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APOLLO 12 LUNAR-SAMPLE INFORMATION

by Jeffrey Warner, Compiler

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16. ABSTRACT

Scientific data obtained during the preliminary examination of the lunar samples returned from the Apollo 12 mission are presented. The sample-collecting tools and techniques and the contingency, selected, documented, and tote-bag samples are described. A preliminary search was conducted to determine the lunar-surface location and orientation of each sample, and the results are discussed. The results of the various chemical and isotopic analyses are given. Photographs and mineralogical/petrological descriptions of the samples, plots and descriptions of the controls and samples subjected to organic analyses, details of the organic-contamination monitors and controls, and an index of the photographic documentation both on the lunar surface and in the Lunar Receiving Laboratory are included in the report.

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CONTENTS

TABLES

FIGURES

Figure | Page

Figure		Page

Figure		Page

Figure		Page

APOLLO 12 LUNAR-SAMPLE INFORMATION

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SUMMARY

The second manned lunar landing occurred on November 19, 1969, when the Apollo 12 lunar module touched down on the Ocean of Storms. The scientific data obtained between November 25, 1969, and January 30, 1970, during the preliminary examination of the lunar samples returned from the Apollo 12 mission are presented in this report. Descriptions of the sample-collecting tools and techniques and of the contingency, selected, documented, and tote-bag samples are given. A preliminary search was conducted to determine the localities and orientations of the samples on the lunar surface; however, much work remains to be done to complete this task. Mineralogical/petrological, chemical, gamma-ray spectrometry, noble gas, total carbon, organic mass-spectrometry, and organic-monitor analyses were performed on the lunar samples, and the results are given and discussed.

Photographs and detailed descriptions of the samples, plots and descriptions of the samples and controls that were subjected to organic analysis, and details of the organic-contamination monitors and controls are presented. Photographic documentation is presented in (1) a log of all photographs taken both on the lunar surface and in the Lunar Receiving Laboratory, (2) an index of photographs by sample number and an index of samples by photograph number, and (3) a cross-reference of samples with the lunar-surface collection locations, photographs, and chronological sequence.

The major findings of the preliminary examination of the Apollo 12 lunar samples can be contrasted with the major findings of the samples from the first manned lunar landing (the Apollo 11 mission which landed on the Sea of Tranquility on July 20, 1969) as follows.

1. Although still old by terrestrial standards, the Apollo 12 rocks are approximately 1 billion years younger than the Apollo 11 rocks.

2. Whereas microbreccias comprised approximately one-half of the Apollo 11 samples, the Apollo 12 suite contained only two breccias in the 45 rocks returned.

3. The regolith at the Apollo 12 site was approximately one-half as thick as that at the Apollo 11 site.

4. Considerably less solar-wind material was found in the Apollo 12 fines than in the Apollo 11 fines.

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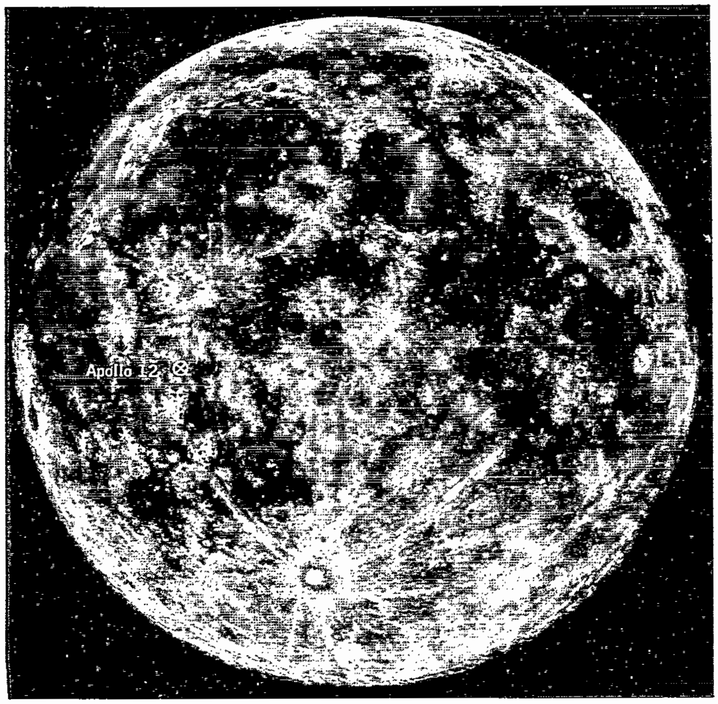
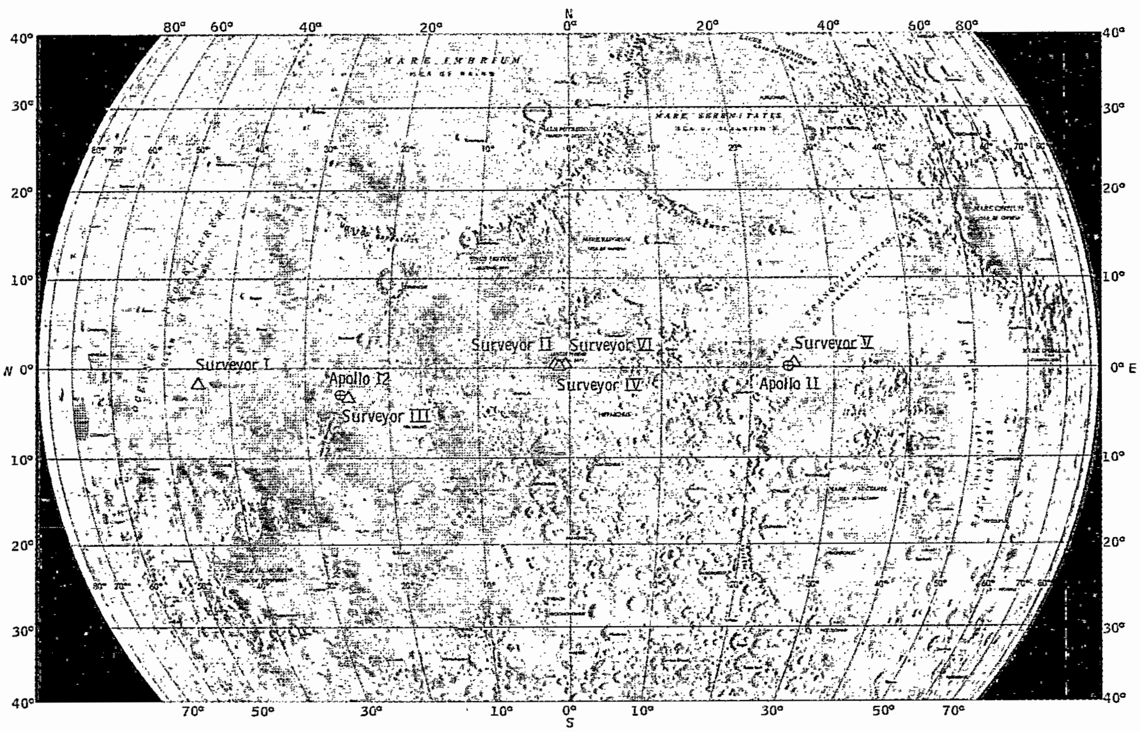
THE APOLLO 12 MISSION

The primary purpose of the Apollo 12 mission was to demonstrate a pinpoint landing capability on the lunar surface. The crewmembers were Charles Conrad, Jr., Commander (CDR), Richard Gordon, Command Module Pilot (CMP), and Alan Bean, Lunar Module Pilot (LMP).

The space vehicle was launched from Kennedy Space Center, Florida, at 11:22 a.m. e.s.t. on November 14, 1969. The lunar module (LM) landed in the Ocean of Storms (fig. 1) at 110:32:35 ground-elapsed time, approximately 200 meters from the Surveyor III spacecraft (fig. 1(d)). The landing coordinates were 2.45° S latitude and 23.34° W longitude.



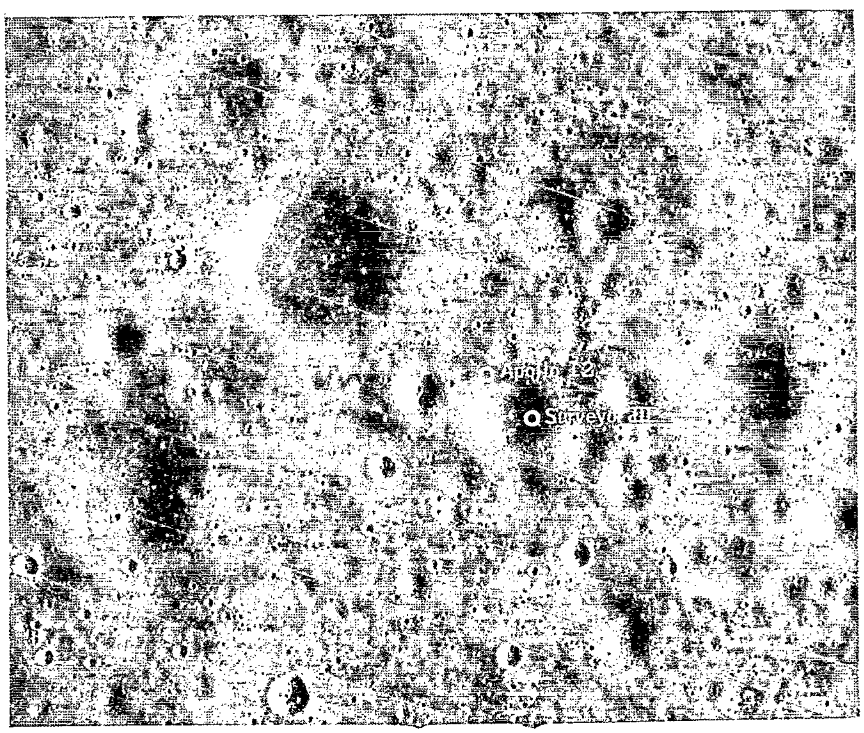
(a) Broad view (NASA-S-69-39524).



(b) General.

Figure 1. - Apollo 12 lunar-landing site.

(c) Regional.



(d) Local.

Figure 1. - Concluded.

Extravehicular Activity

The extravehicular activity (EVA) on the lunar surface was divided into two 4-hour traverses separated by an 8-hour eat/rest period. The length of each EVA was dictated by the capabilities of the life-support system. Four types of samples (contingency, selected, documented, and tote bag) were collected from the lunar surface and returned to the LRL. The sample return is listed in table I.

TABLE I. - LUNAR-SAMPLE RETURN

Type of sample (a)	Weight, g
Contingency sample	
Fines	1 102
Chips	9
Rocks (4)	821
Total	1 932
Selected sample	
Fines	2 716
Chips	50
Rocks (20)	11 940
Core tube (19 cm)	101
Total	14 807
Documented sample	
Fines plus chips	650
Rocks (6)	6 124
Documented bags (13)	
Fines plus chips (7)	1 353
Rocks (11)	2 288
Core tube	
Double tube (40 cm)	246
Unopened	80
Lunar-environment sample container (LESC)	269
Gas-analysis sample container (GASC)	57
Total	11 067
Tote-bag sample	
Fines	21
Chips	10
Rocks (4)	6 488
Total	6 519
Summary	
Fines and chips	5 911
Rocks (45)	27 661
Special samples	753
Total return	34 325

[a]Fines are less than 1 centimeter, chips are between 1 and 4 centimeters, and rocks are larger than 4 centimeters.

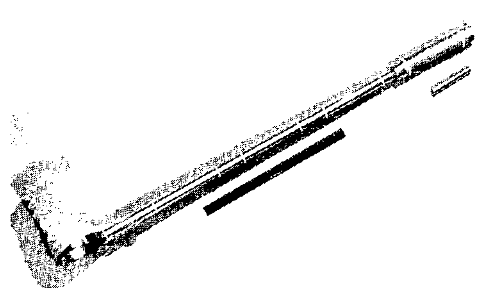
In addition to collecting samples, the main scientific tasks to be accomplished during the extravehicular activities were (1) photographing rocks, the lunar surface, and the moonscape; (2) deploying the Apollo lunar-surface experiments package (ALSEP) during the first EVA; (3) collecting parts from the Surveyor III spacecraft during the second EVA; and (4) deploying and retrieving the solar-wind foil. The ALSEP contained a central-power communication station and five experiment units: the passive seismometer, the cold-cathode ion gage, the suprathermal ion detector, the solar-wind spectrometer, and the magnetometer.

Sample-Collecting Tools and Techniques

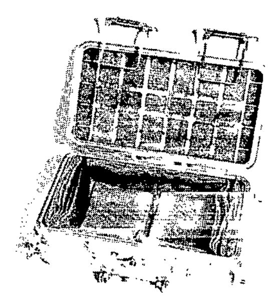
To obtain samples of the lunar surface, the Apollo 12 crew used the sample-collecting tools and techniques described in the following paragraphs. The tools were designed of material that was durable enough to accomplish the tasks yet light enough to conform to the weight and space limitations of the LM stowage area. The limitations imposed on the movements of a crewman while wearing a pressurized space suit also had to be considered; therefore, the tools were designed with quick-disconnect fittings to enable the crewman to attach or detach components with minimum difficulty. Knurled or roughened areas were provided on many tools to improve the crewman's grip, and an extension handle was provided to lengthen the crewman's reach. Prime consideration was given to the selection of the metals and lubricants used in the construction of the tools to avoid elements and isotopes (such as lead (Pb), strontium (Sr), et cetera) that might contribute to serious geochemical contamination of the lunar material.

The contingency-sample container (fig. 2(a)) consisted of a small Teflon bag and a jointed aluminum handle that was approximately 84.5 centimeters long in the fixed extended position. The Teflon bag measured 5.2 by 12.7 by 17.8 centimeters. The contingency-sample container was used to obtain a lunar sample during the early stages of the first EVA.

The two Apollo lunar-sample-return containers (ALSRC) (fig. 2(b)) were portable, sealable aluminum containers. Each ALSRC weighed approximately 6.8 kilograms, measured 20.3 by 26.7 by 44.5 centimeters, and had a capacity of 0.023 cubic meter. Before the lunar landing, the containers housed the core tubes and other related equipment. On the lunar surface, the astronauts opened, filled, and closed the containers. The three seals on the hinged lids (one of indium (In) and two of Viton) preserved the samples in a vacuum environment during transportation back to the LRL.



(a) Contingency-sample container.



(b) Apollo lunar-sample-return container.

Figure 2. - Sample-collecting equipment.

The hammer (fig. 2(c)) was made of tool steel suitable for impact use. The head was coated with vacuum-deposited aluminum to minimize solar heating. The handle was offset slightly so that the crewman could strike a direct blow despite the encumbrance of the pressurized space suit. One end of the hammerhead was shaped for use as a pick or chisel; with the extension handle attached, it could have been used as a hoe for trenching or digging. The hammer also could have been used for driving the core tubes into the subsurface by striking the end of the extension handle.

The tongs (fig. 2(d)) were constructed of anodized aluminum and were used to retrieve samples of pebble size and larger. This tool consisted of a set of opposed spring-loaded fingers attached to a 66-centimeter-long handle. The tongs were operated by squeezing the handles to actuate the cable that opened the fingers.

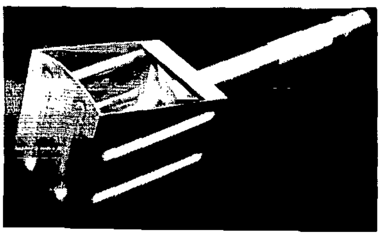
(c) Hammer.

(d) Tongs.

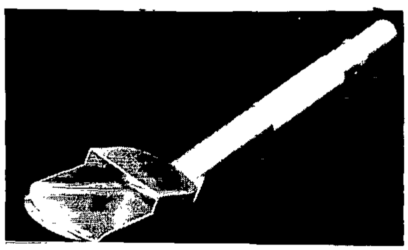
Figure 2. - Continued.

The large scoop (fig. 2(e)) was constructed of anodized aluminum. The length of the scoop and handle was 39.4 centimeters and could have been extended an additional 58.4 centimeters by use of the extension handle. The large scoop was used during the lunar EVA to collect the selected sample.

The small scoop (fig. 2(f)) was 29.8 centimeters in length. The pan of the scoop had a flat bottom that was flanged on both sides and a partial cover on the top to prevent loss of contents. It was used to retrieve sand, dust, or other lunar material too small for the tongs. The small scoop was made of anodized aluminum with a steel-alloy inset on the front edge that was suitable for cutting cohesive material. The handle had a quick-disconnect mount for attaching the extension handle.



(e) Large scoop.



(f) Small scoop.

Figure 2. - Continued.

The core tubes (fig. 2(g)) were constructed of anodized aluminum and were used to obtain samples from the lunar surface in such a manner that the near-surface stratigraphy was preserved. The core tubes were 41.3 centimeters long and could be attached to the extension handle. Four tubes were used on the Apollo 12 mission.

The extension handle (fig. 2(h)) increased the crewman's reach by adding 58.4 centimeters of handle length to various tools. The lower end of the extension handle had a quick-disconnect mount and lock for tool attachment. The upper end was fitted with a sliding T-handle to facilitate torquing operations.

(g) Core tubes.

(h) Extension handle.

Figure 2. - Concluded.

The gnomon was a stadia rod mounted on a tripod and was constructed so that the rod would right itself and point vertically when the legs were put down on the lunar surface. The gnomon was an indicator of the gravitational vector and provided accurate vertical reference and calibrated length for determining the size and position of objects in near-field photographs. The shadow cast by the staff indicated the solar position. The gnomon had a finish painted in shades of gray ranging in reflectivity from 5 to 35 percent in 5-percent increments and a color scale of blue, orange, and green. The scales were provided as a means of accurately determining colors in color photographs. The rod was 45.7 centimeters long, and the tripod base folded for compact stowage in the modularized equipment-stowage assembly.

The individual sample bags also were known as the documented sample bags or as the "Dixie cups." The bags were made of Teflon and had an aluminum crimping ring. Each bag could hold approximately one-third liter.

Lunar Samples

The Apollo 12 sample return and inventory are listed in tables I and II. The mass distribution of the samples is shown in table III.

TABLE II. - LUNAR-SAMPLE INVENTORY

Sample number	Mass, g	Type code (a)	Remarks
Selected samples[b]			
12001	2216.0	D	Less than 1-cm vacuum fines
12202	1529.5	B	Olivine dolerite[c] — vacuum[d]
12003	300.0	D	Fines and chips
12004	585.0	A	Olivine basalt — vacuum
12005	482.0	A	Olivine basalt — vacuum
12006	206.4	AB	Olivine basalt with radiating feldspar laths
12007	65.2	A	Basalt
12008	58.4	AB	Cumulate (ilmenite)
12009	468.2	A	Porphyritic olivine (feldspar) basalt, large depression — vacuum
12010	360.0	A	Basalt — vacuum
12011	193.0	A	Olivine basalt — vacuum
12012	176.2	AB	Olivine basalt — vacuum
12013	82.3	A	Igneous breccia — vacuum
12014	159.4	B	Olivine dolerite — vacuum

[a]Type A, fine-grained vesicular crystalline igneous rocks; type B, medium-grained vuggy crystalline igneous rocks; type C, breccias; type D, fines; and type E, chips.

[b]The S-ALSRC contained 40 to 60 microns of pressure when returned to the LRL.

[c]Dolerite is a rock of basaltic composition with an intermediate crystal size.

[d]Samples 12002 to 12022 labeled "vacuum" were exposed to 1 atmosphere of nitrogen (N) for at least 2 hours.

TABLE II. - LUNAR-SAMPLE INVENTORY - Continued

Sample number	Mass, g	Type code (a)	Remarks
Selected samples[b] - Concluded			
12015	191.2	A	Porphyritic olivine basalt, large depression — vacuum
12016	2028.3	AB	Basalt — vacuum
12017	53.0	AB	Glass-coated basalt — vacuum
12018	787.0	B	Olivine dolerite — vacuum
12019	462.4	A	Basalt — vacuum
12020	312.0	A	Olivine basalt — vacuum
12021	1876.6	B	Pigeonite dolerite, pegmatite — vacuum
12022	1864.3	B	Olivine dolerite — vacuum
Special samples			
12023	269.3	D	LESC
12024	56.5	D	GASC
12025	56.1	D	Core 2010 (second EVA — top of double tube)
12026	101.4	D	Core 2013 (first EVA)
12027	80.0	D	Core 2011 (second EVA — unopened as of Jan. 1, 1970)

[a]Type A, fine-grained vesicular crystalline igneous rocks; type B, medium-grained vuggy crystalline igneous rocks; type C, breccias; type D, fines; and type E, chips.

[b]The S-ALSRC contained 40 to 60 microns of pressure when returned to the LRL.

TABLE II. - LUNAR-SAMPLE INVENTORY - Continued

Sample number	Mass, g	Type code (a)	Remarks
Special samples - Concluded			
12028	189.6	D	Core 2012 (second EVA — bottom of double tube)
12029	6.5	D	Fines with Surveyor scoop
Documented samples[e]			
12030	75.0	D	Bag 1-D — fines
12031	185.0	B	Bag 3-D — olivine dolerite
12032	310.5	D	Bag 4-D — fines
12033	450.0	D	Bag 5-D — fines
12034	155.0	C	Bag 6-D — crystal breccia with glass
12035	71.0	B	Bag 7-D — olivine dolerite
12036	75.0	B	Bag 8-D — olivine dolerite
12037	145.0	D	Bag 8-D — fines
12038	746.0	A	Bag 9-D — basalt
12039	255.0	B	Bag 10-D — olivine dolerite
12040	319.0	B	Bag 10-D — olivine dolerite
12041	24.8	D	Bag 11-D — fines
12042	255.0	D	Bag 12-D — fines

[a]Type A, fine-grained vesicular crystalline igneous rocks; type B, medium-grained vuggy crystalline igneous rocks; type C, breccias; type D, fines; and type E, chips.

[e]The D-ALSRC contained approximately 0.5 atmosphere when returned to the LRL. All of the documented samples were processed in nitrogen cabinets in room 1-126 of the LRL.

TABLE II. - LUNAR-SAMPLE INVENTORY - Continued

Sample number	Mass, g	Type code (a)	Remarks
Documented samples[e] - Concluded			
12043	60.0	A	Bag 14-D — basalt
12044	92.0	D	Bag 14-D — fines
12045	63.0	A	Bag 15-D — basalt
12046	166.0	A	Bag 15-D — basalt
12047	193.0	A	Bag 15-D — basalt
12048	2.0	D	Bag 7-D — fines
12050	1.0	E	Chip for organic analysis
12051	1660.0	AB	Olivine basalt
12052	1866.0	A	Olivine basalt
12053	879.0	A	Olivine basalt
12054	687.0	B	Dolerite with glass splash and shatter structure
12055	912.0	B	Basalt
12056	121.0	AB	Basalt
12057	650.0	DE	Fines and chips from bottom of D-ALSRC

[a]Type A, fine-grained vesicular crystalline igneous rocks; type B, medium-grained vuggy crystalline igneous rocks; type C, breccias; type D, fines; and type E, chips.

[e]The D-ALSRC contained approximately 0.5 atmosphere when returned to the LRL. All of the documented samples were processed in nitrogen cabinets in room 1-126 of the LRL.

TABLE II. - LUNAR-SAMPLE INVENTORY - Concluded

Sample number	Mass, g	Type code (a)	Remarks
Tote-bag samples[f]			
12060	20.7	D	Fines
12061	9.5	E	10 chips from tote bag
12062	738.7	AB	Basalt; has depression with raised cone with radial cracks
12063	2426.0	A	Olivine basalt
12064	1214.3	B	Dolerite with cristobalite
12065	2109.0	AB	Pigeonite porphyry consisting of plagioclase, pigeonite, and ilmenite
Contingency samples[g]			
12070	1102.0	D	Fines
12071	9.16	E	Chips
12072	103.6	A	Basalt
12073	407.65	C	Breccia — originally samples 12073 and 12074 (361.0 + 46.65 g)
12075	232.5	A	Olivine basalt
12076	54.55	A	Basalt
12077	22.63	A	Basalt

[a]Type A, fine-grained vesicular crystalline igneous rocks; type B, medium-grained vuggy crystalline igneous rocks; type C, breccias; type D, fines; and type E, chips.

[f]Studied in nitrogen cabinets; handled by personnel in Crew Reception Area (CRA) for 20 minutes.

[g]Studied in nitrogen cabinets.

TABLE III. - LUNAR-SAMPLE MASS DISTRIBUTION

Mass, g	Sample number	Mass, g	Sample number
1.0	12050	206.4	12006
9.16	[a]12071	232.5	12075
9.5	[a]12061	255.0	12039
20.7	[a]12060	255.0	[a]12042
22.63	12077	269.3	[a]12023
24.8	[a]12041	300.0	[a]12003
46.65	12074	310.5	[a]12032
53.0	12017	312.0	12020
54.55	12076	319.0	12040
56.1	[a]12025	360.0	12010
56.5	[a]12024	407.65	12073
58.4	12008	450.0	[a]12033
60.0	12043	462.4	12019
63.0	12045	468.2	12009
65.2	12007	482.0	12005
71.0	12035	585.0	12004
75.0	[a]12030	650.0	[a]12057
75.0	12036	687.0	12054
80.0	[a]12027	738.7	12062
82.3	12013	746.0	12038
92.0	[a]12044	787.0	12018
101.4	[a]12026	879.0	12053
103.6	12072	912.0	12055
121.0	12056	1102.0	[a]12070
136.0	[a]12048	1214.3	12064
145.0	[a]12037	1529.5	12002
155.0	12034	1660.0	12051
159.4	12014	1864.3	12022
166.0	12046	1866.0	12052
176.2	12012	1876.6	12021
185.0	12031	2028.3	12016
189.6	[a]12028	2109.0	12065
191.2	12015	2216.0	[a]12001
193.0	12011	2426.0	12063
193.0	12047		

[a]Lunar fines or fines and chips.

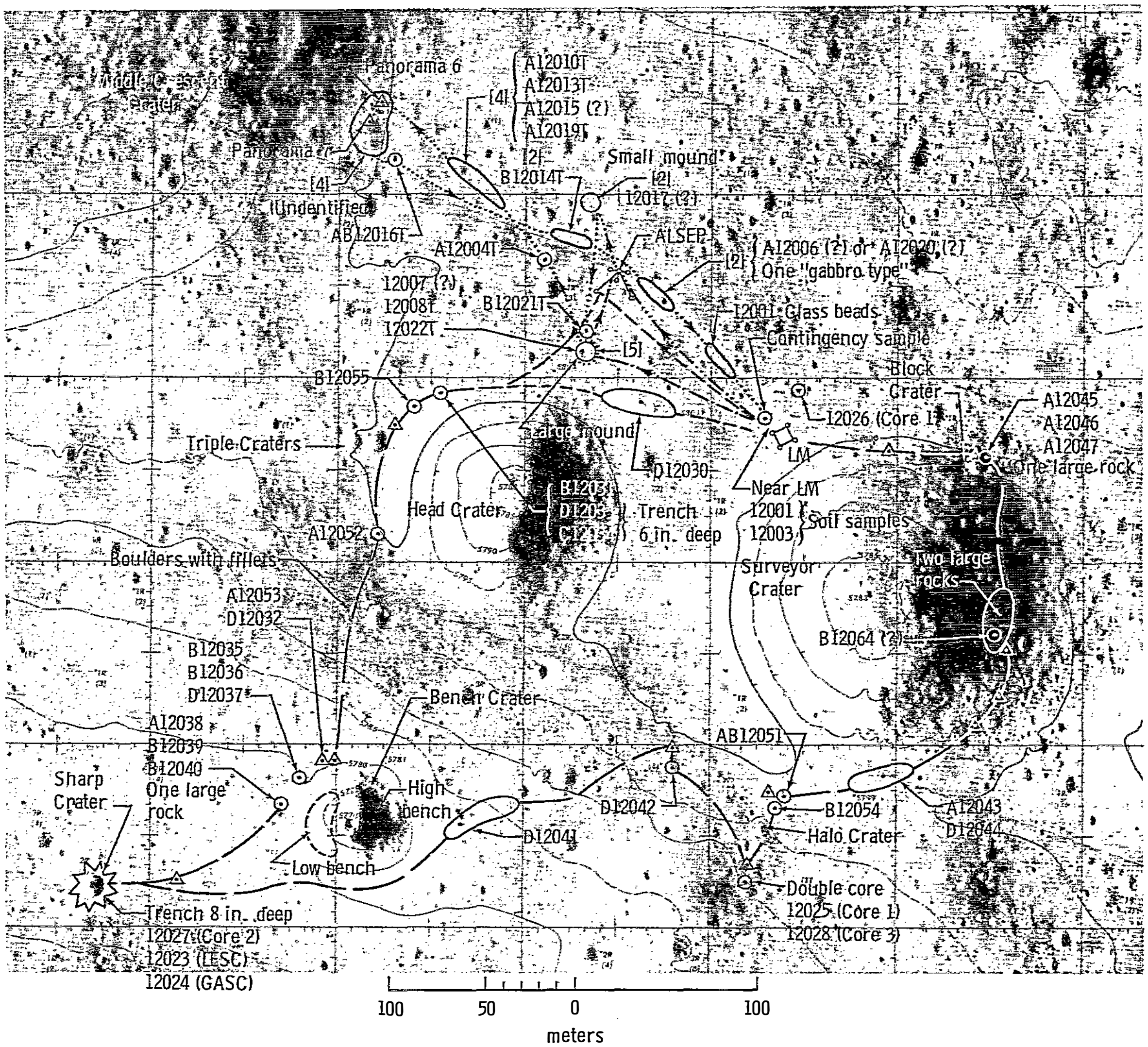
Contingency sample. - The contingency sample (table I) was collected early during the first EVA to assure that some lunar material would be returned in the event that the extravehicular activities were aborted. The CDR collected the contingency sample 10 meters southwest of the LM. Approximately five scoops were made to collect the 2 kilograms (including four rocks) of material.

Selected samples. - The selected samples (table I) replaced the "bulk" samples of Apollo 11 and were collected northwest of the LM (up to 300 meters away) during the last part of the first EVA. Seventeen rocks were collected with the tongs and placed in a large Teflon bag. Three large rocks (about 2 kilograms each) were collected with the tongs and placed in a second large Teflon bag, which then was filled with lunar fines using the scoop. One core tube was driven. The two Teflon bags and the core tube were sealed on the lunar surface in the ALSRC containing the selected samples (S-ALSRC).

The pressure in the S-ALSRC at the time of probing was 40 to 60 microns. Nitrogen (N) and oxygen (O) were the major gases present, with small amounts of helium (He), argon (Ar), and carbon dioxide (CO_2). The N/Ar ratio was essentially that of air. The O/N ratio appeared to be greater than air and possibly signified S-ALSRC leakage within the Apollo spacecraft. Water was quite low and may have been partially absorbed by the lunar material. No organic components above the background level were observed.

Documented samples. - The documented samples (table I) were collected during the second EVA while the astronauts were on their 1.5-kilometer geological traverse (fig. 3). The samples were documented by photography. During the traverse, the astronauts filled 13 individual sample bags with 11 rocks and seven lunar-fines samples. These samples were collected with a scoop and the tongs. Ten additional rocks were collected with the tongs. Two core tubes were driven, one of which was a double tube. The two special samples for the gas-analysis sample container (GASC) and the lunar-environment sample container (LESC), which were designed to be sealed individually, were collected. All of these samples except the four largest were sealed on the lunar surface in the ALSRC containing the documented samples (D-ALSRC).

The pressure in the D-ALSRC at the time of probing was not measured; however, all indications are that the sample box was at a significant fraction of atmospheric pressure. The N, O, and Ar gases were in essentially atmospheric proportions. Compared to N, O was lower and water was higher in the D-ALSRC than in the S-ALSRC. Some amount of excess He was evident. No organics or Freon compounds were observed.



Legend

·········	First EVA traverse	⊙ 12054	Sample locality: number refers to sample number assigned in LRL
	Second EVA traverse		
———	Both astronauts	(ellipse with dot)	Sample locality: precise locality not accurately determined; dot shows preferred location
— — —	CDR		
- - - -	LMP		
△	Photographic control station		
[ ]	Number of samples collected at that site	⊙ 12064 (?)	Sample locality: identification of sample uncertain; based on description only
A	Fine-grained vesicular crystalline igneous rock		
B	Medium-grained vuggy crystalline igneous rock	⊙ 12021T	Sample locality: identification and orientation tentative; based on photographic correlation of sample with lunar-surface photographs
C	Breccia		
D	Fines		

Unlocated large rocks are samples 12056, 12062, 12063, and 12065

Figure 3.- Extravehicular traverse map showing sample localities.

Tote-bag samples. - A tote-bag sample was not collected on Apollo 11. The Apollo 12 tote-bag samples (table I) were the four rocks that were not sealed in the D-ALSRC. The rocks were placed in a large Teflon bag.

All four sample containers were taken into the LM, bagged, and, after rendezvous, transferred to the command module (CM). The S-ALSRC and the D-ALSRC were returned by air to the LRL on November 25, 1969. The contingency and tote-bag sample containers were returned to the LRL in the Mobile Quarantine Facility on November 30, 1969.

LUNAR RECEIVING LABORATORY OPERATIONS

The configuration and operations of the biological barriers in the LRL remained essentially the same as for Apollo 11 (ref. 1). The selected samples were opened and studied in vacuum (generally about 10^{-6} torr). The documented, contingency, and tote-bag samples and the core tubes were opened and studied in dry-nitrogen glove cabinets. Approximately 50 grams of core-tube material and 450 grams of fines and rock chips from the documented and selected samples were designated for biological testing. The compositions of the early and regular biological test samples are shown in table IV.

TABLE IV. - EARLY AND REGULAR BIOLOGICAL TEST-SAMPLE COMPOSITIONS

Sample number	Weight, g	Remarks
Early biological sample		
12028	10.00	Bottom of core tube
12026	47.23	Longitudinal split of core tube
	Total 57.23	
Regular biological sample		
12057	50.72	Documented-sample fines and chips
12052-2	61.03	Chip from rock
12032	20.00	Fines; documented bag 4-D
12033	30.00	Fines; documented bag 5-D
12003	18.40	Selected-sample chips
12001-3	260.00	Selected-sample fines
12006	24.90	Chip from rock
12007	5.10	Chip from rock
	Total 470.15	

FIELD GEOLOGY

Geological Setting

The Apollo 12 LM landed on the northwest rim of the 200-meter-diameter Surveyor Crater (the crater in which Surveyor III landed on April 20, 1967) at 2.45° S latitude and 23.34° W longitude, about 120 kilometers southeast of the crater Lansberg. The site is on a broad ray of the crater Copernicus.

The landing site is characterized by a distinctive cluster of craters ranging in diameter from 50 to 400 meters (fig. 3). The informal names given to these craters for use during the mission also are used in this report. The EVA traverses generally were made on or near the rims of these named craters and on deposits of ejecta from them.

The lunar surface at the Apollo 12 landing site is underlain by fragmental material (the lunar regolith) which ranges from particles too small to be seen with the naked eye to blocks several meters across. Along many parts of the traverse made during the second EVA, the astronauts found fine-grained material of relatively high albedo which, at some places, was at the surface. This light-gray material possibly may be part of a discontinuous deposit observed through the telescope as a ray of the crater Copernicus.

The darker regolith material that generally overlies the light-gray material is only a few centimeters thick in some places; however, it is probably much thicker on the rims of some craters. The darker material varies from place to place in the size, shape, and abundance of the constituent particles and in the presence or absence of patterned ground. Most of the local differences are probably the result of local cratering events.

Beads and small irregularly shaped fragments of glass are abundant both on and within the regolith; glass also is spattered on some of the rocks at the surface and is found in many shallow craters.

The larger craters at the landing site probably differ widely in age. The age sequence from oldest to youngest is interpreted as follows.

1. "Middle Crescent" ("1000 foot") Crater

2. "Surveyor" and "Head" Craters

3. "Bench" Crater

4. "Sharp," "Halo," and "Block" Craters

When looking down into Middle Crescent Crater, the astronauts noticed huge blocks on the wall which probably originated from the local bedrock. The large rock fragments in this crater probably have been exposed the longest and represent the deepest layers excavated at the Apollo 12 landing site.

Both rounded and angular blocks litter the surface of the rims of Head and Bench Craters. Some rocks appeared to be coarse grained to the astronauts; the crystals were clearly visible. Many rocks on the rim of Bench Crater were reported to be spattered with glass.

Samples were collected from three small, very fresh, blocky-rimmed craters that apparently penetrate through the regolith into the underlying materials. The three craters are Sharp Crater (approximately 14 meters across and 3 meters deep), Block Crater (approximately 13 meters across and 3 meters deep), and an unnamed crater (2 meters across and 0.5 meter deep) that lies on the south rim of the Surveyor Crater just north of Halo Crater.

Sharp Crater has a 66.7-centimeter-high rim that is composed of material with a high albedo. The material has been splashed radially around the crater and is softer than the normal regolith. A core tube driven into the rim of the crater penetrated the ejecta without difficulty. Samples collected at this location may show the youngest exposure ages. Sharp Crater appears to have just penetrated the regolith; a terrace on the floor probably is controlled by the subregolith bedrock.

At Block Crater, located high on the north wall of Surveyor Crater, almost all the ejected blocks are sharply angular, which indicates that the crater is very young. Many blocks clearly show lines of vesicles that are similar in appearance to vesicular lavas on earth. The blocks probably are derived from an older coarse blocky ejecta deposit underlying the rim of the Surveyor Crater.

The 4-meter blocky crater on the crest of the southern rim of the Surveyor Crater may have been excavated in an old rim deposit at a depth of less than 0.5 meter. The regolith at this location may be very thin.

One notable difference between the rocks from the Apollo 12 site and those from the Apollo 11 site is that the Apollo 12 rocks are predominantly crystalline, whereas approximately half of the Apollo 11 rocks were crystalline and half were microbreccia. The difference probably is due to the fact that the Apollo 12 rocks were collected primarily on or near crater rims. The regolith on the crater rims is thin or only weakly developed, and many of the rocks are probably from craters that have been excavated in bedrock well below the regolith. The Apollo 11 site, in contrast, was located on a thick mature regolith where many of the observed rock fragments were produced by induration of regolith material and ejected from craters too shallow to excavate bedrock.

Lunar-Soil Mechanics

The properties of the Apollo 12 regolith may be presented best by a comparison with the properties of the Apollo 11 soil. The two sites were similar in the following respects.

1. Lunar module touchdown: Similar penetrations were observed under similar landing conditions, indicating that the soil-bearing capacities at the two sites are of the same order of magnitude.

2. Astronaut boot prints: The depth of the boot prints of the Apollo 12 astronauts was of the same order observed for the Apollo 11 astronauts; that is, less than 1 centimeter in the immediate vicinity of the LM and in the harder soil areas and up to several centimeters in the soft-soil areas, especially in the rims of small and relatively young craters.

3. Color, grain size, adhesion, and cohesion: Most of the Apollo 12 soil samples are visually identical to the Apollo 11 soil samples. The similarities of these properties are discussed further in the section on fines.

The two sites were significantly different in the following respects.

1. Lunar-surface rocket-exhaust erosion: The Apollo 12 astronauts experienced greater loss of visibility because of soil erosion during the LM landing than did the Apollo 11 astronauts. Further analysis is necessary to determine whether the loss of visibility was caused by different soil conditions, by a different descent profile, or by both.

2. Core-tube penetration and trenching: The Apollo 12 astronauts were able to drive the core tubes to the full depth (approximately 70 centimeters for the double core tube); whereas the Apollo 11 astronauts were able to drive the tubes only about 15 centimeters. A different bit design was used on the Apollo 12 core tubes which probably helped in driving them. The Apollo 12 trenches were dug to a depth of 20 centimeters, and the astronauts reported that the trenches could have been extended to a considerably greater depth without difficulty. The Apollo 11 astronauts could dig only about 10 centimeters.

3. Color and grain size: The differences in the color and grain size of the lunar soil are discussed in more detail in the section on fines.

A preliminary comparison of the photographs taken by the Apollo 12 astronauts at the Surveyor III site with the photographs relayed to earth by Surveyor III in April 1967 suggests that the lunar surface has undergone little change in the past 2-1/2 years. The trenches excavated by the Surveyor III soil-mechanics surface sampler and the waffle pattern of the Surveyor III footpad imprint appear much the same in the Apollo 12 photographs as when they were formed. The astronauts reported that Surveyor III was coated with a thin layer of dust.

SAMPLE LOCATIONS

A preliminary search was made to determine the localities of the contingency sample, the selected samples collected during the first EVA, and the documented and tote-bag samples collected during the second EVA. The contingency sample was well documented with Hasselblad photographs taken by the CDR and with 16-millimeter time-sequence photographs taken from the right-hand window of the LM. The scoop marks can be seen clearly in these photographs. Two rock fragments collected as part of the contingency sample have been tentatively identified in the photographs.

Each selected-sample collection site generally was photographed once. A very preliminary search has been undertaken to identify the selected samples in these photographs; however, much work remains to be done to complete this task. Three of approximately 20 sample sites have been tentatively identified.

The collection of samples during the second EVA was planned to be documented by a series of four photographs: three (including a stereopair) to be taken before collection and one to be taken after collection to record the site from which the sample had been removed. This photographic plan was followed in only a few cases, and the documentary record of the samples returned from the second EVA is not sufficient for identification of all the samples. Thus far, eight individual rocks have been identified in the Hasselblad photographs taken during the second EVA. Four samples have been tentatively identified, and the locality of another four samples is fairly well known. The locality of approximately 10 samples is not known.

SAMPLE IDENTIFICATION AND ORIENTATION

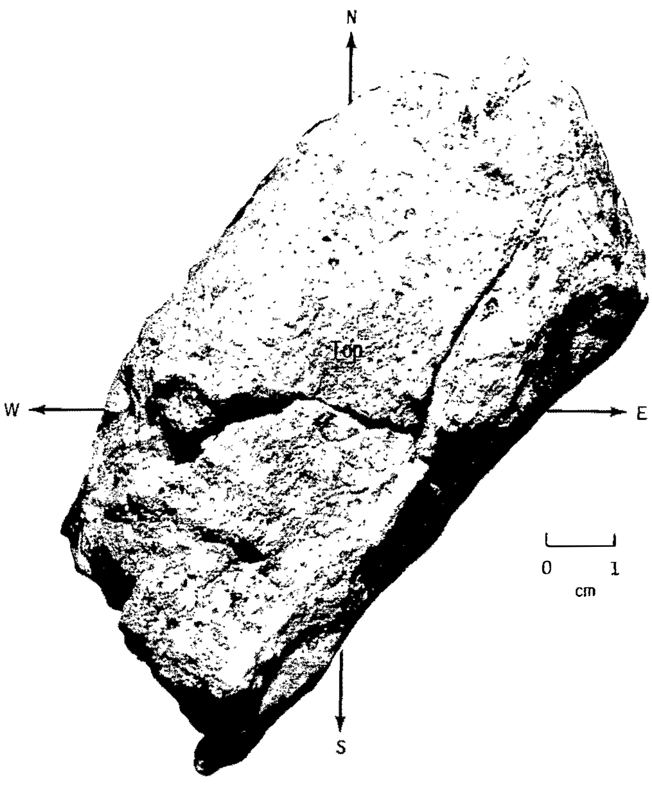
The identification and orientation of the samples were based on the comparison of the photographs taken in the LRL with the photographs taken on the lunar surface before and after the samples were collected. Two sample identifications (samples 12052 and 12054) were verified in the LRL by reorienting the samples under a photographic lamp to duplicate the characteristic shadows shown in the EVA photographs. More samples will be verified this way.

Contingency Sample

The contingency sample was collected in full view of the sequence camera on and near the southeast rim of a 6-meter-diameter crater approximately 15 meters northwest of the LM (figs. 3 and 4(a)). The sample was collected in six distinct scoop motions and consisted of a total of 1.9 kilograms of selected rock fragments (three of which were more than 5 centimeters in the longest dimension), fine-grained material, and at least one glass bead. The locations of the areas that were scooped (fig. 4(a)) were identified in the sequence-camera photographs taken from the LM windows before the first EVA. All six sample scoop marks are documented on surface photographs AS12-46-6719 to AS12-46-6723.

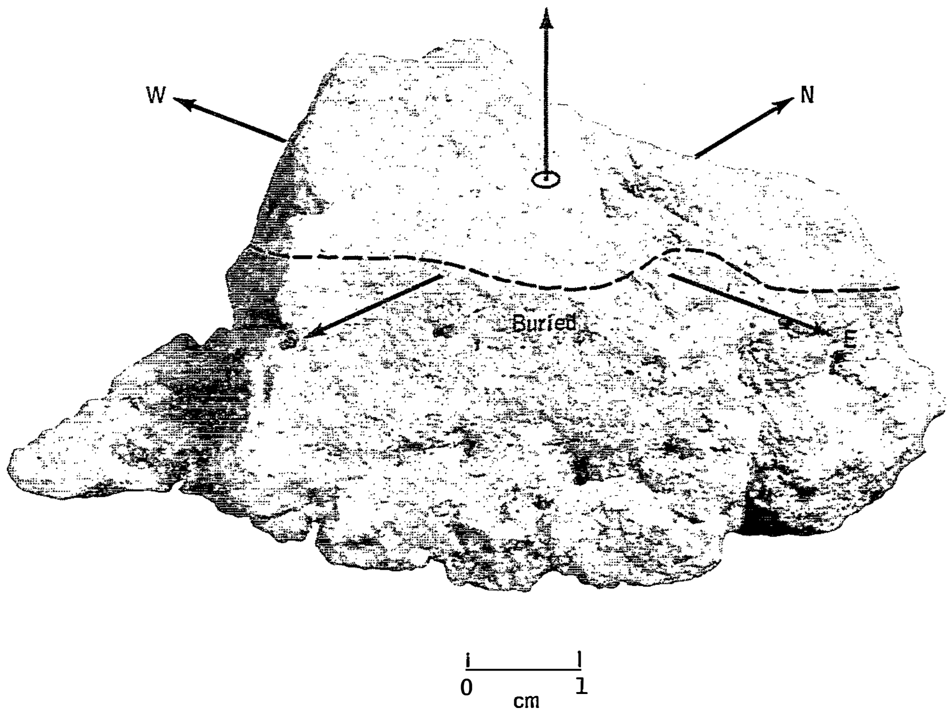
The first and sixth scoops included rock fragments that were visible from the LM windows before sampling; these fragments may be samples 12075 and 12073, respectively. These samples, which are shown in Hasselblad photograph AS12-48-7031 (fig. 4(a)), were collected from a group of small rocks alined roughly northeast/southwest between two small craters located 15 meters northwest of the LM. Most of the rocks appear to have fillets banked against them. The surface near the line of rocks has numerous small craters that may have contributed to the fillets; however, it has not been determined whether any of the rocks were the projectiles that caused the craters. The suggested selenographic orientations of samples 12073 and 12075 are shown in figures 4(b) and 4(c).

(a) Contingency-sample collection area showing the sequence and direction of the six scoops and the positions of the samples before collection (AS12-48-7031).



(b) Suggested selenographic orientation of sample 12073 (NASA-S-69-61060).

Figure 4. - Extravehicular activity photograph and orientation diagrams of Apollo 12 contingency samples.



(c) Suggested selenographic orientation of sample 12075 (NASA-S-69-61490).

Figure 4. - Concluded.

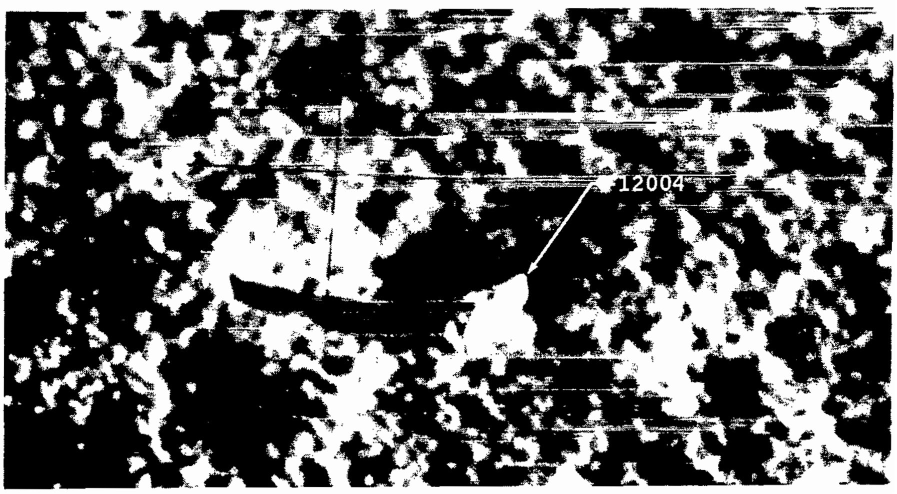
Selected Samples

The identification and orientation of the presampling position of three selected sample rocks (samples 12004, 12021, and 12022) have been tentatively determined. Three other rocks (samples 12006, 12008, and 12014) have been tentatively identified, but the orientation in the surface photographs has not yet been determined. The areal distribution of the selected samples (table V) was determined from the study of surface photographs and from the verbal transcript of the EVA communications. Specific sample numbers are given for several other rocks where identification was aided by the astronaut's description.

TABLE V. - AREAL DISTRIBUTION OF SELECTED SAMPLES

Location	Type of sample	Sample number
Small mound north of ALSEP	Rocks (2)	12017(?)
Large mound south of ALSEP	Rocks (5)	12008(?) 12021(?) 12022(?)
On or near rim of Middle Crescent Crater	Rocks (7)	12004(?) 12006(?) 12014(?) 12015(?) 12016(?)
Intercrater area near ALSEP and northwest of LM	Rocks (6) Fines with glass (1)	(?)

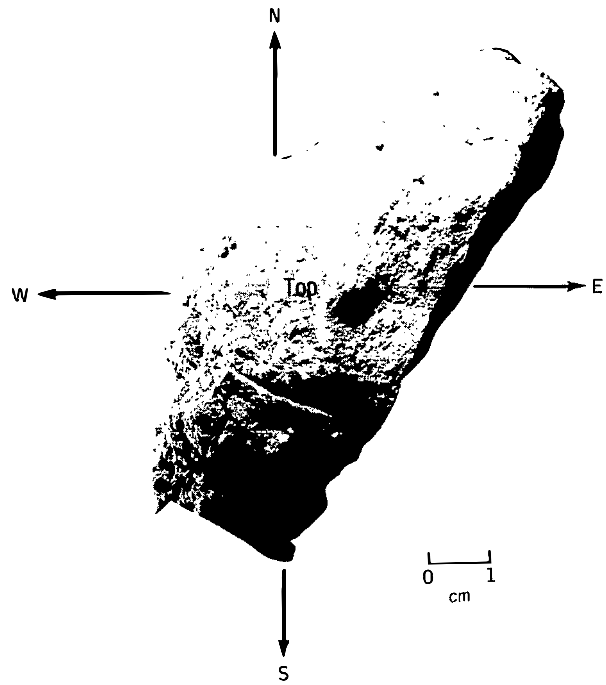
Sample 12004. - Sample 12004 has been tentatively identified in Hasselblad photograph AS12-47-6936 (fig. 5(a)), which was taken at the photographic panoramic site



(a) Sample 12004 before collection (AS12-47-6936).

Figure 5. - Extravehicular activity photographs and orientation diagrams of Apollo 12 selected samples.

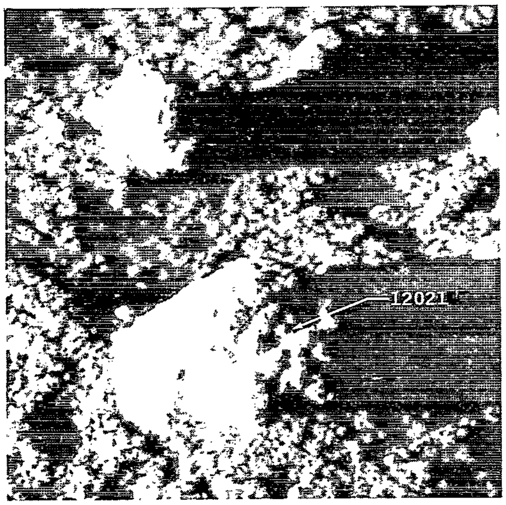
near the rim of Middle Crescent Crater. The rock appears in the photograph as an isolated rock fragment that is standing on end approximately half embedded in the lunar regolith. The specimen was correlated with NASA photograph S-69-62023. The suggested selenographic orientation of sample 12004 is shown in figure 5(b).



(b) Suggested selenographic orientation of sample 12004 (NASA-S-69-62023).

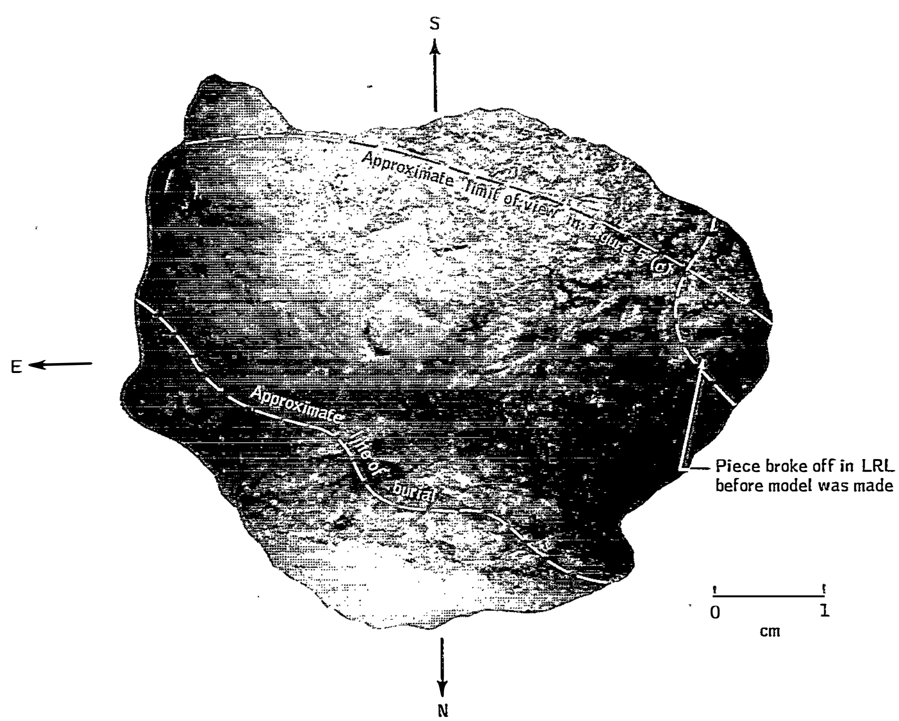
Figure 5. - Continued.

Sample 12021. - Sample 12021 has been tentatively identified in Hasselblad photograph AS12-47-6932 (fig. 5(c)), which was taken from the area near the eastern base of the large mound located between Head Crater and the ALSEP site. The rock specimen was correlated with NASA photograph S-69-61986. A model of sample 12021 under simulated lunar conditions is shown in figure 5(d). The suggested selenographic orientation is shown in figure 5(e).



(c) Sample 12021 before collection (AS12-47-6932).

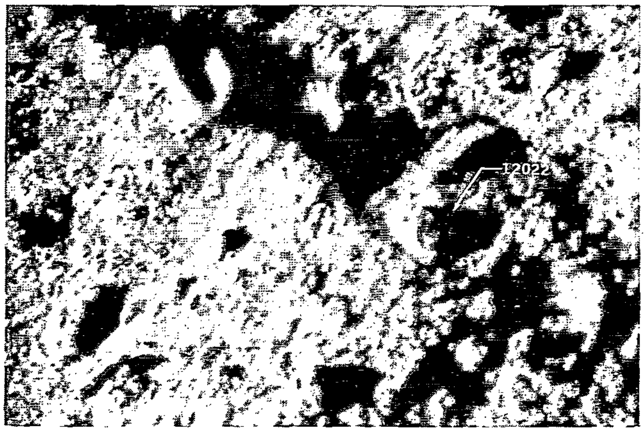
(d) Photograph of model of sample 12021 under simulated lunar conditions.



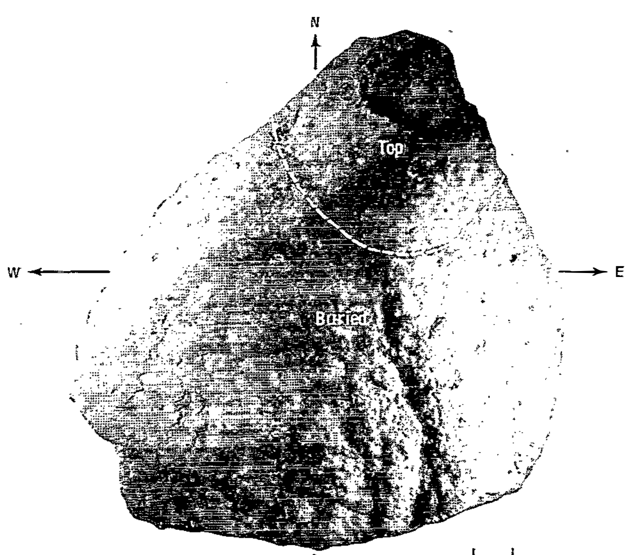
(e) Suggested selenographic orientation of sample 12021 (NASA-S-69-61985).

Figure 5. - Continued.

Sample 12022. - Sample 12022 has been tentatively identified as the rock shown just beneath the tongs in Hasselblad photograph AS12-47-6933 (fig. 5(f)). If correctly identified, the sample is a piece of embedded crystalline rock that was collected approximately 66.7 centimeters from the top of the large mound north of Head Crater. The rock may not be representative of the bulk of the mound material, which appears to be composed predominantly of aggregates of fine particles. The mound may be a large clot of regolith material that was ejected from a nearby crater. The specimen was correlated with NASA photograph S-69-61999 on the basis of the diagnostic triangular shape and the chipped depression at the small end of the rock. The suggested selenographic orientation of sample 12022 is shown in figure 5(g).



(f) Sample 12022 before collection (AS12-47-6933).



(g) Suggested selenographic orientation of sample 12022 (NASA-S-69-61999).

Figure 5. - Concluded.

Documented Samples

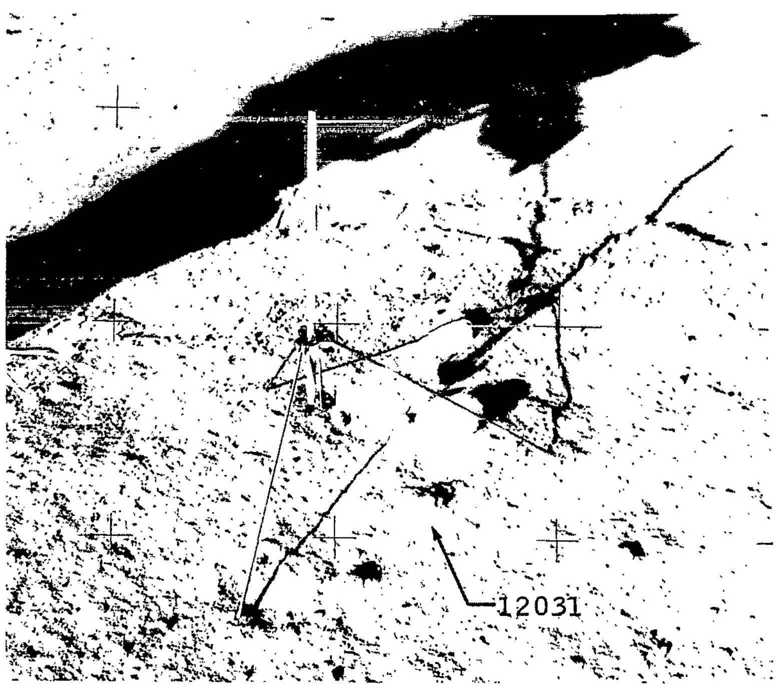
The areal distribution of all samples collected during the documented sample traverse of the second EVA is shown in table VI.

TABLE VI. - AREAL DISTRIBUTION OF DOCUMENTED SAMPLES

Location	Type of sample	Sample number	Container
On or near the rim of Head Crater	Rocks (4)	12031	Bag 3-D
		12034	Bag 6-D
		12052	D-ALSRC
		12055	D-ALSRC
	Fines (2)	12030	Bag 1-D
		12033	Bag 5-D
On or near the rim of Bench Crater	Rocks (6)	12035	Bag 7-D
		12036	Bag 8-D
		12038	Bag 9-D
		12039	Bag 10-D
		12040	Bag 10-D
		12053	D-ALSRC
	Fines (3)	12032	Bag 4-D
		12037	Bag 8-D
		12041	Bag 11-D
On or near the rim of Sharp Crater	Core tube	12027	Core
	Lunar environment	12023	LESC
	Gas analysis	12024	GASC
On the rim of 10-m crater south of Halo Crater	Core tube	12025	Double core 1
	Core tube	12028	Double core 2
On or near the rim of Surveyor Crater	Rocks (11)	12043	Bag 14-D
		12045	Bag 15-D
		12046	Bag 15-D
		12047	Bag 15-D
		12051	D-ALSRC
		12054	D-ALSRC
		12056(?)	D-ALSRC
		12062(?)	Tote bag
		12063(?)	Tote bag
		12064(?)	Tote bag
		12065(?)	Tote bag
	Fines (2)	12042	Bag 12-D
		12044	Bag 14-D

Sample 12030. - Sample 12030 consists of the group of fragments that are shown in Hasselblad photographs AS12-48-7043 and AS12-48-7044. The sample was collected by the LMP from a crater (approximately 1 meter in diameter) located on the outer northeast flank of the rim of Head Crater. The LMP passed this small crater as he traversed from the LM to join the CDR on the north rim of Head Crater; the precise position has not been determined accurately. The sample includes part of the fragmental lining of the 1-meter crater. Most of the lining appears to consist of weakly coherent aggregates of regolith material and resembles the lining observed in experimentally produced secondary craters. The LMP reported the collection from the crater of several small fragments that were partly glass covered. Other fragments that he attempted to pick up with the tongs were soft and crumbled. The fragments with the glass coatings may have been embedded in the regolith at this site or may have been part of the projectile that formed the 1-meter crater.

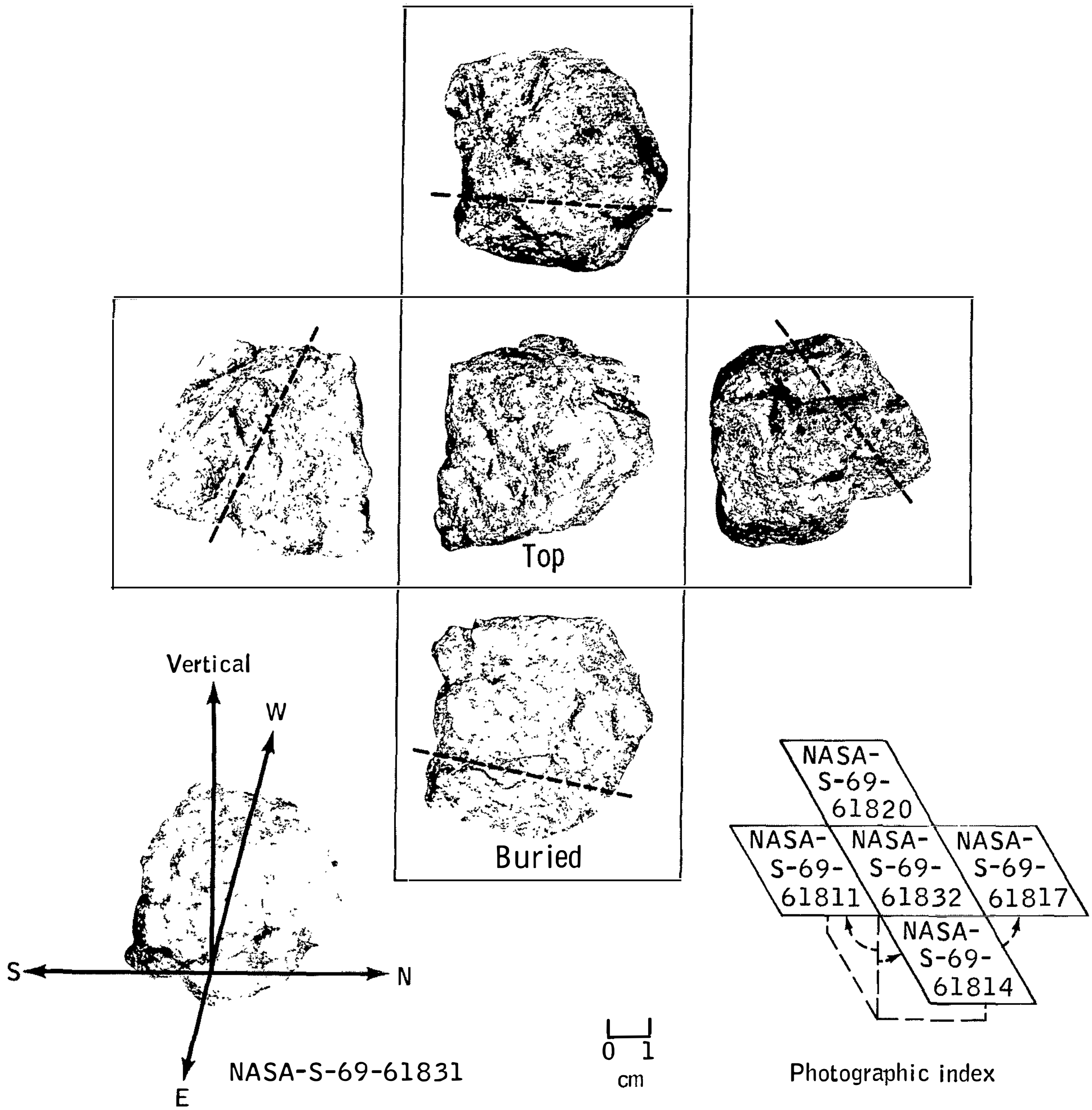
Sample 12031. - Sample 12031 has been identified in Hasselblad photographs AS12-49-7189, AS12-49-7190, and AS12-48-7048 (fig. 6(a)), taken before collection, and in Hasselblad photograph AS12-48-7050, taken after collection. The identification of this sample is precise because photographs were taken both before and after collection and because the sample was put into a prenumbered bag (3-D) and identified when it was picked up. The sample was collected from a small cluster of rocks about 2 meters southeast of the trench that was dug in the northwest rim of Head Crater and was almost half buried in the fine-grained regolith. There is the suggestion of a small fillet banked on the north and northeast sides of the rock. Other



(a) Sample 12031 before collection (AS12-48-7048).

Figure 6. - Extravehicular activity photographs and orientation diagrams of Apollo 12 documented samples.

nearby rocks have fillets with predominantly similar orientations, indicating a possible source of material to the north or northeast. The selenographic orientation of sample 12031 is shown in figure 6(b).



(b) Suggested selenographic orientation of sample 12031.

Figure 6. - Continued.

Sample 12032. - Sample 12032 includes soil and small rock fragments. The sample has not been identified in Hasselblad photographs, but the astronauts indicated that the sample was taken from the north rim of Bench Crater. The astronauts noted light-gray material just below the surface at this locality that was similar to the material which they had observed at the Head Crater trench site.

Sample 12033. - Sample 12033 is a soil sample that was collected approximately 15 centimeters below the surface in a trench dug on the northwest rim of Head Crater near the site of sample 12031. The material that was sampled from the trench was noticeably lighter gray than the surface of the regolith at this site or than the material noticed by the astronauts in the vicinity of the LM and the ALSEP deployment area. The trench, at several stages of excavation, is portrayed clearly in Hasselblad photographs AS12-49-7191 to AS12-49-7196 (taken by the CDR), and AS12-48-7049, AS12-48-7051, and AS12-48-7052 (taken by the LMP).

Sample 12034. - Sample 12034 is a specimen of microbreccia that was dug from the bottom of the trench on the northwest side of Head Crater where soil sample 12033 was taken. After excavation, the specimen was placed on the surface near the trench and photographed by the CDR (Hasselblad photographs AS12-49-7195 and AS12-49-7196). The site where the specimen was placed and later removed is shown in Hasselblad photographs AS12-48-7051 and AS12-48-7052 (taken by the LMP). When unpacked in the laboratory, the specimen was coated with the light-gray fine-grained regolith material in which it was buried in the trench.

Sample 12035. - Sample 12035 consists of six principal fragments that were broken from a fractured almost-buried rock on the northwest rim of Bench Crater. The fractured rock is shown clearly in Hasselblad photographs AS12-49-7336 and AS12-49-7337 (taken by the CDR) and AS12-48-7034 (taken by the LMP). The rock appears to have impacted the surface at this site relatively recently and to have broken on impact. The impact of the rock produced a small crater that is much more freshly formed than other craters on the rim of Bench Crater and is not, therefore, related directly to Bench Crater. Small pieces broken from the rock in the LRL were found to be weak and friable; the original rock was apparently very weak and may have been partly crushed by shock during ejection from some moderately distant crater. It does not appear possible to determine the field orientation of any of the individual fragments returned or to relate them to the individual parts of the original rock in the lunar-surface photograph.

Sample 12036. - Sample 12036 is an individual rock specimen that was collected near the site of sample 12035 on the northwest rim of Bench Crater. On the basis of their field observations, the astronauts believe this rock fragment at some time may have been broken from the fractured rock from which the pieces of sample 12035 were collected. Sample 12036 has not yet been identified in the photographs but may be recognized after further study.

Sample 12037. - Sample 12037 is a soil sample that was collected and placed in the bag with the rock fragment of sample 12036.

Sample 12038. - Sample 12038 is a rock fragment that was collected from the west rim of Bench Crater. The specimen may be shown in Hasselblad photographs AS12-49-7240 and AS12-49-7241 (taken by the CDR) but has not yet been identified. At this locality, abundant coarse rock fragments occur that probably were excavated from beneath the regolith and ejected from Bench Crater.

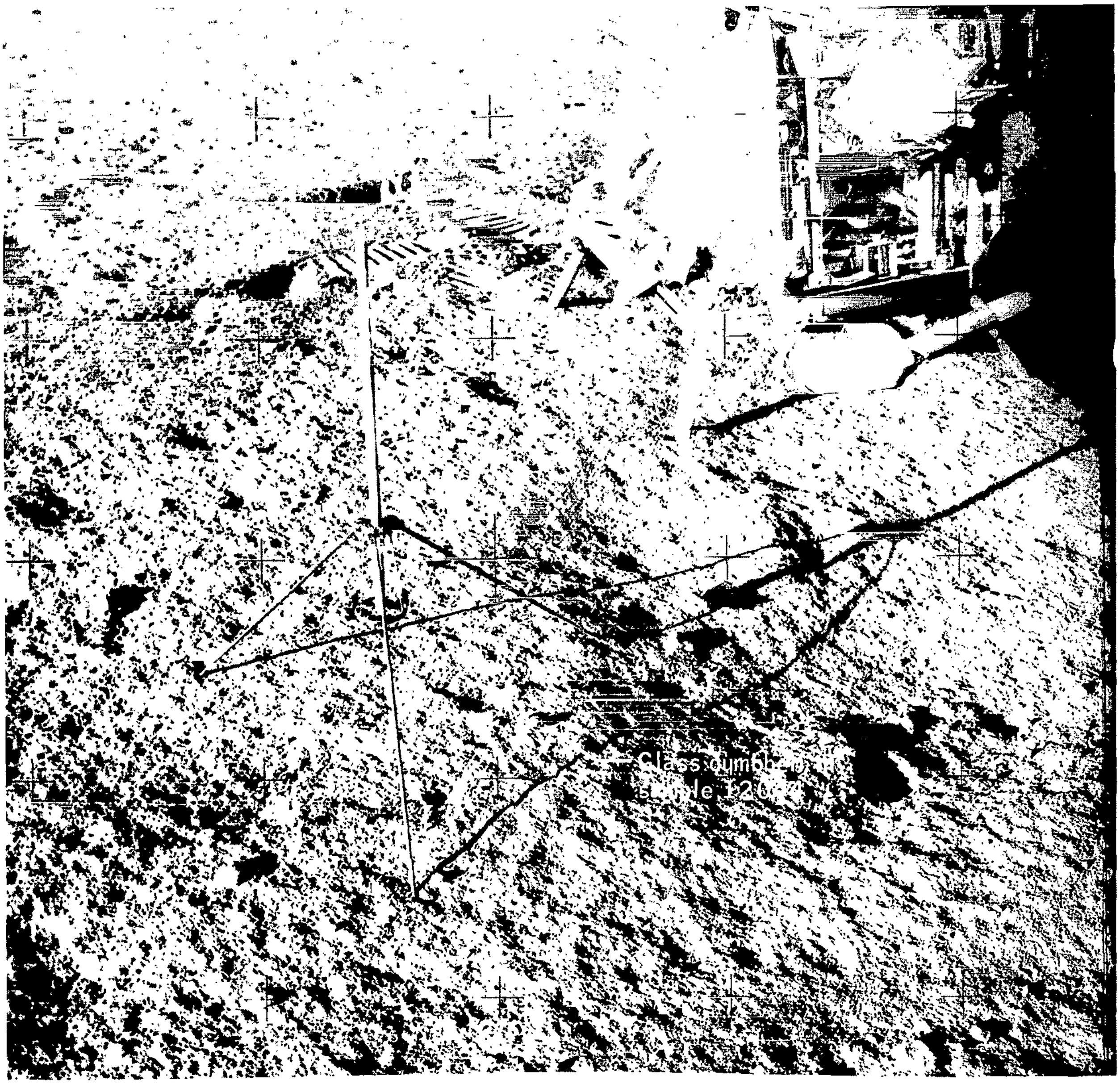
Samples 12039 and 12040. - Samples 12039 and 12040 are rock specimens collected from the west rim of Bench Crater near the site of sample 12038. These rocks may be shown in Hasselblad photographs AS12-49-7240 and AS12-49-7241 (taken by the CDR before sample collection) but have not yet been identified. The specimens were picked up from the surface and then laid down near the tool carrier and photographed by the CDR (Hasselblad photographs AS12-49-7242 and AS12-49-7243) before they were placed in the sample bag. The astronauts tried to be selective in choosing rocks that they thought most likely represented material ejected from the bottom of Bench Crater. Samples 12038, 12039, and 12040 represent the rocks brought back from this selection.

Sample 12041. - Sample 12041 is a soil sample collected a short distance east of Bench Crater on the traverse between Sharp Crater and Halo Crater. The material consists mostly of fine particles but includes a 6.4-millimeter-diameter glass sphere. The locality was not documented by photographs.

Sample 12042. - Sample 12042 is a soil sample taken on the outer flank of the Surveyor Crater rim, about 50 meters northwest of Halo Crater. The general site from which the sample was taken is shown in Hasselblad photographs AS12-49-7282 to AS12-49-7284 (taken by the CDR) and AS12-48-7072 to AS12-48-7076 (taken by the LMP). This area was noted by the astronauts as being different in texture from the other parts of the lunar surface over which they had walked. The surface was strewn with abundant cohesive clots or aggregates of fine-grained regolith material ranging in diameter from 1 to 2 millimeters to a few centimeters. Many of the clots occupied small pits that probably were formed by the impact of the clots on the surface. The area is evidently a small patch or ray of secondary particles, but the probable source of the particles has not been determined. The precise spot from which the sample was taken apparently was not photographed after sample collection.

Samples 12043 and 12044. - Sample 12043 is a rock specimen collected on the south rim of the Surveyor Crater during the traverse between Halo Crater and the Surveyor III spacecraft. The rock appears to be resting mostly on the surface and has no clear-cut genetic relation to any of the surrounding surface features. Sample 12043 is the largest of three specimens collected at a spot where the astronauts observed a prominent double glass bead on the surface.

Sample 12044 is a soil sample that includes a double bead of glass. The glass has been identified in Hasselblad photographs AS12-48-7082 and AS12-48-7083 (fig. 6(c)) (taken by the LMP). The bead is 3 centimeters long and initially was included with the sample that was assigned the number 12044 after removal from sample bag 14-D in the LRL.

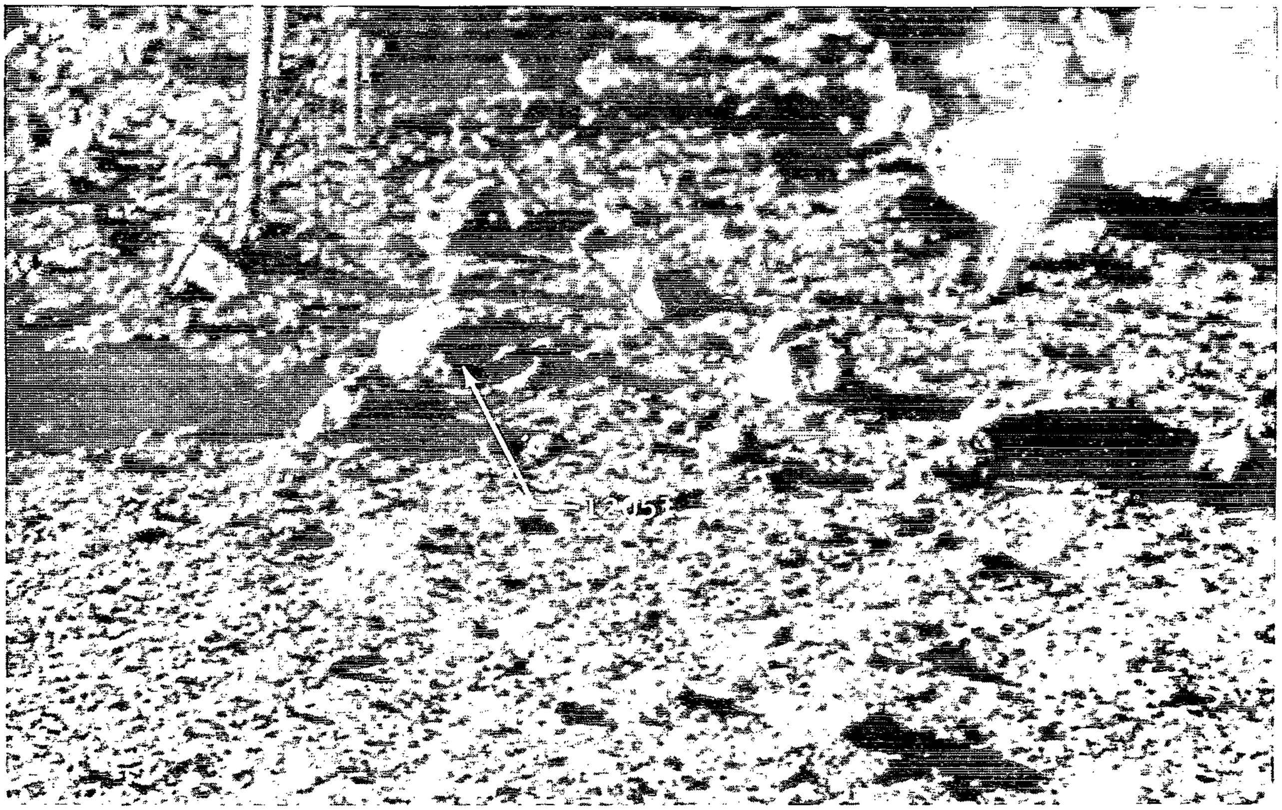


(c) Samples 12043 and 12044 before collection (AS12-48-7083).

Figure 6. - Continued.

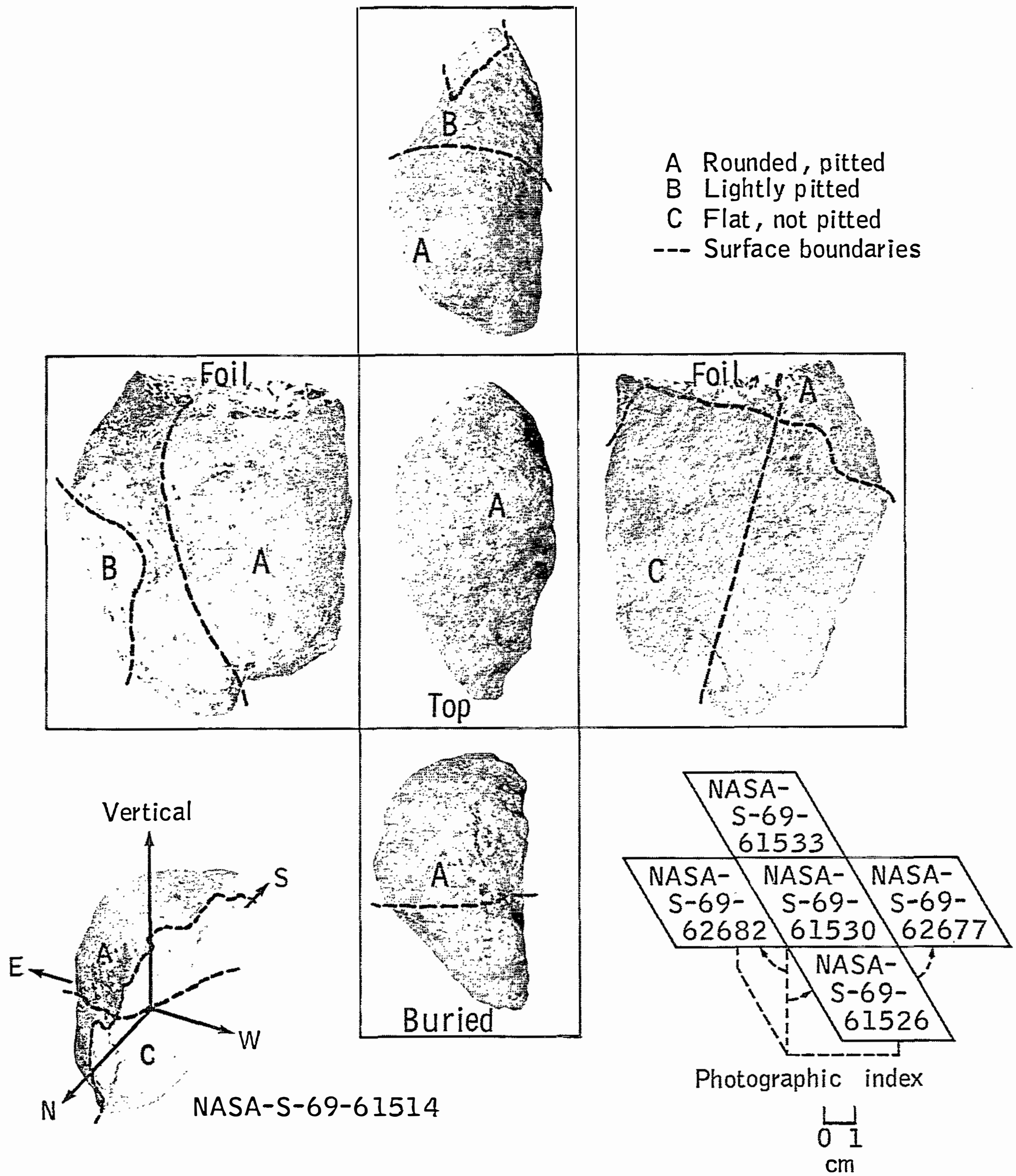
Samples 12045, 12046, and 12047. - The sample locality for these three rock specimens was the northeast rim of Block Crater. The three samples probably are shown in Hasselblad photographs AS12-48-7148 to AS12-48-7150 (taken by the LMP) but have not been recognized so far. The locality is on the ejecta rim of a very fresh crater (Block Crater) that has been formed on the north wall of the Surveyor Crater and is characterized by abundant angular fragments. Most of the fragments probably were derived from Block Crater, which was excavated, in turn, in the ejecta rim of the Surveyor Crater. Thus, these samples probably were derived ultimately from the Surveyor Crater and may have come from depths as great as several tens of meters at this locality on the Ocean of Storms.

Sample 12051. - Sample 12051 is one of the distinctive large fragments collected during the second EVA. The fragment is part of the blocky ejecta from a fresh 4-meter-diameter crater on the south rim of the Surveyor Crater and is shown clearly in Hasselblad photographs AS12-49-7318 (fig. 6(d)) and AS12-49-7319 (taken by the LMP). The sample was picked up by hand by the CDR while the LMP steadied him with a strap from the tote bag. The site from which the sample was removed is shown in Hasselblad photograph AS12-49-7320. This specimen is characterized by a sheared surface on one side that was described by the astronauts. Part of both the sheared surface and the opposite convex surface of the specimen was buried in the regolith. The suggested selenographic orientation of sample 12051 is shown in figure 6(e).



(d) Sample 12051 before collection (AS12-49-7318).

Figure 6. - Continued.



(e) Suggested selenographic orientation of sample 12051.

Figure 6. - Continued.

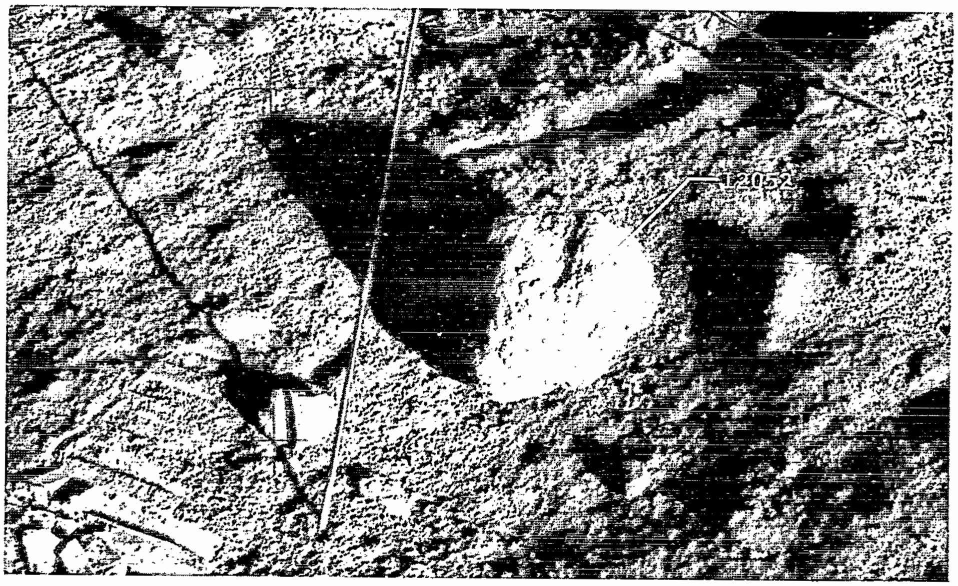
The surface of sample 12051 exhibits three faces that have distinctly different shapes and weathering characteristics, indicating different exposure ages. Surface A (fig. 6(e)) is rounded and covered by many small glass-lined pits; surface B is apparently a fracture surface and displays only a few small pits; surface C is flat and appears to be a freshly broken surface without pits. At the time of collection, the rock was standing on the small end approximately half embedded in the regolith.

Surface B on sample 12051 appears to be an older fracture face that probably resulted from another blow by impact at an earlier time. The minor pitting and weathering of surface B indicates postfracture exposure on the lunar surface before the event that formed surface C and buried surface B.

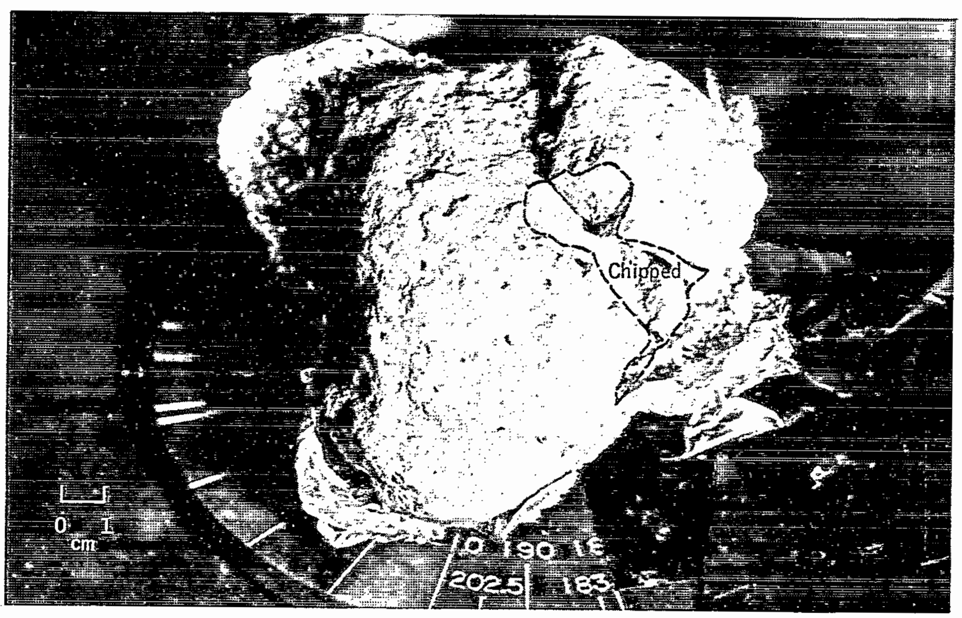
The rounded heavily pitted appearance of surface A indicates a long period of exposure on the lunar surface for sample 12051. The two broken surfaces of different ages (surfaces B and C) attest to multiple bombardment and tumbling of the rock at or near the surface of the regolith.

The occurrence of this rock and other rounded and angular rocks in the rim of the rocky young crater indicates high probability that sample 12051 represents ejecta from the small crater — either from a fragmented impacting body or from displaced regolith or subregolith material at the impact site. In either case, the unpitted shear face probably resulted from the impact that formed the small crater. The angle of the specimen when found suggests that the rock fell into place together with enough surrounding fine material to hold it in position. Determining the exposure age of the portion of the flat side which was above the lunar surface might date the small crater.

Sample 12052. - Sample 12052, a large rock rounded on one side, was collected from the west rim of Head Crater and is shown clearly in Hasselblad photographs AS12-49-7217 and AS12-49-7218 (taken by the CDR) and AS12-48-7059 (taken by the LMP). The rock apparently was moved from the original site before the photographs were taken. Therefore, although the specimen can be oriented precisely with respect to the position in the photographs, the orientation shown in the photographs probably does not represent the orientation of the rock before it was disturbed. The lower angular part of the rock apparently was partially buried in the regolith, but the rock rested on the surface in the position shown in the photographs. A drag mark near the sample indicates the place from which the rock was removed. At least two pieces on one side of the specimen were broken off after the rock was photographed on the lunar surface and before it was photographed in the LRL. Sample 12052 is shown in figure 6(f) as it was photographed on the lunar surface and in figure 6(g) as it was photographed in the LRL with nearly identical orientation and shadow characteristics.



(f) Sample 12052 before collection (AS12-49-7218).



(g) Reconstructed selenographic orientation of sample 12052 (NASA-S-70-22673).

Figure 6. - Continued.

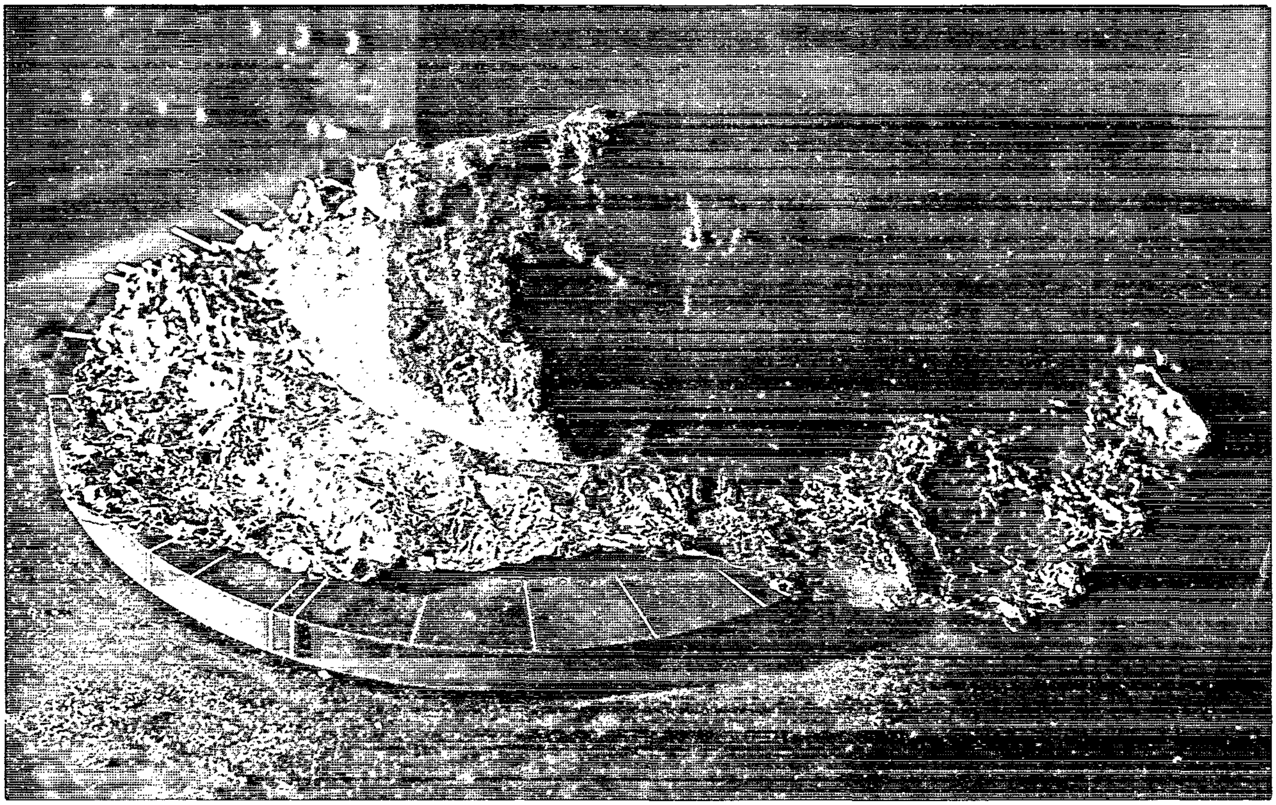
Sample 12053. - Sample 12053 is an angular fragment collected from the northwest rim of Bench Crater. The fragment appears to be part of a field of coarse fragments on the rim that probably were ejected from the crater. The specimen is identified readily in Hasselblad photographs AS12-49-7234 and AS12-49-7235 (taken by the CDR) and AS12-48-7063 (taken by the LMP). The rock was rotated out of the original position before the first photographs were taken; therefore, the original orientation is uncertain even though the site is well documented.

Sample 12054. - Sample 12054 is an unusual glass-coated rock collected a short distance south of the fresh 4-meter crater with which sample 12051 is associated. The astronauts believed that the rock may have been ejected from this small fresh blocky crater. The specimen is shown clearly in Hasselblad photographs AS12-49-7313 to AS12-49-7315 (fig. 6(h)) (taken by the LMP). In these photographs, the specimen can be seen to be resting on the surface. Three sides of the rock are coated with glass and two sides are free of glass. When photographed, the specimen was resting on one glass-free side; the other glass-free side was oriented toward the southeast. The field relations suggest that the rock was sprayed with glass in the position in which it was found on the surface and that the spray came from the west. Because the rock was found to exhibit shock damage in the LRL, an alternate possibility is that the glass was

(h) Sample 12054 before collection (AS12-49-7315).

Figure 6. - Continued.

