Lab 5: Topography and Topographic Maps

In this lab, you'll learn some of the tools available to help geologists recognize and interpret the **topography** of Earth's surface. Topography refers to the 3-dimensionality of the surface of a place—hills, valleys, plains, streams, etc. For instance, the topography of Kansas is boringly simple because the area is so flat, but the topography of the Bay Area is highly varied.

A **topographic map** is a two-dimensional (flat) representation of three-dimensional topography. Like a road map, a topographic map shows features laid out according to the chief compass directions N, S, E, and W, but it also shows information about the height of the land surface by using **contour lines** (commonly called **contours**).

A **contour is simply a line connecting points of exactly the same elevation.**

Topographic maps are essential tools for geologists, geographers, backpackers, forestry crews, surveyors, land planners, military personnel, engineers, emergency response teams, and anyone else who deals with features on the Earth's surface.

I. Visualizing Topography

Topography is notoriously difficult to portray in words or using two-dimensional surfaces like paper. However, we can use computer representations of topography that, although technically two-dimensional, fool our brains into "seeing" in three dimensions.

The Gallery of Virtual Topography was developed by Professor Steve Reynolds at the University of Arizona. The site has many cool images and movies, but they take a while to load so **PLEASE** follow the instructions below (and those of your instructor).

Click on the following links in the following order:

Simple Hill — Choose "QTVR Movie"
Rotate the image to see how the contours reflect the real shape of this hill.

Complex Valley — Choose "QTVR Movie"
Rotate the image to see how the contours reflect the real shape of this river valley (formally called a stream drainage).

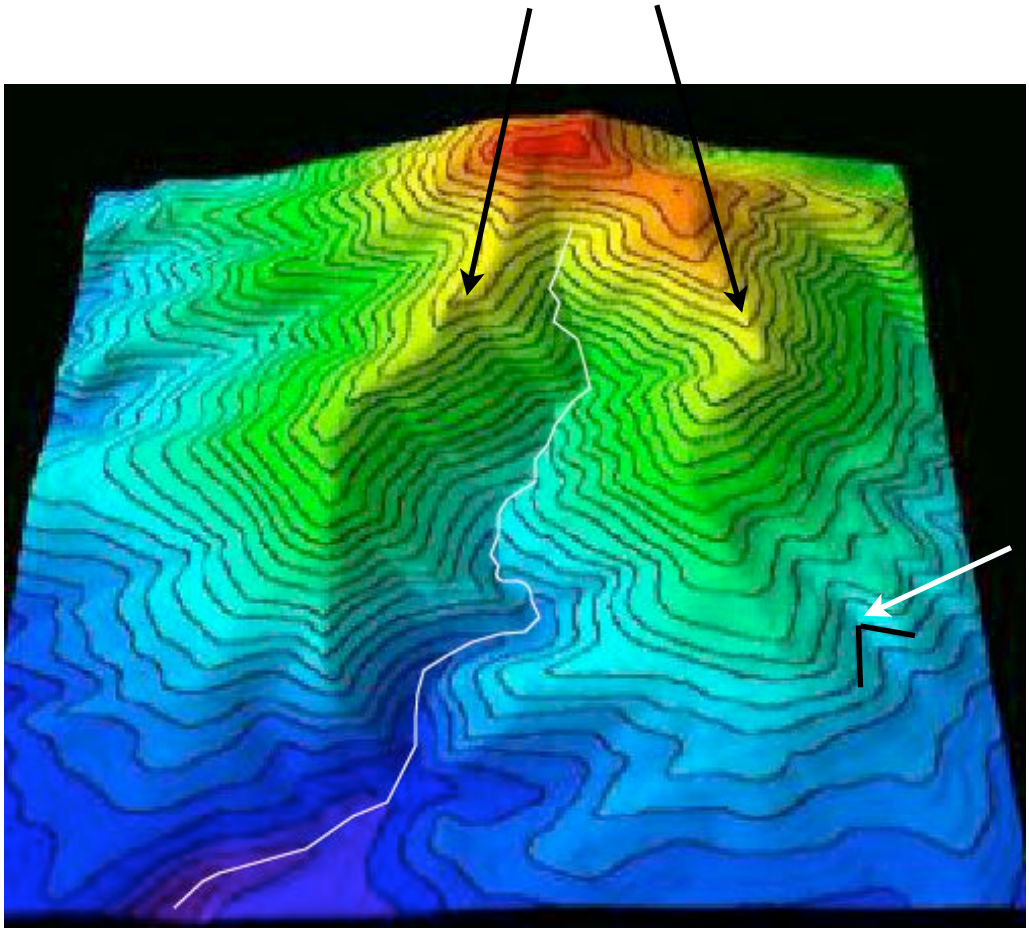
New River Mesa, Arizona — Choose "Movie with contours and water plane"
Drag the cursor up and down to cause sea level to "rise" and "fall" in this region.

