A New Lunar Meteorite Naming Nomenclature

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The Apollo missions collected 382 kg of rock (2196 individual samples) from six sample sites in the equatorial regions of the lunar nearside. The Apollo sample suite contains a wide variety of lunar rock and soil samples, collected with excellent local geologic context. However, the Apollo suite was collected over a relatively restricted geographic region of the Moon, and each of the sites are strongly influenced by a single geologic event, the Imbrium Impact. In contrast, there are currently 562 lunar meteorite stones (926.6 kg) listed in the Meteoritical Bulletin Database [1]. Detailed pairing relationships are difficult to demonstrate in all cases, particularly for the large number of brecciated feldspathic meteorites, but these 562 stones represent at least 144 lunar meteorite pairing groups [2] and come from at least 40-50 source craters on the Moon. The source craters for lunar meteorites are essentially randomly distributed across the lunar surface, which makes lunar meteorites the most representative suite of lunar samples and the best estimate of the global composition of the lunar crust [3].

Unlike the Apollo samples, which have a more-or-less coherent nomenclature across the entire collection, the classification of lunar meteorites in the Meteoritical Bulletin Database is less consistent and less detailed (Table 1). The lack of a consistent nomenclature for lunar meteorites inhibits selection of samples for more detailed follow-on studies and makes comparison of samples between the Apollo and lunar meteorite collections more difficult. This abstract represents a progress report of an ad hoc committee assembled by the lunar and meteorite subcommittees of ExMAG (Extraterrestrial Materials Analysis Group [5]). The goal of the effort is to provide a framework for classifiers to use for consistent naming of future lunar meteorites, and perhaps to retroactively reclassify existing lunar meteorites (though it would be a significant effort).

Table 1: Current Lunar Meteorite Classifications

Lunar Meteorite categories	Number
Lunar	98
Lunar (anorth)	78
Lunar (bas. breccia)	19
Lunar (bas/anor)	3
Lunar (bas/gab breccia)	2
Lunar (basalt)	23
Lunar (feldsp. breccia)	283
Lunar (frag. breccia)	21
Lunar (gabbro)	11
Lunar (melt breccia)	11
Lunar (norite)	1
Lunar (olivine gabbro)	1
Lunar (olivine gabbronorite)	1
Lunar (troct)	3
Lunar (troct. anorth.)	5
Lunar (troct. melt rock)	2

Figure 1 shows the current iteration of our naming scheme for lunar meteorites. We propose, barring special circumstances, that all future lunar meteorites should be classified into one of the following six classifications (the bottom row of blue boxes in Figure 1): (1) Lunar Meteorite – Basalt; (2) Lunar Meteorite – Plutonic; (3) Lunar Meteorite – Granulitic Breccia; (4) Lunar Meteorite – Impact-Melt Breccia; (5) Lunar Meteorite – Fragmental Breccia; and (6) Lunar Meteorite – Regolith Breccia. Classifying a meteorite into one of these categories requires a small number of electron microprobe analyses and textural information obtained from back-scattered electron and/or optical petrographic microscopy. This scheme does not change the type of analyses currently needed to classify a lunar meteorite. There are three steps to the proposed classification process:

Step 1 – Show that the meteorite is lunar based on the Fe:Mn ratio in mafic silicates and the Ca-rich nature of the plagioclase. It can also be done through oxygen isotope measurements (falling on the terrestrial fractionation line).

Step 2 – Determine if the lunar meteorite is igneous or non-igneous. Igneous lunar meteorites have textures consistent with igneous samples, they are unbrecciated, and lack clasts or abundant FeNi-rich metal. Conversely, non-igneous samples have sedimentary or metamorphic textures, contain clasts set in a fine-grained matrix, and commonly have FeNi metal grains with a composition similar to those seen in chondritic meteorites.

Step 3a – For igneous lunar meteorites, determine if it is a basalt (extrusive) or plutonic (intrusive) sample. Basaltic lunar meteorites have igneous textures and are dominated by zoned pyroxene grains and calcic plagioclase grains (An_{80-90}), with minor and variable amounts of ilmenite, olivine, and silica (as well as trace other phases). In contrast, plutonic samples tend to have unzoned mafic silicate phases (when present), are coarse grained, and they can have both igneous and cumulate textures.

Step 3b – Non-igneous samples, under the currently proposed plan, fall into one of 4 breccia groups based on the following criteria. Fragmental breccias are clast-rich and typically have a wide variety of clast compositions, with a matrix that is clastic or a combination of clastic and glassy. Regolith breccias have the same clast and matrix characteristics as fragmental breccias, but also contain specific components that only form at or above the lunar surface, such as impact glass spherules or agglutinates. Impact-melt breccias tend to clast poor (typically with a more limited variety of clast compositions), with a matrix that is crystalline and/or glassy, and often contains vesicles or vugs. Granulitic breccias are typically clast poor, with a crystalline matrix where the minerals show evidence of recrystallization (e.g., 120° triple junctions).

