ASSESSING THE DISTRIBUTION AND ORIGIN OF WATER-RELATED FEATURES IN THE NORTHERN LOWLANDS OF MARS; A GEOGRAPHIC INFORMATION SYSTEM APPROACH. E. M. McGowan and G. E. McGill, Department of Geosciences, University of Massachusetts, Amherst, MA 01003. emcgowan@geo.umass.edu and gmcgill@geo.umass.edu.

Introduction: The origin and history of the northern lowlands of Mars are controversial. Models for the origin are based mainly on theoretical concepts, whereas history is based on physical evidence derived from materials and landforms. Most researchers believe that water in some form modified the northern lowlands and this issue continues to be an active area of research [1-13]. A tremendous amount of data, increasing at a rapid rate, currently exist for the northern lowlands. These data have been collected in different coordinate systems and formats making them difficult to use when location and spatial relationships are important to a study. To address this problem we have constructed a Geographic Information System (GIS) containing map layers of the putative water-related features and other data that may pertain to water in the northern lowlands. GIS is being used to define the spatial distribution of features and to find correlations among different features to help understand the past distribution of water in the northern lowlands.

Methodology: The purpose of constructing a GIS of the northern lowlands is to bring many different data sets (table 1) together in one reference system, and then to use GIS techniques to look for relationships based on location. Using Mars Orbiter Laser Altimeter (MOLA) data a high-resolution topographic map (231 m/px) was created of the northern lowlands. This topographic map is used as a basemap to georeference data sets of putative water-related features and other pertinent data such as material units [14, 15].

Examples of data sources. Many different data sources are used to create layers in the GIS. Thermal Emission Imaging System (THEMIS IR) 100 m/px daytime thermal infrared images, the highest resolution images with global coverage available, are being used to map the locations of features throughout the northern lowlands. Barlow [16] has catalogued all craters greater then 5 km in diameter on Mars; those in the northern lowlands were extracted from this data set for use in the GIS. The map of the northern lowlands by Tanaka, et al. [15] is used for a material units layer. High-resolution data sets for areas of particular interest are included in the GIS if available. For example, in Cydonia Mensae, an area containing a large number of putative water-related features, ~42 m/px resolution Viking imagery is available. In addition the map of Cydonia Mensae Southern Acidalia [14] includes material units and features that may be water related.

Examples of data input. Several techniques are used to add the data to the GIS depending on the format of the source data. Barlow's [16] crater catalogue is an EXCEL spread sheet so this format can be loaded directly into the GIS as X,Y data. For image data sets 2 steps are involved: first a rubber sheeting technique is used to georeference the image to the topographic basemap, and then the features of interest are digitized onto individual layers in the GIS.

Results: To date two studies have been completed using the GIS: the distribution of rampart craters with respect to material units in the Utopia Planitia region [19] and the distribution of polygonal terrain and pitted cones in Cydonia Mensae and Southern Acidalia Planitia [20]. Using the GIS to calculate the density distribution of rampart craters in Utopia Planitia, we found that the highest density of rampart craters correlates with Amazonian terrain. In the Cydonia Mensae Southern Acidalia Planitia region there is an anti-correlation between high densities of pitted cones and high densities of giant polygons, with the two populations separated by a section of the putative Deuteronilus shoreline [17].

Although the morphology of the pitted cones in Cydonia Mensae appears variable, and the cones occur in different geological settings, our current work [21] suggests that the pitted cones belong to a single population based on pit diameter/cone diameter (p/c) ratio and daytime surface temperatures (used as a proxy for material properties). Qualitatively, the pitted cone morphologies appear to define two groups: 1) well formed individual cone-like features surrounded by plains material, and 2) more irregular, pitted cone groups surrounded by what appears to be flow material that is spatially associated with the cone groups. The putative flow material also contains many pit-like features that were not measured owing to the lack of an edifice. A Difference of Means statistical test [22] was used to compare pit/cone (p/c) ratios, and the surface temperatures of the two populations of pitted cones, putative flow material, and plains material. P/c ratios of both types of cones were measured using Mars Orbiter Camera (MOC) images with resolution of 2-6m/pix. Comparing the means of these two populations, we found, with 95% confidence, that there is no significant difference between the p/c ratio of the well-formed isolated cones and the p/c ratio of the cone groups surrounded by putative flow material. Surface temperatures of the individual, well-formed pitted

pitted cones, the plains material, the irregular cones in groups, and the putative flow material were sampled from THEMIS IR images. Individual pitted cones are too small to be resolved at THEMIS IR resolution (100m/pix), so georeferenced MOC (2-6 m/px) images and THEMIS Visible (VIS) images (19 m/px) were used to identify locations for sampling. We found, with 95% confidence, that there is no significant difference between the surface temperatures of the cones or the putative flow material, but both are clearly different from the temperature of the surrounding plains material.

These results suggest that the two pitted cone populations have similar origins and that the putative flow material is the same as the cone edifice material. The pit-like features that exist throughout the putative flow material may simply be a different type of feature created by the same process that created the pitted cones. The pits must be the same age or younger then the putative flow material.

Future Work: Populating the GIS database with the 5 remaining data layers from Table 1 is our first priority. Ultimately this will allow us to look at the distribution of all putative water-related features across the northern lowlands assessing "the big picture". As higher resolution data becomes available, for particular areas of interest, they will be added to the database allowing research like that done in Cydonia Mensae to be continued in other areas.

GIS Data layers for the northern lowlands:		
Layer Name	Currently in use	Future use
High resolution gridded topographic map	X	
Pitted cones [14]	X	
Giant polygons	X	
Material units [14, 15]	X	
Rampart craters [16]	X	
Thumbprint terrain		x
Labyrinths		x
Channels		x
Putative shorelines [17]		x
Subsurface water content [18]		x
Small polygons		x

Table 1- Data sets of putative water related features and attributes that are or will be included in the GIS database for the northern lowlands of Mars.

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