VALLES MARINERIS DUNE FIELDS: THERMOPHYSICAL PROPERTIES, MORPHOLOGY, AND PROVENANCE. M. Chojnacki[1] and J. E. Moersch[1], [1]Planetary Geosciences Institute, Department of Earth and Planetary Sciences, 306 EPS Building, University of Tennessee, Knoxville, TN, 37996 USA (chojan1@utk.edu).

Introduction: Dune fields on Mars offer an opportunity to investigate the nature of eroded sediments and their interactions with the atmosphere. We examined and re-mapped 20 dune fields in Valles Marineris (VM) originally mapped by the Mars Global Digital Dune Database (MGD^3) [1] to identify significant trends in composition, thermophysical properties, morphology and origin. In addition, five new dune fields were identified, doubling the total VM dune area to ~16,000 km^2. Valles Marineris has large topographic relief (~10 km), relatively high atmospheric pressure (>8 mb), and multiple geologic units as potential sediment sources. Dune grain sizes and inferred provenance will be compared with previous studies of other Martian dune fields to further understand the global context and processes of the VM environment. If dunes are determined to be locally derived this will provide insight into the regional composition of VM.

Motivation: Despite three decades of study [2-4], questions remain regarding the composition, age, morphology and sediment supply (present and past) for Martian dunes. The dune fields in VM show a large range of dune morphologies, thermophysical properties and potential sand sources. The rift system exposes a ~10-km-thick section of Martian stratigraphy from which dune material may be derived. The driving questions for this study are: What are typical grain sizes? Is the sediment derived locally or trapped from outside VM? Are VM dunes similar to typical mid-latitude crater-derived dunes outside VM?

Method: Twenty-five VM dune fields were mapped and characterized using 25 different parameters, including: MOLA elevation, slopes, TES albedo, DCI, TES [5] and THEMIS thermal inertia [6]. Particle sizes were derived from TES and THEMIS thermal inertia measurements using the method described in [7]; however only values $\leq 350\ Jm^{-2}K^{-1}s^{-1/2}$ were considered. Geologic context for the dune fields were acquired with visible image data from the Mars Reconnaissance Orbiter (MRO) instruments CTX and HiRISE. Our remapping effort used co-registered THEMIS thermal inertia and CTX visible images to ensure dune field boundaries excluded bedrock and rubble that could spuriously elevate thermophysical measurements. Visible trends were sought for regions, dune morphology, elevation and composition.

Results: In general, VM dune fields display greater topographic relief and closer proximity to their inferred source regions than is typical for mid-latitude dune fields elsewhere on Mars. These dunes have a relatively high TES-derived thermal inertia mean value (392 $Jm^{-2}K^{-1}s^{-1/2}$, units hereafter assumed) which corresponds to grains ~1.7 mm in size, or very coarse sand. A comparison of thermal inertia values for the 25 dune fields inside VM and 25 mid-latitude dune fields outside of VM (Figure 1) with an average thermal inertia of 298 or medium sand grains (~700 µm), suggests the difference in grain size for the two populations of dune fields is real.

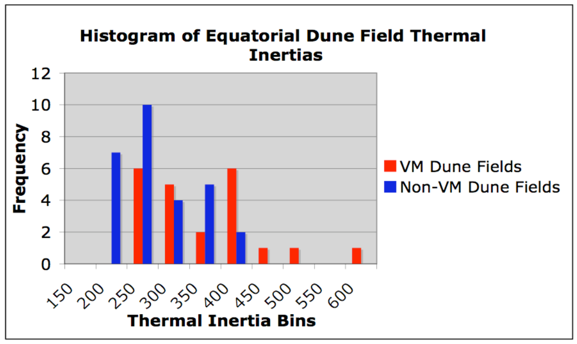

Figure 1. A TES nighttime thermal inertia histogram of equatorial (+/-30° latitude), dune fields reveals a bimodal distribution of grain sizes. Bin size is 50 thermal inertia units.

Coprates Chasma contains of eight dune fields within both the depressions to the south and main chasm. The southern fields are comprised of isolated barchanoid dunes, in close proximity to or atop wall material that has been deposited by mass wasting. Dark-toned, coarse-grained (~1 mm) sand eroding from wall outcrops merge into the dune field, suggesting these dunes are almost certainly locally derived.

