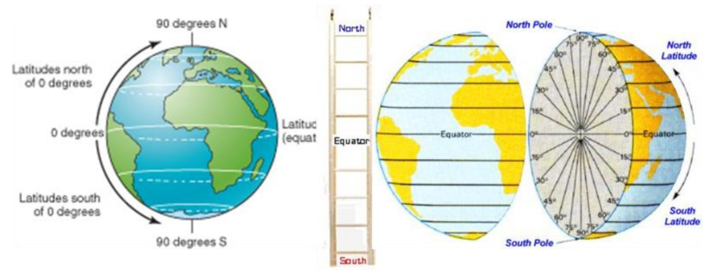
Latitude-Longitude and Topographic Maps Reading Supplement

Latitude and Longitude

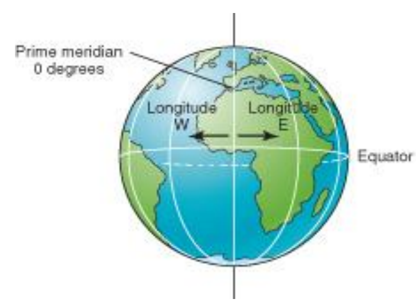
A key geographical question throughout the human experience has been, "Where am I?" In classical Greece and China, attempts were made to create logical grid systems of the world to answer this question. The ancient Greek geographer Ptolemy created a grid system and listed the coordinates for places throughout the known world in his book *Geography*. But it wasn't until the middle ages that the latitude and longitude system was developed and implemented. This system is written in degrees, using the symbol °.

Latitude



When looking at a map, latitude lines run horizontally. Latitude lines are also known as parallels since they are parallel and are an equal distant from each other. Each degree of latitude is approximately 69 miles (111 km) apart; there is a variation due to the fact that the earth is not a perfect sphere but an oblate ellipsoid (slightly egg-shaped). To remember latitude, imagine them as the horizontal rungs of a ladder ("ladder-tude"). Degrees latitude are numbered from 0° to 90° north and south. Zero degrees is the equator, the imaginary line which divides our planet into the northern and southern hemispheres. 90° north is the North Pole and 90° south is the South Pole.

Longitude



The vertical longitude lines are also known as meridians. They converge at the poles and are widest at the equator (about 69 miles or 111 km apart). Zero degrees longitude is located at Greenwich, England (0°). The degrees continue 180° east and 180° west where they meet and form the International Date Line in the Pacific Ocean. Greenwich, the site of the British Royal Greenwich Observatory, was established as the site of the prime meridian by an international conference in 1884.

How Latitude and Longitude Work Together

To precisely locate points on the earth's surface, degrees longitude and latitude have been divided into minutes (') and seconds ("). There are 60 minutes in each degree. Each minute is divided into 60 seconds. Seconds can be further divided into tenths, hundredths, or even thousandths. For example, the U.S. Capitol is located at 38°53'23"N , 77°00'27"W (38 degrees, 53 minutes, and 23 seconds north of the equator and 77 degrees, no minutes and 27 seconds west of the meridian passing through Greenwich, England).

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 the Earth.

What is a Topographic Map?

Mapping is a crucial part of earth science. **Topographic maps** represent the locations of major geological features. Topographic maps use a special type of line, called a **contour line**, to show different elevations on a map. Contour lines are drawn on a topographic map to show the location of hills, mountains and valleys. When you use a regular road map, you can see where the roads go, but a road map doesn't tell you why a road stops or bends. A topographic map will show you that the road bends to go around a hill or stops because that is the top of a mountain. Let's look at topographic maps.

Look at this view of Bryce Canyon National Park, Utah (Figure 2.26). You can see the rugged canyon walls and valley below. The terrain clearly has many steep cliffs. There are high and low points between the cliffs.

Figure 2.26: View of Bryce Canyon National Park.