While 3-D visualizations help us imagine how contours express the true shape of part of the Earth's surface, most topographic information is expressed on 2-D digital or paper maps.

Stream valleys are fundamental features on topographic maps, and you have to be able to recognize them in order to "get around" on these maps. The line of a stream is sometimes shown in the valley bottom, indicating that water is usually present, but most valleys in the western U.S. are dry most of the time, and stream lines are not shown.

In order to identify a valley without the help of a stream line, use the "Law of Vs." The 3-D block diagram below (from the Gallery of Virtual Topography web site, which is highly recommended) shows a thin white line in a valley that extends from the top of the mountain to the lower left foreground. Wherever the white line crosses a contour line, it bisects a "V" in the contour line, with the point of the V pointing uphill. Look where the white line crosses any other contour line, and you'll see the same pattern: at a valley, the "V" of contour lines points uphill.

Note that the contours also make Vs on the adjoining ridges, but these Vs point *down*hill.

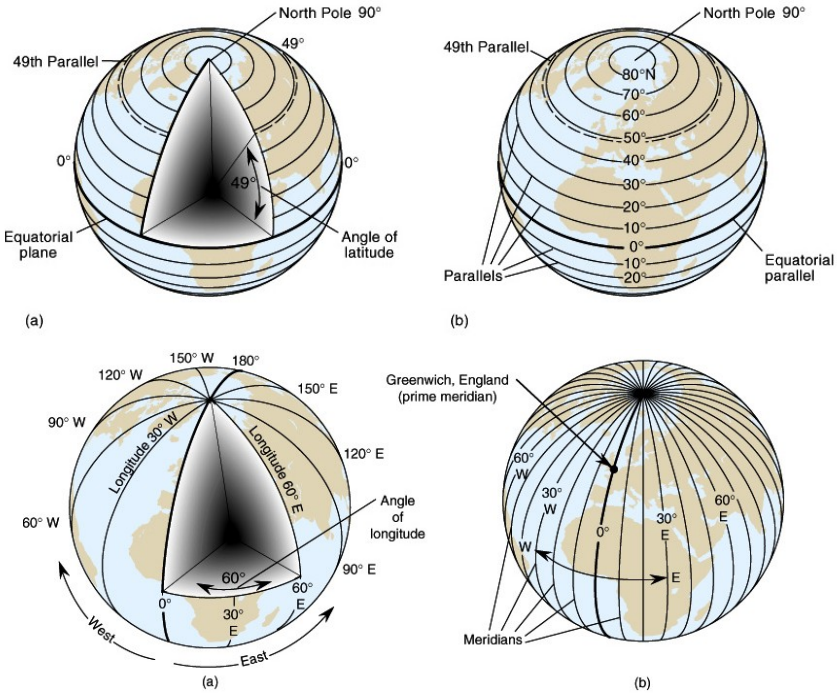


Find the V drawn on the diagram near the bottom right. The point of the V aims uphill, so this must be a valley (although a small one compared to the one with the white line).

II. Latitude and Longitude

The *coordinates* of a point on Earth's surface are its **latitude** and **longitude**.

Latitude is expressed in degrees north (N) or south (S) of the equator, which has latitude 0°. The north pole has latitude 90°N.

