Chapter 1. Map Study and Interpretation

1.1. Maps

A map is a visual representation of an area—a symbolic depiction highlighting relationships between elements of that space such as objects, regions, and themes. Many maps are static two-dimensional, geometrically accurate (or approximately accurate) representations of three-dimensional space, while others are dynamic or interactive, even three-dimensional. Although most commonly used to depict geography, maps may represent any space, real or imagined, without regard to context or scale; e.g. brain mapping, DNA mapping, and extraterrestrial mapping.

1.2. Types of Maps

Maps are one of the most important tools researchers, cartographers, students and others can use to examine the entire Earth or a specific part of it. Simply defined maps are pictures of the Earth's surface. They can be general reference and show landforms, political boundaries, water, the locations of cities, or in the case of thematic maps, show different but very specific topics such as the average rainfall distribution for an area or the distribution of a certain disease throughout a county. Today with the increased use of GIS, also known as Geographic Information Systems, thematic maps are growing in importance.

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There are however applications for different types of general reference maps when the different types are understood correctly. These maps do not just show a city's location for example; instead the different map types can show a plethora of information about places around the world.

The following is a list of each major map type used by geographers and a description of what they are and an example of each kind.

Political Map: A political map does not show any topographic features. It instead focuses solely on the state and national boundaries of a place. They also include the locations of cities - both large and small, depending on the detail of the map. A common type of political map would be one showing the Indian States and their borders along with the International borders

Physical Map: A physical map is one that shows the physical landscape features of a place. They generally show things like mountains, rivers and lakes and water is always shown with blue. Mountains and elevation changes are usually shown with different colors and shades to show relief. Normally on physical maps green shows lower elevations while browns show high elevations. An example of a physical map is one showing the state of Hawaii. Low elevation coastal regions are shown in dark green, while the higher elevations transition from orange to dark brown. Rivers are shown in blue.

Topographic Map: A topographic map is similar to a physical map in that it shows different physical landscape features. They are different however because they use contour lines instead of colors to show changes in the landscape. Contour lines on topographic maps are normally spaced at regular intervals to show elevation changes (e.g. each line represents a 100 foot (30 m) elevation change) and when lines are close together the terrain is steep. For example a topographic map showing the Big Island of Hawaii would have contour lines that are close together near the steep, high elevation mountains of Mauna Loa and Kilauea. By contrast, the low elevation, flat coastal areas show contour lines that are spread apart.

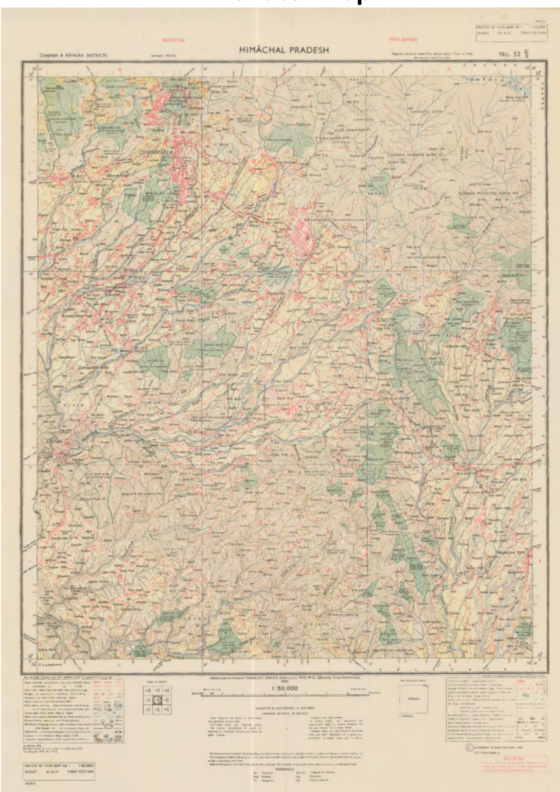
Climate Map: A climate map shows information about the climate of an area. They can show things like the specific climatic zones of an area based on the temperature, the amount of snow an area receives or average number of cloudy days. These maps normally use colors to show different climatic areas.

