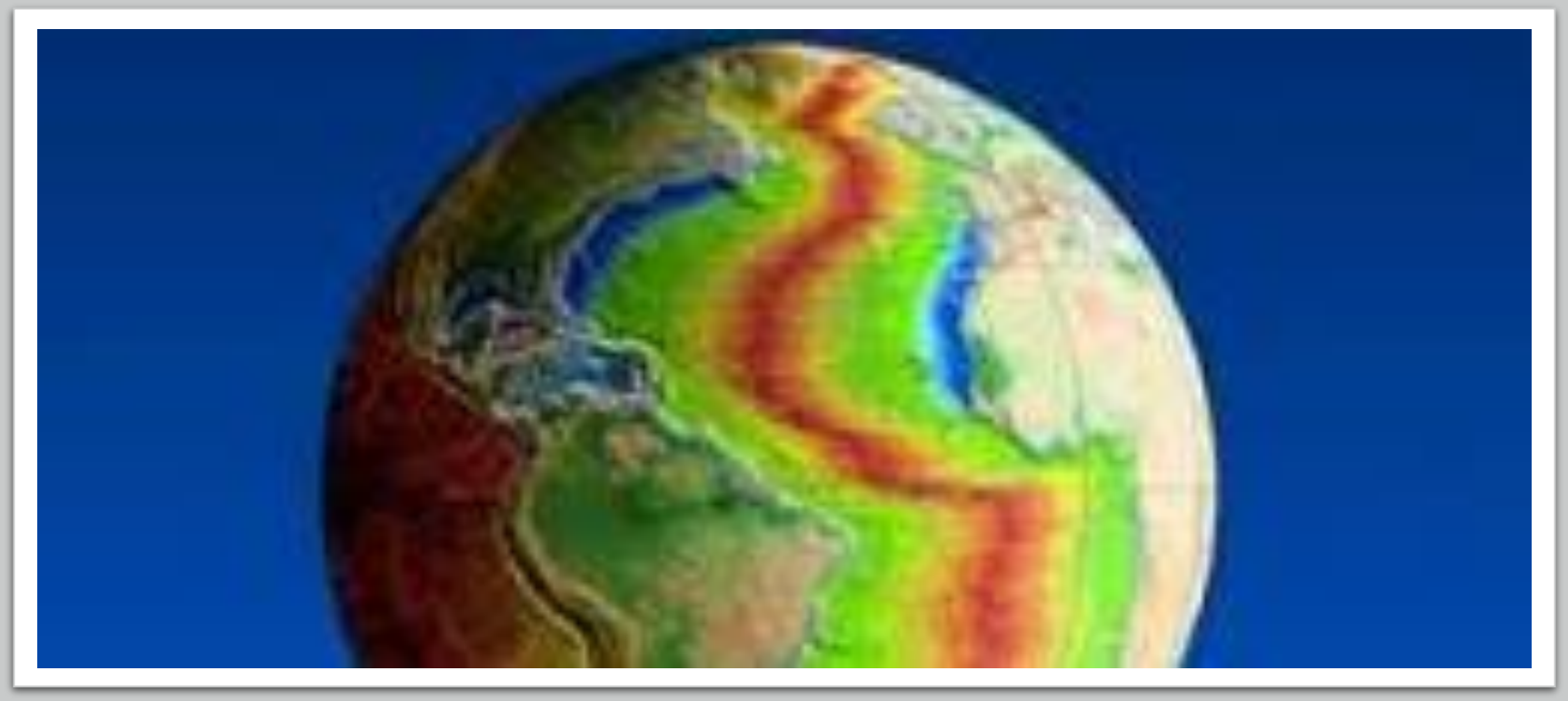


Earth Science

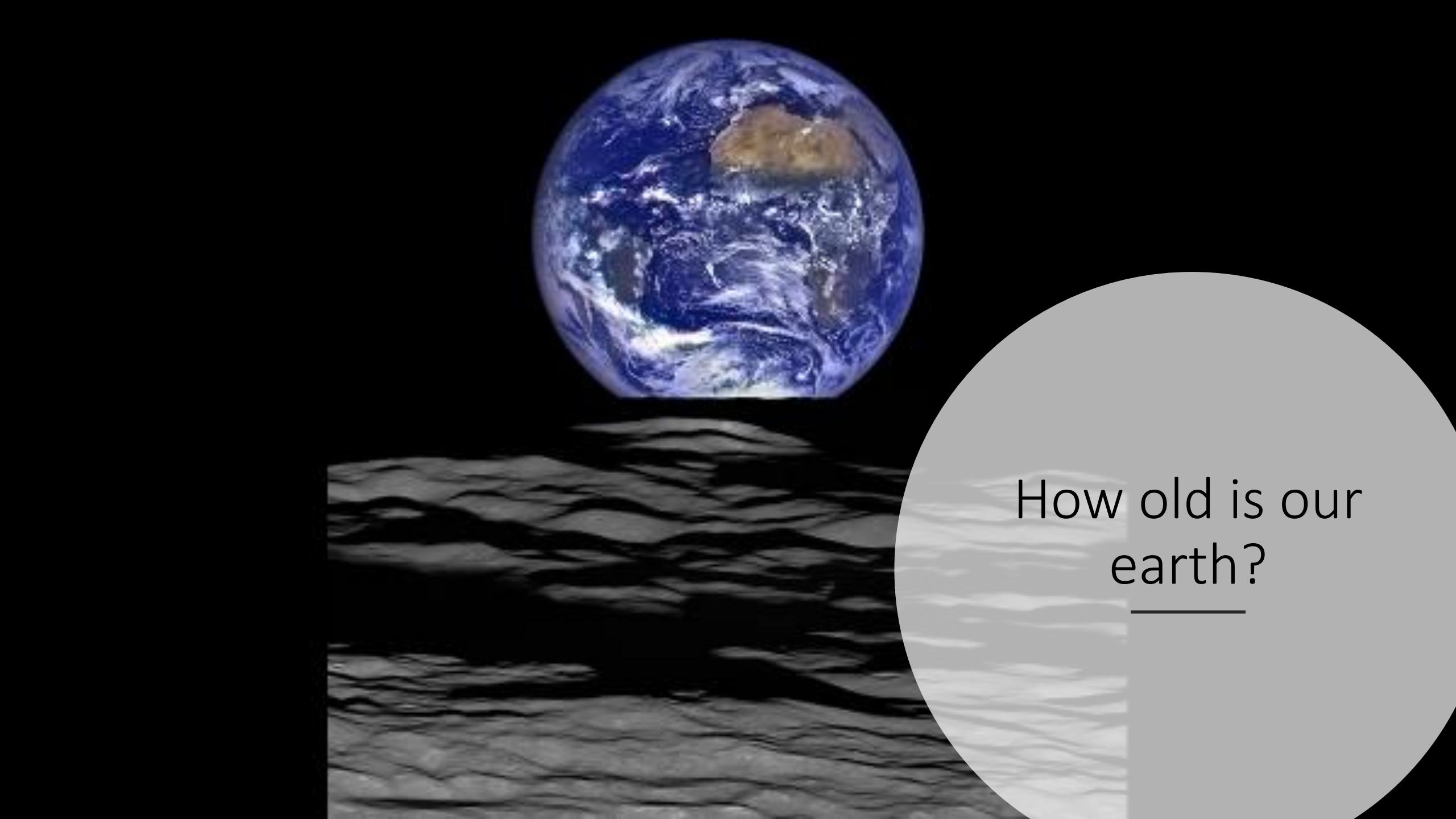
Time and Space

Sreedhar, Environics Trust

Interaction with Students of

Poorna Learning Centre

19th November 2020



How old is our earth?

THE
SCIENTIFIC MONTHLY

NOVEMBER 1957

Measuring Geologic Time

ADOLPH KNOPF

Dr. Knopf received his training in geology at the University of California. He joined the U.S. Geological Survey in 1906 and, for the next 5 years, engaged in the study of the areal geology and ore deposits of Alaska. He then pursued similar investigations in Montana, California, Nevada, Colorado, and other western states. From 1920 to 1951 he was a member of the faculty of Yale University, being named Silliman professor of geology in 1937 and Sterling professor in 1938. He now holds the position of visiting professor of geology at the School of Mineral Sciences, Stanford University.

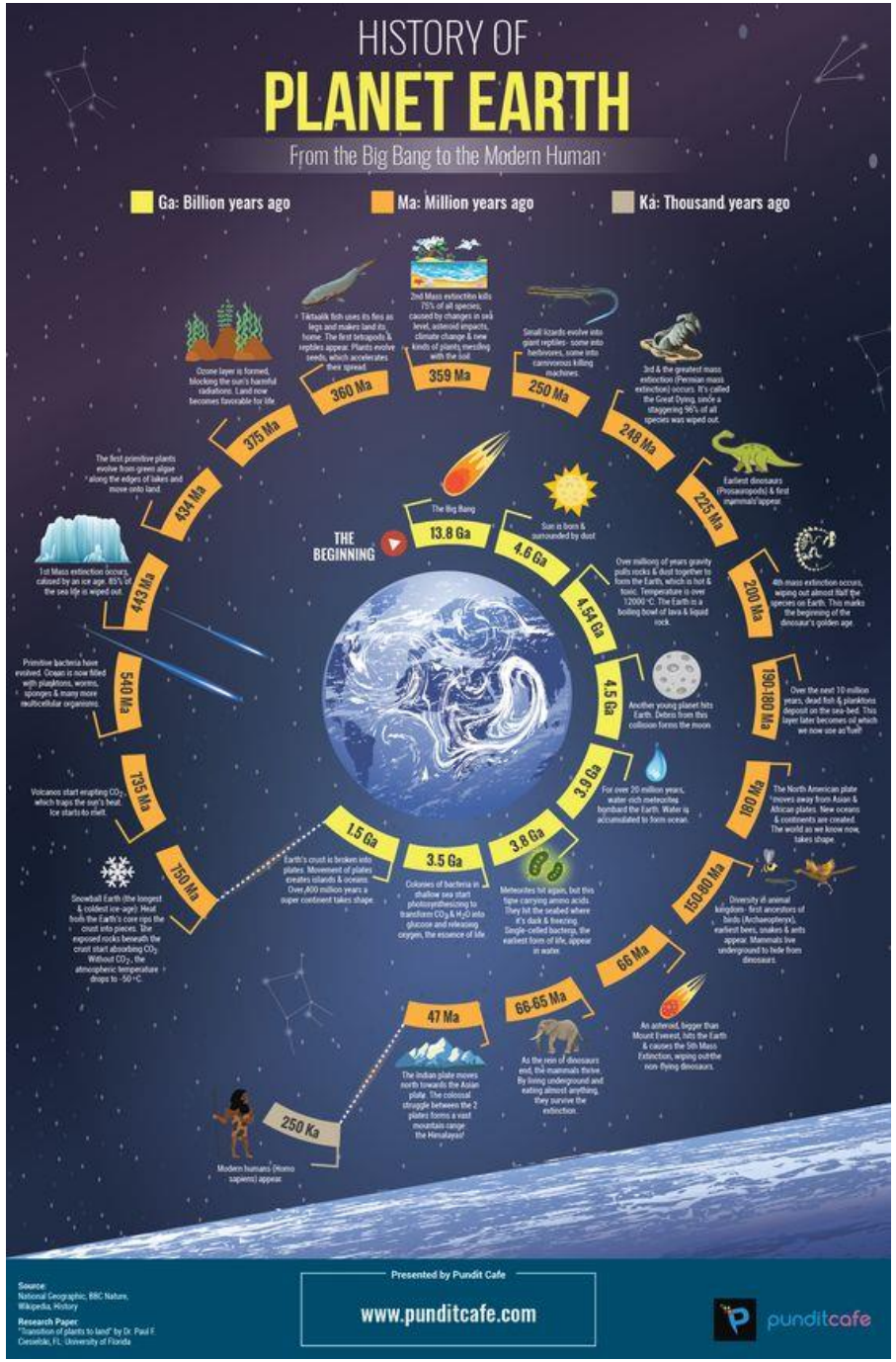
IN recent years our earth has been aging a billion years each decade. Between the beginning of the present century and 1930, an age of the earth of 100 million years had become generally accepted. In that year it was suggested that, in the light of the new discoveries of geology and radioactivity, the earth is at least 2000 million years old (*1*). Now, in 1957, we are envisaging an age of 4500 million years, and the end of the enormous lengthening of time appears to be in sight. Astronomers had estimated that the universe began to expand 1860 million years ago. However, this figure became geologically unacceptable when it became apparent that it was less than the age of the oldest rocks on our own planet. Recently, the distance of the Andromeda nebula was redetermined at Palomar and was found to be twice as great as it had previously been calculated to be. The distance of the Magellanic Cloud was also redetermined and set at twice the earlier figure. Since these distances were the yardsticks for measuring the extragalactic distances, all distances were doubled. These findings, together with Hubble's rate of recession of the galaxies, indicate that the age of the universe is 4000 million years—a figure which is in much better agreement with the age deduced from the rocks of our earth than previous estimates had been.

