

P62B-10 1605h INVITED

Expanded Coverage: Mid-infrared Field Spectroscopy Through a Range of Distances and Viewing AnglesSteven W. Ruff¹ (480-965-6089; ruff@tes.asu.edu)Amy Trueba Knudson¹Trevor G. Graff¹Timothy D. Glotch¹Joseph R. Michalski¹¹Arizona State University, Department of Geological Sciences, Moer Building Room 131, Tempe, AZ 85287-6305, United States

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 ObservationsLaurel Kirkland¹ (281-486-2112; kirkland@lpi.usra.edu)John Mustard² (John_Mustard@Brown.edu)John McAfee³ (mcphi@lanl.gov)Bruce Hapke⁴ (hapke+@pitt.edu)Michael Ramsey⁵ (ramsey@ivis.pitt.edu)¹Lunar and Planetary Institute, 3600 Bay Area Blvd., Houston, TX 77058-1113, United States²Brown University, Box 1846, Providence, RI 02912, United States³Los Alamos National Laboratory, MS P918, Los Alamos, NM 87545, United States⁴University of Pittsburgh, 200 SRCC Building, Pittsburgh, PA 15260, United States⁵University of Pittsburgh, 200 SRCC Building, Pittsburgh, PA 15260, United States

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 m². 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.

Parts of this work were performed under contract to NASA.

URL: <http://www.aas.org/~dps/decadal/>

P71A-0433 0830h POSTER

Rock-Mechanical Constraints on SPH Applications to Asteroid Impact EvolutionLindsey Bruesch¹ (831 459 5778; asphaug@es.ucsc.edu)Erik Asphaug¹ (831 459 2260; asphaug@es.ucsc.edu)¹University of California (UCSC), Earth Sciences Department, Santa Cruz, CA 95064, United States

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

experiments, but never for a suite of experiments spanning size scale and energy scale. It would be prudent, before relying upon model predictions for km-scale rock masses, to benchmark our code against laboratory experiments, in particular the controlled set of laboratory experiments of Housen and Holsapple (Icarus 1999) designed to examine the dependence of a body's strength on its size. On our new computers we are running suites of numerical simulations to reproduce these experiments in which our only varied parameters are the laboratory impact conditions themselves: projectile and target diameter, for identical rock types (granite and basalt).

P71A-0434 0830h POSTER

Alteration Mineralogy and Geochemistry at Swansea, Arizona: A Potential Analog for Brine-Basalt Interaction on Mars

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In this study, we use thermal infrared spectroscopy and petrographic and chemical analyses to understand the alteration mineralogy and geochemistry at Swansea, Arizona. The goals of the study are to: 1) understand the alteration and mineralization history of the Swansea area, 2) determine the relationship of alteration at Swansea to regional tectonism, 3) model the geochemistry of the mineralizing fluid and its relationship to fluids that altered the adjacent Harcurvar Mountains, and 4) establish a relationship between field observations, geochemical and mineralogical studies, and remote sensing of hydrothermal alteration of basalt as a planetary analog.

Swansea is located in the Buckskin Mountains of western Arizona. The various host rocks at Swansea have been largely hydrothermally altered, and have undergone Cu-Fe-Mn mineralization. Bulk mineralogies of samples of basalt, limestone, and basin fill conglomerate, were determined from deconvolution of thermal infrared spectra. Mineralogy recovered from spectral deconvolution was confirmed by X-ray diffraction. Basalt has been completely metasomatized to calcite, clay, hematite, and potassium feldspar. Conglomerate, which originally consisted of clasts of felsic and intermediate crystalline rocks, has been altered to clay, potassium feldspar, and calcite. Limestone was altered to mostly calcite with minor clay, potassium feldspar, and hematite.

Mineral mapping using Landsat TM ratios and deconvolution of Thermal Infrared Multispectral Scanner (TIMS) data show that: 1) mineralogies of field samples are representative of the sampled rock units, and 2) alteration was pervasive throughout the Swansea area. Similar alteration has been documented in the Harcurvar Mountains to the east, where deep (10 km) crustal brines that migrated along the Tertiary Buckskin-Rawhide detachment fault metasomatized various host rocks. However, alteration mineralogy in the Harcurvar Mountains includes abundant quartz and is calcite-poor. The fluids that altered each locality are likely genetically related, but their chemistry may reflect evolution of the fluid through time and space.

Future work will include the development of a model for alteration of basalt by brine on the Earth and Mars. Although some of the variables between terrestrial analogs and Martian conditions are obviously different, this study may lead to models of alteration or albification of basalt by brines on Mars.

P71A-0435 0830h POSTER

The Thermal Environment of the World's Highest Lake: Results from the First Field Season at Licancabur Volcano and Implications for Astrobiology

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At 5916 meters above sea level, the crater lake of Licancabur volcano (22°50' S 67°53' W) is the highest lake in the world and remains largely unexplored. In particular, the physical environment of the lake is not well understood: in this part of the Andes, liquid water is uncommon above 17,000 feet (~5200 meters). Most high lakes of the region are permanently frozen, and according to one account, water was even poured and frozen for a building foundation (Rudolph 1955). However, the crater lake at Licancabur is ice covered only part of the year and has higher bottom water temperatures than predicted. Calculating the temperature of maximum density (as per Eklund 1983) suggests that bottom waters should be no warmer than 4 °C, while a high-altitude diving expedition measured them at 6 °C (Leach 1984). Here, we investigate the possibility that the bottom water temperature anomaly may be due to one or more of the following factors: 1) geothermal heating, 2) solar heating/greenhouse effect from ice cover, and 3) heating due to environment/local topography, especially seepage of heated groundwater from the crater walls.

The role of geothermal heating in the energy budget of the Licancabur crater lake is estimated here using measurements of water column temperature and heat flux from the bottom sediments. We also present temperature data for the water column and bottom sediment, as well as profiles of the pH and total dissolved solids (TDS) as a function of depth. Dataloggers will also be placed in the lake and surrounding terrain to monitor the effects of solar UV flux and ice cover on the lake's energy budget through the course of one year.

