Homework 2b:
Bathymetric Profiles
[based on the Chauffe & Jefferies (2007)]

2-5. BATHYMETRIC PROFILES

A bathymetric profile provides a "skyline view" of the sea floor; in which hills are seen as rises and valleys as depressions. For a graphical profile to illustrate the true shape of the sea floor, a ratio of 1:1 for vertical and horizontal distances must be the same or have a ratio of 1:1. This means that one unit on the vertical scale is the same distance as one unit on the horizontal scale. However, the slopes of ocean features (i.e., relief) are generally so small that it is difficult to see sea floor features. Typical Atlantic Ocean basin features are only a few kilometers high, while the basin itself extends laterally for thousands of kilometers. If the profile were displayed with a 1:1 ratio on a regular sheet of paper, it would appear as a flat line.

In order to illustrate the details of the sea floor relief, the depth scale of an ocean profile is vertically exaggerated (stretched) relative to the horizontal scale. Vertical exaggeration causes distortion in the shapes of the bathymetric features that are being illustrated; with the amount of distortion increasing with the amount of exaggeration. To convince yourself of this, draw a circle on a wide rubber band. As the rubber band is stretched, the circle will be distorted into an oval and eventually an ellipse. As vertical exaggeration increases on a profile, hills appear to be higher, valleys deeper and the slopes between them become much steeper. Slopes, that in reality are gentle, will look steep; steep slopes will appear to be precipitous.

For example, when the vertical scale has been stretched four times relative to the horizontal scale, we have a vertical exaggeration (VE) of 4. This vertical exaggeration or stretching can be easily demonstrated with a rubber band. On an unstretched rubber band, measure and mark quarter inch segments for the distance of an inch. We will assume that an inch represents 100 ft so that each quarter inch equals 25 ft-as illustrated in Figure 2-10. Now stretch the rubber band until the original inch is 4 inches long. If you measure along the stretched rubber band, then you will discover that 1 inch now represents only 25 ft. Vertical distances have been stretched by a factor of four.
Thus for most profiles, there are two scales - one for horizontal distances and an exaggerated one for the vertical distances. In the above example, the horizontal scale is 1 in = 100 ft and the vertical scale is 1 in = 25 ft. The vertical exaggeration (VE) associated with a general profile is found by dividing the horizontal scale by the vertical scale according to:

\[ \text{VE} = \frac{\text{Horizontal Scale}}{\text{Vertical Scale}} \]

For this example,

\[ \text{VE} = \frac{1 \text{ in} = 100 \text{ ft}}{1 \text{ in} = 25 \text{ ft}} = 4 \]

### 2-6. CONSTRUCTION OF A BATHYMETRIC PROFILE

To construct a bathymetric profile follow the following steps (Figure 2-11).

1. Choose the line, called a trace (or transect), on the chart along which you want to construct the profile. Determine the total vertical excursion along the transect by subtracting the value of the shallowest contour from the deepest contour that crosses the trace.

2. Determine the desired vertical exaggeration (VE) and then scale the profile sheet appropriately. The profile sheet is scaled by drawing a series of equally spaced parallel lines the length of the transect. The distance between the lines is determined by the vertical exaggeration.

For example, if the horizontal scale is 1 in = 6000 ft and the vertical exaggeration is x 12, then the parallel lines could be spaced 1/5 inch apart with each line representing a change in depth of 100 ft according to:

\[ \text{VE} = \frac{\text{Horizontal Scale}}{\text{Vertical Scale}} \]

\[ 12 = \frac{1 \text{ in} = 6000 \text{ ft}}{\text{Vertical Scale}} \]

\[ \text{Vertical Scale} = \frac{1 \text{ in} = 6000 \text{ ft}}{12} \]

\[ \text{Vertical Scale} = 500 \text{ ft} \]
3. Label the lowest line on the profile sheet with the value that is at least one contour interval deeper than the deepest contour the trace intersects. For the example in Figure 2-11, the deepest contour crossed by the transect is 300 ft, so label the lowest line 500 ft is appropriate.
4. Place the profile sheet so that the profile scale lines are parallel to the trace (Figure 2-11). Holding the sheet firmly in place, wherever a contour line intersects the transect, sketch a faint line perpendicularly upward from the trace to the scaling line on the profile sheet that corresponds to that depth.

5. After all contours along the transect have been marked on the profile sheet, connect the ends of the perpendicular lines with a smoothly curving line. This line is the bathymetric profile along the transect.
Exercise 2 - Bathymetric Profiles

1. Sandy Harbor Chart
   a. On the Sandy Harbor chart (Figure 2-8), contoured in Exercise 1, are the letters D D’ and EE’. The dashed lines connecting the corresponding pairs of letters are traces for profiles.
   
b. Using the appropriate profile sheets provided (Figure 2-12a & b), draw the profile between DD’ and EE’.

c. Determine the vertical exaggeration for each.
   
   - To determine the horizontal verbal scale for the Sandy Harbor chart, use a centimeter scale (ruler) and measure along the length of the chart scale. From 0 to about 1.5 km on the chart scale is a distance of 2.0 cm on the centimeter scale. This provides the vertical scale of 2.0 cm = 1.5 km or 1 cm = 0.75 km.

   - To determine the vertical scale for the profiling sheet, use a centimeter scale (ruler) and measure vertically from the 0 fathom profile line downward to where another profile line intersects a division on the centimeter scale. For profile sheet DD’, the 3.5 fathom line intersects the 3.0 cm line. This means that the vertical verbal scale is 3 cm = 3.5 fathoms or 1 cm = 1.17 fathoms. Convert units as needed and substitute values into the formula to determine vertical exaggeration.
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**Figure 2-12a Sandy Harbor Transect DD’**

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**Figure 2-12b Sandy Harbor Transect EE’**
Figure 2-8 Sandy Harbor Sounding Chart
2. Portion of the southern Pacific Ocean
   a. On the southern Pacific Ocean chart (Figure 2-9) contoured in Exercise 1 are the letters FF'. Connect these letters with a straight line, the trace for the profile.
   b. Using the appropriate profile sheet provided (Figure 2-12), draw the profile between FF'.
   c. Determine the vertical exaggeration for each.
**Figure 2-12c Southern Pacific Transect FF’**

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**Figure 2-13. Profile sheet for comparing effect of distortion from vertical exaggeration.**
Laboratory 2: Exercise 3 - Distortion From Vertical Exaggeration

1. Using the Sandy Harbor chart (Figure 2-8), draw the profile along trace EE' on the profile sheet provided on Figure 2-13 and determine the vertical exaggeration. Compare this profile to the profile of EE' drawn on Figure 2-12b to answer the following questions.
   a. Explain how vertical exaggeration alters the shape of the profiles.
   
   b. If vertical exaggeration distorts slopes, why does it not distort flat areas?
   