# LAB 7: INTERPRETING TOPOGRAPHIC MAPS AND AERIAL PHOTOS

OBJECTIVES:

1. to learn how to read topographic maps and to be able to derive qualitative and quantitative data (e.g., distance, elevation) from them;
2. to learn how to determine the position of points on topographic maps using latitude and longitude and the Land Office Grid system;
3. to learn how to construct topographic profiles;
4. to learn how to view and read aerial photos

Preparatory reading in Marshak: p. 546-548

INTRODUCTION:

Topographic maps and air photos form the basis for the construction of geologic maps and for interpretation and mapping of landforms and erosional processes. Quantitative data derived from topographic maps (e.g., slope, distance, elevation, relief, orientation) are of use not only in geology, but also in engineering, forestry, planning, ecology, land management, geography, recreation, and construction,

Being able to read maps and air photos easily is a useful skill. The following exercises are designed to help you develop that skill.

## Map Types

Two types of maps are in common use:

*Planimetric maps* depict the true distances and directions between objects on the earth's surface, but make no attempt to indicate the three-dimensional shape of the land surface. Most road maps are typical examples.

*Topographic mops* are planimetric maps to which have been added *contour lines*--lines which provide us with a detailed, *quantitative* picture of the shape of the land surface. With topographic maps we can determine the elevation and slope of land surface at any point on the map with reasonable accuracy. They are the most generally useful sort of map, and this exercise deals almost entirely with them.

## Map properties and definitions:

*Scale:* The *scale* of a map is the ratio of the distance between two points on the map to the distance between the same two points on the ground. It is expressed as a fraction. For example, if the scale of a map is 1:10,000, 1 inch on the map equals 10,000 inches on the ground; 1 foot on the map equals 10,000 feet on the ground, and so on.

*Map orientation and magnetic declination:* Maps indicate their geographic orientation by having a *north arrow* somewhere in their margins; in addition, most maps have sides which run N-S, while the top and bottom run E-W. On topographic maps you will also find an arrow indicating the *magnetic declination* for the map. This shows the difference in direction between *magnetic north* (to which a compass needle points) and *true (geoqraphic) north*. This is necessary because the magnetic north pole and the true north pole, while close to one another, do not coincide.

*Contour lines:* A *contour line is* an imaginary line on the land surface, every point of which is at the same elevation--that is, it is a horizontal (level) line drawn on the ground surface. If you were to walk along a contour line, you would walk neither uphill nor downhill but would always remain on an exactly horizontal plane. To accomplish this, you would have to walk back "into" valleys and "out" around ridges, as you do when walking along a level trail.

*Contour interval:* Although contour lines can be drawn at any elevations you desire, in practice they are drawn at arbitrary, fixed, equal vertical intervals such as 20, 50, 80, or 100 feet. This vertical distance between adjacent contours is the *contour interval*. For example, if the contour interval is 20 feet, then each contour line represents an elevation 20 feet higher or lower than the adjacent contour line.

*Elevation:* The *elevation* of a point on a map is its vertical distance above or below some given datum (that is, zero) plane, usually mean sea level.

*Relief:* The *relief* of a feature is the difference in elevation between its highest and lowest points. The relief of an area is the difference in elevation between the highest point and the lowest point in that area.

**Reading contour maps:**

If you have never used contour maps before, they may appear to be a confusing clutter of lines; however, with a little effort and practice you can develop considerable skill at reading them -- actually visualizing the shape of the land from the contours. You will find that not only can this be useful (e.g. in planning hiking, biking, kayaking or skiing trips, etc., and locating where you are once you are on the trip, but it can also be fun.

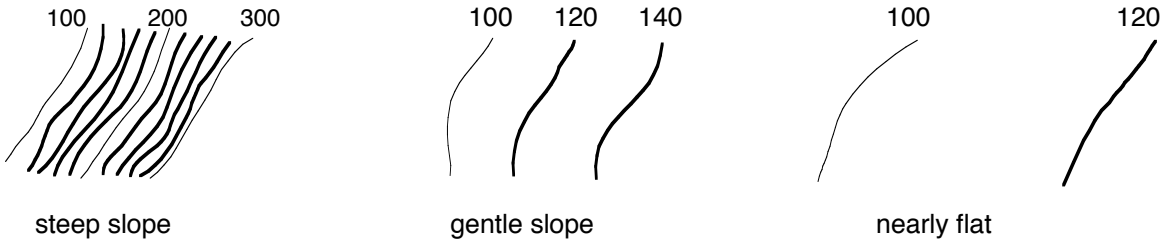
To read a contour map, there are really only two things you must master:

a. telling steep slopes from gentle slopes, and having a general idea how steep or gentle the slope is;

