EXPLORING A SUB-CLASSIFICATION SCHEME FOR IRREGULAR MARE PATCHES (IMPs), L. Qiao\textsuperscript{1,\textsuperscript{2}}, J. W. Head\textsuperscript{3}, Z. Ling\textsuperscript{4} and L. Wilson\textsuperscript{5}, \textsuperscript{1}Inst. Space Sci., Shandong Univ., Weihai, 264209, China (LeQiao.GEO@Gmail.com), \textsuperscript{2}Dep. Earth, Env. & Planet. Sci., Brown Univ., Providence, RI, 02912, USA, \textsuperscript{3}Lancaster Env. Centre, Lancaster Univ., Lancaster LA1 4YQ, UK.

Introduction: Lunar irregular mare patches (IMPs), extremely unusual and pristine-appearing features defined by Braden et al. [1], consist of dozens of occurrences that are widely distributed across the lunar maria, and interpreted to be extremely young in age (<100 Ma), representing very young volcanic activity on the Moon. Alternative models suggest formation during the period of peak mare volcanism, between 3-4 Ga [2-4].

IMPs have a variety of geologic settings, different sizes, morphologies and textures. In this analysis, we wish to understand the IMP population as a whole, and so we are striving toward a sub-classification scheme that illustrates all the characteristics and variables that need to be explained in order to understand the origin of IMPS. Here we explore various types and contexts of IMPS as a preliminary contribution towards our broader classification scheme in which our goal is to examine all IMPS and characterize the following: a) What is the range of morphologies, textures and structures observed in the total population of IMPS? b) What are the associations among these morphologies, textures and structures? c) What are the modes of occurrence and settings of each of these morphologies, textures and structures? d) What is the areal distribution of these features? In what regions of the Moon do they occur, and what is the age of their host unit?

An Updated Catalog of IMP Occurrences: We firstly collected IMP occurrences from four sources, namely Braden et al. 2014 catalog [1], Braden et al. 2013 catalog [5], two identifications by the recent Zhang et al. work [6], and several identifications by amateur scientists from THE MOON wiki site [7]. Each reported IMP occurrence was visually checked and confirmed in sub-meter LROC NAC images. In total, our updated catalog included 81 IMPS (Fig. 1).

Classification of Geologic Settings of IMP Occurrences. We used LROC WAC and NAC images to investigate the geologic settings of each documented IMP, and produced a preliminary geologic setting sub-classification scheme as follows (Fig. 1a):

Context #1: Within small shield summit pit crater, on the floor. We found three such IMPS, namely Ina, Manilus-2 and Cauchy 5, and a possible one (Maskelyne).

Context #2: Within other dike-tip pit craters [8]. We found five such IMPS, namely Sosigenes, Nubium, #44 IMP (# in the [1] catalog), Hyginus IMP and Rima Prinz source vent floor IMP, and three possible ones (associated with a possible dike-tip pit crater, or very near to a dike-tip pit/depression/graben).

Context #3: Within mare plains. We found 66 such IMPS, and one possible example (also very near to the edge of flank of a small shield).

Context #4: On small shield flanks. We found two such IMPS, namely Cauchy 5 flank and Arago 5 IMP, and one possible example (also very near to the surrounding mare plains).

Context #5: On non-mare crater ejecta. We found only one such IMP, on the Aristarchus North ejecta (#24).

Classification of the IMP Characteristics. We employed high-resolution LROC WAC and NAC images to examine the detailed geomorphologies and structures of all the 81 IMP features and derived a preliminary sub-classification scheme of IMP characteristics (Fig. 1b):

Type #1: Composed of a clear combination of positive-relief mounds and lower rough hummocky terrains. We found five such IMPS, namely Sosigenes, Ina, Cauchy 5 (floor), Maskelyne, and Nubium (#1-5).

Type #2: Composed of rough, bright pits within mare plains/flat surface, sometimes with blocky exposures. We found 59 such IMPS, including Cauchy 5 flank, Arago 5 (shield flank), Maskelyne (flank), Manilus-2 shield summit pit floor, Hyginus IMP and Aristarchus north ejecta IMP.

Type #3: Composed of rough, bright pits (similar to Type #2 IMPS) at upper walls of depressions or on slopes. Some IMPS of this type occur in clusters. We found 33 such IMPS, including Cauchy 5 flank, Maskelyne (flank) and Hyginus IMP.

Type #4: Composed of rough, bright pits/depressions with ridged, vermicular features on floors, being within mare plain. These appear to be deeper than type #2-3 IMPS (perhaps indicating thicker foamy flows [2]). We found three such IMPS, namely Aristarchus north ejecta IMP (#24), #55 and Bessarion-V-1 (from THE MOON wiki site).

Type #5: Composed of rough, bright depressions with ridged, vermicular features on floors (similar to Type #4 IMPS), occurring at the upper walls of depressions. We found only one such IMP, namely Bessarion-V-1 (from THE MOON wiki site).

Type #6: Composed of rough, bright pits on the floor of a source vent of sinuous rilles. We found only one such IMP, at the source vent floor of Rima Prinz (from [6]).
**On-going and Future Works:** The preliminary classification scheme of lunar IMP settings and characteristics (present above) provide substantial information for our future investigation of all the IMP population. We are currently constructing geomorphological maps of individual IMP occurrences to correlate IMP sub-types, textures and modes of occurrence as an aid in testing hypotheses of origin [1-4 and others].


**Fig. 1.** Preliminary sub-classification scheme for the (a) geologic settings and (b) characteristics of the newly cataloged 81 IMP occurrences. All the IMP and context types are identified as one-digital numbers (1-6), a two-digital number means a combination of the two types, e.g., “14” mean this feature contain both type #1 and type #4 IMPs. The question mark (?) in the context map means the interpretation is uncertain.