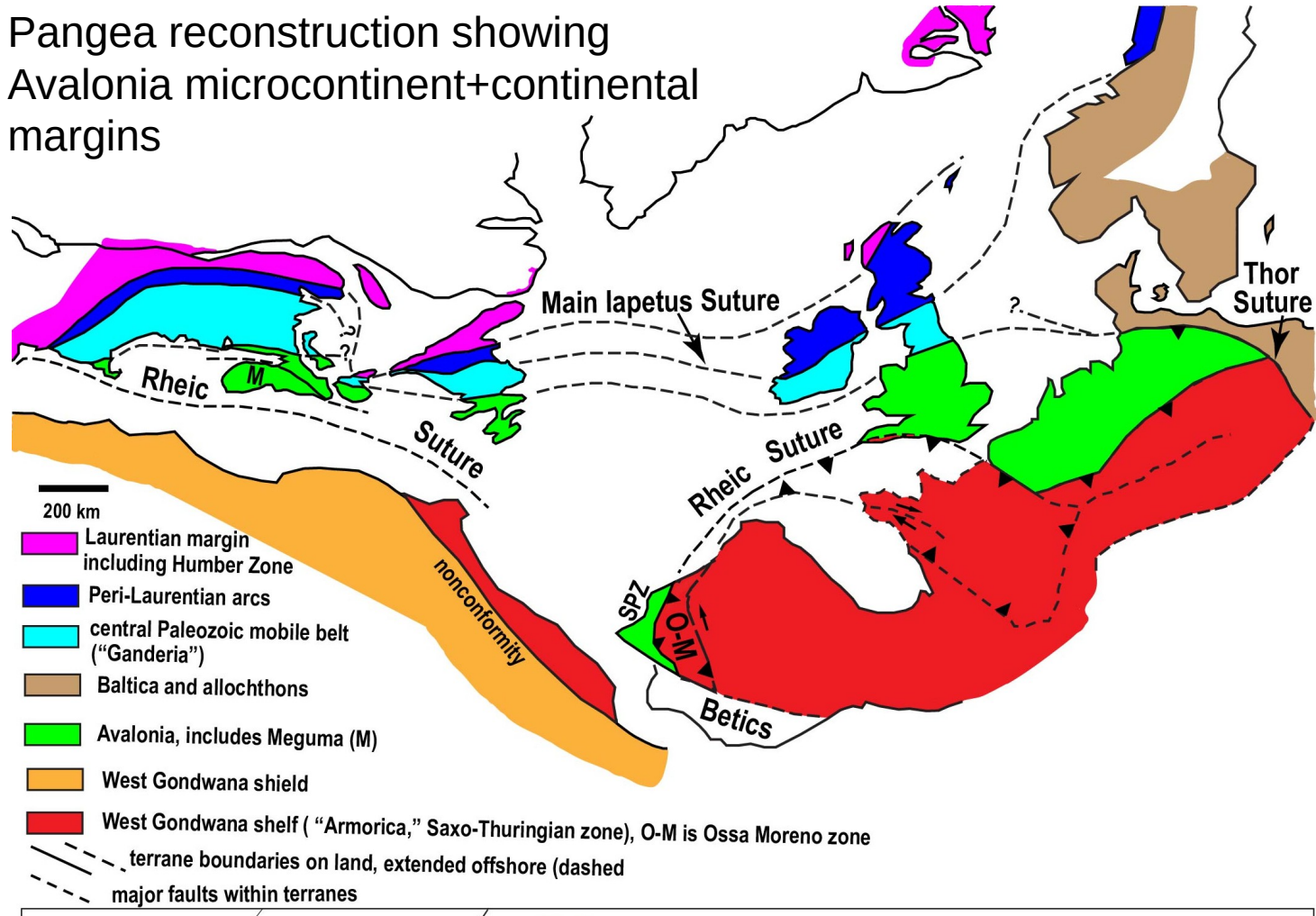


Avalonia – an exotic microcontinent

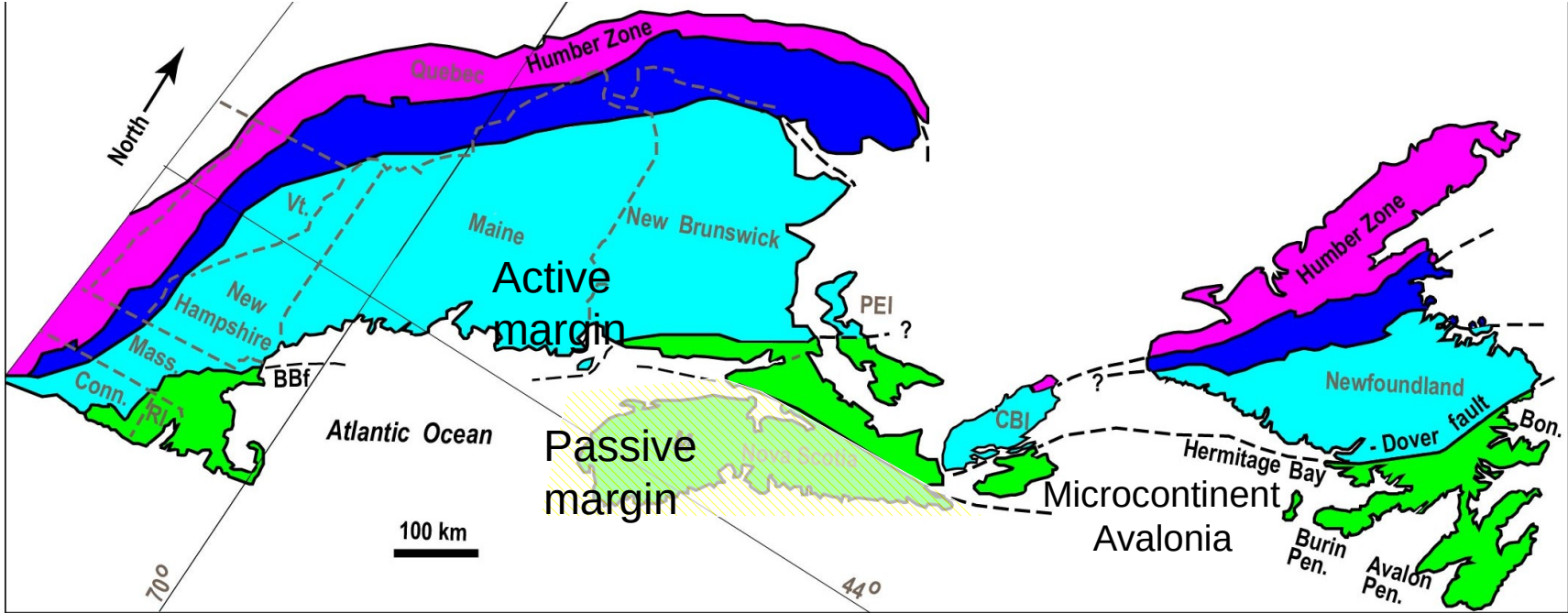
Precambrian – Cambrian & Ordovician

1,000 Ma to 440 Ma

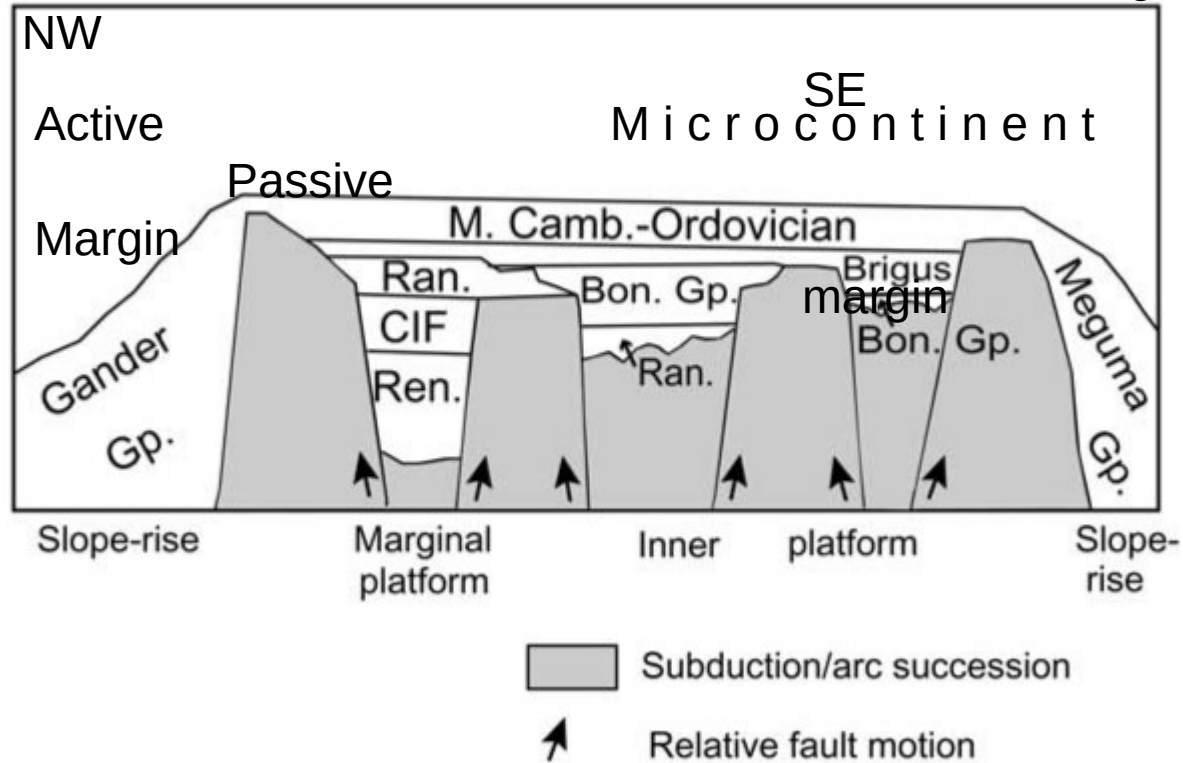
Pangea reconstruction showing Avalonia microcontinent+continental margins



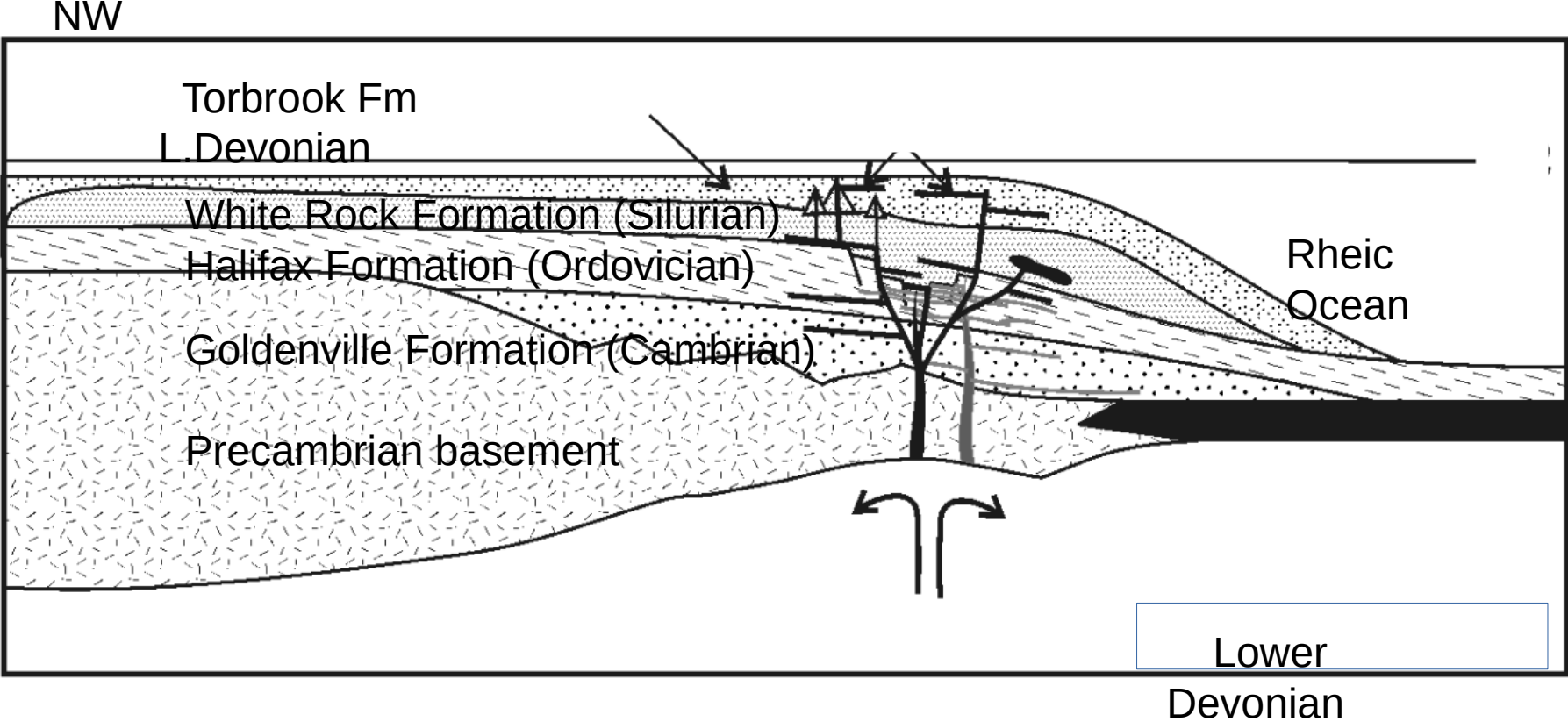
Present distribution of Avalonia + fringing continental margins



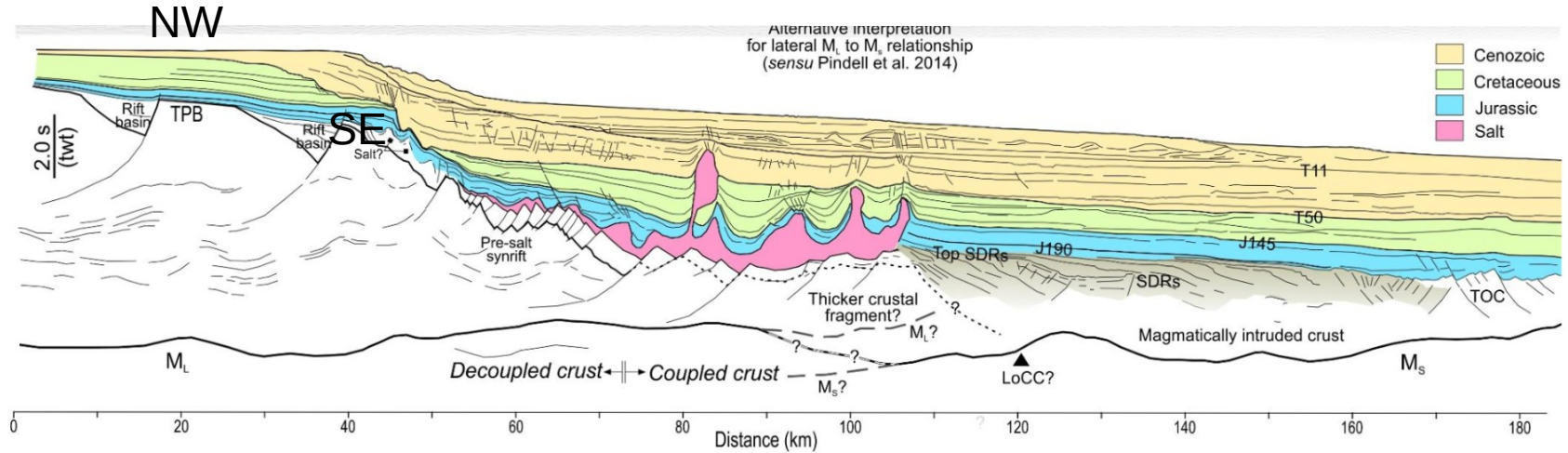
Cambrian cross-section across Avalonia and continental margins



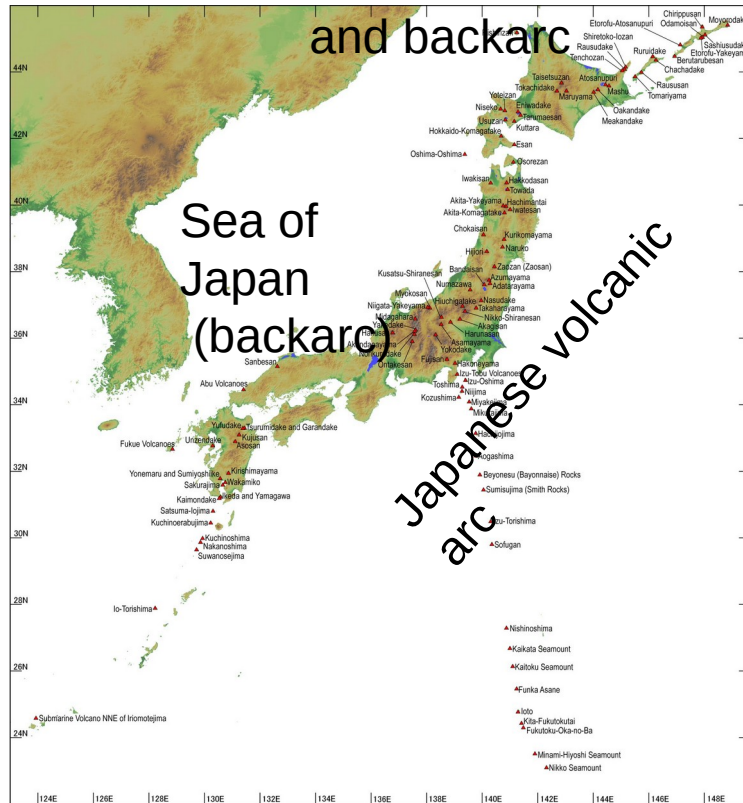
Southern NS Cross-section of Lower Paleozoic passive margin (White & Barr 2003)



