OBSERVATIONS OF THE LAYERING STRUCTURE IN THE SOUTH POLAR LAYERED DEPOSITS WITH THE MARSIS INSTRUMENT. A. B. Ivanov[1], A. Safaeinili[1], J. J. Plaut[1], S. M. Milkovich[1], G. Picardi[2], [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*.

Introduction

One of the many questions of Martian exploration is to uncover the history of Mars through analysis of the polar layered deposits (PLD) (extensive reviews in [1] and [2]). Martian polar ice caps contain most of the exposed water ice on the surface on Mars and yet their history and physical processes involved in their formation are unclear. This work will concentrate on analysis of the internal structure of the South Polar Layered Deposits using Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) [3] experiment data.

Considerable advances have been made in recent years to understand the internal structure of the polar layered deposits. Researchers have employed large amount of imaging data returned by the Mars Global Surveyor and Mars Odyssey spacecraft. [4] have tested a hypothesis on the internal structure of the South Polar Layered Deposits (SPLD) and concluded that the top most layers are most likely parabolic in shape and therefore ablation and sublimation are most prominent forces in forming those layers. [5] have analyzed MOC images taken in the North Polar Layered Deposits (NPLD) and found that albedo patterns are consistent with 30m thick alternating units and that layer sequences are broadly distributed. [6] describes in detail possible mechanisms for formation of the basal unit, discovered by [7]. [8] expands this work, presenting an updated sedimentary history of the NPLD based on data from MOC and THEMIS instruments. Work in [8] clearly distinguishes between brighter units sitting unconformably on top of the dark layers. To explain observations in the SPLD, [9] have suggested an eolian-based model for accumulation and erosion in the Promethei Lingula region.

There is an ongoing debate on the extent the flow in the ice caps. Work by [4] in the SPLD has suggested that structure of the top portion of SPLD is not consistent with flow. Meanwhile work in [10], [11], [12], among others argue that part of the NPLD may have flown in the past. All investigations, including cited above, suggest a certain structure that would be observed according to presented models. The ultimate goal of work described in this abstract is to validate those hypotheses using MARSIS data.

The MARSIS instrument

MARSIS is a multi-frequency pulse-limited radar sounder [3], 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.

Data and Observations

The MARSIS instrument has already shed some light on the subsurface interface in the NPLD [3]. Now MARSIS provided very dense coverage of the subsurface interface and layering structure in the SPLD [13] These observations are the first direct measurement of the subsurface structure of the Polar Layered Deposits.

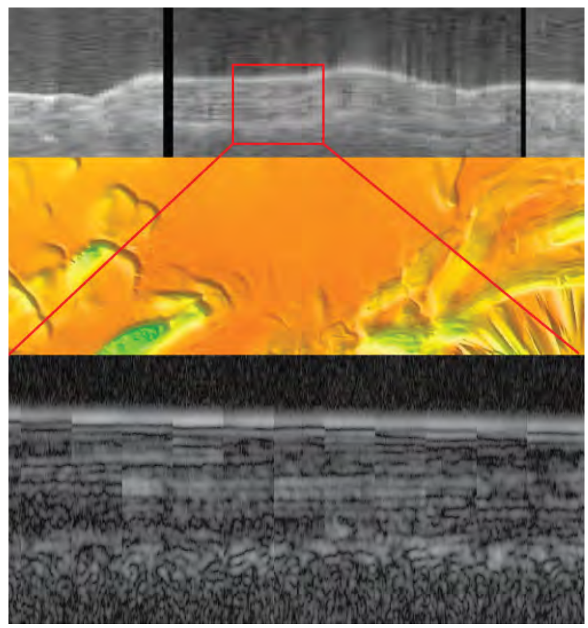

Figure 1: Fine scale details of the South Polar Layered Deposits resolved by the MARSIS instrument. Data shown were taken on Mars Express orbit 2581 [13]. Top picture is regular MARSIS data (coherently summed) with spectra-to-spectra distance of about 5km. Middle image represents MOLA shaded relief DEM with colors showing absolute elevation. The bottom image represents data taken in individual echoes mode. This mode allows a much finer view of the layers. Black stripes in the top image are due no-data gaps between instrument mode changes.

