**ESCI 101 ~ Principles of Earth Science I**

## Oceans & Coasts

**Notes**

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- Landscapes Beneath the Sea - Ocean Water - Ocean Currents - Tides - Waves - Coastal Landforms

### Landscapes Beneath the Sea

- **Bathymetry** - variation in depth of the ocean floor

Bathymetry map of the SE U.S., colors represent different elevations.
○ **Continental Shelves** - a gently sloping submerged edge of the continent
  - Sand- and mud-covered platform
  - Water depth does not exceed 500 m
  - Fringes the continent

○ **Continental slopes** - region of steep slopes between the continental shelf and the continental rise
  - Covered in mud
  - Cut by deep submarine canyons

○ **Continental Rise** - a broad and gently sloping ramp that rises from an abyssal plain to the continental slope
  - Muddy and sandy sediment
  - 100's of kilometers wide

Depiction of the coast off of Los Angeles
- **Abyssal Plain** - a flat, sediment-covered province of the sea floor
  - Covered in microscopic plankton shells (which eventually could be transformed into oil) and mud, both of which settle out of suspension
  - 4,000 - 6,000 m below sea level
  - Broken by occasional submerged volcanoes (**seamounts**)

![Nannoplankton found on the abyssal plain](image)

- **Mid-Ocean Ridge** - a series of mountains formed by volcanism at a plate rift
  - 2-km high submarine mountain belt

![Mid-Ocean Ridge](image)

- **Plate Margin Types**:
  - **Passive Continental Margin** - margins that are not plate boundaries and host few earthquakes
    - Broad continental shelves
    - Shelf formed from stretched continental crust that cools and sinks
    - Covered with sediment washed off the continent
- **Active Continental Margin** - a margin that coincides with a plate boundary and hosts many earthquakes
  - Narrow continental shelves
  - Sediment from the continent spreads out over the accretionary prism (material scraped off the downgoing plate)
  - Steep descent to the sea floor - trench
  - > 8 km deep

- **Ocean Water**
  - **Composition**
    - **Salinity** - concentration of salt (Sodium (Na+)) in water
      - 3.5% dissolved salt ions (freshwater - 0.02%)
      - Increases water's density
        - Reason why you float higher in salt water than in freshwater
      - Not constant
        - Can be diluted by the input of freshwater from streams or melting glaciers
        - Can be concentrated by evaporation of water which leaves behind salt
      - Changes with depth
Other components
- Potassium (K\(^+\)), Calcium (Ca\(^{2+}\)), and Magnesium (Mg\(^{2+}\)) - from chemical weathering of rocks
- Chloride (Cl\(^-\)) and Sulfate (SO\(_4^{2-}\)) - from volcanic gases

Ocean Components

- Temperature
  - Average temperature 17 °C (62.6 °F)
  - Ranges from freezing to 35 °C (95 °F)
  - Varies with depth
  - Warm, less dense water floats on top of cold water
  - Water temperature decreases abruptly

Density
- Both salinity and temperature affect density
- Average density 1.025 g/cm³ (freshwater - 1 g/cm³)
- Mostly controlled by salinity
- Density varies with depth

Density distribution graph (vertical density changes)

- **Ocean Currents**
  - 2 levels of currents:
    - **Surface currents** - affects the upper 100 m's
    - **Deep currents** - affects water at the bottom of the sea

- **Surface currents:**
  - Major surface currents result from the interaction between the sea surface and the wind
    - Air molecules shear across the surface of the water
    - Friction between air and water drags water along
    - Movement of water due to wind shear does not exactly parallel the movement of the wind
  
  ![Animation of global surface currents](image)

- Consequence of the Earth's rotation - creates the Coriolis effect
  - Causes surface currents in the Northern Hemisphere to veer toward the right and in the Southern Hemisphere to veer toward the left
The Coriolis Effect

- Deep Currents
  - Water also circulates in the vertical direction
    - **Downwelling zones** - where near-surface water sinks
    - **Upwelling zones** - places where deep water rises

- Occurs along coastal regions because wind blows parallel to coastlines
  - Wind drags surface water along and the Coriolis effect causes water to deflect at an angle to the wind
    - Water moves towards the coast - too much water → **downwelling**
    - Water moves away from the coast - too little water → **upwelling**
Zones of Upwelling

- Can also be driven by contrasts in water density - differences in temperature and salinity
  - thermohaline currents
    - Cold salty water tends to sink
    - Warm, less salty water rises

Thermohaline currents including the warm Gulf Stream

- Variations in density (due to temperature) causes the oceans to be vertically stratified into moving water masses
- Water masses mix very slowly
Various water masses including the Antarctic bottom water and Antarctic circumpolar water

- **Tides**
  - **Tides** - cycles of regular rise and fall of the level of water in oceans
    - 2 cycles daily - 2 high tides and 2 low tides
    - **Tidal reach** - the difference in sea level between high and low tides

- **Flood tides** - rising water, nearshore flooded
- **Ebb tides** - decreasing water, nearshore draining seaward

- **Tidal Flat** - a broad, nearly horizontal surface covered and uncovered by the tides
Tidal Flat

- **Tide-generating force** -
  - Gravitational attraction of the Moon (and Sun) causes water to bulge outward on the side nearest the moon.
  - On the opposite side, inertia created by Earth's rotation causes ocean water to bulge outward in the opposite direction.

- **2 oceanic bulges**
  - When a location lies under a bulge, it experiences a high tide. When it passes under a depression, it feels a low tide.
  - Earth rotates, bulge remains stationary.
  - Any given coastline will move westward through both bulges each day.

- Animation of gravitational attraction of the moon and how it produces tides.
Tidal bulge

Reading tidal graphs - curve shows sea level height for one day and depicts the timing of high and low tides.

Number of factors influence the timing and reach of tides:
- Earth's tilt - 2 tides do not reach the same level (one is larger)
- Moon's orbit - gravitational attraction between the Earth and Moon changes seasonally
- Sun's gravity -
  - Sun and Moon are at right angles (quarter moon) - extra low tides (Neap Tide) -
    - Sun's attraction counteracts the Moon's
  - Sun is on the same side as the Moon (new moon or full moon) - extra high tides (Spring Tide) -
    - Sun's attraction adds to the Moon's
- Basin shape - controls the tidal range:
  - Open ocean - 0.5 m tidal reach
  - Restricted basins (narrow inlets) - can be greater than 20 m (Bay of Fundy)

Go on to more notes on Oceans