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New Insights into the Long-Term Evolution of Planum Boreum, Mars from SHARAD Investigations of Internal Stratigraphy Combined with Modeling

John Holt (1), Roger Phillips (2), Ralf Greve (3), Aymeric Spiga (4), and Roberto Seu (5)

(1) Institute for Geophysics, University of Texas at Austin, Austin, Texas, USA (jack@ig.utexas.edu), (2) Southwest Research Institute, Boulder, Colorado, USA, (3) Institute of Low Temperature Science Hokkaido University, Sapporo, Japan, (4) Laboratoire de Météorologie Dynamique, Université Pierre et Marie Curie, Paris, France, (5) INFOCOM Dept., Universita di Roma "La Sapienza," Rome, Italy

Data from several instruments on multiple Mars orbiting missions have shed new light on polar processes in recent years. In particular, orbital radar sounding has revealed the internal structure and stratigraphy of Planum Boreum. The Shallow Radar (SHARAD) instrument on Mars Reconnaissance Orbiter has proven itself particularly effective for mapping the north polar layered deposits (NPLD) and the contact of the NPLD with the underlying "basal unit" (BU). This has led to new insights regarding the relative age and processes leading to major features including Chasma Boreale and the spiral troughs. It has become evident that currently-observed processes are likely to be responsible for these landforms.

Most recently, we have examined the overall growth/retreat history of Planum Boreum as recorded in stratigraphic sequences bounded by unconformities. Truncation surfaces associated with these unconformities have been previously observed within the NPLD at multiple stratigraphic levels, in both optical and radar data but have not been correlated over large areas.

Our integrated, three-dimensional mapping of SHARAD stratigraphy, incorporating over 1,000 orbital tracks, reveals that the major unconformities were likely formed during just two or three regional erosional events mostly confined to the outer margins of Planum Boreum. These retreat events interrupted otherwise continuous deposition of the NPLD over a highly non-uniform upper surface of the BU. NPLD accumulation also can be quantified for specific stratigraphic intervals, indicating highly non-uniform accumulation during some intervals and essentially uniform in others.

The radar stratigraphy further indicates a recent period of laterally extensive deposition combined locally with lateral transport associated with spiral trough migration. The overall sequence of deposition and erosion as derived from SHARAD data is consistent with results from orbitally-forced climate models that predict net polar ice accumulation only in the past 4 Ma, two or three significant retreat events during that period, and the most recent period as being dominated by deposition rather than erosion.

Since internal reflectors are isochrones, we can also map paleotopography as it has evolved within Planum Boreum. Accumulation patterns are derived from the differencing of specific stratigraphic horizons. Comparisons of these results reveal clear feedbacks between topography and subsequent accumulation, indicating strong atmosphere-surface interactions. The role of winds is being evaluated with mesoscale models.