Future work will continue to this end?to better understand a unique terrestrial environment in terms of its counterparts on Earth?but will also be applied to better understand the environment and history of analogous sites elsewhere in the solar system. In particular, the low temperature, low pressure, high UV environment atop Licancabur makes it a unique terrestrial analog to relict lacustrine environments (e.g. volcanic lakes, impact crater lakes, hot springs, etc.) that may have given refuge to life on Mars. Results from this and future field seasons will be applied to constrain models of martian impact crater lake cooling and to better target future astrobiological missions to Mars.

P71A-0436 0830h POSTER

Modeling Shoreline Formation on Mars and Titan

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We present forward models of crater lake basin evolution motivated by the identification of intracrater landforms on Mars which exhibit possible evidence for a history of surface water. Proposed lacustrine Martian landforms include shorelines, terraces, and wave cut benches features that have received considerable attention in terrestrial lacustrine geomorphology but which have never been quantitatively addressed with sufficient rigor on Mars. In particular, the existing body of terrestrial research has yet to be applied adequately to planets of different gravity, temperature (or working fluid) and atmospheric pressure, such as Mars and Titan.

Geomorphic evidence of surface water on Mars has important implications for planetary surface evolution, as well as for the continuing exploration of the planet as future landing sites are selected. Here we present the first quantitative forward modeling of shoreline formation under Martian conditions. Model parameters include basin size, initial topography, rock hardness, and the effects of crater impact formation on the subsequent erosional process and on sediment migration within the basin. Equations for erosion are based on terrestrial rocky coastline evolution model and have been modified for martian conditions, for instance how gravity, wind speed, and basin size, especially as the latter affect wave length and amplitude. This model will be modified for Titan as described above to explore intracrater lacustrine and shoreline processes in anticipation of the arrival of the Cassini spacecraft in the Saturn system in 2004.

P71A-0437 0830h POSTER

Pahoehoe Flows with a'a Margins: Surface Morphology, Emplacement Styles, and Fractal Dimensions

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Using the structured-walk technique described by Bruno et al. [1994], we determined the fractal dimensions of the margins of the following lava flows erupted from the East Rift Zone of Kilauea volcano, Hawaii: the 1960 Kapoho flow, the 1970, 1972, and 1974 Mauna Ulu flows, and the 1990 Kalapana flow.

Previous work determined that Hawaiian a'a lava-flow margins have fractal dimensions (D) of 1.05-1.09, whereas for pahoehoe lava-flow margins, D = 1.14-1.23. Our work emphasizes that the fractal dimensions of flow margins do not define the surface flow morphology; but rather lava emplacement style or mechanism. A'a flows are commonly channeled, or emplaced as a single continuous lobe, and pahoehoe flows are ordinarily emplaced as a complex network of interconnected lobes. Thus, a flow with a'a surface morphology may have had a pahoehoe-like emplacement yielding a fractal dimension that falls in the pahoehoe range. For example, the surface of the 1960 Kapoho flow clearly displays an a'a morphology: the margin displays D = 1.1805; r² = 0.9851. This dimension falls within the pahoehoe range indicating that this flow was emplaced via a complicated lobe network.

Similarly, margins of individual channeled pahoehoe lobes within the 1972 Mauna Ulu flow were measured. A lateral margin gave D = 1.0821 with r² = 0.9722; a terminal margin yielded D = 1.0597 with r² = 0.9178. The fractal dimensions of both these pahoehoe lobes fall within the a'a range because they were emplaced as a single, channeled unit. These examples illustrate the dominance of internal dynamics of the flow over the surface texture in generating a lava-flow margin

P71A-0438 0830h POSTER

Compound Lava Flow Fields on Planetary Surfaces: Hawaiian Analogue Studies

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Quantitative, process-oriented analyses of planetary volcanism have primarily been based on analogue studies of single-lobed lava flows emplaced as discrete units. Comparative analyses of compound lava flow fields on the Earth and terrestrial planets are being conducted in order to include volcanic styles characterized by complex distributary systems, stratigraphic relationships, and emplacement histories. Field observations, differential Global Positioning Systems (dGPS) measurements, and visible, thermal, and radar remote sensing are being used to characterize Hawaiian lava flow fields and develop techniques for analyses of planetary flow fields using datasets with high spatial and/or spectral resolution, such as MOC and THEMIS. These terrestrial studies allow flow field surface morphology, topography, and lava textures as well as detailed maps of distributary networks to be used to examine flow field growth and development. Information on flow field evolution is provided by delineating relationships between remote sensing signatures, surface morphology, and lava transport processes and by identifying input parameters for flowfield emplacement models.

Investigations of the Mauna Ulu (1969-1974) and Puu Oo (1983-present) flow fields (Kilauea Volcano, HI) have focused on understanding the nature of distributary networks at various scales in order to determine spatial and temporal variations in lava transport. Initial work at Mauna Ulu has included analyses of 1) the distribution, network morphology, and volumetric significance of lava channels in the medial zone of the flow field, and 2) the distribution, lava texture, and volumetric significance of breakthroughs from surface conduits and subsurface storage. Analyses of the temporal evolution of individual conduit systems provide the basis for interpretation of complex patterns of overlapping surface units that characterize local flow stratigraphy. Reconstruction of lava transport networks and relationships to surface units in terrestrial flow fields is critical for evaluating flow field emplacement on planetary surfaces.

