P33A-02 1330h POSTER

Paleomagnetic Pole Positions of Mars

Daniel Boutin[1] ((514) 398-5342; dboutin@eps.mcgill.ca)

Jafar Arkani-Hamed[1] ((514) 398-6772; Jafar@eps.mcgill.ca)

[1]Earth and Planetary Sciences, McGill University 3450 University St., Montreal, QC H3A 2A7, Canada

Attempts have been made to estimate the position of the paleomagnetic dipole field axis of Mars using its magnetic anomalies. The results strongly depend on the accuracy of the anomalies. The immense amount of the magnetic data, measured by Mars Global Surveyor during its mapping period, provides good opportunity to derive highly accurate magnetic anomalies. We extract the least contaminated radial component of the magnetic data, and only those acquired at nighttime to further minimize contribution from the external magnetic field. The data are separated to two sets of almost equal size, acquired from March 1999 to February 2001 and from February 2002 to April 2003. The low altitude science and areobreaking phase data are not considered because they are daytime data and are contaminated by the external magnetic field. Each set of data is bined over 0.5x0.5 degree girds, and the mean value of a grid is determined. We model the source bodies of the 9 small and isolated magnetic anomalies we had previously identified, by a uniformly magnetized vertical prism of elliptical cross section using a space domain algorithm. Four models are calculated for the source body of each magnetic anomaly, as follows. The first two models are directly obtained using the two bined data sets. The other two are obtained using the low-pass filtered version of the bined data sets. For this purpose we extract the magnetic data over a given anomaly from the two bined data sets, and select their covariant parts using the Fourier domain algorithm. Assuming that a model source body is magnetized by a dipole magnetic field, we calculate the position of the dipole axis. This results in 4 paleomagnetic pole positions for each isolated magnetic anomaly. The 4 pole positions of 6 anomalies almost overlap indicating the high reliability of the pole positions. The 4 pole positions differ by no more than 10 degrees for the other 2 anomalies, indicating that the external field has minor contribution to these magnetic anomalies. The 4 pole positions of the remaining anomaly differ by as much 30 degrees, implying appreciable contribution from the external field. The pole positions show clustering in general agreement with those obtained by other investigators. We will discuss the geophysical implications of the new results.

P33A-03 1330h POSTER

Crustal Magnetic Spectra from Correlated Sources on Mars

Coerte V. Voorhies (301-614-6456; Coerte.V.Voorhies@nasa.gov)

Geodynamics Branch, Code 921, NASA's Goddard Space Flight Center, Greenbelt, MD 20771, United States

The spectral method for distinguishing crustal from core-source magnetic fields has been re-examined, modified and applied to both a comprehensive geomagnetic field model and an altitude normalized magnetic map of Mars [Voorhies, Sabaka and Purucker, 2002; JGR]. These observational spectra are fairly fitted by theoretical forms expected from certain elementary classes of magnetic sources. For Earth we found fields from a core of radius 3512 +/- 64 km and a crust represented by a shell of random dipolar sources at radius 6367 +/- 14 km. For Mars we found only a field from a crust represented in same way, but 46 +/- 10 km below the planetary mean radius. More realistic theoretical spectra, allowing for crustal thickness, oblateness and magnetization by a planet centered dipole, were derived and discussed, as were spectral effects of laterally correlated sources. The main effect of laterally correlated sources is to soften the spectrum at high degrees. We tend to over-estimate source shell depth when this is omitted. To include this effect simply, size and magnetization distribution functions for extended sources are recast as a characteristic diameter and mean square magnetization amplitude for an ensemble of vertically magnetized spherical caps on a shell. For small caps, and at moderate degrees, the partial derivatives of the log-theoretical spectrum with respect to amplitude, shell radius, and cap diameter are approximately proportional to 1, n, and -n**2, respectively. Separation of diameter from amplitude and depth should thus be straightforward, unlike separation of amplitude from layer thickness. Results from applications to observational spectra are discussed, noting that there are now several fine field models for Mars [Cain et al., 2000; Connerney et al., 2001; Arkani-Hamed, 2001, 2002; Hutchinson and Zuber, 2002; Langlais et al., 2002]; moreover, the terrestrial magnetic spectrum at high degrees, as revised [Sabaka, Olsen and Langel, 2002], updated with high precision Oersted data, and upgraded with high resolution Champ data, appears softer than before.

