part of the Mars Odyssey Participating Scientist program. We use these THEMIS data in order to understand the morphology and color/thermal properties of the NPLD over relevant (i.e., m to km) spatial scales. We have assembled color mosaics of the data in order to map the distribution of ices, the different layered units, dark material, and underlying basement. The color information from THEMIS is crucial for distiguising these different units, which are less distinct on Mars Orbiter Camera images. In the NPLD, we wish to understand the nature of the marginal scarps and their relationship to the dark material. Co-registered Mars Orbiter Laser Altimeter (MOLA) data provide a measure of scarp morphologies and may help identify the process(es) eroding the NPLD (e.g., mass wast-ing, wind, sublimation). The dark material (or perhaps a darker layered unit in planar configuration) is present at the feet of many scarps, but expresses dune bedforms only tens of kilometers away from the scarps. MOLA will help identify the relationship between the spatial distribution of dark material, the presence of bedforms, and the influence of topography. We have derived the thermophysical properties of the different materials using THEMIS and Mars Global Surveyor Thermal Emission Spectrometer (TES) data, also resulting in a new map of the thermal inertia of Mars' northern hemisphere. Such analyses are complicated by the need for atmospheric correction (of both radiatively active CO2 and dust) and accurate surface temperatures. In order to derive thermal inertias and thermally derived albedos, we employ a 1-D, radiative-convective thermal model of Mars surface, subsurface and atmosphere. The model uses simultaneous (or seasonally relevant) TES atmospheric dust opacities. We also are studying the effects of surface slopes on insolation using MOLA topographic data.

P21C-07 1150h

Martian polar layered deposits: the latest from the THEMIS investigation.

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In this work we present the latest imaging data acquired by the Mars Odyssey THermal EMission Imaging System (THEMIS) and place it into context of the Mars Global Surveyor (MGS) data. This work concentrates on comparison of properties of North and South polar layered deposits (PLD) observed in thermal IR and visible channels of the THEMIS camera. We are primarily interested in major properties of the layers in both ice caps: their continuity, morphology and stratigraphy. These questions can be addressed by THEMIS VIS color images, along with MOC high resolution data and MOLA Digital Elevation Models (DEM). THEMIS Visible Imaging Subsystem (VIS) was used to obtain full coverage of the South Polar Layered Deposits (SPLD) during early spring, when this area is still covered by seasonal frost. This mosaic covers all of the South Polar region poleward of 80S. The staircase structure of the layered deposits is clearly seen. Layers in the North PLD (NPLD) are much smoother and don't exhibit staircase structure. Discontinuities and unconoformities are much more evident in the SPLD rather than in NPLD. MOC high-resolution images taken along the troughs and layers provide excellent context. We will also present initial results on monitoring seasonal changes in "swiss cheese" terrains. The most useful band for polar observations with THEMIS IR camera is band 9 (12.57 micron). Band 10 (14.88 micron) data can be used for atmospheric calibration. High resolution THEMIS IR data allows us to distinguish bulk properties of of layered terrain and ice. While we were not able to distinguish between individual layers, we will present initial observations of temperature trends in the polar layered deposits. Our ultimate goal is to characterize continuity, morphology and stratigraphy of the polar layered terrains and suggest mechanisms and timescales for their formation. Our approach is to use THEMIS VIS images to investigate continuity of the layers in the layered deposits and their stratigraphic relationships using high-resolution MOLA topography. MOC images provide important morphological detail. We will also attempt to detect heating or cooling trends in THEMIS Thermal IR imagery for selected troughs in the PLD and interpret these data in terms of thermophysical properties (e.g. thermal inertia) of the layers.

P21C-08 1205h INVITED

Results from the Martian Radiation Environment Experiment

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Ionizing radiation in space presents a potentially serious health hazard to astronauts on long-duration missions outside the geomagnetosphere. As a precursor to possible human exploration, the Martian Radiation Environment Experiment, MARIE, is returning the first detailed radiation data from Mars. MARIE is designed to measure the nearly constant flux of energetic Galactic Cosmic Rays (GCR) and intermittent Solar Particle Events (SPE). Despite considerable uncertainties in the normalization of MARIE data, comparisons to model calculations show good agreement, well within the estimated errors. The radiation dose equivalent on Mars from GCR is predicted to be 0.2 - 0.3 Sieverts/yr. (This is approximately 1000 times higher than the cosmic ray dose received on Earth.) In Mars orbit, over the first 16 months of operation, MARIE data show an annual dose equivalent of 0.4 +- 0.1 Sv/yr. That the measured rate is higher than the calculation is expected, since in orbit there is a contribution from low-energy particles that do not survive transport through the atmosphere. Additionally, SPE during this period have contributed about 0.04 Sv/yr to the average annual dose equivalent, a figure that can vary substantially over the course of the solar cycle. The implications of these data for human exploration will be discussed.

