**A MARTIAN PALEOMAGNETIC POLE ESTIMATE MADE USING THE DISTRIBUTION AND INTENSITY OF LARGE SCALE MAGNETIC FEATURES.** M.E. Purucker[1] and K.A. Whaler[2], [1]Raytheon ITSS at Planetary Geodynamics Branch, Goddard Space Flight Center, Greenbelt, MD USA (purucker@geomag.gsfc.nasa.gov), [2]University of Edinburgh, Edinburgh, UK (kathy.whaler@ed.ac.uk).

**Introduction:** Paleomagnetic pole estimates from Mars have used inversions of magnetic field observations over isolated dipoles [1,2], and inversions of magnetic field observations over multiple, overlapping sources [3,4]. Utilizing our new, continuously varying magnetization model [4], we estimate the paleomagnetic pole position based on the knowledge that an axially-centered dipolar magnetic field aligned with the rotation axis increases in strength with latitude. Large-scale terrestrial magnetic features of crustal origin mapped from satellites can be shown to have such a dependence with magnetic latitude [5]. If this also holds for the Martian magnetic features, it would suggest that the magnetization high (Figure 1) centered over Terra Cimmeria and Sirenum was formed at a magnetic pole in the Early Noachian. The corresponding paleomagnetic poles (45N,0E and 45S, 180E) would suggest that the Tharsis bulge was within 20 degrees of the magnetic equator when the Martian magnetic field was active.

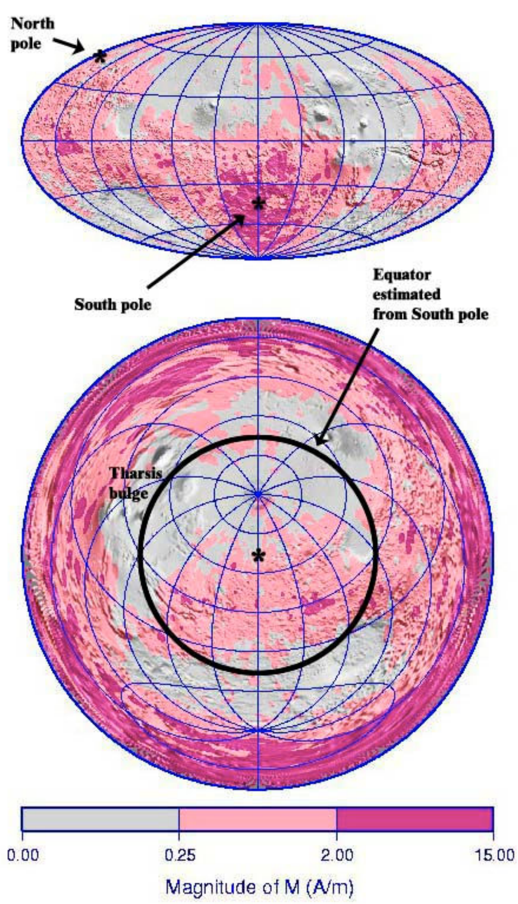


**Figure 1 (Top) Magnetization magnitude (A/m) for a 40 km thick crust from global model [4]. Shown on a global Hammer projection centered at 180 degrees longitude. (Bottom) Same as top but using an azimuthal equidistant projection centered at 0 degrees longitude, 45 degrees N latitude. Longitude and latitude grid is 30 degrees for both maps.**

**A new continuous magnetization model:** Using a three-component magnetic field data set at over 100,000 satellite points previously compiled for spherical harmonic analysis [6], we have produced a continuously varying magnetization model for Mars (Figure 1). The magnetized layer was assumed to be 40 km thick, an average value based on previous studies of the topography and gravity field. The severe non-uniqueness in magnetization modelling is overcome by seeking the model with minimum root-mean-square (RMS) magnetization for a given fit to the data, with the trade-off between RMS magnetization and fit controlled by a damping parameter. Our model is expressed as a linear combination of the Green's functions relating each observation to magnetization at the point of interest within the crust, leading to a linear system of equations of dimension the number of data points. Although this is impractically large for direct solution, most of the matrix elements relating data to model parameters are negligibly small. We therefore apply methods applicable to sparse systems, allowing us to preserve the resolution of the original data set. Thus we produce more detailed models than any previously published, although they share many similarities. Our preferred model has magnetizations up to 15 A/m, and patterns reminiscent of structural and tectonic features on Earth. Our method can also be used to upward and downward continue magnetic data, and a comparison with other levelling techniques at Mars' surface is favourable.

**Paleomagnetic pole position:** The Terra Cimmeria region has a magnetization strength pattern that is consistent with acquisition in a region centered on a magnetic pole (Figure 1). Our model also solves for the inclination of the magnetization vector and we find that steep positive and negative inclinations characterize this region. We take the middle of the magnetization high in the Terra Cimmeria region as our South pole. Reprojecting the data on a global azimuthal equidistant projection centered at the computed North pole, we see a much-distorted South polar region girdling the plot. Inside of that is a weakly magnetic region consistent with a low-latitude origin, and finally, in the center we see a more strongly magnetic region, again consistent with a high latitude origin. The magnetic equator has been geometrically located on the lower plot, and can be seen to be close to the Tharsis mass bulge [7]. The paleomagnetic pole deduced here is significantly different from those estimated by [1], which were located mostly within a circle of radius 30 degrees centered at 25 degrees N and 230 degrees E, and those estimated by [2], which are clustered in a region NW of Olympus Mons at 40 degrees N and 210 E.

**Discussion:**.An axially-centered dipole aligned with the rotation axis in a spherical planet is a factor of two stronger at the poles than at the equator. Multipolar, but dipole-dominant, fields like that of the Earth typically have even larger ratios [5]. The ratio at Mars, calculated from 10 degree averages over the Cimmeria region, is about 10. We expect that other factors, including variations in magnetic mineralogy, will contribute to regional magnetization variations. In cases where the terrain has been demagnetized by subsequent impact (Hellas, Argyre) or heating (the great volcanoes), our hypothesis will obviously not apply. The paleomagnetic poles (45N,0E and 45S,180E) calculated here would suggest that the Tharsis bulge was within 20 degrees of the magnetic equator when the Martian magnetic field was active. Since none of the Tharsis volcanoes exhibit significant magnetic signatures, this might imply either a long history for the bulge and associated volcanism, or that it was emplaced in its present near-equatorial position.

**References:** [1] Arkani-Hamed, J. (2001) *GRL, 28,* 3409–3411. [2] Hood et al. (2004) *LPS XXXV, Abstract #1108* [3] Langlais et al. (2004) *JGR,* 109. [4] Whaler, K.A and Purucker, M.E. (2005) in review for *JGR*. [5] Maus, S and Haak, V. (2002), J. Indian Geophysical Union, January 30, 2002. [6] Cain et al. (2003) *JGR*, 108 [7] Melosh, J (1980) *Icarus,44, 745.*