GLY 102

Introduction to Geology II

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Dr. Atunima E. Jonathan

and

Dr. James A. Adeoye

Department of Geosciences

aejonathan@mtu.edu.ng

jaadeoye@mtu.edu.ng

Course Description

This Course makes use of the principles and techniques of geology to reconstruct and understand the geological history of Earth. It focuses on evolution of organism , their distribution, classification, occurrence and uses as fossil for relative dating of rocks.

The course also explains the use of stratigraphy, structural geology and paleontology to tell the sequence of rock formation and the timing of other events observed on rocks during different time periods in the geological timescale. Account of historical geologists will also be thought.

Learning Objectives

By the end of this Course and after answering tutorial questions and assignments, students should be able to understand:

•The historical development of the field of geology

•The development of the basic geologic principles employed by historical geologists.

•The evolution of the geologic time scale

•The history of the Earth from its inception to the present

Course Contents

WEEK	TOPIC
1	Theory of Evolution of Organism
2	Theory of Evolution of Organism
3	Distribution and Classification of Major Fossil Groups
4	Distribution and Classification of Major Fossil Groups
5	Uses of Fossil
6	Principles of Historical Geology -Earth's History
7	Global Dating of the Rock Record
8	First Continuous Assessment
9	Global Dating of the Rock Record
10	Unconformity
11	The Founders of Historical Geology
12	Second Continuous Assessment
13	Rock Cycle
14	The water Cycle
15	Revision
16	Examination
17	Examination

Additional Textbooks

- Understanding Earth Sixth Edition Edition by John Grotzinger (Author), Thomas H. Jordan
- Principles of Geology: (Classic Reprint) Paperback – June 15, 2012 by Charles Lyell.
- System History - Text 3RD EDITION by Steven M. Stanley. W.H. Freeman, 2009

Global Dating of the Rock Record

Geologic Time

- Human perspective

  seconds, hours, days, years

- Ancient human history

  hundreds or even thousands of years

- Geologic history

  millions, hundreds of millions, billions of years

Global Dating of the Rock Record

Geologic Time Scale

- **resulted from the work of many 19th century geologists who**
  - ✓ pieced together information from numerous rock exposures
  - ✓ constructed a sequential chronology based on changes in Earth's biota through time

- **the time scale was subsequently dated in years**
  - ✓ using radiometric dating techniques

Global Dating of the Rock Record

Geologic Time Scale

By examining layers of sedimentary rock, geologists developed a time scale for dividing up earth history. The Earlier in the 20th century, radiometric-dating techniques allowed scientists to put absolute dates on divisions in the geologic time scale.

In this segment, we will learn how geologists:

- ❖determine the relative ages of rock units,
- ❖determine the divisions of the geologic time scale, and
- ❖how radiometric techniques can be used to date some rocks.

Global Dating of the Rock Record

How do geologists determine how old rocks are?

1. ***Relative dating*** -- determine whether the rock is older or younger than other rocks

Relative - know order of events but not dates

- Napoleonic wars happened before W.W.II
- Bedrock in Scotland formed before the glaciers came

2. ***Absolute dating*** -- use radiometric dating techniques to determine how long ago the rock formed in the exact number of years

*Not all rocks can be dated absolutely, so combinations of techniques are used.

Absolute - know dates

- Civil War 1803-1815
- World War II 1939-1945
- Glaciers finally left Scotland About 11,000 Years Ago

Global Dating of the Rock Record

Absolute Dating

Radiometric dating techniques use naturally-occurring radioactive isotopes.

Isotope -- form of an element that has additional neutrons

Radioisotope -- isotope that spontaneously decays, giving off radiation

Rate of radioactive decay

Radioisotopes decay at a constant rate.

Rate of decay is measured by half-life

Half-life -- time it takes for one-half of the radioactive material to decay.

Global Dating of the Rock Record

Absolute Dating

Decay products

- Radioisotopes may decay to form a different isotope or a stable isotope.
- May be a series of radioactive decays before a stable isotope is formed.
- Stable isotope is called the "**daughter**" formed from decay of radioactive "**parent**"

Radiometric Age Dating

- Radioisotopes are trapped in minerals when they crystallize.
- Radioisotopes decay through time, and stable isotopes are formed.
- Determining the **ratio** of parent isotope to daughter product reveals the number of half-lives that has elapsed.

