Isotope Geochemistry I

Lectures
&
tutorials

Syllabus

The focus of both courses a) & b) is on stable and radiogenic isotope systems and their principles and applications in Geology and Environmental Science. Topics and systems include:

a) K-Ar and Ar-Ar methods, Sm-Nd, Lu-Hf and Re-Os systems; isotopes as tracers of sources and processes; presentation of case studies

b) Radionuclides and their measurement techniques, U-Th-Pb, Rb-Sr methods, U-Series Geochemistry, Radiocarbon dating, fractionation of stable isotopes of H, C, N, O and S, climate change geochemistry

Teaching form

a) Lecture

b) Lecture (short course at the end of summer semester)

Examination form

Achievement of learning goals (unmarked): regular attendance

a) & b) Examination: one marked written examination

Literature

G. Faure: *Principles of Isotope Geology* (3. Aufl. 2005)

A. Dickin: *Radiogenic Isotope Geology* (2. Aufl. 2005)

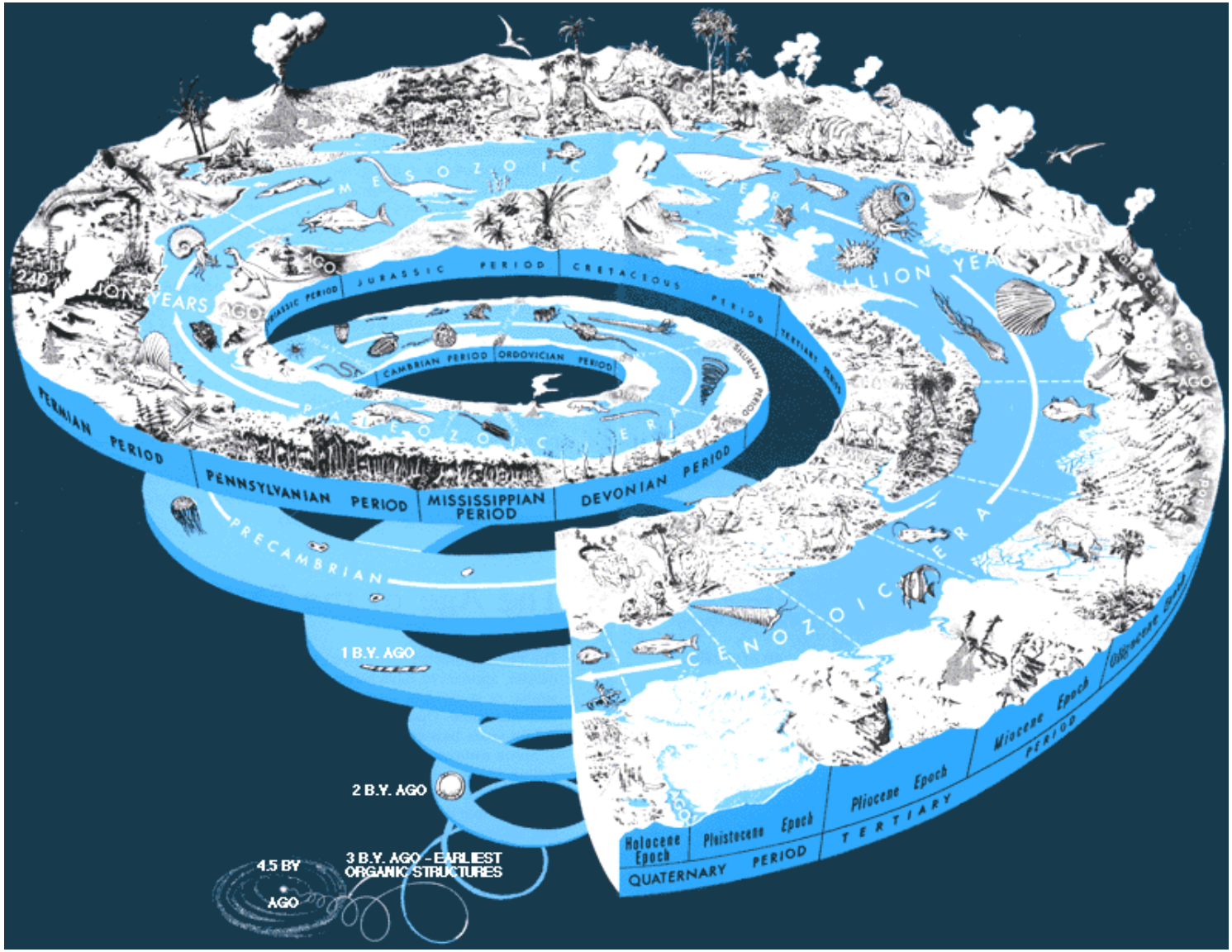
B. White: Lehrbuch im Netz:
http://www.geo.cornell.edu/geology/classes/geo455/Chapters.HTML

G. Stosch: Einführung in die Isotopengeochemie
http://www.dmg.uni-koeln.de/Lehre.html

Abb. Zur Vorlesung:
http://homepages.uni-tuebingen.de/wolfgang.siebel/

Radiometric dating

A time machine to the past



Wieso Isotope?

