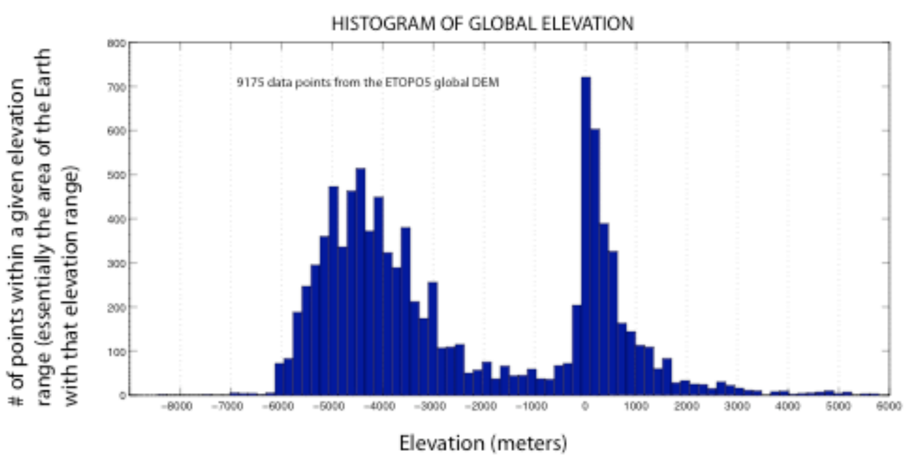
# Lab 1: Getting to Know the Earth's Surface through Maps

A big part of geoscience is the presentation of information about the characteristics of the Earth's surface; the elevation, the underlying geologic materials, the hydrologic features, and geophysical attributes such as the gravity and magnetism. Because of this, it is important to develop a few basic map-reading skills — these will serve you well through the rest of the semester. But first, we need to review a few basic things about the whole Earth, this quasi-spherical planet on which we live.

## The Shape of the Earth

The Earth is, of course, roughly a sphere. The average radius is 6371 km, but it differs from 6356 km along the poles to 6378 km along the equator. This means that the circumference is roughly 40,000 km and the surface area is 510,000,000 km$^2$. Humans have superimposed on this sphere a set of latitude and longitude lines to help describe different places on the surface. Latitude lines run east-west and go from 0° at the equator to 90°N and 90°S; longitude lines all pass through the two poles and go from 0° (the prime meridian, passing through Greenwich, England) to 180° E and 180°W (alternatively, longitude runs from 0° to 360° in a CCW fashion looking down from the north pole). Both latitude and longitude are subdivided into units of minutes (60 per degree) and seconds (60 per minute). This spherical surface is depicted best in the form of a globe, but the difficulties of printing onto a sphere have led people to develop a range of different strategies for projecting parts of this sphere onto planar sheets of paper. Some of these projections preserve (i.e., do not distort) area, others preserve angles; a full rundown on various map projections can be found at the US Geological survey web page (google map projections USGS).

The highest point is Mt. Everest, at 8850 m and the lowest point is in the Marianas Trench at -10,924 m. This total range of almost 20 km, over the circumference of the Earth of 40,000 km makes the Earth comparatively smoother than an orange, so even though on a local, human scale, the topography can seem impressive, on a global scale it is pretty minor. The reasons why the relief is so minimal have a lot to do with a very active hydrologic cycle on Earth, with rain and glaciers constantly wearing away at the high spots. Looking more closely at the global elevation, a rather startling fact appears; elevation on our planet is bimodal — there are two main peaks rather than just one on a histogram.




Why is this distribution of elevations bimodal? To most geoscientists, this suggests that there are two fundamentally different kinds of crust on our planet. This in turn suggests two main processes for forming crust. Later, we will look at similar plots for other planets as a way of understanding some basic things about those planets.

