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Deep Time

One of the great contributions by the science of Geology to our collective store of knowledge was the discovery of "deep time". The story of the discovery of deep time is fairly complex, involving many people and their work, rivalries, mistakes and the lesson of all their effort. Keep that in mind when reading the brief summary below.

From their study of geology, James Hutton and Charles Lyell both recognized that the earth was probably very old; they just couldn't find the evidence to give a definitive age¹. One of the first attempts to calculate an age for the earth from known scientific principles was by William Thomson, Lord Kelvin. Starting with the assumption that the earth was originally molten and estimating heat transfer from the earth to space, Lord Kelvin believed that the earth was between 20 and 100 million years old².

The flaw with Lord Kelvin's estimate, made in 1863, was that it did not take into account the heat from radioactive decay. The discovery of radioactive elements by Marie Curie in 1898 led to further investigations into radioactive minerals by many other researchers. Thousands of research papers have resulted in an accumulation of knowledge; this in turn has led to the current estimate that the earth is approximately 4.54 billion years old³.

A Very Long Time

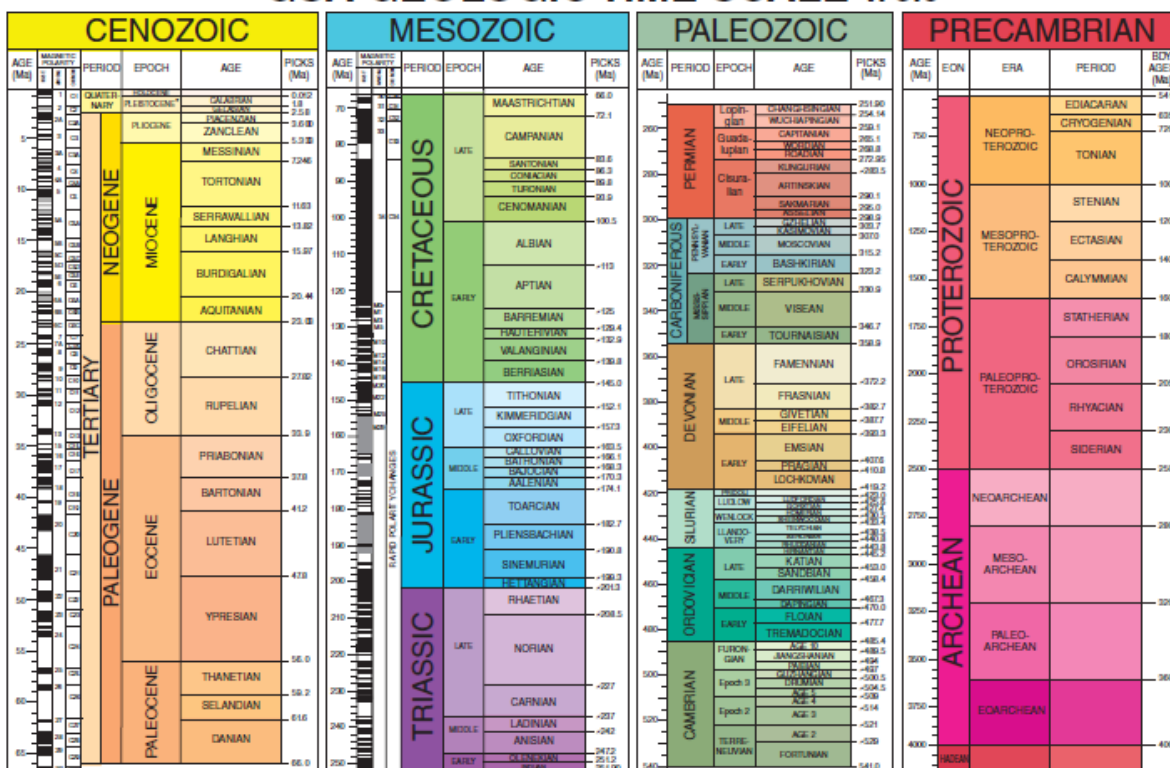
4.54 billion years is an immense period of time. To visualize it, imagine a line where every millimetre (mm) represents a thousand years and every metre (m) is a million years. On this scale, the line representing the total age of the earth will be 4,540 m long. 4,000 m (4 km) of the line represents the length of the Precambrian. The next 540 m represents the Phanerozoic Eon, the age of complex life. Approximately 252 million years ago, 252 m on the time line, the Paleozoic ended with the Permian mass extinctions. 66 m from the present on the time line, the Cretaceous ended with the K/T mass extinction. The entire existence of Homo sapiens, 300,000 years⁴, can be represented by 30 cm, a little less than a foot in the old imperial measurement system. The 5 thousand years of recorded history amounts to 5 mm and a human life of 80 years equals 0.08 mm on this scale.

