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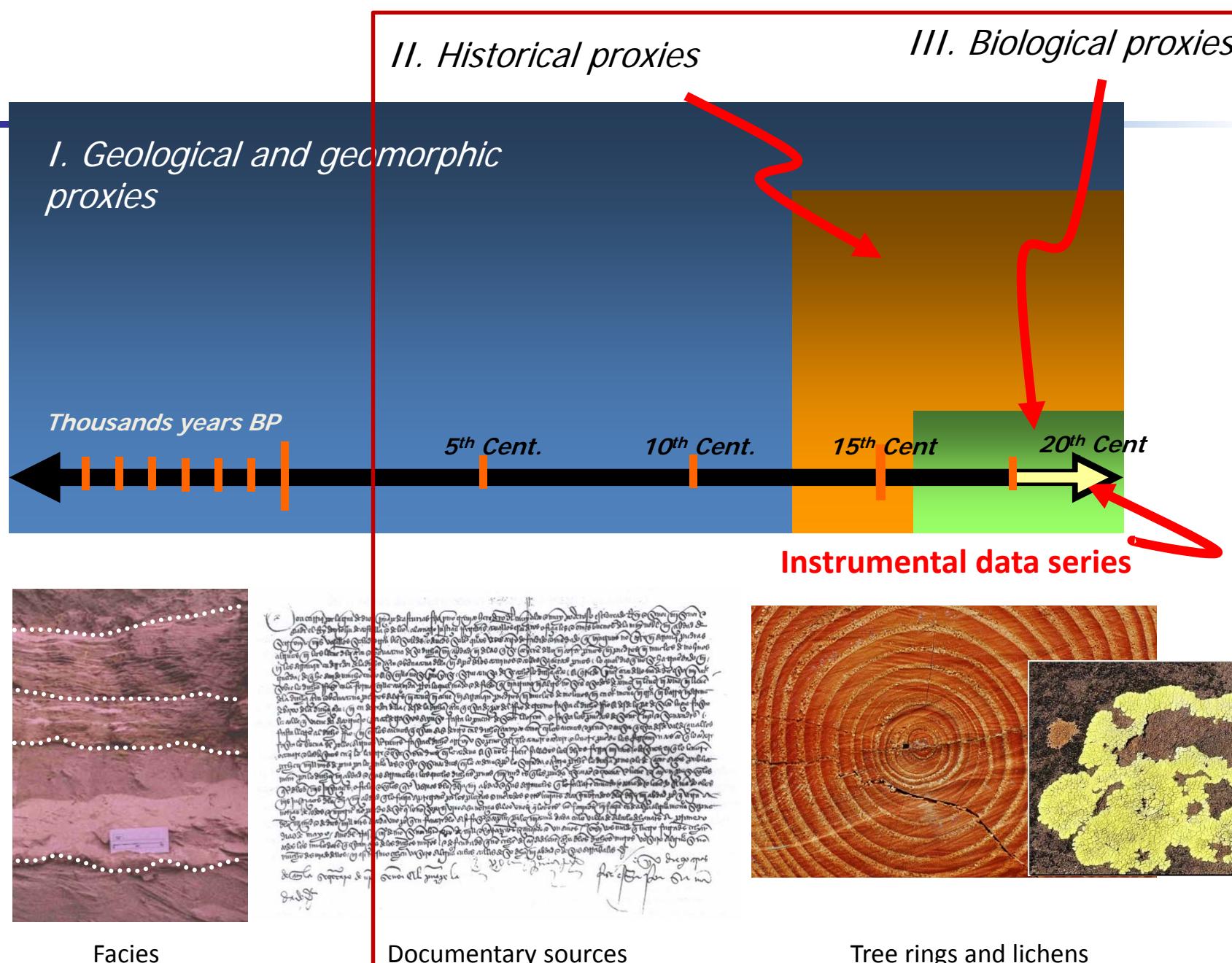
University of
Zurich^{UZH}

LANDFORM DATING, PROCESS RECONSTRUCTIONS

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And Prof. Markus Stoffel

IHCAP – Indian Himalayas Climate Change Adaptation Programme
Capacity building programme “Cryosphere” Level-1 (September 10, 2014)



PROCESS RECONSTRUCTIONS

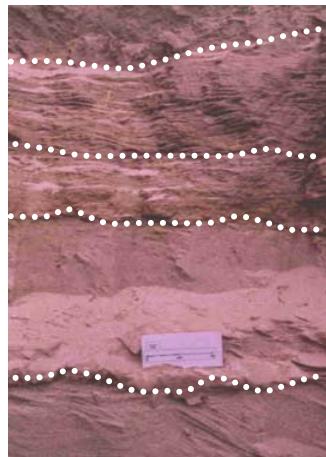
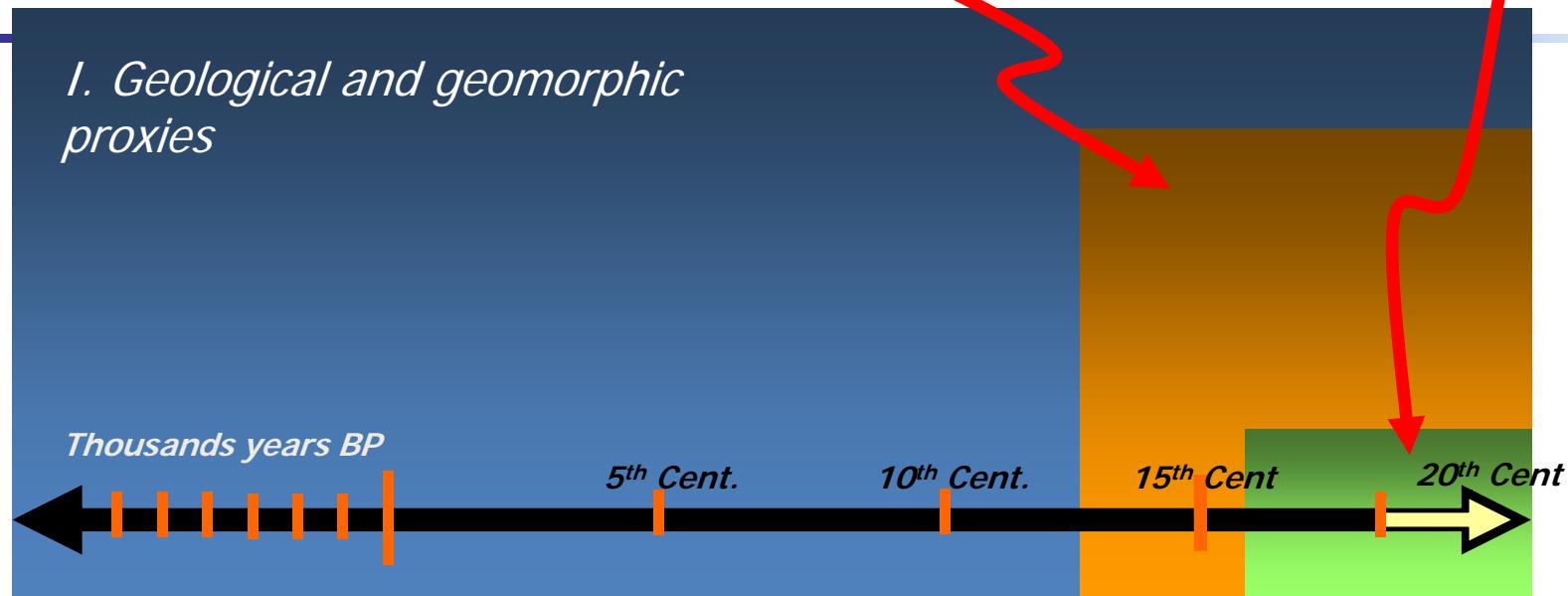
Existing data on past events is not complete, and that more data is needed to understand the processes more fully:

- *the magnitude and frequency of past natural phenomena (floods, landslides...)*
- *the vulnerability of past societies to climate extremes and natural hazards.*

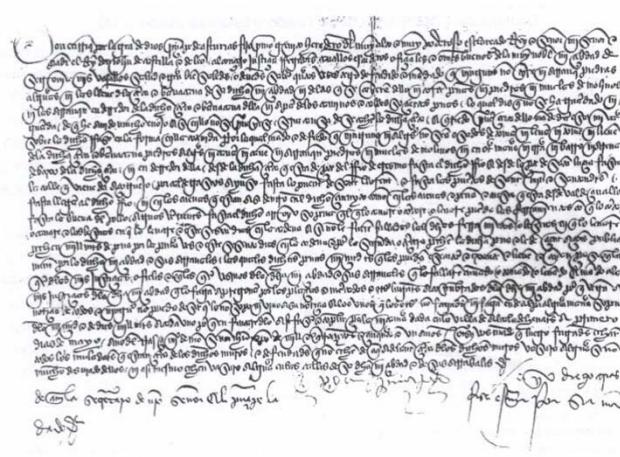
Having a better knowledge of past natural disasters may allow more efficient environmental management in the future.



Even if the past might not be 1:1 the key to the future, a good understanding of what went on in the past will be extremely helpful to fine-tune models (calibration, validation) so that one can then do scenario-based modeling



Facies
Landform Dating, Process Reconstructions



Documentary sources



Tree rings and lichens
10/09/2014

BOTANICAL SOURCES

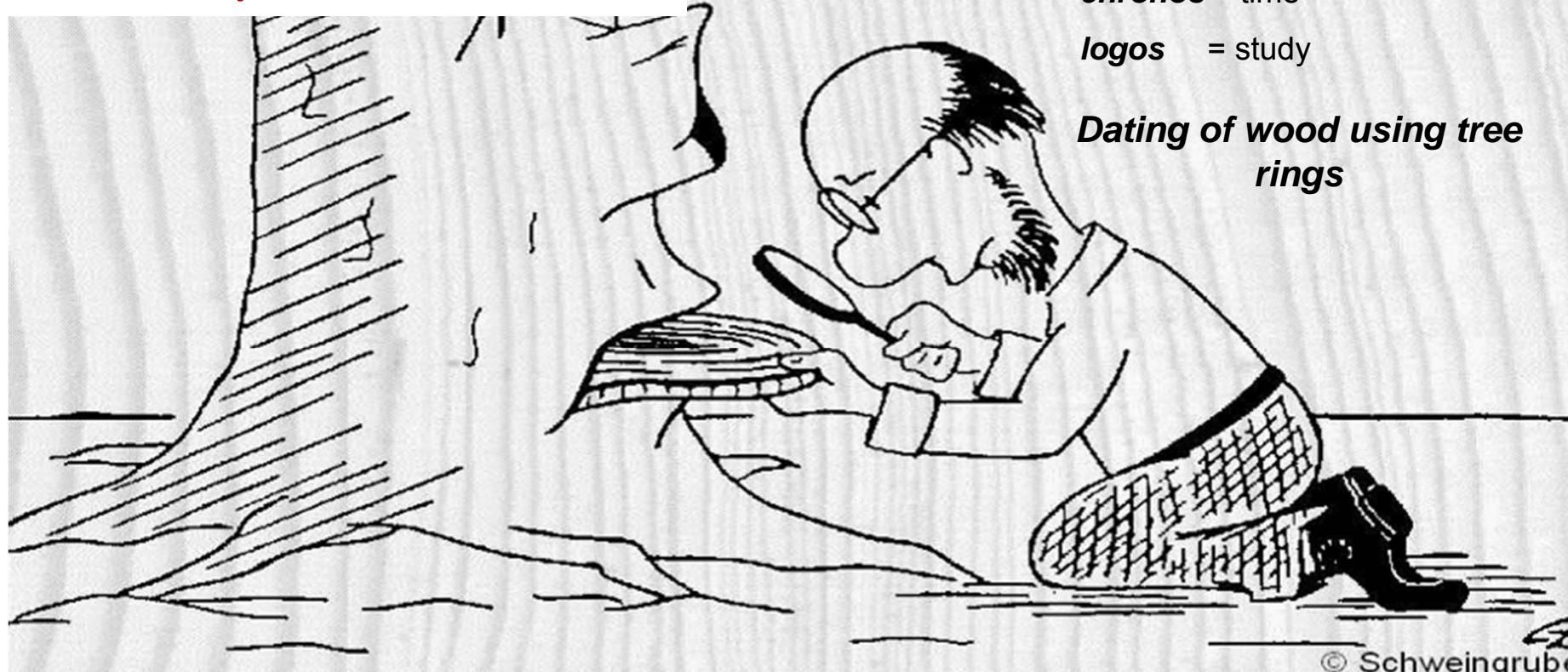
Tree rings:

1. What is dendrochronology?
2. Application fields
3. Natural processes and tree rings: Dendrogeomorphology
6. Methodologies



What is dendrochronology?

The aim is to develop annual tree-ring chronologies which allow to date natural events or analyze different environmental parameters



Dendrochronology

dendron = tree-rings

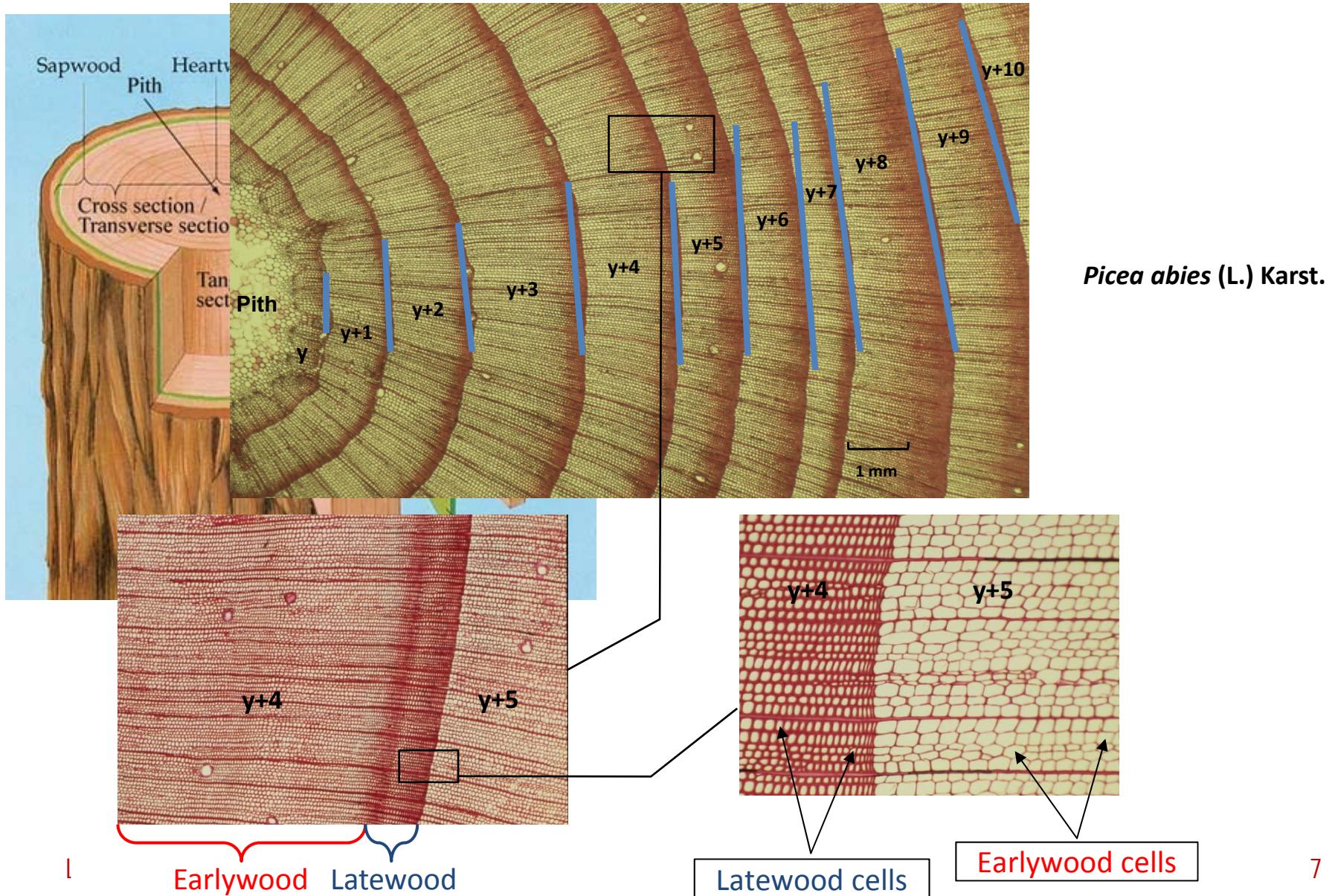
chronos = time

logos = study

Dating of wood using tree rings

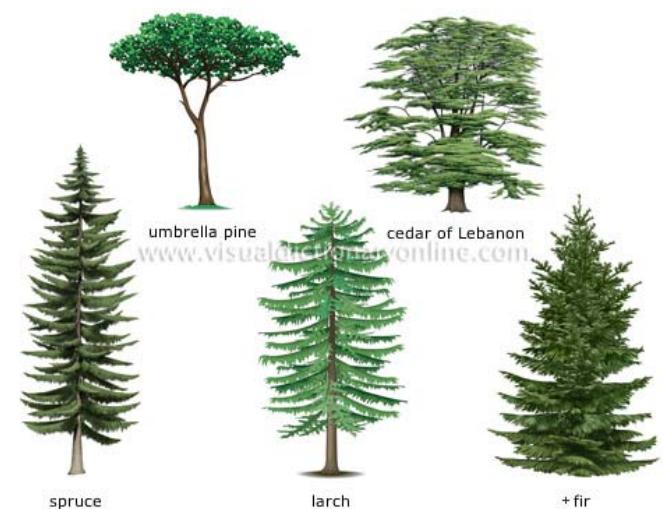
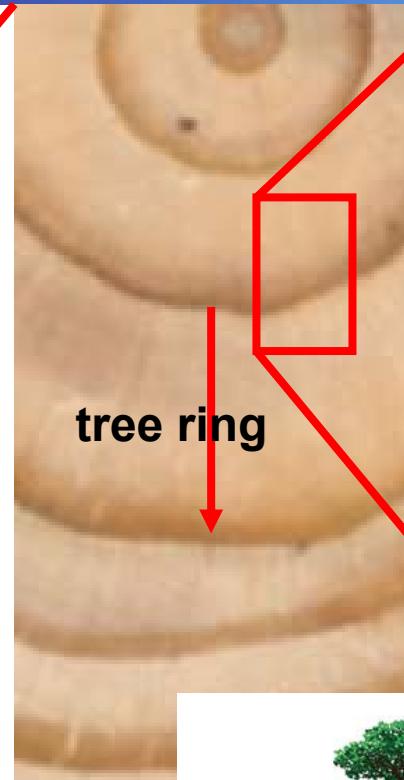
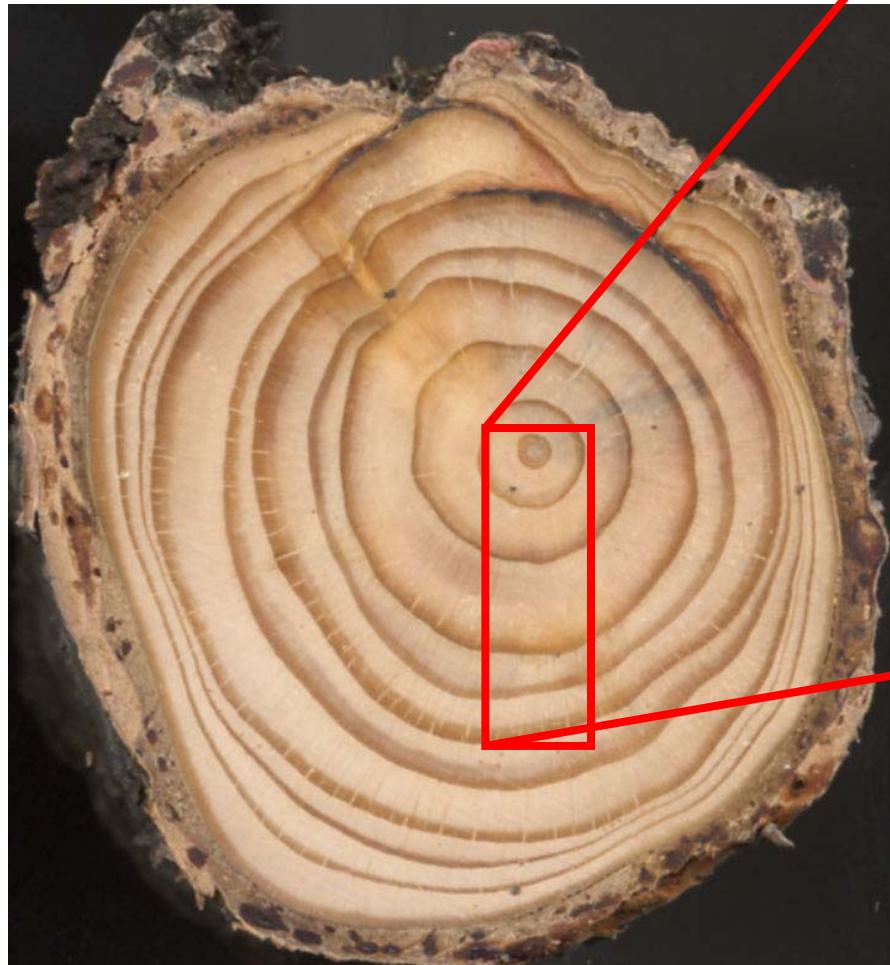
© Schweingruber

What is dendrochronology?



What is dendrochronology?

Conifers



Landform Dating, Process Reconstructions

What is dendrochronology?

Coniferous wood

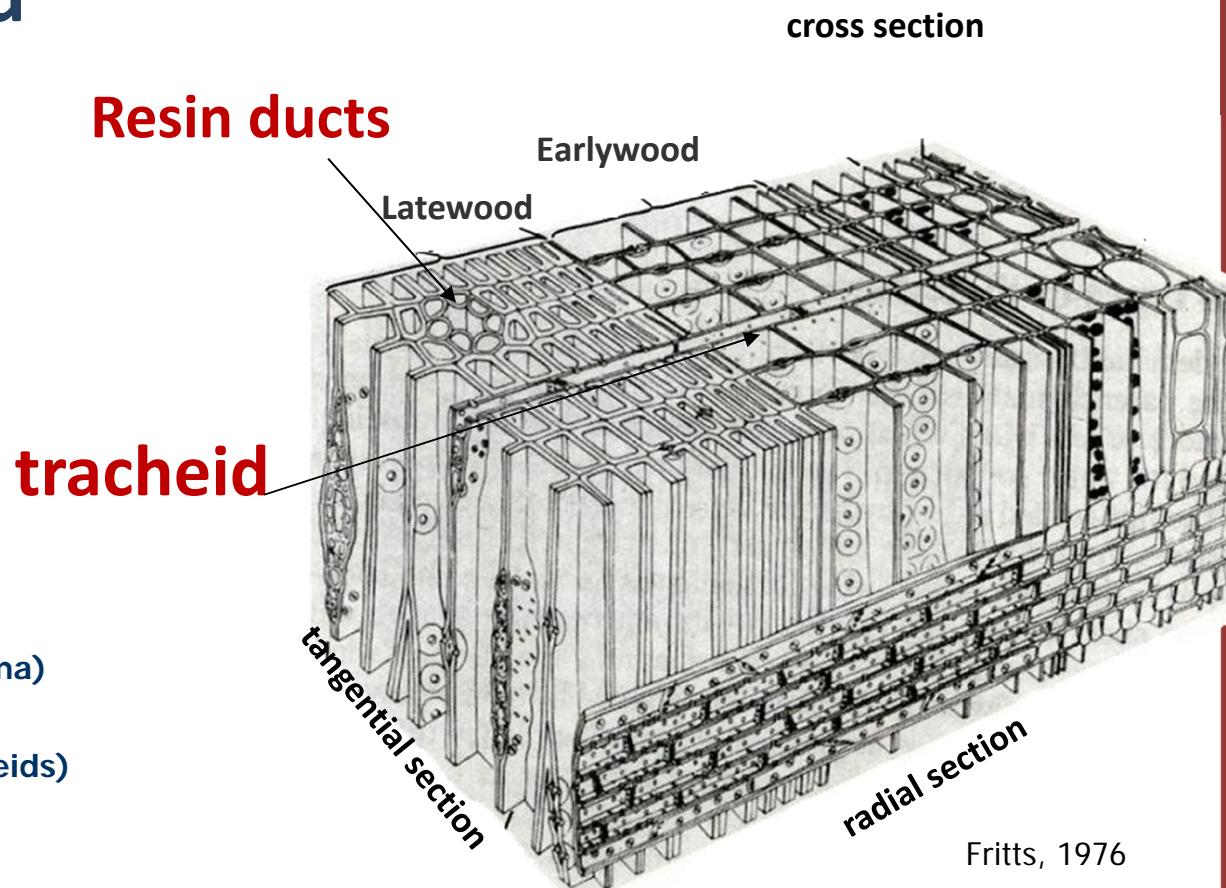
1) Axial system:

- tracheids

2) Radial system:

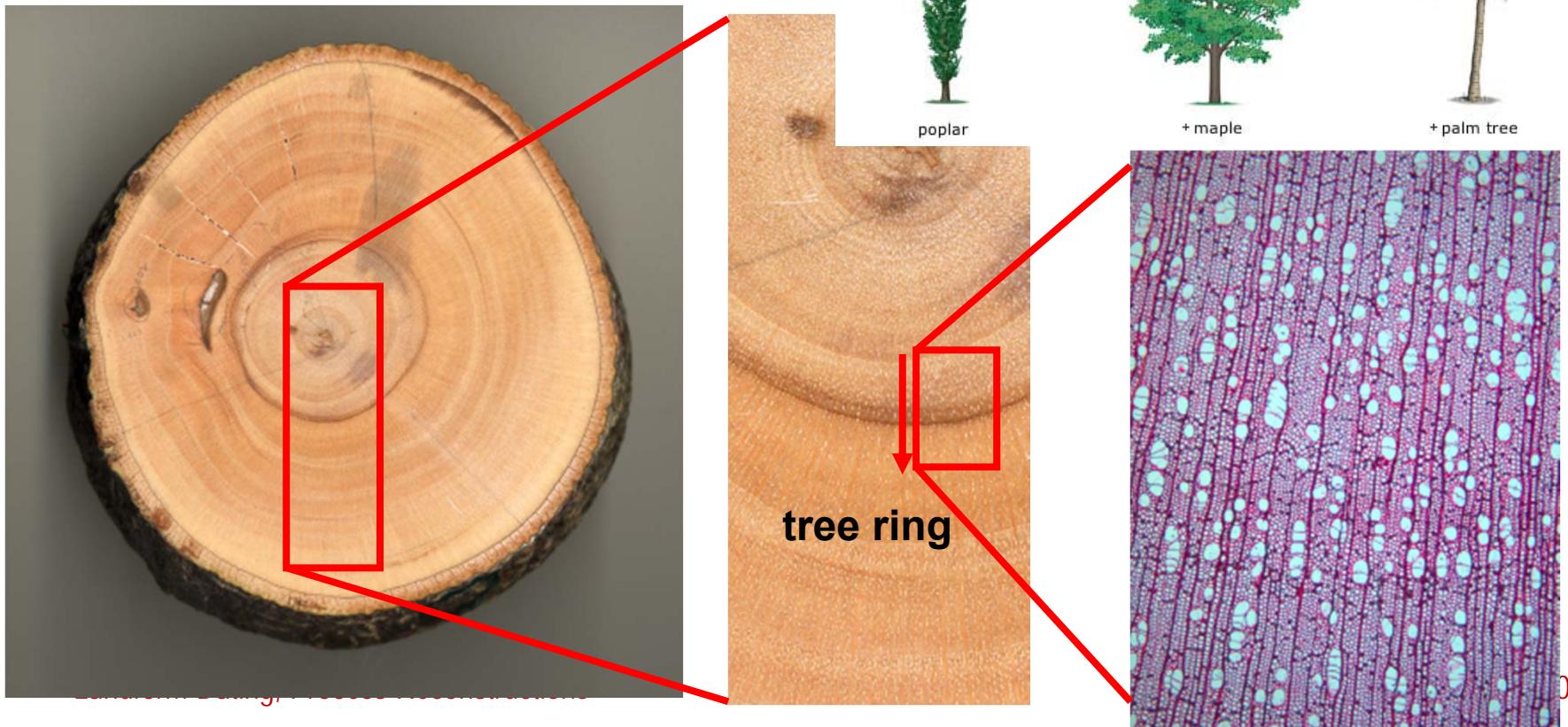
- radial cells (parenchyma)
- Heterocellular rays
(parenchyma and tracheids)

