GLOBAL MINERAL MAPS OF THE MOON. P. G. Lucey[1] and D. Steutel[2], [1]lucey@higp.hawaii.edu, [2]dsteutel@higp.hawaii.edu, [1,2]Hawaii Institute of Geophysics and Planetology, University of Hawaii, 1680 East-West Road, Honolulu, HI, USA, 96822.

Introduction: Determining the global distribution of minerals on the Moon has been an important goal of lunar science [1]. Lunar mineralogy is relatively simple, being dominated by just five minerals. Tompkins and Pieters [2] showed that the major lunar minerals can be detected using data from the Clementine UVVIS camera for locations that are sufficiently immature such that the effects of space weathering can be neglected. They also employed a Hapke-based mixing model to construct a framework within which to interpret their results. Building on that work, we used an improved Hapke mixing model to determine the mineralogy of the approximately 1% of the lunar surface with low enough maturity for analysis. We then interpolated these data to prepare maps of the entire lunar surface of the distribution and abundance of olivine, orthopyroxene, clinopyroxene and plagioclase.

Data: We used a 1 km four-band global mosaic of the Moon derived from the USGS Flagstaff digital image model. We produced images of maturity using the method of [3] and selected all spectra with optical maturity values exceeding 0.3, about 1% of the lunar surface. This one percent principally occurs at recent impact sites and the walls of craters and other steep slopes where downslope movement exposed fresh material. The density of immature locations is not random, but shows high density in the mare where regolith is thin allowing small craters to excavate fresh material. Fewer exposures of fresh material occur in the highlands.

Mixing model and mapping algorithms: We founded our analysis on a Hapke-based [4] spectral analysis model. This model includes the ability to vary modal abundance, grain size, Mg-number, glass abundance and composition and degree of space weathering via inclusion of the effects of submicroscopic iron [5]. We precalculated over 2,500 different model spectra of varying abundances of the lunar minerals and space weathering parameters. For each Clementine four-band spectrum all precomputed models are compared and the similarity recorded as the average absolute value of the difference between the model and the unknown spectrum. Models matching the data within 0.5% are retained. The result is a relatively sparse image of the abundance of plagioclase, clinopyroxene, orthopyroxene and olivine. We then interpolated the sparse data using a nested resolution algorithm.

Results: Figures 1 through 4 show the images of the minerals prepared as orthographic images centered on both the near and farside.

The plagioclase image (Figure 1) shows a distribution similar to the inverse of iron as derived from LP and Clementine data. The highlands show high values of plagioclase abundance (up to nearly 100%) with the mare showing low values near 40%. The clinopyroxene image (Figure 2) is similar to an iron map: values are high in the mare and low in the highlands. South Pole-Aitken (SPA) Basin appears very clinopyroxene-rich. This is largely due to our interpolation process because the thin regolith in SPA mare ponds produces more fresh crater material than the thick regolith in the SPA non-mare material. Thus clinopyroxene is over-represented in this region. As expected the orthopyroxene image (Figure 3) shows higher values in the highlands than the mare, except where the abundance of plagioclase is very high. Few exposures of norite are present, with a small concentration on the northern nearside and within the rim of SPA. The olivine image (Figure 4) shows enhanced values in the western maria as previously observed by Staid and Pieters [6] and isolated exposures in other mare and the highlands.

In addition to the images shown, a specific search for troctolite specifically shows the locations previously identified by Pieters and Tompkins [7] and a few others. Images of the ratio of olivine to the sum of mafics shows a strong variation in the highlands. The central farside shows the anorthositic material is essentially free of pyroxene. This is consistent with the observation by Pieters and Tompkins [7] that troctolites in central peaks seem concentrated in an equatorial band. Our results show this olivine enrichment includes even the most anorthositic material. Elsewhere in the highlands, the mafic assemblage is dominated by orthopyroxene in plagioclase-rich units.

Conclusions: Application of a quantitative radiative transfer model allows estimation of the mineralogy for the portions of lunar surface that are sufficiently immature for analysis. The distribution of minerals points out the anomalous nature of SPA, and shows that regional differences in anorthosites are present.

References: [1] LExSWG Final Report (1995). [2] Tompkins, S. and C. M. Pieters (1999) *Meteorit. Planet. Sci.. 34 (1)*, 25-41. [3] Lucey P. G., D. T. Blewett, G. J. Taylor, and B. R. Hawke (2000) *JGR, 105, E8*, 20297-20305. [4] Hapke, B. (1993) Theory of Reflectance and Emittance Spectroscopy, Cambridge Univ. Press, Cambridge. [5] Lucey, P. G. (2002) *GRL, 29 (10)*, 2001GL014655. [6] Staid, M. and C. M. Pieters (2001) *JGR, 106 (E11)*, 27887-27900. [7] Pieters, C. M. and S. Tompkins (1999), *JGR, 104 (E9)*, 21,935-21,949.

