

Welcome to Earth!



The Longue Durée



The Longue Durée

French



The Longue Durée

French

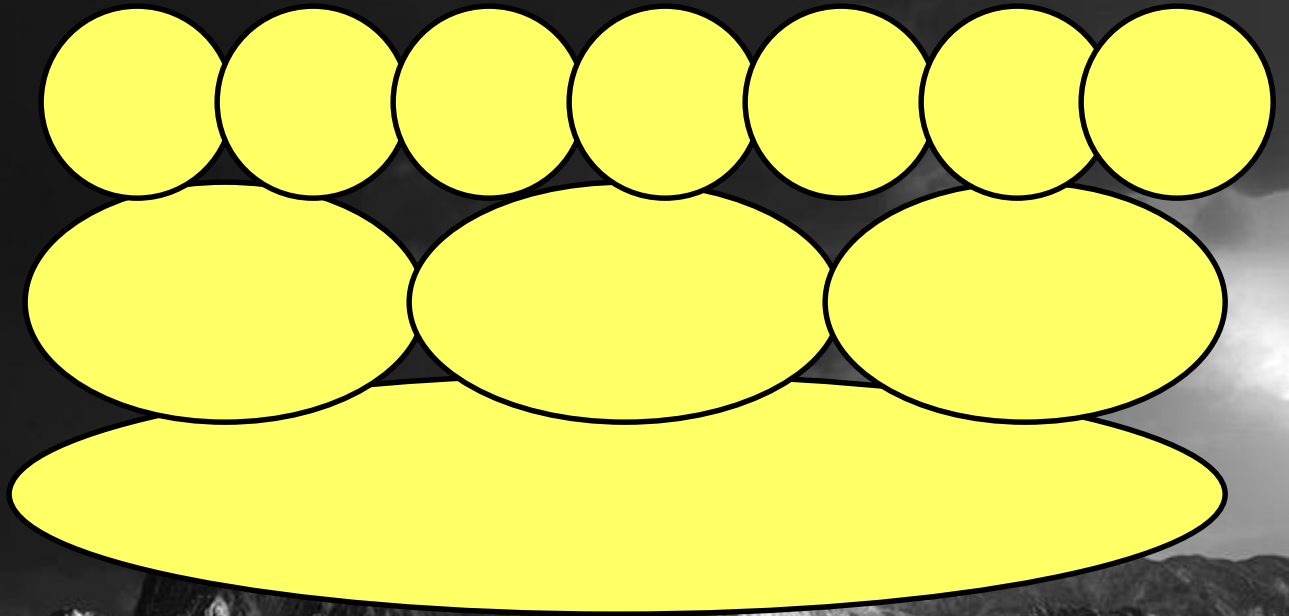
(Long Duration)



The Longue Durée

French

(Long Duration)



The Longue Durée

Political/Historical Change

Organizational/Structural Change

Geological/Environmental change

Fernand Braudel

The Longue Durée



Fernand Braudel

How old is this thing?



How old is this thing?

4004 BC?



How old is this thing?

4004 BC?

100 million years?



How old is this thing?

4004 BC?

100 million years?

4.55 billion years!



How do we know?

Knowledge Production!

What is science?

Predictive Accuracy?

Quantitative Analysis?

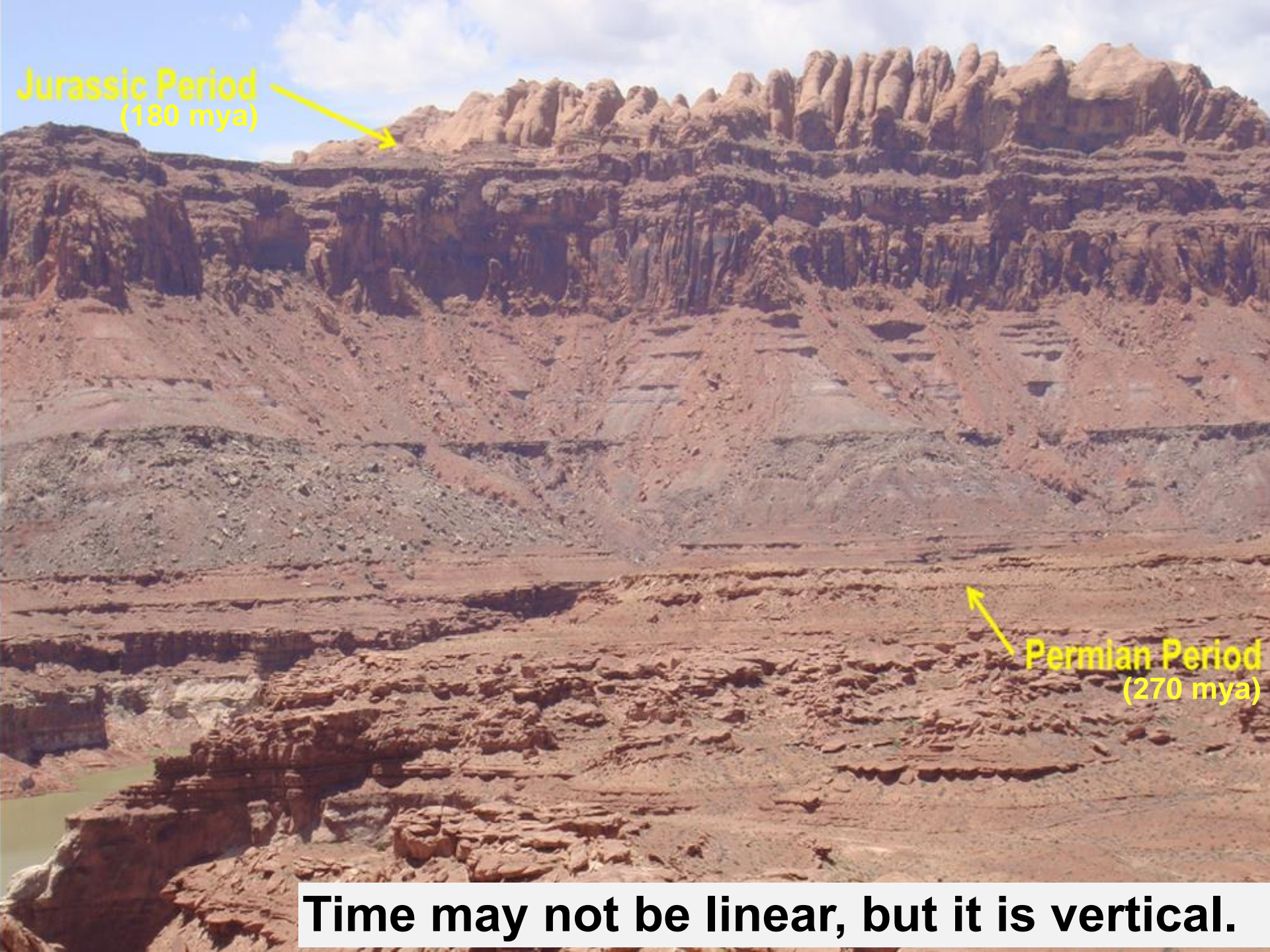


u n i v e r s e

Earth is born 4
billion years ago

The universe
starts 13.4 billion
years ago

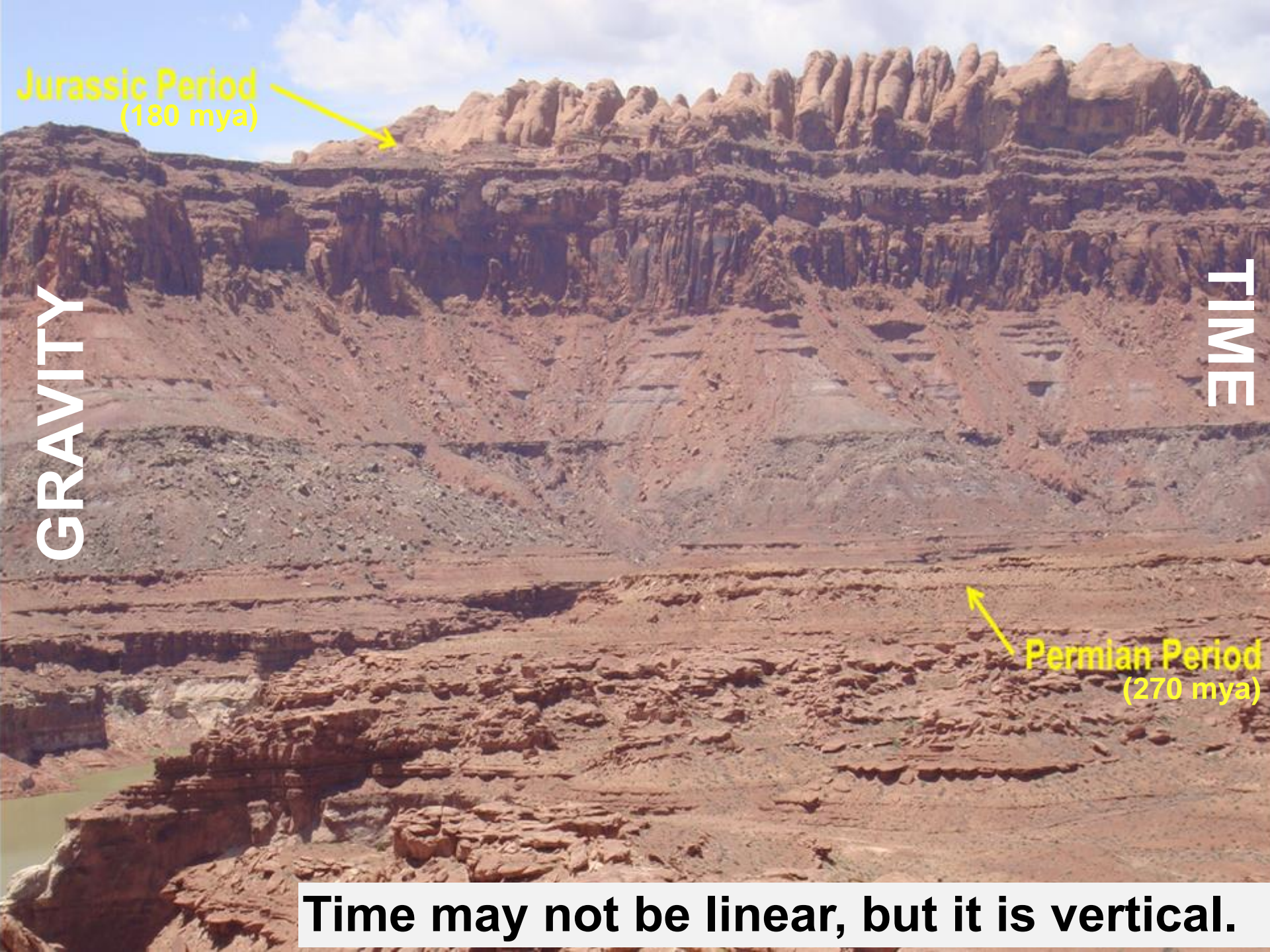
t i m e l i n e



Jurassic Period
(180 mya)

Permian Period
(270 mya)

Time may not be linear, but it is vertical.