P71A-0439 0830h POSTER

Detecting lunar lava tubes by a landing mission with the Ground Penetrating Radar

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Lunar mare lavas are previously believed to be formed by vast eruptions of flood-type lavas, however, some features of mare lava flows including sinuous rills and rimae (collapsed features) suggest that they can be related to slow movements of low-viscosity lava flows. These features are often interpreted to be formed by successive collapses of roofs of ancient lava tubes. Recent studies show that lava tubes enhance lava flow advancements very effectively by preventing significant cooling, which strongly supports the idea that they are responsible for feeding many long lava flows and resurfacing of volcanic terrains. Detailed descriptions of these complex systems of lava tubes are quite important. In addition to that, a lunar lava tube is known as a good candidate for a future lunar base. This is because that the lava tube can be an ideal natural shelter in itself to prevent from dangerous or hazardous agents such as cosmic ray, micrometeoroids, and severe changes in temperature. Although the presence of an uncollapsed lunar lava tube is indirectly suggested, no one has ever determined its existence directly. For

this reason, mapping uncollapsed lunar lava tubes is extremely important from a future lunar-exploration viewpoint. We propose a new landing mission with a ground penetrating radar (GPR) system, which can detect lava tubes clearly and directly. The mission profile has five phases: 1) low altitude (of less than 10km) orbiting phase to investigate the lava tube candidates; 2) pin-point (within a few hundred meters) landing phase to detect the lava tubes; 3) surface contact phase to study of the structure of a lava tube below the landing module; 4) re-lift off and long-distance traveling phase for investigating the network structure of lava tubes; and 5) final hovering phase at the entrance of a tube. A GPR system with a central frequency of 280 to 320 MHz and transmitter power of 3W should be able to detect lava tubes in this mission profile. To assess the feasibility of the GPR method, we have applied a GPR system to a terrestrial basaltic lava flow and successfully detected a known and an unknown lava tubes.

P71A-0440 0830h POSTER

A Xenolith-rich, Basaltic Peperite on Earth: Analogue for Other Planets?

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Peperites are typically the product of wet sediment-magma/lava/hot volcanoclastic deposits interaction and are therefore indicative for the existence of frozen/liquefied or fluid water in the history of a planet. Most of the peperites on Earth are found in a paleo-near-surface environment and are exposed to alteration if burial did not protect them (Skilling et al. 2002). Sediments can be incorporated into ascending magma (Obenholzner et al. 2003). These macro- or micro-xenoliths show various degrees of metamorphism. Carbonate and evaporite xenoliths brought to the surface could include fossils or even bacteria, otherwise hidden deeply in the sedimentary record. A xenolith-rich basaltic peperite of Pliocene age is exposed in a quarry at Neuhaus/Kl./Burgenland/Austria. These alkali basalts are related to the time-equivalent volcanism of the W Pannonian Basin/Hungary. Although the peperite sequence is highly altered the primary structures are well preserved. The xenolith spectrum comprises marls, argillitic and other basement rocks showing various degrees of metamorphism. The xenoliths are white to yellow colored, egg-shaped or blocky and typically mantled by the grey basalt in peperite fragments. This encapsulation of xenoliths by the basalt protects the xenoliths against various atmospheric interaction, except for Earth where water easily enters the peperite fragments. This sequence could be used as a structural model for similar sequences on planets known for the occurrences of basaltic volcanism and potential water-bearing sediments. The Neuhaus peperite represents a training site for scientists working with remotely operated analyzers to differentiate between xenoliths, the peperite (basalt and sandy sediment) and alteration-related structures. Similar peperites could be encountered on Mars and would be a proof for the existence of water or other fluids in its history, even if the alteration history of peperite sequences would be different from what is known on Earth. Xenoliths might provide a new view into the sedimentary record of Mars.

Obenholzner et al. 2003. Particles from the plume of Popocatepetl volcano Mexico - the FESEM/EDS approach. In: Oppenheimer, Pyle, Barclay (eds.): Volcanic Degassing, Geol. Soc. UK, in press. Skilling et al. 2002. Peperite: a review of magma-sediment mingling. *JVGR*, 114, 1-17.

P71A-0441 0830h POSTER

Mapping Lithologic Units on Cinder Cones at the Summit of Mauna Kea Using AVIRIS Hyperspectral Reflectance Data

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Spectral reflectance data (0.4 to 2.4 micrometers) derived from the Airborne Visible Infrared Imaging Spectrometer (AVIRIS) instrument are used in combination with field and laboratory work to map the distribution of ferric oxide minerals and phyllosilicates exposed on cinder cones at the summit of Mauna Kea Volcano, Hawaii. Analysis of 0.4 to 1.1 micrometer data identified electronic transition features for hematite,

palagonite, and jarosite. Three spectrally distinct units of hematite are identified and mapped based on the depth of the ferric absorption features. Kaolinite, montmorillonite, and saponite are also identified and mapped based on metal-OH absorptions in the wavelength region of 2.0 to 2.5 micrometers. Analysis of laboratory reflectance spectra of tephra samples collected from thirteen sites on Puu Poliahu are consistent with the AVIRIS data and thus provide validation for the derived unit map. Surfaces of relatively fresh, uneroded cinder cones are typically dominated by the concentric zoned hematite units where hematite with the deepest ferric absorption bands occurs at the summit of the cones. Surfaces of eroded, hydrothermally altered cinder cones such as Puu Poliahu, have several localized exposures of the phyllosilicate, alunite, and jarosite units that may reflect strong alteration along fractures that focused hydrothermal fluids. Apparent alteration zones (as sensed remotely) are amplified by downslope mass wasting around mineralized outcropping zones.