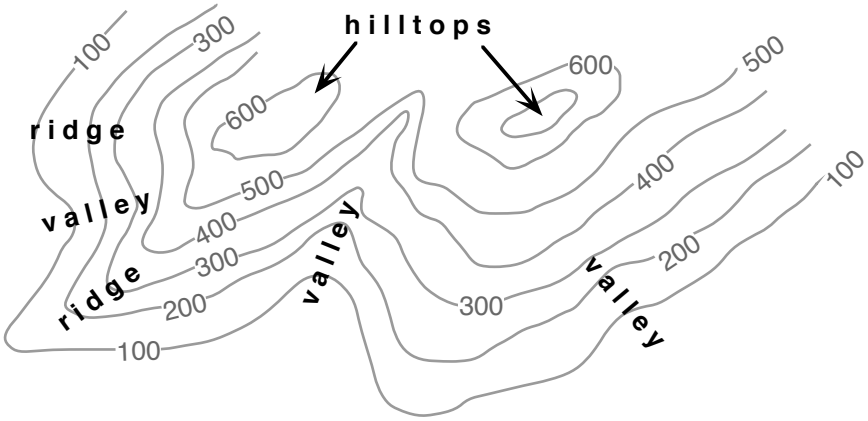
b. telling hillslopes and ridges from valleys.

The guidelines below will help you to do this.

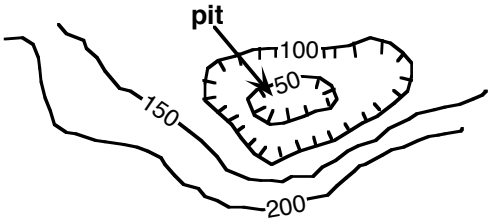
1. Where the land surface is steep, contours are close together; where it is gentle, they are farther apart. The closer the contours are together, the steeper the slope.




2. Where a contour crosses a valley, it will make a "V" or a "U" which opens out toward the lower elevations.
3. Where a contour crosses a ridge, or runs around a hillside, it makes a "V" or "U"which opens out toward the higher elevations.
4. Hilltops-- and the highest points on many ridges-- are shown by closed contours (contours that make circles, ellipses, or other closed loops).




5. Closed depressions (e.g. pits) are indicated by closed contours with hachures (short lines) on the inside.



## I. Reading Topographic Maps

**a. Topographic Map Exercises on the Arcata North 7.5 Quadrangle**: The following questions on the Arcata North quadrangle will help familiarize you with basic properties of topographic maps. Be sure to check your answers against those posted.

1. When was the map made? _____

2. What is the fractional scale of the map? _____

3. Express this scale as the following verbal scales:

   How many *feet* on the ground does one *inch* on the map represent? 1 inch =_____feet

   How many *miles* on the ground does one *inch* on the map represent? 1 inch =_____miles

   How many *meters* on the ground does one *cm* on the map represent? 1 cm = _____meters

   Remember: 1 mile = 5280 feet 1 meter = 100 cm

4. What is the contour interval of this map? _____feet

5. What is the magnetic declination of this map? _____

6. What is the elevation of:

   a. the top of the small hill on the flat immediately N of Squaw Cr. _____feet

   b. Essex Pond _____feet

   c. the benchmark (BM) closest to HSU _____feet

   d. Founders Hall on the HSU campus _____feet

7. What is the *difference in elevation* between Dows Prairie School and Widow White Creek where it crosses Redwood Highway? _____feet

8. What is the *relief* in Section 23 in the SE corner of the map? _____feet

9. What is the *maximum relief* on the map? _____feet

10. How long (in feet) is the NW-SE runway at Arcata Airport? _____feet

11. Measured along the most direct road, how far is it (in meters) from Fieldbrook School to road junction "82" by Essex Pond? _____meters

