THE COMPOSITION OF THE LUNAR SURFACE RELATIVE TO LUNAR SAMPLES

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Introduction: The non-mare pristine samples are divided into two major suites, the ferroan anorthosites (FAN) and the Mg-suite [1]. FAN is typically characterized by high values of plagiophile interelement ratios, for example, the calcium content of plagioclase, and very high plagioclase content (though more mafic members exist). FAN is well separated from the Mg-suite on a plot of Mg-number vs. plagiophile element ratios, though there is substantial overlap in both quantities treated in a univariate sense. Presently, plagiophile element ratios are unavailable to remote sensing analysis, so as a proxy, Cahill et al. 2008 (this volume) showed that in lunar samples for which good modes are available Mg-suite and FAN are also well separated on a plot of Mg-number vs absolute plagioclase content. These parameters are available from analysis of spectral reflectance data, including data from Clementine (2),

We applied the methods of [2,3] to Clementine data in order to compare the distribution of data moon-wide with the distribution of samples. The remote sensing data is interpolated from immature exposures of lunar material covering about 3% of the lunar surface [3]. Figure 1 shows the distribution of remotely determined plagioclase content and Mg-number, and the distribution of fields for the major lunar rock types on the same diagram. These data are consistent with three units: mare basalt (low plagioclase, low Mg'), FAN (high plagioclase and variable Mg' with a peak in Mg' near 75), and Mg-suite norites (low plag and Mg' near 75).

Discussion: The characteristics of the Mg-suite suggest an origin in moderate sized magma bodies intruded into the highlands crust [*4*], but their volumetric importance and moonwide occurrence is very poorly known.Jollif et al. 2000 [*5*] went as far as to suggest that the Mg-suite is a peculiarity of the PKT, a product of the unique thermal environment of that terrain. In contrast, in a study of KREEP poor feldspathic meteorites, [*6,7*] suggested that a magnesian component in these meteorites were derived from a KREEP-poor or free variety of Mg-suite (a characteristic that is not observed in the samples). In a study of much the same rocks, (*8)* noted that mafic magnesian lithologies are absent from these meteorites, and the magnesian component of these meteorites are derived from a source other than the Mg-suite, or that the feldspathic meteorites are derived from magnesian, rather than ferroan, anorthosites. The compositions plotting within the norite field have two possible explanations: 1) the coincidence of the peak Mg' of the anorthosites and the more mafic units is no coincidence, and these points represent more mafic members of the FAN suite; or 2) the presence of these points in the norite field is no coincidence, and these points represent true Mg-suite. The resolution of these possibilities probably requires detailed geologic analysis of the occurrence of the mafic highland exposures, for example, to determine if their settings are consistent with a small Mg-suite-like magma body. This type of analysis is probably available using very high resolution Kaguya and M3 data. In either case, the more magnesian members of the Mg-suite appear to be absent at this spatial scale (~2 km).

The anorthosites show considerable spread in Mg' values, as do the anorthosite samples. These results show no obvious clustering into ferroan and magnesian varieties, but the spatial distribution of the data suggests there may be a geographical separation of these types (Figure 2). It should be noted that the Mg' signal is from the mafic minerals which are not abundant in these rocks, so uncertainties are high, and results may be susceptible to subtle calibration errors in the underlying Clementine data. The same methods can be applied to Kaguya and M3 data, so corroboration is possible shortly.

References: 1) Warren, P. H., and G. W. Kallemeyn (1984), *J. Geophys. Res.*, *Proc. Lunar Planet. Sci. Conf., 89*, C16-C24.; 2) Cahill, J. T., and P. G. Lucey (2007), J. Geophys. Res., 112, E10007, doi:10.1029/2006JE00286; 3) Lucey, P. G. (2004), *Geophys. Res. Lett.*, *31*(8), doi:10.1029/2003GL019406; 4) James, O.B., and M.K. Flohr, *Proc. Lunar Planet. Sci. Conf., 13th, Part 2, J. Geophys. Res.*, *88*, suppl.,A603-A614, 1983; 5) Jolliff, B.L., J.J. Gillis, L.A. Haskin, R.L. Korotev, and M.A. Wieczorek, *Journal of Geophysical Research- Planets*, *105* (E2), 4197-4216, 2000. 6) Warren, P.H.,, *Meteoritics & Planetary Science*, *40* (3), 477-506, 2005; 7) Warren, P.H., F. Ulff-Moller, and G.W. Kallemeyn, *Meteoritics & Planetary Science*, *40* (7), 989-1014, 2005; 8) Korotev, R.L., *Chemie Der Erde-Geochemistry*, *65* (4), 297-346, 2005.