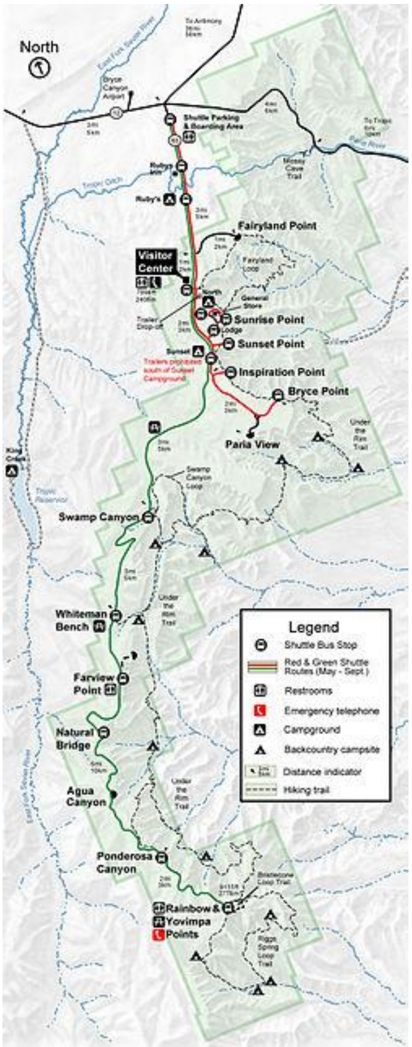


Figure 2.27: Portion of Bryce Canyon National Park road map.

Now look at the corresponding section of the Visitor's map (Figure 2.27). You can see a green line which is the main road. The black dotted lines are trails. You see some markers for campsites, a picnic area, and a shuttle bus stop. But nothing on the map shows the height of the terrain. Where are the hills and valleys located? How high are the canyon walls? Which way will streams or rivers flow?

You need a special type of map to represent the elevations in an area. This type of map is called a topographic map (Figure 2.28).

What makes a topographic map different from other maps? Contour lines help show various elevations.

Figure 2.28: Topographic map of Swamp Canyon Trail portion of Bryce Canyon National Park.

Contour Lines and Intervals

Contour lines connect all the points on the map that have the same elevation.

Each contour line represents a specific elevation and connects all the places that are at the same elevation. Every fifth contour line is in bold. The bold contour lines are labeled with numerical elevations.

- The contour lines run next to each other and NEVER cross one another. That would mean one place had two different elevations, which cannot happen.
- Two contour lines next to one another are separated by a constant 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. The legend on the map will also tell you the contour interval.
    - Take the difference in elevation between 2 bold lines.
    - Divide that difference by the number of contour lines between them.

If 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 = 20 ft).

Interpreting Contour Maps

How does a topographic map tell you about the terrain? Well, in reading a topographic map, consider the following principles:

1. *Contour lines can indicate the slope of the land.* Closely-spaced contour lines indicate a steep slope, because elevation changes quickly in a small area. In contrast, broadly spaced contour lines indicate a shallow slope. Contour lines that seem to touch indicate a very steep or vertical rise, like a cliff or canyon wall. So, contour lines show the three-dimensional shape of the land. For example, on this topographic map of Stowe, Vermont (Figure 2.29), you will see 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. Using the contour lines, you can see that the hill has a sharp rise of about 200 ft and then the slope becomes less steep as you proceed right.

