Solar System Exploration and Solar and Space Physics decadal surveys recommendations. Using a combination of gravity and magnetic field observations, microwave radiometry, in-situ fields and particles, and remote sensing, the mission can help to answer the above referenced key scientific questions. An overview of mission design, science payload, and measurement requirements will be presented. The mission will be proposed as a candidate for NASA's New Frontiers program. The JPL contribution to this paper was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

P41B-0416 0830h POSTER

SIR- Upcoming Near Infrared Investigations of lunar surfaces

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Multispectral photometry has proven to be an extremely useful tool to investigate the surface chemistry, mineralogy, and light scattering properties of the Moon. ESA's upcoming SMART-1 mission to the Moon should significantly extend our knowledge about lunar evolution by providing new high resolution multispectral images over a wider range of illumination/ observation geometries compared with earlier missions. We will present an overview of SIR - the new compact lightweight NIR instrument on SMART-1, operating between 940-2400 μm and will discuss some of the targets SIR is going to investigate.

P42A MCC: Level 1 Thursday 1330h

Geological Evidence for Recent Climate Change on Mars III Posters

(joint with A, C, GC)

Presiding: **L K Fenton,** Arizona State University**; M Kreslavsky,** Brown University

P42A-0417 1330h POSTER

Secondary Crater Populations on the Martian South Polar Layered Deposits

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Understanding the formation and evolution of the Mars South Polar Layered Deposits (SPLD) is an important step toward unraveling Martian climate history. The cratering record on the SPLD suggests that the surface of these deposits has been recently modified. Extremely shallow large (>800 m) impact craters along with a lack of small (<800 m) impact craters might argue for a recent resurfacing event that erased small craters and degraded large ones (Koutnik et al. 2002). Secondary crater fields on the SPLD, produced by the ejection of material from a primary impact event, are important stratigraphic markers that can shed light on the modification history of the deposits. Using MOC, THEMIS and MOLA data, we examined the broad secondary crater field surrounding McMurdo crater (84.5S, 0W) on the SPLD, the field surrounding a 15 km crater at 80.5S, 284W on the SPLD, and the field surrounding a 43 km crater at 81S, 285W off of the SPLD. These datasets provided us with the opportunity to compare and contrast the morphologies of craters in different secondary crater fields both on and off of the deposits. We measured the depth to diameter (d/D) ratios of secondary craters and compared them with those of other primary craters on the deposits measured by Koutnik et al (2002). Among secondary craters on the SPLD, we found a correlation between crater d/D and the steepness of the slope on which the crater resides. Specifically, craters with extremely low d/D ratios (indicating high modification) are found more often on flat areas. Those with high d/D ratios are often associated with scarps and are on higher slopes. This indicates that there have been different resurfacing rates over areas as small as several hundred square kilometers and that modification occurs more readily on flat areas. We examine different mechanisms that may have led to decreased d/D ratios such as blanketing, ice flow, wind erosion or viscous relaxation. We find that the d/D ratios of secondary craters on flat regions of the SPLD are comparable with the extremely low d/D ratios of the primary craters elsewhere on the deposits measured by Koutnik et al (2002). The d/D ratios of secondary craters on the SPLD on slopes are comparable with the d/D ratios of the secondary craters off of the SPLD in rock. This indicates that craters on slopes have been protected from significant modification. Koutnik, M., S. Byrne, and B. Murray (2002) JGR, 107, (E11).

P42A-0418 1330h POSTER

Seasonal Variations of Albedo and Temperature of the North Polar Cap of Mars.

