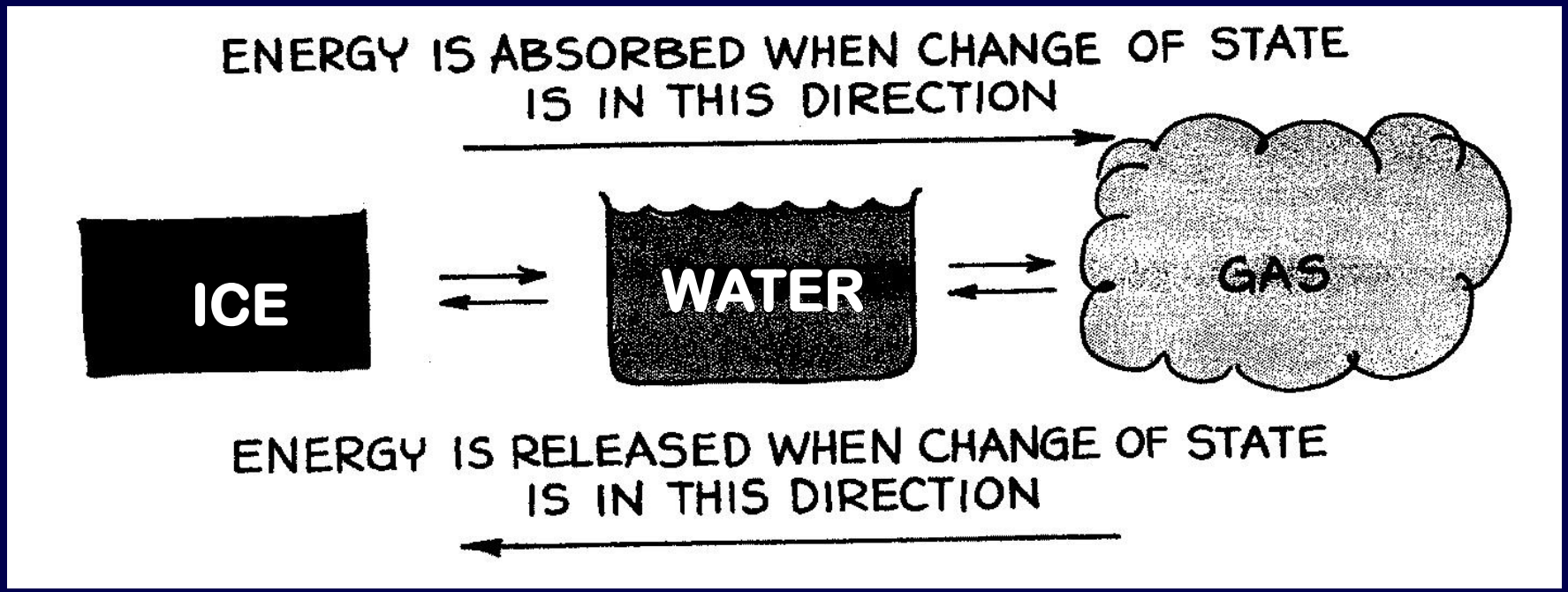
REVISTING: THERMAL ENERGY & PHASE CHANGES IN H_2O

Energy stored as LATENT ENERGY

(energy is "hidden" & not sensed)

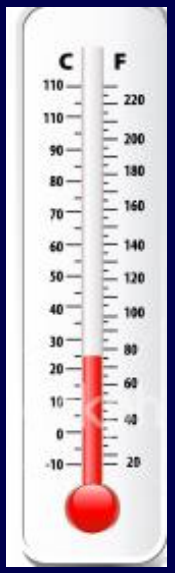


Energy released as SENSIBLE HEAT

(i.e. the warmth can be "sensed")

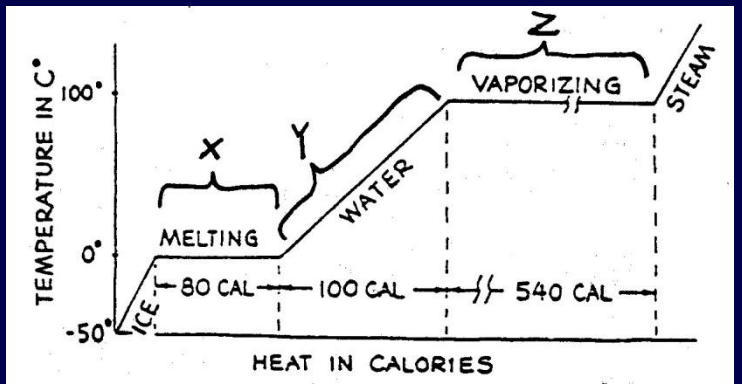
Now back to p 47

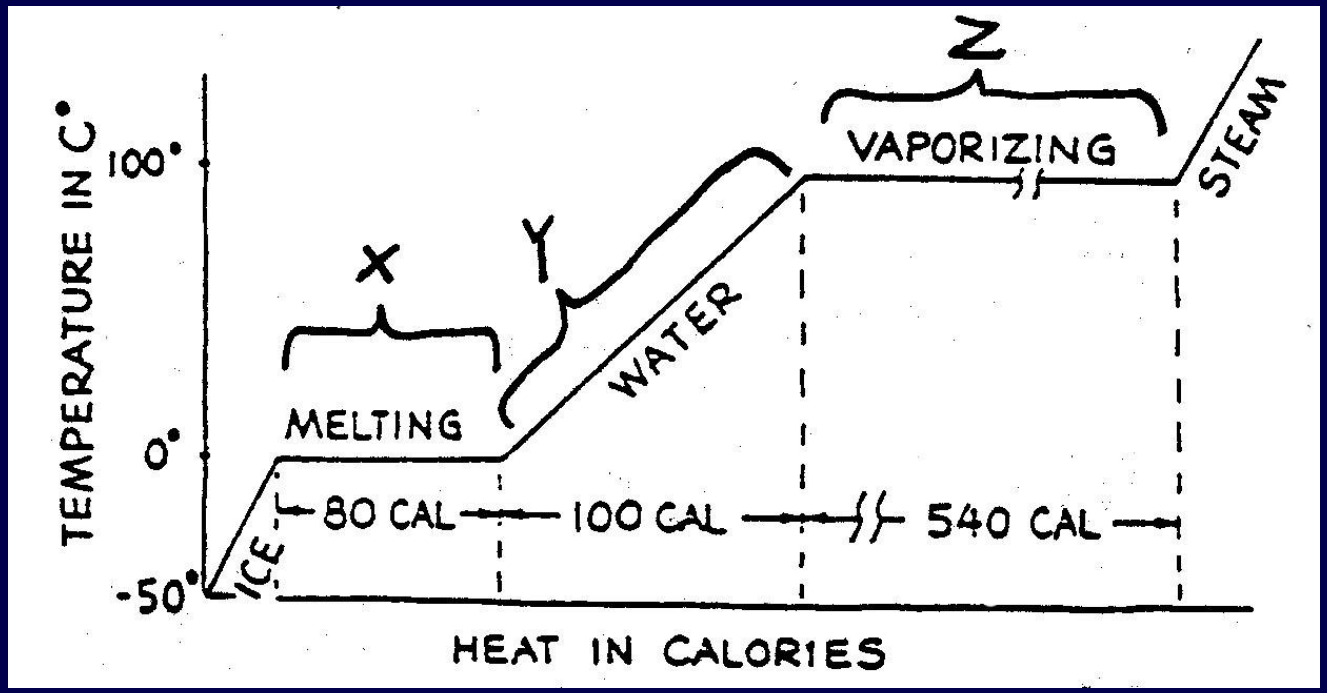
REVIEW / BACKGROUND:



SENSIBLE = the energy can be SENSED (e.g., with a thermometer, by the environment, etc.)

LATENT (means "HIDDEN") = the energy is there, but it is NOT SENSED by the environment, a thermometer . . . or YOU!

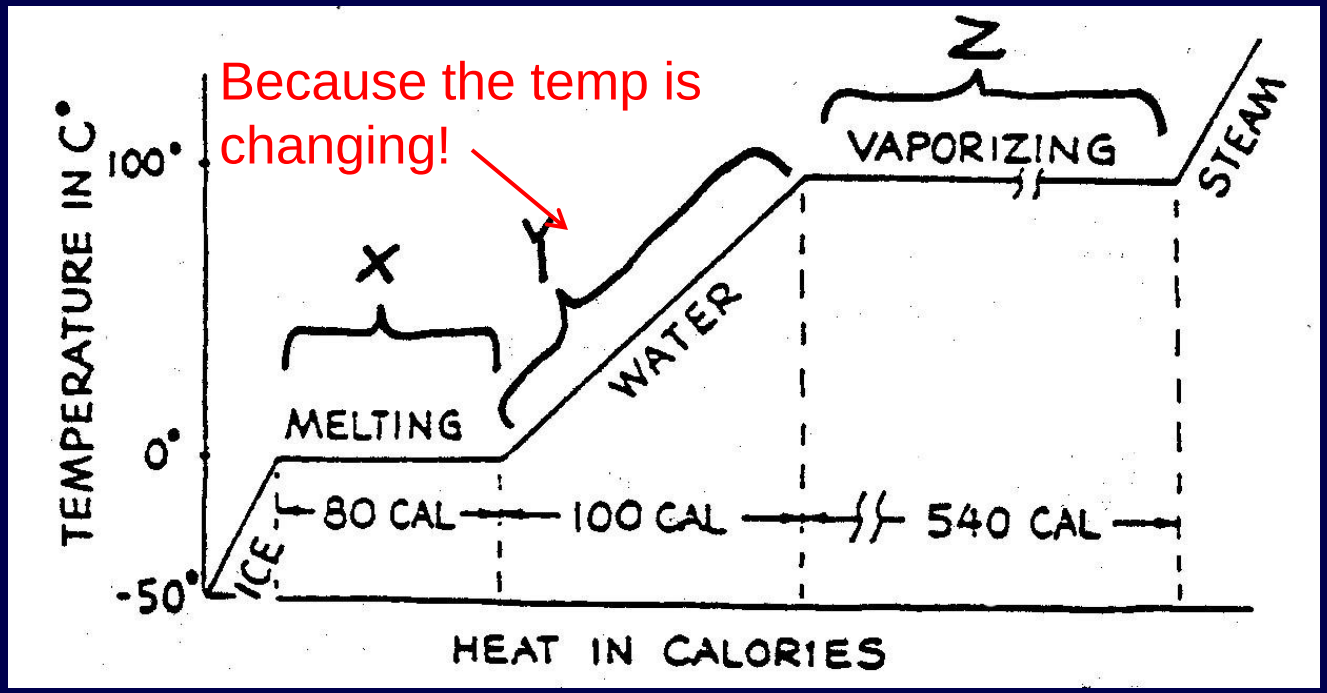




Q1 -- Which segment or segments of the graph represent(s) **SENSIBLE HEAT (H)** ?

1 = X & Z **3 = Y only**

2 = X only **4 = Z only**



Q1 -- Which segment or segments of the graph represent(s) **SENSIBLE HEAT (H)** ?

1 = X & Z

3 = Y only

2 = X only

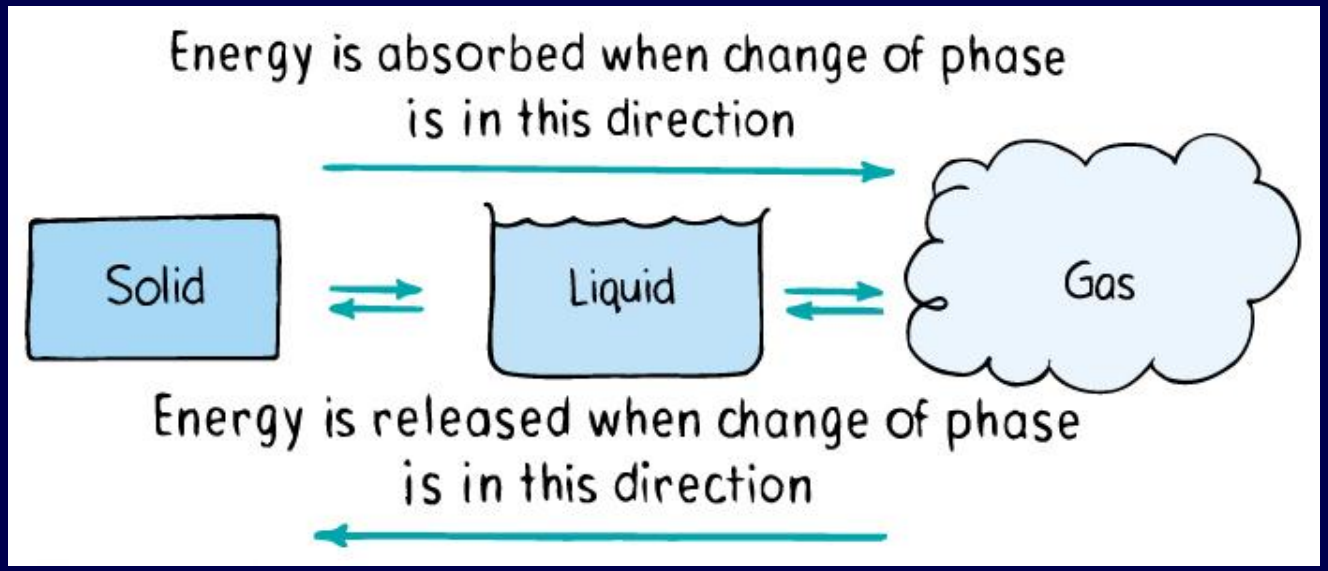
4 = Z only

Q2- In a phase change from ice to water or water to water vapor, <u>WHAT</u> is absorbing the energy?

