PETROGRAPHIC STUDIES OF A BOULDER FROM THE SOUTH MASSIF, D. B. Stoeser, R. W. Wolfe, U. B. Marvin, J. A. Wood, and J. F. Bower, Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory, Cambridge, Mass. 02138

The Apollo 17 astronauts collected four samples from Boulder 1 at Station 2, a visibly stratified boulder (Fig. 1A) that appears to have rolled to its present position from high on the South Massif. Two of the four samples (72275, 72255) have been studied by members of the CONSORTIUM INDOMITABILE, to which they were allocated.

The bulk composition of 72275 (Table I, column A) is intermediate between those of KREEP norite and lunar anorthositic rocks, being rather closer to the KREEP norite composition (compare with B and C in Table I). 72255 appears (from petrographic examination) to be very similar in composition to 72275.

The boulder samples are polymict breccias, consisting of clasts embedded in fine-grained matrices. The four types of matrix material currently recognized in boulder samples are, in order of decreasing abundance:

(1) Light-gray, porous, friable, polymict breccia. Makes up the bulk of 72275; some present in 72255. Chemical composition very similar to the bulk composition of 72275 (Table I, A).

(2) Medium-gray, non-porous, competent polymict breccia. Makes up the bulk of 72255. Probably very similar to (1) in composition. All gradations between (1) and (2) occur in 72255.

(3) Porous, friable zones of crushed pigeonite basalt (see below), largely uncontaminated by other lithologies. Fairly abundant in 72275.

(4) Light-colored, porous, friable, plagioclase-rich streaks and zones. Sparsely distributed in 72275 and 72255.

Principal types of clasts encountered to date, in order of abundance, are:

(1) Small, angular, monominerallic clasts of all the lunar rock-forming minerals (Fig. 1C). Abundances of mafic and feldspar clasts are comparable.

(2) Hard, dark breccia clasts, rounded in form and almost opaque in thin section (Figs. 1B, C). These are compositionally similar to 72275 overall (Table I, D). The clast population is composed largely of small (5-50 μ) angular mineral clasts, with somewhat larger lithic and mineral clasts also included (Fig. 1C). The darkness of the clasts is due to very fine (0.1-0.5 μ), evenly disseminated metallic iron. Dark breccia clasts sometimes have light-colored lithic cores (Fig. 1C), usually of anorthositic composition.

(3) Anorthositic clasts, granulitic in texture; types common in the soils and breccias of earlier missions.

(4) Cataclastic anorthosite clasts (Table I, E).

(5) Pigeonite basalt clasts, mostly (but not solely) in the zones of that material noted above (Table I, F). Pyroxene, mostly Fs_{25-35}, Wo_{5-10}; plagioclase, An_{89-96}; K-rich mesostasis; minor ilmenite, spinel, olivine. (Pigeonite basalt has been observed only in 72275.)

(6) Troctolitic basalt clasts.

(7) Microgranitic clasts; highly varied in character (Table I, G).

(8) Breccia derived from a coarse, plutonic norite. Most is present in a single 2-cm clast in 72255, dubbed "Civet Cat" (Table I, H).

We tentatively interpret the boulder as a large fragment of bedded deposits of ejecta from a single major cratering event, probably the Serenitatis basin-forming catastrophe. Some strata were laid down hotter than others, and these sintered (quickly, before temperatures equalized) into more resistant layers, such as the source of 72255. The dark breccia clasts are the most unusual aspect of the boulder specimens. Their internal structure is dominantly clastic and only very rarely do they contain vesicles, so they cannot be interpreted simply as devitrified blobs of impact-melted glass. They seem accretional in character. We suggest they formed by accretion of mineral fragments and melt droplets (sometimes upon larger lithic-fragment cores), in ballistic trajectory or in the base-surge aftermath of a basin-forming event. Enough melt component was present to bind the mineral fragments together and lend fluidity to the aggregation, accounting for the rounded shapes of the dark breccia clasts.

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Table I.

Analyses of rock material from Boulder 1/Station 2, and other lunar samples

	A	B	C	D	E	F	G	H
SiO_2	47.5	47.97	44.80	48.7	42.7	48.3	65.6	50.3
TiO_2	0.9	1.48	0.09	1.1	0.0	0.6	0.1	1.8
Al_2O_3	17.0	17.80	31.54	19.6	34.9	16.1	17.6	14.4
FeO	11.6	9.62	3.41	10.3	0.2	11.6	0.7	9.6
MnO	0.2	0.13	0.06	0.1	–	0.2	0.0	0.3
MgO	9.3	9.79	2.42	9.5	0.1	8.0	0.2	15.7
CaO	11.7	11.16	18.09	11.5	19.1	11.4	3.5	7.9
Na_2O	0.4	0.79	0.26	0.5	0.6	0.4	0.4	0.3
K_2O	0.3	0.60	0.01	0.3	0.1	0.4	8.1	0.1
P_2O_5	0.3	0.56	0.00	0.5	0.2	0.3	0.2	0.0
Sum	99.2	99.90	100.68	102.1	97.9	97.4	97.1	100.4

A. PET analysis of 72275.
B. KREEP norite breccia 14318 (Rose et al., Proc. 3rd Lunar Sci. Conf., vol. 2, p. 1219).
C. Gabbroic anorthosite 67075 (PET analysis).
D. 72275: dark breccia clasts (average of 31 100 μ defocused-beam microprobe analyses (DBA's)).
E. 72275: cataclastic anorthosite clast (core; enveloped by dark breccia clast material. Average of 23 DBA's).
F. 72275: pigeonite basalt clasts (average of 4 600 μ × 100 μ DBA traverses).
G. 72275: microgranitic clasts (0.7% BaO also present. Average of 5 DBA's).
H. 72255: "Civet Cat," a clast of relatively coarse norite (one 2 mm × 100 μ DBA traverse in mafic-rich area, one in plagioclase-rich area; weighted average analysis based on relative amounts of mafic (dark) and feldspathic (light) minerals visible in a macroscopic photograph of entire clast).

