IDENTIFICATION OF NESTED CRATERS ON MARS. N. R. Valentour[1] and N. G. Barlow[2], [1]Department of Physics, University of Nebraska, Omaha, NE 68182-0266, [2]Department of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6100; nvalentour@mail.unomaha.edu; Nadine.Barlow@nau.edu.

Introduction: A nested crater forms when a target impact contains a weak layer overlying a stronger rock layer. The crater morphology displays a central bowl-shaped depression surrounded by an elevated platform, both of which lie below the surrounding terrain. Observations of marine target impacts on Earth show that they often display a nested crater appearance because of the weaker seafloor sediments deposited over underlying bedrock [1]. Large bodies of water have been postulated to have occurred on Mars in the past and several researchers have proposed that nested craters might occur on the martian surface. A few possible nested craters have been identified [2]. This study extends those earlier reviews to examine the morphology and topography of additional candidates.

Method: THEMIS visible (VIS) and day-time near infrared (IR) images were used to survey the northern lowlands of Mars for possible nested craters. VIS images, which have a resolution of 18 meters per pixel, were utilized for a detailed investigation when available. The day-time IR images, with resolutions of 100 meters per pixel and providing nearly complete coverage of the northern lowlands, were investigated when VIS images were unavailable. Narrow-angle Mars Orbiter Camera (MOC) images were examined in this study, but MOC images containing potential nested craters were not found.

Java Mission-planning and Analysis for Remote Sensing (JMARS) is a java-based geographic information system developed by Arizona State University for analysis of martian spacecraft data [3]. JMARS allowed us to obtain topographic profiles of craters greater than 5 km in diameter. JMARS also has the ability to scan at lower resolutions using Viking Mars mosaicked digital image model 2.0 (MDIM) and Mars Orbiter Laser Altimeter (MOLA) digital image models, both containing similar resolutions of about 230 meters per pixel with a wide range depending on location.

When a potential nested crater was found, its THEMIS VIS or IR image number, location, diameter, inner basin diameter, center of crater elevation, rim elevation, and surrounding terrain elevation were recorded. A topography analysis was not available for the smaller craters because of JMARS limitations.

Preliminary Results: The search was restricted to the northern plains and nearby areas proposed to have possibly been submerged with large bodies of water [4, 5]. After an extensive survey of northern surface craters one additional potential nested crater was found that is in accordance with both morphology and topography of a nested crater (Figure 1). The crater contains no elevated rims. In addition, the crater may exhibit an overturned inner basin rim, thought to be a characteristic of impact into a substantial water column [2]. Post-impact modification appears to have destroyed parts of the eastern crater rim. Unfortunately no THEMIS IR, THEMIS VIS, or MOC images were found covering the eastern rim of this crater. A JMARS screenshot using Viking MDIM 2.0 is shown in Figure 2 of the surrounding region. With such amount of material removed in the region, alternative origins of the unusual crater morphology other than a marine-target impact are plausible.

Similar crater morphologies: A few additional craters were encountered which displayed similar morphologies to a nested crater, but lacked a nested crater topographic profile. Processes such as volumetric compaction and mass wasting can explain the nested crater appearance for these similar craters [5]. A sharp concentric V-shaped valley just inside the outer crater rim is seen in Figure 3. This nested crater appearance can be explained by slumping of crater rim walls, perhaps by groundwater sapping out of the crater rim.

Discussion: Ormo et al. [2] estimate that the total number of preserved nested craters on Mars ranges from 1 – 1400. A complete survey of nested craters could suggest duration, depth, and spatial extent of ancient large bodies of water in the northern plains [1, 2]. The most difficult obstacle in this search is the large amount of sediment deposited over the northern lowlands. For now, a surface distribution of potential nested craters may just reveal northern lowland regions of low sediment deposition rates. The shallow subsurface sounding radar (SHARAD) onboard the recently arrived Mars Reconnaissance Orbiter (MRO) will help expand the search for subsurface nested craters.

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References: [1] Ormo J. et al. (2002) *JGR, 107,* doi: 10.1029/2002JE001865. [2] Ormo J. et al. (2004)

Meteoritics & Planet. Sci., 39, 333–346. [3] Gorelick, N. S. et al. (2003) LPS XXXIV, Abstract #2057l [4] Head. J. et al. (1998) *GRL, 25,* 4401–4404. [5] Parker T. et al. (1993) *JGR, 98,* 11061-11078. [6] Buczkowski D. L. and Cooke M. L. (2004) *JGR, 109,* doi: 10.1029/2003JE002144.