P71A-0442 0830h POSTER

Hyperspectral Mapping and Identification of Lava Flows, Ash Deposits, and Solfataras in the Kau Desert, Hawaii

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Airborne panchromatic, false color infrared, and hyperspectral reflectance data from the Airborne Visible/Near-Infrared Imaging Spectrometer (AVIRIS) were examined in combination with field and laboratory observations in order to create geomorphologic and mineralogic maps for the Kau Desert, Kilauea, Hawaii. The basal Older Flows unit is 300-500 years old and exhibits iron-oxide and smectite spectral signatures near 0.85 and 2.2 μm , respectively. Patches of finely stratified, indurated Keanakakoi Ash (100-300 years old) covered by a coarse, black aeolian ash. At AVIRIS resolution (approximately 15 meters per pixel), the mapped Ash unit includes both the indurated and aeolian materials, and is dominated by a spectral signature resembling clinopyroxene with dual absorptions near 1.0 and 2.2 μm . The aeolian ash also partially mantles younger 1974 and 1974 flows, which are otherwise characterized by an iron-bearing glassy coating that is whitish in appearance and distinguished spectrally by a peak at 0.5 μm and prominent negative slope into the infrared. Fissures and cracks alongside the 1974 flow host active solfataras zones, evidenced by accumulations of gypsum, native sulfur, and opaline silica. A combination of absorption bands at 1.0, 1.2, 1.8 and 2.2 μm is indicative of the sulfate phases. The wide variety of basaltic materials and volcanic landforms present in the Kau Desert constitute an ideal terrain for Mars analog studies. Furthermore, the method of utilizing multiple remote datasets together with field and lab analyses has direct applicability for upcoming Mars missions, including OMEGA on the 2003 Mars Express and CRISM on the 2005 Mars Reconnaissance Orbiter.

P71A-0443 0830h POSTER

The Chemistry and Mineralogy of Atacama Desert soils: A Possible Analog for Mars Soils

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The Atacama Desert of northern Chile is the driest desert in the world, having experienced its present hyper-arid climate since the Miocene. While Mars is vastly more dry and cold than the Atacama, the Atacama environment may be one of the best terrestrial Mars analog environments accessible to researchers. Because of the long-term hyperaridity, the soils retain

atmospherically-derived elements, which accumulate to economically valuable quantities. The objective of this work was to examine physical and chemical evolution of the soils of the hyper-arid Atacama Desert to provide insight as to what soil properties may be found on Mars.

Three soils were excavated and examined on widely representative landforms along a south to north transect (Copiapo > Altimira > Yungay) that coincides with decreasing moisture levels (15mm to 2 mm yr⁻¹, south to north). Total chemical analyses were used to calculate strain (i.e. volume change) and elemental gains or losses (τ). Relative to parent material values, the Yungay and Altimira soils have expanded over 400% in certain horizons, while the Copiapo soil has collapsed by as much as 48%. The expansions are driven by elemental gains; the collapse by weathering losses. Calculations of τ indicate a 380 000% enrichment in Cl (halite) in the lower horizons, and S enrichments (anhydrite, gypsum) as high as 50 000% in the upper horizons, of the Yungay soil. The Altimira soil had a 110 000% enrichment of S (gypsum) and a 16,000% enrichment of carbonate, reflecting the higher precipitation and the relative solubility of salts. The southern, higher rainfall Copiapo soil had small τ values for S (283%) and Cl (63%) in the middle horizons, but significant gains of CaCO₃ (τ values as high as 4 000% in certain horizons). In general, the type and depth of Cl, S, and CaCO₃ enrichment in the soils varied predictably with rainfall.

The results of this work, which document enormous atmospherically-derived elemental gains and volumetric expansion, differ from trends in soil evolution in humid conditions which show pervasive weathering losses and collapse. From the precipitation gradient, it appears there is a critical water balance for soil formation below which the long-term accumulation of atmospherically-derived elements (e.g., S, Cl) exceeds weathering losses and landscapes undergo continual expansion (e.g., Yungay soil) as opposed to collapse (e.g., Copiapo soil). This critical crossover point appears to be quite arid, possibly between 2 and 15 mm of annual precipitation. Elevated levels of S and Cl found at the Viking and Pathfinder sites are consistent with our expectations of soil formation during long periods of growing aridity and pervasive planetary aerosol transport. Finally, the Atacama Desert soils provide insights into the type and concentrations of near surface mineralogical resources available to any future manned mission.

P71A-0444 0830h POSTER

The Altiplano-Puna Plateau as an Analog for Mars

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The Altiplano-Puna Plateau of the Central Andes of Bolivia has experienced a climatic and geologic evolution that has resulted in an enticing array of potential Martian analog geologic environments and features. Elevated 3 ? 4 km above the adjacent Atacama desert, the Altiplano-Puna is the highest plateau in the world associated with extensive volcanism; it is second only to Tibet in height and extent. The high elevation adds extreme cold, wind, and lower atmospheric pressure to a hyper-arid climate making this region a compelling analog environment for Mars.

The plateau is dominated by the Altiplano basin, which developed as a major intermontane basin since at least 25Ma. This is flanked by major volcanic provinces to the east and south. To the south is the Altiplano-Puna Volcanic Complex (APVC) where regionally extensive ignimbrite sheets and associated eruptive centers are amongst the largest known volcanic features in the world. The region has proven to be an excellent natural laboratory for remote sensing and field-based studies of volcanism. The extreme cold, wind, and the wide diurnal temperature range, results in geomorphic expressions dominated by physical weathering and aeolian erosion. These factors make this region one of the premier analog environments for Martian features like Amazonian Planitia, and Hadriaca, Alba, and Tyrrhena paterae, as well as the enigmatic Medusa Fossae Formation (MFF) materials. Large ignimbrite shields, are prominent features of volcanic geology of the plateau

and are the subject of an ongoing terrestrial analog study for the MFF.

The Altiplano basin preserves a long Pleistocene lake history recorded in a well-preserved lake shore geomorphology consisting of both erosional and depositional features. These features are easily identified and studied in the field and on remotely sensed images and may lend valuable insight into the debate over putative paleoshorelines in the northern plains of Mars. Throughout the basin are several smaller volcanic features (maars, cinder cones, buttes) and rare large composite cones. These monogenetic and polygenetic features represent potential analogs to smaller volcanic features on Mars.