Jurassic Period
(180 mya)



GRAVITY

TIME



Permian Period
(270 mya)

Time may not be linear, but it is vertical.

Era	Period	Epoch	M.y.a.	Significant Events
Cenozoic	Quaternary	Holocene	0.01	• Modern genera of animals
		Pleistocene	2.0	• Early humans; Glaciation
	Tertiary	Pliocene	5.5	• Anthropoid radiation
		Miocene	25	• Expansion and modernization of mammals
		Oligocene	38	
		Eocene	54	
		Paleocene	65	
Mesozoic	Cretaceous		135	• Rise and Fall of Dinosaurs
	Jurassic		180	• Earliest mammals
	Triassic		245	• Large amphibians
Paleozoic	Permian		270	• Primitive reptiles replace amphibians
	Carboniferous		350	• Amphibians dominant
	Devonian		400	• Dominance of fish; first amphibians
	Silurian		440	• Primitive fish; first plants
	Ordovician		500	• First vertebrates; invertebrates dominate
	Cambrian		540	
Pre-Cambrian				<ul style="list-style-type: none"> • Oldest rocks • Few multicellular invertebrates • Single-cell organisms appear
			4600	



Anthropocene

1945 - ????

Holocene

10 kya - present
(iPods, fast food)

Pleistocene

2 mya - 10 kya
(Homo Sapiens)

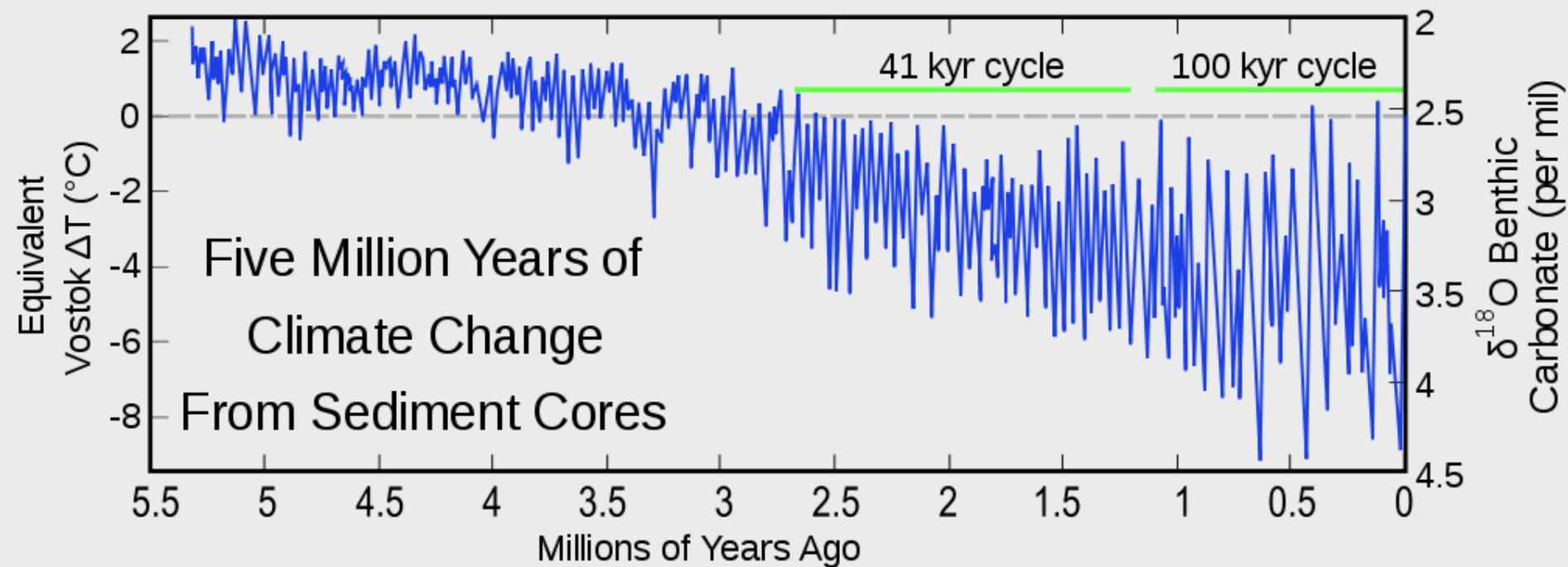
Pliocene

5.5 mya - 2 mya
(bipedal hominins)

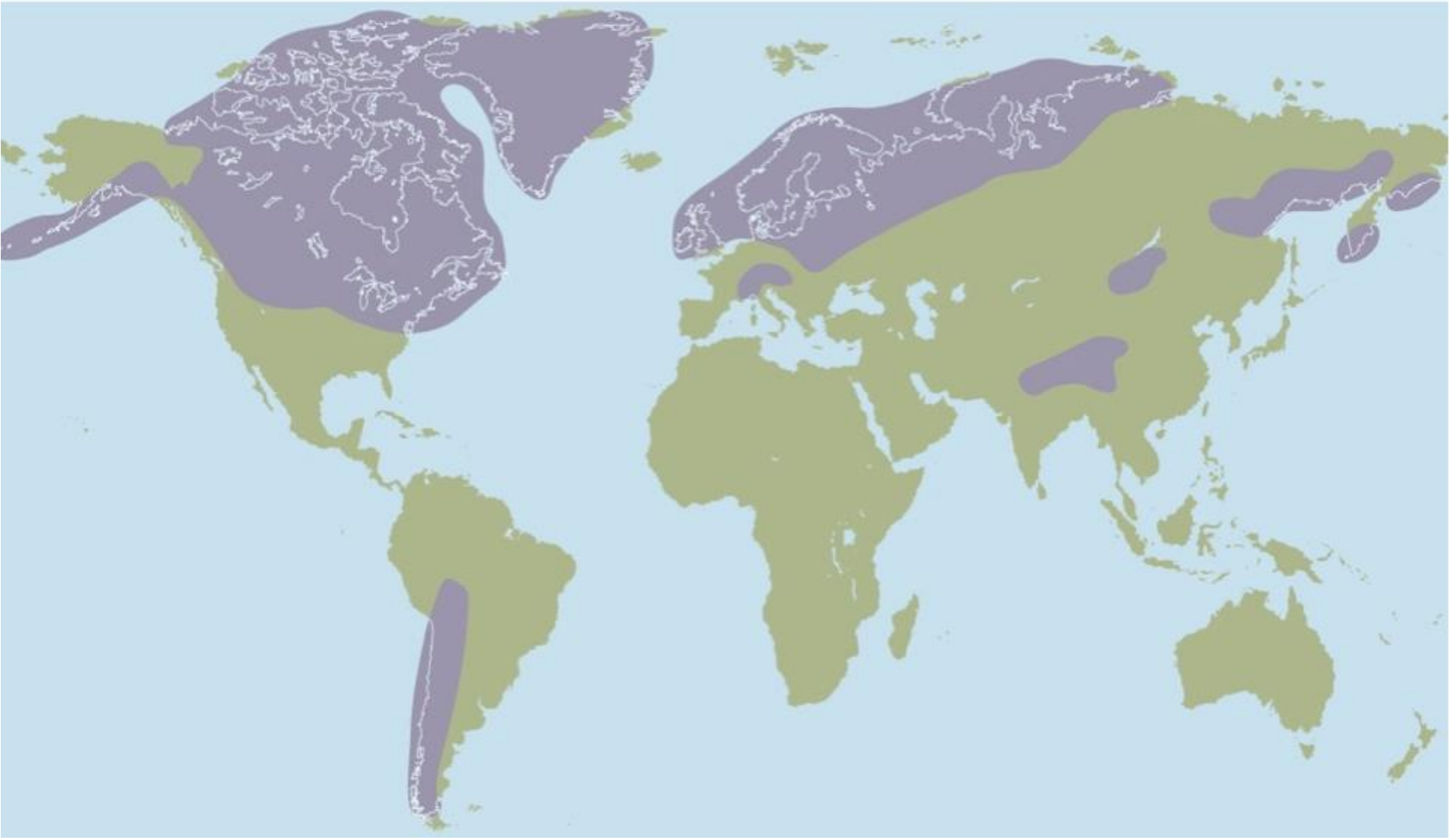
Miocene

25 mya - 5.5 mya
(Hominids appear)

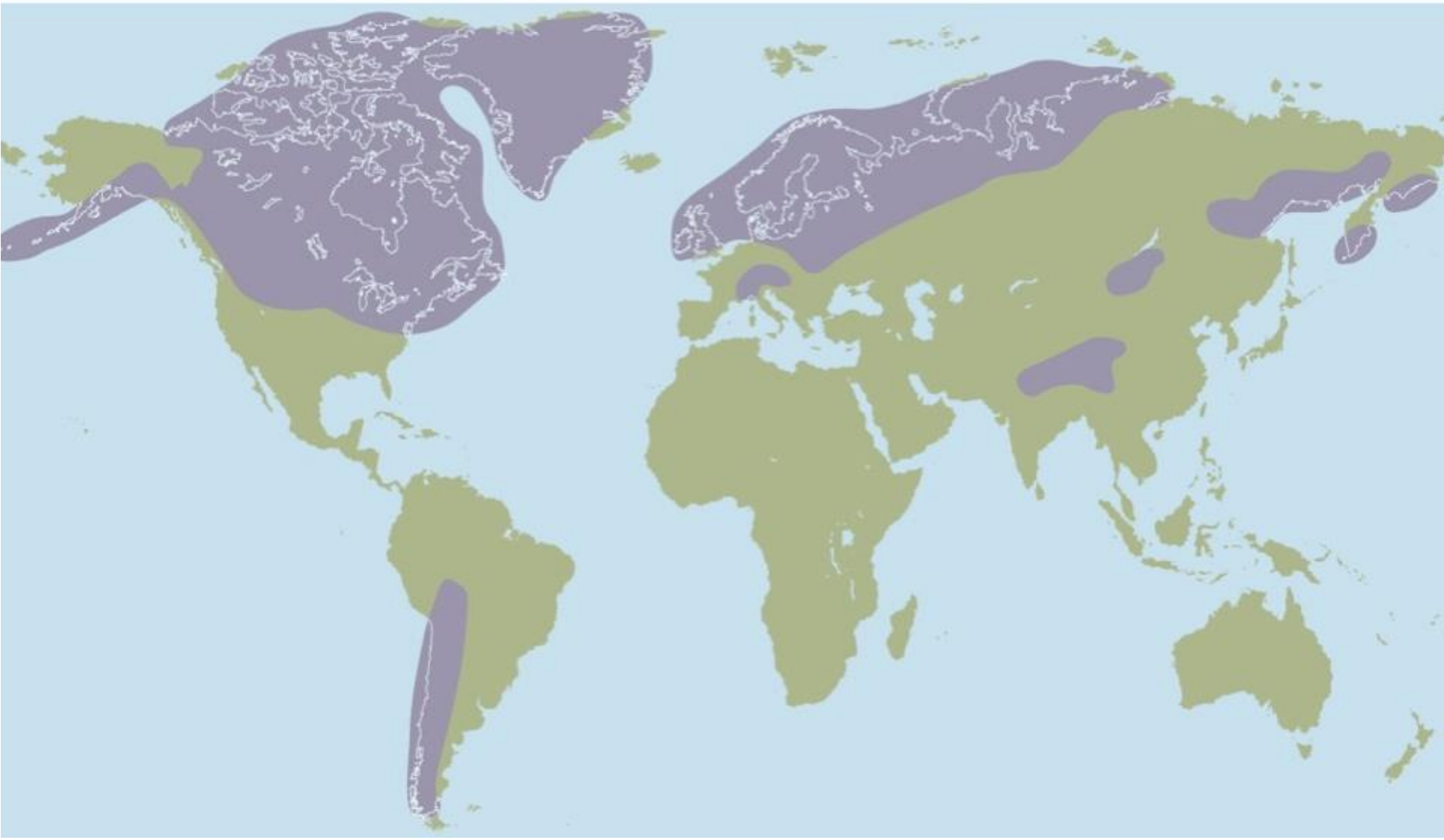
Climate change over the Hominin lifespan