1 = the surrounding environment

2 = the H_2O molecules

3 = both the environment & the H_2O



Q2 - In a phase change from ice to water or water to water vapor, WHAT is absorbing the energy?

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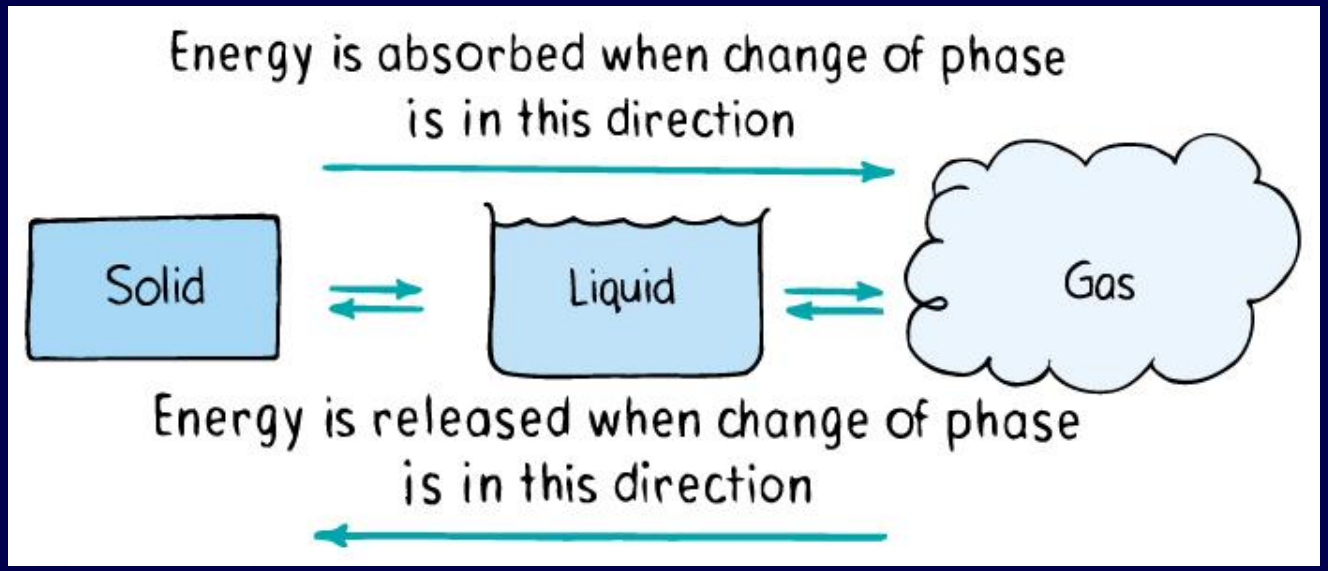
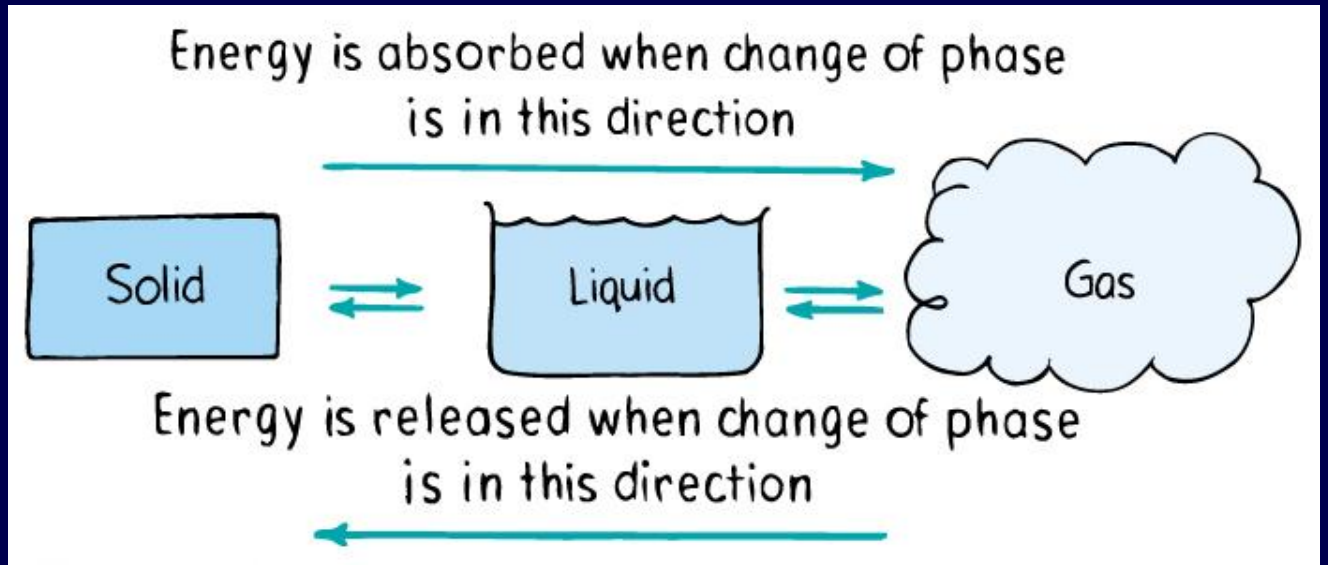


Q3 - In a phase change from water vapor to liquid water or liquid water to ice, TO WHERE is the energy being released?

1 = into the surrounding environment

2 = into the H_2O molecules

3 = into both the environment & the H_2O



Q3 - In a phase change from water vapor to liquid water or liquid water to ice, TO WHERE is the energy being released?

1 = into the surrounding environment

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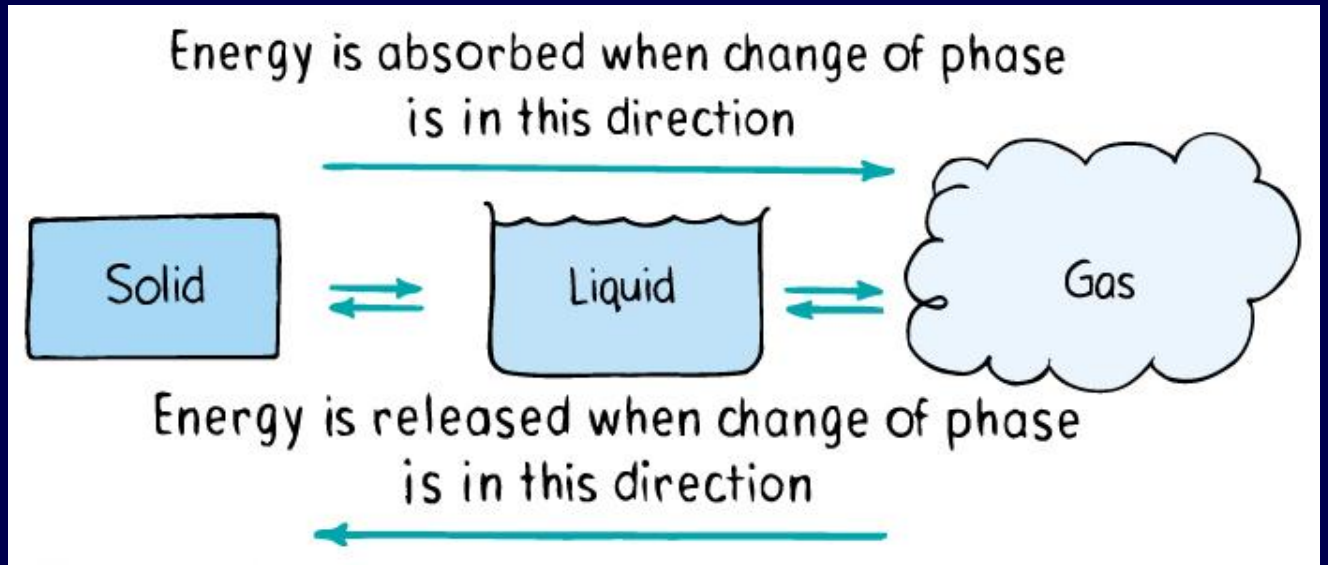
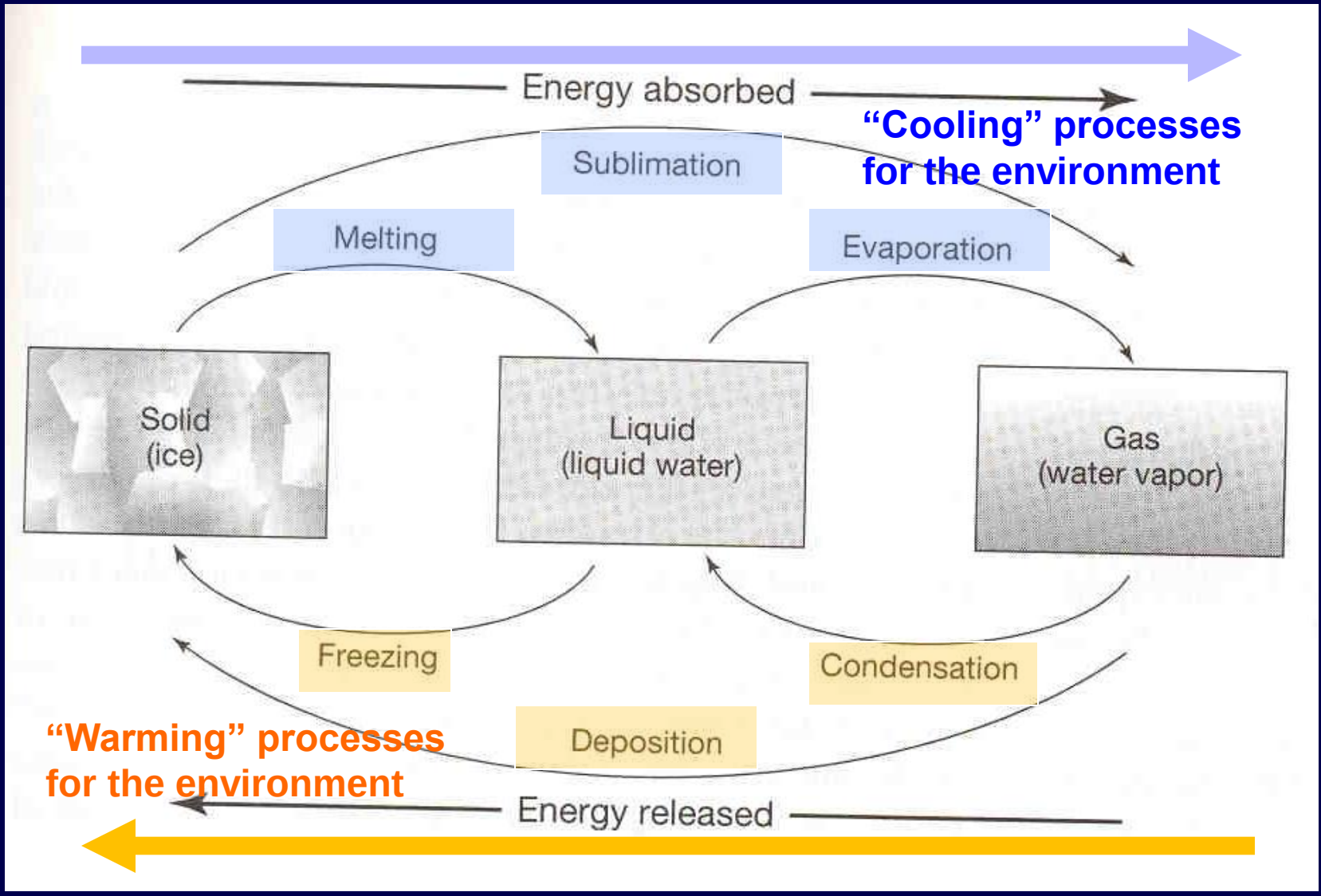
3 = into both the environment & the H_2O