Data from the MARSIS instrument can come in two basic types: standard data, which is processed on the spacecraft to reduce data rate and raw data, which contains raw echoes as received by the MARSIS instrument. Raw data mode, also known as, "individual echoes" mode, requires a much higher data volume and therefore is not used frequently. MARSIS allows simultaneous collection of standard data and individual echoes.

Figure 1 illustrates first results obtained by the MARSIS investigation [13] in SPLD. This figure illustrates the advantages of the "individual echoes" mode. Ground processing allows much greater resolution (30 m) along the track compared to 5km for standard data products. The individual layers and the bottom interface are clearly seen in Figure 1. Note that if an internal layer is not parallel to the MEX tangential velocity over 5km, it will be smeared and this what we observe with MARSIS in the standard data products (Figure 1, top panel). This "raw data" mode represents our best possibility at identifying thick (relative to an individual layer) sequences in the SPLD structure.

Summary

We will present MARSIS observations of the SPLD internal structure. Basis of our analysis will be MARSIS data taken in the "individual echoes" mode. We will attempt at correlating observed sequences with the layer exposures evident in the imaging data. This work will help to test hypothesis described in [4] on the internal structure of SPLD. Additionally, we will pay special attention to the Promethei Lingula region to compare MARSIS data with work described in [9].

References

[1] P. Thomas, S. Squyres, K. Herkenhoff, A. Howard, and B. Murray. Polar deposits of Mars. In H. H. Mars, Kieffer, B. M. Jakosky, C. W. Snyder, and M . S. Matthews, editors, *chapter 23*, pages 767–798. The University of Arizona Press, 1992.

[2] S. M. Clifford, et al. The State and Future of Mars Polar Science and Exploration. *Icarus*, 144:210–242, April 2000.

[3] G. Picardi, MARSIS Science Team, Radar Soundings of the Subsurface of Mars. *Science*, 310:1925–1928, December 2005.

[4] S. Byrne and A. B. Ivanov. Internal structure of the Martian south polar layered deposits. *Journal of Geophysical Research (Planets)*, 109:11001–+, November 2004.

[5] S. M. Milkovich and J. W. Head. North polar cap of Mars: Polar layered deposit characterization and identification of a fundamental climate signal. *Journal of Geophysical Research (Planets)*, 110:1005–+, January 2005.

[6] K. E. Fishbaugh and J. W. Head. Origin and characteristics of the Mars north polar basal unit and implications for polar geologic history. *Icarus*, 174:444–474, April 2005.

[7] S. Byrne and B. C. Murray. North polar stratigraphy and the paleo-erg of Mars. *Journal of Geophysical Research (Planets)*, 107:11–1, June 2002.

[8] K. L. Tanaka. Geology and insolation-driven climatic history of Amazonian north polar materials on Mars. *Nature*, 437:991–994, October 2005.

[9] E. J. Kolb and K. L. Tanaka. Accumulation and erosion of south polar layered deposits in the Promethei Lingula region, Planum Australe, Mars. *Mars*, 2:1–9, April 2006.

[10] A. V. Pathare and D. A. Paige. The effects of martian orbital variations upon the sublimation and relaxation of north polar troughs and scarps. *Icarus*, 174:419–443, April 2005.

[11] D. P. Winebrenner, M. Koutnik, E. D. Waddington, A. V. Pathare, B. C. Murray, S. Byrne, and J. L. Bamber. Evidence for Past Flow in the Martian North Polar Layered Deposits from Ice Flow Inverse Modeling. In S. Mackwell and E. Stansbery, editors, *37th Annual Lunar and Planetary Science Conference*, pages 1875–+, March 2006.

[12] C. S. Hvidberg and K. E. Fishbaugh. Recent Flow Rates of the Martian North Polar Layered Deposits. In S. Mackwell and E. Stansbery, editors, *37th Annual Lunar and Planetary Science Conference*, pages 2053–+, March 2006.

[13] J. J. Plaut, MARSIS Science Team, MARSIS Subsurface Sounding Observations of the South Polar Layered Deposits of Mars. In S. Mackwell and E. Stansbery, editors, *37th Annual Lunar and Planetary Science Conference*, pages 1212–+, March 2006.