3.2 Topographic Maps

Is it possible to show a mountain on a flat map? In this section, you will learn about special map lines called *contour lines* that show mountains and other land features. Relief maps and topographic maps are used to show mountains and valleys.

VOCABULARY

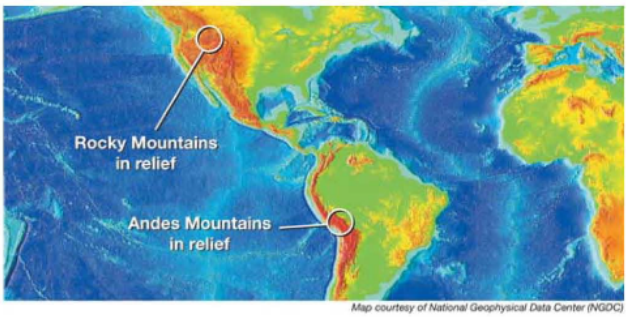
relief - the distance between a high and low place on a map.

elevation - the height of an object measured from a reference level such as sea level.

sea level - the average level of the ocean; the halfway point between high tide and low tide.

Relief and elevation

Relief **Relief** describes the distance between high and low places on a map. Shaded relief maps (see below) show mountains and other land features using bumps and colors. In the map below, the western edges of North and South America have bumpy, dark-orange ridges indicating mountain ranges.



Map courtesy of National Geophysical Data Center (NGDC)

Elevation The high, low, and flat places on Earth's surface can be further described using numbers. **Elevation** is the height of an object measured from a reference level, usually sea level. **Sea level** is the average level of the ocean (Figure 3.14). The highest mountain on Earth is Mt. Everest in Nepal, with an elevation of 8,850 meters. The highest mountain in North America is Mt. McKinley in Alaska, with an elevation of 6,194 meters. The lowest point on land is the Dead Sea shore at 417.5 meters below sea level. The lowest point in North America is Death Valley, California, at about 86 meters below sea level.

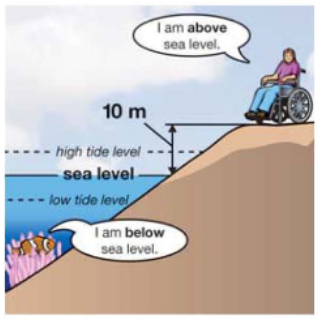


Figure 3.14: *Elevation and sea level. You might know that oceans experience tides—sea level is the halfway point between high tide and low tide.*

What is a topographic map?

Mapping the height of a mountain

Bumps or ridges can show mountains on a map. But to know exactly how high a mountain is, the best kind of map to look at would be a topographic map. A **topographic map** (or topo map for short) is a map that uses *contour lines* to show elevation.

Contour lines

Contour lines indicate all points where the elevation is the same. The zero contour line on a topo map indicates all the points on the map that are at sea level. A 100-meter contour line indicates points that are 100 meters above sea level (Figure 3.15). Contour lines also show the slope of land. **Slope** (also called *gradient*) is a measure of how steep land is.

Legends for topographic maps

The legends for topo maps (and other maps) use a range of symbols to show rivers and lakes, roads, railroad tracks, airports, types of vegetation, buildings, and many other things.

Topographic contour	8000	River	
Campground		Lake	
Railroad track		Highway	
School		Woodland	
Many buildings		Orchard	

National Map Accuracy Standards

The United States Geological Survey (USGS) publishes about 57,000 topographic maps of the United States. These maps are drawn according to the National Map Accuracy Standards. The standards define accurate measurements for mapmaking so that any map you read can be compared to another map.

What are some uses of topographic maps?

Topographic maps are very useful for emergency responders. When a search and rescue team plans a mission, the team members must use topo maps to help them become familiar with the area, particularly if the terrain is rugged and unpopulated. Topo maps are also useful for hiking, orienteering, scientific research, and outdoor resource management.

VOCABULARY

topographic map - a map that uses contour lines to show elevation.

contour lines - curved lines on a map that indicate all the points where the elevation or depth is the same.

slope - a measure of how steep land is; also called gradient.

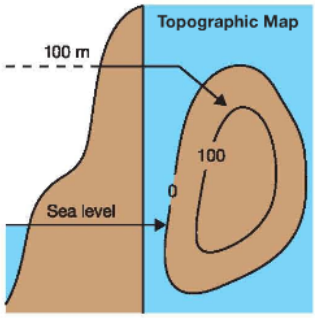
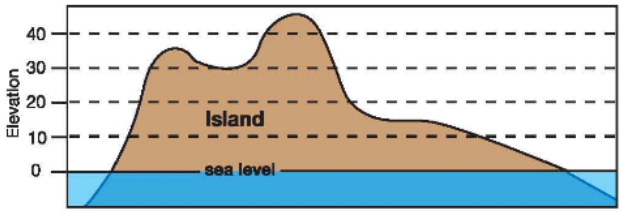


Figure 3.15: *The 0 contour line is always at sea level. A 100-meter contour line shows all places on the map where the elevation is exactly 100 meters above sea level.*

Making a topographic map

Drawing contour lines

To understand how contour lines relate to the shape of a land form, imagine that you have a three-dimensional form in a box. The form represents an island. You pour water into the box to a starting level that represents sea level or the 0-meter contour line. By adding more water to the box, the edges of the island get covered. If you look down at the form from above, you will see the shape of the island at an elevation of 10 meters (Figure 3.16).



What does the map look like?

