A NEAR-INFRARED REFLECTANCE SURVEY ACROSS LUNAR CRATER ARISTOTELES.

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Introduction: The 87.3 km lunar crater Aristoteles is interpreted as Eratosthenian in age [i.e. 1,2]. It straddles across a highly diverse terrain comprising Mare Frigoris in the North and Montes Alpes in the East. Since the impact post-dates both mare units in the north, dated at around 3.6 Ga [3], and the Imbrian mountains, we expect the excavated, shocked, melted, and displaced materials to display a variety of spectral signatures, mostly reflecting their mineralogical differences. We have analyzed and interpreted new high-resolution NIR data from the SIR-2 instrument [4] to map spectral variations across the crater's central section.

Sample analysis: Spectral properties of lunar surface materials (e.g. Fig. 2) are dictated by their compositional (mineralogy) and physical properties (e.g. grain sizes, space weathering processes) [6,7]. Remote sensing lunar science is built on the foundations laid by laboratory analysis of returned lunar samples supported by theoretical studies and direct measurements of the spectral properties of key minerals [8].

We used a Comparative Normalization Analysis (CNA, Bugiolacchi et. al, submitted) technique to emphasize spectral features and track absorption variations and characteristics focusing on 18 key mineralogical band centers (Fig. 3). The data show significant spectral variations across the crater and in particular three areas corresponding (from the North) to the terraces/crater floor boundary, the central peaks region, and top of the southern rim (highlighted on the left).

Interpretation. We have compared each sample point spectrum to known laboratory spectral mineralogical types and interpreted them accordingly, as simplified in Fig. 2, representing actual data points. This classification process was automated but also relied on the qualitative and subjective interpretation of each spectrum thereafter, especially in cases where the absorption features could not be easily and clearly associated with one or more mineralogical groups or phases.

We found that most spectra can be broadly interpreted to belong to five spectrally-dominant mineralogical components (cpx, opx, mixed px, olivine, anorthite) and two generic petrological types: Fe-rich Glass and Mature Mare. The latter represents mostly spectra with very subdued absorption features, comparable to highly weathered mare materials.

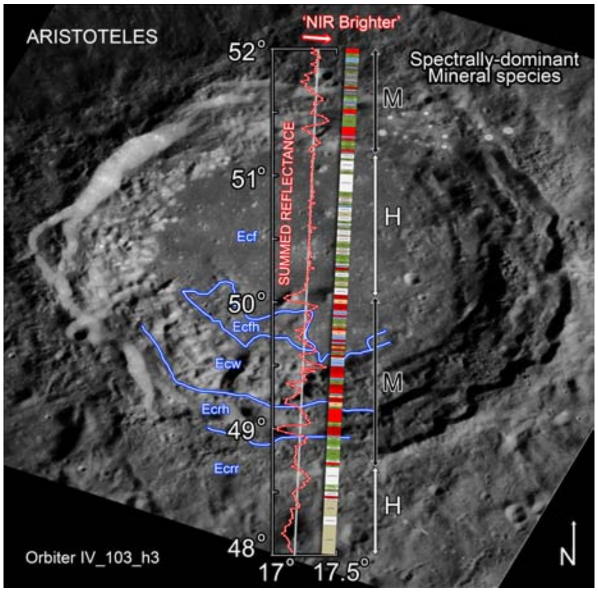

Fig. 1. Aristoteles crater. As reference, the orbital path also represents the average summed NIR reflectance. Geological units/boundaries from [5] . 'H' and 'M' stands for Highland and Mare respectively.

Discussion and Conclusions: As we can see from Fig. 1 (also highlighted in Fig. 4) two very broad spectral typologies can be observed: one encompassing the northern rim and terraces, the southern floor and terraces ('M'), and the other the northern crater floor and ejecta blanket materials outside the crater in the south ('H'). The 'M' group contains materials with stronger pyroxenes signatures, mostly associated with steep slopes and presumably belonging to more crystalline and unweathered materials. Plagioclase absorption features are either absent, or more probably shadowed by those of mafics, outside the crater floor in the north, probably due to the presence of more basaltic target materials (i.e. Mare Frigoris basalts). Olivine's characteristic absorption features are particularly strong along fault scarps and in particular in association with slump masses. The geometrical centre of the crater floor also shows a strong olivine presence. The 'undiluted' orthopyroxene signature is found only in the southern half of the crater along with most of the Fe-rich glasses.

In essence, as indicated in Fig. 1, the distribution of surface materials within and just outside Aristoteles crater suggests a heterogeneous target site, enriched in olivine (probably originating from basin-forming events [9]). The asymmetric distribution of mineral species within the crater floor, and the off-set location of the central peaks, could also be in part explained by an oblique impact event.