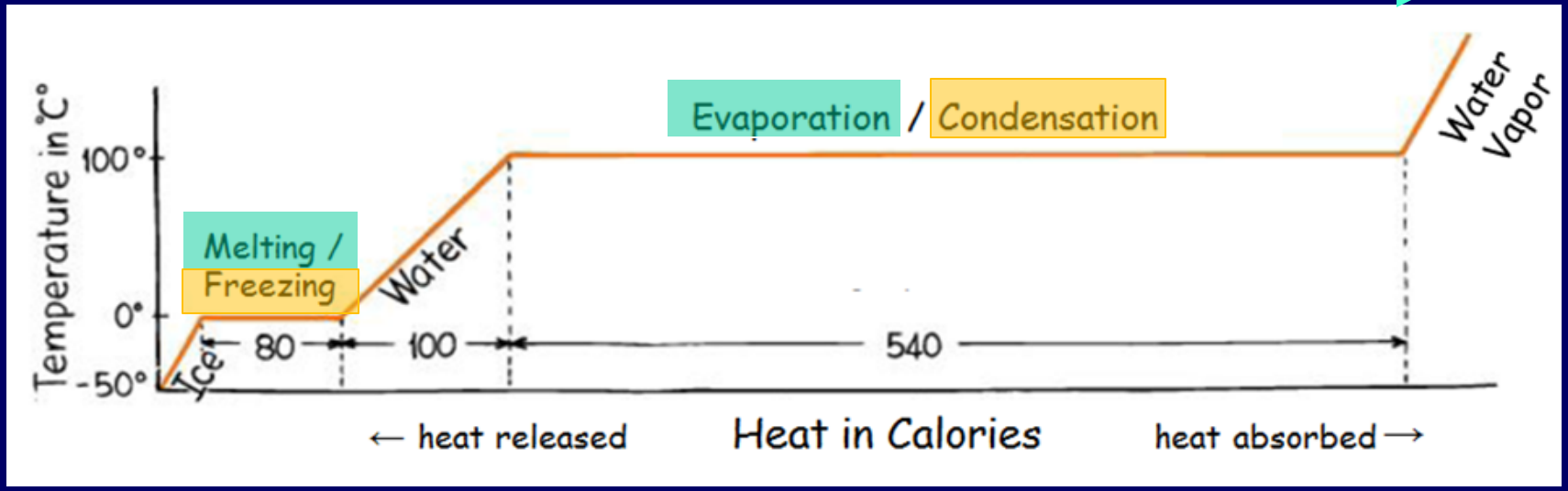
PHASE CHANGES (another view)



This is in your textbook: Fig 4-23 p 77 in SGC E-text

ANNOTATED VERSION OF FIGURE (from Test #2)

During MELTING & EVAPORATION, thermal energy (that is SENSED) flows into the H_2O molecules where it is ABSORBED (when that happens, it becomes "hidden" LATENT ENERGY)

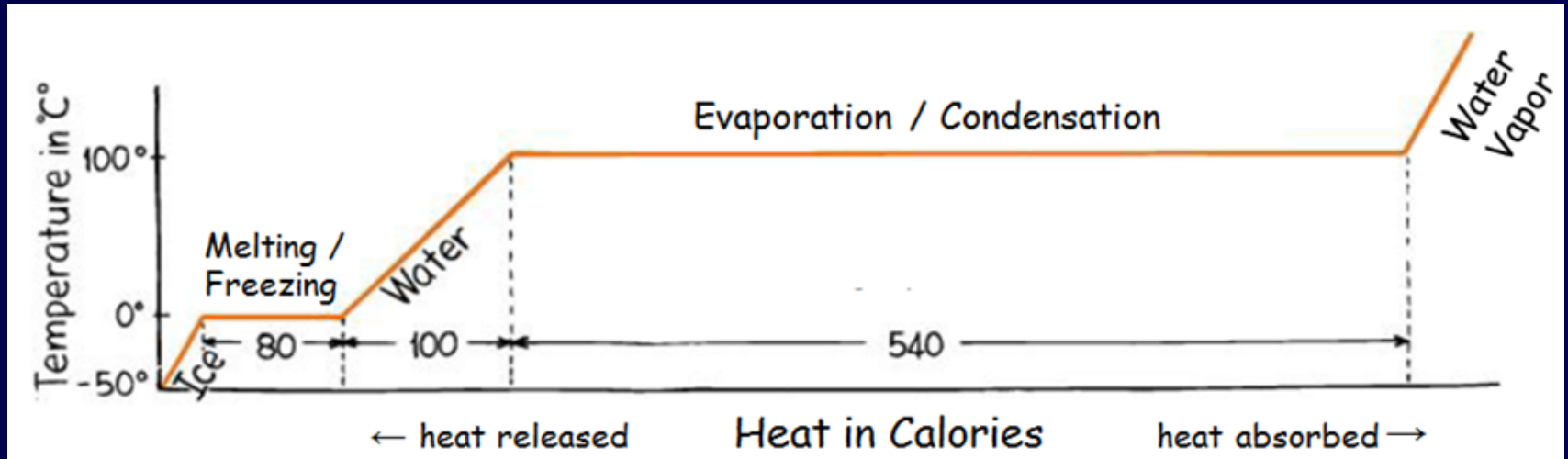


During CONDENSATION & FREEZING, thermal energy (that is LATENT) is RELEASED by the H_2O molecules & flows into the surrounding environment (when that happens, it becomes SENSIBLE HEAT)

Q4- The figure below illustrates temperature change when one gram of H_2O goes through various **phase changes.**

Which of the processes labeled on the figure involves the **flow of energy** from **sensible heat** **to latent energy**?

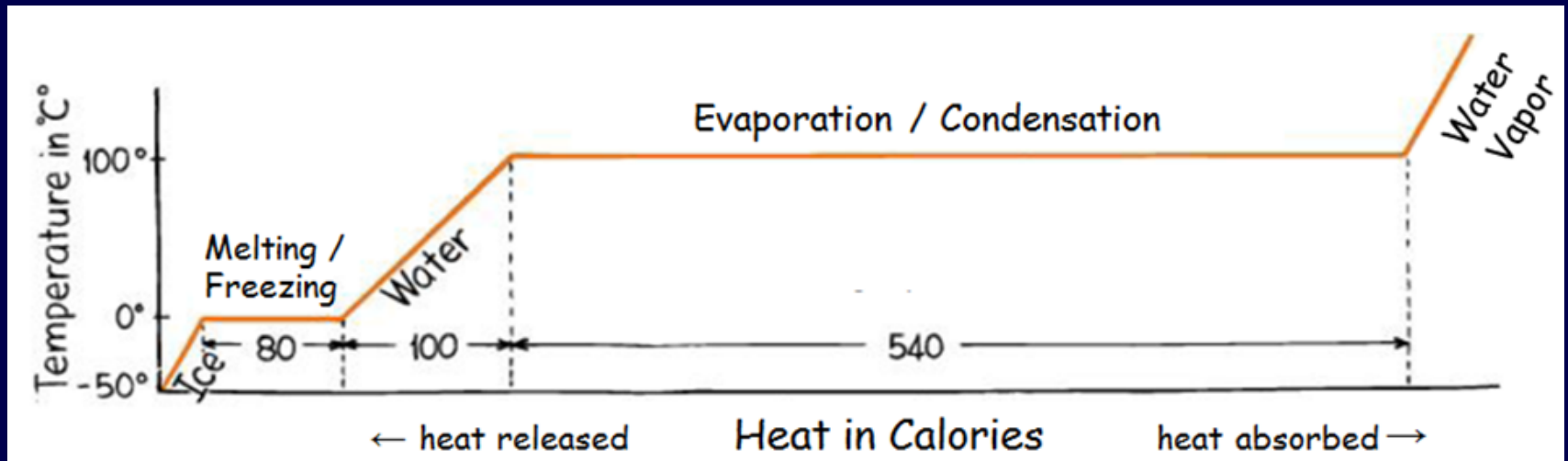
1 - Freezing 2 – Evaporation 3 - Condensation



Q4- The figure below illustrates temperature change when one gram of H_2O goes through various **phase changes.**

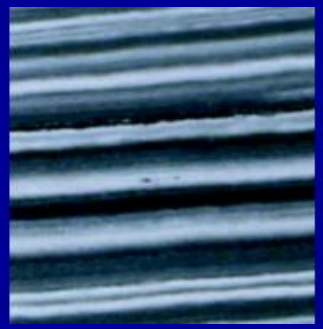
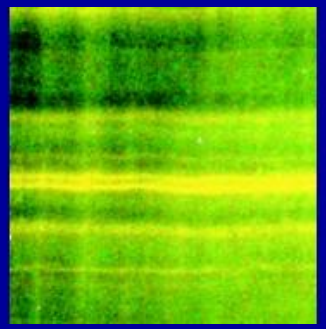
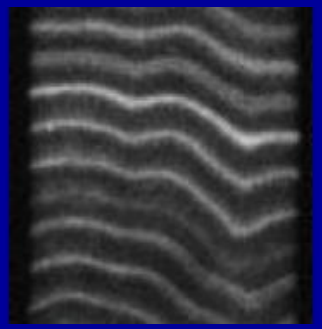
Which of the processes labeled on the figure involves the **flow of energy** from **sensible heat** to **latent energy**?

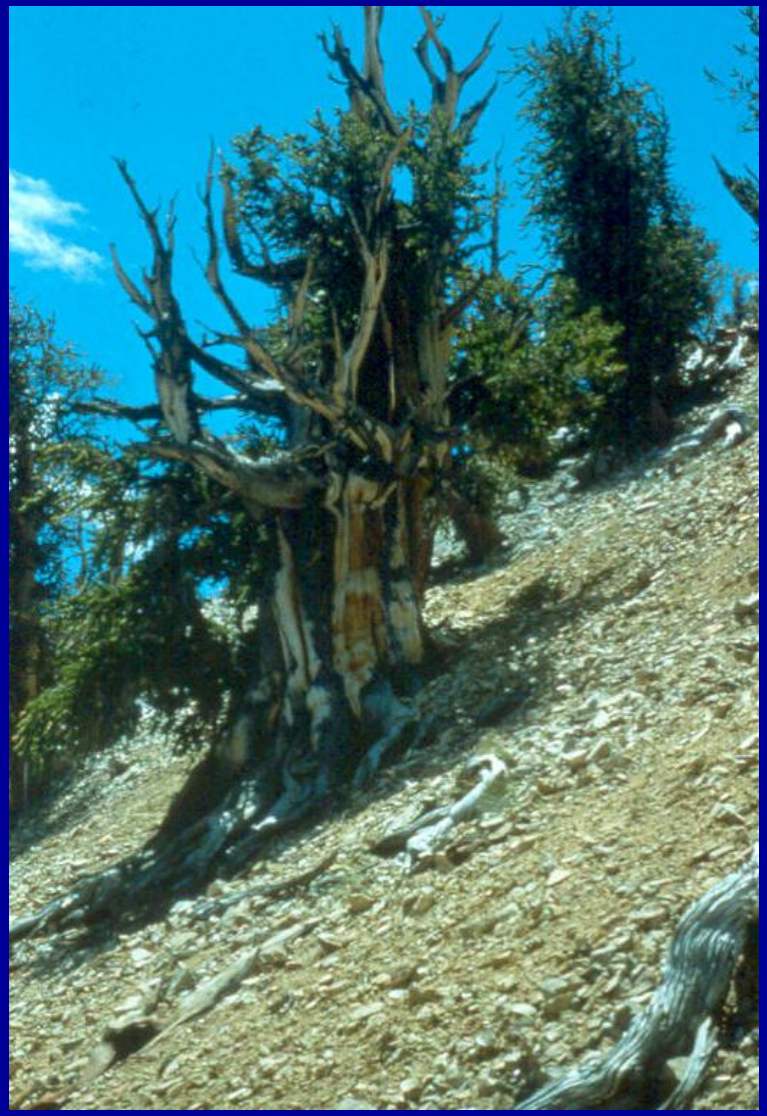
1 - Freezing 2 – Evaporation 3 - Condensation



TODAY'S TOPIC:

