DEFINITION AND CHARACTERIZATION OF MARS GLOBAL SURFACE UNITS: PRELIMINARY UNIT MAPS. T.B. McCord[1], R.B. Singer[1], J.B. Adams[2], B.R. Hawke[1], J.W. Head[3], R.L. Huguenin[4], C.M. Pieters[3], S.H. Zisk[5], and P. Mouginis-Mark[3] Hawaii Inst. of Geophysics, Univ. of Hawaii, Hon., HI 96822[1]; Dept. of Geological Sci., Univ. of Wash., Seattle, WA 98195[2]; Dept. of Geological Sci., Brown Univ., Providence, RI 02912[3]; Dept. of Physics and Astro., Univ. of Mass., Amherst, MA 01002[4]; Northeast Radio Obs. Corp., Haystack Obs., Westford, MA 01886[5].

Definition and characterization of global surface units are required to understand the origin, evolution and present state of Mars. The Planetary Remote Sensing Consortium (FORSE) developed an approach to providing such information utilizing a wide variety of remote sensing data(1), and it has applied this approach in several regional studies of the Moon(2). With the thought that the data base for Mars has recently reached a sufficient level to make a successful attempt to defining and characterizing global surface units, the project described here was begun. The goals of this study are to (a) identify, ascertain availability, evaluate, describe and (where needed) cast into a common format the available data sets, (b) classify the data sets according to whether they are defining, characterizing or supporting(1), (c) produce a global surface unit map where boundaries are as much as possible a function of composition as well as of morphology, (d) characterize these units in terms of composition, morphology, age, physical nature and any other specific and quantitative parameters, (e) discuss the implications of this information for understanding the present state and geologic history of Mars and the processes responsible, (f) provide a basis for and identify future more specific studies of Mars geology, geochemistry and geophysics, and (g) define requirements for new data. This paper presents the early results of this effort.

A preliminary unit map has been prepared and used to characterize a variety of martian surface units. The preliminary data used were Viking II approach images acquired at 0.45 μm and 0.59 μm ($L_s \simeq 105°$) as described by Soderblom et al.(3). These data were used because (a) they provide information concerning surface composition, (b) the images provide global coverage, and (c) early analysis by Soderblom et al.(3) and by us suggested that units defined using these images could readily be correlated with other remote sensing data. We have reprocessed these data in digital form to produce graytone and false-color images of red albedo, violet albedo and red-to-violet albedo ratios.

In the violet albedo images (Figure 1), contrasts are especially enhanced between condensates (bright) and rock and soils (dark). At this martian season condensates are very prevalent in regions such as Tharsis and Hellas, as well as in the bottoms of many craters. The red albedo images (Figure 2) shows reduced contrast between condensates and rocks and soils but is better than the violet image for distinguishing different surface material units.

To generate the red-to-violet albedo ratio map (Figure 3) the violet albedo data were divided into the red albedo data. After the preliminary R/V map was prepared and studied, the continuous distribution of R/V data numbers was treated by a classification analysis. All red albedo values were plotted against all violet albedo values in a scatter diagram. Clusters in this diagram were found to exist. Some clusters were then defined as units in a R/V unit map, after several interations between eyeball and computer analysis. Some clusters were found to be artifacts in the data but others are thought to be real expressions of Mars surface properties at the time the data were acquired. Table 1 gives the preliminary definitions of units. R_1 to B_1 refers to the reddest to the bluest units; D_1 to L_1 refers to the darkest (lowest albedo) to lighest red albedo units.

We have begun to characterize these units using supporting data (Table 1). Compositional information is now being sought for condensate-free areas utilizing spectroscopic data(4). Both global dust and less- or differently-weathered immobile material of a variety of compositions are seen. Relationships between the albedo-ratio units and surface morphology exist. For example, in the region south of Vallis Marineris(3), old heavily crateres terrain generally correlates with the R_2 or R_3 color units. These eroded crustal remnants are topographically high and are somewhat "bluer" than the old cratered terrain. Both the volcanic plains and the cratered terrain appear dark (D_2 unit) in the red albedo map. Also south of Amazonis Planitis the R_2-R_3 boundary correlates with the contact between the old, heavily cratered terrain which dominates the southern portion of this area and the younger plains, some of eolian origin, which occur in the north. This correlation can also be seen in the violet and red albedo maps.