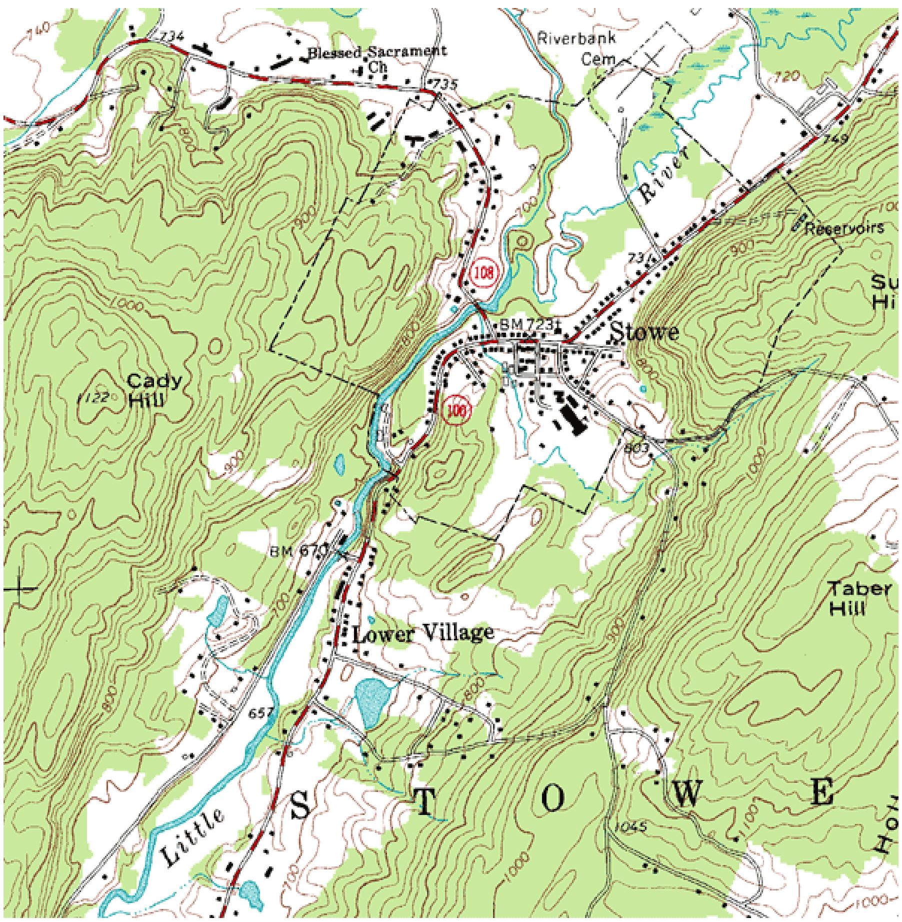


Figure 2.29: Portion of a USGS topographic map of Stowe, VT. In this map, you can see how the spacings of the contour lines indicate a steep hill just to the right of the city of Stowe in the right half. The hill becomes less steep as you proceed right.

2. *Concentric circles indicate a hill.* Figure 2.30 shows another side of the topographic map of Stowe, Vermont. When contour lines form closed loops all together in the same area, this is a hill. The smallest loops are the higher elevations and the larger loops are downhill. If you look at the map, you can see Cady Hill in the lower left and another, and another smaller hill in the upper right.