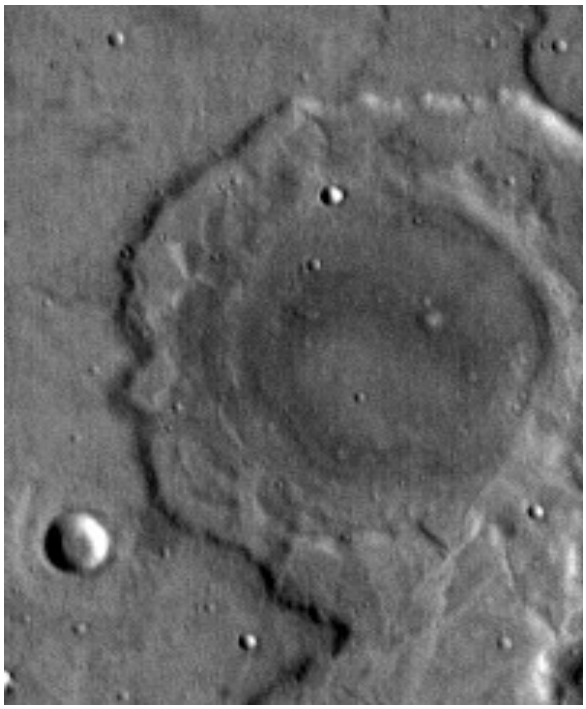

Figure 1. The crater (42° lat., 303° lon.) fits nested crater topography and the inner basin appears to contain an overturned rim. The inner crater diameter is 13 km, outer crater diameter is 22 km. THEMIS IR Image I03310002.

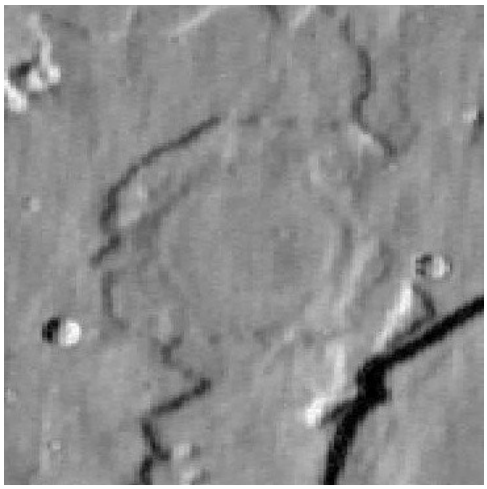

Figure 2. JMARS screenshot of same crater as Figure 1 and surrounding terrain. Eastern rim is discontinuous.

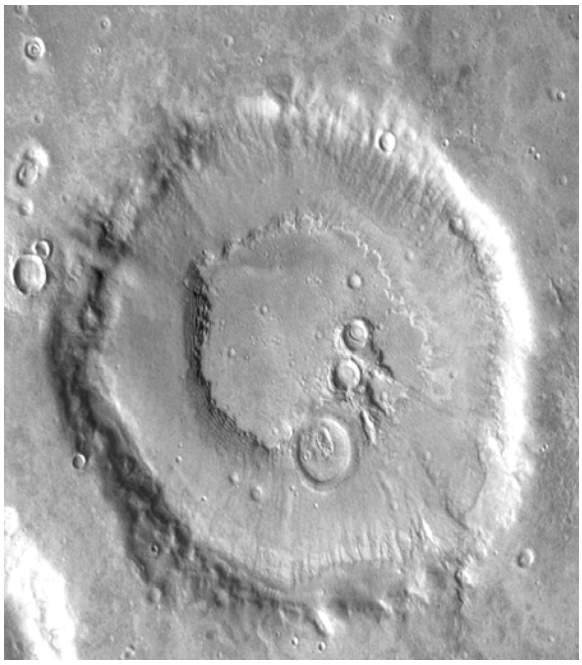

Figure 3. THEMIS VIS image V09574015 (4.74° lat., 9.36° lon.). An example of a crater that has undergone mass wasting, possibly by saturation of crater walls through groundwater sapping. Note the V-shaped slump valleys concentric with the crater rim and the linear streaks originated from the crater wall. Crater is approximately 17 km in diameter.