Captions for Figure 1 (next page).

A. Boulder 1 at Station 2, showing locations of the four samples returned, before they were detached. Note crude stratification.

B. Face of sample 72275 that was exposed at the surface of the boulder. Note dark clasts, up to 2 cm in diameter, which tend to stand out in relief.

C. Thin section of 72275, by unpolarized transmitted light. Dark breccia clasts, with characteristically rounded forms, are prominent. Two angular lithic fragments enveloped by dark breccia clast material appear at upper left.

D. Polished section of a dark breccia clast in 72275, by reflected light. Angular clasts of pyroxene and olivine (dark gray) and plagioclase (light gray) are abundant. Black: voids; white specks: metal grains.

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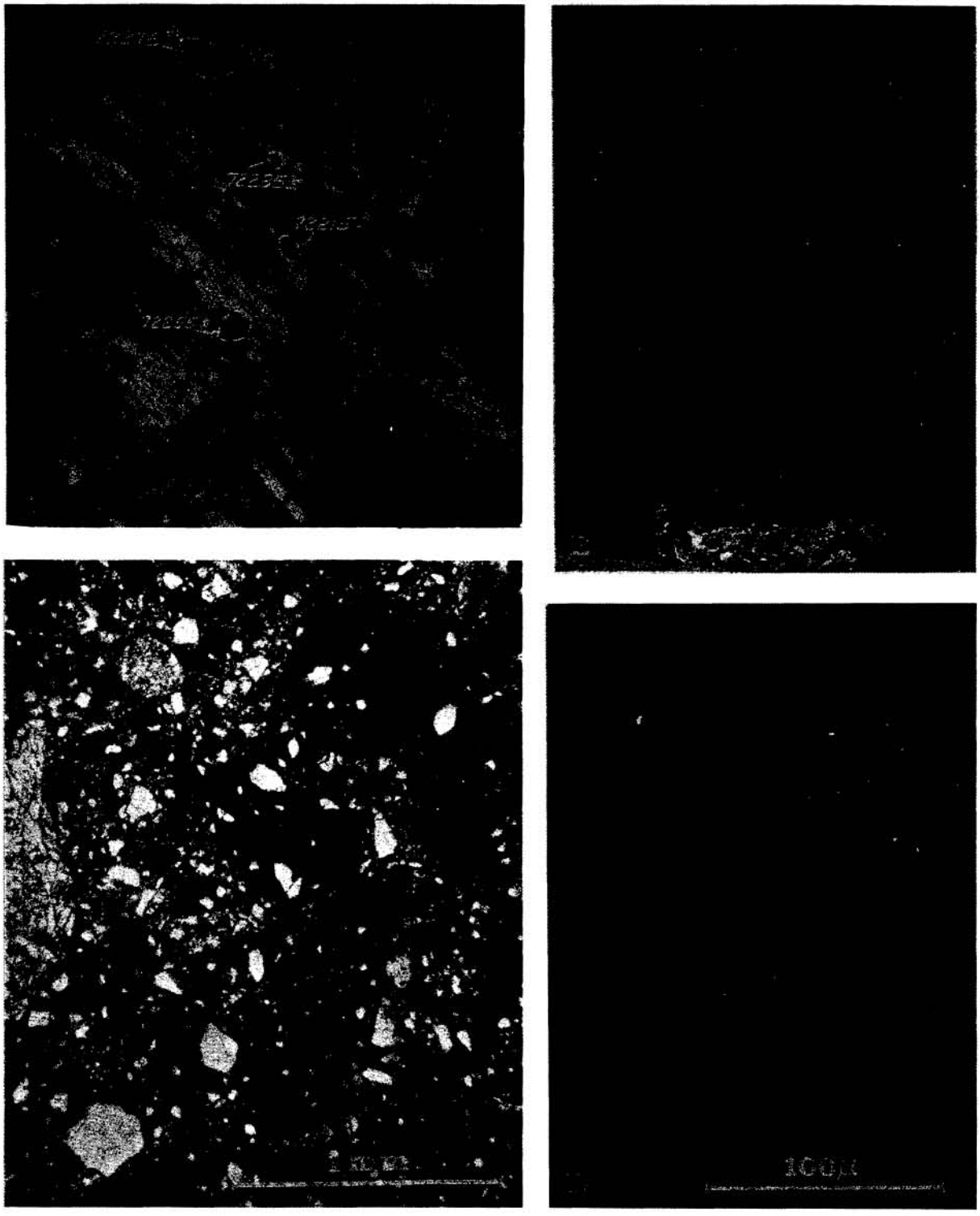

Fig. 1.