

How We Got Here

The Universe and Life on Earth

GMAC MEETING 15 DECEMBER 2023 BEIJING, CHINA



Did you know:

The solar system rotates around the galaxy once every 225-million years.

The last time we were in our current position, dinosaurs were just beginning to walk the Earth!

...now you do

2

<https://agustinadearagon.school.blog/spot.com/2016/10/solar-system-infographic.html>

Do you think you're sitting still right now?

You're on a planet that is orbiting a star at 30km/s.

That star is orbiting the centre of a galaxy at 250km/s.

That galaxy is moving through the universe at a rate of 600km/s.

Since you started reading this, you have travelled about 3,000km.

<https://agustinadearagon.school.blogs.pot.com/2016/10/solar-system-infographic.html>

Today's Talk

4

- ▶ The History of The Universe
- ▶ Dimensions and Locations
- ▶ Formation of Solar System, our Earth and the Moon
- ▶ How Life Began on Earth
- ▶ Evolution
- ▶ Extinctions
- ▶ Human Evolution
- ▶ Human Global Expansion

From the Big Bang to the Modern Human

Ga: Billion years ago

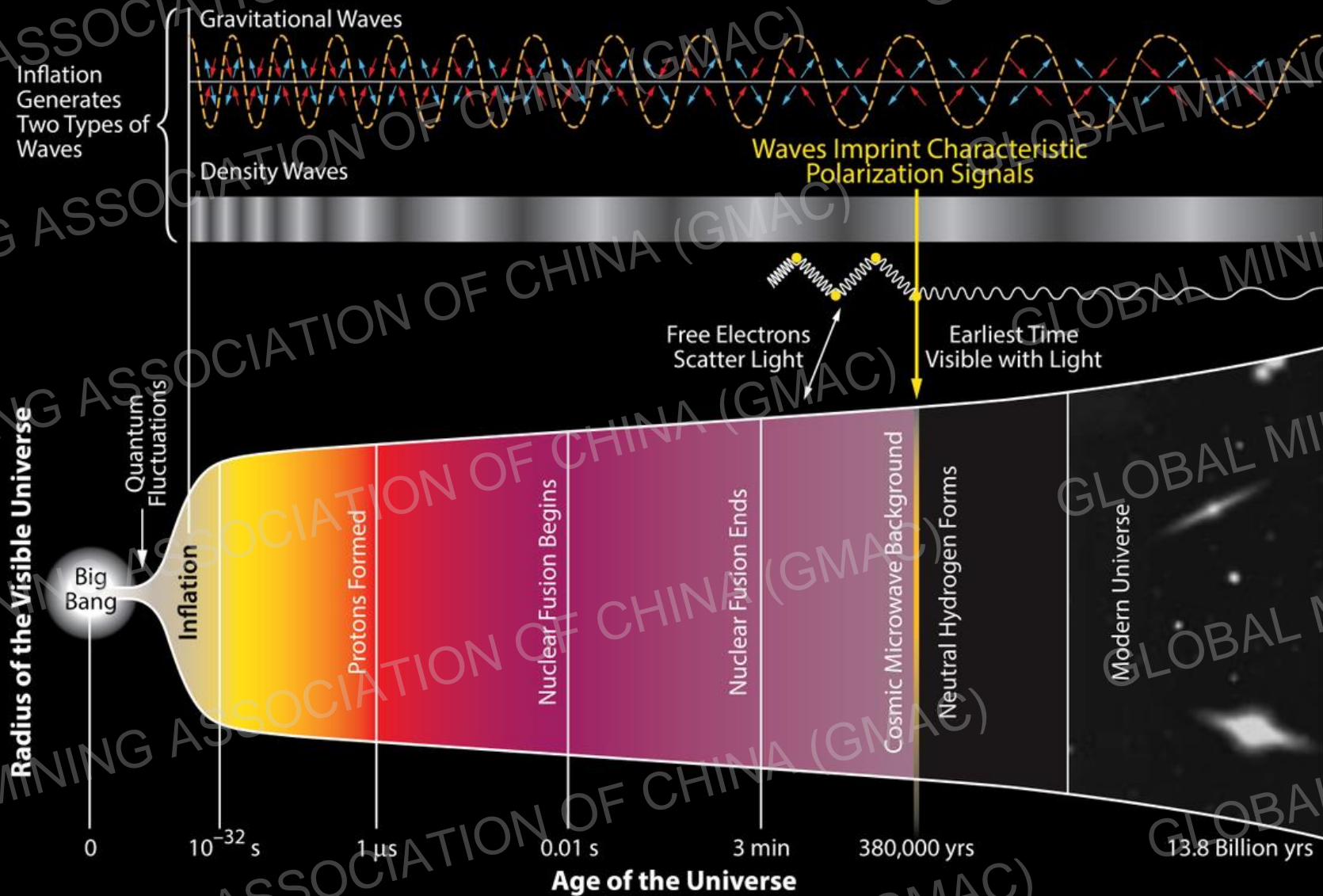
Ma: Million years ago

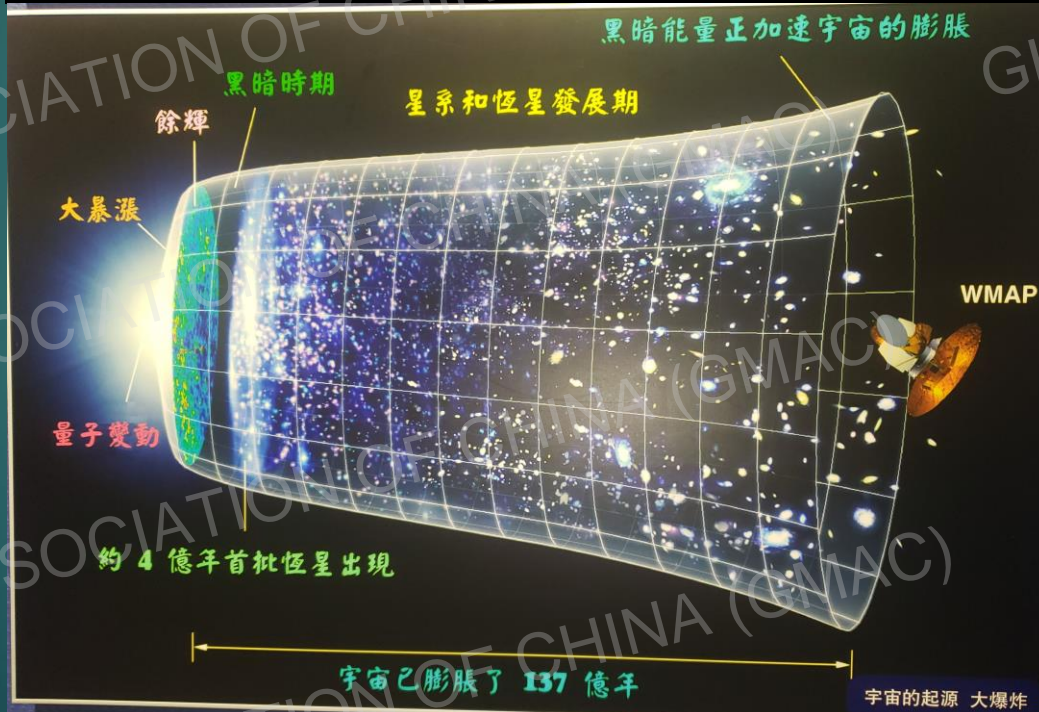
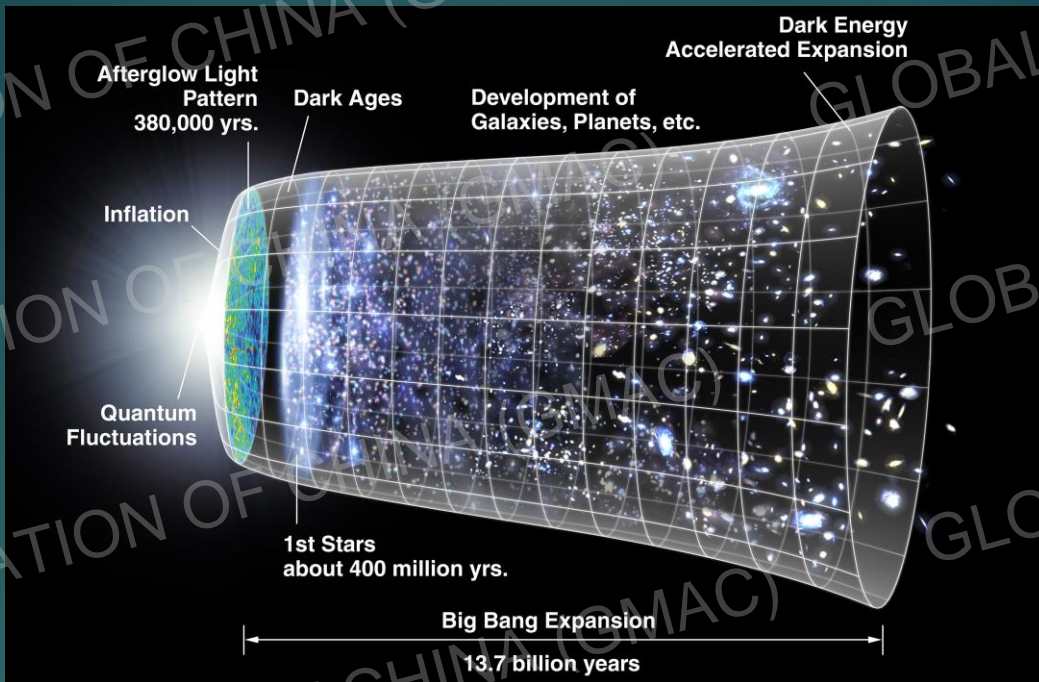
Ka: Thousand years ago



<https://dailyinforgraphic.com/the-history-of-planet-earth-from-the-big-bang-to-humans>

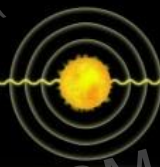
History of the Universe





<https://www.collegesidekick.com/study-guides/geophysics/formation-of-the-universe>

DOPPLER EFFECT



When a star is stationary relative to an observer, the light produced looks the same no matter what direction it is seen from. Our sun is a good example of a star that is not moving much nearer or farther from the Earth.

If stars move either towards or away from our vantage point, however, the motion shifts the way their light looks to us.

RED SHIFT

When a star moves away from us, it runs away from the light it emits in our direction. This makes the light waves we see expand.

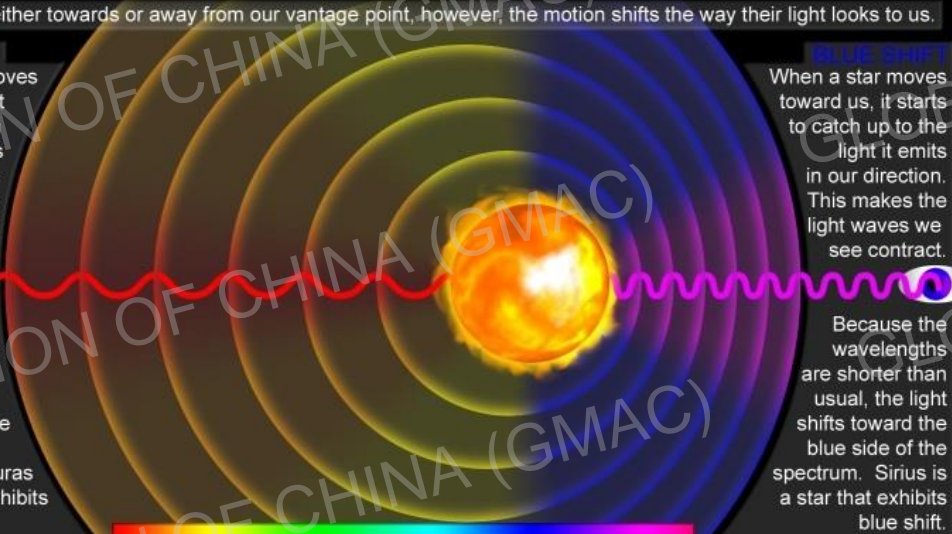
Because the wavelengths are longer than usual, the light shifts toward the red side of the spectrum. Arcturus is a star that exhibits red shift.



BLUE SHIFT

When a star moves toward us, it starts to catch up to the light it emits in our direction. This makes the light waves we see contract.

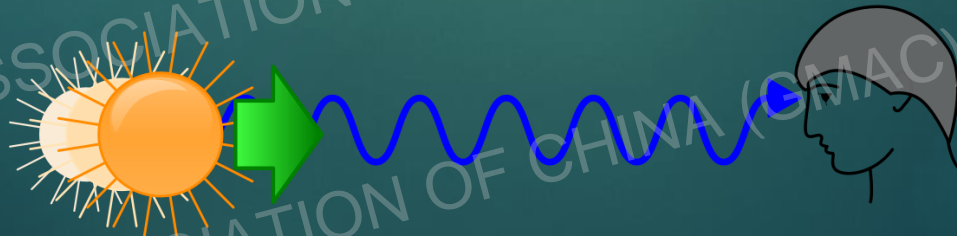
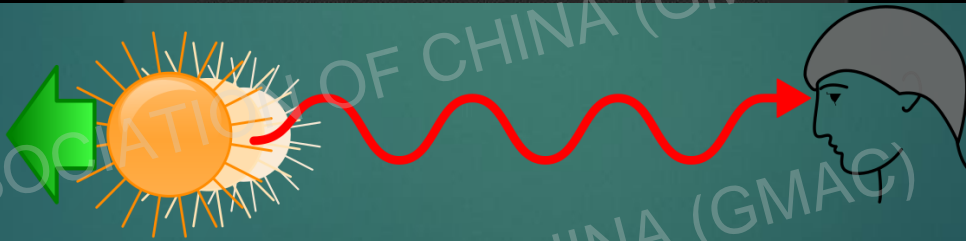
Because the wavelengths are shorter than usual, the light shifts toward the blue side of the spectrum. Sirius is a star that exhibits blue shift.



RED SHIFT BLUE SHIFT

Most shifts can not be seen with the naked eye, but astronomers can measure them to learn whether other stars are advancing or receding.

<https://socratic.org/question/s/how-does-the-expansion-of-the-universe-affect-light>



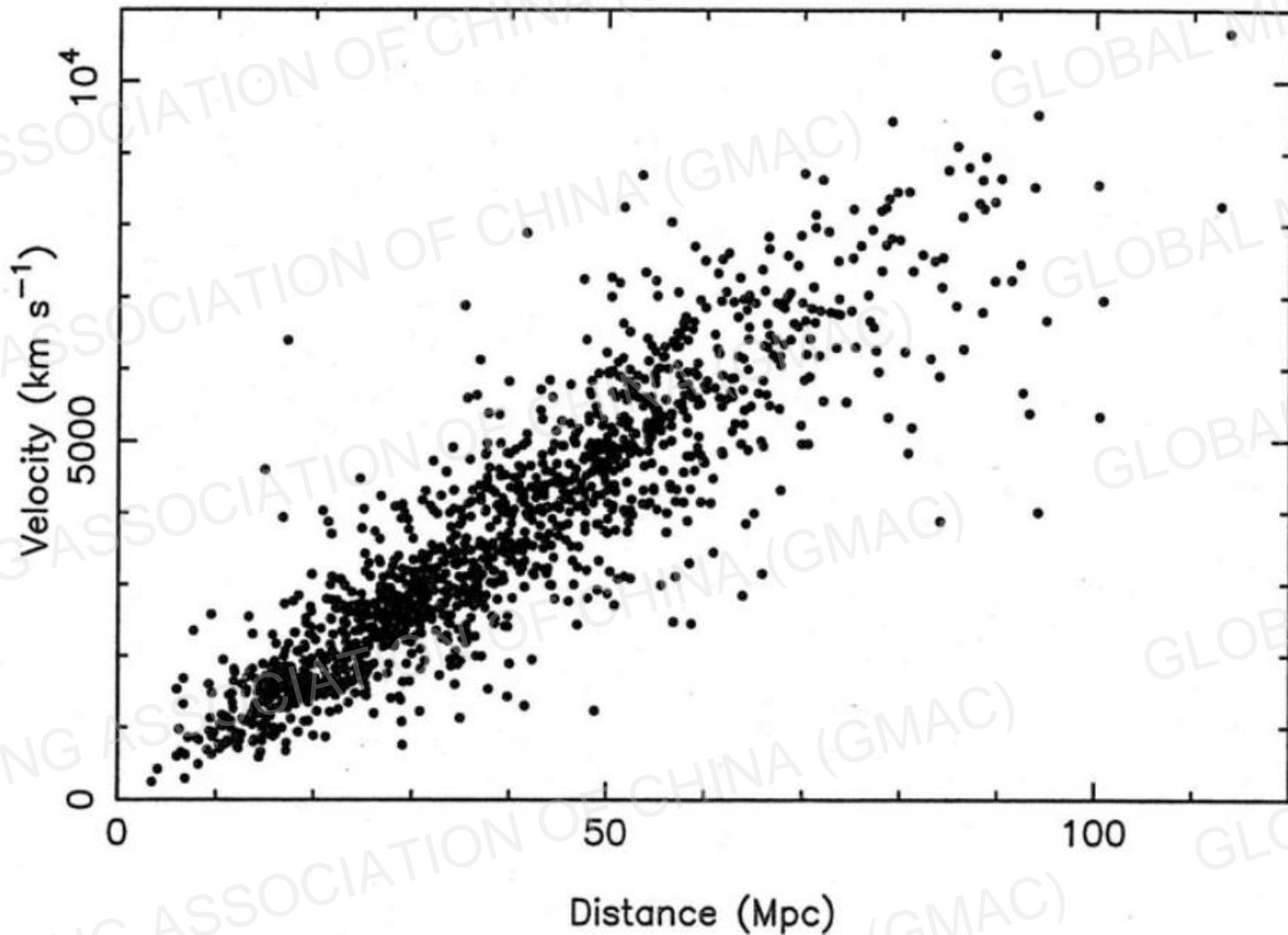
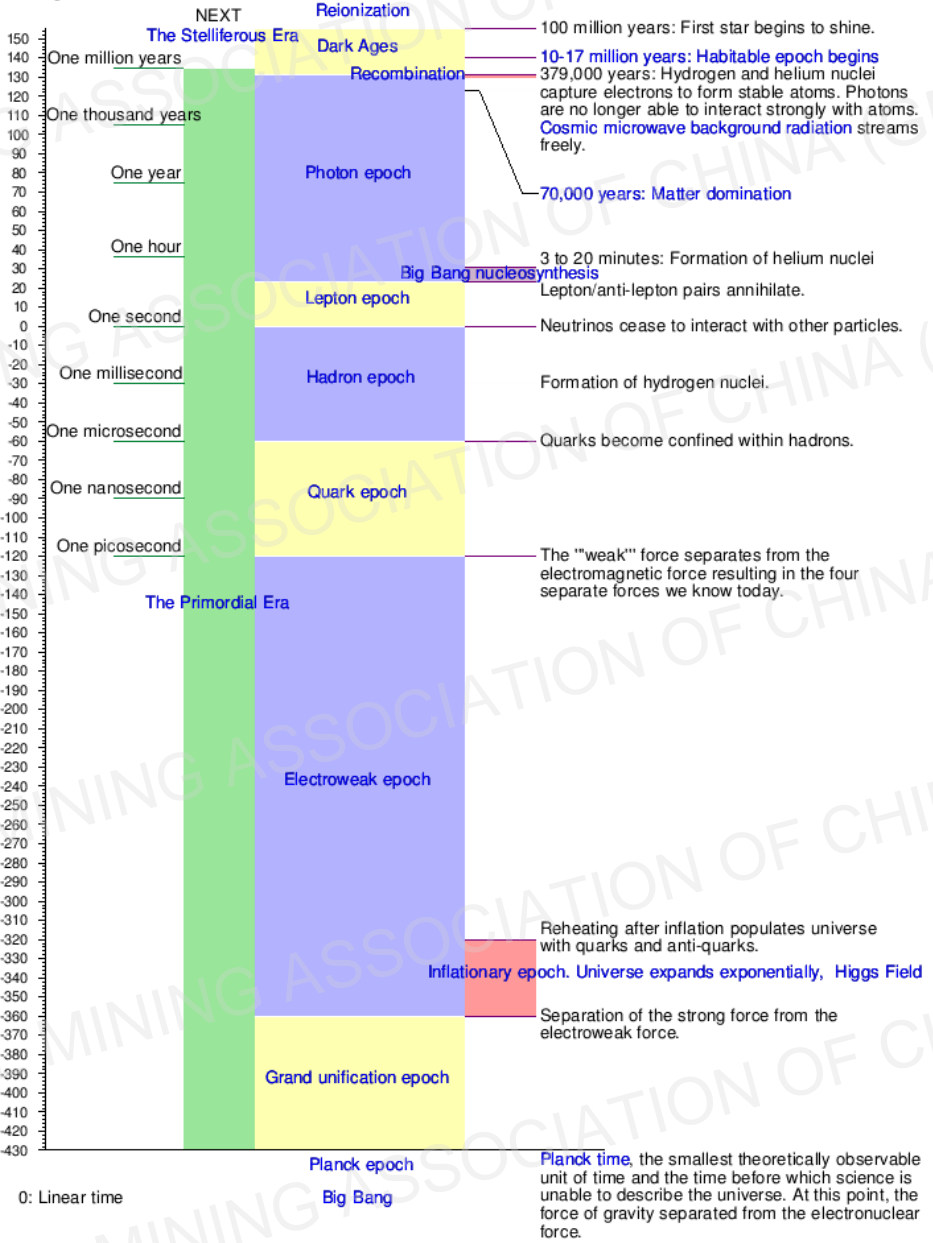


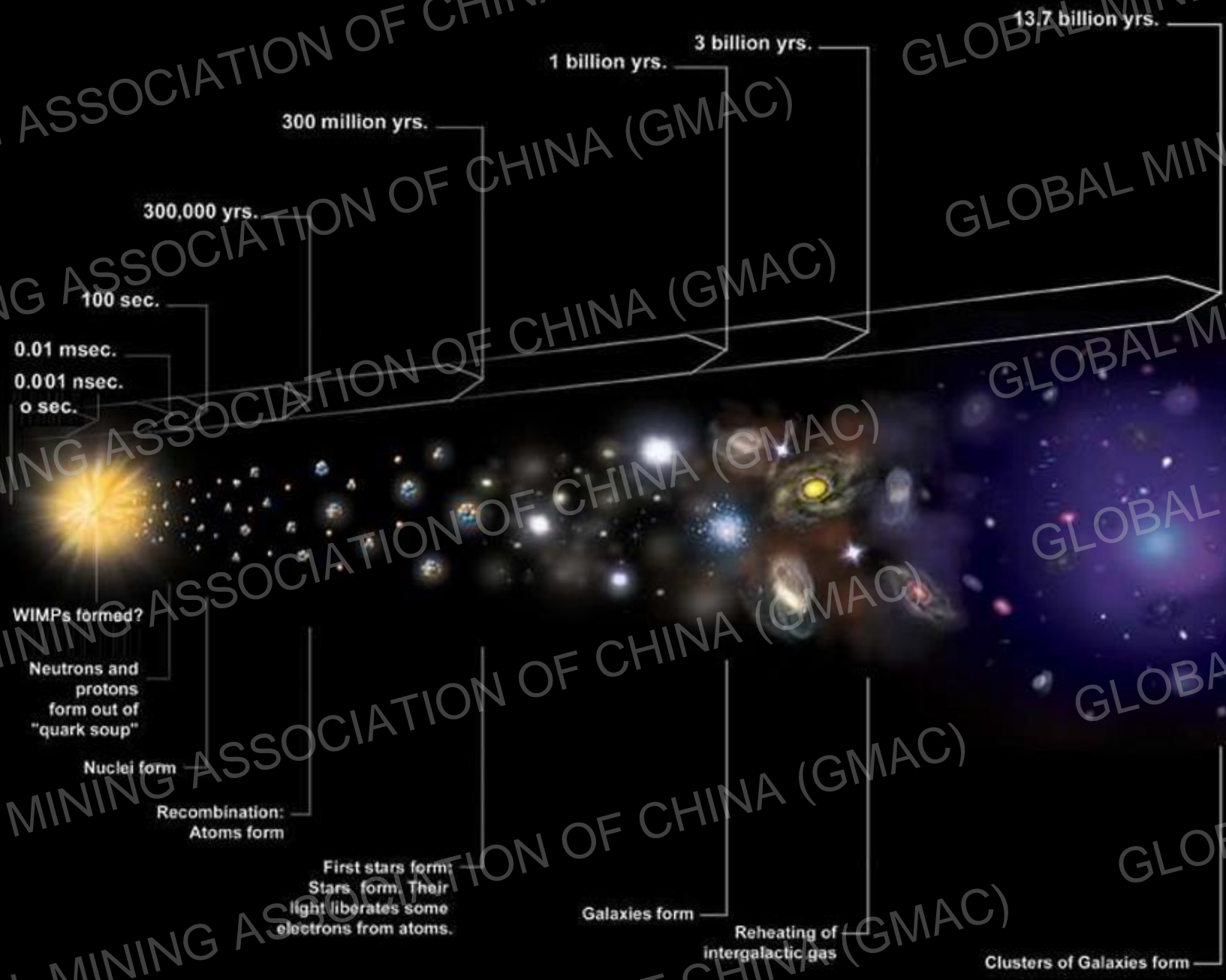
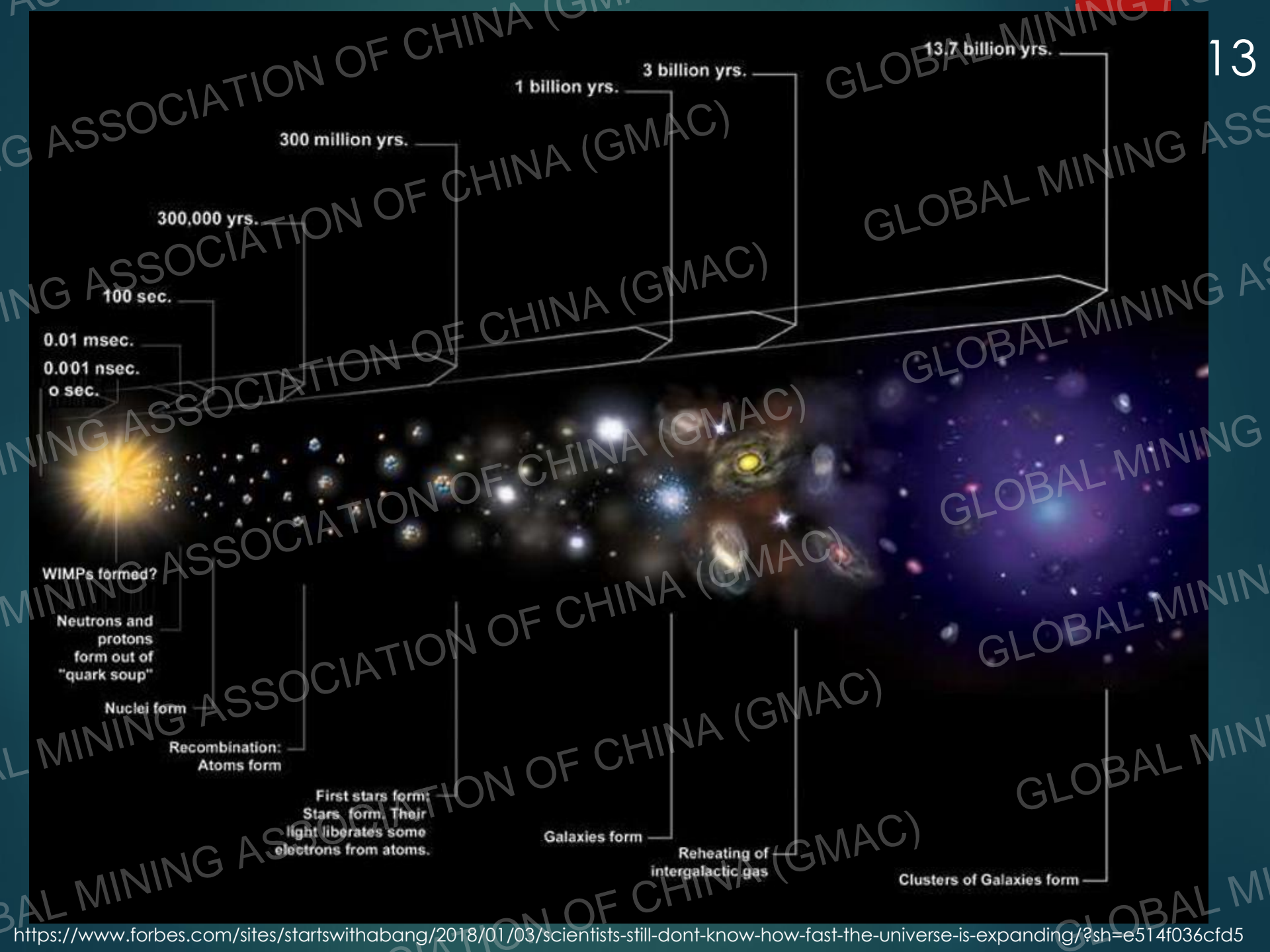
Figure 2.5 A plot of velocity versus estimated distance for a set of 1355 galaxies. A straight-line relation implies Hubble's law. The considerable scatter is due to observational uncertainties and random galaxy motions, but the best-fit line accurately gives Hubble's law. [The x -axis scale assumes a particular value of H_0 .]