"NATURAL ARCHIVES"
as
Global Change Tools

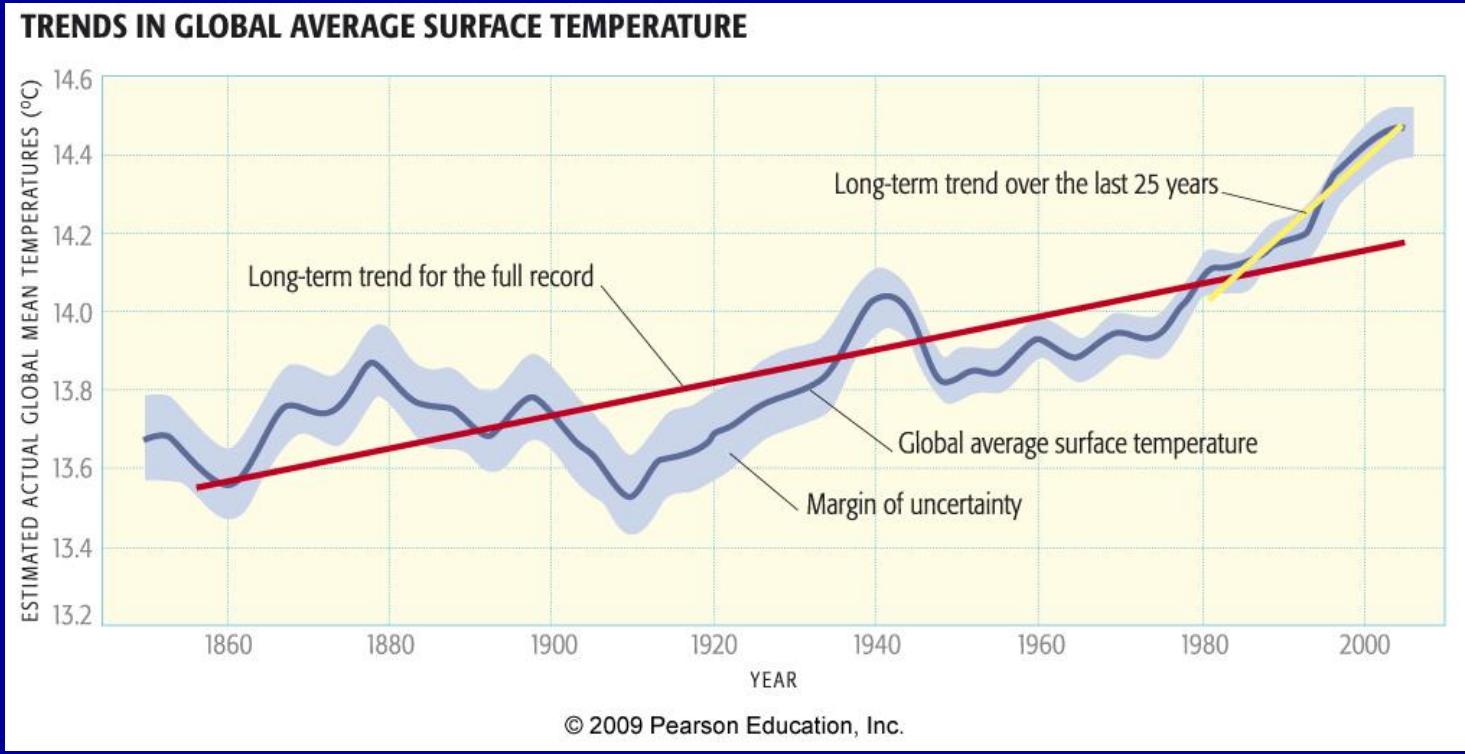
Trees and stones will teach you that which you can never learn from masters.

~ St. Bernard of Clairvaux

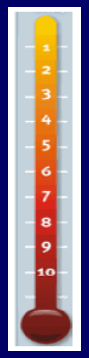
DETECTING GLOBAL WARMING:

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

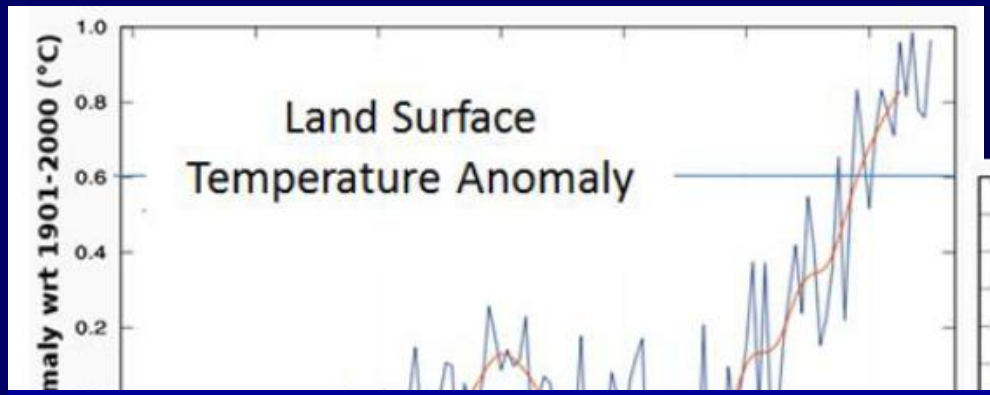
Temperature Trends →



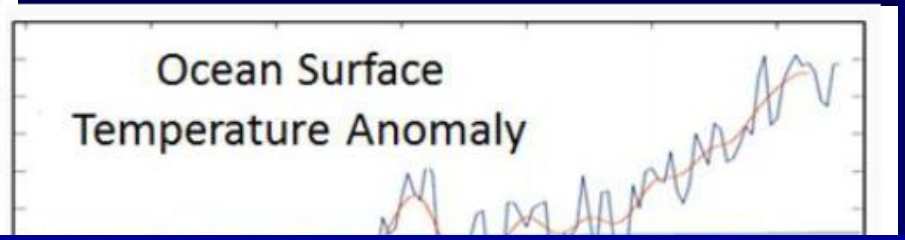
From Dire Predictions, p 36



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 1880 or 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?

Review: p 46

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)

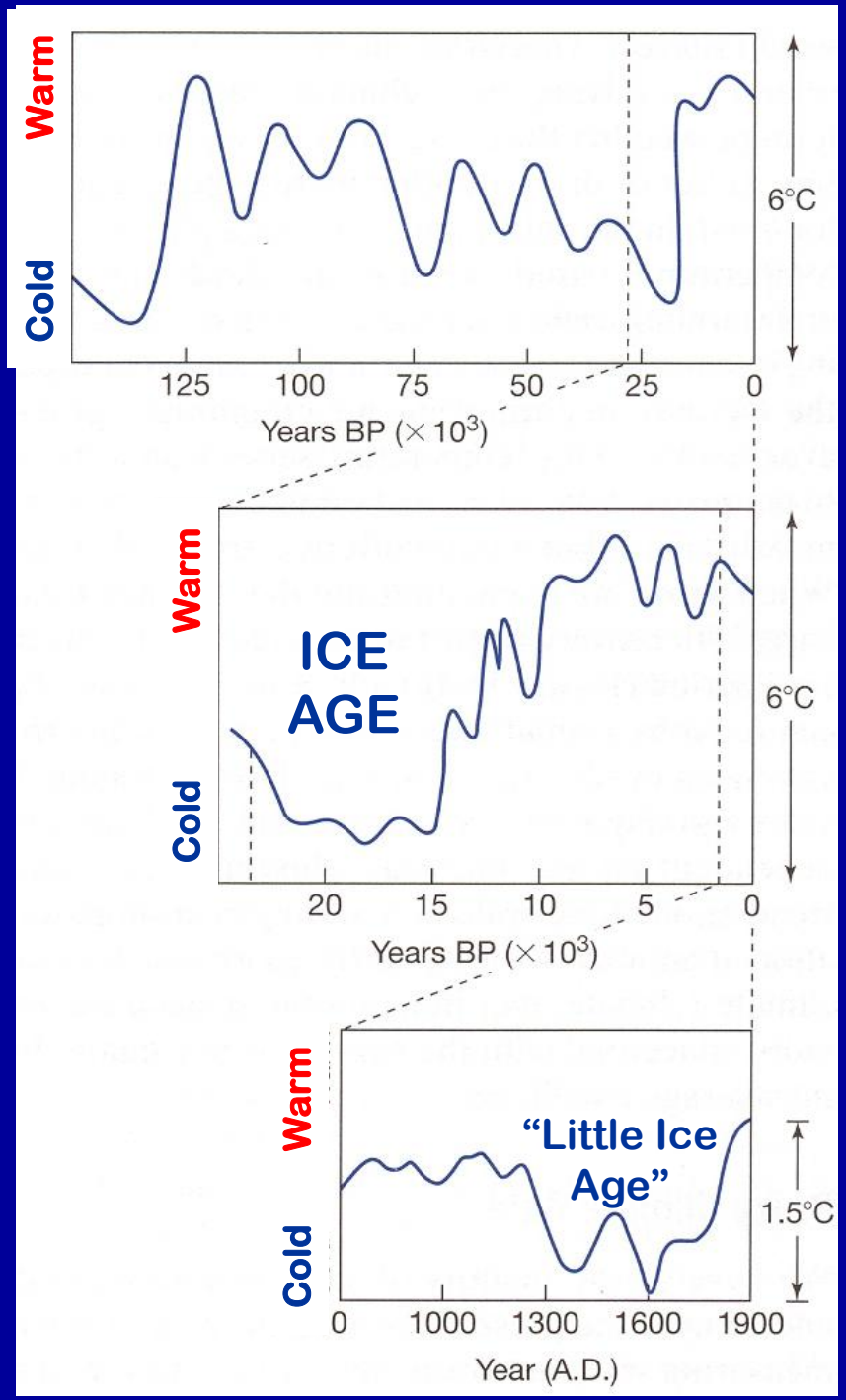
Review: p 21

"NATURAL ARCHIVES" CAN GIVE US INSIGHTS INTO THE PAST . . . .

. . . over different "Telescoping" Time Scales Of Variability about:

Global Temperature Change

Since The Last Glacial Maximum
(Years BP = "years before present")



Generalized oxygen isotope curve from **deep-sea sediments**

Generalized estimates from **pollen data & alpine glaciers** (mid-latitudes of eastern N. America & Europe)

General estimates from **historical documents** (emphasis on the North Atlantic region)

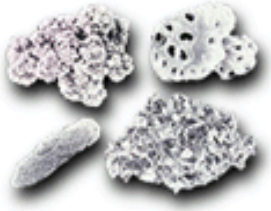
Review: p 21

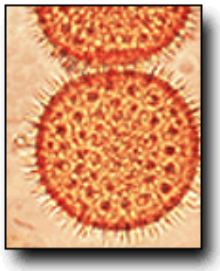
NATURAL ARCHIVES of CLIMATE

(sometimes called "PROXY" DATA)

