viscosity of $2x10^{15}$ Pa s calculated from the flow law and published results from numerical models with viscosity values of 10^{17} Pa s for a homogeneous convecting mantle and 10^{8} to 10^{12} Pa s for a thin convecting asthenosphere. Therefore, additional experiments on partially molten mantle rocks with relatively high ϕ are required to constrain the dynamic properties of Io's mantle.

P12B-1070 1330h POSTER

PGEs, Re, Mo, W and Au in Meteoritic Fe-Ni Metal and the Differentiation of Metal-rich Meteoritic Parent Bodies

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Extinct nuclide (182Hf, 53Mn, 26Al) evidence suggests that achondrite parent planets formed and differentiated within 2-4 Ma of the origin of the Solar System. Since then many of these parent planets have been disrupted, often leaving behind only fragments of their cores in the form of iron meteorites. Thus, chemical and isotopic studies of iron meteorites can provide important information about the early differentiation of asteroidal parent bodies. Iron meteorites exhibit both old metal-silicate segregation ages (182Hf-182W extinct nuclide system) and younger crystallization ages (long-lived 187Re-190Pt-187,186Os systems). To make use of the discordant age information exhibited by different isotopic systems we have initiated a study aiming to model the trace element behavior during the early stages of planetary evolution together with the isotopic evolution of both long-lived and extinct isotope systems. We expect to establish reliable timescales of the metal-silicate fractionation and core crystallization in the parent planets of iron meteorites. For the purpose of such study we have obtained, for the first time, a consistent set of concentrations of Mo, Ru, Rh, W, Re, Os, Ir, Pt, and Au in the iron meteorites Arispe, Bennett County, Grant, Cape of Good Hope, Cape York, Carbo, Chinga, Coahuila, Duchesne, Gibeon, Henbury, Mundrabilla, Negrillos, Odessa, Sikhote-Alin, and Toluca. The measurement technique involves EPMA and LA-ICP-MS analyses of individual phases of iron meteorites, followed by calculation of bulk compositions. The comparison of our LA-ICP-MS data for a number of iron meteorites with high-precision isotope dilution and INAA data demonstrates good precision and accuracy of our technique. The narrow ranges of variations of Mo and Pd concentrations within individual groups of iron meteorites suggest that these elements can provide important insights in the evolution of parent bodies of iron meteorites. Mo concentrations can be used to estimate mass fractions of the metal-sulfide cores in the parent bodies of iron meteorites. Pd variations within a group of iron meteorites can serve as a useful indicator of S content in the core of its parent body.

P12B-1071 1330h POSTER

Search for Far-Side Deep Moonquakes: Progress Report II

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All but one of the nests of deep moonquakes found during and immediately following the Apollo missions were on the near (Earth-facing) side of the Moon. A possibility remains, however, that there are many more deep moonquake nests on the far side but they escaped our detection because of the high attenuation of shear waves through the lunar lower mantle; without clear shear-wave arrivals it was nearly impossible to identify them visually on seismograms. To pursue this possibility, we have recently started a computer search to identify far-side deep moonquakes among 9000+ events that remained unidentified at the end of our earlier analysis. This involves several steps: (1) waveform cross-correlation of every possible pair of previously unidentified events to find formerly unrecognized groups of events with matching waveforms; (2) stacking of waveforms to enhance signal-to-noise ratio; (3) picking of seismic phases on the stacked seismograms; and (4) location of newly identified nests. So far, we have completed the first two steps and are now preparing to perform step (3). We have identified nearly 250 new nests, of which 88 show finite-amplitude signals at three or more stations. Preliminary examination of the stacked waveforms reveals that there are at least 15 new nests for which the waveforms are similar to those of the lone far-size deep moonquake nest, A33, found earlier, with no distinct shear-wave arrivals at some stations, and thus constituting potential candidates for far-side deep moonquakes. In addition, at least 13 of the newly identified seemingly near-side nests are clearly in the southeast quadrant of the Moon, where there was a large gap in deep moonquake distribution earlier. Reliable picking of P- and S-wave arrivals must be done with greatest care. We are now looking into possible use of receiver functions to perform this task.

