Dating – what it is and how it is done?

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Lecture notes by M.K. Hughes and T.W. Swetnam,
modified by Ramzi Touchan, DISC: Dendro Intensive Summer Courses Pression
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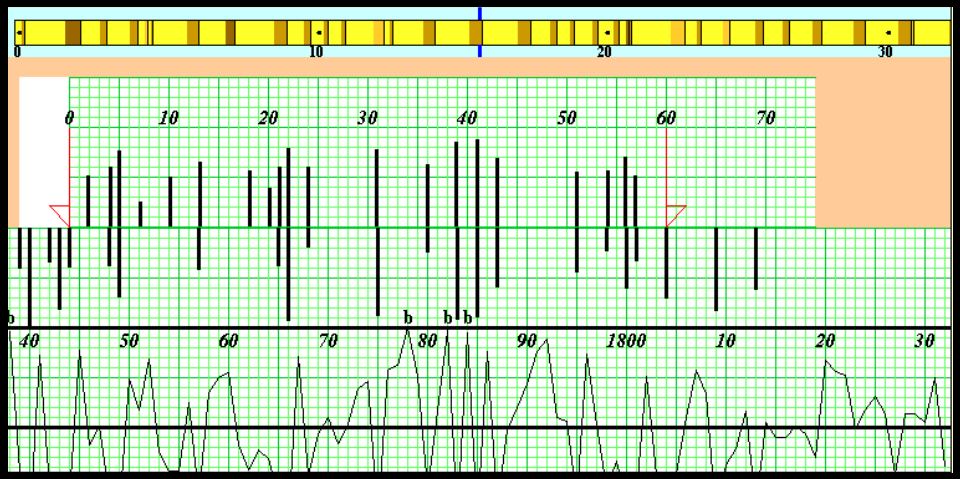
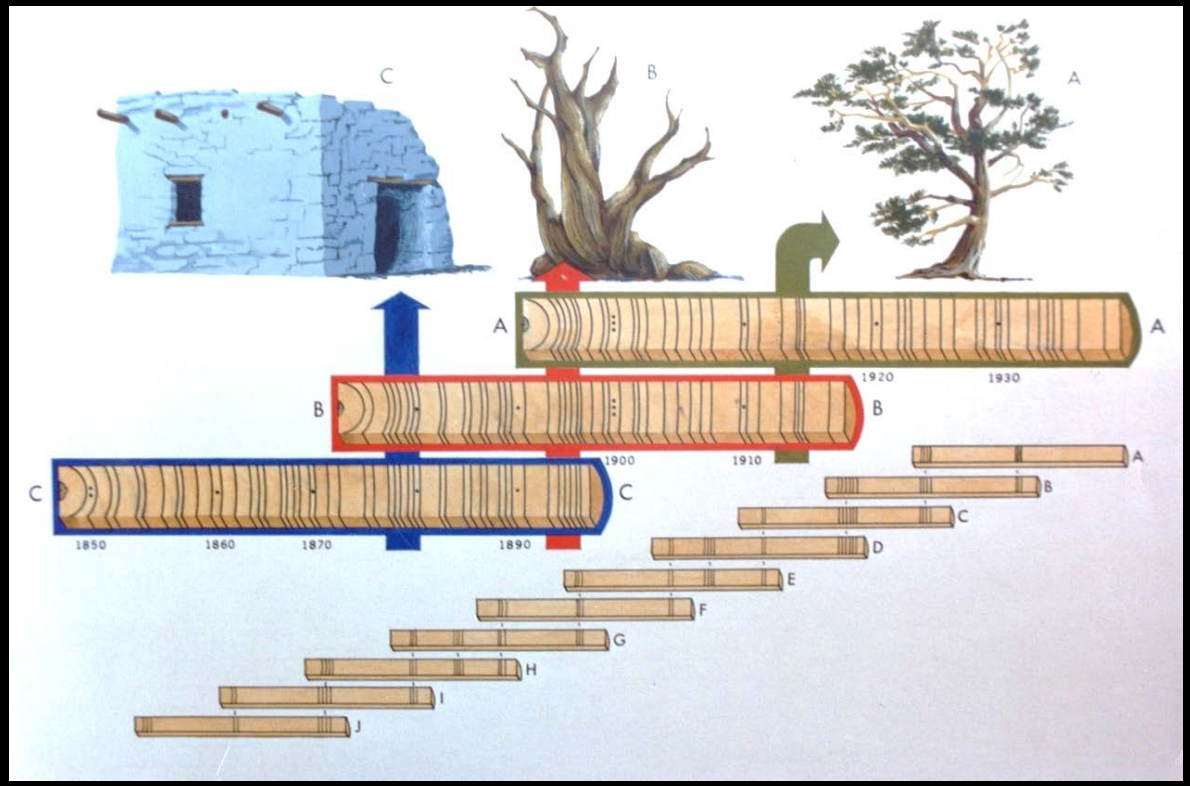
Dating – what it is and how it is done?



- What is cross-dating?
- "On-the-wood dating"
- Memory aids
- Rules of evidence
- A look forward – making a site dating chronology

Crossdating: The Basic Principle of Dendrochronology

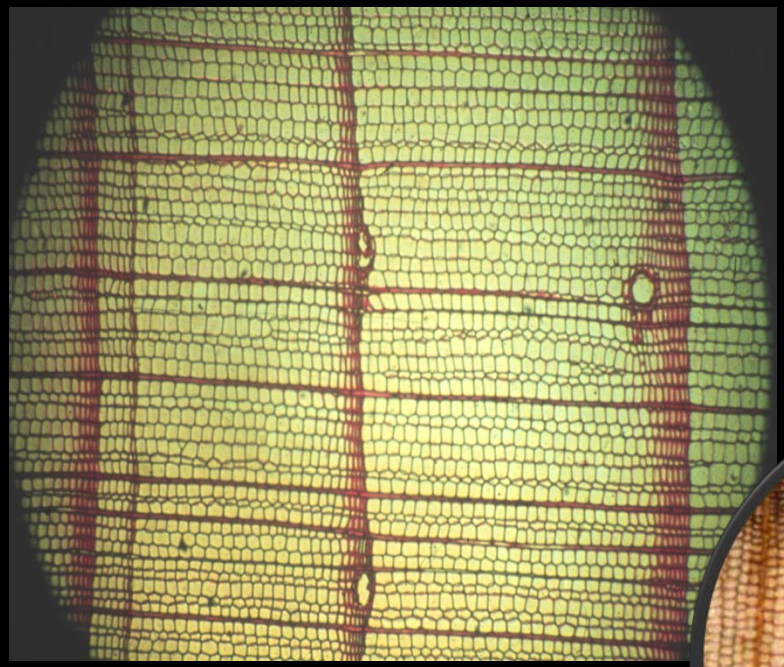
This is a term used to describe the process of assigning year dates to annual tree rings by cross-comparison of rings from several trees growing in the same area (Stoke & Smiley 1968).

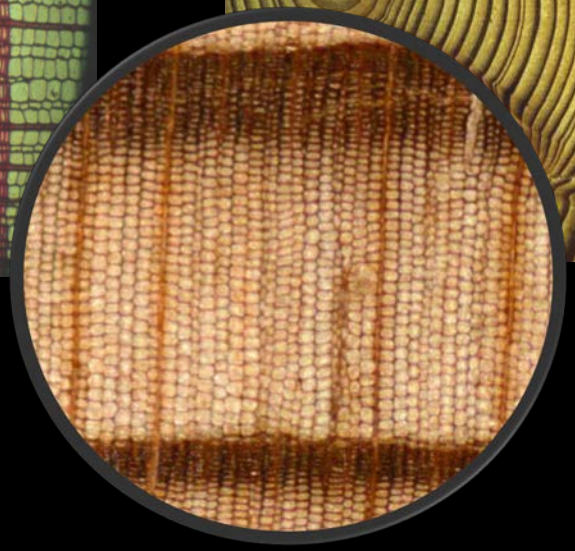


<<<<<<<"Bridging" back in time<<<<<<<

WHAT IS CROSSDATING

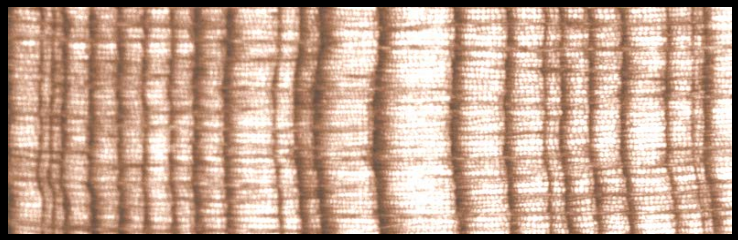
1. The trees that will be used for crossdating should produce one ring for each year.





