The Abdus Salam International Centre for Theoretical Physics

CENTRO FERMI Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi

CENTRE FOR ARCHAEOLOGICAL SCIENCE CAS | UNIVERSITY OF WOLLONGONG AUSTRALIA

Fisica & Evoluzione Umana

Claudio Tuniz

Frascati, 10 ottobre 2018

The science of human origins

data from many disciplines

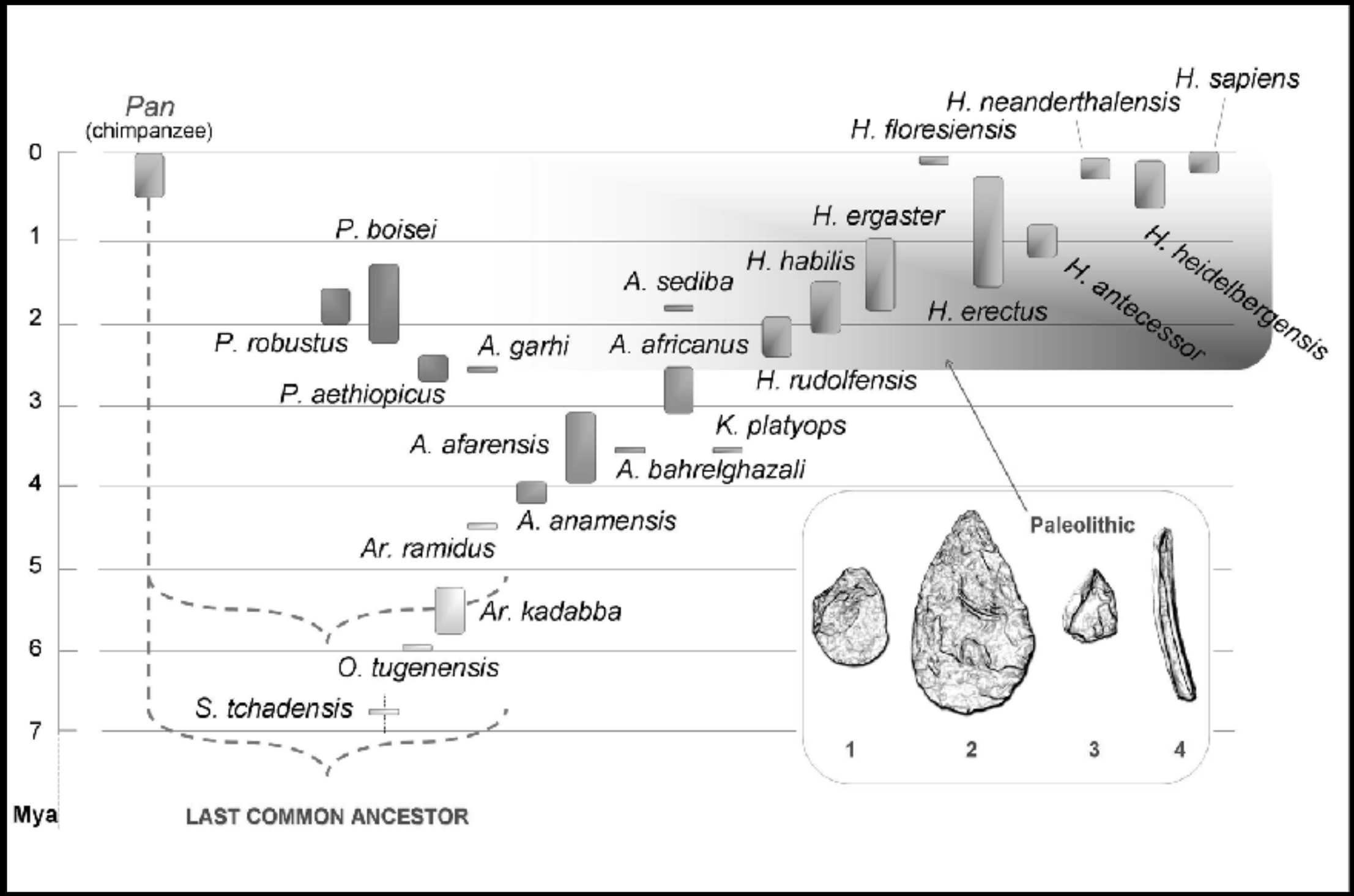
- Anthropology
- Archaeology
- Paleontology
- Paleo-neurology
- Geology
- Biology
- Physics
- Chemistry
- Engineering
- Oceanography
- Climatology
- Environmental science
- Ecology
- Genetics
- Medicine
- Demography
- Evolutionary psychology

The science of human origins

areas of progress

- Exploration
  - ✦ Satellite imaging, georadar, laser scan
- Caracterisation of fossils and archaeological remain
  - ✦ Geo-chronometers
  - ✦ Microscopies and spectroscopies with X-rays, neutrons, ions
  - ✦ Microprobes (elements and isotopes)
  - ✦ Paleogenetics, paleogenomics
- Paleoenvironment
  - ✦ proxy data
  - ✦ models

Hominin evolution



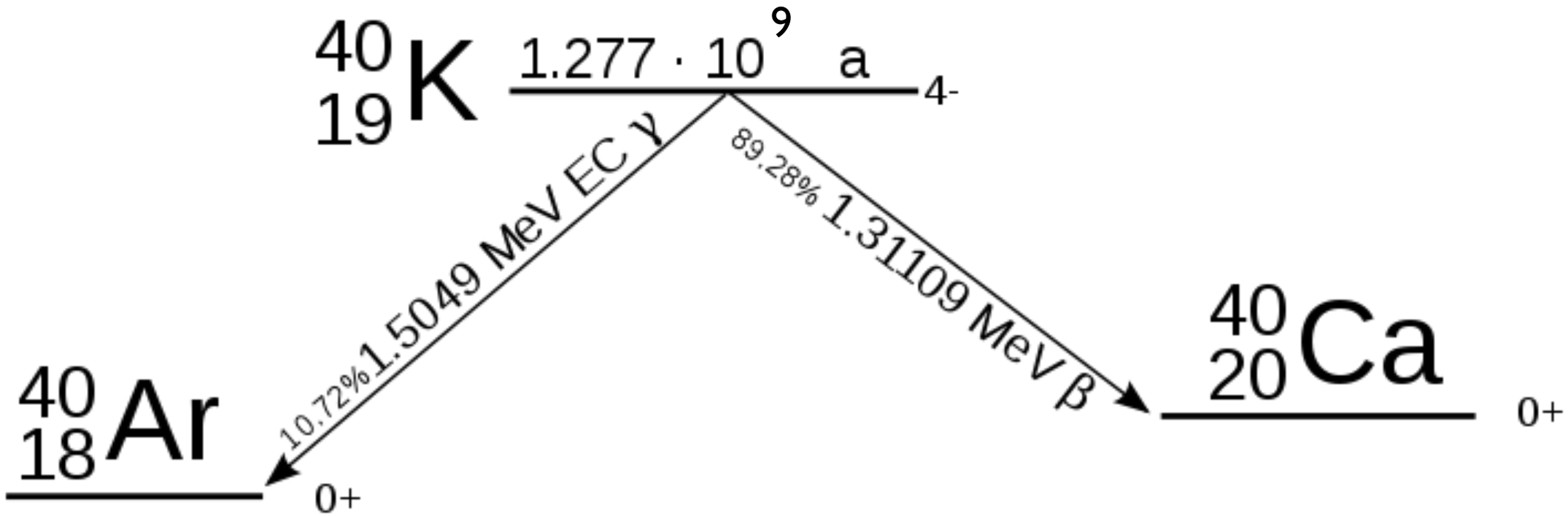
40K-40Ar

10Be/26Al

Potassium-argon dating

Principles

- ^{40}K decays to both ^{40}Ar and ^{40}Ca



Principles

- mineral forms (e.g. from molten rock)
- “ argon-free
- “ have potassium

$$^{40}\mathrm{Ar} = {}^{40}\mathrm{Ar}_{\mathrm{initial}} + 0.105\,{}^{40}\mathrm{K}(1 - \mathrm{e}^{-\lambda t})$$

t is the “age”