Others interesting feature:
resin ducts



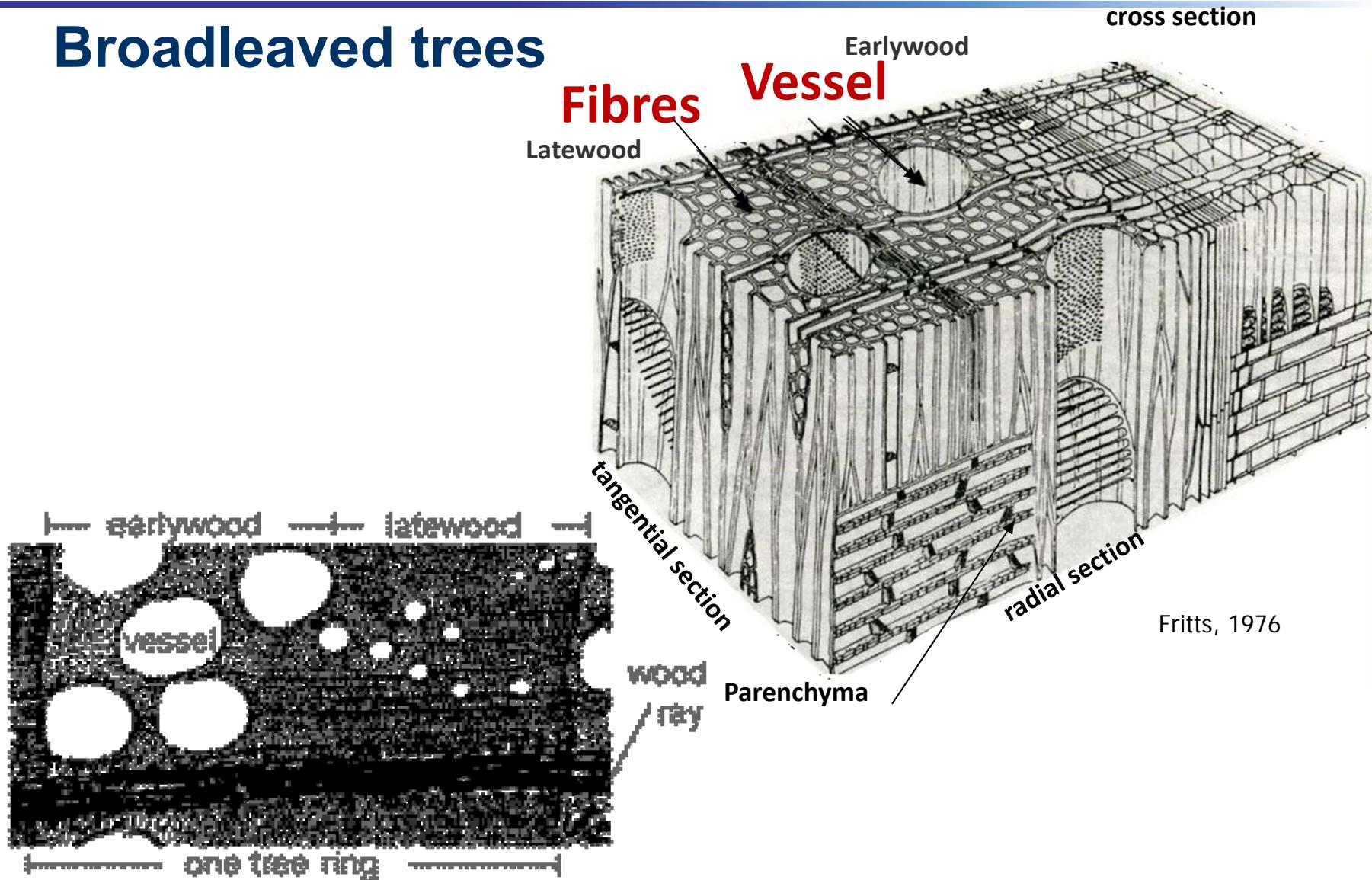
What is dendrochronology?

Broadleaved trees



What is dendrochronology?

Broadleaved trees



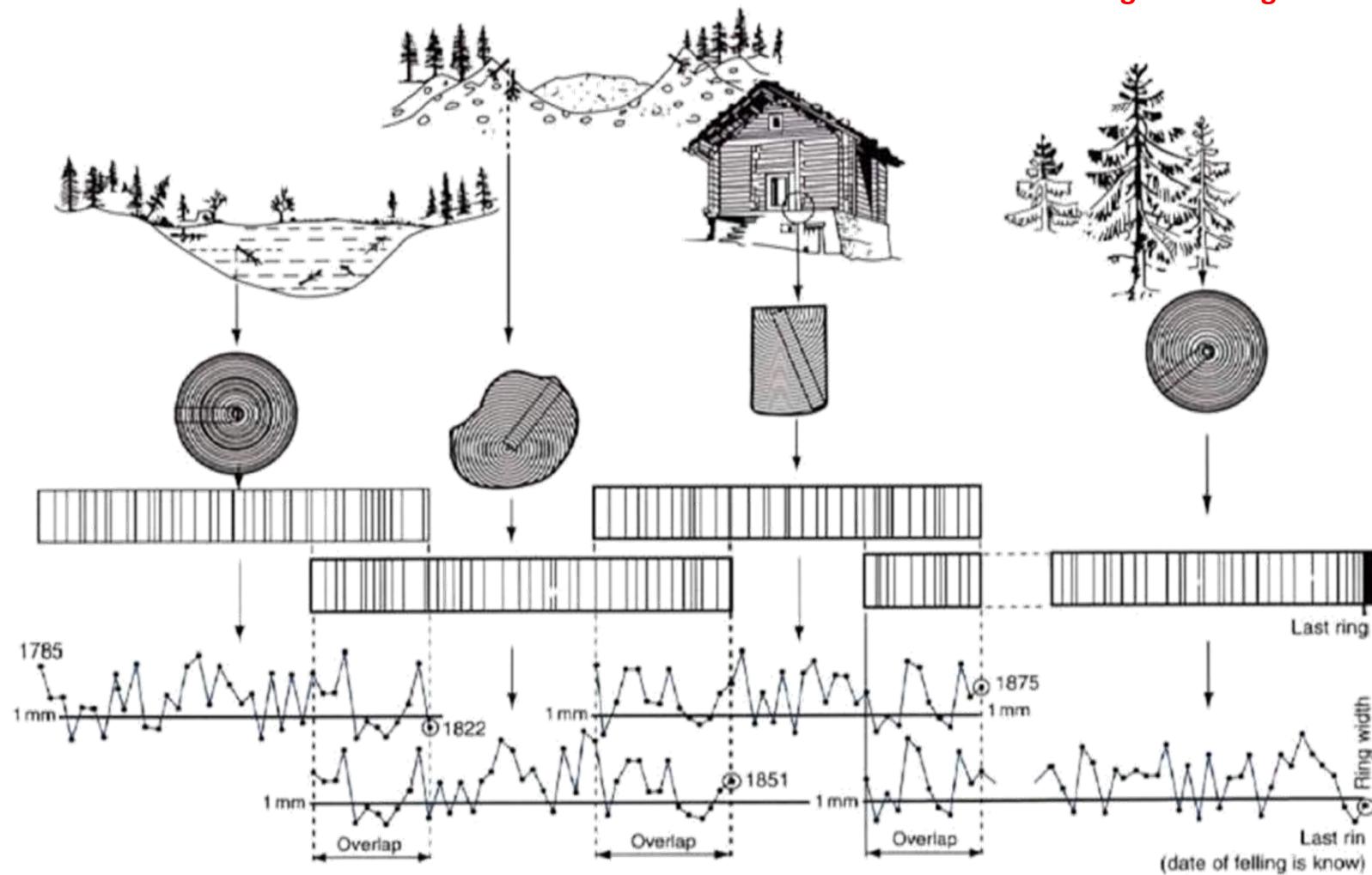
What is dendrochronology?



What is dendrochronology?

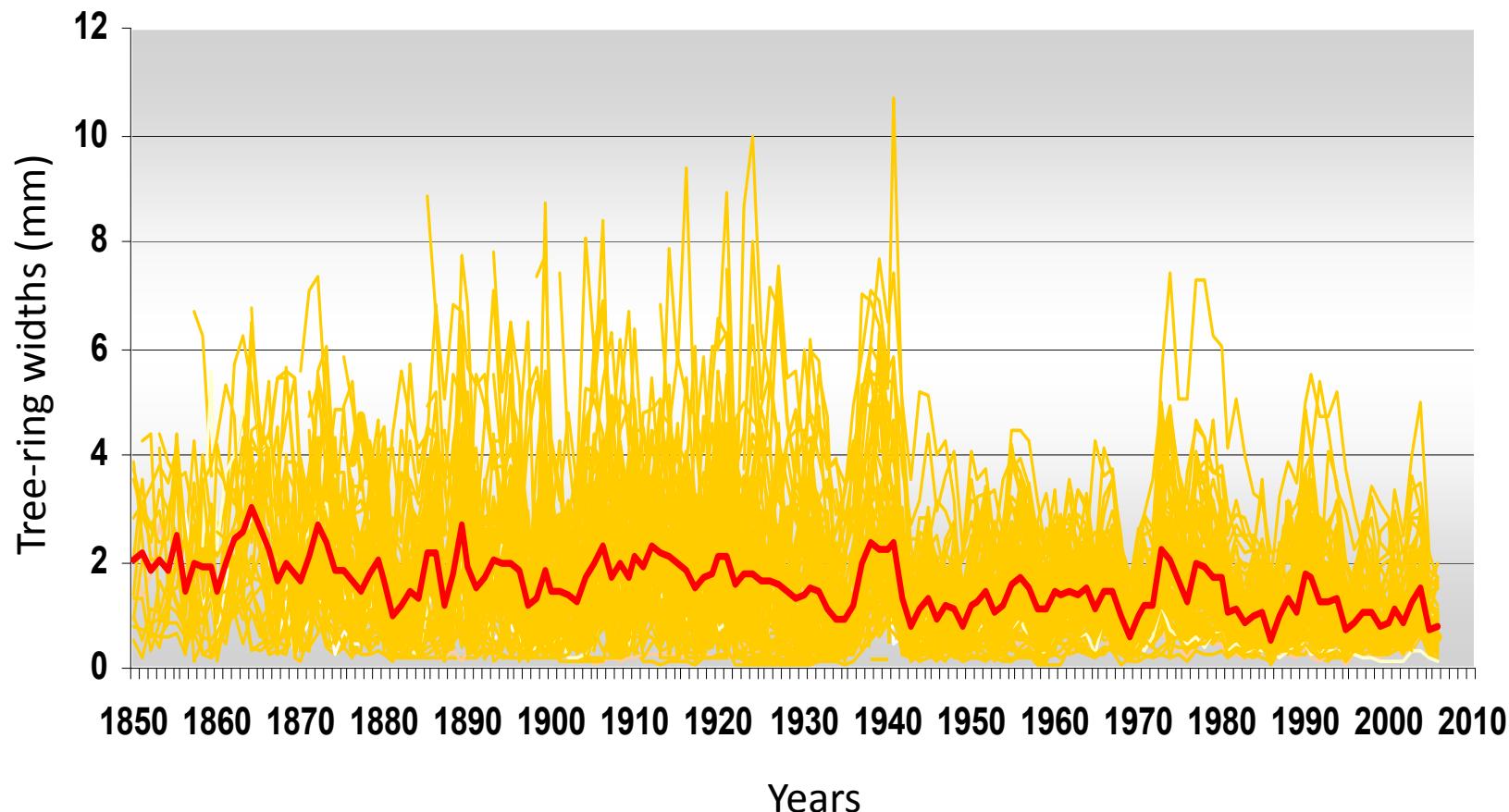
From where do we get tree-ring information?

The aim is to develop annual tree-ring chronologies

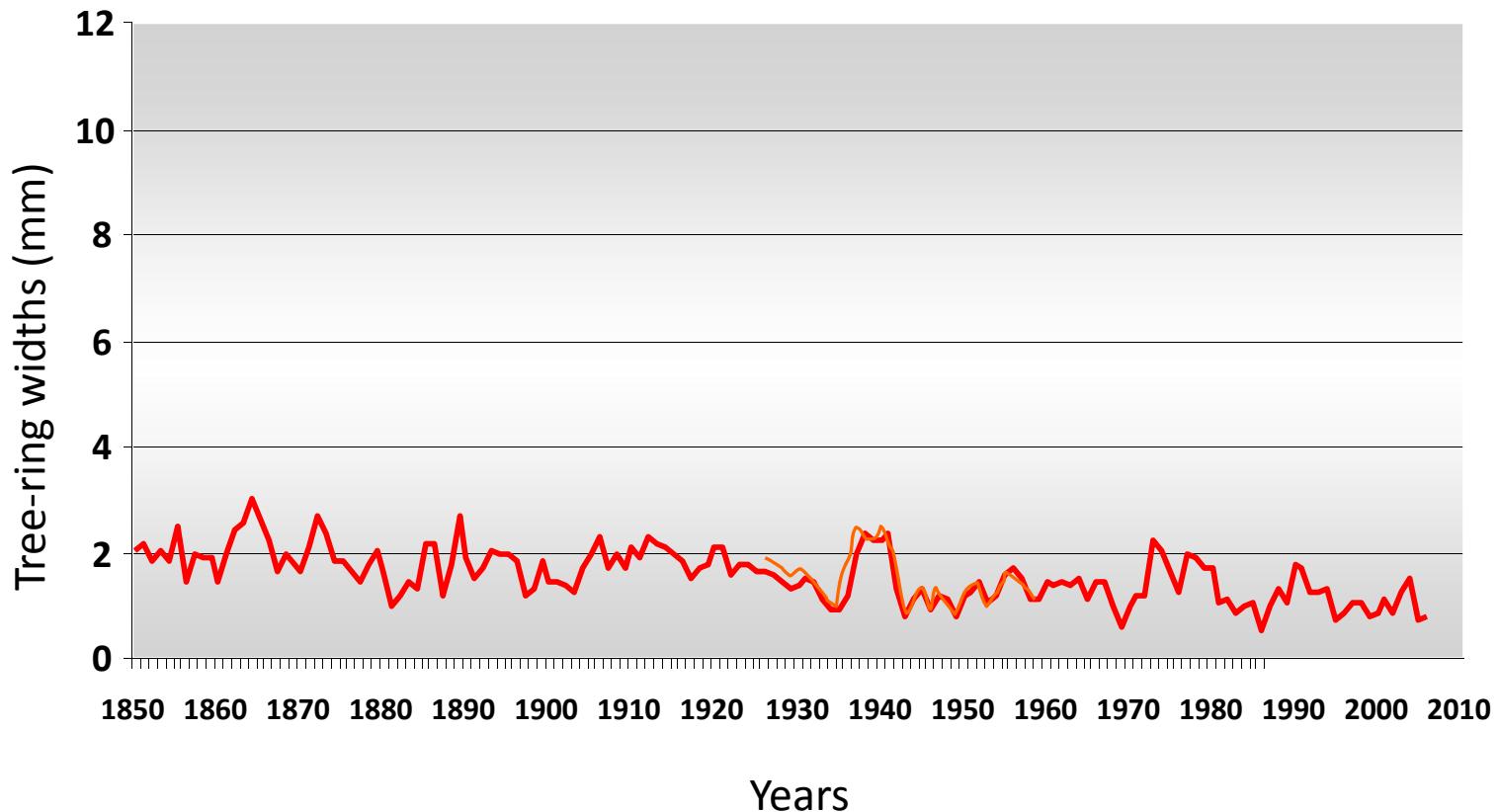


What is dendrochronology?

Crossdating Principle. Different human and environmental factors are likely to influence tree growth in uniform physiographic area in a similar way and through a comparable variability in tree-ring width. The characterization of these patterns allows to date and synchronize tree-ring series and to position them correctly in time by using various statistical techniques.



What is dendrochronology?



BOTANICAL SOURCES

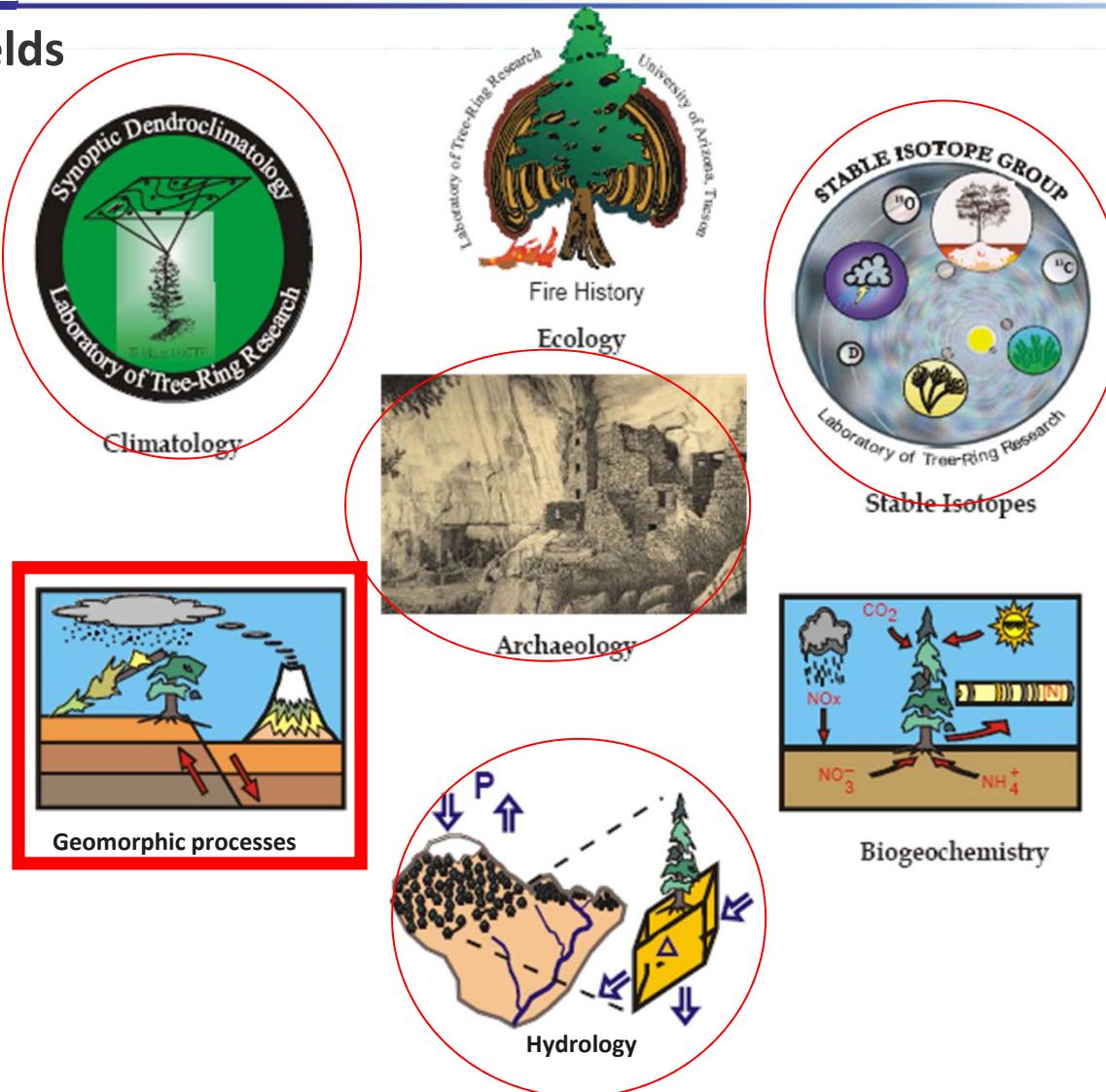
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Application fields

Application fields



Application fields: «Tree as a weather station»

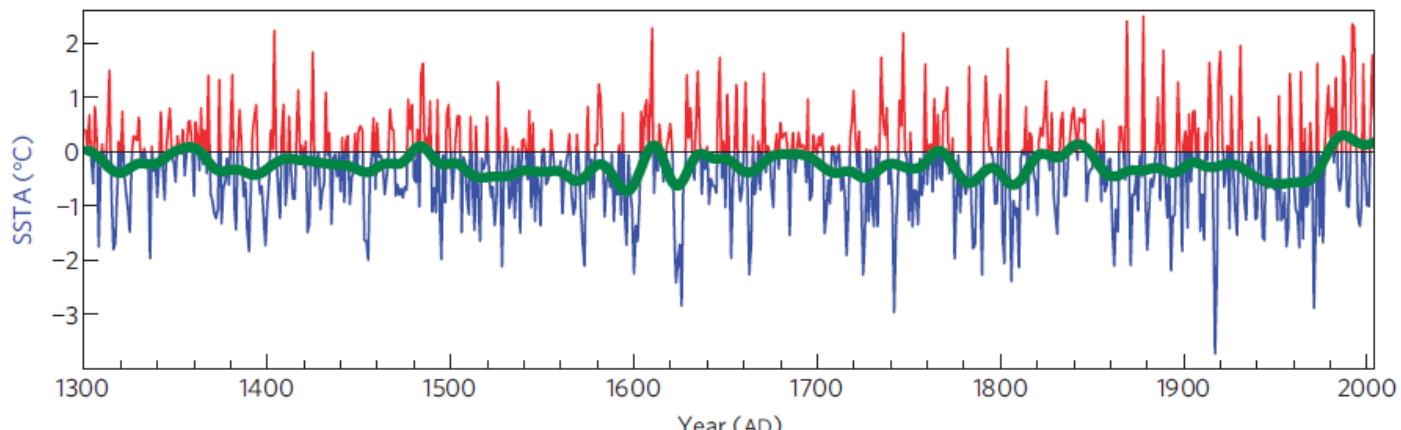
- Dendroclimatology

Aims :

- ✓ Investigating the trees' response to climate
- ✓ Reconstructing past climate

Several climatic parameters can be reconstructed using tree rings:

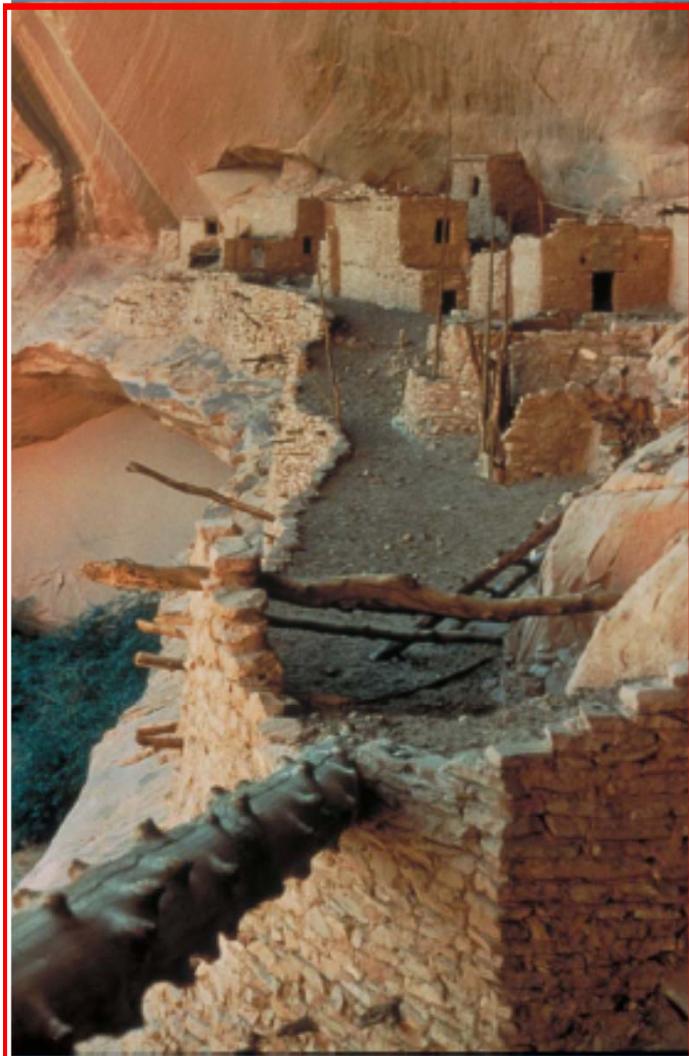
- ✓ Temperature
- ✓ Precipitation
- ✓ Drought
- ✓ Streamflow
- ✓ Snowpack
- ✓ NOA index
- ✓ ENSO Index



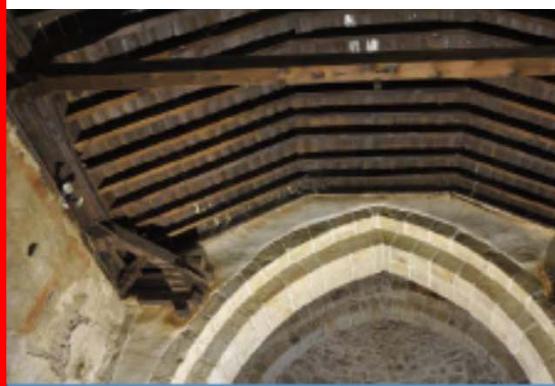
ENSO reconstruction, Yang et al., 2013, *Nature Climate Change*

Application fields: archaeology

- Dendroarchaeology



**Building structures or human settlements,
furniture, musical instruments, old boats, or sub-
fossil material**



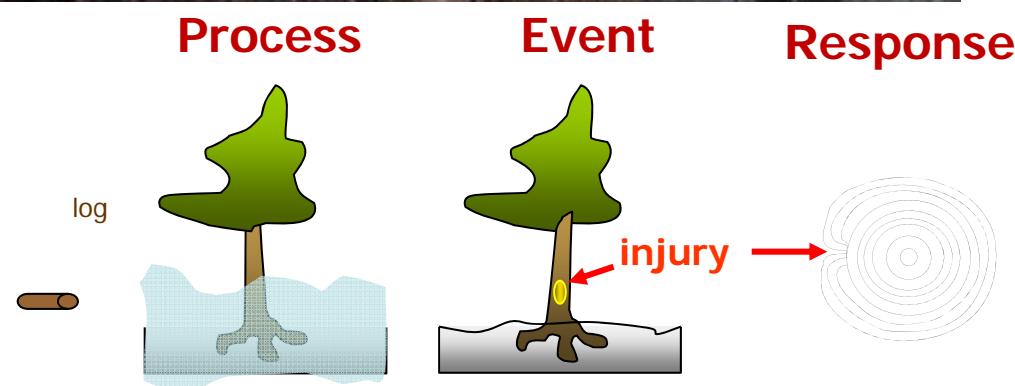
Landform Dating, Process Reconstructions

10/09/2014

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Application fields: dendrogeomorphology



BOTANICAL SOURCES

Tree-rings:

1. What is dendrochronology?
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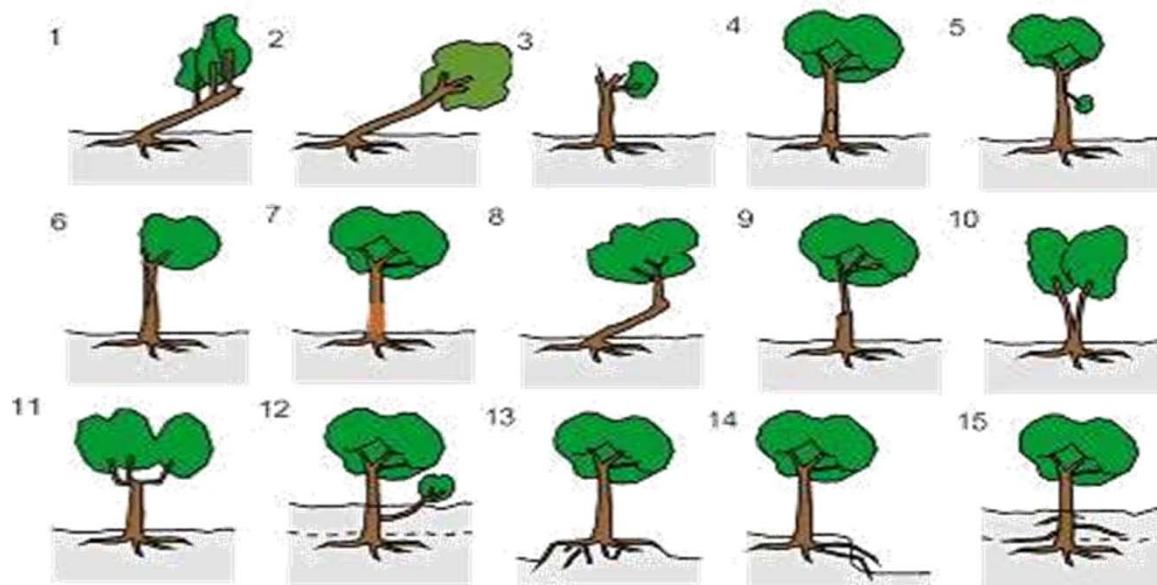
Dendrogeomorphology

What geomorphic processes can influence tree growth?

