

Planetary Geochronology

How Old is That?

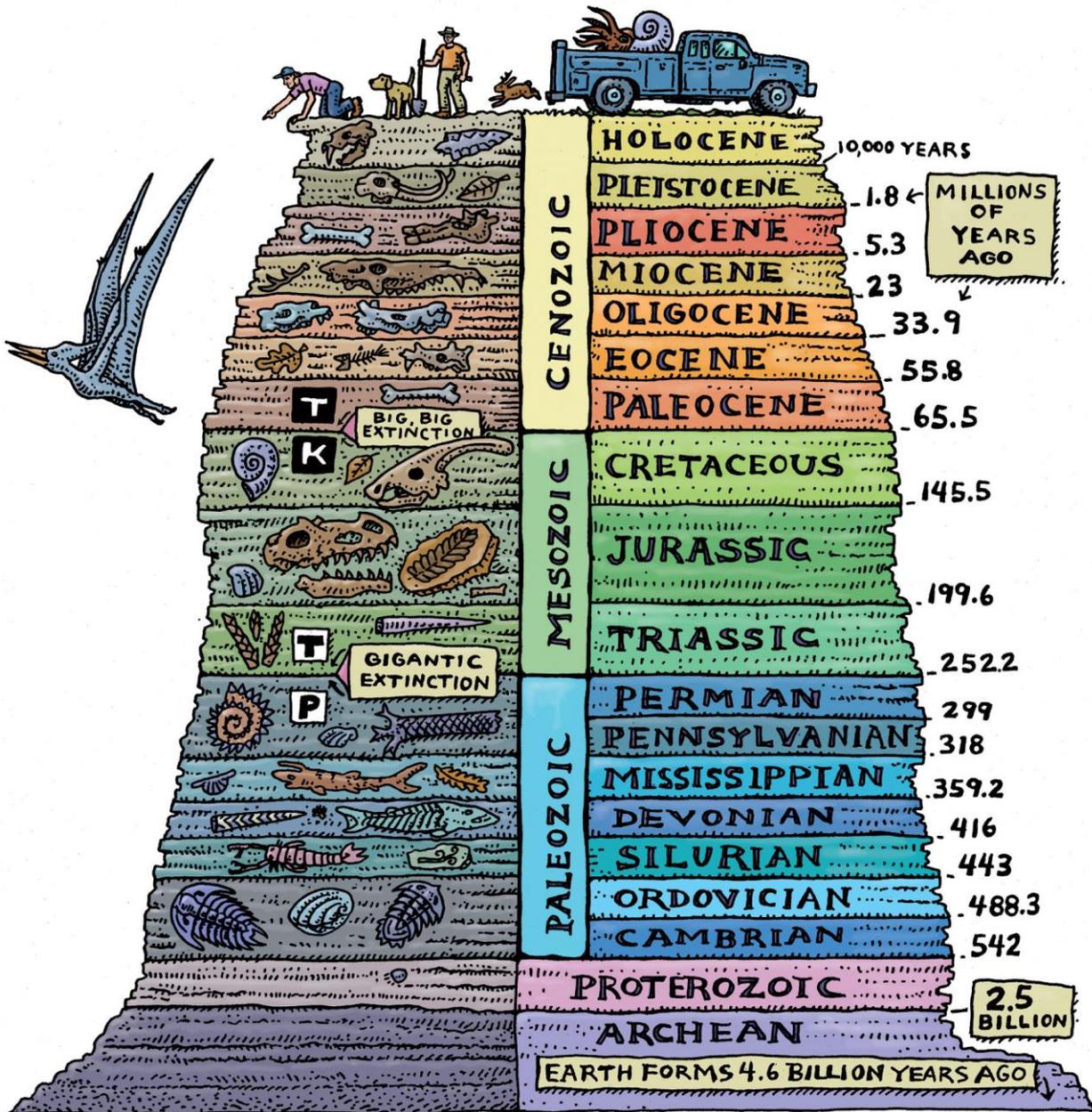
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Some things stay the same, but...

