ORBITAL (ISM) AND TELESCOPIC NEAR-INFRARED OBSERVATIONS OF THE SURFACE OF MARS: COMPARISON AND IMPLICATIONS.

M.de GRENIER, P.PINET, S.CHEVREL. UPR234/GRGS,OMP,TOULOUSE,FRANCE.

These last 20 years, a number of reflectance data of the martian surface have been obtained by both ground-based and spacecraft instruments in the (0.3-5μm) spectral domain. Based on the broadband (0.3-0.65μm) multispectral imagery and IRTM Viking data, a classification of surface units in the equatorial regions was proposed (1). Besides, the spectroscopic earthbased observations were achieved in the visible and near-infrared (0.3-2.6μm) (e.g.,2,3,4,5). These results (4,5,6,7) concentrated on quantifying the difference in reflectance properties of bright and dark regions, likely corresponding to different mineralogy units (4), due to a combination of ferric oxydes and mafic silicates rocks (3). Lately, telescopic spectra showed strong Fe^{3+} characteristic absorption features, indicative of the presence of cristalline iron oxyde minerals (8). However, in spite of the absorption features detected from the telescopic spectroscopic observation, and of the surface rock abundance, derived from IRTM data (10), that showed that there are no 1°*1° regions that are rock free, no simple correlation between mineralogical and geomorphological units was established.

Detailed compositional mapping allowing mineralogical variations existing across a planetary surface to be directly correlated with observed morphological changes, requires high spatial and spectral resolution. This kind of observation has become available with the development of solid-state imaging technology and permits global mapping within the visible and near-infrared domains where mineralogical absorption features are known to occur (9,11). The telescopic data presented here were obtained during the 1988 opposition, from September 23 to 29 at the Pic du Midi Observatory in France, and concentrated on the 0.9-1.05μm domain; the spatial resolution on the surface of Mars was around 100km at the sub-Earth point. Imaging coverage extends from 10°W to 170°W longitude and 35°N to 90°S latitude and is centered on Syrtis Major shield (11). First interpretations (11) showed that the brightness exhibit spatial variations consistent with those observed by Viking in the visible wavelength range and that the strongest absorptions features due to olivine and clinopyroxene are spatially associated within Syrtis Major to the Nili-Meroe Paterae, calling for an ultramafic composition .

In parallel, spaceborne near-infrared imaging spectroscopic data of the martian surface were acquired from February 21 to March 27, 1989 with the ISM experiment on board Phobos-2 (12). The major scientific objectives of ISM were to provide a mineralogical mapping for the low latitude zones of Mars at a spatial resolution on the order of $20*20$ km^2 (12).

The goals of this paper are to compare the two different sets of data and to demonstrate their degree of fitness and their complementarity. To carry such a comparison, telescopic data have been projected onto a geographic martian coordinate grid. In order to keep the spatial resolution better than 200km, the projection area is limited within 45° around the sub-earth point.

The ISM instrument sweeped two "equatorial windows" across the Eastern hemisphere, covering a part of Isidis Planitia, of the South Terra Arabia and the volcanic complex Syrtis Major. The ISM Syrtis Major window is represented within projections (figure 1,2). As a critical test, two different analyses were carried out:

-i)cross comparison of the spectral mapping at a given wavelength (fig.1);

-ii)cross comparison of spectral ratio images (fig.2).

For this purpose, the spectral band 0.98μm and the spectral ratio 0.91/0.98μm were selected within the telescopic data set. The major spectral features (fig.1) are in excellent agreement with the ISM data (12, see plate 2). These data present the same contrast variations within a factor 3 and same spatial distribution in the spectral units. Besides, the variations derived from telescopic observation (fig. 2), within the spectral ratio 0.91/0.98μm normalized to Terra Arabia, present a very good global agreement with the same ratio, derived from ISM data, although slight discrepancies are detected at the edges of the different spectral units.
The performed comparison analysis:-i) validates indirectly the instrumental calibration of ISM instrument in the 1μm domain (13); -ii) indicates that the spectral signal from the martian surface presents sufficient spatial homogeneity at the scale of 100km, for allowing a similar statistical response at the 2 different scales ($20*20km^2$ and $100*100km^2$); -iii) reveals that the main spectral surface features are stable through time, within a five months time span and thus are not significantly affected by seasonal effects. A future valuable task will be to extend the spectro-mineralogical cartography derived within the ISM windows (14) outward to characterize the main martian surface units of the Eastern hemisphere.