P33A-04 1330h POSTER

Interpretation of the Mackenzie River Magnetic Anomaly, Canada, From Satellite, High- and Low-Altitude Magnetic Data

Mark Pilkington[1] (1-613-996-9316; mpilking@nrcan.gc.ca)

Larry Lane[2] (llane@nrcan.gc.ca)

[1]Geological Survey of Canada, 615 Booth Street, Ottawa, ON K1A 0E9, Canada

[2]Geological Survey of Canada, 3303, 33rd Street NW, Calgary, AB T2L 2A7, Canada

We characterize the nature of the source of the high-amplitude, long-wavelength, Mackenzie River magnetic anomaly (MRA), Yukon and Northwest Territories, Canada, based on magnetic field data collected at three different altitudes: 300m, 3.5 km and 400 km. The MRA is the largest amplitude (13 nT) satellite (CHAMP) magnetic anomaly over the Canadian landmass. In aeromagnetic data, the MRA is contiguous to the so-called Fort Simpson anomaly (FSA) that extends over 1000 km south to British Columbia. Within the MRA, source depth estimates (8-12 km) from Euler deconvolution of low-altitude aeromagnetic data show some coincidence with basement depths interpreted from reflection seismic data. The character of the MRA and FSA, i.e., a belt of long-wavelength, positive, high-amplitude magnetic anomalies suggests that they are caused by a magmatic arc. Estimated magnetization levels from inversion of high-altitude aeromagnetic data are similar to other sampled and modeled arc complexes. Only the FSA basement has been sampled but the intersected granitic lithologies support the arc interpretation. For the long-wavelength part of the MRA and FSA, the source is expected predominantly from the middle crust (10-25 km). The upper crust in the region is mainly sedimentary and only weakly magnetized (with the exception of some short-wavelength contributions from sills and dykes). The contribution from the lower crust remains undetermined.

P33B CC: 220 C-E Wednesday 1330h

Emerging Views of Mars: Formation, Evolution, and Current State II Posters *(joint with GP, S, T, V, NG)*

Presiding: **P R christensen,** Arizona State University**; H L Redmond,** Purdue University

P33B-01 1330h POSTER

Martian Dust Devil Electric Fields: The Connection of Fluid Physics to Electrodynamics

William M. Farrell[1] (william.farrell@gsfc.nasa.goc)

Gregory T. Delory[2] (gdelory@ssl.berkeley.edu)

Nilton O. Renno[3] (nrenno@umich.edu)

[1]NASA/Goddard SFC, Code 695

[2]Univ. of California at Berekely, Space Science Labs

[3]Univ. of Michigan, Dept. of Atmospheres, Oceans, and Space Sci.

It is known that dust devils generate large electric fields via tribo-electricity (contact electrification between mixing grains). By analogy, it is anticipated that the larger dust devils on Mars will also generate electric fields. In this work, we present an analytical argument for the generation of these field, starting with the basic fluid processes in the dust devil that account for grain lifting and the microscopic grain-grain tribo-charging processes through to the development of the electric field based on current flow in the dust devil. With this model, we can then predict the anticipated large scale electric fields based upon macroscopic meteorological parameters.

