

# Reading Topographic Maps

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## Quadrangle Name

The first thing to notice on a topographical map is the title. It is found in the top right hand corner of the map (Fig. 1).

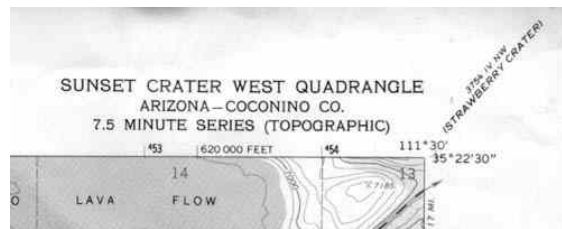


Fig. 1. Quadrangle title.

The title for this particular map is, "Sunset Crater West Quadrangle." At the corner, but in smaller print is another title called Strawberry Cheater. That is the title of the next topographical map to the northeast of this one. You will find similar titles on all the corners of a topographical map as well as halfway between the corners. Use that information to find the other maps that you may need.

## Latitude, Longitude, and UTM'S

The next thing that you should notice on a topographical map are the numbers running all around the outside of the map. These numbers represent two grid systems that can be used to find your exact location. The first is called latitude and longitude. The exact latitude and longitude is given at each corner of that map and at equally spaced intervals between the corners. The second is called UTM's. These are the smaller bold numbers that run along the border of the map (Fig. 2).

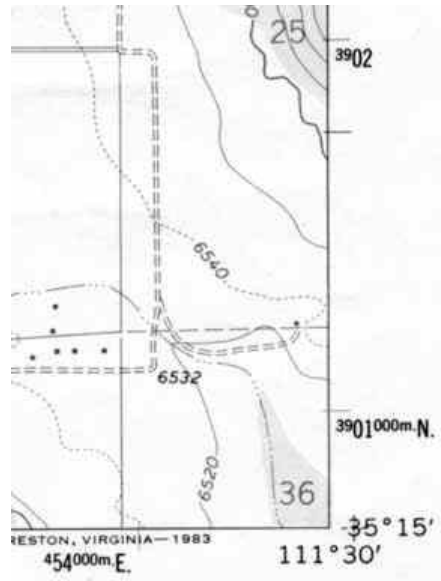


Fig. 2. Latitude and longitude and UTM coordinates.

## Latitude & Longitude

Latitude and longitude is the most common grid system used for navigation. It will allow you to pinpoint your location with a high degree of accuracy. Latitude is angular distance measured north and south of the Equator. The Equator is 0 degrees. As you go north of the equator the, latitude increases all the way up to 90 degrees at the north pole. If you go south of the equator, the latitude increases all the way up to 90 degrees at the south pole. In the northern hemisphere the latitude is always given in degrees north and in the southern hemisphere it is given in degrees south.

Longitude works the same way. It is angular distance measured east and west of the Prime Meridian. The prime meridian is 0 degrees longitude. As you go east from the prime meridian, the longitude increases to 180 degrees. As you go west from the prime meridian longitude increases to 180 degrees. The 180 degree meridian is also known as the international date line. In the eastern hemisphere the longitude is given in degrees east and in the western hemisphere it is given in degrees west.

## How Accurate Can Latitude and Longitude Get?

At the equator, one degree of latitude or longitude represents approximately 70 statute miles. At higher latitudes the distance of one degree of longitude decreases. Latitude stays the same because they are always equally spaces apart. If you look on a globe you will see this to be the case. On the other hand, if you look on a globe you will notice that the lines of longitude get closer together as they approach the north and south poles.

