# ARISTARCHUS CRATER SPECTROSCOPIC HETEROGENEITY FROM CLEMENTINE UV-VIS-NIR DATA.

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A detailed remote sensing survey of the eastern part of Aristarchus crater and surroundings (fig. 1) has been carried out from the Clementine multispectral data. A mosaic using 3 independent NIR frames has been produced through the heuristic method recently developed [1, 2] and a multispectral cube established (Le Mouélic et al., companion abstract), including the 0.41, 0.75, 0.90, 0.95, 1.00, 1.1, 1.25, 1.5 and 2 µm wavelengths. Its location is overlain on a Lunar Orbiter image (fig. 1a) and a related sketch map is shown in fig. 1b. A refined radiometric calibration has been made, using 3 telescopic spectra (2C, 2B, 4C from [3]), Galileo data [4] and an extended UV-VIS mosaic harmonized at a 1-2% absolute reflectance level [5]. The consistency in the spectral shapes is better than 0.7% with [3] when considering independent spectra. Then, a Principal Component Analysis (PCA) is performed to determine the useful dimensionality of the data set and understand how the cloud distribution is clustered in factor space. To emphasize the main spectroscopic contributions and trends, PCA is applied to scaled reflectance spectra. The first 4 axes bear 98% of the spectral variance distributed as follows : 89.9, 3.4, 2.9 and 1.7%. The first axis traces the overall continuum slope variation, the second one is sensitive to the depth and width of absorption features in the 1.-1.5 µm domain, the third and fourth ones are predominantly influenced by the 1 µm band and 1.5-2 µm slope inflection. The distribution in the first 3 axes is represented on figure 2 as a projection in each principal plane, the (0, 0, 0) coordinates corresponding to the barycenter point of the population. The scatter plot reveals two sub-clouds, the right one corresponding to the crater mare surroundings and crater rim ejecta, the left one to the crater interior (peaks, floor, walls). Introducing a method derived from the Maximum Likelihood Classification technique, we use the notion of topological neighborhood in the PC space for detecting the extreme spectral types, their associated distribution and the possible mixing trends [6]. From this, we derive a supervised spectral classification (figs. 2 and 3) with its related spatial distribution in the image (figs. 1a, 1b). 7 types are needed to encompass the observed spectroscopic variability : AP (Aristarchus Peak), AF (Aristarchus Floor), ANR (Aristarchus Northern Rim), AER (Aristarchus Eastern Rim), AEJ (Aristarchus Ejecta), NE (North-East mare unit) and OL (Olivine-rich bearing unit).The reflectance spectra in fig. 3 correspond to the average spectra related to the black ellipses in fig. 2. The error bars indicate the standard deviation and ranges between 2 - 5% in reflectance, and 1 - 2.5 % in scaled reflectance. As an example, the spectrum referred 2C from [3] is displayed and compares with AF. In figs. 4a, 4b, the same spectra are displayed after removing the continuum, using a straight line fitting between the 0.75 and 1.5 µm wavelengths.

The AP unit identifies areas where anorthosites are prevailingly exposed in the uplifted central peak while the OL unit maps 2 well-defined patches of olivine-rich materials [1, 7]. The AF unit, widely distributed across the crater floor, is consistent with an assemblage of pyroxene, olivine and feldspar and has very close characteristics with Class 2 from [3]. The ANR unit maps pyroxene-rich exposed materials, with a combination of feldspar and olivine in minor proportion and is rather detected in the lower part of the northern walls. The AER unit maps the upper part of the eastern walls and has spectral characteristics consistent with a high-calcium clinopyroxene component (16% absorption depth with minima occurring between 0.95 and 0.99 µm) combined with a crystalline Fe-bearing plagioclase component. However, a mixture involving more than one composition of pyroxene may occur. It corresponds to the features seen by [3] in the upper part of the western walls and referred to as Class 1, and is also close to gabbroic type G [8]. The AEJ unit is the most clinopyroxene-rich (12% depth at 0.99-1 µm). Its distribution is consistent with a sheet of ejecta and its low albedo suggests the presence of impact melts and Fe-bearing glasses. An other low albedo unit is NE which maps the mare surroundings. It has typical mare-like spectral features, as recognized in a previous regional spectral mixture analysis [5] and earlier by photogeology [9].

The regional stratigraphy reflects a change of the petrology with depth. The deepest material exposed in the uplifted central peak indicates an anorthositic horizon, overlain by an olivine/pyroxene-rich horizon, with a progressive change in the pyroxene/olivine ratio, the pyroxene abundance increasing as the depth decreases.

**References:** [1] Le Mouélic et al., *JGR, in press* (1999); [2] Le Mouélic et al., *GRL, submitted*; [3] Lucey, P.G. et al., *J.G.R., 91*, B4, 344 (1986); [4] Pieters et al., *JGR 98*, E9, 17127 (1993); [5] Pinet, P.C. et al., *LPSC. 27th*, 1037 (1996); [6] Chevrel et al., *JGR, in press* (1999); [7] McEwen, A.S. et al., *Science, 266*, 1858 (1994); [8] Pieters, *Rev. of Geoph., 24*, N°3, 557 (1986); [9] Zisk et al., *The Moon, 17*, 59 (1977).

