

THE SEDIMENTARY RECORD

What is the most conspicuous feature of sedimentary rocks?
layers; stratification or bedding

Each stratum = episode of deposition
successive strata separated by bedding planes

- laminae = layers <1 cm thick
- beds = strata >1 cm thick

Destruction of bedding planes:

- bioturbation
- dolomitization of limestones
- recrystallization due to metamorphism

Why do layers/strata form?
sediments accumulate under the influence of gravity

Stratigraphy

the study of stratified rock; geometric form and distribution, composition, origin, and age relations

Stratified rocks can be classified and described by different attributes:

1. rock type (**lithostratigraphy**)
*basic unit = **Formation***
2. fossil content (**biostratigraphy**)
*basic unit = **Biozone***
3. magnetic polarity (**magnetostratigraphy**)
*basic unit = **Magnetochron***
4. other attributes
 - *relative age (chronostratigraphy)*
 - *stable isotopes (chemostratigraphy)*
 - *seismic velocity*

the Stratigraphic Section is key to interpreting the geologic history of stratified rocks

the process:

1. distinguish individual rock units
 - lithology = rock type(s)
2. interpret depositional environment of each unit
 - *geometries of rock units*
 - *characteristics of beds including sedimentary structures*
 - *fossils (relative age and environment)*
 - *contacts*
3. if possible, organize rock units into time-rock units
 - *units based on fossils and relative time*
4. establish correspondence (correlation) with other sections
 - *correlate rock units on local scale*
 - *correlate time-rock units on regional or global scale*

Rock units are based on *lithology only*
primary lithostratigraphic unit = ***Formation***

Formations are distinctive because each is produced in a particular depositional environment

However, many environments shift laterally with time,
Therefore, boundaries of rock units commonly do not coincide with time units

Formations are commonly **diachronous** (i.e., time-transgressive), by contrast a volcanic ash bed is **isochronous** (i.e., time-parallel)

Examples of laterally migrating depositional systems:

1. advance (=transgression) and retreat (=regression) of the sea
 - coastal environments (e.g., barrier island complexes, beaches)
 - carbonate platforms and barrier reefs
2. progradational systems
 - alluvial fans
 - river deltas
 - deep-sea fans
3. other examples
 - fluvial environments (braided and meandering streams and rivers)
 - glacial environments
 - playa lakes

Two attributes of **all formations**:

1. **distinct** lithologic characteristics*
**does not have to be uniform lithology*
2. must be a **mappable** unit

Formation name has 2 parts:

1. geographic locality
where the unit is well-exposed and typical characteristics can be observed
2. rock name, or 'Formation' (for units with mixed lithologies)

*Sugarloaf Arkose, Mancos Shale,
Turners Falls Sandstone, Mt. Toby Conglomerate, Redwall Limestone
Morrison Formation, Spearfish Formation*

formal Lithostratigraphic Units:

Group
Formation
Member
Bed

Facies

lateral changes* in sedimentary rock units resulting from deposition in adjacent and related sedimentary environments

**often observe intertonguing and lateral gradation of adjacent sedimentary environments*

Walther's Law

only those facies can be superposed in a *conformable stratigraphic sequence* which were deposited in adjacent sedimentary environments

Breaks (Gaps) in the Sedimentary Record:

Unconformity

surface of discontinuity representing a long period of geologic time with no sedimentary record preserved; typically caused by erosion

Nonconformity

stratified rocks overlying unstratified igneous or metamorphic rocks

Angular Unconformity

stratified rocks overlying tilted or folded strata

Disconformity

stratified rocks separated by other parallel strata by an erosional break

Baselevel controls erosion vs. accumulation

above: sediments can't accumulate permanently, therefore, **net erosion**

below: *potential* area of **net accumulation**

exceptions:

- non-deposition (e.g., sediment supply)
- erosion by currents
- displacement (e.g., mass wasting)

Baselevel is the hypothetical level that separates net erosion and weathering of the Earth's surface from net accumulation of sediments that have the potential to become sedimentary rocks. It is influenced by the following factors:

Factors:

- sediment supply
climate, tectonics
- basin subsidence
tectonics, load from sediment, water, or ice; "accommodation space"
- hydraulic energy
storms, waves, currents
- sea level*

Baselevel is not stationary!

*Sedimentation in many depositional environments is discontinuous (episodic)
partly a function of shifting baselevel

Diastems

breaks in sedimentary record of "short" duration

Diastem

typically no overall change in depositional environment

baseline fluctuations, but net accumulation

Unconformity

typically, but not always, significant change in depositional environment

baselevel moves down (=deep and persistent erosion), much later baselevel moves up (=return to net accumulation)

Do bedding planes represent more time than the beds themselves?

More breaks (gaps) than preserved sedimentary record in many depositional systems!

Sediments typically accumulate in areas of ***net subsidence***

Where do you predict to find areas of net subsidence?

The thickest accumulations of sedimentary rock occur along great belts parallel to the margins of the continents*

**transition from continental crust to oceanic crust*

- Mesozoic-Cenozoic Gulf and East Coast coastal plains and continental margins
wide shelf-slope-continental rise: "passive margins"
- Cenozoic West Coast
narrow shelf-slope-forearc basin: "active margin"
- Mesozoic margin of California
deformed & accreted margin
- Paleozoic Cordilleran and Appalachian provinces
deformed & accreted margins

Also, basins formed on continental crust*

**formed by tectonic forces*

- **intracratonic basins** (compression and loading)
- **foreland basins** (compression and loading)
- **rift basins** (tension and crustal thinning)

Sea level change

Impact on the sedimentary record

- **transgressive-regressive facies** are very common in the rock record; lateral migration of facies with rising and falling sea level
- changing water table and base-level
- **sedimentary architecture** to reconstruct sea level, (sequence stratigraphy: transgressive, highstand, and lowstand systems tracks, maximum flooding surface, sequence boundary; seismic stratigraphy: onlap, downlap of seismic reflectors)

Other consequences

- sea level impact on **climate** (albedo: climate is warmer when global sea level is high)
- **ocean circulation** (distribution of heat)
- **evolution** (availability of shallow water environments; epicontinental seas when sea level is high)
- **paleobiogeography** (distribution of organisms)

What drives sea level change? eustasy = global sea level

- **glacioeustasy** (large continental ice sheets draw their water from the ocean: lower sea level during glaciations, higher sea level during deglaciations or interglacials)
- **continental break-up** (new ocean basins, greater length of spreading centers, young hot oceanic crust, thinned continental crust at the margins: higher sea level)
- **continental aggregation** (continental collisions, vertical tectonics, thicker continental crust, old cold oceanic crust: lower sea level)