

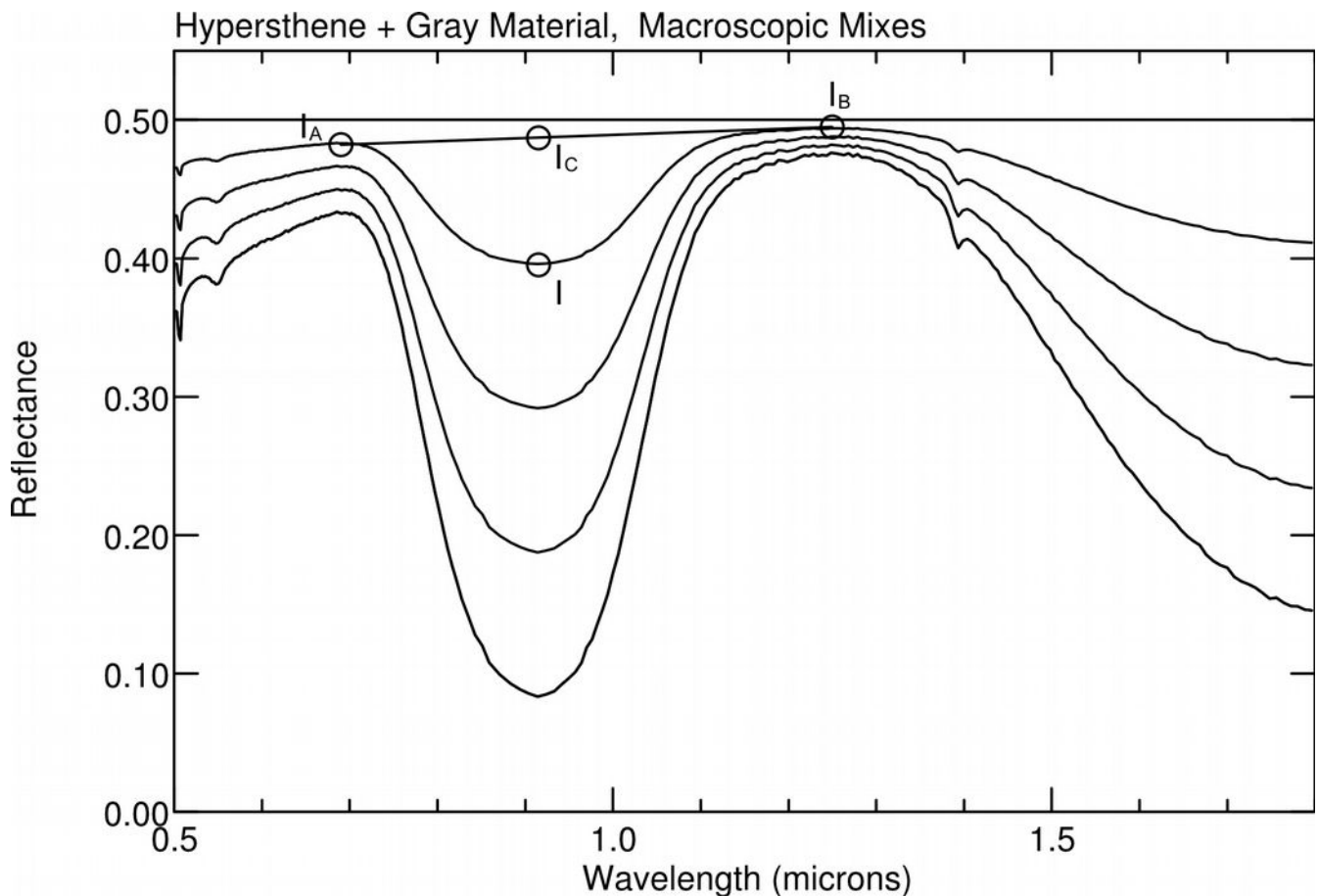
Homework #7
Geology 4113 (Remote Sensing)
Assigned Mar. 09, 2018
Due March 23, 2018

#1) Band Depth Ratios and macroscopic mixtures (20 points)

Band Depth Ratios (band depths for short) are used to quantitatively measure the depth of absorption bands. They will range from 0 (no absorption) to 1 (complete absorption). When mixtures of materials are present they can be used to estimate abundances.

Simply defined, the band depth is the fraction of the light absorbed at the center of the band, relative to what you would expect if that particular band had not been present. In the graph below to measure that band depth you interpolate from adjacent points outside the band (I_A and I_B) to estimate the “continuum” intensity (I_C) that you would expect if the band had not been present, then you measure the depth of the band (at I) relative to that I_C . If I is equal to I_C then the band depth is zero. If I drops all the way to 0 intensity, then the band depth is one. The detailed equations and an example are given on the next page.

The graph below shows the spectra expected for a surface covered completely with 60- μm size grains of hypersthene (the bottom curve), a gray material with a reflectance of 0.50 (top curve – actually a straight line) plus various macroscopic (i.e. large scale or checkerboard) mixes of the two. The various I are only shown for the top mixture.



Note the continuum points **are not** spaced symmetrically around the band for this problem, so you can't simply say that I_C is the average of those two continuum points as we will in lab #8.

Detailed instructions:

Part A. (10 points)

Find the band depth for all 4 curves graphically – by drawing lines and measuring distances on the plot. Note you don't need to convert those distances into reflectance, since you only care about ratios of distances. Show on the plot the distances you measure and record those numbers.

For example, for the top curve the distance from the deepest point on the band down to the $y=0$ line is 7.35 cm while the distance from the interpolated continuum point I_C down to the $y=0$ line is 9.02 cm, so the band depth is $1-(7.35/9.02) = 1 - 0.815 = 0.185$. (The distances may be slightly different on the finally Xeroxed version of the homework.) You could also obtain this (with more work) by noting that I at the deepest part of the band is 0.395 while I_C is 0.484 so $BD = 1 - (0.395/0.484) = 1-0.816 = 0.184$, essentially the same without roundoff and measurement error. Repeat this for the lower 3 curves.

Part B. (5 points)

When we are working with digital data, once we pick the bands which correspond to λ_A , λ_B , and λ , we can program our computers to automate this calculation. To be sure you understand the technique involved, for one curve (the lowest) we will perform the calculation manually.

For that lowest curve, find the actual value of the two continuum intensities I_A and I_B and also I at the deepest part of the band. Also find the corresponding wavelengths λ_A , λ_B , and λ . You should try to make these measurements accurate to a few percent by using a ruler and interpolating using the X and Y scales and using a calculator. For example in Y every cm corresponds to 0.054 units in I, at least before xeroxing. Since that may have changed in your copy, determine the scale yourself.

Next, compute the interpolated continuum intensity I_C at the deepest part of the line from the following formula, which is the equation of a line passing through points (λ_A, I_A) and (λ_B, I_B) .

$$I_C = I_A + \frac{I_B - I_A}{\lambda_B - \lambda_A} (\lambda - \lambda_A)$$

Finally, using I and I_C find the band depth. Does the result you obtained here agree with the value you obtained graphically in part A?

Part C. (5 points)

If you have an areal mixture, with a fraction f of the surface covered with hypersthene, and the remaining fraction $(1-f)$ covered with a gray material, then the band depth you observe will be equal to f times the band depth of pure hypersthene (the lowest curve).

$$BD_{\text{Observed}} = f \times BD_{\text{Hypersthene}}$$

Use this to estimate the fractional hypersthene coverage for the three intermediate curves.