Cross-section of present Atlantic margin (Deptuk 2020)
 – comparable to Paleozoic margin: ~500 million year cycle



Modern analog
Japan: arc
volcanoes



TOOLS for paleogeographic reconstruction

Magnetic stripes – not available

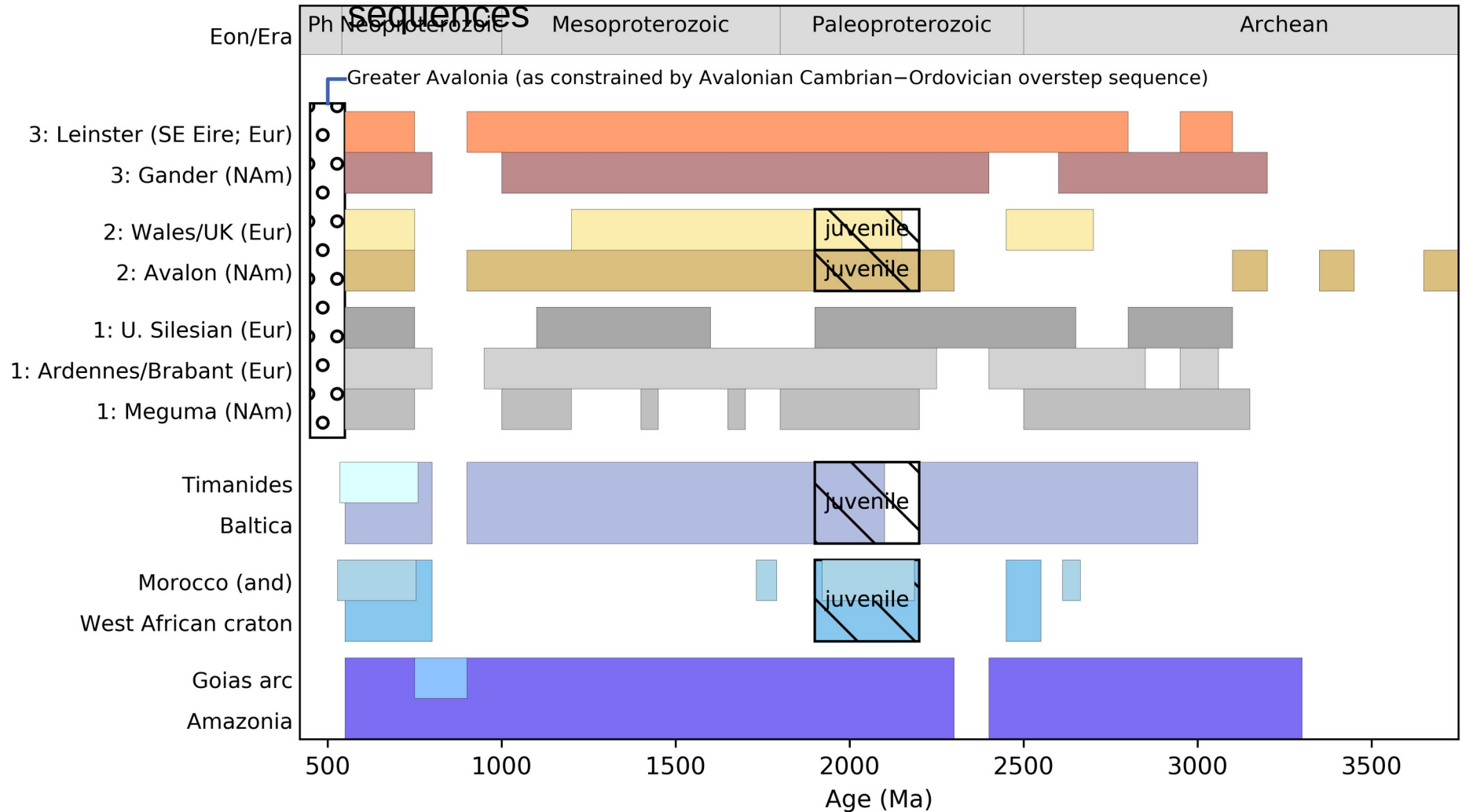
Paleomagnetism – rarely available

Faunal provinces – available after 550 Ma

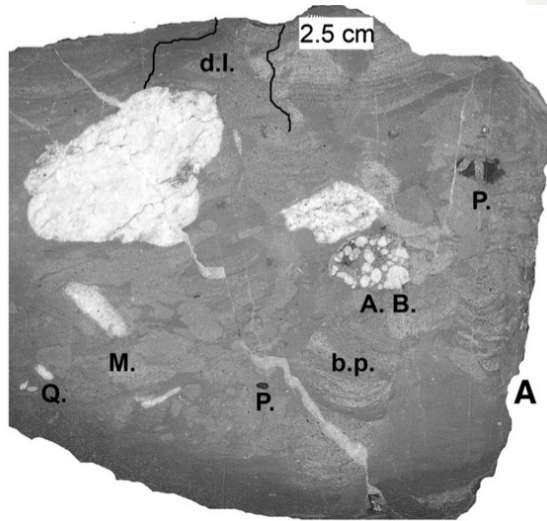
Detrital zircons – available but unreliable

