D3. GEOLOGY OF AREAS NEAR SOUTH RAY AND BABY RAY CRATERS

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INTRODUCTION

The surface of the southern part of the Apollo 16 ding site is dominated by fragmental debris derived m South Ray crater (fig. 1). Although the crater was of actually visited, several samples collected can be directly attributed to that impact event. Premission maps by Hodges (1972a) and Milton (1972) from Apollo 14 orbital photographs show a distinct ray pattern around the crater. Traverse station 8 was planned as a sampling site for ray material excavated from South Ray crater, station 9 as an interray sampling site. South Ray Crater, 680 m in diameter and 135 m deep, is near the western flank of the Descartes mountains on a plains surface underlain by the Cayley Formation. Mapped as a young Copernican crater by Hodges (1972a), it appears extremely fresh, with a sharp, raised rim and abundant blocky ejecta (fig. 2). A smaller, 130-m diameter crater, Baby Ray, lies about 1.8 km northeast of South Ray crater, also in smooth plains. Younger than South Ray crater (mapped as the youngest Copernican crater material by Hodges, 1972a), its rays overlie the South Ray debris.

The two major rock types collected in the station 8 and 9 areas are dark-matrix breccias and light-colored igneous rocks. This paper presents evidence that the samples collected are impact ejecta from South Ray crater and that they represent some of the materials visible in the walls of the crater.

DESCRIPTION OF SOUTH RAY AND BABY RAY CRATERS

SOUTH RAY CRATER

South Ray crater is a fresh-appearing blocky crater with a sharp, raised rim (figs. 2, 3). About 50 m below the rim crest, is a discontinuous terrace is visible on the low-sun photographs. The interior of the crater is exter-emely blocky; a large mound of blocky debris occupies the central part of the floor. A few dark patches are visible in the upper third of the crater wall.

On the high-sun Apollo 16 photographs, bright rays extend at least 15 km northeast, overlying North Ray crater ejecta, 10 km to the north (fig. 4) (ALGIT, 1972a and AFGIT, 1973). Blocks were deposited in abundance as far as Survey ridge, 4.5 km to the northeast, where the highest concentration of blocks found during the traverse occurred (Muehlberger and others, 1972).. It is likely that the 10-m relief on Survey ridge is constructional, made up of ejecta from South Ray, as ages with amplitudes of 10 to 30 m are common the plains. The ridge probably formed by the intersection of two large old subdued crater rims that. intercepted a mass of South Ray impact debris traveling on low: trajectory.

The ejecta are distributed asymmetrically around South Ray crater, being practically absent southwest of the crater. Boulders appear concentrated mainly in three directions (fig. 1) that correspond roughly to the three principal trends of high-albedo material. One of these blocky rays trends directly toward stations 8 and 9. Several linear grooves on the surface are radial to South Ray crater. At the ends or along the margins of many of the grooves are large boulders. The continuous ejecta thins rapidly outward from the crater, as several dark-haloed craters have excavated dark material from beneath the light South Ray ejecta.

BABY RAY CRATER

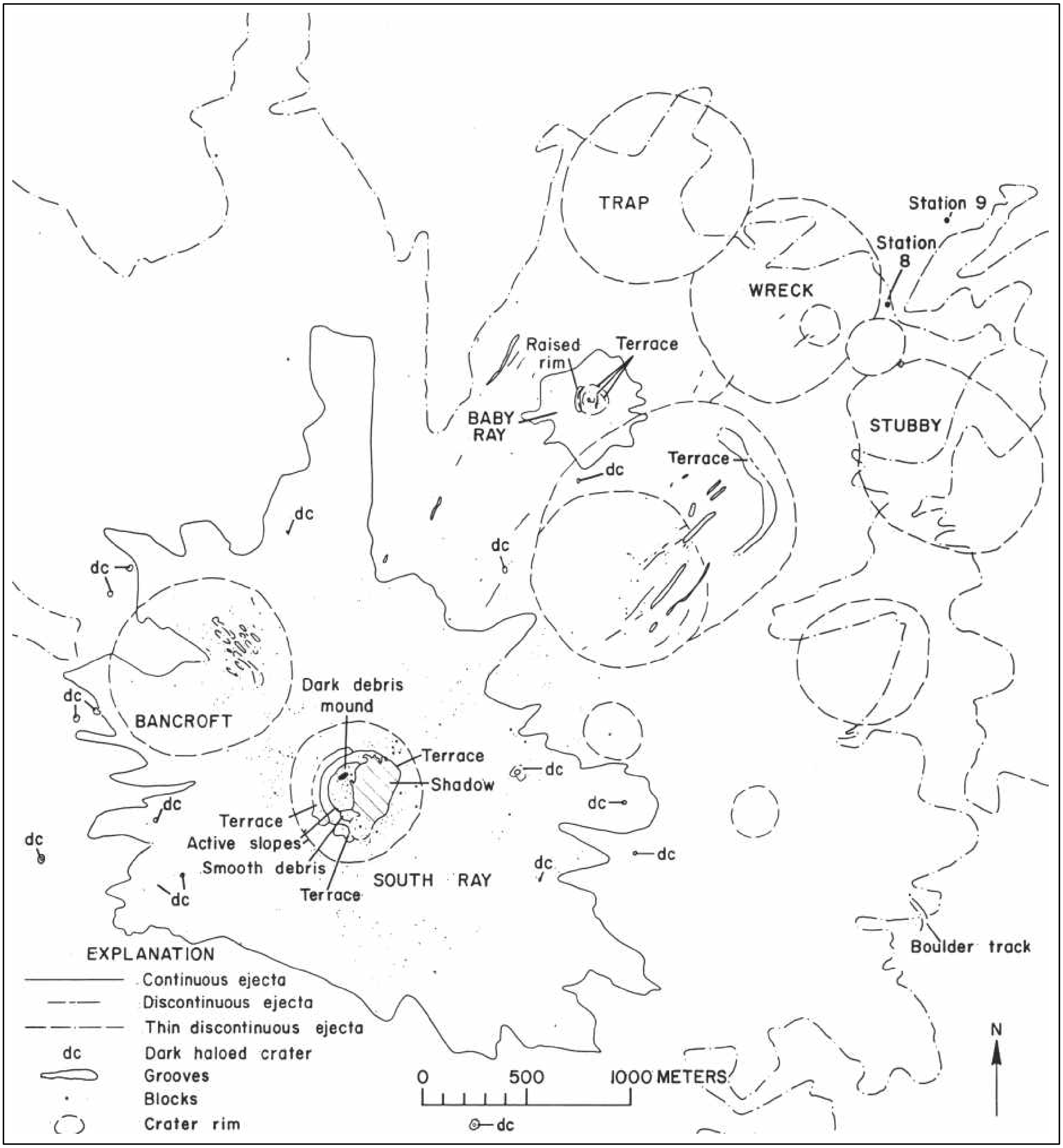
Baby Ray crater (figs. 3, 5) is a fresh blocky crater, 130 m in diameter, about 1.8 km northeast of South Ray crater on the rim of an old, subdued 1.1-km crater. Debris ejected from Baby Ray overlies South Ray ejecta. High albedo of the underlying South Ray material makes it difficult to trace the rays much farther than the limit of the continuous ejecta. Scattered blocks are visible in the orbital photographs and abundant in the telephotographs. In general, the blocks on Baby Ray are smaller and more numerous than on. South Ray.

The interior of Baby Ray crater is unusual-in the following respects. About one-third of the way down the western crater wall is a faint discontinuous concentric terrace (fig. 5). In the eastern wall are two distinct terraces, one in the upper wall, discontinuous across the crater, another that extends almost across the entire width of the crater. These may be slump features rather than terraces reflecting different lithologies. A small dark-haloed crater nested in the center of Baby Ray is similar to other nested craters of the same size range within the landing area. Some subsurface stratum, perhaps more consolidated than the overlying material, may have influenced this morphology (Quaide and Oberbeck, 1968).

GEOLOGY OF THE STATION AREAS

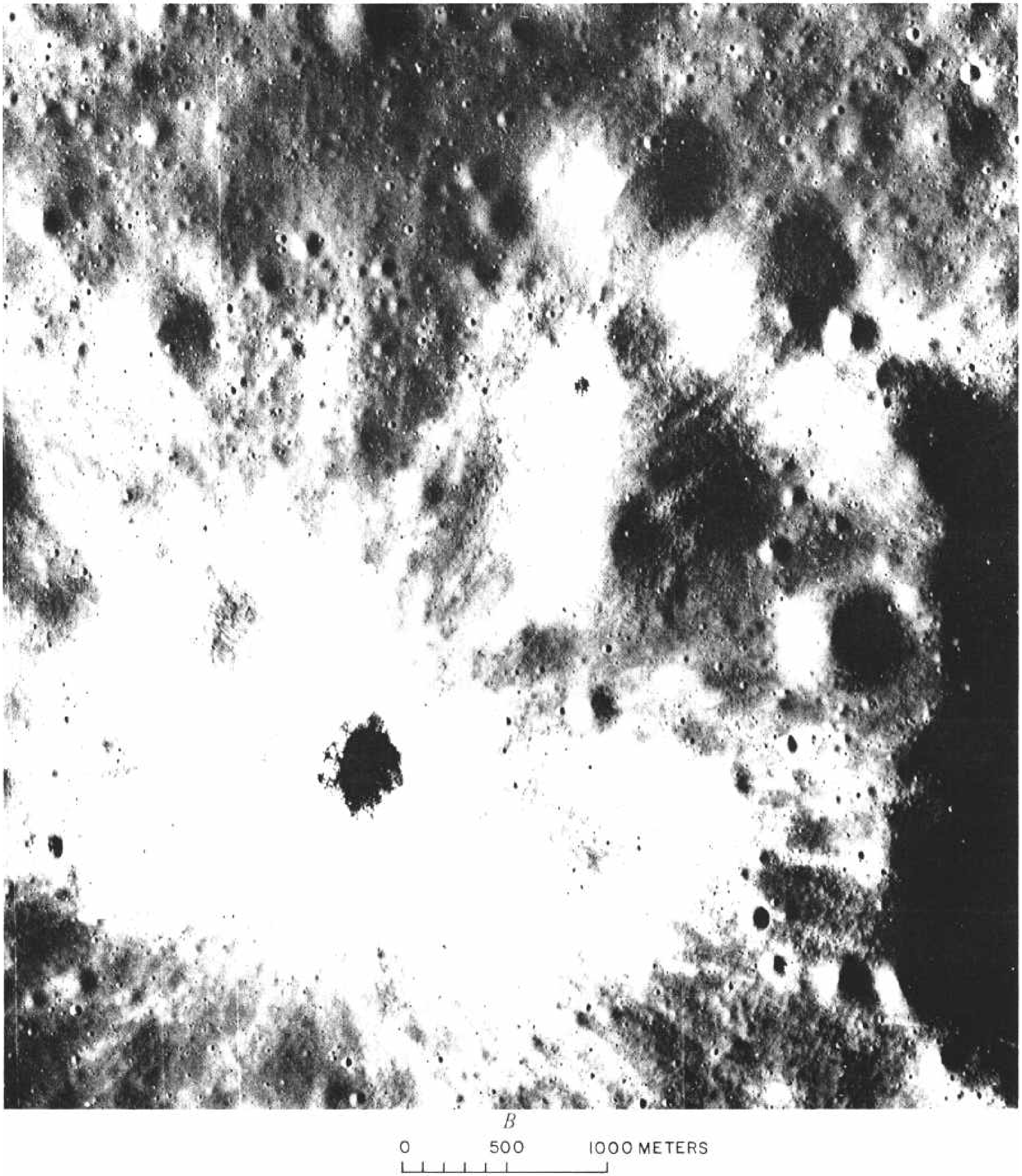
GENERAL DESCRIPTION

Of all Apollo 16 traverse stations, station 8, on the north edge of a high-albedo ray, had the highest probability of location in predominantly South Ray material. Station 8 was planned as a prime sampling station of ejecta from South Ray crater, 3.3 km (about 5 crater diameters) to the southwest. Station 9, between two visible rays near the rim of a 110-m subdued crater about 400 m northeast of station 8, was planned for collection of surface samples in Cayley plains in an area free of South Ray debris. Although stations 4, 5, and 6 were designed for collection of Descartes materials.