Logarithmic time:
10 - log10 second



History of the Universe

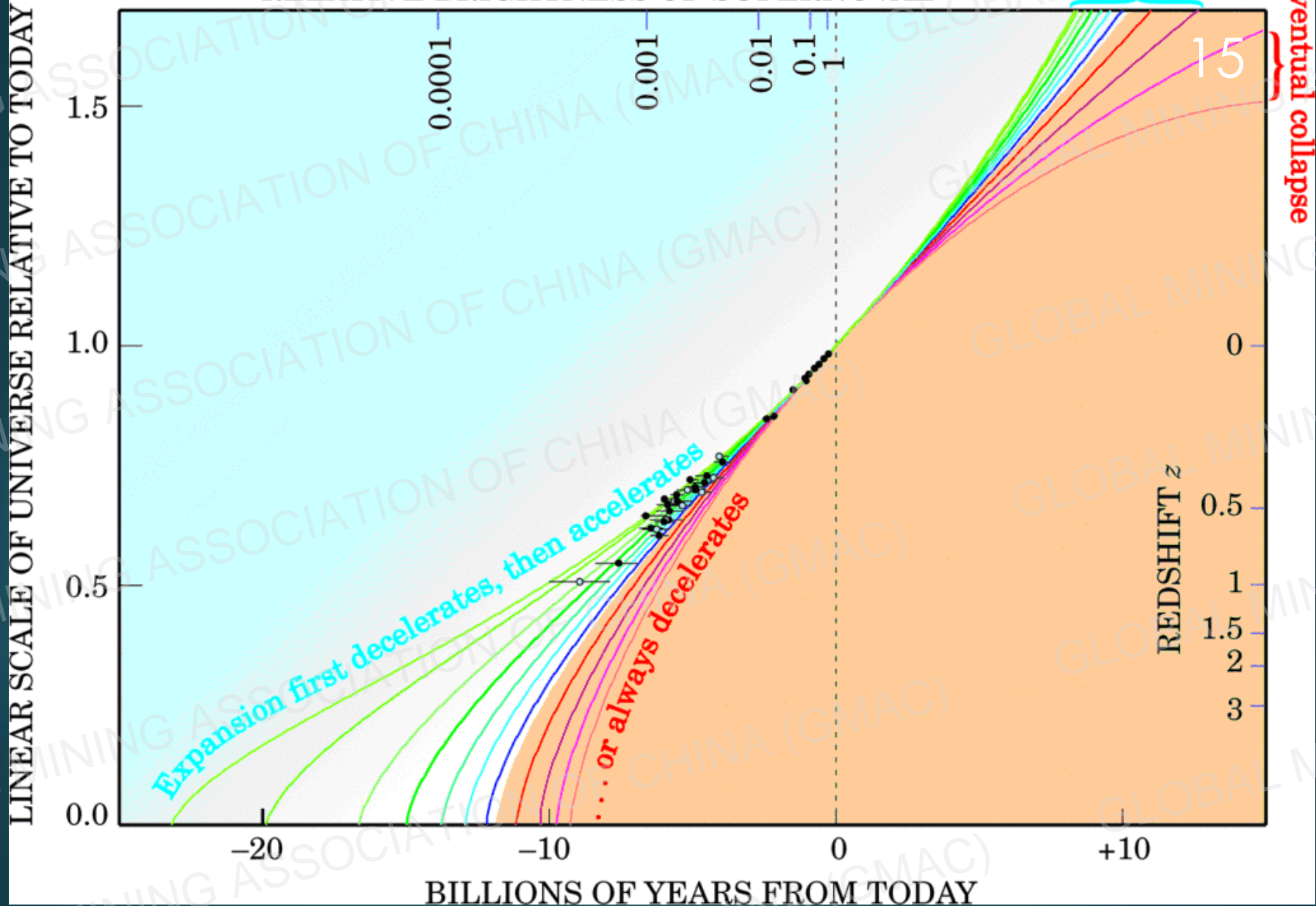






<https://www.rankred.com/dark-matter-may-have-existed-before-big-bang/>

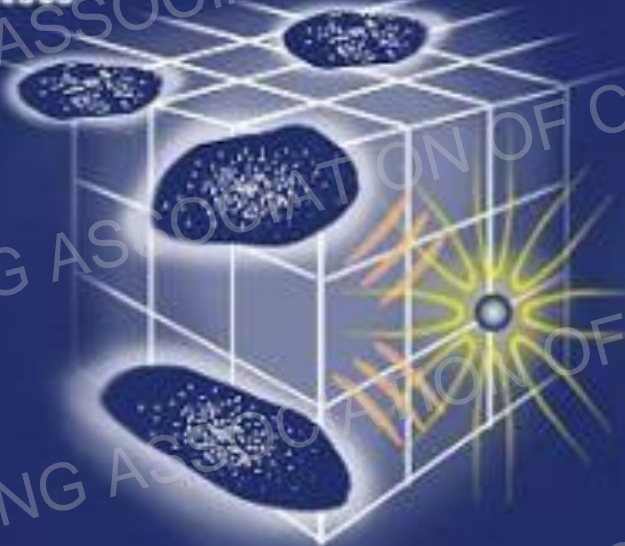
RELATIVE BRIGHTNESS OF SUPERNOVAE



<https://little-bang.info/predictions-of-future-data/>

Multiverse: The evidence

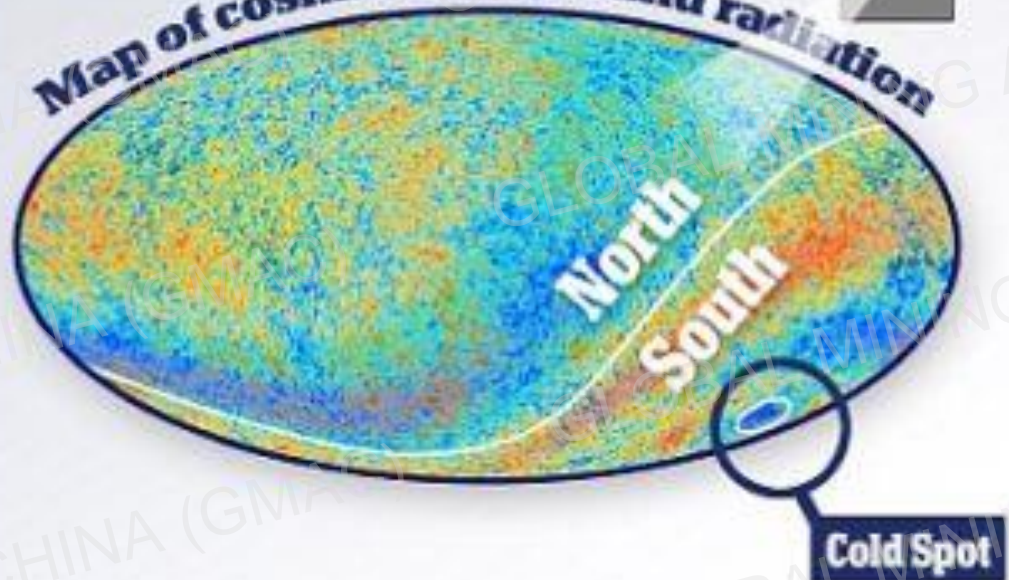
Anomalies in cosmic background radiation could be the first hard evidence for other universes



1 Other universes exerted a 'pull' on our universe as it formed - leaving an imprint in the cosmic background radiation

© daily mail / european space agency

Map of cosmic background radiation



2 Cosmic microwave radiation should be evenly spread out but it is stronger in southern half of the sky

3 A large 'cold spot' is also inexplicable under conventional physics

<https://www.dailymail.co.uk/sciencetech/article-2326869/Is-universe-merely-billions-Evidence-existence-multiverse-revealed-time-cosmic-map.html>

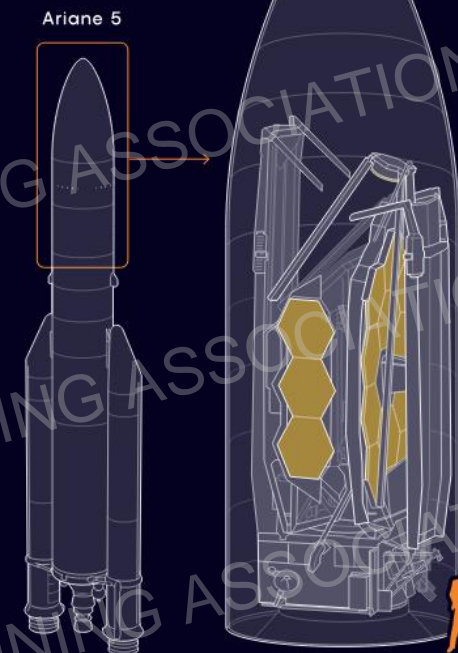
The James Webb Space Telescope

To collect enough infrared light to see the faintest structures in the cosmos, the JWST must be so big that it has to fold. It also needs to block heat coming from the Earth, moon and sun.

Mirrors - The mirrors are made of lightweight beryllium coated with gold, which is highly reflective of infrared light.



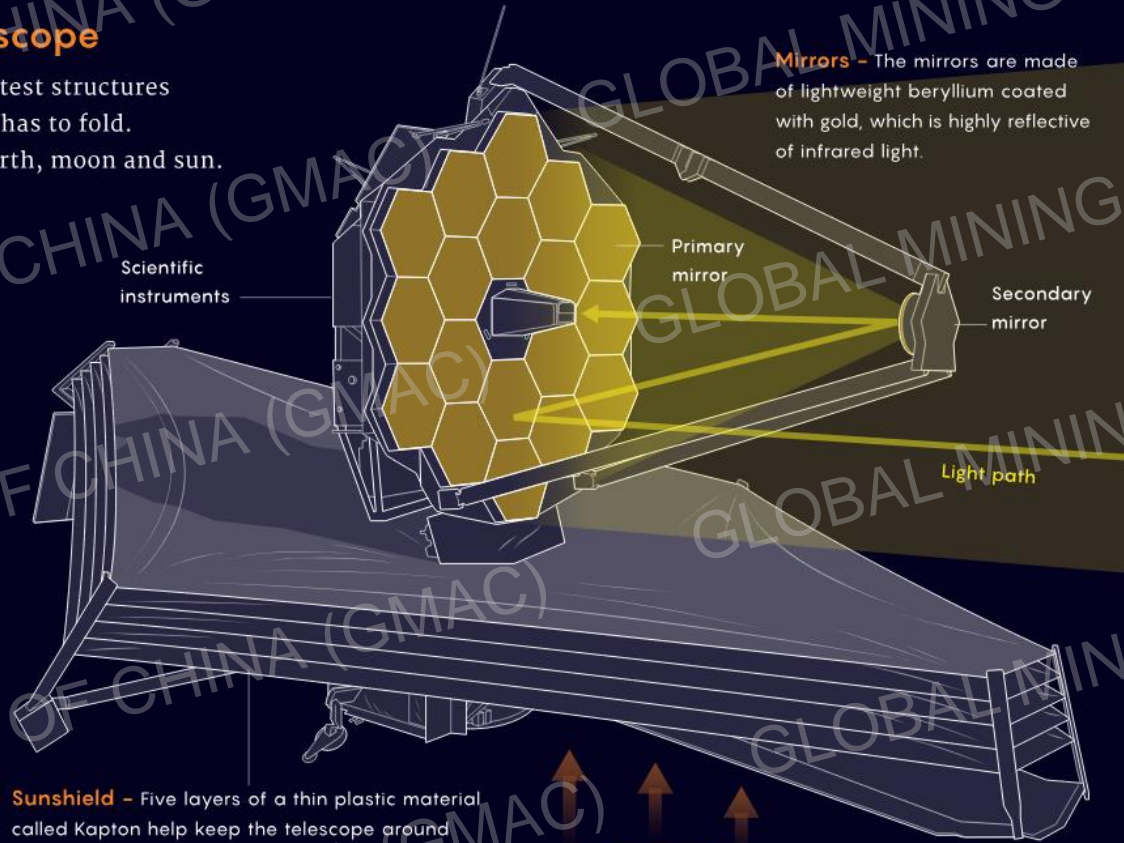
Launch site:
Kourou,
French
Guiana



Ariane 5

ASTRO ORIGAMI

The telescope's 6.5-meter-wide segmented mirror and 20-meter-wide sunshield fold to fit in the 5.4-meter-wide fairing of the European Space Agency's Ariane 5 rocket.



Scientific instruments

Primary mirror

Secondary mirror

Light path

Sunshield - Five layers of a thin plastic material called Kapton help keep the telescope around 50 degrees above absolute zero.

Solar heat



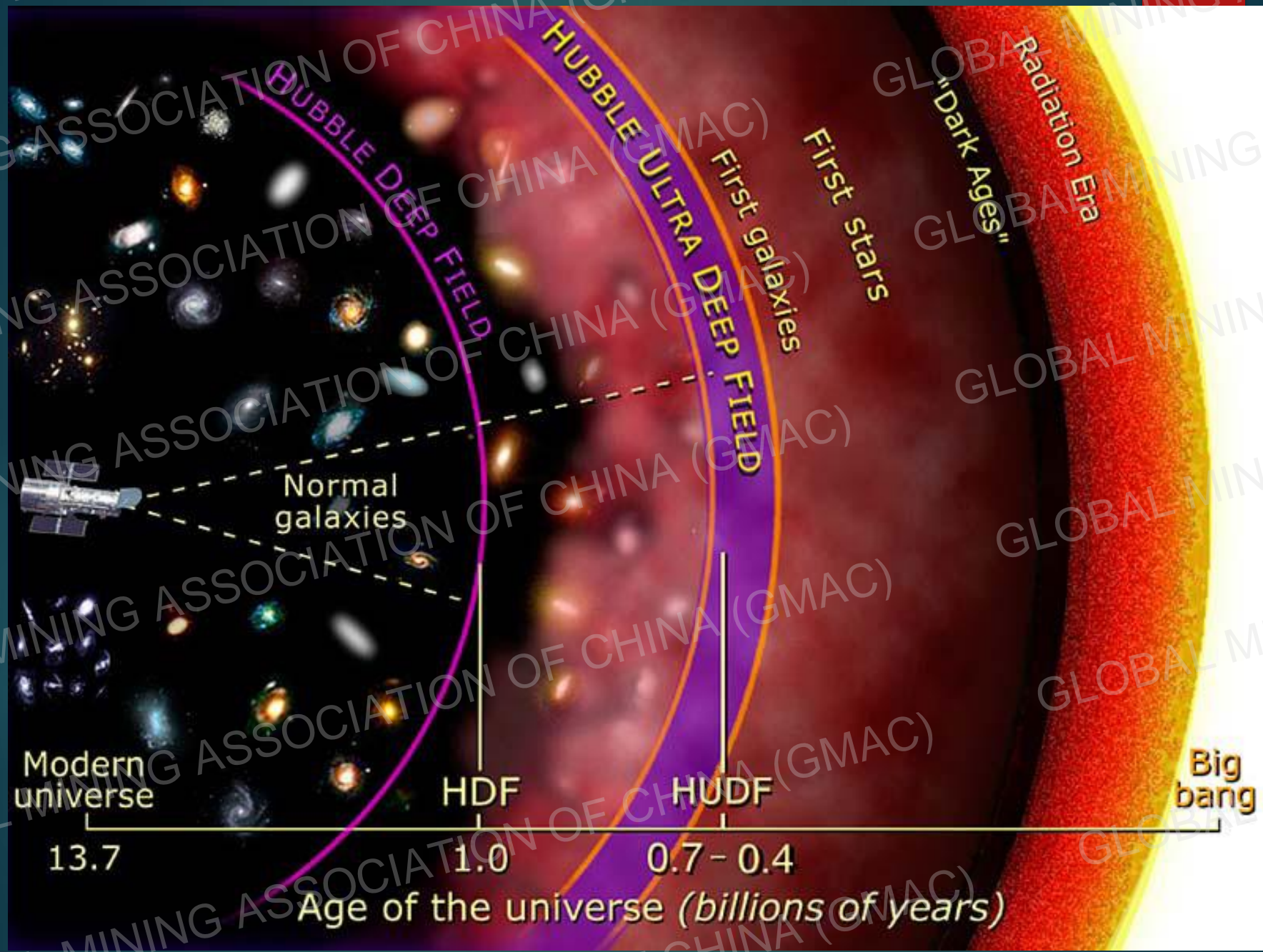
Webb's orbit around L2

DEEP DESTINATION

The Webb will orbit around a gravitationally stable point in space almost 1 million miles from Earth called Lagrange point 2.

ONBOARD INSTRUMENTS

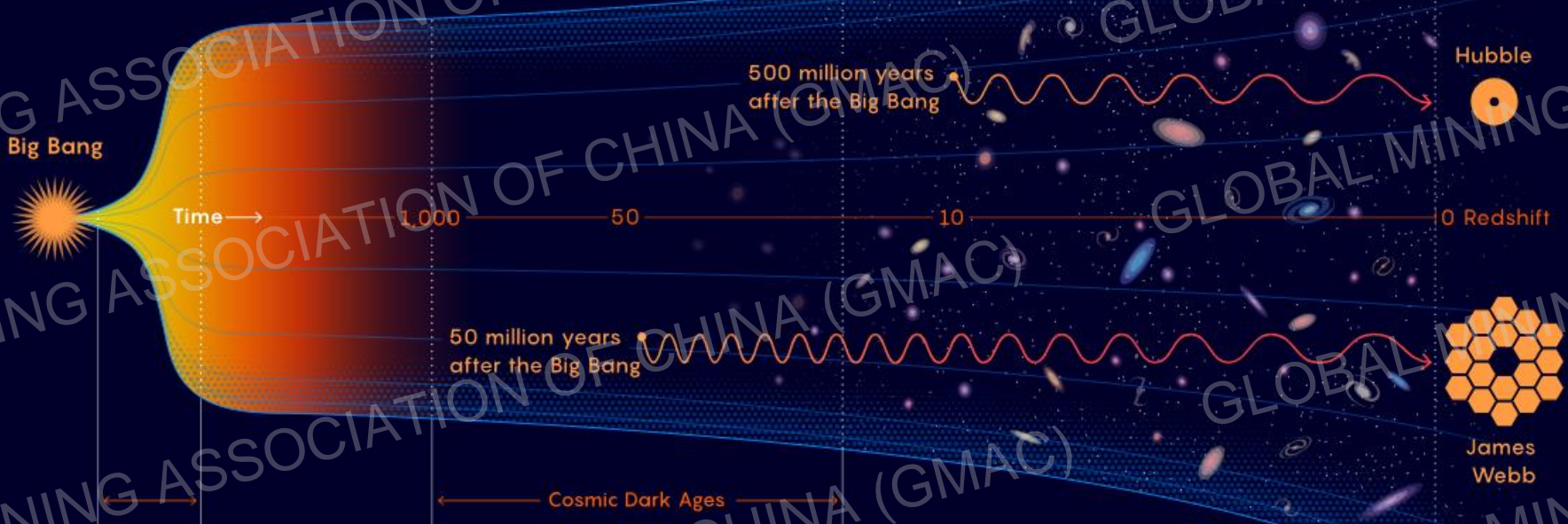
- **Near-Infrared Camera**
Workhorse instrument; most sensitive.
- **Near-Infrared Spectrograph**
Breaks starlight into its spectrum.
- **Mid-Infrared Instrument**
Will collect light from the very first stars.
- **Near-Infrared Imager and Slitless Spectrograph**
Extremely high-resolution planet finder.



<http://news.bbc.co.uk/2/hi/science/nature/3773117.stm>

The Growth of Cosmic Structure

Over billions of years, the universe went from smooth to structured. Powerful space telescopes have gradually uncovered much of the story of how this happened. The James Webb Space Telescope aims to reveal the crucial period when stars and galaxies first formed.



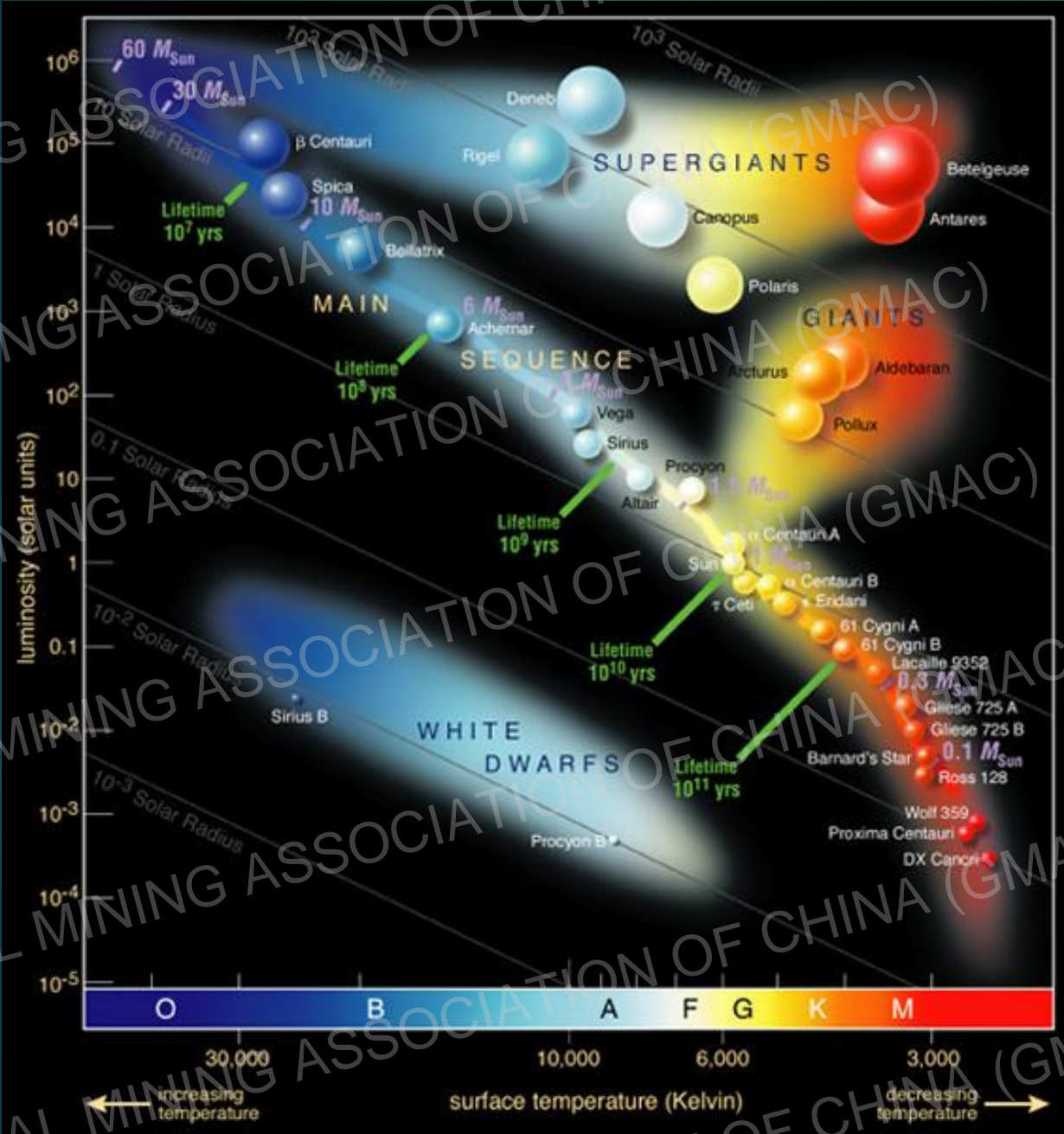
10⁻³⁶ to 10⁻³³ seconds
Inflation
During this period of exponential expansion, quantum fluctuations created density variations.

380,000 years
Cosmic Dark Ages Begin
After the first atoms formed, the universe was dark and structureless for eons.

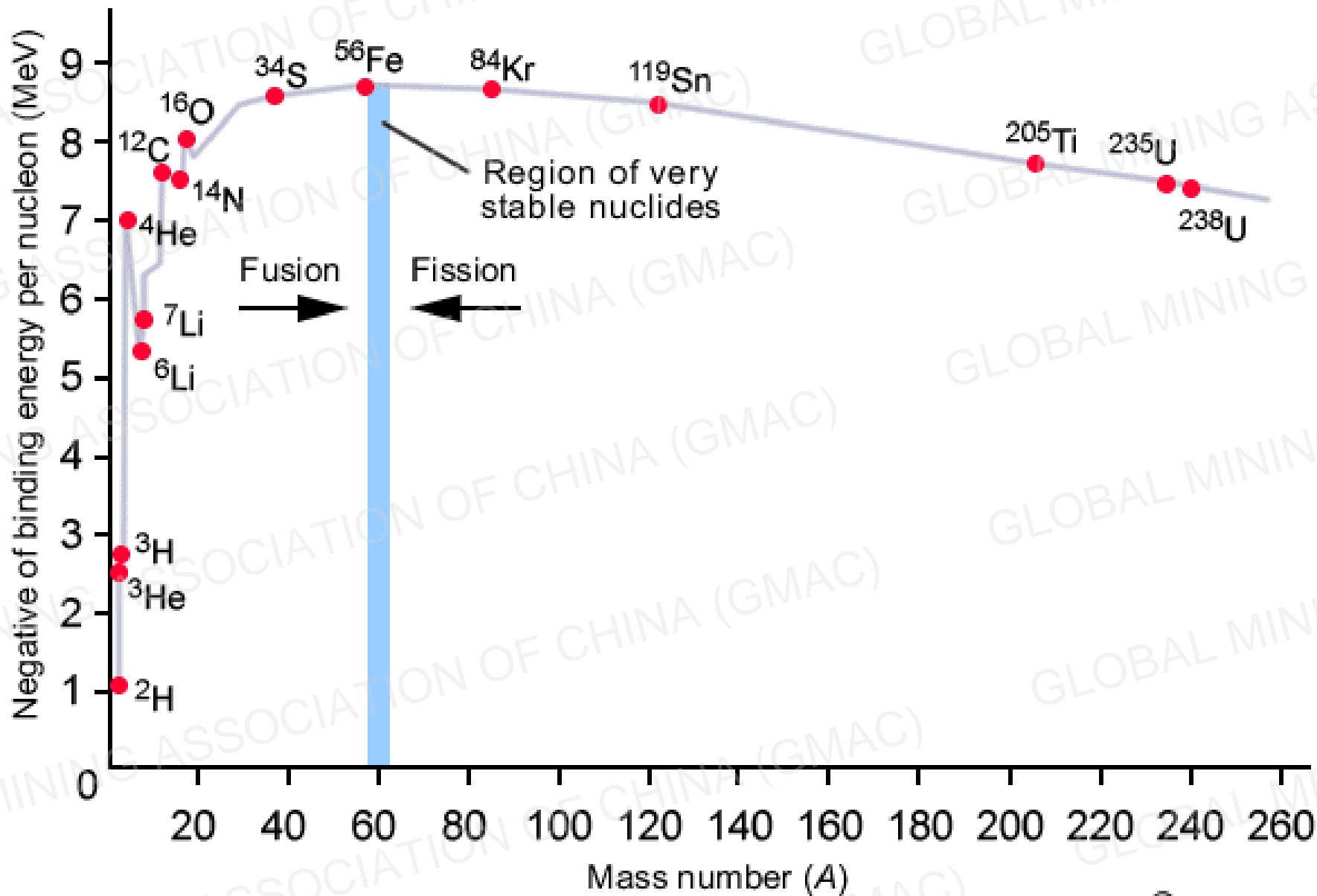
100 million years?
Galaxies Form
At some point, dark matter corralled atoms into forming stars and proto-galaxies.

13.8 billion years
Today
Galaxies have become dimmer and more structured, appearing as spirals and ellipses.

<https://www.quantamagazine.org/why-nasas-james-webb-space-telescope-matters-so-much-20211203/>



https://www.researchgate.net/figure/1-An-HR-diagram-showing-many-well-known-stars-in-the-Milky-Way-galaxy_fig1_326412740



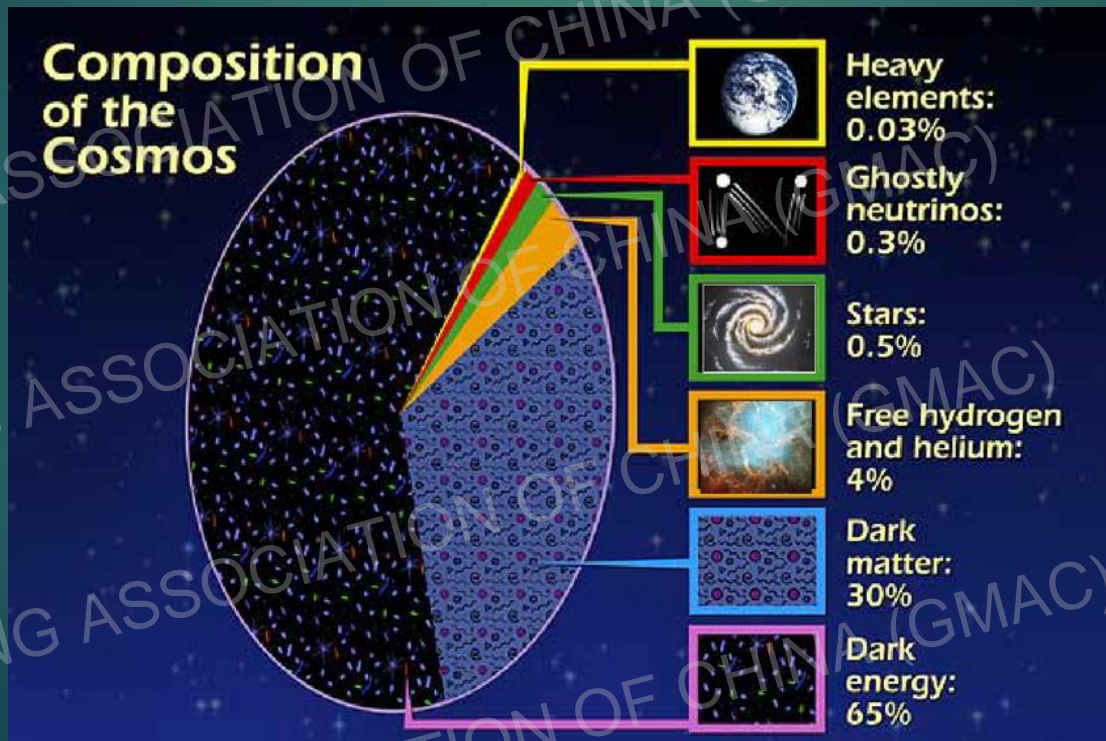
©NCSSM 2002

https://www.researchgate.net/figure/Averaged-binding-energy-as-a-function-of-the-mass-number-34_fig2_355195129

宇宙的組成分



Composition of the Cosmos



https://www.researchgate.net/figure/Our-Changing-View-of-the-Universe-courtesy-of-Jonathan-M-Dorfan-Conceptions-of-the_fig1_2372344

