

DISTRIBUTION OF SMALL (<25 KM) VOLCANOES IN MARTIAN NORTHERN PLAINS. J. E. Green, T. K. P. Gregg and S. E. H. Sakimoto, University of Buffalo, 126 Cooke Hall, Buffalo, NY 14260 (jgreen24@buffalo.edu).

Introduction: Small (<25 km basal diameter) volcanoes in the northern plains of Mars are found within Amazonian-aged units [1,2]. These observations have implications for the thermal and volatile evolution of the Martian northern hemisphere.

The small volcanoes in the northern plains are circular in plan view, and reach heights of up to a kilometer based on Mars Orbiter Laser Altimeter (MOLA) data [3]. Two distinct morphologies are reported [1, 2, 4]: one resembles low shields with flank slopes between 0.5° and 5°, and another resembles cinder cones with flank slopes between 1° and 7°. The volcanoes are located between 60°N and 80°N latitude, and the majority are observed between 30°W and 120°W [2] (Figure 1).

Previous studies analyzed the morphology of the volcanoes [1,2], but did not study them in a broader geologic context because sufficient image data were not yet available. Whereas previous studies relied solely on Mars Orbiter Laser Altimeter (MOLA) data, we use a combination of MOLA and Mars Reconnaissance Orbiter (MRO) context camera (CTX) [5] data to identify and interpret targets, allowing for a more comprehensive view of northern plains volcanism. This project seeks to build upon this previous research by establishing a classification system that will aid identification and characterization of these volcanic edifices, and by analyzing their spatial distribution in the northern plains.

Methods: Target features are identified using JMARS, a Java-based GIS [6]. The Thermal Emission Imaging System (THEMIS) daytime and nighttime infrared basemaps, which have resolutions of ~100 meters/pixel [7], are used to identify targets for further study. The basal diameter, height, and flank slope of the target is measured using MOLA data to ensure that it satisfies the morphometric criteria (Table 1). Flank slope is measured by taking 4 orthogonal transects of the feature, simplifying each transect as a truncated cone, and averaging the basal interior angle measurements of all 4 transects together.

Table 1. Morphometric criteria used to identify targets for closer study [taken from 1, 2, 4].

Morphology	Height (km)	Basal Diameter (km)	Flank Slope (deg)
Low shields	$0.025 < x < 1$	$2 < x < 25$	$0.5 < x < 5$
Cinder cones	$0.025 < x < 1$	$2 < x < 25$	$1 < x < 7$

Once the feature of interest has been shown to meet the morphometric criteria, it is evaluated against a set of morphologic criteria designed to determine whether or not the target can be described as volcanic (Figure 2). These criteria are classified as “strong”, “intermediate”, or “weak” (Table 2). Feature morphology is studied using two cameras on MRO: CTX, with a resolution of ~6 m/pixel, and the High Resolution Imaging Science Experiment (HiRISE), with a resolution of 0.25 m/pixel [4, 8].

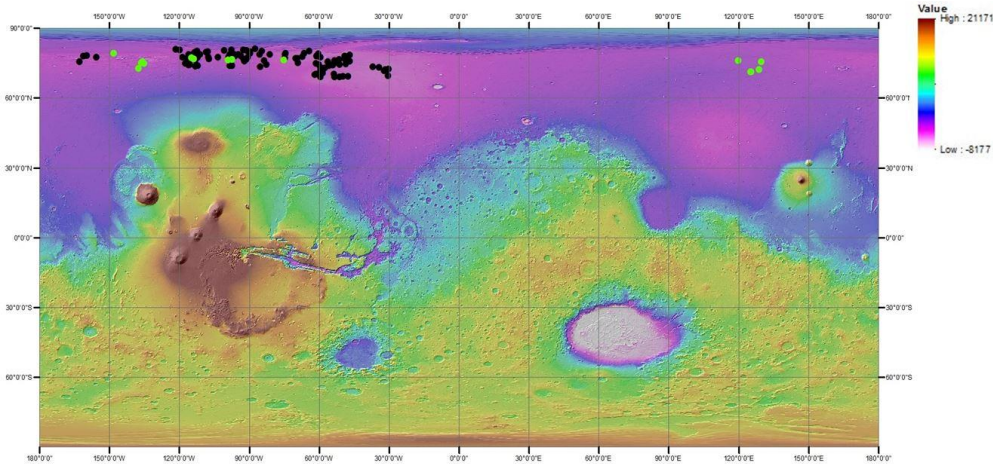


Figure 1. Topographic map of Mars [3], with interpreted features marked with black and green dots. Black dots indicate features previously identified [2], and green dots indicate features identified to date in this study.

