CHARACTERIZING THE BEDROCK MINERALOGY OF DUSTY REGIONS OF MARS USING REMOTE SENSING OF LOW ALBEDO "WINDOWS" THROUGH THE DUST. J.F. Bell III, J.C. Lai, B. Horgan, and D.F. Wellington; School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287 (Jim.Bell@asu.edu)

Introduction: Much of the Martian surface is obscured by dust. The bright and ubiquitous nature of this dust makes remote sensing spectral analysis of the underlying surface materials difficult or impossible. As a result, the composition and mineralogy of the substrate materials in large areas of Mars have yet to be characterized in detail.

Still, even in the dustiest regions of Mars, small holes or "windows" a few to a few tens of kilometers in size can be identified where the dust cover is substantially thinner or non-existent. These windows through the dust provide an opportunity to analyze the composition of potentially local sediments and/or bedrock. In this study, we are using a combination of imaging and spectroscopic data sets from the Mars Global Surveyor Thermal Emission Spectrometer (TES), the Mars Express Observatoire pour la Mineralogie, l'Eau, les Glaces et l'Activité (OMEGA), the Mars Odyssey Thermal Emission Imaging System (THEMIS), and the Mars Reconnaissance Orbiter Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) to identify and characterize the mineralogy of such windows in some of the dustiest regions on Mars. Here we focus on 13 such windows identified in Amazonis Planitia, and on the distribution of ferrous minerals in local low albedo substrate/sediments that can potentially be identified in these regions from OMEGA data.

Methods: TES "albedo channel" [1] and dust cover index (DCI) [2] data were initially used to identify less dusty windows in the northern hemisphere of Mars, where many of the classical martian dusty regions are located (*e.g.*, Amazonis, Tharsis, Elysium). Our definition of a less dusty window was based on a combination of DCI < 0.3 and TES broadband albedo < 0.2. Amazonis Planitia was found to contain the greatest number of such windows resolvable by TES (approximately 3x5 km footprint). Specifically, 13 such regions were identified in Amazonis, within a region centered near 15°N, 180°E (Fig. 1).

These regions are being initially analyzed in corresponding calibrated and mapped OMEGA near-IR quadrangles processed to align and smooth the spectra [3]. For example, maps of several OMEGA and CRISM spectral parameters designed to provide sensitivity to ferrous (Fe^{2+}-bearing) minerals typically found in basalts [*e.g.*, 4-6] have been created from OMEGA data in the regions in and surrounding the identified windows. Specifically, we used the spectral slope concavity parameter, OLINDEX2, HCPINDEX, and LCPINDEX parameters to detect and map iron-bearing glass, olivine, clinopyroxene, and orthopyroxene respectively, as well as the general pyroxene index from [4]. OMEGA spectra of spectra within each window were also ratioed with typical nearby dusty pixels (from the same OMEGA image cube), to enhance the spectral contrast of weak ferrous absorptions.

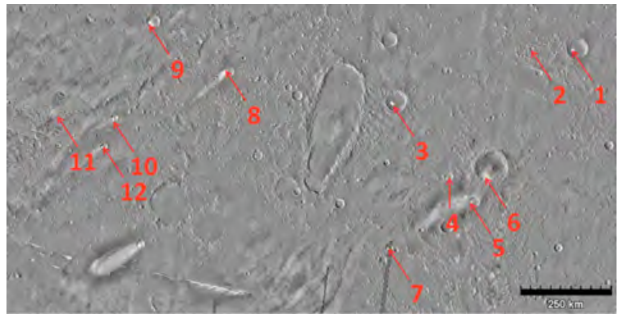

Figure 1. THEMIS daytime thermal-IR map of Amazonis Planitia centered near 15°N, 180°E showing 12 of the "windows" in the dust mapped for this study.

Initial results: All but one of our initially-identified windows in Amazonis occur within crater interiors as dark "splotches" at the km-scale resolution of TES and OMEGA data sets. Detailed examination of these regions in higher-resolution MGS/MOC, MRO/CTX, and MRO/HiRISE images reveals them to typical be intracrater dune deposits. These deposits are universally located in the south to southwest side of their host craters and are typically tens of km across.

OMEGA spectral parameter maps reveal interesting information about the ferrous mineralogy in these regions. For example, the spectral slope concavity parameter shows strong signatures with a cluster of windows centered at approximately 12°N, 184°E. Figures 2a through 2d highlight two such examples, overlaid on a CTX mosaic. Complementary analyses of the concavity parameter in other low albedo regions [7,8] show it to be associated with weathered glass in impact or volcanic sediments, consistent with its enhancement in the duneform deposits studied here. Some of the windows identified in Amazonis also show a correlation with olivine distribution, as mapped by the OLINDEX2 parameter (Figs. 2e,f).

Discussion: Initial results suggest that our methods can effectively identify small but spectrally interesting regions within typically highly dust covered areas of Mars like Amazonis Planitia. Many of these regions appear to be intracrater dune deposits, likely consisting of basaltic sands based on our initial assessments of OMEGA parameter maps. However, not all of the regions yet identified exhibit the same ferrous mineral signatures, suggesting that these deposits could be, or at least could include, a significant component of sediments derived from local bedrock substrate materials, rather than only globally-homogenized aeolian sands. Thus, a more detailed assessment of the mineralogy of these small, scattered low albedo regions could provide new insights into the mineralogy of lavas or other bedrock materials in regions like Amazonis, Tharsis, and Elysium, where large-scale mineralogic assessments of the (presumably basaltic) substrate are presently lacking. Important goals of such an assessment would be to compare the inferred mineralogies of these regions with those of other low albedo regions that have been well-characterized through remote sensing (such as Syrtis Major [9,10] and Acidalia Planitia [8,10]), as well as comparing the inferred mineralogies of the basalts in these provinces to the mineralogy and composition of SNC meteorites [*e.g.*, 11]. Our methods of identifying and characterizing dust-free windows thus have the potential to be an effective way of constraining the mineralogy of large regions of the planet that are obscured by extensive dust cover.

