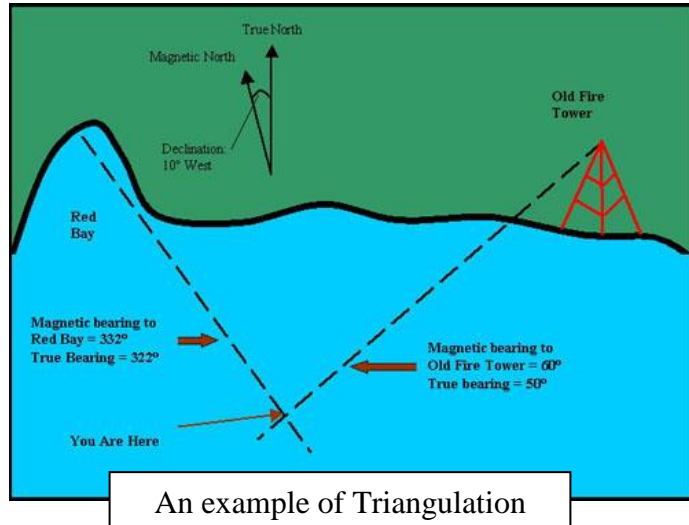


There are two main objectives to this lab:

- Determine location at sea using triangulation.
- Recognize the shape of underwater features using contoured bathymetric maps.

### Part 1. Chart location by triangulation.

The best way to determine location at sea is by determining the bearings to two or more known locations on land. The intersection of these bearings is the location of the observer. Obviously, this only works in clear conditions when land is visible. As discussed in lab 1, compass directions are given in degrees from  $0^\circ$  (true north) to  $90^\circ$  (east), to  $180^\circ$  (south), to  $270^\circ$ , to  $360^\circ$  (back to true north). Bearings can be thought of as imaginary lines of known orientation on the map. Any two bearings will intersect at a single, unique, point on the map, which is your location. Note that this is the very same way that satellite systems, such as GPS (Global Positioning System), work, except that signals use the satellites as the known positions rather than physical objects within the line of sight.



**Please note, all of these exercises require you to draw very light lines on the Monterey chart. Please erase these lines, and a few others, after you are done. Karma will reward you. Remember, pens are forbidden near the charts for the duration of this exercise.**

#### Example.

Question: Plot a bearing of  $63^\circ$  towards the Moss Landing stacks and a bearing of  $187^\circ$  towards Pt Pinos. What is the latitude and longitude of your location?

Answer:

- 1) Align one side of the parallel rulers on the compass rose through  $63^\circ$ . Put an edge of the other ruler on the Moss Landing stacks. Draw a **very light** line along the ruler that goes through the Moss Landing Stacks. Your location is somewhere along this line.
- 2) Align one side of the parallel rulers on the compass rose through  $187^\circ$ . Put an edge of the other ruler on Pt Pinos (use the letter "o" in "horn" as an exact location). Draw a **very light** line through Pt Pinos.
- 3) The location where the two lines intersect is your location. What is the latitude and longitude of your location? Note that a third bearing could provide a test to confirm your location. Answer =  $121^\circ 55' W$ ,  $36^\circ 45' N$ .

## Problems.

1. Out at sea in Monterey Bay, you obtain bearings of  $33^\circ$  on the radio towers between Twin Lakes and Soquel Pt. You also obtain a bearing of  $96^\circ$  the stacks at Moss Landing. What is the latitude and longitude of your location?
2. A little while later, you obtain bearings of  $12^\circ$  on the lighthouse at Pt Santa Cruz and  $135^\circ$  on Pt Pinos. Where are you now in terms of lat and long? Which direction have you been sailing?

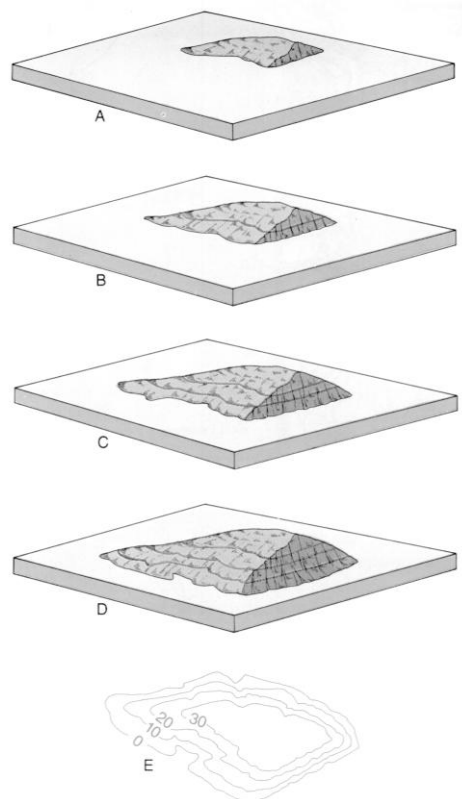
## Part 2. Contoured Bathymetric and Topographic Maps.

