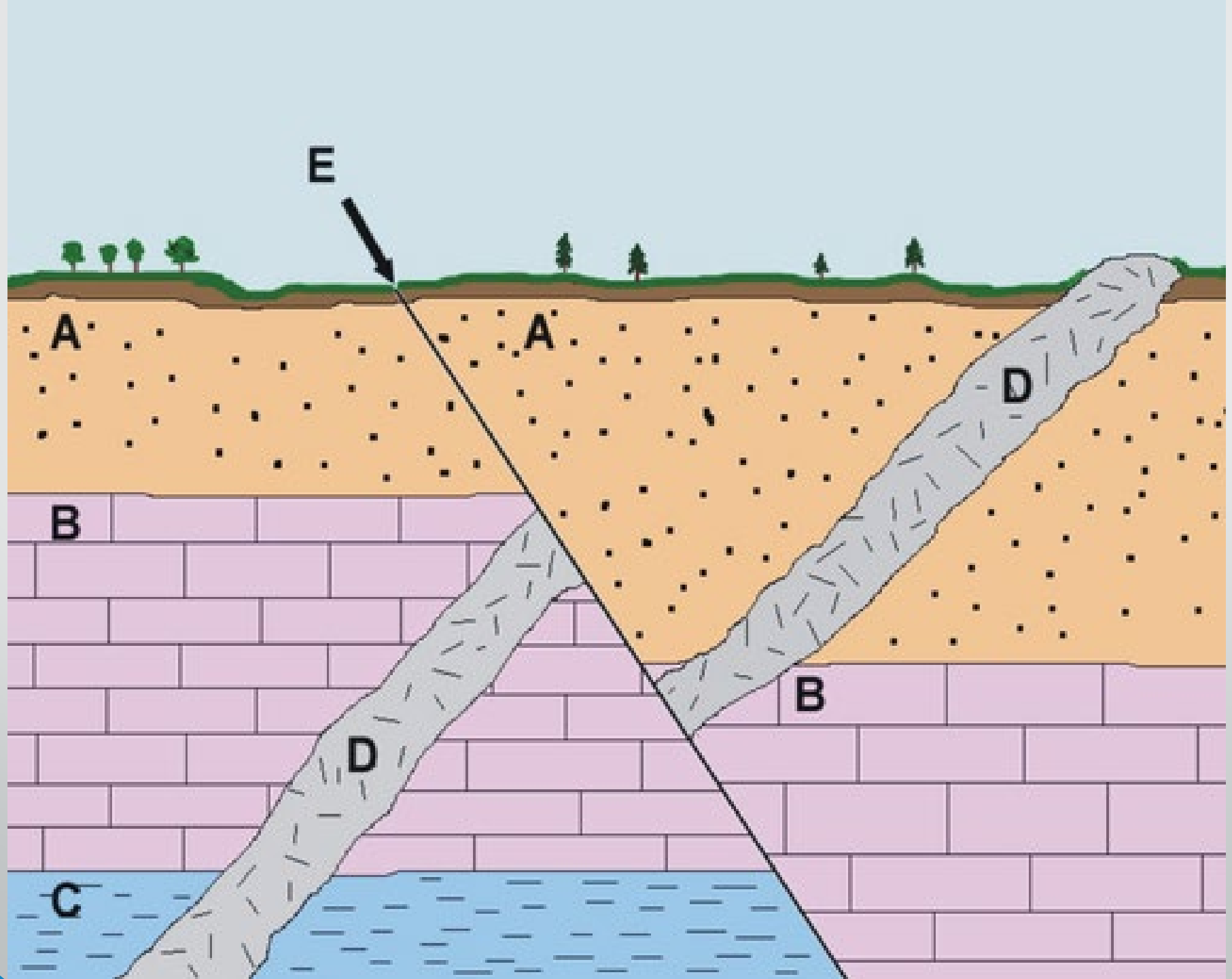
GEOARCHAEOLOGY

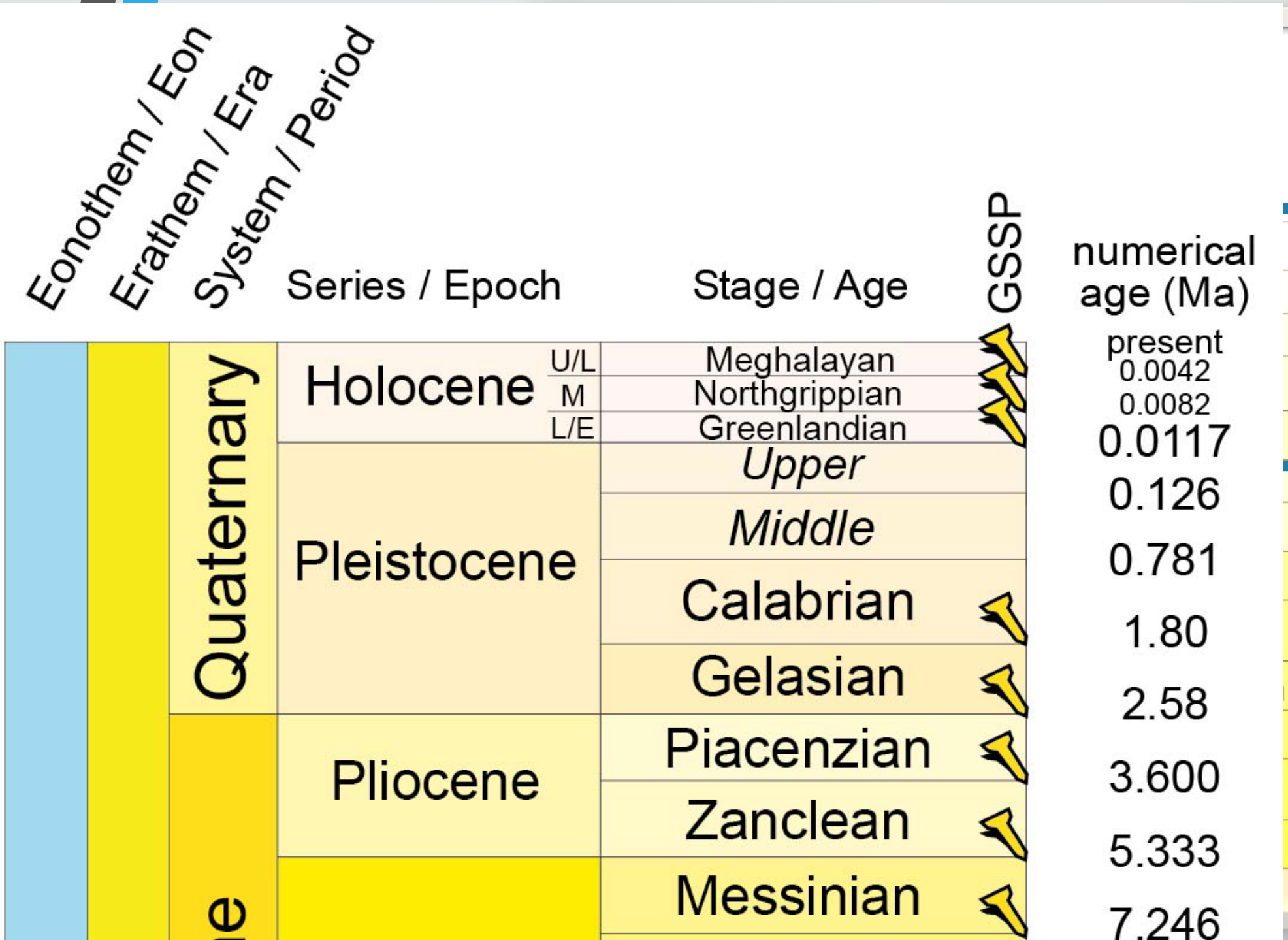
Estimating Time

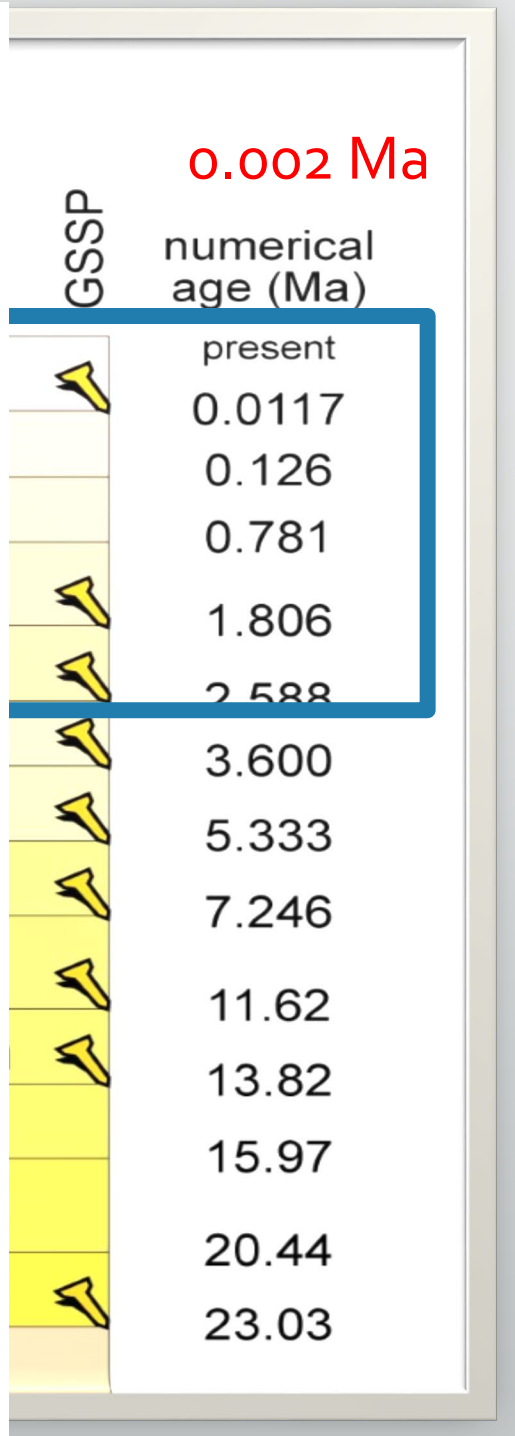
Chapter 5

Time

- Relative
  - Principles (Superposition, Cross-cutting relationships, inclusions)
- Absolute/Numeric
  - Measurable physical and chemical properties


E
A
A
D
B
B
D
C

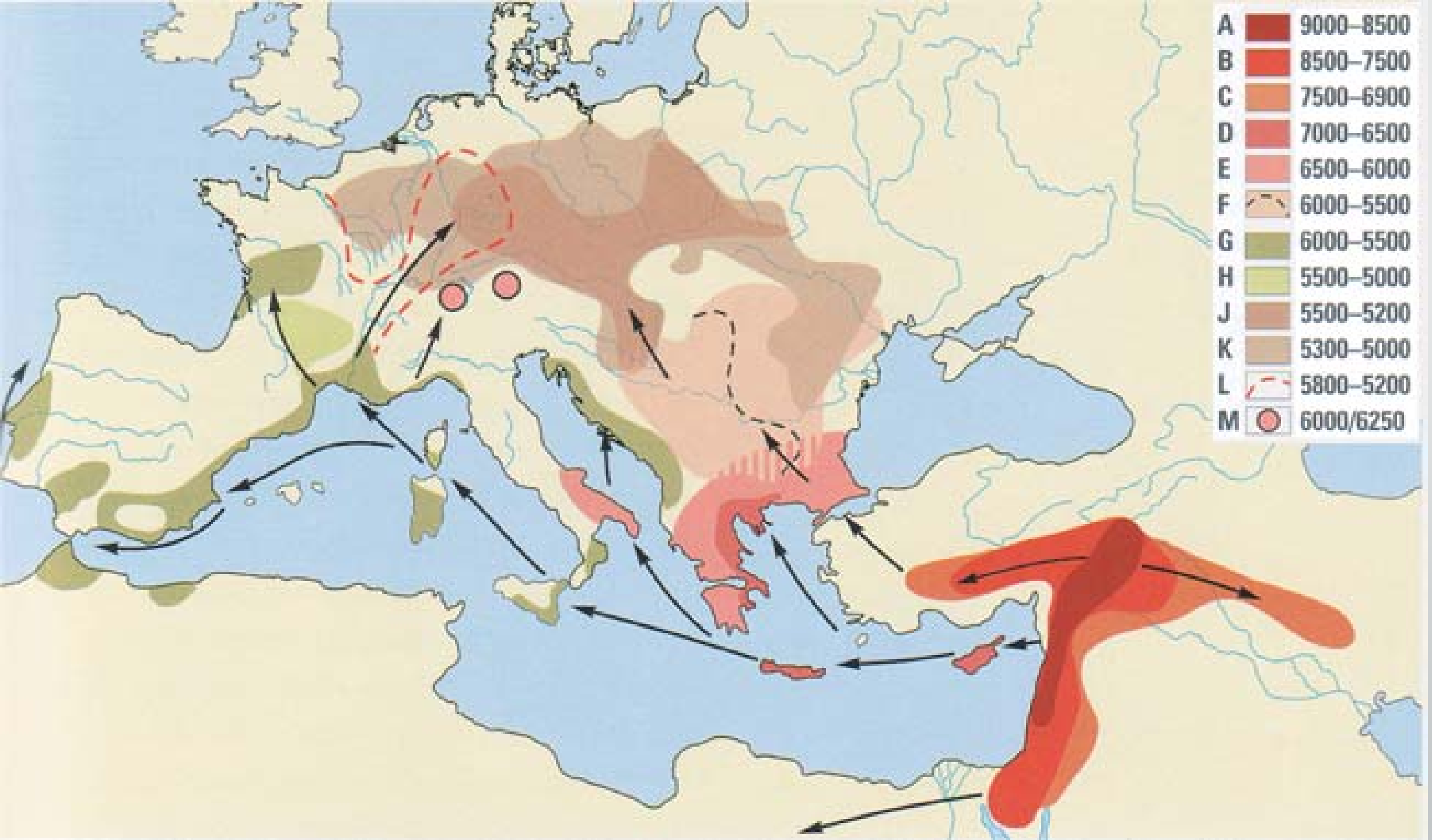

Eonothem / Eon
Erathem / Era
System / Period
Series / Epoch
Stage / Age
GSSP
numerical age (Ma)
Quaternary
Holocene
U/L
M
L/E
Meghalayan
Northgrippian
Greenlandian
present
0.0042
0.0082
0.0117
Pleistocene
Upper
Middle
Calabrian
Gelasian
0.126
0.781
1.80
2.58
Pliocene
Piacenzian
Zanclean
3.600
5.333
Messinian
7.246


0.002 Ma
GSSP
numerical age (Ma)
present
0.0117
0.126
0.781
1.806
2.588
3.600
5.333
7.246
11.62
13.82
15.97
20.44
23.03

Artifacts and dating

Geological Period	Archaeological Period BP (Before Present) / BC (Before Christ)		Glacial Period	Sea Level
Middle Pleistocene	Palaeolithic-	Lower Palaeolithic (700,000 - 150,000 BP)	Anglian glaciation (480,000 to 425,000 BP)	Low
Late Pleistocene		Middle Palaeoli (150,000 to 30,(		
		Early Upper Pal (30,000 to 12,0(		
		Late Upper Pal (12,000 to 10,5(= 8,500 BC)		
Holocene	Mesolithic	(8,500 to 4,000		