12. What direction does Warren Creek flow? _____

    How do you know? _____

13. What does the green on the map indicate? _____

14. Determine the approximate latitude and longitude of Azalea State Reserve

    Lat: _____

    Long.: _____

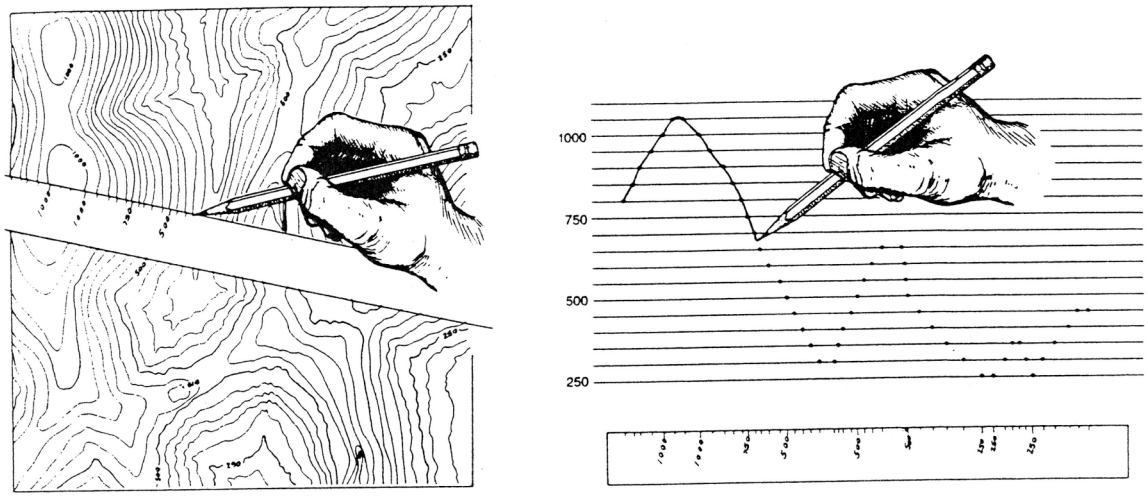
15. Give the location, to the nearest quarter of a quarter section, of the gaging station on the Mad River

    _____1/4 of _____1/4 of Sec. _____ of T. _____, R. _____

**b. Constructing a topographic profile**

From a topographic map it is possible to construct a topographic profile, or cross-section view, through a critical area so that features of the landscape can be studied in detail. To construct a topographic profile, follow these steps (see example below):

1) Lay a strip of paper along the line for which the profile is to be constructed.
2) On the paper, mark the points where each contour line, stream, and ridge intersects the profile line.
3) Label each mark with the elevation of the contour line it represents. In most cases, you will only need to use and label the heavy contour lines (every fifth line).
4) Prepare a piece of graph paper by labeling horizontal lines to correspond to the elevation of the heavy contour lines on your profile.
5) Put the marked paper along the labeled graph paper, and transfer points to the proper elevations.
6) Connect all of the points on the profile.