Geological record – available but subject to multiple interpretations

Age of Detrital zircon ages in Cambrian overstep



Avalonian Cambrian rocks and fossils



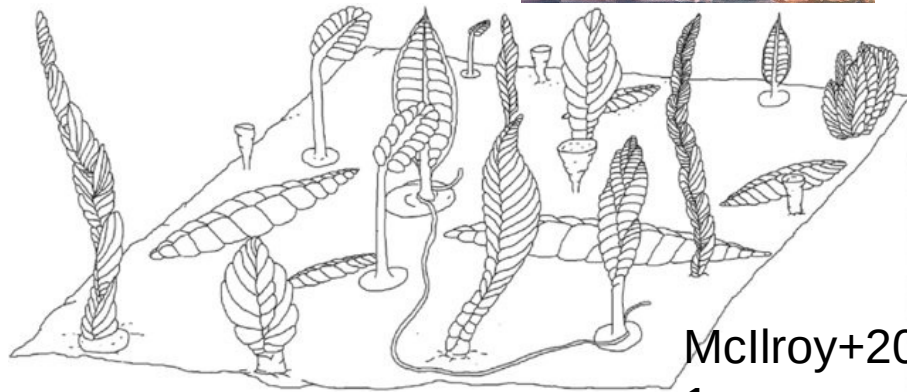
Stromatolites

Trilobites: Olenus

Dropstones

Late Precambrian rocks and fossils

Mistaken Point
Newfoundland

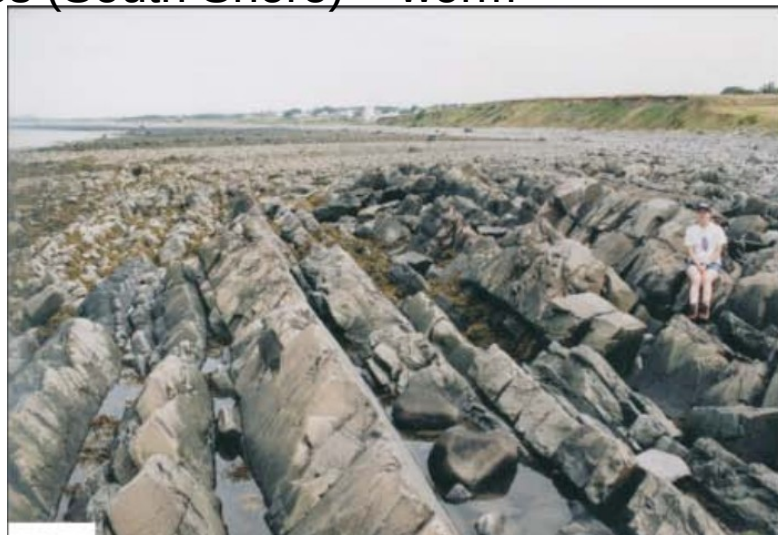


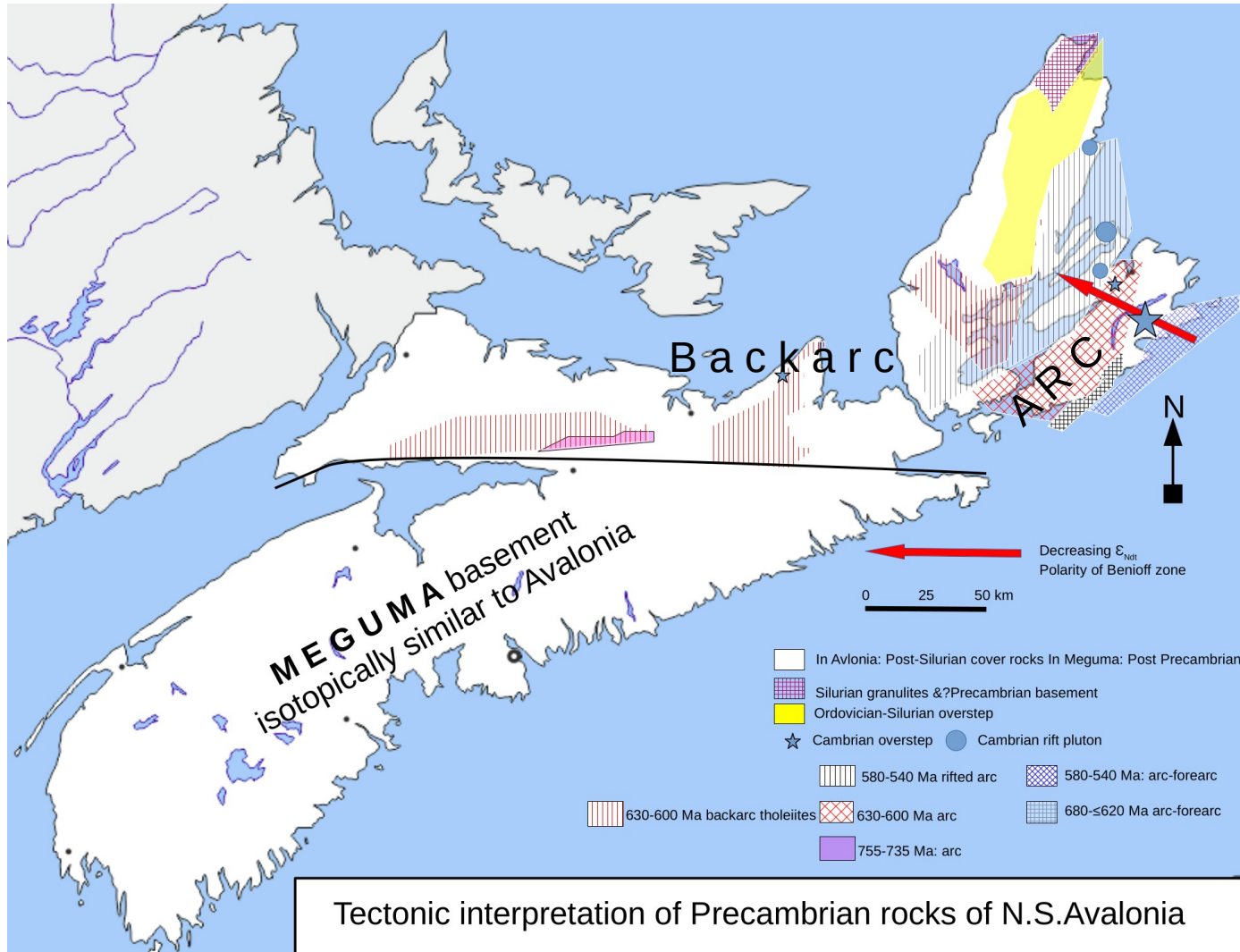
McIlroy+202

1

Turdidites (South Shore) + worm

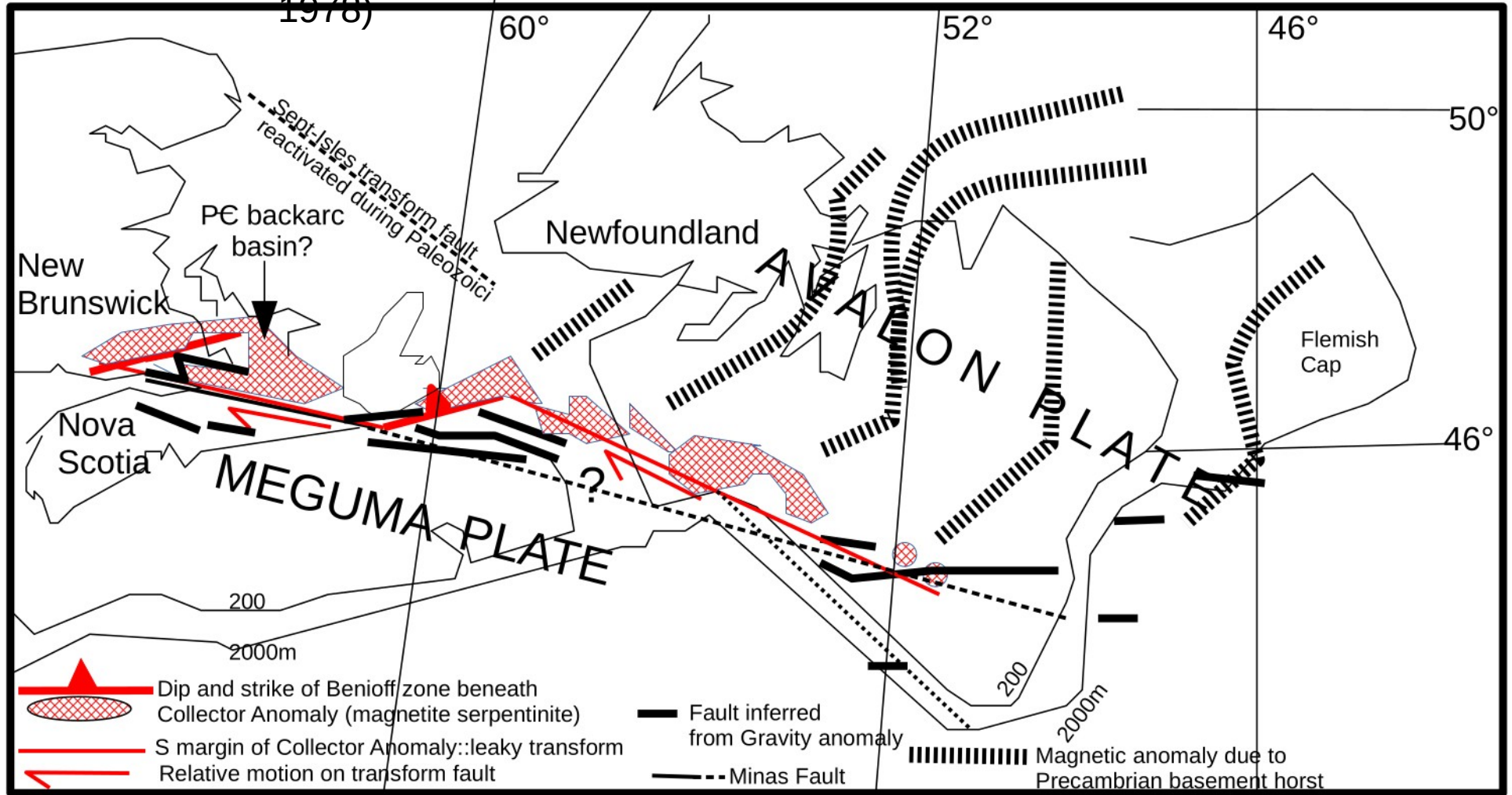
burrow



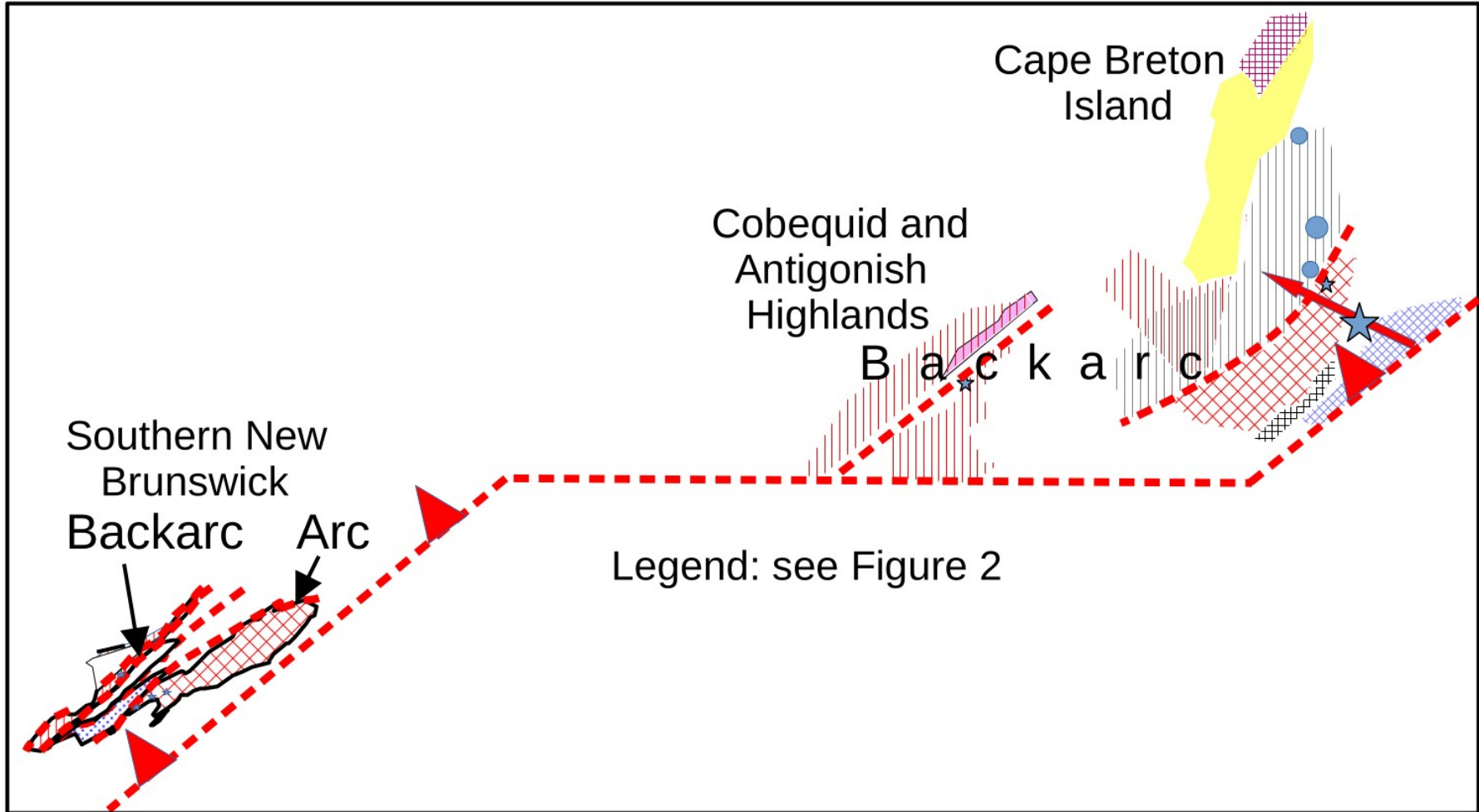


Tectonic interpretation of Precambrian rocks of N.S.Avalonia

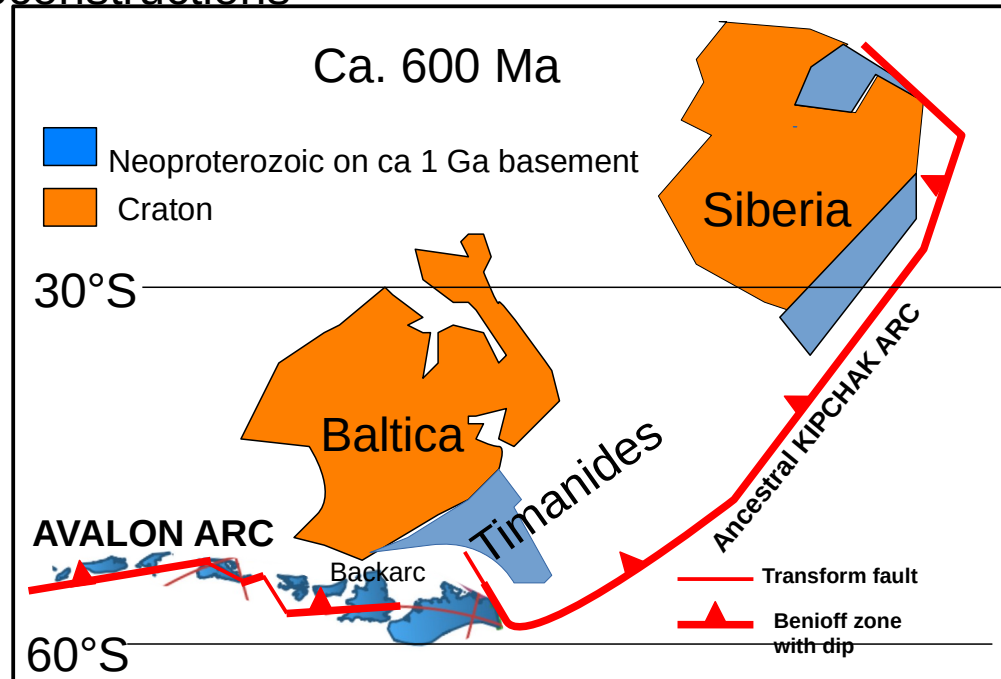
Magnetic anomalies in Atlantic Canada (Haworth and Lefort 1978)



Late Precambrian reconstruction of Maritime Canada (Keppie+ in press)



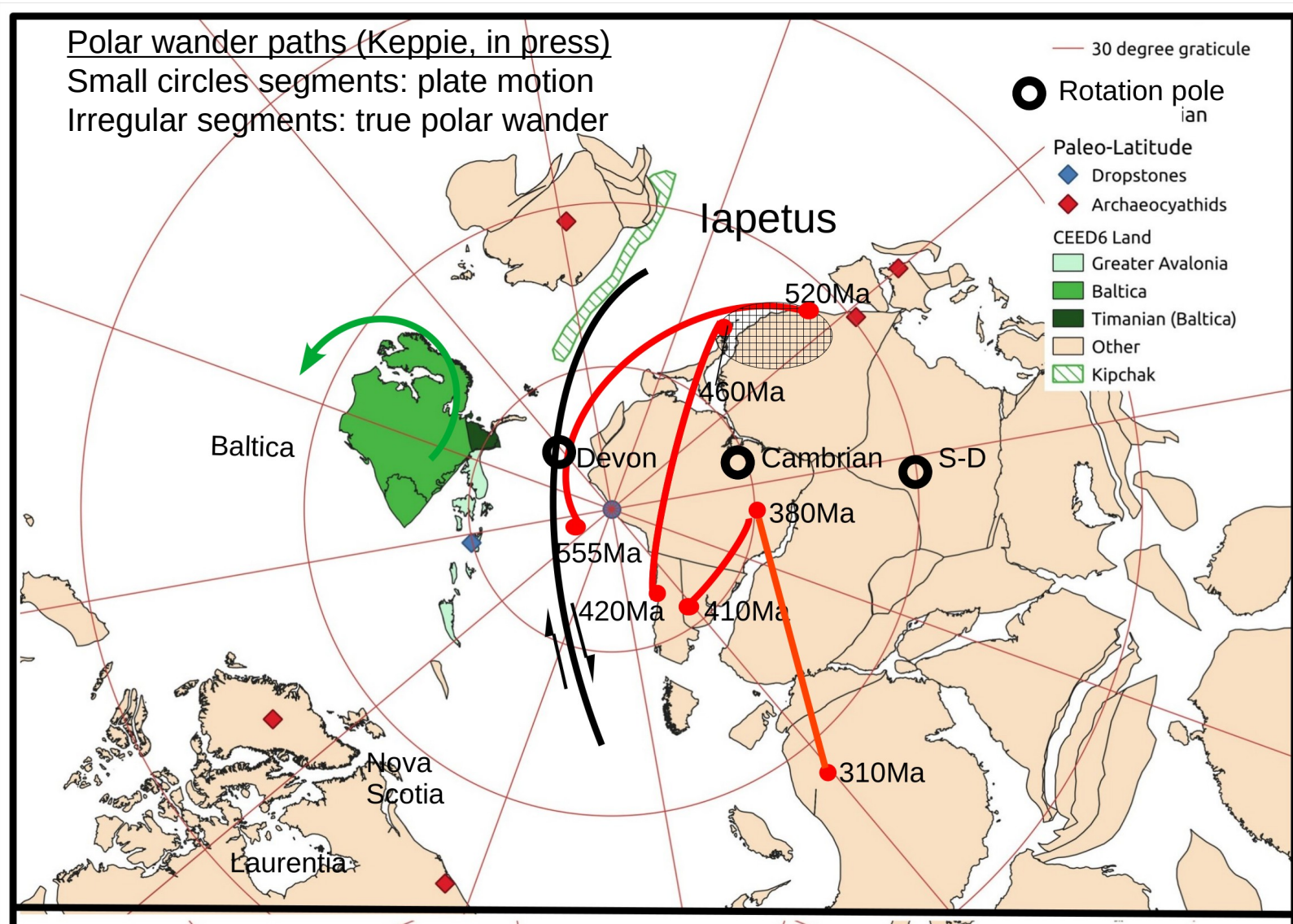
Late Precambrian and earliest Cambrian reconstructions



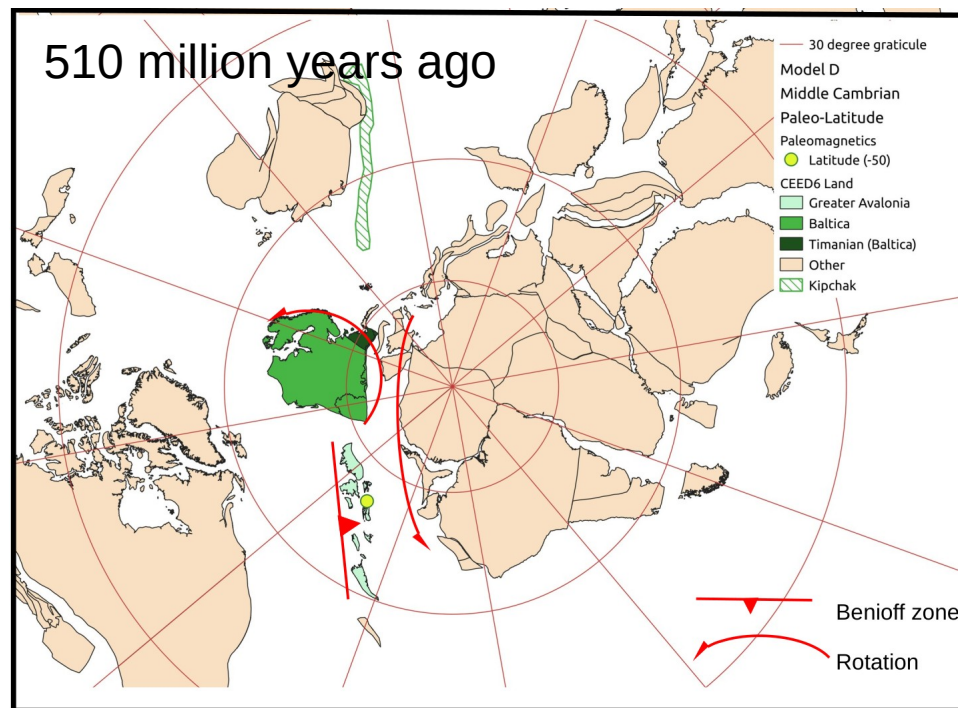
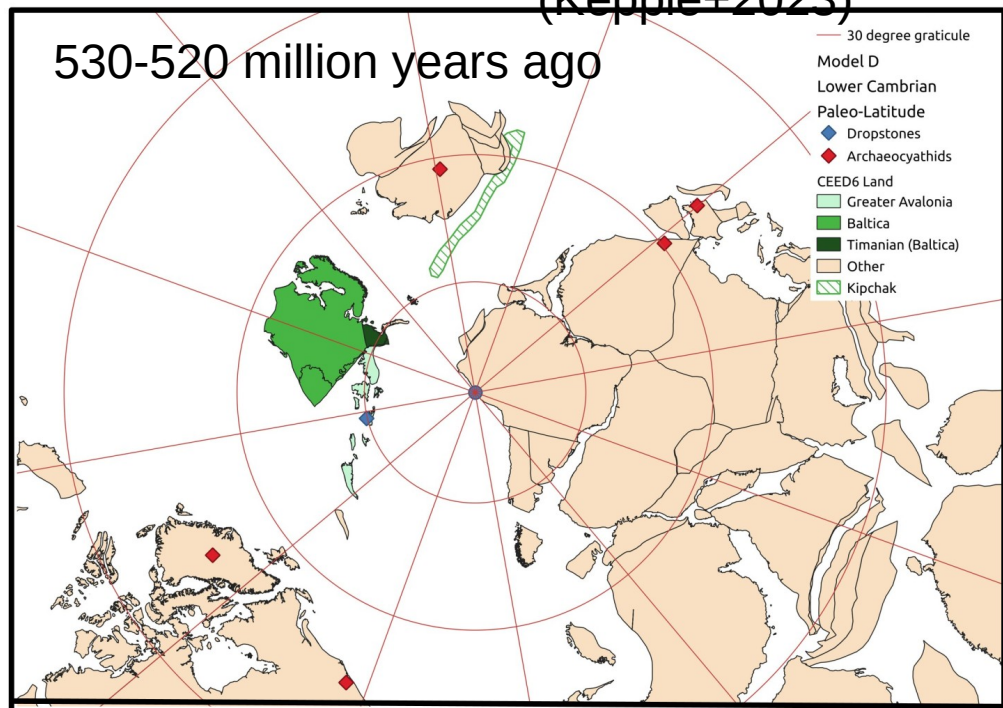
Polar wander paths (Keppie, in press)

Small circles segments: plate motion

Irregular segments: true polar wander



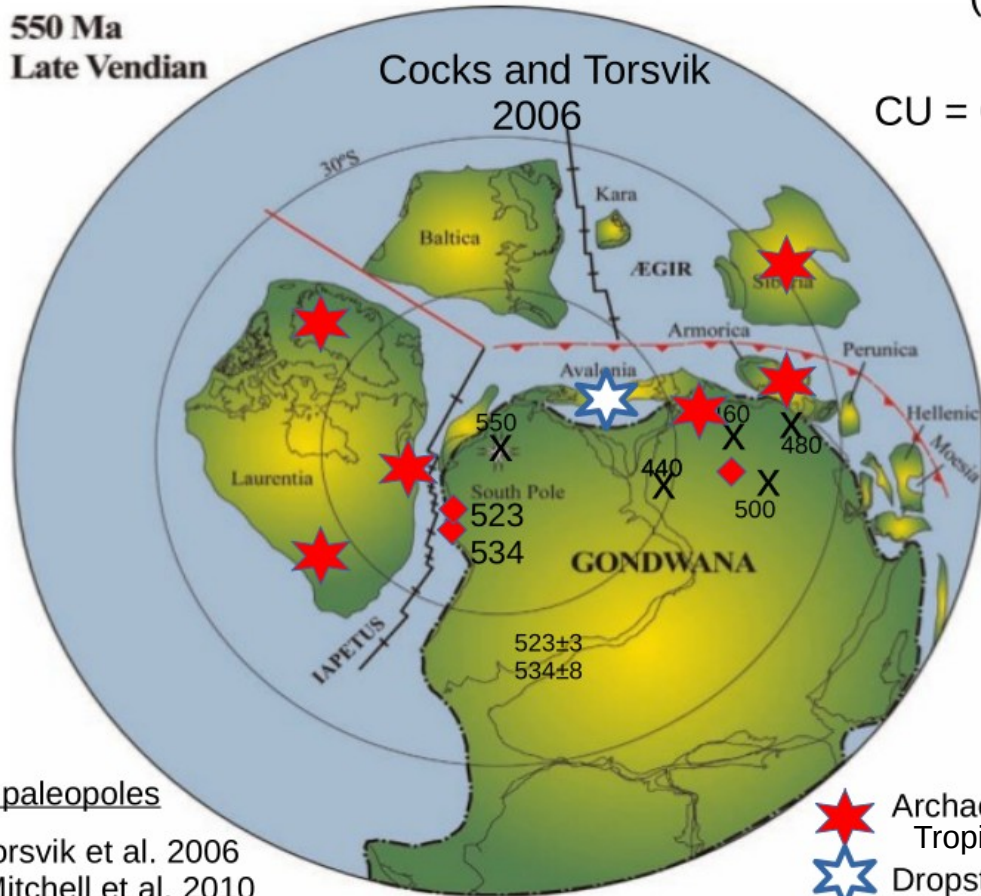
Cambrian reconstructions (Keppie+2023)



