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 propagate, 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 + H2O* creates **magmas of intermediate to felsic composition** (i.e., continental crust)
   *H2O 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