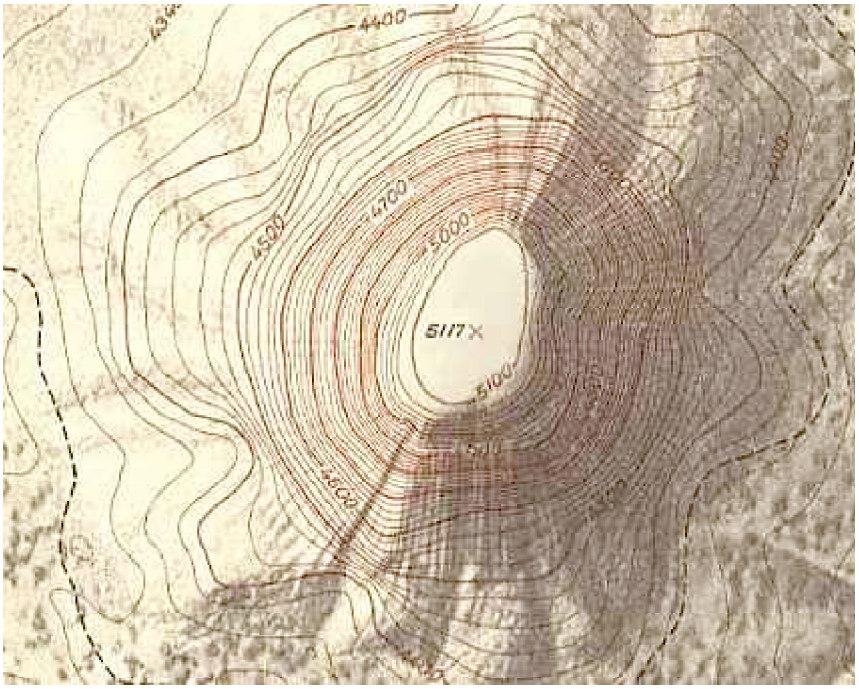


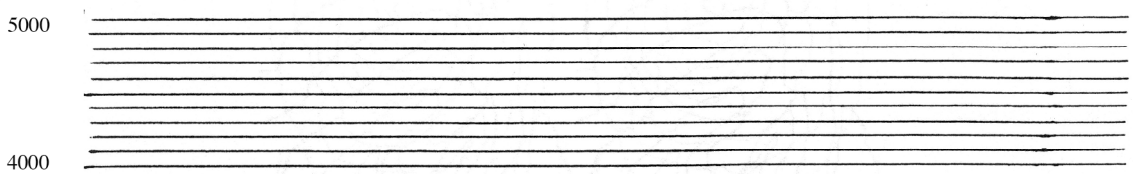

**Exercise:** Draw a topographic profile across the area shown on the map using the graph paper on the following page. The profile should run directly west to east across the middle of the map (through elevation point 5117). The map has a 20 foot contour interval; bold contour lines are spaced 100 feet apart. Horizontal lines on the graph paper are 100 feet apart, and the lowest one represents 4,000'.

Which one of the photos on the following page is shown by the topographic map and your topographic profile?

_____

(this exercise from http://www.compassdude.com/contour-quiz.shtml)




a) 

b) 

c) 

d) 

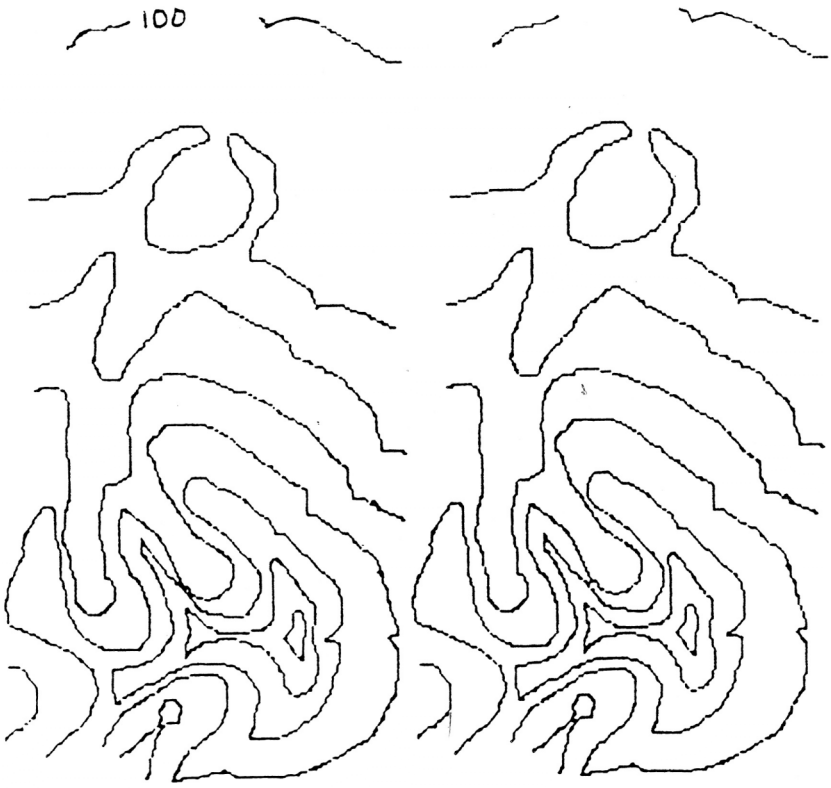
e) 

## II. Stereoscopic Viewing of Paired Contour Maps and Aerial Photographs

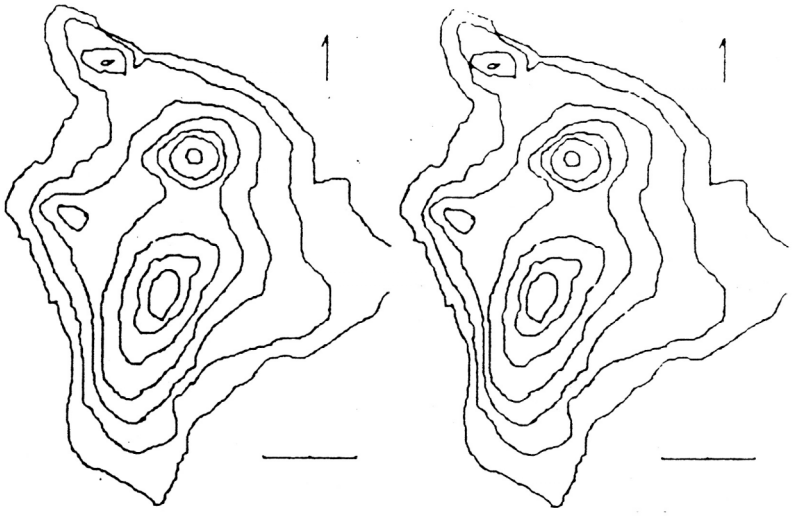
### a. Using stereoscopes to look at paired contour maps

