Geodynamics
G456-556

Lab #3: Seafloor Subsidence

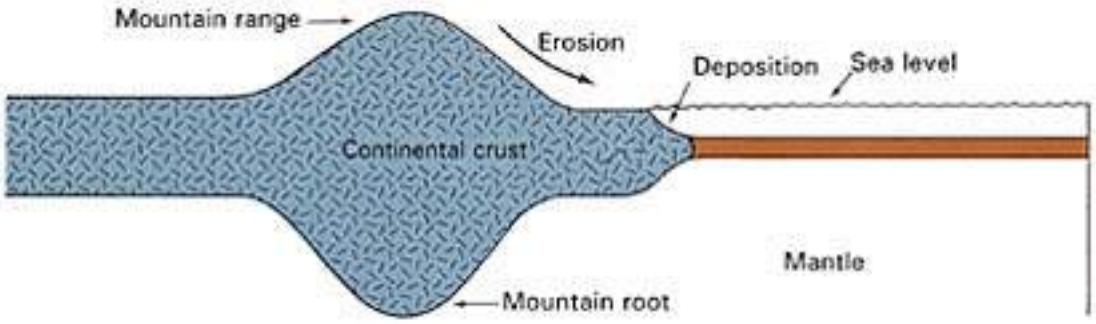
Objectives: 1) determine plate velocities by modeling thermal subsidence of oceanic lithosphere

2) develop matlab skills:

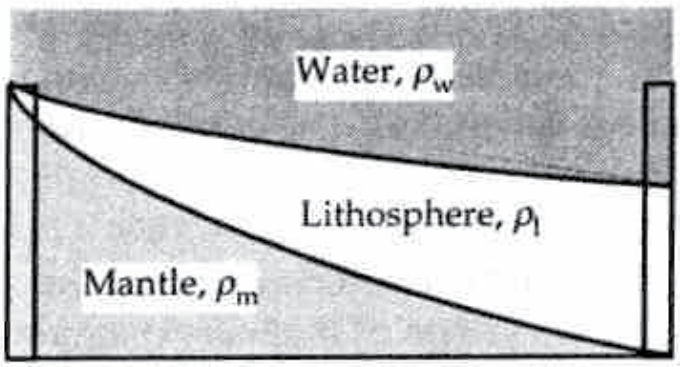
- Make figures with multiple data sets
- use "for " loops in matlab

Thermal Subsidence

The tectonic plates of the Earth "float" on the asthenosphere. The concept of isostacy tells us that more buoyant plates "float higher", and less buoyant plates "float lower", and thus the dense oceanic plates (composed of dense minerals) are at a lower elevation than continental parts of the plates (composed of less dense minerals).



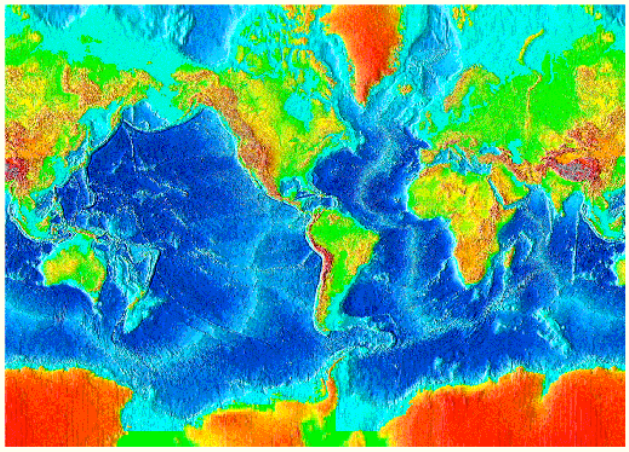
Oceanic plates are formed at mid-ocean ridges, where they are very thin. As the plate (lithosphere) "ages", it cools and becomes thicker

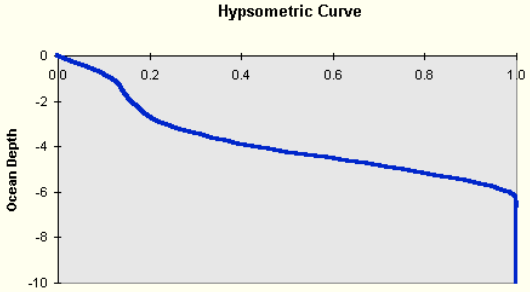


As the oceanic lithosphere becomes thicker and denser, it weighs more, so it "sinks" into the asthenosphere. Thus, where the ocean lithosphere is older, the ocean is deeper. By understanding how oceanic lithosphere cools, geologists have been able to estimate the relationship between the age of the oceanic lithosphere, and the depth of the ocean:

Topography of the Ocean Basins

Relief





As the lithosphere ages it cools and contracts. On ocean basin scales this cooling is principally by conduction and oceanic topography can be modelled, as we shall see, by conductive cooling of the lithosphere such that:

$$w = 3.2\times10^{-5}\ \text{deg}^{-1}\left(\frac{3300}{-2300}\right)(-1350\ \text{deg})\left(2\sqrt{\frac{25\ \text{km}^2\ \text{My}^{-1}}{\pi}}\right)\sqrt{t}$$

$$= 0.35\ \text{km My}^{-1/2}\ \sqrt{t}$$

Thus, you can predict the depth of the ocean (w) anywhere on the sea floor, if you know the age of the ocean floor (t) :

$$w = 0.35\ \text{km My}^{-1/2} * (t)^{1/2}$$

where w= depth, and
t= age of lithosphere

making figures with multiple datasets

In this lab, you will be provided cross sections of the bathymetry across the Oceans. For each ocean, you will plot this data, and then, on the same graph, plot your calculated bathymetry. To do this, you need to load the bathymetric data, and then plot two different data sets on one plot

```
load Bath.mat; %this loads the data into matlab
figure, plot (Bath.atlanticx, Bath.atlanticz, 'r') % plot bathymetry of Atlantic Ocean, using red line
hold on  %this keeps the plot "open" so you can add more data to it
        %you may have a bunch of code between the two calls to plot
        %
        %
plot (a different x-axis data, a different y-axis data, 'b') % plot your results, using blue line
```

Introduction: "for" loops in matlab

In this lab, you will be trying to find the spreading velocity that best fits your data. This will be somewhat of a trial and error technique. You could write a script, and manually change the value of velocity in the script

Or, you could write a "for loop" and have the script run through all the trial velocities for you . For example

```
for i=1:2:10;
    a:=1;
    b:=i^2
    print(a,b)
end for
```

Will print out 5 pairs of numbers,

```
1  1
3  9
5  25
7  49
9  81
```

Supplies:

A matlab data file with bathymetry along the atlantic ocean and pacific ocean (Bath.mat)

To do:

Estimate the spreading velocity of the Pacific and Atlantic plates.

Procedure:

You'll need to download the data (Bath.mat) from the course website

Then, once you're in matlab, you will write a script to

- load and plot the bathymetric data
- code-up the equation for depth as a function of distance and velocity (from above)--- (you were given the equation in terms of age- so you'll need to use the relationship

  age= f(velocity and distance)
- plot the calculated depth as a function of distance
- vary your input velocity until your calculated plot matches the plotted bathymetry of the Atlantic and Pacific oceans

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To hand in:

1- Question 1: Are your velocities spreading rates, or half spreading rates
2- Your M-Flie
3- Your 2 plots: including data, calculated depths, labeled axes, legend, title (with estimated velocity). Make sure you have units, and appropriate sig figs.

Hints: for your x-axis distances, you can have your script determine how many km wide you want to go. You can use

```
maxdist=max(Bath.pacificx);
```

for matlab to figure out how wide your data set is