	Neolithic	(4,000 to 2,400		
	Bronze Age	(2,400 to 700 BC		
	Iron Age	(700 BC to 43 AI		
	Romano-British	(43 AD to 410 A		
	Early Medieval	(410 to 1066 AD		
	Medieval	(1066 to 1500 A		
	Post-Medieval	(1500 to 1800 A		
	Modern	(1800 to Present		

Mesolithic	(8,500 to 4,000 BC)
Neolithic	(4,000 to 2,400 BC)
Copper Age	
Bronze Age	(2,400 to 700 BC)
Iron Age	(700 BC to 43 AD)
Romano-British	(43 AD to 410 AD)
Early Medieval	(410 to 1066 AD)
Medieval	(1066 to 1500 AD)
Post-Medieval	(1500 to 1800 AD)
Modern	(1800 to Present Day)


A 9000–8500
B 8500–7500
C 7500–6900
D 7000–6500
E 6500–6000
F 6000–5500
G 6000–5500
H 5500–5000
J 5500–5200
K 5300–5000
L 5800–5200
M 6000/6250

Iowa's Archaeological Timeline

Early Paleoindian	Late Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Early Woodland	Middle Woodland	Late Woodland	Late Prehistoric	Historic				
11,500 - 10,500 BCE	10,500 - 8,500 BCE	8,500 - 5,500 BCE	5,500 - 3,000 BCE	3,000 - 800 BCE	800 - 200 BCE	200 BCE - CE 300	CE 300 - 1250	CE 1250 - 1673	CE 1673 - 1832	CE 1832 - 1842	CE 1842 - 1860	CE 1860 - 1885	Beyond 1885
1000 years	2000 years	3000 years	2500 years	2200 years	600 years	500 years	950 years	423 years	159 years	10 years	18 years	25 years	

*BCE = Before Common Era (or BC, Before Christ).

