# Chapter 2
# Reading Topographic Maps and Making Calculations

*In this chapter you will learn about:*

- *Reading the margins*
- *Interpreting contour lines*
- *Estimating slope*
- *Estimating aspect*
- *Estimating acreage*
- *Estimating distances*
- *Estimating percent contained*

*A nice reference to have while reading this chapter is a USGS color topographic map.*

A topographic map is printed on a flat piece of paper yet it provides a picture of the terrain and man-made features through the use of contour lines, colors and symbols. Contour lines represent the shape and elevation of the land, such as ridges, valleys, and hills. Colors and symbols are used to represent other features on the land, such as water, vegetation, roads, boundaries, urban areas and structures.

The USGS produces a series of topographic maps that are extremely accurate. The United States was systematically divided into precise quadrangles based on latitude and longitude lines and these maps are commonly referred to as "quads."

This chapter starts with tips on how to read the margins of a topographic map. Then it describes how to interpret contour lines. Finally, it covers how to estimate slope, aspect, acreage, distances, and percent contained using a topographic map.

# Reading the Margins

This section addresses how to read the information that is in the margins of a USGS topographic map. It starts with the upper left corner of the map and moves clockwise around the map.

## Agency or Author Who Created Map (upper left corner of map)

In Figure 2-1, the United States Department of the Interior Geological Survey is the agency that created the map. This same information can also be found in the bottom left corner.

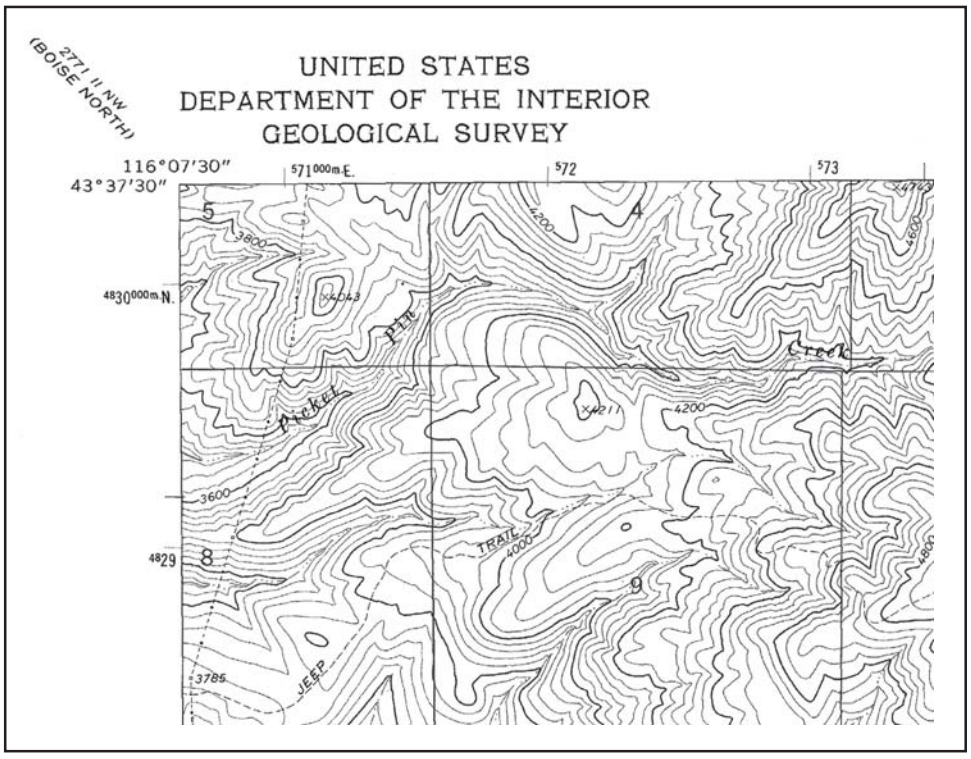


**Figure 2-1. Agency or author who created map.**

## Map Title (upper right corner of map)

This corner section provides the name of quadrangle, state (and sometimes the county) where the quadrangle is located, and map series. Quadrangles are often named after a prominent town or feature that is in the quadrangle. In Figure 2-2, the name of the quadrangle is "Lucky Peak" which is located in Idaho. The map series indicates how much land area is on the map; for example, in Figure 2-2 the Lucky Peak quadrangle is a 7.5 minute series which indicates it covers a four sided area of 7.5 minutes of latitude and 7.5 minutes of longitude.