0.105 is the ‘branching ratio’ to ^{40}A

Argon-argon

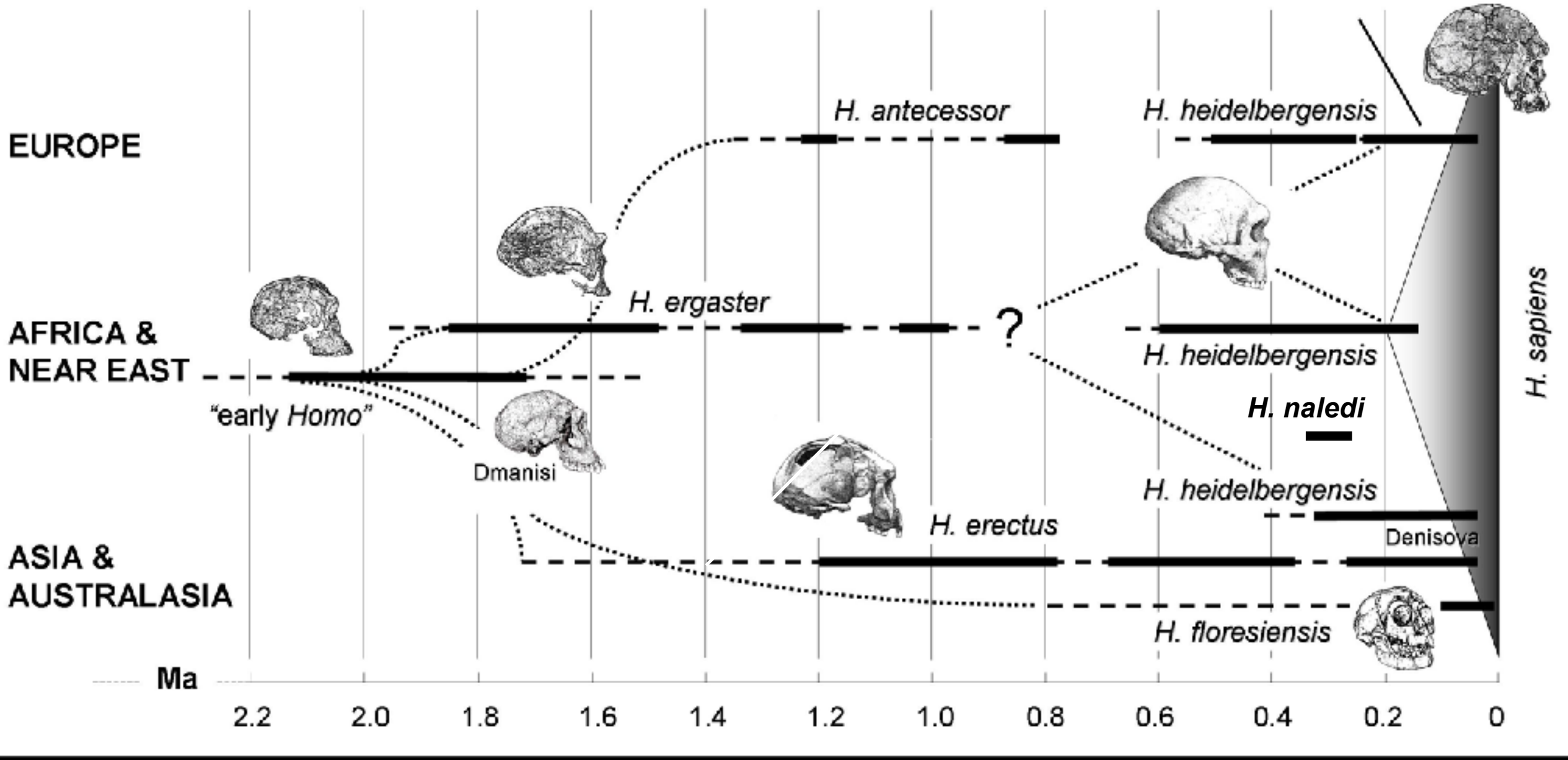
- $^{40}Ar/^{39}Ar$ is measured
- ^{39}Ar produce by reaction

$$^{39}K(n,\gamma)^{39}Ar$$

Ar - Ar dating

- grains irradiated in reactor for 2 h (2.5 x10^{17} n / cm^2
- gas extraction with infrared laser (50 W)
- mass spectrometry