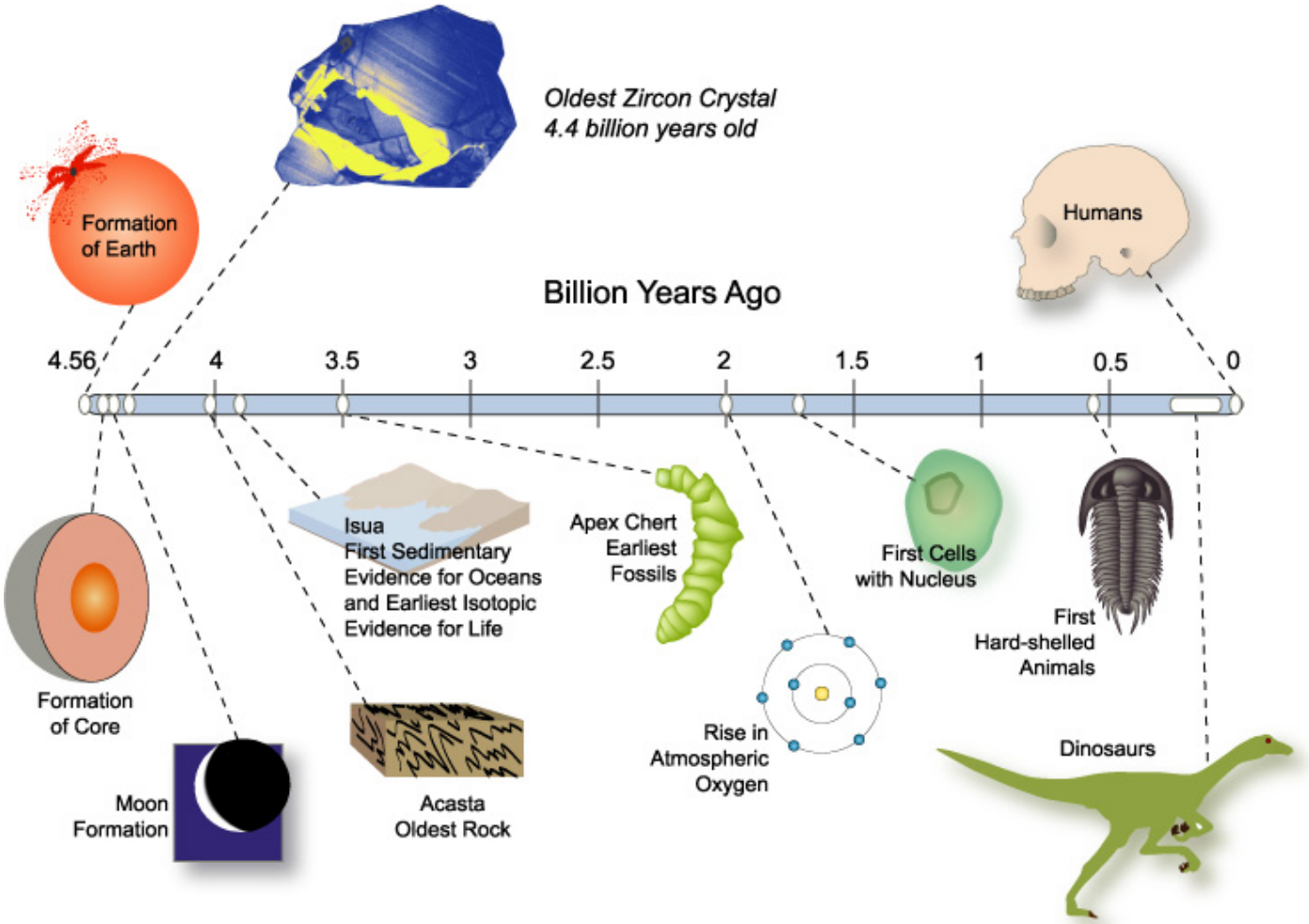
Datierung mit radioaktiven Isotopen ist der einzige Weg geologische Zeit quantitativ zu messen.
Hier einige fundamentale Beispiele:

Bestimmung des Erdalters

Entstehung von Gebirgen

in welchen Zeiträumen entstehen sie und wie schnell werden sie wieder erodiert?

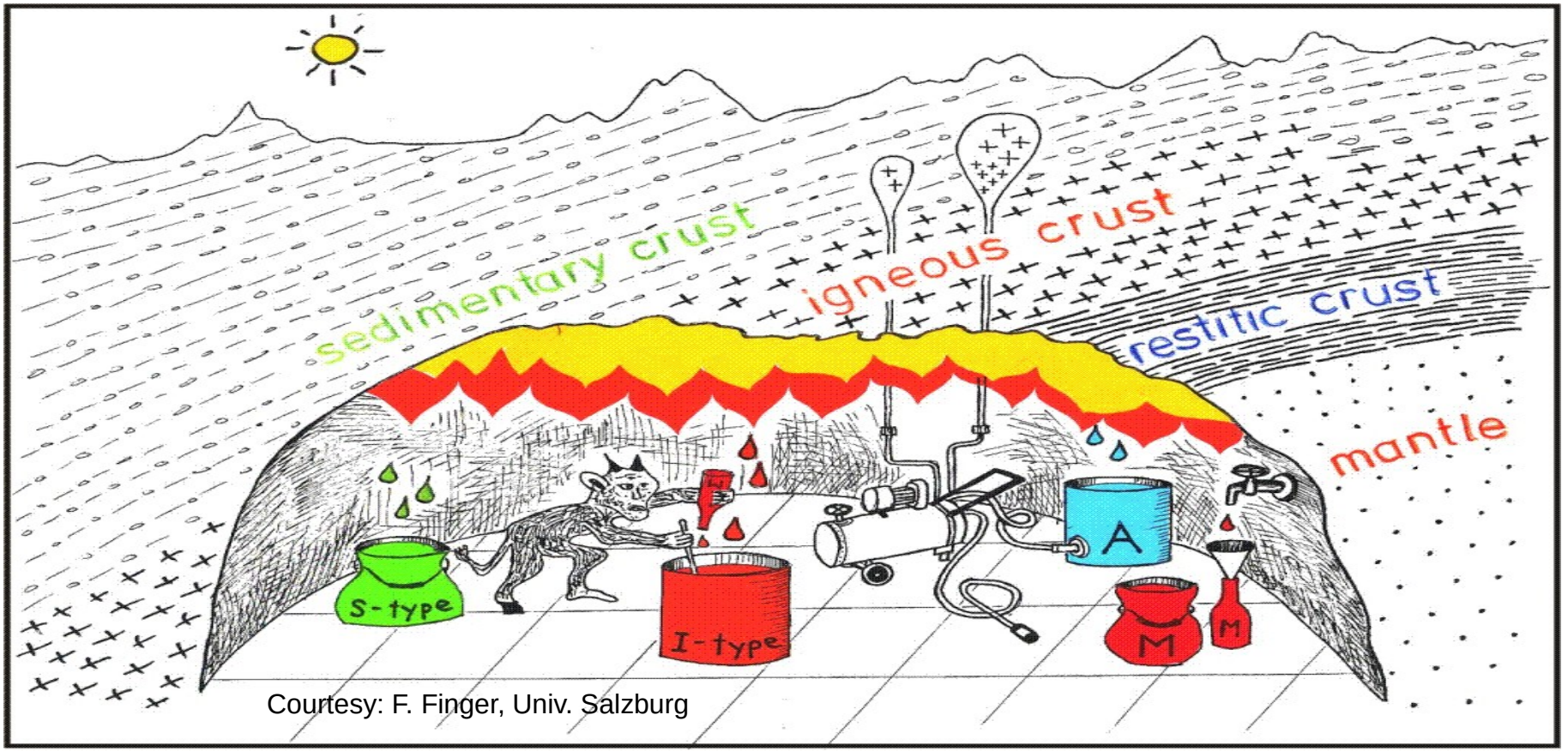
Evolutionsgeschwindigkeit von Lebewesen



http://www.mineralogie.uni-wuerzburg.de/projects/frimmel03.html

Wieso Isotope?

Unterschiedliche Reservoire auf der Erde (z.B. Mantel, Kruste) besitzen unterschiedliche Isotopensignaturen. Das ermöglicht uns die Bestimmung der Herkunft von Gesteinen (z.B. können wir mit einer Isotopenanalyse feststellen ob ein bestimmter Granit aus einer Mantel- oder einer Krustenschmelze stammt).



