Plate Tectonics and Sedimentation: Where do sediments accumulate?

How and why do continents break-up and new ocean basins form?

- *what are the principal steps involved?*
- *where do sediments tend to accumulate and what types of sediments*
- *how long does it take for a new ocean basin to form?*
- *how is oceanic crust formed?*

Over time heat builds-up under large continents

- upwelling limb forms in the Asthenosphere
- result: series of "**hot spots**"

Rift Stage (Continental Break-Up)

- crust heated from below, thermally expands and **thins**
- creation of **tension fractures** (= normal faults)
- **extension** causes collapse of thinned crust (= **horsts & grabens**)
- creation of long, narrow, **fault-bounded central rift valley**
- **thick sequences of continental deposits** due to rapid subsidence and high relief
  alluvial fans and alluvial plains; braided streams and lakes or playas
- intrusion of diabase sills and extrusion of basaltic lava flows

Commonly, each hot spot produces 3 arm rift (triple junction)

- **rifts propogate**, those that **hook-up** become the incipient ocean basin
- others become aborted pull-apart basins or "**failed rifts**"
  Hartford/Deerfield Basin, Newark Basin

Drift Stage (Opening of New Ocean Basin)

- rifting continues, **basalt** forms in the central axis of the rift valley (= **new oceanic crust**)
- the ocean invades the graben
- **seafloor spreading** begins (= divergence)
- **oceanic crust** cools, contracts, and **subsides** as it moves away from the active spreading center
- rifted (thinned) continental margins subside and a **passive continental margin** is born

Evolution of a Convergent Plate Margin

Ocean basins are relatively young features
- <180 Ma (middle Jurassic)
- ~4% of Earth history

Continents are old
- too thick & buoyant to be subducted
- cont. crust is preferentially preserved

Continents consist of a core of old rocks
"***stable craton***" *or* "***Precambrian Shield***"

Continents grew by plate tectonic processes:

1. **ocean-continent collision**
   - growth of magmatic arc
   - accretion of island arc*

   **island arcs are formed by ocean-ocean collision*

2. **continent-continent collision**
   - accretion of continental crust*

   **begins as phase of ocean-continent collision*

3. **strike-slip accretion of terranes**

Accretion of oceanic or continental "terranes" may also involve the obduction of oceanic crust and deep-sea sediments
these are called ***ophiolite sequences***

Creation of Mountains due to Convergence

ocean-continent (e.g., Andes, Cascades)
continent-continent (e.g., Himalaya)
begins as ocean-continent collision

1. rise of **central igneous core**
   "***magmatic arc***"
   - partial melting of oceanic crust + sediments + H_2O* creates **magmas of intermediate to felsic composition** (i.e., continental crust)

   **H_2O lowers the melting temp.*
   - andesitic volcanics, granitic plutons

2. **metamorphic belt**
   - high T, relatively low P
   - plastic deformation

3. **fold & thrust belt**
   - enormous mass of magmatic arc causes collapse
   - huge **thrust sheets** spread laterally
   - brittle deformation

4. **foreland basin**
   - craton-side of arc
   - mass of arc + thrust sheets buckle crust downward
   - thick sedimentary deposits
   - sometimes deep enough to be invaded by the ocean

5. **forearc basin**
   - ocean-side of arc
   - thick sedimentary deposits

6. **accretionary prism** (or wedge)
   - deformation of sediments and crust at the leading edge of convergence

   "***subduction melange***"
   - low T, high P metamorphism

Deposition & Deformation in the **Foreland Basin**

in general, 2 phases:

1. **Flysch**
   - syn-orogenic **marine deposits**
   - high accumulation rates
   - thick sequence of +/-fossiliferous, +/-muds and fine sandstones interbedded with coarse sandstones and conglomerates

As mtn. building continues, fold & thrust belt migrates inland
   - may cause deformation of flysch deposits
   - foreland basin fills with sediment

2. **Molasse**
   - mostly post-orogenic **continental deposits**
   - thick sequence of **alluvial fan** and **alluvial plain** conglomerates, sandstones, and mudstones