Topographic Maps

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CHAPTER 1

Topographic Maps

Lesson Objectives

- Describe a topographic map.
- Explain what information a topographic map contains.
- Explain how to read and interpret a topographic map.
- Explain how various Earth scientists use topographic maps to study Earth.

Vocabulary

- contour interval
- contour lines
- topographic map

Introduction

Anyone who knows how to read a topographic map can "see" the landscape of a region without being there. A mountaineer could plan the best route for a mountain climbing trip. An engineer could plan the best location for a road or power plant. A tourist can get an idea of what they are going to see on their vacation. Topographic maps are interesting and fun to use.

What is a Topographic Map?

Mapping is an important part of Earth Science. **Topographic maps** use a line, called a contour line, to show different elevations on a map. **Contour lines** show the location of hills, mountains and valleys. A regular road map shows where a road goes. But a road map doesn't show if the road goes over a mountain pass or through a valley. A topographic map shows you the features the road is going through or past. Let's look at topographic maps.

Look at this view of the Swamp Canyon Trail in Bryce Canyon National Park, Utah (**Figure** 1.1). You can see the rugged canyon walls and valley below. The terrain has many steep cliffs with high and low points between the cliffs.

Now look at the same section of the visitor's map (**Figure** 1.2). You can see a green line that is the main road. The black dotted lines are trails. You see some markers for campsites, a picnic area, and a shuttle bus stop. The map does not show the height of the terrain. Where are the hills and valleys located? What is Natural Bridge? How high are the canyon walls? Which way do streams flow?

A topographic map represents the elevations in an area (**Figure** 1.3). We mentioned topographic maps in the section on orienteering above.

FIGURE 1.1

View of Swamp Canyon in Bryce Canyon National Park.

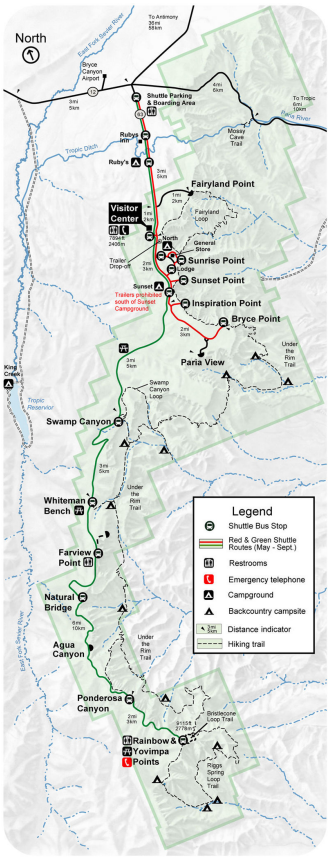

FIGURE 1.2

A map of a portion of Bryce Canyon National Park road map showing Swamp Canyon Loop.

Contour Lines

Contour lines connect all the points on the map that have the same elevation. Let's take a closer look at this (**Figure** 1.3).

Each contour line represents a specific elevation. The contour line connects all the points that are at the same

FIGURE 1.3
Topographic map of Swamp Canyon Trail portion of Bryce Canyon National Park.

elevation. Every fifth contour line is made bold. The bold contour lines have numbers to show elevation. Contour lines run next to each other and NEVER cross one another. If the lines crossed it would mean that one place had two different elevations. This cannot happen.

Contour Intervals

Since each contour line represents a specific elevation, two different contour are separated by the same difference in elevation (e.g. 20 ft or 100 ft.). This difference between contour lines is called the **contour interval**. You can calculate the contour interval by following these steps:

a. Take the difference in elevation between 2 bold lines.

b. Divide that difference by the number of contour lines between them.

Imagine that the difference between two bold lines is 100 feet and there are five lines between them. What is the contour interval? If you answered 20 feet, then you are correct (100 ft/5 lines = 20 ft between lines).

The legend on the map also gives the contour interval.

Interpreting Contour Maps

How does a topographic map tell you about the terrain? Let's consider the following principles:

1. **The spacing of contour lines shows the slope of the land**. Contour lines that are close together indicate a steep slope. This is because the elevation changes quickly in a small area. Contour lines that seem to touch indicate a very steep slope, like a cliff. When contour lines are spaced far apart the slope is gentle. So contour lines help us see the three-dimensional shape of the land.

Look at the topographic map of Stowe, Vermont (**Figure** 1.4). There is a steep hill rising just to the right of the city of Stowe. You can tell this because the contour lines there are closely spaced. The contour lines also show that the hill has a sharp rise of about 200 feet. Then the slope becomes less steep toward the right.

