



Lecture 4:

Evidence of evolution:
Principles of geology

Course 410

Molecular Evolution



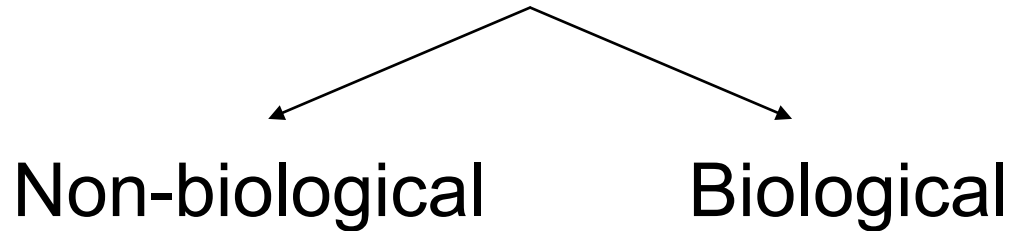
Now we need to review some evolution

What is evolution?

What is to evolve?

Evolution in general

Change through time



Is evolution a fact or a theory?

Evolution (biological and non-biological) is a fact that is explained by theories

Not buying it?

Evolution in general

Can you think of a theory that explains the evolution of:

- 1) Food and cuisine (ex. Machboos)
- 2) Cars (ex. Ferrari)**
- 3) Houses and cities (ex. skyscrapers)
- 4) Clothes and fashion (ex. Deshdasha)



1898



1905



1906



1940



1950



1962



1973



1991



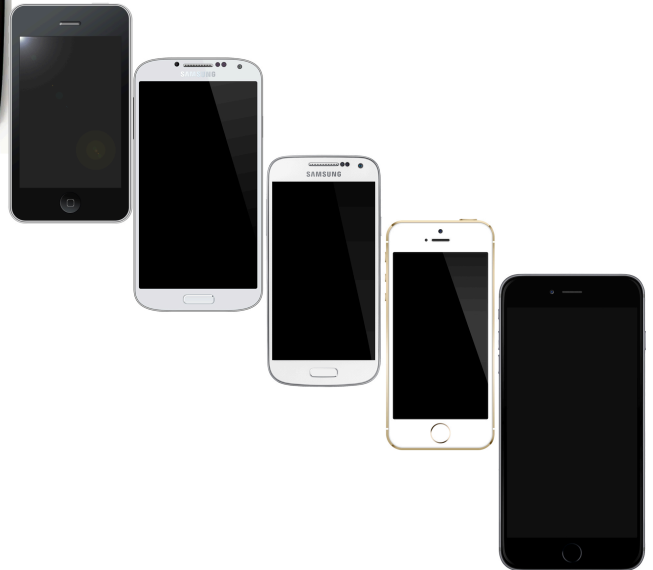
1998



2005



2008





What about biological evolution?