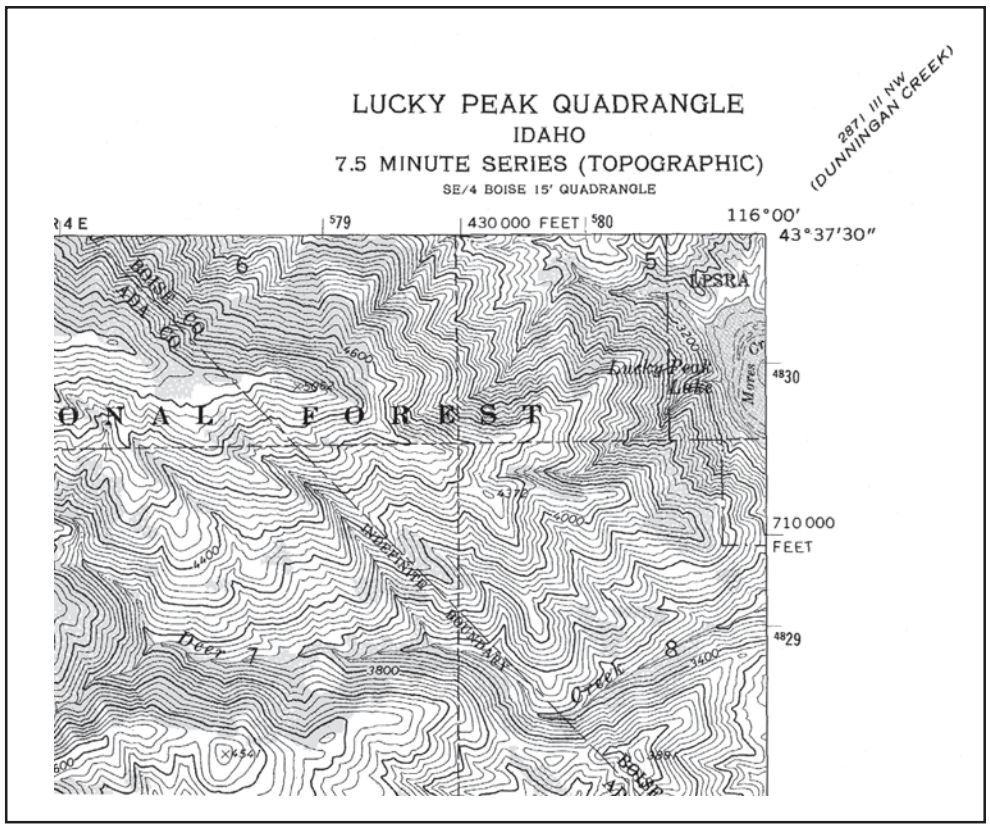


**Figure 2-2. Map title.**

## Road Classification (bottom right corner of map)

Road and trail symbols may be found in this legend (Figure 2-3).

## Revision Date (bottom right corner of map)

Some maps have a revision date, which is when the map was last updated. If the map is old, it may not be accurate. In Figure 2-3 the revision date is 1972. Refer to the "Map Production Information" block in the bottom left corner for additional information on map dates.

## Quadrangle Location (bottom right corner of map)

The location of the quadrangle is pinpointed on a map of the state (Figure 2-3).

## Adjoining Quadrangle Legend (corners of map)

Names of adjoining quadrangles are frequently indicated in the corner margins of USGS topographical maps; *Mayfield* is the joining quadrangle in Figure 2-3.

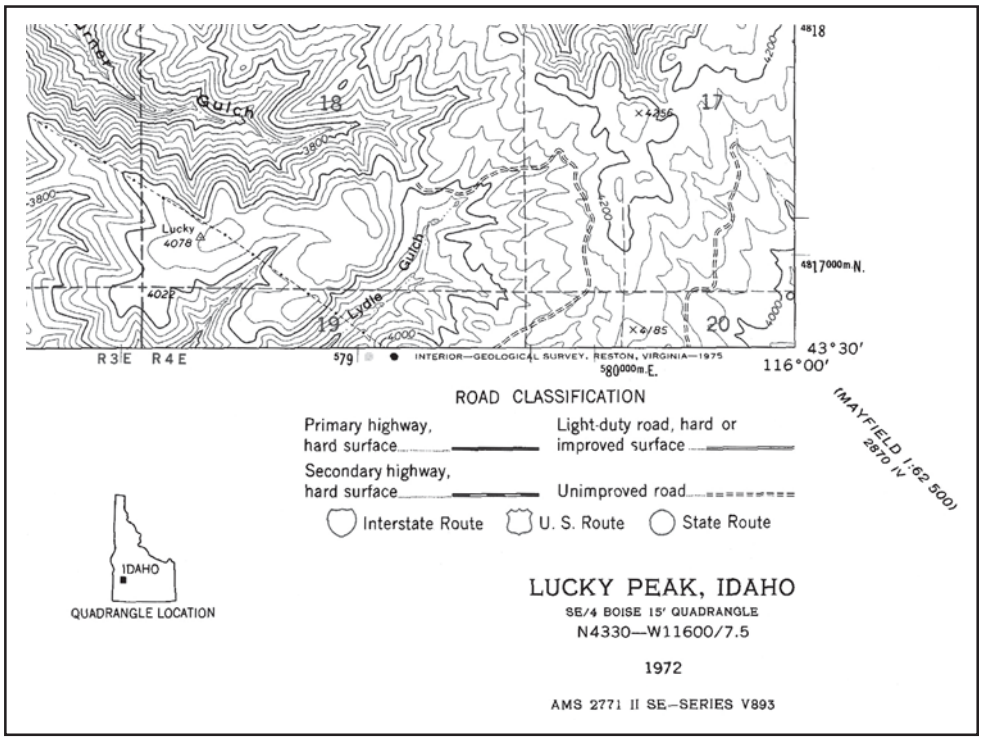


**Figure 2-3. Road classification, revision date, quadrangle location and adjoining maps.**

Some topographic maps will have an adjoining quadrangle legend (Figure 2-4).

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 1. NORTHEAST EMMETT<br>2. MONTOUR<br>3. HORSESHOE BEND<br>5. CARTWRIGHT CANYON<br>6. STAR<br>7. EAGLE<br>8. BOISE NORTH |
| 4 | PEARL | 5 | |
| 6 | 7 | 8 | |

**Figure 2-4. Example of an adjoining quadrangle legend.**

## Map Scale (bottom center of map)

The map scale indicates the ratio or proportion of the horizontal distance on the map to the corresponding horizontal distance on the ground (Figure 2-5).