Maps that show the shape of the Earth's surface are called bathymetric maps (underwater) and topographic maps (on land). Both of these kinds of maps use *contour lines* to accurately represent the shape of the Earth's surface on a flat piece of paper. Contour lines are lines of equal elevation that enable one to visualize the topography or bathymetry of the Earth's surface. Contour lines are a method to visualize shapes in three dimensions.

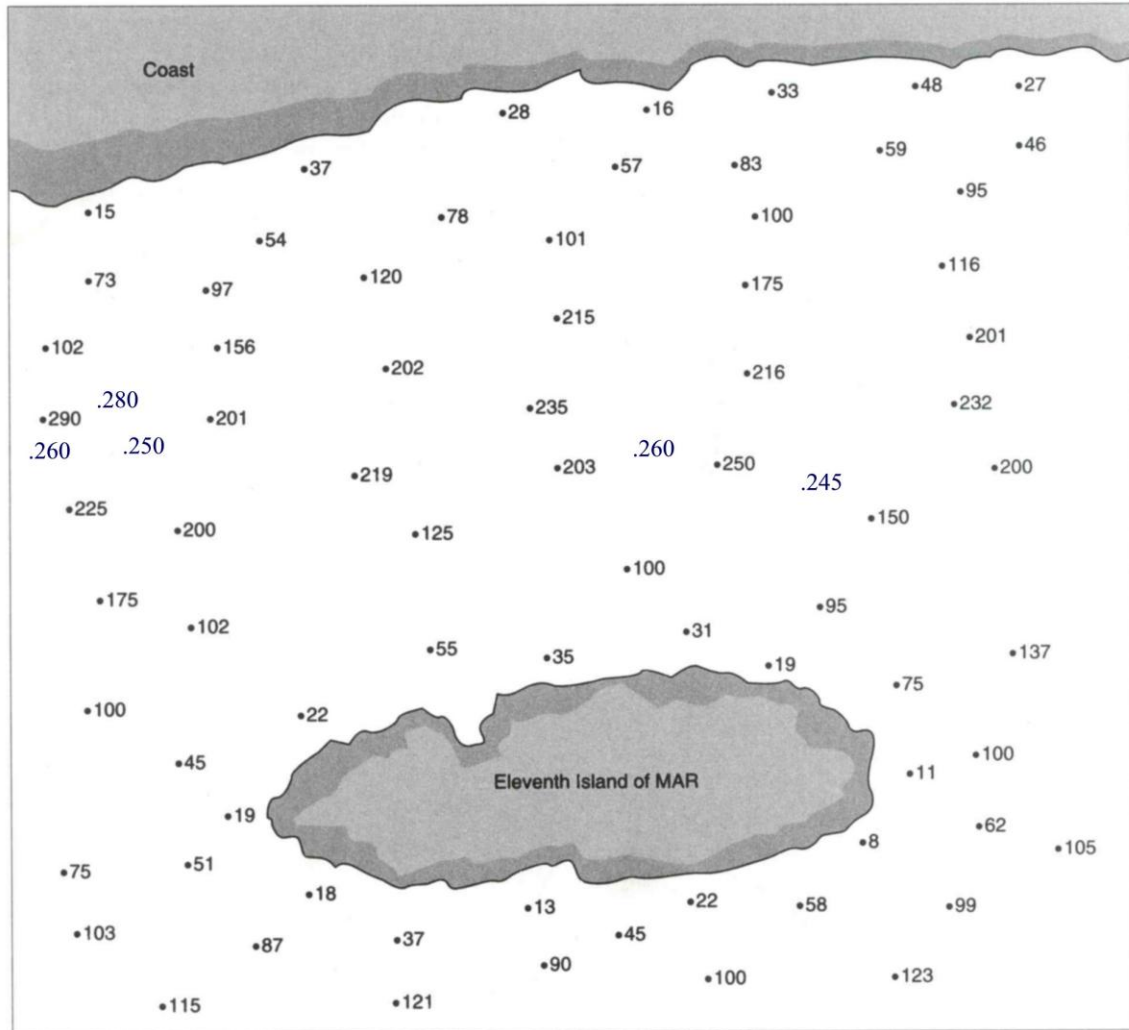
In the example to the right, the contour lines in E represent distance above sea level. Thus, it is a topographic map. Each of the contour lines in E (0 through 30) represents a horizontal surface that can be thought of the line to which water would rise during a flood, as shown in A-D.