Degrees are not accurate enough to find a precise location. At best, one degree of latitude and longitude would define a 70 square mile area. To over come this problem, 1 degree is divided into 60'(minutes). So if 1 degree equals 70 miles and one degree can be divided into 60' then 1' equals 1.2 miles. Dividing 1 degree into 60' allows one to calculate their position with much better accuracy. In some instances even more accuracy is needed. To do this we can divide 1' into 60"(seconds). If 1' equals 1.2 miles and we can divide it into 60", then 1"

equals 0.02 miles. It is worth taking a few seconds to memorize the following numbers. It will help you to use latitude and longitude more effectively:

- 1 degree = 70 miles
- 1' = 1.2 miles
- 1" = .02 miles

If you look at the picture above you will notice the latitude and longitude in the lower right hand corner of the map. You would read it as 35 degrees 15 minutes north latitude and 111 degrees 30 minutes west longitude.

Below the title you will notice the words 7.5 minute map. This means that the map covers an area of approximately 7.5 minutes of latitude and longitude.

### UTM Coordinates

UTM Stands for Universal Transverse Mercator. It is another grid system that can be used to find your position. It is most commonly used in the military and for research as well as survey purposes. The UTM system divides the surface of the earth up into a grid. Each grid is identified by a number across the top called the zone number and a letter down the right hand side called the zone designator. For example, Albuquerque, New Mexico is in UTM grid 13 S (Fig 3).

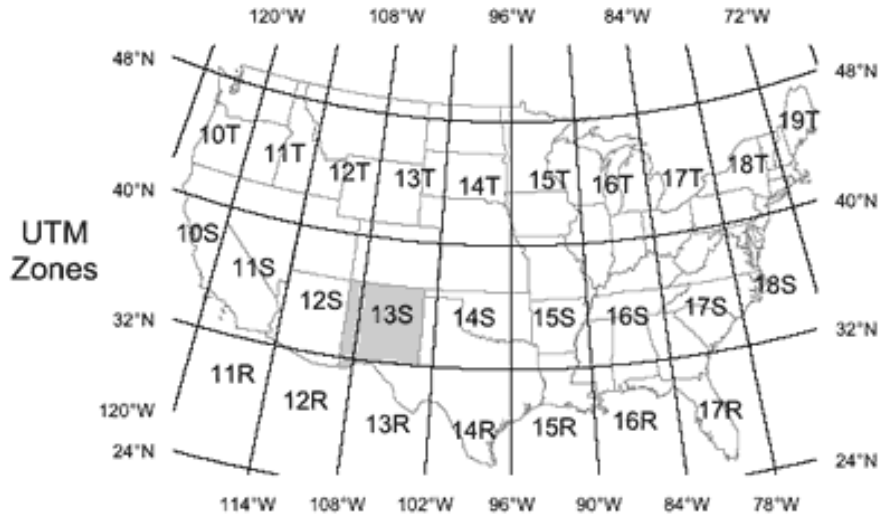


Fig. 3. Latitude and longitude and UTM coordinates.

Every spot within a zone can be defined by a coordinate system that uses meters. Your vertical position is defined in terms of meters north and your horizontal position is given as meters east. They are sometimes referred to as your northing and easting. In the following picture you can see the northing and easting coordinates on the boarder of the topo map. They are the small bold black numbers. Along the edge of the map the first UTM shown is 3901000 meters north. On a regular topo map the dash above that number would be blue. As you go up the right hand side of the map, the next UTM is 3902000 meters north. As you go up the right hand side of the map every time you pass a the small blue dash you have

gone up 1000 meters (one meter = 3.281 feet). The same applies with the UTM's across the bottom of the map.

## Map Scale

Map scale represents the relationship between distance on the map and the corresponding distance on the ground. The scale on the topo map is found at the bottom center of the map (Fig. 4).

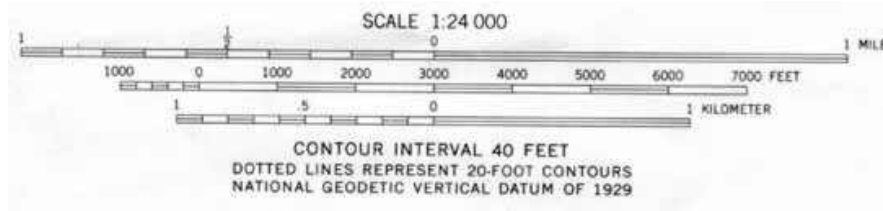


Fig. 4. Topo map scale.