We suggest that four major science themes of critical relevance to Mars can be addressed in this region. 1) The geomorphology, volcanology, and remote sensing of large-scale volcanic deposits (ignimbrites) and associated eruptive centers; 2) Physical weathering, erosion, and depositional features in cold deserts dominated by volcanic deposits; 3) The geomorphic expression and features of a major paleolake basin; and 4) The geomorphology, volcanology, and remote sensing of small-scale volcanic phenomena

P71A-0445 0830h POSTER

INVESTIGATIONS INTO DUNE FEATURES IN ATHABASCA VALLES, MARS

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Athabasca Valles is the youngest known channel system on Mars. Evidence of its fluvial origin is provided by a variety of geomorphic features in the channel, including transverse dune-like forms similar in appearance to subaqueously-formed dunes in terrestrial floodscapes. We used a 1-D photoclinometry technique to measure the stoss and lee slopes of the dunes, and dune topography. The stoss slopes are shallower than the lee slopes, indicating the features are dunes formed at lower Froude number subcritical flow. This is in contrast to anti-dunes, which have steeper stoss slopes than lee slopes, and form at higher Froude number subcritical or supercritical flow. The measurements also show the dunes have flat upper surfaces, which suggests they are depth-limited dunes.

A model for estimating paleoflow depths and velocities from dune morphology was previously developed and applied to relict flood dunes in the Altai Mountains of Siberia. The Altai dunes are on the order of a few tens of meters long and a few meters high, and the model gives a velocity of a few meters per second. We are applying the same model to the Athabasca Valles dunes. Photoclinometry techniques are sensitive to albedo, so that light-colored dust in the troughs introduces error into our topographic measurements. However, we have developed a way to constrain the amount of dust in-fill in the dune troughs, allowing us to estimate that error. We will use the dune geomorphology-based model with the photoclinometric measurements of the dunes to estimate the channel's paleoflow velocity. This velocity, in conjunction with the cross-sectional area, will provide a volumetric discharge estimate.

P71A-0446 0830h POSTER

The Northwestern Slope Valleys Region, Mars: A Prime Target for the Future Exploration of Mars

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Mars is a water-enriched planet theorized to have had Earth-like conditions during its embryonic stages of evolution (Early into Middle Noachian or > 3.8 GA). The Earth-like conditions include: (1) plate tectonism, (2) an active hydrosphere resulting in higher erosion rates and the presence of layered sedimentary deposits, and (3) a potential biosphere. Due to its smaller size and lower gravity, its thermal energy rapidly declined, sending the planet into a permanent monoplume regime. The Tharsis superplume, Elysium superplume, and structural discontinuities in the lithosphere are sites of long-lived energy releases and hydrothermal activity. Furthermore, as its atmosphere thinned and cooled, and water was lost to hydrodynamic escape, the Earth-like hydrological cycle transitioned into a persisting cold desert climate, approximating the present-day climate of the Dry Valleys in Antarctica. Stratigraphic, hydrogeomorphic, and paleotectonic information indicate an active Mars (e.g., late-stage superplume activity) that experienced punctuated periods of magmatic-driven hydrologic activity long after the Earth-like hydrologic regime had ended. Existing geologic, geomorphic, geophysical, topographic, impact cratering, spectral, and elemental information collectively point to a prime target site for future exploration that has the potential to yield significant geologic, paleoclimatic, paleohydrologic, and exobiologic information. The Northwestern Slope Valleys (NSVs) region archives traits similar to terrestrial field sites where the processes associated with: (1) fluvial, eolian, and hydrothermal activity, (2) modification due to landslides and glaciers, and (3) the formation of diverse rock assemblages (e.g., provenances include Noachian Thaumasia highlands mountain range and Europe-sized sedimentary basin and Noachian-Amazonian basaltic and possibly silica-enriched volcanoes and lava flow fields) are recorded. The region is especially remarkable since it encapsulates at least three distinct paleohydrologic regimes: Noachian-Early Hesperian NSVs flooding (~10⁸ - 10¹⁰ m³/sec), Late Hesperian-Early Amazonian Mangala Valles flooding (~10⁷ m³/sec), Amazonian sapping channel formation (~10³ m³/sec), and recent groundwater seeps (<10² m³/sec), all of which expose deposits for in-situ study and sample return. Terrestrial analogs include: (1) Wet Beaver Creek, Arizona, which reveals intriguing geologic, hydrogeologic, and geomorphic similarities to a well-developed martian sapping channel, Abus Vallis, and (2) the Gray Mountain FIDO rover test site, which records diverse geological terrains similar to what might be encountered at the proposed NSVs prime target site.

P71A-0447 0830h POSTER

From the Canadian High Arctic to Mars by Analogue

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Planetary scientists are limited in their understanding of physical bodies in the solar system by the lack of primary data or knowledge. Analogue science is science practised in absentia, precisely in those instances when a non-terrestrial physical environment lies beyond one's direct, empirical grasp. Recognising that some environments on Earth may mirror present or past conditions on Mars, planetary scientists have invoked terrestrial analogues with increasing regularity over the last thirty years as fonts of putative understanding. Notwithstanding its ubiquity in planetary science, analogical reasoning has stood, by and large, unconstrained by rules or guidelines of usage. In order to redress this imbalance we propose to take two steps: 1. introduce primary data on newly discovered pingos at Axel Heiberg Island in the Canadian High Arctic, and 2. coalesce these and related data on Martian glacial, peri-glacial and fluvio-glacial landforms as a model with which to evaluate the meaningfulness of analogical reasoning in planetary science.

P71A-0448 0830h POSTER

Investigation of small-scale polygonal networks on Mars using models of terrestrial fracture and ice-wedge networks.

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Polygons formed by closely spaced (tens to hundreds of meters) interconnected troughs, visible in Mars Orbiter Camera images, are qualitatively similar to ice-

and sand-wedge patterns in lowland Arctic and Antarctic terrain on Earth. The spacing and relative orientation between troughs in Mars networks varies between polygonal networks. Terrestrial networks, which form by recurrent opening of tension fractures in perennially frozen ground during periods of rapid cooling in winter, also display broad variations in the characteristic spacing, width and intersection angles of ice- and sand-wedges. Hypothesized causes for variations between terrestrial networks include variability in magnitude and orientation of maximum cooling-induced tensile stress, in substrate-dependent strength and heterogeneity, and in limits to downward propagation of fractures owing to a temperature-dependent brittle/ductile transition at depth.