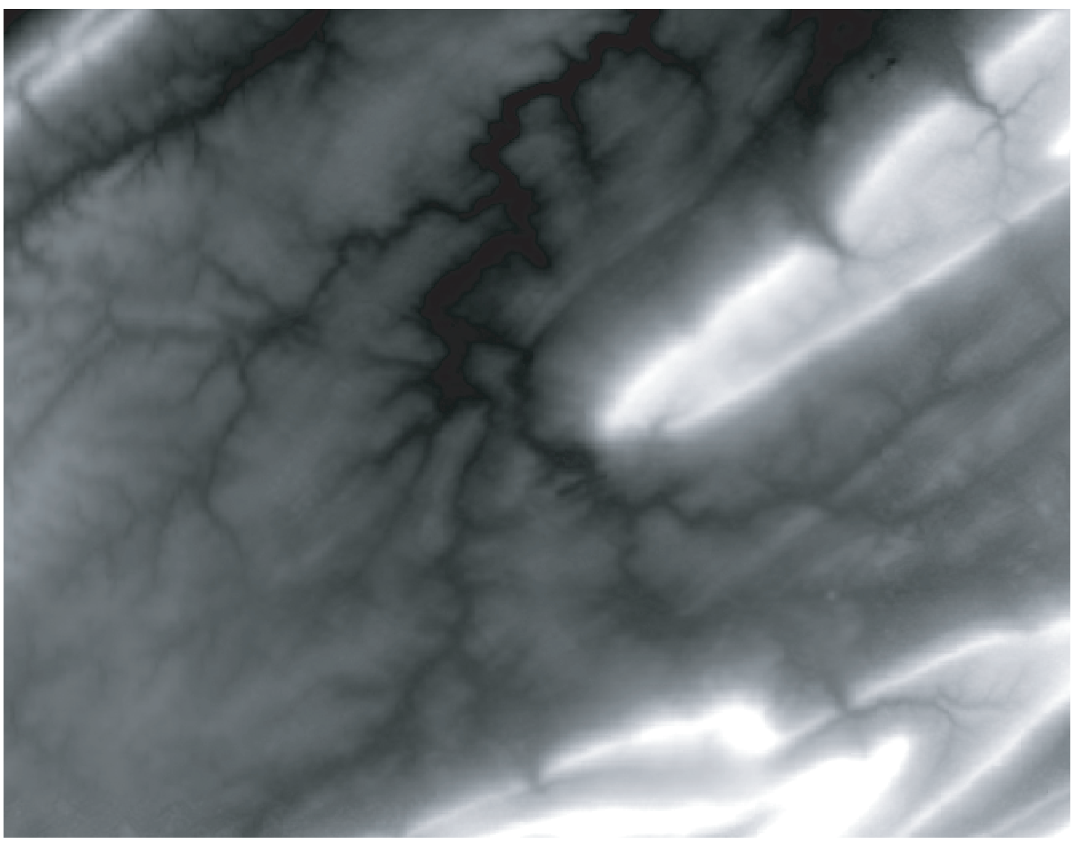
## Maps in the Geosciences

Traditionally, the main kinds of maps geoscientists use are topographic maps and geologic maps. Topographic maps depict the form of the earth's surface via a set of contour lines that connect points of equal elevation. Topo maps also show lakes, rivers, springs, roads, trails, buildings, and many other cultural features; many of them also indicate forested regions. Geologic maps show the different kinds and ages of rocks that are either exposed at the surface or lie beneath a veneer of soil at the surface; this information usually is drawn over the top of a topographic map, so they depict a tremendous amount of information. Geologic maps also show information about faults, folds, the orientation of planar features in the rocks. To fully understand geologic maps, one must first understand topographic maps.

Geophysical maps overlay information about geophysical characteristics such as the strength of the magnetic or gravity fields. Hazard maps show the potential for earthquake, volcano, landslide, or flooding damage on top of normal topographic maps.

In recent years, a vast range of satellite maps have become available to help us understand the nature of the surface and the changes to the surface. The satellite sensors can provide information about the surface temperature, the vegetative activity, and the mineralogical content of the rocks and soil at the surface.

The development of faster and faster computers has led to a new form of topographic map — the digital elevation model or DEM. Here is a sample DEM for the State College area (the light shades are higher elevations; the Mt. Nittany ridge that extends from near the center to the upper right corner)



DEMs convey the same information about the shape of the land surface, but they do it by color-coding each pixel of an image according to its elevation. DEMs can be enhanced by artificially lighting the terrain to generate synthetic shadows that help your eye identify the relief of the surface. They can also be rendered as 3D surfaces, and other information can be "draped" over them, as you will see in the GeoWall demo.

## Understanding and Reading Topographic Maps

Go to the GeoWall in the Museum, where your TA will show you a few demonstrations that illustrate the relationship between topographic contour lines and the 3D form of the land surface. You may want to return to the GeoWall at some later points in the lab to look more carefully at the State College 3D topography.

Now, back to lab room and the topographic maps for some analysis.

1. What are the longitude and latitude coordinates of the Deike Building? Give your answer to the nearest 10".

Longitude _______________

Latitude _________________

2. When I was a kid, someone told me that if you dug straight down, you'd come out in China. Was this right? If you dug a hole straight down, where would you come out on the other side? (this will require consulting a globe or some world maps)