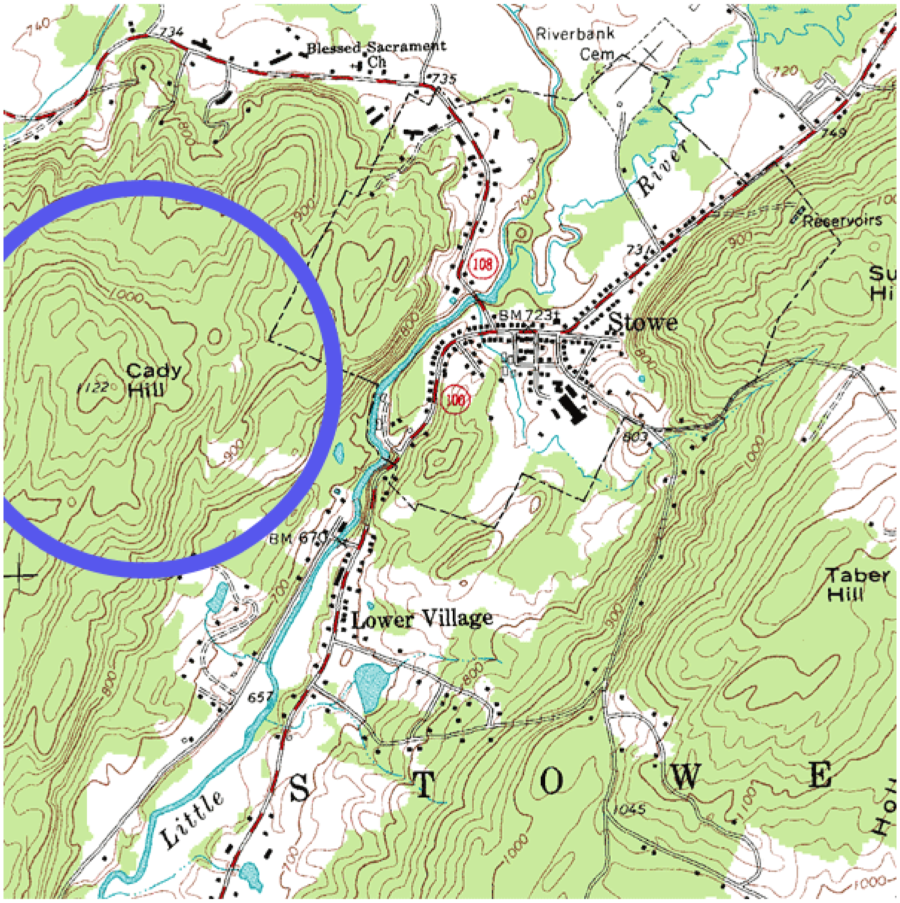


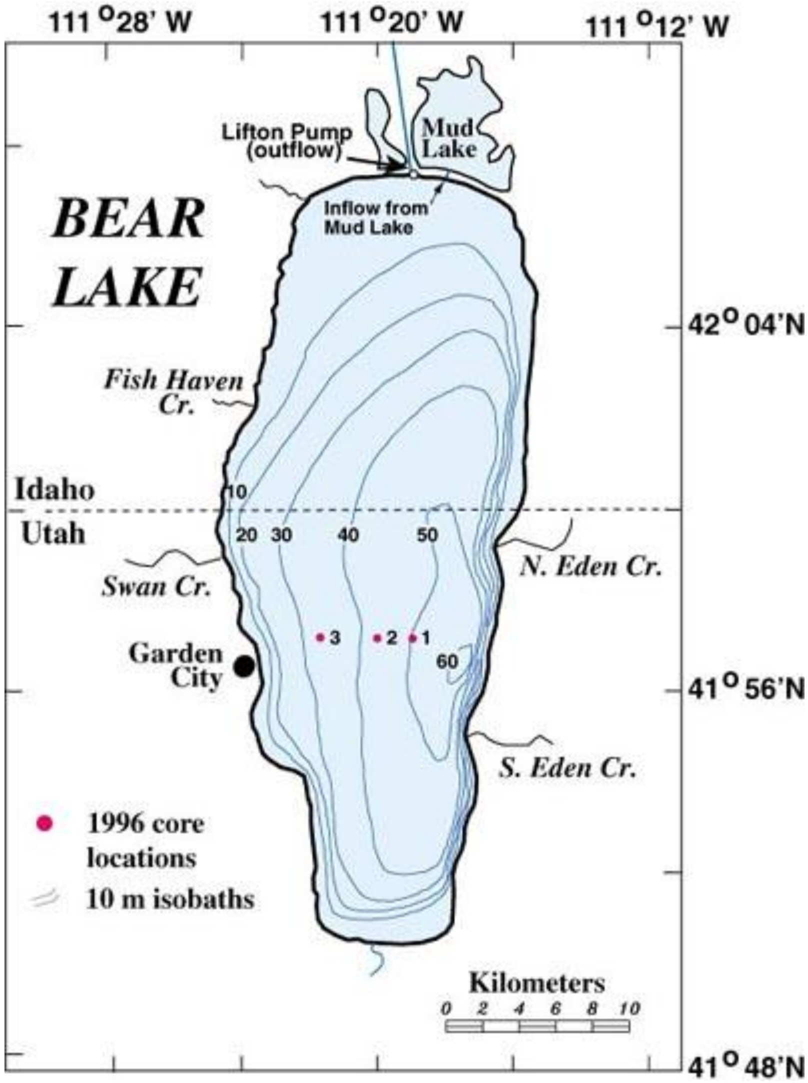
Figure 2.30: Portion of a USGS topographic map of Stowe, VT. In this map, you can see Cady Hill (elevation 1122 ft) indicated by concentric circles in the lower left portion of the map and another hill (elevation ˜ 960 ft) in the upper right portion of the map.

3. *Hatched concentric circles indicate a depression.* The hatch marks are short, perpendicular lines inside the circle. The innermost hatched circle would represent the deepest part of the depression, while the outer hatched circles represent higher elevations.
4. *V-shaped portions of contour lines indicate stream valleys.* Here the V- shape of the contour lines “point” uphill. The channel of the stream passes through the point of the V and the open end of the V represents the downstream portion. Thus, the V points upstream. A blue line will indicate the stream if water is actually running through the valley; otherwise, the V patterns will indicate which way water will flow.
5. Like other maps, topographic maps have a scale on them to tell you the horizontal distance. The horizontal scale helps 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

So, the contour lines, their spacing intervals, circles, and V-shapes allow a topographic map to convert 3-dimensional information into a 2-dimensional representation on a piece of paper. The topographic map gives us an idea of the shape of the land.

How Do Earth Scientists Use Topographic Maps?

Figure 2.31: Bathymetric map of Bear lake, UT.



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, ground water, 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 also use topographic maps when planning development projects like housing projects, shopping malls, and roads.

Oceanographers use a type of topographic map called a **bathymetric map** (Figure 2.31). In a bathymetric map, the contour lines represent depth from the surface. Therefore, high numbers are deeper depths and low numbers are shallow depths. Bathymetric maps are made from depth soundings or sonar data. Bathymetric maps help oceanographers visualize the bottoms of lakes, bays, and the ocean. This information also helps boaters to navigate safely.

