P72B-0505 1330h POSTER

Coupled Thermal-Orbital Evolution of Europa

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Tidal dissipation plays an important role in system of the Galilean satellites. Here, implications of tidal heating for Europa's present state and for its thermal orbital evolution are discussed. The polar moment of inertia and cosmochemical arguments suggest that Europa consists of an iron rich core, a silicate layer and an outer ice/water-layer of 70-170 km thickness. The lower part of the ice/water-layer is expected to be liquid due to internal heating. The existence of a subsurface ocean is consistent with the detection of an induced magnetic field in Europa. The tidal deformation and the dissipation rate within its ice layer strongly increase if an inviscid ocean is present underneath the ice. Two different Europa models are discussed. In the first model, tidal dissipation is assumed to occur in the silicate mantle layer. In the second model dissipation within the ice shell is considered. The tidal dissipation rate is calculated using the viscoelastic field theory for self gravitating, incompressible, hydrostatically equilibrated, spherical planets in synchronous rotation. The response of the planetary material to the periodic tidal forcing is calculated assuming a Maxwell rheology. The relaxation function is determined by the two parameters viscosity and rigidity, which are taken to be temperature dependent. The tidal dissipation rate is proportional to the imaginary part of the complex tidal Love number k_2. Since dissipation is an internal heat source, the thermal evolution is linked to the orbital evolution through the temperature dependent rheology. Using heat balance equations for Io and Europa, conservation laws for energy and angular momentum, and conditions for the Laplace resonance, a set of first order differential equations is derived, describing the thermal and orbital states of Io and Europa. The numerical integration shows that scenarios are possible in which Europa passes through high dissipation states. If dissipation within Europa's silicate layer is assumed, these phases are continuing until about 500 Ma before the present time. Additionally, orbital elements and internal temperatures oscillate on a timescale of the order of 100 Ma. During Io's oscillatory phase Europa is heated gradually and reaches high interior temperatures after several oscillations. This is accompanied by a final cold phase of Io. If dissipation within the ice layer is taken into account, Europa's ice thickness varies between about 10 and 50 km during the oscillatory phases, including both convective and purely conductive phases. The ocean is found to be stable over geological timescales.

P72B-0506 1330h POSTER

Forced and Free Libration of the Galilean Satellites

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Numerical simulations of the coupled orbital and rotational dynamics of the Galilean satellites show the presence of both free and forced librations. Jupiter's large mass implies periods of the free librations of the Galilean satellites shorter than the Moon's. While the period of the Moon's free zero longitude libration is 2.9 yr, the same period is only about 13 days for Io, 53 days for Europa, 185 days for Ganymede and 900 days (2.5 yr) for Callisto. Our simulations also reproduce the pole wobble of the Moon with a period of 75 yr and show analogous variations for the Galilean satellites' poles with periods of about 230 days for Io, 1756 days (4.8 yr) for Europa, 30 yr for Ganymede and 300 yr for Callisto. Simulations including tides will be carried out to determine the most likely rotational state of the Galilean satellites as the end state of the tidal evolution.

P72B-0507 1330h POSTER

Cumulates, Dykes and Pressure Solution in the Ice-Salt Mantle of Europa: Geological Consequences of Pressure Dependent Liquid Compositions and Volume Changes During Ice-Salt Melting Reactions.