36

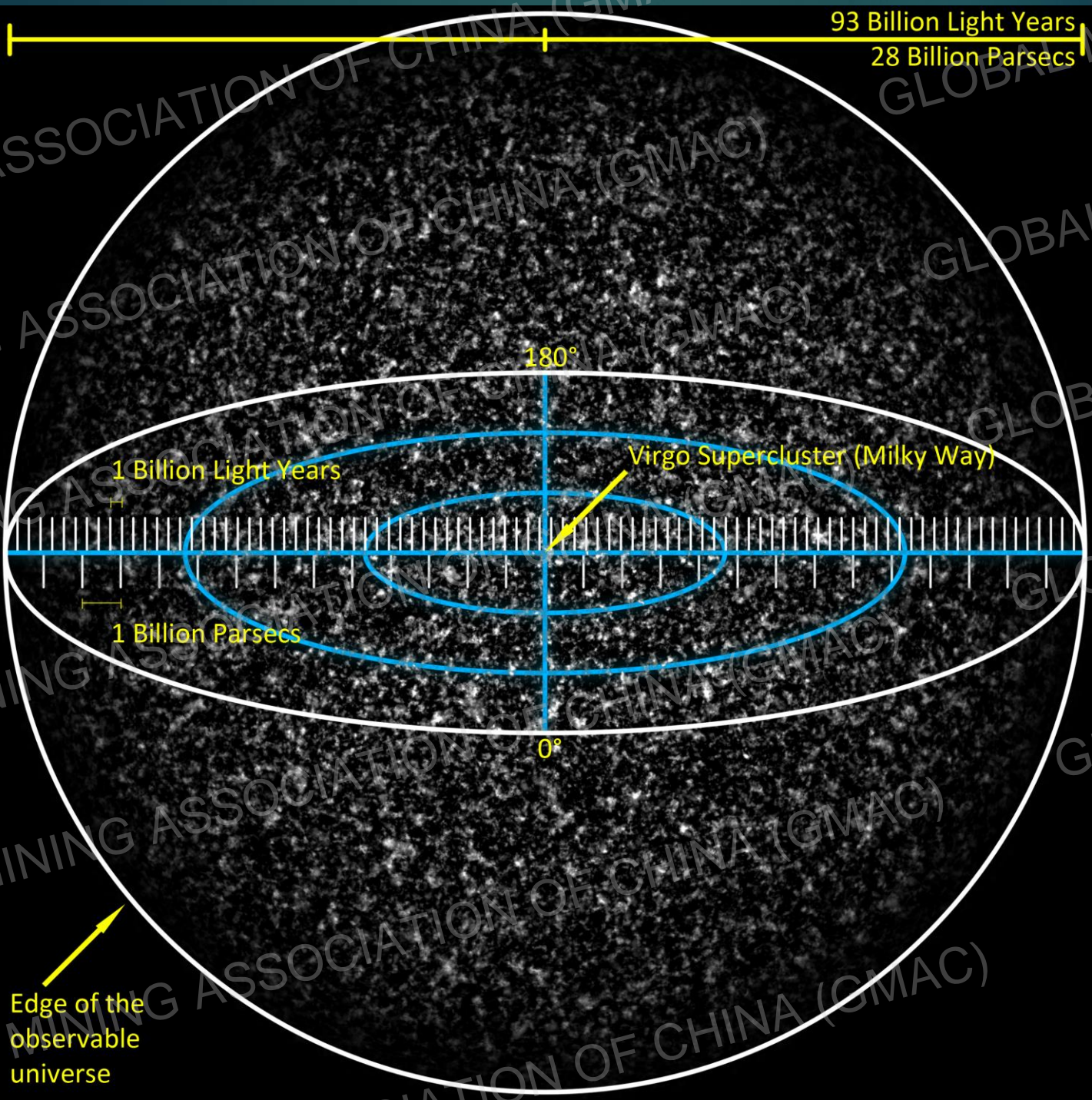
Dimensions and Locations

光速：299792458米/秒



<https://www.slideshare.net/reginakornell/ch-121-31929548>

93 Billion Light Years
28 Billion Parsecs



<https://www.mapsland.com/space/large-detailed-map-of-the-universe>

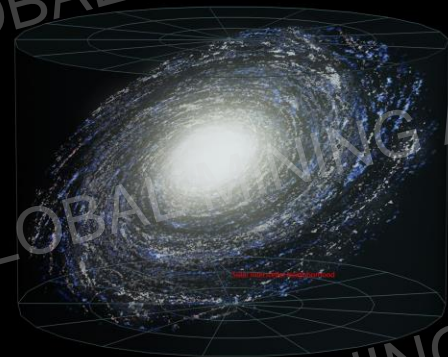
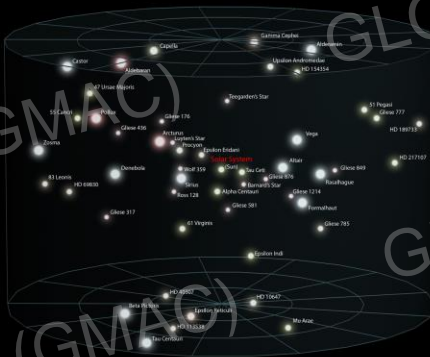
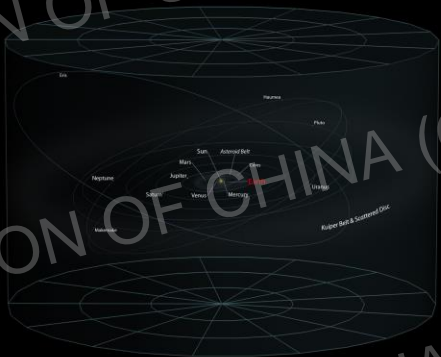
Edge of the observable universe

EARTH

SOLAR SYSTEM

INTERSTELLAR NEIGHBORHOOD

MILKY WAY GALAXY

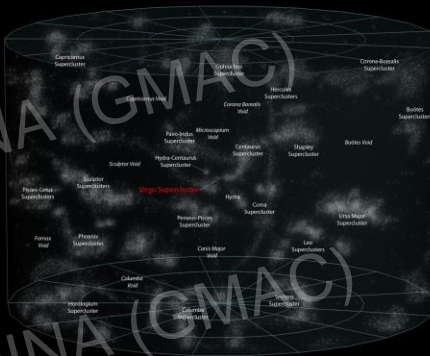
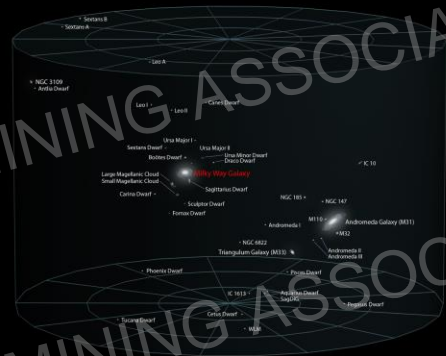


LOCAL GALACTIC GROUP

VIRGO SUPERCLUSTER

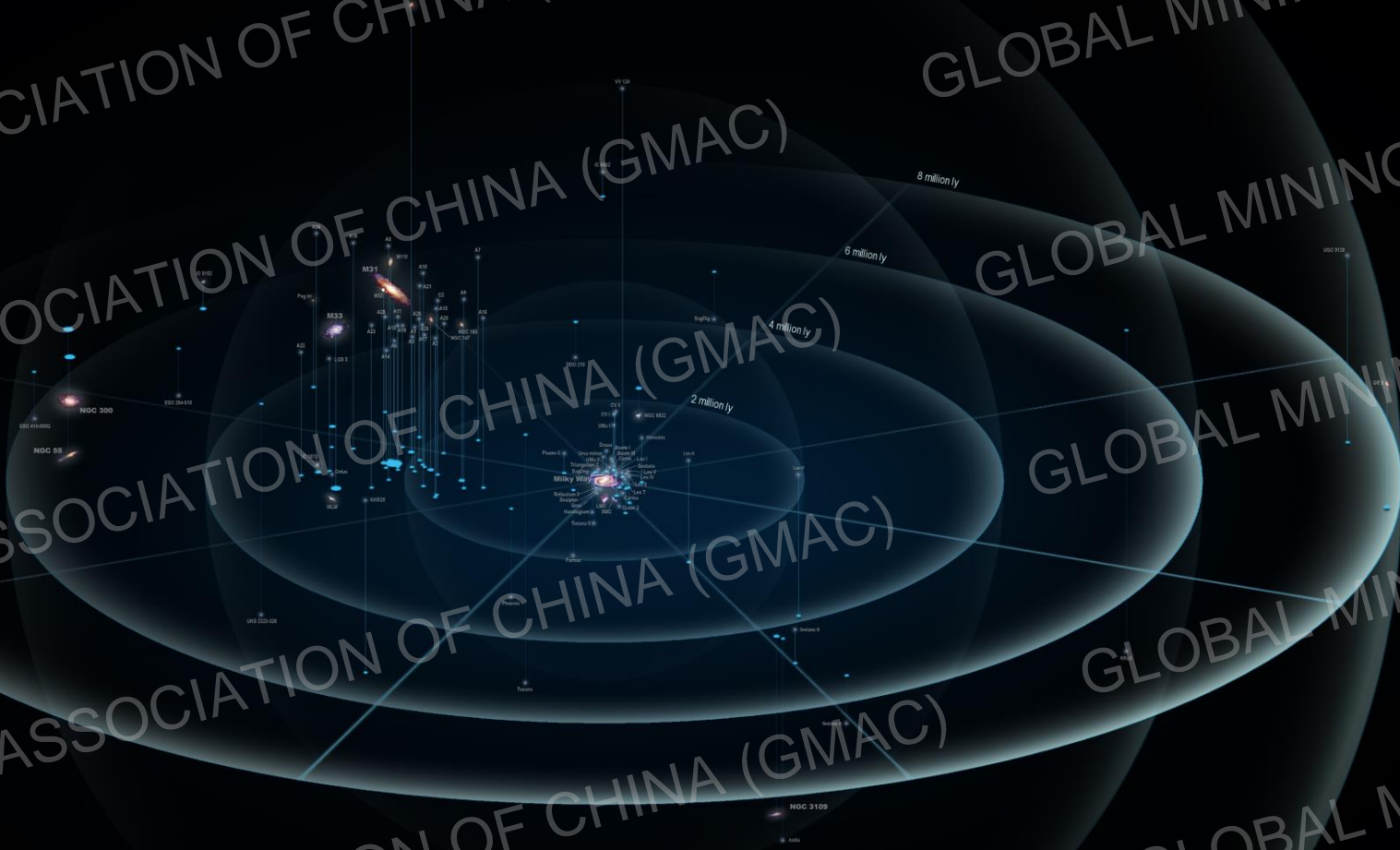
LOCAL SUPERCLUSTERS

OBSERVABLE UNIVERSE



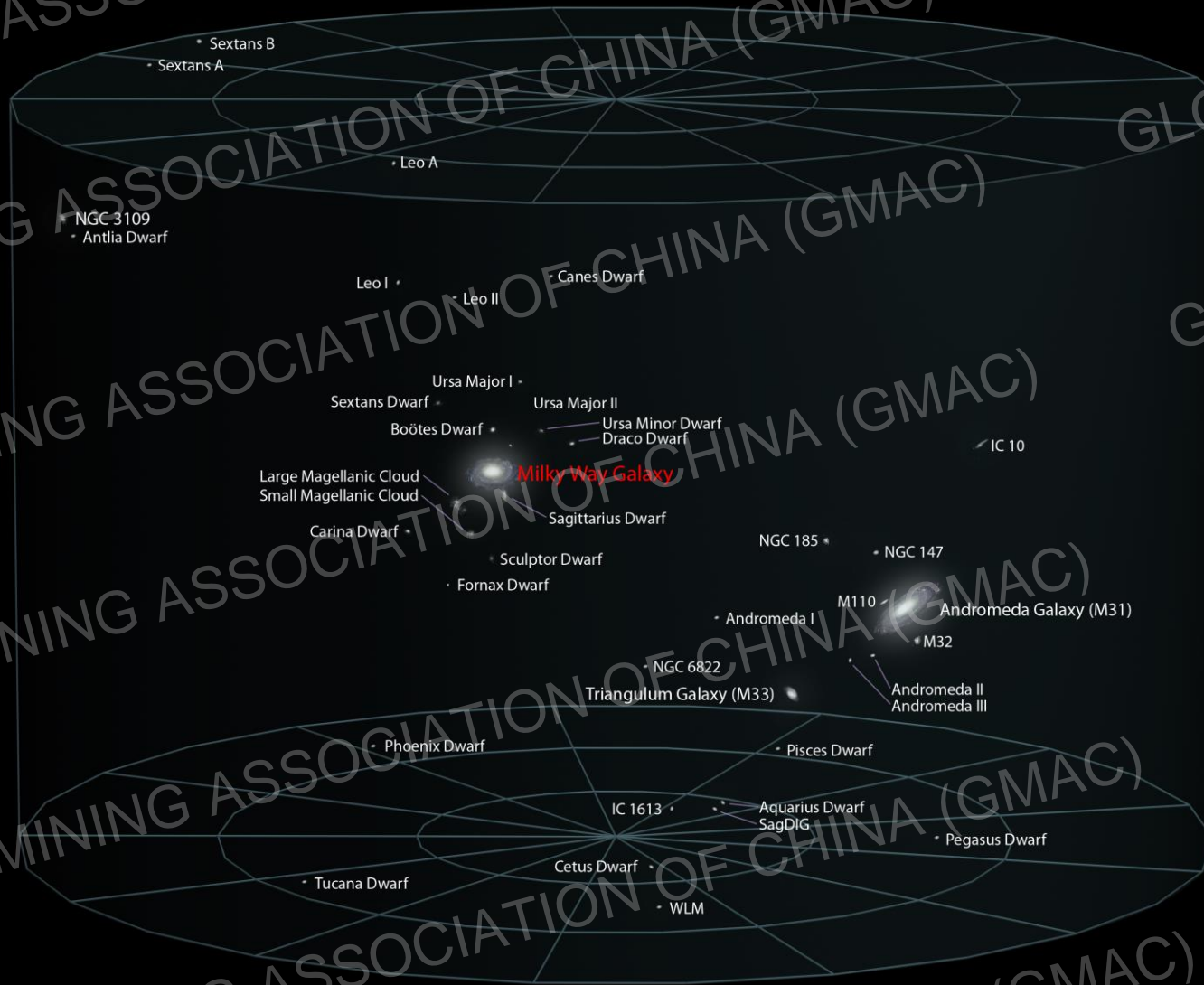
<https://www.quora.com/Is-the-solar-system-bigger-than-some-galaxies>

Local Group and nearest galaxies



LOCAL GALACTIC GROUP

30



<https://www.quora.com/How-big-is-our-observable-universe-in-comparison-to-the-estimated-size-of-our-galactic-cluster-and-supercluster>

Milky Way Galaxy

About 13.2 billion years old.
200–400 billion Stars, with at least 100 billion Planets, 500 million of which may support Life

125,000 Light Years
in Diameter.

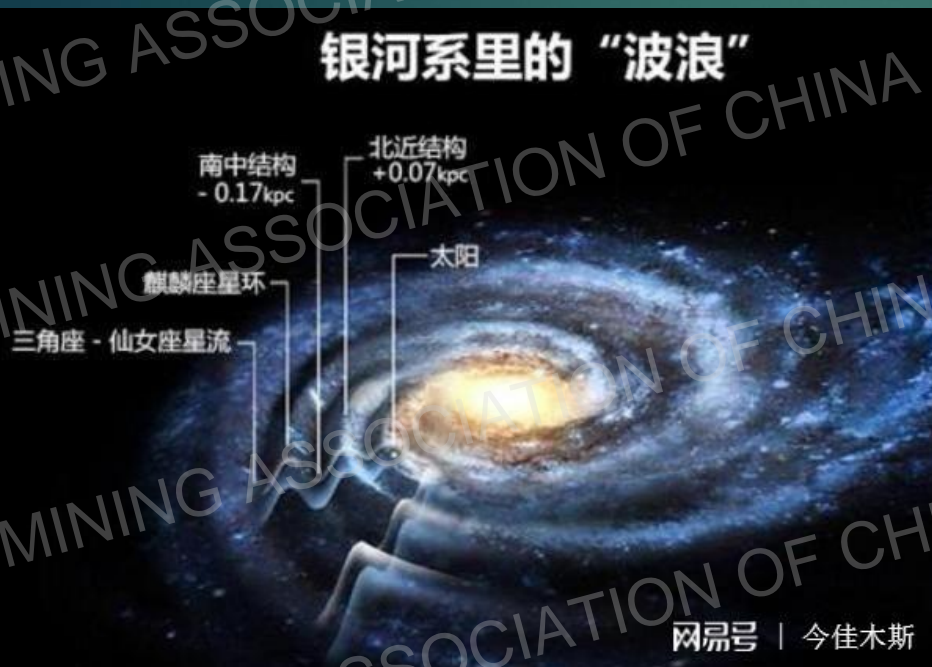
The Milky Way is moving at a rate of 552 to 630 km per second, being pushed away from the Local Void at 600,000 mph. Our Solar System travels at 447,000 MPH and takes 250 Million years to complete one Galactic Rotation.

You Are Here

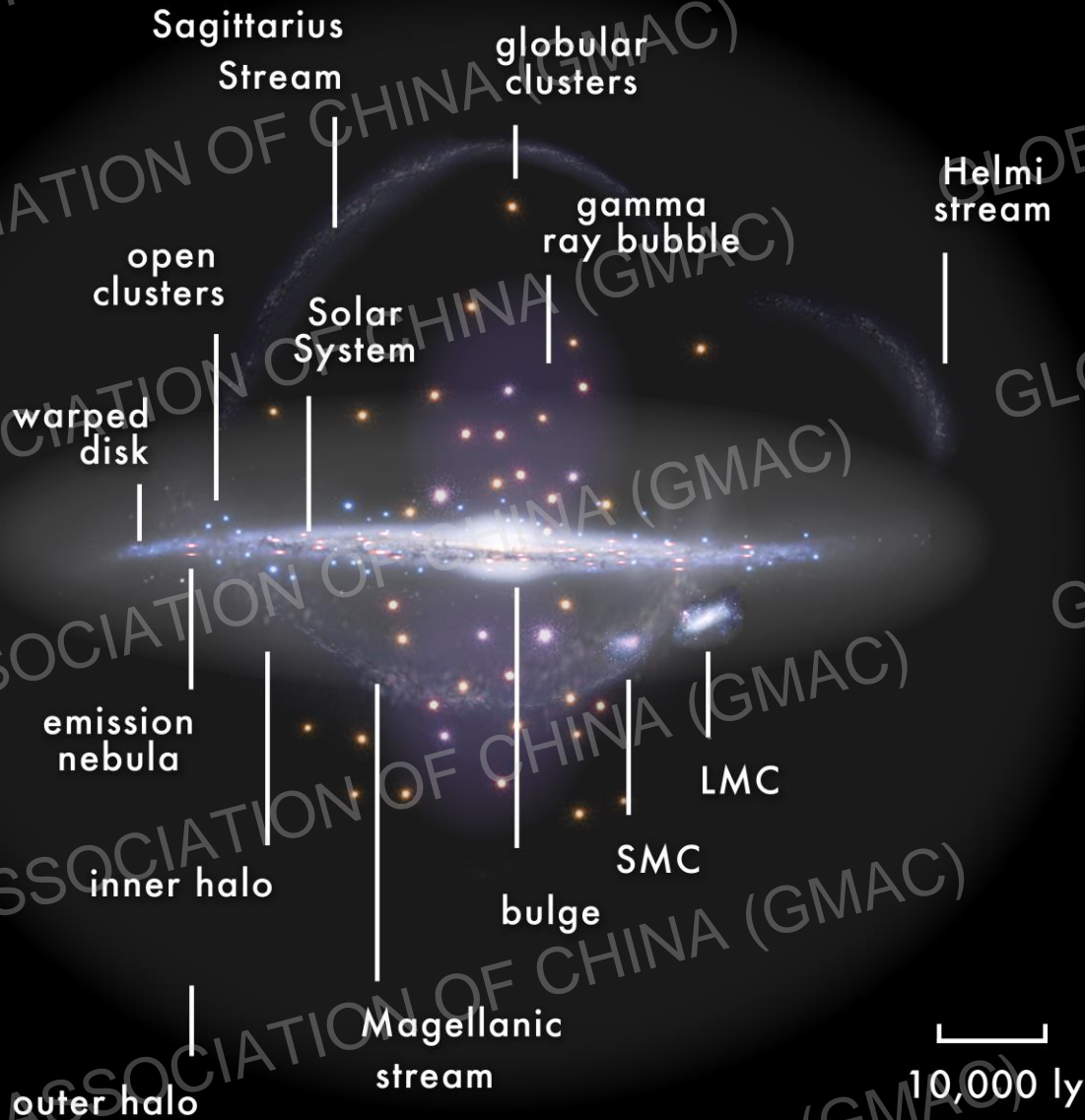
26,000 light years away from the Black Hole at the center of the Milkyway

<https://www.quora.com/Why-do-stars-group-into-galaxies>

银河系里的“波浪”



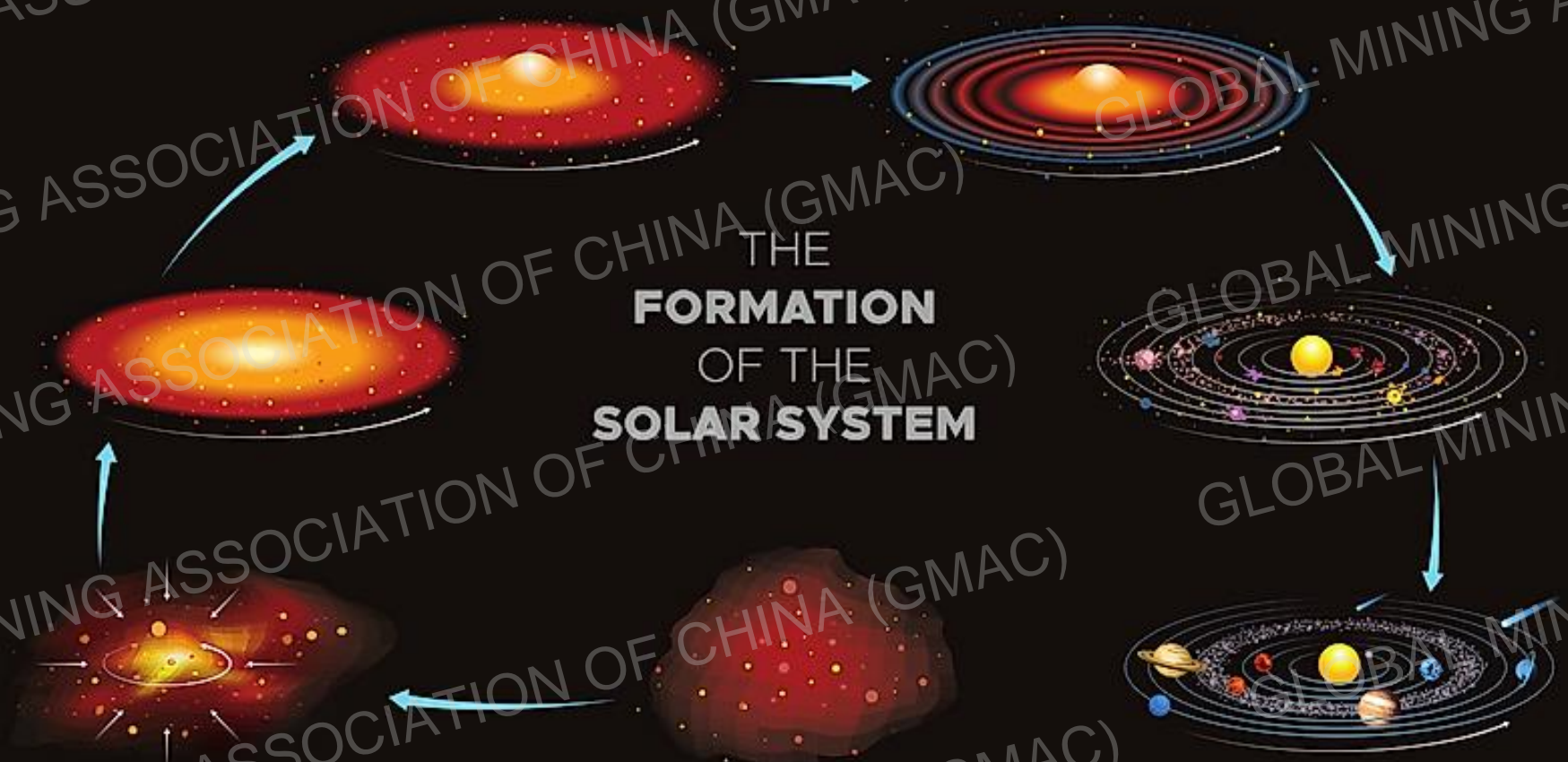
<https://www.mattspective.com/SolarSite/page2.html>



https://en.wikipedia.org/wiki/File:Milk_y_Way_side_view.png

Formation of the Solar System, our Earth and the Moon

THE
FORMATION
OF THE
SOLAR SYSTEM

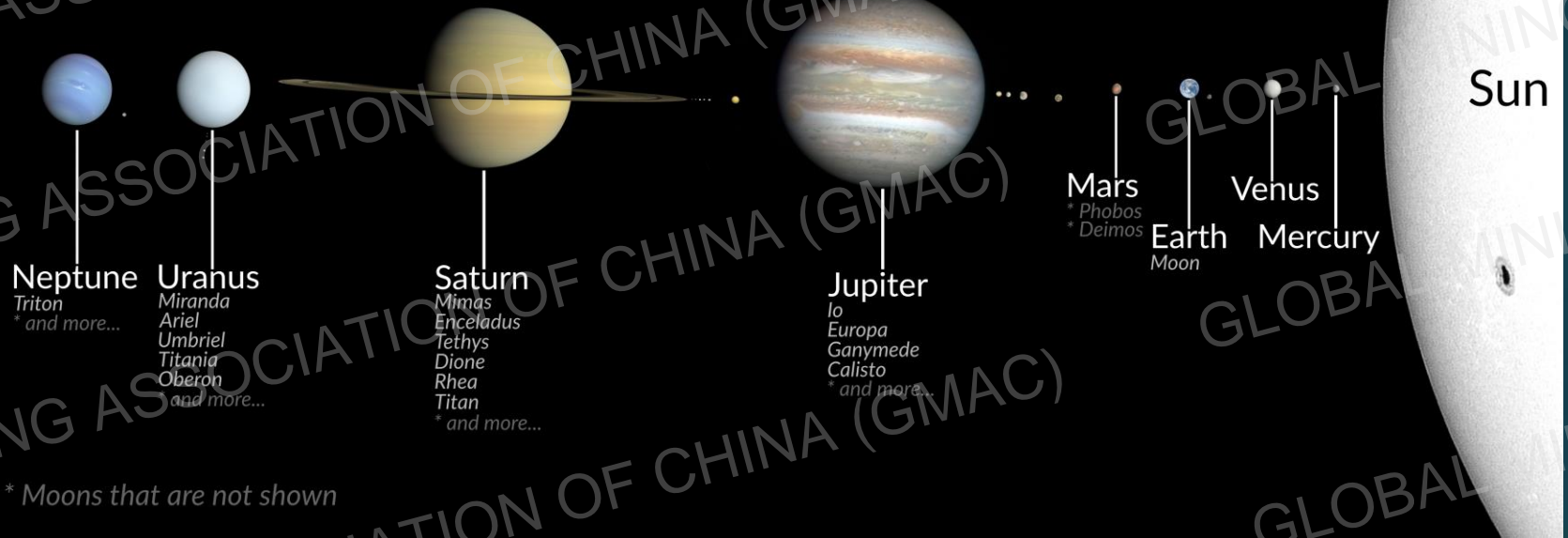


<https://www.worldatlas.com/space/the-origin-of-planet-earth.html>

Solar System in true imagery, color and size

37

- Sedna
- Gonggong Xiangliu
- Eris Dysnomia
- Orcus Vanth
- Quaoar Weywot
- Makemake S/2015 (136472) 1
- Haumea Namaka, Hi'iaka
- Pluto Charon, * Styx, * Nix, * Kerberos, * Hydra



