

## P21A-06 0915h

### Advance and Recession of the Southern Seasonal Polar Cap as Observed by the Mars Odyssey Neutron Spectrometer

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Data acquired by the neutron spectrometer aboard 2001 Mars Odyssey cover the advance and much of the recession of the seasonal CO<sub>2</sub> cap in the southern hemisphere during 2002 and 2003 (from L<sub>S</sub> 0° to L<sub>S</sub> 250°). We analyzed neutron counting data to determine the areal density (units of g/cm<sup>2</sup>) of the CO<sub>2</sub> frost as a function of latitude on 5° L<sub>S</sub> intervals during southern winter. We determined that the seasonal inventory of surface CO<sub>2</sub> achieved a maximum at 8x10<sup>18</sup> g, roughly 30% of the total atmospheric mass, between 160° and 170° L<sub>S</sub>. The measured latitude dependence of the phase angle of the peak in CO<sub>2</sub> frost inventory was generally consistent with predictions by the Ames Research Center General Circulation Model (GCM). The maximum depth of CO<sub>2</sub>, averaged over the footprint of the spectrometer (roughly 600 km full width at half maximum), was observed to be 105 g/cm<sup>2</sup>. Accompanying the build up of CO<sub>2</sub> frost during winter was a local enrichment of the non-condensable portion of the polar atmosphere, which includes N<sub>2</sub> and Ar. The enrichment of N<sub>2</sub> and Ar was evident from loops traced in parametric plots of thermal versus epithermal count rates as a function of time. Thermal and epithermal neutron count rates depend on the amount of CO<sub>2</sub> frost on the surface. However, while epithermal neutrons are not significantly affected by atmospheric composition, thermal neutrons are strongly absorbed by atmospheric N<sub>2</sub> and Ar. We find that for a given epithermal count rate (or, equivalently, areal density of CO<sub>2</sub> frost), the thermal neutron count rate is lower during the build up of frost during winter than during the recession. Based on this observation, we conclude that the areal density of non-condensibles in the polar atmosphere increases during winter as CO<sub>2</sub> is deposited on the surface, and decreases during spring as the frost sublimates and replenishes the atmosphere with CO<sub>2</sub>. The observed variation in the thermal neutron count rates is consistent with roughly a factor-of-three seasonal variation in the abundance of N<sub>2</sub>+Ar at the south pole. In this study, we use epithermal and thermal neutron count rates to determine the amount of N<sub>2</sub>+Ar in the atmosphere and the areal density of the seasonal CO<sub>2</sub> frost as a function of position and time. The distribution of CO<sub>2</sub> frost determined from neutron spectroscopy is compared to orbital photography and telescopic observations of the seasonal cap boundary. The seasonal variation of N<sub>2</sub>+Ar is used to estimate the degree of horizontal mixing of the polar atmosphere. The measured distribution of surface frost and atmospheric composition are compared with predictions by the GCM.

## P21A-07 0930h

### Density, Depth, and Distribution of seasonal CO<sub>2</sub> deposition on Mars

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Recent observations of the polar cap mass changes by the Neutron Detector on board Mars Odyssey combined with observations of volume change from the Mars Orbiter Laser Altimeter on board Mars Global Surveyor allow estimates of the density of the seasonal deposits. The resulting density is about 0.6 gm/cm<sup>3</sup>, and while it is somewhat lower than previous estimates based on gravity and high-energy neutrons, we do not regard the various estimates as inconsistent since the error budgets are large. The derived density is about one third that of solid CO<sub>2</sub> ice, implying significant pore space in the deposits. Decomposition of the MOLA height changes demonstrates a spatial heterogeneity in frost/snow thickness, that in some cases, correlates with local geologic setting.

## P21A-08 0945h

### Preliminary Thickness Measurements of the Seasonal Polar Carbon Dioxide Frost on Mars

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The exchange of carbon dioxide between the atmosphere and the polar caps on Mars creates a seasonal cycle of growth and retreat of the polar caps. CO<sub>2</sub>, the major component of the Martian atmosphere, condenses in the polar regions of the planet during the winter seasons, precipitating as CO<sub>2</sub> frost. It then sublimates during the spring and summer seasons in response to solar radiation. The concentration of an element within the top few tens of centimeters of the surface is proportional to the flux of the gamma-rays emitted at the element's characteristic energy. Variations in the thickness of the carbon dioxide frost over time can be approximated by observing the attenuation of this signal caused by increases and decreases in CO<sub>2</sub> coverage throughout the Martian seasons.