Courtesy: F. Finger, Univ. Salzburg

Arthur Holmes 1913:
The age of the Earth


HENRI
BECQUEREL


270
SVERIGE
NOBELPRIS 1921
SODDY

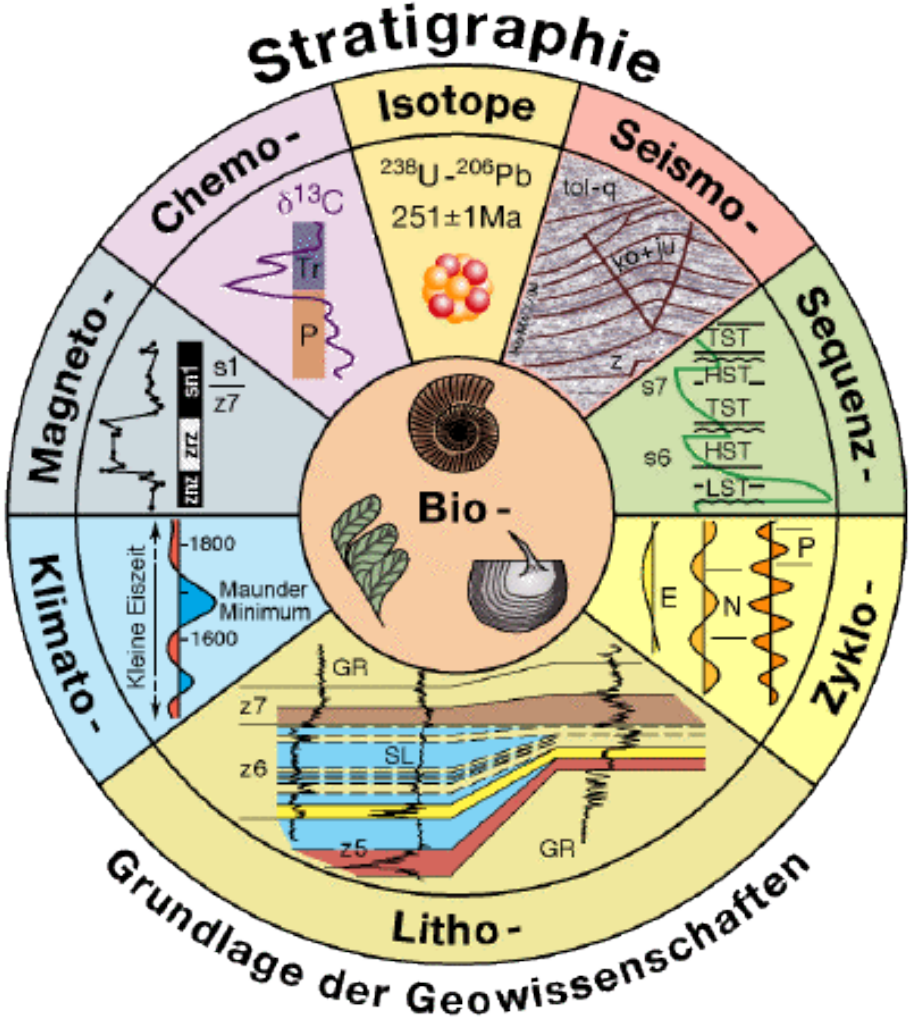

A


B

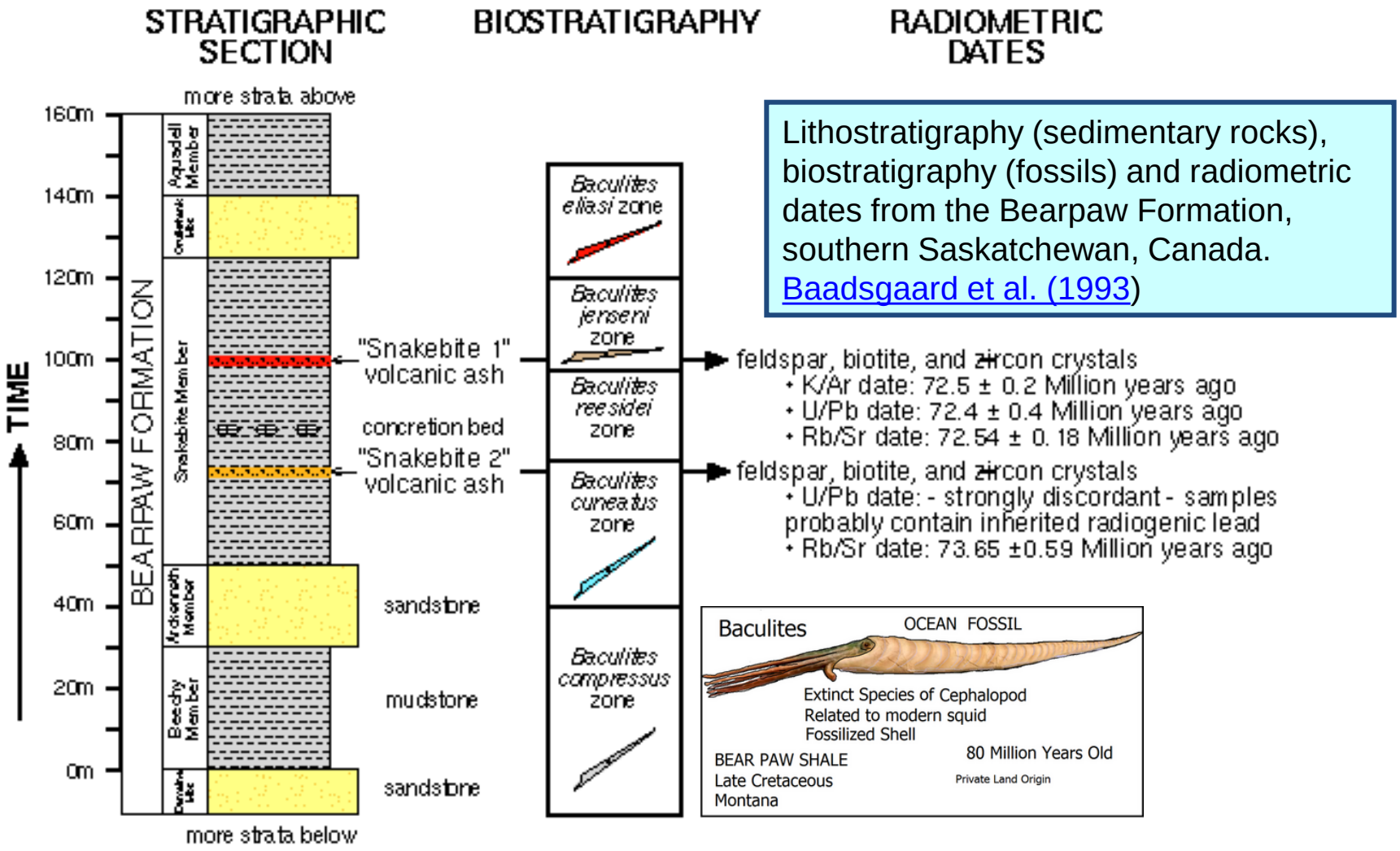

C
SHRIMP IIe


D

Stratigraphie und Datierung (Chronostratigraphie)