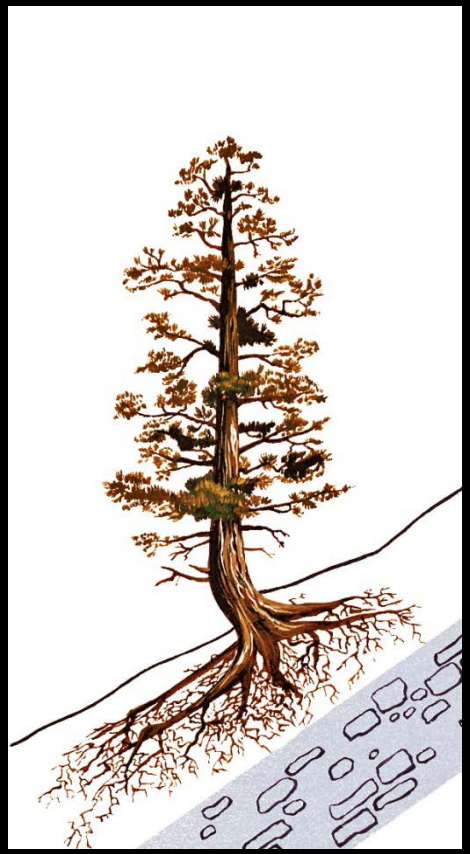
WHAT IS CROSSDATING

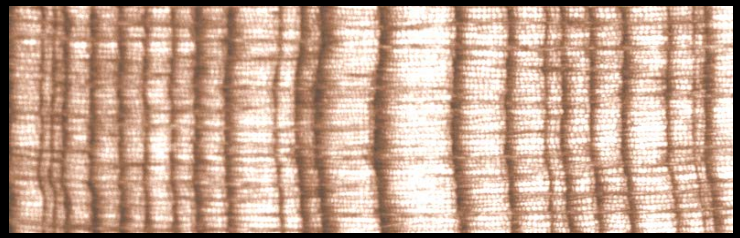
2. One environmental factor must dominate in limiting the annual growth such as precipitation or temperature.



WHAT IS CROSSDATING

3. The intensity of growth-limiting environmental factor must vary from year to year and the resulting annual rings faithfully reflect such variation in their growth.



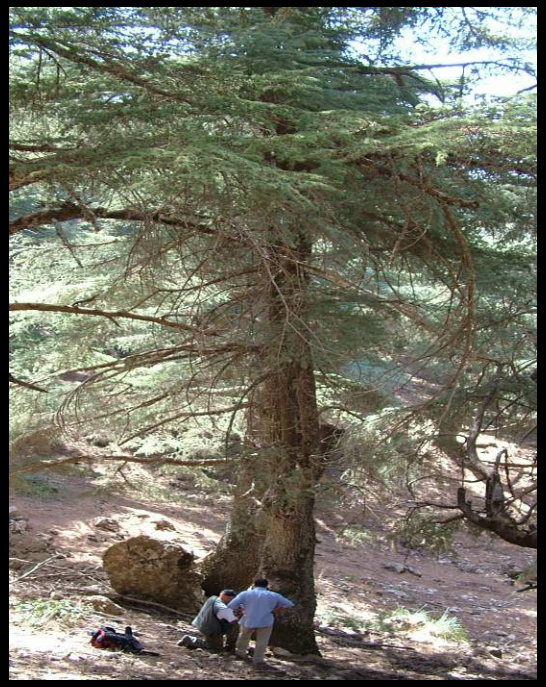


Sensitive

WHAT IS CROSSDATING

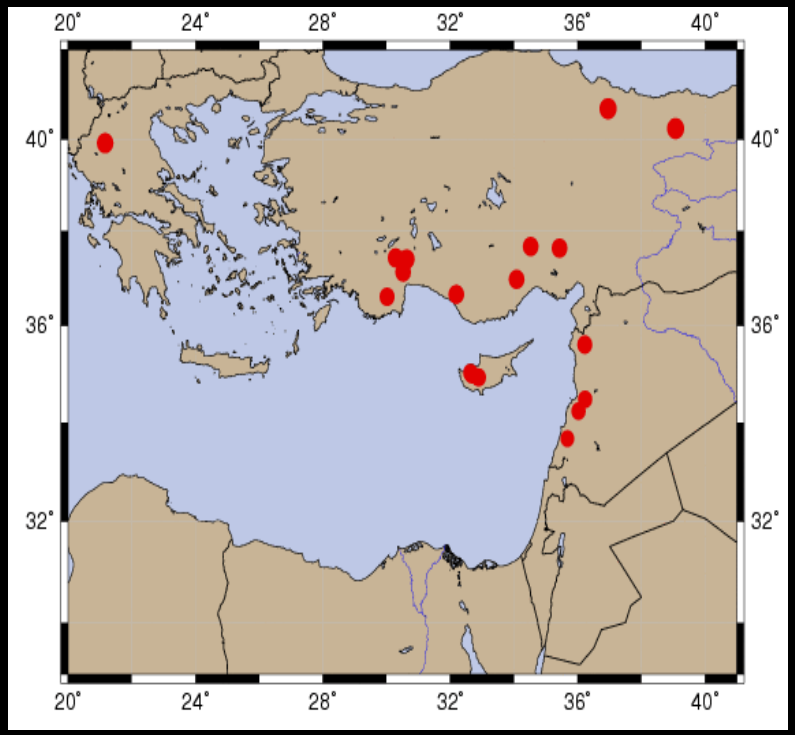
3. The intensity of growth-limiting environmental factor must vary from year to year and the resulting annual rings faithfully reflect such variation in their growth.

Complacent



WHAT IS CROSSDATING

4. The growth-limiting factor must be effective over a large geographical area.



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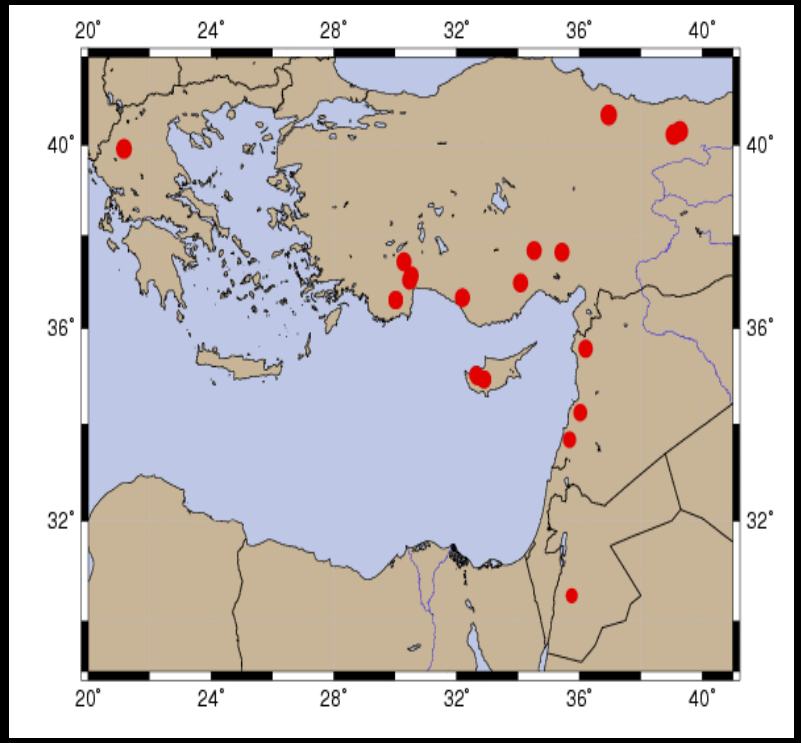
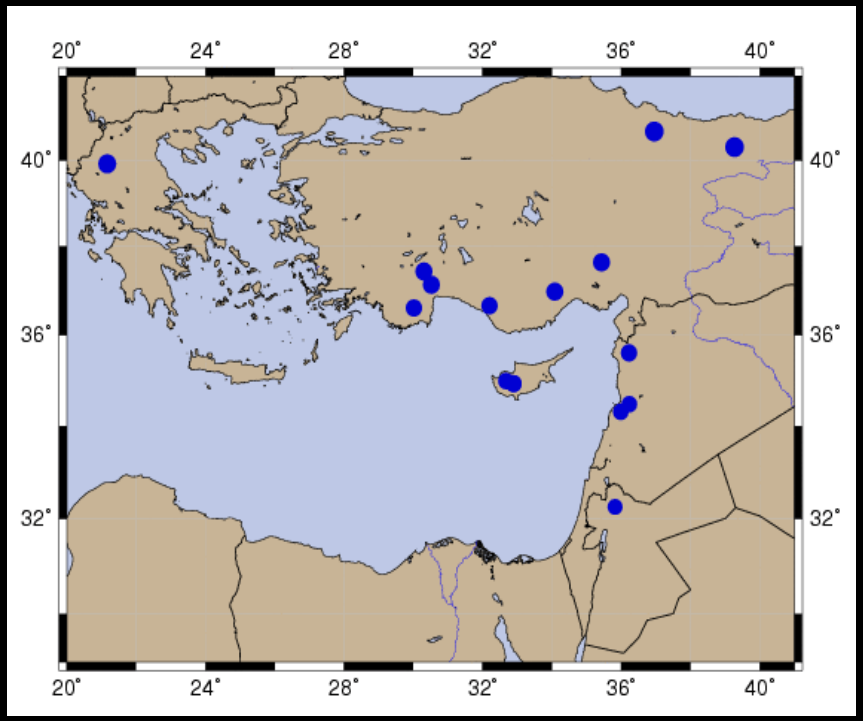


