EROSION AND BASIN MODIFICATION OF SMALLER COMPLEX CRATERS IN THE ISIDIS REGION, MARS. J.A. McLaughlin[1] and A.K. Davatzes[2], [1]Temple University, jess.mclaughlin@temple.edu, [2]Temple University, alix@temple.edu.

Introduction: Crater erosion and morphology are indicators of the climatic and erosional history of the area in which the crater is found [1][2]. Here we present a detailed analysis of crater erosion and morphology in the Isidis Planitia Basin region. The goal of this work is to produce a thorough database of crater properties and document the modification processes that dominate locally and regionally. Crater degradation, age, and geomorphology are all considered and cross-correlated to narrow down the timing and dominance of persistent fluvial, lacustrine, and volcanic processes on Mars. These geologic processes modify the crater rims and floor, often in distinguishable ways that provide insight into past environmental conditions. These environments may hold clues to past habitable environments that are of particular interest for future missions searching for life on Mars [2][3].

Methods: A region of interest (ROI) of 3,000 km x 1,747.5 km was defined surrounding Isidis Planitia to include the Nili Fossae, Amenthes Fossae, and geologic units on both sides of the dichotomy (Fig. 1). Craters with diameters ranging from 20 to 50 km were cataloged. Crater diameter, depth, % rim material remaining, age, and geomorphological structures present within each crater were documented using all available datasets for each crater through JMARS. We compared this independent crater count with the Robbins and Hynek Martian Crater Database [4] in order to obtain the most accurate and complete sample database of craters within the ROI.

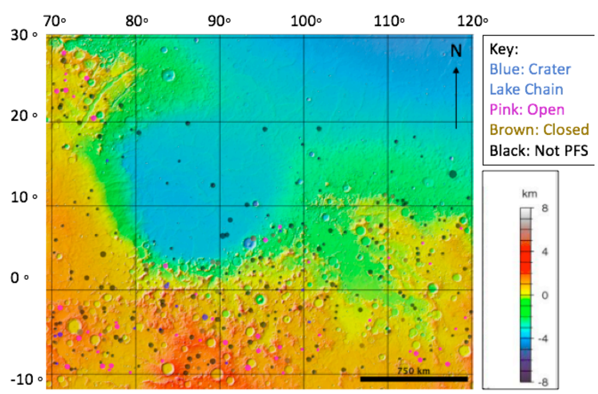

Figure 1: *Study area with all craters of 20-50km identified. Here, craters are classified according to type of paleo fluvio-lacustrine system (PFS) [3]. Map created in JMARS with THEMIS DayIR image base layer, MOLA overlay, and Crater Counting shape layer.*

Level of Degradation (LOD) was defined for each crater using depth to diameter ratios (d/D) and percentage of crater rim remaining. This categorizes craters into four types; 1 is the least degraded and 4 is the most degraded. Criteria are based on the following:

TYPE	RIM	DEPTH-TO-DIAMETER	FLOOR FEATURES
1	Pristine; sharp >75% present	High > 0.05	No infill; pristine features
2	Rounded; modified 75-50% present	Moderate ~0.05 to 0.035	Infilled; features still visible
3	Heavily modified 49-5% present	Low ~ 0.035 to 0.005	Infilled; featureless
4	Ghost of a rim <5% present	Very low < 0.005	Ghost floor; featureless

Floor features are complex and variable, but structures indicative of the following processes were identified: Volcanic, Aeolian, Impact, Glacial, Mass Wasting, and Water Interaction. When possible, percent floor cover of features such as lava flows, mass wasting, dune and dust coverage were documented. Other floor or wall structures identified included: wrinkle ridges, secondary ejecta, alluvial fans, gullies, slope lineae, deltas, pingos, lineated valley fill, and chaotic terrain. Central mound heights were calculated where present. In addition to floor features, the crater ejecta were classified as single layer ejecta, double layer ejecta, and multilayer ejecta based on [2].

Results and Discussion: Variability in the Level of Degradation (LOD) for craters present in each of the geologic units demonstrates a change from highly degraded in the Noachian to very highly degraded in the Hesperian to less degraded overall in the Amazonian (Fig. 2). Craters in the early and middle Noachian units are dominantly highly degraded, with the majority having an LOD of 3. In these craters, mass wasting and slumping are the cause of much of the degradation. These craters also tend to have a high dune cover percentage. A spike in LOD of 4 throughout the Hesperian, from HNt to lHl is due to Hesperian-aged volcanic activity, resulting in lower d/D due to infill of craters. The Amazonian Hesperian Impactor (AHi) unit, which is the youngest age observed, contains many craters with an LOD of 3 due to slumping.

