INVESTIGATION 6

The Moon *and* Tides

Project

PURPOSE

- Find, organize, graph, and analyze tide data for one month
- Track and graph the relative positions of Earth, the moon, and the sun for the same month
- Explain the occurrence and heights of the tides in view of the motions of these bodies

PART I

BACKGROUND

For thousands of years humans have recognized the effect the moon has on the changing water levels you observe at the beach. Winds and ocean currents cause waves, but the periodic changing of water level we call tides is more complex. Tides vary from day to day, based on the relative positions of Earth, the moon, and the sun in space. On most coastlines there are two high and two low tides per twenty-five hour period. These are called **semidiurnal tides**.

Fig. 6-1

Low tide occurs as the Earth rotates out of the tidal bulge.

The gravitational effect of the moon and sun are the major cause of tidal variation, but other factors also are an influence. The Gulf of Mexico has **diurnal tides**, or only one high and one low tide per twenty-five hour period, because the Gulf of Mexico is not an open body of water, but semi-enclosed. Mexico's coastline blocks the in-and-out flow of water that normally causes two high and two low tides in the same period.

In this project you will use the Internet to examine more closely the water level patterns that exist at a particular location. You will investigate a probable cause and effect relationship between the moon and the regular variation in water level.

Procedure

Step 1 You and your partner will use the Internet to find tide data for one month. Any location along our coastline is acceptable. You may find this Web site helpful:

http://tidesonline.nos.noaa.gov/

Set your parameters as follows (Sandy Hook, in northern New Jersey, is used as an example):

Station: 8531680 Sandy Hook, NJ (or any other you may select)
Tide interval: W3 High/Lows
Datum: MLLW (for distance above **M**ean **L**ower **L**ow **W**ater)
Begin Date: 20041101
End Date: 20041130
Time: LST (for Local Standard Time)
Data Units: meters (1 m = 3.28 ft)

Then press View Data

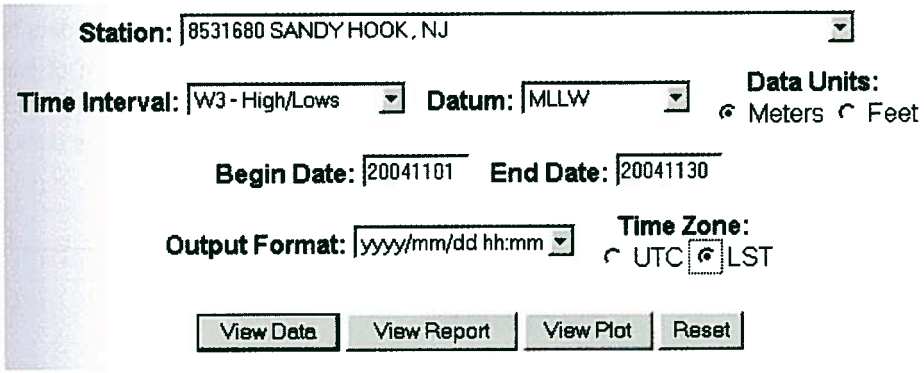

Fig. 6-2: Data Entry Field at National Ocean Service Web Site

Step 2 On a data sheet that you will organize, enter the heights of all the high and low tides for the month, in order. (As an option, you might print out the data from the Web site, then enter the data into a spreadsheet to make analysis easier.)

Step 3 Prepare a graph with time along the horizontal axis and the heights along the vertical axis. To make the horizontal scale simple to read, number the high and low tides from the first to the last day of the month.

Let your data determine the intervals of the vertical scale, also making allowances for possible negative values. In making a graph you want to spread the data out over most of the graph paper, so set your scales accordingly.

Step 4 Plot your data. Connect the high tide marks with a smooth, best-fitting line. Do the same for the low-tide data.

1a. What general patterns do you observe?

b. How do the high-tide data vary over the month? Are all high tides equally high? Why or why not? Explain.

c. How do the low-tide data vary over the same time period? Are all low tides equally low? Why or why not? Explain.

d. Define and explain ***spring tide*** and ***neap tide***.

Analysis

Analysis

e. Are the high tides on the same day of equal heights? What about the low-tide heights on the same day? What could explain such observations?

2. Compare the variation of the high-tide data and the low-tide data relative to each other over the month. Why do the high points on one curve occur during the low points on the other?

3. Compare your data with those of another group who used a different site and/or month. Describe and explain the similarities and differences.

4. Give two examples of why is it important, from a biological point of view, to understand the tides.

5. There are trillions of watts of energy produced by the tides. Doing research as necessary, describe one method that might be developed to harness that energy for use by humans.

PART II

BACKGROUND

The moon has apparent phases because of where we stand on Earth and how much of its face we see illuminated. The sun continuously lights up one full side of the moon, but that side is not always visible from our vantage point on Earth as the moon revolves in its 27.3 day orbit around our planet. This 27.3 day period is called the **sidereal month** and is the true orbital period. The phase cycle takes a bit longer to complete because Earth also is moving in an orbital path around the sun. The phase cycle is the **synodic month** and it is 29.5 days long.

Fig. 6-3

The Moon in Full Phase

The phases of the moon do not cause the variation in the tides; the positions of the moon and sun with respect to Earth do. The phases are a visual way to keep track of the positions of these bodies.

Procedure

Step 1 Use the following Web site to find the phases of the moon for the month for which you have collected tide data:
http://aa.usno.navy.mil/data/docs/MoonPhase.html

Step 2 Record on your graph the days on which the various moon phases occurred.

Step 3 In the space below, draw how Earth, the moon, and the sun would be relatively positioned for each phase.

Analysis

6. How do you think the combined gravity of the sun and moon and the rotation of the Earth influence the height of the oceans?

7. From your sketches and the data on your graphs, draw some conclusions:

   a. Why are there high and low tides?

   b. Why are there usually two high and two low tides each day in most places?

   c. Why do the heights of the high and low tides fluctuate over time?

   d. From what you know about the orbit of the moon around Earth, explain why the high tides do not occur at the same time each day.

Analysis

8. The moon presently is about 239,000 miles away, on the average, and takes a little over 27 days to complete one orbit of Earth. About 900,000 years ago the moon was only about 200,000 miles away and it took about 20 days for one orbit. Geologic and astronomical evidence suggest that the moon has been moving away at a steady rate of about 3.82 cm/yr (1.5 inches per year). Earth and the moon are gravitationally connected and because of that Earth's rotation has slowed down over the same time period from 18 hour days to the present 24 hours. This means that 900,000 years ago the year was 481 days long.

a. Why is the length of the day lengthening as the moon's orbit expands?

b. Describe how the tides would vary under the conditions of 900,000 years ago.

c. Outline two ways the day-night cycle and the tidal variations affect life on Earth.