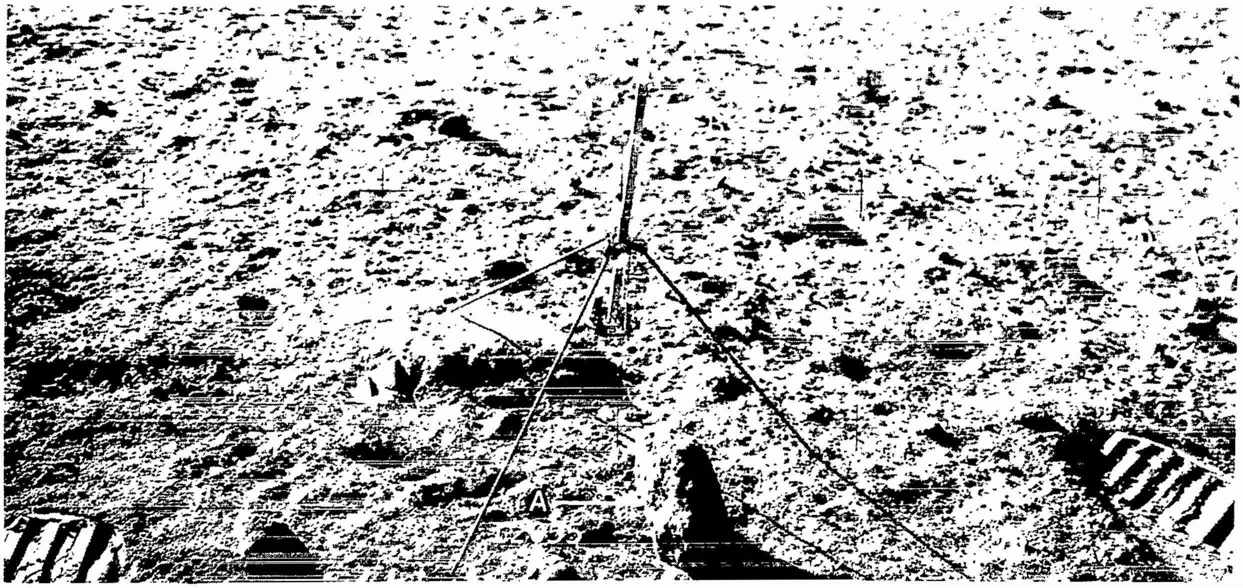
sprayed onto the rock as it was ejected from an impact crater and, by coincidence, the rock landed on a side not coated with glass. The LRL reconstruction of the orientation and lighting as seen in the lunar-surface photograph of sample 12054 is shown in figure 6(i).



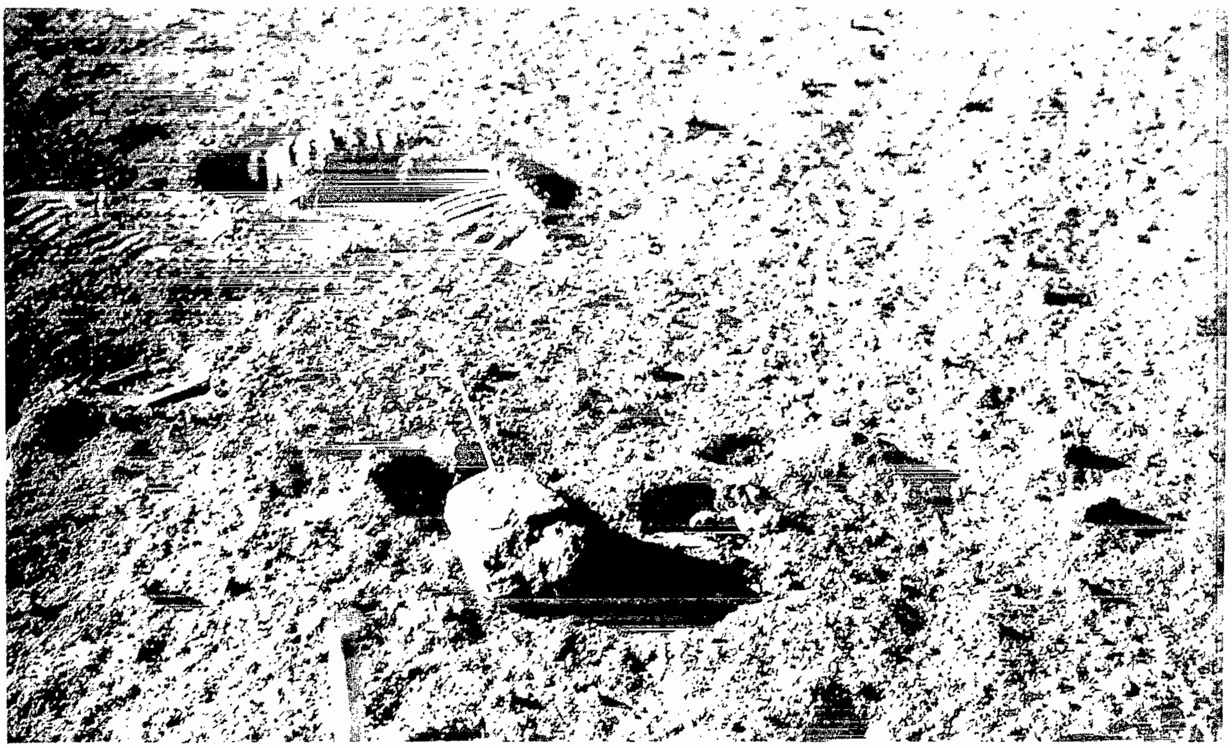
(i) Reconstructed selenographic orientation of sample 12054 (NASA-S-70-22696).

Figure 6. - Continued.

Sample 12055. - Sample 12055 is a tabular rock that is shown undisturbed before collection in Hasselblad photographs AS12-49-7197 (fig. 6(j)) and AS12-49-7198. The sample was moved slightly from the original position, as shown in photographs AS12-49-7199 and AS12-49-7200 (fig. 6(k)) (taken by the CDR) and AS12-48-7053 to AS12-48-7055 (taken by the LMP). After it was moved, the sample was described by the LMP as having a distinctly gray tone on the lower half (shown clearly in photograph AS12-48-7055). The color change apparently represented the line of burial; however, it is interesting to note in the undisturbed photograph (fig. 6(j)) that a fillet almost covers the northeast side of the rock to a point well above the reported line of color demarcation. This implies that the fillet may be relatively young in the exposure history of sample 12055 in the orientation in which it was collected, because no obvious color difference was related to the line of fillet burial.



(j) Sample 12055 (rock A) in undisturbed position before collection (letters A to E are for location reference in fig. 6(k)) (AS12-49-7197).



(k) Disturbed rock not sampled at site of sample 12055 (letters B to E are for location reference in fig. 6(j)) (AS12-49-7200).

Figure 6. - Concluded.

Sample 12056. - Sample 12056 is a tabular angular rock that has not been recognized in the surface photographs; however, the sampling locality has been tentatively placed near the Surveyor spacecraft. The rock is believed to be one of the four selected loose rock fragments described by the astronauts.

Tote-Bag Samples

Sample 12062. - Sample 12062 is tentatively identified in Hasselblad photograph AS12-48-7139, which was taken near the Surveyor spacecraft. The rock is viewed from the southeast in the surface photographs, displaying the most rounded and densely pitted side of the rock. The rock appears to be about one-third buried, and a fillet is well developed on the east side.

Sample 12063. - Sample 12063 was the largest rock returned in the tote bag and, thus far, has not been recognized in any of the surface photographs.

Sample 12064. - Sample 12064 is a large rock that has a distinctively angular shape. This rock may be the one described by the astronauts as a square rock collected near the Surveyor spacecraft.

Sample 12065. - Sample 12065 has not been identified in the Hasselblad photographs but may be the "grapefruit" rock described by the CDR on the traverse between the ALSEP site and Head Crater early during the second EVA.

SAMPLE INFORMATION

Mineralogy/Petrology

Most of the large rock samples returned from the Apollo 12 mission are holocrystalline and have ranges of textures and mineralogical compositions that are characteristic of igneous origin. Two breccias also were returned. The crystalline rocks are similar to the Apollo 11 microgabbros and basaltic rocks in that they consist essentially of clinopyroxene, calcic plagioclase, olivine, and ilmenite. However, they contrast with the Apollo 11 suite in that they exhibit wide ranges in modal mineralogy, grain size, and texture.

Mineralogical composition. - The mineral species identified in the Apollo 12 samples are similar to those observed in the Apollo 11 materials. Glass, plagioclase, pyroxene, olivine, low cristobalite, ilmenite, sanidine, spinel, troilite, and iron (Fe) metal have been identified positively. Tridymite, metallic copper (Cu), and the Fe analog of pyroxmangite have been tentatively identified. X-ray data are presented in table VII.

Plagioclase is present in every rock sample and ranges from approximately 5 to 10 percent (sample 12075) to 70 percent (sample 12013). The estimates of composition were based on extinction-angle measurements and indices of refraction and range from An_{50} to An_{90}, with the median value falling near An_{80}. Although some plagioclase is zoned, most is twinned. Lath-shaped crystals prevail, and pyroxene/plagioclase intergrowths are very common.

TABLE VII. - X-RAY DATA

Sample number	Pigeonite	Diopside	Plagioclase anorthite	Olivine (fayalite percent) (a)	Ilmenite	Troilite	Magnetite	Pyroxene (unidentified)	Monticellite	Quartz
				X-ray data 1						
12060	Very strong		Very strong	Weak (40)	Moderately weak		Possible			
12062	Very strong		Very strong		Weak	Weak		Strong		
12063	Very strong		Very strong	Moderately weak (40)	Moderate			Strong		
12070	Strong		Very strong	Moderately weak (50)	Moderately weak	Weak	Possible	Very strong		
12071	Very strong		Very strong	Moderately weak (50)	Moderately weak	Weak		Strong		
				X-ray data 2						
[b]12077				(50)						
12077	Very strong		Very strong					Strong	Weak	
[b]12076				(44)						
12009				(44)					Weak	
12012	Very strong		Very strong	(32)	Moderate					
				X-ray data 3						
12013	Strong		Very strong							Strong
12014	Very strong		Very strong	Strong (36)	Moderate					
12015	Strong	Very strong	Strong	Strong (44)	Moderate					
12018	Very strong		Very strong	Strong (32)	Moderately weak					
12004	Very strong		Very strong	Very strong (32)	Moderately weak					
				X-ray data 4						
12020	Very strong		Very strong	Very strong (32)	Moderately weak					
12065	Very strong		Very strong		Moderate					

[a]Numbers in parentheses indicate percent.
[b]Olivine sample.

Pyroxenes were identified by X-ray diffraction and by optical properties. Pigeonite and subcalcic augites are the most common, as determined optically. Refractive indices indicate that the ratio of Fe to Mg (magnesium) is about 0.5. Zoned pigeonite phenocrysts occur in porphyritic and coarse-grained rocks. Pigeonite occupies the core of some crystals, and subcalcic augite forms the rim. The subcalcic augite is a deeper brown than the pigeonite. The groundmass pyroxenes are fine grained, are darker than the phenocrysts, and are not zoned. Pyroxene/plagioclase intergrowths are common and range in size from 1-centimeter-long crystals to aggregates in which the particles are only several microns across. Pyroxenes are the dominant minerals in all but three samples.

Olivine was identified by X-ray diffraction and by optical properties. The estimates of composition that were based on optics disagree with those that were based on X-ray data. The discrepancy was shown by spectrographic measurements to be caused by a fairly high calcium (Ca) content. The samples for which X-ray, optical, and spectrographic data are available indicate a composition of about $Ca_{.05}Mg_{.60}Fe_{.35}$. Olivine commonly contains inclusions which are filled with devitrified glass or aggregates of plagioclase, pyroxene, and ilmenite. Some grains contain spherical-glass inclusions. Fayalite grains were tentatively identified by their optical properties. In contrast to the Apollo 11 rocks, olivine occurs in almost all of the Apollo 12 samples.

Low cristobalite occurs as interstitial aggregates and as euhedral to subhedral crystals.

Ilmenite was identified by X-ray diffraction, by morphology, and by optical properties. The abundance ranges from less than 1 percent to 25 percent. In reflected light, some grains show intergrowths with an unidentified oxide phase.

The presence of spinel is suggested by the octahedral forms of opaque minerals of unknown composition that occur in olivine grains and in vugs. At least three other unidentified opaque phases also are present.

Troilite is a ubiquitous phase in all polished thin sections.

Metallic Fe occurs as interstitial blobs not commonly associated with troilite grains rather than as blobs in troilite as noted in the Apollo 11 rocks. It is more commonly associated with ilmenite than with any other phase.

Metallic Cu, tridymite, and the Fe analog of pyroxmangite were tentatively identified by optical methods.

Glass occurs as minute interstitial material in some crystalline rocks, as beads and groundmass in clastic rocks, and as a thin coating on several rocks.

Igneous rocks. - Approximately one-half of the igneous rocks have vesicles present, and all have vugs. The vesicles range in diameter from 0.1 to 40 millimeters and commonly are lined by tangentially or subparallel-oriented crystals of plagioclase, pyroxene, or olivine. The vugs contain euhedral crystals of pyroxene and olivine and less well-formed crystals of plagioclase, ilmenite, and spinel. The volume occupied by vugs and vesicles in any rock is generally less than that in the Apollo 11 rocks. The vugs are irregular and occur in the coarser rocks at the termination of the sheaflike aggregates of pyroxene and plagioclase. In one sample, pyroxene crystals appear in raised relief along a joint surface. Crystals in vugs and along joints are considerably coarser in grain size than the crystals in the groundmass minerals. Variations in cooling rates could be an explanation of the variety of grain sizes observed.

The grain size of the igneous rocks ranges from 0.05 to 35 millimeters. The textures show remarkable variations, many of which are common to volcanic and plutonic rocks on earth. Many of the rocks are equigranular gabbros, some are ophitic to subophitic diabases, and others are variolitic basalts. Feathering sheaves of pyroxene/plagioclase intergrowths are found in the groundmass of porphyritic rocks containing phenocrysts of pigeonite. The olivine crystals in more rocks are equant euhedral grains that are somewhat coarser than the groundmass.

The mineralogical composition of the igneous rocks reflects the high FeO content. The lower TiO_2 contents (compared to the Apollo 11 rocks) are reflected in the smaller amounts of ilmenite. The textural and mineralogical variations can be explained readily by fractional crystallization and mineral accumulation during the cooling of basaltic magmas.

The modal mineralogy shows a wide variation (fig. 7), especially when contrasted with the Apollo 11 modes. The modes range from peridotites (sample 12075: 50 percent pyroxene, 40 percent olivine, and 10 percent plagioclase), olivine gabbros

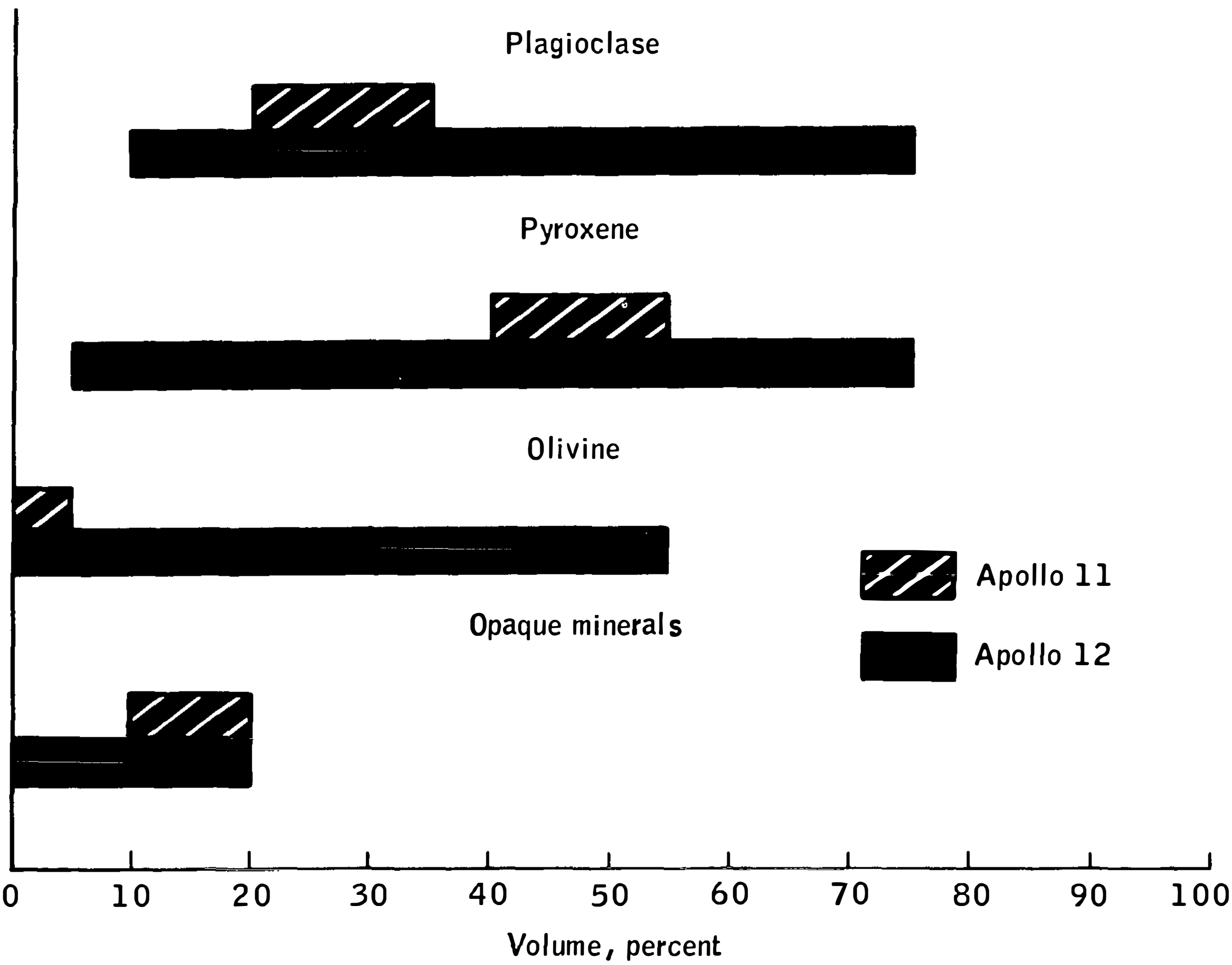


Figure 7. - Apollo 11 and 12 lunar-sample modal analyses.

(sample 12036: 25 percent pyroxene, 40 percent olivine, and 25 percent plagioclase), and gabbros (sample 12052: 40 percent pyroxene, 30 percent plagioclase, 15 percent olivine, and 15 percent opaque minerals) to troctolites (sample 12035: 15 percent pyroxene, 40 percent olivine, and 45 percent plagioclase) to picritic basalts (sample 12045).

Sample 12013, which consists largely of plagioclase and sanidine, appears to be a late-stage differentiate on the basis of the modal mineralogy and trace-element content.

Some rocks show evidence of planar features (such as fractures and lines of vugs) but the rocks are generally without marked foliation or lineation. All of the rocks are fresh and show no evidence of the hydration or oxidation reactions common during late-stage terrestrial magmatic processes.

Breccias. - One rock is a fragmental breccia that is similar to the Apollo 11 breccias (ref. 1). Two breccia chips also were collected. The dominant constituents of the breccias appear to be pyroxene and plagioclase with accessory olivine and glass. Lithic fragments also are present. The average mineralogical composition appears to be less olivine-rich than the majority of rock types collected. The fragmental breccia appears to have a foliation in which both lithic and mineral fragments are subparallel. The lithic fragments are as large as 20 by 10 millimeters and are both igneous and fragmental rocks, indicating several periods of fragmentation and consolidation.

Fines. - The Apollo 12 lunar fines contrast with the Apollo 11 fines in that they consist of different proportions of phases and, consequently, are lighter in color. The major constituents (in decreasing order of abundance) are pyroxene, plagioclase, glass, and olivine. The minor constituents, which total only a few percent, are ilmenite, tridymite, cristobalite, nickel (Ni) Fe, and several unidentified phases. The Fe analog of pyroxmangite was tentatively identified.

Glass totals roughly 20 percent of the Apollo 12 fines and includes spheroidal and dumbbell-shaped objects and angular fragments. The color of the glass ranges from colorless through pale yellow brown and brown to dark brown; the index of refraction generally ranges from 1.55 to 1.75. Bubbles and solid inclusions are common in the colored glasses. In contrast to the Apollo 11 fines, feldspar glass, dark to nearly opaque spheroidal glass, and dark scoriaceous glass fragments are relatively rare.

The pyroxenes, mostly pale yellow to tan and brown, range widely in composition and include augite, subcalcic augite, and pigeonite. They constitute about 40 percent of the fines. The range of the indices of refraction is somewhat greater than that of the pyroxenes of the Apollo 11 fines. Plagioclase has indices of refraction mostly in the bytownite/anorthite range. A small amount of more sodic plagioclase also is present. The olivine totals approximately 5 to 10 percent and is more abundant than in the Apollo 11 fines. The few carefully measured grains fell in the compositional range Fo_{60-70}. Many lithic fragments are present. Low tridymite is in the form of anhedral grains, and the low cristobalite occurs as microgranular aggregates.

There are two fines samples of notably different character: (1) the light-colored layers in the double core tube and (2) sample 12033, a documented fines sample collected from a trench dug near the northwest rim of Head Crater. The color of both samples is light gray. Sample 12033 consists of clear, angular grains of feldspar with some olivine and pyroxene and abundant basaltic glass. The coarser 1-millimeter-diameter glass fragments are pumiceous, exhibiting well-developed flow structure and stretched vesicles, and the finer fragments are angular and somewhat vesicular. The finer shards also show a flow structure consisting of oriented microlites. Sample 12033 is tentatively considered a crystal-vitric ash.

A significant feature of the fines is the presence of numerous very well-rounded grains that have minutely chipped surfaces and that resemble grains in terrestrial detrital sands. Many of the grains are slightly elongate oblate bodies with a beanlike shape and occur in size to well below 0.1 millimeter. Presumably the result of mechanical abrasion, the grains are chiefly glass; however, some are composed of pyroxene, plagioclase, or intergrowths of these minerals.

Rock-surface features. - Most of the larger Apollo 12 crystalline rocks are similar to the Apollo 11 rocks in that they are rounded on one surface and have glass-lined pits. Angular fractured surfaces occur on some of the rocks.

Small pits (similar to those described in ref. 1) occur on the rock surfaces; the density ranges from 1 to 30 pits/cm^2. The angular bottom surfaces have few or no pits. The pits that are visible under a binocular microscope range from 0.1 to 10 millimeters in diameter and the depth-to-width ratios are approximately 1: 5. Most of the pits are circular; exceptions are the oval-shaped pits in the coarse crystalline rocks that have the long axis parallel to elongated feldspar or pyroxene crystals. The glass linings of the pits vary greatly in thickness and vesicularity. Pulverized minerals form 0.5- to 1.0-crater-width white halos around the pits on the crystalline rock surfaces. Where pit density is high, a 1- to 2-millimeter-thick crust of pulverized minerals is formed on the rock surface. Impact pits in glass coatings are surrounded by radiating fractures. On many of the medium- to coarse-grained crystalline rocks, the glass linings of the pits are raised slightly above the rock surface. These glass-topped pedestals appear to be more resistant to erosion than the rock.

Irregular patches of glass are spattered on the rock surfaces. Two types (which grade into one another) can be distinguished: thin films and thick, highly vesicular coatings. The thin (less than 0.1 millimeter thick) films are brownish black in reflected light and brown in transmitted light, cover a 1- to 16-square-centimeter area, are usually slightly vesicular, and adhere tightly to the rock surface. The thick (0.1 to 1 centimeter) coatings, which were found on samples from the bottom of a 1-meter crater, are light to dark brown, have vesicle sizes increasing from 0.1 to several millimeters from the base to the outer surface, and have smooth botryoidal surfaces. Several highly fractured breccias and fine-grained crystalline rocks are covered with the thick coating. The fractures in these rocks are filled to a depth of several centimeters. The contacts between the glass and the rock are sharp. The glass coatings locally contain a large number of angular, highly shocked rock chips. Some of the vesicular glass has been partly devitrified. A light-gray glass fragment of uncertain origin with pronounced flow structure also was collected.

Impact metamorphism. - Impact metamorphism in the Apollo 12 samples is similar to and as common as in the Apollo 11 samples. Impact-fused glass spherules and beads and shock-vitrified mineral fragments are present both in the fines and in the microbreccias.

Most of the large crystalline rocks apparently are unshocked or only weakly shocked; several of the smaller crystalline rocks show evidence of moderate to strong shock. A thin section of one of the smaller rocks shows extensive fracturing of the plagioclase and partial vitrification and development of lamellar microstructures. The coexisting clinopyroxenes have one or two sets of closely spaced lamellar twinning that are absent in the clinopyroxene of similar unshocked crystalline rocks. Another rock shows extensive shock vitrification.

Shocked microbreccia also is present in the Apollo 12 samples. Many small fractured microbreccia fragments are held together by glass spatters. Breccia within breccia, indicating a multiple-shock history, also was found.

Small pebbles were collected that are either glassy or aphanitic. The pebbles are highly vesicular and some are vuggy. The pebbles are presumably the result of melting and fragmentation caused by impact metamorphism. Some of the vesicles are as large as 10 millimeters in diameter and occupy up to 50 percent of the preserved fragment.

Chemical Analyses

Chemical analyses of the samples were conducted inside the biological barrier of the LRL, mainly by optical spectrographic techniques, using an instrument with a dispersion of 5.2 Å/mm. Three separate techniques were conducted as follows.

1. Determination of silicon (Si), titanium (Ti), aluminum (Al), Fe, Mg, cobalt (Co), manganese (Mn), chromium (Cr), sodium (Na), and potassium (K) with Sr used as the internal standard

2. Determination of Mn, Cr, zirconium (Zr), Ni, Co, scandium (Sc), vanadium (V), barium (Ba), Sr, yttrium (Y), and ytterbium (Yb) and other involatile elements, using palladium (Pd) as the internal standard

3. Determination of lithium (Li), rubidium (Rb), Pb, boron (B), and other volatile elements, using Na as the internal standard

The procedures were generally similar to those used to analyze the Apollo 11 samples; however, as a result of the experience with the Apollo 11 material, modifications were made to cope more effectively with the high concentration of the refractory elements. For example, the ratio of admixed carbon (C) to the sample was increased from 1:1 to 4:1 for the method using Pd as the internal standard, and the range of possible intensity measurements was increased by a factor of 3, enabling a wider range of concentrations to be covered effectively (for example, Ba and Zr). The reduction of a sample to a powder was done in Spex agate vials in a mixer mill, in contrast to hand-grinding in agate mortars for the Apollo 11 samples.

Computer programs were used to provide intensity data from the photoplate densitometer data, in contrast to the hand processing of the Apollo 11 data. The overall precision of the determinations is ± 5 to 10 percent of the amount present. Accuracy of the results was controlled by use of the international rock standard samples (G-1, W-1, SY-1, BCR-1, AGV-1, GSP-1, G-2, PCC-1, and DTS-1) for calibration. In addition, the results were compared with the analyses of the Apollo 11 samples.

The spectrographic plates were examined to establish the presence or absence of all elements that have spectral lines in the wavelength regions covered (2450 to 4950 Å and 6100 to 8600 Å). Line interferences were checked for all lines (in particular by elements such as Ti, Cr, Y, and Zr) present in high concentrations compared to most terrestrial rocks. Wavelengths of the several principal lines were checked for those elements that were not detected because line interferences caused by common elements were occasionally visible. Several samples were brought from behind the biological barrier and analyzed by atomic absorption procedures for Al, Ca, Mg, Fe, Ti, Na, and K, and by a chemical colorimetric procedure for Si. The data reported for these elements in sample 12013 were obtained by these methods. The spectrographic data are presented in tables VIII to XI and the atomic absorption data in table XII. The sample weights provided for analysis were larger than for the Apollo 11 suites and were typically 100 to 150 milligrams.

The samples appear to be free from inorganic contamination, either from the rock box or from the LM. Niobium (Nb), which constitutes 88 percent of the LM descent-engine skirt, was detected in only two samples, sample 12013 with 170 ppm and sample 12033 with 44 ppm. This amount is almost certainly indigenous to the rocks and is geochemically consistent with the high abundance of the geochemically associated elements Zr and Y. Indium, present in the seal of the rock boxes, was not detected (the detection limit was 1 ppm). Values for Cu are not reported for the Apollo 12 rocks. Sporadic contamination of the samples (up to several hundred ppm) was found because of abrasion of the copper parts of the door mechanisms in the class III biological cabinets where the sample preparation work was done.

TABLE VIII. - EMISSION SPECTROGRAPHIC DATA FOR FINES MATERIALS

(a) Elements

Sample number	Rb, ppm	Ba, ppm	K, ppm	Sr, ppm	Ca, percent	Na, percent	Yb, ppm	Y, ppm	Zr, ppm	Cr, ppm	V, ppm	Sc, ppm	Ti, percent	Ni, ppm	Co, ppm	Fe, percent	Mn, ppm	Mg, percent	Li, ppm	Ga, ppm	Al, percent	Si, percent
[a]12060	2.3 ± 0.2	180 ± 20	1000	210 ± 20	7.85	0.30	--	100 ± 10	300 ± 30	2800 ± 100	78 ± 5	54 ± 5	2.25	110 ± 10	38 ± 4	16.3	2100 ± 200	6.0	8 ± 2	11 ± 1	6.9	18
[b]12070	3.2 ± 0.2	420 ± 20	1500	170 ± 20	7.1	.30	--	130 ± 10	670 ± 50	2800 ± 100	64 ± 5	47 ± 5	1.85	200 ± 20	42 ± 5	13.2	1900 ± 200	7.2	11 ± 2	--	7.4	19.6

(b) Oxides

Sample number	SiO_2, percent	TiO_2, percent	Al_2O_3, percent	FeO, percent	MgO, percent	CaO, percent	Na_2O, percent	K_2O, percent	MnO, percent	Cr_2O_3, percent	ZrO_2, percent	NiO, percent	Total percent
[a]12060	39 ± 2	3.8 ± 0.5	13 ± 1	21 ± 1	10 ± 1	11 ± 1	0.40 ± 0.05	0.12 ± 0.01	0.27 ± 0.01	0.41 ± 0.02	0.04 ± 0.005	0.014 ± 0.001	99.05
[b]12070	42 ± 2	3.1 ± 0.5	14 ± 1	17 ± 1	12 ± 1	10 ± 1	.40 ± 0.05	.18 ± 0.01	.25	.41	.09 ± 0.005	.025 ± 0.001	99.5

[a]Tote-bag sample.

[b]Contingency sample.

TABLE IX. - EMISSION SPECTROGRAPHIC DATA FOR SELECTED SAMPLES

(a) Elements

Sample number	Rb, ppm	Ba, ppm	K, ppm	Sr, ppm	Ca, percent	Na, percent	Yb, ppm	Y, ppm	Zr, ppm	Cr, ppm	V, ppm	Sc, ppm	Ti, percent	Ni, ppm	Co, ppm	Fe, percent	Mn, ppm	Mg, percent	Li, ppm	Ga, ppm	Al, percent	Si, percent
12004	0.47	60	480	145	7.1	0.35		52	170	5800	85	45	2.0	90	50	17.9	1750	9.0	4.2		5.6	17.3
12009	.57	65	520	110	7.1	.38		48	150	5200	77	42	2.0	67	46	15.5	1450	7.5	5.5		5.7	19.2
12010	2.0	180	1300	145	7.0	.39		87	380	3050	90	50	2.2	80	39	15.2	1400	6.6	7		6.1	20
12011	(a)	60	570	120	7.6	.41		52	165	4000	85	56	2.0	85	30	16.3	1650	5.9	6.2		5.8	19.6
12012	.64	38	460	110	6.6	.39		40	120	3900	65	38	1.85	135	48	17.9	1300	10.6	3.9		5.7	16.4
12013	33	2150	1.66	150	4.5	.51	20	240	2200	1050	13	21	.72	105	13	7.8	950	3.6	100		6.3	28.5
12014	.60	55	560	100	6.8	.34		40	125	4000	80	40	1.74	105	52	17.9	1350	10.6	4.4		5.3	16.4
12015	1.0	44	510	115	7.0	.27		46	160	3900	95	44	1.92	70	47	17.1	--	8.4	10		5.8	17.8
12018	.58	70	520	110	6.2	.29		48	155	3500	82	50	2.0	65	50	15.9	1500	10.3	7		5.3	18.2
12020	.37	58	650	120	6.6	.37		42	150	3800	50	49	1.68	80	51	16.3	1450	9.6	6.0		5.1	18.2
12022	.17	38	560	160	7.0	.27		62	160	2650	65	52	3.36	40	36	17.1	1350	7.8	3.1		5.8	16.8

[a]Not detected.

(b) Oxides

Sample number	SiO_2, percent	TiO_2, percent	Al_2O_3, percent	FeO, percent	MgO, percent	CaO, percent	Na_2O, percent	K_2O, percent	MnO, percent	Cr_2O_3, percent	ZrO_2, percent	NiO, percent	Total percent
12004	37	3.4	10.6	23	15	10	0.48	0.058	0.23	0.85	0.023	0.011	100.7
12009	41	3.3	10.8	20	12.5	10	.51	.063	.19	.76	.020	--	99.1
12010	43	3.7	11.5	19.5	11	9.8	.53	.16	.18	.45	.051	--	99.9
12011	42	3.4	11	21	9.7	10.7	.55	.069	.21	.58	.022	.011	99.2
12012	35	3.1	10.8	23	17.5	9.3	.53	.055	.17	.57	.016	.017	100.0
12013	61	1.2	11.9	10	6.0	6.3	.69	1.5	.12	.15	.30	.013	99.7
12014	35	2.9	10	23	17.5	9.5	.46	.068	.17	.58	.017	.013	99.2
12015	38	3.2	11	22	14	9.8	.37	.062	.33	.57	.022	--	99.4
12018	39	3.3	10	20.5	17	8.7	.39	.063	.19	.51	.021	--	99.7
12020	39	2.8	9.7	21	16	9.3	.50	.078	.19	.55	.020	.010	99.1
12022	36	5.6	11	22	13	11	.36	.068	.17	.39	.022	--	99.6

TABLE X. - EMISSION SPECTROGRAPHIC DATA FOR DOCUMENTED SAMPLES

(a) Elements

Sample number	Rb, ppm	Ba, ppm	K, ppm	Sr, ppm	Ca, percent	Na, percent	Yb, ppm	Y, ppm	Zr, ppm	Cr, ppm	V, ppm	Sc, ppm	Ti, percent	Ni, ppm	Co, ppm	Fe, percent	Mn, ppm	Mg, percent	Li, ppm	Ga, ppm	Al, percent	Si, percent
12033	7.5	720	3240	260	8.2	0.40	12	260	950	2100	37	33	1.56	140	34	12.4		6.5	15		8.5	19.2
12034	--	460	3500	--	7.4	.48	--	270	2100	2400	--	--	1.50	140	--	10.3	1400	5.1	--	--	8.0	22
12038	.70	230	470	230	7.9	.45		68	260	2200	70	55	1.92	14	23	13.2		3.9	5.5		6.4	22.9
10240	--	54	440	--	5.4	.13	--	63	180	4800	--	--	1.50	170	--	16.7	2200	10.3	--	--	3.3	19
12051	.37	48	470	165	8.6	.22		53	175	2200	75	58	2.96	16	25	15.5		5.7	4.5		6.4	18.7
12052	.80	50	570	135	7.9	.33		42	170	3700	105	52	2.16	32	42	16.3		6.0	4.5		5.8	19.6

(b) Oxides

Sample number	SiO_2, percent	TiO_2, percent	Al_2O_3, percent	FeO, percent	MgO, percent	CaO, percent	Na_2O, percent	K_2O, percent	MnO, percent	Cr_2O_3, percent	ZrO_2, percent	NiO, percent	Total percent
12033	41	2.6	16	16	10.7	11.5	0.54	0.39	0.23	0.31	0.13	0.018	99.4
12034	47	2.5	15.1	13.3	8.4	10.4	.65	.42	.19	.35	.28	.018	98.6
12038	49	3.2	12	17	6.5	11	.60	.057	.26	.32	.035	--	100.0
12040	41	2.5	6.3	21.5	17.0	7.6	.18	.053	.28	.70	.024	.022	97.3
12051	40	4.9	12	20	9.5	12	.30	.057	.30	.32	.024	--	99.4
12052	42	3.6	11	21	10	11	.45	.069	.31	.54	.023	--	100.0

TABLE XI. - EMISSION SPECTROGRAPHIC DATA FOR TOTE-BAG AND CONTINGENCY SAMPLES

(a) Elements

Sample number	Rb, ppm	Ba, ppm	K, ppm	Sr, ppm	Ca, percent	Na, percent	Yb, ppm	Y, ppm	Zr, ppm	Cr, ppm	V, ppm	Sc, ppm	Ti, percent	Ni, ppm	Co, ppm	Fe, percent	Mn, ppm	Mg, percent	Li, ppm	Ga, ppm	Al, percent	Si, percent
12062	>1	100	650	225	8.3	0.34	--	65	180	2600	105	78	2.8	29	34	15.5	2000	5.1	7.0	--	6.3	19.2
12063		100	650	225	7.9	.32	--	85	190	3100	95	75	3.1	30	36	16.7	2000	5.4	7.5	--	5.8	19.2
12064	.76	55	700	165	8.8	.31	--	55	170	3000	100	60	2.9	15	40	17.0	2500	4.8	6.7	--	6.3	18.7
12065	.72	70	600	135	9.0	.29	--	48	180	3500	135	60	2.3	25	34	17.1	3200	6.6	6.0	--	6.4	18.7
[a]12071	4.5	550	1800	250	8.2	.31	--	160	1300	2400	42	41	1.85	140	28	12.8	1400	6.6	25	--	7.9	19.6
[a]12073	4.9	510	2100	230	8.2	.29	--	180	1200	2800	50	42	1.85	350	30	13.0	1500	6.6	25		7.9	19.1
12077	.66	60	460	120	7.1	.23	--	40	130	6200	100	46	1.91	105	54	18.7	3200	10.5	6.5		5.8	15.4

(b) Oxides

Sample number	SiO_2, percent	TiO_2, percent	Al_2O_3, percent	FeO, percent	MgO, percent	CaO, percent	Na_2O, percent	K_2O, percent	MnO, percent	Cr_2O_3, percent	ZrO_2, percent	NiO, percent	Total percent
12062	41	4.6	12	20	8.5	11.6	0.46	0.078	0.26	0.38	0.024	--	98.9
12063	41	5.2	11	21.5	9	11	.43	.078	.26	.45	.026	--	99.9
12064	40	4.9	12	22	8	12	.42	.084	.32	.44	.023	--	100.2
12065	39	3.8	12	22	9	12.6	.39	.072	.41	.51	.024	--	99.8
[a]12071	42	3.1	15	16.5	11	11.5	.42	.22	.18	.35	.18	.018	100.5
[a]12073	41	3.1	15	16.7	11	11.5	.50	.25	.19	.41	.16	.044	99.9
12077	33	3.2	11	24	17.5	10	.31	.056	.41	.91	.018	.013	100.4

[a]Breccia.

TABLE XII. - ATOMIC ABSORPTION DATA

Sample number	K_2O, percent	Na_2O, percent	CaO, percent	MgO, percent	Al_2O_3, percent	FeO, percent	TiO_2, percent	MnO, percent	Cr, percent	[a]SiO_2, percent
12013	1.96	1.20	6.30	8.00	12.0	12.6	1.17	0.19	0.245	61.2
12024										
Breccia	.405	.61	10.0	9.53	14.3	15.3	2.5	.193	.24	46.0
Glass	.285	.49	10.0	9.80	12.7	15.3	2.5	.203	.24	45.5
12024	.075	.32	9.0	11.95	8.7	22.5	4.0	.277	.40	43.0
12033	.33	.65	10.2	9.1	14.0	14.4	2.3	.185	.245	47.2
12034	.42	.65	10.4	8.35	15.1	13.3	2.5	.193	.24	47.2
12038	.057	.66	10.70	6.75	13.2	17.8	3.5	.245	.245	48.0
12040	.053	.18	7.6	17.10	6.3	21.5	2.5	.277	.48	43.5
12051	.057	.30	10.70	7.30	10.5	19.8	4.67	.274	.245	46.5
12055	.060	.285	10.60	7.45	10.5	18.7	3.5	.30	.360	46.5
12057	.12	.91	9.70	8.61	11.3	21.6	5.84	.30	.283	41.4
12072	.060	.215	8.20	14.1	9.8	20.6	3.5	.274	.475	45.5
12075	.051	.19	7.53	15.5	7.7	20.0	2.3	.245	.515	45.0
Biological test sample	.19	.46	9.9	10.3	13.2	17.0	2.3	.21	.320	45.0

[a]The data for SiO_2 were obtained by spectrophotometric analysis.

The major constituents of the samples are (in order of decreasing abundance) Si, Fe, Mg, Ca, Al, and Ti. The major silicate and oxide mineral phases present in the samples indicate that O comprises the major anion. The elements Cr, Na, Mn, and K are the minor constituents and have concentrations ranging from 0.05 to 0.6 percent; occasionally, Ba and Zr reach these concentration levels. The other constituents are present mostly at less than 200 ppm (0.02 percent). The volatile elements (Pb, B, bismuth (Bi), thallium (Tl), and so forth) are generally below the limits of detection of the spectrographic methods used, although Pb (approximately 30 ppm) and B (approximately 20 ppm) were detected in sample 12013. Gold, silver, and the platinum-group elements were not detected in any samples.

The chemistry of the crystalline rocks is distinct from that of the fines material and the breccias. The rocks are lower in Rb, K, Ba, Y, Zr, Ni, and Li and higher in Fe and Cr. Several critical element ratios are also distinct. The K/Rb ratio averages 850 in the rocks compared to 450 in the fines. The average Fe/Ni ratio of 3000 in the rocks (range from 2000 to 11 000) is much higher than the fines material ratio of approximately 600. The Rb/Sr ratio is very low in the rocks (0.005) but is higher in the fines (0.02).

The fines material and the breccias are generally very similar in composition and could not have been formed directly from the large crystalline-rock samples. The Ni content of the breccias and fines material places an upper limit on the amount of meteoritic material contributed to the lunar-surface regolith. Using an average meteoritic Ni content of 1.5 percent, the Ni content of the fines material represents a meteoritic contribution of the order of 1 percent if all the Ni were extralunar.

The crystalline rocks show minor but significant internal variations in chemistry. Nickel shows a striking decrease in concentration, by an order of magnitude. Chromium displays a smaller relative decrease in the same direction, and Co shows a slight decrease. Silicon increases as Mg decreases. Similar trends are shown by V, Sc, Zr, Y, K, Ba, and Ca, although the variations are small. Critical element ratios (Fe/Ni, Ni/Co, and Cr/V) decrease, and the V/Ni ratio increases with a decrease in Mg. No significant trends are shown by K/Rb, Rb/Sr, or K/Ba ratios.

Sample 12013 is chemically unique. It is not analogous chemically to a terrestrial anorthosite. The sample contains the highest concentration of silicon oxide (SiO_2) (61 percent) yet observed in a lunar rock. The amounts of K, Rb, Ba, Zr, Y, Yb, and Li are enriched by 10 to 50 times compared to the other rocks. These high concentrations are suggestive of the terrestrial enrichment of elements in residual melts during the operation of fractional-crystallization processes, and the sample may have crystallized from a small volume of residual melt late in the cooling of a pool of silicate melt. The ferromagnesian elements (Mg, Fe, Cr, Mn, Ti, Sc, and Co), although low in sample 12013 in comparison with the other rocks, are not strikingly depleted. Nickel, in particular, is not depleted as it would be in terrestrial analogs. Sample 12033 from the light-gray fines material shows some analogs in composition that contain high concentrations of Yb, Nb, and Rb.

A comparison of the Apollo 12 samples from the Ocean of Storms with the Apollo 11 samples from the Sea of Tranquility shows that the chemical characteristics of the samples at the two maria sites are clearly related. Both suites show the distinctive features that most clearly distinguish lunar from other material — high concentrations of "refractory" elements and low concentrations of volatile elements. In detail, numerous and interesting chemical differences exist between the Apollo 12 and the Apollo 11 rocks. The main differences are as follows.

1. The Apollo 12 rocks and fines material have a lower concentration of Ti. The range is 0.72 to 3.4 percent Ti (1.2 to 5.1 percent TiO_2) compared with the range in the Apollo 11 rocks of 4.7 to 7.5 percent Ti (7 to 12 percent TiO_2).

2. The Apollo 12 samples have lower concentrations of K, Rb, Zr, Y, Li, and Ba.

3. The Apollo 12 crystalline rocks have higher concentrations of Fe, Mg, Ni, Co, V, and Sc. These concentrations are consistent with the more mafic character of the Apollo 12 rocks.

4. The significant variation in the Apollo 12 rocks is among the ferromagnesian elements, entering the principal mineral phases. In the Apollo 11 suite, a much wider variation existed in the concentration of elements such as K and Rb, indicating a wider range of crystallization. However, sample 12013 represents a much more extreme composition (and probable later crystal fraction) than that of any of the Apollo 11 rocks.

5. The fines material collected at the Apollo 12 site differs from that collected at the Apollo 11 site in that it contains approximately half the Ti content; more Mg; and possibly higher amounts of Ba, K, Rb, Zr, and Li. The light-gray fines material of sample 12033 is strongly enriched in Rb, Zr, Yb, and Nb relative to the other fines material.

The chemistry of the Apollo 12 samples does not resemble that of chondrites. Nickel, in particular, is strikingly depleted. The samples are closest in composition to the eucrite class of the basaltic achondrites; sample 12038 shows some similarities to this class (table X). The possible "lunar acid" rock (sample 12013) does not resemble terrestrial granites or rhyolites or even tektites in the abundances of most elements. The Apollo 12 material is enriched in many elements by one to two orders of magnitude in comparison with estimates of cosmic abundances.

Gamma-Ray Spectrometry Analyses

Operation of the radiation-counting laboratory (RCL) followed the general procedures developed for the Apollo 11 studies (ref. 1). The first RCL sample was received for measurement on November 30, 1969, and probably would have been received approximately 1 day earlier if a glove failure had not delayed operations in the vacuum laboratory. Because of the experience gained during the Apollo 11 analyses, the preparation of samples for the RCL generally was completed more rapidly and at more regular intervals.

For the RCL analyses, 11 samples were chosen from the contingency sample, the selected samples, the documented sample box, the documented sample bags, and the tote-bag samples. Analysis was performed by use of the NaI(Tl) low-background spectrometer and the on-line computer data-acquisition system described in reference 1. The samples were mounted in stainless steel cans that had 16.2-centimeter diameters, 0.8-millimeter wall thicknesses, and bolt-type indium seals. Standard containers with overall heights of 5.6 or 7.6 centimeters were used for all rock samples. The fines were packaged in a cylindrical container, which was used in searches for magnetic monopoles.

For this preliminary study, calibrations were obtained with a series of radioactive standards prepared by dispersing known amounts of radioactive material in quantities of Fe powder. Time did not permit recording a library of standard spectra with the standard sources placed inside the actual steel containers. Therefore, empirical corrections for the effects of the containers were made; these corrections were least important for the ^{40}K data and most serious for the ^{26}Al and ^{22}Na data.

The results of the analyses are summarized in table XIII. Because of the preliminary nature of the investigation, rather large errors were assigned. In addition to the statistical errors of counting, these errors include estimates of possible systematic errors caused by uncertainties in the detector-efficiency calibration.

Although many qualitative similarities exist between the RCL data on the Apollo 11 and the Apollo 12 samples, some notable differences also exist. The K concentration of the Apollo 12 crystalline rocks is remarkably constant at about 0.05 percent, and the ratio of K to uranium (U) is about 2200. These properties appear to be significantly lower than for the typical crystalline rocks from Apollo 11; however, the composition

TABLE XIII. - GAMMA-RAY DATA

Sample number	Weight,[a] g	K, percent	Th, ppm	U, ppm	^{26}Al, dpm/kg	^{22}Na, dpm/kg	Other radionuclides detected	Remarks
Crystalline rocks								
12002	1530	0.044 ± 0.04	0.96 ± 0.1	0.24 ± 0.033	72 ± 14	53 ± 10	^{54}Mn, ^{52}Mn, ^{56}Co, ^{46}Sc, ^{48}V	
12004	502	.048 ± 0.004	.88 ± 0.09	.25 ± 0.033	112 ± 22	65 ± 13	^{54}Mn, ^{56}Co, ^{46}Sc, ^{48}V	
12039	255	.060 ± 0.005	1.20 ± 0.12	.31 ± 0.040	80 ± 16	45 ± 9	^{56}Co, ^{54}Mn	
12053	879	.051 ± 0.004	.89 ± 0.09	.25 ± 0.033	85 ± 17	42 ± 9	^{56}Co, ^{48}V, ^{46}Sc, ^{54}Mn	
12054	687	.052 ± 0.004	.77 ± 0.08	.21 ± 0.030	43 ± 9	42 ± 9	^{48}V, ^{56}Co, ^{54}Mn, ^{46}Sc	
12062	730	.052 ± 0.004	.81 ± 0.08	.21 ± 0.030	65 ± 13	34 ± 7	^{48}V, ^{56}Co, ^{54}Mn, ^{46}Sc	
12064	1205	.053 ± 0.004	.88 ± 0.09	.24 ± 0.035	58 ± 12	44 ± 9	^{56}Co, ^{46}Sc, ^{48}V, ^{54}Mn	
Miscellaneous samples								
12034	154	0.44 ± 0.035	13.2 ± 1.3	3.4 ± 0.4	58 ± 12	27 ± 6	^{54}Mn	Breccia
12073	405	.278 ± 0.022	8.2 ± 0.8	2.0 ± 0.3	125 ± 25	60 ± 12	^{56}Co, ^{54}Mn, ^{46}Sc	Breccia
12070	354	.206 ± 0.016	8.6 ± 0.6	1.5 ± 0.2	140 ± 25	65 ± 13	^{56}Co, ^{48}V, ^{46}Sc, ^{54}Mn	Fines material
12013	80	2.02 ± 0.016	34.3 ± 3.4	10.7 ± 1.6				Feldspathic differentiate

[a]Weight of sample counted.

of one of the coarsely crystalline Apollo 11 rocks (sample 10003) very closely resembled the chemical composition of the crystalline rocks shown in table XIII. The ratio of thorium (Th) to U is approximately 4 for all typical materials in table XIII, the same as for the materials from the Sea of Tranquility. The concentrations of the radioactive elements K, Th, and U in the crystalline rocks of table XIII are all remarkably constant and, on the average, much lower than for the comparable Apollo 11 rocks. Because so few samples from the two sites can be compared, the factor of biased sampling of the lunar-surface material cannot be discounted.

The breccias and fines are very different from the crystalline rocks in several respects. The K/U ratio for the breccias and fines is only 1400 to 1500, compared with an average of approximately 2800 for the Apollo 11 materials. Thus, the Apollo 12 samples show even greater differences from terrestrial rocks and meteorites than did the surface material from the Sea of Tranquility. Although the Th/U ratio remains at approximately 4, the concentrations of all radioactive elements are much higher in the breccias than in the crystalline rocks.

In general, the amount of cosmogenic ^{26}Al and ^{22}Na appears to be saturated but shows variations that may be related to chemical composition or to cosmic-ray exposure. For example, sample 12034 was collected from a trench dug during the second EVA and was buried approximately 10 to 20 centimeters. The saturation activities of ^{26}Al and ^{22}Na are reduced by the amount expected because of attenuation of the irradiation flux in the lunar soil.

Noble Gas Results

Several samples each of the fines material, breccias, and crystalline rocks returned by the Apollo 12 astronauts have been analyzed for noble gas isotopes. The analyses were performed by mass spectrometry, and the general procedures were the same as for the preliminary examination of the Apollo 11 samples (ref. 1). Similar to the Apollo 11 materials, the Apollo 12 fines and breccias are characterized by large abundances of noble gases of solar-wind origin, as exemplified by the large relative abundances of He and by the characteristic $^{4}He/^{3}He$ and $^{20}He/^{22}He$ ratios. Conversely, the crystalline rocks contain much smaller amounts of the noble gases that arise mainly from spallation reactions within the samples or from radiogenic decay. The noble-gas isotopic contents for typical samples of all three types of the Apollo 12 lunar material are listed in table XIV. The ratios are believed to be accurate to within ± 2 percent (except $^{4}He/^{3}He$, which has a larger uncertainty) and the abundances to within ± 20 percent (except ^{84}Kr (krypton), which is considerably greater).

Despite the general similarity in the noble gas content of the Apollo 12 and Apollo 11 material, several real and significant differences exist. The noble gas contents (in cc/g at STP) of the Apollo 12 fines and breccias are lower; the fines by a factor of 2 to 5 and the breccias by an order of magnitude. Using a model of formation of the fines material by (1) degradation of surface rock, (2) surface irradiation by constant solar wind, and (3) subsequent burial by additional fines material, the lower gas content of the fines implies a higher accumulation rate of material. The gas content of the

TABLE XIV. - RARE-GAS DATA

Sample number	Type of sample	Total weight, g	Rare-gas contents in 10^{-8}, cc/g for —									
			^{3}He	^{4}He	^{20}Ne	^{21}Ne	^{22}Ne	^{36}Ar	^{38}Ar	^{40}Ar	^{84}Kr	^{132}Xe
12060	Fines	--	2000	4 000 000	70 000	200	5 000	10 000	2000	10 000	4	1
12070	Fines	1099	3000	7 000 000	100 000	400	10 000	20 000	4000	10 000	10	3
12034	Breccia	160	100	100 000	8 000	50	700	2 000	300	3 000	1	1
12071	Breccia	--	800	2 000 000	30 000	100	3 000	5 000	1000	5 000	5	1
12010												
Light phase		--	90	20 000	100	10	20	20	10	1 000	.01	.02
Dark phase		--	1000	3 000 000	100 000	300	7 000	10 000	2000	40 000	3	1
12004	Rock	585	100	10 000	50	10	10	10	5	1 000	.02	.01
12009	Rock	460	100	30 000	200	20	40	40	20	1 000	.02	.01
12013	Rock	--	40	400 000	100	5	10	10	6	800 000	.2	.1
12022	Rock	1858	200	30 000	400	30	60	40	20	800	.005	.01
12040	Rock	319	200	10 000	80	40	50	20	20	1 000	.06	.02
12052	Rock	1866	100	30 000	200	40	60	60	30	1 000	.06	.03
12054	Rock	687	200	20 000	70	20	30	30	30	1 000	.04	.02
12062	Rock	727	100	10 000	60	20	30	20	30	1 000	.07	.02
12063	Rock	2420	60	10 000	70	10	20	20	10	1 000	--	.05
12064	Rock	1210	200	10 000	60	30	40	30	30	1 000	.03	.01
12065	Rock	2100	200	20 000	100	30	40	50	40	1 000	.04	.01

Apollo 12 breccias is lower than that of the Apollo 12 fines by approximately a factor of 2, which constitutes a reversal of the trend observed with the Apollo 11 material and implies that the Apollo 12 breccias were formed from fines material of lower solar-wind gas content. The breccias apparently were formed at some distance or depth from the location at which they were collected.

For sample 12034 (a breccia), the total noble gas content is low enough for a spallation component to be quite evident. Sample 12010 is an unusual breccialike rock that was identified on the basis of the noble gas content. The rock is characterized by a large relative abundance of the lithic phase, with the darker fine-grained material occurring as veins. The dark phase of sample 12010 contains approximately 70 percent of this fine-grained material, while the light phase is essentially pure lithic material. The typical breccialike nature of sample 12010, in terms of the noble gas content, is obvious.

The $^{40}Ar/^{36}Ar$ ratio in the Apollo 12 fines and breccias (with the exception of sample 12010) is lower than that for Apollo 11, although the ratio still shows larger values for breccias than for fines. Theoretical considerations prohibit $^{40}Ar/^{36}Ar$ ratios even as large as 0.6 for the sun, making a solar-wind origin of the ^{40}Ar unlikely. The amount of ^{40}Ar in the fines is too large to be generated by in situ decay of K; however, for the breccias, this mode of origin may be possible. The fines material thus appears to have acquired excess ^{40}Ar of lunar origin. The amount of ^{40}Ar and the $^{40}Ar/^{36}Ar$ ratio in sample 12010 demonstrate this phenomenon well. Although the lithic phase resembles the other crystalline rocks in Ar content, the fine-grained material shows not only large amounts of solar-wind Ar but also large excesses of ^{40}Ar.

The crystalline-rock samples discussed in this section are completely interior chips and contain noble gas several orders of magnitude less than the fines material. The exceptions are ^{3}He, ^{21}Ne (neon), ^{40}Ar, and some of the lighter isotopes of Kr and xenon (Xe), isotopes the abundances of which have been greatly increased by spallation reactions and radioactive decay. By use of the K concentrations obtained for the rocks by the chemical analysis group of the PET, the K-Ar ages were calculated. Several crystalline rocks show ages between 1.7 and 2.7 billion years, with an average age of 2.3 billion years. Sample 12013 has a unique chemical composition, characterized in part by much higher abundances of K and U and, consequently, of radiogenic ^{4}He and ^{40}Ar. The sample also contained excess radiogenic ^{40}Ar, rendering the K-Ar age meaningless. However, the U-^{4}He and Th-^{4}He ages are consistent with a value of approximately 2.3 billion years, as is the case for many of these crystalline rocks. This age is considerably less than that found for the Apollo 11 crystalline rocks, although the range of ages for the two sites overlaps. At least this portion of the Ocean of Storms apparently has a more recent crystallization age than the rocks from the Sea of Tranquility, which implies that lunar maria have a formation history of at least 1 billion years.

Cosmic-ray exposure ages (that is, integrated exposure time at the lunar surface) were calculated for several rocks on the basis of 2π geometry and of a ^{3}He production rate of 1×10^{-8} ccSTP/g/10^{6} years. These ages show the much wider range of 1 to 200 million years, with some apparent grouping of ages, and resemble the ages found for the Apollo 11 rocks. The breccias also show radiation ages in this range. Spallation-produced isotopes other than ^{3}He are consistent with the ^{3}He ages and with the special chemistry of the lunar material. Because of the abundances of high-alkaline earth, Y, and Zr, spallation-produced Kr and Xe are very obvious in the rocks. The amounts of these gases are also roughly consistent with the chemical composition.

Total Carbon Analyses

The total C content of the lunar samples was determined using O combustion followed by gas-chromatographic detection of the CO_2 produced. Samples weighing from 50 to 600 milligrams were placed with Fe chips and a copper-tin accelerator in a preburned refractory crucible. The crucible was then heated to more than 1600° C in an O atmosphere with an induction heater. The combustion products were carried by the O through a dust filter to remove metal oxides and through a manganese oxide trap to remove sulfur (S) gases. Any carbon monoxide (CO) that was formed was converted to CO_2 in a heated catalyst tube. Moisture was removed by an anhydrone trap before the CO_2 was passed into a LECO No. 589-600 Analyser. The CO_2 was carried by the O stream into a collection trap. After a fixed collection time, the trap was heated and the released CO_2 was carried by He through a silica-gel column into a thermal-conductivity measuring cell. The detection method used the difference in thermal conductivity between He and CO_2. The imbalance in the bridge circuit containing the thermal-conductivity cell was integrated and read directly on a digital voltmeter.

The system was calibrated using the National Bureau of Standards Steel Standard 101e. Samples of this standard containing 5 to 50 micrograms of C were run under the same conditions as the lunar samples. To reduce the background, the crucible was burned in air at 1000° C for at least 1 hour. Only crucibles from a single burn batch were used in a sequence of standards and samples. The precision of the method was evaluated by making replicate runs on sample blanks. A typical standard deviation on a series of 10 runs was 2 micrograms of total C. At all times, the samples were handled as little as possible to reduce laboratory contamination. The results for the standard samples were plotted on linear graph paper, and the C content in the lunar samples was read directly from the standard linear curve.

The results of the total C analyses are given in table XV. The highest C abundances, as for the Apollo 11 samples, usually are found in the fines. The exceptions to this generalization are samples 12032 and 12033, which are fines from the bottoms of trenches. The breccias have more C than the igneous rocks, which (including the heavily shocked sample 12052) are consistently low in C. A total C abundance of approximately 40 ppm appears to be indigenous to lunar rocks. Additional C apparently was added to the fines and subsequent breccias by meteoritic impact, the solar wind, and possible contamination. The low abundances even in the fines material indicate that C has not accumulated to any great degree. The total C results alone give no indication of the specific chemical species present.

TABLE XV. - TOTAL CARBON DATA

Sample number	Weight, g	C, μg	C, ppm	Remarks
[a]1200	1.0082	7	7 ± 2	Quartz sand
12003-1	.1480	20	120 ± 10	Fines
	.1605	32.5	200 ± 10	
	.1571	29	185 ± 20	Fines
	.1128	22	195 ± 25	
12024-7	.1395	16	115 ± 20	GASC
12032-1	.1519	4	20 ± 10	Fines from documented sample bag 4-D
12032-1	.3813	9.5	25 ± 4	

[a]Control sample.

TABLE XV. - TOTAL CARBON DATA - Concluded

Sample number	Weight, g	C, μg	C, ppm	Remarks
12033	0.1254	10	80 ± 10	Fines from documented sample bag 5-D; contaminated
12033-1	.1997	4	20 ± 5	Fines from documented sample bag 5-D
	.6014	13.5	22.5 ± 2	
12034-2	.2446	16	65 ± 12	Light-colored breccia
12038	.1528	7	46 ± 10	Rock; contaminated
12040-2	.2245	10	45 ± 15	Coarse crystalline rock
12042-1	.2452	31	125 ± 5	Fines from documented sample bag 12-D
	.3409	45	132 ± 5	
12044-2, -1	.3071	13.5	44 ± 5	Fine-grained crystalline rock
12051	.1207	31	260 ± 20	Olivine basalt; contaminated
12052-4	.4487	11	24.5 ± 4	Coarse-grained, shocked
	.3326	11.5	34 ± 10	
	.1261	8.5	65 ± 15	
12057	.2194	27	120 ± 10	Medium-dark breccia
12059-1	.1533	35	230 ± 15	Fines
	.1270	31	240 ± 25	
	.1336	16	120 ± 15	Fines including rock chip
12063	.2755	9.5	35 ± 10	
12065	.4920	14	28.5 ± 4	
	.1438	5.5	38 ± 10	Pigeonite porphyry

Organic Mass-Spectrometry Analyses

A complete description of the system used for acquiring and presenting the mass spectral data from the organic analyses of the Apollo 11 samples is given in reference 1. The same procedures were used for the Apollo 12 mission with the following modifications.

1. Because of the problems encountered in the Apollo 11 analyses with the sterilization procedures necessary for sample transfer from the various sample-handling facilities to the mass spectrometer, a different approach was used. All samples were placed in previously cleaned stainless steel containers that were sealed (gastight) with aluminum caps. The containers were dry-heat sterilized at 130° C for 30 hours and

then transferred to the gas-analysis laboratory (GAL). This method eliminated the previous problems with the peracetic acid and ethylene oxide sterilization agents. The sample-transfer containers were opened and samples were handled in a clean nitrogen glove box in the GAL. All samples were put into a single Ni capsule. The same capsule was used for all the analyses, thus eliminating the contamination caused by improperly cleaned Ni capsules. To shorten the sample run time, the Ni capsule was cooled in Freon between runs; this procedure introduced the very slight amount of m/e 84 and 86 that is apparent in the mass spectra of some samples.

2. New programs were added to the system to allow plotting of a specific mass intensity as a function of the scan number. Some of these plots are included in appendix B in the data associated with each sample and are labeled with the particular mass chosen (for example, m/e 44).

3. The summarization plots presented in appendix B give the ion current as a function of the scan number. The following masses have been deleted from the Apollo 12 summary: m/e 14, 16 to 20, 23, 26 to 28, 32, 35 to 37, 40, and 44.

Both shallow and deep core-tube samples, coarse- and fine-grained rocks, a breccia, and other fines material and random chips have been analyzed. The following statements can be made with respect to all analyses. In general, the samples are very clean (much cleaner than the Apollo 11 samples), with only one sample (sample 12059-1) contaminated severely. The most striking feature of all of the organic analyses is the liberation of relatively large amounts of CO and CO_2 during the sample runs. The characteristics of the evolution of these gases indicate that they are the result of a pyrolysis process. This feature may have been true of the Apollo 11 samples also; however, no effort was made to monitor CO and CO_2 during the Apollo 11 analyses.

Organic-Monitor Analyses

The analytical results of the various Apollo 12 organic monitors (OM), both from the ALSRC and from the Ottawa sand used to monitor the LRL processing, are presented in appendix C. The data in appendix C comprise the most significant information available on the Apollo 12 contamination history. All tools used for the Apollo 12 sample processing were cleaned at the NASA White Sands Testing Facility and are assumed to have the same amount and type of contaminants as the Apollo 11 tools.

The principal organic monitors used for the S-ALSRC and the D-ALSRC were the York-mesh samples. The results given in appendix C include only the data for the coupons removed during the outbound processing. The coupon that remained in each ALSRC for the entire flight will be analyzed. The organic-contamination potential was reduced notably during the Apollo 12 lunar-sample processing, as evidenced by the use of the processing cabinets and by the very low levels (less than 1 ppm) of organic material added to the monitors by exposure to the processing cabinets.

CONCLUSIONS

The major findings of the preliminary examination of the Apollo 12 lunar samples are the same as the conclusions reached from the examination of the Apollo 11 samples. The major findings are as follows.

1. The fabric and mineralogy of the rocks divide them into two genetic groups: fine- and medium-grained crystalline rocks of igneous origin (probably originally deposited as lava flows, then dismembered and redeposited as impact debris) and breccias of complex history.

2. The modal mineralogy and bulk chemistry of the crystalline rocks show that they are different from any terrestrial rock and from meteorites.

3. Erosion has occurred on the lunar surface because most rocks are rounded. Some rocks have been exposed to a process that gives them a surface appearance similar to that of sandblasted rocks. There is no evidence of erosion by surface water.

4. The probable presence of the iron-troilite-ilmenite assemblage and the absence of any hydrated phase suggest that the crystalline rocks were formed under extremely low partial pressures of oxygen, water, and sulfur (in the range of those in equilibrium with most meteorites).

5. The absence of secondary hydrated minerals suggests that there has been no surface water at the Sea of Tranquility or the Ocean of Storms at any time since the rocks were exposed.

6. Evidence of shock or impact metamorphism is common in the rocks and fines.

7. All the rocks display glass-lined surface pits that may have been caused by the impact of small particles.

8. The level of indigenous organic material capable of volatilization or pyrolysis (or both) appears to be extremely low (that is, no more than 10 to 200 ppb).

9. Elements that are enriched in iron meteorites (that is, nickel, cobalt, and the platinum group) either were not observed or were very low in abundance.

10. Of the 12 radioactive species identified, two were cosmogenic radionuclides of short half-life; namely, ^{52}Mn (5.7 days) and ^{48}V (16.1 days).

11. The uranium and thorium concentrations are near the typical values for terrestrial basalts; however, the ratio of potassium to uranium determined for lunar-surface material is much lower than those ratios determined for either terrestrial rocks or meteorites.

12. The fines material and breccias contain large amounts of all the noble gases that have elemental and isotopic abundances that are almost certainly indicative of

solar-wind origin. The fact that interior samples of the breccias contain these gases implies that the samples were formed at the lunar surface from material previously exposed to the solar wind.

13. The high ^{26}Al concentration observed is consistent with the long exposure age to cosmic rays inferred from the rare-gas analyses.

14. No evidence of biological material has been found in the samples to date.

15. The lunar soil at the landing site is predominantly fine-grained, granular, slightly cohesive, and incompressible. The soil is similar in appearance and behavior to the soil at the Surveyor landing sites.

The following differences were observed in the examinations of the Apollo 12 and Apollo 11 lunar samples.

1. The Apollo 12 crystalline rocks show a wide range in both texture and mode, whereas the Apollo 11 crystalline rocks had essentially one texture (lath-shaped ilmenite and plagioclase with interstitial pyroxene) and similar modes (50 percent pyroxene, 30 percent plagioclase, 20 percent opaque minerals, and 0 to 5 percent olivine).

2. Most of the igneous rocks fit a fractional-crystallization sequence, indicating that they represent either parts of a single intrusive sequence or samples of a number of similar sequences.

3. Breccias are of lower abundance at the Ocean of Storms than at the Sea of Tranquility, presumably because the regolith at the Ocean of Storms is less mature and thinner than that at the Sea of Tranquility.

4. A complex stratification exists in the lunar regolith that is presumed to be caused primarily by the superposition of ejecta blankets; at present, the possibility of a layer of volcanic ash cannot be discounted (for example, sample 12033).

5. The greater carbon content of the breccias and fines compared with that of the crystalline rocks is presumed to be caused largely by contributions of meteoritic material and solar wind.

6. The amount of noble gas of solar-wind origin is less in the Apollo 12 fines and breccias than in the Apollo 11 fines and breccias. The breccias contain less noble gas of solar-wind origin than the fines, indicating that the breccias were formed from fines that had less solar-wind noble gases than the fines presently at the surface.

7. The ^{40}K-^{40}Ar measurements on the igneous rocks show that they crystallized 1.7 to 2.7 billion years ago. The presence of nuclides produced by cosmic rays show that the rocks have been within 1 meter of the lunar surface for 1 to 200 million years.

8. The Apollo 12 breccias and fines are similar chemically and contain only half the titanium content of the Apollo 11 fines. The composition of the crystalline rocks is distinct from that of the fines in that the rocks contain less nickel, potassium, rubidium, zirconium, uranium, and thorium.

9. The Apollo 12 samples contain less titanium, zirconium, potassium, and rubidium and more iron, magnesium, and nickel than the Apollo 11 samples. Systematic variations occur in the magnesium, nickel, and chromium content of the crystalline rocks; however, only small differences exist in the potassium and rubidium content.

10. Sample 12013 has a distinctive composition that is similar to that of a late-stage basaltic differentiate. The sample contains larger amounts of silicon, potassium, rubidium, lead, zirconium, yttrium, ytterbium, uranium, thorium, and niobium than were found in any of the other Apollo 12 samples or in any of the Apollo 11 samples.

Manned Spacecraft Center
National Aeronautics and Space Administration
Houston, Texas, June 11, 1970
914-50-16-08-72

REFERENCE

1. The Lunar Sample Preliminary Examination Team: Preliminary Examination of Lunar Samples from Apollo 11. Science, vol. 165, no. 3899, Sept. 19, 1969, pp. 1211-1227.

APPENDIX A

MINERALOGICAL/PETROLOGICAL DESCRIPTIONS

The descriptions presented in this appendix were compiled during the preliminary examination of the Apollo 12 lunar samples by members of the Preliminary Examination Team (PET) and the Lunar Field Geology Experiment Team. The name of the team member who compiled the information is given on the first line of each description. Selected photographs of most samples are included.

SAMPLE 12001

SAMPLE NO. 12001.0 WEIGHT 2216 GRAMS

FINE MATERIAL FROM SELECTED SAMPLE BOX
HISTORY

THE SELECTED SAMPLE BOX WAS OPENED IN THE F201 VACUUM SYSTEM ON NOV.26.1969. WITHIN AN HOUR AFTER OPENING THE CONTENTS OF THE LARGER OF THE TWO TEFLON SAMPLE BAGS WAS OPENED. THREE LARGE ROCKS WERE REMOVED. AND THE REMAINING FINE MATERIAL WAS SCOOPED INTO A 1 CM. MESH SIEVE. LESS THAN 20 GRAMS OF CHIPS REMAINED ON THE SIEVE. THE REST. WHICH PASSED THROUGH THE SIEVE. WAS SEALED IN A STAINLESS STEEL CAN AND COMPRISES SAMPLE 12001.

WHILE THIS MATERIAL WAS BEING SIEVED AND CANNED. THE F201 CHAMBER PRESSURE WAS DECREASING FROM 5.3 X 10-6 TORR TO 4.2 X 10-6 TORR.

THE CAN WAS RE-OPENED AT 0800 DEC 5 AND RE-CANNED IN FOUR SEPARATE CANS. THE PRESSURE DURING THIS OPERATION CHANGED AS SHOWN BELOW.

0800	3.4 X 10-6
0830	3.9 X 10-5
0900	5.0 X 10-6

THE RESIDUAL GAS ANALYZER SCANS MADE AT TIMES NEAREST TO THESE TIMES ARE LISTED BELOW.

DATE	HOUR	H1	H2	C12	N14	HOH	(N2.CO2)	O2	AR	CO2
11/26	2030	.09	.22	.012	.028	.33	.11	.21	.026	.051
11/27	0400	.15	.19	.017	.051	.31	.20	.032	.027	.019
12/5	0500	.11	.1C	.014	.072	.39	.27	.021	.026	.004

NOTES ON FINES IN SIEVING (BY R FRYXELL) APPARENT TEXTURE SILTY FINE SAND TO FINE SANDY LOAM. VERY WEAKLY COHERENT. RETAINS IMPRESSION OF SCOOP DURING PERIOD BETWEEN INDIVUDUAL DELIVERIES OF MATERIAL TO SCREEN. WEAK VERY FRAGILE TEMPORARY AGGREGATES TO 1 MM DIAMETER AS MATERIAL IS MOVED. 1.5 CM MAX DIAMETER). COLOR EST. MED. GRAY. SLIGHT BROWNISH HUE. (LOW VALUE. LOW CHROMA OCCASIONAL SAND SIZE GRAINS APPEAR PRESENT. ONE CHIP ON SIEVE APPEARS VERY GLASSY. FINES ADHERE TO ROCKS AND RETAIN TOOL MARKS WHEN TOUCHED WHEN CAN IS TIPPED TO 45 DEGREE ANGLE. FINES REMAIN COHERENT WITHOUT SLUMPING (PROCEDURE FOLLOWED TAPPING CAN ON CHAMBER FLOOR). NO ACTUAL AGGREGATES OF CLEARLY LUNAR ORIGIN OBSERVED.

ANALYSES OF FINE MATERIAL IS LISTED IN SEPARATE TABLES

ANALYSIS	SAMPLE NUMBER	COMMENT
X-RAY DIFF.	12070	CONTINGENCY FINES
EMISSION SPEC.	12033	DOCUMENTED FINES
EMISSION SPEC.	12060	TOTE BAG FINES
EMISSION SPEC.	12070	CONTINGENCY FINES
TOTAL CARBON	12003	SELECTED SAMPLE FINES
TOTAL CARBON	12032	DOCUMENTED FINES
TOTAL CARBON	12033	DOCUMENTED FINES
TOTAL CARBON	12042	DOCUMENTED FINES
RARE GAS ANAL.	12060	TOTE BAG FINES
RARE GAS ANAL.	12070	CONTINGENCY FINES

SAMPLE 12002

SAMPLE NO. 12002 MORRISON. WARNER AND ANDERSON
F201 DESCRIPTION OF THE FIRST RCL ROCK 1529.5 GRAMS. 11 X 9 X 6 CM.
THIS IS A SPECKLED MEDIUM BROWN GREY ROCK WITH SOME DUST ADHERING TO THE SURFACE
THE ROCK IS A FINE TO MEDIUM GRAINED HOLOCRYSTALLINE BASALT.
MODE

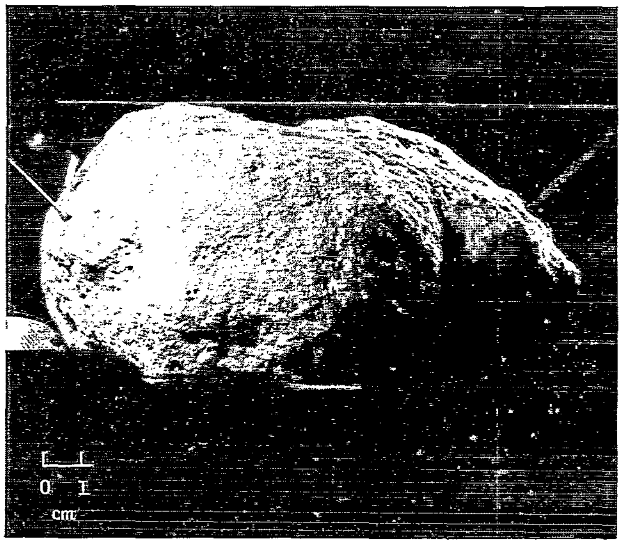
PYROXENE	50 0/0	0.08 MM	DARK GRAY
PLAGIOCLASE	30 0/0		
OLIVINE	15 0/0	0.15 MM	LIGHT GREEN
ILMENITE	3-4 0/0	0.08 MM	OPAQUE

TEXTURE - HOLOCRYSTALLINE GRANULAR
VUGS ARE PRESENT. RARE IN ABUNDANCE. SCATTERED OVER ROCK. THE ROCK IS ROUNDED TO SUBROUNDED. IT HAS A PROMINENT FRACTURE. NUMEROUS 3 TO 4 MM GLASS LINED PITS IN EXCESS OF 1 PER SQUARE CM. THIS ROCK IS A BASALT OR A FINE GRAINED DOLERITE.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

RCL ANALYSIS

NASA-S-69-60369



NASA-S-69-60377

Figure A-1. - Sample 12002.

SAMPLE 12003

SAMPLE NO. 12003.0 ESTIMATED WEIGHT 300 GRAMS ANDERSON
THIS SAMPLE CONSISTS OF FINE MATERIALS AND THE +1 CM PIECES OBTAINED FROM SIEVING SN 1200'. ALL FROM THE SELECTED SAMPLE BOX OPENED IN THE VACUUM CHAMBER. THE FINES WERE OBTAINED FROM THE BOTTOM OF THE SAMPLE RETURN CONTAINER AS WELL AS THE FINE MATERIAL FROM THE SMALLER OF THE TWO TEFLON SAMPLE BAGS FROM THE SELECTED SAMPLE BOX (SEE SN 12001). THERE MAY BE SMALL PIECES OF ALUMINUM WIRE FROM THE MESH LINING OF THE ALSRC IN THIS SAMPLE.
THE SAMPLE WAS SEALED IN A STAINLESS STEEL CAN IN THE VACUUM SYSTEM AND TRANSFERRED TO A STERILE NITROGEN ATMOSPHERE CABINET LINE. SAMPLES OF THE FINES WERE TAKEN THERE FOR ANALYSIS AND THE CHIPS WERE REMOVED FOR BIO ANALYSIS. THE CAN WAS RESEALED BEFORE THE CABINET LINE WAS OPENED TO APPRECIABLE TERRESTRIAL CONTAMINATION.
SEE TOTAL CARBON ANALYSIS TABLES.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

TOTAL CARBON ANALYSIS

SAMPLE 12004

SAMPLE NO. 12004   F201 DESCRIPTION   WARNER
WEIGHT 585 GRAMS   DIMENSIONS 9 X 8 X 4 CM
SAMPLE BROKE IN TWO IN CAN

1. 501.8 GRAM FRAGMENTS (TO RCL)
2. 87.4 GRAMS VACUUM STORAGE
3. 1 GRAM CANNED IN 1-0024 FOR PCTL.

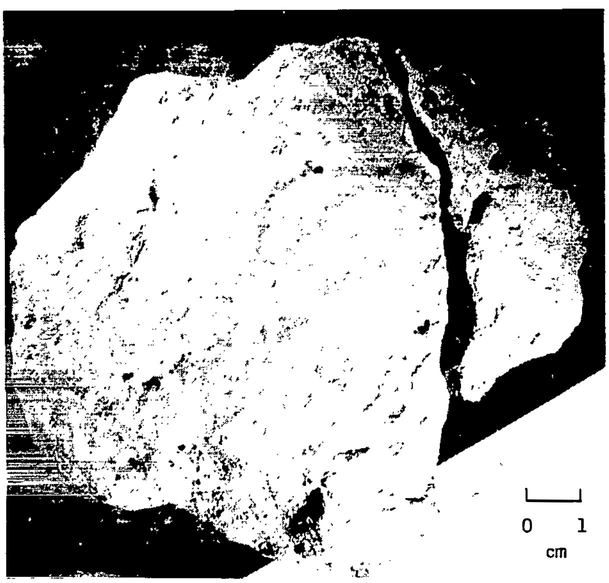
THE ROCKS SHAPE IS PARTLY ROUNDED. IT HAS A FLAT BOTTOM. VERTICAL SIDES. AND A DOME LIKE TOP. THE SURFACE IS SMOOTH WITH ABOUT 1 GLASS LINED PIT PER CM 2. FRACTURES PARALLEL TO THE SURFACES (BOTH TOP AND BOTTOM) ARE PRESENT.
TEXTURE. THE ROCK IS GENERALLY DENSE. IRREGULAR SHAPED VUGS ARE FOUND ABOUT THREE PER CM3.
FABRIC. THE SAMPLE IS HOLOCRYSTALLINE WITH MORE OR LESS EQUANT CRYSTALS.
MODE.

PYROXENE. HONEY BROWN   60 PERCENT   .3 MM
FELDSPAR. LATHS OR WHITE GRANULAR   18 PERCENT   .1 X .5 MM
OLIVINE. LIGHT GREEN   15 PERCENT   .7 MM
ILMENITE. OPAQUE PLATES   7 PERCENT   .6 MM

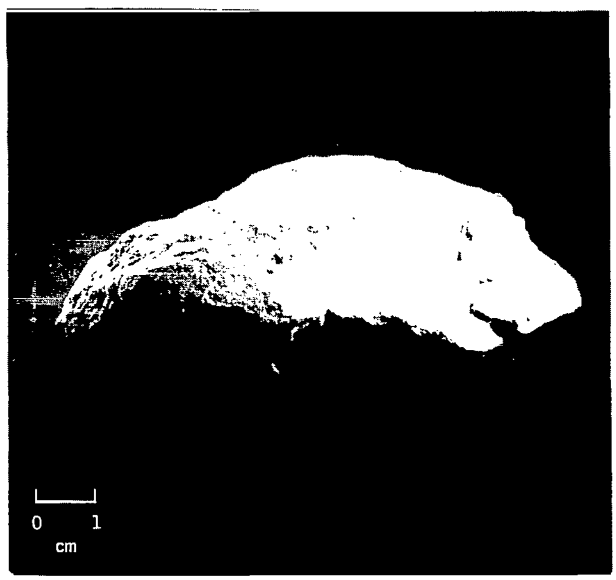
NAME. OLIVINE BASALT

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
X-RAY ANALYSIS



NASA-S-69-62019



NASA-S-69-62031

Figure A-2.- Sample 12004.

SAMPLE NO. 12005 WEIGHT 482 GRAMS DIMENSIONS 10 X 5 X 5 CM BUTLER
CHARCOAL GRAY SURFACE WITH WHITE PATCHES AND STREAKS. SURFACE WAS DUST COVERED WHEN PHOTOGRAPHED AND WAS BRUSHED OFF FOR OBSERVATION. ROCK IS ROUNDED ON A GROSS SCALE. BUT IS IRREGULAR IN A FIELD OF 1 TO 2 CM. GLASS LINED PITS RANGING TO 4 MM DIAMETER. MUCH OF THE SURFACE CONSISTS OF PULVERIZED OR CRUSHED MINERALS A CIRCULAR 4 MM PATCH IS COMPOSED OF WHITE POWDER AND FINE GRAINS.
GLASS LINED PITS ON THE SURFACE. RECOGNIZABLE PITS HAVE LINING OF BLACK GLASS. ARE A CIRCULAR SECTOR OF A SPHERE. ARE MOST COMMONLY 0.5 MM IN DIAMETER AND RANGE UP TO 1 MM. DENSITY ON THE OBSERVABLE SURFACE IS GREATER THAN OR EQUAL TO 10 PER CM2. THE FULLY PRESERVED PITS ARE RAISED FROM THE SURFACE OF THE ROCK ON A CIRCULAR MOUND OF WHITE POWDER AND SMALL GRAINS. THESE MOUNDS SEEM QUITE DELICATE AND EASILY DESTROYED WITH HANDLING.
VUGS HAVE AN IRREGULAR DISTRIBUTION BUT THEIR AVERAGE DENSITY IS ABOUT 1 PER CM2. THEIR SHAPES ARE IRREGULAR BUT ARE ROUGHLY EQUIDIMENSIONAL. THE AVERAGE SIZE IS 1 TO 2 MM.
HOLOCRYSTALLINE WITH MOST GRAINS OF THE MAJOR CONSTITUENTS IN THE SIZE RANGE 0.2 TO 0.5 MM. THERE ARE A FEW PATCHES OF COARSER OLIVINE AND PYROXENE WHOSE GRAINS ARE ABOUT 1 MM IN DIAMETER. SOME OF THESE OCCUR ON OR NEAR THE FRACTURE. COARSER OLIVINE (0.5 TO 1 MM) ALSO OCCUR IN THE WALLS OF VUGS.
MODE (SURFACE EXAMINATION ONLY)

- OLIVINE (PALE GREEN) 35 PERCENT AVERAGE SIZE 0.5 MM
- PYROXENE (PALE TO MEDIUM BROWN) 30 PERCENT AVERAGE SIZE 0.5 MM
- PLAGIOCLASE (WHITE) 30 PERCENT AVERAGE SIZE 0.5 MM
- ILMENITE (BLACK OPAQUE. PLATY) 3 PERCENT

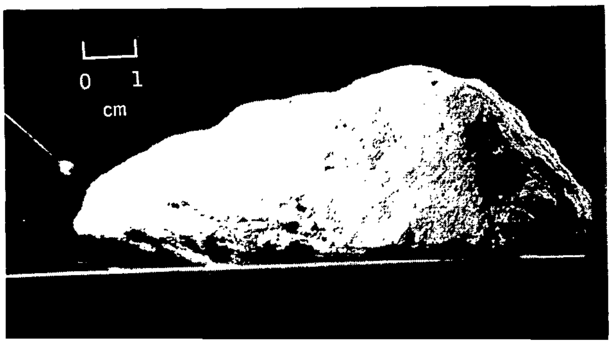
SEGREGATIONS OF MINERALS 3 TO 4 MM ACROSS
NOTE. ROCK WAS PHOTOGRAPHED BEFORE EXAMINATION. WE DECIDED THAT THIS ROCK WOULD BE VERY SUITABLE FOR THE STUDY OF WEATHERING PROCESSES. AND AS SUCH RECONTAINERIZED IT AFTER OUR EXAMINATION WITHOUT CHIPPING OR FURTHER HANDLING. THE SURFACE HAS BEEN BRUSHED WITH A STAINLESS STEEL BRUSH HOWEVER.
TERRESTRIAL ANALOGUE OF SPECIMEN. OLIVINE BASALT.

SAMPLE NO. 12005 F201 ADDITIONAL COMMENTS WARNER

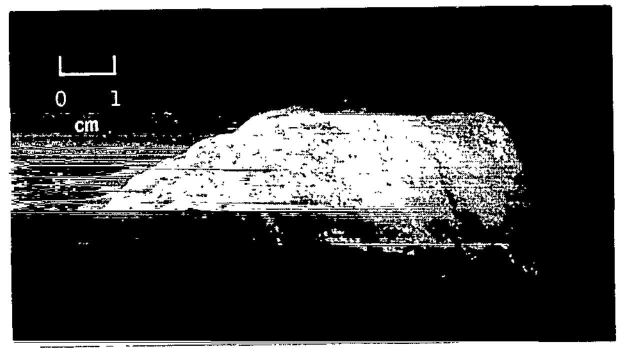
1. VUGS CONTAIN A VARIETY OF CRYSTALS. SOME CONTAIN OLIVINE. OTHERS ILMENITE. ONE VUG HAS CRYSTALS GROWING NORMAL TO VUG WALL.
2. MODE

OLIVINE	25 PERCENT
ILMENITE	5 PERCENT
PYROXENE	40 PERCENT
FELDSPAR	30 PERCENT

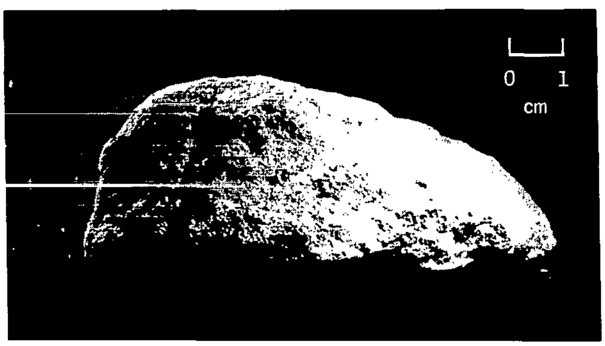
3. TEXTURE HOLOCRYSTALLINE GRANULAR. THERE APPEARS TO BE A GROSS SEGREGATION OF PHASES. THESE SEGREGATIONS ARE ABOUT 1 CM3 IN VOLUME. THEY ARE
   - A. FELDSPAR / OLIVINE
   - B. PYROXENE / VERY LITTLE OLIVINE



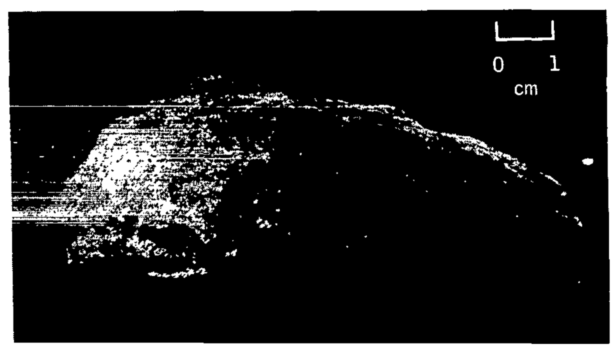
NASA-S-69-62297



NASA-S-69-62294



NASA-S-69-62298



NASA-S-69-62295

Figure A-3. - Sample 12005.

SAMPLE NO. 12006 WEIGHT 181 GRAMS DIMENSIONS 6 X 6 X 4 CM GREENWOOD (DESCRIPTION AFTER CHIPPING FOR BIOPOOL). VUGGY (UP TO 10 MM DIAMETER) OLIVINE BASALT FINE GRAINED (ABOUT 1 MM) MATRIX WITH FELDSPAR LATHS UP TO 3 MM. PLAGIOCLASE LATHS RADIATE IN THREE DIMENSION. TEXTURE IS TRACHYTIC. THE ROCK IS HOLOCRYSTALLINE. CRYSTALS ARE COARSER NEAR VUGS AND GROW OUT INTO THE FREE SPACE. OLIVINE (ABOUT 1 MM GRAIN SIZE) IS EQUANT YELLOW GREEN ABOUT 15 PERCENT OF THE ROCK. A RED BROWN PYROXENE IS FINER GRAINED (ABOUT 1/2 MM) THAN OLIVINE AND ABOUT 25 PERCENT OF THE ROCK. A BLACK LUSTEROUS OPAQUE IS ABOUT 5 PERCENT OF THE ROCK. PLAGIOCLASE IS ABOUT 55 PERCENT OF THE ROCK.
THE ROCK IS FLAT BOTTOMED WITH ANGULAR EDGES. THE TOP AND SIDES ARE WELL ROUNDED AND HAVE NUMEROUS PITS. THE BOTTOM SHOWS FEWER OBVIOUS PITS. THE BOTTOM IS DARK GRAY COATED. THE ERODED TOP IS MEDIUM DARK GRAY WITH WHITE AREAS NEAR PITS. THE FRESH BROKEN SURFACE IS AN EVEN MEDIUM GRAY. NO LINEATION OR LAYERING WAS OBSERVED. VUGS ARE IRREGULAR SHAPED , CRYSTAL BOUNDED, AND ARRANGED ALONG PLANES IN THE ROCK. THE ROCK IS NOT FRIABLE OR FRAGILE AND SHOWS NO OBVIOUS SHOCK HISTORY. AFTER CHIPPING THE ROCK HAS A SMALL AREA OF NEW SURFACE.

SAMPLE NO. 12006 PIT COUNTS HEIKEN

SIDE 1 - SUBROUNDED - SOME DUST ADHERING TO THE SURFACE. ARE SEVERAL INTERESTING PIT LININGS WHICH ARE RAISED ABOVE THE SURFACE AND HAVE A DULL WEATHERED APPEARANCE.
AREA-CIRCLE, 1 CM DIAMETER.

NUMBER	NUMBER OF PITS	
1	7	0.1 TO 1 MM DIAMETER
2	16	EXCELLENT HALVES
3	5	
4	0	
5	2	

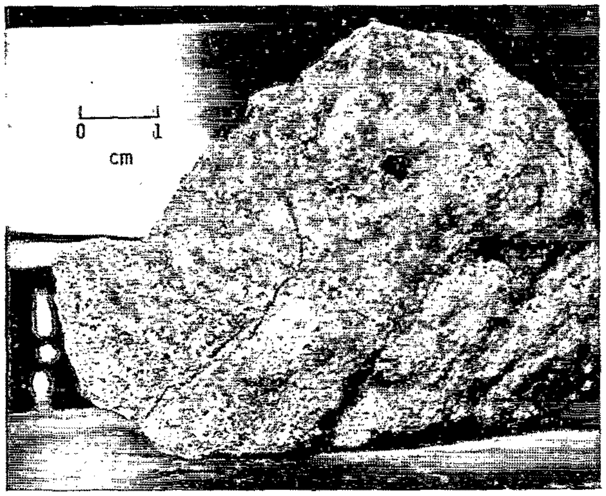
MUCH OF THE GLASS LININGS ARE RAISED OR ERODED AWAY, LEAVING ONLY A WHITE HALO AS EVIDENCE OF IMPACT.

SIDE 2 - ONE HALF IS FRESH FRACTURE, WITH NO PITS AND ONE HALF IS OLD-WITH PITS (BELOW). PIT LININGS ARE RAISED ABOVE ROCK SURFACE AND VERY DULL. SOME PROCESS OF EROSION AT WORK, WITH GLASSY LINGINS MORE RESISTANT THAN THE ROCK.

NUMBER	NUMBER OF PITS
1	8
2	7
3	9

SIDE 3 - VUGGY, SUBROUNDED.

NUMBER	NUMBER OF PITS
1	2
2	7
3	9
4	8
5	10



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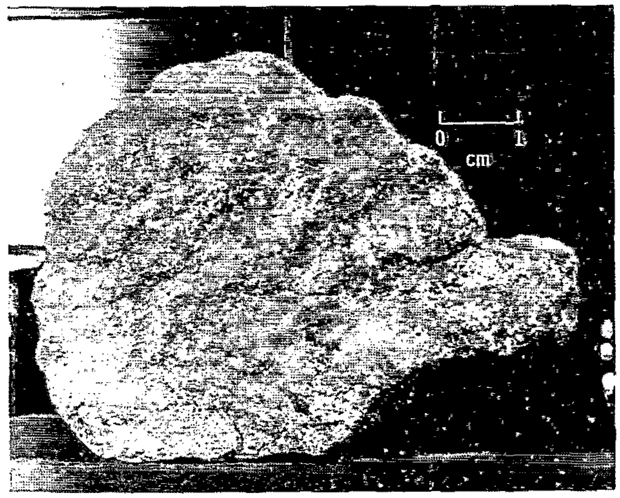

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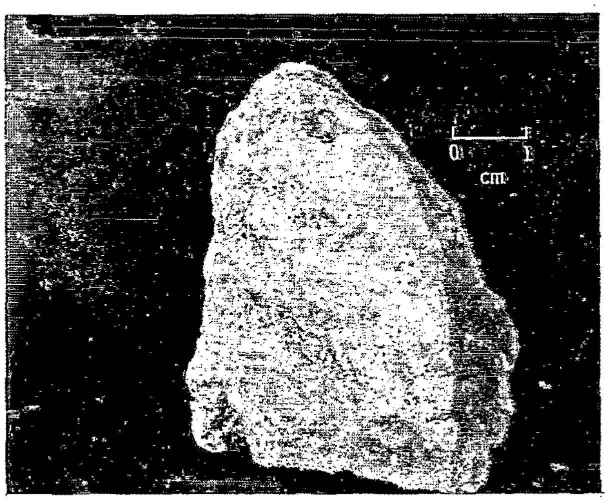

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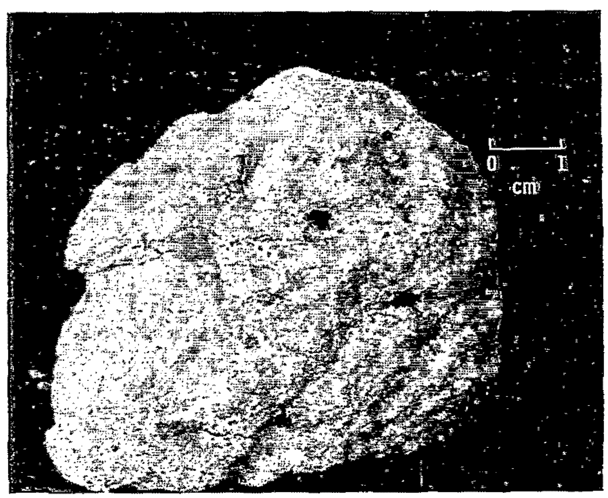

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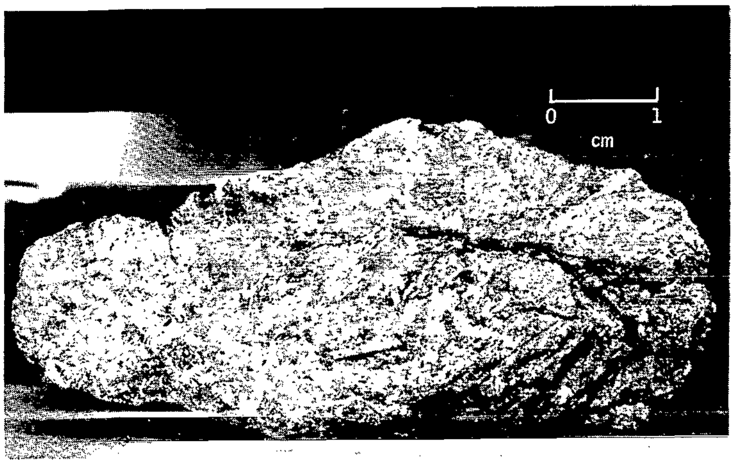
Figure A-4. - Sample 12006.