2. **Concentric circles indicate a hill**. **Figure** 1.5 shows another side of the topographic map of Stowe, Vermont. When contour lines form closed loops, there is a hill. The smallest loops are the higher elevations on the hill. The

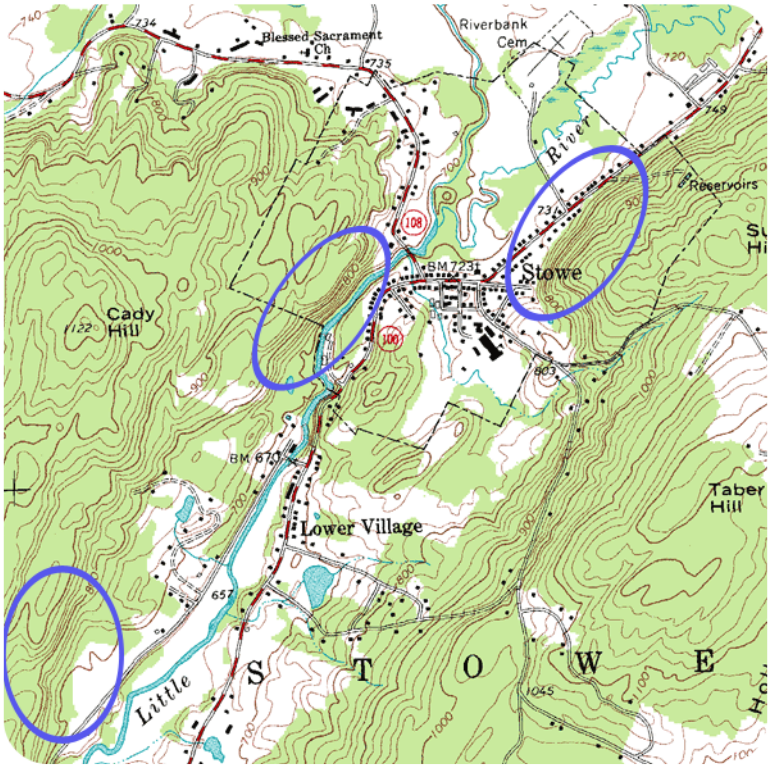

FIGURE 1.4

Portion of a USGS topographic map of Stowe, VT.

larger loops encircling the smaller loops are downhill. If you look at the map, you can see Cady Hill in the lower left and another, smaller hill in the upper right.

3. **Hatched concentric circles indicate a depression**. The hatch marks are short, perpendicular lines inside the circle. The innermost hatched circle represents the deepest part of the depression. The outer hatched circles represent higher elevations (**Figure** 1.6).

4. **V-shaped portions of contour lines indicate stream valleys.** The "V" shape of the contour lines point uphill. There is a V shape because the stream channel passes through the point of the V. The open end of the V represents the downstream portion. A blue line indicates that there is water running through the valley. If there is not a blue line the V pattern indicates which way water flows. In **Figure** 1.7, you can see examples of V-shaped markings. Try to find the direction a stream flows.

5. **Like other maps, topographic maps have a scale so that you can find the horizontal distance**. You can use the horizontal scale to calculate the slope of the land (vertical height/horizontal distance). Common scales used in United States Geological Service (USGS) maps include the following:

- 1:24,000 scale –1 inch = 2000 ft
- 1:100,000 scale –1 inch = 1.6 miles
- 1:250,000 scale –1 inch = 4 miles

Including contour lines, contour intervals, circles, and V-shapes allows a topographic map to show three-dimensional information on a flat piece of paper. A topographic map gives us a good idea of the shape of the land.

