3

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Topographic Maps

3.1 INTRODUCTION

A topographic map is an extremely useful type of map that adds a third dimension (vertical) to an otherwise two dimensional map defined by the north, south, east, and west compass directions. This third dimension on a topographic map is represented by contour lines, which are imaginary lines drawn on a map that represent an elevation above average sea level (a.s.l.) or mean sea level (m.s.l). A map with such elevation lines will provide the map reader with detailed information regarding the shape of the Earth's surface. Knowledge of how to interpret a topographic map will allow a person to locate and identify features on the Earth's surface such as hills, valleys, depressions, steep cliffs and gentle slopes. In addition, the map reader will be able to identify areas that may be prone to geologic hazards such as landslides and flooding. Any person interested in purchasing property, landscaping, planning a hike or camping trip, or who needs to survey an area for construction of a road, dam, or building will want to first consult a topographic map.

3.1.1 Learning Outcomes

After completing this chapter, you should be able to:

- Recognize topographic patterns and geologic patterns
- Read and construct contour lines
- Determine gradients
- Read map scales and convert fractional scales
- Construct a topographic profile

3.1.2 Key Terms

- Bar Scale
- Benchmarks
- Contour Interval
- Contour Line
- Equator
- Fractional (Ratio) Scale

- radient
- achure Marks
- ndex Contour
- atitude
- ongitude
- Prime Meridian
- Relief
- Topographic Profile
- Verbal Scale
- Vertical Exaggeration

3.2 MAP ORIENTATION AND SCALE

All topographic maps produced by the U.S. Geological Survey (U.S.G.S) are oriented with north at the top of the map. Therefore if you locate a position on the map, and move towards the top of the map you are moving in a northerly direction, and if you are moving to the bottom of the map, you are moving towards the south. Any movement to the right will be towards the east, and a movement towards the left will be towards the west. These maps are oriented with their sides oriented parallel to lines of longitude, which are imaginary lines that circle the globe and are oriented so that they pass through the north and south geographic poles . Starting with the 0° longitude line (known as the Prime Meridian) that passes through the town of Greenwich, England, these lines increase up to 180° in both directions east and west of the Prime Meridian (Figure 3.1). It may help to visualize longitude lines if you think of an orange, which when peeled will show the sections of orange oriented like longitude lines that section the Earth. All longitude lines converge at the navel of the orange (or the geographic north and south poles of the Earth).

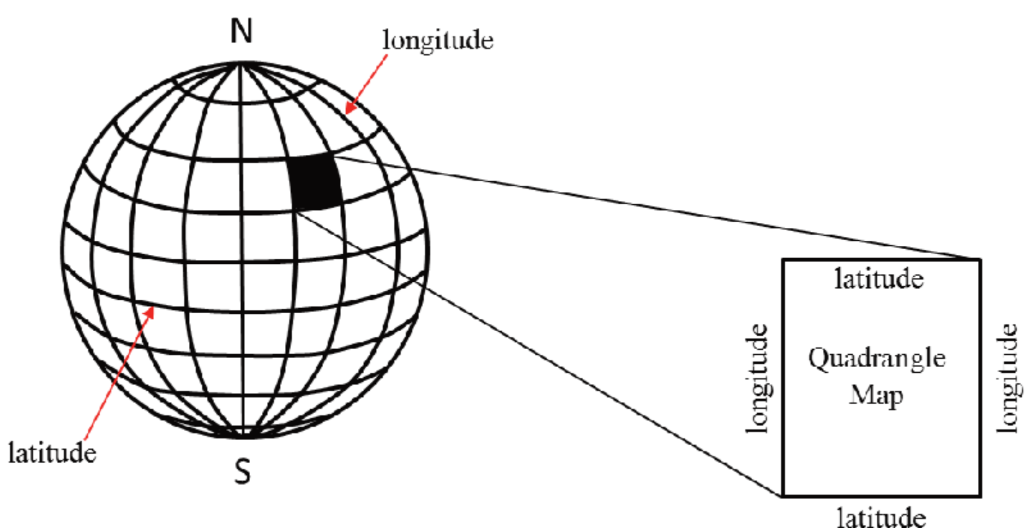

Figure 3.1 | Latitude and Longitude grid system of the Earth.
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The top edge and bottom edges of a topographic map are oriented so that they are parallel to lines of **latitude**, which are imaginary lines that circle the globe and are oriented at right angles to the Earth’s axis. The 0° latitude line is the Earth’s **Equator**; latitude lines increase up to 90° north or 90° south of the Equator, so that the North Pole has a latitude of 90°N, and the South Pole has a latitude of 90°S.

This grid system of latitude and longitude allows a position on the Earth to be uniquely defined, provided that the values for latitude are always identified by their position N or S of the Equator, and longitude is identified as E or W of the Prime Meridian. A degree of latitude or longitude represents a large distance on the Earth, therefore degrees have been further subdivided into minutes (a minute of distance is not the same as a minute of time!), and these minutes of distance are further subdivided into seconds. There are 60 minutes (60’) of distance in 1° of latitude or longitude, and there are 60 seconds (60”) of distance in one minute. An example of a precise location on the Earth’s surface would be 33°34’22”N, 85°05’46”W (the author’s location at the time of writing this chapter!), which is read as “33 degrees, 34 minutes, 22 seconds north latitude, and 85 degrees, 5 minutes, 46 seconds west longitude.”

The latitude and longitude coordinates of each topographic map are found at the corners of the map. Often these maps represent an area of the Earth that is smaller than one degree of distance. For example a common topographic map will show only 7.5 minutes of distance (7’ 30”) for both latitude and longitude; in this case, the top and bottom edges of a map will represent a distance of 7.5 minutes of latitude, and the left and right edges of the map will represent a distance of 7.5 minutes of longitude. Because the degree of distance is unchanging on the map, a