Our concept of geologic time has thus been increasing enormously, and this extension is a remarkable item in the history of ideas. At this point I may allude to the well-known estimate made by the Anglican Archbishop Usher, in 1654, that the earth was created in 4004 B.C. (Later, this estimate was improved upon and refined by the learned John Lightfoot, vice chancellor of Cambridge University, the greatest Hebrew scholar of his day. He declared that God had created Adam out of the dust of the earth on the morning of Friday, 17 September at 9 o'clock. I have this information from Shotwell's absorbing book on *The History of History*) (*2*). It was therefore something of a surprise to find Shakespeare's Rosalind saying, in *As You Like It*, which was produced in 1599, more than 50 years before the archbishop's pronouncement, "The poor world is almost 6000 years old, and in all this time there was not any man died in his own person, *videlicet*, in a love cause." Had Rosalind taken a modern elementary course in geology, she would have soon felt that she had made a grievous understatement!

How ingrained had become the belief that the earth was 6000 years old is shown by the first proposal ever made to measure the age of the earth quantitatively. In 1715 the Astronomer Royal, Edmund Halley, wrote "A short account of the

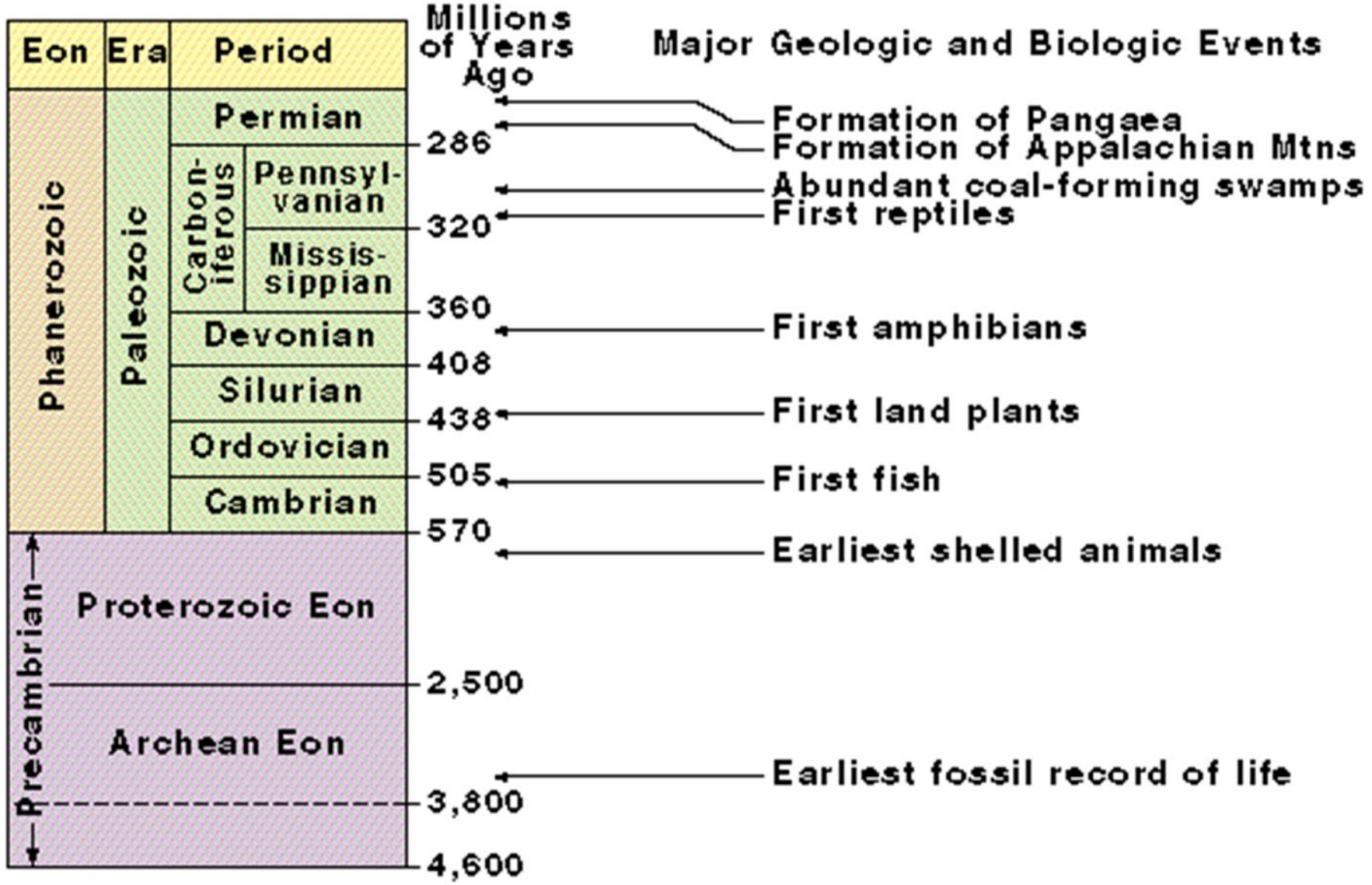
Geochronology

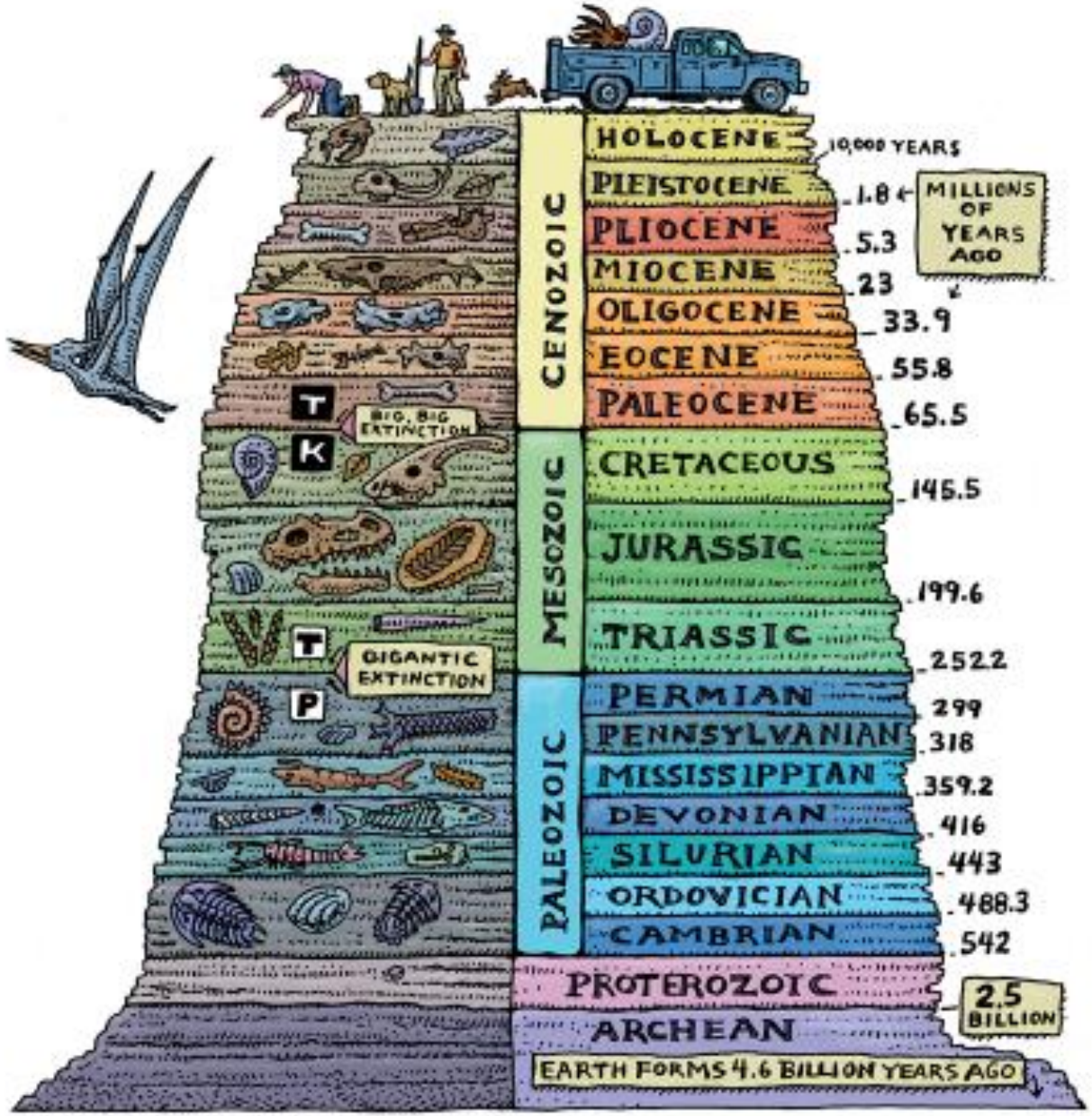
Geochronology is the science of determining the age of rocks, fossils, and sediments using signatures inherent in the rocks themselves. Absolute geochronology can be accomplished through radioactive isotopes, whereas relative geochronology is provided by tools such as palaeomagnetism and stable isotope ratios.



Ga Ma Ka?