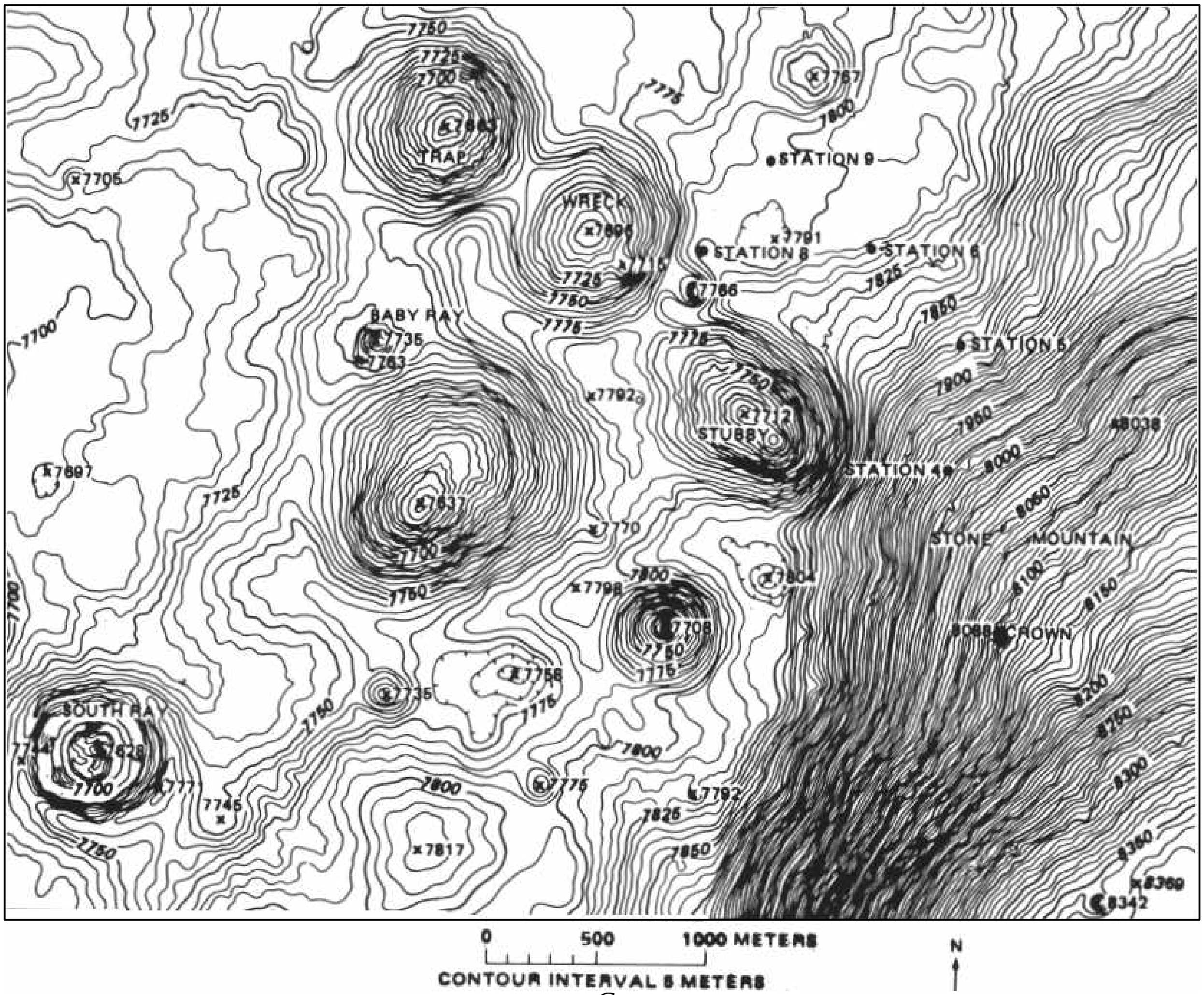
A

FIGURE 1.-South Ray crater and surrounding area. *A*, Geologic map. *B*, Apollo 16 panoramic camera frame 4623 on which the geologic map was compiled. *C*, Topographic map of the southern part of the Apollo 16 landing site. Prepared by G. M. Nakata from Apollo 16 panoramic camera frames 4618 and 4623.



B

FIGURE l.-Continued.



C

FIGURE 1.-Continued.

on Stone mountain, there is evidence (Sanchez, this volume; Muehlberger and others, 1972) of contamination by South Ray debris.

At station 8, fragments larger than 2 cm occupy about 3 percent of the surface, between stations 8 and 9, as much as .6 percent (Muehlberger and others, 1972). In the area of station 9, the fragment population drops to 2 percent, and in the LM/ALSEP area, fragments range from less than 1- percent to as much as 3 percent of the surface, the percentage of larger rock fragments (greater than 15 cm) decreasing northward.

The stratigraphy at stations 8 and 9 was complex prior to the deposition of South Ray ejecta. As station 8 is within the ejecta blankets or continuous rim deposits of four craters having a diameter of about 1 km, the regolith in the vicinity of these stations is probably made up of a series of several overlapping ejecta blankets. Superposed on this surface is debris excavated from South Ray crater. that apparently consists mainly of blocks with very minor distinguishable fines. Evidence against South Ray's being the source of fine material in the soils collected around these stations is the considerably older exposure age of the soils relative to the age of rocks more convincingly representative of South Ray crater (McKay and Heiken, 1973; Schaeffer and Husain, 1973; Adams and McCord, 1973; D. A. Morrison and others, 1973; Behrmann and others, 1973; Huneke and others 1973b; Kirsten and others, 1973; Drozd and others, 1974).

Counts of light and dark fragments in the down-sun photographs in the panoramas, where the reflectance most nearly approaches the albedo of the surface, indicate that at least. 75 percent are dark breccias. This estimate is probably somewhat low, as it is difficult to distinguish a dark-colored rock having a flat surface directed toward the sun from a light colored rock.

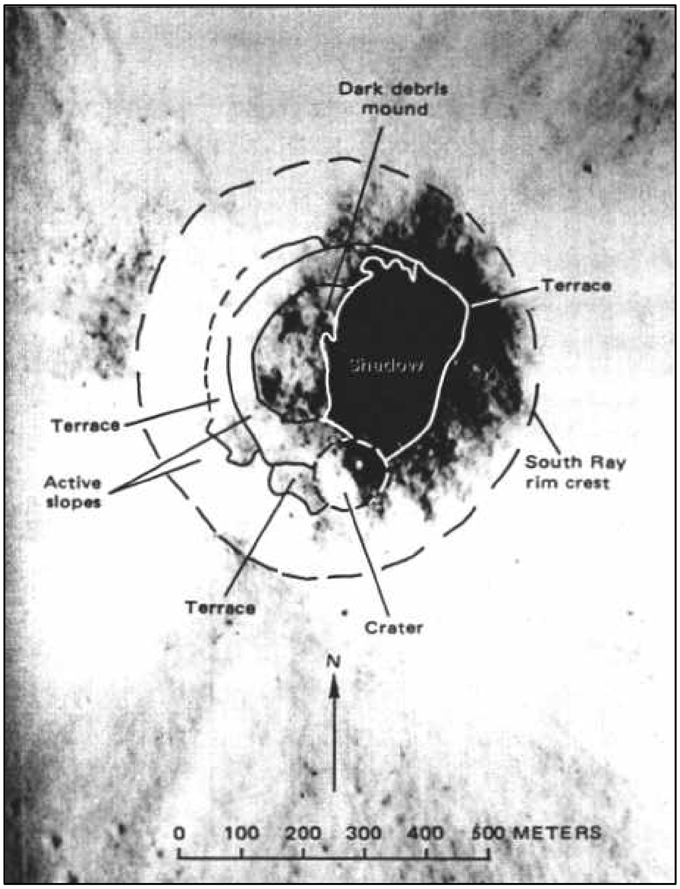


FIGURE 2.-Prominent features of South Ray crater. Photograph enlarged from Apollo 16 panoramic camera frame 4623 (fig. 1*B*).

SAMPLING

Three 0.5- to 1.5-m boulders were sampled at station one 0.5-m boulder at station 9 (figs. 6 and 7). Several soil samples and small fragments were collected from he surface. These samples are shown by rock type in table 1. The larger samples are pictured in figure 8 and photomicrographs of parts of the samples in figure 9.

STATION 8

DESCRIPTION

Station 8 is located on an undulating surface near two subdued 15- to 20-m craters. Regionally the surface slopes gently up to the northeast. Several scattered rock fragments, most of which are in the size range of 5-20 cm, are visible on the surface. The largest block in the area, one from which sample 68815 was collected, is about 1.5 m across.

A small (15-20 m) subdued crater provides direct evidence for the presence of South Ray ejecta in the station 8 area (fig. 10). Boulder 1, from which sample 68115 was collected (fig. 11), is perched on its rim. On the northeast wall, small fragments are abundant and small, fresh craters numerous. The opposite wall is nearly devoid of rocks and fresh craters. The downrange side of this old crater (the side facing South Ray crater) appears to have collected South Ray debris, whereas the uprange side was ballistically shadowed.

SAMPLING

Boulder 1. Boulder 1, approximately 1.5 m across, perched on the northeast rim of its own secondary crater, is rounded in appearance and friable (fig. 11). A large fragment chipped from the boulder (sample 68115) is a dark-matrix dark-clast breccia (B_5) that separated from the boulder along fracture planes intruded by glass. The boulder itself has a predominantly dark matrix with an abundance of light clasts (B_4?,fig. 12). Sample 68115 may represent only the matrix.

The presence of a few small vesicles (fig. 12) suggests that the boulder was at one time partly molten. One area where some of the light clasts have been smeared out appears to have been heated sufficiently to allow mobilization of the matrix. The many fractures in the rock probably account for its friable nature. Dark glass was injected along some of these fractures.

Boulder 2. Boulder 2, a light-gray rock about onehalf m across, was reported by Astronaut Duke to be representative of several he could see on the surrounding surface. Two samples were collected, 68415 from the side and 68416 from the top (fig. 13). The boulder appears homogeneous in photographs of its surface, but minor differences in phenocryst content are seen in the

TABLE 1.-*Samples collected at stations 8 and 9*

A. Boulder samples

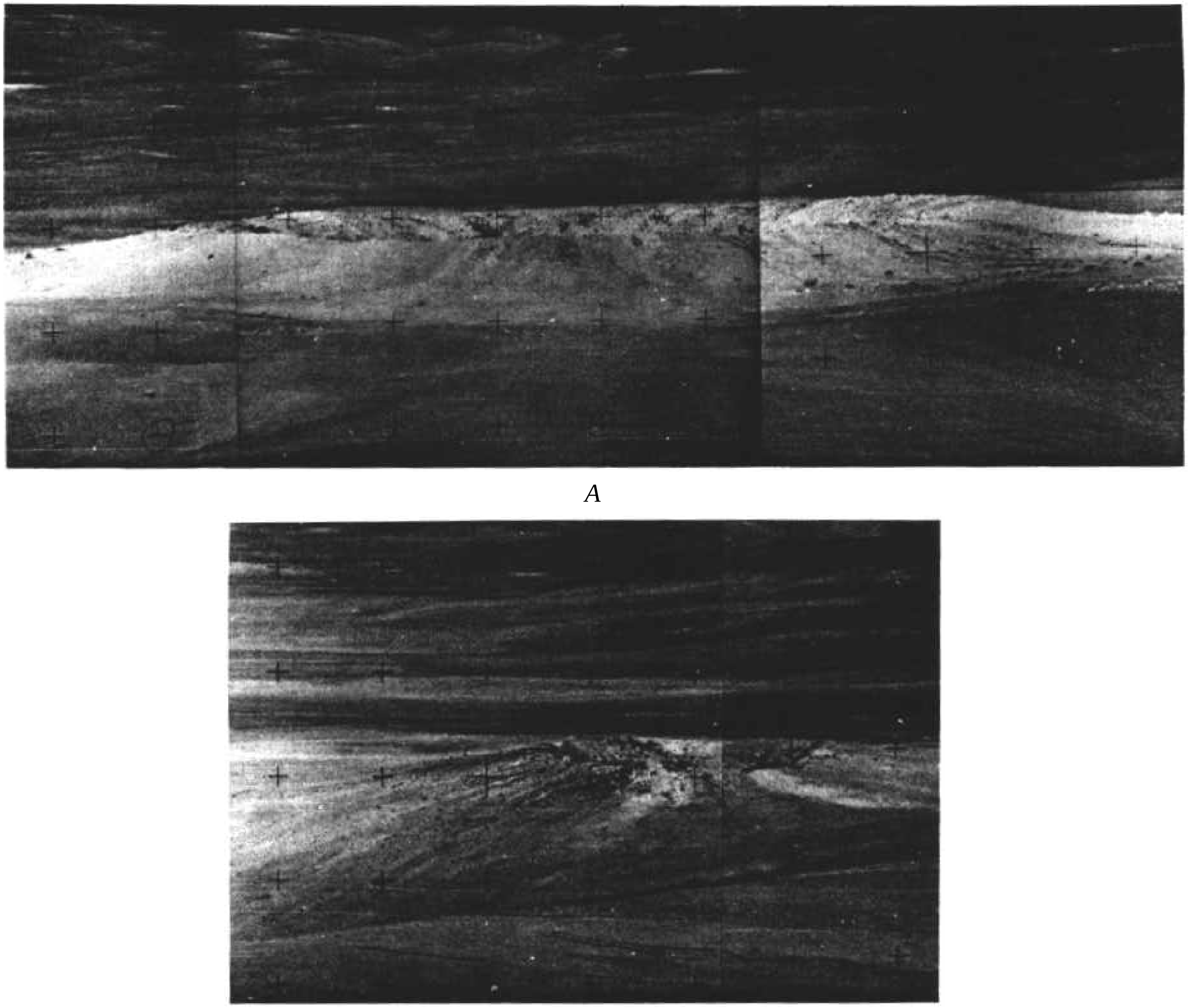
	Rock type[1]	Location
68035	B_2	Small fragment near raked area.
68115	B_5	Boulder 1, station 8.
68415	C_1	Boulder 2, station 8.
68416	C_1	Boulder 2, station 8.
68815	B_5	Boulder 3, station 8.
69935	B_4	From top of boulder, station 9.
69955	C_1	From bottom of boulder, station 9.

