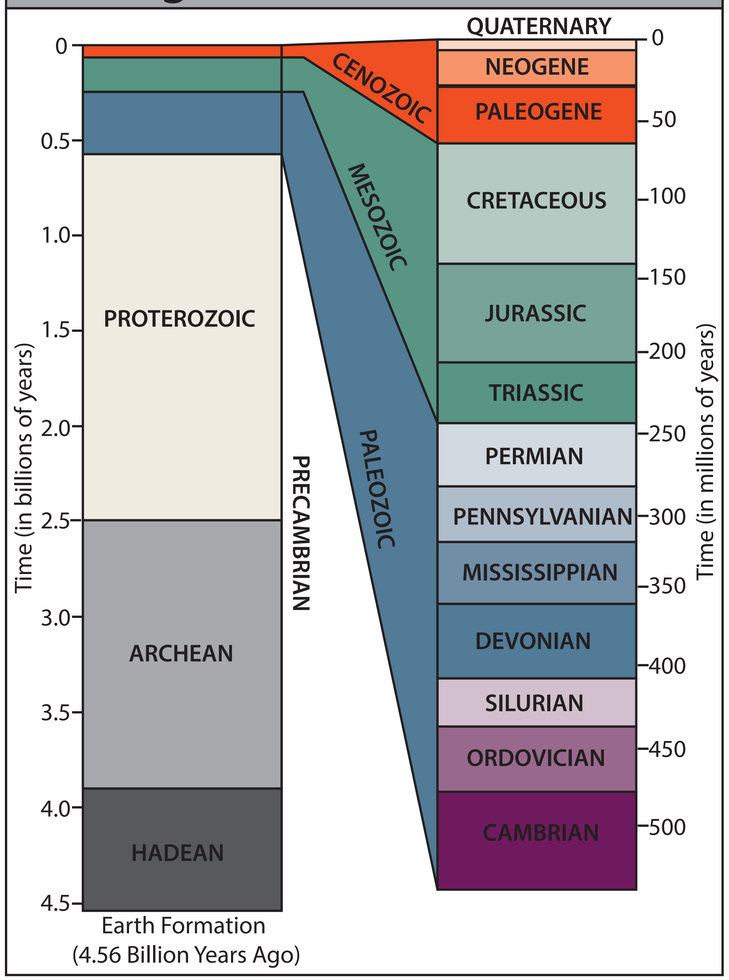
Telling Geologic Time

Darwin Day Tennessee 2016
M.A. Henderson, PhD Student, Earth and Planetary Sciences

Geologic Timescale

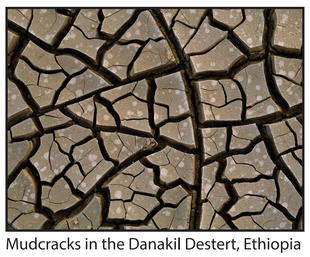


Earth Formation
(4.56 Billion Years Ago)

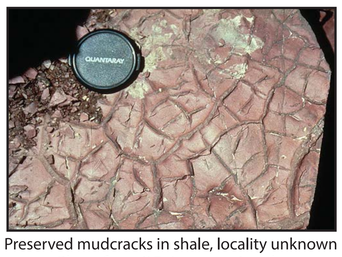
Uniformitarianism

Principle of Uniformitarianism - James Hutton (1785)
States that the physical processes we observe happening today also operated in the past. Thus the processes that we observe in modern envinronments are responsible for the formation of geologic features we observe in rock outcrops.

Simply put "The present is the key to the past".



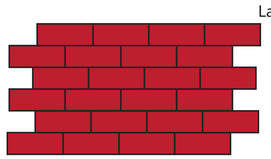
Mudcracks in the Danakil Destert, Ethiopia
Photo by Carsten Peter from National Geographic



Preserved mudcracks in shale, locality unknown
Photo from C.E. Jones at pitt.edu

Relative vs. Numerical Ages

Relative age - the age of a feature with respect to another



Brick wall

The first layer of bricks was deposited first and is therefore the oldest layer. The consequetive layers of brick were laid after the first and are thus younger than the previous layers.

Numerical age - the age of a feature given in years; often a radiometric age of radioactive trace elements in a mineral

Minerals like zircon ($ZrSiO_4$) contains impurities of radioactive isotopes such as uranium (U), which has two radioactive isotopes ^{238}U and ^{235}U. These isotopes decay to lead (Pb) over millions to billions of years.