We have attempted here to quantize the time-dependence, spatial extent, and thickness of the polar carbon dioxide frost through the use of gamma-ray data measured by the Gamma-Ray Spectrometer (GRS) instrument suite on Mars Odyssey. Both the north and south poles are studied using the hydrogen neutron-capture gamma-ray line at 2.223 MeV.

CO<sub>2</sub> thickness versus latitude plots are created by incorporating this gamma-ray flux data binned over 5° by 360° latitude bands. Depths are given in terms of the mass abundance of the column of CO<sub>2</sub> (g/cm<sup>2</sup>) above the surface to avoid assumptions regarding the density of the column. As sublimation of carbon dioxide to the atmosphere occurs on one pole, the growth of the CO<sub>2</sub> cap can be seen on the opposite pole. Retreat/growth takes place at a fairly constant rate as the seasons progress. As expected, greater frost depth is observed at increasingly poleward latitudes for both hemispheres.

The growth and retreat of the seasonal carbon dioxide frost can also be plotted at specific latitudes as a function of L<sub>S</sub>. CO<sub>2</sub> thickness will be plotted for latitudes poleward of approximately ±62.5°. In addition to the increase of frost depth as we move toward the poles, the CO<sub>2</sub> cap coverage continually decreases (increases) over time for any specific latitude band from approximately L<sub>S</sub> = 0° to 180° in the north (south), at which point the frost begins again to condense (sublimate).

Polar maps of the seasonal CO<sub>2</sub> frost can be produced from 5° by 5° gridded gamma-ray data using IDL analysis software and incorporating smoothing techniques. For all calculations, the H gamma-ray signal is basically completely attenuated above 80 g/cm<sup>2</sup>, so accurate CO<sub>2</sub> thickness measurements are not possible.

## P21B MCC: Level 1 Tuesday 0830h

### The Surface Composition of Mars: An Integrated Picture From Orbital, Telescopic, and in Situ Observations I Posters (joint with V)

Presiding: J L Bishop, SETI Institute, NASA Ames Research Center; M D Lane, Planetary Science Institute

## P21B-0045 0830h POSTER

### Identifying Minerals on Mars Through VNIR and Mid-IR Spectral Deconvolution based on the Martian Meteorites

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Coordinated VNIR and mid-IR spectral analyses of the mineralogy of Mars are important in order to fully understand the composition of the surface. We have been refining and testing the Modified Gaussian Model (MGM) developed by Sunshine et al. (1990) on VNIR martian meteorite spectra. This technique enables detection of minerals based on the electronic absorptions in the spectra. Deconvolutions of thermal emission spectrometer (TES) spectra of the same samples are also underway based on spectral features due to vibrational absorptions in the minerals. The martian meteorites included in the study are ALH 84001, EETA 79001, Los Angeles, Dar al Gani 670, and NWA 1068. These samples contain primarily pyroxenes ranging from orthopyroxene to pigeonite to augite, feldspar (and maskelynite), fayalitic and fosteritic olivine, silica, and glass. We are comparing the deconvolution results of the two spectral regions with each other and with the meteorite petrology from other studies. Combining spectral analyses of Martian meteorite chips and powders enables characterisation of spectral bands for remote detection of potential source regions for meteorite-like rocks on the surface of Mars. Although some surface regions have been identified that exhibit the spectral properties of Martian meteorites, these make up only a small fraction of the surface (Hamilton et al., 2003). Deconvolving the spectra of the meteorites down to the minerals present in these rocks also enables spectral searches of one or more mineral components in the Martian spectra without looking for the whole meteorite spectral signature on the surface. We will be applying these techniques to the Imager for Mars Pathfinder (IMP) extended visible-region spectra, the imaging spectrometer for Mars (ISM), and TES datasets. Hamilton, V. E. et al. 2003, MAPS, in press. Sunshine, J. M. et al. 1990, JGR, 95, 6955.

