

## Summary

- Strata provide a basis for reconstructing Earth history and past surface environments.
- Most strata were horizontal when deposited (law of original horizontality), and all strata accumulated in sequence from bottom to top (principle of stratigraphic superposition).
- Stratigraphic superposition concerns relative time. The relative ages of two strata can be fixed according to whether one of the layers lies above or below the other.
- Unconformities are physical breaks in a stratigraphic sequence marking a period of time when sedimentation ceased and erosion removed some of the previously laid strata.
- Angular unconformity results when rocks are disturbed by tectonic activity prior to deposition of overlying strata.

- A formation is a fundamental rock unit for field mapping distinguished on the basis of its distinctive physical characteristics and usually named for a geographic locality.
- Systems are rock sequences and are the primary time-stratigraphic units used to construct the geologic column.
- Geologic time units are based on time-stratigraphic units and represent the time intervals during which the corresponding systems accumulated.
- Correlation of strata from place to place is based on physical and biological criteria that permit demonstration of time equivalence. Reliability of correlation is greatest if several criteria are used.
- The geologic column is a composite section of all known strata, arranged on the basis of their contained fossils or other age criteria.
- The geologic time scale is a hierarchy of time units established on the basis of corresponding time-stratigraphic units. Systems (time-stratigraphic units) and periods (geologic-time units) are based on type sections or type areas in Europe and North America.

- The geologic time scale constitutes the global standard to which geologists correlate local sequences of strata.

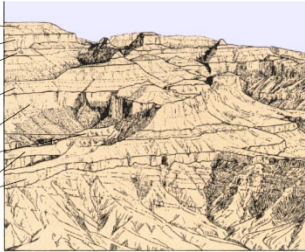
## Stratigraphy

- Progression of Geologic Events
  - Deposition
  - Erosion
- Correlation of Rock Units
  - Sequences
  - Unconformities
- Relative vs Absolute Age



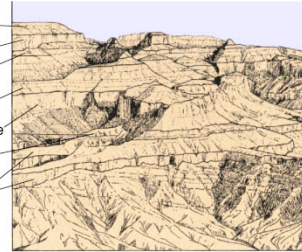
B

Kaibab-Toroweap  
Limestone  
Coconino  
Sandstone  
Hermit Shale  
Supai Sandstone  
Redwall Limestone  
Muav Limestone  
Brighter Angel Shale  
Tapeats  
Sandstone



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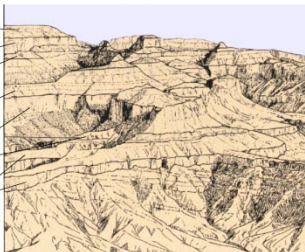


Kissing  
Takes  
Concentration  
However  
Sex  
Requires  
Movement,  
Balance, and  
Timing



B

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Know  
The  
Canyon's  
History.  
Study  
Rocks  
Made  
By  
Time



## Stratigraphy

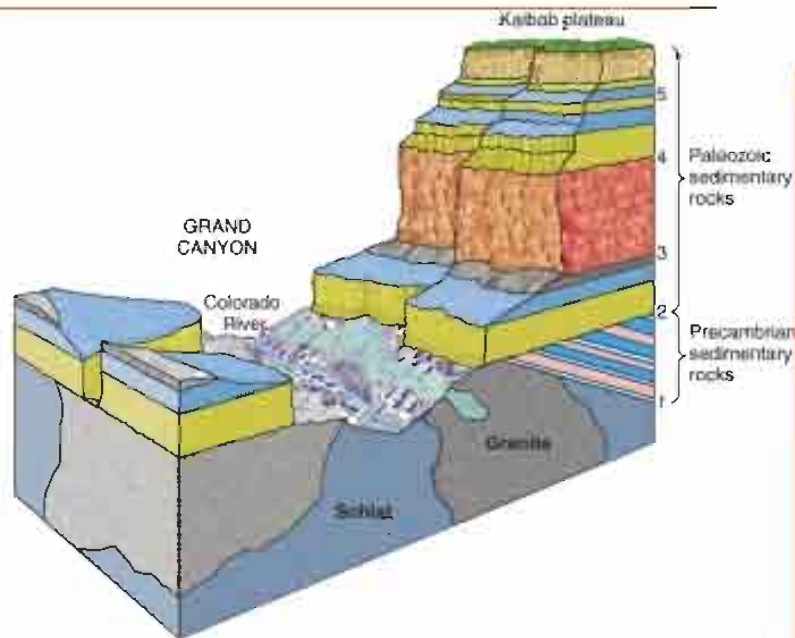
### The Simple Principals

- **Original Horizontality**
  - (or nearly so)
- **Stratigraphic Superposition**
  - All rocks accumulate upward in temporal order

