A NEW ROCK TYPE FOUND AT TYCHO; P. G. Lucey, University of Hawaii, Honolulu, HI, 96822 USA, D. J. Lawrence, W. C. Feldman, R. C. Elphic, and T. H. Prettyman, Los Alamos National Laboratory, Los Alamos, NM, 87545 USA, S. Maurice, Observatoire Midi-Pyrénées, 31400 Toulouse, France

Introduction: The 85 km crater Tycho excavated a rock type not present in the sample collection. Combining new Lunar Prospector results for Tycho with previous spectral analysis tightly constrains the plagioclase to mafic ratio and Mg-number of Tycho and excludes all known lunar rock types and reported lunar samples. Detailed spectral analysis of a ground-based spectrum of Tycho including the constraints imposed by other observations suggests a rock-type related to the Mg-suite. The integrated analysis suggests Tycho exposes an anorthositic gabbro with iron content 2-4 wt% FeO, a plagioclase to mafic-plag ratio of 65-70, a mafic mineral assemblage dominated by high-Ca pyroxene, and a Mg-number of 70-80. These characteristics are unknown in the sample collection.

Tycho: This large Copernican crater has long been known to expose a material possessing a strong ferrous iron band indicative of the presence of a mafic silicate assemblage containing large amounts of high-Ca pyroxene\(^1\). The strength of its band has led to the interpretation that the exposed material is highly mafic, leading to an interpretation of gabbro (<60% by volume plagioclase, mafics >50% high Ca pyroxene)\(^2\). The recent discovery that Tycho appears to be poor in iron as perceived by the Lunar Prospector instruments\(^3\) is startling and indicates the presence of a highly unusual composition.

LP gamma-ray data suggest an FeO content of 3-4 wt.%\(^3\), but LP neutron data show the Tycho anomaly perhaps to be smaller than the GRS footprint, and so leading to even lower actual iron values. Such low iron is very infrequently represented in the Mg-suite. Taking into account the spectral detection of a gabbroic pyroxene assemblage, stoichiometric calculations define a trajectory in plagioclase: mafic ratio vs. Mg-number within which the Tycho rock type must occur. The field shown in Fig. 1 assumes an iron range of 2-4 wt%, and a mineral assemblage ranging from high-Ca pyroxene: total pyroxene ratio of .75 to 1.0.

![Figure 1. Mg-number vs. plagioclase content showing major rock type fields. The rocks similar to Tycho’s mafic mineralogy, the gabbronorites\(^4\), are typically too iron rich and too opx rich to be similar to Tycho material. FAN and norites overlap the allowed field constrained by mineralogy and FeO content, but the latter do not match the mineralogy. Spectral modeling suggests a composition slightly less magnesian than norites and less mafic than most, but not all norites. Rock fields from (4) and (5).](image-url)
field, clinopyroxene-dominated anorthositic are rare and gabbroic norites are occur only as the previously discussed gabbro-norites

Detailed modeling was conducted initially to exploit the intensity of the ferrous iron absorption to constrain the plagioclase to mafic ratio, similar to the analysis of (2). Our spectral model is considerably more complete than that of (2), and includes the ability to vary the grain size, Mg-number and degree of space-weathering in model spectra. We found that the intensity of the Tycho ferrous feature did not constrain the plagioclase to pyroxene ratio along the chemically prescribed trajectory principally because the iron is constant. Along this locus, mafic assemblages possess magnesian mafics with weak absorptions, while anorthositic models contain ferroan mafics with strong absorptions; these combinations lead to near-perfect compensation of absorption intensity as plagioclase to pyroxene ratio varies. However, the detailed shape of the absorption was not modeled well by either highly anorthositic or highly mafic models. A distinct maximum in goodness-of-fit occurs at Mg-numbers of 70-80 and plagioclase contents of 65-70% by volume. The anomalous intensity of the Tycho ferrous band can be explained by its extreme immaturity, and is not due to a highly mafic assemblage. The composition implies an unusual Fe-poor melt with a high Ca/Al ratio to account for the high abundance of clinopyroxene.

![Figure 2. Goodness of fits of model spectral shapes vs. plagioclase content and Mg-number. Solid line corresponds to fit vs. plagioclase, dashed line corresponds to fit vs. Mg-number. Plagioclase content and Mg-number were linked to maintain FeO=3 wt.% for all models.](image)