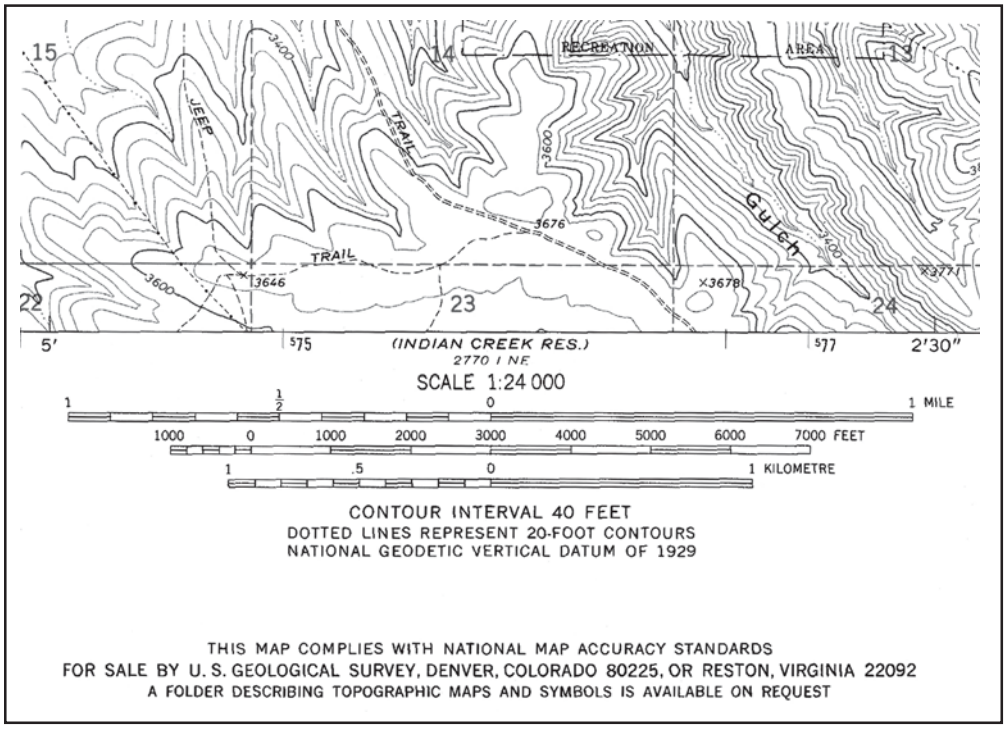


**Figure 2-5. Map scale (fractional scale and bar scale) and contour interval.**

There are two types of scales on the topographic map:

- Fractional Scale

  The fractional scale expresses the ratio of the map distance to the ground distance in **like** units of measurements. It is usually written as a fraction or ratio. For example, the map in Figure 2-5 has a map scale of 1:24,000 which means one inch on the map is 24,000 inches on the ground.

  Typically, USGS produces maps using the 1:24,000 scale, but will also produce maps using 1:62,500 and 1:250,000 scale. The 1:24,000 scale provides larger and clearer details than the 1:250,000, but it does not cover as large an area.

  The maps produced at a 1:24,000 scale (1 inch represents 24,000 inches or 2000 feet) are commonly known as 7.5-minute quadrangle maps; each map covers 7.5 minutes of latitude and 7.5 minutes of longitude, which is approximately 8 miles (north/south) and 6 miles (east/west). The primary scale used in Alaska topographic maps is 1:63,360 (1 inch represents 1 mile) due to the size of the state. The Alaska quadrangle map covers 15 minutes of latitude and varies from 20 – 36 minutes of longitude.

- Bar or Graphic Scale

  A graphic scale or comparison scale is entirely different from the representative fraction scale. It usually compares map distances to the ground distance in **different** units of measurements.

  Usually a graphic scale is a line marked off on a map indicating so many inches or millimeters equal to so many feet, kilometers, chains, or miles on the ground. A comparison scale of 1 inch to 2000 feet means that 1 inch on the map is proportioned to 2000 feet on the ground. We are comparing inches and feet which are **different units** of measurement.

## Contour Interval (bottom center of the map)

Contour interval is the difference in elevation between two adjacent contour lines. In Figure 2-5, the contour interval is 40 feet. On USGS maps, contour intervals are usually 1, 5, 10, 20, 40, and 80 feet. If the contour interval is not printed on the map, it can be calculated (which is discussed later in this chapter).

## North Arrow, Declination, and Map Production Information (bottom left corner of map)

It is common practice for maps to be oriented with true north at the top. Most USGS maps have a symbol of arrows pointing to the geographic North Pole (shown by a star), magnetic north (MN) and grid north (GN). Grid north shows the difference between geographic north (latitude/longitude) and the UTM grid.

In Figure 2-6, the magnetic north is 18.5 degrees east. The difference between the geographic North Pole and magnetic north is the magnetic declination for that map.