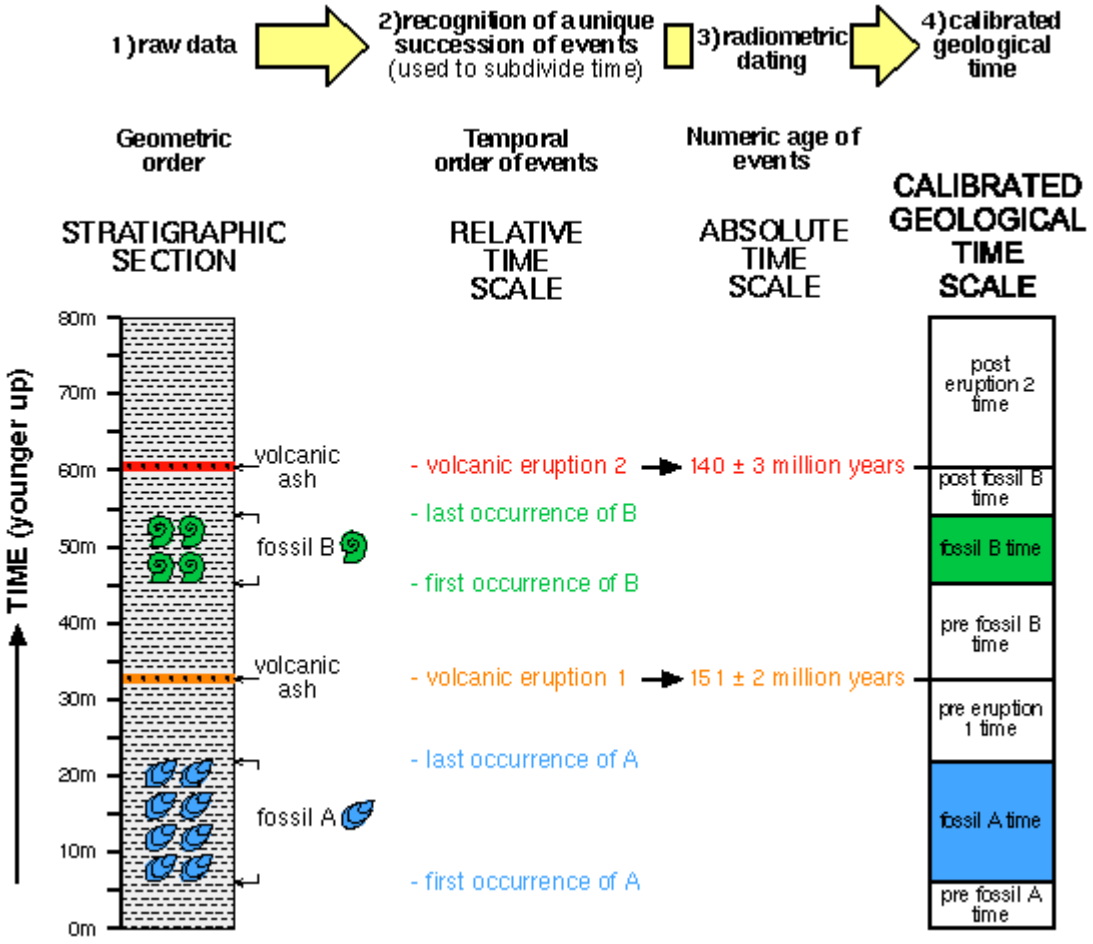


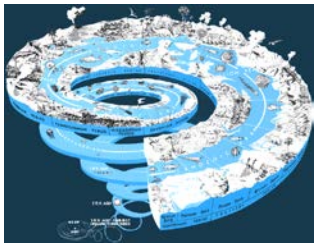
Towards a calibrated geological time scale



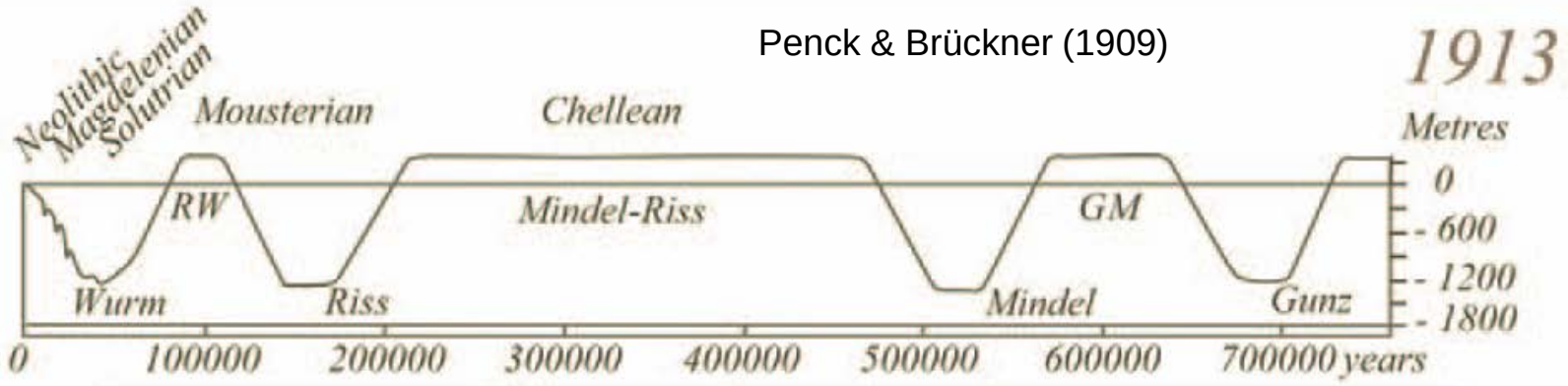
Lithostratigraphy (sedimentary rocks), biostratigraphy (fossils) and radiometric dates from the Bearpaw Formation, southern Saskatchewan, Canada. Baadsgaard et al. (1993)

