TOPOGRAPHIC MAP SKILLS

Topographical maps are essential tools in the first stages of site characterization. A topographic map gives the field team information on the layout of the area under study. From this, they can learn more about surface water drainage and the geologic origins of the area. The location of lakes, swamps, and springs also gives the team some information about the potential depth and flow of ground water beneath the site. With information learned by studying topographic maps, researchers can determine areas where further study will be required.

4.33 Types of Maps

What is a map?

How can maps help us?

Maps are devices used to represent the surface of Earth so that we can tell such things as where we are, how to travel to other locations, or who owns or controls various pieces of land. There are many kinds of maps, each made for a particular purpose. A road map, for example, shows the roads and highways we might use to drive from one town to another. There are probably maps around your school which show the United States or the world. These maps might be political maps that use colors to designate States or countries in order to show who controls various regions of the world.

4.34 Topographic Maps

What is a topographic map?

What is the distinctive characteristic of a topographic map?

Another special type of map is the *topographic map*. The word “topographic” is of Greek origin and means “to describe or draw a place.” Essentially, a topographic map is the projection of a landscape onto a piece of paper (Figures 1a and 1b). Both natural and manmade features are indicated by symbols. The distinctive characteristic of a topographic map is the information

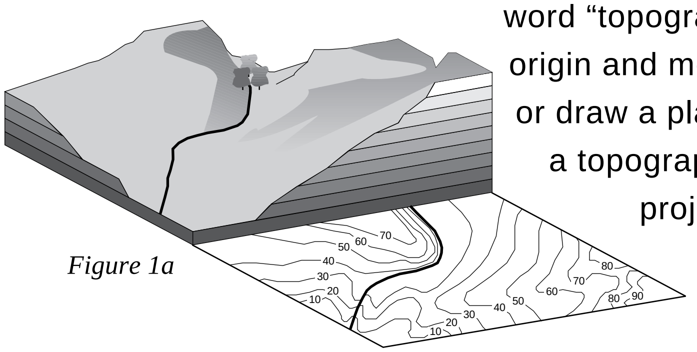


Figure 1a

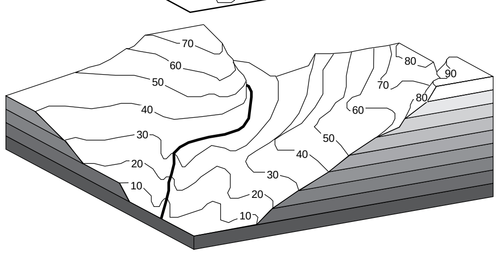
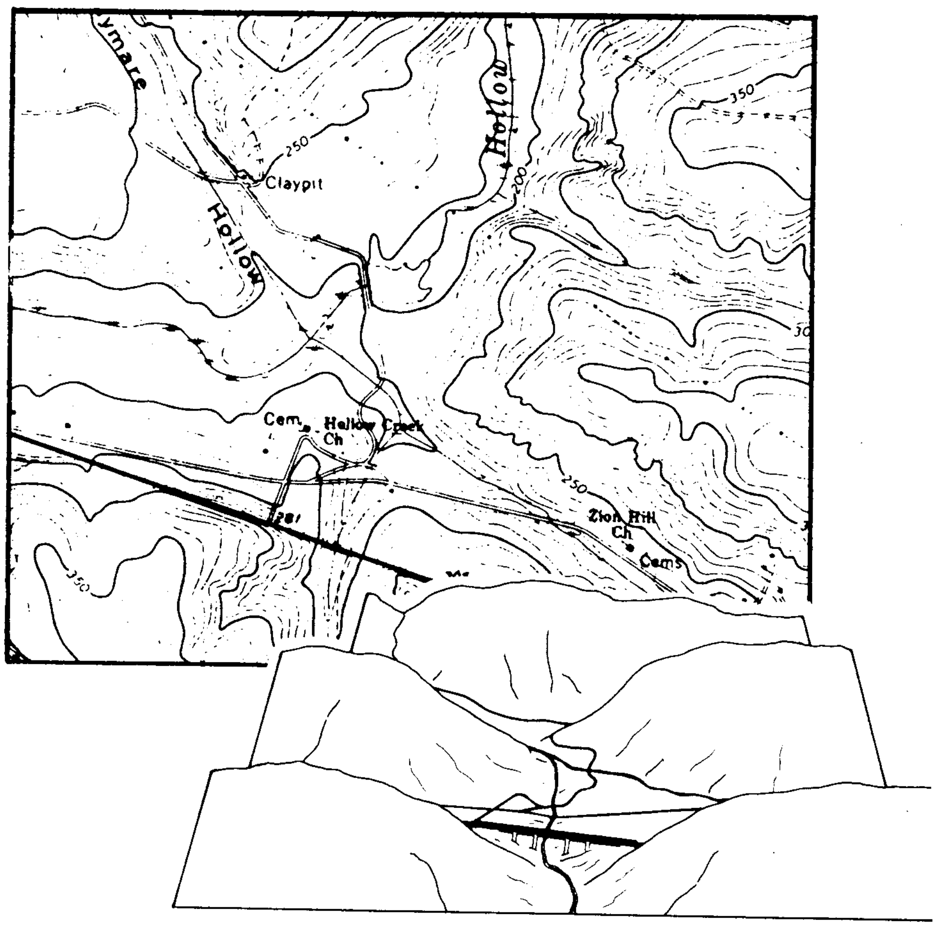


