THE FLUVIAL HISTORY OF KASHIRA CRATER, MARS, AND IMPLICATIONS FOR THE GEOLOGIC HISTORY OF MARGARITIFER TERRA. K. A. Lutz[1,2], M. C. Bossett[2], and M. R. Salvatore[2], [1]Department of Astronomy, Yale University, New Haven, CT 06511, katherine.lutz@yale.edu, [2]Department of Astronomy and Planetary Science, Northern Arizona University.

Background: Kashira crater is a 60 km diameter impact crater centered at 27.0°S, 341.7°E in the Margaritifer Terra region of Mars, which shows ample evidence for widespread fluvial and lacustrine activity during the earliest stages of martian history [1-3] (Fig. 1). Previous work on Kashira crater has shown that this paleolake basin contains light-toned mound deposits that host kaolin-group minerals [2,4], specifically 10–30% halloysite [3]. These light-toned mounds are embayed by a volcanically resurfaced plains unit that is younger than the mounds and was emplaced ~3.6 Ga [5] after the end of valley network activity that fed the paleolake in Kashira [1,6].

The origin of Kashira's light-toned mounds is not well understood as few studies focus on these mounds and their history [2,3,5]. Here we aim to reconstruct the fluvial history of Kashira crater and the surrounding area within Margaritifer Terra to better understand the fluvial and lacustrine history of the crater and its relation to the halloysite-bearing mound.

Methods: All mapping was performed using the Java Mission-planning and Analysis for Remote Sensing (JMARS) software [7]. Units were distinguished and mapped using Thermal Emission Imaging System (THEMIS) daytime and nighttime IR mosaics and Mars Global Surveyor Mars Orbiter Laser Altimeter (MOLA) digital elevation model base map. The geologic units outlined in this work were based on differences in observed morphology, topography, stratigraphy (where visible), and thermophysical properties. MOLA data provided topographic information at a resolution of 128 pixels per degree (~460m/pixel), allowing us to identify overall trends and localized differences in elevation. Mars Odyssey THEMIS data (100m/pixel infrared (IR) daytime and nighttime images) were pivotal in characterizing regional morphology and thermophysical properties. Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) images (~5-6 m/px) were used to map both the inlet and outlet channels into Kashira crater.

In addition to the age dating performed in Goudge et al. [3], preliminary crater counting was performed on both the inlet and outlet channels using areal (e.g., [8]) and buffered crater counting methods [6]. The *CraterStats* software was used to determine best fit model ages [9]. These efforts are still ongoing to ensure accuracy and to further understand any apparent resurfacing history.

Results and Interpretation: We performed regional geologic mapping at a scale of 1:1,000,000 to investigate the regional hydrological contributions in and surrounding Kashira crater (Fig. 2). These mapping efforts help to visualize the distribution and geologic contributions of hydrological systems in Margaritifer Terra and, in particular, of the region immediately surrounding Kashira crater. Of the mapped geologic units, of particular note are the highlands units that likely represents the heavily dissected and fluvially eroded Noachian crust. These units are consistent with previously mapped Terra Units [10] that are similarly interpreted as ancient Noachian terrains. Other mapped units and features include crater floor deposits, fluvial networks, and tectonic graben.

Preliminary crater counting of the Kashira inlet and outlet channels reveal interesting temporal patterns that are possibly related to the hydrological activity in and around Kashira crater. The outlet channel (Fig. 3) was dated to approximately 3.6 ± 0.1 Ga, which is consistent with the age of the volcanically resurfaced floor as mapped by [3,5]. However, the inlet channel was mapped to approximately 2.5 ± 0.3 Ga, significantly younger than the other components of the Kashira crater system.

Interpretations and Conclusions: What can the hydrologic history of Kashira crater tell us about the history of water in Margaritifer Terra? What is the relationship between Kashira crater and other well-developed fluvial networks in Margaritifer Terra? Our work aims to address these questions and to develop a stronger understanding of the fluvial history in the ancient martian past.

The geologic mapping of Kashira crater and the surrounding terrain identified many widespread and

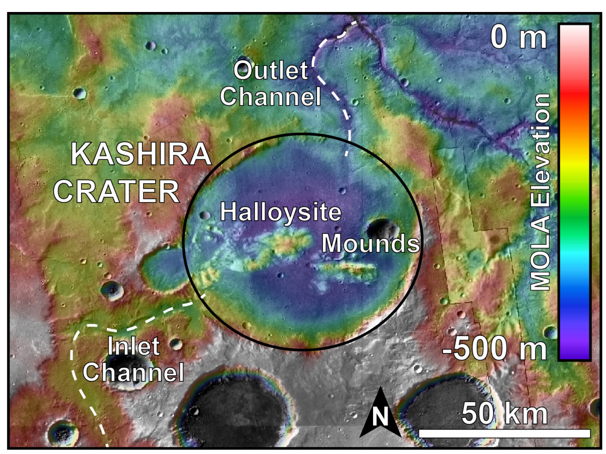

Fig. 1. Overview map of Kashira crater in Margaritifer Terra. Inlet and outlet channels are annotated.