SAMPLE NO. 12007 DIMENSIONS 5.5 X 3.2 X 4.0 CM WEIGHT 65.2 GRAMS HEIKEN
TABULAR. ANGULAR REDDISH BROWN ROCK. LONG AXIS IS PARALLEL TO PLANAR FRACTURE RUNNING THE LENGTH OF THE ROCK.
MEDIUM GRAINED. HOLOCRYSTALLINE ROCK. PORPHYRITIC. WITH 3.0 TO 3.5 CM LONG PYROXENE CRYSTALS IN A GROUNDMASS OF 1 TO 2 MM CRYSTALS. PYROXENE AND FELDSPAR CRYSTALS FORM IN VARIOLITIC CLUMPS IN SEVERAL PLACES.
IRREGULAR AND PLANAR FRACTURES ARE SUBPARALLEL OR PARALLEL TO THE LONG AXIS OF THE ROCK. NO CHANGE IN MINERALOGY NEAR THE FRACTURES. A FLAT SIDE (PROBABLY A FRACTURE SURFACE) IS COATED WITH DUST WHICH ADHERES TIGHTLY TO THE SURFACE.
ARE SOME VUGS (DIAMETER GREATER THAN 0.2 MM) BETWEEN FELDSPAR CRYSTALS.
NO SURFACE PITS OR SPLASHES.
MINERALOGY.
COLORLESS TO CREAMY WHITE FELDSPAR. SUBHEDRAL LATH SHAPED CRYSTALS. 1 MM TO 2 CM LONG. EXHIBITS GOOD ALBITE TWINNING. 40 PERCENT.
REDDISH BROWN TO DARK BROWN PYROXENE. ELONGATE. SUBHEDRAL CRYSTALS. 0.5 MM TO 3 CM LONG. THE PHENOCRYSTS HAVE CORES OF OLIVINE. SMALLER PYROXENE CRYSTALS (MUCH LIGHTER IN SHADE) HAVE NO SUCH CORES. 45 PERCENT.
OLIVINE - PALE GREEN. ANHEDRAL. EQUANT CRYSTALS. INDIVIDUAL CRYSTALS RANGE FROM 0.5 TO 2 MM IN DIAMETER. THE OLIVINE CORES IN THE PYROXENE PHENOCRYSTS ARE UP TO 1 MM SIDE. 5 PERCENT
ILMENITE - BLADES OF THIS MINERAL UP TO 2 MM WIDE. METALLIC LUSTER-BLACK 10 PERCENT.
TERRESTRIAL ANALOGUE. OLIVINE DIABASE.



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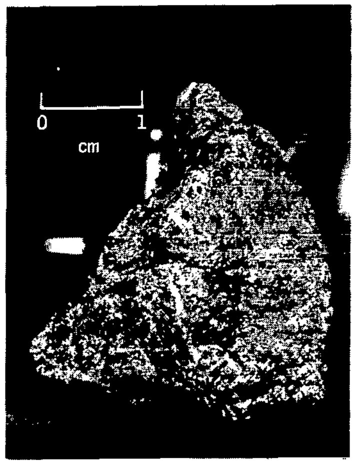

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Figure A-5. - Sample 12007.

SAMPLE NO 12008 WEIGHT 58 GRAMS DIMENSIONS 2 X 3.5 X 5 CM GREENWOOD
SMALL BRIQUET SHAPED ROCK WITH FLAT TO SLIGHTLY CURVED BOTTOM AND ERODED ROUNDED SUBPYRAMIDAL TOP, GIVING THE ROCK A LENS SHAPE. THE ERODED SURFACE IS DARK GRAY TO BLACK AND SHOWS BRIGHT ADAMANTINE CLEAVAGE PLANES. THE BOTTOM AND TOP SURFACES ARE POCKED AND PITTED. AT LEAST ONE GLASS LINED PIT (2 MM) IS PRESENT. NO VESICLES OR VUGS WERE SEEN. THE ROCK IS COMPOSED PREDOMINANTLY OF A BLACK MEDIUM GRAINED MINERAL 92 PERCENT, WITH ABOUT 7 PERCENT
MAJOR PHASE MAY BE ILMENITE.
EQUANT PLAGIOCLASE AND ABOUT 3 PERCENT OLIVINE (TERMINATED CRYSTALS).
NO LINEATION OR LAYERING WAS OBSERVED. THE ROCK IS NOT FRIABLE OR FRAGILE.

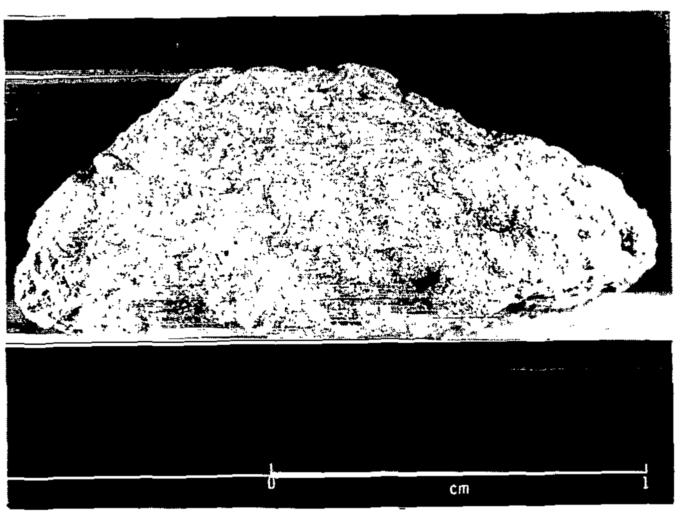
SAMPLE NO. 12008 HEIKEN

SIDE 1 - SUBANGULAR - MOST PITS ARE ABOUT 0.1 TO 0.4 MM IN DIAMETER. LINED WITH BROKEN GLASS - BOTH SMOOTH AND BUBBLY GLASS.

LOCATION	NUMBER OF PITS
1	6
2	6
3	3
4	4
5	2

SIDE 2 - SUBANGULAR - ONE SMALL 0.5 CM SPLASH-VERY THIN.

LOCATION	NUMBER OF PITS
1	0
2	4
3	2
4	2



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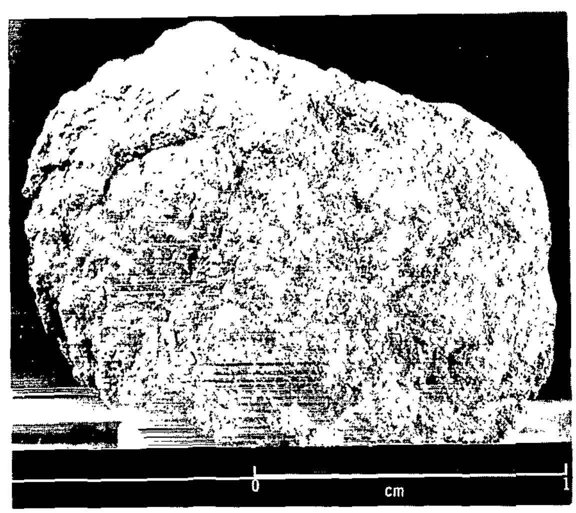

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Figure A-6. - Sample 12008.

SAMPLE NO. 12009 WEIGHT 468 GRAMS DIMENSIONS 10 X 7 X 5 CM BUTLER/WARNER
AFTER BRUSHING ABOUT HALF OF THE SURFACE AREA STILL HAS A LAYER OF MEDIUM BROWN DUST. THIS DUST TENDS TO BE IN DEPRESSIONS. BUT NOT EXCLUSIVELY. THEREFORE THE DUST IS PROBABLY QUITE ADHERENT. THE ROCK BENEATH THE DUST IS DARK GRAY. THE SURFACE CRAGGY AND UNEVEN. APPARENTLY BECAUSE PARTS HAVE FLAKED AND SPALLED OFF. PARALLEL AND SUBPARALLEL FRACTURES FORM A STRONGLY DEVELOPED SET IN PLANES ABOUT 30 DEGREES TO THE HORIZONTAL SPECIMEN SUPPORT. THE FRACTURE PLANES ARE SPACED 1/2 TO 1 CM APART.
A FEW SMALL AREAS OF WHITE POWDERED MATERIAL ARE DISTRIBUTED ON THE SURFACE. UPPER SURFACE IS AT LEAST 70 PERCENT COVERED WITH BLACK GLASS. ALTHOUGH THESE ARE SCATTERED ONTO 1 MM PATCHES OF CLEAR BLACK GLASS. MOST OF THE GLASS IS MIXED WITH FINE GRAINED BROWN (TURBID) GRANULAR MATERIAL (CALLED DUST ABOVE). THE GRANULES OF BROWN MATERIAL ARE SPHEROIDAL AND RANGE IN SIZE UP TO .05 MM THEY'RE PROBABLY AGGREGATES OF FINE MATERIAL TO JUDGE FROM THEIR ROUGH SURFACES. THREE OF THE SO CALLED EGGSHAPED CAVITIES ARE PROMINENT ON THIS ROCK. THESE CAVITIES HAVE SMOOTH WALLS ON A MEGASCOPIC SCALE. THEIR SHAPES ARE THAT OF A SEGMENT OF A TRIAXIAL ELLIPSOID WITH ROUGHLY THE SAME PROPORTIONS AS AN EGG. THE DIMENSIONS OF THE INTERMEDIATE SIZED CAVITY IS 1.5 X 3 CM RIM TO RIM. MAJOR SEMI AXIS IS ABOUT 1.5 CM. INTERMEDIATE AND MINOR SEMI AXES ARE ABOUT 1 CM. THE LARGEST CAVITY IS MARKEDLY ELONGATED COMPARED WITH AN EGG. FROM RIM TO RIM IT IS 5 X 3 CM. THE MAJOR SEMI AXIS IS ABOUT 7 CM. THE SMALLEST CAVITY (WHICH IS THE ONLY ONE PROBABLY CLEARLY VISIBLE ON THE SIDE PHOTOGRAPHS TAKEN) IS ABOUT 2 X 2 CM RIM TO RIM.
THERE ARE A FEW VUGS IN THE ROCK. TWO ARE SPHEROIDAL AND ABOUT 1 MM DIAMETER. NO LARGE CRYSTALS ARE ASSOCIATED WITH THEM. IRREGULARLY SHAPED CAVITIES ARE ASSOCIATED WITH SOME OF THE OLIVINE PHENOCRYSTS.
*PORPHYRITIC 0.5 TO 2 MM PHENOCRYSTS OF OLIVINE ARE THE ONLY PROMINENT MINERAL GRAINS. THESE PHENOCRYSTS FORM ABOUT 20 PERCENT OF THE ROCK. THE MATRIX IS DARK GRAY.
*FELDSPAR LATHS ARE RANDOMLY ORIENTED.
*OLIVINE 0.5 TO 2 MM. EQUANT AND STUBBY COLUMNAR.
*PLAGIOCLASE IS EVIDENCED ONLY BY THE REFLECTION OF LIGHT FROM CLEAVAGES.
SHAPE. COLLECTION OF CHIPS FROM F201. SIZE. 1 X 1.5 X 2. 1 X 1 X 1.
IT IS LATH SHAPED AND 1 MM X .02 MM. SMALLER LATHS ARE ALSO DISCERNABLE IN MATRIX. PLAGIOCLASE IS SO THIN THAT IT SHOWS ONLY THE DARK GRAY COLOR OF THE MATRIX MATERIAL.
*OBSERVATIONS ON FRESHLY CHIPPED SURFACE • MODES. OLIVINE 20 PERCENT
PLAGIOCLASE 5 PERCENT
APHANITIC MATRIX 75 PERCENT
TEXTURE. VUGGY. VESICULAR. PORPHYRITIC. FINE GRAINED. OLIVINE GRAINS IN A PORPHYRITIC BASALT WITH OLIVINE AND PLAGIOCLASE PHENOCRYSTS. THE WALL OF LARGEST EGG SHAPED CAVITY IS FORMED OF A MATTE OF PLAGIOCLASE LATHS. SIZE OF THE LATH AVERAGES 0.5 MM X 0.1 MM. THE LONG AXES OF THE LATH ARE PARALLEL TO THE CAVITY SURFACE. BUT THEY ARE OTHERWISE RANDOMLY ORIENTED. ABOUT HALF THE CAVITY SURFACE HAS ADHERING SPHEROIDAL BROWN CLUMPS AS DESCRIBED ABOVE. THE SMALLER OF THE BOTTOM EGG SHAPED CAVITIES IS ALSO WALLED BY PLAGIOCLASE LATHS. WHICH ARE IN POORLY DEVELOPED RADIATING AGGREGATES.

SAMPLE NO. 12009.1 WONES
SHAPE. COLLECTION OF CHIPS FROM F201. SIZE. 1 X 1.5 X 2. 1 X 1 X 1. 1 X 0.5 X 0.3. 0.3 X 0.5 X 0.1 CM. SMALLER PIECES TO GO GAL. OES.
COLOR. NEUTRAL N6 TO N7.
TEXTURE. VUGGY. VESICULAR. PORPHYRITIC. FINE GRAINED. OLIVINE GRAINS IN A RANDOM AND IRREGULAR MATRIX OF PYROXENE. PLAGIOCLASE AND PROBABLY OPAQUES. OLIVINE PHENOCRYST 0.5 MM PYROXENE AND PLAGIOCLASE ACICULAR. LARGEST GRAINS 0.1 X 0.5 VESICLES ABOUT 1 PERCENT VOLUME.
FABRIC. APPARENT PARTING TO SPECIMEN. VESICLES AND VUGS TEND TO BE SUB

PARALLEL TO IT. VESICLES AND VUGS HAVE IRREGULAR SHAPES.
FRACTURES. MANY PARTING SUBPARALLEL. ORTHOGONAL FRACTURE. SUBPARALLEL TO FACES.
SURFACE FEATURES. ONLY ONE ORIGINAL SURFACE PRESERVED. OTHERS ARE ALL FRESH. THE ONE ORIGINAL SURFACE IS A UNIQUE FEATURE AND IS BEING PACKAGED SEPARATELY IT IS A PERFECTLY FLAT SURFACE. PARALLEL TO THE PARTING IN THE MATERIAL. IT HAS THE APPEARANCE OF BEING ETCHED AND IS A LOG JAM OF PYROXENES WITH EUHEDRAL FORMS. THERE ARE SEVERAL POSSIBILITIES. MOST LIKELY IS THAT A PARTING SURFACE ACTED AS A VUG. HOWEVER IT IS POSSIBLE THAT GAS ETCHING TOOK PLACE. THIS IS UNLIKELY AS PYROXENES ARE LARGER THAN THOSE IN GROUNDMASS. (0.1 X 0.5 MM). THERE ARE NO GLASS SPLASHES OR PITTING ON THIS SURFACE.
MINERALOGY.
OLIVINE. OCCURS AS EUHEDRAL GREEN YELLOW VITREOUS CRYSTALS 0.5 MM DIAMETER.
PYROXENE. OCCURS AS ACICULAR CRYSTALS 0.1 MM X 0.5 MM MAXIMUM SIZE. SIZE RANGES DOWN TO LESS THAN 10 MICRONS. LARGE CRYSTALS ON PECULIAR TEXTURE (SEE ABOVE).
PLAGIOCLASE. OCCURS IN GROUNDMASS. SUBORDINATE TO PYROXENE.
OPAQUES. PRESENT AS 0.05 MM INCLUSIONS IN OLIVINE. NOT RESOLVED IN GROUNDMASS.
MODE. OLIVINE 10 PERCENT
GROUNDMASS 90 PERCENT
NO INCREASE OF MINERALS NEAR VESICLES OR VUGS.
VESICULAR OLIVINE BASALT.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
X-RAY ANALYSIS

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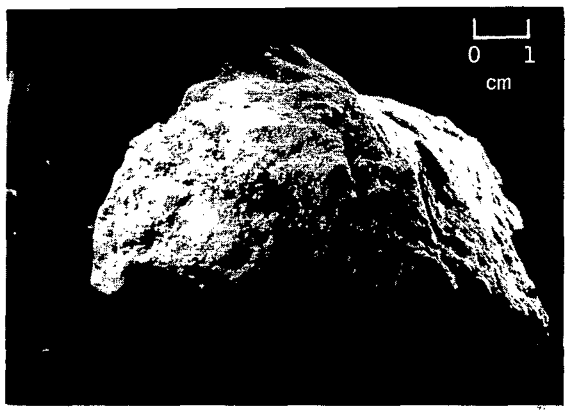

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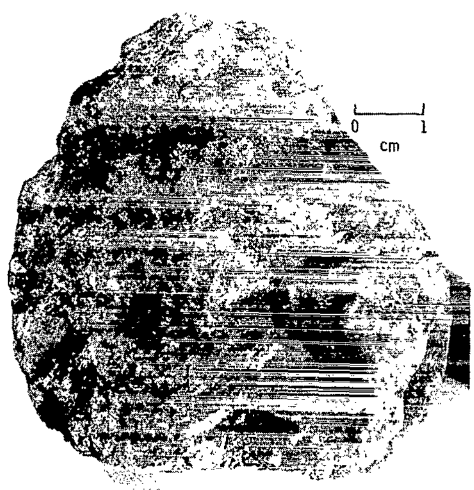
Figure A-7. - Sample 12009.

SAMPLE 12010

SAMPLE NO. 12010.1 DECEMBER 11. 1969 WONES
SHAPE. SUBSPHERICAL LUMP. DIAMETER 1 CM.
COLOR. NEUTRAL N7 TO N8. LIGHT GRAY.
TEXTURE. FINE GRAINED. SUBOPHITIC. BADLY SHOCKED. ALL GRAINS BADLY FRACTURED FELDSPAR IS ALL WHITE. TURBID. IMPOSSIBLE TO DISTINGUISH VUGS. BUT 1 MM PHENOCRYSTS OF OLIVINE (NOW BADLY SHATTERED) ARE PRESENT. MAXIMUM SIZE OF PLAGIOCLASE AND PYROXENE IS 0.5 MM.
FABRIC. NOT POSSIBLE TO DETECT LINEATIONS ETC. BECAUSE OF SHATTERING.
FRACTURES. THROUGH GOING. ENTIRE SAMPLE IS FRACTURED. EXTREMELY FRIABLE. NO PREFERRED ORIENTATION.
SURFACE FEATURES. 50 PERCENT OF THIS LUMP IS COVERED WITH PITS APPROXIMATELY 6 PER CM2. THERE ARE GLAZES PRESENT AND FRAGMENTS OF OTHER ROCK TYPES ADHERING TO GLAZE. PITS ARE GLASS LINED. SOME HAVE HALOES. LARGEST PIT IS 0.5 MM IN DIAMETER.
MINERALOGY.
MODE.
PYROXENE 60 PERCENT
PLAGIOCLASE 30 PERCENT
OLIVINE 5 PERCENT
OPAQUES 5 PERCENT
PYROXENE. GROUNDMASS. HARD TO TELL MUCH ABOUT PRESHOCK MORPHOLOGY.
PLAGIOCLASE. WHITE TURBID LATHS IN A SUBOPHITIC TEXTURE. 0.1 X 0.5 MM.
OLIVINE. SHATTERED OVOIDAL GRAINS 1 MM LONG.
OPAQUES. BLADED CRYSTALS INTERGROWN WITH PYROXENE.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

A-A CHEMICAL ANALYSIS
E-SPEC ANALYSIS
RARE GAS ANALYSIS



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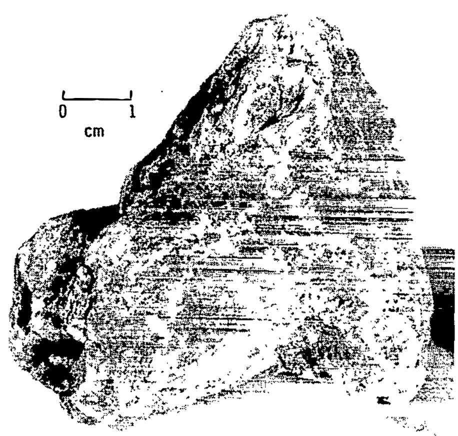

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Figure A-8. - Sample 12010.

SAMPLE NO. 12011 WEIGHT 193 G DIMENSIONS 5 X 5 X 4 CM WARNER/GIBSON
GENERAL SHAPE IS A ROUNDISH BLOB. COLOR IS BROWNISH. CHARCOAL GREY.
SURFACE IS SMOOTH WITH GLASS LINED PITS. NO FRESH BROKEN SURFACES. VERY FEW (ABOUT 5 ON TOP OF ROCK). SMOOTH LINED VUGS. NO FRACTURES. GLASS LINED PITS (2 TO 3 MM ACROSS) OCCUR ABOUT 1 TO 2 PER CM2. FINE DUST ADHERING TO SURFACE AFTER GCO BRUSHING LIKE SAMPLE 12009. LOTS OF GLASS ON SURFACE. MOSTLY UNDER THE DUST.
VESICLES. 3 MM ACROSS, ABOUT 1 PER CM2 OF INTERIOR SURFACE. SMOOTH WALLED AS CONTRASTED WITH ROCKS SUCH AS 12020.
COLOR OF INTERIOR. MEDIUM TO LIGHT CHARCOAL GREY. VERY LITTLE BROWN.
MODE.

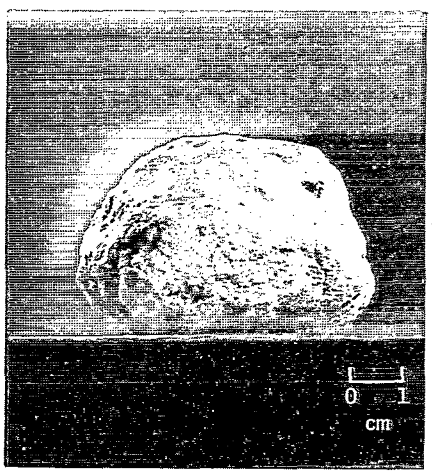
OLIVINE . LIGHT GREEN	20 PERCENT	.3 MM
PYROXENE. PALE HONEY BROWN	45 PERCENT	.1 X 2 MM
ILMENITE . BLACK OPAQUE	20 PERCENT	.3 MM
FELDSPAR. COLORLESS	15 PERCENT	.1 MM

TEXTURE HOLOCRYSTALLINE. THE PYROXENE AND TO SOME EXTENT THE FELDSPAR OCCURS IN LATHS. THE LATHS FORM RADIATING STARS. LOOKS LIKE CHICKEN TRACKS. VESICLES ARE GLASS LINED. GLASS IS CLEAR SO YOU CAN SEE THE CRYSTALS UNDER THE GLASS. VESICLES ARE SPHERICAL. ROCK NAME. PYROXENITE.
ADDITIONAL F201 COMMENTS BY GIBSON
BROKEN FACE APPEARANCE. LIGHT TO MEDIUM CHARCOAL COLOR. FINE GRAINED TYPE A ROCK. HOLOCRYSTALLINE ROCK. VESICLES. LINED WITH BLACK GLASS. RAYS OF HONEY BROWN PYROXENE CRYSTALS 0.2 X 1.2 MM IN VESICLE.
MODE.

OLIVINE. PALE BOTTLE GREEN	10 PERCENT	0.2 TO 0.4 MM
PYROXENE. HONEY BROWN	30 PERCENT	.2 TO 1.4 MM
PLAGIOCLASE/FELDSPAR. CLEAR TO TURBID WHITE	40 TO 50 PERCENT	
ILMENITE. BLACK	15 TO 20 PERCENT.	

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS



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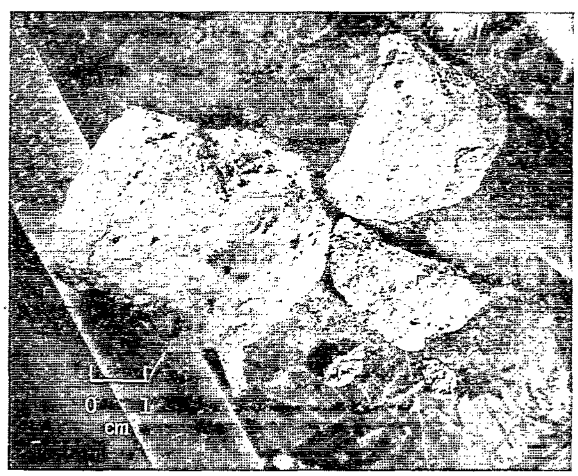

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Figure A-9. - Sample 12011.

SAMPLE 12012

SAMPLE NO. 12012.0 WEIGHT 176.2 G DIMENSIONS 6 X 6 X 4 CM ANDERSON/GIBSON
MEDIUM GRAY BLOCKY ANGULAR ROCK WITH NUMEROUS VUGS IN WHICH ARE VISIBLE MANY ELONGATED CRYSTALS. NO OBVIOUS IMPACT PITS CAN BE SEEN WITH UNAIDED EYE. ROCK IS COARSE GRAINED WITH ABUNDANT OLIVINE VISIBLE ON SURFACE.
TYPE AB ROCK.
MINERALOGY MORE OBVIOUS THAN USUAL.
MODE.

MINERAL	COLOR	GRAIN SIZE	ABUNDANCE
OLIVINE	PALE BOTTLE GREEN	0.5 MM	25 PERCENT
PLAGIOCLASE/FELDSPAR		0.5 MM	20 PERCENT
ILMENITE	BLACK	0.5 MM	1 PERCENT
PYROXENE	HONEY BROWN	0.5 TO 5 MM	55 PERCENT

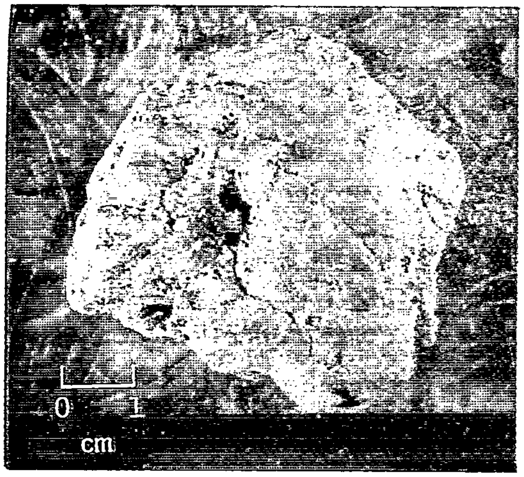
FELDSPAR IS NOT AS OBVIOUS AS OLIVNE AND PYROXENE.
VUGS OF ALL SIZES 5 MM TO SUBMICROSCOPIC GIVING ROCK VERY POROUS APPEARANCE. UNDER MICROSCOPE COLOR APPEARS GREENISH BROWN. THE DUST COVERED PORTION OF ROCK APPEARS LIGHTER IN COLOR. PERHAPS TOP. TOP IS SMOOTHER THAN OTHER ANGULAR PORTIONS OF PARENT ROCK.
THIS ROCK WAS CHIPPED (CHIP FROM BLOCKY BOTTOM) AND MOTHER ROCK AND CHIPS PHOTOGRAPHED. FINAL WEIGHT OF MOTHER ROCK IS 169.8 GRAMS.
TEXTURE. HOLOCRYSTALLINE.
NO LINEATIONS OBVIOUS. MANY IRREGULAR FRACTURES. NO PARTICULAR ORIENTATION.
NOTE. THE PYROXENE AND OLIVINE CRYSTALS ARE VERY PRONOUNCED AND THE GENERAL STRUCTURE IS OPEN WHICH WOULD MAKE THE CRYSTALS VERY EASY TO PICK OUT.
TERRESTRIAL ANALOGUE. OLIVINE PYROXENITE.

SAMPLE NO. 12012.5 AND 12012.6 THIN SECTION

MODE	12012.5	12012.6
PLAGIOCLASE	15	15 0/0
PYROXENE	50	55 0/0
OLIVINE	30	20 0/0
OPAQUE	5	10 0/0

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
X-RAY ANALYSIS



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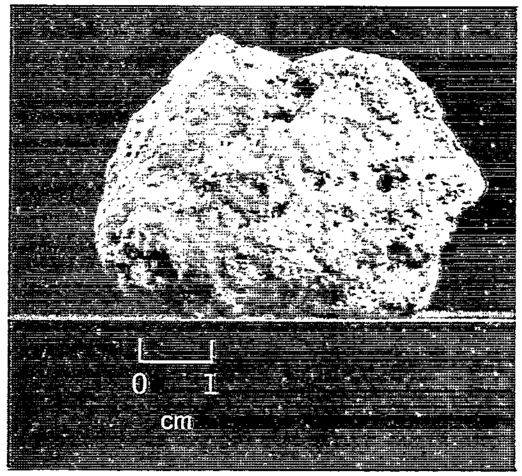

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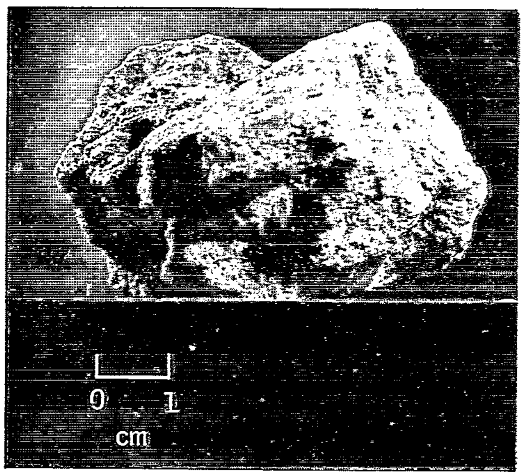

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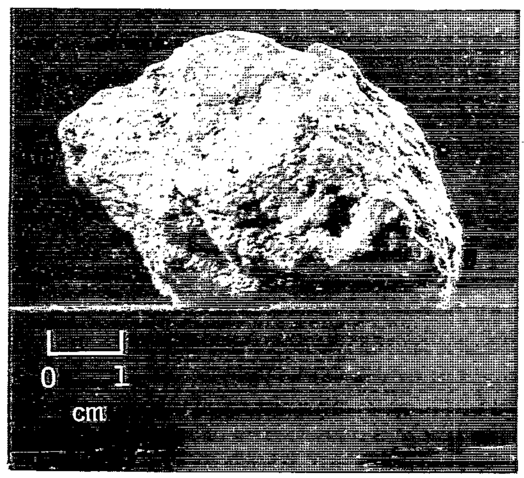

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Figure A-10. - Sample 12012.

SAMPLE NO. 12013.0 F201 DESCRIPTION ANDERSON
WEIGHT 82 GRAMS DIMENSIONS 4 X 3 X 2 CM.
LIGHT GRAY ANGULAR ROCK. LARGELY COMPOSED OF TURBID WHITE CRYSTALS WHICH ARE PROBABLY FELDSPAR. THESE ARE NEARLY EQUIDIMENSIONAL WITH NO APPARENT LINEATIONS OR OTHER PREFERRED FABRIC. THE ROCK IS RATHER VUGGY. BUT NO IMPACT PITS CAN BE SEEN. SOME DARKER MINERALS ARE PRESENT IN SEGREGATED PATCHES.
MODE.

PLAGIOCLASE	80 PERCENT
PYROXENE	10 PERCENT TO 15 PERCENT
ILMENITE	5 PERCENT
OLIVINE	POSSIBLE TRACE

A 2 MM PHENOCRYST WHICH IS PROBABLY FELDSPAR IS PRESENT AND SEVERAL HIGHLY REFLECTIVE OPAQUE CRYSTALS WHICH MAY PROVE TO BE ILMENITE.
TERRESTRIAL ANALOGUE. ANORTHOSITE.

SAMPLE NO. 12013.4 OVAL THIN SECTION DIMENSIONS 11 X 6 MM WARNER
THE SECTION DISPLAYS THREE DISTINCT LITHOLOGIES.
LITHOLOGY 1. - VARIOLITIC TEXTURE
MODE

PLAGIOCLASE	70 PERCENT	0.1 X 1.5 MM (AN-JM)
GLASS	10 PERCENT	0.4 MM
INTERSTISTIAL PHASE	10 PERCENT	0.1 MM (QUARTZ OR K-FELDSPAR)
PYROXENE	5 PERCENT	0.3 MM
OPAQUE	5 PERCENT	0.1 MM

THE FELDSPAR LATHS EXHIBIT THE EXCELLENT RADIATING (VARIOLITIC) TEXTURE. THE LOW AN VALUE OF THE FELDSPAR WAS DETERMINED BY ALBITE EXTINCTION ANGLES.
IN PLANE LIGHT THIS LITHOLOGY LOOKS WHITE WITH A FEW BLACK SPOTS.
ROCK NAME - DACITE
LITHOLOGY 2. - ANHEDRAL-HOLOCRYSTALLINE TEXTURE WITH SUBANGULAR BLOCKS OF LITHOLOGY 1.
MODE

PYROXENE	25 PERCENT	0.2 MM
PLAGIOCLASE	35 PERCENT	0.2 MM
SANIDINE AND/OR QUARTZ	25 PERCENT	0.2 MM
OPAQUE	15 PERCENT	0.01 MM

THE CONTACT BETWEEN THE BLOCKS OF LITHOLOGY 1. AND THE MATRIX ARE SHARP.
IN PLANE LIGHT THIS LITHOLOGY LOOKS GREY - CONSISTING OF
1. LIGHT SPOTS OF LITHOLOGY 1.
2. LIGHT MATRIX WITH LOTS OF SMALL BLACK SPOTS (SALT AND PEPPER).

ROCK NAME - BASALT.
LITHOLOGY 3. - ANHEDRAL-HOLOCRYSTALLINE TEXTURE WITH INCLUSIONS OF ANGULAR TO ROUNDED CRYSTALS.
MODE OF MATRIX

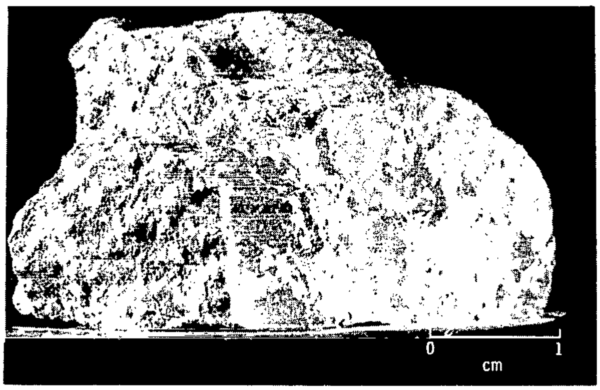
PYROXENE	55 PERCENT	0.2 MM
PLAGIOCLASE	25 PERCENT	0.2 MM
OPAQUE	20 PERCENT	0.05 MM

THE BLOCKS OF CRYSTALS ARE IN SHARP CONTACT WITH THE MATRIX. THERE IS SOME INDICATION OF SOME ABSORPTION OF THE BLOCKS. THE BLOCKS ARE 1 TO 2 MM ACROSS.
THEY CONSIST OF -
PLAGIOCLASE (AN-85 BY ALBITE EXTINCTION)
OPAQUES
PYROXENE (CONTAINS LOTS OF INCLUSIONS)
GLASS
IN PLANE LIGHT THIS LITHOLOGY LOOKS VERY DARK GREY WITH LARGE WHITE SPOTS OF THE PLAGIOCLASE BLOCKS.
ROCK NAME - ANDESITE BRECCIA
RELATION AMONG THE LITHOLOGIES.

LITHOLOGY 1. FORMS A 5 X 5 MM CORE OF THE THIN SECTION.
LITHOLOGY 2. ALWAYS OCCURS BETWEEN LITHOLOGIES 1. AND 3. BLOCKS OF LITHOLOGY 1. ARE FOUND IN LITHOLOGY 2.
LITHOLOGY 3. INTRUDES LITHOLOGY 2.
SAMPLE TERRESTRIAL ANALOGUE - IGNEOUS OR VOLCANIC BRECCIA.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
X-RAY ANALYSIS



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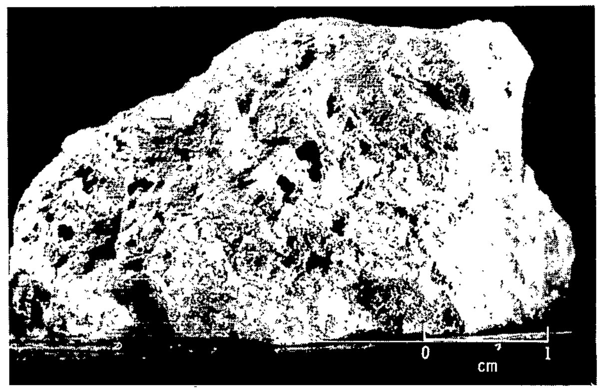

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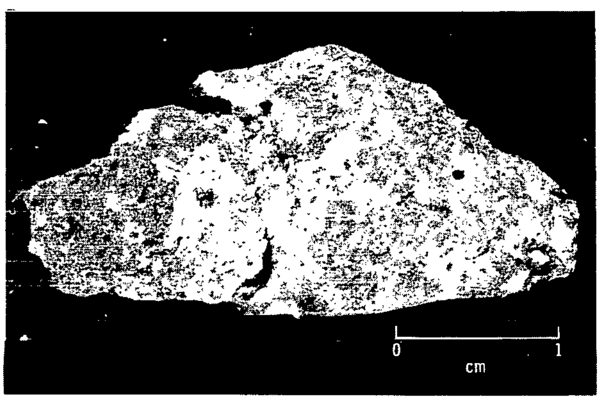

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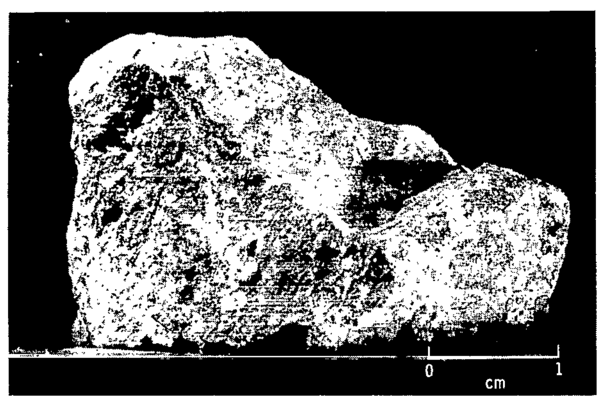

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Figure A-11. - Sample 12013.

SAMPLE NO. 12014.0 F201 DESCRIPTION PRESPLIT GIBSON
WEIGHT 159 GRAMS SIZE. 2 X 2 X 1 1/2 INCHES
ROCK TYPE. PORPHYRITIC OLIVINE MICROGABBRO.
(CHIPPED OFF APPROXIMATELY 8 GRAMS FOR PCTL).
THE ROCK IS RECTANGULAR AND ANGULAR. EDGES AND CORNERS ARE SUBROUNDED.
TEXTURE IS HOLOCRYSTALLINE INEQUIGRANULAR. GRAIN SIZES AVERAGES 0.7 MM WITH
EUHEDRAL PYROXENE LATHS UP TO 1 CM IN VUGS. ESSENTIAL MINERALS ARE OLIVINE.
PYROXENE (POSSIBLY 2 TYPES). AND FELDSPAR. ESTIMATED MODE IS.

OLIVINE 15 TO 20 PERCENT
PYROXENE 25 TO 35 PERCENT
FELDSPAR 40 TO 50 PERCENT.

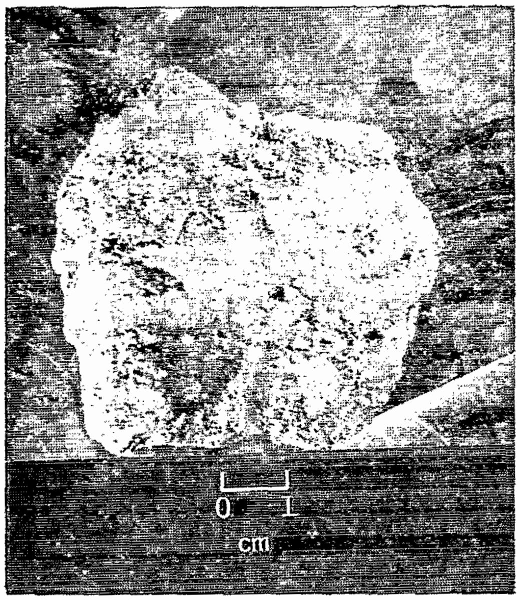
OPAQUES ARE MINOR (5 PERCENT). ACCESSORY MINERALS OCCUR BUT ARE NOT IDENTIFIED.
THE ROCK IS FRACTURED BUT NOT SEVERELY. VUGS (MIAROLITIC CAVITIES) FORM
5 PERCENT OF OLIVINE. THESE ARE LINED AND FILLED WITH COARSE CRYSTALS.
INCLUDING PYROXENE LATHS 1 CM IN LONG AXIS AND 1 MM IN CROSS SECTION.
SOME OLIVINE FORMS PHENOCRYSTS FROM 1 TO 1.5 MM. FELDSPAR IS INTERSTITIAL AND
ANHEDRAL. FELDSPAR APPEARS MILKY AND MAY BE SHATTERED.
NO GLASS SPLASHES WERE SEEN. ONLY ONE GLASS LINED PIT WAS SEEN.

SAMPLE NO. 12014.5 THIN SECTION
MODE

PLAGIOCLASE	20 PERCENT
PYROXENE	55 PERCENT
OLIVINE	21 PERCENT
OPAQUE	3 PERCENT
CRISTOBALITE	1 PERCENT

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
X-RAY ANALYSIS



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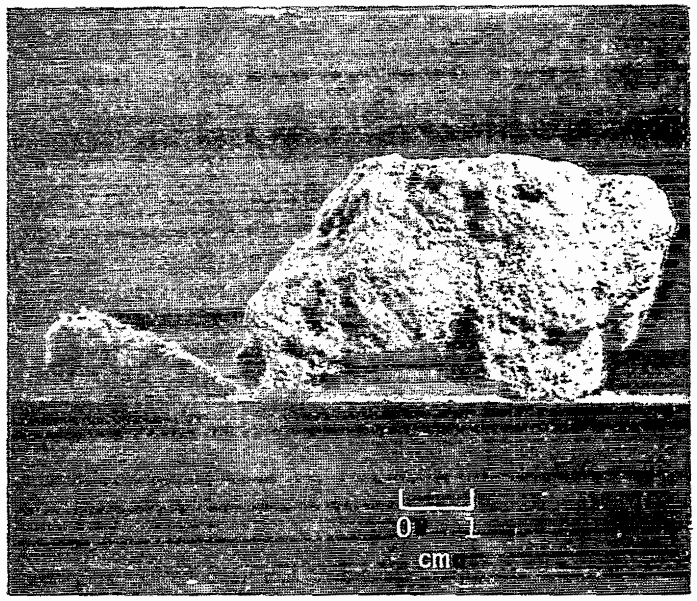

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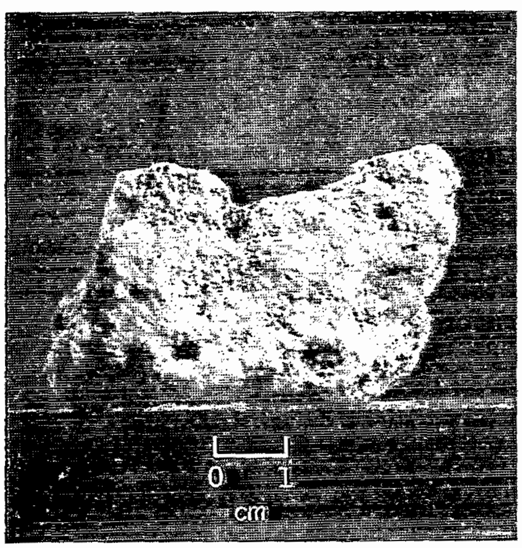

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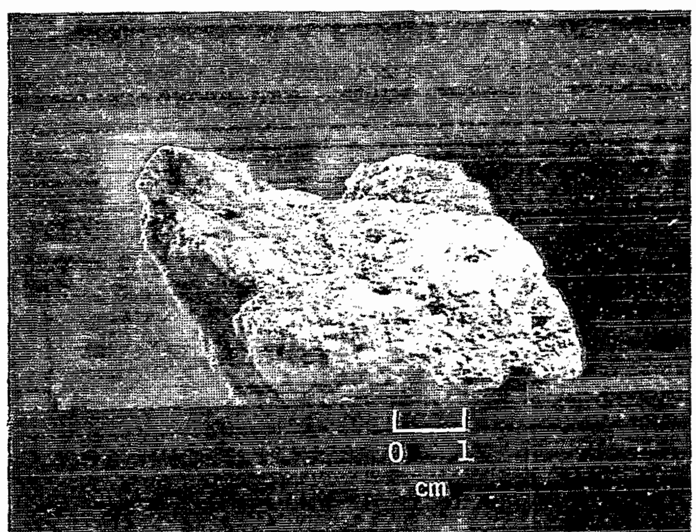

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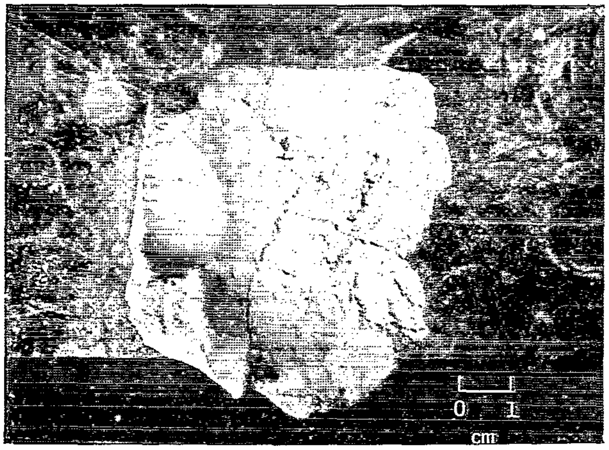
Figure A-12. - Sample 12014.

SAMPLE NO. 12015.0 HANDLE SPECIMEN WITH CARE HARMON/GIBSON
WEIGHT. 191 GRAMS 4 CM X 4 CM X 2 CM.
POSSIBLE SPECIMEN FROM MOUND.
ANGULAR. HIGHLY FRACTURED SPECIMEN. CONCAVELY LENS SHAPED (SPALLED BLACK).
AN EDGE CONTAINS A SPHERICAL CAVITY THAT IS APPROXIMATELY ONE INCH IN DIAMETER.
THE WALLS OF CAVITY ARE VERY SMOOTH. APPEARANCE OF A FORMER OBJECT REMOVED. NO LARGE (GREATER THAN 0.5MM) CRYSTALS SEEN ON WALLS OF CAVITY AS IN OTHER PREVIOUS ROCKS. ULTRA FINE GRAINED GROUNDMASS WITH LARGER OLIVINE AND PYROXENE CRYSTALS GROUNDMASS APPEARS TO BE A COMPACTED SOIL. THERE ARE SMALL CAVITIES IN GOUNDMASS.
COLOR. SOIL GRAY OR CHARCOAL BROWN. SPECIMEN IS HIGHLY FRACTURED. VERY FRAGILE APPEARANCE. GROUNDMASS CONTAINS A LARGE PERCENTAGE OF FINE GRAINED FELD SPAR WITH PYROXENE AND OLIVINE PHENOCRYSTS. THE CAVITY IS LINED WITH CRYSTALS ORIENTED TANGENTIAL TO THE CAVITY.
SHOCKED BASALT SCORIA. TEXTURE OF CRYSTAL TUFF. NO LITHIC FRAGMENTS.

SAMPLE NO. 12015 ROBIN BRETT
SIZE. SEE PHOTOGRAPH. HAS SINCE BROKEN INTO 3 FRAGMENTS OF ABOUT EQUAL SIZE.
SAMPLE FRACTURED ON BOTH MACRO AND MICROSCALE SUGGESTIVE OF SHOCK.
SURFACE ROUNDING. ONE SOMEWHAT ROUNDED SIDE HAS EXTREMELY LOW DISTRIBUTION GLASS LINED PITS PER UNIT AREA. REST OF ROCK SHOWS NONE. LACK OF ROUNDING AND PITS SUGGESTS LOW EXPOSURE AGE.
MOST REMARKABLE SURFACE FEATURE IS PORTION OF AN EXTREMELY LARGE VESICLE. OVOID. ABOUT 4 X 2.5 CM. SURFACE OF VESICLES EXTREMELY SMOOTH. FINE GRAINED MASS OF DARK IRRESOLVABLE MINERALS. CONTAINING A MAT OF FELDSPAR LATHS WHOSE AB OR AC PLACE IS PARALLEL TO SURFACE OF VESICLE.
REMAINDER OF ROCK IS QUITE RICH IN SMALL IRREGULAR VUGS FROM 0.2 TO 2 MM. GRAIN SIZE OF ROCK INCREASES TO ABOUT 0.3 MM IN VICINITY OF VUGS.
MINERALS TOO FINE GRAINED FOR IDENTIFICATION UNDER BINOCULAR EXCEPT FOR WIDESPREAD SOMEWHAT FRACTURED OLIVINE PHENOCRYSTS TO 0.5 MM. A MEAN GRAIN SIZE OF ROCK ABOUT 0.1 MM. GRAIN MOUNT INDICATES THAT ROCK IS ABOUT 70 PERCENT THETOMORPHIC (IMPACT PRODUCED) GLASS. CRYSTALLINE MATERIAL CHARACTERISTICALLY SHOWS LOWER THAN NORMAL BIREFRINGENCE.
MINERALS. PLAGIOCLASE
PYROXENE (VERY LIGHT BUFF COLOR)
OLIVINE
OPAQUES (ABOUT 10 PERCENT).
NO FURTHER DETAILS ON MINERALOGY DUE TO EXTREME SHOCK. NOR ON MODE. OLIVINE LEAST SHOCKED OF ALL MINERALS.
DUST WHICH TENACIOUSLY COATS SAMPLE WAS EXAMINED. THIS CONTAINS ABOUT 70 0/0 THETMORPHIC GLASS AND ABOUT 10 PERCENT GLASS SPHERULES. CRYSTALLINE MINERALS SIMILAR TO ROCK IN MODE AND DEGREE OF SHOCK.
SIMILARITY OF DUST TO ROCK. DIFFERENCE OF DUST TO BULK APOLLO 12 DUST. AND EXTREME SHOCK OF ROCK COMPARED TO ANY OF APOLLO 11 OR 12 SUGGESTS THAT ROCK MAY NOT BE FROM A LOCAL SOURCE. SPECULATION MUST STILL BE ADMITTED THAT ROCK 12015 MAY BE FROM THE MOUND.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
X-RAY ANALYSIS



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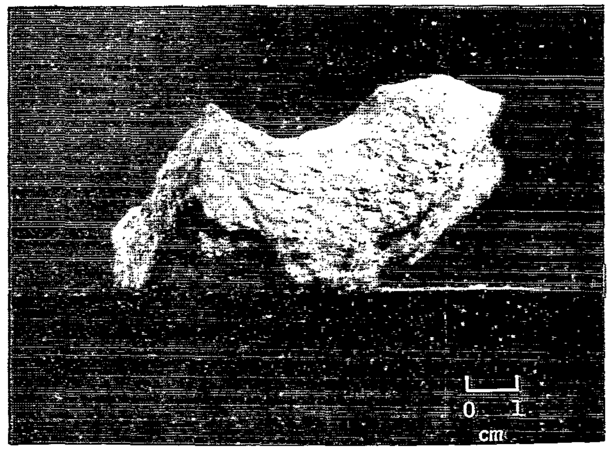

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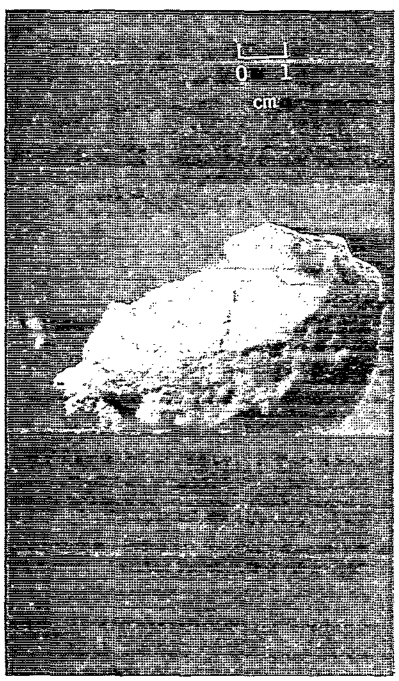

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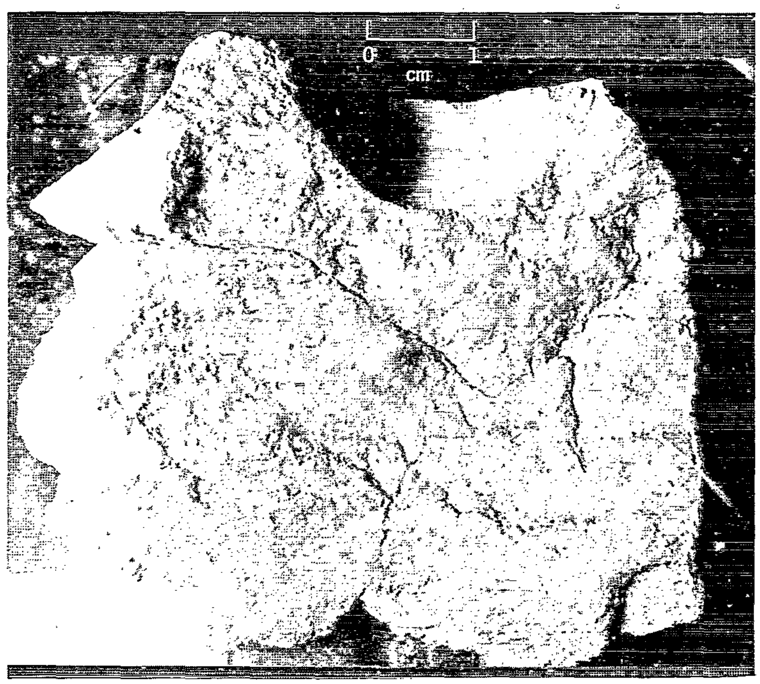

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Figure A-13. - Sample 12015.

SAMPLE NO. 12016.0 SMITH
F201 DESCRIPTION SUB NAPOLEONS HAT SHAPE CONCAVE ON BOTTOM. SUBANGULAR TO SUB-ROUNDED ON TOP VESICULAR MEDIUM GREY WITH WHITE PATCHY AREAS (PRESUMABLY THE MILKY FELDSPAR CRUSTY SURFACE SEEN ON APOLLO 11 CRYSTALLINE ROCKS)
DUST COVERED BUT A FEW SMALL 2 TO 3 MM GLASSY PITS ARE VISIBLE AND ONE SMALL AREA SUGGESTS SPLASH. TEXTURE NOT VISIBLE. FRACTURES VISIBLE ON ONE END NO APPARENT RELATION TO ROCK SHAPE. THIS END SHATTERED AND FRIABLE. SOME VESICLES ARE COALESCED AND APPEAR VUGGY. ONE AT LEAST, HAS REFLECTING CRYSTAL FACES. MOST VESICLES ARE IN THE RANGE OF 1 TO 4 MM. THE DUST IS STRONGLY ADHERENT TO ROCK AND RETAINS IMPRINTS OF TOOLS AND GLOVE ABRASIONS. FINE PINPOINT GLITTERS SUGGEST SOME
CRYSTALLINE MINERALS ARE PRESENT IN THE DUST. BOTH THE GENERAL APPEARANCE AND ALL DETAILS THAT CAN BE NOTED RECALL
SPECIFICALLY THE COARSER GRAINED FACIES OF APOLLO 11 TYPE A. WE SEEM TO BE DEALING WITH THE SAME OR VERY SIMILAR ROCKS.

SAMPLE NO. 12016.0 WEIGHT 2028.0 G DIMENSIONS 7 X 5 X 4 IN. HARMON
F201 DESCRIPTION
SHAPE IS SUBANGULAR WITH ROUNDED IRREGULAR SURFACES. COLOR IS A BROWNISH GREY WHERE DUST COVERED. A LIGHTER GREY ON FRESHER SURFACES (WHERE BRUSHED). THE ROCK HAS A RATHER SALT AND PEPPER TEXTURE AND IS DEFINITELY CRYSTALLINE. THE THE ROCK IS VESICULAR, BUT THE DENSITY OF VESICLES ON THE SURFACE APPEARS LOW THE ROCK ALSO APPEARS TO HAVE A THIN SURFACE CRUST TYPICAL OF THE APOLLO 11 CRYSTALLINE ROCKS (A SHATTER CRUST). THE DENSITY OF SURFACE PITS APPEARS LOW, BUT ARE VERY NICE IMPACT CRATERS (PIT) ABOUT 1.5 CM IN DIAMETER CAN BE SEEN ON ONE SIDE OF THE ROCK. THE THIN END OF THE ROCK ALSO HAS A FRACTURE RUNNING DIAGONALLY ACROSS IT. THE BOTTOM (CONCAVE) SURFACE OF THE ROCK APPEARS TO BE MORE SHATTERED THAN OTHER SURFACES. THE CRYSTAL GRAINS ARE VISIBLE TO THE AIDED EYE, BUT NO MINERALOGY CAN BE DETERMINED. SOME GRAINS ARE LARGE ENOUGH TO MAKE REFLECTIONS VISIBLE BY MOVING ONES HEAD BACK AND FORTH. A MEDIUM GRAIN CRYSTALLINE ROCK SLIGHT GLASS SPHERULES MAY ALSO BE PRESENT ON THE SURFACE.

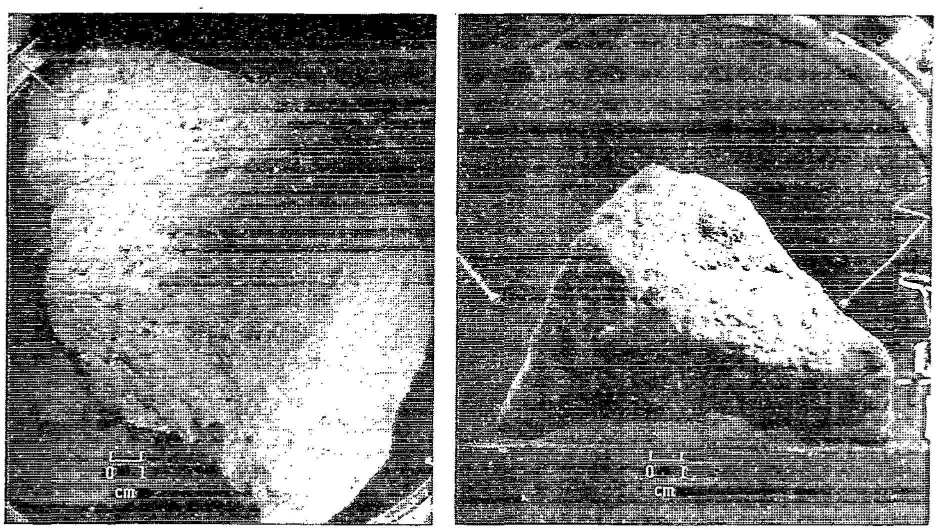

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Figure A-14. - Sample 12016.

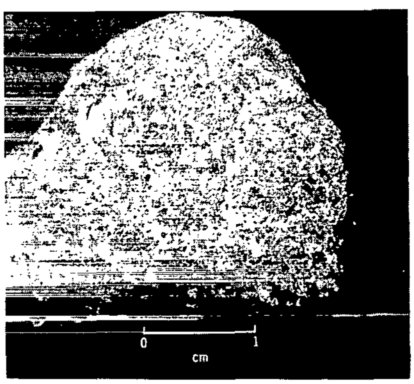
SAMPLE 12017

SAMPLE NO. 12017.0 F201 DESCRIPTION D. ANDERSON/E. GIBSON
WEIGHT 53 GRAMS DIMENSIONS 5 X 3 X 2.5 CM
A COARSLY CRYSTALLINE MICROGABBRO TYPE ROCK WITH ABOUT 80 PERCENT OF ONE SIDE COVERED WITH A DARK SHINY GLASS LAYER. THE ROCK IS ROUGHLY PYRAMIDAL WITH VERY SHARP CORNERS AND FLAT SIDES. IT APPEARS HOLOCRYSTALLINE WITH THE FOLLOW ING MINERALOGY.

PLAGIOCLASE FELDSPAR (CLEAR TO TURBID WHITE) APPROXIMATELY 50 PERCENT
PYROXENE. HONEY BROWN APPROXIMATELY 35 PERCENT (ONE CRYSTAL ABOUT 3MM LONG)
ILMENITE APPROXIMATELY 10 PERCENT
OLIVINE LESS THAN 5 PERCENT.

THERE ARE NO APPARENT LINEATIONS. VUGS. VESICLES OR PITS ON ROCK. THE DUST COVER OBSCURES BASE ROCK BUT DOES NOT STICK TO GLASS EXCEPT FOR VERY THIN LAYER IN PLACES.
THE OUTSTANDING FEATURE IS THE LARGE GLASSY PATCH. THE GLASS HAS LUSTRE OF POLISHED MOLYBDENUM. IT APPEARS THINNEST AT POINTED END AND THICKEST AT OPPOSITE END OF SIDE WITH GLASSY SURFACE. THE FOLLOWING FEATURES WERE OBSERVED ON THE GLASS.

1. NO IMPACT PITS ON SURFACE OF GLASS.
2. GLASS IS SOMEWHAT FRACTURED (ONLY A FEW LARGE FRACTURES).
3. BASE ROCK IS NO MORE ROUNDED UNDER GLASS THAN ELSEWHERE.
4. GLASS HAS NOT COMPLETELY WETTED ROCK BUT THERE ARE REGIONS WHERE BASE ROCK SHOWS THROUGH DIMPLES.
5. THERE ARE DARKER GREENISH BROWN ELONGATE GLASS PATCHES ON SURFACE OF BLACKER GLASS. THESE ARE SUBPARALLEL AND APPEAR TO BE EVIDENCE OF A LATER SPLASH. SOME OF THESE ARE 2 MM LONG BUT MOST ARE LESS THAN 1 MM.
6. THERE ARE SHALLOW DEPRESSIONS IN GLASS SURFACE WHICH ARE LIGHTER COLORED. THESE ARE OVAL AND ARE ABOUT 2 TO 3 MM DIAMETER.
7. AT ONE END OF THE PATCH THERE ARE TWO PLACES WHERE THE GLASS APPEARS TO BE ALMOST 1 MM THICK WITH A SHARP STRAIGHT EDGE AS IF FRACTURED OFF. ON ONE OF THESE VERTICAL SURFACES SEVERAL VESICLES MAY BE SEEN IN THE GLASS.
8. ALONG ONE EDGE OF THE GLASS SURFACE. THE GLASS AND PART OF BASE ROCK SEEM TO BE BROKEN AWAY EXPOSING A BLEACHED SURFACE INDICATING THAT THE ORIGI NAL SURFACE OF THE ROCK HAS BEEN COVERED UP WITH GLASS.
9. A THICK (1 MM) KNOB IN GLASS IN ONE PLACE MAY BE A PIECE OF SOLID MATERIAL IN GLASS WHICH IS NOW COVERED UP.



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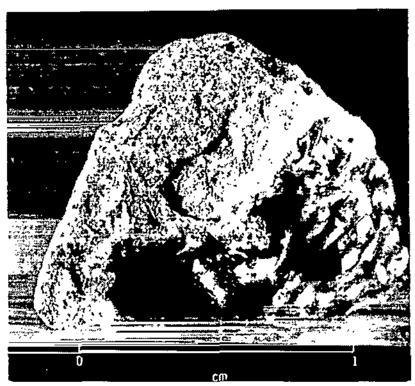

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Figure A-15. - Sample 12017.

SAMPLE 12018.0 WEIGHT 786.98 G DIMENSIONS 8 X 6 X 6 CM ANDERSON
F201 DESCRIPTION MEDIUM GRAINED CRYSTALLINE ROCK. SIMILAR TO TYPE B ROCK OF APOLLO LL. OLIVINE GRAINS 1/2 MM. WHITENED FELDSPARS. BLACK MINERAL/WHITE MINERAL ABOUT 50/50. OVERALL BLOCKY WITH ONLY SLIGHT ROUNDING OF CORNERS. SEVERAL LARGE GLASS LINED PITS. FEW SMALL ONES. PIT DENSITY LESS THAN 1/CM2. PITS ABOUT 1 MM DIAMETER.
NO VUGS ARE EASILY SEEN. NO LINEATION OR FRACTURES. NO GLASS SPLASHES AND ONLY A FEW GLASS LINED PITS WHICH ARE DEEP AND HAVE RAISED RIMS.
WHEN ROCK WAS TURNED OVER. A FEW OF SAME PITS ON OTHER SIDE. SOME PYROXENES APPEAR TO BE UP TO 1 1/2 MM. TEXTURE SEEMS EQUIGRANULAR. ILMENITE NOT OBSERVED. PROBABLY MINOR. ROCK WAS BRUSHED LIGHTLY WITH S.S. BRUSH TO REMOVE DUST. NO SCRATCHES SEEN. WHITE MINERAL NOT EUHEDRAL.

SAMPLE 12018.0 F201 DESCRIPTION P. BUTLER
EXAMINATION OF CHIPPED SURFACES. ONLY THE TWO UPPER SURFACES ARE ACCESSIBLE TO THE BINOCULARS.
MINERALOGY.
PYROXENE. MEDIUM TO DEEP BROWN (DEPENDING ON SIZE OF THE GRAIN). MOST GRAINS ARE ABOUT 0.2 MM IN SIZE. ANHEDRAL AND EQUIDIMENSIONAL. ON THE TWO CHIPPED SURFACES ACCESSIBLE TO EXAMINATION. HOWEVER. THERE ARE SEVERAL POLY CRYSTALLINE AGGREGATES OF PYROXENE 1.5 TO 2 MM ACROSS COMPOSED OF 0.5 MM INDIVIDUALS. SOME OF THESE LARGER GRAINS EXHIBIT APPROXIMATELY 90 DEGREE CLEAVAGES. ONE 2 MM PYROXENE IS BY ITSELF IN THE FINER GRAINED MATRIX.
OLIVINE. PALE GREEN. FINE GRAINED (ABOUT 0.1 MM) GENERALLY SOMEWHAT SMALLER THAN PYROXENE GRAINS. ANHEDRAL AND EQUANT IN SHAPE. AS WITH THE PYROXENE. THERE ARE A FEW AGGREGATES OF COARSER GRAINED OLIVINE VISIBLE.
PLAGIOCLASE. WHITE TURBID PATCHES (ABOUT 0.1 TO 0.2 MM). VERY IRREGULAR IN SHAPE. NO CLEAVAGES OBSERVED. INTERSTITIAL TO THE OTHER MINERALS.
ILMENITE. BLACK SHINY GRAINS. GENERALLY 1/2 TO A FULL ORDER OF MAGNITUDE SMALLER THAN THE AVERAGE OLIVINE AND PYROXENE GRAINS. WELL DISSIMINATED ACROSS THE CHIPPED FACES.
MODE.
PYROXENE (BROWN) 50 PERCENT
OLIVINE (PALE GREEN) 20 PERCENT
PLAGIOCLASE (TURBID WHITE) 25 PERCENT
ILMENITE (OPAQUE BLACK) 5 PERCENT
SURFACE ZONE. SECTION PROVIDED BY THE CHIPPED SURFACE FROM THE SURFACE OF THE ROCK INWARD SHOWS AN OUTER ZONE (APPROXIMATELY 2 MM THICK) IN WHICH MOST OF THE MINERALS ARE WHITE AND POWDERY AS THOUGH PARTIALLY CRUSHED. THIS ZONE MAY NOT BE ON ALL SURFACES AND COULD BE HELPFUL IN THE ORIENTATION OF THIS ROCK.
VUGS. CLOSE EXAMINATION REVEALS THE PRESENCE OF SEVERAL VUGGY AREAS (ROUGHLY 2.3 MM BROAD) THAT ARE AT LEAST HALF FILLED WITH A JUMBLE OF RANDOMLY ORIENTED COLUMNAR PLAGIOCLASE AND PYROXENE CRYSTALS. MOST CRYSTALS HAVE A LENGTH TO BREADTH RATIO OF AT LEAST 10. DENSITY OF VUGS LESS THAN 1/CM2.
CHANGES IN MINERALS NEAR VUGS. NO MARKED INCREASE IN SIZE. GREAT CHANGE IN SHAPE OF PYROXENE FROM EQUANT TO ELONGTATED COLUMNAR. PLAGIOCLASE OCCURS ONLY IN THE VUGS AS DISTINCT INDIVIDUAL CRYSTALS.
ALTERATION. NONE OTHER THAN PLAGIOCLASE AND SURFACE ZONE CRUSHING NOTED ABOVE.
TERRESTRIAL ANALOGUE. MEDIUM GRAINED GABBRO.

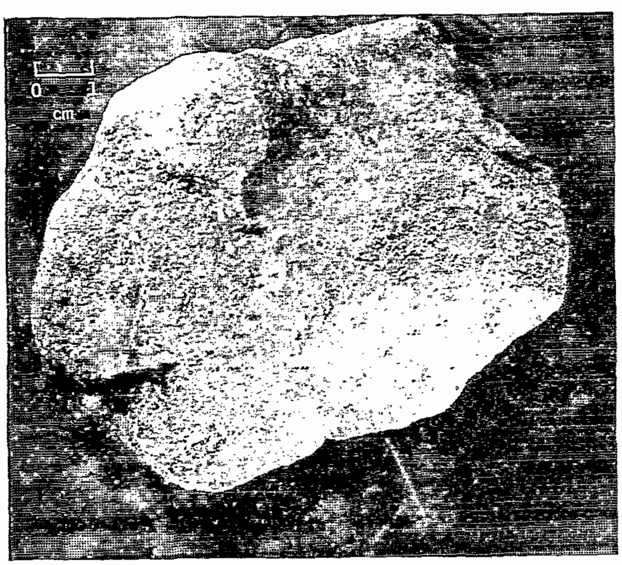
SAMPLE 12018 CHIPS. SMALLEST TO LARGEST (A TO D).
CHIP A 0.7 X 0.8 X 0.5 CM 1 GRAM
CHIP B 1.5 X 1 X 0.8 2 GRAMS
CHIP C 1.5 X 1.5 X 1 2 GRAM WEDGE SHAPED
CHIP D 2 X 2.5 X 1 CM 5 GRAMS
ONE OF THE THREE SMALLER CHIPS (A, B, OR C) FELL OFF THE ROCK DURING MANIPULA

TION. THE LARGEST (D) AND THE OTHER TWO WERE ALL SPLIT OFF BY THE SAME HAMMER BLOW ON THE SPLITTER.

SAMPLE NO. 12018.3 WONES
SHAPE. WEDGE SHAPED, SIMILAR TO STONE AGE IMPLEMENTS. 0.6 X 1.2 X 2.0 CM.
COLOR. NEUTRAL GRAY N7 TO N6
TEXTURE. VUGGY EQUIGRANULAR. EQUANT OLIVINE AND PYROXENE WITH OCCASIONAL LATHS OF PLAGIOCLASE. AVERAGE GRAIN SIZE .4 MM. OLIVINES TEND TO BE 0.6 MM.
FABRIC. NONE DETECTED. VUGS ARE WIDESPREAD AND IRREGULAR.
FRACTURES. NONE DETECTED.
SURFACE FEATURES. CONCAVE SIDE OF FRAGMENT APPEARS TO BE AN ORIGINAL SURFACE. TWO PIT/CM2. SOME GLASS LININGS PRESERVED. SOME GLASS IS ALSO PRESENT.
MINERALOGY.
MODE.
PYROXENE 75 PERCENT
OLIVINE 8 PERCENT
PLAGIOCLASE 15 PERCENT
OPAQUES 2 PERCENT
PYROXENE. EQUANT GRAINS, HONEY TO DARK BROWN IN COLOR, 0.4 MM AVERAGE DIAMETER TEND TO BECOME ACICULAR AT VUGS.
OLIVINE. EQUANT GRAINS, YELLOW GREEN APPEAR TO BE TANGENTIAL TO ONE VESICLE. AVERAGE DIAMETER IS 0.6 MM.
PLAGIOCLASE. TABULAR CLEAR CRYSTALS 0.05 X 0.4 CONCENTRATED TOWARD VUGS.
OPAQUES. DISPERSED AS BLADED CRYSTALS THROUGHOUT ROCK.
TRIDYMITE. CLEAR LATH LIKE CRYSTALS IN VUGS.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

A-A CHEMICAL ANALYSIS
E-SPEC ANALYSIS
X-RAY ANALYSIS



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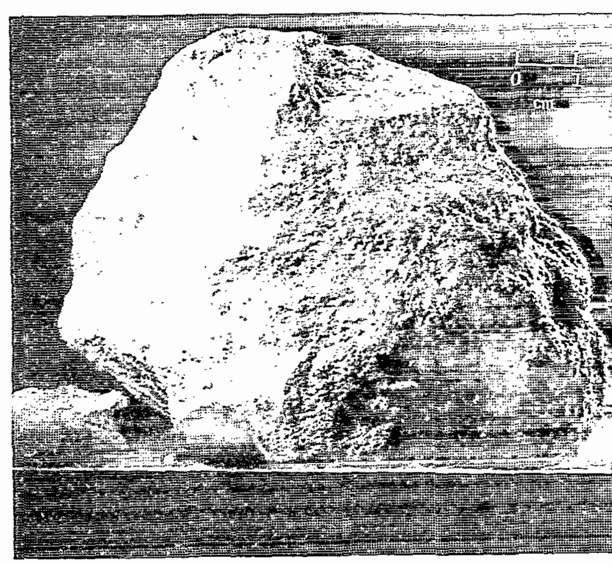

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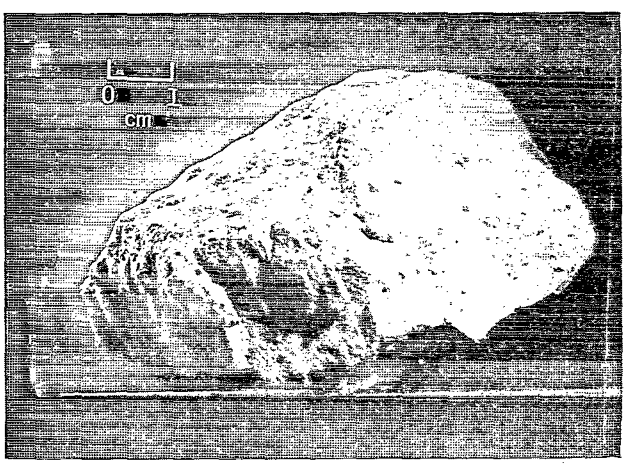
Figure A-16.- Sample 12018.

SAMPLE NO. 12019.0 WEIGHT 462.39 G DIMENSIONS 9 X 7 X 6 CM GIBSON
LAST ROCK DESCRIPTION FROM F201.
SPECIMEN COLOR. LIGHT TO MEDIUM CHARCOAL GRAY.
SURFACE FEATURES. SMOOTH GENERALLY WITH NUMEROUS GLASS LINED PITS. FREQUENCY OF PITS IS 3 TO 4 PER SQUARE CM. ONE SIDE OF SPECIMEN HAS 2 FRACTURES. ONE IS PERPENDICULAR TO THE OTHER.
ONE SMALL AREA OF SURFACE OF SPECIMEN APPEARS NOBBY. PERHAPS BOTTOM. TOP IS SMOOTH WITH GLASS PITS MORE ABUNDANT THAN FRACTURED REGION WHICH HAS FEW PITS. PROBABLY FRACTURED REGION WAS BOTTOM OF ROCK AND SMOOTH SURFACE WITH GLASS LINED PITS THE TOP. THERE IS NO APPARENT BATH TUB RING ON THIS SPECIMEN AS OBSERVED FROM THE SO PORT OF F201.
THE SURFACE OF SPECIMEN IS DUSTY AND THE DUST IS FOUND IN NUMEROUS GLASS PITS AND VUGS PROHIBITING FURTHER EXAMINATION OF BOTTOM AND SIDES OF VUGS AND PITS. NO WAY TO TELL IF VUGS ARE LINED WITH CRYSTALS.
THE GLASS LINED PITS RANGE IN SIZE FROM 0.5 MM TO 2 MM. PITS ARE LINED WITH A BLACK GLASS WHICH RANGES IN THICKNESS FROM 0.02 TO 0.2 MM DEPENDING UPON THE SIZE OF THE PIT. THE DEPTH OF THE PITS RANGE FROM 0.2 MM TO 0.5 MM.
THE ROCK IS A FINE GRAINED ROCK. NO LINEATIONS ARE APPARENT. REGIONS OF SURFACE WHICH ARE NOT DUST COVERED APPEAR HOLOCRYSTALLINE.
THERE ARE NO APPARENT GLASS SPLASHES ON THE SPECIMEN AS VIEWED FROM THE SO PORT.
MINERALOGY. MODE.

PLAGIOCLASE FELDSPAR	CLEAR TO TURBID WHITE	LT 0.1 TO 0.2	60 TO 70 PERCENT
OLIVINE	PALE BOTTLE GREEN	0.1 TO 0.2	LESS THAN 5 PERCENT
PYROXENE	HONEY BROWN	0.1 TO 0.2	20 PERCENT
ILMENITE	BLACK OPAQUE	0.2 TO 0.4	10 PERCENT

TERRESTRIAL ANALOGUE. MICROGABBRO.
SPECIMEN WAS NOT CHIPPED. IT WAS CANNED IN CAN 3-32 IN F201. PROBABLY EASIER TO CHIP THIS SPECIMEN IN PCTL THAN IN F201.
TYPE A ROCK.



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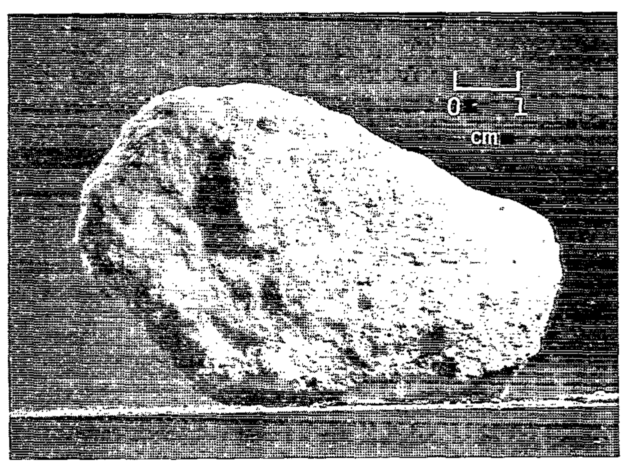

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Figure A-17. - Sample 12019.

SAMPLE 12020

SAMPLE NO. 12020 WEIGHT 312 GM DIMENSIONS 8 X 6 X 6 CM WARNER
GENERAL SHAPE IS TRIGIONAL DIPYRAMID. SPECKLED BROWNISH CHARCOAL GREY.
SURFACE IS ROUGH. VUGGY. ONE PREDOMINATE PLANAR FRACTURE. GLASS LINED
PITS. VERY FEW. MOSTLY FRESH BROKEN SURFACES. MANY FRACTURES LOOKS LIKE A
FRAGILE ROCK.
MANY VUGS. 4 CM ACROSS. ABOUT 2 PER CM2 OF SURFACE AREA. VUGS CONTAIN FANTASTIC
CRYSTALS.

1. LARGER ONES
2. PRISMS (STRICTED) OF FELDSPAR AND PYROXENE .5 MM X 2 MMP
3. ALSO OLIVINE. BUT NO ILMENITE.

TEXTURE HOLOCRYSTALLINE. GRANULAR.
PCTL CHIP FROM E CORNER ON CAMERA 1 PRESPLIT PHOTO CHIPS IS 2 X 3 X 1 1/2 CM
ESTIMATED MASS = 13 GRAMS. NEW MODE ESTIMATE.
MINERALOGY.

FELDSPAR. COLORLESS	45 PERCENT	.1 MM
PYROXENE. HONEY BROWN	30 PERCENT	.2 MM
OLIVINE. DEEP YELLOW GREEN	20 PERCENT	.5 MM
ILMENITE. BLACK OPAQUE	5 PERCENT	.2 MM

IN VUGS.

A) FELDSPAR LATHS. .1 MM X 2 MM
B) PYROXENE LATHS. 6 SIDED. .1 MM X 1 MM

TERRESTRIAL ANALOGUE OF SPECIMEN. OLIVINE BASALT

SAMPLE NO. 12020.5 THIN SECTION
MODE

PLAGIOCLASE	20 PERCENT
PYROXENE	48 PERCENT
OLIVINE	30 PERCENT
OPAQUE	2 PERCENT

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
X-RAY ANALYSIS

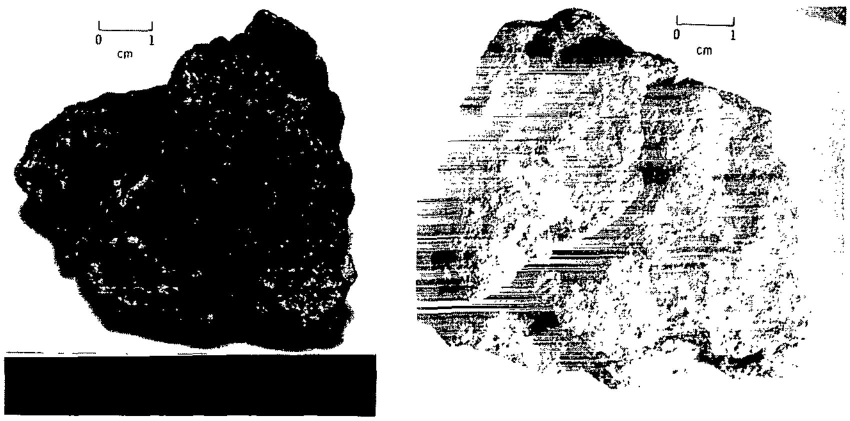

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Figure A-18. - Sample 12020.

SAMPLE 12021

SAMPLE NO. 12021.0 DIMENSIONS 14 X 12 X 8 CM CAN 40016 WONES
SMALL CHIPS. CAN ITR4
DEFORMED TRIANGULAR PRISM WITH A CONCAVE BASE. APPEARS TO BE A SPALLED BLOCK. NEUTRAL GRAY WITH GREENISH CAST. COARSE. PEGMATITIC PYROXENE. IN RADIATING SHEAVES. OPHITIC TEXTURE. GRAINS OF PYROXENE UP TO 3 CM LONG X 4 MM WIDE. PINKISH APPEARANCE UNDER BINOCULAR. BROWN PYROXENE GRAINS 1 MM X 1 MM IN INTERSTICES ON BLADED PLAGIOCLASE. DEEPER BROWN MINERAL. GREEN MINERAL AND OPAQUES SCATTERED THROUGH PYROXENE AND PLAGIOCLASE. SOME BLADED ILMENITE. MESH OF COARSE PYROXENE WITH INTERSTITIAL PYROXENE AND PLAGIOCLASE. ILMENITE AND BROWN MINERAL (SPHENE) SCATTERED THROUGH SAMPLE. VUGS PRESENT. NO VESICLES. FABRIC / 1. NO OBSERVATION OF LINEATIONS. CANNOT TELL IF PLAGIOCLASE IS TRULY RANDOM. 2. VUGS APPEAR AT INTERSECTION OF PLAGIOCLASE GRAINS. FRACTURES/ 1. OCCUR NEAR EDGES. APPEAR TO BE CONTROLLED BY PYROXENE SHEAVES. 2. ORIENTATION CONTROLLED BY SURFACE AND PYROXENE. 3. CON CENTRATED ON ONE SIDE WITH SHATTER ZONE. SURFACE FEATURES / CONVEX SURFACE SHOWS TEXTURES VERY WELL. NO APPARENT EROSION OF SURFACE. FRESH LARGE CRYSTALS EASILY OBSERVED EVEN THOUGH SOME DUST STILL ADHERES.
CONCAVE SIDE PITTED. SMALL PITS WITH HALOES. THIS IS SO COARSELY CRYSTALLINE THAT STUDIES OF PITTING ON SPECIFIC MINERALS WOULD BE POSSIBLE. SHATTER ZONE ON SURFACE SEEMS FAIRLY THICK ON ONE SIDE. GOOD DEAL OF DUST ADHERING TO SAMPLE. SHATTERED MATERIAL PROMINANT ON SURFACE OF CHIP.
CHIP OFF OF MOST PRO-
TRUDING CORNER APPEARS FINED GRAINED AND MORE OLIVINE RICH THAN REST OF SAMPLE. SIDE THAT IS A SHATTER ZONE HAS MANY FRACTURES.
MODE. 12021.0

PLAGIOCLASE	55 PERCENT
PYROXENE	40 PERCENT
OLIVINE	2 PERCENT
BROWN MINERAL	2 PERCENT
OPAQUES	1 PERCENT

MODE. 12021.1

PLAGIOCLASE	60 PERCENT
PYROXENE	30 PERCENT
OLIVINE	7 PERCENT
BROWN MINERAL	2 PERCENT
OPAQUES	1 PERCENT

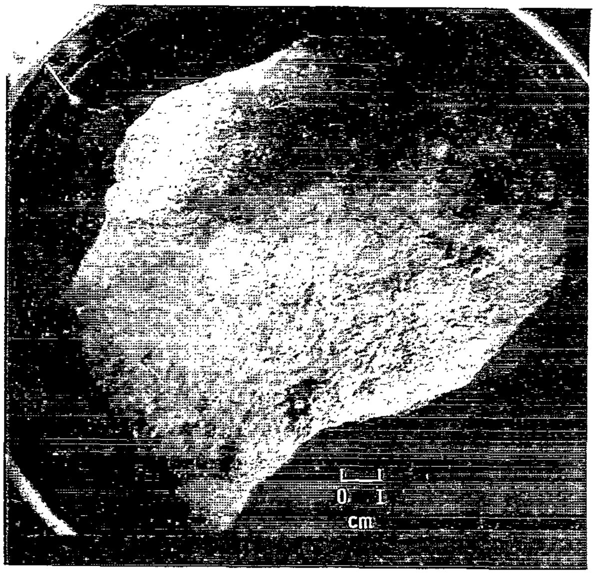
SIZE AND SHAPE. PLAGIOCLASE. 30 MM X 4 MM TO 5 MM X 1 MM. LATHS OCCURRING IN SHEAVES. PYROXENE. 1 MM X 1 MM TO SMALLER. BLOCKY CRYSTALS IN INTERSTICES. OLIVINE. 2 MM X 2 MM. ROUNDED TEXTURE. ILMENITE THIN BLADED. 1 MM X LESS THAN 0.1 MM. ROUND EQUANT GRAINS LESS THAN 1 MM X LESS THAN 1 MM. CONCENTRATION OF ILMENITE AT VUGS. PERHAPS SAMPLE IS TRUE FOR OLIVINE. NO ALTERATION OBSERVED. ROCK NAME = GABBRO

SAMPLE 12021.0 WEIGHT 1876.58 WONES
ONE SIDE OF ROCK HAS RELATIVELY DUST FREE AREA SHOWING. RADIATING BLADED CRYSTAL UP TO 2 1/2 CM LONG. THESE BLADES SEEM LIGHTLY COLORED IN PLACES. KHAKI TO GREY WITH A DARK BACKGROUND. THEY ARE SOMEWHAT TRANSLUCENT. THE BLADES HAVE SOME STRUCTURE OFTEN WITH LIGHT COLORED CORE AND DARKER OUTER PART. THESE BLADES HAVE ONE CLAVAGE PLANE PARALLEL TO LONG AXIS OF CRYSTAL.
OLIVINE IS ABUNDANT LIGHT GREEN. BROWN (GARNET COLORED) GRAINS MAY BE SPHENE. LIGHTER BROWN (HONEY BROWN) MAY BE PYROXENE. A FEW ROUND BLEBS OF OPAQUE MINERAL POSSIBLY ILMENITE.
PHOTOS WERE TAKEN WITH THE ROCK IN TWO POSITIONS. POSITION 1. RECORDS ONLY. POSITION 2. RECORDS AND STEREO.

SAMPLE NO 12021 WEIGHT 7.19 GRAMS SMITH
ANGULAR FRAGMENT 20 X 15.8 X 15.8 MM WITH COAREST GRAIN SIZE YET SEEN IN LUNAR

ROCKS. BLADED STRUCTURE CAUSED BY INTERGROWTH OF LONG PRISMATIC CRYSTALS OF PLAGIOCLASE AND CLINOPYROXENE. SOME OF THESE BLADES ARE AT LEAST 16 MM LONG AND REPRESENT INCOMPLETE CRYSTALS THAT WERE BROKEN OFF AT BOTH ENDS DURING CHIPPING. ONE END OF FRAGMENT REPRESENTS THE OUTER EXPOSED SURFACE OF ROCK BEFORE CHIPPING AS EVIDENCED BY CHALKY FELDSPAR, ADHERING DUST AND RARE GLASS PITS.
THE LARGE PYROXENE CRYSTALS ARE CHARACTERIZED BY HONEY YELLOW CORES AND DARK CIN NAMON BROWN RIMS. THE HONEY YELLOW CORES STRONGLY RESEMBLE YELLOWISH OLIVINE BUT ARE PROBABLY PIGEONITE. THERE IS A TENDENCY FOR THE AGGREGATES OF BLADES TO ASSUME OPHITIC ARRANGEMENT SURROUNDING VUGGY CAVITIES.
APPROXIMATE MODE. CLINOPYROXENE (2 TYPES) 55, PLAGIOCLASE 40, OPAQUES (ILMENITE) 5.
PLAGIOCLASE N GREATER THAN 1.570 (ABOUT AN 85 TO 90).
THE CINNAMON BROWN PYROXENE HAS LARGER 2V AND NG ABOUT 1.736 (VARIABLE DUE TO ZONING).

SAMPLE NO. 12021 CHIP WILCOX
CRUMBS FROM CHIP, MANY APPARENTLY FRAGMENTS FROM THE LONG PALE BROWNISH GREEN CRYSTAL IN CHIP. THESE FRAGMENTS ARE GLASSY CLEAR, POLYGONAL FRACTURE PIECES. THREE FRAGMENTS ON SPINDLE STAGE SHOW HOMOGENEOUS CRYSTALS OPTICS, ALTHOUGH SOME FINE LAMELLAE STRUCTURE PARALLEL TO PARTING.
UNCALIBRATED LIQUIDS BUT NEWLY OPENED.
NX 1.695, 1.695, 1.694, PLUS OR MINUS .001
NY 1.696, 1.696, 1.695 PLUX OR MINUS .001
NZ 1.717, 1.716, 1.716 PLUS OR MINUS .002
NZ MINUS NX .002, .021, .022 PLUS OR MINUS .003
ONE MOUNT GAVE A BXA FIGURE, FROM WHICH 2VZ = 15 DEGREES PLUS/MINUS 5 DEGREES.



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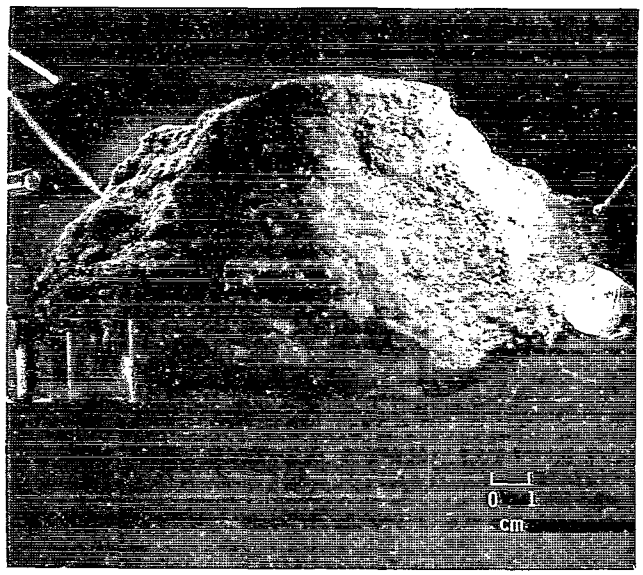

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Figure A-19. - Sample 12021.

R LESS THAN V STRONG.
THESE CHARACTERISTICS WOULD FIT PIGEONITIC CLINOPYROXENE ALTHOUGH BIREFRIGENCE IS ON THE LOW SIDE.

SAMPLE NO. 12021 CHIP CHAO
WEIGHT 7.1 GRAMS DIMENSIONS ABOUT 2 X 1.5 X 1.5 CM TRAPEZOIDAL-SHAPED FRAGMENT.

GENERAL APPEARANCE - LAVENDER BROWN COARSELY HOLOCRYSTALLINE ROCK WITH LONG PRISMATIC PHENOCRYSTS GREATER THAN 1 CM LONG AND 2-3 MM WIDE. ROCK IS SLIGHTLY VUGGY.

TEXTURE AND GRAIN SIZE - PORPHYRITIC. COARSE GRAINED. GROUNDMASS GRAIN SIZE 0.3 - 0.6 MM.

SURFACE FEATURE - A CHIP. SEE DESCRIPTION OF WHOLE SPECIMEN.

MINERALS -

1. PIGEONITE PHENOCRYSTS - DISTINCTLY ZONED. SOME HAS A ELONGATED CORE OF PLAGIOCLASE. THE INNER ZONE CONSISTS OF GREENISH YELLOW PIGEONITE WITH BASAL PARTING. RIMMED BY NARROW WINE BROWN SUBCALCIC AUGITIC PYROXENE. SEE GRAIN MOUNT DESCRIPTION.
2. CLEAR PLATY LUSTROUS CALCIC PLAGIOCLASE. SEE GRAIN MOUNT FOR ESTIMATE OF COMPOSITION.
3. BLACK METALLIC PLATES - ILMENITE.
4. YELLOW UNRIMMED GRAINS PROBABLY OLIVINE.

SHOCK - NO EVIDENCE.

SPINDLE NOUNT -

1. GREENISH YELLOW PIGEONITE. 2V ABOUT 5 DEGREES BIAX. POSITIVE
   NA = 1.691 PLUS/MINUS 0.001 GRADATIONAL FILTER
   NG = 1.712 PLUS/MINUS 0.001
   BIREFRINGENT = 0.021
2. CALCIC PLAGIOCLASE BIAX. (-). LARGE 2V.
   NB = 1.582 PLUS/MINUS 0.001 EST. AN ABOUT 90-95 PERCENT.

REMARKS - THIS IS A VERY COARSE GRAINED VARIETY OF 12065. DISTINCTLY PORPHYRITIC WITH VARIOLITIC-LIKE GROUNDMASS. THE INTERMEDIATE GRAIN SIZE WOULD BE 12039.

SAMPLE NO. 12021 THIN SECTION CHAO
THIN SECTION. CONSISTING OF ONE LARGE ZONED PRISMATIC CLINOPYROXENE AND SURROUNDING GROUNDMASS.

TEXTURE AND GRAIN SIZE - THE LARGE CRYSTAL IS GREATER THAN 2 CM LONG (BROKEN). AND ABOUT 1.5 MM WIDE. GROUNDMSSS PLAGIOCLASE ARE 0.3 TO 0.6 MM IN LENGTH.

MINERALS -

1. ZONED PIGEONITE
2. CALCIC PLAGIOCLASE
3. ILMENITE

NO OLIVINE IN THIS SECTION OR CRISTOBALITE. THIS THIN SECTION IS NOT SUITED FOR ESTIMATING MODAL COMPOSITION.