SOME THINGS CHANGE

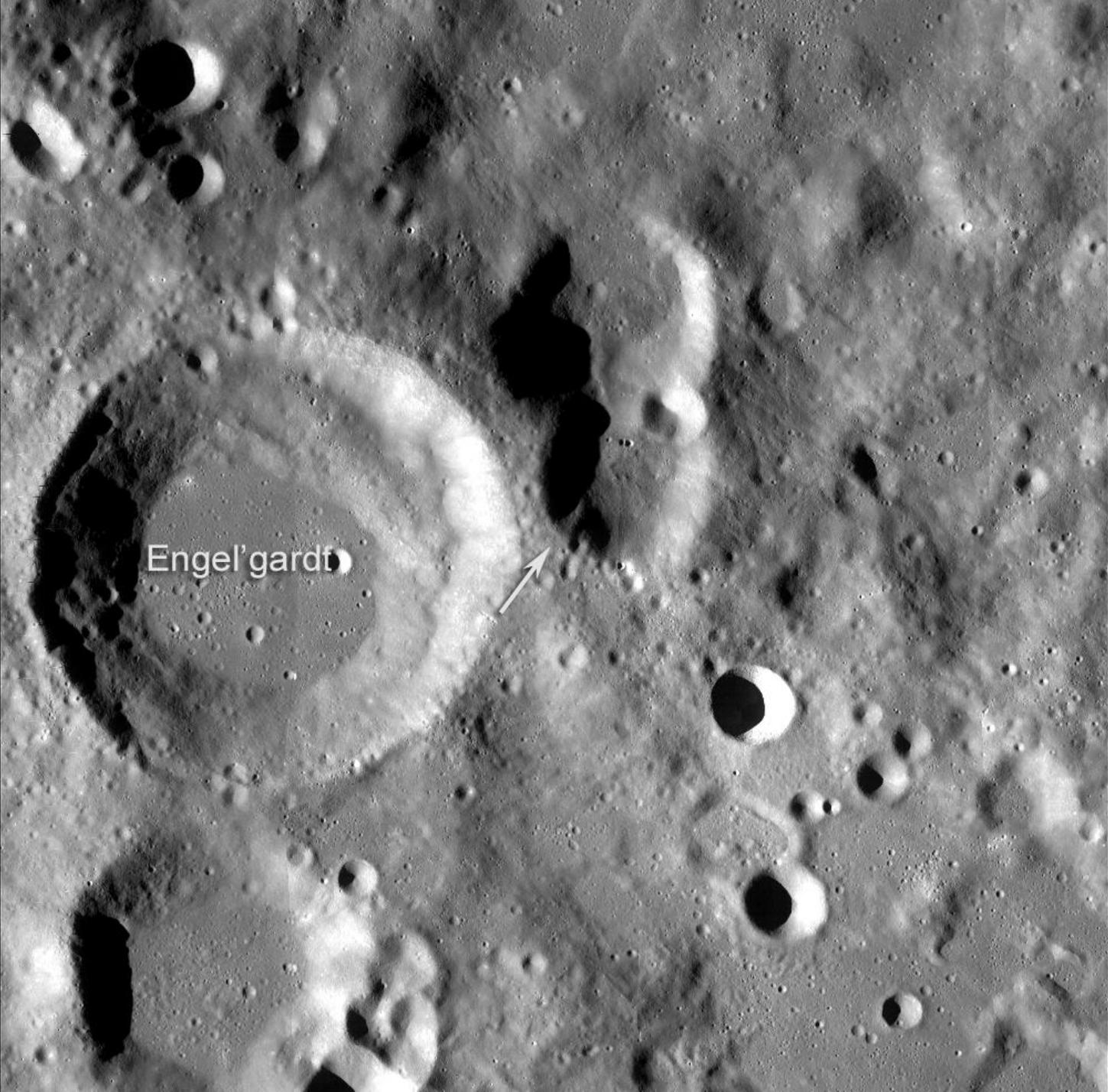


Fantastic drawing by Ray Troll

When do things happen?

What is the tempo of planetary evolution?