- Debris flow
- Rockfall
- Avalanches
- Land slides
- Erosion processes
- Floods / inundations
- Volcanoes (lahars)
- Glacier lake outburst flood
- ...

Dendrogeomorphology

DENDROGEOMORPHOLOGICAL EVIDENCE



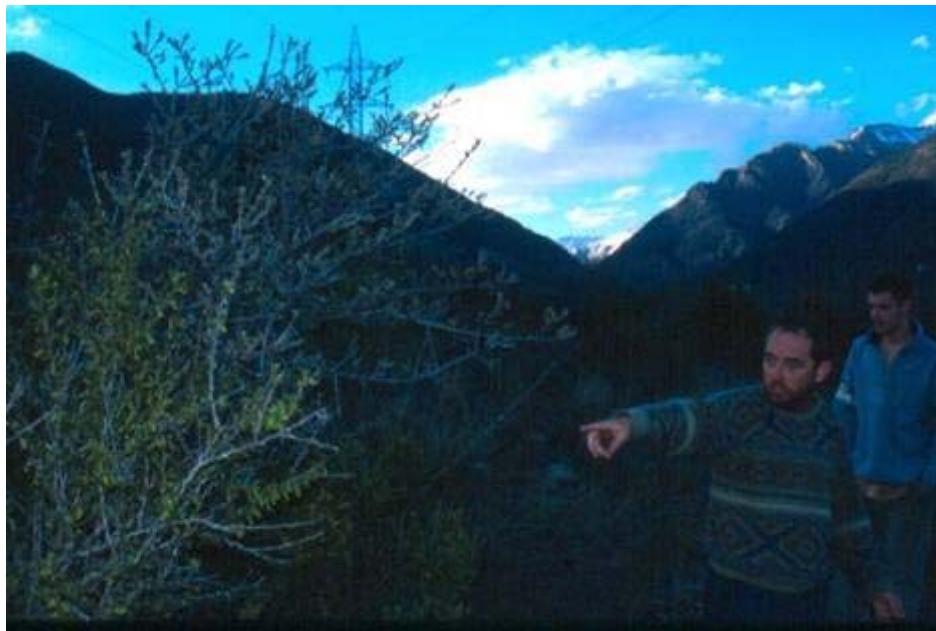
1 - tree chandelier, 2 - foot inclined, 3 - beheaded; 4 - scars, 5 - boot branches 6 - friction from falling neighbor trees; 7 - erosion, 8 - elbows and angles, 9 - sudden narrowing of the shaft , 10 - forks, 11 - elbows and angles in branches 12 - shoots from buried logs, 13 - exposed roots; 14 - floating roots, 15 - new roots from buried logs.

SPACIAL SCALE	STUDIED ELEMENT	TYPE OF DENDROGEOMORPHOLOGICAL INDICES		No.
		Bottomland vegetation patterns	Coverage distribution pattern Ages distribution pattern	
km hm	Individual tree or bush	Complete tree or bush	Candelabra growth	ID 1
			Tilted and overturned trees	ID 2
			Decapitated trees (tops missing)	ID 3
		Trunk	Sediment load impact	ID 4
			Stripped bark with callus marks	ID 5
			Branches torn off	ID 6
			Scraping from other falling trees	ID 7
			Erosion	ID 8
			Sudden narrowings in trunk	ID 9
			Elbows and angles	ID 10
m	Part of tree or bush	Branches	Bifurcations	ID 11
			Sprouts from buried trunks	ID 12
			Sprouts from buried trunks	ID 13
		Roots	Elbows and angles	ID 14
			Exposed roots	ID 15
dm	Tissues, wedges and slices	Rings	Stripped bark and erosion	ID 16
			Float roots without substrate contact	ID 17
			New roots from buried trunks	ID 18
		Tissues	Eccentric growths (reaction wood)	ID 19
			False tree rings	ID 20
			Discontinuities, erosion, and internal scars	ID 21
		Cells	Changes in parameters (width, % early wood, late wood, etc)	ID 22
			Ratio parenchyma-lignification tissue	ID 23
			Size and density of vessels	ID 24
cm	Thin slice	Cells	Changes in cell parameters	ID 25
			Size and morphometry of lumen cells	ID 26
			Cell wall thickness	ID 27
		Cell wall	Traumatic resin ducts (TRDs)	ID 28
			Fiber-tracheid	ID 29
mm	Cellulose	Isotopic fractionation	Traumatic structures in cell wall	ID 30
			$^{18}\text{O}/^{16}\text{O}$ ratio	ID 31
μm				
Å				

Dendrogeomorphology

At large spatial scales: Species distribution

SPACIAL SCALE	STUDIED ELEMENT	TYPE OF DENDROGEOMORPHOLOGICAL INDICES	No.
km hm	Bottomland vegetation patterns	Species distribution pattern Coverage distribution pattern Ages distribution pattern	ID 1 ID 2 ID 3



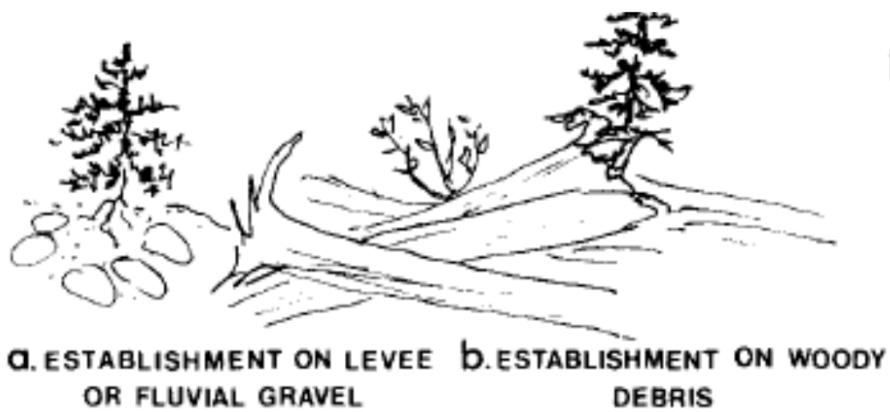
Hippophae rhamnoides

The presence of particular plant species reflects torrential conditions and allows a first qualitative estimation of flood frequency in one place. This applies to the presence of the shrub ***Hippophae rhamnoides*** alluvial fan in the Canyon Arás Biescas (Huesca, Spain).

Dendrogeomorphology

At large spatial scales: Age distribution

SPACIAL SCALE	STUDIED ELEMENT	TYPE OF DENDROGEOMORPHOLOGICAL INDICES	No.
km		Species distribution pattern	ID 1
hm	Bottomland vegetation patterns	Coverage distribution pattern	ID 2
		Ages distribution pattern	ID 3



ESTABLISHMENT DATE



C. SECTION COUNTED TO PITH

(Gottesfeld & Gottesfeld, 1989)

Old vegetation on a deposit = minimum age of the process (+ stabilization period)

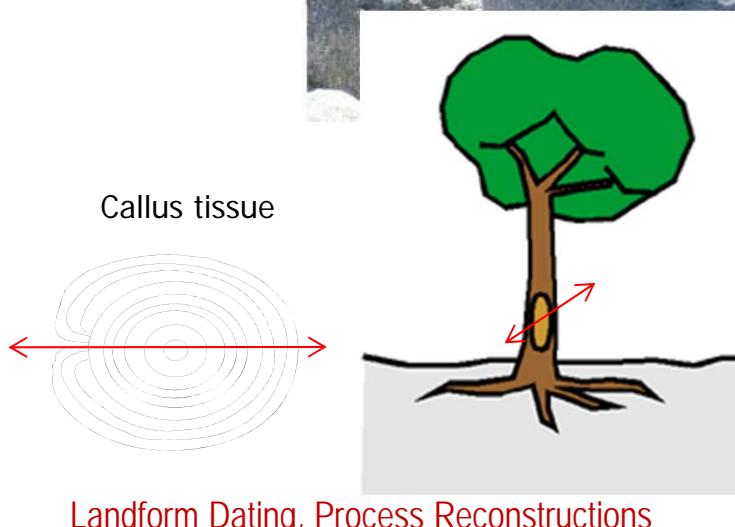
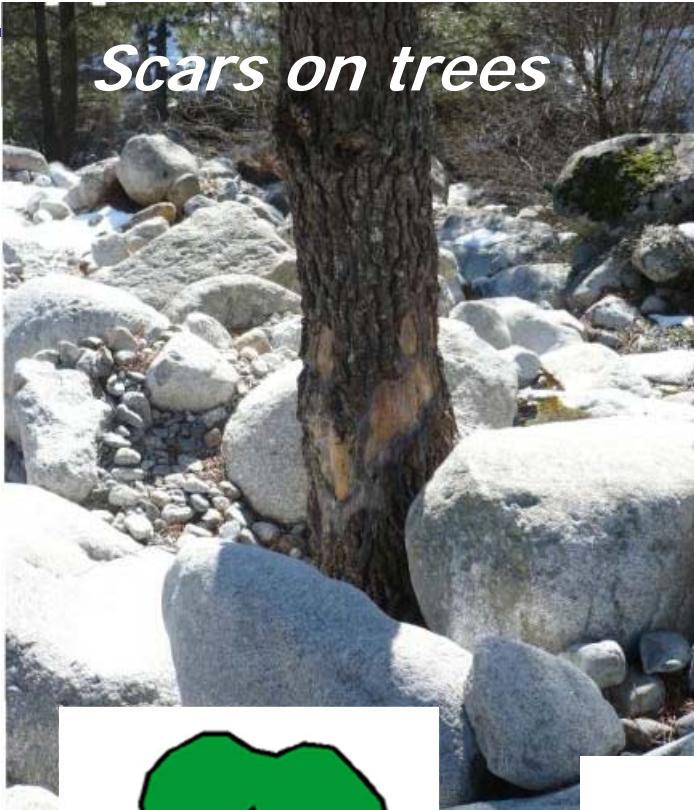
Dendrogeomorphology

At local spatial scales

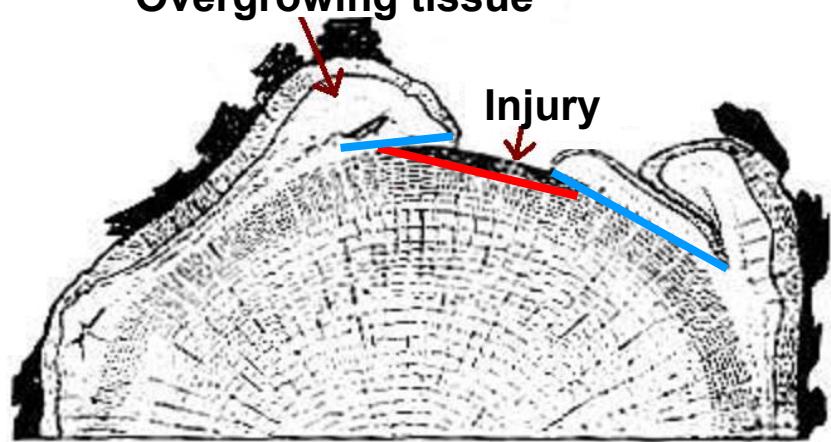
- DENDROGEOMORPHIC EVIDENCE

SPACIAL SCALE		STUDIED ELEMENT		TYPE OF DENDROGEOMORPHOLOGICAL INDICES		No.
km	hm	Bottomland vegetation patterns		Species distribution pattern	ID 1	
				Coverage distribution pattern	ID 2	
				Ages distribution pattern	ID 3	
dm		Complete tree or bush		Candelabra growth	ID 4	
				Tilted and overturned trees	ID 5	
m	Macroscopic	Individual (tree or bush)		Decapitated trees (tops missing)	ID 6	
				Sediment load impact	ID 7	
dm		Part of tree or bush	Trunk	Stripped bark with callus marks	ID 8	
				Branches torn off	ID 9	
cm			Branches	Scraping from other falling trees	ID 10	
				Erosion	ID 11	
			Roots	Sudden narrowings in trunk	ID 12	
				Elbows and angles	ID 13	
				Bifurcations	ID 14	
				Sprouts from buried trunks	ID 15	
				Sprouts from buried trunks	ID 16	
				Elbows and angles	ID 17	
				Exposed roots	Stripped bark and erosion	ID 18
					Float roots without substrate contact	ID 19
				New roots from buried trunks	ID 20	
				Eccentric growths (reaction wood)		

Dendrogeomorphology

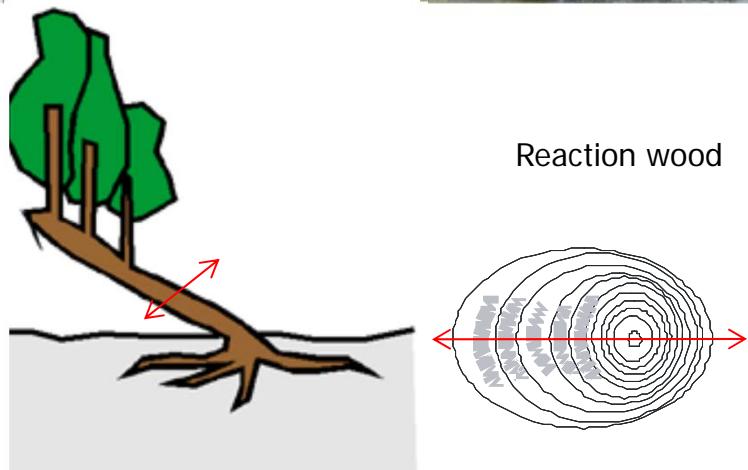


Overgrowing tissue

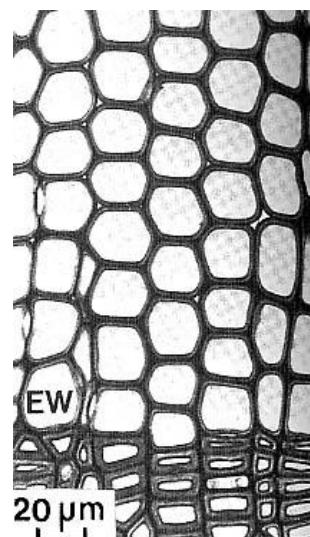
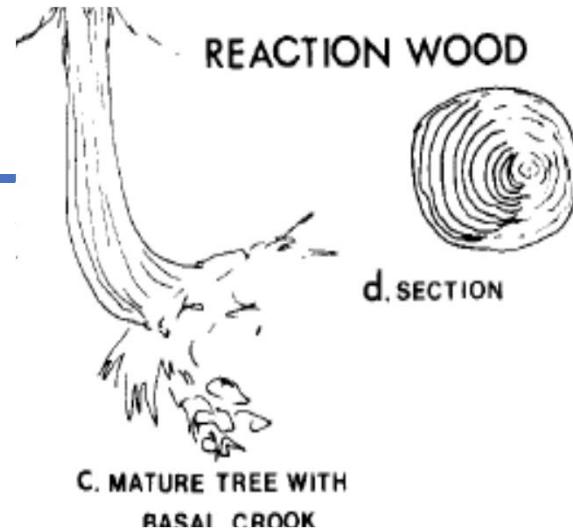


(Gottesfeld & Gottesfeld, 1989)

Dendrogeomorphology

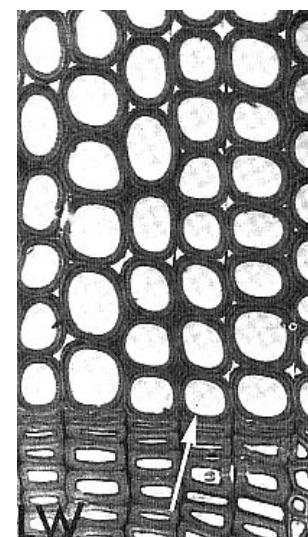


Landform Dating, Process Reconstructions



(Schweingruber, 2001)

Regular wood

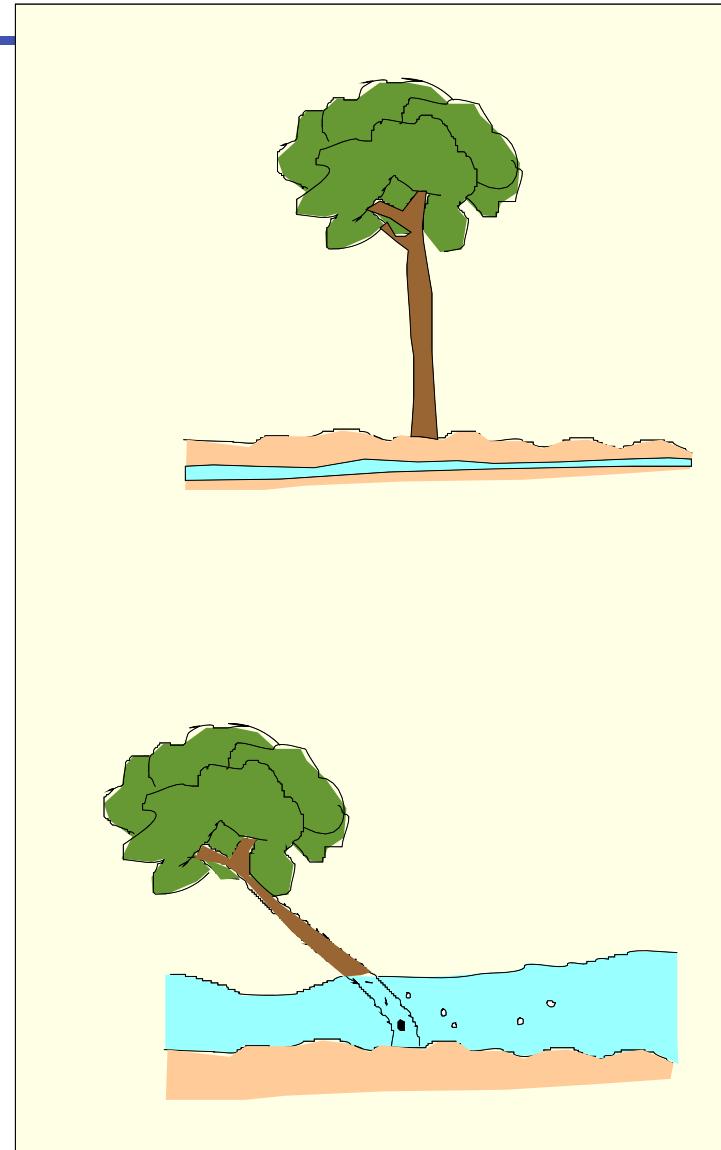


Reaction wood

Dendrogeomorphology



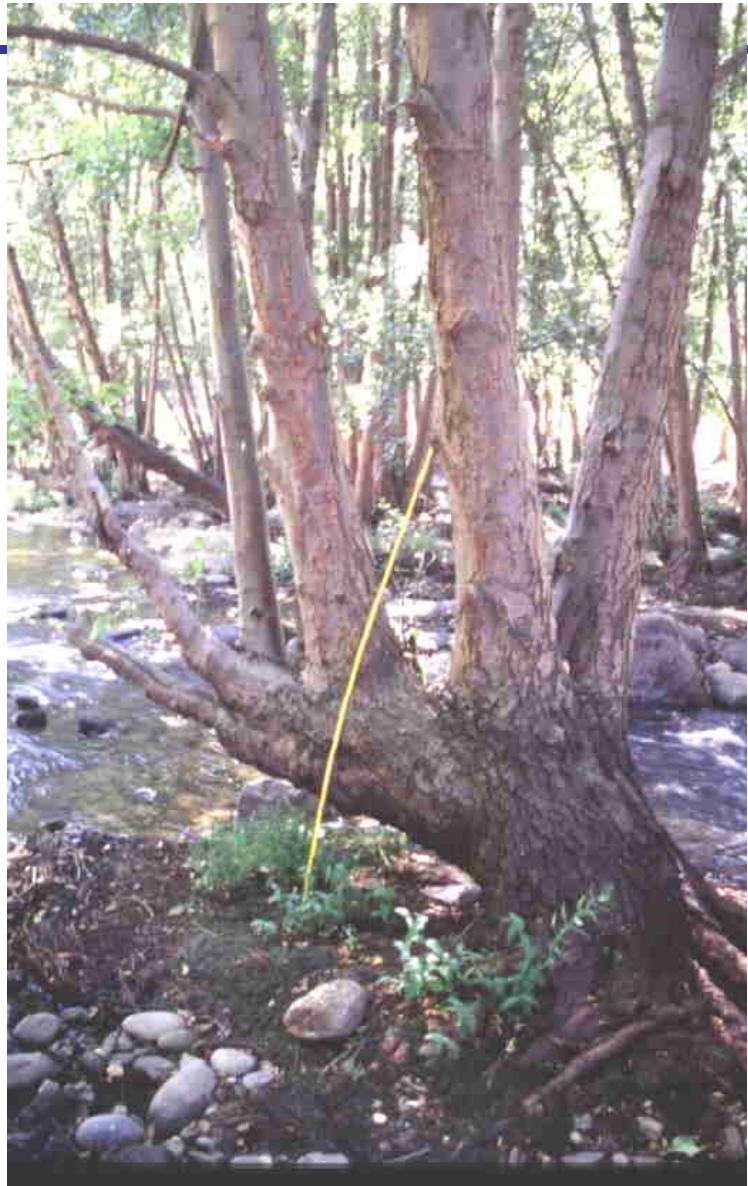
Landform Dating, Process Reconstructions



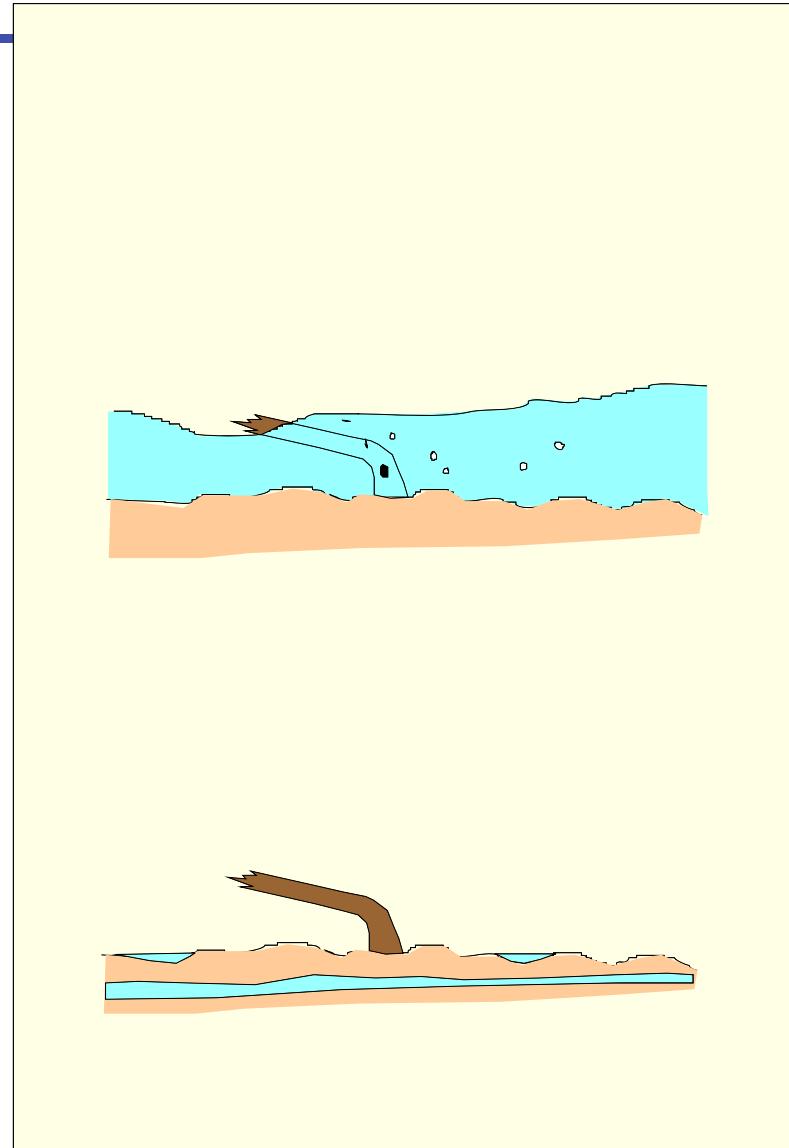
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Dendrogeomorphology