Common isotopes used in age dating

- U-Pb -- half-life of U-238 is 4.5 b.y.
- K-Ar -- half-life of K-40 is 1.3 b.y.
- Rb-Sr -- half-life of Rb-87 is 47 b.y.
- Carbon 14 -- half-life of C-14 is 5730 yrs

Global Dating of the Rock Record

Absolute Dating Example

By using the appropriate radioactive isotope (knowing its half-life time), and measuring the quantity of the isotope present in the rock, one can deduce how long it has taken to decay down to the present amount in the rock.

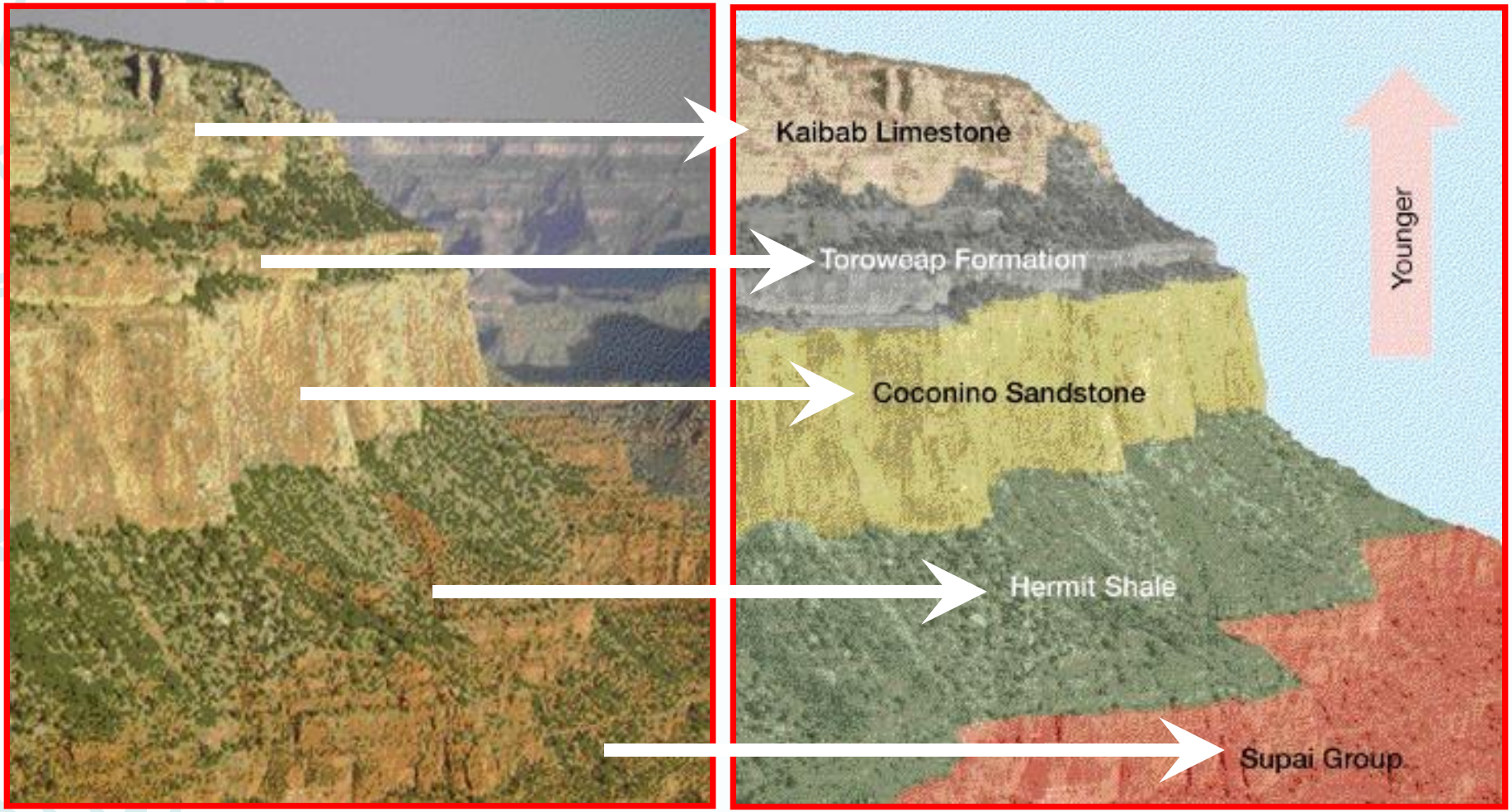
Example: A rock has 0.5 (one-half) of the original carbon 14 material in it. One can deduce that knowing the half-life of carbon 14 is 5730 years, the rock must have decayed (lost) 50% of its original carbon 14 material and is now 5730 years old.