Human evolution



OSL, 234U/230Th

14C

40K-40Ar

10Be/26Al

Cosmogenic dating

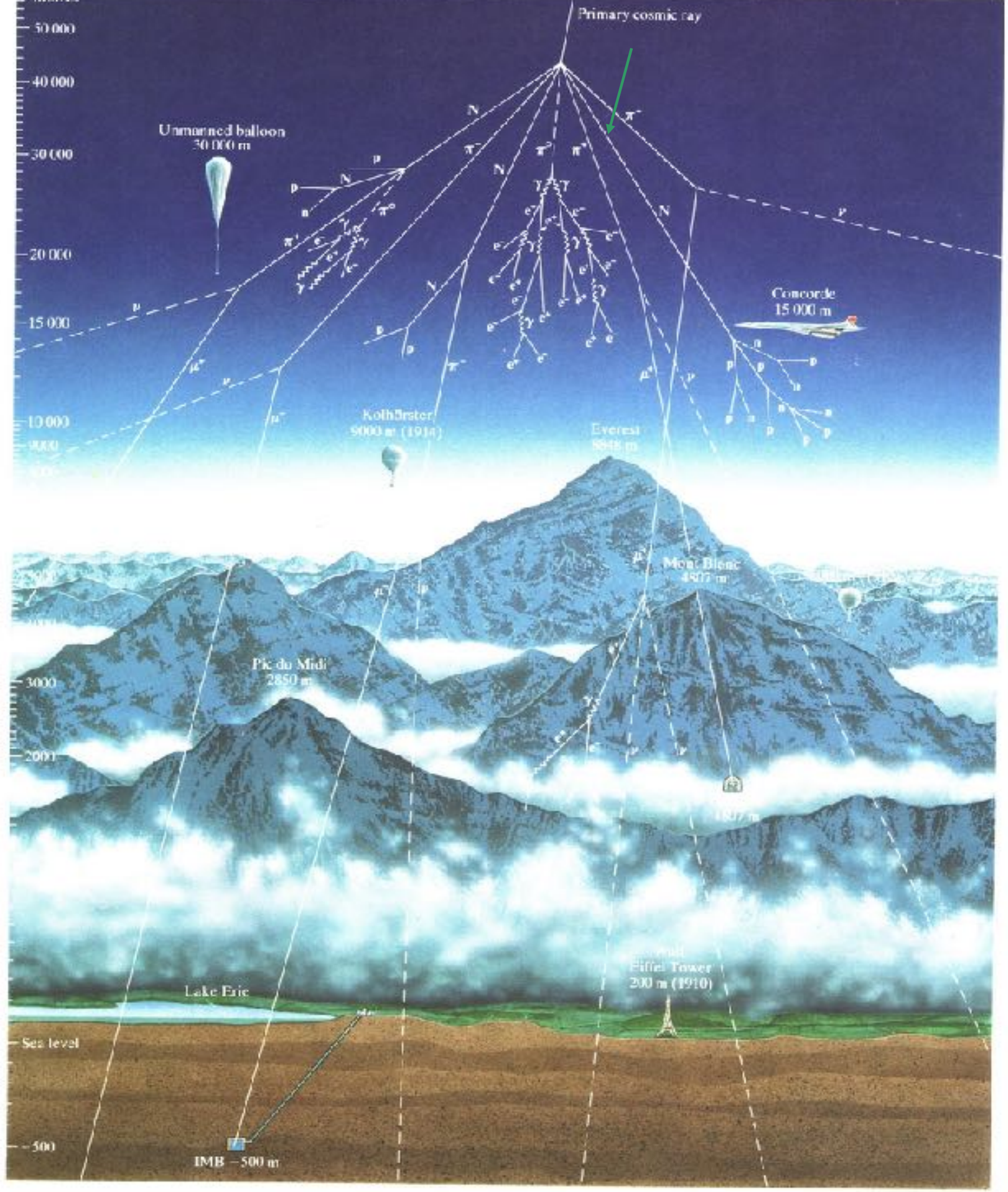
Atmospheric production

^{14}C

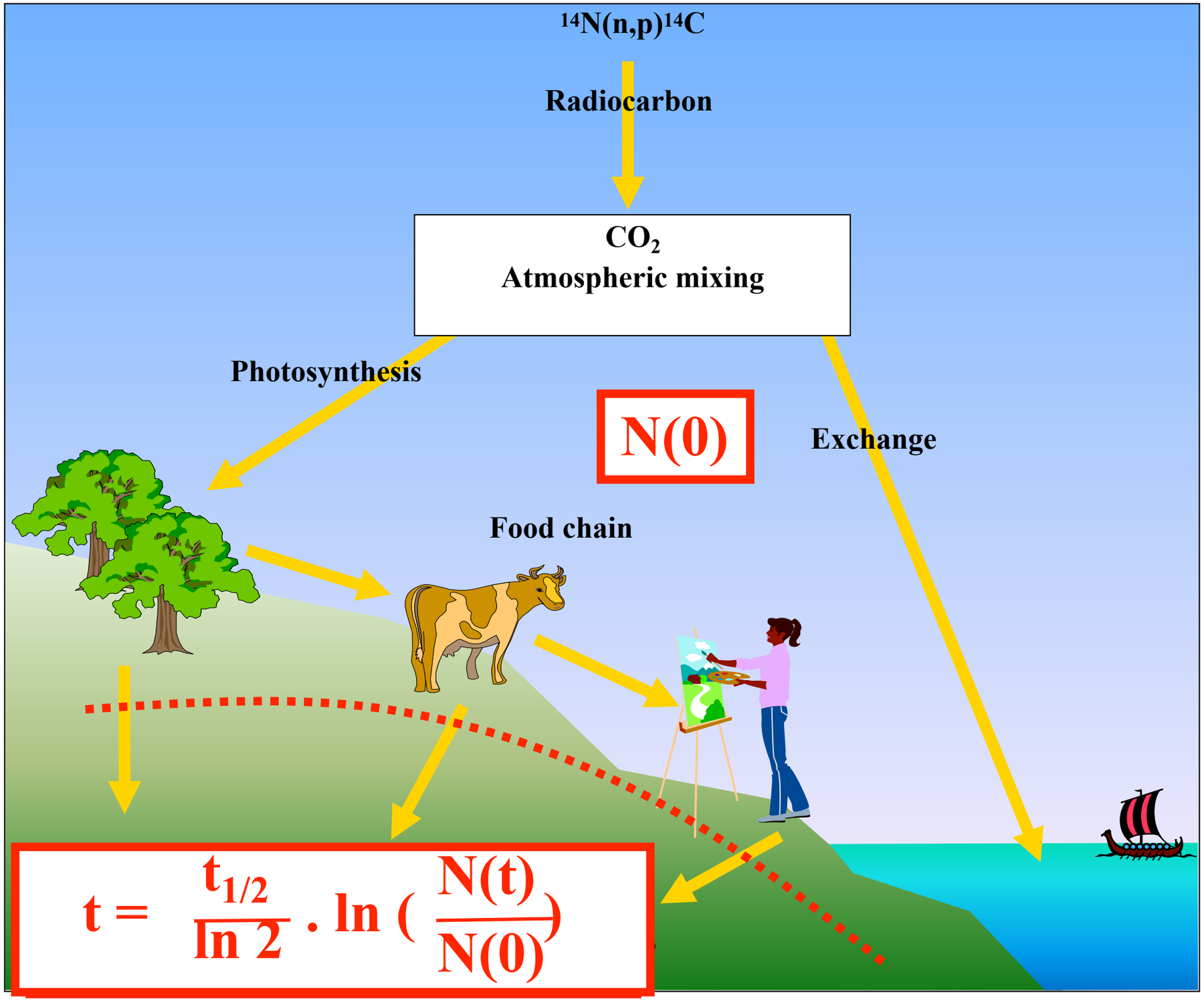
$T_{1/2}$ 5730 years

Surface production

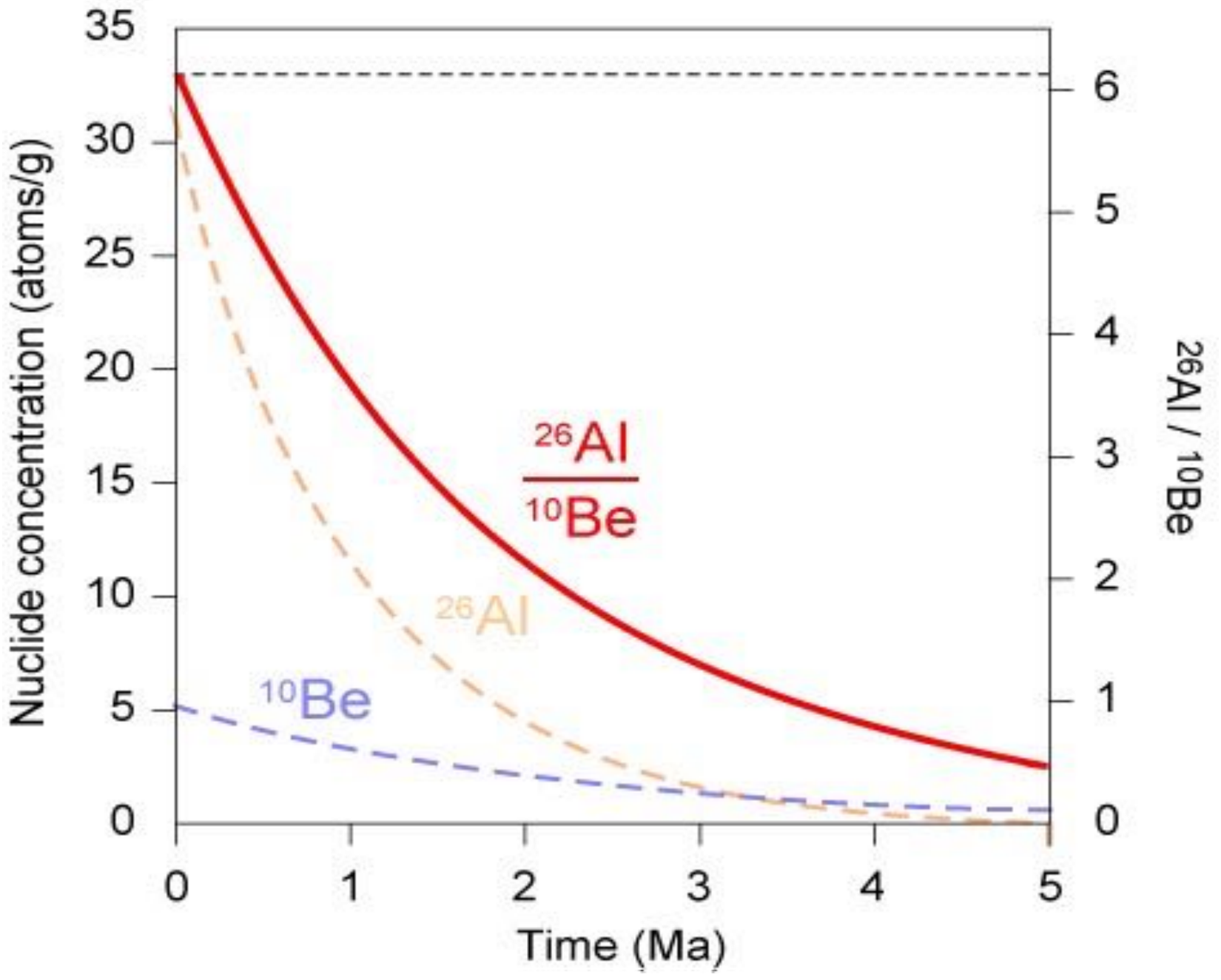
	^{26}Al	^{10}Be
$T_{1/2}$	0.7 Myr	1.5 Myr