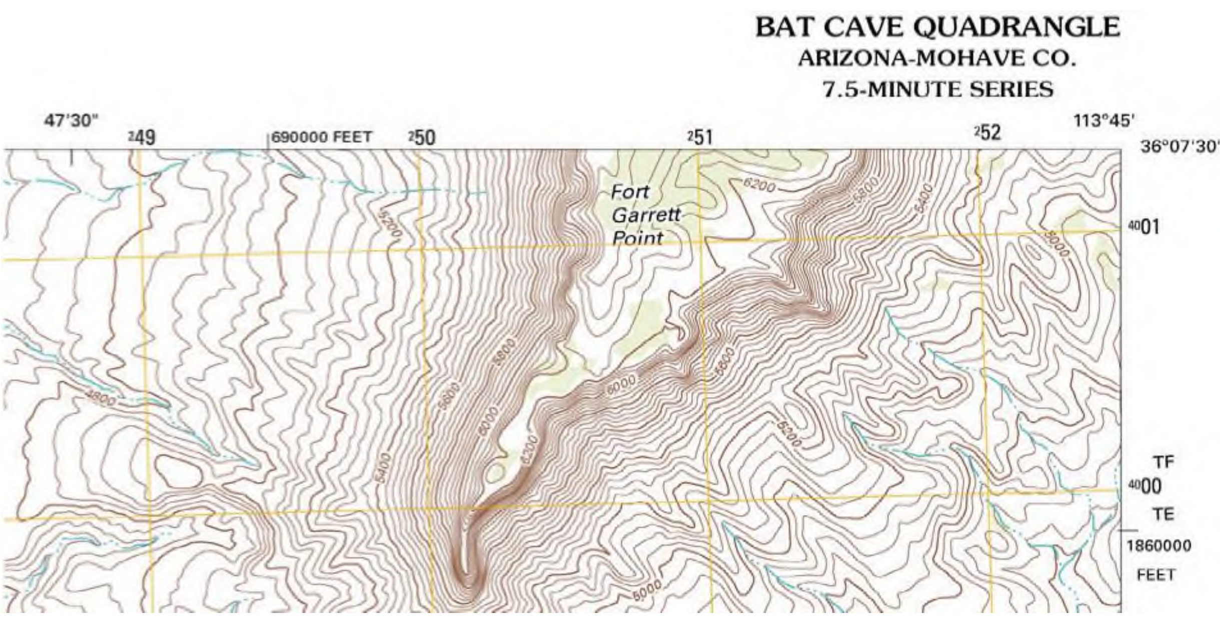

Figure 3.2 | This is the top right corner of a topographic map covering an area of 7’ and 30” of latitude and longitude. Note that the coordinates are written out completely in the corner of the map, but shorthand notation is used for the longitude coordinate on the top edge of the map (47’30”). Since the number increased towards the left (by a distance of 2’30”), we know that these are west longitude numbers (meaning the longitude at that tick mark is 113°47’30” W), since only lines of longitude located west of the Prime Meridian increase with distances to the left.

Author: USGS
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shorthand notation of just the change in minutes and seconds is labelled at certain positions on the map's edge. Only at the corners of the map will the degrees be included for the latitude and longitude coordinates. See the example above, which shows the top right corner of a 7.5 minute map or 7.5 minute quadrangle (the shape of most topographic maps). Additional numbers other than latitude and longitude are also shown on the edges of the map; these are a different grid system and will not be explained here.

Remember that the top and bottom edges of a topographic map are oriented parallel to lines of latitude. In Figure 3.2, the top edge of the map is a latitude line, so the coordinates that are changing as you move along the top of the map (in an East-West direction), must be longitude coordinates, since the latitude should not change. The bottom edge of this map is not shown, but you can predict what the latitude on the bottom edge should be: this map is of a region in Arizona, and since Arizona is located north of the Equator the latitude lines should increase from the bottom of the map, towards the top of the map (as all latitude lines increase as you move north of the Equator). For a 7.5-minute map, the increase in latitude from the bottom corner to the top corner should be exactly 0°7'30"N. This gives the bottom corner of the map a latitude of 36°00'00"N.

All maps are a scaled down version of the region of the world that they depict; if this were not the case, then the map that a person must carry would be the exact same size as a city (if it is a city map) or the size of a state (if it is a state map). Imagine trying to carry around with you a map of the entire country! The word "scale" refers to the amount of reduction, and all maps provide a map scale to indicate how much the area on the map has been reduced. Map scales are provided so that a map reader can determine exactly how much distance is actually represented on their map, or to measure the distance between two points on a map, or even to calculate the gradient of a hill or river. The two commonly used map scales on a topographic map are the **bar scale** (or **graphical scale**) and the **fractional scale** (also known as a **ratio scale**).

In Figure 3.3 there are three bar scales; each bar is a graphical representation of distance on the map, and it is up to the map reader to decide if they want to measure distances in kilometers, meters, miles, or feet. To find the distance between

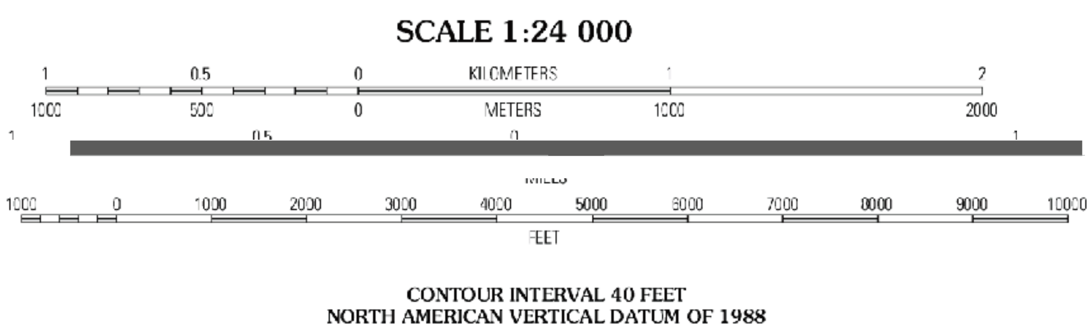

Figure 3.3. Map scales typically located on the bottom of a topographic map. Note that the bar scales start at zero in the interior of each bar for kilometers, miles, and feet. The bar to the left of zero is further subdivided for more accurate distance determinations.
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any two points on a map, a person could use a piece of paper to transfer the two points down to the bar scale and read the distance directly from the bar scale. Notice that each bar scale has the starting point (zero) within the interior of the scale, and not on the end of each scale (Figure 3.3).

The other type of map scale is the fractional scale; in the Figure 3.3 the fractional scale is 1:24,000. No units are reported as this ratio of 1 to 24,000 is valid for any unit of measure, provided that it is the same unit. For example, if using inches, then this map scale indicates that 1 inch on the map is actually covering 24,000 inches of ground (the distance between two locations in the real world). Or if using centimeters, then 1 centimeter on the map is actually covering 24,000 centimeters of ground. If our map was the same size as the area that it is representing (say for example, a map of the room you are currently sitting in), then the fractional scale of your map would be 1:1, and your map would be the exact same size as your room! This brings us again to the definition of a map, which is a scaled down version of a region that it is made to represent; maps that are greatly scaled down (greatly reduced) are called small scale maps even though they represent large sections of the Earth. For example, a 1:500,000 map will show a large section of the Earth, but small details are lost (such as building locations or small streets), whereas a 1:12,000 map is a large scale map even though it shows a much smaller region of the Earth's surface, but details can be seen (such as buildings, roads, and other landmarks). Placing your fingertip on the surface of a small scale map may cover an area of several miles, but placing your fingertip on a large scale map (such as 1:12,000) may cover only 1/10 of a mile.