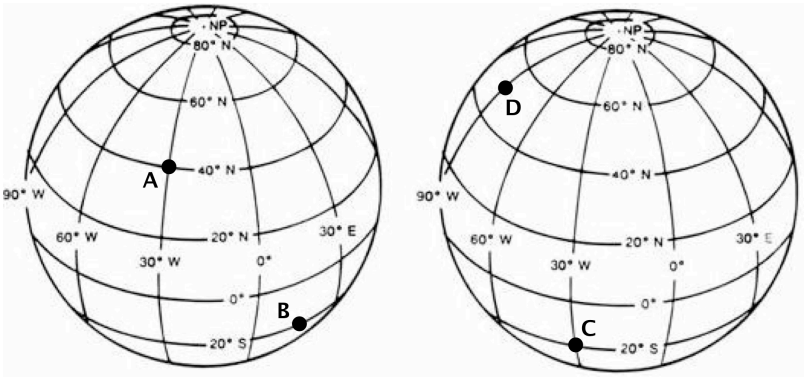


Longitude is expressed in degrees east (E) or west (W) of the prime meridian— the 0° longitude line that runs through Greenwich (GREENitch), England.

Degrees of latitude and longitude are subdivided into 60 minutes (′), and each minute is divided into 60 seconds (″). In other words, 1° = 60′ = 3600″.

The coordinates of a point are its latitude and longitude. In the diagram at right, point A has latitude 40°N and longitude 30°W, generally just given in the form 40°N, 30°W.

Point B's coordinates are 20°S, 15°E.



1. What are the coordinates of points C and D in the far-right diagram?

point C: _____ point D: _____

2. On the far-right diagram, place a dot labeled "E" at 30°N, 60°W.

3. On the far-right diagram, place a dot labeled "F" at 70°N, 45°E.

Glossary of terms and features you'll find on maps in this lab

Map name: The name of the quadrangle is shown in the upper right corner.

Map publisher: The publisher of the map is indicated in the upper left corner; in the U.S., topographic maps are published by the U.S. Geological Survey.

Latitude and longitude: These are marked at the four corners of the map (in the white area just outside the map); intermediate values are shown at a few points along the map edges.

Township, range, and sections: The U.S. government developed this method of subdividing land in the late 1700s so it could more easily distribute farmland to settlers. Townships are 1-mile-high horizontal subdivisions, ranges are 1-mile-wide vertical subdivision, and sections are the squares formed by the intersection of a township and range—roughly 1 mile on a side. All township, range, and section information is shown in red ink on U.S. topographic maps.

Scale: Every map is a scale model of the real world, so it must specify the ratio by which the real world was reduced to fit on the map. This **ratio scale** usually is printed just below the map. The most common scale for U.S. topographic maps is 1:24,000, which means that 1 unit of measurement (inch, cm, foot, etc.) on the map equals 24,000 of those same units in the real world. Maps also include one or more **graphic (bar) scales** in the bottom map panel, which you can use with a ruler to calculate distances between points.

Contour lines: Imaginary lines that connect points of exactly the same elevation above sea level. A contour line separates areas above its elevation from areas below its elevation. On most U.S. maps, every fifth contour line is a bit thicker than other contour lines and is called an *index contour*. The difference in elevation of two adjacent contour lines is the **contour interval**, which is specified in the bottom map panel beneath the bar scales.

Relief: The difference in elevation of two points. For instance, if a hill is 500 feet high and an adjacent valley floor is 100 feet high, then the relief between them is 400 feet.

Control stations (aka **benchmarks)**: Some points on the map have been surveyed precisely, and their elevations are shown as specific numbers, generally printed next to an X or a triangle.

Symbols: Every map uses numerous symbols to convey information, but they aren't always explained on the sheet. Symbols are used for roads, bridges, railways, waterways, mines, vegetation type, buildings, and many other features.

Magnetic declination: Lines of longitude run exactly from the north pole to the south pole, but magnetic compasses point to Earth's north magnetic pole, which currently lies about 700 km (450 mi) from the north pole. The angle between the the directions of true geographic north and magnetic north is called the magnetic declination, and is usually shown in the bottom map panel.