B. Other samples

	Description	Location
68002168001	Double drive tube	10 m west of 15-m crater.
68120	Soil	Near boulder 1, station 8.
68500	do	From within rake area.
68505	C_2	Collected with the soil 68500.
68510	Rake fragments[2]	From 1 m^2 area near 15-m crater.
68820	Soil	At base of boulder 3, station 8.
68840	do	5 m from boulder 3, station 8.
69001	Single drive tube	10 m NW. of station 9.
69903, 69904	Surface samples	Near station 9 boulder.
69920	Soil	Beside station 9 boulder.
69940	do	Do.
69945	C_2	Collected with soil 69940.
69960	Soil	Beneath station 9 boulder.

[1]Rock types from Wilshire and others (1973, and this volume):
C_1-Crystalline igneous
C_2-Metaclastic
B_2-Light-matrix, dark-clast breccia
B_4-Dark-matrix, light-clast breccia
B_5-Dark-matrix, dark-clast breccia

[2] Twelve rake sampe fragments were collected from a 1-m-square area on the north rim of a 15-m subdued crater. Of the 12, 6 were igneous and metamorphic rocks, 6 partially melted breccias (LSPET, 1972). Of the rake fragments examined by Wilshire and others (this volume), 3 are B_2 breccias (68515, 68517, and 68519), 3 C_2 metaclastic rocks (68526, 68527, and 68535).



A

B

FIGURE 3.-Telephotographs of South Ray crater (top) and Baby Ray crater (bottom) taken from station 4 on Stone mountain (AS16-112-18246, 18247, and 18256, South Ray, and AS 16-112-18253 and 18254, Baby Ray). South Ray is about 680 m in diameter.

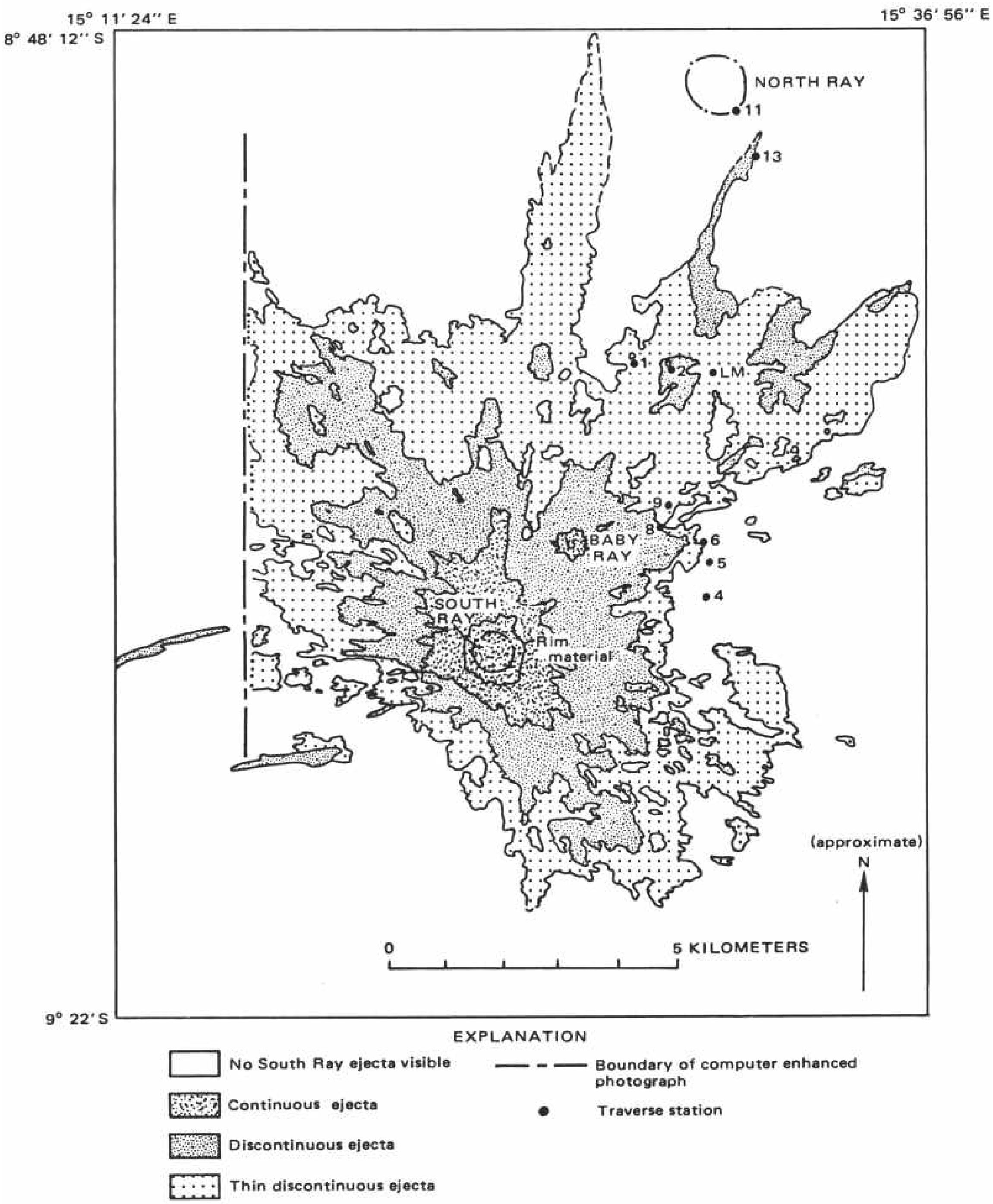


FIGURE 4.-Map of debris ejected from South Ray crater. Compiled on computer-enhanced Apollo 16 panoramic camera frame 5328.

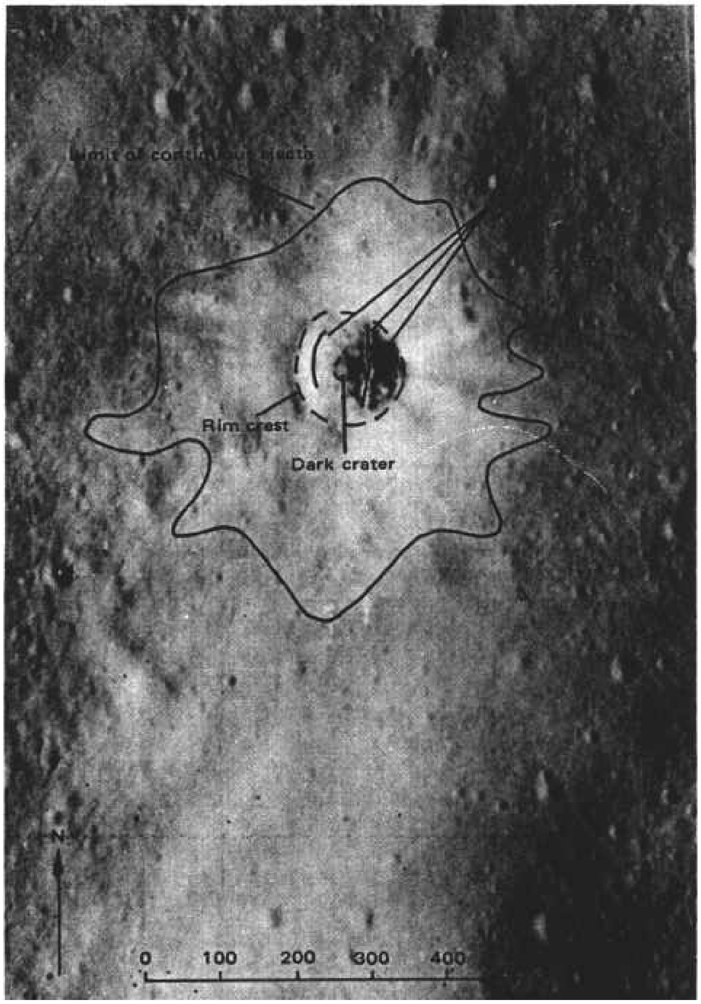


FIGURE 5.-Features of Baby Ray crater. Photograph enlarged from Apollo 16 panoramic camera frame 4623 (fig. 1*B*).

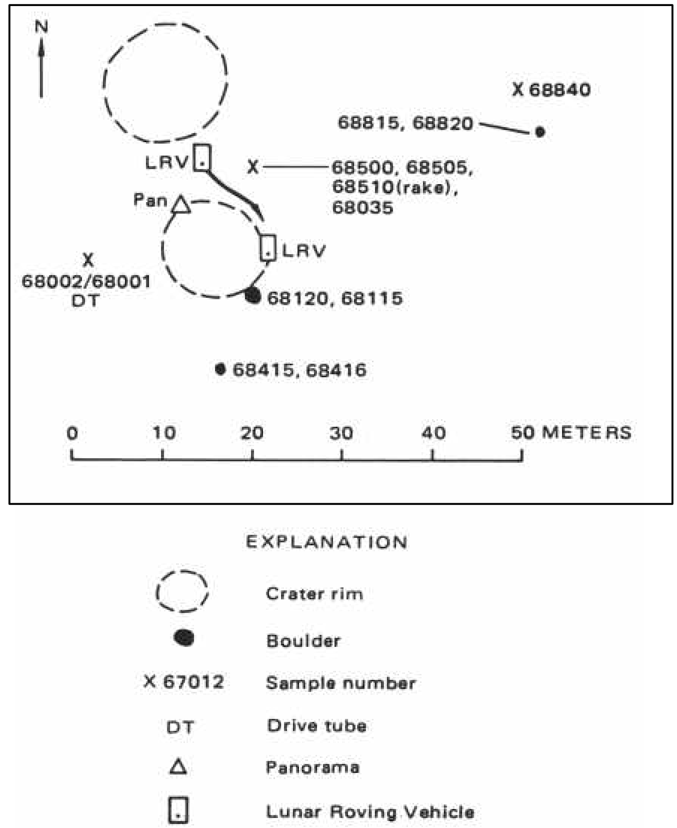


FIGURE 6.-Planimetric map of station 8 showing locations of samples.

samples. Both samples are fine-grained, highly feldspathic rock (Wilshire and others, 1973). Sample 68415, an igneous-textured rock, is composed of 79.3 percent plagioclase, 4.8 percent olivine, 4.4 percent augite, and 10.3 percent pigeonite (Helz and Appleman, 1973). Plagioclase An_{98-56} makes up 75 volume percent (Hodges and Kushiro, 1973). Both samples are texturally homogeneous but have a few shocked plagioclase inclusions in a fine-grained matrix (fig. 9*B*). It has been suggested that these rocks were produced not by partial melting of the deep lunar interior but rather by shock melting of an anorthositic rock (Wilshire and others, 1973; Helz and Appleman, 1973; Hodges and Kushiro, 1973; Walker, Longhi, Grove, and others, 1973; L. A. Taylor and others, 1973; and Warner and others, 1974) and rapid crystallization (Hodges and Kushiro, 1973; Nord and others, 1973) and that the inclusions represent unmelted anorthosite (Helz and Appleman, 1973, Wilshire and others, 1973).

Boulder 3. The third boulder sampled (fig. 14) at station 8, a 1.5-m dark boulder about 40 m northeast of boulders 1 and 2, is very coherent and angular and has only a few small fractures. Scattered large vesicles are visible. A "fillet" soil sample collected on the north side of the rock appears to be old regolith pushed up when the boulder landed rather than a fillet formed by rock degradation.

Sample 68815, termed a "fluidized lithic breccia," (Brown and others, 1973) contains a variety of basaltic and anorthositic clasts. Swirls of basaltic and feldspathic glasses or pockets of glass are common. Most of the material that has flowed is of plagioclase composition, whereas the basalt clasts have sharp unmelted boundaries (Brown and others 1973). Large, wormlike tubular vesicles are present (LSPET, 1972). Sample 68815, similar to 68115, is a dark-matrix dark-clast (B_5) breccia. The dark clasts in both differ only slightly from the matrix, and gas cavities are well developed in the matrices (Wilshire and others, 1973).

