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In this study we report modeling results for anomalies within the region of high field strength in the southern hemisphere of Mars, between 130°E and 240°E. A high resolution magnetic field map of the southern hemisphere produced using mapping phase (approx. 380-450 km altitude) Mars Global Surveyor data has been used to determine the approximate locations of the anomalies within the cluster. An iterative modeling technique (Hood and Zakharian, JGR, v. 206, p. 14601, 2001) has then been applied (assuming circular sources of uniform magnetization and variable diameter) to estimate approximate bulk directions of magnetization, paleomagnetic pole positions and lower limits on bulk magnetization. The estimation of the lower limits on bulk magnetization for the strongest Martian anomalies will indicate whether the presence of unusually highly magnetized material is necessary to explain Martian crustal anomalies or whether they can be explained by large areas of lower bulk magnetization materials. Models for the southern hemisphere anomaly cluster and required bulk magnetizations will be presented at the time of the conference.

P62A-0373 1330h POSTER

Evidence for Weak Crustal Magnetic Fields Over the Hellas Basin

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The Electron Reflectometer (ER) onboard Mars Global Surveyor (MGS) detected a plasma boundary between the ionosphere and the solar wind as the latter is diverted around and past the planet [Mitchell *et al.*, GRL **27**, 1871, 2000; Mitchell *et al.* JGR **106**, 23419, 2001]. Above this boundary the 10-1000 eV electron population is dominated by solar wind electrons, while below the boundary it is dominated by ionospheric photoelectrons. This "photoelectron boundary", or PEB, is sensitive to pressure variations and moves vertically in response to changes in the ionospheric pressure from below and the solar wind pressure from above.

The PEB is also sensitive to crustal magnetic fields, which locally increase the total ionospheric pressure and positively bias the PEB altitude. A map of the PEB altitude closely resembles maps of the crustal magnetic field intensity measured at 400 km by the MGS Magnetometer. As expected, the best correlation is between the PEB altitude and the horizontal magnetic field component, which provides vertical pressure support.

We have analyzed more than 4.8 million electron spectra obtained in the mapping orbit, covering over 1.5 Martian years. We have empirically modeled and removed systematic variations in the PEB altitude associated with the solar wind interaction, thus isolating perturbations caused by crustal magnetic fields. We find a PEB altitude bias over the Hellas basin that is consistent with a horizontal magnetic field with an intensity of several nanotesla at 400 km altitude. This is compatible with upper limits to the horizontal crustal field strength set by MGS Magnetometer measurements. Weak crustal magnetic fields within the Hellas basin suggest that a weak Martian dynamo was still present when that basin cooled. No detectable PEB or magnetic signature is observed over the younger Argyre basin.

P62A-0374 1330h POSTER

Timing the Martian Dynamo II: Impact Basins, Edge Effects and Volcanic Edifices

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The discovery by Mars Global Surveyor of strongly magnetized regions within Mars crust, demonstrated the past existence of an Earth-like dynamo operating in its core and which is now extinct. Because of its intensity Mars crustal magnetization is attributed to thermoremanence (TRM) as the molten material cooled in the presence of the field. A determination of the epoch when this dynamo ceased to operate provides a strong constraint for models of the interior of Mars and its thermal evolution. The close correlation that exists between the magnetized terrain and its age, derived from the cratering record and accepted Lunar/Martian chronology estimates, strongly suggests that the dynamo had ceased to operate when the northern lowlands and dichotomy boundary were formed. Moreover, the absence of magnetization within the Hellas, Argyre and Isidis impact basins also suggests that the dynamo was extinct when they were formed, very early in the planets history. Did the Mars dynamo die and restart at a later epoch when an inner core solidified as some authors have suggested based on Lunar paleomagnetic data? This paper will review the different arguments and present analyses of Mars Global Surveyor, Lunar Prospector and paleomagnetic data which support (or not) the interpretations.

