Preliminary Correlations of Mars GRS Elemental Abundances with Thermal Inertia, Albedo, and Rock Abundance. J. M. Keller[1], W. V. Boynton[1], G. J. Taylor[2], K. Kerry[1], D. M. Janes[1], D. Hamara[1], M. A. Chamberlain[1], S. W. Squyres[3], S. Karunatillake[3], O. Gasnault[4], and the Mars GRS Team, [1]Lunar and Planetary Laboratory, Univ. Arizona, Tucson, AZ 85721 (jkeller@lpl.arizona.edu), [2]Hawaii Inst. Of Geophys, and Planetology, 1680 East-West Rd., Honolulu, HI 96822, [3]Cornell University, Ithaca, NY 14853, [4]Centre d'Etude Spatiale des Rayonnements, 9, avenue Roche, 31028 Toulouse, France.

Introduction: One year into the mapping phase of the Mars Odyssey Mission, the Gamma Ray Spectrometer (GRS) has collected data with strong enough statistics to make preliminary determinations of elemental abundances on the surface Mars. While the instrument's 10-degree x 10-degree footprint and the slow rate of gathering gamma rays from the planet surface limit our analysis at this early stage, we have gathered enough data to conduct preliminary correlations between elemental abundances and the following parameters: thermal inertia, albedo, and rock abundance. With continued data collection over the lifetime of the instrument, enhanced signal-to-noise will allow for an even stronger future analysis.

Correlation Methodology and Results: Comparing measured gamma ray production with a predictive theoretical model, MCNP-X, and applying corrections described in Boynton et al. [1], we created 15-x-15 degree global maps of elemental abundances for hydrogen, potassium, silicon, iron, chlorine, and thorium. Using these derived maps, we compared the spatial distribution of these elements with Viking data for thermal inertia and albedo as well as a model for rock abundance. Thermal inertia measurements come from ~30 km-resolution night-time IRTM observations [2], and the albedo data come from a Viking bolometric study by Pleskot & Miner [3]. Rock abundance values were obtained from a model by Christensen [4] based upon multiwavelength thermal observations. These higher resolution Viking datasets were first averaged into comparable 15-x-15 degree bins and then correlated with elemental abundances. Table 1 below shows the slope, r^2-value, and level of significance (p) for each observed non-zero correlations observed. The level of significance indicates the probability that the reported correlation may actually have a value of zero.

	Rock		Inertia		Albedo	
	a	r^2	a	r^2	a	r^2
H_2O	-.3679	$.1608^{***}$	-.3625	$.1232^{***}$	15.663	$.0785^{**}$
K	.0068	$.0773^{**}$	.0056	$.0424^{*}$	---	---
Si	.1935	$.0517^{*}$	.2029	$.0476^{**}$	---	---
Fe	---	---	---	---	11.975	$.0662^{**}$

Table 1: Slope and r^2 for statistically significant correlations with rock abundance, thermal inertia, and albedo (level of significance: $^{*}p<0.013$, $^{**}p<0.01$, $^{***}p<0.0001$).

Weak yet significantly non-zero correlations were found between hydrogen (reported here as H_2O) and all the three parameters: rock abundance, thermal inertia, and albedo. Weaker, yet still potentially significant correlations were found for three other elements: K and Si with rock abundance and thermal inertia and Fe with albedo. No statistically significant non-zero correlations were found for Th and Cl at this time.

Figures 1-3 below provide scatter plots of three of the correlations shown in Table 1. Additional scatterplots of all significantly non-zero correlations are provided in the poster.

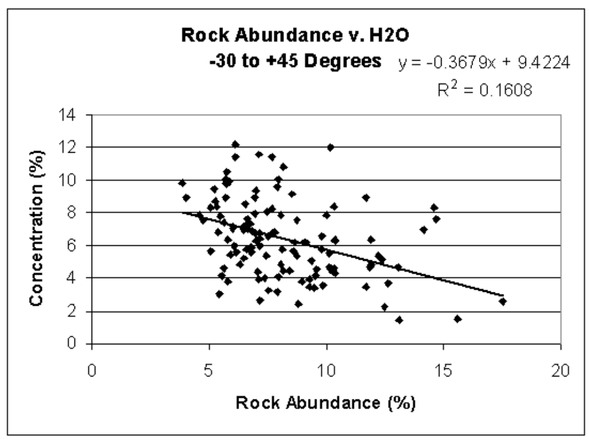

Figure 1: Correlation between rock abundance and H_2O based upon 15-x-15 degree comparison.

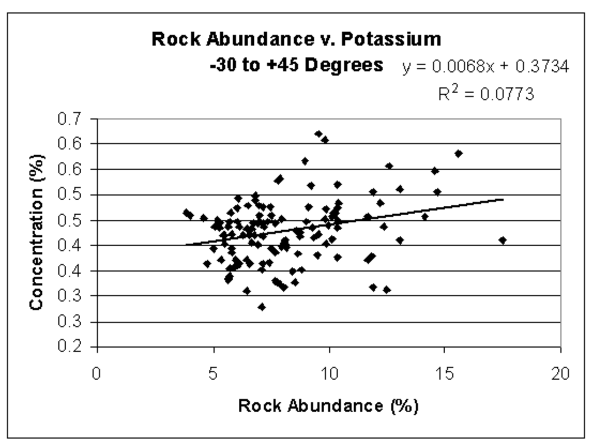

Figure 2: Correlation between rock abundance and K based upon 15-x-15 degree comparison.

