THE PHYSICAL PROPERTIES OF DARK INTRACRATER MATERIALS ON MARS: EXAMINATION OF PHOTOGRAPHIC AND THERMAL INFRARED DATA.
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The dark materials found on the floors of many martian craters are attributed to formation by aeolian processes [1,2]. Most are thought to be accumulations of sediment [3-7], although some may be erosional lag surfaces [7,8]. Commonly termed "splotches," [2,7], the intracrater deposits typically have low albedos (0.10 to 0.28) and relatively high thermal inertias (I= 4 to 26 x 10^{-3} cal x cm^{-2} x $sec^{-1/2}$ x K^{-1}), implying effective grain sizes of 0.1 mm to 10 mm [6], or fine sand to medium pebbles [9]. Some intracrater deposits show dune forms [3,5,10], especially those in the high southern latitudes [7]. Preliminary analysis suggests that many may have relatively rock-free surfaces (rocks are grains ≥ 10 cm) [6,11,12], and do not seem to have much incorporated dust (grains << 0.1 mm) [7,13]. It is uncertain whether the dark intracrater materials are composed of the same type of material planetwide or if there are local or regional composition types [6,7,13], but they are probably composed of slightly oxidized mafic or ultramafic rock or mineral grains [13,14].

The main objective of the present work is to examine in detail the relationships between particle size, rock abundance, morphology, composition, and location of dark intracrater materials in order to better understand the origin and transport history of sand-sized materials on Mars. The major questions addressed by this work are: (1) what are the physical properties of the dark intracrater materials? (2) are they currently or recently active? (3) what constraints can be placed on their composition and compositional variations? and (4) what is their origin, for example, are the sediment sources outside or inside the crater? The approach has been to locate the dark intracrater materials, describe each deposit in terms of location within the crater, dimentions of the deposit, and occurrence of dunes using the highest resolution Viking Orbiter and Mariner 9 B-frame images available for each. Viking thermal infrared (IRTM) data have been used to determine relative grain size [15] and rock abundance [16] for each deposit for which the data has sufficient resolution to isolate intracrater materials. The IRTM albedo and Viking Orbiter color data will be examined in order to detect dust coatings and to determine activity and variability of the dark materials. Five-point thermal spectra will be constructed from the five IRTM thermal wavelength channels in order to address composition.

Work has been focused upon examining materials in four regions, delineated by Mars Charts MC-12, 19, 23, and 27. The first three were chosen because each is heavily cratered and each has a different average albedo, representing the range of albedos on the martian surface. To some extent, the range of regional albedos presumably reflects grain size and compositional differences in aeolian-transported materials [17-19]. In Arabia (MC-12), the albedo is generally high (≥ .26), in Aeolis (MC-23), the albedos are moderate (.16 to .20), and in the Margaritifer Sinus region (MC-19), the albedos are low (.10 to .16) [17, 18]. The fourth area, the Noachis region (MC-27), was chosen because many of the intracrater deposits are known to have large, prominent duneforms [3,10].

The correlation of photographic and thermal infrared data is particularly suited to detailed studies of specific dark intracrater regions. One of the highest thermal inertia surfaces (I= 21) previously identified, corresponding to grain sizes slightly larger than 1 cm, is correlated with a low albedo region just outside and to the northwest of the rim of Holden Crater (-27°, 34°). Holden Crater (135 km diameter) also has two dark intracrater regions. A thermal image of the crater shows considerable structure in both the dark intracrater surfaces, and the higher inertia (I= 21) extracrater area. One of the dark intracrater surfaces, located in the northeastern quarter of the crater, has a thermal inertia of about I= 12.5, indicating the presence of a very coarse sand. The other dark region occurs in the southwestern quarter, just north of the termination of Uzboi Vallis, which breaches the rim of Holden Crater. The thermal inertia of this dark material is highest (I> 13.0) where the valley intercepts the crater, and decreases away from this point. This dark material may consist of sediments or lag related to channelized winds blowing through the Uzboi valley, as observed for some of the large martian outflow channels [20,21].

The areas thus far examined demonstrate that there are some regional average differences in the grain sizes of intracrater materials. In general, the dark intracrater materials in the MC-19 Margaritifer Sinus region seem to consist of coarser sand than those in Aeolis (MC-23). Intracrater materials in the eastern Oxia region (MC-12-SW), some of which exhibit duneforms, have thermal inertias of about I= 9.0 (coarse sand). This contrasts with the large intracrater dunefields in the Hellespontus region (MC-27), where the thermal inertias are about I= 6.5 (medium sand). This observation is consistent with Thomas' results for Oxia and Hellespontus as derived from Viking color data [7]. The terrains surrounding the large Hellespontus dunefields have thermal inertias of I= 5.0 to 5.6. This suggests that the entire Hellespontus region may be generally covered with medium sand which forms large dunes in localized topographic traps.

Christensen [6] suggested that for martian intracrater materials there might be a relationship between dune spacing and effective grain size, based on the Viking IRTM observations and experimental work by Tsoar and Greeley [22]. In the example presented here, the most coarse intracrater materials, found in MC-19 and MC-23, do not seem to have duneforms, while some coarse sand forms small dunes in the Oxia region, and medium sand comprises the large, prominent dunefields in Hellespontus. There is some experimental and field evidence that, as expected, coarser-grained materials form lower dune profiles [22-26], but the relationships between grain size and other physical parameters to dune morphology is controversial [27,28]. For some terrestrial crescentic dune fields located in topographically unconfined portions of the Gran Desierto, Namib, and Kalihari Deserts, there are some apparent grain size and dune spacing relationships [29]. Based on these results [29], it is not clear that aeolian deposits within confined areas, such as a crater floor, would have a relationship between grain size and dune morphology. Given the limitations of the data resolutions, the results presented here and by Christensen [6] seem to be consistent with a hypothesis relating grain size to dune spacing and profile.

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