How to Read Topographic Maps

by Mary Cochenour April 22, 2020

Knowing how to read a topographic map is the foundation to any backcountry adventure. Through the use of contour lines, topo maps bring a 3-dimensional element to a 2-dimensional paper map, allowing you to visualize the rise and fall of the land and "see" the depths of canyons, the location of boggy meadows, and the height and shape of mountains.

But, make no mistake about it, learning to read and understand topographic maps takes time and practice. Whether you're new to topo maps or a seasoned wilderness navigator, this article will help explain the basic features, like lines, numbers, symbols, and colors, found on topo maps so that you can read them with ease and confidence.

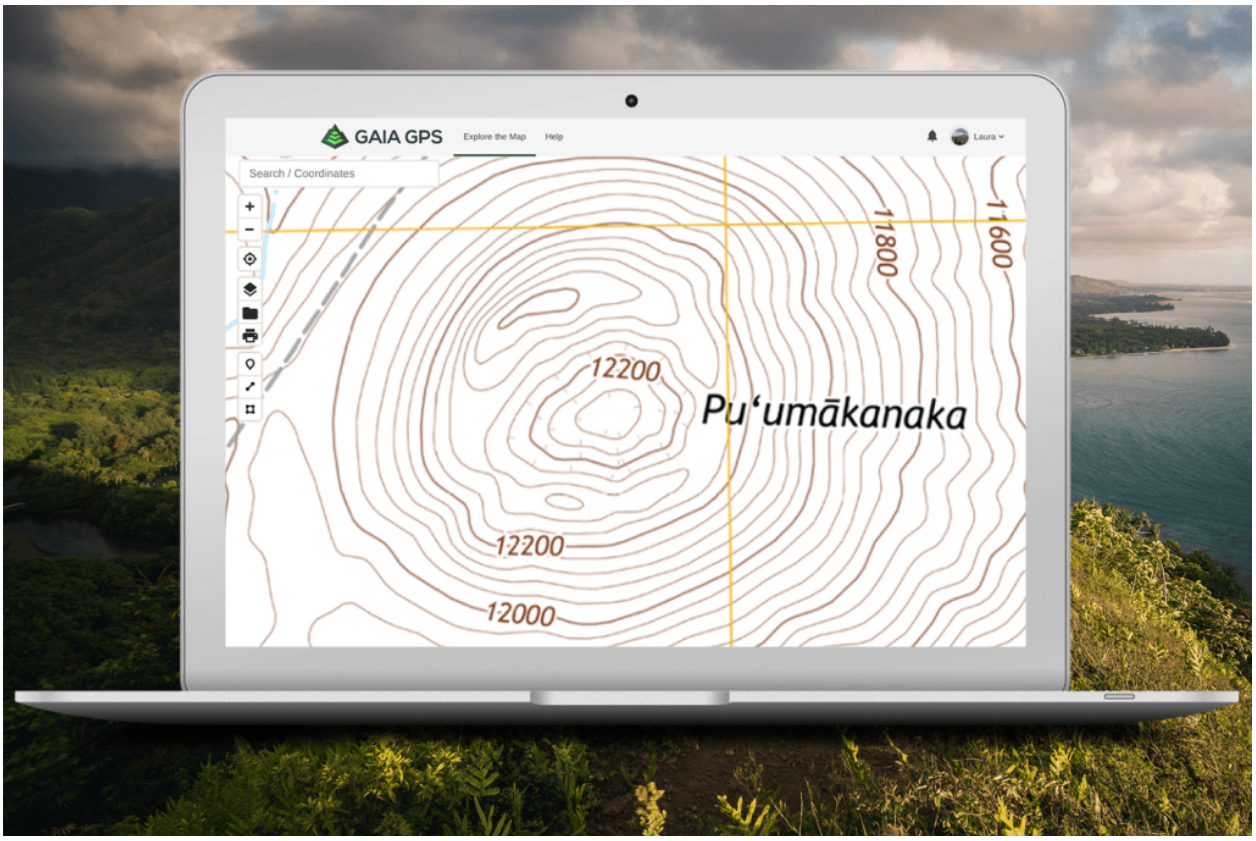
This article covers:

Contour Lines

Contour lines are the primary and most important feature on a topo map. They show the shape of the terrain, including its hills, slopes, and depressions, by tracing a constant line of elevation on the map that corresponds with the landscape in the real world. Think of contour lines as imaginary horizontal planes sliced through the terrain surface.

Visualizing Contour Lines

It may be helpful to visualize contour lines as stacked "layers" of the landscape, similar to a layer cake. A large mountain appears as a dense group of lines with a small circle in the center that represents the peak—just picture looking down at a wedding cake from above. Areas with few contours appear relatively flat—more like a 2-tier birthday cake. A topo map provides a bird's eye view of those concentric circles, allowing you to "see" both the height and shape of the mountain on the map.



From the [USGS Topo on Gaia GPS](), the summit of Pu'umakanaka, Hawaii is a near-perfect cone as indicated by the evenly spaced and round contour lines. Notice the tick marks on the contour lines in the center of the map. Those marks indicate a crater or depression at the summit.