Geologic Maps

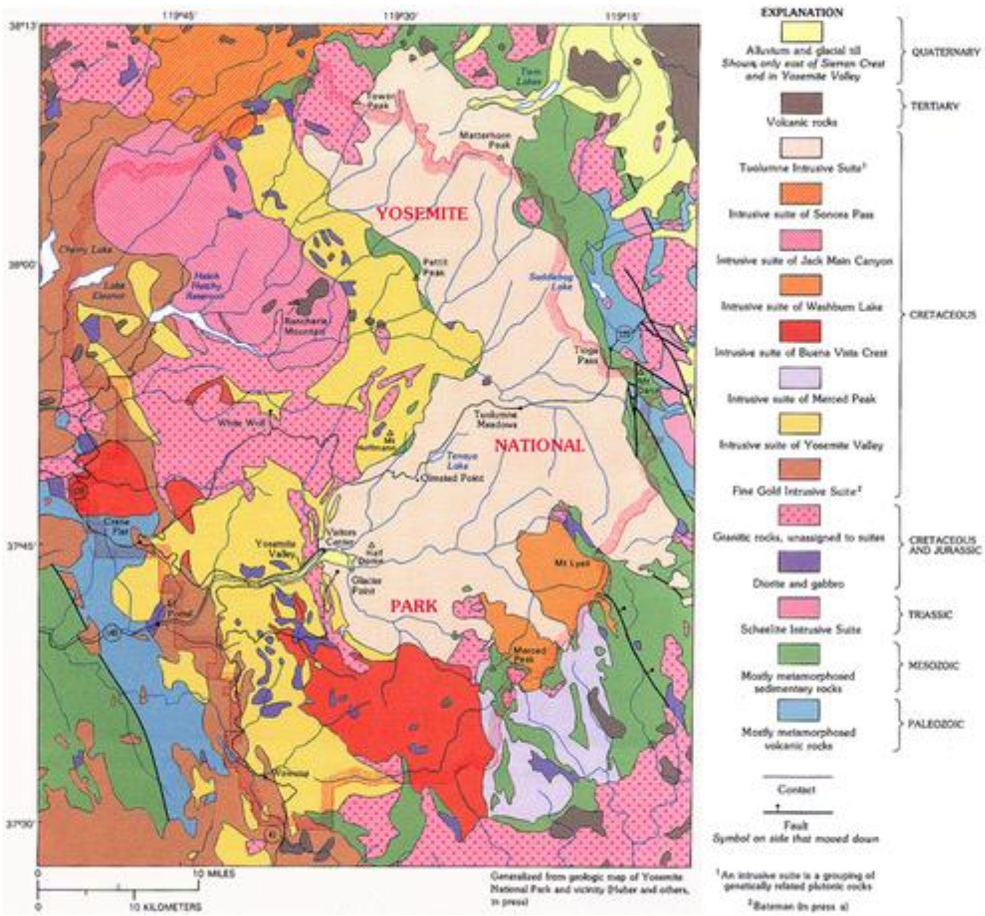


Figure 2.32: Geologic map of the Yosemite area.

A geologic map shows the geological features of a region. Rock units are shown in a color identified in a key. On the map of Yosemite, for example, volcanic rocks are brown, the Tuolumne Intrusive Suite is peach and the metamorphosed sedimentary rocks are green. Structural features, for example folds and faults, are also shown on a geologic map. The area around Mt. Dana on the east central side of the map has fault lines.

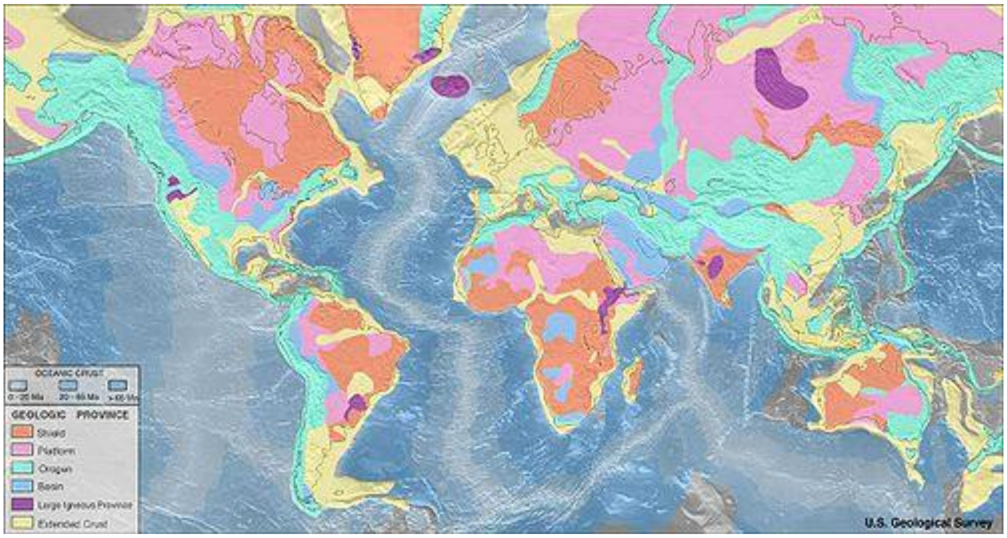


Figure 2.33: On a large scale geologic map, colors represent geological provinces.