Inside human evolution fossil remains

Deciphering signals of the past

Southern Cross University

Southern Cross GeoScience

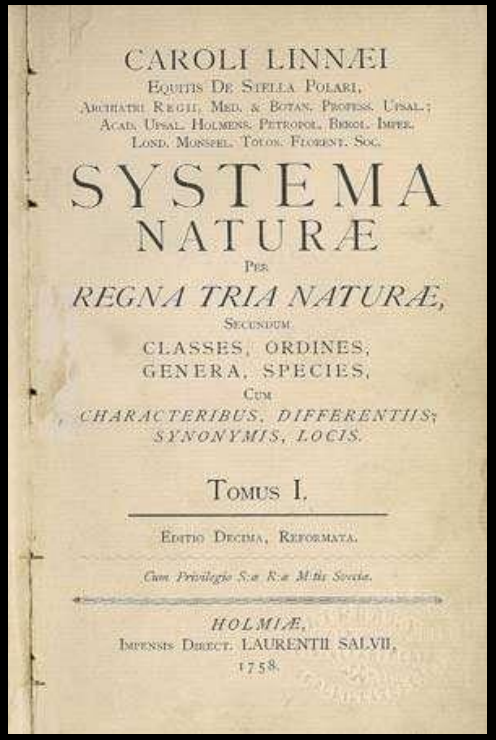
GARG Geoarchaeology and Archaeometry Research Group

Dr Renaud Joannes-Boyau
BSouthport, 2018
renaud.joannes-boyau@scu.edu.au

Did all the species always existed ?

Aristotle's book ΤΩΝ ΠΕΡΙ ΤΑ ΖΩΙΑ ΙΣΤΟΡΙΩΝ (wrongly) translated to English as *The history of animals* is the mother book of zoology

The concept of extinction seems obvious to us nowadays



CAROLI LINNÆI

EQUITIS DE STELLA POLARI,
ARCHIATRI REGII, MED. & BOTAN. PROFESS. UPSAL.;
ACAD. UPSAL. HOLMENS. PETROPOL. BEROL. IMPER.
LOND. MONSPEL. TOLOS. FLORENT. SOC.

SYSTEMA NATURÆ

PER

REGNA TRIA NATURÆ,

SECUNDUM

CLASSES, ORDINES,
GENERA, SPECIES,

CUM

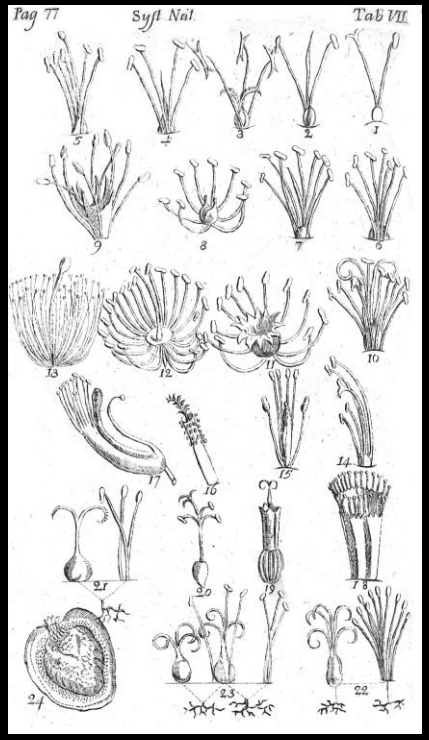
CHARACTERIBUS, DIFFERENTIIS,
SYNONYMIS, LOCIS.

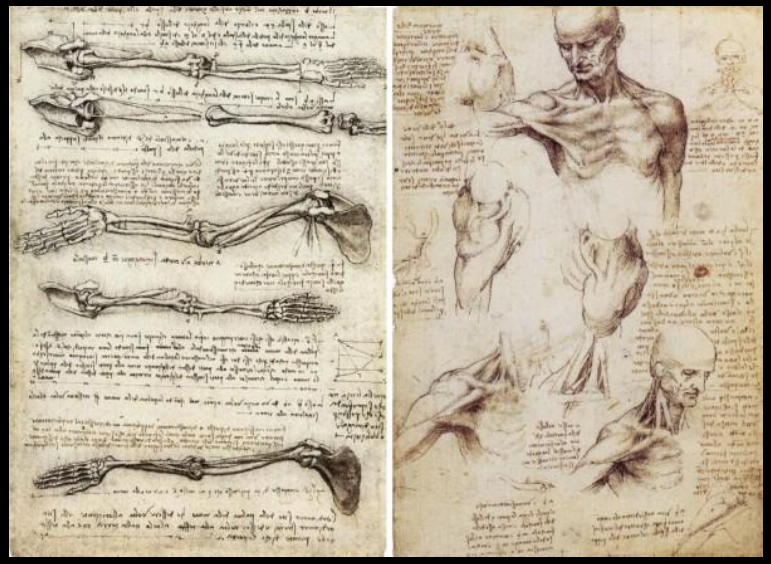
TOMUS I.

EDITIO DECIMA, REFORMATA.

Cum Privilegio S.æ R.æ M.tis Sveciæ.

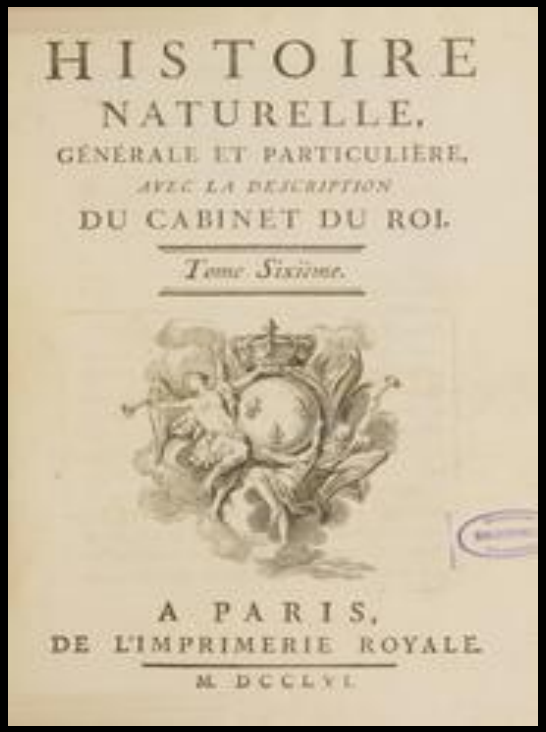
HOLMIÆ,
IMPENSIS DIRECT. LAURENTII SALVII,
1758.





Georges-Louis Leclerc, Comte de Buffon (1707-1788)

Life, like Earth has an history

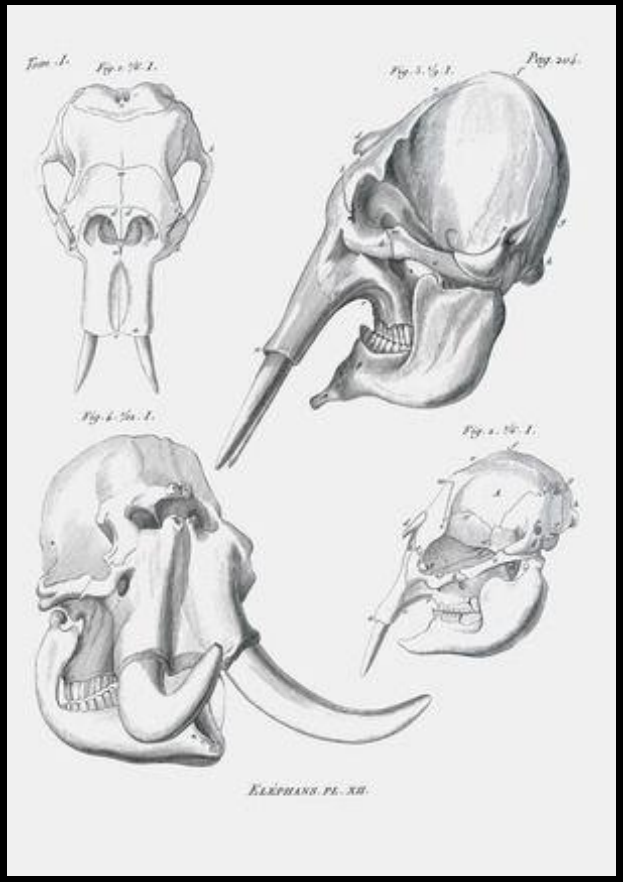

HISTOIRE
NATURELLE,
GÉNÉRALE ET PARTICULIÈRE,
AVEC LA DESCRIPTION
DU CABINET DU ROI.

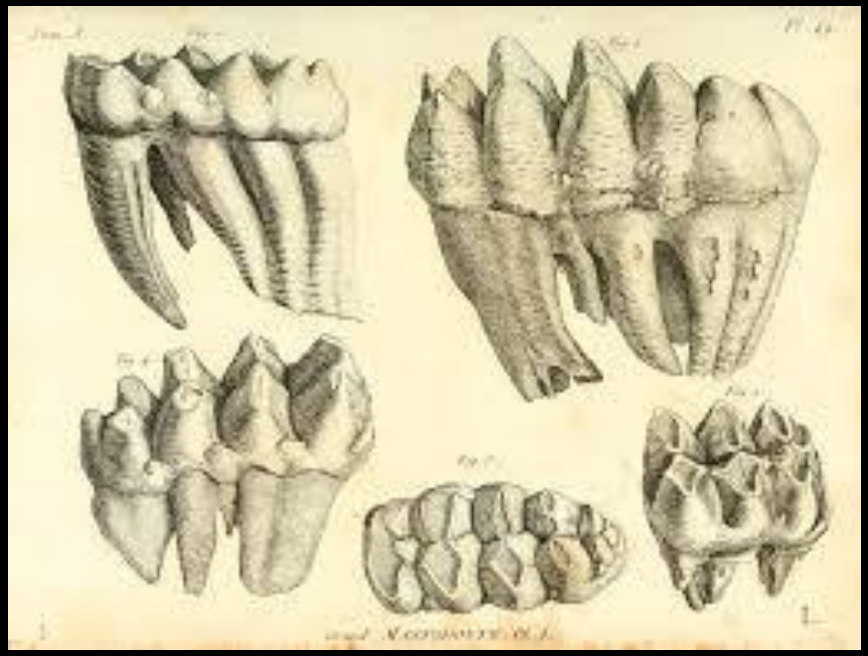
Tome Sixième.

A PARIS,
DE L'IMPRIMERIE ROYALE.
M. DCCLVI.

Georges Cuvier (1769-1832)

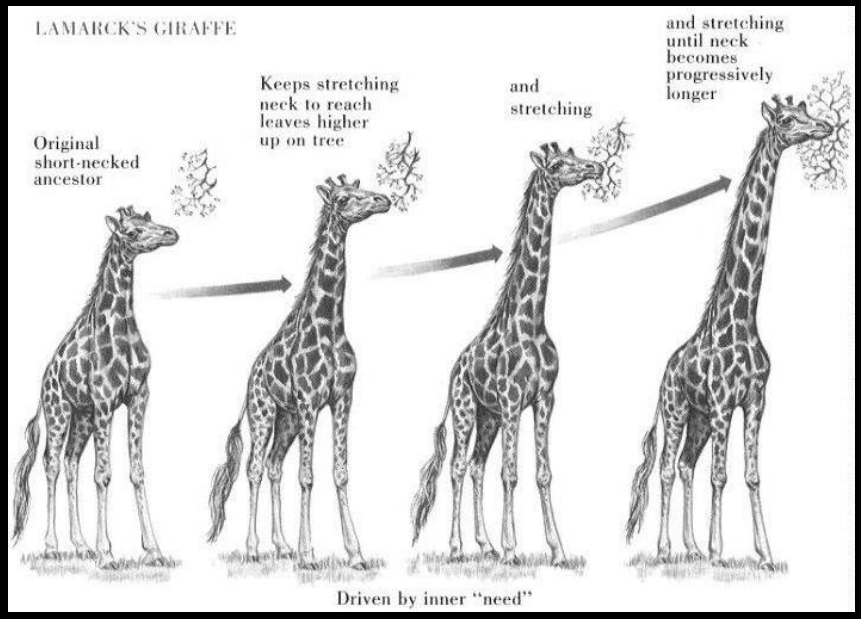
Extinction happened, "Espèces perdues"





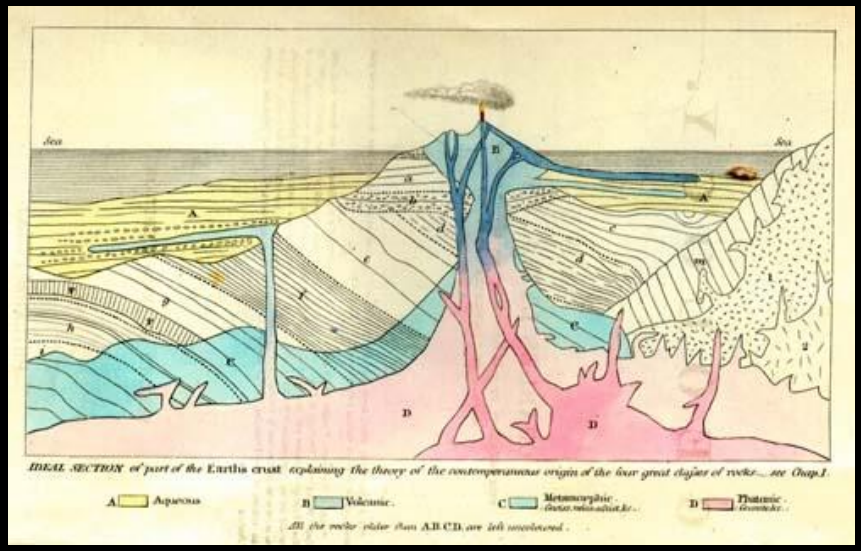
Jean-Baptist Lamarck (1744-1829)

Adaptation and idea of inheritance



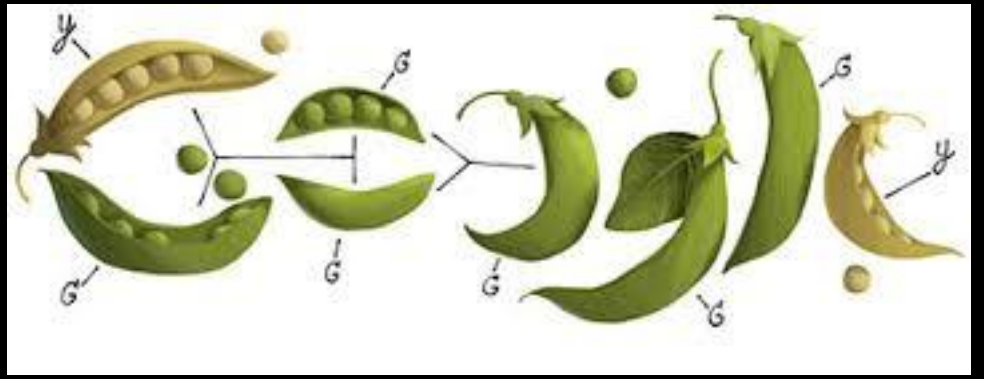
Charles Lyell (1797-1875)

Geological changes over time



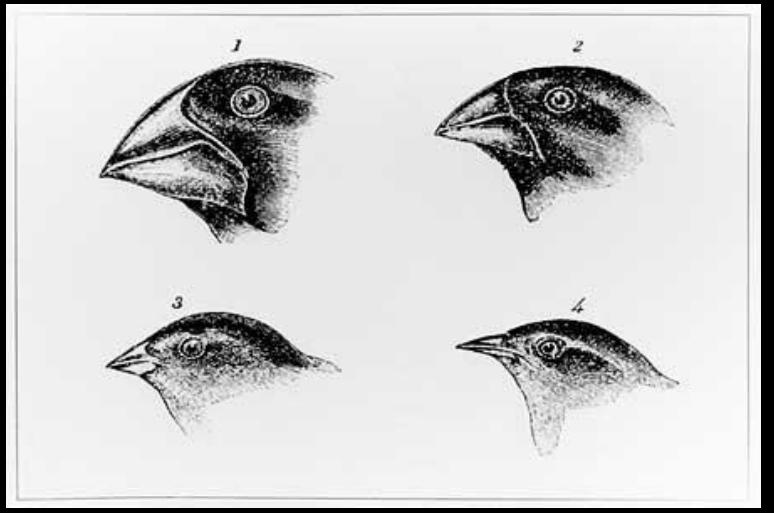
Gregor Mendel (1822-1884)

Heredity and selection



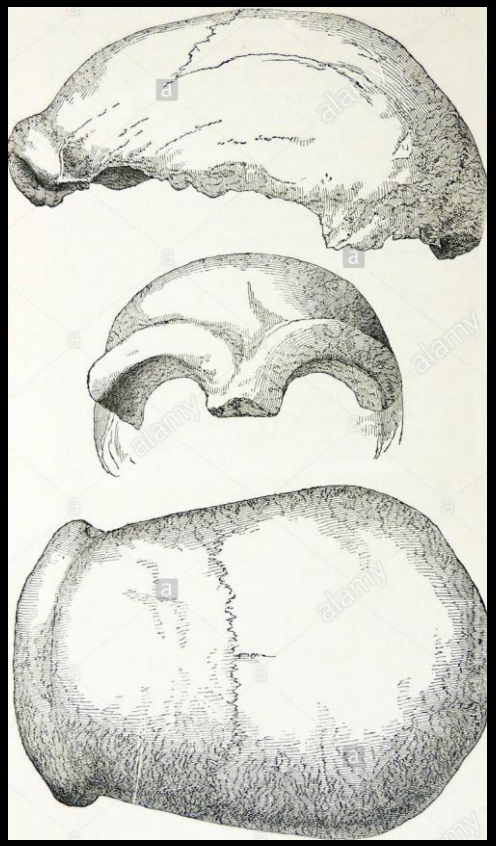
Charles Darwin (1809-1882)