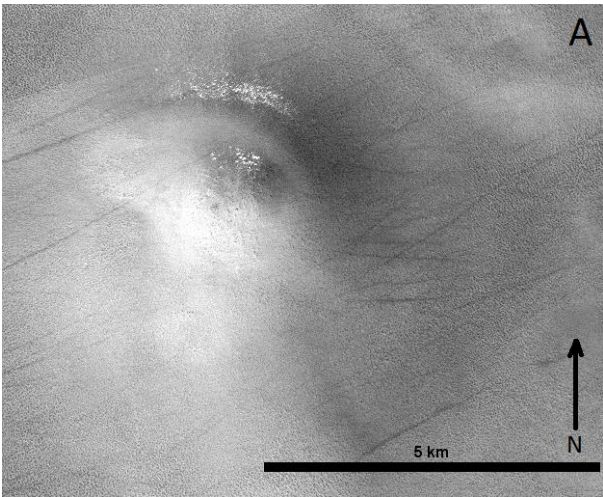


Figure 2. Feature displaying many strong morphologic criteria (see Fig. 3), interpreted to be volcanic. Feature located at 74.98°N, 224.87°E, image G01_018481_2540_XN_74N134W.

Interpreting targets based on a set of weighted criteria results in an objective classification, and allows the separation of constructs into categories based on interpretation confidence.

Features determined to be volcanic are entered into a database cataloguing their morphometrics, the morphologic criteria, and the MOLA transects used to determine slope angle. Relevant image IDs are also included (Figure 3).

Future Work: The establishment of a simple, accessible database to catalogue these volcanic features is one of the major goals of this work, and can be used in the future for continued study of the thermal evolution of Mars in the northern plains.

Feature ID	22	Image IDs
Fagan et al. ID	--	B01_009844_2576_XN_77N137W
		G01_018481_2540_XN_74N134W
Latitude	Longitude	
74.98	224.87	
Height (km)	Basal diameter (km)	
0.166	9.91	
Flank slope (deg)		
12.06		
Morphologic Justification		
Asymmetrical summit crater		
Summit crater offset from center of feature		
Flank slope does not steepen to greater than angle of repose		
Summit crater diameter small relative to basal diameter		
Lack of continuous ejecta ring		
Circularity difference between summit crater and feature base		
Presence of circular summit crater		

Figure 3. Example of an entry in the interpreted feature database, shown for the feature in Figure 2.

Spatial statistics will be used to determine whether the arrangement of these volcanoes is random or ordered, and can help interpret characteristics of the magma source. A random distribution indicates several discrete source vents, whereas clustered features imply a larger source feeding many different volcanoes.

Similar features have been observed in the southern hemisphere of the planet [1, 2], though they are not as numerous as in the northern hemisphere. They also warrant further study in their spatial and temporal distribution.

References: [1] Garvin J. B. et al. (2000) *Icarus*, 145, 648-652. [2] Fagan A. L. et al. (2010) *JGR*, 115, 1-19. [3] Zuber M. T. et al. (1992) *JGR*, 97, 7781-7797. [4] Wilson L. and Head J. W. (1994) *Rev. Geophys* 221-263. [5] Malin M. C. et al. (2007) *JGR*, 112, 1-25. [6] Christensen P. R. et al. (2009) <http://adsabs.harvard.edu/abs/2009AGUFMIN22A..06C>. [7] Christensen P. R. et al. (2004) *SSR*, 110, 85-130. [8] McEwen A. S. et al. (2007) *JGR*, 112, 1-40.

Table 2. Table of morphologic criteria used to interpret target features.

Strong evidence	Good evidence	Weak evidence
Lobate margins containing darker, rougher material	Summit craters do not fall on depth-diameter distribution for impact craters	Lack of continuous ejecta ring
Asymmetrical summit crater	Presence of pit craters on flanks	Presence of circular summit crater
Meter-scale sinuous troughs running radial to feature on flanks	Summit crater offset from center of feature	Bright deposits on flanks
Nested summit crater	Meter-scale sinuous troughs running roughly radial to feature within one radius from flanks	Circularity difference between summit crater and feature base
	Flank slope does not steepen to greater than angle of repose	