Some of the basic points:

- The difference in elevation between contour lines is called the *contour interval* and is usually measured in feet, meters, or fathoms.
- Contour lines never cross or divide.
- Contour lines are very close together when representing a steep slope or cliff.
- Contour lines are far apart when representing flat terrain (see diagram to right).
- Hills and knobs are shown as closed contours.
- Closed depressions are shown by closed contours with hatch marks on the down hill side.



The following map has soundings given in meters. Complete the map by drawing in the contour lines. Use a 40 meter contour interval. Start with the 40m contour line and follow the shape of the beach as a guide. Label your contour lines with their appropriate depth.

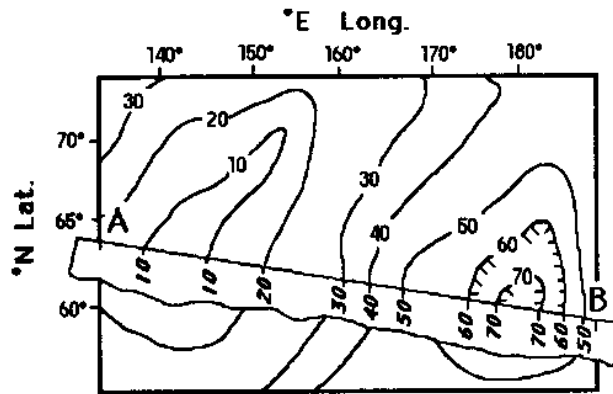


Now color your map using the colored pencils provided to make your contour map look like the color bathymetric maps to the right of the chalkboard. Use the following color scheme:

- Blue: >200 meters
- Green: 160-200 meters
- Yellow: 120-160 meters
- Orange: 80-120 meters
- Red: <80 meters

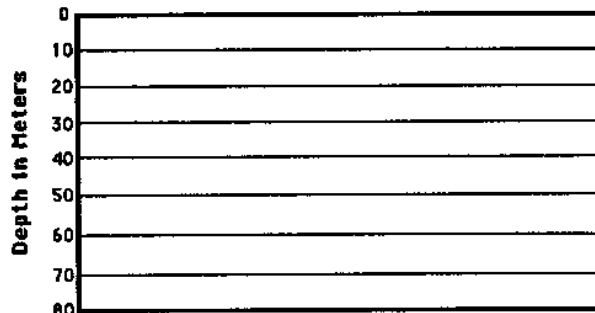
### Step-by-step Profile Construction

- The line along which the profile is to be drawn is placed on the map. In practice, a strip of paper is placed along the line of profile (A-B). >>>
- A mark is made at each point where a contour crosses the line of profile, and the depth of that contour is written on the strip of paper. The ends of the profile are also marked on the paper strip.

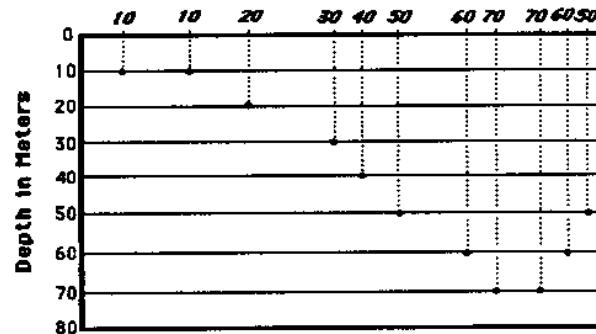


**Bathymetric Chart**  
Contour Interval 10 m

- Another sheet of paper is prepared with horizontal lines spaced at equal intervals corresponding to the contour interval (10 m in this example). This grid can be drawn at any convenient scale. The full range of depths on the map, from the shallowest feature to the deepest, is entered on the left side of the graph.

