VALLES MARINERIS DUNE FIELDS: SEDIMENT PATHWAYS AND PROVENANCE. M. Chojnacki[1], J. E. Moersch[1], D. M. Burr[1], and J. J. Wray[2], [1]Planetary Geosciences Institute, Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996 (chojan1@utk.edu), [2]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, GA, 30332.

Introduction and Motivation: The Valles Marineris (VM) hosts nearly a quarter of the global inventory of dune area [1–2] on Mars. These VM dune fields show a large range of dune morphologies and thermal inertia values, and a variety of potential sand sources (*e.g.*, interior layered deposits (ILDs), spur-and-gully walls, extra-rift sources) motivating further investigation. Here we test the hypothesis that VM dune fields are derived from a variety of local (intra-chasma) sediment sources. If dunes are determined to be locally derived, this finding would provide insight into sediment pathways and the degree to which VM sand-sized sediments have been homogenized.

Data: Geologic context for the dune fields was provided by visible-wavelength images from the CTX [3] and HiRISE [4] instruments. CRISM [5] provided visible to near-infrared (0.4–2.6 μm) reflectance spectra to determine compositions of dunes and potential source outcrops. CRISM hyperspectral (at 18 or 36 m/pixel) and multispectral (at 100 or 200 m/pixel) data were processed and corrected via the method described by [6]. Thermal inertia (TI) data from the THEMIS thermal infrared imager [7] were used to create thermophysical unit maps and infer particle sizes.

Results and Interpretations:

Coprates Chasma. In eastern Coprates Chasma, dune fields are commonly below or among spur-and-gully walls [1]. For example, Fig. 1 shows a dune field in collapse pits south of the main chasm in close association with a series of eroding spurs (15°S, 302.3°E). Fans of scree with rock sizes down to the limit of HiRISE resolution (*i.e.,* ~1 m) are observed southward into the dune field (Fig. 1b-1d, inset). THEMIS TI (Fig. 1a) of these dunes indicates relatively high values consistent with coarse sand. CRISM observations of lower spurs show broad absorption features near 1.0–1.3 μm and/or 2.3–2.5 μm depending on the location. Dunes and scree downslope of western eroding spurs have the same broad absorption feature from 1.0 to 1.3 μm, consistent with olivine (Fig. 1e). Eastern spur-derived scree also have spectra that are nearly identical (not shown) to those of downslope (south) dune sand, except that the ~1 μm feature narrows in the sand spectrum, and a slight inflection longward of ~2 μm is present. This effect is likely a result of pyroxene-bearing sand mixing with the dominantly olivine sand. Upper spurs show narrow absorption features at 1.4, 1.9, and 2.2 or 2.3 μm, likely due to the presence of Al- (*e.g.*, kaolinite) or Fe/Mg- (*e.g.*, smectite) phyllosilicates, respectively (Fig. 1f). Weak hydration features are present in scree and some dune spectra as well, but diminish rapidly southward into the dunes. Not all outcrops or scree display matching spectral characteristics with dunes. Based on the thermophysical, morphologic, and compositional evidence we suggest the Coprates Chasma dunes are derived from upslope spur and scree materials.

Juventae Chasma. Juventae Chasma hosts a massive (~4600 km^2) erg or sand sea filling the southern half of the chasm, whereas smaller floor dunes are found among ILDs and chaotic material to the north [1]. One prominent sulfate-bearing ILD [8], informally named Mound C [9], has a small dune field atop its summit and a dark-toned mantling unit ~4 km above the chasma floor (Fig. 2a; 3.5°S, 298.2°E). Previous morphological analysis [9] suggested this mantling unit to be the sediment source for local dunes (Fig. 2a, white

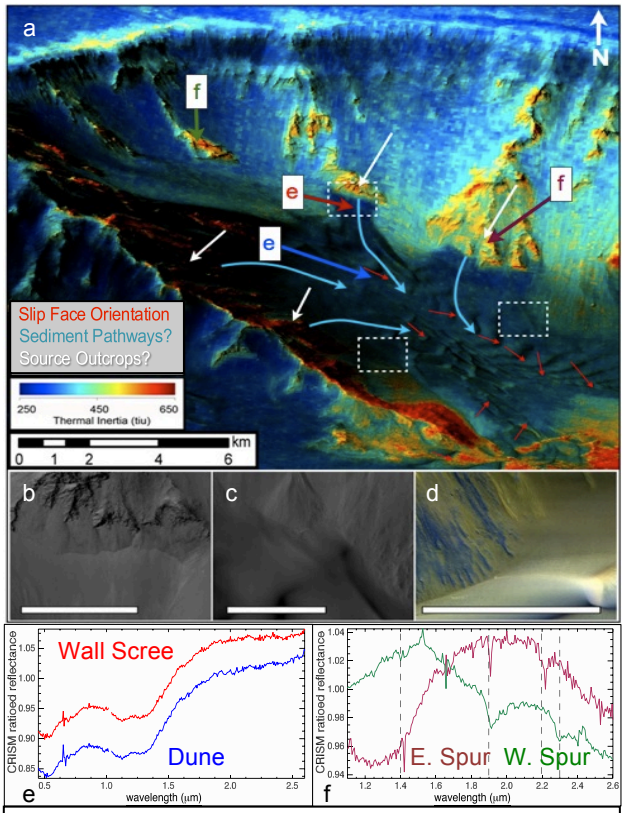

Fig. 1. (a) A CTX perspective view using a HRSC DTM colorized with THEMIS TI of wall outcrops, scree, and dune fields in collapse pits south of Coprates Chasma. (b-d) Close-up HiRISE views of select locations in (a). Scale bars are ~1 km. (e) CRISM spectra (FRT 1FD85) of wall scree and dunes, both consistent with olivine, are remarkably similar. (f) Additional detections of Fe/Mg- and possibly Al-phyllosilicates (though with unusually narrow absorption features) are found associated with eroding spurs. Note: the olivine (e) and phyllosilicate (f) spectra are presented from 0.4–2.6 μm and 1–2.6 μm, respectively.