*CE = Common Era (or AD, anno Domini).

The earliest known people to arrive in Iowa made fluted spear points called Clovis and Folsom.

Late Paleoindian groups were hunting bison in Iowa ten thousand years ago.

Mammoth and Mastodon teeth and bones have been discovered in every county in Iowa. Did Paleoindian people hunt them here as elsewhere?

Dalton points are a common Paleoindian projectile point found in Iowa sites.

The atlatl, or spear thrower, was introduced during the Paleoindian period, increasing the distance a spear could travel and the force of its impact.

White-tailed deer became an important food animal as prairie and woodlands were established across Iowa in the Holocene, after the end of the ice age.

This bone flute from Cherokee is the oldest musical instrument in Iowa.

Milling stones, known from local sites, reflect the growing importance of nuts and seeds.

Nuts and wild plants became increasingly important foods during the Archaic period.

The Palace site in Polk County has the earliest known burials in Iowa. Manteno type points have been found there (4800 BCE).

Evidence of the first domesticated dogs in Iowa (5400 BCE).

Beads and tools made from bone and antler are often found in Archaic period sites.

Ground stone axes came into widespread use early in Middle Archaic times as activities like woodworking became more important.

Cultivation of goosefoot as a food crop began during Late Archaic times; corn was not important until after CE 900.

Ground, pecked, and polished stone artifacts become common during the Archaic period.

Archaeologists have discovered evidence for some of the earliest houses in Iowa in Polk, Louisa, and Muscatine counties. These houses are more than 6,000 years old.

Native copper from Lake Superior was used to make tools in Archaic times; this tanged point was found in Louisa County.

Pottery became widespread in Iowa after 500 BCE.

Stemmed points like this Waubesa are common in Early Woodland sites.

Agriculture became increasingly important during the Woodland period.

Boone Mound was perhaps the largest Middle Woodland mound west of the Mississippi River. These sacred sites are protected by Iowa Law.

Effigy mounds were built by Late Woodland groups in northeast Iowa.

Artifacts such as marine shells, obsidian, and pipestone are evidence of far-ranging trade networks at some Middle Woodland sites.

Small points found in Late Woodland sites indicate the use of the bow and arrow.

Mill Creek farmers in northwest Iowa created specialized raised bed gardens. This bison horn scoop was used as a gardening tool.

Hooded water bottle from a Mill Creek culture site.

Glenwood Collared Ware is found in southwestern Iowa.

Glenwood earthlodges were a distinctive feature in the Missouri Valley.

Shell-tempered Oneota pottery occurs in some Late Prehistoric sites.

People of the Great Oasis culture built earthlodges and farmed in central and northwest Iowa.

The French arrived along the Mississippi in 1673.

Rantchewaime, White Cloud, and No-Heart, Ioway, from Charles Bird King portraits. The Ioway Nation likely descended from the Late Prehistoric Oneota culture.

Meskwaki and Sauk arrived in Iowa ca. 1736.

John Gilbert was a trader for the American Fur Company when he first set up his post in 1832 near what is now Iowa City.

Black Hawk Purchase 1832; first government land purchase from Indians in Iowa.

After the Black Hawk purchase, Iowa opened to settlement. Settlers poured into the territory, establishing homes, farms, and businesses.

Fort Atkinson, 1840-1849, was established to monitor the Ho-Chunk who had been forced to move to the Neutral Ground in northeast Iowa.

The arrival of the railroad in 1855 brought a new and efficient way to carry goods from farms and factories to markets. The locations of the tracks and stations had a profound effect on the growth or decline of towns and cities in Iowa.

A network of Underground Railroad routes and safe houses for escaping slaves extended across Iowa in the 1850s and 1860s.

Cascade Mill in Dubuque County.

Archaeological study of central Des Moines area sites such as Coalport and Noah Creek has provided details of a 19th Century pottery industry.

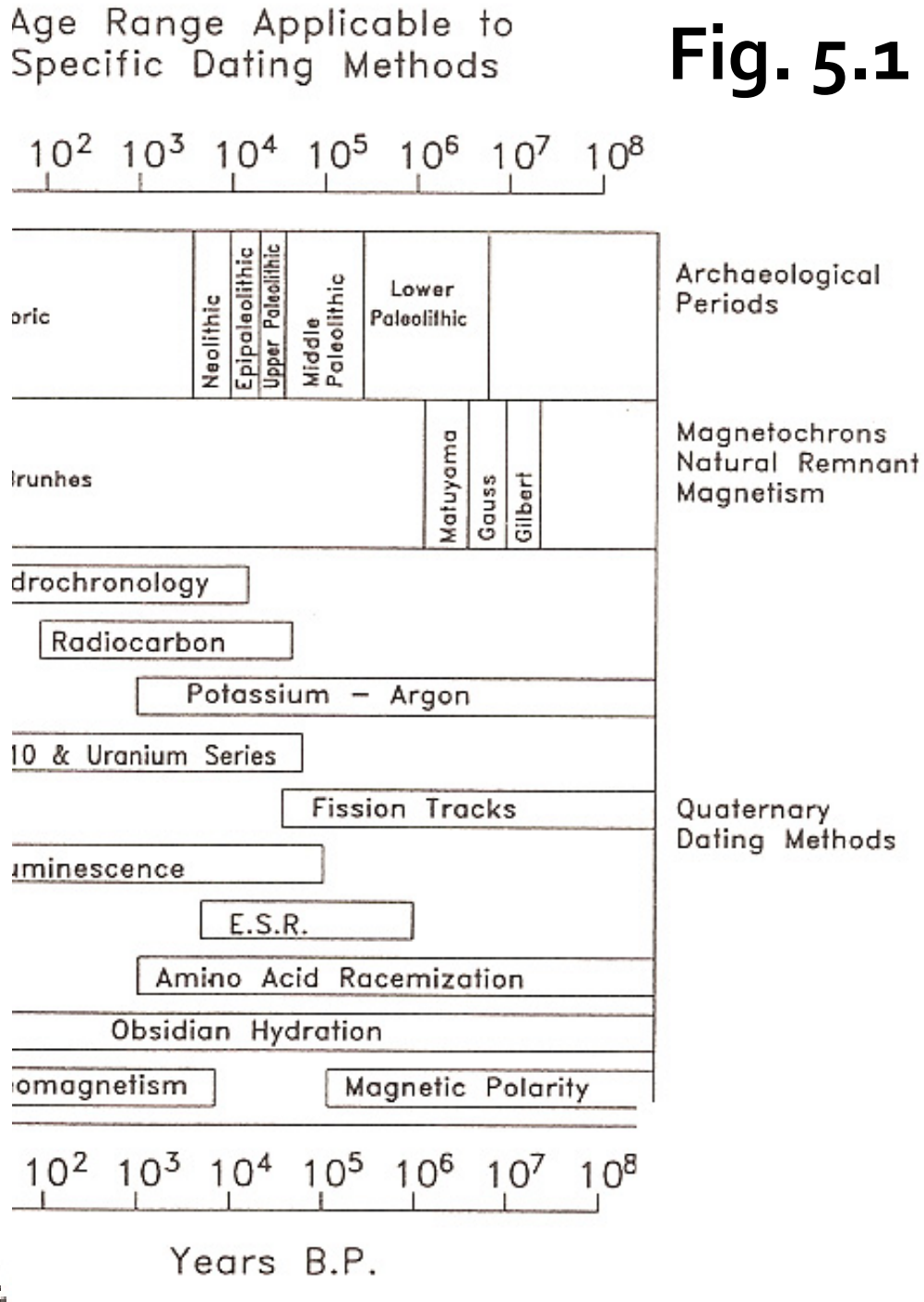
This 1905 Beau Arts fountain, built for the Des Moines Library, was partially demolished and buried for over 50 years until archaeologists rediscovered it in 2004. The preserved font was incorporated into the newly renovated library in 2011.