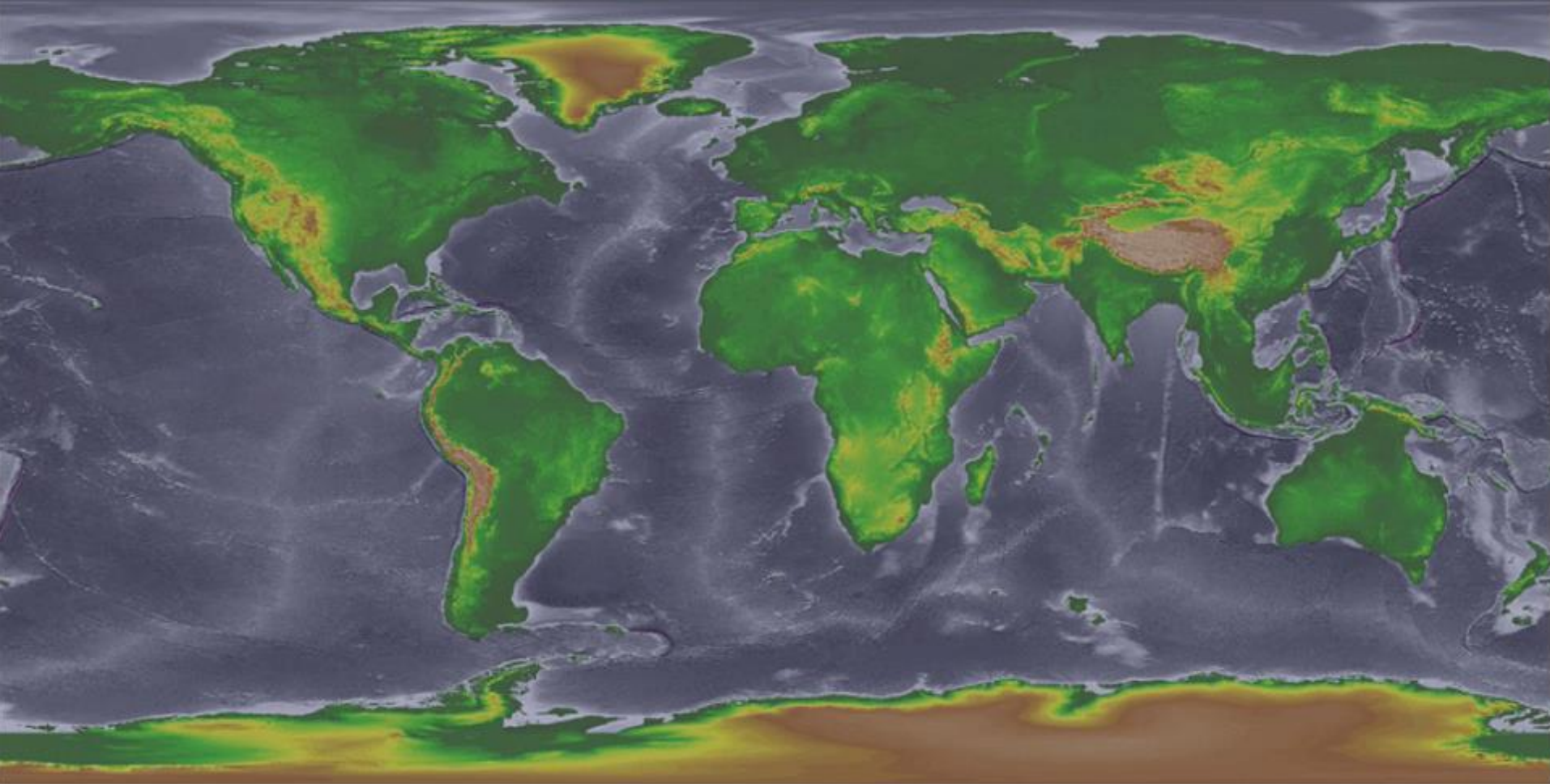


Climate Flux!



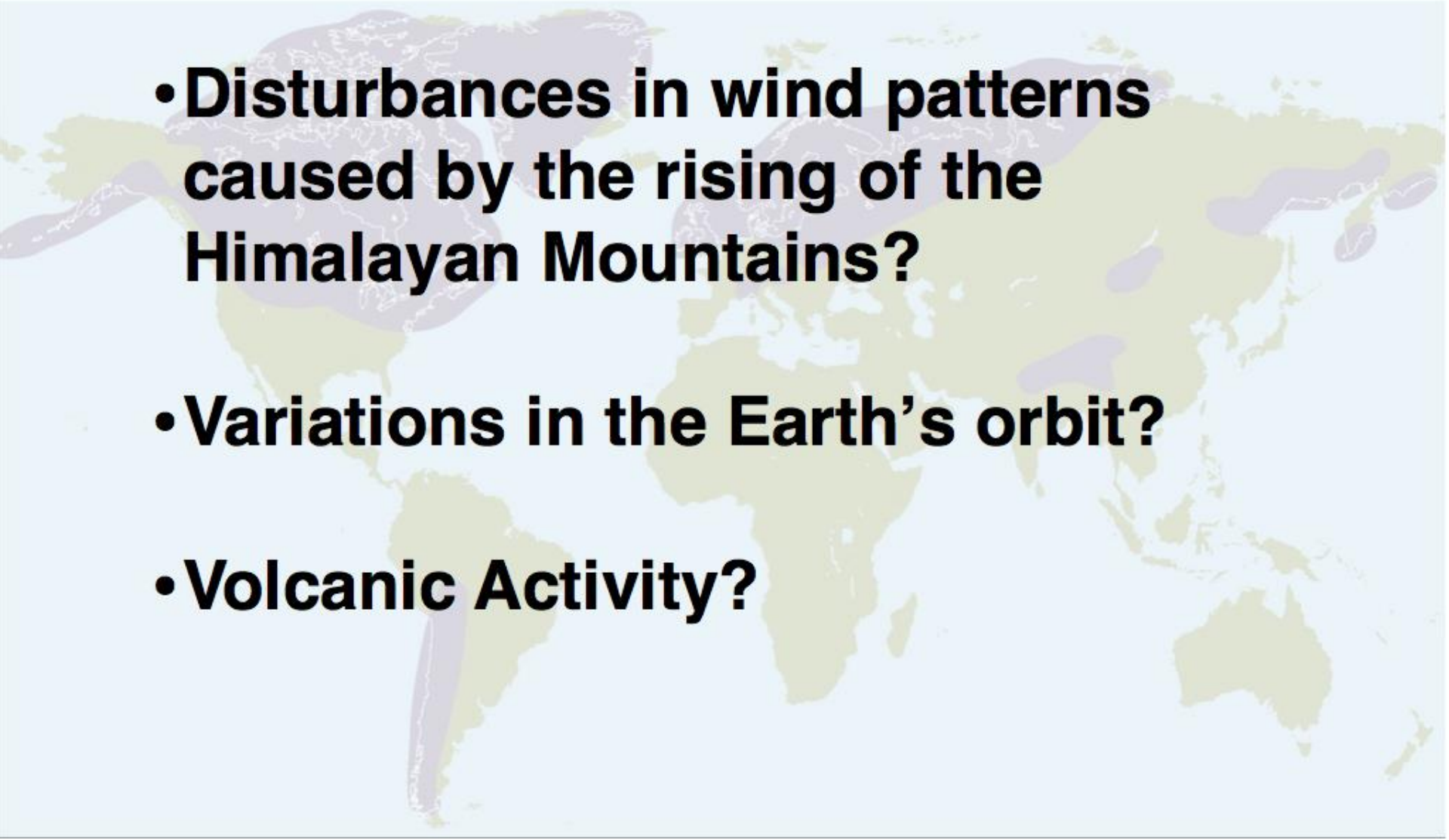
Glaciated Regions





Ice Age Sea Levels

Drivers of Climate Change

- 
- **Disturbances in wind patterns caused by the rising of the Himalayan Mountains?**
 - **Variations in the Earth's orbit?**
 - **Volcanic Activity?**

Interglacials (Now)

- **Are we in an interglacial now?**
- **Our current interglacial has lasted 12,000 years. The last interglacial lasted 20,000 years (110,000 BP and 130,000 BP).**
- **The previous interglacial lasted at least 100,000 years.**
- **Is our 12,000 years of temperate climate just a blip in the pattern of Quaternary Ice Ages?**

Environmental Backdrop

Sea level - rises and falls
500ft

Glaciation - 1.7 of the past 2
million years have been “Ice
Age”