Landform Dating, Process Reconstructions



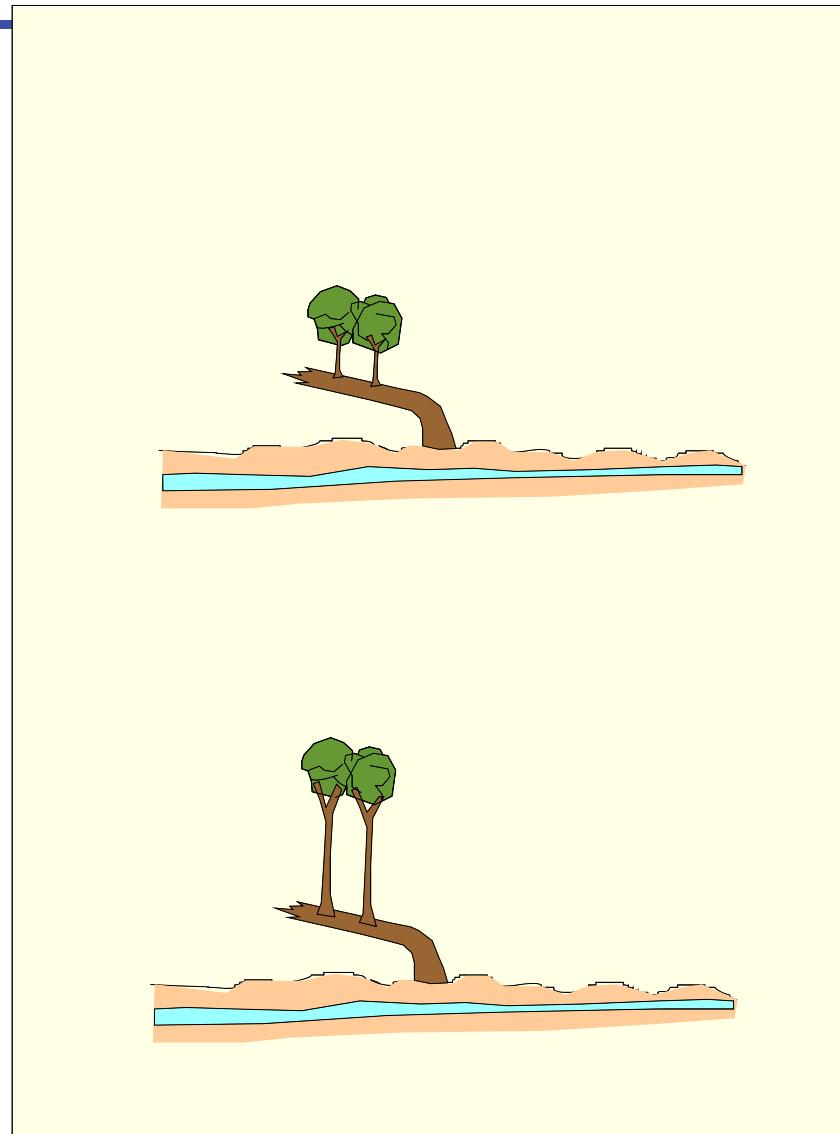
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Dendrogeomorphology



Landform Dating, Process Reconstructions

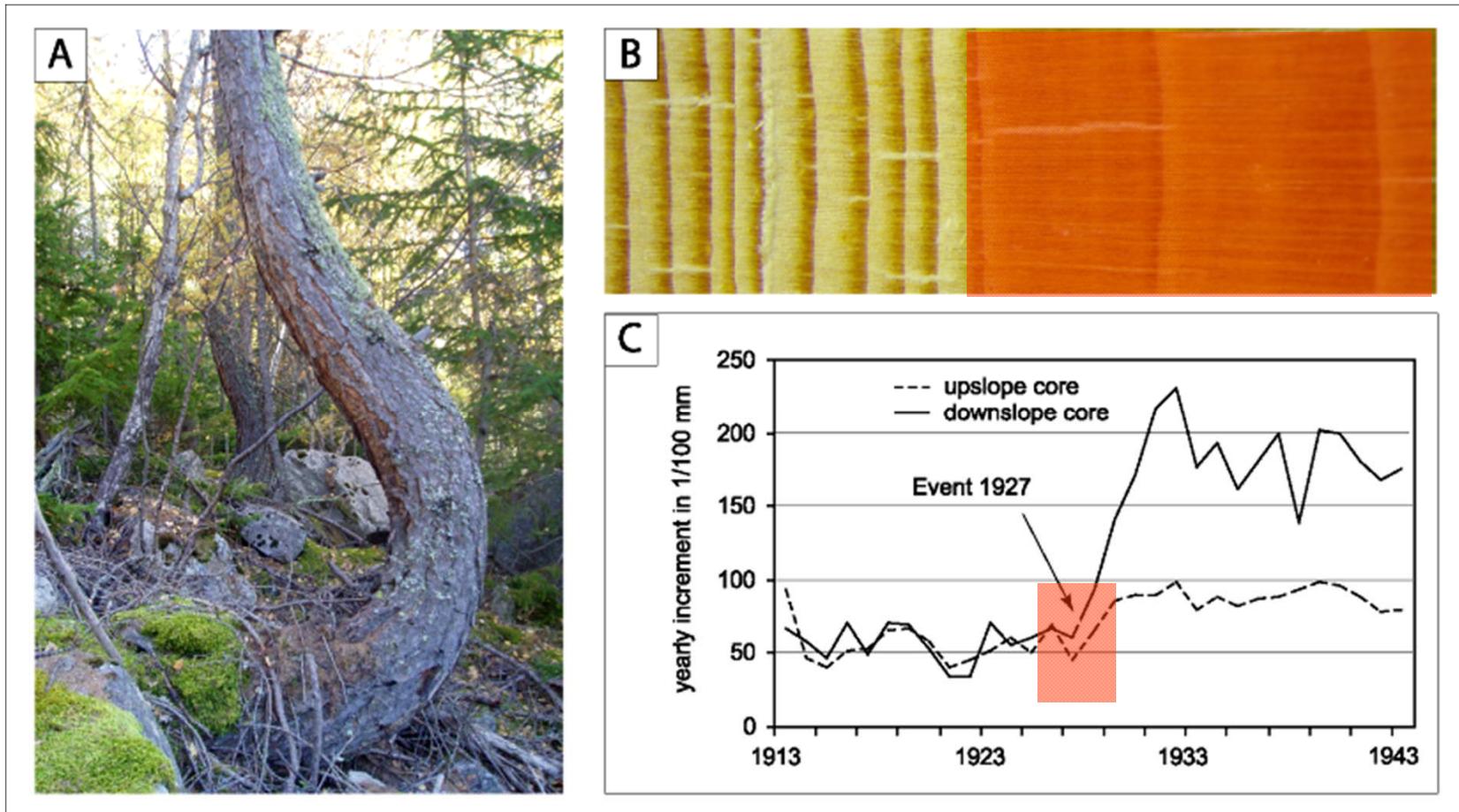


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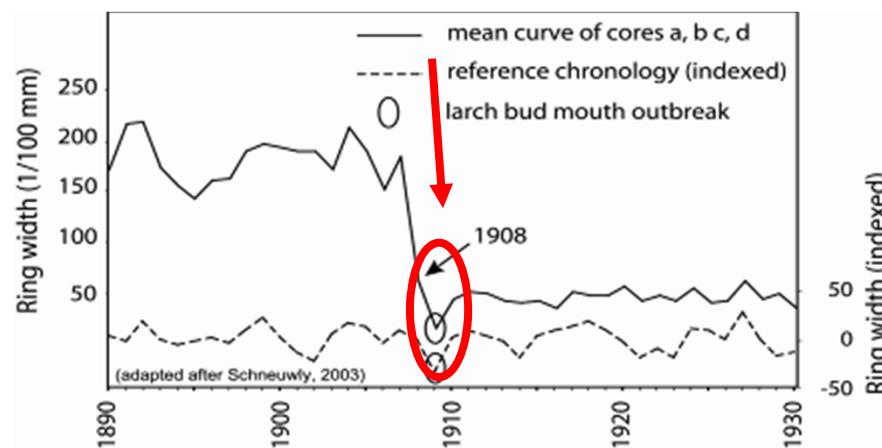
Dendrogeomorphology

Stem tilting: eccentric growth and reaction wood

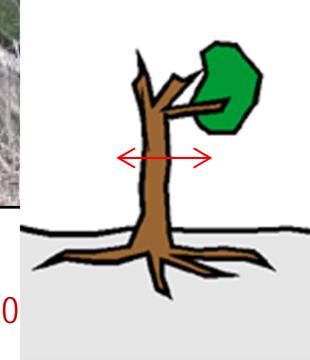


Dendrogeomorphology

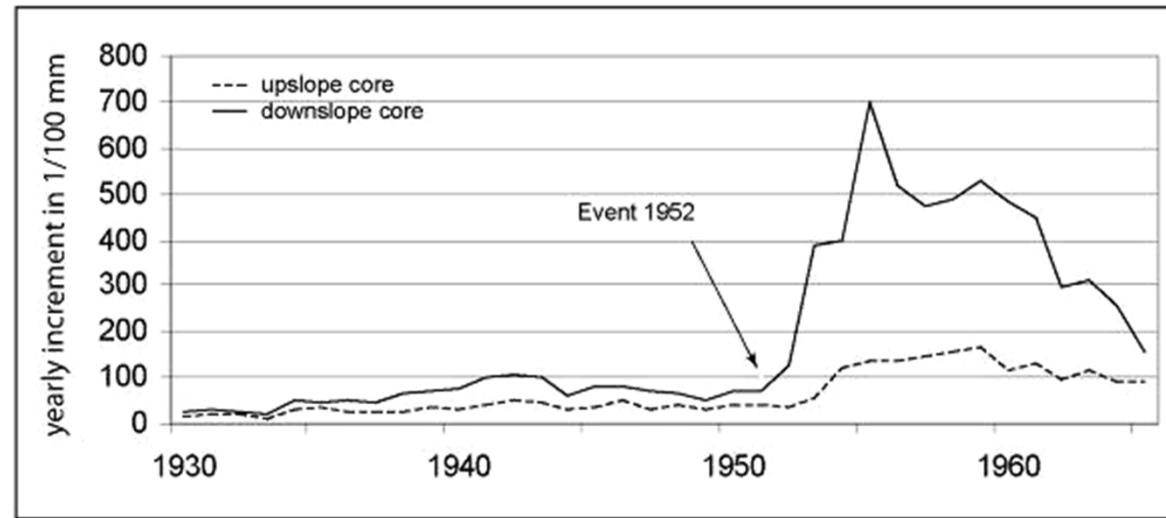
Decapitated trees



Growth decrease!

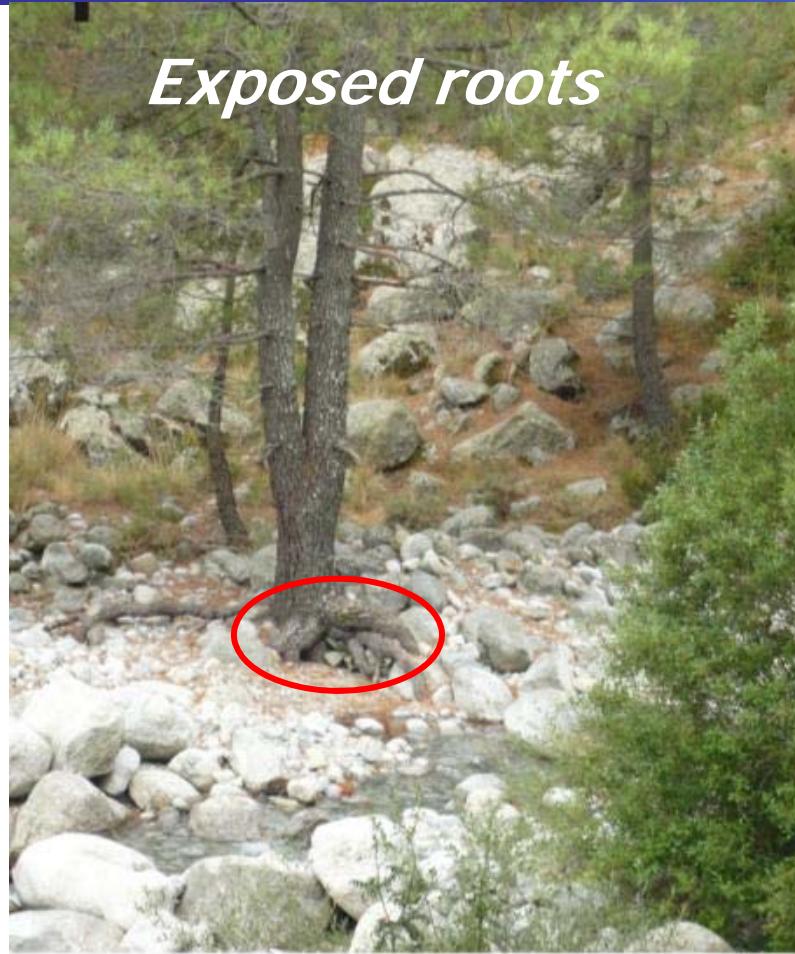


Dendrogeomorphology

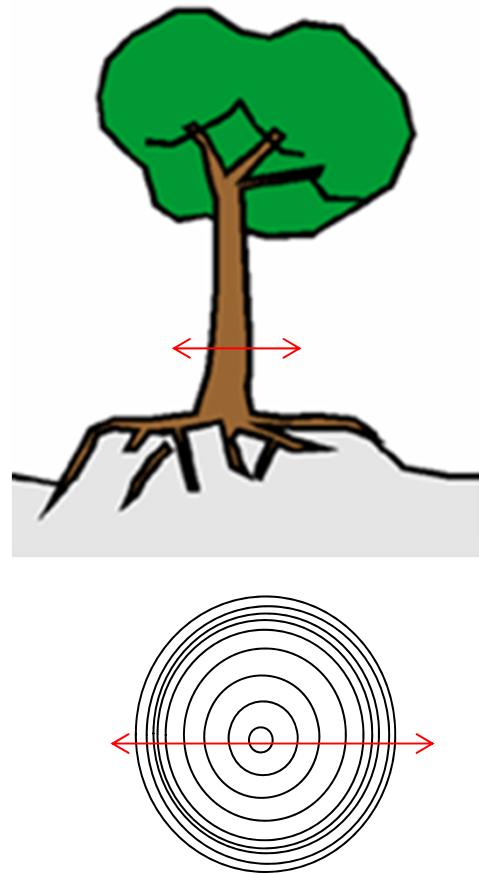


Growth increase!

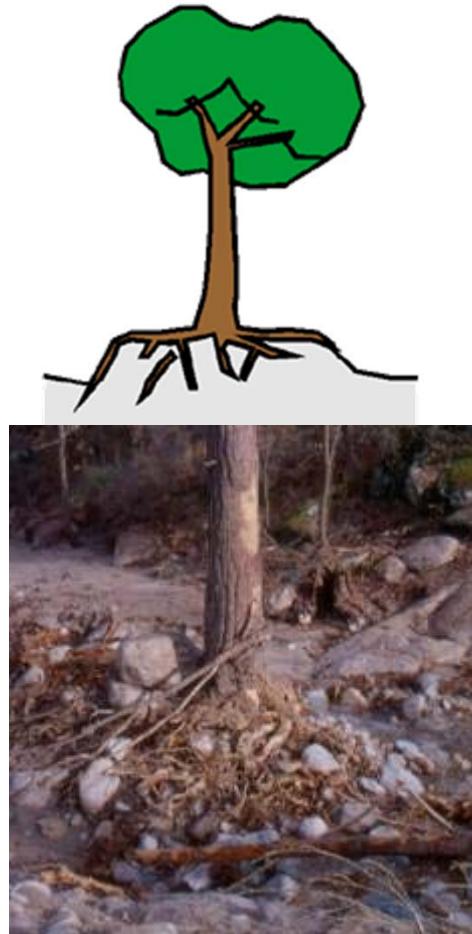
Dendrogeomorphology



Growth decrease!



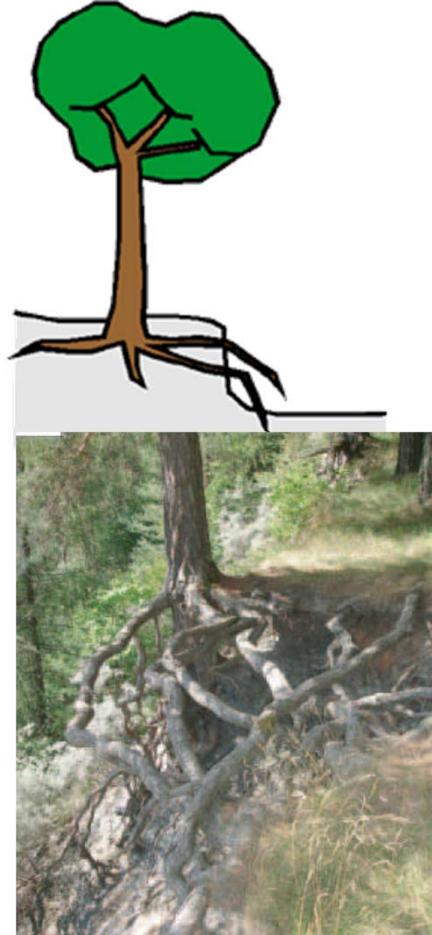
Dendrogeomorphology



Totally exposed roots

eccentric growth rings in roots

Landform Dating, Process Reconstructions



Partially exposed roots



Adventitious roots

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Dendrogeomorphology

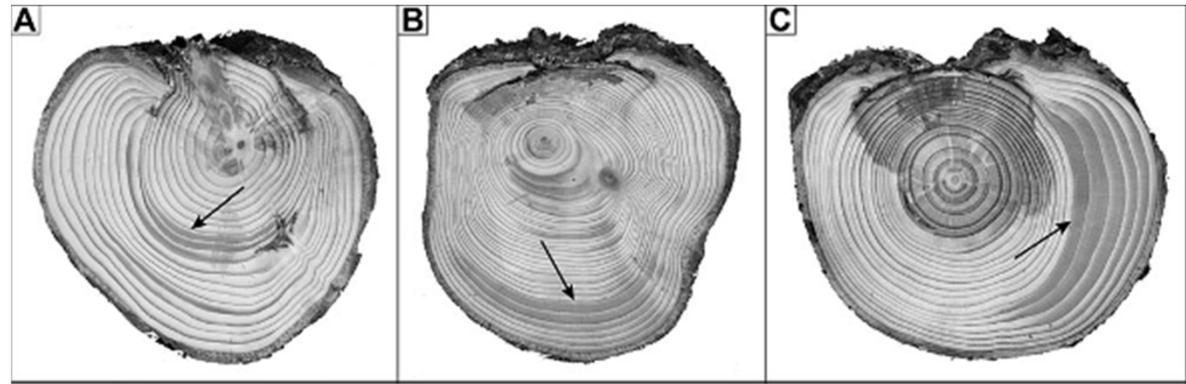
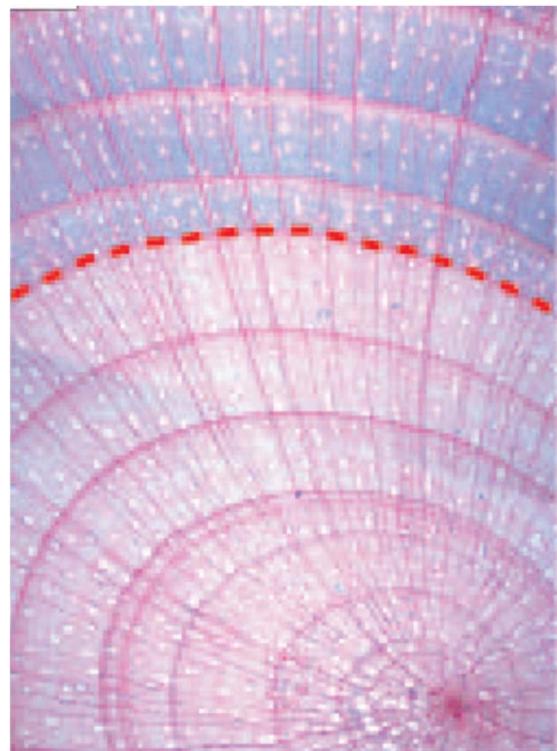
Microscopical scale

- DENDROGEOMORPHIC EVIDENCE

mm	Mesoscopic	Tissues, wedges and slices	Rings	Eccentric growths (reaction wood)	ID 20
				False tree rings	ID 21
				Discontinuities, erosion, and internal scars	ID 22
			Tissues	Changes in parameters (width, % early wood, late wood, etc)	ID 23
				Ratio parenchyma-lignification tissue	ID 24
				Size and density of vessels	ID 25
μm	Microscopic	Thin slice	Cells	Changes in cell parameters	Size and morphometry of lumen cells
					ID 26
					Cell wall thickness
				Appearance and/or abundance of special types of cells	ID 27
					Traumatic resin ducts (TRDs)
					ID 28
					Fiber-tracheid
					ID 29
					Traumatic structures in cell wall
					ID 30
Å	Atomic	Cell wall	Cellulose	Isotopic fractionation	$\delta^{18}\text{O}/\delta^{16}\text{O}$ ratio
					ID 31

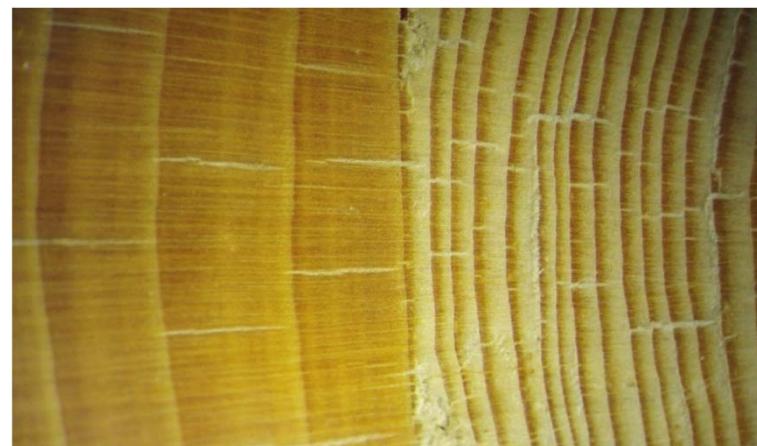
Dendrogeomorphology

Reaction wood (tension wood) in *Acer pseudoplatanus L.* (Source: Hitz, 2008).



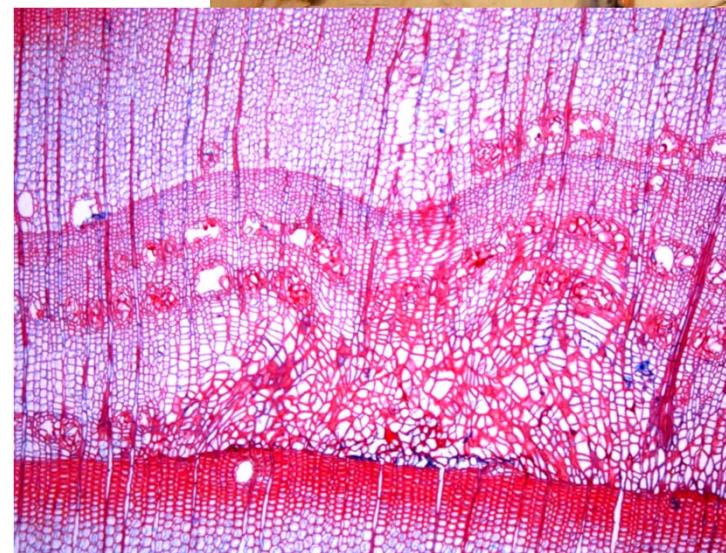
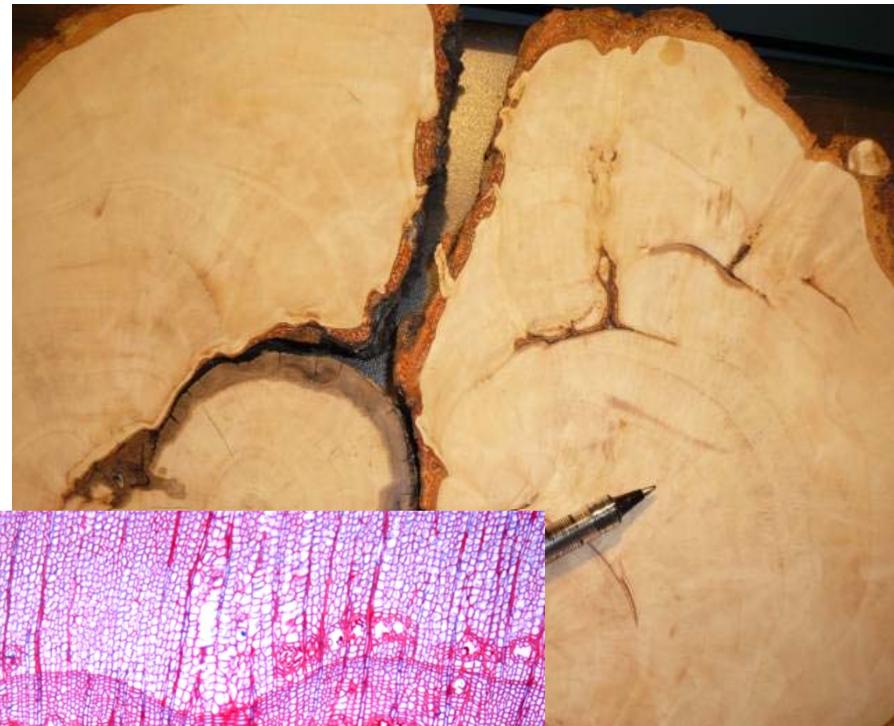
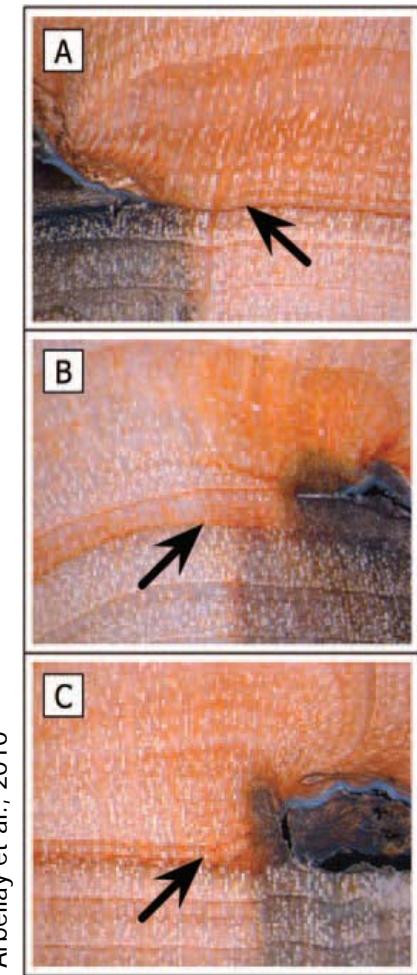
(SCHNEUWLY et al., 2009)

Different kind of cells (more lignin (conifer trees) or mucilaginous (broadleaved trees)!



