DUNE SLIPFACE FEATURE MORPHOLOGIES AND THEIR RELATIONSHIP TO MINERALOGY.

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Introduction: Martian dune slipface features occur at all latitudes where dunes are present. Previous work has classified these slipface features into nine different classes based on combinations of alcoves, channels, fans, and slope streaks that were observed during a global survey of dune fields [1]. Slipface feature classes include: alcoves, channels, and fans (ACF); alcoves and channels (AC); alcoves and fans (AF); alcoves (A); channels (C); slope streaks (SS), slope streaks with alcoves (SSA), north polar region (NPR); and no slipface features. Formation mechanisms include CO_2 frost sublimation, dry mass movement, and melting of water ice. Class AC most likely forms from CO_2 frost sublimation [1][2][3], class AF from dry grain flow oversteepening [1][4][5][6], and class ACF from CO_2 flow creating a lubricated flow down the slipface [1][7]

In order to further constrain slipface feature formation mechanisms, we studied the mineralogy and morphology of these dune fields to determine whether a genetic relationship is present between the two. Studying the mineralogy could give insight as to the formation and evolution of the stated classifications. If present, this could tell us more about where the source of the sand is located, how dunes migrate across the surface, if aqueous processes are affecting mineralogy/morphology, and how or if dunes are modified after impact events or other localized events (i.e. glaciation, gully formations, etc.).

Methods: Dune fields in this study only included the ones documented and classified from the global survey of [1] (Fig. 1A). To determine if a relationship between mineralogy and morphology existed, we first organized the dune fields into three broad categories: northern (+30° to +90°), equatorial (+30° to -30°), and southern (-30° to -90°). The preliminary dune fields in this study were mapped using the Java Mission-planning and Analysis for Remote Sensing (JMARS) software [8], then cross-referenced with the Mars Global Digital Dune Database [9] (Fig. 1B), and further analyzed with the High Resolution Imaging Science Experiment (HiRISE). Datasets for mineral analysis were taken from the Mars Global Surveyor Thermal Emission Spectrometer (MGS-TES). Minerals were selected from the mineral spectral library from the Mars Flight Facility-ASU Spectral Library [10]. The emissivity data was then applied with atmospheric correction [11]. This preliminary study only took the average of two TES datasets on each dune field. Over twenty different minerals were listed in three broad groups: sulfates/carbonates/clays/high-silica phases (gypsum, kieserite, calcite), feldspars (anorthite, K-glass), and Iron-Magnesium-based minerals (hematite, magnetite, olivines). Unfortunately, MGS-TES data does not exceed 83°N latitude without considerable errors, so we were limited to only seven northern dune fields in this subset. From there, seven dune fields were also studied in the subsets corresponding with the equatorial and southern regions. Dune type, wind direction, and whether or not the dune field is inside or outside of craters were recorded as part of the morphological study.

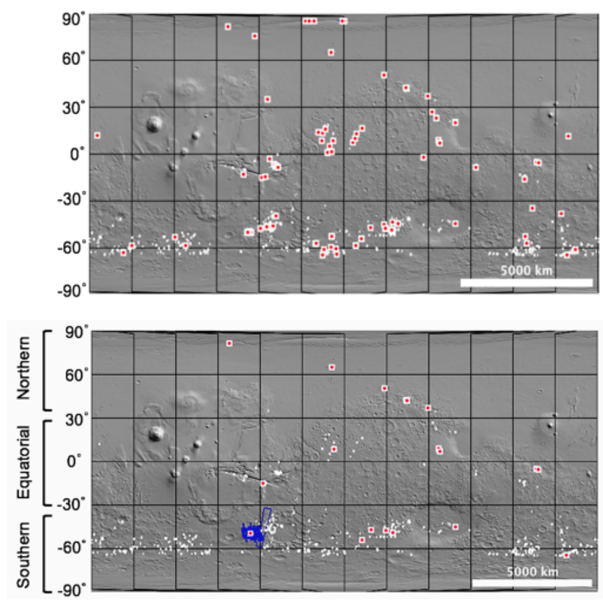

Figure 1: A: (Top) Global dune field survey from [1]. Small, white dots show dune fields from the USGS Mars Dunes Database (JMARS) and red dots show dune fields studied. **B:** (Bottom) Subset of dune fields from this study, showing seven dune fields (in red) from the north, equator, and south.

Results: With just seven data points from each region, we have only been able to identify limited trends between mineralogy and slipface features. Preliminary mineralogy trends (Fig. 2) include: SSA are primarily feldspathic/olivine-rich, ACF contain more feldspars (especially in the south), fan-based features exhibit more clays, and channel-based features have more olivine and magnesium minerals. From this preliminary analysis, clays and felsic-type minerals are probably associated with fan morphologies, while mafic or basaltic-type minerals are associated with cross-cutting geologic structures.

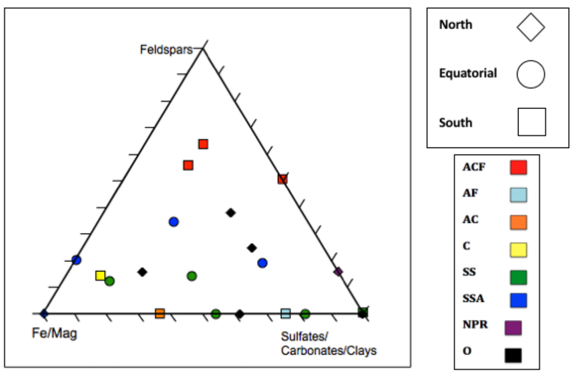

Figure 2: Ternary diagram showing mineral percentages and possible trends relative to slipface features. Color-coding corresponds to slipface feature classes, and data point shapes correspond to location subset.

Morphological trends were primarily based on dune shape and if dune fields were inside or outside of craters for analyzing the localization of mineral material and influences of minerals within craters to influence morphology [12]. All seven of the northern dune fields were barchan-shaped, and all but one dune field was outside of craters. This is expected, as the northern hemisphere of Mars has significantly less craters than the equatorial and southern regions, therefore, less opportunities for sand to migrate into craters. Wind directions in the north were all southwestern. Equatorial dune field types displayed a combination of barchans and transverse ridges, and were found equally inside and outside of craters. No uniform wind direction was detected in this subset. The majority of southern dune fields were transverse in shape, but we also found star-shaped and barchan-shaped dune fields. All but one of the southern dune fields were inside of craters, and we found no pattern in wind direction thus far.

Future Work: Our future work includes forming more subsets of minerals from our three broad categories to form a better understanding of the silicate phases and basaltic materials involved that influence shape or maturity of the dune fields. Understanding the localized or regional mineralogy that influence these slipface features could provide insight as to their evolution, particularly if a dune field is within a crater or regionally exposed. Additionally, we will investigate if recent aqueous activity affects the global movement of dunes. If alteration phases are associated with certain classes of slipface features, this could tell us that recent aqueous processes are causing induration in the dunes, for example.

Further, we plan to expand our dataset in two ways: locality and placement. Locality pertains to adding more dune fields to our study within the three latitudinal regions. Placement refers to if the dune field of study is within a certain geologic setting, such as near glacial, seasonal, cratered, or volcanic systems. We also plan to analyze wind directions more in-depth to possibly constrain the sources of some of the sand. We will use the HiRISE database for confirmation of small-scale properties and structures of the various classes. Another important factor that we will expand on in this preliminary study is the dissection of large dune fields with multiple slipface features to study the possible gradient change in mineralogy.

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