GEOLOGY OF LAYERED SEQUENCES IN ARABIA TERRA, MARS. K.L. Tanaka[1], T. Poruznick[1,2], J.A. Skinner, Jr.[1], and T.M. Hare[1]. [1]Astrogeology Team, U.S. Geological Survey, Flagstaff, AZ 86001 (ktanaka@usgs.gov); [2]Geoscience Dept., Northland College, Ashland, WI 54806.

Introduction. Arabia Terra includes the majority of exposed Noachian cratered materials in the northern hemisphere, which are much less extensive than those of the southern hemisphere. A variety of interpretations have been proposed for the Arabia materials, which exhibit unique topographic, geophysical, surficial, stratigraphic, and compositional characteristics [e.g., 1, 2]. All or parts of Arabia Terra have been interpreted to be crater ejecta [1], volcanic materials [1, 3-5], ice and dust accumulations [3-4, 6], paleo-polar deposits [6], and paleo-ocean sediments [7]. New Mars Global Surveyor and Mars Odyssey topography and image data sets permit re-evaluation of how Arabia Terra deposits may be characterized and differentiated.

We therefore have begun an investigation with the following objectives: (1) Assess the origin of Arabia Terra materials through time and space, (2) determine what forms of geologic activity and climate controls governed their formation, and (3) ascertain how Arabia materials vary within Arabia itself and with other highland areas. Our preliminary results indicate that Arabia Terra is made up of Noachian, indurated layered deposits and younger, friable layered deposits of Late Noachian to Amazonian age. The change in induration state may be related to drying and/or cooling of the climate that affected induration processes and rates.

Regional topography. Mars Orbiter Laser Altimeter data show that Arabia Terra forms the lowest expanse of highlands, with elevations ranging from –4,000 to 0 m. Arabia Terra slopes regionally from a broad high northwest of Hellas basin down into the northern plains.

Surficial geology. Central Arabia Terra is a very dusty part of Mars (high albedo and low thermal inertia) [e.g., 8], and recent wind models suggest that it may be a long-term dust sink [9]. Moderate to low albedo areas that appear to be dust-free to partly dusty surround most of central and southern Arabia Terra. Periodic high obliquity could have resulted in the collection of water in Arabia [9], commensurate with the current high hydrogen abundance there [2].

Stratigraphy. Augmenting Viking images, high-resolution (1.4 to <10 m/pixel) Mars Orbiter Camera (MOC) images reveal sequences of layered material throughout cratered highland rocks on Mars [10]. Fig. 1 shows the distribution of such layers in Arabia Terra that we have identified thus far. In most cases, layering is expressed as terraces marking series of flat-lying steps and benches in scarps of eroded material; wind-swept surfaces also reveal albedo variations among layers. Because the distribution of MOC images is neither complete nor uniform, with only Meridiani Planum densely imaged, our study lacks complete observations.

We identify two fairly distinct sequences of layered materials. Older layered deposits (OLD) are dominantly Early to Middle Noachian as indicated by their pre-dating of degraded, pre-Hesperian craters. Younger layered deposits (YLD) are Late Noachian and younger as they embay and infill large, degraded, chiefly Early and Middle Noachian craters.

OLD are exposed in crater and channel walls and scarps and seem to make up the bulk of the Noachian cratered highland material. OLD lack apparent eolian erosion and thus may be moderately to well indurated. Some OLD may be ice rich, such as parts of northern Arabia Terra that make up fretted terrain [e.g., 11].

The YLD appear to have high albedo, where not covered by dust, and are moderately to heavily degraded and eroded (Fig. 2). They form fairly continuous deposits in southwestern and northeastern Arabia [3, 6] and other scattered occurrences. In Meridiani Planum in southwestern Arabia Terra, the YLD consist of relatively eroded layers of contrasting albedo and include hematite detected from orbit by the Thermal Emission Spectrometer (TES) [12] and are presently being explored on the ground by the Mars Exploration Rover Opportunity. The rover investigations indicate that the Meridiani YLD may have been deposited and subsequently altered in water [13]. Surrounding Meridiani Planum, YLD in southwestern Arabia are heavily degraded into yardangs and pedestal craters (Fig. 1) [6]. Throughout Arabia, YLD are degraded into knobs and flat-topped buttes indicative of mass wasting [e.g., 14]. Thus most of YLD appear to be poorly indurated.

Implications. The transition from indurated OLD to mostly non-indurated YLD may signal a permanent drying and/or cooling of the climate, thereby slowing down induration processes. The Meridiani YLP may represent local, youthful activity of water sufficient to promote hematite formation, which suggests volcanic and/or geothermal activity [e.g., 15-16]. We will continue to assess the new Mars data sets to test these ideas in detail and to elucidate further the geologic history of Arabia Terra.