P12C MCC: 2000 Monday 1340h

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

Presiding: **V E Hamilton,** University of Hawaii**; M E Minitti,** Arizona State University

P12C-01 1340h INVITED

Hubble Space Telescope Imaging and Spectroscopy of Mars During the Extremely Close Approach of 2003

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We observed Mars using HST during Aug. and Sept. 2003. These observations took advantage of the closest Earth-Mars encounter in nearly 60,000 years as Mars passed within 0.372 AU of Earth and subtended an apparent angular diameter of 25.1"; this is the closest the planet will come to Earth until the year 2287. We used four instruments on HST to take advantage of this unprecedented spatial resolution as well as the telescope's unique UV and near-IR capabilities. The observations were also designed to provide scientific and calibration data that are complementary to observations being obtained from Mars orbit by the NASA Mars Global Surveyor and Mars Odyssey spacecraft. Our observing program consisted of: (1) Multispectral images using the WFPC2 CCD camera at six rotational aspects and using 10 to 12 filters spanning 255 nm to 1042 nm. These observations have a spatial resolution of 13 km/pixel near the sub-Earth point on the planet. The filters were chosen to detect atmospheric ozone in the UV, weak crystalline Fe^{3+} absorptions in the UV and visible/near-IR in altered surface or airborne dust materials, and Fe^{2+} absorptions in the near-IR from relatively less-altered volcanic materials, and to extend the long-term coverage at these wavelengths from WFPC2 programs in 1997, 1999, and 2001; (2) Multispectral images using the NICMOS near-IR camera at four rotational aspects and using 15 filters covering 970 to 2370 nm. These observations have a resolution of 13 to 26 km/pixel near the sub-Earth point. The NICMOS filters were chosen to detect CO_2 and water vapor/clouds as well as surface OH-bearing minerals; (3) Multispectral and multi-polarization images using the ACS/HRC CCD camera imaging a single hemisphere of the planet over 5 phase angles from 6^o to 16^o. These observations have a resolution of 7 km/pixel near the sub-Earth point–the highest spatial resolution observations of Mars ever made from the Earth. The ACS filters, three 120^o polarizers, and phase angles were all selected to characterize the nature of the Mars phase curve, which can reveal information about the physical and compositional properties of the materials; and (4) Imaging spectroscopic observations using the STIS CCD spectrograph at four rotational aspects and from 270 to 590 nm at a spectral resolution of 0.275 nm/channel. The 0.2x50" STIS slit was "pushbroomed" to generate hyperspectral image cubes of the surface south of about 40^oN and at approximately 13x52 km/spectrum. These data are being analyzed for evidence of absorption features diagnostic of specific Fe^{3+} mineral phases on Mars as well as information on the physical and radiative properties of airborne dust. All of the planned observations have been successfully acquired and highlights will be shown here. The martian atmosphere was relatively free of both dust and water ice clouds during this southern Mars summer/perihelion observation period (L_s=250^o). These observations can be directly compared to our similar 2001 HST measurements that were taken during conditions of high atmospheric dust opacity, providing an excellent opportunity to derive new information on dust compositional and physical properties from the comparison of dusty and dust-free observations from the same instruments and at comparable spatial scales.

URL: http://hubblesite.org/newscenter/2003/22/

P12C-02 1355h INVITED

Mars Surface Composition Through Pan-spectral Analysis: Mafic Mineralogy, Alteration, and Hydration

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In the next five years there will be global data sets for Mars spanning the wavelength range 0.4-50 microns encompassing the reflected solar and emitted thermal regimes (pan-spectral). These data sets provide critical information on surface mineralogy and composition. The reflected solar region is most sensitive to electronic processes associated with iron minerals (e.g. ferric oxides, mafic silicates) and vibrational processes associated with hydroxyl, water, and other anions. The emitted thermal region is sensitive to the lattice mode vibrations of minerals. Thus these regions are extremely complementary in the specific information provided,. While laboratory measurements have been used to investigate the pan-spectral properties of materials, we have just completed a study of the pan-spectral properties of the martian surface using spacecraft observations. We merged data from the spatially-limited ISM experiment that flew on the Phobos-II mission in 1989 with thermal emission observations from the TES experiment with arrived at Mars in 1998. Our strategy was to test hypotheses developed through the analysis of ISM data (electronic and vibrational spectroscopic interpretations) with TES data (lattice-mode interpretations). The key areas of investigation are the composition of dark regions, mineralogic interpretations of unique materials on the floor of Eos Chasma, variations in spectral properties across Syrtis Major, and the mineralogy of hydrated deposits typical of dark red regions. Dark region mineralogies are complementary and consistent using pan-spectral analysis, though differences remain on the nature of the pyroxene composition. The materials on the floor of Eos Chasma are apparently more pyroxene rich than typical dark materials. The variations in visible and infrared spectral properties across Syrtis Major are most consistent with penetrative oxidation rather than surface coatings. And the mineralogy of dark red regions is consistent with a sulfate-cemented dust. The results indicate that with new global visible-infrared data sets to complement the existing global thermal infrared data, a highly refined picture of martian surface composition will emerge.