Created by Office of the State Archaeologist, the University of Iowa

Modified from original larger version, 2015

Fig. 5.1

	Magnetism	Hydration	Amino Acid	E.S.R.	Luminescence	Fission Tracks	Uranium Series	Potassium–Argon	Radiocarbon	Dendrochronology
Volcanic	*			*	*	*	*	*		
Glass						*				
Obsidian	*	*				*				
Unburnt Sediment	*				*					
Burnt Flint & Stone				*	*					
Slag					*	*			*	
Pottery, Baked Earth	*			*	*				*	
Precipitated Calcite	*			*			*		*	
Shells			*	*			*		*	
Tooth Enamel			*				*		*	
Bone, Antler, Ivory, Teeth			*				*		*	
Wood, Plant, Seeds, Etc.									*	*



Climate Change and Geologic Time

- Fossil record demonstrates primate diversification over the past 65 Ma
- Correlation with major tectonic events
  - Eocene – Joining of Asia and India
  - Miocene – Dramatic uplift of the Tibetan Plateau
  - Pliocene – Closing of the Panama seaway
- Northern hemisphere glaciation and inter-glacial
  - Starts between 3 and 2.5 Ma
  - Appears to have greatly influenced hominid speciation (Australopithecus and Homo)

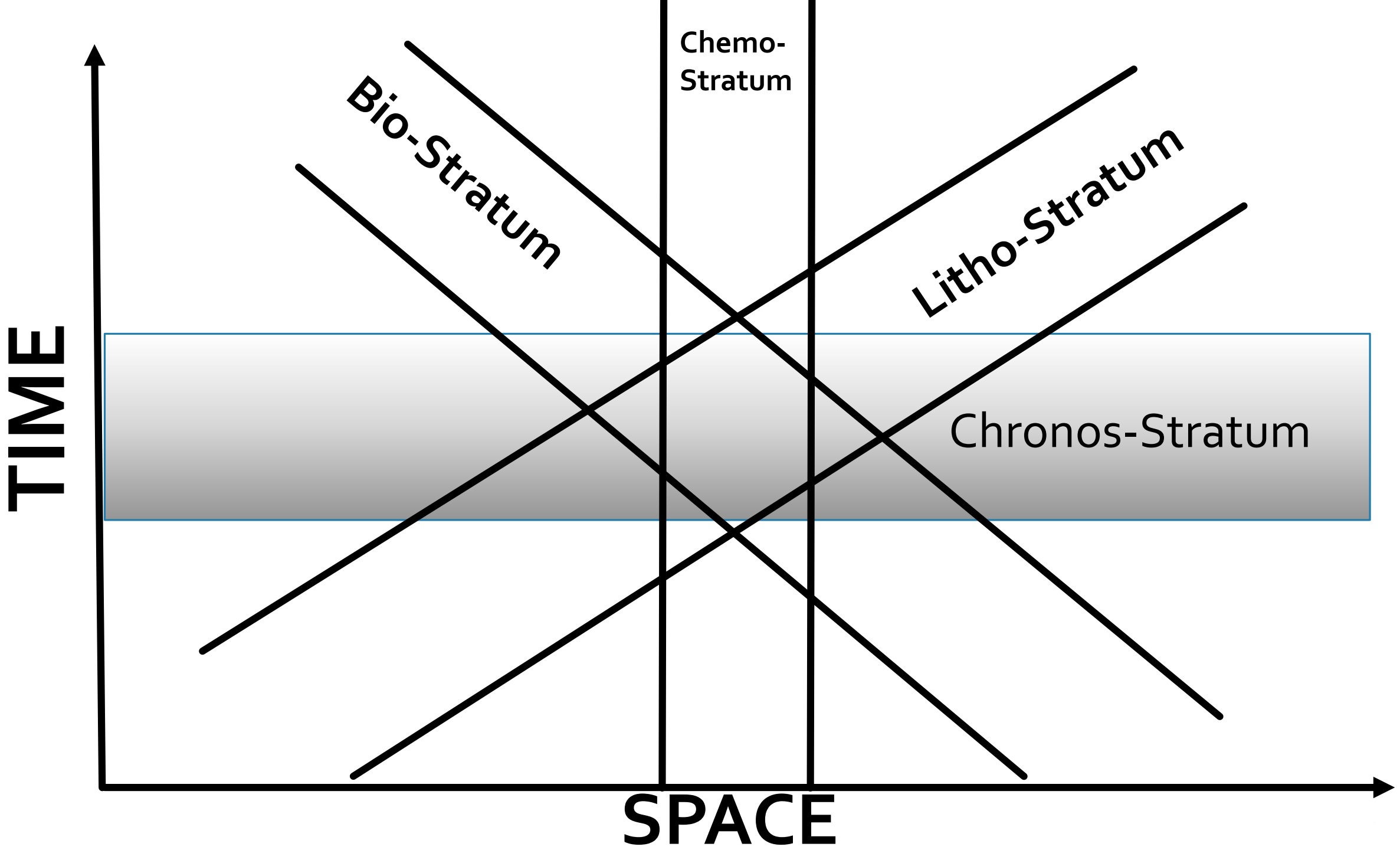
Stratigraphy

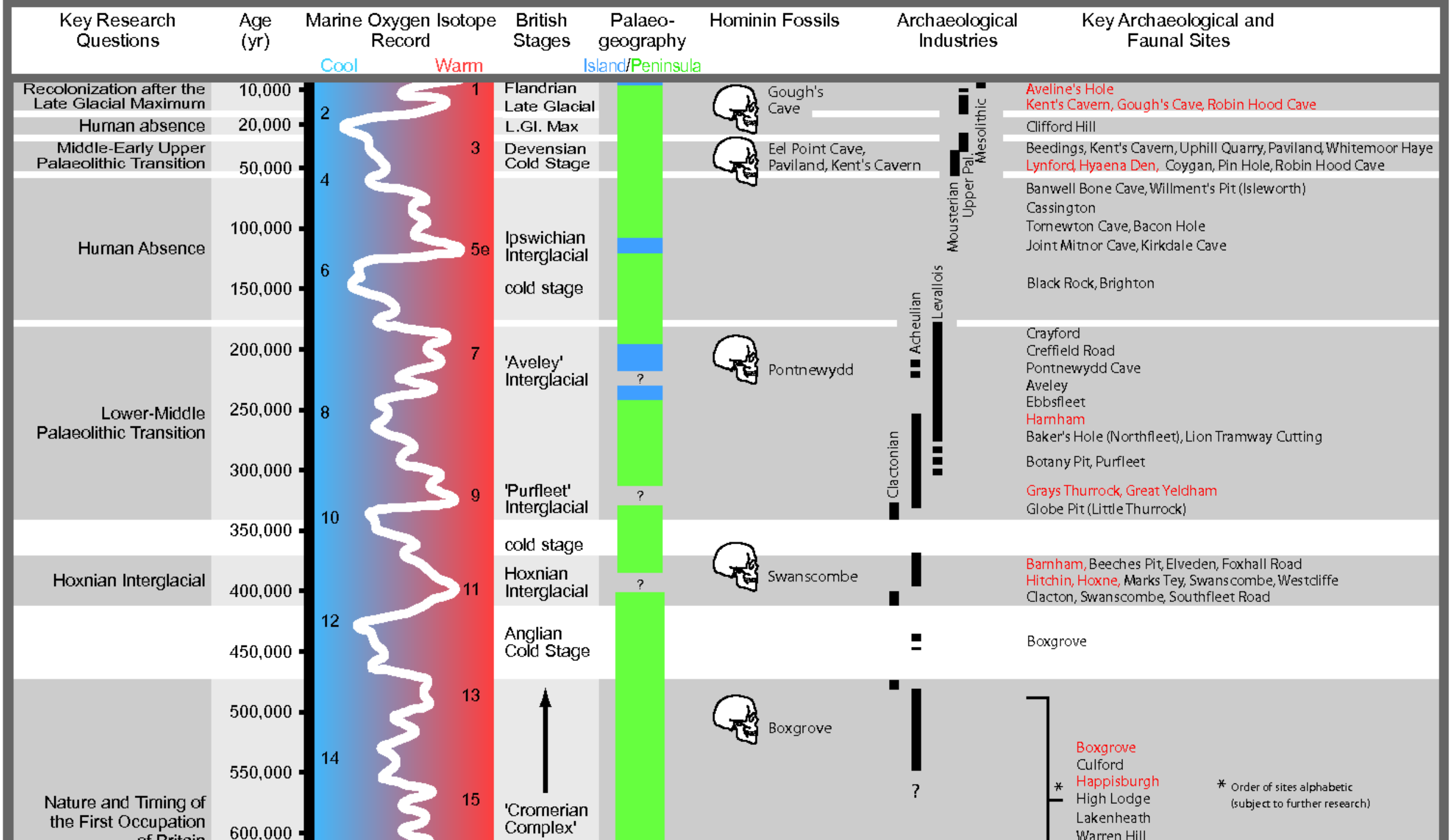
Stratigraphy

- Litho-
- Chemo-
- Bio-
- Archaeo-
- Chrono-

Principles

- Superposition
- Original horizontality
- Walther's Law


Chemo-
Stratum
Bio-Stratum
Litho-Stratum
Chronos-Stratum
TIME
SPACE

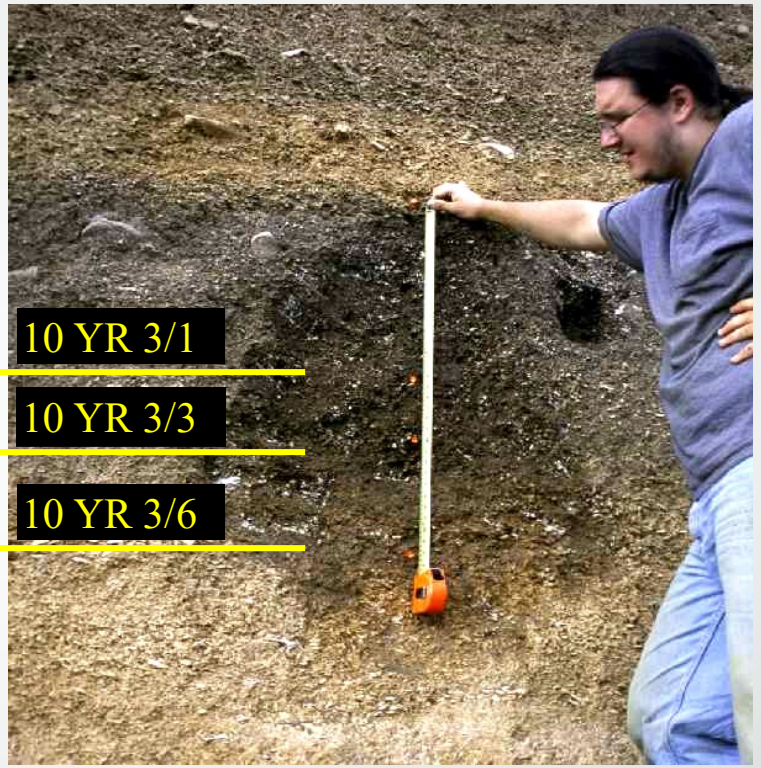

Key Research Questions
Age (yr)
Marine Oxygen Isotope Record
Cool
Warm
British Stages
Palaeo-geography
Island/Peninsula
Hominin Fossils
Archaeological Industries
Key Archaeological and Faunal Sites
Recolonization after the Late Glacial Maximum
Human absence
Middle-Early Upper Palaeolithic Transition
Human Absence
Lower-Middle Palaeolithic Transition
Hoxnian Interglacial
Nature and Timing of the First Occupation
10,000
20,000
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
450,000
500,000
550,000
600,000
1
2
3
4
5e
6
7
8
9
10
11
12
13
14
15
Flandrian Late Glacial
L.Gl. Max
Devensian Cold Stage
Ipswichian Interglacial
cold stage
'Aveley' Interglacial
'Purfleet' Interglacial
cold stage
Hoxnian Interglacial
Anglian Cold Stage
'Cromerian Complex'
Gough's Cave
Eel Point Cave, Paviland, Kent's Cavern
Pontnewydd
Swanscombe
Boxgrove
Mesolithic
Upper Pal.
Mousterian
Levallois
Acheulian
Clactonian
Aveline's Hole
Kent's Cavern, Gough's Cave, Robin Hood Cave
Clifford Hill
Beedings, Kent's Cavern, Uphill Quarry, Paviland, Whitemoor Haye
Lynford, Hyaena Den, Coygan, Pin Hole, Robin Hood Cave
Banwell Bone Cave, Willment's Pit (Isleworth)
Cassington
Tornewton Cave, Bacon Hole
Joint Mitnor Cave, Kirkdale Cave
Black Rock, Brighton
Crayford
Creffield Road
Pontnewydd Cave
Aveley
Ebbsfleet
Harnham
Baker's Hole (Northfleet), Lion Tramway Cutting
Botany Pit, Purfleet
Grays Thurrock, Great Yeldham
Globe Pit (Little Thurrock)
Barnham, Beeches Pit, Elveden, Foxhall Road
Hitchin, Hoxne, Marks Tey, Swanscombe, Westcliffe
Clacton, Swanscombe, Southfleet Road
Boxgrove
Boxgrove
Culford
Happisburgh
High Lodge
Lakenheath
Warren Hill
* Order of sites alphabetic (subject to further research)

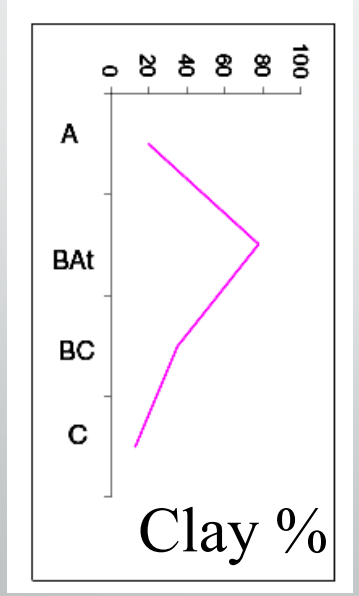
Rhythmites – Varves (annual)