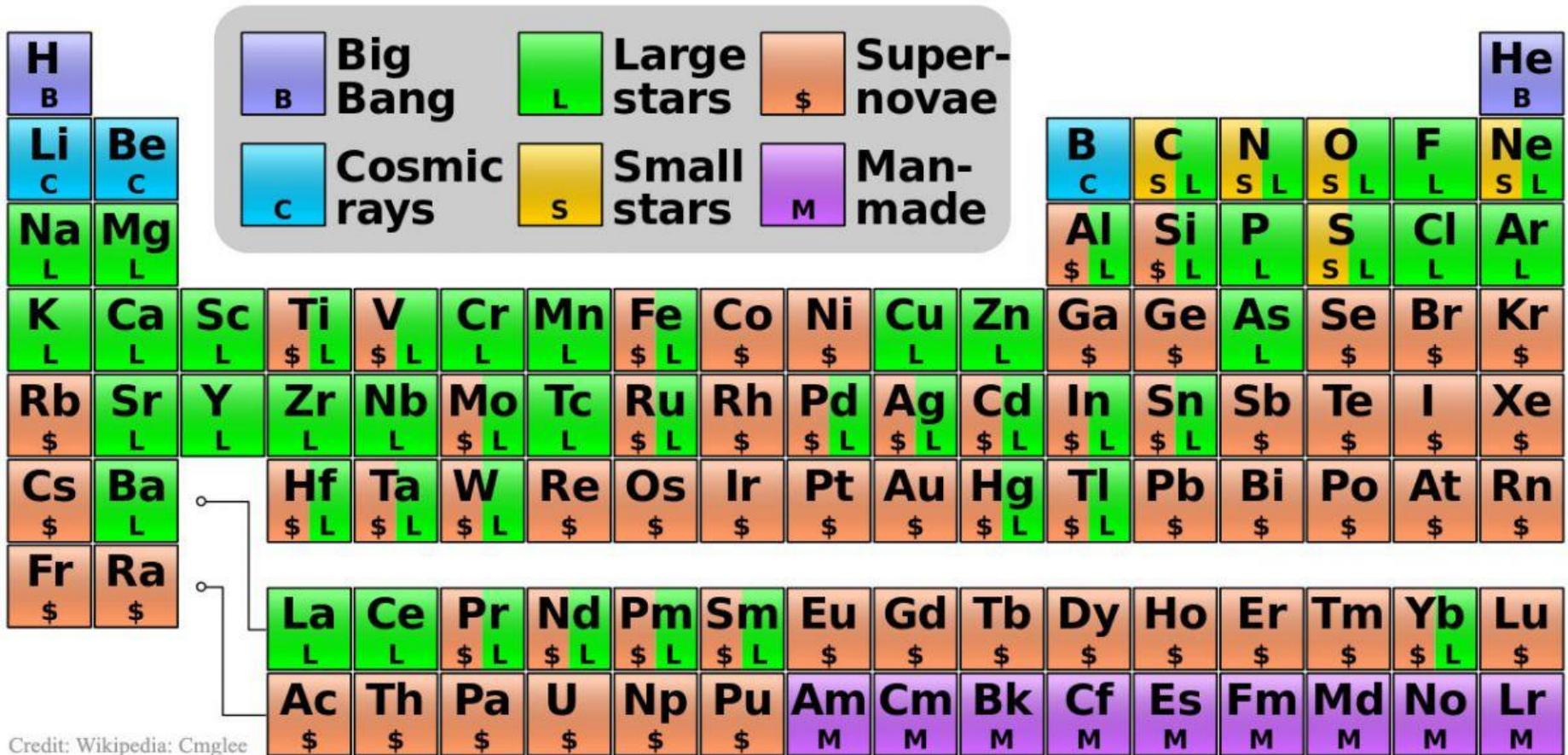
Engel'gardt



Some things stay the same, but...

SOME THINGS CHANGE

What are things made of? Where does it come from?