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Previous observations of Viking and MOC have suggested that the north polar residual ice cap exhibits albedo variations between Mars years and within the summer seasons. Our work makes use of the Mars Global Surveyor-Thermal Emission Spectrometer (MGS-TES) data sets. TES can supplement these initial observations, since it provides calibrated albedo, temperature and repeat coverage of the poles, allowing for detailed seasonal coverage. The TES data of the northern summer season allows us to observe the albedo and temperature evolution and explore how that variability relates to climate and atmospheric models. While TES provides excellent seasonal coverage the spatial footprint is 3x6 km eliminating the level of detail somewhat. We will present seasonal and interannual variations of temperature and albedo as observed by TES. To date we have explored variations in the first northern summer, which were taken from March to May of 1999. The first part of the season has a large high albedo area from approximately -60 to 60 W and 80 to 85 N. This area decreases significantly in albedo during the season. Some outlying valleys of the cap appear to show some brightening later in the season from 30 to 90 W and 85 N. This area may have been interpreted in the past as brightening albedo but it appears to be only relative brightening compared to the larger area that has since decreased in albedo. We see an anomalous bright spot throughout the season at -30 W and 88 N. We also see some bright outliers later in the season at 180 W and 75 N,which is near Kovolev, and 10 to 15 W and 78 N. The temperature of the cap is shown to have a stronger variation at the beginning of the season and towards the end it has a more homogeneous temperature. There appears to be a 50 % decrease in temperature extremes from the beginning of the season to the end. Through comparisons with MOC and MOLA data we hope to observe where topography and smaller scale albedo variations may be affecting our measurements. Acknowledgments: This material is based on work currently supported by NASA under the MDAP program, Grant: NAG5-12223 to the University of Nevada, Reno.

P42A-0419 1330h POSTER

Earthly and Otherworldly Glaciers on Mars: Expressed Subsurface Subpolar Ice and "Plate Tectonic" South Polar Ices

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DIRTY SUBPOLAR GLACIERS: Deeply etched internal structures of debris-covered glaciers or rock glaciers occur widely on Mars at middle latitudes. Differentially sublimated folds, crevasses, medial moraines and flow lines are expressed now as a variety of pits, troughs, hummocks, and ridges; they reveal much about the extent of sublimation and the history of flow and accumulation that originally gave rise to these structures. In many regards, they appear like usual terrestrial debris-covered glaciers (including rock glaciers). These sublimated remnant structures are not uniformly distributed on the planet; they exhibit a definite relationship to latitude. The more deeply etched icy flows occur generally in the latitude belt from 30 to 40 degrees (north and south), where possibly very little ice remains near the surface. Between 40 and 55 degrees, most of these partly sublimated flows appear to be still icy. Poleward of that, many of them show very little evidence of any sublimational loss of ice, and instead appear as thick mantling blankets sometimes having subtle flow lines. Inferences for the distribution of ground ice and the role of sublimation are similar to those inferred from the distribution and morphology of small polygons; these results are also consistent with theoretical models of the distribution of ground ice and with Mars Odyssey neutron spectroscopy of the distribution of hydrogen in the upper meter of Mars. A peculiar aspect of dirty glaciers on Mars is their current lack of an evident zone of atmospherically driven accumulation; instead, accumulation of some dirty glaciers appears to be due to load-driven expression of ice originating probably in massive crustal layers; for others, atmospheric accumulation may occur at other times during the obliquity cycle of Mars. SOUTH POLAR ICE SHEET: Previously I have reported on evidence for flowing, faulting, folding south polar ice, with the evidence for the more ductile types of deformation concentrated within the area of perennial CO2 ice. This part of the polar cap exhibits strong evidence for convergent flow tending to close the quasi-spiral structured troughs, as predicted by finite-element modelers. A rich phenomenology accompanies this closure. In some cases, good evidence exists for one icy sheet overriding another. Elastic plate flexural responses, with attendant small-scale tectonism, is quite common, as is evidence for ductile deformation. Analogs drawn from Earth's lithosphere provide compelling explanations for some of these features. Smooth, topographically enclosed flat areas in the south polar deposits may be the surface expressions of subglacial lakes or refrozen lakes.