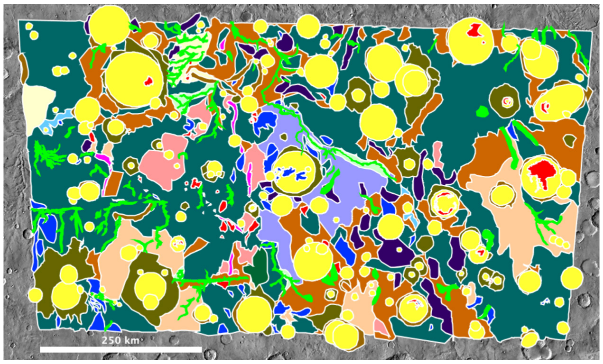

Fig. 2. Geologic map of the Kashira crater region of Margaritifer Terra, centered on Kashira crater. North is up. Sixteen unique units were identified.

highly integrated fluvial networks, suggesting that Margaritifer Terra was once a hydrologically dynamic location on the martian surface. Both open- and closed-basin lakes are widespread in this region of the southern highlands [2] and suggest that Kashira crater is not an anomaly in the regional geologic history. The halloysite-bearing deposits in the center of Kashira, however, are unique to this region, and suggest either a unique formation mechanism or a unique exposure of these otherwise buried materials. Additional searches are underway for halloysite-bearing crater floor deposits throughout Margaritifer Terra, but these searches are limited by the availability of spectroscopic data necessary for mineralogical confirmation.

Why might the inlet channel to Kashira be so much younger than the outlet channel and the volcanically resurfaced floor materials? If accurate, these ages may suggest that Kashira crater filled with water and breached its northeastern rim around 3.6 Ga, followed by the relatively rapid volcanic resurfacing. Perhaps these events were geologically related - could volcanic activity have liberated groundwater or caused the widespread melting of (sub)surface ice that overfilled the crater? The inlet channel may have remained active for a longer duration, as it is integrated into other fluvial networks in the region that may have been hydrologically active independent of Kashira crater. Perhaps the activity within the inlet channel never substantially filled Kashira or modified its surface following volcanic resurfacing.

Alternatively, perhaps the younger age derived for the inlet channel is a manifestation of subsequent resurfacing by non-fluvial processes. For example, aeolian modification may have infilled the inlet channel to a greater degree than the outlet channel or the crater itself. There are also several large young craters near the inlet channel whose ejecta may have modified the surface enough to alter the derived crater retention age. Additional work is ongoing to confirm this derived crater retention age and to compare it to other major geologic events preserved in the surrounding area.

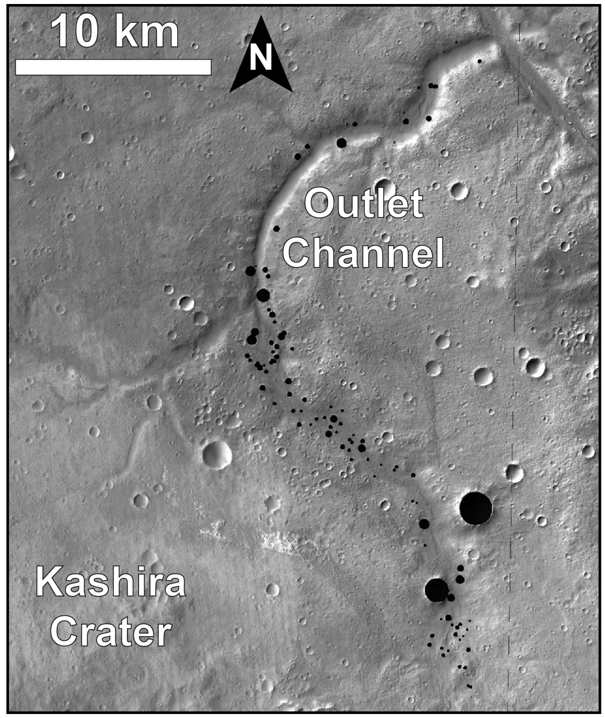

Fig. 3. The Kashira crater outlet channel with the craters counted (black circles) to calculate the absolute age of this feature. We utilized the buffered crater counting technique developed by [6].

To conclude, revisiting the hydrologic history of Kashira crater serves as an important look into the dynamic nature of Margaritifer Terra during its peak in geologic activity. The uniquely preserved mounds on the floor of Kashira crater in addition to the crater's location amongst other well-developed fluvial and lacustrine systems make this region a compelling location for additional analyses. This work is critical towards advancing our understanding of martian hydrological systems and their implications for prolonged water-rock interactions that may be capable of sustaining astrobiological ecosystems.

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