QUALIFYING MARTIAN MAARS USING CTX IMAGERY. K. S. Sewell[1], C. G. Hughes[1], and A. H. Graettinger[2] , [1]EKU Department of Geosciences, Richmond KY Christopher.Hughes@eku.edu, [2]UMKC, Kansas City MO, USA

Introduction: The purpose of this project is to attempt to identify and characterize maars on Mars. We digitized all depressions greater than one kilometer in diameter around Ravi Vallis within a 1° x 1° area (318°E - 319°E, 1°N -2°N) to gather data about Martian morphology. This data will help recognize candidate maars on Mars and differentiate them from impact craters, collapsed pingos, and other similar features. Accurate description and count of maars will provide information on the geologic history of Mars, including the subsurface presence of water at the time of the eruption. This area was chosen because previously observed lava flows, thermokarst, and collapse features [1] make it a possible location for Martian maars.

Background: Maar volcanoes are produced by rising magma coming into contact with groundwater / ground ice which causes a series of subsurface explosions. The maar is the crater formed by the explosions, and sits on top of an underground cone of debris known as a diatreme. A maar on Earth is recognizable as a depression with a shallow angled tephra ring. The tephra ring is the ejecta produced by the explosions that makes it out of the crater (Figure 1). The depressions are typically non-circular and usually found with other maars, other volcanic features, and occur at a range of elevations and latitudes on Earth [2].

Methods: High resolution Mars imagery was accessed via JMARS [3]. For the purpose of this study CTX imagery [4] was used because of its near global coverage and 6 m per pixel resolution. The depressions were traced on a custom shape layer at 8192 pixels per degree (Figure 2). The digitized features were then input into a spreadsheet and described in terms of their cross cutting relationships, dunes, central latitude, central longitude, major and minor axes, symmetry, area, and perimeter. JMARS calculates the area and perimeter of polygons, as well as their center latitude and longitude. Information on the dimensions (major and minor axes) and the polygon name (recorded as Poly###) were entered manually into the metadata. Because CTX images are collected on different dates with different view angles, the scene number used for digitization was recorded too.

Criteria: Candidate maars include non-circular closed depressions with rims (Figure 3). Depressions that fit these criteria, based on observations of Earth maars, will be analyzed in regards to two-dimensional shape parameters, including aspect ratio, elongation, and isoperimetric circularity [2]. For this study, the aspect ratio is defined by the equation AR=(Dminor)/(Dmajor), where Dminor represents the depression's minor axis and Dmajor represents the depression's major axis. A perfectly circular depression has an AR of 1. The closer the AR is to zero, the greater the difference between the minor and major axis. Elongation is defined by the equation $EL=(\pi(Dmajor/2)^2)/A$, where A is the area of the depression as calculated by JMARS. A perfectly circular depression has an EL of 1 and less circular depressions will have a greater EL. Isoperimetric circularity is defined by the equation $IC=(4\pi A)/P^2$, where P is the perimeter of the depression as calculated by JMARS. IC measures the variation in curvature; a circle has an IC of 1 and more complex shapes have an IC less than 1 (Figure 3). Earth maars have non-circular elongate shapes with large variations in curvature (Average AR: 0.8, EL:0.9 , IC:1.31).

Preliminary Conclusion: Our results indicate that Ravi Vallis contains depressions that should be investigated as candidate maars. If these are maars, that would support previous work that argued that there is or was subsurface water in Ravi Vallis. This would make Ravi Vallis a good place for further investigation into the paleoclimate and paleohydrology of Mars.

Maars are optimal features for conducting further research into Martian geologic history and mantle petrology [5]. Cross-cutting relationships with impact craters and other surface features provide relative ages for the magma / water interactions that produced the maars. Maar-diatremes represent sites where stratigraphy has been inverted [6] and older crustal rocks as well as possible mantle xenoliths are brought to the surface [7].The number and distribution of maars would indicates the availability of subsurface volatiles, which provides valuable information on Martian paleoclimate.

Future Work: The next step to test our interpretation of candidate Martian maars is to investigate the relationships with other volcanic features such as lava flows and scoria cones. The spatial relationships of the candidate maars and regional structural features will also be considered. The study area will also be expanded to include other locations with evidence for groundwater / ice and volcanic activity. All of these fields will then be compared with each other and with Earth maars.