To investigate mechanisms for variability in Mars and terrestrial networks and to test if properties of some or all measured Mars networks fit within the range of terrestrial variability, we explore the response of a recently-developed computational model for terrestrial networks to changes in substrate strength and heterogeneity, maximum tensile stress, and fracture depth. The model treats initiation, propagation and arrest of fractures in a tensile stress field perturbed by neighboring fractures, and includes the growth of ice or sediment wedges along fracture paths. Modeled networks are compared to 20 1x1 km network regions from MOC images of Utopia Planitia using two methods. In the first method, joint distributions of relative orientation and spacing between troughs are used to characterize mean spacing and orthogonality of networks. In the second method, regions of a pixelated image of a network are used to predict the pixel pattern of displaced regions with a nonlinear spatial forecasting algorithm that operates on pixel brightness. Prediction error as a function of algorithm parameters is used to assess the degree of nonlinearity and stochasticity in processes that generate the patterns. To test whether patterns on Mars form by single fracture episodes or through recurrent fracturing, measured patterns are compared with those generated by simulations of a single fracture episode and with recurring fracture episodes.

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P71A-0449 0830h POSTER

Morphology of Small-Scale Patterned Ground in Utopia Planitia, Mars: A Comparison With Terrestrial Polygonal Terrain

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Small-scale polygons on Mars (<300 m diameter) are often considered analogous to patterned ground on Earth. While the polygons appear similar to terrestrial polygons, their formation remains ambiguous. A survey of narrow angle images from the Mars Orbiter Camera identifies over 600 localities with small-scale (30-200m) patterned ground. Roughly 80% of these polygons are located south of 60°S latitude, in a region rich in hydrogen, supporting a periglacial origin. Of the remaining polygons in the northern hemisphere, over 70% of the small-scale polygons are clustered within Utopia Planitia and do not coincide with near-surface hydrogen enrichment. The absence of ground ice may imply either a different formation process or climate change in the Utopia region. This study investigates the 63 polygon localities in Utopia Planitia in detail, in an attempt to differentiate between periglacial, desiccation, and tectonic origins. Preliminary geometric analyses reveal that a majority of crack intersections are orthogonal, and are aligned in a N/NE direction. Some elongation of polygons on slopes is observed, supporting a periglacial origin. When scalloped depressions are found in conjunction with patterned ground, polygons are preferentially found on the higher, undisturbed surfaces. Results from this study will be compared with similar scale terrestrial polygons, including those formed by both desiccation and periglacial processes.

P71A-0450 0830h POSTER

Detecting a liquid and solid H₂O layer by geophysical methods

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The objective is to detect the hydrological and cryological structure of the cold continuous permafrost subsurface using geophysical methods. We believe that a lot of water potentially exists as solid and liquid phases underground on Mars. It is likely that the liquid fluid would be high in saline concentration (brine). The ground freezing process involves many hydrological processes including enrichment of the brine layer. The brine layer is an important environment for ancient and/or current life to exist on terrestrial permafrost regions. The existence of a Martian brine layer would increase the possibility of the existence of life, as on Earth. In situ electric resistivity measurement will be the most efficient method to determine brine layer as well as massive H₂O ice in the permafrost. However, the wiring configuration is unlikely to operate on the remote planetary surface. Satellite-born Radar and/or EM methods will be the most accessible methods for detecting the hydrological and cryological structure. We are testing several geophysical methods at the brine layer site in Barrow and massive pingo ice site in Fairbanks, Alaska. The radar system is affected by the dielectric properties of subsurface materials, which allows for evidence of liquid phase in the frozen ground. The dielectric constant varies greatly between liquid water and frozen ground. The depth of the terrestrial (and probably Martian) brine layer is frequently located deeper than the maximum detecting depth of the impulse type of the ground penetrating radar system. Once we develop a radar system with a deeper penetrating capability (Lower frequency), the dispersion of the ground ice will be the key function for interpretation of these signals. We will improve and use radar signals to understand the hydrological and cryological structure in the permafrost. The core samples and borehole temperature data validate these radar signals.

P71A-0451 0830h POSTER

EXTASE - An Experimental Thermal Probe for Applications in Snow Research and Earth Sciences

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EXTASE is a spin-off project from the Rosetta Lander (MUPUS) thermal probe, funded by DLR. The application of this probe is to be tested in different fields, e.g. in snow research, agriculture, permafrost etc. The system consists of the probe itself with a portable field electronic and a computer for control of the system and storage of the data. The probe penetrates the surface ca. 32 cm deep and provides a temperature profile (16 sensors) and thermal conductivity profile of the penetrated layer. The main advantages of the probe in comparison to common temperature profile measurement methods are:

- no need to excavate material - minimized influence of the probe on the temperature field - minimized modification of the microstructure of the studied medium.

Presently we are concentrating on agriculture (soil humidity) and snow research. Further applications could be e.g.: monitoring waste deposits and the heat released by decomposition, volcanology and ground truth for remote sensing.

We present the general concept of the probe and also data obtained during different field measurement campaigns with prototypes of the probe.