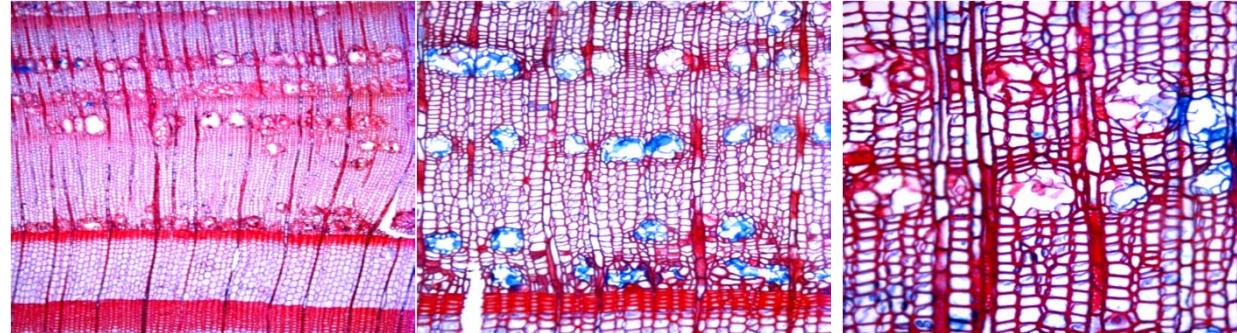
Dendrogeomorphology

Anatomical features associated to scars in trees

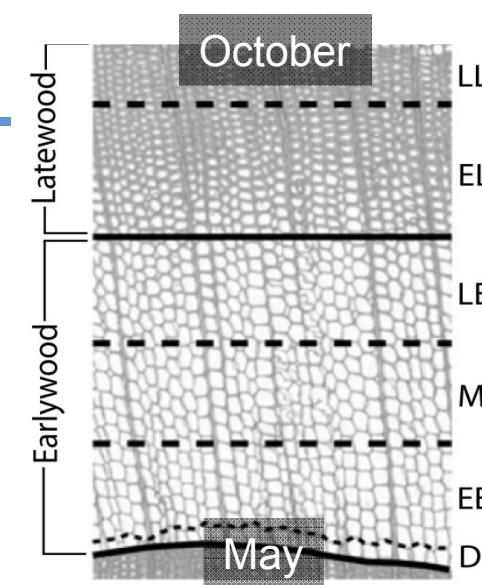
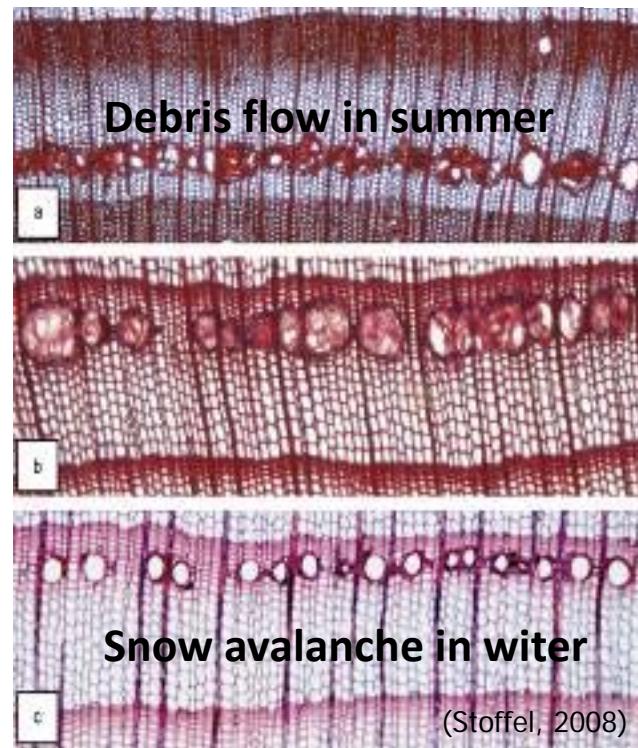


Dendrogeomorphology

Anatomical features associated to scars in trees



In some **conifers** trees (Larix, Picea or Abies): Tangential rows of **traumatic resin ducts (TRD)**



BOTANICAL SOURCES

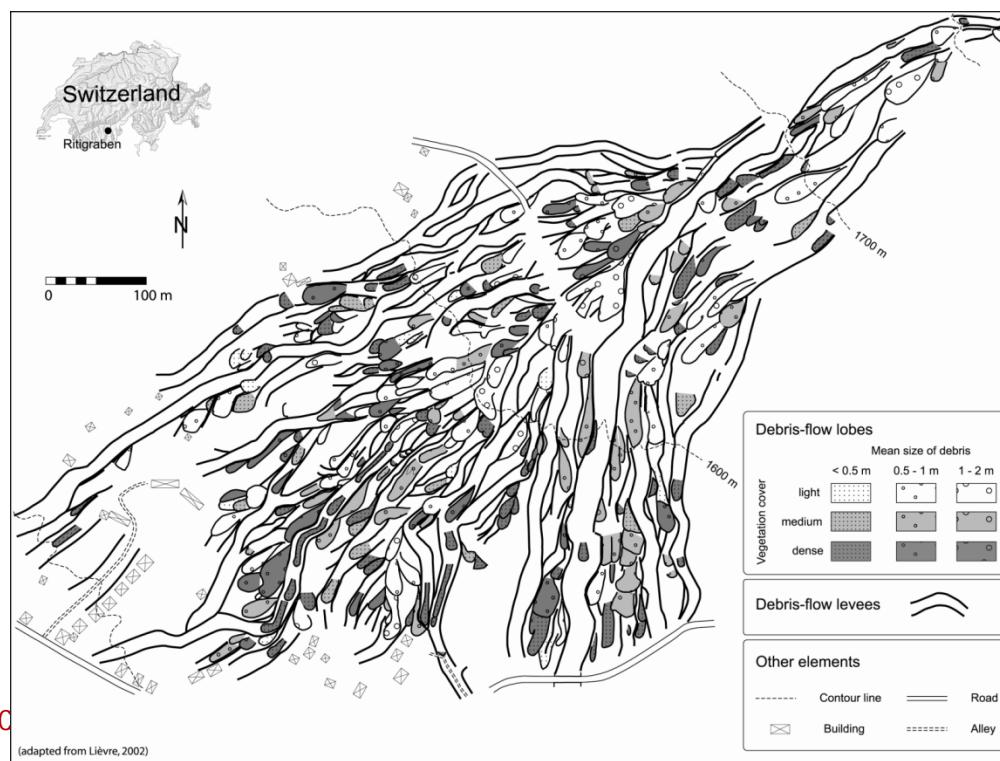
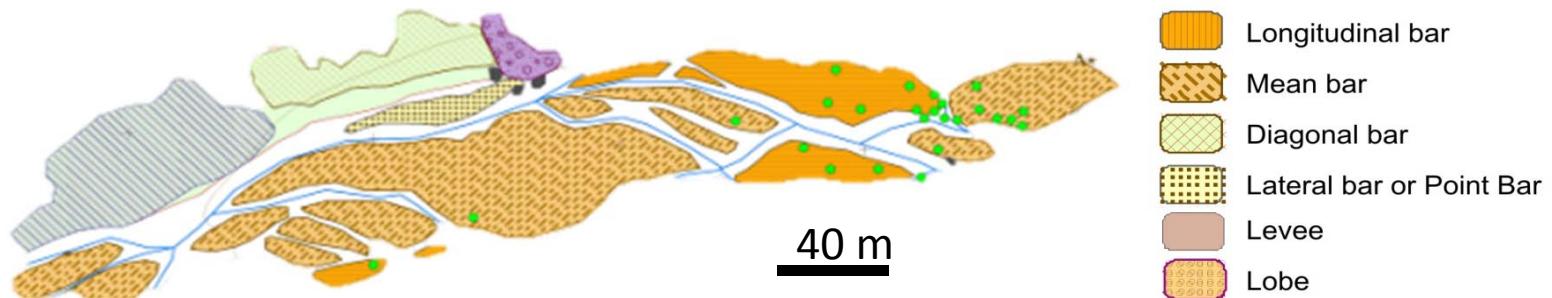
Tree-rings:

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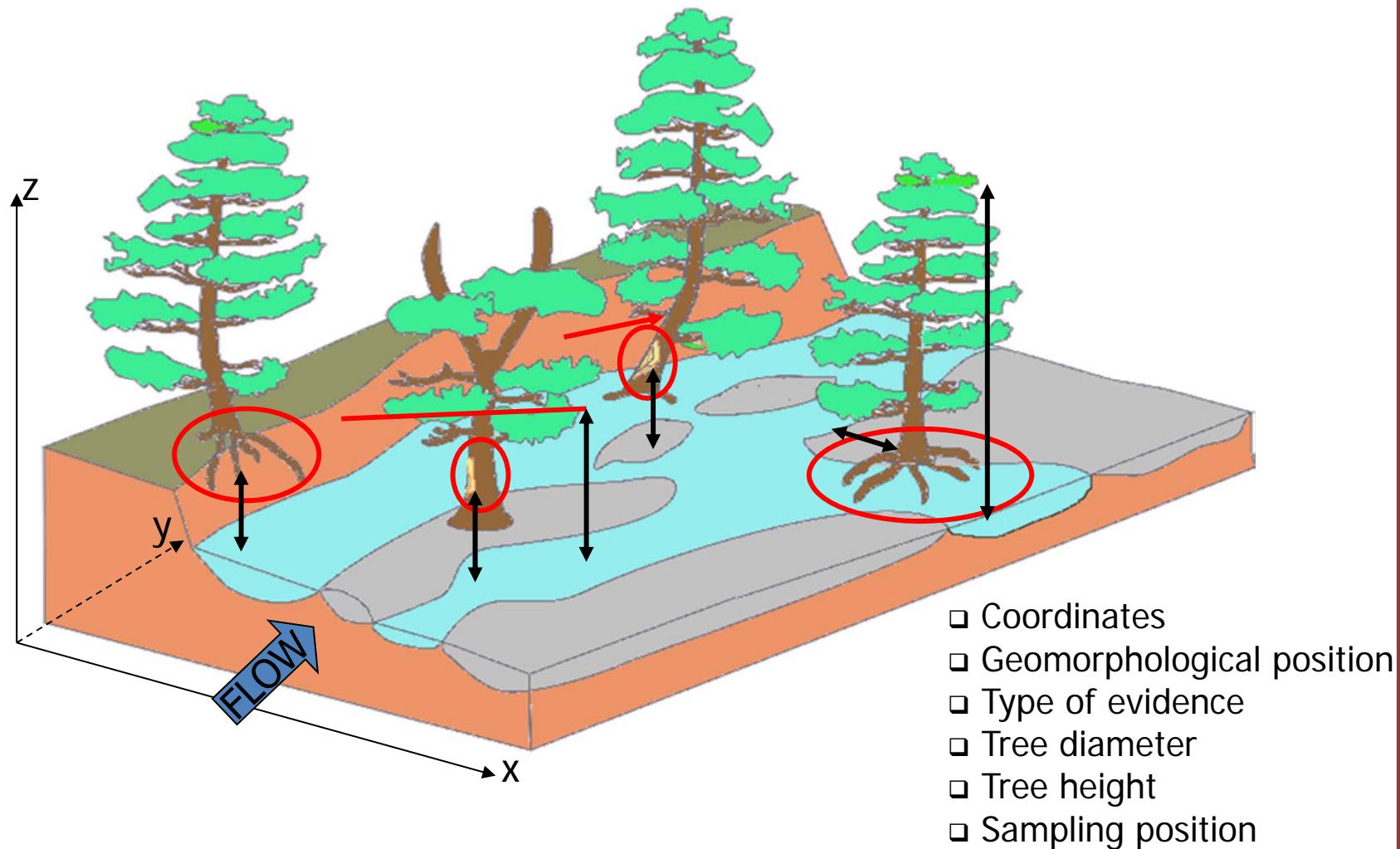
Dendrogeomorphology

- FIRST TASK: Geomorphic mapping



Dendrogeomorphology

- SECOND TASK: Description of dendrogeomorphic evidence and sampling

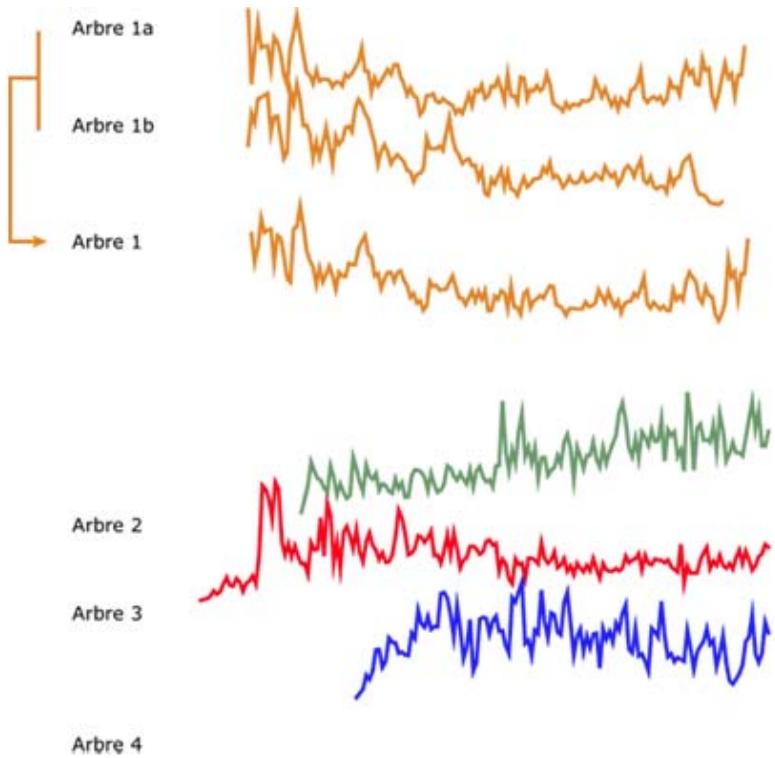


Dendrogeomorphology



Dendrogeomorphology

- The environmental signal being investigated (P, T, drought, ...) can be maximized (and the amount of noise minimized) by sampling more than one core per tree and more than one tree per site.
 - Replication is important to build a robust chronology.



Dendrogeomorphology

- SECOND TASK: ... sampling
- How to sample?



Landform Dating, Process Reconstructions



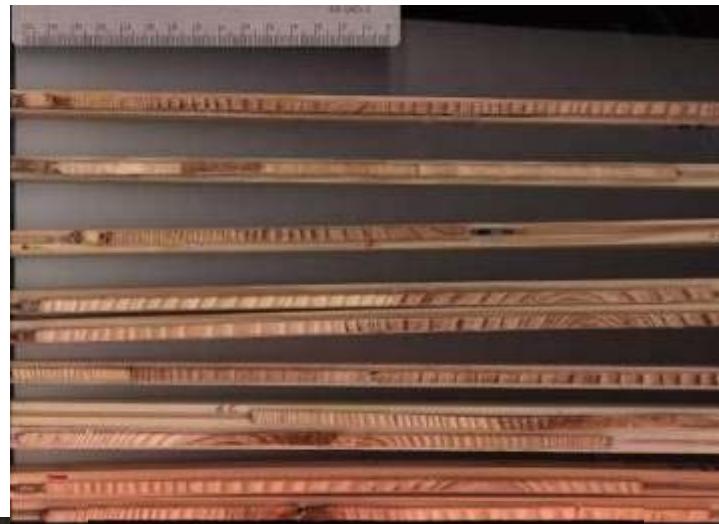
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Dendrogeomorphology

- SECOND TASK: ... sampling

- How to sample?



Dendrogeomorphology

- SECOND TASK: ... sampling
- Where to sample?

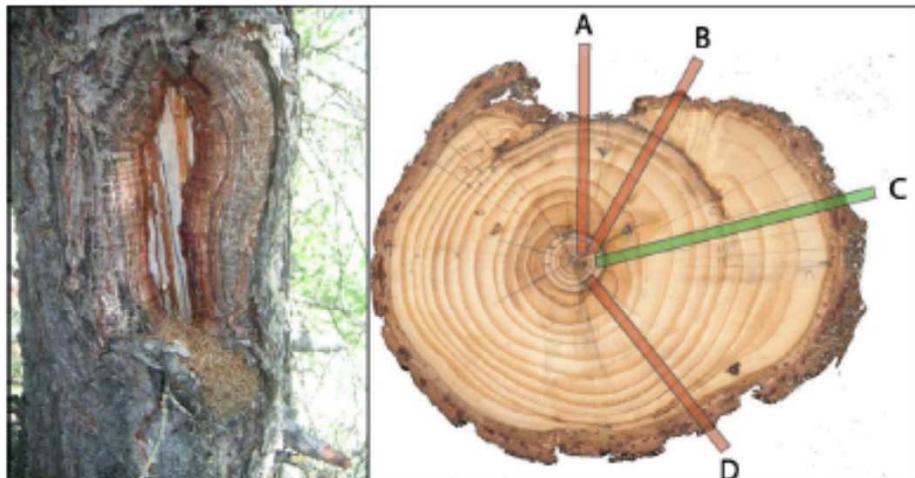


Figure 5: When sampling injured trees, special attention needs to be paid to the correct location. When extracting samples from the positions A or B, tree rings will be missing and a correct dating of the injury is not possible. The good position for the sampling would be position C where the injury just finishes and the overgrowing callus tissue and the bordering TRD start. In contrast, D is too far from the injury and no GD can be determined here.

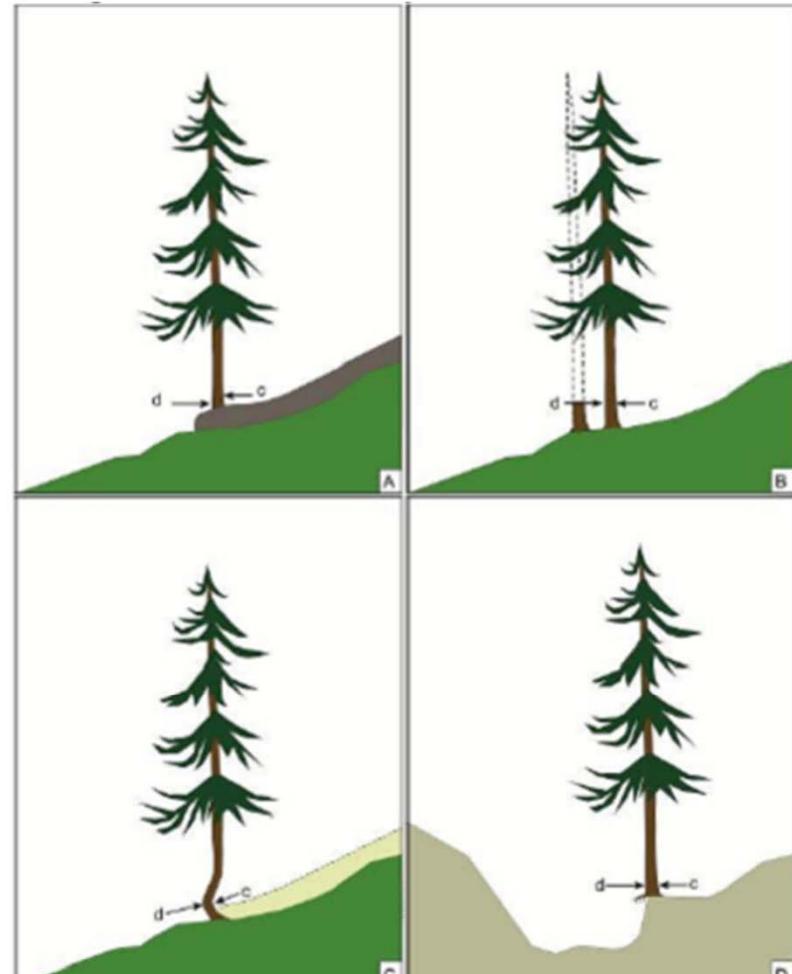
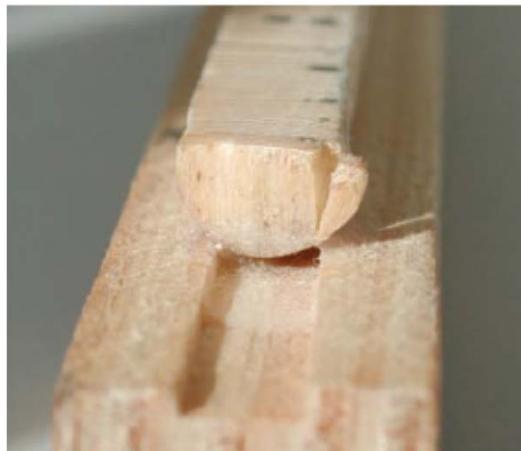


Figure 4: Position and height of sampling of trees with buried stem base (A), eliminated neighboring tree (B), tilted stem (C) or root erosion (D).

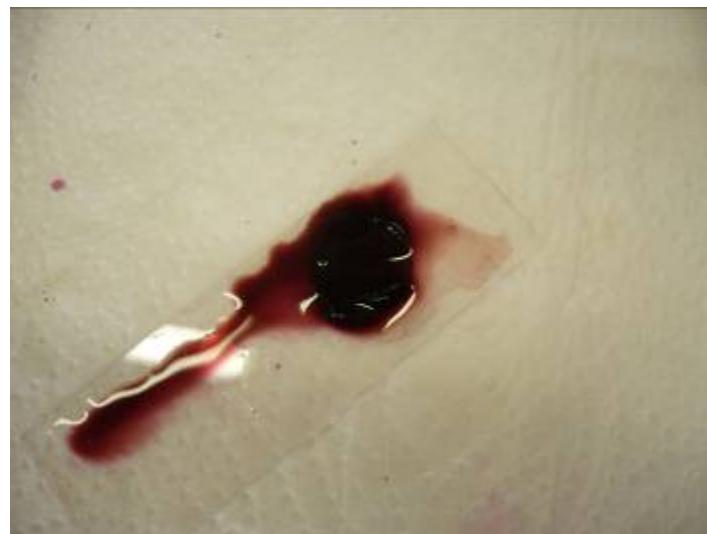
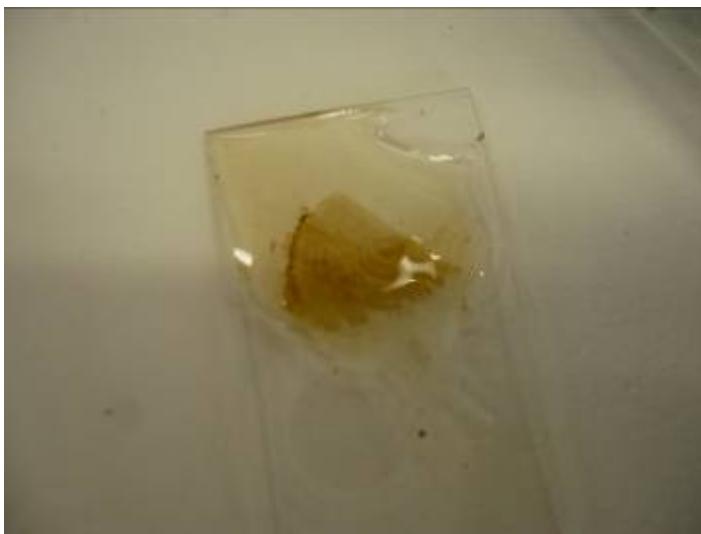
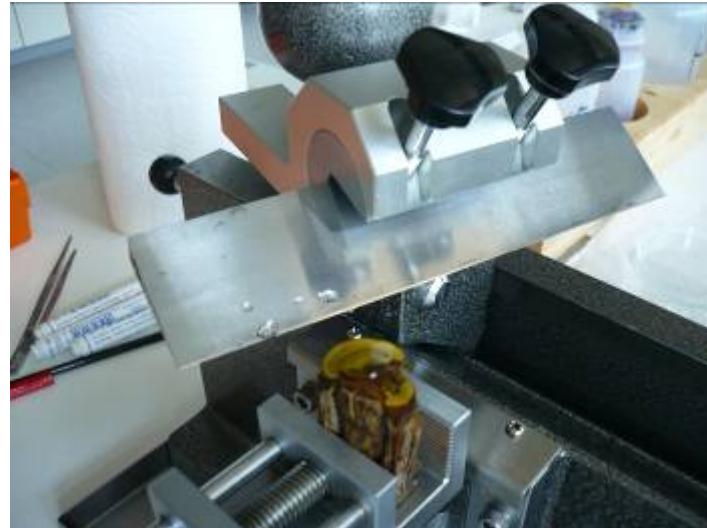
Dendrogeomorphology

- THIRD TASK: Sample preparation



Dendrogeomorphology

- THIRD TASK: Sample preparation



Dendrogeomorphology

- FOURTH TASK: Analysis of samples

Methods of analysis Counting, measuring and crossdating

- 1) Subjective visual methods: SKELETON PLOTS
- 2) Statistical methods: TSAP, COFECHA