References:

[1] Berman D.C. and Rodriguez A.P. (2016) *Proceedings Lunar and Planetary Science Conference*, 2674. [2] Graettinger A.H. (2016) *Lunar and Planetary Science Conference*, 47. [3] Christensen P.R. et al. (2016) *JMARS-A Planetary GIS*. [4] Malin M.C. et al. (2007) *Journal of Geophysical Research*, 112. [5] White J.D. and Ross P.S. (2011) *Journal of Volcanology and Geothermal Research*, 1-29. [6] Lorenz V. (1986) *Bulletin of Volcanology*, 48, 265-274. [7] McGretchin T. and Ullrich G.W. (1973) *Journal of Geophysical Research*, 78, 1833-1853. [8] Valentine G.A. et al (2011) *Bulletin of Volcanology*, 73, 753-765.

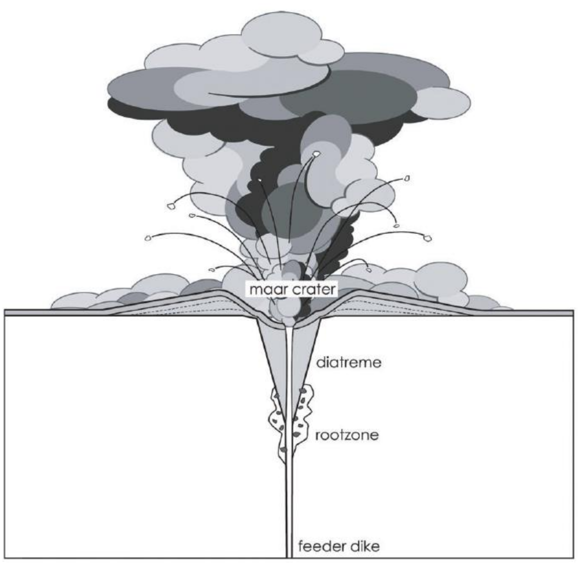

Figure 1. Idealized diagram depicting the formation and structure of a maar volcano in cross section [8].

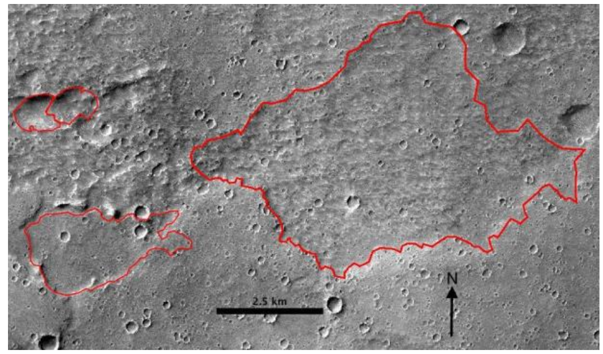

Figure 2. Digitization of low relief depressions CTX: D22_035884_1783, Location: -1.38°E, 318.14°N

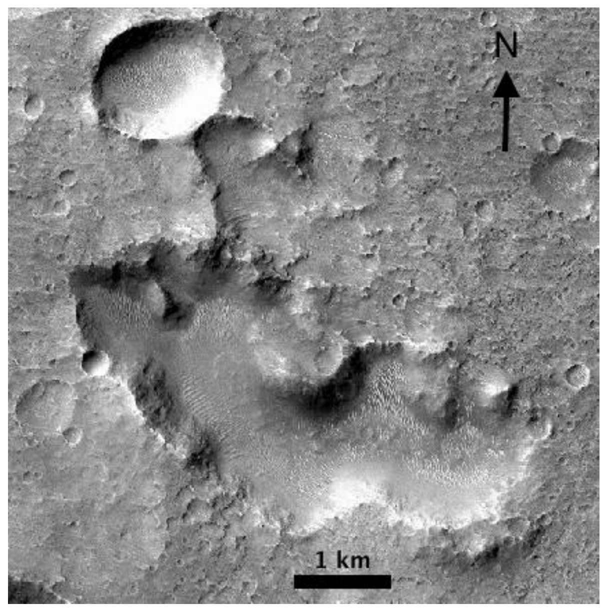

Figure 3. An example depression to be investigated as a possible candidate maar, displaying a non-circular shape and complete rim. CTX: D22_035884_1783, Location: -1.90°E, 318.80°N