Accordion tectonics

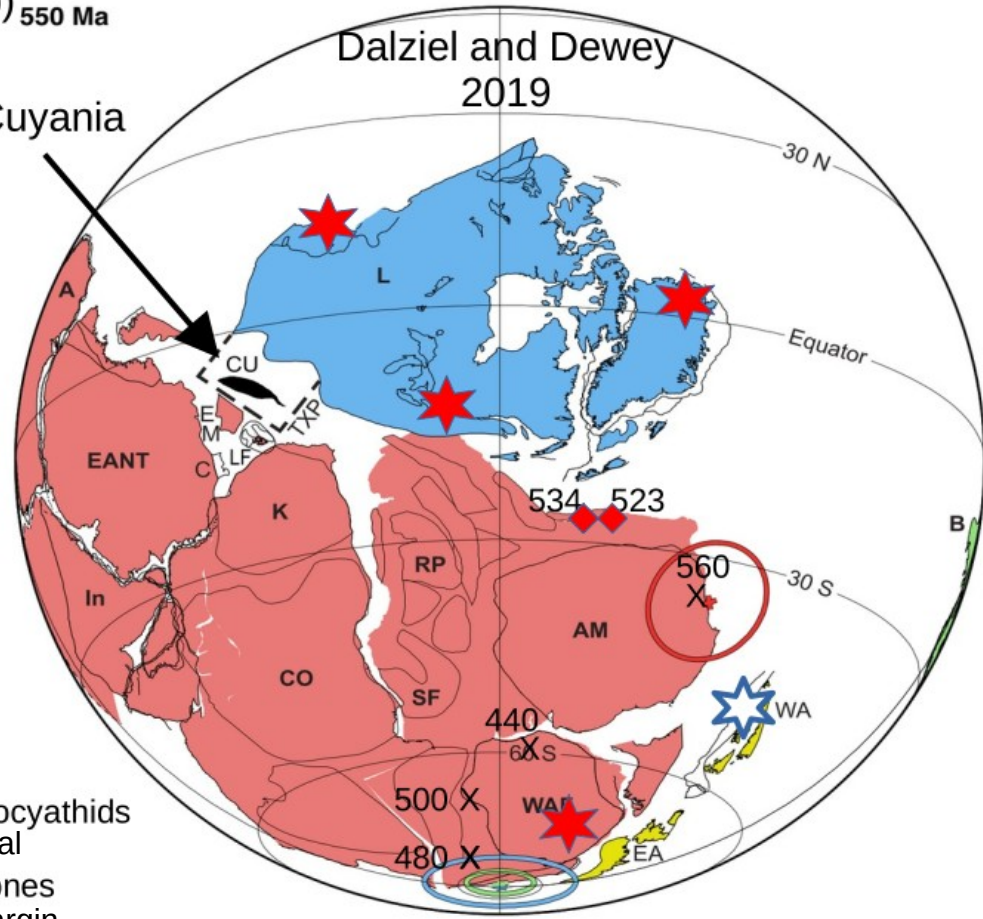
Dance tectonics: *shasey*

(a) 550 Ma
Late Vendian

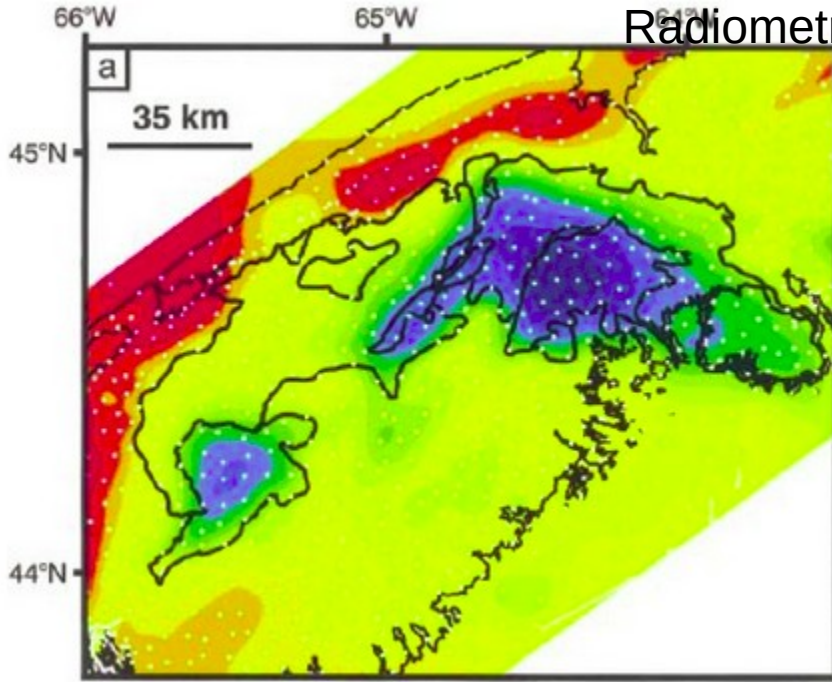


(b) 550 Ma

CU = Cuyania

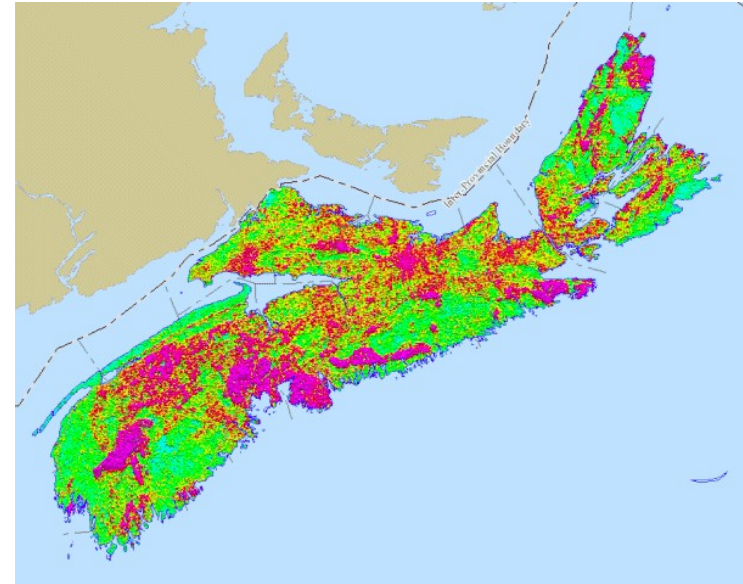
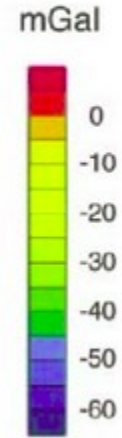


Gravity map



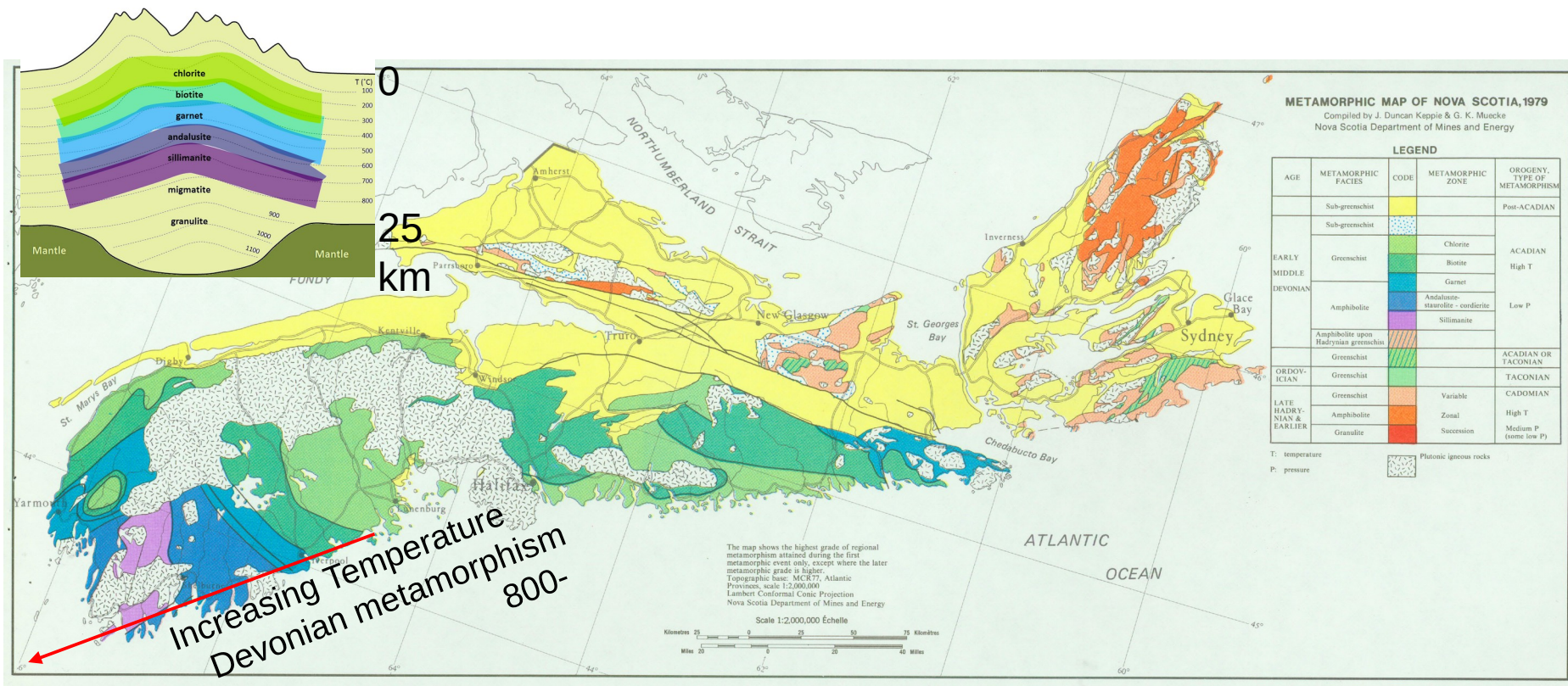
Granites: low gravity

Radiometric map



Granite (purple):
high radioactive potassium

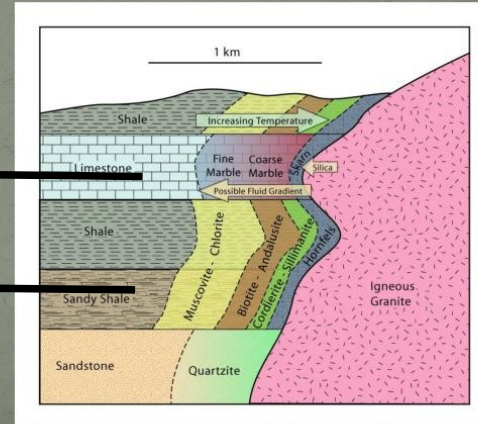
Metamorphic map of Nova Scotia (Keppie and Muecke 1979)



Contact metamorphism in sedimentary rocks next to granite
Intrusion of hot granite produces contact metamorphism shown by
Metamorphic minerals: clay > biotite > andalusite > garnet with a
distribution that may have been produced by TONE

Contact Metamorphism

Contact metamorphism occurs when magma moves into rock, heating and changing it. Contact metamorphism fewer changes to the rock, in a much small area.





Biotite



Andalusite

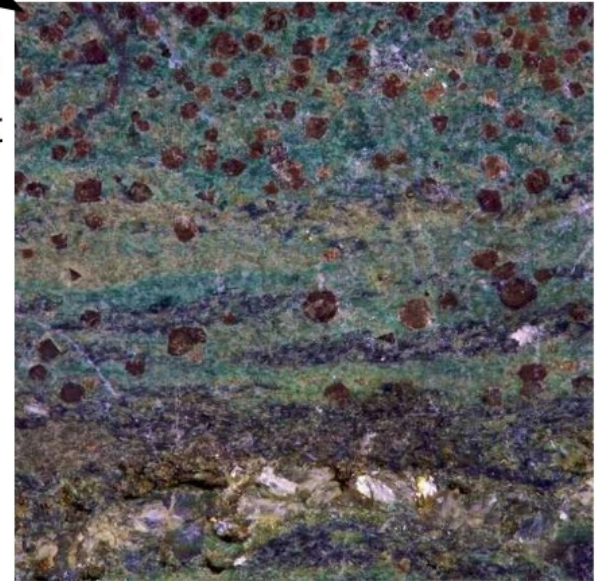


Sillimanite

Temperature →

P
r
e
s
s
u
r
e
↓

Garnet
blueschist

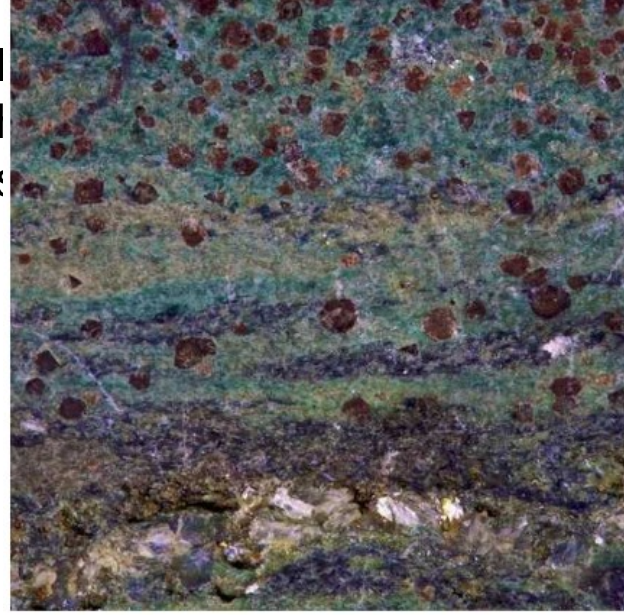


Note ~uniform distribution of large crystals— possible cause: RESONANCE

METAMORPHIC



Biotite schist



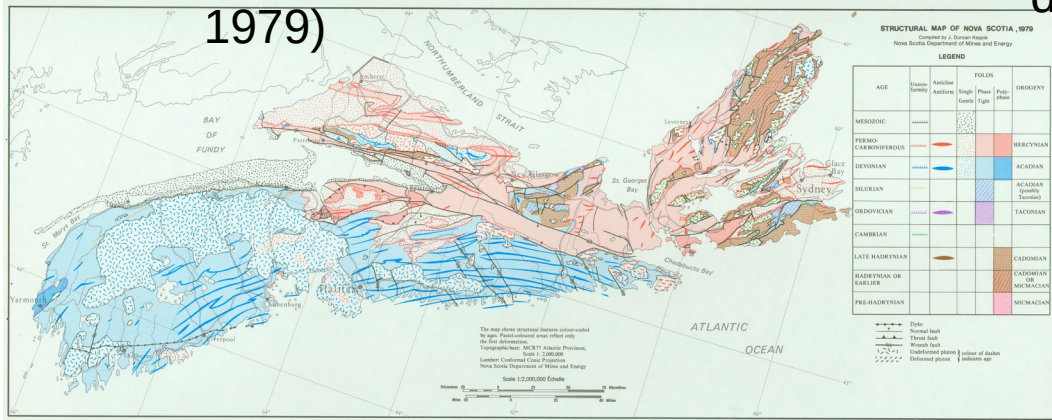
Garnet eclogite

Megacrystic
IGNEOUS
granite

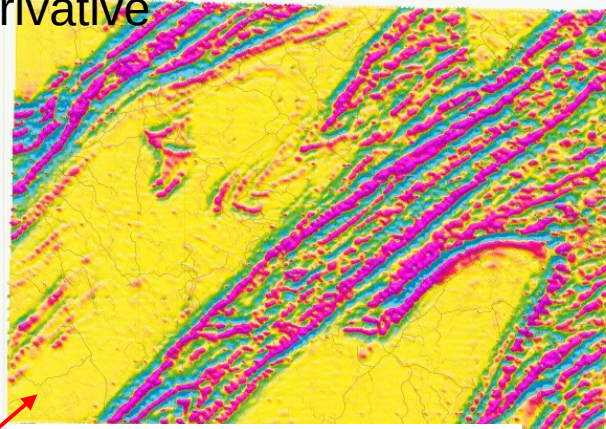


2-mica granite under microscope

NS Structural map (Keppie 1979)