This classification scheme is designed to accommodate the vast majority of lunar rock samples, without being analysis intensive or requiring extensive experience with lunar samples in order to successfully classify a meteorite. The final publication will contain abundant images that demonstrate the distinguishing features and textures discussed above to further aid in this. These new, more detailed meteorite classifications, if used consistently, will greatly aid in selection of samples for more detailed follow-on studies. Moreover, the classification scheme will also include more detailed information about the subdivision of the six meteorite classifications into chemical (e.g., feldspathic or mafic regolith breccias) or lithologic (e.g., whether plutonic samples are anorthosites, norites, etc.) subcategories (the green and yellow boxes in Figure 1). This additional information would not be captured in the top-level meteorite classifications in the Meteoritical Bulletin, but could be included in the notes section for a meteorite within the Bulletin if it was known at the time of submission.

References [1] Meteoritical Bulletin Database [2] List of Lunar Meteorites. [3] Korotev et al. (2003), *GCA* Vol 67: 4895-4923. [4] Extraterrestrial Materials Analysis Group.

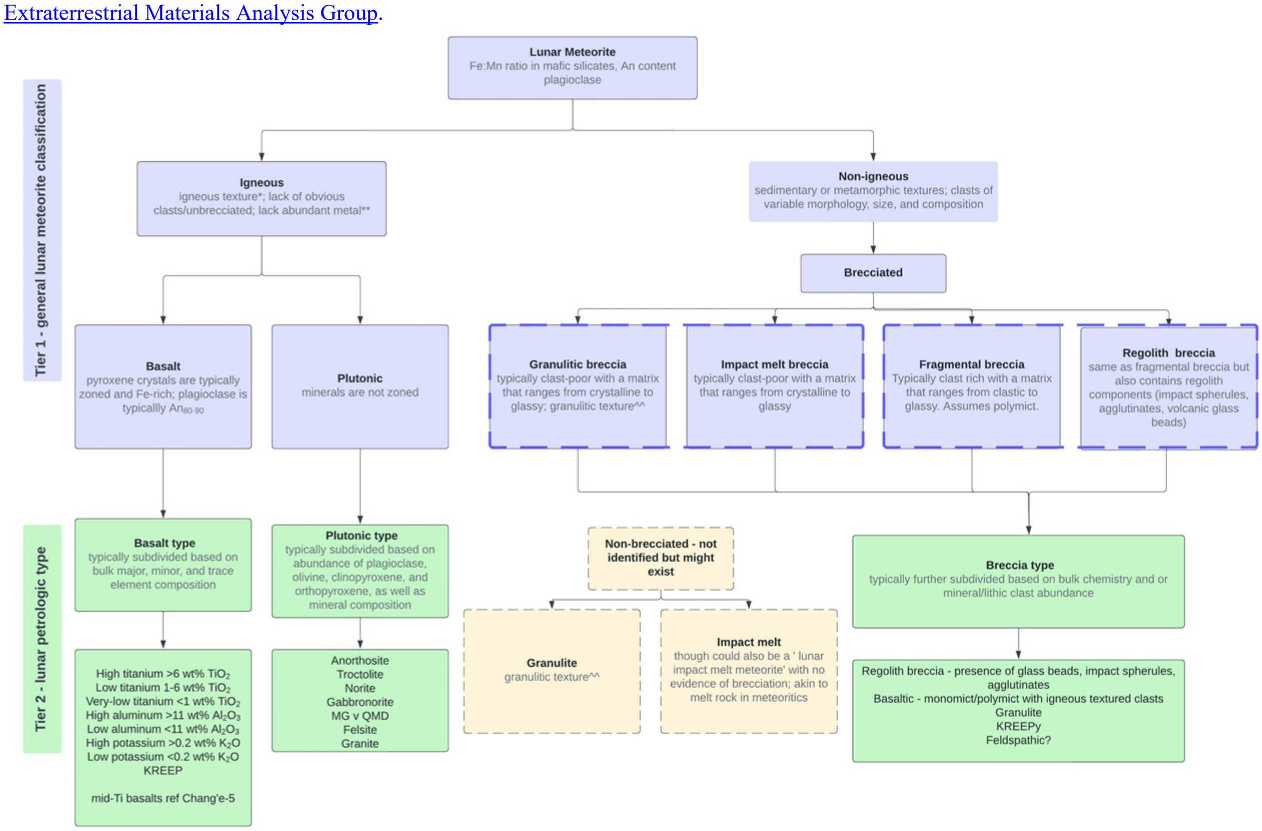

Figure 1: Schematic diagram showing proposed lunar meteorite classifications (in blue), as well as additional chemical and lithologic subdivisions (in green and yellow) to enable follow on studies.