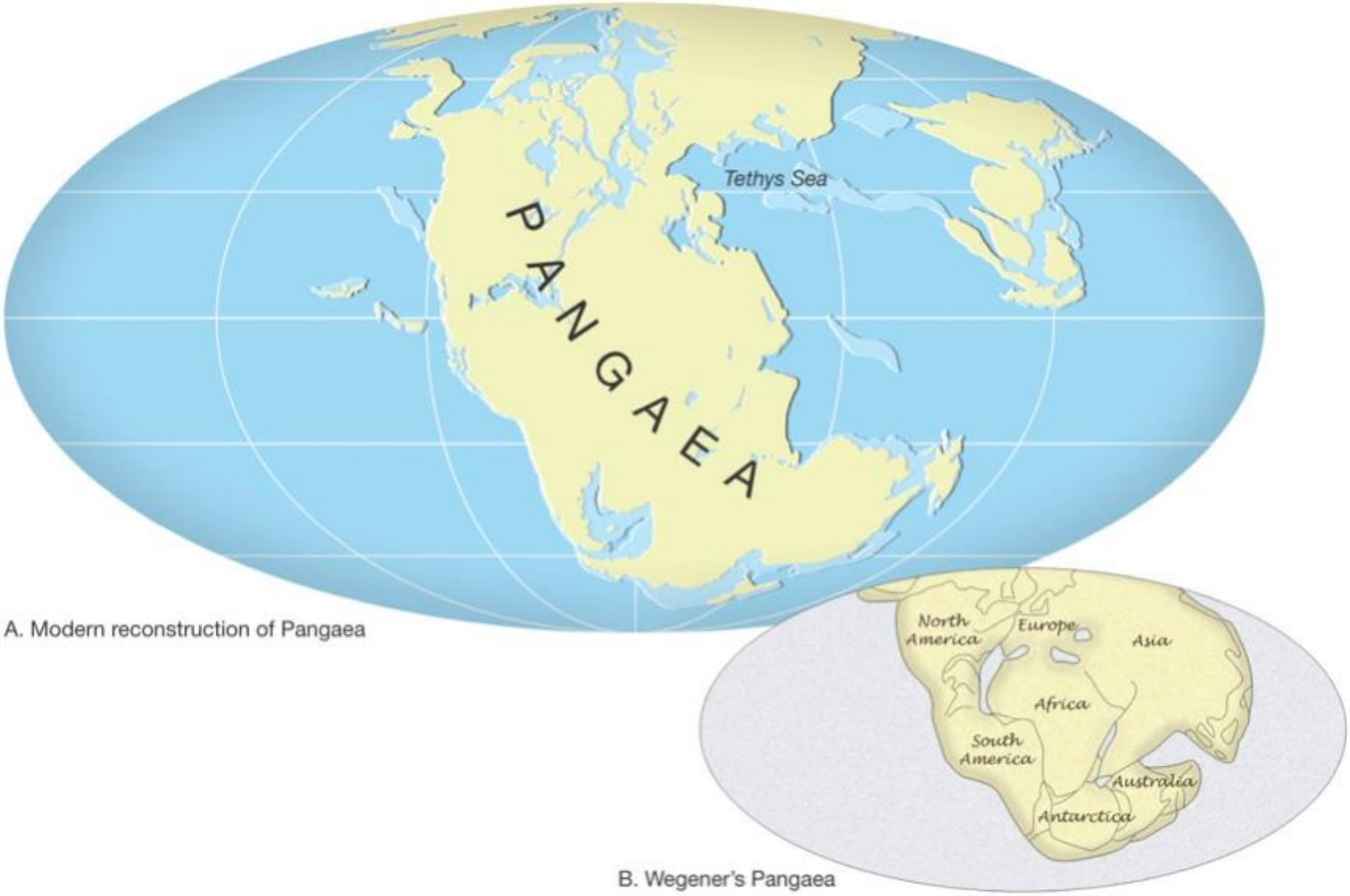
MKS System of Time


Eon
Era
Period
Millions of Years Ago
Major Geologic and Biologic Events
Phanerozoic
Paleozoic
Permian
Carbon-iferous
Pennsyl-vanian
Missis-sippian
Devonian
Silurian
Ordovician
Cambrian
Precambrian
Proterozoic Eon
Archean Eon
286
320
360
408
438
505
570
2,500
3,800
4,600
Formation of Pangaea
Formation of Appalachian Mtns
Abundant coal-forming swamps
First reptiles
First amphibians
First land plants
First fish
Earliest shelled animals
Earliest fossil record of life