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## P21B-0046 0830h POSTER

### Change of Martian surface height associated with polar cold spots

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For the past 30 years, orbiting microwave radiometers have observed anomalously low emission temperatures during Martian polar winters. While the physical surface temperature cannot drop significantly below 148K—the point at which CO<sub>2</sub> starts to condense—radiometric temperatures of 110K or lower at 25μ wavelength are commonly found in isolated “cold spots” throughout both northern and southern polar winters. These form roughly circular patches, tens to hundreds of km in diameter, and persist for no more than a few days. Three models have been proposed to account for them: (a) an atmospheric effect that accompanies CO<sub>2</sub>

snowfall; (b) fresh surface deposits of CO<sub>2</sub> snow; or (c) a change in the properties of CO<sub>2</sub> slab ice. Following the success of Smith *et al.*<sup>1</sup> in using the MOLA laser altimeter aboard Mars Global Surveyor to directly measure the growth of the winter polar caps, we have applied the same technique to ask whether cold spots are accompanied by a sudden change in surface height. To identify the cold spots, we first examined all polar observations made by the TES radiometer that was co-borested with MOLA, and made gridded images of  $\partial T/\partial \lambda$ , the derivative of the brightness temperature *wrt* wavelength,  $20\mu \leq \lambda \leq 25\mu$ , over  $5^\circ$  ranges in  $L_S$ . A total of 169 cold spots were readily located in the 3 winters (one northern, two southern) during which MOLA operated, and their times of first appearance were noted. We then examined the individual MOLA tracks that crossed these regions from 30 days before, to 30 days after, the cold spot appearances. Three sets of crossing points were assembled: (a) both pairs of tracks were made before the cold spot appearance, (b) both after the appearance, and (c) one before and the other after. For each crossing point, the surface height was interpolated from the 3 nearest altimeter footprints in each of the two tracks. The difference between the resulting pair of heights was averaged over all crossing points, and the RMS variance of the height differences was used as a measure of the statistical error in the measurement. Preliminary results show small height differences before the appearance of a cold spot, as expected, but no abrupt jump in surface height immediately after one appears. This suggests that the cold spots are not formed by deep (> 50cm) CO<sub>2</sub> snow deposits, but it cannot help us decide between the alternatives of CO<sub>2</sub> snowfall or a change in slab ice properties. <sup>1</sup> Smith, Zuber, and Neumann, *Science*, **294**, 2141-2146, 2001.

#### P21B-0047 0830h POSTER

##### Investigations of Hematite Deposits in Valles Marineris

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Gray, crystalline hematite deposits have been identified using Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) data at three areas of Mars: Meridiani Planum, Aram Chaos, and the Valles Marineris system. Detailed studies of the deposits in Meridiani Planum and Aram Chaos reveal that the hematite occurs in coherent, in-place stratigraphic units. In contrast, the Valles Marineris occurrences are small (5 - 35 km) and scattered throughout the canyon system. The largest hematite deposits are in Ophir and Candor Chasma, where hematite appears to be associated with dark materials near or within the interior layered deposits of the canyon and may represent erosional remnants or in-place units within the layered deposits. A variety of different formational processes have been proposed for these layered deposits, many of which involve liquid water. However, little work has been done to date on the context of the hematite in this locality and the relationship with the layered deposits. This study investigates the details of the hematite occurrences in Valles Marineris, re-mapping hematite occurrence at TES pixel resolution and incorporating multiple datasets to further investigate and interpret the formation, compositional relationships, and history of these deposits. Data from the Mars Odyssey Thermal Emission Imaging System (THEMIS), the MGS Mars Orbiter Camera (MOC), and the MGS Mars Orbiter Laser Altimeter (MOLA) are used along with TES data to map the compositional, thermophysical, and geomorphic context of the hematite deposits throughout the chasma system. Numerous small, isolated occurrences are investigated along with the larger deposits in Ophir and Candor Chasma in order to determine whether the deposits share common origins or represent distinct geologic events.

#### P21B-0048 0830h POSTER

##### Thermal Emission Spectroscopy of Sulfates and Sulfate-bearing Minerals: Application to Mars

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Sulfates and sulfate-bearing minerals are likely to be present on Mars as suggested by the sulfur abundances measured at the Viking and Pathfinder landing sites (5-10% by weight SO<sub>3</sub>). The currently orbiting midinfrared instruments (TES, THEMIS) and the Mini-TES on the upcoming landers may enable a positive identification and determination of the chemistry of the sulfates. Critically important to the identification of these minerals is the presence of their spectra in a spectral library. This ongoing study will produce

thermal emission spectra of many sulfates and sulfate-bearing minerals that will be well characterized for inclusion in the online spectral library hosted by Arizona State University.