Road Map: A road map is one of the most widely used map types. These maps show major and minor highways and roads (depending on detail) as well as things like airports, city locations and points of interest like parks, campgrounds and monuments. Major highways on a road map are generally red and larger than other roads, while minor roads are a lighter color and a narrower line.

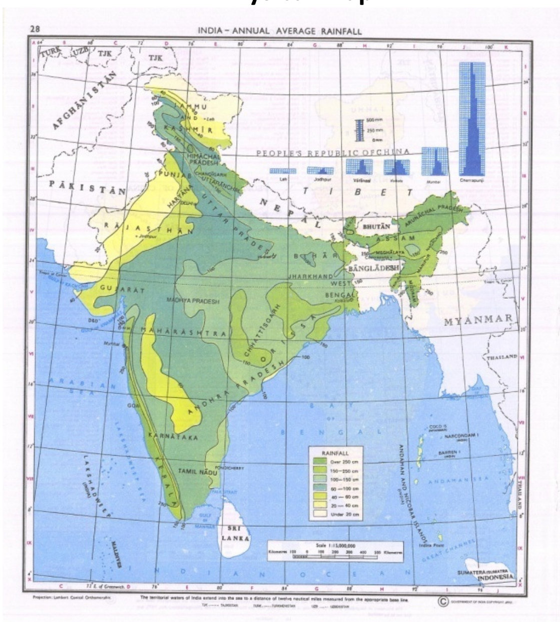
Thematic Map: A thematic map is a map that focuses on a particular theme or special topic and they are different from the six aforementioned general reference maps because they do not just show natural features like rivers, cities, political subdivisions, elevation and highways. If these items are on a thematic map, they are background information and are used as reference points to enhance the map's theme.

Political Map

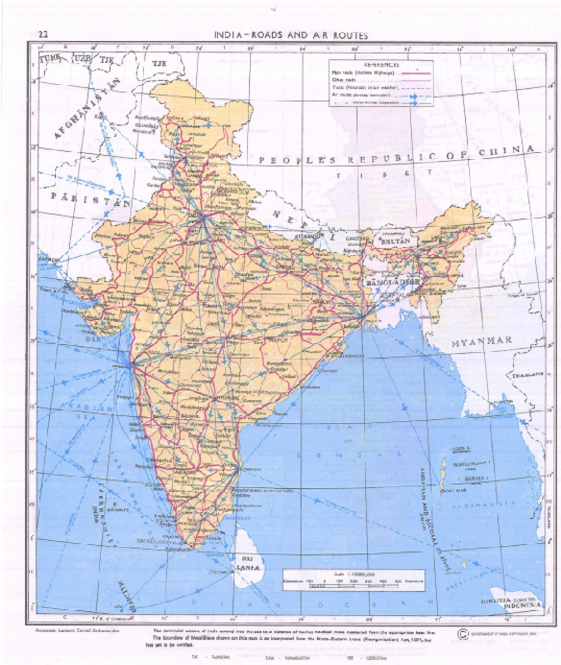
Physical Map



Topographic Map



Climate Map



Road Map

Thematic Map

1.3. Orientation of maps

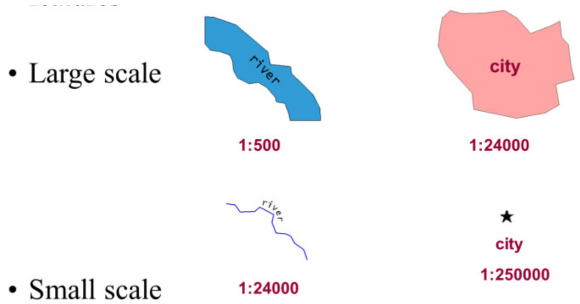
The orientation of a map is the relationship between the directions on the map and the corresponding compass directions in reality. The word "orient" is derived from Latin oriens, meaning East. Modern digital GIS maps typically project north at the top of the map, but use math degrees (0 is east, degrees increase counter-clockwise), rather than compass degrees (0 is north, degrees increase clockwise) for orientation. Compass decimal degrees can be converted to math degrees by subtracting them from 450.