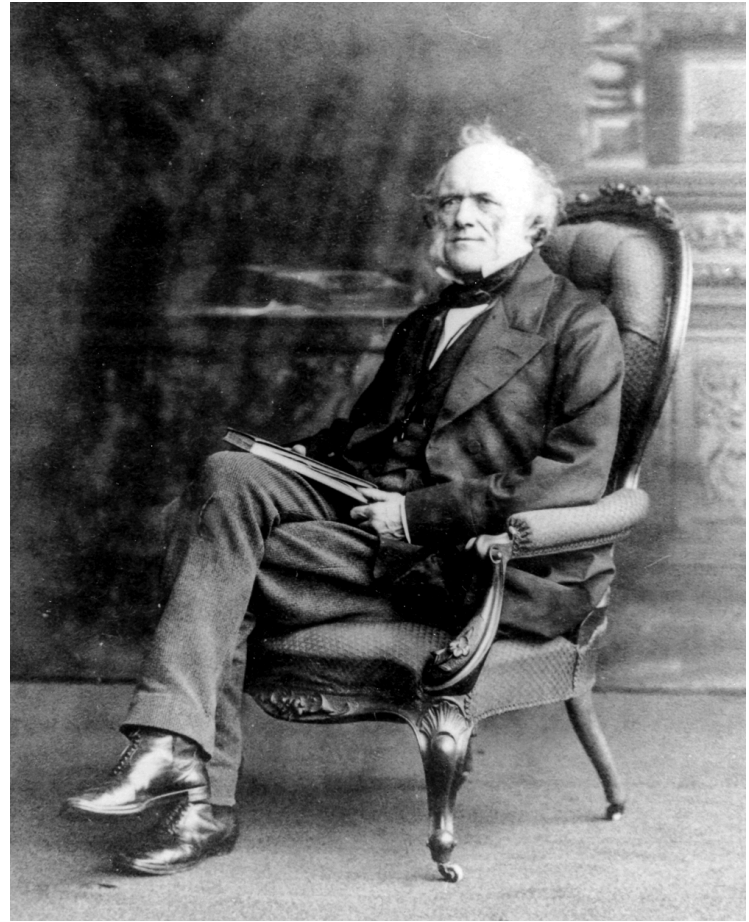
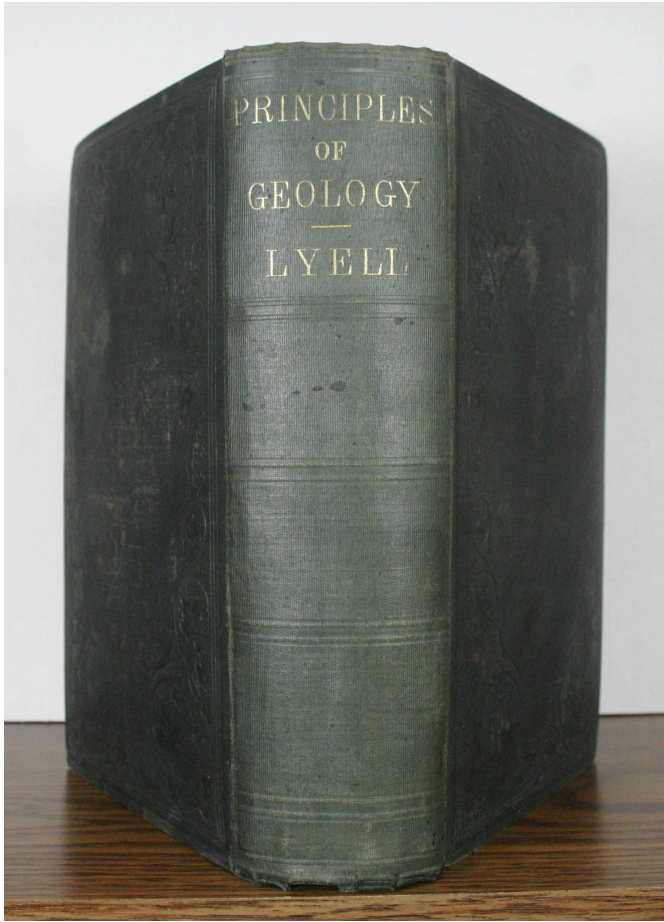
Need evidences?



Evidence of evolution

1. Changes of earth over time

Lessons from geology



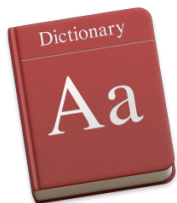
stratigraphy

stra·tig·ra·phy | strə'tigrəfē |

noun

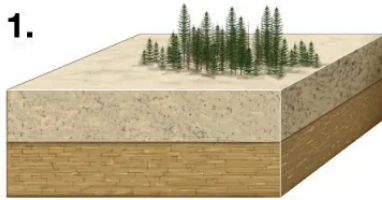
the branch of geology concerned with the order and relative position of strata and their relationship to the geological time scale.

- the analysis of the order and position of layers of archaeological remains.
- the structure of a particular set of strata: *you can find materials at the surface which are samples from the deeper stratigraphy.*



Steno's laws of stratigraphy

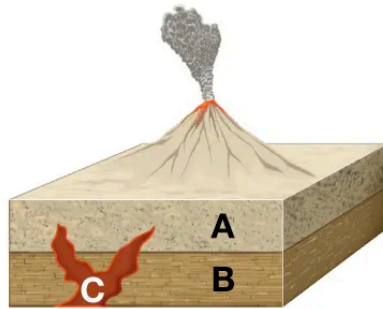
1.



Law of superposition

Younger layers of rock sit atop older layers.

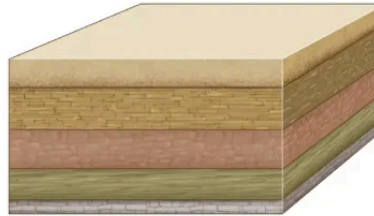
3.