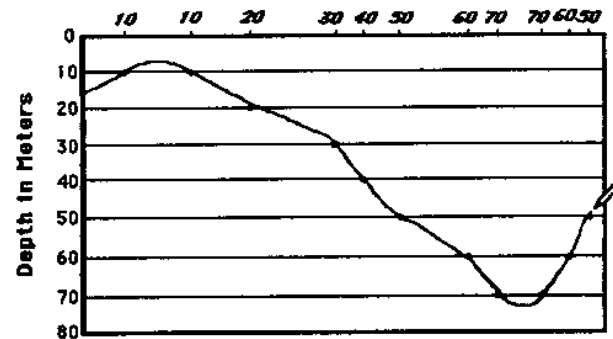


- The paper strip is placed along the top line of the profile graph and the marks, with their depth values, are transferred along the top line.



- A grid is then constructed by extending dotted lines straight down the page from each marked depth to the horizontal line that corresponds to that depth. Place a dot at the point where they intersect.

- These points are then connected with a smooth curve, resulting in a profile of the features on the chart. Note that there are no sharp angles.

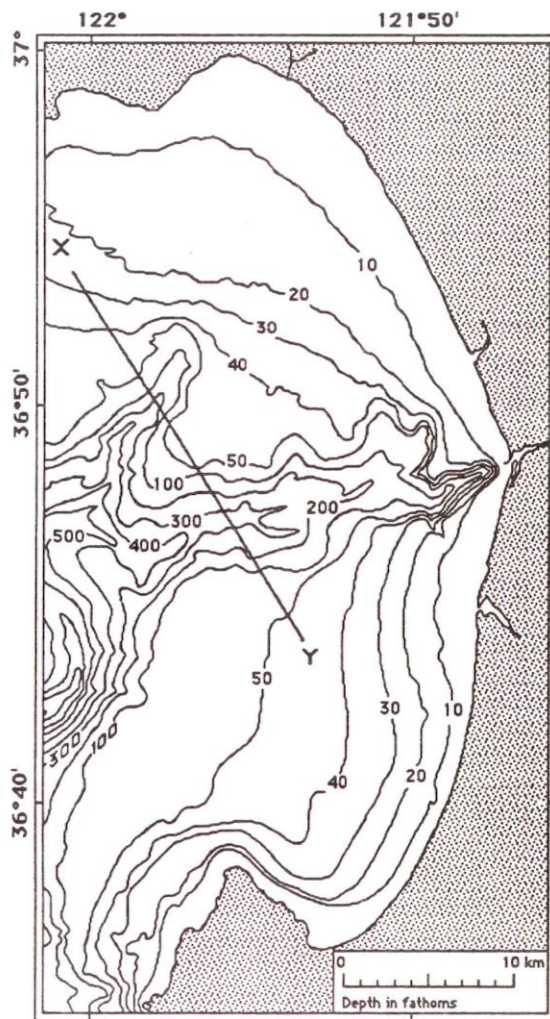


**Profile**

- Where two adjacent marks represent the same depth (see the 10 m and the 70 m marks >>>) the profile line extends slightly above or below the depth line, depending on the trend of adjacent slopes. Use your judgment how far above or below, but it may not cross the next contour depth.

- Now you can easily see that the feature on the left of the chart is a hill, the feature on the right a basin.

Follow the directions given on the preceding page to construct a profile of the Monterey Canyon using the data given in the bathymetric map below.



MONTEREY BAY, CALIFORNIA

In this exercise you'll learn to construct profiles and will observe the impact of vertical exaggeration.

If this is your first experience with making profiles, you should first review the **step-by-step instructions on the following page.**

On the grid below, make a profile of the line labelled X-Y on the map. This grid is set up so that the vertical exaggeration is 18.5 times.



Now try to make a profile of the same area, this time on a grid set up with a vertical exaggeration of just 2 times.



*Which profile was easier to plot?*

*Which shows the features most clearly?*

You can think of the colorful global bathymetric maps to the right of the chalkboard as contour maps as well. The only difference is that they show terrain at different elevations as different colors.

6. In the space given below, draw a *bathymetric map* of the following items. Remember, in a bathymetric map, the labels of the contour lines increase with depth. Use a contour interval of your choice. **Be sure to label the contour lines in your drawings.**

a. a ridge trending in a northwest direction	b. a conical shaped seamount
c. a steep valley.	d. a very broad valley.