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Water-salt analogue experiments used to investigate cumulate processes in silicate magmas, along with observations of sea ice and ice shelf behaviour, indicate that crystal-melt separation in water-salt systems is a rapid and efficient process even on scales of millimetres and minutes. Squeezing-out of residual melts by matrix compaction is also predicted to be rapid on geological timescales. We predict that the ice-salt mantle of Europa is likely to be strongly stratified, with a layered structure predictable from density and phase relationships between ice polymorphs, aqueous saline solutions and crystalline salts such as hydrated magnesium sulphates (determined experimentally by, inter alia, Hogenboom et al). A surface layer of water ice flotation cumulate will be separated from denser salt cumulates by a cotectic horizon. This cotectic horizon will be both the site of subsequent lowest-temperature melting and a level of neutral buoyancy for the saline melts produced. Initial melting will be in a narrow depth range owing to increasing melting temperature with decreasing pressure: the phase relations argue against direct melt-though to the surface unless vesiculation occurs. Overpressuring of dense melts due to volume expansion on cotectic melting is predicted to lead to lateral dyke emplacement and extension above the dyke tips. Once the liquid leaves the cotectic, melting of water ice will involve negative volume change. Impact-generated melts will drain downwards through the fractured zones beneath crater floors. A feature in the complex crater Mannan'an, with elliptical ring fractures around a conical depression with a central pit, bears a close resemblance to Icelandic glacier collapse cauldrons produced by subglacial eruptions. Other structures resembling Icelandic cauldrons occur along Europan banded structures, while resurgence of ice rubble within collapse structures may produce certain types of chaos region. More general contraction of the ice mantle due to melting may be accommodated across banded structures by deformation and pressure solution. Expansion and contraction during different parts of a melting (and freezing) episode may account for the complexity of banded structures on Europa and inconsistent offsets of older structures across them.

P72B-0508 1330h POSTER

The Pressure Factor in Europas Aqueous Evolution

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Equation of state data at high pressure need to be incorporated into computational efforts to understand the evolution of the composition of Europa's ocean. These efforts also have applications to other planetary bodies and for Earth's deep oceans. While investigators refer to some experimental constraints in consideration of the likely effects of high pressures on the relevant aqueous geochemistry, calculations have not yet taken them into account. Specific processes requiring a better understanding of the role of high pressures include devolatilization within the rocky interior, the evolution of volatiles released into the ocean, metamorphism of hydrated salts on the seafloor, and temperature oscillations of the system in response to changes in tidal heating. We derive chemical potentials for aqueous solutions from speeds of sound measured as functions of pressure and temperature. These parameters are determined in our laboratory through the method of impulsive stimulated scattering. A complete equation of state for aqueous sodium sulfate up to 34 kbar and 573 K is reported in terms of activity coefficients and volumes of mixing. Systematic trends within this important chemical system provide guidance in constructing the overall framework of aqueous geochemistry in multicomponent systems at elevated pressures.

URL: http://virgilio.ess.washington.edu/lab/

P72B-0509 1330h POSTER

Surface Manifestation of Solid-State Convection in Europa's Ice Shell

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Europa's surface displays a diversity of geologic terrains. The two dominant terrain types are the ridged plains, which consist of successive generations of overprinted ridge pairs, and the chaos terrains, which are comprised of hummocky material and disrupted crustal blocks. In addition, numerous small (< 20 km) landforms were imaged by Galileo, including pits, domes, platforms, irregular uplifts, irregular lobate features, and smooth, flat regions embaying topographic lows. Uplifts and pits have been suggested to result, at least in part, from deformation of the lithosphere by solid-state convection in the ice crust. To test this idea, we will present preliminary two-dimensional numerical simulations of solid-state convection in Europa's ice shell performed using the Conman finite element code with temperature-dependent viscosity and viscosity contrasts relevant for the stagnant-lid regime. The goals are to determine (i) the parameter regimes under which convection can occur, (ii) whether the convection can produce topographic features tens to hundreds of meters in vertical relief, and the horizontal scale and time-dependence of these features, and (iii) whether the convection is likely to fracture the lithospheric ice. Internal tidal heating, and a flux of heat from below, are included. Furthermore, the spatial distribution of pits and uplifts sometimes appears to be tectonically controlled (e.g., pits often lie between lineaments but avoid the lineaments themselves), and so we will include faults in some simulations to determine their effect on the surface manifestation of the convection.

P72C MCC: 131 Sunday 1330h

Extant Water on Mars: Its Abundance, Physical State, and Role in Modern Geologic Processes I *(joint with C, A, H)*

Presiding: **N Bridges,** Jet Propulsion Laboratory**; T N Titus,** U.S. Geological Survey

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P72C-01 1330h INVITED

The Occurrence of Ground Ice on Mars

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In its present climate Mars is globally covered by permafrost, a region of the subsurface that regardless of ice content is always below 273 K. The upper boundary of this zone ranges from the surface to a depth of only a few centimeters. The lower boundary is as much as several kilometers deep, where geothermal energy warms the deeper regolith, but can be less than a kilometer near the equator. Water may be present in the permafrost as an interstitial vapor, as a solid (ground ice), or as a thin adsorbed layer on the surface of soil grains. Liquid water can persist only as a concentrated brine.

