INTERNAL STRUCTURE OF THE DOMED DEPOSIT WITHIN KOROLEV CRATER, MARS FROM RADAR SOUNDING. M. W. Moore[1], J. W. Holt[1], and B. A. Campbell[2], [1]University of Texas Institute for Geophysics, Jackson School of Geosciences, University of Texas, Austin, TX 78758, [2]Center for Earth and Planetary Studies, Smithsonian Air and Space Museum, Washington, DC 20013 (m.william.moore@mail.utexas.edu; jack@utig.ig.utexas.edu)

Introduction: Korolev Crater (73 N 195.5 W) is an 84-km-wide crater located in the Mare Boreum quadrangle of Mars (Fig. 1). Thermal studies of Korolev undertaken in 2005 indicated that the crater contained, at minimum, several meters thick of ice or ice rich regolith [1]. Recent investigations using radar sounding have shown that the water ice contained in Korolev may approach 2-km thick. More importantly, these radar data from the Mars Reconnaissance Orbiter (MRO) exhibit multiple reflectors similar to those observed in the north polar layered deposits (NPLD) [2-3]. The reflectors found in the deposit in Korolev therefore likely result from a similar process, i.e., variations in dust content that also create visible layers images [4-6]. This would indicate the possibility of a climate-forced deposit in Korolev similar to that of the NPLD [7].

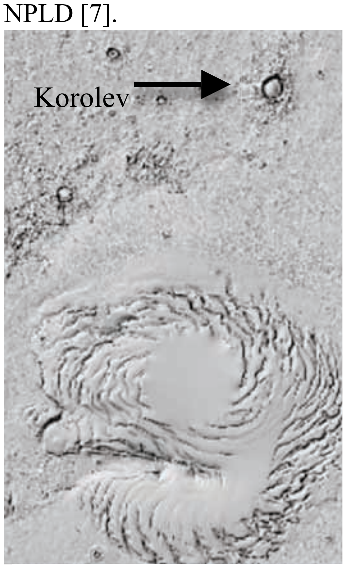

Figure 1. *Korolev relative to the NPLD. While the crater is ~600 km from the NPLD, it shows similar morphology.*

This layering within Korolev could provide useful information on the regional climate history and may therefore help in determining the history of the NPLD, an important part of the Mars global climate record. However, several key questions remain regarding how the two are related. It is unclear if the reflectors in Korolev formed during the same time period as those found in the NPLD, or if they formed in the same way. Understanding how the two relate to each other will provide a better understanding of the history of both Korolev and the NPLD.

Methods: This study probes the internal structure of Korolev using orbital tracks from the Shallow Radar (SHARAD) onboard the MRO [8]. This instrument distinguishes reflectors separated by ~0.1 μs in time, or ~9 m in ice. Data collected is checked against surface clutter using a simulation developed at the University of Texas Institute for Geophysics. Due to the complex

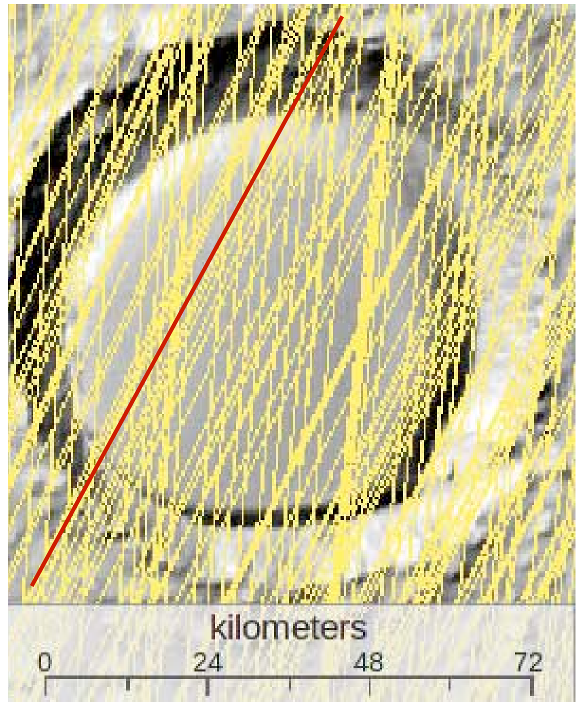

Figure 2. SHARAD *data coverage for Korolev. Each yellow line represents an observation track, with many covering the center of the crater. Red line indicates the track shown in Fig. 3.*

surface morphology of the crater edge and region, verifying that the reflectors are not surface clutter is an important procedure. Reflectors verified as arising from the subsurface are mapped using seismic interpretation software.

Coverage of the Korolev area includes approximately 60 tracks (Fig. 2), with many of the samples located near the center of the Crater. Tracks along the edge of the crater generally do not reveal much of the internal structure of Korolev. Recent observations have been more targeted on the center of the crater, providing a clearer picture of the subsurface.