P22A MCC: Level 1 Tuesday 1330h

Latest Results From Mars Odyssey III Posters

Presiding: **O Aharonson,** California Institute of Technology; **K A Milam,** Planetary Geosciences Institute, University of Tennessee

P22A-0057 1330h POSTER

Specular Reflection of Odyssey's UHF Beacon from the Northern Latitudes of Mars

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In the morning (UTC) of August 29th, 2003, with Mars in it closest opposition in 60,000 years, the Mars Odyssey spacecraft was tracked with the SRI 46-m dish antenna located in the Stanford foothills. At 07:44 UTC, Odyssey's UHF Relay was turned on, with its 10 watt beacon in CW mode, and a 22 dB/Hz SNR signal was received three minutes later at the SRI dish. The Doppler compensated frequency of 437.100 MHz was observed using real time spectrograms that revealed a weaker, 0 dB/Hz SNR signal crossing the Odyssey beacon with the apparent Doppler signature of a specular surface reflection. Further analysis of the Doppler profile supports the interpretation of a surface reflection which traverses northern Martian latitudes from 16 N to close to the pole and back down to 60 N. The reflection's intensity profile laid across the ground track affords a comparison of the UHF's 0.7 m wavelength with the surface reflections from the X-band MGS occultation profiles.

P22A-0058 1330h POSTER

THEMIS Observations of Domes and Associated Lineaments in Arcadia Planitia

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The northern plains of Mars contain several high concentrations (Acidalia, Utopia, Elysium, etc.) of small (<10 km diameter) domes, proposed to be volcanic. Recent data sets from the Mars Global Surveyor and Mars Odyssey spacecraft provide new insight into the formation of domes in Arcadia Planitia. Daytime and nighttime thermal infrared (TIR) data from the Thermal Emission Imaging System (THEMIS), visible images from THEMIS and the Mars Orbiter Camera, and elevation data from the Mars Orbiter Laser Altimeter were used to study a 390,000 km ^{2} area ∼1500 km to the northwest of Elysium Mons. Of interest is a region centered on Tyndall crater and bordered by Phlegras Montes to the west. The area is characterized by gentle, westward-sloping plains, with noticeable slope breaks along several N-S trending wrinkle ridges. Several hundred circular domes dot this area. Domes display features consistent with a volcanic origin. Most are circular to slightly elliptical at their base, with basal diameters ranging from 0.5-6 km. Summits typically rise <300 m above the surrounding plains. Domes have shallow slopes (lacking significant slope breaks) that range from 1-9°. Visible images and TIR-derived temperature data suggest that slopes are composed of finer-grained material (as compared to the coarser-grained summits). Less than 25% of domes appear to have summit depressions and 1% show fractured summit areas. Some domes appear to be randomly distributed, but many are aligned in chains according to wrinkle ridge orientations. Using THEMIS data, we have detected over 165 domes that are aligned with and superimposed upon over 145 lineaments. Most lineaments are <500 m in width and range from 1-66 km in length. Many lineaments do follow N-S trends similar to those of wrinkle ridges, although other orientations are common. Several lineaments can be seen as open fractures, while others appear to be filled with fine-grained sediment. While most domes are superimposed upon lineaments, 3 domes area appear to be cross-cut by lineaments. No laterally extensive flows have been detected as emanating from lineaments, nor have similar lineaments been detected immediately outside the study area. The association of domes and lineaments is consistent with observations of volcanic constructs along open fissures in many terrestrial volcanic fields. Assuming a volcanic origin, the dome-lineament relationship suggests localized, structurally-controlled eruptions along open fissures. Initial extension caused the opening of fractures, which was followed by localized extrusions. Such localized development can provide information about eruption rates, magma compositions, or the physical properties of erupted lava. Either during or after volcanic activity, continued extension led to several domes being dissected by fissures.

P22A-0059 1330h POSTER

Can Chabazite Account for the Water Observed on the Equator of Mars?