Figure 1b

it provides about the shape of Earth's surface. Topographic maps show detailed surface features, such as elevation and slope.

Figures 2a and 2b introduce some important features of topographic maps. Figure 2a is from a map of an area in South Carolina, and Figure 2b is a portion of a map of an area in Nevada. Included with each figure is a sketch of the landscape represented by the map. These maps show contour lines and contour intervals and quickly give a general impression about the land represented.

Figure 2a



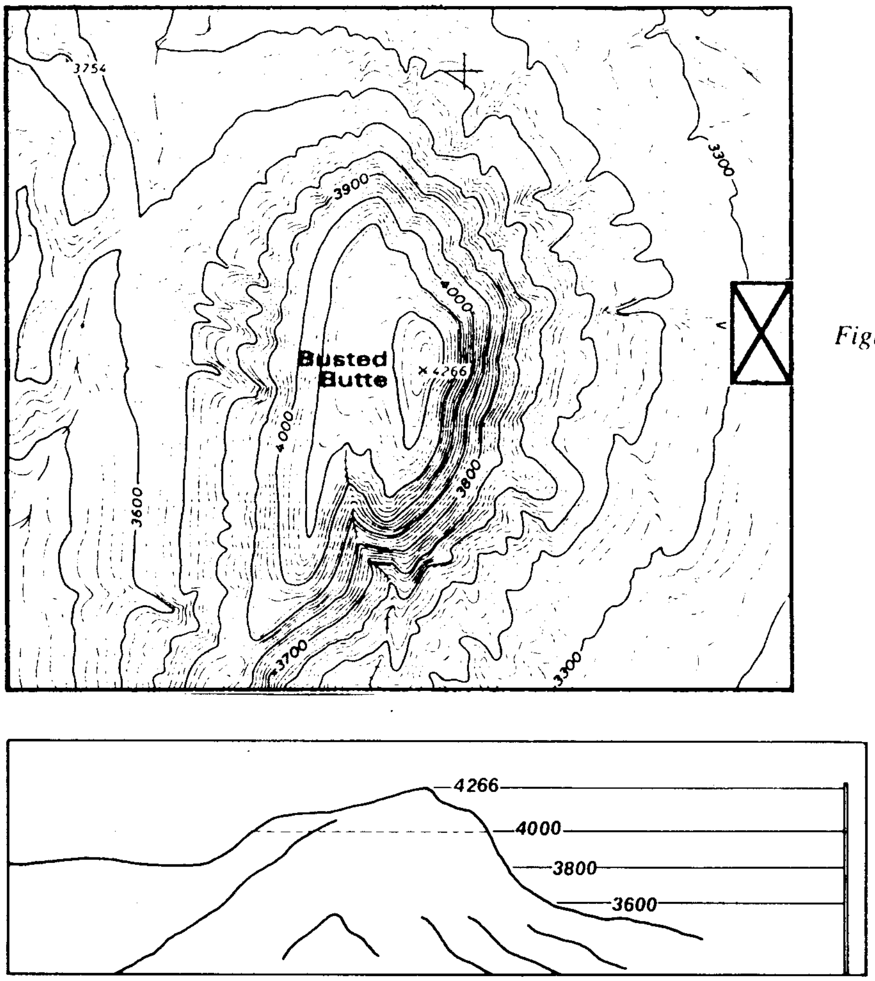

3754
3300
3900
4000
Busted Butte
× 4266
4000
3600
3800
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Figure 2b

4.35 What are contour lines?

Define contour lines.