Really makes you feel important doesn't it?

It gets worse, the fossil evidence indicates that most of the species that have ever lived have gone extinct⁵ and there is no reason to believe that humans are exempt from this fate.

A graphical portrayal of the geological time scale from The Geological Society of America⁶ is shown below

GSA GEOLOGIC TIME SCALE v. 5.0



Walker, J.D., Gassman, J.W., Shewey, S.A., and Babcock, L.F., compilers, 2018, Geologic Time Scale v. 5.0, Geological Society of America, <https://doi.org/10.1130/G5018.0>. Q2018 The Geological Society of America
 *The Proterozoic is divided into four ages, but only two are shown here. What is shown as Cambrian is actually time ages—Cambrian from 1.80 to 0.781 Ma, Middle from 0.781 to 0.126 Ma, and Late from 0.126 to 0.0117 Ma.
 The Cenozoic, Mesozoic, and Paleozoic are the Eras of the Phanerozoic Eon. Names of units and age boundaries usually follow the Gradstein et al. (2012), Cohen et al. (2012), and Cohen et al. (2013, updated) compilations. Numerical age estimates and picks of boundaries usually follow the Cohen et al. (2013, updated) compilation. The numbered epochs and ages of the Cambrian are provisional. A "-" before a numerical age estimate typically indicates an associated error of ±0.4 to over 1.0 Ma.
 REFERENCES CITED
 Cohen, K.M., Flory, S., and Gibbard, P.L., 2012, International Chronostratigraphic Chart, International Commission on Stratigraphy, www.stratigraphy.org (accessed May 2012). (Chart reproduced for the 34th International Geological Congress, Brisbane, Australia, 5–10 August 2012.)
 Cohen, K.M., Flory, S.C., Gibbard, P.L., and Fan, J.-X., 2013, The ICS International Chronostratigraphic Chart: Episodes v. 36, no. 3, p. 199–204 (updated 2017, v. 2, <http://www.stratigraphy.org/index.php/ics-chart-chronologic>, accessed May 2018).
 Gradstein, F.M., Ogg, J.G., Schmitz, M.D., et al., 2012, The Geologic Time Scale 2012, Boston, USA, Elsevier, <https://doi.org/10.1016/B978-0-444-59402-5.00004-4>.
 Previous versions of the time scale and previously published papers about the time scale and its evolution are posted to <http://www.geosociety.org/timescale>.



Living with the Facts

If we hope to benefit from science, then we should adopt an attitude of radical realism. From our understanding of deep time a couple of lessons stand out:

- We are the heirs of an immensely long history of life, that history is rich, complex and we are part of it.
- We are not as important as we would like to think we are and that is a good thing.

In the end, we are left to ponder lessons of deep time.

References

1. Gould, S. J., 1987, *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*, Harvard University Press, Cambridge MA

2. Lamb, E., June 2013, *Lord Kelvin and the Age of the Earth*, Scientific American, <https://blogs.scientificamerican.com/roots-of-unity/lord-kelvin-age-of-the-earth/>
3. United States Geological Service (USGS), July 2007, Age of the Earth, <https://pubs.usgs.gov/gip/geotime/age.html>
4. Science News, September 2017, *Modern humans emerged more than 300,000 years ago new study suggests*, <https://www.sciencedaily.com/releases/2017/09/170928142016.htm>
5. Quora, March 2015, *Why do scientists think that over 99 percent of all species that ever lived have gone extinct?* <https://www.quora.com/Why-do-scientists-think-that-over-99-percent-of-all-species-that-ever-lived-have-gone-extinct>
6. The Geological Society of America, Aug. 2018, GSA Geologic Time Scale, Version 5.0, https://www.geosociety.org/GSA/Education_Careers/Geologic_Time_Scale/GSA/timescale/home.aspx