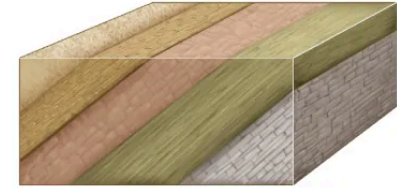
Law of cross-cutting relationships

Rock layers A and B must be older than the intrusion (C) that disturbs them. (Principle later reinforced by James Hutton.)

2.



A. Original orientation

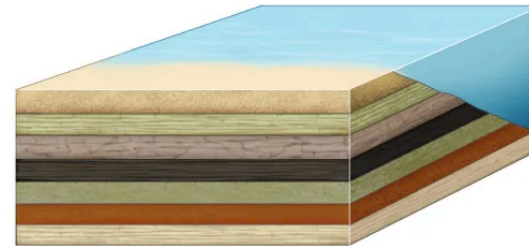


B. Orientation after tilting (folding)

Law of original horizontality

Layers of sedimentary rock are originally deposited flat.

4.



Law of lateral continuity

Layers of rock are continuous until they encounter other solid bodies that block their deposition or until they are acted upon by agents that appeared after deposition took place.

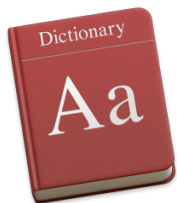
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plate tectonics

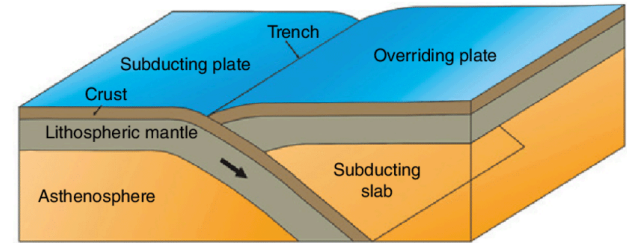
plate tec·ton·ics | ,plāt ,tek'täniks |

plural noun [*treated as singular*]

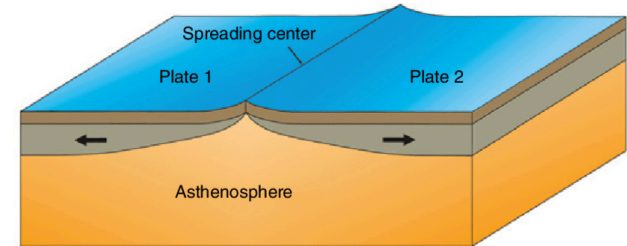
a theory explaining the structure of the earth's crust and many associated phenomena as resulting from the interaction of rigid lithospheric plates which move slowly over the underlying mantle.



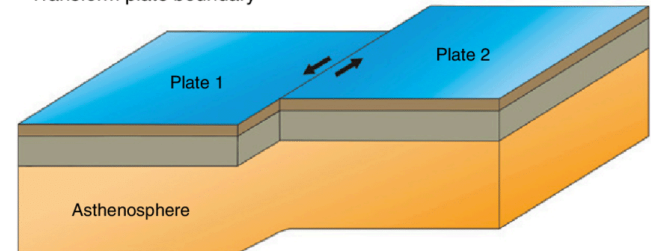
Convergent plate boundary: subduction zone



Divergent plate boundary



Transform plate boundary



Uniformitarianism

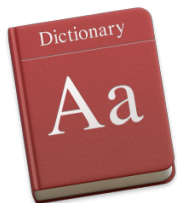


u·ni·form·i·tar·i·an·ism

| ,yōōnə,fōrmə'terēə,nizəm |

noun *Geology*

the theory that changes in the earth's crust during geological history have resulted from the action of continuous and uniform processes. Often contrasted with *noun catastrophism*.



Gradualism



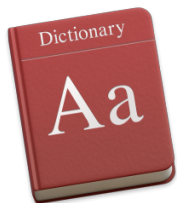
grad·u·al·ism

| 'graj(ə)wə,liz(ə)m, 'grajə,liz(ə)m |

noun

a policy of gradual reform rather than sudden change or revolution.

- *Biology* the hypothesis that evolution proceeds chiefly by the accumulation of gradual changes (in contrast to the punctuationist model).