When you look at the maps in Figures 2a and 2b, you will see that they are just a collection of lines. These are called *contour lines*. Like the boundary lines for States, contour lines are imaginary lines. On topographic maps they are printed in brown and follow the land surface at a constant elevation.

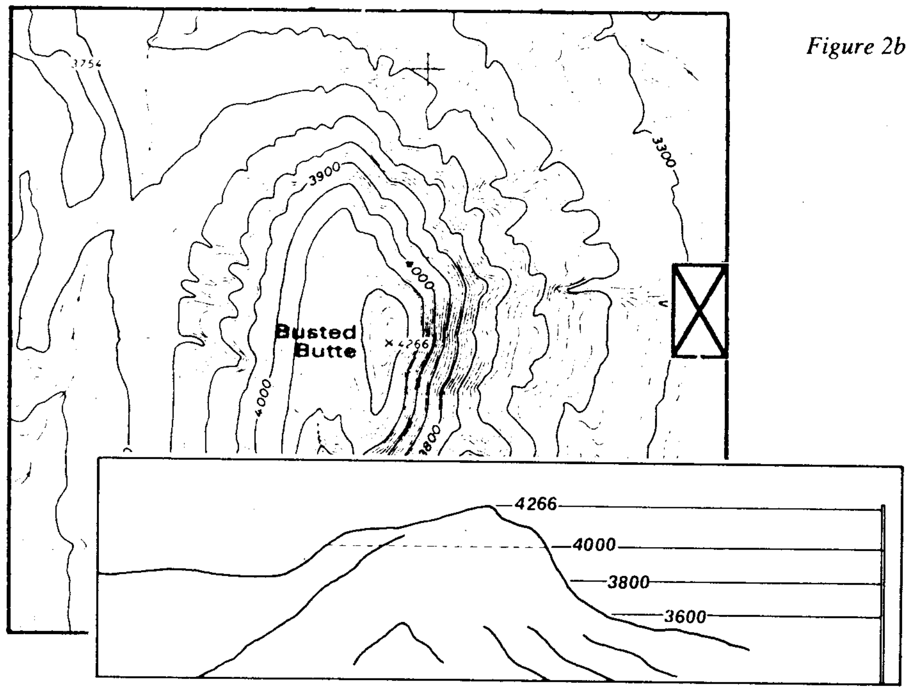

Figure 2b

Do contour lines change elevation?

Examine Figure 2b to see exactly what contours are. The important thing to remember is that a contour line never changes elevation. In Figure 2b, the contour labeled 4000 is an imaginary line that follows the land surface at 4,000 feet above sea level. If you were on the ground directly on this contour, you could walk along the contour and circle Busted Butte without ever having to go up or down. If you had friends in a helicopter looking at Busted Butte from directly above the **X** shown on the map, they would see your progress as shown in the sketch.

If your friends wanted a view similar to the one represented on the map, they would have to fly to a much higher elevation directly over Busted Butte. This tells us another interesting fact about topographic maps: they portray the landscape as if you were looking directly down onto the Earth's surface from high above the land. In fact, most topographic maps made today are developed from aerial photographs.

Contour Interval

What is a contour interval?

Another important feature of topographic maps is the contour interval, which is the elevation difference between adjacent contour lines. The contour interval for a given map is a constant distance, usually given in feet or meters. Look at the 3,900 foot contour line in Figure 2b. Now count the contour lines between the 3,900 foot line and the 4,000 foot line. There are four contour lines between the 3,900 and 4,000 foot contours. This means there are five intervals (count them if you like) in the 100 feet between 3,900 and 4,000 feet. We know that the distance between lines on the map is constant. Therefore, we can figure the contour interval by dividing the total distance of 100 feet (4,000 feet to 3,900 feet) by the number of intervals (which is 5): 100 feet divided by 5 intervals = 20 feet per interval. Each contour line is 20 feet different (either higher or lower) from the ones adjacent to it. Therefore, we say this map has a contour interval of 20 feet.

How many feet is each contour line?

Contour interval may be different from map to map because it is chosen to show sufficient elevation differences without cluttering the map or obscuring other features. Generally, mountainous terrain is shown with larger contour intervals and flat terrain is shown with smaller contour intervals. The reason for this can be understood by comparing the maps in Figures 2a and 2b.

The contour interval for the map of Busted Butte in Figure 2b is 20 feet. You can see how close together the contour lines are here. This is because the slope is very steep. Now look at Figure 2a. The contour interval of this map is 10 feet. If the contour interval for Figure 2b were 10 feet, there would be so many lines that we could not read the map in the steep areas. If the contour interval for Figure 2a were 20 feet, we could read the map easily but a lot of detail would be missing. (Imagine the figure with every other contour line missing.)

