GENETIC CLASSIFICATION AND NOMENCLATURE OF LUNAR HIGHLAND ROCKS BASED ON THE TEXTURE AND GEOLOGIC SETTING OF TERRESTRIAL IMPACT BRECCIAS.

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The petrogenesis and the chronology of the primordial crustal rocks of the Moon which potentially give important evidence of planet-forming processes, are still a matter of dispute mainly because to-day these rocks form displaced fragments within complex polygenetic breccia formations of the highlands. A geologically and stratigraphically meaningful interpretation of the chemical, physical and mineralogical properties of lunar highland breccias is largely dependent on a genetically oriented, common classification in which macroscopic and microscopic textural properties are used as prime criteria for classifying each sample. In this respect previous classifications (1-7) are often non-uniform and incompatible with each other so that much confusion among those lunar scientists who are not primarily concerned with the sample petrography, was created in the past. A major obstacle for the development of one common, petrogenetically acceptable rock classification was that different kinds of criteria for classification were used by different authors or even within one single classification model. This is best revealed by the present nomenclature of breccias in which non-equivalent terms such as genetic ("thermally metamorphosed", "partially molten"), textural ("poikilitic", "cataclastic"), color ("black and white", "light gray") or petrographic ("micronoritic", "feldspathic") terms were applied within one and the same classification. A great deal of the difficulty to achieve a satisfactory common classification of lunar breccia samples is due to the lack of or the insufficient use of information about the geological setting of a sample,and to the inadequate consideration or disregard of the well-established classification and petrogenesis of terrestrial impact breccias and their spatial relation to the pertinent crater in which they were formed.

The present paper uses data from two different research projects in which the texture and petrography of all major types of lunar breccias (8,9) and of terrestrial impact breccias at the Ries, Rochechouart, Mien, Dellen, Lappajärvi and Sääksjärvi craters located in central Europa and Scandinavia (10-12)were studied by quantitative stereometric analysis. Comparison of both sets of data clearly shows that there is nothing to be observed in the texture of lunar highland rocks which could not be reconciled or would be in conflict with observations made at terrestrial impact breccias. The results of this comparative study combined with the geological model of breccia formation and distribution at terrestrial craters provides a solid basis for a revised classification of lunar highland rocks. Similar to previous classifications (e.g. 1,2) it is built on the unifying genetic concept that the observed rock textures are predominantly produced by impact-induced processes such as

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melting, fracturing, mechanical mixing and transportation and that the primary rock material (target material) has been affected by such processes repeatedly.

In our proposal (Table 1) each class of breccia established on the basis of textural parameters gets a genetic connotation with respect to the analoguous terrestrial breccia class. This genetic system is irrespective of the multiplicity of brecciation events observed in a particular sample. It concerns only the last impact event which forms the "youngest" matrix of the breccia in question. The petrogenetic history of the various breccia classes is illustrated in Fig.1 and 2. It is proposed to use the terms "impact cataclasite", "impact melt rock", "suevitic impact breccia", "clastic (or fragmental) impact breccia" and "regolith breccia" to denominate the five broad classes of lunar breccias. Within these classes further subdivisions may be made on the basis of the textural characteristics of the matrix (9). Also the terms "crystalline matrix breccia" (2) and "clastic matrix breccia" continue to be useful for the denomination of a subgroup of the impact melt rocks and of the combined two classes of breccias with clastic matrix, respectively. The crystalline matrix breccias may be subdivided most easily by using adjectives such as equigranular, subophitic, poikilitic, or granoblastic in connection with a grain size measure to designate the matrix type (9, 1, 2).

The misconception of large-scale thermal metamorphism (3, 2, 1) which was believed by these authors to affect formations of clastic or glassy matrix breccias to form crystalline matrix breccias is excluded explicitely from this genetic classification. Observations at terrestrial craters indicate that thermally induced solid state recrystallization is restricted to lithic clasts incorporated into hot impact melts. Also the breccias with granulitic matrix (13) could be formed in this way. Granulitic textures alone - so far observed in rather small samples - do not necessarily require a large scale granulite metamorphism as postulated by (13).

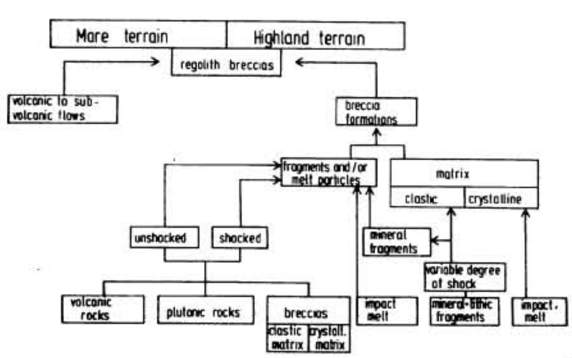

Fig. 1

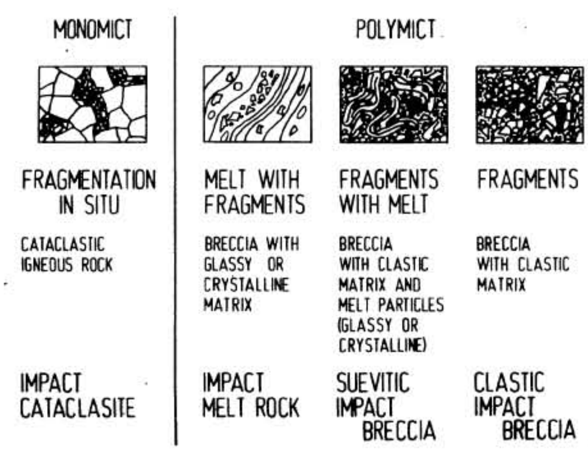

Fig. 2

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Table 1: Classification of lunar highland rocks and their relation to the geological setting within impact craters.

Breccia type	Lunar rock examples	Terrestr. equivalents	Relation to the crater topogr.
monomict			
cataclastic igneous rock	cataclastic ANT-rocks	cataclastic target rocks	crater basement and ejected megablocks
polymict and allochthonous			
breccia with clastic matrix	"light matrix" (3) breccia (in part)	"Bunte breccia" at Ries crater (1)	continuous crater deposits inside and outside the crater
breccia with cl. matrix and melt particles	Apollo 14 "White rocks"	suevite (2)	continuous or discont. uppermost impact formation inside and outside the crater
breccia with glassy matrix	fragment-laden glasses	quenched impact melt particles (e.g.glass bombs in suevite)	ejecta of the uppermost impact formation inside and outside the crater (ballistic transport)
↑ transitions ↓		↑ transitions ↓	
breccia with crystall.matrix	Fra Mauro breccias light-,blue-,green-gray br., poikil. and granobl. brecc.	coherent crystallized impact melt rocks or dikes of melt	large, sheet-like bodies mostly in central part of crater, seldom outside (no major ballistic transport) or intrusions into basement rocks
breccia with cl. matrix bound by vesic. glass	regolith breccias	none	inside and outside of small sized craters located within the lunar regolith

(2) ballistic and subseq. ground surge mode of emplacement (with secondary mass transport for (1)), (3) many of the large boulders belong to this class.

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