Radiocarbon dating



Cosmogenic dating

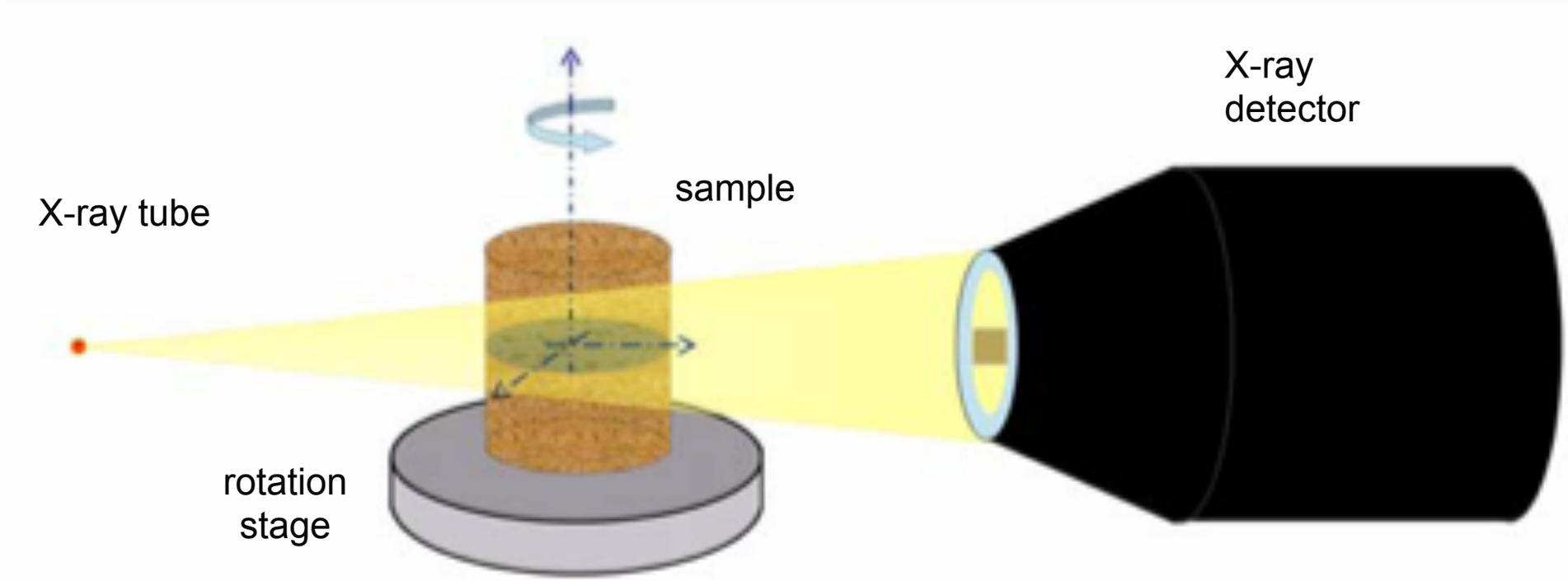


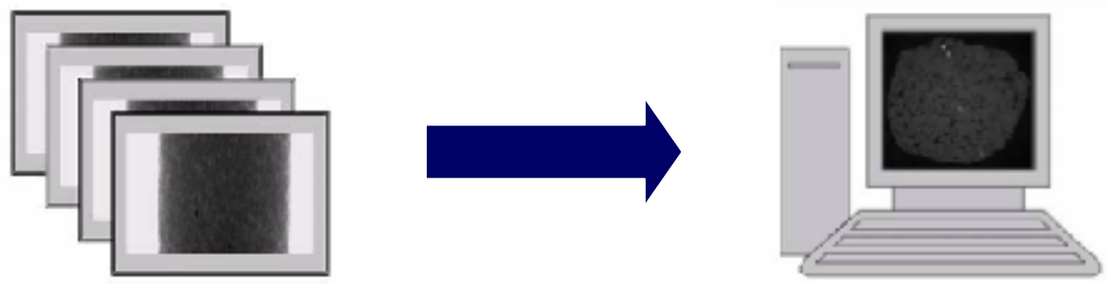
Atom counting system

CIRCE - Caserta, Italy

The bone readers

X-ray 3D imaging

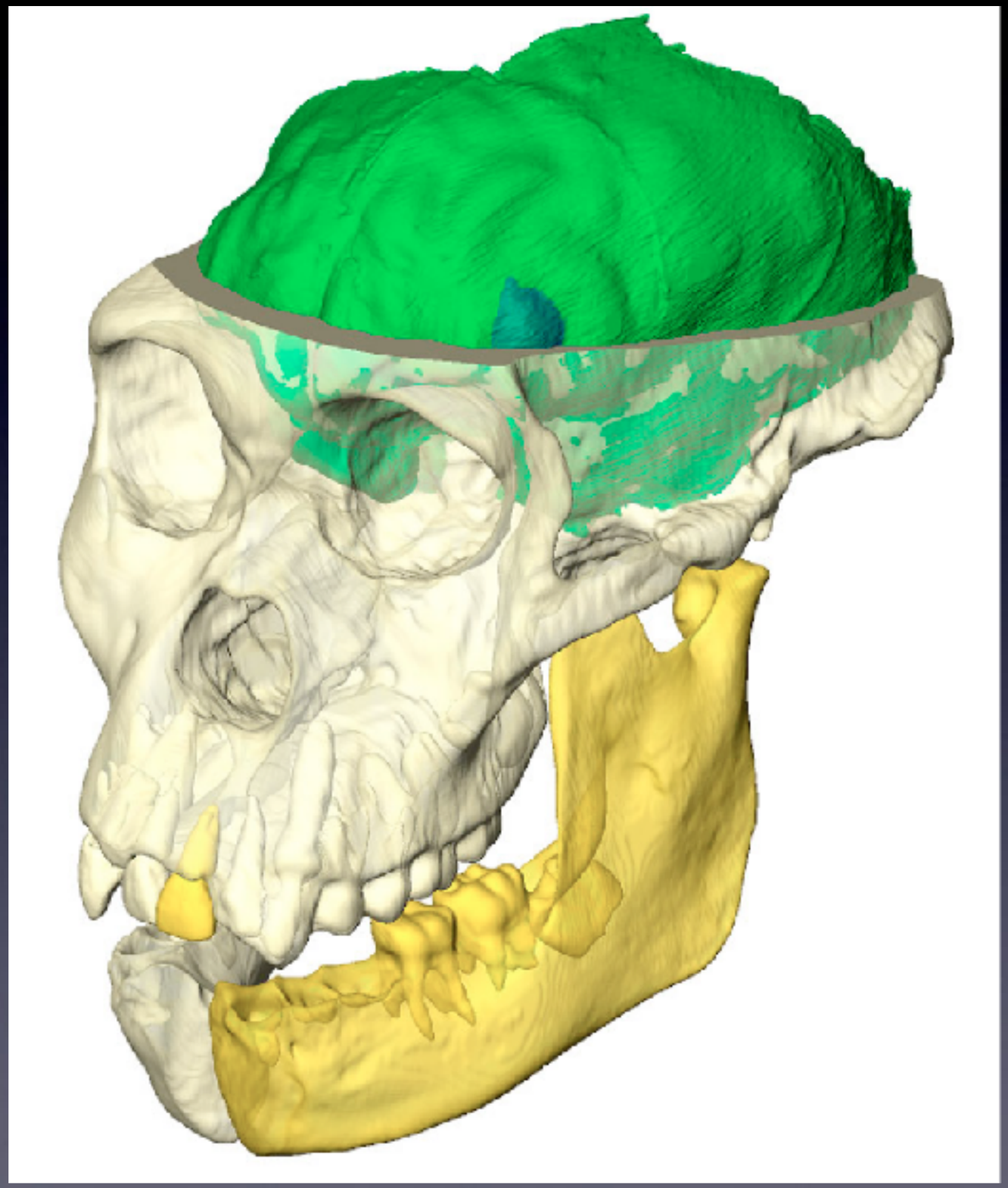




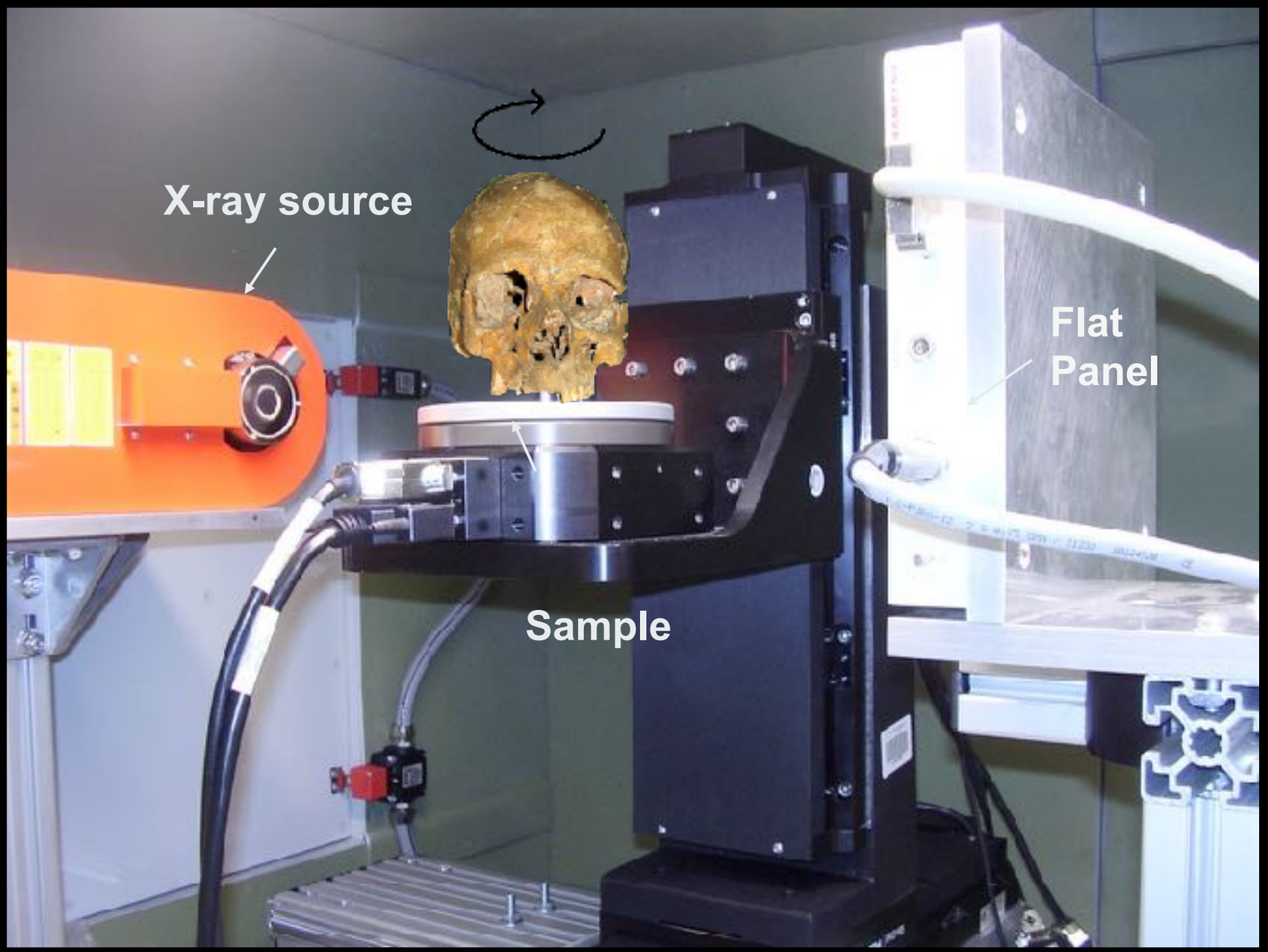
planar radiographs

slice reconstruction

Australopithecus sediba Lee Berger, 2010



x-ray imaging @ ICTP



SCIENTIFIC REPORTS

OPEN

Digital reconstruction of the Ceprano calvarium (Italy), and implications for its interpretation

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Published online: 25 October 2017

Fabio Di Vincenzo[1,2], Antonio Profico[1,2], Federico Bernardini[3,4], Vittorio Cerroni[5], Diego Dreossi[6], Stefan Schlager[7], Paola Zaio[5], Stefano Benazzi[8,9], Italo Biddittu[2], Mauro Rubini[2,5,10], Claudio Tuniz[4,3,11] & Giorgio Manzi[1,2]

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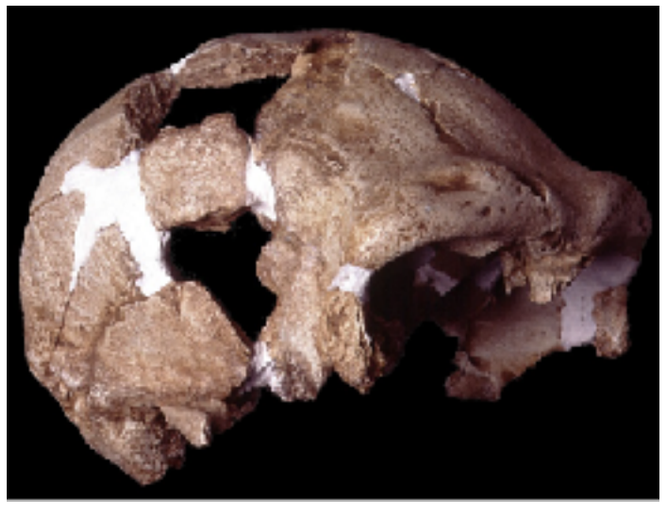
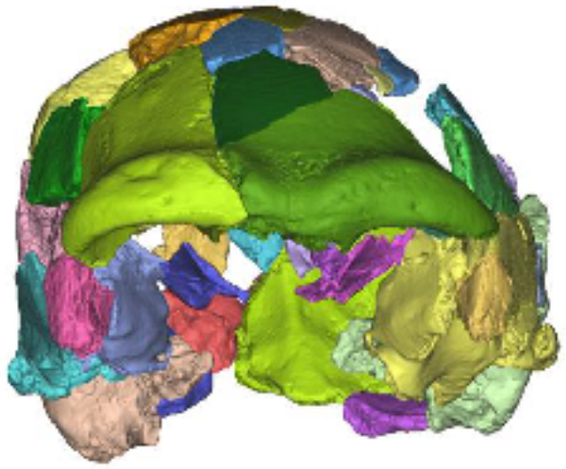
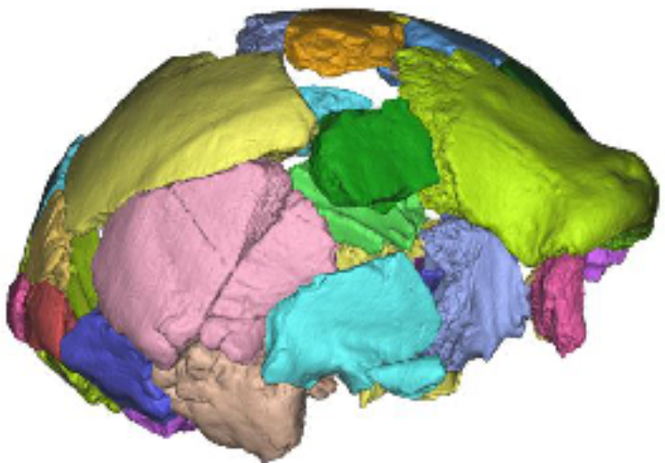
Reconstruction of Ceprano skull (400,000 years BP)