This study also uses an enhanced processing technique relative to previous investigations. This provides an improved view of steeply sloping reflectors. In a relatively small area such as Korolev, detecting these sloping reflectors is pivotal towards understanding the history of the structure. However, this processor also introduces more clutter to the radargram and therefore must be carefully analyzed to ensure false reflectors are not being mapped (Fig. 3).

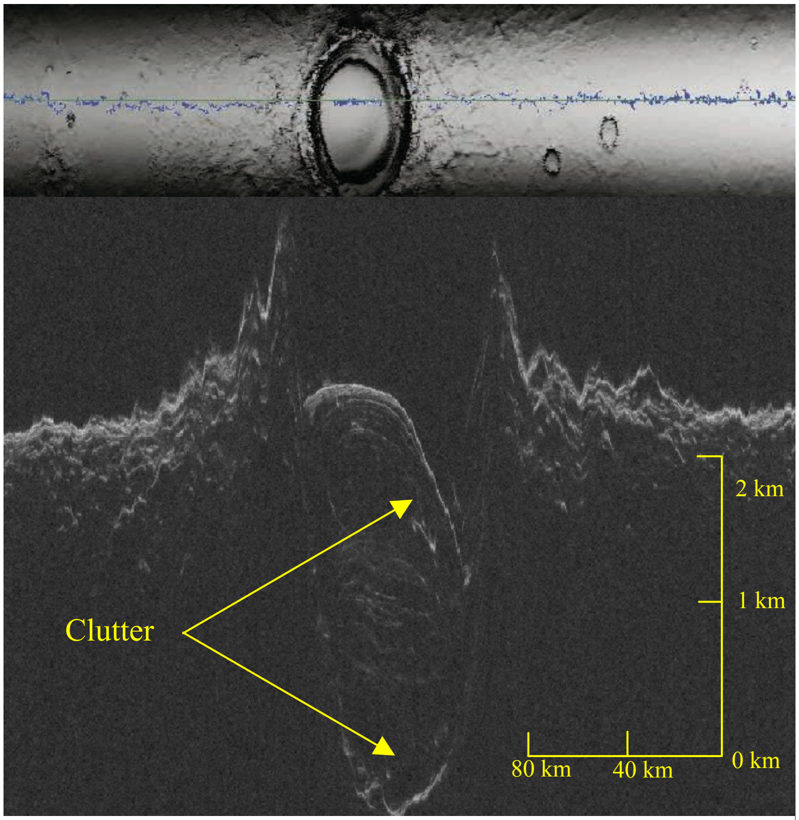

Figure 3. *(top) Location of ground track of SHARAD observation 554201. Blue dots show computed locations of first echoes from the surface. (bottom) Korolev radargram shown after depth correction analysis, assuming a water ice bulk composition. Asymmetry of dome continues into the subsurface as shown by upper reflectors, but is not as evident in lower reflector.*

Results: Korolev provides a unique location for the understanding of Martian ice. The crater contains one of the larger reservoirs of non-polar ice on Mars. More importantly, the radargrams of Korolev include approximately 20 reflectors. This is one of the largest collections of reflectors found outside the ice caps and indicates a low-loss material similar to the NPLD where bulk radar velocity was constrained to be equivalent to water ice [2]. Assuming a water-ice composition, the Korolev reflectors reach a maximum depth of ~ 1.8 km. This is approximately the same thickness as the NPLD [2]. There is also noticeable asymmetry of the layers in the subsurface region. This corresponds to the asymmetry of the crater surface.

There is a higher concentration of reflectors towards the top of the deposit, which may be due to natural processes or observational bias. However, there are still a large number of reflectors found at a greater depth in the crater. There does appear to be a distinction between the upper and lower reflectors. The upper reflectors are both closer together and more uniform in shape when compared to the reflectors found towards the bottom of the sequence. However, these reflectors certainly seem valid when compared to the cluttergram (they are not present in these images).

Discussion: Previous work done in the region has indicated that craters found in the northern area of Mars with domes have features formed through atmospheric deposition. This was done through the measurement of the asymmetry in both the north-south and east-west direction. Host craters act as a cold trap, leading to the formation of a dome-like structure [9].

This asymmetry found on the surface of Korolev is also apparent in the upper reflectors, to a depth of approximately 1 km. This may imply that the depositional features that led to the creation of a dome have been occurring during the time period of the crater deposit formation. The asymmetric morphology, which is greatly vertically exaggerated in Fig. 3, is present in the topmost 10 reflectors but not in the lower set.

Conclusions: Understanding the morphology and evolution of the NPLD has been mostly limited to direct observations and measurements from the local region. Korolev provides a possibly independent method of exploring the history of the NPLD. Further investigation will map the reflectors in three dimensions to create paleosurfaces and will attempt to correlate the reflectors found in Korolev to those found in the NPLD through climate modeling.

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