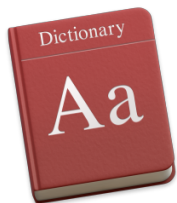
Catastrophism



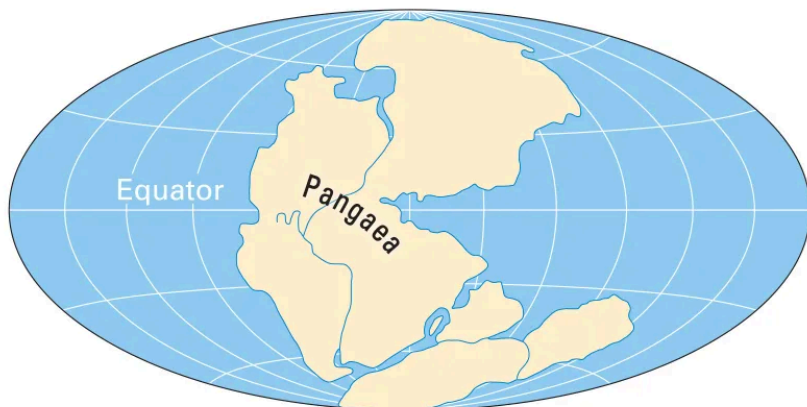
ca·tas·tro·phism | kə'tastrə,fiz(ə)m |

noun *Geology*

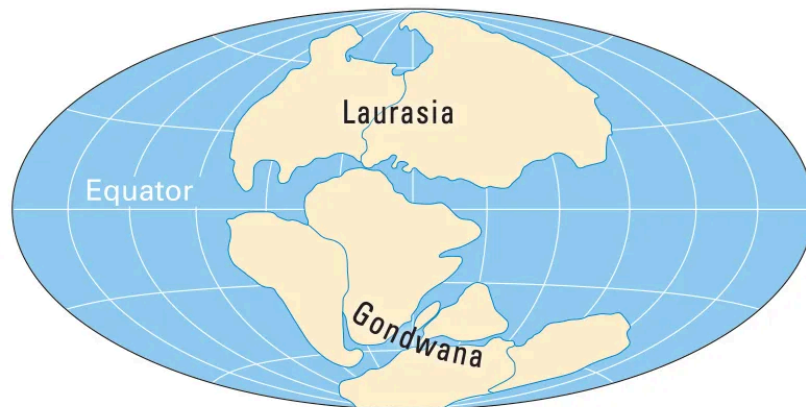
the theory that changes in the earth's crust during geological history have resulted chiefly from sudden violent and unusual events. Often contrasted with [uniformitarianism](#).