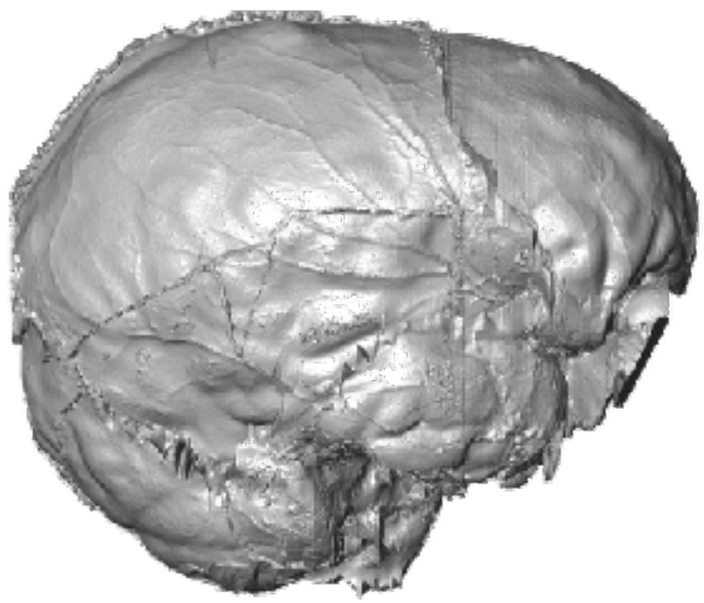




Objective: define its phylogenetic and taxonomic position

Procedure: correct the deformation that affected the specimen by a computer-assisted procedure based on geometric morphometrics and Finite Element Analysis

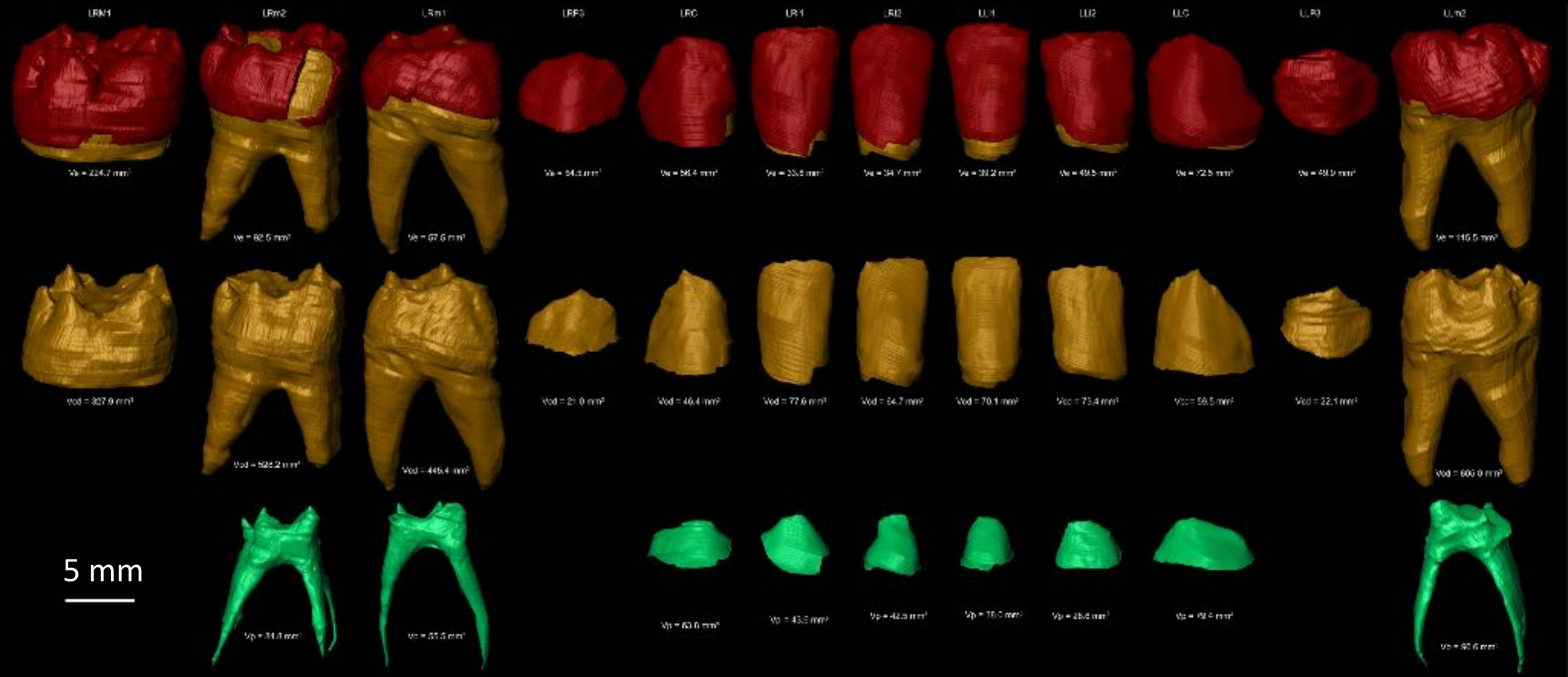
Virtual brain



Romito skull

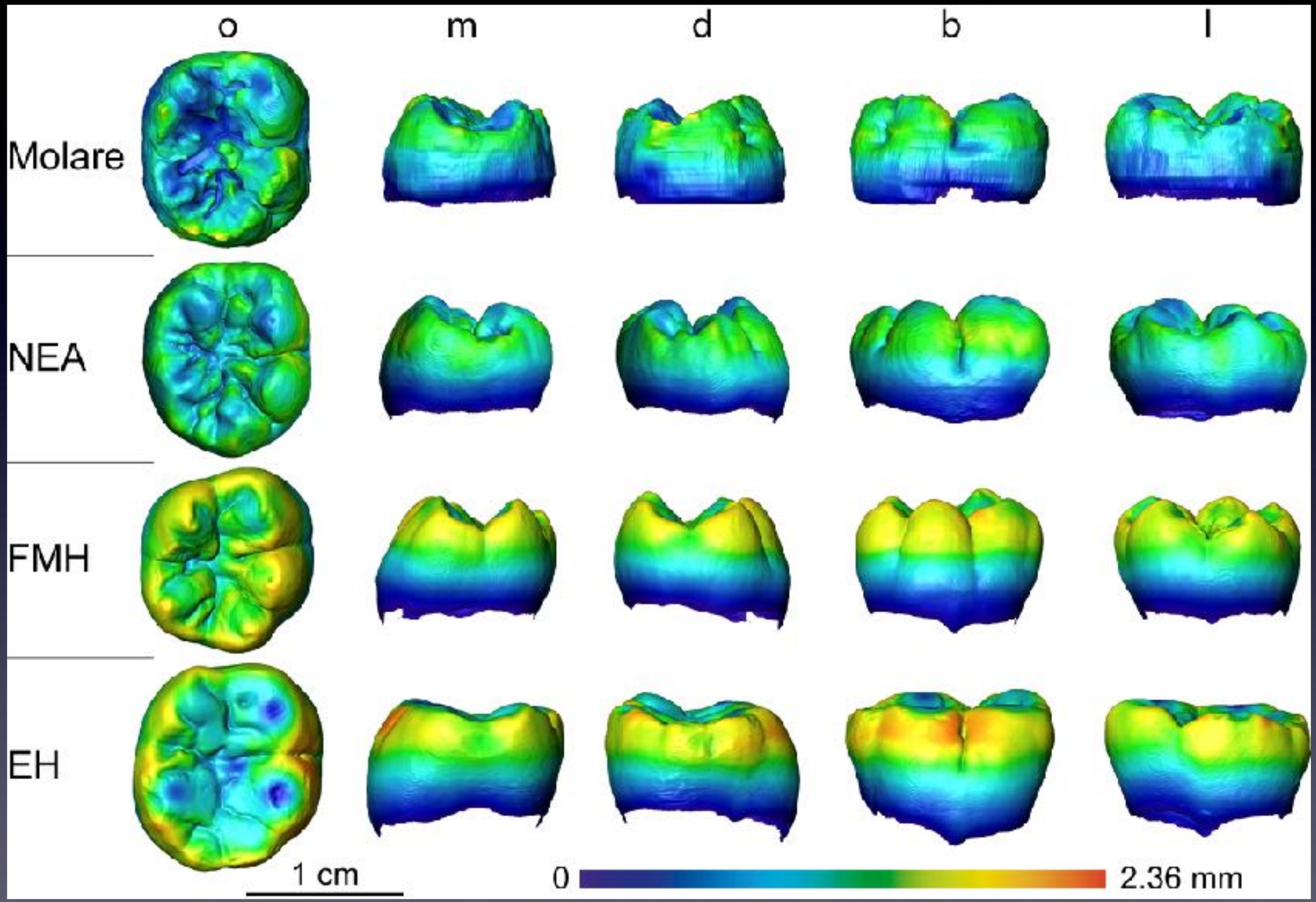
Italian Neanderthal child ~ 100 ka

Tuniz, C. et al 2012. A new assessment of the Neanderthal child mandible from Molare, SW Italy, using x-ray microtomography. Proc. Europ. Soc. Hum. Evol. 1, 196