One advantage to using a fractional or ratio scale is that any unit of measure can be used, and conversions are easy to make when needed. For example, for a 1:12,000 map 1 inch on the map is equal to 12,000 inches on the Earth's surface, and since there are 12 inches in 1 foot, we can also say that 1 inch on the map is equal to 1000 feet on the Earth's surface (convert the 12,000 inches to feet by multiplying by the conversion factor 1ft/12in). Simply verbalizing this scale by saying "on this map, 1 inch represents 1000 feet" is a third type of map scale, which for obvious reasons is called a **verbal scale**. Writing the phrase "1 inch equals 1000 feet" is a way of adding a verbal scale to your map.

Table 3.1 | Some useful conversion factors:

foot = 12 inches	meter = 3.28 feet
mile = 5280 feet	mile = 63,360 inches
kilometer = 1000 meters	kilometer = 0.62 miles

Remember that since conversion factors are equalities, such as 1 foot = 12 inches, then dividing one by the other (1ft/12in) gives you 1, and since multiplying anything by 1 does not change any value, all we really are doing is changing the units. Therefore the calculation 5.5 ft x (12in/1foot) will allow 5.5 ft to be expressed as inches, which in this case would be 66 inches.

3.3 LAB EXERCISE

Part A – Practice Questions (non-graded)

The following problems are for practice; answers to these questions are provided at the end of the chapter.

1. A 15 minute quadrangle map of a region within the United States with a longitude of 76°00'00" in the right corner of the map, will read what longitude in the left corner?

2. A 15 minute quadrangle map of a region within the United States with a latitude of 43°15'00" in the top corner of the map, will read what latitude in the bottom corner?

3. A fractional scale of 1:24,000 means that 1 inch = ______feet.

4. A fractional scale of 1:24,000 means that 1 foot = ________ kilometers.

3.4 CONTOUR LINES

Contour lines allow a vertical dimension to be added to a map and represent elevations above sea level. Since each individual contour line connects points of equal elevation, then following that line in the real world means that you are staying at the same elevation while walking along that imaginary line. If you were to move off that line, you are either walking up or down in elevation. Imagine if you are on a small circular island in the ocean, and you walk from the shore up to 10 feet above the shoreline. If you were to walk around the island and stay exactly 10 feet above shore, you would be walking a contour line that represents 10ft of elevation above sea level. If you move off that line, you are either moving uphill or downhill. If you could walk uphill another 10ft and again stay at that elevation (now 20ft above sea level) while circling the island, then you are now walking the 20ft contour line. The vertical change in elevation between these two adjacent contour lines is called the **contour interval**, which in this case is 10 feet. If you were to transfer these imaginary lines onto a map, you would see three lines forming concentric circles that represent 0 ft (the seashore or sea level), 10ft and 20ft, and your map would look like a bull's eye pattern. Congratulations, you've made your first topographic map!

A topographic map will have contour lines shown as brown lines, and all maps will have a contour interval that is specific for that map. However, the elevations represented by the contour lines are not always labeled on each line (see Figure 3.2). Instead, every 5th contour line is labelled with an elevation, and is darkened; such a contour line is called an **index contour**. The use of index contours allows a map to be visually more appealing, especially when the contour lines are numerous and closely spaced to one another.

To determine the elevation of each contour line you must first know the contour interval for the map. By using the values of two adjacent index contours, one can easily calculate the contour interval between each line. For example, there are 4 contour lines between the 5200ft and 5400ft index contours (see Figure 3.2), which means that there are 4 contour lines separating the 200ft of elevation between the index contours into 5 sections. Dividing this 200ft elevation change between the index contours by 5 gives a contour interval of 40 ft (just as cutting a ruler in half creates two 6 inch pieces, or dividing the ruler into 3 evenly spaced cuts yields four 3 inch pieces). To verify this, locate the 5200ft index contour on the western side of the map in Figure 3.2, and increase the elevation by 40ft each time you cross a contour line while traveling east (to the right) towards the 5400ft contour line. Luckily there is no need to do this calculation to find the contour interval on a complete topographic map, as all topographic maps give the contour interval at the bottom of the map near the bar and fractional scales (see Figure 3.3). The contour interval must be obeyed for each contour line on a map; for example if the contour interval is 50 ft, then an example of possible contour lines on such a map could be 50ft, 100ft, 150ft, 200ft, etc.

You may be wondering why some contour lines are closely spaced in some areas of a map (such as the central portion of the map in Figure 3.2) and why they are farther apart in other areas of a map (such as the western part of the map in Figure 3.2). Imagine yourself again on the circular island in the ocean, and you are standing 10ft above sea level (on the 10ft contour line). If you want to walk up the hill to reach the 20ft elevation, how far did you have to walk? It depends on how steep the hill is; if it is a gentle slope you may have to walk a long time before you reach a higher elevation of 20ft. On a topographic map, the contour lines for this hill would be spaced far apart. However, if the hill's slope is very steep, you do not need to walk as far up the hill to reach a 20ft elevation, and the contour lines representing such a steep slope will be closely spaced on a topographic map. Recall that a slope (**gradient**) is the change in elevation divided by the distance; you can easily calculate the slope of your hill or any region on a topographic map if you know the change in elevation between two points, and if you know the distance between those same two points. Gradients are usually reported in feet per mile (ft/mile), but other units are also used. Remember to use the contour lines to determine the elevations, and the bar scale on your map to measure the distance.

In addition to contour lines, topographic maps will also have **benchmarks** (actual surveyed points) in various locations on your map. These surveyed points are exact elevations above sea level and are commonly used to mark the elevations of mountains, hilltops, road intersections and airport runways. These benchmarks are rarely located on a contour line and instead are usually identified by a black “x” or identified with the letters “BM” and with the elevations included in black numbers (as opposed to the brown numbers on index contours). Benchmark locations will normally be found in the area between contour lines; for example a benchmark of 236ft will be found somewhere between the 230ft and 240ft contour line (if the contour interval is 10ft), or between the 235ft and 240ft contour line (if the contour interval is 5ft).

In addition to obeying the set contour interval for a map, contour lines should never branch (split) or simply end inside of the mapped region. Instead these lines are continuous, although they can continue off the edge of the map. Contour lines also never touch or overlap, unless certain rare instances occur, such as if there is a vertical or overhanging cliff. In the case of a vertical cliff, the contour lines will appear to merge.