1949

WHAT IS CROSSDATING

4. The growth-limiting factor must be effective over a large geographical area.



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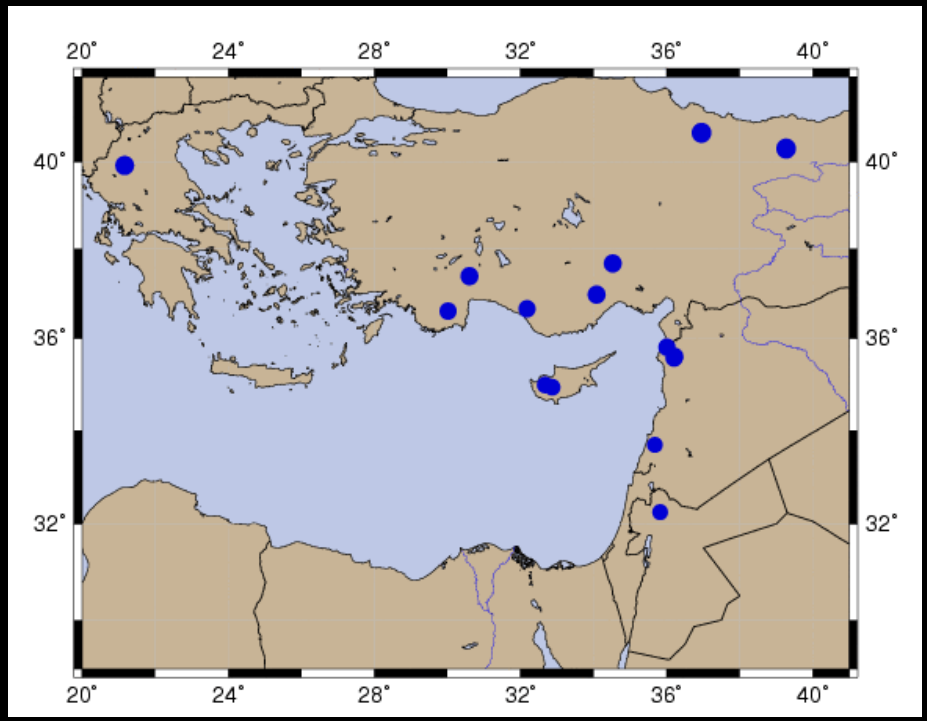
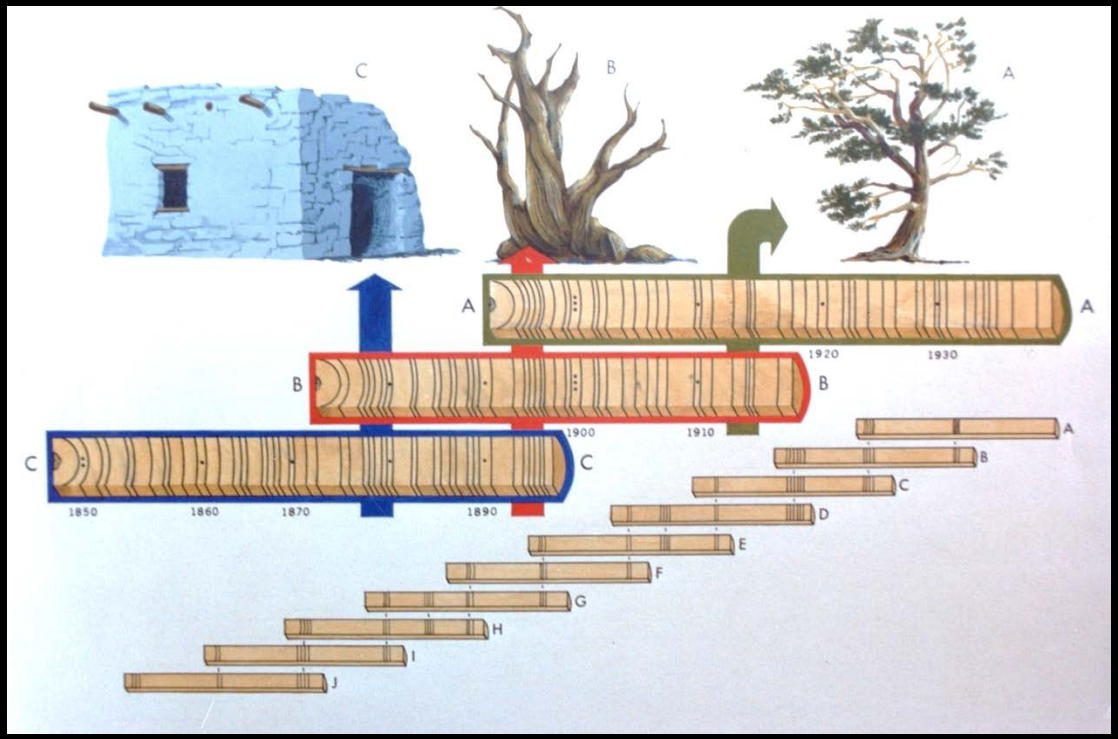


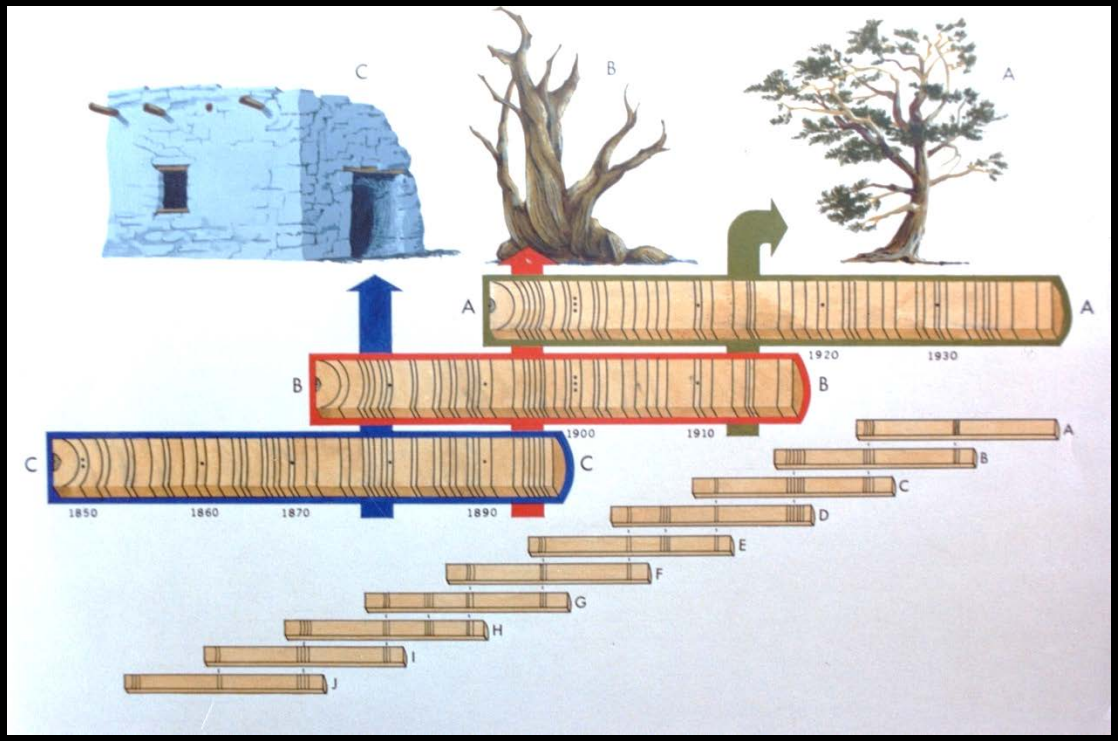
1979

What is cross-dating?



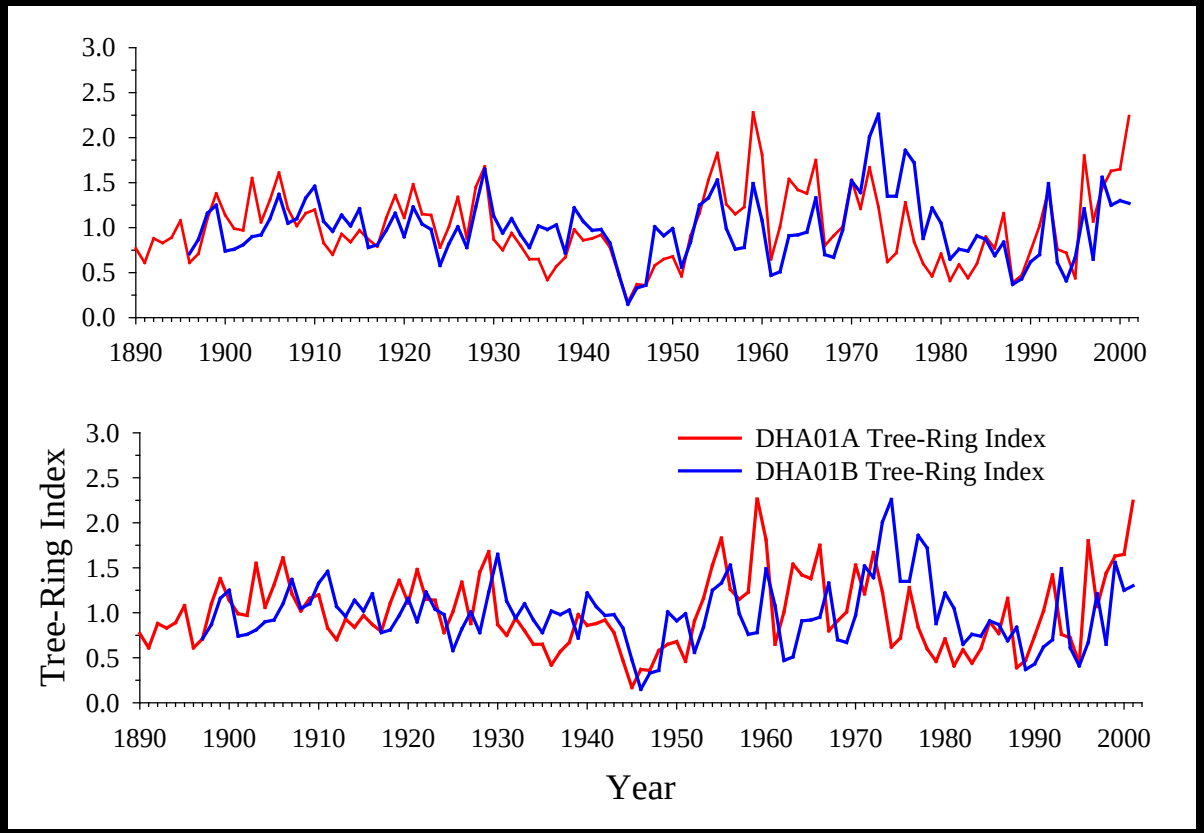
- If the shared pattern of **inter-annual variability** in tree-ring properties is strong enough, and if a long enough series of rings is available in each case, it is possible to match the ring pattern of wood of unknown age against dated wood and thus attribute each growth ring in the former sample to a calendar year.

