COMPOSITION AND SOURCES OF DARK AEOLIAN SEDIMENTS WITHIN MARTIAN CRATERS ASSOCIATED WITH CENTRAL MOUNDS. C. Pan¹, C. S. Edwards¹, K. A. Bennett² ¹Dept. of Physics and Astronomy, Northern Arizona Univ., Flagstaff, AZ 86011 (cong.pan@nau.edu), ²USGS Astrogeology Science Center, Flagstaff, AZ 86011.

Introduction: The sources and origins of dark aeolian sediments within craters are not clear since they have been first observed by Mariner 6 and 7 [1]. Edgett [2] suggested eroded layered materials might contribute a portion of the dark dunes within craters at Arabia Terra. Fenton[3] proposed that sand may be eroding from a widespread regional and local source in dune fields at Noachis Terra. A global survey of dark aeolian sediments within craters suggested that the crater walls and floors are most likely the local source of the dark intracraterr aeolian deposits [4].

It has been proposed that central mounds are remnants of previously more extensive large-scale sedimentary deposits based on a global survey of mounds within large craters [5]. However, the sources of the sand dunes surrounding the mounds are uncertain. If these sand dunes are sourced from mound material, then studying them could help us better understand central mounds. Investigation of the composition of sand materials may help to reveal their origins. In Gale crater, Bagnold dune sands are compositionally distinct from smaller bedforms and typical soils [6]. The broad similarity between Bagnold dune sands and Gale crater sandstones indicated the likely importance of local processes and erosion of local Stimson formation sandstone [6]. Tirsch [4] proposed that the generally consistent mafic composition of dark sediments may indicate volcanic origin.

Here, we investigate the compositional, thermophysical, and morphological properties of sand dunes within impact craters that hosting central mounds, to study the relationships between central mounds and sand dunes, which will help to understand the sources of the sand dunes and the surface processes that contribute to the formation of sand materials, such as volcanic and aqueous processes.

Data and Methods: In this work, we first used the data set of 50 features categorized as central mounds [5] to identify the relatively darker aeolian sediments with Context Imager (CTX) images. We then used Thermal Emission Imaging System (THEMIS), Thermal Emission Spectrometer (TES) and Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) images to examine mineralogy where possible.

We also a thermal model (KRC) [7] to derive the thermal inertia values of interest areas from THEMIS nighttime data. The THEMIS thermal inertia will be derived on a pixel by pixel base with an improved method that will significantly reduce the uncertainties related to albedo, slope, azimuth and elevation by taking the advantage of spatially registered data at the same scale as the THEMIS infrared data [8].

Results: Our work shows that there are 30 craters with central mound hosting dark aeolian sediments (Figure 1). More than 60% of them are at Arabia Terra, and a few isolated craters are located at Noachis Terra, Terra Hyrrhena, Elysium Planitia and Promethei Terra.

For the 25 sand dunes with high quality infrared images coverage (high SNR, short durations between shutter closing calibration images and data acquisition, no dropouts, undersaturated or over saturated pixels, etc.), 10 of them show no spectral distinct within the entire crater, possibly due to high dust coverage. For the rest of the dunes, there are compositional variations between sand dunes and mounds: 6 sand dunes are more mafic than mounds, 8 are less mafic than mounds and 3 exhibit clay minerals in mounds or sand dunes. One example is Crater 25 (located at Arabia Terra), where there are sand dunes composed of mafic materials located to south of the mound (Figure 2). The mafic enrichment of the dunes as compared to the mound is supported by the color variation of THEMIS DCS image (Figure 2.C) and spectral observation of THEMIS, TES and CRISM data (Figure 2.D-F). Another example (Crater 26) is also located at Arabia Terra with a small sand dune to the south of the mound (Figure 3.A-B). Though there is color variation within THEMIS DCS image (Figure 3.C), the THEMIS spectra of the sand dune and mound are similar (Figure 3.D). The TES spectra of sand dune suggests it is low in mafic material (Figure 3.E). Spectra from CRISM suggests the sand dune may be consistent with clay minerals (Figure 3.F).

Discussion: The compositional variation of sand dunes within Arabia Terra suggest that sand may not from single source. In other words, if the sand sources are regional sediments which may have similar composition in a small area, it is less possible that there are both mafic rich and poor sand dune within nearby craters (e.g. craters within 2°~8°N and 350°~355°E) within the same geologic terrain (Middle Noachian highland). Alternatively, local sediments may contribute to the formation of some sand dunes. However, it is not clear whether the central mounds are source of the sand materials. Volcanic process may contribute to the formation of mafic rich sand dune in craters similar to Crater 25. This is also supported by the volcanic resurf ace features within crater floor and surrounding area.
Further, the clay-bearing sand dune may indicate that aqueous alteration played an important role in the sand source.


Figure 2. Crater 25 (14.35°N, 0.14°W). A. CTX image shows the dark sand dune, the red polygon is the region of interest of CRISM, red arrows point to volcanic resurface features. B. HRSC and MOLA blend image shows the white polygon outline of central mound. C. THEMIS DCS image shows the color variation. D. THEMIS spectra of sand dune and central mound indicates composition variation. E. TES spectra and modeled abundance shows the sand dune is mafic rich (region of interest is the red polygon in C). F. CRISM spectra shows consistency of diopside and/or olivine.

Figure 3. Crater 26 (11.86°N, 6.66°E). A. CTX image shows the dark sand dune, the red arrows point to the region of interest of CRISM. B. HRSC and MOLA blend image shows the white polygon outline of central mound. C. THEMIS DCS image shows the color variation. D. THEMIS spectra of sand dune and central mound indicates no composition variation. E. TES spectra and modeled abundance shows the sand dune is mafic poor (region of interest is the red polygon in C). F. CRISM spectra shows consistency of clay.