P12C-03 1410h

An Emerging Picture of the Volcanic History of Syrtis Major From Multiple Dataset Views

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Syrtis Major Planum is a classical low albedo feature on Mars that contains one of the largest shield volcanoes on the planet. It is the only volcano of its size that is nearly free of a spectrally obscuring dust layer, making it an ideal target for investigation using the full range of available Mars datasets. Recent datasets from Mars Global Surveyor and Mars Odyssey provide compositional and morphologic information that has not been incorporated previously. Shaded relief topography from MOLA data presents the clearest view of the overall scale and morphology of the volcano. Lava flows, wrinkle ridges, and structural features all are readily discernable. THEMIS daytime and nighttime IR images supply a new level of detail on the morphology of the lava flows. The nighttime images are especially well suited to identifying flows, which appear slightly warmer than their surroundings. A clear radial pattern is evident emanating from the summit caldera complex. The occurrence of these flows is notably biased toward the western half of the volcano, perhaps indicative of an age or compositional asymmetry. Spectral indices sensitive to compositional variations in TES thermal IR data generally correspond with this asymmetry. Variations in visible/near infrared spectral parameters observed in Phobos 2 ISM data also depict an east/west asymmetry. A picture is emerging in which volcanic

processes have varied during the construction of the Syrtis shield. Complicating this picture is the abundant evidence for post-emplacement modification of the upper surface of the volcano. Aeolian processes clearly have been active in redistributing materials across the volcano, generally from east to west. Dunes and wind streaks are evident in most of the imaging datasets, highlighted in great detail by MOC narrow angle images. Color images from the THEMIS visible camera provide dramatic views of reddish wind streaks in the lee of craters, apparently a zone of accumulation for airborne dust. Elsewhere, visibly dark streaks thinly mantle lava flows with material that appears compositionally distinct as shown by THEMIS multi-spectral IR images. While the wealth of information provided by multiple datasets adds complexity, careful scrutiny of the myriad details should create a clearer picture of the volcanic history of Syrtis Major.

P12C-04 1425h INVITED

Synthesis of Spectral Data From the Grey Hematite Regions of Mars

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The martian surface has been mapped by a number of visible and infrared spectral instruments from orbit. Telescopic and historical data sets noted the global albedo distribution of bright and dark units. Work in the near infrared (1 to 5 μm) identified subtle spectral variations and the appearance of areas with unique signatures. Broad classification of color and near-infrared spectral units include bright ferric material (dust), dark ferrous material (mafic rocks and pyroxene), dark "crystalline" ferric material (low albedo but with strong ferric absorptions) and water of hydration in surface materials. The Thermal Emission Spectrometer (TES) on MGS has identified two dominant surface units (mafic/basaltic and basaltic/andesitic-or-glassy-or-weathered). Small outcrops where the spectral signature of bulk grey hematite is exposed at the surface have been identified in Meridiani, Aram Chaos and Valles Marineris. Data from both the Infrared Spectrometers (IRS) on Mariner 6 and 7 and the Imaging Spectrometer for Mars (ISM) show the hematite locations to be more hydrated than other surface regions. Initial comparisons between ISM and the Gamma Ray Spectrometer (GRS) on Odyssey show the increased infrared signature of water in regions also found by GRS to contain more hydrogen. The GRS also shows a broad enhancement of hydrogen over Meridiani and Arabia which covers the hematite outcrop but is much larger in extent. This can be explained if GRS is sensitive both to surface hydration and water at depth in minerals or ice. The preferred interpretation for the bulk hematite units is an aqueous precipitate and synthesis of multiple spectral data sets support that conclusion. A synthesis of the data from these instruments at the hematite locations will be presented. The largest of the sites, in Terra Meridiani, is the landing site for the "Opportunity" Mars Exploration Rover which lands Jan 25, 2004. Consideration of constraints imposed by these orbital data sets suggests either ground water or sub-aqueous formation mechanisms and hypotheses for both can be tested at the rover site. The Athena Science instrument suite will provide new information to be integrated with data from orbit to constrain the origins of these units.