What is cross-dating?



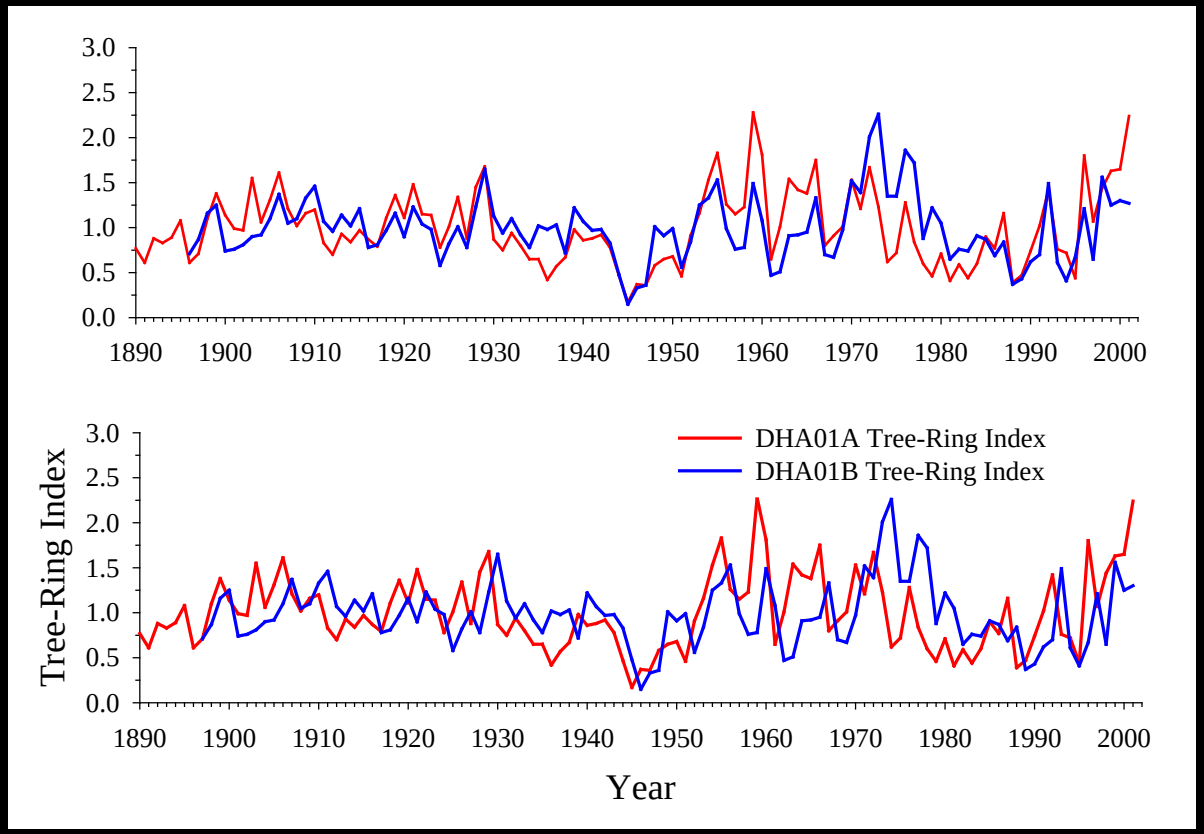
So – we date each ring. After that we may use the dates of the rings to draw conclusions about the piece of wood or the tree.

Why interannual variability?



Because it's the only way to get dates good to a particular year!

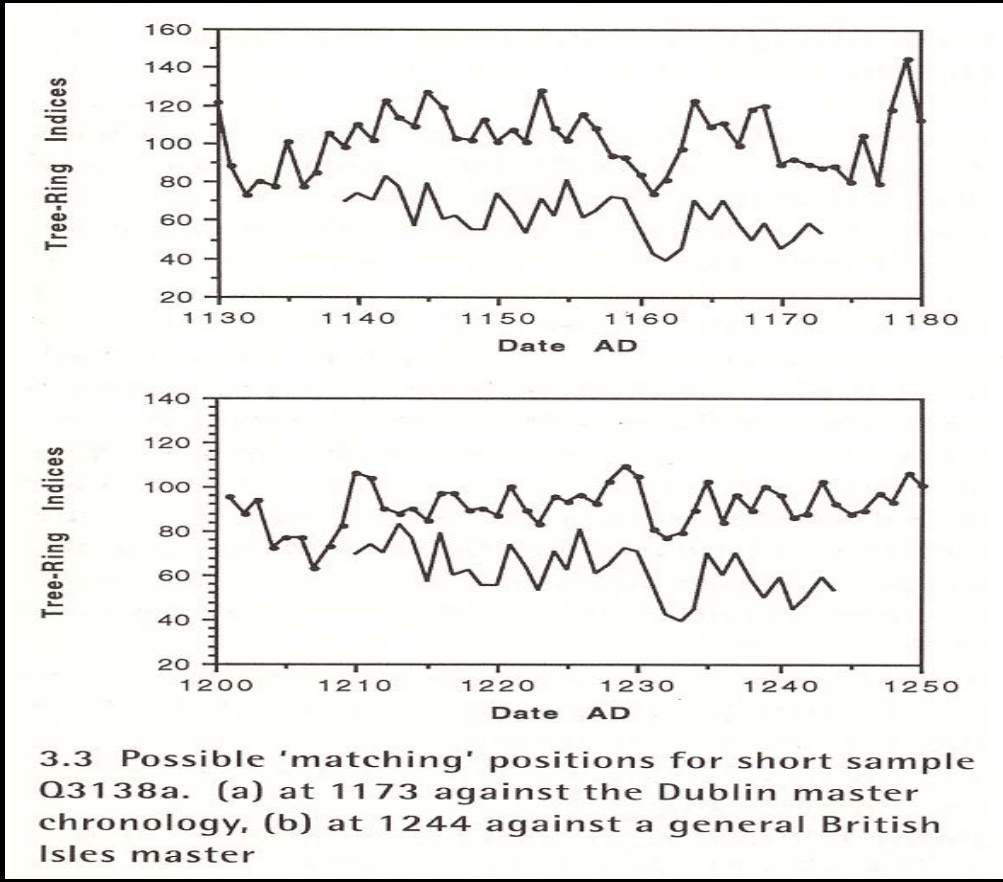
Why **interannual variability?**



Because it provides many more points of comparison, and hence eventually allows better statistical quality control.

Why "a long enough series of rings"?

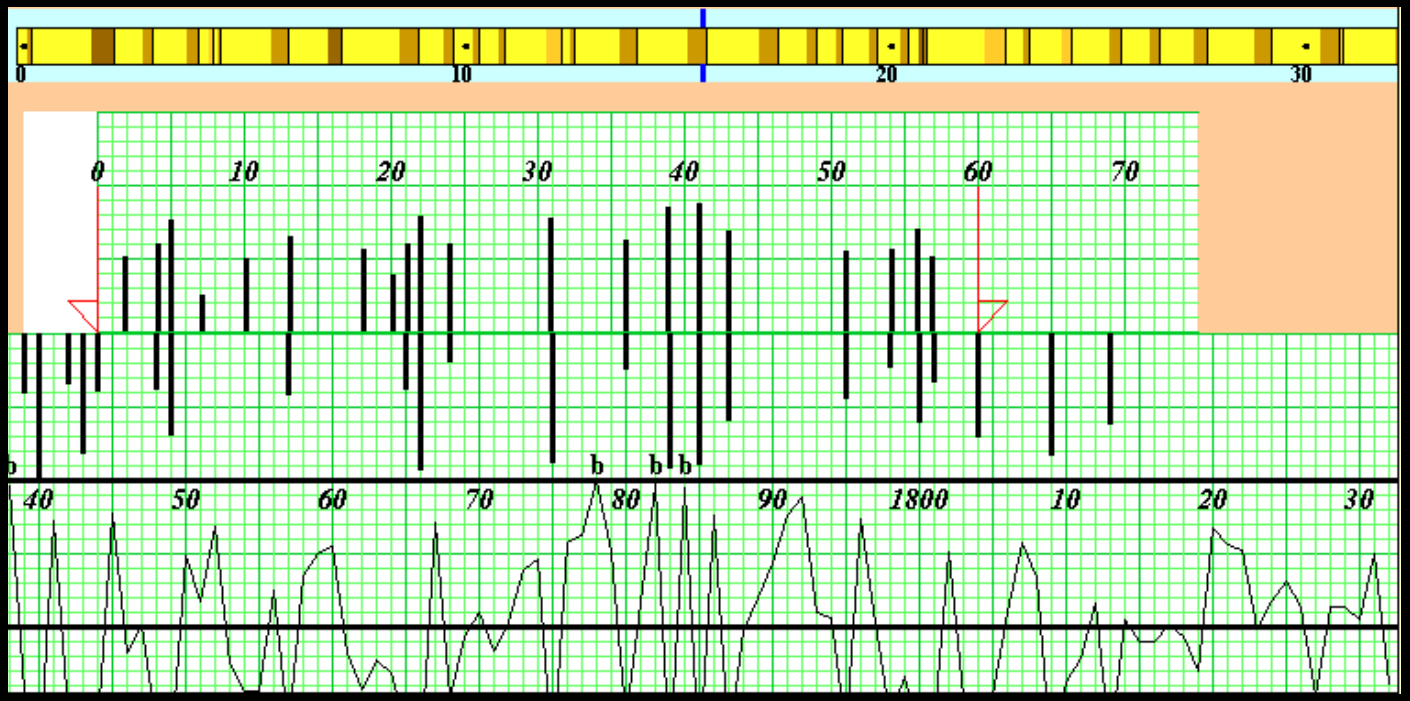
- A piece of wood with only twenty rings, matched against another piece with a thousand, or against a chronology, is much more likely to match in several different positions, equally well, than a piece with 200 rings.