The bulk chemical compositions of rocks from station

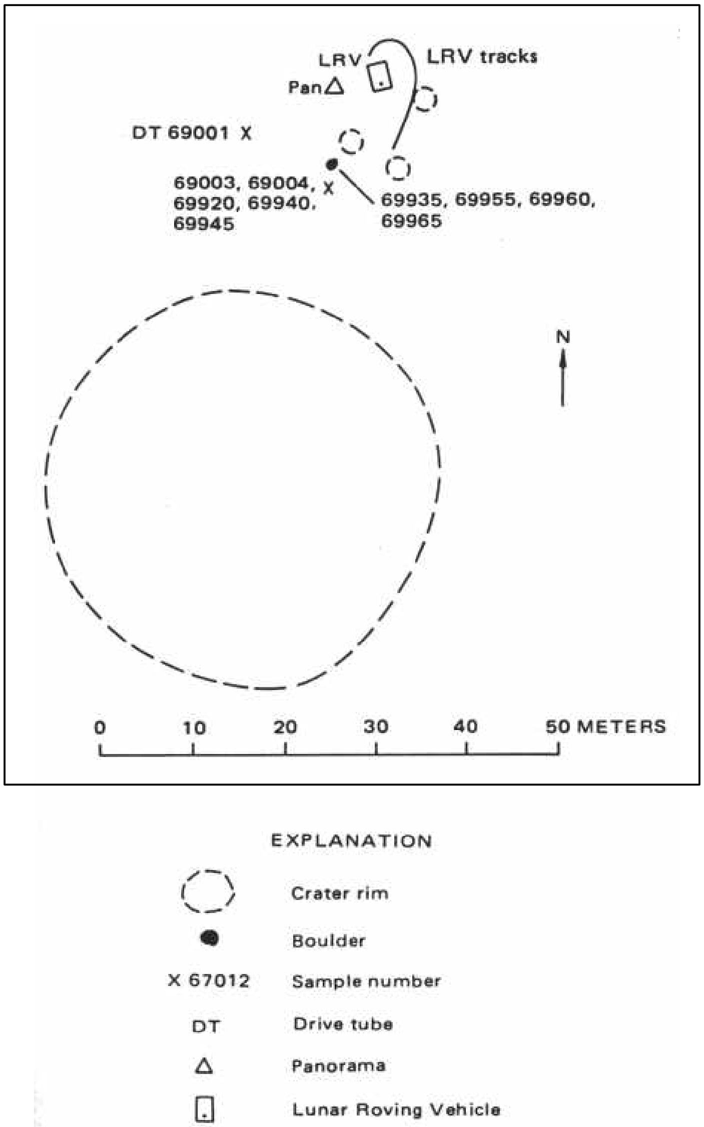


FIGURE 7.-Planimetric map of station 9 showing locations of samples. Symbols same as in figure 6.

8 boulders, shown in table 3, reveal a close similarity their chemistry that reflects a common source material despite the varied histories recorded in their textures.

TABLE 2.-*Chemical compositions of samples 68415, 68115, and 68815, station 8*

Rock type	C_1	B_5	B_5
Sample No.	68415,79	68115	68815,120
	Boulder 2	Boulder 1	Boulder 3
Source	(Nava, 1974)	(S. R. Taylor and others, 1974)	(Scoon, 1974)
SiO_2	45.9	44.8	45.33
Al_2O_3	28.19	27.6	27.59
Fe0	4.01	5.10	5.17
Mg0	4.41	5.79	5.38
CaO	16.39	15.4	15.56
Na_2O	.47	.47	.48
K_2O	.060	.06	.17
H_2O	....	......	.05
TiO_2	.28	.34	.48
P^2O^5	.072	......	.21
MnO	048	......	.05
Cr_2O_3	.07	......	.08
S			.06
Total	99.90	99.56	100.61

STATON 9

DESCRIPTION

Station 9, about 400 m northeast of station 8, is in an area of lower albedo. The surface is considerably smoother than at station 8, where there are many small, sharp-rimmed fresh craters. The small craters at station 9 are rimless and subdued. The fragment population varies in both size and abundance; fragments are fewer and mean size is smaller than at station 8.

SAMPLING

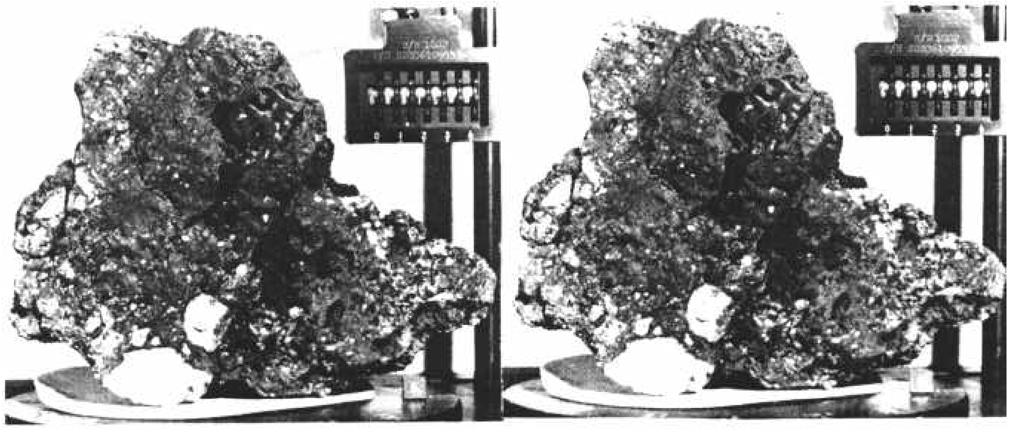
At station 9, the sampling was confined to the immediate vicinity of one boulder, about one-half m across, perched on the north rim of a small crater that may be a secondary crater formed by the boulder. Two rock chips were taken from the boulder, 69935 from the top and 69955 from the bottom. The photographs show that the rock consists predominantly of dark material but has a large component of light material (fig. 15), visible as discrete clasts as well as "streamed" through the boulder (fig. 16). Sample 69935 came from a predominantly dark part of the boulder. The boulder appears coherent, mostly angular, and is fractured throughout. Although most of the bottom was soilcaked, some of the rock is visible. One part of the bottom face is covered with dark glass. No glass was reported by the crew on the top, but apparently some glass has been injected into fractures.

Sample 69935 is a dark-matrix light-clast breccia (B_4). The sample from the bottom, 69955 (fig. 17), is an igneous (C_1) clast form within the dark matrix. Most of the other clasts in this boulder appear to be breccias.

Several soil samples designed to collect successively deeper regolith material were taken in the vicinity of the boulder: first, two surface samples (69003, 69004) collected the uppermost layer of regolith; then a skim sample (69920, penetration 5mm), a scoop sample (69940, penetration 3 cm), and a drive-tube sample (69001, penetration 27 cm) were taken. For comparison, a soil sample was collected from beneath the boulder.

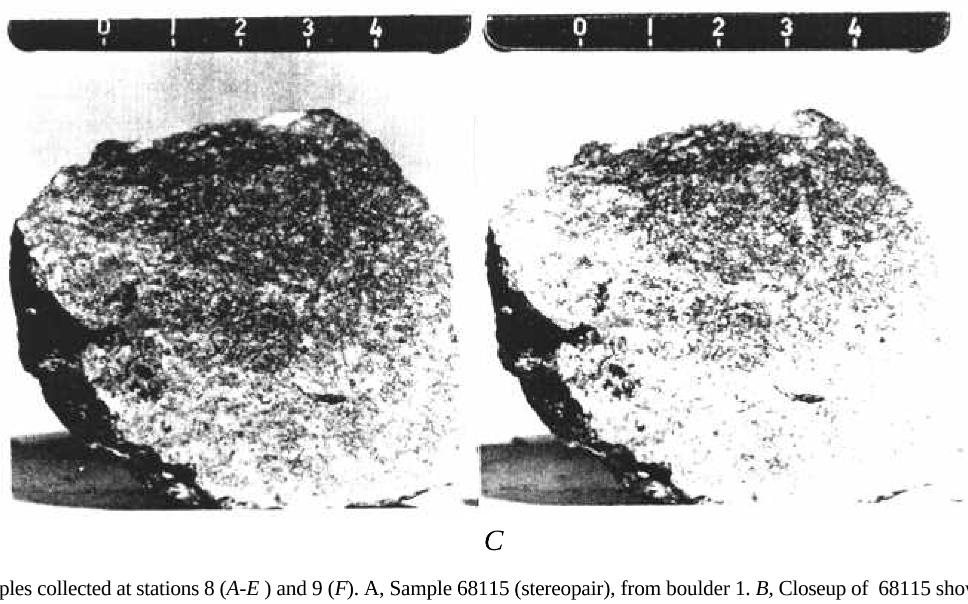
AGE OF SOUTH RAY CRATER

The presence of distinct, light-colored rays in the vicinity of stations 8 and 9 in-orbital and surface photographs suggests a substantial thickness of South Ray-derived material in this region. The exposure ages of rocks and soils collected at stations 8 and 9, however, have generated some uncertainty, (McKay and Heiken, 1973) as to the amount of South Ray debris actually



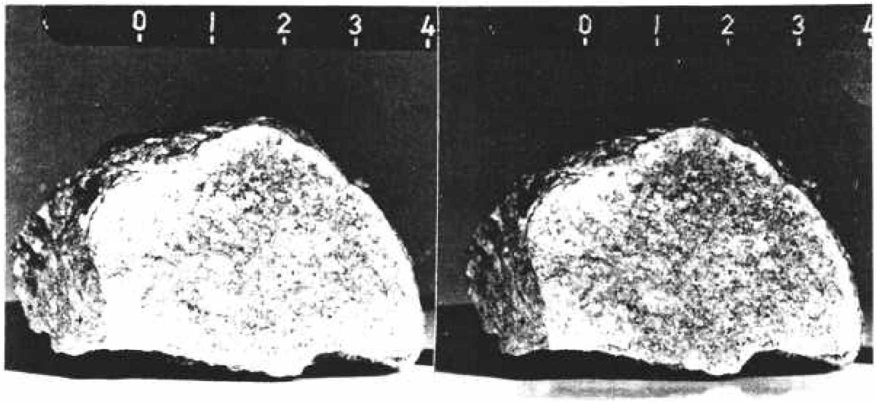
A

B



C

FIGURE 8.-Larger samples collected at stations 8 (*A-E*) and 9 (*F*). A, Sample 68115 (stereopair), from boulder 1. *B*, Closeup of 68115 showing boulder 3. *F*, Sample 69955 (stereopair). from



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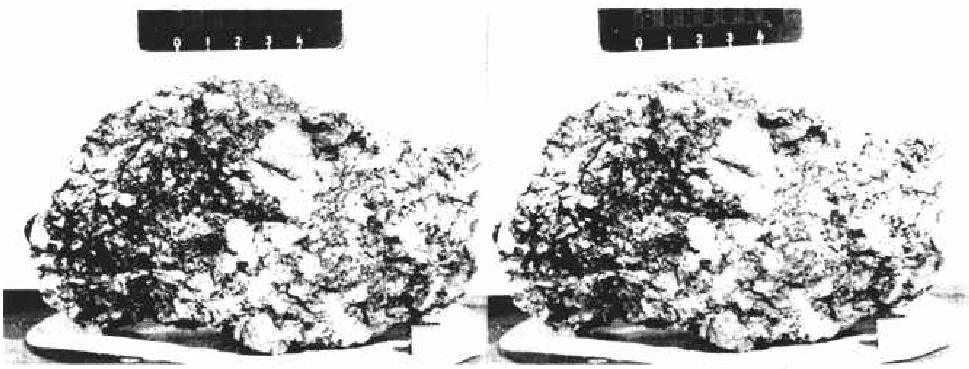
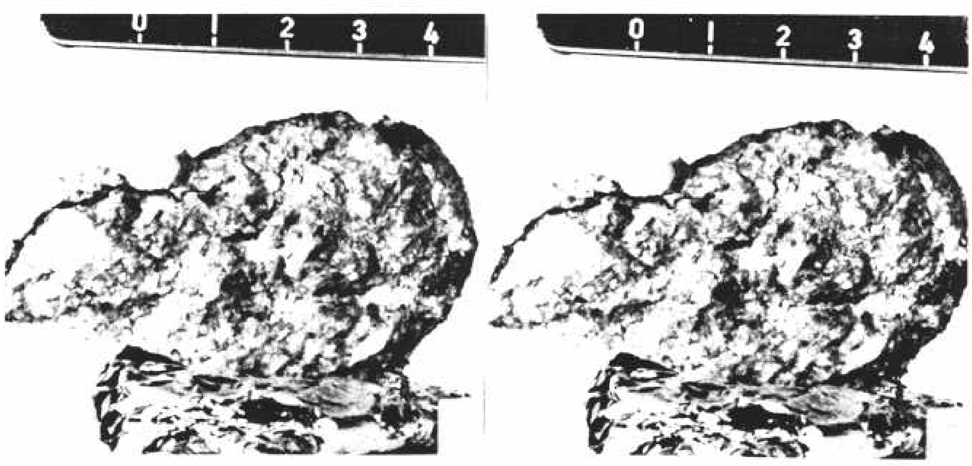


E



F

vugs. *C*. Sample 68415 (stereopair), from boulder 2. *D*, Sample 68416 (stereopair), from boulder 2. *E*, Sample 68815 (stereopair), from bottom side of the boulder. Scales in centimeters.