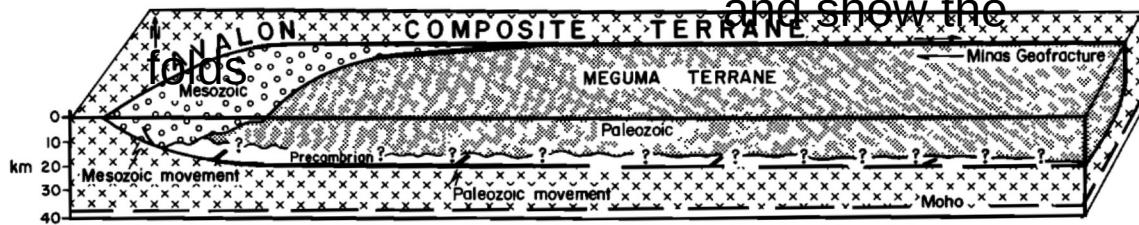


Magnetic Map: 2nd vertical derivative



Magnetic map outlines highly magnetic slates

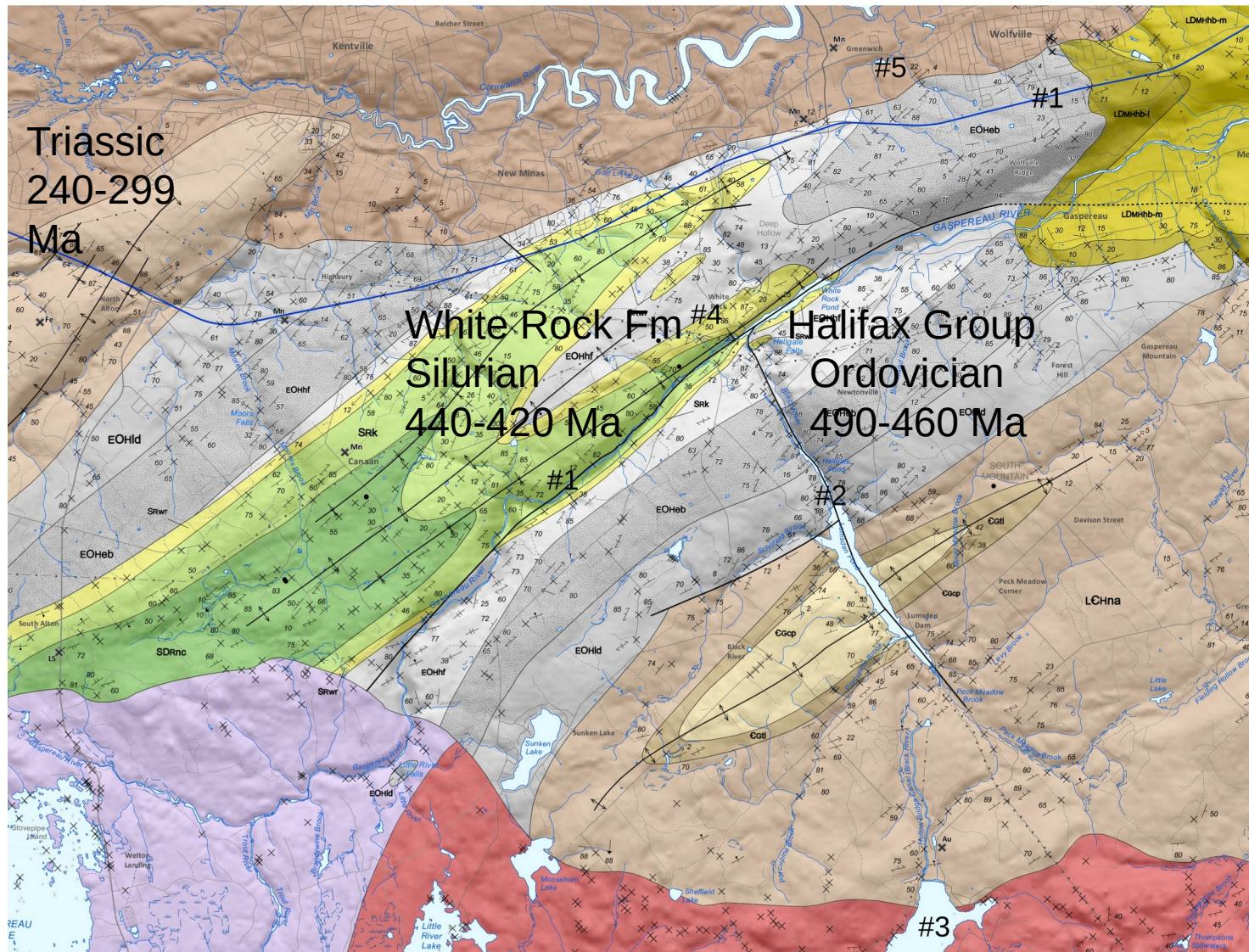
and show the



Keppie & Dallmeyer 1987



Fold In the slates at the Ovens

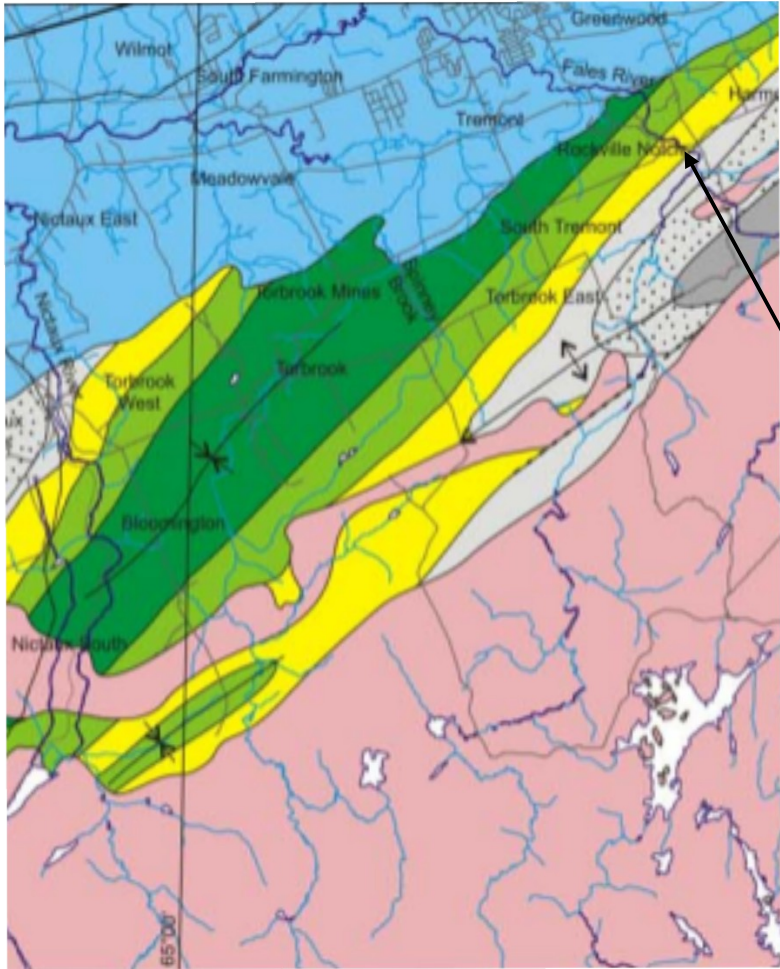


GEOLOGICAL MAP: NEW MINAS

Upper Devonian
Carboniferous
380-320 Ma

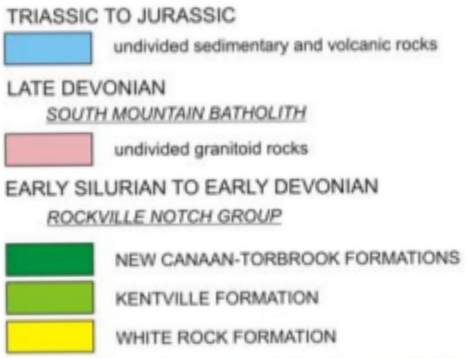
Goldenville
Group
490-550 Ma

Granite 370 Ma



AGE (millions of years)

<240
370-385
405-418
418-425
425-442



Fales River & McMaster Park

500

RADIOACTIVITY

DATING THE AGE OF
MINERALS

and

RESONANCE

PERIODIC TABLE OF ELEMENT ISOTOPES

All elements have ≥ 1 isotopes indicating radioactive decay to a “stable” isotope

KEY

- Element name
- Element symbol
- No. of known isotopes
- No. of stable isotopes – red colour indicates no stable isotopes are known

All data for this table was sourced from the IUPAC periodic table of elements and isotopes (IPT EI): <https://iupac.org/iptei/>

RED: no stable isotopes

HYDROGEN										HELIUM													
H										He													
7 2										8 2													
LITHIUM		BERYLLIUM										BORON		CARBON		NITROGEN		OXYGEN		FLUORINE		NEON	
Li		Be										B		C		N		O		F		Ne	
10 2		12 1										13 2		15 2		16 2		17 3		18 1		20 3	
SODIUM		MAGNESIUM										ALUMINIUM		SILICON		PHOSPHORUS		SULFUR		CHLORINE		ARGON	
Na		Mg										Al		Si		P		S		Cl		Ar	
21 1		22 2										23 1		23 3		24 1		24 4		25 2		25 3	
POTASSIUM	CALCIUM	SCANDIUM	TITANIUM	VANADIUM	CHROMIUM	MANGANESE	IRON	COBALT	NICKEL	COPPER	ZINC	GALLIUM	GERMANIUM	ARSENIC	SELENIUM	BROMINE	KRYPTON						
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
26 3	27 5	27 1	27 5	28 2	27 4	30 1	31 4	32 1	35 5	32 2	32 5	32 2	33 4	33 1	33 5	32 2	34 6						
RUBIDIUM	STRONTIUM	YTRIUM	ZIRCONIUM	NIOBIUM	MOLYBDENUM	TECHNETIUM	RUTHENIUM	RHODIUM	PALLADIUM	SILVER	CADMIUM	INDIUM	TIN	ANTIMONY	TELLURIUM	IODINE	XENON						
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
33 1	35 4	34 1	36 4	35 1	38 6	37 0	40 7	42 1	40 6	41 2	41 6	42 1	41 10	38 2	39 6	39 1	40 8						
CAESIUM	BARIUM	La-Lu	HAFNIUM	TANTALUM	TUNGSTEN	RHENIUM	OSMIUM	IRIDIUM	PLATINUM	GOLD	MERCURY	THALLIUM	LEAD	BISMUTH	POLONIUM	ASTATINE	RADON						
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
40 1	41 5		38 5	40 2	42 4	42 1	43 3	41 2	43 5	41 1	46 7	42 2	43 4	41 0	41 0	40 0	40 0						
FRANCIUM	RADIUM	Ac-Lr	RUTHERFORDIUM	DUBNIUM	SEABORGIUM	BOHRIUM	HASSIUM	MEITNERIUM	DARMSTADTIUM	ROENTGENIUM	COPERNICIUM	NIHONIUM	FLEROVIUM	MOSCOVIUM	LIVERMORIUM	TENNESSINE	OGANESSON						
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og						
37 0	34 0		13 0	13 0	12 0	10 0	11 0	9 0	10 0	7 0	6 0	6 0	5 0	4 0	4 0	2 0	1 0						
LANTHANUM		CERIUM	PRASEODYMIUM	NEODYMIUM	PROMETHIUM	SAMARIUM	EUROPIUM	GADOLINIUM	TERBIUM	DYSPROSIUM	HOLMIUM	ERBIUM	THULIUM	YTERBIUM	LUTETIUM								
La		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Lu									
39 1		40 4	40 1	39 5	36 0	38 5	40 1	36 7	36 1	36 7	37 1	35 6	38 1	38 7	39 1								
ACTINIUM		THORIUM	PROTACTINIUM	URANIUM	NEPTUNIUM	PLUTONIUM	AMERICIUM	CURIUM	BERKELIUM	CALIFORNIUM	EINSTEINIUM	FERMIUM	MENDELEVIUM	NOBELIUM	LAWRENCIUM								
Ac		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr								
32 0		31 0	29 0	27 0	22 0	20 0	22 0	21 0	22 0	20 0	18 0	20 0	17 0	16 0	14 0								



Periodic repetition of properties is comparable to musical scale

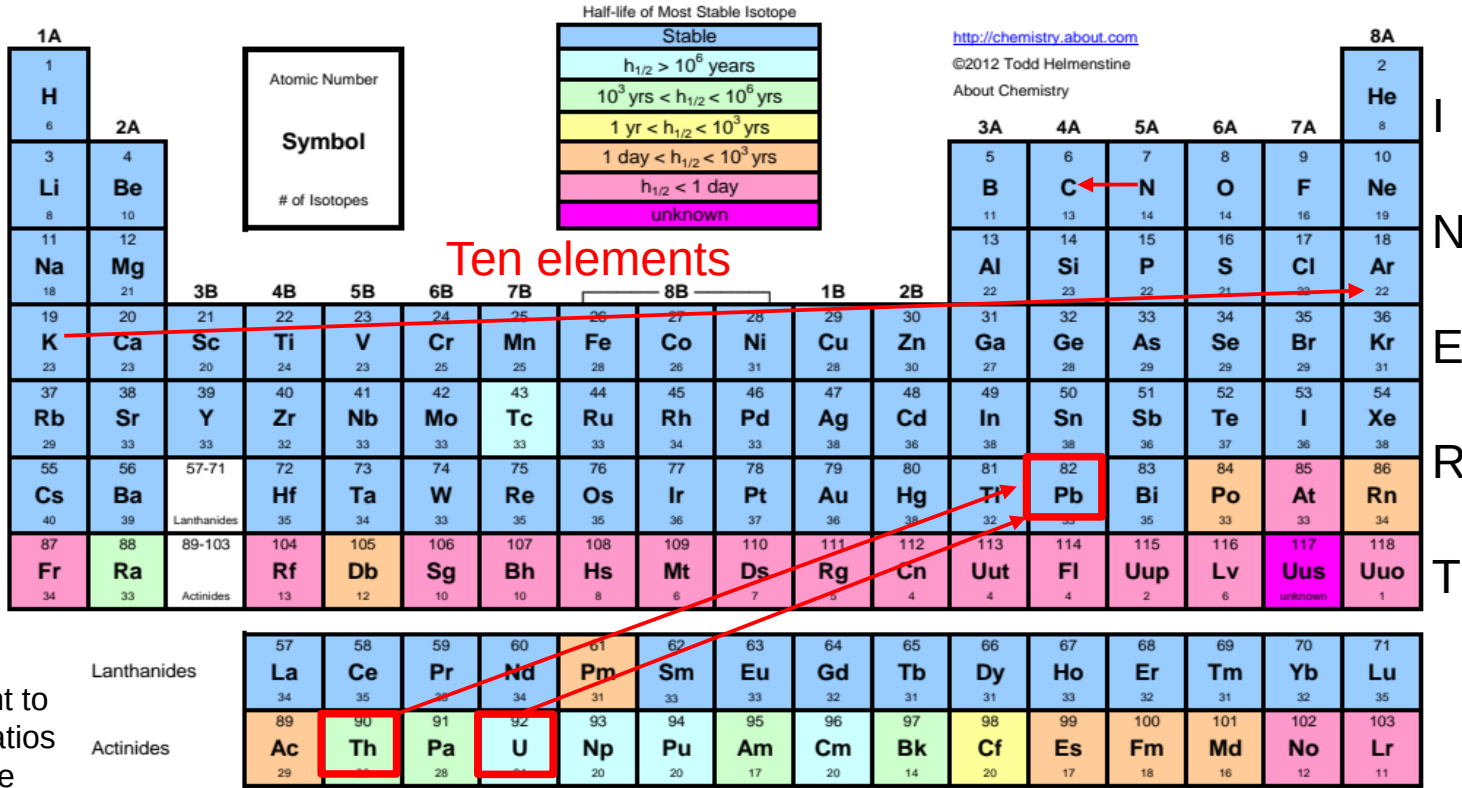
Two elements

Periodic Table of the Radioactive Elements

Six elements

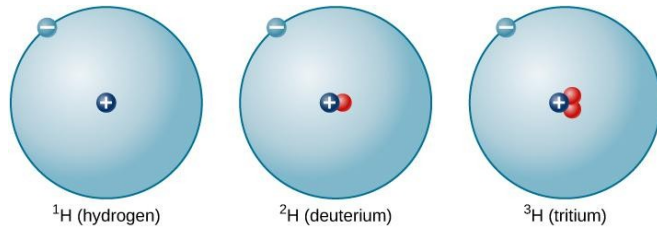
S
I
M
I
L
A
R

P
R
O
P
E
R
T
I
E
S



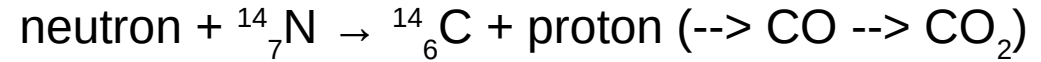
Ten elements

Fifteen elements

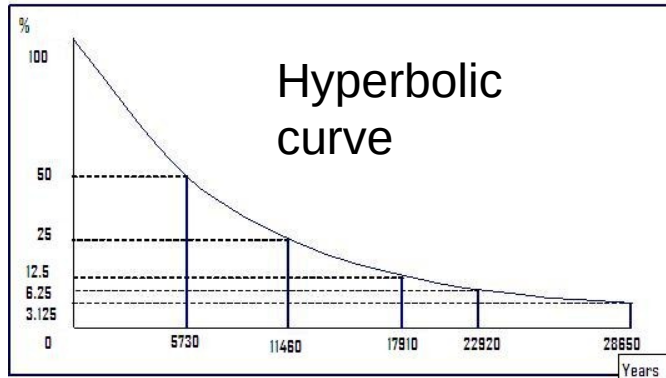


Radioactivity and carbon dating

Cosmic rays --> ^{14}N --> ^{14}C (--> ^{12}C death of organism):

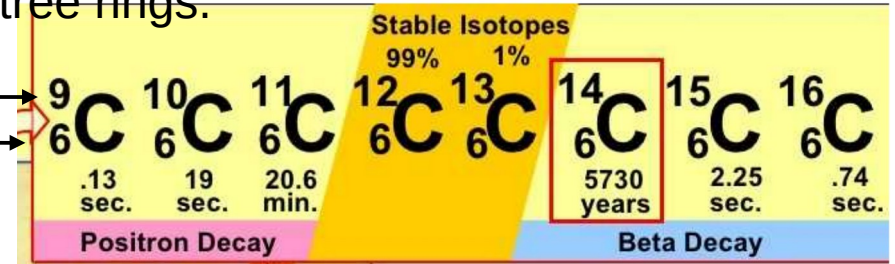


levels of C-14 have varied in the atmosphere through time -ocean bottom topography, water temperature, coastline shape and paired samples of terrestrial & marine objects. Check against tree rings.