Corals

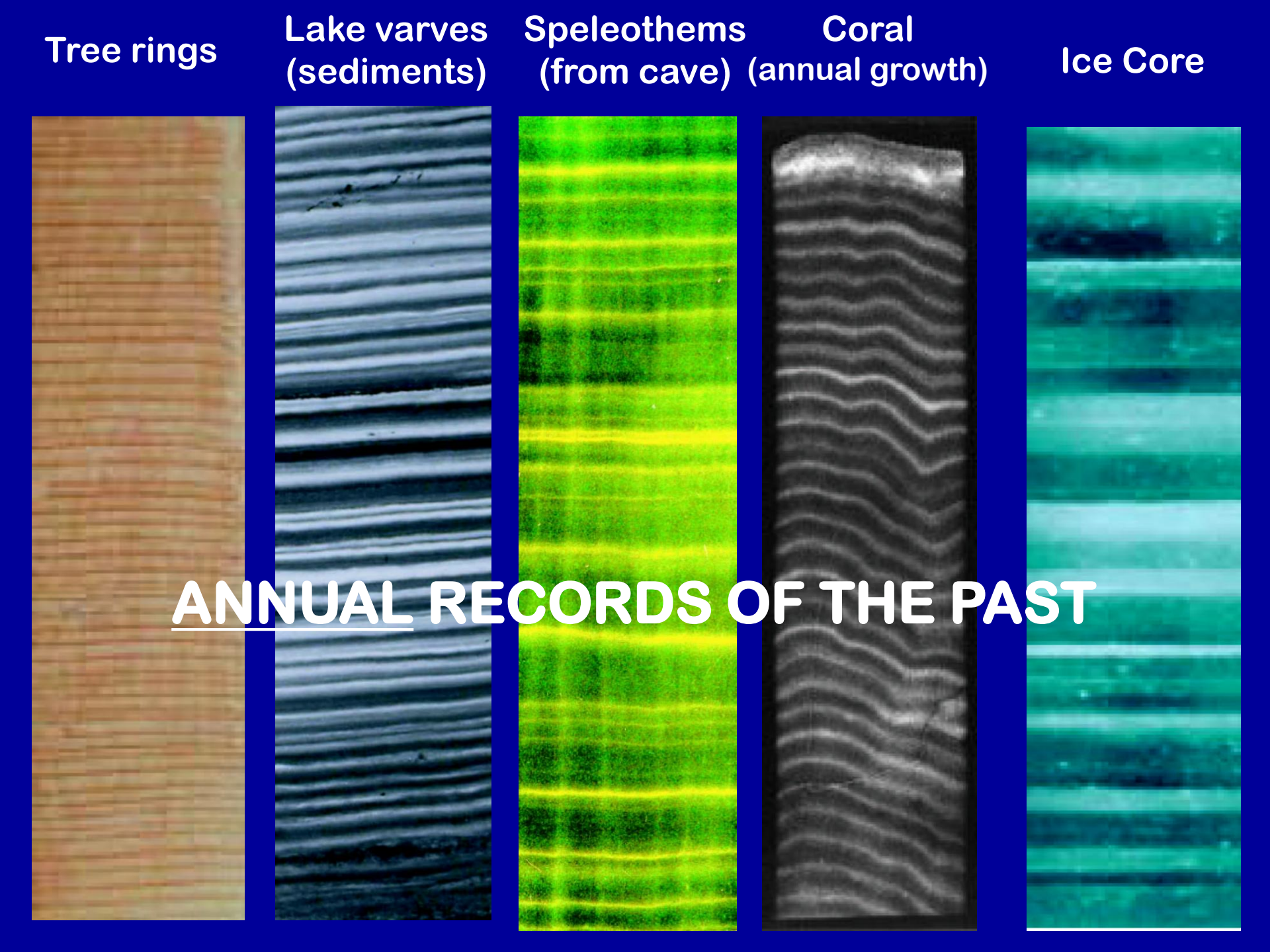
Ice cores





Pollen

Lake, bog & ocean sediments


Tree rings
Lake varves (sediments)
Speleothems (from cave)
Coral (annual growth)
Ice Core
ANNUAL RECORDS OF THE PAST

INTRODUCTION TO TREE RINGS & DENDROCHRONOLOGY Part I

CLASS NOTES
Appendix: p 117

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

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

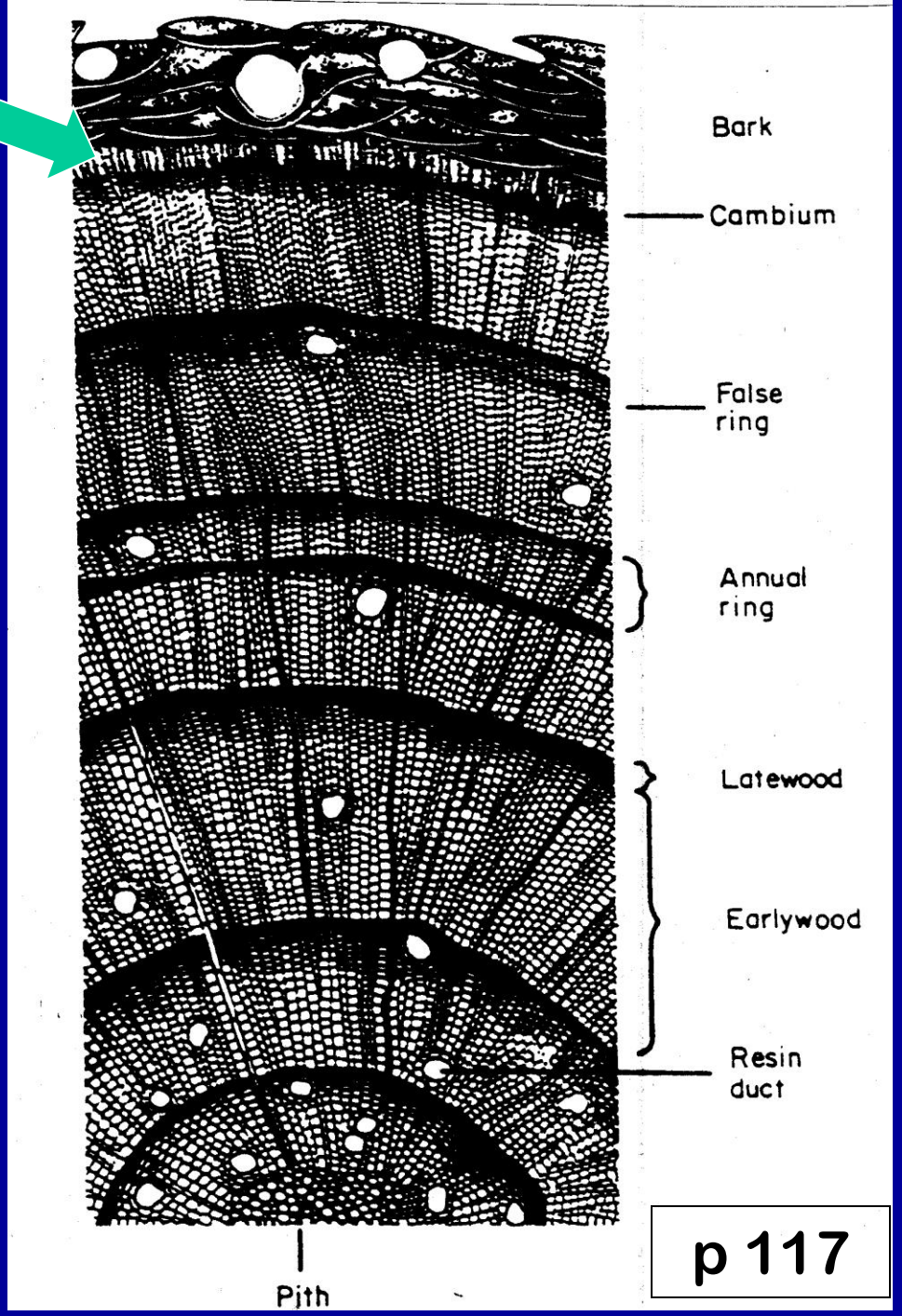
The current year's actively growing cells are just underneath the bark

Partial cross-section of a coniferous tree

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

7 years old

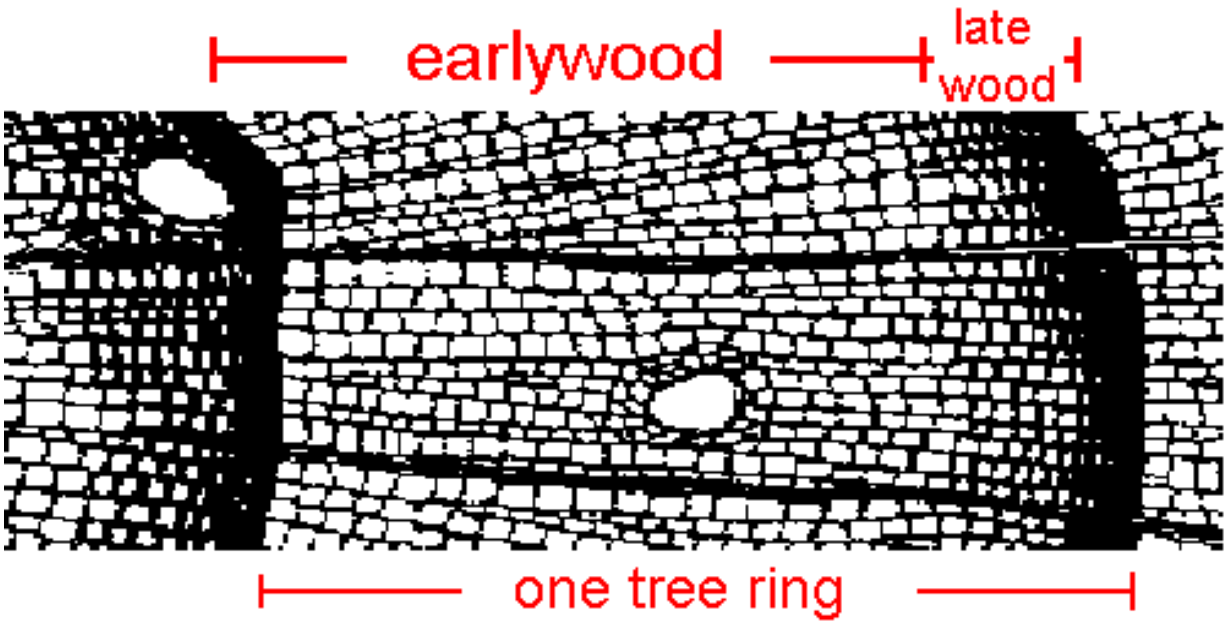
(now in 8th year of growth)



