

difficult and finally impossible with decreasing grain size. In coarser size fractions agglomerates are similar to glass coated breccia fragments and exactly distinguishable from them only in thin sections.

*Glassy coating of rocks.* Some fragments of breccias, basaltic rocks, and minerals are partly or completely covered by a brown glass containing vesicles, schlieren, fragmental inclusions, and very often, metallic spherules. Glass coated breccias and glassy agglomerates are difficult to distinguish without thin sections.

*Glassy matrix of breccias.* Brownish glass was observed as an important constituent of the fine-grained matrix of many Apollo 11 and Apollo 12 breccias. As far as can be judged from microscopic observation this glass consists mostly of minute irregular particles. Some matrix glass has a vesiculated appearance.

*Glass lining small impact craters.* Pit craters in the millimeter and submillimeter range on rock surfaces are lined with thin glass coatings formed by shock melting of the target rock (HÖRZ *et al.*, 1971; CHAO *et al.*, 1970b; NEUKUM *et al.*, 1970).

### Chemical types

Chemical compositions of 38 Apollo 11 glasses and 62 Apollo 12 glasses have been determined by microprobe analysis. Results for Apollo 11 glasses have been previously published (ENGELHARDT *et al.*, 1970). Results for Apollo 12 glasses are given in Tables 2 to 4. On the basis of chemical composition the investigated shock produced glasses may be divided into five main types: (1) Colorless diaplectic glasses of feldspar composition (plagioclase and alkalifeldspar) (ENGELHARDT *et al.*, 1970, p. 371). (2) Colorless to pale green glasses of "anorthositic" composition (Table 2). (3) Colored glasses of fairly variable "basaltic" composition (Table 3). (4) Maroon-brown glasses ("KREEP"-type) (Table 4). (5) Red-brown to black glasses of "pyroxenitic" composition (ENGELHARDT *et al.*, 1970, Table 4).

Table 2. Electron microprobe analyses of colorless (25-30) and pale-green (31-34) glasses of anorthositic composition from Apollo 12 (wt. %).

	25	26	27	28	29	30*	31	32	33	34
SiO <sub>2</sub>	52.10	45.66	50.33	49.18	50.65	44.66	43.25	44.02	44.01	43.21
TiO <sub>2</sub>	0.51	0.50	0.53	0.82	2.93	0.91	0.28	0.30	0.26	0.29
Al <sub>2</sub> O <sub>3</sub>	16.60	24.36	15.80	13.37	17.25	26.85	23.94	24.06	24.82	24.66
FeO	9.76	8.09	11.08	13.37	11.64	5.26	5.48	5.55	5.78	5.28
MnO	0.09	0.08	0.11	0.15	0.13	0.08	0.06	0.07	0.03	0.07
MgO	9.16	4.87	9.28	9.80	9.50	5.29	8.58	8.48	7.82	7.63
CaO	10.53	14.77	10.71	9.46	10.45	14.60	15.39	15.43	15.71	15.86
Na <sub>2</sub> O	0.36	0.29	0.10	0.51	0.76	0.98	0.05	0.17	0.09	0.12
K <sub>2</sub> O	0.08	0.06	0.00	0.19	0.58	0.22	0.00	0.00	0.00	0.00
ZrO <sub>2</sub>	—	—	0.02	0.02	0.04	—	—	—	—	—
Cr <sub>2</sub> O <sub>3</sub>	—	—	—	—	—	—	—	—	—	—
BaO	—	—	0.04	0.02	0.01	—	—	—	—	—
TOTAL	99.19	98.69	98.01	96.90	103.94	98.85	96.99	98.04	98.53	97.08
Sample	12010,4	12010,4	12010,4	12010,4	12010,4	12010,4	12001,84	12001,84	12070,139	12070,139
No.	K16	K23	K28	K36	K39	K44	207	215	216	217

\* Regular form of revolution.

Refractive indices of 4 glasses (microprobe analysis number is parenthesized): 1.597(31); 1.598(32); 1.599(33); 1.590(34).