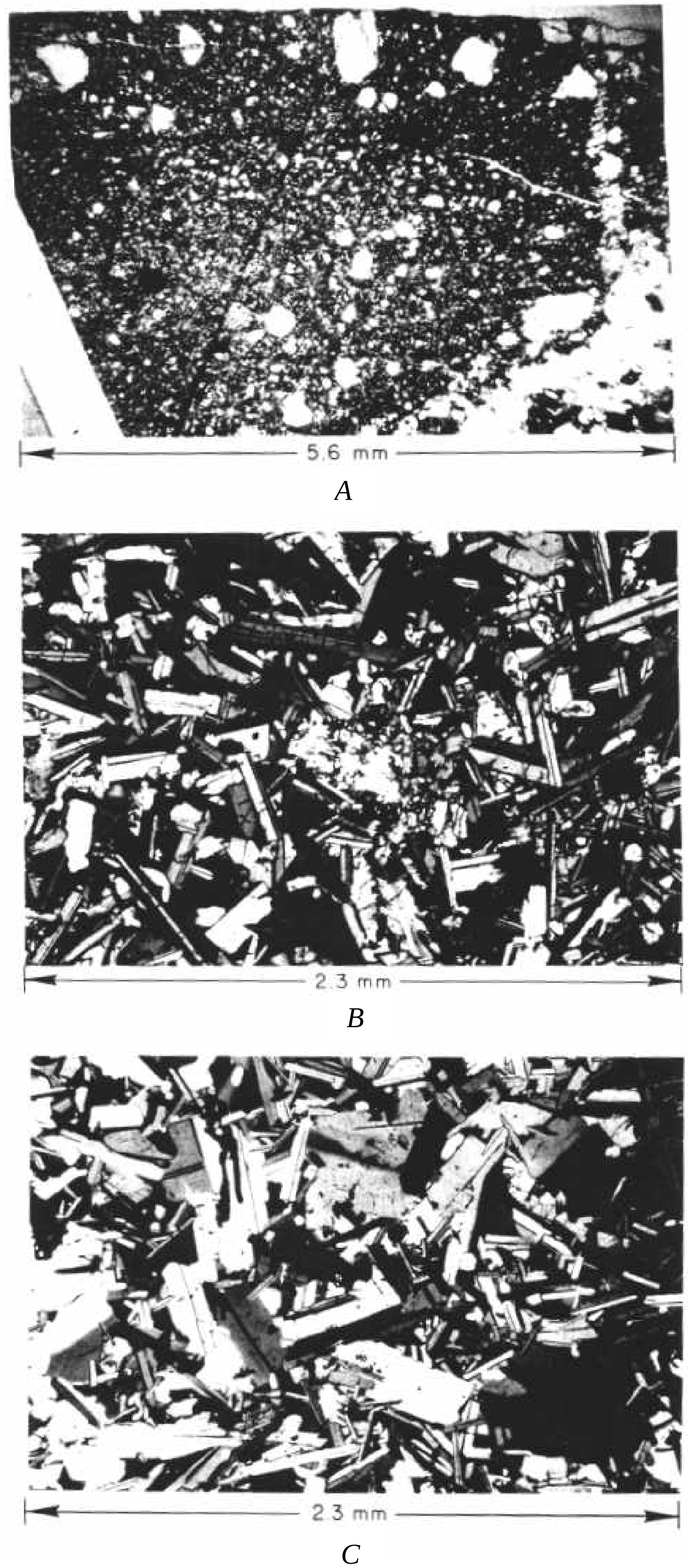
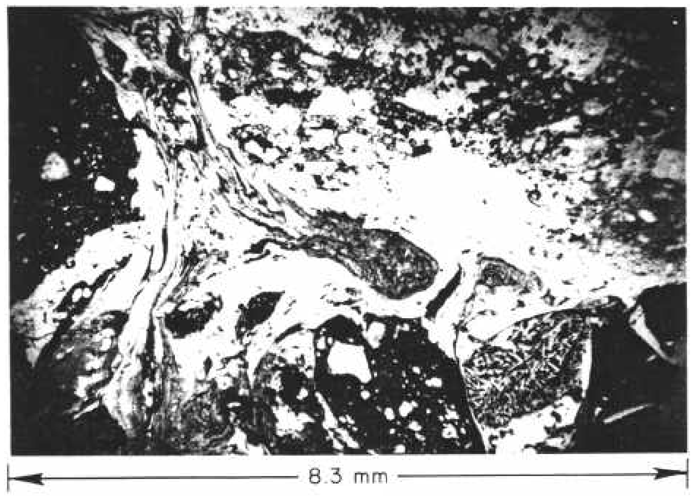


FIGURE 9. -Photomicrographs of rocks shown in figure 8. *A*, 68115, 95, plane-polarized light; glass and crushed plagioclase groundmass with relict plagioclast clasts. *B*, 68415, 142, cross-polarized light; subophitic plagioclase (twinned laths) and pyroxene with clast of shocked



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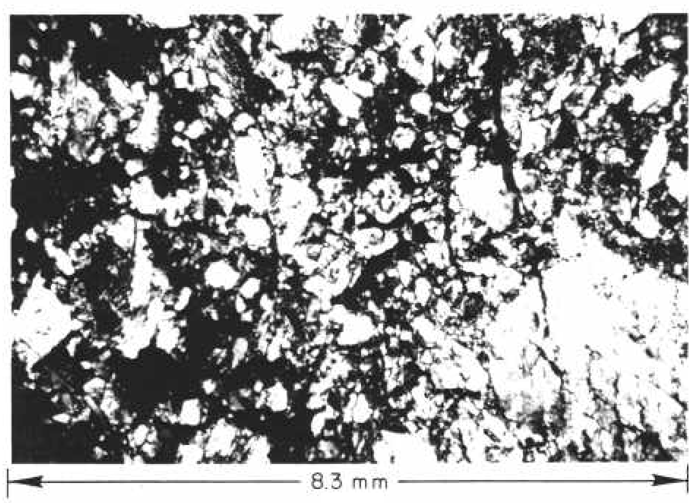
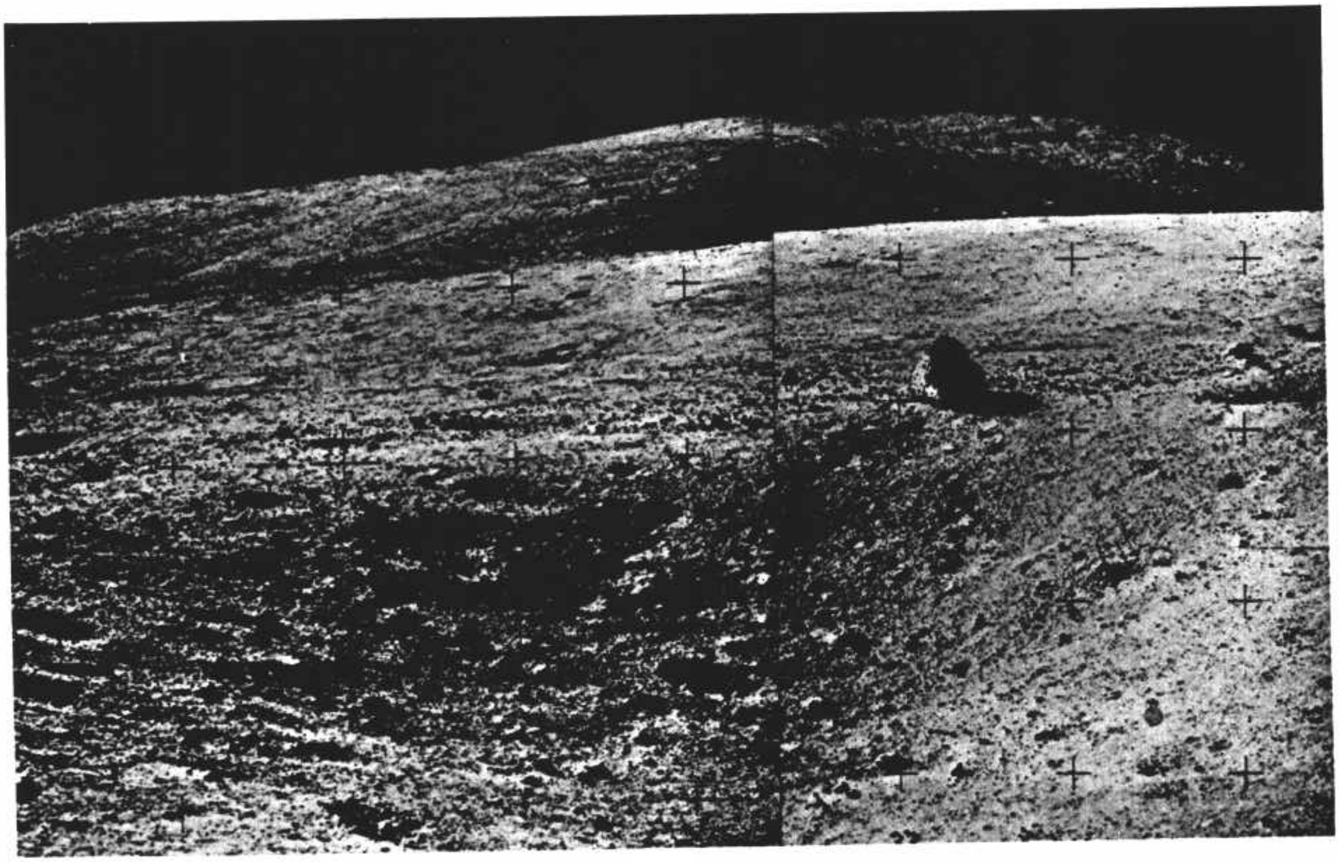
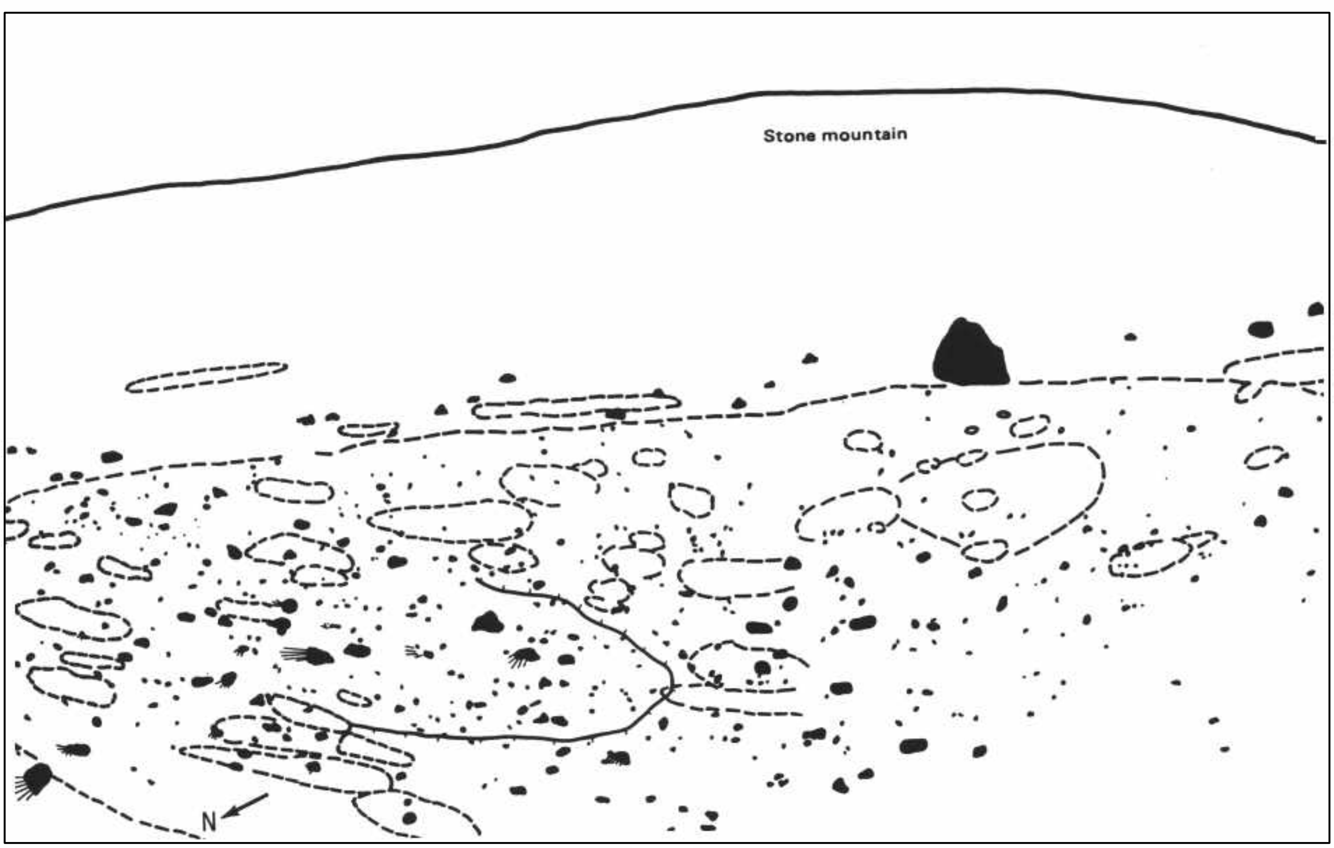


E

plagioclase in center. *C*. 68416, 78, cross-polarized light; seriate twinned plagioclase with pyroxene. *D*, 68815, 142, plane-polarized light; brown glass invading polymict breccia indicating several shock events. *E*. 69955, 30, cross-polarized light; shocked, partly melted coarse grained anorthosite.