P62B MCC: 131 Saturday 1330h

Closing the Loop: Remote Analysis of Terrestrial and Planetary Surfaces I *(joint with V)*

Presiding: **J Mustard,** Brown University**; M Ramsey,** University of Pittsburgh

P62B-01 1330h

Testing the Foundation: A Blind Test of the Hapke Model

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In order to maximize the remote sensing return from airborne or space based observations of the Earth and terrestrial planets, the foundations of our conceptions must be ruthlessly tested. The connections between space-based, ground-based, and laboratory studies all rely upon fundamental theories and models of the interaction between light and geologic surfaces. The most ubiquitous models are those developed by Hapke [Theory of Reflectance and Emittance Spectroscopy,1993; Icarus, 2002]. We conducted a blind test of the model using the Bloomsburg University Goniometer (B.U.G.) Laboratory [Shepard, LPSC abstract, 2001; see associated URL]. The first author selected and measured the spectro-photometric behavior of well characterized powder samples. The results of the measurements were sent in the blind to the second author who fit the data using the Hapke [1993, 2002] model and made quantitative and comparative estimates of the surface roughness, grain size, sample bulk porosity, and albedo. These estimates were compared with the known properties. A similar blind methodology is suggested for testing our abilities to extract meaningful data using terrestrial analog sites.

URL: http://facstaff.bloomu.edu/mshepard

P62B-02 1345h INVITED

Measured vs. Modeled: The Importance of Model Evaluation in Closing the Loop Between Laboratory and Remote Sensing Spectral Measurements

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With the vast quantities of spectral data returned from current and future planetary missions in this decade it is tempting to focus chiefly on the analysis of these data, searching out exciting new discoveries. However, the knowledge derived from rigorous laboratory research is critically important to the accurate, quantitative interpretation of remote sensing data and must not be neglected during periods of intense planetary exploration. Some of the laboratory work that provides this knowledge is initiated independently of existing remote sensing data, motivated by obvious gaps in our spectral libraries or our understanding of certain processes or conditions affecting the spectral measurement. Other laboratory studies may arise out of discoveries made in the course of analyzing new remote sensing data and point us in new directions that were not obvious routes of exploration before the discovery was made. Regardless of the inspiration for the laboratory research, it is important that we undertake these studies with the goal of applying them to the quantitative analysis of remote sensing data. Achieving this goal requires rigorous testing of compositional and mixing models using a wide variety and large number of samples. The most important products of these tests are well-defined model uncertainties, not only under laboratory conditions, but also under conditions that simulate remote sensing conditions, e.g., spectral resolution, signal-to-noise, elimination of regions obscured by atmospheric absorption, complex mixtures, etc. This presentation will describe existing models, current research, and future directions for laboratory spectroscopy studies that support remote sensing observations, focusing on the need for quantitative analyses that will assure the greater planetary science community that the results we publish are quantitative and useful, and fully close the loop between the laboratory and remote sensing data.

P62B-03 1400h

A Complete First Order Model of the Near-Infrared Spectral Reflectance of the Moon

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Introduction: The spectral reflectance properties of the Moon are governed by the minerals and glasses composing the lunar regolith, their physical state, and the optical effects of soil maturity. Work by Hapke and others has provided all the tools necessary to pro-duce a model of near-IR spectra of the Moon within simplifying assumptions. We have produced such a model and are beginning to apply it to lunar science problems. Two classes of problems are amenable to immediate use: determining compositions of lunar surface regions using groundbased and Clementine data, and understanding the detection limits for miner-als and rock types using existing and planned data sets. Model: Our model is based on the equations of Hapke [1] who showed how the visible and near-IR spectra of mixtures of minerals could be computed from their optical constants at arbitrary grain sizes and relative abundances, and recently it was shown how the method of Hapke [1] could be modified to include the effects of submicroscopic particles [2].

In the forward implementation of the model, the chemistry of minerals, grain sizes, modal abundances and abundance of submicroscopic iron are defined. From the mineral and glass chemistries optical constants are computed, which are then modified by submicroscopic iron coatings. These modified optical constants are then converted to single scattering albedo and mixed according to their modal abundances. Qualitatively, the model produces spectra which closely mimic the appearance of lunar spectra, sharing albedo, continuum slope, and spectral contrast, as well as the shape of the absorption features. Validation of the forward model is proceeding using the spectra and analyses of [3]. The validation will determine, for example, when the model prescribes a certain grain size, or grain size distribution, how this optical grain size corresponds to that measured via sieving.

