OBSERVATIONS OF THE "STEALTH" RADAR FEATURE IN THE MARS EXPRESS MARSIS INVESTIGATION.

A. B. Ivanov[1], A. Safaeinili[1], G. Picardi[2], J. J. Plaut[1], [1]*Jet Propulsion Laboratory, MS168-416, Pasadena, CA, 91106; e-mail : anton.ivanov@jpl.nasa.gov*, [2]*Infocom Department, "La Sapienza" University of Rome, 00184, Rome, Italy*.

1 Introduction

In 1991 a bistatic Goldstone/VLA experiment revealed [1] a continental size feature in the Medussae Fossae region on Mars. The most striking property of this feature is that no measurable echo was detected from it in the first and following experiments [2, 3]. This feature, called "Stealth", was interpreted as a medium free of rocks and clumps of centimeter size and larger that would act as subsurface scatterers. Additionally, the surface material must have significant absorption since no reflections are seen from an ubiquitous rock sublayer. Passive microwave observations [4] suggest that the material comprising this feature has very low density. Nothing similar has been reported on the Earth or is known to exist on other terrestrial planets or the Moon. "Stealth" lies on the equator, west of the massive Tharsis volcanoes. There are two major hypotheses on the origin of this deposit: (1) pyroclastic deposits formed form Tharsis volcanoes lava flows [1, 2, 4] and (2) wind-blown volcanic ash deposits [5].

The Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) [6], which is an instrument on the European Space Agency's Mars Express orbiter, has obtained data over the "Stealth" region. We will interpret MARSIS data in the context of geological and cm-wavelength radar data.

2 The MARSIS instrument

MARSIS is a multi-frequency pulse-limited radar sounder, which uses synthetic aperture techniques to maximize signal-to-noise in the received data. MARSIS can be effectively operated at any altitude lower than 800 km in subsurface sounding mode, and below 1200 km in ionosphere sounding mode. The instrument consists of a dipole and a monopole antenna assemblies and an electronics assembly. Maximum penetration depths are achieved at the lowest frequencies. Penetration will be in the order of a few kilometers, depending on the nature of the material being sounded. On the dayside of Mars, the solar wind-induced ionosphere does not allow subsurface sounding at frequencies below approximately 3.5 MHz. In the subsurface sounding mode, MARSIS can operate at 4 different frequencies: 1.8, 3.0, 4.0 and 5.0 MHz, hence allowing a capability to operate in the presence of the ionosphere.

3 Data and observations

The MARSIS radar has began observations of Mars in June of 2005 and continuing to collect data. Figure 1 summarizes MARSIS coverage of the "Stealth" feature. Unfortunately, operational constraints did not allow extensive coverage of the "Stealth" feature. Moreover, most of the tracks that cross the Medussae Fossae formation, which includes the "Stealth" feature, were taken in sub-optimal conditions, when the solar-flare induced ionospheric activity was very strong.

On orbits 1963 and 1974, the radar acquired data in the "Stealth" region, which contains measurable echoes coming after the echoes from the surface interface. These echoes may come from a subsurface interface, surface clutter features or may be due to signal distortion by the ionosphere. We have constructed radar clutter model specific for MARSIS in order assess signature of secondary reflections, induced by topography. Highest resolution MOLA DEM [7] was used. The second interface is not observed in the clutter model simulations. Subsurface nature of the second interface seems to be a plausible explanation, however full analysis of ionospheric effects is not yet complete. As Mars Express orbit pericenter precesses away from the South Pole towards equator, we hope to to obtain more coverage of the "Stealth" feature in conditions optimal for MARSIS.

4 Summary

MARSIS radar data from the "Stealth" feature inside the Medussae Fossae formation exhibits features, indicative of a subsurface interface. We can not however, completely rule out an explanation that these features are produced by either surface topography or distortion of radar signal in the ionosphere. Detailed analysis of this data will address possibility of a subsurface interface in the geologic context of Medussae Fossae formation. We will also present results of more detailed clutter modeling and ionospheric processing [8].

References

[1] D.O. Muhleman, B.J. Butler, A.W. Grossman, and M.A. Slade. Radar images of Mars. *Science*, 253(5027):1508–1513, 1991.

[2] B.J. Butler. *3.5 cm Radar investigation of Mars and Mercury: planetological implications.* PhD thesis, California Institute of Technology, 1994.

[3] J. K. Harmon, et al. Mars mapping with delay-Doppler radar. *JGR*, 104:14065–14090, June 1999.

[4] A. B. Ivanov, et al. Microwave Thermal Mapping of the Stealth Region on Mars. *Icarus*, 133:163–173, June 1998.

[5] K. S. Edgett, et al. Geologic context of the Mars radar "Stealth" region in southwestern Tharsis. *JGR*, 102:21545–21568, September 1997.

[6] G. Picardi, J. J. Plaut, et al. Radar Soundings of the Subsurface of Mars. *Science*, 310:1925–1928, December 2005.

[7] D.E. Smith, M.T. Zuber, et al. The global topography of Mars and implications for surface evolu tion. *Science*, 284(5419):1495–1503, 1999.

[8] A. Safaeinili, et al. MARSIS Radar Echo Ionospheric Correction and The Estimation of Mars Ionosphere's Total Electron Content. *AGU Fall Meeting Abstracts*, pages B150+, December 2005.

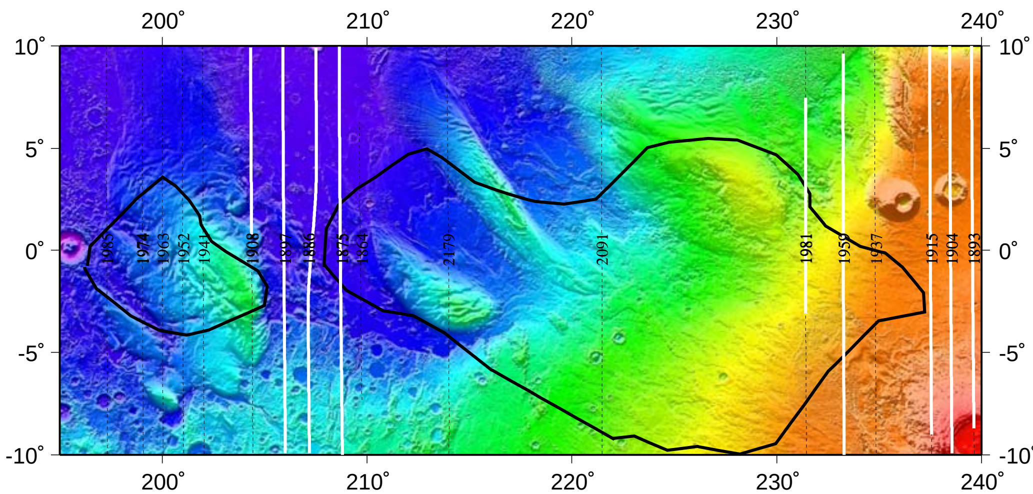

Figure 1: MARSIS ground tracks inside the "Stealth" radar feature (solid black line, from [2]) White tracks show where MARSIS radar obtained high quality data. Dash line tracks show where MARSIS radar obtained data, but quality varies highly. Data discussed in this work are obtained on orbits 1963 and 1974 which are in the westernmost part of the "Stealth" area.