A



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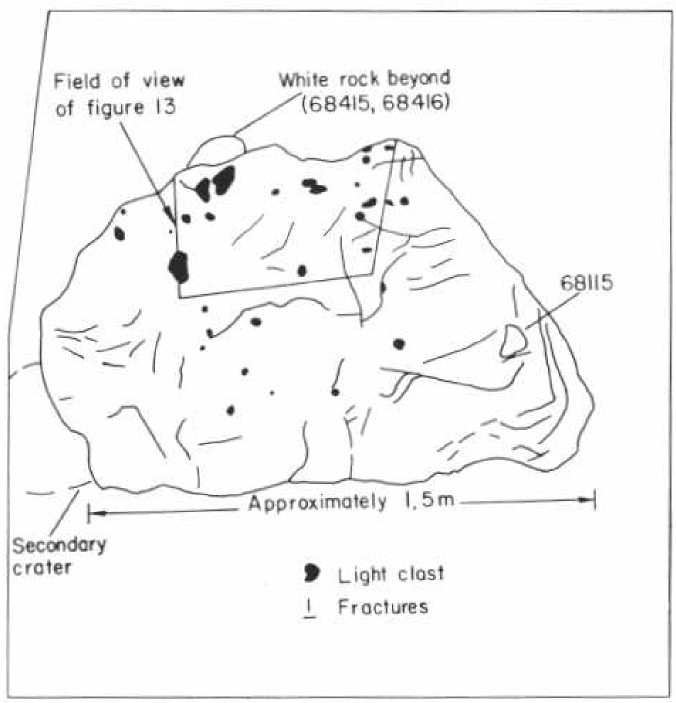
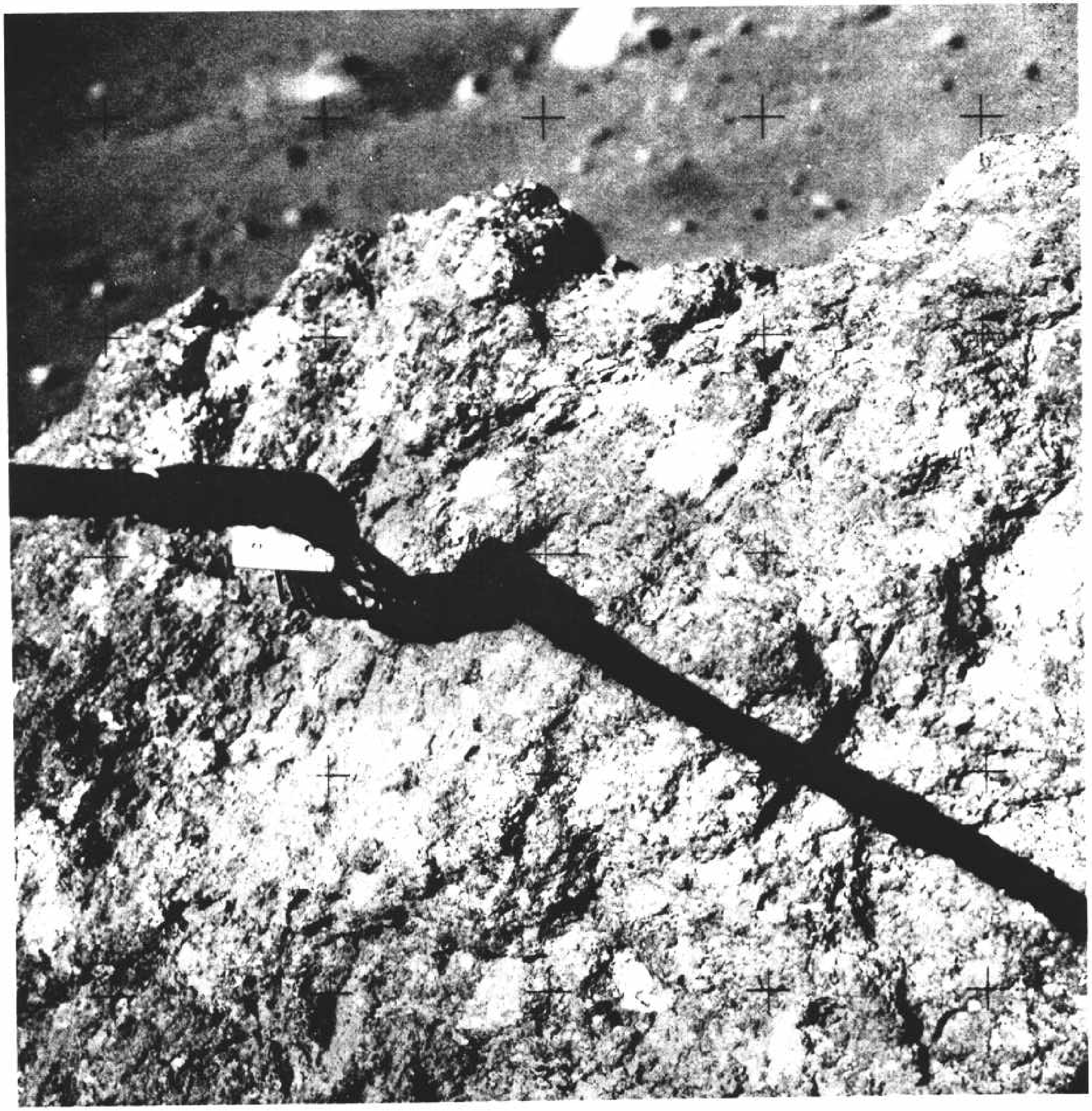


B

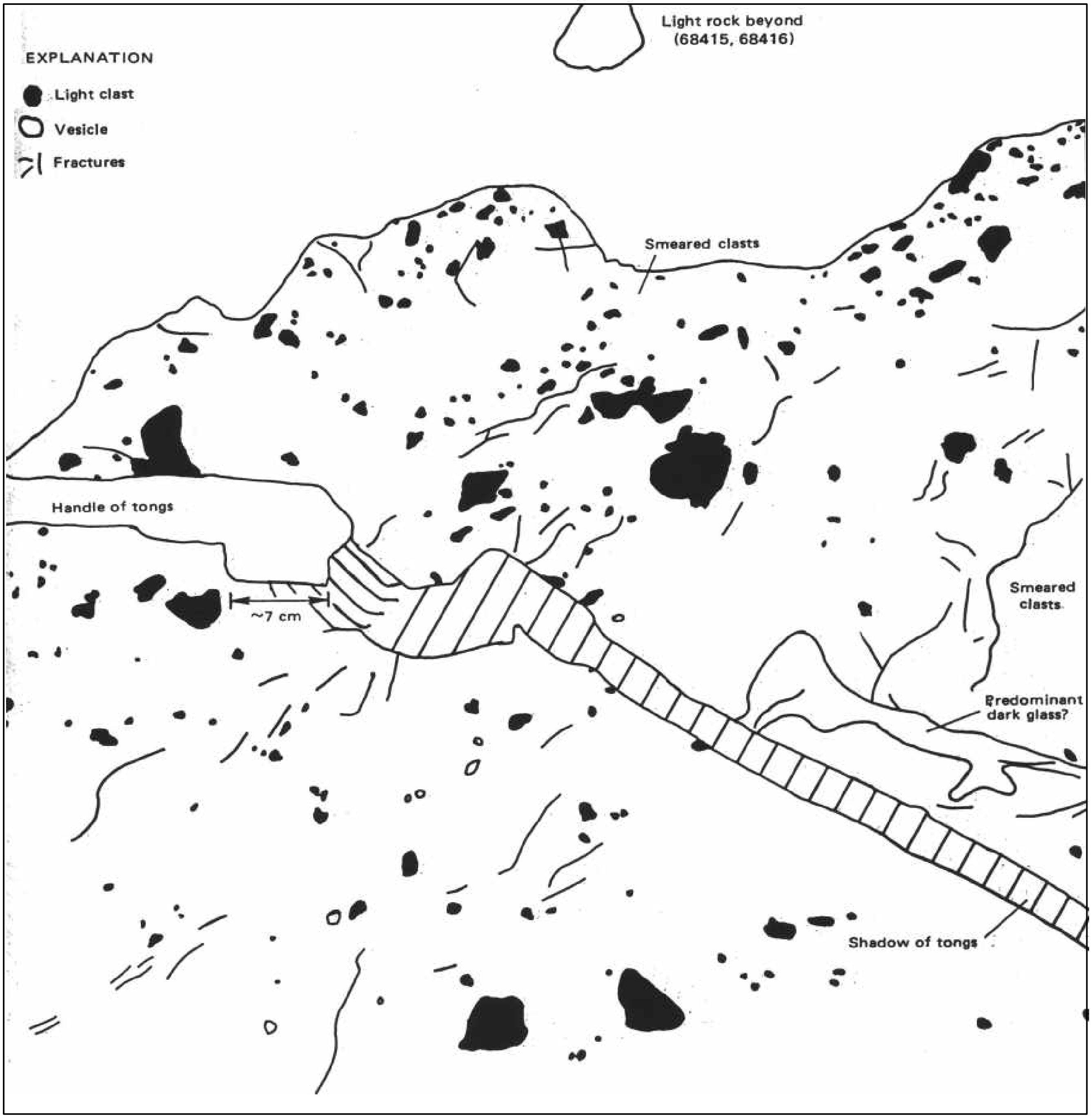
FIGURE 11.-Boulder 1, station 8. *A*, Photograph, view is southwest, AS16-108-17689. *B*, Sketch map.

< FIGURE 10.-Crater at station 8 that predates South Ray crater. *A*, Southeast view of 15-m crater. South Ray material is preferentially deposited on the downrange (left) side of the crater (AS16-108-17676). *B*, Sketch map of fragments (solid), fillets (whiskers), and craters (dashed) drawn from *A*.



A

FIGURE 12.-Boulder 1, station 8. *A*, Closeup view,



B

Apollo 16 photograph, AS16-108-17694 *B*, Sketch map.

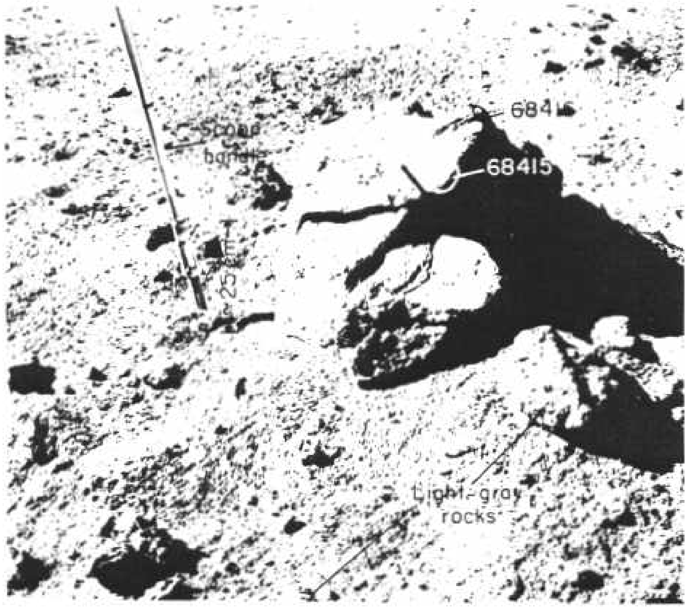
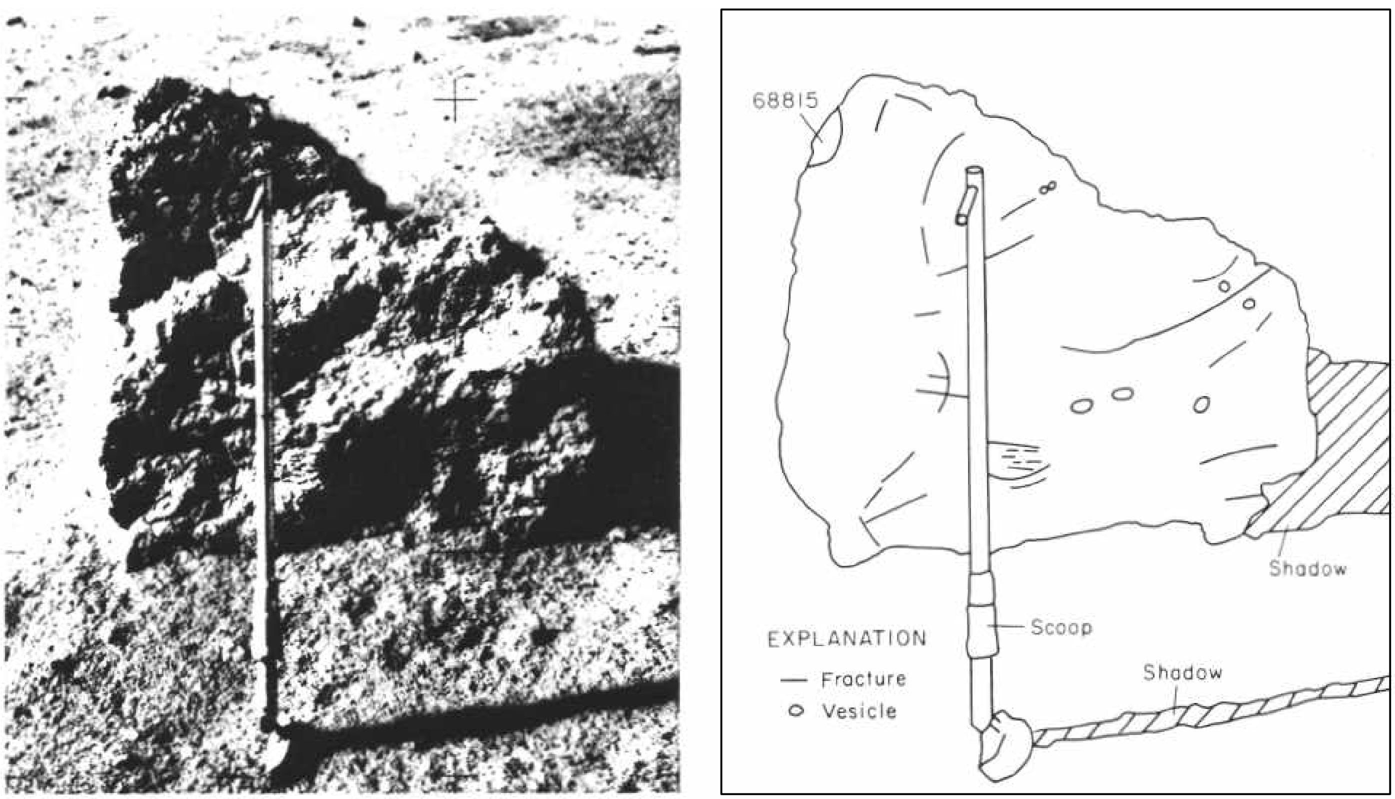
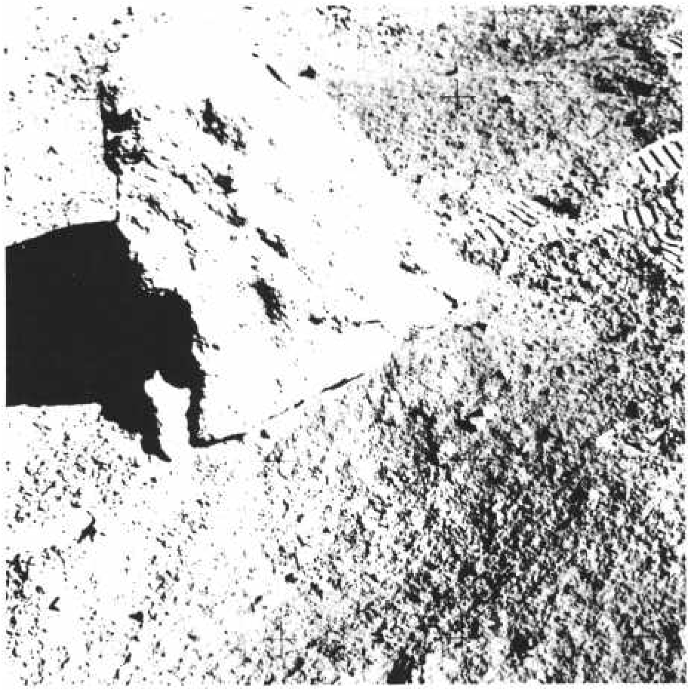