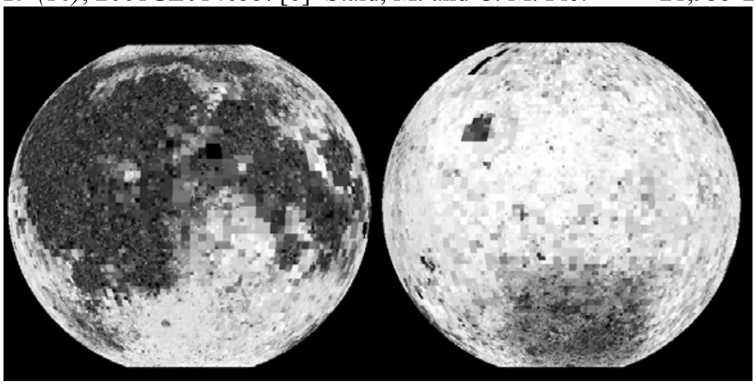

Figure 1. Plagioclase abundance.

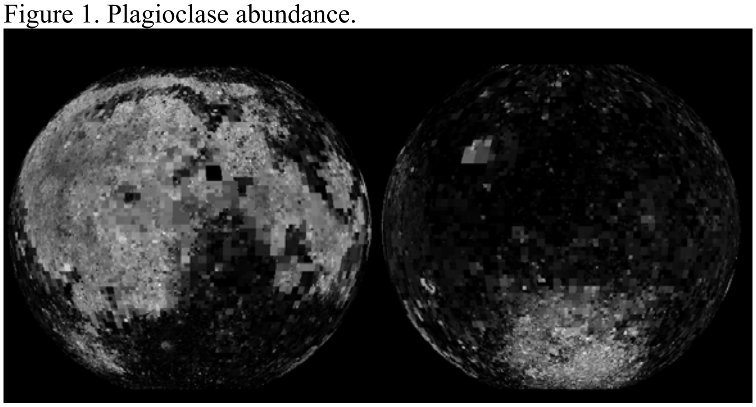

Figure 2. Clinopyroxene abundance.

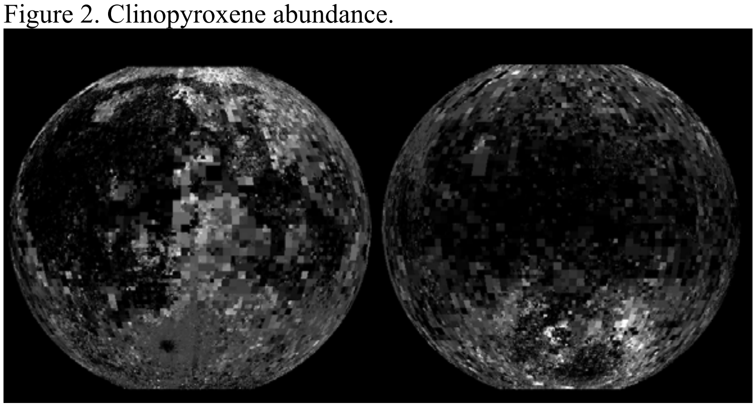

Figure 3. Orthopyroxene abundance.

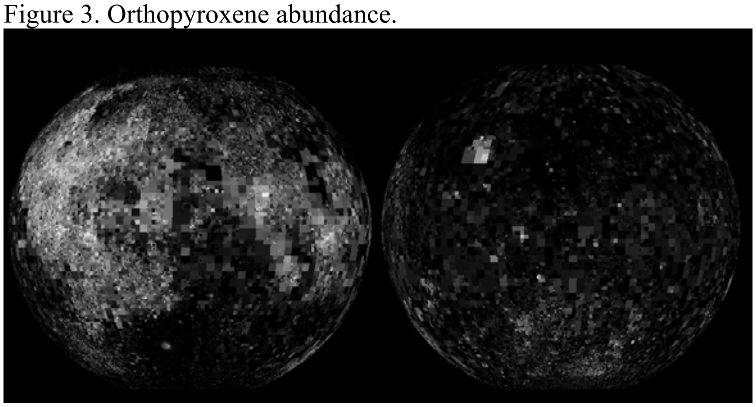

Figure 4. Olivine abundance.