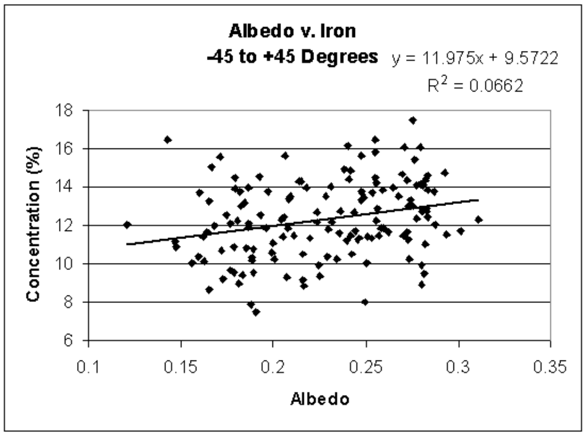

Figure 3: Correlation between albedo and Fe based upon 15-x-15 degree comparison.

In addition to the above analysis, we also smoothed both the high resolution Viking maps and the 15-x-15 degree GRS maps using a circular step function with a radius of 10 degrees at the equator. This smoothed data was rebinned into a 1-x-1 degree grid and elemental abundances were again compared with thermal inertia, albedo, and rock abundance. The results of this analysis agree with the correlations presented above. In addition, the 1-x-1 degree scatterplots indicate the presence of regions on the planet the may be of particular interest. Ongoing work to identify and describe these regions will be presented in the poster.

Discussion: We outline some generalized observations and interpretations based upon the above analyses. For hydrogen, which is reported here as H_2O, weak negative correlations exist with both rock abundance and thermal inertia, while a weak positive correlation exists with albedo. For K and Si, possible positive correlations exist with rock abundance and thermal inertia. For Fe, a possible positive correlation exists with albedo.

At this point in the mission, the statistical uncertainties are large and the correlations presented here, which are based upon low resolution, 15-x-15 degree data, are still tentative. Additionally, while the correlations are non-zero to the level of significance listed in Table 1, they still represent rather weak correlations, with the strongest correlation (between H_2O and rock abundance) showing an r^2-value of only 0.16. Thus, our understanding and interpretation of these results remain tentative.

In spite of these uncertainties, our preliminary results support interpretations of the chemical properties of Martian surface materials made from data acquired by Viking and Sojourner and from studies of Martian meteorites. The correlations between rock abundance and Si and K mimic those determined for Pathfinder (summarized by [5]). The Pathfinder calculated soil-free rock is higher in K and Si than the mean soil at the site. In addition, Fe is lower in soil-free rock than in the soil. As shown by Boynton et al. [1], Si tends to be lower in the GRS data than Pathfinder soil-free rock, mean soils, or Martian meteorites. On the other hand, though Fe ranges in concentration [1], many areas have Fe levels similar to those in Martian meteorites, Pathfinder soil-free rock, and Pathfinder soils. Fe and Si are also weakly correlated globally. These data suggest Si and K should be correlated with rock abundance and high thermal inertia. Such a correlation is observed. The abundance of H_2O decreases as the abundance of rocks increases, suggesting that it is associated with the non-rock, altered component of the surface. The behavior of Fe is more complicated. Given the global correlation between Si and Fe, one would expect to also find that Fe correlates with these physical properties. At this time, we are only able to identify a positive correlation with albedo.

We suggest that the simplest explanation for these preliminary observations is that the Martian surface is composed of a range of rocks that are low in H_2O content (igneous and perhaps clastic sedimentary rocks derived from them). The rocks are mixed locally to varying extents with an alteration product (or products) that contains less Si, K, and Th (which is correlated with K [6]) and more Fe and H_2O. The H_2O may reside in hydrous minerals in the altered component or as adsorbed water trapped in the porous soil.

As described above, continued data collection with the GRS instrument should provide stronger statistics and the ability to produce higher resolution elemental maps as we strive towards better understanding the elemental and eventually mineralogic distribution of materials on the planet Mars. Our understanding of the preliminary correlations provided here will be strengthened with the continued success of this mission.

References: [1] Boynton W. V. et al. (2003) this volume. [2] Christensen P. R. & Moore H. J. (1992) *Mars*, Univ. Arizona Press, 686-729. [3] Christensen P. R. (1988) *JGR, 93,* 7611-7624. [4] Christensen P. R. (1986) *Icarus, 68,* 217-238. [5] Wanke H. et al. (2001) *Space Science Reviews, 96,* 317-330. [6] Taylor et al. (2003) this volume.