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Science results from the MARSIS and SHARAD subsurface sounding radars on Mars and their relevance to radar sounding of icy moons in the Jovian system

R. Orosei (1), G. Alberti (2), L. Bruzzone (3), A. Frigeri (4), E. Heggy (5), W. Kofman (6), G. Komatsu (7), J. J. Plaut (5) and R. Seu (8)
(1) Istituto di Fisica dello Spazio Interplanetario, Italy, (2) Consorzio di Ricerca su Sistemi di Telesensori Avanzati, Italy, (3) Università di Trento, Italy, (4) Università di Perugia, Italy, (5) Jet Propulsion Laboratory, California, USA, (6) Université Joseph Fourier, France, (7) International Research School of Planetary Sciences, Italy, (8) Università di Roma "La Sapienza", Italy (roberto.orosei@ifsi-roma.inaf.it / Fax: +39-06-49934383)

Abstract

The MARSIS and SHARAD subsurface radar sounders have been observing the Martian polar terrains, which are considered a close analogue to the material forming the crusts of Europa and Ganymede. MARSIS and SHARAD results are reviewed and discussed, and expected capabilities and challenges for similar instruments on the two Jovian moons are assessed.

1. Introduction

The model scientific payload of the Jupiter Ganymede Orbiter (JGO) in the Europa Jupiter System Mission (EJSM) includes a subsurface sounding radar experiment (SSR) to explore the upper few kilometres of the icy crust of Ganymede and, to a lesser extent, Callisto [1]. Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) [2] and SHAllow RADar sounder (SHARAD) [3] are two similar experiments currently operating on Mars, carried respectively on ESA'a Mars Express and NASA's Mars Reconnaissance Orbiter. They function by transmitting a low-frequency radar pulse that is capable of penetrating below the surface, and is reflected when it encounters dielectric and structural discontinuities in the subsurface.

2. MARSIS and SHARAD

Both MARSIS and SHARAD have observed ice deposits (see e.g. [4], [5], [6], [7], [8]) that are expected to be a close analogue to the material forming the crusts of the two Jovian satellites. Whereas MARSIS is optimized for deep penetration, having detected echoes down to a depth of 3.7 km over the South Polar Layered Deposits [4], SHARAD is capable of a tenfold-finer vertical resolution, namely 15 m or less, depending on the dielectric constant of the material being sounded [3]. MARSIS is capable of transmitting at four different bands between 1.3 MHz and 5.5 MHz, with a 1 MHz bandwidth. SHARAD operates at a central frequency of 20 MHz transmitting a 10 MHz bandwidth.

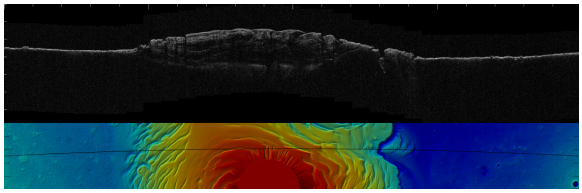

Figure 1: SHARAD data acquired over the Northern Polar Layered Deposits (NPLD) of Mars during orbit 16825. Multiple reflections within NPLD are likely caused by vertical variations of dust content. These echoes, when followed along the ground track of the spacecraft, outline a layered structure which can be connected with lateral exposures of the stratigraphy observable in images. The base of the polar layered deposits, at about 1500 meters below the surface, can be also seen.

3. Outlook

Radar sounding results on Mars from both MARSIS and SHARAD highlight the scientific capabilities of this type of experiments and show the effect of design parameter choices on instrument performance. They also prove the potential of SSR to provide unique information in the study of the geological and geophysical evolution of icy satellites. Moreover, the experience gained in the analysis of SHARAD and MARSIS echoes is very important in the design of SSR in order

to develop an instrument and a set of data processing techniques capable to address the limitations observed in the Mars experiments.

References

[1] Lebreton, J., Pappalardo, R. T., Blanc, M., Bunce, E. J., Dougherty, M. K., Erd, C., Grasset, O., Greeley, R., Johnson, T. V., Clark, K. B., Prockter, L. M., and Senske, D. A.: The Joint ESA-NASA Europa Jupiter System Mission (EJSM), American Geophysical Union Fall Meeting, 14–18 December 2009, San Francisco, California, USA, 2009.

[2] Picardi, G., and 12 co-workers: MARSIS: Mars Advanced Radar for Subsurface and Ionosphere Sounding, In: Mars Express: the scientific payload, ESA Publications Division, pp. 51–69, 2004.

[3] Seu, R., Phillips, R. J., Biccari, D., Orosei, R., Masdea, A., Picardi, G., Safaeinili, A., Campbell, B. A., Plaut, J. J., Marinangeli, L., Smrekar, S. E., and Nunes, D. C.: SHARAD sounding radar on the Mars Reconnaissance Orbiter, Journal of Geophysical Research, Vol. 112, CiteID E05S05, 2007.

[4] Plaut, J.J., and 23 co-workers: Subsurface Radar Sounding of the South Polar Layered Deposits of Mars, Science, Vol. 316, pp. 92–95, 2007.

[5] Seu, R., and 51 co-workers: Accumulation and Erosion of Mars' South Polar Layered Deposits, Science, Vol. 317, pp. 1715-1718, 2007.

[6] Phillips, R. J., and 26 co-workers: Mars North Polar Deposits: Stratigraphy, Age, and Geodynamical Response, Science, Vol. 320, pp. 1182–1185, 2008.

[7] Grima, C., Kofman, W., Mouginot, J., Phillips, R. J., Hérique, A., Biccari, D., Seu, R., and Cutigni, M.: North polar deposits of Mars: Extreme purity of the water ice, Geophysical Research Letters, Vol. 36, CiteID L03203, 2009.

[8] Milkovich, S. M., Plaut, J. J., Safaeinili, A., Picardi, G., Seu, R., and Phillips, R. J.: Stratigraphy of Promethei Lingula, south polar layered deposits, Mars, in radar and imaging data sets, Journal of Geophysical Research, Vol. 114, CiteID E03002, 2009.