In a period of 5730 years from now, the rock will contain 0.25 (25%) of its original carbon 14 material.

Theoretically, there will always be some trace of carbon 14 present in the rock…it will <u>never</u> decay totally.

Global Dating of the Rock Record

Example of Relative Age Dating and Correlation



Global Dating of the Rock Record

Geologic Time Scale

❖The Geological time scale is a record of the life forms and geological events in Earth's history.

❖ Scientists developed the time scale by studying rock layers and fossils worldwide

❖ Radioactive dating helped determine the absolute divisions in the time scale

❖Geologic Time Scale was developed in 1800s from relative dating of rocks .

❖Many of the names in geolocic time scale relate back to their localities e. g in England (Ex: Devonian from Devonshire)

Global Dating of the Rock Record

Geologic Time Scale

Divisions of Geologic Time Scale:

Eons

Precambrian -- Phanerozoic

Eras:

Paleozoic -- Mesozoic -- Cenozoic

Oldest ----------> Youngest

Periods

e.g of the Phanerozoic: Paleozoic - Era

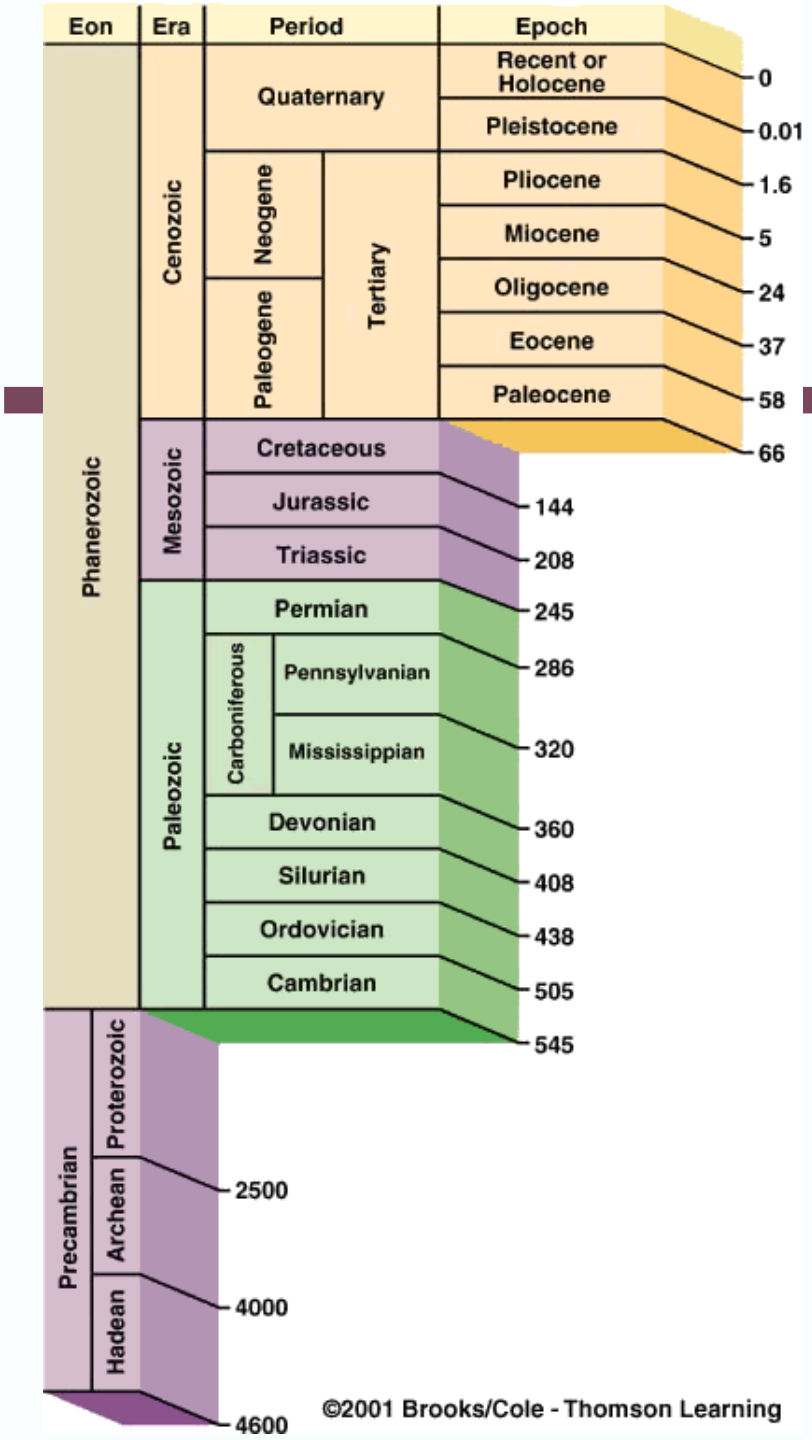
Permian (youngest)

