**Martian Paleopole Investigations using MAVEN-MAG data.** P. Thomas[1], M. Grott[1], D. Pietsch[2], and A. Morschhauser[3], [1]German Aerospace Center, Departement of Planetary Physics, Berlin, Germany (paul.thomas@dlr.de; matthias.grott@dlr.de), [2]Freie Universität Berlin, Departement of Geophysics (dpietsch@zedat.fu-berlin.de), [3]German Center for Geosciences, Departement for Geomagnetism, Potsdam,Germany (mors@gfz-potsdam.de).

**Introduction:** In the past two decades, the study of the Martian lithospheric magnetic field was based on data acquired by the Mars Global Surveyor (MGS) Mission, and a number of paleopole investigations have been performed either using the MGS-MAG track data itself [1] or using local or global models of the magnetic field [2,3,5]. While using track data has the advantage of making use of the full local resolution, the use of field models allows for a better treatment of measurement errors and noise in the data. Furthermore, measurements can be evaluated at constant altitude.

Since 2014, the Mars Atmosphere and Volatile Evolution (MAVEN) mission is in orbit around Mars, and new vector magnetic field measurements are acquired by the MAVEN-MAG instrument [6]. Due to the high ellipticity and low periapsis of the MAVEN orbit, new low altitude data is currently becoming available. MAVEN-MAG data show a more uniform spatial coverage below an altitude of ~400 km [7] when compared to MGS data

The new data agrees well with previously published spherical harmonics (SH) models of the Martian lithospheric magnetization [5,7]. Discrepancies appear mostly in amplitude, and it seems likely that unmodeled signals of lithospheric origin increase the residuals between the SH-model and MAVEN-MAG data at low altitude [7]. This indicates that MAVEN data could be useful for studying small-scale anomalies which have not been captured by previous studies [7] or could reveal more detailes of already observed anomalies.

**Method:** We have applied Parker's method [4] to determine paleopole locations associated with isolated crustal magnetic field anomalies and compared the results obtained using MGS and MAVEN data, respectively. Parker's method is based on the assumption of uniform magnetization in the study area, and a number of $N$ equally spaced dipoles with magnetization strengths $M_i$ and uniform orientation are distributed in the investigation region. The magnetic orientation is set a priori, and the predicted magnetic field is calculated. The magnetization strengths $M_i$ are then determined by fitting the data in a least square sense, and the calcualtion is repeated for all possible magnetic orientations. In this way, a measure of misfit is obtained as a function of paleopole location [3,4].

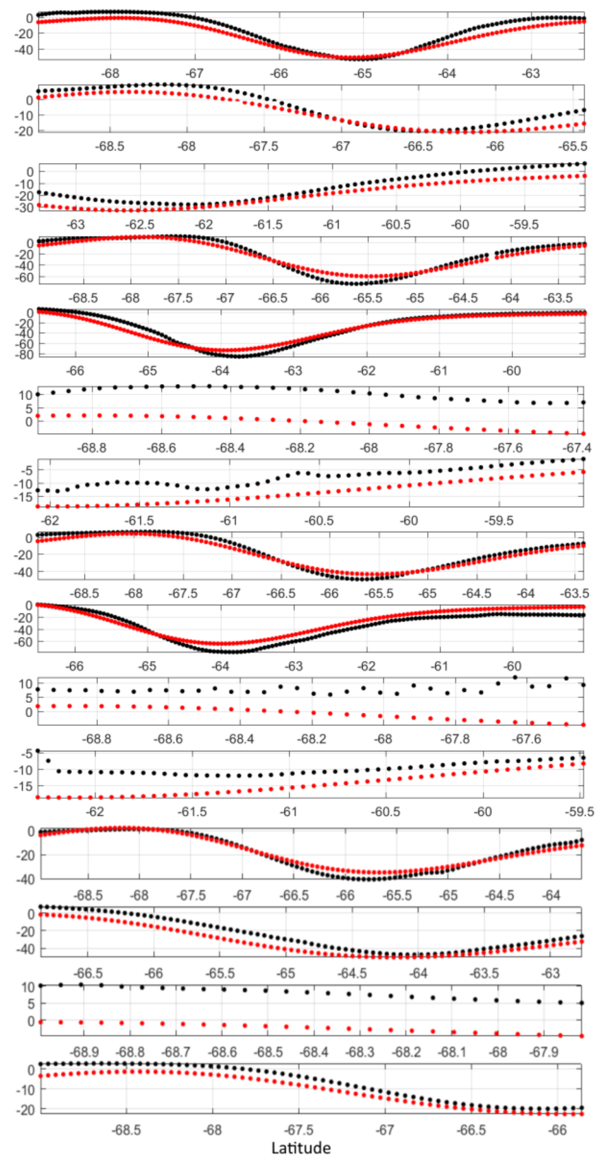


**Figure 1** *Comparison of the magnetic field down component* $\boldsymbol{B_z}$ *derived from a SH-model of MGS data [5] (red) and the MAVEN-MAG data (black) at the South Crater magnetic anomaly as a function of latitude. Track altitudes vary between 107 and 180 km.*

As no global model of the Martian lithospheric magnetization including MAVEN data is currently available, we will use MAVEN magnetic field track data in the following. Along track data was selected to be below an altitude of 180 km and only night-time data was chosen. No filtering or additional data processing took place. In order to be able to directly compare the results obtained using MAVEN data to those obtained using MGS data, a SH-model of MGS data [5] was evaluated at the locations of the MAVEN tracks and the above calculations were repeated.