Dendrogeomorphology

- FOURTH TASK: Analysis of samples

Counting of tree rings

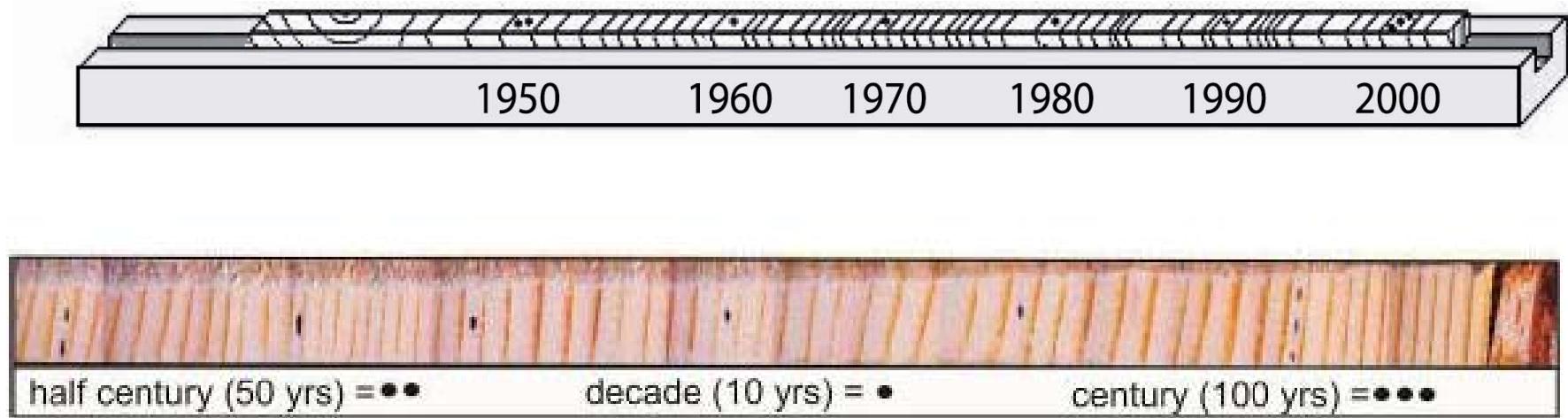


Figure 6: An example of a increment core of a *Picea abies* (L.) Karst each decade is indicated with one point, half-centuries with two points and centuries with three points

Dendrogeomorphology

- FOURTH TASK: Analysis of samples

Methods of analysis: Skeleton plots

Legend for Skeleton Plot

Abbreviations

- S = scar
- A = abrupt growth change (+ or -)
- F = frost ring
- R = radial crack
- C = compression wood
- T = traumatic resin canal (resin duct)
- E = early wood
- L = late wood
- () = other side of pith

Notation

- * = an event
- = date of establishment – a dashed circle indicates an estimate due to stem burial
- ↔ = over the circle indicates an estimate
- = date of pith – actual if skeleton plot line solid, estimated if line dashed
- = date of end of core or wedge
- ↔ = core or wedge continues, establishment date not estimated

Visual Growth Analysis

Growth reductions (shown below the tree plot line with a “-A”):

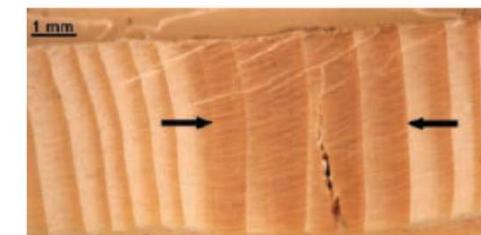
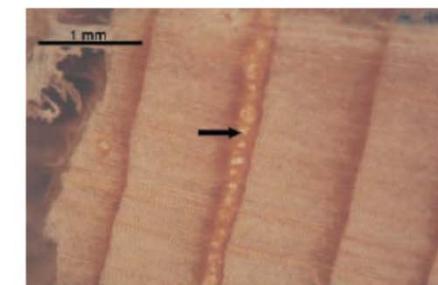
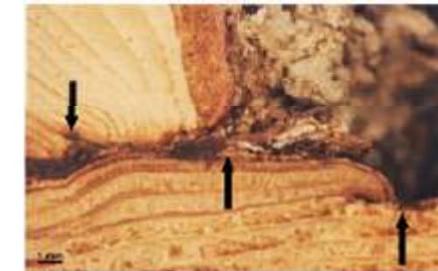
- slight = 40–55%
- moderate = 56–70%
- strong = >71%

Growth increase (shown above the tree plot line with a “+A”):

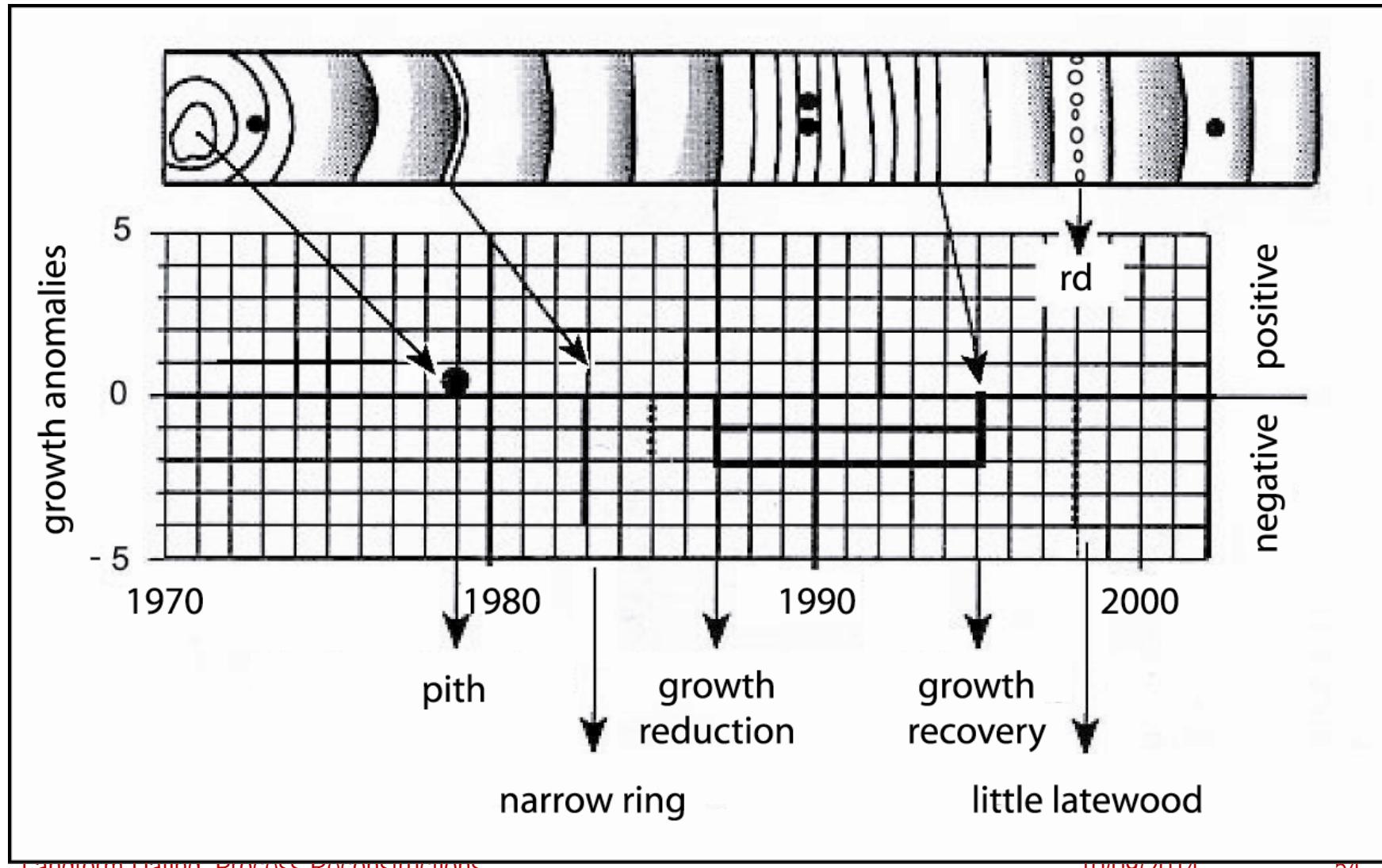
- slight = 50–100%
- moderate = 101–200%
- strong = > 201%

In cases where growth changes are gradual, two approaches are used in the skeleton plots:

- “release” / “suppression” indicates a gradual change starting at that point. This is used in cases where the growth is in long-term change due most likely to a change in stand conditions.
- ↔ a dashed diagonal line from the start of change to the point where growth has changed enough to achieve the required ring width. This is used in cases where growth change is gradual, but most likely due to a hydrogeomorphic event—the tree generally returns to normal growth after a period of time.



Dendrogeomorphology



Dendrogeomorphology

SKELETON PLOTS

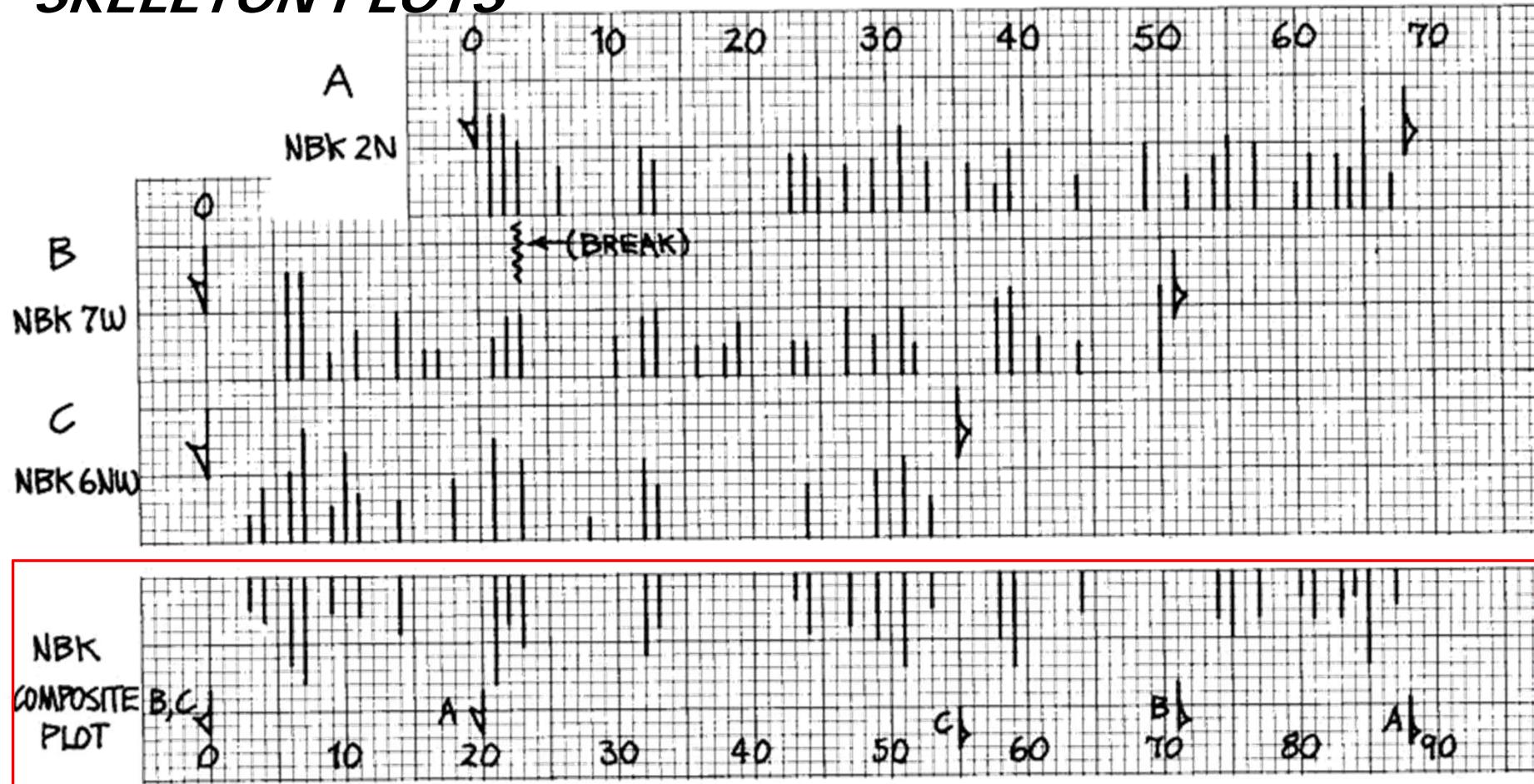


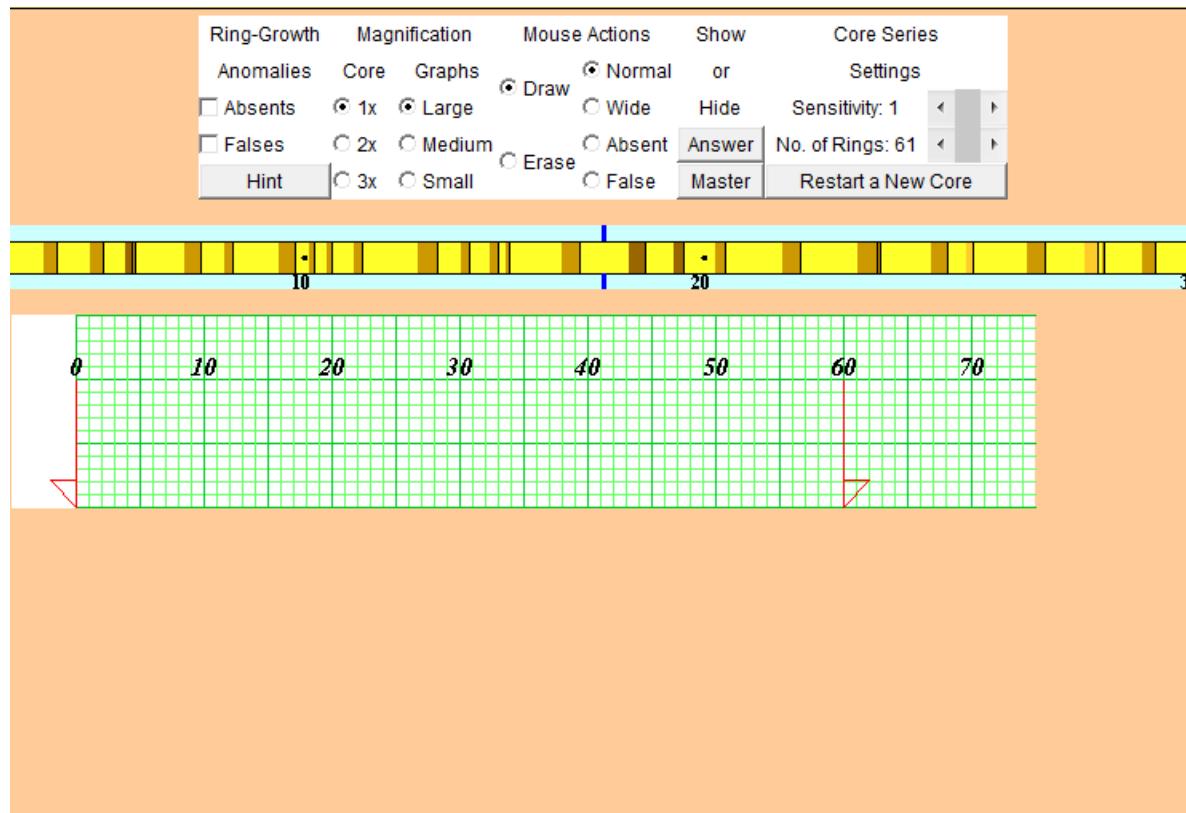
Figure 12—Skeleton plots for three Nancy Brook (NBK) cores and composite plot.

Dendrogeomorphology

Paul R. Sheppard

Laboratory of Tree-Ring Research, The University of Arizona

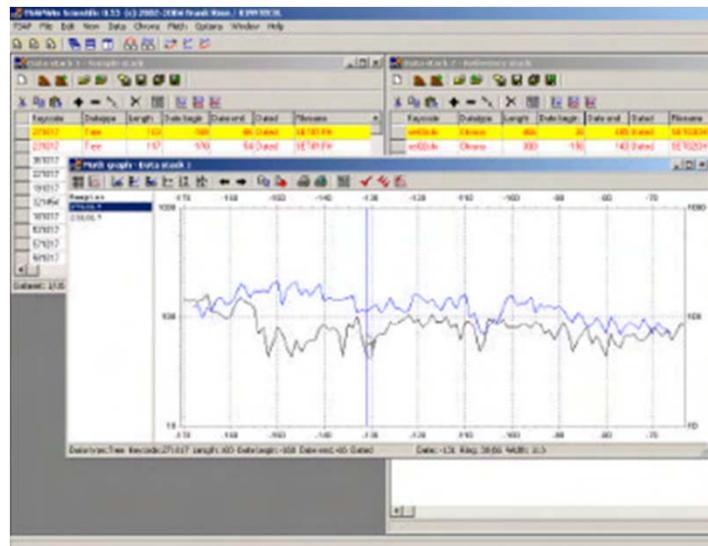
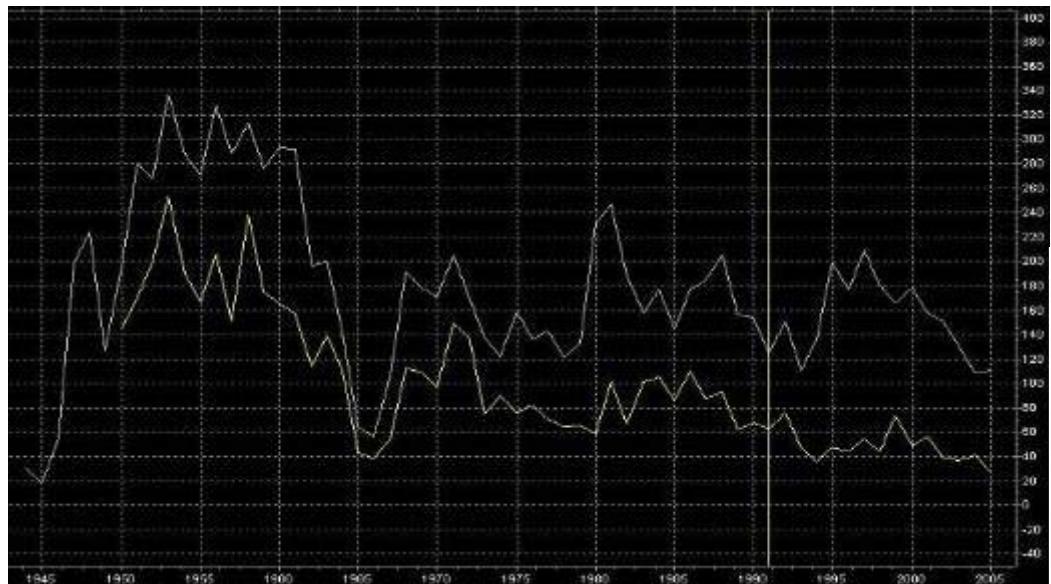
URL: <http://tree.ltrr.arizona.edu/skeletonplot/SkeletonPlot19.htm>



Dendrogeomorphology

- FOURTH TASK: Analysis of samples

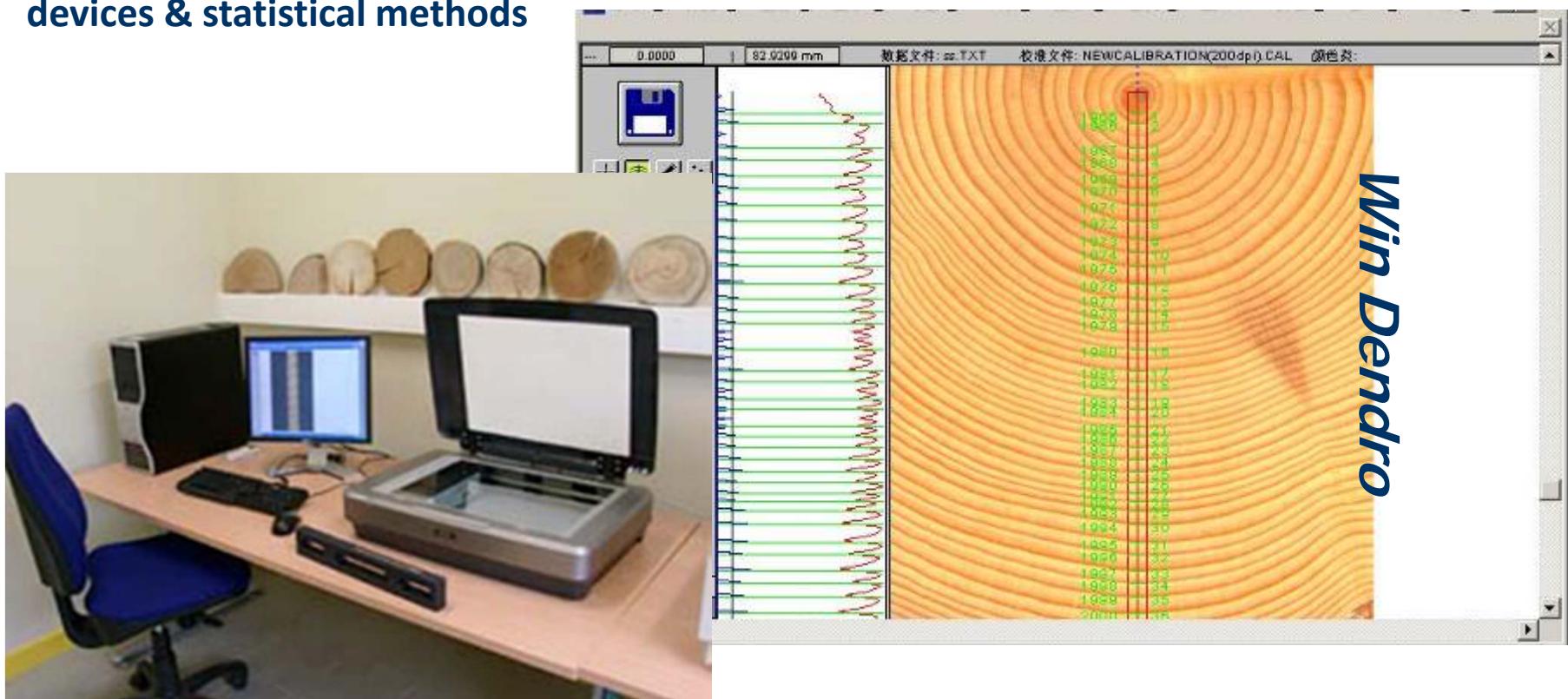
Methods of analysis: Measuring devices & statistical methods



Dendrogeomorphology

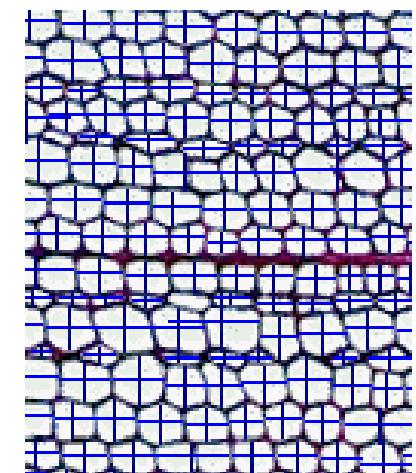
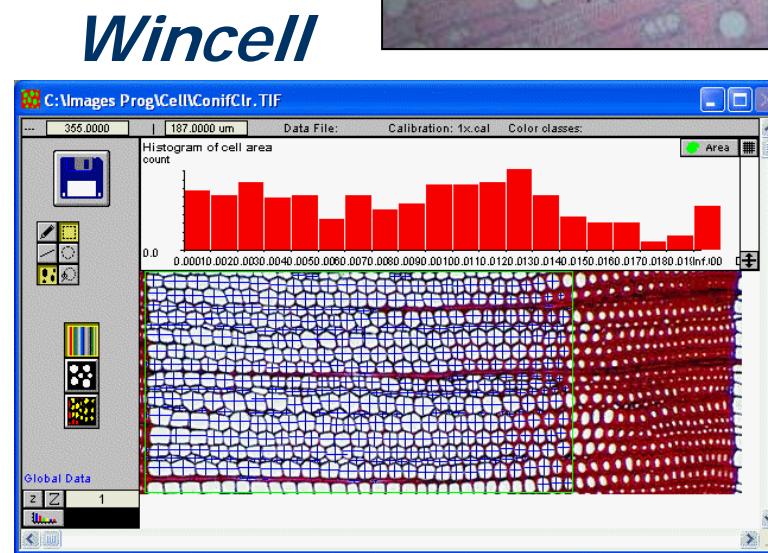
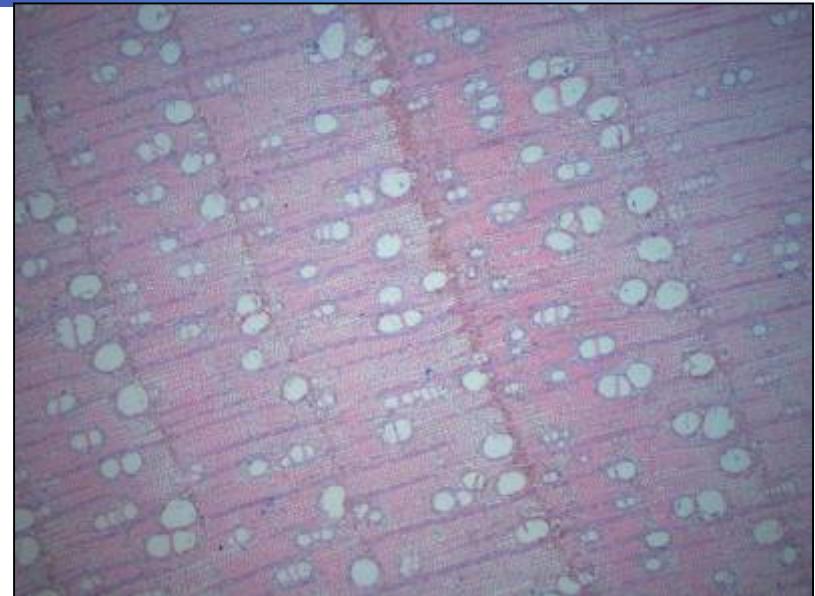
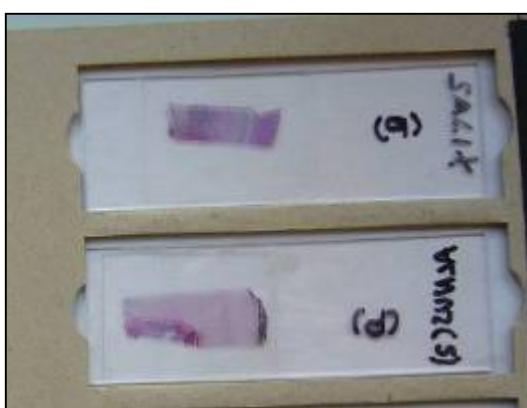
- FOURTH TASK: Analysis of samples

