Evaluation Test for Deriving planetary surface composition from orbiting observations from spacecraft

The Lunar Prospector Gamma-Ray Spectrometer (GRS) collected gamma-ray measurements as it orbited the Moon from 1998 to 1999. Each spectra contains characteristic features (peaks) that measures the elemental composition of the surface. See example summed spectra below (Figure 1). The summed spectra were used to map surface composition from orbit, with an example shown in Figure 2.

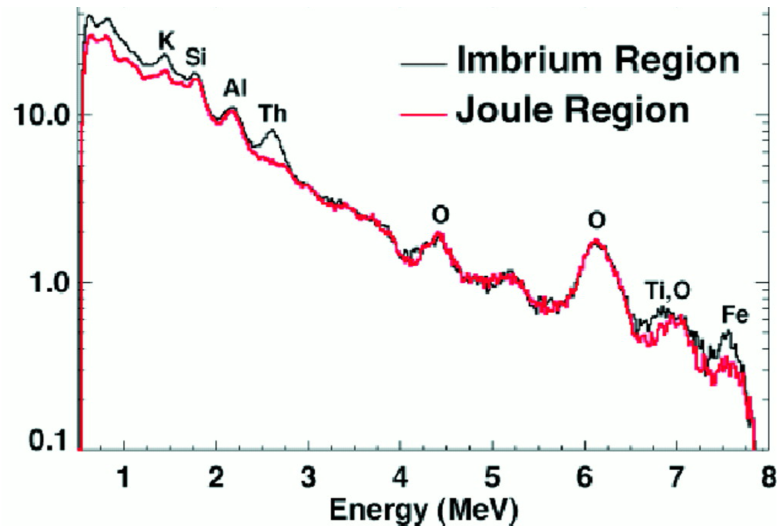

Figure 1. Summed gamma-ray spectra, with units of counts per 32 seconds, collected over two chemically distinct regions of the Moon. Many individual measurements were summed to produce these two spectra.

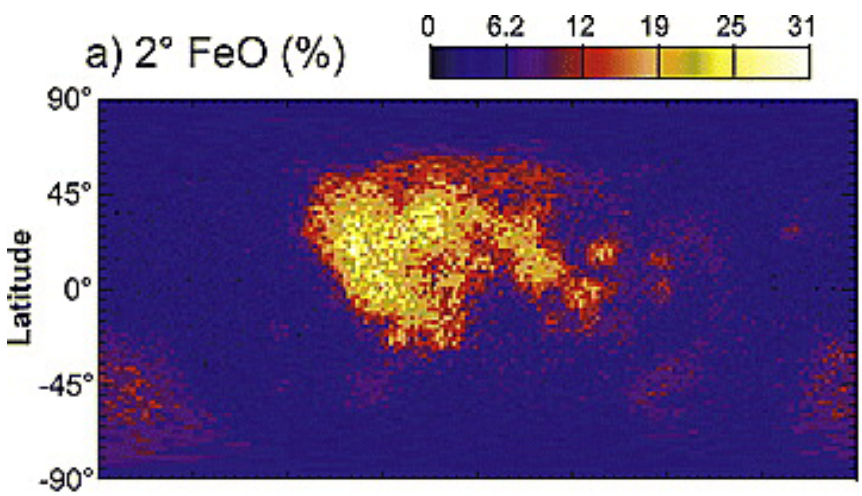

Figure 2. Variations in the concentration of Fe on the Moon. The map ranges from -180 to 180 longitude, with 0 in the middle. The high-iron locations are the dark lunar mare visible by eye.

Task 1: Data Retrieval and Parsing

The Lunar Prospector Gamma-Ray Spectrometer collected data at 32-s intervals for 18 months as it orbited the Moon at altitudes of ~100 km () and ~30 km (). The data are collected in files containing data from a single day. For example:

1998_270_grs.dat

Is a binary file containing all of the data collected on DOY 270 in 1998 (). The contents of the binary file are described in the corresponding label (.lbl) file accompanying each binary data file. These data are located at:

https://pds-geosciences.wustl.edu/lunar/lp-l-grs-3-rdr-v1/lp_2xxx/grs/

This project involves the handling of all Lunar Prospector gamma-ray data, Task 1 is to demonstrate the ability to retrieve and plot GRS data. You may incorporate existing python tools in your Jupyter notebook for this task.

https://nasa-pds.github.io/pds-api-client/
https://github.com/RyanBalfanz/PyPDS

Task 2: Data Handling

Read the entire Lunar Prospector dataset, and demonstrate the ability to isolate and sum data based on location and altitude by producing summed spectra for the following conditions:

All data, collected at 100 km altitude (±10 km), collected within :

Latitude:	Longitude:
0 to 30° N	-45 to 0° E (315 to 360° W)
-15 to 15° N	20 to 40° E
20 to 45° N	90 to 120° E

Plot all three spectra, normalized for total time, on the same plot and identify differences in the spectra that reveal differences in composition (e.g. Figure 1).

Repeat this exercise for data collected at an altitude of 30 km altitude (±3 km).

Task 3: Application of Machine Learning

Retrieve the 5° elemental composition maps from:
https://pds-geosciences.wustl.edu/missions/lunarp/reduced_special.html

Split the maps into two datasets at your discretion, and select one as the training dataset. Develop an ML model of your choice to train your code to derive elemental data directly from the gamma-ray spectra. Evaluate the accuracy of your ML model using the other half of the data. Discuss the results, accuracy, and methods to improve the processes during a potential GSOC summer project.