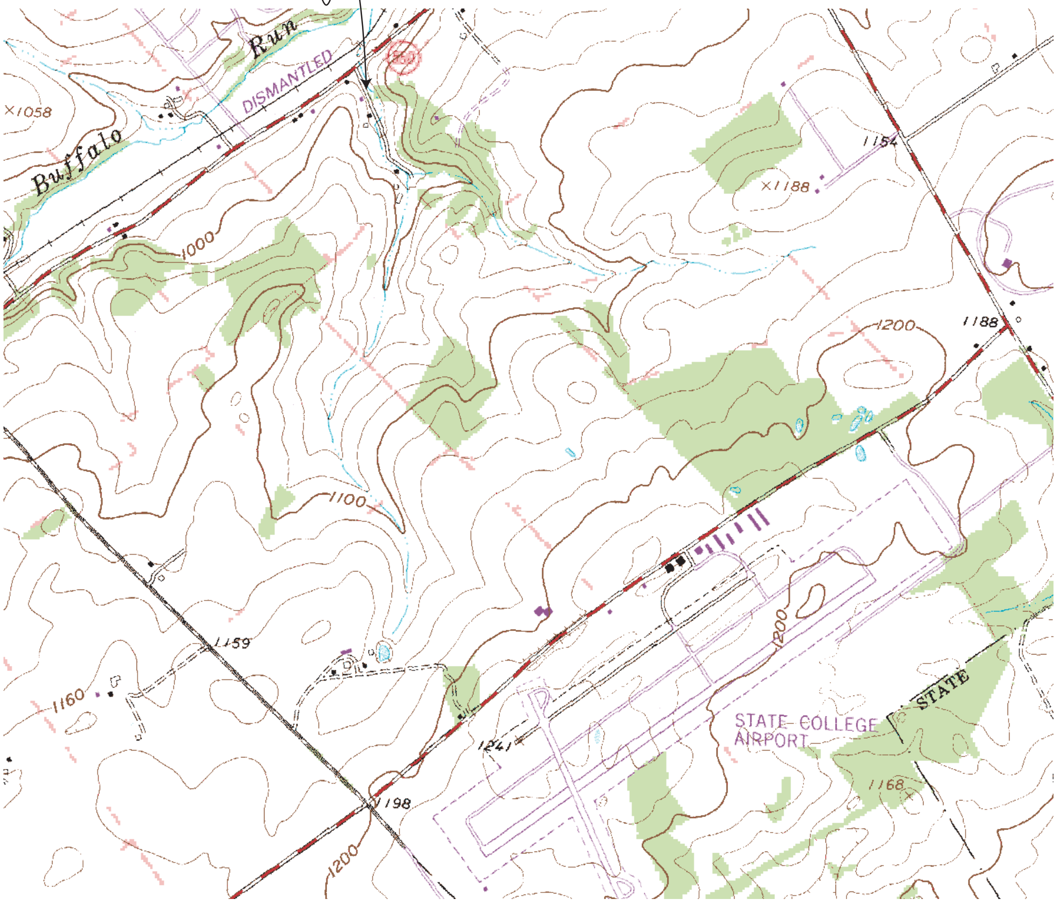
3. What is the highest elevation point in the State College quadrangle? Describe the feature and its distance and azimuth (compass direction) from Deike building.

4.a What is the stream gradient of Spring Creek from Oak Hall to just upstream of Houserville? Use a piece of string to measure the path length of the stream between the places where contour lines cross the stream. Express this as an angle (this will require some basic trigonometry — remember that the tangent of an angle is the opposite over the adjacent).

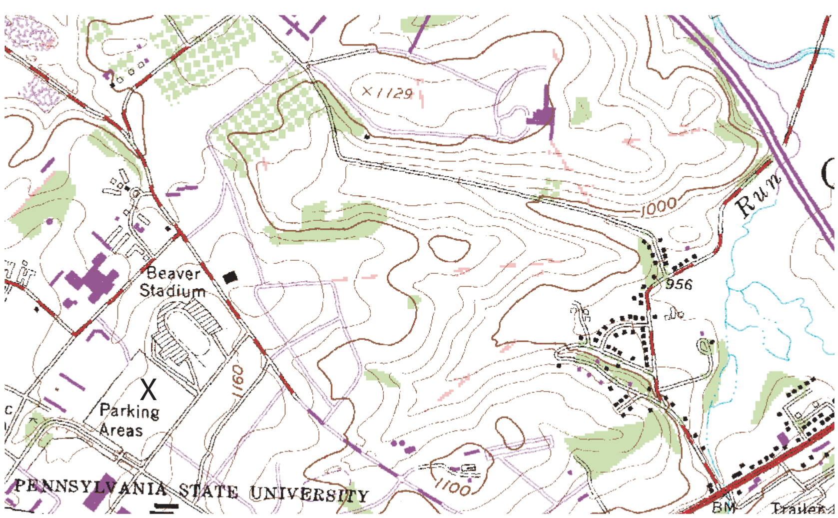
4.b What is the stream gradient of Roaring Run from its beginning to the mouth of Shingletown Gap (just before the small reservoir)? Express this as an angle.

5. Draw the boundaries of the watershed for the small stream located to the north of the airport, indicated by the arrow in the figure below.

draw the watershed boundary for this stream




6. The map below shows one of the parking lots around the stadium (X marks the spot). The parking lot is a place where a variety of pollutants can be concentrated; when it rains, these pollutants follow a pathway that is governed by the topography. Draw the flow path of water leaving the parking lot.



7. Construct a topographic profile along line A-A', passing through the Nittany Mountain ridge. Take a strip of paper with a straight edge and lay it along the line (just to the right of the line); make a tick mark on the strip where each contour line intersectsthe line of profile, labeling each tick mark with the appropriate elevation. Move the strip of paper to the top of the grid and without moving it around, make a dot in the grid below each tick mark (on the grid, the right side is up, the bottom is down, the top is NW and the botttom is SE and the vertical lines are labelled according to elevation). Then connect the dots to make the topographic profile and then check the result by studying the map to make sure ridges and valleys are in the right places. We'll use this profile later on to draw the subsurface geology based on our field studies of rocks exposed at the surface. Note that here, we use a 5x vertical exaggeration — the vertical scale is 1" = 400' rather than 1"=2000'.