Neptune

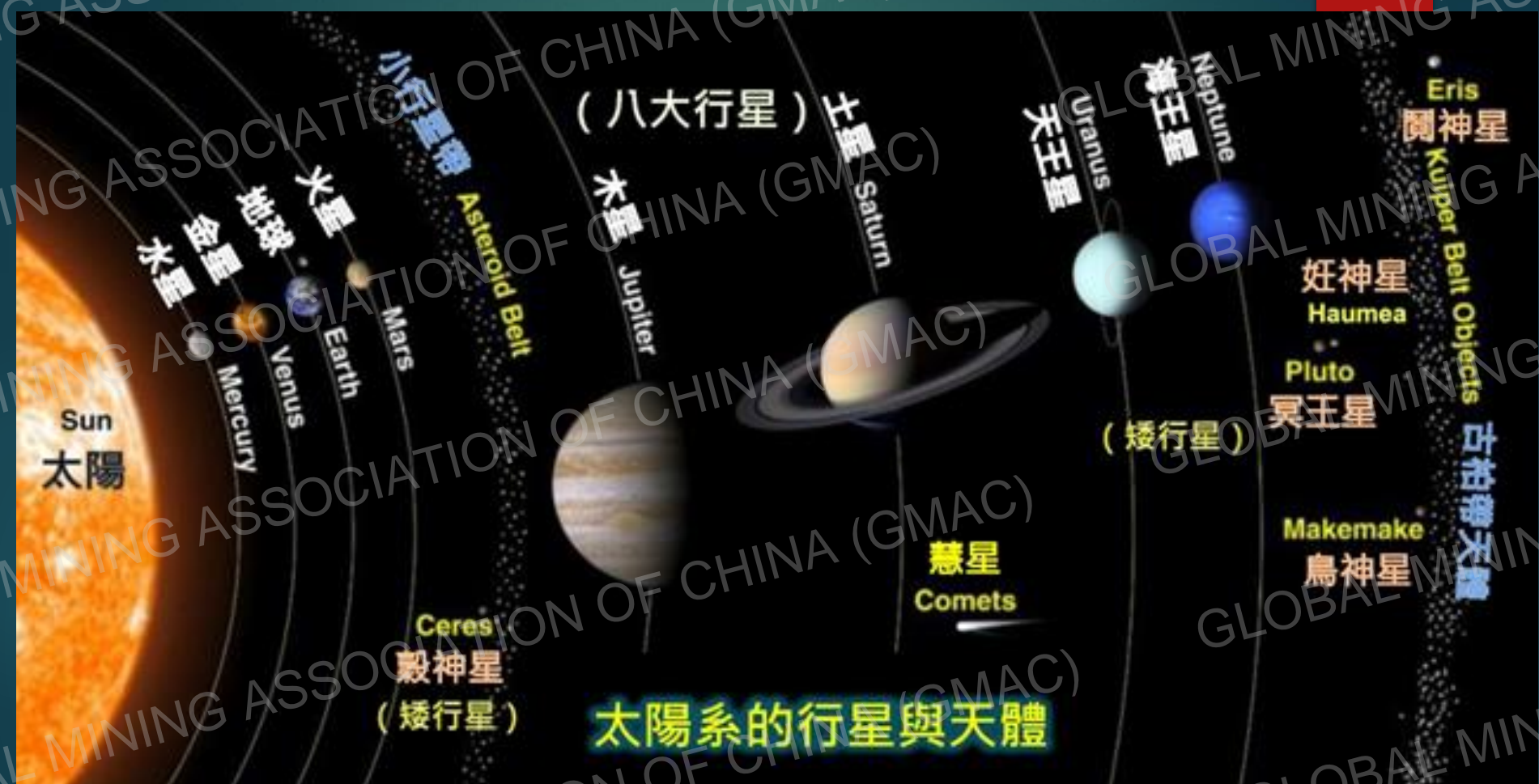
Uranus

Saturn

Jupiter

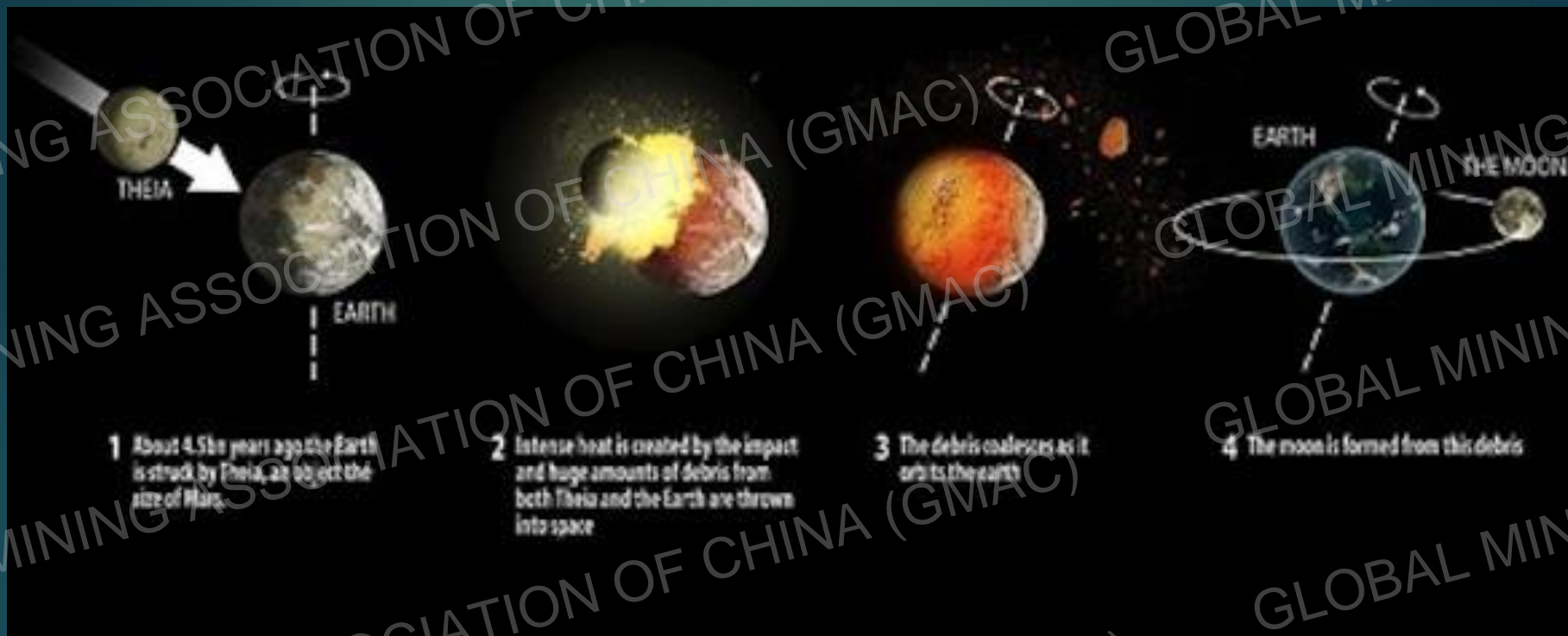
Inner planets
Sun

https://en.wikipedia.org/wiki/Solar_System



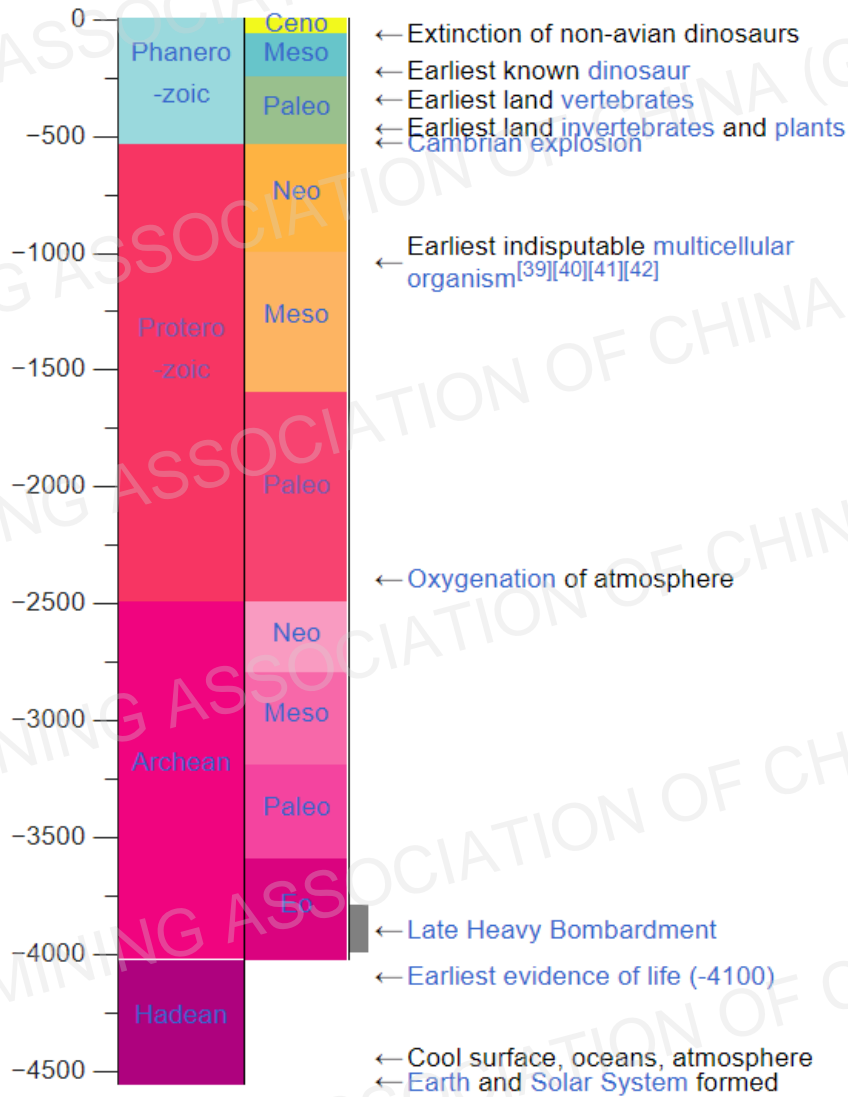
Formation of the Moon

39

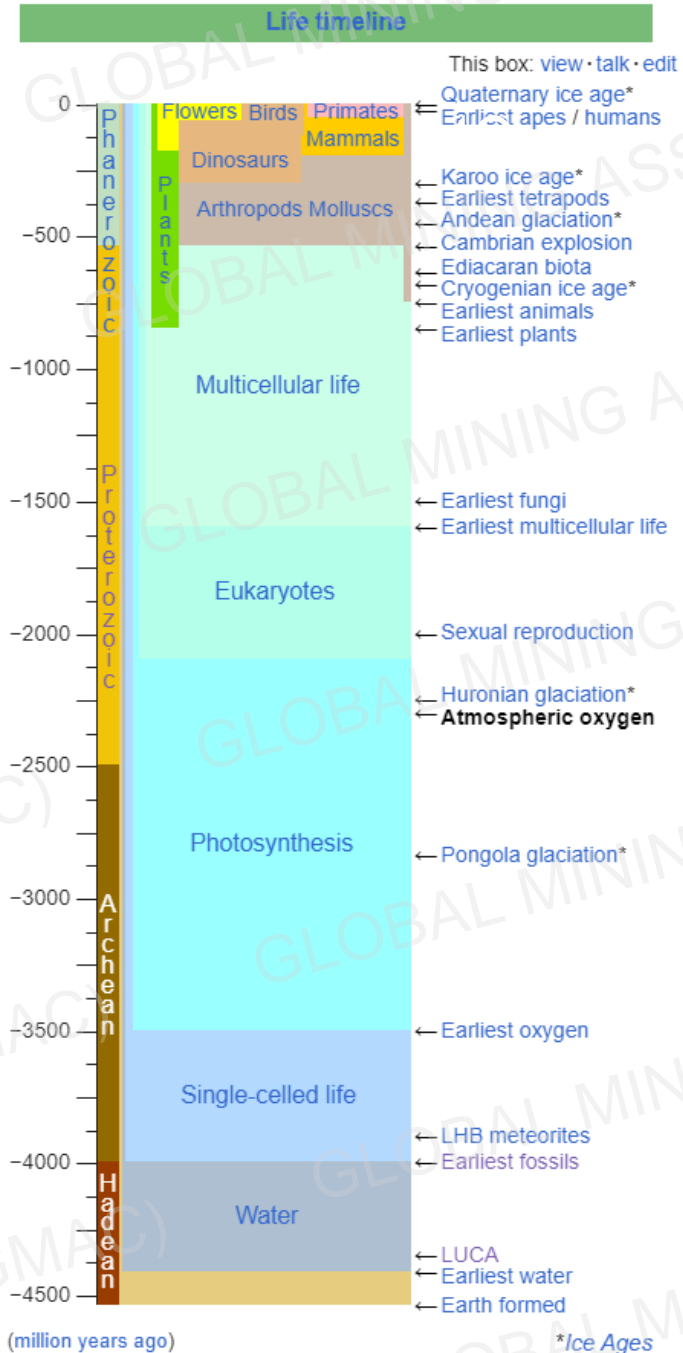


- ▶ <https://woostergeologists.scotblogs.wooster.edu/2015/07/07/classifying-the-unknown-the-lunar-edition/>

History of Earth and its life

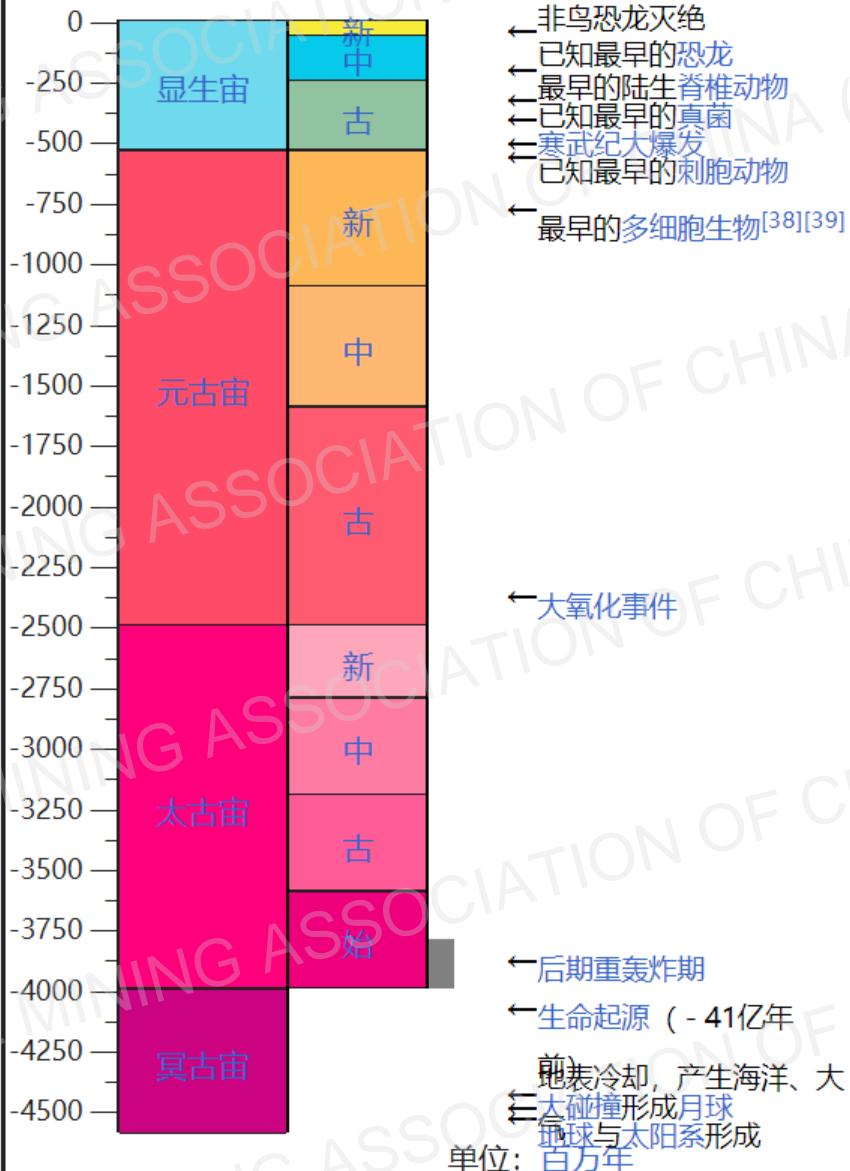


Scale: Ma (Millions of years)



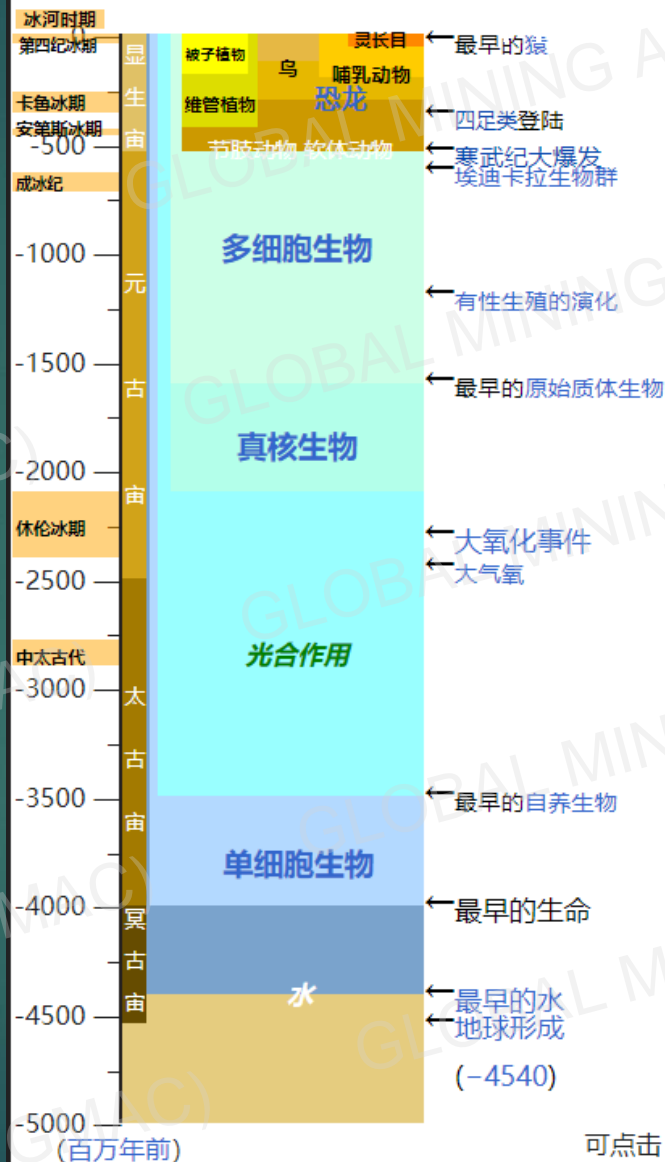
<https://www.quora.com/Why-do-we-think-theres-a-good-chance-aliens-exist-if-the-main-variable-abiogenesis-for-determining-their-existence-is-unknown-We-cant-replicate-abiogenesis-therefore-making-it-unreliable-variable-for-calculation>

地球及生命史



生命演化历程

查·论·编

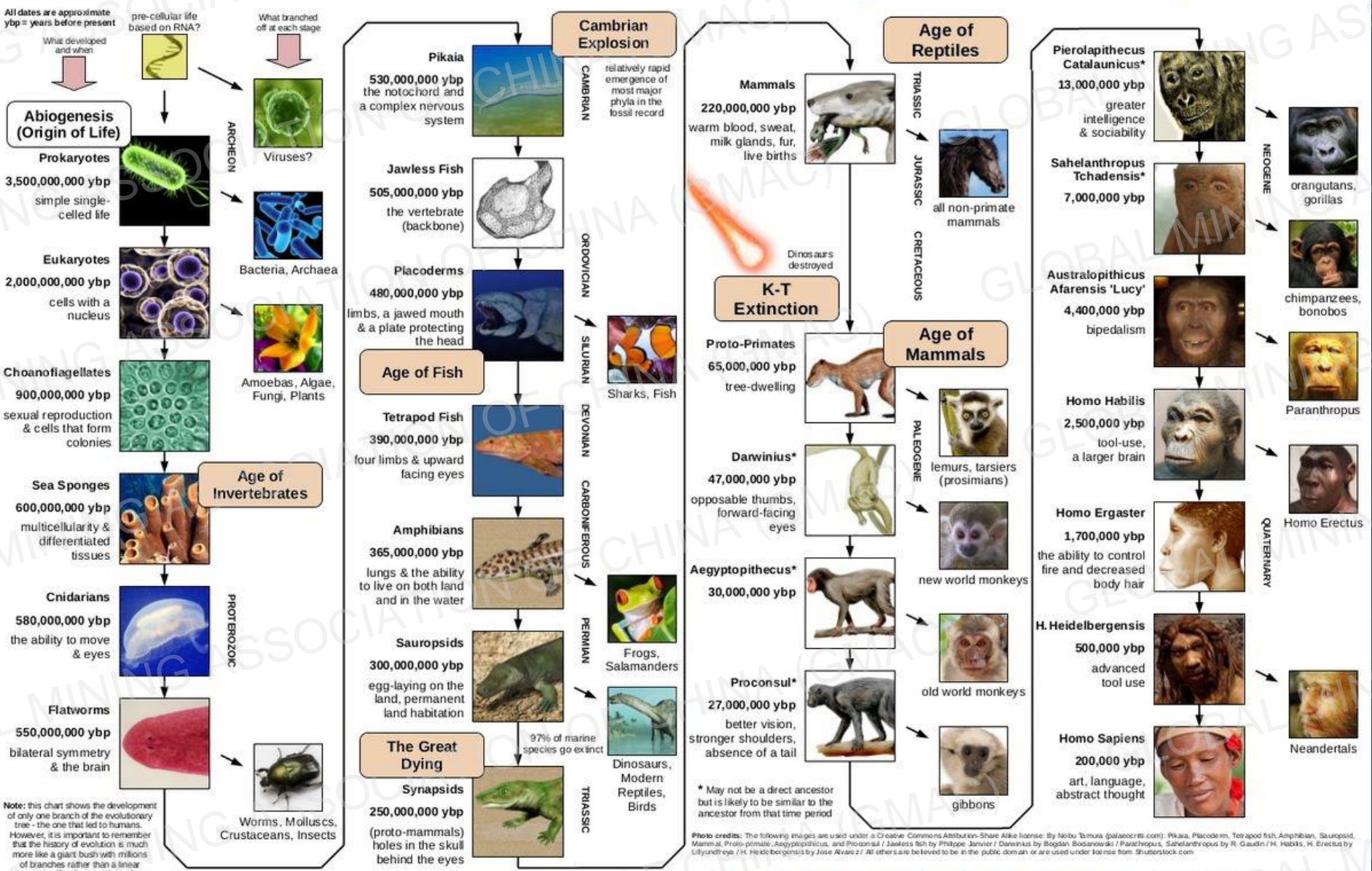


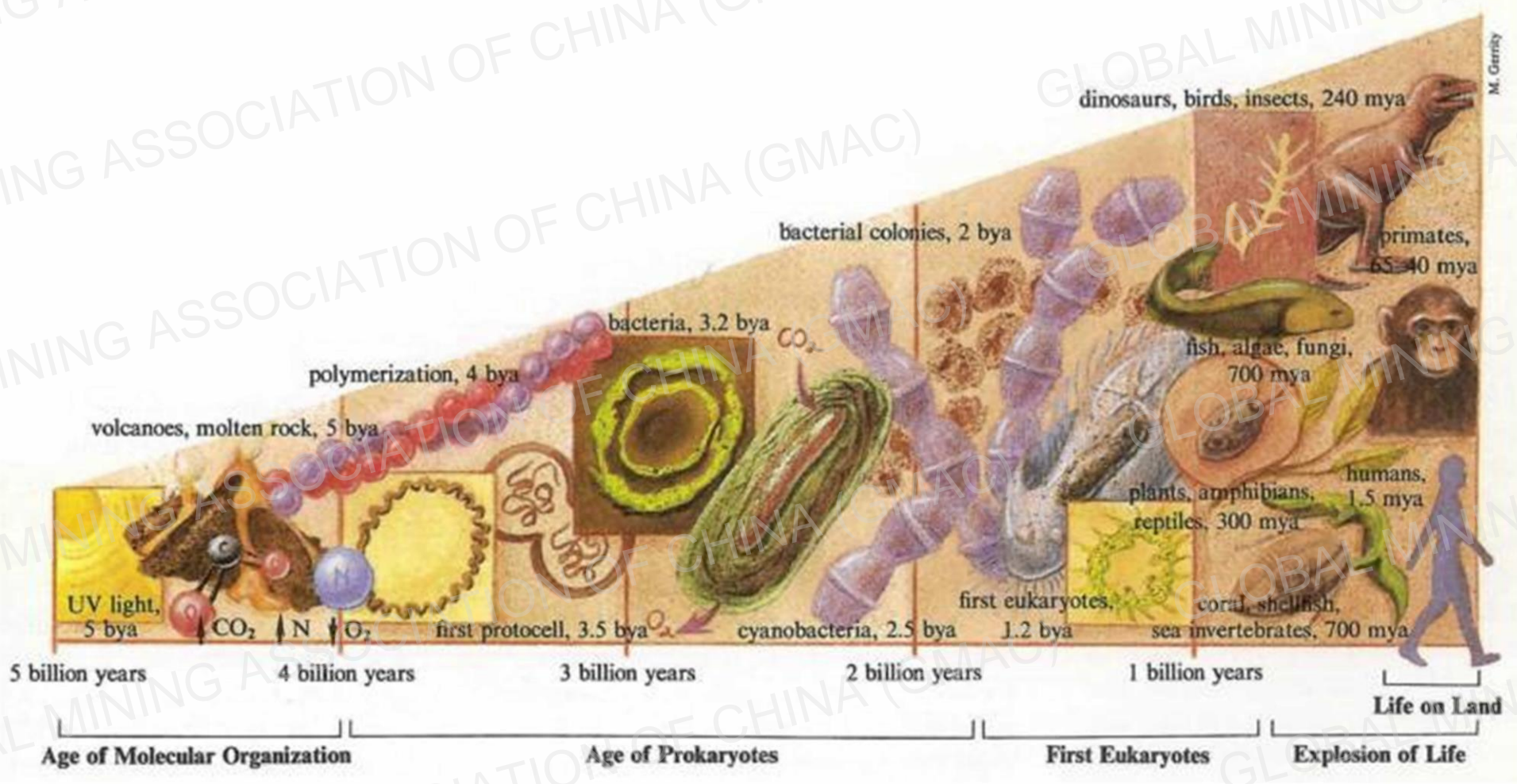
(另见: 人类演化历程和自然演化历程)

可点击

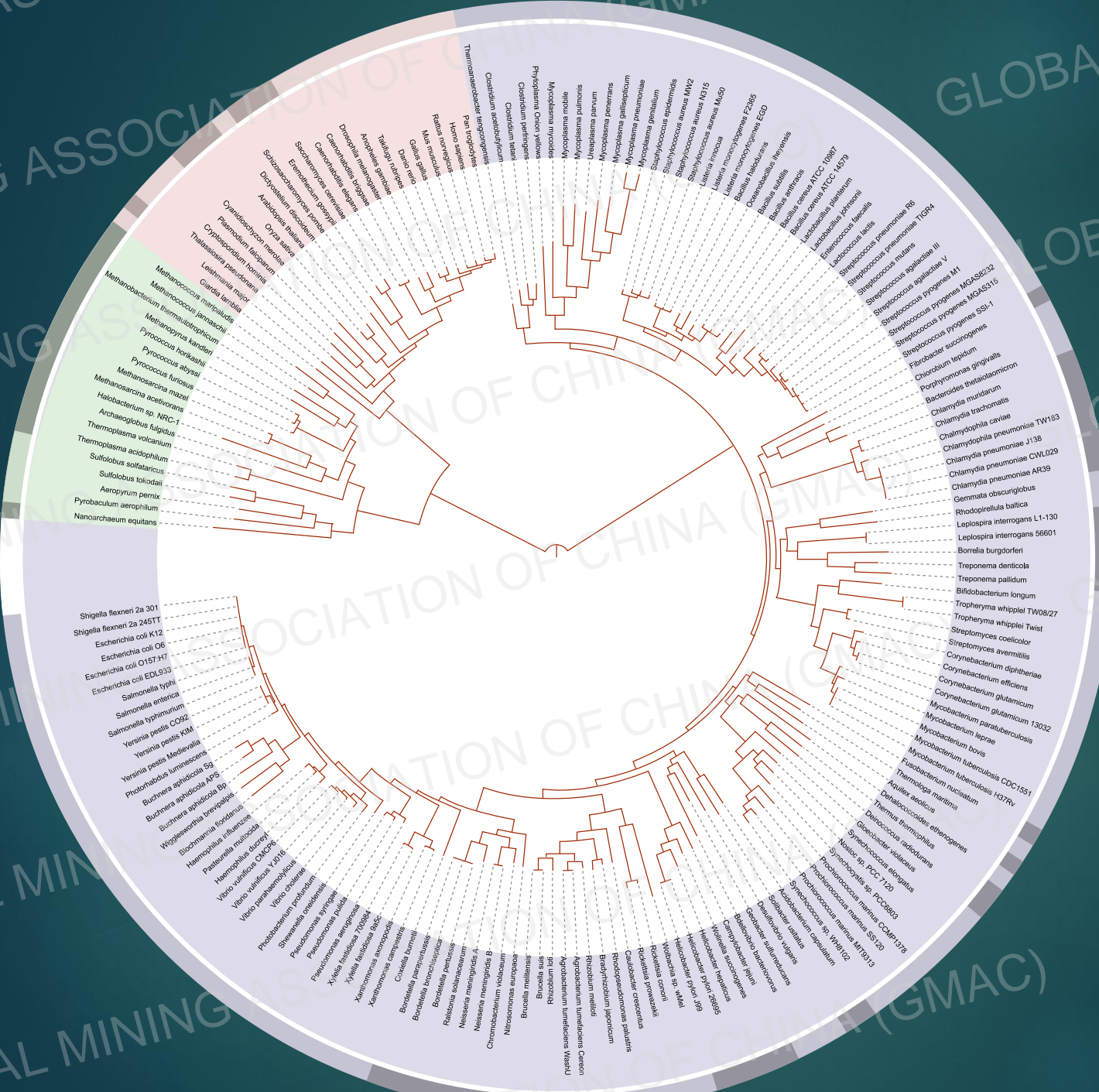


The Evolution of Humans from Single Cells to Today



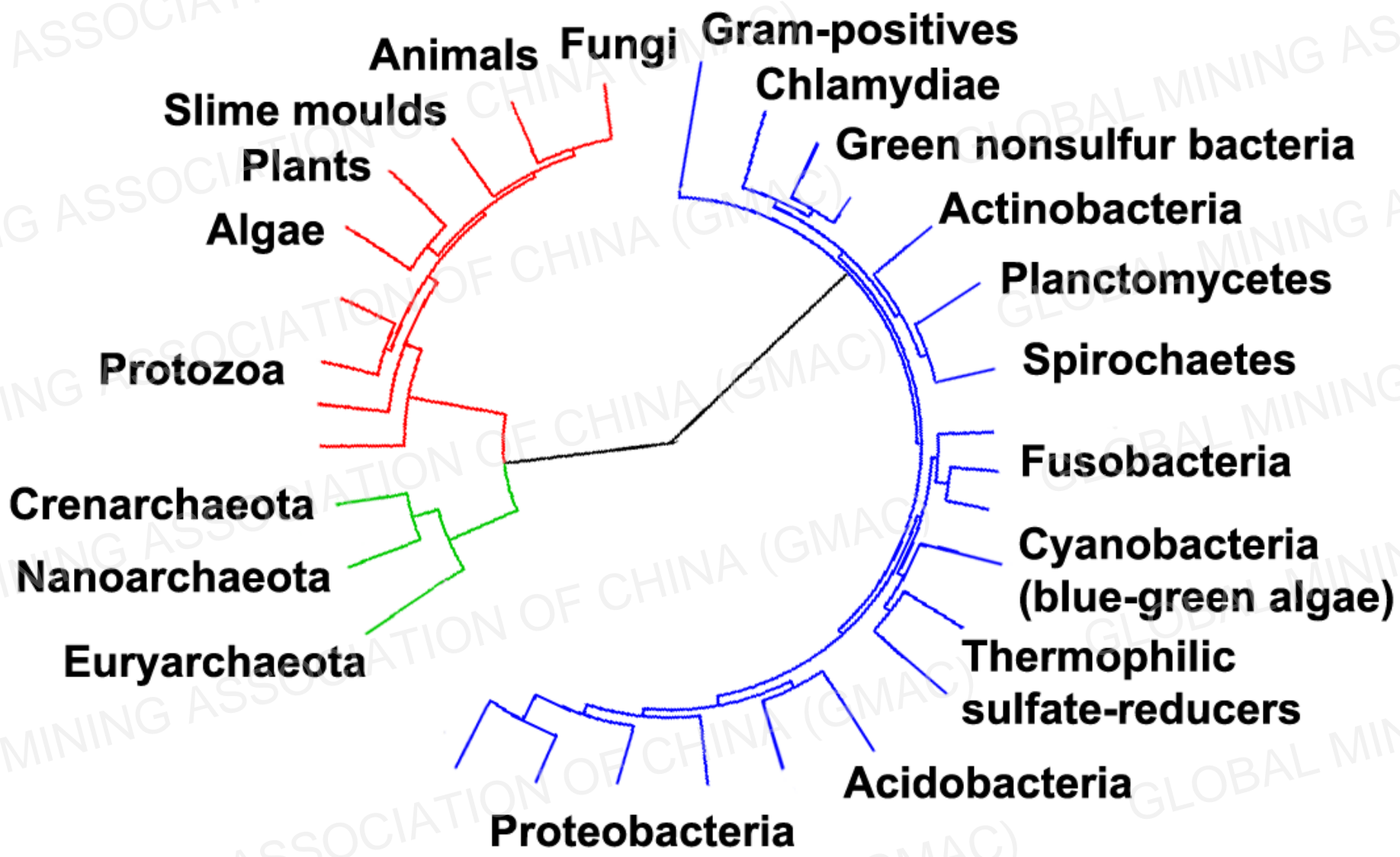


<https://kaleahrchs.weebly.com/evolution.html>



A highly resolved, automatically generated tree of life, based on completely sequenced genomes

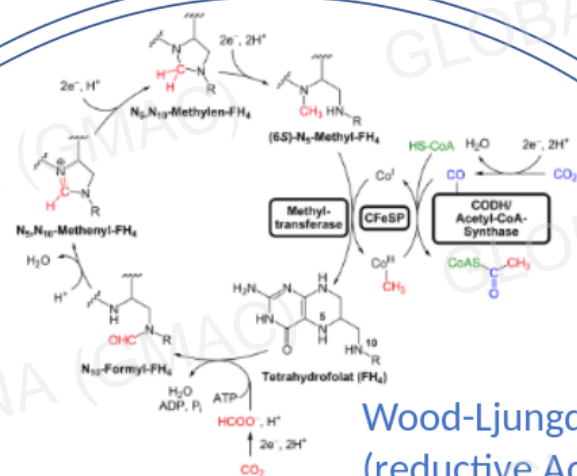
Letunic, Ivica; Bork, Peer (1 January 2007). "Interactive Tree Of Life (iTOL): an online tool for phylogenetic tree display and annotation"



N_2
 CO_2

Nitrogen fixation

Carbon fixation



Wood-Ljungdahl pathway (reductive Acetyl CoA)