Knuckle Mountain

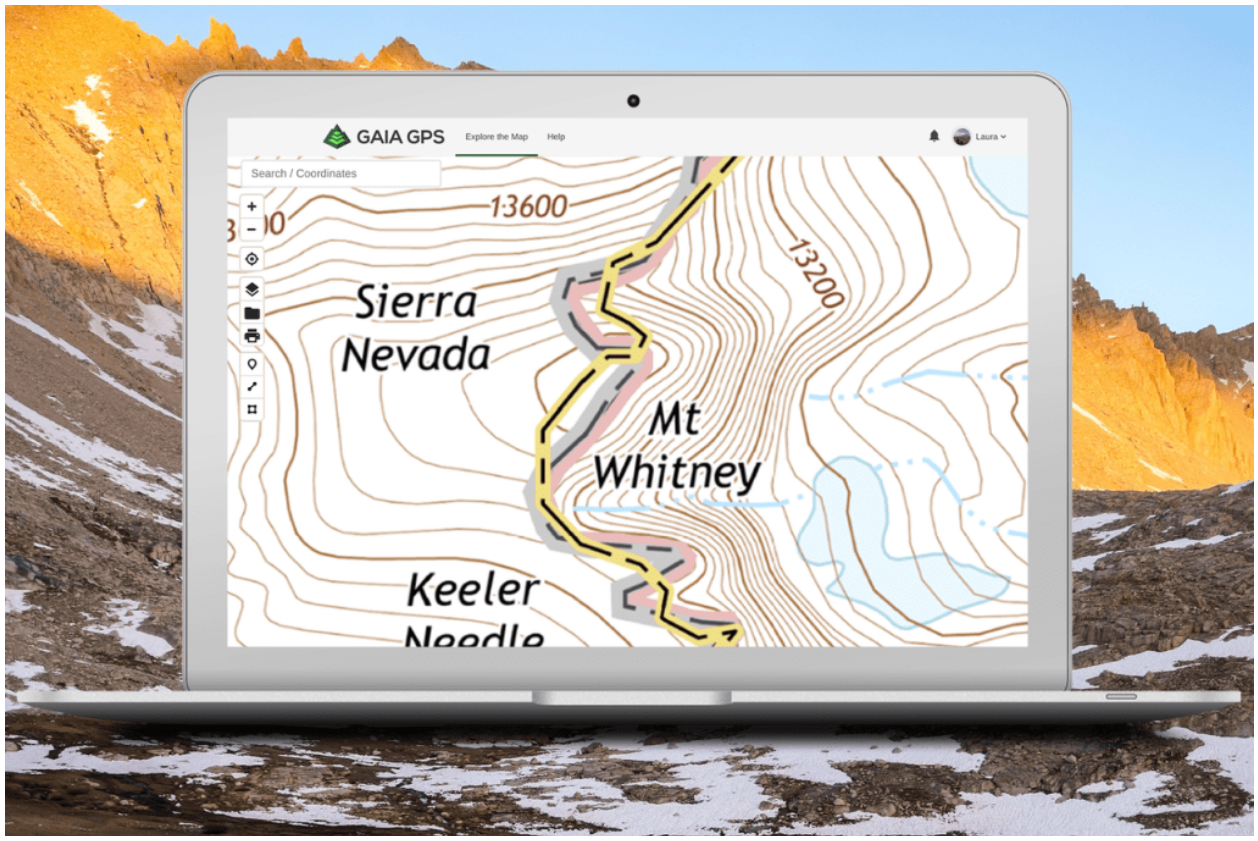
Try this quick exercise at home to get a better understanding of contour lines:

1. Make a fist with your hand, taking note of the "features" on your fist. There are four knobs (knuckles), a gentle slope (back of your hand), and four small ridges (fingers) separated by ravines (space between the fingers).
2. With your other hand, mark an "x" on the knuckle that sticks up the highest to mark the "summit." Using a pen, drop down from the summit a quarter-inch and make a contour line around the peak of "knuckle mountain." Follow the elevation around the mountain, without dropping or climbing, until you complete the contour line and close the circle. Drop down another quarter of an inch and repeat. Do that again and again, until you've mapped out your entire fist.
3. Next, lay your hand flat with your palm on the table. Find the spread out contour lines on the back of your hand, indicating a gentle slope. Notice the "v" shaped topo lines where the ravines

were between your fingers. The areas by your fingers have contour lines that are close together, indicating steepness. Find an hourglass-shaped topo line for the saddle between your knuckles.

Reading Slope Steepness on a Topo Map

Contour lines present in very predictable ways on the map. When the slope is gentle, the contour lines are spread far apart. Conversely, when the slope is steep the contour lines pack closely together. On a cliff, the contour lines are stacked on top of each other. A flat meadow is void of contour lines.