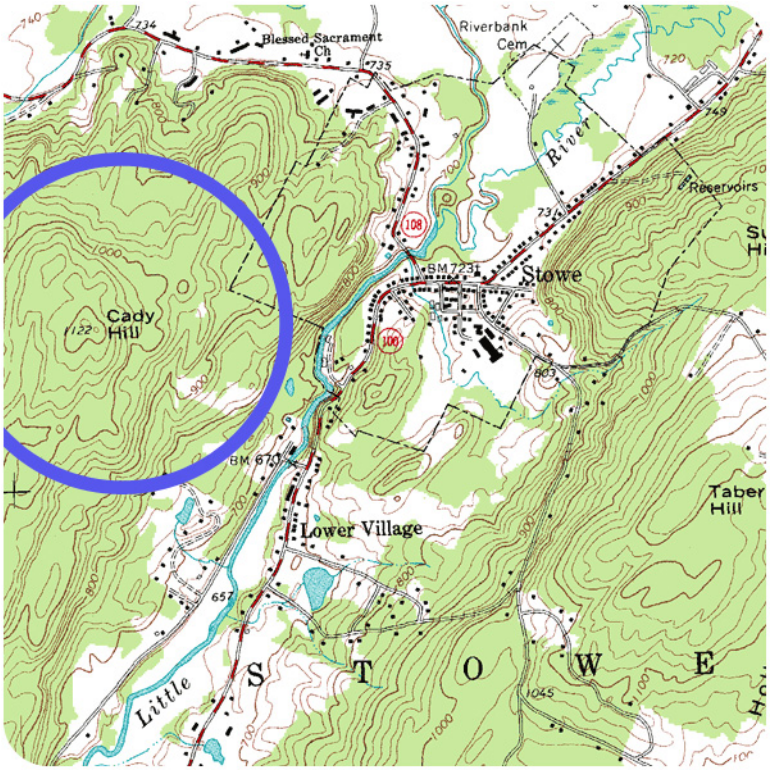

FIGURE 1.5

Portion of a USGS topographic map of Stowe, VT. Cady Hill (elevation 1122 ft) is shown by concentric circles in the lower left portion of the map. Another hill (elevation ~ 960 ft) is on the upper right portion of the map.

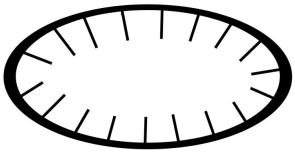

FIGURE 1.6

On a contour map, a circle with inward hatches indicates a depression.

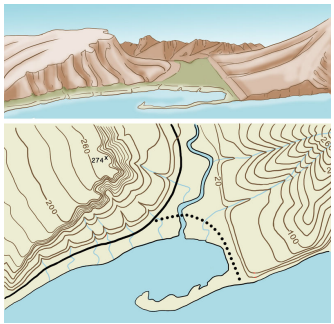

FIGURE 1.7

Illustrations of three-dimensional ground configurations (top) and corresponding topographic map (bottom). Note that the V-shaped markings on the topographic maps correspond to drainage channels. Also, the closely-spaced contour lines denote the rapid rising cliff face on the left side.

Information from Topographic Maps

As we mentioned above, topographic maps show the shape of the land. You can determine a lot of information about the landscape using a topographic map. These maps are invaluable for Earth scientists.

How Do Earth Scientists Use Topographic Maps?

Earth scientists use topographic maps for many things:

- Describing and locating surface features, especially geologic features.
- Determining the slope of the Earth's surface.
- Determining the direction of flow for surface water, groundwater, and mudslides.

Hikers, campers, and even soldiers use topographic maps to locate their positions in the field. Civil engineers use topographic maps to determine where roads, tunnels, and bridges should go. Land use planners and architects use topographic maps when planning development projects, such as housing projects, shopping malls, and roads.

Bathymetric Maps

Oceanographers use a type of topographic map that shows water depths (**Figure** 1.9). On this map, the contour lines represent depth below the surface. Therefore, high numbers are deeper depths and low numbers are shallow depths. These maps are made from depth soundings or sonar data. They help oceanographers understand the shape of bottoms of lakes, bays, and the ocean. This information also helps boaters navigate safely.

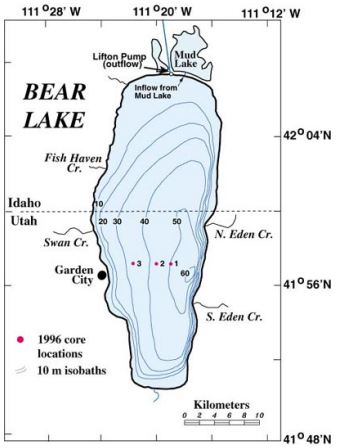

FIGURE 1.8

Bathymetric map of Bear Lake, Utah.

Geologic Maps

A geologic map shows the different rocks that are exposed at the surface of a region. Rock units are shown in a color identified in a key. On the geologic map of the Grand Canyon, for example, different rock types are shown in different colors. Some people call the Grand Canyon "layer cake geology" because most of the rock units are in layers. Rock units show up on both sides of a stream valley.