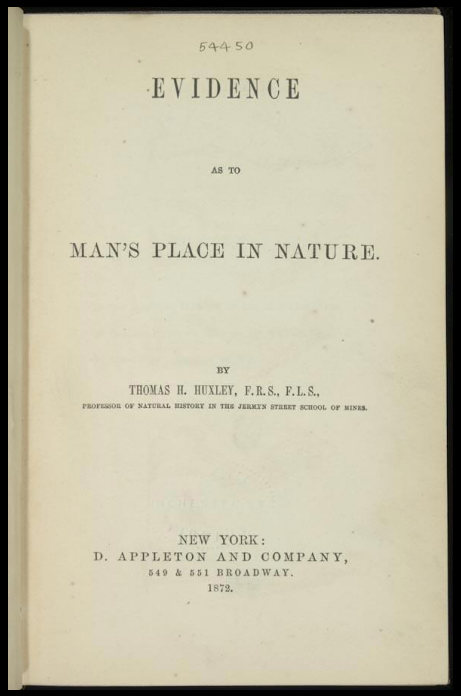
Origin of species and natural selection



Thomas Huxley (1825-1895)

Man and apes common ancestor





54450

EVIDENCE

AS TO

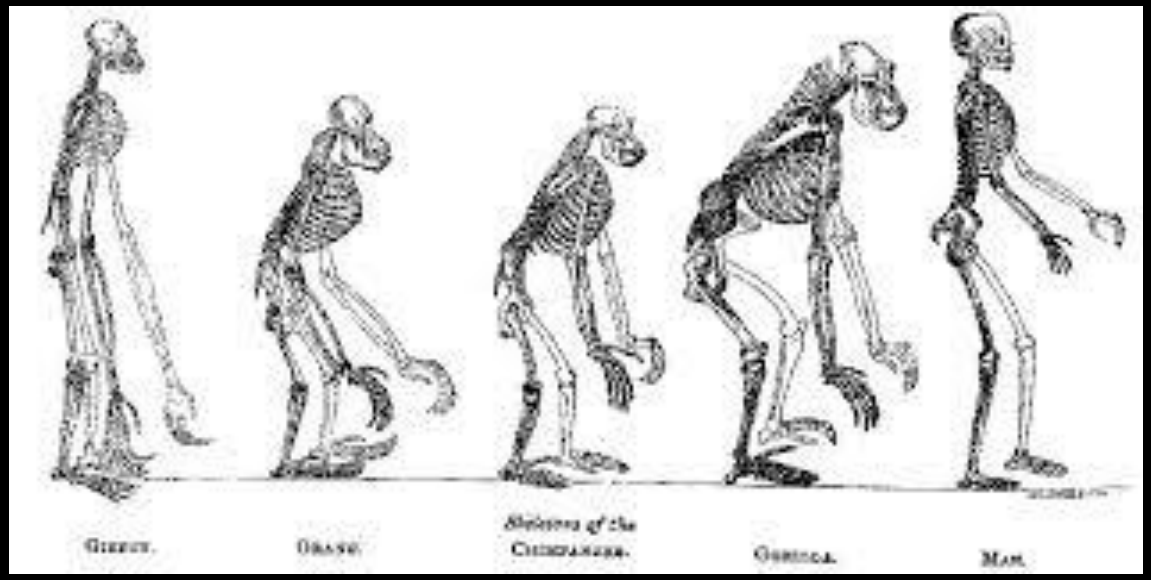
MAN'S PLACE IN NATURE.

BY

THOMAS H. HUXLEY, F.R.S., F.L.S.,

PROFESSOR OF NATURAL HISTORY IN THE JERMYN STREET SCHOOL OF MINES.

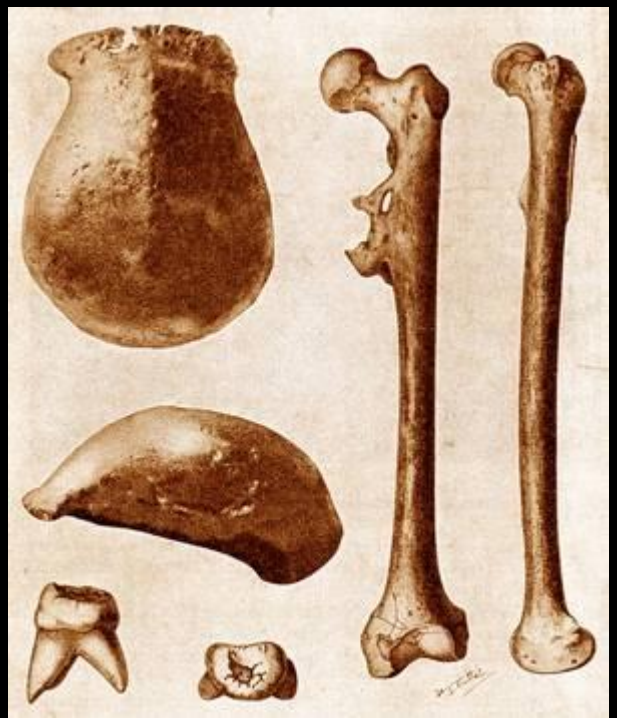
NEW YORK:
D. APPLETON AND COMPANY,
549 & 551 BROADWAY.
1872.

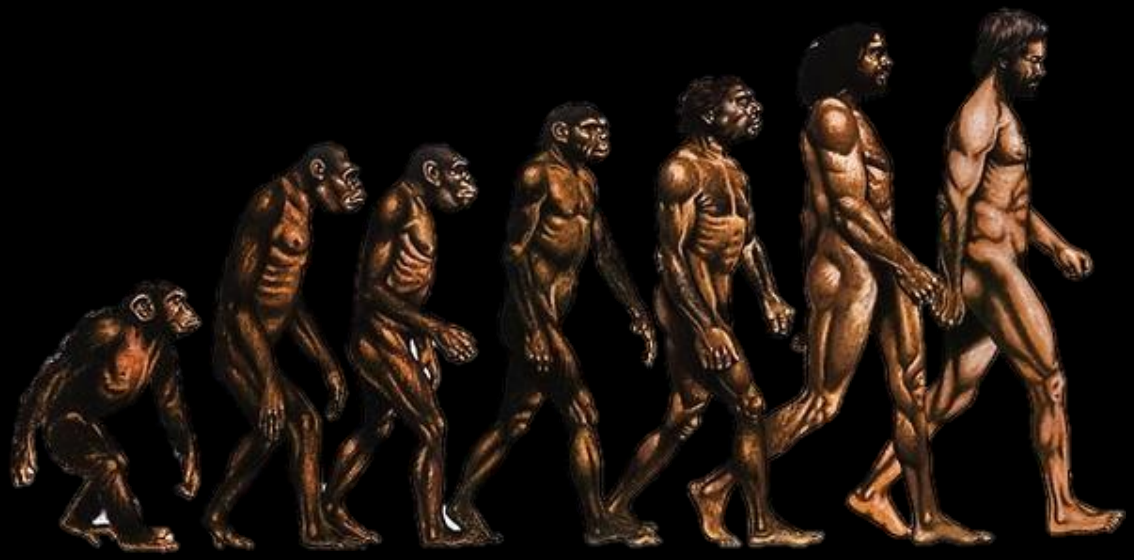


Eugene Dubois (1858-1940)

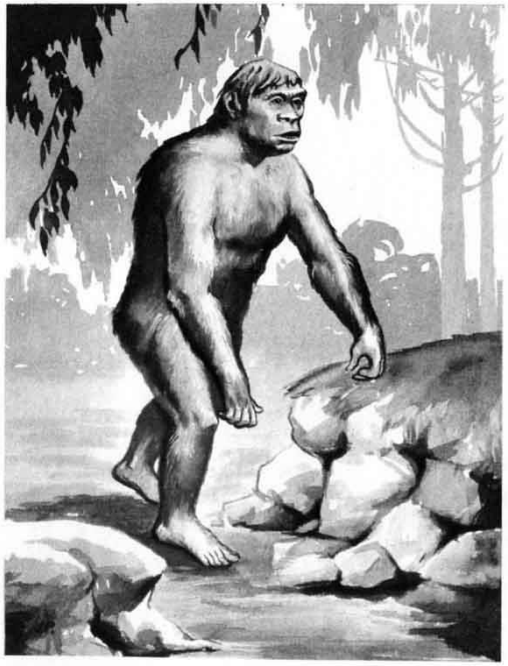
Java Man, discovered in Trinil (Indonesia, 1886)

Homo erectus

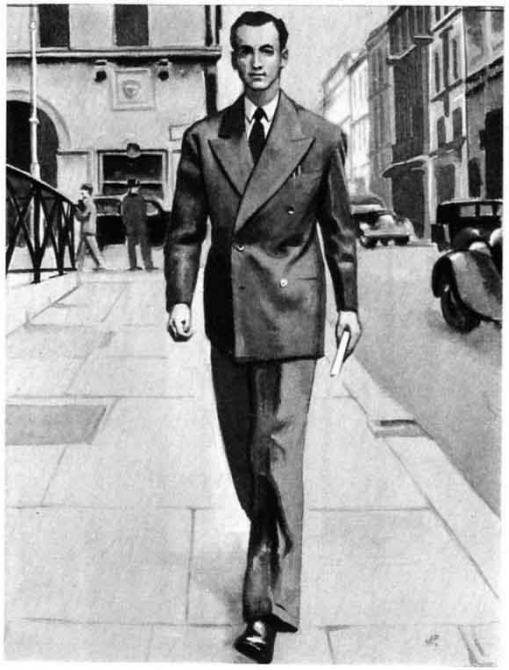


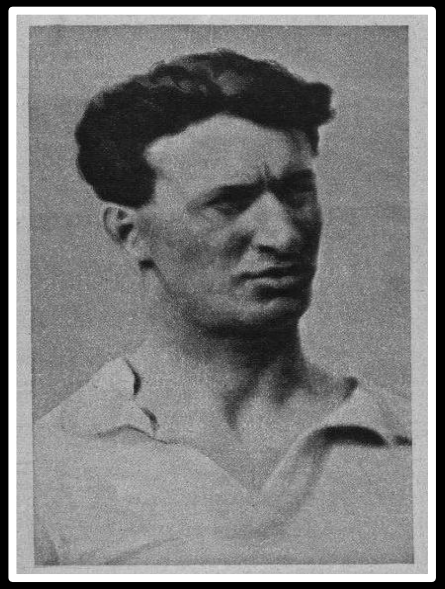


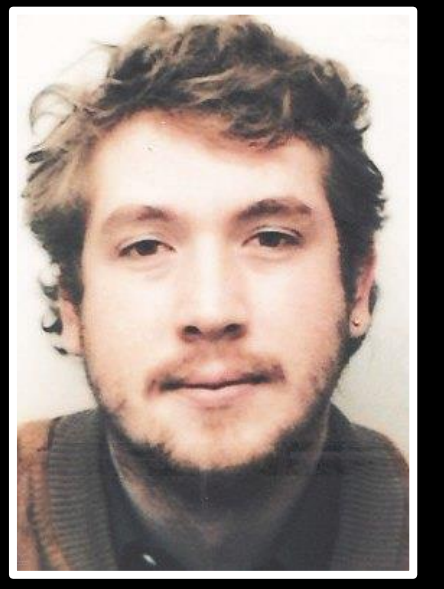
FROM SUCH BEGINNINGS. Ape-like in appearance, short, stocky, barrel-chested and strongly-muscled, Neanderthal man takes his place amongst our earliest ancestors.



AND NOW TODAY. His upright carriage, slim build, high brow, head posture, straightened legs, non-protruding jaw and fang-rooted teeth distinguish the modern man.



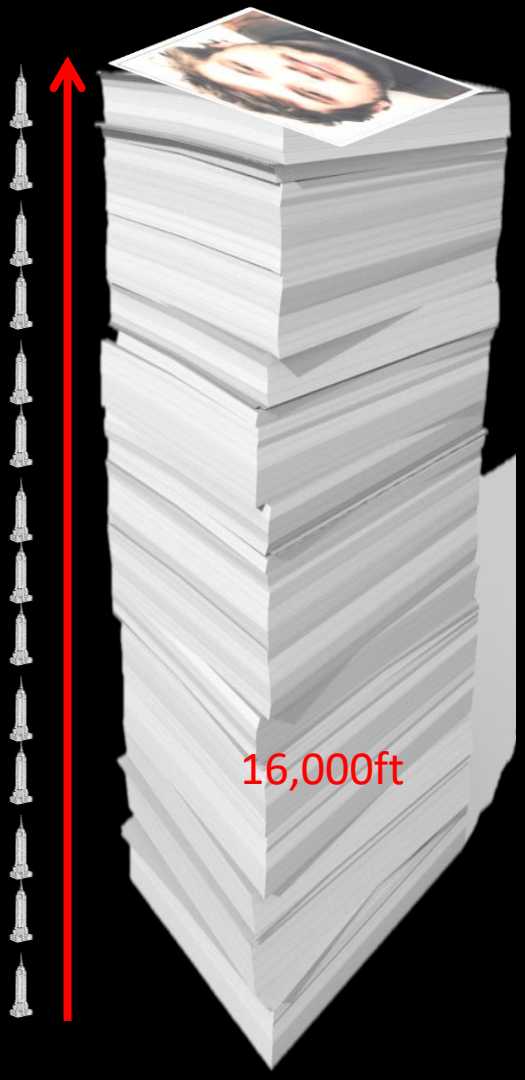


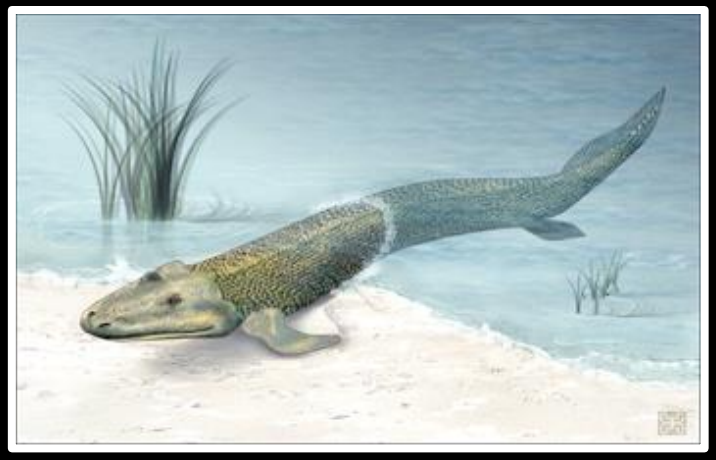
Time

Time

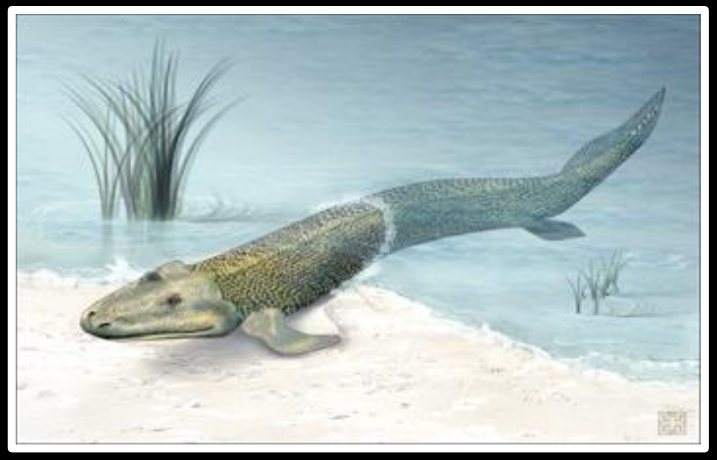
Each individual is the same species as their parents and grand parents….