ISOTOPES

- Atoms of an element that have equal numbers of protons but different numbers of neutrons
- Different isotopes have different masses



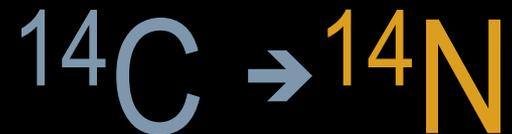
RADIOACTIVE DECAY

- The spontaneous breakdown of an atomic nucleus resulting in the release of both energy and matter.
- Reflects the natural tendency of matter to seek stability.



RADIOACTIVE DECAY

- A **radioisotope** like ^{14}C decays spontaneously to a stable isotope, in this case ^{14}N



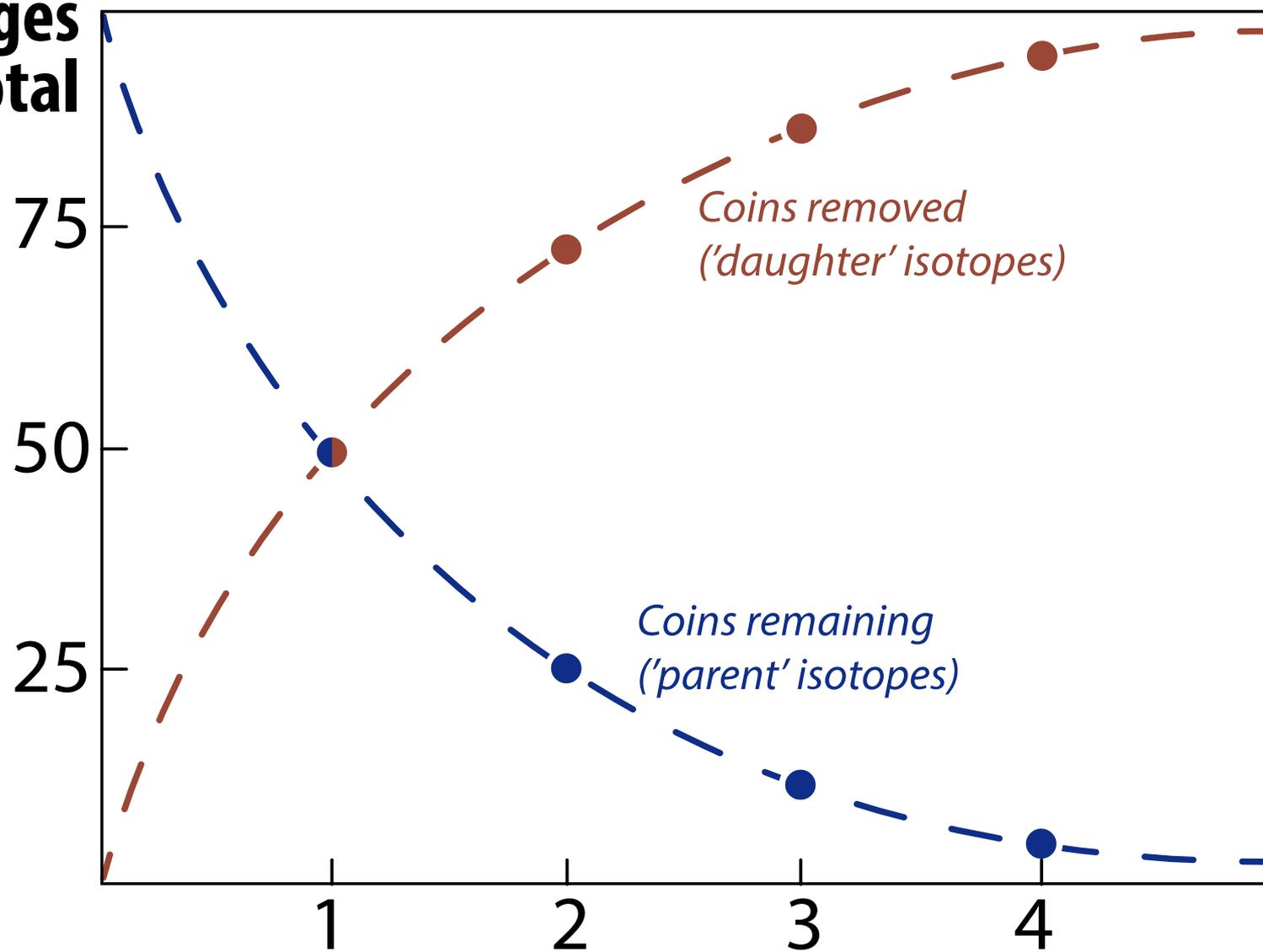
ISOTOPIC 'CLOCKS'