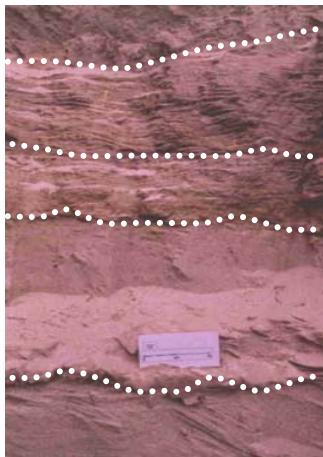
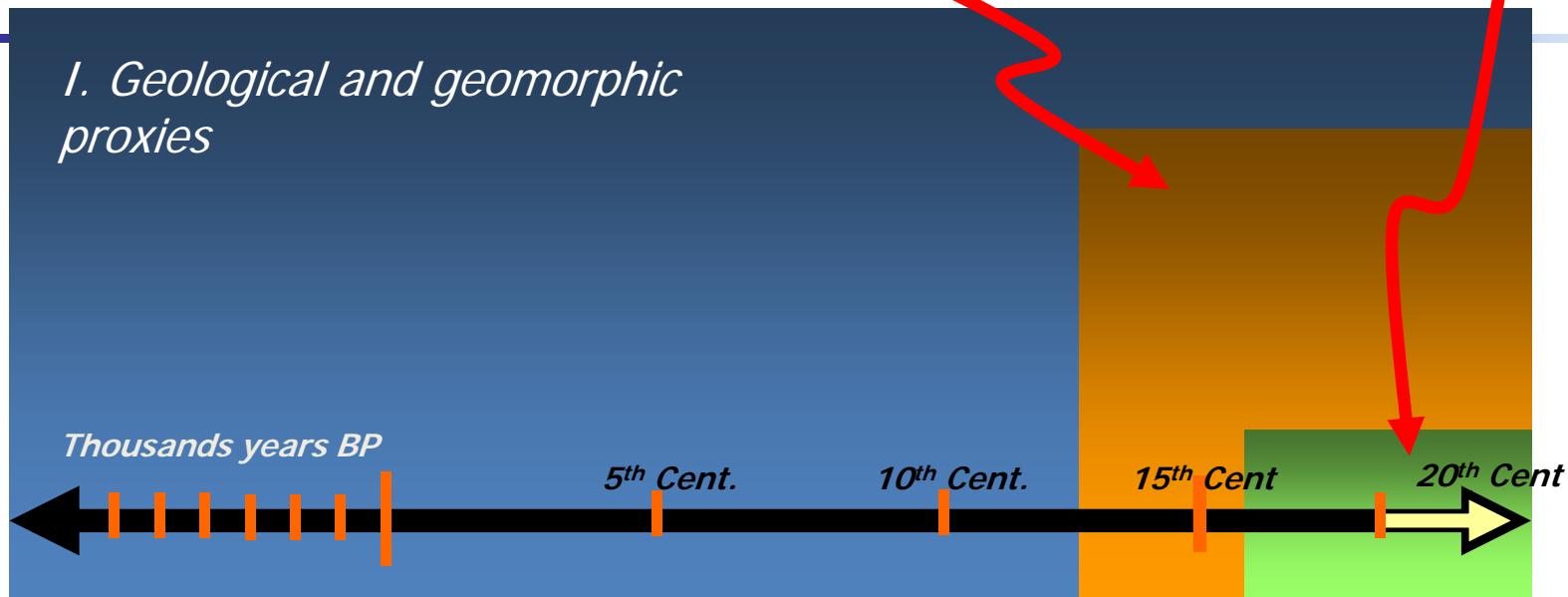
Methods of analysis: Automatic measuring devices & statistical methods



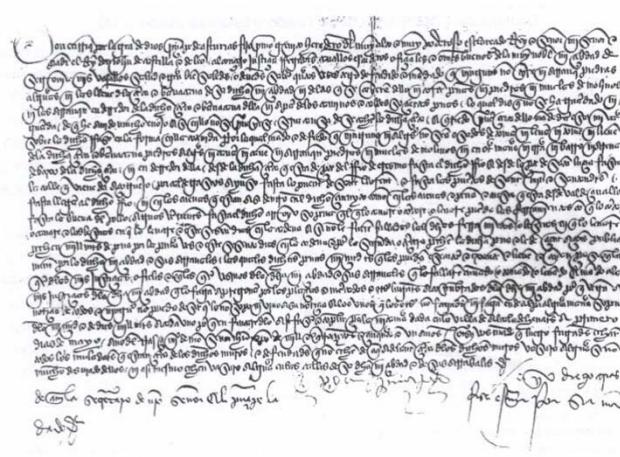
Dendrogeomorphology

- FOURTH TASK: Analysis of samples
 - Methods of analysis: anatomical procedures and biometric automated measurements





Facies
Landform Dating, Process Reconstructions



Documentary sources



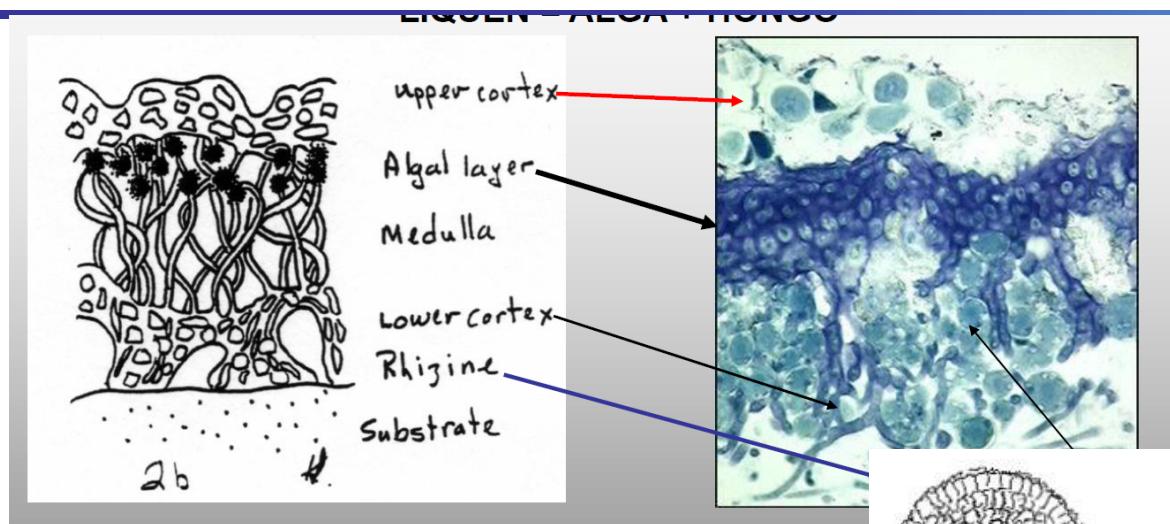
Tree rings and lichens
10/09/2014

Lichenometry

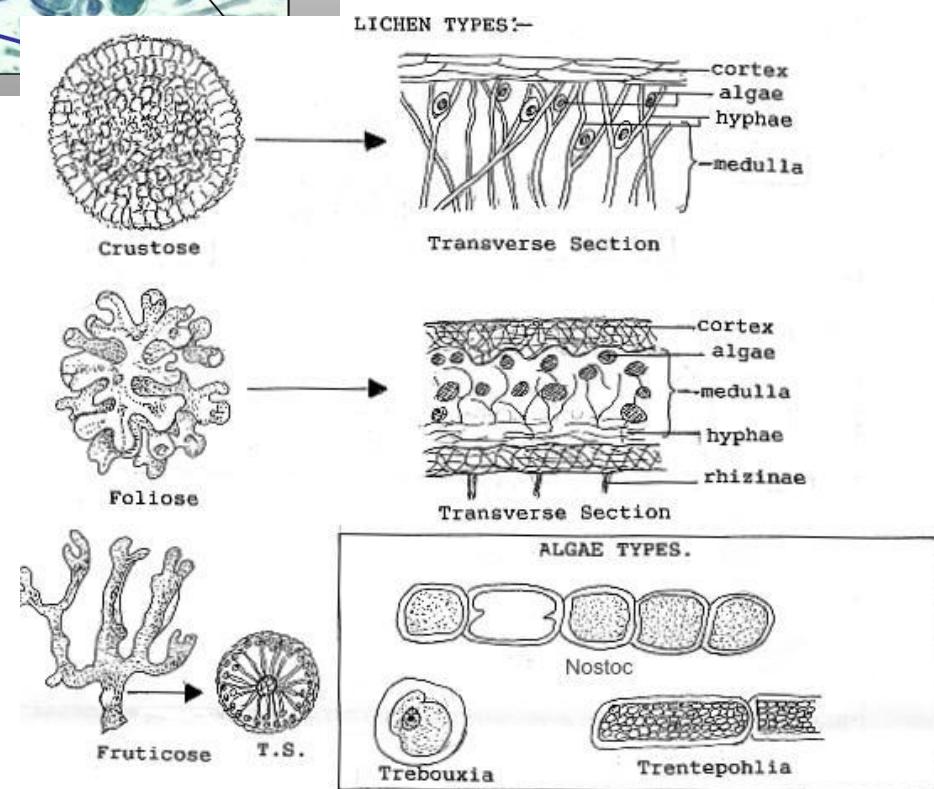
- What is a lichen? Some types...
- Methodology
- Applications



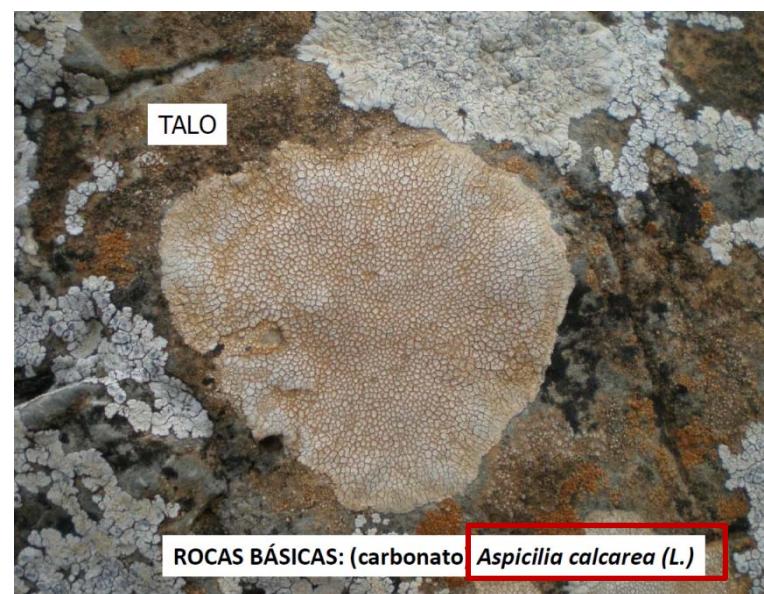
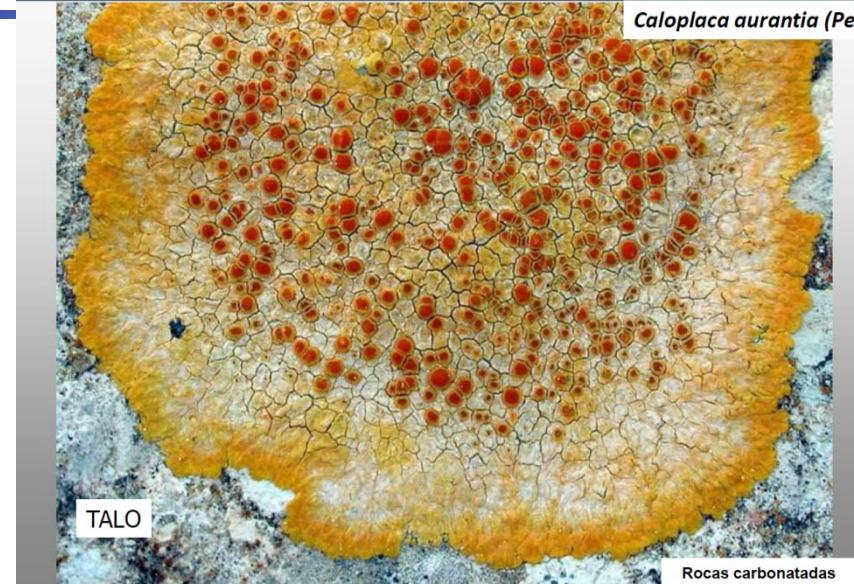
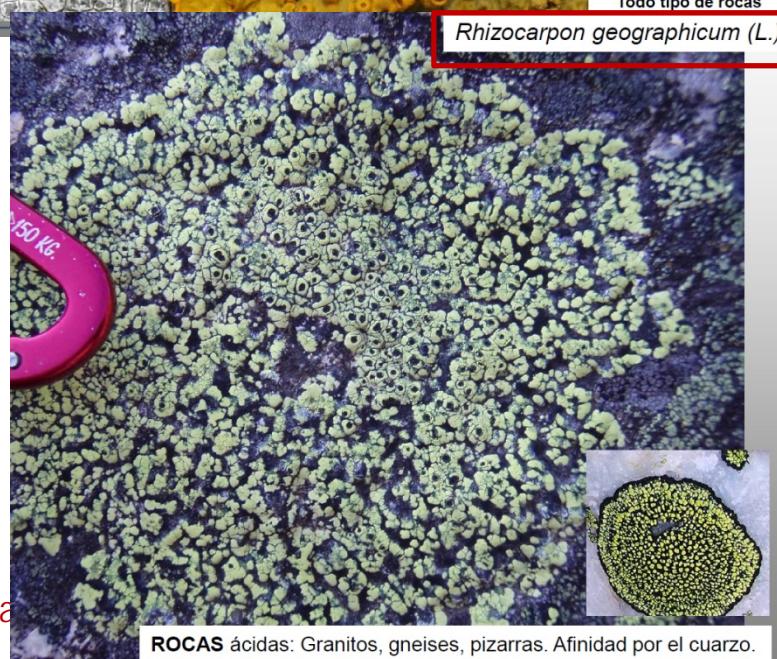
Lichenometry



composite organisms consisting of a **fungus** and a photosynthetic partner (**algae**) growing together in a symbiotic relationship.



Lichenometry

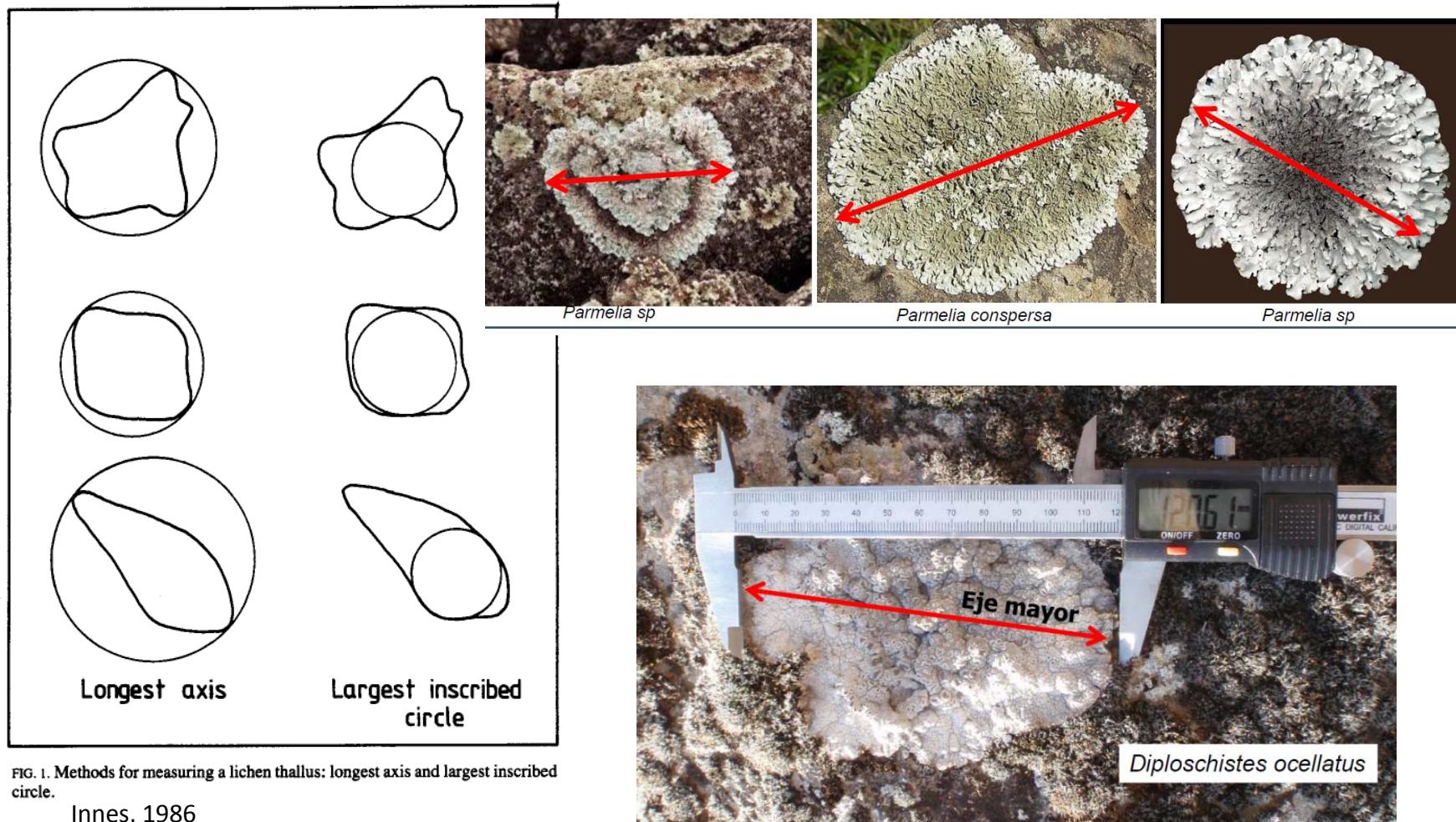


Lichenometry

- What is a lichen? Some types...
- Methodology
- Applications



Lichenometry



Longest inscribed circle and longest axis

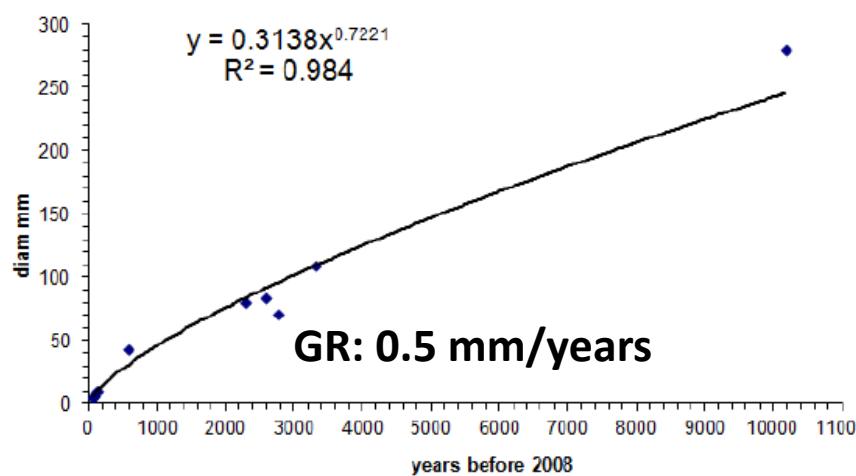
Lichenometry



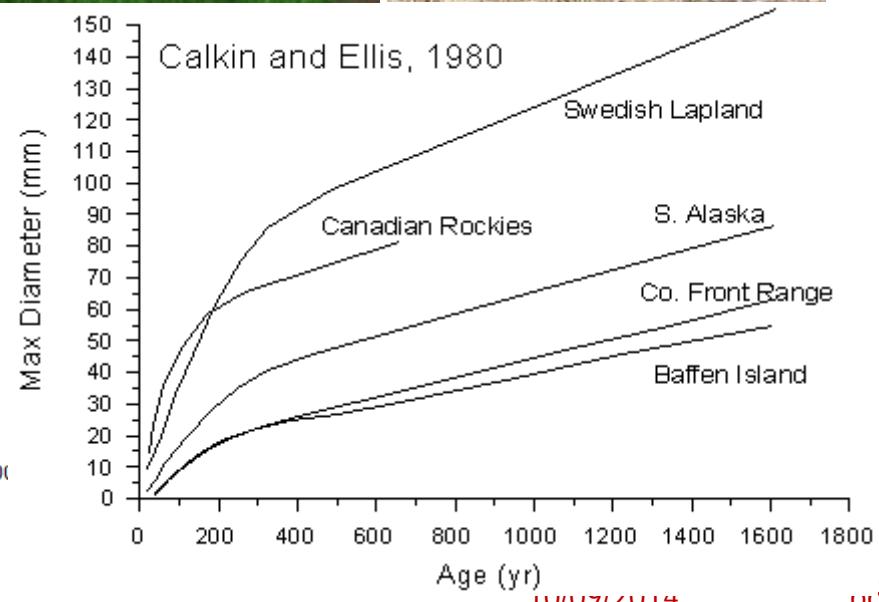
(photo: Jomelli)



Rhizocarpon g. s.l. Briner et al., 2008



Landform Dating, Process Reconstructions



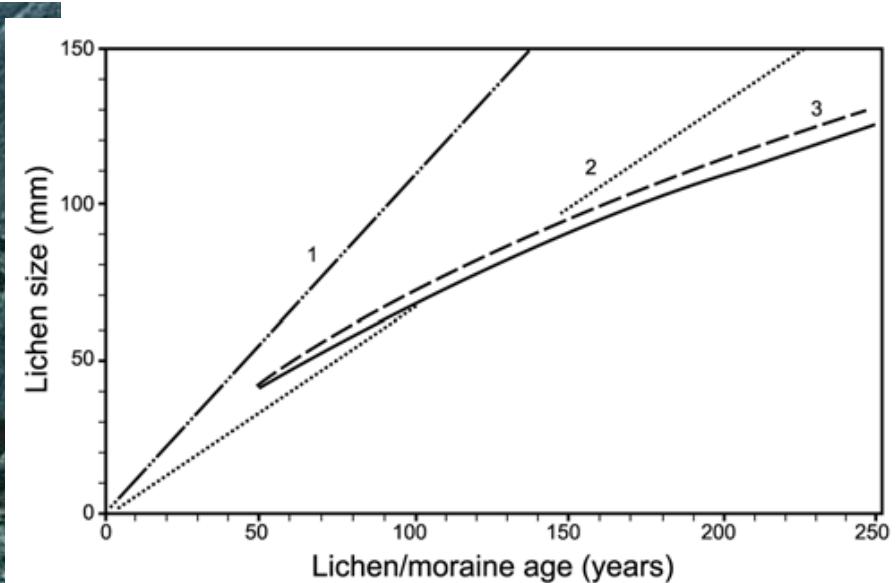
Lichenometry

- What is a lichen? Some types...
- Methodology
- Applications



Lichenometry

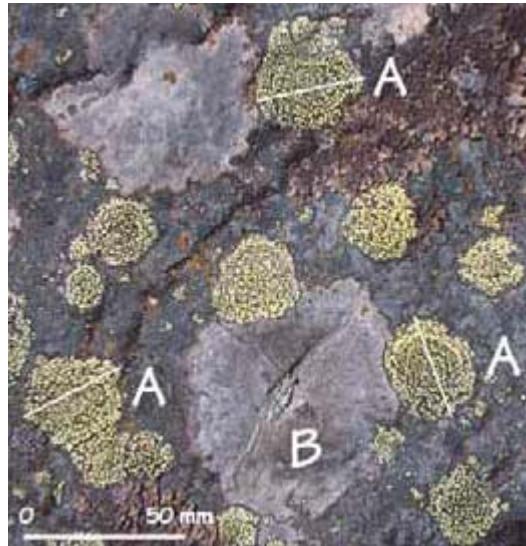
The application of lichenometry in dating of glacier deposits



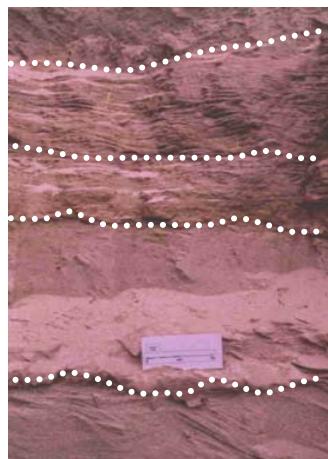
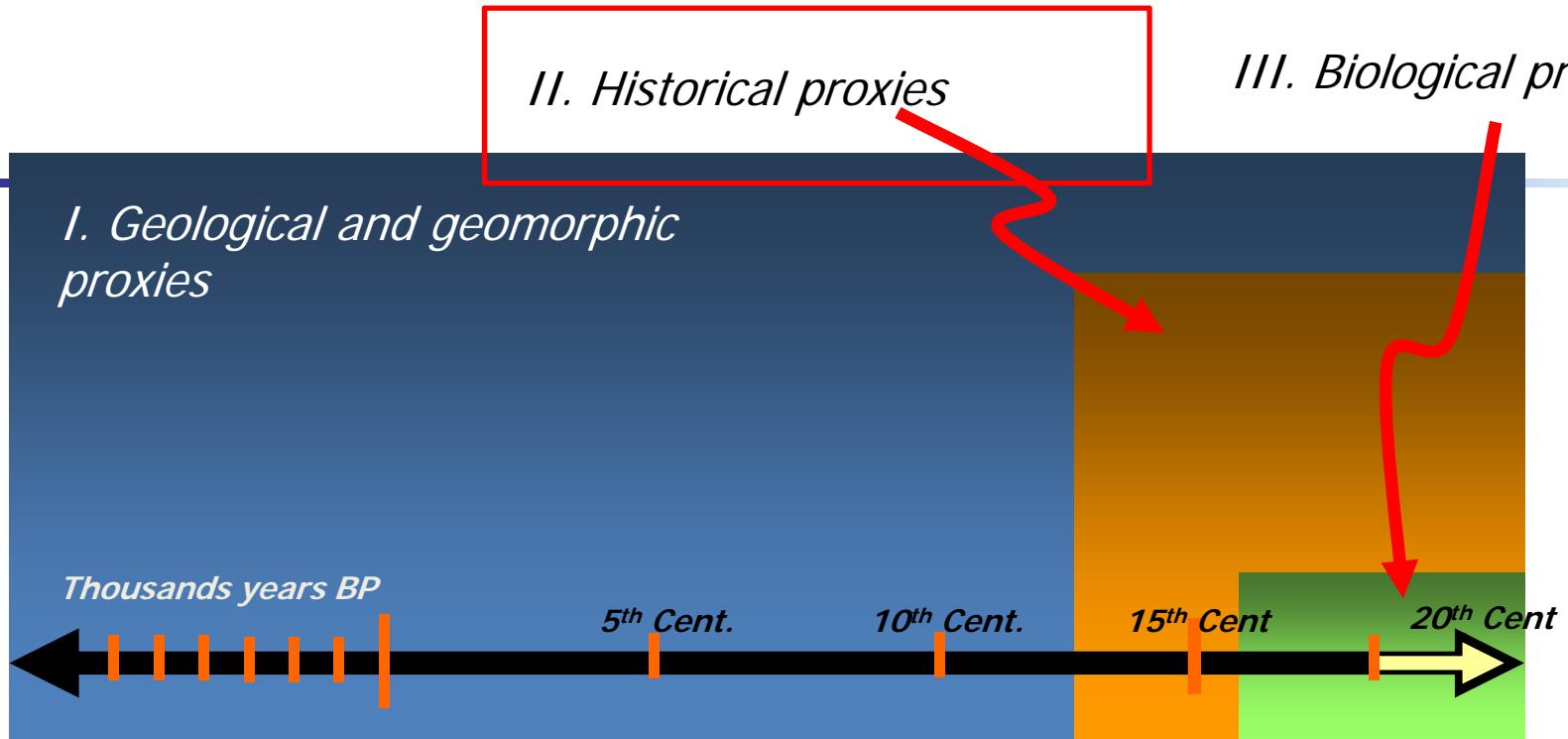
Boulders with lichen vegetation on a moraine ridge in the glacier foreland at the Mittivakkat Glacier