Fantastic drawing by Ray Troll

Earth ~200 million years ago

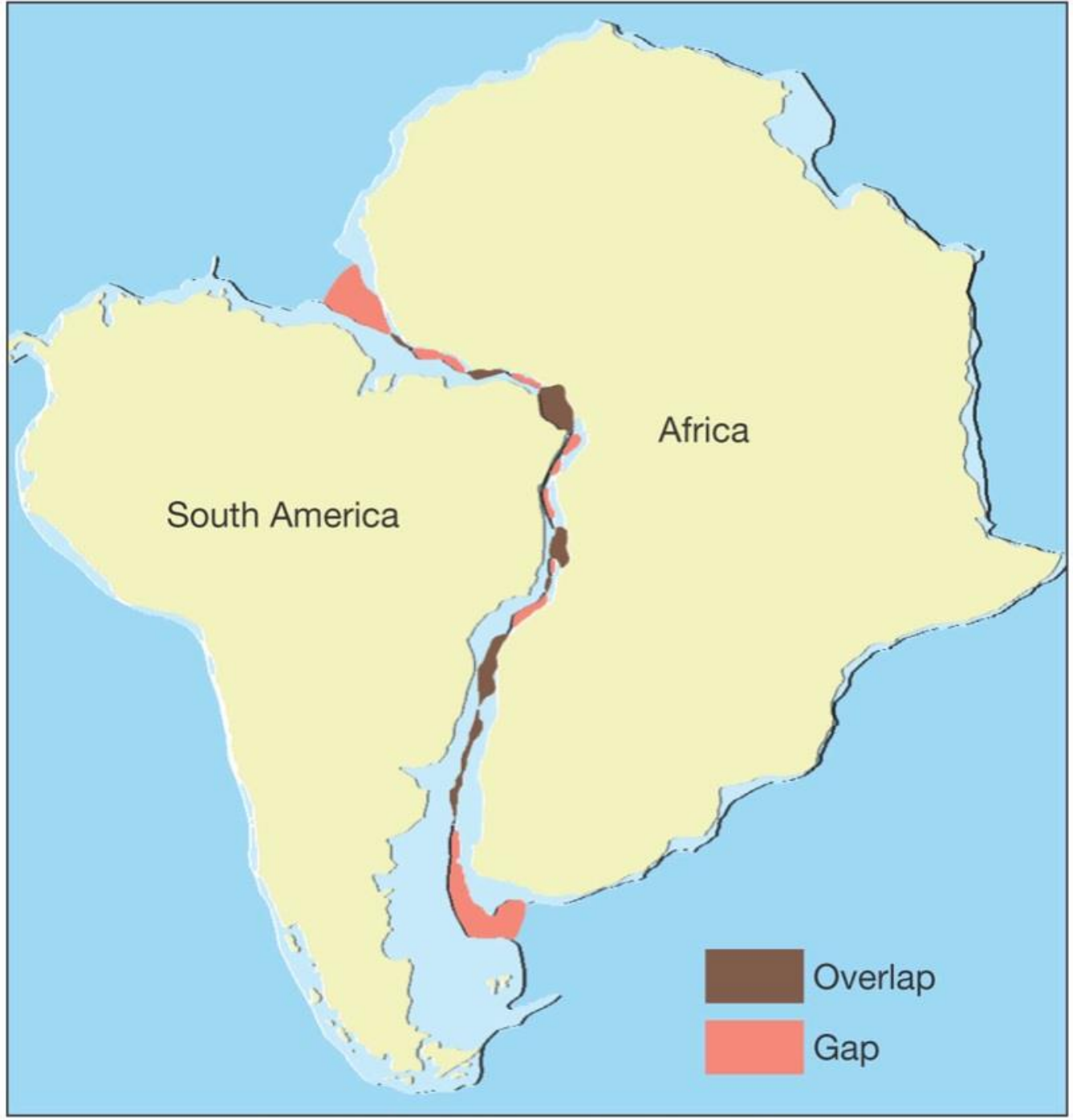


A. Modern reconstruction of Pangaea

B. Wegener's Pangaea

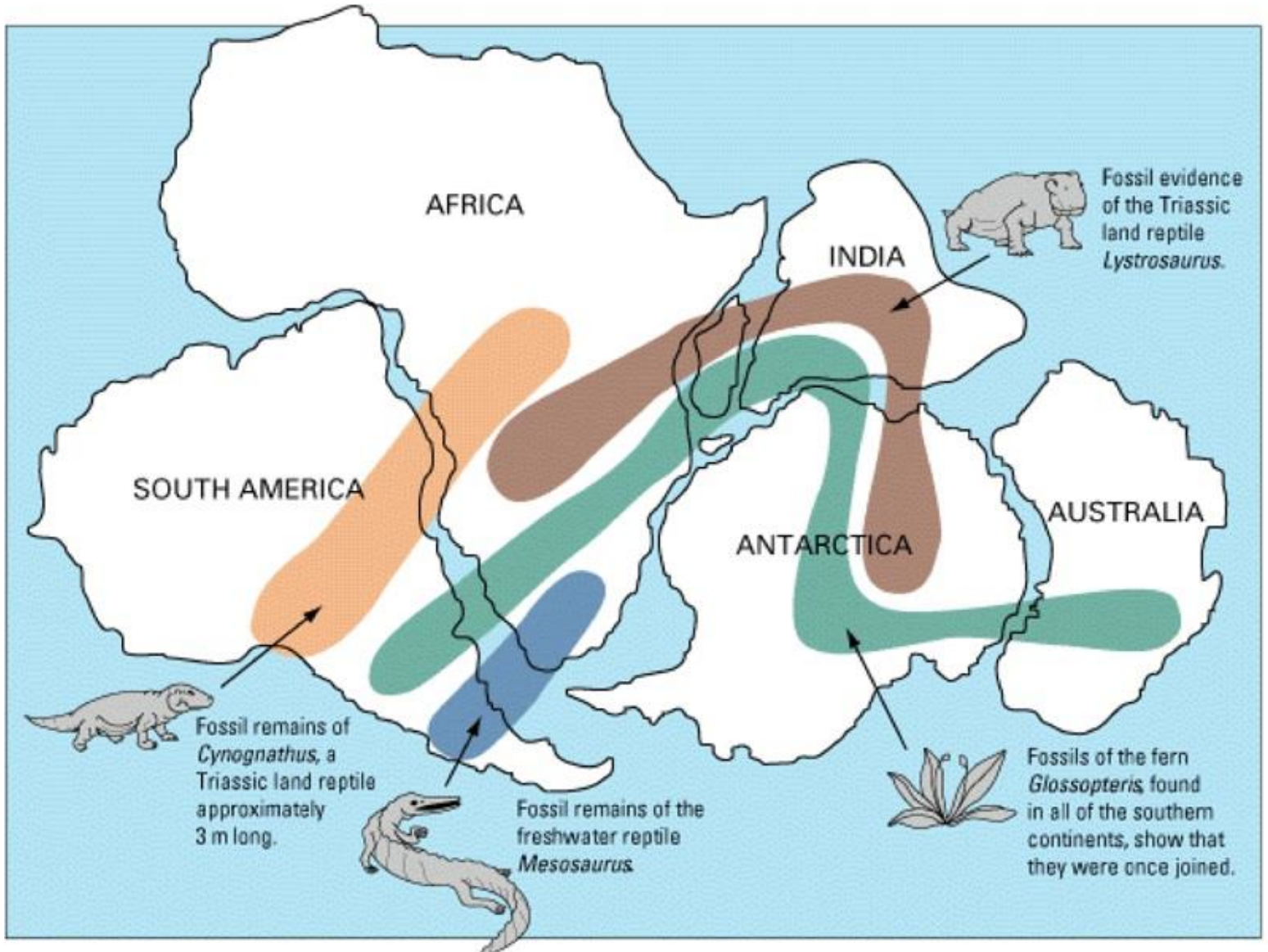
Continental Drift: Evidence

Tight fit of the continents, especially using continental shelves.



Continental Drift: Evidence

Fossil critters and plants



Continental Drift: Evidence

Correlation of mountains with nearly identical rocks and structures

Continental Drift: Evidence

Glacial features of the same age restore to a tight polar distribution.