P12C-05 1440h INVITED

Chemistry of Young Martian Meteorites and the Ancient Mars Crust

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The chemical compositions of the martian crust and mantle are commonly inferred from SNC meteorites. However, with one exception, SNCs sampled young volcanic centers and are not necessarily chemical proxies for the ancient crust. Compositional information on the Noachian crust is provided by Mars Pathfinder APXS analyses and chemistry calculated from mineral deconvolutions of Mars Global Surveyor TES spectra. Here we compare SNC compositions with TES global surface types 1 and 2 (ST1, ST2), previously interpreted as basalt and either andesite or partly weathered basalt. On an alkalis versus silica diagram, SNC lavas plot as basalt, whereas ST1 plots as basaltic andesite and ST2 as andesite (near the Pathfinder rock). On a FeO*/MgO versus silica diagram, SNCs plot within the tholeiite field, as appropriate for dry magmas. They are clearly resolvable from ST1 and ST2, which fall within the calc-alkaline field. If the ancient crust compositions represent igneous rocks, they imply a much wetter early martian mantle than previously envisioned. Alternatively, both ST1 and ST2 compositions and the Pathfinder rock could be partly weathered volcanic materials, as suggested by their positions on chemical weathering diagrams. In this case, weathering must produce silica enrichment, as well as depletion in soluble elements. These materials have high Al/Si, as do terrestrial weathering products of basalts. A weathering scenario is consistent with the 2 wt % water in alpha-mode APXS analyses of Pathfinder rocks. SNCs are the only source of data on trace elements, isotopes, and redox state. Key element ratios (e.g. Fe/Mn, K/La, Ni/Mg, Ga/Al) are diagnostic of SNCs and presumably would be similar in the ancient crust and the mantle. Oxidation and enrichment in LREE and radiogenic isotopes in shergottites may reflect crustal assimilation, so the admixed component would provide additional information on the ancient crust. Preservation of early-formed 182W and 142Nd anomalies and chondritic element ratios (Zr/Hf, Nb/Ta) established during accretion indicates that convective mixing in the martian mantle was limited. If ST1 and ST2 are igneous, they require hydrous melting and fractionation. The chemistry and petrogenesis of the ancient martian crust are distinct from the younger crust, which must represent remelting of a relatively dry mantle source that was previously depleted by formation of the voluminous early crust. Alternatively, if ST1 and ST2 represent weathered materials, we do not know how their volcanic protoliths compare to SNCs.

P12C-06 1455h INVITED

Chemistry of the Martian Soils and Rocks at the Pathfinder Landing Site as Determined by the APXS.

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The chemical compositions of Martian rocks and soils examined with the Alpha Proton X-ray Spectrometer (APXS) during the Mars Pathfinder 1997 lander mission were not previously fully determined. Preliminary chemical results included major element abundances determined by the incomplete calibration of the X-ray mode. The data collected from the alpha and proton detectors were not previously analyzed due to significant atmospheric contributions to the spectra. The back-up instrument of the Pathfinder Alpha Proton X-ray Spectrometer flight instrument has been used to complete the instrument calibration under simulated Martian conditions at the University of Chicago. The calibrated Pathfinder APXS instrument is capable of measuring concentrations of all major and minor rock-forming elements ranging from carbon through zirconium in atomic number. Therefore, it is capable of constraining the petrology of the measured samples. Final Pathfinder soil and rock sample abundances from the alpha, proton, and X-ray modes have been quantified. The abundances suggest that: 1.) the rocks are covered with various amounts of soil; 2.) the soil-free rocks, on a volatile-free basis, have some element ratios similar to Mars meteorites, yet have different bulk chemistry indicative of more evolved rocks with higher silica abundances; 3.) the carbon and nitrogen contents are below detection limits; and 4.) the alpha mode oxygen reveals excess amounts of oxygen in some samples which is indicative of sample-bound water (contained within minerals or glasses in samples). The presence of some water, up to 4 wt%, in some Pathfinder rocks implies that they may have been altered by some non-igneous process.