The contour interval of a topographic map is clearly shown on the bottom margin of the map. On the map itself, contour elevations are labeled in the same units (feet or meters) that are used to specify the contour intervals. Note that every fourth or fifth contour is in bold print. This is simply to make the contours easier to read.

Visual Impression of Contours

How is the visual impression of contours used?

The visual impression of contours allows the user to gain an understanding of the lay of the land without reading the elevation of every single contour. Steep slopes will have closely spaced contours while gentle slopes will have widely spaced contours (Figure 3).

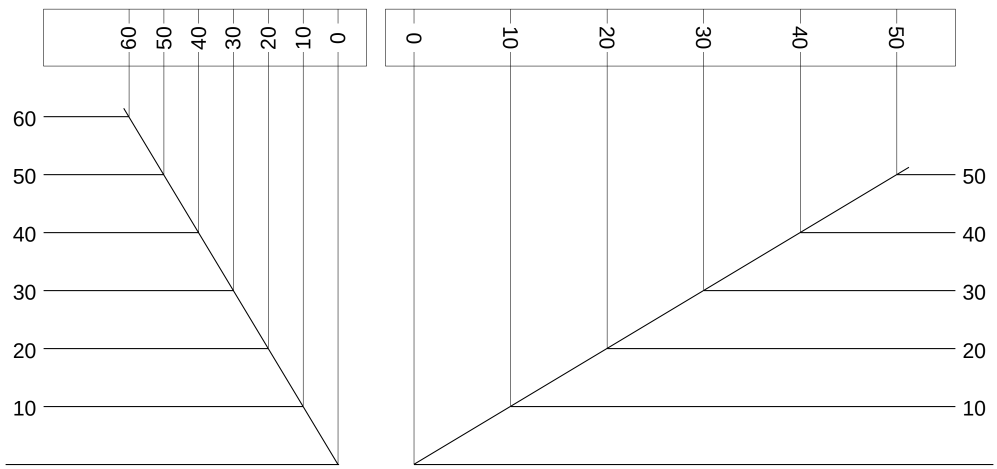

Figure 3

Flow Direction of Rivers or Streams

What is used to show the direction flow of rivers, streams, and creeks?

The flow direction of rivers, streams, or creeks can be determined by the shape of the contours as they cross the water. The contour always makes a sharp V-shaped turn which points upstream. This can be seen in Figure 4, which shows the flow of a stream. The contours make sharp V-shaped bends as they cross the streams. These V's always point upstream, as shown in the sketch.

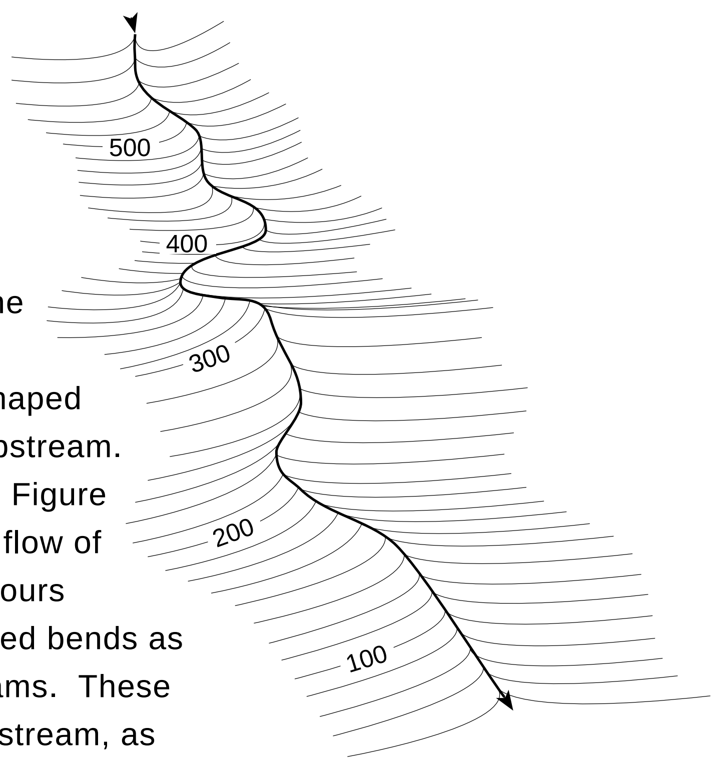

Figure 4

4.36 Scale

What is scale?
Where is it indicated?