## Stratigraphy

### Vocabulary

- **Aggradation**
  - Deposition
- **Degradation**
  - Erosion
- **Unconformity**
  - A break or gap in a sedimentary sequence
- **Sequence**
  - Preserved part of original rock layer
  - Bounded by unconformities
- **Hiatus**
  - The missing time at an unconformity
  - cause? many including erosion or non-deposition



## Stratigraphy

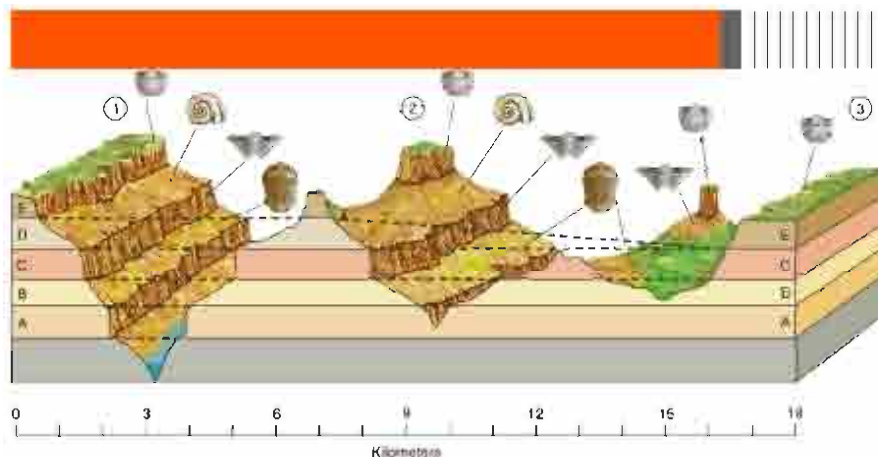
### Time

- Time is **NOT** directly Represented
- **Why?**
  - Accumulation and Erosion follow irregular order
  - Older Rocks are exposed because of erosion



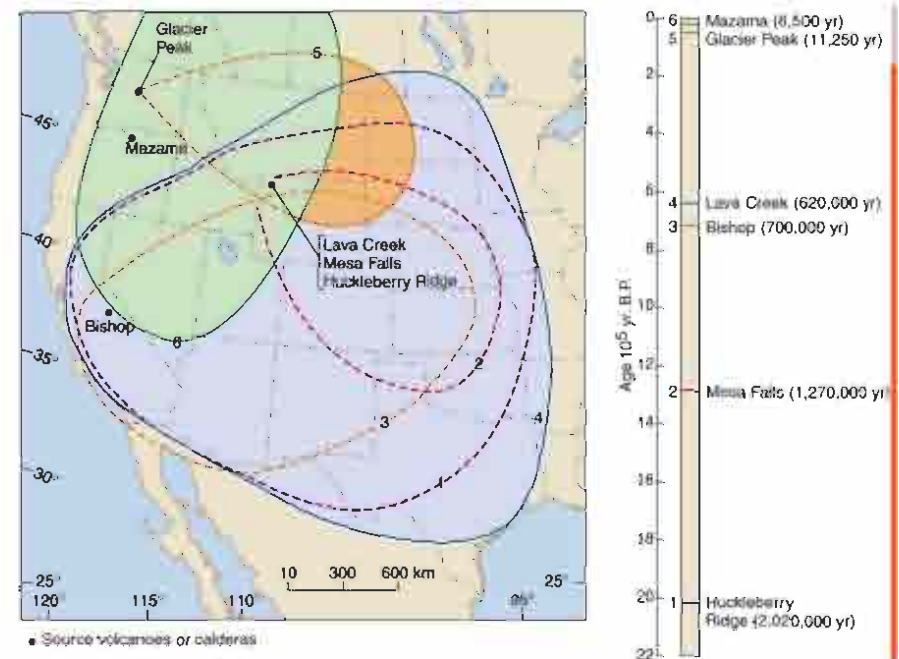
## Stratigraphy the Caveats

- Thickness of Strata does **NOT** define the duration of deposition
  - Erosion works from top down, destroying the time record, but leaves rock record as preservational remnant
- Erosion reduces rock record in reverse order of accumulation
- Duration of erosion may not be recorded



## Stratigraphy Correlation Criteria

- Physical
  - Physical Continuity
    - Uncommon
  - Lithologic similarity
    - key beds
  - Distinctive repetition of patterns
  - Others
    - isotopes, magnetic, radiometric
- Biological
  - Index Fossils
  - Evolution stage
  - paleo-climate