It is worth noting that the use of along track data complicates the definition of a confidence interval for the obtained paleopole locations, and previously established methods cannot be applied [3,8]. Therefore, we will here choose a confidence limit corresponding to three times the minimum misfit as a threshold for admissible paleopole locations.

**Results**: Figure 1 shows a comparison of the $\boldsymbol{B_z}$ magnetic field component between the MAVEN-MAG (black) night time track data and a SH-model (red) of MGS data as a function of latitude. The chosen tracks cross the South Crater crustal magnetic field anomaly located southeast of the Hellas basin, and track altitudes vary between 107 and 180 km. The MGS SH-model and MAVEN along track data agree very well, and differences at high amplitudes are of the order of 10%, but increase for low amplitude data.

Figure 2 shows the results of paleopole inversions using the tracks shown in Figure 1. The top panel shows the resulting area of admissible paleopole locations obtained for the MGS SH-model and the bottom panel shows the resulting area of admissible paleopole locations from the MAVEN-MAG data. The contour lines show only minor variations. Small differences concern the minimum misfit as well as the locations of the best fitting paleopoles.

**Conclusions:** For the anomalies studied so far, differences between MGS and MAVEN data are relatively small in the center regions of the studied anomalies, but increase in the low field regions towards the edges of the anomaly. However, the confidence limits for admissible paleopole locations associated with the studied anomalies are comparable for both datasets. While this confirms the robustness of the applied method, it also implies that currently little additional information can be extracted from the MAVEN data as compared to MGS.

This situation could improve if new isolated anomalies could be detected in the MAVEN data or if neighboring and previously unresolved anomalies could be separated. Such a systematic search would best be performed using a global model of MAVEN magnetic field data, as data could then be investigated at constant altitude.

To separate admissible and non-admissible magnetization orientations and thus determine admissible paleopole locations, a confidence limit for the allowable misfit needs to be defined. This is usually done by estimating the amount of non-modeled background field in the study area [3,8], but this method relies on knowledge of the background field at close to constant altitude. This could be achieved by field continuation, but would again require, e.g., a SH-model of the MAVEN data, which is currently not available.

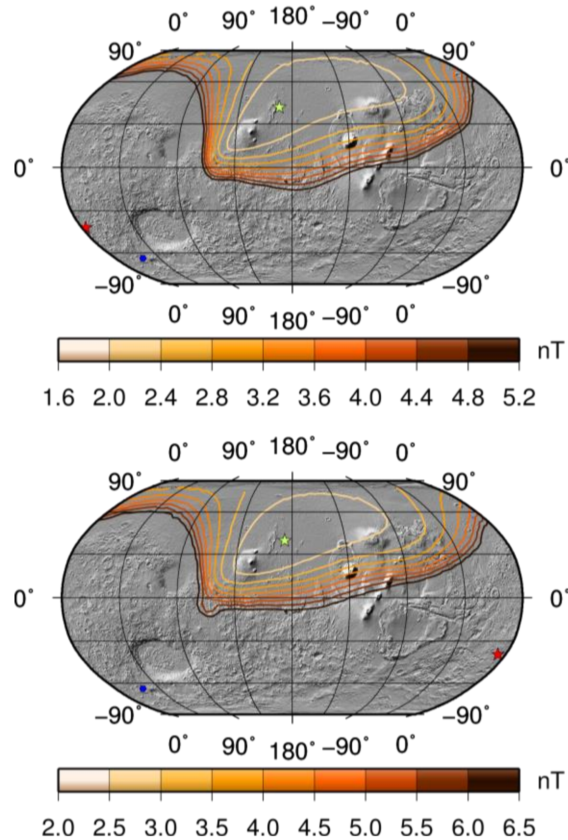


**Figure 2** *Contour line plot of the misfit as a function of paleopole location for the South Crater magnetic anomaly. Anomaly location, (blue) as well as best fitting magnetic North (green) and South (red) Pole are indicated. Top: Inversion results using MGS data. Bottom: Results using MAVEN data.*

**References:** [1] Hood L. L. and Zakharian A. (2001) *JGR, 106*, 601–619. [2] Plattner A., and Simons F. J. (2015) *JGR., 120*, 1543-1566. [3] Thomas et al. (2017) *JGR., submitted*. [4] Parker R.L. (1991) *JGR, 108*, 16101-16112. [5] Morschhauser et al. (2014) *JGR, 119(6),* 1162-1188. [6] Connerny et al. (2015) *Space Sci. Rev*., *195*, 257-291. [7] Mittelholz A. and Johnson C. L., *LPSC XLVII*, Abstract #1674. [8] Oliveira, Wieczorek, (2017) *JGR., 122*, 383-399.