The entire third dimension (elevation) represented by the contour lines on a topographic map is called the **relief**, and is easily determined if you can find the highest and lowest contour line elevations and subtract the two values to determine the vertical relief represented in the map. The hardest part is finding these highest and lowest elevations on the map. Start by finding the highest index contour line and continue counting lines until you reach the lowest contour line. In Figure 3.2, the highest contour line is the line that runs through the letter “r” in Fort (of Fort Garrett Point). This same contour line circles back and goes through the letter “o” in Fort. The elevation of this line is 6360ft (based on the contour interval of 40ft). Recall that this is only a small portion of a 7.5 minute map (or quadrangle), and because of this, some of the index contours appear to be missing the identifying elevation numbers, but it is still easy to identify the index contours because all index contours are in bold (darkened lines). To find the lowest elevation on the map, find the lowest index contour line and continue counting lines in the downhill direction. An easy way to determine which way is downhill is to find a water feature on the map; water is colored blue on topographic maps, and flowing water such as a river or stream is a blue line. A dashed blue line such as in Figure 3.2 implies that the stream is dry part of the year (this is called an intermittent stream). Since water collects in low spots, such as a basin (where ponds, lakes, or oceans are found) or a valley (such as a stream or river valley), then the contour lines should represent decreasing elevation as you move towards a water feature on a map. Referring back to Figure 3.2, it is apparent that the highest portion of the map is the central portion where Fort Garrett Point is located, and that any point west, south and east of this is a downhill direction. Note all of the streams are flowing away from this Fort Garrett Point region. The lowest elevation will be a contour line that is crossing the stream just before leaving the map area. Close examination of the contour lines reveals that the lowest contour line is in the lower right corner of the map; the contour line that is crossing the stream in this portion of the map represents an elevation of 4560ft.

So for this small portion of the 7.5 minute map shown in Figure 3.2, the relief of the map region is 6360ft (highest contour) – 4560ft (lowest contour) = 1800ft.

An interesting feature regarding flowing water such as streams and rivers is that they erode the landscape and as a result the topography of the land is affected; we see this as a deflection of the contour lines on a map as they cross flowing water. Notice in Figure 3.2 that the contour lines form a "v" shape as they cross the water, and that the pointed end of this "v" is pointing in the upstream direction. We can use this to easily determine which way water is flowing without even paying attention to the elevation of the contour lines. Notice in Figure 3.2 that the contour lines that cross the streams are pointing toward the central hill (Fort Garrett Point), which means that the streams are all flowing away from the central portion of this map and towards the edges of the map region.

3.5 LAB EXERCISES

Part B - Practice Questions

For Questions 5 through 9, refer to Figure 3.4 below, which shows a hill, an intermittent stream, and two index contours (darkened contour lines). Assume the contour interval for this map is 5ft, and the index contour that is crossing the stream has an elevation of 70ft.

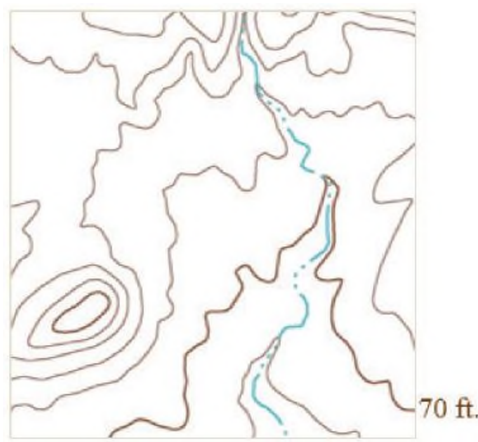

Figure 3.4 | Portion of the 7.5 minute Quadrangle of Bat Cave, Arizona
Author: USGS
Source: USGS
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5. Which way is the stream flowing, to the North to the South?

6. What is the elevation of the highest contour on this portion of the map?

7. Calculate the relief of this map (Hint: Review the "Contour Lines" section in this chapter for assistance calculating relief).

8. Calculate the gradient of the stream between the highest and lowest contour lines that you can see cross the stream. These two contour lines are 2 miles apart.

9. The hill in the above diagram has a slightly steeper side on which side of the hill, the west or east side?

You have learned that the spacing between contour lines indicates the slope of the Earth's surface, and that the shape of the contour line as it crosses flowing water can indicate the slope direction. You have also learned that enclosed (circular) contour lines indicate a hill or mountain. However, sometimes there are circular depressions (for example, a sinkhole) found on the Earth's surface and these depressions may appear as hilltops on a topographic map unless a new convention is used. Contour lines with small perpendicular lines (called **hachure marks**) are used for such depressions on a topographic map. The contour interval for the map is still obeyed when contouring a depression. The only difference is that the hachure marks on the contour lines indicate that you should count down in elevation, not up, as you move towards the center of the hachured contour circles. However, if there is a depression at the top of a hill or mountain (for example, a volcanic crater), then the first contour line that is hachured must be the same elevation of the closest contour line that is not hachured. The reason for the repeat is that a person climbing the hill will reach the highest contour line, and walk a little higher still, before descending into the depression (crater), and will therefore encounter the same elevation line while descending (see Figure 3.5).

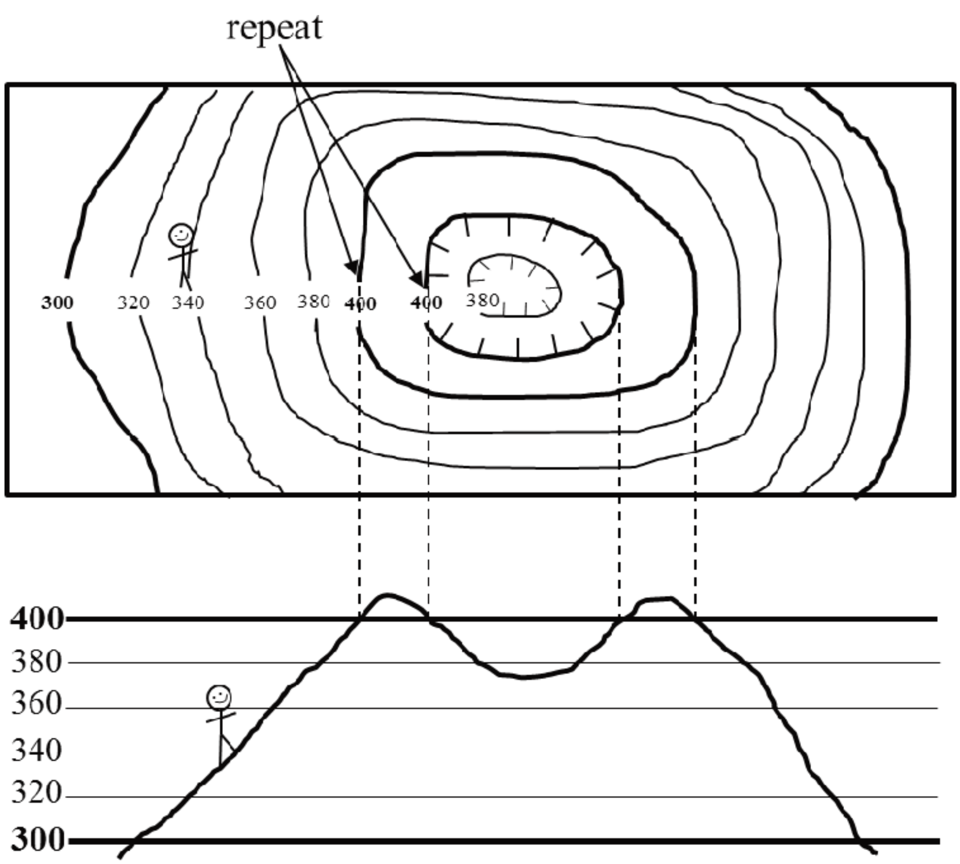

Figure 3.5 | Contours and hachured contours for a depression at the top of a hill. Notice that the first hachured depression is a repeat of the closest non-hachured contour line.
Author: Karen Tefend
Source: Original Work