P33B-02 1330h POSTER

Slope Measurements of Terraces in Melas Chasma as an Example for 3D Basin Analysis from Remote Sensing Data of Layered Deposits on Mars

Rocky Persaud[1] (416-978-0658; rocky.persaud@utoronto.ca)

Eric de Kemp[2] (613-947-3738; edekemp@nrcan.gc.ca)

[1]University of Toronto, Dept. of Geology, 22 Russell Street, Toronto, ON M5S 3B1, Canada

[2]Geoscience Integration Section, Continental Geoscience, Division Geological Survey of Canada, 615 Booth Street, Ottawa, ON K1A 0E9, Canada

An interesting problem for planetary scientists interpreting depositional and erosional histories of features evident in many satellite photos of Mars, such as scarps, terraces, plateaus and layering, is the correlation of linear and planar features between images to construct a regional or basin-wide three-dimensional visual model. As high resolution (10m/pixel) topographic digital elevation models becomes available, the measurement of linear and planar slopes may be accomplished with ordinary GIS software. The software used to make measurements of the strike/dip of selected features was the GIS package ArcView 3.1 with the 3D Geology extension provided by the Geological Survey of Canada. Additional work used GoCAD to construct three-dimensional visual models of the measured structures. The Geological Survey of Canada has produced an extension for GoCAD called SPARSE that allows the construction of three-dimensional visual models of the measured planar and linear features. This package would be useful in constructing models of basins from satellite imagery and topography data. The Melas Chasma region of the Valles Marineris on Mars is used as an example since it is one of the few regions for which 10-meter digital elevation models are publicly available. Plateaus in Melas Chasma are examined using techniques described in this poster presentation to reconstruct local stratigraphic relationships. An interpretation of features observable in images of Melas Chasma is offered.

P33B-03 1330h POSTER

Dry or wet conditions in the Martian mantle: Constraints from crustal evolution and magnetic field history

Doris Breuer[1] (+49 251 8339057; breuer@uni-muenster.de)

Tilman Spohn[1] (+49 251 8333566; spohn@uni-muenster.de)

[1]Westfaelische Wilhelms-Universität Muenster, Institut für Planetologie, Wilhelm-Klemm Str. 10, Muenster 48149, Germany

Surface structures on Mars indicate that a significant amount of water had been present during the early evolution of the planet's surface. However, it is strongly debated how much water had been present in the Martian mantle and whether it is still present or not. The chemistry of the SNC meteorites has been interpreted to suggest that the Martian mantle stayed relatively dry since the time of core formation. New geochemical evidence from the shergotty meteorites, however, suggests water contents of up to 1.8 % in the pre-eruptive magma and places some doubts about the earlier assumption of a dry mantle, although, the origin of this water, from the mantle or the crust, is uncertain. Furthermore, the analyses by the APX on Mars Pathfinder and TES on MGS have identified rocks with chemical compositions similar to those of andesitic rocks. Several hypotheses for the origin of these rock types have been suggested. The andesitic rocks can either be explained by hydrous melting from a wet mantle or by weathering processes close to the surface. The latter might eliminate the need for hydrous melting and may also be consistent with a dry mantle. Water is a dominant factor influencing the rheology of the mantle; a dry Martian mantle composition suggests a stiff mantle with a high viscosity, whereas the presence of water suggests a weak mantle with a low viscosity. In the present study, the influence of the viscosity and the initial temperature distribution after core formation has been investigated on models of the crustal and the magnetic field evolution. Those models use a parameterized scaling law assuming for Mars a stagnant lid regime throughout its entire evolution. To explain both the observed crustal thickness of about 50 to 100 km with a continuous decline of global volcanism since the Noachian and the lack of a present-day core dynamo, a dry Martian mantle with a viscosity of 10^{21} Pas at a reference temperature of 1600 K and an initial mantle temperature of about 2000 $\pm$ 100 K is required. A wet Martian mantle with a viscosity of less than 10^{20} Pas at a reference temperature of 1600 K can easily explain the crustal evolution but is difficult to reconcile with the present lack of a self-generated magnetic field. A weak mantle rheology would result in an efficient cooling of the interior with core temperatures decreasing below the melting temperature of about 1900-2000 K (assuming a core sulphur content of 14 % as derived from the SNC meteorites). The associated freezing of the inner core then would induce chemical convection in the outer core due to the release of positively buoyant light material. This chemical convection in the core can efficiently drive a dynamo and would be active till the present day; inconsistent with the lack of a self-generated magnetic field.