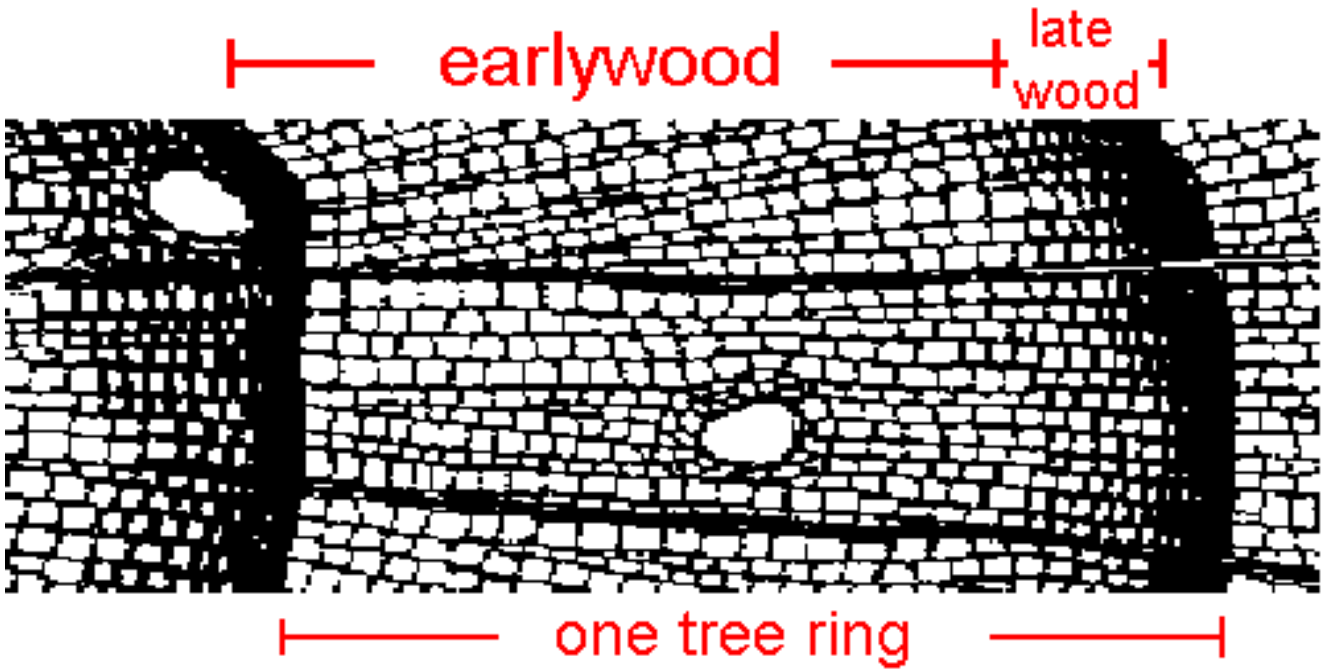
p 117

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

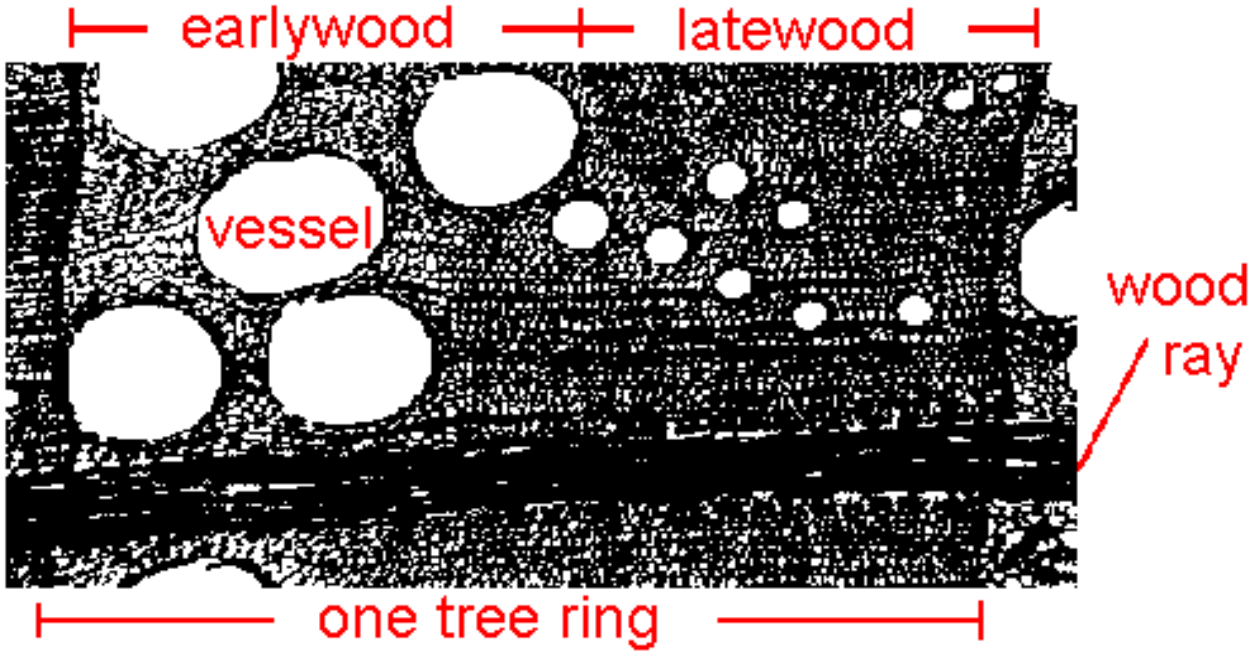
Conifer Tree Ring (cross-section view)



- 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)

The rings display much variation:

Tree growth (adding new cells) is this way

← Pith
(center of tree)

Oldest part of tree

Bark →
(outer rings of tree)

Newest growth of tree

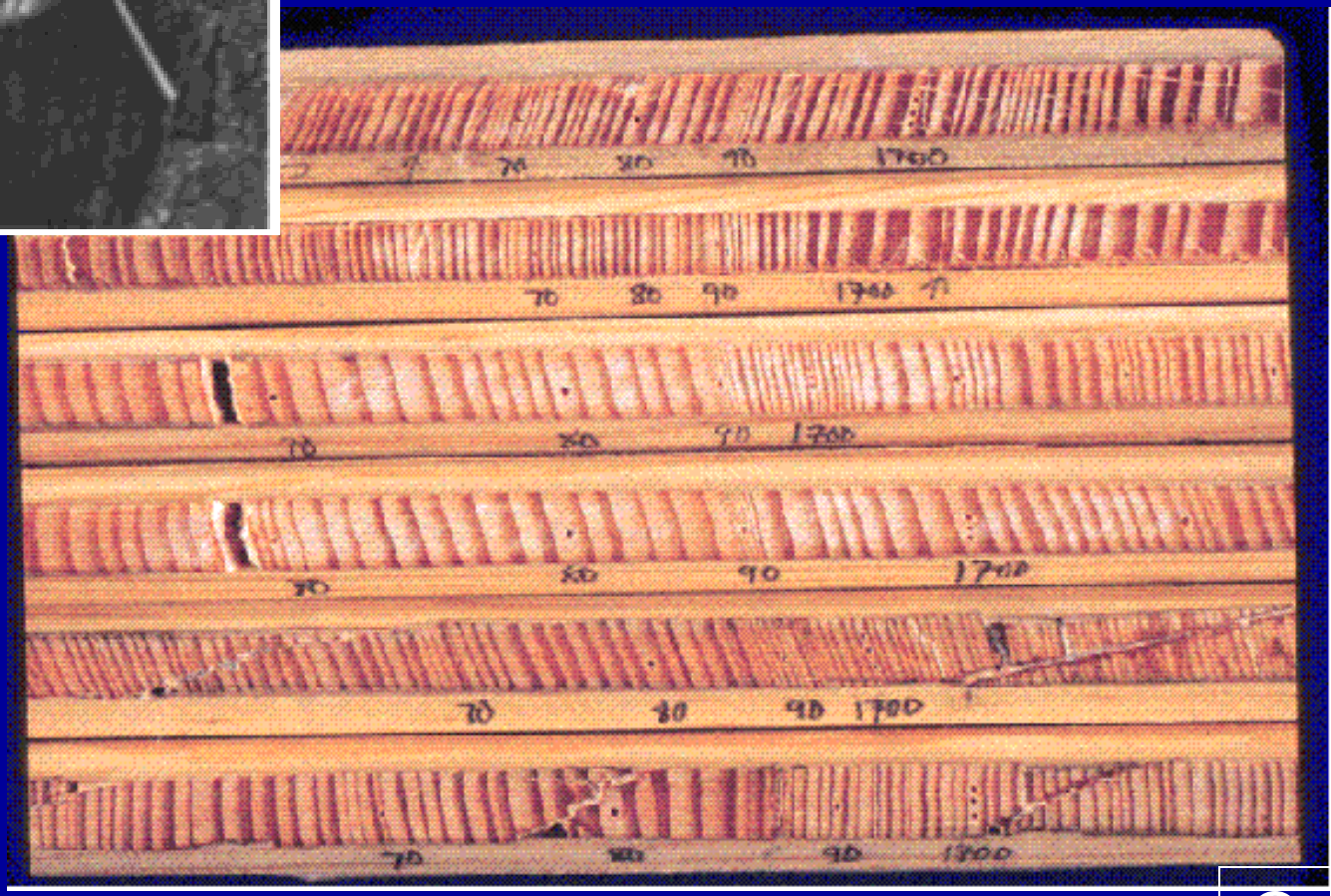
Variation in these rings is due to variation in environmental conditions when they were formed.

(cold or warm temperatures / dry or moist soil conditions, etc. – even insect outbreaks and non-climatic factors, too)

Thus, studying this variation leads to improved understanding of past environmental conditions and is the basis for many research applications of dendrochronology.

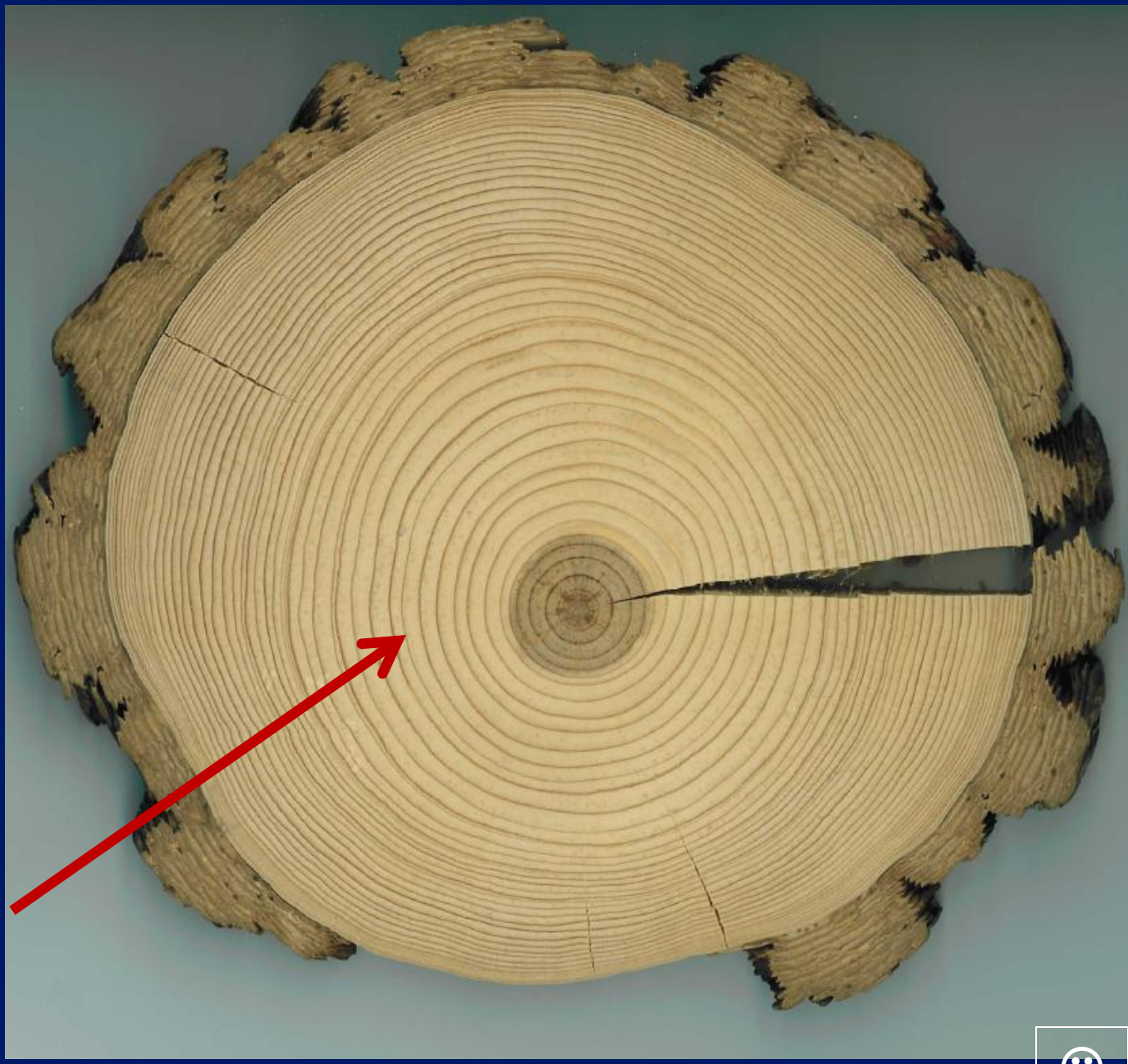
How do we get the tree rings without killing the trees!

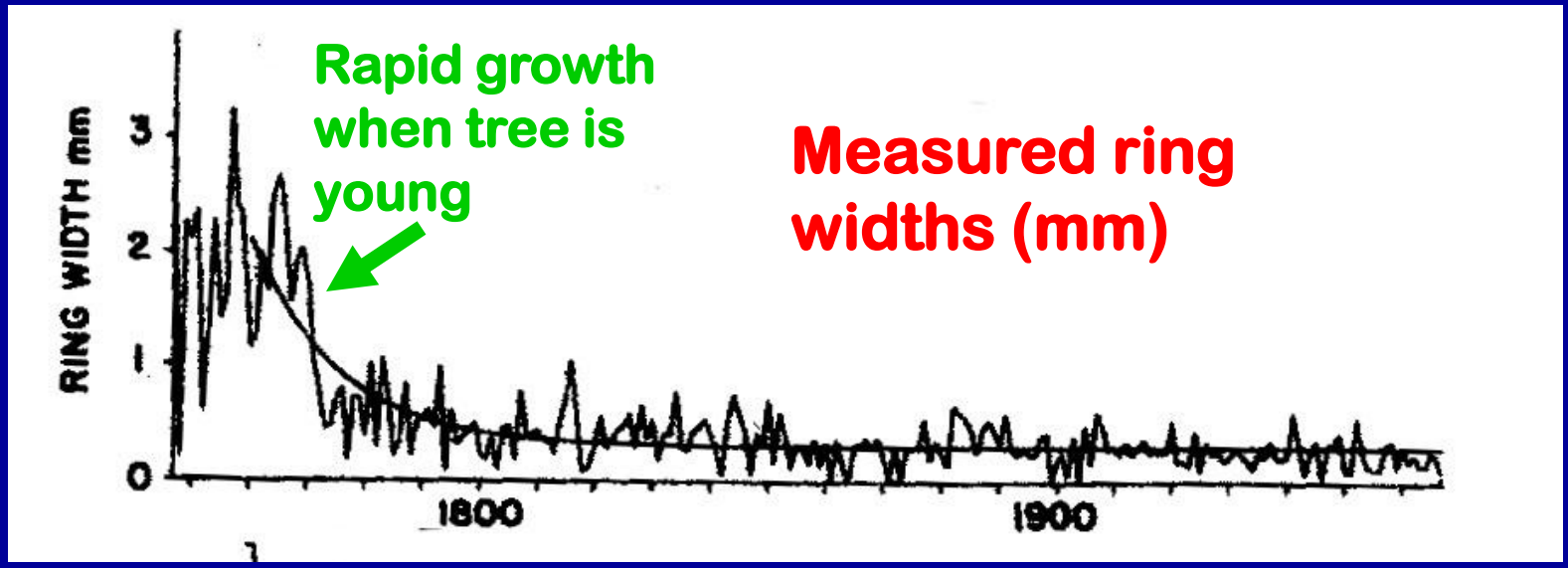
Cores are extracted with an increment borer