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Up to 13 weight% of water-equivalent hydrogen has been reported for large near-equatorial areas of Mars based on neutron data from the Mars Odyssey orbiter (Feldman et al., 2003). Water ice is unlikely to explain this observation because it is not stable near the martian equator. Magnesium sulfate hydrate, clays, and zeolites have been suggested as possible water-bearing mineral constituents on the surface of Mars, perhaps partially accounting for this enigmatic water. Whether these minerals can retain H_2O under extreme Martian surface conditions is, however, not well constrained. The present study focuses on the natural zeolite chabazite (ideally $Ca_2Al_4Si_8O_{24}.12H_2O$) because chabazite is a common alteration product of basaltic rocks similar to those that are likely to be common on Mars. It also forms in the soils of the Dry Valleys region of Antarctica, cited by several studies as analogs

of martian near-surface alteration. The objectives of this study were to determine experimentally the hydration/dehydration behavior and energetics of this zeolite over a wide range of temperature (T) and water-vapor pressure (P(H_2O)) and predict its hydration state under low-T and low-P(H_2O) conditions such as those existing on the surface of Mars. Chabazite-H_2O equilibria were investigated by isothermal thermogravimetry using a system equipped with automated relative humidity (RH) control. Isothermal data were collected over a range of temperature from 25 to 315°C and pressure from 0.3 to 26 mbar. The relationship of the equilibrium constant (K) to the water content (X) was used to develop a thermodynamic model for hydration (X= gram of H_2O/gram of dry chabazite; $K = \frac{X}{P(H_2O)}$). Fits of $ln(K)$ vs. X isotherms clearly indicate the existence of three distinct hydration sites in chabazite with different energies. Extrapolation of the corresponding thermodynamic data to low-temperature and low-P(H_2O) indicate that if chabazite formed in the past on the surface of Mars it would still retain some of its water today (from 11 to 22 weight%). In order to explain the rather large amount of H_2O observed by the Mars Odyssey observer, chabazite or similar zeolites and clays would have to present at abundances >59 %. This is unlikely and other sources of water may be required to explain the H_2O present at equatorial regions on the surface of Mars. Nevertheless, hydrous minerals such as zeolites and clays, and hydrated salts, could account for a measurable portion of the water observed in martian regolith by the Odyssey spacecraft. Reference: Feldman, W.C., Prettyman, T.H., Boynton, W.V., Squyres, S.W., Bish, D.L., Elphic, R.C., Funsten, H.O., Lawrence, D.J., Maurice, S., Moore, K., Tokar, R.L., Vaniman, D.T. (2003) The global distribution of near-surface hydrogen on Mars. Sixth International Conference on Mars, July 20-25, 2003, Caltech, Pasadena, California, Abstract 3218. This research was supported by Los Alamos National Laboratory-Directed Research and Development funding.