P33B-04 1330h POSTER

Response of Stagnant-Lid Convection to Sudden Dichotomy Formation

Dave R Stegman[1] (dave.stegman@sci.monash.edu.au)

Mark Richards[2] (markr@eps.berkeley.edu)

Mark Jellinek[3] (markj@physics.utoronto.ca)

Michael Manga[2] (manga@eps.berkeley.edu)

John Baumgardner[4] (baumgardner@lanl.gov)

[1]Monash University, School of Mathematical Sciences, Monash University, Bldg 28, Monash University, Clayton, VIC 3800, Australia

[2]University of California, Berkeley, Dept. of Earth and Planetary Science, University of California, Berkeley, 307 McCone Hall, University of California, Berkeley, Berkeley, CA 94720, United States

[3]University of Toronto, Dept. of Physics, University of Toronto, 60 St. George Street, Toronto, Ont M5S 1A7, Canada

[4]Los Alamos National Laboratory, heoretical Division, Los Alamos National Laboratory, Mail Stop B216, Los Alamos National Laboratory, Los Alamos, NM 87545, United States

Did the thermal event responsible for the Tharsis volcanic plateau occur as a consequence of a sudden formation of the Martian crustal dichotomy? Using a 3-D spherical mantle convection model with temperature-dependent viscosity, we explore the effect of the sudden emplacement of hemispheric-scale crustal thickness variations on stagnant-lid mantle convection. Thickened crust in the "southern" hemisphere of the model causes insulation of that hemisphere which may effect the underlying mantle circulation. This leads to a transient, regional-scale partial melting event sufficient to generate the Tharsis rise during the first 0.5-1.0 billion years following the formation of the crustal dichotomy.

P33B-05 1330h POSTER

Geological Models for the Uppermost Martian Crust

John Spray (506 453 3550; jgs@unb.ca)

Planetary and Space Scence Centre, University of New Brunswick 2 Bailey Drive, Fredericton, NB E3B 5A3, Canada

Prototype cross-sections through the uppermost 100 m of the Martian crust are attempted for several distinct terrains: (a) young and uncratered (northern lowlands); (b) young and cratered (northern lowlands); (c) older and cratered (southern highlands) and (d) older and uncratered (southern highlands). Polar regions are also considered. The cross-sections are built from four main materials (1) uncemented sediment (i.e., dust and aeolian deposits); (2) cemented sediment (e.g., evaporites, sediments consolidated by diagenesis); (3) igneous rock (e.g., basaltic lavas and related hypabyssal intrusions, impact melt); and (4) megaregolith (i.e., impact-bombarded and impact-mixed material derived from 1-3 above). Megaregolith constitutes the foundation component, given that the entire crust had probably been impact processed by the end of the heavy bombardment period. The cross-sections have been constructed primarily in order to optimize the design of an orbiting synthetic aperture radar (SAR)/Sounder system for Mars. The cross-sections are also intended for use in mission planning (i.e., site selection, rover design and equipment selection). Understanding the composition and structure of the uppermost 100 m of the Martian crust is important for future missions. We need to estimate the likely substructure for landing sites so that we can optimize mission design. This is particularly important for rover-based drilling, ground-penetrating radar technology, sampling for evidence of life, and accessing H2O. Constructing cross-sections is an iterative process, largely based on existing remote sensing data (Mariner, Viking, MGS, Odyssey), combined with analogies with other terrestrial planets, especially Earth and the Moon. In this respect, Mars shows similarities with both the Moon (e.g., in megaregolith development and its preservation) and Earth (e.g., recent volcanism, presence of sedimentary deposits).