#### P21B-0049 0830h POSTER

##### TES Mineralogy in the Wings of the CO<sub>2</sub> Band. Constraining the Mineralogy of Type 2 Terrain.

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In search for further telltale mineralogical absorptions to constrain the mineralogy of the Type 2 terrain, we have corrected for the atmospheric absorption in the wings of the 15- $\mu$  m CO<sub>2</sub> band. Bandfield *et al.* (*Science*, Vol. 287, Issue 5458, pp. 1626-1630, 2000) identified two primary types of terrain in TES spectra, one associated primarily with highland material (Type 1 terrain), and the second associated with lowland material (Type 2 terrain). The spectrum of Type 1 terrain was shown to match that of basalt, whereas the best match for the spectrum of Type 2 terrain was shown to be basaltic andesite. Wyatt and McSween (*Nature*, Volume 417, Issue 6886, pp. 263-266, 2002) later showed that the spectrum of weathered basalt could provide an equally good match for the Type 2 terrain. Most recently, Ruff (*Mars* 6, #3258, 2003) searched the 530 cm<sup>-1</sup> region for evidence of clay-type minerals such as Montmorillonite, Nontronite, and Fe-smectite, and found no absorption whose global distribution could correlate to that of the Type 2 terrain. Although the 530 cm<sup>-1</sup> region does contain mineralogical absorptions of interest, it is not the limit, and additional absorptions by plausible alteration minerals can occur further into the shoulders of the CO<sub>2</sub> band. In this work, we corrected the 500-600 cm<sup>-1</sup> region for the effect of the low wavenumber CO<sub>2</sub> wing. Because such atmospheric work requires accurate knowledge of the wavenumbers in the spectra, we recalibrated the TES wavenumbers using the atmospheric absorption of water vapor at high and low wavenumbers, and CO<sub>2</sub> hot- and isotope- bands at the intermediate wavenumbers. This method showed discrepancies (which increased at large wavenumbers) between our results and those reported by the TES team, leading us to adopt our calibrated wavenumbers for this work. To correct for the wings in the CO<sub>2</sub> band, we used the correlated-k method along with the retrievals of aerosol loading and vertical temperature distributions that were originally described by Conrath *et al.* (*JGR*, V.105, E4, pp.9509-9520, 2000) and provided by the PDS. We applied this correction and a band-finding algorithm to the data from the first 3000 orbits. Preliminary results suggest the presence of an absorption band centered at 563 cm<sup>-1</sup>. This absorption exists in some sheet silicates such as smectite clays (*ie*: kaolinite, dickite) and micas (muscovite), some iron oxides (*ie*: hematite, magnetite), and some phosphates (apatite). Further work will involve the inclusion of more observations, mapping of this feature index and a search for features in the higher wavenumber wing of the CO<sub>2</sub> band.

#### P21B-0050 0830h POSTER

##### Thermal Emission Spectrometer Derived Chemical Abundances of Low-Albedo Surfaces on Mars

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The mineralogical and chemical properties of the dust, soil, and rocks that comprise the martian regolith are a reflection of the igneous and sedimentary processes that create and modify these materials. TES derived mineral abundances have been used to constrain the bulk composition of the martian surface and

provide insight to the degree of differentiation of the martian crust and mantle and the nature of surface-atmosphere interactions. TES is primarily a mineralogical tool, but it can also provide a means of estimating chemistry. Bulk rock geochemistry can be accurately calculated from deconvolved modal mineralogies by combining the compositions (wt.% oxides) of the spectral end-members in proportion to their relative modeled abundances. Derived chemical abundances from thermal emission spectra are thus a recasting of rock compositions into a form which complements modeled mineral abundances. In studies of terrestrial volcanic rocks at both laboratory (2 cm<sup>-1</sup>) and TES (10 cm<sup>-1</sup>) spectral samplings, the one- $\sigma$  standard deviations of the absolute differences between measured and modeled major oxide abundances (SiO<sub>2</sub>, Na<sub>2</sub>O, K<sub>2</sub>O, CaO, MgO, FeO, Al<sub>2</sub>O<sub>3</sub>) range from 0.4 to 2.6 wt.%. Derived chemistries have been used to accurately classify volcanic compositions and demonstrate the feasibility of using similar techniques for the interpretation of terrestrial laboratory samples and TES-resolution data. In this study, we report initial global major oxide abundance maps (4 pixels/degree or 15 km/pixel) of low-albedo materials to be used with existing global mineral abundance maps for accurately classifying martian surface compositions. Volcanic rocks are commonly assigned petrologic names by their chemical compositions because their modal mineralogies, even when quantified, are not always diagnostic. TES derived major oxide abundance maps can also serve for comparison to 2001 Mars Odyssey Gamma Ray Spectrometer derived element abundance maps (1 pixel/degree or 600 km/pixel). Examining both mineralogical and chemical relationships over spatial and temporal scales will provide additional insight to better understand the relative roles of igneous and sedimentary processes on Mars.