THE PALEOLITHIC

2.5 mya - 15 kya



**MIGRATION
INNOVATION
CLIMATE FLUX**

2.5 mya - 15 kya

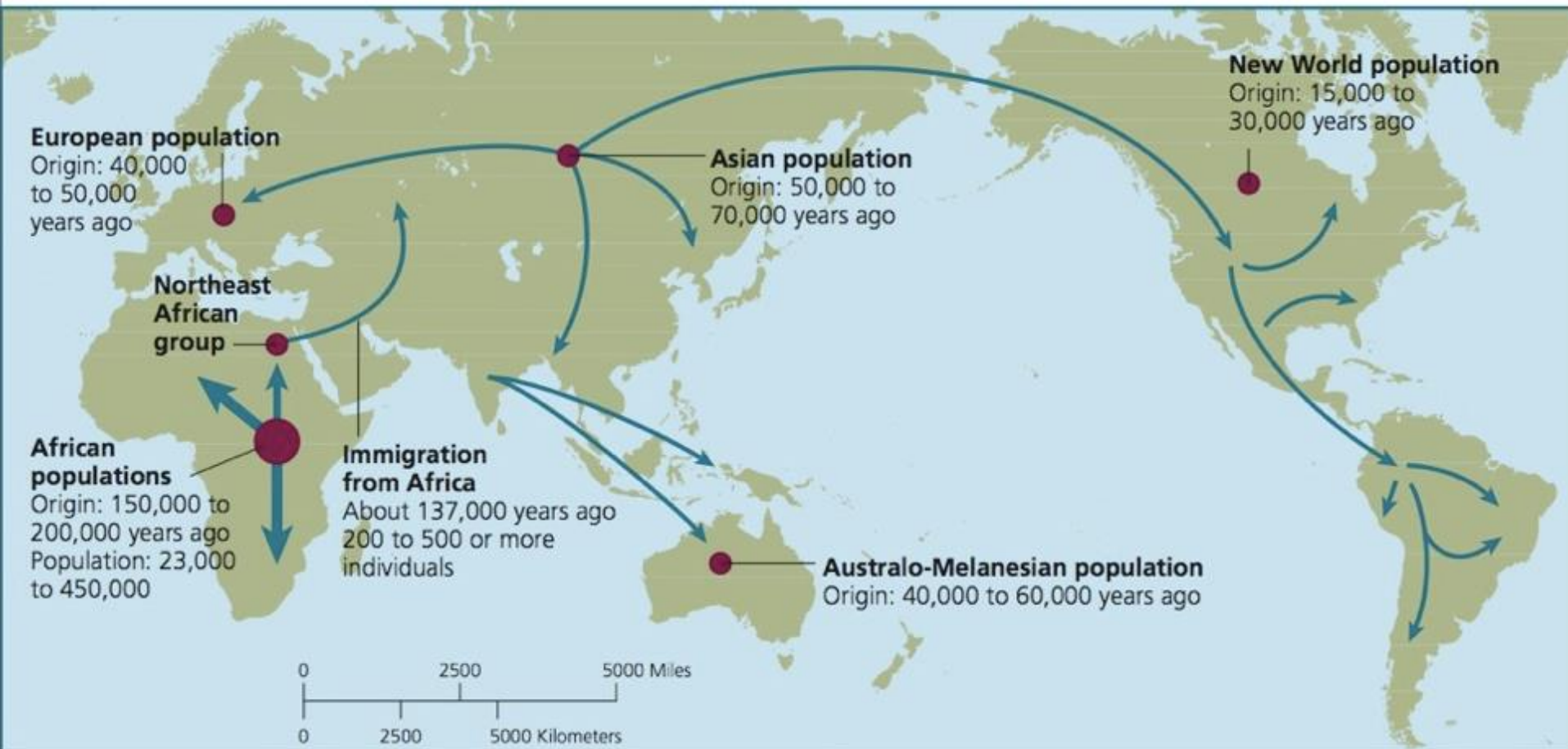
Um...Fire. nbd.

Innovations of the Paleolithic

- **Fire**
- **Big game hunting**
- **Definitive living structures (homes)**
- **Intentional burial of the dead**
- **Art**

2.5 mya - 15 kya

Migration Patterns



Migration Patterns

Rate of expansion: expanding 10 miles per generation (20 yrs), it would take 20,000 years to cover the distance between East Africa and Southeast Asia (10,000 miles) -- 0.02% of the Homo erectus timeline.

• This brief period is completely indistinguishable with radiopotassium dating.

• We have much more time to work with than space.



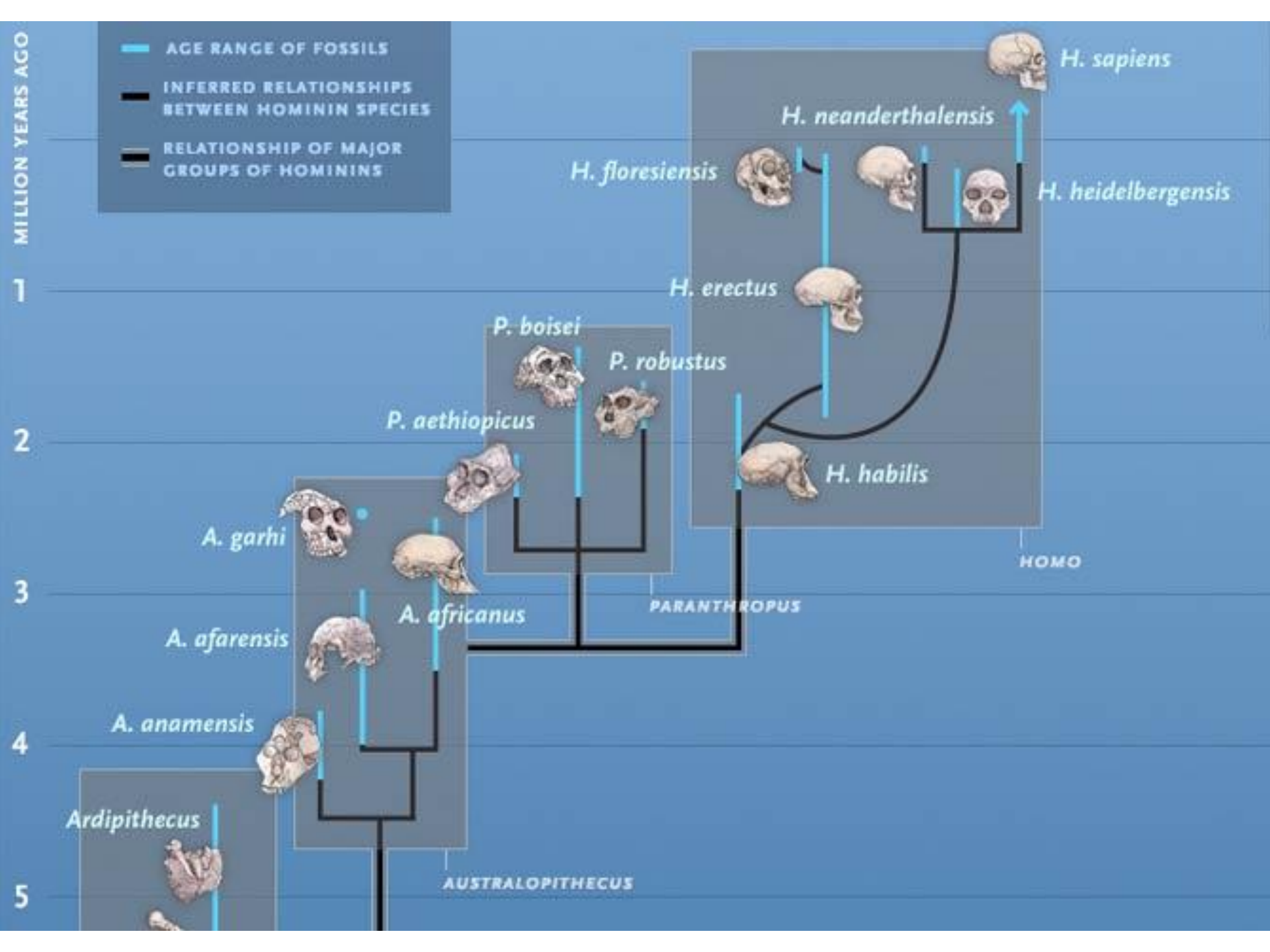
Becoming Human

Homo habilis (2.4 mya)

Homo erectus (1.9 mya)

Homo heidelbergensis (600 kya)

Homo sapiens (200 kya)



Belly vs. Brain



Belly vs. Brain

**Dietary choices impact
evolution of primate
bodies.**

**Fruit makes you
smarter!**

Intelligence isn't cheap!