REMARKS - COARSE-GRAINED PORPHYRITIC GABBRO. THIS VARIETY IS PROBABLY A COARSE PHASE OF THE FINE-GRAINED FLOW UNIT OF 12065. EXCELLENT MATERIAL FOR THE STUDY OF NEARLY PURE PIGEONITE. FOR MINERAL SEPARATION OF SUCH.

SAMPLE NO. 12021.2 THIN SECTION
MODE

PLAGIOCLASE	40 PERCENT
PYROXENE	55 PERCENT
OPAQUES	5 PERCENT
CRISTOBALITE	T

SAMPLE 12022

SAMPLE NO. 12022   WEIGHT 1864.3 GR   D. H. ANDERSON/VSA
F201 DESCRIPTION
MEDIUM GRAINED CRYSTALLINE ROCK (GRAIN SIZE APPROXIMATELY 0.1 MM) WITH NUMEROUS VISIBLE SURFACE PITS. PITS RANGE IN SIZE FROM 2 MM TO 0.1 MM WITH A PIT DENSITY OF TWO PITS PER SQUARE MILLIMETER. THE PITS ARE ALL GLASS LINED. THE OUTER MOST MILLIMETER OF THE ROCK APPEARS TO BE UNIFORMLY MORE WHITE THAN THE INTERIOR OF THE ROCK. THE INTERIOR IS APPARENTLY OF A DARK GRANULAR TEXTURE. THE SMALL PORTION VISIBLE APPEARS SUGARY. ONE CORNER NEAR THE APEX OF THE ROCK APPEARS TO HAVE BEEN BROKEN OFF. BUT A VERY FEW GLASSY PITS ON THIS SURFACE INDICATE IT MAY HAVE HAPPENED SOME TIME AGO. THE OVERALL SURFACE OF THE ROCK IS FAIRLY SMOOTH WITH FEW PLACES CLEAN ENOUGH TO SHOW THE TRUE SURFACE. THE ROCK IS APPARENTLY RATHER HARD BECAUSE THE TOOL IN THE VACUUM CHAMBER HAVE LEFT METAL SCRAPPINGS ON THE SHARP CORNERS OF THE ROCK. THERE IS NO INDICATION OF LAYERING OR PREFERRED FRACTURE PLANS FROM THE POSITION OBSERVED.
THE COLOR IS DARK GREY OVERALL WITH LIGHT PATCHES SHOWING THROUGH THE DUST.
NO MODE CAN BE DETERMINED YET. BUT THE DARK MINERALS APPEAR TO BE MORE ABUNDANT THAN THE LIGHT. A FEW GREENISH GRAINS (OLIVINE) APPEAR ON THE SURFACE. THIS VIEW IS WITH THE ROCK IN THE SAME POSITION AS IN THE PHOTOS.
COLOR. SPECKLED LIGHT GRAY WITH A BROWNISH GREENISH CAST.
TEXTURE. VERY VUGGY. COALESCED VUGS AS MUCH AS 1 CM IN DIAMETER. THUS MAKING THIS SPECIMEN EXCELLENT FOR CRYSTALLINE STUDY. HOLOCRYSTALLINE GRANULAR.
ABUNDANCE OF FRACTURES IS MINOR.

SAMPLE NO. 12022.0   WEIGHT 1864.3 GR   DIMENSIONS 14 CM X 9.5 CM X 7 CM   HARMON
THIS ROCK HAS A BLOCKY SHAPE (THAT OF AN IRREGULAR PYRAMID. THE COLOR IS A MEDIUM GREY WHERE THE SURFACE IS COVERED WITH DUST. BUT AREAS OF A LIGHTER GREY AND WHITE ARE SCATTERED OVER THE SURFACE OF THE ROCK WHERE THE DUST IS NOT PRESENT AND DARKER WHERE FRESH SURFACES ARE EXPOSED BELOW THE SURFACE OF THE ROCK. THE ROCK IS CRYSTALLINE AND OF A MEDIUM FINE GRAIN SIZE. THE ROCK SHOWS NO FRACTURING TO THE UNAIDED EYE OR THROUGH THE STEREO MICROSCOPE EXCEPT THAT ONE CORNER OF THE ROCK HAS BEEN BROKEN OFF. NUMEROUS MICROMETEORITE IMPACT PITS ARE PRESENT ON ALL SURFACES OF THE ROCK. THE FRACTURED SURFACE HAVING FEWER THAN OTHER SURFACES. THESE PITS ARE ALMOST ALWAYS GLASS LINED. BUT SOME GLASS WAS OBSERVED ON THE SURFACE OF THE ROCK. NO MINERALOGY IS READILY IDENTIFIABLE BY BINOCULAR MICROSCOPE EXAMINATION OF THE SAMPLE OTHER THAN PERHAPS A FELDSPAR (WHITE LATH SHAPED MINERAL). SOME OLIVINE (LIGHT GREEN. EQUANT GRAINS). AND AND A MINERAL WITH A GREY METALLIC LUSTER. IN ONE SPOT ON THE SURFACE AN EQUANT BROWN GRAIN (1/4 MM) IS PRESENT ALL ALONE ON THE SURFACE OF THE ROCK. IT APPEARS TO BE GLASS. BUT MAY BE THE HONEY BROWN MINERAL SEEN IN SOME APOLLO 11 ROCKS. THE SURFACE OF THE ROCK TO DEPTH OF ABOUT 1 MILLIMETER APPEARS TO BE A SHATTER CRUST AS THE AREAS WHERE WHITE AND LIGHT APPEAR (AREAS OF NO DUST). THESE GRAINS ARE HIGHLY BROKEN UP. THE INTERIOR OF THE ROCK GENERALLY APPEARS TO BE QUITE DARK BELOW THIS SHATTER CRUST / A DARK GREY/GREEN.

SAMPLE NO. 12022.1   POST SPLIT F201 DESCRIPTION   WARNER
WEIGHT. ABOUT 5 GRAMS   DIMENSIONS. 1 X 3 X 2   PCTL CHIP

OLIVINE (PHENOCRYSTS)	15 PERCENT	3 MM
ILMENITE (PLATES)	3 PERCENT	1 X .2 MM
PYROXENE	35 PERCENT	.2 MM
PLAGIOCLASE	45 PERCENT	.1 MM

SAMPLE NO. 12022   CHIP   CHAO
WEIGHT 3.9 GRAMS   DIMENSIONS ABOUT 2 X 1.5 X (.4 - .8) CM
GENERAL APPEARANCE - A CHIP OF MEDIUM GRAY FINE-GRAINED HOLOCRYSTALLINE ROCK WITH A BROWNISH PURPLISH TINGE. SLIGHTLY VUGGY. TRUE VESICLES NOT PRESENT ON CHIP.

TEXTURE AND GRAIN SIZE - SLIGHTLY PORPHYRITIC. PROBABLY SIMILAR TO 12065. CHECK NEEDED FROM THIN SECTION. EXCEPT OLIVINE THE GRAIN SIZE IS AVERAGE ABOUT 0.3 MM.

MINERALS - MEGASCOPIC

1. PINKISH BROWN. PURPLISH BROWN CLINOPYROXENE. ABUNDANT. 50 + PIGEONITIC NOT AS WELL ZONED AS OTHER PORPHYRITIC TYPE (SEE THIS SECTION).
2. GLASSY CRYSTAL. RECTANGULAR OR LATH-SHAPED. PLAGIOCLASE.
3. GREENISH YELLOW. VITREOUS LUSTER OLIVINE. ABOUT 20 PERCENT. SLIGHTLY BIGGER IN GRAIN SIZE THAN OTHERS.
4. PLATY ILMENITE - EQUAL TO OR LESS THAN 10 PERCENT. NOT EASILY SEEN.
5. CUBIC HABIT OPAQUES ALSO PRESENT.

GRAIN MOUNT -

OLIVINE - BIAX. (-). LARGE 2V. N GREATER THAN 1.696 OK.

PLAGIOCLASE OK.

CLINOPYROXENE FINELY INTERGROWN WITH ILMENITE AND SOME PLAGIOCLASE. TYPICAL COLOR. GRAINS TOO FINE FOR GOOD FIGURES.

OLIVINE RICH. PORPHYRITIC. (VARIOLITIC TEXTURE) BASALT. (FAIR AMOUNT OF ILMENITE) LOOKS LIKE AN OLIVINE BASALT OR A PICRITE BASALT.

SAMPLE NO. 12022 COVERED THIN SECTION IN 64-7998 CHAO

PORPHYRITIC (GROUNDMASS VARIOLITIC. BLADED. FAN PATTERNED).

GRAIN SIZE - WINE INTENSE BROWN CLINCPYROXENE 0.3 X .8 MM.
OLIVINE (CLEAR) - UP TO 1.2 X 2.0 MM. MOSTLY 0.2 X 0.35 MM.
PLAGIOCLASE - ONLY IN GROUNDMASS - LATHS. SOME SMALLER AVERAGE 15 X 50 MICRO UNITS.

MINERALOGY -

1. WINE BROWN CLINOPYROXENE - 2V ABOUT 35 DEGREES TO 40 DEGREES BIAX. (+) SUBCALCIC AUGITE (QUESTION). PHENOCRYSTS CHECKED ONLY. SIMPLE TWIN. NOT OBVIOUSLY ZONED ABOUT 25 PERCENT.
2. OLIVINE - PHENOCRYSTS BIAX. (-). 2V ABOUT 85 DEGREES TO 90 DEGREES WITH ROUND DROPLETS OF GLASSY INCLUSIONS (FINELY CRYSTALLIZED) - LIQUID TRAPPED BY THE CRYSTALLING OLIVINE. ABOUT 25 PERCENT.
3. ILMENITE THIN PLATES CROSS CUTS BLADED GROUNDMASS (THUS THEY ARE PROBABLY NEEDLES). SKELETAL HABIT COMMON.
4. GROUNDMASS -BOOKS OR PACKS OF ALTERNATING PRISMATIC CLINOPYROXENE AND PLAGIOCLASE FELDSPAR. MORE PRISMATIC THAN PLATY. ABOUT 50-50. TOTAL GROUNDMASS 50 PERCENT.

SHOCK - NO EVIDENCE OF SHOCK.

REMARKS - MODAL COMPOSITION YET TO BE MEASURED. THE CRUDE ESTIMATES GIVEN SUGGEST THAT THE ROCK MAY BE CLASSIFIED AS A PICRITE BASALT WITH A PORPHYRITIC. VARIOLITIC (QUESTION) TEXTURE.

MODAL ANALYSIS OF ROCK 12022

REFLECTED AND TRANSMITTED ILLUMINATION WERE USED TO COMPLETE A MODAL ANALYSIS ON THE POLISHED THIN SECTION 12022.6.

USING TRANSMITTED LIGHT. A TOTAL OF 1.723 POINTS WERE COUNTED ON A GRID OF 0.3 MILLIMETER. WITH A TOTAL MAGNIFICATION OF 200X. THE FOLLOWING IS A SUMMATION OF THE MINERALS AND THEIR VOLUME PERCENTAGES.

OLIVINE	29.3
CLINO-PYROXENE	26.8
PLAGIOCLASE	22.7
OPAQUE MINERALS	21.2

USING REFLECTED LIGHT. A TOTAL OF 1.298 POINTS WERE COUNTED ON A GRID 0.3 MILLIMETER. A TOTAL MAGNIFICATION OF 250X WAS USED FOR OBSERVATION. THE USE OF REFLECTED LIGHT ALLOWS THE DIFFERENTIATION OF THE OPAQUE MINERALS AND THEIR PERCENTAGES AS FOLLOWS.

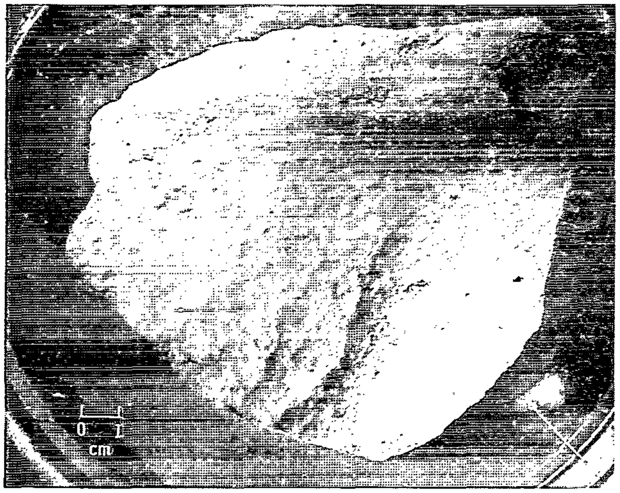
ILMENITE	9.1
SPINEL	2.0
NATIVE IRON	.5
TROILITE	.2
TRANSPARENTS	88.2

IT IS QUITE NOTICEABLE THAT THE OPAQUE MINERALS OBSERVED BY TRANSMITTED LIGHT ARE ABOUT TWICE THE PERCENTAGE OBSERVED USING REFLECTED LIGHT. SINCE BOUNDARIES OF OPAQUE MINERALS IN THE PLANE OF THE ANALYSIS CANNOT BE ACCURATELY DETERMINED BY THE USE OF TRANSMITTED LIGHT. THE TRANSMITTED VALUE MUST BE CORRECTED. THEREFORE. THE VALUE FOR THE IDENTIFIED OPAQUE MINERALS BY REFLECTED LIGHT MUST BE SUBSTITUTED FOR THE TRANSMITTED OPAQUE VALUE.
THE CORRECTED MODAL ANALYSIS FOR ROCK 12022 IS AS FOLLOWS.

TRANSPARENTS	PERCENT
OLIVINE	32.8
PYROXENE	29.9
PLAGIOCLASE	25.5
OPAQUES	
ILMENITE	9.1
SPINEL	2.0
NATIVE IRON	.5
TROILITE	.2

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS



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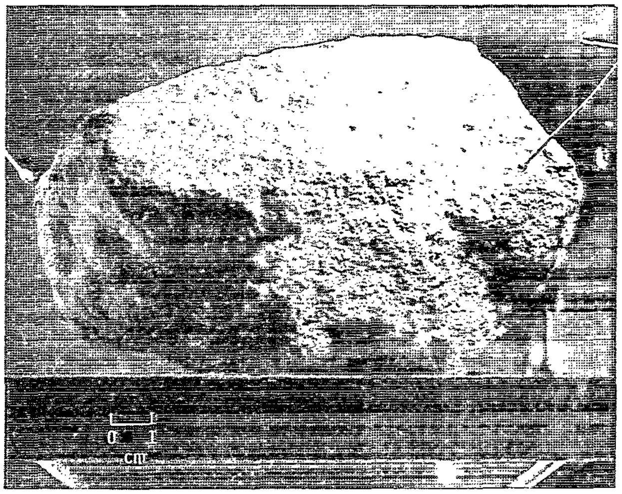

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Figure A-20. - Sample 12022.

SAMPLE NO. 12023 WEIGHT 269.3 GRAMS
LUNAR ENVIRONMENT SAMPLE - STORED IN VACUUM IN F201.

SAMPLE 12024

SAMPLE NO. 12024 WEIGHT 101.4 GRAMS HARMON
GAS ANALYSIS SAMPLE CONTAINER. FILLED ON THE LUNAR SURFACE AND OPENED IN THE GAS ANALYSIS LABORATORY. NOW STORED IN AIR-CONTENTS WERE FINES AND SMALL ROCKS /MAINLY GLASS COATED BRECCIAS).

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

TOTAL CARBON ANALYSIS

SAMPLES 12025, 12026, 12027, AND 12028

Four drive-tube core samples were collected from three localities and returned by the Apollo 12 crew. The location of the core-tube samples is shown in figure 3. The second and third core tubes were screwed together in a successful attempt to penetrate a light-colored layer underneath a dark layer. The first three core tubes were opened, described, and dissected to provide samples for biological and physical analyses. The fourth core tube remains in storage.

The Apollo 12 core samples differ from those collected at the Sea of Tranquility in that they have easily recognizable stratigraphy and two coherent crustlike layers; otherwise, they resemble the Apollo 11 cores in their dominantly fine-grained textures and loose consistency; in their restricted range of medium-gray colors and fresh unoxidized appearance; and in their abundance of glass, including some spherules. As in the case of sediment from the Apollo 11 cores, dissection of the Apollo 12 cores produced weakly coherent ephemeral structures ranging from fine subrounded crumblike units 1 to 2 millimeters in diameter to subangular blocky or occasional angular units with maximum dimensions of 5 millimeters. The coherence throughout most of the sediment was sufficiently adequate to permit careful dissection of small 1-centimeter-high vertical faces before slumping occurred.

All cores opened were broken by fine fracture planes, usually transverse to the core tube. Where such fractures coincide with changes in the character of the sediment, they are interpreted as bedding planes. Other more complex fracture zones not coinciding with morphological changes may be shear fractures produced when the drive tubes were rotated as the samples were collected.

The core collected on the first EVA is 19.3 centimeters long and is uniformly medium to dark gray. The stratification is shown clearly in the abrupt change in the abundance of rock fragments and glass particles larger than 1 millimeter below a transverse fracture at a depth of 5.9 centimeters. This stratification also is reflected by changes in the mean grain size with depth (fig. A-21). Because of the coherence of the fine particles, reliable mechanical analyses below 0.062 to 0.031 millimeter could not be obtained. Coarse material larger than 2.00 millimeters could not be analyzed because of the limited sample size.

The three mechanical analyses (fig. A-21) of the first core are similar to those of the Apollo 11 cores. The slope of the cumulative curves, and thus the sorting, is very similar for all three samples; however, successively deeper samples are progressively coarser. The median grain size changes from 0.062 millimeter for the surface sample to 0.074 millimeter for the middle sample and 0.11 millimeter for the deepest sample.

Stratification and morphological changes are most evident in the double-tube core sample collected at Halo Crater. The entire lower tube (32 centimeters) and 9.3 centimeters of the upper tube were filled with sediment. At least 10 layers or horizons have been recognized. The most distinctive of these units is a coarse layer of angular rock fragments, minerals, and glass that is comprised mostly of olivine grains and olivine-rich gabbros. The fourth mechanical analysis (fig. A-21) is of this coarse layer. The slope of the cumulative grain-size curve, and thus the sorting, is similar to the fines material but displaces markedly towards the coarse end of the graph. Extrapolating to the 50 percentile, the median grain size is approximately 4.9 millimeters.

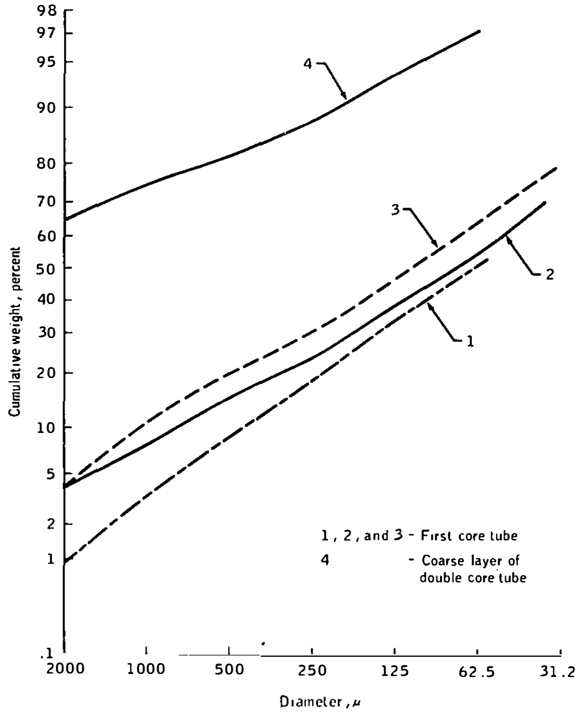

Figure A-21. - Mechanical analyses of first core tube and of coarse layer of double core tube.

The sharp contact with the fines material above and below the coarse layer and the lack of fines and the log-normal distribution of the coarse layer suggest that the layer is of primary-impact origin. The gradual increase in grain size with depth shown by the three analyses from the first core also suggests that the grain size of the debris has decreased because of reworking, probably by successive impacts.

Other units found in the deep core include a fine-textured zone of lighter medium-gray material, a zone of mixed incoherent light- and medium-gray sediments, and, at the base of the core, a layer of much lighter gray material. This lowermost layer is similar in appearance to sample 12033.

Both the coarse layer and a medium-gray 2-centimeter-thick layer (collected just below the surface at the Halo Crater site) have a friable consistency unlike any Apollo 11 core materials. Coarse particles larger than 1 millimeter in both layers may be strongly bonded aggregates that are indigenous to the layers rather than admixed fragments.

The first division of the Apollo 12 core tubes is shown in table A-I. Core-tube samples 12028 and 12026 are shown in figure A-22; core-tube samples 12025 and 12028 are shown in figure A-23. An X-ray radiograph of core-tube sample 12027 is shown in figure A-24.

TABLE A-I. - FIRST DIVISION OF CORE-TUBE SAMPLES

Sample number	Weight, g	Depth below surface, cm	Sample number	Weight, g	Depth below surface, cm
12025-14	1.19	0 to 0.4	12028-29	2.25	25.4 to 26.1
12025-13	1.83	.4 to 1.2	12028-30	2.50	26.1 to 26.9
12025-12	1.33	1.2 to 1.7	12028-31	2.56	26.9 to 27.8
12025-11	2.28	1.7 to 2.5	12028-32	3.22	27.8 to 28.8
12025-10	2.16	2.5 to 3.3	12028-33	3.00	28.8 to 30.0
12025-9	2.72	3.3 to 4.0	12028-34	1.87	30.0 to 30.6
12025-8	2.62	4 to 5	12028-35	1.16	30.6 to 31.2
12025-7	2.66	5 to 6	12028-36	2.95	31.2 to 32.2
12025-6	3.02	6 to 7	12028-37	2.86	32.2 to 33.2
12025-5	2.49	7 to 8	12028-38	2.45	33.2 to 34.2
12025-4	2.54	8 to 9	12028-39	2.82	34.2 to 35.2
12025-3	.70	9.0 to 9.4	12028-40	2.21	35.2 to 36.2
12028-11	1.37	9.4 to 11.0	12028-41	1.51	36.2 to 36.7
12028-12	1.53	11 to 12.0	12028-42	1.0	36.7 to 37.2
12028-13	2.29	12.0 to 12.8	12028-43	2.44	37.2 to 38.2
12028-14	1.20	12.8 to 13.2	12028-44	2.84	38.2 to 39.2
12028-16	3.27	13.2 to 14.4	12028-45	1.0	39.2 to 39.8
12028-17	3.09	14.4 to 15.4	12028-46	1.82	39.8 to 40.0
12028-18	2.42	15.4 to 16.4	12028-6	.009	16.2
12028-19	2.74	16.4 to 17.4	12028-7	.019	18.2
12028-20	2.49	17.4 to 18.4	12028-8	.049	14.4
12028-21	2.41	18.4 to 18.9	12028-10	.029	13.4
12028-22	1.68	18.9 to 19.7	12028-2	.170	11.0
12028-23	3.04	19.7 to 20.8	12028-3	.149	16.8
12028-24	2.86	20.8 to 21.8	12028-4	.119	22.0
12028-25	2.19	21.8 to 22.5	12028-5	.170	33.6
12028-26	2.87	22.5 to 23.5	12028-15	.13	13.3
12028-27	2.63	23.5 to 24.5	12025-1	.12	8.0
12028-28	2.38	24.5 to 25.4	12025-2	.11	1.9

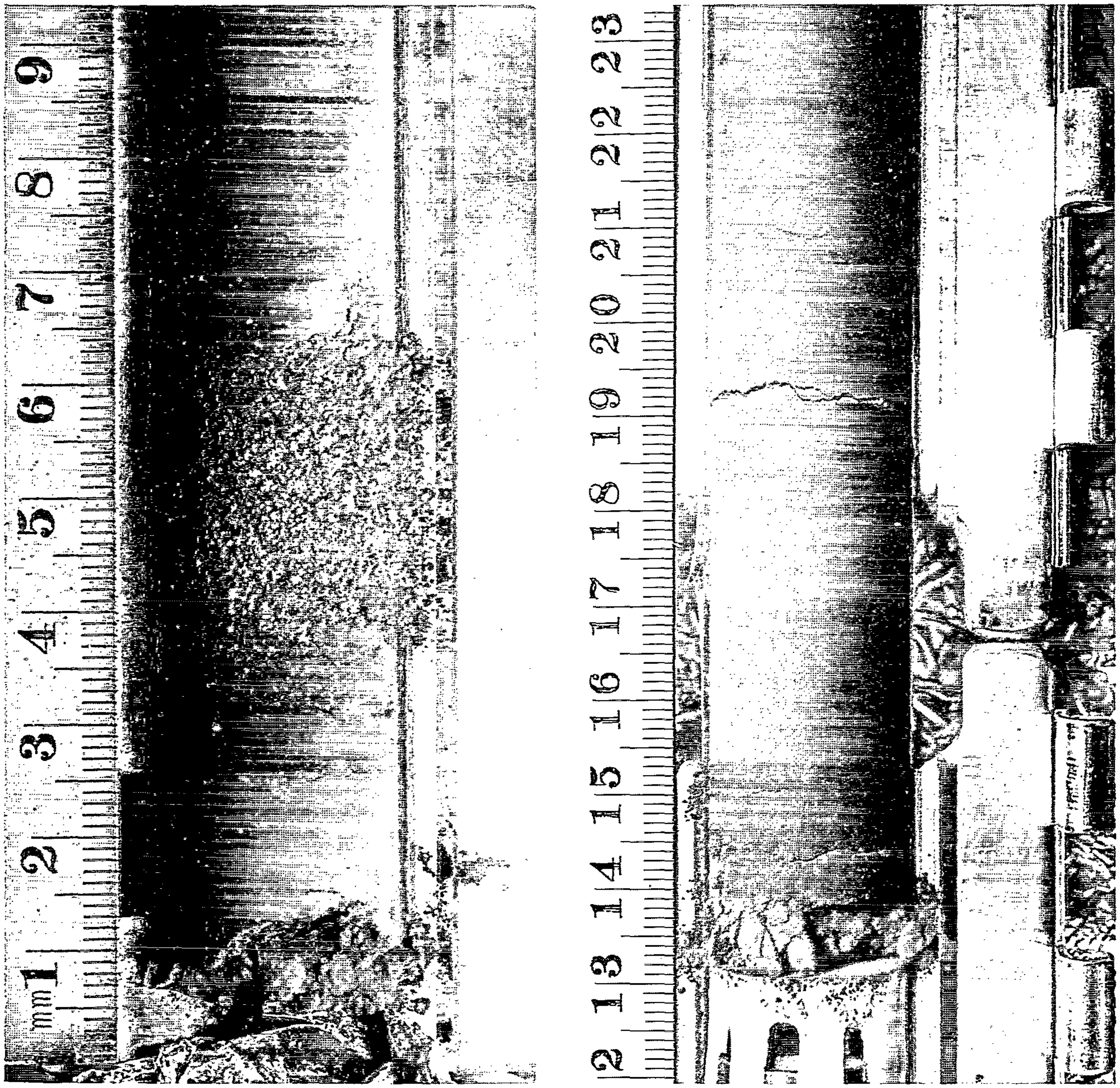

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Figure A-22. - Core-tube samples 12028 and 12026.

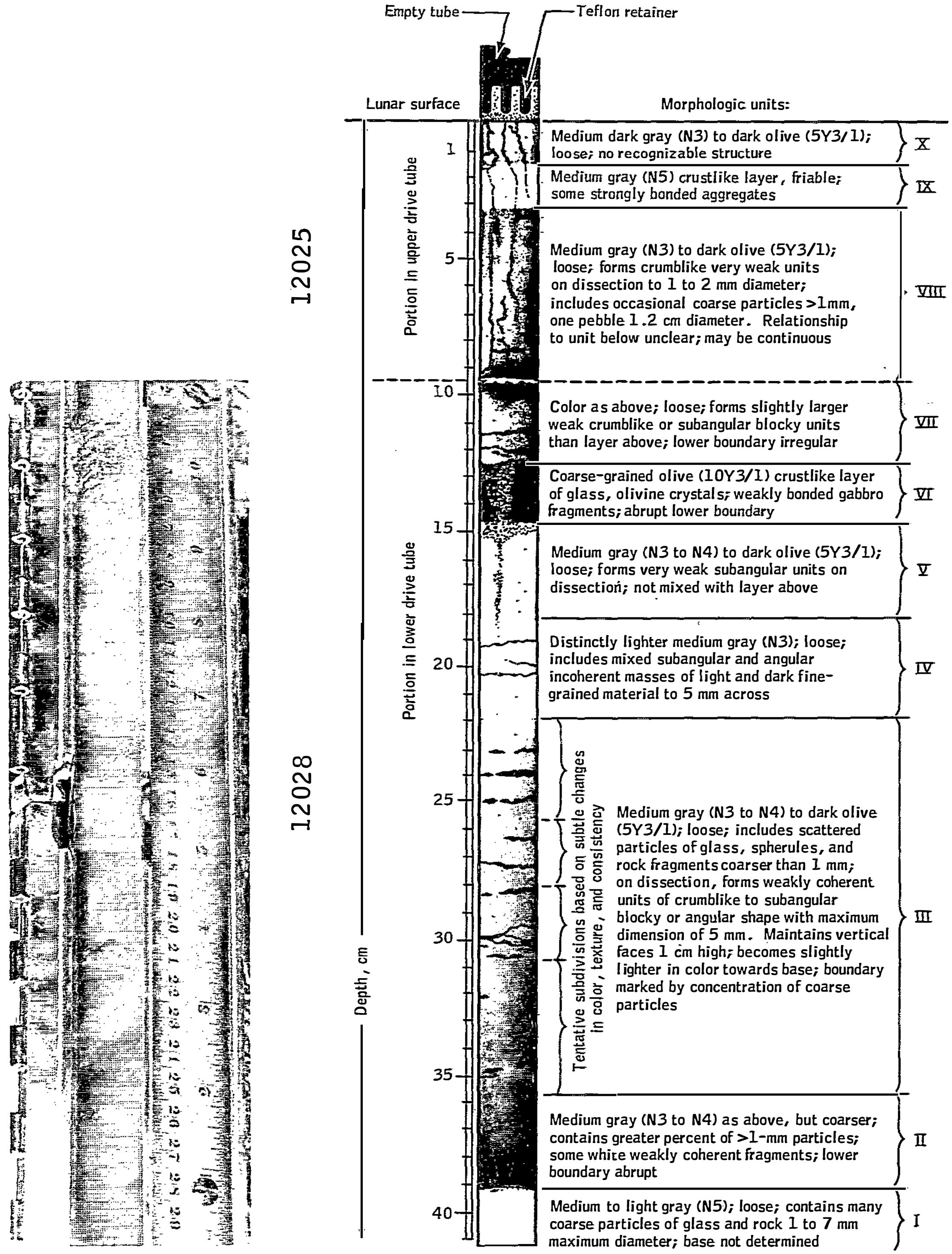

Figure A-23.- Core-tube samples 12025 and 12028.

Figure A-24. - X-ray radiograph of sample 12027 illustrating some of the internal structure.

SAMPLE 12030

SAMPLE NO. 12030   80.9 GM.   WARNER
FIELD SAMPLE NO. 1-D
SAMPLE CONSISTS OF FINES PLUS A FEW CHIPS.
ONE CHIP ITSELF CONSISTS OF MICROBRECCIA FRAGMENTS, EACH 1-2 CM.
THESE CHIPS ARE CEMENTED TOGETHER BY BEING STUCK IN A THICK GLASS LAYER

SAMPLE NO. 12030   WEIGHT 80.9 G (+ BAG). 1 D FINES.   HEIKEN
WELDED GLASSY SPUTTER. EXTREMELY IRREGULAR CLUMPS WHICH ARE WELDED TO THE SURFACE OF A HIGHLY SHATTERED FINE GRAINED BRECCIA. COLOR IS A DARK BROWNISH BLACK. GLASS COATING IS ALMOST 1 CM THICK IN SOME PLACES. HOLDING THE SHATTERED BRECCIA TOGETHER ARE HIGHLY VESICULAR, WITH VESICLES FROM .1 TO 1 MM IN DIAMETER. MANY VESICLES ARE BROKEN OPEN TO THE SURFACE. IT APPEARS TO HAVE BEEN THROWN ONTO AN EXTREMELY IRREGULAR SURFACE, IN THAT IT FILLS DEEP CRACKS COVERS PROTRUDANCES. IT APPEARS THAT THE CONTACT BETWEEN THE GLASS AND BRECCIA IS SHARP WITH NO OBVIOUS THERMAL EFFECTS. DEEPER INTO SOME CRACKS, EXPOSED TO EDGES ARE SMALL OVOID DROPLETS OF GLASS ADHERING TO THE SURFACE. WHERE CRACKED OPEN, THE INTERIOR OF THE GLASS COATING IS HIGHLY VESICULAR, WITH AVERAGE VESICLE SIZE INCREASING FROM BASE TO SURFACE. SOME OF THE EXTREMELY SMOOTH, GLASSY SURFACE IS MARKED BY IMPACT PITS, 0.1 MM IN DIAMETER. EXTREMELY SMALL CRACKS EXTEND OUT FROM PIT CENTERS.
BRECCIA. MEDIUM LIGHT GRAY, CONSISTS OF A FEW HOLOCRYSTALLINE ROCK FRAGMENTS PLUS SOME BLACK GLASSY FRAGMENTS IN A MATRIX OF VERY FINE GRAINED OLIVINE, PYROXENE AND CRYSTALS AND GLASSY GRAINS. THE ROCK IS TIGHTLY COMPACTED DOES NOT CRUMPLE EASILY. A FEW GLASS SPHERES SCATTERED THROUGH ROCK. FRAGMENTS UP TO 4 CM LONG.

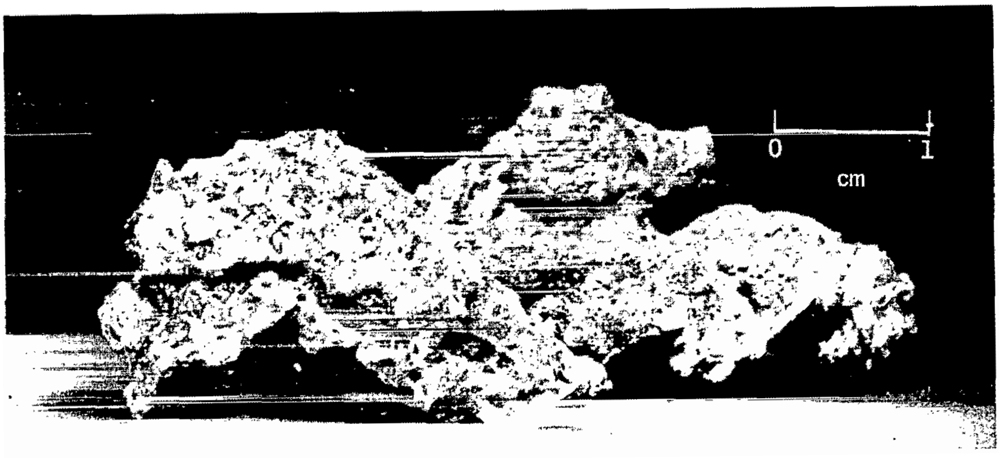

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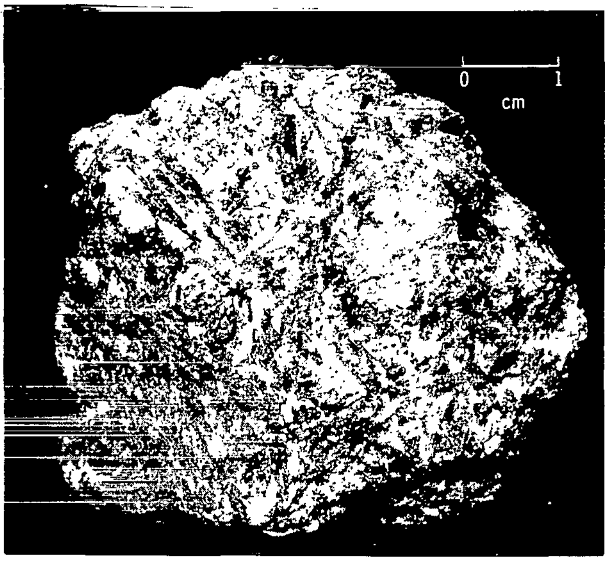
Figure A-25. - Sample 12030.

SAMPLE NO. 12031 WEIGHT 185 G DIMENSIONS 5.5 X 5 X 5 CM HEIKEN
BLOCKY. EQUANT SUBANGULAR ROCK. BROWNISH GRAY. COARSE GRAINED HOLOCRYSTALLINE TEXTURE. DISTINCT ORIENTATION OF FELDSPAR LATHS. POSSIBLY FLOW STRUCTURE SMALL IRREGULAR FRACTURE WHERE PIECES ARE ABOUT TO SPALL OFF ON BOTTOM SIDE. THERE IS A SMALL SYSTEM OF AXIALITIC STRUCTURE CONSISTING OF ABUNDANT FELDSPAR AND PYROXENE QUITE DIFFERENT FROM ORIENTATION ON TOP. NO VESICLES OR VUGS. A FEW TINY SURFACE PITS. LINED WITH BLACK GLASS LESS THAN 1/2 MM IN DIAMETER. ANY SURFACE FEATURES THAT MAY HAVE BEEN PRESENT HAVE PROBABLY CRUMBLED OFF IN TRANSIT. ONE VUG APPROXIMATELY 1 MM WIDE SLIGHTLY OFF CENTERED ACROSS THE ROCK LINED WITH GOOD FELDSPAR AND PYROXENE CRYSTALS GROWING PARALLEL TO THE WALL. THE ORIENTED FELDSPAR CRYSTALS INTERSECT THIS VUG AT APPROXIMATELY 30 DEGREES.
FELDSPAR. MILKY WHITE LATHS UP TO 12 MM LONG. THEY ARE PRETTY BADLY SHATTERED. MANY INCLUSIONS OF THE DARK MINERAL INTO THE FELDSPAR APPROXIMATELY 65 PERCENT OF ROCK.
PYROXENE. REDDISH BROWN. AN TO SUBHEDRAL CRYSTALS. ELONGATE AND ENCLOSE OLIVINE CORES UP TO 8 MM LONG AND 12 MM WIDE. APPROXIMATELY 15 PERCENT OF ROCK. APPROXIMATELY 1 MM DIAMETER OCCUR IN CLUSTERS ALWAYS ASSOCIATED WITH PYROXENE.
OLIVINE 10 PERCENT. ANHEDRAL CRYSTALS MOSTLY EQUANT. SOME ELONGATE. EQUANT
ILMENITE 10 PERCENT. BLADE LIKE CRYSTALS UP TO 3 MM LONG. SOME CONCAVE OF ILMENITE CLOSE TO VUGS. ALSO SOME HELD AS INCLUSIONS IN FELDSPAR.
COARSE GRAINED DIABASE.

SAMPLE NO. 12031 WEIGHT 185.0 DIMENSIONS 5 X 5 X 4.5 BAG 3 D CHAO
HOLOCRYSTALLINE. SPECKLED GRAY. COARSE GRAINED CRYSTALLINE ROCK. ROUGHLY CUBIC SHAPED. GLASS LINED PIT SURROUNDED BY MILKY WHITE HALO. PROBABLY CRUSHED FELDSPAR OCCUR ON SURFACE WITH PATCHES OF DUST. (PITS ARE APPROXIMATELY .7 MM).
TEXTURE. SLIGHTLY VUGGY. VUGS APPROXIMATELY .7 MM DIAMETER. WIDELY SCATTERED. TEXTURE IS CHARACTERIZED BY LONG RADIATING CRYSTALS PRINCIPALLY PYROXENE WITH MIXTURES OF FELDSPAR AND PYROXENE FILLING THE INTERSTICES BETWEEN LONG BLADED CRYSTALS OPHYTIC.
APPROXIMATELY 35 PERCENT MINERAL PIGEONITIC CLINOPYROXENE. OCCURS AS ZONED LONG PRISMATIC CRYSTALS AS MUCH AS 2.5 CM LONG AND 1.5 MM WIDE. PRISMS. THESE PRISMS CONSIST OF A CORE OF WHITE PLAGIOCLASE FELDSPAR WITH RIM OF GREEN YELLOW PIGEONITE WHICH IS BORDERED BY DARK CINNAMON AUGITIC CLINOPYROXENE. THESE PRISMS SHOW DISTINCT PARTING AT STEEP ANGLES TO THE ELONGATION.
THE INTERSTICIAL MINS CONSIST OF CLEAR TO WHITE PLAGIOCLASE (30 PERCENT) WITH VITREOUS LUSTER. INTERGROWN WITH CINNAMON BROWN AUGITE CLINOPYROXENE APPROXIMATELY 20 PERCENT.
ILMENITE OCCURS AS BLACK GRAINS APPROXIMATELY .7 MM ACROSS WITH VERY METALLIC LUSTER. ASSOCIATED WITH INTERSTICIAL FELDSPAR AND CLINOPYROXENE USUALLY IN PLATY HABITS APPROXIMATELY 10 PERCENT.
MODAL COMPOSITION SHOULD BE ESTIMATED AND CHECKED BY T.S.
LIGHT BUFF COLORED FINE GRAIN MINERAL WHICH COULD BE TRIDYMITE.
SOME EQUIGRANULAR YELLOW GRAINS SHOULD BE CHECKED FOR OLIVINE WITH A T.S.
FRACTURE. SEVERAL IRREGULAR COARSE FRACTURES CUT THRU THE ROCK GIVING IT A FRIABLE APPEARANCE.
SHOCK. EXCEPT LOCALLY ON THE SURFACE WHERE MILKY WHITE PATCHES OF CRUSHED FELDSPAR OCCUR THERE IS WEAK MEGASCOPIC EVIDENCE OF SHOCK PRESENT BY THE FINE FRACTURING OF MOST OF THE MINS PRESENT.
CAN BE REFERRED TO AS A GABBRO WITH CHARACTERISTIC BLADED AND FEATHERY COARSE PIGEONITIC CLINOPYROXENE.
COLOR. SPECKLED LIGHT GRAY WITH A BROWNISH GREENISH CAST.
TEXTURE - VERY VUGGY HOLOCRYSTALLINE GRANULAR ROCK
COALESCED VUGS AS MUCH AS 1 CM IN DIAMETER.



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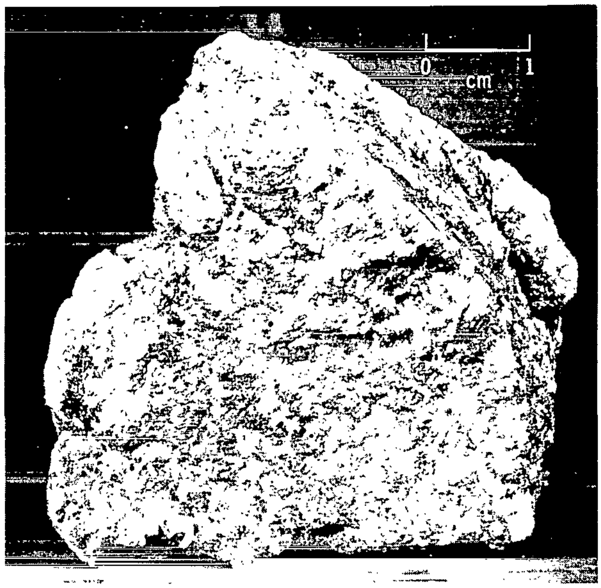

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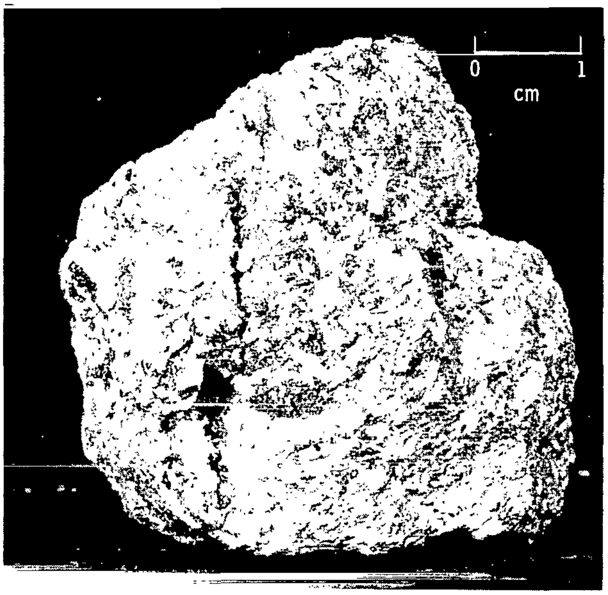

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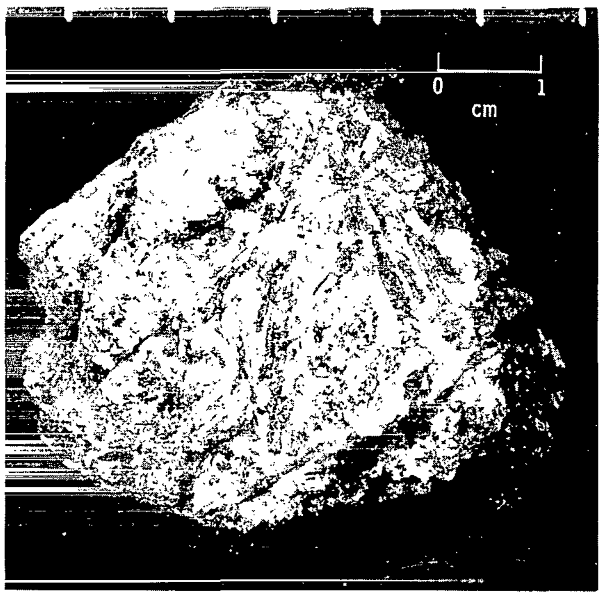

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Figure A-26. - Sample 12031.

SAMPLE 12032

SAMPLE NO. 12032 WEIGHT 310.59 G (+ BAG). FINES. 4 D. HEIKEN
MEDIUM DARK GRAY. POORLY SORTED. MOSTLY SANDY SILT SIZE MATERIAL. SOME ANGULAR FRAGMENTS UP TO 4 MM. LARGER FRAGMENTS INCLUDE FLAT PIECES OF GLASS (VESICULAR). POSSIBLY SPATTER. FINE GRAINED MATERIAL INCLUDES GRAINS OF OLIVINE. FELDSPAR. PYROXENE AND GLASS AND BRECCIA.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

TOTAL CARBON ANALYSIS

SAMPLE 12033

SAMPLE NO. 12033 FINES 5D HEIKEN
FINE GRAINED MATERIAL. MEDIUM GRAY (N5). MUCH LIGHTER THAN FINE GRAINED SOIL FROM ELSEWHERE AT THE SURVEYOR SITE. GRAIN SIZE. PEBBLE BEARING. SAND SILT. THERE ARE A NUMBER OF 1 MM TO 10 MM LONG ANGULAR AND SUBANGULAR ROCK FRAGMENTS IN THE SOIL SAMPLE (IDENTIFICATION NOT MADE DUE TO DUST COVERING). MOST FRAGMENTS APPEAR TO BE LESS THAN 0.05 MM IN DIAMETER. MODERATELY SORTED. APPEAR TO BE MOSTLY SMALL FELDSPAR AND PYROXENE CRYSTALS WITH MINOR AMOUNT OF GLASS. ARE SOME (LESS THAN 1 PERCENT) 1 MM DIAMETER OLIVINE CRYSTALS. SEVERAL OF THE LARGER FRAGMENTS PULLED OUT. ARE TWISTED. PUMICEOUS GLASS FRAGMENTS. DARK BROWN GLASS.

SAMPLE NO. 12033 HEIKEN
A PINCH STUDIED IN A DROP OF 1.515 R.I. IMMERSION OIL. IS A BIMODAL DISTRIBUTION AT THIS SCALE. ANGULAR FRAGMENTS OF DIAMETER OF 0.17 MM. (20 PERCENT) AND FRAGMENTS LESS THAN 0.02 MM.
THE COARSER MODE CONSISTS OF SHARP. ANGULAR SHARD-LIKE PIECES OF DARK RED-BROWN GLASS. THE GLASS CONTAINS MICROPHENOCRYSTS OF OLIVINE (QUESTION) AND MICROLETES. EMPHASIZING SOME FLOW STRUCTURE.
THE FINER MODE CONSISTS OF ANGULAR. EUHEDRAL TO SUBHEDRAL CRYSTALS. 0.025 TO 0.002 MM IN DIAMETER. IT CONSISTS OF APPROXIMATELY.-

1. 75 PERCENT FELDSPAR
2. 15 PERCENT OLIVINE AND PYROXENE
3. 10 PERCENT DARK BROWN GLASS AND OPAQUES.

GLASS FRAGMENTS ARE SUBROUNDED TO ANGULAR (ROUNDED ONES REWORKED OR ERODED IN AN ERUPTION CLOUD). ONE GLASS SPHERE WAS SEEN.
IS SIMILAR IN MANY RESPECTS TO HYALOCLASTIC GLASSES.
COARSEST FRACTION STUDIED EARLIER IN BIO PREP. CONSISTS OF 1 MM DIAMETER OLIVINE CRYSTALS AND MANY TWISTED. PUMICEOUS DARK BROWN GLASS FRAGMENTS. CONTAIN ELONGATE. PIPE-LIKE VESICLES AND SHOW ABUNDANT FLOW FEATURES.
DUE TO LACK OF ROCK FRAGMENTS. SHOCKED CRYSTALS AND TO THE PRESENCE OF PUMICEOUS AND SHARD-LIKE FRAGMENTS OF BASALTIC GLASS. THE SAMPLE APPEARS TO BE A CRYSTAL-VITRIC ASH OF VOLCANIC ORIGIN. THIS SAMPLE MAY BE THE SAME AS THE WHITE LAYER IN THE BOTTOM OF THE CORE TAKEN AT HALO CRATER.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
TOTAL CARBON ANALYSIS

SAMPLE 12034

SAMPLE 12034.0 DOCUMENTED SAMPLE 6 D DECEMBER 4. 1969 W. R. GREENWOOD
MEDIUM LIGHT GRAY MATRIX (A) OF FINE GRAINED MATERIAL INCLUDES CRYSTAL FRAGMENTS AND FRAGMENTS OF A NUMBER OF ROCK TYPES.
THERE IS A FAINT PREFERRED SHAPE ORIENTATION DEFINED BY THE ELONGATION OF TWO LARGE ROCK INCLUSIONS (UNIT B AND C).
MATRIX (A) INCLUDES CRYSTAL FRAGMENTS OF BLACK PYROXENE UP TO 7 MM WHICH ARE HIGHLY ANGULAR. THE LARGER PYROXENE CRYSTAL FRAGMENTS APPEAR TO HAVE A MUCH PREFERRED SHAPE ORIENTATION PARALLEL TO THE ELONGATION OF UNITS (B) AND (C). PYROXENE CRYSTALS COMPRISE 70 PERCENT OF THE CRYSTAL FRAGMENTS LARGER THAN .2 MM IN MATRIX (A). MILKY WHITE FELDSPAR MAKES UP THE REMAINING 30 PERCENT. IN THE SMALLER SIZES LESS THAN .2 MM FELDSPAR APPEARS TO MAKE UP A LARGER PERCENTAGE OF THE CRYSTAL FRAGMENTS. ABOUT 10 PERCENT OF THE ROCK IS MADE UP OF ROCK FRAGMENTS. ABOUT 20 PERCENT OF THE ROCK IS CRYSTAL FRAGMENTS GREATER THAN .2 MM.
UNIT (B) IS LIGHT GRAY WITH SHARP BUT SOMEWHAT SOFTENED BOUNDARIES WITH MATRIX (A). UNIT (B) HAS SOMEWHAT IRREGULAR PANCAKE SHAPE. UNIT (B) APPEARS TO BE COMPOSED OF WHITE FELDSPAR CRYSTAL FRAGMENTS LESS THAN .2 MM AND BLACK PYROXENE CRYSTAL FRAGMENTS UP TO 2.0 MM IN SIZE. THE PYROXENE CRYSTALS ARE ANGULAR. UNIT (B) APPEARS TO BE A WELDED FRAGMENTAL ROCK. THERE IS SUGGESTION OF ELONGATION OF PLAGIOCLASE SHARDS NEAR AND PARALLEL TO THE ELONGATE SIDE OF UNIT (B). UNIT (B) IS LOCATED AT ONE EDGE OF THE FRESH FACE OF THE ROCK AND IS 30 MM X 8 MM IN SECTIONS. WITH A FLATTENED PYRAMID SHAPE WITH ROUNDED CORNERS AND SOMEWHAT IRREGULAR BOUNDARIES . WHISPS OF THE SAME UNIT ARE FOUND NEAR AND PARALLEL TO UNIT (B) IN MATRIX (A).
UNIT (C) IS SLIGHTLY LIGHTER GRAY THAN MATRIX (A) BUT CONSIDERABLY DARKER THAN UNIT (B). UNIT (C) IS COMPOSED OF CRYSTAL FRAGMENTS (ABOUT 40 PERCENT) AND A MEDIUM GRAY MATRIX. THERE IS A IRREGULAR SHARP BOUNDARY BETWEEN UNIT (C) AND THE MATRIX (A). UNIT (C) IS LOCATED NEAR THE MIDDLE OF THE FRESH FACE. ONE FRAGMENT IS ABOUT 20 MM X 7 MM IN SECTIONS. A SMALLER FRAGMENT IS 10 MM X 5 MM ON THE SAME PLANE AS FRAGMENT (1). THESE TWO FRAGMENTS ARE SEPARATED BY A NARROW (6 MM) SIDE OF MATRIX (A).
UNIT (C) CRYSTAL FRAGMENTS ARE WHITE PLAGIOCLASE UP TO 1 MM. 90 PERCENT OF TOTAL FRAGMENTS. 10 PERCENT OF THE FRAGMENTS ARE BLACK PYROXENE UP TO 1 MM. UNIT (C) MAY BE A SHOCKED AND PARTIALLY MELTED ROCK ON AN OLDER BRECCIA. ADDITIONAL SMALLER FRAGMENTS OF UNIT (C) ARE LOCATED NEAR THE LAYER FRAGMENTS. THERE ARE TWO INTERSECTING FRACTURE SETS. ORIENTATION OF THE INCLUDED ROCK FRAGMENTS. THE FRACTURES ARE CLOSELY SPACED AND LOCALLY PRODUCE A STRONG CLEAVAGE . THE FRACTURE SETS INTERSECT AT ABOUT 40 DEGREES.
ONE OF THE FRACTURE PLANES IS PARALLEL OR NEARLY SO TO THE PREFERRED ORIENTATION OF INCLUDED ROCK FRAGMENTS IN THE ROCK.
THE ROCK IS NOT FRIABLE OR FRAGILE. NO GLASS BALLS OR FRAGMENTS WERE SEEN MEGASCOPICALLY. THE ROCK IS NOT MEGASCOPICALLY VESICULAR. ONE OF THE BROKEN FACES HAS A DARK LINEATED SURFACE THAT MAY BE A RELIC OF A SLICKENSIDED SURFACE.
SOME OLIVINE CRYSTALS LESS THAN 5 PERCENT OF TOTAL CRYSTAL FRAGMENTS IN MATRIX (A). ONE VERY SMALL FRAGMENT APPROXIMATELY 1 MM DIAMETER IS COMPOSED OF BLACK GLASS. SHATTERED OLIVINE. AND MILKY TO VITREOUS GLASS PLAGIOCLASE. THE FRAGMENT APPEARS TO BE PARTIALLY SHOCK MELTED.
UNIT (B) HAS A STREAMED OUT END BY FLOWING AND IN MATRIX IS A LINE PARALLEL TO THE BOUNDARY PRODUCED BY FLOWING. THERE IS PARTING PARALLEL TO THIS FLOW. IN UNIT (B). ONE OF THE SHATTERED FELDSPAR HAS A CORE OF TRANLUSCENT PLAGIOCLASE NO VITREOUS MATRIX WAS SEEN IN MATRIX (A) AT HIGHEST MAG APPROXIMATELY 100X. THE ROUNDED SIDE OF THE ROCK APPEARS TO HAVE A SUBVITREOUS SKIN OF ABOUT 1 TO 3 MM THICK (MEDIUM DARK GRAY) VESICULAR PARTIALLY CRYSTALLINE GLASS. THE GLASSY MATERIAL HAS A COATING OF LIGHT GRAY SOIL WHICH APPEARS BONDED ON. WHEN THIS SAMPLE WAS FIRST RETURNED THE COATING WAS ABOUT 1 TO 3 MM THICK. NOW ABOUT 1/2 TO 1 MM OF DUST COATS THIS SIDE. IT IS VERY DIFFICULT TO REMOVE.

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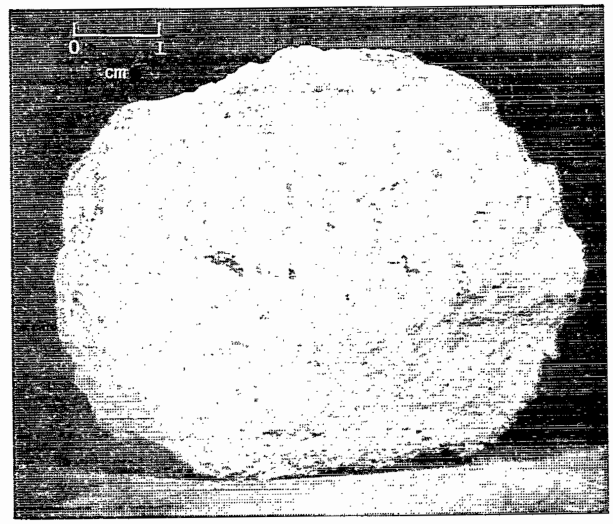

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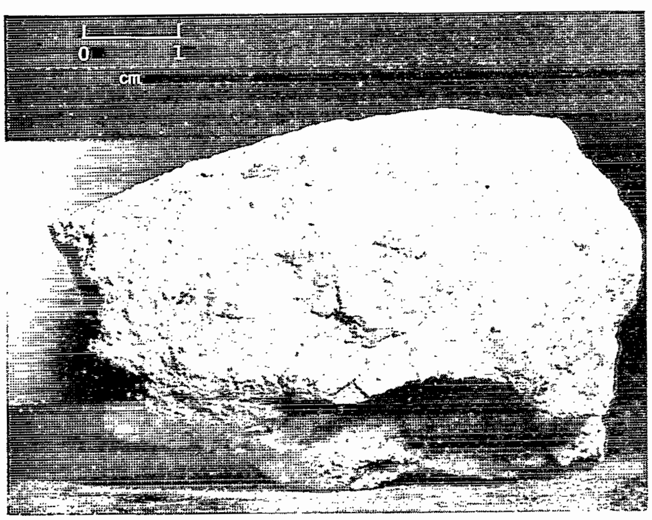

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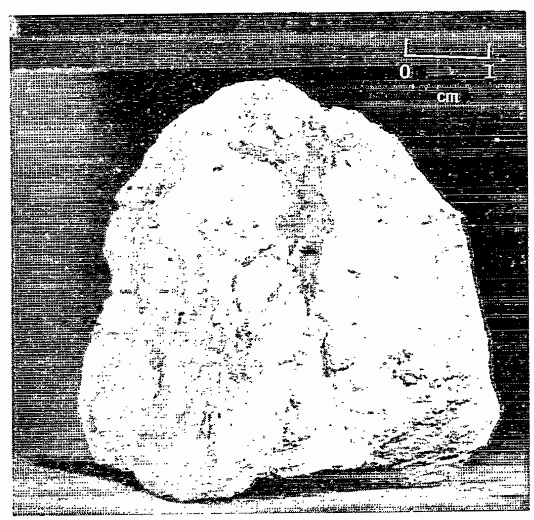

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Figure A-27. - Sample 12034.

DUST IS MORE EASILY REMOVED FROM THE FRESH BROKEN SIDES. THE GLASS COATING FOLLOWS THE ROUNDED TOPOGRAPHY OF THE ROCK EXTENDING DOWN INTO FRACTURES. VESICLES IN THE GLASS ARE ELONGATED PARALLEL TO THE SURFACE OF THE ROCK. AFTER FORMATION OF THIS ROCK BY WELDING OR SOME OTHER PROCESS IT WAS BLASTED TO THE SURFACE (DEVELOPING THE CLEAVAGES). ON THE SURFACE THE ROCK WAS ROUNDED. SUB SEQUENTLY IT WAS PARTIALLY COATED WITH MOLTEN ROCK MATERIAL . THE ROCK WAS SUBSEQUENTLY BROKEN AND DEPOSITED AT THAT TIME OR LATER IN THE LIGHT GRAY DUST LAYER.

SAMPLE NO. 12034 CHIP 1.5 X 0.75 X 0.5 CM ROBIN BRETT
BRECCIA. LIGHT GRAY IN COLOR COMPARED TO ALL APOLLO 11 BRECCIAS. GRAIN SIZE OF FINE MATRIX ABOUT 0.1 MM. ROCK CONSISTS OF 25 PERCENT FRAGMENTS UP TO 1 MM. SHAPE OF ROCK NO CONSEQUENCE AS IT IS A CHIP WITH NO OUTSIDE SURFACE. A FEW SMALL FRACTURES PRESENT. CLASSED IN ORDER OF ABUNDANCE ARE.

1. DARK ANGULAR GLASS FRAGMENTS SHOWING RARE CLASTS TO 0.2 MM OF GLASS OF DIFFERENT COMPOSITION. SHOCKED FELDSPAR. PYROXENE. RARE VESICLES IN GLASS.
2. SHOCKED ANGULAR TO SUBROUNDED PLAGIOCLASE GRAINS FROM MILKY WHITE TO VITREOUS.
3. BUFF TO CINNAMON BROWN ANGULAR PYROXENE GRAINS.
4. GREEN ANGULAR OLIVINE GRAINS. NO SPHERULES EVIDENT.

GRAIN MOUNT OF MATRIX SHOWS FOLLOWING ANGULAR GRAINS (IN ORDER OF ABUNDANCE)

1. PLAGIOCLASE. MOSTLY LIGHTLY SHOCKED UP TO THE THETAMORPHIC. SOME POLYSYNTHETIC TWINS.
2. PYROXENE . MAINLY SHOCKED.
3. ANGULAR OPAQUE GLASS FRAGMENTS.
4. ANGULAR ILMENITE.

HIGH PLAGIOCLASE CONTENT EXPLAINS LIGHT GRAY COLOR.
ROCK NAME. MICROBRECCIA.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

A-A CHEMICAL ANALYSIS
E-SPEC ANALYSIS
RARE GAS ANALYSIS
TOTAL CARBON ANALYSIS

SAMPLE 12035

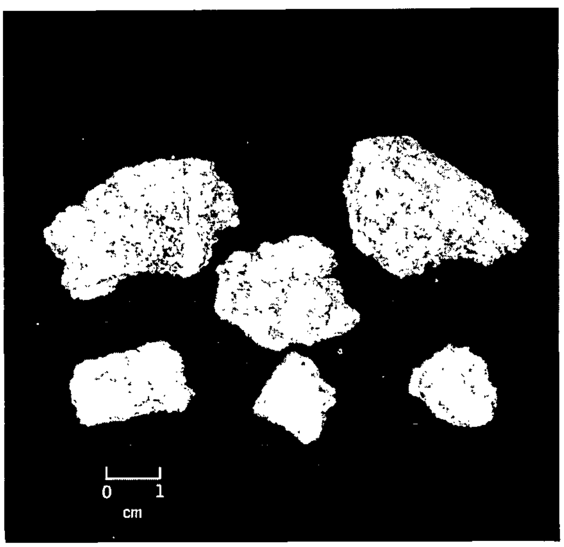
SAMPLE NO. 12035 DIMENSIONS 5 X 4 X 1.5 CM WONES
SHAPE. TRIAXIAL ELLIPSOID. NOW FRAGMENTED INTO 5 LARGE PIECES AND FINES.
SIZE OF FRAGMENTS. 1.5 X 2 X 4. 2 X 1.5 X 3. 1.5 X 1.5 X 1.5. 2 X 2 X 1.
1 X 1 X 0.5 CM.
COLOR. LIGHT OLIVE GRAY.
TEXTURE. COARSE. CUMULAR. HYPIDIOMORPHIC.
FABRIC. VUGGY. VUGS ARE IRREGULAR 4 MM OR MORE. NO ORIENTATION OR CLUSTERS.
FRACTURES ARE THRU GOING AND ABUNDANT. THE ROCK IS FRIABLE. NO OBSERVED ORIENTATION OF FRACTURES. SURFACE TEXTURES ALL APPEAR TO BE FRESH FRACTURED SURFACES.

OLIVINE 40 PERCENT EUHEDRAL. EQUANT. APPROXIMATELY 1 MM MEAN DIAMETER. CLEAR. GREEN. CONTAIN OPAQUE INCLUSIONS.

PLAGIOCLASE 45 PERCENT GLASSY. TWINNED. PRISMATIC. INTERSTITIAL WITH OLIVINE INTERGROWN WITH PYROXENE APPROXIMATELY 1 MM MEAN SIZE 2 TO 1 RATIO AVERAGE 1 X 1/2 MM.

PYROXENE 15 PERCENT PRISMATIC MAXIMUM 2.0 MM MOST .3 MM LONG. EQUANT EXCEPT IN VUGS ASICULAR IN RATIO OF 5 TO 1. HONEY BROWN COLOR.

OPAQUES LESS THAN 1 PERCENT. BLADED. LUSTROUS. TEND TO CONC. AROUND VUGS. BUT ARE PRESENT AS INCLUSIONS IN OLIVINE.
OLIVINE IS PRESENT IN VUGS. SEQUENCE OF CRYSTALLIZATION IS OPAQUES. OLIVINE. PLAGIOCLASE. PYROXENE ALL PERSIST IN TERMINAL CRYSTALLIZATION. NO ALTERATION OBSERVED.
ROCK NAME TROCTOLITE



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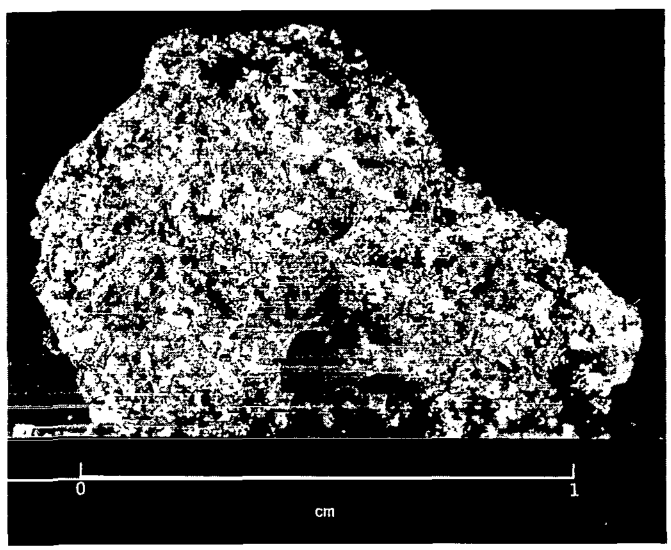

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Figure A-28. - Sample 12035.

SAMPLE NO. 12036 WEIGHT 75 G DIMENSIONS 6 X 3.5 X 2.3 CM CHAO
FROM BAG 8 D.
MINERALOGY. THIS ROCK CONSISTS OF ABUNDANT GRAYISH YELLOW EUHEDRAL TO GRANULAR CRYSTALS OF OLIVINE IN A MATRIX OF INTERGROWN FELDSPAR AND BROWN PYROXENE AND SOME OCTAHEDRAL SPINEL.

1. OLIVINE. 40 PERCENT. FORMS EUHEDRAL CRYSTALS UP TO 2 TO 2 MM ACROSS WITH WELL DEVELOPED CRYSTALLINE FACES PARTICULARLY THOSE IN THE VUGS. THESE CRYSTALS USUALLY CONTAIN DARK BLACK REFLECTING CRYSTALS SOME OF WHICH SHOW OCTAHEDRAL HABIT. SPINEL. FROM CHROMITE OR MAGNETITE.

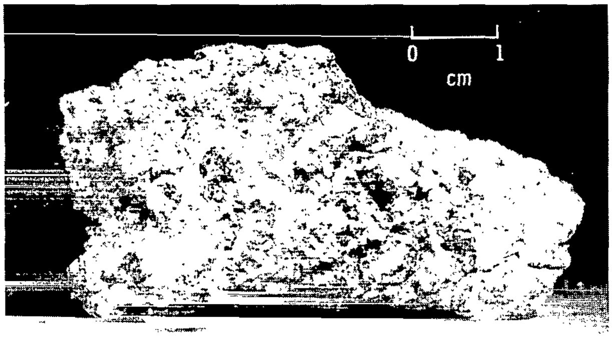
2. PLAGIOCLASE FELDSPAR. 40 PERCENT. OCCURS AS GRANULAR IRREGULAR PATCHES. CLOSELY INTERGROWN WITH OLIVINE AND BROWN PYROXENE UP TO 2.5 MM AVERAGING APPROXIMATELY 1.0 MM.

3. CINNAMON BROWN CLINOPYROXENE. 15 PERCENT. PROBALBY PIGEONITIC. FORMS STUBBY PRISMATIC CRYSTALS NEAR VUGS OR LARGE CRYSTALS THAT ARE POIKILITIC. SUGGESTING LATE CRYSTALIZATION. ALSO OCCURS AS FINE GRAINS INTERGROWN WITH FELDSPARS.

4. OPAQUE MINERALS APPROXIMATELY 5 PERCENT. SOME DARK MINERALS WITH METALLIC LUSTER. USUALLY FINE GRAINED (LESS THAN 1 MM) MAY BE ILMENITE (VERY SMALL AMOUNT) WIDE SPREAD ARE SMALL GRAINS OF EQUIGRANULAR OPAQUE. WHICH ARE PROBABLY SAME AS OCTAHEDRAL CRYSTALS AS OF SPINEL GRAINED GROUP.

SHOCK. NO MEGASCOPIC CLEAR EVIDENCE OF SHOCK.
ROCK NAME. A GABBRO OR A PIGEONITIC TROCTOLITE.

SAMPLE NO. 12036 WEIGHT 75 G DIMENSIONS 6 X 3.5 X 3.5 HEIKEN
ELONGATE. VERY IRREGULAR SHAPE. SUBANGULAR. MEDIUM GRAINED HOLOCRYSTALLINE ROCK. EXTREMELY VUGGY. VUGS MAKE UP APPROXIMATELY 15 PERCENT OF VOLUME OF ROCK. VERY CRUDE ORIENTATION OF VUGS PARALLEL TO LONG AXIS OF ROCK. NEAR EDGES. VUGS ARE FROM 0.5 TO 4.0 MM IN DIAMETER . SOME FRACTURES EXTENDING OUT FROM VUGS. ON OTHER SIDE IS ONE GOOD FLAT SURFACE (FRACTURED) AND HAS DUST ADHERING TO IT. NO VISIBLE PITS OR SPLASHES.
CLEAR GREENISH YELLOW OLIVINE SUB TO EUHEDRAL CRYSTALS 1 TO 3 MM DIAMETER. APPROXIMATELY 40 PERCENT.
FELDSPAR SUB TO EUHEDRAL CRYSTALS FROM 0.5 TO 2.0 MM LONG. MOST ARE COLORLESS EXCELLENT TWINNING APPROXIMATELY 25 PERCENT.
PYROXENE. REDDISH BROWN TO DARK REDDISH BROWN APPROXIMATELY 25 PERCENT. FROM 2 TO 5 MM SUBHEDRAL CRYSTALS PRISMATIC CRYSTALS. BLADED ILMENITE CRYSTALS UP TO 3 MM LONG 10 PERCENT. IN VUGS CRYSTALS ARE EXCELLENT WITH GOOD CRYSTAL FACES.



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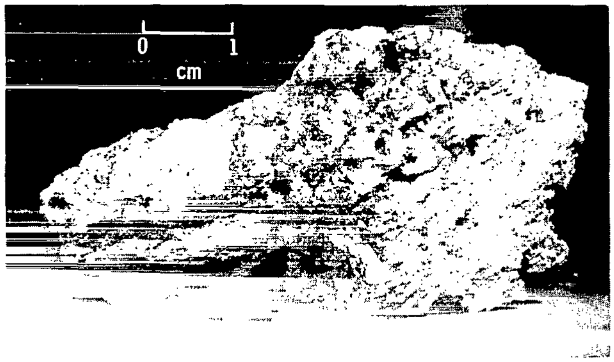

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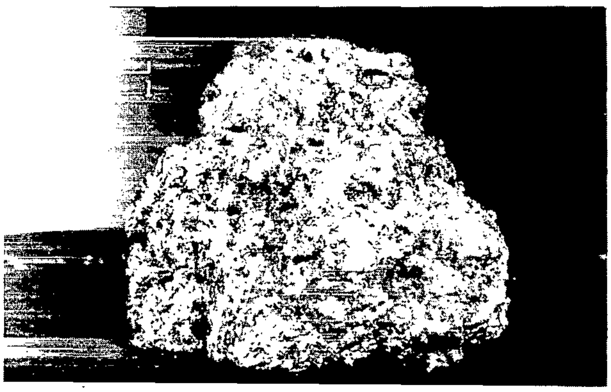

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Figure A-29. - Sample 12036.

SAMPLE 12037

SAMPLE NO. 12037 WEIGHT 145.0 GRAMS 8 D FINES HEIKEN
DARK GRAY. VERY POORLY SORTED. A GRANULE SANDY SILT SIZED MATERIAL. MOST GRANULES CONSIST OF .

1. SUBANGULAR FRAGMENTS OF COMPRESSED MATERIAL. THESE BLASTA ARE UP TO 8 MM LONG.
2. SUBANGULAR FRAGMENTS OF MEDIUM GRAINED HOLOCRYSTALLINE GABBROS UP TO 4 MM DIAMETER. SOME 1 MM GRAINS OF OLIVINE.
3. FINE GRAINED MATERIAL CONSISTS OF FELDSPAR, PYROXENE AND POSSIBLY GLASS.

THE MATERIAL CLUMPS QUITE EASILY AND CLINGS TO S.S. SURFACES.

SAMPLE 12038

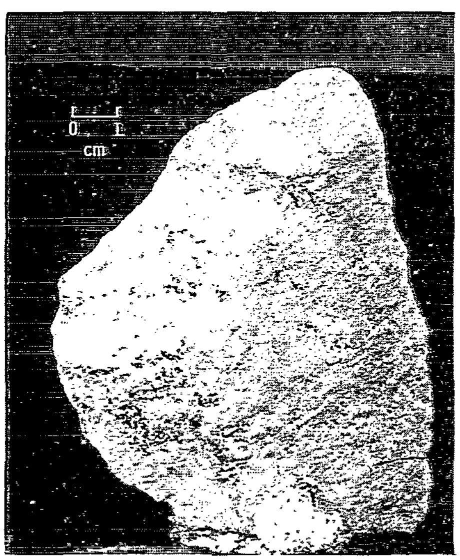
SAMPLE NO. 12038 DIMENSIONS 12.5 X 7.5 X 5.5 WEIGHT 746 GM LINDSAY
THE UPPER SURFACE WAS HORIZONTAL WHICH MEANS THE LONG AXIS WAS DIPPING APPROXIMATELY 5 DEGREES. SUBANGULAR. ROUGHLY TRIANGULAR. BURNED WITH APEX DOWNWARD ROUGHLY ONLY 2 CM OF ROCK WAS ABOVE SURFACE. ROCK IS BELOW SURFACE N5 MEDIUM GRAY. ABOVE N4 MEDIUM DARK GREY. VUGS. MORE NUMEROUS ON LUNA BOTTOM. FINE TO MEDIUM GRAINED ROCK. EQUIGRANULAR. NOTHING APPARENT CONCERNING LINEATIONS. NO VESICLES BUT CRYSTAL LINED VUGS. MOST ARE LINED WITH ACICULAR CRYSTALS OF PYROXENE. SLAB LIKE FRACTURES. ONE FRACTURE PARALLEL TO TABULAR SURFACE. THE TOP IS MORE ROUNDED AND WEATHERED WHILE THAT BELOW IS MORE ANGULAR MEDIUM CRYSTALLINE ROCK - CRYSTALS ARE 0.4 TO 0.6 MM LONG.
APPROXIMATE MODES.
50 PERCENT FELDSPAR
40 PERCENT PYROXENE
10 PERCENT OLIVINE
ILMENITE IN VUGS ASICULAR. SOME TABULAR FELDSPAR IN VUGS.
FELDSPAR ELONGATED ACICULAR OR TABULAR. PYROXENE AND OLIVENE ARE EQUANT EXCEPT IN VUGS WHERE PYROXENE IS ACICULAR

SAMPLE NO. 12038.2 THIN SECTION
MODE

PLAGIOCLASE	40 O/O
PYROXENE	50 O/O
OPAQUE	5 O/O
CRISTOBALITE	5 O/O

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
TOTAL CARBON ANALYSIS



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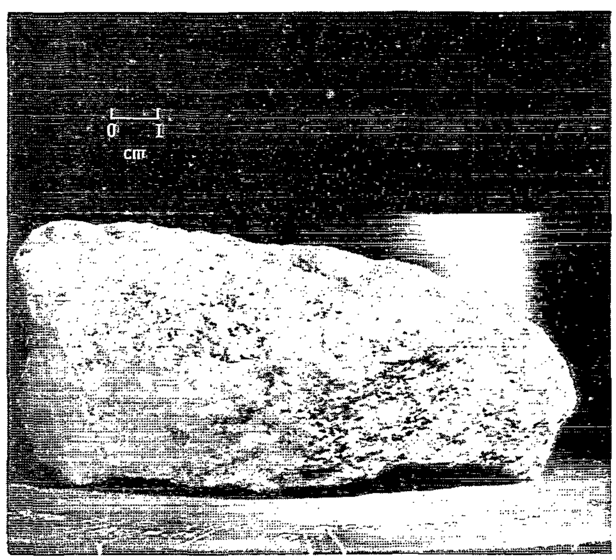

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Figure A-30. - Sample 12038.

SAMPLE 12039

SAMPLE NO. 12039 DIMENSIONS 6.3 X 4.5 X 4 CM LINDSAY
SUBANGULAR TO SUBROUNDED. GRAY WITH MOD. PROP. OF LT MINS. EQUIGRANULAR TEXTURE. A FEW SMALL VUGS. UNFRACTURED. VERY FEW SURFACE PITS.
APPROXIMATE MODES. OLIVINE APPROXIMATELY 20 PERCENT
FELDSPAR APPROXIMATELY 60 PERCENT
PYROXENE 15 PERCENT
ILMENITE BLADES 5 PERCENT.
OLIVINE EQUANT UP TO 1 MM. FELDSPAR TABULAR RATIO 5 TO 1 UP TO 4 MM LENGTH.
PYROXENE FORMS AGGREGATES UP TO 5 MM ACROSS.
FINE GRAINED GABBROIC ROCK.

SAMPLE NO 12039 DIMENSIONS 6 X 7 X 4 CM MORRISON
ANGULAR TO SUBROUNDED CRYSTALLINE ROCK. DUSTY GRAY IN COLOR. EQUIGRANULAR TEXTURE. NO VESICLES BUT SOME VUGS. VUGS ARE FEW AND SCATTERED. ONE WELDED FRACTURE PARALLEL TO ONE SIDE. NO GLASS SPLASHES. SOME GLASS LINED. SURFACE PITS. BUT THEY ARE FEW. NORMAL SHAPE LESS THAN 1 MM. FEWER THAN 1/59 CM
APPROXIMATE MODES.
FELDSPAR 40 PERCENT
DARK BROWN PYROXENE AND LIGHT PYROXENE 50 PERCENT
OPAQUES 5 TO 10 PERCENT
NO OLIVINE.
TERRESTRIAL ANALOGUE. PYROXENE GABBRO.

SAMPLE NO. 12039 IN DOCUMENTED BAG 10-D CHAO
DIMENSIONS ABOUT 6 X 7 X 4 CM TRIANGULAR PYRAMIDAL SHAPE

GENERAL APPEARANCE - THIS IS A SPECKLED MEDIUM GRAY COARSE-GRAINED PORPHYRITIC HOLOCRYSTALLINE ROCK. WITH A GREENISH. YELLOWISH BROWN TINGE.

TEXTURE AND GRAIN SIZE - DISTINCTLY PORPHYRITIC. VARIOLITIC (QUESTION) GROUNDMASS. AND VUGGY. PHENOCRYSTS OF CLINOPYROXENE 2 MM X ABOUT 1 CM. GROUNDMASS AVERAGE ABOUT 0.5 MM. UP TO 0.8 MM.

MINERALOGY -

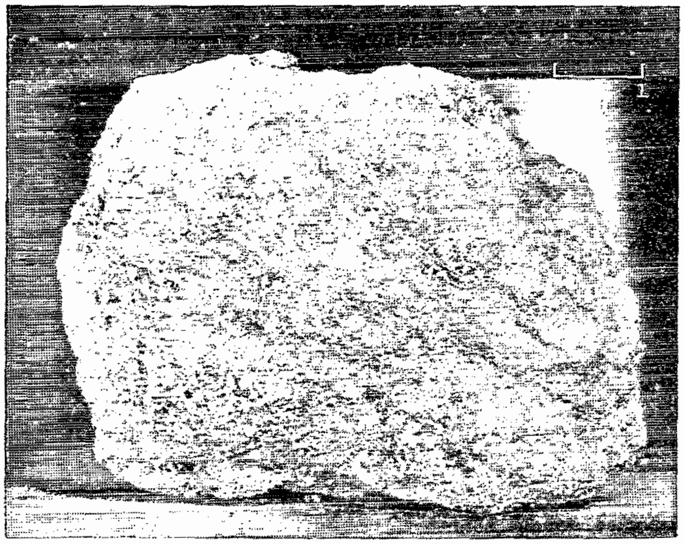
1. ZONED PHENOCRYSTS OF CLINOPYROXENE CONSISTING OF AN INNER GREENISH YELLOW CORE OF PIGEONITIC PYROXENE. RIMMED BY A THIN MARGINAL ZONE OF PURPLISH BROWN CALCIC AUGITE. ABOUT 10 PERCENT.
2. GROUNDMASS - ABOUT 90 PERCENT.
   PLAGIOCLASE 40 PERCENT
   CLINOPYROXENE 30 PERCENT
   OLIVINE 20 PERCENT

GRANULAR CLEAR TO WHITE PLAGIOCLASE AND PURPLISH BROWN SUBCALCIC AUGITIC (QUESTION) CLINOPYROXENE.

3. OLIVINE - THESE ARE GREENISH YELLOW CLEAR CRYSTALS WITHOUT BASAL PARTING. CHECK THIN SECTION. SINCE THIS IS DIFFICULT TO DETERMINE MEGASCOPICALLY THESE GREENISH YELLOW GRAINS ARE HOWEVER NOT ZONED. SIDE BY SIDE THE OLIVINE IS MORE GRAYISH IN COLOR. (SEE GROUNDMASS) LESS THAN 5 PERCENT.
4. OPAQUES - LARGELY IN SMALL SPECKS 0.1 MM WIDELY SCATTERED AND AS INCLUSIONS. ABOUT ILMENITE GREATER THAN 5 PERCENT.

SHOCK - NO MEGASCOPIC EVIDENCE OF SHOCK.

REMARKS - THIS ROCK IS SIMILAR IN TEXTURE AS 12065. AND IS MEDIUM OR INTERMEDIATE IN GRAIN SIZE BETWEEN 12065 AND 12021.



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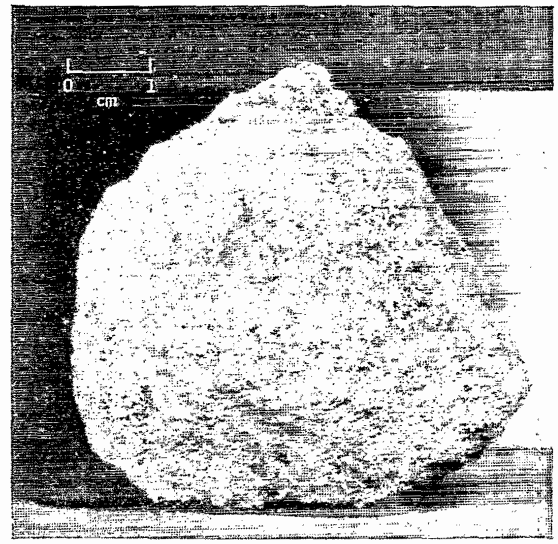

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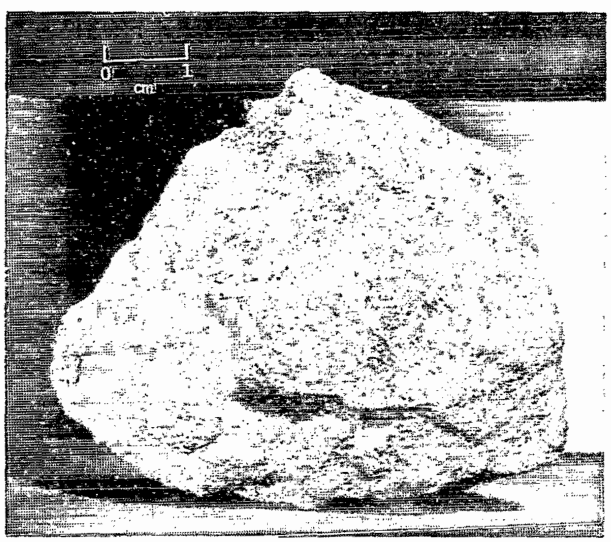

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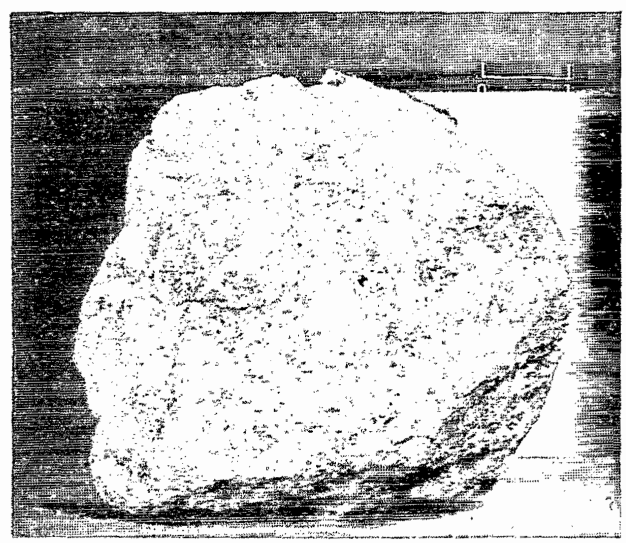

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Figure A-31. - Sample 12039.

SAMPLE 12040

SAMPLE NO. 12040 DIMENSIONS 6.5 X 5.5 X 6.5 LINDSAY
EQUANT SHAPE. LIGHT GRAY WITH SLIGHT GREENISH TINGE DUE TO OLIVINE. EQUI-GRANULAR TEXTURE. NO VESICLES. BUT A NUMBER OF VUGS UP TO 5 MM IN WIDTH AND 1 1/2 CM LONG. WEAKLY ORIENTED. VUGS ARE LINED WITH EUHEDRAL CRYSTALS MOSTLY OLIVINE AND PYROXENE WITH A LITTLE FELDSPAR. APPROXIMATELY 6 FRACTURES RADIATE FROM A POINT. POSSIBLY A SHATTER CONE EFFECT. NO APPARENT SURFACE PITS.
APPROXIMATE MODES. OLIVINE 20 PERCENT
FELDSPAR 50 PERCENT
PYROXENE 30 PERCENT.
PYROXENE RIMS ON SOME OLIVINE CRYSTALS UP TO 5 MM.
OLIVINE EQUANT 1 MM
PYROXENE EQUANT 1.5 MM
SOME TABULAR PYROXENE

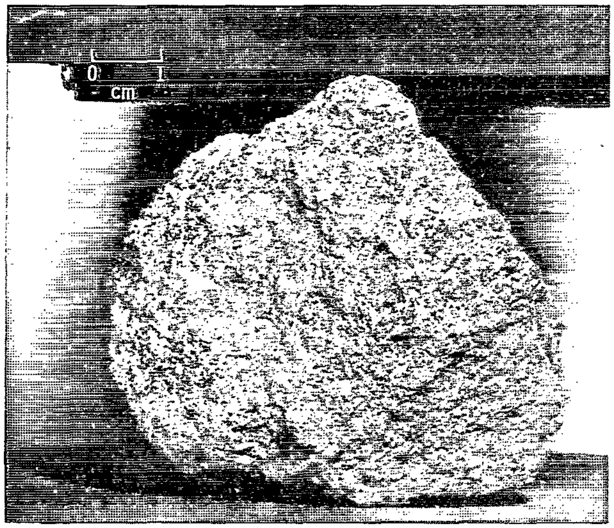
SAMPLE NO. 12040 DIMENSIONS 7 X 6.2 X 5.5 CM SUTTON
NEARLY EQUANT. ROUGHLY PYRAMIDAL . SUBANGULAR TO SUBROUNDED WITH RELATIVELY FLAT SIDES. MEDIUM GRAY N4 1/2. UNDER DIRECT CONE LIGHT APPEARS ONE CONE OF OLIVINE. OF DUSTY YELLOWISH GREEN 5GY 5/2 MOTTLED IN WITH GRAY.
ONE FLAT SIDE SHOWS COARSE CRYSTALS WITH CONE OF OLIVINE WITH VUGS COINCIDENT DEEPEST VUGS ARE APPROXIMATELY GREATER THAN 4 MM. OTHER SIDE IS MOST ROUNDED AND IS COVERED WITH MOST DUST. FEW VUGS ARE SEEN. ALL LESS THAN .2 MM.
MOD. HIGH CONE OF VUGS. SEVERAL CREAMY SPLOTCHY AREAS. POSSIBLY FELDSPAR ON ROADSIDE. ALL OCCUR IN ARE 1 1/2 X 2 CM. CRYSTALLINE NATURE CAN BE SEEN THRU SPLOTCHES. SEVERAL DEEP FRACTURES APPROXIMATELY 1 MM ACROSS TO 3 CM LONG. FRACTURES AND VUGS ARE ALL LINED WITH CRYSTALS. DO NOT APPEAR TO BE EXFOLIATION FRACTURES. RELATE MORE TO INTERNAL VUG ARRANGEMENTS. TENDS TO BE SLIGHTLY FRIABLE WITH CRYSTAL FRAGMENTS.
APPROXIMATE MODES. OLIVINE 35 PERCENT
PLAGIOCLASE 40 PERCENT
PYROXENE 25 PERCENT
OLIVINE YELLOWISH GREEN 1 TO 2 MM . VITREOUS LUSTER NEARLY EQUANT SUBHEDRAL. SEVERAL AGGREATES UP TO 3 MM.
PLAGIOCLASE STUBBY TO LATH SHAPED HABIT LESS THAN 1 MM TO 4 MM LONG. GENERAL AREA IDEALLY LATH SHAPED.
PYROXENE REDDISH GRAYISH BROWN IN STUBBY AND SEMILATH CRYSTALS UP TO 4 MM LONG.
TERRESTRIAL ANALOGUE. OLIVINE GABBRO MEDIUM TO COARSE GRAINED.

SAMPLE NO. 12040 SMITH
CRYSTALLINE ROCK FRAGMENTS CONSISTING OF SMALL FRIABLE CHIPS AND CRYSTAL GRAINS. THE LARGEST FRAGMENT WAS TAKEN FOR THIN SECTION. COLOR IS BROWNISH GEEEN SPECKLED WITH WHITE. TEXTURE IS MICROGABBROIC WITH A TENDENCY TOWARDS VUGGINESS.
ESTIMATED MODE IS.
- OLIVINE 40 PERCENT
- CLINOPYROXENE 30 PERCENT
- PLAGIOCLASE 25 PERCENT
- OPAQUES 5 PERCENT.

OLIVINE CRYSTALS AND CRYSTAL AGGREGATES UP TO 2.5 MM ARE POIKILITICALLY ENCLOSED BY LARGER CINNAMON BROWN CLINOPYROXENE CRYSTALS.
PLAGIOCLASE CONTAINS ABUNDANT MULTIPHASE INCLUSIONS.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

- A-A CHEMICAL ANALYSIS
- E-SPEC ANALYSIS
- TOTAL CARBON ANALYSIS
- RARE GAS ANALYSIS



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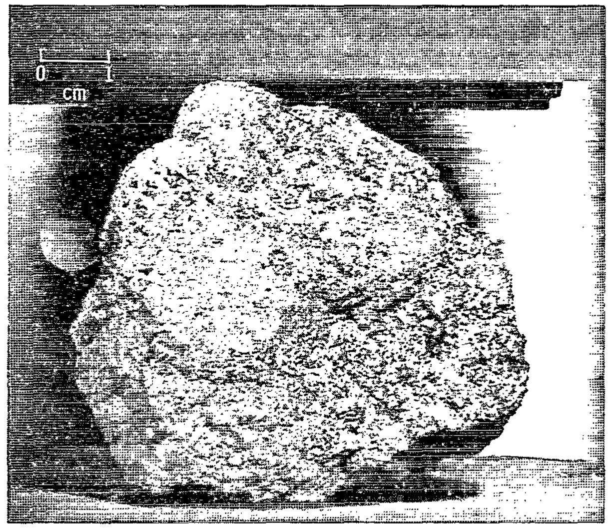

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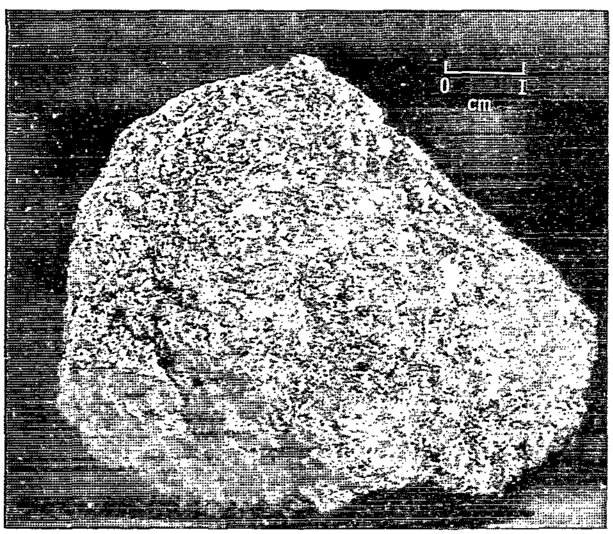

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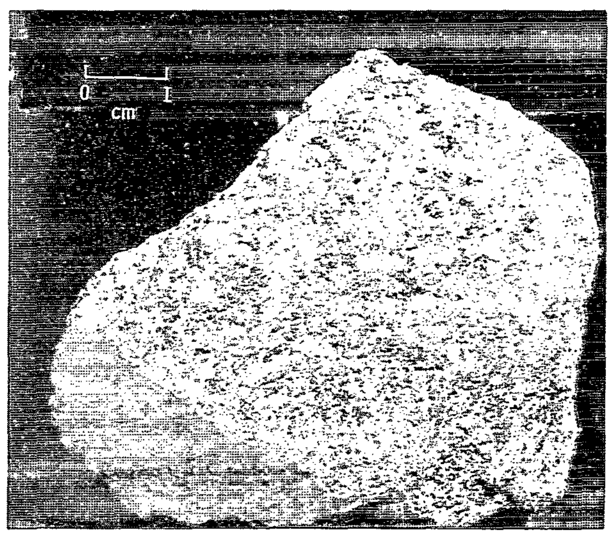

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Figure A-32. - Sample 12040.