3.3 Possible 'matching' positions for short sample Q3138a. (a) at 1173 against the Dublin master chronology, (b) at 1244 against a general British Isles master

Baillie, 1995

What is "a long enough series of rings"?

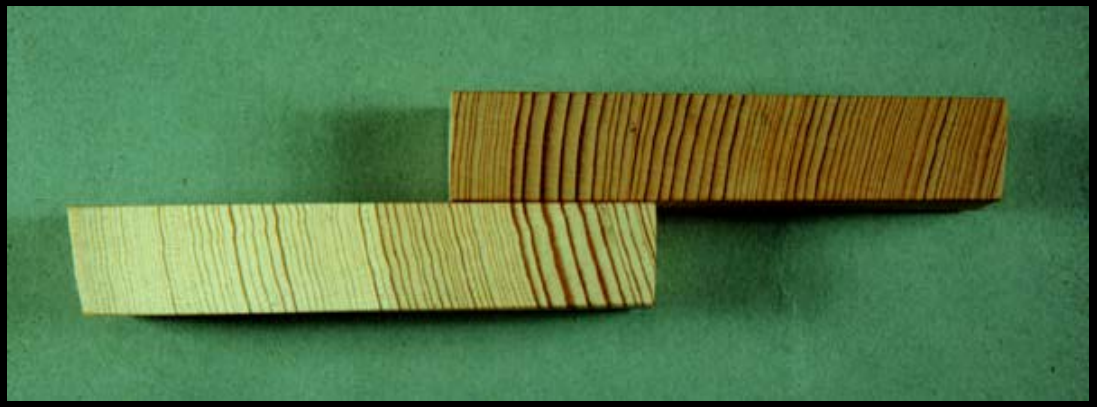


- The minimum number of rings that can be matched securely will depend on the strength of the shared pattern of interannual variability.

- We can see these features on the crossdating applet at :
- http://tree.ltrr.arizona.edu/skeletonplot/SkeletonPlot18.htm

"On-the-wood dating"

- This would be the ideal, where we could directly compare all the features of each piece of wood directly with others of known dates, and then assign rings to years.

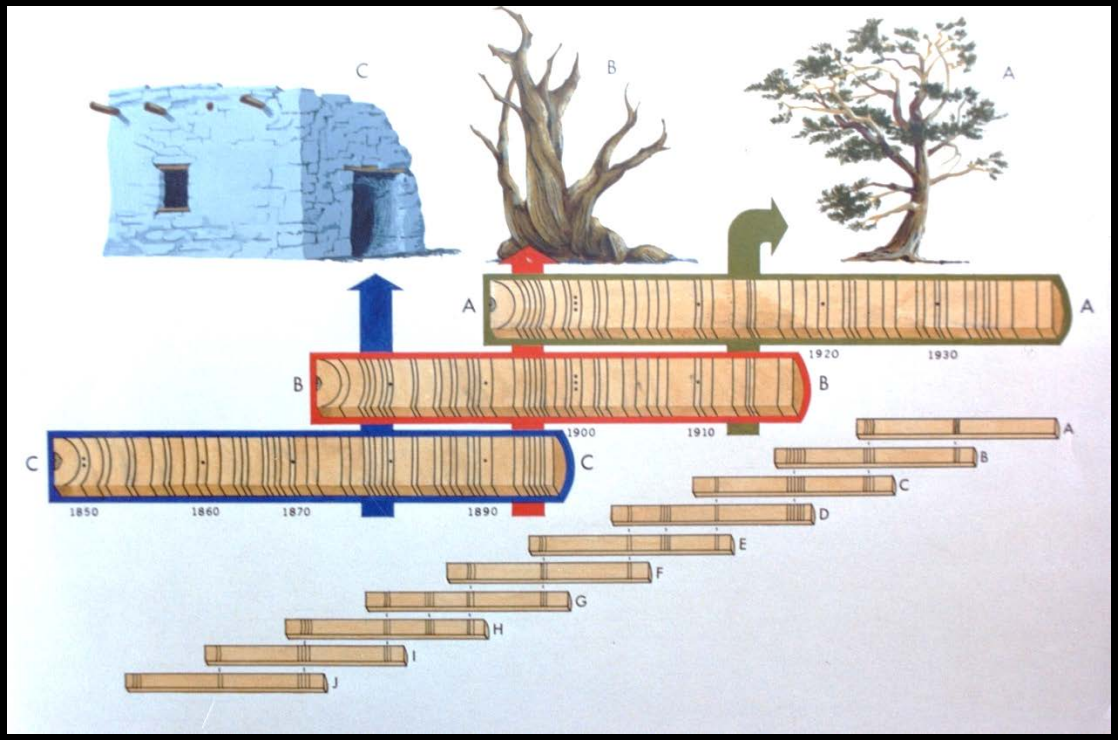


- Andrew Douglass (1943) wrote: “To reach a feeling of security in cross-dating there is no substitute for minute personal comparisons between actual ring records in different trees”.

- A dendrochronologist experienced with a particular species and region may well be able to date an unknown piece of wood at first sight, seeing patterns they have seen many times before.

What is "pattern-matching?"

- We see features with several characteristics, a fixed number of rings apart, repeated on several trees.
- We record these patterns mentally, giving greatest weight to those clearly shown in most or all samples.

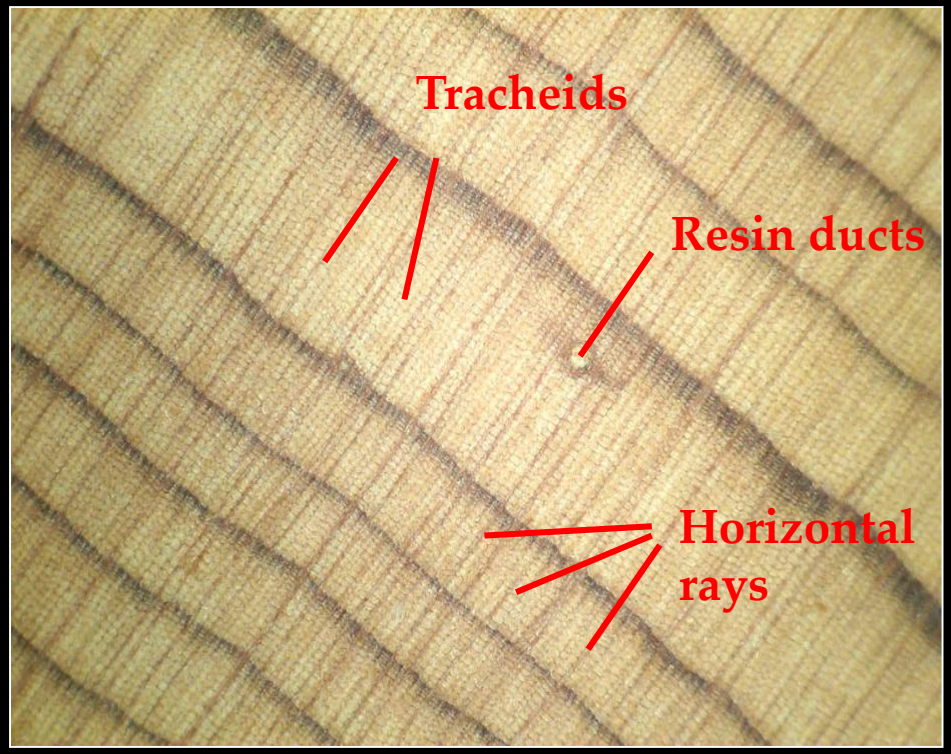


What is "pattern-matching?"

- We look for the same recorded patterns on the piece of unknown age, paying special attention to the elements of the pattern found in the greatest proportion of the samples of known date.

