

THE EFFECTS OF MAGNETIC ANOMALIES DISCOVERED AT MARS ON THE STRUCTURE OF THE MARTIAN IONOSPHERE AND THE SOLAR WIND INTERACTION AS FOLLOWS FROM RADIO OCCULTATION EXPERIMENTS. N. F. Ness¹, M.H. Acuna², J.E.P.Connerney², P. Cloutier³, A.J. Kliore⁴, T.K. Breus⁵, A.M. Krymskii⁵, S.J. Bauer⁶, ¹ Bartol Research Institute, 215 Sharp Laboratory, University of Delaware, Newark, 19716, DE, USA e-mail: nfness@bartol.udel.edu, ² NASA Goddard Space Flight Center, Greenbelt, USA, ³ Department of Space Phys. and Astron., Rice University, Houston, USA, ⁴ Jet Propulsion Laboratory, Institute of Technology, Pasadena, California, USA, ⁵ Space Research Institute Russian Academy of Sciences, Moscow, Russia, ⁶ University of Graz, Austria.

Introduction: The electron density distribution in the ionosphere of nonmagnetic (or weakly magnetized) planet depends not only on the solar ultraviolet intensity, but also on the nature of the SW interaction with this planet.

Two scenarios previously have been developed based on the observations of the bow shock crossings and on the electron density distribution within the ionosphere. According to one of them Mars has an intrinsic magnetosphere produced by a dipole magnetic field and the Martian ionosphere is protected from the SW flow except during "overpressure conditions, when the planetary magnetic field can not balance the SW dynamic pressure. In the second scenario the Martian intrinsic magnetic dipole field is so weak that Mars has mainly an induced magnetosphere and a Venus-like SW/ionosphere interaction.

Today the possible existence of a sufficiently strong global magnetic field that participates in the SW/Mars interaction can no longer be supported. The results obtained by the Mars-Global-Surveyor (MGS) spacecraft show the existence of highly variable, but also very localized magnetic fields of crustal origin at Mars as high as 400-1500 nT [1-4].

The absence of the large-scale global magnetic field at Mars makes it similar to Venus, except for possible effects of the magnetic anomalies associated with the remnant crustal magnetization. However the previous results on the Martian ionosphere obtained mainly by the radio occultation methods show that there appears to be a permanent existence of a global horizontal magnetic field in the Martian ionosphere. Moreover the global induced magnetic field in the Venus ionosphere is not typical at the solar zenith angles explored by the radio occultation methods.

The main objectives of this study: Thus there are several problems to be addressed in this paper:

1. Whether or not a contradiction exists between the MGS observations of the magnetic field and the indirect assessments of the magnetic field characteris-

tics. It is possible that the radio occultation experiments had covered only the regions at Mars where the magnetic anomalies insignificantly affect the radio occultation data.

2. Whether the radio occultation profiles derived from the total electron content along the ray-path measurements simply reflect the low resolution of this method or are indicative of the presence of some large-scale magnetic field above the magnetic anomalies. Whether or not this magnetic field is responsible for differences in the structure of the Martian and Venusian ionosphere at the solar zenith angles explored ($45^{\circ} - 80^{\circ}$).

3. Whether or not "over-pressure" conditions exist on the dayside of Mars up to the terminator, when the SW dynamic pressure compresses the interplanetary magnetic field permanently into the Martian ionosphere. This conflicts with Venus observations and with the detailed pressure balance condition at moderate and high zenith angles determined at Mars [5].

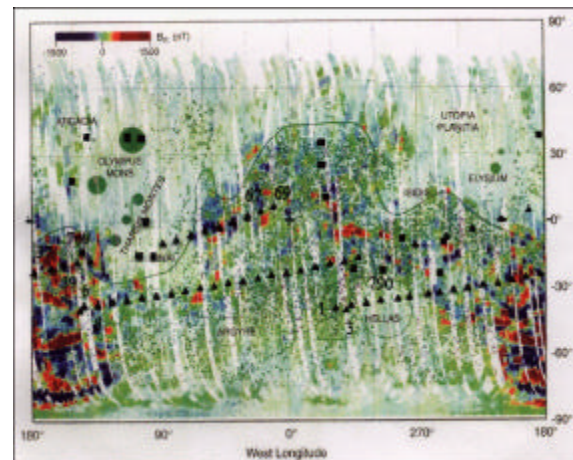


Figure 1. Occultation locations (triangles –Mariner 9, squares-Viking 1) together with the color-coded radial components of the magnetic fields measured by the MGS/MAG.

Results and discussion: The derived scale heights of the topside density profiles and their variations with

solar zenith angle (SZA) and solar wind dynamic pressure can reveal properties associated with the presence of a magnetic field in the ionosphere and even the nature of this magnetic field. Addressing the problems listed above the scale-heights of the electron density profiles obtained by Mariner 9 and Viking 1 are statistically analyzed at the altitude higher than the topside boundary of the photoequilibrium in the magnetic field free ionosphere. Local increase of the mean scale height in the altitude range 180-250 km related to the effects of a non-horizontal magnetic field associated with the magnetic anomalies have been revealed and analyzed. In particular, there are 12 orbits in the Mariner 9 data set when the radio occultation occurred in the Southern hemisphere in longitudes less than -120 E or larger than $+150$ E. That coincides with the region where numerous magnetic anomalies are concentrated (Fig.1). The results of comparison and analysis of magnetic anomalies' effects on the Martian ionosphere structure and behavior as well as on the SW/ Mars interaction are discussed.

References: [1] Acuna M.H., J.E.P. Connerney, P. Wasilewski et al. (1998) *Science*, 279, 1676-1680. [2] Acuna M.H., J.E.P. Connerney, N.F. Ness, et al. (1999) *Science*, 204, 790-793. [3] Ness N.F., M.H. Acuna, J. Connerney et al., (1999), *Adv. Space Res.* in press. [4] Connerney J.E.P., M.H. Acuna, P.J. Wasilewski et al. (1999), *Science*, 204, 794 - 797, [5] Zhang, M.H., and J.G. Luhmann, (1992) *JGR.*, 97, 1017—1025.