P33B-06 1330h POSTER

Gusev crater: direction of active winds derived from the Mars Exploration *Rover Rock Abrasion Tool*

Ronald Greeley[1] (480-965-7045; greeley@asu.edu); Stephen Gorevan[2] (gorevan@honeybeerobotics.com); Shane D. Thompson[1] (shane.d.thompson@asu.edu); Patrick Whelley[1] (patrick.whelley@asu.edu); Steve Squyres[3] (squyres@astro.cornell.edu); Ray Arvidson[4] (arvidson@wunder.wustl.edu); Athena Science Team

[1]Arizona State University, Dept. Geological Sciences, Tempe, AZ 85287-1404, United States

[2]Honeybee Robotics, 204 Elizabeth St., New York, NY 10012, United States

[3]Cornell University, Dept. Astronomy, Ithaca, NY 15853-1301, United States

[4]Washington University, Dept. Geology, St. Louis, MO 63031-4899, United States

The *Mars Exploration Rovers* (MERs) are not instrumented to measure winds directly, but might be able to give insight into wind directions using other techniques. The *Rock Abrasion Tool* (RAT) on the *Instrument Deployment Device* (IDD) on the Mars rover, *Spirit*, was used to remove dust and cut into a basaltic rock named *Adirondack* in Gusev crater on Sol 34 of mission operations. The rock abrasion operation occurred between about 1223 hr and 1518 hr in the afternoon (local solar time) and left a cavity 2.68 mm deep. An image taken after the abrasion operation showed that the rock cuttings were asymmetrically distributed around the cavity and over the rock in a direction suggesting that the cuttings were transported away from the cavity by winds. The distribution pattern (and the inferred wind) is being compared with results from wind tunnel simulations conducted prior to the mission to assess the wind-flow patterns as a function of rock, rover, and IDD positions with respect to the wind. The wind direction inferred from the RAT cuttings are also being compared with wind directions suggested by aeolian bedforms and albedo patterns seen from MER and from orbit, and with directions predicted by a model of the atmosphere for winds at mid-day in Gusev crater.

P33C CC: 220 C-E Wednesday 1330h

Small Bodies Posters *(joint with V)*

***Presiding:* A R Hildebrand,** University of Calgary**; R Binzel,** Massachusetts Institute of Technology

P33C-01 1330h POSTER

ANTS/PAM: Future Exploration of the Asteroid Belt

P. E. Clark[1] (301 286 7457; pamela.clark@gsfc.nasa.gov)

S. A. Curtis[2] (301 286 9188; u5sac@lepvax.gsfc.nasa.gov)

M. L. Rilee[1] (301 286 4743; mike@rilee.net)

C. Y. Cheung[2] (301 286 2780; Cynthia.Y.Cheung@nasa.gov)

[1]L3 Communications, GSI, 3750 Centerview Drive, Chantilly, VA 20151, United States

[2]NASA/Goddard, Code 695 Greenbelt Road, Greenbelt, MD 20771, United States

The Autonomous Nano-Technology Swarm (ANTS) is applied to the Prospecting Asteroid Mission (PAM) concept, as part of a NASA RASC study. The ANTS architecture is inspired by success of social insect colonies, based on the division of labor within the colonies: 1) within their specialties, individual specialists generally outperform general-ists, and 2) with sufficiently efficient social interaction and coordination, the group of specialists generally outper-forms the group of generalists. ANTS as applied to PAM involves a thousand individual specialist sciencecraft', one subswarm per target, in an environment where detection and tracking of irregular, infrequent targets is a major chal-lenge. Workers, carry and operate eight to nine different scientific instruments, including spectrometers, ranging and radio science devices, imagers. The remaining specialists, Messenger/Rulers, provide communication and coordina-tion. The non-expendable propulsion system is based on autonomously deployable and configurable solar sails, a system suitable to a low gravity environment. The design of the neural basis function requires a minimum of 4 or 5 specialists for collective decision making. Allowing for ten instrument specialist teams and compensating for antici-pated high attrition, we calculate an initial minimum of 100 per subswarm should allow characterization of hundreds of asteroids. The difficulty in observing irregular, rapidly moving, poorly illuminated objects is largely overcome by the ANT sciencecraft capability to optimize conditions for each instrument. Components are composed of carbon nanotubules reversibly deployable from NEMS nodes, allowing 100 times decrease in packaging volume. 1000 smart 10 centimeter, 1 kg cubic boxes create a 1000 kg 1 meter cube.