A recently introduced application of this model is to determine detection limits for minerals as a function of soil maturity and data quality (signal to noise ratio). In this process we model a particular soil composition, ensuring that the model spectrum lies within the field of measured lunar spectral properties. We then vary modal and chemical properties to determine the magni-tude of the differential signal that can be detected by a remote sensor. Our preliminary results suggest that 10% differences in mineralogy can only be detected for the most immature surfaces at the 1% precision of Clementine and groundbased data. Future lunar mis-sions should features sensors with much higher signal to noise ratios.

References: [1] Hapke, B., Theory of Reflectance and Emit-tance Spectroscopy, Cambridge Univ. Press, Cambridge, 1993, [2] Hapke, B., , J. Geophys. Res., 106, E5, 10,039-10,074,, 2001., [3] Taylor L. A., Pieters C. M., Keller L. P., Morris R.V., McKay D. S. (2001), J. Geophys. Res. 106, 27,985-27,999.

P62B-04 1415h INVITED

A physical model and inversion approach for remote measurement of snow properties.

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A physical model has been developed for the spectral reflectance of snow based on the complex refractive index of ice. Mie scattering calculations have been used to model the single scattering properties of ice spheres over the spectral range from 400 to 2500 nm at 1 nm spectral resolution. These calculations span a range of grain size and liquid water content. With these inputs, a discrete ordinate radiative transfer code has been used to model the spectral reflectance properties of a snow over a range of grain sizes, melting conditions, illumination, and observation conditions. This model was used to derive grain size and liquid water fraction parameters (with units and uncertainties) from imaging spectrometers measurements. The model has shown good agreement with measured snow reflectance spectra where the liquid water fraction and grain size were independently measured. This remote measurement approach is based upon the optical constants of water and calculations describing the interaction of electromagnetic radiation with matter. It provides an example of the type of remote measurement approach based in physics that may be pursued for other more complex materials.

P62B-05 1430h INVITED

Verification of Imaging Spectroscopy Materials Maps

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Imaging spectroscopy data has the spectral resolution needed to be able to identify and map specific mineralogy and other materials in a spatial context over larger regions with detail never before possible. Verification of mapped mineralogy, however can be extremely difficult. Verification requires methods independent of the analysis algorithms.

Virtual verification can be done by examining the remote sensing data directly if there is sufficient spatial and/or spectral information to positively identify objects in the image by inspection. Certain materials have unique absorption features so that they can be verified by extraction of spectra with a computer and without visiting the site. However, such virtual verification can only have a high certainty if the spectral feature is strong relative to the noise in the spectrum, and if there are no other minerals present with similar spectral features that can confuse the identification.

In situ verification requires direct sampling of the environment to verify the remotely sensed information. Samples are then analyzed by classical methods including X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Induction Coupled Plasma (ICP), lab-spectroscopy, hand lens, streak, and acid-fizz tests. Analyses like XRD have different sensitivities than do spectroscopy, so one method may detect some materials while another method detects different ones, both being correct. For example, vis-near-IR spectroscopy is usually more sensitive to iron oxides and clays than XRD, but XRD is often more sensitive to carbonates.

To add to the difficulty in verification of imaging spectroscopy analyses, subtle differences in spectral feature shapes are often required to distinguish small changes in mineralogy and those changes may be difficult to detect in the field. Examples of field data collected along traverses for verification of AVIRIS mineral maps will be shown to illustrate the subtleties in spectral discrimination required the identify and map variations in mineralogy. We have found that spectral feature fitting algorithms often find significant mineralogical differences using the 3rd decimal place of the correlation coefficients even at levels greater than 0.95. Such discrimination requirements imply the need for very high signal-to-noise ratios and an accurate calibration to reflectance.

