COMPARATIVE STUDIES OF IMPACT GLASSES AND BRECCIAS.

K. Fredriksson, P. Brenner, J. Nelen, A. Noonan, Smithsonian Institution, Washington, D. C. 20560, A. Dube, Geol. Survey of India, Calcutta and A. Reid, Johnson Space Center, Houston, Texas 77058.

Detailed analyses of impact glasses from the Lonar Meteorite Crater have confirmed some preliminary conclusions (1). More than 90% of these glasses, bombs ("Flädle") and fragments, closely represent the average of the basalt flows penetrated (Table 1, #1-5). Smaller particles, especially spherules, often lost substantial amounts of alkalis, Table 1, #6-7, and presumably other volatiles including water. Most spherules are also homogenous but variation in alkali content was observed, mostly decreasing from center towards periphery. Although the basalt flows vary in grain size and some have large phenocrysts, glasses strongly deviating from the basalts are rare. This seems to support the contention (2) that the average composition of groups of lunar glasses might represent rock types.

Morphologically the Lonar glass spherules resemble their lunar equivalents which in turn have many analogies with meteoritic chondrules as has now been observed by a number of investigators. We have, however, especially noted the relative abundance of "blistered" spherules, Figs. 1 to 6, common in chondrites, less abundant in Moon soil and around Lonar, and apparently non-existent among volcanic (or artificial) glass droplets. We propose that these spherules are formed from superheated (by impact) droplets which by extremely fast radiative cooling form a rapidly shrinking "skin" through which hot liquid is forced out in form of blisters which again cool rapidly. The process would resemble the ejection of microdroplets from a freezing undercooled water droplet described by Cheng (3); it is noteworthy that the shape of the cooling curve is similar to the cooling curve observed by Keil et al. (4) for artificially produced chondrule-like droplets.

Although Lonar breccias are products of a single impact in basalt, they are, in thin section, texturally similar to many lunar breccias. However, there is little or no evidence in the Lonar agglomerates for induration by shock or recrystallization, so common in lunar rocks and chondrites; rather, secondary processes may have caused the induration. "In situ" monomict impact breccias from ~450m below the Lonar rim may have a more direct genetic relationship to some lunar breccias, e.g. 60135 or 72135, and some chondrites, e.g. Soko Banja (LL6). Except for maskelynite, impact glass is scarce in Lonar breccias and when present is basaltic. In contrast, Moon rocks like 70019 and 79035 contain a variety of impact glasses; a few analyses are listed in Table 2. The most abundant glasses resemble the local soil, while the second most abundant type seems to be formed from local (?) basalts to which is added more exotic varieties. These lunar breccias appear to contain the products of several impacts on a variety of targets.

REFERENCES: (1) Science 180, p.862, 1973. (2) G & C Acta, Suppl.#3, p.363, 1970. (3) Science 170, p.1395, 1970. (4) U. New Mex., Spec. Publ.#7, 1973.

FIGURE CAPTIONS: #1.Spherule from 74420. b)Thin section: white=olivine; grey=glass; black=opaque "glass". #2.Bjurböle chondrule. #3,4.Lonar glass beads. #5.Glass particle from 14259. #6.Ditto from Lonar. b)Thin section, Table 1, #7.

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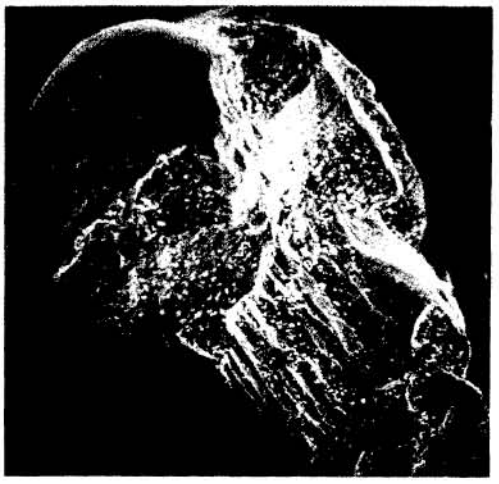
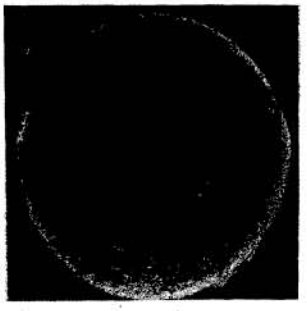