1.4. Scale and accuracy

Many, but not all, maps are drawn to a scale, expressed as a ratio such as 1:10,000, meaning that 1 of any unit of measurement on the map corresponds exactly, or approximately, to 10,000 of that same unit on the ground. The scale statement may be taken as exact when the region mapped is small enough for the curvature of the Earth to be neglected, for example in a town planner's city map. Over larger regions where the curvature cannot be ignored we must use map projections from the curved surface of the Earth (sphere or ellipsoid) to the plane. The impossibility of flattening the sphere to the plane implies that no map projection can have constant scale: on most projections the best we can achieve is accurate scale on one or two lines (not necessarily straight) on the projection. Thus for map projections we must introduce the concept of point scale, which is a function of position, and strive to keep its variation within narrow bounds. Although the scale statement is nominal it is usually accurate enough for all but the most precise of measurements.

Large scale maps, say 1:10,000, cover relatively small regions in great detail and small scale maps, say 1:10,000,000, cover large regions such as nations, continents and the whole globe. The large/small terminology arose from the practice of writing scales as numerical fractions: 1/10,000 is larger than 1/10,000,000. There is no exact dividing line between large and small but 1/100,000 might well be considered as a medium scale. Examples of large scale maps are the 1:25,000 maps produced for hikers; on the other hand maps intended for motorists at 1:250,000 or 1:1,000,000 are small scale.

It is important to recognise that even the most accurate maps sacrifice a certain amount of accuracy in scale to deliver a greater visual usefulness to its user. For example, the width of roads and small streams are exaggerated when they are too narrow to be shown on the map at true scale; that is, on a printed map they would be narrower than could be perceived by the naked eye. The same applies to computer maps where the smallest unit is the pixel. A narrow stream say must be shown to have the width of a pixel even if at the map scale it would be a small fraction of the pixel width.



Visual Representation of Map Scale

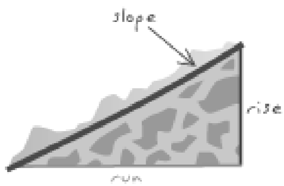
Standard Scales:

1:1000,000	Country level	(1mm = 1000 m)
1: 250, 000	State level	(1 mm = 250 m)
1: 50,000	District level	(1mm = 50 m)
1: 12,500	Micro level	(1mm = 12.5 m)

Survey of India Maps (topographic maps) are available at all above scales except 1:12,500

Standard Scales followed for representations

1.5. Slope



Slope can be defined as the steepness or gradient of a unit of terrain, usually measured as an angle in degrees or as a percentage. Aspect can be defined as the direction in which a unit of terrain faces. Aspect is usually expressed in degrees from north. Slope can be measured in degrees from horizontal (0–90), or percent slope (which is the rise divided by the run, multiplied by 100). A slope of 45 degrees equals 100 percent slope. As slope angle approaches vertical (90 degrees), the percent slope approaches infinity. The slope of a TIN face is the steepest downhill slope of a plane defined by the face. The slope for a cell in a raster is the steepest slope of a plane defined by the cell and its eight surrounding neighbors.

1.6. Hill Shading

Hill shading can be described as the hypothetical illumination of a surface according to a specified azimuth and altitude for the sun. Hillshading creates a three-dimensional effect that provides a sense of visual relief for cartography, and a relative measure of incident light for analysis. In simpler terms, it is Shadows drawn on a map to simulate the effect of the sun's rays over the varied terrain of the land. It simulates the cast shadow thrown upon a raised relief map, or more abstractly upon the planetary surface represented. The shadows normally follow the English convention of top-left lighting in which the light source is placed near the upper-left corner of the map. If the map is oriented with north at the top, the result is that the light appears to come from the north-west. Many people have pointed out that this is unrealistic for maps of the northern hemisphere, because the sun does not shine from that direction, and they have proposed using southern lighting.