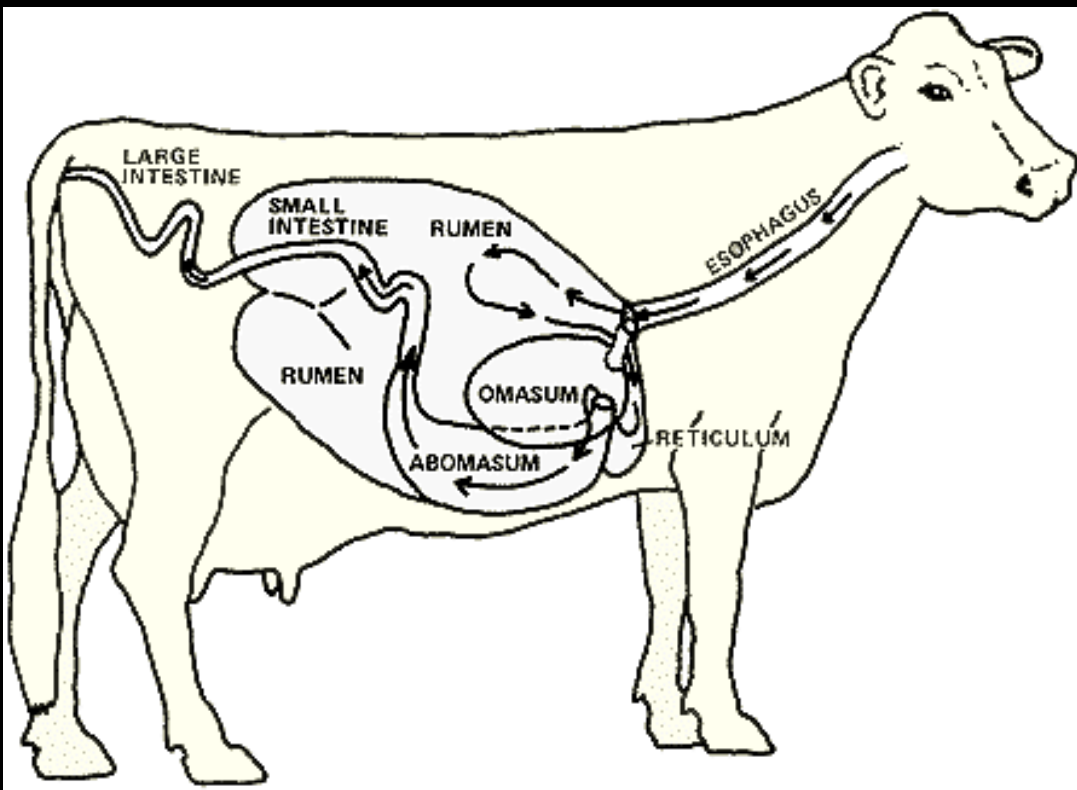


Belly vs. Brain



**Nutrient
Extraction**

Belly vs. Brain



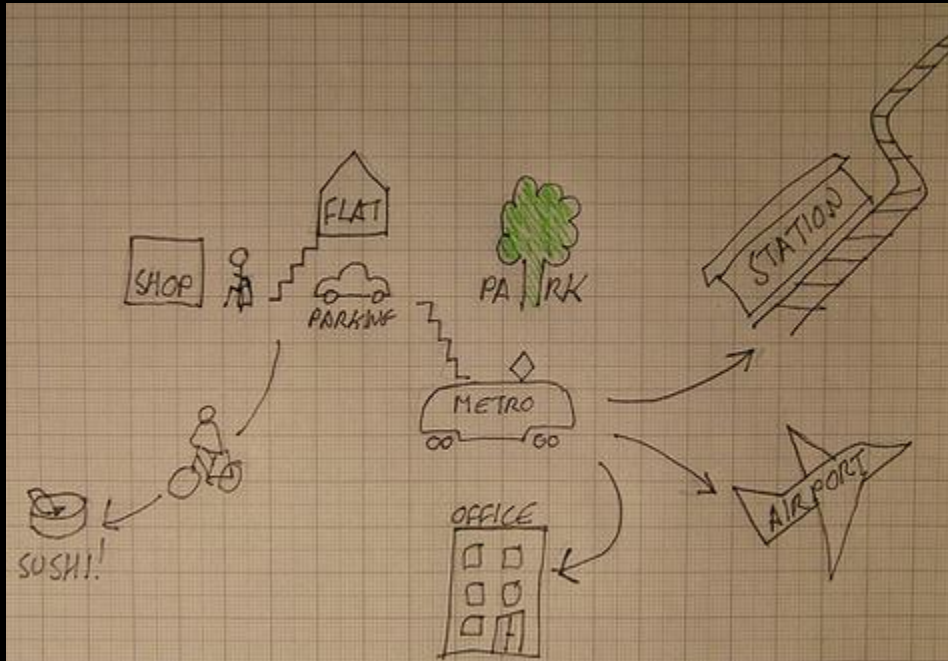
**Nutrient
Extraction**

Belly vs. Brain



**Visual
acuity &
pattern
recognition**

Belly vs. Brain



**Mental
Maps**

Belly vs. Brain



**Less efficient
stomachs
=
more efficient
brains**

Belly vs. Brain



**Poor stomachs
gave us:**

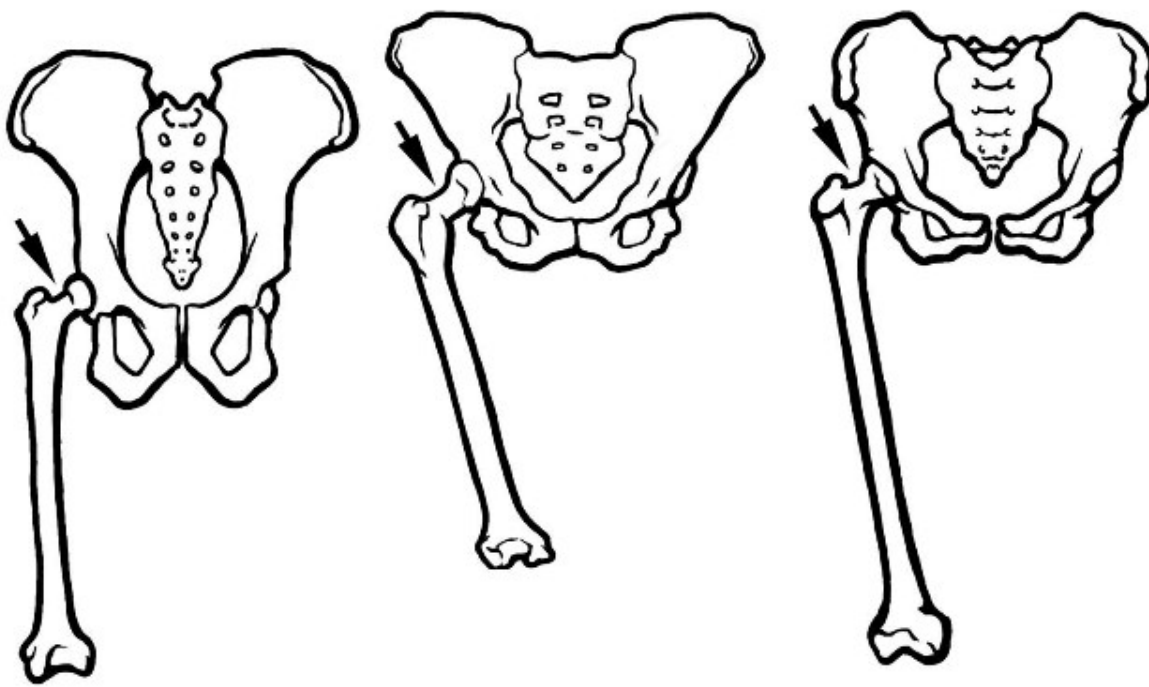
- Advanced visual acuity.
- Grasping hands
- Big brains

Belly vs. Brain



Brains evolve complexity to mentally map locations of productive foods?

Early Homo maintained diet quality in the face of changing environments.



Drawings of upper leg bones of a chimpanzee (left), early human (middle), and modern human (right).

Bipedalism?

Climbing v. Walking?

Carrying Goods?

The pursuit of game?

Climate changes?

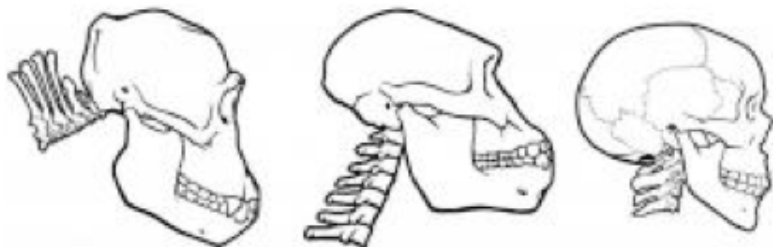
The opening up of the savannah?

Tall Grass?

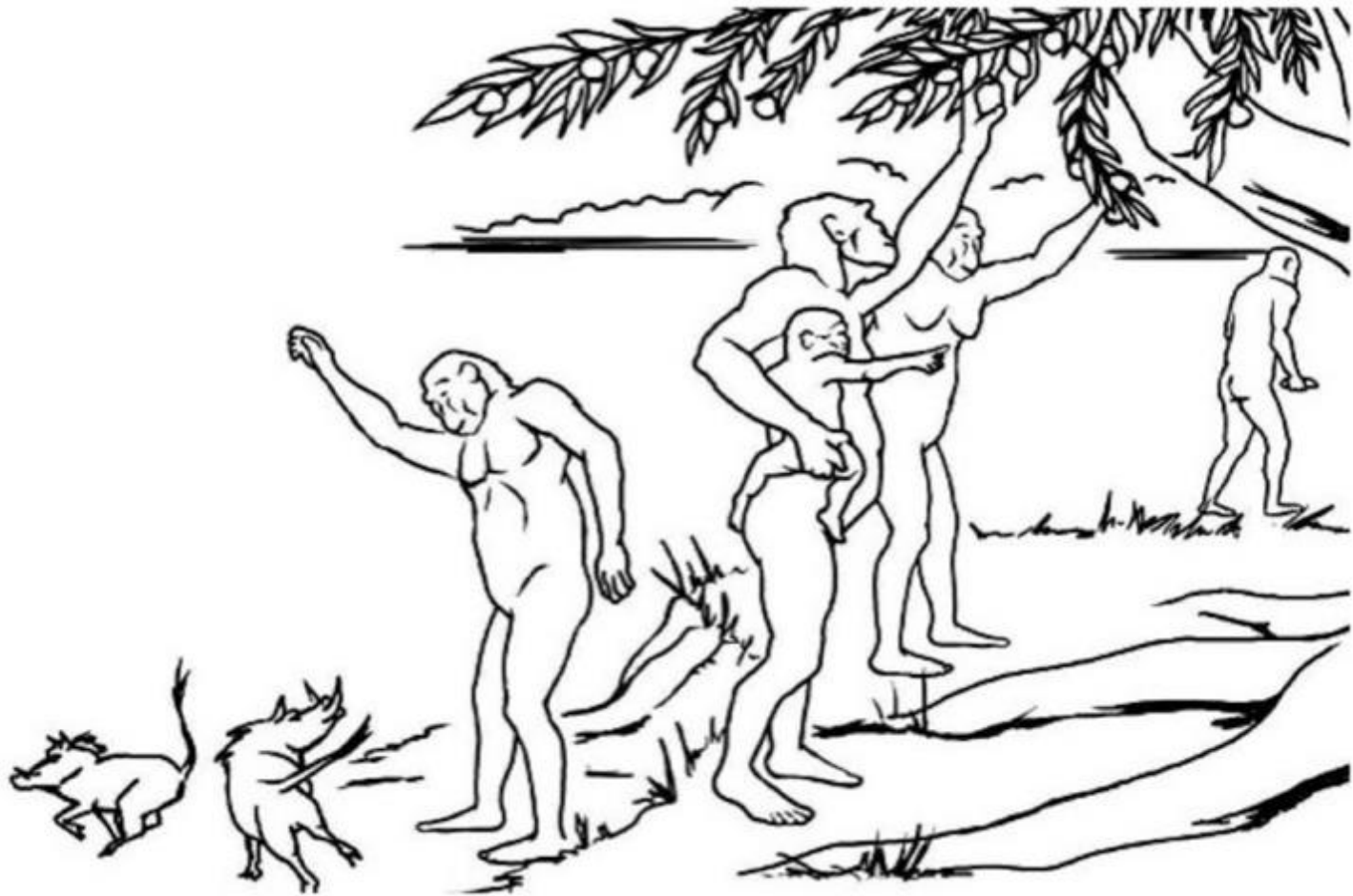
Asymmetry of the brain?

Handedness?

Surface area exposed to sun?