Tuniz, C. et al 2012. A new assessment of the Neanderthal child mandible from Molare, SW Italy, using x-ray microtomography. Proc. Europ. Soc. Hum. Evol. 1, 196

virtual paleoanthropology



Tuniz, C. et al 2012. A new assessment of the Neanderthal child mandible from Molare, SW Italy, using x-ray microtomography. Proc. Europ. Soc. Hum. Evol. 1, 196

SCIENTIFIC REPORTS

OPEN

Virtual histological assessment of the prenatal life history and age at death of the Upper Paleolithic fetus from Ostuni (Italy)

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Published online: 25 August 2017

Alessia Nava[1,2], **Alfredo Coppa**[1], **Donato Coppola**[3,4], **Lucia Mancini**[5], **Diego Dreossi**[5], **Franco Zanini**[5], **Federico Bernardini**[6,7], **Claudio Tuniz**[6,7,8] & **Luca Bondioli**[2]

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x-ray imaging @ Elettra

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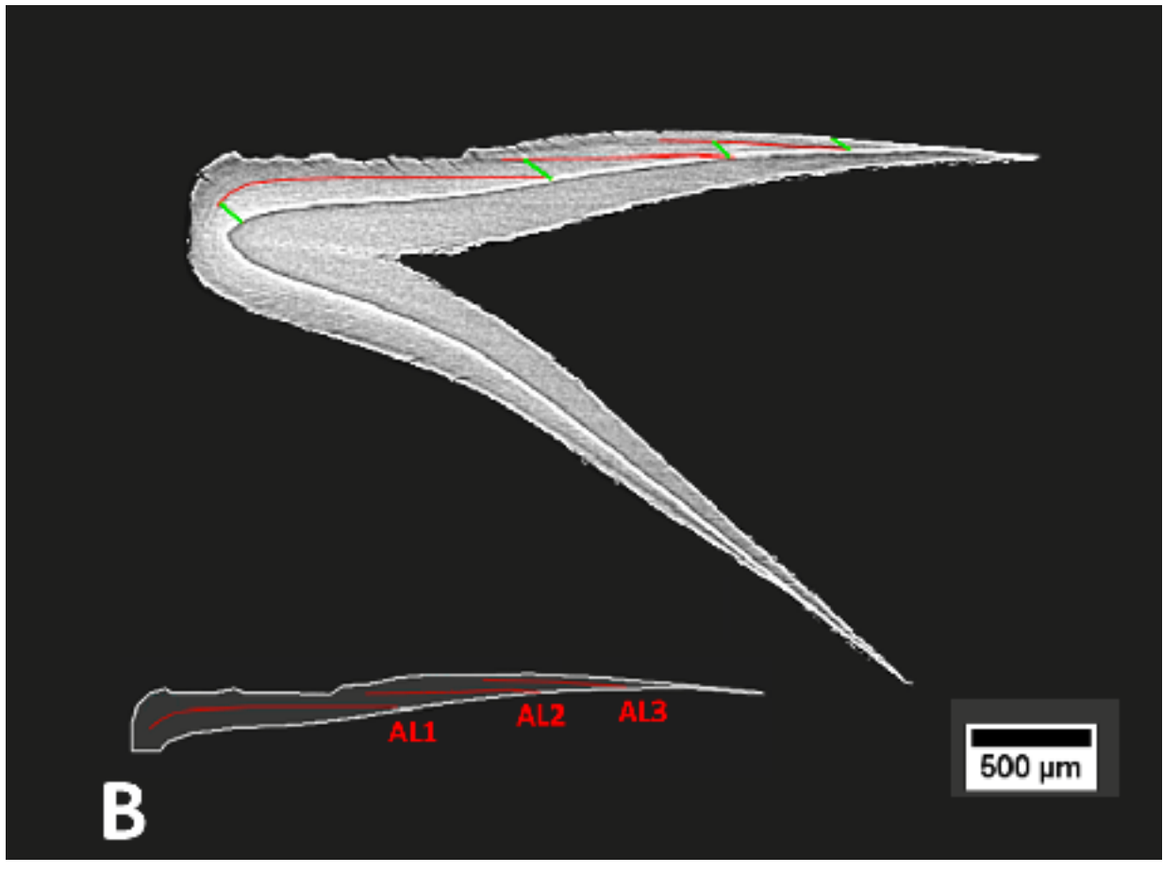
MUSEO STORICO DELLA FISICA E CENTRO STUDI E RICERCHE ENRICO FERMI

S.A.P.I.E.N.S
Scienze per l'**A**rcheologia e la **P**aleoantropologia:
Interpretare**E** la **N**ostra **S**toria

The Abdus Salam International Centre for Theoretical Physics

Paleolithic fetus from Ostuni
27.000 years BP

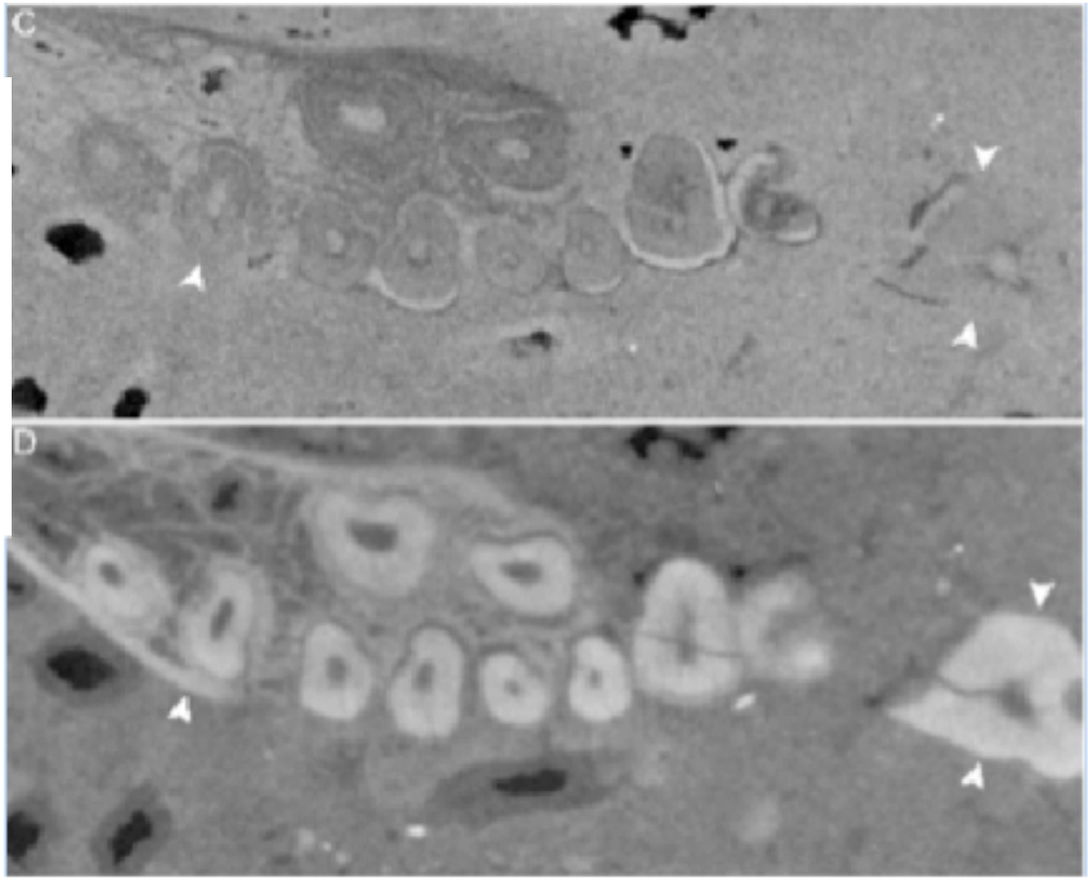


n-imaging @ ANSTO, Australia

Neutron micron CT

First application of neutron microtomography (n-microCT) to paleoanthropological cases where X-rays have previously failed to deliver sufficient contrast between different dental tissues of fossilized specimen.

South African cercopithecoid maxilla embedded in hard breccia rock



x-ray mCT
ICTP

neutron mCT
ANTARES

H. sapiens evolution

Mainstream theory

- Evolved in East Africa 200.000 years ago
- Out of Africa 60.000 years ago
- Replaced all ‘archaic’ human species in Eurasia

Emerging facts and ideas

- Accretion of modern human traits
- Modern humans in China earlier
- African multiregional origins
- Interbreeding