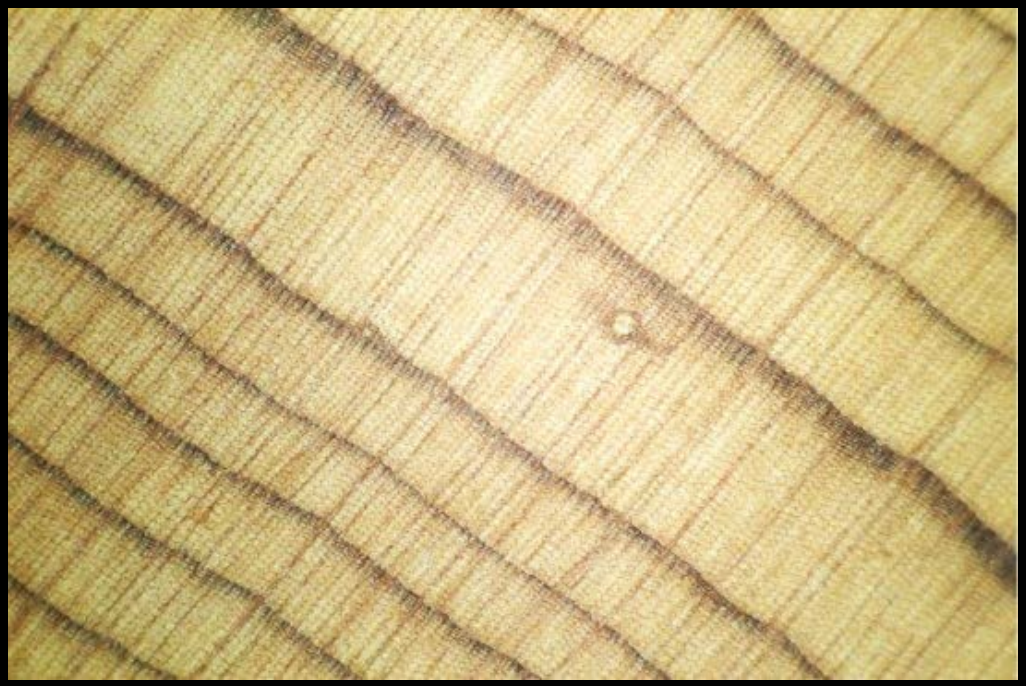
Needs of "On-the-wood" dating

- Must be able to see the patterns, which means not just vague lines, but anatomical features must be clearly visible– earlywood, latewood, false latewood, frost rings, and so on. An excellent surface and correct fiber alignment is essential.



Needs of "On-the-wood" dating

- Pilcher (1991) writes "No amount of fancy computerized equipment will produce satisfactory measurements and dating if the sample preparation is inadequate.



Needs of "On-the-wood" dating

- Need help in remembering the patterns, even if just comparing one chronology or one sample with many rings to one with fewer rings. This problem is even more severe when comparing a larger number of samples to build a chronology.

- The problem is also made worse by the same relative ring patterns appearing on trees with very different absolute rates of growth. This makes it impossible just to line up the wood specimens edge to edge to compare their rings.

Memory aids

- Thus, we need *memory aids*. These could be:
- A list of notable rings, with notes
- A sketch of an important sequence of rings
- A diagram where one increment, for example on the horizontal axis, represents one ring, and the size or some other property of the ring is indicated by a line in the vertical direction. The problem is, this would involve noting every ring, (it would be quicker to measure them) OR

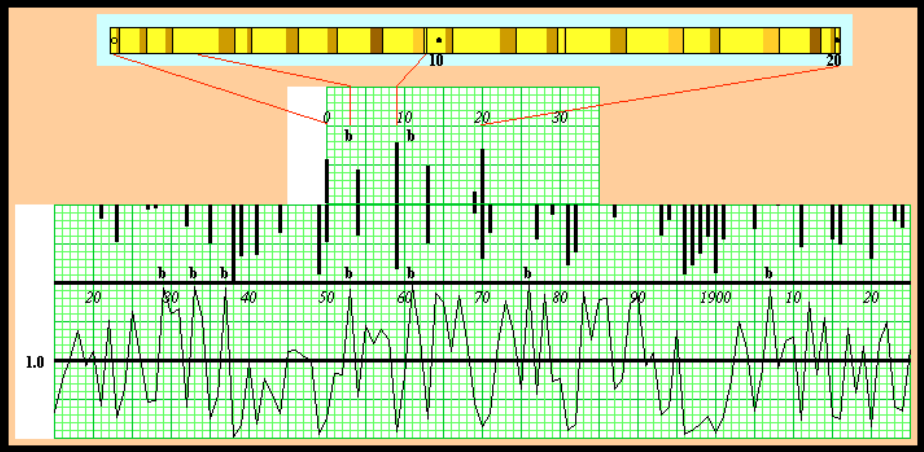
Bare bones

- We could make this same kind of diagram, which has the advantage of allowing us to line up the patterns of two or more samples growing at different overall rates, but only note and draw lines for the rings that make up distinctive pieces of pattern – capturing just the skeleton of the patterns.

skeleton plots

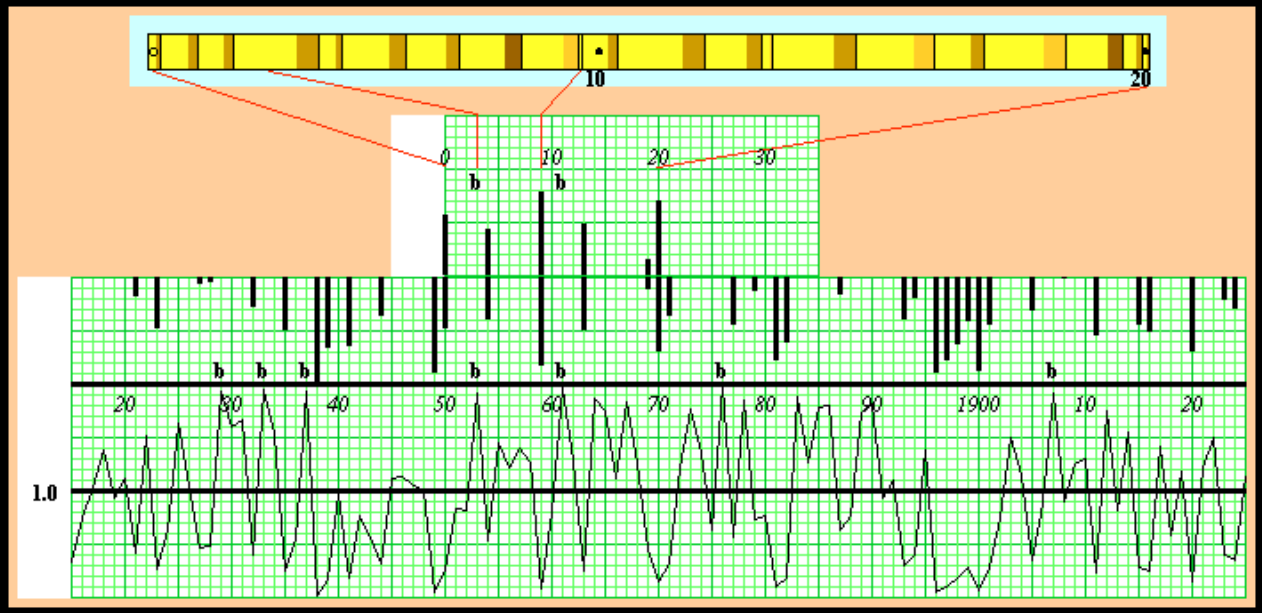
Andrew Douglass' memory aid

- In fact, Douglass saw that he could make it even simpler, because we mostly see ring patterns in terms of the relative differences between a fairly small set of neighboring rings – three for some people, maybe as many as seven for others.



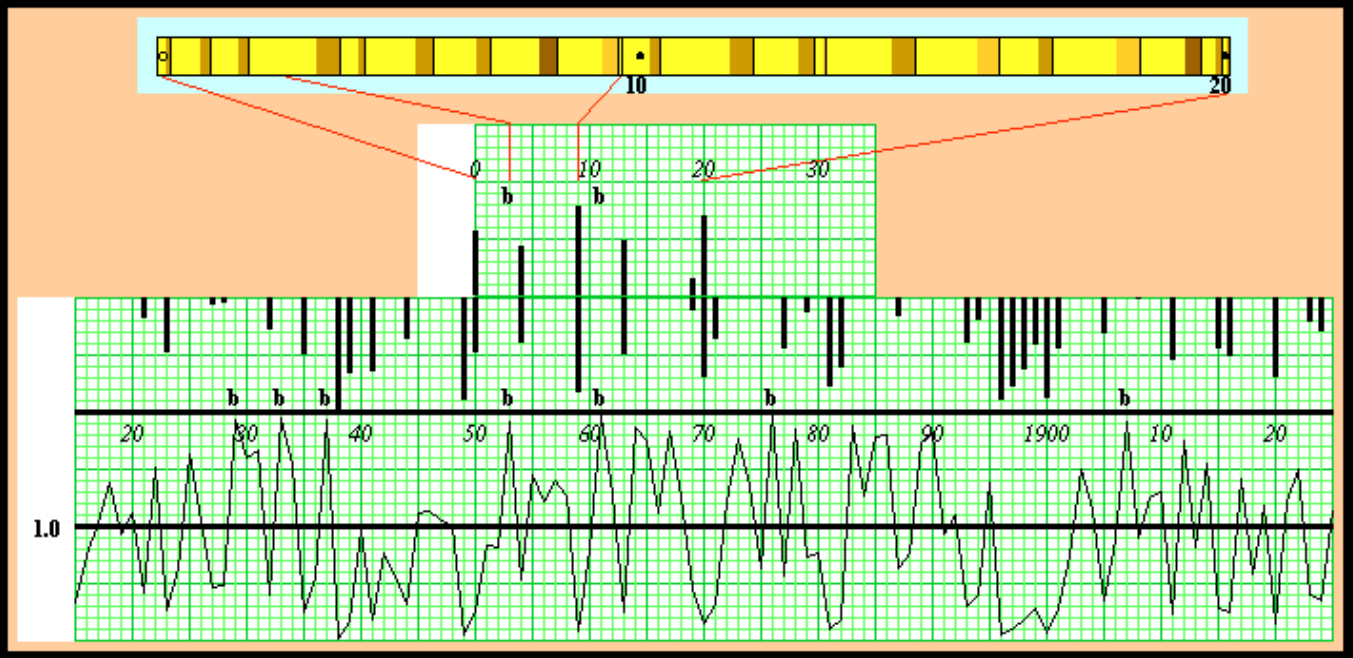
- So, in his system of ***skeleton plots***, he concentrated on the properties of the ring relative to its neighbors, something you can see without measurement.