P12C-07 1510h

Martian Provinces From Neutron and Gamma Spectrometry

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This study intends to identify and characterize the major provinces at the surface of Mars. We used the data from the Neutron Spectrometer (NS) and the Gamma-ray Sensor Head (GSH) aboard Mars Odyssey. NS data help to define broad provinces that should present uniform composition. GSH data can be then summed over these provinces to derive their chemical compositions with good statistics. At the present stage, we manage to conduct the first step that identifies the provinces, while the second step is still under progress to characterize them. Variations in NS epithermal and fast neutron data are largely dominated by the distribution of hydrogen and carbon at the surface or at shallow depths. Neutrons are also affected by the presence of an atmosphere. To limit these effects, we chose frost free data (i.e. measured during the summer at high-latitudes), between -60 and +60 degrees latitude, and corrected for atmospheric thickness (normalization to 16 g/cm2). On the other hand, it has been demonstrated that neutron fluxes can be used as a proxy for composition: thermal neutrons are strongly attenuated by absorbing elements such as iron, titanium, chlorine, gadolinium, and samarium; on the contrary, the fast neutron flux increases in presence of high-atomic mass elements such as iron or titanium. For a dry and airless body it is known that the ratio of epithermal over fast neutron counts is correlated to the ratio of thermal over fast neutron counts. This correlation leads to a unique parameter, which characterizes the various soil compositions. A similar behaviour has been observed within our subset of NS data. Effects of hydrogen and carbon are quite obvious, allowing us to focus on secondary components, which are driven by soil composition. From there, we derived four provinces besides the poles. The first province is made of H-rich equatorial regions (Arabia Terra and south of Lucus Planum). The second and third provinces are found north and south of the crustal dichotomy corresponding to lowlands and highlands, respectively. In particular the second province includes Acidalia Planitia and Utopia Planitia (Amazonis Planitia is an exception as it falls into the third province). Finally the fourth province covers the highest terranes (above 5-6 km): Tharsis Montes, Olympus Mons and Alba Patera. One possibility to explain these distinctive neutron signatures can be variations of iron and chlorine contents in the soil. Indeed, iron and chlorine are the neutron absorbers having the most significant abundance on Mars. Preliminary GSH analysis reveals that the second province (lowlands) is richer in iron, as well as in potassium and thorium, then the other provinces. The fourth province (high elevations) is richer in chlorine than the others [see J. Keller abstract, same session]. This analysis is still under progress, and more datasets may be included as they will become available.

P12C-08 1525h

Preliminary GRS Measurement of Chlorine Distribution on Surface of Mars

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Ongoing measurements with the Gamma Ray Spectrometer (GRS) aboard Mars Odyssey provide preliminary detection of chlorine at the surface of Mars. Summing all data since boom deployment and using a forward calculation model, we estimate values for chlorine concentration at 5° resolution. Rebinning this data and smoothing with a 15-degree-radius boxcar filter reveal regions of noticeable chlorine enrichment at scales larger than the original 5° resolution and allow for preliminary comparison with previous Mars datasets. Analyzing chlorine concentrations within 30 degrees of the equator, we find a negative correlation with thermal inertia ($R^2 = 0.55$) and positive correlation with albedo ($R^2 = 0.52$), indicating that chlorine is associated with fine, non-rock surface materials. Although possibly a smoothing artifact, the spatial correlation is more noticeable in the region covering Tharsis and Amazonis than around Arabia and Elysium. Additionally, a noticeable region of chlorine enrichment appears west of Tharsis Montes (∼0 to 20N, ∼110 to 150W) and chlorine concentration is estimated to vary in the equatorial region by over a factor of two. A simplified two-component model involving chlorine-poor rocks and a homogenous chlorine-rich fine material requires rock abundance to vary from zero to over 50%, a result inconsistent with previous measurements and models. In addition to variations in rock composition and distribution, substantial variations in chlorine content of various types of fine materials including dust, sand, and

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duricrust appear important in explaining this preliminary observation. Surprisingly, visual comparison of surface units mapped by Christensen and Moore (1992) does not show enrichment in chlorine associated with regions of indurated surfaces, where cementation has been proposed. Rather, Tharsis, a region of active deposition with proposed mantling of 0.1 to 2 meters of recent dust (Christensen 1986), shows the greatest chlorine signal. In light of suggested fine material formation mechanisms, this preliminary result is intriguing. Tentative models involving venting of chlorine from hydrothermal systems (Newsom 1999), enrichment of chlorine through volcanic aerosols (Settle 1979) or acid fog reactions (Banin et al 1997), and preferential deposition of a proposed salt component in Mars fines (Clark 1993), if more easily mobilized from the Martian duricrust, are viable. Finally, this preliminary measurement will be improved through further data collection by Mars Odyssey and comparisons with MER and future missions.