3.6 DRAWING CONTOUR LINES AND TOPOGRAPHIC PROFILES

Constructing a topographic map by drawing in contours can be easily done if a person remembers the following rules regarding contour lines: 1) contour lines represent lines connecting points of equal elevation above sea level; 2) contour lines never cross, split or die off; 3) contour intervals must be obeyed, therefore the contour line elevations can only be multiples of the contour interval; and 4) contour lines make a “v” pattern as they cross streams and rivers, and the “v” always points towards the upstream direction.

As you draw a contour line on a map you will notice that the elevations on one side of your line will be lower elevations, and elevations on the other side of your line will be higher elevations. Once your contour lines are drawn, you will notice that you had to draw some lines closer together in some areas and wider apart in other areas, and that you may have even enclosed an area by drawing a contour line in a circular pattern. These circular patterns indicate hilltops, like in the diagram below (Figure 3.6). To illustrate what these hills look like in profile (or, how they would look if you saw them while standing on the ground and looking at them from a distance), you can draw what is known as a topographic profile. Essentially a topographic profile is a side image of a topographic map, but the image is only a representation of the area shown on the line on the topographic map (line A-B on Figure 3.6). To construct a profile, you need graph paper, a ruler and a pencil. You want to have the y-axis of the graph paper represent the elevations of the contour lines that intersect your drawn line (line A-B in this case). By using a ruler, you can transfer these elevation points from your topographic map straight down onto your graph paper such as shown in Figure 3.6. Be sure to only plot those elevations that are at the intersection of the contour line with line A-B. Once your points are plotted on the graph paper, you simply connect the dots. As a rule, hill tops will be slightly rounded to show a slight increase in elevation to represent the crest of the hill, but be careful not to draw the hill top

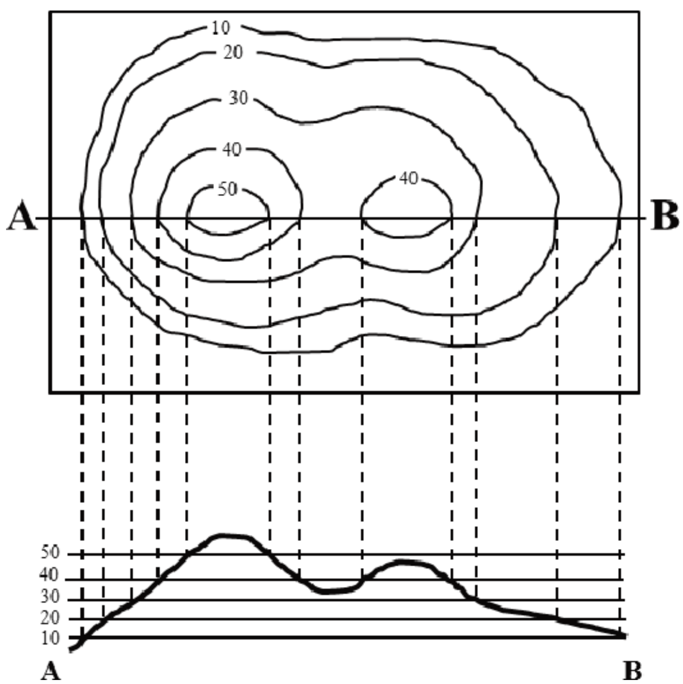

Figure 3.6 | Contour map and topographic profile of two hills and a valley between them.

Author: Karen Tefend

Source: Original Work

too high on your graph paper. For example, the first hill on the left has a top contour line of 50ft. Because there isn't a 60ft contour line on this hill top, we know that the hill's highest point (the crest) is some elevation between 50 and 60ft. When connecting the points on your graph paper in the area between the two hills in the Figure 3.6, you again want to round out the area to represent the base of your valley between the hills, but be careful not to make the valley floor too deep, as according to the topographic map the elevation is below 40ft, but not as low as 30ft.

If you examine the graph showing the topographic profile in Figure 3.6, can you image what would happen to your profile if we changed the spacing for elevations on the y-axis? When the vertical dimension of your graph is different from the horizontal dimension on your map, you may end up with a graph that shows a **vertical exaggeration**, and the features of the Earth represented by your topographic profile may be deformed such as in Figure 3.7.

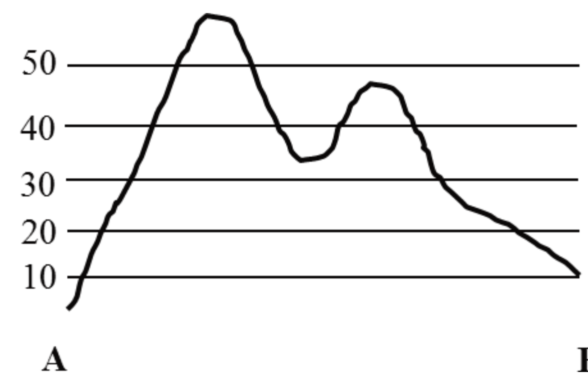

Figure 3.7 | A stretched profile (from Figure 3.6) to demonstrate what vertical exaggeration can do to an image. Notice how much steeper the slopes are in this image. **Author:** Karen Tefend **Source:** Original Work **License:** CC BY-SA 3.0

Sometimes vertical exaggeration is desired, but in some cases you may not want it. To avoid having your profile distorted so that it accurately conveys what the surface of the Earth really looks like in profile, you will want both the vertical and horizontal scales to match. For example, if your map scale is 1 inch = 50 ft, then one inch on your graph's y-axis should only represent 50ft of elevation. If the topographic map in Figure 3.6 has a fractional scale of 1:12,000 then 1 inch is equal to 12,000 inches or 1000ft; this 1inch = 1000ft equivalency is for the horizontal scale. When we hold a ruler to the y-axis of the topographic profile in Figure 3.6, we see that 0.5 inches = 50ft, which means 1 inch = 100ft on the vertical scale. To calculate the vertical exaggeration in the topographic profile shown in Figure 3.6 we divide the horizontal scale by the vertical scale: (1000ft/1inch)/(100ft/inch) = 10. Therefore the topographic profile in Figure 3.6 represents a profile of the map surface (along the A-B line) that has been vertically exaggerated by 10 times (10X).