Hydrothermal vent

Chemiosmosis, Ion transport

Thermophilic

LUCA



DNA

Genetic code, mRNA, tRNA, ribosomes

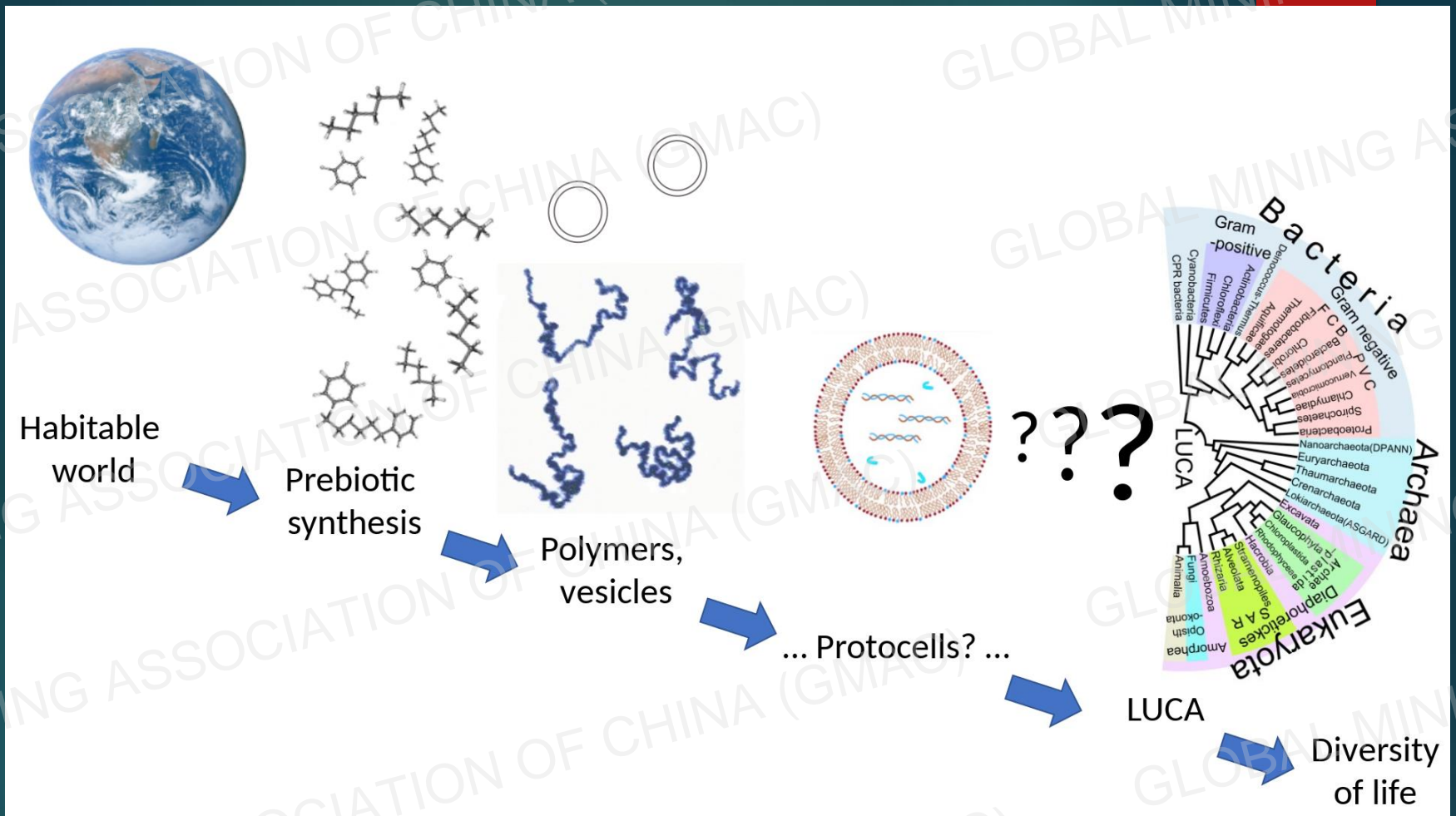
Transcription

Translation

Cell division

Proteins: Enzymes inc. DNA polymerase

Lipid bilayer membrane



By Chiswick Chap - Own workImages used:, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=117557658>

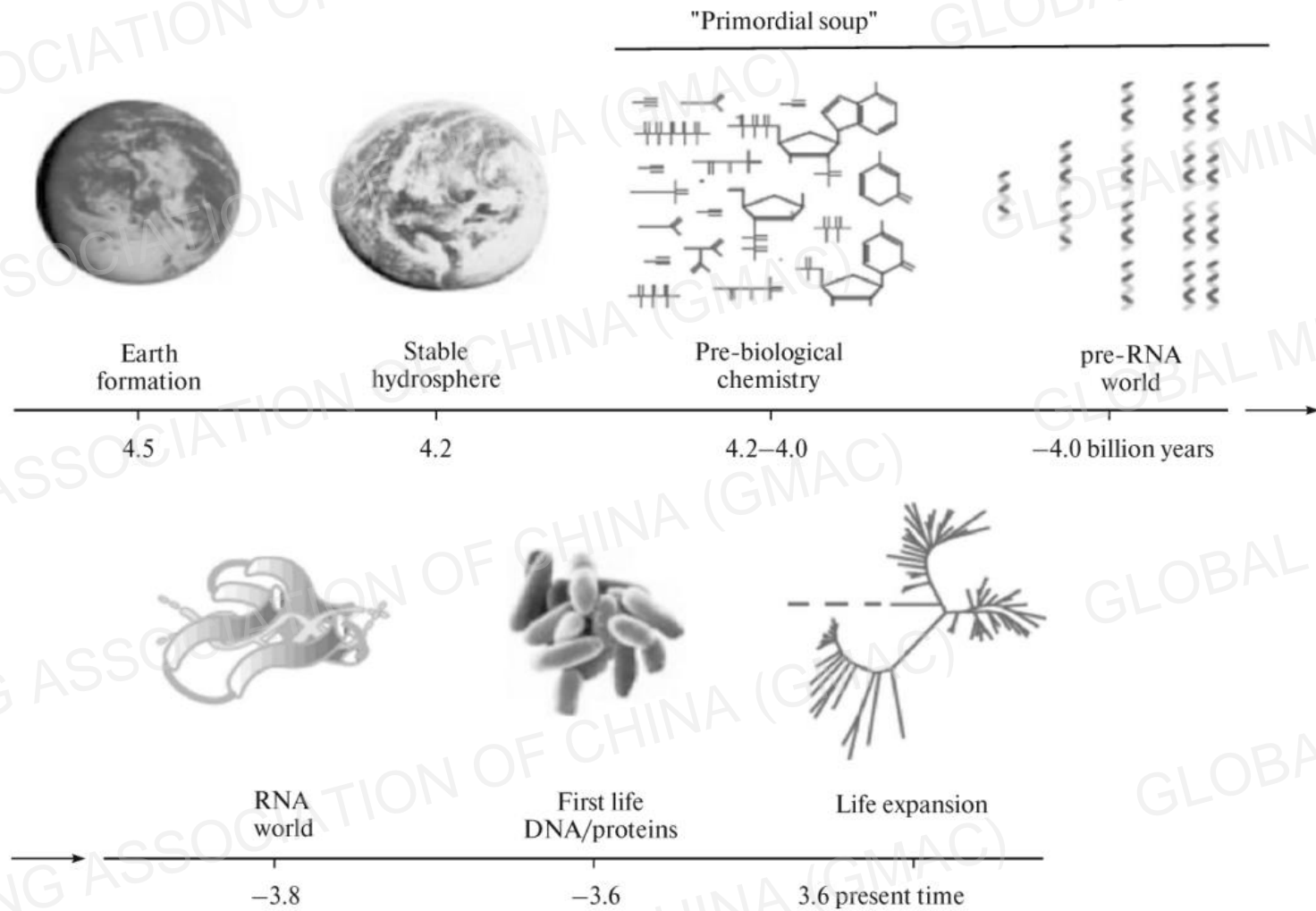
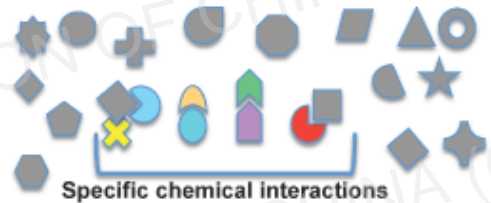


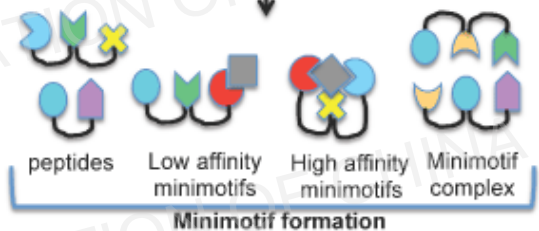
Fig. 3. Putative diagram of the key stages in the origin and evolution of life on Earth according to the “RNA World” hypothesis (modified from [28]).

“RNA World”, a highly improbable scenario of the origin and early evolution of life on earth. January 2015 Journal of Evolutionary Biochemistry and Physiology 51(1):72-84 Authors: Piotr Bregestovski Aix-Marseille Université

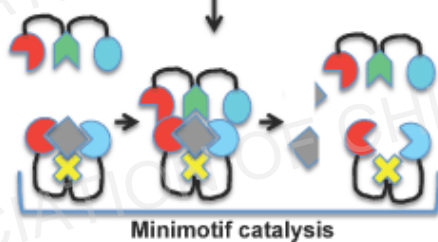
Part I
Prebiotic evolution
of molecular specificity



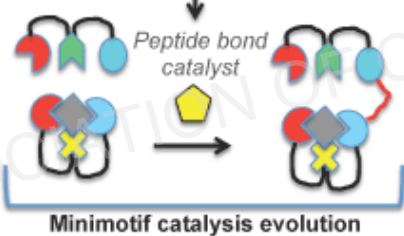
Part II
Prebiotic evolution
of peptide specificity



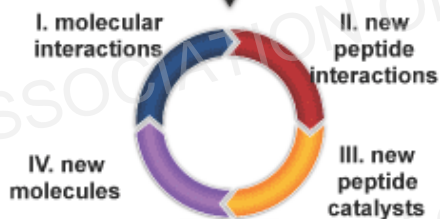
Part III
Peptide catalyst



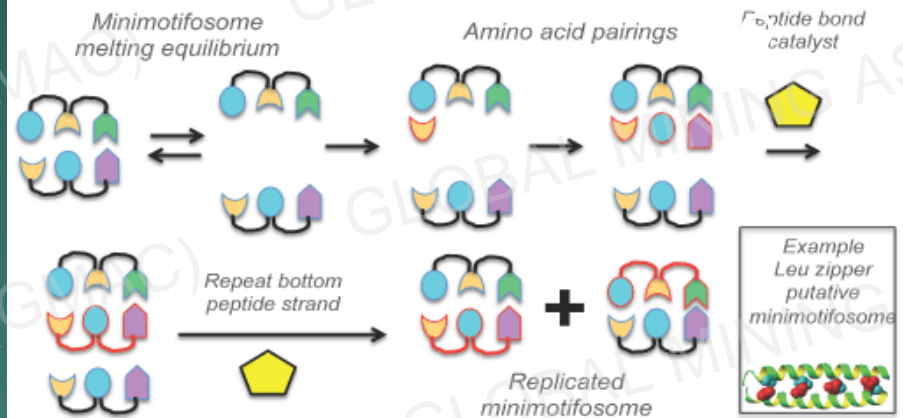
Peptide catalysis
evolution



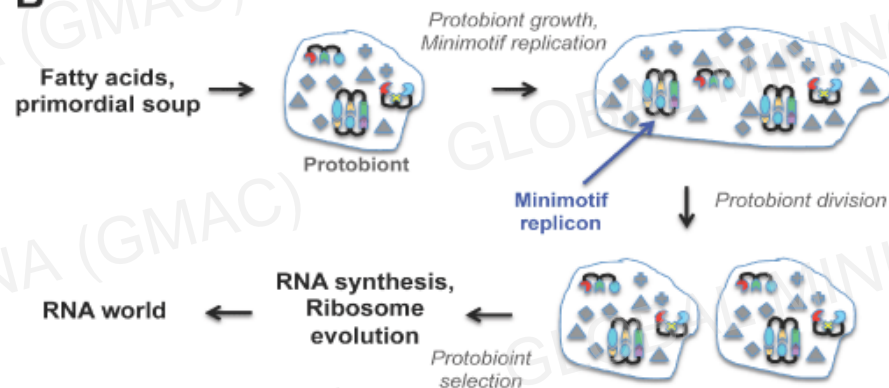
Part IV
Primordial Soup
hypercycle



A



B



<https://www.oatext.com/The-minimotif-synthesis-hypothesis-for-the-origin-of-life.php>

CHEMISTRY

BIOLOGY

Earth's prebiotic evolution by cycling diurnal gradients

Interacting chemistries of atmosphere, hydrosphere & lithosphere

The universal ancestor: the progenotes

Progenotes crossing the Darwinian threshold

Earth's chemical & Darwinian evolution

≈ 4.5 bya



≈ 3.5 bya

Archaea

≈ 2.0 bya

Evolution of microspaces and molecular crowding

Proto-gene evolution by cycling temperatures

Co-evolution of metabolic & information processing

Bacteria

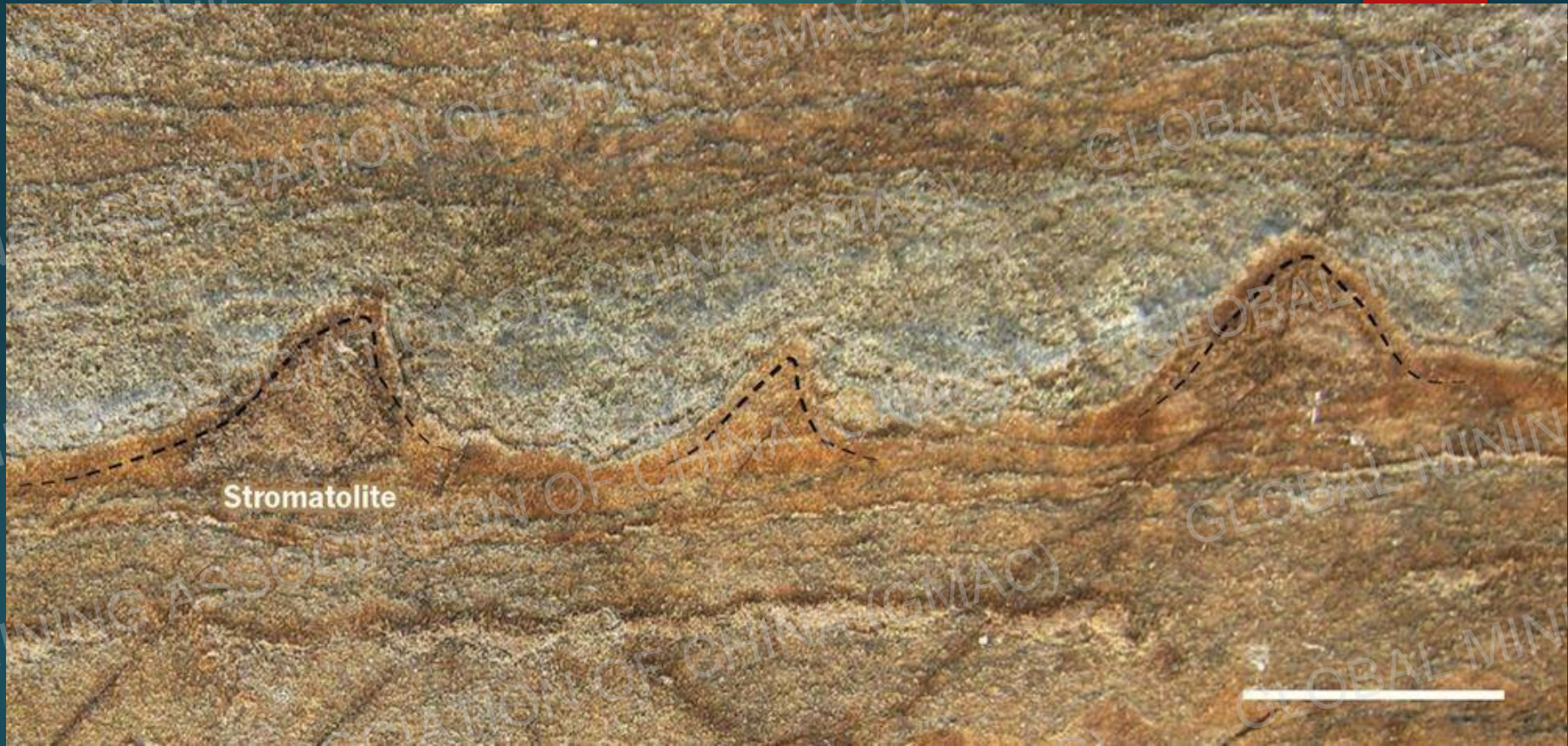
Macro-evolution: membrane disruptions & fusions

Single-cell Eukarya

Increasing chemical complexity

Emergence of cellular life





These cone-shaped structures discovered in 3.7-billion-year-old rocks in Greenland, about the size of a quarter, may be fossilized colonies of microbes and the earliest fossils of life on Earth, researchers say. (Image credit: Allen Nutman/Nature)

Endosymbiosis in a nutshell:

1. Start with two independent bacteria.



2. One bacterium engulfs the other.



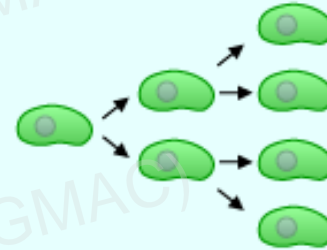
3. One bacterium now lives inside the other.



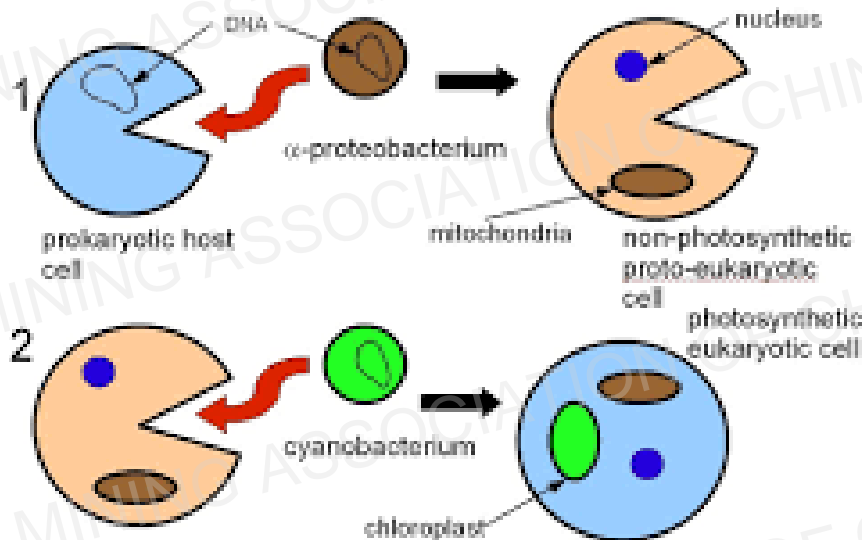
4. Both bacteria benefit from the arrangement.



5. The internal bacteria are passed on from generation to generation.

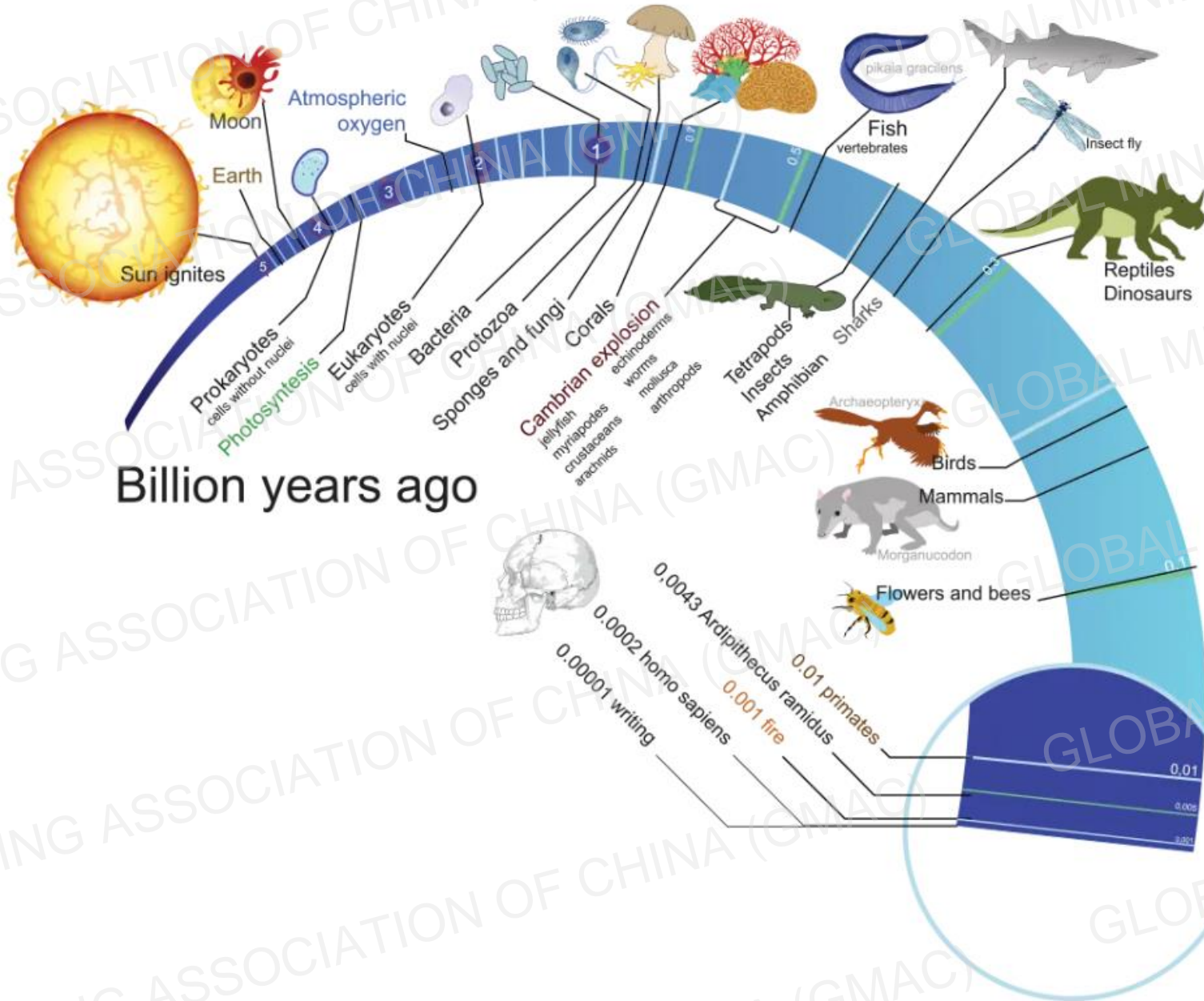


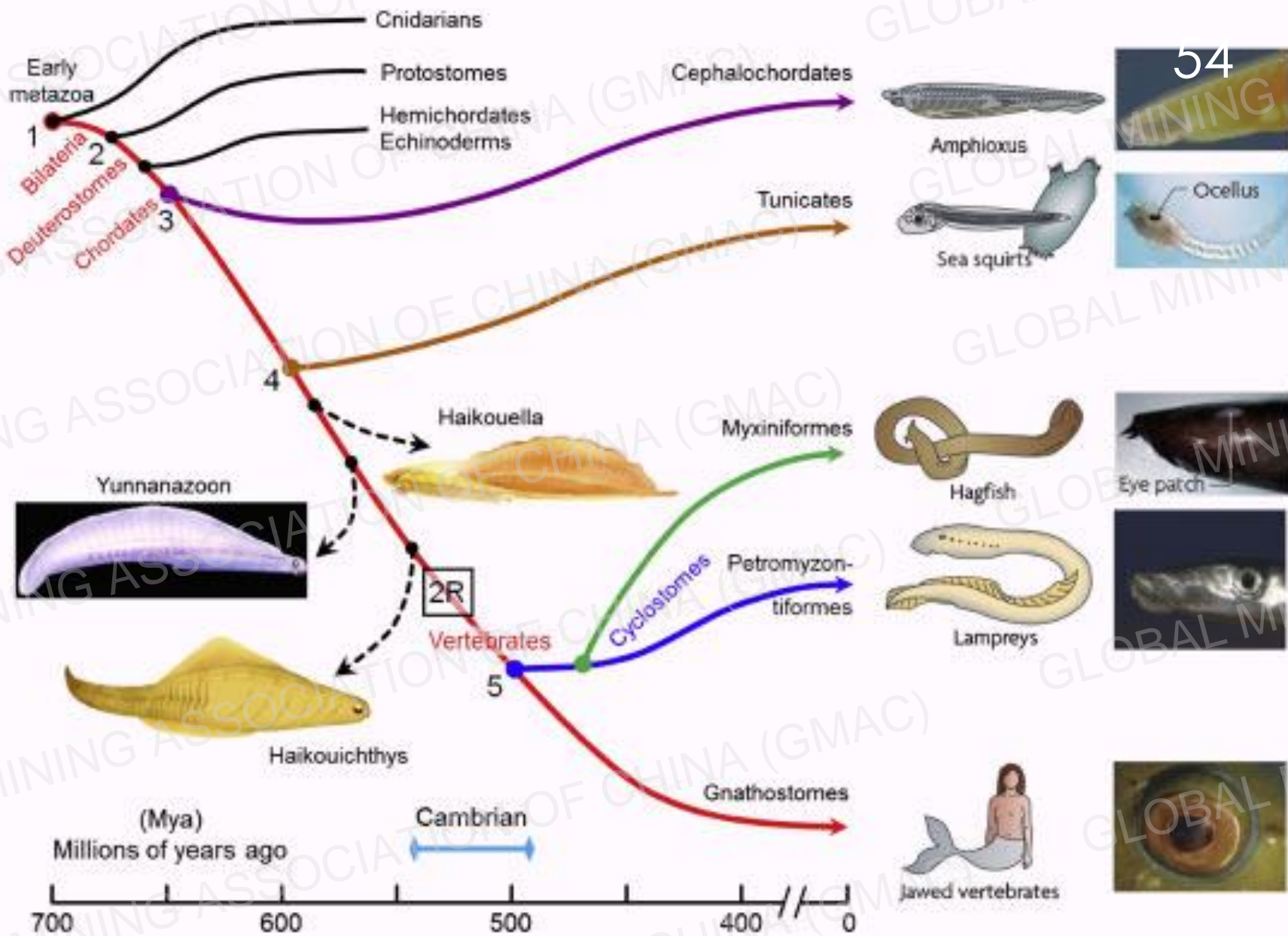
Two endosymbiotic events c.2.7 bya



真核生物的进化

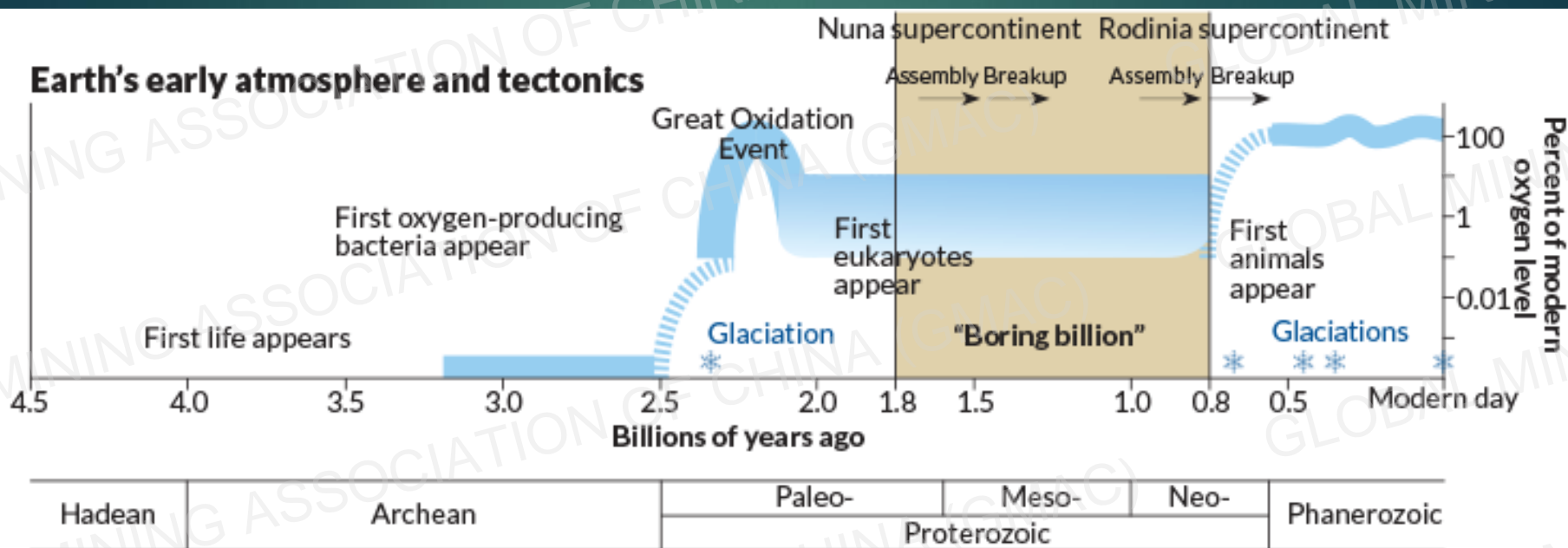
<https://www.quora.com/Why-are-mitochondria-believed-to-be-prokaryotic-cells-engulfed-by-eukaryotic-cells>



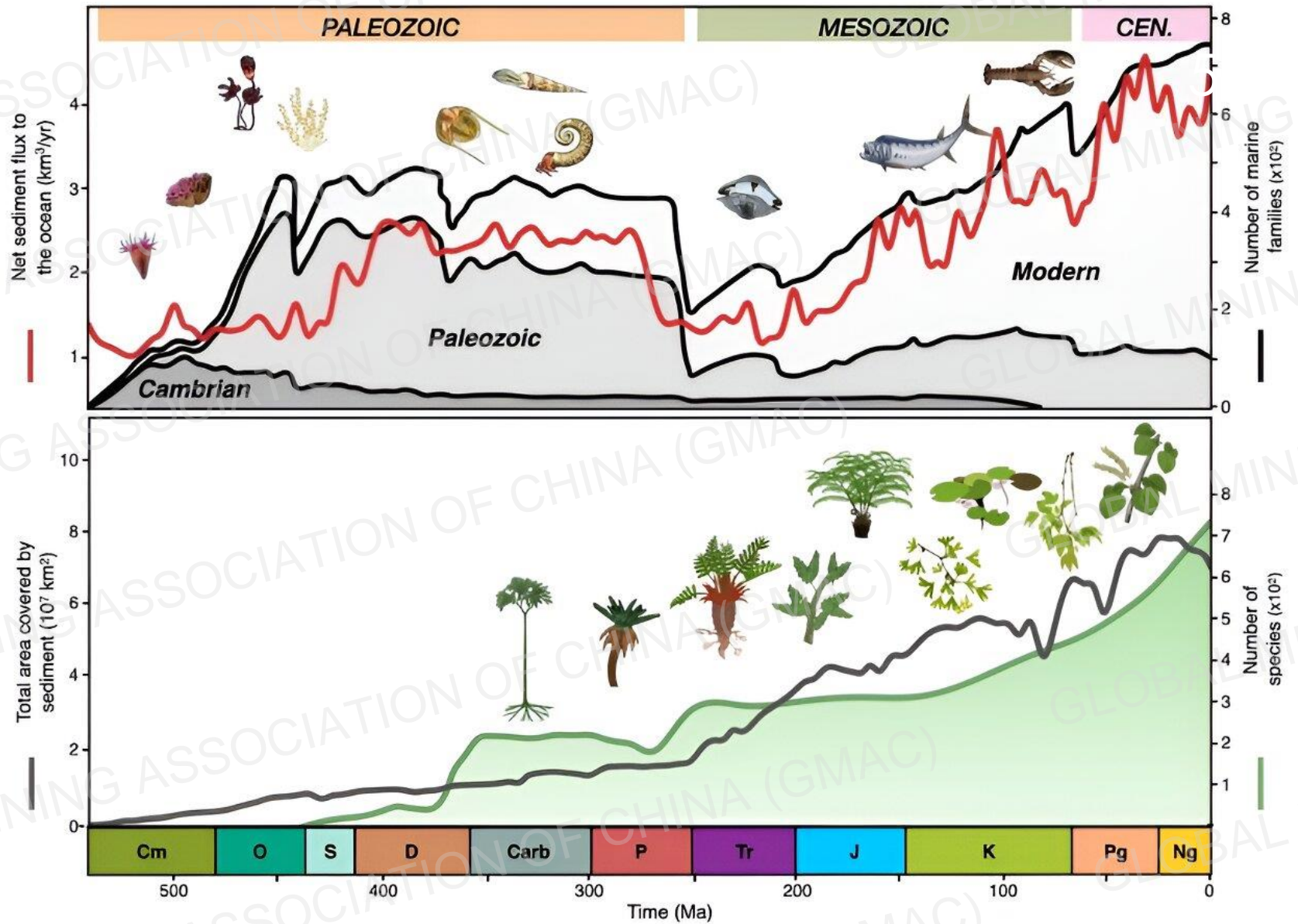


大氧化事件

The Great Oxidation Event (GOE)