Scale is represented in two different ways on a topographical map. The first is a ratio scale. The ratio scale on this map is 1:24,000. What it means is that one inch on the map represents 24,00 inches on the ground. Below the ratio scale is a graphic scale representing distance in miles, feet and meters. The graphic scale can be used to make fast estimates of distances on the map. The space between the 0 and the 1 mile mark on the scale is the distance you must go on the map to travel one mile.

## Contour Lines

One of the advantages to using a topographical map is that it shows the three dimensional lay of the land. It does this by using contour lines. A contour line is a line that connects points of equal elevation. On the topo map they appear as the brown lines.

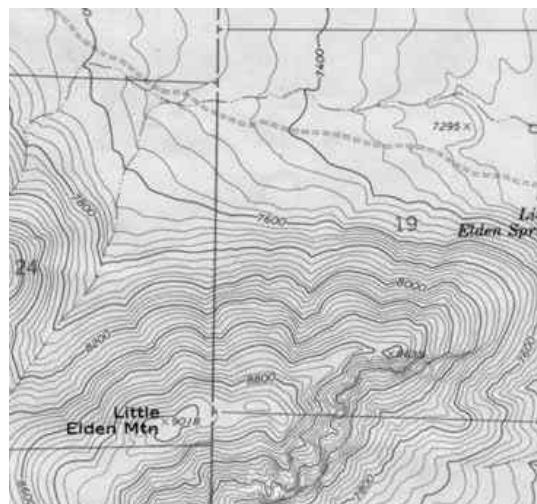


Fig. 5. Contour lines on a topographic map.

The contour line traces the outline of the terrain at evenly spaced elevations. These are determined by the contour interval. The contour interval is found below the map scale. For this map, the contour interval is 20 feet. That means that every time you go up to another brown line the elevation increases by 20 feet and every time you go down a brown line the

elevation decreases by 20 feet. In the lower left hand corner of the map there is a mountain. Notice how the contour lines define the shape of the mountain. The lines are closer together at the top of the mountain where it is steeper. The spacing between the lines decreases as the slope of the mountain decreases.

Some guides for understanding contour lines are as follows:

1) Every point on a contour line represents the exact same elevation (remember the glass inserted into the mountain). As a result of this every contour line must eventually close on itself to form an irregular circle (in other words, the line created by the intersection of the glass with the mountain cannot simply disappear on the backside of the mountain). Contour lines on the edge of a map do not appear to close on themselves because they run into the edge of the map, but if you got the adjacent map you would find that, eventually, the contour will close on itself.

2) Contour lines can never cross one another. Each line represents a separate elevation, and you can't have two different elevations at the same point. The only exception to this rule is if you have an overhanging cliff or cave where, if you drilled a hole straight down from the upper surface, you would intersect the earth's surface at two elevations at the same X,Y coordinate. In this relatively rare case, the contour line representing the lower elevation is dashed. The only time two contour lines may merge is if there is a vertical cliff (Fig. 6).

