IRON ABUNDANCES ON THE MOON AS SEEN BY THE LUNAR PROSPECTOR GAMMA-RAY SPECTROMETER. D. J. Lawrence[1], W. C. Feldman[1], B. L. Barraclough[1], R. C. Elphic[1], S. Maurice[2], A. B. Binder[3], and P. G. Lucey[4]; [1]Los Alamos National Laboratory, Group NIS-1, MS-D466, Los Alamos, NM, 87545, djlawrence@lanl.gov; [2]Observatoire Midi-Pyrénées, Toulouse, France; [3]Lunar Research Institute, Tucson, AZ; [4]University of Hawaii.

Introduction: Measurements of global iron (Fe) abundances on the Moon are important because Fe is a key element that is used in models of lunar formation and evolution. Previous measurements of lunar Fe abundances have been made by the Apollo Gamma-Ray (AGR) experiment [1] and Clementine spectral reflectance (CSR) experiment [2]. The AGR experiment made direct elemental measurements for about 20% of the Moon. However, these measurements had large uncertainties due mostly to low statistics [3] and an absence of thermal neutron data (see below). The CSR derived Fe data has much better coverage (100% coverage equatorward of ±70° latitude) and spatial resolution (~100 m surface resolution versus ~150 km surface resolution for the AGR data), but there have been questions regarding the accuracy of these data far from the Apollo landing sites [4].

Here, we present preliminary estimates of the relative Fe abundances using the Lunar Prospector (LP) gamma-ray spectrometer (GRS). While these data are important and useful by themselves, the ultimate goal of this study is to combine the LP Fe data with the CSR data to obtain a better calibrated and more accurate picture of the Fe abundances on the Moon.

Data Analysis: To derive Fe abundances, we are using two γ-ray lines near 7.6 MeV. These γ-rays are produced by thermal neutron capture. Here, Fe nuclei absorb thermal neutrons, become energetically excited, and then de-excite with the production of γ-rays. Because this process depends upon thermal neutrons, the measured flux of 7.6 MeV γ-rays is proportional not only to the Fe abundances, but also to the thermal neutron number density. Here, we use measurements from the LP neutron spectrometer (NS) [5] to correct for this thermal neutron effect. As seen in [5], this correction is quite large as the thermal neutron count rate varies over the Moon by a factor of 3. Many considerations need to be taken into account to make sure an appropriate correction is applied. These include: 1) converting the measured thermal neutron flux into a true thermal neutron number density; 2) accounting for composition effects such as thermal neutron absorption due to Gd and Sm [6]; 3) equating the instrument surface resolution for the GRS and NS. To take care of most of these considerations, detailed calculations need to be carried out. Yet with some assumptions, a preliminary estimate of the thermal neutron correction can be obtained.

To relate the measured thermal neutron flux to the thermal neutron number density, we assume that the thermal neutron energy distribution is Maxwellian and independent of soil composition. With this assumption, the measured neutron flux, F, is proportional to both the neutron number density, n, and the square root of the mean lunar surface temperature, T:

$$F \propto n\sqrt{T} \ .$$

Here, the measured neutron flux also includes epithermal neutrons which contribute to the overall neutron number density. To obtain a global surface temperature, we have used a mean equatorial surface temperature of 250K and scaled it as $\cos(\text{latitude})^{1/4}$. Because this scaling results in very low temperatures at the poles, a low temperature cutoff has been set at 130K.

Results: For this study, we have used the high altitude GRS data to obtain the relative Fe abundances. We correct for the thermal neutron effect using the low altitude summed thermal and epithermal neutron data smoothed to the footprint of the high altitude GRS data set. The resulting relative Fe abundance map is shown in Figure 1. A comparison between this map and the published CSR Fe map shows a good correspondence. This correspondence is shown more quantitatively in Figure 2 which is a scatter plot between the two data sets. Here, the CSR data has been smoothed to the footprint of the GRS data. As seen, for most of the Moon, there is a good correlation between the data sets with a correlation coefficient of 0.93. One region of some disagreement is in South Pole Aitken (SPA) basin (red points) where the CSR measurements correspond to a ~20% higher count rate than is observed with the GRS data.

In contrast to the corrected GRS data, the blue points show the GRS data before the thermal neutron correction is applied. The correlation coefficient between the uncorrected GRS data and the CSR data is poorer at 0.73. In addition, the spread of the GRS data at a given CSR abundance (~5 channels) is almost as large as the entire dynamic range of the uncorrected count rate (~6 channels) which implies there exist large uncertainties in the uncorrected data.

Because there are many assumptions leading to Figure 1, the uncertainties of these data are not yet known. For example, it is not clear if the discrepancy seen in SPA is real or is some effect of the simplified data reduction technique. Even so, we are demonstrating the ability to compare LP and CSR Fe data sets and show that they may indeed agree quite well.