Parent

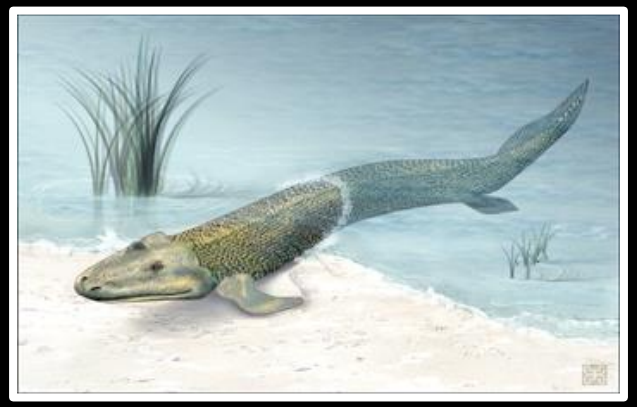


Offspring

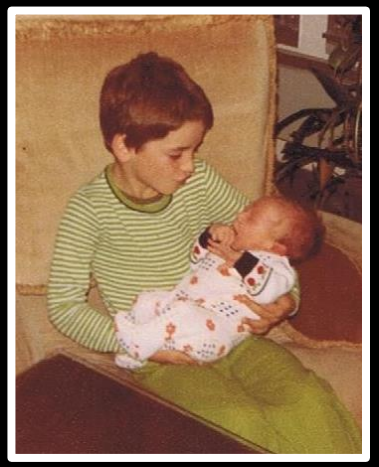


Time

Each individual is the same species as their grand parents

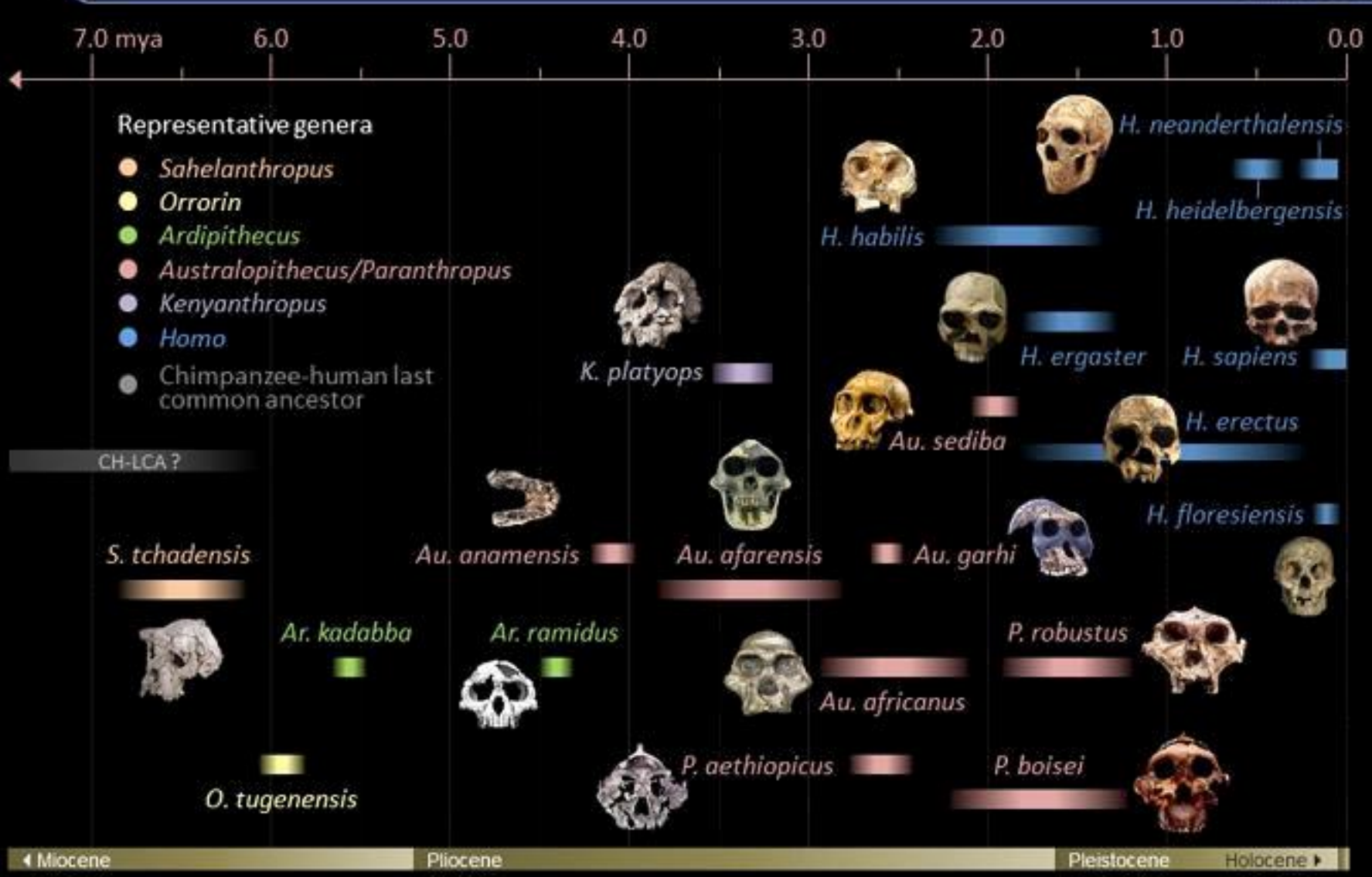


About 500M years between us

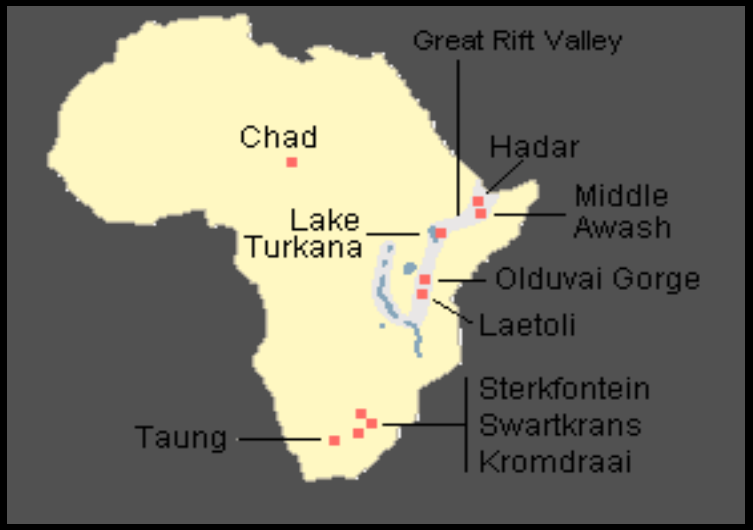


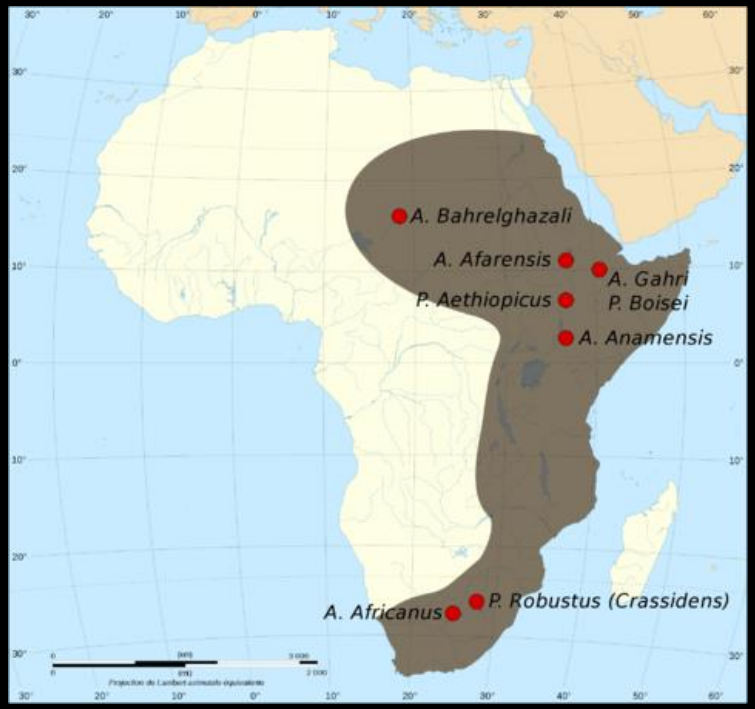

מוקשים
احترس من الالغام!
DANGER MINES !

Hominid evolution

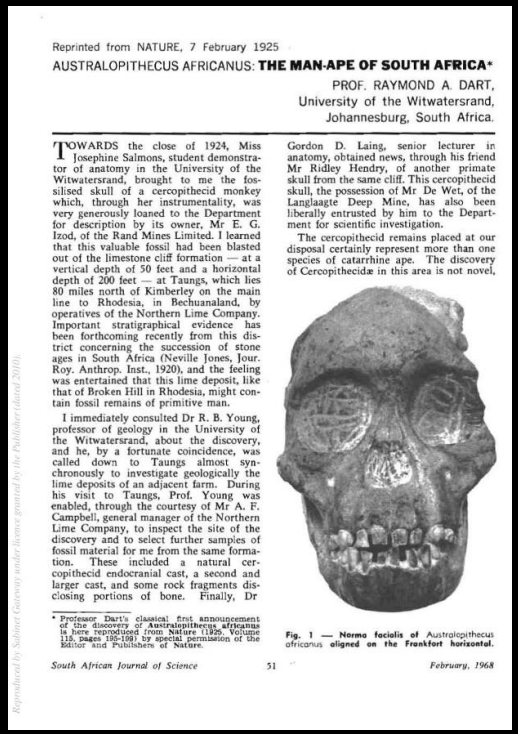


Australopithecus





R. Dart 1925



Reprinted from NATURE, 7 February 1925

AUSTRALOPITHECUS AFRICANUS: **THE MAN-APE OF SOUTH AFRICA***

PROF. RAYMOND A. DART,
University of the Witwatersrand,
Johannesburg, South Africa.

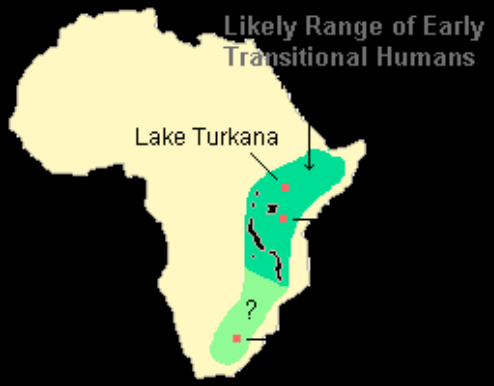
TOWARDS the close of 1924, Miss Josephine Salmons, student demonstrator of anatomy in the University of the Witwatersrand, brought to me the fossilised skull of a cercopithecid monkey which, through her instrumentality, was very generously loaned to the Department for description by its owner, Mr E. G. Izod, of the Rand Mines Limited. I learned that this valuable fossil had been blasted out of the limestone cliff formation — at a vertical depth of 50 feet and a horizontal depth of 200 feet — at Taungs, which lies 80 miles north of Kimberley on the main line to Rhodesia, in Bechuanaland, by operatives of the Northern Lime Company. Important stratigraphical evidence has been forthcoming recently from this district concerning the succession of stone ages in South Africa (Neville Jones, Jour. Roy. Anthrop. Inst., 1920), and the feeling was entertained that this lime deposit, like that of Broken Hill in Rhodesia, might contain fossil remains of primitive man.

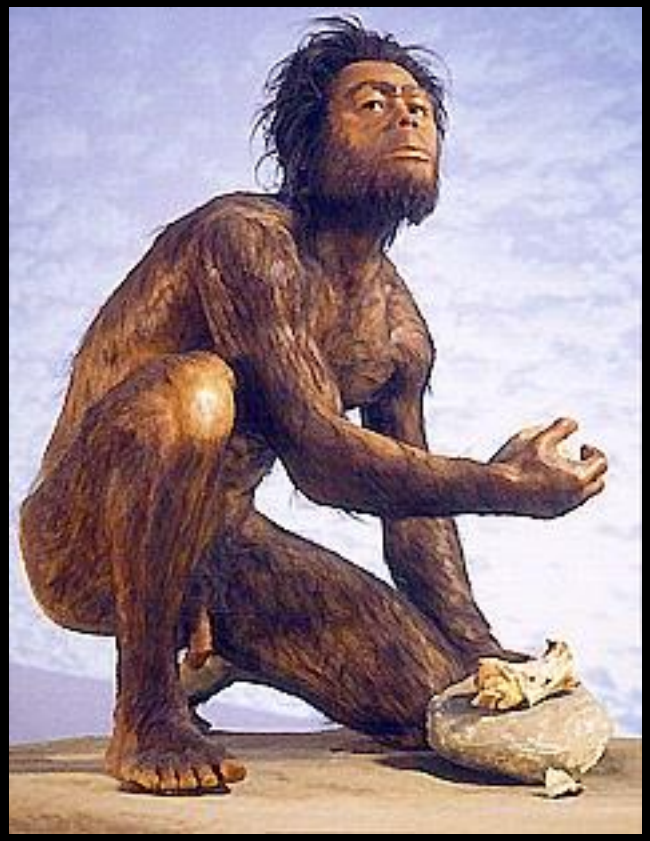
I immediately consulted Dr R. B. Young, professor of geology in the University of the Witwatersrand, about the discovery, and he, by a fortunate coincidence, was called down to Taungs almost synchronously to investigate geologically the lime deposits of an adjacent farm. During his visit to Taungs, Prof. Young was enabled, through the courtesy of Mr A. F. Campbell, general manager of the Northern Lime Company, to inspect the site of the discovery and to select further samples of fossil material for me from the same formation. These included a natural cercopithecid endocranial cast, a second and larger cast, and some rock fragments disclosing portions of bone. Finally, Dr Gordon D. Laing, senior lecturer in anatomy, obtained news, through his friend Mr Ridley Hendry, of another primate skull from the same cliff. This cercopithecid skull, the possession of Mr De Wet, of the Langlaagte Deep Mine, has also been liberally entrusted by him to the Department for scientific investigation.

The cercopithecid remains placed at our disposal certainly represent more than one species of catarrhine ape. The discovery of Cercopithecidæ in this area is not novel,

* Professor Dart's classical first announcement of the discovery of **Australopithecus africanus** is here reproduced from **Nature** (1925, Volume 115, pages 195–199) by special permission of the Editor and Publishers of **Nature**.

Fig. 1 — Norma facialis of Australopithecus africanus **aligned on the Frankfort horizontal.**



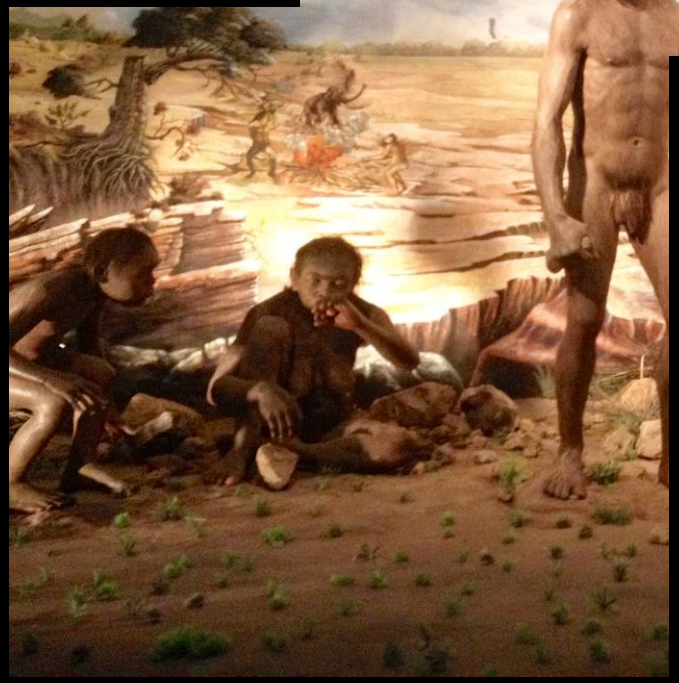


Homo habilis

about 2.1M to 1.5M years ago, (famous fossil KNM ER 1813)

Homo erectus

about 1.9M to 150ka (?) years ago, (famous fossil KNM-WT 15000)

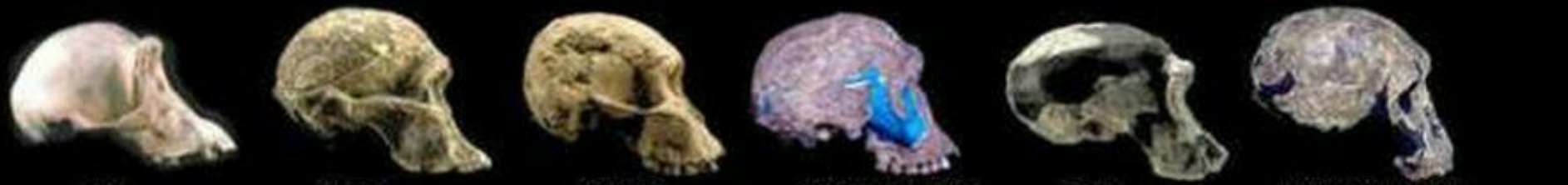


Homo floresiensis

about ? to 45ka (?) years ago, (famous fossil LB-1)

Homo erectus

about 1.9M to 150ka (?) years ago, (famous fossil KNM-WT 15000)



Chimpanzee
Pan troglodytes
modern
300-500 mL

STS 5
Australopithecus africanus
2.5 million years
487 mL

STS 71
A. africanus
2.5 million yrs
450 mL

KNM-ER 1813
Homo habilis
1.89 million yrs
506 mL

OH24
Homo habilis
1.8 million yrs
586 mL

KNM-ER 1470
Homo rudolfensis
1.89 million yrs
776 mL

KNM-ER 3733
Homo ergaster
1.78 million yrs
825 mL

Broken Hill 1
Homo heidelbergensis
0.35 million yrs
1310 mL

La Ferrassie 1
Homo sapiens neanderthalensis
0.07 million yrs
1650 mL

La Chapelle-aux-Saints
Homo sapiens neanderthalensis
0.05 million yrs
1609 mL

Cro-Magnon I
Homo sapiens sapiens
0.03 million yrs
1616 mL

Homo sapiens sapiens
Modern
Average cranial capacity:
1375 / 1215 (male/female)