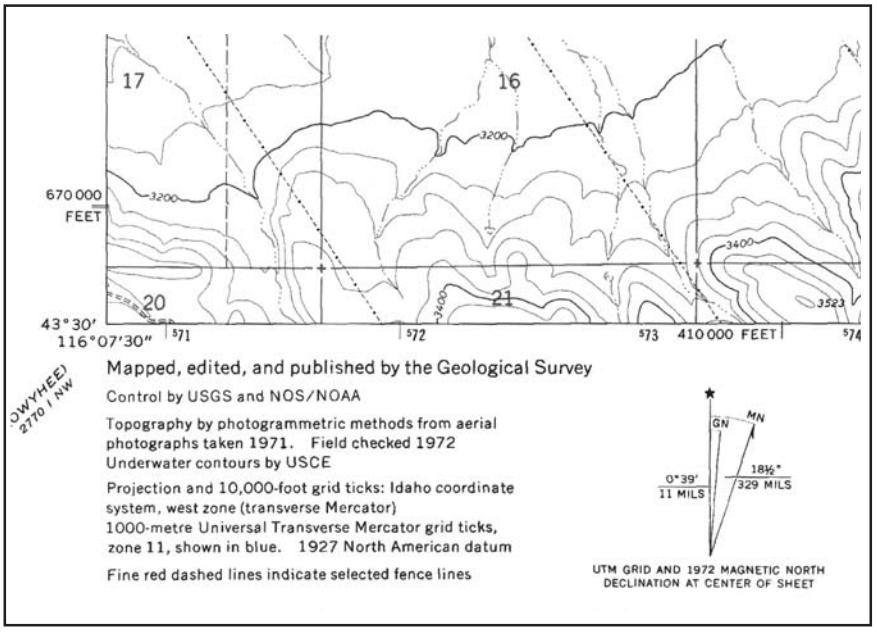


**Figure 2-6. North arrow and magnetic declination.**

If the declination is not indicated on the arrow diagram, it can be found in the "Map Production Information" which is in the lower left corner of the map (Figure 2-7). The map production information section provides additional information on how and when the map was created. Sometimes the magnetic declination is printed here.

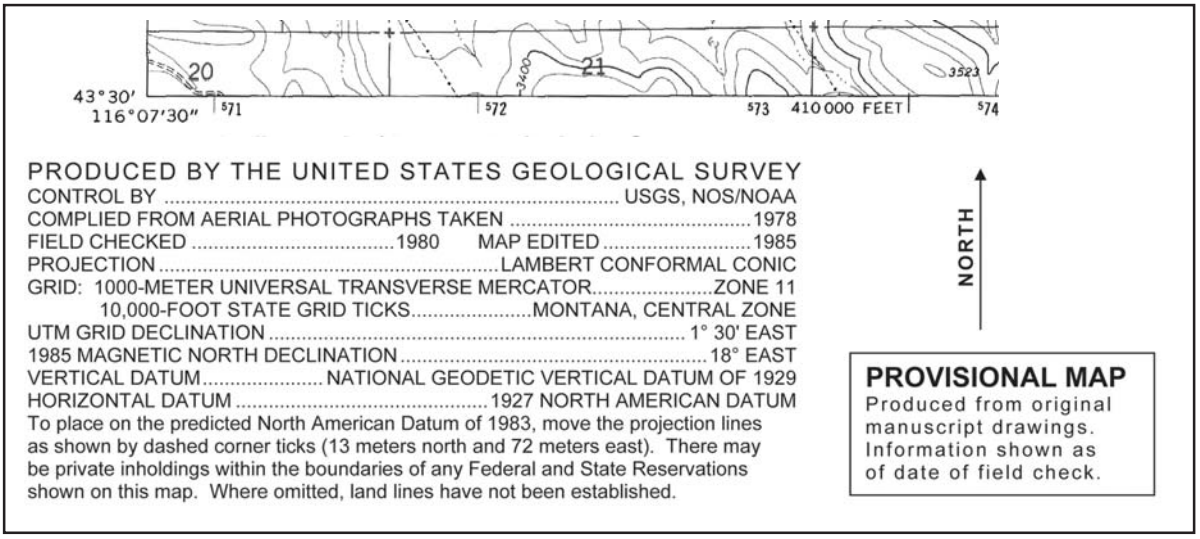


**Figure 2-7. Map production information block often includes revision dates, datum, and UTM zone.**

## Datum and UTM Zone

The datum and UTM zone, which are extremely important when using a GPS receiver, can also be found in this block (Figure 2-7). Vertical and horizontal datums may be listed on the map; however, if the map lists only one datum then the vertical and the horizontal datum are the same.

## Latitude and Longitude (edges of map)

Latitude and longitude lines are indicated with fine black tick marks along the edges of the map (Figure 2-8). Topographic maps do not show the latitude/longitude lines – just the tick marks. The numbers next to the tick marks indicate degrees (°), minutes (') and seconds ("). On 1:24,000 scale maps, latitude and longitude tick marks are indicated every 2.5 minutes.

- Longitude tick marks are on the top and bottom edges of the map and latitude tick marks are on the right and left edges. Note that the degrees may be left off (as an abbreviation) and you may only see the minute and/or second designations.

- Reference coordinates for latitude and longitude (degrees, minutes, and seconds) are black and located on the four corners of the map.

- The intersection of latitude and longitude lines are noted by cross-marks (+).

When reading latitude/longitude, pay close attention to the units (degrees, minutes, seconds) because it is easy to misread them. Refer to Chapters 3 and 6 for additional information on latitude and longitude.