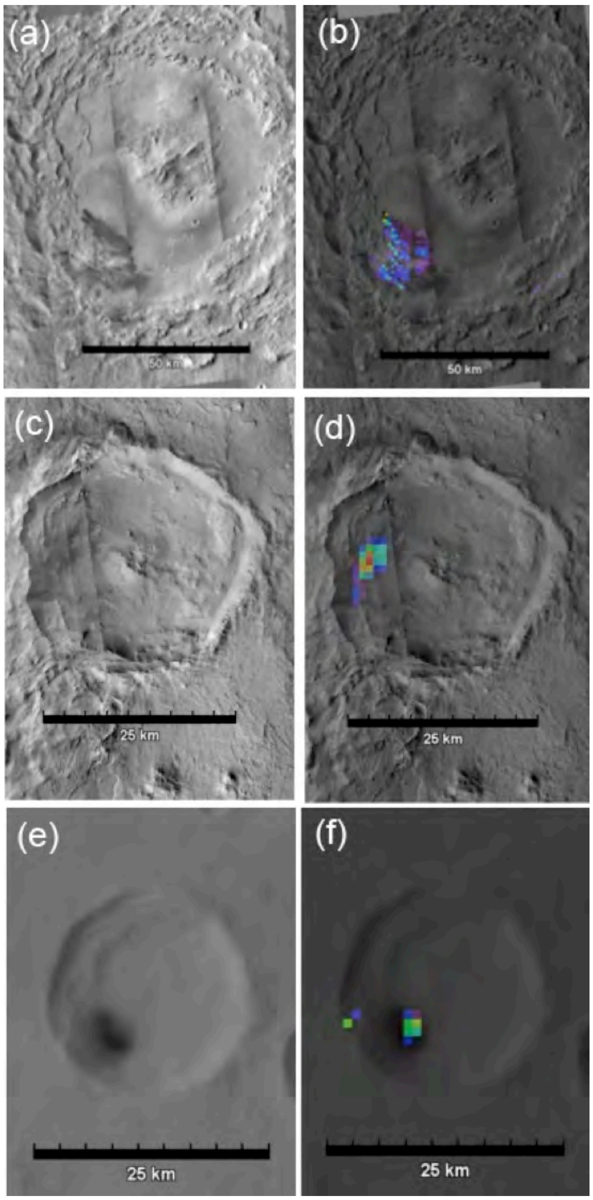

Figure 2. (a) CTX mosaic of the crater containing window #6 from Fig. 1. (b) Spectral slope concavity parameter overlaid on CTX mosaic. Note the spatial coincidence between the parameter signature and window (low-albedo splotch). (c) CTX mosaic of the crater containing window #5 from Fig. 1. (d) Spectral slope concavity parameter overlaid on CTX mosaic. The window, which appears as a low-albedo splotch on the western floor, spatially coincides with the concavity parameter signature. (e) CTX mosaic of the crater containing window #7 from Fig. 1. (f) OLINDEX2 parameter overlaid on CTX mosaic. The primary olivine detection is centered above a low-albedo intracrater dune deposit.

Future work: Our OMEGA-based analysis is being expanded to include a complementary assessment of the bedrock mineralogy of dusty regions in Amazonis, Tharsis, Elysium, and other areas based on the small clusters of mid-IR TES spectra that are being used to initially identify many of the windows through the dust, as well as analyses of higher spatial resolution THEMIS mid-IR multispectral images and CRISM near-IR hyperspectral imaging data sets covering these areas. Time-lapse km-scale color mosaics by the MRO Mars Color Imager (MARCI) during the last three Mars years are also being used to help identify new windows that may have appeared since the end of the MGS/TES investigation [12]. An important goal of this ongoing multi-wavelength, multi-instrument study is to better determine whether significant differences exist between intracrater deposits and other identified low albedo relatively dust-free regions, potentially providing additional support for the hypothesis that the deposits in these windows through the dust truly represent locally-derived bedrock materials.

References: [1] Christensen, P. *et al.* (2001) *J. Geophys. Res., 106*, 23823. [2] Ruff, S.W., and P.R. Christensen (2002) *J. Geophys. Res., 107*, 5127. [3] Bell III, J.F. *et al.* (2012) *LPSC 43rd*, Abs. #1739. [4] Poulet, F., *et al.* (2007) *J. Geophys. Res., 112,* E08S02. [5] Salvatore, M. R., *et al.* (2010) *J. Geophys. Res., 115*, E07005. [6] Horgan, B.H. and J.F. Bell III (2012) *Geology, 40*, 391. [7] Horgan, B. *et al.* (2009) *J. Geophys. Res., 114,* E01005. [8] Horgan, B. *et al.* (2013) this conf. [9] Mustard, J.F. *et al.* (1993) *J. Geophys. Res., 98*, 3387. [10] Rogers, A.D. and P.R. Christensen (2007) *J. Geophys. Res., 112,* E01003. [11] Mustard, J.F. and J.M. Sunshine (1995) *Science, 267,* 1623. [12] Bell III, J.F. *et al.* (2012) *AGU Fall Meeting,* Abs. #24B-05.