between 25° and 25°S, planetocentric. The equatorial region (15°N to 15°S) is much cooler than the rest of the planet in both the troposphere and the stratosphere, with a slightly warmer band detectable in the upper stratosphere within 1–2° latitude of the equator. Besides the prominent zonal wave structure in Saturn's troposphere, the most prominent zonal features are those which are observable at 5.2 μm, showing the optical thickness of clouds at the NH_3 condensation level. Distinct brightening of the ring system is apparent as a function of placement in orbit, with the coolest portion of the rings being those in shadow behind the planet. Ring brightess as a function of distance from the planet generally follows the same qualitative trend of optical thickness as in the visible.

P31A CC: 519 B Wednesday 0830h

Magnetic Field of Planetary Lithosphere I *(joint with GP)*

Presiding: **M Purucker,** NASA Goddard Space Flight Center**; J Arkani-Hamed,** McGill University

P31A-01 0830h INVITED

Mars' Magnetic Lithosphere: Candidate Minerals

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Mars' southern-hemisphere magnetic anomalies require a large Martian magnetic field at the time the lithosphere acquired thermoremanent magnetization (TRM), large magnetic mineral concentrations compared to Earth's lithosphere, a mineral or minerals whose grain size and resulting domain structure generate intense TRM, and/or a high Curie temperature and deep Curie-point isotherm. Based on Martian meteorites and spectroscopy of the Martian surface, the magnetic minerals likely to be important in Mars' lithosphere are magnetite, hematite and pyrrhotite. Martian anomalies are likely an integrated effect over a depth interval of 20-30 km. Pyrrhotite has a low Curie point (320oC) and is found only in specialized settings on Earth, although demagnetization around Hellas and Argyre craters may favor pressure-induced cycling of near-surface pyrrhotite through its 2.8 GPa phase transition. More promising as deeper sources are magnetite and hematite, which are ubiquitous on Earth and have high Curie points (580 and 675oC). TRM of magnetite decreases inversely with increasing grain size, while the opposite is true for hematite. The two minerals have the same TRM intensity around 10-20 micrometers, close to both the upper limit for pseudo-single-domain (PSD) behavior in magnetite and the critical single-domain size of hematite. The lack of any substantial self-demagnetizing field permits a TRM in multidomain hematite orders of magnitude larger than the TRM of multidomain magnetite for field strengths like the Earth's. Either single-domain/ PSD magnetite or multidomain hematite could explain strong anomalies. Single-domain magnetite requires less concentration but has restrictively small (submicron) grain sizes. Recently single-domain hematite has been found to have more intense TRM than previously measured, and it too could be viable. Depending on magmatic conditions, fine-grained magnetite and hematite can occur as segregated phases within titanomagnetite and titanohematite. Ultrafine subdivision might give rise to lamellar magnetism, as reported for terrestrial titanohematites. Thermoviscous magnetization is probably negligible for Mars because of the small present field and the minor enhancement of TRM that likely occurred in ancient fields.

P31A-02 0900h INVITED

A review of our knowledge of the crustal magnetic field of Mars

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The data collected by the magnetometer experiment aboard the Mars Global Surveyor since 14 September 1997 have been used by numerous investigators to define the structure of that field, which has turned out to be only of crustal origin to the accuracy of the observations. The various techniques used include representations by spherical harmonics of the global potential function, averages of field at altitude, or by magnetized elements at the surface. Data were collected from the highly elliptical braking orbits down to an altitude of 102 km from the planet's surface during mainly daytime conditions. Such data were found to contain contributions from the interactions of the planetary atmosphere with the solar wind, including ionospheric currents so generated. After being placed into a "mapping" orbit in March 1999 it was then possible to utilize data from the dark side, presumably nearly free of such external influences, but the lowest altitudes were no less than about 365 km and ranged up to about 435 km. The local times since then have been kept to nearly 2 pm and 2 am for non–polar latitudes. This review evaluates the accuracy of the models and maps of field, and estimated magnetization parameter derived from the data and models.

URL: http://geomag.gfdi.fsu.edu/mars/index.html

P31A-03 0930h

A Coherent Magnetic Field Model of the Martian Crust

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The tangential components of the magnetic field of Mars measured by Mars Global Surveyor (MGS) have appreciable contributions from the external magnetic field than the radial component. The immense amount of data acquired during the mapping phase of MGS provides good opportunity to derive a more accurate model of the magnetic potential field of the Martian crust using only the least contaminated radial component data. For this purpose the radial component data measured since the satellite resumed its mapping phase are divided into 2 sets of data, acquired from March 1999 to February 2001, and from February 2001 to April 2003. Each set is expanded in spherical harmonics using harmonics of degree up to 65, and their most repeatable signatures are selected through covariance analysis. The model tangential components derived from the model potential field are significantly different from those of the observed ones. Not only their small-scale features are different, but also their global scale features specified by spherical harmonics of degree 1-3 show appreciable differences, indicating the global scale external magnetic field contribution. Although the external field has negligible contribution to the strong anomalies of the south hemisphere, it may have appreciable contribution to the weak magnetic anomalies. The more reliable magnetic field model allows us to downward continue the anomalies to the surface of the planet and better delineate the relationship between the tectonic processes and the magnetic anomalies of Mars. The downward continued maps show numerous small scale magnetic anomalies over the northern lowlands, but no significant anomalies inside the giant impact basins.

