The composition of lunar central peaks relative to lunar samples J.T.S. Cahill[1], P.G. Lucey[1], and M.A. Wieczorek[2], [1]University of Hawaii at Manoa (jcahill@higp.hawaii.edu), [2]Institut de Physique du Globe de Paris.

Introduction: Impact crater central peaks offer a unique opportunity to remotely examine material that was once deep in the crust (1-3). They also offer the added advantage that they consist of material that has undergone less extensive rock-type mixing typical of other surface exposures potentially offering a less confounded account of lunar geologic history. Here we examine a series of peaks using existing Clementine eight band visible and near-infrared reflectance spectra. With this information we can infer the compositional diversity of the lunar crust both laterally and vertically. Placing these data in the context of lunar sample allows us to make petrologic inferences into lunar crustal formation.

Method of Analysis: Crater central peaks are analyzed by comparing Clementine reflectance spectra to radiative transfer modeled spectra. The radiative transfer approach of (4-6), mineral optical constant data of (7) and iron optical constant data of (8) are used in this model. Similar implementations of the model used here are reported by (9, 10), and explained in detail by (11). The mineral mapping approach is similar to (12) and (10) but differs by including both Clementine UVVIS and NIR data to enable better mineralogical interpretations. Clementine near-infrared spectra are calibrated to Earth-based telescopic spectra from various locations on the lunar nearside. Documentation for these correction procedures and their results are posted on the USGS website (http://astrogeology.usgs.gov/Projects/ClementineNIR/) courtesy of *Denevi and Lucey* (personal communication).

Central Peak Composition Relative to Lunar samples: Recently, in support of interpretation of remote sensing analyses we compiled modal mineral abundances and corresponding mafic Mg' (10). This information can be used as a starting point to make direct comparisons between cataloged lunar samples and mineral abundances inverted from spectral studies of lunar surface rocks. These mineral data are displayed on modifed Stöffler diagrams in **figure 1** (13).

Inverted mineralogy of central peak spectra show a large diversity of average lithologies but most of them are dominantly mafic (**Fig. 1**). Peaks with mafic model mineralogy also show many similarities to olivine-bearing gabbronorite Mg-suite rocks of the lunar sample collection. However, peak pyroxene abundances show more diversity with orthopyroxene-rich gabbroic norite and clinopyroxene-rich noritic gabbro lithologies both being present. Several peaks modeled also have anorthositic mineralogies and show similarities to both lunar FANs and anorthositic Mg-suite rocks.

The typical method to discern lunar petrologic suites is to compare mafic mineral Mg' with one of the numerous "plagiophile loving" elements or ratios (e.g., Ca/Ca+Na, Al, Ti/Sm, Al/Eu, etc.) (14). At present remote sensing cannot measure these plagiophile ratios. What we can determine is mafic Mg' and plagioclase abundance. Using the compilation of modal mineralogy and Mg' for ~100 lunar FAN and Mg-suite rocks by (10), we plot plagioclase abundance directly versus Mg' in **figure 2.** This plot effectively separates the lunar FAN and Mg'- petrologic suites (though it cannot separate alkali anorthosites verses FAN). This offers a tool to make direct comparisons between remotely determined impact crater central peak composition and the

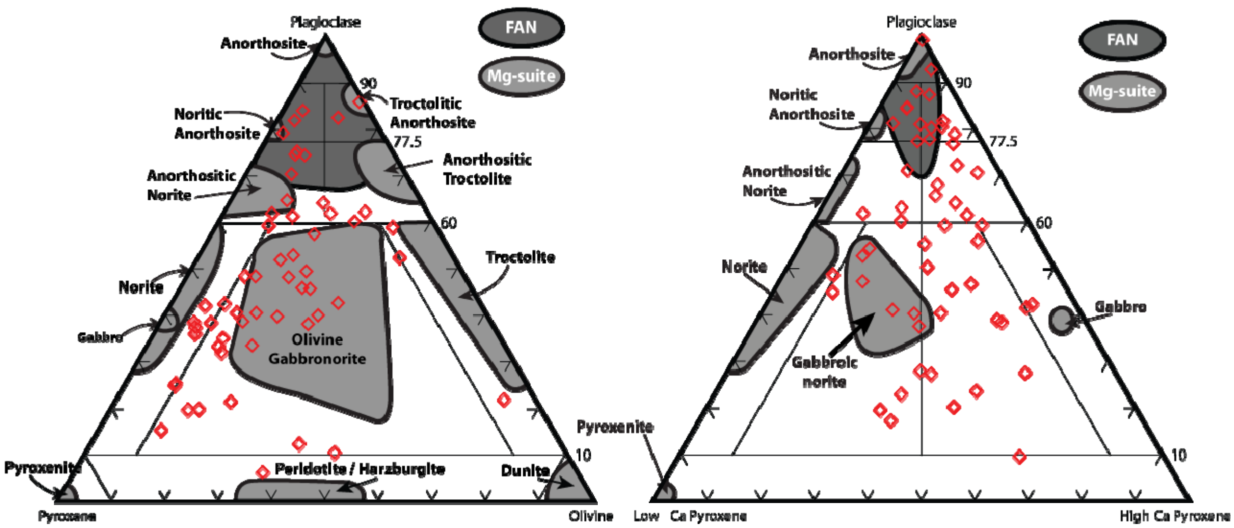

Figure 1: Impact crater central peak mineralogy (red diamonds) relative to lunar highland FAN (light grey fields) and Mg-suite (dark grey fields) rock samples.

lunar sample collection (**Fig. 2**). Quantitative analysis of spectra from lunar central peaks show these peaks plot in or near the Mg-suite fields. These Mg-suite-like peaks are plagioclase-poor (<60 vol. %) and vary from ferroan to magnesian varieties (Mg' 55-94), or may be plagioclase-rich (>60 vol. %) with an Mg' of 78-85. A few central peaks plot within the FAN field.