2cm or smaller

Paleosols

Structure	Horizons
Gr/platy	A
SBK	BAt
SBK	BC
Ma	C





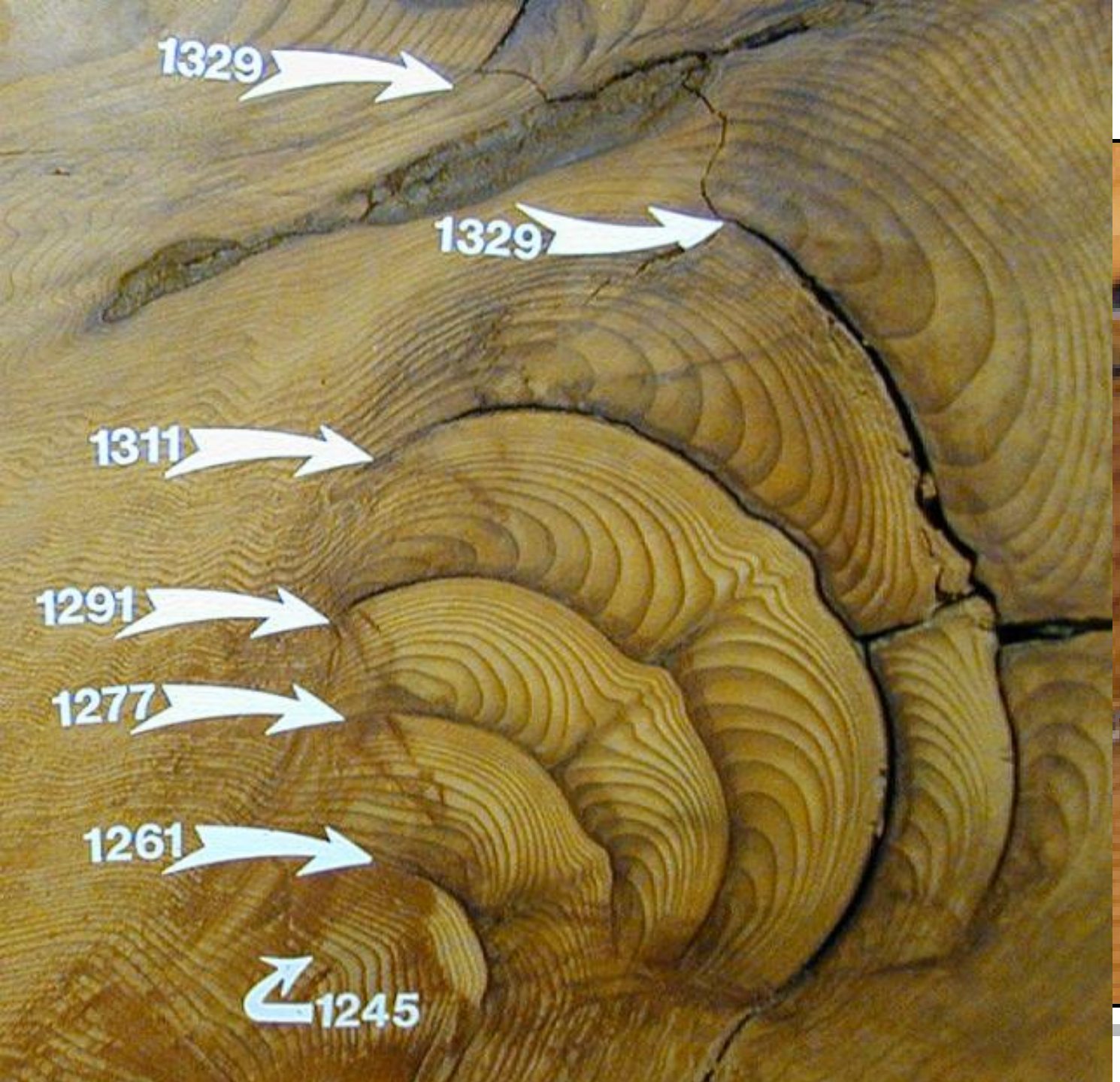
(6084 to 5837 cal. yrs. BC)
or
(7786 to 8033 cal. yrs. BP)