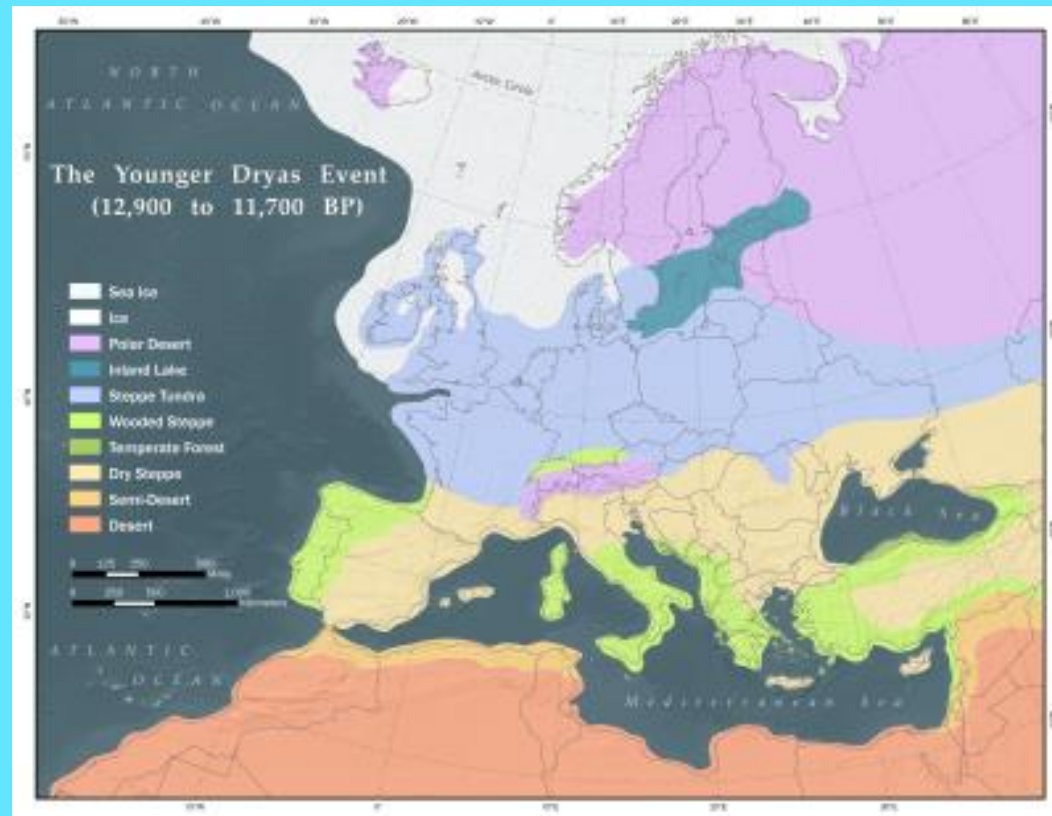
Drawings of skulls of a chimpanzee (left), early human (middle), and modern human (right)



Scene illustrating a few of the benefits of upright walking

Pleistocene > Holocene

YOUNGER DRYAS!



Pleistocene > Holocene

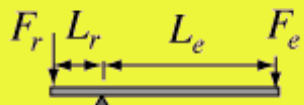
- Approx 2 mya to 10 kya
- High climate variability
- Mostly glacial
- Continents take their current geography
- Fire, art, complex stone work

- 10 kya to Present
- Global temperature rise
- Agriculture and domestication of plants and animals begins
- The forging and use of metals begins

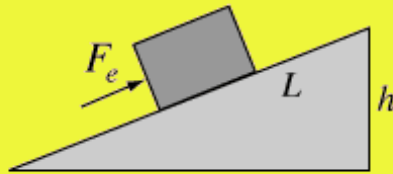
Pleistocene > Holocene

TRANSITION PERIOD

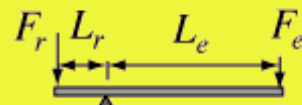
- Extinction of large mammals
- Novel environments open up
- Diet becomes more complex (more marine-based)
- Technology becomes more specialized
- Moving away from Hunting & Gathering



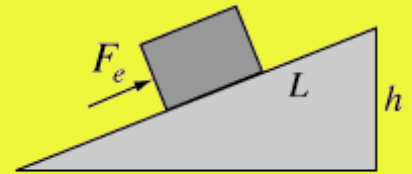
Lever $IMA = \frac{L_e}{L_r}$



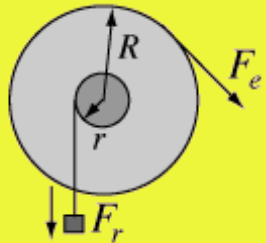
Incline $IMA = \frac{L}{h}$



Lever $IMA = \frac{L_e}{L_r}$



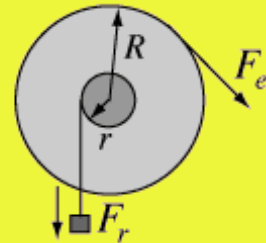
Incline $IMA = \frac{L}{h}$



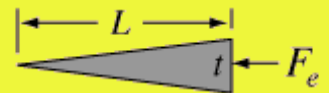
Wheel and axle $IMA = \frac{R}{r}$



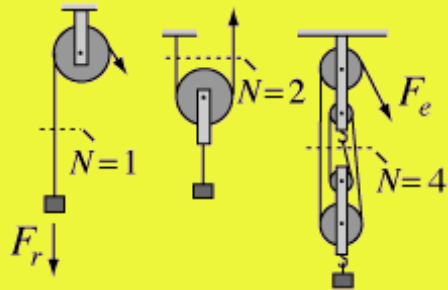
Wedge $IMA = \frac{L}{t}$



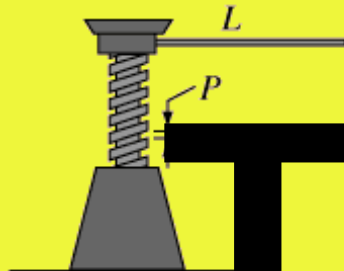
Wheel and axle $IMA = \frac{R}{r}$



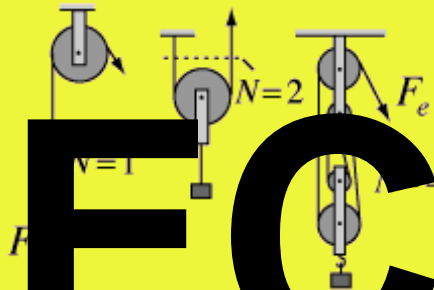
Wedge $IMA = \frac{L}{t}$



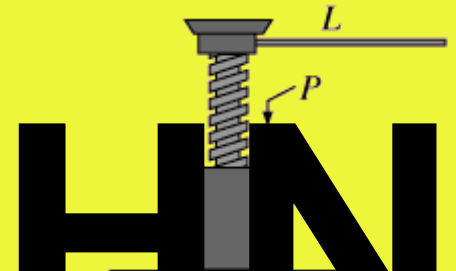
Pulley $IMA = N$



Screw $IMA = \frac{L}{P}$

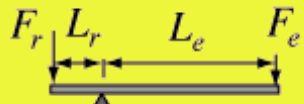


Pulley $IMA = N$

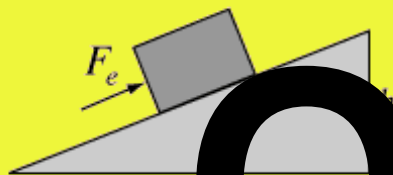


Screw $IMA = \frac{L}{P}$

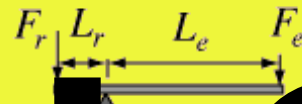
TECHN



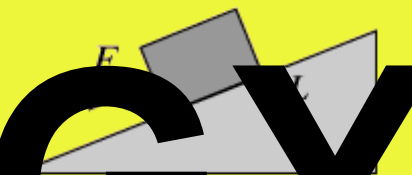
Lever $IMA = \frac{L_e}{L_r}$



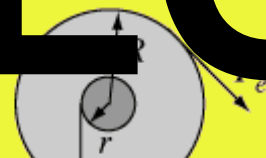
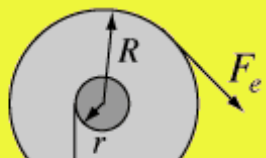
Incline $IMA = \frac{L}{h}$



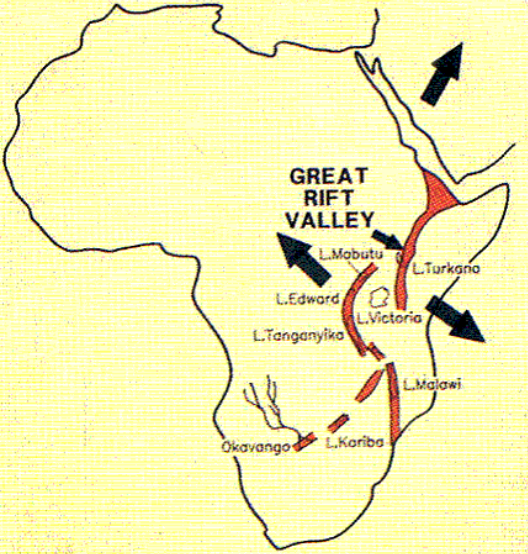
Lever $IMA = \frac{L_e}{L_r}$



Incline $IMA = \frac{L}{h}$



LOGY



Rift Valley

Olduvai Gorge

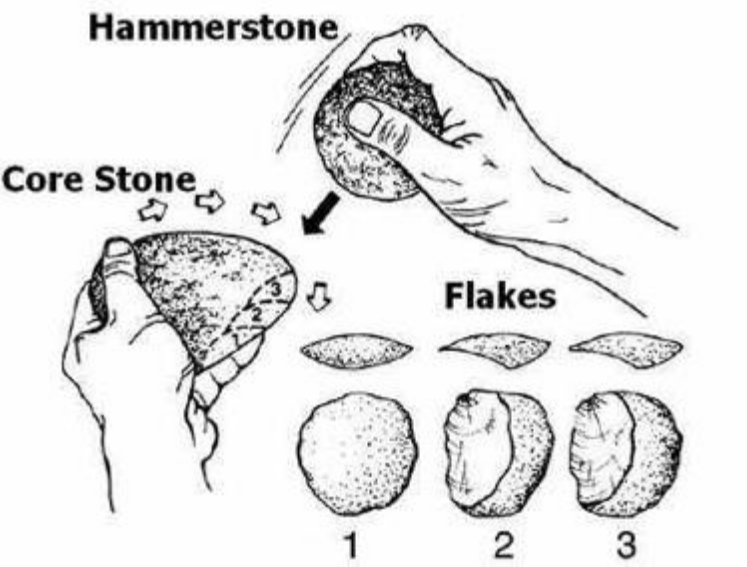




Olduvai Gorge

The Leakys

- **Olduvai Gorge, located in northern Tanzania, is one of the most famous prehistoric sites in the world.**
- **Two million years ago, the area was a large bowl-shaped basin which trapped rainfall, forming lakes and wetlands.**
- **Along the shores of the lakes lived many creatures whose remains fossilized when they died.**

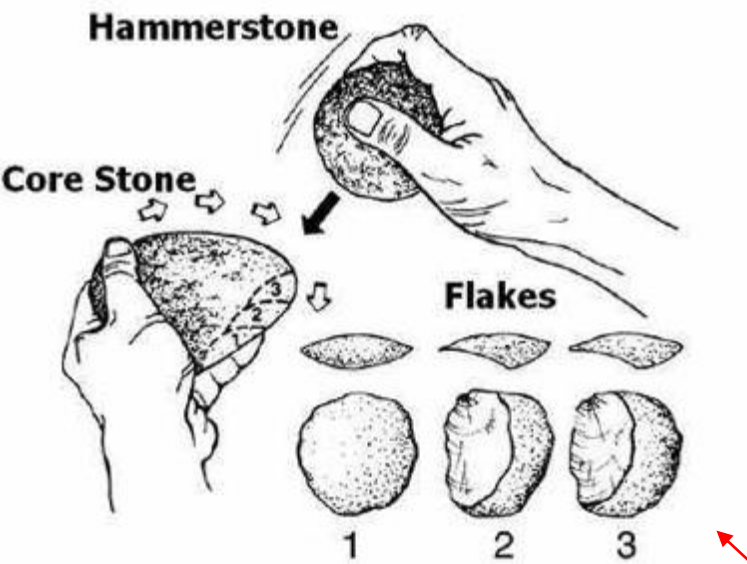


Oldowan Tools

2.6 mya to 1 mya

(million years ago)

- Significant brain expansion during this period, doubling from ~450cc to ~900cc
- Is this a cause or effect of tool use and development?
- Early hominins carry tool making outside of Africa!