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

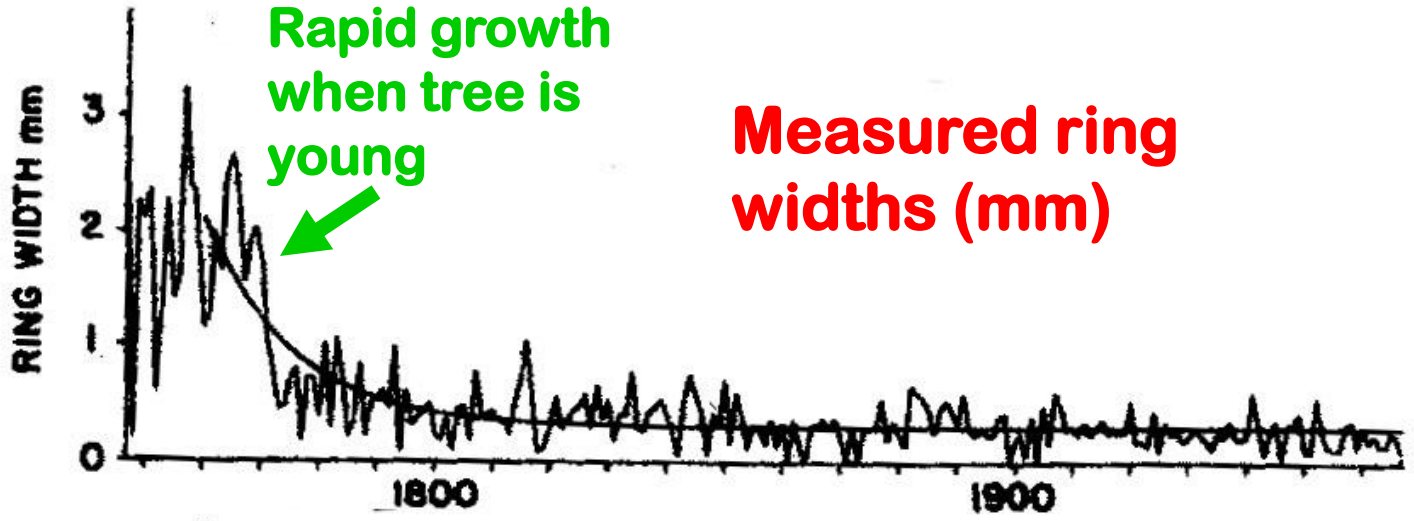
Notice how wide the rings in the center are – this was when the tree was young and growing faster!

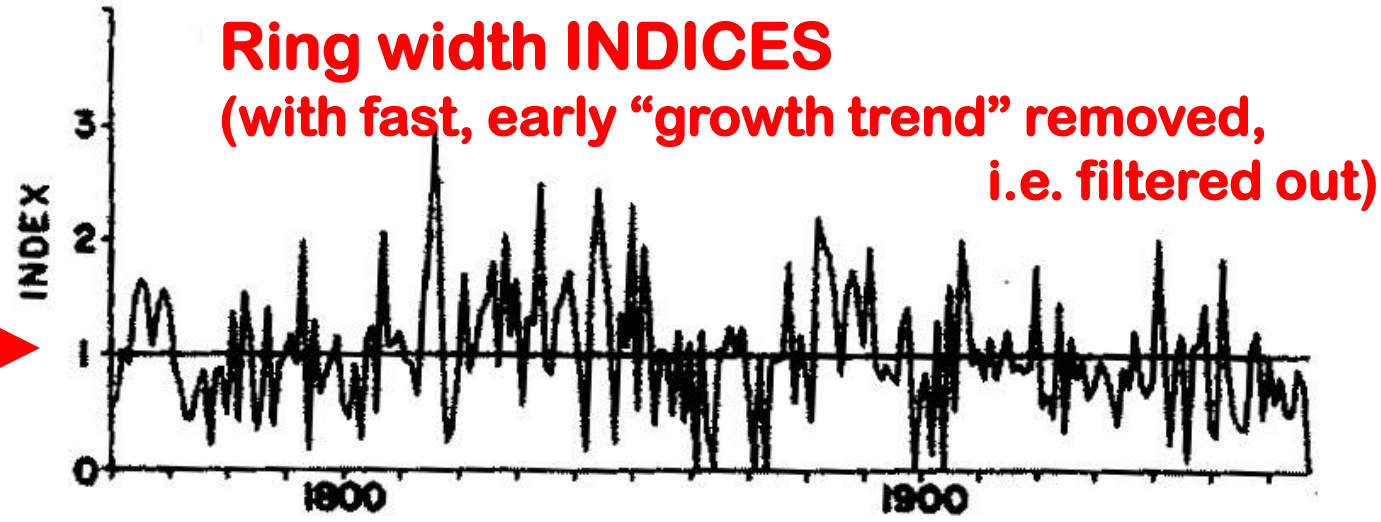




TREE-RING WIDTH CHRONOLOGY

A time series plot!

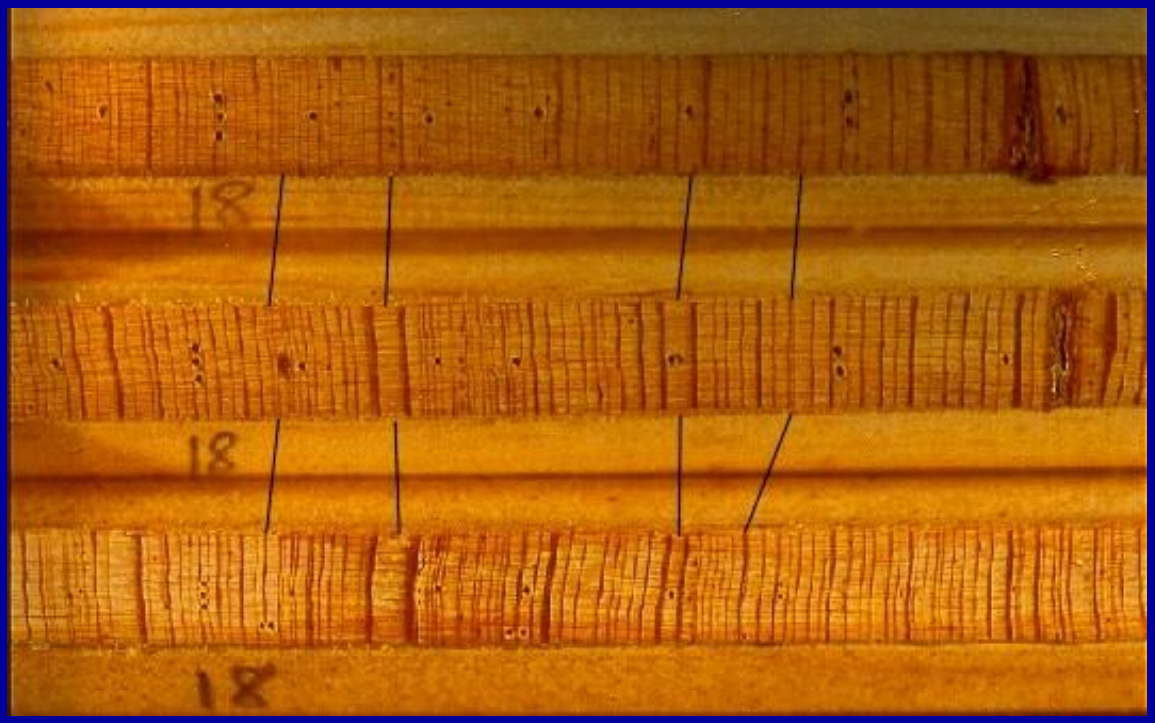


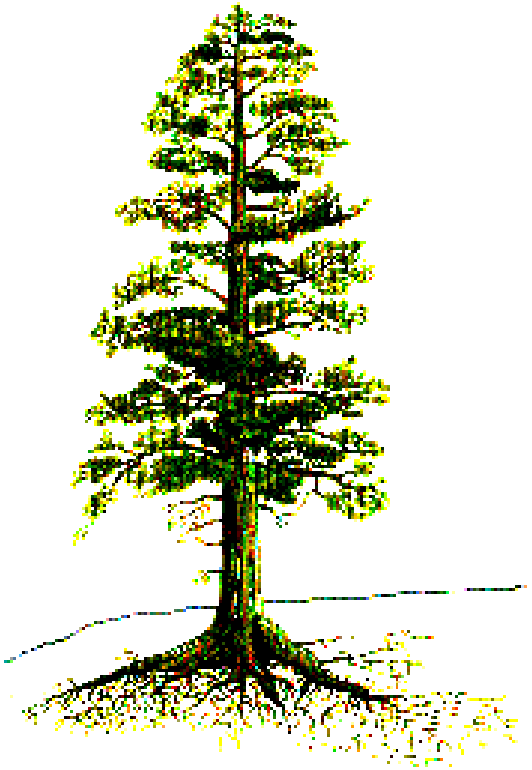


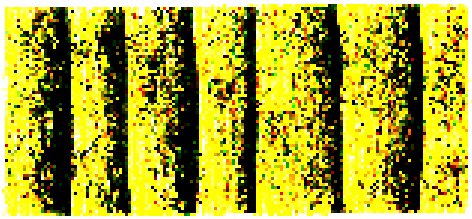
TREE-RING WIDTH CHRONOLOGY

"CROSSDATING" = matching patterns in rings of several tree-ring series to allow precise dating to exact year.

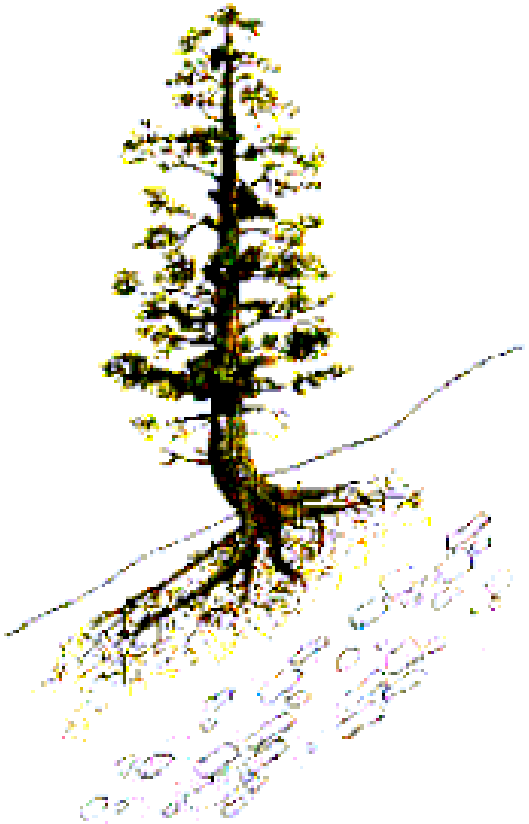
Can be done most easily with a **SENSITIVE tree ring width series** with lots of variation in wide and narrow rings (esp. the NARROW ones)!