#### P21B-0051 0830h POSTER

##### Laser-Induced Breakdown Spectroscopy (LIBS) for the Analysis of Water Ice and Water Ice/Soil Mixtures

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The elemental analysis method of laser-induced breakdown spectroscopy (LIBS) is being developed for the stand-off analysis of geological samples for eventual use on robotic landers and rovers on the Martian surface. There is also interest in the ability of LIBS to analyze water ice and ice/soil mixtures. The stratified layers of ice and soil believed to exist in the polar layered deposits represent an archive of the past geologic history of the planet. In addition, the ices may contain remnants of past life, if any, on Mars. LIBS promises to be a very powerful analytical technique for these studies due to its ability to analyze samples at stand-off distances up to 20 m with only optical access to the sample required. In addition, a LIBS measurement can be carried out rapidly (< 2 minutes) and the method has good detection sensitivity for many elements of interest (1-500 ppm). Here the main results of a study to characterize LIBS for the analysis of water ice and water ice/soil mixtures in a simulated Mars atmosphere (7 Torr CO<sub>2</sub>) are presented. Topics to be addressed include (1) the spectrum of water ice and ice/soil mixtures, (2) the effect of water ice concentration on the soil spectrum, (3) detection limits for selected elements in ice/soil mixtures, and (4) the ability to analyze ice samples at distances up to 6.5 m. In addition, the ability to ablate through a thick ice layer (16 mm) while recording LIBS spectra will be described.

URL: <http://libs.lanl.gov>

#### P21B-0052 0830h POSTER

##### Searching for Aqueous Mineralogy on Mars Utilizing a Surface Water Flow Model, Mars Global Surveyor and Mars Odyssey Data

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Studies of Martian surface geomorphology and the recent detection of near-surface water ice by Mars Odyssey gamma ray spectrometer suggest that Mars may have had a water rich past. While 2 to 5 wt.% of carbonate has been detected in the Martian dust (e.g., 1), no spectral evidence for significant deposits of evaporites (e.g., carbonates or sulfates) have been found. Most investigations into Mars aqueous mineralogy have been global in scope with only a few directed studies into localized areas (e.g., 2). We have begun searching for localized deposits of carbonates or sulfates in putative lacustrine basins. We utilize a hydrologic routing model to identify basins with large drainage areas that are shallow because such basins are more likely to accumulate aqueous minerals in high concentration. This model uses MOLA topography to determine drainage and basin patterns and depths of depressions. Evidence for surface water flow activity in these lacustrine basins are then compiled by examination of MOLA shaded relief maps, and available MOC and THEMIS imaging. Shallow basins which contain evidence for surface flow activity (stream features, ancient lakebeds) in the image data are prioritized for spectral analysis. TES emissivity spectra of candidate basins are assembled into a hyperspectral cube that allows visualizing spatial relationships that might be missed if the spectra were examined individually. The Minimum Noise Fraction (MNF) transform algorithm is run on the hyperspectral cube, producing a multiband MNF image. These images allow inter-orbital (i.e., atmospheric) variation to be identified and removed from the scene so that remaining spectral variation is related to surface spectral units. Areas of spatially-continuous MNF values are defined as regions of interest (ROI) and average spectra from each ROI are collected. These mean ROI spectra are examined by linear deconvolution using Acidalia-Syrtis-type, hematite, two atmospheric dust, two water-ice cloud, and surface dust endmembers. Spectra that are not well matched by any combination of the above endmembers are then atmospherically corrected. The atmospherically-corrected spectra are then analyzed by applying both linear deconvolution and the USGS Tetracorder algorithm using the ASU TES spectral library to determine if aqueous minerals are present. We will present TES spectra of lacustrine basins as detected by the basin fill model near Flaugergues crater and discuss their potential to harbor evidence of aqueous mineralogy. [1] Bandfield et al. 2003, Science 301, 1084; [2] Stockstill et al. 2003, Sixth Mars Conf, #3183.