1a 0.1 mm

1b

2 0.5 mm



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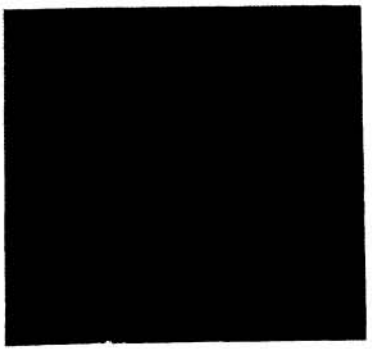

5 0.1mm

6a 0.2mm

6b

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Table 1. Chemical composition of Lonar, India, rocks and glasses.

	#1	#2	#3	#4	#5	#6	#7
SiO_2	48.5	50.1	51.3	52.4	51.3	49.1	48.5
TiO_2	3.36	2.43	2.20	2.12	2.21	2.34	2.33
Al_2O_3	13.4	14.3	14.4	15.0	14.5	12.8	12.7
FeO	15.5	14.5	14.0	13.2	12.9	16.5	16.0
MnO	0.27	0.17	0.17	0.14	nd	0.14	nd
MgO	5.40	5.48	5.45	4.70	5.54	7.24	7.19
CaO	10.1	10.1	9.80	10.1	9.82	9.00	9.04
Na_2O	2.52	2.34	2.50	2.43	2.27	1.76	1.67
K_2O	0.46	0.36	0.60	0.50	0.61	0.28	0.29
P_2O_5	0.45	0.23	nd	nd	nd	nd	nd
Cr_2O_3	< 0.10	<0.10	nd	nd	< 0.10	nd	< 0.10
Total	100.0	100.0	100.4	100.6	99.2	99.2	97.7

#1. Basalt, drillcore ~500 m below rim. #2. Basalt, outcrop N. rim. #3. Impact glass bomb ("Flädle"), light homogeneous. #4. From same sample as #3; dark inhomogeneous vesicular with inclusions; average. #5. Clear impact glass shard ~1 mm, from trench E. of crater. #6. Homogeneous glass spherule, ~1 mm. #7. Complex glass particle, see Fig. 6, ~1 mm.

Table 2. Chemical composition of selected lunar breccias and glasses.

	Bulk*	70019,12-A4 Glasses			79035,29-5 Glasses		
		#1	#2	#3	#4	#5	#6
SiO_2	41.4	40.0	38.4	33.3	41.9	39.4	41.4
TiO_2	7.24	8.26	8.65	8.12	7.44	9.05	1.20
Al_2O_3	12.8	13.2	6.74	17.2	13.8	6.21	22.0
FeO	16.3	17.3	22.2	14.6	15.8	22.7	6.39
MnO	0.26	nd	nd	nd	nd	nd	nd
MgO	9.95	10.1	15.3	11.6	10.0	14.6	14.7
CaO	10.6	10.9	7.15	13.4	11.3	7.58	13.1
Na_2O	0.28	0.31	0.35	0.10	0.33	0.32	0.11
K_2O	0.15	0.11	0.19	<0.10	0.11	<0.10	<0.10
Cr_2O_3	0.46	0.46	0.71	0.40	0.25	0.61	<0.10
P_2O_5	<0.10	nd	nd	nd	nd	nd	nd
Total	99.4	100.6	99.7	98.7	100.9	100.5	98.9

* Electronprobe analysis of $Li_2B_4O_7$ bead of 0.03g sample.
#1. Most common glass, crust, fragments. #2. "Basalt" glass sphere, typical. #3. High alumina glass, representative of variable group. #4. Similar to #1. and to soil samples from the area. #5. "Basalt" glass sphere. #6. Rare Al-rich, Ti-poor spherule.

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