The other fundamental characteristic of a topographic map besides the contour interval is the scale. The scale is also prominently displayed along the bottom margin. The scale of the map is the relationship between distance on a map and the corresponding distance on the ground.

How is scale represented?

Why is scale expressed by a ratio useful?

The graphic representation of the scale is easy to understand. One mile on the ground is represented on the map by the length of the appropriate bar scale. The scale expressed as a ratio is more useful because it allows the user to determine distances with a greater degree of precision by doing the appropriate calculation. For instance, 1:24,000 may mean one inch on the map is 24,000 inches on the ground. Dividing 24,000 by 12 to get feet tells us that one inch on the map equals 2,000 feet on the ground.

What is the easiest way to think of the scale of a map?

Now the distance between any two points on the map can be determined by measuring with a suitable ruler and multiplying. If a ruler accurate to a tenth-of-an-inch measures the distance between two points as 8.3 inches, then the distance on the ground is 8.3 x 2,000 feet = 16,600 feet. Since the scale is a ratio, its general meaning applies to any suitable unit of length. Therefore, the easiest way to think of the scale is this: one unit on the map is 24,000 units on the ground. Units can be U.S. or metric.

4.37 Map Coordinates

What are the units of measurement used in standard USGS maps?

The dimensions of standard U. S. Geological Survey (USGS) topographic maps are measured in degrees, minutes, and seconds of latitude and longitude. A USGS map is always oriented with true north in the vertical direction at the top of the map. The coordinates of each corner are shown in the margins of the map. The dimensions of a standard 1:24,000 scale map are 7-1/2 minutes of latitude by 7-1/2 minutes of longitude. The maps are further subdivided into 2-1/2-minute sections by two small ticks along each edge of the map and four cross ticks in the interior of the map (Figure 5). By using these ticks to lightly pencil in the 2-1/2-minute sections, it is possible to determine the coordinates of any point on the map to one second of latitude and longitude. The only additional tool required is an engineer's scale with appropriate divisions.

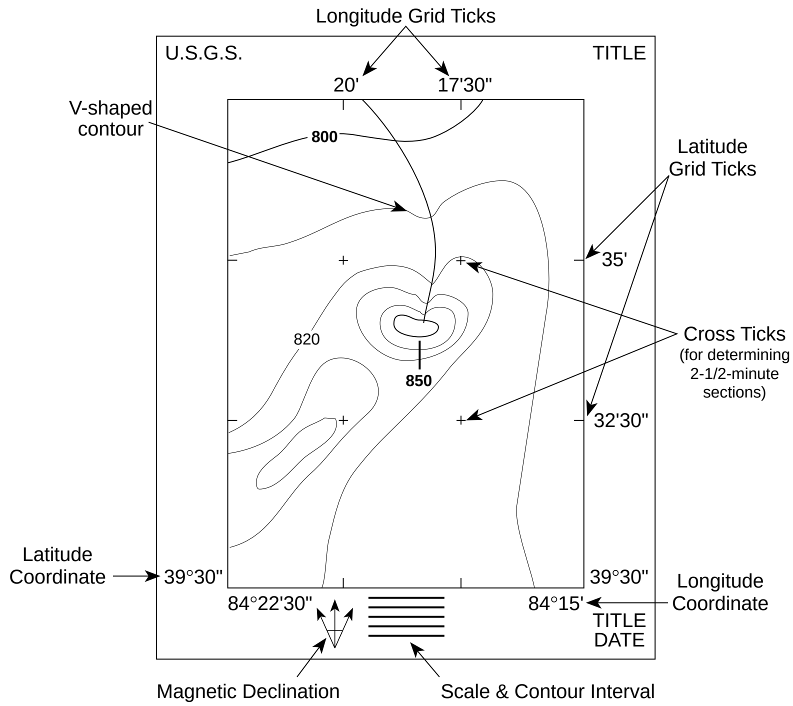

Figure 5. 7-1/2-Minute Map

How does one divide the 5x5 minute section into 300 divisions?

Locating a point's coordinates on a map is demonstrated schematically in Figures 6 and 7 below. On this 15-minute map, each section would have dimensions of 5 minutes of latitude by 5 minutes of longitude. The location of a point in this section can be determined to the nearest second if we can divide the section into 300 divisions (60 seconds per minute x 5 minutes = 300 seconds). By using the 50 division scale on the engineer's scale, it is possible to effectively divide the 5 x 5 minute section into 300 divisions. This is done by laying the scale down with the zero on one line of longitude and the 300 on the other line of longitude while making sure the point we are interested in lies along the edge of the scale. (To do this, slide the scale until all three points are as illustrated.) This effectively divides the section longitudinally into 300 divisions (Figure 6).