P42A-0420 1330h POSTER

Evidence for an Ocean in the Northern Lowland Plains of Mars Based on Crater Depth/Diameter Measurements

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It has been suggested that the complex history of Mars includes one or more ancient oceans and that the Vastitis Borealis Formation (VBF) is an ice-rich, fine-grained sedimentary deposit left as a remnant of these oceans. In many places in the northern lowland plains the VBF partially fills craters and mantles the surrounding terrain. Here we examine new crater depth (d) and diameter (D) measurements to test the hypothesis that VGF was deposited from a large body of water. The d and D for 2,102 craters (D ranging from 2 km to >100 km) were measured in the northern lowlands in Utopia, Arcadia, Acidalia, and North Pole regions, and in the northern highlands in the Tempe Terra, and Deuteronilus regions. Crater depths were measured in two ways, from the floor to the rim (d_R), and from the floor to the surface surrounding the crater (d_S). The data show that both types of d/D relationships (d_S/D and d_R/D) of craters in the northern plains are different than the same type of relationships for craters in the northern highlands or anywhere else on the planet. In particular, the d_S/D relationship shows that the floors of many craters in this region are at or near the same elevation as the surrounding terrain, unlike in all other regions where depth is a function of diameter. Examination of THEMIS and MOC images has revealed that craters with floors at or near the same elevations as the surrounding terrain are also the ones partially filled with VBF. This suggests that the VBF is the cause of the unique d_S/D relationship. In addition, the partially filled craters north of 45°N are typically shallower than similar craters south of 45°N (the latitude predicted for Mars' maximum obliquity). These relationships are consistent with those predicted for a terrain mantled by an ice-rich sedimentary mantle that is undergoing deflation by sublimation and with the hypothesis that VBF is a ice-rich deposit left by an ancient ocean.

P42A-0421 1330h POSTER

The Big Chill: Did The Lyot Impact Produce a Late Climate Cooling on Mars?

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The Lyot impact basin is a double ringed basin of outer diameter 200km that formed late in Mars history. It was noted by the author[1,2] that the creation of the Lyot impact basin in the Northern Hemisphere of Mars in the early Amazonian Epoch [3] appears to coincide with the 30x reduction of fluvial and peri-glacial resurfacing rates between the Late Hesperian and Early

Amazonian Epochs. Recovery of peri-glacial resurfacing rates in the middle Amazonian is followed by fluvial resurfacing rate recovery only in the late Amazonian. This suggests that the impact which formed the Lyot basin may have induced a strong cooling event on the planet. This suggestion of the profound disruption of any extant planetary climate system by the Lyot impactor is reinforced by the study of hydrogen fractionation in water samples from Mars rocks of various ages. Hydrogen fractionation in the water found in the rocks is con-stant from ALH84001 at 4.5 Gyr years old to Nahkala at 1.2.Gyr age, but increases rapidly in the Shergottites at 0.3Gyr age [4]. It has been noted recently that the Lyot basin is surprisingly free of fluvial features[5] relative to its surroundings. [1] Brandenburg J. E. (1995) Earth Moon and Planets, 67, 35-45. [2] Brandenburg J.E. (Absract)2002 Metoritics Soc.Meeting [2] Tanaka K.L. (1986). LPSC 17, JGR Suppl. 91:E139-E158. [4] Watson , L.L. Epstein S. , and Stolper, E. M, Meteoritics , 29, 547, (abstract)[5] Head J. W.III (2002) 33rd LPSC .