URL: http://speclab.cr.usgs.gov

P62B-06 1445h

Quantitative Estimates of Land Surface Emissivity Using ASTER Data

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With the successful launch of the Terra satellite in December 1999 a new tool for observing land surface properties became available, i.e. multispectral thermal infrared data from the Advanced Spaceborne Thermal Emission and Reflection (ASTER) radiometer. ASTER has 5 channels in the 8 to 12 micrometer wave band with 90 meter resolution. These data can be used to assess the spectral variations of surface emissivity. Knowledge of the surface emissivity is important for determining the radiation balance at the land surface. This is significant for arid lands with sparse vegetation because the emissivity of the exposed soils and rocks is highly variable. The results we will present are from ASTER data acquired over the Jornada Experimental Range in New Mexico during 2000, 2001 and 2002. The Jornada site is typical of a desert grassland where the main vegetation components are grass and shrubs with a large fraction of exposed soil. The Temperature Emissivity Separation (TES) algorithm is used to extract the temperature and 5 emissivities from the 5 channels of ASTER data. TES makes use of an empirical relation between the range of observed emissivities and their minimum value. In spite of the 90 m resolution, the results appear to be in quantitative agreement with laboratory measurements of the emissivity for the quartz rich soils of the site with values $<$ 0.85 for the 8 - 9 micrometer channels. For the longest wavelength channel little spatial variation of the emissivity was observed with values of 0.96 +/- 0.005 over large areas. The White Sands National Monument with its dunes of gypsum sand was also within several of the scenes. Emissivity values from the ASTER data from these scenes for the gypsum at White Sands were in good agreement with values calculated from the lab spectra for gypsum and with each other. The results for vegetated targets show little or no spectral variation with emissivities $>$ 0.97. Ground TIR brightness temperature measurements were made in 7 x 7 grids with 5 m spacing using broadband radiometers at several sites. The resulting average temperatures were in good agreement with those derived from the ASTER data.

P62B-07 1500h

Thermal Infrared Surface Mineral Mapping at Steamboat Springs, Nevada: Comparison of Airborne and Field Spectral Measurements

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This study focuses on corroboration of remotely derived surface mineral maps based on thermal infrared (TIR = 7-14 microns) radiance measurements of field samples from Steamboat Springs, Nevada. Steamboat Springs is an active geothermal area with recent siliceous sinter deposits and a variety of exposed alteration minerals, including kaolinite, alunite, chalcedony and quartz. Wavelength-dependent reflection and absorption characteristics in the TIR range are diagnostic of most rock forming minerals, such as silicates, carbonates, and sulfates. Overlapping MASTER and SEBASS airborne TIR image data were acquired over Steamboat Springs in September 1999. The MASTER instrument has 10 channels in the TIR region and spatial resolution of 5 m, and SEBASS has 128 channels in the TIR and 2-m pixels. For each instrument, TIR emissivity spectra were extracted from atmospherically corrected radiance data and compared to field- and laboratory-measured emissivity spectra of samples collected from numerous sites within the scenes. Field sites were typically sampled over a 15x15 m^2 area and spectral data from 5-10 samples at each site were averaged together to represent the area covered by a 3x3 pixel region in the MASTER image, and a 7x7 pixel region in the SEBASS image.

Mineral maps were created by classifying image pixels based on matching known input spectra to unknown image spectra. MASTER and SEBASS both distinguish silica- and clay-rich areas. Minerals identified remotely generally agree with the dominant minerals identified in the lab. The best agreement occurs where the ground is warm and vegetation is sparse. Poor correlation between remote, field, and lab spectra occurs in areas that are shadowed or more densely vegetated. Hyperspectral TIR data show significant improvement over multispectral thermal imaging by distinguishing a wider variety of surface materials.

Mineral maps will be presented along with spectral emissivity data acquired in the field as well as from samples measured in the laboratory.

P62B-08 1535h INVITED

Observations and Modeling of Dust Deposition and Disturbed Surfaces on Mars and Earth

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Visible/near-infrared and thermal infrared spectroscopy of planetary surfaces undergoing physical weathering provides opportunities to study the compositional properties of subsurface and surface materials. Field, laboratory, and remote observations of surfaces subjected to either natural erosion or deposition (e.g., aeolian, fluvial, or slope processes) or man-made disturbances (e.g., robotic rover operations) can be combined with theoretical modeling to better understand spectral variations and prepare for future observations.