arrows). We tested this hypothesis using CRISM and THEMIS. Spectra of dunes and the mantling unit include a broad ~1-μm feature, consistent with olivine (Fig. 2b). Adjacent light-toned outcrops do not provide a good spectral match, instead showing other features centered at ~2.1 and ~2.4 μm attributed to kieserite [8]. THEMIS data (not shown) provide similar TI values for both areas, with the dunes having slightly lower values that are consistent with coarse sand. Dark-toned detrital material flanking mantling units appears to have similar TI values, but without bed forms. We find the similarities in composition and TI values to provide supporting, though not conclusive, evidence for the hypothesis that dune sand is locally derived from the mantling unit [9]. Other floor dune fields east of Mound C (Fig. 2a, lower right) also contain olivine and may be partially sourced from these mantling units. Interestingly, the barchanoid dunes west of Mound C do not display the olivine spectral feature in CRISM multispectral observations. Rather, spectra of these dunes, southern sand sheets, and the fan of mid-toned material eroding sediment off the west side of Mound C produce features at ~1.1 and ~2.3 μm that are consistent with high calcium pyroxene (HCP) (Fig. 2a, inset). This ILD material may be a separate source for local erg sand.

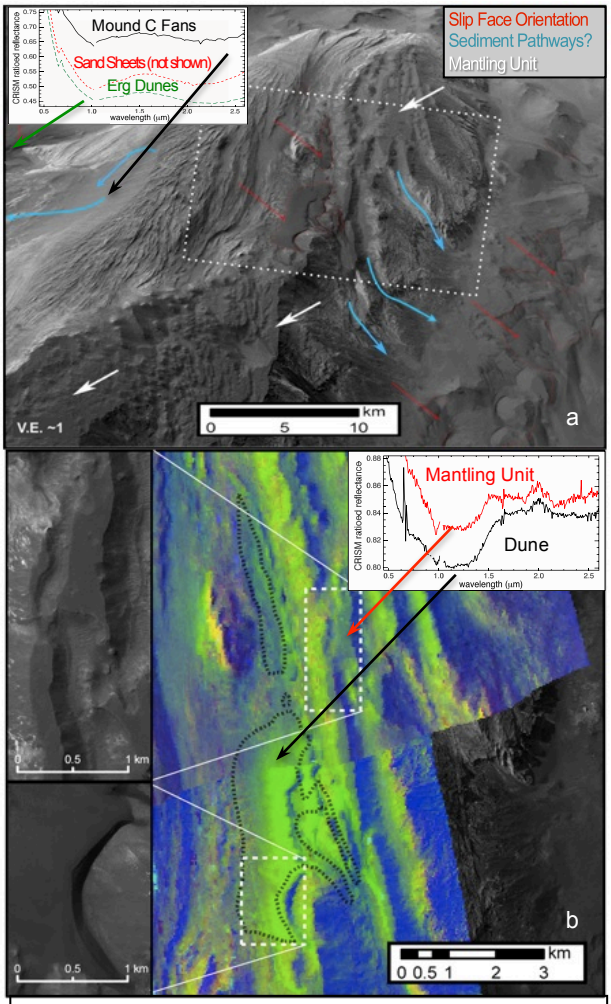

Fig. 2. (a) Oblique northward perspective view of dune fields on and around Juventae Chasma's Mound C (CTX using a HRSC DTM). CRISM multispectral observation shows HCP associated with mound fans, dunes, and sand sheets. (b) CRISM hyperspectral products (HRL 444C north, HRL 28A6 south) over CTX with IRA albedo (red), OLINDEX (green), and LCPINDEX (blue), as defined by [10]. Spectra of both the dunes and mantling unit (insets) exhibit absorption features consistent with olivine.

Discussion and Summary: Numerous CRISM and THEMIS observations in east Coprates Chasma link specific outcrops to individual dune fields, although multiple sources, including other dunes and extra-rift material, also seem likely. Spectra of local falling dunes (a type of topographically constrained dune form [11]) and floor dunes are similar to spectra of adjacent upslope outcrops and match each other. This spectral pairing, along with morphologic and thermophysical evidence, suggests discrete, local (<10 km) sediment pathways from wall gullies down to chasm floors. Based on mapping in Coprates Chasma, we propose a sediment transport system, in which: (1) upper wall outcrops provide sediment for falling dunes located in gullies; (2) falling dunes that descend lower slopes provide sand for floor dunes; and (3) lower wall outcrops provide additional sediment for floor dunes (*e.g.*, Fig. 1).

Olivine-bearing dunes at the summit of Juventae Chasma's Mound C have a similar composition to that of a regional mantling unit, first hypothesized to be a local sediment source [9]. Additional dark-toned material is observed being shed downslope to the east, where other olivine-bearing dunes are located. In contrast to this trend, western dunes, sand sheets to the south, and ILD-sourced fans have a similar HCP-bearing composition, possibly indicating a genetic relationship. Having two dune populations in close proximity to one another (~10 km) but with different spectral signatures (*i.e.*, olivine and HCP) argues for discrete, relatively unmixed sediment sources, and a low degree of sediment homogenization. In some cases, THEMIS TI decreases in the inferred paleodownwind direction from putative source outcrops, suggesting a decrease in the particle size distribution. THEMIS and CRISM provide compelling evidence that some dune populations in Coprates and Juventae Chasmata are locally derived (*i.e.*, from wall outcrops, mantling units, and ILDs).

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