1.7. Layer Coloring

The method of showing relief features with the help of a scheme of graded colours especially in atlas and wall maps is termed as Layer Coloring. There are different forms of layer coloring namely Hypsometric, Thematic, Natural etc.

Hypsometric:

Hypsometric colors vary with the terrain's elevation and thereby emphasize the third dimension. Hypsometric maps represent the elevation of the terrain with colors. The area between two neighboring contour lines receives one specific tint. Hypsometric colors are most common in topographic maps at small scales, either applied as continuous gradients or intervals. The succession of colors occurs according to different rules.

The cartographer has to choose the number of different color classes, their limiting contour lines and the colors. Generally, relatively light colors are preferable and the basic principle "higher is brighter" is advice worth heeding. Nevertheless, good alternative color schemes exist that employ different rules.

1.8. TOPOGRAPHIC MAP

A topographic map is a type of map characterized by large-scale detail and quantitative representation of relief, usually using contour lines in modern mapping, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features. A topographic map is typically published as a map series, made up of two or more map sheets that combine to form the whole map. A topographic map is a detailed and accurate graphic representation of cultural and natural features on the ground.

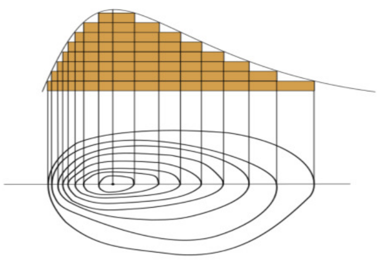
Topographic maps are based on topographical surveys. Performed at large scales, these surveys are called topographical in the old sense of topography, showing a variety of elevations and landforms. Topographic surveys were prepared by the military to assist in planning for battle and for defensive emplacements. As such, elevation information was of vital importance.

As they evolved, topographic map series became a national resource in modern nations in planning infrastructure and resource exploitation. Topographic maps have multiple uses in the present day: any type of geographic planning or large-scale architecture; earth sciences and many other geographic disciplines; mining and other earth-based endeavors; and recreational uses such as hiking or, in particular, orienteering, which uses highly detailed maps in its standard requirements.

1.8.1 Topomap conventions

- The various features are represented by conventional signs or symbols. These signs are usually explained in the margin of the map, or on a separately published characteristic sheet.
- conventionally show topography, or land contours, by means of contour lines.
- These maps usually show not only the contours, but also any significant streams or other bodies of water, forest cover, built-up areas or individual buildings (depending on scale), and other features and points of interest.
- Today, topographic maps are prepared using photogrammetric interpretation of aerial photography, LIDAR and other Remote sensing techniques. Older topographic maps were prepared using traditional surveying instruments.

1.8.2 Contour Line



- A contour line is a combination of two line segments that connect but do not intersect; these represent elevation on a topographic map.
- Technically, it's a line of a function of two variables or is a curve along which the function has a constant value.
- In cartography, a contour line (often just called a "contour") joins points of equal elevation (height) above a given level, such as mean sea level.

1.8.3 Scale

Scale is the relationship between the distance on a map and the real distance on the earth's surface.

It may be expressed as a *representative fraction* (ratio), a *line scale* or a *statement scale*. It is an important element of a map because it gives relative picture of the ground reality. Maps are generally classified into large scale and small scale. However, there is no universally accepted standard for classifying maps according to scale. What one considers to be large, may appear to be small or medium for others.

The same person may consider a map to be of large scale for one purpose but of small scale for another purpose. As a matter of convention, **maps having a scale 1:50,000 upto are classified as large scale maps, those falling between 1:50,000 and 1:1,000,000 as medium scale maps and those having scales above 1:1,000,000 are treated as small scale maps.** The million sheets of the Survey of India and the National Atlas of India are considered to be medium scale maps.

Methods of Expressing Scales

The scales can be expressed in three ways:

1. Statement: The scale may be indicated in the form of a written statement. For example 1cm on the map represents 1 km on the ground. The scale is written as 1 cm to 1 km. This means that 1 cm on the map corresponds to 1 km on the ground. Although it is simple to express in words, it is difficult for those who are not familiar with the unit of measurement used. Besides, the scale will not be the same when the original map is reduced or enlarged. As such, this method is not very useful.