- The rate of radioactive decay is constant over time, meaning that we can use them as clocks
- We tend to talk about the rate of decay in terms of a half-life: the time required for half of an amount of a radioisotope to transform.
- The half-life of ^{14}C is 5,730 years



Experiment details at: exploratorium.edu/snacks/radioactive-decay-model and serc.carleton.edu/quantskills/activities/PennyDecay.html

**Percentages
of total**



*Coins removed
(‘daughter’ isotopes)*

*Coins remaining
(‘parent’ isotopes)*

Tosses (Half-lives)

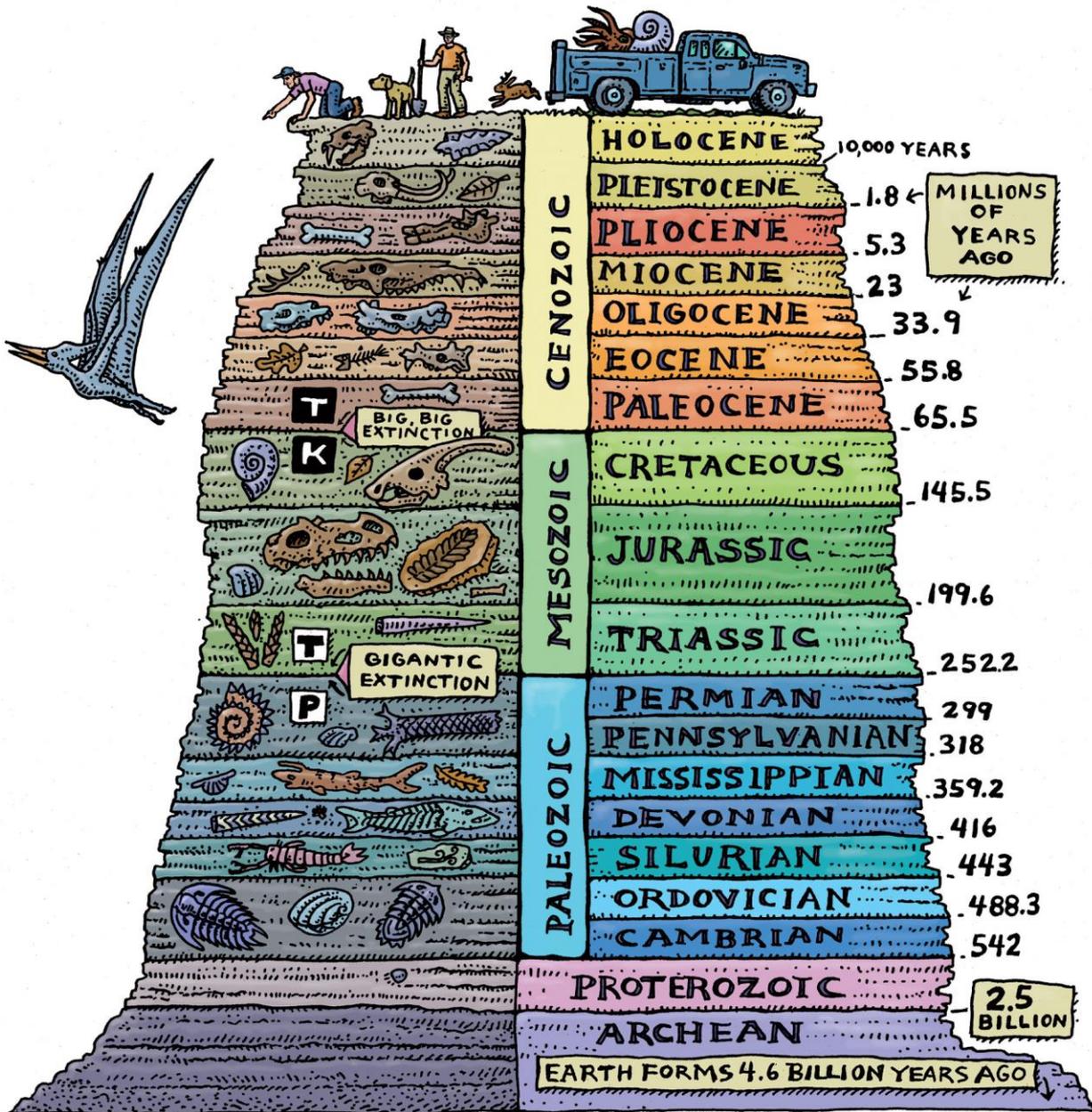
ISOTOPE GEOCHRONOLOGY

- Parent isotope must have an appropriately long half-life
 - The minerals and rocks must have been closed systems with respect to gain or loss of parent and daughter isotopes
