Geophysical Research Abstracts
Vol. 14, EGU2012-5134-1, 2012
EGU General Assembly 2012

Three Dimensional Structure of the Mars North Polar Basal Unit from MARSIS data

A. Frigeri (1), R. Orosei (1), M. Cartacci (1), A. Cicchetti (1), G. Mitri (1,2), S. Giuppi (1), R. Noschese (1), G. Picardi (3), and J. Plaut (4)

(1) Istituto Nazionale di Astrofisica, Istituto di Astrofisica e Planetologia Spaziali, Roma, Italy (alessandro.frigeri@ifsi-roma.inaf.it), (2) Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona, USA;, (3) Università "La Sapienza", Rome, Italy;, (4) NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA.

Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) is an orbital subsurface sounder aboard ESA's Mars Express spacecraft . It transmits a low-frequency radar pulse that is capable of penetrating below the surface, and is reflected by subsurface dielectric discontinuities. MARSIS has been used to probe both the south and the north polar caps of Mars, revealing their thickness and structure. We report on the results of a campaign of observations of the north polar ice cap of Mars that took place between May and December 2011 in uniquely favorable conditions and produced data of unprecedented quality. The focus of this work is the so-called Basal Unit, a dark, ice-rich, complexely layered geologic unit lying stratigraphically between the polar layered deposits and the Vastitas Borealis Formation, and extending beneath most of Planum Boreum and Olympia Planitia. The objective of this work is the to study the full three dimensional structure of the Northern Polar Deposit and in particular of the Basal Unit (BU).

It was recently found that the BU consists of two markedly different units, called the *Rupes Tenuis* unit and the *Planum Boreum cavi* unit. The *Rupes Tenuis* unit appears to be older, horizontally layered, and lacking erosional contacts. It has been thus interpreted as the result of precipitation and cold-trapping of dust-laden volatiles. The *Planum Boreum cavi* unit displays cross-bedding, indicating dune accumulation. Bright layers within it are interpreted as being made of ice-cemented dust, while dark layers should consist of weathered basalt fines. It seems likely that, in places, the Planum Boreum cavi unit rests directly on the Vastitas Borealis, without the Rupes Tenuis unit in between. Because the two units in the BU have formed much earlier than the north polar layered deposits, and at some interval from each other, they bear evidence of past climatic conditions that were very different from present, so that they "could potentially be a Rosetta Stone for the Martian climate".

Subsurface sounding radar investigations by both MARSIS and SHARAD revealed that the BU has radar properties that are different from both the polar layered deposits and the Vastitas Borealis Formation, probably because of a mostly icy composition, but with a larger fraction of impurities than the polar layered deposits above. The upper surface of the BU exhibits significant relief, with features appearing to be erosional cutbacks and reentrants, indicating a complex accumulation history. Higher dust content and the resulting stronger attenuation is thought to be the reason why SHARAD radar signal could not penetrate through the BU and detect its bottom face. However, such a volume fraction cannot be much larger than the polar layered deposits, since MARSIS data revealed strong returns from the BU-Vastitas Borealis Formation interface, implying a relatively low fraction of impurities within the BU.

From the summer phase of the Polar Campaign of data acquisition we have selected 161 radargrams. The radargrams were processed in order to cancel the effect of the ionosphere and to align the primary echo to a datum. The post-processed radargrams have been ingested into a *Free Open Source* software stack for geophysical imaging and interpretation.

We find weak echoes within the BU that appear to outline a two-layer structure, perhaps corresponding to the Rupes Tenuis unit and the Planum Boreum Cavi unit. This was found through visual inspection, however, because echoes within the BU are too sporadic to be automatically picked, so further data processing and analysis is needed to confirm the result. As first results we found that the BU has a dielectric constant significantly greater than that of water ice, and thus that it contains a much larger dust fraction than the NPLD above them. We find, however, that no single value can produce the correct topographic relationship over the whole BU, which implies either that the topography of Planum Boreum beneath the polar cap is not a regular continuation of the topography outside the cap, or that the dielectric permittivity of the BU, and thus its dust content, is laterally inhomogeneous. Work to

verify these two hypotheses is currently ongoing.