P22A-0060 1330h POSTER

Mg-Sulfate Salts as Possible Water Reservoirs in Martian Regolith

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Neutron spectrometer data from the Mars Odyssey orbiter provide evidence of high water-equivalent hydrogen abundance in some near-equatorial locations on Mars. In broad regions shallow (<1 m) regolith appears to have water abundances of up to ~13 wt%. Water ice is predicted to be unstable at the present time at all depths below the surface in these equatorial regions. If present in hydrous silicate minerals such as clays or zeolites, which may contain water in abundances of ~10-20% at Martian surface conditions, the Odyssey data require a regolith very enriched in hydrous silicates - an unlikely proposition. Viking X-ray fluorescence data and alteration assemblages in martian meteorites suggest the presence of sulfate salts in martian regolith. Viking data from excavated duricrust indicate that Mg and S are correlated and that ~10% of an Mg-sulfate salt is a likely cementing agent. However, the range of possible Mg sulfates is large. Epsomite (7-hydrate, 51% water) and hexahydrite (6-hydrate, 47% water) are the most hydrated; both form structures of isolated SO_4 tetrahedra with isolated octahedral sites consisting of Mg coordinated by six H_2O molecules (epsomite has an extra H_2O in addition to the six required to coordinate with Mg). Pentahydrite (5-hydrate, 43% water) has infinite chains of alternating SO_4 tetrahedra and Mg octahedra, with 4/5 of the water forming apices in octahedral sites. Starkeyite (4-hydrate, 37% water) has clusters of two SO_4 tetrahedra and two Mg octahedra, linked only by hydrogen bonds. The Mg-sulfate sanderite (2-hydrate, 23% water) is rare and has poorly known structure. Kieserite (1-hydrate, 13% water) is relatively common in evaporite deposits and has a framework structure of infinite tetrahedral-octahedral chains cross-linked by hydrogen bonds. The stability of Mg-sulfate hydrates under martian near-surface conditions depends on their structures; those with excess water beyond that required to form the octahedral Mg site (e.g., epsomite, pentahydrite) lose that excess readily. Experiments with epsomite and hexahydrite indicate great sensitivity to environmental conditions; epsomite is not stable at 295 K at relative humidity (RH) values less than about 55%, below which hexahydrite is the observed phase. More importantly, hexahydrite - with all water coordinated to Mg in octahedral sites - is unstable at pressures less than ~20 mtorr. X-ray diffraction analysis of hexahydrite held at 20 mtorr for six hours shows that structural degradation is slow at 100 K but becomes obvious in 1 hour at 273 K. Thermogravimetric analysis of this amorphous solid shows that it contains ~26% H_2O (compared with 47% in crystalline hexahydrite), and its observed macroscopic expansion behavior suggests that it can reversibly hydrate and dehydrate. Although neither epsomite nor hexahydrite is likely to be stable near the surface of Mars, their amorphous derivatives or crystalline forms of the lower hydrates might be present (preliminary thermogravimetric data indicate that kieserite is likely to be stable). However, the limited rehydration of structurally degraded hexahydrite indicates that unrealistically large amounts (~50%) would be required in the upper meter of regolith to account for the higher water contents (~13%) suggested for some martian equatorial regions; even larger amounts of kieserite (~100%) would be required. A more important role for sulfates may be in the formation of a low-permeability salt crust that could restrict dewatering of underlying soil horizons.

P22A-0061 1330h POSTER

THEMIS Observations of Ares Vallis Geology

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Thermophysically and compositionally distinct layers are exposed in the walls and floor of Ares Vallis (~1000 km upstream from the Pathfinder landing site) and in an unnamed 20 km-diameter crater north of Ares Vallis (7.4 N, 340.4 E). Nighttime temperatures exceed 219 K in some areas; these temperatures are consistent with bedrock surfaces. THEMIS daytime radiance images over this region were selected for spectral analysis. A decorrelation stretch (DCS) was applied to each image using several different band combinations, in an effort to reveal any mineralogic variations that are present. Relative to many low-albedo regions on Mars, Ares Vallis displays a high degree of spectral variability at sub-TES-pixel resolution (~3 km). Three primary spectral units are readily identified in the DCS images. Extensive spectral analysis with TES and THEMIS data indicates that these color units represent surface dust, basalt and an olivine-rich unit. The olivine-rich layer is exposed along a ~250 km stretch of the outflow channel floor, and also in the wall and ejecta of the nearby unnamed crater. It is ~50-100 m thick and is overlain by ~1.5 km of crust. This thickness is comparable to that of other olivine-rich units found in Ganges Chasma and Nili Fossae [1-3]. The olivine-rich layer within the crater is ~100 m thick, and the bottom of the layer is separated by 400 m of elevation from the top of the olivine-rich layer near the floor of Ares Vallis. The olivine-rich layer in the crater is likely part of the same layer as that within the floor of Ares Vallis, and was simply uplifted during the impact that formed the crater. MOLA data is being used in conjunction with THEMIS data to better establish the stratigraphy of exposed units in this region.

The spectral variation in Ares Vallis illustrates that the crust of Mars is compositionally-layered at subkilometer scales, and provides an excellent example of how TES and THEMIS can be used together as a high spectral/spatial resolution tool for lithologic mapping. The stratigraphy and geologic relationships of Ares Vallis units will be presented, as well as the geologic implications for the history of this region. [1] Hoefen T. M. et al., *Bull. Am. Aston. Soc., 32(1118)*, abstract 62.03, 2000; [2] Hamilton, V. E. et al., *Meteor. Planet. Sci.*, in press, [3] Christensen P. R. et al., *Science, 300*, p. 2056-2061, 2003.