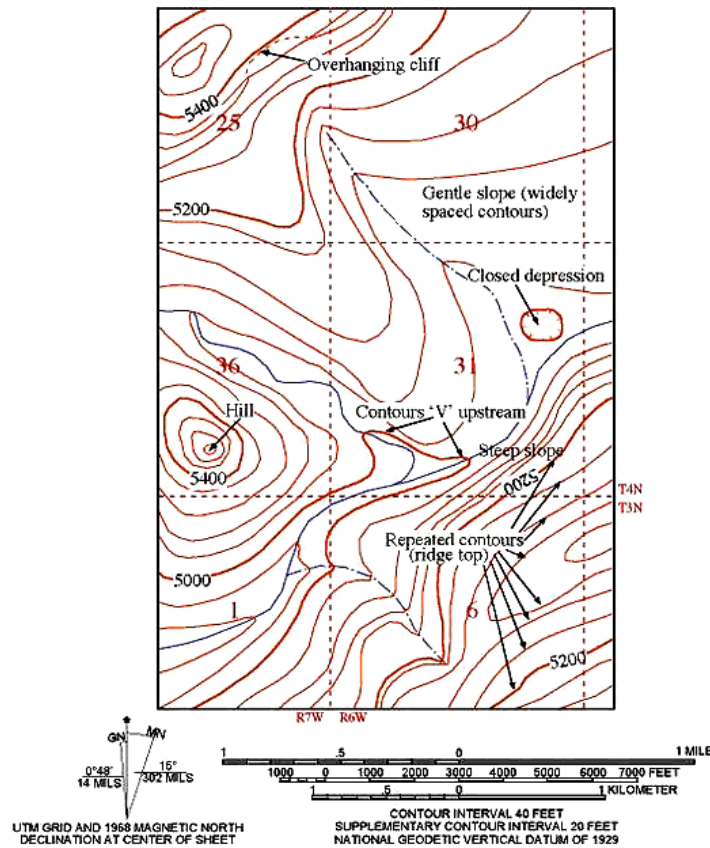


Fig. 6. Features of contour lines.

- 3) Moving from one contour line to another always indicates a change in elevation. To determine if it is a positive (uphill) or negative (downhill) change you must look at the index contours on either side (Fig. 6).
- 4) On a hill with a consistent slope, there are always four intermediate contours for every index contour. If there are more than four index contours it means that there has been a change of slope and one or more contour line has been duplicated. This is most common when going over the top of a hill or across a valley (Fig. 6).
- 5) The closer contour lines are to one another, the steeper the slope is in the real world. If the contour lines are evenly spaced it is a constant slope, if they are not evenly spaced the slope changes.
- 6) A series of closed contours (the contours make a circle) represents a hill. If the closed contours are hatched it indicates a closed depression (Fig. 6).
- 7) Contour lines crossing a stream valley will form a "V" shape pointing in the uphill (and upstream) direction.

## Magnetic Declination

At the lower left hand corner of topographical maps there is a symbol called the magnetic declination (Fig. 7). The symbol is used in conjunction with a compass for navigational purposes. The center line with the star above represents the direction of true geographic north. The line coming of to the right represents the direction of magnetic north, When using a compass, the needle always points to magnetic north. The symbol tells you that for the area the map covers, the magnetic compass needle will always point 13.5 degrees to the east of true geographic north. To the left of the true north line is the grid north line. This tells you how much the UTM grid and zone lines are offset from true north.

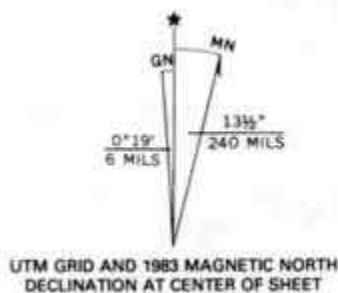


Fig. 7: Magnetic declination indicator.

## Public Land Survey System

The final grid system discussed here is the public land survey system (PLSS). Although the geographic, UTM, state plane, and PLSS coordinate systems are the most common, there are other coordinate systems in use today. The public land survey system is most often used on topographic maps published in the United States and has its roots in the early surveys of North America in the 1700s. The PLSS system differs from the coordinate systems described above in that it is more descriptive, and relies less on absolute measurements of

location. It is useful in that it is a good way to give a quick approximation of a location, but the main drawback is its lack of accuracy.

In most Midwestern and western states, early surveyors established a principal meridian running north-south, and a base line running east-west. These initial survey lines served as a basis for subsequent survey lines spaced at 24 mile intervals along the eastern, western, and southern boundaries.