Subsurface ice (ground ice) within the permafrost can persist if stability conditions allow. In the absence of a liquid phase, the transport of water within the permafrost occurs primarily by vapor diffusion. As a result ground ice can be dynamic, exchanging with atmospheric, polar, and other ground-ice reservoirs over time. Based on results from numerical dynamic-equilibrium models, ground ice is stable against sublimation in geographic locations and at depths where the annual-mean subsurface saturation density of water vapor is below the water-vapor density of the atmosphere. These are also geographic locations where the annual-mean temperatures are below the frost point of the atmosphere (the temperature at which atmospheric water vapor saturates and begins to condense as frost). In a porous regolith in diffusive contact with the atmosphere, water vapor will condense in the pore space

forming ground ice where these stability conditions exist.

Numerous theoretical investigations over the past few decades have suggested that near-surface ground ice should be found in the mid and high latitudes of Mars at depths less than a few tens of centimeters from the surface. In contrast, the equatorial region should be absent of ice unless it is isolated from the atmosphere. Recent observations of abundant near-surface hydrogen have confirmed the presence of ice approximately in these higher-latitude regions and provide constraints for refinement of our models. The theory of ground ice stability and its distribution, dynamics, and nature will be reviewed. Comparisons will be drawn between martian and terrestrial ice-rich permafrost and placed into the context of various observations of Mars.

P72C-02 1350h INVITED

Water, water everywhere ...: Observations of Solid Water on Mars

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H_2O is directly observed on Mars in the vapor state and as a solid in clouds, surface frosts, and as the permanent North polar cap. Liquid H_2O is not stable at the surface of Mars under current conditions. However, first-order stability of the solid requires only that the mean annual saturation pressure, derived from the physical temperature, be below the mean annual H_2O vapor pressure; this condition occurs widely on Mars, and there has been a general expectation of abundant ice in the soil/regolith. Odyssey GRS observations suggest extensive water-ice, beneath about 400 kg/m^2 of soil, around the south pole. Although water ice is prominent and abundant near the North pole, until recently (this conference) water ice had not been observed at the surface in the south polar region; new thermal observations indicate dirty water-ice is directly exposed in isolated locations there. Water ice is expected to accumulate in the seasonal CO_2 cap, but the amounts are on the order of 0.1 kg/m^2 and are expected to sublime in less than a sol after the disappearance of solid CO_2. Transient brightenings have been observed on or near the summer north polar cap, and off the edge of the winter seasonal cap at the Viking II site, all at temperatures too high for CO_2. These are consistent over years in their general region, but vary in detail between years. Specific areas well away from the perennial cap show late-summer brightness and temperature behavior suggesting solid ice immediately (cm) below the surface. Comparison of diurnal and annual temperature variations suggest permafrost surrounds the north polar cap. There are countless inferences of the presence of water-ice in the indeterminent present or past on geomorphological grounds. Water is probably common as interstital ice or with relatively minor fractions of dirt over much of Mars. Precise locations and depths will become increasing well known as exploration techniques improve.

P72C-03 1410h

Exposed Water ice Discovered Near the South Pole of Mars.

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Although near-surface H_2O ice was expected from thermodynamic stability considerations, and recent GRS observations indicate abundant hydrogen in the near surface of the south polar region, the lack of exposed H_2O ice, so obvious in the north polar region, had been puzzling. Initial examination of the Mars Odyssey Thermal Emission Imaging System (THEMIS) images, combined with Viking imaging and Thermal Emission Spectrometer (TES) temperatures, indicates there may be many such isolated areas of exposed H_2O ice near the perennial CO_2 cap.

