Chapter 8

Tides

LEARNING OBJECTIVES

1. Understand the forces generating the tides and the factors that cause tides to vary geographically and with time.
2. Know the characteristics and causes of daily tidal types and why they vary in a monthly cycle.
3. Explain the movement of tides in the ocean and smaller basins.

CHAPTER OUTLINE

8-1. Tidal Characteristics

A. Tides have a wave form, but differ from other waves because they are caused by the interactions between the ocean, Sun, and Moon.
    1. Crest of the wave form is **high tide** and trough is **low tide**.
    2. The vertical difference between high tide and low tide is the **tidal range**.
    3. **Tidal period** is the time between consecutive high or low tides and varies between **12 hrs 25 min** to **24 hrs 50 min**.
    4. There are three basic types of daily tides defined by their period and regularity.
        a. **Diurnal tides** have one high and one low tide each day and a tidal period of 24 hrs 50 min.
        b. **Semidiurnal tides** have two high and two low tides of similar tidal range each day and a tidal period of 12 hrs 25 min.
        c. **Mixed tides** have two high and two low tides of dissimilar tidal range each day and a tidal period between 12hrs 25 min and 24 hrs 50 min.
    5. Over a month the daily tidal ranges vary systematically with the cycle of the Moon.
        a.**Spring tides** are the two tides each month with the largest tidal range.
        b. **Neap tides** are the two tides each month with the smallest tidal range.
    6. Tidal range is also altered by the shape of a basin and sea floor configuration.

8-2. Origin of the Tides

B. Tides result from gravitational attraction and centrifugal effect.
   1. Gravity varies directly with mass, but inversely with distance.
   2. Although much smaller, the Moon exerts twice the gravitational attraction and tide-generating force as the Sun because the Moon is closer.
   3. **Gravitational attraction** pulls the ocean towards the Moon and Sun, creating two gravitational tidal bulges in the ocean (high tides).
   4. **Centrifugal effect** is the push outward from the center of rotation.
      a. As Earth orbits the Sun, centrifugal effect raises a tidal bulge on the side of Earth facing away from the Sun.
      b. Earth and Moon revolve around a point between them. Centrifugal effect raises a tidal bulge on the side of the Earth facing away from the Moon.
   5. Latitude of the tidal bulges is determined by the **declination**, the angle between Earth's axis and the lunar and solar orbital plane.
      - As Earth rotates on its axis a point on Earth's surface alternately passes through and between tidal bulges, experiencing high and low tides respectively.
   6. In two weeks the tidal range varies from maximum to minimum to maximum.
      a. **Spring tides** occur when Earth, Moon and Sun are aligned in a straight line and the tidal bulges display constructive interference, producing very high, high tides and very low, low tides.
         - Spring tides coincide with the **new** and **full moon**.
      b. **Neap tides** occur when the Earth, Moon, and Sun are aligned forming a right angle and tidal bulges displaying destructive interference, producing low high tides and high low tides.
         - Neap tides coincide with the **first** and **last quarter moon**.
   7. Earth on its axis and the Moon in its orbit both revolve eastward and this causes the tides to occur 50 minutes later each day.
      - By the time the point on the Earth that was directly below the Moon has completed one rotation, the Moon has advanced in its orbit and an additional 50 minutes of Earth rotation is required before that point is again directly below the Moon.

C. Movement of tides across ocean basins is deflected by Coriolis, blocked by continental landmasses and forms a rotary wave, which each day completes two cycles around the basin if the tide is semidiurnal or one cycle if it is diurnal.
   1. High tide at the ocean basin's western edge creates a pressure gradient sloping downward towards the east.
   2. As water flows down the gradient, Coriolis deflects water towards the equator, where it accumulates and establishes a pressure gradient sloping downward towards the pole.
   3. Water flowing down this gradient is deflected eastward, forming a pressure gradient sloping downward to the west.
   4. Westward flow along this gradient is diverted poleward forming a pressure gradient sloping downward toward the equator.
   5. Finally, the flow toward the equator is deflected westward, completing the cycle.