Tephrochronology


10 CM
5 CM
www.RiteintheRain.com

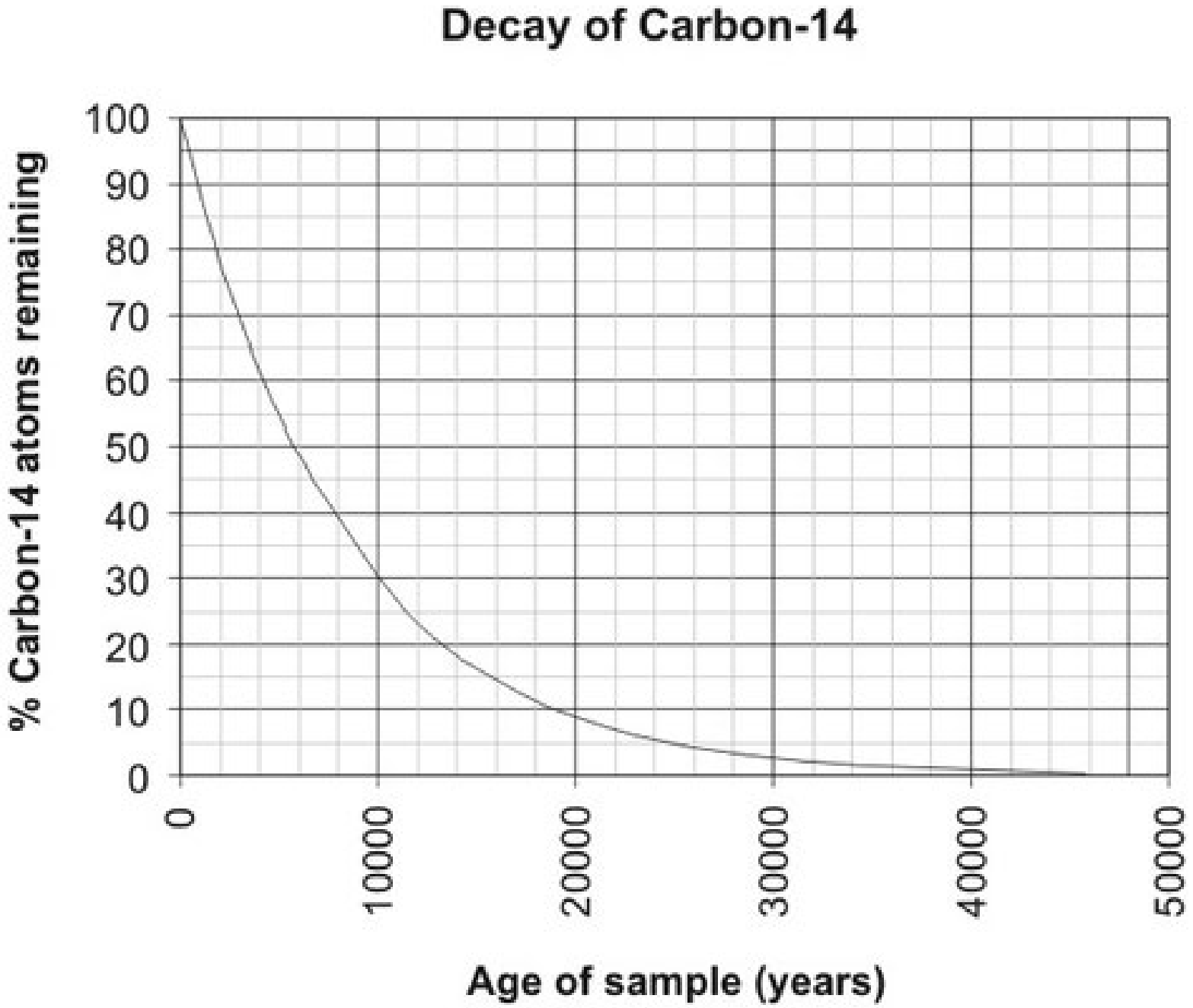
Paleontology

Dendrochronology

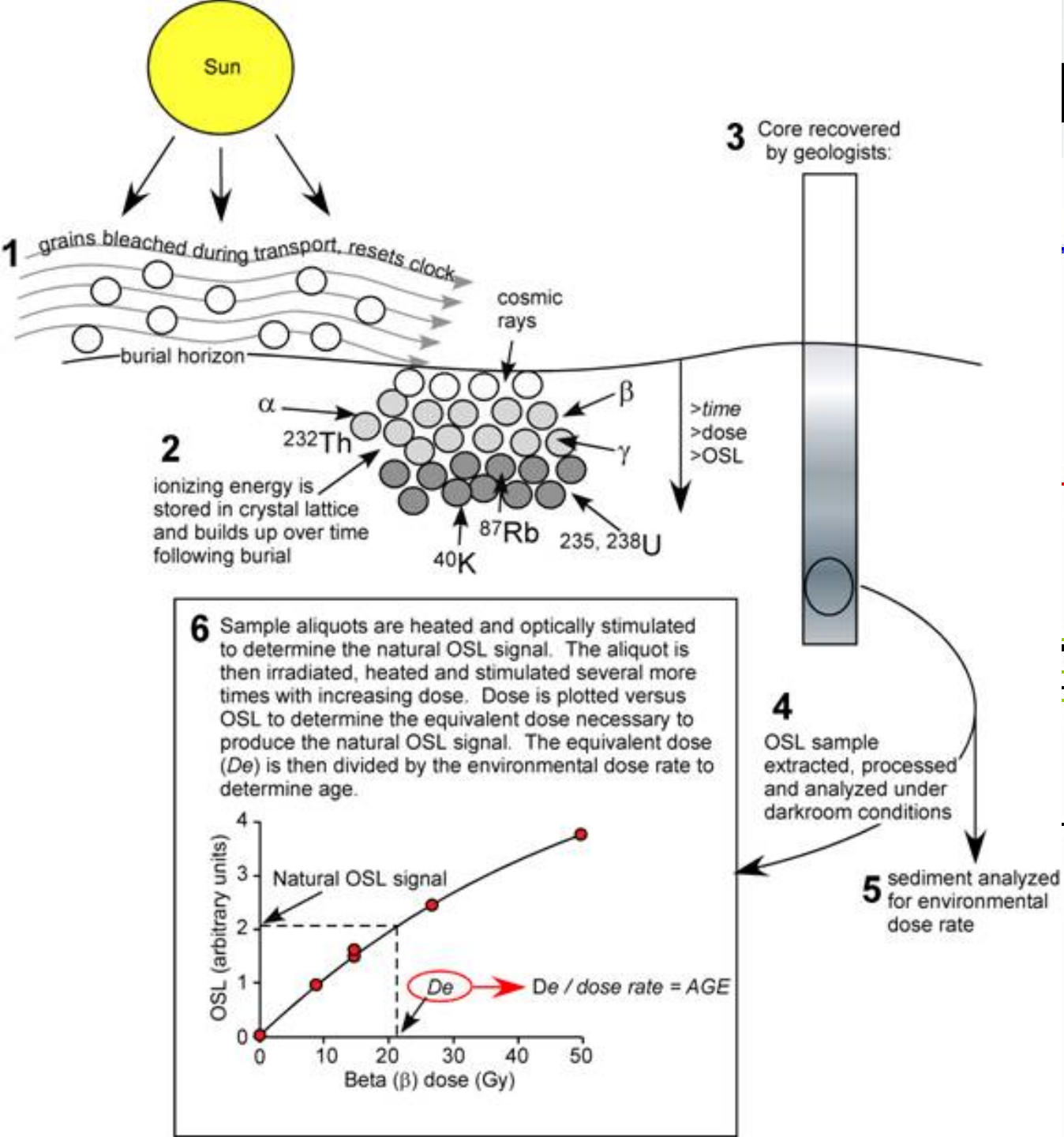


1 cm

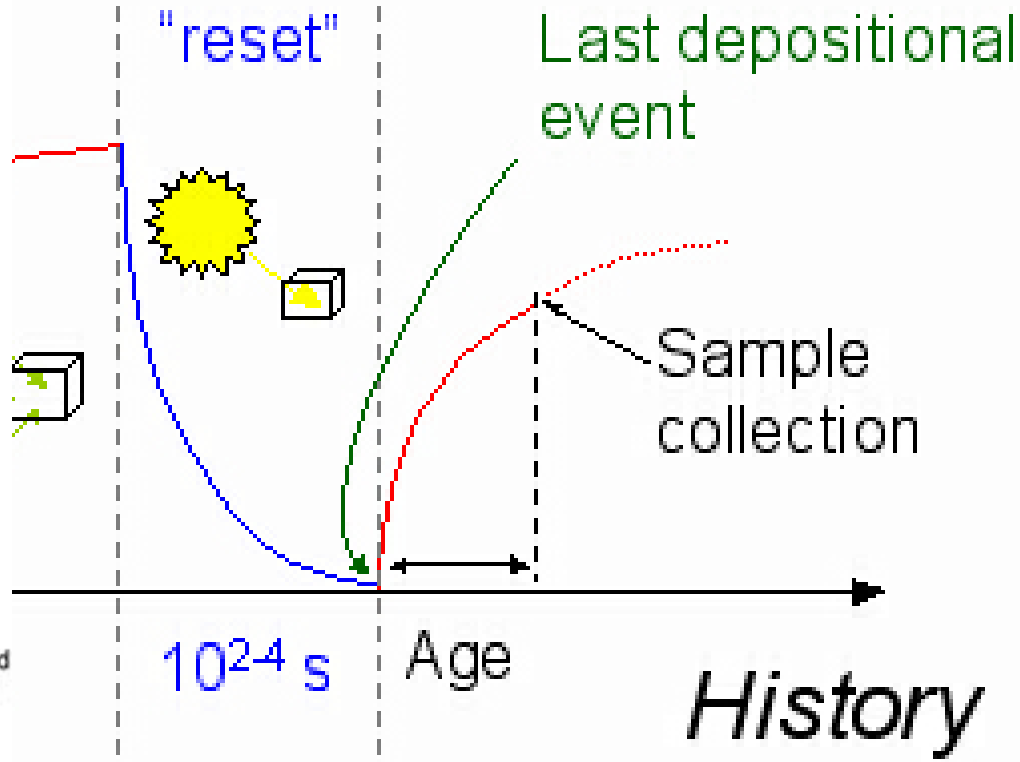
Radiocarbon dating