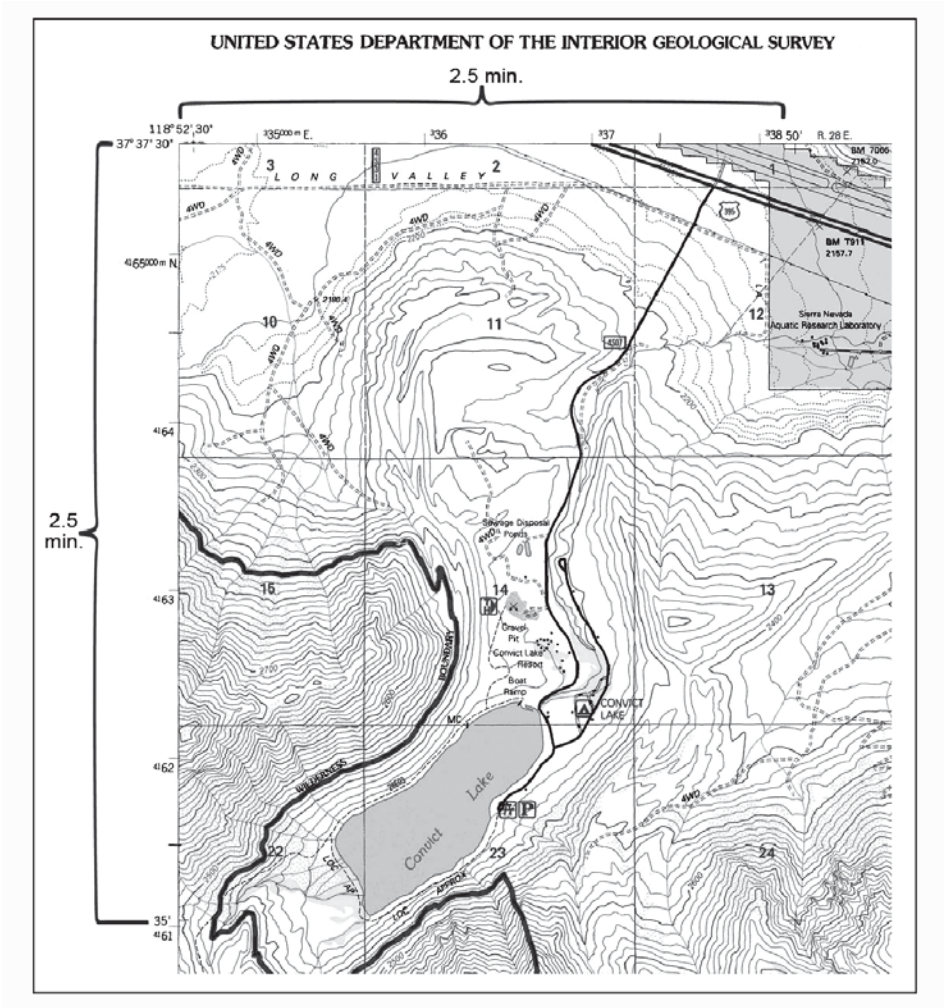


**Figure 2-8.**
**Longitude tick marks (50'), latitude tick marks (35'), reference coordinates (118° 52' 30" and 37° 37' 30"), and cross-mark (+) in bottom right corner.**

## Universal Transverse Mercator (UTM) (edges of map)

Prior to 1978, USGS topographic maps used blue tick marks along the edge of the map to illustrate where the UTM grid lines were located. Since 1978, USGS topographic maps actually show UTM grid lines (black) on the map and the coordinate values are in the margin. On USGS topographic maps, 7.5 quadrangle, the UTM grid lines are marked at 1,000 meter increments (Figure 2-9).

- Abbreviated easting values, for example $^{3}$**36**, are located on the top and bottom edges of the map.
- Abbreviated northing values, for example $^{41}$**64**, are located on the right and left edges of the map.
- Reference coordinates for UTM are located near the southeast and northwest corners of the map. Notice that the large bold numbers increase as you go north and east.

Refer to Chapters 3 and 6 for additional information on UTM.