References: [1] Davis, P. A., *JGR* 85, 3209, 1980; [2] Lucey et al., *JGR*, 103, 3679, 1998; [3] Davis, P. A. and Spudis, P. D., *JGR* 92, E387, 1987; [4] Clark, P. E. and Basu, A., *29th LPSC*, 1998; [5] Feldman et al., *Science*, 281, 1489; [6] Elphic et al., *Science*, 281, 1493, 1998;

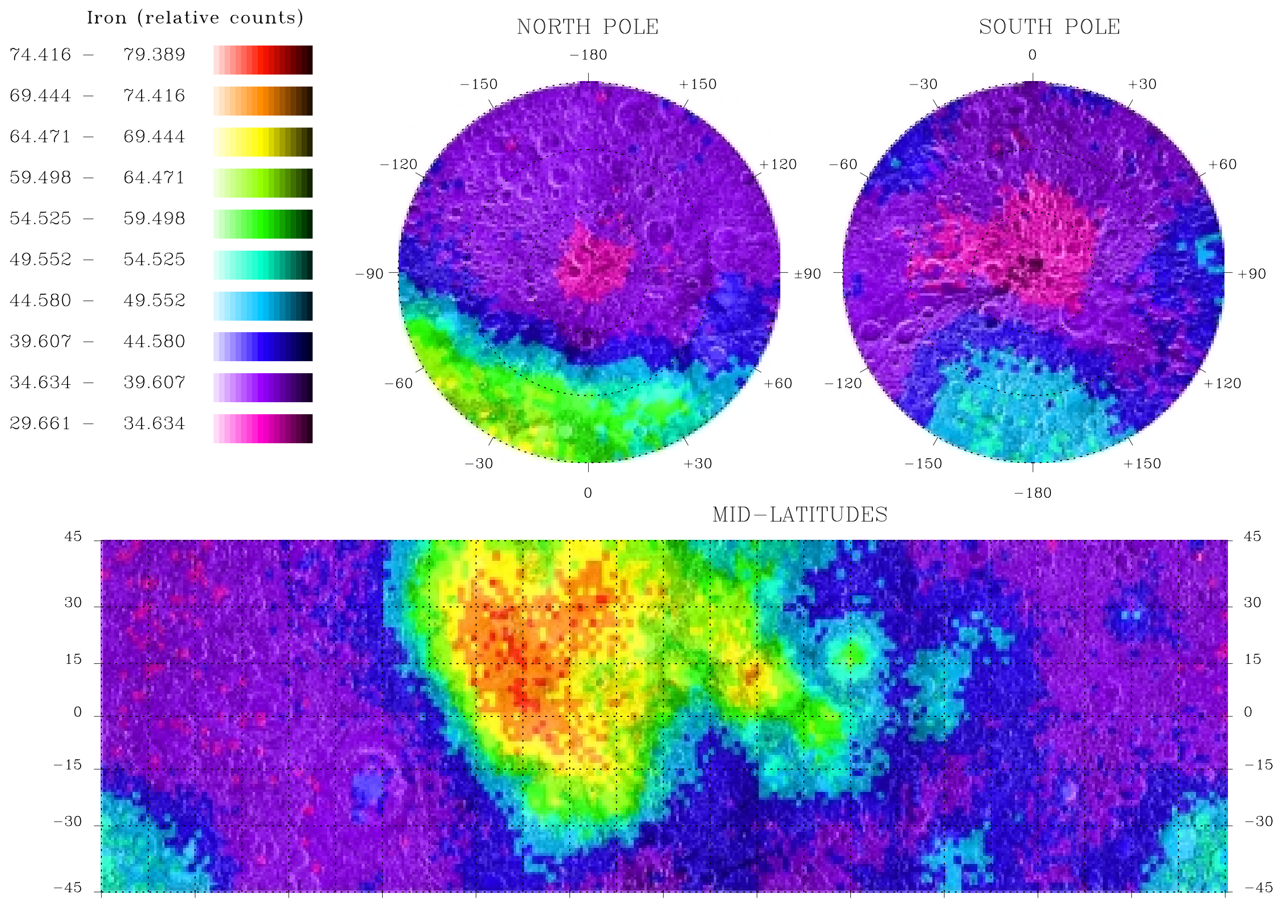

Figure 1: Global map of relative iron abundances from the LP GRS overlaid with a lunar surface features

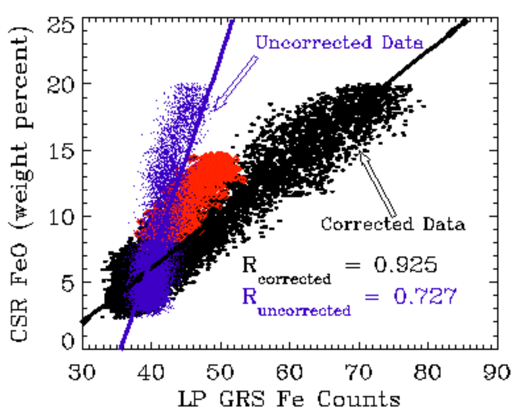

Figure 2: Scatter plot of LP GRS Fe data versus CSR FeO data. Uncorrected LP data shown in blue; corrected LP data shown in black.