SAMPLE 12042

SAMPLE NO. 12042 WEIGHT 225.57 GRAMS (+BAG) HEIKEN
12 D FINES. DARK GRAY. MODERATELY SORTED. FINE SAND SIZED. A LOT OF FELDSPAR GRAINS AND SOME OLIVINE AND SOME GLASS. NO FRAGMENTS GREATER THAN 0.2 MM VISIBLE IN THIS PARTICULAR SPLIT. E.
EXTREMELY COHESIVE. WHEN COMPACTED A VERTICAL WALL CUT INTO IT STANDS VERY EASILY. WHEN TOSSED ABOUT LOOSELY IT TENDS TO CLUMP IN CLUMPS APPROXIMATELY 1.0 MM IN DIAMETER.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

TOTAL CARBON ANALYSIS

SAMPLE NO. 12043.0 HEIKEN
SUBROUNDED. OVOID ROCK. ONE END HAS ANGULAR FRESHLY FRACTURED SURFACE. BLUISH GRAY. MEDIUM GRAINED HOLOCRYSTALLINE. VARIOLYTIC VESICULAR WITH SPHERICAL VESICLES UP TO 2 MM IN DIAMETER. VESICLES ARE APPROXIMATELY 10 PERCENT OF VOLUME. NO ORIENTATION OF VESICLES. ON ANGULAR SIDE ARE A NUMBER OF SMALL FRACTURES PARALLEL TO SURFACE. A HALF MM WIDE IMPACT PIT EVERY 25 MM. 4 PITS LESS THAN 0.2 MM IN DIAMETER IN THE SAME AREA. THE PITS ARE LINED WITH VERY THIN. TRANSPARENT LAYER OF GLASS WITH A BUBBLY SURFACE. SOME CRYSTALS CAN BE SEEN THROUGH GLASS. MANY PIT LININGS ARE RAISED SLIGHTLY ABOVE THE ROCK. AS IF THE ROCK AROUND HAS BEEN ERODED AWAY. EACH HAS A 0.4 MM WIDE WHITE CORONA OF CRUSHED MINERALS. ONE CORNER APPROXIMATELY 2 1/2 X 2 CM. IS COVERED WITH IRREGULAR SPLASHES OF BLACK GLASS LESS THAN 0.1 MM THICK. CONTAINS SEVERAL BLOBS OF GLASS WHICH HAVE BEEN WELDED TO SURFACE. ONE BLOB IS HIGHLY VESICULAR. VESICLES BEING APPROXIMATELY .05 MM IN DIAMETER. MUCH OF THE THIN GLASSY SURFACE IS IRREGULAR DUE TO BROKEN COALESCING VESICLES. SOME OF THIS GLASS IS ALSO SLIGHTLY RAISED ABOVE THE SURFACE OF THE ROCK. ONE LARGE VESICLE IS PARTLY COATED WITH GLASS SPLASH.

MINERAL NO. 1 MILKY WHITE FELDSPAR. EXHIBITS ALBITE TWINNING. CRYSTALS VARY FROM 0.5 TO 2.0 MM LONG MOSTLY THIN LATHS 45 PERCENT.

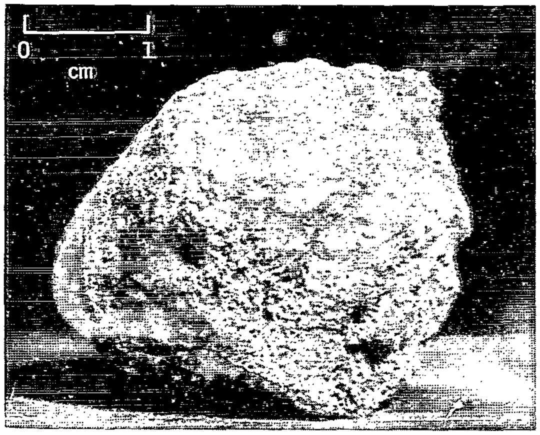
MINERAL NO. 2 GROWING PARALLEL TO FELDSPAR ARE REDDISH BROWN PYROXENE 0.5 TO 2.0 MM LONG. APPROXIMATELY 40 PERCENT.

MINERAL NO. 3 EQUANT 1 MM DIAMETER GRAINS OF PALE GREEN OLIVINE. APPROXIMATELY 5 PERCENT.

MINERAL NO. 4 ANHEDRAL. EQUANT CRYSTALS OF ILMENITE USUALLY LESS THAN 1 MM LONG. 10 PERCENT.

SOME VESICLES HAVE EUHEDRAL CRYSTALS OF PYROXENE AND FELDSPAR GROWING SUBPARALLEL TO WALLS. VARIOLYTIC DIABASE.

SAMPLE NO. 12043.0 DIMENSIONS 3.5 X 4.5 X 2.5 CM GREENWOOD
MEDIUM GRAY WITH LIGHT GRAY AROUND PITS. WELL ROUNDED. SOMEWHAT OF A LEVER SHAPE THAT HAS BEEN BROKEN ON MOON. THE OLD SURFACE IS PARTIALLY COATED WITH BLACK GLASS SPLASHES. NEAR BLACK GLASS SPLASHES AND RELATED IS A DULL BLACK COATING THAT CHIPPED AWAY. THE GLASS COATING IS ON THE OLDEST SURFACE AND FOLLOWS THE TOPOGRAPHY AROUND THE CORNER OF THE LENSE. THE OLD SURFACE IS VERY DENSELY PITTED WITH IMPACT PITS HAVING GLASS LININGS AND BRIGHT HALOES. THE BROKEN SURFACE ALSO HAS PITS WITH GLASS LININGS BUT THEY ARE NOT SO NUMEROUS. THE BROKEN SURFACE IS SUBANGULAR TO SUBROUNDED. THE CORNER THAT WAS FRESHLY CHIPPED IN LABORATORY IS DARK GRAY AND SHOWS BOTH VUGS AND SPHERICAL VESICLES. THE VUGS ARE CRYSTAL LINED. THE VESICLES ARE ALSO CRYSTAL LINED BUT HAVE A SMOOTHER SURFACE AND MAY HAVE SOME GLASS IN THE LINING. THE FRESH SURFACE HAS A ROUGH. HACKLY. FRACTURE. THE VUGS ARE ALIGNED ALONG ZONES. THE LINING OF IMPACT PITS IS CLEAR GLASS. CLEAR TO BROWN. HAS BOTRYOIDAL SURFACE. FELDSPAR AND PYROXENE LATHS RADIATE AWAY FROM OLIVINE CENTERS IN VARIOLITIC FORM. LATHS UP TO 3 MM LONG. OLIVINE ABOUT 1 MM DIAMETER. PYROXENE IS REDDISH BROWN. ABOUT 30 PERCENT OF ROCK. OLIVINE. YELLOW GREEN (10 PERCENT). ILMENITE. BLACK ADAMANTINE (15 PERCENT). FELDSPAR 45 PERCENT. HALVES PRODUCE BRIGHTENING IN ALL MINERALS.
OLDER SURFACE OF ROCK BRIGHTENED AND SHATTERED BY IMPACT PITS. ROCK IS NOT FRAGILE. CRYSTALS APPEAR TO BE ALIGNED AROUND SPHERICAL VESICLES AND PARALLEL TO VUGS. NO OBVIOUS LAYERING OR LINEATION. ONE FRAGMENT INCLUSION OF BRECCIA. IT WAS ANGULAR. CONTAINS A CLEAVAGE. IS QUITE FRIABLE. BUT IS A ROCK. VERY FINE GRAINED BUT PARTICULATE WELDED MATERIAL. MEDIUM BROWNISH GRAY. THE BOUNDARY BETWEEN BRECCIA AND ROCK IS VERY SHARP AND SMOOTH. IT IS POLYGONAL AND HAS SHARP CORNERS. THE MELT WAS ON THE SURFACE AND THE BRECCIA FELL INTO IT. SOME PYROXENE CRYSTALS ARE UP TO 5 MM LONG AND GIVE THE TEXTURE A PORPHYRITIC TEXTURE. OLIVINE BASALT.



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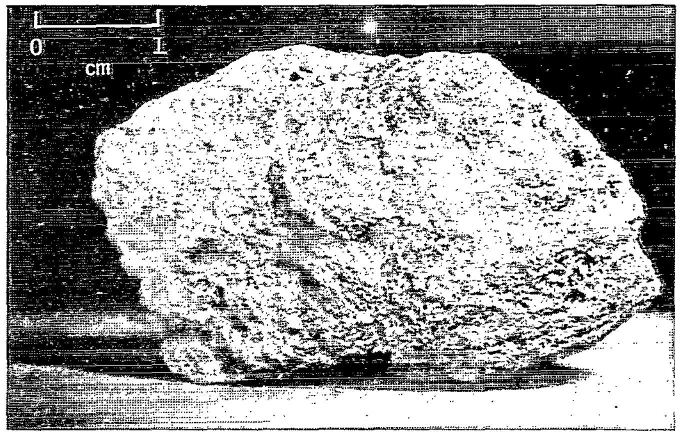

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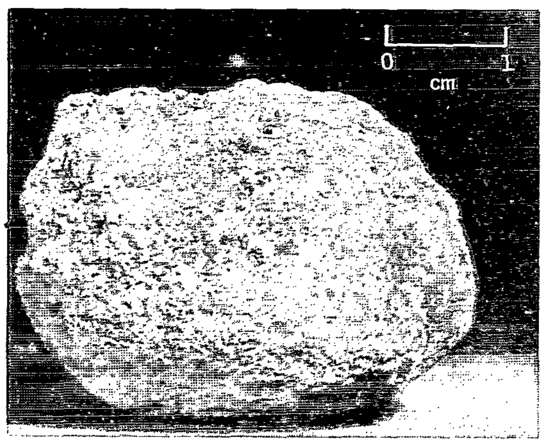

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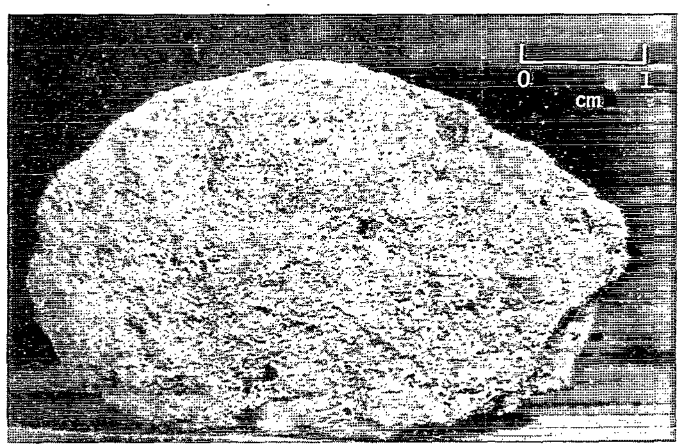

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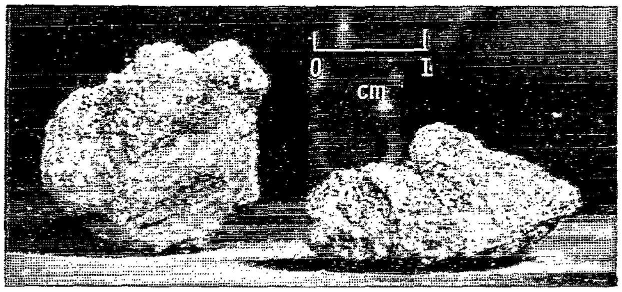
Figure A-33. - Sample 12043.

SAMPLE 12044

SAMPLE NO. 12044.1 HEIKEN
ANGULAR. ELONGATE FRAGMENT. HOLOCRYSTALLINE. MEDIUM GRAINED. REDDISH GRAY COLOR. HIGHLY FRACTURED. IRREGULAR FRACTURES. THERE IS NO APPARENT ORIENTATION OF CRYSTALS. NO VESICLES. SOME VUGS ALIGNED WITH FRACTURES. ONE SIDE IS ROUNDED. NO APPARENT PITS BUT SOME THIN BLACK GLASS SPLOTCHES BRIDGING OPEN FRACTURES.
MINERAL NO. 1 MILKY WHITE TO COLORLESS FELDSPAR. MOST LESS THAN 1.0 MM LONG APPROXIMATELY 45 PERCENT . EQUANT CRYSTALS.
MINERAL NO. 2 PYROXENE. REDDISH BROWN EQUANT APPROXIMATELY 30 PERCENT. MOST LESS THAN 1.0 MM LONG.
MINERAL NO. 3 VERY LIGHT GREEN. ANHEDRAL OLIVINE CRYSTALS APPROXIMATELY 15 PERCENT
APPROXIMATELY .5 MM DIAMETER EQUANT CRYSTALS.
MINERAL NO. 4 ILMENITE. SHINY. EQUANT TO BLADED CRYSTALS APPROXIMATELY 10 PERCENT.
IN VUGS. OLIVINE CRYSTALS UP TO 2 MM DIAMETER. ALSO 1 MM EUHEDRAL PYROXENE.
DIABASE.

SAMPLE NO. 12044.1 WEIGHT 15.5 GRAMS DIMENSIONS 3.5 X 2 X 1.5 CM GREENWOOD
SUBROUNDED. PITTED. COATED WITH DARK GRAY DUST HAS OVERALL MEDIUM DARK GRAY APPEARANCE EXCEPT AT IMPACT PIT WHERE IT IS BRIGHTER. ROCK IS FRIABLE AND FRAGILE AND THE FRAGMENTS HAVE COME FROM SAME ROCK. THE FRESH FRAGMENT IS MEDIUM GRAY. HIGHLY ANGULAR. RARE OLIVINE CRYSTALS ARE PHENOCRYSTS UP TO 1.5 TO 2.0 MM IN A MATRIX OF FINER GRAINED PYROXENE AND FELDSPAR. PYROXENE IS APPROXIMATELY 45 PERCENT OF ROCK. FELDSPAR IS APPROXIMATELY 45 PERCENT OF ROCK. A FEW LATHS OF PLAGIOCLASE UP TO 2 MM BUT MATRIX APPEARS TO BE EQUIGRANULAR. SMALL PATCHES OF GLASS STANDING IN RELIEF TO OLD SURFACE. THIN BLACK GLASS IMPACT PITS HAVE A CLEAR TO TRANSLUCENT BROWN COLOR. HAS VUGS LINED WITH CRYSTALS. ILMENITE APPROXIMATELY 5 PERCENT. PYROXENE IS REDDISH BROWN. ROCK HAS A TRACHYTIC TEXTURE HOLOCRYSTALLINE ROCK. BOTH 44.1 AND 44.2 HAVE BLACK GLASS COATING ON SURFACE.
OLIVINE MICROGABBRO.
THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

TOTAL CARBON ANALYSIS



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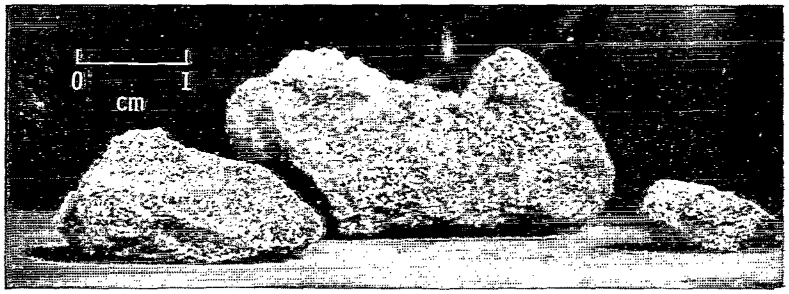

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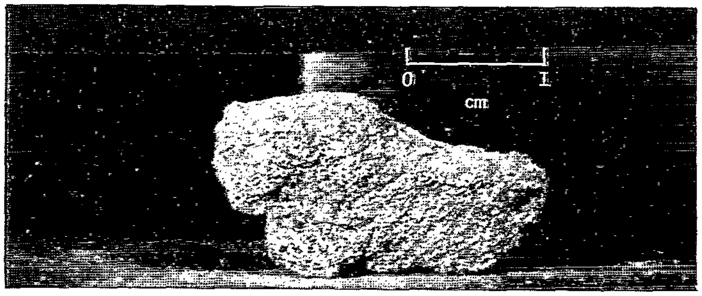

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Figure A-34. - Sample 12044.

SAMPLE NO. 12045 WEIGHT 63 GRAMS DAHLEM
FLAT. TABULAR. ONE SIDE IS FLAT AND THE OTHER IS CONVEX. THE SURFACE IS SLIGHTLY ROUNDED BUT FINE TEXTURE IS HACKLY WITH SOME SLIGHT ROUNDING. RELIEF IS APPROXIMATELY 1/2 MM. SURFACE IS MOTTLED DARK GRAY. TEXTURE IS GRANULAR AVERAGE GRAIN SIZE IS LESS THAN 1/2 MM. ONLY A FEW FRACTURES VISIBLE AND ARE NOT THRU GOING. SOME FRACTURES HAVE A DISCOLORED ZONE OF DULL GRAY AND GOES TO LIGHT GRAY. NO APPARENT STRATIFICATION AND NO APPARENT MAJOR STRUCTURE FEATURES.
SURFACE IS PITTED WITH SMALL GLASS LINED PITS RANGING FROM LESS THAN 0.5 UP TO 1.5 MM IN DIAMETER. GLASS LININGS OF PITS ARE VITREOUS. BLACK TO BROWN. RANGE FROM EVEN VITREOUS TO FINE GRAINED EVEN LUSTERS. CIRCULAR PITS ARE COMMONLY SURROUNDED BY SCATTER ZONE. TRANSCENDING MINERALOGY. THE OUTER CONTACTS ARE IRREGULAR AGAINST SHATTER ZONE AND IS ADOPHYLITIC INTRUDING THE MATRIX . WINDOWS IN GLASS LINING ARE RARE. BUT DO ALLOW A VIEW OF SHATTERING IN BOTTOM OF PITS. INTERNAL REFLECTION IS VISIBLE IN GLASS LINING. THE LININGS ARE LOCALLY SEVERELY FRACTURED. ON FLAT SURFACE RANGE IS FROM 7 TO 14 CM2 FELDSPAR WITH 10/CM2 BEING AVERAGE. THE AVERAGE PIT SIZE ON CONVEX SIDE IS APPROXIMATELY 1.0 MM. THE PIT LINING OCCASIONALLY INCLUDES GRAINS OF OLIVINE. VUGS RANGE FROM APPROXIMATELY 1.0 MM TO COELESCING GROUPS UP TO 5.0 MM. RANGE IN DEPTH FROM LESS THAN 1.0 MM UP TO 3.0 MM. WALLS INCLUDE ALL MATRIX MINERALS. MOST OBVIOUS BEING OPAQUE MINERAL. WHICH IS EUHEDRAL. MOST OF SURFACE IS COVERED WITH FINES.

1. THE ROCK HAS 55 PERCENT BROWNISH GRAY EQUANT PYROXENE LESS THAN 0.5 MM AVERAGE GRAIN SIZE. PRISMATIC WITH 2 WALL LEVEL CLEAVAGES.
2. WHITE. GREENISH WHITE. TABULAR. PLAGIOCLASE 20 PERCENT MAXIMUM GRAIN SIZE APPROXIMATELY .8 MM LONG .3 MM WIDE.
3. APPLE GREEN. EQUANT MINERAL 10 PERCENT. OCCURS AS 0.5 MM AVERAGE SIZE. IN DISCRETE INDIVIDUAL AND MULTIGRANULAR SEGMENTS UP TO 1.0 MM IN DIAM.
4. OPAQUE. DARK GRAY. METALLIC LUSTER. TABULAR. WEDGE SHAPED HABIT. COMMONLY EQUANT 7 TO 10 PERCENT.
5. LOCAL AREAS OF VERY FINE GRAINED GRANULAR MATERIAL OF ALL MATRIX MINERALS BUT VERY FINE (LESS THAN 0.1 MM). LOCAL AREAS IN THESE WITH EXTENDED TRAINS OF OPAQUE MATERIAL TRANSCENDING FINE GRAINED MASS.

SCATTERED IN THE MATRIX ARE WHISPS AND INDIVIDUAL OF RED BROWN MATERIAL WITHIN FELDSPAR AND ALONG GRAIN BOUNDARIES BETWEEN GRAINS. OCCURRENCE OF FINE TRAINS OF OPAQUE MATERIAL IS FAIRLY COMMON IN THIS SAMPLE. IT IS FOUND IN BOTH FINE GRAINED MATERIAL AND IN PYROXENE GRAINS. THESE ARE PROBABLY EXSOLUTION PHENOMENA. THE PYROXENE/OPAQUE/OLIVINE INTERGROWTH IS MOST OBVIOUS. CALLED A BASALT.

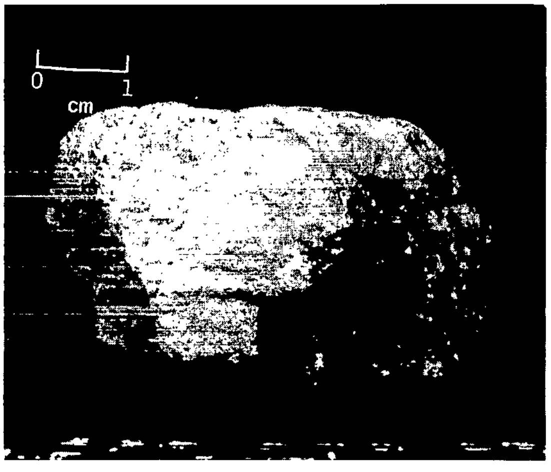
SAMPLE NO. 12045 WEIGHT 63 G DIMENSIONS 5 X 3.5 X 2.0 CM WONES
NEUTRAL COLOR. SHAPE FLATTENED ELLIPSOID. BROKEN VERY FINE GRAINED. VUGGY OLIVINE PHENOCRYSTS. NO ORIENTATION OF MINERALS OR VESICLES OR VUGS. SOME TENDENCY OF VUGS TO CLUSTER. MAY BE THRU GOING SYSTEM OF FRACTURES PERPENDICULAR TO SHORT AXIS. MINOR FRACTURES PARALLEL TO EDGES. MANY GLASS LINED PITS. 6 PITS/CM2 PITS GREATER THAN 0.5 MM. SMALL CLOUDY MILKY FELDSPAR PLAGIOCLASE EQUANT GRAINS 0.3 MM X 0.3 MM MAXIMUM SIZE APPROXIMATELY 20 PERCENT. OLIVINE PHENOCRYSTS 3.0 MM LONG. 1 MM WIDE. SOME 4 X 4 MM APPROXIMATELY 5.0 PERCENT OF ROCK VESICLES DOMINATED BY PYROXENE. SURFACE IS SHATTERED AND IMPACTED.
TERRESTRIAL ANALOGUE. BASALT

SAMPLE 12046

SAMPLE NO. 12046 WEIGHT 166 DIMENSIONS 7 X 4 X 3 CM WONES
RECTANGULAR PRISM WITH AN IRREGULAR BLOB AT ONE END . NEUTRAL WITH A TOUCH OF BROWN. VUGGY TEXTURE. OPHITIC. FINE GRAINED. FELDSPAR LATHS RANDOMLY ORIENTED. OPEN VUGS 2 MM MAXIMUM SIZE. NO ORIENTATION OR CLUSTERING OF VUGS. VUGS MAKE UP LESS THAN 1 PERCENT OF ROCK. FRACTURES ARE CONC AT SURFACE. APPEAR TO BE SPALLING FEATURES. GLASS LINED PITS ON ALL FACES. WHITE MILKY FELDSPAR ON ALL FACES. PIT COUNT FOR LONG FACES. PITS GREATER THAN 0.5 MM APPROXIMATELY .5 PITS/CM2. 1.0/CM2 AND 1.5/CM2. 2.0/CM2. 2 SIDES ARE MORE ROUNDED THAN OTHER TWO SIDES. APPEAR SLIGHTLY LIGHTER. AND HAVE A SLIGHTLY HIGHER DENSITY OF PITS. AND NO APPARENT WATERMARK. PITS ARE ALL CIRCULAR. LARGEST PRESERVED IS APPROXIMATELY 2.0 MM. GLASS LINED. 0.5 MM DEEP. ROCK IS FELSIC.

PLAGIOCLASE 40 PERCENT
PYROXENE 58 PERCENT
ILMENITE 2 PERCENT

PLAGIOCLASE TWINNED CLEAR LATH LIKE CRYSTALS. MAXIMUM LENGTH 2.0 MM. 0.4 MM WIDE AVERAGE LENGTH 0.6 MM. 0.1 MM WIDE 6 X 1 AVERAGE ESTIMATE OF RATIO.
PYROXENE LIGHT TO DARK BROWN. IN ALL SHADES OF BROWN. EQUANT WITH MAXIMUM GRAIN 0.3 X 0.3. MEAN 0.2 X 0.2 MM.
OPAQUES BLADED. LUSTROUS MAXIMUM LENGTH 0.4 MM. RATIO OF 10/1 . VUGS APPEAR TO BE FILLING WITH SAME TEXTURE AND COMPOSITION PERHAPS A CONC OF OPAQUES IN VUGS.
OLIVINE NOT APPARENT. LOOKED FOR BUT NOT FOUND.
NO ALTERATION OBSERVED EXCEPT IMPACT SHATTERING BRECCIATION.
CALLED A DIABASE.



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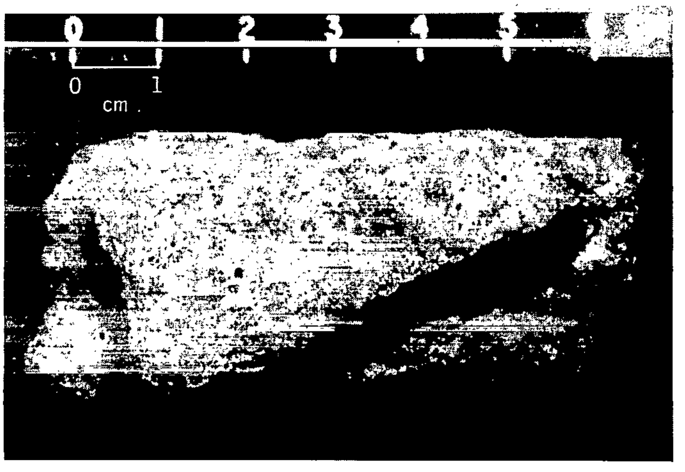

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Figure A-35. - Sample 12046.

SAMPLE NO. 12047 WEIGHT 193 GRAMS DIMENSIONS 9 X 2.5 X 6 CM HEIKEN
TABULAR. SUBROUNDED ROCK. MEDIUM GRAY. HOLOCRYSTALLINE. MEDIUM GRAINED.
FELDSPAR ARE GROUPED IN SMALL RADIAL BUNCHES. A FEW VESICLES UP TO 8 MM IN DIAMETER. SOME ARE COELESCING. ALL ARE SPHERICAL. NONE OVOID. OTHER THAN FELDSPAR THERE IS NO OBVIOUS LINEATIONS. OR ORIENTED CRYSTALS. IN A 1 CM CIRCLE THERE IS AN AVERAGE OF 1 GLASS LINED IMPACT PIT. SOME PITS DO NOT HAVE HALOES THE GLASS IS BLACKISH BROWN. HAS A BUBBLY SURFACE.
ONE CM DIAMETER CIRCLE ON BOTTOM GIVES 8 SURFACE PITS ABOUT 0.8 MM ACROSS.
CRACK WHICH IS HELD TOGETHER BY AN IMPACT PIT. MEDIUM GRAINED BASALT.
MEDIUM GRAY. UNDER SCOPE CONSISTS OF BROWNISH MINERAL. WHITE MINERAL AND METALLIC LUSTEROUS MINERAL. HYPIEDIOMORPHIC GRANULAR TWO SYSTEMS OF FRACTURES ONE PARALLEL TO PLANE OF SAMPLE AND SECOND IS CONC. WITH RESPECT TO ROUNDED EDGES ON ONE END . THE FIRST IS MORE PERSISTENT. ONE SYSTEM OF COELESCING VUGS ON ONE SIDE THROUGH WHICH A FRACTURE PARALLEL TO LONG DIMENSION CUTS THE FRACTURE DOES NOT CUT ONE OF THE GLASS LINED PITS ON THE SURFACE.
TWO PARALLEL FRACTURES REPEATING AT APPROXIMATELY 2 MM INTERVALS. DUST STILL ADHERES TO ALL SIDES EVEN THOUGH IT HAS BEEN BLOWN CONSIDERABLY. GLASSY PATCHES AND GLASS LINED CIRCULAR PITS ARE COMMON RANGING IN SIZE UP TO APPROXIMATELY 2.0 MM WITH DEPTH .1 MM. SPLOTCHES ARE BOTRIODAL. SPECULAR. VITREOUS TO VERY FINE GRAINED GRANULAR SPECULAR. AT LEAST ONE SHOWS CONCENTRIC. RIBBED TEXTURE INSIDE PIT. THE PITS ARE MORE ABUNDANT ON ONE SIDE THAN THE OTHER. THE SIDE WITH VUG AND FRACTURE SYSTEM HAS MORE PITS. THE FLATTER SIDE HAS FEWER LARGE PITS BUT THEY ARE 3 MM IN DIAMETER. THE GLASS LINING OF PITS ON FLAT SIDE IS BROWNISH BUT ON ROUNDED SIDE IS BLACK. SOME EVIDENCE OF ERODING OF AREA AROUND PITS WHICH LEAVES A RAISED LIP ON PITS. THE DUST COVERING IS HEAVIER ON FLAT SIDE. THE GLASS LININGS ARE SOMEWHAT FRACTURED BECAUSE OF NEWTON RINGS OF FRACTURE SEEN. ON ROUNDED SIDE THE RANGE IN PITS/CM2 IS FROM 4 TO 12 AND AVERAGE IS APPROXIMATELY 7 IN PITS GREATER THAN 0.5 MM.
ON FLAT SIDE THE RANGE OF PITS GREATER THAN 0.5 MM IS 2 TO 5 WITH 3 TO 4 BEING AVERAGE. THE HALOES EXTEND IRRESPECTIVE OF MINERALOGY UP TO ONE CRATER DIAMETER. THE MINERALS ARE FELDSPAR AND MILKY PYROXENE. SOME ARE CHALKY AND FINE GRAINED ENOUGH TO HAVE LOST LUSTER. TWO OTHER TYPES OF DEPRESSIONS . FIRST IS SPHERICAL WITH EUHEDRAL CRYSTALS LINING WALLS. SECOND IS A VUG. LINED WITH EUHEDRAL CRYSTALS CHARACTERISTIC OF MATRIX. MAY BE TENDENCY OF FELDSPAR TO CONCENTRATE IN VUGS. THE FLAT LARGE SIDE MAY HAVE BEEN DOWN. BUT TUMBLING IS COMPLEX.
FOUR PHASES.

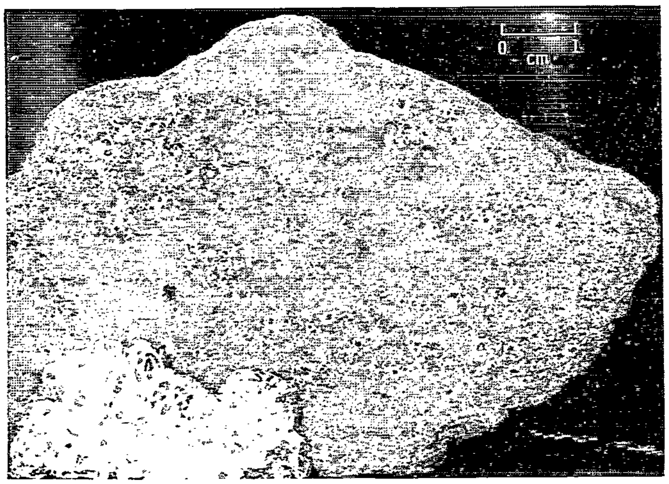
1. TAN. CREAM. PHASE. PYROXENE 40 PERCENT OF ROCK.
2. WHITE TO CLEAR PLAGIOCLASE 30 PERCENT
3. BLACK METALLIC OPAQUE. PROBABLY ILMENITE 20 PERCENT
4. APPLE GREEN PROBABLY OLIVINE APPROXIAMTELY 5 PERCENT
5. 5 PERCENT UNDECLARED

1. EQUANT TO SLIGHTLY ELONGATE. OCCURS PRINCIPALLY (INTERSTITIALLY WITH) AS SPACE FILLING BETWEEN PLAGIOCLASE GRAINS. AVERAGE .3 TO .4 MM

2. TABULAR. RANGES UP TO 1.5 MM LONG AND 0.5 MM ACROSS. TWINNING IS LAMELLAE AND PERPENDICULAR TO LAMELLAE. COMMONLY IN SEMI RADIAL HABIT IN CLUMPS WITH NO INTERGROWN PYROXENE AND OPAQUES. SOME CARLSBAD TWINNING. SOME CLUMPS ARE APPROXIMATELY 1.5 MM ACROSS.

3. SCATTERED AT RANDOM. PLANAR HABIT. SOME PIE SHAPED AND COMMONLY INTERGROWN WITH PYROXENE.

NO ALTERATION IS APPARENT IN ANY MINERALS.
GLASS PIT LINING. IN ONE CASE INCLUDES A FUSED LATH OF FELDSPAR. THE GLASS IS DARK EVEN TONED EXCEPT FOR DIAMETER ORIENTED CLEAR SWATH.
CALLED A MICROGABBRO.



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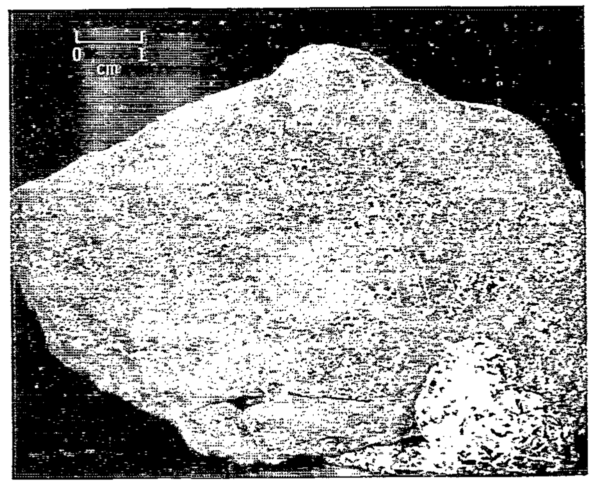

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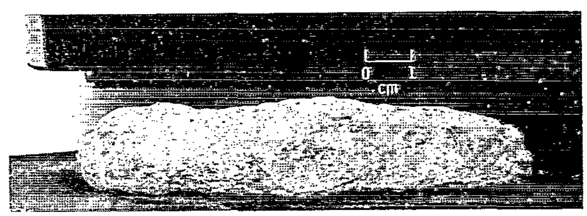

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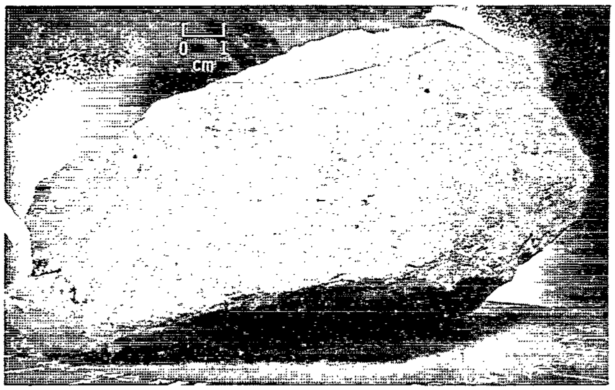
Figure A-36. - Sample 12047.

SAMPLE 12051

SAMPLE NO. 12051 WEIGHT 1660 DIMENSIONS 16 X 11.5 X 7 CM HEIKEN
LOAF SHAPED ROCK. BOTTOM IS A PLANAR FRACTURE SURFACE. THE BOTTOM IS A DARK BROWNISH GRAY. A SERIES OF SPALLATION TYPE FRACTURES PARALLEL TO THE BOTTOM OF THE ROCK . THE EDGES OF FRACTURE ARE VERY ANGULAR . UPPER PART IS VERY ROUNDED. LIGHT BROWNISH GRAY. THERE IS A DISTINCT COLOR DIFFERENCE BETWEEN TOP AND BOTTOM. TEXTURE IS HOLOCRYSTALLINE. MEDIUM GRAINED. MOST CRYSTALS ARE RANDOMLY ORIENTED. SOME HAVE A VARIOLITIC TEXTURE. ONE DEEP FRACTURE VISIBLE AND CUTS THRU THE WHOLE ROCK. THERE ARE SURFACE AREAS WHICH DO NOT NECESSARILY HAVE VESICLES BUT HAVE A DICTYTAXITIC TEXTURE. SOME VESICLES PRESENT UP TO 4 MM DIAMETER. THERE ARE SURFACE GLASS LINED PITS FROM 0.1 TO 2 MM IN DIAMETER. THE GLASS LINING IS APPROXIMATELY .2 MM THICK WITH A BUBBLY SURFACE. THE GLASS HAS MULTIPLE COLORS FROM COLORLESS TO BLACK CAUSED BY FUSION OF CRYSTALS IN PLACE. THE WHITE CORONA OF CRUSHED MINERALS IS APPROXIMATELY 1/2 CRATER WIDTH WIDE. RANDOM 1 CM WIDE AREAS GIVE 6 AND 2 AND 3 AND 3. SOME VERY THIN SPLASHES OF BLACK GLASS ON A SLIGHTLY WEATHERED SURFACE. THE SPLASHES ARE APPROXIMATELY 1 TO 2 MM ACROSS WITH IRREGULAR BOUNDARIES. THE FLAT BASE HAS NO SURFACE PITS OR GLASS SPLOTCHES AND HAS A MUCH DARKER COLOR BECAUSE THERE ARE NO MINERALS FRACTURED OR SHATTERED. THERE IS GRAY DUST ADHERING TIGHTLY TO THIS SURFACE.
FELDSPAR APPROXIMATELY 45 PERCENT. AVERAGE LENGTH OF LATHS IS APPROXIMATELY 1 MM. COLORLESS TO MILKY WHITE.
PYROXENE APPROXIMATELY 30 PERCENT. REDDISH BROWN PYROXENE SUBHEDRAL CRYSTALS .5 TO 1 MM LONG.
OLIVINE OR PYROXENE APPROXIMATELY 15 PERCENT. VERY LIGHT GREENISH YELLOW APPROXIMATELY .5 MM DIAMETER. EQUANT CRYSTALS.
ILMENITE APPROXIMATELY 10 PERCENT. VERY THIN BLADED CRYSTALS UP TO 3 MM LONG. AND SOME SMALL MORE EQUANT CRYSTALS.
NEAR VESICLES AND VUGS ARE EUHEDRAL CRYSTALS OF ALL TYPES MENTIONED ABOVE. BUT SIZES ARE NOT ANY LARGER.
DIABASE.

SAMPLE NO. 12051 WEIGHT 1660 GRAMS DIMENSIONS 16 X 11 X 6 CM CHAO
MINERALOGY.
OPHYTIC. WHITE TO MILKY WHITE. TO LUSTROUS. PLAGIOCLASE FELDSPAR ALSO OCCURS AS PLATES IN VUGS. APPROXIMATELY 50 PERCENT.
INTERSTICIAL CINNAMON BROWN CLINOPYROXENE. PRISMATIC HABIT IN VUGS. APPROXIMATELY 45 PERCENT.
GREENISH YELLOW PHENOCRYSTIC OLIVINE. SPARSELY DISTRIBUTED UP TO 2.0 MM ACROSS. LESS THAN 1 PERCENT.
OPAQUE MINERAL 5 PERCENT. BLACK WITH VITREOUS LUSTER. PROBABLY ILMENITE.
THE OPHYTIC TEXTURE IS PRONOUNCED ON THE ROUNDED SIDE. THEREFORE. OLIVINE BEARING A DIABASE OR BASALT.
SHOCKED.
SHAPE. LIKE COW DUNG. FLAT ON ONE SIDE AND ROUNDED AND CONVEX ON OTHER SIDE.
COLOR. BROWNISH SPECKLED GRAY.
TEXTURE. OPHYTIC.
SLIGHTLY VUGGY AND VESICULAR. NUMEROUS PITS ROUNDED CONVEX WHICH ARE COATED WITH DUST 0.3 TO 2 MM IN DIAMETER ABUNDANT. GREATER THAN 2 PER CM2. NO PITS ON FLAT SIDE INDICATING IT IS THE BOTTOM SIDE. THE OTHER THE TOP SIDE.
TERRESTRIAL ANALOGUE. DIABASE.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE
- E-SPEC ANALYSIS
- TOTAL CARBON ANALYSIS



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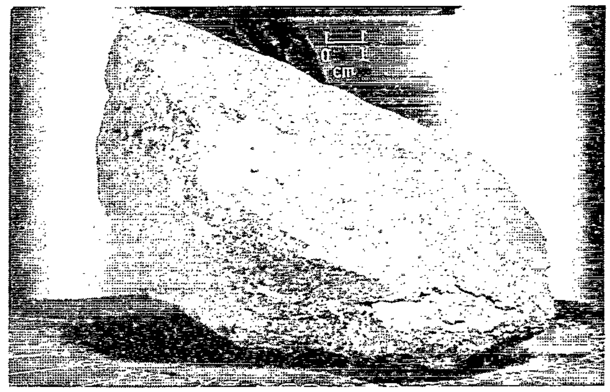

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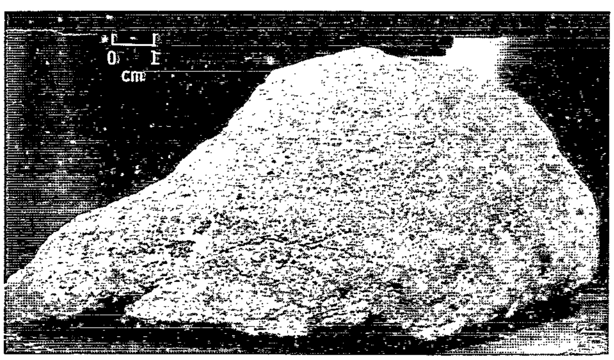

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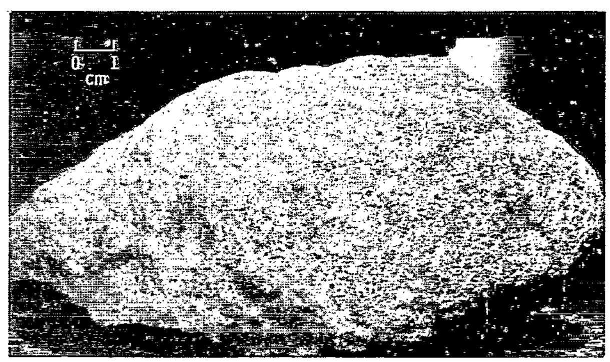

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Figure A-37. - Sample 12051.

SAMPLE NO. 12052 HEIKEN AND ANDERSON
MOD WELL ROUNDED DARK GRAY CRYSTALLINE ROCK WITH NUMEROUS GLASS LINED PITS MOST OF WHICH HAVE A WHITE SHOCK RING AROUND THEM. THE PIT DENSITY IS APPROXIMATELY 20 PER SQUARE CM. THE ROCK IS VUGGY AND COARSE GRAINED. NO LINEATIONS OR OBVIOUS FRACTURES VISIBLE EXCEPT FOR A FEW SMALL EXFOLIATION CRACKS. TEXTURE AND MINERALOGY. TWO PHASES EASILY IDENTIFIABLE. HONEY BROWN PYROXENE CRYSTALS APPROXIMATE 3 MM LONG LESS THAN 1 MM WIDE FORM BLADES IN CLUSTERS RADIATING FROM COMMON CENTERS WITH FELDSPAR CRYSTALS PRESENT INTERSTITIALLY BETWEEN RADIATING BLADES. COARSE PYROXENE CRYSTALS MAY BE OBSERVED IN SOME VUGS. A FEW GREENISH OLIVINE CRYSTALS MAY BE SEEN ON ROCK SURFACE . IN SOME PLACES THE RADIATING CRYSTAL STRUCTURE SEEMS TO BE FELDSPAR LATHS. THE ABUNDANT GLASS PITS FREQUENTLY HAVE RAISED RIMS. THE GLASS IN THE PITS SEEMS TO VARY FROM OLIVE GREEN TO DARK BROWN.
ANGULAR TO SUBANGULAR . ONE SIDE OF TOP IS ROUNDED BY PLANAR FRACTURES. LINEATION ALONG FRACTURE PLANES. COLOR MEDIUM DARK GRAY. ON FRACTURED SIDE THERE ARE SMALL AREAS WITH ABUNDANT 2 MM DIAMETER VESICLES. ON ROUNDED SIDE THERE ARE ABUNDANT GLASS LINED IMPACT SURFACE PITS WITH WHITE HALOES. VESICLES SHOW NO PREFERRED ORIENTATION. TEXTURE IS HOLOCRYSTALLINE FINE GRAINED.
NO IMPACT PITS ON FRESH SURFACE SIDE. ONE PATCH OF INTERCONNECTING VESICLES APPROXIMATELY 2 CM IN DIAMETER IS FILLED WITH A NETWORK OF GREENISH BROWN PYROXENE CRYSTALS UP TO 8 MM LONG 0.5 MM WIDE. THE ROUNDED SIDE IS COVERED WITH NUMEROUS SURFACE PITS RANGING FROM 0.1 MM TO 2 MM IN DIAMETER. ALL ARE LINED WITH DARK BROWN GLASS. WITH A HALO OF DAMAGED CRYSTALS AROUND EACH PIT. HALO'S WIDTH IS APPROXIMATELY DIAMETER OF PIT WHEREVER THE FRAGMENT IMPACTED ON ORIENTED CRYSTALS THE PIT IS ELONGATED IN RESPECT TO THE ORIENTATION OF THE CRYSTALS. MINERALOGY IS DIFFICULT TO DETERMINE BECAUSE AVERAGE CRYSTAL SIZE IS LESS THAN 0.5 MM.
APPROXIMATE MODE.

REDDISH BROWN PYROXENE	40 PERCENT
FELDSPAR	30 PERCENT
OLIVINE	15 PERCENT
ILMENITE	15 PERCENT

SOME FELDSPARS ARE UP TO 1 CM LONG IN VERY THIN LATHS.
BOTTOM SIDE. ROUNDED TO SUBROUNDED. 5 PERCENT BY VOLUME VESICLES. VESICLES UP TO 3 MM IN DIAMETER COVERED WITH ABUNDANT SURFACE PITS IN A 1 CM DIAMETER CIRCLE APPROXIMATELY 21 PITS. SOME ORIENTATION OF FELDSPAR MOSTLY IN RADIAL PATCHES.

SAMPLE NO. 12052.2 LINDSAY
FIVE FRAGMENTS ALL QUITE ANGULAR. LARGEST PIECE 5 CM LONG.
TRACHYTIC TEXTURE. SOME VESICLES 1 CM IN DIAMETER. LARGE VUG 2 CM LONG 5 MM WIDE. THREE SURFACE PITS PER SQUARE CM.
APPROXIMATE MODES. HOLOCRYSTALLINE WITH OLIVINE PHENOCRYSTS UP TO 0.1MM FORMING ABOUT 5 PERCENT. SOME PYROXENE. VUGS LINED WITH ACICULAR ILMENITE 5 MM LONG .5 MM WIDE.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
TOTAL CARBON ANALYSIS

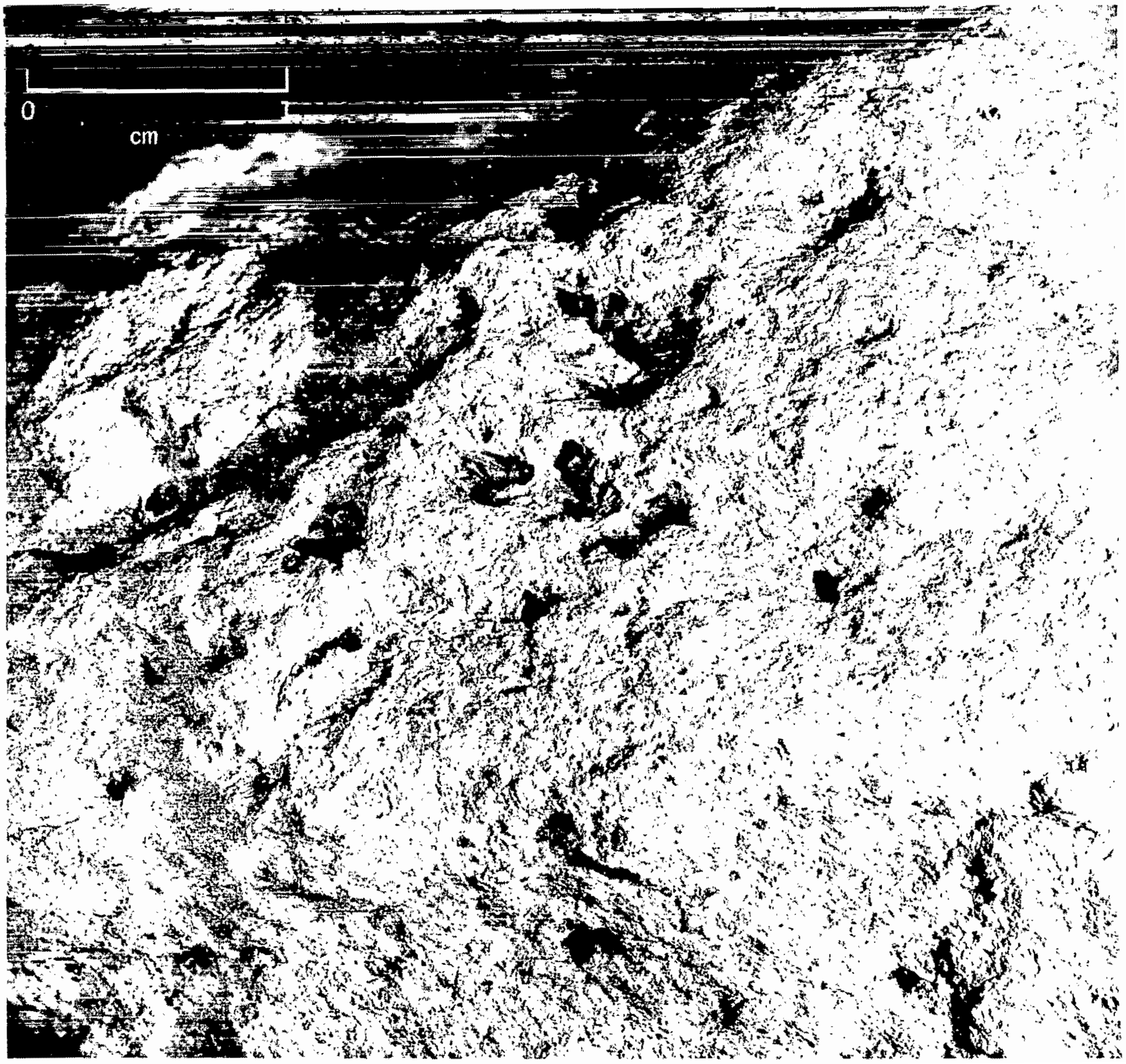
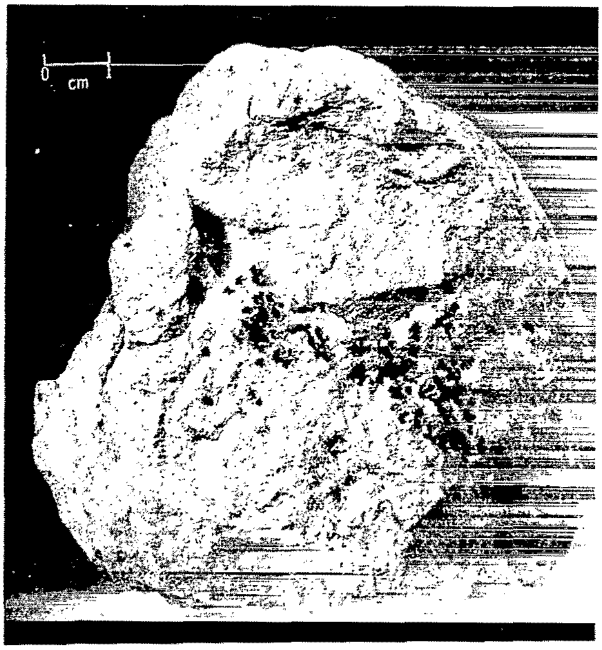


Figure A-38. - Closeup of sample 12052 (NASA-S-70-21312).



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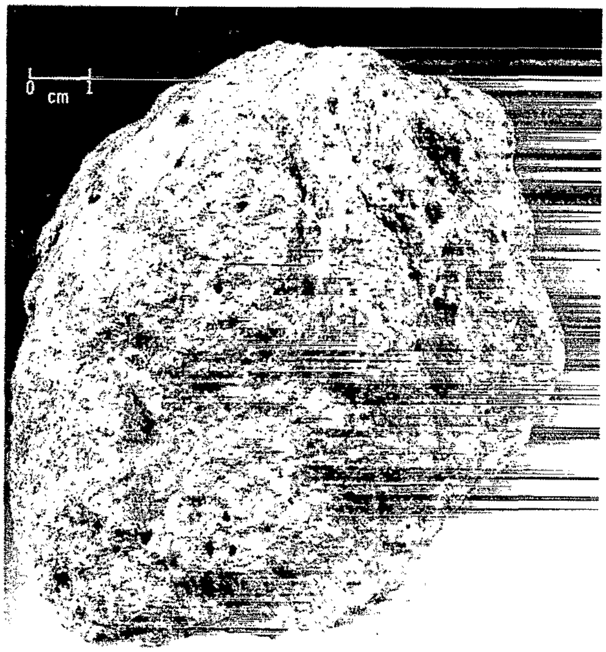

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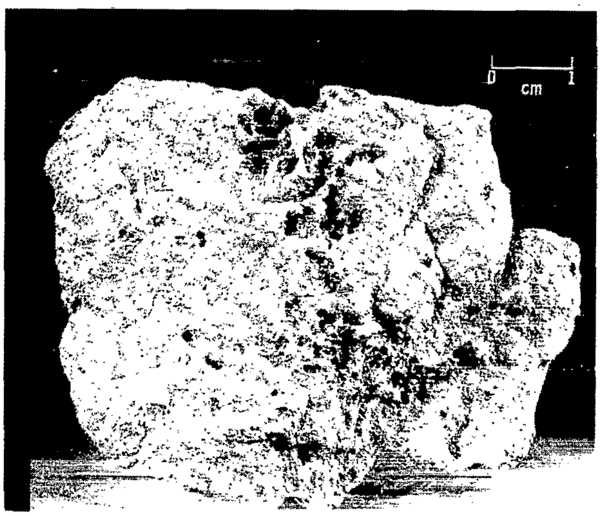

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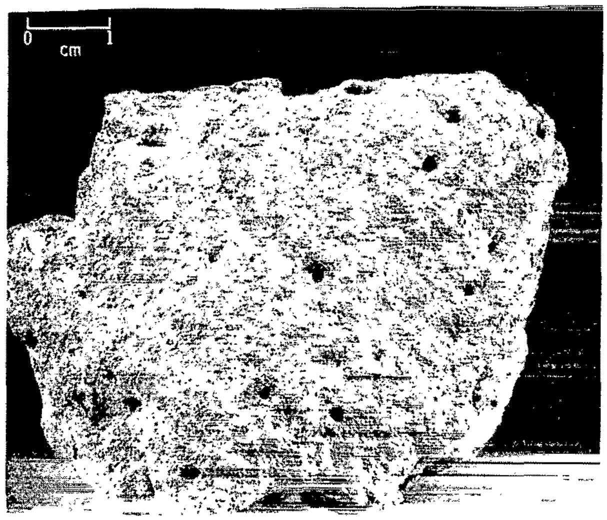

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Figure A-39. - Sample 12052.

SAMPLE 12053

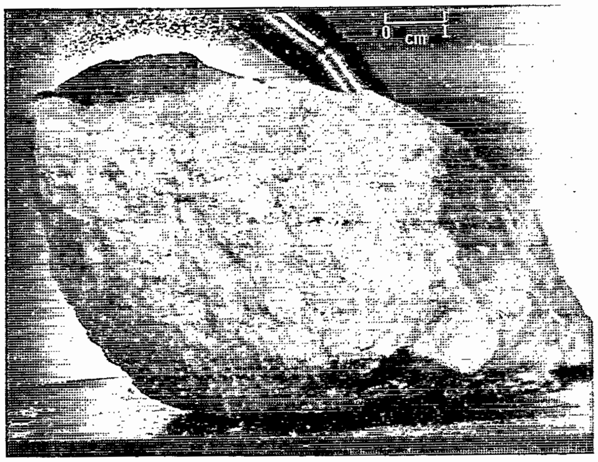
SAMPLE NO. 12053 WEIGHT 879 G DIMENSIONS 12 CM X 8.5 CM X 5 CM GREENWOOD OLIVINE BASALT. ROCK HAS A FLAT BOTTOM WITH ANGULAR EDGES AND A SUBROUNDED PEAKED TOP. THE TOP SURFACES ARE PITTED WITH A SMOOTH PEPPERED ROUNDED SURFACE MEDIUM GREY OUTSIDE EXCEPT FOR A LUSTROUS BLACK GLASS WHICH LINES SOME PITS. THESE ARE ALSO INFREQUENT 2 TO 3 MM VESICLES, WHICH ARE LINED WITH CRYSTALS . THE GLASS LINED PITS HAVE A BRIGHT HALO OF FRACTURED ROCK AROUND THEM. THE BOTTOM SURFACE HAS A SMALL 1 X 1 CM PATCH OR BLACK CRYSTAL. A FRESH SURFACE HAS SAME COLOR AS WEATHERED (MEDIUM GREY) AND THERE IS A SUBPLANAR FRACTURE SET PARALLEL TO THE BASE.
THERE IS ALSO A SET OF (INTERSECTING) FRACTURES WHICH AT 40 DEGREES AND THE BASE PLANE BISECTS THE SMALL ANGLE BETWEEN THE FRACTURES. THE ROCK IS FINE GRAINED, WITH NEEDLES OF FELDSPAR UP TO 3 MM LONG, TRACHYTIC TEXTURE. THE VESICLES ARE LINED WITH FINE MINERALS, RATHER THAN GLASS. THE MAFIC MINERALS APPEAR TO BE YELLOW GREEN OLIVINE (10 PERCENT), DARK GREY MATRIX (APPROXIMATELY 25 PERCENT). THERE IS AN OPAQUE MINERAL ILMENITE OR MAGNETITE, 2 OR 3 PERCENT. FELDSPAR 60 PERCENT. THE VESICLES ARE LINED WITH COARSER CRYSTALS OF THE MATRIX. THE VESICLE CRYSTALS ARE PYROXENE AND OLIVINE. THE TEXTURE TENDS TO DICTYTAXITIC AND THE ROCK IS HOLOCRYSTALLINE GRANULAR. THE BLACK COATING ON BOTTOM IS BOTRYOIDAL GLASS. THERE IS NO APPARENT OVERALL PREFERRED CRYSTAL ORIENTATION. LOCALLY THE FELDSPAR CRYSTALS APPEAR TO HAVE A ROSETTE HABIT. THE ROCK IS NOT FRIABLE OR FRAGILE. THE ROCK IS ABOUT 5 PERCENT VOIDS (CRYSTALLINE LINED VESICLES). THERE ARE NUMEROUS IMPACT PITS ON THE TOP OF THE ROCK. NO IMPACT PITS WERE SEEN ON THE BOTTOM. NO ALTERATION EXCEPT FOR IMPACT FRACTURING WAS SEEN.
ONE SIDE IS ANGULAR TO SUBANGULAR WITH THIN EXFOLIATION TYPE FRACTURES ON ONE SIDE. THE OTHER SIDE IS WELL ROUNDED WITH CONSIDERABLE DUST ADHERING TIGHTLY TO ROUNDED SIDE. FINE GRAINED HOLOCRYSTALLINE. MOST CRYSTALS APPROXIMATELY 0.2 TO 0.3 MM LONG. EQUIGRANULAR MOST CRYSTALS ARE LATH SHAPED SOMETIMES APPEARING IN BUNCHES GROWING RADIALLY OUT FROM A CENTRAL POINT.

FELDSPAR	60 PERCENT
PYROXENE	20 PERCENT CINNAMON BROWN ELONGATE LATH SHAPED
ILMENITE	15 PERCENT BLADED
OLIVINE	5 PERCENT VERY LIGHT GREEN

THE SURFACE IS COVERED WITH
SHALLOW PITS FROM 1/20 TO 1 MM. NUMBER OF PITS IN A CIRCLE 1 CM IN DIAMETER. 32 PITS IN FIRST COUNT, 15 PITS IN SECOND COUNT.
ON TOP IS A VERY THIN GLASS SPATTER APPROXIMATE 6 MM IN DIAMETER WITH IRREGULAR EDGES. VERY DARK BROWN. IN A NUMBER OF INSTANCES, THE GLASS LINED PITS ARE RAISED SLIGHTLY ABOVE THE ROCK SURFACE. IT APPEARS THAT THE ROCK HAS BEEN DIFFERENTIALLY ERODED, WITH GLASS LININGS AS RESISTANT HIGHS.
FOUR VESICLES ON UPPER SURFACE ALL LESS THAN 1/2 MM IN DIAMETER.
ANGULAR (BOTTOM) SIDE IRREGULARLY SPACED VESICLES APPROXIMATELY 1 MM IN DIAMETER AVERAGING APPROXIMATELY 1 PER CM CIRCLE LINING WALLS OF VESICLES ARE ABUNDANT OLIVINE CRYSTALS APPROXIMATELY 2 MM ON LONG AXIS . NO IMPACT PITS ON BOTTOM. ON BOTTOM IS A PATCH OF THIN GLASS SPATTER 0.5 X 0.6 CM. THE SURFACE IS HIGHLY IRREGULAR AND BOTRIOIDAL. BLACK WITH SHINY GLASSY LUSTER.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

RCL ANALYSIS



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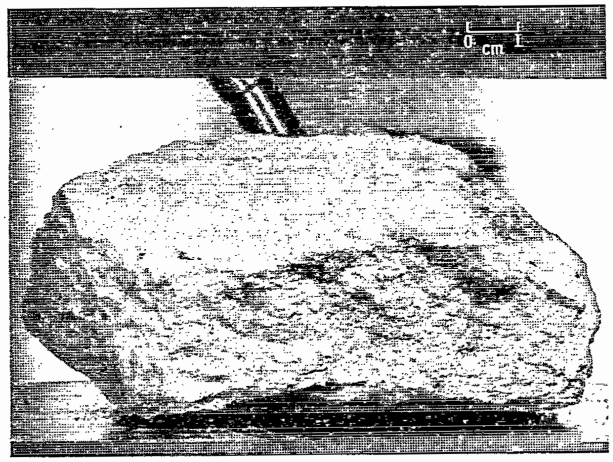

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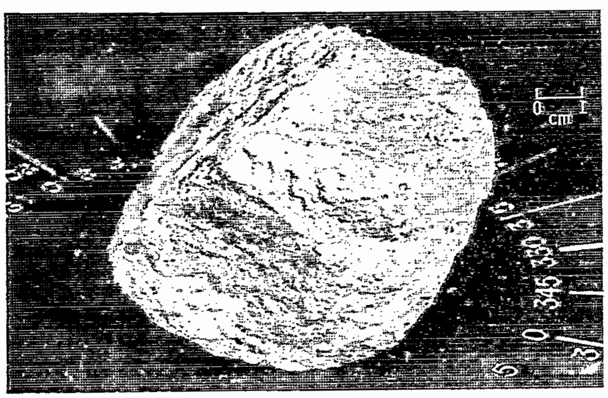

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NASA-S-69-60958

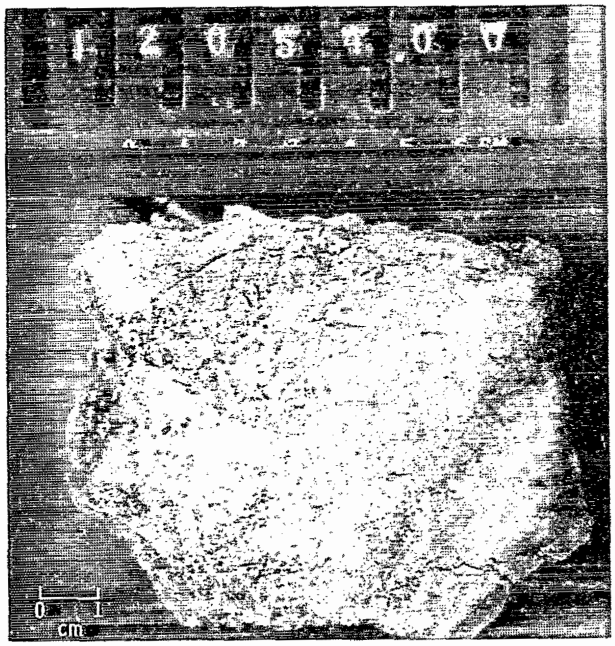
Figure A-40. - Sample 12053.

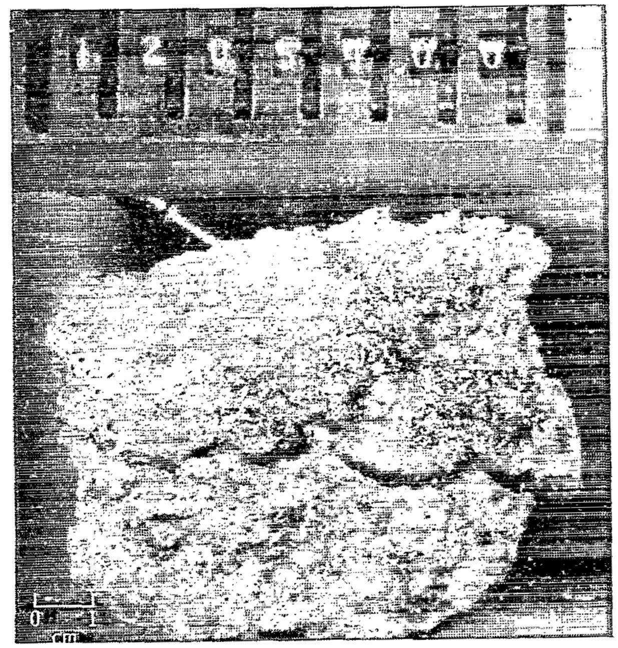
SAMPLE 12054

SAMPLE NO. 12054 WEIGHT 687 GRAMS DIMENSIONS 9 X 7 X 7 CM GREENWOOD
HIGHLY ANGULAR NO ROUNDING. PYRAMIDAL SHAPED BASE IS COVERED WITH BLACK GLASS THIN COAT OF VESICULAR GLASS APPROXIMATELY 1/4 MM THICK. THE GLASS COVERS UP APPROXIMATELY 1/2 WAY UP THE PYRAMID. THE ROCK IS LIGHT GRAY . MEDIUM TO COARSE CRYSTALLINE FELDSPAR LATHS ARE 2 TO 3 MM IN LENGTH. LIGHT GREENISH BROWN MATRIX PYROXENE. COARSE 7 MM PHENOCRYST OF PYROXENE APPEARS EUHEDRAL. THE PYRAMID TOP OF ROCK APPEARS TO BE A SHATTERCONE. THERE ARE CONVERGING SLICKENSIDED SURFACES WITH GROUND UP AND SMEARED OUT MINERALS. THE BASE OF THE PYRAMID HAS ONE LARGE AND SEVERAL SMALL OPEN FRACTURES. THE FRACTURES ARE WELDED TOGETHER BY GLASS. THE ROCK APPEARS TO BE EXPANDED WITH BREADCRUST FASHION AND IS HELD TOGETHER BY THE GLASS. AT THE TOP OF THE PYRAMID IS A FRACTURE WITH A VEIN FILLED WITH REDDISH YELLOW GLASS. THE ROCK IS VERY FRIABLE AND FRAGILE AND MUCH FRACTURED UP. IN ADDITION TO GLASS COATING ADJACENT TO IT AND EXTENDING BEYOND THERE IS A BROWNISH BLACK DULL COATING ON ROCK THAT GOES INTO FRACTURES. IT IS DARKER THAN MEDIUM GRAY DUST AND APPEARS RELATED TO EVENT THAT CAUSED GLASS. IT IS THIN LESS THAN 0.1 MM AND IS EASILY SCRATCHED OFF WITH A NEEDLE. IT MAY BE EITHER BAKED DUST BELOW GLASS. WHICH WAS CHIPPED OFF OR A CHEMICAL SUBLIMATE ON THE ROCK.
AT THE INTERSECTION OF OPEN FRACTURES THE ROCK IS GRANULATED AND SOME FRACTURES HAVE BLACK GLASS FILLINGS. THE PYROXENE IS MICROFRACTURED ALSO AND THE FELDSPAR IS WITHOUT CLEAVAGE AND IS WHITE . THERE SEEMS TO BE A NUMBER OF IMPACT PITS THROUGH THE GLASS AND INTO THE ROCK. THE IMPACT PITS ARE GLASS LINED AND APPEAR TO HAVE BEEN SPALLED OUT. THE GLASS HAS A YELLOW BROWN INTERNAL REFLECTION WHERE ITS THIN. IT HAS A NUMBER OF BROWN VESICLES SOME GLASS IN PITS IS LIGHT COLORED. LIGHT BROWN TO CLEAR. THERE APPEARS TO BE A NUMBER OF SMALL SPHERULES APPROXIMATELY 2 MM IN DIAMETER TO 5 MM BONDED TO THE SURFACE. THERE IS NO EVIDENCE OF THE GLASS ALTERING THE ROCK BELOW IT. THE LIQUID MUST HAVE BEEN OF VERY LOW VISCOSITY TO SPREAD SO THIN AND TO GO INTO THE FRACTURE. WHERE IMPACT PITS ARE IN THE GLASS THE VERY SMALL ONES ARE LINED WITH REDDISH BROWN GLASS AND SURROUNDED BY A HALO OUT TO 1 CRATER DIAMETER OF SHATTERED GLASS OF A LIGHT YELLOW BROWN COLOR. THERE ARE A GREAT NUMBER OF THESE SMALL PITS IN THE GLASS. THE PITS GREATER THAN 1 MM GO INTO THE ROCK. LESS THAN 1 MM DO NOT. THE LARGER ONES BLAST AWAY THE GLASS AND HAVE A DARKER GLASS LINING OF GLASS.
THE ROCK ITSELF HAS PLAGIOCLASE LATHS. IT HAS A TRACHYTIC TEXTURE. HOLO-CRYSTALLINE. MAY BE A SUBTLE ORIENTATION OF PLAGIOCLASE CRYSTALS NEAR THE BASE. FRAGMENTS OF THIS ROCK TYPE ARE WELDED TO THE OUTSIDE OF THE GLASS. THERE MAY BE AN IMPACT PIT ON ONE OF THE SIDES THAT IS IN GENERAL GLASS COVERED. THE PIT IS GLASS LINED APPROXIMATELY 3 MM ACROSS BUT THE AREA AROUND IT IS FREE OF GLASS THE ROCK IS THOROUGHLY FRACTURED WITH SUBPOLIGONAL FRACTURE SETS AND APPEARS TO BE EXPANDED ON A MICROSCALE. FRACTURES EXTEND THROUGH BLADES OF ILMENITE AND OTHER CRYSTALS. FELDSPAR IS APPROXIMATELY 50 PERCENT OF THE ROCK. THERE ARE DARK PYROXENE PHENOCRYSTS THROUGHOUT THE ROCK. NO VUGS IDENTIFIABLE. BONDED TO THE OUTSIDE OF THE GLASS THERE ARE CRYSTALS OF FELDSPAR AND PYROXENE WHICH ARE SEMITRANSLUCENT AND APPEARS IN THE ROCK WITH ITS GLASS COATING. THE ROCK WITH ITS GLASS COATING APPEARS TO HAVE FALLEN ON SOIL WHILE THE GLASS WAS STILL NOT BONDING THE SOIL TO THE ROCK. SEVERAL OF THE FRACTURES RADIATE OUT FROM THE CENTER IN CARTWHEEL FASHION. THE FELDSPAR IS HIGHLY ALTERED BY SHOCK. THERE IS A REDDISH BROWN ACCESSORY MINERAL THAT IS PRISMATIC IN HABIT APPROXIMATELY 1/10 MILLIMETERS IN LENGTH.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

RARE GAS ANALYSIS





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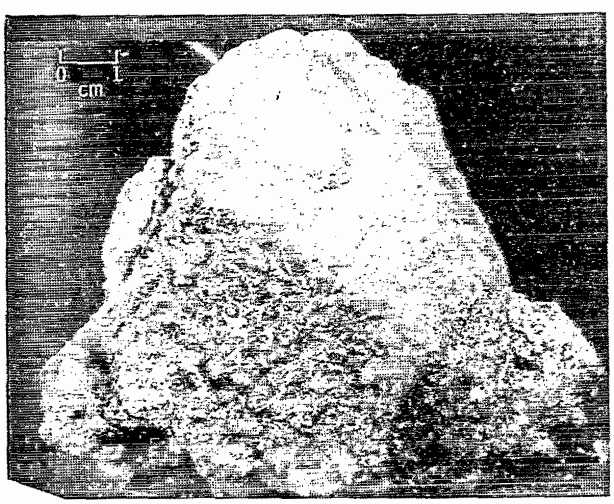

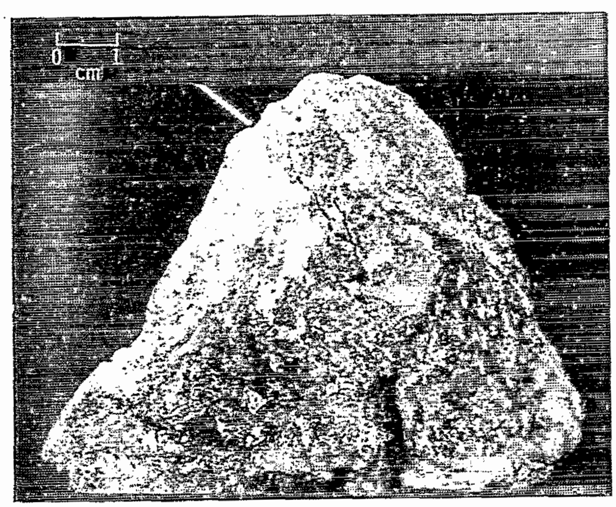

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NASA-S-69-60967

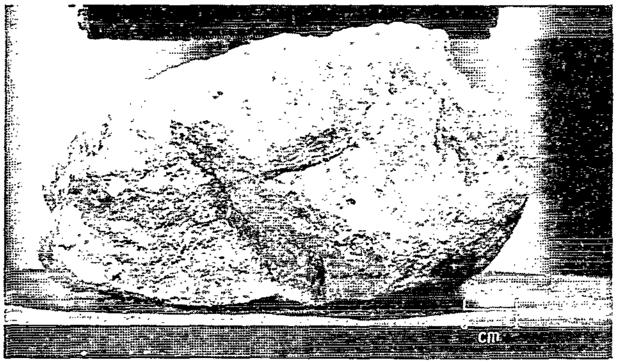
Figure A-41. - Sample 12054.

SAMPLE 12055

SAMPLE NO. 12055 DIMENSIONS 12.5 X 10 X 5 CM HEIKEN
ROCK IS POSSIBLY TERRESTRIALLY CONTAMINATED.
SIDE 1 (UPPER) SUBROUNDED. HIGHLY FRACTURED WITH ELONGATION PARALLEL TO FRACTURES. COLOR LIGHT GRAY COVERED WITH RADIATING MASSES OF FELDSPAR LATHS. THE ROCK IS MEDIUM GRAINED HOLOCRYSTALLINE. VUGS ARE ASSOCIATED WITH FRACTURES BUT NO VISIBLE VESICLES. FRACTURES ARE IRREGULAR, MOST ARE PARALLEL TO EACH OTHER. SURFACE FEATURES ABUNDANT GLASS LINED IMPACT PITS RANGING FROM 1/2 TO 3 MM PITS ARE LINED WITH DARK BROWN BUBBLY GLASS. THE GLASS IS LESS THAN 0.2 MM. SEVERAL 4 MM BLACK GLASS SPLASHES ON SURFACE. A FEW VESICLES.
MINERAL 1 APPROXIMATELY 45 PERCENT MILKY WHITE TO COLORLESS FELDSPARS. LATHLIKE, BEING 0.2 MM WIDE ON AVERAGE AND 1 TO 8 MM LONG. THESE SHOW SOME ALBITE TWINNING. PROBABLY PLAGIOCLASE. NO. 2 APPROXIMATELY 30 PERCENT LIGHT REDDISH BROWN PYROXENE APPROXIMATELY 0.2 MM WIDE 1 TO 3 MM LONG. SUBHEDRAL AND SHOW EXCELLENT CLEAVAGE. NO. 3 APPROXIMATELY 15 PERCENT VERY THIN BLADED LIKE CRYSTALS OF ILMENITE UP TO 1 1/2 MM LONG. NO. 4 APPROXIMATELY 10 PERCENT EQUANT 1 MM DIAMETER CRYSTALS LIGHT GRAY OLIVINE. THE ELONGATE FELDSPAR LATHS, PYROXENE CRYSTALS, AND BLADES OF ILMENITE ARE ALL SUBPARALLEL IN RADIALLY ORIENTED CLUMPS. THE CLUMPS ARE APPROXIMATELY 5 TO 8 MM IN DIAMETER AT JUNCTIONS BETWEEN CLUMPS ARE SMALL MORE EQUANT CRYSTALS OF ILMENITE. VUGS WITHIN FRACTURES ARE FILLED WITH WELL FORMED CRYSTALS OF ALL TYPES DESCRIBED.
SHAPE. ELLIPSOIDAL, ONE END BROKEN OFF.
COLOR. NEUTRAL N7
TEXTURE. VUGGY, MEDIUM GRAINED, SUBOPHITIC.
FABRIC. NO OBSERVED LINEATIONS, RANDOM VUGS, 2 CM DOWN TO 2 MM . NO VESICLES.
FRACTURES. THROUGH GOING FRACTURES APPROXIMATELY PARALLEL TO SURFACE SHAPE OF ROCK IS CONTROLLED BY FRACTURES.
SURFACE FEATURES. GLASS LINED PITS COMMON ON ALL SIDES 1 TO 4 MM IN DIAMETER. SOME SHATTERED TEXTURE ON SURFACE. ROUNDING INDENTATIONS PRESENT. LARGE PITS AND ROUNDING COMMON ON ROUNDED END OF ELIPSE, BOTTOM HAS A FRESH BROKEN SURFACE.
MINERALOGY. MODE.

PLAGIOCLASE 45 PERCENT
PYROXENE 50 PERCENT
OLIVINE 5 PERCENT
OPAQUES, THIN BLADES APPROXIMATELY 1 PERCENT

PLAGIOCLASE UP TO 1 CM LONG .04 MM WIDE. SOME IS 1 MM X 0.2 MM. SOME TIMES OCCURS AS SHEATHS. CLEAR TO WHITE.
PYROXENE EQUANT 1 X 1 MM GRAINS BROWN.
OLIVENE, 0.4 EUHEDRAL EQUANT GRAINS.
OPAQUES, BLADED BLACK, 0.1 X 0.01 MM.
VUGS, DOMINANT MINERAL IN VUGS IS PYROXENE. APPEARS TO BE PLAGIOCLASE AND OLIVINE IN VUGS TOO. PYROXENES ARE APPROXIMATELY 1 CM LONG APPROXIMATELY 0.8 MM WIDE. RANDOM ORIENTATION, NO CHANGE IN GROUND MASS NEXT TO VUG. PYROXENE APPEARS DARKER BROWN THAN PYROXENE WITH GROUND MASS. SHOCK ALTERATION OF SURFACE MINERALS. CALL IT AN OLIVINE BASALT.
SIDE 2 (BOTTOM) SUBROUNDED APPEARS TO HAVE AS MANY GLASS LINED PITS AS OTHER SIDE. TEXTURE IS SAME AS SIDE 1 WITH EXCEPTION THERE IS APPROXIMATELY 5 PERCENT BY VOLUME OF OVOID VESICLES. THE VESICLES ARE LINED WITH ALL VARIETIES LINING THE WALLS PARALLEL TO WALLS WITH EXCEPTION OF A LARGE COELESCED VESICLE WITH TOTAL LENGTH OF APPROXIMATELY 16 MM. THE CAVITIES ARE PARTIALLY FILLED WITH INTERTWINED PYROXENE CRYSTALS UP TO 5 MM LONG WITH SLIGHT GREENISH TINGE. THE SIDES OF THE ROCK HAVE NUMEROUS GLASS LINED PITS ALSO.



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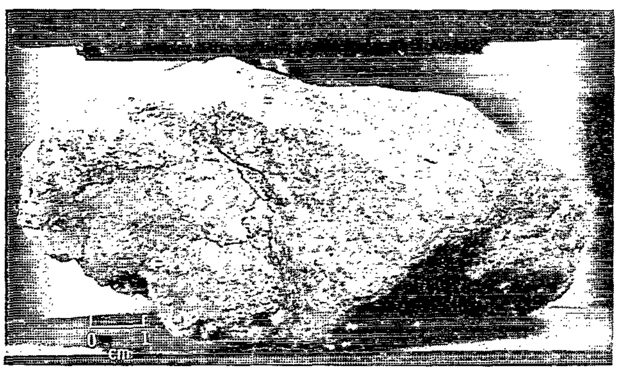

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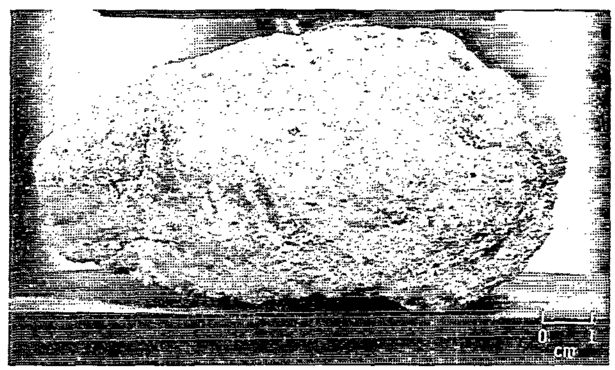

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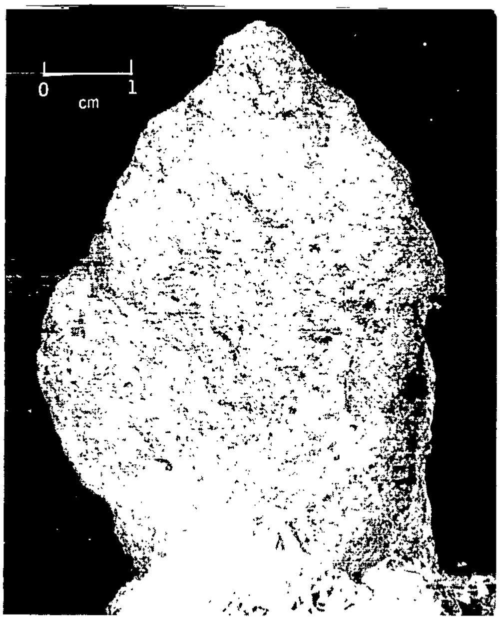
Figure A-42. - Sample 12055.

SAMPLE NO. 12056 WEIGHT 121.0 G DIMENSIONS 8 X 2.5 X 5 CM HEIKEN
ONE SIDE IS SUBROUNDED. ANGULAR WITH FRESH FRACTURE SURFACES . MEDIUM GRAINED HOLOCRYSTALLINE. VARIALITIC TEXTURE. SOME FRACTURING PARALLEL TO SURFACE AROUND EDGES APPROXIMATELY 2 PERCENT VESICLES .5 MM DIAMETER AND LARGER. SURFACE IMPACT PITS 0.1 TO 2 MM IN DIAMETER GLASS LINED. DARK BROWN TO BLACK GLASS LINING. IN A CIRCLE 1 CM DIAMETER THERE ARE 5 PITS. BUBBLY SURFACE IN THE GLASS. PITS IN GLASS LININGS ARE SLIGHTLY RAISED ABOVE ROCK SURFACE INDICATING HIGHER RESISTANCE THAN SURROUNDING ROCK.
FELDSPAR MILKY WHITE TO COLORLESS. LATH SHAPED CRYSTALS UP TO 1.5 MM LONG. 40 PERCENT.
PYROXENE . LIGHT REDDISH GRAY TO REDDISH BROWN . ELONGATE CRYSTALS 1 TO 1.5 MM LONG GROWING SUBPARALLEL TO THE FELDSPAR CRYSTALS. GROWING RADIALLY AROUND WHAT APPEARS TO BE A PYROXENE NUCLEUS AND IN OTHER CASES AN OLIVINE NUCLEUS. 35 PERCENT.
ILMENITE CRYSTALS .5 TO 1 MM LONG. 20 PERCENT. FORM BOTH EQUANT AND BLADED CRYSTALS.
OLIVINE 5 PERCENT. VERY PALE YELLOWISH GREEN OLIVINE. EQUANT CRYSTALS .5 MM DIAMETER.
SOME VESICLES AND VUGS HAVE EUHEDRAL PYROXENE AND OLIVINE CRYSTALS GROWING IN THEM BUT ARE NOT MUCH BIGGER THAN THE REST OF THE ROCK. ON THE BOTTOM SIDE ARE SOME ELONGATE CHAINS OF VESICLES.
VARIOLITIC DIABASE

SAMPLE NO. 12056 WEIGHT 121 G DIMENSIONS 8 X 2.5 X 5 CM WONES
SHAPE. ASSYMMETRIC TRIANGULAR PYRAMID.
COLOR. BROWNISH GRAY. 5YR 6/1.
TEXTURE. VUGGY. FINE GRAINED. SUBOPHITIC.
FABRIC. NO OBSERVED LINEATIONS. PRONOUNCED TENDENCY FOR VUGS TO BE ALIGNED ALONG SUBPARALLEL PLANES. VUGS ABUNDANT. IRREGULAR IN SHAPE.
FRACTURES. FRACTURES COMMON AT EDGES. SET OF FRACUTRES SUBPARALLEL TO FRESH SURFACE. SHAPE OF ROCK PROBABLY CONTROLLED BY FRACTURES.
SURFACE FEATURES. 2/4 MAJOR SURFACES ARE FRESH. OLDER SURFACES HAVE HALOED PITS WITH GLASS LININGS. MILKY WHITE SHOCKED FELDSPARS. INDENTATIONS AND ROUNDING. LARGEST PITS ARE 1.5 MM. PITS GREATER THAN 0.2 MM 6/CM2. SOME GLASS ADHERING TO SURFACE OF ROCK.
MINERALOGY.
MODE.
PYROXENE 60 PERCENT
PLAGIOCLASE 30 PERCENT
OLIVINE 3 PERCENT
OPAQUES 7 PERCENT
OLIVINE. GREEN. GLASSY. ROUNDED GRAINS. 0.2 MM.
PYROXENE. BROWN. LIGHT TO DARK. EQUANT. FORMS GROUNDMASS ONLY SLIGHTLY SMALLER THAN OLIVINE.
PLAGIOCLASE. CLEAR. LATH SHAPED CRYSTALS. 0.2 X 0.8 MM AVERAGE GRAIN SIZE.
OPAQUES. LUSTROUS. BLADED. 0.01 X 0.2 COMMON SIZE.
VUGS APPEAR TO CONTAIN MORE PLAGIOCLASE THAN GROUNDMASS. PYROXENE AND OLIVINE ARE PRESENT IN VUGS.
TERRESTRIAL ANALOGUE IS MICROGABBRO.



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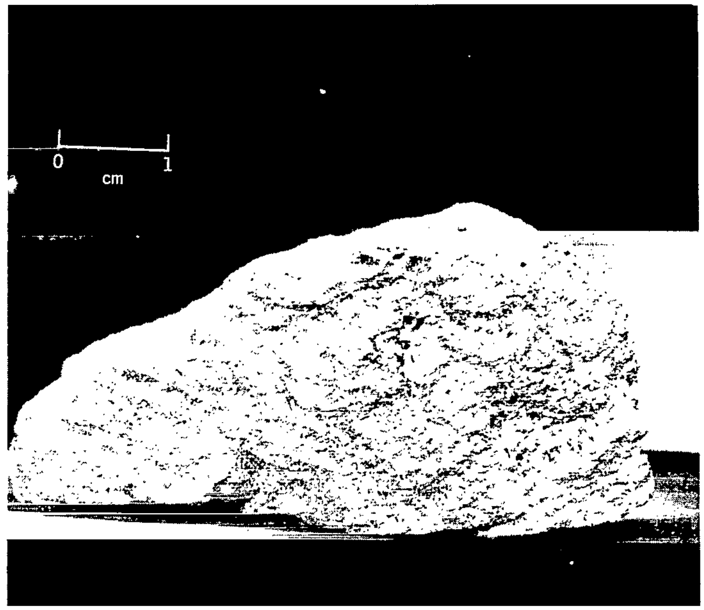

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Figure A-43. - Sample 12056.

SAMPLE 12057

Sample 12057 consists of fines and chips from the bottom of the D-ALSRC. The fines and chips were numbered and subsequently divided into the following subsets.

12057:

- 12057
- 12057-1
- 12057-2
- 12057-3

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Sample 12057

SAMPLE NO. 12057 WEIGHT 650 GRAMS WARNER
THIS SAMPLE CONSISTS OF FINES AND CHIPS FROM BOTTOM OF DOCUMENTED ALSRC.

SAMPLE NO. 12057 WEIGHT NONE DIMENSIONS CHIPS LESS THAN 1 CM AND GREATER THAN 1 MM INVESTIGATOR HEIKEN
TYPE NO. 1 APPROXIMATELY 20 PERCENT OF WHOLE SAMPLE. ANGULAR HOLOCRYSTALLINE. EQUIGRANULAR . AVERAGE CRYSTAL SIZE IS APPROXIMATELY 0.7 MM LONG. CONSISTS OF 1. APPROXIMATELY 20 PERCENT OF ROCK LIGHT TAN MINERAL WITH NO VISIBLE CLEAVAGE. ELONGATE. POSSIBLY PYROXENE. 2. MILKY WHITE ANHEDRAL CRYSTAL POSSIBLY HEAVILY FRACTURED FELDSPAR. MAKES UP APPROXIMATELY 55 PERCENT OF ROCK. 3. THIN BLADE LIKE CRYSTALS OF ILMENITE APPROXIMATELY 5 PERCENT.
TYPE NO. 2 APPROXIMATELY 40 PERCENT. WELL ROUNDED. COMPRESSED OR CEMENTED FINE GRAINED SURFACE MATERIAL. MEDIUM LIGHT GREY. AVERAGE GRAIN SIZE IS APPROXIMATELY LESS THAN 0.1 MM. ONLY IDENTIFIABLE FRAGMENTS ARE SAND SIZE PARTICLES OF BLACK GLASS.
TYPE NO. 3 APPROXIMATELY 10 PERCENT SUBANGULAR. FINE GRAINED HOLOCRYSTALLINE ROCK WITH RAISED GLASS LINED PITS. COLOR IS LIGHT BLACKISH GREY. FINE GRAINED

PROBABLY BASALTIC.
TYPE NO. 4 APPROXIMATELY 40 PERCENT. GREYISH-OLIVE GLASS ANGULAR FRAGMENTS EXHIBITING GOOD CONCHOIDAL FRACTURE. ROUND VESICLES APPROXIMATELY 1/2 MM IN DIAMETER. SURFACE IS COVERED WITH WHITE SPOTS .05 TO 0.2 MM. THESE HAVE A RADIAL SPHERULITIC APPEARANCE. POSSIBLY DEVITRIFICATION PRODUCTS.
SUBTYPE OF TYPE NO. 4 CONSISTS OF A MASS OF HIGHLY VESICULAR WELDED SPATTER WITH EXTREMELY IRREGULAR APPEARANCE. WELDED. WITH GLASSY SPATTER. ARE LESS THAN .1 MM GRAINS OF LUNAR SOIL. MANY OF DIFFERENT ROCK TYPES HAVE ON ONE OR TWO SIDES A THIN COAT OF DARK REDDISH BROWN GLASS. THE THIN COAT HAS A BUBBLY SURFACE.
TYPE NO 5. APPROXIMATELY 10 PERCENT. COARSE GRAINED HOLOCRYSTALLINE ROCK PORPHYRITIC. THE PHENOCRYSTS CONSIST OF 1. OLIVINE CRYSTALS UP TO 5 MM LONG PISTACHIO GREEN. SUBHEDRAL. HIGHLY FRACTURED. 2. SOME SMALLER PHENOCRYSTS APPROXIMATELY 1 MM LONG SUBHEDRALS BLADES OF ILMENITE IN GROUND MASS. THE AVERAGE GRAIN SIZE OF OLIVINE APPROXIMATELY 1 MM LONG AND ARE SUBHEDRAL. OLIVINE MAKES UP APPROXIMATELY 30 PERCENT OF ROCK. ILMENITE MAKES UP APPROXIMATELY 10 PERCENT. 3. CINNAMON BROWN PYROXENE. SUBHEDRAL APPROXIMATELY 0.8 MM APPROXIMATELY 45 PERCENT. ROCK IS GABBROIC.
TYPE NO. 6 IN TRACE AMOUNTS THERE ARE 1 MM GLASS BALLS IN MOD. OLIVINE BROWN.
TYPE NO. 7 IN TRACE AMOUNTS INDIVIDUAL ENHEDRAL CRYSTALS OF CINNAMON BROWN PYROXENE APPROXIMATELY 3 MM LONG.
TYPE NO. 8 IN TRACE AMOUNTS FINE GRAINED HOLOCRYSTALLINE ROCK CONSISTS OF 1/2 MM FELDSPAR CRYSTALS. IN A MEDIUM GREY MATRIX. MATRIX MINERALS ARE INDETERMINATE. BUT APPEAR BASALTIC. VESICLES FROM 1/10 TO 2.0 MM IN DIAMETER.
THIS ROCK IS EXPECTED TO BE LOW IN TITANIUM. CHECK WITH CHEMICAL ANALYSIS.

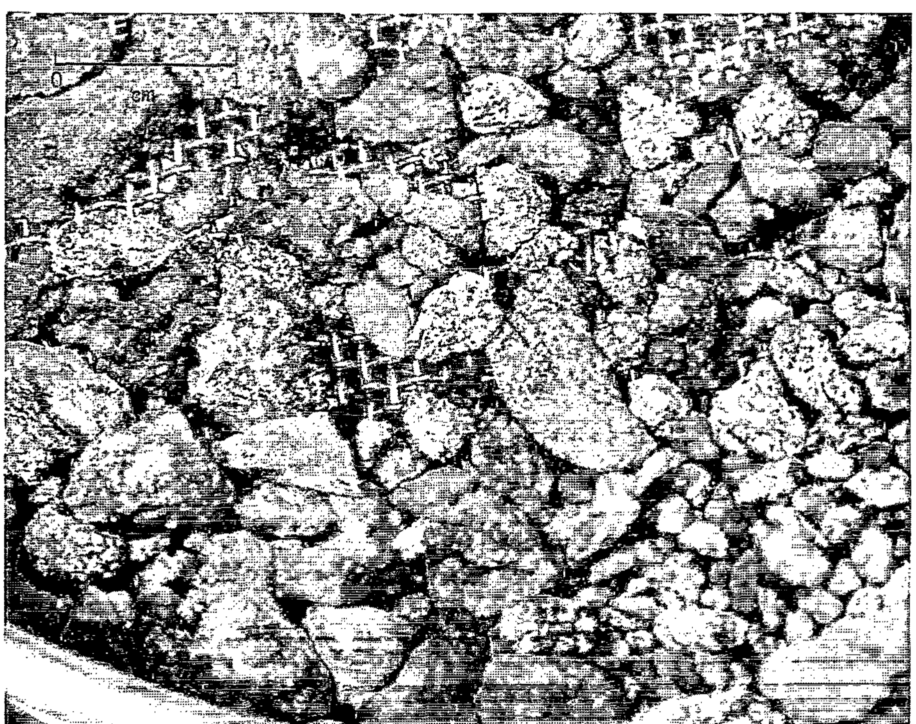


Figure A-44. - Sample 12057; chips less than 1 centimeter but more than 1 millimeter in diameter (NASA-S-69-60961).

