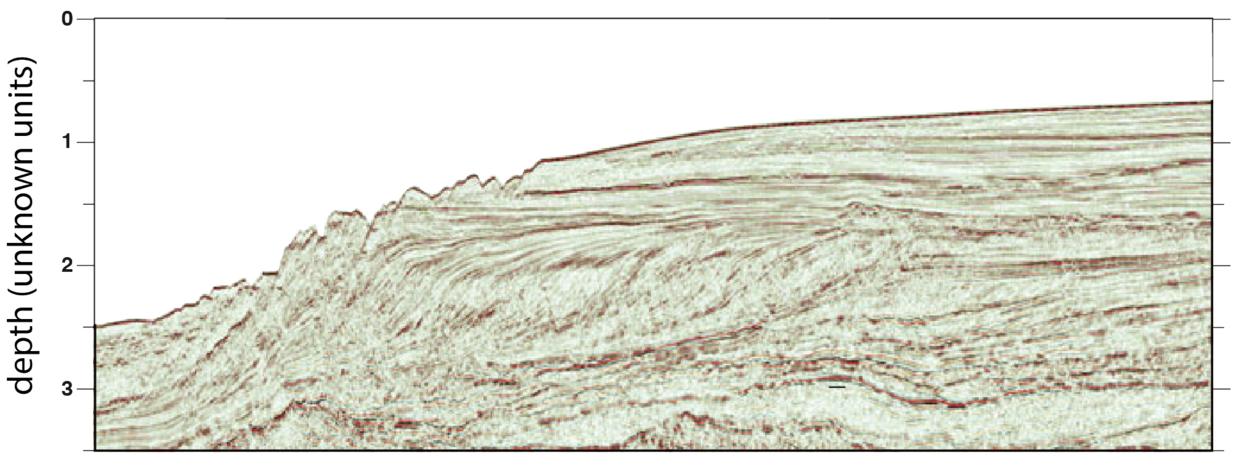
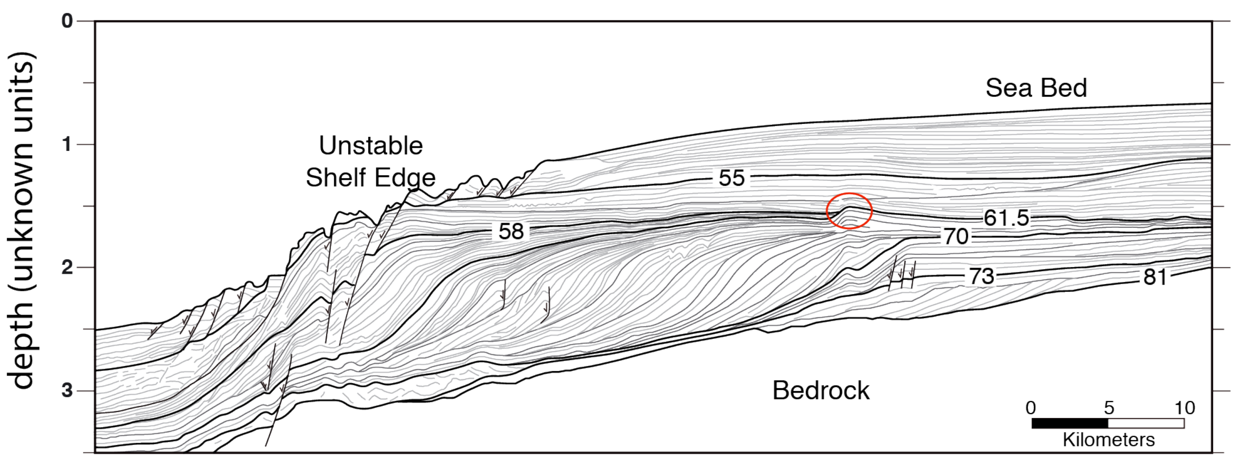
Problem set 1 for EESCW4235 – Sea level change
Due on February 2nd per mail to Roger Creel (rcreel@ldeo.columbia.edu)

1. Sea level from seismic reflection

Interpret sea level change from the seismic reflection profile shown below. The figure shows you a real seismic reflection profile (top panel), which has been interpreted (bottom panel) and specific layers have been dated (thick layers with numbers, ages are in Ma). You may use the interpreted version (lower panel) for your analysis. Left is the oceanward side and right is the landward side.

a) Mark the clinoform rollover position for layers where it is clearly identifiable with a dot or circle. (It might be easiest to screenshot the figure and then include an annotated version in your response).
b) For each time interval describe whether you identify progradation / degradation / aggradation / retrogradation (or a combination of them).
c) Use your results from a) to describe how local sea level has qualitatively changed from 81 Ma to 55 Ma and provide explanations for your sea level interpretation.
d) Is this an area with generally high sediment input or not?





2. Hypsometry and continental flooding

Investigate differential sea level change in Australia between the North and the South using hypsometry:

a) Produce a hypsometric curve for Australia. To do this load the provided topography grid (etopo_ice_15.mat or etopo_ice_15.mat, whichever format you prefer) and isolate Australia. Since Australia is relatively close to the equator you may assume that a lat-lon projection is equal area. Calculate the cumulative amount of area per elevation (i.e. hypsometric curve), starting at elevation -200m to the highest elevation present. Present two plots, one showing the topographic map isolating Australia that you're using and the other being the hypsometric curve. In addition to the plots, please submit your code that you use to calculate the hypsometric curve.

b) Now we will compare hypsometry in the northern part of the island versus the southern part. First, remove areas that have undergone recent volcanism and basin formation. To do that you can remove areas east of 135ºE in your analysis. Next produce a hypsometric curve for the northern part (you may choose this to be north of 25ºS) and the southern part (you may choose this to be south of 25ºS). Present again two plots, one showing the topographic map isolating the northern and southern region that you're using (could be two separate plots) and the other being the hypsometric curves for each region.

c) Assuming 30% of the northern and southern part of the continent from b) (including shelves down to -200m) was flooded during the Miocene. At what elevation would you find the Miocene paleo shoreline today? What does that tell you about the relative motion between the northern and the southern part of the continent?

If you use matlab, you might find the functions 'inpolygon' and 'find' helpful for this exercise.

3. Mid-ocean ridge spreading rate changes and sea level change

Calculate the amount of sea level rise during faster mid ocean ridge spreading. Consider a 2D transect through an ocean basin (see figure below) that stores 20,000 km^2 of water.

a) What is H_0 if we assume a half-spreading rate of 5cm/yr. You can use the values for constants listed below. Show the equations you are using – if you use pen and paper feel free to submit a photo of it or use a phone app like 'Tiny Scanner' to scan it.

b) Assume an increase in half-spreading rate (dashed black and blue lines) to 7cm/yr. Determine H_1 and ΔH. Show your work.

c) The figure below assumes passive margins, i.e. no subduction of the oceanic crust underneath the continents to the side. Could the presence of subduction zones affect ΔH and if so, would it lead to a decrease or increase in ΔH?

Mantle temperature 1300ºC, ocean bottom temperature 10ºC, thermal diffusivity 10^{-6} m^2/s, thermal expansivity 3×10^{-5} 1/K, density of water 1000 kg/m^3, density of sublithospheric mantle 3000 kg/m^3