Remote Sensing/GIS Lab: GG 5920 - Geothermal Systems for Geoscientists

We will be working with an ASTER image which has been geo-referenced and undergone haze correction. Your task is to choose appropriate band-ratio combinations to represent hydrothermal alteration minerals.

Please use your web browser and go to this web site: http://speclab.cr.usgs.gov/This is an excellent resource that includes a rich suite of laboratory spectra which you can view to help make your decisions. Choose a few (e.g. kaolinite, alunite, gypsum, calcite, illite, chlorite). Look at their spectra and determine if ASTER data will work specifically for a mineral, or perhaps for a group of minerals. Sensor characterizes are found in the ASTER users handbook - http://asterweb.jpl.nasa.gov/content/03_data/04_documents/aster_user_guide_v2.pdf. It is also on this website.

1. Write down the band ratios you will use, and the rationale for their use, in a text document.

You will now use ArcGIS to create your band-ratios. This is not efficient image processing software, but many geothermal companies now use it for their GIS work and it can be used for rudimentary image processing and analysis.

Load ASTER.img into ArcGIS as individual bands. Do this by double clicking the image name – this will reveal all of the available bands. This image contains the first nine bands (excluding off NADIR band 3).

You must have the Spatial Analyst extension activated. You will be using the Raster Calculator. There is a trick you must use with the Raster Calculator as you will want the output to be floating point decimal. Therefore, each band you use must have this format "float([b1])" – a ratio would be created like this:

float([b1]) div float([b2])

the "div" operator is only used with floating point data. Replace b1 etc. with your band names. I suggest you change them to b1, b2, ...

However, before you proceed you must consider what factors may influence your ratios besides minerals. For example, vegetation can have a deleterious effect on ratios as can clouds. Clouds can generally be edited out of the image. Vegetation can be dealt with using a number of methods. The most straight-forward is using a normalized vegetation index (NDVI), or one of the several similar techniques, to highlight vegetation. You then choose a vegetation threshold value by inspection. An NDVI is calculated as follows:

Infrared – visible red/infrared + visible red

Calculate an NDVI and then compare it to a false color composite of AVIRIS bands 3,2,1 = R,G,B. Using the ArcGIS Identify tool choose a threshold value. It may require some trial-and-error to achieve your ideal goal of removing vegetation cover between ~70% and 100%.

Here is the formula to use in the Raster Calculator to both create a ratio and remove vegetation:

Con([NDVI] >= threshold value, 0, float([b1]) div float([b2]))

Con sets up a conditional statement that is similar to an If-Then-Else statement. In essence it is stating:

If NDVI >= threshold value then
Output = 0
Else
Perform the ratio
End if

After you finish your band ratios you can create a multiple band image using "Composite Bands" which can be found in the tool box under Data Management Tools>Raster. This will allow you to assign specific bands to create a false color composite. This is important because you can combine the ratios in a manner which facilitates the identification of a certain mineral or group of minerals.

2. Using the rationale you described in question 1, assign your data to false color composites and write down the bands you used and why.

GIS

GIS can be used to visualize spatially correlated data, ask questions of the data (queries), and even to develop geothermal exploration models. Many data sets that are related to geothermal exploration can be found in the Internet. One such site is http://www.unr.edu/geothermal/ which has data for the Great Basin and Nevada. The UGS has data for Utah: http://geology.utah.gov/

Obviously the more good data one has access to, that is related to geothermal exploration, the more chance of success one has in finding a resource. Considering what you have learned in this course, ponder the data that you would need to perform a regional exploration model.

ArcGIS can be used to create summation, weighted sum, fuzzy logic, Boolean and other models.

3. Consider a theoretical weighted sum model and discuss the data you would use (ideally) and how you would weight the various input data.

E-mail the text file you create to gnash@emcity.net by the last week of the semester.