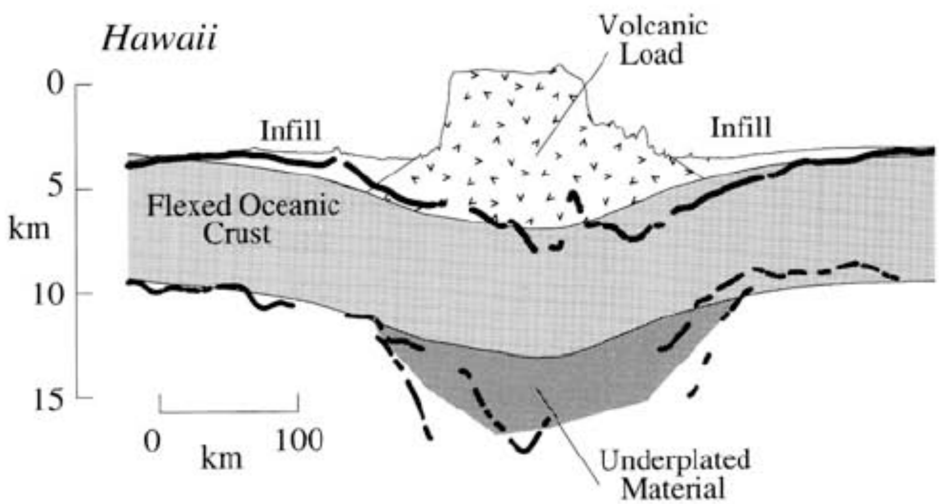
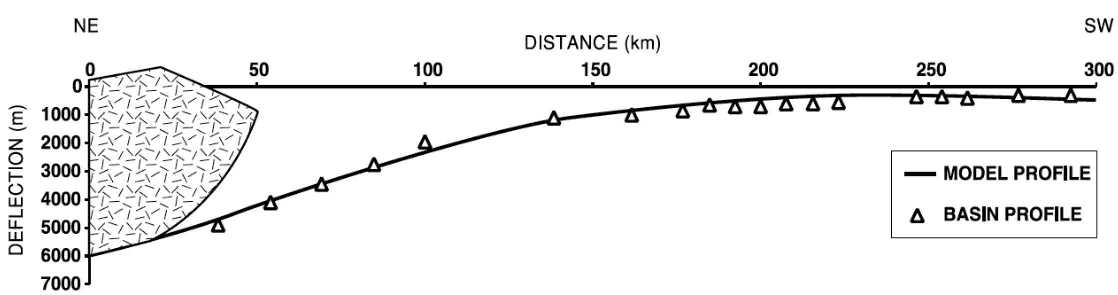
G520 Homework Set #4

1. The figure below shows seismic reflections that are interpreted to be the top and bottom of the oceanic crust under Hawaii. You will use the lithosphere flexure equations derived in class to find a range in elastic thicknesses that fit the shape of the top of the oceanic crust reasonably well. The locations of points on the top reflector are provided in a text file, hawaii_top.txt. The depths of the points have been adjusted so that the top of the lithosphere (crust) is approximately zero far from the volcanic island. Assume E = 50GPa and mantle density of $\rho_m = 3300$ kg/m^3. Find a range of values for T that reproduces the flexural shape reasonably well using the line load model derived in class. Plot the data and model curves for range of T values that fit the data.



2. Paradox basin problem. The figure below is from the Barbeau paper (provided, data in file called Paradox_basin.txt). This is a flexure model for the Paradox basin in Colorado and Utah, next to the Uncompahgre uplift. Use the box model to compute basin deflection profiles. Represent the exhumed mountain range with a block load with density $\rho_c = 2700$ kg/m^3. Represent the basin fill with several boxes (thinning to the SW) with sediment density of $\rho_s = 2300$ kg/m^3. Experiment with heights and widths of box loads for the mountain belt and the sedimentary basin fill. Note that the top of the sedimentary basin fill should be at approximately zero elevation. Find a load and an elastic thickness that best fits the basin profile (triangles below). Assume a mantle density of $\rho_m = 3300$ kg/m^3. Plot the best-fitting profile (along with the data) and note the values for T and box widths/heights used.



3. Use the dike solution to determine how long it takes a 1.5 meter wide basaltic dike intrusion to crystalize. To get an approximate answer, assume the basalt melt is 1000° C. Plagioclase begins to crystalize at, say, 900° C. Assume the thermal diffusivity of basalt is 1.0×10^{-6} m^2/s. Plot T(x=0,t) and T(x=0.7m,t) for this diffusivity and T_d. At what time after emplacement does the dike begin to crystalize at the center (x=0) and near the edge (x=0.7m)?

4. Puna dike-injection problem. See Rudman and Epp paper. The HGP-A well is located about 100 m from a dike. Assume the magma was injected into the dike instantaneously at 1200° C. The thermal diffusivity of the basalt in Hawaii has been measured as 1.0×10^{-6} m^2/s. Dikes in the region are typically about 1.5 m wide, but can be as wide as 15-25 m.

Use the solution for an infinitely long dike of thickness 2a to plot the temperature in the well as a function of time. Show plots of temperature with time for 1.5 m and 25 m wide dikes. According to Figure 3 in the Rudman and Epp paper, the temperature at the bottom of the well was about 350° C. Does the well reach 350° C assuming all of the heat is due to the injected magma in a dike of width 25 m or less? What is the minimum dike width necessary to heat up the well to 350° C (again, assume the well is 100 m from the center of the dike)? Show the temperature time plot for this model.