Answers to Practice Lab Exercises, Parts A and B

1. 76°15'00" W longitude
2. 43°00'00" N latitude
3. 2000 ft
4. 1 ft = 24,000 ft, and 24,000 ft x (1km/3280ft) = 7.32 km
5. South

6. 95 ft (this is the index contour at the top of the hill)
7. 95 ft – 65 ft = 30 ft
8. (80ft – 65 ft)/2miles = 7.5 ft/mile
9. East

3.7 LAB EXERCISE

Part C - Topographic Maps

This is a graded activity. The following pages must be printed and completed by the student, and mailed to the instructor in order to be scored. Alternatively, you may scan the activity and send it electronically to the instructor; unreadable scans will not be accepted, so be sure to send in legible work. Please remember to include your name in the provided blank.

Name ____

3.8 TOPOGRAPHIC MAPS LAB ASSIGNMENT

Note: This lab is in color. Therefore, if you print it out in black and white please refer back to the electronic copy to avoid confusion.

This Lab Assignment is to be mailed to your Instructor at the contact address recorded in the Syllabus. Make sure that you use additional postage if needed. There is no online assessment for the Topographic Maps Lab.

Complete the entire assignment and mail to your instructor postmarked by the assignment deadline. You should make an extra copy to practice on and mail in a clean and neat version for grading. Make sure to include your name on every page and staple all of the pages together.

Please take advantage of all of the resources available to you. Be sure to read the corresponding lecture which contains directions to work out the solutions to the problems below. You should also review the instructional videos located in the unit content area within the course for additional assistance. Finally, check the Topographic Map Unit Discussion forum and the tutor talk area for additional resources and hints.

3.8.1 Topographic Maps Lab

NOTE: For all of the following figures, assume North is up.

1. (10 pts) The following topographic map (Map 3.1) is from a coastal area and features an interesting geological hazard in addition to the Ocean. Using a contour interval of 40 meters, label the elevation of every contour line on the map below. (Note: elevation is meters above sea level, which makes sea level = ____m).

Map 3.1
Author: Brad Deline
Source: Original Work
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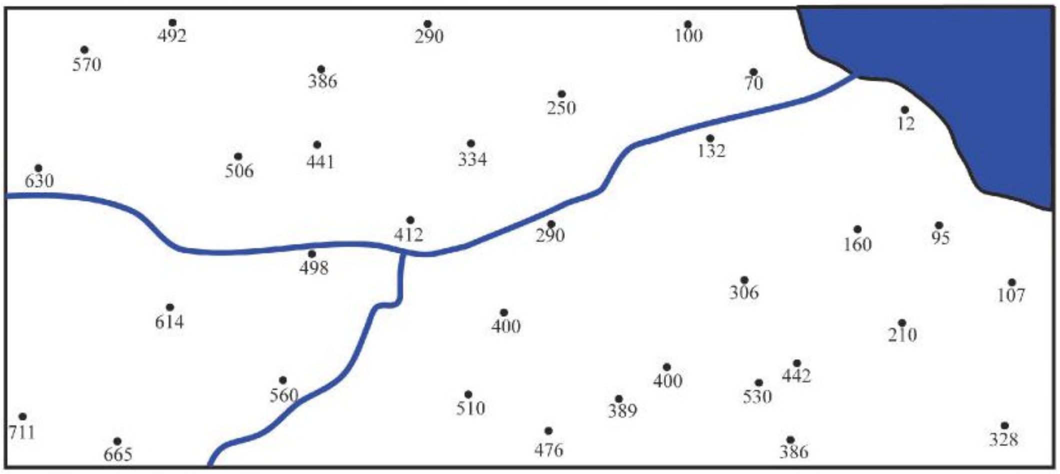
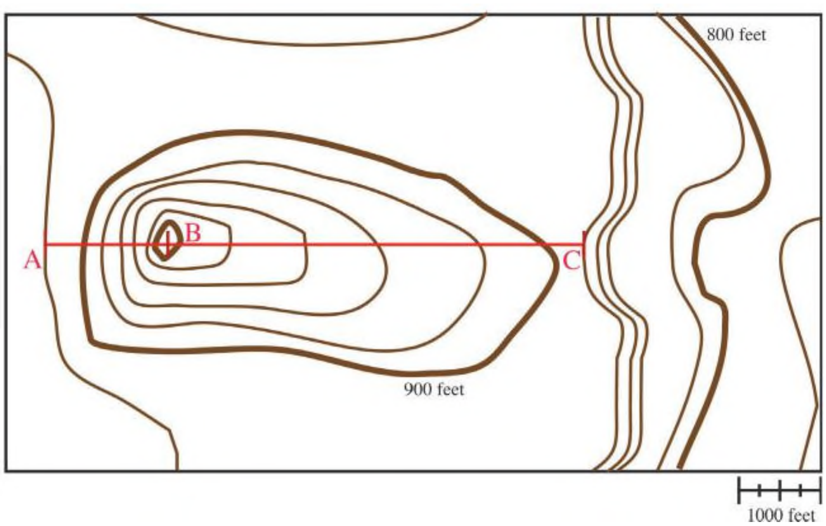
2. (10 pts) Imagine you are a geologist for the United States Geological Survey. You are tasked with creating your own coastal Topographic map, so you hike around the area with a GPS receiver (Global Positioning System) and every so often you record your position along with the elevation in meters at that point, which results in the following map (Map 3.2). Complete Map 3.2 by adding in the contour lines using a contour interval of 100 meters. Draw the contour lines so that they are continuous (do not die off), and either continue off the map or form an enclosed circle (look at the topographic map in the problem 1 for an example). More often than not, your contour lines will fall between the GPS points on your map, so do your best to determine the contour line positions.



Map 3.2
Author: Brad Deline
Source: Original Work

For questions 3-7 refer to the Map 3.3. The following topographic map shows an interesting and informative geological feature called a drumlin, which is a pile of sediment left behind by a retreating glacier.



Map 3.3
Author: Brad Deline
Source: Original Work

3. (2 pts) What is the contour interval on Map 3.3?