Further subdivision of these 'squares' led to the creation of 16 smaller squares, or **townships**, measuring six miles on a side (see the diagram below). Townships are numbered using a grid based on the baseline and meridian. The north-south grid is also referred to as "**township**" (in some localities a township is referred to as a "tier"). The east-west grid is called "**range**". So, a 36 square mile township located between six and twelve miles east of the principal meridian and twelve to eighteen miles north of the base line would be called township (or tier) three north, range two east (written as **T3N, R2E**).

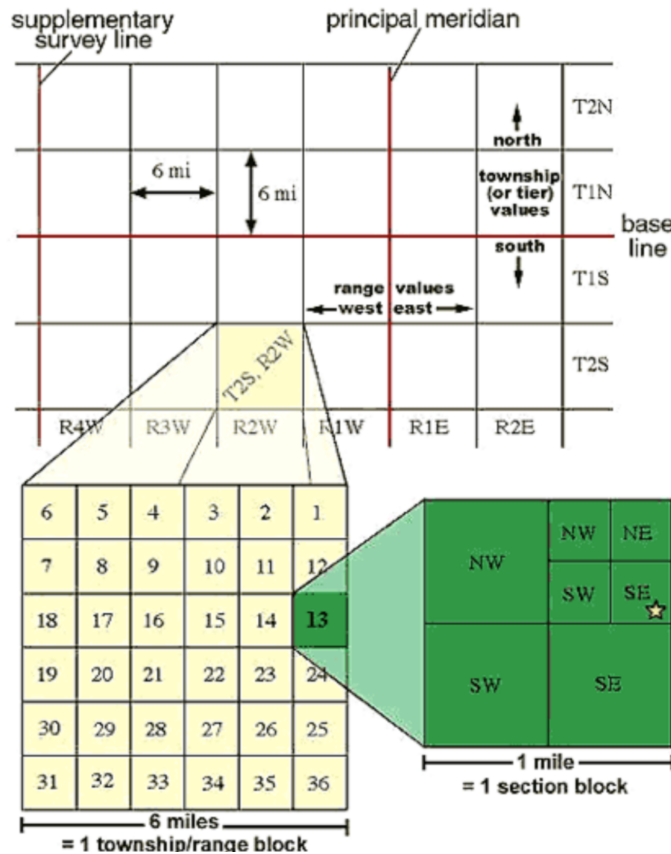


Fig. 8. Township, range, and section system.

Each township (tier) is further subdivided into 36 smaller squares called **sections**, each one covering roughly 1 square mile. Sections are numbered within a township from the upper right to the lower right in an alternating manner, as shown below. These one mile squares are the smallest formal subdivision in the PLS system. Individual sections are then subdivided into half sections and quarter sections, and the quarters are quartered again, as shown below. The location of the star in the figure below would be described as the southeast quarter of the southeast quarter of the northeast quarter, section thirteen,

township two south, range two west. The shorthand for this is: SE1/4, SE1/4, NE1/4, sec. 13, T2S. R2W.

On a topo map, you will notice a grid with red lines and text crisscrossing the map. The lines represent the borders of the various sections in the township and range of that area. In the map below you can see sections 23, 24, 26 and 25 of T.22N, R.7E.

## Field Notes

To ensure that the location and stratigraphic unit from which a fossil was collected can be reconstructed accurately once the fossil is removed from the field, detailed information about the collecting site should be recorded in field notes and on topographic maps.

It is helpful to record the location in your field notes in several ways. In addition to the field number you have given a specimen, record the following: (1) date, county and state, rock unit as a header or in the margin of the page; (2) quadrangle name, township, range, section, and quarter quarter section; (3) latitude and longitude (as measured from GPS or topographic map); (4) verbal description of the site (e.g., western slope of gully cut into the top of the Brule Fm.).

If you have a paper or electronic topographic map, mark the site on the map and indicate the field number you have given the specimen.