COMPARISON OF THE MINERAL COMPOSITON OF THE SEDIMENT FOUND IN TWO MARS DUNEFIELDS: OGYGIS UNDAE AND GALE CRATER. H. R. Charles[1,2] , T. N. Titus[1], R. K. Hayward[1], and C. S. Edwards[1], [1]U.S.G.S. Astrogeology Science Center, 2255 N. Gemini Dr., Flagstaff, AZ 86001, [2]Northern Arizona University, Flagstaff, AZ 86001.

Introduction: Ogygis Undae, one of the few formally named dune fields outside of the north circumpolar erg, is located just outside of the Argyre Planitia and has an area of roughly 1904 km^2 [1]. Due to its large area, Ogygis Undae is an excellent candidate for a compositional analysis with orbital datasets.

Our method utilizes thermal emissivities from the Thermal Emission Spectrometer (TES) [2] and deconvolves the spectra in the DaVinci program [3]. Two previous investigations showed an unusual variation in mineral distribution [4,5]. To validate the results showing a possible non-uniform distribution, as well as the method used to obtain those results, we analyzed the composition of a dune field in Gale crater. We also compared nighttime TES thermal inertia data in Ogygis Undae to mineral abundances.

Background and Motivation: Multiple studies of the (also large) NE-SW trending dune field in Gale crater have been conducted both from orbit and in situ, making it an excellent way to validate the TES methods employed here [6,7]. Conversely, Ogygis Undae has not been analyzed as thoroughly.

To explain the apparent variation in mineral groups across Ogygis Undae, one previous analysis suggested problems with the spectral library [4]. The next analysis showed that modifying the spectral library increased the error in the results without removing the variation [5]. A possible explanation was suggested that Ogygis Undae had a bimodal distribution of mineral types, which means that there may be an additional characteristic to observe while cataloguing the features of all the dune fields on Mars.

Methods: TES emissivity spectra are available in Java Mission-planning and Analysis for Remote Sensing (JMARS), a geographical information system (GIS) created by Arizona State University (ASU) [8]. These spectra were then deconvolved within the programming environment DaVinci [3] by separating the surface and atmospheric components and using a mineral spectral library created by Rogers and Fergason [9].

JMARS was also used to obtain the nighttime TES thermal inertia data for Ogygis Undae. These values were also analyzed as a function of longitude and compared to the mineral distribution.

To validate the methods used, the same analysis techniques were applied to the Gale crater dune field. The results were compared to previous examinations of this dune field [6,7].

Results: In Ogygis Undae, the three mineral groups which were present above the detection limit of ~10% include feldspar, pyroxene, and high-silica phases (Fig. 1). Sulfate abundances were near the detection limit, only exceeding the detection threshold in two orbital tracks but remaining below in the other six [10]. Olivine, quartz, hematite, and carbonate were not present at significant levels (Fig. 1).

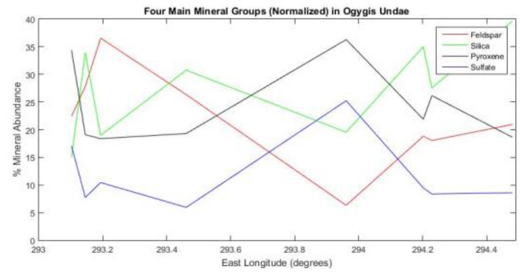

Figure 1: The normalized mineral abundances for feldspar, pyroxene, high-silica phases, and sulfate from west to east in Ogygis Undae.

The Gale crater dune fields, however, appeared to be composed of an olivine-rich basaltic material, and the distribution of the mineral groups present was relatively uniform. The abundances can be seen in Fig. 2 below.

	Ock 8110	Ock 20025	Ock 20113	Ock 20201	Ock 20465
Feldspar	5.48 (8.19)	53.12 (3.34)	59.16 (4.44)	38.19 (4.10)	1.4 (3.54)
Silica	22.42 (11.01)	10.25 (3.16)	6.77 (4.20)	10.06 (3.39)	10.68 (9.16)
Pyroxene	33.04 (7.76)	22.59 (3.59)	19.37 (4.51)	33.92 (4.07)	39.46 (5.96)
Sulfate	18.77 (4.46)	0	1.08 (0.72)	1.84 (0.62)	9.01 (2.68)
Hematite	0	0	0	0	0
Carbonate	7.32 (1.05)	1.05 (0.29)	1.6 (0.45)	2.01 (0.46)	9.11 (1.14)
Olivine	12.97 (5.47)	12.99 (1.92)	12.02 (2.59)	13.98 (2.47)	25.53 (4.49)
Quartz	0	0	0	0	4.81 (1.52)

Figure 2: The mineral abundances for the NE-SW trending Gale crater dune field. Red-highlighted numbers indicate the largest mineral abundance in an orbital track, green indicates the second largest, and blue the third largest.