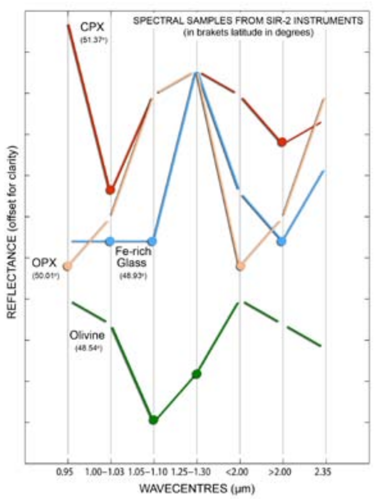

Fig. 2. Examples of actual reduced spectra from this study's data set .

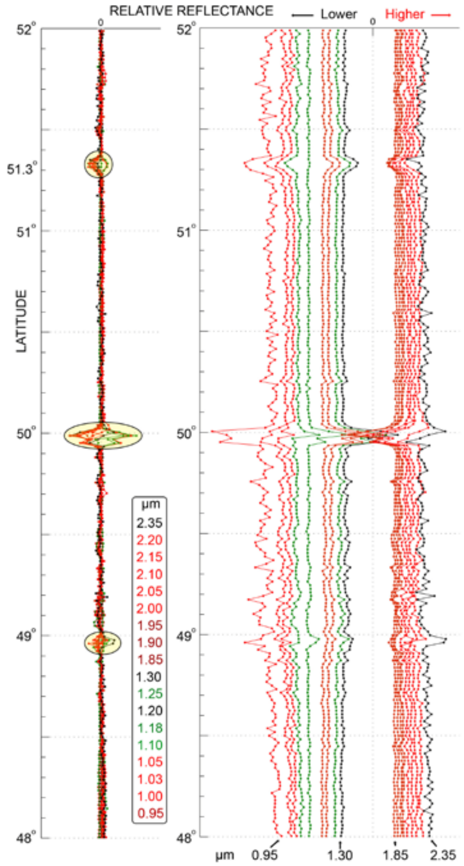

Fig. 3. Comparative Normalization Analysis (CNA) of 18 spectrally diagnostic band centers. The graph to the left represents a further normalization step to highlight the larger spectral variations within the sample pool.

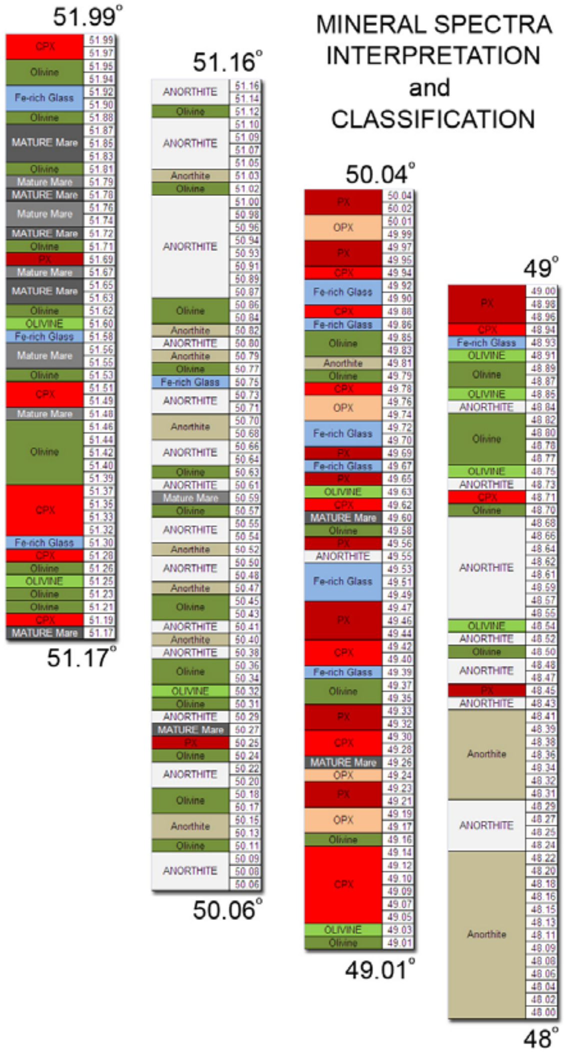

Fig. 4. Mineralogical and petrological interpretation of spectral absorption characteristics. Samples run continuously from north to south, but here are presented staggered in aid of clarity.

References:

[1] Wilhelms and McCauley (1971) *U.S. Geol. Survey Misc. Geol. Inv. Map*, I-703. [2] Baldwin R.B. (1984) *Icarus 61, 62-91.* [3] Hiesinger et al. (2010) *J. Geophys. Res.*, 115, E03003. [4] Mall U. et al. (2009) *Current Sci. 96, No 4.* [5] Lucchitta B.K. (1972) *U.S. Geol. Survey Misc. Geol. Inv. Map*, I-725 [6] Adams and McCord (1971) *Science, 171, 567-871.* [7] Noble et al. (2007) *Icarus 192, 629-642.* [8] Pieters C. M et al. (2002) *Icarus 155, 285-298.* [9] Yamamoto et al. (2010), *Nature Geoscience* 3, 533-536.