Pennsylvanian together with Mississippian are called "Carboniferous" in Great Britain

Epochs

e.g of Tertiary and Quaternary

Paleocene→Eocene→Oligocene→Miocene →Pliocene→Pleistocene



FOUR Eras…

- **PRE-CAMBRIAN** – 88% of earth's history
- **Paleozoic (ancient life)**
  - 544 million years ago…lasted 300 million yrs
- **Mesozoic (middle life)**
  - 245 million years ago…lasted 180 million yrs
- **Cenozoic (recent life)**
  - 65 million years ago…continues through present day

Today…

- Today we are in the Holocene **Epoch** of the Quaternary **Period** of the Cenozoic **Era**.

Which unit is the largest?

Which unit is the smallest?

Global Dating of the Rock Record

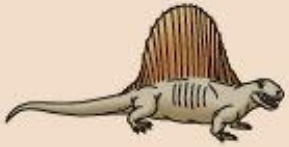
Geologic Time Scale

Quaternary	Latin, “fourth”	1822
Tertiary	Latin, “third”	1760
Cretaceous	Latin *creta*, “chalk”	1822
Jurassic	Jura Mountains, Switzerland	1795
Triassic	Latin, “three-fold”	1834
Permian	Perm, Russia	1841
Carboniferous	Carbon-bearing	1822
Devonian	Devonshire, England	1840
Silurian	*Silures*, a pre-Roman tribe	1835
Ordovician	*Ordovices*, a pre-Roman tribe	1879
Cambrian	Latin *Cambria*, “Wales”	1835

Global Dating of the Rock Record

Geologic Time Scale

TABLE 1.2 Some Important Ages in the Development of Life on Earth

Millions of Years before Present	Noteworthy Life		Eras	Periods
5	Earliest hominids		Cenozoic	Quaternary *Neogene *Paleogene
66	First important mammals			
	Extinction of dinosaurs			
	First dinosaurs		Mesozoic	Cretaceous Jurassic Triassic
252				
300	First reptiles		Paleozoic	Permian Pennsylvanian Mississippian Devonian Silurian Ordovician Cambrian
400	Fishes become abundant			
541	First abundant fossils			
600	Some complex, soft-bodied life		Precambrian**	(The Precambrian accounts for the vast majority of geologic time.)
3,500	Earliest single-celled fossils			
4,550	Origin of the Earth			

*Note, in 2009 the International Commission on Stratigraphy replaced the Tertiary Period with the Paleogene and Neogene Periods.
**The Precambrian is not an era; it is a long span of time that predates the Paleozoic era.