Paleo fluvio-lacustrine systems (PFS), defined by one or more channels cutting through the rim or other sedimentary structures such as a delta [3], are only identified in the Noachian and early Hesperian units (eNh, mNhm, mNh, lNh, HNt, eHv), and are predominantly in the early to mid Noachian units (Fig 3). The three types of these systems include “open”, “closed” and “crater-lake chain” [3]. Four deltaic structures were identified, three in closed basins and one in an open basin. These structures are all within craters that are at low latitudes, and are all found in the mid Noachian highland unit (mNh). These delta structures suggest the presence of persistent water in these craters.

Ejecta is not well-preserved around open basin craters and crater-lake chains (0% and 14%, respectively), but are observed around closed basin craters (92%). The absence of ejecta may be due to differences in erosion, as these may have been less affected by spillover. Central peaks are found in 79% of crater lake chains, 88% of open basins, and 85% of closed basins. All craters in each type of PFS show about equal amounts of slumping (coherent mass wasting), other (non-coherent) mass wasting, dunes, and lava flows, mostly being affected by latitude.

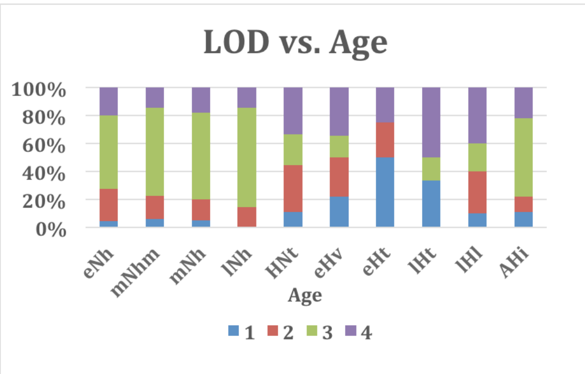

Figure 2: *Normalized frequency of Level of Degradation (LOD) of craters within each age unit observed. Craters with little to no degradation are classified as a 1; the most degraded craters are a 4. Geologic units eNh: Early Noachian highland unit, mNhm: Middle Noachian highland massif unit, mNh: Middle Noachian highland unit, lNh: Late Noachian highland unit, HNt: Hesperian and Noachian transition unit, eHv: Early Hesperian volcanics unit, eHt: Early Hesperian transition unit, lHt: Late Hesperian transition unit, lHl: Late Hesperian lowland unit, AHi: Amazonian Hesperian impactor unit [5].*

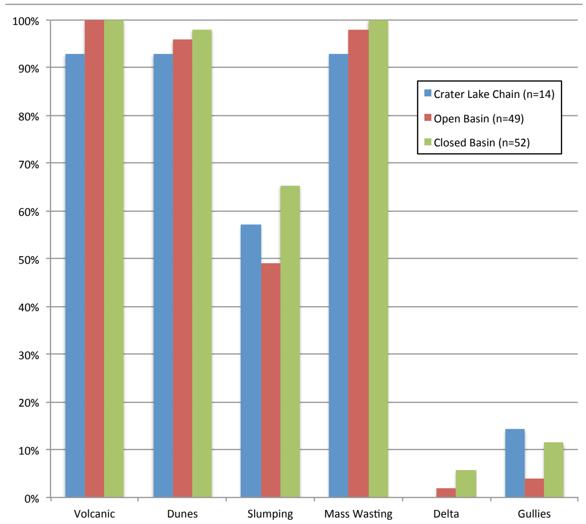

Figure 3: *Frequency of each type of morphological/erosional feature observed within craters of each type of paleo fluvio-lacustrine system (PFS). Sample sizes provided for number of craters of each type of system.*

Conclusion: The identification of deltas and channels in some of the craters, in addition to the valley networks that cut through and around many of the craters through the Noachian highlands of this region suggests complex and extensive fluvial and lacustrine activity. Consistent with previous studies, it is clear that most of the water related activity and erosion occurred prior to volcanic activity. The extent of lava flow in this region makes identification of central peaks and mounds challenging. Craters with fluvio-lacustrine features such as channels and deltas are ideal places to search for biosignatures as they suggest water flowed for an extended period of time, long enough to have possibly supported life.

References: [1] Mangold et al. (2012) *JGR, 117,* 2156-2022. [2] Barlow N. G. (2010) *GSA Bulletin, 122*, 644-657. [3] Cabrol N. and Grin E. (1999) *Icarus, 142,* 160-172. [4] Robbins, S.J., and B.M. Hynek (2012) *JGR, 117,* 2156-2022. [5] K.L. Tanaka et al. (2014) Geologic map of Mars: U.S. Geological Survey Scientific Investigations Map 3292, scale 1:20,000,000, pamphlet 43 p., *https://dx.doi.org/10.3133/sim3292*.