The exposed surface ice was first observed by THEMIS as a low albedo region whose temperature did not fit the expectations for CO_2 or dry soil. The putative H_2O ice region is a strip about 10km wide along the base of a slope below a CO_2-covered plateau. Seasonal coverage is not yet available from THEMIS, but TES observations from the prior year indicate that after complete sublimation of the solid CO_2, the temperature rises rapidly with little diurnal variation, versus a neighboring "dry soil" region where diurnal variations of ~20K developed. Thermal modeling of the ice region indicates a good fit to temperatures expected for a surface of thermal inertia ~2000, appropriate for solid H_2O; there is no indication of a thin low-inertia covering layer. Visual Viking images from 25 years ago provide evidence that the boundary between the H_2O ice region and the dry soil region has been stable over the last quarter century.

An alternate explanation of these observations, that the region is a uniform, exposed solid rock, has shown to be implausible.

P72C-04 1425h

Mars Polar Thermal Inertia and Albedo Properties Using TES Data

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We present north and south polar thermal inertia and albedo maps derived from MGS TES observations. The maps were derived using the same robust approach developed to make polar thermal and inertia and albedo maps using IRTM observationsby Paige, Bachman, and Keegan (1994) and Paige and Keegan (1994). The data processing approach involved reading TES reduced data records in PDS format using the Vanilla software tool, and sending the data down a processing pipeline that constrains and bins the data, and compares it to the results of a diurnal and seasonal thermal model to obtain the best fit thermal inertia and apparent albedo. To facilitate comparison, the TES maps were created at the same Ls ranges as the published IRTM maps using TES spectral surface temperature results. The north polar maps used TES nadir observations obtained during a 50-day period from Ls 98.39 to Ls 121.25. The south polar maps used TES nadir observations obtained during a 30-day period from Ls 321.58 to 338.07. The creation of these maps employ a basic thermal model that does not include the effects of the atmosphere, as well as a one-dimensional radiative-convective model that does include the effects of the atmosphere. The spatial resolution of the north polar maps is 0.1 degrees of latitude and 1.0 degrees of longitude. The spatial resolution of the south polar maps is 2 degrees of latitude and 2 degrees of longitude.

The TES north polar maps show the residual cap area in significantly greater detail than has been available previously. The IRTM maps showed that the north polar sand sea that surrounds the cap has unusually low thermal inertia. The TES maps confirm this conclusion, but also show that the dark reentrant features in chama boreal and elsewhere on the cap also have low thermal inertias. This strongly supports the proposal that these dark rentrants are the sources of the dune material. The TES maps also show that the darker layered deposits which are found at the periphery of the cap have high thermal inertias, just like the brighter water ice deposits elsewhere on the cap. This strongly supports the conclusion that even the darker north polar layered deposits are mostly ice. The TES south polar maps show similar features to those observed by IRTM, including the presence of a low thermal inertia region centered on the south pole, and a region of anomalously high apparent albedo southward of 78 degrees latitude.

References:

Paige, D. A., J. E. Bachman and K. D. Keegan, Thermal and albedo mapping of the polar regions of Mars using Viking thermal mapper observations: 1. North polar region, J. Geophys. Res. 99, 24,959-25,991, 1994.

Paige, D. A. and K. D. Keegan, Thermal and albedo mapping of the polar regions of Mars using Viking thermal mapper observations: 1. South polar region, J. Geophys. Res. 99, 24,993-26,013, 1994.

URL: http://mars.ucla.edu/~josh/AGU_fall_2002.html

P72C-05 1440h

Possible Mechanism for Formation of Martian Ground Ice

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Mars Odyssey disclosed the existence of the vast quantities of water-ice beneath the Martian ground surface. Now we have become to able to discuss the ground ice on Mars, admitting its existence. However, another question was brought up ; we need to explain *how* this ice was formed.

Through the analysis of surface landform, we now almost agree for that Martian environment was warm and wet in the past, and (at least) once had much water on its surface. Nevertheless, the existing of ice-rich layer in just near from the surface is controversial. There is no good idea to supply enough amount of water to subsurface.

As the Martian environment cooled down, due to decrease of precipitation, it should have become dry like terrestrial polar desert. In this case, water should go to deeper part of the ground. The "wet and cold" situation is hard to imagine. And after once Martian environment had cooled and dried, even if liquid water was supplied from the surface, the volumetric ice content of the soil cannot be more than the porosity of the soil (20-30% would be reasonable).