2. Representative Fraction (R.F.): It is also called as numerical scale. It is expressed as a ratio of map distance and ground distance. For example 1:1,000,000 means one unit of distance on the map corresponds to 1,000,000 units of distance on the ground. The advantage of R.F. is that it can be used universally irrespective of the local unit of measurement of distance. The mapcan be reduced or enlarged without changing the R.F.

3. Linear Scale or Graphical Scale: This scale is expressed as a horizontal or straight line. The base is calibrated to express visual equivalents of representative fraction or verbal scale. The bases are divided into a number of equal parts and are marked to show what these divisions represent on actual ground. The scale has the advantage that it remains true even after reduction or enlargement of the map. However, it is useful only to those who are familiar with the particular unit of measurement.

Distances on the map are smaller than the corresponding distances on actual ground. Scale is the means which enables us to reduce the whole or a part of the earth to a size which is not only convenient and handy but also logical and scientific. A general definition of scale is that it is a ratio between the distance on a map and the corresponding distance on the earth. For example if two points located 10 km apart are shown 1 cm apart on a map, then the scale of the map would be 1 cm to 10 km. It may also be converted into R.F as given below.

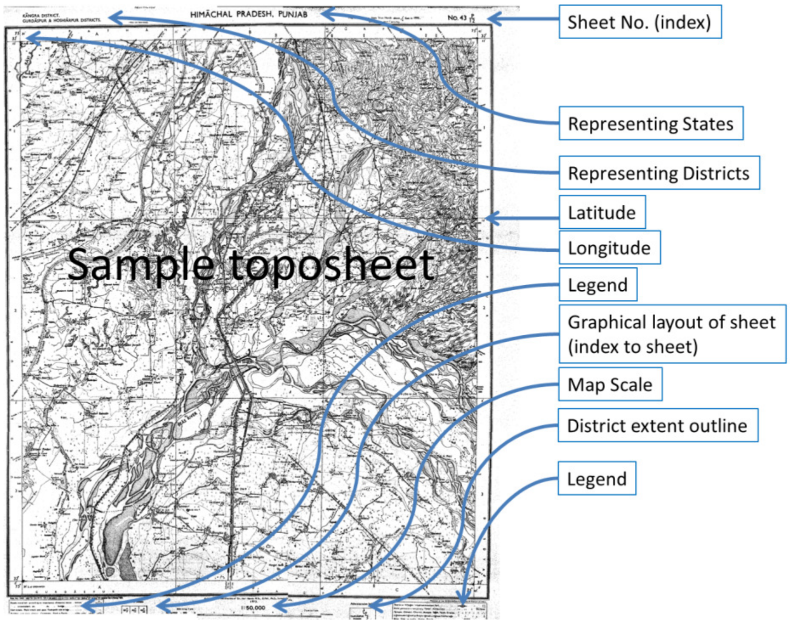
Suppose, 1 cm = 10 KM. (1 cm) / (10 km)

(MAP DISTANCE) / (GROUND DISTANCE) => = (1 cm) / (10 x 10,000 cm)

= 1: 1,000,000

1.8.4 Reading Topographic Maps

This section addresses how to read the information that is in the margins of a Survey of India topographic map.



Agency or Author Who Created Map: This information generally includes the name of the surveyor and is available in the bottom of the topographic sheet.

Toposheet Header

Center : The states represented in the toposheet is generally the title of the map.
Left
Type: classification of toposheet. The sheets which are prohibited are marked RESTRICTED.

District: the districts represented are named.

Surveyed: the year of survey conducted is marked.