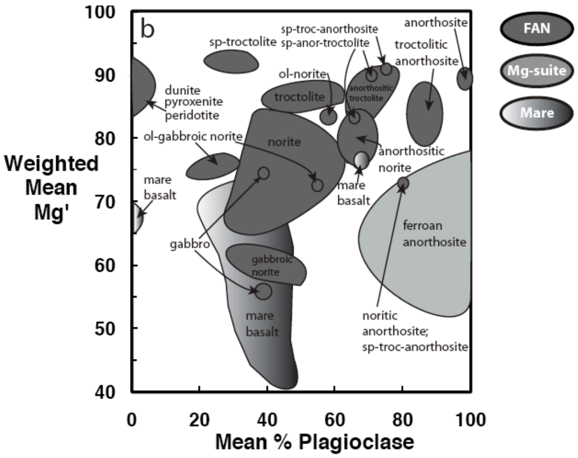

Figure 1a. Distribution of classified pristine rocks. Note the horizontal axis is plagioclase abundance, not a plagiophile element ratio.

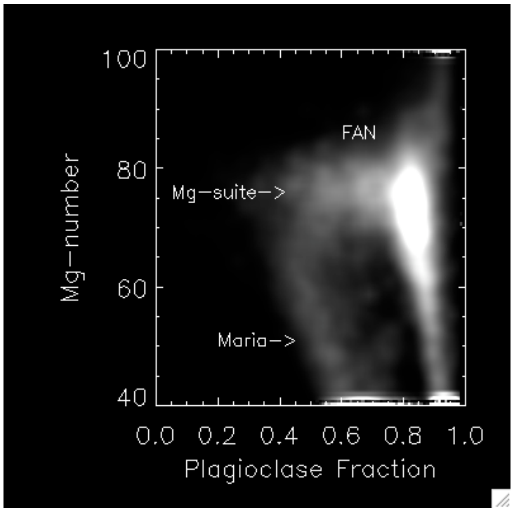

Figure 1b. Distribution of remotely sensed points for the entire lunar surface. While large pixels cause mixing, three cluster appear evident, and correspond with known major rock types.

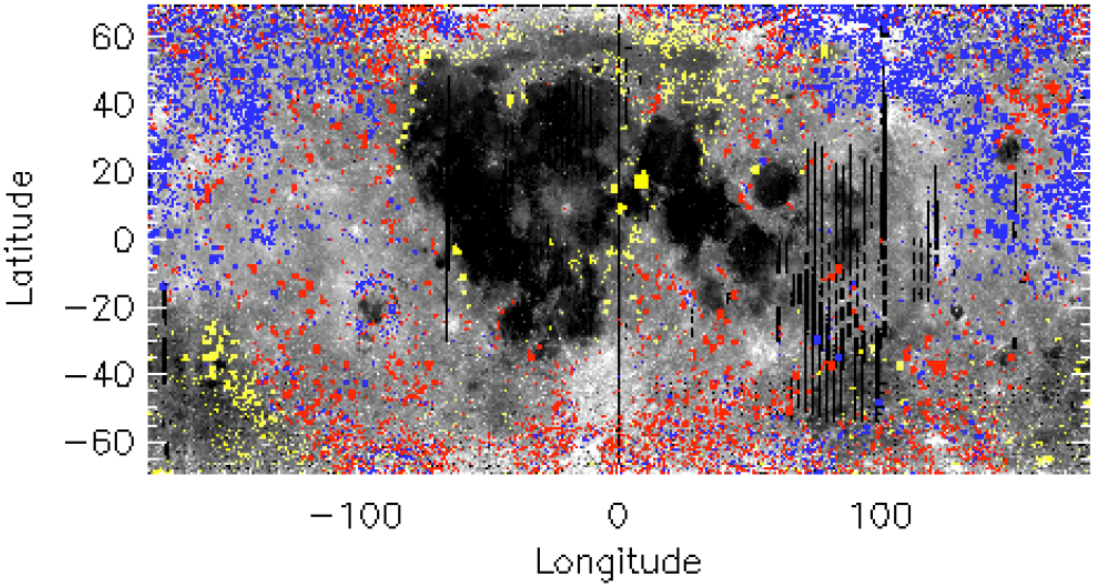

Figure 2. Distribution of magnesian (Mg’ < 70, red) anorthosite, ferroan (Mg’ > 70, blue) and Mg-suite-like (yellow). Anorthosites appear separated in space and Mg’