#### P21B-0053 0830h POSTER

##### Thermal Infrared Spectra of Experimentally Shocked Basalt

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We acquired thermal infrared (3-40 microns) emissivity and hemispherical reflectance spectra of experimentally shocked samples of a fine-grained basalt from Grand Falls, AZ to document the spectral effects of shock as a function of increasing shock pressures (17-57 GPa). This sample contains 25% pyroxene, 20% olivine, and 45% feldspar, making it a suitable analog to the Surface Type 1 (basalt) observed in Thermal Emission Spectrometer (TES) data of Mars. Reflectance data (3-14 microns) were acquired using a Nexus 470 FTIR spectrometer at the HIGP, University of Hawaii, and emission spectra (5-40 microns) were acquired using a Nicolet Nexus 670 emission spectrometer at Arizona State University. These data complement similar previous measurements of experimentally shocked plagioclase and pyroxene relevant to interpreting spectra provided by TES. The samples were shocked using the 25-mm barrel gun at Johnson Space Center and provided 400 mg per sample. Large (2-10 mm) chips of recovered material were separated from the samples and washed to remove clinging fines, and the residual was powdered to provide a consistent grain size (~20 microns). Spectra were obtained of both the chips and the powder samples. Results for the chips show a shift in band positions in the 900-1200 wavenumber (wn) region compared to unshocked samples, consistent with the structural degradation of feldspar and subsequent formation of maskelynite and glass. The development of a band near 460 wn at high pressures is also consistent with glass formation in feldspars. Conversely, absorptions related to pyroxene remain present even at high pressures, consistent with previous work. Results for the powders show little variations with increasing pressure except for the loss of minor transparency features in the 800-900 wn region. Additional visible/near-infrared (0.35-2.50 microns) measurements of the powdered basalt samples also will be acquired at the RELAB facility. Future work will include acquisition of thermal infrared and visible/near-infrared spectra of shocked basaltic andesite from SP Flow, AZ. Acknowledgments: The authors thank P. Christensen

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#### P21B-0054 0830h POSTER

##### Gray Hematite Distribution within Valles Marineris

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Valles Marineris is one of three regions on Mars where TES has identified gray crystalline hematite. In the other two locations, Meridiani Planum and Aram Chaos, a strong correlation between the hematite distribution and geologic units has been found. We have used MOC, THEMIS, and MOLA data to determine if a similar correlation exists for hematite within Valles Marineris. After studying the larger patches of hematite within the canyons, we find a correlation between hematite abundance and distinctive geologic units for some patches, but not all. In Ophir and Candor Chasma, the hematite correlates to relatively brighter, dustier units in daytime THEMIS infrared images, but the correlation is moderate and other units with similar infrared properties have no corresponding hematite. Using the narrow angle MOC images, we have determined that the hematite signatures correspond to areas where patches of brighter material are exposed from beneath overlying dark units and dunes. This type of exhumation is similar to the hematite unit at Meridiani Planum. In Eos and Capri Chasma, the hematite appears to cross over geologic units seen in the THEMIS data sets, but no MOC images are available to assess the geology at the higher resolution. The presence of hematite also varies widely with topography, with one patch of hematite occurring across 2 km of relief in central Candor Chasma. In general, hematite occurs more prevalently on the canyon floors adjacent to the interior layered deposits, rather than on the layered deposits themselves. Our current results are based upon the hematite distribution map of Christensen et al. [J. Geophys. Res., 105, 9623-9642, 2000] but we hope to refine these TES positional maps in order to more precisely correlate hematite to geologic features seen in the MOC and THEMIS data sets.