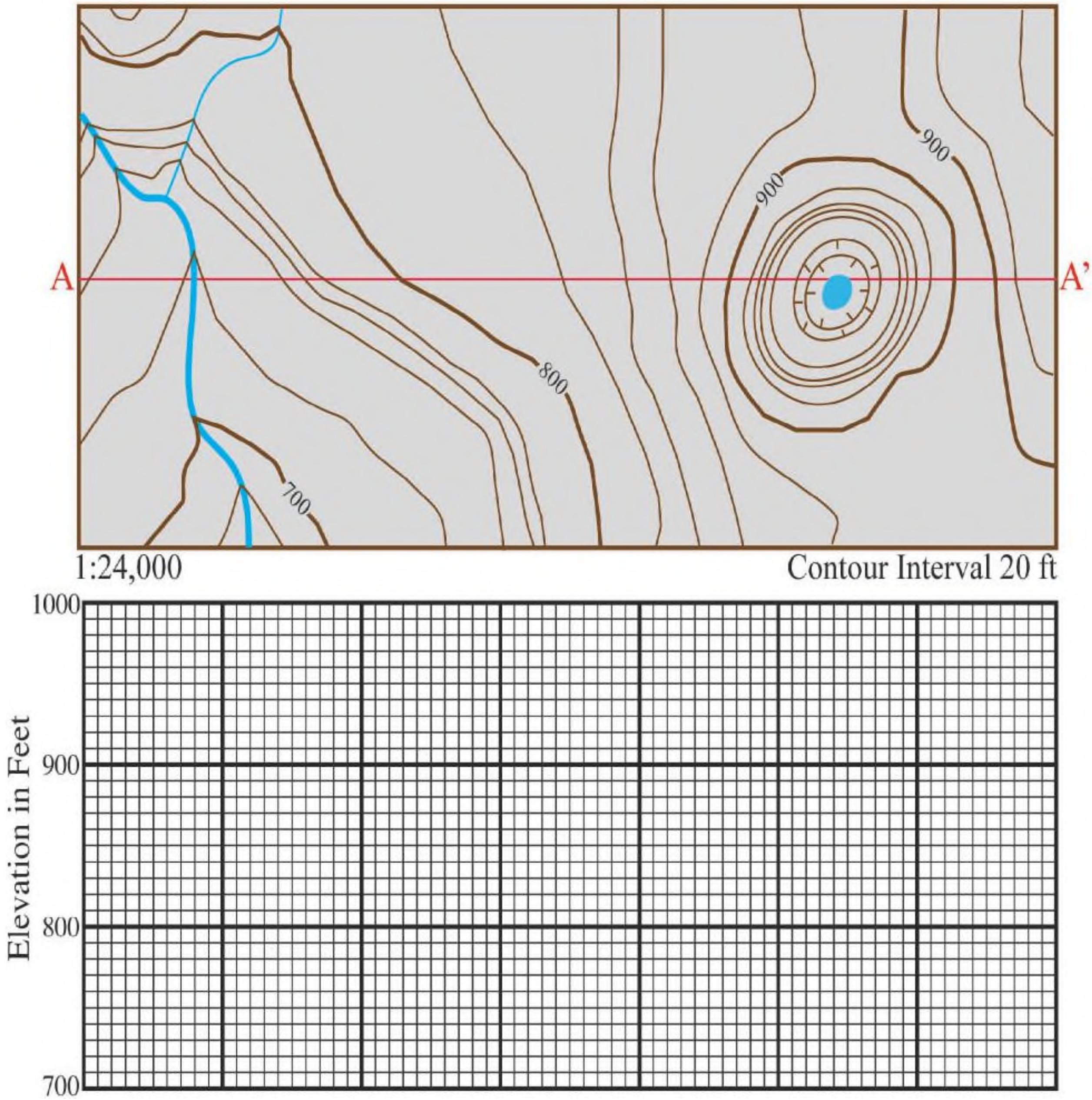
4. (2 pts) What is the regional relief on Map 3.3?

5. (5 pts) Using the contour lines on Map 3.3, which area along the red line is steeper A to B or B to C? Explain how you came to this conclusion.

6. (5 pts) What is the gradient from A to B and B to C on Map 3.3? Show your work.

7. (2 pts) Drumlins can be used to determine the direction of movement in the glacier with the glacier moving toward the shallower side of the structure. Using your previous answers for Map 3.3, what direction was the glacier traveling? Note: unless indicated otherwise, assume that North is up (towards the top of the map).

8. (20 pts) Construct a topographic profile from A to A’ on the graph paper below.



Map 3.4
Author: Brad Deline
Source: Original Work

9. (5 pts) Based on the scale you choose for the topography (vertical axis) in question 8, calculate the amount of vertical exaggeration on the topographic profile you constructed above. Show your work.

For this part of the lab you will need to use Maps 3.5 and 3.6 (appearing at the end of this chapter). Following Maps 3.5 and 3.6 is a Map Key that you can use to identify the various symbols found on topographic maps.Also, note that the maps are in color and the colors have significance in terms of the symbols.

Questions 10-18: Rome North Quadrangle (27 pts)

10. (2 pts) What is the ratio scale of this map?

11. (2 pts) Explain in a sentence how this type of scale works.

12. (2 pts) What is the latitude on the north edge of the map?

13. (2 pts) What is the longitude on the east edge of the map?

14. (6 pts) Find Big Dry Creek, which is north of Rome. What direction does that river flow? Explain two reasons why you came to this conclusion.

15. (2 pts) Examine the large Ridge in the Northwestern portion of the map. What is the tallest point in this ridge? How tall is it?

16. (2 pts) How much higher is that point from Lake Conasauga?

17. (5 pts) What is the gradient between Lake Conasauga and the tallest point in the ridge? Show your work (Hint: zooming out will let you see both features on the map at the same time and may make it easier to measure).

18. (4 pts) How would the gradient change if you measured from Swan Lake to the tallest point in the ridge rather than Lake Conasauga? Explain why.

Questions 19-22: Grand Tetons (12 pts)

19. (3 pts) Explain why this map is referred to as a 7.5 minute map?

20. (3 pts) What is the relief on this map?

21. (2 pts) Does Taggert Creek flow into Taggert Lake or Lake Taminah? What direction does the creek flow?

22. (4 pts) Garnet Canyon (a little to the west of the word Garnet) is a common camping location for hikers and mountain climbers at the Grand Teton's National Park. Examine the topography surrounding Garnet Canyon and the Middle Teton. What would be the easiest and safest route from Garnet Canyon to the top of the Middle Teton? Explain why. (Drawing a simple map will help).