SAMPLE NO. 12057 WEIGHT 479 SAMPLE 675 CAN + SAMPLE DIMENSIONS FINES HEIKEN IN/CM 6 CHIPS ABOVE 1 CM IN DIAMETER. EACH CHIP WAS WRAPPED IN ALUMINUM FOIL AND STORED IN CAN MARKED FINES CHIPS.
FINES CHIPS GREATER THAN 1 CM IN DIAMETER.
CHIP A. 1.1 X 1.6 X 1.0 CM SUBROUNDED MEDIUM CYRSTALLINE ROCK. MEDIUM GREY. OLIVINE RICH GABBROIC. VUG ON ONE SIDE CONTAINS PERFECT CRYSTAL OF OLIVINE AND ILMENITE.
MINERALOGY. 1. 40 PERCENT OLIVINE. PISTACHIO GREEN WITH CONCHOIDAL FRACTURE. CRYSTALS APPROXIMATELY 0.6 MM IN DIAMETER. 2. 10 PERCENT REDDISH BROWN STUBBY CRYSTALS WITH GOOD CLEAVAGE FACES PYROXENE. 3. ILMENITE. BLACK WITH VERY SHINY METALLIC LUSTER. FORMS BLADES UP TO 3 MM LONG. 10 PERCENT. 4) 40 PERCENT FELDSPAR. SUBHEDRAL AND ANHEDRAL MILKY WHITE CRYSTALS UP TO 2 MM LONG.
CHIP B. 1.2 X 1.2 X 1.2 CM. SUBANGULAR. FINE CRYSTALLINE ROCK. NO GLASS. ONE MAIN FRACTURE ACROSS THE MIDDLE OF THE ROCK WHICH BRANCHES INTO 3 DIRECTIONS ON OPPOSITE SIDE. PYROXENES AND FELDSPARS ARE ORIENTED. A SMALL IMPACT PIT ON THE SURFACE IS 1 MM IN DIAMETER AND 0.2 MM DEEP. IT IS LINED WITH A THIN LAYER OF LIGHT GREEN GLASS WITH A BUBBLY SURFACE. THERE IS A 1/4 MM WIDE WHITE HALO AROUND THE PIT. .
MINERALOGY. 1. ABOUT 15 PERCENT OLIVINE (LIGHT GREEN. ANHEDRAL CRYSTALS).
2. 15 PERCENT DARK REDDISH BROWN SUBHEDRAL PYROXENE. 3. 15 PERCENT ILMENITE.
4. 55 PERCENT POWDERY WHITE FELDSPAR.
CHIP C. 1.2 X 1.0 X 1.0 CM. HOLOCRYSTALLINE. MEDIUM GRAINED CRYSTALLINE ROCK. ANGULAR.
MINERALOGY. 1. 40 PERCENT MILKY WHITE FELDSPAR WITH 2 MM LONG LATHS. SOME PHENOCRYSTS UP TO 6 MM LONG. 2. LIGHT PINKISH BROWN SUBHEDRAL CRYSTALS UP TO 2 MM LONG. MOST ARE PARALLEL TO THE FELDSPAR LATHS. PYROXENE. 3. 20 PERCENT LONG. THIN SHEETS OF ILMENITE. 0.1 MM THICK AND 2 MM LONG.
CHIP D. 1.3 X 2.0 X 1.0 CM. ANGULAR. FINE GRAINED HOLOCRYSTALLINE FRAGMENT. FRACTURES PARALLEL TO SURFACE. IDENTICAL IN COMPOSITION AND TEXTURE TO CHIP B.
CHIP E. 2.5 X 3.2 X 1.0 CM. FINE GRAINED CRYSTALLINE BASALT. AVERAGE CRYSTAL SIZE IS ABOUT 0.2 MM. CONSISTS OF 35 PERCENT FELDSPAR. 30 PERCENT REDDISH BROWN PYROXENE. 20 PERCENT ILMENITE AND 15 PERCENT OLIVINE. IT CONTAINS ONE SURFACE PIT. 1 MM IN DIAMETER. LINED WITH PALE GREENISH YELLOW GLASS. A FRACTURE ACROSS ONE CORNER OF THE ROCK IS IN LINE WITH A 0.5 MM WIDE VUG. THE VUG CONTAINS GOOD CRYSTALS OF OLIVINE AND ILMENITE. ON ONE SIDE OF THE ROCK ARE SEVERAL PATCHES UP TO 2 MM ACROSS. WHICH HAVE A DIKTYTAXITIC TEXTURE.
CHIP F. 1.4 X 1.0 X 0.7 CM. MEDIUM GREY. MEDIUM TO COARSE GRAINED HOLOCRYSTAL-LINE. MINERALOGY. 1. 50 PERCENT WHITE TO COLORLESS FELDSPAR CRYSTALS. UP TO 2 MM LONG. 2. 40 PERCENT DARK REDDISH BROWN PYROXENE. UP TO 1.0 MM LONG.
3. 10 PERCENT ILMENITE. 4. LESS THAN 1 PERCENT AMBER TO YELLOWISH BROWN SUB-HEDRAL MINERAL. OLIVINE (QUESTION).

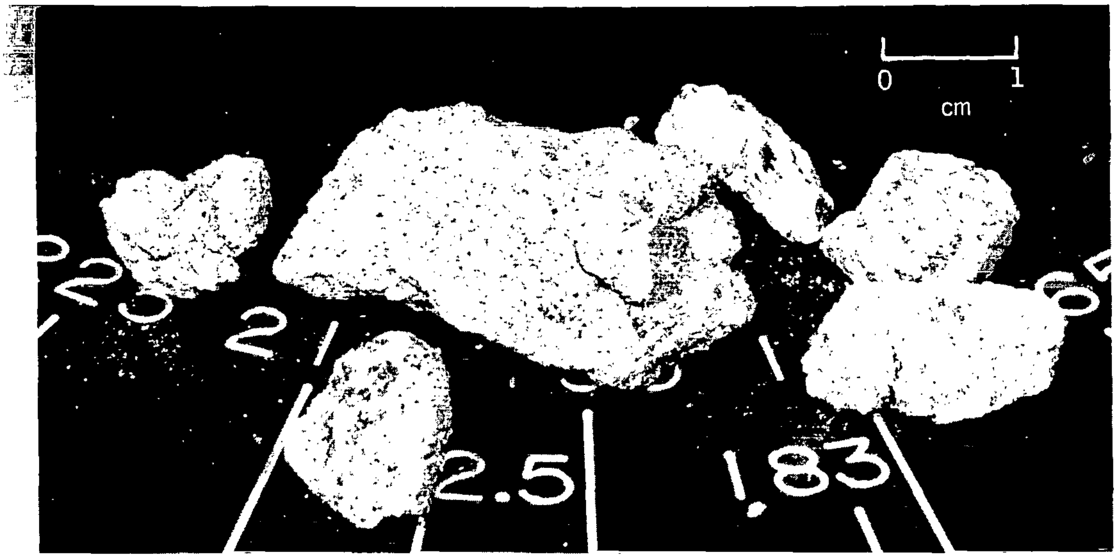


Figure A-45. - Sample 12057; chips more than 1 centimeter in diameter (NASA-S-69-60962).

Sample 12057-4

SAMPLE NO 12057.14 OPAQUES BRETT

1. ILMENITE
2. TROILITE
3. IRON
4. UNKNOWN BROWN PURPLE GREY OXIDE.
5. UNKNOWN PINK BROWN EITHER SULFIDE OR OXIDE
6. KHAKI COLORED PHASE

ILMENITE IN LATHS. COMMONLY SHOWING STRONG FRACTURING. RARELY AS ANHEDRAL MASSES. RARE EXSOLUTION OF VERY SMALL AMOUNTS OF 4.
ILMENITE IS ABOUT 85 PERCENT OF OPAQUES.
TROILITE IN IRREGULAR MASSES. COMMONLY CONTAINING SMALL IRON BLEBS. NO PARAGENESIS POSSIBLE EXCEPT ILMENITE EARLY.
IRON AS ABOVE. ALSO. AS IRREGULAR SOMEWHAT ROUNDED DISCRETE GRAINS.
UNKNOWN BROWN IN IRREGULAR GRAINS. LATH LIKE GRAINS AND AS POSSIBLE EXSOLUTION IN ILMENITE. RARELY CONTAINS EXSOLUTION LAMELLAE ON A FINE SCALE OF GREY PHASE. ILMENITE.
TWO GRAINS OF THIS PHASE. REFLECTIVITY APPEARS BETWEEN THAT OF A SULFIDE AND OXIDE. ISOTROPIC.
ONE SMALL GRAIN OF KHAKI PHASE. NEXT TO ILMENITE. WEAKLY ANSOTROPIC.
FOLLOWING APPARENT COMPATIBILITIES SEEN.

I / TR / FE
4 / I
4 / TR / FE
6 / I

A FEW SMALL VEINS CONTAINING VERY FINE GRAINED I / FE / TROILITE. SUGGESTIVE OF SHOCK VEINS.

SAMPLE NOS. 12057.14 AND 12057.15 SECTIONS FRONDEL
MICROGABBROS THAT HAVE BEEN SEVERELY SHOCKED (SEE PHOTOGRAPHS). SHOWS GRANULATION. BENDING AND DISLOCATION OF TWIN LAMELLAE IN PLAGIOCLASE. ETC. CRISTOBALITE PRESENT IN BOTH ROCKS. IN PART EUHEDRAL AND IN PART AS SKELETAL CRYSTALS. THE ACCESSORY ILMENITE IS SMALLER AND MORE EQUANT IN HABIT THAN USUAL.

SAMPLE NO. 12057.15 STANDARD THIN SECTION WILCOX
COARSE GRAINED SUBDIABASIC TEXTURE. WITH MUCH FRACTURING OF CRYSTALS (SHOCK). BUT VERY LITTLE DIFFERENTIAL DISPLACEMENT. CRYSTALS AND PLATES UP TO 2 1/2 MM LONG. SOME IN SUBRADIAL CLUSTERS.
APPROXIMATE MODE.
CLINOPYROXENE 45 PERCENT
PLAGIOCLASE 40 PERCENT
OPAQUE OXIDE 10 PERCENT
CRISTOBALITE OR TRIDYMITE 4 PERCENT
CLINOPYROXENE OCCURS IN LONG CRYSTALS. INTENSELY FRACTURED. SOME WITH STRONGLY DEVELOPED LAMELLAE TWINNING (FROM STRESS). COLOR ZONED FROM VERY PALE BROWN AT CENTERS TO BROWNISH RED AT EDGES. OPTIC ANGLE POSITIVE. VARIABLE 0 TO 35 DEGREES. EXTERIOR ANGLE LARGE. ZAC NEAR 45 DEGREES OR GREATER.
PLAGIOCLASE APPEARS TO BE CALCIC. PERHAPS AN70 TO AN901 EST. FROM RELIEF AND HI EXTERIOR ANGLES. CRYSTALS ARE VERY LONG. WITH BROAD LAMELLAE TWINNING MUCH SHATTERED BUT NOT SEPARATED.
OPAQUE GRAINS OCCUR IN LONG CROSS SECTIONS (PLATES) VERY DARK GRAY IN REFLECTED LIGHT (FLASHLIGHT ON UNPOLISHED SURFACE). (A FEW YELLOW REFLECTING SMALL MASSES ARE SCATTERED THROUGH THE ROCK).
CRISTOBALITE OR TRIDYMITE. MASSES OF STRONG NEGATIVE RELIEF AND VERY LOW VARIABLE BIREFRINGENCE ARE NOT UNCOMMON. THEY RANGE UP TO SEVERAL TENTHS OF A MM IN LENGTH AND HAVE GEOMETRICALLY STRAIGHT SIDES IN MANY CASES. THEY HAVE A VERY PALE BROWN COLOR. SURFACE TEXTURE IS WRINKLED. RETICULATED. REMINISCENT OF CRISTOBALITE. SECTION ACROSS ONE MASS OF THIS MATERIAL ABOUT 0.2 X 0.3 MM SHOWS INCLUSIONS OF PYROXENE AND OPAQUES.

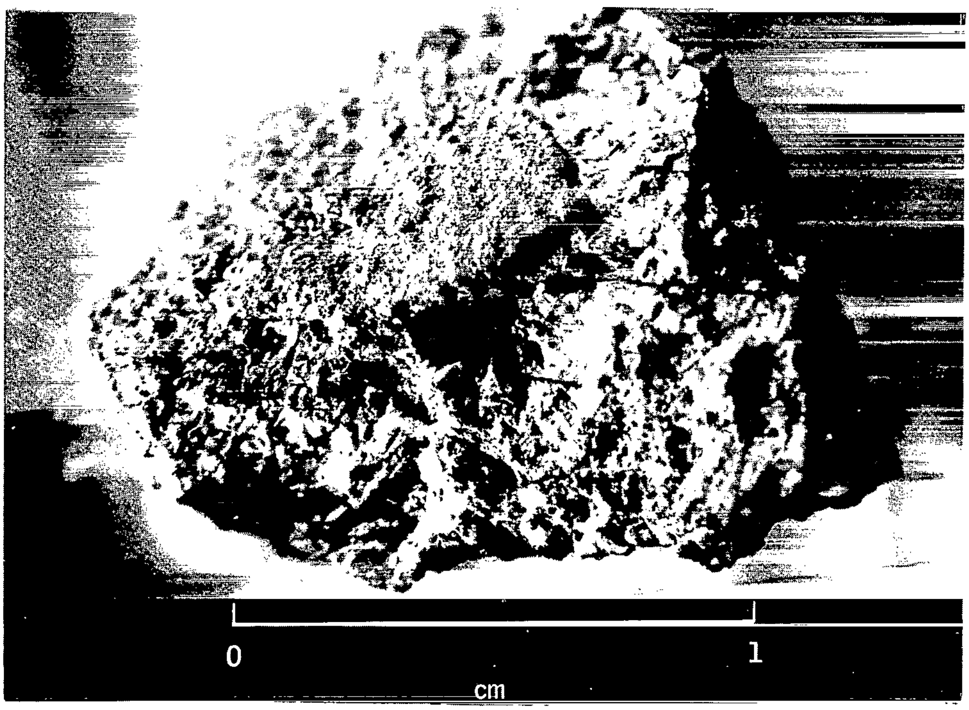


Figure A-46. - Sample 12057-4 (NASA-S-69-61393).

Sample 12057-5

SAMPLE NO. 12057.5 HARMON
STEREO MICROSCOPE EXAMINATIONS OF AN APPROXIMATE 1 CM3 CHIP. A HOLOCRYSTALLINE HIGHLY SHOCKED ROCK. MICROGABBRO.
MINERALOGY.
PHASES READILY IDENTIFIABLE ARE DESCRIBED AS FOLLOWS.

1. GROUNDMASS MATERIAL. VERY FINE GRAINED. WHITE COLOR. WITH A SUGARY TEXTURE. SOME GRAINS LARGE ENOUGH TO BE SEEN UNDER 4X MAGNIFICATION ARE LATH SHAPED. THE GROUNDMASS MATERIAL. ON THE WHOLE. APPEARS TO HAVE A POOR TO FAIR CLEAVAGE. A PLAGIOCLASE FELDSPAR. HIGHLY SHOCKED CAUSING THE GRANULAR TEXTURE. A PLAGIOCLASE FELDSPAR 30 PERCENT.
2. MAJOR MINERAL PHASE PRESENT. GRAIN SIZE RANGING UP TO 1 MM. A BROWN GREEN COLOR. LARGER CRYSTALS SHOW GOOD CLEAVAGE. MOST GRAINS ARE HIGHLY FRACTURED. CLINOPYROXENE APPROXIMATELY 50 PERCENT.
3. SECOND MAJOR MINERAL PRESENT. VERY PLATY HABIT. WITH A BLACK COLOR. THESE GRAINS CROSSCUT ALL OTHERS AND THE PLATES RANGE UP TO 0.3 CM IN LENGTH. ILMENITE APPROXIMATELY 15 PERCENT.
4. ACCESSORY PHASE. COLORLESS. CLEAR. OCCURRING IN EQUANT GRAINS USUALLY VERY ANGULAR WITH A SEMICONCHOIDAL FRACTURE. ANORTHITE FELDSPAR APPROXIMATELY 5 PERCENT.

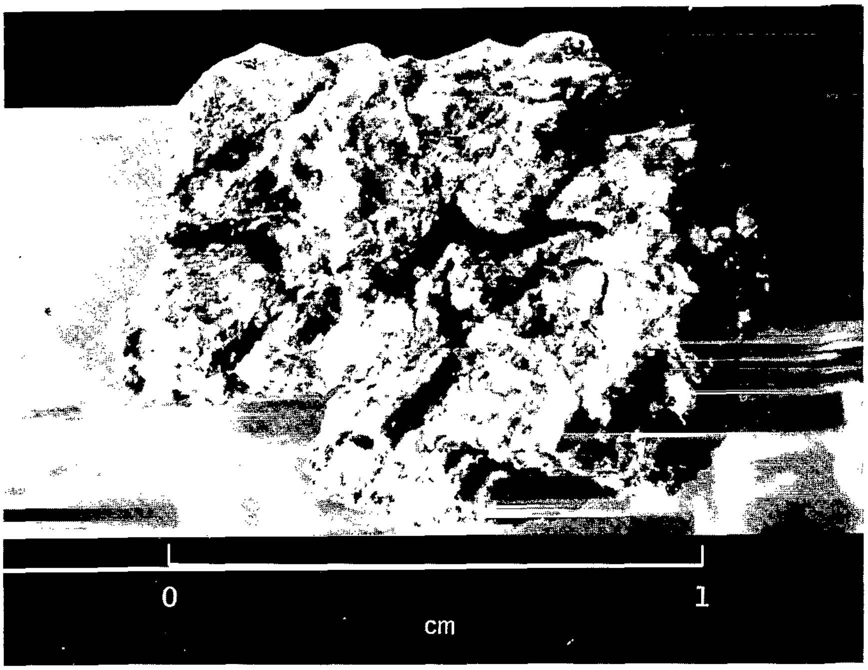


Figure A-47. - Sample 12057-5 (NASA-S-69-61395).

Sample 12057-6

SAMPLE NO 12057.17 THIN SECTION FRONDEL
COARSE GRAINED MICROGABBRO. WITH CLINOPYROXENE. ANORTHITE. ILMENITE. ABUNDANT CRISTOBALITE AND VERY LITTLE OR NO OLIVINE. A FEW GRAINS OF AN UNIDENTIFIED PALE YELLOW MINERAL WERE OBSERVED. NOT PLEOCHROIC.

SAMPLE NOS. 12057.18 AND 12057.17 THIN SECTION FRONDEL
OBSERVATIONS ON CRISTOBALITE IN SAMPLES.
CRISTOBALITE IS ABUNDANT IN THESE MICROGABBROS. IT IS GENERALLY EUHDORAL TO SUB HEDRAL AND RANGES IN GRAIN SIZE UP TO ABOUT 0.5 MM. THE CRYSTALS WERE ORIGINALLY HIGH CRISTOBALITE THAT HAVE INVERTED TO A MICROGRANULAR AGGREGATE OF LOW CRISTOBALITE. THERE IS A CONSIDERABLE DEGREE OF PREFERRED ORIENTATION IN THE GRAINS OF THE INVERSION PSEUDOMORPHS. AS SHOWN BY THE NEARLY UNIFORM EXTINCTION BETWEEN CROSSED NICOLS AND BY THE PARALLEL ALIGNMENT OF INDIVIDUAL SETS OF INVERSION TWINS. THE HIGH CRISTOBALITE CRYSTALS APPEAR TO BE OCTA-HEDRONS FLATTENED ON A (111) FACE. SOME CRYSTALS WERE HEXAGOREAL IN OUTLINE WITH LATERAL EDGES ALTERNATELY SLOPING UP AND DOWN.) LATERAL SECTIONS THROUGH THESE TABULAR CRYSTALS ARE ELONGATE. GENERALLY WITH SIX EDGES (OR FACES). TRIDYMITE WAS NOT IDENTIFIED WITH CERTAINTY IN THESE ROCKS ALTHOUGH IT OCCURS TOGETHER WITH CRISTOBALITE IN APOLLO 11 ROCKS. CRISTOBALITE ALSO WAS OBSERVED TO OCCUR IN SKELETAL CRYSTALS RESEMBLING FOUR LEAFED CLOVERS (SEE PHOTOGRAPHS OF THESE AND OF OTHER CRISTOBALITE CRYSTALS).

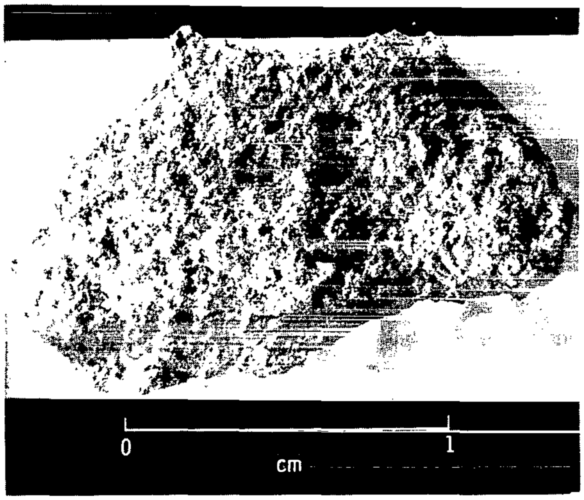


Figure A-48. - Sample 12057-6 (NASA-S-69-61406).

Sample 12057-7

SAMPLE NO. 12057.13 THREE CHIPS 12057.7 1.9 GRAMS HARMON
BINOCULAR MICROSCOPE EXAMINATION AND IMMERSION OIL GRAIN MOUNTS. THE CHIP IS HOLOCRYSTALLINE. WITH A GRANULAR TEXTURE. GRAINS OF ALL MINERAL PHASES PRESENT ARE GENERALLY EQUANT WITH GRAIN SIZE RANGING UP TO 0.2 MM. THE CHIPS ALL HAVE A VERY FRESH LOOKING APPEARANCE. SMALL (0.1 TO 0.5 MM) IRREGULAR CAVITIES (VUGS) ARE PRESENT IN ALL OF THE CHIPS BUT NO INCREASE IN GRAIN SIZE OF THE MINERALS SURROUNDING THESE CAVITIES IS OBSERVED. ONE OF THESE CHIPS SENT FOR AA CHEMICAL ANALYSIS.
MINERALOGY.
THE SAMPLE IS BASICALLY COMPOSED OF FOUR MINERAL PHASES. THREE PRIMARY PHASES AND ONE ACCESSORY PHASE.

1. A MILKY WHITE TO COLORLESS MINERAL. GENERALLY EQUANT TO LATH SHAPED. OCCURRING IN AGGREGATES. TWO POOR FAIR CLEAVAGES. THE MILKY WHITE GRAINS ARE ALWAYS SMALLER AND MORE FRACTURED THAN THE CLEAR. COLORLESS GRAINS. INDEX OF REFRACTION APPROXIMATELY 1.57. GRAIN SIZE UP TO 0.2 MM. EXCELLENT POLYSYNTHETIC TWINNING FELDSPAR (ANORTHITE) APPROXIMATELY 35 PERCENT.

A. A COLORLESS MINERAL. OCCURS AS PLATELETS IN PARALLELOGRAM AND POLYGONAL SHAPES. THE BASE CLEAVAGE IS EXCELLENT. GRAIN SIZE IS GENERALLY LARGER THAN THAT OF THE FELDSPAR DESCRIBED ABOVE. RANGING UP TO 2.0 MM. INDEX OF REFRACTION LESS THAN 1.48. ISOTOPIC WITH ABUNDANT INCLUSIONS. (MAY BE A SHOCKED FELDSPAR. MORE ACIDIC THAN THE PURE ANORTHITE) APPROXIMATELY 5 PERCENT. PRIMARILY OCCURRING IN THE VUGS IN THE ROCK NOT SEEN AT ALL IN THE GROUNDMASS. THIS MAY BE A CONTAMINANT.

2. A HONEY YELLOW TO BROWN MINERAL. GENERALLY EQUANT GRAINS. GRAIN SIZE RANGES UP TO 0.5 MM. SOME GRAINS SHOW A POOR/FAIR CLEAVAGE AND OTHERS HINTS OF A PRISMATIC HABIT. INDEX OF REFRACTION GREATER THAN OR EQUAL TO 1.71. MODERATE BIREFRINGENCE. EXTINCTION ANGLE APPROXIMATELY 35 PERCENT. (CLINO-PYROXENE/PIGEONITE) APPROXIMATELY 40 PERCENT.

3. A BLACK OPAQUE MINERAL. GRAINS ARE IRREGULARLY SHAPED. GRAIN SIZE RANGES UP TO 1.0 MM WITH MOST GRAINS ABOUT 0.5 MM. MUCH SMALLER GRAINS OCCUR AS INCLUSIONS IN ALL THE OTHER MINERAL PHASES PRESENT. SOME GRAINS HAVE A PLATY HABIT. (ILMENITE) APPROXIMATELY 20 PERCENT.

4. A GREEN MINERAL. GRAINS ARE EQUANT WITH GRAIN SIZE AVERAGING ABOUT 0.5 MM. ONE GRAIN OBSERVED SHOWED ELONGATION INTO A PRISMATIC HABIT WITH THE LONG AXIS 2X THE OTHER AXIS. MOST GRAINS HAVE INCLUSIONS OF THE BLACK OPAQUE MINERAL. FRACTURING IS SEMI CONCHOIDAL. INDEX OF REFRACTION GREATER THAN 1.71 (OLIVINE) APPROXIMATELY 5 PERCENT.

SECTION 120057.18 CHIP FROM ROCK 1 TO 6 IN DOCUMENTED BOX.
W. R. GREENWOOD DECEMBER 6. 1969
A MEDIUM FINE GRAINED HOLOCRYSTALLINE ROCK (AVERAGE GRAIN SIZE APPROXIMATELY 1 MM) WITH TRACHYTIC TEXTURE. COMPOSED OF

1. LIGHT SALMON CLINOPYROXENE 60 PERCENT
2. PLAGIOCLASE / AN APPROXIMATE 75 PERCENT APPROXIMATELY 3 PERCENT
3. ILMENITE 7 PERCENT
4. LIGHT YELLOW GREEN ORTHOPYROXENE APPROXIMATELY 3 PERCENT
5. OLIVINE APPROXIMATELY 2 PERCENT
6. CRISTOBALITE APPROXIMATELY 2 PERCENT
7. ACCESSORIES. RUTILE AND REACT. ZONES APPROXIMATELY 1 PERCENT

THE CLINOPYROXENE AND THE PLAGIOCLASE ARE COMPOSITIONALLY ZONED.
OLIVINE IS COMMONLY FOUND AS CORES OF CLINOPYROXENE CRYSTALS WITHOUT A REAC. OF RIM. WHERE ORTHOPYROXENE IS HANDED IN PART BY CLINOPYROXENE AND IN PART BY PLAGIOCLASE A COMPLICATED REACTION ZONE IS FORMED BETWEEN BOTH THE PYROXENES AND BETWEEN ORTHPYROXENE AND PLAGIOCLASE. THE INTERGROWTH INCLUDES A CLEAR LOW BIREFRINGENT HIGH RELIEF GLOBULAR TO SAUSAGE SHAPED MINERAL WHICH GROWS IN THE PLAGIOCLASE AND IN THE PYROXENE.
THE HIGH RELIEF MINERAL IS ENCLOSED IN A LOW RELIEF AND BIREFRINGENT ZONE IN THE PLAGIOCLASE. A FIBROUS. FINE GRAINED. INTERGROWTH OF A HIGH RELIEF AND BIRE-FRINGENT MINERAL AND OPAQUES REPLACE ORTHOPYROXENE. CRISTOBALITE TO HAVE CRYSTALLINE FROM THE RELIEF LIQUID INTO WHICH THE LAST PLAGIOCLASE WAS GROWING ALTERNATIVELY IT COULD BE ON SOLID STATE REPLACEMENT GROWTH.
ONE LATH OF PLAGIOCLASE APPEARS TO NUCLEATE OR AND GROW PARALLEL TO BOTH SIDES OF A CLINOPYROXENE BLADE WITH INCREASING SODIUM CONTENT THROUGH TIME. LATHS OF CLINOPYROXENE TEND TO GROW FROM COMMON NUCLEATION CENTERS TO DEFINE SECTIONS OF CRYSTALLIZATION. THESE NUCLEATION POINTS MAY HAVE BEEN CRYSTALS OF OLIVINE AND ORTHOPYROXENE IN THE MELT. SIMULTANEOUS GROWTH OF PLAGIOCLASE ON THE CLINOPYROXENE PRODUCED LONG BLADES WHICH TEND TO DOMINATE LOCAL TEXTURE (UP TO 1 CM ACROSS). DIFFERENT NUCLEATION CENTERS HAVE DIFFERENT ORIENTATION PATTERNS. PERHAPS DUE TO OUT EFFECT. THE BOUNDARY ZONE BETWEEN THE NUCLEATION SECTORS HAS MORE COMPLICATED INTERGROWTHS OF CLINOPYROXENE AND PLAGIOCLASE AND SOME SHEARING AND RECRYSTALLIZATION ALSO PERHAPS A HIGHER CONTENT OF CRISTOBALITE.
CRISTOBALITE CONTAINS TINY SAUSAGE SHAPED RED BROWN HIGH RELIEF INCLUSION THAT MAY BE RUTILE.

SAMPLE NO. 12057.18 HARMON

THIN SECTION EXAMINATION OF A CHIP OF 12057.17 UNDER THE PETROGRAPHIC MICROSCOPE.

THE SAMPLE IS HOLOCRYSTALLINE WITH A MEDIUM TO MEDIUM COARSE GRAIN SIZE WITH FIVE MAJOR MINERAL PHASES PRESENT. SOME SMALL CAVITIES AND FRACTURES PRESENT.

1. PLAGIOCLASE FELDSPAR. GENERAL OCCURRENCE IS LATH SHAPED GRAINS WITH VERY IRREGULAR BOUNDARIES . OFTEN GRAINS ARE VERY MUCH ELONGATED IN ONE DIRECTION. MANY OF THE GRAIN BOUNDARIES OF THE FELDSPARS ARE CUT BY ALL OF THE OTHER PHASES PRESENT. BUT IN SOME CASES FELDSPAR GRAINS ENCLOSE PYROXENE GRAINS. SOME OF MORE ELONGATE GRAINS RANGE UP TO OVER 1 MM IN LENGTH WITH THE AVERAGE GRAIN SIZE BEING ABOUT 0.5 MM. MOST GRAINS SHOW TYPICAL FELDSPAR TWINNING AND DO NOT APPEAR TOO SHOCKED. NO PREFERRED ORIENTATION OF THE FELDSPAR GRAINS WAS NOTED.

2. CLINOPYROXENE . GENERAL OCCURRENCE IS IN EQUANT TO PRISMATIC GRAINS. MANY OF THE GRAINS SHOW MORE HIGHLY DEVELOPED CRYSTAL FORMS THAN THE FELDSPAR INDICATING AN EARLIER CRYSTALLIZATION. SOME GRAINS REACHING 1 MM IN SIZE ARE PRESENT. BUT THE AVERAGE GRAIN SIZE IS ABOUT 0.3 MM.

3. OPAQUE OXIDE (ILMENITE). GENERAL OCCURRENCE IS IN PLATY TO IRREGULARLY SHAPED OPAQUE GRAINS. THE LARGER BETTER DEVELOPED GRAINS ARE 0.2 TO 0.3 MM LONG AND CUT ACROSS ALL OTHER PHASES PRESENT.

4. OLIVINE. A VERY FEW EQUANT. HIGHLY BIREFRINGENT GRAINS WERE OBSERVED. SEMI CONCHOIDAL FRACTURING. WITH GRAIN SIZE AVERAGING ABOUT 0.2 MM.

5. CRISTOBALITE. GENERALLY OCCURS AS BOTH INTERSTITIAL MATERIAL AND AS INDIVIDUAL GRAINS. LOWLY BIREFRINGENT. CHARACTERISTIC TWINNING AND GENERAL MOTTLED APPEARANCE. SOME LARGER GRAINS RANGE UP TO 0.3 MM.

TWO POINT COUNTS OF 500 POINTS WAS CONDUCTED WITH THE FOLLOWING RESULTS.

	NUMBER POINTS	PERCENTAGE
PLAGIOCLASE FELDSPAR	145	29.0
CLINOPYROXENE	252	50.4
OPAQUE	63	10.3
OLIVINE	13	2.6
CRISTOBALITE	17	3.5
VOID SPACES	10	2.0
PLAGIOCLASE FELDSPAR	131	26.2
CLINOPYROXENE	243	48.6
OPAQUE	60	12.0
OLIVINE	33	6.6
CRISTOBALITE	24	4.8
VOID SPACES	12	2.4

SAMPLE NO. 12057.18 STANDARD THIN SECTION (FROM CHIP 7) WILCOX

THIS IS A COARSE GRAINED CRYSTALLINE ROCK WITH MUCH CLINOPYROXENE AND CALCIC PLAGIOCLASE. LESS OPAQUE OXIDE AND OLIVINE. AN UNKNOWN GREEN MINERAL IS PRESENT IN SMALL QUANTITY.

MODE (VERY APPROXIMATE)

CLINOPYROXENE 40 PERCENT
PLAGIOCLASE 30 PERCENT
OPAQUE 15 PERCENT
OLIVINE 10 PERCENT
UNKNOWN GREEN MINERAL 3 PERCENT
CRISTOBALITE 2 PERCENT

UNKNOWN GREEN MINERAL AS SCATTERED STUBBY CRYSTALS HAS PALE BOTTLE GREEN TO PALE YELLOW GREEN PLEOCHROISM IN THIN SECTION. POSSIBLY 2 CLEAVAGES AT ABOUT 90 DEGREES. PARALLEL EXTINCTION. STRONG POSITIVE RELIEF. STRONG BIREFRINGENCE (NEAR 0.04) AND OPTIC ANGLE 2V NEGATIVE. SMALL (LESS THAN 30 DEGREES). IT SHOWS REACTION IN CONTACT WITH CLINOPYROXENE AND PLAGIOCLASE. IN REFLECTED LIGHT (FLASHLIGHT) THESE CRYSTALS ARE PALE POWDERY WHITE. AS IF DECOMPOSING. CLINOPYROXENE IS MOSTLY IN LONG CRYSTALS SLIGHT BROWN REDDISH COLOR. PLEOCHROISM WEAK OR ABSENT. SOME FAINT ZONING OF COLOR. SOME BUNDLES AND ROSETTES OF THIN CRYSTALS IN PLAGIOCLASE. OF SEVERAL 2V ESTIMATES NONE WERE LOWER THAN 40 DEGREES. SLIGHTLY HIGHER BIREFRINGENCE ON RIMS OF SOME CRYSTALS.

PLAGIOCLASE ELONGATE. NOT STRONGLY EUHEDRAL. ONLY MILD PROGRESSIVE ZONING CALCIC COMPOSITION (BETWEEN AN60 TO AN 90).
OLIVINE NEARLY COLORLESS. PRESENT AS CORES AND RELICS. NON EUHEDRAL. WITH OVERGROWTHS OF CLINOPYROXENE.
OPAQUE GRAINS MANY ELONGATE PLATES. DARK GRAY COLOR IN REFLECTED LIGHT (FLASH LIGHT). THERE ARE A FEW SCATTERED BRIGHTLY REFLECTING GRAINS.
CRISTOBALITE NOT EXAMINED IN DETAIL.

SAMPLE 12057.19 OPAQUES BRETT
1. ILMENITE
2. TROILITE
3. IRON
4. PURPLE BROWN PHASE
5. BLUISH PURPLE GREY PHASE
ILMENITE LATHS. SCARCELY FRACTURED COMPARED TO 12057.14. NO EVIDENCE OF EXFOLIATION.
TROILITE. AS FOR 12057.14.
IRON. AS FOR 12057.14.
PURPLE BROWN. PROBABLY SAME PHASE AS (4) IN 12057.14. CHARACTERISTICALLY CONTAINS CORE OF BLUISH PURPLE GREY. ONLY OCCURRENCE OF BLUISH PURPLE. THIS MAY BE ZONING. NO NEW PHASE OR EXSOLUTION. PHASES APPEAR TO GRADE INTO ONE ANOTHER. SURELY THE SAME STRUCTURE IF NOT THE SAME MINERAL.
I / TR / FE

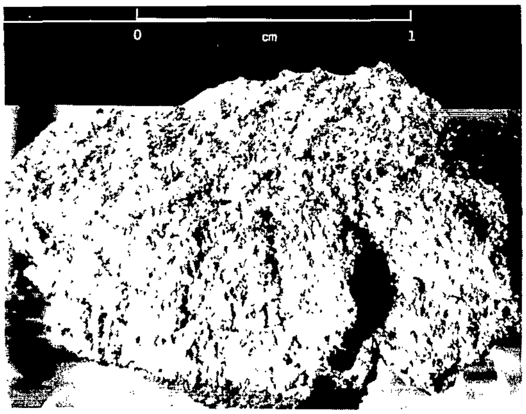


Figure A-49. - Sample 12057-7
(NASA-S-69-61390).

Sample 12057-8

SAMPLE NO. 12057.8 SMITH
DIMENSIONS 12.6 X 10.08 X 6.3 MM COLOR. GREENISH GRAY SPECKLED.
FRACTURED AND FRIABLE. PERHAPS FROM ARTIFICAL BREAKAGE. RECOGNIZABLE MINERALS FROM STEREO MICROSCOPE EXAMINATION ARE OLIVINE 30 PERCENT. CLINOPYROXENE 40 PERCENT. PLAGIOCLASE 25 PERCENT. OPAQUES 5 PERCENT.
OLIVINE OCCURS IN CLEAR OLIVE YELLOW GREEN APPROXIMATELY EQUANT CRYSTALS RANGING FROM .25 TO 3.8 MM. THE OLIVINE GRAINS CONTAIN TINY OPAQUE INCLUSIONS .05 TO .075 MM IN DIAMETER.
CLINOPYROXENE OCCURS IN CLEAR PALE CINNAMON BROWN CRYSTALS 0.6 TO 7.5 MM LONG. THE LARGER CRYSTALS POIKILITICALLY ENCLOSE OLIVINE AND THE OTHER MINERALS.
PLAGIOCLASE OCCURS IN LATH LIKE AND GRANULAR MASSES 0.6 TO 2.5 MM LONG MOSTLY CLEAR TO MILKY TRANSLUCENT. POLYSYNTHETIC TWINNING READILY VISIBLE.

OPAQUE MINERALS ARE OF AT LEAST TWO TYPES.

1. TINY GRAINS .05 TO .075 MM INCLUDED IN OLIVINE AND
2. LARGER GRAINS UP TO 1 MM OCCURRING AS A MAJOR MODAL MINERAL.

ONE SMALL AREA OF THE FRAGMENT SHOWS A TINY DARK GREY BROWN GLASS SPLASH ABOUT .05 MM IN DIAMETER.

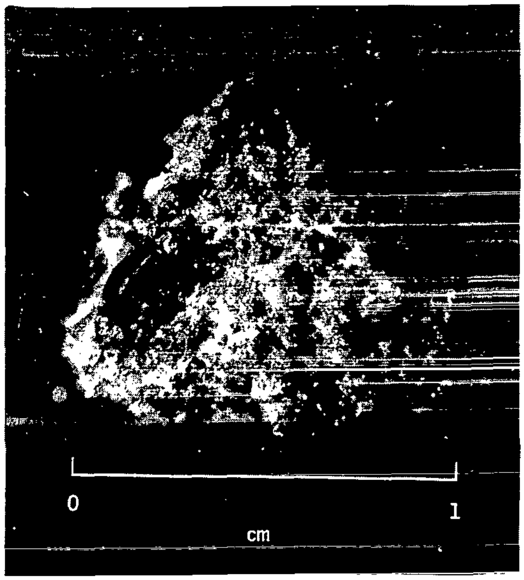


Figure A-50. - Sample 12057-8 (NASA-S-69-61388).

Sample 12057-9

SAMPLE 12057.21
W. R. GREENWOOD DECEMBER 6. 1969 OLIVINE GABBRO CHIEF DESCRIPTION
A HOLOCRYSTALLINE EQUIGRANULAR ROCK COMPOSED OF
OLIVINE 45 PERCENT
CLINOPYROXENE 30 PERCENT
PLAGIOCLASE 20 PERCENT
OPAQUES 5 PERCENT
OLIVINE IS EUHEDRAL. SOME CRYSTALS HAVE CORES OF PYROXENE.
PYROXENE AND OLIVINE FORM AGGREGATE CLUSTERS WITH THE INTERVENING AREA FILLED WITH PLAGIOCLASE.
PLAGIOCLASE IS ABOUT AN 64.
THE OVERALL TEXTURE APPEARS ENVEALED. NO OBVIOUS ZONING WAS SEEN IN PLAGIOCLASE OR PYROXENE. THE TEXTURE IS SIMILAR TO COMULATE TEXTURES IN THE STILLWATER.
PYROXENE SHOWING TWINNING AND OR BINDING. OLIVINE CONTAINS NEGATIVE CRYSTALS. SOME OF WHICH ARE FILLED WITH FINE CRYSTALLINE INTERGROWTHS. SOME APPEAR EMPTY.
THIS ROCK MAY BE THAT FROM WHICH THE ANORTHOSITE WAS EXTRUDED.

SAMPLE 12057.21 HARMON
A 100 POINT COUNT OF THE SECTION WAS MADE WITH THE FOLLOWING RESULTS.

PLAGIOCLASE	21 POINTS	21 PERCENT
CLINOPYROXENE	59 POINTS	59 PERCENT
OPAQUE OXIDE	7 POINTS	7 PERCENT
VOID SPACE	4 POINTS	4 PERCENT
OLIVINE	9 POINTS	9 PERCENT

SAMPLE NO. 12057.21 STANDARD UNPOLISHED THIN SECTION WILCOX
COARSE OLIVINE RICH. CLINOPYROXENE. PLAGIOCLASE GRANULAR ROCK.
APPROXIMATE MODE.

OLIVINE 55 PERCENT
CLINOPYROXENE 20 PERCENT
PLAGIOCLASE 20 PERCENT
OPAQUE 5 PERCENT

OLIVINE HAS FAINT COLOR. BROWNISH YELLOW ON THIS SCOPE. HAS 2V APPROXIMATELY 90 DEGREES (SEVERAL OPT EX SECTIONS). LITTLE CLEAVAGE. GOOD UNIFORM EXTINCTION. INCLUSION OF VERY DARK GLASS AND CRYSTALLINE MATERIAL. OFTEN SHOWING CRYSTAL FORM. (SOME OF THESE SHOW UP AS NEGATIVE CRYSTALS CONTAINING TRUE OPAQUE INCLUSION. USING REFLECTED LIGHT (FLASHLIGHT). OTHER INCLUSIONS ARE OPAQUE OXIDE AND CLINOPYROXENE.
CLINOPYROXENE HAS FAINT COLOR. REDDISH BROWN. NOT MUCH MORE INTENSE THAN THE OLIVINE. EXCEPT ONE CASE OF DISTINCT PLEOCHROISM TO BROWNISH LAVENDER AT EDGE OF ONE CRYSTAL. SOME TWINNING. HAS A 2V VERY SMALL (5 DEGREES TO 30 DEGREES) IN SEVERAL FAVORABLE SECTIONS. VARIABLES IN SOME CRYSTAL. NO LARGE 2V OBSERVED. EXTINCT ANGLE LARGE (50 DEGREES AIC). MODERATELY ZONED AS SEEN NEAR OPTIC AXIS SECTION.
PLAGIOCLASE HAS BROAD TWIN LAMELLAE. SOME STREAKS OF INCLUSIONS. OTHERWISE OPTICALLY HOMOGENEOUS AND UNZONED. HAS POSITIVE RELIEF BUT NOT HIGH. AS SEEN ON THIS MICROSCOPE. HAS EXT. ANGLE LARGE. BUT NO STRATEGIC SECTIONS FOUND FOR AN CONTENT. WITHIN THE WIDE LIMITS ALLOWED UNDER THESE CONDITIONS OF ILLUMINATION THIN PLAGIOCLASE MIGHT BE SOMEWHERE BETWEEN AN 60 AND AN 90.
OPAQUE OXIDE HAS VARIOUS FORMS. NEARLY EQUANT TO LONG

Figure A-51. - Sample 12057-9
(NASA-S-69-61403).

SAMPLE NO. 12057.12 SMITH
ONE LARGER (5.0 X 4.4 X 3.2 MM) AND THREE SMALLER (LESS THAN 2.5 MM) CHIPS. DARK GRAY BLACK VESICULAR ROCK PORPHYRITIC WITH SPHERICAL VESICLES RANGING FROM .63 MM DOWN TO LESS THAN .025 MM. THE LARGEST CHIP HAS ONE ROUNDED OUTER SURFACE WITH A PATCH OF CHALKY WHITE FELDSPAR THAT MAY REPRESENT AN EXPOSED OUTER SURFACE IN THE LUNAR ENVIRONMENT. THE CHALKY WHITE PATCH APPROXIMATELY 1.0 X 1.5 MM CONTAINS TINY AREAS OF MORE CLEAR PALE YELLOWISH CRYSTALLINE MINERAL.
ONE OF THE SMALLER CHIPS SHOWS A TINY GLASS LINED PIT.
ALL CHIPS CONTAIN PLAGIOCLASE AS PHENOCRYSTS OR XENOCRYSTS UP TO .6 MM LONG.
ONE PALE YELLOW OLIVINE PHENOCRYST APPROXIMATELY .4 MM WAS REMOVED AND CHECKED OPTICALLY (SEE BELOW).
PETROGRAPHIC EXAMINATION OF GRAINS SHOWS THE PLAGIOCLASE (N GREATER THAN 1.55) TO BE XENOCRYSTIC IN A GROUNDMASS OF DARK BROWN GLASS (N GREATER THAN 1.55). FELDSPAR LATHS AND MINOR OLIVINE AND PYROXENE. PLAGIOCLASE SHOWS BOTH POLY-SYNTHETIC TWINNING AND ZONING. THE GROUNDMASS MINERALS ARE LIQUIDOUS CRYSTALS OR MICHOLITE, NOT DEVITRIFICATION PRODUCTS.
OPTICS INDICATE
OLIVINE - FO LESS THAN 80, PERHAPS ABOUT 70.
PLAGIOCLASE - AN ABOUT 65
GLASS - N GREATER THAN 1.57.

SAMPLE NO. 12057.23 BRECCIA CHIP WILCOX
THIS APPEARS TO BE A BRECCIA OF SEVERAL GENERATIONS OF CLASTS, HEALED AND REMELTED TO VARYING EXTENTS. PREDOMINANT FRAGMENTS ARE CALCIC PLAGIOCLASE, CLINOPYROXENE AND AGGREGATES OF SAME, IN SERIAL SIZE DISTRIBUTION FROM ABOUT 1.5 MM DOWN TO IRRESOLVABLE PARTICLES.
ONE PROMINENT CLAST ABOUT 4 MM DIAMETER IS MADE UP CHIEFLY OF CALCIC PLAGIO-CLASE FRAGMENTS. IN THIS MASS IS ONE ROUNDED FRAGMENT OF SANIDINE ABOUT 0.3 MM DIAMETER. IT HAS LOW NEGATIVE RELIEF, 2V NEGATIVE, ABOUT 20 DEGREES, AND LOW BI REFRINGENCE. ONE GOOD CLEAVAGE SHOWN, POSSIBLY A SECOND CLEAVAGE PRESENT. DEVELOPING IN THE PERIPHERY ARE SMALL MASSES OF HIGHER POSITIVE RELIEF AND HIGHER BIREFRINGENCE THAN THE HOST SANIDINE, AND THESE RESEMBLE THE PRE-DOMINANT CALCIC PLAGIOCLASE OF THE ROCK.
ANOTHER CRYSTAL FRAGMENT NEAR EDGE OF SLIDE SHOWS MODERATE NEGATIVE RELIEF, LOW BIREFRINGENCE, FAR OFF CENTER FIGURE POSSIBLY NEGATIVE SIGN. (THE MODERATE NEGATIVE RELIEF ARGUES AGAINST SANIDINE FOR THIS FRAGMENT).
ADDENDUM TO NOTE OF 12/9/69 ON THIS THIN SECTION.
IN THE SAME BRECCIA FRAGMENT AS THE SANIDINE REFERRED TO ALREADY ARE SEVERAL CLOTS OF STRONG NEGATIVE RELIEF, VERY LOW BIREFRINGENT MATERIAL (CRISTOBALITE/ TRIDYMITE) IN WHICH ARE SET NUMEROUS STUBBY CRYSTALS OF POSITIVE RELIEF (PYROXENE). THESE MAY BE VUG FILLINGS, BUT THE ARRANGEMENT OF PYROXENE CRYSTALS IN SOME CLOTS IS REMINISCENT OF THAT IN GHOSTS OF QUARTZ XENOCRYSTS IN SOME BASALTS.
FURTHER ADDENDUM. IN REGARD TO THE SILICA-RICH CLOTS MENTIONED IN MY NOTE OF DECEMBER 11, A FURTHER POSSIBLE ORIGIN TO BE CONSIDERED, AND ONE WHICH SEEMS MORE PLAUSIBLE THAN THOSE 2 PREVIOUSLY SUGGESTED, WOULD BE THAT THEY ARE RELICS OF SILICA-RICH GLASS FRAGMENTS IN THE BRECCIA. SUCH GLASS COULD LIQUIFY READILY ON REHEATING OF THE ROCK WHITE THE PREDOMINANT CALCIC PLAGIO-CLASE AND THE SCATTERED OLIVINE AND PYROXENE FRAGMENTS REMAINED ESSENTIALLY UNAFFECTED. SUBSEQUENT SLOW COOLING WOULD RESULT IN THE FELDSPAR-TRIDYMITE MASSES OBSERVED.

SAMPLE NO. 12057.23 CHAO

TRIANGULAR-SHAPED THIN SECTION COVERED. IT IS A BRECCIA EMBEDDED IN A RECRYSTALLIZED VESICULATED MELT.

VESICULAR DARK FINE-GRAINED GROUNDMASS WITH NUMEROUS FELDSPAR CHIPS BOTH ANGULAR AND ROUNDED. AND A LARGER FRAGMENT OF BRECCIA THAT IS RICH IN FELDSPAR. A FEW SMALLER ROUNDED BRECCIA FRAGMENTS ALSO INCLUDED. THE ABUNDANCE OF FELDSPAR-RICH ROCK FRAGMENTS IS WORTH NOTING.

THE VESICULAR DARK GROUNDMASS CONSISTS OF SMALL LATH-SHAPED CRYSTALS OF LOW BIREFRINGENCE PROBABLY FELDSPAR AND FINE-GRAINED MAT OF PROBABLY PYROXENE.

A FEW VESICLES 0.6 TO 1.4 MM ACROSS SPACED 1 TO ABOUT 3 MM APART. CHIP SIZE FROM ABOUT 20 MICRO UNITS TO 1.5 MM THE LARGE FRAGMENT IS 5 X 5 MM. SEE MENTION OF SANIDINE (QUESTION) IN THIS BRECCIA BY WILCOX.

THE BRECCIA SEEMS EMBEDDED IN A VESICULAR GLASS WHICH HAS RECRYSTALLIZED. THE THIN LAYER OF GLASS AROUND THE LARGE BRECCIA (OLD) FRAGMENT IS A COMMON OCCURRENCE AMONG IMPACT-PRODUCED BRECCIAS.

THE ROUNDING OF SOME OF THE FRAGMENTS MAY HAVE BEEN PRODUCED PRIOR TO INCLUSION IN THE MELT SINCE SMALLER FRAGMENTS APPEAR TO RETAIN SHARP ANGULAR SHAPE.

THE ABUNDANCE OF GRAGMENTS IN THE RECRYSTALLIZED GLASS IS PERHAPS UNUSUAL. ONE TWINNED PLAGIOCLASE FRAGMENT SHOW LAMELLAR MICROSTRUCTURE OF PROBABLE SHOCK ORIGIN.

THE BRECCIA IS PROBABLY AN IMPACT BRECCIA. THE RECRYSTALLIZED GLASS IS PROBABLY PRODUCED BY IMPACT. I FIND IT DIFFICULT TO ABSOLUTELY RULE OUT THE POSSIBILITY THAT SUCH PULVERIZED ROCK CHIPS COULD NOT HAVE BEEN CAUGHT IN A MELT MAGMATIC ORIGIN.

SAMPLE 12057.23 OPAQUES ROBIN BRETT

ROCK IS BRECCIA AND CONTAINS UNCOMMONLY LOW OPAQUE CONTENT. A FEW ILMENITE GRAINS AND METAL BLEBS REMINISCENT OF METAL IN IMPACTITES.

SAMPLE NO. 12057.23 THIN SECTION FRONDEL

A POLYMICT MICROBRECCIA. ON THE WHOLE THE ROCK APPEARS TO BE MORE FELDSPATHIC THAN THE APOLLO 11 MICROBRECCIAS. THE LATTER ALSO CONTAINED MORE LITHIC FRAGMENTS OF IGNEOUS ROCK TYPES INCLUDING BOTH GABBROIC AND BASALTIC TYPES AND ALSO MORE GLASS. A FRAGMENT OF A CURIOUS ROCK TYPE WAS OBSERVED THAT CONTAINED ELONGATE TINY FELDSPAR CRYSTALS AND THAT MAY BE A DEVITRIFIED GLASS.

W. R. GREENWOOD DECEMBER 6. 1969 THIN SECTION 12057.23

VESICULAR CRYSTAL AND ROCK FRAGMENT PYROCLASTIC ROCK. SIMILAR IN APPEARANCE TO IMPACTITE FROM METEOR CRATER, ARIZONA.

THE MATRIX (A) OF THE ROCK IS A FINE INTERGROWTH OF CRYSTALS AND BROWN GLASS PROBABLY PYROXENE, PLAGIOCLASE AND ILMENITE. THIS MATRIX VARIES IN GRAIN SIZE FROM ONE EDGE AT 100U OR SO TO THE INTERIOR AT (50U.

PYROXENE FRAGMENTS (OLIVINE MAY ALSO BE PRESENT / INSPECTION TOO BRIEF TO TELL) CONSTITUTE ABOUT 20 TO 30 PERCENT OF THE FRAGMENTS IN THE MATRIX (A). PLAGIOCLASE FRAGMENTS DOMINATE. THE PLAGIOCLASE AND PYROXENE LATHS WHICH ARE CRYSTALLIZED OUT OF THE MATRIX (A) FORM AN INTERGROWTH WHICH IS SIMILAR TO THE MATRIX OF IMPACTITE FROM METEOR CRATER, ARIZ. MATRIX (A) INCLUDES A LARGE UNIT OF MATRIX (B) COMPOSED OF PLAGIOCLASE CRYSTAL FRAGMENTS AND ALMOST DEVOID OF PYROXENE OR OLIVINE. MATRIX (B) CONTAINS A ROCK FRAGMENT OF ANORTHOSITE. MATRIX (B) ALSO CONTAINS ONE LARGE ROUNDED CRYSTAL FRAGMENT WHICH WILCOX INDICATES HAS PARADINE OPTICS. A LARGE PLAGIOCLASE CRYSTAL FRAGMENT IN MATRIX (B) ACTS AS A NUCLEATION POINT FOR PLAGIOCLASE CRYSTALS WHICH GROW OUT INTO THE MATRIX. NO PYROXENE WAS OBSERVED IN A BRIEF INSPECTION OF THE CRYSTALS GROWING IN THE MATRIX (B). ALSO THE MATRIX (B) LACKS THE BROWN COLOR OF MATRIX (A). THE LARGE PLAGIOCLASE CRYSTAL HAS BEEN SHEARED AND GRANULATED IN PLACE IN MATRIX (B), SUGGESTING THAT MATRIX (B) WAS BROKEN UP BEFORE INCLUSION IN MATRIX (A). NO GLASS SPHERES OR GLASS FRAGMENTS WERE SEEN IN EITHER MATRIX (A) OR (B). ONE LARGE IRREGULAR VESICLE IN MATRIX (A) (MATRIX (B) NOT VESICULATED) IS FILLED WITH LOOSE LUNAR SOIL INCLUDING BROWN GLASS SPHERES.

THE SANADINE CRYSTAL FRAGMENT MAY BE RELATED TO A LAST STAGE DIFFERENTIATE OF THE ANORTHOSITE MAGMA WHICH MAY HAVE PREVIOUSLY BEEN DIFFERENTIATED FROM THE CUMULATE TEXTURED GABBRO (12057.21).

SAMPLE NO. 12057.23 SMITH

THIN SECTION EXAMINATION OF THIS ROCK INDICATES THAT THE CHIP IS NOT REPRESENTATIVE OF THE WHOLE SAMPLE. THE ROCK REPRESENTED BY THE THIN SECTION IS A CURIOUS MIXTURE OF XENOCRYSTS AND ROCK FRAGMENTS IN A GROUNDMASS OF VESICULATED GLASSY ROCK THAT WAS CRYSTALLIZING TINY CRYSTALS OF PLAGIOCLASE AND PYROXENE WHEN QUENCHED.

MANY OF THE PLAGIOCLASE XENOCRYSTS SHOW MELTING RELATIONS WITH THE GROUNDMASS GLASS AND IN SOME THE FELDSPAR GLASS SHOWS RECRYSTALLIZATIONS PRODUCTS.

THE ROCK SEEMS CLEARLY A PRODUCT OF SOME KIND OF BRECCIATION. FUSION. VESICULATION. PARTIAL RECRYSTALLIZATION. ASD QUENCHING IN THAT ORDER OR PERHAPS MIXING OF FUSED AND BRECCIATED MATERIAL. FURTHER PARTIAL FUSION OF FELDSPAR AND PROBABLY PYROXENE. VESICULATION. PARTIAL RECRYSTALLIZATION AND QUENCHING.

THE GENERAL RELATIONS SEEN IN THIS ROCK ARE ATYPICAL OF VOLCANIC PHENOMENA ALTHOUGH IT PROBABLY CANNOT BE RULED OUT AND ARE MORE SUGGESTIVE OF COMPLEX IMPACT HISTORY.

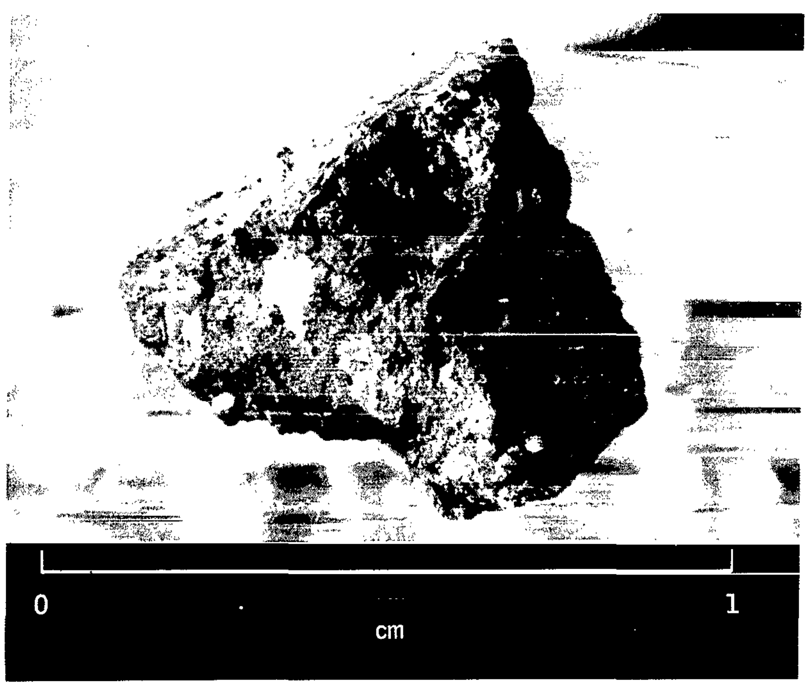


Figure A-52. - Sample 12057-11 (NASA-S-69-61405).

SAMPLE 12059

SAMPLE NO. 12059
FINES AND A ROCK CHIP - SWEEPINGS FROM BIO PREP.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

TOTAL CARBON ANALYSIS

SAMPLE 12060

SAMPLE NO . 12060 PCTL C. FRONDEL DESCRIPTION OF FINES FROM TOTE BAG. THE FINES CONSIST OF PYROXENE ABOUT 40 PERCENT. ANORTHITE ABOUT 30 PERCENT. OLIVINE ABOUT 10 PERCENT OR LESS. GLASS ABOUT 20 PERCENT. LESS THAN 1 PERCENT TRIDYMITE IS PRESENT. THE AMOUNT OF GLASS IS MUCH LESS THAN IN THE FINES FROM THE APOLLO 11 SITE. THE GLASS RANGES FROM COLORLESS THROUGH PALE GREEN. PALE YELLOW. TAN. BROWN AND DARK RED BROWN. ON THE WHOLE. THE GLASS AND ALSO THE BULK FINES ARE SOMEWHAT LIGHTER IN COLOR THAN IN THE APOLLO 11 MATERIAL. THE PALE YELLOW GLASS HAS AN INDEX OF REFRACTION BELOW 1.640 THE TAN AND DARKER COLORED GLASS IS OVER 1.640. THE COLORLESS GLASS IS NOT ABUNDANT. SOME GRAINS ARE JUST BELOW 1.570. BUT MOSTLY THE INDEX IS SOMEWHAT OVER 1.570. FELDSPAR GLASS SEEMS TO BE MUCH LESS ABUNDANT THAN IN THE APOLLO 11 SAMPLE. GLASS SPHERES. DUMBBELLS. RODS. AND TEARDROPS ARE PRESENT IN ADDITION TO ANGULAR FRAGMENTS. AN UNIDENTIFIED DARK BROWN MINERAL. NOT PLEOCHROIC. WITH INDICES BELOW 1.570 WAS NOTED. MANY OF THE MINERAL GRAINS ARE WELL ROUNDED. AS IN A DETRITAL SAND OR DUNE SAND (SEE PHOTOS).

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
X-RAY ANALYSIS

SAMPLE NO. 12061 CHIPS LARGEST CHIP WEIGHT EST. WT. 3 GMS.
SAMPLE NO. LARGEST CHIP
DIMENSIONS 2 X 2 X 1/2 CM CHAO
THIS IS A HOLOCRYSTALLINE MEDIUM FINE GRAINED MICROGABBROIC ROCK WITH OLIVINE. SIMILAR TO APOLLO 11 TYPE B WITH PROBABLY LESSER AMOUNT OF ILMENITE. THE TYPE OF BROWN PYROXENE APPEARS TO BE THE SAME AUGITIC CLINOPYROXENE OF APOLLO 11 SAMPLES IN COLOR AND HABIT.. FLAT AND SLIGHTLY CONVEX. DISK SHAPED. SPECKLED BROWNISH GREY. SUBOPHITIC TO GRANULAR TEXTURE. HOLOCRYSTALLINE. VESICLES PRESENT. THE FLAT SURFACE IS A FRACTURE SURFACE. SEVERAL GLASS LINED PITS ON CONVEX SIDE SURROUNDED BY A HALO OF MILKY WHITE MATERIAL. FRACTURED FELDSPAR. 200 TO 500 U IN DIAMETER. ON THE CONVEX. ROUNDED SIDE NOT ON THE FLAT FRACTURED SIDE. AVERAGE GRAIN SIZE IS ABOUT 2 TO 300 MICRONS. LARGEST CRYSTAL ABOUT 1.5 MM. LARGER CRYSTALS PROBABLY PLAGIOCLASE AND ILMENITE. FRACTURED MILKY PLAGIOCLASE ON ROUNDED CONVEX SURFACE. MINERALOGY. 1. CLEAR PLATY LATH SHAPED TO IRREGULAR SHAPED CRYSTALS WHICH ARE PROBABLY PLAGIOCLASE. ABOUT 45 TO 50 PERCENT. PROBABLY POIKILITIC. 2. PALE BROWN TO CLEAR BROWN STUBBY PRISMATIC TO IRREGULAR CRYSTALS. PROBABLY PYROXENE SIMILAR TO CLINOPYROXENE OF APOLLO 11. ABOUT 40 TO 45 PERCENT. 3. BLACK PLATY AND HIGHLY REFLECTING MINERAL WITH LUSTROUS FRACTURES. PROBABLY ILMENITE 5 TO 10 PERCENT. 4. GREENISH YELLOW MINERAL IN SMALL AMOUNTS ABOUT 2 TO 300 MICRONS ACROSS AND OCCURRING IN PATCHES. PROBABLY OLIVINE.

SAMPLE NO. 12061 SECOND LARGEST CHIP DIMENSIONS 2 X 1 X 0.6 CM CHAO
ELONGATED WITH TRIANGULAR CROSS SECTION. SPECKLED BROWNISH GREY. SIMILAR TO THE LARGEST CHIP. VUGGY IRREGULAR CAVITIES EXIST WITH TABULAR PLAGIOCLASE AND STUBBY PYROXENE PROTRUDING INTO THEM. THEY SOMETIMES COALESCE TO FORM OPENINGS 2 TO 3 MM IN LENGTH. ROUND HEMISPHERIC 1 MM IN DIAMETER. HAVE BEEN NOTED AS SURFACE FEATURES. THERE IS THE SUGGESTION THE SURFACE AREA AROUND THE PITS WHICH ARE AS MUCH AS 1 MM IN DIAMETER. AVERAGE CRYSTAL SIZE IS AGAIN ABOUT 2 TO 300 MICRONS. LONG PLATY CRYSTALS OVER 1 MM IN LENGTH HAVE BEEN NOTED. MINERALOGY. QUITE SIMILAR TO THE MINERALOGY NOTED IN THE PREVIOUS CHIP. PRE-DOMINANTLY CLEAR PLATY PLAGIOCLASE FELDSPAR. BROWN CLINOPYROXENE. AND PLATY BLACK ILMENITE. ACCESSORY OLIVINE IS ALSO PRESENT.

SAMPLE NO. 12061/THIRD LARGET CHIP DIMENSIONS 1 X 1 X 0.4 CM CHAO
FLAT WITH SOME FRACTURING. ALSO SPECKLED BROWNISH GREY. SIMILAR TO THE LARGEST CHIP. ABUNDANT VESICLES. AT TIMES THEY COALESCE TO 1 TO 1.5 MM IN LENGTH. IRREGULAR VUGS ARE AGAIN PRESENT WITH PRISMATIC AND PLATY BROWN PYROXENES ALONG WITH CLEAR PLATY PLAGIOCLASE IN THEM. NO PITS ARE OBVIOUS AND SO SUSPECTED TO BE AN INTERIOR CHIP. WELL FORMED SHORT PRISMATIC PYROXENE CRYSTALS ARE PRESENT. AVERAGE GRAIN SIZE OF THE CRYSTALS IS ABOUT 100 TO 200 MICRONS. LARGE CRYSTALS ARE AS MUCH AS 1 MM. MINERALOGY. A LARGE GREEN YELLOW OLIVINE CRYSTAL ABOUT 0.8 MM IN DIAMETER WAS NOTED. OLIVINE AGAIN EXISTS AS AN ACCESSORY MINERAL. MINERALOGY IS AGAIN SIMILAR TO THAT OF THE LARGEST CHIP.

SAMPLE NO. 12061/FOURTH LARGEST CHIP DIMENSIONS 1 X 0.8 X 0.3 CM. CHAO
FLAT OBLONG SHAPED FRAGMENT. SIMILAR TO OTHER CHIPS. SIMILAR TEXTURE. LONG LATH-LIKE PLAGIOCLASE CRYSTALS ABOUT 1 MM IN LENGTH APPEAR POIKILITIC. NO PITS NOTED. AVERAGE GRAIN SIZE IS ABOUT 2 TO 300 MICRONS. MINERALOGY. SIMILAR.
SAMPLE NO. 12061 2 SMALLEST CHIPS DIMENSIONS ABOUT 0.8 X ABOUT 0.7 X ABOUT 0.3
CHAO COLOR SAME AS OTHERS. TEXTURE SAME AS OTHERS. VUGGY AND SIMILAR. ONE SURFACE PIT NOTED. LONG PLATY PLAGIOCLASE CRYSTALS OCCUR ABOUT 1 MM IN LENGTH. MINERALOGY. SIMILAR TO OTHER CHIPS.

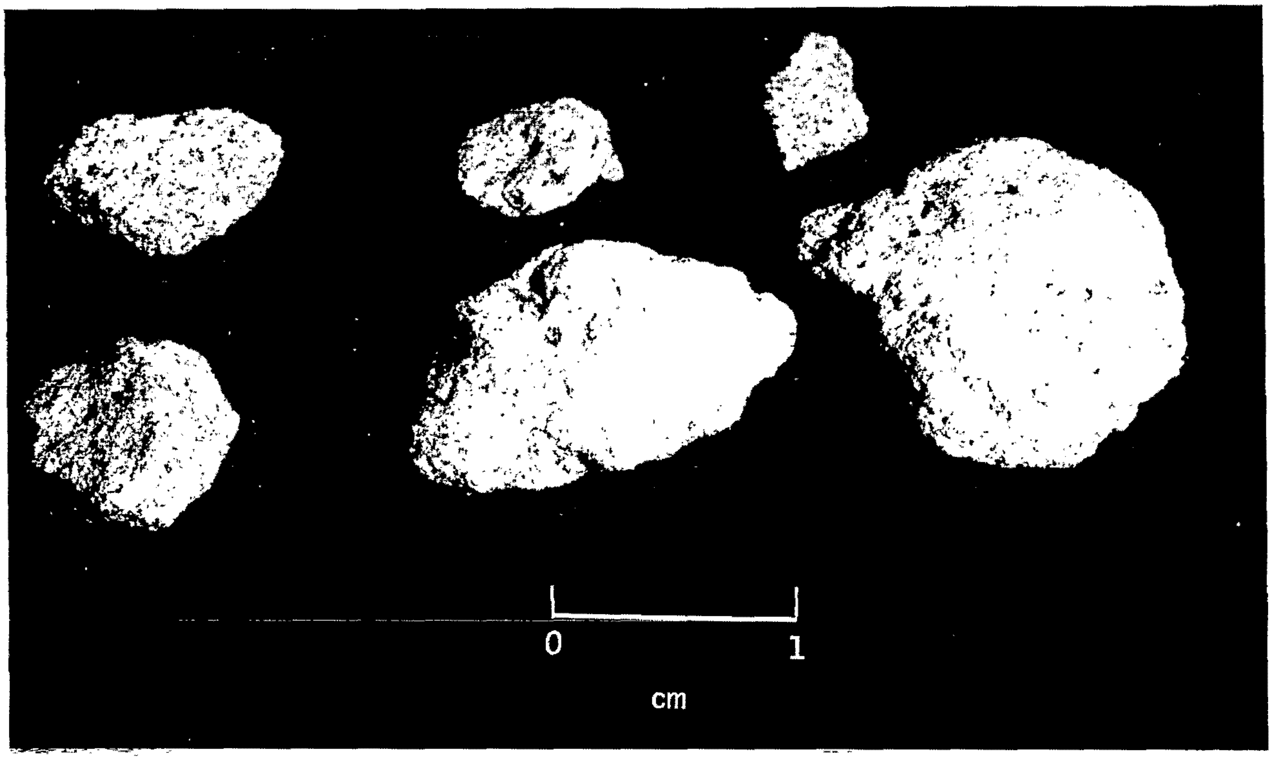


Figure A-53. - Sample 12061 (NASA-S-69-61659).

SAMPLE 12062

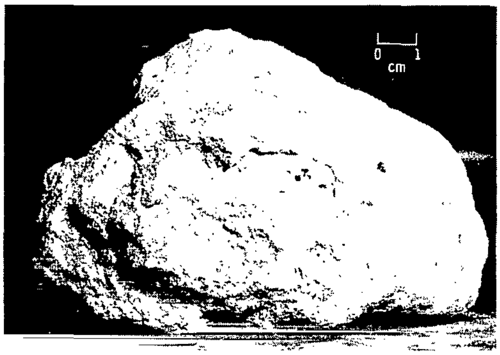
SAMPLE NO. 12062 WEIGHT 787.7 GRAMS DIMENSIONS 12 X 8 X 4 CM SMITH
THIS ROCK HAS THE APPROXIMATE SHAPE OF AN IRREGULAR FLATTENED HALF DOME. WITH PARTLY CONCAVE BOTTOM. ANGULAR BROKEN SIDE. AND ROUNDED TOP. COLOR IS MEDIUM GRAY TO LIGHT GRAY WITH WHITISH MOTTLING. SOME OF THE WHITISH AREAS ARE HALOES SURROUNDING GLASS PITS (NOT ABUNDANT ON THIS SPECIMEN). OTHER WHITISH AREAS ARE SIMPLY SPOTS OF CHALKY FELDSPAR THAT REMAIN AFTER GLASS PITS HAVE ERODED AWAY. PART OF THE CONCAVE BOTTOM AND A PORTION OF THE BROKEN SIDE ARE DARKER AND LESS MOTTLED THAN THE REMAINDER OF THE ROCK AND MAY REPRESENT A BURIED OR OTHERWISE PROTECTED PART OF THE ROCK ON THE LUNAR SURFACE.
CONCENTRIC FRACTURES SUBPARALLEL TO THE ROCK SURFACE APPEAR ON PART OF THE TOP AND BORKEN SIDE AND RESEMBLE EXFOLIATION FRACTURES. SOME OF THESE FRACTURES SEEM TO PENETRATE DEEPLY. A RADIAL SET OF FRACTURES CENTER OF THE EXFOLIATION SPHEROID AND SUGGEST THAT THE WHOLE SYSTEM IS IMPACT INDUCED.
SMALL VESICLES AND VUGS ARE PRESENT BUT NOT ABUNDANT AT VIEWING SCALES.
ONE SMOOTH WALLED VESICLE (APPROXIMATELY 3 TO 4 MM) APPEARS ON THE BROKEN SIDE AND SHOWS BRIGHTLY REFLECTING CRYSTAL FACES OF FELDSPAR.
TEXTURE IS BEST DESCRIBED AS OPHITIC TO SUBOPHITIC. WITH LARGER CRYSTALS IN VUGGY AREAS.
MAJOR MINERALS ARE CINNAMON RED TO BROWN PYROXENE. FELDSPAR. OPAQUES AND OLIVINE THE OLIVINE IS SPAR . BUT OCCURS IN LARGE (UP TO 7 MM) CRYSTAL AGGREGATES.
MUCH OF THE CONCAVE BOTTOM SIDE HAS FINE TEXTURED HACKLY SURFACE WITH STRONGLY ADHERING DUST AND SCATTERED AREAS OF GLASS SPLASH NOT FOUND ON TOP SURFACE.
A FEW GLASS LINED PITS OCCUR ON THE OUTER PERIPHERY OF THE CONCAVITY. BUT NONE WERE FOUND IN THE CENTRAL PART WITHIN AN AREA ABOUT 3.3 CM IN DIAMETER. IN THE CENTER OF THE CONCAVE SURFACE IS A SUBDUED FLAT CONE OR MOUND ABOUT 1.2 CM IN DIAMETER AND SEVERAL MM HIGH THAT FORMS THE FOCUS FOR A SUBTLE RADIAL FRACTURE SET.
IT SEEMS PROBABLY THAT THIS CONCAVE SURFACE IS ACTUALLY AN IMPACT CRATER AND THE CONCENTRIC AND RADIAL FRACTURE PATTERN ON ROCK'S OPPOSITE SIDE IS GENETICALLY RELATED.
AT LEAST ONE OTHER LARGE ROCK IN THE APOLLO 12 RETURN HAS ONE DEEP CONCAVE SIDE (FIRST ROCK LOOKED AT IN F201). PERHAPS THESE CONCAVE SIDES HAVE SIMILAR ORIGINS.
MORPHOLOGY. MACROSCOPIC
FLAT HALF DOME. BOTTOM SIDE PARTLY CONCAVE. BROKEN SIDE OF DOME ANGULAR. REMAINDER OF TOP ROUNDED. MEDIUM GRAY TO LIGHT GRAY AND WHITISH MOTTLED. PROBABLY SUBOPHITIC TO OPHITIC. MEDIUM GRAINED LUNAR ROCK. COARSE TYPE A. NO LINEATIONS OBVIOUS. VESICLES PRESENT BUT NOT ABUNDANT AT THIS SCALE OF VIEWING. ONE LARGE SMOOTH WALLED VESICLE ON BROKEN SIDE (APPROXIMATELY 3 MM) CONTAINS BRIGHTLY REFLECTING CRYSTAL FACES. FRACTURES PRESENT BUT NOT ABUNDANT. ONE FRACTURE OF DOMICAL TOP AND BROKEN SIDE SHOWS CONCENTRIC EXFOLIATION FRACTURES. THESE SEEM TO PENETRATE DEEPLY INTO ROCK AND ARE ASSOCIATED WITH A RADIAL SET CENTERING ON THE EXFOLIATION SPHEROID. NO SPLASHES NOTED ON TOP. SURFACE PITS PRESENT OVER DOMAL TOP AND SIDES BUT SEEMINGLY NOO ABUNDANOH
APPROXIMATE MODES. OLIVINE LESS THAN 1 PERCENT
PYROXENE 50 PERCENT
FELDSPAR 40 PERCENT
OPAQUE LESS THAN 10 PERCENT
PYROXENES APPROXIMATELY EQUANT
FELDSPAR LATH LIKE
OPAQUES TABULAR TO PLATY.
CRYSTALS LARGER NEAR VUGS. NO OBVIOUS ALTERATION.
TERRESTRIAL ANALOGUE. FINE GRAINED DIABASIC OLIVINE BEARING BASALT.

SAMPLE NO. 12062 WEIGHT 737.7 GRAMS DIMENSION 10 X 6 X 4 CM HARMON
THE GENERAL SHAPE OF THE ROCK IS THAT OF 1/4 OF A SPHERE OR RATHER AN ELLIPSOID SUBSEQUENTLY. SOME OF THE CORNERS AND EDGES OF THE ROCK APPEAR TO HAVE ERODED

AWAY. THE ROUNDED SURFACE OF THE ROCK HAS WEATHERED TO AN EXTENT THAT IT APPEARS LIKE A SMALL SCALE EXFOLIATION DOME. THE COLOR OF THE ROCK IS A LIGHT MEDIUM GREY WITH AREAS OF THE SURFACE COVERED WITH SPLOTCHES OF A WHITE COLOR. IN TWO PLACES THESE WHITE AREAS ARE ASSOCIATED WITH IMPACT PITS IN THAT THEY ARE SHATTERED AREAS SURROUNDING THE CRATERS TO ABOUT ONE CRATER DIAMETER OUT FROM THE CRATERS. THESE OTHER WHITE SPLOTCHES NOT ASSOCIATED WITH PITS ARE PROBABLY SHATTER AREAS UNDERLYING PITS THAT HAVE SINCE BEEN ERODED AWAY. ONE VERY NICE VESICLE ABOUT 2 MM IN DIAMETER IS PRESENT ON ONE SURFACE OF THE ROCK. THIS ROCK SHOWS A MODERATE AMOUNT OF FRACTURES CHARACTERIZED BY THE EXFOLIATION FEATURES. THE DENSITY OF PITS AND VESICLES IS VERY LOW. THE (BOTTOM) CONCAVE SURFACE OF THE ROCK IS ALSO A FRACTURE SURFACE AND APPEARS ALSO TO BE AN EXFOLIATION FEATURE. THE (TOP) CONVEX SURFACE OF THE ROCK ALSO APPEARS TO HAVE A SHATTER CRUST THAT IS LIGHTER IN COLOR THAN THE FRESH SURFACES OF THE ROCK WHERE EXPOSED ALONG EXFOLIATION FRACTURES. LATH SPADED MINERALS AND A MINERAL WITH A METALLIC LUSTER ARE OBVIOUS IN GROUND MASS ON A MACROSCALE.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
X-RAY ANALYSIS



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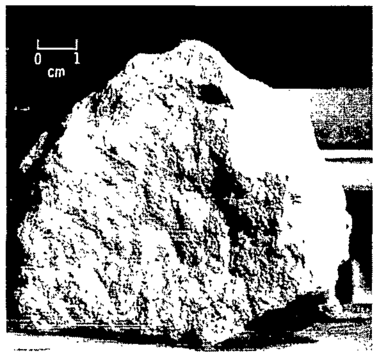

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Figure A-54. - Sample 12062.

SAMPLE 12063

SAMPLE NO. 12063 WEIGHT 2426.0 G DIMENSIONS 12 X 8 X 18 CM FOSS
IRREGULAR. SUBANGULAR TO SUBROUNDED. SOME PLANAR SURFACES. ONE MAJOR CONCAVITY FORMED BY PLANAR FRACTURES (ONE 2 1/2 X 5 CM). LIGHT TO MEDIUM GREY. WEATHERED SURFACE VUGGY AND LIGHTLY PITTED. FRESH SURFACE SHOWS OPHITIC TEXTURES NONPORPHYRITIC. HAVE SOME VESICLES ELONGATE IN PLANE. MOST VESICLES CONCENTRATED IN SINGLY PLANAR ZONE THAT INCLUDES THE LONGEST AND SHORTEST AREA OF PIT. 1 PARALLEL VESICLE PLANE. ONE SET OF 3 OR 4 APPROXIMATELY 30 DEGREE TO THIS. ONE LARGE CAVITY BANGLED BY PLANAR FRACTURES. ONE SPALL (CONCENTRIC) ONE SPLASH 6 MM X 1 CM. AVERAGE SIZE. HALO OF CHALKY FELDSPAR AROUND GLASS SPLASH. TERRESTRIAL ANALOGUE DIABASE.

SAMPLE NO. 12063 LARGE ROCK FROM TOTE BAG CHAO
WEIGHT 2426 GRAMS DIMENSIONS 16 X 9 X 7.5 CM ELONGATE WITH TRIANGULAR CROSS SECTION. ONE FLAT SIDE.

GENERAL APPEARANCE - IT IS A MASSIVE SPECKLED. MEDIUM GRAY FINE-GRAINED HOLOCRYSTALLINE ROCK WITH A BROWNISH TINGE. SLIGHTLY VUGGY. CONTAINS TRUE VESICLES 1.5-2.5 MM DIAMETER. WIDELY SCATTERED. THE VESICLES APPEAR TO BE MORE CONCENTRATED ON THE FLAT SIDE. FORMING FUNNELS INDICATING A FLAT JOINT SURFACE FROM WHICH GASES ESCAPED PARALLEL TO THE FUNNEL AXIS (UPWARDS).

SURFACE FEATURES - GLASS PITS ABUNDANT FROM 0.1 MM TO ABOUT 1 MM IN SIZE. LINED WITH DARK GLASS. A FEW PER SQUARE CM ON ALL SIDES.

TEXTURE AND GRAIN SIZE - MOSTLY EQUIGRANULAR. IN PLACES PLAGIOCLASE LATHS APPEAR IN SUBPARALLEL ARRANGEMENT BUT NOT PRONOUNCED.
GRAIN SIZE 0.2 TO 1 MM AVERAGE ABOUT 0.3 MM.

MINERALS - MEGASCOPIC

1. CINNAMON BROWN CLINOPYROXENE ABOUT 45 PERCENT.
2. LATH-SHAPED AND EQUIGRANULAR CLEAR TO WHITE PLAGIOCLASE ABOUT 40 PERCENT.
3. SMALL PLATY OPAQUE ILMENITE. WIDELY SCATTERED ABOUT 10-15 PERCENT.
4. GREENISH YELLOW OLIVINE. SOME ARE MICROPHENOCRYSTIC UP TO 0.6 MM ACROSS ABOUT 2-5 PERCENT. THE GREENISH COLOR IS QUITE PRONOUNCED.

SHOCK - THE ROCK IS LARGELY UNFRACTURED. NO EVIDENCE OF SHOCK.

REMARKS - THIS ROCK MAY BE A REPRESENTATIVE TYPE AND MAY BE CLASSIFIED AS A FINE-GRAINED ILMENITE MICROGABBRO SIMILAR TO APOLLO 11. THE COMPOSITION OF OLIVINE. CLINOPYROXENE AND PLAGIOCLASE SHOULD BE ESTIMATED OR DETERMINED

SAMPLE NO. 12063.5 POLISHED THIN SECTION IN 64-7950 CHAO

TEXTURE - SUBOPHITIC

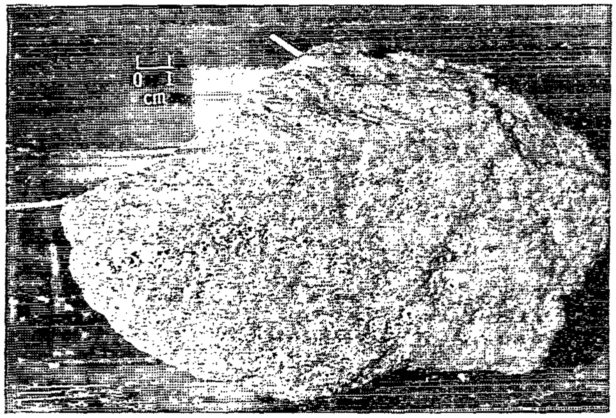
GRAIN SIZE - LATH-SHAPED PLAGIOCLASE UP TO 1.5 MM LONG STUBBY PRISMS OF CLINOPYROXENE 0.3 X 0.6 MM OLIVINE. AVERAGE 0.3 MM.

MINERALS -

1. PALE WINE-BROWN CLINOPYROXENE - MORE ABUNDANT THAN PLAGIOCLASE. BIAX. (+). 2V 25-30 DEGREES THUS PIGEONITIC. SLIGHT WAVY EXTINCTION ESTIMATED ABOUT 45 PERCENT.
2. CLEAR PLAGIOCLASE. POLYSYNTHETICALLY TWINNED. EXTINCTION ANGLE IN ZONE 1 (010) ABOUT 43 DEGREES. ESTIMATED AN 75 + ESTIMATED ABOUT 40 PERCENT.
3. OLIVINE - IN SEPARATE GRAINS. SOME AS CORES TO CLINOPYROXENE. BIAX. (-). VERY LARGE 2V ESTIMATED ABOUT 2-5 PERCENT.
4. ILMENITE - PLATY. MOSTLY 0.1 X 0.6 MM OPAQUE ABOUT 10 PERCENT.
5. CRISTOBALITE - CLEAR. LOW INDEX. COMPLEX TWINNING. SIMILAR TO THE LOW CRISTOBALITE IN APOLLO 11 MICROGABBRO. LESS THAN 1 PERCENT.
6. DUSTY. HIGH RELIEF. HIGH BIREFRINGENCE MINERAL BIAX. (-) SMALL TO MODERATE 2V. FAYALITE (QUESTION). OCCUR NEAR CRISTOBALITE.

THE MODAL COMPOSITION SHOULD BE DETERMINED INSTEAD OF ESTIMATES. THE SECTION

REMARKS - CONFIRMS MEGASCOPIC DESCRIPTION AS AN ILMENITE MICROGABBRO WITH SUBOPHITIC TEXTURE. SOME OLIVINE AND TRACE OF CRISTOBALITE.



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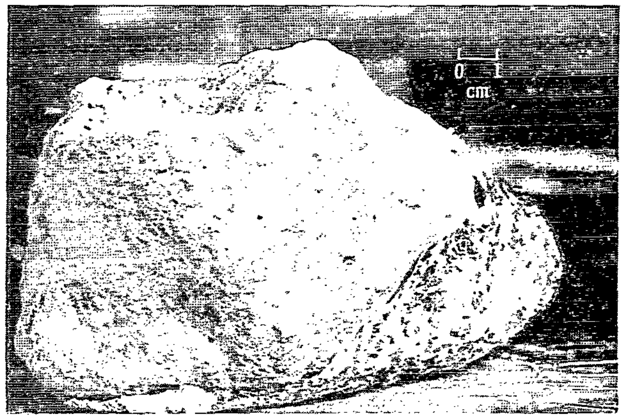

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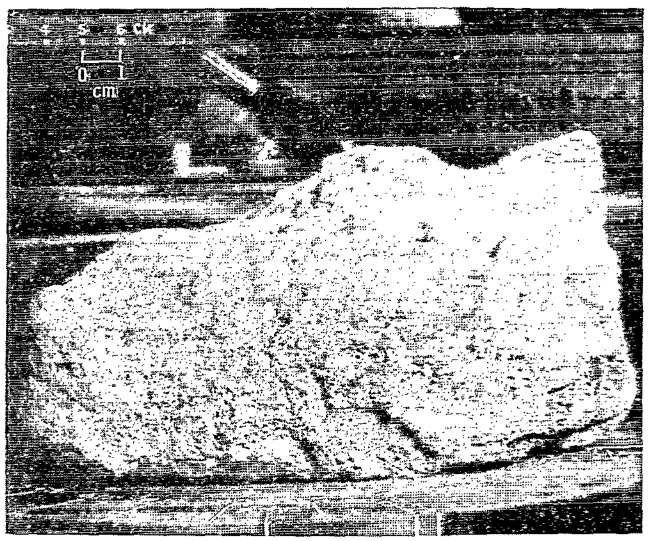

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Figure A-55. - Sample 12063.

SAMPLE NO. 12063.6 WEIGHT 4.5 GRAMS DIMENSIONS 4.5 X 3 X 2 CM FOSS
(HAND SPECIMEN 12063 AND CHIP 12063.6). THE ROCK IS IRREGULARLY SHAPED, SUB-ANGULAR TO SUBROUNDED, WITH SEVERAL PLANAR, SUBPARALLEL SURFACES, AND ONE MAJOR CONCAVITY FORMED BY PLANAR FRACTURES (2.5 X 5 CM). THE DIMENSIONS OF THE LONGEST, INTERMEDIATE AND SHORTEST AXES OF THE ROCK ARE 18 CM, 12 CM, AND 8 CM RESPECTIVELY. THE SHAPE IS ROUGHLY THAT OF A SMALL, PARTIALLY COLLAPSED FOOTBALL.

THE ROCK IS LIGHT TO MEDIUM GRAY IN COLOR, WITH MANY DARKER SPOTS CAUSED BY GLASS IN SMALL PITS AND SHADOWED VUGS. THE FRESH SURFACE IN THE FRACTURE BOUNDED CONCAVITY SHOWS A SUBOPHITIC TO OPHITIC TEXTURE OF WHITE FELDSPAR LATHS INTERGROWN WITH A BROWNISH GLASSY MINERAL, PROBABLY PYROXENE.

A RATHER STRIKING FEATURE OF THE ROCK IS A PLANAR ZONE OF SOMEWHAT FLATTENED VESICLES THAT INCLUDES THE LONG AND SHORT AXES OF THE ROCK. THE VESICLES ARE FLATTENED PERPENDICULAR TO THE ZONE AND HAVE AN AVERAGE LONG DIMENSION OF ABOUT 0.5 CM. THE REMAINDER OF THE ROCK IS RELATIVELY FREE FROM VESICLES, ALTHOUGH SOME SMALL (LESS THAN 0.5 CM) VUGGY CAVITIES ARE PRESENT THROUGHOUT THE ROCK.

THERE APPEARS TO BE ONE MAJOR FRACTURE THAT COINCIDES WITH THE PLANE OF VESICLES. A SET OF 3 OR 4 CLOSELY SPACED FRACTURES CROPS OUT ON ONE SURFACE OF THE ROCK, AT AN ANGLE OF ABOUT 30 DEGREES TO THE VESICLE ZONE. ONE LARGE CAVITY IN A CORNER OF THE ROCK IS BOUNDED BY PLANAR FRACTURES, AND ONE CORNER IS EXPOSED BY A CONVEX OUTWARD SMALL FRACTURE.

THE ROCK EXHIBITS ONE LARGE PATCH OF GLASS (6 MM BY 1 CM) THAT MAY BE THE BOTTOM OF A LARGE IMPACT PIT OR A GLASS SPLASH FROM ELSEWHERE. THE TWO MAJOR EXTERIOR SURFACES OF THE ROCK OTHER THAN THE SUBPARALLEL PLANAR SURFACES HAVE ABUNDANT SMALL APPROXIMATELY 1 MM IMPACT PITS. THE SUBPARALLEL PLANAR SURFACES ARE RELATIVELY FREE FROM PITS. THERE IS A DISTINCT WHITISH HALO OF CHALKY FELDSPAR AROUND THE PITS AND AROUND THE GLASS PATCH.

THE ROCK IS ANALOGOUS TO A TERRESTRIAL DIABASE OR FINE GRAINED GABBRO.

THE CHIP HAS THE SHAPE OF A ROUGH HEMISPHERE WITH ONE FLATTENED SIDE AND A SLIGHTLY CONCAVE BASE. DIAMETER OF HEMISPHERE 4.5 CM, DIAMETER TO FLATTENED SIDE 3 CM, HEIGHT 2 CM.

THE CHIP IS LIGHT BROWNISH GRAY ON A FRESHLY BROKEN SURFACE AND SHOWS A SUB-OPHITIC TEXTURE. THE ROCK CONTAINS SOME VUGS THAT APPEAR TO BE OF TWO TYPES. SOME ARE ANGULAR AND ABOUNDED BY CRYSTAL FACES OF PLAGIOCLASE FELDSPAR. OTHERS ARE MORE ROUNDED AND HAVE CRYSTALS OF FELDSPAR, PYROXENE, AND ILMENITE GROWING INTO THEM. THE ILMENITE AND PYROXENE CRYSTALS SHOW GOOD CRYSTAL FACES IN THE VUGS.

THE ROCK IS MADE UP OF / 1. 50 PERCENT GLASSY TABULAR CRYSTALS OF PLAGIOCLASE WITH AVERAGE SIZE 0.1 MM. 2. 40 PERCENT LIGHT BROWN TO AMBER EQUANT CRYSTALS OF PYROXENE WITH AVERAGE SIZE 0.01 MM. 3. 5 PERCENT BLACK METALLIC BLADE LIKE CRYSTALS OF ILMENITE WITH AVERAGE SIZE 0.02 MM. 4. LESS THAN 5 PER CENT PALE GREEN GLASSY CRYSTALS OF OLIVINE WITH AVERAGE SIZE 0.9 MM.

ROCK HAS A DEFINITE PORPHYRITIC TEXTURE OF OLIVINE PHENOCRYSTS IN A SUBOPHITIC GROUNDMASS OF PLAGIOCLASE, PYROXENE AND ILMENITE.

SAMPLE NO. 12063.6 STANDARD THIN SECTION WILCOX
COARSE GRAINED CLINOPYROXENE, OLIVINE, PLAGIOCLASE, ILMENITE ROCK.
APPROXIMATE MODE.

CLINOPYROXENE 40 PERCENT
PLAGIOCLASE 30 PERCENT
OLIVINE 10 PERCENT
OPAQUE (ILMENITE) 13 PERCENT
UNKNOWN GREEN, TRIDYMITE, AND ACCESSORIES = 7 PERCENT

CLINOPYROXENE VARIOUSLY COLORED. MOSTLY PALE REDDISH BROWN, AS ILL FORMED CRYSTALS. SOME OVERGROWN ON ANHEDRAL OLIVINE CORES.

PLAGIOCLASE, LONG BLADES, CALCIC, TWINNED.

OLIVINE NEARLY COLORLESS. SOME EUHEDRAL. SOME AS CORES OF CLINOPYROXENE CRYSTALS
OPAQUES LONG BLADES. NOT EXAMINED IN REFLECTING LIGHT.
UNKNOWN GREEN. PALE GREEN. HI RELIEF. HI BIREFRINGENCE. MODERATE (MINUS) 2V. (FAYLITE). THIS ASSOCIATION WITH THE TRIDYMITE AND SEVERAL COLORED ACCESSORY MINERALS.

SAMPLE NO. 12063.7 CRUSHED GRAINS WILCOX
LEMMON YELLOW CRYSTAL (OLIVINE).
UNCALIBRATED LIQUIDS. 2VX 85 DEGREES PLUS/MINUS 5 DEGREES (OA FIGURE)

NX 1.704 PLUS /MINUS .002
NY 1.726 PLUS/MINUS .002
NZ 1.744 PLUS/MINUS .002
NZ MINUS NX 0.040 PLUS/MINUS .004

MODAL ANALYSES OF ROCK 12063
A MODAL ANALYSIS WAS MADE IN REFLECTED LIGHT ON POLISHED THIN SECTION NUMBER 12063.5. SIX HUNDRED FORTY POINTS WERE COUNTED ON A 0.3 MILLIMETER GRID. A TOTAL MAGNIFICATION OF 125 WAS USED FOR OBSERVATION. TRANSMITTED LIGHT WAS USED TO AID IDENTIFICATION OF NON-OPAQUE CONSTITUENTS. THE PHASES RECOGNIZED AND THEIR VOLUME PERCENTAGES FOLLOW.