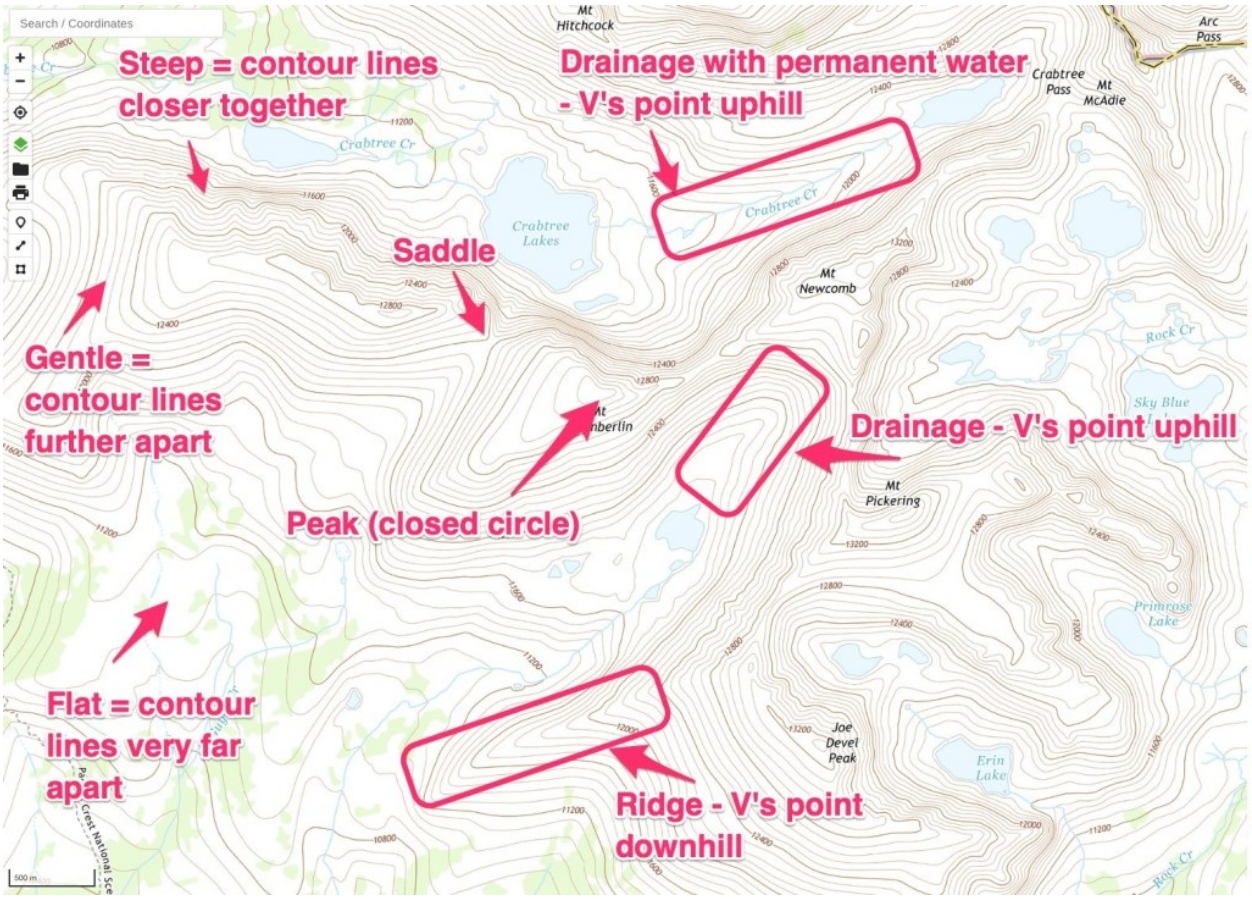


California's Mount Whitney, at 14,505 feet, the tallest mountain in the lower 48 states, is steep on its east face as indicated by the closely spaced contour lines. Whitney's west face is marked by low-angle slopes, as depicted by the wide-spaced contour lines.

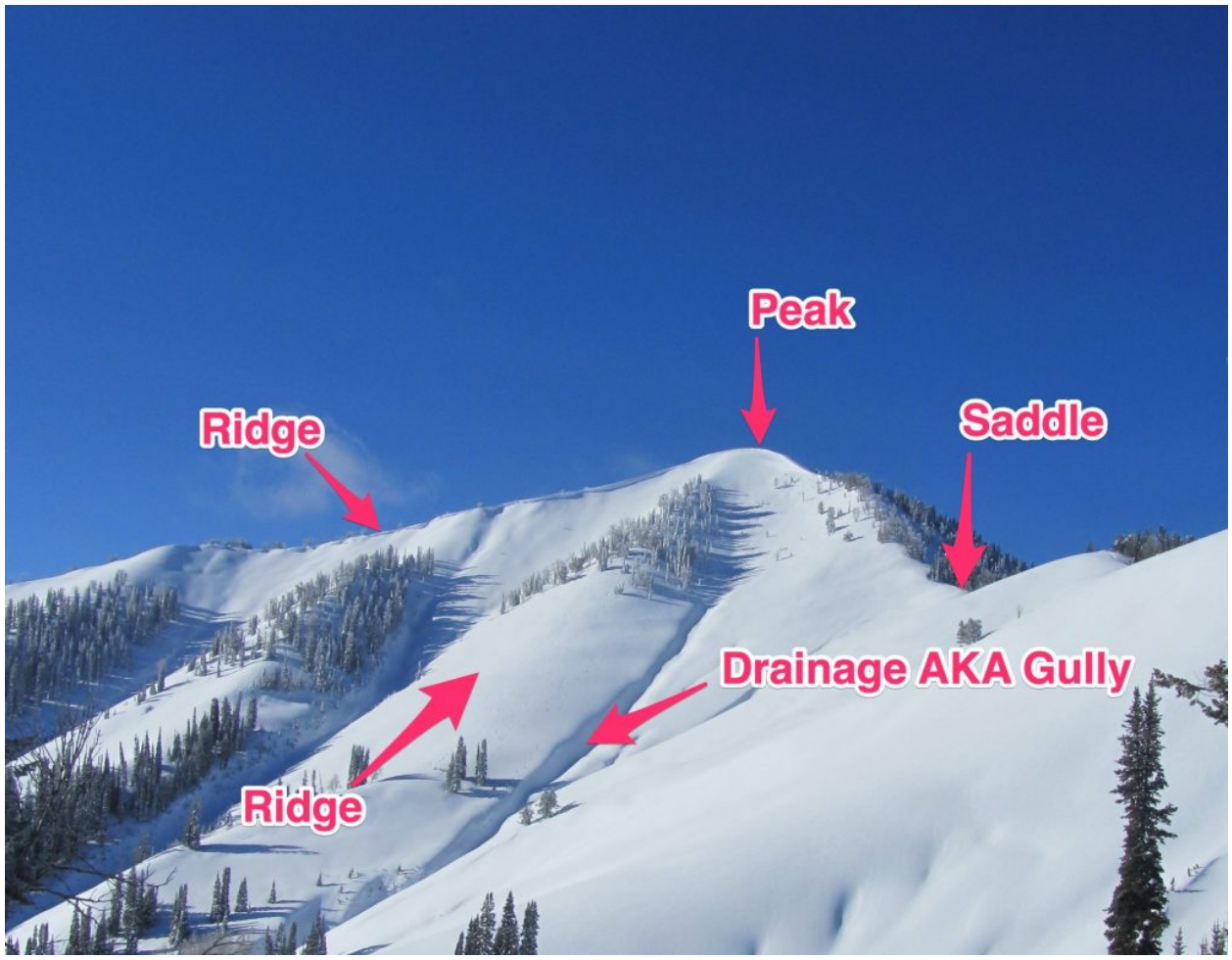
Identifying Features with Contour Lines

Contour lines show more than just the steepness of a slope or the elevation of a peak. You can pick out major land features on the map by the way the contour lines are shaped.