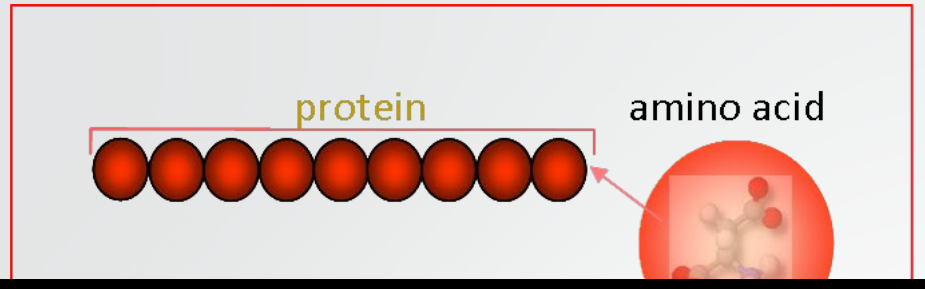


Luminescence (OSL)



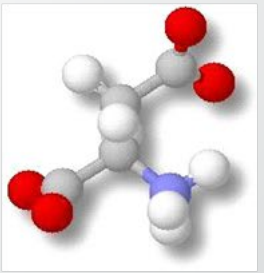
minescence Dating





AMINO ACID RACEMISATION DATING (AAR)

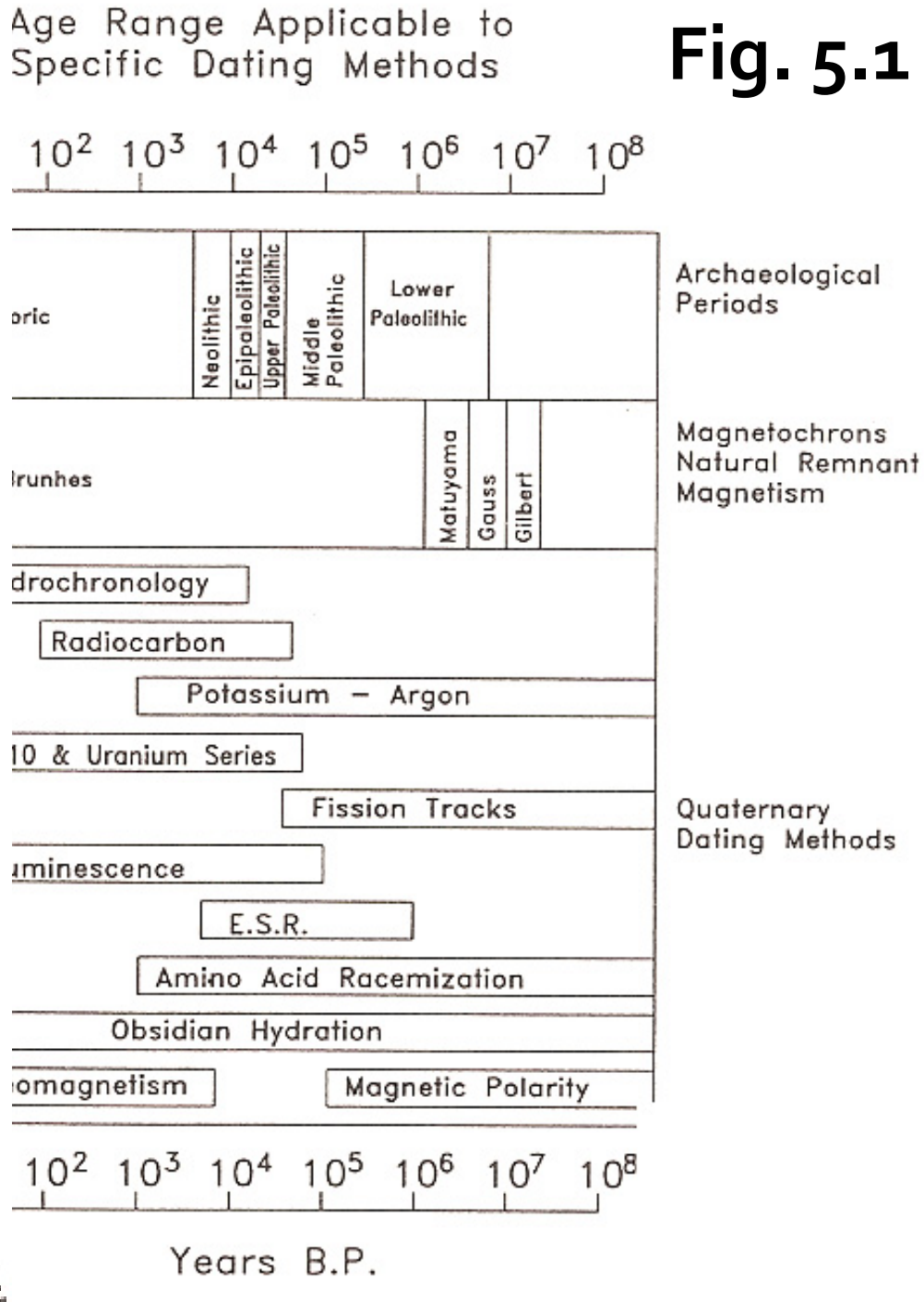
Time 0 - Organism alive:
Only L- amino acids