1. PALE YELLOW TO TAN. WEAKLY PLEOCHROIC CLINEPYROXENE. 52.8 PERCENT
2. CLEAR PLAGIOCLASE. AN 78. BYTOWNITE BY MICHEL LEVY'S METHOD. 28.0 PERCENT.
3. PALE YELLOW OLIVINE. 9.8 PERCENT.
4. PINKISH-BROWN BLADED ILMENITE. 5.5 PERCENT.
5. PALE GREEN UNIDENTIFIED MINERAL AND REACTION PRODUCES. 2.7 PERCENT. THIS MINERAL IS BIAXIAL-NEGATIVE WITH A MODERATE OPTIC ANGLE. BIREFRENGENCE IS AT LEAST 0.031. IT NORMALLY EXHIBITS A CLOUD OF REACTION PRODUCTS WHICH ARE AT LEAST IN PART GLASS. IT IS USUALLY IN CLOSE SPATIAL RELATIONSHIP WITH CRISTOBALITE.
6. CLEAR. CHARACTERISTICALLY FRACTURED AND TWINNED CRISTOBALITE 1.1 PERCENT
7. TROILITE. 0.1 PERCENT.
8. METALLIC IRON. LESS THAN 0.1 PERCENT.

A MODAL ANALYSIS WAS MADE IN TRANSMITTED LIGHT ON THIN SECTION 12063.6. ONE THOUSAND THIRTY ONE POINTS ON A 0.3 MM GRID WERE IDENTIFIED AND TABULATED. A TOTAL MAGNIFICATION OF ABOUT 157 WAS USED FOR OBSERVATION. THE PHASES RECOGNIZED ARE AS FOR THE MODAL ANALYSIS FOR SECTION 12063.5 EXCEPT THAT THE OPAQUE MINERALS ARE UNDIFFERENTIATED. VOLUME PERCENTAGES ARE AS FOLLOWS.

CLINO-PYROXENE	51.4 PERCENT
PLAGIOCLASE (BYTOWNITE. AN 78)	27.0 PERCENT
OPAQUE PHASES	10.7 PERCENT
OLIVINE	7.7 PERCENT
CRISTOBALITE	1.7 PERCENT
PALE GREEN. UNIDENTIFIED MINERAL AND REACTION PRODUCTS	1.5 PERCENT
DARK INCLUSIONS IN FELDSPAR	0.1 PERCENT

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
TOTAL CARBON ANALYSIS
X-RAY ANALYSIS

SAMPLE NO. 12064 WEIGHT 1214.3 G CHAO
THIS IS A FAIRLY COARSE GRAINED HOLOCRYSTALLINE GABBROIC ROCK WITH CRYSTALS MOSTLY 0.5 TO 1 MM ACROSS. EQUIGRANULAR TO SUBOPHITIC TEXTURE. CONSISTING ESSENTIALLY OF CLEAR PLAGIOCLASE. BROWN PYROXENE AND BLACK ILMENITE AND ACCESSORY MILKY WHITE CRACKLY LOW CRISTOBALITE (SAME APPEARANCE AS IN APOLLO 11 TYPE B ROCK). OLIVINE LOOKED FOR BUT NOT FOUND. A GOOD ROCK FOR BASIC MINERAL IDENTIFICATION. NO SHOCK EVIDENCE EXCEPT AROUND GLASS PITS AND THE WHITE CRUST ON ROUNDED SURFACES.. SPECKLED BROWNISH MEDIUM GREY. HOLOCRYSTALLINE NEARLY EQUIGRANULAR ROCK WITH AN AVERAGE GRAIN SIZE OF 0.5 MM TO 1 MM WITH SOME AS LARGE AS 3 MM. VUGS FROM 1 TO 1.5 MM ARE PRESENT (MIAROLITIC). THIN PLATY CLEAR CRYSTALS (PLAGIOCLASE) AND BROWN PRISMATIC PYROXENE OCCUR IN THE VUGS. A FEW WIDELY SPACED FRACTURES ARE PRESENT. WIDELY SCATTERED GLASS PITS OCCUR ON SEVERAL SURFACES FROM 0.1 TO 1 MM IN DIAMETER. THE GLASS LINING IS EITHER A CLEAR TO PALE BROWN COLOR OR BLACK. BOTH OCCUR. EXCEPT FOR THE SURFICIAL CRUST THERE IS NO EVIDENCE OF SHOCK. MINERALOGY. 1. LATH SHAPED RECTANGULAR CROSS SECTION TO PLATY CLEAR PLAGIOCLASE IS THE MOST ABUNDANT MINERAL. APPROXIMATELY 45 PERCENT. 2. BROWN STUBBY PRISMATIC TO IRREGULAR CLINOPYROXENE IS THE NEXT MOST ABUNDANT MINERAL. APPROXIMATELY 40 PERCENT. 3. BLACK PLATY ILMENITE IS ALSO PRESENT (5 TO 10 PERCENT). 4. MILKYWHITE LOW CRISTOBOLITE IS ALSO PRESENT. 5. A RARE ORANGE YELLOW MINERAL IS ALSO PRESENT

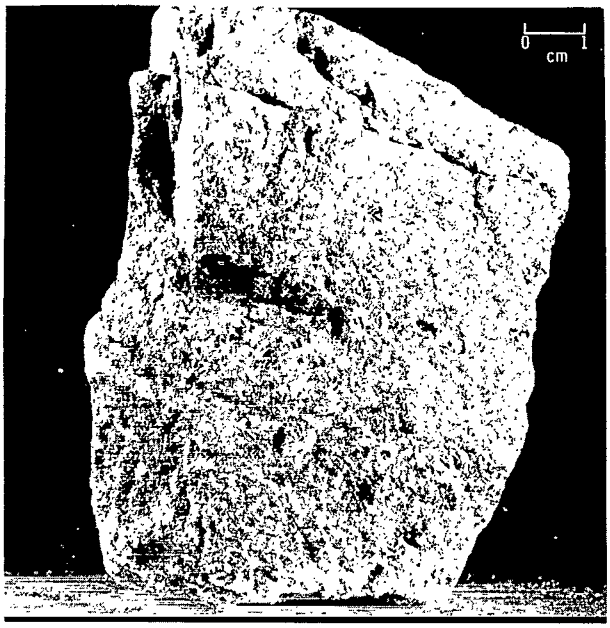
PLAGIOCLASE	45 PERCENT
PYROXENE	40 PERCENT
OPAQUE	5 TO 10 PERCENT
CRISTOBALITE	T

SAMPLE NO. 12064 WEIGHT 1214.3G DIMENSIONS 11 CM X 8 CM X 6 CM LOFGREN/HARMON
THIS ROCK HAS A BLOCHY SHAPE WITH WELL DEFINED CORNERS AND ANGLES . A VERY ANGULAR ROCK WITH LITTLE OR NO ROUNDING. THE ROCK IS HIGHLY FRACTURED WITH THREE MAJOR FRACTURES CUTTING THROUGH THE ROCK. ONE SURFACE DOES SHOW A LITTLE SURFACE ROUNDING AND A FEW IMPACT PITS (ASSUMED UP SIDE). NO OTHER SURFACES SHOW ANY IMPACT PITS. ONLY TWO GLASSLINED PITS ARE PRESENT AND ON THE SLIGHTLY ROUNDED SURFACE. THE ROCK IS COURSE GRAINED CRYSTALLINE ROCK WITH A LIGHT GREY COLOR. PITS ON THE UP SURFACE SHOW THE WHITE HALO. THE ROUNDED (UP) SURFACE ALSO HAS A LIGHTER CAST THAN THE REMAINDER OF THE ROCK (SHATTER CRUST). PLAGIOCLASE FELDSPAR. EVEN ON A MACRO SCALE. IS THE PREDOMINENT MINERAL OCCURRING IN TRACHYTIC AGGREGATES IN PLACES / GRAINS ARE EQUANT TO TABULAR IN SHAPE. A MINERAL WITH A METALLIC LUSTER. ILMENITE. IS PRESENT. BUT NOT ABUNDANT. VUGS ARE PRESENT IN MODERATE QUANTITY WITH CRYSTAL GROWTH BEING LARGER IN THESE FEATURES. VUGS ARE IRREGULARLY SHAPED WITH SOME BEING ALMOST CLOSED. THE MINERAL PROTRUDING INTO THE VUGS APPEAR TO BE ILMENITE. GRAIN SIZE RANGES UP TO 3 MM FOR THE PLAGIOCLASE. AND ILMENITE LATHS RANGE UP TO 5 MM.

SAMPLE NO. 12064.A ROCK FRONDEL
A MICROGABBRO VERY SIMILAR TO THE COARSER GRAINED MICROGABBRO FROM THE APOLLO 11 SITE. GRAIN SIZE UP TO 1 MM. POROUS OR VUGGY ON A SMALL SCALF WITH EUHEDRAL CRYSTALS OF ANORTHITE. PYROXENE AND ILMENITE PROJECTING INTO CAVITIES. PYROXENE BROWN TO YELLOWISH BROWN IN COLOR. A SECTION NEARLY PERPENDICULAR TO THE C AXIS SHOWED CONCENTRIC COLOR ZONING. OLIVINE SPARINGLY PRESENT AS PALE YELLOW GREEN GRAINS. ANORTHITE IN PART GLASSY CLEAR. NOT MUCH EVIDENCE OF SHOCK.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
RCL ANALYSIS



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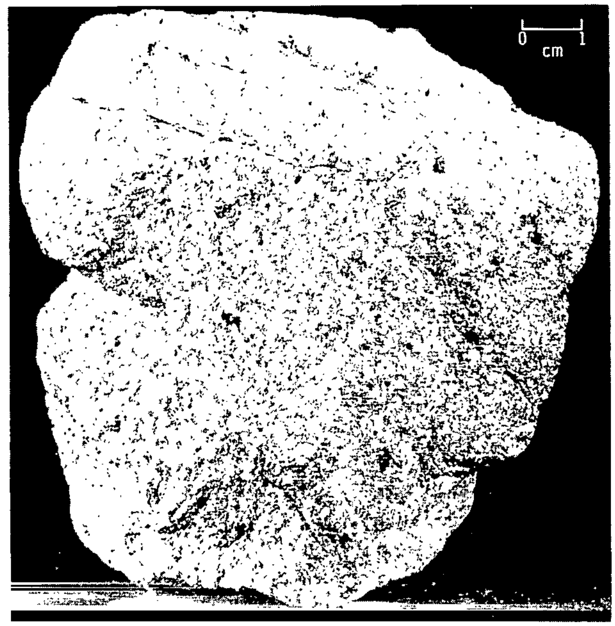

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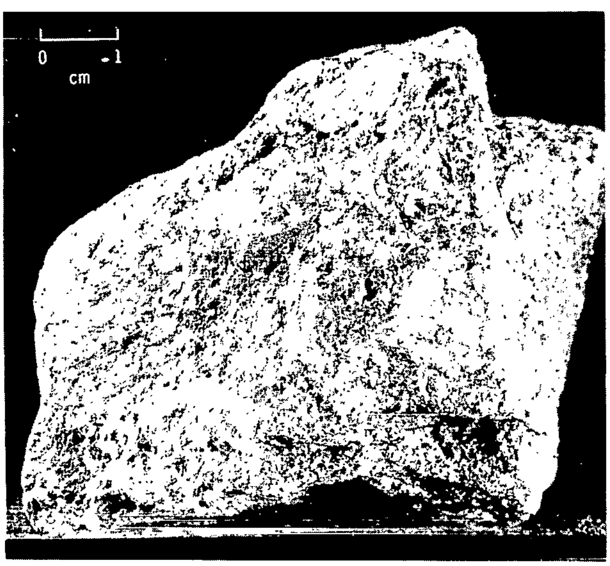

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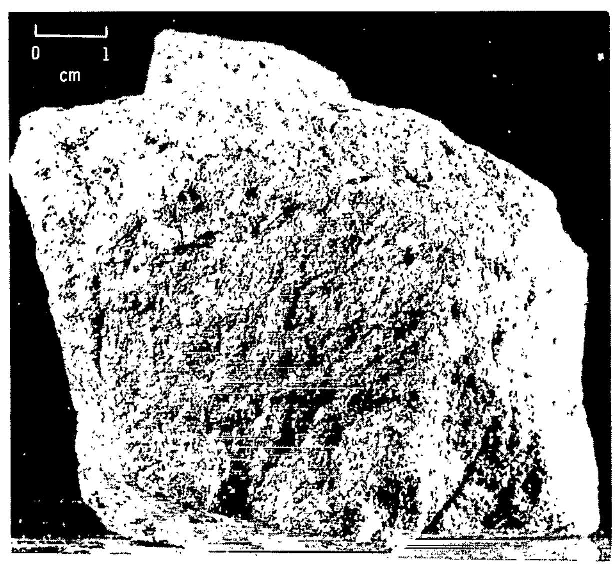

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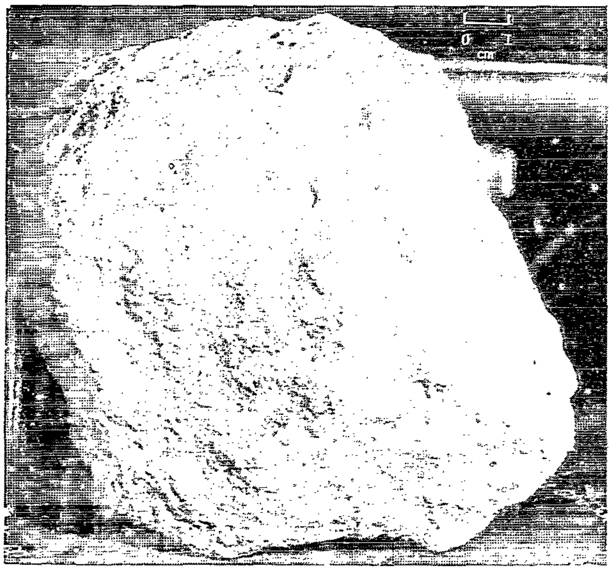
Figure A-56. - Sample 12064.

SAMPLE 12065

SAMPLE NO. 12065 DIMENSIONS 11.8 X 12 X 9 CM D. R. WONES
SHAPE. RECTANGULAR PRISM WITH AN ASYMMETRIC TERMINATION (PYRAMIDAL).
COLOR. NEUTRAL (N6 TO N8) WITH A TOUCH OF 10 YR 6/2 (GSA ROCK COLOR CHART). VARIABLE COLOR DEPENDING ON THE AMOUNT OF GLAZE.
TEXTURE. COARSE. INDIVIDUAL CRYSTALS UP TO 1 CM LONG (PIGEONITE). MANY ARE 5 MM LONG X 0.5 TO 1.0 MM WIDE. SMALLER EQUANT CRYSTALS PRESENT (0.5 TO 1 MM) PROBABLY PYROXENE. OPAQUES PRESENT. TEXTURE SUBOPHITIC WITH PYROXENE LATHS. VUGS ARE PRESENT UP TO 1 CM ACROSS.
FABRIC. NO LINEATIONS. NO APPARENT ORIENTATION OF VUGS.
FRACTURES. FRACTURES ARE RELATED TO PRESENT SURFACES.
SURFACE FEATURES. NO OBVIOUS GLASS SPLASHES. WHITE CRUST COVERS MOST OF SURFACE. BLACK AGGREGATES ARE PRESENT ON SURFACES. LARGE NUMBER OF INDENTATIONS ON ALL SIDES. A GIRDLE APPEARS AROUND ROCK ORTHOGONAL TO SMALL DIMENSIONS. ONE FACET HAS LESS PITTING. PITS HAVE HALOES. 1.3 MM AVERAGE SIZE 0.3 MM DEPTH. THERE ARE 1 TO 2 PITS PER SQUARE CENTIMETER.
MINERALOGY.
PYROXENE 70 PERCENT. OCCURS AS LATH LIKE PHENOCRYSTS .10 MM X 0.5 MM (10 X 0.1 MM MORE COMMON). AND AS EQUANT (0.5 MM) GRAINS IN GROUNDMASS. BOTH PIGEONITE AND SUBCALCIC AUGITE PRESENT. PIGEONITE HAS ALPHA LESS THAN 1.700. GAMMA ABOUT 1.740.
AUGITE HAS ALPHA ABOUT 1.710. GAMMA ABOUT 1.745. THIS INDICATES FE/FE+MG OF ABOUT 0.5 OR GREATER.
PLAGIOCLASE 20 PERCENT. LATH SHAPED CRYSTALS INTIMATELY INTERGROWN WITH PYROXENE.
OLIVINE 1 PERCENT. CLEAR GREEN EQUANT GRAINS. ONLY SEEN IN POWDERED GRAIN MOUNTS. NOT OBVIOUS IN HAND SPECIMEN ALPHA ABOUT 1.700. BETA ABOUT 1.720. GAMMA ABOUT 1.740. THIS INDICATES FE/FE+MG OF ABOUT 0.35.
OPAQUES 9 PERCENT. BLADED. PROBABLY ILMENITE.
THERE APPEARS TO BE A CONCENTRATION OF DARK MINERALS TOWARD VUGS.
TERRESTRIAL ANALOGUE. DIABASE.

SAMPLE NO. 12065 LARGE ROCK FROM TOTE BAG CHAO
SIMENSIONS ABOUT 12 X 10 X 8 CM ROUNDED RHOMBIC-SHAPED BLOCK.
GENERAL APPEARANCE - THIS IS A MASSIVE MEDIUM GRAY FINE-GRAINED HOLO-CRYSTALLINE ROCK WITH A LAVENDER BROWNISH TINGE. SLIGHTLY VUGGY. WITH RARE BUT TRUE VESICLES (LESS THAN 1 MM IN DIAMETER). ALTHOUGH THE SURFACE IS ROUNDED. DUE TO THE PREDOMINANT PLATY OR PRISMATIC HABIT OF THE MINERALS PRESENT. THE ROCK HAS. IN DETAIL. A HACKLEY OR STEP-LADDER SUBPARALLEL FABRIC OF THE ROCK.
SURFACE FEATURES - GLASS (DARK) LINED PITS A FEW PER SQUARE CM UP TO 3 MM ACROSS ON ALL SIDES. WHITENING OF MINERALS DUE TO FRACTURING IS CHARACTERISTIC ON SUCH ROUNDED SURFACE. PATCHES OF GLASS SPLASHES (GLOBULAR MASSES. DARK COLORED) ALSO PRESENT.
TEXTURE AND GRAIN SIZE - PORPHYRITIC. SUBPARALLEL TO FAN-SHAPED OR STEP-LADDER ARRANGEMENT OF GROUNDMASS (MOSTLY BLADED OR PRISMATIC-SHAPED CRYSTALS). I.E.. TNED TO BE TRACHYTIC. THIS TEXTURE IS DISTINCT FROM THE MICROGABBRO 12063 OR THE OPHITIC TEXTURE OF DIABASE 12038. BASED ON THE TEXTURE ALONE. THIS ROCK IS THE FINE-GRAINED EQUIVALENT OF 12021.
MOST GRAINS ARE PLATY OR PRISMATIC 0.05 - 0.1 X 0.4 - 0.6 MM. AVERAGE GRAIN SIZE LESS THAN 0.3 MM.
MINERALS - MEGASCOPIC
1. LAVENDER OR PURPLISH BROWN PRISMATIC. PLATY CLINOPYROXENE ABOUT 45 PERCENT.
2. MILKY WHITE TO CLEAR LATH-SHAPED TO SHEAFS ALTERNATING WITH THE CLINOPYROXENES ABOUT 40 PERCENT.
3. BLACK. VITREOUS LUSTER ON FRACTURES. NARROW PLATY HABIT. ILMENITE ABOUT 10 - 15 PERCENT.



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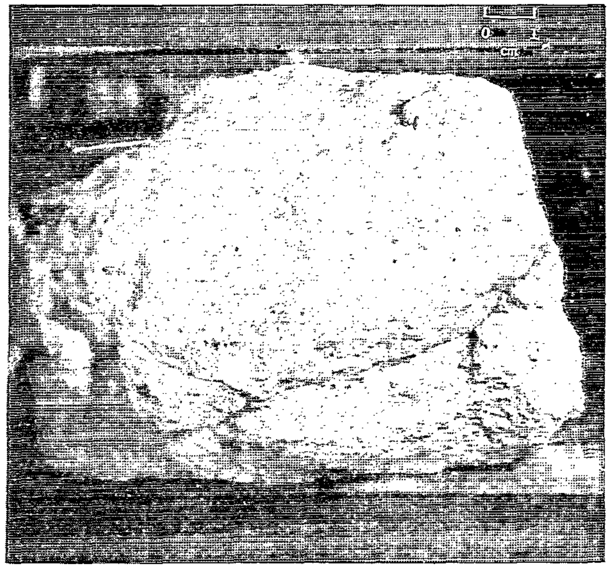

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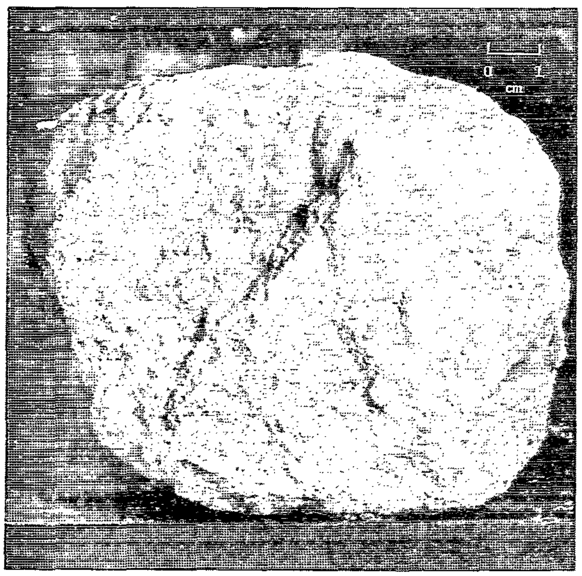

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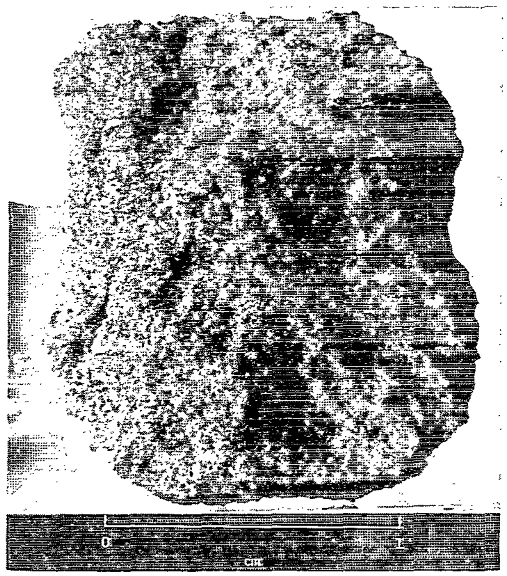

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Figure A-57. - Sample 12065.

4. GREENISH YELLOW OLIVINE ABOUT 2 PERCENT (LESS THAN 2 PERCENT).

SHOCK - NO EVIDENCE OF SHOCK. FRACTURES ARE OF NO SPECIAL SIGNIFICANCE.

REMARKS - THIS ROCK IS SIMILAR TO 12063 IN MINERAL COMPOSITION BUT DISTINCT IN TEXTURE. THE SUBPARALLEL AND ELONGATE HABIT OF THE MAJOR MINERALS SUGGEST THAT IT IS A PART OF A FLOW UNIT UNLIKE THE MICROGABBRO.
BECAUSE OF ITS UNIQUE TEXTURE THIS ROCK IS OF PETROGRAPHIC INTEREST. ALSO SUITABLE FOR BULK CHEMICAL COMPOSITION AND BULK ROCK AGES. IT IS OF PARTICULAR INTEREST IN THE ORIGIN OF THE TEXTURE AND THE PARAGENESIS OF THE MINERALS.
MINERAL COMPOSITION NOT DETERMINED OPTICALLY.
THIS ROCK IS AN OLIVINE-BEARING TITANIFEROUS BASALT WITH A VARIOLITIC-LIKE TEXTURE OR A NEW TEXTURE CHARACTERISTIC OF COOLING IN A CERTAIN LUNAR ENVIRONMENT.

SAMPLE NO. 12065.1 SMITH. R. L.
DARK YELLOWISH BROWN HOLOCRYSTALLINE ROCK CHIP. 15 X 14.5 X 5.7 MM
SAWED FACE SHOWS ONE SMOOTH WALLED VESICLE. 1 MM IN DIAMETER THAT OPENS ON ONE SIDE INTO A VUGGY AREA AND OPEN MESHWORK OF GROUNDMASS PYROXENE/FELDSPAR CRYSTALS UP TO .75 MM LONG. THE ROCK IS PORPHYRITIC WITH LARGE PRISMATIC PHENOCRYSTS OF ZONED PIGEONITE SET IN A PECULIAR GROUNDMASS (SEE PHOTOS) OF SUBRADIAL. STELLAR. AND CURVED RADIAL INTERGROWTHS OF CLINOPYROXENE AND PLAGIOCLASE. THESE INTERGROWTH BUNDLES TEND TO GROUP IN OPHITIC PATTERNS. PIGEONITE PHENOCRYSTS 30 0/0. GROUNDMASS CLINOPYROXENE 20 0/0. PLAGIOCLASE 45 PERCENT. OPAQUES 5 PERCENT. OLIVINE 1 PERCENT.

OLIVINE	PIGEONITE
NB APPROXIMATELY 1.732	2V = 5 DEGREES TO 10 DEGREES
NA GREATER THAN 1.732	R GREATER THAN V
NG LESS THAN 1.748	

SAMPLE NO. 12065.1 THIN SECTION FRONDEL
THE CLIMOPYROXENE IN THIS ROCK IS PIGEONITE. THE 2V WAS OBSERVED TO RANGE FROM ABOUT 5 DEGREES UP TO ABOUT 12 DEGREES. A VARIATION IN 2V IN INDIVIDUAL CRYSTALS WAS GENERALLY OBSERVED.

SAMPLE NO. 12065.6 POLISHED THIN SECTION IN 64-7952 CHAO

TEXTURE - PORPHYRITIC. VARIOLITIC-LIKE.

GRAIN SIZE - CLINOPYROXENE PHENOCRYSTS - THIN LONG .150 MM WIDE 4 MM LONG TO .4 X 3.0 MM.

GROUNDMASS - 10 MICROGRAMS X 300 MICROGRAMS BLADES.

MINERALOGY -

1. CLINOPYROXENE PHENOCRYSTS - PALE PINKISH BROWN OUTER ZONE WITH CLEAR INNER CORE. DISTINCTLY ZONED (USUALLY 2 CLEAR ZONES. MOST SHOW SMALL 2V. SOME THE INNER CORE HAS 2V NEAR ZERO. THE OUTER ZONE 2V ABOUT 15 DEGREES. OTHERS THE CORE HAS 2V ABOUT 10 DEGREES AND OUTER ZONE 2V ABOUT 25 DEGREES. BIAX. (+). THUS PREDOMINANTLY PIGEONITIC.
CLINOPYROXENE IN GROUNDMASS - VARIES FROM PARALLEL GROWTH ALTERNATING WITH CALCIC PLAGIOCLASE TO SUBPARALLEL TO FAN-SHAPED. PREDOMINANTLY WINE PALE BROWN COLOR. 2V ABOUT 30 DEGREES BIAX. (+). THUS MORE SUBCALCIC AUGITE AND PIGEONITE MIXTURE.

2. PLAGIOCLASE - LONG BLADED. POLYSYNTHETICALLY TWINNED. ORIENTATION NOT SUITABLE FOR ESTIMATING COMPOSITION. SOMETIMES 2 OR SEVERAL BLADES EXTINCT TOGETHER. SLIGHTLY LONGER THAN THE INTERGROWTH PRISMATIC CLINOPYROXENE.

3. OLIVINE - AT LEAST HALF A DOZEN GRAINS OBSERVED. EQUANT. UP TO 0.5 MM BIAX. (-) LARGE 2V. CLEAR. PHENOCRYSTIC.

4. OPAQUES - A. THIN PLATY UP TO 0.6 MM LONG BUT ONLY 60 MICRO UNITS WIDE. ILMENITE.

B. CUBIC OUTLINE. OR CUBO-OCTAHEDRAL OUTLINE - SPINEL GROUP - CHROMITE. LESS COMMON.

SOMEONE SHOULD MEASURE THE MODE -

REMARKS - THIS IS A PORPHYRITIC, OLIVINE BEARING (LESS THAN 1 PERCENT) ILMENITE BASALT WITH A UNIQUE TEXTURE. THE SUBPARALLEL PHENOCRYSTS SUGGEST FLOW. THE TEXTURE SHOULD BE OF INTEREST TO THE PETROGRAPHERS. THE AMOUNT OF ILMENITE IS LESS THAN APOLLO 11 ROCKS. THIS TEXTURE IS UNIQUE TO APOLLO 12. NOT STUDIED WITH REFLECTED LIGHT.

SAMPLE NO. 12065.7 A THIN SECTION OF A TOTE BAG SAMPLE HARMON

A HOLOCRYSTALLINE ROCK WITH A GENERALLY APHANITIC GROUNDMASS AND PYROXENE PHENOCRYSTS. FOUR BASIC MINERAL PHASES ARE PRESENT. A CLINOPYROXENE, A PLAGIOCLASE FELDSPAR, AN OPAQUE OXIDE AND OLIVINE.

1. CLINOPYROXENE. OCCURS AS BOTH PHENOCRYSTS AND GROUNDMASS MATERIAL. THE LARGER GRAINS RANGE UP TO 2 MM IN GRAIN SIZE. THESE PHENOCRYSTS ARE MOSTLY EUHEDRAL GRAINS THAT RESORPTION OR REMELTING EFFECTS AS SHOWN BY THE FACT THAT CRYSTAL BOUNDARIES ARE IRREGULAR AND MOST CROSS SECTIONS PRESENT SHOW ZONING. IN THE GROUNDMASS IT OCCURS AS ELONGATE RADIATING CRYSTAL AGGREGATES, INTER GROWN WITH PLAGIOCLASE FELDSPAR. A TEXTURE INDICATIVE OF RAPID COOLING. MANY OF THE PHENOCRYSTS OF CLINOPYROXENE SHOW A ZONED CROSS SECTION WITH THESE GROUNDMASS AGGREGATES OF CLINOPYROXENE AND FELDSPAR IN THE CENTER. PHENOCRYSTS ARE PIGEONITE.

2. PLAGIOCLASE FELDSPAR. OCCURS AS GROUNDMASS MATERIAL IN TWO FORMS.

A) STUBBY, LATH SPADED GRAINS, RECTANGULAR IN HABIT AND

B) RADIATING ELONGATE GRAINS INTERGROWN WITH THE A CLINOPYROXENE OF THE SAME HABIT.

3. OPAQUE OXIDE. OCCURS AS PLATY AND IRREGULARLY SHAPED GRAINS. MOST GRAINS CUT ACROSS GRAINS OF ALL OTHER PHASES, BUT SOME OF THE LARGER GRAINS TOTALLY ENCLOSE SOME SMALL FELDSPAR GRAINS. OPAQUES APPEAR TO BE MORE ABUNDANT IN THIS ROCK THAN ANY OTHER OBSERVED TO DATE.

4. OLIVINE. OCCURS AS LARGE GRAINS UP TO 1 MM IN GRAIN SIZE. MOST GRAINS ENCLOSE SMALLER GRAINS OF THE OPAQUE.

ROCK NAME. OLIVINE BEARING PIGEONITE, ILMENITE BASALT

A 500 POINT COUNT OF THIS SECTION RESULTED IN THE FOLLOWING MODES.

	NUMBER POINTS	PERCENTAGE
PIGEONITE PHENOCRYSTS	162	32.4
CLINOPYROXENE GROUNDMASS	136	27.2
OPAQUE OXIDE	63	12.6
PLAGIOCLASE GROUNDMASS	115	23.0
OLIVINE	13	2.6
VOID SPACE	11	2.1

SAMPLE NO. 12065.7 FINE GRAINED BUT UNPOLISHED WILCOX

(FIELD 1.2 MM DIAMETER WITH 10X OBJECTIVE). THIS IS A COARSE PORPHYRITIC ROCK, WITH MANY LONG PHENOCRYSTS OF CLINOPYROXENE UP TO 2 MM LENGTH. A FEW OF OLIVINE (UP TO 1/2 MM), AND BLADES, ETC., OF OPAQUES. GROUNDMASS IS ACICULAR BUNDLE AND ROZETTE INTERGROWTHS OF CLINOPYROXENE AND PLAGIOCLASE UP TO ABOUT 0.5 MM LENGTH AND ELONGATE OPAQUES.

A STRKING FEATURE OF THE CLINOPYROXENE PHENOCRYSTS IS THEIR STRONGLY EXPRESSED ZONING. A CENTRAL PORTION OF SLIGHT COLOR AND LOW OPTIC ANGLE RIMMED BY PALE REDDISH BROWN PYROXENE OF MODERATE OPTIC ANGLE AND HIGHER BIREFRINGENCE THAN THAT OF THE CENTER. FROM THE CENTER OUTWARD THE OPTIC ANGLE INCREASES, FROM NEAR 0 DEGREES TO SAY 10 OR 15 DEGREES AT ABOUT 3/4 OF THE WAY OUT, THEN RAPIDLY TO ABOUT 40 OR 50 DEGREES IN THE RIM.

APPROXIMATE MODE.

PHENOCRYSTS ABOUT 40 PERCENT

GROUNDMASS 60 PERCENT

CLINOPYROXENE 65 PERCENT

PLAGIOCLASE 20 PERCENT

OPAQUES 8 PERCENT
OLIVINE 5 PERCENT
CRISTOBALITE 2 PERCENT
LAVENDER MINERAL TRACE

CLINOPYROXENE (SEE ALSO ABOVE)
PHENOCRYSTS ELONGATE SOME CROSS SECTIONS ARE LOZENGE SHAPED ZONED. GROUNDMASS CLINOPYROXENE ARE MORE STRONGLY COLORED THAN RIMS OF PHENOCRYSTS. IN YELLOWISH BROWNISH HUES. OPTIC ANGLE ESTIMATED MODERATE. POSITIVE ON ONE CRYSTAL.
BIREFRINGENCE STILL HIGHER THAN PHENOCRYST RIMS.
PLAGIOCLASE APPEARS TO BE CALCIC BUT NO CLOSE ESTIMATE OF AN CONTENT MADE. IT IS COMMONLY PRESENT IN GROUNDMASS AS A GRAPHIC INTERGROWTH WITH PYROXENE AND OPAQUES.
OPAQUE MINERAL OCCURS CHIEFLY AS PLATES WITH ENHEDRAL TERMINATIONS. RARELY GRADING INTO TRANSLUCENT DEEP RED BROWN COLOR (A SEPARATE MINERAL).
OLIVINE OCCURS AS SCATTERED STUBBY CRYSTALS
CRISTOBALITE SCATTERED GRAINS INTERSTITIAL TO GROUNDMASS PLAGIOCLASE AND CLINOPYROXENE.
LAVENDER MINERAL (SPINEL) IS PRESENT AS RARE SMALL PLATES. HIGH INDEX. LOW OR NO BIREFRINGENCE.

SAMPLE NO. 12065.7 THIN SECTION FRONDEL
AN UNUSUAL ROCK. CHARACTERIZED BY PHENOCRYSTS OF PIGEONITE WITH A RELATIVELY COARSE GROUNDMASS COMPOSED OF FAN LIKE TO RADIAL TO SUBPARALLEL AGGREGATES OF LONG PRISMATIC TO ACICULAR PLAGIOCLASE AND PIGEONITE. THE PIGEONITE IS VERY STRONGLY ZONED. THE TEXTURED RELATIONS INDICATE RAPID CRYSTALLIZATION DURING THE CLOSING STAGES. A SIMILAR BUT MUCH LESS MARKED TEXTURE WAS NOTED IN 12057.19 SEE PHOTOGRAPHS. ROCK IS A PIGEONITE BASALT.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
TOTAL CARBON ANALYSIS
X-RAY ANALYSIS

SAMPLE 12070

SAMPLE NO. 12070.0 WEIGHT. 1102.0 GRAMS HARMON
CONTINGENCY FINES WILL NOT BE EXAMINED DURING PET TO PREVENT CONTAMINATION.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RARE GAS ANALYSIS
X-RAY ANALYSIS

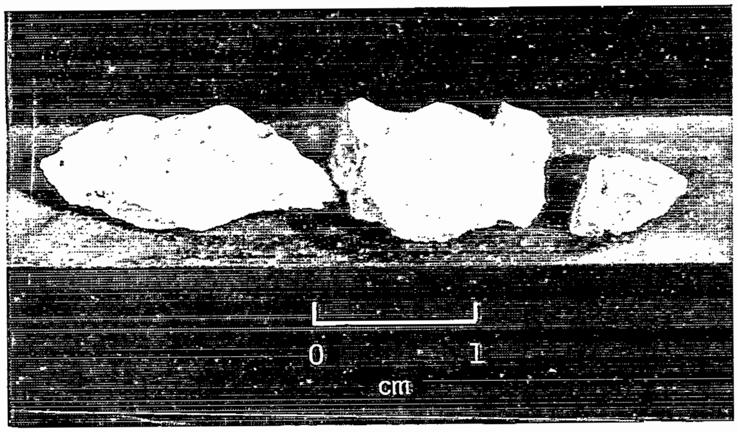
SAMPLE 12071 DECEMBER 5, 1969 WONES
SEPARATED THESE CHIPS INTO DAUGHTER SAMPLES.
12071 FINES IN CAN 34 29 .89 GRAMS
12071.6 MICROBRECCIA CHIPS IN CAN 52 0203 2.08 GRAMS
12071.3 BASALT SCORIA IN CAN 31 0171 3.55 GRAMS
12071.4 OLIVINE BASALT IN CAN 51 0172 1.15 GRAMS
12071.5 CHIHUAHUA SPOOR IN CAN 551 0151 1.38 GRAMS

SAMPLE NO. 12071.6
THREE CHIPS. ALL HAVE IRREGULAR POLYHEDRAL SHAPES.
LARGEST. 1.5 X 1.0 X 0.7 CM
MIDDLE. 1.0 X 1.0 X 0.7
SMALLEST. 0.5 X 0.5 X 0.7 CM
NEUTRAL (N7) WITH WHITE SPECKS (N9). FRAGMENTAL. LARGEST ROCK AND MINERAL FRAGMENT 2 MM IN DIAMETER. PLAGIOCLASE/PYROXENE ROCK DOMINANT TYPE. OLIVINE AGGREGATES AND OPAQUES OBSERVED. GLASS SPHERES ALSO SEEN. CHIPS TOO SMALL FOR MACROFABRIC. NO FRACTURES OBSERVED, EXCEPT FOR BRECCIATION OF OLIVINE AND PLAGIOCLASE. PITS AND GLASS ADHERING TO SURFACES. GLASS. PLAGIOCLASE. PYROXENE OLIVINE AND OPAQUES. TERRESTRIAL ANALOGUE. MICROBRECCIA.
MICROBRECCIA. LARGEST FRAGMENT 2 MM DIAMETER. PLAGIOCLASE/PYROXENE DOMINANT ROCK FRAGMENTS. OLIVINE. OPAQUES GLASS SPHERES ALSO OBSERVED. PITS AND GLASS ADHERING TO SURFACE. VERY SMALL CHIPS.

SAMPLE NO. 12071.3 DIMENSIONS 1.7 X 1.5 X 1.3 CM WONES
ROCK PLACED IN CAN 51 0171. IRREGULAR LUMP. NEUTRAL (N7) GRAY. VESICULAR. LARGE (1 CM) COALESCING VESICLES WITH POLYHEDRAL SHAPES. FINE GRAINED CRYSTAL LINE LESS THAN 0.1 MM GROUNDMASS WITH 0.1 MM CIRCULAR VESICLES. NO FRACTURES OBSERVED. MAJORITY OF SURFACES FRESH. SOME SHATTER ZONES. GLASS AND PITTING ON ONE FACE.
MINERALOGY. PLAGIOCLASE AND PYROXENE. NOTHING ELSE LARGE ENOUGH TO SEE. NO ALTERATION OF CRYSTALS IN VESICLES.
TERRESTRIAL ANALOGUE. BASALT SCORIA.
BASALT SCORIA. LARGE COALESCING POLYHEDRAL VESICLES. FINE GRAINED (LESS THAN .1 MM) GROUNDMASS. NO FRACTURES. MOST FACES FRESH. GOOD VOLCANIC TEXTURE.

SAMPLE NO. 12071.4 DIMENSIONS 1.0 X 1.0 X 0.8 CM WONES
PLACED IN CAN 51 0172. IRREGULAR LUMP. NEUTRAL GRAY (N2). VUGGY. FINE GRAINED LESS THAN 0.1 MM GROUND MASS PORPHYRITIC. NO LINEATION. VUGS MAY BE CLUSTERED. NO FRACTURES OBSERVED. PITS. GLASS SMEARS. SHATTERED ZONES ON SURFACE.
MINERALOGY MODE. GROUNDMASS 90 PERCENT
OLIVINE PHENOCRYSTS 10 PERCENT
OLIVINE. EUHEDRAL EQUANT 0.2 MM GRAINS.
TERRESTRIAL ANALOGUE. OLIVINE BASALT.

SAMPLE NO. 12071.5 DIMENSIONS 2.0 X 0.7 X 0.8 CM DEUS EX MACHINA
LONG IRREGULAR LUMPY (CHIHUAHUA SPOOR). LIGHT GRAY (N8). HIGHLY IRREGULAR. VESICULAR. FINE GRAINED. COARSE GRAINED. GLASSY. IN SHORT. A REAL MESS. SCORIACEOUS WITH CRYSTALS IN CAVITIES. GLASSY LAYERS. ADHERING DUST. VESICLES APPEAR POLYHEDRAL. NO FRACTURES OBSERVED. ADHERING DUST. NONE OF TYPICAL LUNAR MATERIAL.
MINERALOGY. MODE RIDICULOUS. CLEAR PLATY CRYSTALS IN VESICLES. MAY BE TRIDYMITE. 0.2 MM DIAMETER.
TERRESTRIAL ANALOGUE. LITHOPHYSAE. COPROLITE. BRECCIATED SCORIA. YOU PICK IT
LARGE CRYSTALS IN CAVITIES. MAY CONTAIN TRIDYMITE.



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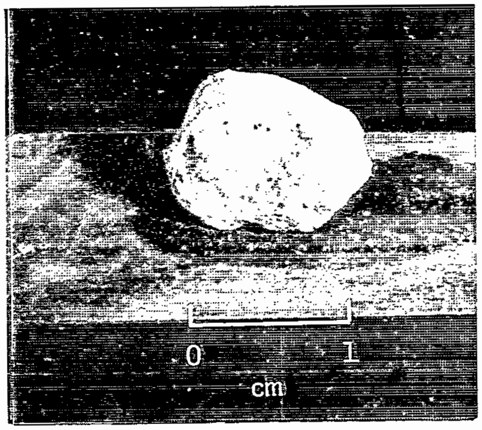

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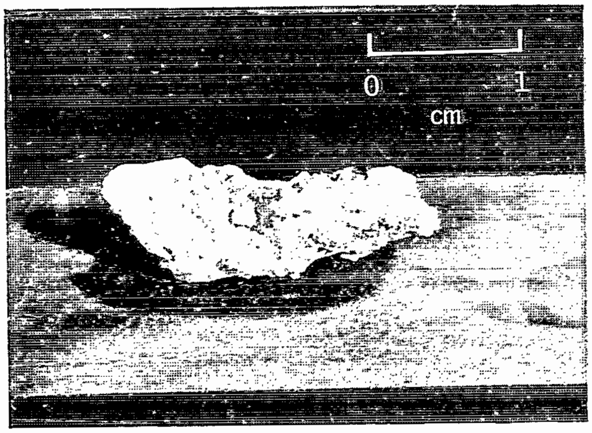

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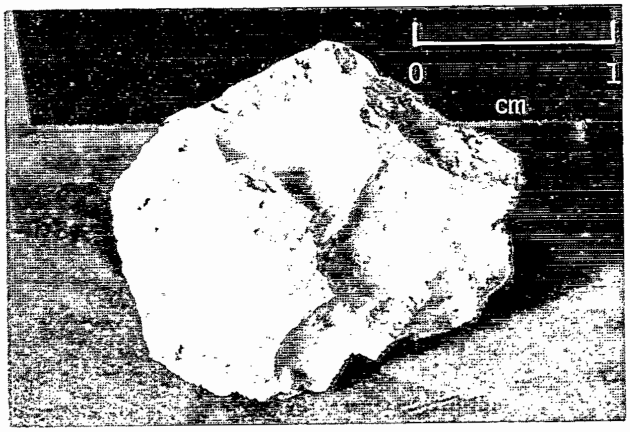

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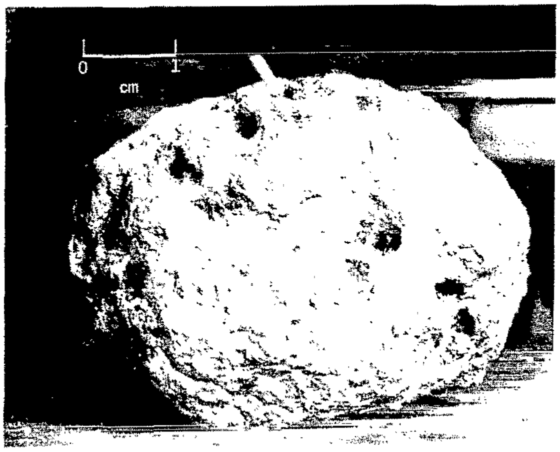
Figure A-58. - Sample 12071.

SAMPLE NO. 12072 WEIGHT 103.6 DIMENSIONS 5 X 3 X 2.7 CM LOFGREN
AN EGG SHAPED MEDIUM GRAY IGNEOUS APPEARING VUGGY ROCK . THE SURFACE IS SLIGHTLY PITTED AND SHOWS A SURFACE WHITENING PRESUMABLY RELATED TO CHALKY FELDSPAR CRYSTALS ON SURFACE. THE VUGS ARE SUBROUNDED AND LINED WITH CRYSTALS OF PYROXENE AND OLIVINE. THE LATTER BEING RARE. THE VUGS ARE RANDOMLY ORIENTATED AND IRREGULARLY DISTRIBUTED THROUGHOUT THE ROCK. FRACTURES ARE FEW AND PARALLEL THE SURFACE. PITS ARE GLASS LINED AND RANGE FROM 0.5 TO 1.5 MM IN DIAMETER. MOST HAVE HALOES OF WHITE MATERIAL. SOME ARE AT THE SURFACE AND SOME PITS STILL BOTTOM BELOW THE SURFACE UP TO 1/2 MM DEEP. DENSITY IS SMALL AND ABOUT SAME ON BOTH SIDES APPROXIMATELY 1/CM2. OLIVINE IS ABUNDANT 5 TO 10 PERCENT. PLAGIOCLASE AND PYROXENE BOTH OBVIOUS. PYROXENE IS HONEY BROWN. ILMENITE IS NOT OBVIOUS.



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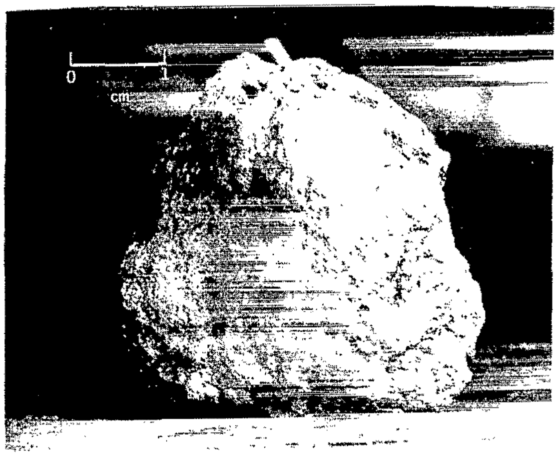

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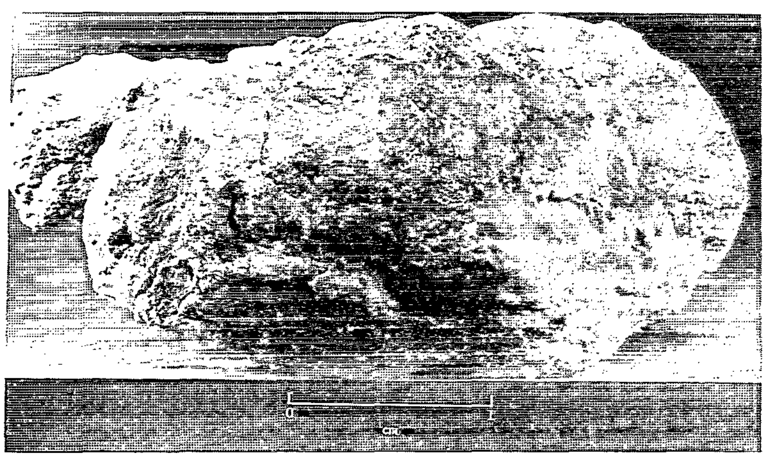
NASA-S-69-61748

Figure A-59. - Sample 12072.

SAMPLE 12073
SAMPLE NO. DIMENSIONS 10 X 6 X 6 CM LOFGREN
NO VESICLES EXCEPT IN FRAGMENTS. FEW FRACTURES. RANDOM FRACTURE ORIENTATION. MUCH GLASS ON SURFACE.
IS A MEDIUM GRAY RECTANGULAR MODERATELY ROUNDED BRECCIA OR TYPE C ROCK. THE COLOR OF A FRESHLY BROKEN SURFACE IS ONLY SLIGHTLY LIGHTER THAN ORIGINAL SURFACE THE SURFACE IS PITTED AND HAS GLASS COATING. THE PITS ARE GLASS LINED AND SHALLOW. THEY RESEMBLE THE PITS ON CRYSTALLINE RX MORE THAN THE PITS ON THE BRECCIAS IN THE APOLLO 11 ROCKS. SOME EVEN HAVE SLIGHT HALOES. THE SURFACE DENSITY IS REASONABLY EVEN OVER THE SURFACE APPROXIMATE 2 TO 3 CM2. THE ROCK HAS LARGE AREAS OF VESICULAR GLASS SPLASH THAT APPEARS TO BE A COATING. ANOTHER AREA OF GLASS SEPARATE FROM THE LARGE SPLASH HAS MORE THE APPEARANCE OF BEADED SOLDER WITH RADIATING FRACTURES AND RIDGES FROM THE GLASS. THE LARGE GLASS COATING SHOULD BE COLLECTED AND PROBED. THERE ARE NO LINEATIONS AND FRACTURES ARE MODERATELY ABUNDANT AND RANDOMLY ORIENTATED.
THIS BRECCIA IS HARDER THAN THE AVERAGE APOLLO 11 BRECCIA AND MOST SIMILAR TO APOLLO 11 BRECCIA 10056 WHICH APPEARS TO BE BAKED. THE CRYSTALLINE FRAGMENTS ARE MOSTLY VESICULAR AND FINE GRAINED. SOME ARE COARSE GRAINED AND VUGGY. FEW OLIVINE RICH FRAGMENTS WERE OBSERVED.
ROCKS 12073 AND 12074 ARE PARTS OF THE SAME ROCK. I RECOMMEND THAT WE COMBINE THE NUMBERS TO 12073 AND MAKE THE PIECES ONE ROCK NUMBER.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
RCL ANALYSIS



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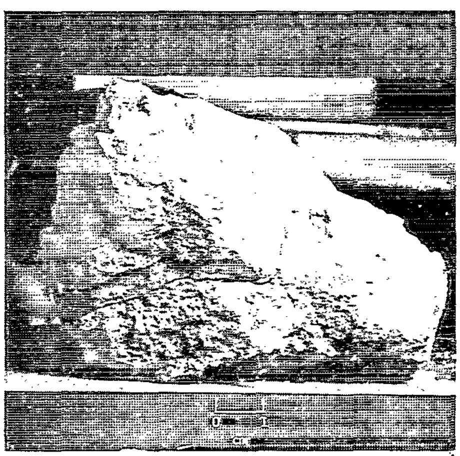

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Figure A-60. - Sample 12073.

SAMPLE 12075

SAMPLE NO. 12075 WEIGHT 232.5 DIMENSIONS 8.5 X 5 X 5 CM. D.R. WONES
SHAPE. TRIANGULAR PRISM WITH PROJECTION AT ONE END. ROUNDED EDGES ON ONE END. EXTENDED CORNER ABOUT TO BREAK OFF.
COLOR. NEUTRAL GRAY N5 TO N6 GSA ROCK COLOR CHART.
TEXTURE. VUGGY. FINE GRAINED (LESS THAN 0.1 MM GROUNDMASS) PORPHYRITIC. EUHEDRAL OLIVINE PHENOCRYSTS (0.2 MM) IS A GROUNDMASS DOMINATED BY PLAGIOCLASE AND PYROXENE. EUHEDRAL CRYSTALS OF PYROXENE AND PLAGIOCLASE (0.4 MM) ARE IN VUGS. VUGS ARE CLUSTERED AND RANGE FROM 2 TO 7 MM IN DIAMETER.
FABRIC. NO LINEATIONS. VUGS TEND TO BE IN A PLANAR MASS. FAIRLY ABUNDANT 5 TO 10 PERCENT.
FRACTURE. FRACTURE ON EDGE OF POINTED PROJECTION (SEE ABOVE). ORIENTATION RELATED TO PRESENT SURFACES OF BLOCK.
SURFACE FEATURES. ONE SIDE FRESH, LONG SIDES ROUNDED, COVERED WITH SHATTERED MATERIAL, PITTED WITH SOME HALOES. SURFACE FEATURES NOT NOTABLE.

PLAGIOCLASE	50 PERCENT
PYROXENE	30 PERCENT
OLIVINE	20 PERCENT

MINERALOGY. OLIVINE (20 PERCENT). EUHEDRAL. GREEN, TABULAR, PHENOCRYSTIC. BUT ALSO IN VUGS. OPTICS. (WILCOX AND WONES) ALPHA ABOUT 1.695. BETA ABOUT 1.720, AND GAMMA ABOUT 1.740. FE/FE + MG ABOUT 0.30. X RAY. (W.B.NANCE) 130 D SPACING INDICATES 0.45 FE/FE+MG. DISCREPANCY DUE TO 0.05 CA. VERIFIED BY OES (ROSS TAYLOR) SI.MG GT FE GT GT CA GT GR MN, TI. AL, NI, ZR NOT DETECTED.
PLAGIOCLASE (50 PERCENT). LATH SHAPED. WHILE STRIATED, SUBOPHITIC IN GROUNDMASS. LARGEST LATH 0.2 MM, WELL SHAPED IN VUGS. GAMMA LESS THAN 1.586 (WILCOX)
PYROXENE (30 PERCENT). EQUANT TO LATH SHAPED. OPTICS (WILCOX) ALPHA ABOUT 1.700, BETA ABOUT 1.705, GAMMA ABOUT 1.725. THIS WOULD INDICATE FE/FE+MG OF ABOUT 0.50. UNCOLORED PYROXENE HAS SLIGHTLY LOWER GAMMA.
OPAQUES (LESS THAN 1 PERCENT). SOME ILMENITE LAMELLAE. LARGEST GRAIN IN VUGS CONTAIN COARSER CYRSTALS. ALL ARE PRESENT IN VUGS, BUT OLIVINE CONTENT IS LOWER, MORE OPAQUES IN VUGS.
TERRESTRIAL ANALOGUE. OLIVINE BASALT.
SPECIAL RECOMMENDATION. VUGS SHOULD BE PRESERVED FOR SINGLE CRYSTAL WORK. SMALL OPAQUE OCTAHEDRA SHOULD BE IDENTIFIED.THEY COULD BE MAGNETITE. THIS WOULD BE IMPORTANT IN DETERMINING WHETHER ANY LATE STAGE OXIDATION TOOK PLACE. CRYSTALS SHOULD BE PRESERVED BEFORE THEY ARE LOST.

SAMPLE NO. 12075 CONTINGENCY BAG CHAO
WEIGHT 232.5 GRAMS DIMENSIONS 8 X 5 X 4.5 CM LOAF OF BREAD SHAPED

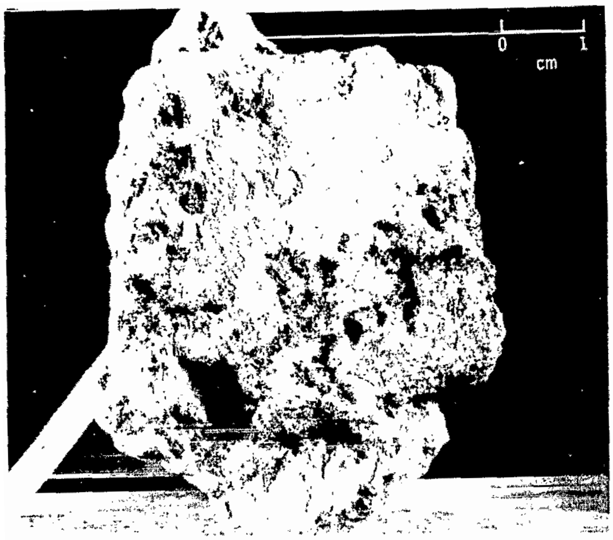
GENERAL APPEARANCE - THIS IS A MEDIUM GRAY, FINE-GRAINED, VERY VUGGY, HOLO-CRYSTALLINE ROCK WITH A LAVENDER TINGE. IT IS SIMILAR TO 12065 IN APPEARANCE.

SURFACE FEATURES - TOP ROUNDED SURFACES COVERED WITH MANY SMALL GLASS LINES PITS. THE FLAT FRACTURE SURFACE OR BASE IS FREE OF GLASS PITS. WITH VUGS UP TO 0.8 CM. IN ONE QUADRANT OF THIS FLAT SURFACE. VESICLES NOT FOUND.

TEXTURE AND GRAIN SIZE - SLIGHTLY TRACHYTIC, PORPHYRITIC. SIMILAR TEXTURE AS 12065 EXCEPT THIS ONE IS MORE PORPHYRITIC.
THE GREENISH YELLOW OLIVINES ARE COARSER AND PHENOCRYSTIC (UP TO 1 MM). THE LAVENDER OR PURPLISH BROWN CLINOPYROXENE OCCURS AS LONG PRISM (UP TO 1.8 MM. IN THE VUGS.

MINERALOGY - MEGASCOPIC

1. GREENISH YELLOW OLIVINE, PHENOCRYSTIC, CONTAINS DARK OPAQUE INCLUSIONS SOME ARE BEAUTIFUL OCTAHEDREA (SPINEL GROUP, CHECK CHROMITE), ABOUT 30 + 0/0.
2. LAVENDER BROWN PRISMATIC CRYSTALS OF (YELLOWISH CORE) CLINOPYROXENE WITH BUNCHES OF RADIATING PRISMATIC CRYSTALS ALONG THE LARGER PHENOCRYSTIC CLINOPYROXENE, ABOUT 50 PERCENT. THE YELLOWISH CORES ARE PROBABLY PIGEONITE.
3. CLEAR PLAGIOCLASE, INTERGROWN WITH SMALL CLINOPYROXENE BLADES, ABOUT 15 PERCENT.



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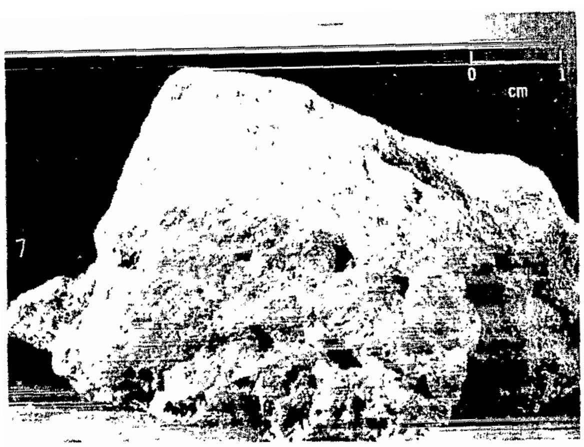

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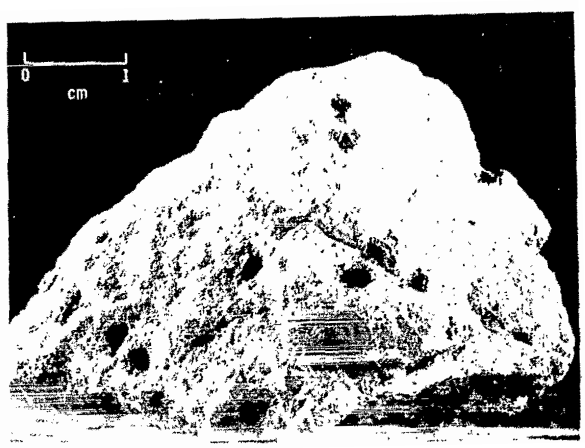

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Figure A-61. - Sample 12075.

4. PLATY THIN BLACK ILMENITE. ALSO PARALLEL SHEAF GROWTH WITH EITHER PLAGIOCLASE OR CLINOPYROXENE. ABOUT 5 PERCENT.

5. SMALL (UP TO 100 MICROGRAMS) OCTAHEDRAL OPAQUE SPINEL - CHROMITE.

SHOCK - NO EVIDENCE. FRACTURES NOT IMPORTANT.

REMARKS - THIS IS A CUMULATIVE OLIVINE RICH ROCK (PICRITE BASALT) SIMILAR TO 12065 IN TEXTURE. EXCEPT THE OLIVINE CONTENT. VUGGY. NICE CRYSTALS OF CHROMITE. OLIVINE AND CLINOPYROXENE CAN BE PICKED OUT FOR DETAILED MINERALOGICAL AND X-RAY CRYSTAL STUDIES.

ROCK MAY BE CLASSIFIED AS SIMILAR TO A PICRITE BASALT. THE AMOUNT OF PLAGIOCLASE AND OF OLIVINE SHOULD BE BETTER ESTIMATED FROM A THIN SECTION. AS WELL AS TO CONFIRM THE SIMILAR TEXTURE BETWEEN THIS ROCK AND 12065. THIS ROCK IS ALSO MORE PORPHYRITIC.

SAMPLE NO. 12075.1 ROCK FRONDEL

AN OLIVINE PYROXENITE. CONTAINS VERY LITTLE PLAGIOCLASE. THE ROCK IS UNUSUAL IN CONTAINING VUGS INTO WHICH PROJECT WELL FORMED PRISMATIC CRYSTALS OF PYROXENE. NO OPTICAL DATA TAKEN BUT SUSPECT PYROXENE TO BE AUGITIC. PHOTOGRAPHS TAKEN OF ROCK. TERRESTRIAL PYROXENITES GENERALLY LACK VUGS OR CAVITIES OTHER THAN CAUSED BY LATER HYDROTHERMAL ACTION.

SAMPLE NO 12075.1 BRETT

THE ROCK IS AN ANGULAR FRAGMENT. A CHIP. SO SHAPE IS OF NO GREAT SIGNIFICANCE. APPROXIMATE DIMENSIONS ARE 1.5 X 1 X 0.75 CM. COLOR MEDIUM GREY. SALT AND PEPPER WITH GREEN OLIVINE CRYSTALS EVIDENT UPON CLOSE MACROSCOPIC INSPECTION. TEXTURE HOLOCRYSTALLINE BASALTIC. NO LINEATIONS EVIDENT EXCEPT AN EXTREMELY IRREGULAR PLANE RICH IN IRREGULAR VUGS UP TO 2 MM IN DIAMETER UP TO ABOUT 10 PER SQUARE CM. REMAINDER OF ROCK CONTAINS NO VUGS. VUGS ARE OVOID TO SPHERICAL TO IRREGULAR DUE TO COALESCENCE. VUGS ARE VERY RICH IN WELL DEVELOPED PRISMATIC LAVENDER BUFF PYROXENE CRYSTALS UP TO 2 MM. THESE RARELY PROJECT INTO VUG. LINE VUGS FORMING ONE OR MORE WALLS OF A VUG AND ARE RICH IN THAT PORTION OF THE ROCK SURROUNDING VUGS. RARE PLAGIOCLASE PLATES ALSO LINE VUGS. MARKED COARSENING OF GRAIN SIZE IN REGIONS SURROUNDING VUGS. NO FRACTURES EVIDENT. NO SURFACE FEATURES EVIDENT.

MINERALOGY. MODAL PERCENTAGES ARE VERY APPROXIMATE.

OLIVINE 45 PERCENT

PYROXENE 40 PERCENT

PLAGIOCLASE 5 TO 10 PERCENT

ILMENITE 5 TO 10 PERCENT

GLASS LESS THAN 1 PERCENT

OLIVINE. IN MAIN MATRIX OF ROCK GREEN OLIVINE GRAINS EASILY VISIBLE AS CRYSTALS TO 0.3 MM IN A FINER GRAINED MATRIX. INDEX VERY APPROXIMATE G = 1.735 (SMITH) GIVING FO70 OR SO. VERY ROUGH. FINER GRAINED OLIVINE 0.1 MM OR SO IN THE FINE GRAINED MATRIX. IS IT SAME COMPOSITION.

PYROXENE. AS PRISMATIC CRYSTALS ASSURED VUGS. ALSO AS FINER GRAINED SUBHEDRAL GRAINS ABOUT 0.1 MM IN MATRIX. ARE 2 PYROXENES PRESENT.

PLAGIOCLASE. RARE 0.1 MM SOMEWHAT LATH LIKE GRAINS AND RARE SHEAVES BETWEEN INTERSTICLES OF MINERALS. NO TWINNING SEEN.

ILMENITE. OPAQUE LATHS AND SUBHEDRAL GRAINS PRESENT. 0.1 MM OR SO. NO POSITIVE IDENTIFICATION FOR ILMENITE.

GLASS. DARK. NEARLY OPAQUE GLASS SPHERES TO 0.5 MM IN LARGER OLIVINE CRYSTALS. RARE. A GRAIN IF IT CONTAINS SPHERES USUALLY CONTAINS SEVERAL.

TERRESTRIAL ANALOGUE. OLIVINE PYROXENITE. TEXTURE AND MINERALOGY SUGGEST A CUMULATE ROCK.

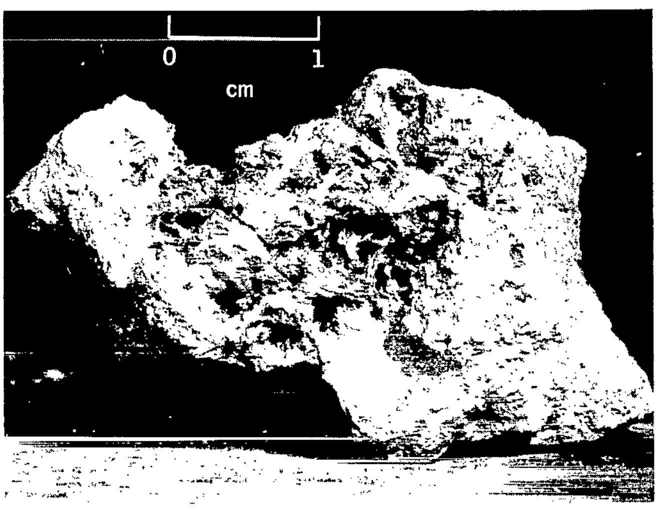
STRONGLY RECOMMEND SAMPLE BE USED FOR CRYSTALLOGRAPHIC STUDIES

SAMPLE 12076

SAMPLE NO. 12076 WEIGHT 54.55 DIMENSIONS 5.0 X 4.3 X 2.6 WONES
IRREGULAR LUMP. VERY FRIABLE. WILL BE IN SEVERAL CHIPS BEFORE LONG. NEUTRAL GRAY N7 SPECKLED WHITE. FINE GRAINED. SUBOPHITIC. VUGGY. NO LINEATIONS OBSERVED. LARGE IRREGULAR VUG. ABUNDANT FRACTURES. NO COMMON ORIENTATION. THROUGH GOING. SPECIMEN FRIABLE. MOST SURFACES ARE FRESH. THE ONE OLD SURFACE HAS PITS WITH GLASS LININGS. VUG COATED WITH SPLASH.
MINERALOGY.
MODE PLAGIOCLASE 40
PYROXENE 55
OLIVINE 5
OPAQUE LESS THAN 1
MINERALS PLAGIOCLASE. LATH 1 MM TO 0.1 MM AND SMALLER CLEAR TO WHITE.
PYROXENE. BROWN EQUANT 0.1 MM TO 0.1
OLIVINE. EUHEDRAL GREEN EQUANT 0.2 MM GRAINS.
OPAQUE. SMALL LESS THAN 0.05 MM BLACK.
LARGE CRYSTALS OF PYROXENE. PLAGIOCLASE. AND OLIVINE. RADIATING ACICULAR PYROXENE SHEAVES. ALSO COATING OF SPLASH OR SHATTER ON CRYSTALS IN VUGS. SHATTER TEXTURES ON SURFACES OF MINERALS. ALTERATION.
TERRESTRIAL ANALOGUE. VUGGY OLIVINE BASALT.

SAMPLE NO. 12076 WONES
X RAY DATA (W. NANCE) AGAIN SHOWS ANOMALOUS 130 SPACING INDICATIVE OF CA IN OLIVINE.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE
X-RAY ANALYSIS



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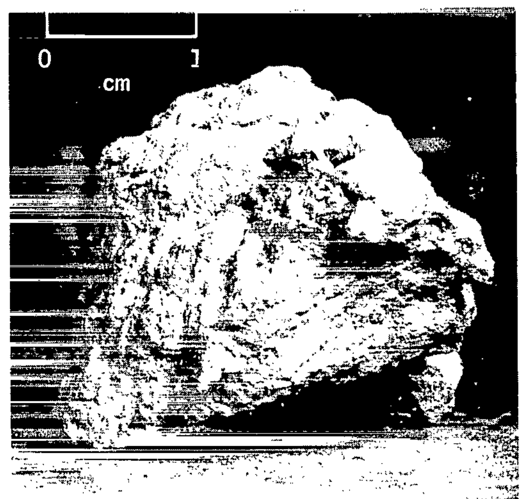

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Figure A-62. - Sample 12076.

SAMPLE NO. 12077.0 WEIGHT 22.63 DIMENSIONS 4.6 X 2 X 1.5 CM WONES
CHIP FELL OFF AFTER ORIGINAL CANNING. CHIP IS LABELED 12077.1. APPROPRIATE
SHAPE. RECTANGULAR PRISM.
COLOR. LIGHT GRAY, N7.
TEXTURE. VUGGY, FINE GRAINED, SUBOPHITIC.
FABRIC. LINEATION NOT OBVIOUS, BUT ROCK IS ELONGATE AND VUGS MAY BE ALIGNED
PARALLEL TO LONG DIMENSION.
FRACTURE. THROUGH GOING FRACTURE PARALLEL TO LONG DIMENSIONS. SHAPE OF ROCK
DUE TO FRACTURE SYSTEM. ROCK IS FRIABLE AS A RESULT.
SURFACE FEATURES. TWO SIDES ARE ROUNDED AND PITTED. SOME GLASS SPLASH, SOME
SHATTERED MATERIAL. NOT ESPECIALLY GOOD FOR SURFACE FEATURES.
MINERALOGY.
PLAGIOCLASE (13 PERCENT), GREY STRIATED LATHS 0.5 MM X 0.05 MM. BETA
ABOUT 1.570. EXT ON 010 LESS THAN 38 DEGREES. AN90.
PYROXENE (65 PERCENT). EQUANT 0.05 MM X 0.05 MM VARIOUS SHADES OF BROWN.
DARKER BROWN APPEARS TO HAVE LOWER REFRACTIVE INDEX. GAMMA ABOUT 1.740
INDICATES VERY IRON RICH. QUITE DUSTY WITH OPAQUE INCLUSIONS.
OLIVINE (20 PERCENT). EQUANT, EUHEDRAL, GREEN, 0.2 MM. ALPHA ABOUT
1.700, GAMMA ABOUT 1.743. THIS INDICATES FE/FE AND MG OF 0.35. X-RAY (NANCE)
IMPLIES FE/FE+MG OF 0.50. DISCREPANCY COULD BE DUE TO CA. TAYLOR ANALYZED
MATERIAL AND FOUND SI,MG GT FE GT GT CA. AL,N,ZR NOT DETECTED.
OPAQUE. PLATY LESS THAN 0.04 MM . LUSTROUS.
OPAQUES 3 PERCENT
ALL MINERALS ARE PRESENT IN VUGS.
TERRESTRIAL ANALOGUE. OLIVINE BASALT.

SAMPLE 12077,4 D. R. WONES
OIL IMMERSION MOUNTS OF POWDERED MATERIAL.
USED OILS 1.570, 1.700, 1.743,

OLIVINE--A APPROXIMATELY 1.700+/-.005 FO65 FA35
G APPROXIMATELY 1.743+/-.010 FO65 FA35

PYROXENE--B APPROXIMATELY 1.743+/-.010 Z-B APPROXIMATELY 40 DEG

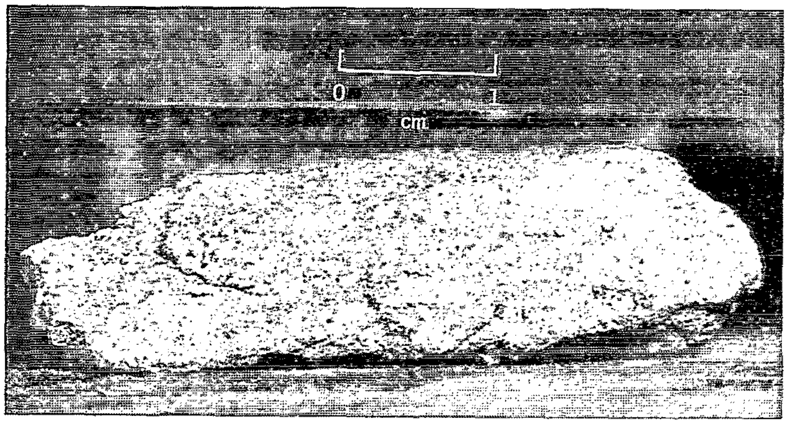
HIGHLY VARIABLE COLOR, DARKER COLOR LOWER INDEX. (MAY BE PIGEONITE AND AUGITE).

PLAGIOCLASE B)1.570--EXT-010 APPROXIMATELY 38 DEG AN90

ESTIMATES OF PLAGIOCLASE IN HAND SPECIMEN TOO HIGH.
MODE. OLIVINE 20 PERCENT
PLAGIOCLASE 13 PERCENT
PYROXENE 65 PERCENT
OPAQUES APPROXIMATELY 2 PERCENT
SMALL SPHERE OF ORANGE GLASS OBSERVED. MAY BE ADHERING FINES.

THE FOLLOWING EXPERIMENT WAS CONDUCTED ON THIS SAMPLE

E-SPEC ANALYSIS
X-RAY ANALYSIS



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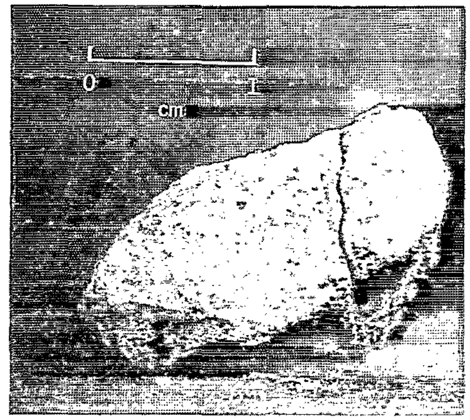

NASA-S-69-61843

NASA-S-69-61856

NASA-S-69-61851

Figure A-63. - Sample 12077.

THIN SECTIONS

Figures A-64 to A-95 are photomicrographs of the Apollo 12 lunar-sample thin sections. Descriptions of these photomicrographs are presented in table A-II.

TABLE A-II. - DESCRIPTION OF THIN-SECTION PHOTOMICROGRAPHS

Figure number	Sample number	NASA photograph number	Light	Special notes
A-64	12002-7	S-70-31576	Plane polarized	Variolitic texture
A-65	12004-10	S-70-31582	Reflected	Variolitic texture
A-66	12008-15	S-70-44572	Reflected	Olivine phenocrysts
A-67	12009-17	S-70-25428	Reflected	Skeletal olivine stringers
A-68	12010-29	S-70-44542	Reflected	Breccia
A-69	12012-5	S-69-24220	Plane polarized	Variolitic texture
A-70	12013-4	S-69-24223	Plane polarized	Breccia
A-71	12014-5	S-69-24210	Plane polarized	Pyroxene and olivine phenocrysts
A-72	12018-79	S-70-44547	Reflected	Pyroxene and olivine phenocrysts
A-73	12020-9	S-70-30253	Plane polarized	Variolitic texture
A-74	12021-5	S-69-24219	Plane polarized	Large pigeonite crystals
A-75	12021-4	S-69-24205	Plane polarized	Hourglass structure and pigeonite
A-76	12022-10	S-70-24742	Reflected	Skeletal ilmenite and olivine
A-77	12034-3	S-70-28217	Reflected	Breccia
A-78	12035-21	S-70-45637	Plane polarized	Granular texture
A-79	12038-2	S-69-24203	Plane polarized	Lath-shaped plagioclase
A-80	12040-3	S-69-24211	Plane polarized	Ophitic texture
A-81	12044-2	S-69-24207	Plane polarized	Granular texture
A-82	12051-55	S-70-40811	Reflected	Ophitic texture
A-83	12052-6	S-70-25417	Reflected	Plagioclase and olivine phenocrysts (variolitic texture)
A-84	12053-76	S-70-36474	Plane polarized	Variolitic texture
A-85	12057-14	S-69-64831	Reflected	Granular texture
A-86	12057-37	S-69-23374	Plane polarized	Lath-shaped plagioclase
A-87	12057-18	S-69-63411	Plane polarized	Ophitic texture
A-88	12057-36	S-69-23371	Plane polarized	Large pyroxene crystals
A-89	12057-22	S-69-63404	Reflected	Breccia
A-90	12062-18	S-70-30256	Plane polarized	Ophitic texture
A-91	12063-17	S-70-30270	Plane polarized	Subophitic texture
A-92	12064-9	S-70-30264	Plane polarized	Granular texture
A-93	12065-6	S-69-23378	Plane polarized	Variolitic texture
A-94	12073-5	S-70-20744	Reflected	Breccia
A-95	12075-23	S-70-44546	Reflected	Olivine phenocrysts

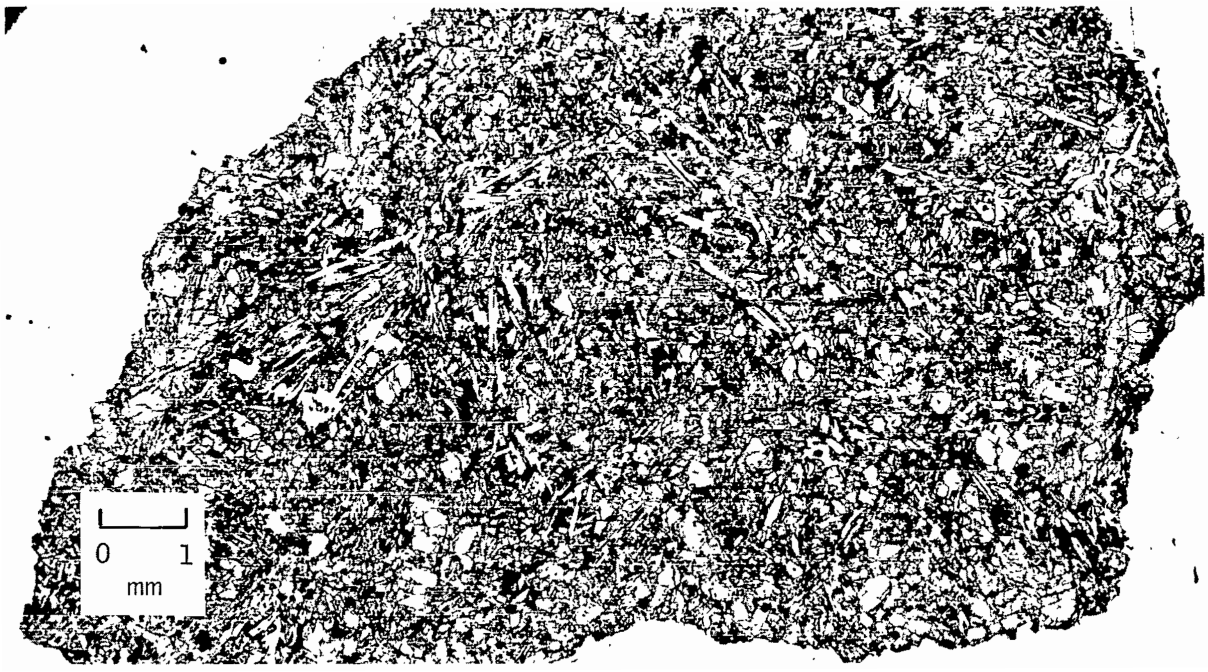

Figure A-64. - Sample 12002-7 (NASA-S-70-31576).

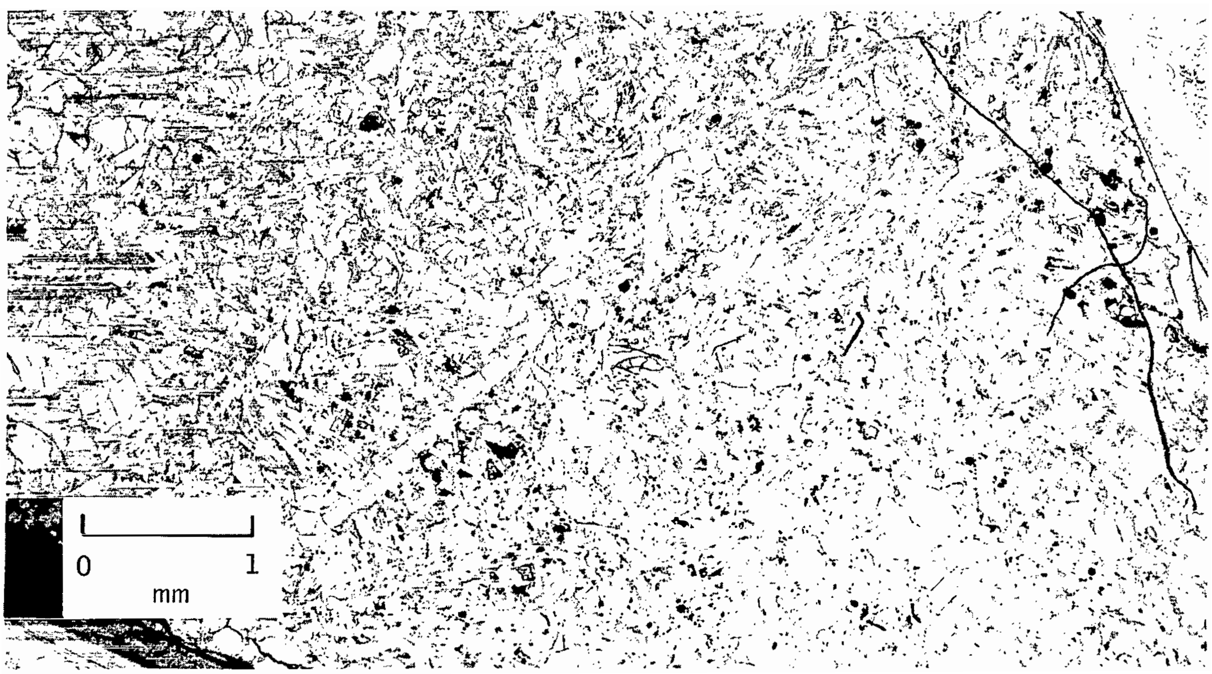

Figure A-65. - Sample 12004-10 (NASA-S-70-31582).

Figure A-66. - Sample 12008-15 (NASA-S-70-44572).

Figure A-67. - Sample 12009-17 (NASA-S-70-25428).

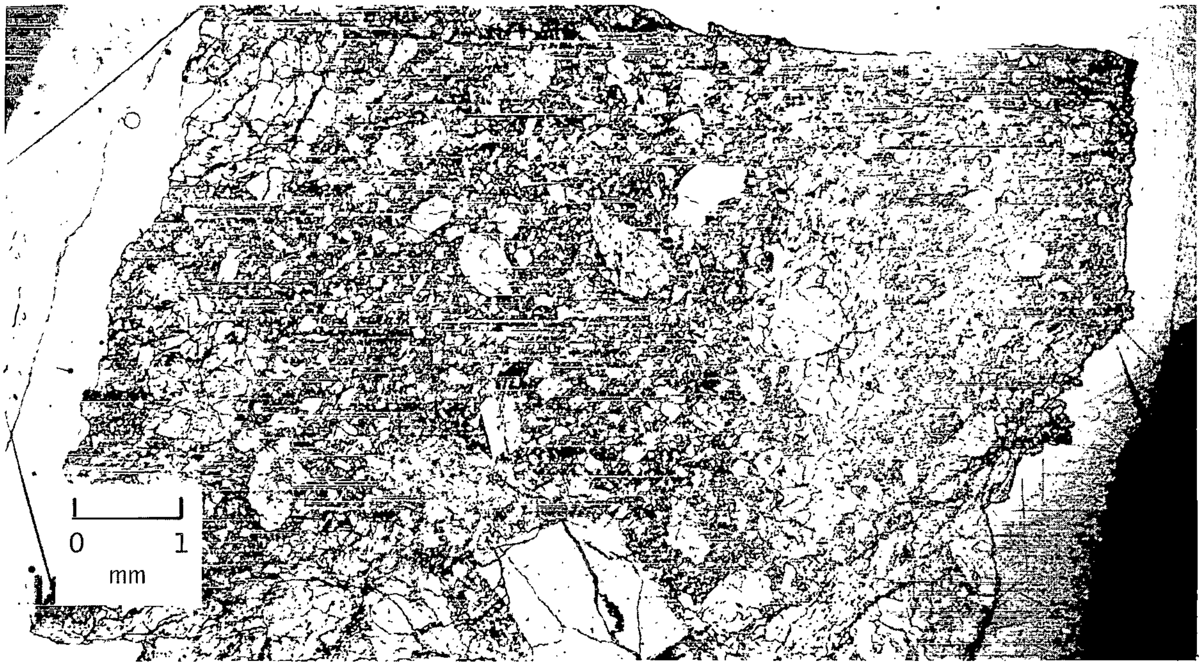

Figure A-68. - Sample 12010-29 (NASA-S-70-44542).

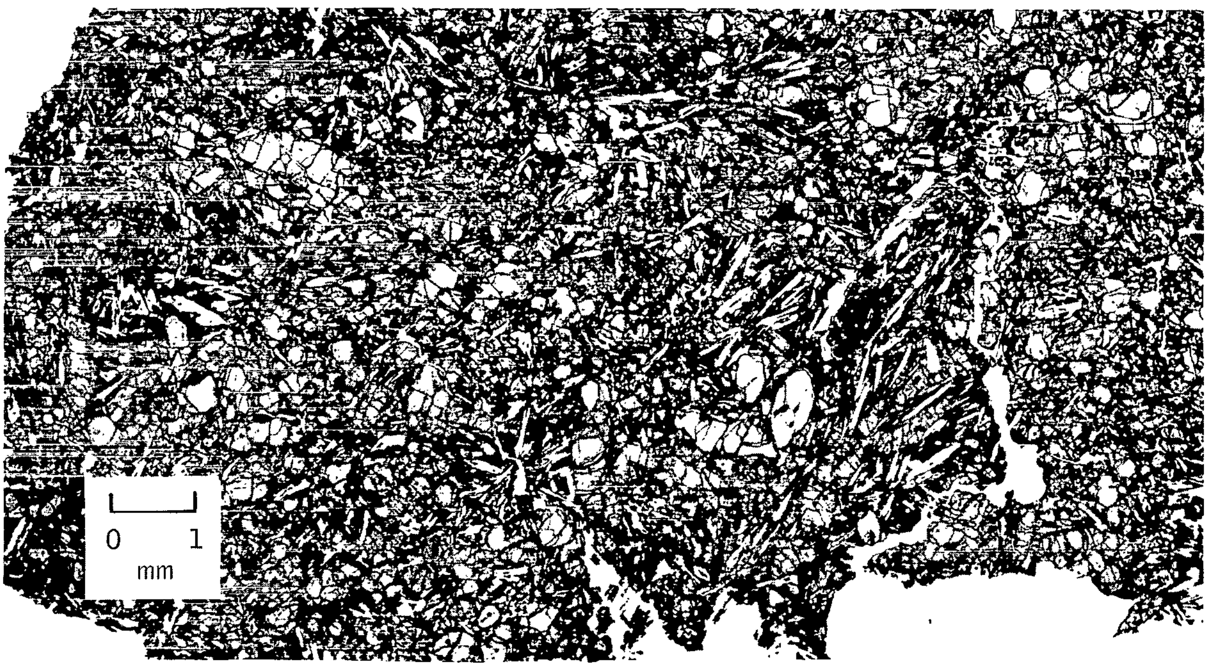

Figure A-69. - Sample 12012-5 (NASA-S-69-24220).

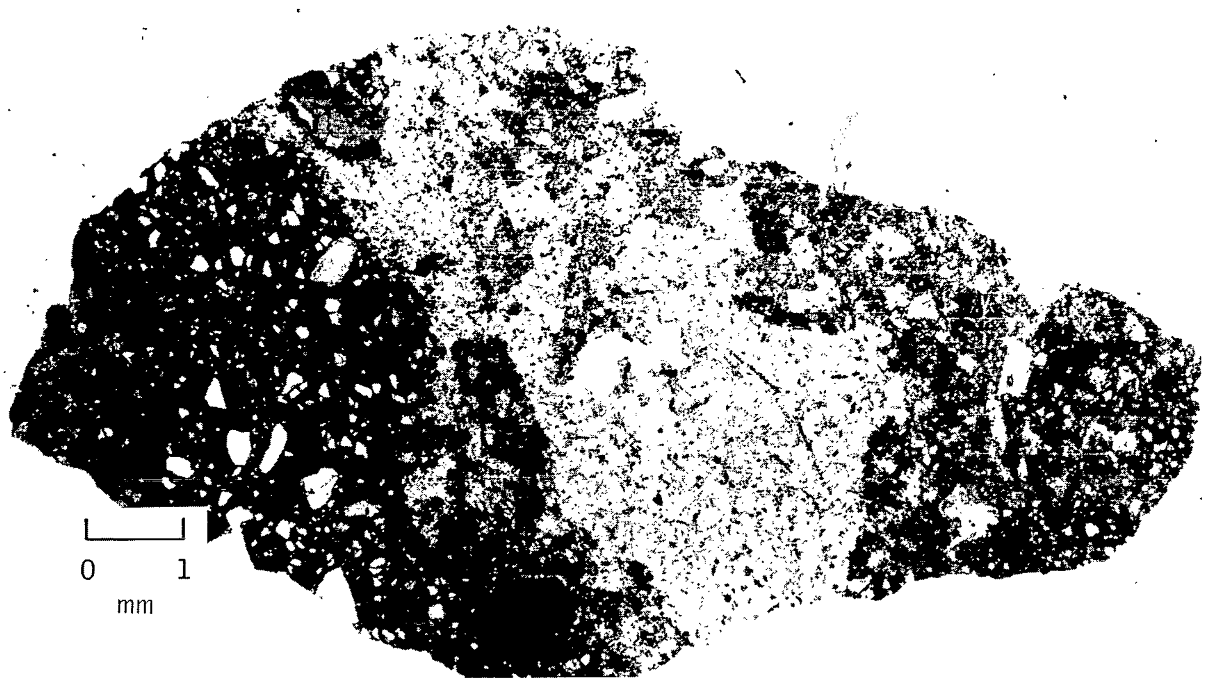

Figure A-70. - Sample 12013-4 (NASA-S-69-24223).

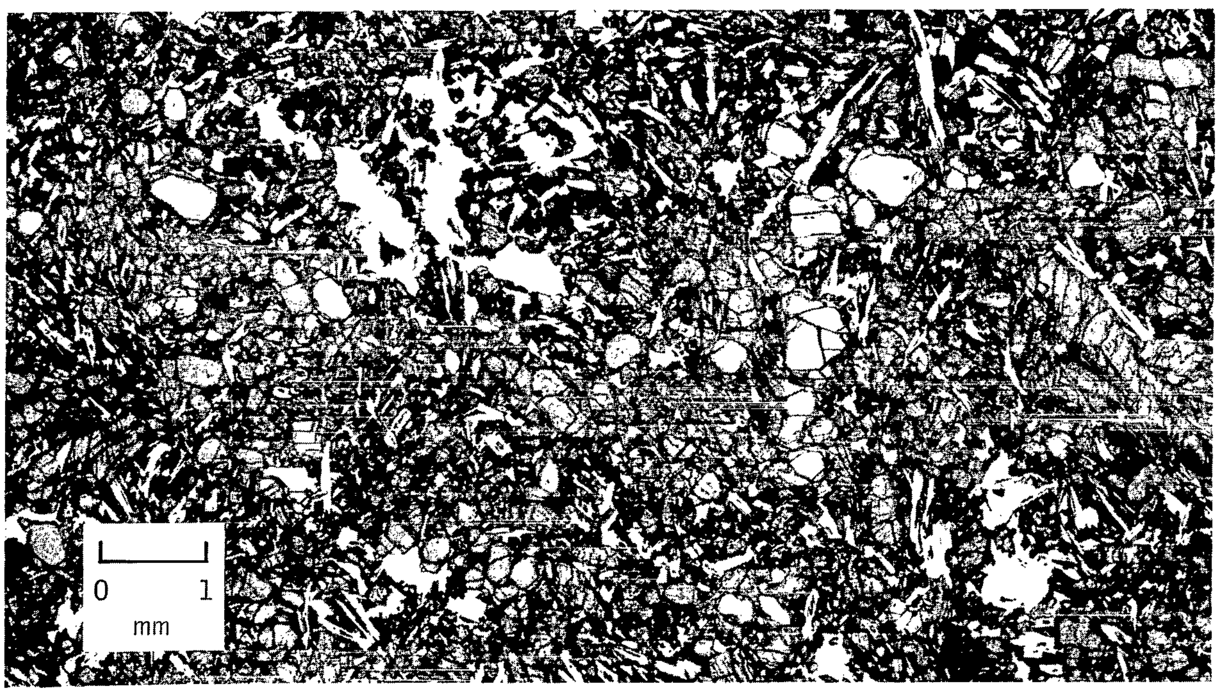

Figure A-71. - Sample 12014-5 (NASA-S-69-24210).

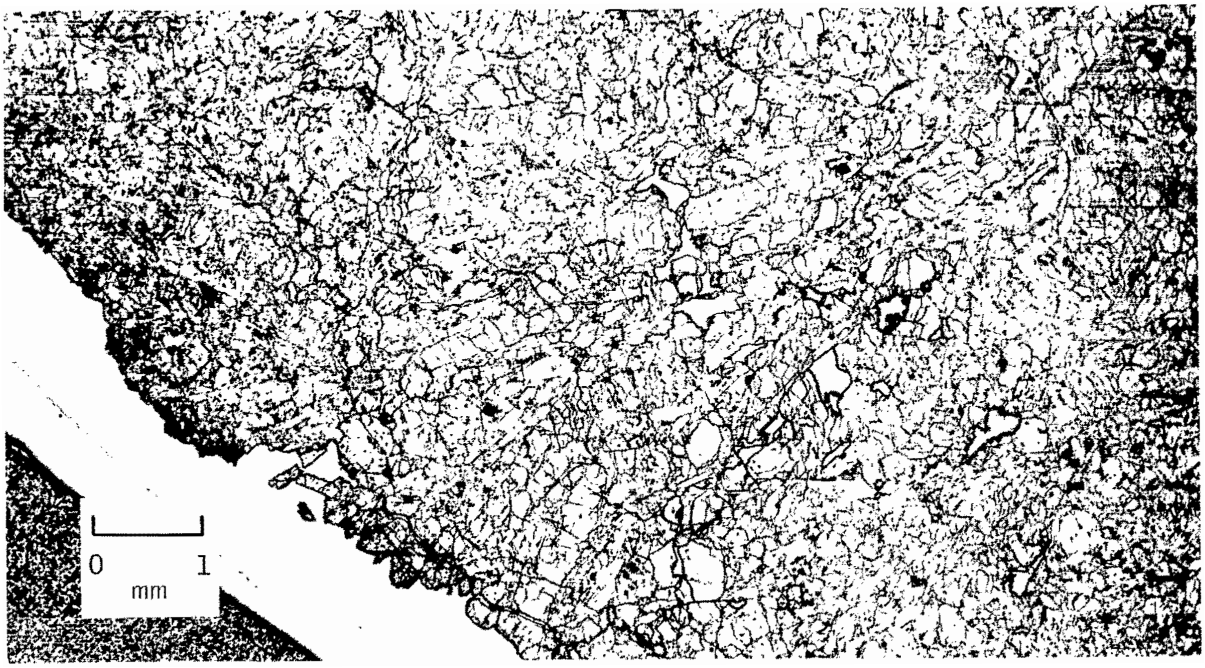

Figure A-72. - Sample 12018-79 (NASA-S-70-44547).

