MARS NORTH POLAR LAYERED DEPOSIT STRATIGRAPHY NEAR GEMINI LINGULA FROM HIRISE IMAGERY AND DTMS. P. S. Russell[1], S. Byrne[2], S. Mattson[2], S. Christian[3], J. W. Holt[4], S. M. Milkovich[5], N. E. Putzig[6], [1]Center for Earth and Planetary Studies, Smithsonian Institution, Washington DC 20013, russellp@si.edu, [2]Lunar and Planetary Laboratory, Univ. Arizona, Tucson AZ 85721, [3]Dept. Geology, Bryn Mawr College, Bryn Mawr PA 19010, [4]Inst. Geophysics, Univ. Texas, Austin TX 78712, [5]Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 90042, [6]Southwest Research Institute, Boulder CO 80302.

Introduction: Layering in Mars' north polar layered deposits (NPLD) was discovered in Mariner 9 and Viking (resolutions down to ~50m/pix) and has long been recognized as a critical record of Mars' recent climate, volatile, and dust cycles [1-4]. Mars Orbiter Camera (MOC) images (resolutions down to ~1.5 m/pix but typically ~5 m/pix or more) have been investigated for periodic signals and links to climate parameters [5-7] and have been correlated over wide expanses of the NPLD [8]. The Shallow Radar (SHARAD) and the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) have also detected radar layering within the NPLD [e.g. 9]. This radar detection within the volume of the NPLD has allowed for a host of new studies on the structure, history, and processes that have affected the NPLD. With high-resolution (0.25 – 0.5 m/pxl) images and stereo-derived Digital Terrain Models [10] from the High-Resolution Imaging Science Experiment (HiRISE), we now have our highest-resolution view yet of the NPLD, as well as the ability to compile a quantitative stratigraphy of individual and packets of NPLD layers [11]. A crucial link between visual studies of the NPLD exposed in gently sloping, spiraling troughs and radar studies of internal layering remains missing: it is as yet unknown how the radar layering relates to the visible layering. This piece of information would represent a powerful tool by helping to integrate the findings derived from both types of studies. Here we present our current steps toward addressing this issue. This abstract deals largely with HiRISE and other image data; progress on radar analysis towards this goal is reported in [12; Christian et al. this conference].

HiRISE DTM and Context: With one DTM-derived stratigraphic column already completed [11], we here describe a second that was targeted and created explicitly for the purpose of matching internal radar layers with visible surface layers. The widest extent of correlated stratigraphic sections over the NPLD [8] as well as the first DTM-derived stratigraphic column [11 are located within a few degrees of the pole, in troughs cutting the main topographic dome of NPLD (Fig. 1). However, in SHARAD data, some of the flattest, most uniform layers appear beneath the saddle region between the main dome and the lobe of Gemini Lingula. Critically, the radar layers here also approach relatively close to the edge of the trough in the radargrams, minimizing the distance over which extrapolations must be made. Thus, the location of this DTM (~ 82.3°N, 34.1°E; Fig. 1) was chosen to optimize the methods and technique of linking radar and visible layers. This knowledge will then in the future be applied to areas where the visual layering stratigraphy is better characterized but the expression of radar layering is more complex.

In order to establish the consistencies and variability within the NPLD stratigraphy in this region, we compare the layer sequences in HiRISE images in nearby troughs (Fig. 1), following the guidelines of [8, 11]. Sections of the local stratigraphy within each image that are correlateable are identified and mapped in ArcGIS ®. This both gives an indication of how far from the DTM site layers may be expected to occur, in both radar and visible data, and ensures the radar matching is focused on a section of the stratigraphy that is widely geographically present.

The DTM (Fig. 2a), created from HiRISE stereo pair ESP_018870_2625 (Fig. 2b) and ESP_0018910_2625, includes nearly the full height of the trough, spanning just over 500 m. The horizontal scale is 1 m/pxl, with a vertical accuracy of ~ 0.3 m. The images were acquired only ~3 days apart, at Ls ~129, to minimize frost coverage and changes between images. NPLD layers are continuous and only slightly curving along the face of the outcrop, allowing us to take and compare several elevation profiles down the layer sequence. The slope is greatest at the top, where the most prominent layers appear, and shallows at the bottom, where finer layers are visible as they intersect the surface. Along-strike variation in the slope of the trough face is largely limited to a section ~ 300 m down the image, leading to slight splaying of the layers and formation of a subtle, broad alcove. We attempt to measure the dip of layers from this section and from points more widely spaced across the image, although this DTM was not chosen for optimal measurement of this quantity.

As indicated in [11], topography can be a key criterion for identifying a layer in such an exposure. A major, future challenge in relating the individual layers and packets on the scale of one to a few meters thick identified here to radar layers is that the radar returns represent a signal integrated over a larger ~ 10-m thickness scale [12].

