Bathymetry Pre Lab

Objectives:

• To understand the methods used to sound (measure) ocean depths
• To covert a series of position and depth measurements into contours (isobaths) on a bathymetric chart
• To visualize a sea floor landscape using a bathymetric chart
• To visualize and draw a cross section of sea floor topography using a chart showing bathymetric contours
• To understand the concept of vertical exaggeration in a cross section
• To calculate vertical exaggeration in a topographic cross section
Definitions

**Bathymetry**: the measurement of water depth (*bathus*, Greek, depth and *-metry*, to measure). Multiple measurements of depth can be used to visualize the topography of the sea floor.

**Sounding**: an early method used to measure water depth by dropping a weighted line into the water. As the line was pulled aboard, the sailor would measure the length of the line in *fathoms*, the distance between his outstretched hands. The pseudonym “Mark Twain” was derived from the words shouted to “mark” the water depth. A sailor would call to the captain, "by the mark, twain" (meaning, mark two fathoms).

**Fathom**: 6 feet.

**Contours, isobaths** (*iso* – same, *bath* – depth): lines of equal depth.

**Cross section**: a two-dimensional side view of bottom topography.
**Fathometers** (echo sounders) revolutionized our ability to determine ocean depths. Knowing the speed of sound and the 2-way travel time, one can easily calculate the distance travelled and therefore the depth (Figure 1).

![Diagram of depth sounding using an echo method](Image)

- **Sound pulse sent by ship**
- **Return sound pulse bouncing off bottom**
- **Reflected pulse received by ship**

\[
\text{speed} = \frac{\text{distance}}{\text{time}}
\]

\[
\text{distance} = \text{speed} \times \text{time}
\]

**Distance sound travels is twice depth (up and down)**

\[
\text{depth} = \frac{\text{speed} \times \text{time}}{2}
\]

**Figure 1.** Depth sounding using an echo method.
When many depth soundings and positions have been recorded, it is possible to construct a map showing depths, a bathymetric chart (Figure 2).

**Figure 2.** A bathymetric chart illustrating a guyot (a flat-topped seamount) on sea floor.
When you view a chart with contour lines (isobaths) it is possible to visualize the features of the sea floor.

Try to find the feature called “Catalina Canyon” (Figure 3). Start at the top of the canyon and draw a line down the canyon.

This is the path of sediment from the island to the sea floor.

Figure 3. Bathymetry of the sea floor off the southwest end of Santa Catalina Island. Depths in fathoms
Contour line Rules

1. Contour lines never split or divide.
2. Contour lines never end except at the edge of the map.
3. A given contour line represents a single depth.
4. A contour line never intersect other contour lines (Overhanging cliffs are an exception).
5. Contour lines form a V-pattern when crossing submarine canyons. The “V” always points upstream.
6. Closely spaced contour lines represent a steep slope; widely spaced lines indicate a gentle slope.
7. Concentric circles of contour lines indicate a hill or seamount.
8. Concentric circles with hachure marks on contour lines indicate a small closed depression (Figure 4). The hachure marks point into the depression.
Figure 4. A small depression in the bottom and the resulting bathymetric chart showing hachure marks.
Cross Sections

Cross sections are two dimensional side views of the bottom topography constructed from bathymetric charts using contour lines for depth references.

Figure 5 shows a bathymetric chart of a guyot similar to the one shown in Figure 2. We will construct two cross sections based on this chart on the following page.

Figure 5. Bathymetric chart of a guyot.
Cross Sections and Vertical Exaggeration

To make a cross section, we draw a line of section (A—B in this case) on the bathymetric chart.

Where the contour lines intersect the line A—B, points are plotted at the corresponding depth on a vertical scale.

In this example, the *horizontal* scale for both sections is the same; 1 cm (on the cross section) represents 2500 m (in real life).

In the top section, the vertical scale = the horizontal scale.

In the bottom section, the vertical scale is *exaggerated*, or expanded. 1 cm on this cross section represents only 1000 m (in real life).

Figure 6. Two cross sections generated from bathymetric contours. The top cross section has a vertical exaggeration of 1. In the bottom cross section the vertical exaggeration = 1:1000/1:2500, or 2.5X.
Cross Sections and Vertical Exaggeration

To calculate vertical exaggeration, divide the vertical scale by the horizontal scale.

In this example, 1:1000 divided by 1:2500.

\[
\frac{1}{1000} \div \frac{1}{2500} = \frac{1}{1000} \times \frac{2500}{1} = 2.5
\]

Cross sections are exaggerated to show vertical features in more detail. For instance, we can better appreciate the cliff on the left side of the guyot in the lower cross section of Figure 6.
In this lab you will:

1. Sound the depths in a cardboard box model of bottom topography.
2. Create a cross section for the box topography.
3. Create a contour map of the box topography.
4. Create a contour map of the sea floor between Catalina Island and the mainland.
5. Create a cross section of the sea floor between Two Harbors on Catalina Island and Point Fermin on the mainland.
Sounding the Depths of the Ocean Floor

We will supply you a topographic model box and a sounding rod. **Do not** open the box.

Inside the box is a model sea floor. You will determine the topography of this model by “sounding”.

When you have finished the lab, you may open the box and determine the accuracy of your methods.
To practice making depth soundings:

1. Place the box on the table with the grid side up (Figure 6).
2. Gently push the sounding rod into one of the holes in the top of the box. Keep the rod vertical!
3. When you reach the bottom, use your fingers to mark the depth of the rod in the box.
4. Withdraw the rod and measure the depth to the nearest 0.1 cm.

Figure 6. Making a depth sounding in the topography box
Practice making depth soundings

The top of the sounding box is shown in Figure 7. Notice it has a scale on it.

Each hole lies on a Cartesian grid of letters and numbers. Thus, you can exactly specify any hole with one letter and one number. In the figure, the hole “f 7” has been indicated.

![Figure 7. Lid of the topography box showing coordinate system](image-url)
Pre-Lab Questions

1. A fathom is equal to ______ feet.
   a. 4  b. 2  c. 6  d. 8  e. 10

2. “Mark Twain” means ______ fathoms.
   a. 4  b. 2  c. 6  d. 8  e. 10

3. Contours are the same as:
   a. isobaths  b. cross sections  c. soundings  d. hachure marks

4. In order for a fathometer to correctly measure depth, you need to know:
   a. the speed of sound in water  b. the depth of water
   c. the speed of the boat  d. the bottom topography

5. In Figure 3, the Catalina Channel is oriented:

6. Contour lines form “V” shaped patterns when crossing:
   a. guyots  b. submarine canyons  c. depressions  d. Cliffs

7. If the vertical scale = 1 to 100 and the horizontal scale is 1 to 300, the vertical exaggeration =
   a. 3  b. 300  c. 1/3  d. 0.333

8. When you first receive your sounding box, your first task is to open the box.
   a. True  b. False