P31A-04 0945h

Correlated Magnetic and Gravity Anomalies West of the Isidis Basin, Mars and Implications for Plains Magnetism

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The magnetic field of Mars reflects strong crustal magnetism resulting from an ancient internal field. The crustal anomaly pattern parallels the geologic dichotomy in that most of the anomalies detected by the Mars Global Surveyer are located within the persumably older southern highlands while the northern lowlands has weak or no magnetic signature at satellite atltiudes. We have analyzed a section of the dichotomy boundary whose geology has been studied extensively in order to examine the implications of correlations between gravity and magnetic anomalies for the regional distribution of magnetic sources. The study area contains some of the strongest magnetic anomalies observed outside the area of high-amplitude anomalies found within the Terrae Cimmeria and Sirenum sector of the southern highlands. Several strong magnetic and gravity anomalies in the area of the Ismenius quadrangle are associated with a mapped normal fault, but the magnetic and gravity peaks and troughs are out of phase. The isostatic gravity anomalies indicate higher density bodies flanking the mapped normal fault. If we assume common sources of both the gravity and magnetic anomalies, and a coherent direction of magnetization within a spatially variable source layer, we acheive the best fit to both the gravity and magnetic fields using a low inclination for the magnetization direction (30 degrees), in general agreement with published paleopole estimates for Mars. This solution requires a continuous magnetic source layer extending north beneath the plains to avoid a large edge effect anomaly; this layer produces near-zero field away from the fault. An alternate model assumes that the gravity anomalies correspond to areas of demagnetization of a preexisting continuous magnetic source layer. This model fits best for an inclination near -45 degrees and does not require a source layer in the northern plains. Candidate geologic processes that could have produced such source distributions in the study area include extension and volcanic intrusion focused near the dichotomy boundary, and hydrothermal alteration which created, destroyed, or reduced the magnetism. The product of layer thickness and magnetic intensity implied by these models is roughly 5-10 times less than inferred in the highly magnetized region of the southern highlands, indicating significantly different genesis or evolution of the crust occurred in that region as compared to the rest of Mars.

P32A CC: 519 B Wednesday 1030h

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

Presiding: **D Stegman,** Monash University**; M Jellinek,** University of Toronto

P32A-01 1030h INVITED

Mars Magnetic Field: Implications for Crustal Formation and Evolution

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One of the most dramatic discoveries of the Mars Global Surveyor (MGS) mission is that of crustal magnetic field sources of multiple scales, strength and geometry. Current global field models exhibit similar large-scale features: intense magnetic fields (requiring crustal magnetizations approximately an order of magnitude greater than on Earth) over the Noachian-age Terra Cimmeria southern hemisphere region, weaker isolated anomalies over the northern hemisphere and over other southern hemisphere areas, and a general paucity of strong magnetic fields over the major impact basins. Challenges in constructing such models include the variable maximum spatial resolution in the magnetic field data, and the removal of magnetic fields of non-crustal origin. Three hypotheses for the timing of a dynamo have been proposed. In the first hypothesis, dynamo onset post-dates the youngest observed impact basins on Mars. In the second hypothesis, the dynamo is short-lived, with onset in the early Noachian and cessation prior to the formation of Argyre and Hellas. In the third hypothesis, early Noachian dynamo onset is invoked, but duration into the late Noachian or early Hesperian is permitted. Fundamental to distinguishing among these various hypotheses and to explaining the observed global distribution of magnetic anomaly amplitudes is establishing the relative timing of crustal formation, the duration of any dynamo regime (and indeed the driving mechanism for such a dynamo), and the effect of post-emplacement crustal modification on any acquired magnetic remanence. Accordingly, in this talk we review progress in addressing the following issues essential to understanding the history of Mars' magnetic field: (1) The timing of crustal formation in northern and southern hemispheres, (2) A quantitative assessment of magnetic anomalies in the major impact basins (specifically Hellas and Argyre), (3) Potential candidates for the magnetic carrier, along with rock magnetic properties that are important to remanent acquisition and any subsequent demagnetization, (4) An assessment of the effectiveness of thermal, hydrothermal, and shock demagnetization mechanisms, and geographically where these may have been active, (5) Energetics available to drive a martian dynamo. Based on