- Peak: A mountain or hill that is marked by concentric contour lines. The summit may be marked with a name, an "X", or an elevation.
- Valley: A landform with a depression in which water, if present, would flow down. Also know as gullies, drainages, ravines, and couloirs, valleys are indicated by "V"or "U" shaped contour lines that "point" uphill, toward higher elevation.
- Ridge: A landform with an elevated crest that slopes down on the sides. Ridges are also shown by "V" or "U" shaped contours, but these "point" downhill, toward lower elevations. Remember, water never runs along ridge tops.
- Saddle: A low spot between two peaks marked by hourglass-shaped contour lines.



Basic topographic landforms (peak, saddle, ridge, drainage) and a comparison of relative steepness as seen on [US Topo] in gaiagps.com.



Basic landforms on Thompson Peak, Idaho.

Contour Intervals and Index Marker

The contour interval is the amount of elevation change between each contour line. Contour intervals vary from map to map. Intervals set at 40-feet are common on 1:24,000 scale maps. But many maps, especially small scale maps, have 50-foot or 100-foot intervals. Index contours are the more prominent, bold colored lines with the elevation marked on them.

Index contours on the [NRCAN Canada Topo layer.](#) Index contours are every 5th line, and there are 500 feet between index contours, so the contour interval is 100 feet.

Discover the contour interval in two ways:

1. Find the contour interval on the map margin or legend, or
2. Calculate the contour interval between index contours, which are are the more prominent, bold-colored lines with the elevation marked on them. First, subtract the lower number from the higher number and then divide the result by the number of contour lines. For example, if the index contours elevations are 8000 and 7500 feet as shown in the picture above, the difference is 500 feet. If every fifth line is bold, then divide by 5. The contour interval is 100 feet.

Topo Map Scales

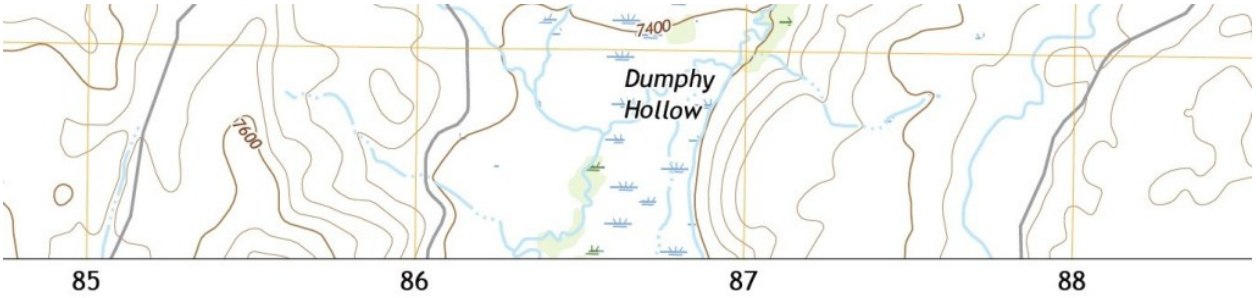
Map scale is important because it tells you how detailed a topo will be. Map scale is defined as one single unit of measurement equal to a definitive number of *the same* number of units in the real world. You'll find the map scale written as a ratio in the bottom margin of a topo map.

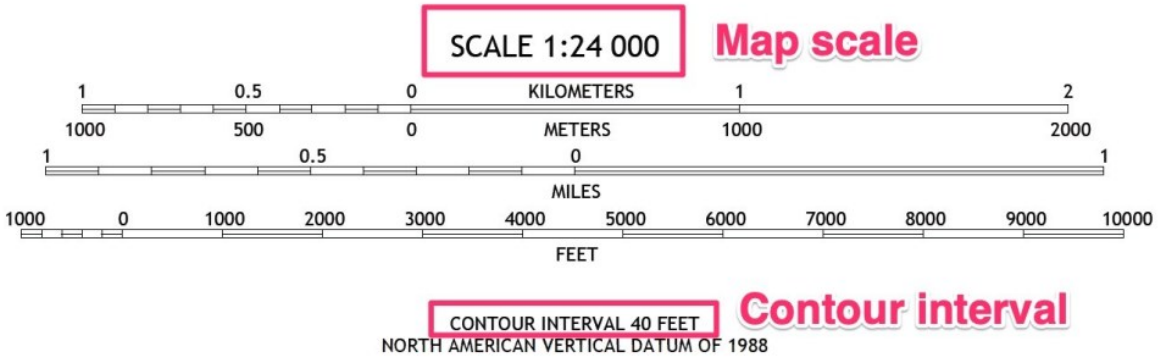
Map scales vary greatly across different topo maps, but the most common scale is 1:24,000 for topo maps created in the United States. On a 1:24,000 scale map, 1 inch on the map is representative of 24,000 inches, or 2000 feet, on the ground. The United States Geological Survey quadrangle maps are scaled to 1:24,000. These are large scale maps and bring a lot of detail into focus.

A map scale of 1:63,360 is common in Forest Service maps, and maps throughout Alaska. These are smaller-scale maps, with less intricate detail. Some National Geographic maps use a scale of 1:65,000, which allows a large area of land to be packed onto a single topo map.