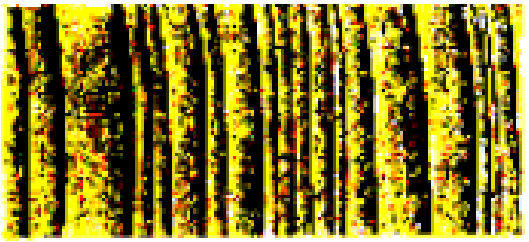






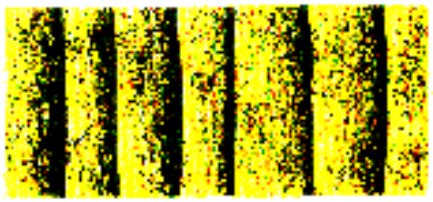
Complacent





Sensitive

"COMPLACENT" TREE GROWTH:



- **Little ring width variation** & rings roughly same width

- **Growth not limited** in certain years

- Favorable growing sites; moisture probably available: (deep soil, close to water)

- **Difficult to crossdate: matching patterns is harder when not much variation exists !**

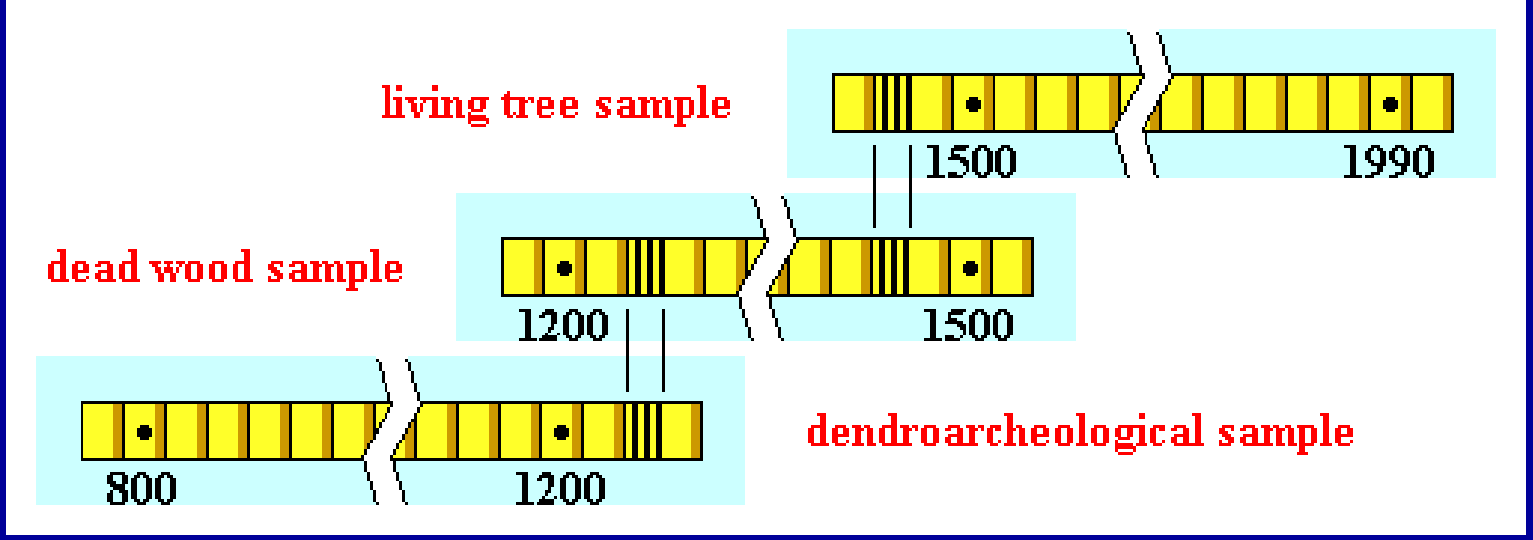
"SENSITIVE" TREE GROWTH:

- **Lots of ring width variation** w/ wide and narrow rings intermixed over time

- **Factors which could limit growth** in a particular year (e.g., rainfall) are highly variable year to year

- Especially true for harsh sites (e.g., steep/rocky)

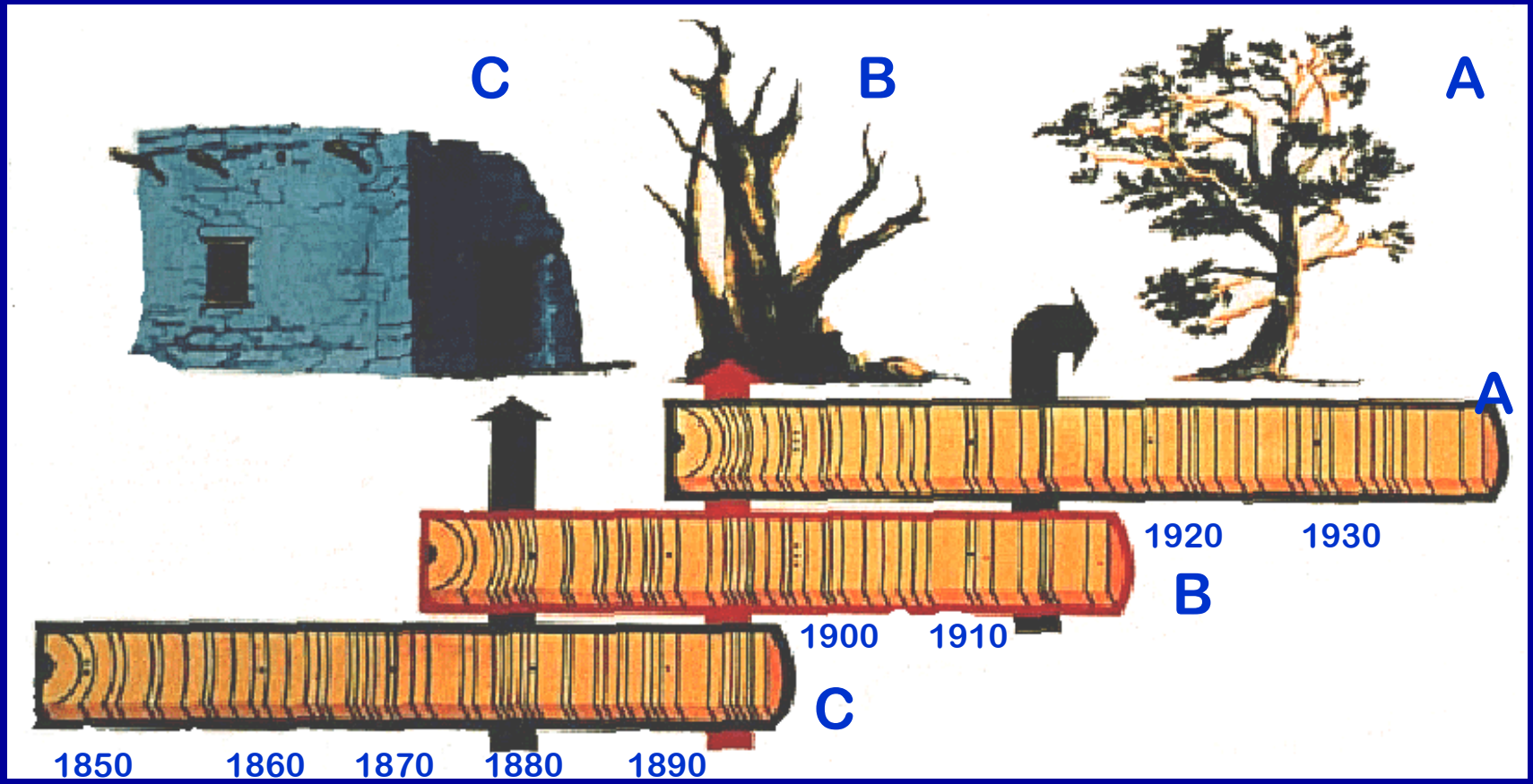
- **Easier to crossdate:**
  Can match patterns of wide and narrows rings from tree to tree when ample variation exists



After crossdating, dendrochronologists can:

- **Assign the true year of formation for every ring of each sample**
- **Analyze past environmental and/or human events.**
- **Overlap crossdated samples (as above) to extend the record back in time:**

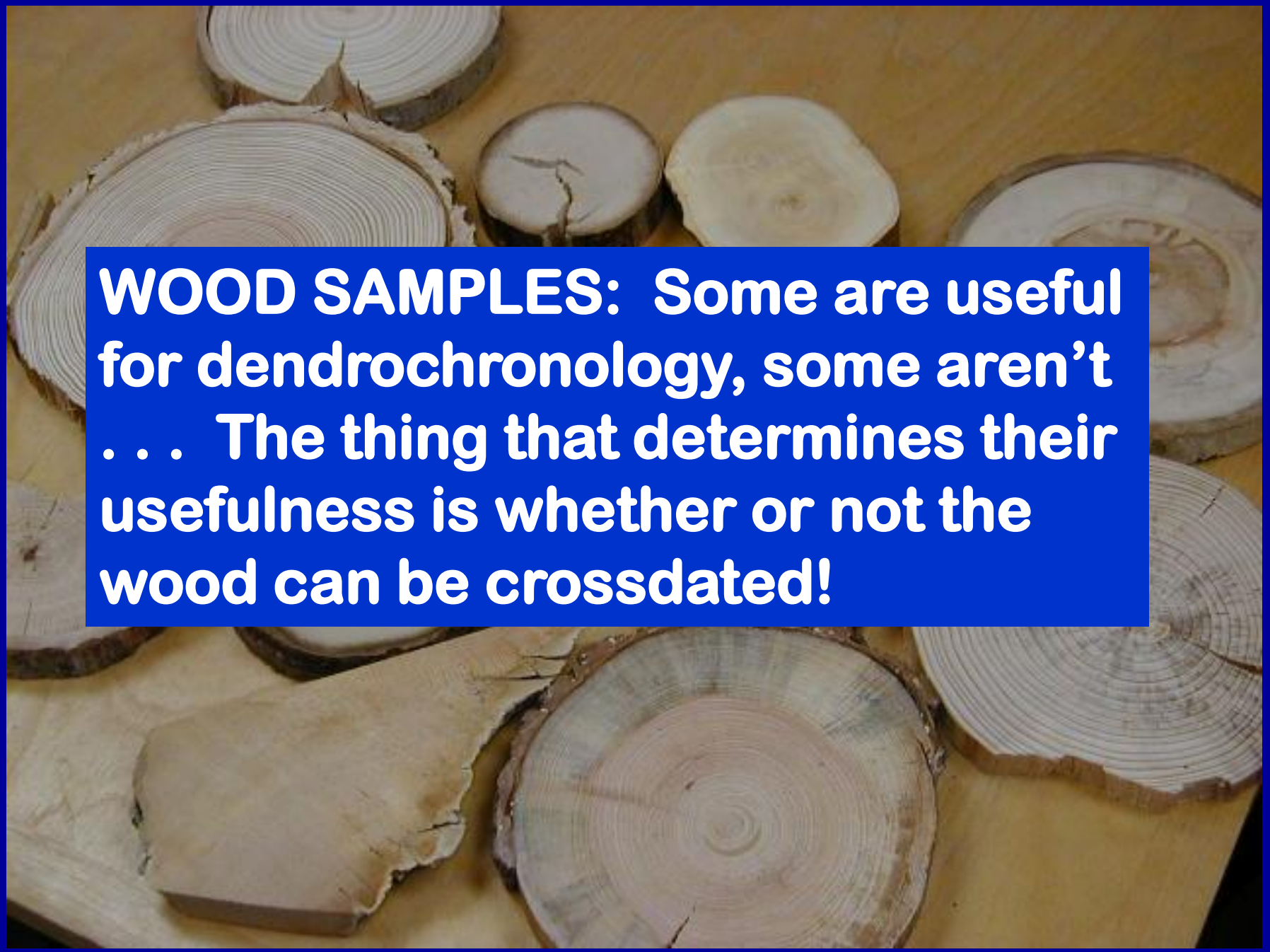
CROSSDATING: The Basic Principle of Dendrochronology



Calendar dates can be assigned throughout the record from known dates in the present, back in time!

NEXT: G - 3 “Wood Kits”

Classifying Wood Samples from Different Types of Trees to see if they are good candidates for CROSSDATING!


WOOD SAMPLES: Some are useful for dendrochronology, some aren't . . . The thing that determines their usefulness is whether or not the wood can be crossdated!

THE CHARACTERISTICS THAT MAKE A TREE SUITABLE FOR CROSSDATING :

- the tree has a ring growth structure
  (not all trees have rings!)

- the tree-ring boundaries are distinct

- the tree rings are annual, i.e., one ring is formed each calendar year
  (hard to tell just by looking!)

p 119
bottom

THE CHARACTERISTICS THAT MAKE A TREE SUITABLE FOR CROSSDATING (cont.):

- the tree growth pattern is sensitive not complacent

. . . . so that variations from year-to-year ("interannual variations") show enough variations and distinct patterns that can be matched from core to core and tree to tree.

THE CHARACTERISTICS THAT MAKE A TREE SUITABLE FOR CROSSDATING (cont.):

the tree growth pattern has
"circuit uniformity"

i.e. the rings are continuous around the entire circumference of the tree

(so that the same ring pattern will appear if you core different sides of the tree.)

- the length of tree-ring record is long enough so that a valid pattern match can be made

  (in general, a tree-ring record of 50 continuous rings or more is needed)

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.

When you complete G-3, you will be ready for INDIVIDUAL ASSIGNMENT I-2 which will be explained and assigned after the Midterm Exam

But first, let's finish up the G-2 Assignment!!