P42A-0422 1330h POSTER

Debris Aprons in the Tempe/Mareotis Region of Mars

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Martian debris aprons are considered to be geomorphic indicators of ground ice, and thus are important in understanding the climate and volatile inventory on Mars. Their presence suggests storage of ice in the Martian regolith, either currently or in the recent geologic past. Recent studies of aprons have focused on the eastern Hellas and Deuteronilus/Protonilus Mensae regions of Mars, which have some of the highest apron concentrations on the planet. However, there are several other locales that have significant populations of aprons. We have initiated a new study of aprons located along the northern lowlands-southern cratered highlands boundary in the Tempe/Mareotis Fossae region (43-55N, 274-294E). Seventy-three apron complexes have been identified in Viking images, and we further document their surface textures, morphometric properties, and topographic characteristics using MOC narrow-angle images, MOLA PEDR profile data, and THEMIS daytime (VIS and IR) and nighttime (IR) images. Debris apron complexes generally consist of one or more lobate deposits that surround individual massifs or small knobs, but have also been observed along the bases of escarpments and inner crater walls. The Tempe/Mareotis aprons have a similar planimetric morphology to those observed elsewhere on Mars. A series of distinctive textures are observed on the surfaces of Tempe/Mareotis aprons that can be attributed to differences in preservation state. Smooth, pitted, ridge and valley, and knobby textures characterize upper apron materials, which often appear to be mantled by a fine-grained deposit. Smooth and ridged erosional textures appear to form in low-lying areas where upper apron material has been removed. The degradation of upper apron material generally begins with a smooth, mantled surface that is gradually removed by sublimation, melting, and/or aeolian activity, which leaves behind a hummocky surface texture composed of knobs, ridges, or both. Further degradation produces subdued and smooth erosional textures in some areas, which may have contained greater abundances of ice. MOLA profiles across many of the Tempe/Mareotis aprons show a well-defined convex-upward shape similar to those observed in the eastern Hellas and Deuteronilus/Protonilus Mensae regions. However, not all apron profiles have such shapes, and many have a linear slope or a slightly convex-upwards shape. The combined textural and morphometric variability of Tempe/Mareotis aprons suggest potential differences in emplacement style or ice content in addition to preservation state. Our continued study of Tempe/Mareotis aprons will also assess the influence of geology and geologic history relative to aprons observed in other regions of Mars.

P42A-0423 1330h POSTER

Rheological properties of slope streaks with anastomosing patterns on Mars

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Slope streaks have formed during the Mars Global Surveyor mission marking geologic activity at the Martian surface. Here, we present results from numerical modeling to help explain flow-like, morphologic characteristics, which include branching and anastomosing patterns influenced by local small topographic barriers. With a photoclinometric technique to estimate their sizes, numerical simulations of slow-moving plastic flows show that a fluid rheology and a short formation period are necessary to explain these features. We estimate that the typical values of a bulk viscosity and a bulk yield strength are less than 10 Pa s and less than 10 Pa, respectively (less than 1Pa s and 1Pa are more likely). The fluidity may be attributed to water-related flow with the solid content less than 20%, but a dry grain flow with extremely low cohesion and friction angle supported by dispersive pressure or lubricant such as atmosphere or subsurface discharge of gas is also possible. The continuous features of slope streaks from point sources are more easily explained by continuous discharges of material or lubricant. In this case, the estimated flow rate is less than several m^3/s and the flow duration estimated to be less than 1day.

P42A-0424 1330h POSTER

Seasonal Weather Patterns Influencing Dune Morphology in Noachis Terra, Mars: Using a Mesoscale Model for Surface Science

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The work of the wind is the one sedimentary process that both acts on the surface and interacts with the lower atmosphere of Mars. Wind-sculpted landforms such as sand dunes are among the few features visible in spacecraft images that provide information on the aeolian sedimentary environment and surface wind circulation patterns of Mars. The study of the placement and orientations of sand dunes leads to the depositional, erosional, and transport history of sand across a region. When correlated with wind predictions from an atmospheric model, dune orientations provide not only model verification but also an understanding of the seasonal weather patterns that influence dune morphology. We have applied a mesoscale model to Noachis Terra, an 1800 km x 3500 km area of Mars containing several dune fields. The Mars Mesoscale Model 5 (Mars MM5), developed from the PSU/NCAR MM5, was run in periods spanning the Martian year, predicting seasonal wind patterns for each of nine dune fields in Noachis Terra. Dune slipface orientations were measured for all dune fields imaged by the Mars Orbiter Camera (MOC) on the Mars Global Surveyor. Preliminary results indicate a high correspondence of dune morphology with present-day seasonally-dependent wind patterns predicted by the Mars MM5.