In the main chasm, previously undocumented

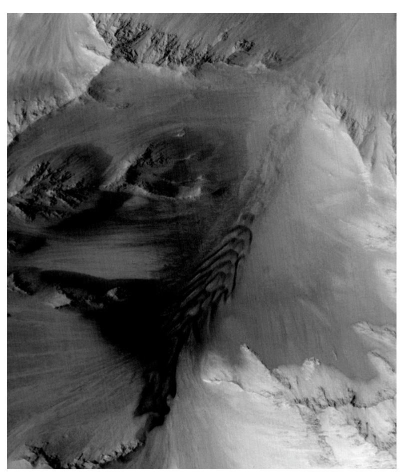

Figure 2. A CTX image of falling dunes in Coprates Chasma gullies. Down slope is to the top right and image is 4 km across.

dunes composed of large grain sizes (1-1.7 mm), as inferred from THEMIS thermal inertia, are found in CTX images within gullies 2-3 km above the canyon floor (Figure 2). These dunes are interpreted as a type of falling dune, where morphology is largely controlled by microtopography. Mass wasting coupled with katabatic, or down slope winds help to develop these rare dune types. TES spectra of these dunes indicate a basaltic composition, suggesting that the nearby wall units, also thought to be of a basaltic composition [8], could be the source of the dune sediments.

Ganges Chasma has the highest concentration of dunes in VM, including the largest non-polar dune field on Mars. We have re-mapped this large dune field, originally suggested to be 6000 km^2 [1], using THEMIS thermal inertia and CTX visible images and found its area to be ~12,000 km^2. One challenge in mapping this dune field is distinguishing between local mantling material and a sand sheet type dune, as the two commonly merge into one another. While both are smooth and do not possess slip faces, sand sheets show evidence for ground transport of particles when interacting with local topography [2]. The THEMIS thermal inertia of the dune field is ~210, implying an average grain size of 160 µm. The dunes are composed almost exclusively of sand sheet dune morphology except where they interact with layered deposits, knobs or wall material. In these locations, barchanoid dunes are found, which are largely an effect of the local topography and flow separation of the wind [2].

The majority of Ganges dune fields are found surrounding the sulfate-bearing Ganges Mensa and other layered deposits. In one location, a light-toned yardang containing CRISM-detected hydrated sulfates and mafic minerals [9] has shed fans of fine-grained material, contributing sediment to the dunes (PSP_005952_1725). Dune slip face orientation suggests the dominant wind direction was blowing east to west at the last time of dune activity. This direction agrees with that of the more recent, lighter-toned deposits atop the dark-toned sand sheets to the west, as observed in HiRISE and THEMIS thermal inertia images. These lighter-toned materials, inferred to be composed of grains (~440 µm), form bright ripples which gradually disappear away from the yardang. Other HiRISE and CTX images of mafic- and sulfate-bearing layered deposits in Ganges (identified by OMEGA and CRISM) show similar mass-wasting proximal to dune fields. In addition, recent MRO observations of other VM sulfate-bearing layered deposits have found dark-toned ripples emanating from discrete friable layers [10]. This suggests that sulfate-bearing layered deposits are a likely source (perhaps one of several) for sediment in these dune fields. Whether the sulfates constitute a significant percentage of the dune composition is currently under investigation.

Discussion: Both large- and small- scale topography affect local dune morphology and location within the chasms of Valles Marineris. The continuous chasms of the central east-west rift system (Ius, Melas and Coprates) typically have isolated dunes (barchanoid or transverse) on the flanks of the canyon, while the reentrant chasms in northeastern VM (Ganges and Juventae) have more expansive chasm-filling dune fields where sand sheets dominate.

These two endmembers have distinct thermophysical properties as well. While thermal inertia measurements indicate VM dune fields, on average, have significantly larger grain sizes than other mid-latitude dune fields (~1700 µm vs. ~700 µm grains) the histogram in Figure 1 is not area-weighted. The fine-grained (~200 µm) sand sheets of Ganges and Juventae account for the majority of VM dune field area and are similar to other Martian dunes.

In contrast to the fine-grained sand sheets several dune fields in Ius, Melas and Coprates chasmata show anomalously high thermal inertia values (>400) and large derived grain sizes (~1.7 mm). This is unexpected because wind tunnel studies with Viking atmospheric data have shown that 100-200 µm particles are the most-easily moved grains under present Martian conditions [2]. It is possible that the high thermal inertia values are indicative of indurated (fossilized) dune surfaces, rather than large individual grain sizes. Another possibility is that the higher atmospheric pressures found at the bottom of VM, along with wind speeds accentuated by the local topography, could allow for saltation of larger grains under current conditions. Mineralogy may also be a factor, as the finer-grained dune fields of Ganges and Juventae are found proximal to layered deposits, where as coarser-grained dunes appear to be derived from wall material. Future spectroscopic investigation will attempt to determine if there is a compositional distinction between the fine- and coarse-grained VM dune fields.

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