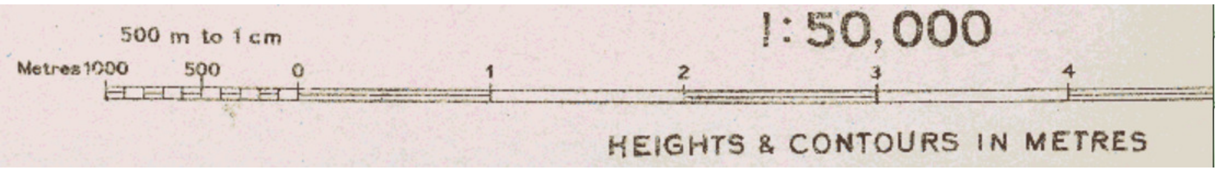
Right : *No.*The index of the sheet. E.g. 43P/12 means 12th sheet of series 43 .
Magnetic Variation: True north (geodetic north) is the direction along the earth's surface towards the geographic North Pole. Magnetic variation is the angle between magnetic north (the direction the north end of a compass needle points) and true north.

Toposheet Footer

Index to sheets
Since toposheets are series of maps, index tells who are the neighbors of present sheet (current sheet will be highlighted) Administrative index indicates bird's eye view of administrative regions covered.

Scale

Scale is represented as Statement, RF and Linear Scale. The units of heights (contours) are also mentioned.

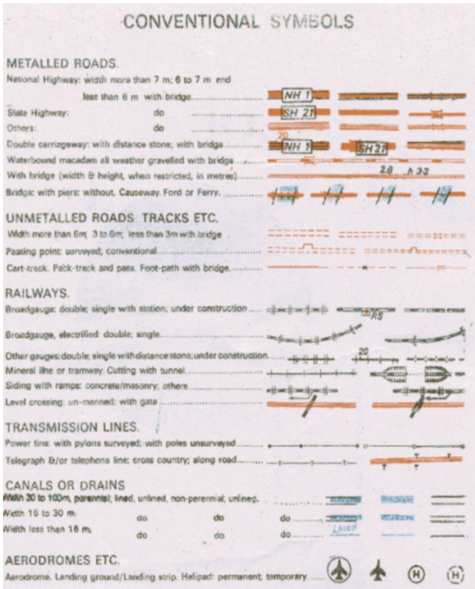


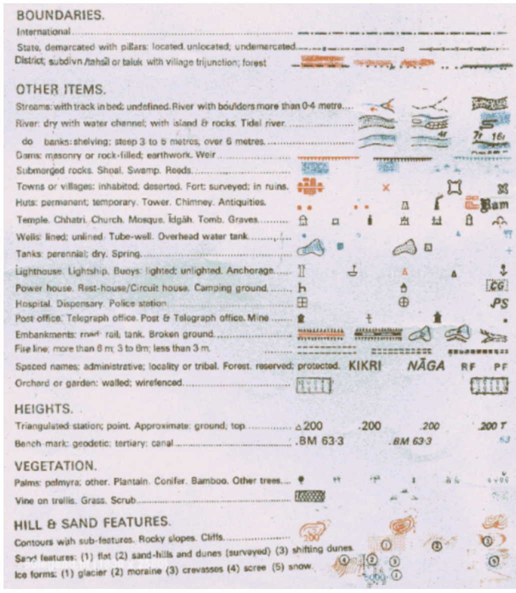
Latitude and Longitude (edges of map)

Latitude and longitude lines are indicated along the edges of the map. Reference coordinates for latitude and longitude (degrees, minutes, and seconds) are black andlocated on the four corners of the map. The intersection of latitude and longitude lines are noted by cross-marks (+).