Towards a calibrated geological time scale



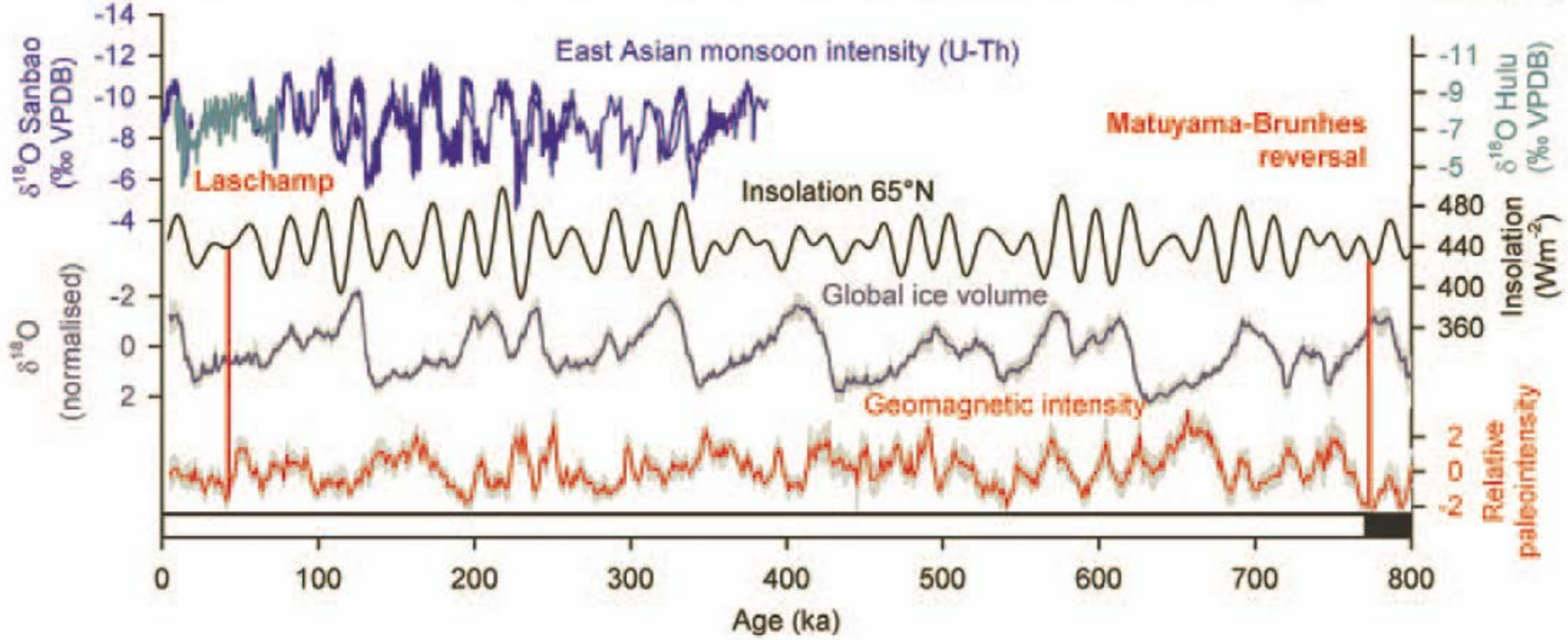


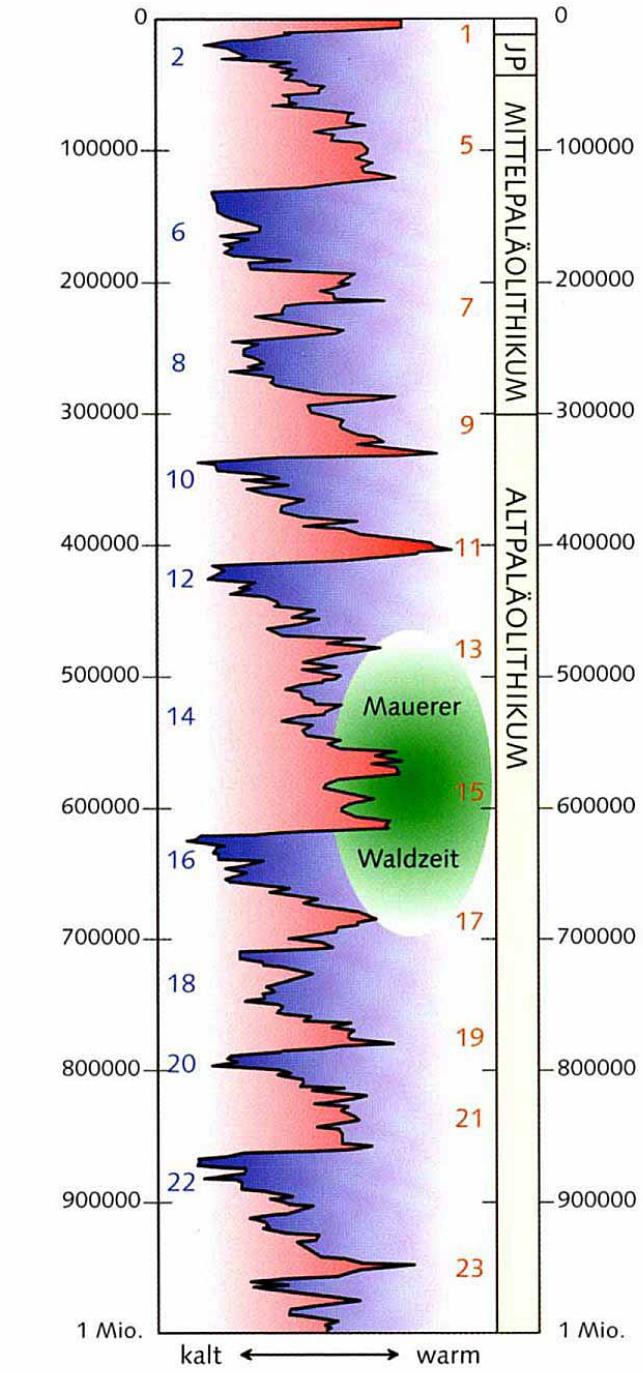
Penck & Brückner (1909)