Place a stereoscope over the pair of contour maps below so that each eyepiece is centered over one map. When you look through the stereoscope, the two images should merge to form what looks like a 3-dimensional contour map. **If you have difficulties getting the 3-D effect, ask your instructor for help.**

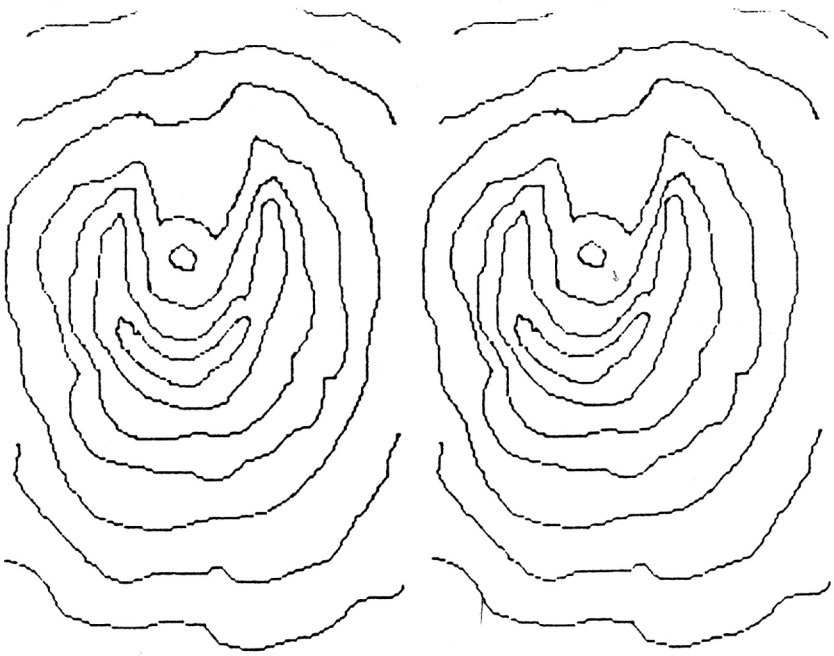
1. **Topographic map:** The elevation of the contour line at the upper edge of the map has been labeled as 100 feet. Using a 50 foot contour interval, label the rest of the contour lines.



2. **Hawaii**: The pair of maps below show the "big island" of Hawaii. The island consists of 5 volcanoes. Look at the map with a stereoscope and use the topography of the island to identify the individual volcanoes. Draw the approximate boundaries between the 4 or 5 volcanoes you can identify on the map.



3. **Mt. St. Helens:** This pair of maps shows Mt. St. Helens after the 1980 catastrophic eruption. Draw and arrow to show the direction of the lateral blast that formed the crater, and label the new volcanic dome that is forming in the crater.