What you need to know is that the bigger the number on the bottom of the ratio, the smaller the scale and the less detail:

- 1:24,000= a large scale map that depicts a smaller region of land in intricate detail
- 1:63,360= a small scale map that depicts a larger area of land in less detail





The map scale and contour intervals are usually found in the bottom margin or in the legend of the topo map.

Distance Scale

The distance scale in the margin identifies the distance on the ground in relation to a straight line on a map. For example, in a 1:63,360 map, one inch on the map equals one mile on land. On a larger scale 1:24,000 USGS quadrangle map, as referenced in the photo above, one inch on the map equals 2,000 feet on the ground. This is important when you're out in the field because it places context to distances on the map's representation of the landscape.

The bar scale doesn't take into account distance added by switchbacks and twists and turns of a trail. But you can use the lanyard of your compass, a guy line from your tent, or the shoelace from your boot to trace the bends of the trail and then measure the lanyard against the linear bar scale. This will give you a more accurate assessment of distance than a straight-line measurement on the map's surface.

Map Legend

A map legend explains what the map's symbols, lines, and colors represent. Look for the legend in the margin or in the corner of a map. On gaiagps.com, click on the map's thumbnail in the layers menu to access the legend.

Large scale USFS recreation maps often include a robust legend with keys for recreation symbols, like campgrounds and restrooms. There may be a listing of points of interest, such as prominent peaks and glaciers, and a legend defining roads, trails, and manmade features like gates and power lines.

Colors on the Map

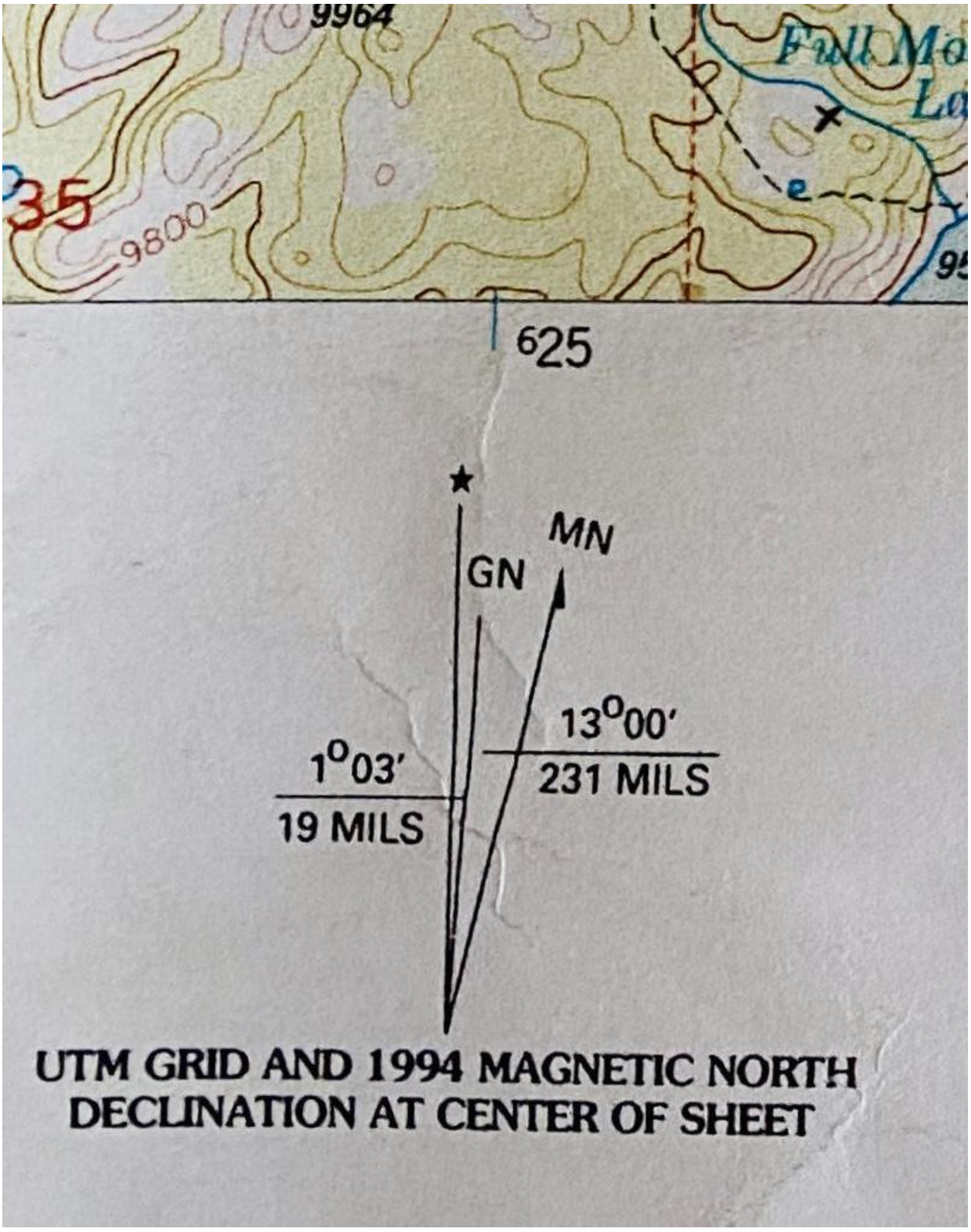
Some legends define what different colors represent on the map:

- Blue represents water in the form of creeks, rivers, and lakes.
- White areas outlined by a thin blue line indicate a year-round snowfield.
- Green areas are sections of land covered with vegetation, like trees.
- White, or the color of the base map, represents land that lacks tall vegetation.