URL: <http://ifp.uni-muenster.de/pp/MUPUS/>

P71A-0452 0830h POSTER

Optical Constants of Planetary Analogs Using KBr Pellet Transmission

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Optical Constants of Planetary Analogs Using KBr Pellet Transmission

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Optical constants of bulk materials are needed for radiative transfer models used to simulate remote sensing measurements. Many minerals are difficult or impossible to study in bulk form, leading to various attempts to derive optical constants in other ways (e.g. measuring the Fresnel reflection from a polished or packed surface, which is not sensitive to regions of small absorption). We are starting a campaign to re-measure, or measure for the first time, many planetary analog materials (clays, oxyhydroxides, etc.) using a potassium bromide pellet technique, where the mineral powder is sparsely dispersed in KBr matrix such that the pellet is transparent through much of the mid-infrared (2.5-30 μm). The strongly absorbing regions can be measured if the grain size is small enough, and the weakly absorbing regions are measured by increasing the density of particles. The KBr pellet method has long been used because scattering at the matrix-particle interface is minimized due to the similarly high real indices of refraction between the matrix and particles, but interpretation of the measured extinction is still not straightforward because one is not measuring the absorption of a thin bulk film, but rather the absorption extinction of particles of comparable size to the wavelength. There is also the possible presence of scattering voids or bubbles in the matrix. In our case, there is also a weak absorption spectrum present due to impurities in the KBr powder. We will present the results from our first measurements of the clay Montmorillonite. The extinction of the Montmorillonite cloud in an absorbing medium will be modeled using Mie scattering and a full plane parallel radiative transfer model, utilizing available information on the size distribution and densities of the powder. The measurements will be matched by adjusting the optical constants input into the model. The need to match several measurements at each wavelength provides for a robust determination of the optical constants.

P71A-0453 0830h POSTER

Infrared Characterisation of Planetary Analogues: Plagioclases

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Laboratory characterisation of terrestrial analogues of planetary materials is a fundamental step for a correct analysis of remote sensing data returned by space instrumentation or ground-based observations. Among the most common minerals in our Solar System, the plagioclase feldspars, that we know are present on the surface of Mars, of the Moon and probably of the most of the solid planetary bodies. In this work we show morphological, chemical and infrared spectroscopic analysis of a large suite of plagioclases having different end-member composition (the albite-anorthite series). For each of the four powdered samples, with size ranges <20, 20-50, 50-100, 100-200 microns, we give the dimensional analysis and the spectral behaviour in the 6000-400 cm⁻¹ spectral interval at a resolution of 2 cm⁻¹. In the analysis of the diffuse reflectance spectra we found a clear shift of the main stretching vibration bands towards the lower wavenumbers with the increasing of anorthite content, in agreement with previous studies. This effect is evident for the Christiansen feature (Cf) too. Since the Cf is usually more diagnostic in retrieving mineral composition from infrared data, especially for finer dusty samples, we tried to find a clear relation between the anorthite content of the plagioclase material and the location of the Cf. Moreover, by applying the Lorentz oscillator model to the specular reflectance data, we were able to retrieve the optical constants. The set of spectroscopic results forms a reference frame useful to obtain quantitative information from planetary observations once used in appropriate radiation transfer models.

P71A-0454 0830h POSTER

Laboratory Measurements of Radar Penetration of Sand and Dust: Implications for Mars

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Over the past two decades, imaging radar has become a useful remote sensing tool for planetary mapping. Because much of the bedrock geology on Mars is likely covered by sand and dust, a radar imaging system should be considered a necessary complement to other remote sensing instruments at or planned for Mars. In anticipation of such a mission and future terrestrial radar missions, radar backscatter and transmission experiments were conducted for dry and wet sand and a Mars analog dust.

To address the ability of radar to penetrate sand and dust, the experiments measured the change in radar signal for various radar and target properties to determine attenuation (dB/m), or the decrease in signal per meter. The transmission experiments were conducted using dry sand (0.3% water), two wet sands (5 and 11% water), and dry Carbondale Red Clay (CRC), an analog for martian dust because of its grain size (2 μm) and iron content (19% Al_2O_3 and 12% Fe_2O_3). The backscatter experiment was performed using dry sand, and all experiments were run over the frequency range of imaging radars (0.5 to 12 GHz).

Results show that dry sand, sand with 5% water content, and dry CRC dust all result in attenuation less than 2 dB/m at 0.5 GHz. Sand with 11% water results in attenuation of only 4 dB/m. Although it is expected that low-frequency radar will have low attenuation, the low attenuations for wet sand challenge previous claims that subsurface penetration requires extremely dry sand. Those attenuations also question the ability of a low frequency Mars radar to detect moist soil efficiently. At higher frequencies, attenuation due to wet sand increases rapidly to values that prohibit significant penetration, but dry sand exhibits a much slower increase in attenuation. At 9.6 GHz, dry sand causes attenuation of only 5.9 dB/m. It is therefore expected that higher-frequency (shorter wavelength) radar energy can penetrate dry sand deposits, possibly as much as a meter depending on the sensitivity of the radar. The attenuation due to the CRC dust is still low (5.8 dB/m) at 1.24 GHz but rises to 67.4 dB/m at 9.6 GHz. These results suggest that a multi-frequency Mars imaging radar would be most useful. Results can also help select other radar parameters to meet the science goals of future radar missions.

P71A-0455 0830h POSTER

Comparison Between the Fluid Effect on the Rotation of Earth and Mars

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The interaction between the Earth and its fluid layers (namely the fluid core, the atmosphere and the ocean) is the major cause of the fluctuations of the Earth rotation. An analogy to Mars can be made since the two planets have many similarities. In this study, we review the interaction processes on Earth and use this knowledge to investigate Mars.

It is known for more than one century that the Earth rotation is not a constant in time, and present fluctuations at various timescale. The knowledge of the angular momentum of the fluid allows to compute its effect on the Earths rotation. A similar approach can be applied to Mars. The properties relevant to the effect of the fluid layers on the planet rotation can be deduced from the angular momentum budget equation. A priori, on Mars, the inertia and surface characteristic, core status, atmosphere, CO₂ condensation/sublimation process and dust storms drive the interaction processes. In analogy to the case of Earth, the details of the interaction between Mars and its fluid layers will be studied in order to estimate the relative importance of the different components of the system.