100 years of geochronology

2013




0
100000
200000
300000
400000
500000
600000
700000
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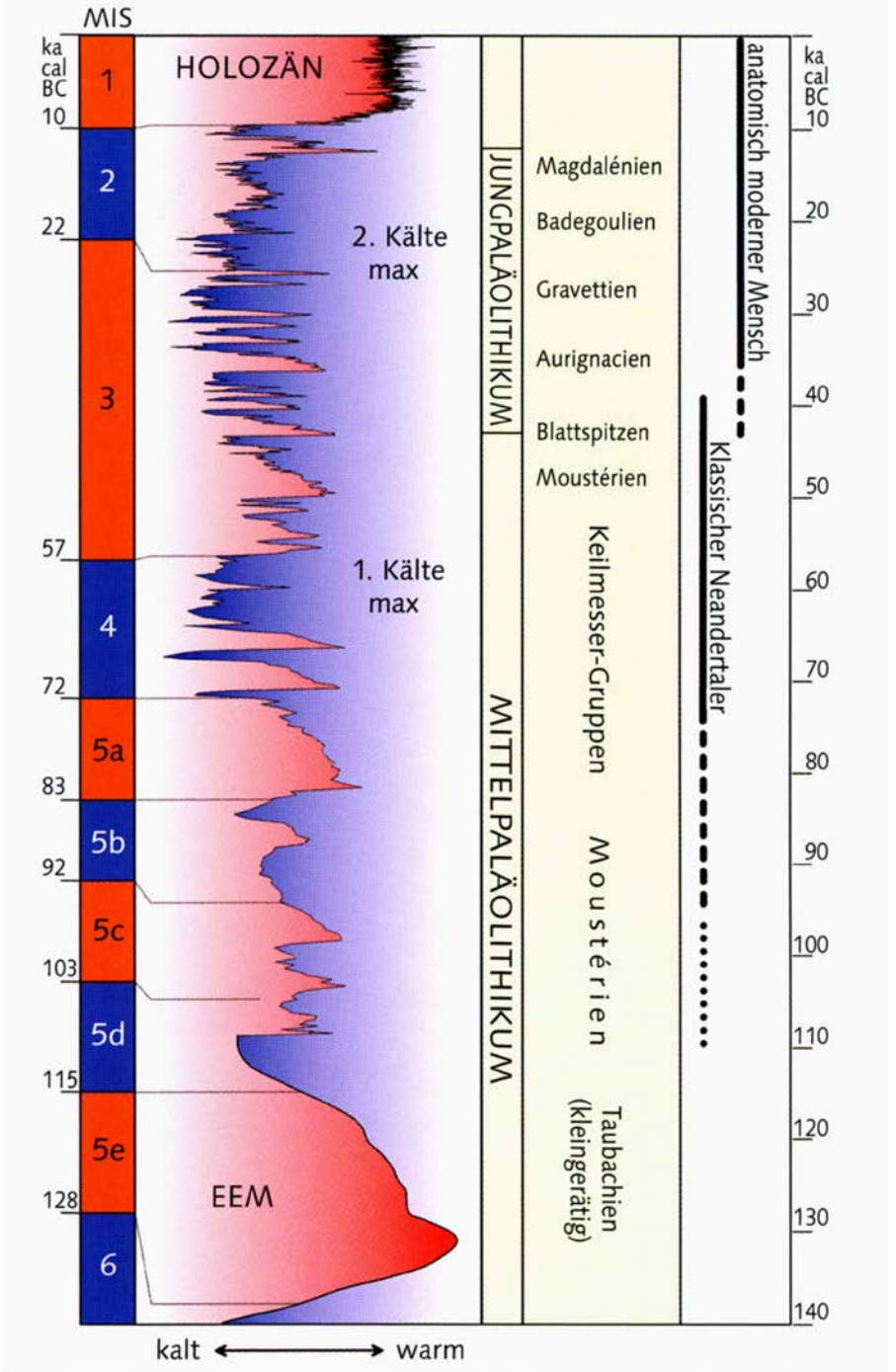
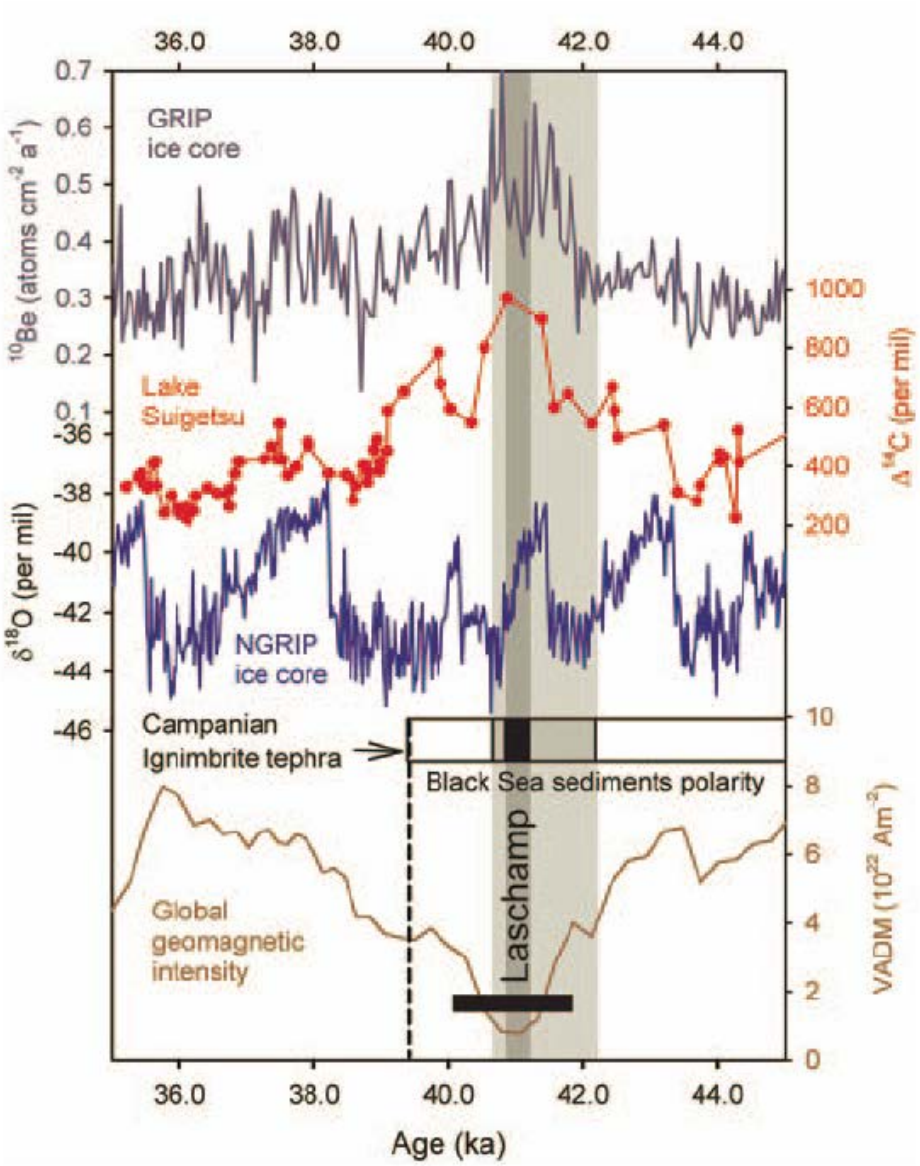
900000
1 Mio.
JP
MITTELPALÄOLITHIKUM
ALTPALÄOLITHIKUM
Mauerer
Waldzeit
kalt
warm


MIS
ka cal BC
HOLOZÄN
2. Kälte max
1. Kälte max
EEM
JUNGPALÄOLITHIKUM
MITTELPALÄOLITHIKUM
Magdalénien
Badegoulien
Gravettien
Aurignacien
Blattspitzen
Moustérien
Keilmesser-Gruppen
Moustérien
Taubachien (kleingerätig)
anatomisch moderner Mensch
Klassischer Neandertaler
kalt
warm