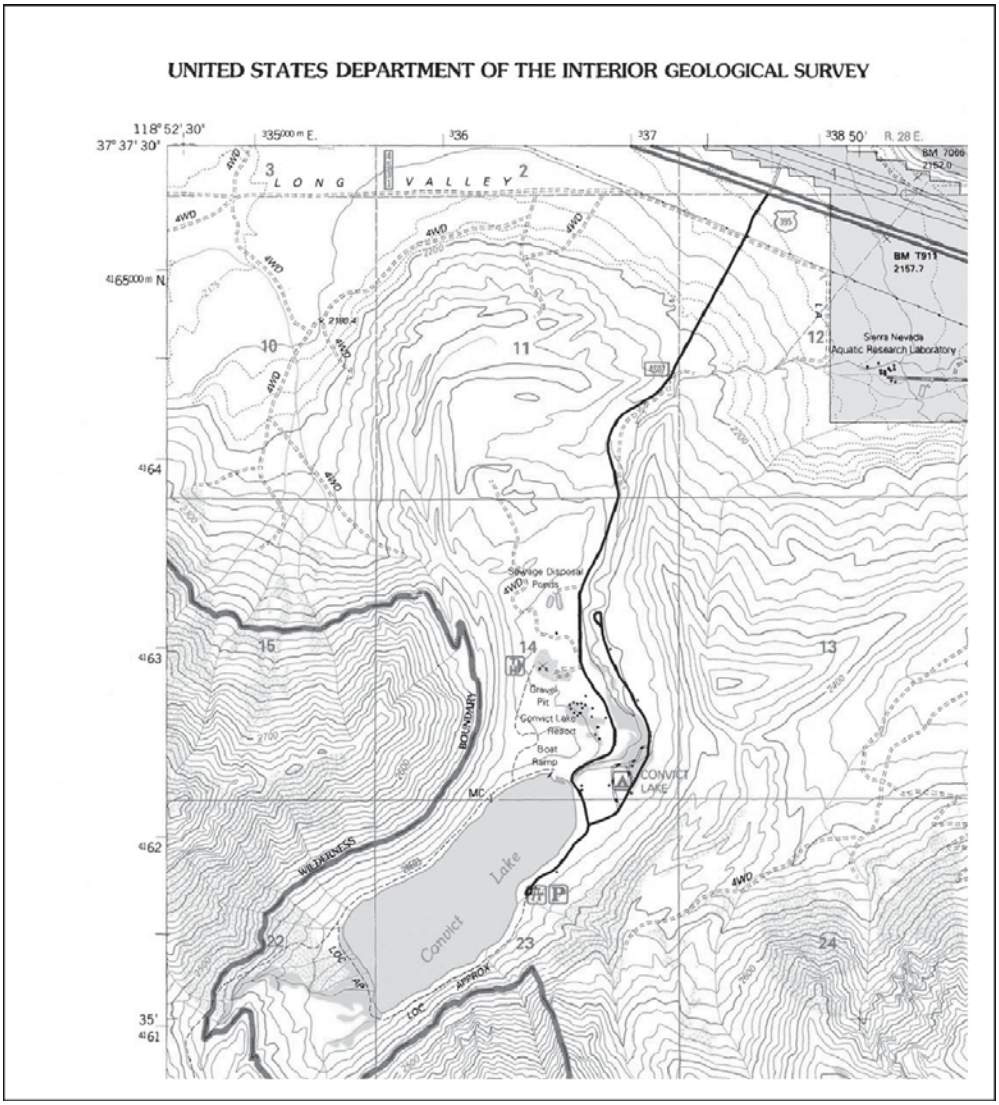


**Figure 2-9. Easting ($^{3}$36, $^{3}$37, $^{3}$38) and northing ($^{41}$64, $^{41}$63, $^{41}$62, $^{41}$61) value tick marks and reference coordinates ($^{3}35^{000m}$E. and $^{41}65^{000m}$N.).**

## Section, Township, and Range (edges of map)

Section, township, and range numbers are red.

- Section numbers may be printed along the edge, but they are typically printed in the center of the section. In Figure 2-10, some of the section numbers include 15, 16, 17, 18, 19.
- Township numbers are printed along the right and left edge of the map. In Figure 2-10, the township numbers are T.2S and T.3S.
- Range numbers are printed on the top and bottom edge of the map. In Figure 2-10, the range numbers are R.1E and R.2E.

Refer to Chapter 3 for additional information on section, township, and range.

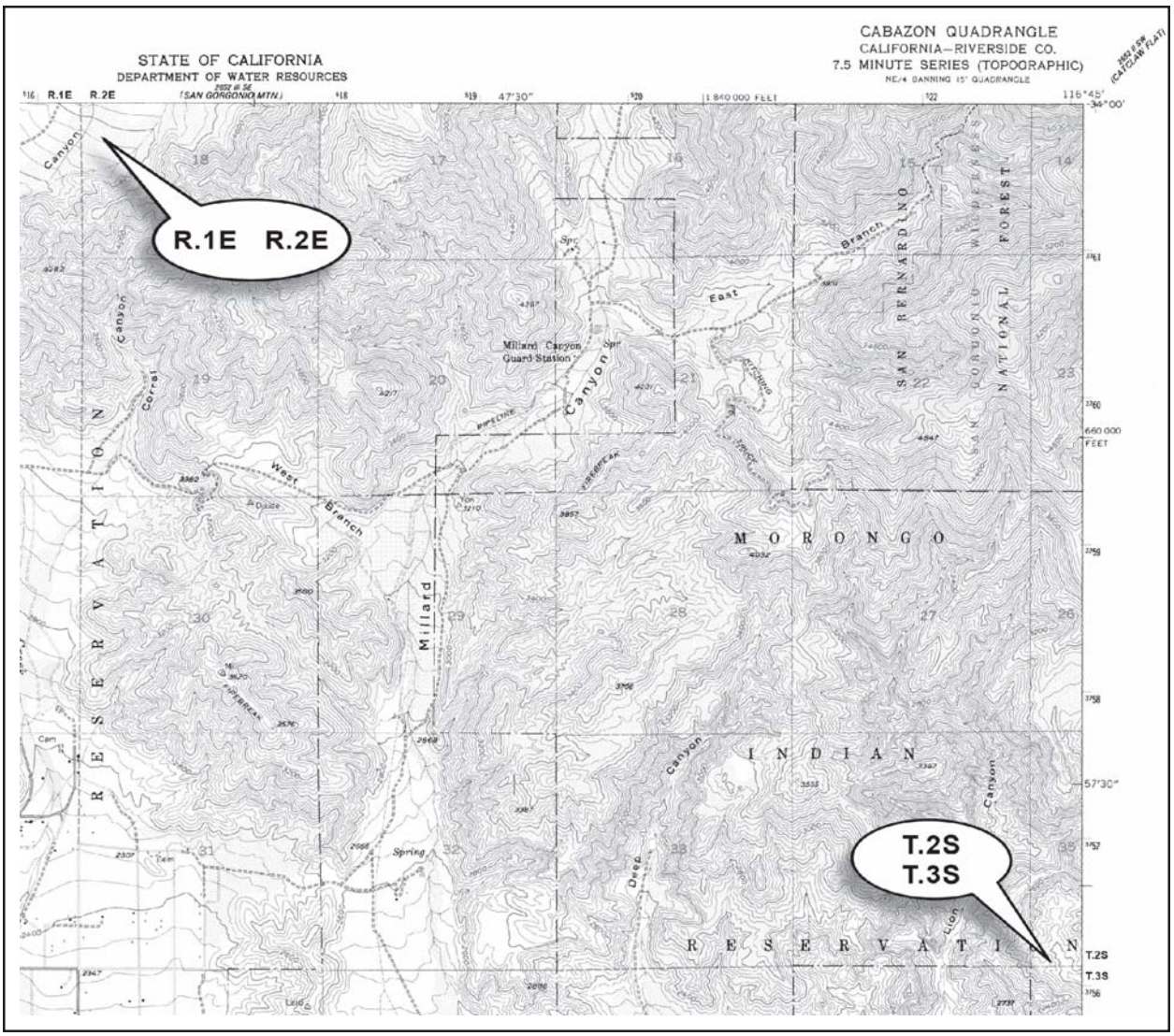


**Figure 2-10. Sections, townships, and range.**

## Interpreting Contour Lines

Contour lines on a map show topography or changes in elevation. They reveal the location of slopes, depressions, ridges, cliffs, height of mountains and hills, and other topographical features. A contour line is a brown line on a map that connects all points of the same elevation. They tend to parallel each other, each approximately the shape of the one above it and the one below it. In Figure 2-11, compare the topographic map with the landscape perspective.

