Lab 3. The Juan de Fuca Plate

Please write out your answers on a separate sheet of paper.

In this exercise you are going to be looking at the bathymetry of the Juan de Fuca plate region, identifying interesting features and their characteristics, and attempting to interpret what you see. Some of the questions may be difficult for you to answer now (although hopefully not at the end of the Quarter) – part of the objective is to get you to look carefully at the maps and think rather than immediately writing down an answer. The Instructor and TAs will be coming around the lab answering questions.

Figure 1 shows the plate boundaries for the Juan de Fuca plate region and you will use this as your road map as you explore the Juan de Fuca plate with the program GeoMapApp, a versatile program that is used by researchers to look at bathymetry and other seafloor data.

To run GeoMapApp do the following
1. Start GeoMapApp on the lab computer from the Start menu or from the Desktop Icon if you have one. If it asks you to install a new version you do not have to.
2. Select the default Mercator Base Map (left hand map)
3. Learn to use the “Zoom In”, “Zoom Out” and “Pan the Map” tools. You can use the “Zoom In” tool either by clicking on the map or holding the mouse button down to rubber-band a box of interest. The Overlays menu allows you to add a Distance Scale and Color Bar.
4. Learn to use the “Distance/Profile Tool” (sixth from the left). When you select it the colors on the map scale may change. Once everything is loaded you can click & hold, drag and release a line on the map and get a plot of the bathymetry along that profile. Remember to unselect this tool when you have finished. You can toggle back and forth between the two color schemes by checking/unchecking “Global Multi-Resolution Topography (GMR)” in the Layer Manager window
5. Once you can do this you are ready to zoom in on the Juan de Fuca plate region and do this exercise. For each feature you look at you will have to make extensive use of the “Zoom In” tool to see enough detail to answer the questions.

(a) From Figure 1 you can see that the Mendocino and Blanco transform faults are not parallel.
   (i) This creates a geometric space problem. Briefly (in 1-2 sentences) explain why?
   (ii) Draw arrows on Figure 1 showing the sense of motion on either side of these transforms.
   (iii) Because the transforms are not parallel, one of the transforms is under compression and one is under extension. Based on your answer to (ii), explain which one is under which.
   (iv) Now look at the bathymetry of the transforms with GeoMapApp. Can you identify features on each transform that support your answer to (iii)? Briefly describe these features with the help of sketches.
(b) Look at the Gorda Plate region. The Gorda plate is undergoing extensive deformation because of the geometric problem created by the non-parallel transforms.

(i) Look at the whole region and if necessary zoom in on key regions. Sketch the bathymetric features that are indicative of deformation?

(ii) Can you deduce the type and direction of the deformation (for example you might identify “extension in a NE-SW direction”)? Explain your answer.

(c) Look at a portion of the Gorda Ridge and then a portion of the Juan de Fuca Ridge south of Axial Seamount

(i) These ridges have very different topography along the ridge axis. Describe the differences perhaps with the aid of quick sketches showing a bathymetric profile across the spreading axis. You can use the profile tool to see cross sections but it only works well if you are zoomed in on the region of the profile.

(ii) Can you suggest a reason why the two ridge look so different?

(d) Find Axial Volcano and the Cobb Eickelberg Seamount Chain (you will not need to zoom in for this question). Axial Volcano overlies a small hotspot and the age of the rocks on the seamount chain increases steadily as you move to the NW.

(i) If the hotspot is still in the mantle reference frame, what is the direction of motion of the Pacific plate over the mantle?

(ii) Now assume that the Pacific plate is moving over the hotspot at a velocity of 5 cm/yr. The spreading rate of the Juan de Fuca Ridge is 6 cm/yr. What is the approximate direction and rate of motion of the Juan de Fuca Plate over the mantle? It helps to think about this graphically drawing vectors of motions but it is difficult, so move on and do not worry if you do not understand it. For an even harder challenge try to deduce the motion of the North American Plate relative to the other plates and the hotspot reference frame (think of the relative motion of the North America and Pacific required by the San Andreas Fault which slips at 5 cm/yr).

(e) Look at the subduction zone off the Oregon Coast and find a region where there is high-resolution bathymetry.

(i) Is the boundary between undeformed flat sediments and deformed seafloor sharp or gradual?

(ii) Find an example of a landslide on the continental slope – you may have to search a bit but there are quite a few. Sketch what you see (note the latitude and longitude on your sketch). What might have triggered these landslides?

(f) The seafloor of the Juan de Fuca plate is cut by some prominent channels.

(i) Look near the mouth of the Columbia River. Sketch what the channel’s look like. How might they have formed?

(ii) Can you find a channel that cuts the Blanco Transform. Sketch what it looks like and speculate on how it might have formed and how it might be related to the channels near the mouth of the Columbia River.
Figure 1. Plate boundaries and major features of the Juan de Fuca Plate