P22A-0062 1330h POSTER

THEMIS Observations of Aram Chaos: Evidence for an Ice-Covered Lake

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Aram Chaos is a large 280 km diameter crater centered at 2.5 N, 338.5 E. Similar to other nearby craters, it has been filled with a large amount of material since its formation. The interior deposits of this crater, however, differ substantially in two ways from those of other craters in the area; 1) Aram Chaos contains the second-largest deposit of gray hematite on Mars, with an areal coverage of 5000 km^2. 2) The sedimentary units in the interior of the crater are capped by a light-toned caprock that has a much higher thermal inertia than the underlying sedimentary units. The association of Aram Chaos with the outflow channels, its obvious basin morphology, the presence of friable interior layered deposits, and the presence of gray, crystalline is indicative of past surface and/or subsurface liquid water in the region. Aram Chaos was divided into twelve distinct units that were mapped based on their geomorphological, thermophysical, and compositional properties, primarily using THEMIS, but including TES, MOLA, and MOC data sets,. In at least three locations, stratigraphic relationships indicate that the layered materials in the interior of the crater were deposited after the formation of the chaotic terrain. There are three possibilities for the origin of these deposits; 1) volcanic, 2) aeolian, and 3) fluvial. A volcanic origin for these layers is unlikely, given the poor spectral match between magnetite-derived hematite and the martian hematite spectrum. If the deposits are simply aeolian in nature, then the presence of a distinct hematite rich layer in the middle of these sediments must be explained. Instead, we propose a model in which the layers were deposited in a lake fed by subsurface water flow. The lake was most likely ice-capped because liquid water would probably not have existed on the surface for a long period of time during the Hesperian when the layered materials are inferred to have been deposited. After the initial catastrophic release of subsurface water that formed the chaotic terrain, subsurface water continued to flow at lower rates to the inner basin in Aram Chaos, which would have been the area of least hydrologic head. The water filled the center of Aram Chaos, carrying sediment, and continually raising the ice cap. For a brief period of time, an Fe-rich fluid interacted with the subsurface water to deposit an Fe-oxide rich layer that was subsequently altered to gray hematite.

P22A-0063 1330h POSTER

Understanding Rocky Surfaces on Mars: Observations from TES and THEMIS

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The TES and THEMIS experiments have provided complementary data for interpreting the physical characteristics of surfaces on Mars. Thermal inertia and rock abundance values derived from TES data have been used to make interpretations of surface materials and characteristics while THEMIS data provide high-resolution morphology and temperature which can serve to test and develop the interpretations from the TES investigation. A global view of rock abundance on Mars is presented here followed by an analysis of the physical characteristics of surfaces on both a regional and high-resolution scale. The overall goal of this investigation is to identify the processes which may be responsible for exposing or generating rocks, and estimate the scales at which these processes may have been at work. A rock is defined as a surface material that has a thermal inertia of 1250 J/m2-s1/2-K (30 cal/cm2-s1/2-K) or greater. A surface with a high rock abundance value could be exposed bedrock, blocky debris, indurated materials or a combination. The TES rock abundance data were binned at 8 pixels/degree to produce a global map of percent aerial coverage of rocks on the surface of Mars. This new rock map is visually similar to global thermal inertia maps, but differences between the datasets suggest that there are complicated processes generating and exposing rocks on the surface. A number of regions with interesting thermophysical characteristics are being investigated to determine the relationships between thermal inertia, rock abundance and morphology. We are focusing on understanding regions with anomalous rock abundance/thermal inertia characteristics, including the southeastern slope of Arsia Mons, the northern scarp of Olympus Mons, Solis Planum, Ares Vallis, and Isidis rim. On a global scale, the TES rock abundance and thermal inertia values suggest that where a thick layer of dust is not completely mantling the surface, that the high thermal inertia material is not homogeneous and is composed of a mixture of coarse particulate (sand, gravel) and rock. Even in regions covered in dunes, some of the surface that surrounds and underlies the sand can have a higher thermal inertia than saltating material. There are a few places on Mars where the thermal inertia and rock abundance suggest that there have been processes at work to produce or expose unique materials that either have not formed elsewhere on Mars or have been removed.