In the thermal infrared, disturbed soils exhibit decreased spectral contrast due to fine-grained particle coatings, some of which may be compositionally different than the surface. In the visible/near-infrared, similar compositional effects are observed, combined with albedo variations. During the 1999 Marsokhod rover field test, disturbed soils were brighter and exhibited more clay-rich spectral features. But during the Mars Pathfinder (MPF) mission, rover tracks were darker than undisturbed terrain and exhibited spectral variations suggestive of coarser-grained subsurface soils. This is consistent with a thin dust layer comprising the pristine soils, most likely fall-out of atmospheric dust. Laboratory analyses of airfall-deposited dust on rocks show decreases in spectral contrast in the thermal infrared and increased albedo in the visible/near-infrared consistent with these observations.

On Mars, dust deposition affects solar power production and calibration of data. Observations and radiative transfer modeling of the MPF calibration targets show dust contaminated the surfaces at the MPF site. Additional modeling efforts will be bolstered by new goniometer measurements of dust-coated rocks and other lander/rover components obtained at a variety of illumination geometries and wavelengths.

The synergistic exploration of field, laboratory, and in-situ rover observations combined with theoretical modeling will improve our understanding of dust deposition and disturbed soil effects on Mars and Earth and our ability to determine composition of both dust coatings and underlying materials. The upcoming Mars Exploration Rovers are planning observations to track and compensate for the effects of atmospheric dust deposition, as well as investigate soil disturbances to compare the surface and subsurface properties of soils.

P62B-09 1550h INVITED

Synthesis of Orbital and Rover-based Infrared Remote Sensing in the Exploration of Mars: Lessons Learned from Terrestrial Field Experiments

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NASAs strategy for the exploration of Mars calls for extensive orbital reconnaissance to precede detailed exploration by rovers at selected sites on the surface. Infrared mapping of surface composition by the Mars Global Surveyor Thermal Emission Spectrometer (TES) and Mars Odyssey Thermal Emission Imaging System (THEMIS) experiments is currently setting the stage for the twin Mars Exploration Rovers, which will land in 2004. Each of these rovers will carry a miniature thermal emission spectrometer for remote determination of the composition of rocks and soils at the landing sites. The combination of overhead IR remote sensing at modest spatial resolutions (3km spectroscopy and 100m imaging) with close-up rover-based spectroscopy in the same wavelength region will provide unique scientific and operational advantages, as well as a few challenges. Overhead remote sensing can be used to set the overall regional geologic context for a rover landing site, which in turn can lead to more strategic, hypothesis-driven exploration by the rovers. At grab bag landing sites, where multiple rock types may have been transported from distant sources, rover spectra of suspected exotic rocks may be compared to the spectra of units mapped from above to determine provenance. The relatively short atmospheric pathlength inherent to most rover spectral observations will facilitate their use as calibrators of atmospheric removal techniques used on orbital data. Rover-based spectra of rocks on the martian surface may not be immediately comparable to orbit-based or lab spectra, however. In particular, the somewhat unusual horizontal-viewing geometry inherent to rover observations is prone to target adjacency effects that can change the spectral contrast and shape of a rocks thermal infrared spectrum relative to how it would look from above or in a lab spectrometer. Examples of the synergies between orbital remote sensing and rover spectra, as well as illustrations of some of the challenges involved in making comparisons, will be drawn from work at blind rover field tests and field work the author has been involved in over the past several years.

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P62B-10 1605h INVITED

Expanded Coverage: Mid-infrared Field Spectroscopy Through a Range of Distances and Viewing Angles

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Field spectroscopy for geological applications typically is done to support airborne or orbital remote sensing data sets. In this context, a tripod-mounted field spectrometer is oriented in a downward-viewing position to simulate the nadir views provided by a remote sensing platform. The upcoming 2003 Mars Exploration Rover (MER) mission will include a mid-infrared spectrometer (mini-TES) that will view its surroundings through a periscope-like mast mounted to the deck of the rover. The role of this instrument is to offer remote compositional analysis of the different materials within view of the rover. The scene will be observed through a range of distances and angles unlike those of typical field spectral measurements. In an effort to gain experience with such measurements, a Designs and Prototypes micro-FTIR mid-infrared field spectrometer (7-14 microns) was used during a NASA-sponsored MER mission simulation exercise in the summer of 2002. During this 10-day exercise, 60 rock and soil targets were measured with the spectrometer. The targets ranged from those directly below the tripod-mounted spectrometer to those several 10s of meters away on boulders and cliff faces in the vicinity of the rover. Atmospheric downwelling radiance can be a significant contribution to such measurements and must be accounted for to achieve well-calibrated spectra. For targets in the near-field, a gold diffuse reflector plate was measured to characterize the downwelling radiance. For more distant targets, this measurement was impractical. It was found that a direct measurement of the sky with the spectrometer fore-optic oriented at 30 degrees above the horizon could be used in the calibration of spectra from more distant targets. Using this strategy, spectra from the far-field targets were remarkably interpretable, bringing a true remote sensing capability to the field setting. No adverse effects of viewing targets off-nadir were observed. The results from the field exercise bode well for the success of similar measurements to be obtained on the surface of Mars.

