Deep Time

WELLS CATHEDRAL SCHOOL

Poster By: Alexandra Meek, Adele Potts, Phoebe Morton, Henry Ames-White and Alex Corum

Abstract

Deep Time, is a term first coined in the 18th century by the Scottish geologist James Hutton. He identified deposition, pressure & heat as the main process in the formation of sedimentary rocks and that new land surfaces were formed due to volcanism and other processes which were in turn eroded. Uniformitarianism rather than Catastrophism was seen to be a major force over long periods of geological time.
Various methods were used by scientists such as Comte De Buffon, Kelvin & Joly to identify the absolute age of the Earth, before radiometric dating in the 20th Century enabled a more accurate geochronology to be established and an age of 4.54 billion years to be accepted. Through uniformitarianism Geologists are time travellers in to the distant past, and also the future.

Early Pioneers

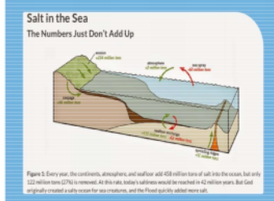
Aristotle was saw that fossil seashells from rocks were similar to those found on the beach and inferred that the fossils were once part of living animals. He reasoned that the positions of land and sea had changed over long periods of time's but alas his idea would not catch on.

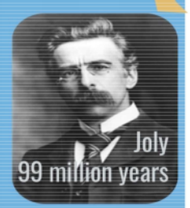
In the 17th century, 'Nicolas Steno' developed the idea that geological strata forming from deposition of sediments happens over a large timescale. He argued that rock strata are laid down in succession and formulated the law of superposition, which states that ' any given stratum is probably older than those above it and younger than those below it.'

Absolute Dating (Early Attempts)

Archbishop Ussher of Ireland counted back the dates and family relationships in the bible, Ussher calculated that the Earth was created at midnight on October 26, 4004 BC.

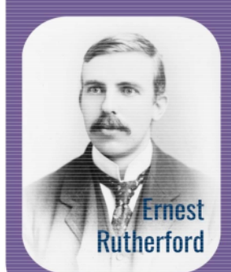
Both the Comte De Buffon and Lord Kelvin attempted to work out the rate of cooling of the Earth to determine it's age. However, both of their methods had flaws. De Buffon did his experiment representing the Earth as a steel ball, when in fact the Earth is more composed of silicates. This means the cooling time would be far longer than that of steel. Kelvin also made the mistake of presuming that the Earth started as molten material, which affected his calculations. In addition, neither scientist had an understanding of the heat produced by radioactive decay, so





In 1899 Joly read a paper titled ' An Estimate of the Geological Age of the Earth' to the Royal Dublin Society. This paper proposed that to calculate the age of the earth you just had to gauge the accumulation of sodium in the waters of the oceans. He calculated the rate at which the oceans should have accumulated sodium from erosion processes, and determined that the oceans were about 80 to 100 million years old. In 1903 he published an article in which he discussed the possibility of using radium to date the Earth and went on to study the radioactive content of the Earth's crust to formulate a theory of thermal cycles He examined the radioactive constituents of certain rocks as a means of calculating their age.

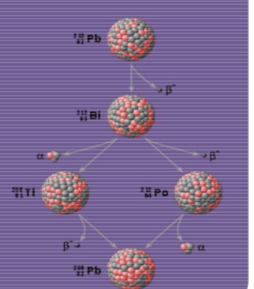
Absolute Dating (Radiometric)



Late in 1904, Rutherford took the first step toward radiometric dating, by suggesting that the alpha particles released by radioactive decay, could be trapped in a rocky material as helium atoms. Some radioactive materials have short half-lives; some have long half-lives. Uranium and thorium have long half-lives, and so persist in Earth's crust, but radioactive elements with short half-lives have generally disappeared. This suggested that it might be possible to measure the age of Earth by determining the relative proportions of radioactive materials in geological samples.

Holmes focused on lead dating, because he regarded the helium method as unpromising. He performed measurements on rock samples and concluded in 1911 that the oldest (a sample from Ceylon) was about 1.6 billion years old.These calculations were not particularly trustworthy. For example, he assumed that the samples had contained only uranium and no lead when they were formed.

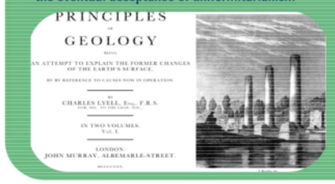
His work was generally ignored until the 1920s, Holmes's persistence finally began to pay off in 1921, when the speakers at the yearly meeting of the British Association for the Advancement of Science came to a rough consensus that Earth was a few billion years old, and that radiometric dating was credible. Holmes published The Age of the Earth, an Introduction to Geological Ideas in 1927 in which he presented a range of 1.6 to 3.0 billion years.