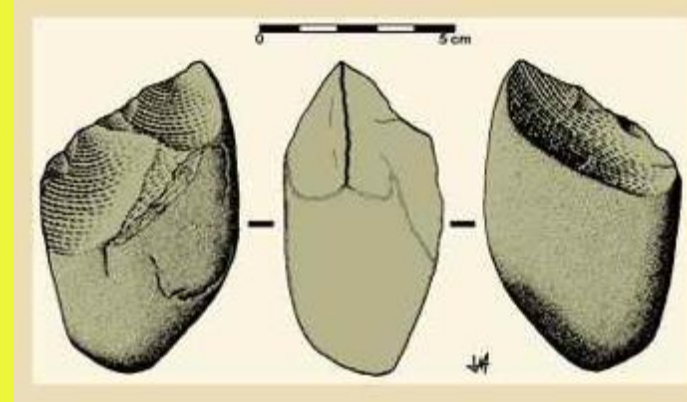


Oldowan Tools

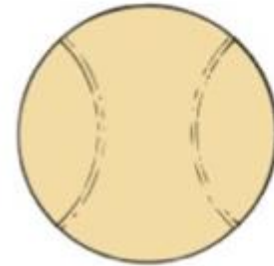
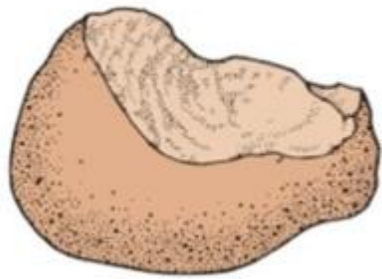
2.6 mya to 1 mya

(million years ago)

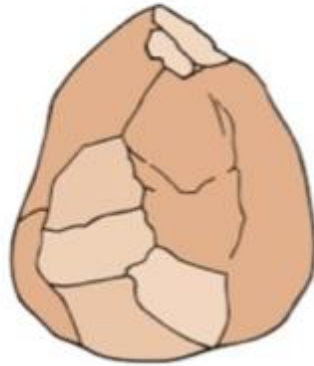
- Tools used to create tools!
- Importing / exporting raw materials?
- This requires great forethought and imagination?
- How are cognitive capacities inhibited or determined by morphological capacities?



TOOLS

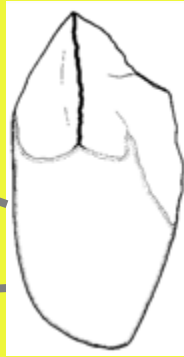


0 5 cm



Lithic Technologies

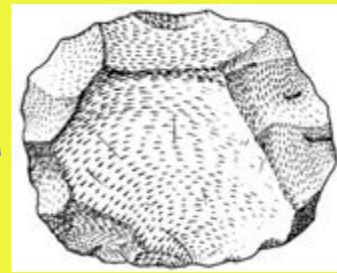
Oldowan



Acheulean



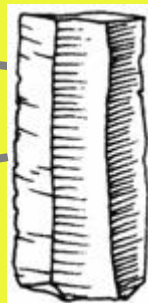
Mousterian



Châtelperronian



Aurignacian



Microliths



MEMORY

TECHNOLOGY

INTENTION

How are these related?

Neanderthal & Homo Sapiens technology does not differ much at 50kya.

But at approx. 40kya Homo Sapiens technology “explodes,” leaving Neanderthal technology behind.

Was there a key component Neanderthals lacked?

Abstract Representation



Photograph by Sisse Brimberg

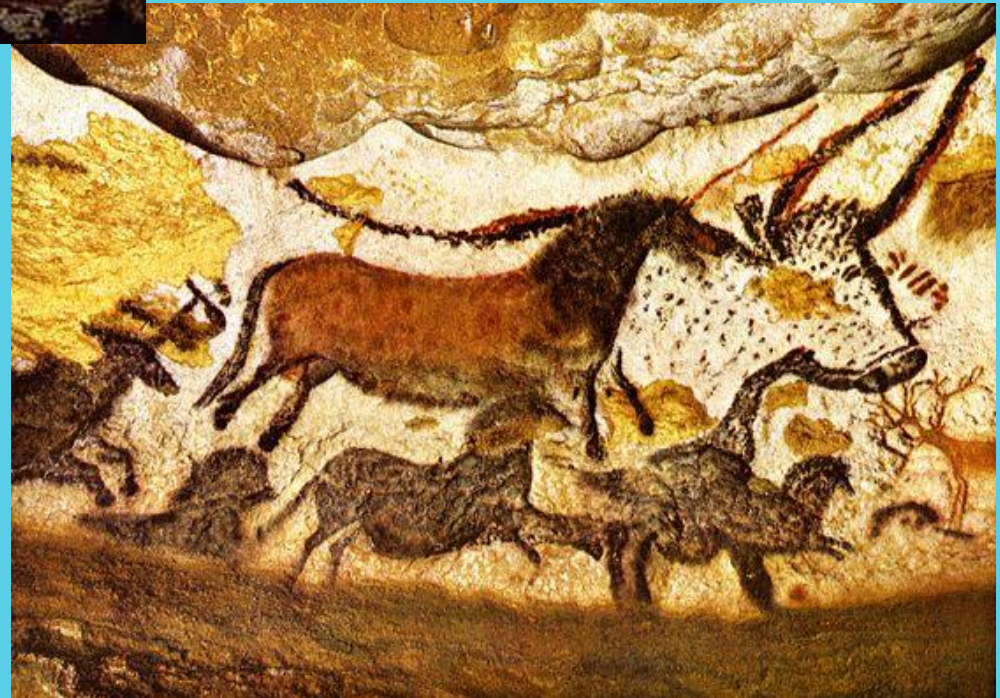
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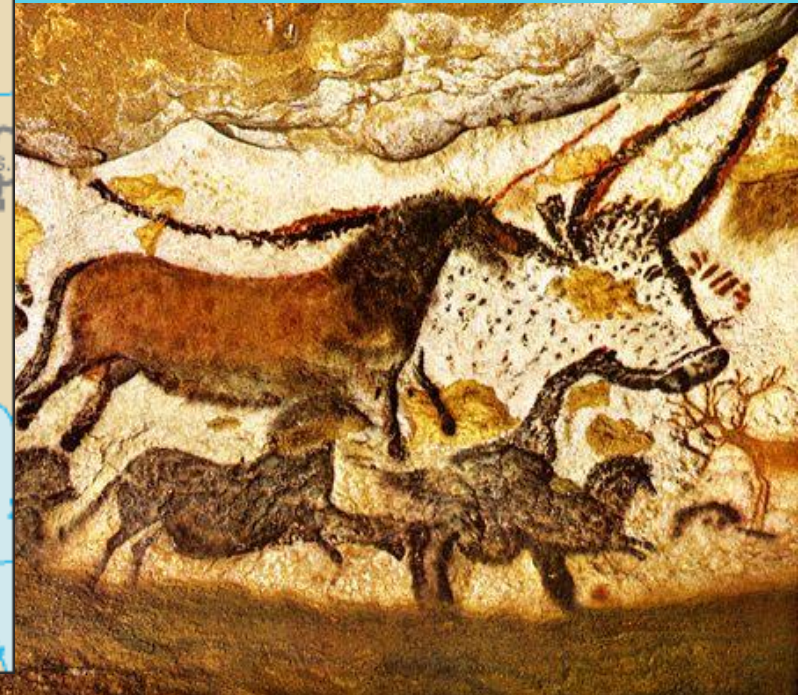
Abstract Representation



Abstract Representation



Abstract Representation

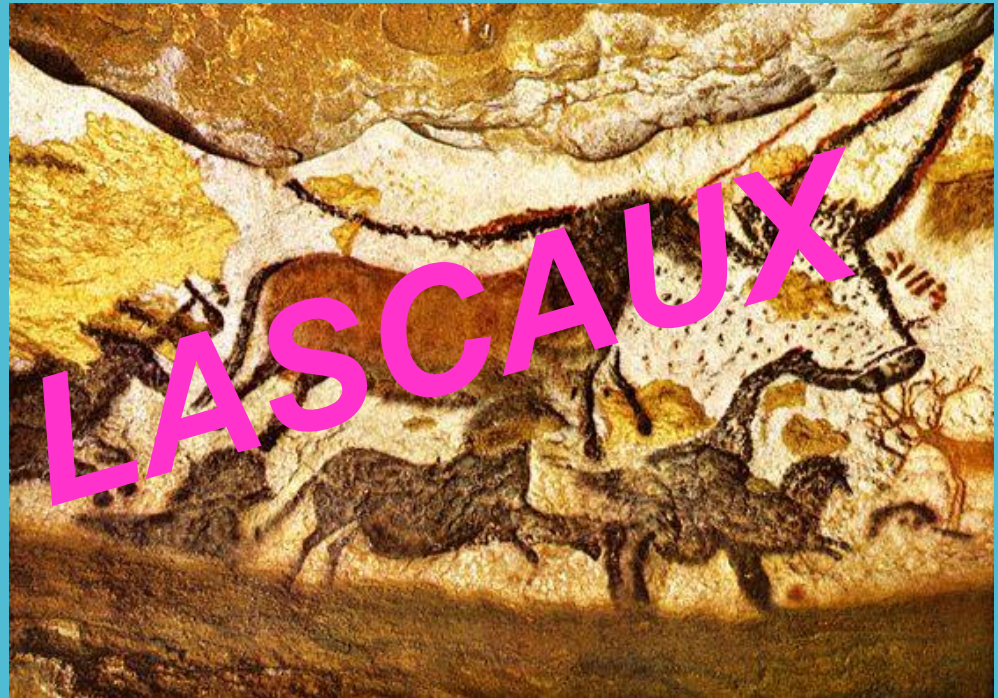


Lascaux

Chauvet

Abstract Representation

- Cave of Lascaux, sealed for 15,000 years
- Murals: found mostly in France and Spain
- Not living space, only visited
- Most paintings of animals



Abstract Representation

-Artificial light and some kind of scaffolding would have been necessary to paint the walls