Laschamp

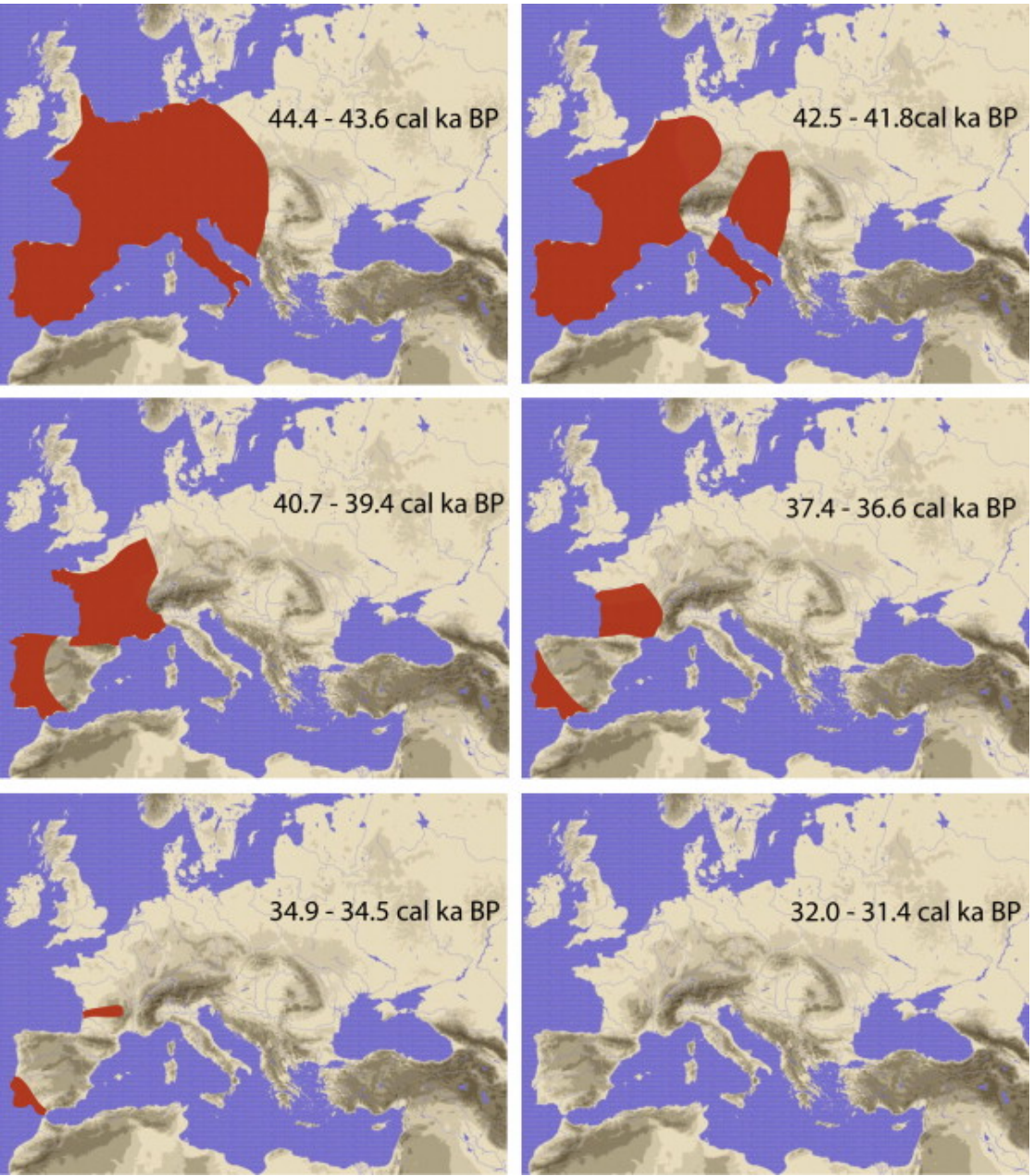
the Earth at 40 ka

short and fast reversal of the Earth's magnetic field

short-term climate variability of the last ice age

and volcanic eruption in Italy

Laschamp event



short and fast reversal of the Earth's magnetic field

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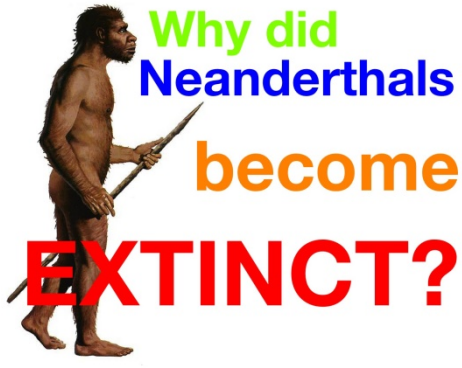
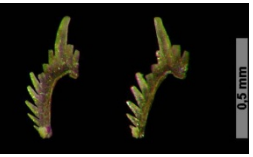
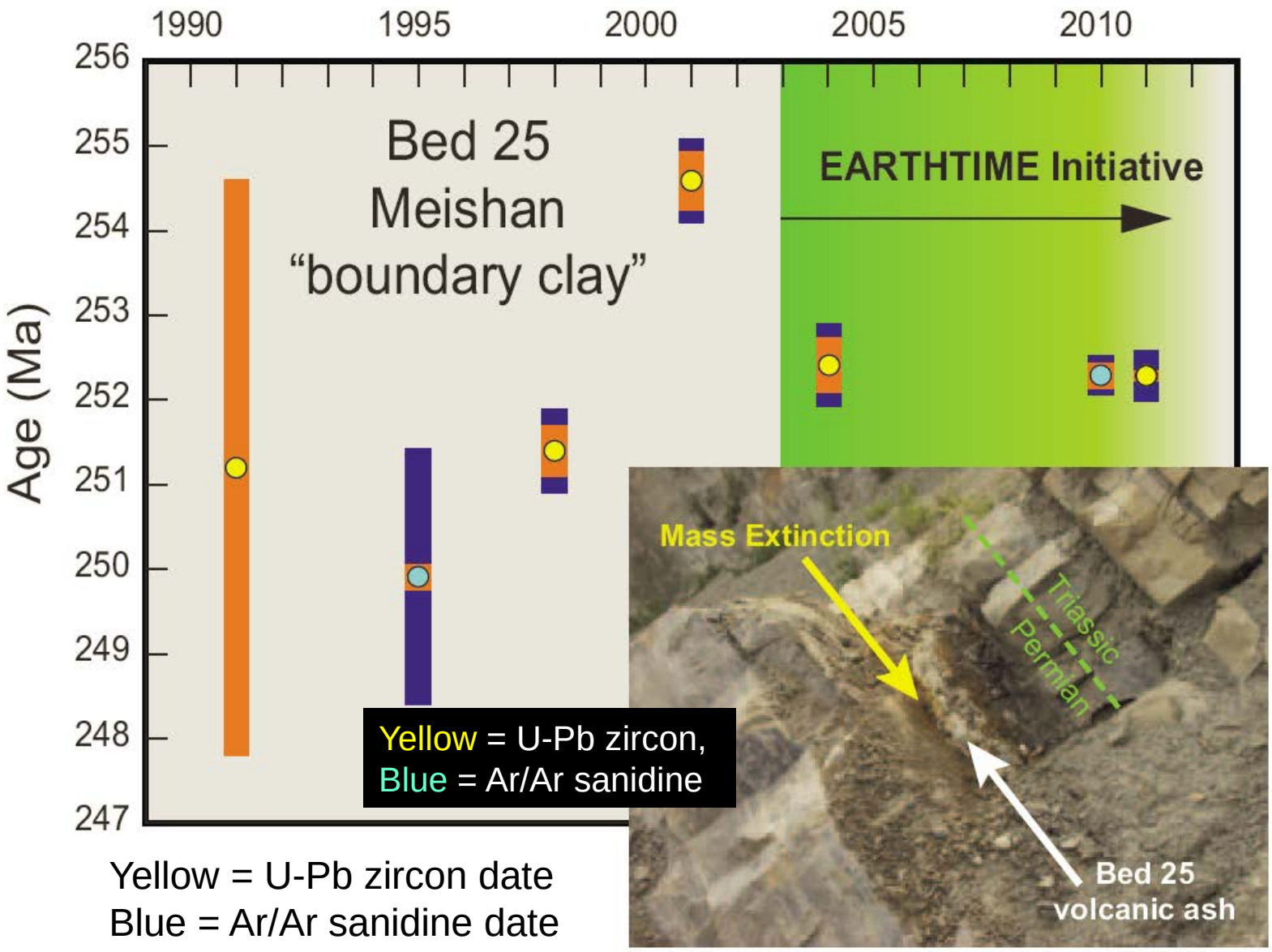