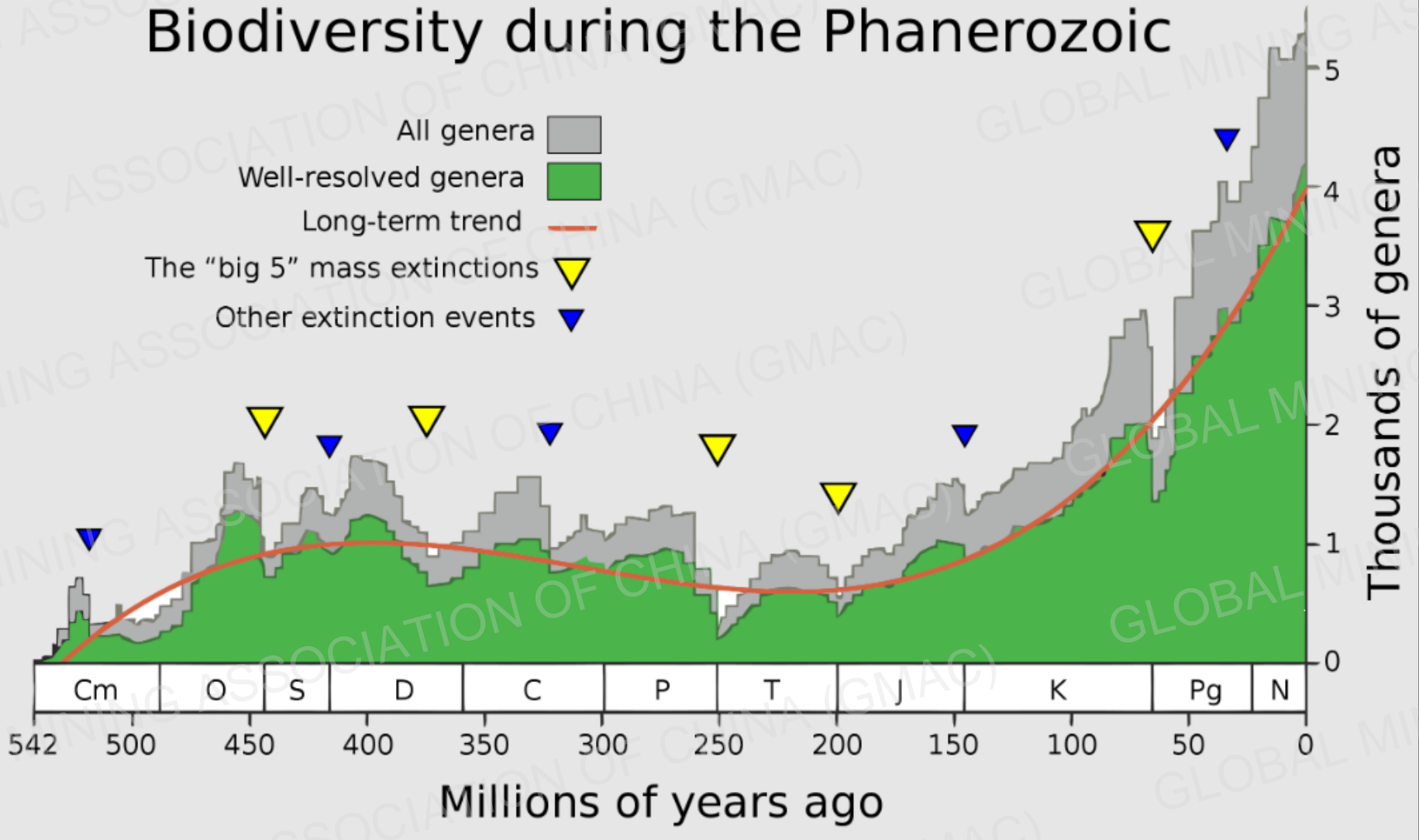


<https://commondescentpodcast.com/2019/11/30/episode-75-the-great-oxidation-event/>

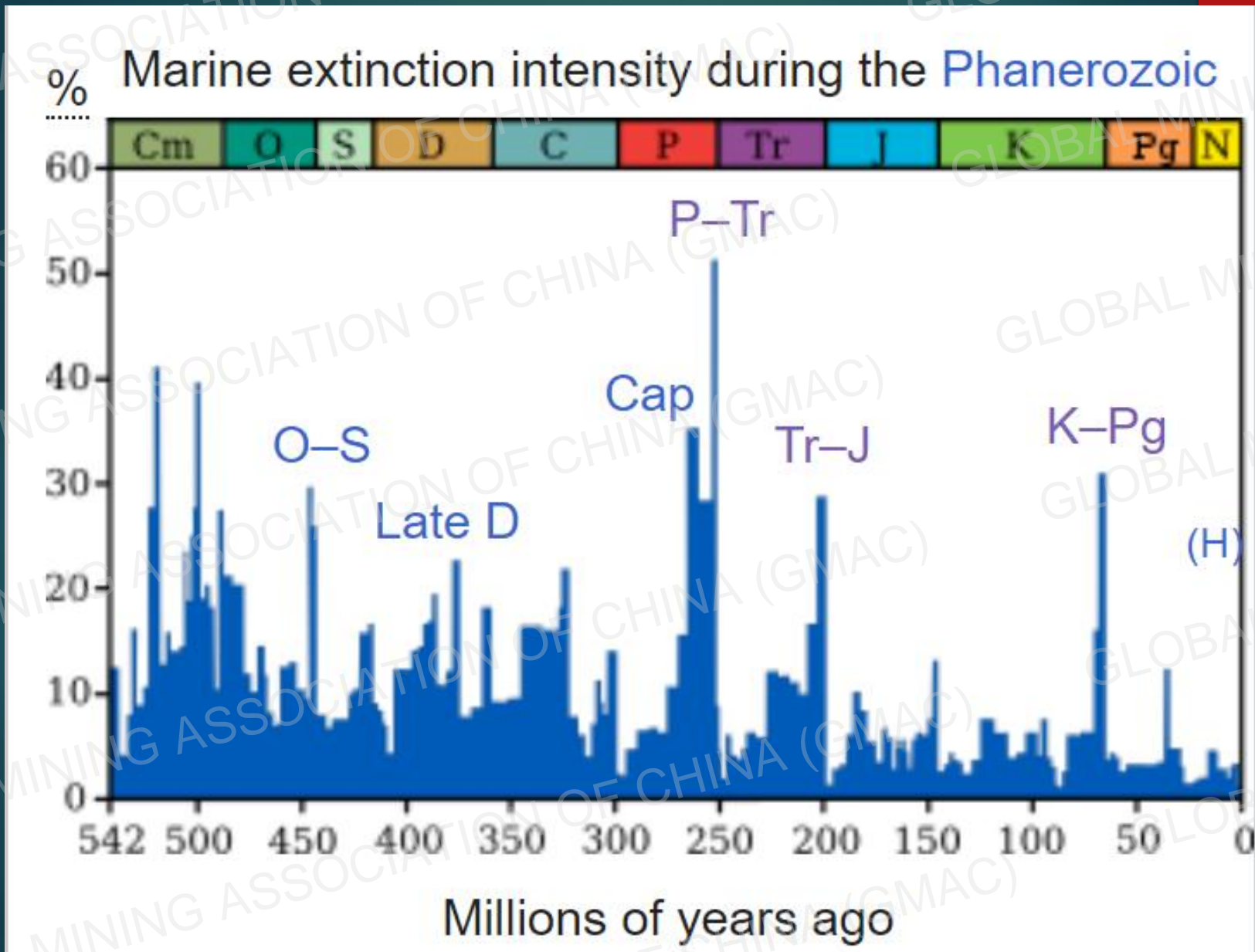


<https://riuters.com/landscape-dynamics-evolution-biodiversity-earth/>

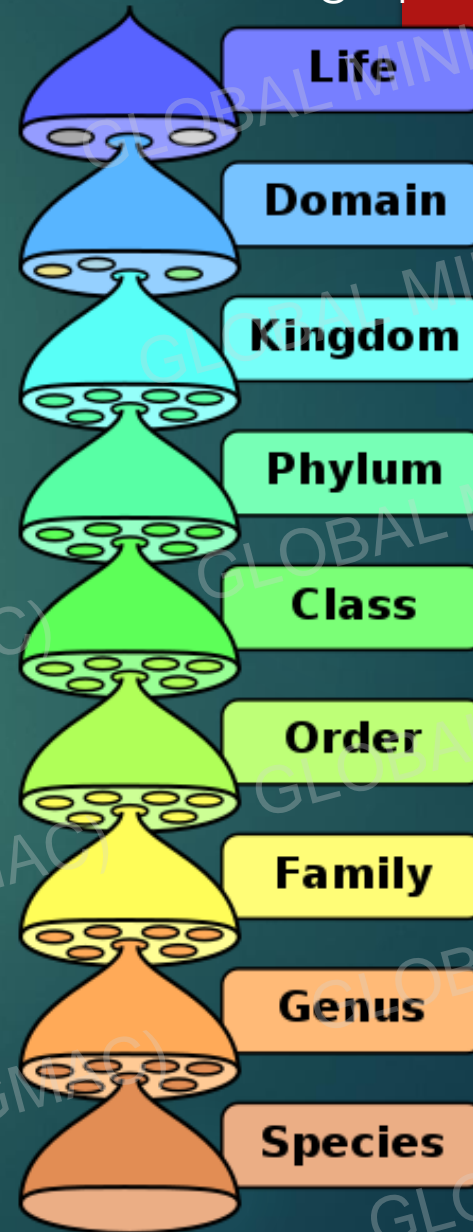
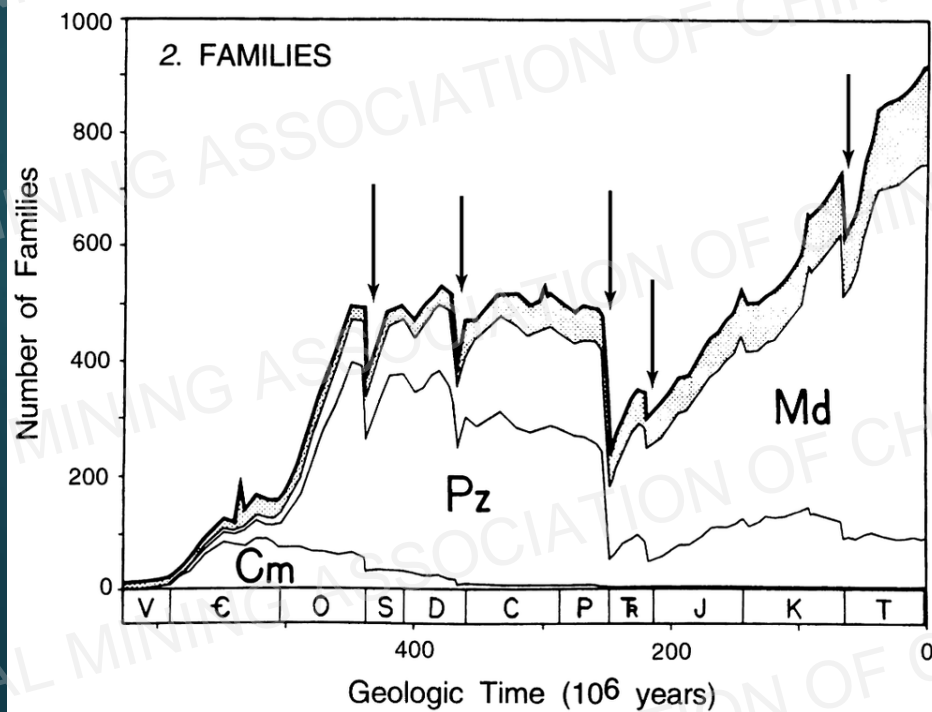
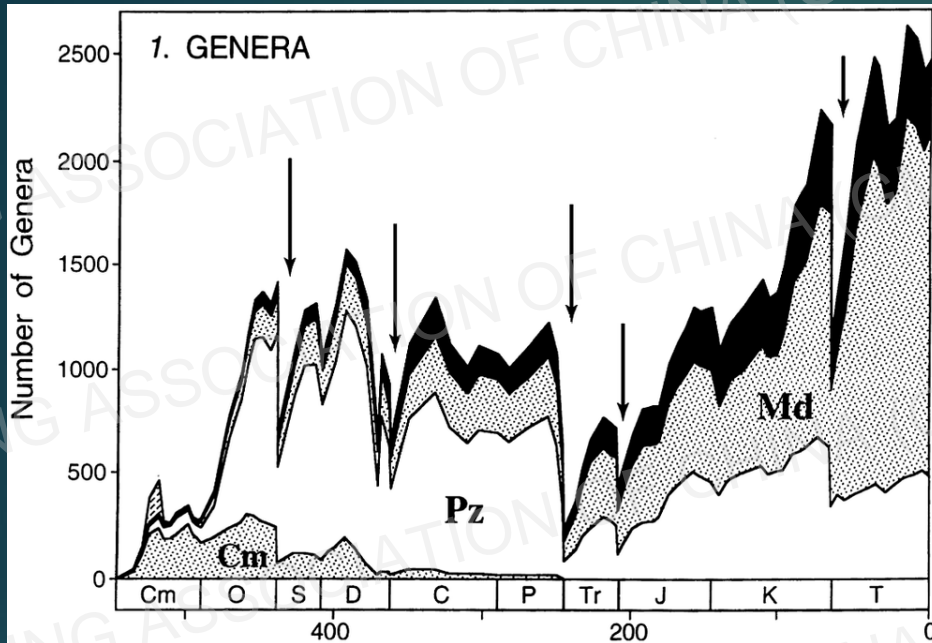
Biodiversity during the Phanerozoic



Extinctions 生物集群灭绝



https://en.wikipedia.org/wiki/File:Sepkoski_1997_extinction_graphs.png



MILESTONES OF VERTEBRATE EVOLUTION

Scientists have been trying to solve the mysteries of animal evolution for over 200 years. Although some details are still obscure, they have been able to determine a great many relationships. These are based on physical characters resulting from the evolutionary process. Some of the most important ones are shown and explained at left. They are referred to as "Milestones of Evolution." The main design is a stylized Evolution Tree that shows how different groups of animals are related to each other. It identifies the most important groups along with the milestones that define them. It is superimposed over a geological time chart that puts everything in the context of when the progress occurred. The thickness of each branch symbolically represents the relative abundance or scarcity of each group at that time. Many representative species are shown. Insets provide information on important related subjects. The result is a truly comprehensive overview of how life evolved on Earth.

FEATHERS & BONES
Feathers were long the defining characteristic of birds, but the recent discovery of feathery dinosaur fossils has changed these. Birds were also thought to be the only animals that had true endosteal bones, but they have also been found on dinosaurs. Birds are now thought to be endosteal animals with true endosteal bones. CLADE: AVES

PLACENTA
The placenta is a temporary organ that only in female mammals and placental marsupials living pregnancy. It permits the mother to carry the baby within her body. The placenta provides nutrition and the means to provide nutrients and remove waste, permitting the baby to reach an advanced stage of development prior to birth. CLADE: PLACENTATA

MAMMARY GLAND
Mammals were defined as animals in which the female has a mammary gland that produces milk for her babies. This provided an essential way for mothers to feed their young. Characteristic of mammals, but mammals are not the only animals that have true mammary glands. Some birds also have milk to protect their young, which is most used for camouflage. CLADE: MAMMALS

HINGE-LIKE ANKLE
Most reptiles have a sprawling gait where the upper leg joints from the side of their body, a good example is the lizard. The hinge-like ankle permitted legs to be directly to the ground, so weight was shifted straight down. It was an evolutionary step toward the mammalian stance. An ankle joint that is able to rotate the dinosaurs to stand upright on their rear legs. This modification was active lifestyle. CLADE: ORNITHOMIANS

ANTORBITAL FENESTRATION
This is an opening in the skull between the eye socket and the nostril. It allowed an increase in the size of the brain. This resulted in a larger skull and larger openings below that the ear can be held up to the face. CLADE: MAMMALS

ENDOTHERMY
Some animals have evolved a way to maintain their body temperature. This was a constant source of energy for their metabolism. This was a major step toward the ability to regulate their body temperature. Mammals and birds are the only animals that have true endothermy. CLADE: MAMMALS

TO BE DETERMINED

AMNIOTE EGG
One of the most important developments in animal evolution. The egg has a protective shell that protects the embryo from drying out. The yolk is contained in a separate compartment. This is the yolk sac. CLADE: AMNIOTES

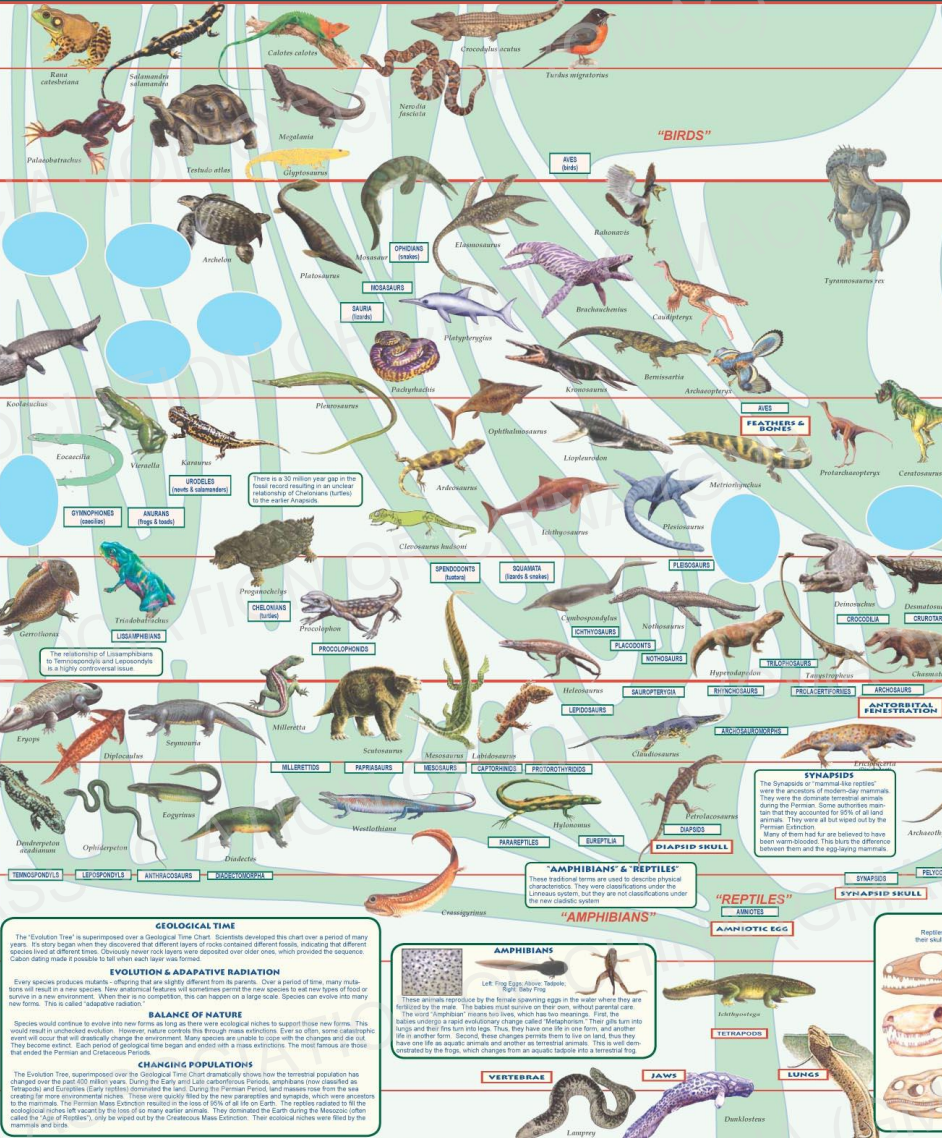
FOUR DIGITS
Five evolved into four digits. The muscular limb generally has well-defined joints and digits (fingers and toes) that have a characteristic claw called "claw." CLADE: TETRAPODS

LUNGS
Lungs permitted animals to breathe water. CLADE: SACCOPTERYGIANS

JAWS
The jawless fish were succeeded by the jawed fish. CLADE: GNASTHOMES

VERTEBRAL COLUMN
A vertebral column is a series of vertebrae that provides the spinal cord. It is a series of vertebrae that provides the spinal cord. It is a series of vertebrae that provides the spinal cord. CLADE: VERTEBRATES

GENEOZOIC
Cenozoic 24-18 MYA
Neogene 24-18 MYA
Paleogene 66-24 MYA
Cretaceous 145-66 MYA
Mesozoic 252-145 MYA
Jurassic 200-145 MYA
Triassic 252-200 MYA
Permian 299-252 MYA
Late Carboniferous 359-299 MYA
Early Carboniferous 359-299 MYA
Paleozoic 541-252 MYA
Devonian 419-359 MYA



"BIRDS"
Gallus gallus, Meleagris gallopavo, Bucefala americana, Columba livia, Anas platyrhynchos, Falco sparverius, Corvus corax, Tachycineta thalassina

"MAMMALS"
Canis lupus familiaris, Felis catus, Mus musculus, Rattus norvegicus, Homo sapiens, Equus caballus, Bos taurus, Sus scrofa, Sus scrofa domestica, Oryzomys latipes, Peromyscus leucopus, Mus musculus, Rattus norvegicus, Homo sapiens, Equus caballus, Bos taurus, Sus scrofa, Sus scrofa domestica, Oryzomys latipes, Peromyscus leucopus

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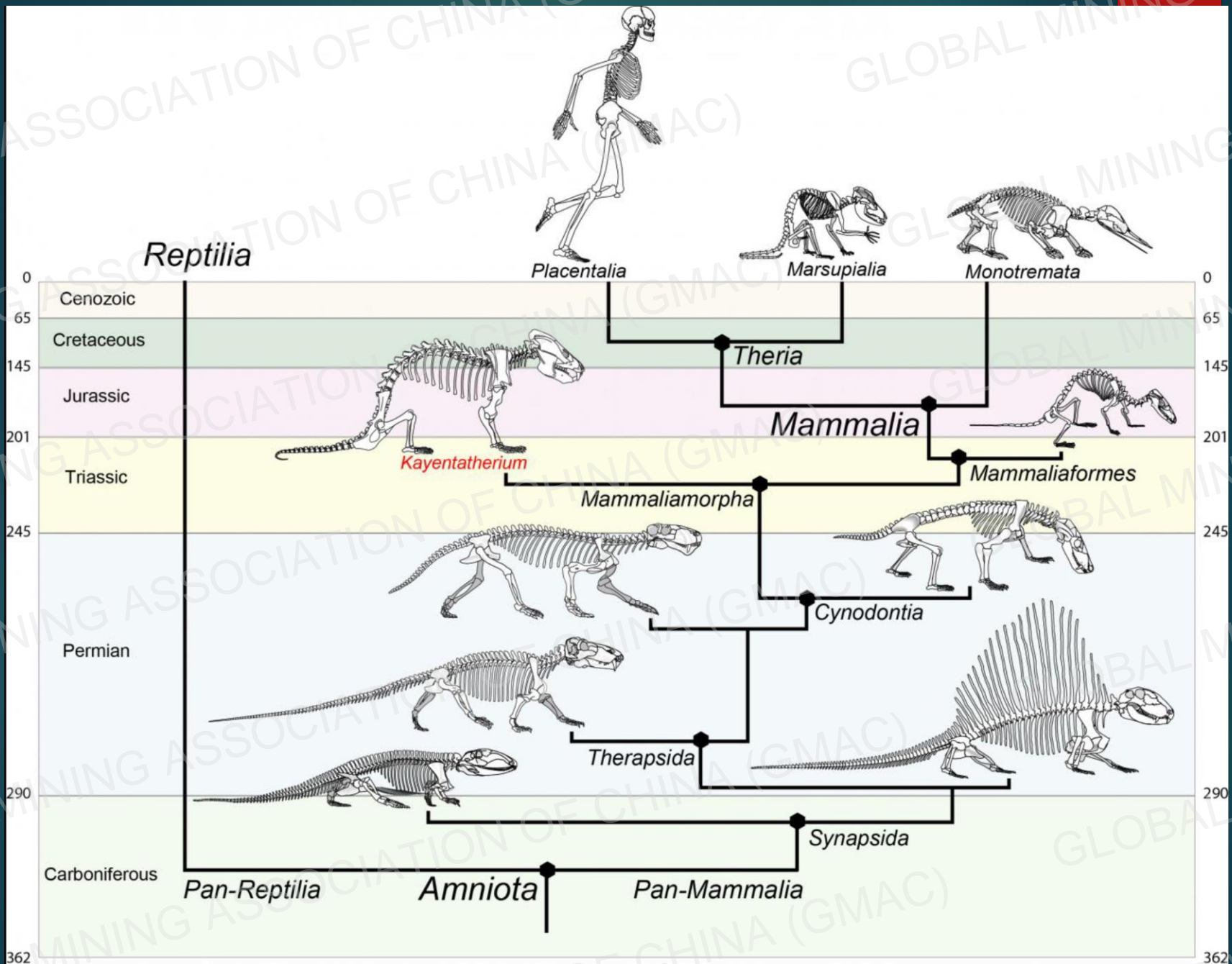
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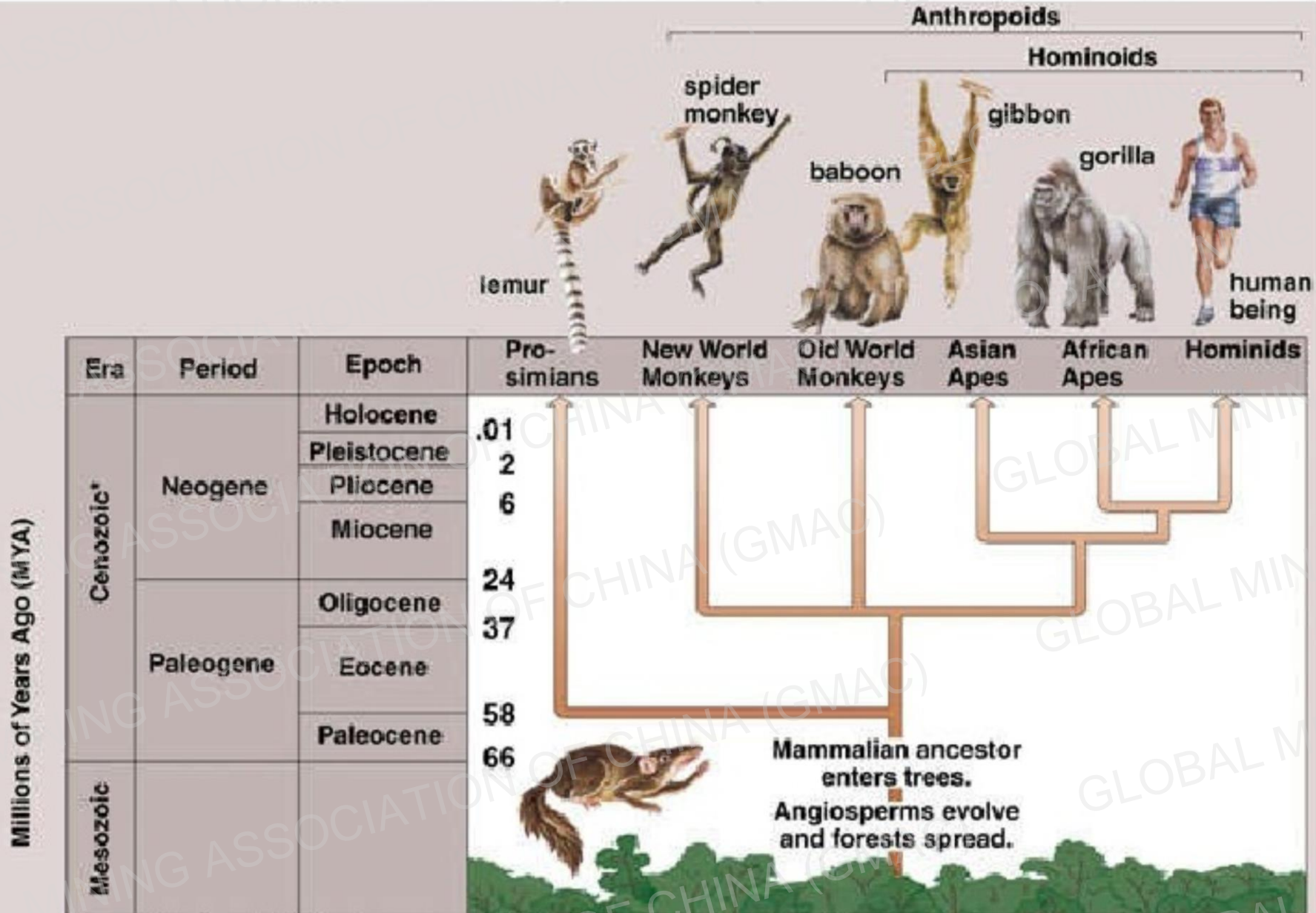
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<https://www.quora.com/If-evolution-is-correct-wouldnt-the-best-designed-animals-be-the-ones-that-survived-the-longest-unchanged-Wouldnt-the-worm-and-the-clam-be-better-designs-than-birds-and-lions-And-would-all-life-evolve-into-the-best>

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*Many authorities divide the Cenozoic era into the Tertiary period (contains Paleocene, Eocene, Oligocene, Miocene, and Pliocene) and the Quaternary period (contains Pleistocene and Holocene).