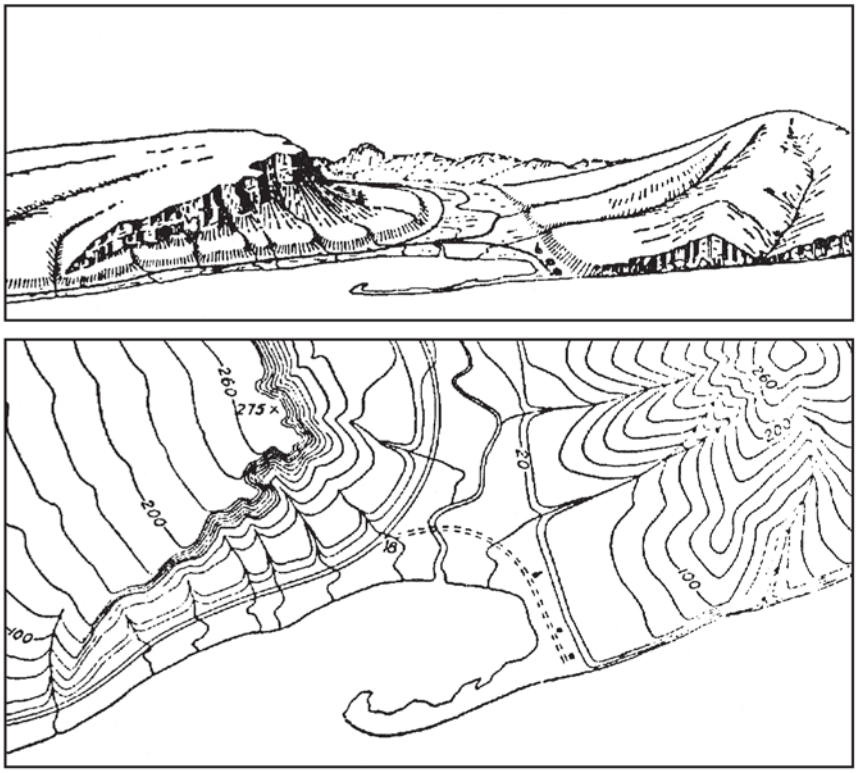


**Figure 2-11. A contour map and what it looks like from a landscape perspective. Note that contour lines are far apart for level land and almost touch for cliffs.**

## Contour Characteristics

Contours have general characteristics; some of which are illustrated in Figures 2-12 and 2-13.

- Concentric circles of contour lines indicate a hill.
- Evenly spaced contours indicate uniform slope.
- Widely spaced contours indicate a gentle slope.
- Widely spaced contours at the top of a hill indicate flat hilltop.
- Close together contours indicate steep slope, wall, or cliff.
- Close together contours at the top of a hill indicate a pointed hilltop.
- Crossing or touching contours indicate overhanging cliff.

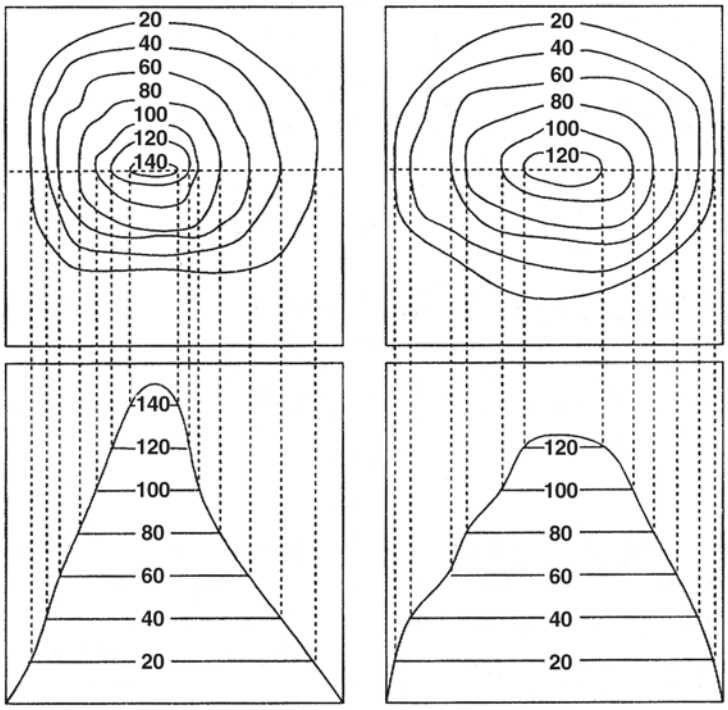


**Figure 2-12. Evenly and widely spaced contours indicate type of slope and shape of hilltop.**

- Jagged, rough contours indicate large outcrops of rocks, cliffs, and fractured areas.
- "V" shape contours indicate stream beds and narrow valleys with the point of the "V" pointing uphill or upstream.
- "U" shape contours indicate ridges with the bottom of the "U" pointing down the ridge. A saddle is a ridge between two hills or summits.
- "M" or "W" shape contours indicate upstream from stream junctions.
- Circles with hachures or hatch lines (short lines extending from the contour line at right angles) indicate a depression, pit, or sinkhole.
- Spot elevations (height of identifiable features) such as mountain summits, road intersections, and surfaces of lakes may also be shown on the map.