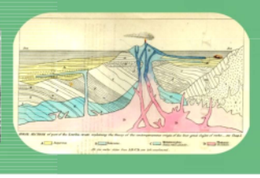


James Hutton and Charles Lyell

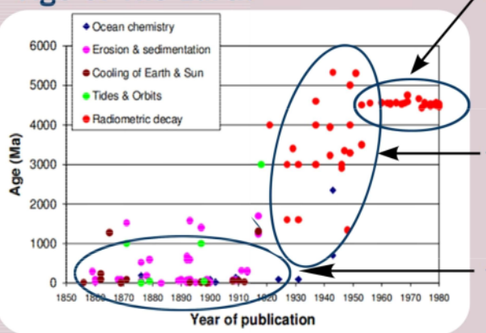
James Hutton was a Scottish geologist who originated the theory of uniformitarianism and consequently the concept of Deep time. He saw soil was washed into irrigation ditches to be later transported into the sea. He then made the connection that this soil must then be compacted over millions of years, and uplifted above sea level again and then eroded, in a full cycle. Hutton then built upon this observation, and began to question how long this rock cycle would take.

Lyell followed on from Hutton to develop and refine the theory of deep time as a key concept of uniformitarianism. Lyell agreed with Hutton that the earth was shaped entirely by slow-moving forces still in operation today, acting over a very long period of time. Once again, Lyell was another opposer to the theory of Catastrophism. Lyell's work resulted in the eventual acceptance of uniformitarianism





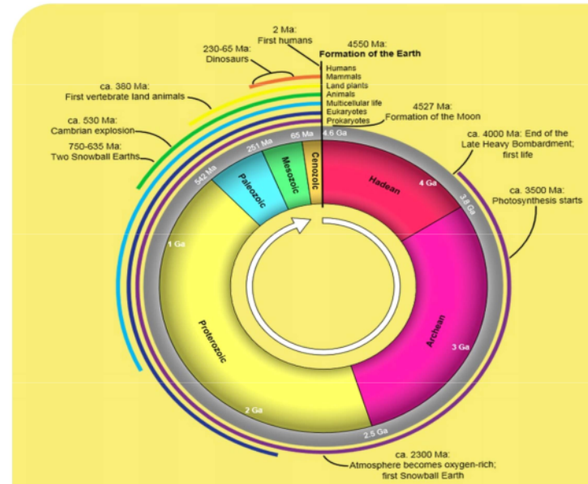
Age of The Earth



-Increasing consensus has been reached at 4.54 billion years incorporating advances in mass spectrometry,sampling and laser heating.

- In the early 20th Century radiometric techniques pushed the date to between1and 5 billion years.

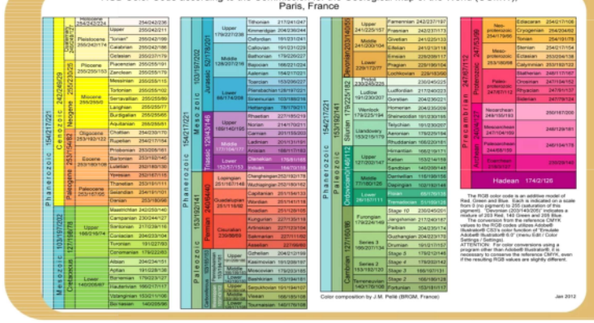
- Early attempts seriously underestimated the age of the Earth.



"Deep time" refers to the time scale of geologic events, which is vastly, almost unimaginably greater than the time scale of human lives and human plans.

Uniformitarianism: Changes in the Earth, such as the development of species or the deposition, have taken place slowly, without sudden and violent transitions.

Catastrophism: vast geological changes in earth's history were caused by catastrophes rather than gradual processes.



Geological Time scale

John Phillips introduced a statistical approach to palaeontology. He developed upon William Smith's ideas on using fossils to prove the correct stratigraphy of geological deposits. By doing this he identified and named the major geological eras Palaeozoic, Mesozoic, and Caenozoic, and demonstrated the mass extinctions between them.'

Phillips's ideas where then later adapted by Richard Owen in 1861, he showed the appearance of major animal types in rock ssrata to identify geological periods.

The model timescale created by the combined efforts of Phillips and Owen, while being relatively accurate, was still far from perfect. We would only have to wait until 1913 when Arthur Holmes published the first geologic time scale to included
absolute dates thanks to his understanding of radioactivity to get even closer to the timescale we know today.

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