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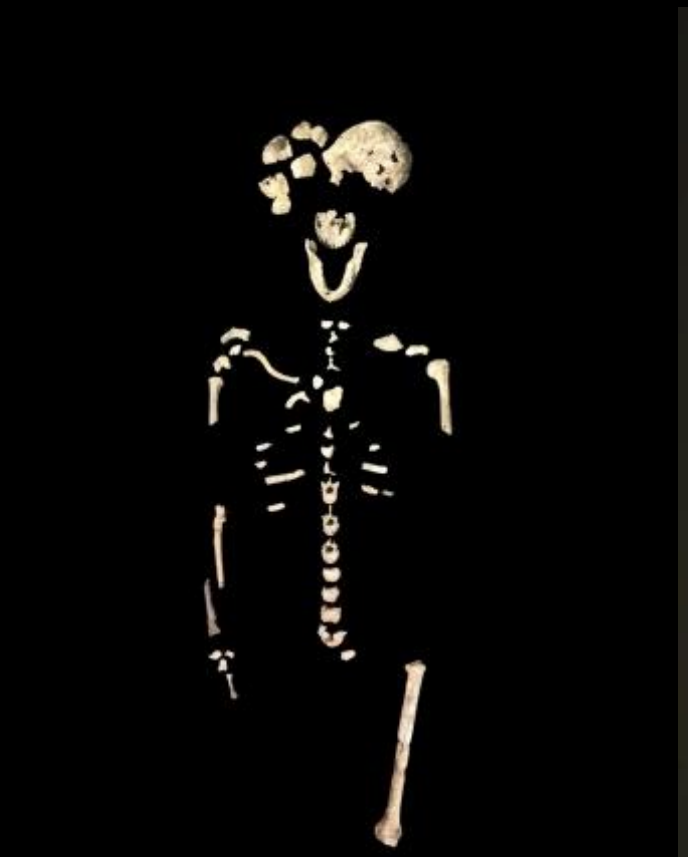
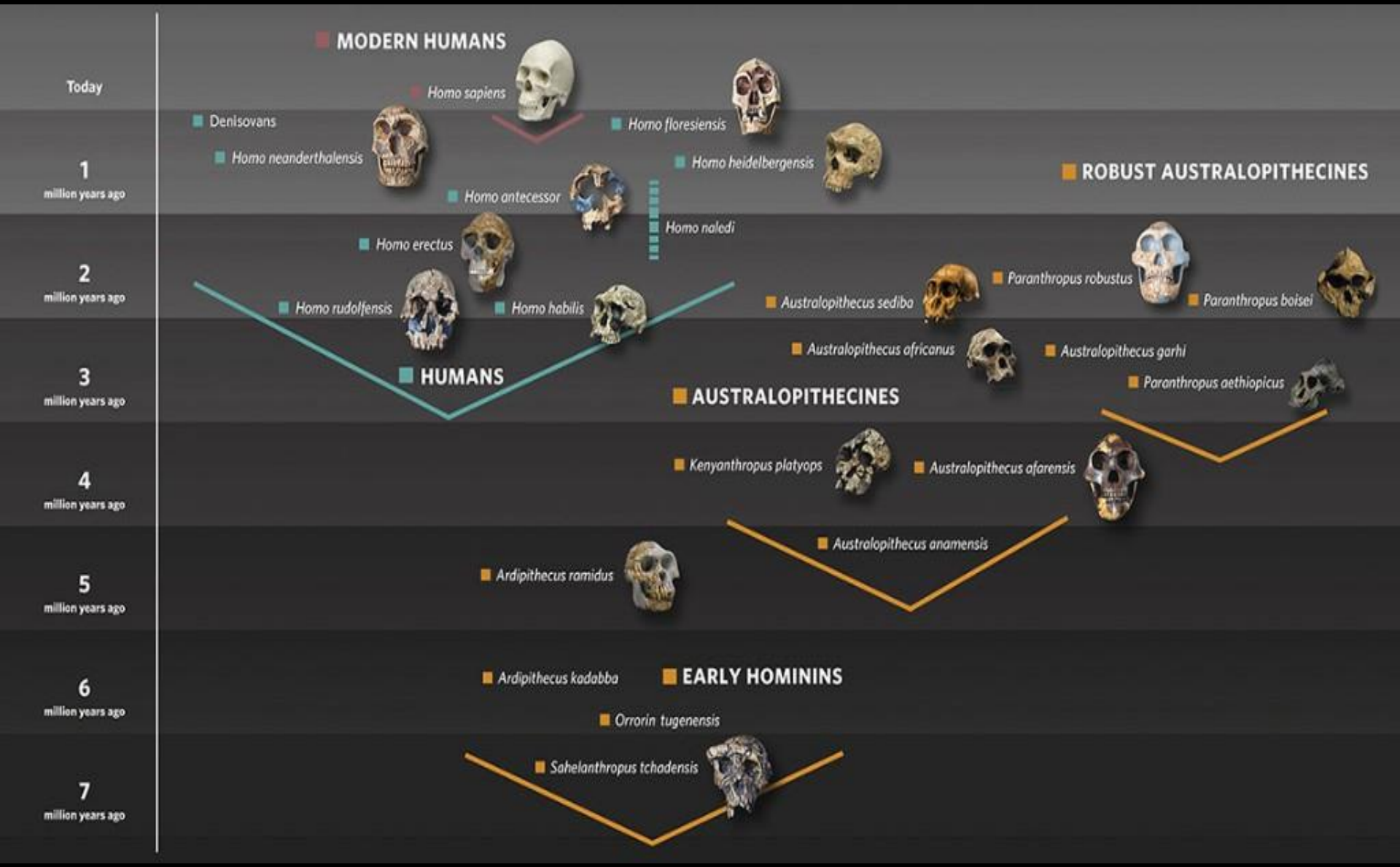
RESEARCH ARTICLE

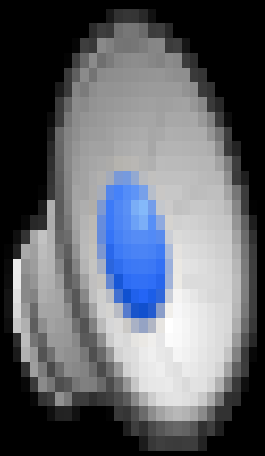
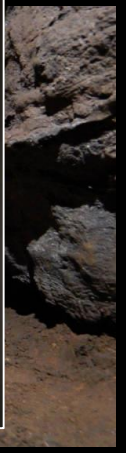
The age of *Homo naledi* and associated sediments in the Rising Star Cave, South Africa

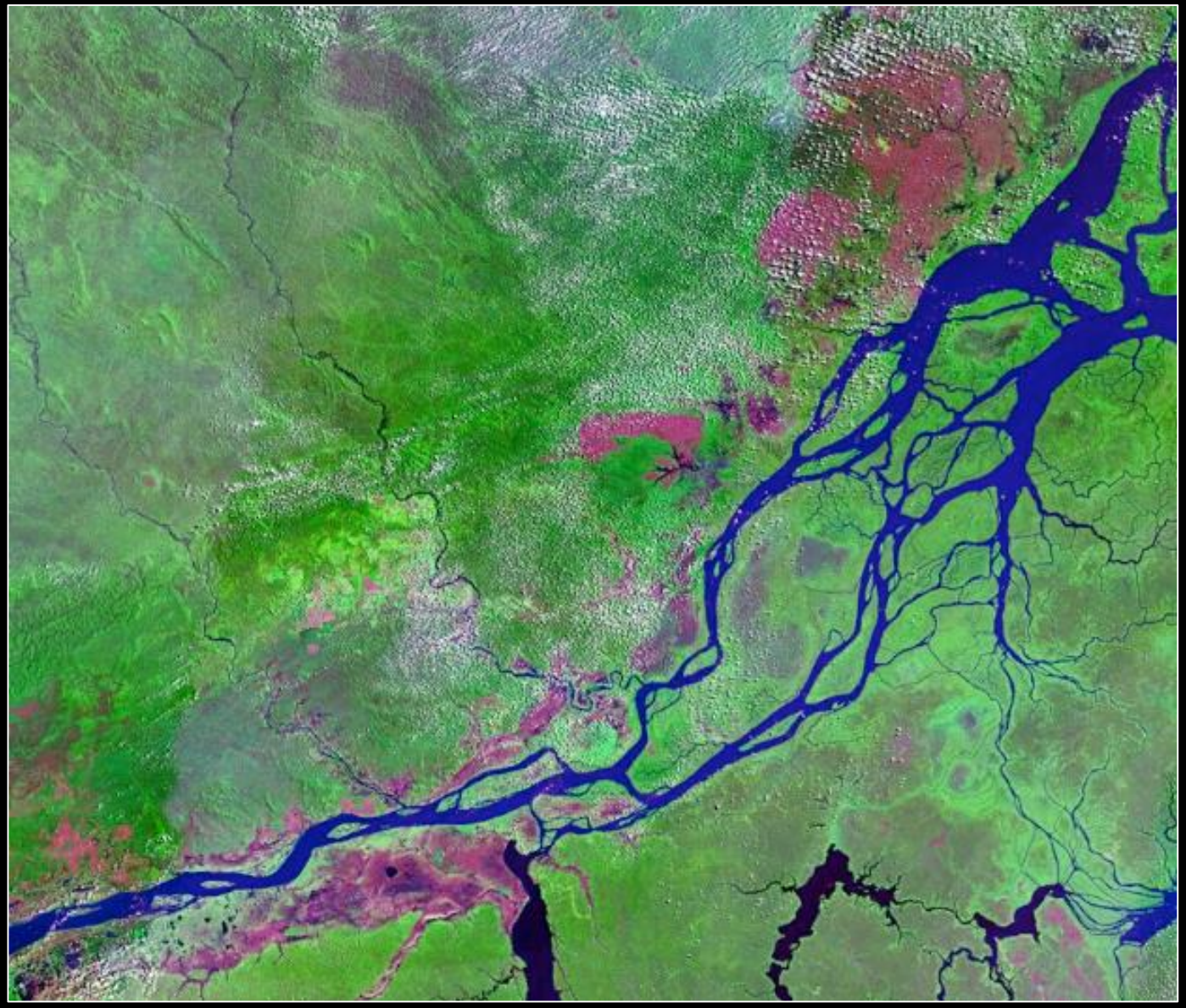


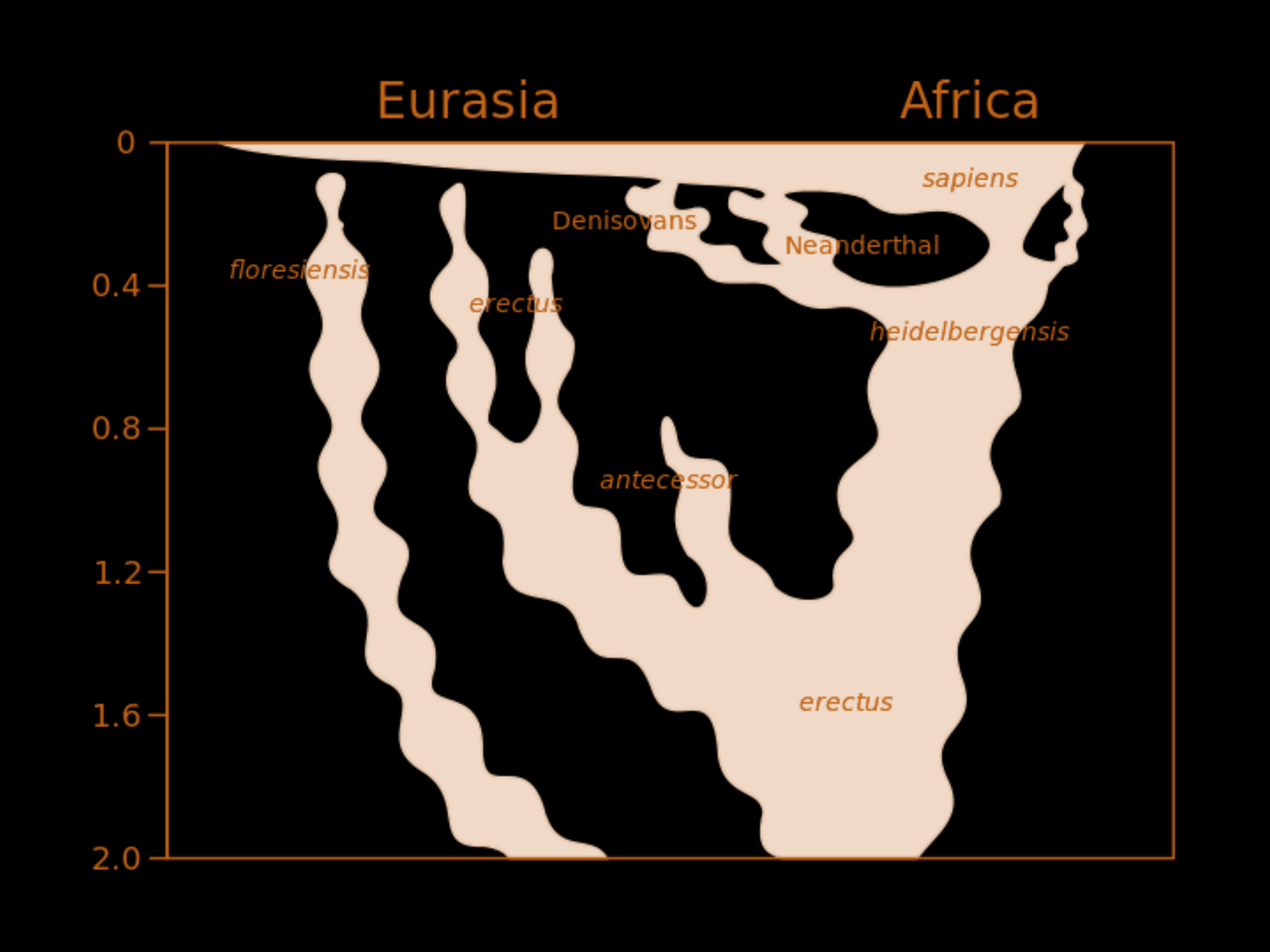

Today
1 million years ago
2 million years ago
3 million years ago
4 million years ago
5 million years ago
6 million years ago
7 million years ago
MODERN HUMANS
Homo sapiens
Denisovans
Homo neanderthalensis
Homo floresiensis
Homo heidelbergensis
Homo antecessor
Homo naledi
Homo erectus
Homo rudolfensis
Homo habilis
HUMANS
ROBUST AUSTRALOPITHECINES
Paranthropus robustus
Paranthropus boisei
Australopithecus sediba
Australopithecus africanus
Australopithecus garhi
Paranthropus aethiopicus
AUSTRALOPITHECINES
Kenyanthropus platyops
Australopithecus afarensis
Australopithecus anamensis
Ardipithecus ramidus
Ardipithecus kadabba
EARLY HOMININS
Orrorin tugenensis
Sahelanthropus tchadensis


AMKIND

ark Zone
n a chamber nam
hrough a narrow c
rance. How they g
so far: Bodies wer
Dragon's
Back




Eurasia
Africa
0
0.4
0.8
1.2
1.6
2.0
sapiens
Denisovans
Neanderthal
floresiensis
erectus
heidelbergensis
antecessor
erectus

LETTER

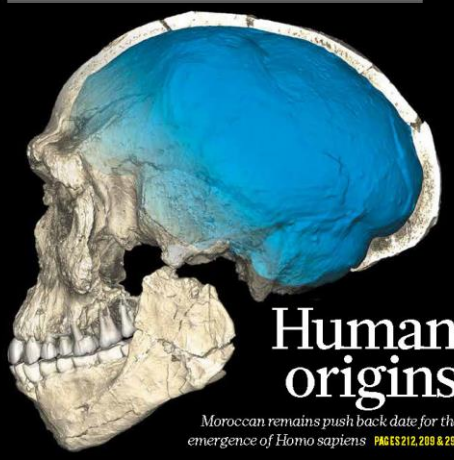
doi:10.1038/nature22335

The age of the hominin fossils from Jebel Irhoud, Morocco, and the origins of the Middle Stone Age

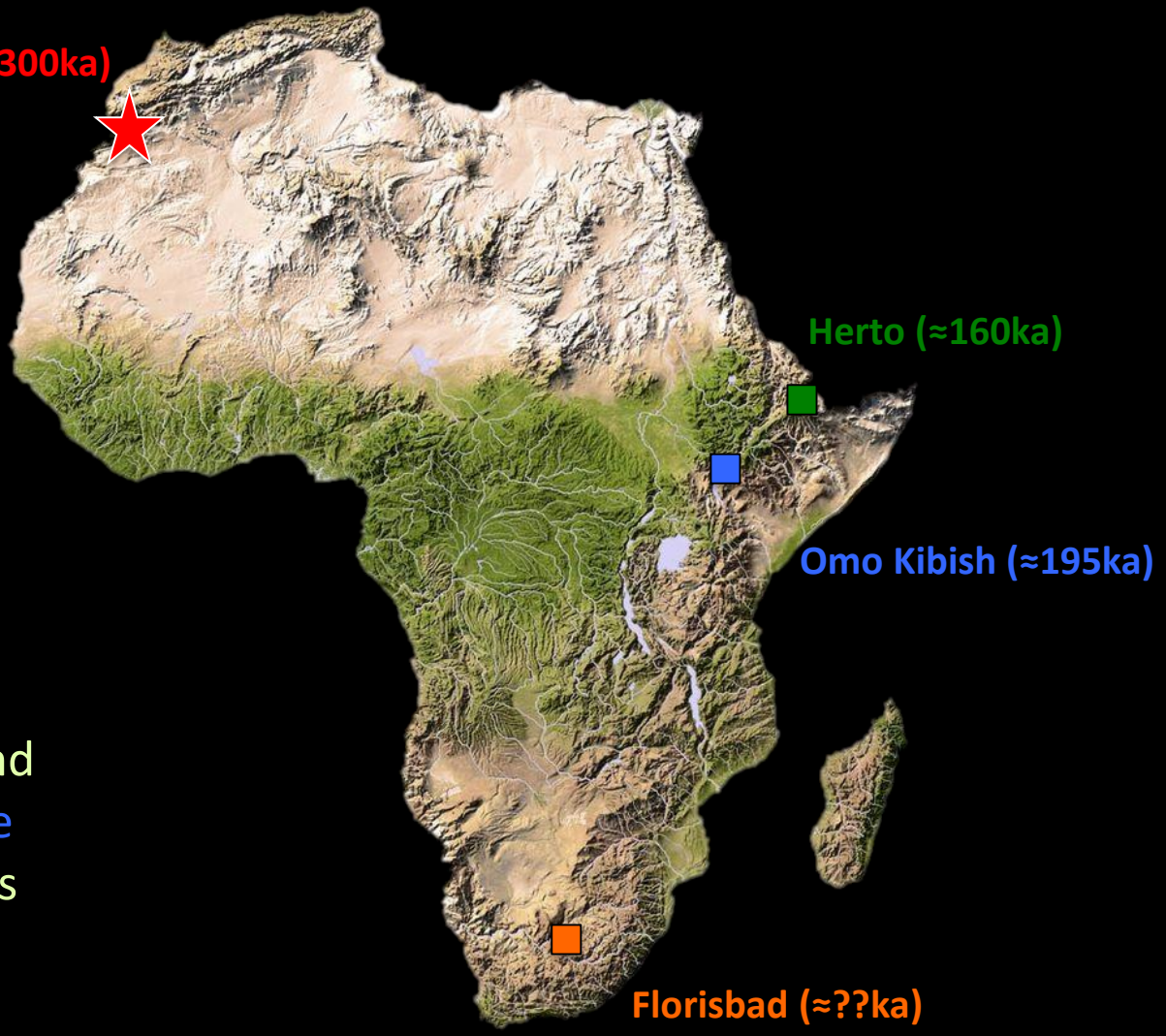
Daniel Richter[1,2,3], Rainer Grün[4,5], Renaud Joannes-Boyau[4,6], Teresa E. Steele[1,7], Fethi Amani[8], Mathieu Rué[9,10], Paul Fernandes[9,11], Jean-Paul Raynal[1,11], Denis Geraads[1,12], Abdelouahed Ben-Ncer[8], Jean-Jacques Hublin[1,13] & Shannon P. McPherron[1]