In this study, we proposed one possible scenario to form this ice-rich permafrost layer, and discussed the required conditions. Our concept is taking account of the migration of the soil water during its freezing, like the frost heaving or the formation of the ice lenses.

We applied the 1-D soil model for Martian condition, assuming the simple cooling climate history and constant heatflow value. The original idea of the model was developed by Harlan (1973), both of the flow of heat and soil moisture were taken into account.

We calculated the soil water migration and ice segregation, to estimate how much ice can be formed near the surface. Calculation was performed under the several parameter sets of surface cooling rate, initial water content of the soil, and crustal heatflow value.

From these numerical experiments, we found that this mechanism could work in some range of the parameters. As to the surface temperature, the slow decrease (we assumed the monotonous cooling) is adequate. About the heatflow, neither too small nor too large value were appropriate, but medium value was suitable for producing ice-rich layer.

P72C-06 1515h INVITED

Seasonally-Active Water on Mars: Vapour, Ice, Adsorbate, and the Possibility of Liquid

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Seasonally-active water can be defined to include any water reservoir that communicates with other reservoirs on time scales of a year or shorter. It is the interaction of these water reservoirs, under the influence of varying solar radiation and in conjunction with surface and atmospheric temperatures, that determines the phase-stability field for water at the surface, and the distribution of water in various forms below, on, and above the surface. The atmosphere is the critical, dynamical link in this cycling system, and also (fortunately) one of the easiest to observe.

Viking and Mars Global Surveyor observations paint a strongly asymmetric picture of the global seasonal water cycle, tied proximately to planetary eccentricity, and the existence of residual ice caps of different composition at the two poles. The northern summer experiences the largest water vapour columns, and is associated with sublimation from the northern residual water ice cap. The southern summer residual carbon dioxide ice cap is cold trap for water. Asymmetry in the water cycle is an unsolved problem. Possible solutions may involve the current timing of perihelion (the water cap resides at the pole experiencing the longer but cooler summer), the trapping of water ice in the northern hemisphere by tropical water ice clouds, and the bias in the annual-average, zonal-mean atmospheric circulation resulting from the zonal-mean difference in the elevation of the northern and southern hemispheres.

Adsorbed and frozen water have proven harder to constrain. Recent Odyssey Gamma Ray Spectrometer results suggest substantial ground ice in the mid- and high-latitudes, but this water is likely below the seasonal skin depth for two reasons: the GRS results are best fit with such a model, and GCM models of the water cycle produce dramatically unrealistic atmospheric vapour distributions when such a very near surface, GRS-like distribution is initialized - ultimately removing the water to the northern and southern caps. Similar climate-models of the water cycle also do not need much exchangeable adsorbed water in order to explain the observed vapour distributions.

The possibility of liquid water is tantalizing, but difficult to definitively judge. On scales greater than a meter or so, Mars is most definitely well away from the water triple point–although the surface pressure can exceed 6.1 mbars, the partial pressure of water vapor (to which the triple point refers) is at best orders of magnitude lower. Several careful studies have shown, however, that locally transient (meta-stable) liquid is possible, if the net heating of ice deposits is high enough. This process is aided if the total surface pressure exceeds 6.1mbar (this prevents boiling, or the explosive loss of vapour into the atmosphere) or if the liquid is covered by a thin ice shell, and is only possible if surface temperatures exceed 273K (for pure water, or the appropriate eutectic for brines) and if ice is present. The former challenge is much easier to meet than the latter. The melt scenario requires that ice deposited in winter must be protected from sublimation as surface temperatures increase in spring, but then exposed to the peak of solar heating in summer.

Available spacecraft observations of seasonal water will be discussed with the aid of GCM model simulations, and examined in the context of water distributions and phases.

P72C-07 1535h

Seasonal Migration of Water Frost on Mars

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The annual recession of the north polar cap of Mars has been studied with Viking IRTM and MAWD instruments and, more recently, with MOC, TES, and MOLA instruments on the Mars Global Surveyor spacecraft. Discrepancies between certain of these measurements have been attributed to a band of water ice that accompanies and lags behind the retreat of the CO2 seasonal cap. This "migration" would transport heat by transfer of latent heat of sublimation and condensation – a far more efficient process for achieving local thermal equilibrium than atmospheric convection under martian conditions. Related considerations suggest that the form of this migrating water will be low density hoarfrost, which could average centimeters in thickness at the highest latitudes. Local coldtrapping in sheltered locations could further concentrate these seasonal deposits into drifts where, with sufficient heating, localized melting may be possible.