First Arboreal Mammals

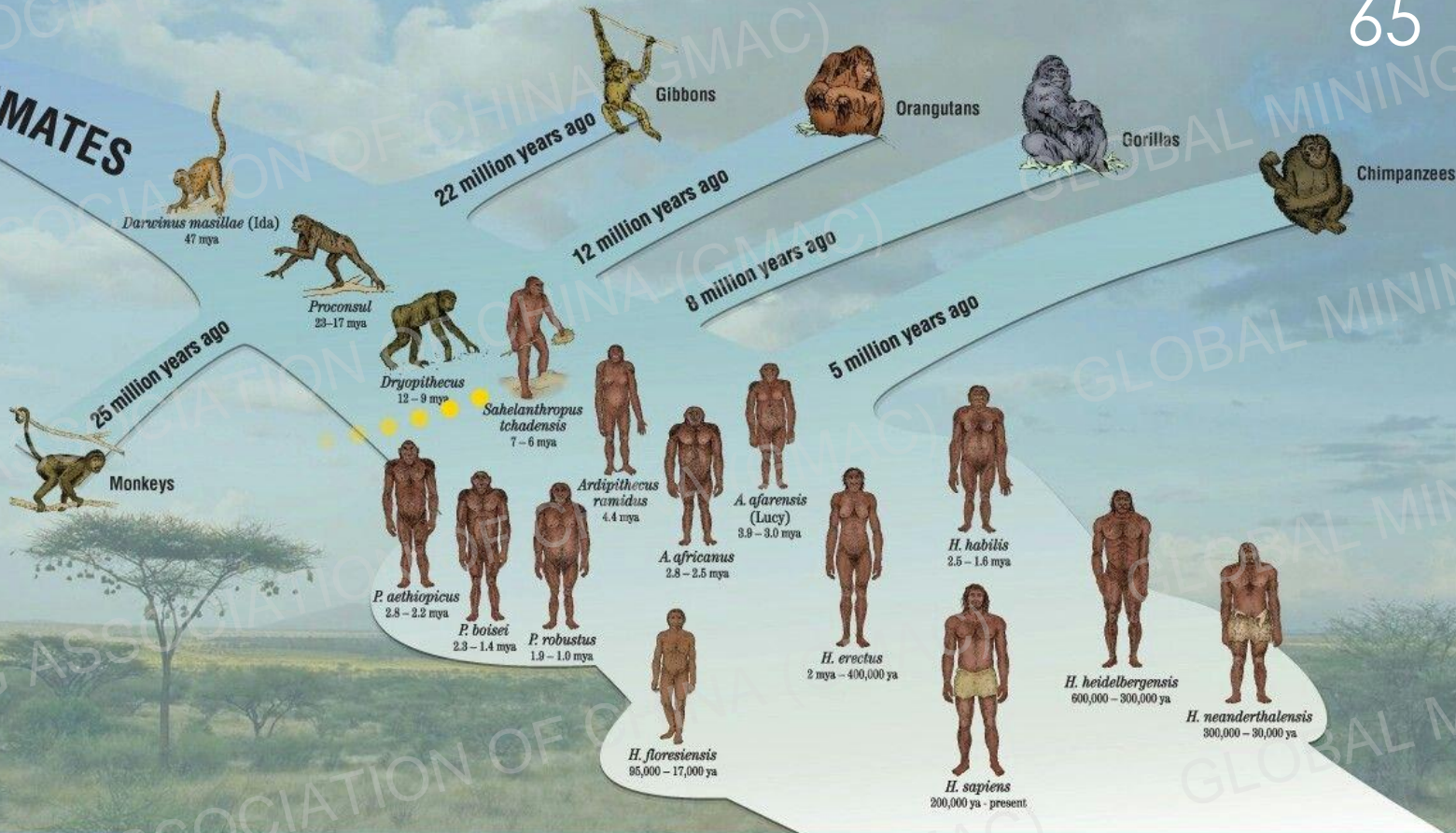


Scientific classification

Domain:	Eukaryota
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Primates
Suborder:	Haplorhini
Infraorder:	Simiiformes
Family:	Hominidae
Subfamily:	Homininae
Tribe:	Hominini
Genus:	<i>Homo</i>
Species:	<i>H. sapiens</i>

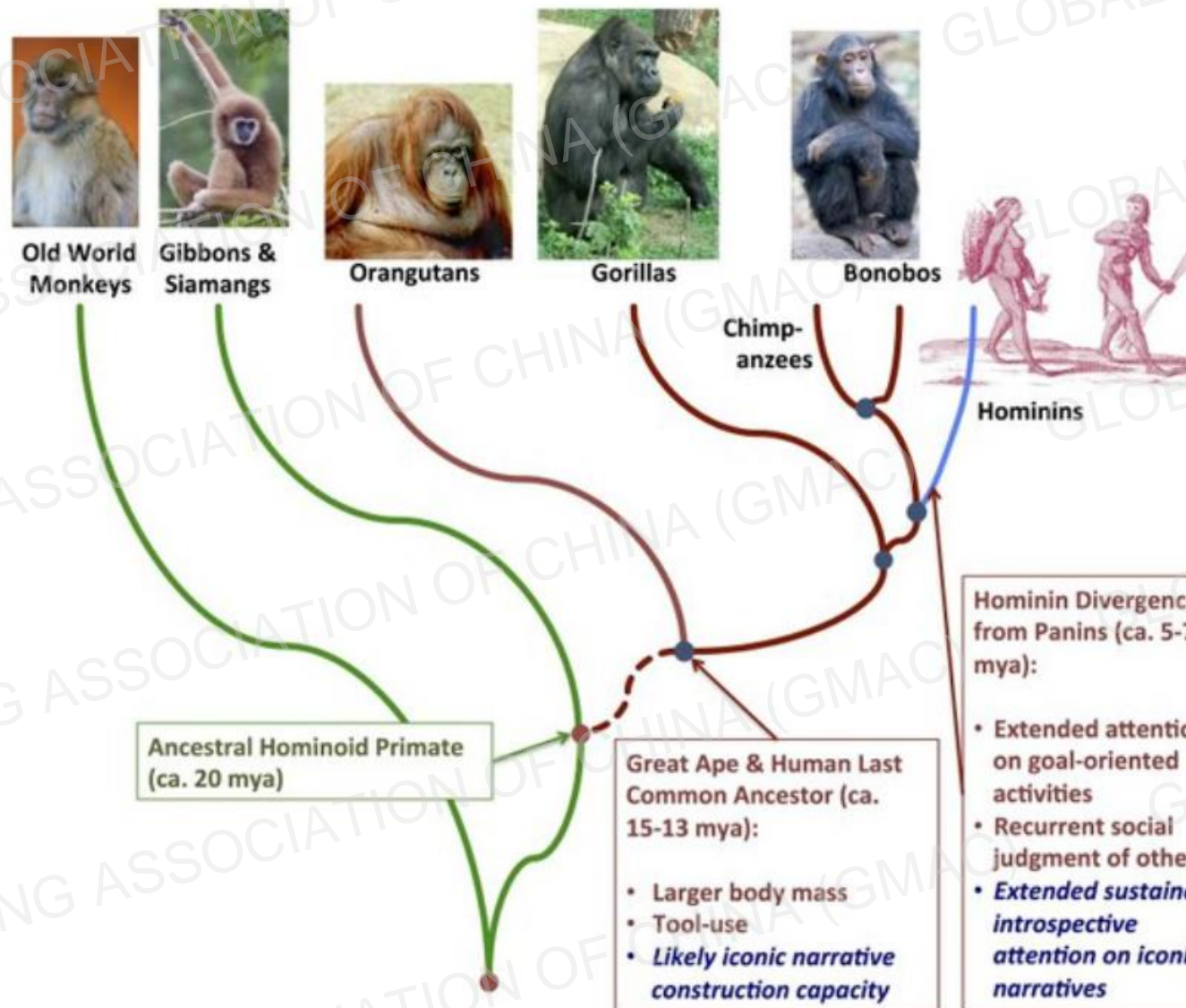


PRIMATES

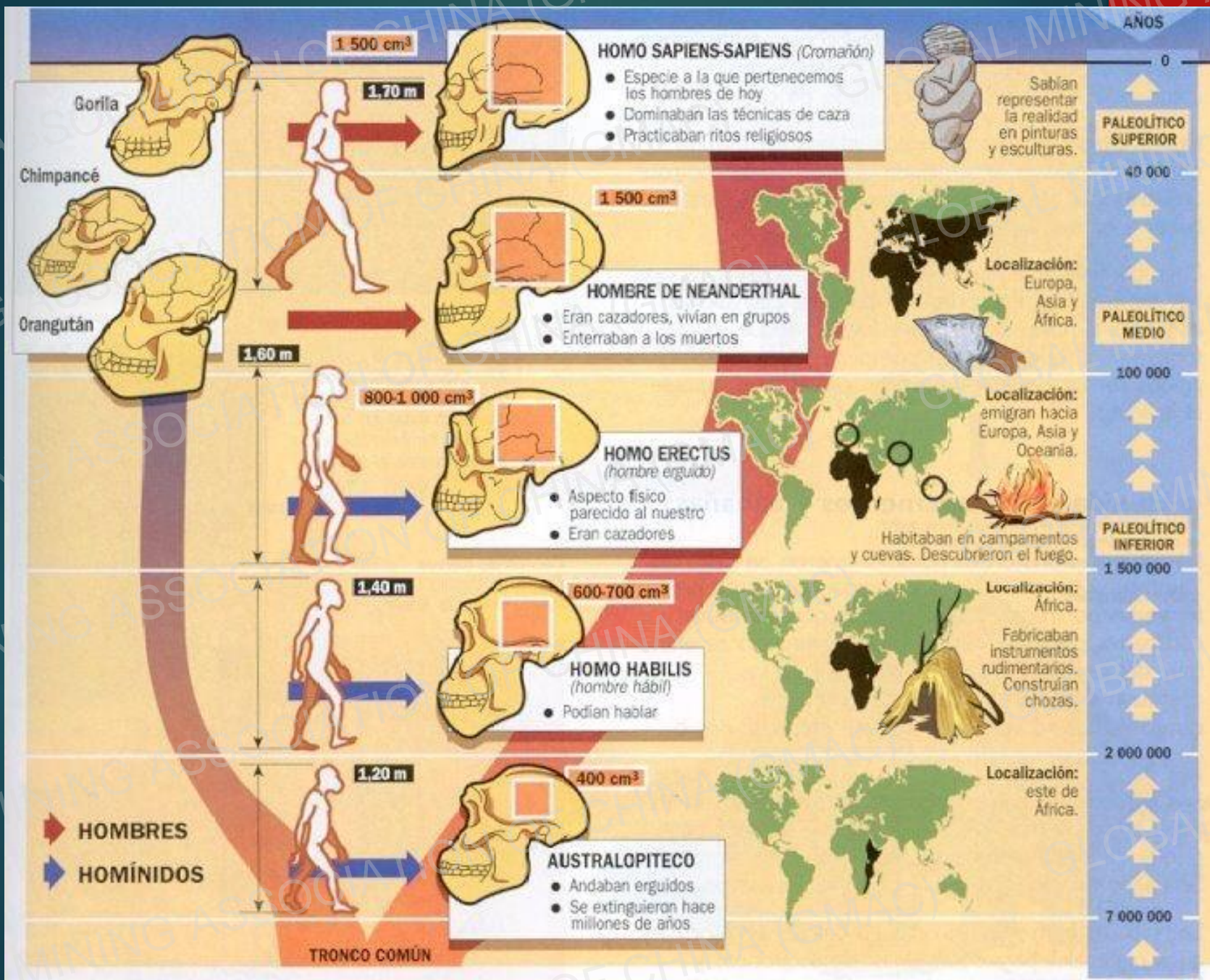


HUMAN EVOLUTION

<https://themelower.com/>

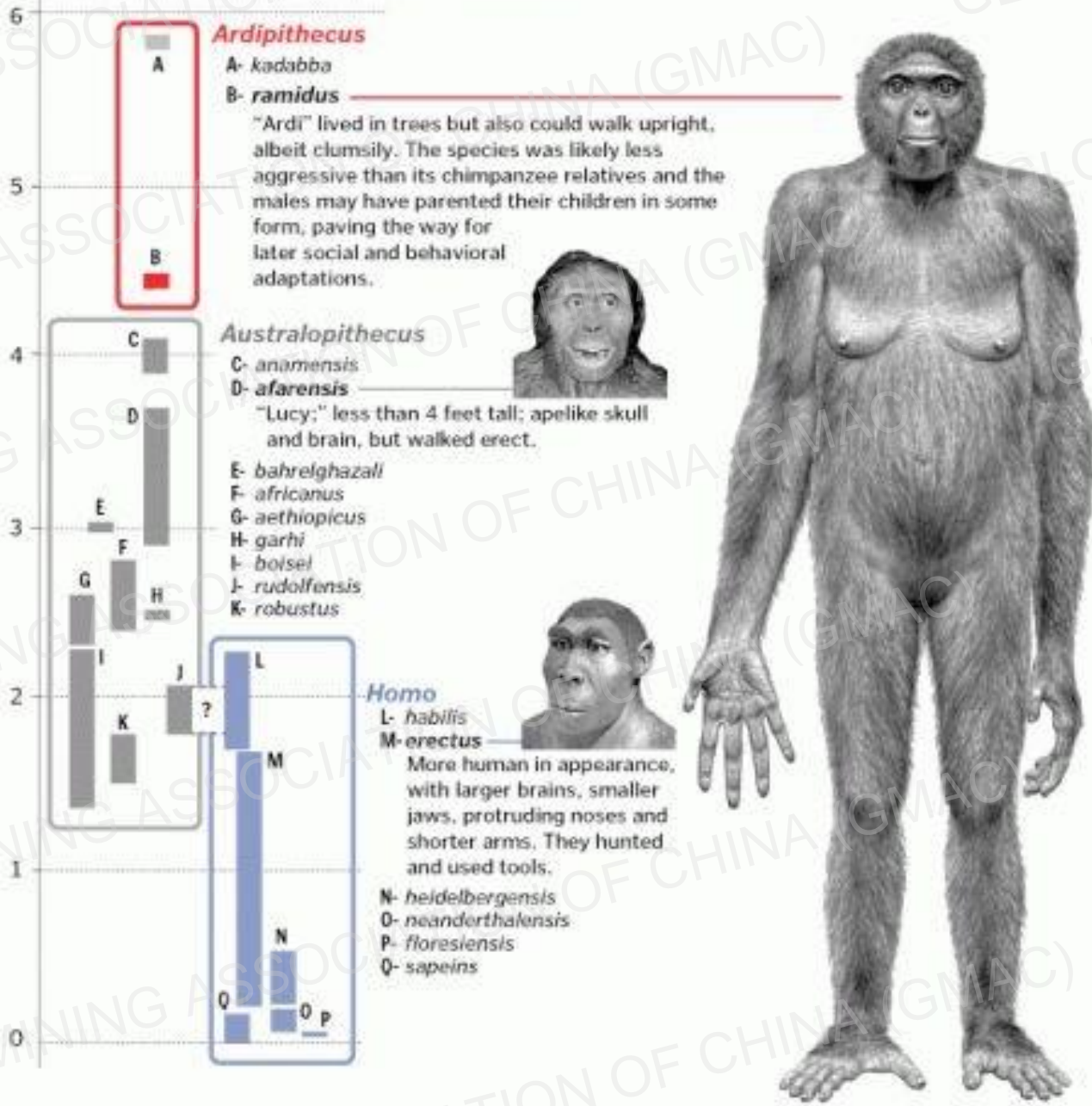


https://www.researchgate.net/publication/264417273_Embodied_Niche_Construction_in_the_Hominin_Lineage_Semiotic_Structure_and_Sustained_Attention_in_Human_Embodied_Cognition?_p=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjojX2RpcmVjdCJ9fQ



MILLIONS OF YEARS BEFORE THE PRESENT (Proximity of lines suggests evolutionary relationship)

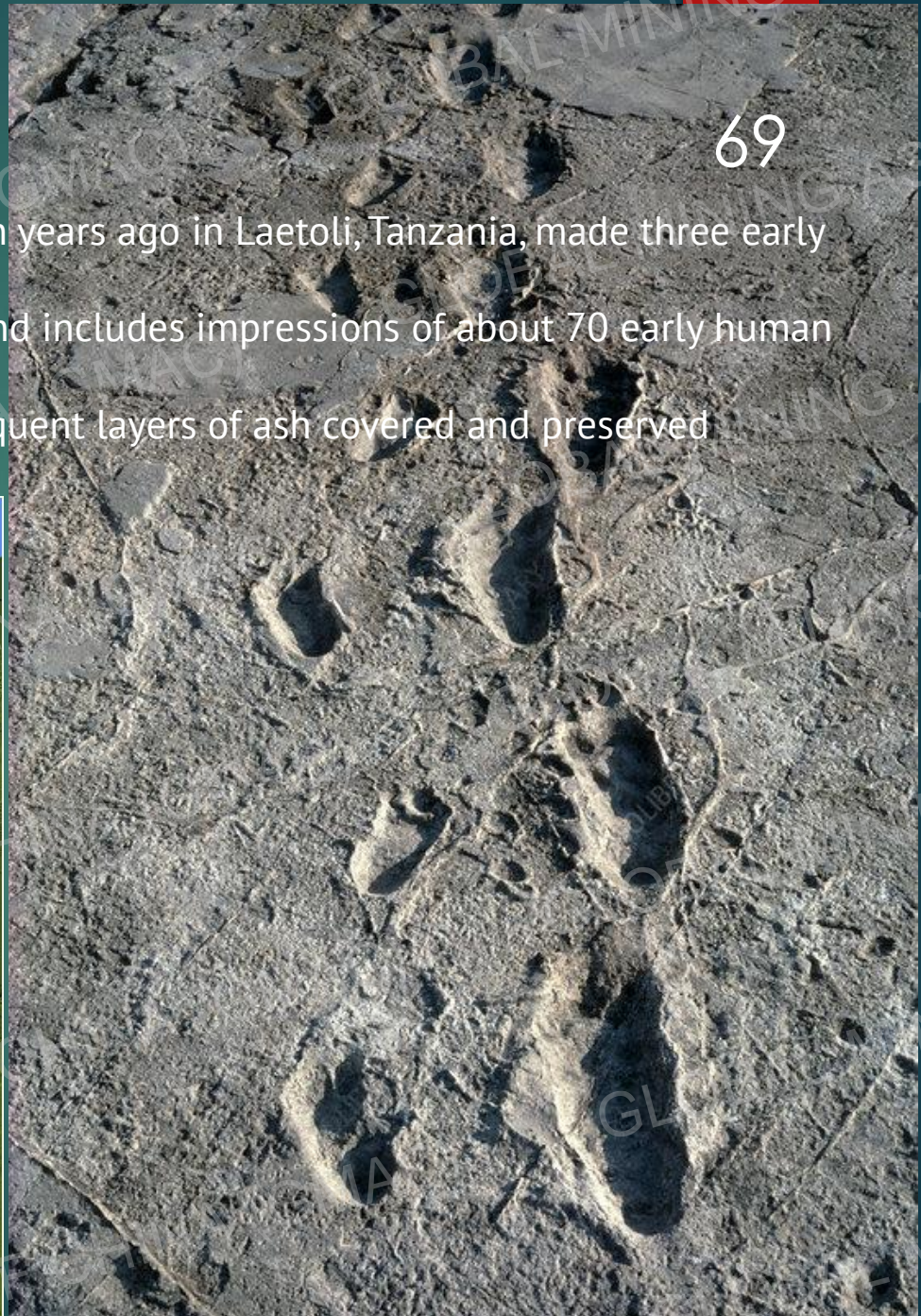
The last species before humans split from other primates existed more than 6 million years ago. This Holy Grail for anthropologists has not been found.

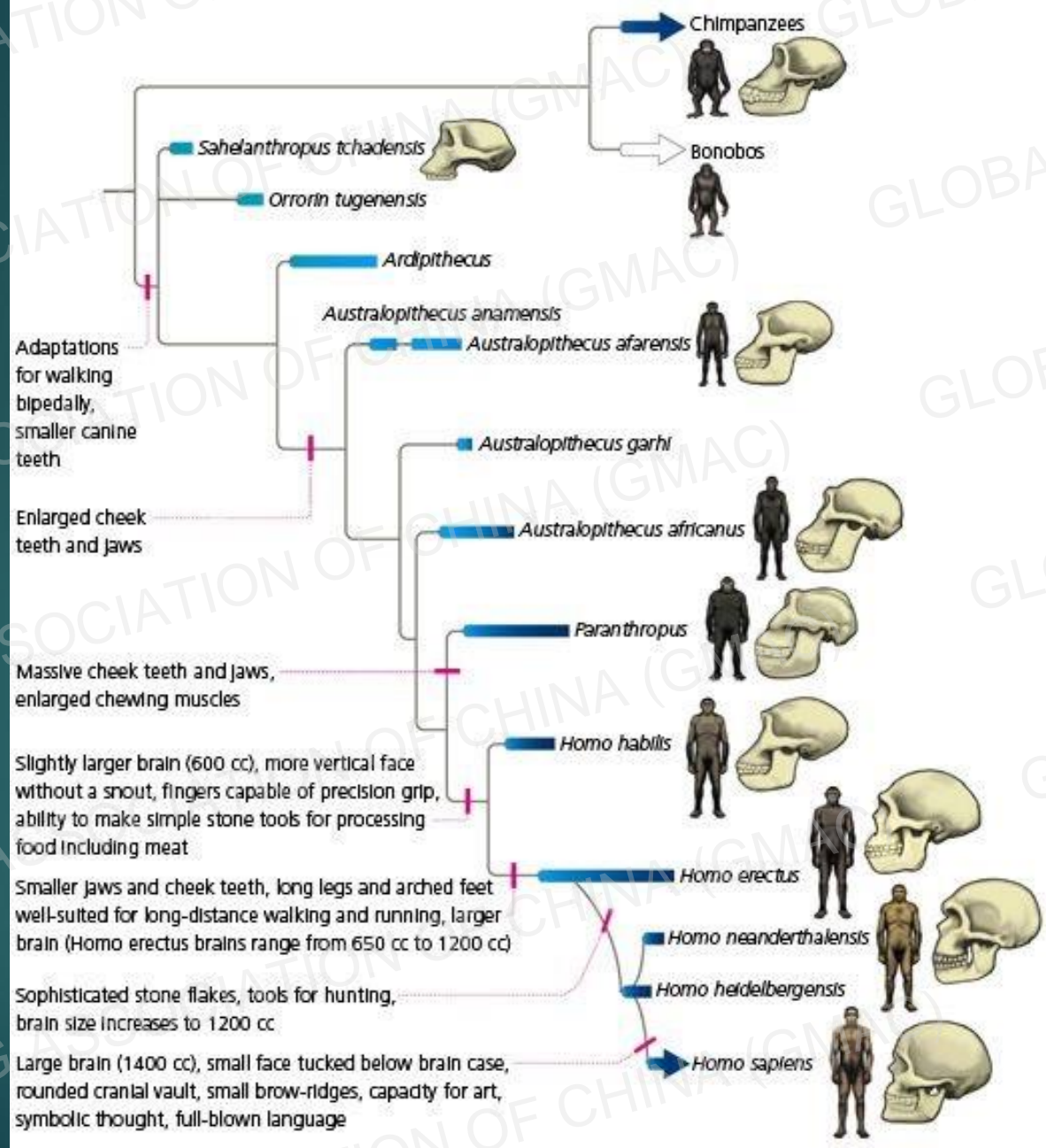
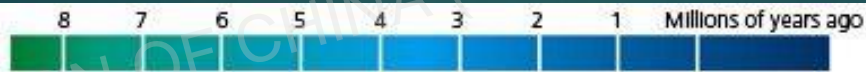


<https://www.pinterest.com/evanjburrows/pithecus/>

Laetoli Foot Prints

Most likely made by *Australopithecus* 3.6 million years ago in Laetoli, Tanzania, made three early humans walked through wet volcanic ash. The entire footprint trail is almost 27 m long and includes impressions of about 70 early human footprints. When the nearby volcano erupted again, subsequent layers of ash covered and preserved the oldest known footprints of early humans.





Adaptations for walking bipedally, smaller canine teeth

Enlarged cheek teeth and jaws

Massive cheek teeth and jaws, enlarged chewing muscles

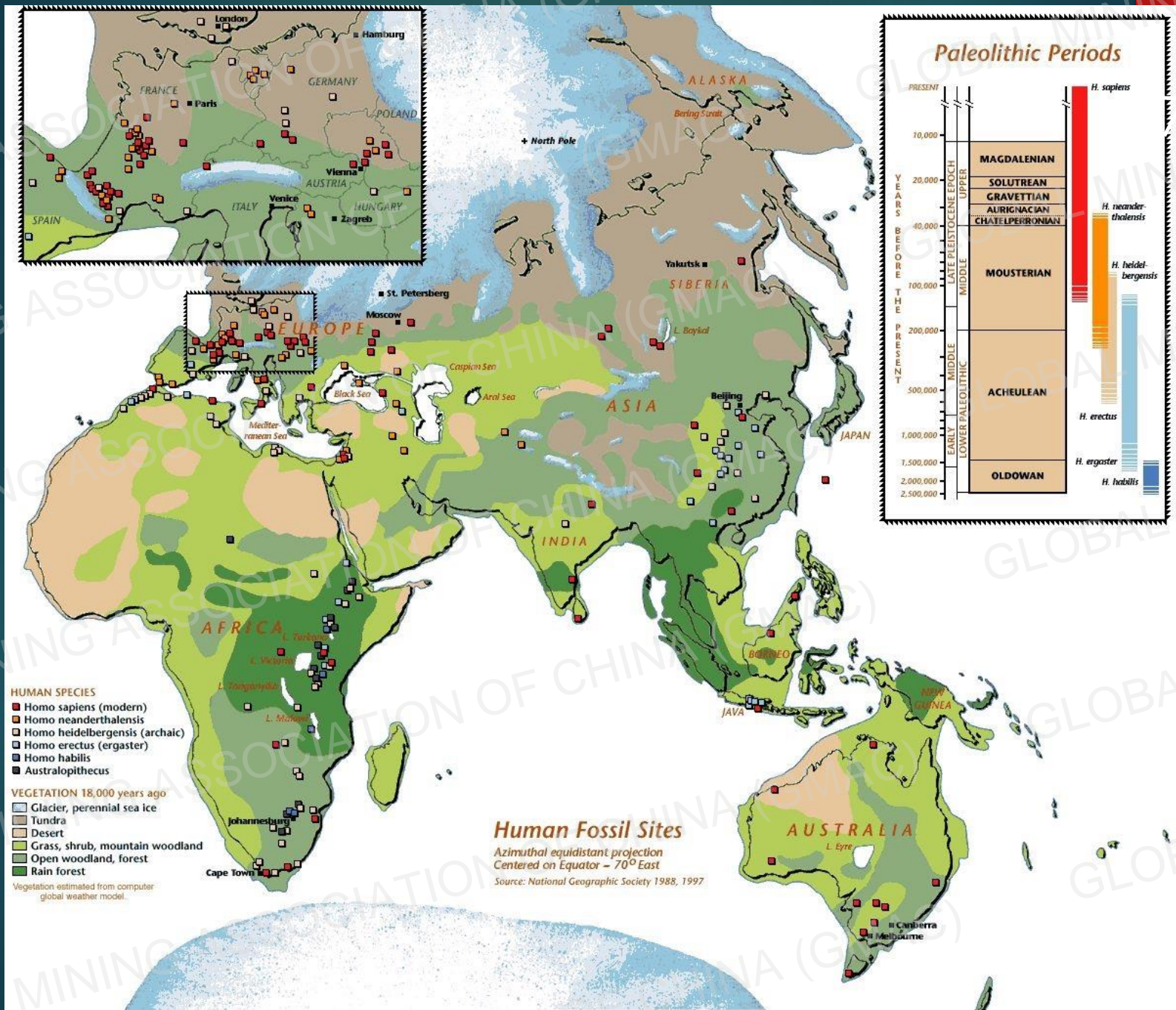
Slightly larger brain (600 cc), more vertical face without a snout, fingers capable of precision grip, ability to make simple stone tools for processing food including meat

Smaller jaws and cheek teeth, long legs and arched feet well-suited for long-distance walking and running, larger brain (Homo erectus brains range from 650 cc to 1200 cc)

Sophisticated stone flakes, tools for hunting, brain size increases to 1200 cc

Large brain (1400 cc), small face tucked below brain case, rounded cranial vault, small brow-ridges, capacity for art, symbolic thought, full-blown language

<https://www.quora.com/What-animal-did-we-evolve-from>

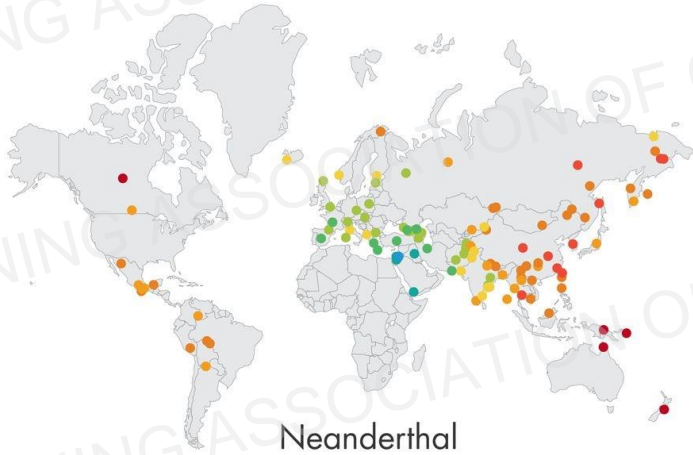




WHERE THE HOMININS ROAMED

As modern humans spread out of Africa, they interbred with Neanderthals and Denisovans. Traces of DNA from those archaic humans remains in our genomes, though some populations tend to have higher concentrations of our extinct ancestors' DNA than others.

Percentage of archaic DNA



Neanderthal



Denisovan

Early Humans Since Lucy

New fossil discovery may provide the missing link.

3.2 Million Years Ago



"Lucy"

Lucy was from *Australopithecus afarensis*. Although she had several ape-like features, Lucy stood upright and had small canine teeth, much like modern humans.

2.8 Million Years Ago



LD 350-1

We have a new oldest human fossil. Briefly, it looks like *Homo* genus arose by about 2.8 million years ago — almost half a million years earlier than once thought.

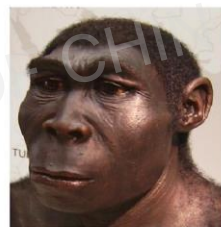
2.5 Million Years Ago



Homo habilis

One of the earliest modern humans, *Homo habilis* had a larger head and smaller face than Lucy, but retained many of her ape-like features.

1.8 Million Years Ago



Homo erectus

Homo erectus had relatively human-like body proportions, with longer legs and shorter arms for walking and possibly even running.

200 Thousand Years Ago



Homo sapiens

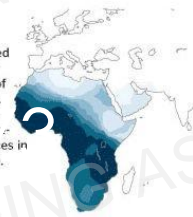
The only surviving species of the genus *Homo*. Molecular studies suggest that all modern humans diverged from a common ancestor about 200,000 years ago.

Mapping Recent Human Evolution

About 10 percent of human genes have continued to evolve since modern human beings emerged in Africa 200,000 years ago. Traits for disease resistance and environmental adaptation are undergoing natural selection.

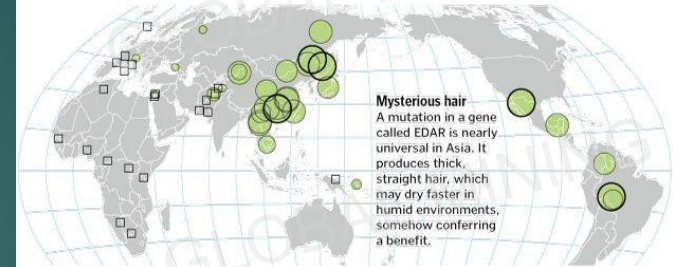
Malaria's pressure

A mutation in the "Duffy" red blood cell protein protects against vivax malaria, one of three types of the infection. The mutation is common in Africa but nearly absent elsewhere. Such great differences in the human genome are rare.