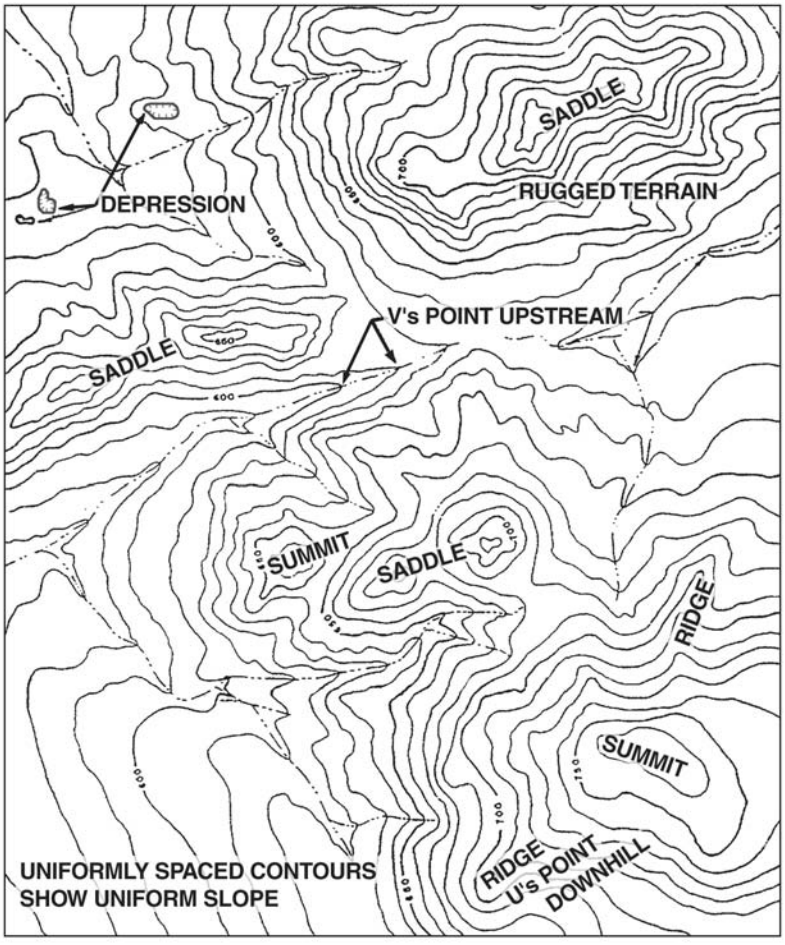


**Figure 2-13. Contour lines and topographic features.**

## Contour Interval

Contour interval is the difference in elevation between two adjacent contour lines. On USGS maps, contour intervals are usually 1, 5, 10, 20, 40, and 80 feet. Occasionally you will find a map with a 25 foot contour interval or metric units, but not often. To make the contours easier to read, every fifth one is the **index contour** which is printed darker and has the elevation in feet from mean sea level marked on the line (Figure 2-14). The thinner or lighter colored contour lines are called **intermediate contours**.

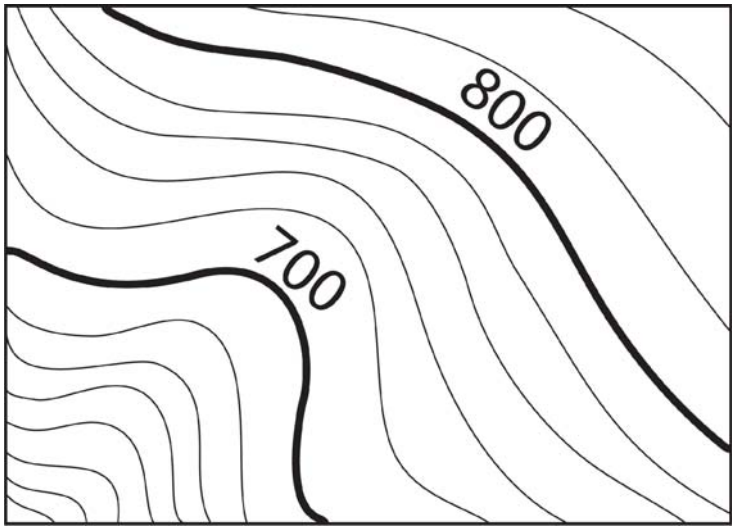


**Figure 2-14. Topographic map showing elevation of two index contours (700 and 800).**

The contour interval is typically printed at the bottom of the map; however, if the contour interval is unknown, there is a way it can be calculated. Follow the steps in Table 2-1 to calculate the contour interval of the topographic map below.

**Table 2-1. Calculating the contour interval.**

| Steps | Directions |
|---|---|
| 1 | Find two index contours near each other:<br>The index contours marked **4400** and **4600.** |
| 2 | Determine the **difference** in elevation between the two index contours:<br>4600 ft. – 4400 ft. = **200 ft.** |
| 3 | Count the number of contour lines between the two index contours:<br>There are **5** lines.<br>**Note:** There are actually 4 contour lines between the two index contours, but you always count one of the index contours as well as all of the contours in between. |
| 4 | Divide the difference (step 2) by the number of lines (step 3):<br>200 ft. ÷ 5 = **40 ft.**<br>This is the contour interval. |