D/L = 0

Fig. 5.1

	Magnetism	Hydration	Amino Acid	E.S.R.	Luminescence	Fission Tracks	Uranium Series	Potassium–Argon	Radiocarbon	Dendrochronology
Volcanic	*			*	*	*	*	*		
Glass						*				
Obsidian	*	*				*				
Unburnt Sediment	*				*					
Burnt Flint & Stone				*	*					
Slag					*	*			*	
Pottery, Baked Earth	*			*	*				*	
Precipitated Calcite	*			*			*		*	
Shells			*	*			*		*	
Tooth Enamel			*				*		*	
Bone, Antler, Ivory, Teeth			*				*		*	
Wood, Plant, Seeds, Etc.									*	*

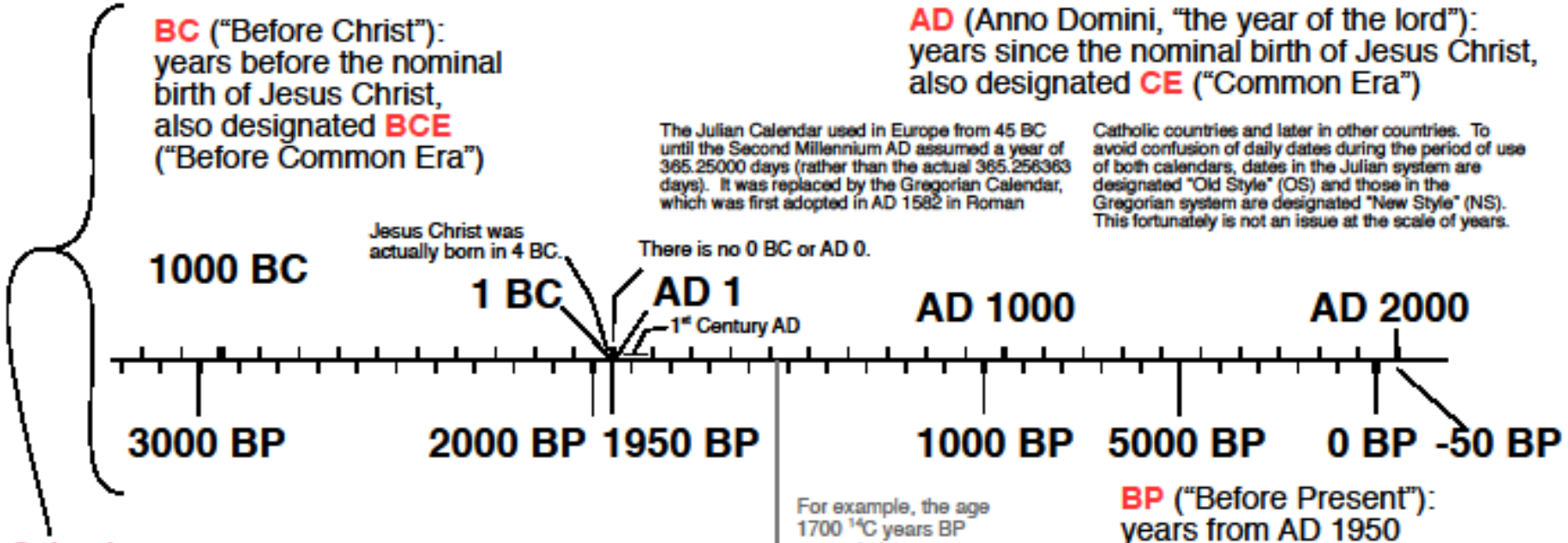


AD, CE, BC, BP, calendar years, radiocarbon years, and all that

BC ("Before Christ"): years before the nominal birth of Jesus Christ, also designated **BCE** ("Before Common Era")

AD (Anno Domini, "the year of the lord"): years since the nominal birth of Jesus Christ, also designated **CE** ("Common Era")

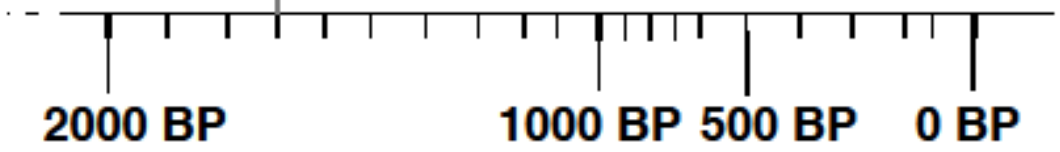
The Julian Calendar used in Europe from 45 BC until the Second Millennium AD assumed a year of 365.25000 days (rather than the actual 365.256363 days). It was replaced by the Gregorian Calendar, which was first adopted in AD 1582 in Roman Catholic countries and later in other countries. To avoid confusion of daily dates during the period of use of both calendars, dates in the Julian system are designated "Old Style" (OS) and those in the Gregorian system are designated "New Style" (NS). This fortunately is not an issue at the scale of years.



Calendar years: Periods of 365.2564 days in which Earth orbits Sun

For example, the age 1700 ^{14}C years BP converts to 1530 calendar years BP, and thus to AD 420.

BP ("Before Present"): years from AD 1950 (a convention arising from the details of radiocarbon dating)

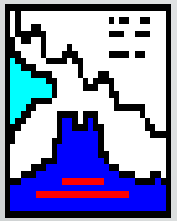


Radiocarbon years or **^{14}C years**: Time required for the radioactive ^{14}C in a particular ancient material to have decayed to its present proportion relative to the stable ^{12}C and ^{13}C in that material, *assuming* that the ^{14}C concentration of the atmosphere when that ancient material formed was the same as that of the modern (late 1940s) atmosphere. That assumption is not valid in detail, so that measured ^{14}C ages must be converted to calendar ages. Conversion from ^{14}C years to calendar years is called "calibration" of the age. Two further *SFMG* pages address that topic.

One bit of good news is that U-Th or ^{230}Th dating requires no calibration – it yields ages in calendar years. Those ages were commonly expressed relative to the time of analysis but are more recently expressed as years BP.

CALIB Radiocarbon Calibration

M. Stuiver, P.J. Reimer, and R. Reimer



OxCal Program v3.10

UNIVERSITY OF OXFORD
RADIOCARBON ACCELERATOR UNIT

$$\delta f = f_{j+1} - f_j$$
$$\delta t = t_{j+1} - t_j$$
$$d_j = (f_{j+1} - f_{j-1})/(t_{j+1} - t_{j-1})$$
$$d_{j+1} = (f_{j+2} - f_j)/(t_{j+2} - t_j)$$
$$a = \frac{3\delta f - \delta t(2d_j + d_{j+1})}{\delta t^2}$$
$$b = \frac{d_{j+1} - d_j - 2a\delta t}{3\delta t^2}$$
$$f(t) = f_j + d_i(t - t_j) + a(t - t_j)^2 + b(t - t_j)^3$$