## Stratigraphy

### How to order?

#### ■ Stratigraphic Units

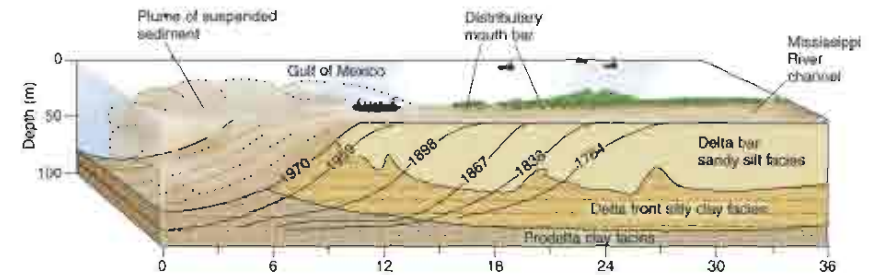
- Lithologic Homogeneity
- Distinct, mappable units
- Group
  - Formation
  - Member
  - Bed

#### ■ Time-Stratigraphic Units

- all rocks that were formed during a given interval of time
- How do you know?
- FOSSILS!

#### ■ Unconformity Bounded Sequences

- Tectonic implications
- Solemic Stratigraphy



## Stratigraphy

### Geologic Time Scale

#### ■ The Geologic Time Scale is a composite of preservational remnants of:

#### ■ Unconformity Bounded Sequences (UBS)

#### ■ Preserved World Wide

- WHY?
- Plate Tectonics!

## Stratigraphy

### Plate Tectonics

#### ■ Depths of oceans depends on age of Oceanic Lithosphere

- Older lithosphere is colder and denser
- Dense lithosphere sinks deeper
- Spreading center depth - 1.5 km
- 100 ma depth - 4.5 km

#### ■ Average ocean depth related to spreading rate

- Fast spreading leads to reduced average lithosphere age
  - this reduces the average depth

#### ■ Change Spreading Rates: Change Sea Level!

- For a fixed amount of ocean water and ocean basin area

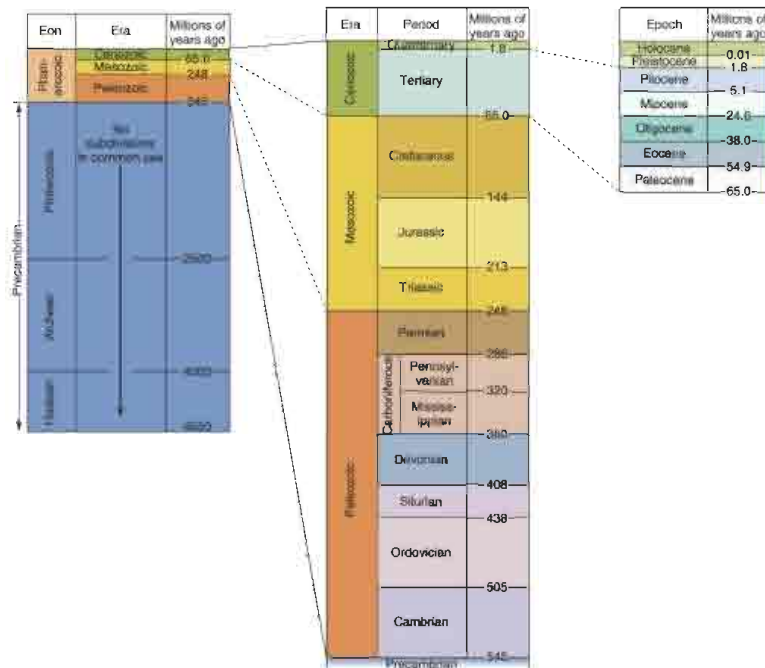
## Stratigraphy The Geologic Time Scale

### ■ EON - 100s of million years

#### • ERA 100 million years

#### – PERIOD 10-100 million years

#### • EPOCH 10s million years



## Eons

### ■ Hadean

- 4.56-4 billion years
- Period of intense bombardment
- No record on Earth – but visible on Moon and other planets

### ■ Archean

- 4 - 2.5 billion years
- Oldest rocks
- Earliest life
- Little free oxygen in atmosphere

### ■ Proterozoic

- 2.5 - 0.5 billion years
- Oxygen level increases in atmosphere with more life
- Life evolves from single cells to multicellular

### ■ Phanerozoic

- 600 million years to present
- Multicellular life takes off!

## Eras (of Phanerozoic)

- **Paleozoic (old life)**
  - 540 to 230 million years
  - Early land plants
  - Abundant sea life
- **Mesozoic (middle life)**
  - 230 to 60 million years
  - Dinosaurs dominated
  - Mammals and flowering plants first appeared
- **Cenozoic (recent life)**
  - 60 million years to present
  - Mammals dominate
  - Grasses first appear

## Periods

- **Paleozoic: Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian**
- **Mesozoic: Triassic, Jurassic, Cretaceous**
- **Cenozoic: Tertiary, Quaternary**
  - Epochs: Paleocene, Eocene, Oligocene, Miocene, Pliocene, Pleistocene, Holocene