Table 3. Electron microprobe analyses of colored glasses of basaltic composition from Apollo 12 (wt. %).

	1	2	3	4	5	6	7	8	9	10
SiO <sub>2</sub>	48.24	43.22	48.20	48.00	48.58	41.77	48.09	45.22	47.09	45.17
TiO <sub>2</sub>	2.44	3.26	2.46	2.95	2.44	3.30	2.45	4.68	2.93	2.95
Al <sub>2</sub> O <sub>3</sub>	15.11	10.83	14.42	14.16	14.85	10.47	15.29	9.78	15.16	15.65
FeO	11.69	19.59	11.98	12.71	11.94	20.35	10.85	21.22	11.59	13.43
MnO	0.18	0.19	0.16	0.15	0.18	0.16	0.14	0.22	0.15	0.10
MgO	9.15	9.57	9.25	9.04	9.08	10.11	10.19	7.94	9.38	7.61
CaO	10.31	9.70	9.85	10.01	10.00	9.60	9.78	10.81	10.38	12.12
Na <sub>2</sub> O	0.72	0.21	0.75	0.62	0.76	0.23	0.78	0.26	0.70	0.92
K <sub>2</sub> O	0.56	0.00	0.57	0.46	0.55	0.02	0.57	0.03	0.56	0.34
ZrO <sub>2</sub>	0.13	—	0.15	0.13	0.13	—	0.12	0.04	0.14	—
Cr <sub>2</sub> O <sub>3</sub>	—	—	—	—	—	—	—	—	—	—
BaO	0.09	—	0.10	0.08	0.09	—	0.06	0.03	0.08	—
Total	98.63	96.57	97.88	98.33	98.60	96.02	98.32	100.23	98.18	98.29
Color	Y	YB	GY	Y	Y	YB	RB	VB	Y	B
Sample No.	12010,4 K12	12010,4 K13	12010,4 K15A	12010,4 K17	12010,4 K18	12010,4 K20	12010,4 K27	12010,4 K29	12010,4 K40	12070,139 208

Table 3 (continued)

11	12	13	14	15	16*	17*	18*	19*	20*
43.13	46.13	48.08	45.65	46.51	48.76	49.18	47.84	41.13	46.69
5.35	1.23	3.36	3.22	2.83	2.00	2.57	2.37	3.49	2.86
10.05	19.61	12.72	9.20	11.71	13.99	14.53	14.40	11.97	4.36
18.78	6.81	17.17	19.39	15.79	12.95	13.00	13.64	19.31	15.43
0.18	0.07	0.17	0.17	0.14	0.09	0.15	0.15	0.23	0.19
6.06	8.47	5.54	9.46	9.41	10.50	8.24	8.21	9.26	12.62
10.85	12.83	11.55	10.63	10.21	10.36	10.21	10.31	11.60	14.85
0.11	0.68	0.74	0.15	0.18	0.45	0.70	0.41	0.03	0.14
0.03	0.36	0.00	0.37	0.19	0.22	0.62	0.29	0.00	0.00
—	—	0.01	0.01	—	—	—	0.09	0.01	—
—	—	0.23	0.41	—	—	—	—	—	—
—	—	0.02	0.12	—	—	—	0.07	0.04	—
94.53	96.19	99.60	98.83	96.97	99.32	99.21	97.80	97.08	97.14
YB	Be	B	B	O	GY	Y	GY	Y	YB
12001,84 212	12070,139 213	12033,74 193.13	12033,74 193.15	12070,139 167K1	12010,4 K9	12010,4 K11	12010,4 K14	12010,4 K34	12010,4 K37

Color code: B—Brown; Be—Beige; G—Greenish; O—Olive green; R—Red; V—Violet; Y—Yellow.

\* Regular forms of revolution.

Refractive indices of 3 glasses (microprobe analysis number is parenthesized): 1.641(10); 1.669(11); 1.597(12).