Maps 3.5, 3.6, and Map Key (appearing on following pages)
Author: USGS
Source: USGS

BATHYMETRIC FEATURES

Area exposed at mean low tide; sounding datum line***

Channel***

Sunken rock***

BOUNDARIES

National

State or territorial

County or equivalent

Civil township or equivalent

Incorporated city or equivalent

Federally administered park, reservation, or monument (external)

Federally administered park, reservation, or monument (internal)

ate forest, park, reservation, or onument and large county park

rest Service administrative area*

ographic

lex

Small park (county or city)

BUILDINGS AND RELATED FEATURES

Building

School; house of worship

Athletic field

Forest Service ranger district*

National Forest System land status, Forest Service lands*

National Forest System land status, non-Forest Service lands*

Built-up area

Forest headquarters*

Ranger district office*

Guard station or work center*

Racetrack or raceway

Airport, paved landing strip, runway, taxiway, or apron

Unpaved landing strip

Well (other than water), windmill or wind generator

Tanks

Covered reservoir

Gaging station

Located or landmark object (feature as labeled)

Boat ramp or boat access*

Roadside park or rest area

Picnic area

Campground

Winter recreation area*

Cemetery — Cem Unmf

COASTAL FEATURES

Foreshore flat

Coral or rock reef

Rock, bare or awash; dangerous to navigation

Group of rocks, bare or awash

Exposed wreck

Depth curve; sounding

Breakwater, pier, jetty, or wharf

Seawall

Oil or gas well; platform

CONTOURS

Depression

Cut

Fill

Approximate or indefinite

Intermediate

Approximate or indefinite

Supplementary

Continental divide

Bathymetric

Index***

Intermediate***

Index primary***

Primary***

Supplementary***

CONTROL DATA AND MONUMENTS

Principal point**

U.S. mineral or location monument — USMM 438

River mileage marker

Boundary monument

Third-order or better elevation, with tablet — BM 9134

Third-order or better elevation, recoverable mark, no tablet — 5628

With number and elevation — 67 4567

Horizontal control

Third-order or better, permanent mark — Neace

With third-order or better elevation — BM — Pike BM393

With checked spot elevation — 1012

Coincident with found section corner — Cactus

CONTROL DATA AND MONUMENTS – *continued*

Vertical control

Third-order or better elevation, with tablet	BM 5280
Third-order or better elevation, recoverable mark, no tablet	528
Bench mark coincident with found section corner	BM 5280
Spot elevation	7523

GLACIERS AND PERMANENT SNOWFIELDS

- Contours and limits
- Formlines
- Glacial advance
- Glacial retreat

LAND SURVEYS

Public land survey system

Range or Township line	
Location approximate	
Location doubtful	
Protracted	
Protracted (AK 1:63,360-scale)	
Range or Township labels	R1E T2N R3W T4S
Section line	
Location approximate	
Location doubtful	
Protracted	
Protracted (AK 1:63,360-scale)	
Section numbers	1 - 36 1 - 36
Found section corner	
Found closing corner	
Witness corner	WC
Meander corner	MC
Weak corner*	

Other land surveys

- Range or Township line
- Section line
- Land grant, mining claim, donation land claim, or tract
- Land grant, homestead, mineral, or other special survey monument
- Fence or field lines

MARINE SHORELINES

- Shoreline
- Apparent (edge of vegetation)***
- Indefinite or unsurveyed

MINES AND CAVES

Quarry or open pit mine	
Gravel, sand, clay, or borrow pit	
Mine tunnel or cave entrance	
Mine shaft	
Prospect	X
Tailings	Tailings
Mine dump	
Former disposal site or mine	

PROJECTION AND GRIDS

Neatline	39°15′ 90°37′30″
Graticule tick	55′
Graticule intersection	
Datum shift tick	

State plane coordinate systems

Primary zone tick	640 000 FEET
Secondary zone tick	247 500 METERS
Tertiary zone tick	260 000 FEET
Quaternary zone tick	98 500 METERS
Quintary zone tick	320 000 FEET

Universal transverse metcator grid

UTM grid (full grid)	273
UTM grid ticks*	269

RAILROADS AND RELATED FEATURES

- Standard guage railroad, single track
- Standard guage railroad, multiple track
- Narrow guage railroad, single track
- Narrow guage railroad, multiple track
- Railroad siding
- Railroad in highway
- Railroad in road
- Railroad in light duty road*
- Railroad underpass; overpass
- Railroad bridge; drawbridge
- Railroad tunnel
- Railroad yard
- Railroad turntable; roundhouse

RIVERS, LAKES, AND CANALS

- Perennial stream
- Perennial river
- Intermittent stream
- Intermittent river
- Disappearing stream
- Falls, small
- Falls, large
- Rapids, small
- Rapids, large
- Masonry dam
- Dam with lock
- Dam carrying road

RIVERS, LAKES, AND CANALS – *continued*

- Perennial lake/pond
- Intermittent lake/pond
- Dry lake/pond
- Narrow wash
- Wide wash
- Canal, flume, or aqueduct with lock
- Elevated aqueduct, flume, or conduit
- Aqueduct tunnel
- Water well, geyser, fumarole, or mud pot
- Spring or seep

ROADS AND RELATED FEATURES

Please note: Roads on Provisional-edition maps are not classified as primary, secondary, or light duty. These roads are all classified as improved roads and are symbolized the same as light duty roads.

- Primary highway
- Secondary highway
- Light duty road
- Light duty road, paved*
- Light duty road, gravel*
- Light duty road, dirt*
- Light duty road, unspecified*
- Unimproved road
- Unimproved road*
- 4WD road
- 4WD road*
- Trail
- Highway or road with median strip
- Highway or road under construction
- Highway or road underpass; overpass
- Highway or road bridge; drawbridge
- Highway or road tunnel
- Road block, berm, or barrier*
- Gate on road*
- Trailhead*

SUBMERGED AREAS AND BOGS

- Marsh or swamp
- Submerged marsh or swamp
- Wooded marsh or swamp
- Submerged wooded marsh or swamp
- Land subject to inundation

SURFACE FEATURES

- Levee
- Sand or mud
- Disturbed surface
- Gravel beach or glacial moraine
- Tailings pond

TRANSMISSION LINES AND PIPELINES

- Power transmission line; pole; tower
- Telephone line
- Aboveground pipeline
- Underground pipeline

VEGETATION

- Woodland
- Shrubland
- Orchard
- Vineyard
- Mangrove

* USGS-USDA Forest Service Single-Edition Quadrangle maps only.
In August 1993, the U.S. Geological Survey and the U.S. Department of Agriculture's Forest Service signed an Interagency Agreement to begin a single-edition joint mapping program. This agreement established the coordination for producing and maintaining single-edition primary series topographic maps for quadrangles containing National Forest System lands. The joint mapping program eliminates duplication of effort by the agencies and results in a more frequent revision cycle for quadrangles containing National Forests. Maps are revised on the basis of jointly developed standards and contain normal features mapped by the USGS, as well as additional features required for efficient management of National Forest System lands. Single-edition maps look slightly different but meet the content, accuracy, and quality criteria of other USGS products.

** Provisional-Edition maps only.
Provisional-edition maps were established to expedite completion of the remaining large-scale topographic quadrangles of the conterminous United States. They contain essentially the same level of information as the standard series maps. This series can be easily recognized by the title "Provisional Edition" in the lower right-hand corner.

*** Topographic Bathymetric maps only.

Topographic Map Information

For more information about topographic maps produced by the USGS, please call: 1-888-ASK-USGS or visit us at http://ask.usgs.gov/

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