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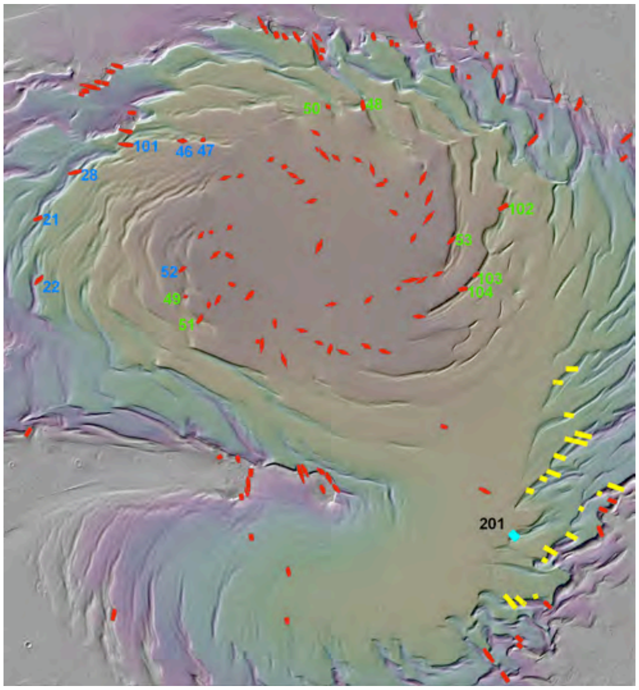

Fig. 1. Colored relief map of the north polar region. Red polygons are locations of overlapping HiRISE image pairs. The location of the current DTM presented here is highlighted in cyan. Blue labels are locations of the MOC-based Lower Correlated Sequence from [8] and green labels are locations of the Upper Correlated Sequence from [8] (numbers arbitrary). Yellow polygons are locations of all individual HiRISE images overlapping a trough on the interior of the NPLD between 10° E and 80° E, which are examined to determine consistencies and variability within the NPLD stratigraphy in the region of the DTM. SHARAD radar tracks for future comparison with HiRISE-derived stratigraphy will come from the area between the DTM and the black label ‘201’.

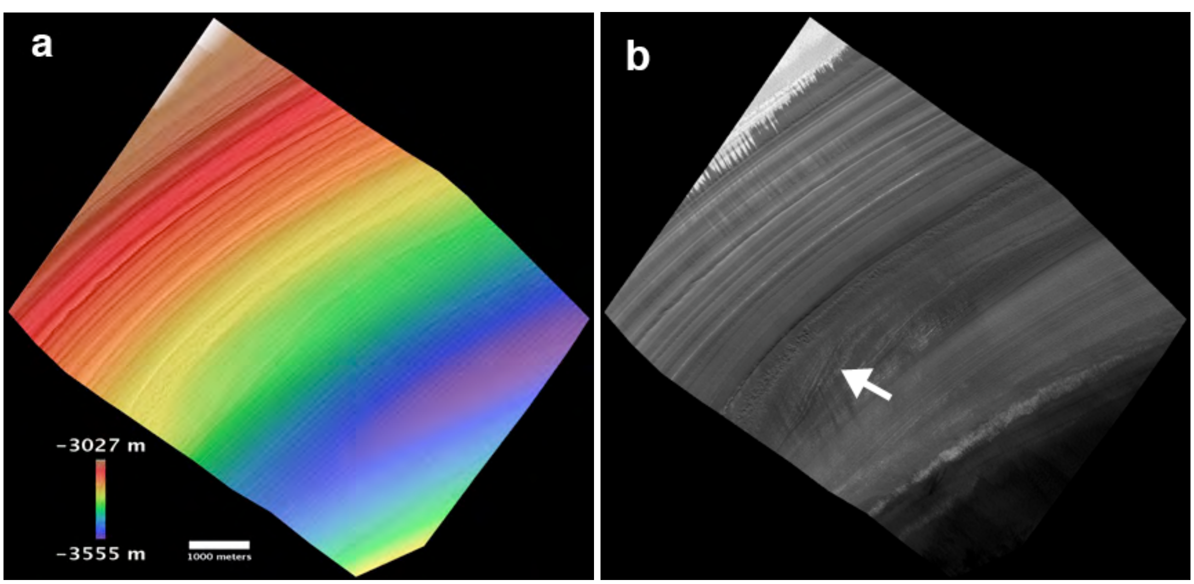

Fig. 2. a) HiRISE DTM of NPLD trough located between main north polar topographic dome and Gemini Lingula (~ 82.3°N, 34.1°E). b) HiRISE image ESP_018870_2625, one of the pair from which DTM was created, orthorectified. Arrow indicates variation in trough slope and effect on layer appearance.