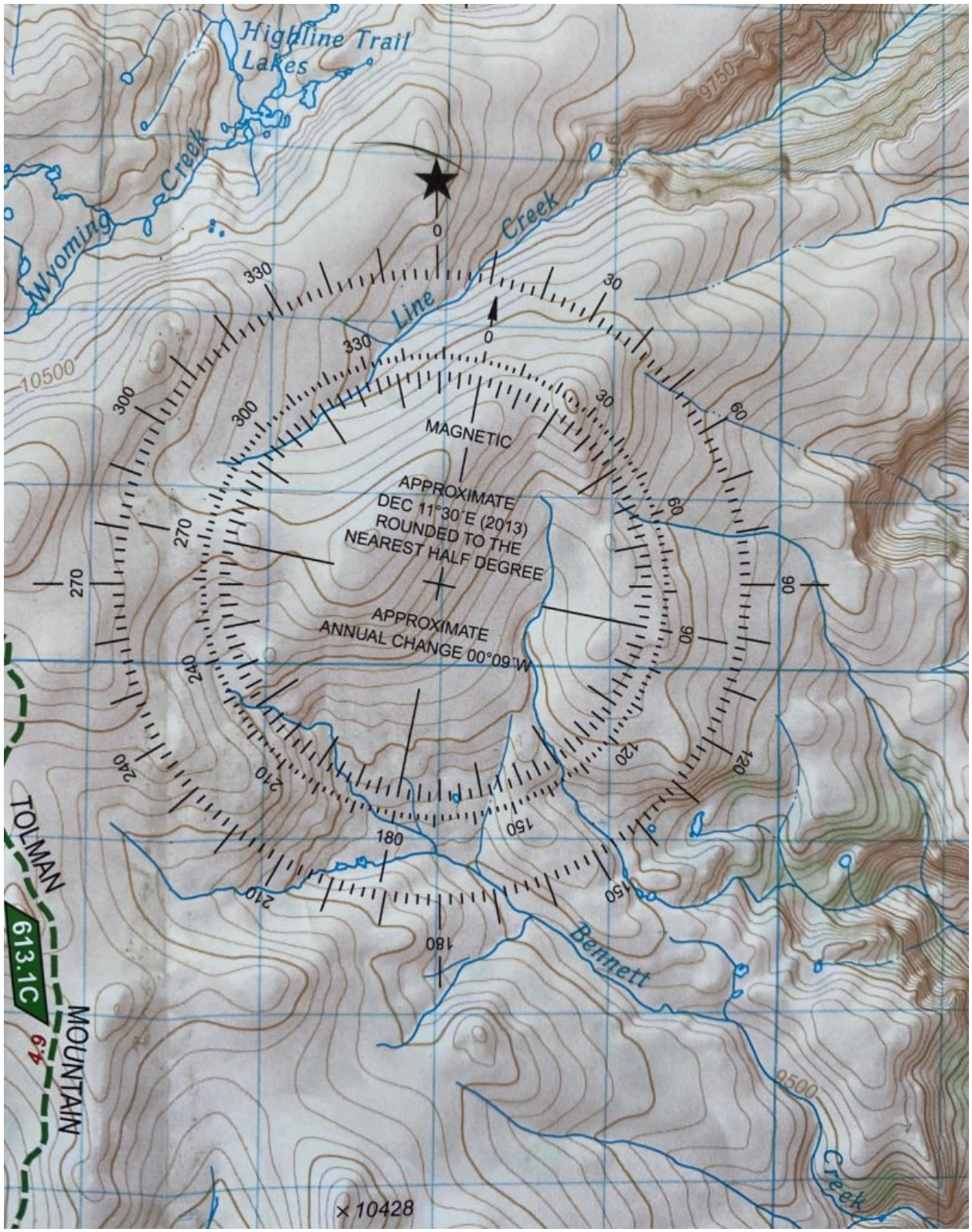
The absence of vegetation can mean many things, including a desert landscape, a meadow, a scree field, a gentle grassy slope high above treeline, or a burn area. Use the contour lines to take a guess at what the surface characteristics will be on the ground without vegetation. If the area is flat with no contour lines and a river flows through the non-vegetated area, then the white-shaded zone is likely a meadow. If the non-vegetated area is high above tree-line, steep, and below a rocky mountain, there is a good chance it's a field of talus.

Declination

Topo maps are oriented to true north, while your compass needle is drawn to magnetic north. Declination is the angle of deviation between the magnetic north and true north. This angle is often depicted in the bottom margin of the map or on the map itself, as seen in the photos below.



UTM GRID AND 1994 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET



- Two ways declination is depicted on maps, in the margin or on the map face.

These diagrams show the declination for the area on the map. Map and compass navigators use the declination angle to adjust their compass to account for the difference between true north on the map and magnetic north,

which lies some 400 kilometers south of true north.

Declination varies with location on the earth, and in one part of the United States may be several degrees different than in another part of the country. Also, declination changes over time as magnetic north responds to the earth's ever-changing magnetic field, so it's important to check the map's publish date as older maps may not accurately reflect the current declination. You can also look up magnetic declination by using this nifty calculator.