Legends

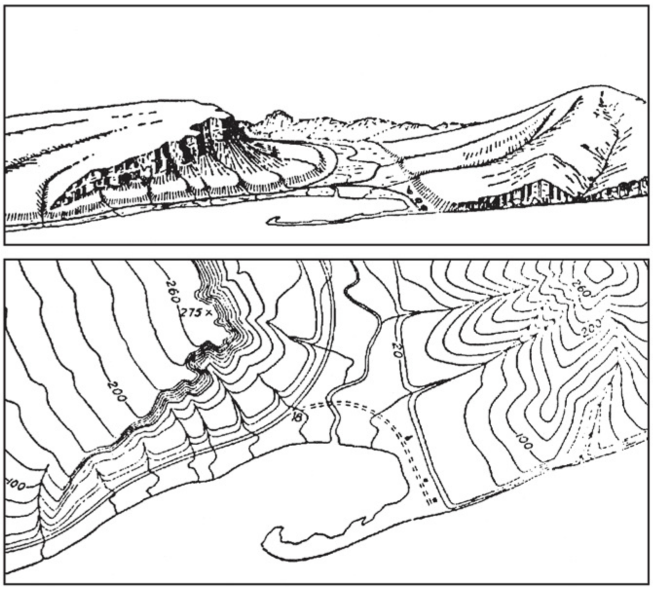
Legends are marked as conventional symbols. They are described on the bottom of the sheet.



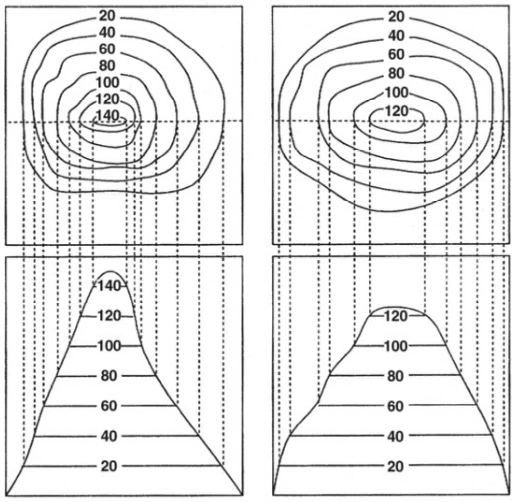


1.8.5 Interpreting Contour Lines

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 lineis 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.

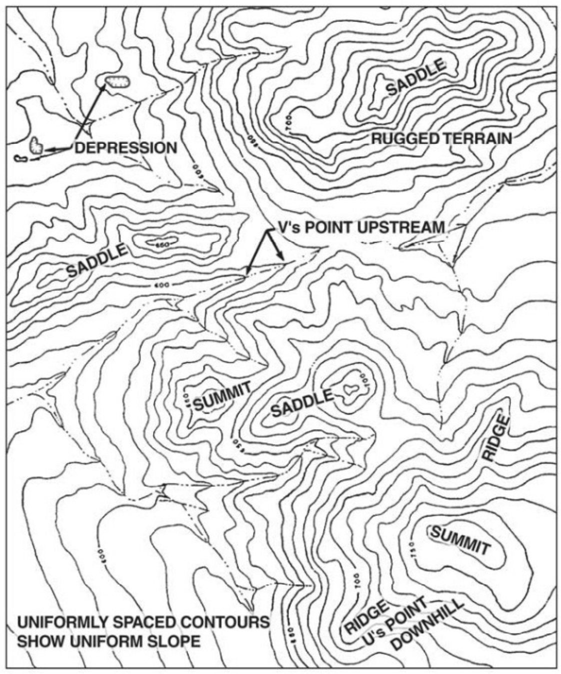


A contour map and what it looks like from a landscape perspective. Note that contour lines are far apart for level land and almost touch for cliffs



Evenly and widely spaced contoursindicate 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 uphillor upstream.
- “U” shape contours indicate ridges with the bottom of the “U” pointing down the ridge. A saddle isa 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, andsurfaces of lakes may also be shown on the map.



Contour lines and topographic features

Contour Interval

Contour interval is the difference in elevation between two adjacent contour lines. To make the contours easier to read, a contour line (generally every fifthone) is the index contour which is printed darker and has the elevation value marked on the line. The contour interval is generally printed in the map. If the contour interval is not given, it can be calculated as:

Steps	Directions
1	Find two index contours near each other: The index contours marked **4400** and **4600.**
2	Determine the **difference** in elevation between the two index contours: 4600 ft. – 4400 ft. = **200 ft.**
3	Count the number of contour lines between the two index contours: There are **5** lines. **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): 200 ft. ÷ 5 = **40 ft.** This is the contour interval.