Discussion: Most peaks examined here have mineral and major element abundances consistent with rocks of the lunar sample collection. The few peaks where FAN compositions are identified are confined within the FHT (craters Berkner, Joliot, and Keeler); the paucity of peaks with anorthosite and FAN composition is likely explained by our method of crater peak sampling. Using geophysical estimates of crustal thickness shows that many of our peaks likely sample lower crustal material, consistent with a mafic lower crust.

Some have said Mg-suite is a product of PKT, these results suggest otherwise (15-18). Recent studies of KREEP-poor, feldspathic and magnesian lunar meteorites inferred to originate in the farside FHT suggest the presence of a magnesian component that influenced their formation (19, 20); however, the characterization of this magnesian component is under question.

The central peaks analyzed here support a magnesian component, perhaps Mg-suite rocks, in both KREEP-rich and KREEP-poor areas and may have sampled the source component suggested to be influencing the chemistry of lunar meteorites. However, despite the commonalities between Mg-suite rocks and the majority of these peaks, it is important to point out that it is plausible interpretation that many of these peaks may consist of late crystallizing mafic ferroan rocks. Although this is a reasonable hypothesis, little evidence is available for this in the sample collection (21, 22). However the possibility merits further investigation.

Conclusions: The majority of peaks analyzed have compositions similar to Mg-suite rocks of the lunar sample collection and they are found to be independent of lunar terrane. This suggests that Mg-suite rocks may not be confined to the PKT and may not be dependent on incompatible concentrations for formation. These results also suggest Mg-suite rocks are a global phenomenon and may have wide ranging incompatible element and mineral abundances; but the main factors that determine Mg-suite rock formation are major element chemistry and geophysical processes. Incompatible element enrichment is an added attribute of Mg-suite rocks within PKT and perhaps to a lesser extent SPA.

References: [1] Cintala and Grieve (1998), *MaPS,* 33. [2] Pieters (1993), *Remote geochemical analysis: elemental and mineralogical composition*, 594. [3] Tompkins and Pieters (1999), *MaPS* 34. [4] Hapke (1981), *JGR,* 86. [5] Hapke (1993), *Theory of reflectance and emittance spectroscopy*. [6] Hapke (2001), *JGR,* 106. [7] Lucey (1998), *JGR,* 103. [8] Paquin (1995) *Properties of metals*, 2. [9] Clark *et al.* (2001), *MaPS,* 36. [10] Cahill and Lucey (2007), *JGR,* 112. [11] Lawrence and Lucey (2006), *JGR.* (in press). [12] Lucey (2004) *GRL,* 31. [13] Stöffler *et al*. (1980), *Proceedings of the Conference on the Lunar Highlands Crust*. [14] Warren and Kallemeyn (1984), PLPSC, 89. [15] Korotev and Gillis (2001), *JGR* 106. [16] Korotev, (2000) *JGR,* 105. [17] Jolliff *et al.* (2000), *JGR,* 105. [18] Wieczorek and Phillips (2000), *JGR,* 105. [19] Korotev et al. (2003), *GCA,* 67. [20] Warren *et al.* (2005), *MaPS,* 40. [21] Wieczorek *et al.* (2006), *Rev Mineral Geochem* 60. [22] Jolliff and Haskin (1995), *GCA,* 59.

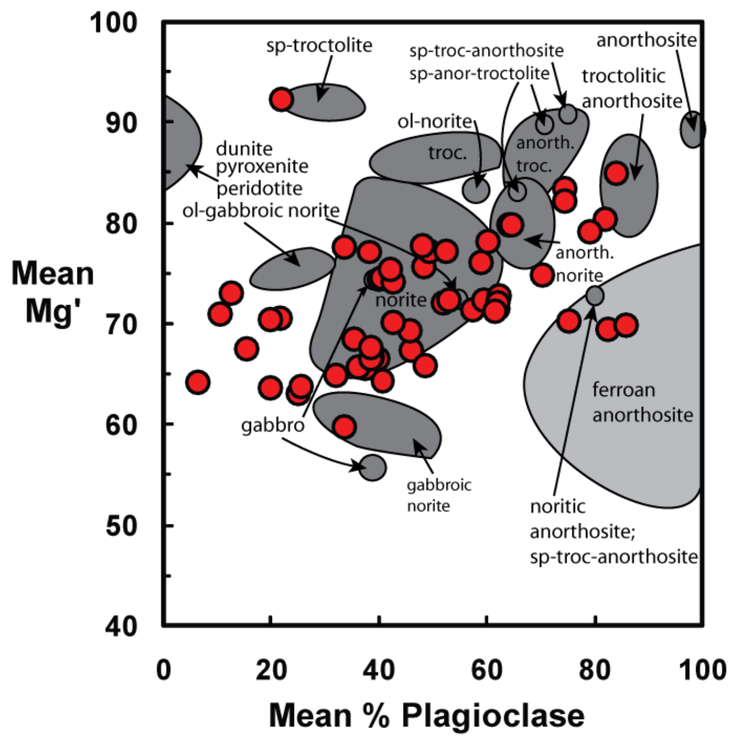

Figure 2: Mean plagioclase versus mafic Mg' of central peak mineralogies (red circles) relative to lunar highlands FAN (light grey field) and Mg-suite (dark grey fields) rocks.