The same method is used to divide the section of latitude into 300 divisions by laying the scale down with the zero on one line of latitude and the 300 on the other line of latitude, while keeping the point along the edge of the scale (Figure 7).

Where do you find the coordinates of each corner? These directions are for a 15-minute map. The procedure for locating a point's coordinates on a 7-1/2-minute map are the same, except that the dimensions of the sections are 2-1/2 minutes by 2-1/2 minutes. Therefore, each section needs to be divided into 150, not 300, divisions (60 seconds per minute x 2-1/2 minutes =150).

What is the procedure for locating a point's coordinates on a 7 1/2 minute map?

Longitude or Latitude

In the example in Figure 6, suppose the point lies adjacent to 142 on the scale. This means the longitude of that point is 142 seconds east of the line 115 ° 30'. Convert this to 2 minutes, 22 seconds east of 115 degrees 30 minutes (142 seconds divided by 60 seconds per minute = 2 minutes, 22 seconds). Subtracting 2 minutes, 22 seconds from 115 degrees, 30 minutes gives 115 degrees, 27 minutes, 38 seconds. We subtract here because longitude is measured from east to west. In other words, higher numbers are farther west. How far west is the point from the line 115 ° 25'? (There are a couple of ways to figure this out.)

How is the longitude or latitude determined?

The latitude of a point is determined in a similar way, as is shown in Figure 7. First, find the distance from the line of latitude. Convert to minutes and seconds. If a point is north of a known latitude, we add. If a point is south of a known latitude, we subtract.

When do you add? Subtract?

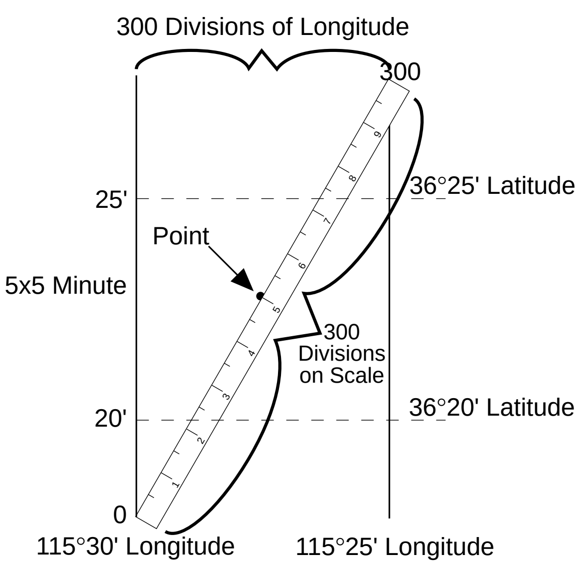

Figure 6.
Locating a point's longitude on a 15-minute map

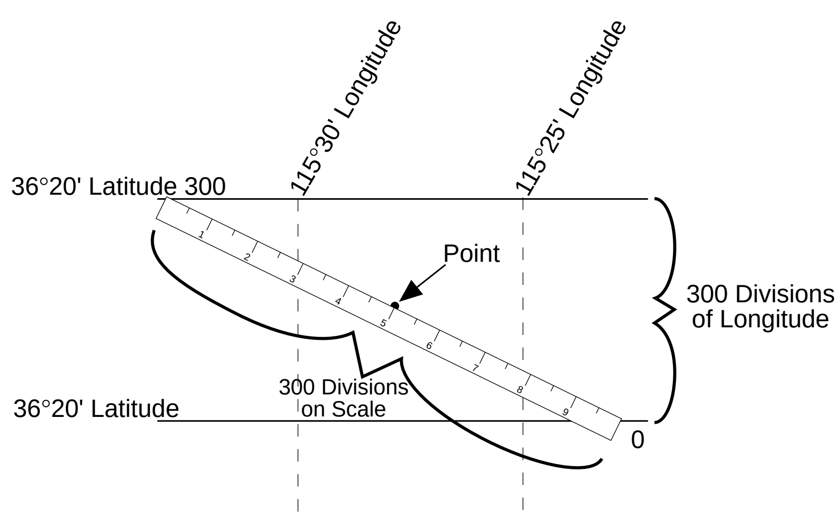

Figure 7.
Locating a point's latitude on a 15-minute map