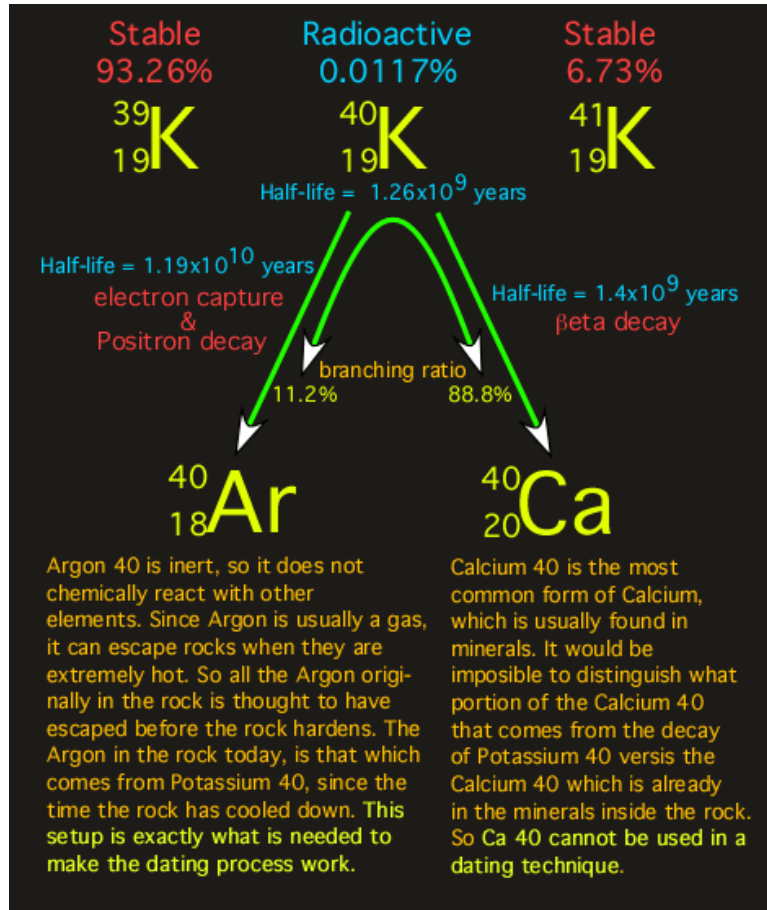


#Neutrons+Proton →

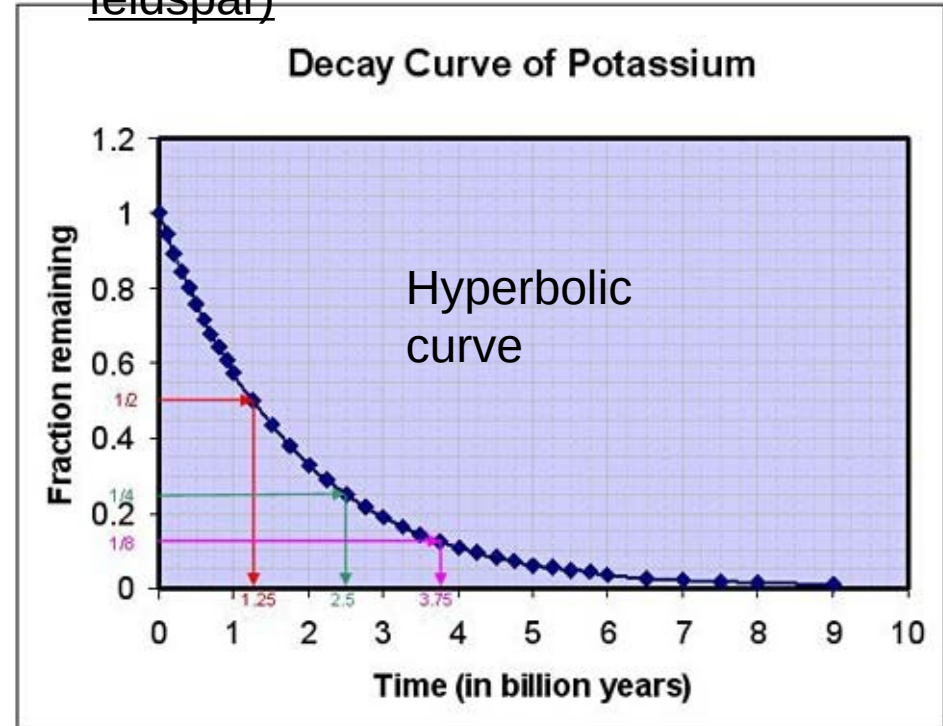
#Protons



^{14}C is constantly being created in the [Earth's atmosphere](#) by the interaction of cosmic rays with atmospheric nitrogen. The resulting ^{14}C combines with atmospheric oxygen to form radioactive [carbon dioxide](#), which is incorporated into plants by [photosynthesis](#); animals then acquire ^{14}C by eating the plants. Carbon-14 is radioactive, with a half-life of about 5,700 years changing into Carbon-12.

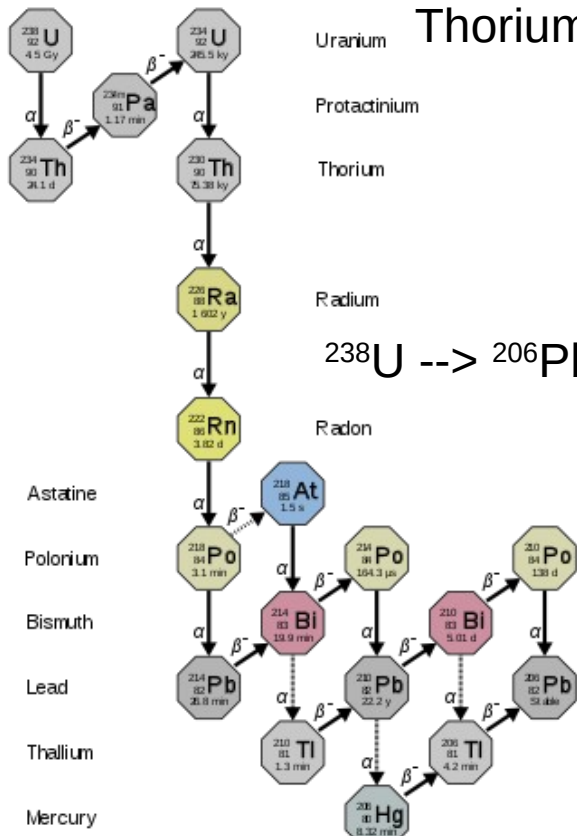


K-Ar Dating (mica, amphibole, feldspar)

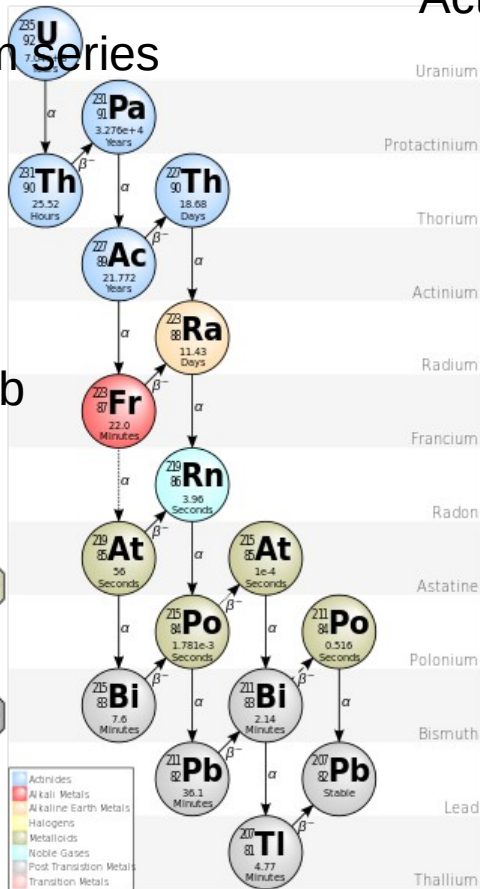


U-Pb decay

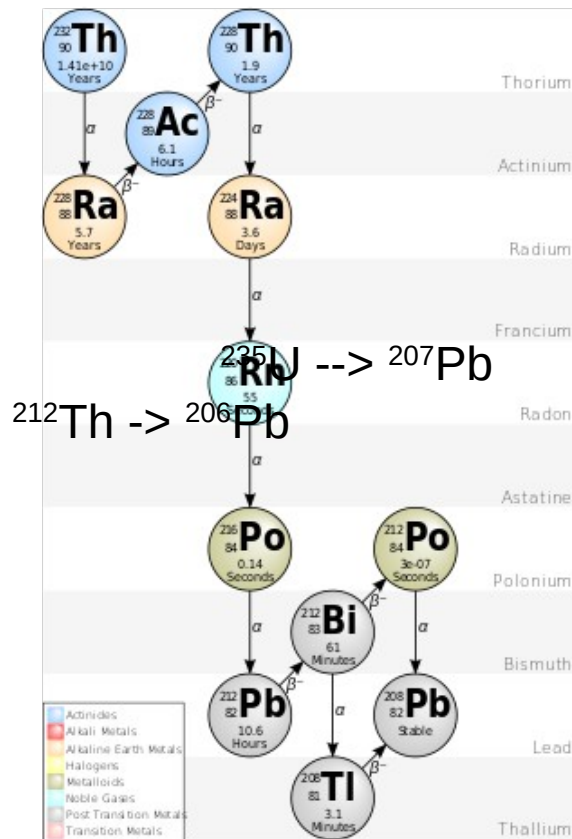
Radium series



Thorium Series



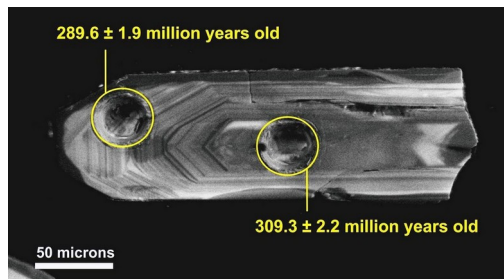
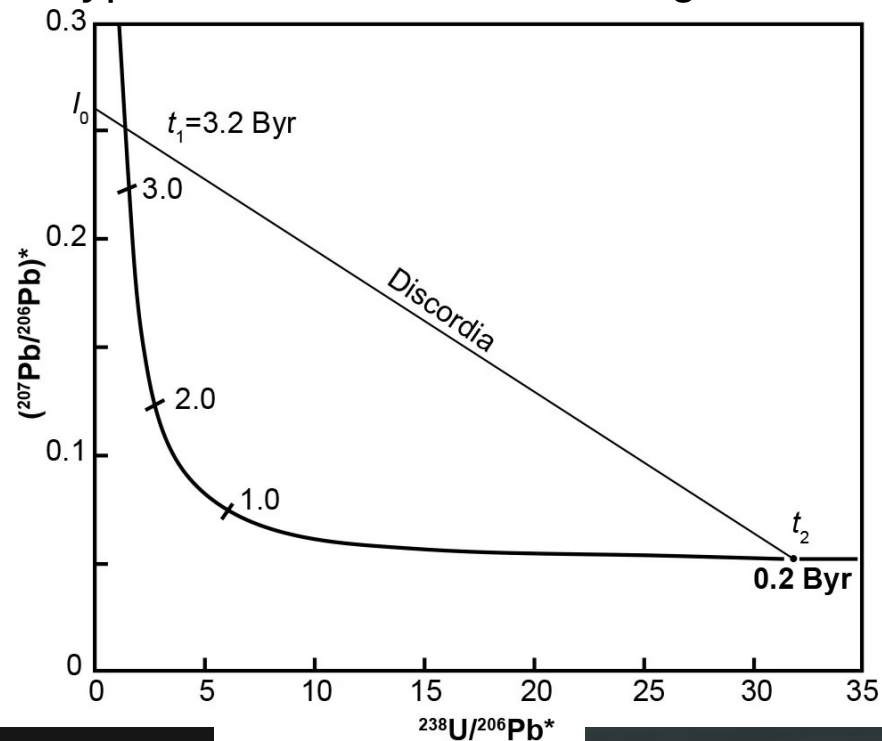
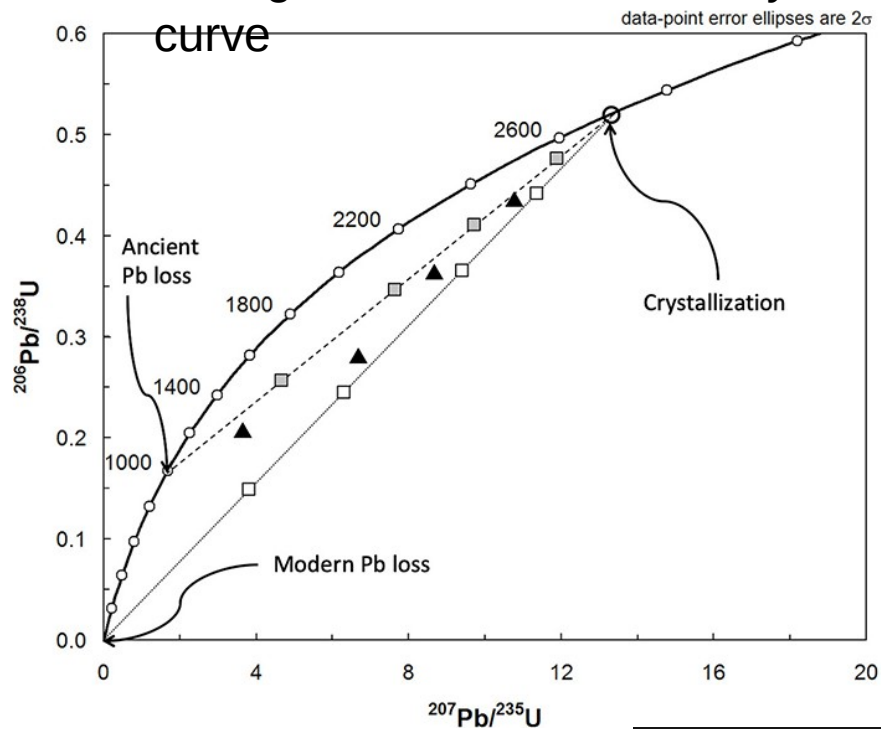
Actinium series



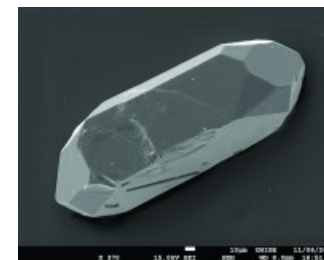
- Actinides
- Alkali Metals
- Alkaline Earth Metals
- Halogens
- Metalloids
- Noble Gases
- Post Transition Metals
- Transition Metals

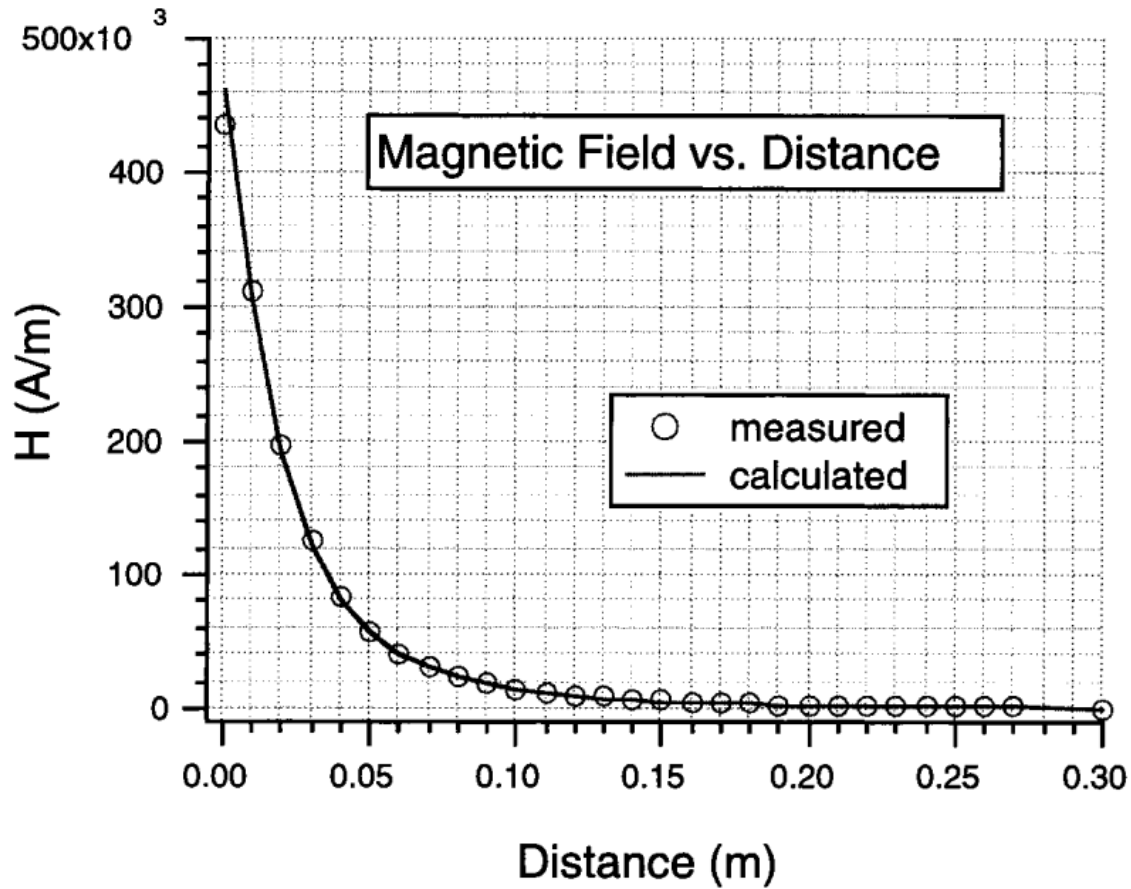
- Actinides
- Alkali Metals
- Alkaline Earth Metals
- Halogens
- Metalloids
- Noble Gases
- Post Transition Metals
- Transition Metals