P71A-0456 0830h POSTER

Effects of Atmospheric Multipath Propagation on Radio Occultation Observables

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Atmospheric multipath propagation is a common source of error in radio occultation experiments in dense atmospheres. If not correctly detected and mapped into the ray asymptote structure, multipath effects produce unrecoverable errors in the inverse problem for the refractive index profile.

Raytracing can be used to clearly illustrate multipath caused by interacting signals following closely spaced paths in the atmosphere. Such dynamic signals occur in connection with sharp variations in refractivity with height and result in multivalued frequency with time. Closed-loop radio receivers based on phase-locked loops that are designed to receive single-valued frequency signals will fail to preserve the multivalued nature of these signals.

In order to use backprojection methods to mitigate multipath effects in the refractive index profile, it is important that there are no breaks in the collected or backprojected data. Data sets must span a continuous time series over the range of ray asymptotes required for a particular retrieval. The receivers used for radio occultation experiments are therefore expected to reliably and continuously collect data even from signals that have propagated through ducts, turbulence, or other abrupt deviations in atmospheric structure. Both high altitude radiosonde data from Earths atmosphere as well as model refractive index profiles are used to illustrate instances in which multipath occurs and to characterize the signal structures produced by multipath propagation.

A functional representation of atmospheric multipath signal structure is used as the input to a phase locked loop. The phase locked loop simulation is representative of autonomous closed-loop receivers as opposed to those that are manually frequency-steered. The tracking performance of the phase locked loop is evaluated for these dynamic signal structure inputs. Cases where the system fails are examined to determine the extent to which closed-loop systems can be used to observe and accurately characterize such signals.

P71B MCC: Hall D Sunday 0830h

Planetary Volcanism and Tectonism Posters (joint with V)

Presiding: J R Zimbelman,
Smithsonian Institution; R Ghent,
Smithsonian Institution

P71B-0457 0830h POSTER

Down-Flow Physical Attributes of Long Lava Flows on Five Planetary Surfaces

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Physical data have been compiled for eighteen long lava flows, most of which are more than 50 km in length. Flows examined include the Carrizozo and McCarty's flows, central New Mexico and the 1907 and 1984 Mauna Loa flows, Hawaii (Earth), flows near Bellona Fossae and Fea Fossae (Venus), flows near Alba Patera and Elysium Mons (Mars), the Phase III Mare Imbrium flow (Moon), and the Amirani flow (Io). Measurements of flow width, flow thickness, and local topographic slope were obtained at regular intervals along each flow. These data reveal several similarities and differences between the flows emplaced in very different environments. All of the longest flows occur on regional plains of shallow slope, generally less than 1 degree. Some flows (e.g. Mauna Loa) are clearly volume-limited while other flows (e.g. Elysium Mons) appear to have components that are cooling-limited. Differences in the gravitational acceleration on the five planetary surfaces do not correlate with flow length, but flow thickness is strongly inversely correlated with gravity except for the two smallest bodies (the Moon and Io). Some flows have relatively small length/width ratios (about 5 for Fea Fossae) while other flows have higher ratios (more than 10 for Mare Imbrium and Alba Patera), or are highly variable along the flow (Carrizozo and Amirani). These data, combined with published rheologic information obtained during emplacement of the 1984 Mauna Loa flow, provide new constraints on likely emplacement conditions for flows on the different surfaces. These new measurements represent the basic input for evaluation of several models of flow emplacement (see abstract #3651 by Peitersen et al.).

P71B-0458 0830h POSTER

Down-flow Geomorphometric Analysis and Rheological Modeling of Long Lava Flows on Five Planetary Surfaces

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A series of statistical analyses and modeling studies on a database of new geomorphometric data for lava flow on five planetary surfaces (abstract #296, Zimbelman et al., AGU Fall 2002) is conducted to constrain the processes active in the emplacement of long lava flows (here defined as flows whose traceable length exceeds 50 km). Flow parameters (widths and thicknesses) and environmental factors (e.g., local slopes) are registered as functions of downflow distance for each lava flow. The data are then evaluated statistically for trends suggested by current emplacement models. A strong inverse correlation has been identified between the local gravitational field and the average flow thickness; this is consistent with most of the conventional rheological flow models. The database parameters are also used to estimate rheological properties (e.g. velocity, viscosity, flow rate); inferences are then drawn. Initial results suggest that a variety of mechanisms dominate the emplacement of long lava flows. Modeled changes in rheology of some flows are consistent with the cooling of simple flow lobes, but others suggest more patterns of greater complexity. Cyclical variations are suggestive of repeated episodes or "pulses" of emplacement, while other flows demonstrate evidence for strong topographic control, or volume-limited behavior.

P71B-0459 0830h POSTER

Lava Lakes on Io

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Calderas are the most ubiquitous volcanic construct on Io's surface. Data from Galileo has shown that many Ionian calderas are active and that activity is often confined to the caldera's interior. We use observations from Galileo's Near-Infrared Mapping Spectrometer (NIMS) to study the thermal emission from several Ionian calderas. Galileo's close fly-bys of Io from 1999 to 2001 have allowed NIMS to image the calderas at high spatial resolution (1-30 km pixel). At these scales, several of the calderas reveal greater thermal emission around the edges, which can be explained as the crust of a lava lake breaking up against the caldera walls. Comparisons with imaging data show that lower albedo areas (which are indicative of young lavas) coincide with higher thermal emission areas on NIMS data. Other calderas, however, show thermal emission and features in the visible that are more consistent with lava flows over a solid caldera floor. Identifying eruption styles on Io is important for constraining eruption and interior models on Io. We will focus on the thermal analysis of NIMS data from the last two successful fly-bys of Galileo, in particular, on observations of the calderas Tapan, Emakong, Gish Bar, Culann, Chaac, and a small caldera near Tohil, and examine the distribution of thermal emission, how it had varied with time, and the implications for eruption styles. The new observations suggest that lava lakes may be common on Io, perhaps much more than on Earth, possibly reflecting differences in volcanic plumbing and magma composition.