THEMIS decorrelation stretch (DCS) images of Bands 8, 7, & 5, 9, 6, & 4, and 6, 4, & 2,appeared to confirm these results. The THEMIS DCS data from Ogygis Undae show variations in color across the dune field while the images from Gale crater show a consistent color across the dune fields that is distinct from the background material.

TES Nighttime Thermal Inertia. TES nighttime thermal inertia were also obtained from JMARS and analyzed as a function of longitude, then compared to composition as a function of longitude in Ogygis Undae (see Fig. 3).

Finally, thermal inertia values were related to particle size, and the particle sizes were then compared to the mineral abundances across the dune field.

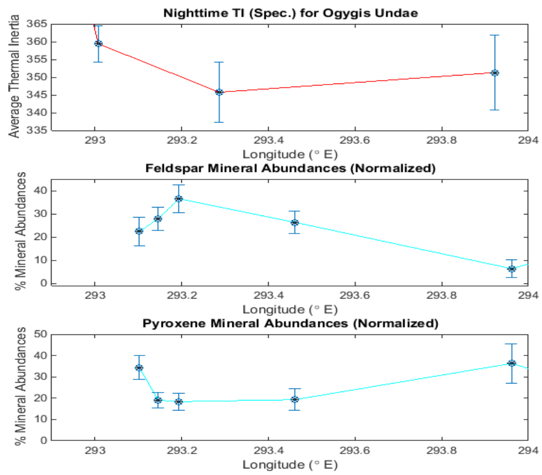

Figure 3: Nighttime thermal inertia values analyzed as a function of longitude and compared to feldspar and pyroxene over the same region. (Each thermal inertia value represents an average of all the values in an orbital track and the bars represent one standard deviation from the mean). Low thermal inertia roughly correlates to greater feldspar abundance, and higher thermal inertia to greater pyroxene abundance.

Discussion: The two main differences between Ogygis Undae and the Gale crater dune field are the olivine content and the uniformity of the mineral types throughout the dunes. The relatively high olivine content we find in the Gale crater dune field can be confirmed by previous analyses using both TES and MRO/CRISM data [6,7]. The presence of olivine in a dune field requires that the source material be olivine-rich. In addition, the higher density of olivine often means that less-dense grains are more likely than olivine grains to be carried by low wind speeds. This factor indicates that the sand in the Gale crater dune field is likely to be locally sourced [11].

The sand in Ogygis Undae was probably olivine-poor, initially. It is possible but unlikely that an olivine component was originally present, and removed due to mechanical weathering or aeolian sorting. What may be more interesting is the apparent variation between the feldspar/high-silica phases and pyroxene components. As seen in Fig. 1 above, higher abundances of pyroxene (and possibly sulfate) roughly correlate with lower abundances of feldspar and high-silica phases, and vice versa. In this case, high silica phases likely indicate weathering/alteration products, which may in turn indicate less-mobile sections of the dune as these materials are more friable than their precursor materials.

The variation in the Ogygis Undae abundances could be explained by a bimodal distribution of two sand types. An analog of this distribution is seen in Grand Falls, AZ. This dune field exhibits visual similarity to images taken from ripples on Mars [12,13]. These terrestrial dunes are composed of fine-grained quartz sand and coarse-grained basaltic sand, derived from two different sources. Due to differences in grain size and shape, the two types of sand may travel at different rates depending on wind velocity and may influence each other's rate of travel. [13].

TES Thermal inertia values and associated particle sizes were compared to mineral abundances in Ogygis Undae to examine this hypothesis (see Fig. 3). The relation between thermal inertia and particle size is governed by the equations found in [14, 15]. Using these equations, the upper limit of thermal inertia corresponded to a diameter of ~1170 µm (very coarse sand) while the lower limit corresponded to a diameter of ~815 µm (coarse sand), with a factor of ~1.4 difference in size [16]. If higher thermal inertia values correspond to higher abundances of pyroxene, the pyroxene may also correspond to the larger grains, while feldspar may correspond to the smaller grains. When subjected to mechanical weathering in an air mill, starting with sand grains of approximately the same size, basaltic grains typically end up larger than quartz and felsic grains [11]. In Grand Falls, the basaltic grains are also larger, which may be partially responsible for the bimodal distribution in this dune field [13].

Conclusion: Like terrestrial dune fields, Martian dune fields appear to exhibit many differences in composition, source, and distribution of mineral groups. The combination of mineral abundance values, thermal inertia, and THEMIS DCS images provide an argument for a bimodal distribution in Ogygis Undae and highlight the differences between this dune field and dune fields such as the one in Gale crater. Further analysis of these aeolian features will yield more information on sediment transport, alteration history and material source regions.

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