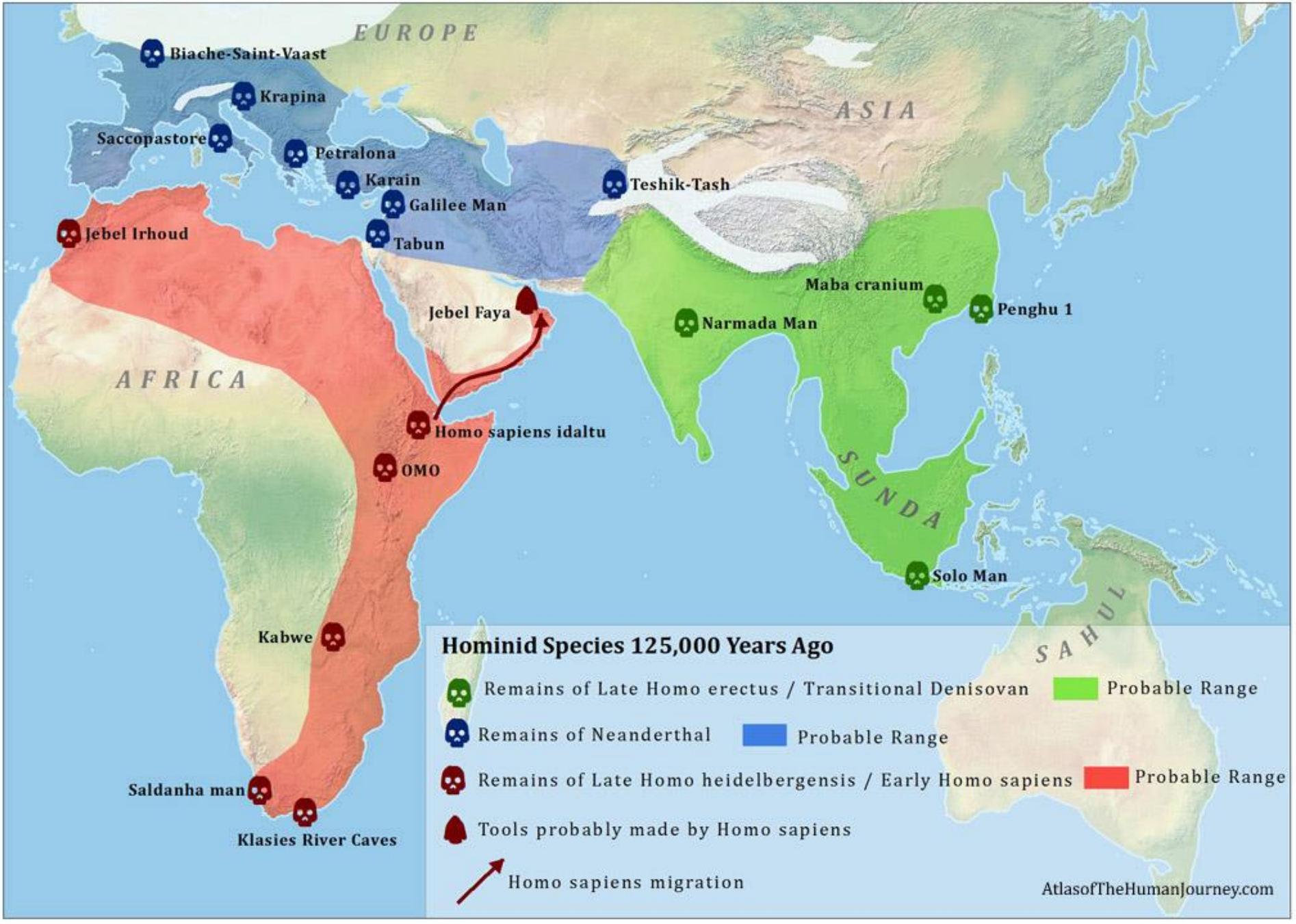
The timing and location of the emergence of our species and of associated behavioural changes are crucial for our understanding of human evolution. The earliest fossil attributed to a modern form of *Homo sapiens* comes from eastern Africa and is approximately 195

also consistent with the faunal and microfaunal[9] assemblages and almost double the previous age estimates for the lower part of the deposits[10,11]. The north African site of Jebel Irhoud contains one of the earliest directly dated Middle Stone Age assemblages, and its



Indeed, we are the lone survivors of a much older and more complex African-wide evolutionary history , that is anything but linear.

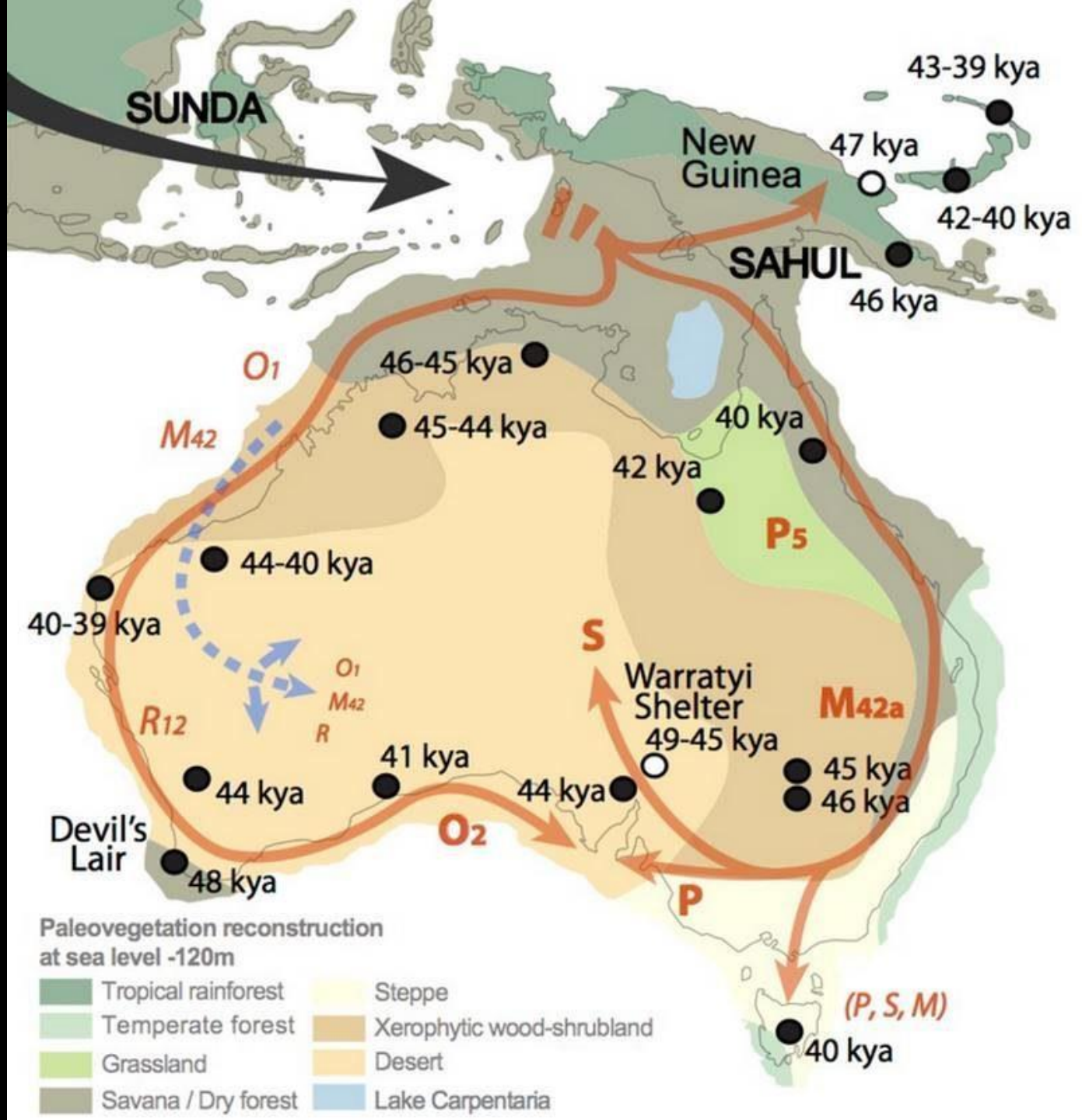



EUROPE
ASIA
AFRICA
SUNDA
SAHUL
Biache-Saint-Vaast
Krapina
Saccopastore
Petralona
Karain
Galilee Man
Tabun
Teshik-Tash
Jebel Irhoud
Jebel Faya
Maba cranium
Penghu 1
Narmada Man
Homo sapiens idaltu
OMO
Solo Man
Kabwe
Saldanha man
Klasies River Caves
Hominid Species 125,000 Years Ago
Remains of Late Homo erectus / Transitional Denisovan
Probable Range
Remains of Neanderthal
Probable Range
Remains of Late Homo heidelbergensis / Early Homo sapiens
Probable Range
Tools probably made by Homo sapiens
Homo sapiens migration
AtlasofTheHumanJourney.com

When did *Homo sapiens* first reach Southeast Asia and Sahul?

James F. O'Connell, Jim Allen, Martin A. J. Williams, Alan N. Williams, Chris S. M. Turney, Nigel A. Spooner, Johan Kamminga, Graham Brown, and Alan Cooper

PNAS August 21, 2018 115 (34) 8482-8490



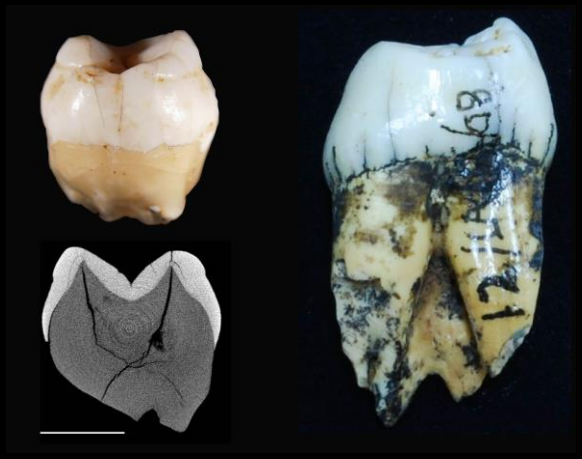
LETTER

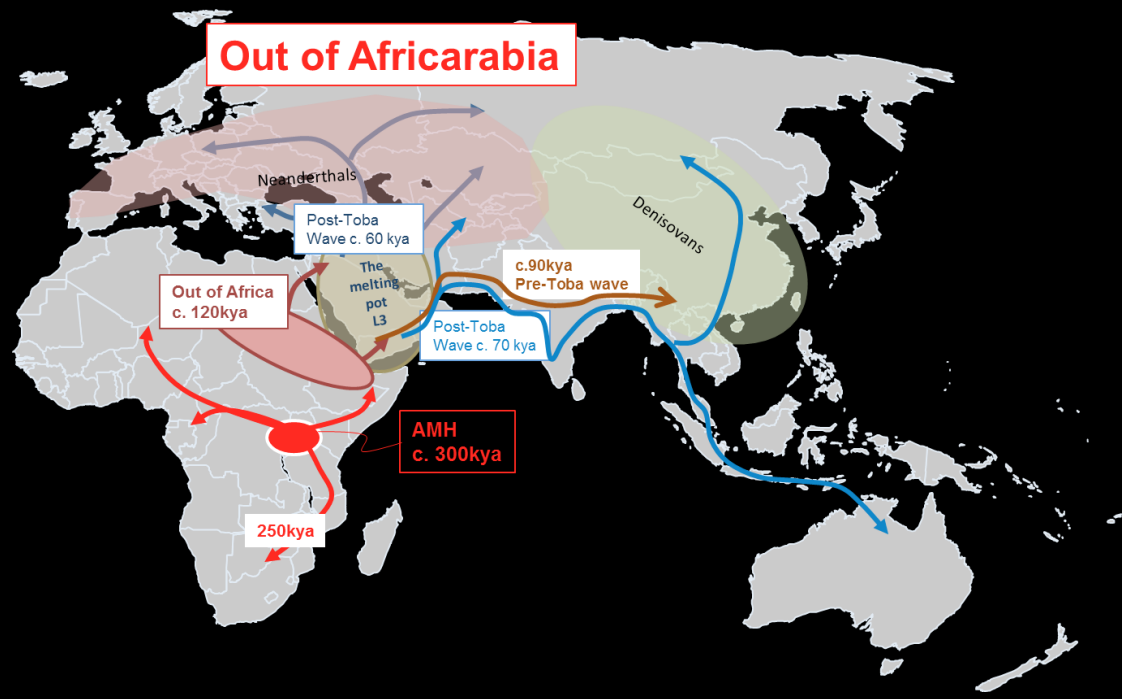
doi:10.1038/nature23452

An early modern human presence in Sumatra 73,000–63,000 years ago

K. E. Westaway[1], J. Louys[2], R. Due Awe[3]‡, M. J. Morwood[4]‡, G. J. Price[5], J.-x. Zhao[5], M. Aubert[6], R. Joannes-Boyau[7], T. M. Smith[8,9], M. M. Skinner[10,11], T. Compton[12], R. M. Bailey[13], G. D. van den Bergh[4], J. de Vos[14], A. W. G. Pike[15], C. Stringer[12], E. W. Saptomo[3], Y. Rizal[16], J. Zaim[16], W. D. Santoso[16], A. Trihascaryo[16], L. Kinsley[17] & B. Sulistyanto[3]

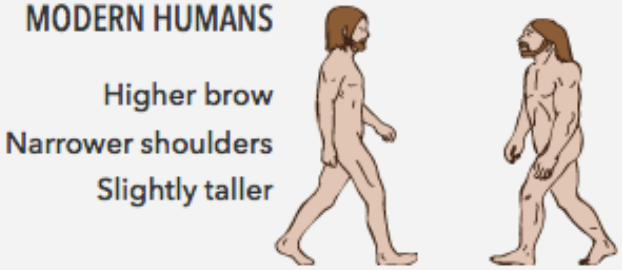
Genetic evidence for anatomically modern humans (AMH) out of Africa before 75 thousand years ago (ka)[1] and in island southeast Asia (ISEA) before 60 ka (93–61 ka)[2] predates accepted archaeological dated to >70 ka by AAR on bone[13]) in addition to numerous unnamed caves excavated by Dubois in the Padang Highlands. Large numbers of orangutan fossils and other closed forest taxa have been recovered from





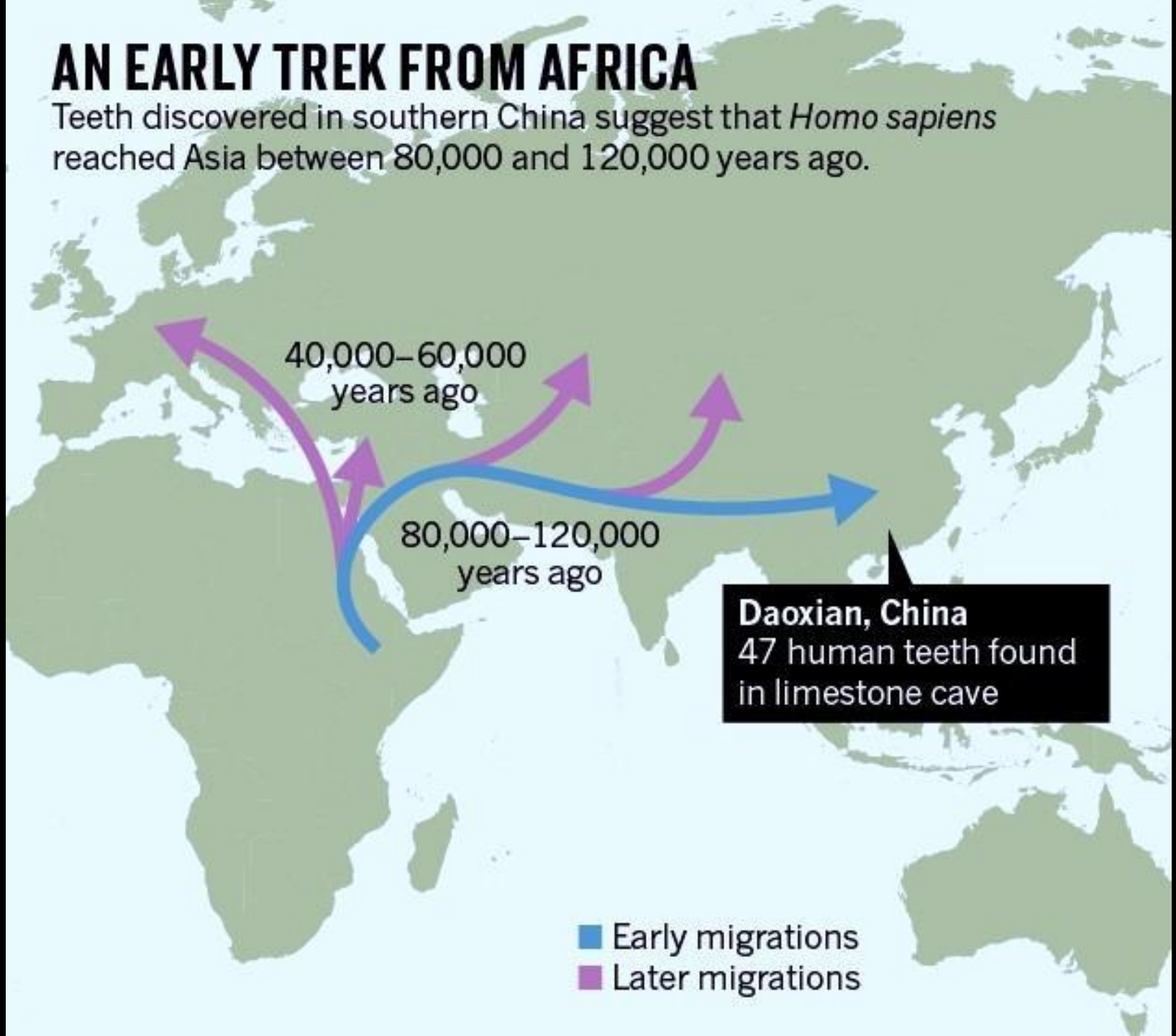
Got Neanderthal DNA?

