ON THE LATITUDINAL DISTRIBUTION OF DEBRIS IN THE NORTHERN HEMISPHERE OF MARS; E.A. Guinness, R.E. Arvidson, and C.E. Leff, McDonnell Center for the Space Sciences, Department of Earth and Planetary Sciences, Washington University, St. Louis, MO 63130.

Examination of Mariner 9 images suggests that the equatorial regions on Mars have been stripped of debris (1) and that the polar regions are covered with a debris deposit that thins equatorward (2). The nature, thickness, and age distributions of debris deposits in the mid-latitude to polar deposits must be understood before climatic changes related to orbital variations can be quantified. The reason is that the CO2 atmospheric pressure is modulated by the polar cap - atmosphere - debris system, with the CO2 being both adsorbed and absorbed on soil particles (3). The character and distribution of debris reservoirs are important parameters in modeling the response of that system when, for example, the average insulation increases at higher latitudes as Mars reaches its maximum spin axis obliquity. Less high latitude debris tends to dampen the CO2 pressure increase. In this paper we concentrate on utilizing the highest resolution Viking Orbiter images to delineate, based on crater size distributions and the presence of depositional landforms, the latitudinal distribution of debris thickness in the northern hemisphere.

One method for estimating the thickness of debris is to use a simple dust filling model, where it is assumed that craters form randomly over the lifetime of a surface, and that the surface has been subjected to a steady state deposition of debris (4). Given those assumptions, the crater size frequency distribution would be in an equilibrium state for craters with sizes small enough to have been completely buried by debris. The distribution would be in production for larger sizes. The predicted slope of the equilibrium population in a log (diameter) verses log (crater areal density) plot would be one unit higher than the slope of the production function. This simple model was used in our work for evaluating crater distributions for 25 areas covering 20 degrees to 80 degrees in latitude in the northern hemisphere. The crater size distribution over the relatively pristine Viking Lander 1 site (5) was used as a model production function. To emphasize slope variations, a polynomial was fit to the VL-1 model production function and used to normalize the other crater data. Numerical simulations using the VL-1 production function and the simple dust filling equilibrium model, done assuming that the craters were observed at Viking Orbiter resolution (§100m), suggest that debris mantles as thin as 10's of meters can be discerned from the data.

The areas selected for crater counts were chosen on the basis of having a relatively high probability for having clear atmospheric conditions, using a cloud and haze catalog developed by Kahn (6). The atmospheric obscuration is a key issue, since haze produces an apparent softening of terrain and an apparent rapid fall-off in small crater abundances. The reason is that the atmosphere adds an additional modulation transfer function to the data, preferentially reducing the contrast and ability to discern of small features. Comparison of the crater distributions as a function of latitude does show that counts located in polar areas have significant slope reductions for small crater sizes. On the other hand, the slopes are steeper than those expected for dust deposition, the fall-off occurs at vastly different deposition rates if it is assumed that the reduction is due to crater burial, and finally, the fall-off begins at roughly the same crater sizes for all polar areas. The similarity in fall-off size strongly implies atmospheric obscuration, an interpretation that is supported by the fact that the images were acquired within 10 degrees of subsolar longitude of one another. Also, counts from two times over the same area show an increase in diameter of fall-off that correlates with increased haze "streaks". Thus, we find that there are no requirements in the crater data for a debris mantle that increases in thickness with increasing latitude.

The lack of evidence for debris from the crater data is corroborated by a detailed examination of higher latitude images, which generally do not show landforms indicative of deposition of 10's to 100's of meters of debris, except poleward of about 80 degrees in latitude. Thus, the best model to use for the northern hemisphere is one where debris thickness generally are less than about 100m, except poleward of 80 degrees in latitude. The Mariner 9 data are misleading and the apparent circumpolar debris deposits are in large part due to atmospheric obscuration. Finally, we note that preliminary examination of high resolution Viking data over the southern hemisphere suggests thick debris deposits extending as isolated patches up to about 50 degrees in latitude. Thus, there seems to be a significant hemispheric asymmetry in debris deposits, an observation that has not been included in any atmosphere-cap-debris model that we have seen.

REFERENCES: (1) McCauley, J.F. (1973) J. Geophys. Res., 78, 4123-4137. (2) Soderblom, L.A., et al. (1973) J. Geophys. Res., 78, 4117-4122. (3) Fanale, F.P., et al. (1982) Icarus, 50, 381-407. (4) Chapman, C.R. and Jones, K.L. (1977) Ann. Rev. Earth Planet. Sci., 5, 515-540. (5) Arvidson, R.E., et al. (1979) Nature, 278, 533-535. (6) Kahn, R. (1984) J. Geophys. Res., 89, 6671-6688.