Accretion of modern human traits

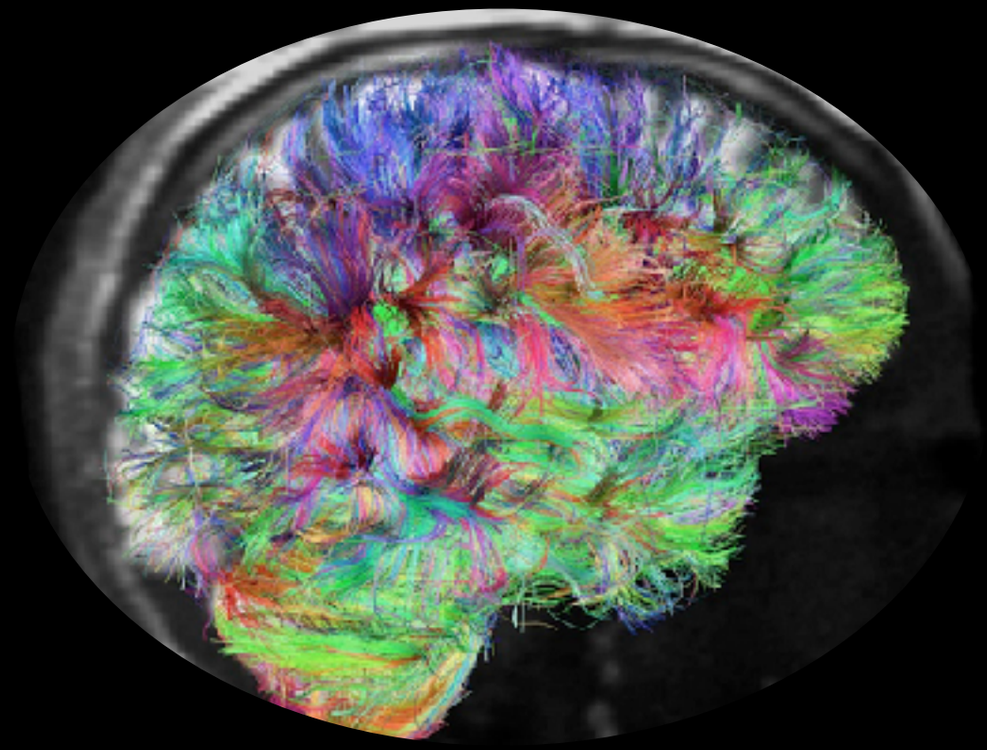
Jebel Irhoud, 300 ka

Qafzeh, 95 ka

Scerri et al, Trends in Ecol and Evol 2018

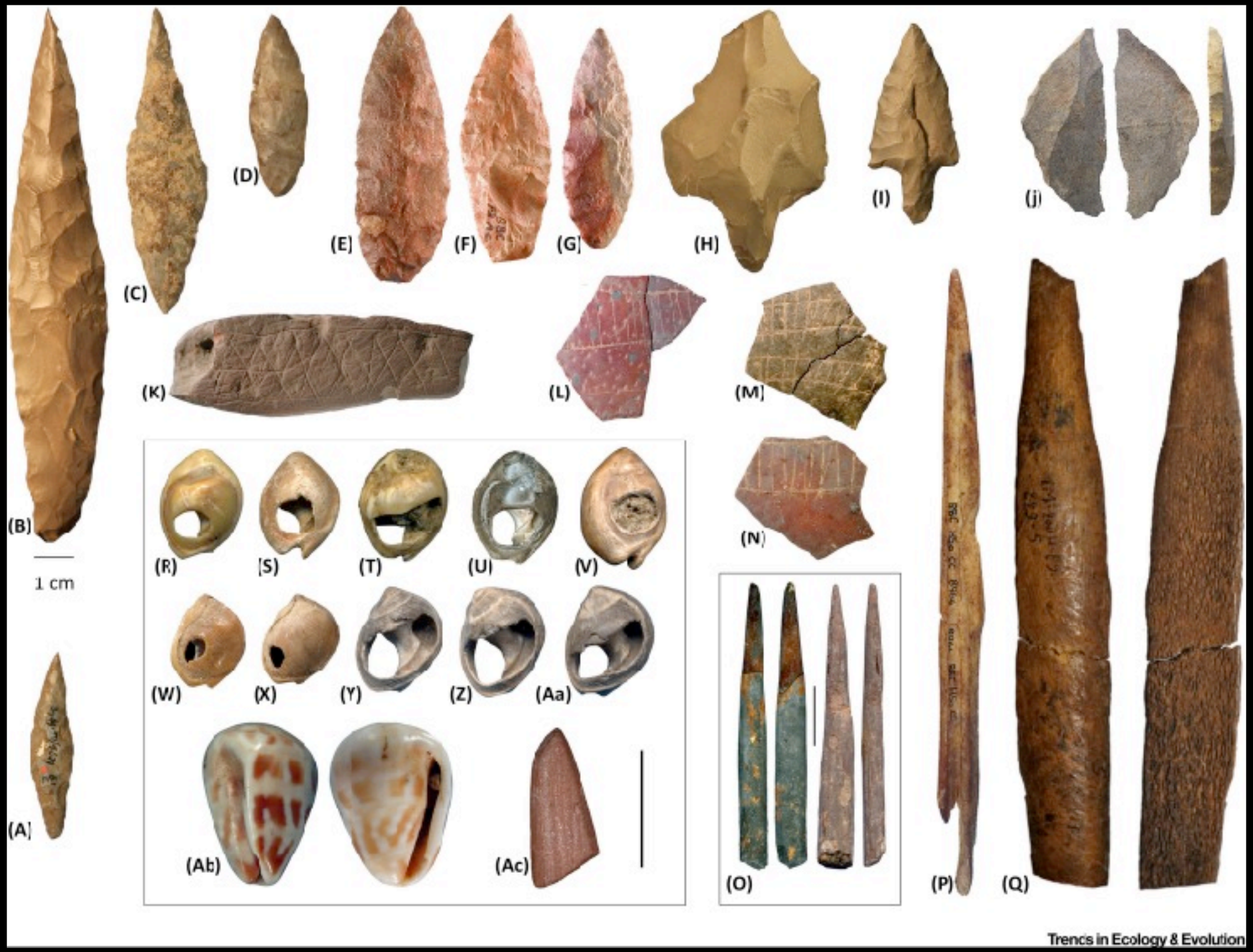
From brains to minds

- Brain size and structure
- Neural networks
- Life history



Africa >100 - 50 ka

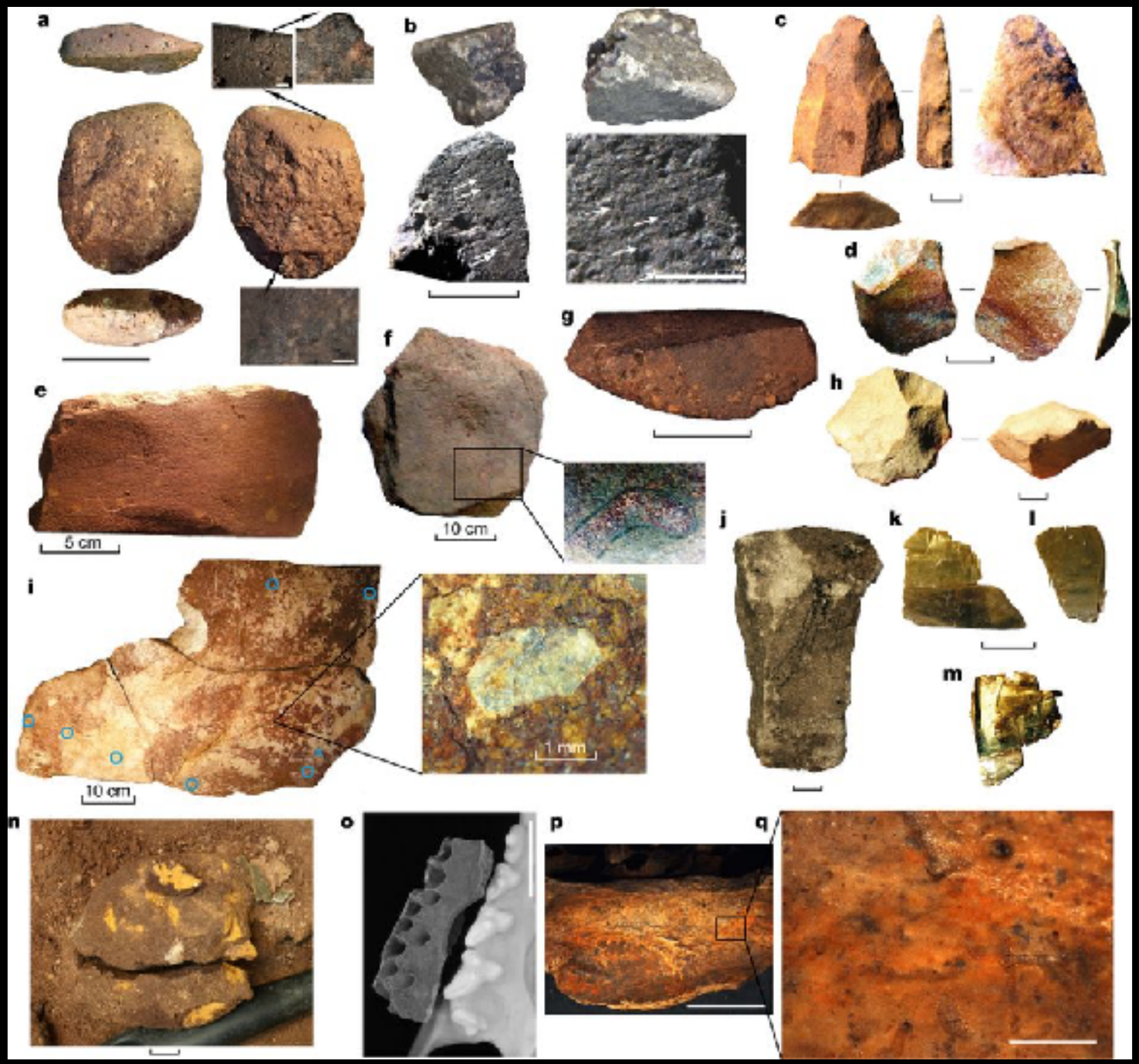
(OSL, uranium-thorium)



Scerri et al, Trends in Ecol and Evol 2018

Australia 65 ka

(radiocarbon, OSL)



Clarkson et al, Nature 2018

Europe 43.000 years

(radiocarbon)

Hohle Fels venus

Hohle Fels flute

Conard, 2009

Europe 35.000 years

(radiocarbon)

Chauvet, France

No man is an island!