**Milk Bottle Pond, Texas, stereo air photo pair**

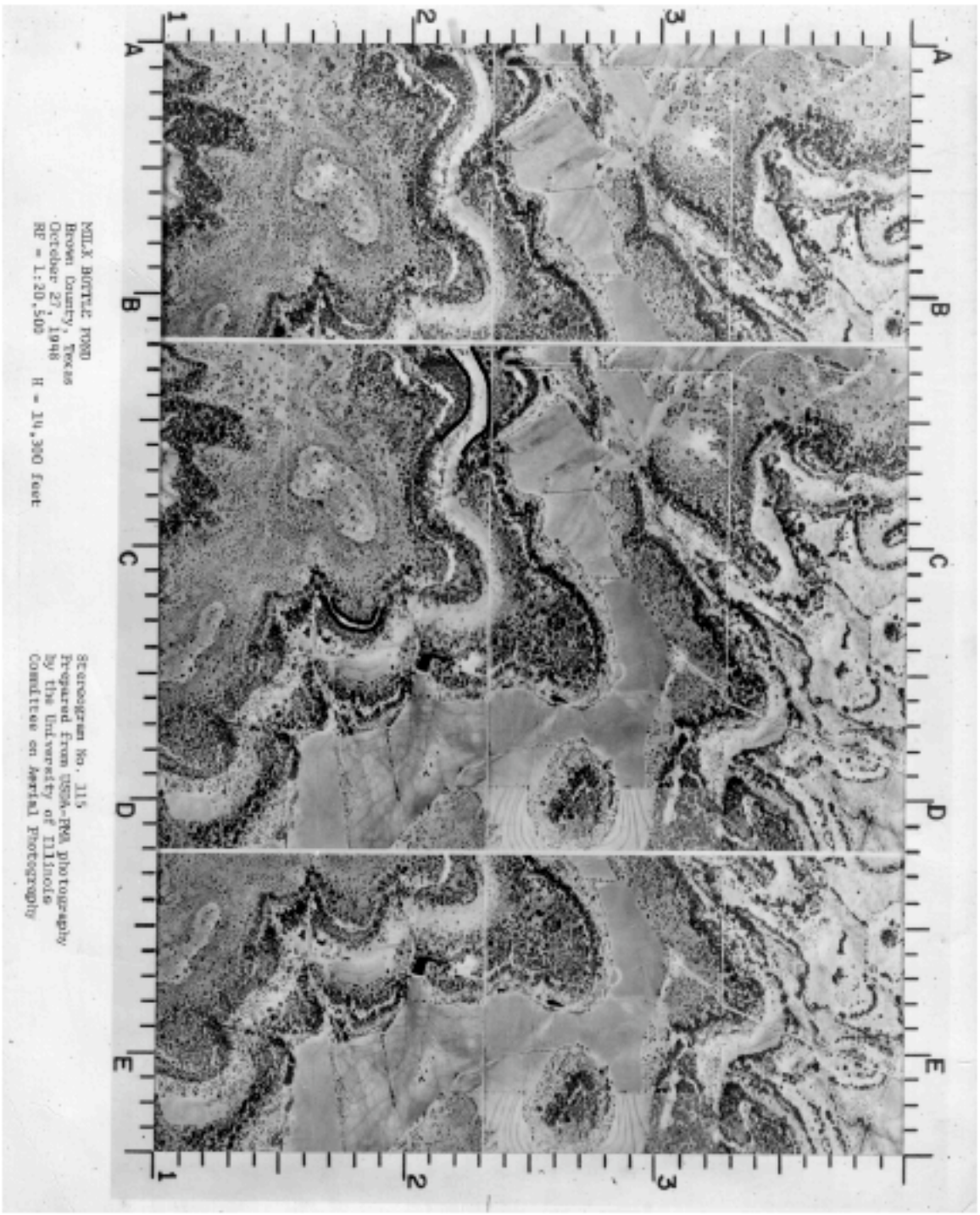
Reproduced below is a stereo pair of air photos of Milk Bottle Pond, central Texas (Stereogram # 115), The rocks underlying this area are alternating relatively thin layers of limestone and shale. The lighter and darker bands on the air photos correspond to the limestone and shale layers.

Two sets of dark lines, drawn on the center photo, mark the edges of two light colored layers. Extend these lines as far as you can across the area, and then color in each of the layers to make a geologic map of these two units.

a. What is the general orientation of the layers? (flat-lying? tilted?) _____

b. Which layer is older? _____

c. If it is assumed that the thickness of each layer is constant, why do the widths of the outcrops of the layers change from place to place?



**WHAT YOU ARE EXPECTED TO KNOW**

**Topographic Maps**

1. You should understand the meaning of the following terms:

   fractional scale
   verbal scale
   magnetic declination
   contour (or contour line)
   contour interval
   elevation
   relief
   topographic profile (or cross-section)
   latitude
   longitude
   township
   range
   section

2. Given a topographic map, I expect you to be able to:

   a) determine the north direction on the map, and find the map's **scale, contour interval,** and **date**
   b) tell steeply sloping areas from gently sloping ones
   c) consistently distinguish valleys (including small gullies and valleys lacking stream channels) from ridges and hilltops on the basis of their contour pattern
   d) determine the approximate **elevation** of any point on the map
   e) determine the **relief** in any specified section of the map
   f) convert a fractional scale into a verbal scale (for example, be able to convert 1:6000 into "1 inch equals 500 feet")
   g) determine the straight-line ground distance between any two points on the map
   h) determine the ground distance between two points measured along a trail or streamcourse (i.e., not measured along a straight line)
   i) draw a **topographic profile** along any designated line on the map
   j) determine (or find) the position of any point on the map using **latitude and longitude**
   k) determine (or find) the position of any point on the map using **township, range, section,** and **quarter-section**.