URL: http://ants.gsfc.nasa.gov

P33C-02 1330h POSTER

ANTS/SARA: Future Observation of Saturn's Rings

P. E. Clark[1] (301 286 7457; pamela.clark@gsfc.nasa.gov)

M. L. Rilee[1] (301 286 4743; mike@rilee.net)

S. A. Curtis[2] (301 286 9188; u5sac@lepvax.gsfc.nasa.gov)

C. Y. Cheung[2] (301 286 2780; Cynthia.Y.Cheung@nasa.gov)

M. J. Mumma[2] (301 286 6994; Michael.J.Mumma@nasa.gov)

[1]L3 Communications, GSI, 3750 Centerview Drive, Chantilly, VA 20151, United States

[2]NASA/Goddard, Code 695 Greenbelt Road, Greenbelt, MD 20771, United States

The Saturn Autonomous Ring Array (SARA) mission concept applies the Autonomous Nano-Technology Swarm (ANTS) architecture, a paradigm developed for exploration of high surface area and/or multi-body targets. ANTS architecture involves large numbers of tiny, highly autonomous, yet socially interactive, craft, in a small number of specialist classes. SARA will acquire in situ observations in the high gravity environment of Saturn's rings. The high potential for collision represents an insurmountable challenge for previous mission designs. Each ANTS nanocraft weighs approximately a kilogram, and thus requires gossamer structures for all subsystems. Individual specialists include Workers, the vast majority, that acquire scientific measurements, as well as Messenger/Rulers that provide communication and coordination. The high density distribution of particles combines with the high intensity gravity and magnetic field environment to produce dynamic plasmas. Plasma, particle, wave, and field detectors will take measurements from the edge of the ring plane to observe the result of particle interactions. Imagers and spectrome-ters would measure variations composition and dust/gas ratio among particles using a strategy for serial rendezvous with individual particles. The numbers and distances of these particles, as well as anticipated high attrition rate, re-quire hundreds of spacecraft to characterize thousands of particles and ring features over the course of the mission. The bimodal propulsion system would include a large solar sail carrier for transporting the swarm the long distance in low gravity between deployment site and the target, and a nuclear system for each craft for maneuvering in the high gravity regime of Saturn's rings.

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P33C-03 1330h POSTER

Diffusion and Structure of Meteor Trails in the E-Region Ionosphere

Yakov S Dimant[1] (1-617-353-7411; dimant@bu.edu)

Meers M Oppenheim[1] (1-617-353-6139; meerso@bu.edu)

Lars Dyrud[1] (1-617-353-5990; ldyrud@bu.edu)

Tengfei Lin[1] (1-617-353-5990; ltf@bu.edu)

[1]Boston University, 725 Commonwealth Avenue, Boston, MA 02215, United States

A meteoroid penetrating the Earth's ionosphere leaves behind a trail of dense plasma which disperses with time. For micrometeoroids, which comprise the majority of all meteoroids bombarding the Earth, the only practical way to observe the trail is using radars. An important feature of radar images from large-aperature radars is the non-specular echoes, which show strong aspect sensitivity and remain visible for a relatively long time in a broad altitude range within the E-region ionosphere. We have argued that non-specular echoes result from radar signals scattered from turbulent electron density irregularities generated by plasma instabilities. Strong electrostatic electric fields and diamagnetic drifts developing during the plasma trail diffusion drive these instabilities. In order to draw quantitative conclusions about the meteoroids based on radar measurements, we need to model this instability process. This modeling in turn requires