Permo-Triassic mass extinction



Conodont zones
Beds in Meishan
Species richness
300
200
100
0
Species distribution
Triassic
Permian
Isarcicella isarcica
39–46
33–38
30–32
29
I. staeschei
28
27d
Hindeodus parvus
27c
Neogondolella taytorae
27b
27a
Hindeodus changxingensis
26
Neogondolella meishanensis
25
Neogondolella yini
24e
24d
24c
24b
24a
252.10 ± 0.06 Myr
Earliest Triassic extinction
50 kyr
252.28 ± 0.08 Myr
Latest Permian extinction
0
50
100
150
200
250
300
350
400
450
500

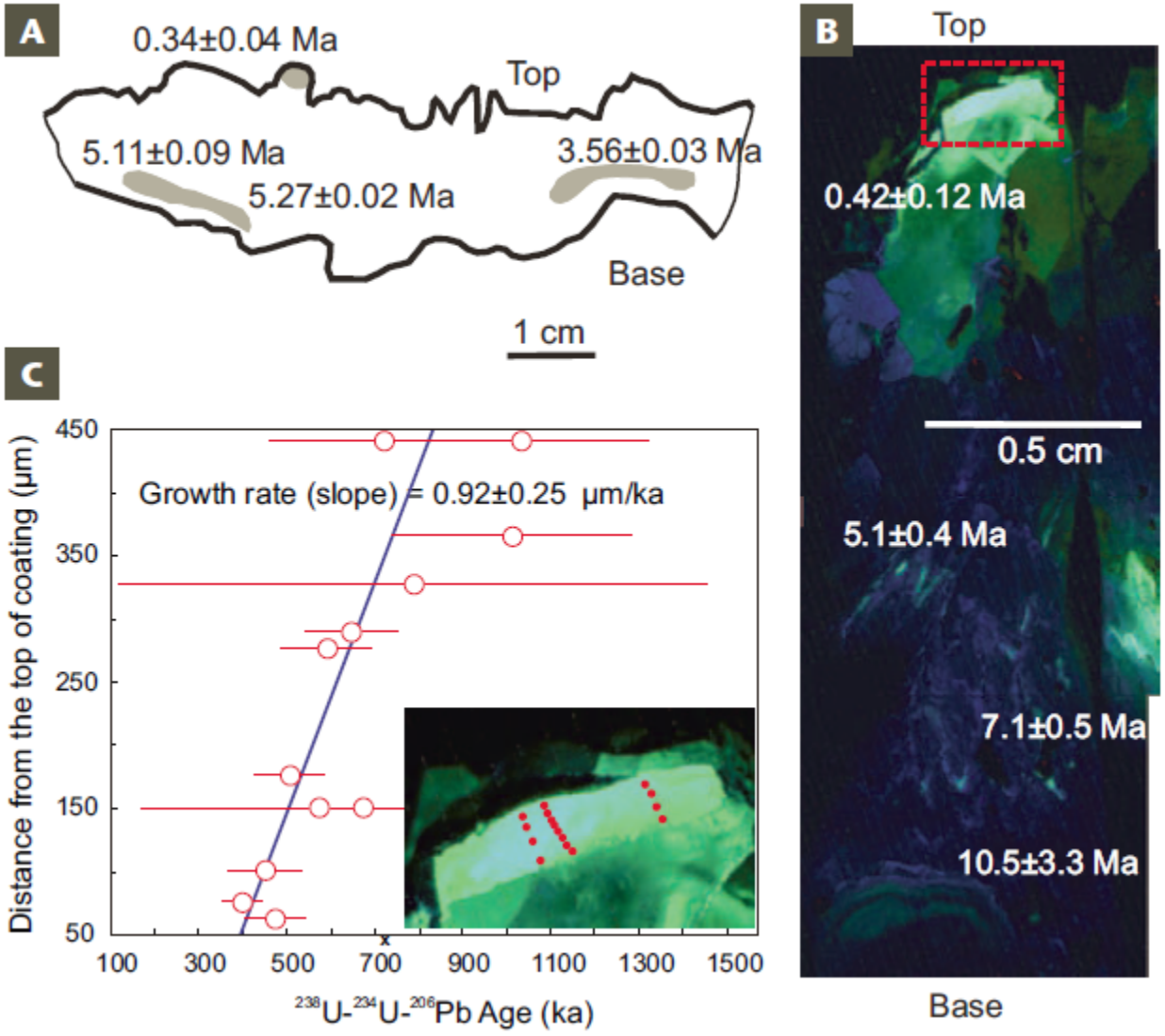
Permo-Triassic mass extinction



Yellow = U-Pb zircon date
Blue = Ar/Ar sanidine date

Beginning of Siberian Traps volcanism: 250.0 ± 1.6 Ma (Renne et al. 1995)

Mineral growth rates



Early evolution of the solar system

extinct radionuclide dating