Dating zircon and U-Pb decay curves: Hyperbolic curve is inverse log curve



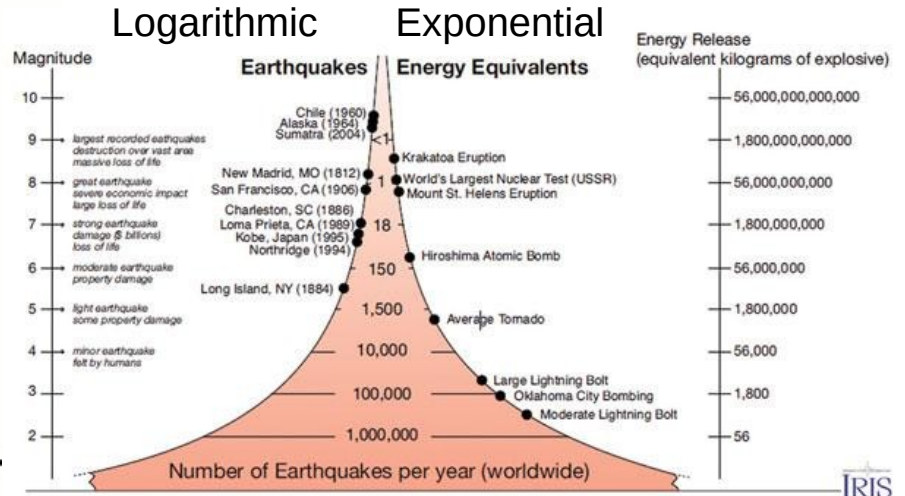
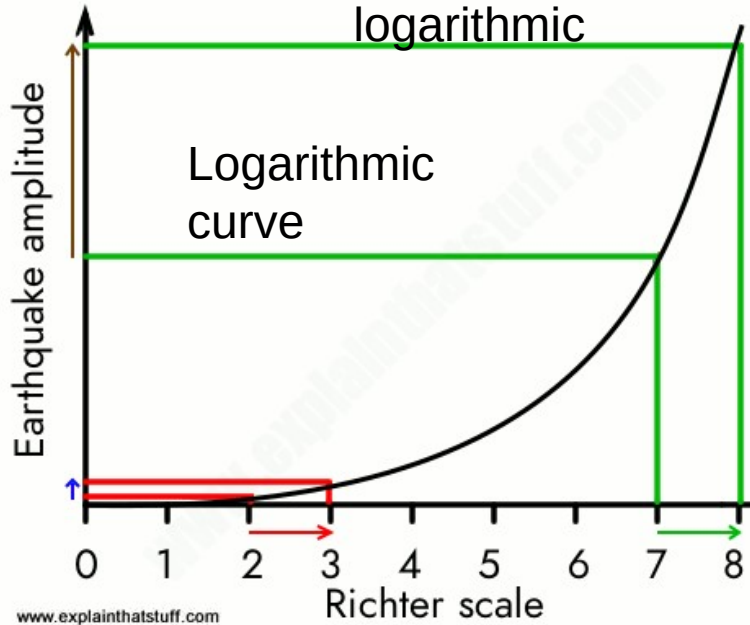
Zircons
zoned





Calculated and measured values of magnetic field strength versus distance away from a magnet Oldenburg+2000.

Earthquake size and magnitude:



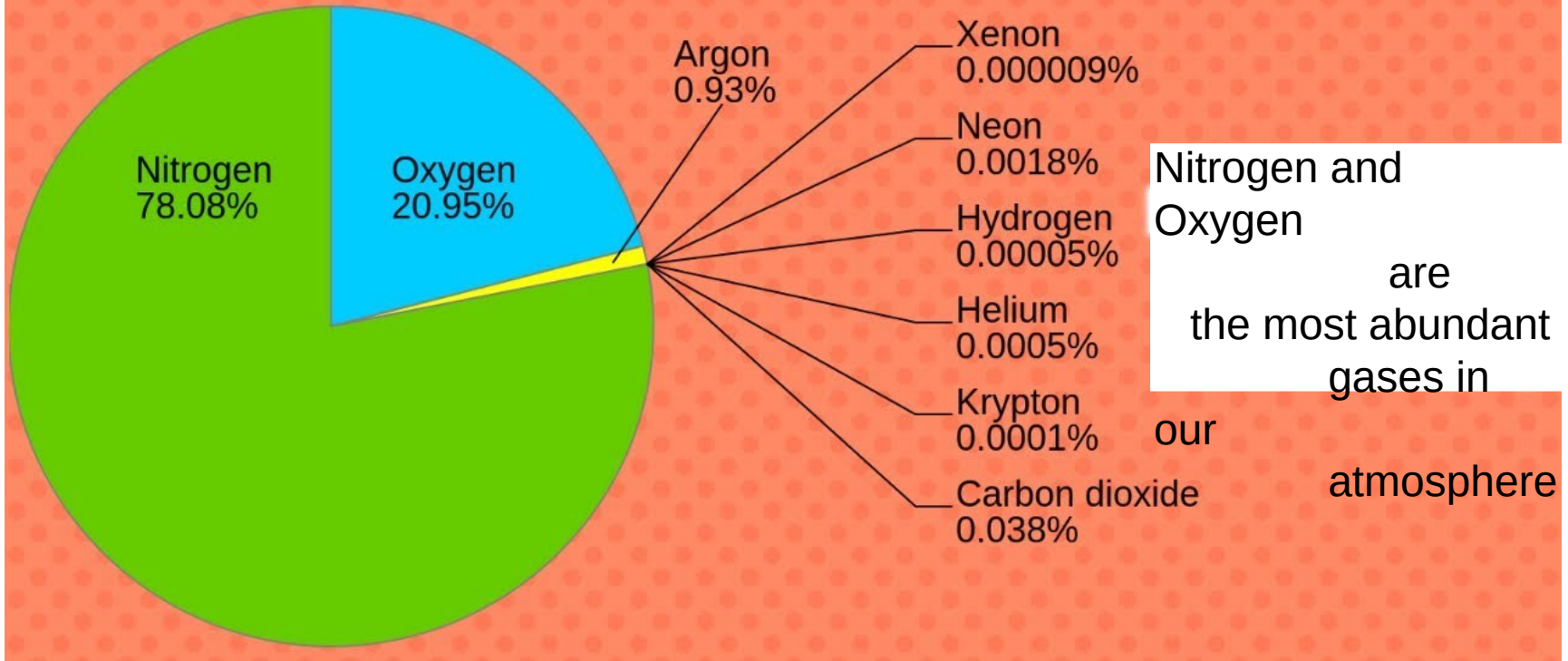
ORIGINS OF EARTH & LIFE

ATMOSPHERE

PRECAMBRIAN ORGANISMS >550
Ma

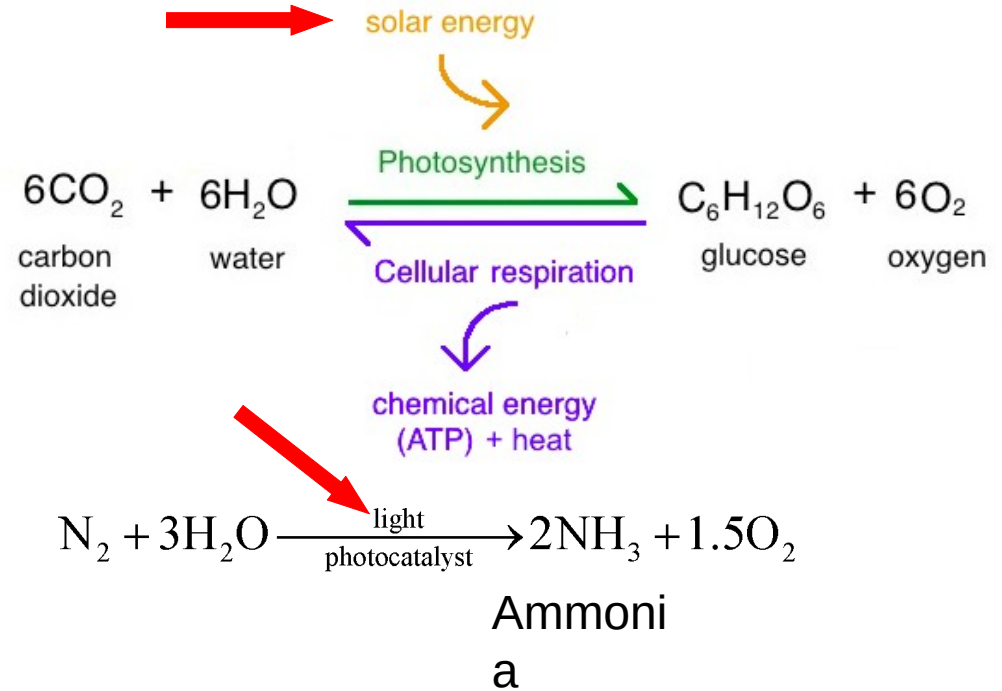
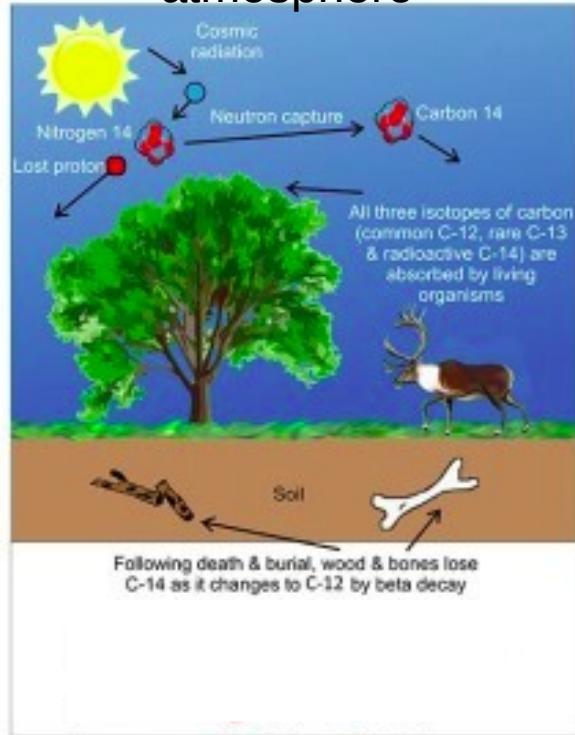
PHANEROZOIC ORGANISMS <550
Ma

Present components Percentage of Different Gases in Atmosphere



Solar energy and Light react with Carbon Dioxide and Nitrogen in ancient atmosphere

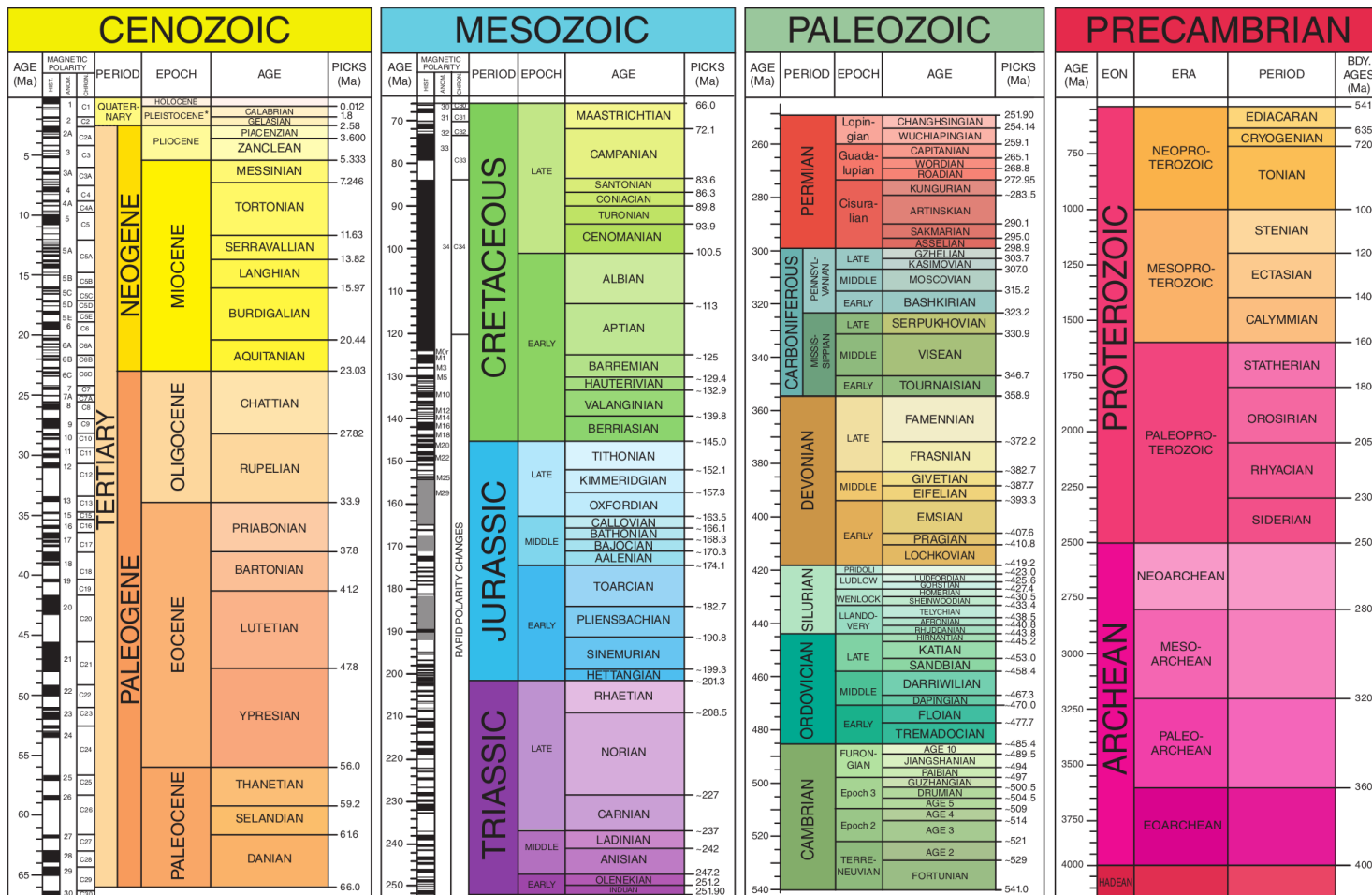
atmosphere



The Geologic Time Scale: The Precambrian Times

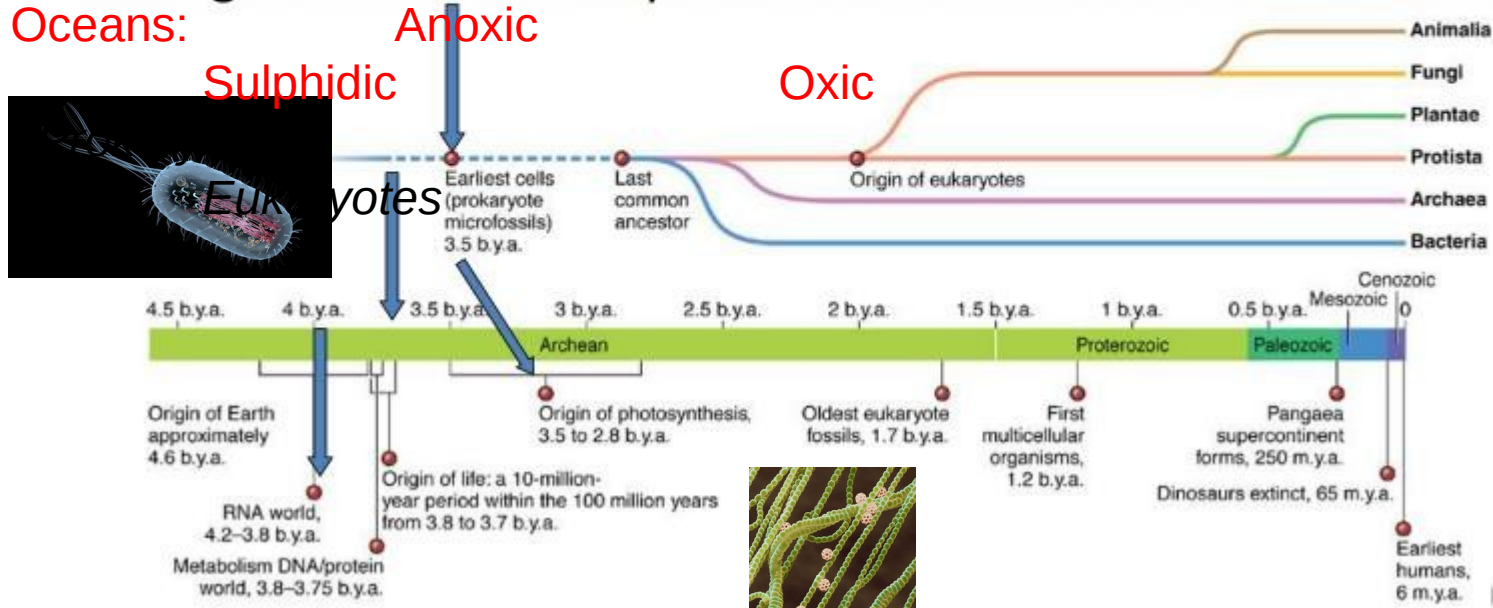
- Includes about 87% of the geological timescale
 - Little or no atmospheric oxygen, N, CO₂, H, CO
 - Lack of ozone shield allowed UV radiation to bombard Earth
 - As Earth cooled water vapour (OH) condensed into water (H₂O)
- First cells came into existence in aquatic environments
 - Prokaryotes
 - Cyanobacteria left many ancient stromatolites fossils
 - Added first oxygen to the atmosphere