P21A MCC: 3002 Tuesday 0800h
Latest Results From Mars Odyssey I

Presiding: **J Plaut,** Jet Propulsion Laboratory, California Institute of Technology**; P R christensen,** Arizona State University

P21A-01 0800h INVITED

The Mars Odyssey Science Mission

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The 2001 Mars Odyssey orbital science mission officially began in late February, 2002. The spacecraft carries three science instrument packages: the Gamma Ray Spectrometer suite (GRS), the Thermal Emission Imaging System (THEMIS), and the Martian Radiation Environment Experiment (MARIE). The GRS suite of three instruments includes the Gamma Sensor Subsystem (GSS), the Neutron Spectrometer (NS) and the High Energy Neutron Detector (HEND). Spacecraft and instrument performance have been nominal to this point in the science mission. Gamma and neutron observations of the high latitudes have been used to identify water-ice-rich soil to 1 m depth at latitudes poleward of 60 degrees north and south. Enigmatic deposits of hydrogen have been identified in mid-latitudes, with water equivalent mass fractions of 2-10%. Gamma ray emission maps for six elements have been constructed, and analysis is ongoing. THEMIS daytime and nighttime infrared imaging shows a remarkable diversity of temperature signatures of surface materials, suggesting that THEMIS will truly provide a "new view" of Mars. An extensive campaign of visible imaging has resulted in a complete map of the south polar layered deposits at 36 m/pixel resolution. The MARIE instrument has detected radiation signatures from the high solar activity during the first 18 months of operations, including events with significantly different signatures at Mars and Earth. The mean local solar time of the Odyssey orbit has been in a slow drift since the start of mapping. An orbit trim maneuver to freeze the mean local solar time at a value of approximately 5:00 was to be executed late in 2003. In early 2004, the orbiter will serve as a data relay platform for the Mars Exploration Rovers, and as a supplement to the Mars Express relay for the Beagle 2 lander. Odyssey's nominal science mission will extend for 917 days, until August, 2004. Extended mission operations appear to be feasible, given the current inventory of propellant. Goals for a possible extended mission include inter-annual comparative observations, global high resolution mapping by the THEMIS visible camera, and synergistic science and operations support for other Mars missions.

P21A-02 0815h INVITED

Mars as seen from the 2001 Mars Odyssey Thermal Emission Imaging System Experiment

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Data from the Thermal Infrared Imaging System (THEMIS) instrument have been used to investigate the surface mineralogy, physical properties, polar regions, and atmosphere of Mars using multi-spectral thermal-infrared and visible images in 14 spectral bands from 0.45 to 15.5 m. These multi-spectral images have provided new information on the physical and compositional properties of the martian surface. Layered basaltic rocks rich in olivine have been detected in the walls of Valles Marineris. The presence of olivine indicates that this region has experienced very little liquid water, either surface or sub-surface, throughout its history. Carbonate outcrops at 100-m scales have not been detected, despite the discovery by the MGS TES instrument of several percent carbonate in the martian dust. Local variations in volcanic bedrock composition have been detected, suggesting compositional variations in a local source region. Variations in the physical properties of layered rock units occur in numerous regions indicating either different lithification/cementation processes or different initial depositional conditions or environments. Regional 100-m resolution mapping has revealed the presence of channel, fan, and delta systems not detected by Viking and not mapped by the high-resolution camera on MGS. To date no nighttime or daytime temperature anomalies have been identified that cannot be attributed to thermophysical properties, such as bedrock or dust exposures, alone. Crater ejecta show differing degrees of rock preservation, providing an additional tool for determining surface modification rates and assessing crater ages. The combination of IR and visible imagery has demonstrated that the dark spots and splotches that form in regions of the south polar cap are CO2 ice, suggesting a complex surface of transparent glaze ice and subtle variations on the absorption/transmission properties of this ice. Numerous aeolian surfaces, including dunes, wind streaks, inter-dune surfaces, lags, and mega-ripples, have been observed in day and night IR, allowing assessment of their grain size and the processes that formed these features.