-17,000BP

-Over 600 paintings, 1500 engravings

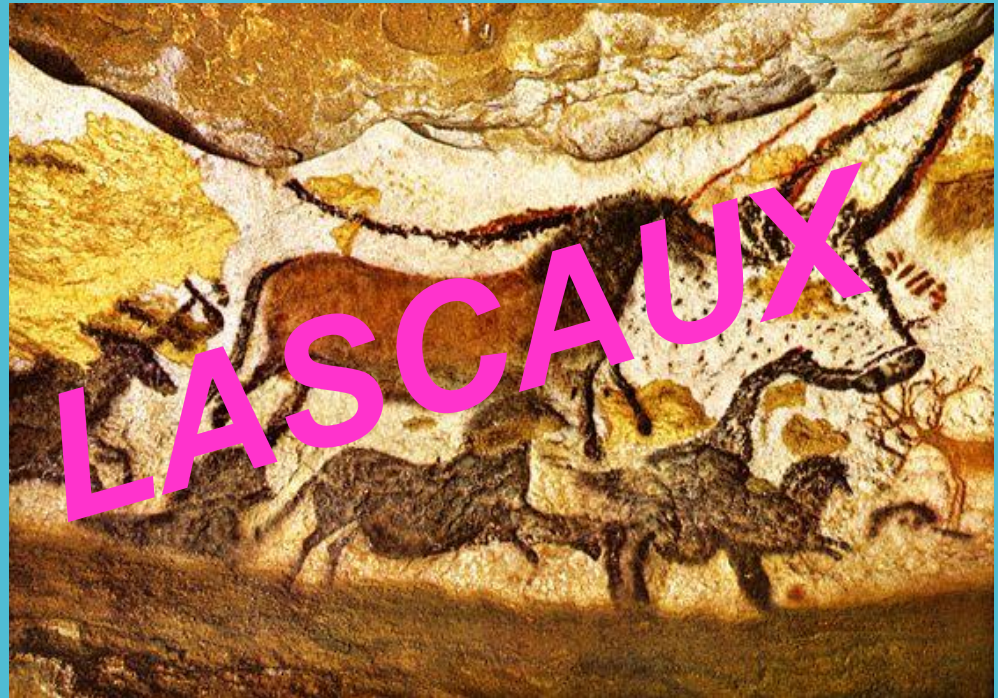
-100 yards long

-Meaning?



Abstract Representation

- Emphasis on pregnant animals = fertility?
- Hunting – strategic and ritual
- Art for art's sake?
- Primitive temples?
- Public v. Private



Abstract Representation



Abstract Representation



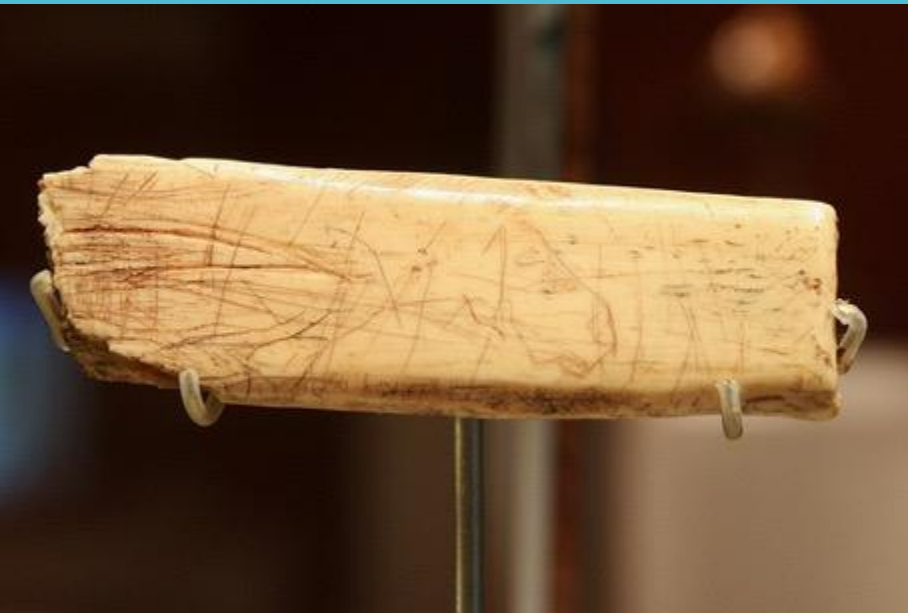
Abstract Representation

-Over 200 painted caves found in France

-Site of Chauvet (discovered 1995) is 400 meters long (five times bigger than Lascaux) and dates to 35,000 bp



Portable Representation



Portable Representation



Portable Representation

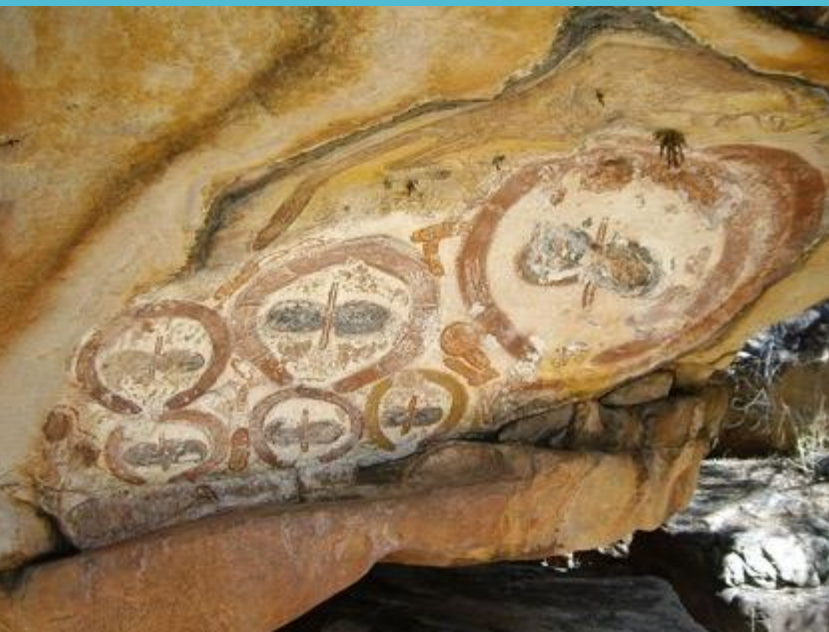


Portable Representation

- Decorative artifacts appear approx. 35 kya.
- What is “Decorative”?
- “Prior to the appearance of modern humans in Europe, there is little evidence of the impractical modification of equipment.”
- Bone & shell becomes more and more commonly used as decoration.

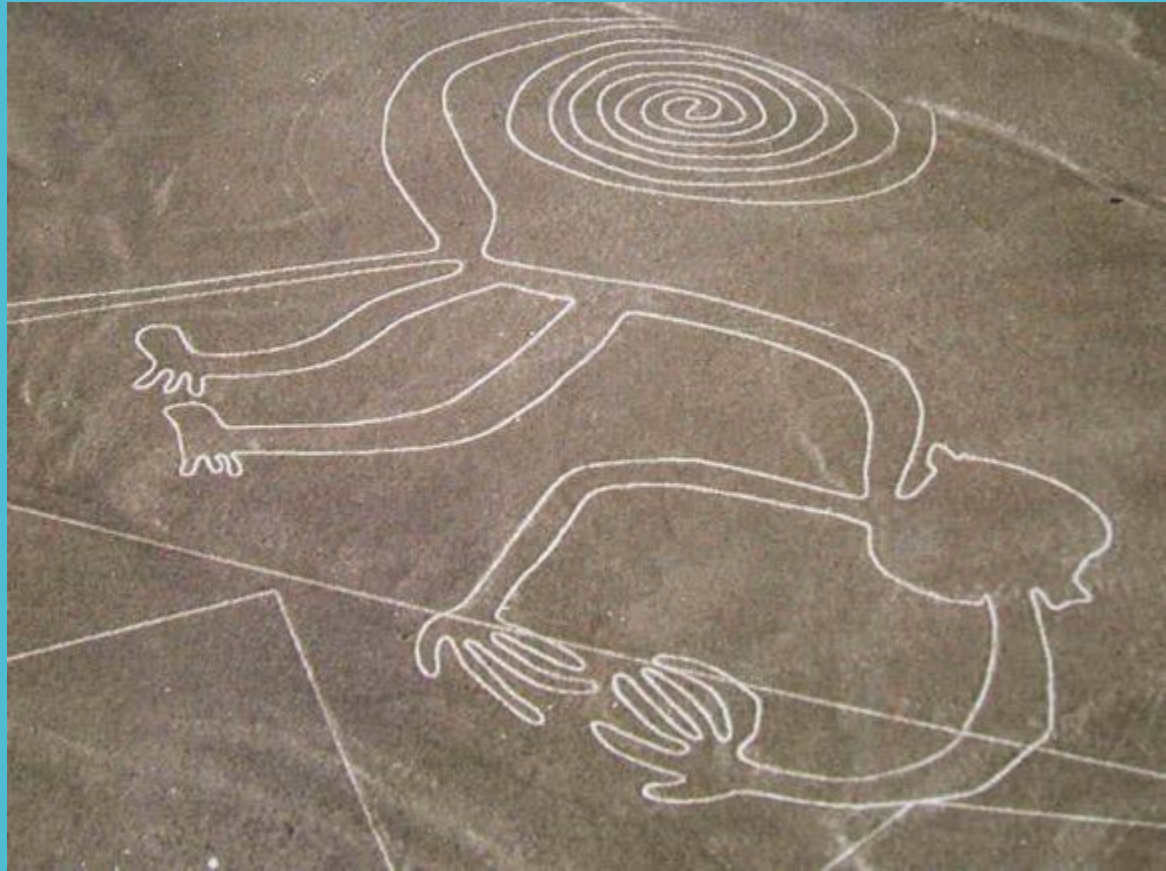
Portable Representation

- 80% of prehistoric art comes from the upper Paleolithic –a statistical anomaly of corrosion of time?
- Some early rock art and wall paintings come from Australia (inhabited 40 kya).



Terrestrial Representation

- Geoglyphs: Large (multi-meter) designs in the earth, best viewed aerially (the first crop circles). Most famously appear in Peru, associated with Nazca civilization (100BC to 800AD, pre-Inca).



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Terrestrial Representation

- Geoglyphs: Large (multi-meter) designs in the earth, best viewed aerially (the first crop circles). Most famously appear in Peru, associated with Nazca civilization (100BC to 800AD, pre-Inca).



Geological // Archaeological

**Pleistocene and
Holocene are
geological distinctions**

**Paleolithic, Mesolithic,
Neolithic are
archaeological distinctions
(meaning they are based
on cultural developments,
not geophysical).**

Geological // Archaeological

Pliocene [5.5mya]



Pleistocene [2 mya]



Holocene [10 kya]

Paleolithic [2.6 mya]

(Basal)
(Lower)
(Middle)
(Upper)



Mesolithic
[Geography dependent]



Neolithic
[Geography dependent]