P22A-0064 1330h POSTER

Development of chemical indicators of aqueous alteration on Mars with applications to the 2004 MER landing sites

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Data collected by the Mars Odyssey Gamma Ray Spectrometer (GRS) and Mars Exploration Rover Alpha Particle X-ray Spectrometers (MER-APXS) will allow for unprecedented chemical information to be obtained from the Martian surface. Phosphorous and iron are two elements that should be measured with some accuracy by MER-APXS (as opposed to MPF). The well-known affinity of iron oxide/hydroxides for sorption of phosphate in oceans, lakes, rivers, and soils will be used to assess the utility of P/Fe (in conjunction with other elements and element ratios measurable by MER-APXS) as an indicator of aqueous activity at the two 2004 MER landing sites. Iron oxide/hydroxides are also an effective sink for Th in terrestrial waters; thus, GRS data may also be valuable in evaluating the nature of aqueous alteration (or lack thereof) at the MER landing sites. For example, the hematite-bearing deposit in Sinus Meridiani (2S, 4W) has a high Th concentration and low K/Th, suggesting that sorption of Th by specular hematite in aqueous solution may have occurred at some point in the geologic history of this region of Mars. Experiments on the sorptive properties of specular hematite and palagonite for PO4 and Th will be used to develop a model for the role of water in formation of deposits at the two MER landing sites.

P31A MCC: 2000 Wednesday 0800h

Planetary Interiors and Geodynamics II *(joint with GP, S, T, V, MR)*

Presiding: **D M Jurdy,** Northwestern University**; S Stanley,** Harvard University

P31A-01 0800h

Convection in giant planets with and without inner cores

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We investigate convection in the interior of an extra-solar giant planet using a simple disk-shaped 2D finite volume model with radial gravity. The finite volume method allows us to easily track fluid motion through the center of the disk (the origin point) for a case without a solid inner core. Our anelastic simulations have a cold, impermeable outer boundary and a radial density stratification. A radial heating source simulates heating by gravitational contraction. We compare convection with and without a solid inner core.

P31A-02 0815h

The Active Period of the Core Dynamo of Mars

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The tremendous amount of magnetic field data acquired during the mapping phase of Mars Global Surveyor (MGS) provides a unique opportunity to derive a more accurate magnetic anomaly map of Mars. A most reliable anomaly map is constructed on a global scale through covariance analysis of the spherical harmonic models derived using data from different periods of the mapping phase. I also constructed most reliable magnetic anomaly maps on regional scales, using the covariance analysis in the Fourier domain. Many weak magnetic anomalies are newly detected over the northern lowlands, which are likely relicts of stronger anomalies that have been partially demagnetized by the lowlands formation process and the subsequent low-temperature hydration. The north-south dichotomy of the magnetic anomalies may not have been as drastic before the formation of the lowlands. The lack of distinct magnetic anomalies associated with the entire Valles Marineris, the dike swarms, and the shield volcanoes, as also confirmed by the science phase and aerobreaking phase MGS data, suggests that the upper at least 5 km of the crust in Tharsis bulge is not significantly magnetized. Rifting a magnetized layer of 5km thickness, with a magnetization similar to that of the mid-ocean ridge basalt (MORB), on the scale of Valles Marineris would have produced an appreciable magnetic anomaly that could have been detected by MGS. A dike cutting the magnetized layer will create a magnetic anomaly. Although the magnetic anomaly of a single dike decays fast with elevation and cannot be detected by MGS, the collective magnetic field of a wide dike swarm can produce a detectable field. Also, the magnetized layer would have been thermally demagnetized by the over lapping shield volcanoes and could have given rise to detectable magnetic anomalies at MGS altitudes. The upper crust of Tharsis bulge is basaltic and expected to have appreciable magnetic minerals, and the bulge has always been a highland where low-temperature hydration may not have been appreciable. If so, then the core dynamo ceased, or considerably reduced in intensity, before the formation of the upper crust in Tharsis bulge.

P31A-03 0830h

Models for Mars' Magnetic Scalar Potential

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Mars Global Surveyor MAG/ER measured strongly magnetized crust, despite Mars' weak field at present, the intensity reaches about 10 times that of Earth's magnetic lineations. We analyze the magnetic lineations in an octant centered at 40°S, 180°W ±40°, concentrated in the more heavily cratered Southern hemisphere. Data from the mapping phase of Mars Global Surveyor, MAG/ER magnetic measurements at an altitude of 404 ±34 km, were made available by Connerney conveniently binned into degree boxes. Using a rotated spherical co-ordinate system centered at 40°S, 180°W, we perform a two-dimensional Fourier analysis over this region. This can be shown to be a good approximation: results can be used to reconstruct the original components as a check. The magnetic field components can be described by the curl of a vector potential or the gradient of a scalar potential. The scalar potential is especially attractive as it can be obtained from the Fourier transform of the vertical magnetic component, H_z. The gradient of this field generates the horizontal magnetic components which can be compared with the rotated horizontal components. The corresponding fields are nearly identical, thus an independent check as the horizontal components were not used to construct the scalar potential. We model the magnetic field using the observed scalar potential. With vertical dipoles we determine depths and magnitudes for selected centers and average surroundings, and find that 8 sources account for 80% of the variance. (Only 4 sources already account for 60% of the variance.) These sources range in depth 260±130 km, and the source magnitudes range over a factor of 4. Using the autocorrelation of the scalar potential, we estimate that there are only 20-30 independent components of the field (which corresponds to a resolution of 4x5 or 5x6).