Eric Steen Hansen, 2008

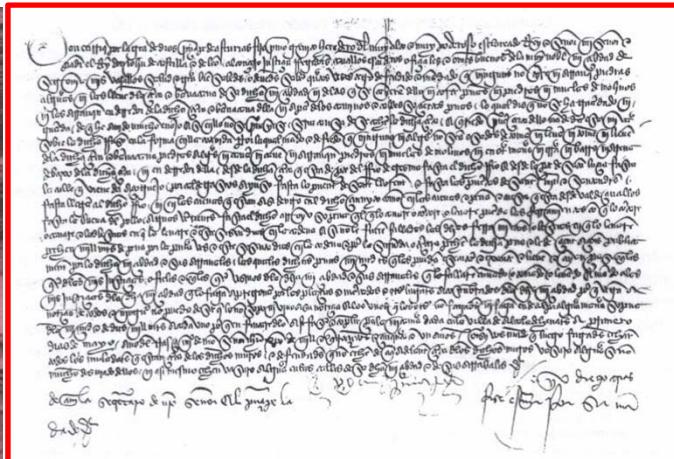
Lichenometry



Lichens growing on a rockfall block at the Barretts landslide site
(Bull, 2003)



Facies
Landform Dating, Process Reconstructions



Documentary sources



Tree rings and lichens

10/09/2014



70

HISTORICAL SOURCES

1. Types of historical documentary sources
2. Presumed problems
3. Methodology

HISTORICAL SOURCES

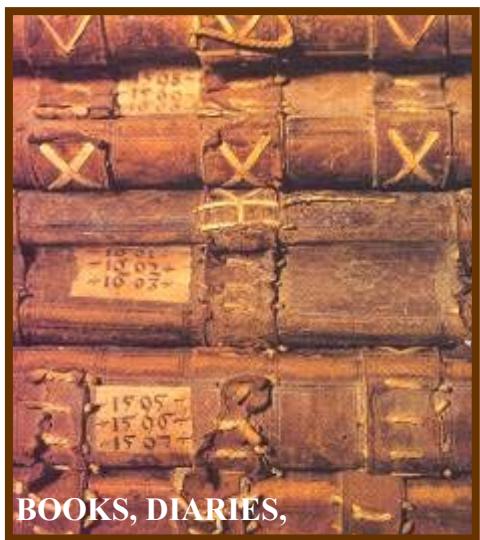
1. Types of historical documentary sources
2. Presumed problems
3. Methodology

Historical sources: types

Written documents

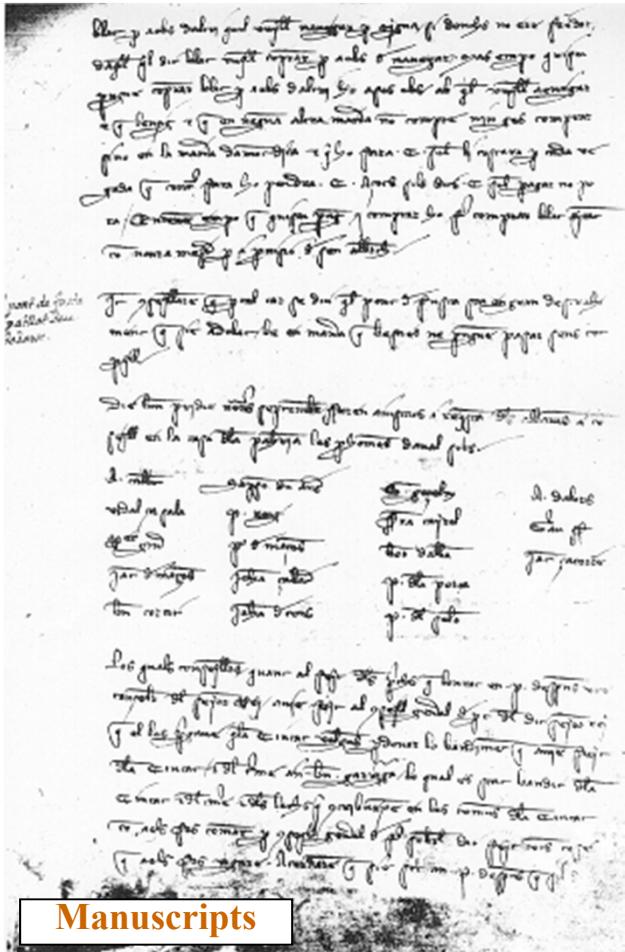


ARCHIVES



Grape harvest dates

Landform Dating, Process Reconstructions



Manuscripts

EL DIARIO DE ÁVILA

Las conferencias culturales del Padre Gastón

Han quedado establecidos todos los detalles para las seis conferencias que el Doctor y sacerdote padriño don Juan Bautista Gastón, de la Universidad de Salamanca, dará en el mes de junio y que comenzarán hoy viernes día 10, a las 18 horas y previsto del conferenciante que se tratarán de variadas temáticas en un gran ambiente cultural.

Dichas seis conferencias, como viene siendo habitual, serán organizadas por el Centro Cívico Alberche y organizadas por su grupo de difusión cultural que dirige don Vicente Gómez de la Torre, y tienen una duración de una hora y media cada una de ellas y se extienden hasta el mes de julio. Los preciosos asientos colgantes que constituyen el aula vienen a costar la veinticinco pesetas.

Los dos primeros encuentros calados el 10 y 11 se celebrarán en el salón de actos del Centro Cívico y consistirán en la noche de la tinta y noche de los poemas y están dedicados al clásico de 1940 el "Trío de Poesía" para las más y más oscuras de nos.

Oportunamente dedicadas a conmemorar las fiestas de San Juan y a las fiestas de los santos patronos y a las fiestas que convocan el público.

Hallazgos

Sa la Comisión de Ciencias y Artes de la Provincia se encargó de desentrañar el misterio de la muerte de don José María de Arellano y un sacerdote de este nombre verá la luz.

SÁNCHEZ PRIETO MÉDICO

2005 - VARIACIONES - 532355
Callejón de la Tercera, 10
y 10 de la esquina
Cuenca de Alcalá, 2.º

De la festividad de San Segundo

La sociedad cultural que hace las lesiones de la localidad de la vecindad de San Segundo, ha publicado en su Boletín Oficial el resultado de la votación que llevó a las filas de la procesión en una igualdad extraordinaria adonde las autoridades, la Iglesia y la Sociedad Cultural dieron la talla de las Flores de la Ciudad de La Orotava, que sin embargo han pasado en la agenda social de la localidad.

Las inundaciones en la cuenca del Alberche han causado daños en huertos y cercados

La techumbre del templo parroquial de Navalmuenga se desplomó anoche apenas terminado el Ejercicio de las Flores

Los no habilitados del temple, el sacerdote don Emilio Martín, que provisoriamente resultó iluso en medio de los desastres

En la noche de Alberche ha producido el desalojo de la iglesia parroquial de Navalmuenga, que pertenece a la villa de Navalmuenga, que ha quedado completamente abandonada y que ha sido declarada población despoblada por el Ayuntamiento de Navalmuenga. Una parte de la noche de ayer, los vecinos de Navalmuenga, que se quedaron viviendo en la localidad, se vieron obligados a abandonar sus casas, ya que el agua de la riada subió hasta la altura de los altares y obligó a los fieles a abandonar la iglesia. La noche de ayer, los vecinos de Navalmuenga, que se quedaron viviendo en la localidad, se vieron obligados a abandonar sus casas, ya que el agua de la riada subió hasta la altura de los altares y obligó a los fieles a abandonar la iglesia.

Los vecinos de Navalmuenga, que se quedaron viviendo en la localidad, se vieron obligados a abandonar sus casas, ya que el agua de la riada subió hasta la altura de los altares y obligó a los fieles a abandonar la iglesia.

En la noche del domingo 10 de junio, Navalmuenga se desplomó completamente la techumbre de la iglesia.

A las 11 horas, al inspeccionar el ejercicio del Misa de Pascua, el sacerdote don Emilio Martín, que preside el templo de Navalmuenga, halló el techo de la iglesia colapsado.

El sacerdote don Emilio Martín, que preside el templo de Navalmuenga, halló el techo de la iglesia colapsado. El sacerdote don Emilio Martín, que preside el templo de Navalmuenga, halló el techo de la iglesia colapsado. El sacerdote don Emilio Martín, que preside el templo de Navalmuenga, halló el techo de la iglesia colapsado. El sacerdote don Emilio Martín, que preside el templo de Navalmuenga, halló el techo de la iglesia colapsado. El sacerdote don Emilio Martín, que preside el templo de Navalmuenga, halló el techo de la iglesia colapsado.

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**REDACCIONES Y ADMINISTRACIONES
PAÍS DEL PRESENTE AÑO
Y VALORES DE
LA LLEGADA AL PODER**

Mediante
Una de las principales finalidades de las administraciones es la mejora de las condiciones de vida de las personas. La administración pública, en particular, tiene como objetivo principal la mejora de las condiciones de vida de las personas. La administración pública, en particular, tiene como objetivo principal la mejora de las condiciones de vida de las personas. La administración pública, en particular, tiene como objetivo principal la mejora de las condiciones de vida de las personas.

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Newspapers

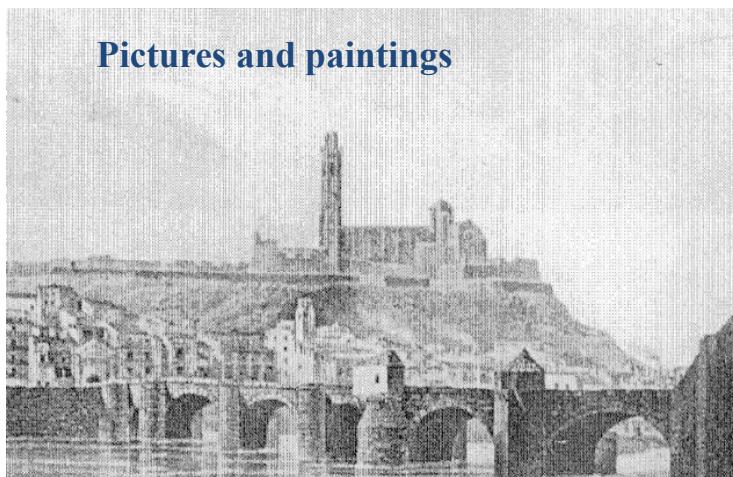
www.oaklandnewspaper.com

www.oaklandnewspaper.com

Newspapers

Historical sources: types

Printed documents and Iconography

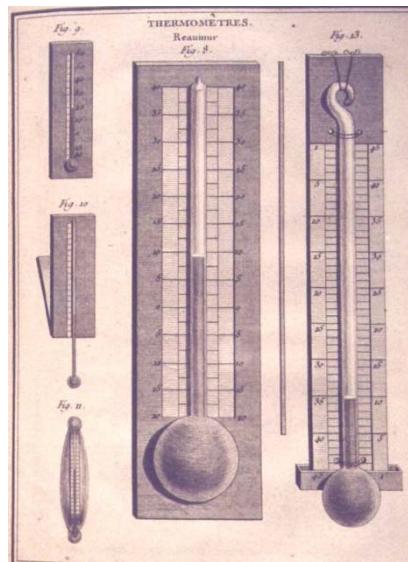


Pictures and paintings

Historical sources: types

meteorological measurements

This image shows two pages from a historical meteorological notebook. The left page is titled 'THERMOMÈTRE' and the right page is titled 'CLOUDS'. Both pages contain handwritten data entries in French, likely temperature and cloud measurements, with columns for date, time, and specific observations.



Bitacora notebooks

This image shows two pages from a Bitacora (logbook) in Spanish. The left page is dated '18 de Septiembre de 1820' and the right page is dated '19 de Septiembre de 1820'. The pages contain detailed handwritten entries about ship operations, weather, and observations, typical of a nautical log.



HISTORICAL SOURCES

1. Types of historical documentary sources
2. Presumed problems
3. Methodology

Historical sources: Presumed problems

Problems in handwritten texts interpretation

Uncertainties concerning the interpretation of historical texts

Die Ebedeckung wird kouffen werden mit Hunderten Silben der vorgenannten gewihten so füllen

Gothic style (13th-14th centuries)

LORIOSISSIMAM CIVITATEM DEI
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stat per patientiam quicad usq; iustitia conuerta
tum in iudicium. deinceps ad eptura per excellentia
in etriam ultimam & pacem perfectam hoc opere
ad te instituto & mea ad te promissione debito de-
fendere aduersus eos qui conditoris eius deos suos p-
serunt filii carissime marcelline suscepit. Magnum

Humanistic style
(15th cent)

ria .i Et Inquit
anglus ad am .
dicit .i abe matia
gru plena .i dñe secu .
Benedic tu ou .i In
muliens .i Due quur

Visigothic style
(9th-10th centuries)

Mod. Manuscript

ABCDEFGHIJ

KLMNOPQRST

UVWXYZ abcdef

ghijklmnopqrstuvwxyz

wxyz123456789

O

Historical sources: Presumed problems

dating problems/dating inaccuracy

It is possible to find unbalances in the respective calendars.



	Roman/Christian (after BC 46)		Muslim after AD 622		French Revolution (AD 1793-1805)	
Ianuarius	31	Moharrem	30	Niv se	30	
Februarius	28-29	afar	29	Pluvi se	30	
Martius	31	Rebi el-awwel	30	Vent se	30	
Aprilis	30	Rebi el-akhir	29	Germinal	30	
Maius	31	Dschumada el- la	30	For al	30	
Iunius	30	Dschumada el-akhira	29	Prairial	30	
Iulius	31	Redschelo	30	Messidor	30	
Augustus	31	Schaban	29	Thermidor	30	
September	30	Ramadan	30	Fructidor	30	
October	31	Schawwal	29	Vend miaire	30	
November	30	Dhul-kade	30	Brumaire	30	
December	31	Dhul-hiddsche	29-30	Frimaire	30	
TOTAL	365-366	TOTAL	354-355	plus 5 days Sansculotides		
				TOTAL	365	

Historical sources: Presumed problems

Measurement systems before the unification of the metric system (mid 19th century) has anthropometric patterns. Most usual are feet and inches.



Spanish Kingdom:

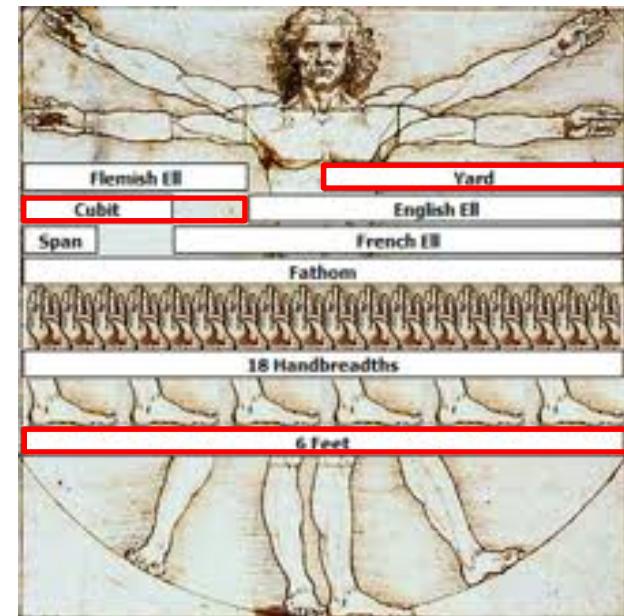
Burgos	Madrid	Teruel	Alicante
1 Foot: 278,64 mm	1 Foot: 281,00 mm	1 Foot: 256,00 mm	1 Foot: 304,00 mm
1 Inch: 23,22 mm	1 Inch: 23,41 mm	1 Inch: 21,33 mm	1 Inch: 25,33 mm

United Kingdom (British Foot):

1 Foot: 304,80 mm.
1 Inch: 25,40 mm.

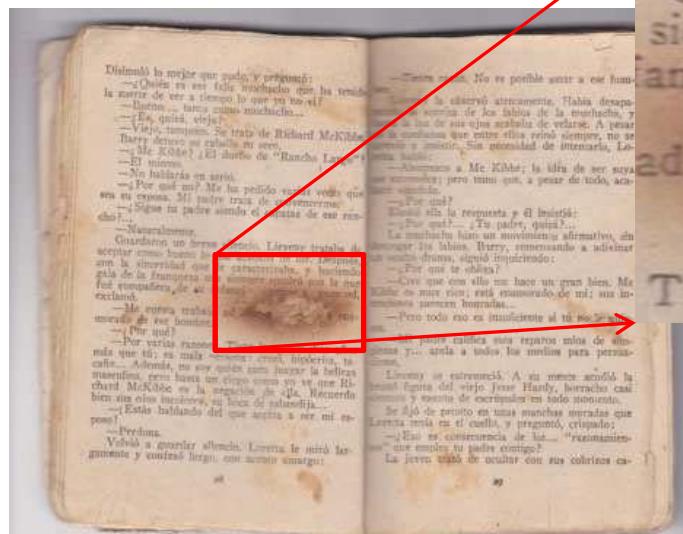
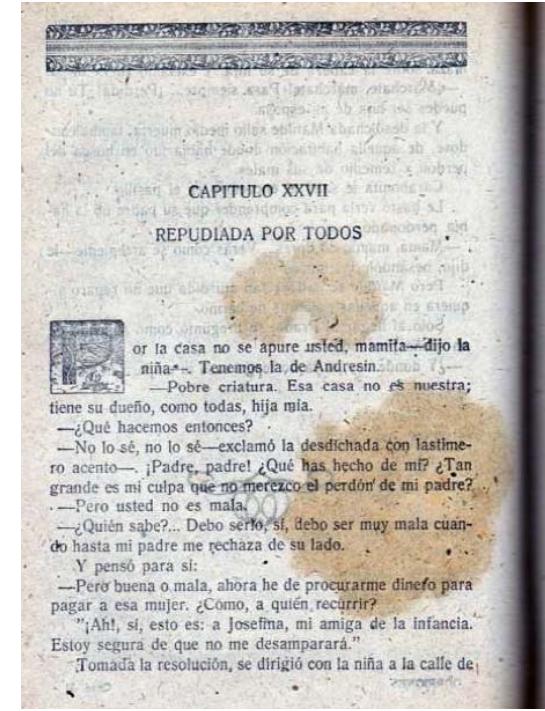
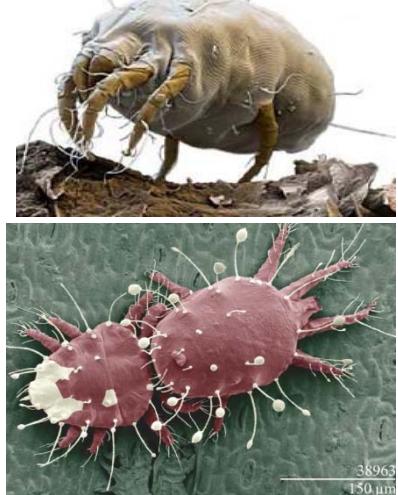
French Kingdom (Paris Foot):

1 Foot: 324,84 mm.
1 Inch: 27,07 mm.



Historical sources: Presumed problems

Preservation and conservation



Landform Dating, Process Reconstructions

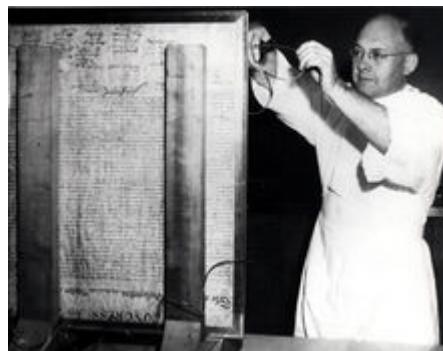
Historical sources: Presumed problems

Preservation and conservation

Structural preservation techniques



Technical preservation/conservation



Digital preservation



HISTORICAL SOURCES

1. Types of historical documentary sources
2. Presumed problems
3. Methodology

Historical sources: methodology

Research procedures steps (based on Barriendos and Coeur, 2004):

1 First approach to specific literature

The first approach to bibliography by geographical location, temporal period to be studied and study matter

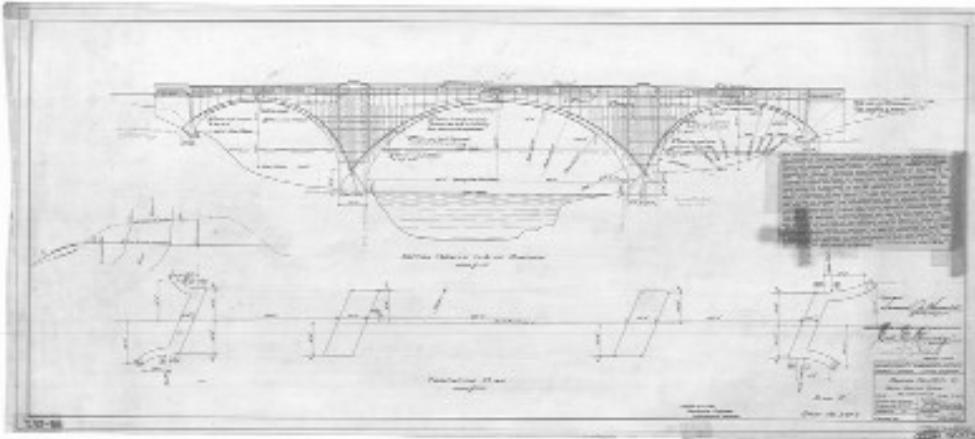
2 Inventory (thematic list) of all elements

involved in the study. All materials and information obtained from bibliographical and documentary sources.



Historical sources: methodology

3 List of the archives and documentary sources to be researched: First reference list with archive inventories (if existing) or directly in the collections (work with the keeper or alone) is compiled.



Historical sources: methodology

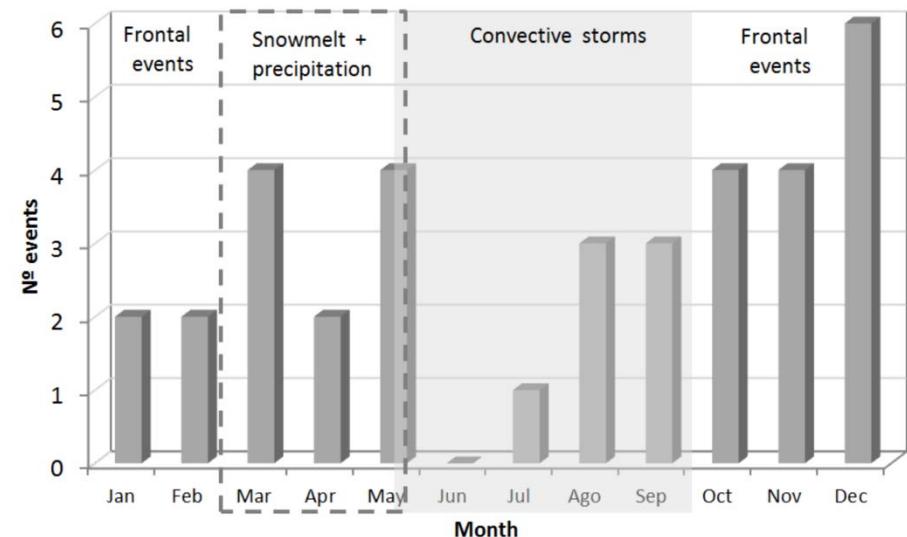
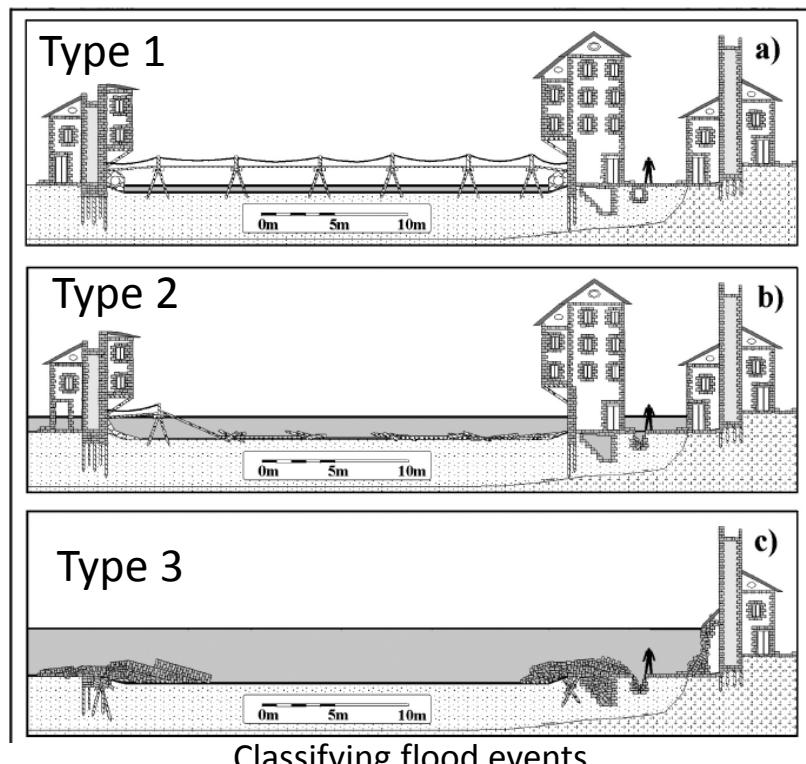
4 Data collection: must be, as much as possible, systematic and complete. All problems to manage the information found in documents must be resolved employing auxiliary technics.

5 Data storage: information collected can be organized and recorded in electronic format by means of different software applications.



Historical sources: methodology

5 Data analysis: Following the specific objectives of every research and workplan, data can be treated. Experience from historical sources show that it is not easy to generate data in similar format than modern instrumental sources.



Seasonality analysis
(Ruiz-Villanueva et al., 2013)

Historical sources: methodology

According to Le Roy Ladurie (1967), documentary sources for the study of climate effects should fulfil the following requests:

- (i) the series must be annual (with the information organised in a temporal sequence which can be easily dated),
- (ii) continuous (without gaps in the documentary records),
- (iii) homogeneous (having a similar content throughout) and
- (iv) quantifiable (containing information which can be processed statistically).



THANK YOU FOR YOUR ATTENTION!

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