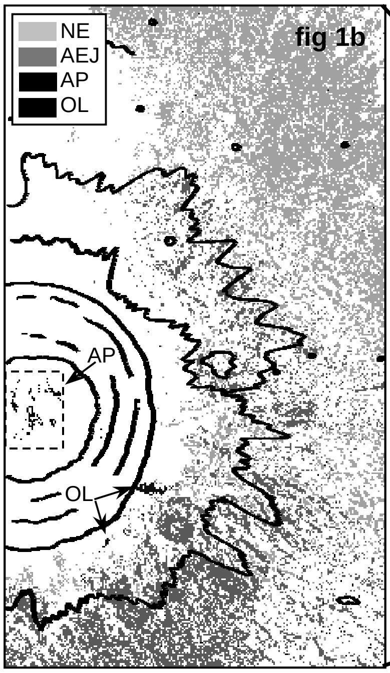
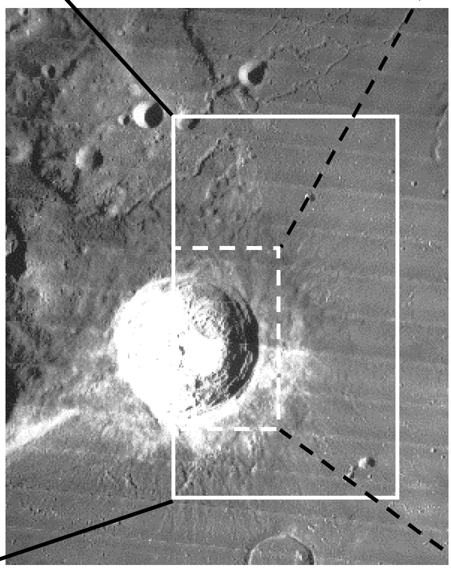


**fig 1b**

**fig 1a : Lunar Orbiter IV-150-H3 view**



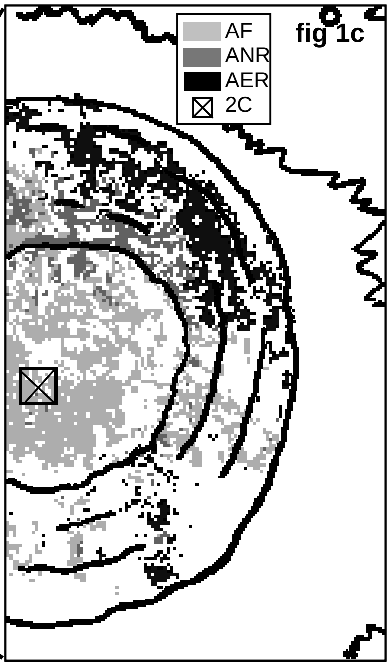


**fig 1c**

**fig 2 : 1st, 2nd, 3rd principal axes scatter plot**

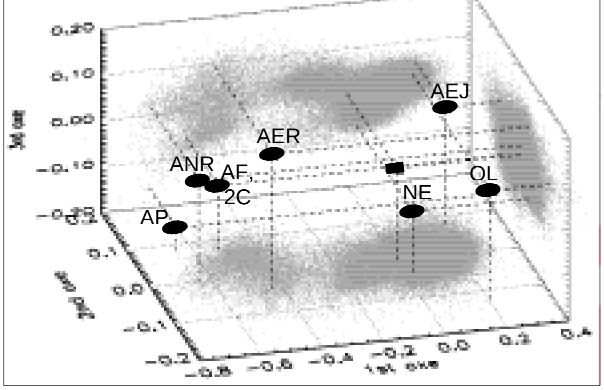


**fig 3 : reflectance spectra**

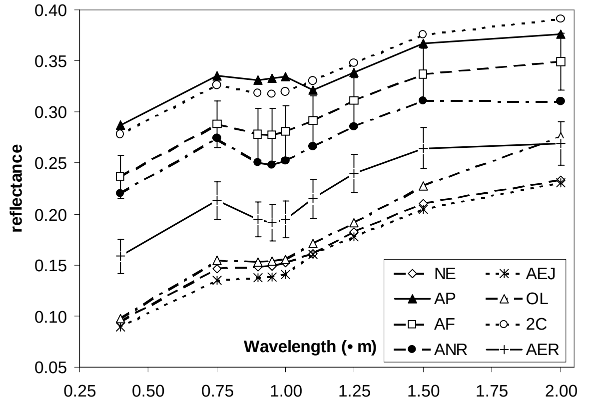


**fig 4a : continuum removed spectra**

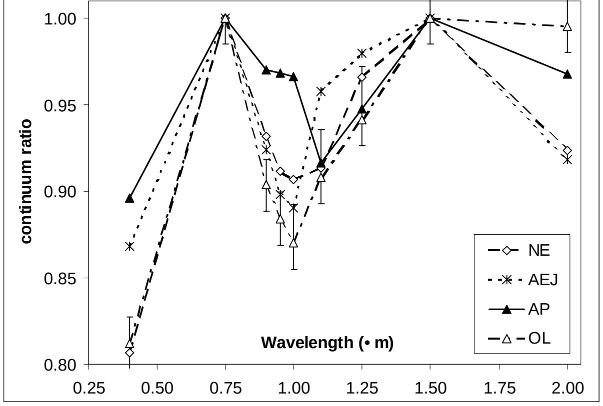


**fig 4b : continuum removed spectra**