Conclusions so far are that (a) units can be defined which are related to surface geological and geochemical properties but others are due to transient condensates. (b) At least some units represent a clustering in the chosen defining parameters and are not the result of arbitrary slicing of the distributions of these parameters. (c) There are a variety of units whose distribution does not strictly follow a simple sequence from brighter-and-redder to

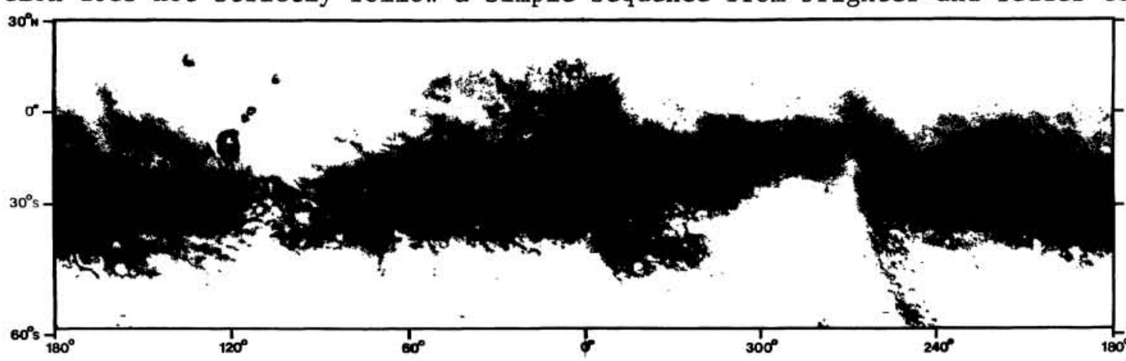

Figure 1

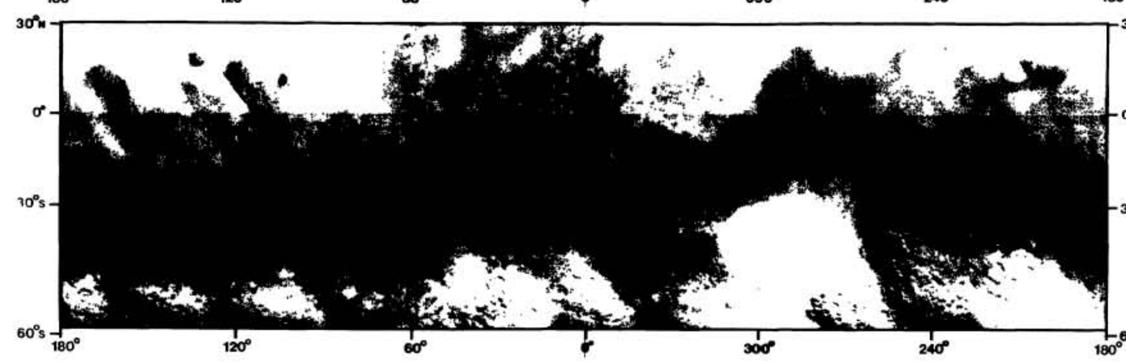

Figure 2

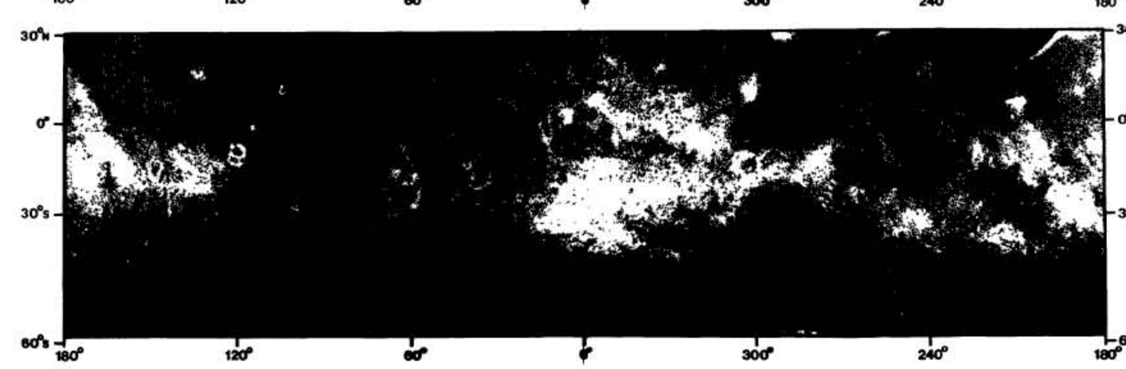

Figure 3

Mars Global Surface Units

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dark-and-bluer; not all combinations of color and albedo are present on Mars. (d) The data available to non-Viking scientists were sufficient to begin this investigation early in 1979, given digital image processing capability, but there is a pressing need to complete the decalibration and release of more orbital data.

