A Reevaluation of Lunar Impact Pit Craters P. T. Malinski[1] and K. A. Milam[1], Department of Geological Sciences, 316 Clippinger Labs Ohio University (pm193604@ohio.edu)

Introduction: Pit craters are a type of impact crater that contain a pit within the central location of the impact [1]. Multiple mechanisms have been proposed in the formation of these enigmatic class of impact craters, but one of the most cited facilitating mechanisms are volatiles (chiefly water) [1]-[6]. It has been observed that populations of pit craters have morphological differences across different bodies that have varying concentrations of volatiles (e.g. Ganymede and Mars) [1]-[3]. Pit craters have been poorly modeled on dry bodies such as the Moon where volatile concentrations are very low and unevenly distributed [7].

The purpose of this study is to map lunar pit craters using LOLA data and identify morphologic and morphometric features to define standard trends observed within pit craters. This will be accomplished by observing pit crater populations and comparing them to the volatile concentrations across the moon. The lunar data will then be compared to existent data from other bodies to identify any trends that would aid in describing the population. This investigation will report the significance of identifying and defining lunar pit craters to the planetary community.

Ultimately we address the poor understanding of pit craters and their relationship to volatiles.

Methods: Within the predefined study area (Fig. 1), we used multiple data sets to identify lunar pit craters and classify them into several predetermined categories. The study area ranged in latitude from -20° to +50° and included both lunar highlands and lunar maria terrain. Craters between 20 km and 60 km were surveyed, the lower end represents the beginning of complex craters and the upper end was chosen to avoid misinterpretation from peak ring morphologies. Predominant data sets used were the Lunar Orbital Laser Altimeter (LOLA) and the wide angle camera imagery from the Lunar Reconnaissance Orbiter. In addition, a database of large lunar craters, and an International Astronomical Union (IAU) crater file was used in conjunction with GIS to aid in identification of lunar craters.

Crater Evaluation

Craters were evaluated by several criteria determined from previous works to accurately identify pits from other features. The criteria called for a presence of a circular pit/depression [1]-[5] which is the defining aspect of a pit typical pit crater. Pit diameter has been identified at a minimum of 0.5 km [1] [7], and the location must be within the region where central peaks form. Finally, the last criteria is a lack of another formational mechanism such as secondary impact, which may create similar pit features to those of pit craters.

Crater Categories

Craters are divided into several categories where each category represents the pit and/or crater state:

i. Red – craters without a pit
ii. Green – craters are likely to have pits
iii. Yellow – craters that have potential to contain pits; however, due to constraints on morphological identification of lunar pit craters , anomalies are indefinable
iv. White – subset of the non-pit crater category (Red) which incorporates craters where rim and/or pit identification is obscured

Ultimately, three methods of evaluating the lunar data was used to investigate lunar pit behavior. First we located pit craters on the surface of the Moon and correlated them to volatile rich terrain (Highland terrain) vs. volatile poor terrain (Lunar Maria). Ages were noted to correlate pit craters temporally to determine if there were favorable conditions in the past. Secondly, comparing the total pit crater population to other pit populations with volitiles will allow comparison between “wet” and “dry” bodies. Ganymede has a pit population of 8.65% and Mars has a pit population of 4.13%, and we hypothesize the Moon to have a lower concentration of pit craters [1]. Finally, comparing morphologic/morphometric measurements of pits to other bodies may tease out morphologic/morphometric relations of these features.

Preliminary Results: Approximately 1,500 craters have been surveyed across the study area where an in-depth evaluation of each crater is currently being conducted. The current evaluation has classified 741 craters from the 1,500; and of that 741 population, 2.70% are likely pit craters. Approximately half of the pit crater population, or 1.35% of the total evaluated population, are located in the highlands. Floor pit craters comprise 65% of the pit population observed and the remainder 35% are summit pits. Pits exist in various states of degradation, where some pit floors have been resurfaced or fracturing/collapse has occurred of pit rims. From the total pit crater population: 45% are Eratosthenian in age, 15% are Imbrian in age, 15% are Copernican in age, 15% are Nectarian in age, 5% are PreNectarian, and 5% are PreNectarian/Nectarian in age.

Discussion: The distribution of pit craters across the surface are seemingly homogenous across all terrains, possibly indicating that terrain has no effect on pit formation. The pit crater population is well below the total populations on either Mars or Ganymede which may indicate a trend of a decreasing pit population from volatile rich to volatile poor bodies. Work is currently underway to fully characterize lunar pit crater morphologies and morphometrics. There is a greater amount of Eratosthenian aged impacts with under half of the population of pit craters in this time. The high amount of Eratosthenian aged (3.2 billion-1.1 billion years ago) pit craters may be from the long duration of this period and/or a product of less obscuration/modification from lunar processes (e.g. subsequent impacts, lava resurfacing, etc.).

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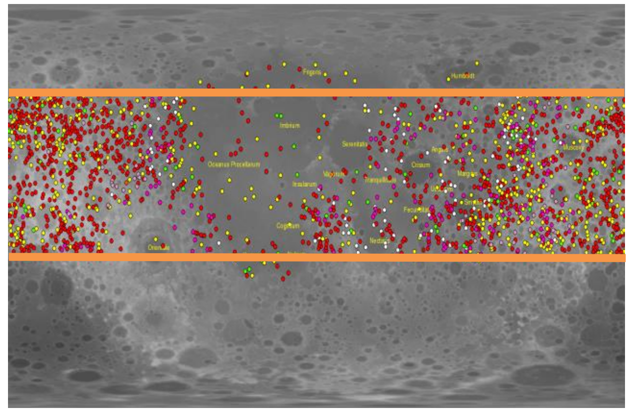

Fig. 1. LOLA generated lunar surface with surveyed pits (dots). The lines represent borders and the area between the lines represent the area survey for the lunar highlands. Maria that fell within the highland study area were evaluated based upon their natural borders.