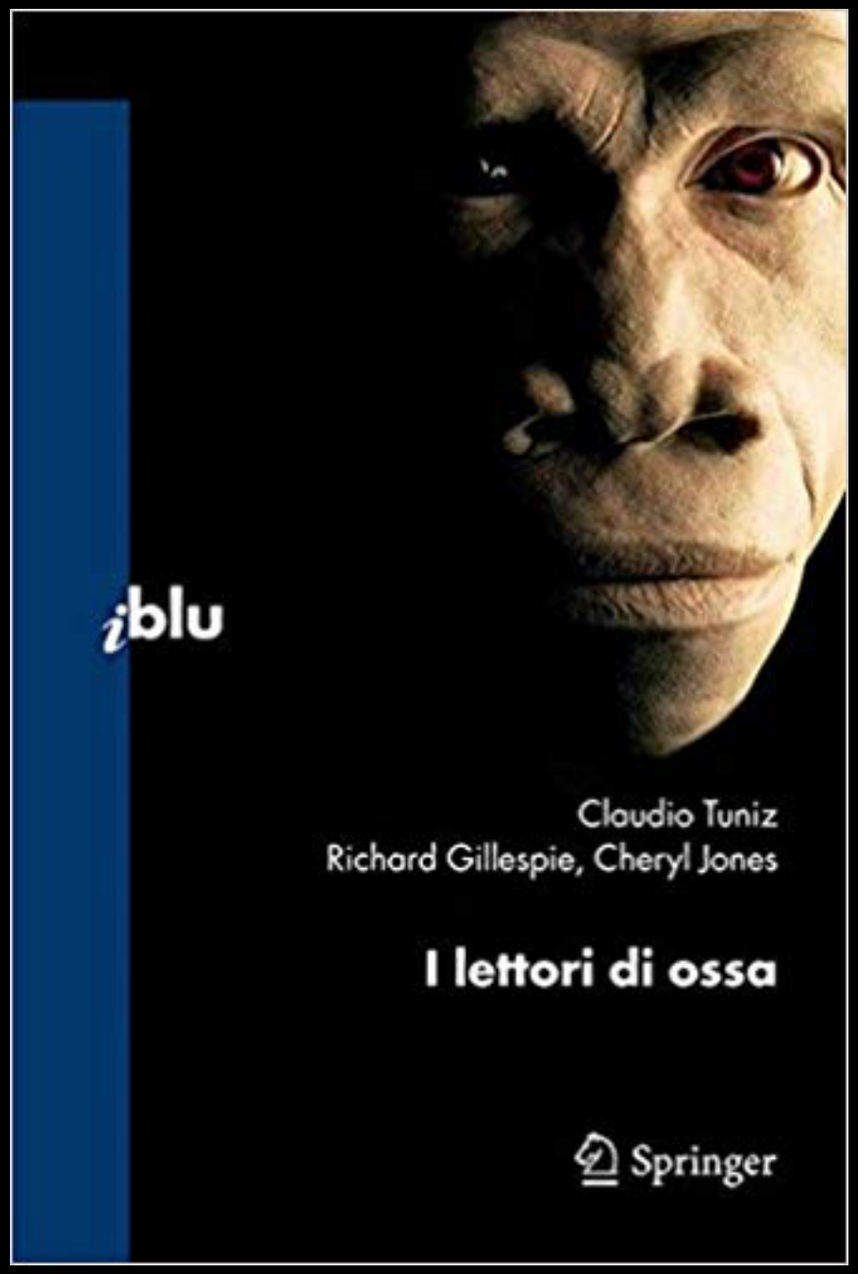
- Extended mind (Bruner, Iriki))
- Emotions (A. Damasio)
- Accumulation of cultural information (K. Laland)
- Social structure (demography, resources, trade, conflict, inequality, division of labor)
- Human self-domestication

Claudio Tuniz | Patrizia Tiberi Vipraio

Dalle tribù di primati all'intelligenza artificiale

LA SCIMMIA VESTITA

Carocci editore Sfere


iblu
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Richard Gillespie, Cheryl Jones
I lettori di ossa
Springer


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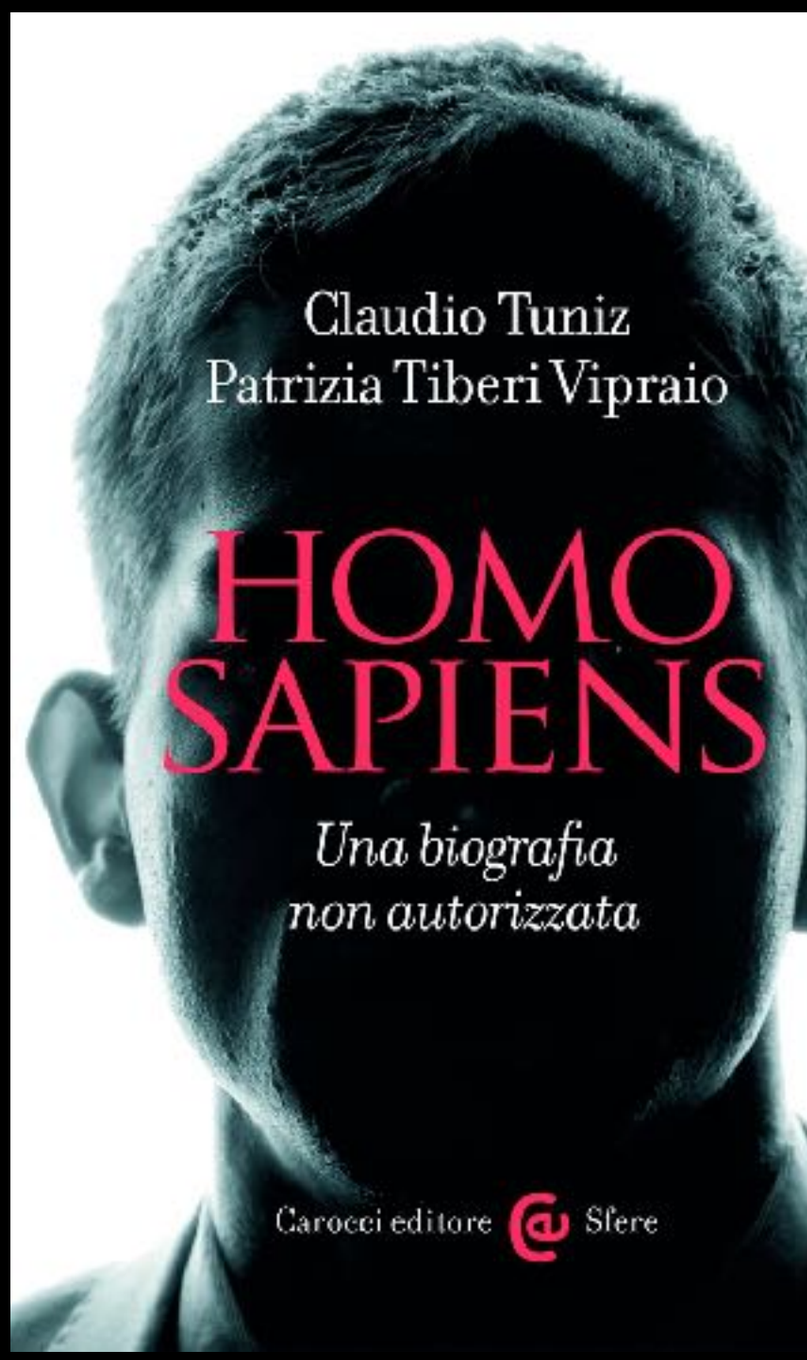
C. Tuniz G. Manzi D. Caramelli
La scienza
delle nostre origini
Editori Laterza


Claudio Tuniz
Patrizia Tiberi Vipraio
HOMO
SAPIENS
Una biografia
non autorizzata
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PLOS ONE

RESEARCH ARTICLE

The Middle Pleistocene (MIS 12) human dental remains from Fontana Ranuccio (Latium) and Visogliano (Friuli-Venezia Giulia), Italy. A comparative high resolution endostructural assessment

Clément Zanolli[1]*, María Martinón-Torres[2,3], Federico Bernardini[4,5], Giovanni Boschian[6], Alfredo Coppa[7], Diego Dreossi[8], Lucia Mancini[9], Marina Martínez de Pinillos[2,3], Laura Martín-Francés[2,3], José María Bermúdez de Castro[2,3], Carlo Tozzi[6], Claudio Tuniz[4,5,10], Roberto Macchiarelli[11,12]

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Citation: Zanolli C, Martinón-Torres M, Bernardini F, Boschian G, Coppa A, Dreossi D, et al. (2018) The Middle Pleistocene (MIS 12) human dental

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journal homepage: www.elsevier.com/locate/jhevol

Inner tooth morphology of *Homo erectus* from Zhoukoudian. New evidence from an old collection housed at Uppsala University, Sweden

Clément Zanolli [a, *], Lei Pan [b, c], Jean Dumoncel [a], Ottmar Kullmer [d, e], Martin Kundrát [f], Wu Liu [b], Roberto Macchiarelli [g, h], Lucia Mancini [i], Friedemann Schrenk [d, e], Claudio Tuniz [j, k, l]

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PLOS ONE

Micro-Biomechanics of the Kebara 2 Hyoid and Its Implications for Speech in Neanderthals

Ruggero D'Anastasio[1], Stephen Wroe[2]*, Claudio Tuniz[3,4], Lucia Mancini[5], Deneb T. Cesana[1], Diego Dreossi[5], Mayoorendra Ravichandiran[6], Marie Attard[7], William C. H. Parr[7], Anne Agur[6], Luigi Capasso[1]

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PLOS ON

Beeswax as Dental Filling on a Neolithic Human Tooth

Federico Bernardini[1]*, Claudio Tuniz[1,2], Alfredo Coppa[3], Lucia Mancini[4], Diego Dreossi[4], Diane Eichert[1], Gianluca Turco[5], Matteo Biasotto[5], Filippo Terrasi[6], Nicola De Cesare[7], Quan Hua[8], Vladimir Levchenko