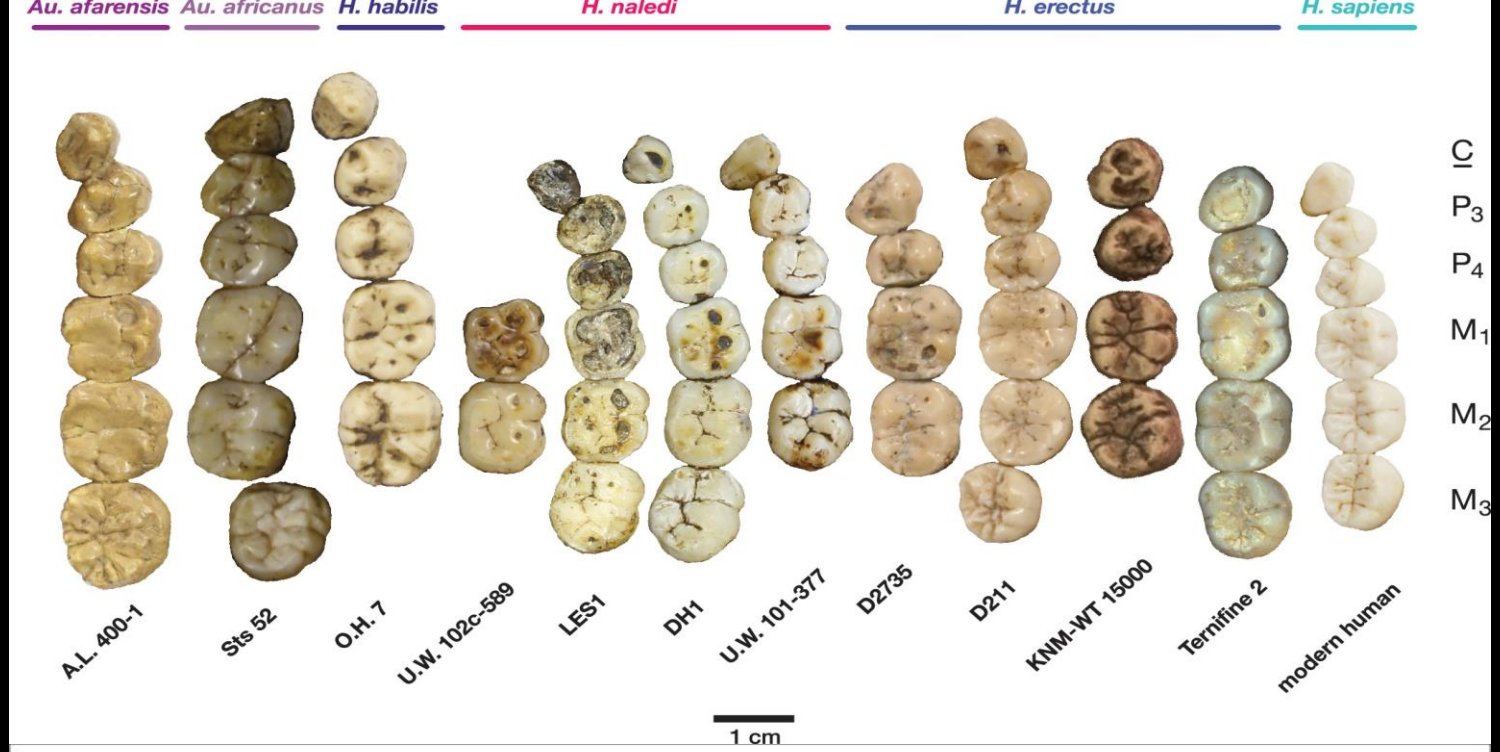
An estimated 2.8% of your DNA is from Neanderthals.

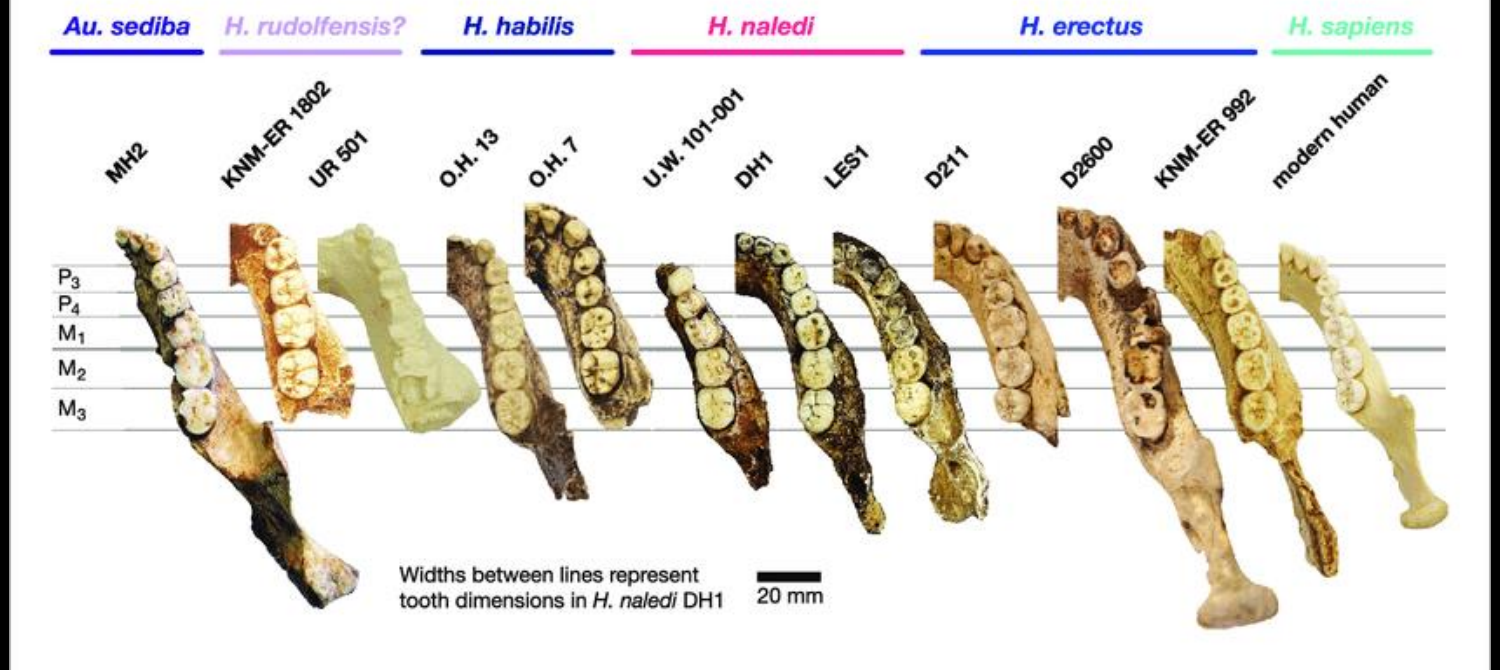


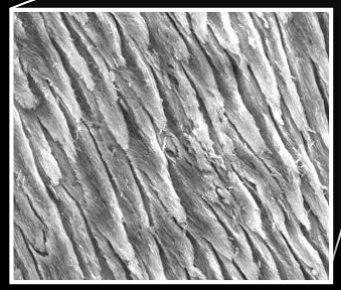
AN EARLY TREK FROM AFRICA

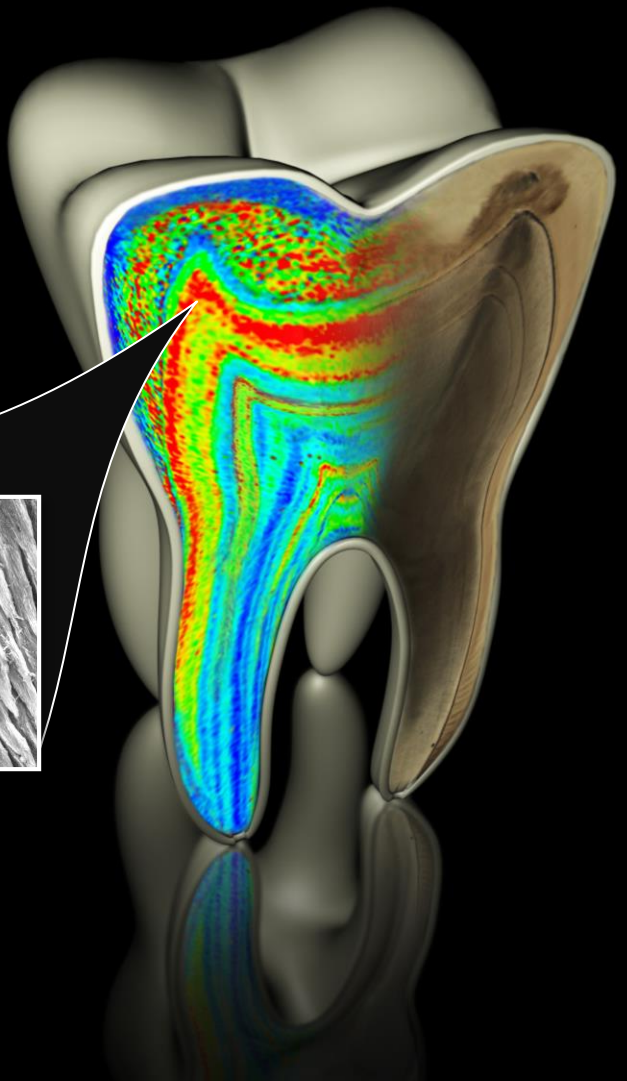
Teeth discovered in southern China suggest that *Homo sapiens* reached Asia between 80,000 and 120,000 years ago.




Au. afarensis
Au. africanus
H. habilis
H. naledi
H. erectus
H. sapiens
C
P3
P4
M1
M2
M3
A.L. 400-1
Sts 52
O.H. 7
U.W. 102c-589
LES1
DH1
U.W. 101-377
D2735
D211
KNM-WT 15000
Ternifine 2
modern human
1 cm

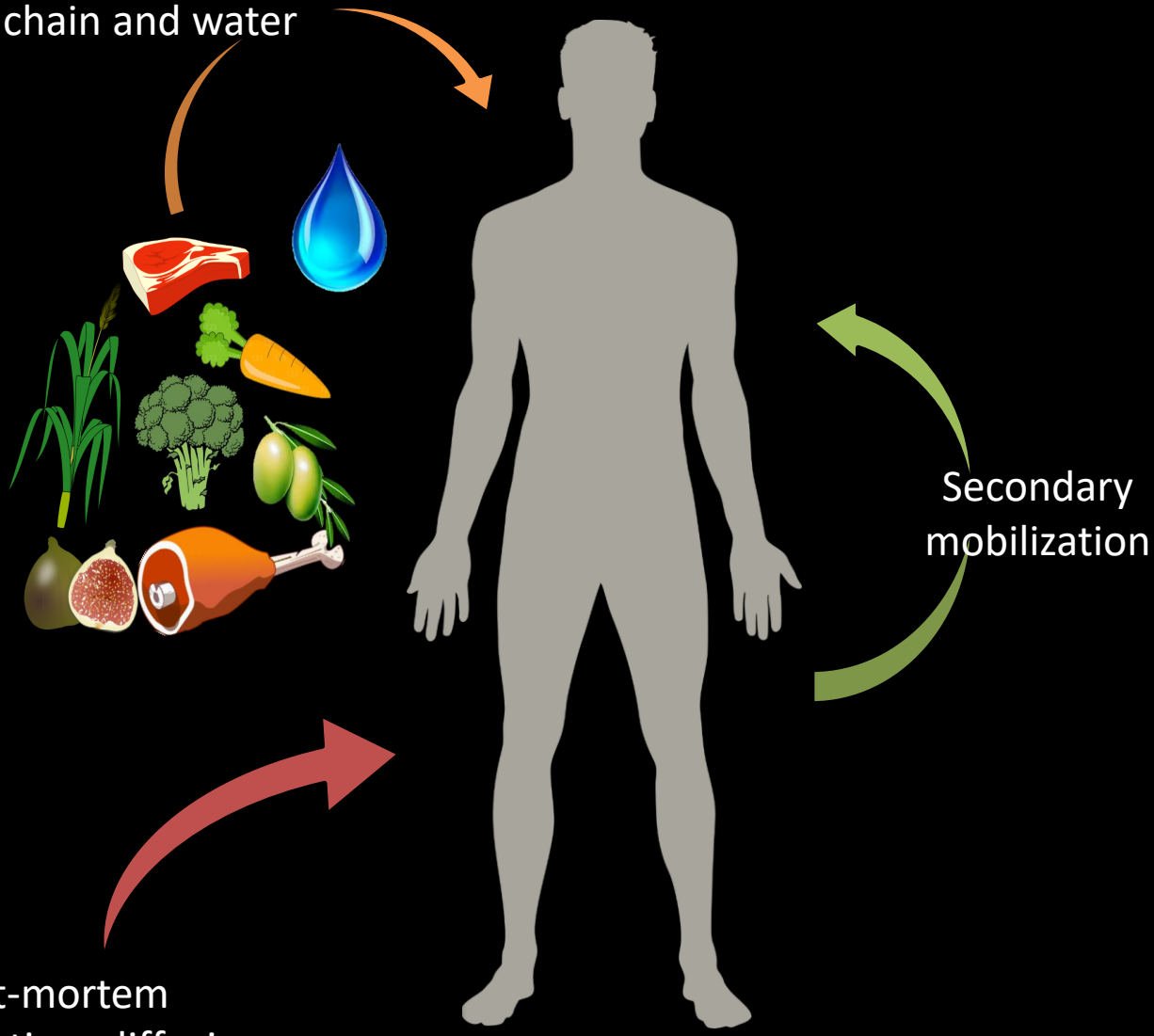

Au. sediba
H. rudolfensis?
H. habilis
H. naledi
H. erectus
H. sapiens
MH2
KNM-ER 1802
UR 501
O.H. 13
O.H. 7
U.W. 101-001
DH1
LES1
D211
D2600
KNM-ER 992
modern human
P3
P4
M1
M2
M3
Widths between lines represent
tooth dimensions in H. naledi DH1
20 mm





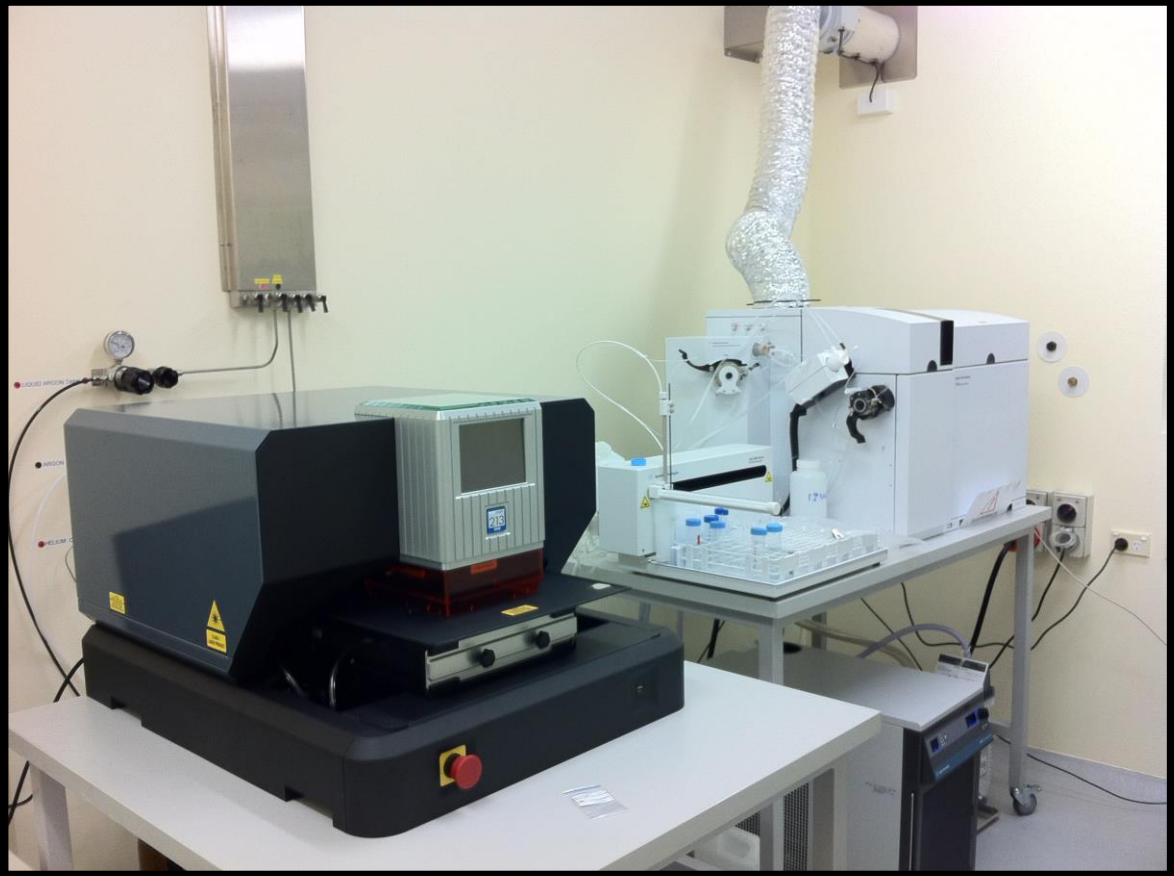
P
Sr
Ba
Cu
Mg

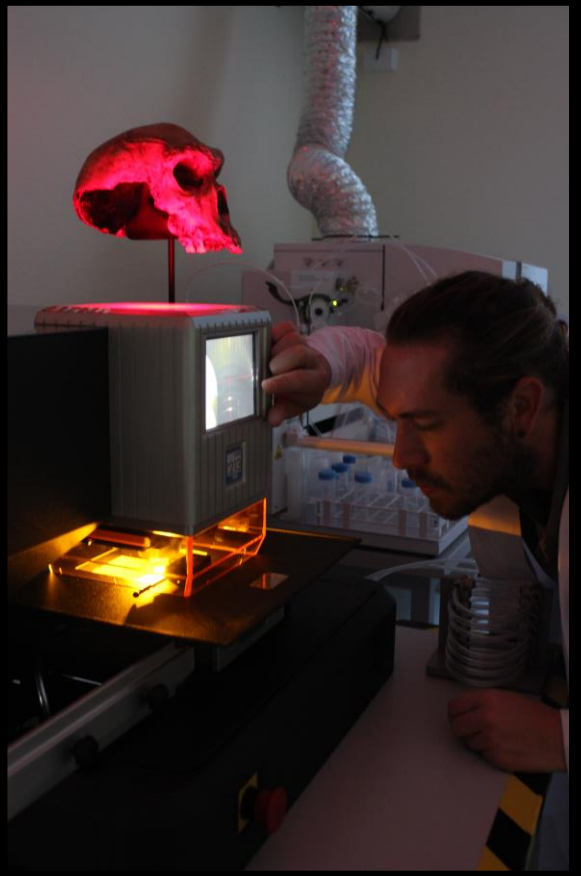
isotopic and trace elements mobilization through chemical processes in the environmental system. Incorporation in the food chain and water systems