Global Dating of the Rock Record

Geologic Time Scale

GEOLOGIC TIME in PERSPECTIVE

Appearance of first Hominids	**3-4,000,000 yBP**
Demise of the Dinosaurs	**65,000,000 yBP**
First Land Plants	**483,000,000 yBP**
First Fish	**505,000,000 yBP**
First Shelled Invertebrates	**570,000,000 yBP**
First Appearance of Life	**3,770,000,000 yBP**
Oldest Known Earth Rocks	**3,960,000,000 yBP**
Age of the Earth	**4,600,000,000 yBP**

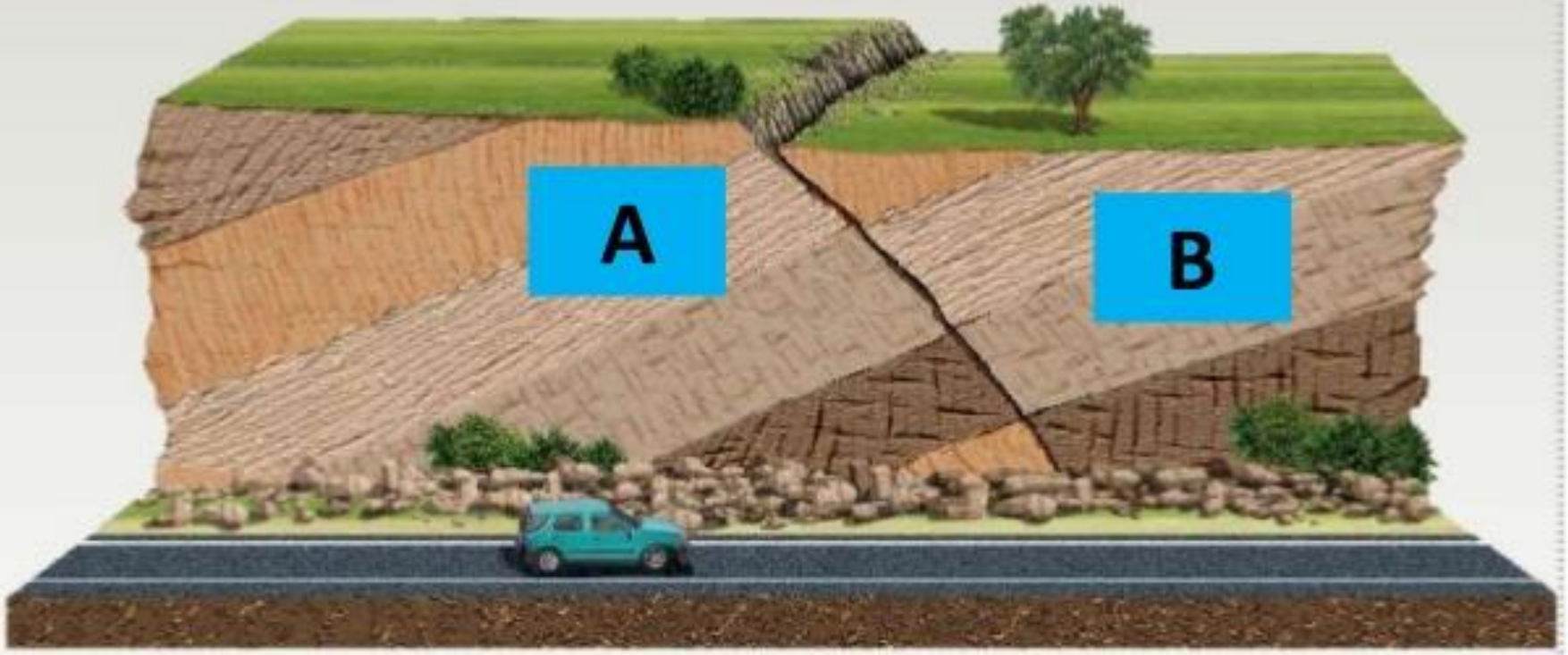