P72C-08 1550h INVITED

Middle- and Polar-latitude Gullies Through the Second Mars Year of MGS MOC Observations

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Middle- and polar-latitude gullies, first observed in Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) 1.5 to 12 m/pixel images [Malin and Edgett, *Science, 288,* 2330-2335, 2000], provide compelling evidence that Mars may have contemporary groundwater at shallow depths (< 500 m). Through July 2002, ~1200 of the ~53,000 high resolution images show these landforms. Gullies occur most often, but not exclusively, on poleward-facing slopes of troughs and craters at middle and high latitudes. Northern hemisphere gullies are more likely than those in the south to be on equator-facing slopes. Except for gullies in Nirgal Vallis, few occur equatorward of 30° latitude. The spatial relations suggest gully genesis is sensitive to solar insolation. Banked, leveed, and anastomosing channels suggest transport involved a fluid with all the properties of liquid water; multi-lobed aprons indicate multiple depositional phases or events. Most gullies appear to be geologically young; most are uncratered, not mantled by dust, and have channels that cut and aprons that superpose surrounding landforms. The channels are free of debris; this observation suggests they experience events of sufficient energy to flush material through the channels, and that these events occurred relatively recently because the channels have not become choked with detritus shed from their walls. Although alternative materials such as CO_2, shallowly-emplaced ground ice, or snowmelt have been proposed, the most likely source of fluid is groundwater (fresh, brine, or frozen), suggested not only by morphology but by the occurrence of regional clusters and associations with specific layer(s), both attributes of aquifers. In the past Mars year, MOC has focused on change monitoring of known gullies (no changes have been observed), imaging at higher resolution and in stereo, and a continued global search for additional gullies. Previously identified subclasses of gullies are now distinguished on size, morphology, geography, and topography. For example, gullies on dune slip faces differ in marked ways from other forms; contrary to some predictions, new examples of these have not formed in the past two Mars years.

P72C-09 1610h

Martian aquicludes required for gully formation

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We continue to study the apparently recent Martian gullies in Nirgal Vallis, Dao Vallis, Hale Crater and Gorgonum Chaos using Mars Orbiting Camera (MOC) images. All gullies analyzed here are found on poleward-facing slopes. Every observed gully emanates from within a single competent subsurface rock layer or from a specific competent layer among multilayered strata. The gullies emanate from the layer, even when the layer is faulted, suggesting a causal relationship. We have measured the elevation of gully heads using Mars Orbiter Laser Altimeter (MOLA) data and found the depth of the gully heads measured ranges from approx. 10 to 800 m (average: 280 m; n=70) below the local surface and 2 km above to 5 km below the MOLA datum. To test the hypothesis that the subsurface depth is related to subsurface geology, we calculated average depths below the local surface of the gully heads as a function of mapped surficial geologic unit. Our data show that the average depth of gully heads is more variable in strata beneath geologic units predicted to have greater primary or secondary permeability. We posit that gully heads with a more regular range of depths within a geologic unit indicate a regionally continuous impermeable layer (e.g., ash or clays) approximately parallel to the local surface. Gully heads that show a greater variability in depths within a geologic unit may indicate the occurrence of faulted and/or semipermeable layers (strata with abundant unconformities or disrupted units at craters and chaos). The average elevations of gully heads show no correlation with latitude, suggesting the layer associated with the gully heads is not permafrost.