P21A-03 0830h

THEMIS Visible and Infrared Investigation of Martian Meteorite-like Compositions on Mars

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Early results from the Mars Odyssey THEMIS have revealed, in high (20 to 100 km/pixel) spatial detail, the distribution of orthopyroxene- and olivine-bearing meteorite-like materials identified in MGS TES data [Hamilton and Christensen, 2003; Hamilton et al., 2003]. The presence of significant quantities of these mafic minerals is important not only to understanding the igneous history of Mars, and the possible origins of the Martian meteorites, but also to understanding the weathering regime(s) to which they have been subjected since they were exposed. These sites now have nearly complete THEMIS coverage (day and night) by the infrared subsystem, and greater than 50 percent coverage by the visible subsystem. We will present updated descriptions of the distribution, visible and infrared spectral characteristics, and thermophysical characteristics of these sites as observed by THEMIS, and discuss how these properties provide information on the history of these materials. Additionally, we will discuss how we have used THEMIS data to confirm TES-based identifications of meteorite-like lithologies in spatially small sites. [1] Hamilton, V. E. and P. R. Christensen, LPSC XXXIV, abstract 1982, 2003. [2] Hamilton, V. E., P. R. Christensen, H. Y. McSween Jr., J. L. Bandfield, Meteor. Planet. Sci., in press, 2003.

P21A-04 0845h

Evolution of the Martian Crust: Evidence from K and Th Measurements by the Mars Odyssey GRS

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Concentrations of K and Th on planetary surfaces record crustal evolution. Both are incompatible elements, so they concentrate in magma. During igneous processing, the ratio of K to Th is approximately constant, so K/Th in igneous rocks reflects that ratio in the bulk silicate planet. However, aqueous processes can fractionate K from Th, in principle giving us a way to investigate the extent of aqueous alteration of a planetary surface. The Mars Odyssey Gamma Ray Spectrometer has obtained global data for K and Th, allowing a fresh look at the evolution of the Martian crust. K and Th are not uniformly distributed on Mars. Some regions are richer in one or both of these elements. K ranges from 1000 to 6000 ppm; Th ranges from 0.2 to 1.1 ppm. The K/Th ratio varies from 2000 to 7000. These variations probably reflect a combination of the variety of surface igneous rocks and the effects of aqueous processes. The GRS and other data suggest: (1) Concentrations of K and Th are higher than those in basaltic Martian meteorites (K = 200-2600 ppm; Th = 0.1-0.7 ppm), suggesting different mantle sources for the meteorites compared to the bulk of the crust: Martian meteorites from depleted sources, the bulk of the crust from undepleted mantle sources. (2) The concentration of Th on Mars does not vary as much as it does on the Moon (where it ranges from 0.1 ppm to 12 ppm), suggesting that the primary differentiation of Mars differed from that of the Moon. This implies a magma ocean did not form on Mars, its characteristics (e.g., formation of garnet at its base, presence of water) differed significantly from those of the lunar magma ocean, or its products are not exposed at the surface. (3) If the average Th concentration (about 0.7 ppm) of the surface is equal to the average of the entire crust, the crust cannot be thicker than about 100 km. If the crust is about 50 km thick, as suggested by geophysical studies, then about half the Th is concentrated in the crust. (4) The variations in the K/Th ratio suggest that aqueous processes might have affected surface deposits. K and Th concentrate in different phases (e.g., K in feldspars and residual glass; Th in apatite) so differential dissolution of phases can cause fractionation of K from Th.

P21A-05 0900h INVITED

Shallow Water and Seasonal Deposits of Carbon Dioxide on Mars: Neutron Data Deconvolution of HEND/Odyssey

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The latest results are presented of 20 months mapping of Mars by High Energy Neutron Detector (HEND) onboard NASA Mars Odyssey. The water content is estimated for distinct geological regions at high and medium latitudes of Mars according to the model of double-layered subsurface. The structure of poleward regions of water-ice permafrost is presented for northern and southern hemispheres. Several spots at equatorial latitudes with the highest observable content of shallow water are discussed in more details. The seasonal time history of carbon dioxide circulation is presented, and the total mass of deposition is estimated for winter at north and south.