#### P21B-0055 0830h POSTER

##### Glass and Phyllosilicate Obufcation (and Clarification) on Mars

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Several authors have postulated that contributions from glasses and phyllosilicates to thermal emission spectra of the Martian surface may be difficult to distinguish TES spectra. We explore this presumption by generating 336 sets of two-component numerical mixtures of glass and phyllosilicate spectra and then deconvolving these mixtures using a linear least squares algorithm with a variety of end member suites. Three end member scenarios are explored for laboratory, TES, and THEMIS-resolution mixtures: 1) a variety of glasses and phyllosilicates including those used to make the mixture are included in the end member suite (a control case), 2) the glass and phyllosilicate spectra used to make the mixture are excluded from the end member suite, and 3) only the phyllosilicate used to make the mixture is excluded. For each mixture and each end member scenario, the modeled abundances of glass and phyllosilicate are tracked, as are the compositions of the mineral end members used in substitutions. Model results indicate that exchange of glasses for phyllosilicates and vice versa does occur when one or both end members used to make the mixture is excluded. The degree of substitution is variable depending on the specific excluded members, however, a few trends are observed. In end member scenario two, glass is underestimated by 10-64% (absolute) if Si-K<sub>2</sub>O glass is in the mixture, and it is overestimated by 11-50% (absolute) if pure Si-glass is in the mixture. Scenario three shows up to 20% absolute difference from the known fraction of glass content, but most analyses show less than 10% absolute difference. This result suggests that when the correct glass end member is included in the end member suite, phyllosilicate end members only minimally substitute for glass end members.

#### P21B-0056 0830h POSTER

##### High-Silica Rock Coatings on Mars: Constraining Secondary Silicate Mineralogy and Chemical Weathering Processes on Mars.

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Thermal Emission Spectrometer (TES) data have been fundamental to understanding Martian surface mineralogy. These data, however, require careful modeling based on laboratory spectroscopic measurements, and modeling of some minerals for Mars has been equivocal. Due to high degrees of spectral similarity, it is difficult to distinguish silicate glass, clay minerals, zeolites, palagonitized glass, and other secondary products such as amorphous silica as components of surface rock spectra. Deciphering the nature of secondary mineral products on Mars is of key importance to understanding the role of water at the Martian surface over time. It is of central interest to distinguish primary glass from secondary silicate minerals, and secondary minerals from one another to better constrain the degree and mechanisms of aqueous alteration. Observations of Martian surface materials indicate some degree of atmosphere-water-rock interaction. These include nanophase ferric-iron oxides from visible/near-infrared spectroscopy, concentrated hematite deposits identified with TES, high water contents of rocks measured by the Alpha Proton X-ray Spectrometer, sulfate and halide minerals inferred from lander geochemical measurements, and carbonate minerals identified in Martian dust with TES data. Mass balance suggests that if there are oxides, salts, and carbonates there must also be secondary silicate phases present on Mars, which may be identifiable with TES. Identifying the types, distribution, and abundance (or absence) of secondary silicates will enable better constraints to be placed on Martian chemical weathering processes and the role water has played at the Martian surface. We suggest that rock coatings dominated by amorphous silica are geologically reasonable for Mars and may be consistent with TES data. Laboratory measurements of silica-coated rocks show that thin, micrometer-scale silica coatings have a substantial impact on rock spectra. Consequently, if authigenic silicates occur as coatings, small amounts of these materials may be identifiable in TES data. In addition, coating and substrate spectra add non-linearly, and means other than linear mineral deconvolution will be required to model Martian surface mineralogy if coatings are present. Pure SiO<sub>2</sub> coatings, however, cannot explain TES observations. Thus, we are investigating a compositional range of Al-bearing amorphous silicates, including Al-bearing opals and alphanones, for inclusion in thermal emission mineral libraries as possible Martian materials. The positions of spectral features in these materials are predicted to match to TES spectra better than pure SiO<sub>2</sub>. Rock coatings of short-range order aluminosilicates would indicate relatively minor water-rock interaction, and may constrain Mars to a cool and dry yet geochemically active planet.

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#### P21C MCC: 3002 Tuesday 1020h

##### Latest Results From Mars Odyssey II

**Presiding: J L Bandfield, Arizona State University; A B Ivanov, Jet Propulsion Laboratory, California Institute of Technology**

#### P21C-01 1020h

##### Martian Surface Emissivity and Surface Spectral Units: Results from the Thermal Emission Imaging System

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A number of atmospheric correction techniques have been developed for use with data returned from the Thermal Emission Imaging System (THEMIS) onboard