Zircon

^{238}U → Radioactive decay → ^{206}Pb

Parent isotope — Daughter isotope

Superposition

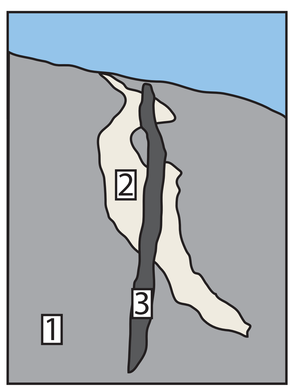
Principle of Superposition - Steno's Law
States that in a sequence of sedimentary rock layers, each layer is younger than the one below, since sediment can't accumulate unless there is already a layer on which it can collect.

Simply put "the layer at the bottom is the oldest and the layer at the top is the youngest".

Cross Cutting Relationships

Principle of Cross Cutting Relationships - Charles Lyell (1830)
States that a geologic feature that cuts across another feature is the younger of the two features.

Simply put "younger features cross older features".

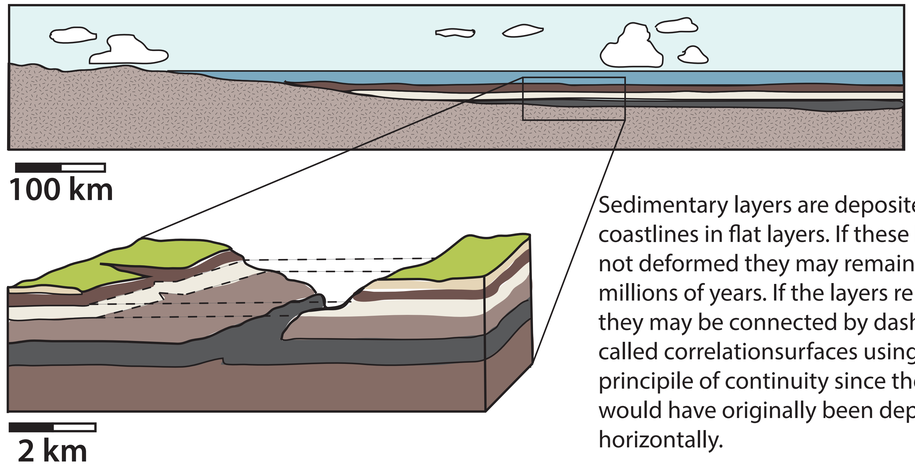


Light-gray igneous intrusion (1) in Sweden cut by younger white pegmatite dike (2).
The white dike is cut by an even younger black diabase dike (3).

Original Horizontality and Continuity

Principle of Original Horizontality - Nicholas Steno (17th century)
States that layers of sediment are deposited horizontally under the action of gravity.

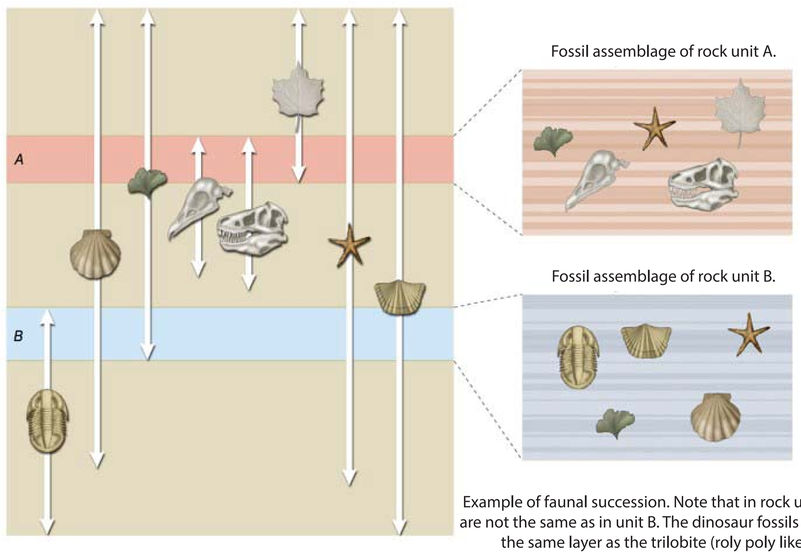
Principle of Continuity - Nicholas Steno (17th century)
States that layers of sediment extend laterally in all directions. This allows rocks layers separated by valleys or erosional features to be connected.



Sedimentary layers are deposited along coastlines in flat layers. If these layers are not deformed they may remain flat for millions of years. If the layers remain flat, they may be connected by dashed lines called correlationsurfaces using the principile of continuity since these layers would have originally been deposited horizontally.

Faunal Succession

Principle of Faunal Succession -
States that some fossils are only found in specific intervals, and not above or below that interval. If a fossil species does not apper above a layer in a stratigraphic sequence, then the layer with the fossil represents the last time before the species went extinct.



Example of faunal succession. Note that in rock unit A, the fossils are not the same as in unit B. The dinosaur fossils are not found in the same layer as the trilobite (roly poly like creature).

Image adapted from http://peterdoumit.webs.com/evolution.htm.