Figure 3.16 illustrates how contour lines are used to make a topographic map. The 0 contour line shows the outline of the island at sea level. At the 10-meter mark, the outline of the island is smaller and lies inside the 0-meter contour. Only the highest of the two peaks is shown on topographic map #3. The second peak is less than 40 meters high but taller than 30 meters. A contour line at 35 meters would be needed to see this peak.

Showing the slope of land

The spaces between the 0-, 10-, and 20-meter contours are wider on the right side of the map than on the left. This shows that the right side of the island is not as steep as the left side. When contour lines are close together, you know that the land is steep. When contour lines are farther apart, the land is not as steep—it slopes gradually.

Using a topographic map for hiking

When you look at a mountain trail map that has contour lines, you can quickly evaluate the difficulty of a hiking trail if you know how to read the map. If you have to choose between two trails to a summit, and you want an easier climb, pick the trail that crosses contour lines that are more widely spaced.

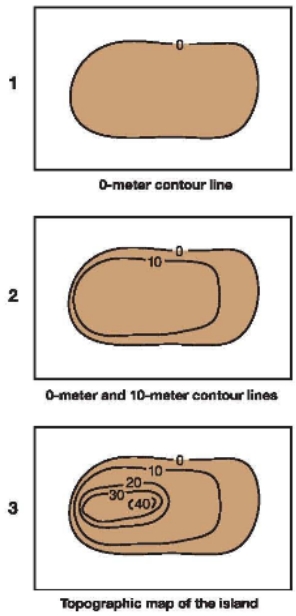


Figure 3.16: *Drawing contour lines to make a topographic map. Note that the space between the 10- and 20-meter contour lines is narrower on the left than the right. This shows that the left side of the island is steeper.*

Technology and making a topographic map

The birth of the USGS

In 1879, the United States Geological Survey (USGS) was created by an act of the U.S. Congress. The USGS was given the task of mapping public lands. Early employees of the USGS had to travel to places that were often difficult to reach in order to carry out this task. Their means of transportation was often a team of pack mules.

Plane table surveying

Of course, mapmakers in the 1800s did not have computers, electronic equipment, or airplanes to help them make their maps. They used a technique called *plane table surveying*. A plane table is a horizontal table on a tripod. From the plane table, a surveyor uses a viewing instrument to gauge the height of land at a particular distance. To help with measurements of elevation, another surveyor holds up a tall measuring stick at the area being measured. This technique was used up until the 1970s.

A scientist doing a plane table survey (1941).

Photo by Captain Francis X. Popper, C&GS. Courtesy of NOAA.

Topographic mapping today

Starting in the 1940s, scientists began using aerial photographs and other techniques to make topographic maps. Today, scientists have computers, electronic devices, and airplanes to help them make maps. Although these tools make it easier to draw an accurate map, it is still a complex process. Today, overlapping aerial photographs are used to create a 3-D image of an area. Special software, computer technology, and stereo glasses are used to make topographic maps (Figure 3.17).

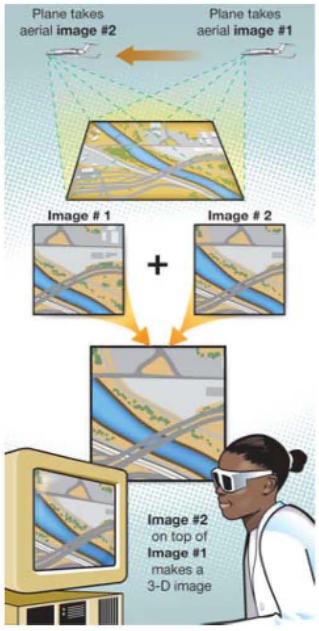
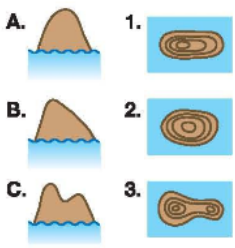


Figure 3.17: *A pair of aerial photographs is used to make a 3-D image that can be translated into a topographic map. Stereo glasses allow the mapmaker to see 3-D images.*

Section 3.2 Review

1. House A is located at 100 meters above sea level. House B is located at 350 meters above sea level.
   a. What is the elevation of House B?
   b. What is the relief between House A and House B?
2. How is elevation related to sea level? What is sea level?
3. True or false: Contour lines are lines on a map that show locations of equal relief. If this statement is false, rewrite it to make it true.
4. On a topographic map, what clue tells you that the land has a very steep slope?
5. Match each island (A, B, and C) with its topographic map.
6. The scale of a topographic map is 1:24,000, which means one centimeter on the map equals 24,000 centimeters on land. How many kilometers is 24,000 centimeters?
7. What does a scale of 1:500,000 mean on a topographic map?
8. The most common type of topographic map created by the USGS is a 7.5 minute by 7.5 minute quadrangle map (Figure 3.18). This means that each side of the map is 7 minutes and 30 seconds. Each minute of latitude is 1,852 meters and each second of latitude is 31 meters. How many meters does this map cover in a north-south direction?



CHALLENGE

Mapping Challenges

1. Make a map that includes a legend and a scale. Your map can be of your town, school, street, or home.
2. Find a map (in a book or atlas) that has a legend and a scale. Write directions for getting from one place to another, using real-life measurements (miles or kilometers) and indicating landmarks along the way.

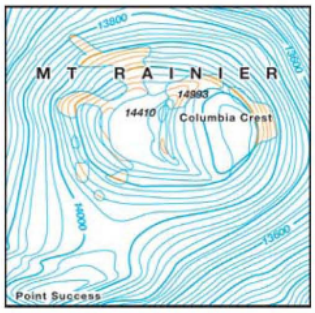


Figure 3.18: *Question 8. These blue contour lines represent the elevation of ice on the mountain top!*