Orient the Map

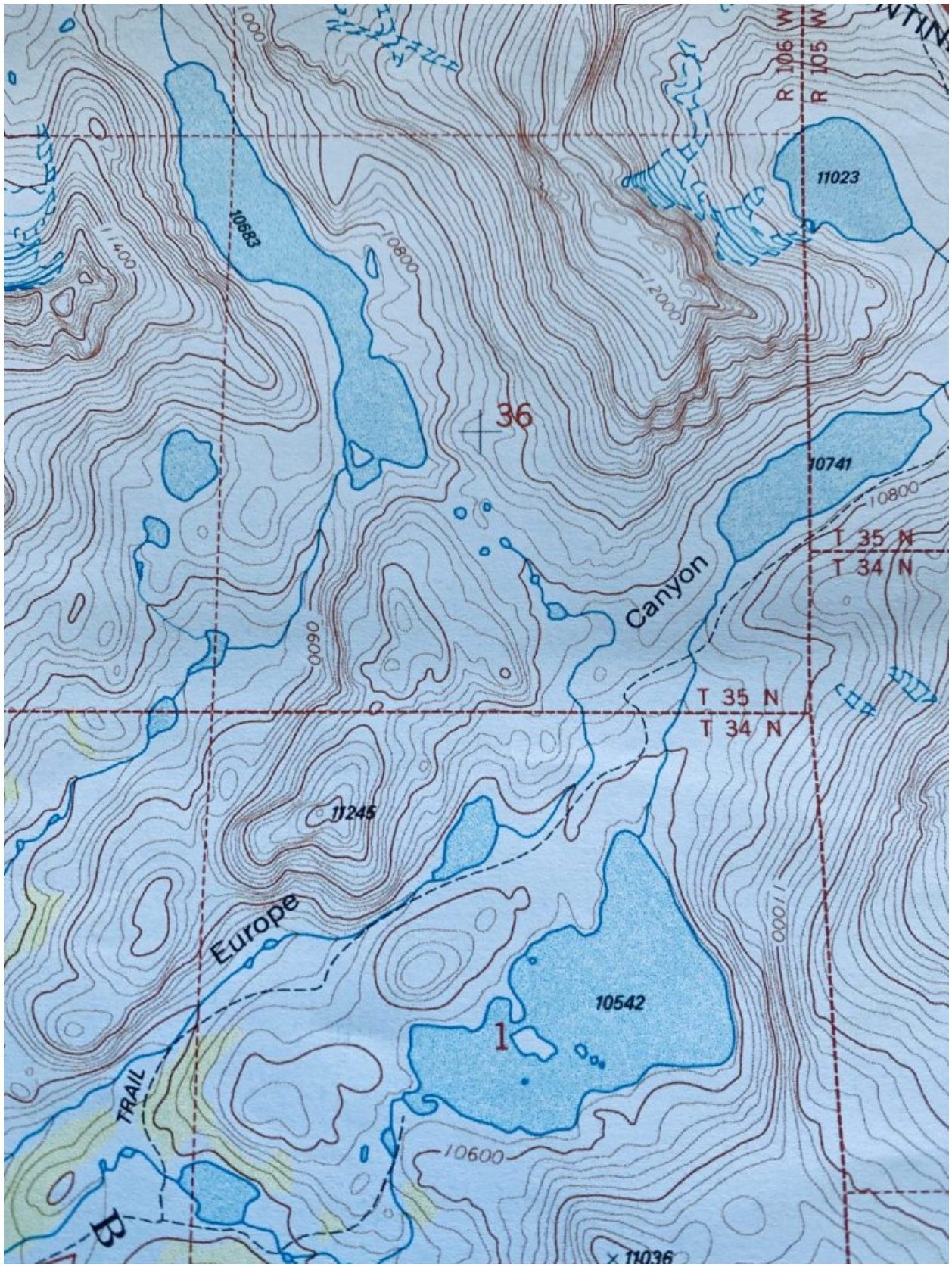
Topographic maps are oriented to true north. If you're holding the map in front of you, and the letters and numbers are right-side up, then the direction of true north is located at the top of the map. This is important because when you are in the field, you'll need to orient the map to true north to bring the map in line with the land features around you. Learn how to orient the map from backpacking guide Andrew Skurka.

When the map is oriented to true north in the field all the surrounding features will line up with the contour lines on the map. This is the time to practice picking out ridges and peaks on the skyline and matching them up with distinctive contour lines on the map.