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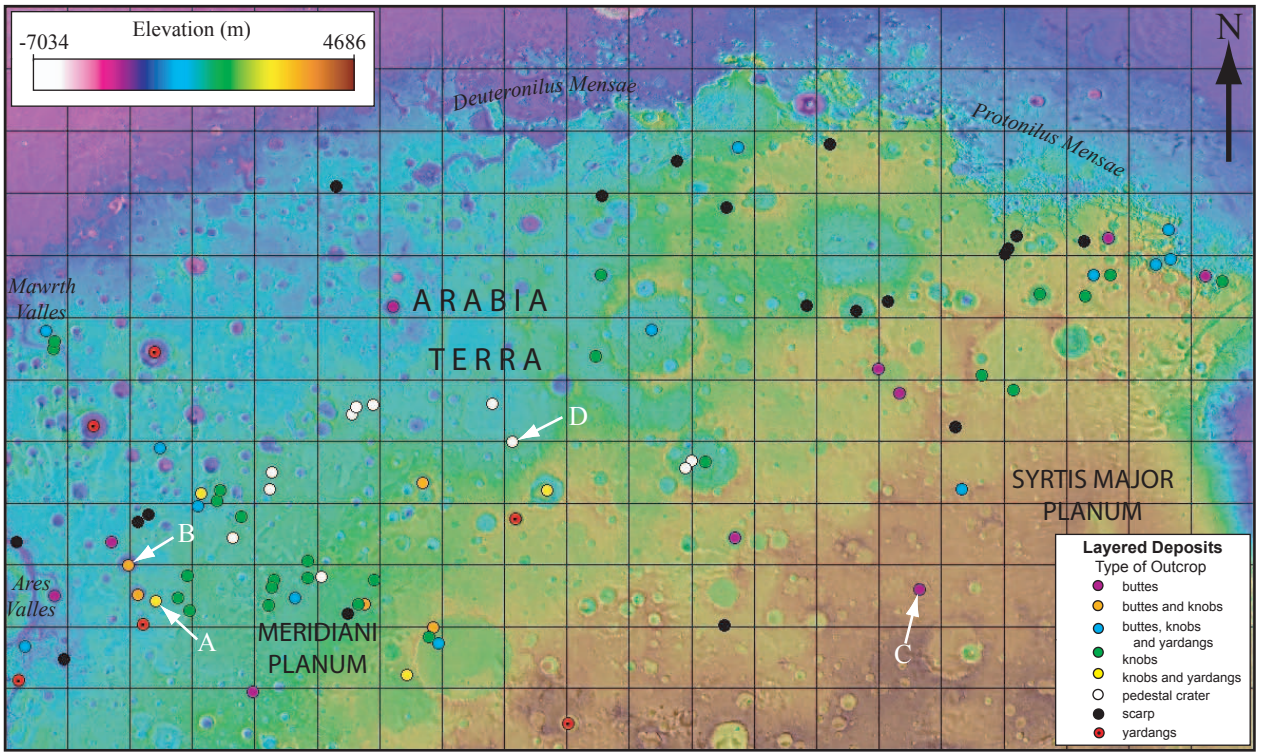

Figure 1. Topographic shaded relief map (resolution 500 m/pixel) of Arabia Terra region of Mars constructed from Mars Orbiter Laser Altimeter (MOLA) data showing occurrences and types of layered deposits. Letters show locations of images in Fig. 2.

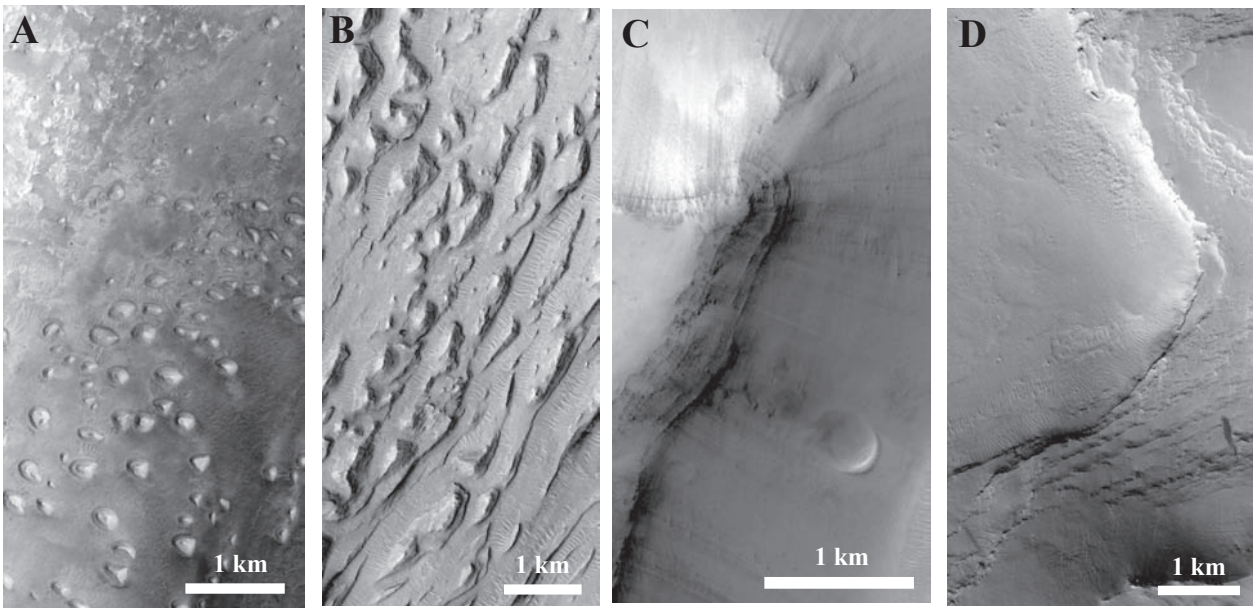

Figure 2. Parts of Mars Orbiter Camera (MOC) images showing examples of layered deposits in Arabia Terra. Illumination from upper left. North at top. (a) Layered knobs. (MOC image m0305599; centered at 2.23ºN, 352.17ºE; 5.88 m/pixel). (b) Layered yardangs. (MOC image e0502302; centered at 2.62ºN, 350.54ºE; 3.53 m/pixel). (c) Part of a layered butte in amongst others on a crater floor. (MOC image e0101215; centered at 3.32ºN, 53.27ºE; 4.89 m/pixel). (d) Section of a layered, pedestal crater scarp. (MOC image e1002130; centered at 15.15ºN, 19.78ºE; 3.65 m/pixel).