P62B-11 1620h

Mars Infrared Spectroscopy: From Theory and the Laboratory to Field Observations

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Visible-infrared spectroscopy has a long history of providing compositional discoveries in the solar system. A primary goal of the Mars visible-infrared spectral community is to provide information to enhance the exploration of Mars.

We are entering an era of Mars exploration with missions every 2 years. It is critical that each mission provide information to optimize the success of the next mission. That will not occur effectively unless the data can be analyzed on a 2-year rate. Our current knowledge of spectral properties of materials and effects of the natural environment are not sufficient for the accurate interpretations needed for such time critical objectives. Relevant instruments include the 1996 TES, 2001 THEMIS, 2003 Mars Express OMEGA and PFS, 2003 MER Pancam and Mini-TES, and the 2005 CRISM.

Two critical gaps that cannot be filled by individual researchers alone exist in moving toward the goal of rapid and accurate analysis. These are in coordinated "end-to-end" field testing and public spectral libraries. Three related gaps are in data from terrestrial sites to aid interpretations of the orbited spectrometers, lack of high quality development data to support landers, and delays in funding non-flight team members owing to lack of coordination between research and analysis proposal dues dates and mission data releases. A detailed discussion of the each of these areas is in a workshop report through the web site below. The two critical gaps are summarized below.

Field Testing.

Field/rover, airborne/satellite, and telescopic measurements are sensitive to very different effects, and these differ from those present in the lab. Thus a convincing determination of uncertainties requires demonstration through coordinated "end-to-end" field testing, using:

(1) Data sets of appropriate terrestrial analog sites that are measured with both geometric and spectral fidelity as close as possible to flight instruments; (2) Interpretation as applied to data of Mars; (3) Reporting interpretations at a community workshop, including a "blind test"; (4) Validation through ground truth.

This will:

(1) Test mission protocols and interpretation methods ; (2) Develop theoretical ties and address uncertainties in detectability, uniqueness of identifications, abundance mapping, and atmospheric compensations; (3) Prepare the community to interpret flight data in a timely manner; (4) Help define and highlight gaps in public spectral libraries, and the importance of the libraries and theoretical work to interpretations.

Coordination through an independent group is critical to maintain and facilitate a clear focus on addressing the central questions. This is imperative to support timely interpretations and to plan and manage future flight instruments, but it cannot be achieved by individual researchers alone.

Public libraries of spectroscopic data.

Interpretation quality is limited to the quality of the accessible spectral libraries. Current public libraries focus on specific issues or conditions (e.g. major groups of igneous minerals). Primary gaps include (1) measurements of other weathering products, coatings, surface textures, particle size ranges; (2) measurements under simulated Martian conditions; (3) transfer of private libraries into the public domain; and (4) systematic development of fundamental optical constants for modeling.

URL: http://www.lpi.usra.edu/science/kirkland

P62B-12 1635h

Closing the terrestrial-planetary remote sensing loop: Spectral, spatial and physical proxies

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The physical and erosional environments on Earth and Mars are clearly very different, however current instruments orbiting each planet offer a unique opportunity for comparative studies. Thermal infrared (TIR) images from the Thermal Emission Imaging System (THEMIS) instrument now returning data from Mars offer the potential of mapping very small regions, with detection limits as low as 500 - 1000 m^2. The Earth-orbiting Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) instrument compares favorably to the spectral and spatial resolution of THEMIS and can be used to test spectral analysis models. However, accurate mineral identification using techniques such as linear deconvolution can be hindered by the multispectral resolution of these instruments, the robustness of current spectral libraries, and complicating surface factors such as dust. The accuracy and confidence in such modeling approaches must rely on precursor field and laboratory investigations that develop a methodology for quantitative extraction of mineralogy using scale-dependant modeling, while completely exploring the data sets.