References: (1) Head, J., Adams, J.B., McCord, T.B., Pieters, C., and Zisk, S. (1978) Icarus 33, 145-172. (2) Hawke, B.R., MacLaskey, D., McCord, T.B., Adams, J.B., Head, J.W., Pieters, C., and Zisk, S. (1979) Proc. Lunar and Planet. Sci. Conf. 10th, in press. (3) Pieters, C.M., Head, J.W., Adams, J.B., McCord, T.B., Zisk, S.H., and Whitford-Stark, J. L. (1979) JGR, in press. (4) Head, J.W., Adams, J.B., McCord, T.B., Pieters, C., and Zisk, S. (1978) Proc. Conf. on Luna 24 - Mare Crisium: The View from Luna 24, 43-74. (5) Soderblom, L.A., Edwards, K., Eliason, E.M., Sanchez, E.M., and Charette, M.P. (1978) Icarus 34, 446-464. (6) Singer, R.B., McCord, T.B., Clark, R.N., Adams, J.B., and Huguenin, R.L. (1979) JGR, in press.

Unit Name		Defining Parameters R/V	Red Albedo	Type Locations	Geologic Occurrence	Preliminary Interpretations	Supporting Data
R_1	D_1	> 3.40	<9%	flanks of Arsia Mons, largearea around (0,30s)	Young Volcanic Mat'l. Hilly and Cratered/ Cratered Plateau	Very red and dark. Least likely of all units to be contauinated by condensates. Hypothesized to be more hematitic (less hydrated) than global dust and rock coatings.	Earthbased Spectrophotometry and Imaging; 1.4 μm Surface Brightness (Farmer et al., 1977, JGR 82); Thermal Inertia and Predown Temperature (Kieffer et al., 1977, JGR 82); Spacecraft Imaging; Laboratory studies of martian analog materials; Earth-based radar observations; Martian Topography (various sources).
	D_2-D_3	> 3.40	9-15%	rim of Huygens Basin	Crater Material		
	L_3	> 3.40	15-19%	around (150, 25-30S)	highland massifs embayed with younger flows		
R_2	D_2	3.10-3.40	9-12%	scattered locations (180°-280°, 20°s-40°s)	mixed, mainly hilly and cratered/ cratered plateau	In places, old, highly-cratered crustal material locally embayed by stratigraphically younger volcanic deposits. Not likely to be contaminated by condensates.	
	D_3-L_3	3.10-3.40	12-19%	around (0,20°s)	hilly and cratered/ cratered plateau		
R_3	D_1	2.80-3.10	<9%	(12°, 22°s)	hilly and cratered/ cratered plateau		
	D_2	2.80-3.10	9-12%	(245°, 30°s) (190°, 30°s)	ridged plains cratered plateau/ channel material interface	Similar to R_2-D_2	
	D_3-L_3	2.80-3.10	12-19%	(210°, 10°s) SW of Arsia Mons region around Schiaparelli	Rolling Plains Tharsis Volcanic Plains Hilly and Cratered/ Cratered Plateau		
R_4	D_1-D_2	2.40-2.80	< 12%	(60°, 30°s) (245, 25°s)	ridged plains ridged plains		
	D_2-D_3	2.40-2.80	9-15%	(150°, 5°s)	multiple units other than hilly and cratered / cratered plateau		
	D_3-L_3	2.40-2.80	12-19%	around (180°-280°, 0°); (350°-40°, 0°-30°N)	boundary of cratered plateau with other units; hilly and cratered/ cratered plateau	Possible global dust unit. Extensive occurrence north of equator.	
	L_1-L_2	2.40-2.80	>19%	inside Hellas; (350°, 25°N)	Smooth Plains Material; Hilly and Cratered/ cratered plateau	Possible combination of condensates and global dust	
B_4	D_2-D_3	2.15-2.40	9-15%	Meridiani Sinus; South of Vallis Marineris	Hilly and cratered/ cratered plateau; Ridged Plains	Evidence for little or no condensate contribution	
	L_1	2.15-2.40	> 22%	in Hellas	Smooth Plains Mat'l	Heavily affected by condensates.	
B_3	D_1-D_2	1.90-2.15	< 12%	(210°, 30°s) 220°-240°, 20-25°s)	Hilly and cratered/ cratered plateau	Rather "blue" but dark enough to preclude major condensate contamination	
	D_3-L_3	1.90-2.15	12-19%	Syrt s Major; Tharsis	Ridged Plains; Tharsis Volcanic Plains	Affected by condensates to some degree; soil still dominant	
	L_1-L_2	1.90-2.15	>19%	in Hellas	Smooth Plains	Significantly affected by condensates; soil still evident.	
B_2	L_3	1.65-1.90	15-19%	around Tharsis	Volcanic Plains	Heavily affected by condensates but distinct from unit below.	
	L_1-L_2	1.65-1.90	>19%	in Hellas	Smooth Plains	Heavily affected by condensates Same associations as B_1 but topograpically not as low.	
B_1	L_1-L_2	<1.65	>19%	in Hellas	Smooth Plains	Optically thick condensates. Prevalent in cold regions and topographic lows	

Table 1