Continental drift



225 Million Years Ago



150 Million Years Ago

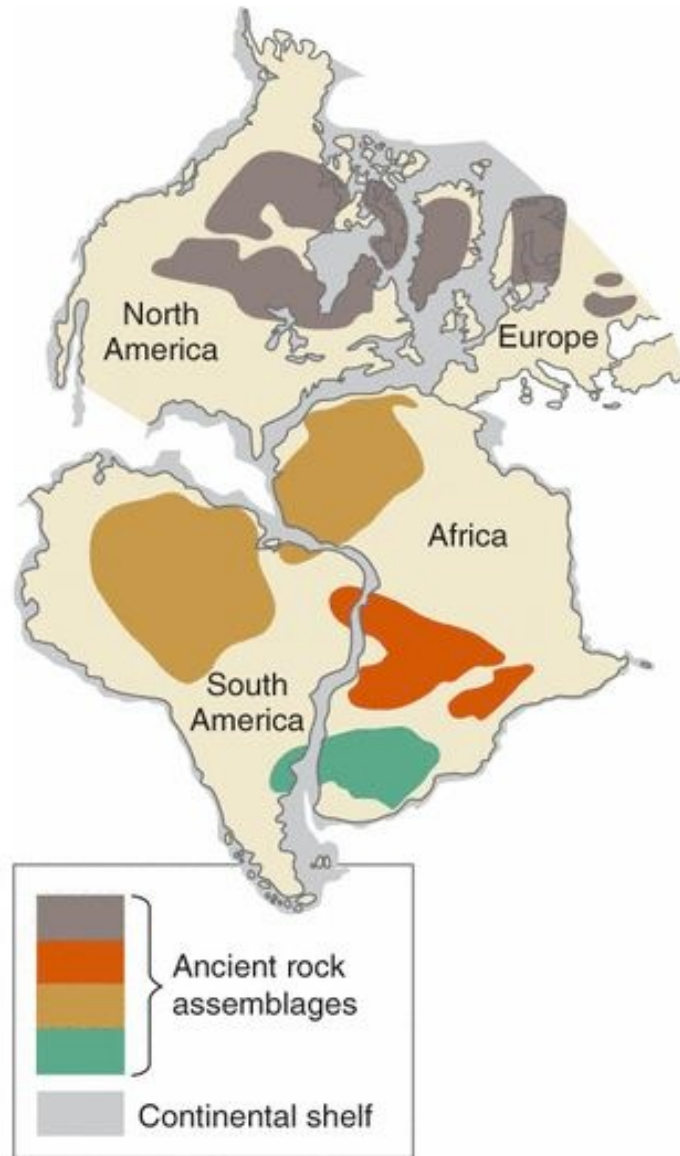


100 Million Years Ago

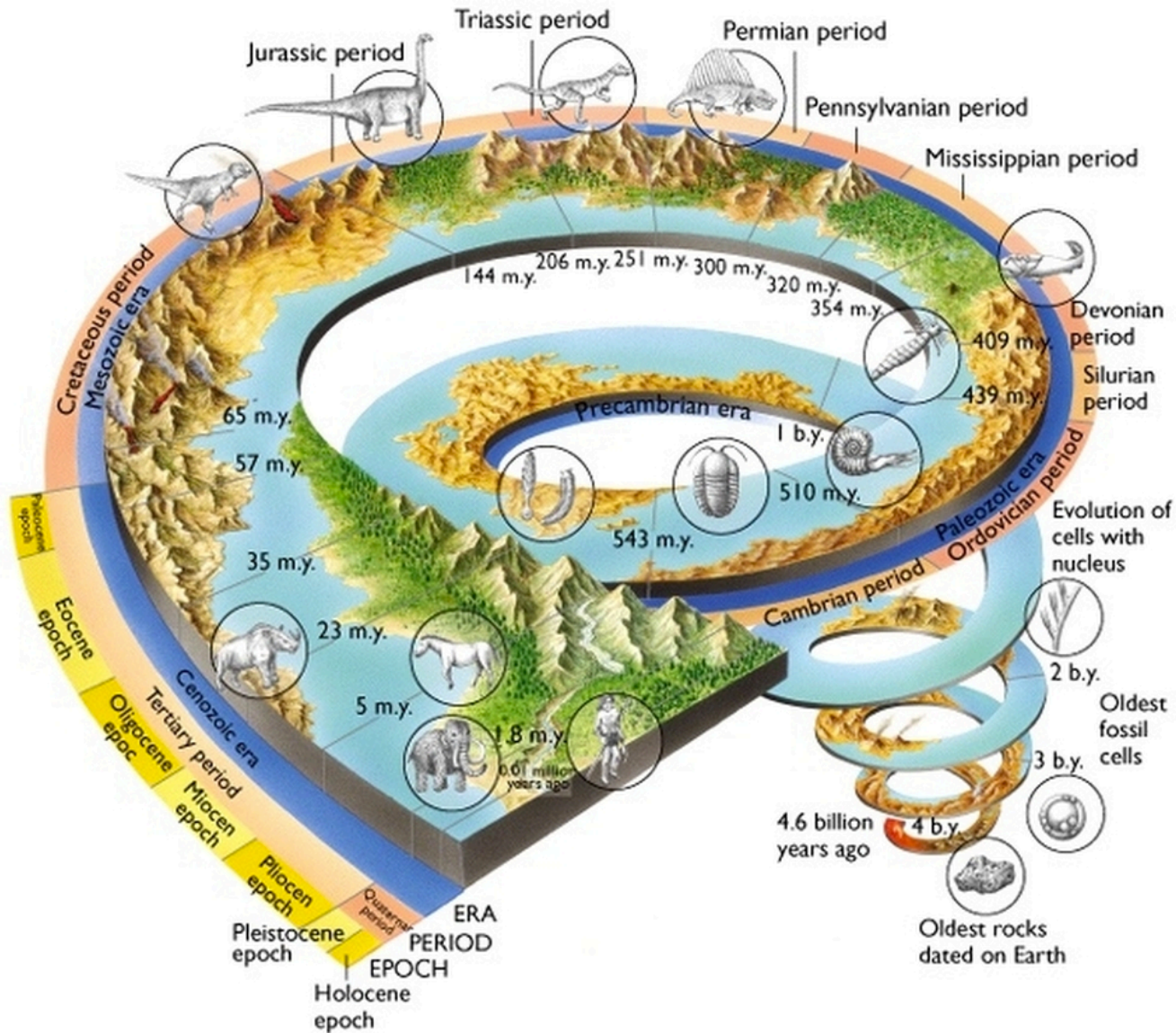


Earth Today

Continental drift



Geologic time scale



Age of earth

Evo Edu Outreach (2010) 3:198–205

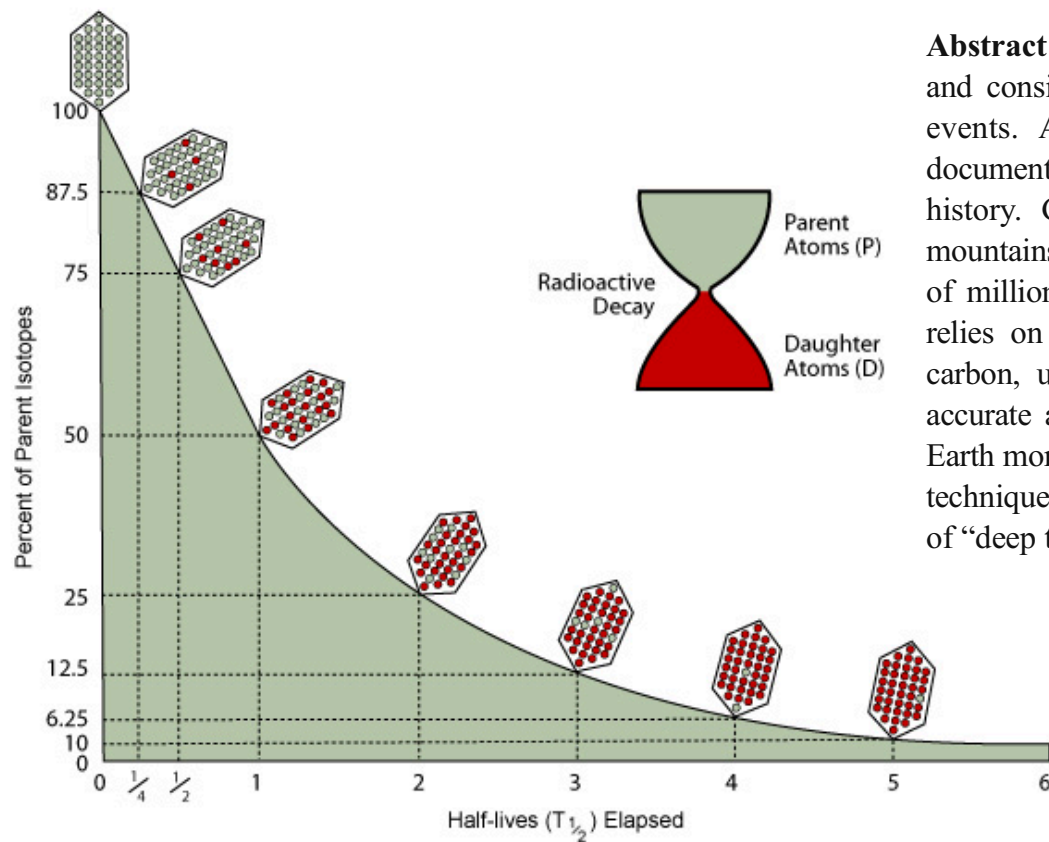
DOI 10.1007/s12052-010-0226-0

CURRICULUM ARTICLE

How Old is Earth, and How Do We Know?

Robert M. Hazen

Abstract Earth scientists have devised many complementary and consistent techniques to estimate the ages of geologic events. Annually deposited layers of sediments or ice document hundreds of thousands of years of continuous Earth history. Gradual rates of mountain building, erosion of mountains, and the motions of tectonic plates imply hundreds of millions of years of change. Radiometric dating, which relies on the predictable decay of radioactive isotopes of carbon, uranium, potassium, and other elements, provides accurate age estimates for events back to the formation of Earth more than 4.5 billion years ago. These and other dating techniques are mutually consistent and underscore the reality of “deep time” in Earth history.



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