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Some comments on "The Composition of the Martian Surface" by R. A. Van Tassel and J. W. Salisbury

by

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Van Tassel and Salisbury (1964) have recently addressed themselves to the composition of the surface of Mars. They state that "...the most common constituent of the present surface layer should be that mineral (or those minerals) which is at the same time both abundant and resistant to abrasion." Since limonite is soft relative to other common minerals, and since its abundance on Mars is probably less than some of these, it should not be the predominant ground cover of the planet as has been suggested by photometric and polarimetric observations. The dilemma is resolved by proposing "a surface composed of either fine or coarse-grained silicates coated with finely divided limonite".

In view of our knowledge of the conditions on Mars I would suggest that this model is improbable. The extensive aeolian erosion which evidently exists would surely quickly remove any soft surface coating from a hard substrate. On Earth this "paint" can be renewed by weathering, in which liquid water plays an essential role. On Mars the rate of this weathering at the present time must be orders of magnitude below the terrestrial rate, and the rate of renewal is almost certainly much less than the rate of removal.

If a soft limonite coating is improbable does it then follow that limonite must be completely excluded? With the premise that the surface material must be both hard and abundant this is necessarily

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the case, but this premise is itself questionable. On Earth the softer minerals are ground into fine particles which are readily blown by the winds and are trapped in vegetated areas or in bodies of water. Van Tassel and Salisbury suggest the corresponding dust sinks on Mars are the dark areas, which may be vegetated. Their ability to regain their initial appearance shortly after the occurrence of a dust storm is cited as evidence for this mechanism. The case then rests on the assumption that vegetation covers these areas and acts to engulf dust particles falling on them, since no alternative operation of the dark areas as dust sinks is proposed. This assumption may prove valid, but on the basis of our present knowledge it can not be accorded any degree of finality. Other explanations for the various phenomena involving the dark areas have been proposed, including their apparent regenerative property (Rea, 1963, 1964). In these there is no sink for the fine dust particles and they are not eliminated from circulation.

In fact, it is my opinion that the softness of limonite may well act to concentrate it on the surface. The atmosphere must act to fractionate the particles with the larger particles settling out faster after a dust storm than the smaller particles. The efficacy of the Martian atmosphere in performing this fractionation is dramatically illustrated by Ryan (1964). He has calculated the fall time from a 6 km altitude for particles of a range of sizes and two different atmospheric models. The results for particles of 3 g cm^{-3} density (typical of common silicate minerals) are

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Grain Diameter (Microns)	Surface Pressure (Millibars)	
	80	25
100	4 hrs.	4 hrs.
50	17 hrs.	17 hrs.
20	4-1/2 days	3-1/2 days
10	18 days	12 days
5	52 days	40 days
1	700 days	300 days

The higher density of limonite will decrease the fall time for such particles by 15 - 40% depending on the particle size. Considering the marked sensitivity of the fall time to the particle size this density effect must be only a minor perturbation. The soft minerals, including limonite, will thus form the smaller particles and be present in the upper layers overlying the larger, harder particles.

By this line of reasoning I am not concluding that the surface is indeed covered with limonite, since the data available are by no means conclusive on this identification. Rather, I am suggesting that a plausible mechanism is available for concentrating limonite on the surface to a level well above its natural abundance.

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References

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