A geologic map looks very complicated in a region where rock layers have been folded, like the patterns in marble cake. Faults are seen on this geologic map cutting across rock layers. When rock layers are tilted, you will see stripes of each layer on the map. There are symbols on a geologic map that tell you which direction the rock layers slant, and often there is a cut away diagram, called a cross section, that shows what the rock layers look like below the surface. A large-scale geologic map will just show geologic provinces. They do not show the detail of individual rock layers.

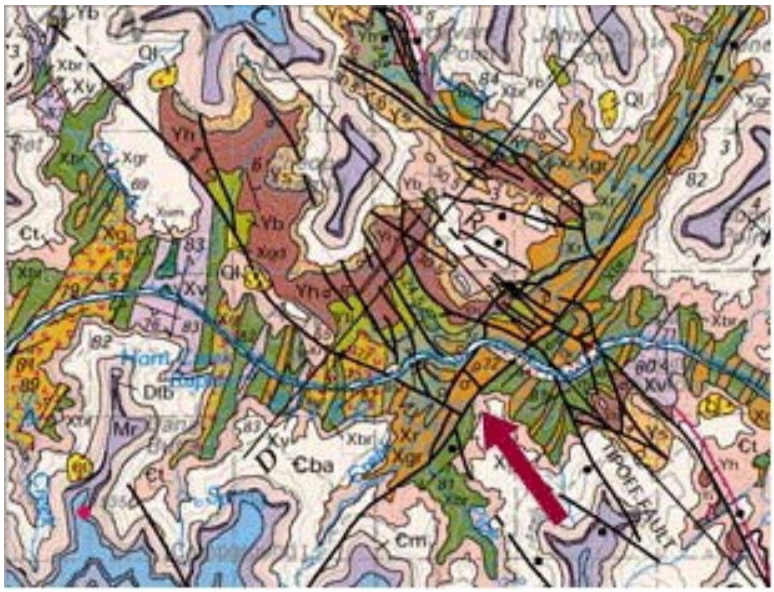

FIGURE 1.9

A portion of the geologic map of the Grand Canyon, Arizona.

Lesson Summary

- Topographic maps are flat maps that show the three-dimensional surface features of an area. Topographic maps help users see the how the land changes in elevation.
- Contour lines on a topographic map connect points of equal elevation above sea level.
- Contour lines run next to each other. Each contour line is separated by a constant difference in elevation, usually noted on the map.
- Topographic maps have a horizontal scale to indicate horizontal distances.
- People use topographic maps to locate interesting landforms, to find their way through an area, and to determine the direction water flows in an area.
- Oceanographers use bathymetric maps to show the features of the bottom of a body of water.
- Geologic maps display rock units and geologic features. A small scale map displays individual rock units while a large scale map shows geologic provinces.

Lesson Review Questions

Recall

1. Describe what the following features would look like on a topographic map.

- a stream channel
- a hilltop
- a valley
- a cliff

2. How do you find a stream valley on a topographic map? How can you tell if the stream has water in it all year round? How can you determine which way the water is flowing?

3. If you were the captain of a very large boat, what type of map would you want to have to keep your boat traveling safely?

Apply Concepts

4. Draw a topographic map of a steep slow that slowly enters a valley. Draw a topographic map of a steep cliff that is almost perpendicular to a valley.

5. On a topographic map, six contour lines span a horizontal distance of 0.5 inches. The horizontal scale is 1 inch equals 2000 ft. How far apart are the first and sixth lines?

Think Critically

6. On a topographic map, five contour lines are very close together in one area. What is the shape of these lines if the feature is a hill? What is the shape of these lines if the feature is a cliff?

7. On a topographic map, a river is shown crossing from Point A in the northwest to Point B in the southeast. Point A is on a contour line of 1800 ft and Point B is on a contour line of 2400 ft. In which direction does the river flow?

8. On the geologic map of the Grand Canyon, a rock unit called the Kaibab Limestone takes up the entire surface of the region. Down some steep topographic lines is a very thin rock unit called the Toroweap Formation and just in from that is another thin unit, the Coconino sandstone. Describe how these three rock units sit relative to each other.

Points to Consider

- Imagine that you are a civil engineer. How could you use a topographic map to build a road, bridge, or tunnel through an area like the one shown in **Figure** 1.5? Would you want your road to go up and down or remain as flat as possible? What areas would need a bridge in order to cross them easily? Can you find a place where a tunnel would be helpful?
- If you wanted to participate in orienteering, would it be better to have a topographic map or a regular road map? How would a topographic map help you?

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