The fundamental goal of remote sensing measurements, whether in the laboratory or from space, is to determine the physical and chemical characteristics of the object under study. One technique employed to ascertain the surface mineralogy is spectral deconvolution, which has been used for a variety of scientific problems involving mixture analyses. This methodology is constrained by several assumptions in order to provide meaningful results. Foremost, the approach allows a maximum number of end-members equal to one plus the total number of equations or instrument wavelengths. This becomes a critical limitation in attempting to deconvolve multispectral data using large spectral end-member libraries. In other words, analyses of these data sets requires a robust search algorithm to winnow mineral libraries for the best possible subset of end-member spectra. This approach is currently being investigated through the use of a combinatorial deconvolution model. Much of the development and testing of this model was carried out on Mars surface analogs such as active dune fields, recent impact craters, and hydrothermal volcanic terrains. In addition, laboratory and field-based TIR spectra have been incorporated. The initial results are promising, with the model correctly identifying the proper suite of end-members in over 94% of the pixels within the dune image. These values of the derived surface percentage also compared very well with previous results. Further analysis of similar proxy data sets should provide insights into fundamental geologic surface processes, and help close the loop between terrestrial and planetary remote sensing.

P71A MCC: Hall D Sunday 0830h

Terrestrial Analogues for Planetary Studies II Posters *(joint with A, B, H, OS, T, V, GC, MR)*

Presiding: **T K Gregg,** University at Buffalo**; N A Cabrol,** NASA Ames Research Center

P71A-0432 0830h POSTER

Terrestrial Analogs to Mars: NRC Community Panel Decadal Report

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A report was completed recently by a Community Panel for the NRC Decadal Study of Solar System Exploration. The desire was for a review of the current state of knowledge and for recommendations for action over the next decade. The topic of this panel, Terrestrial Analogs to Mars, was chosen to bring attention to the need for an increase in analog studies in support of the increased pace of Mars exploration. It is well recognized that interpretations of Mars must begin with the Earth as a reference. The most successful comparisons have focused on understanding geologic processes on the Earth well enough to extrapolate to Mars' environment. Several facets of terrestrial analog studies have been pursued and are continuing. These studies include field workshops, characterization of terrestrial analog sites, instrument tests, laboratory measurements (including analysis of martian meteorites), and computer and laboratory modeling. The combination of all of these activities allows scientists to constrain the processes operating in specific terrestrial environments and extrapolate how similar processes could affect Mars. The Terrestrial Analogs for Mars Community Panel has considered the following two key questions: (1) How do terrestrial analog studies tie in to the overarching science questions about life, past climate, and geologic evolution of Mars, and (2) How can future instrumentation be used to address these questions. The panel considered the issues of data collection and archiving, value of field workshops, laboratory measurements and modeling, human exploration issues, association with other areas of solar system exploration, and education and public outreach activities.

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Rock-Mechanical Constraints on SPH Applications to Asteroid Impact Evolution

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The smooth particle hydrodynamics (SPH) code as adapted for dynamic brittle fragmentation (Benz and Asphaug 1994, 1995) has become a leading technique for modeling meteoroid collisions into asteroids with realistic geologies and shapes (Asphaug et al., Icarus 1996; Nature 1998). Together with earlier techniques relying on the same Weibull-based Grady-Kipp fracture model (e.g. Melosh et al. 1992), it has been used to establish that asteroids larger than a few hundred meters diameter are rubble piles (Benz and Asphaug, Icarus 1999), and is applied for learning how binary asteroids form during tidal events and collisions (Michel et al., Science 2001) and how craters and regolith form on irregular, rotating bodies. But all of these applications, especially when the outcome involves a consideration of mechanical strength, rely upon the assumption that flaws are distributed according to a Weibull distribution throughout a rock mass, and that those flaws are activated dynamically and relieve local stress in a circumscribing volume. Our SPH fragmentation code has been calibrated against a variety of laboratory impact