We advocate a model in which gullies are produced in areas where 1) ground ice is present and 2) is melted in the near-surface within a climate that can sustain liquid water which 3) percolates through any permeable materials down the hydraulic gradient until encountering an impermeable layer (aquiclude). If the impermeable layer dips toward an exposed wall, this groundwater may flow along the layer and discharge at the surface, forming a gully. Implicit in this model is that regions without impermeable layers would lack gullies. At Dao Vallis (approx. 33S to 38S), exiting groundwater contributes to both gullies and deposits of smooth, positive-relief material we interpret to be ice-rich regolith, likely indicative of cooler local surface temperatures than the other gullies examined. The average gully alcove depth of 280 m below the Martian surface probably reflects the relatively high permeability of the upper hundreds of meters due to various weathering processes. The presence of gullies may mark the distribution of subsurface impermeable layers globally. As some of these geologic units are mapped as Noachian, the aquicludes marked by gullies may have controlled the flow of groundwater throughout much of Martian history.

P72C-10 1625h

Mars Polar Gully Modification and Possible Formation from Condensed Volatiles

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The apparently young age of Martian gullies, a morphology indicative of groundwater seepage and surface runoff, and conditions of the near-surface that preclude long-term storage and flow of liquid water has presented a challenge to geologists and theoreticians trying to explain the origin of these enigmatic features. Various hypotheses have been presented and published, including those that invoke obliquity changes and enhanced volatile concentration in the past. Here we present results from MOC image analysis, together with theoretical arguments, showing that water ice is preferentially concentrated in polar gullies by progressive cold trapping in the presence of CO2 frost. Thermal buffering by the CO2 maintains the high concentrations of water within pole-facing gullies until near the summer equinox, when midnight sun incident on steep slopes causes sublimation of the CO2. Water ice may melt under ideal conditions in this scenario or, at the very least, play a role with the CO2 in lubricating surface materials. This process is possible in the present day and is consistent with other observations from surface and orbital Mars platforms showing enhanced volatile concentration over and above atmospheric column abundances. This process likely plays a role in the modification and possibly in the formation of gullies, especially in polar regions of Mars where sufficient volatiles can be concentrated.

P72C-11 1640h

Morphologic, Topographic, and Thermal Analysis of Slope Streaks on Mars

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Surfaces containing features known as slope streaks are common on Mars in regions where thermal-inertia is low and steep slopes are frequent. We have recently compiled a catalog of slope streak images and identified previously unrecognized correlations with surface properties. Building on this work, we analyze data from Mars Orbiter Camera, from Mars Orbiter Laser Altimeter, and from the Thermal Emission Imaging System instrument on board Mars Odyssey, to constrain the physical properties and thermal conditions at the specific sites where slope streaks are forming. A number of proposed theories explaining the formation mechanism of slope streaks can be tested using new data, including an exciting possibility of the potential role of a water phase-transition.

P11A MCC: Hall D Monday 0830h

Small Bodies, Moons, and Earth's Moon Posters *(joint with SM, V)*

Presiding: **R M Nelson,** Jet Propulsion Laboratory**; W D Smythe,** Jet Propulsion Laboratory

P11A-0343 0830h POSTER

Dust Levitation and Transport Near Surfaces

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There are many examples of active dust transport near surfaces in the solar system: dust grains suspended above the lunar surface, spokes observed in Saturn's rings, and recent images of infilled craters from the NEAR spacecraft at Eros. Electrostatic dust levitation and transport have also been theorized to occur on Mercury, asteroids, and comets. Dusty regoliths are produced by the interplanetary micrometeoroid flux on nearly all airless bodies in the solar system. Therefore, understanding dust charging, levitation, and dynamics above surfaces is important for interpreting remote sensing data and analyzing the evolution of most planetary surfaces.

Objects in a plasma, such as planetary bodies in the solar wind, charge to a floating potential determined by the balance between charging currents in the local plasma environment. The primary charging currents are due to collection of electrons and ions from the plasma, photoemission, and secondary electron emission. When photoemission is the dominant charging process, a photoelectron sheath forms near the surface of the object. Positively charged particles released from the surface can levitate above the surface at a height where the gravitational force is balanced by the electric force. In cases where secondary electron emission and photoemission are weak, objects will become negatively charged due to electron collection and will be surrounded by a plasma sheath. Negatively charged dust grains from these surfaces can levitate in the electric field created by the plasma sheath. Dust levitation and transport near surfaces in the solar system is thought to be primarily due to the interaction between charged dust particles and a photoelectron or plasma sheath on the surface.

We report the results of experiments on the levitation and transport of dust particles in an argon

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