FIGURE 13-Boulder 2, station 8, showing location of samples collected; view is south (AS16-107-17549).

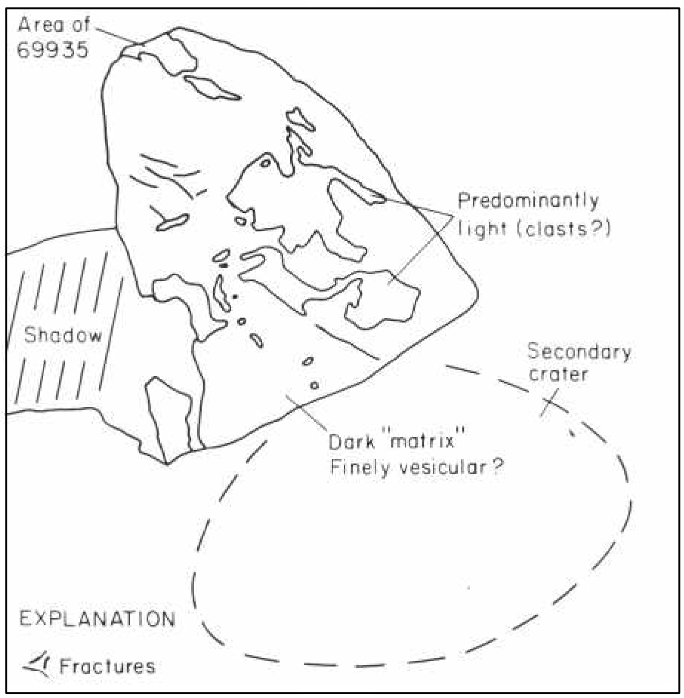


A *B*

FIGURE 14.-Boulder 3, station 8. *A*, Photograph before sampling, view is south (AS16-108-17700). *B*, Sketch map.

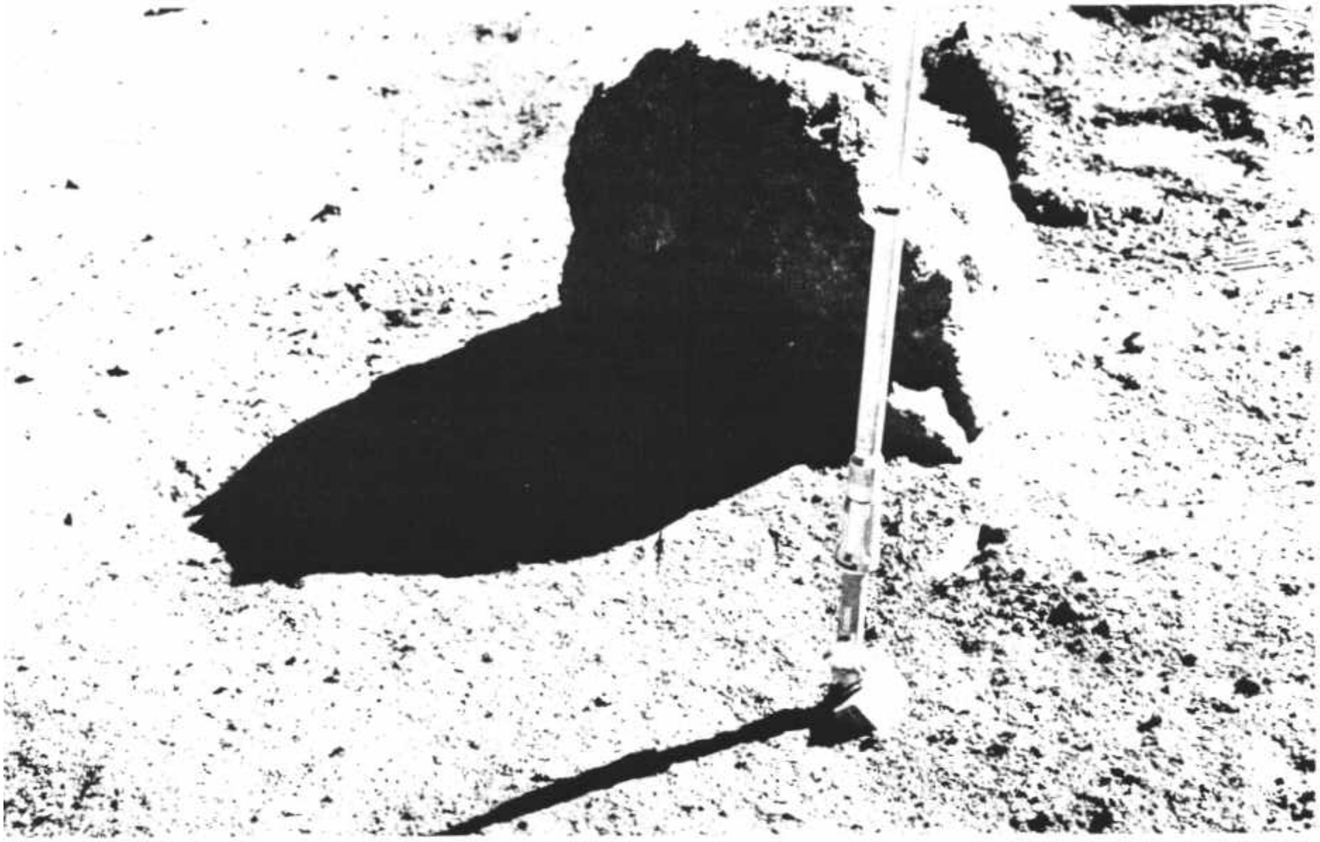


A

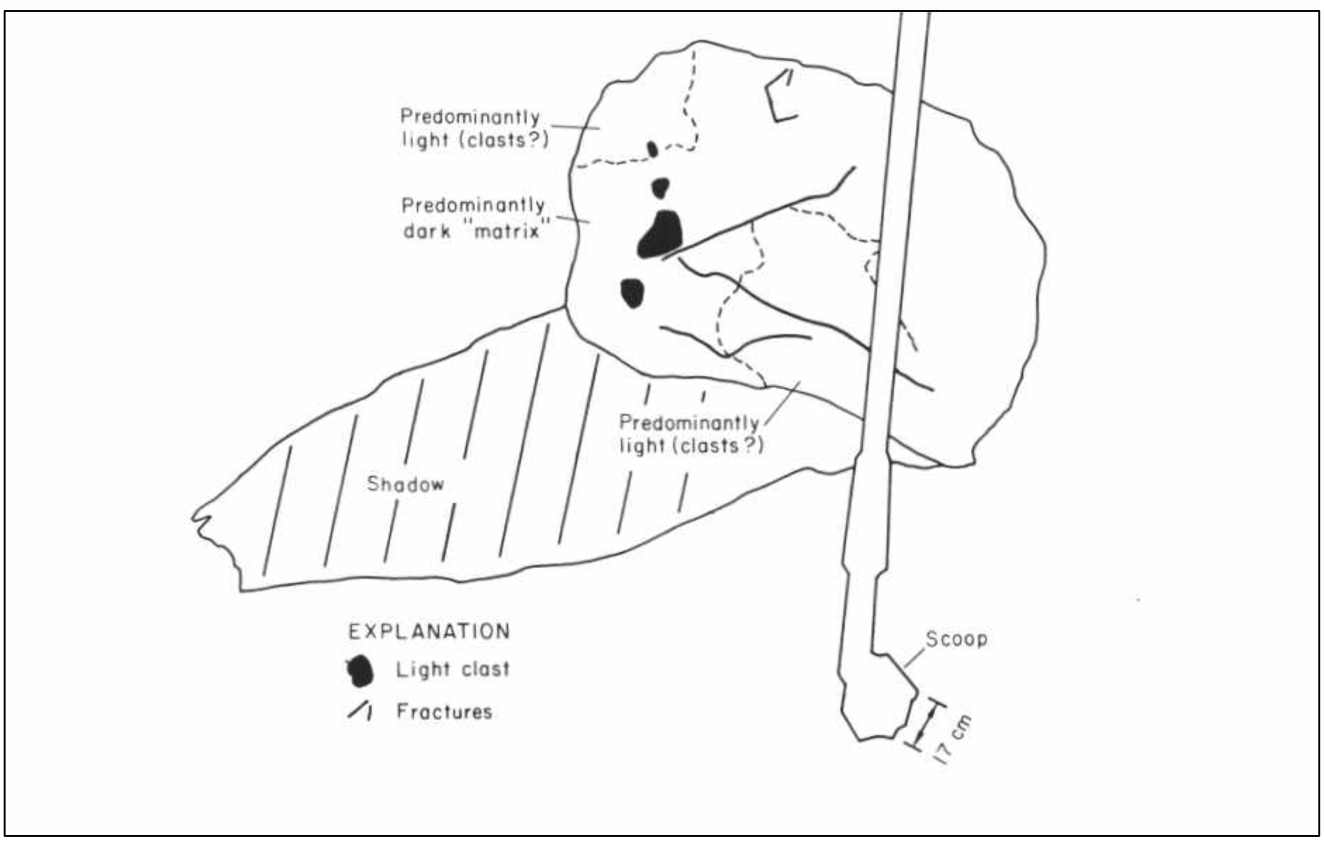


B

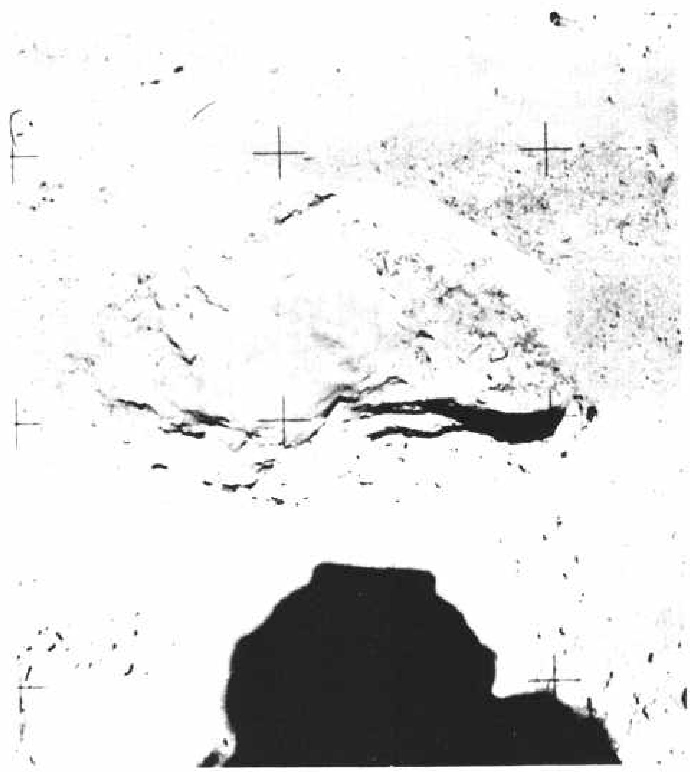
FIGURE 15-Station 9 boulder. *A*, Photograph, view is north, AS16-107- 17558. Boulder is about 50 cm wide. *B*, Sketch map.



