Near and Thermal Infrared Remote Sensing of Bedrock and Sand in Dust-Covered Regions on Mars: Assessing Bedrock Mineralogy Through "Windows" in the Dust

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Bright surface dust masks large regions of Mars from detailed mineralogical and petrological analysis using remote sensing. In order to help address this issue, we assessed a number of orbital data sets to identify and characterize small "windows" through the dust that may reveal the underlying bedrock. Data sets assessed include the Mars Global Surveyor orbiter (MGS) Thermal Emission Spectrometer (TES) Dust Cover Index (DCI), Mars Odyssey orbiter Thermal Emission Imaging System (THEMIS) thermal imaging, and Mars Reconnaissance Orbiter (MRO) Mars Color Imager (MARCI) color mapping observations. Data from the MGS Mars Orbiter Laser Altimeter (MOLA) and high-resolution visible-wavelength images from the MRO Context Camera (CTX) and High Resolution Imaging Science Experiment (HiRISE) provided important topographical and morphological context.

We have identified and characterized 67 individual windows in four classically bright regions of Mars: Amazonis Planitia, Arabia Terra, Elysium Planitia, and Tharsis Montes. These windows are characterized by having one or more of the following characteristics in contrast with the surrounding terrain: low DCI value, low MARCI and/or TES albedo, and/or high THEMIS night/day temperature contrast. Windows are typically tens of kilometers across but larger ones hundreds of km across have also been found, most notably in Tharsis. The majority of windows are associated with impact craters, most commonly as intracrater splotches or streaks of warm and/or dark material emanating from the crater. Some of these craters contain outcrops and, in some cases, distinct layers of dark material on their walls or central mound, providing opportunities to analyze bedrock. Other types of windows have also been found in smaller numbers, including those located on the flanks and summits of Mars' most prominent volcanoes, in addition to the walls and bases of cliffs tens to hundreds of meters in height.

Initial near-IR spectroscopic analysis using our mosaicked Mars Express orbiter Observatoire pour la Minéralogie, l'Eau, les Glaces et l'Activité (OMEGA) quadrangles suggested that the surface materials exposed in a small group of Amazonis windows have a basaltic composition, identified by absorption features resulting from the presence of ferrous iron in the mafic minerals pyroxene and olivine. Here we present OMEGA spectra for a collection of selected windows that are most representative of those identified in all four large classical albedo regions listed above. We also describe their associated morphologies and initial interpretations from deconvolved TES spectra and THEMIS decorrelation stretch images, which provide further mineralogical constraints. Our results provide an assessment of bedrock mineralogy in regions that until now have been excluded from mineralogical studies, thus providing a more complete understanding of the overall composition of the martian surface. In the case of windows that do not expose any bedrock, we compare the mineralogy of the surface sediments to that of the classical low-albedo regions of Mars, in order to determine whether bedrock obscured by dust may act as a local source.