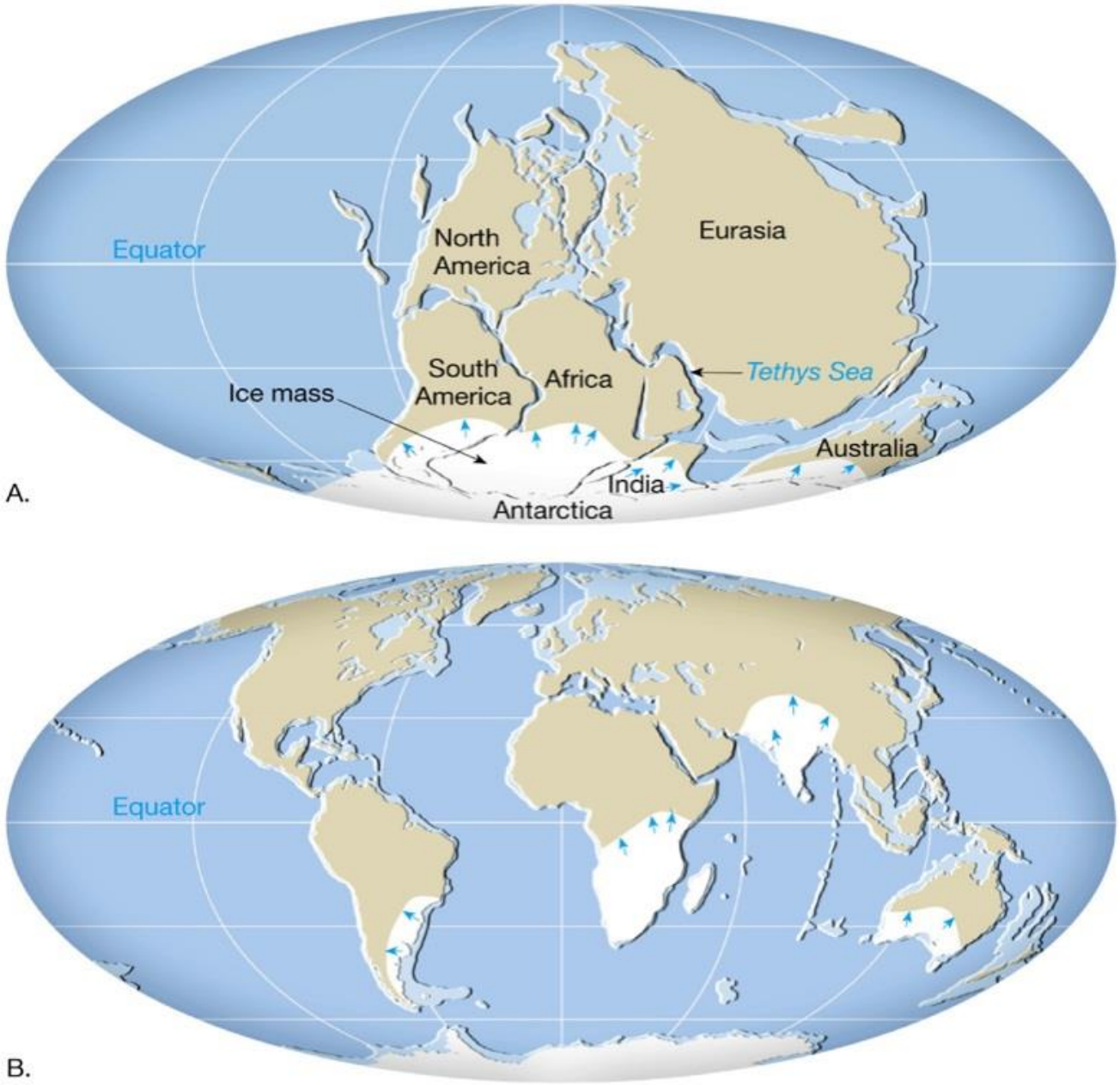
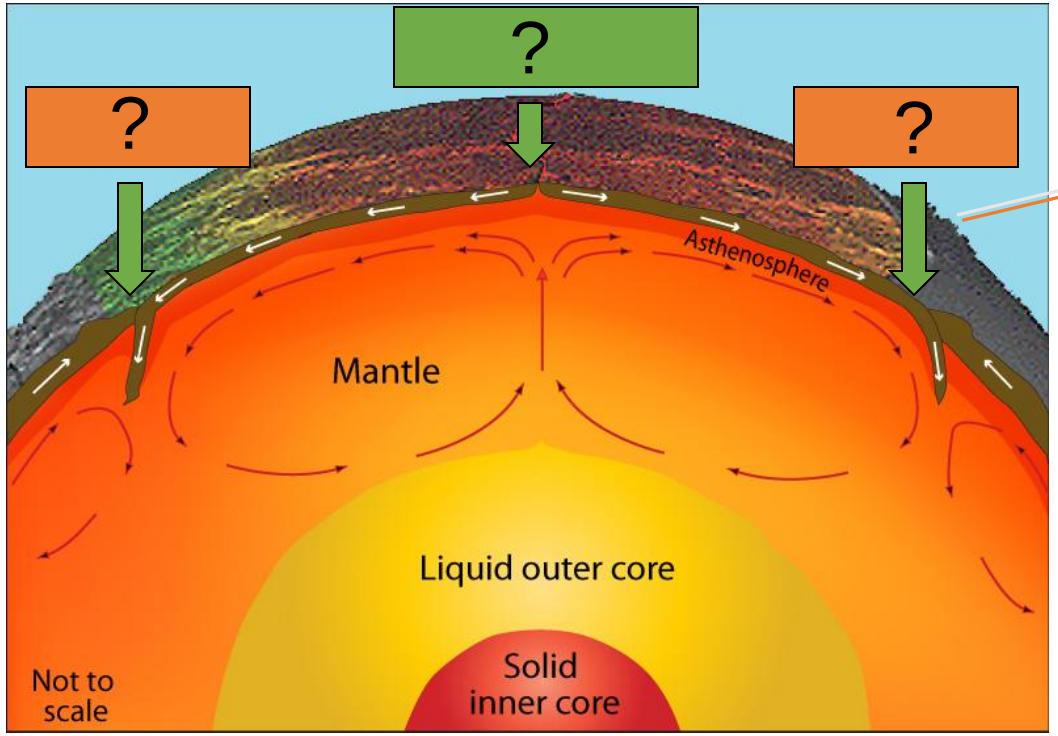


Plate tectonics

Plates are driven by cooling of Earth (convection)
Gravity provides additional force to move plates.