 - Target rocks must include minerals containing the parent element in sufficient abundance
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KEY DECAY SCHEMES

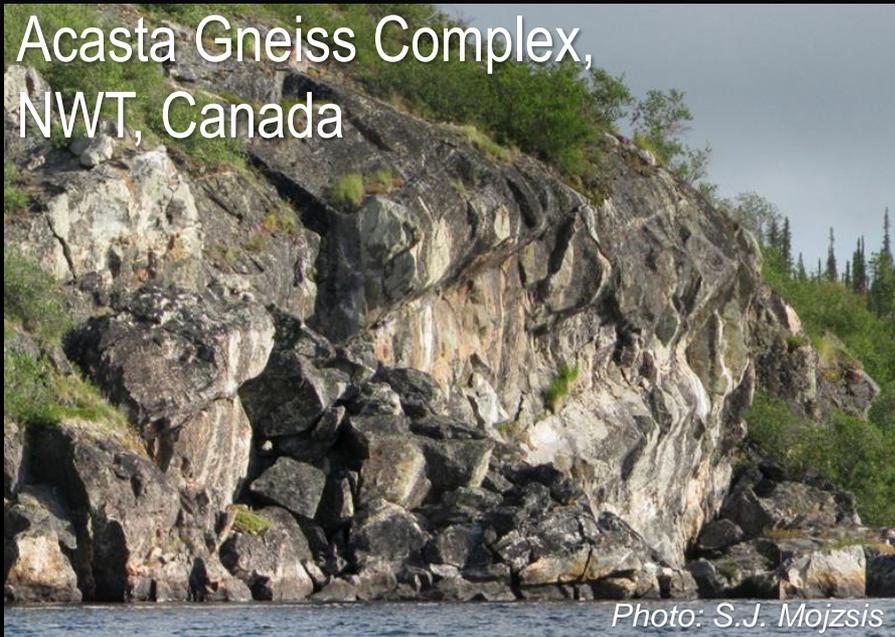
Parent Isotope	Daughter Isotope	Half-Life (Ma)
^{147}Sm	^{143}Nd	106,000
^{232}Th	^{208}Pb	14,100
^{238}U	^{206}Pb	4,470
^{40}K	^{40}Ar	1,251
^{235}U	^{207}Pb	710

'Ma' stands for millions of years



Fantastic drawing by Ray Troll

OLDEST KNOWN ROCK ON EARTH: METASEDIMENTARY GNEISS



Pb-Pb Date:
4031 ± 4 Ma
(Bowring and Williams, 1997)

OLDEST KNOWN ROCK FROM THE MOON: FERROAN ANORTHOSITE



Sample 60025,
Apollo 16 collection

Pb-Pb Date:
 4360 ± 3 Ma
(Borg et al., 2011)

OLDEST KNOWN EARTH MINERALS: ZIRCONS (ZrSiO_4)



Pb-Pb Date:
 4373.6 ± 6.1 Ma
(Valley et al., 2014)