P42A-0425 1330h POSTER

Climate Transition on Mars: CO2 Exchange Process Between Atmosphere and Ice Caps Under Paleoenvironment

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Several lines of evidence suggest that climate warming and cooling have repeated on Mars in its history. In order to study the stability and evolution of Martian climate, we construct a 2-dimensional (horizontal-vertical) energy balance climate model. The long-term CO2 mass exchange processes between the atmosphere and CO2 ice caps are investigated with particular attention to the albedo effects of planetary ices (H2O and CO2) on the climate stability. We make numerical simulations of the climate transition between warm and cold climate states taking into account the evolution of CO2 ice cap topography (areal extent and altitude). Our results are summarized as follows. A few bars of CO2 atmosphere presumed for early ($\sim$ 3.8 Ga) warm and wet Mars possibly begins to condense irreversibly onto polar caps when H2O ices would cover more than several tens % of the Martian surface. This is because the effect of ice albedo causes polar cooling and thus promotes the condensation of atmospheric CO2. Once such condensation is triggered, rapid transition into cold climate state (with lower atmospheric pressure like the present one) occurs within a time scale of about 1000 years. This is caused by the acceleration of CO2 condensation associated with further polar cooling due to the atmospheric pressure drop. We call this transition process "collapse condensation". If the collapse condensation of a few bars of CO2 atmosphere occurs, the resultant polar CO2 ice caps extend toward latitudes as low as 80-70 degrees with mean thickness of several 100 meters. This areal extent is consistent with the distribution of the present polar layer deposits (PLD), and thus PLD may have some information of such CO2 glaciation in the past. On the other hand, the low atmospheric pressure buffered by the CO2 ice caps is possibly unstabilized when the CO2 ice albedo decreases or the Martian obliquity increases. If the ice caps contain a large amount of CO2 (e.g. formed by the collapse condensation), such instability causes the climate jumps to a warm state with high atmospheric pressure owing to complete evaporation of the ice cap. We call this process "runaway evaporation". The time scale for the completion of runaway evaporation is similar to that of the collapse condensation.

P42B MCC: 2000 Thursday 1340h

Applications of Planetary Radars II

(joint with G)

Presiding: **T G Farr,** Jet Propulsion Laboratory, California Institute of Technology**; J J Plaut,** Jet Propulsion Laboratory, California Institute of Technology

P42B-01 1345h INVITED

Investigation of Planets and Small Bodies Using Decameter Wavelength Radar Sounders

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Decameter wavelength radar sounders provide a unique capability for the exploration of subsurface of planets and internal structure of small bodies. Recently, a number of experimental radar sounding instruments have been proposed and/or are planned to become operational in the near future. The first of these radar sounders is MARSIS (Picardi et al.) that is about to arrive at Mars on ESA's Mars Express for a two-year mission. The second radar sounder, termed SHARAD (Seu et. al), will fly on NASA's Mars Reconnaissance orbiter in 2005. MARSIS and SHARAD have complementary science objectives in that MARSIS (0.1-5.5 MHz) is designed to explore the deep subsurface with a depth resolution of $\sim$100 m while SHARAD (15-25 MHz) focuses its investigation to near-surface ($<$ 1000 m) with a higher depth resolution of $\sim$ 10-15 m. In addition to its subsurface exploration goals, MARSIS, that has a frequency range between 0.1 to 5.5 MHz, will study the ionosphere of Mars and providing a wealth of new information on Martian ionosphere. Both MARSIS and SHARAD have the potential of providing answers to a number of questions such as depth of ice-layers in the polar region and recently discovered ice-rich regions in both northern and southern hemispheres of Mars. The next generation of radar sounders will benefit from high power and high data rate capability that is made available through the use of Nuclear Electric generators. An example of such high-capability mission is the Jovian Icy Moons Orbiter (JIMO) where, for example, the radar sounder can be used to explore beneath the icy surfaces of Europa in search of the ice/ocean interface. The decameter wave radar sounder is probably the only instrument that has the potential of providing an accurate estimate for the ocean depth. Another exciting and rewarding area of application for planetary radar sounding is the investigation of the deep interior of small bodies (asteroids and comets). The small size of asteroids and comets provides the opportunity to collect data in a manner that enables Radio Reflection Tomographic (RRT) reconstruction of the body in the same manner that a medical ultrasound probe can image the interior of our body. This paper provides