- He also simplified by focusing mainly on smaller, rather than larger rings (this might not be appropriate everywhere).



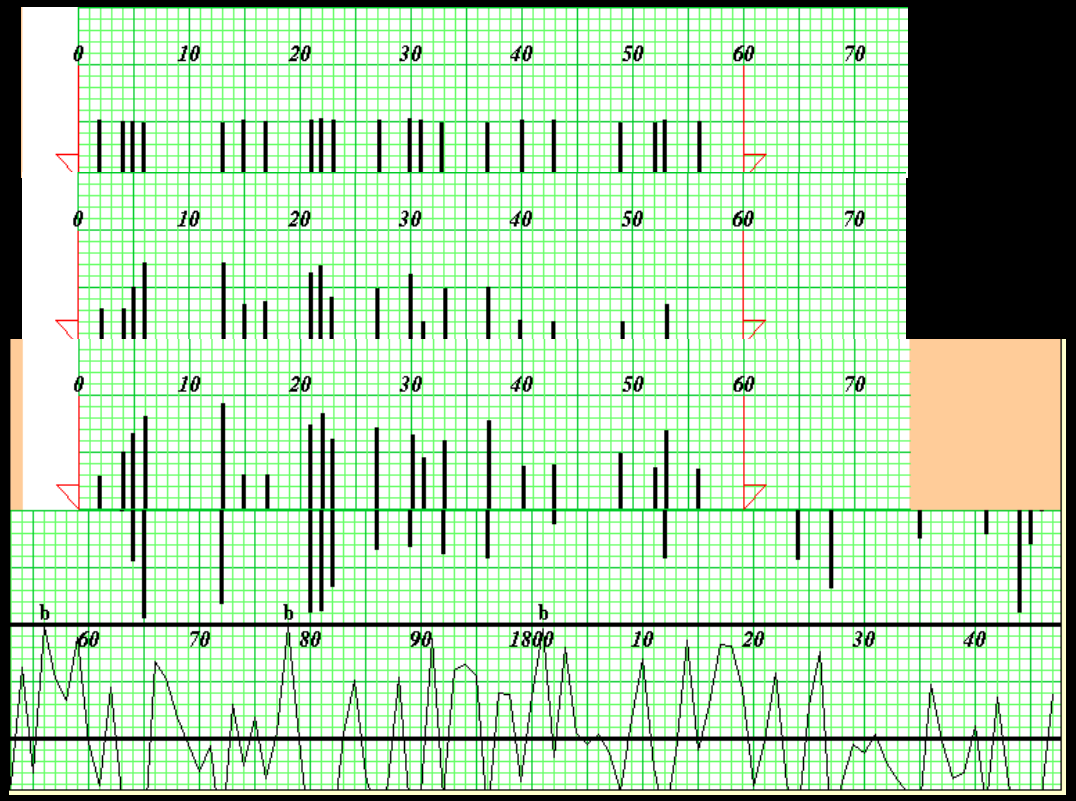
Isn't this very subjective?

- In practice, no, because, given, for example, a series of ring widths, a simple program can produce a skeleton plot that would give the same dates as a "hand-made" one.



The recorded patterns are repeatable.

- different people produce skeleton plots from the same piece of wood that clearly contain the same patterns:



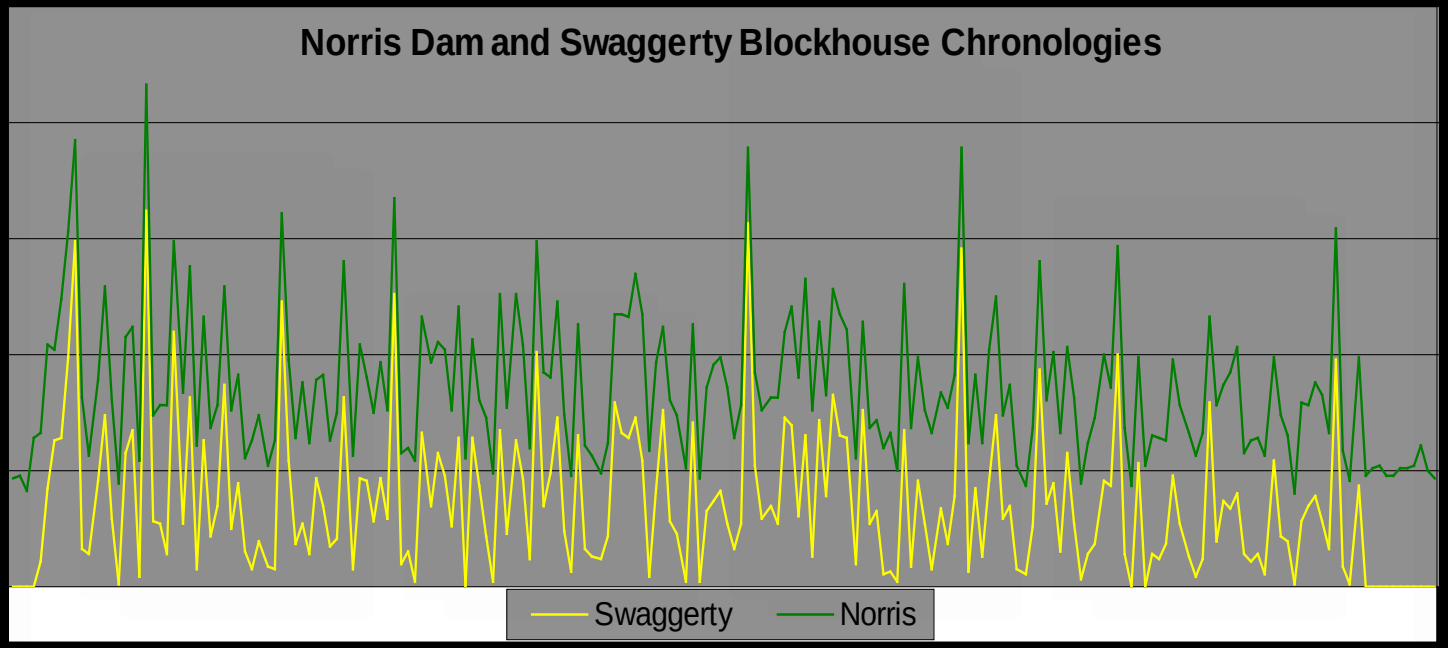
And the results are independently repeatable

- For example, several thousand archeological samples collected and dated in the 1930, 40, and 50s were redated "blind' by different dendrochronologists in the Lab in the 1970s. In almost every case, exactly the same dates resulted.

- 'blind' dating by another dendrochronologist is an important quality control tool.

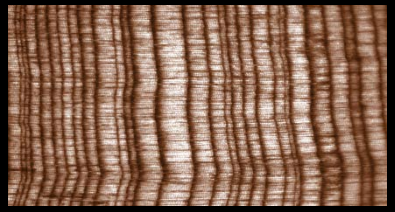
Another approach to dating

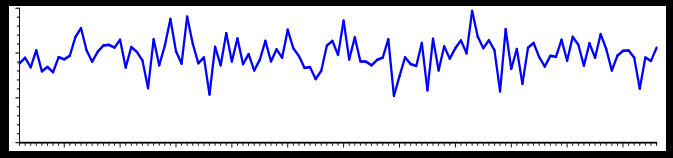
- Most dendrochronologists working in Europe date their samples using a different kind of memory aid to the skeleton plot. They use alignment plots

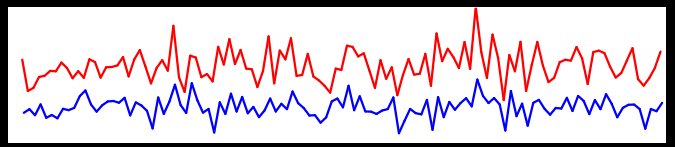


Another approach to dating

- They first measure ring widths, make a graph with ring-width as the vertical axis and number of rings as the horizontal axis, and slide this graph against that of the sample or chronology being used for comparison.

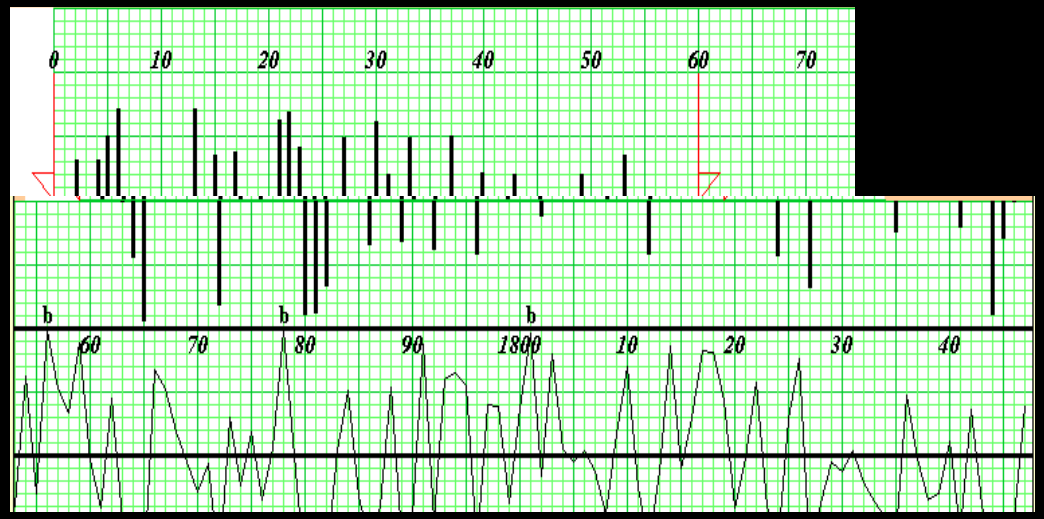






How to use these ‘memory aids’?