Secondary mobilization

Post-mortem incorporation, diffusion and adsorption





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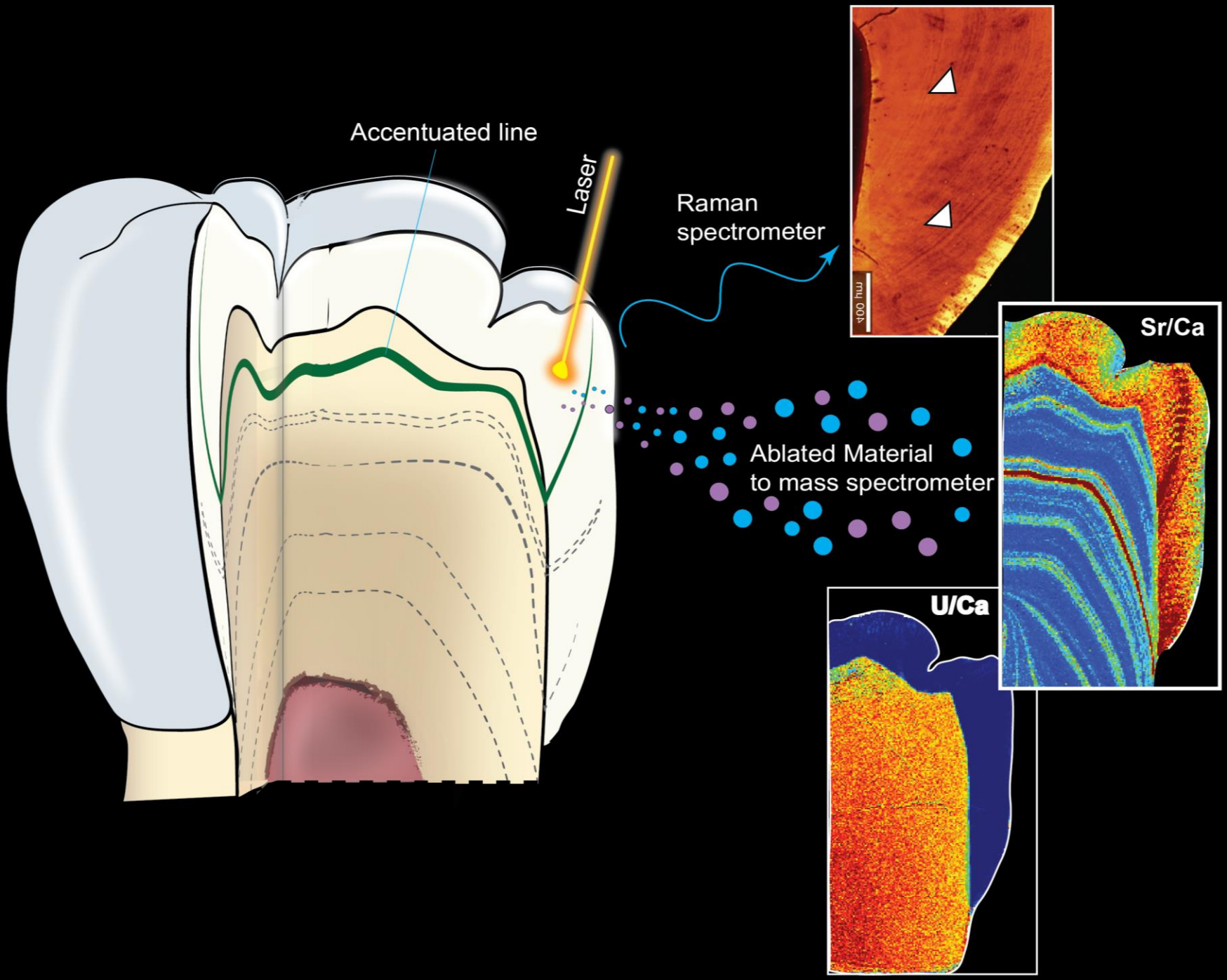
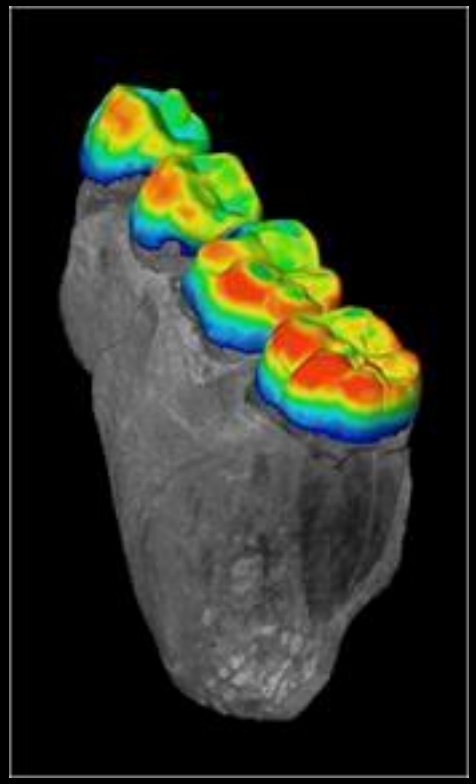
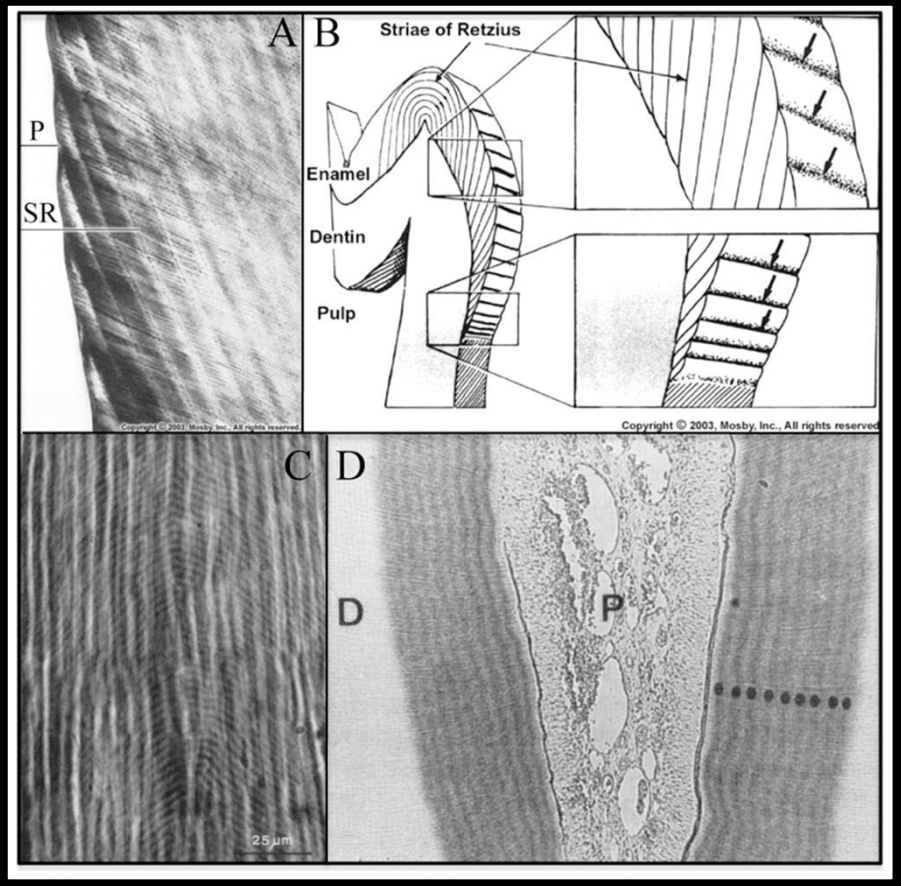
SOLARIS

Southern CrOss Laser-Ablation Research InStrument

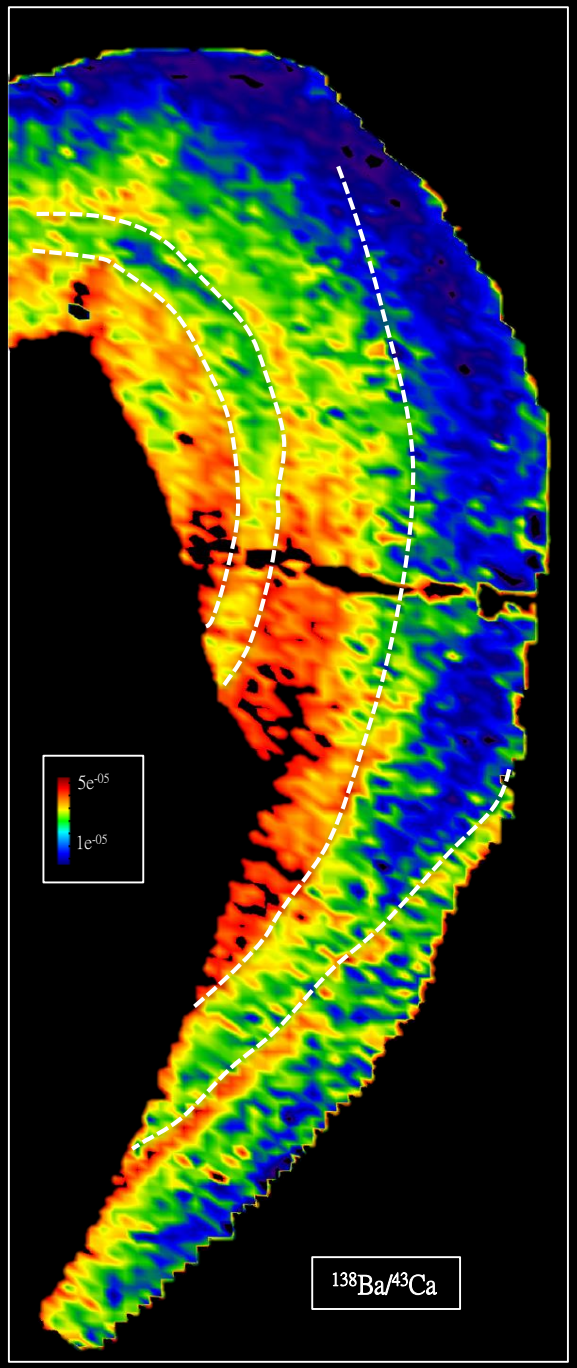
GARG Geochronology and Archaeometry Research Group


Accentuated line
Laser
Raman
spectrometer
Ablated Material
to mass spectrometer
Sr/Ca
U/Ca

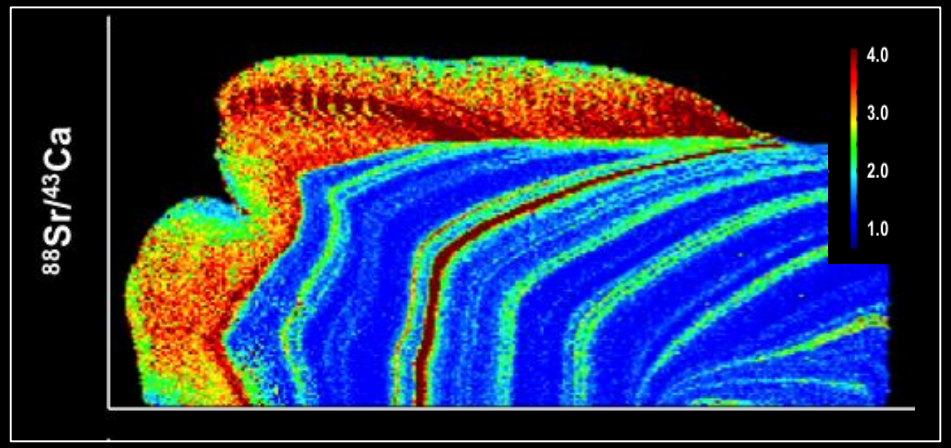



A
P
SR
B
Striae of Retzius
Enamel
Dentin
Pulp
Copyright © 2003, Mosby, Inc., All rights reserved
C
25 µm
D
D
P