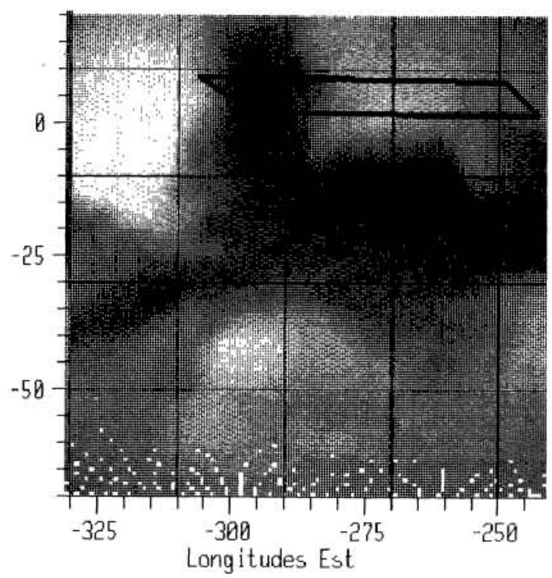

fig.1. Coding ranging from
0.1 (dark) to 0.345 (bright)

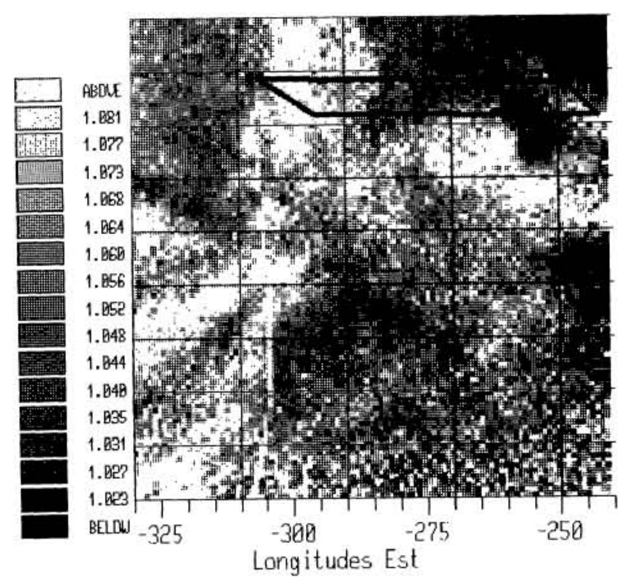

fig.2

References: (1) Arvidson R.E, Guinness E.A. (1982), J.Geophys.Res. 87,10149; (2) Mc Cord T.B. and Adams J. (1969), Science 163,1058; (3) Adams J. and Mc Cord T.B. (1969), J.Geophys.Res. 87,10159; (4) Mc Cord T.B.and Westphal J.A. (1971), Astro.J.168,141; (5) Mc Cord T.B. et al.(1977),Icarus.31,293; (6) Adams J. (1974), J.Geophys.Res. 32,4829; (7) Singer R.B.(1982), J.Geophys.Res. 87,10159; (8) Bell J.F. et al.(1990), J.Geophys.Res.95,14447; (9) Bell J.F. et al. (1990), Proc. L.P.S.C.XX,479; (10) Christensen P.R. (1986), Icarus.68, 217 (11) Pinet P. et Chevrel S. (1990), J.Geophys.Res.95,14435; (12) Bibring J.P. et al. (1990), Proc. L.P.S.C.XX,461; (13) Erard S. et al. (1990). L.P.S.C.XXI,327; (14) Mustard J.F. and al.(1990). L.P.S.C.XXI,835.