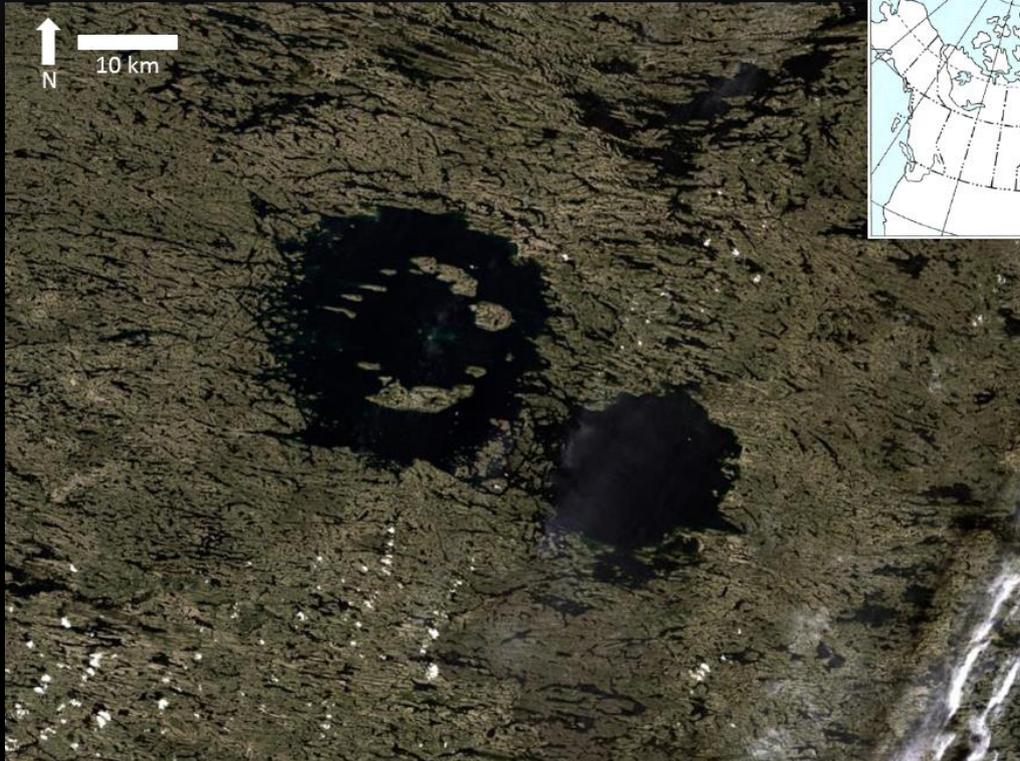
OLDEST KNOWN SOLAR SYSTEM MATERIALS: Ca-Al-RICH INCLUSIONS (CAI)



Pb-Pb Date:
 4568.22 ± 0.17 Ma
(Bouvier and Wadhwa, 2010)



CLEARWATER EAST AND WEST IMPACT SITES QUÉBEC, CANADA



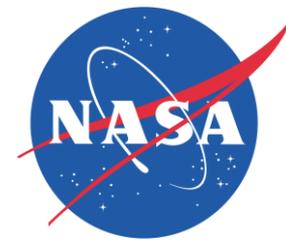
West: ~ 286 Ma
East: ~ 460-470 Ma

EDUCATIONAL RESOURCES

- NSF *Earthtime* resources: www.earth-time.org
- National Association of Geoscience Teachers,
Rates, Dates, and Geologic Time:
serc.carleton.edu/NAGTWorkshops/time/index.html
- Best book: *Ancient Earth, Ancient Skies* by G. Brent Dalrymple



Spaceward Bound



Teachers and students working in the field, side-by-side with NASA scientists, contributing to NASA research in Craters of the Moon National Monument and Preserve

@FINESSE_NASA

<http://spacescience.arc.nasa.gov/finesse/outreach>



International Observe the Moon Night



International Observe the Moon Night (InOMN) is an annual worldwide celebration of lunar science and exploration. One day each year, everyone on Earth is invited to unite to observe and learn about the Moon and its connection to planetary science, and share personal and community connections we all have to the Moon.



#observethemoon

observethemoonnight.org



International Observe the Moon Night



08 October 2016

15 July 2017

Leading up to...



#observethemoon

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