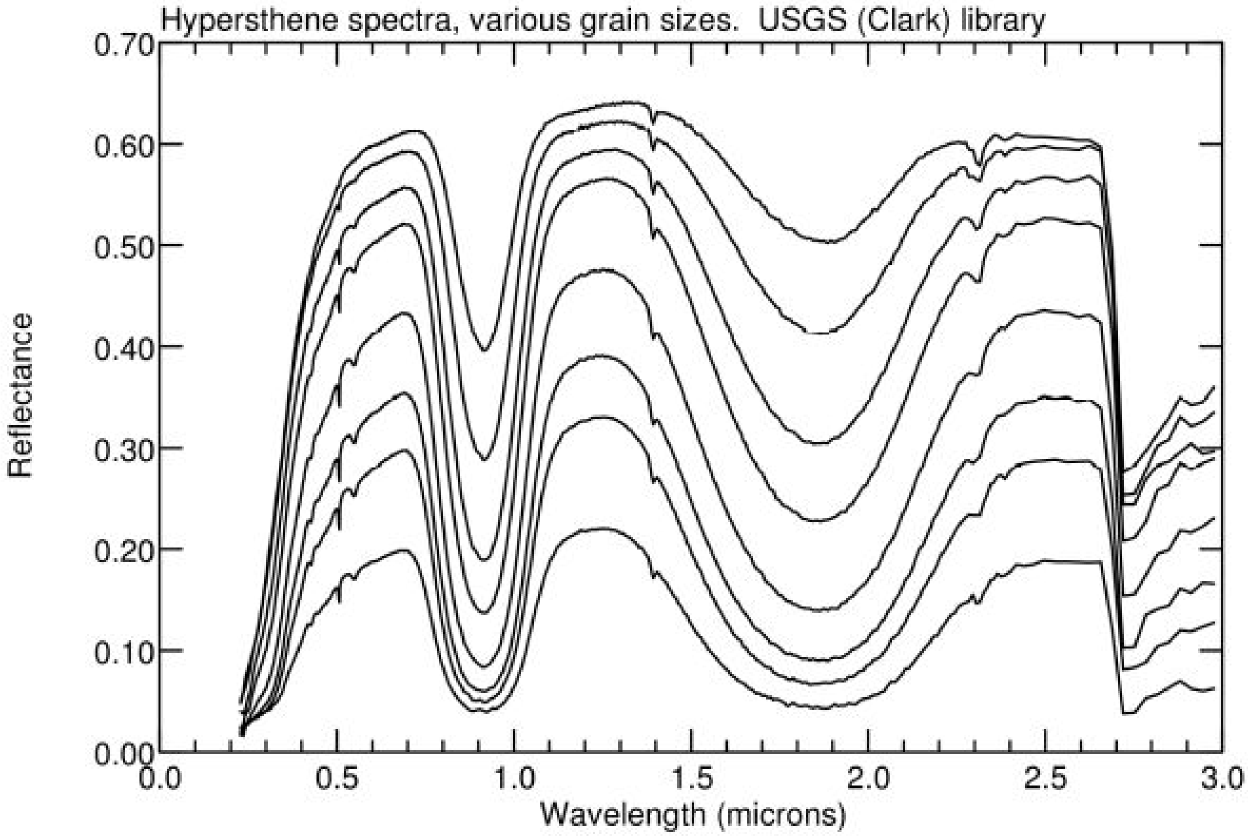
Homework #2
Assigned Feb. 2, 2018
Due Friday Feb. 9, 2018
Geology 4113 (Remote Sensing)

The questions this week refer to spectra of minerals available from the USGS Digital Spectral Library Version 6, by Clark et al., available on-line at <http://speclab.cr.usgs.gov/>. Besides spectra of minerals, this site also has spectroscopy tutorials and other information. For one of the questions I ask you to retrieve information containing spectra of a particular mineral. If you have trouble navigating the site, the page containing the list of minerals and their spectra is located at <http://speclab.cr.usgs.gov/spectral.lib06/ds231/datatable.html>. You will want to look for spectra covering the 0.2 – 3.0 μm region. You can either download an ascii text table of reflectance, or a spectral plot image.

The spectra shown here are all from the same mineral hypersthene, a type of low Ca (and in this case high Fe) pyroxene. Later in the semester we'll see that both of the major absorption bands, at 0.9 and 1.9 μm, are due to Fe in the pyroxene crystal. There are two bands because pyroxene has two different crystal sites the Fe can occupy. Later we'll also see that we can estimate the composition of pyroxene, as these bands shift in position as the relative amounts of Ca, Mg, and Fe change.

For this particular sample the authors of the spectral library started with coarse hypersthene then ground and wet sieved it into the following size bins – labeled on-line as shown below:

Label	Sieve Size
7 μm:	5 - 10 μm
12 μm:	10 - 20 μm
23 μm:	20 - 30 μm
34 μm:	30 - 45 μm
60 μm:	45 - 104 μm
120 μm:	104 - 150 μm
180 μm:	150 - 250 μm
>250 μm:	>250 μm


Hypersthene spectra, various grain sizes. USGS (Clark) library
Reflectance
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Wavelength (microns)

1) **Band Depth vs. Grain Size (30 points)**

a) (15 points) Although I told you the different spectra result from sieved samples with different average grain sizes, in this plot I haven't told you which spectrum goes with which grain size. Using the basic principles of how light interacts with matter discussed on pg. 3 of our text, and using the fact that 3 of these 5 mechanisms are surface effects while 2 are volume phenomena, you should be able to figure out which spectra are produced by the large grains and which are produced by the small grains. Label the spectra in the plot by grain size, and in a few sentences, explain your reasoning.

b) (15 points) Use the on-line library to find spectra of different grain size olivine and print out a spectrum for both a large and a small grain sample, for the same wavelength region shown for pyroxene. You should get the same trend with grain size as in part a. Note the library contains many different olivine spectra, both of different composition samples and of different grain sizes. When you pick the two different grain size spectra to compare, make sure they are both from the same composition original sample, and cover the same wavelengths. To get that, make sure the "name of the sample", which comes right after "Olivine" or "Hypersthene" is the same. The grain size is usually listed next. After that comes more letters which indicate the spectrometer (and wavelength range) used. Make sure they are also the same and only the grain size is different.

2) **Color displays (10 Points)**

Suppose you wanted to map where hypersthene is present on a geologically simple body. Most of the surface is composed of some "gray" mineral which reflects light equally at all wavelengths. The pyroxene reflects as shown above. You obtain a hyperspectral image, and display it with the 0.7 μm channel shown as blue, the 0.9 μm channel as green, and the 1.2 μm channel as red. Most of your displayed image will be gray, but in those regions where pyroxene will be present it will show a different color. What will that color be? Explain, in at most a sentence or two.