Global Dating of the Rock Record

Geologic Time Scale

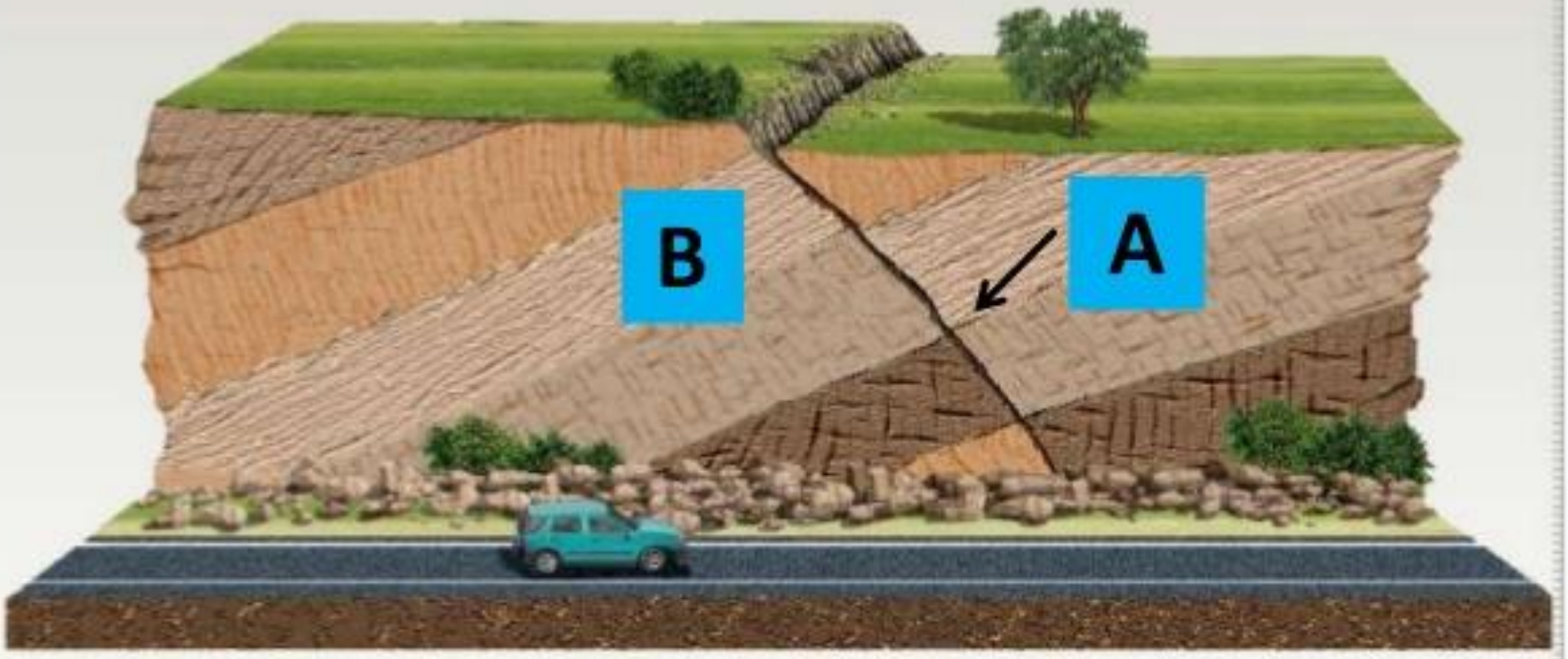
GEOLOGIC TIME in PERSPECTIVE

Appearance of first Hominids	4 mm
Demise of the Dinosaurs	65 mm
First Land Plants	483 mm
First Fish	505 mm
First Shelled Invertebrates	570 mm
First Appearance of Life	3,770 mm
Oldest Known Earth Rocks	3,960 mm
Age of the Earth	4,600 mm

1. Which of these two strata is the oldest?



2. Which is more recent, fault A or stratum B?



3. Which is the oldest strata? A, B or C?