GSA GEOLOGIC TIME SCALE v. 5.0

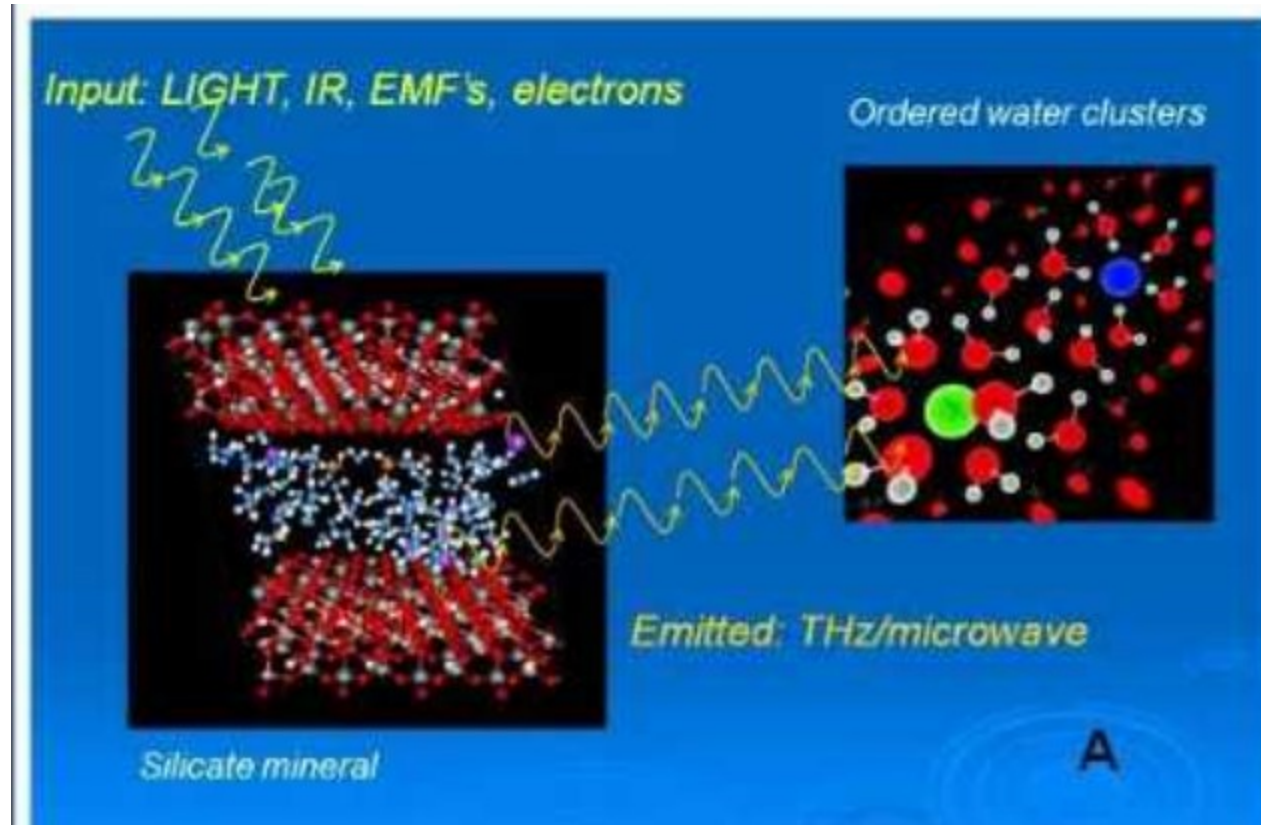


Emergence of Cellular Life

- Based on fossils, chemical evidence, and extrapolation from molecular clocks, the first appearance and relationships of the major kingdoms of life are indicated against a 4.6-billion-year time scale

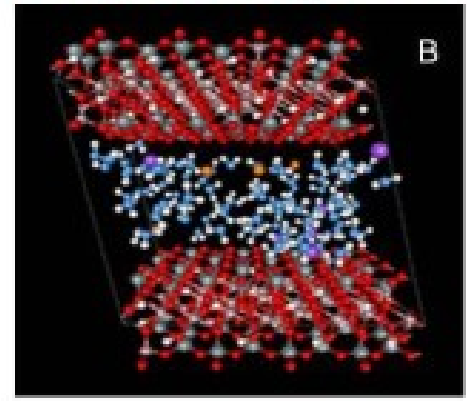
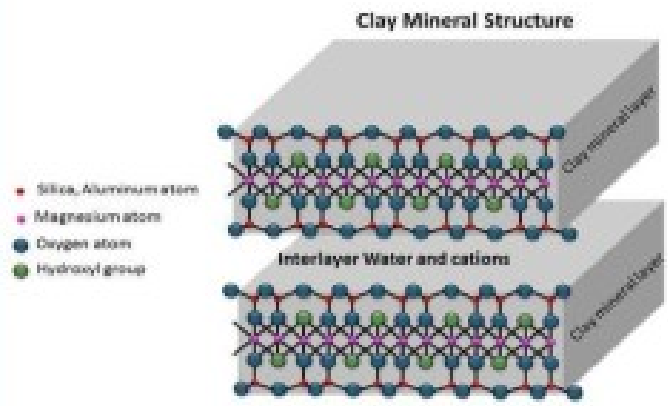


Electromagnetic wave-mediated ordering of **first life** on mineral crystals of clay



Meijer et al 2020, <https://www.researchgate.net/publication/341314198>

Wave frequencies of life, from clay-mediated quantum replication

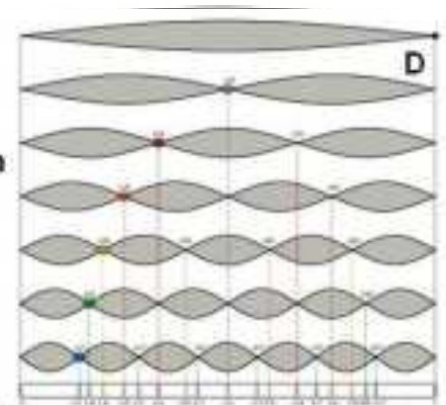


C

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$$

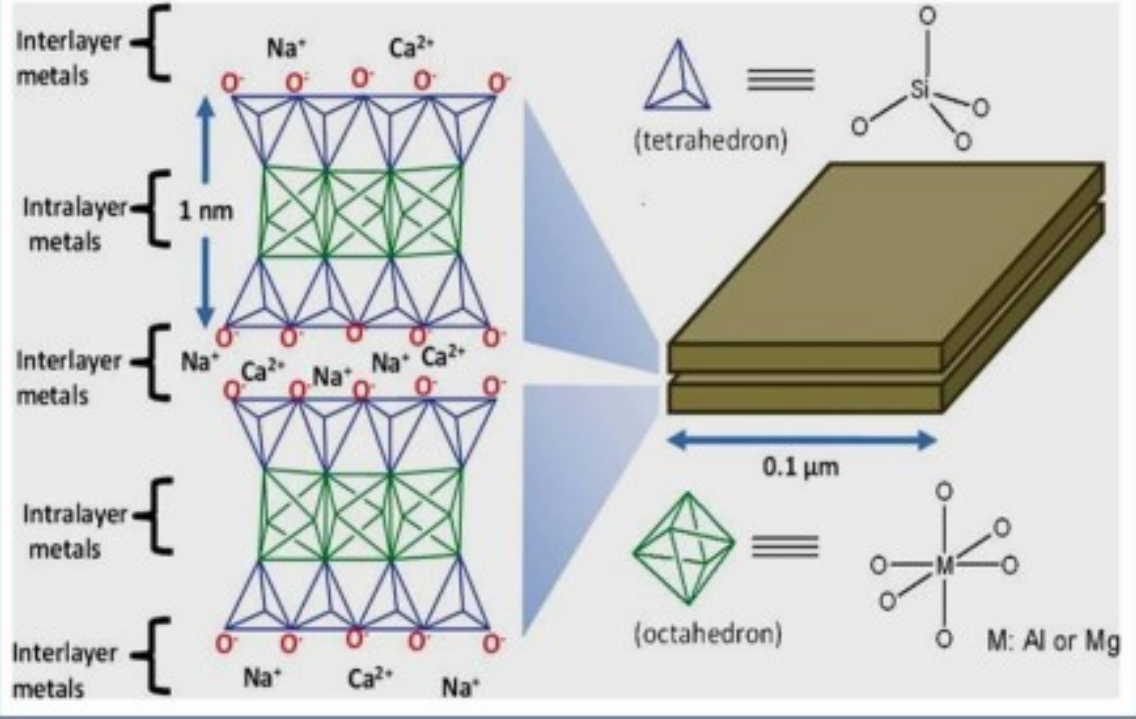
u = string displacement
x = place in string
t = is time
c = fixed constant

Wave Equation₁
Of Life

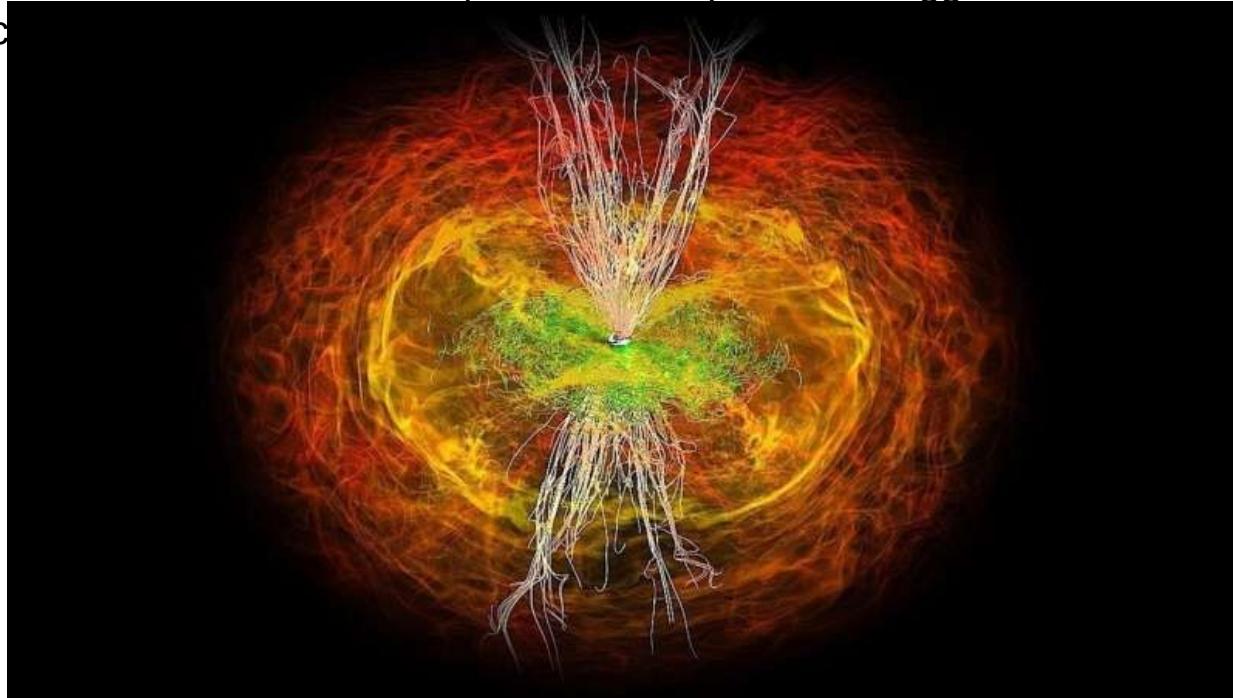


Nodes and standing wave patterns

Phyllosilicate mineral with stabilized ion/ water clathrates

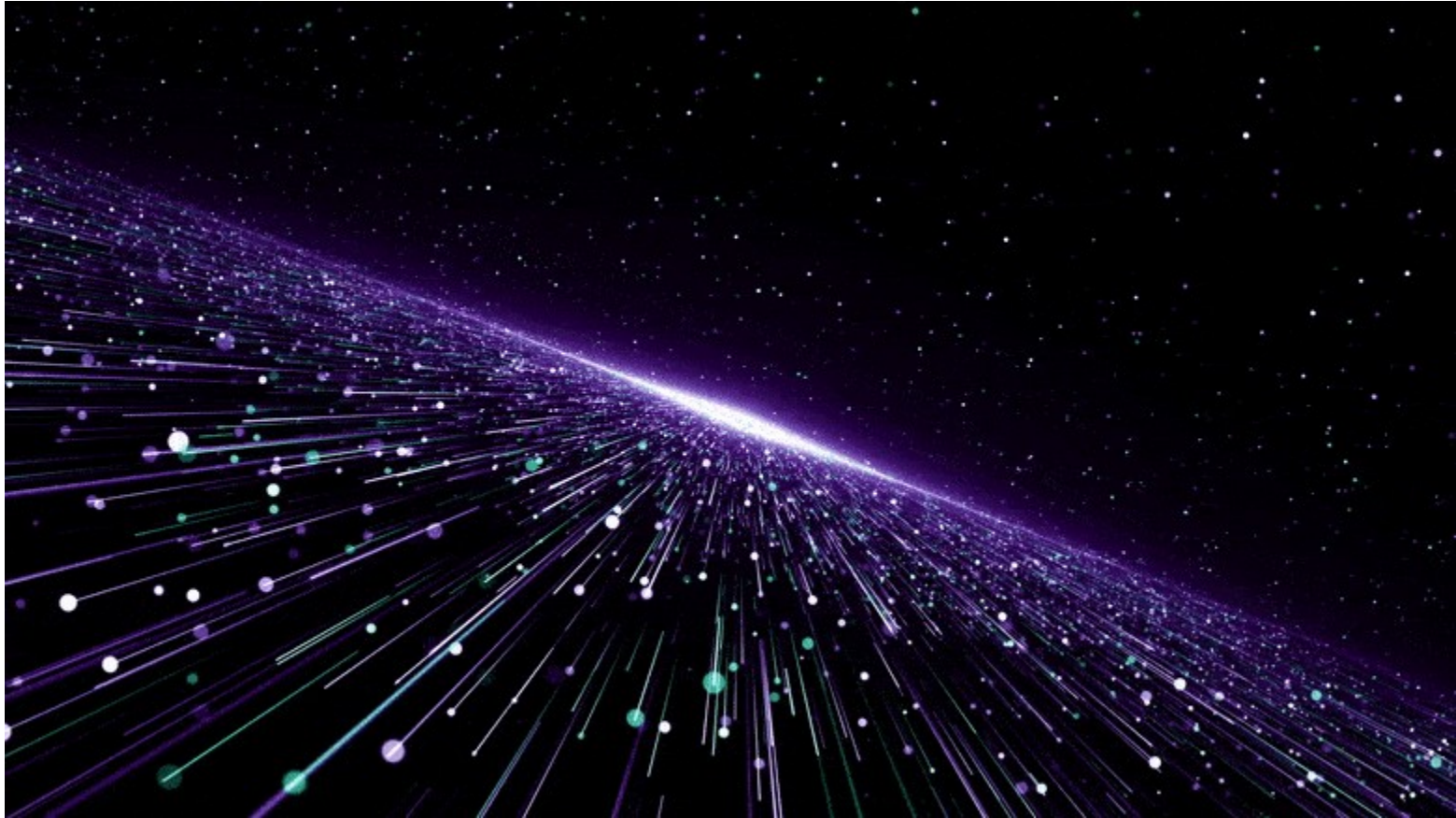


Gravitational waves are ripples in space-time that flow through cosmic gas and dust of the universe to produce the galaxies and planets: explosions of supernovae trigger shock wave & most primary c



DARK ENERGY forms 68% of the universe. which is surrounded by a vacuum that pulls this energy outwards at a present speed of 73.4 kms/sec that is continually accelerating

Silverberg & Eischen 2020, PHYSICS ESSAYS 33,



One possible cause of RESONANCE

Merging of black holes cause gravity waves.

Black holes are at the centre of most galaxies=DARK MATTER=27% OF UNIVERSE

A supernova also produces a shock wave.



<https://scitechdaily.com/future-gravitational-wave-detectors-to-detect-millions-of-black-holes-the-evolution-of-the-universe/>