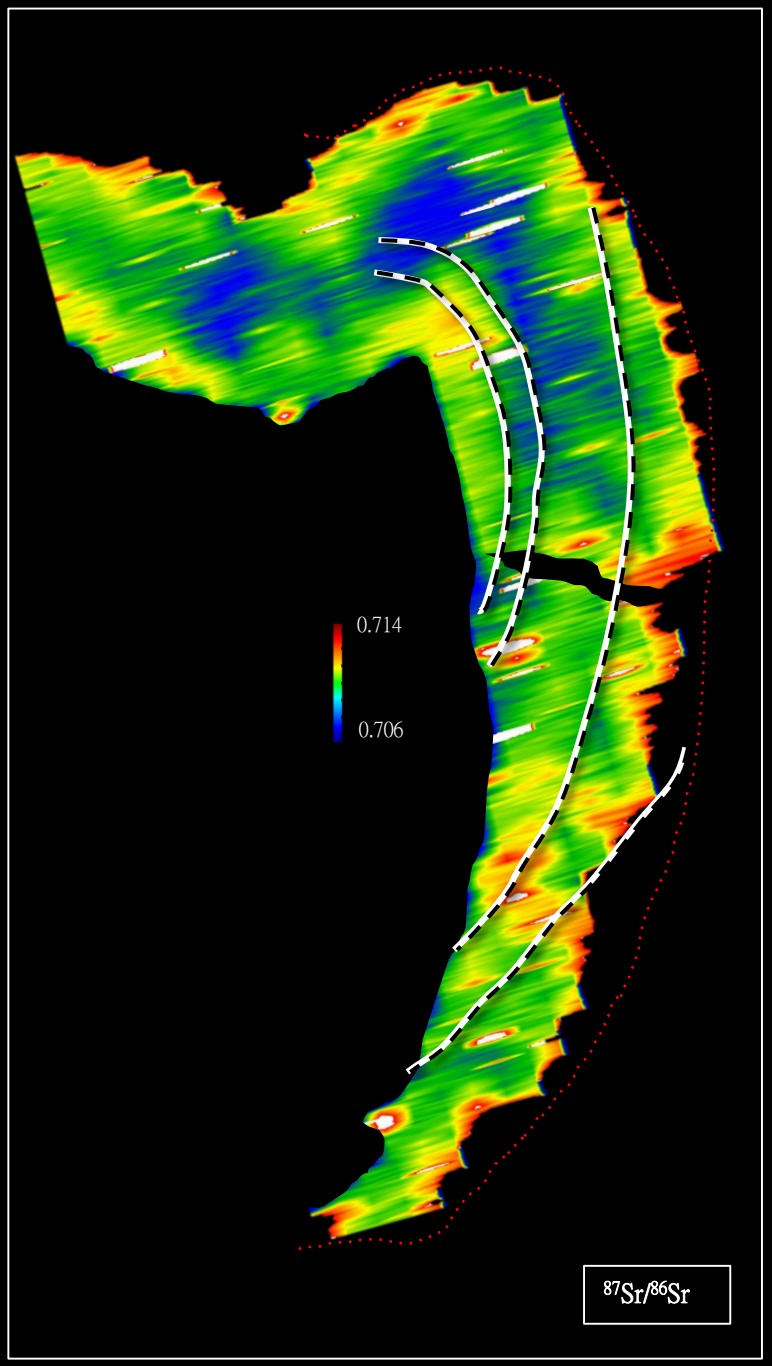
Diet

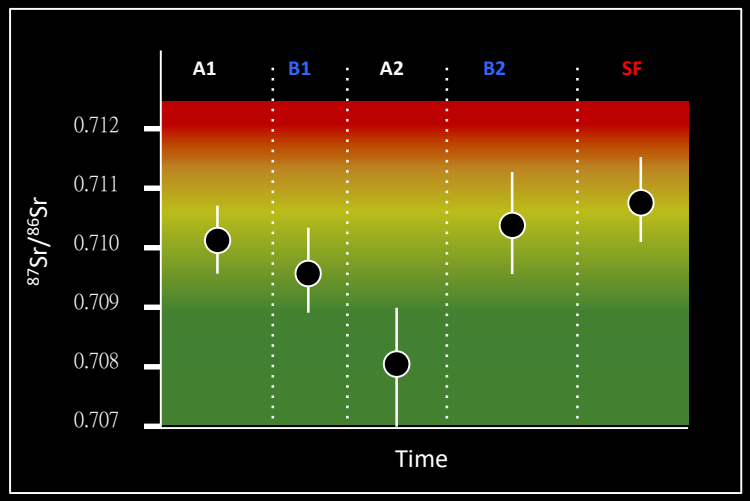


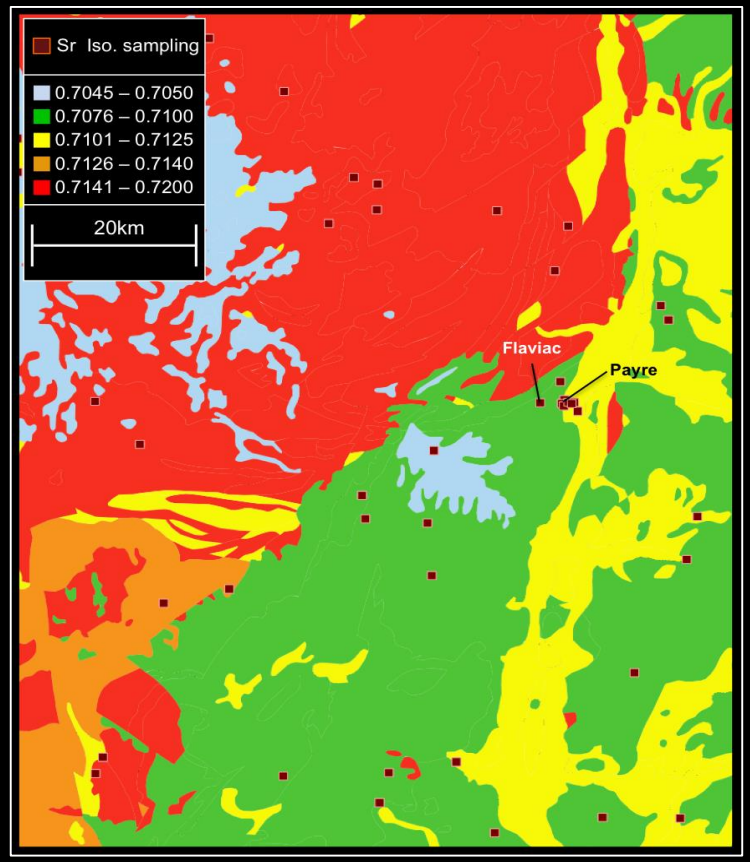
Stress

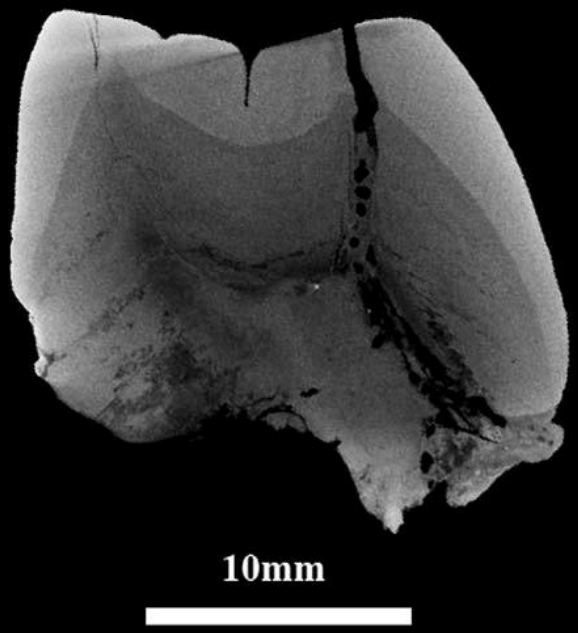


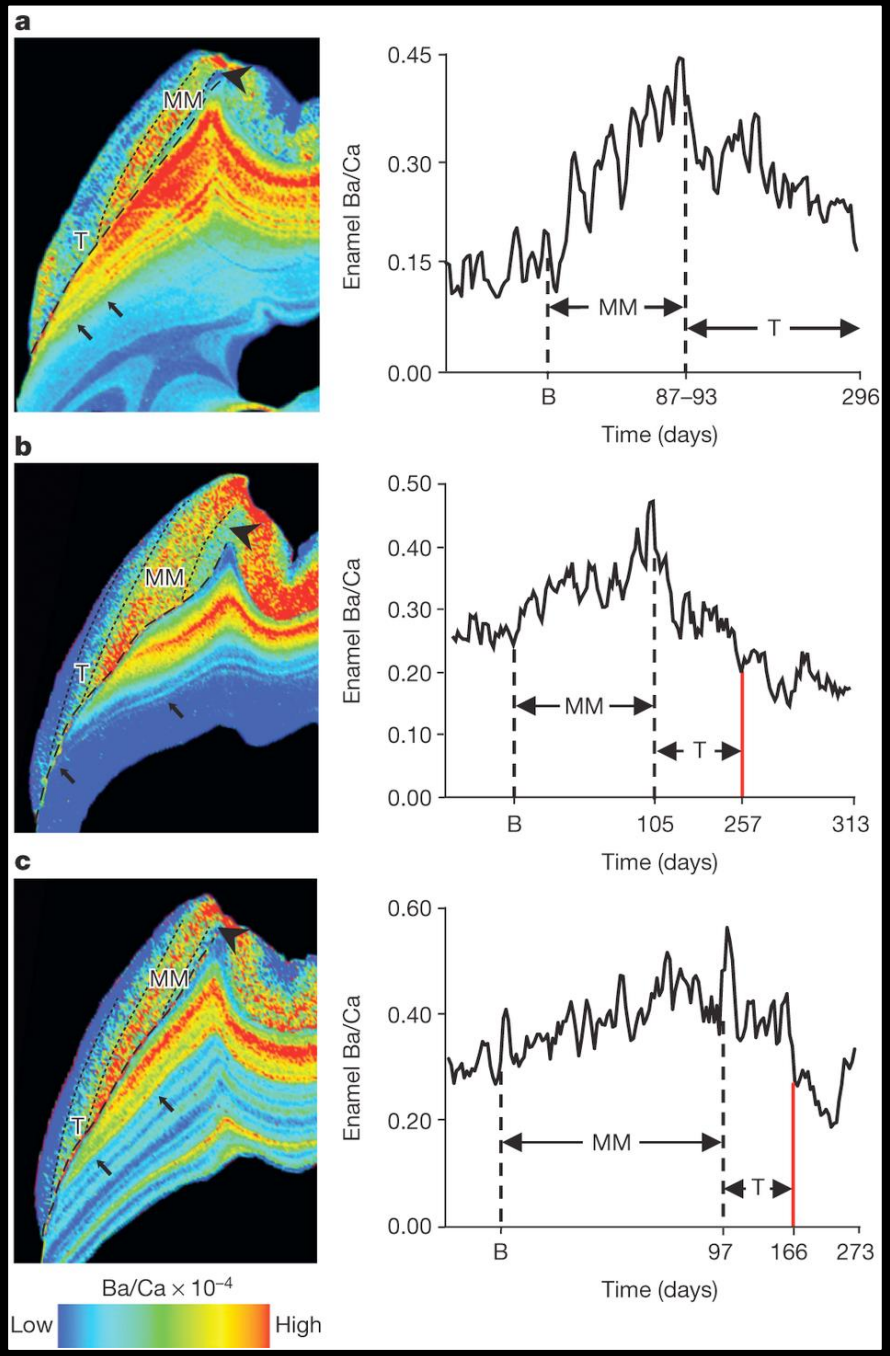
Migration

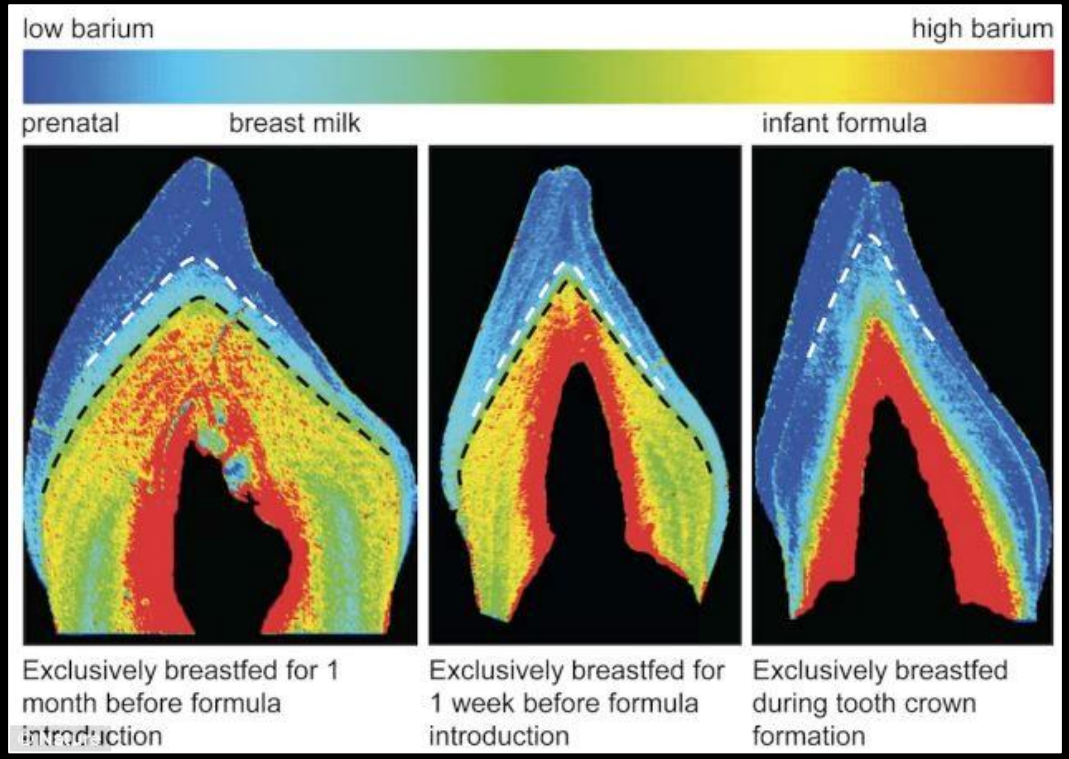

0.714
0.706
$^{87}Sr/^{86}Sr$

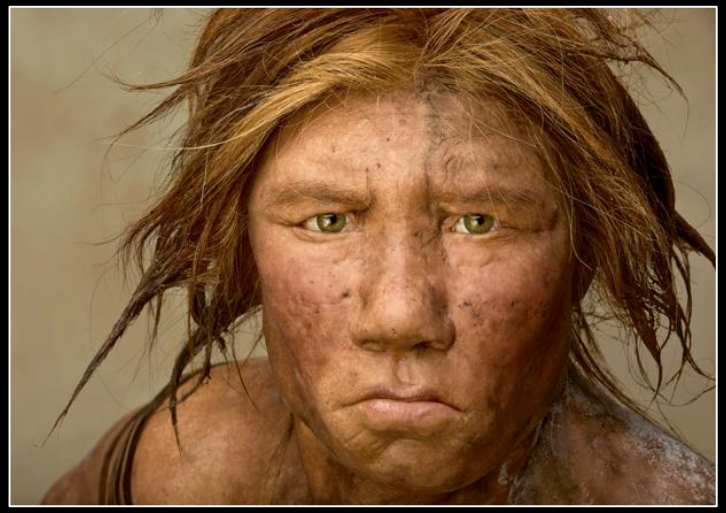

A1
B1
A2
B2
SF
0.712
0.711
0.710
0.709
0.708
0.707
$^{87}Sr/^{86}Sr$
Time

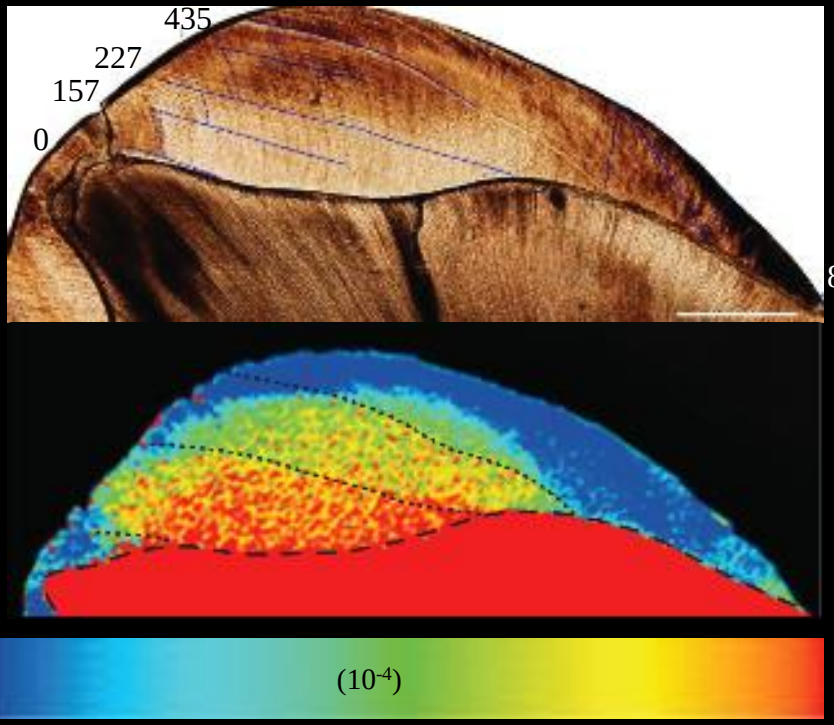

Sr Iso. sampling
0.7045 – 0.7050
0.7076 – 0.7100
0.7101 – 0.7125
0.7126 – 0.7140
0.7141 – 0.7200
20km
Flaviac
Payre

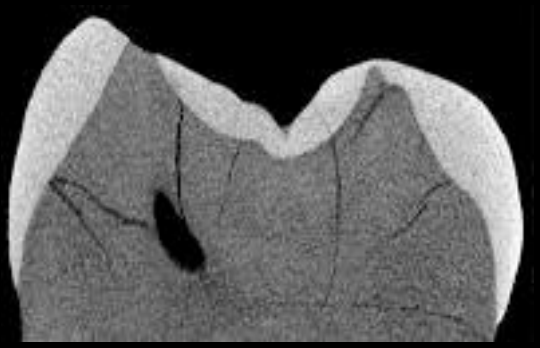

10mm

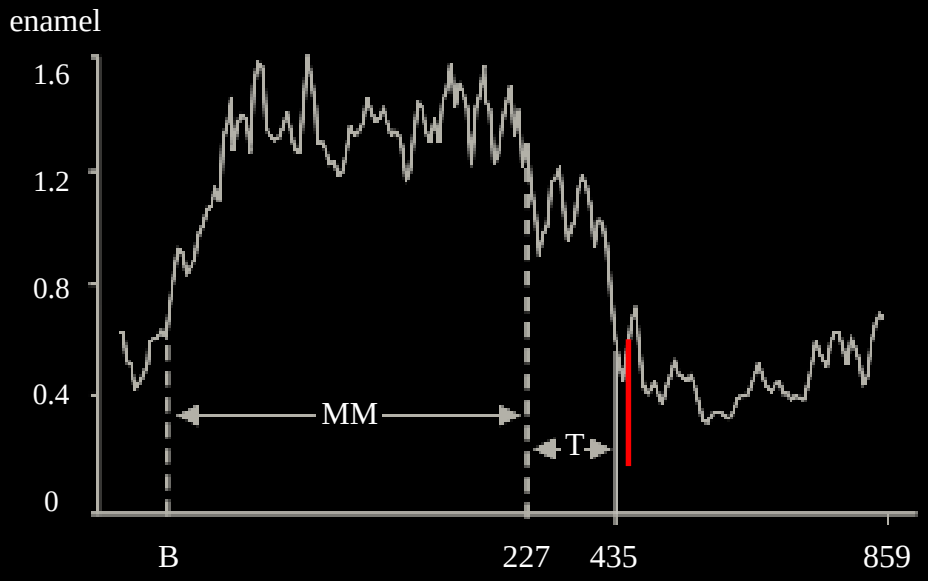

a
MM
T
Enamel Ba/Ca
0.45
0.30
0.15
0.00
MM
T
B
87–93
296
Time (days)
b
MM
T
Enamel Ba/Ca
0.50
0.40
0.30
0.20
0.10
0.00
MM
T
B
105
257
313
Time (days)
c
MM
T
Enamel Ba/Ca
0.60
0.40
0.20
0.00
MM
T
B
97
166
273
Time (days)
Ba/Ca × 10⁻⁴
Low
High


low barium
high barium
prenatal
breast milk
infant formula
Exclusively breastfed for 1 month before formula introduction
Exclusively breastfed for 1 week before formula introduction
Exclusively breastfed during tooth crown formation




435
227
157
0
859
0.18
(10-4)
>1.22




enamel
1.6
1.2
0.8
0.4
0
MM
T
B
227
435
859

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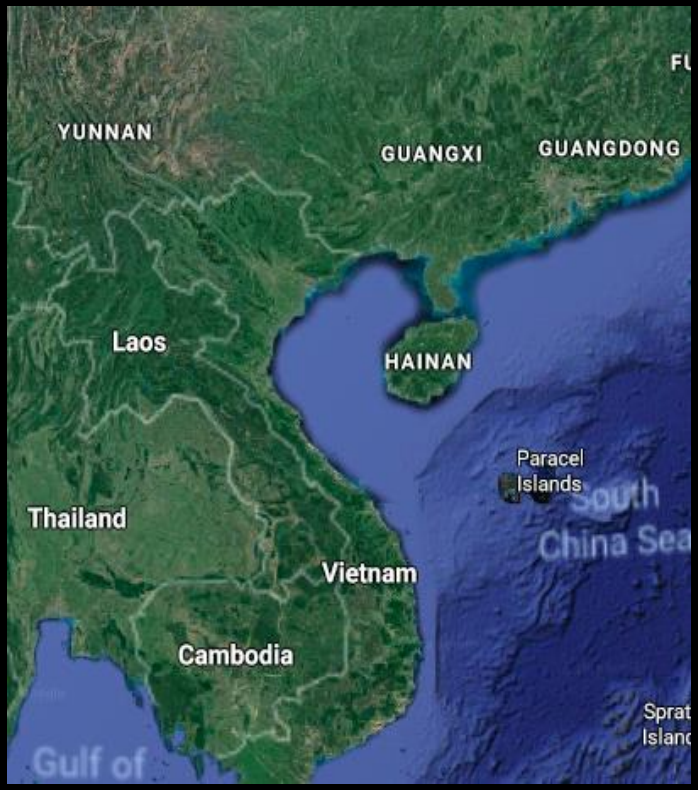
YUNNAN
GUANGXI
GUANGDONG
Laos
HAINAN
Paracel Islands
Thailand
Vietnam
Cambodia
Gulf of