Map Grids

Township and Range

Many maps have grid lines with the numbers 1-36 written in the middle of each box. These numbered boxes are called sections and originate from the township and range survey method that was used throughout the western United States, some midwestern states, and Alabama and Florida. Each square on the map represents one-square-mile on the ground, conveniently giving you the ability to assess distance without having to use the distance bar.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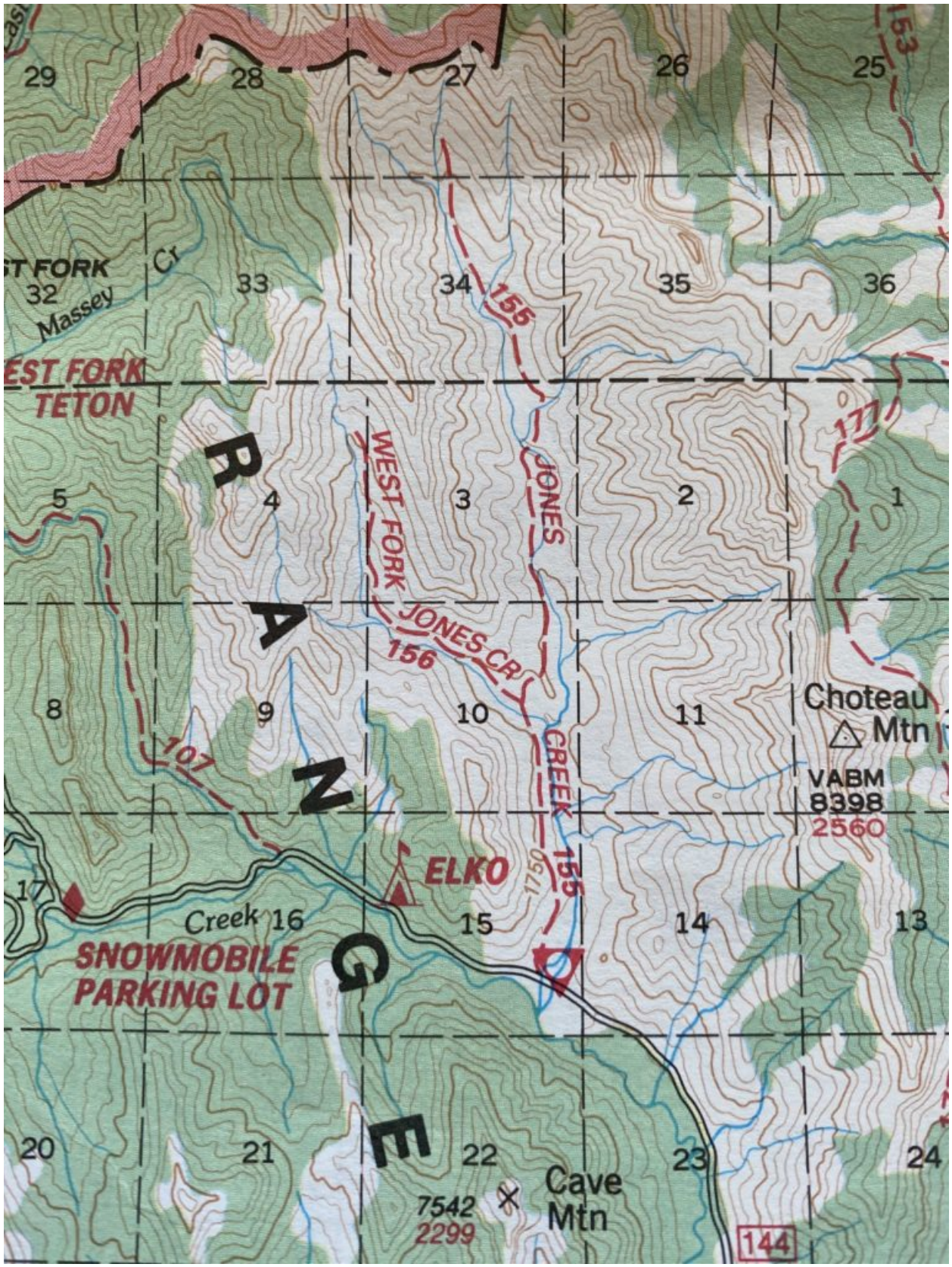


The map on the left shows a large-scale USGS quadrangle map showing township and range

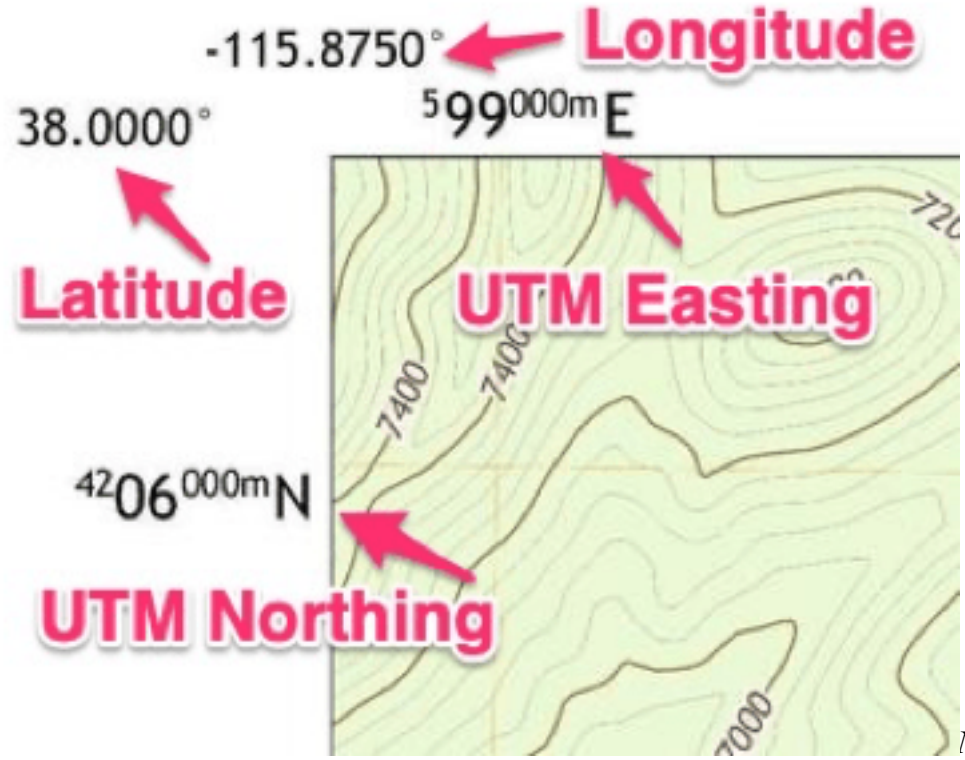
grid lines and section numbers. The map on the right is a USFS large-scale map displaying township, range, and section numbers. Each box represents one square mile.

UTM Coordinates

Some maps, like National Geographic Trails Illustrated, display the Universal Transverse Mercator (UTM) coordinate system, which includes markings on the map for every 1,000 meters on the map's north-south line and east-west line. The measurements on the north-south lines are "northings" and represent the number of meters that point on the map is from the equator. The numbers on the east-west lines are "eastings" and they depict the number of meters east or west of a particular reference line. You can find these measurements along the margins in the USGS quadrangle maps. Some maps display UTM grid lines, and others don't, leaving you to eyeball the exact measurement or use a tool to help calculate the exact point.

Latitude and Longitude

Latitude and longitude coordinates are also listed in the margins of most topographical maps. They present in the form of degrees, as shown in the picture below.



Notice the lat/long coordinates on the upper left margin of this USGS quadrangle map and the UTM "easting" and northing" measurements closer to the edge of the map.