# EARTH-BASED AND GALILEO SSI MULTISPECTRAL OBSERVATIONS OF EASTERN MARE SERENITATIS AND THE APOLLO 17 LANDING SITE

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**Introduction:** Both the Apollo 17 and the Mare Serenitatis region have been observed by Galileo during its fly-by in December 1992. We used earth-based multispectral data to define mare units which then can be compared with the results of the Galileo SSI data evaluation.

Remotely sensed spectral and photometric data are highly indicative of the composition and the physical state of the lunar surface. In 1989 we started a program of telescopic lunar observations to achieve a new multispectral and photometric data base. The observations were made at the Mauna Kea Observatory/Hawaii using the DLR CCD camera equipped with 12 narrow band filters (bandwidth = 20 nm) from 0.38 µm - 1.0 µm. The spatial resolution is 2 km / pixel. In our data reduction the Apollo 16 landing site is used as calibration area and a differentiated photometric correction based on the model of Hapke (1, 2) has been applied to the data in order to remove effects induced by different viewing conditions.The determination of spectral-chemical correlations through laboratory measurements of lunar samples (3) enabled us to calculate the geochemical composition of the spectrally defined basalt units for Fe, Ti, Al, and Ca. Both Apollo 17 and Mare Serenitatis/Tranquillitatis are covered by our earth-based data and by the Galileo EM-2 data (LUNMOS 05). This allows us to compare these data sets directly. The Galileo data have a spatial resolution which is better by a factor of ≈2 compared to the earth-based data. The Galileo data set consists of 6 color channels in the visible light and the near IR (409nm - 993nm). This in combination with our earth-based filter set increases the spectral resolution. Galileo multispectral data of the moon are without any atmospheric distortions. Using the new Galileo data it is also possible to investigate areas which are not visible from Earth. The Galileo data are in good agreement with the earth-based data and allow a more detailed differentiation of spectral units. This all led to the conclusion that the Galileo EM-2 images are now the best available data to define spectral units on the lunar surface.

Previous multispectral imaging data (4) show a well defined compositional differentiation between the basalts of Mare Tranquillitatis and Mare Serenitatis. Mare Tranquillitatis basalts in general have higher contents of $TiO_2$ and FeO ($TiO_2$: 4-6wt%; FeO: >16wt%) than basalts from the center of the Serenitatis basin ($TiO_2$: 2-4wt%; FeO: 14-16wt%). Inside the Serenitatis basin we found several mare units which are different in albedo, $TiO_2$ content and spectral properties. Using color ratios we are able to distinguish at least 6 units including the dark mantle deposits west of crater Littrow and the ejecta of crater Dawes.

Unit I is a very titanium rich basalt located at the boundary region of Mare Tranquillitatis and Mare Serenitatis. We expect this oldest unit to be the base of the Mare Tranquillitatis basalt filling. Unit II consists of Tranquillitatis ilmenite basalts which are also exposed in the boundary region of Mare Tranquillitatis and Mare Serenitatis. This unit is superimposed by the mare basalts of the center of Mare Serenitatis (Unit III). At the eastern border of Mare Serenitatis we found a younger basalt unit IV inside and west of crater Le Monnier. Basalts of the eastern edge of Mare Serenitatis exhibit higher $TiO_2$ contents compared to the central basalts of Mare Serenitatis. Dark mantle deposits west of crater Littrow are characterized by high amounts of agglutinate (low 720/990 ratio) suggesting that this unit V has a pyroclastic origin. It seems that the dark mantle deposits have the highest contents of $TiO_2$ (6-8wt%) of all spectrally defined units. The dark mantle deposits are older than the mare units. In the Serenitatis/Tranquillitatis region the titanium content of the basalts increases with age. North of this area like in the western lunar hemisphere there are again overlying titanium rich basalts (Unit IV) which are the youngest of all investigated mare basalts of the eastern part of the Mare Serenitatis basin. Northwest of crater Dawes we found a unit which is depleted in titanium.. We interpret this unit VI to be ejecta material consisting of fragments of titanium basalt, Tranquillitatis ilmenite basalt, and a third component which is depleted in $TiO_2$. Dawes, a Copernican impact crater (5) probably penetrated the Tranquillitatis ilmenite basalts and excavated the underlying substrate.

| unit | Normalized difference | 400/720 ratio | 720/990 ratio | FeO (wt%) | $TiO_2$ (wt%) | $Al_2O_3$ (wt%) | CaO (wt%) |
|---|---|---|---|---|---|---|---|
| I | very dark | bright | dark | >14 | 6-8 | <9 | <11 |
| II | dark | bright | dark | >14 | 4-6 | <9 | <11 |
| III | bright | dark | bright | 14-16 | 2-6 | 9-13 | 11-12 |
| IV | intermediate | intermediate | intermediate | 14-16 | 4-6 | <9 | <11 |
| V | very dark | bright | very dark | 14-16 | 6-8 | 9-13 | 11-12 |
| VI | intermediate | dark | bright | 14-16 | 2-4 | <9 | 9-11 |

*Table 1:* Summarized results of the spectral units

References:
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