- Slide skeleton plots or ring-width plots against one another to find position of uniquely good fit – could do this manually or by computer.
- If there is a phase shift, one series has a ring the other doesn’t.



How to resolve this?

- Maybe just add in a dummy ring to one of them to bring them into phase?
- **NO**

- That way anything could be made to fit anything else.

- Rules of evidence are needed.

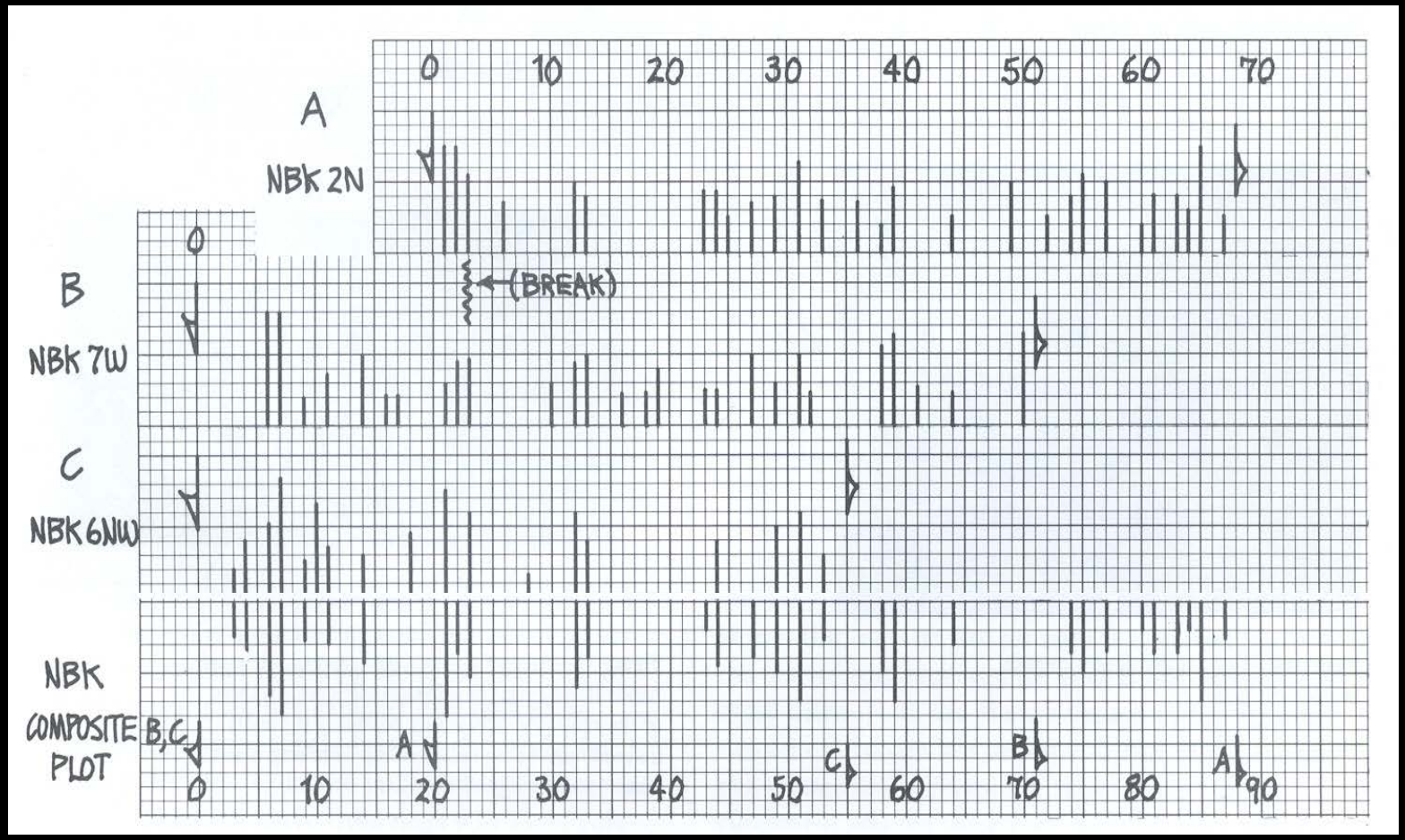
Rules of evidence

- If only two samples, check both around circumference at point of phase shift for micro-rings or lenses on one or a mis-identified false ring– if found correct that skeleton plot.
- Without this, cannot resolve the issue without at least one more, and preferably many samples, where there is a narrow ring present in the position where you think the missing ring is.

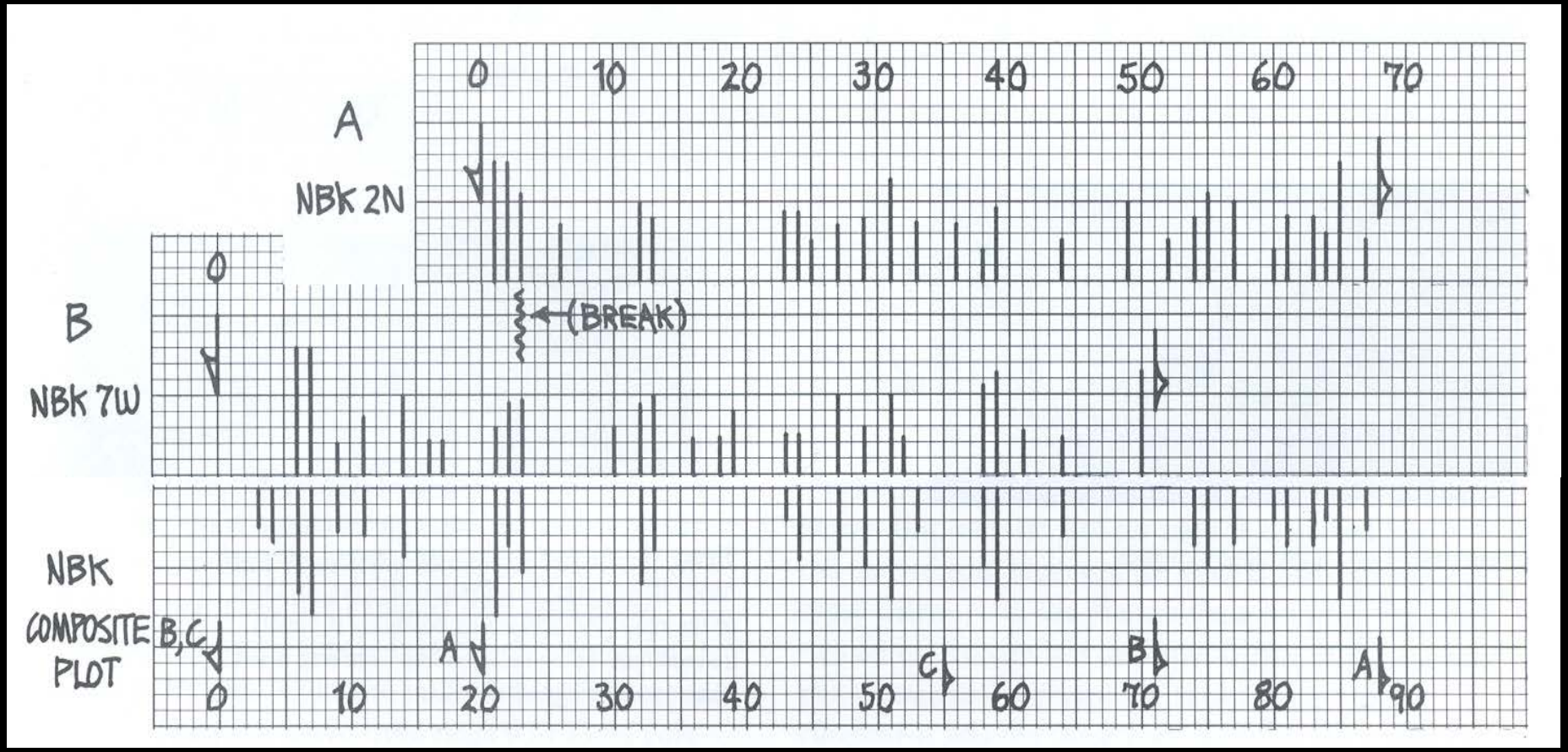
The most important rule

- Stay close to the wood – you can only resolve inconsistencies between ring records in a reliable way by reference to the original material, which means the wood samples individually and as a group.

Here, we have three skeleton plots for three cores. Let's create a master by compositing the weights from these three cores…



Now, how does this master composite plot compare to the middle series?



Pretty good match!

A look forward – making a site dating chronology

This process involves :

- resolving all disparities
-
- setting aside samples where disparities cannot be resolved
- Setting aside samples where pattern matching is weak
- Making a visual average of the remaining plots.

The next step after building a site dating chronology

- Once site chronologies have been established they can be compared – this provides a further opportunity to check their reliability.