P31A-04 0845h

Can Mercury's Weak Surface Magnetic Field be Generated by a Dynamo?

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Mariner 10 observed Mercury's magnetic field during 3 flybys of the planet between 1974 and 1975, revealing the presence of a magnetic field of internal origin with a dipole moment of $\approx 300\mathrm{nT}-R_M^3$ ($1R_M = 2440$ km). Such a field is probably too large to be explained by induction effects or remanent magnetization; however, energetic considerations suggest that it may be too small to be consistent with dynamo action, at least for an Earth-like dynamo. More specifically, energetic considerations provide an estimate of the toroidal magnetic field strength that the dynamo should generate: if the dynamo is Earth-like in the sense that it has similar toroidal-poloidal field strength scaling as the Earth, then the poloidal field should be much stronger than that observed. Before abandoning a dynamo explanation for Mercury's field, we question whether the same toroidal-poloidal scaling should hold for Mercury. If a dynamo is operating in Mercury's iron core, part of the core must be fluid. Thermal evolution calculations estimate that the solid inner core comprises between 0.5 and 0.8 of the total core radius, much larger than the Earth value of 0.35. As a result, the fluid convecting outer core where the dynamo is generated is much thinner for Mercury than for Earth. Here we use 3-D numerical dynamo modeling to investigate dynamos operating in thin shell geometries. We find that the magnetic fields produced by thin shell dynamos can have larger toroidal to poloidal field ratios than Earth-like dynamos. This suggests that a hydromagnetic dynamo may be consistent with the weak surface field observed at Mercury and alternative explanations may not be required.

P31A-05 0900h

Estimating the k2 Tidal Gravity Love Number of Mars

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Analysis of the orbits of spacecraft can be used to infer global tidal parameters. For Mars, the Mars Global Surveyor (MGS) spacecraft has been used to estimate the second degree Love number, k2 from the tracking DSN tracking Doppler and range data by several authors. Unfortunately, neither of the spacecraft presently in orbit are ideally suited to tidal recovery because they are in sun-synchronous orbits that vary only slightly in local time; and, further, the sub-solar location only varies by about ±25 degrees in latitude. Never-the-less respectable estimates of the k2 tide have been made by several authors. We present an updated solution of the degree 2 zonal Love number, compare with previous values, and analyze the sensitivity of the solution to orbital parameters, spacecraft maneuvers, and solution methodology. Estimating the k2 Tidal Gravity Love Number of Mars

P31A-06 0915h

Tharsis: Consequence of Mars' Dichotomy and Layered Mantle

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The two largest and most striking features on Mars are the crustal dichotomy, the nearly hemispheric division in topography, gravity, crustal thickness, and age, and Tharsis, a volcanic center active from the Noachian to the present. Tharsis' long-term persistence of localized volcanism is, to the best of our knowledge, unique in the solar system. Explaining the timing of Tharsis volcanism, from initiation early in martian history to recent activity, has been an enduring challenge.

Here we present an model of the martian mantle that can explain early and persistent volcanism at Tharsis by incorporating the effects of the crustal dichotomy and a compositionally layered mantle. As the crust is expected to be enriched in heat-producing elements, this dichotomy in thickness leads to a dichotomous heat flux boundary condition on the mantle, which affects the internal dynamics. The evidence for layering includes the ability of a layered mantle to simultaneously meet a chondritic bulk composition and the moment-of-inertia factor (Elkins-Tanton et al., in revision), which can not be done with a one-layered mantle. In addition, studies of the martian meteorites suggest that the martian mantle is heterogeneous, a constraint that can be met with layering.

We perform analog laboratory experiments with corn syrup to simulate Mars' thermal evolution. We vary the presence of a partial insulating lid, to simulate the effect of the dichotomy, and layering in the convecting fluid. We show that in the case of a layered mantle and an insulating lid, a large swell, which acts to localize upwelling plumes under the lid, forms early and endures for the scaled equivalent of billions of years.

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