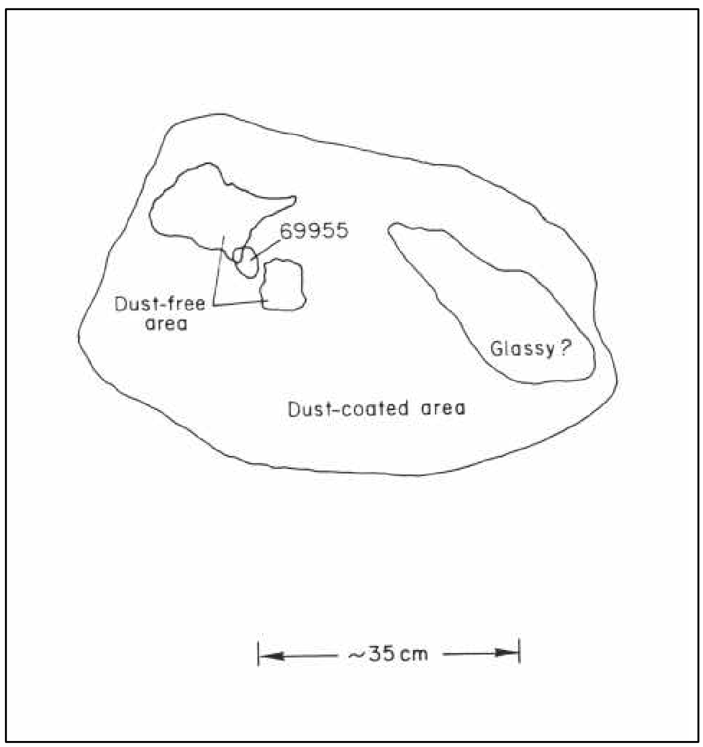
A


Predominantly light (clasts?)
Predominantly dark "matrix"
Predominantly light (clasts?)
Shadow
Scoop
17 cm
EXPLANATION
Light clast
Fractures

B



A



B

FIGURE 17.-Bottom of overturned boulder at station 9. *A*, Photograph before sampling, view is west, AS16-107-17576. *B*, Sketch map.

< FIGURE 16.-Station 9 boulder. *A*, Photograph, view is northeast (AS16-107-17558). *B*, Sketch map.

present. Exposure ages have been calculated for several station 8 and 9 rocks by several investigators (table 4).

The samples collected in the station areas appear to represent two lithologic units penetrated by the South Ray crater. Both light and dark fragments were collected, and light and dark blocks are visible on the rim of South Ray. The upper, dark unit (fig. 18) is about 50 m thick, the lower, light unit at least 70 m thick. (See Ulrich and Reed, this volume, for more detail.)

Most of the exposure ages for the station 8 and 9 boulders are about 2 to 3 m.y., which probably dates the South Ray impact. Older ages, however, indicate that exposure history may be complex or that the different dating techniques used have not yet been reconciled.

Neukum and others (1973) noted that the surface of 68415 is not saturated with microcraters, indicating it is freshly exposed rock. High exposure ages of 87-105 m.y. contradict this evidence but may represent an earlier exposure history for this boulder, preserved somehow in the material analyzed. Behrmann and others (1973) calculated an exposure age of 2 m.y. for 68815 and suggest that, prior to its ejection, it was buried at a depth greater than 7 m, which could place the boulder within the upper part of the dark unit prior to its excavation. Drozd and others (1973) calculated a 4.1-m.y.exposure age for 69955, 2 m.y. for 69935. They suggested that the boulder was in the upper few centimeters of the regolith in the South Ray target area, inverted from its present position for 2.1 m.y., then ejected from South Ray 2 m.y. ago. It seems unlikely, however, that a half-meter boulder near the surface of the South Ray impact point could have survived the event as well as the flight to station 9. More reasonably, the boulder was part of the upper dark layer and was ejected by the South Ray impact 2 m.y. ago. The boulders from which samples 68815, 68115, and 69955 were collected probably all represent the dark unit in South Ray crater, as all three are dark matrix (B_4 and B_5) breccias. The presence of light-gray rocks and fines on South Ray and Baby Ray craters and in the station areas suggests that igneous rocks 68415 and 68416 from boulder 2 are representative of the underlying light layer (impact melt). Crystallization ages reported for these rocks (table 4) are 3.68 to 4.09 b.y. and 3.87 to 4.00 b.y., respectively. These are inferred to represent the approximate age of emplacement of the fluidized material within the Cayley Formation as proposed by Hodges and Muehlberger (this volume). It seems fairly conclusive that the impact that formed South Ray crater occurred 2 to 3 m.y. ago and that the dark breccias and light igneous rocks sampled at stations 8 and 9 are representative of two discrete layers penetrated by South Ray.

The problem of assigning the samples collected at stations 8 and 9 to South Ray crater arises from the exposure ages of the fines (McKay and Heiken, 1973). Walton and others (1973) and Kirsten and others (1973) reported exposure ages of 180 m.y., 170 m.y., and 240 m.y. for 68841, 69941, and 69921, respectively. Schaeffer and Husain (1973) analyzed eight 2- to 4-mm fragments, obtaining exposure ages of 122 to 168 m.y. Adams and McCord (1973) stated that station 8 soils are mature, according to their high agglutinate content.

It appears that little fine debris was sampled that can be attributed directly to South Ray. Two explanations have been proposed: (1) the fines collected represent older regolith ejected by the South Ray impact (McKay and Heiken, 1973) or (2) there is little or no fine South Ray debris in these areas. If the soils do represent older ejected regolith, it would probably be indistinguishable from the preexisting regolith in the station areas. Size analysis of the soils (Butler and others, 1973), however, indicates that there may be recognizable mixing of South Ray and underlying fines and that the coarser fractions are likelier to represent the latest depositional material.

McKay and Heiken (1973) calculated that approximately 20 percent of the material ejected from South Ray was preexisting regolith, based on a regolith thickness of 10-15 m. As the regolith may not be more

TABLE 3.-*Reported exposure ages of rocks collected at stations 8 and 9*

Rock No.	Age (m.y.)	Method	Age source
68415	2-3	Microcraters	D. A. Morrison and others 1973.
	2.2+/-0.3	^{81}Kr-^{83}Kr and ^{81}Kr-^{78}Kr	Behrmann and others, 1973.
	95-105	Cosmic ray	Huneke and others, 1973a.
	87+/-5	^{40}Ar-^{39}Ar	Kirsten and others, 1973.
	92.5+/-13.3	^{81}Kr-Kr	Drozd and others, 1974.
68815	2.0+/-0.2	^{81}Kr-^{83}Kr and ^{81}Kr-^{78}Kr	Behrmann and others, 1973.
	1.7+/-0.4	^{22}Na-^{21}Na	Do.
	2.04+/-0.20	^{81}Kr-Kr	Drozd and others, 1974.
68115	2.08+/-0.32	^{81}Kr-Kr	Do.
68416	2-3	Microcraters	D. A. Morrison and others 1973.
	89+/-4	^{40}Ar-^{39}Ar	Kirsten and others, 1973.
69935	2-3	Microcraters	D. A. Morrison and others 1973.
	1.9+/-0.2	^{81}Kr-^{78}Kr	Behrmann and others, 1973.
	3.3+/-0.3	^{81}Kr-^{83}Kr	Do.
	2.2+/-0.3	^{22}Na-^{21}Na	Do.
	1.99+/-0.37	^{81}Kr-Kr	Drozd and others, 1974.
69955	4.25+/-0.41	^{81}Kr-Kr	Do.

TABLE 4.-*Reported crystallization ages for samples 68415 and 68416, station 8*

Age (b.y.)	Method	Source
68415		
3.84+/-0.01	Rb-Sr	Papanastassiou and Wasserburg, 1972a.
3.68+/-0.08	Total Ar	Kirsten and others, 1973.
3.85+/-0.06	^{40}Ar-^{39}Ar	Do.
3.96+/-0.08	^{207}Pb-^{206}Pb	Anderson and Hinthorne, 1973
4.09+/-0.04	^{40}Ar-^{39}Ar	Huneke and others, 1973a.
3.85+/-0.04	^{40}Ar-^{39}Ar	Do.
3.85+/-0.01	Rb-Sr	Tera and others, 1973.
68416		
3.87+/-0.08	Total Ar	Kirsten and others, 1973.
4.00+/-0.05	^{40}Ar-^{39}Ar	Do.

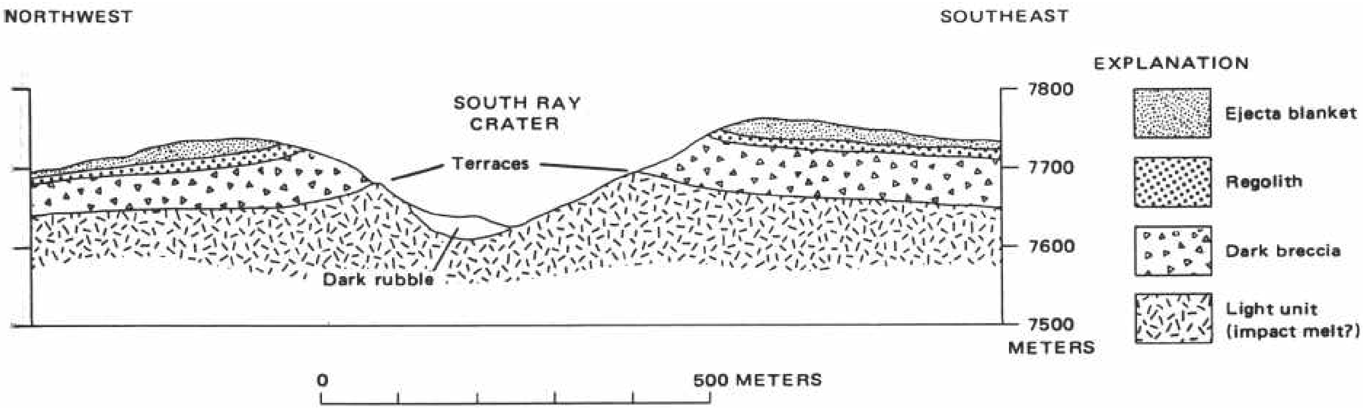


FIGURE 18.-Schematic cross-section through South Ray crater.

than 6-7 m thick (Freeman, this volume), older regolith in the ejecta may be considerably less than calculated. McKay and Heiken suggested that the amount of freshly produced fine material may be very small. It is possible, then, that little fine material in this area can be attributed directly to South Ray, either as older, preexisting regolith or as freshly produced fines.

If there is little or no soil produced by South Ray in the area, there must be another explanation for the high-albedo rayed surface at station 8. In several other station areas, the crew reported light-colored soil underlying a thin dark surface layer. At station 8, the soil appears to be a uniform gray. This uniformity may have been produced by churning of the upper few centimeters of the regolith as fragments from South Ray impacted. Such a process, in the absence of much fine debris, could generate a surface of higher albedo. The surface at station 8 (located on a prominent ray) has a rough appearance suggestive of such churning of the upper regolith, whereas the surface at station 9 has a lower albedo and is much smoother, compatible with a less prominently rayed terrain.

The apparent absence of primary South Ray fines is not surprising considering the intense mixing of the upper regolith as the rays were deposited. It is apparent that there was not a "blanket" of material deposited but rather that the high albedo was produced by a turbulent, churning disturbance of the older, darker regolith surface by South Ray ejecta, which deposited only sparse new material as blocks and fragments in the ray-covered area. This is consistent with the conclusion of Oberbeck and others (1974a, b, 1975) that beyond the continuous ejecta blanket, the proportion of primary material present is small, relative to the local material excavated by secondaries from the crater. These conclusions are also in agreement with a South Ray ejecta model proposed by Hodges and others (1973) (see also Ulrich and others, this volume) that presents an average thickness of ejecta based on fragment population, evenly distributed over 360° of arc. According to their preferred model, "an indeterminate, but small amount of South Ray ejecta should be expected in the interray areas, and the materials of the rays should be dominantly coarse debris."