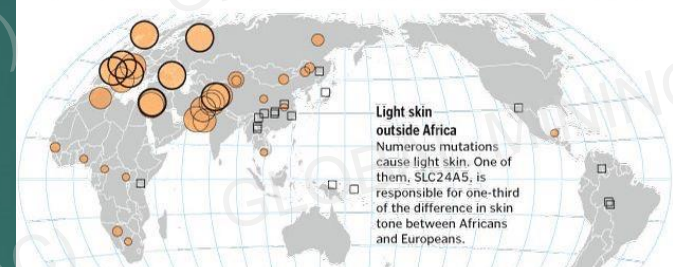


LEGEND

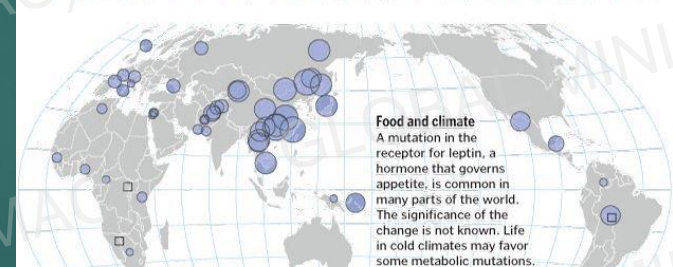
Prevalence of genes in populations tested



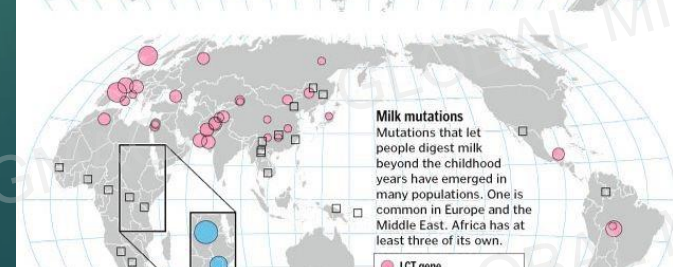
Mysterious hair
A mutation in a gene called EDAR is nearly universal in Asia. It produces thick, straight hair, which may dry faster in humid environments, somehow conferring a benefit.



Light skin outside Africa
Numerous mutations cause light skin. One of them, SLC24A5, is responsible for one-third of the difference in skin tone between Africans and Europeans.

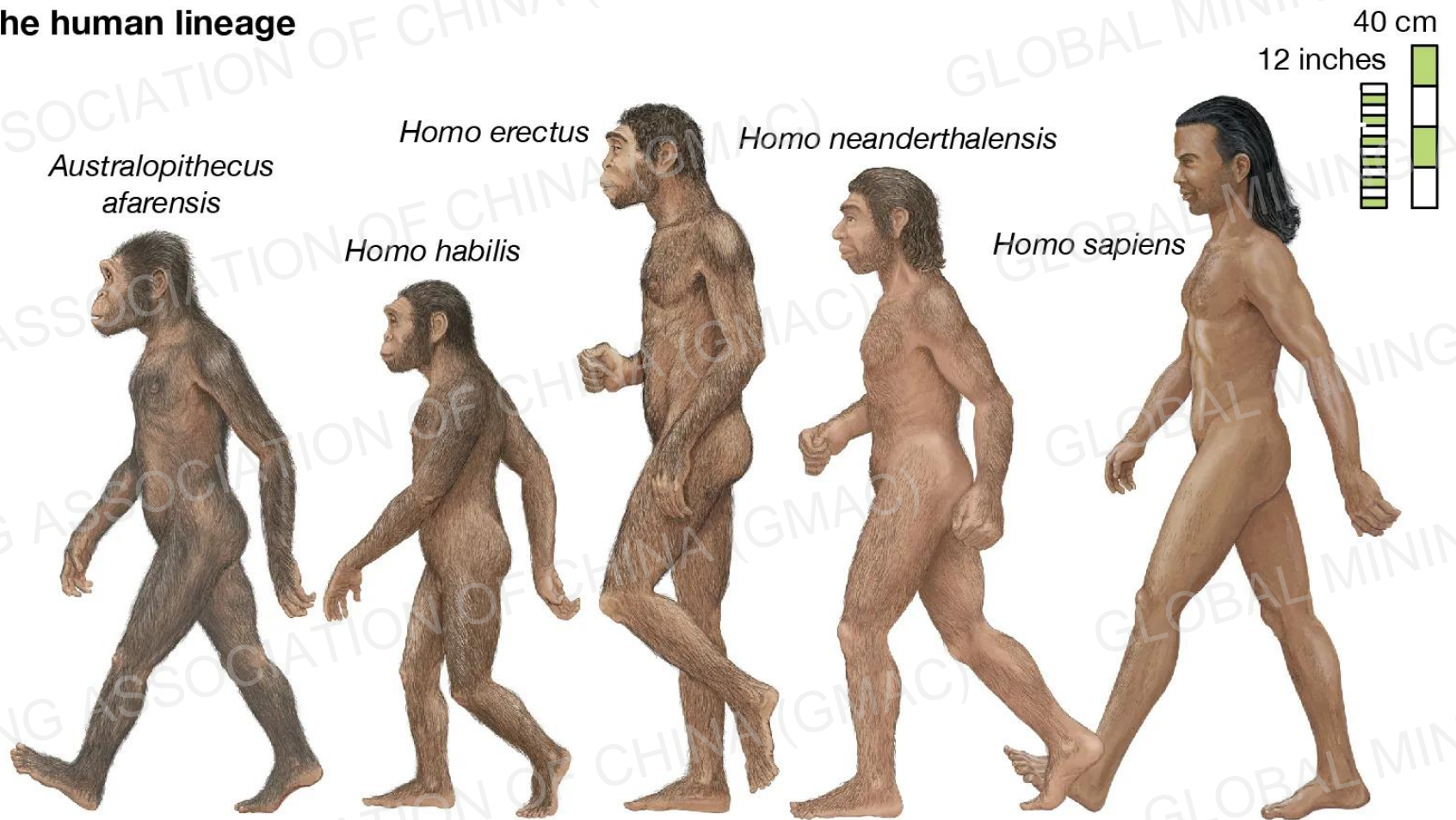


Food and climate
A mutation in the receptor for leptin, a hormone that governs appetite, is common in many parts of the world. The significance of the change is not known. Life in cold climates may favor some metabolic mutations.



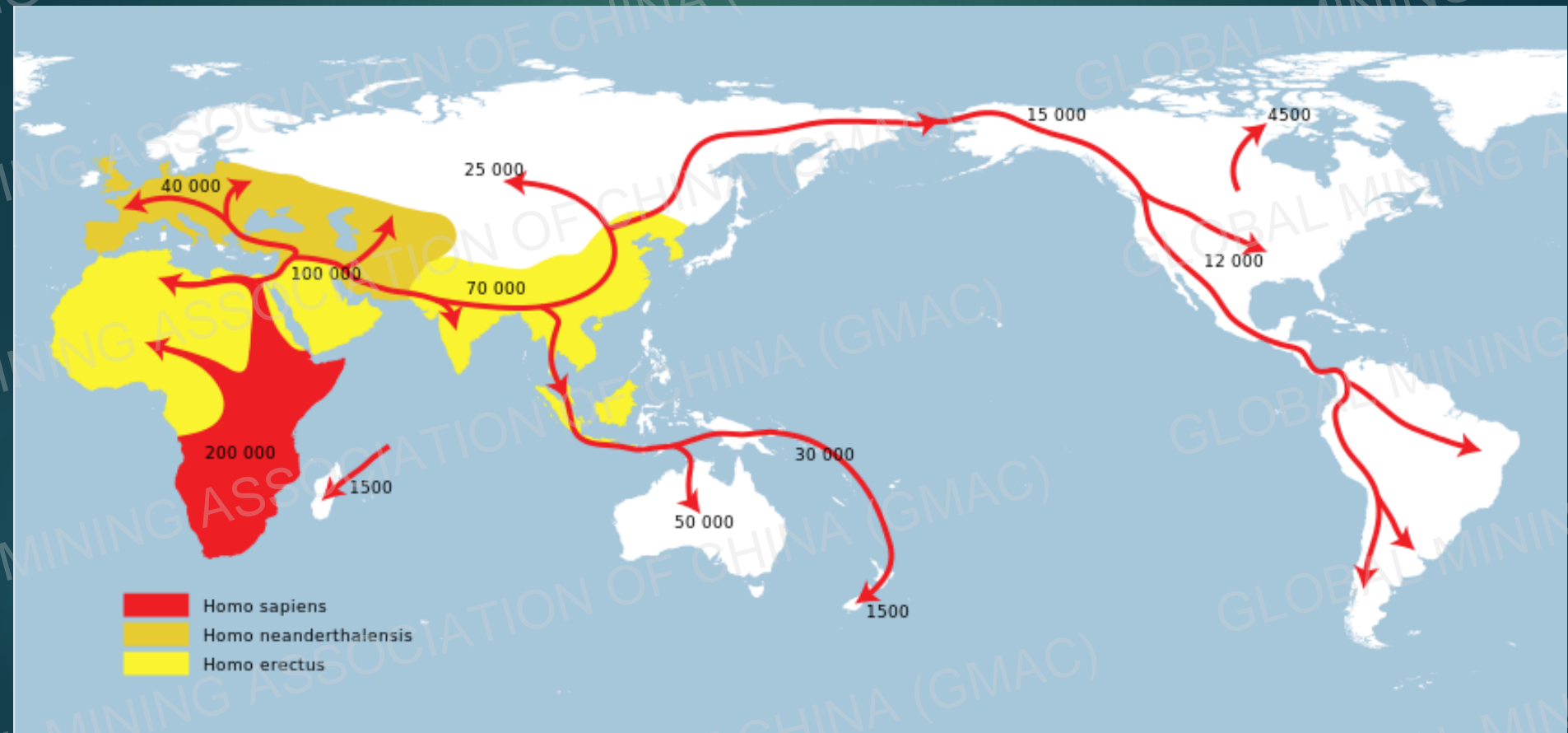
Milk mutations
Mutations that let people digest milk beyond the childhood years have emerged in many populations. One is common in Europe and the Middle East. Africa has at least three of its own.

The human lineage



The earliest species of *Homo* are known from only a few bone fragments. Some doubt that they belong in our genus, preferring to label them as *australopiths*.

The first well-established *Homo*, and the first that we would recognise as looking a bit like us, appeared about 1.9 million years ago. It is named *Homo erectus*.

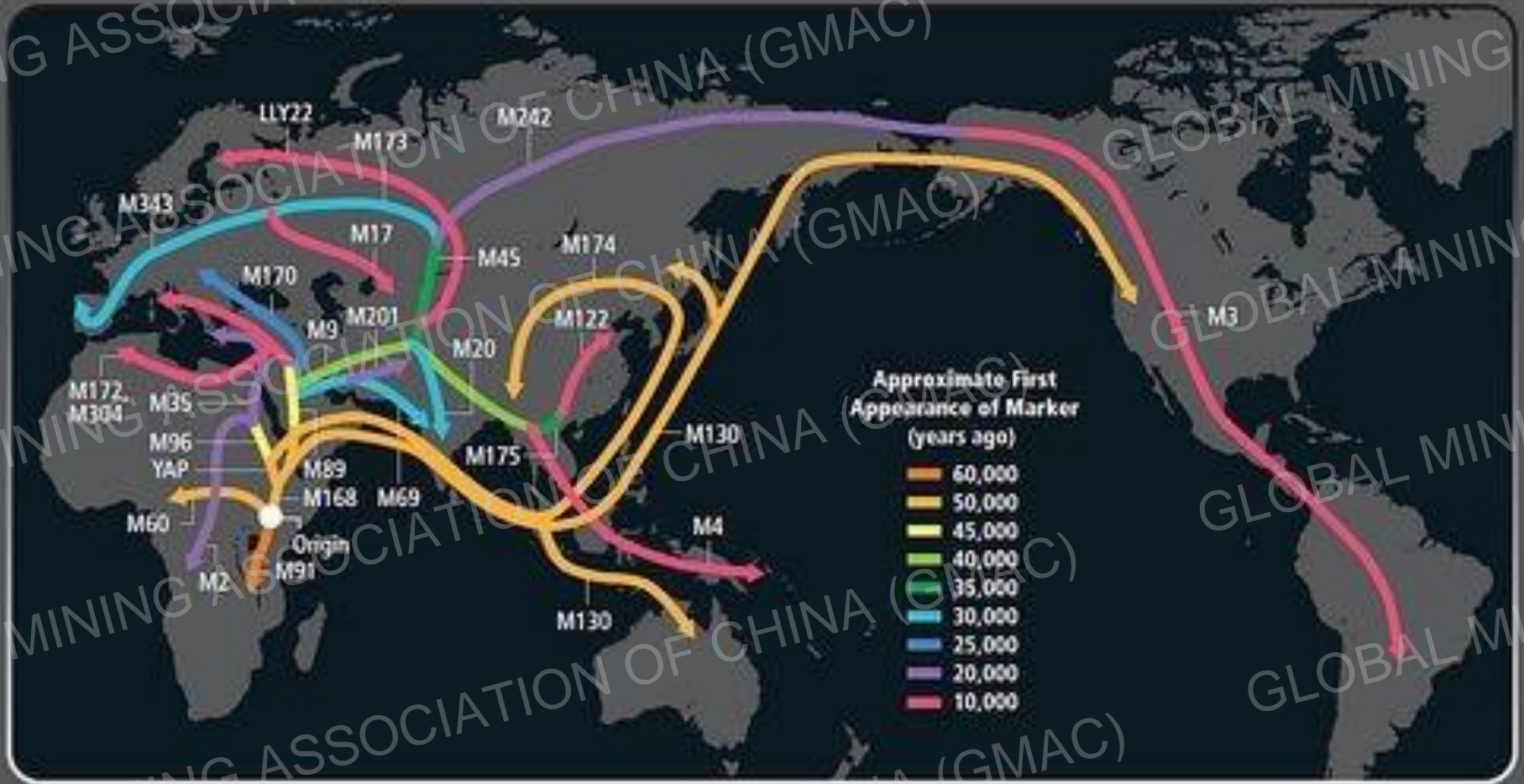


<https://www.quora.com/How-and-why-did-we-as-apes-and-hominids-including-other-species-survive-the-more-extreme-heats-and-colds-in-the-past-thousands-and-millions-years-ago-before-our-current-10-000-year-stable-climate-that-we-wouldnt-now>

[ROUTE MAPS]

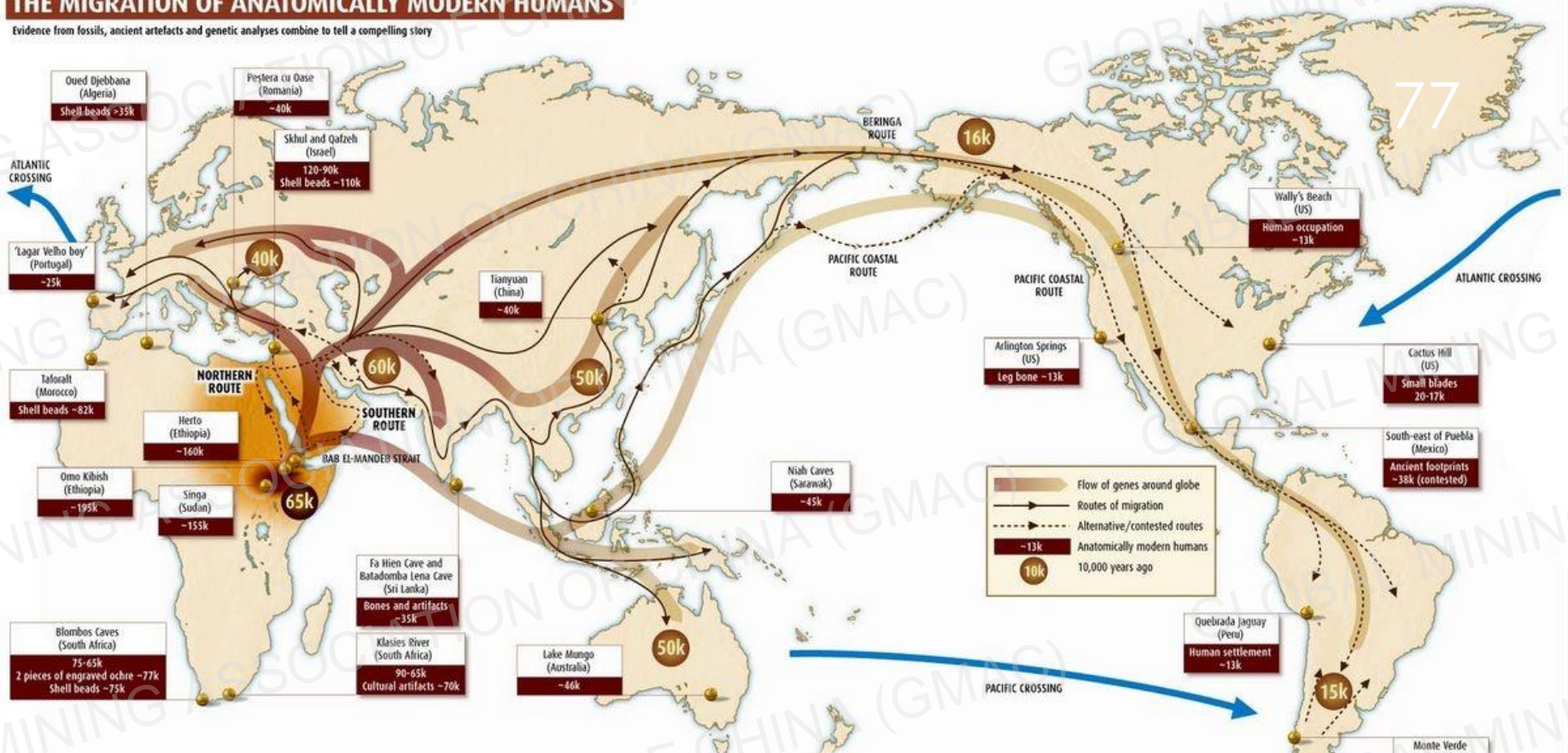
TRACKING Y CHROMOSOMES THROUGH TIME

Geneticists can track the path of ancient migrations by examining genetic markers in Y chromosomes from men who hail from different parts of the world. Each marker, such as M168 or M89, identifies a lineage of men and where the lineage originated. By building an evolutionary tree based on observing many living people with the markers, investigators can determine the approximate ages of the lineages.



THE MIGRATION OF ANATOMICALLY MODERN HUMANS

Evidence from fossils, ancient artefacts and genetic analyses combine to tell a compelling story

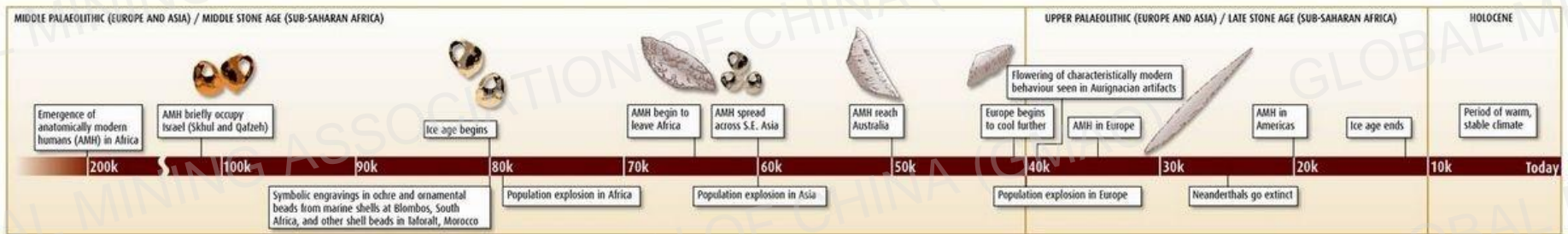


Two routes jump out as prime candidates for the human exodus out of Africa. A northern route would have taken our ancestors from their base in eastern sub-Saharan Africa across the Sahara desert, then through Sinai and into the Levant. An alternative southern route may have charted a path from Djibouti or Eritrea in the Horn of Africa across the Bab el-Mandeb strait and into Yemen and around the Arabian peninsula. The plausibility of these two routes as gateways out of Africa has been studied as part of the UK's Natural Environment Research Council's

programme "Environmental Factors in the Chronology of Human Evolution & Dispersal" (EFCHED). During the last ice age, from about 80,000 to 11,000 years ago, sea levels dropped as the ice sheets grew, exposing large swathes of land now submerged under water and connecting regions now separated by the sea. By reconstructing ancient shorelines, the EFCHED team found that the Bab el-Mandeb strait, now around 30 kilometres wide and one of the world's busiest shipping lanes, was then a narrow, shallow channel.

Early humans may have taken this southern route out of Africa. The northern route appears easier, especially given the team's finding that the Suez basin was dry during the last ice age. But crossing the Sahara desert is no small matter. EFCHED scientist Simon Armitage of the Royal Holloway University of London has found some clues as to how this might have been possible. During the past 150,000 years, North Africa has experienced abrupt switches between dry, arid conditions and a humid climate. During the longer wetter periods huge lakes existed in both Chad and Libya, which would have

provided a "humid corridor" across the Sahara. Armitage has discovered that these lakes were present around 10,000 years ago, when there is abundant evidence for human occupation of the Sahara, as well as around 115,000 years ago, when our ancestors first made forays into Israel. It is unknown whether another humid corridor appeared between about 65,000 and 50,000 years ago, the most likely time frame for the human exodus. Moreover, accumulating evidence is pointing to the southern route as the most likely jumping-off point.



SECOND-WAVE CIVILIZATION NATURAL RESOURCES / TRADE

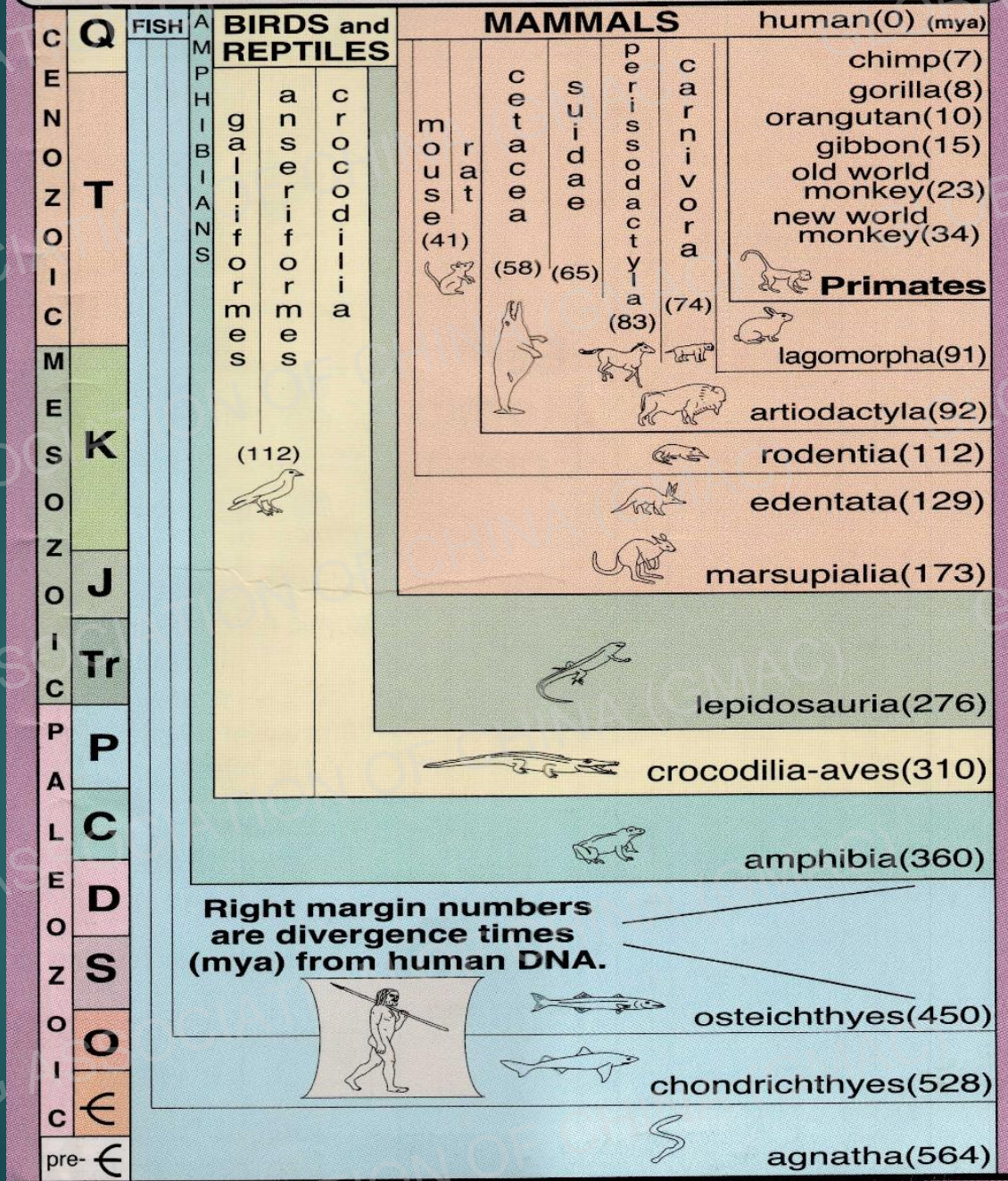


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WORLD HISTORY ENCYCLOPEDIA

<https://www.worldhistory.org/image/17854/second-wave-civilization-natural-resources-and-tra/>

Genetic Timescale



Paul R. Janke, 2009, A Correlated History of Earth

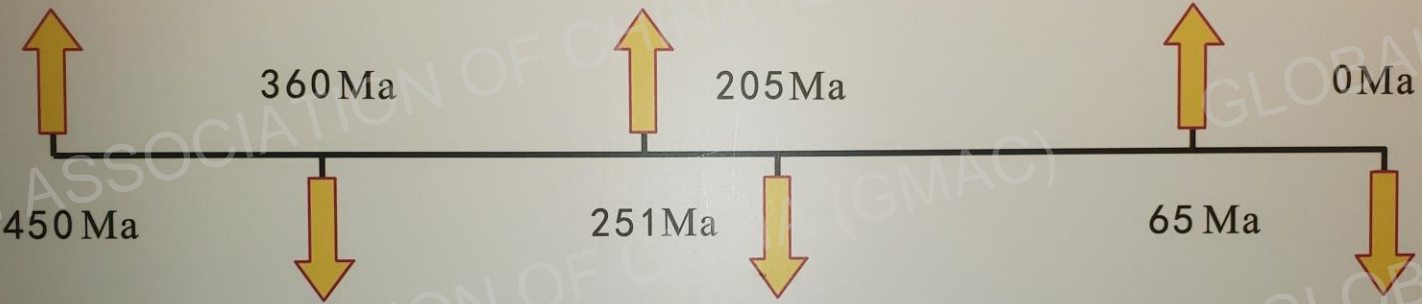
奥陶纪末期



二叠纪末期



白垩纪末期



晚泥盆世



三叠纪末期

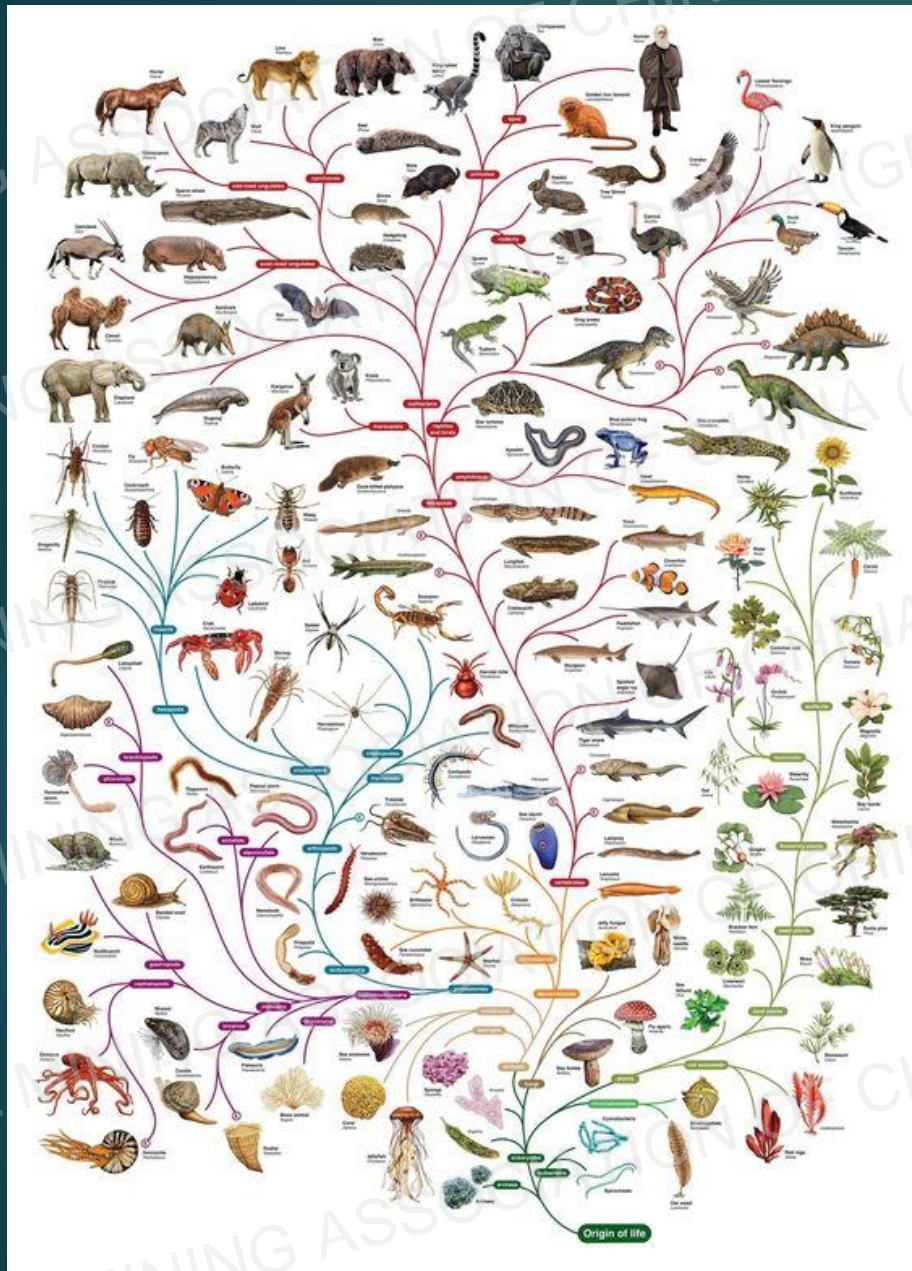


现在

Civilization exists by geological consent, subject to change without notice

Will Durant

显生宙六次生物集群灭绝事件



地球生物一家人

We are all connected



从最小的蚂蚁到参天大树，

从鸟儿遨游天空到鱼儿潜泳水中，

每一种生物都是地球生物圈大家庭的一部分。

让我们积极行动起来，保护我们的地球家园。

保护地球生灵，也就是保护我们自己，

让我们从现在就积极行动起来吧！

A Four Minute Video If We Have Time

Thank You