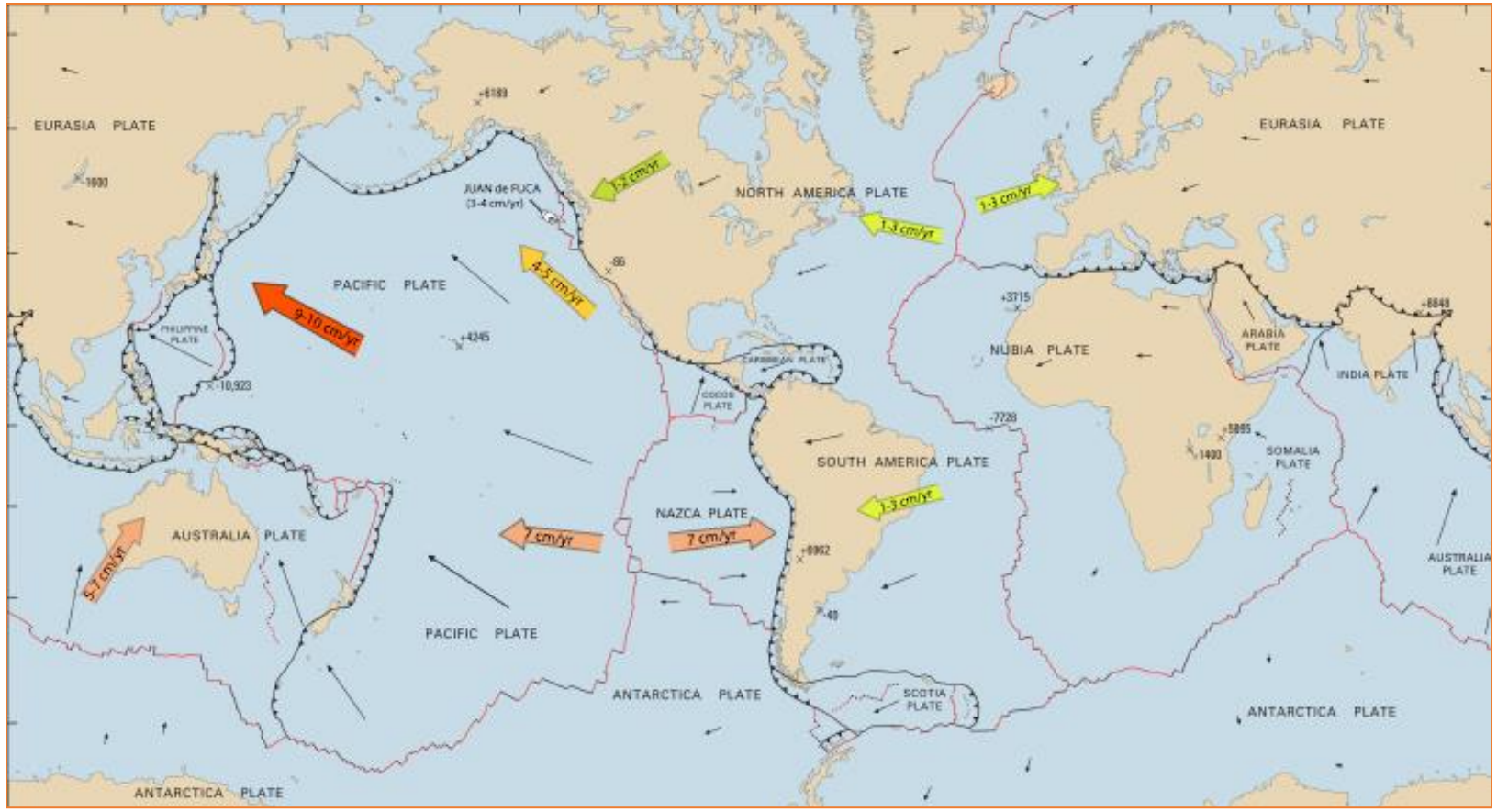
Modified from USGS Graphics

Convection is like a boiling pot. Heated soup rises to the surface, spreads and begins to cool, and then sinks back to the bottom of the pot where it is reheated and rises again.

Tectonic Plates

How fast are the plates moving?

Plates move 1-10 centimeters per year (≈ rate of fingernail growth).



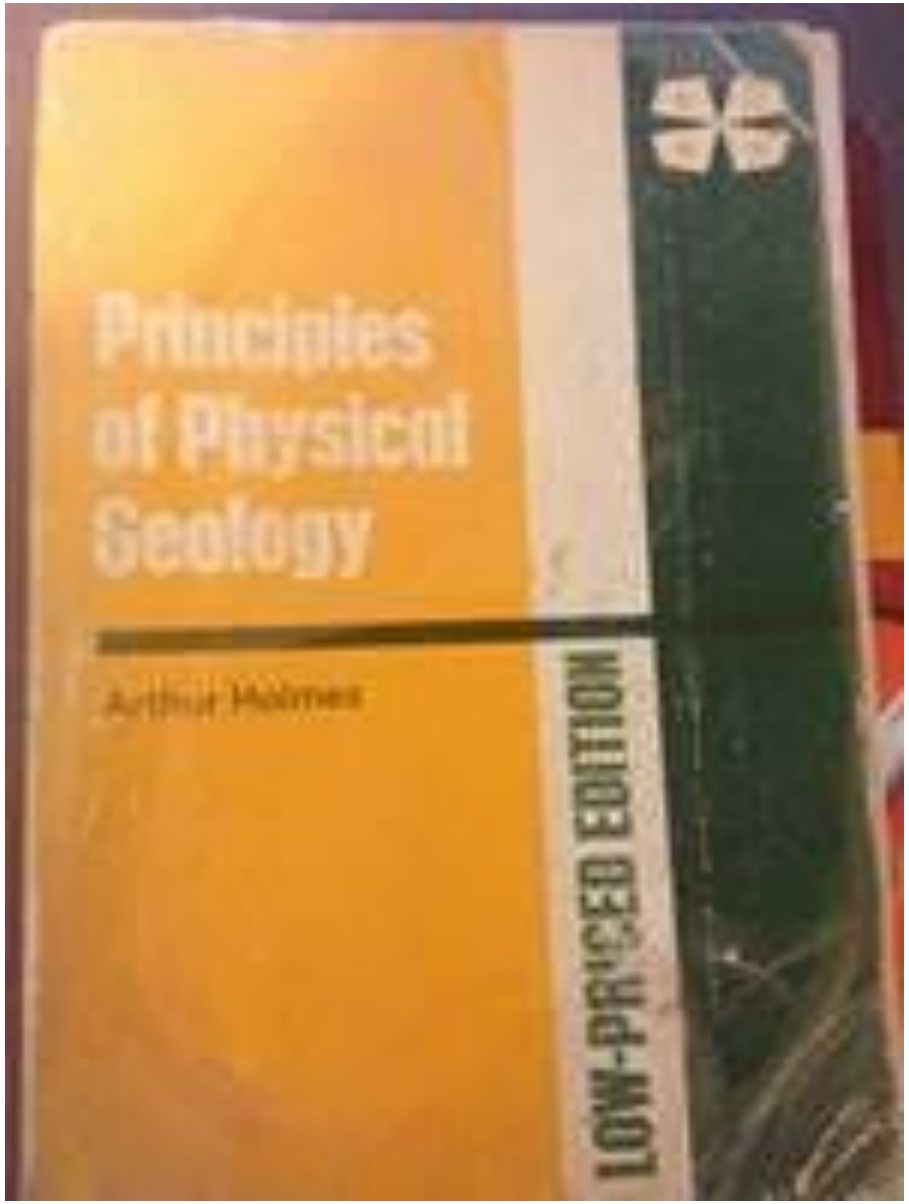
Fingernail growth plotted: http://jclahr.com/science/earth_science/thumbnail/index.html

Modified from USGS Graphics

Some things to explore based on your questions

- https://www.nationalgeographic.org/activity/mariana-trench-deepest-place-earth/
- https://www.youtube.com/watch?v=f4SlMxTRhPM
- https://www.asianagrihistory.org/pdf/volume17/dakargalam.pdf
- https://www.youtube.com/watch?v=OvjgSagxKlM
- https://www.theschoolrun.com/homework-help/rocks-and-soil
- http://www.geosocindia.org/
- https://www.goodreads.com/en/book/show/33407803-indica

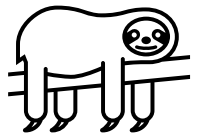
And OFCOURSE I am available at sreedhar@environicsindia.in



A COPY OF THIS BOOK IN A PUBLIC LIBRARY IN SECUNDERABAD PROVOKED AND INSPIRED ME TO BECOME A GEOLOGIST!

THOSE DAYS IN 1960's WE HAD TO PHYSICALLY GO AND FIND BOOKS IN THE LIBRARIES

TODAY I HAVE USED VARIOUS WEB SOURCES FOR THIS PRESENTATION AND THANKS TO THE AUTHORS FOR MAKING MY WORK EASY!



Thank You for Your Patience and Interest
Hope to see many Earth Scientists amongst you!