FOSSILS, ROCKS & GEOLOGIC TIME

A. Fossils
1. Definition & types
2. Bone composition
3. Preservation styles

B. Sedimentary rocks
1. Depositional environments
2. Taphonomic processes

C. Geologic time
1. Relative
2. Absolute

fossilis
→ Latin: ‘dug up’

UNKNOWN ISLAND
FOSSIL CLASSIFICATIONS

Body Fossils

Trace Fossils

BODY FOSSILS:
Hard vs Soft Parts
Calcite  CaCO₃

Living/recent bones and teeth

Hydroxyapatite
Ca₁₀(PO₄)₆(OH,Cl,F,CO₃)₂

Fossil bones and teeth

Fluorapatite
Ca₁₀(PO₄)₆(F,CO₃,OH,Cl)₂

Bone vs Teeth

Bone: ~70% mineral, 30% organic tissue
Enamel: ~97% mineral, 3% organic tissue
Bon appétit -

Non!

Bone apatite -

Oui!

DINOSAUR SOFT PARTS

Scipionyx samniticus
How are vertebrates preserved?

1. Burial
Bones are porous

Bone alteration

permineralization
replacement
recrystallization

Calcite Pyrite Quartz
Taphonomy

*taphos* → Greek: *burial*

Taketh away biologic data but giveth back environmental and ecological data.

Early burial is key!
SURFACE TAPHONOMIC PROCESSES

Predation
Scavenging
Wind/water transport
Trampling
Weathering

T. rex bite marks
Seismosaurus caudal (tail) vertebra

Right side

Left side
SUB-SURFACE TAPHONOMIC PROCESSES

Compaction/fracturing
Scavenging
Bone alteration
Dissolution
Bioturbation

Where did these complete skeletons come from?

GEOLOGIC TIME

EARTH CREATED IN 7 DAYS
GEOMETERS GO TO HELL!
Origin of the geologic time scale:

18th century

Relative Dating

Nicholas Steno and the Principles of Stratigraphy

Superposition = King
LITHOSTRATIGRAPHY

Correlation based on similarity of composition or position of rock types.
Assumes strata are deposited synchronously in different regions.

BIOSTRATIGRAPHY

Based on the Principle of Faunal Succession (i.e. evolution!)

This method assumes that:
1. No two species are identical
2. Species don’t reappear after becoming extinct
3. First and last appearances are rapid and synchronous around the globe

Late Jurassic dinosaurs: Tanzania & North America

Dinosaurs from Tanzania and North America are studied and support the correlation of fossil records.
Absolute Dating

Unstable isotopes → DECAY at rates measure in HALF LIVES

Decay = unstable parent → stable daughter +/− nuclear particles + heat

Decay series commonly used in dinosaur studies:

\(^{40}\text{K}/^{40}\text{Ar}: 1300\text{ my half life}\)
\(^{235}\text{U}/^{207}\text{Pb}: 705\text{ my half life}\)

Radiometric Dating

- since the 1930’s
- materials:
  - volcanic rocks
  - cements in sedimentary rocks

Ancient fossils are rarely dated directly
Are the dates on the geologic time scale written in stone?

First fossils
Dinosaurs first appear
Humans show up at ~5:48 p.m., Dec. 31st
The End