Figure A-73. - Sample 12020-9 (NASA-S-70-30253).

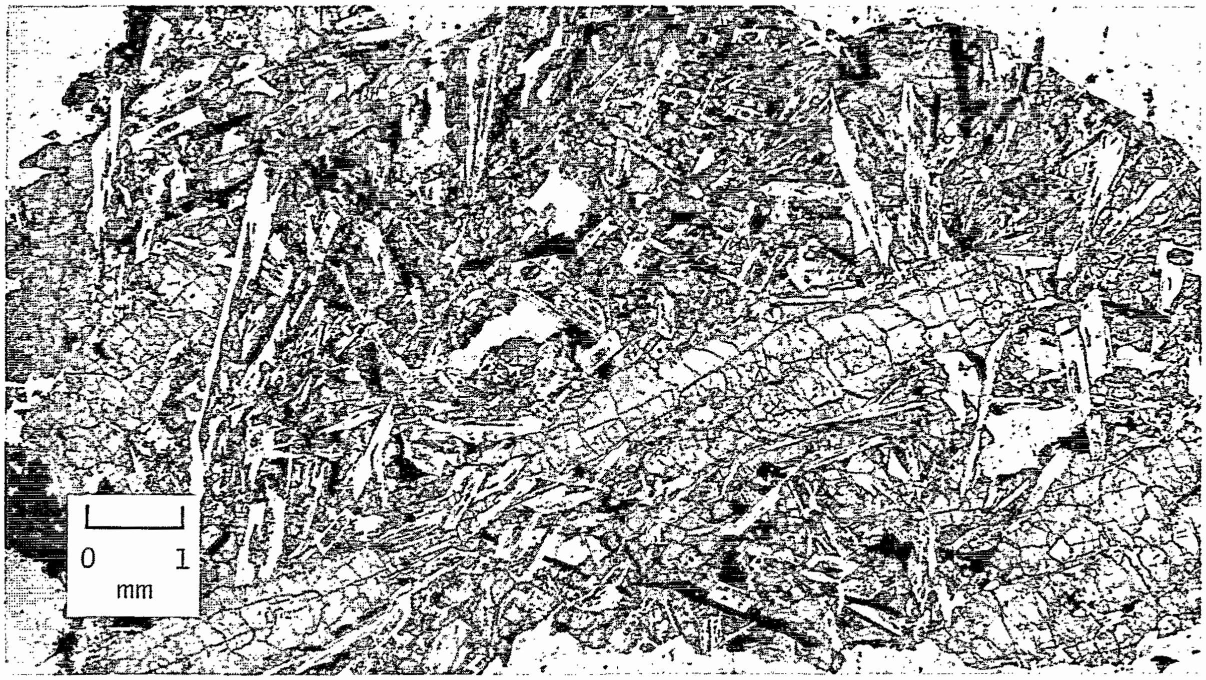

Figure A-74. - Sample 12021-5 (NASA-S-69-24219).

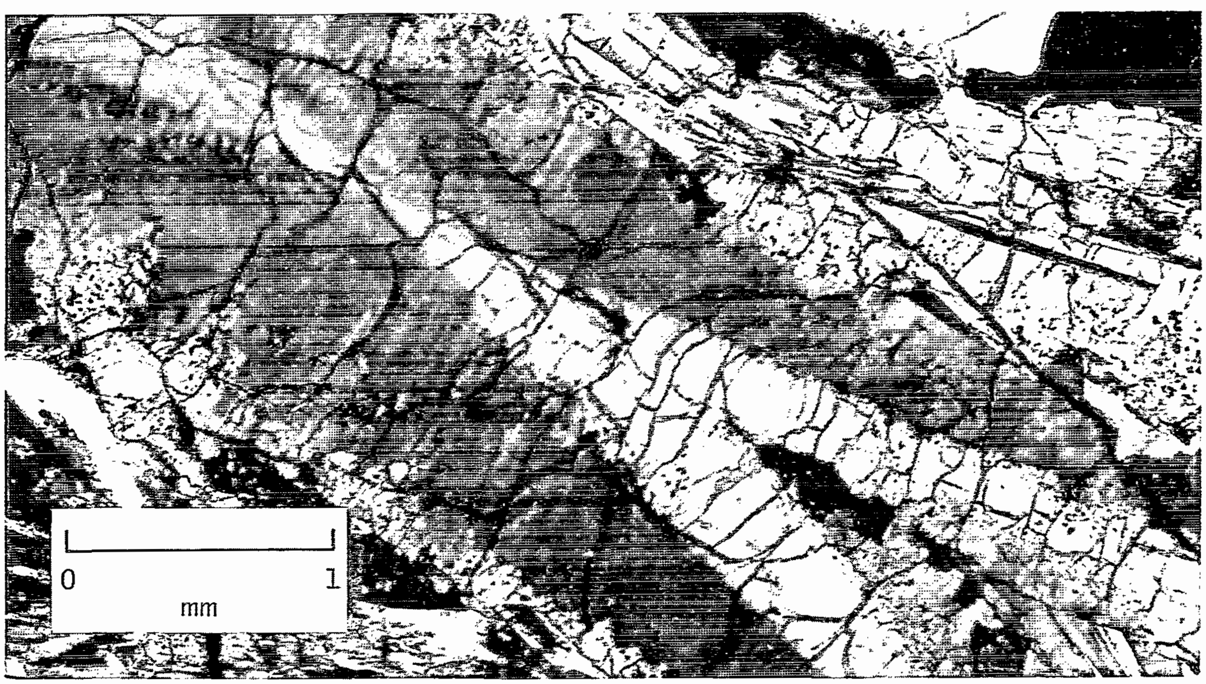

Figure A-75. - Sample 12021-4 (NASA-S-69-24205).

Figure A-76. - Sample 12022-10 (NASA-S-70-24742).

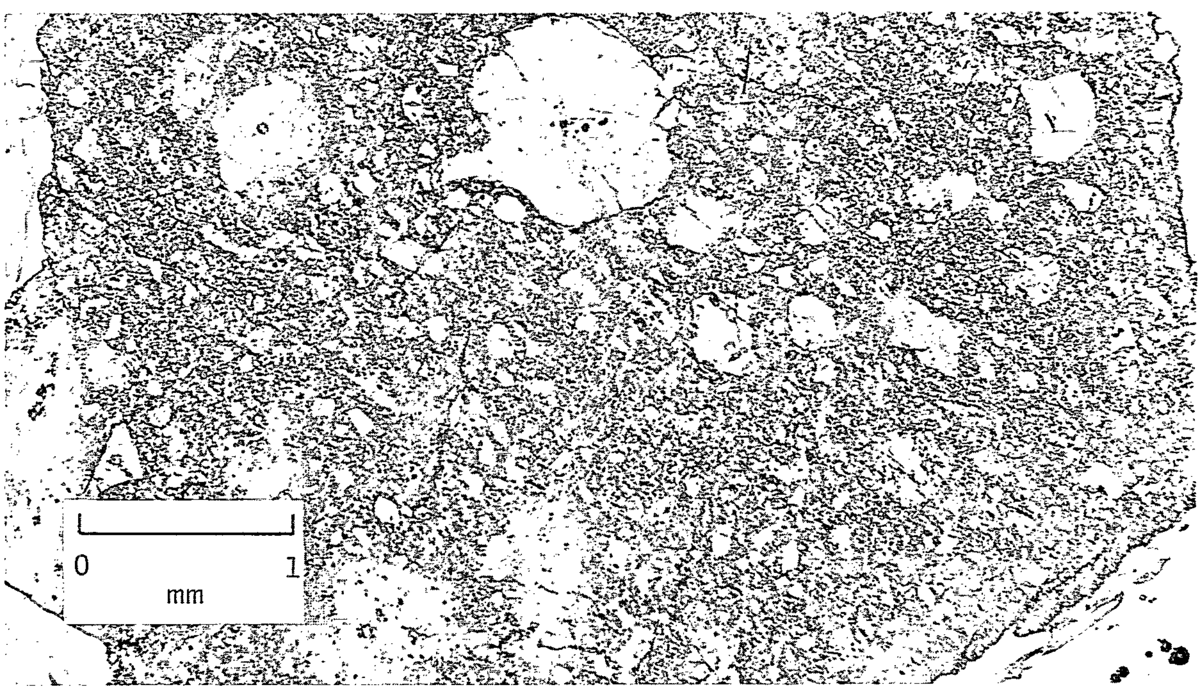

Figure A-77. - Sample 12034-3 (NASA-S-70-28217).

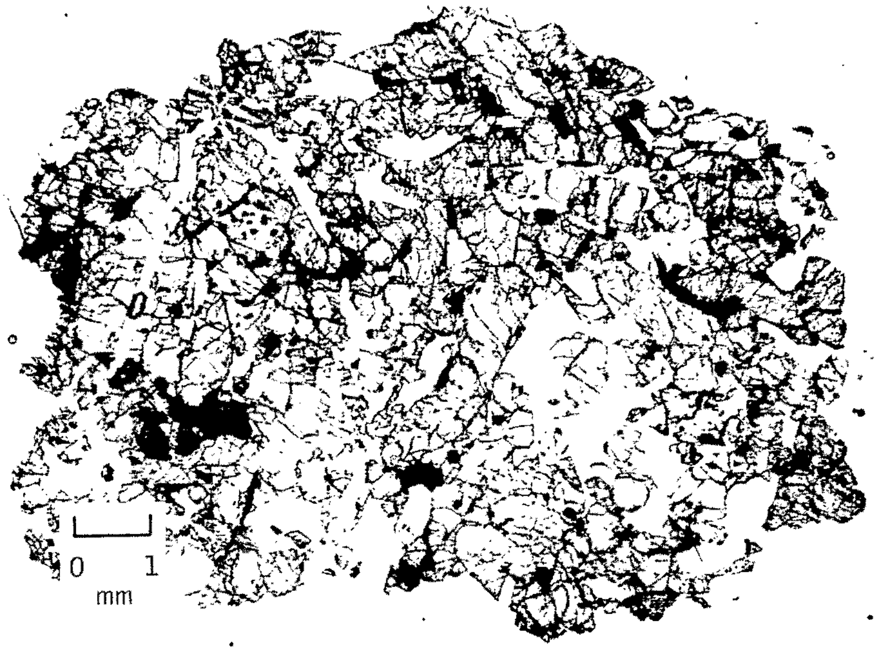

Figure A-78. - Sample 12035-21 (NASA-S-70-45637).

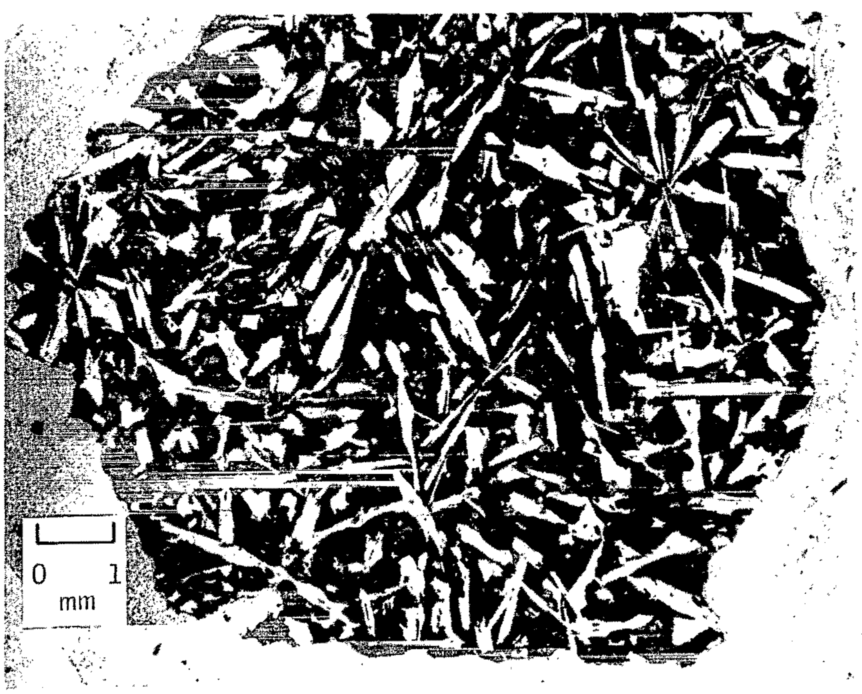

Figure A-79. - Sample 12038-2 (NASA-S-69-24203).

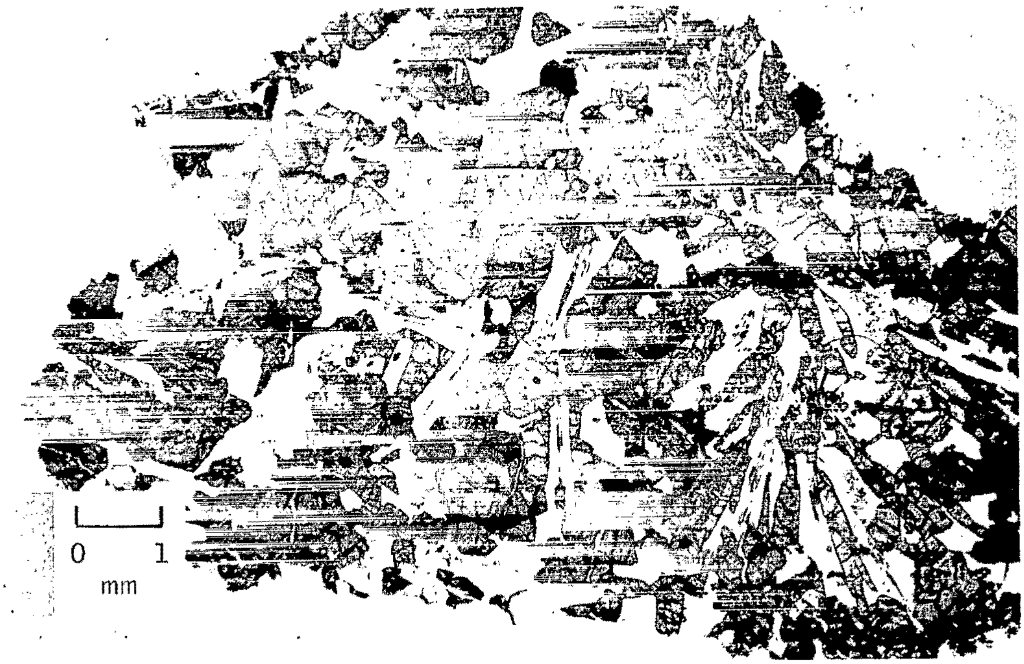

Figure A-80. - Sample 12040-3 (NASA-S-69-24211).

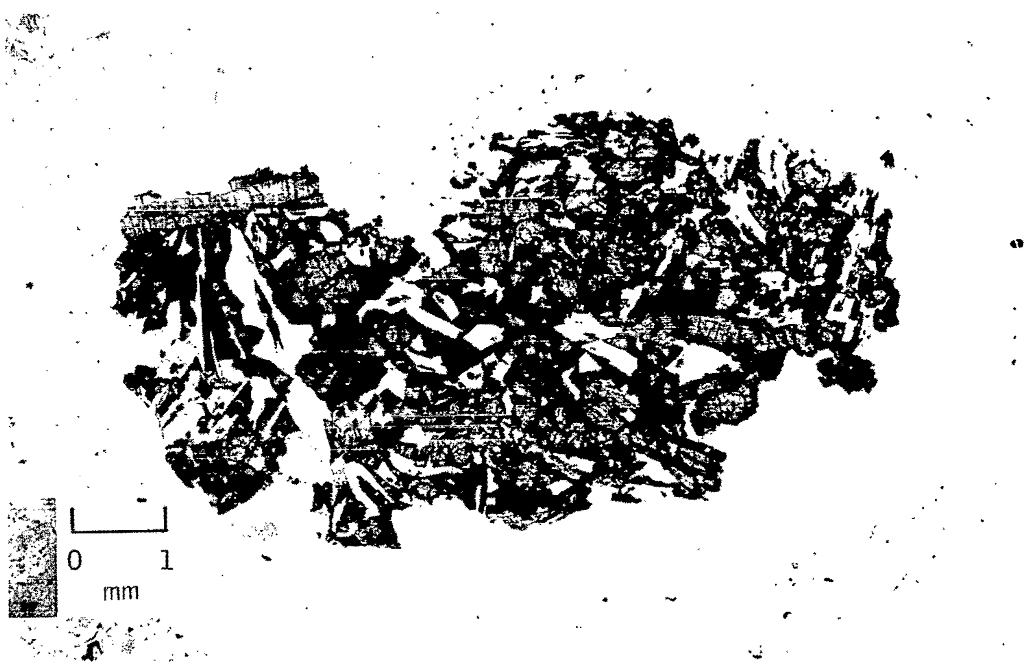

Figure A-81. - Sample 12044-2 (NASA-S-69-24207).

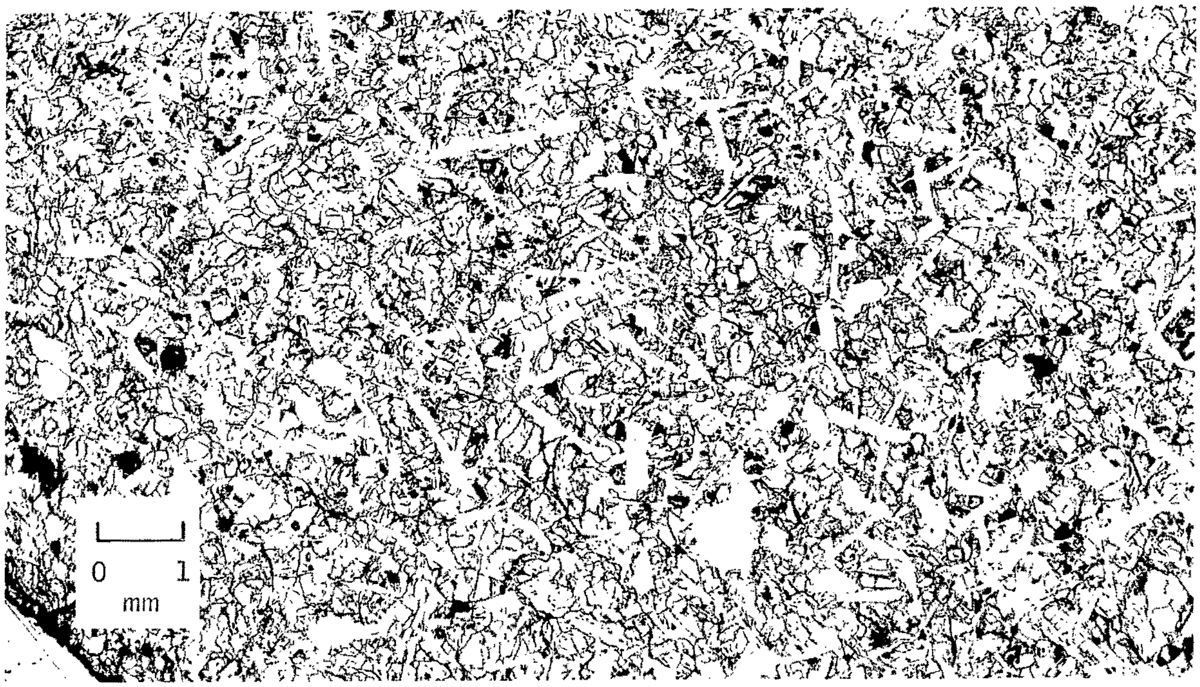

Figure A-82. - Sample 12051-55 (NASA-S-70-40811).

Figure A-83. - Sample 12052-6 (NASA-S-70-25417).

Figure A-84. - Sample 12053-76 (NASA-S-70-36474).

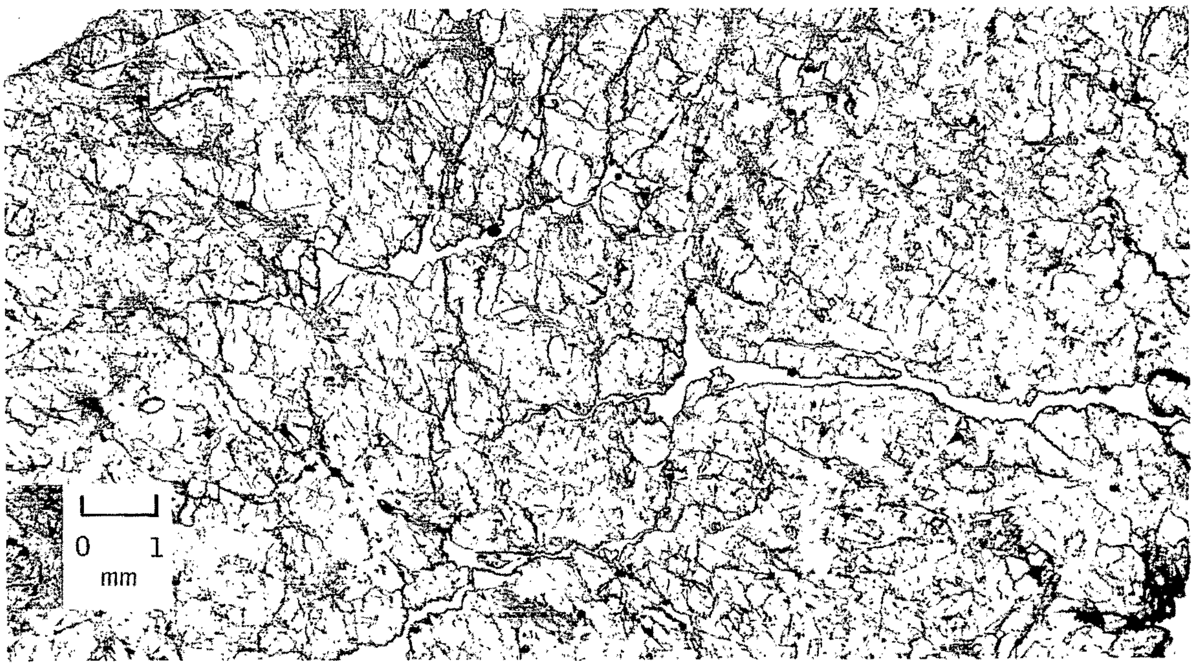

Figure A-85. - Sample 12057-14 (NASA-S-69-64831).

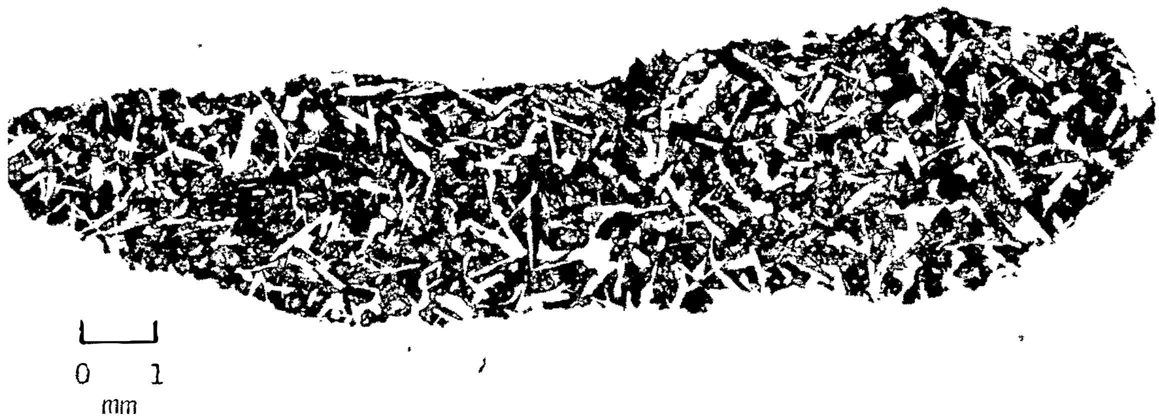

Figure A-86. - Sample 12057-37 (NASA-S-69-23374).

Figure A-87. - Sample 12057-18 (NASA-S-69-63411).

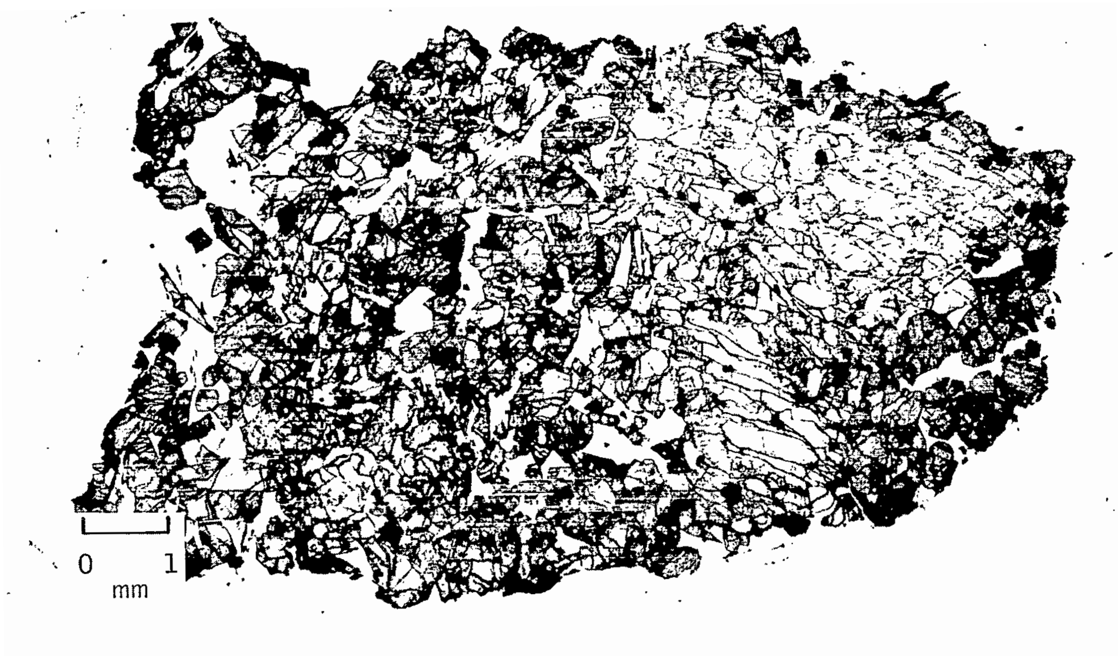

Figure A-88. - Sample 12057-36 (NASA-S-69-23371).

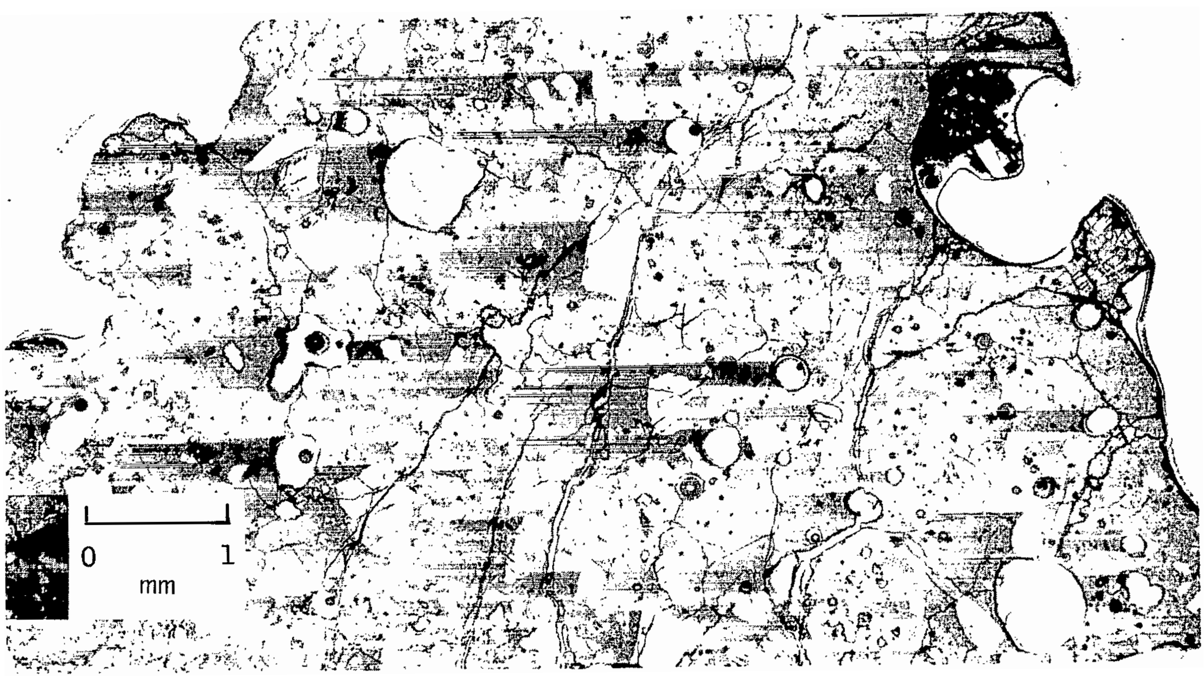

Figure A-89. - Sample 12057-22 (NASA-S-69-63404).

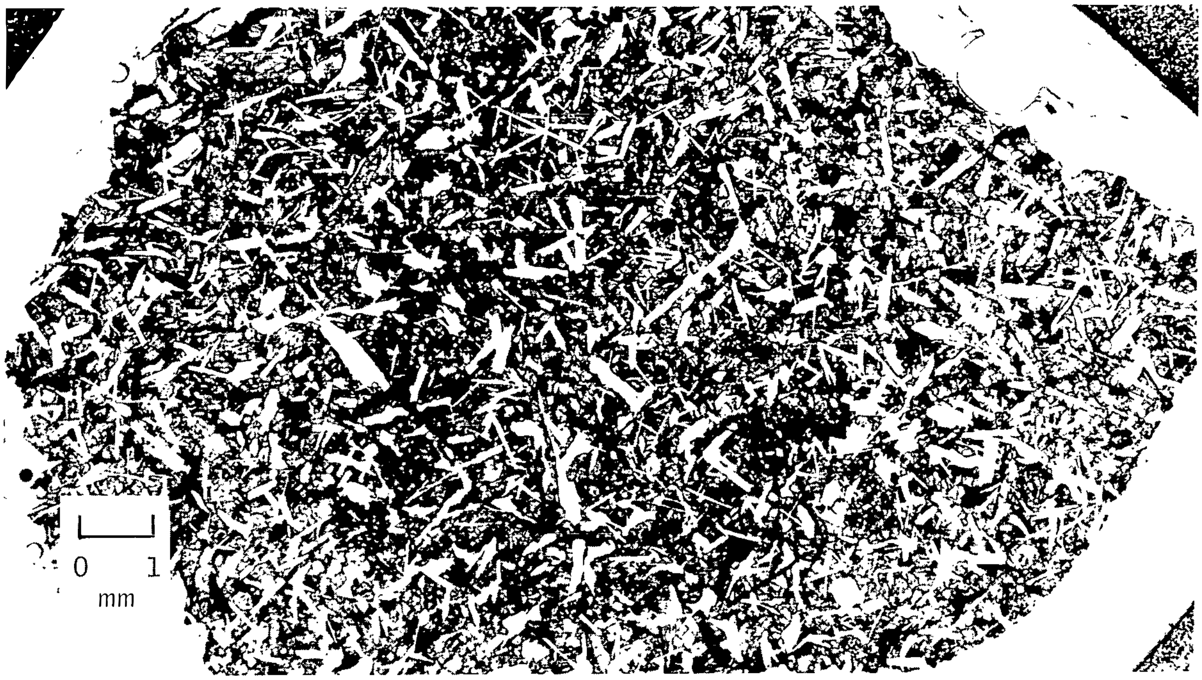

Figure A-90. - Sample 12062-18 (NASA-S-70-30256).

Figure A-91. - Sample 12063-17 (NASA-S-70-30270).

Figure A-92. - Sample 12064-9 (NASA-S-70-30264).

Figure A-93. - Sample 12065-6 (NASA-S-69-23378).

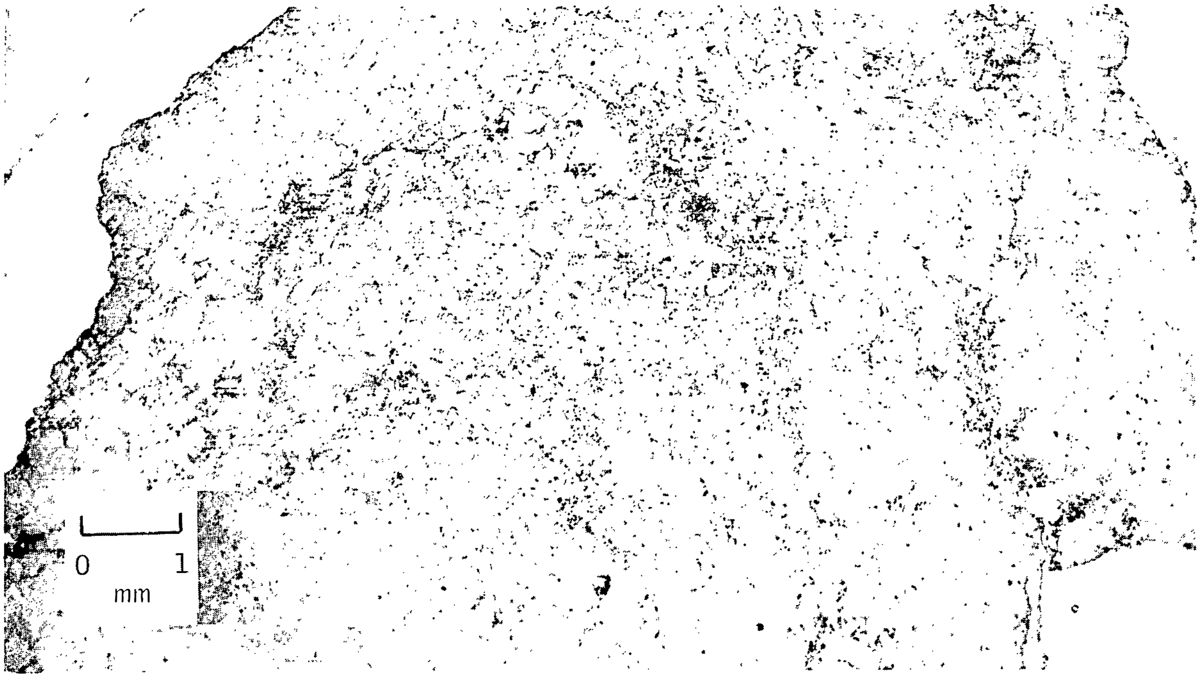

Figure A-94. - Sample 12073-5 (NASA-S-70-20744).

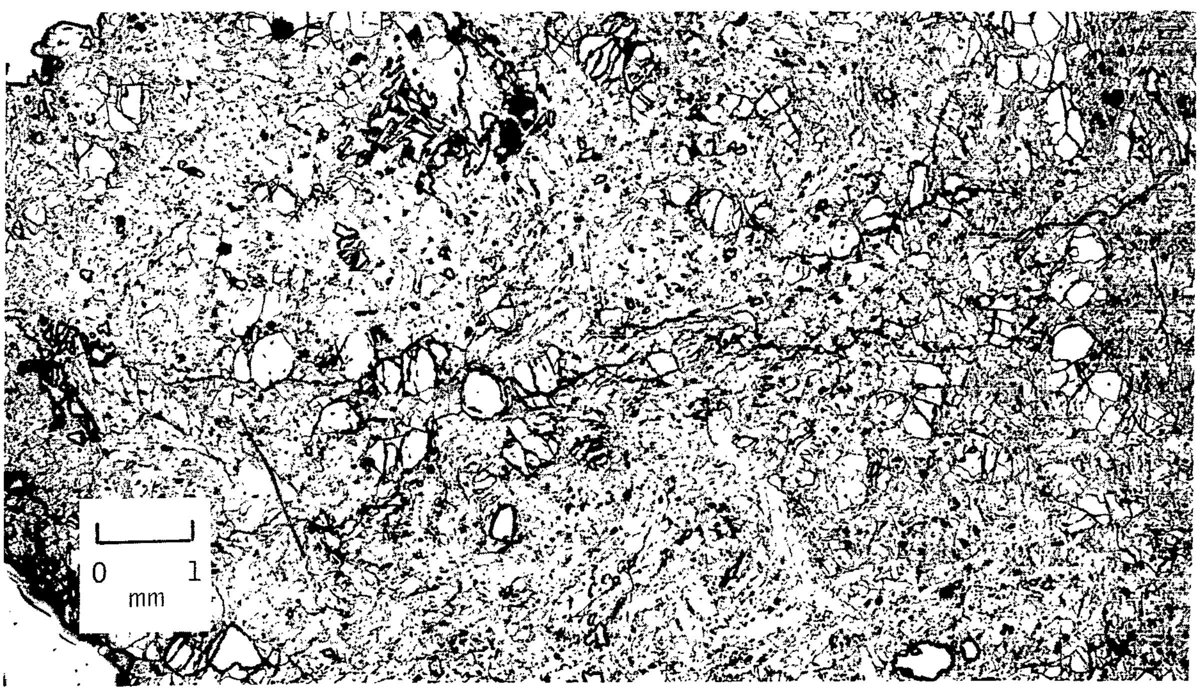

Figure A-95. - Sample 12075-23 (NASA-S-70-44546).

APPENDIX B

TOTAL CARBON AND ORGANIC ANALYSES DATA SHEETS

TOTAL CARBON AND ORGANIC ANALYSIS

1. Control Sample Number: 1200 2. Weight: 100 grams

3. Sample Description (from original description)

   Rock type: Ottawa sand (Ames Research Center (ARC))

   Physical appearance: Control for sand monitor in Biological Preparation Laboratory (Bioprep) (from ARC); analyzed as supplied by ARC

4. Sample History

   Return container:

   Schematic processing diagram: ARC⟶GAL⟶GAL glove box

   Storage container sequence: Glass jar

   Processing comments: The sand was stored in a glass jar with a plastic cap. The reagent-grade Ottawa sand was acid washed and fired by the supplier at 1000° C for 30 hours at ARC and shipped to the LRL in a clean glass jar.

   Control sample number: Not applicable

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	1.0082	7 ± 2

6. Organic Analysis Results

   Maximum total ionization: 2.6×10^4

   Total ionization: 3.3×10^5

   Estimated organic content (total of indigenous and contamination): <0.1 ppm

7. Remarks

   Early spectra data indicate some general mass spectra as seen in the Bioprep monitor.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Control Sample Number: 1201 (originally B108)   2. Weight: 250 grams

3. Sample Description (from original description)

   Rock type: Ottawa sand (ARC)

   Physical appearance: Bioprep cabinet monitor

4. Sample History

   Return container:

   Schematic processing diagram: ARC ⟶ GAL ⟶ Bioprep ⟶ GAL glove box

   Storage container sequence: Glass jar ⟶ Teflon bag ⟶ Quick-seal can ⟶ Wasserburg container

   Processing comments: Control sample 1201 was exposed to the Bioprep cabinet atmosphere for 5 hours during the early stages of the D-ALSRC processing. The sample was sterilized into the Bioprep in a Teflon bag at 160° C.

   Control sample number: 1200

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.4618	4 ± 2

6. Organic Analysis Results

   Maximum total ionization: 3.8×10^4

   Total ionization: 5.2×10^5

   Estimated organic content (total of indigenous and contamination): <0.1 ppm

7. Remarks

   The spectra were characterized by low CO_2 evolution compared to the lunar samples. Material of m/e 58 and other low-weight materials were the obvious contaminants (m/e 84 and 86 is methyl chloride from sample handling). The higher weight materials seen in some of the lunar samples (deep core) were not obvious in this blank. The mass spectrometer scans for control sample 1201 are shown in figure B-1.

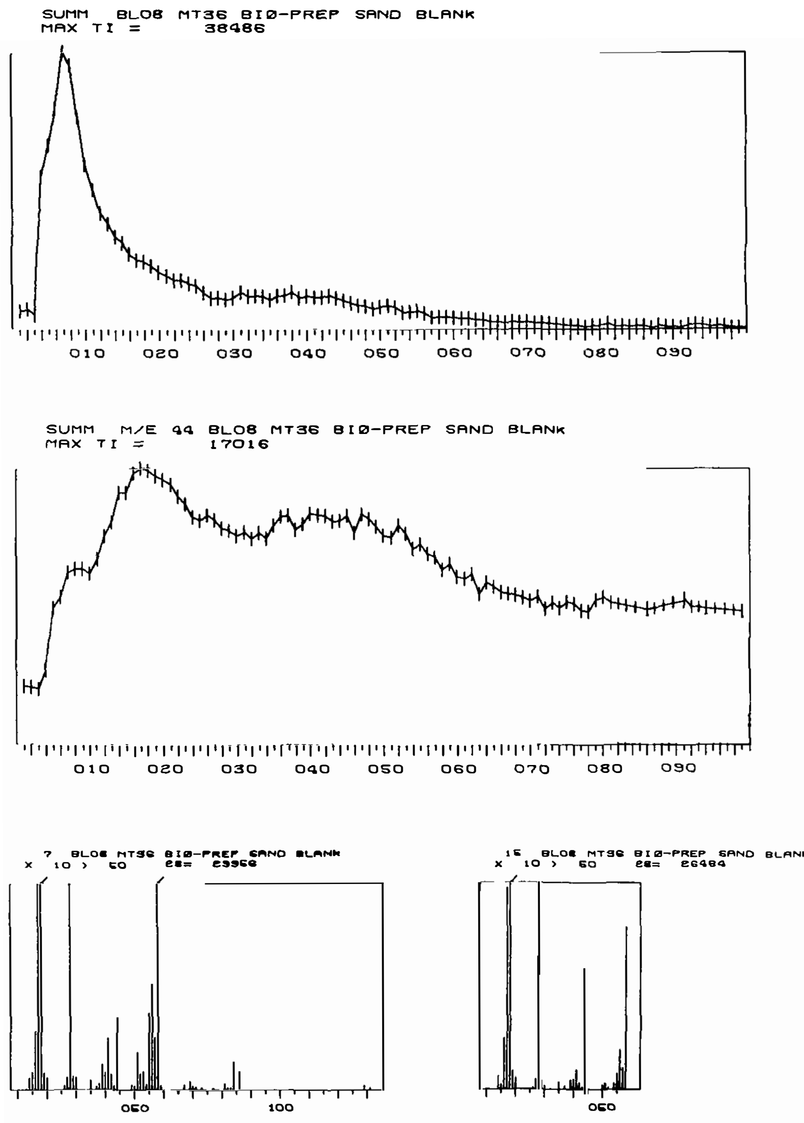

Figure B-1. - Mass spectrometer scans for control sample 1201.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Control Sample Number: 1210 2. Weight: 250 grams

3. Sample Description (from original description)

   Rock type: Ottawa sand (MSC)

   Physical appearance: Control for the sand monitor in the F201 vacuum system; analyzed after cleaning.

4. Sample History

   Return container:

   Schematic processing diagram: Washed → dried at 110° C → fired at 1000° C → sealed in Teflon bag → GAL glove box

   Storage container sequence: Teflon bag

   Processing comments: None

   Control sample number: Not applicable

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	1.0001	18 ± 3

6. Organic Analysis Results

   Maximum total ionization: 7.5×10^4

   Total ionization: 1.5×10^6

   Estimated organic content (total indigenous and contamination): <0.1 ppm

7. Remarks: None

TOTAL CARBON AND ORGANIC ANALYSIS

1. Control Sample Number: 1211 2. Weight:

3. Sample Description (from original description)

   Rock type: Ottawa sand (MSC)

   Physical appearance: F201 system monitor

4. Sample History

   Return container:

   Schematic processing diagram: GAL ⟶ F201 chamber ⟶ GAL glove box

   Storage container sequence: Teflon bag ⟶ bolt-top can

   Processing comments: The Ottawa sand was washed in water, dried overnight at 110° C, and then fired at 1000° C in a muffle furnace for 24 hours in the GAL. The sand was sealed in a Teflon bag for approximately 2 weeks before being loaded into a bolt-top can for transfer into the F201 chamber. The sand was transferred into the bolt-top can on a clean bench. The sample was exposed to the F201 vacuum chamber beginning on November 29, 1969 (0800), and was sampled on December 10, 1969 (0930). During this time, the F201 chamber was backfilled with N three times for a total of approximately 60 hours.

   Control sample number: 1210

5. Total Carbon Analysis Results: Not available

6. Organic Analysis Results

   Maximum total ionization: 7.6×10^4

   Total ionization: 2.3×10^6

   Estimated organic content (total of indigenous and contamination): 0.1 ppm

7. Remarks: None

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12003-1   2. Weight: 300 grams

3. Sample Description (from original description)

Rock type: D

Physical appearance: Chips and loose material from S-ALSRC

4. Sample History

Return container: S-ALSRC

Schematic processing diagram: S-ALSRC ⟶ F201 chamber ⟶ Bioprep ⟶ GAL glove box

Storage container sequence: S-ALSRC ⟶ bolt-top can ⟶ Wasserburg container

Processing comments: This material was collected from the floor of the F201 chamber and from the S-ALSRC York-mesh packing. The sample was exposed in the F201 chamber for 3 days (approximately 70 hours), stored in a bolt-top can, transferred to Bioprep, and sampled for organic analysis within a few minutes after being opened in Bioprep.

Control sample numbers: 1201, 1202, 1211

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.1571	185 ± 20
2	.1128	195 ± 25
3	.1480	120 ± 10
4	.1605	200 ± 10

6. Organic Analysis Results

Maximum total ionization: 1.2×10^5

Total ionization: 4.4×10^6

Estimated organic content (total of indigenous and contamination): 0.3 ppm

7. Remarks

Most of the ion current was due to previously recognized contaminants. This sample was one of the few samples that displayed m/e 78 and 91 as pyrolysis products, a common occurrence in the Apollo 11 preliminary analysis. The additional handling is probably reflected in the higher total C found in this sample relative to other Apollo 12 samples. The mass spectrometer scans for sample 12003-1 are shown in figure B-2.

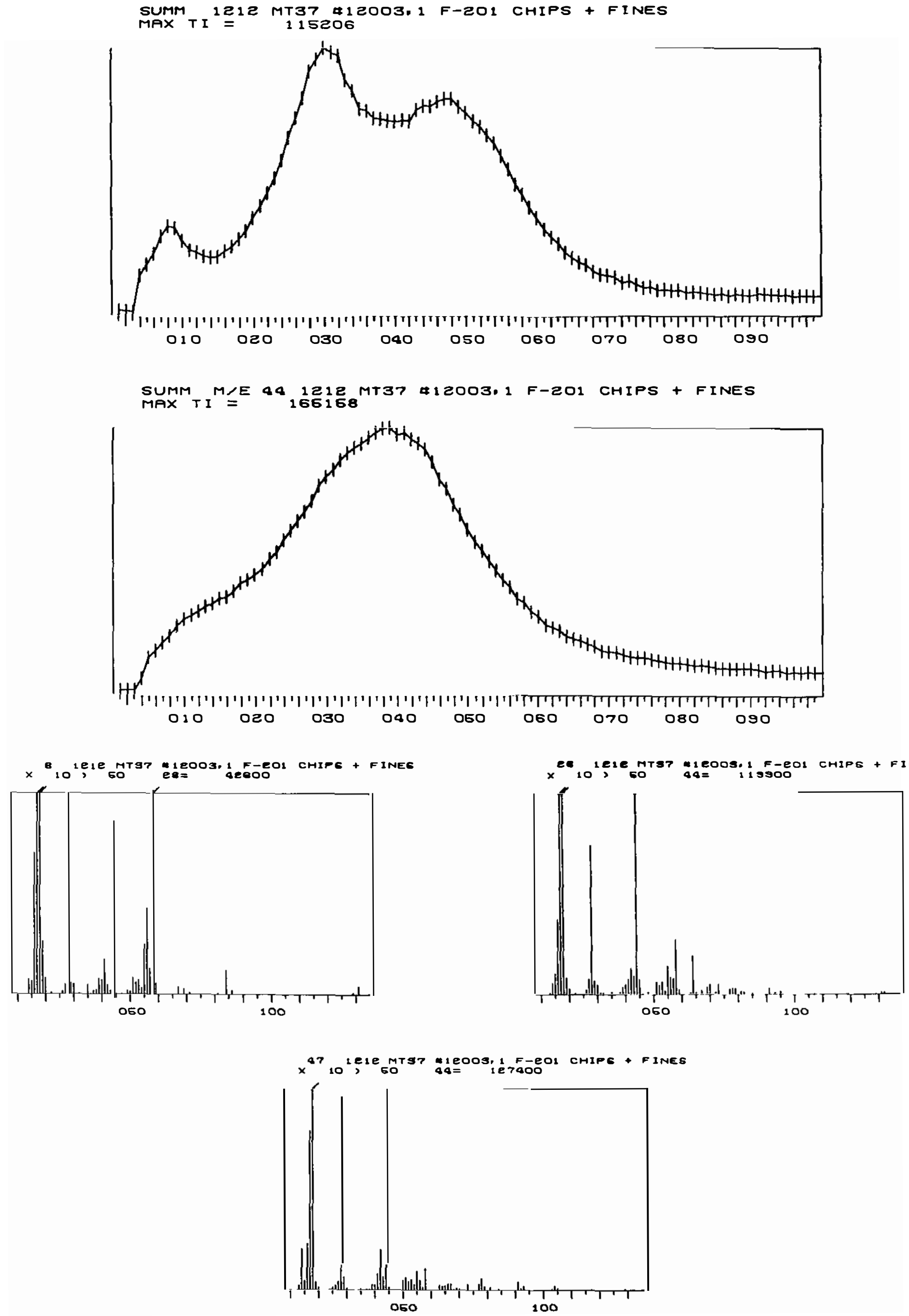

Figure B-2. - Mass spectrometer scans for sample 12003-1.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12024-7 2. Weight: 100 grams

3. Sample Description (from original description)

   Rock type: GASC

   Physical appearance: Fines

4. Sample History

   Return container: GASC

   Schematic processing diagram: D-ALSRC ⟶ Bioprep ⟶ GAL glove box

   Storage container sequence: GASC ⟶ glass vial

   Processing comments: The GASC was not opened until it had been sterilized and transferred to the GAL. It was first punctured on the gas-extraction table. The estimated pressure at the time of puncture was 11 torr. Analysis of the gases indicated that leakage had occurred. The GASC then was valved off, transferred to the glove box, and opened. A total of 600 milligrams of fines material was removed from the GASC and stored in a chromic-acid-cleaned glass vial approximately 30 minutes after opening.

   Control sample number: 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.1395	115

6. Organic Analysis Results

   Maximum total ionization: 5.1×10^4 (1.1×10^5 second run)

   Total ionization: 7.6×10^5 (3.0×10^6 second run)

   Estimated organic content (total of indigenous and contamination): 0.3 ppm (0.3 ppm second run)

7. Remarks

   Two runs were made with very similar results. The higher weight material may be due to exposure to the plastic bottle cap when the Teflon liner developed a crack. The CO and CO_2 evolution was very high. The mass spectrometer scans for sample 12024-7 are shown in figure B-3 for the first run and in figure B-4 for the second run.

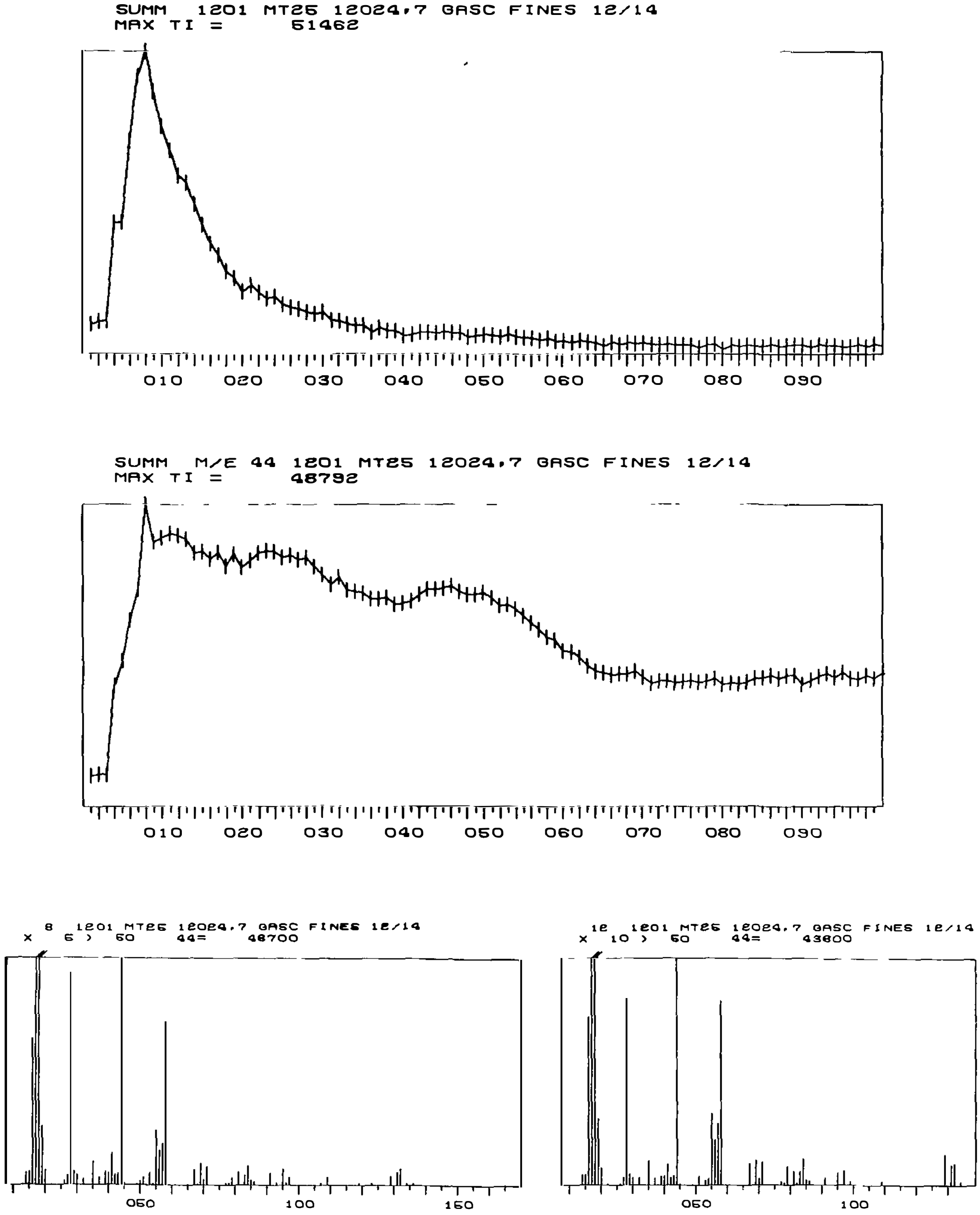

Figure B-3. - Mass spectrometer scans for sample 12024-7, run 1.

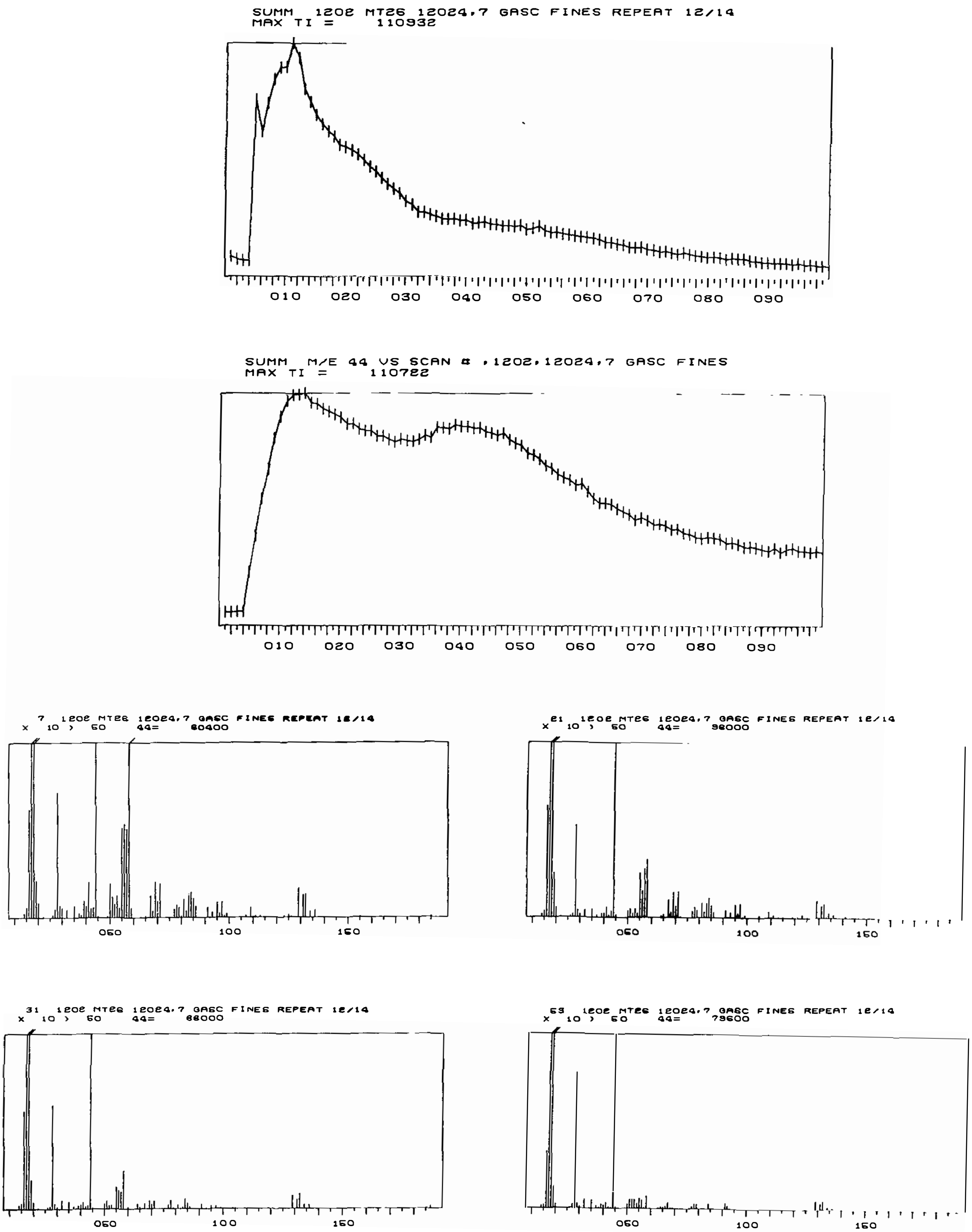

Figure B-4. - Mass spectrometer scans for sample 12024-7, run 2.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12026-1   2. Weight: 54.2 grams

3. Sample Description (from original description)

   Rock type: Core tube 2013

   Physical appearance: Fines from 29-centimeter scale position

4. Sample History

   Return container: Core tube — S-ALSRC

   Schematic processing diagram: S-ALSRC → F201 chamber → Bioprep → GAL glove box

   Storage container sequence: Core tube → Wasserburg container

   Processing comments: The core tube was transferred to Bioprep unopened; it was open in Bioprep for approximately 24 hours before the sample for organic analysis was taken.

   Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.018	44 ± 25

6. Organic Analysis Results

   Maximum total ionization: 6.1×10^4

   Total ionization: 1.1×10^6

   Estimated organic content (total of indigenous and contamination): 0.7 ppm

7. Remarks

   A small amount of low-molecular-weight material was present (notable m/e 64 (S_2 or SO_2)). Considerable CO and CO_2 were evolved. The mass plot of m/e 95, which may be due to indigenous material or to a strongly adsorbed contaminant, was of special interest. The sample weight was too small for a good total C analysis. The mass spectrometer scans for sample 12026-1 are shown in figure B-5.

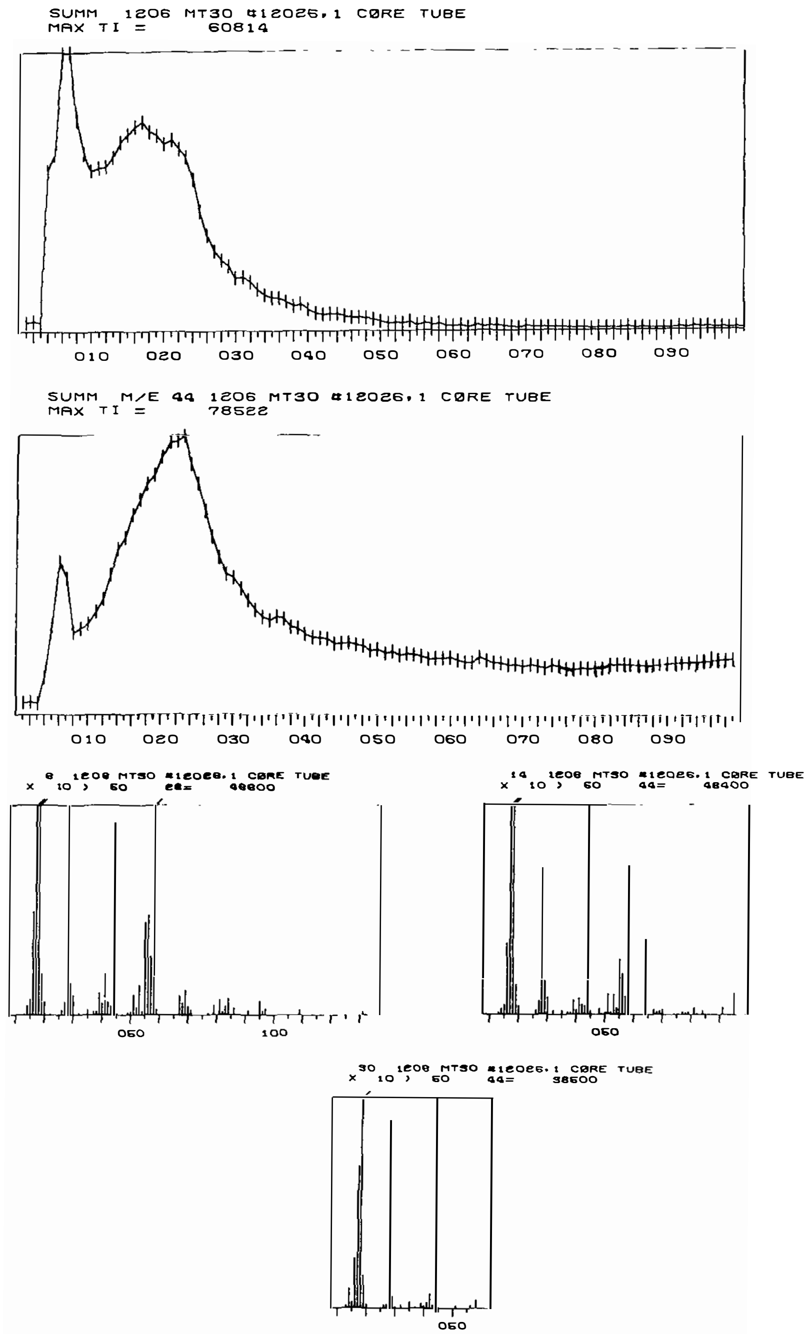

Figure B-5. - Mass spectrometer scans for sample 12026-1.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12026-2   2. Weight: 54.2 grams

3. Sample Description (from original description)

Rock type: Core tube 2013

Physical appearance: Fines from 21-centimeter scale position

4. Sample History

Return container: Core tube — S-ALSRC

Schematic processing diagram: S-ALSRC→F201 chamber→Bioprep→GAL glove box

Storage container sequence: Core tube→Wasserburg container

Processing comments: The processing comments are the same as for sample 12026-1.

Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results: Not available

6. Organic Analysis Results

Maximum total ionization: 4×10^4 (3.3×10^4, second run)

Total ionization: 1.1×10^6 (4.3×10^5, second run)

Estimated organic content (total of indigenous and contamination): 0.5 ppm (0.1 ppm, second run)

7. Remarks

The second run was a re-run of the first run sample and was exposed to the atmosphere in the GAL glove box. Two points are important: (1) m/e 58 and other low-molecular-weight peaks were present in both runs and (2) the CO and CO_2 evolution (compare 1209 and 1211 summation m/e 44 plots in figs. B-6 and B-7) slowly increased in the second run to approximately the level of the first run, indicating that CO and CO_2 are the result of the sample pyrolysis. The mass spectrometer scans for sample 12026-2 are shown in figure B-6 for the first run and in figure B-7 for the second run.

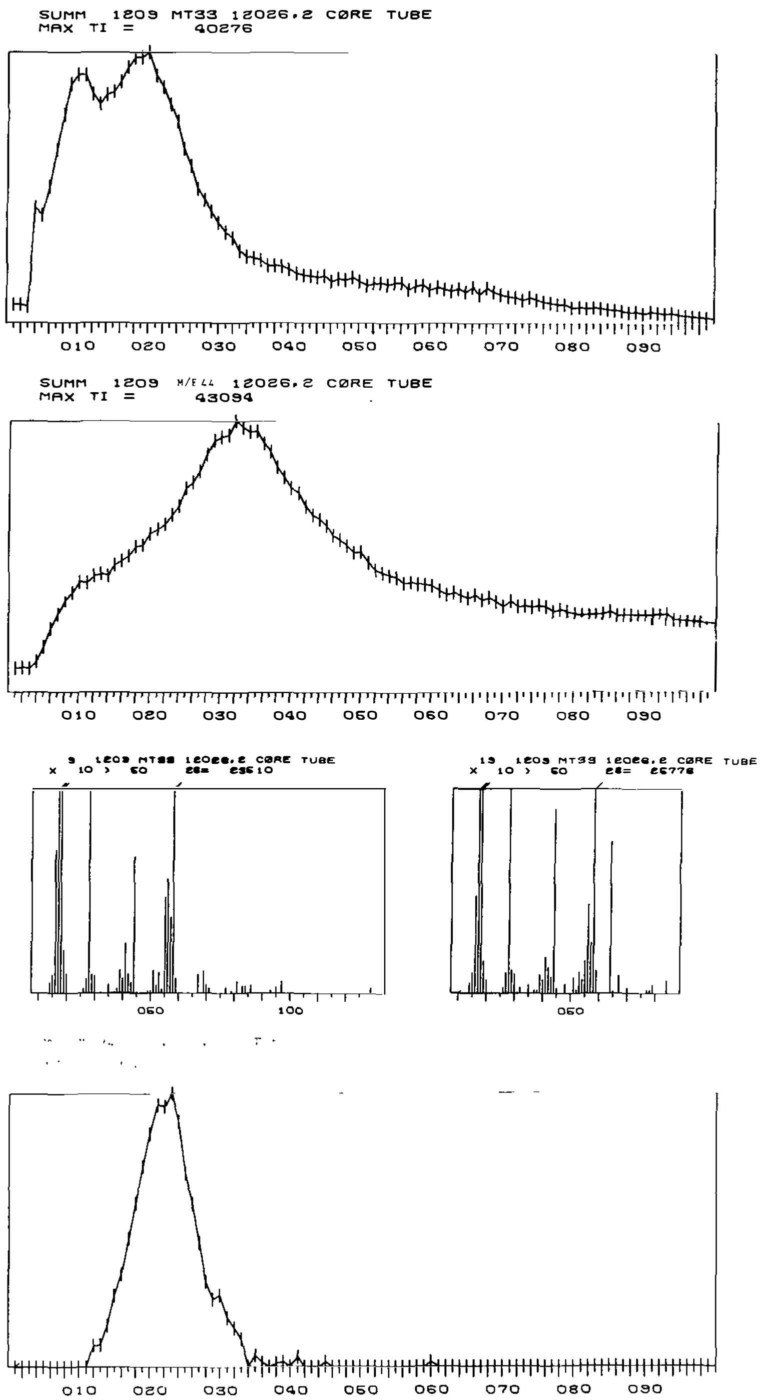

Figure B-6. - Mass spectrometer scans for sample 12026-2, run 1.

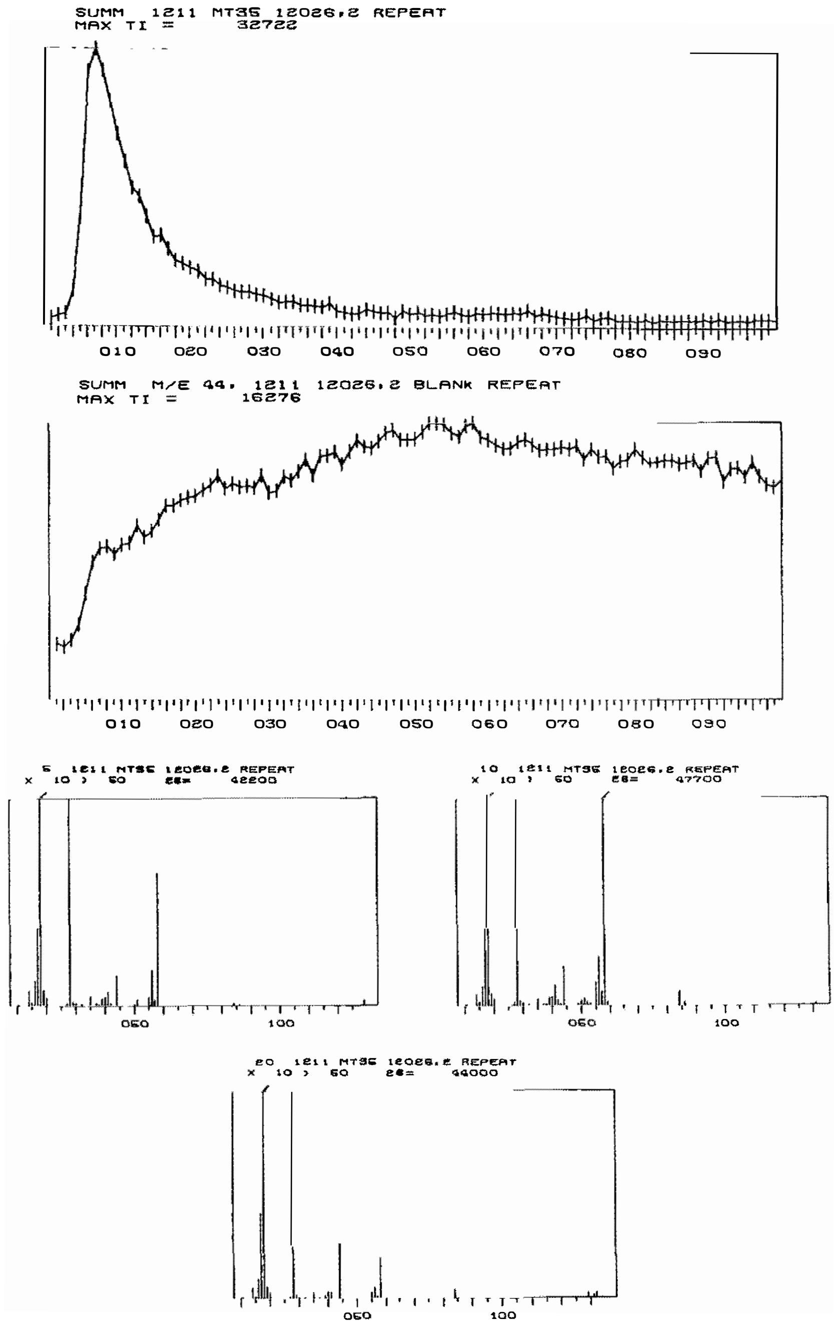

Figure B-7. - Mass spectrometer scans for sample 12026-2, run 2.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12028-1   2. Weight: 96.8 grams

3. Sample Description (from original description)

Rock type: Core tube 2012

Physical appearance: Fines from lower end of core tube; material lighter in color than that from upper end of core tube

4. Sample History

Return container: Core tube — D-ALSRC

Schematic processing diagram: D-ALSRC ⟶ Bioprep ⟶ GAL glove box

Storage container sequence: Core tube ⟶ Wasserburg container

Processing comments: The core tube was opened in Bioprep and the material removed for analysis. The sample was sealed in the Wasserburg container 2 hours after the core tube was opened.

Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results: Not available

6. Organic Analysis Results

Maximum total ionization: 8.1×10^4

Total ionization: 2.5×10^6

Estimated organic content (total of indigenous and contamination): 1.0 ppm

7. Remarks

The summary plot indicates, in later scans, the evolution of organic material that may be indigenous. The spectra are characterized by what may be unsaturated hydrocarbon peaks. High evolution of CO and CO_2 was noted. Sample 12028-1 is the most promising sample analyzed. Some m/e 64 evolved (S_2 or SO_2). The first 10 scans indicate that terrestrial contamination is present; however, later scans in the summary plot show the evolution of material that may be indigenous. The mass spectrometer scans for sample 12028-1 are shown in figure B-8.

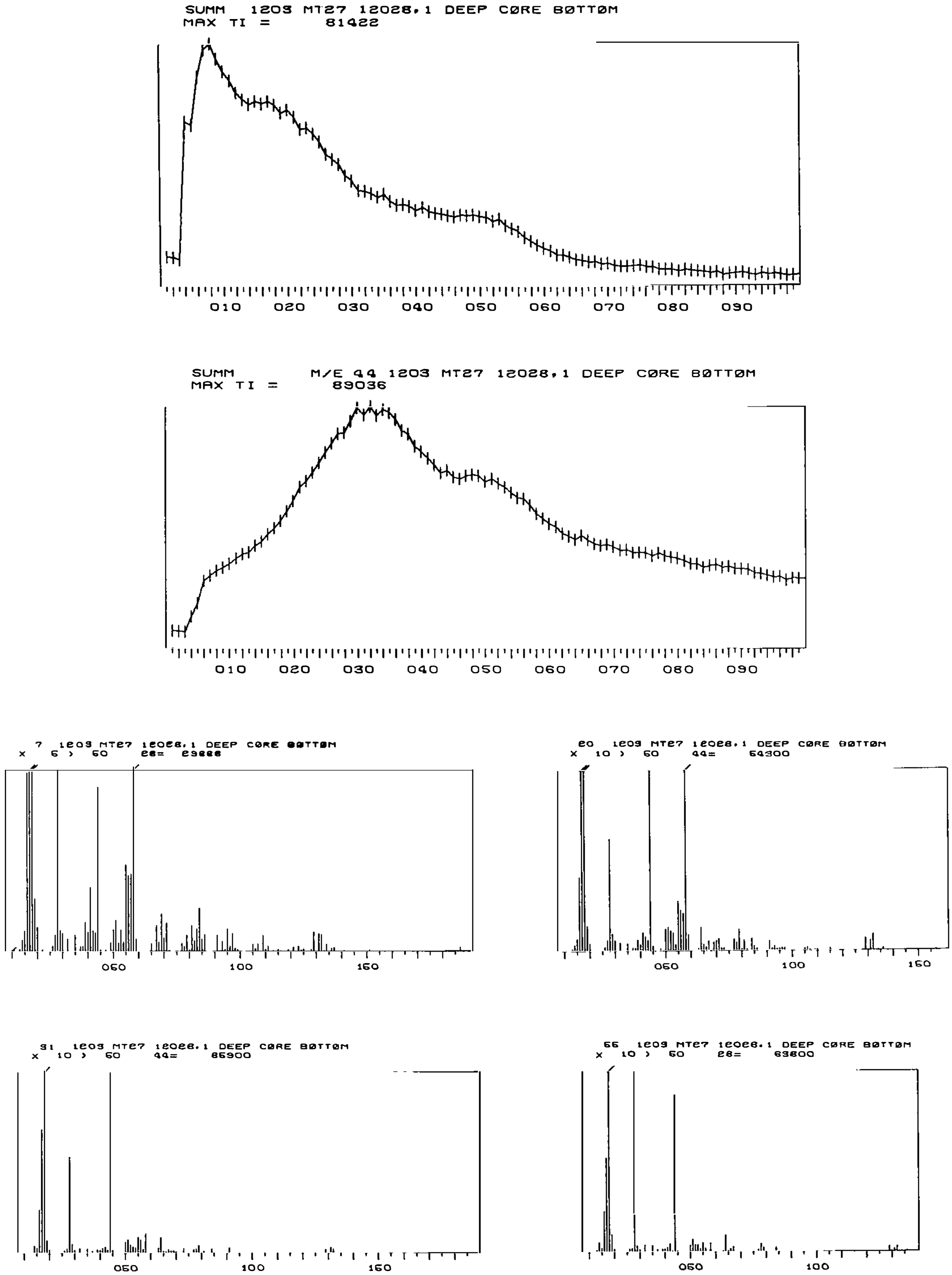

Figure B-8. - Mass spectrometer scans for sample 12028-1.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12032-1 2. Weight: 310.6 grams

3. Sample Description (from original description)

   Rock type: D

   Physical appearance: Fines from documented sample bag 4-D; medium dark gray, poorly sorted; some angular fragments up to 4 millimeters in length

4. Sample History

   Return container: Teflon bag

   Schematic processing diagram: Teflon bag→Bioprep→GAL glove box

   Storage container sequence: Teflon bag→stainless steel can→Wasserburg container

   Processing comments: The material was stored in the Teflon bag inside a stainless steel can until the bag was opened. The sample for organic analysis was taken within 30 minutes after the bag was opened and 15 days after the D-ALSRC was opened in Bioprep.

   Control sample number: 1201

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.1519	20 ± 10
2	.3813	25 ± 4

6. Organic Analysis Results

   Maximum total ionization: 1.0×10^5

   Total ionization: 2.3×10^6

   Estimated organic content (total of indigenous and contamination): 0.1 ppm

7. Remarks

   As with the other sample of fines from a documented bag (sample 12042-1), this sample is extremely low in organic content. The low total C content correlates with the low organic content.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12033-1   2. Weight: 322.7 milligrams

3. Sample Description (from original description)

   Rock type: D

   Physical appearance: Fines from documented sample bag 5-D; described as light-colored volcanic ash

4. Sample History

   Return container: Teflon bag

   Schematic processing diagram: Teflon bag ⟶ Bioprep ⟶ GAL glove box

   Storage container sequence: Teflon bag ⟶ stainless steel can ⟶ Wasserburg container

   Processing comments: The processing comments are the same as for sample 12032-1.

   Control sample number: 1201

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.1997	20 ± 5
2	.6014	23 ± 2
3	.1254	80 ± 10

6. Organic Analysis Results: Not available

7. Remarks

   The sample for the third run was provided by the Physical-Chemical Test Laboratory (PCTL) and was transferred to the GAL in a plastic vial, which explains the high C content. An organic analysis was not performed on this sample.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12034-2 2. Weight: 153 grams

3. Sample Description (from original description)

Rock type: Breccia (C)

Physical appearance: Medium light-gray matrix of fine-grained material; includes crystal fragments and fragments of a number of rock types; documented sample bag 6-D

4. Sample History

Return container: Documented sample bag (Teflon)

Schematic processing diagram: D-ALSRC → Bioprep → GAL glove box

Storage container sequence: Documented sample bag → stainless steel can → Wasserburg container

Processing comments: The rock was exposed in the cabinet for approximately 6 hours before the organic sample was taken. The rock was not touched by rubber gloves, only by Teflon and stainless steel.

Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.2446	65 ± 12

6. Organic Analysis Results

Maximum total ionization: 1.7×10^4

Total ionization: 1.1×10^6

Estimated organic content (total of indigenous and contamination): 0.4 ppm

7. Remarks

The sample was contaminated slightly with Teflon (scan 80, fig. B-9). Other organic material was very low in quantity and was possibly contamination from other sources. The mass spectrometer scans for sample 12034-2 are shown in figure B-9.

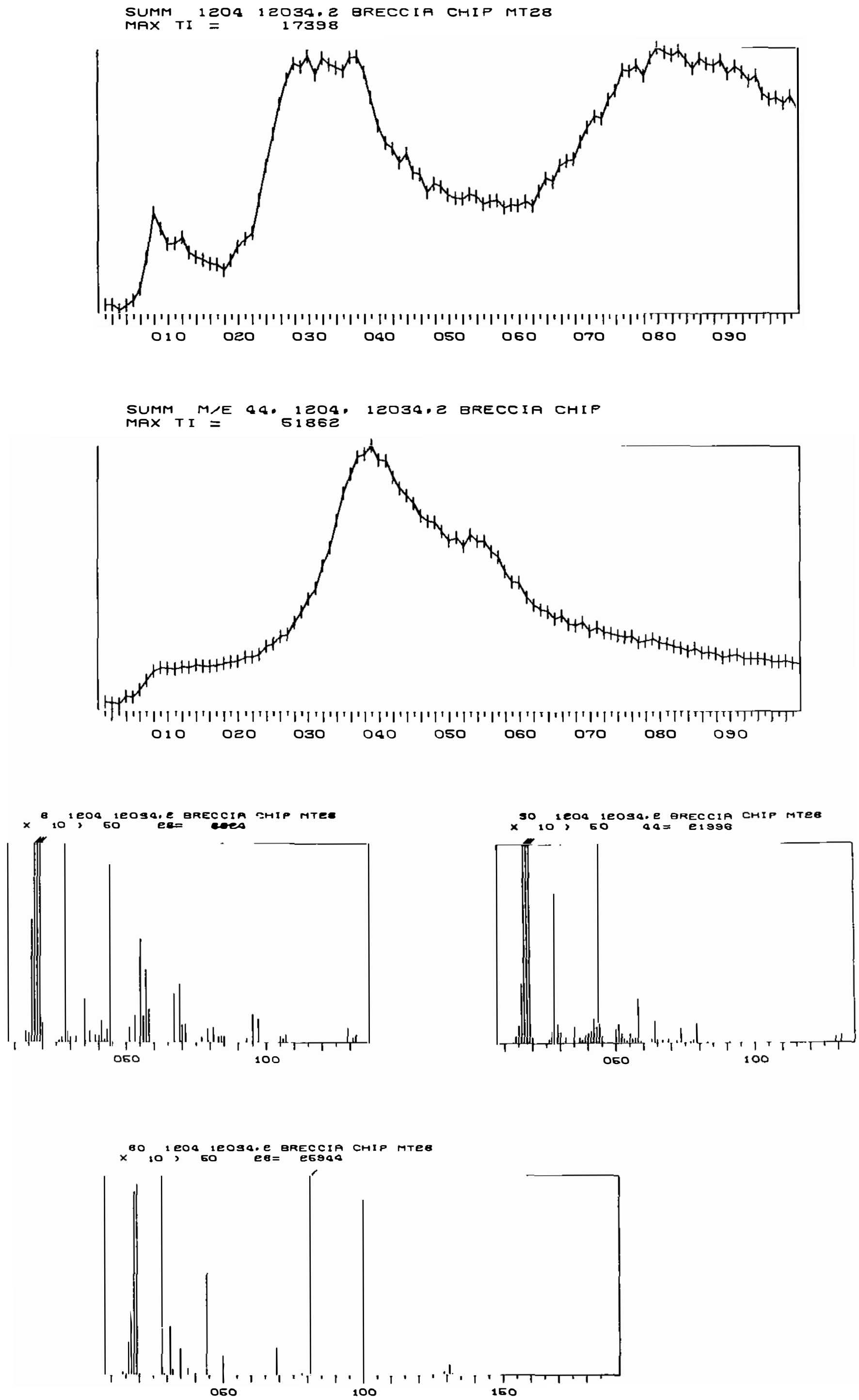

Figure B-9. - Mass spectrometer scans for sample 12034-2.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12040-2 2. Weight: 319 grams

3. Sample Description (from original description)

   Rock type: B

   Physical appearance: Light gray with slight greenish tinge caused by olivine; no vesicles but a number of vugs; high olivine content

4. Sample History

   Return container: D-ALSRC

   Schematic processing diagram: D-ALSRC ⟶ Bioprep ⟶ GAL glove box

   Storage container sequence: D-ALSRC ⟶ stainless steel can ⟶ Wasserburg container

   Processing comments: The rock was exposed to the Bioprep cabinet atmosphere for approximately 6 hours before the organic sample was taken. The material sampled was from the interior surface of the freshly broken rock.

   Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.2245	45 ± 15

6. Organic Analysis Results

   Maximum total ionization: 2.9×10^4

   Total ionization: 1.2×10^6

   Estimated organic content (total of indigenous and contamination): 0.1 ppm

7. Remarks

   Sample 12040-2 shows lower CO and CO_2 evolution and a very small amount of organic material, which is possibly a nylon or dust-particle-type contamination. The mass spectrometer scans for sample 12040-2 are shown in figure B-10.

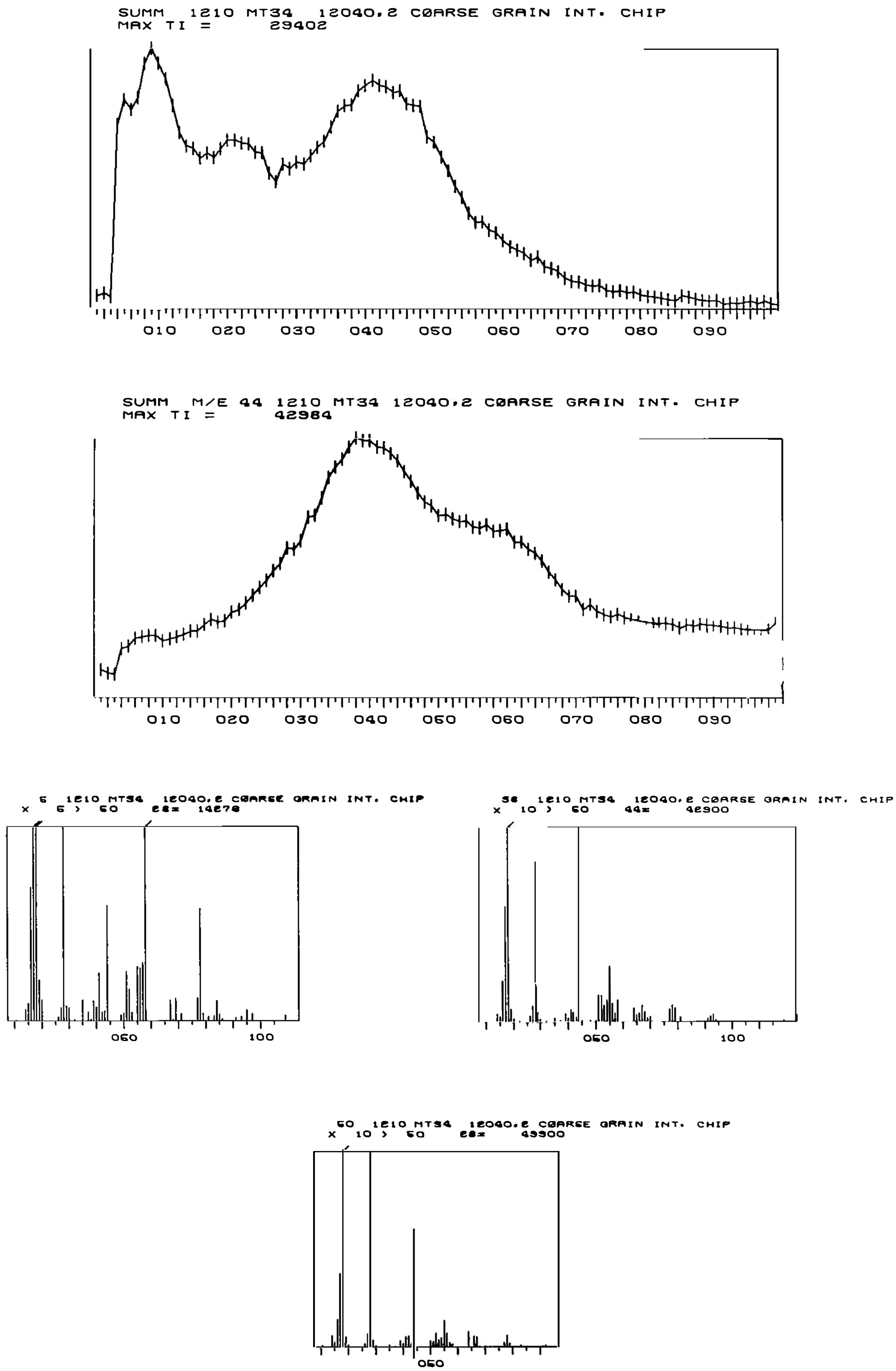

Figure B-10. - Mass spectrometer scans for sample 12040-2.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12042-1 2. Weight: 225.6 grams

3. Sample Description (from original description)

Rock type: D

Physical appearance: Fines from documented sample bag 12-D

4. Sample History

Return container: Teflon bag

Schematic processing diagram: Teflon bag ⟶ Bioprep ⟶ GAL glove box

Storage container sequence: Teflon bag ⟶ stainless steel can ⟶ Wasserburg container

Processing comments: The processing comments are the same as for sample 12032-1.

Control sample number: None

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.2452	125 ± 5
2	.3409	132 ± 5

6. Organic Analysis Results

Maximum total ionization: 2.5×10^4

Total ionization: 1.2×10^6

Estimated organic content (total of indigenous and contamination): 0.1 ppm

7. Remarks

Sample 12042-1 was extremely clean and showed considerably less material than did the fines from other sources. The CO_2 evolution, however, was comparable to other samples of fines.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12044-2, -1

2. Weight: 145.4 milligrams (sample 12044-2)

3. Sample Description (from original description)

Rock type: A

Physical appearance: Fine-grained crystalline rock in documented sample bag

4. Sample History

Return container: Teflon bag

Schematic processing diagram: Teflon bag → Bioprep → GAL glove box

Storage container sequence: Teflon bag → stainless steel can → Wasserburg container

Processing comments: The rock was removed from the bag and stored in a stainless steel can. The sample was taken for organic analysis by chipping the larger rock 15 days after the D-ALSRC was opened. Both the interior and exterior surfaces of the rock were analyzed.

Control sample number: 1201

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.3071	44 ± 5

6. Organic Analysis Results

Maximum total ionization: 1.0×10^5

Total ionization: 1.8×10^6

Estimated organic content (total of indigenous and contamination): 0.2 ppm

7. Remarks

Samples 12044-2 and 12044-1 have the same probable contaminants as the other samples. As in previous runs, this rock sample showed less organic content than did the fines. Considerable CO_2 evolution was noted.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12052-4 2. Weight: 3119 grams (three pieces)

3. Sample Description (from original description)

Rock type: B

Physical appearance: Coarse-grained rock; some pyroxene crystals 810 millimeters long by 0. 5 millimeter wide; high in ilmenite; radially oriented feldspar in patches; rock apparently heavily shocked; olivine basalt

4. Sample History

Return container: D-ALSRC

Schematic processing diagram: D-ALSRC⟶Bioprep⟶GAL glove box

Storage container sequence: D-ALSRC⟶stainless steel can⟶Wasserburg container

Processing comments: The rock was exposed to the Bioprep cabinet atmosphere approximately 6 hours before the organic sample was taken. The rock chip was broken and subdivided in the GAL glove box. The chip was approximately 20-percent exterior surface.

Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0. 3326	34 ± 10
2	. 1261	65 ± 15
3	. 4487	25 ± 4

6. Organic Analysis Results

Maximum total ionization: 3.4×10^4

Total ionization: 6.2×10^5

Estimated organic content (total of indigenous and contamination): 0. 1 ppm

7. Remarks

Considerably less material (organics plus CO and CO_2) was found in sample 12052-4 than in the fines or core-tube samples. The mass spectrometer scans for sample 12052-4 are shown in figure B-11.

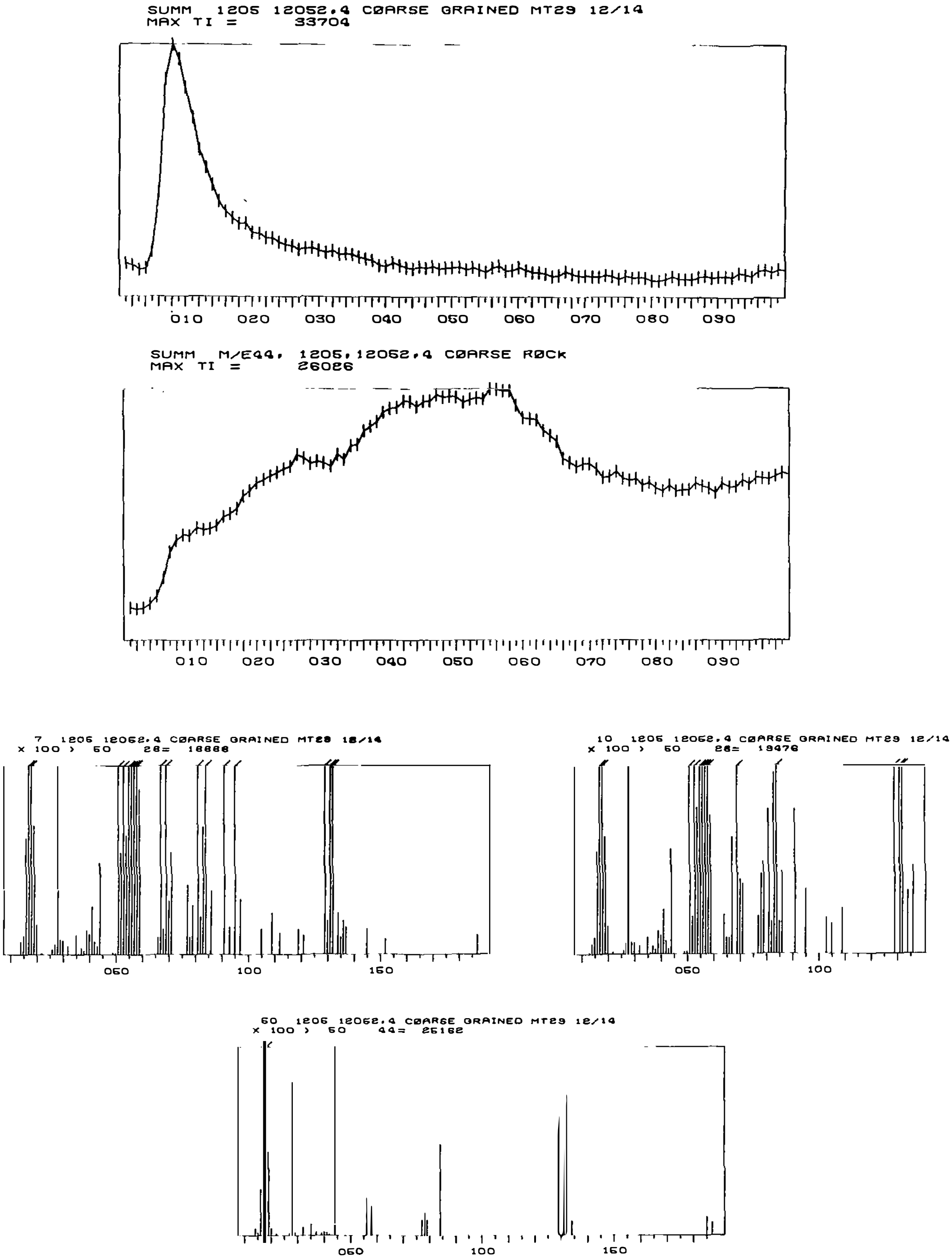

Figure B-11. - Mass spectrometer scans for sample 12052-4.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12057-1 2. Weight: 0.5 gram

3. Sample Description (from original description)

Rock type: D

Physical appearance: Medium dark chip; may be a breccia

4. Sample History

Return container: D-ALSRC

Schematic processing diagram: D-ALSRC → Bioprep → Wasserburg container

Storage container sequence: D-ALSRC → Wasserburg container

Processing comments: The chip was removed from the box and sealed in the Wasserburg container 1 hour after the box was punctured for gas analysis. The lid had been off the box for only 2 minutes when the sample for carbon and organic analysis was collected.

Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.2194	120 ± 10

6. Organic Analysis Results

Maximum total ionization: 2.5×10^4

Total ionization: 1.2×10^6

Estimated organic content (total of indigenous and contamination): 0.3 ppm

7. Remarks

Considerable CO and CO_2 and some m/e 64 was noted. Almost no other material evolved. The mass spectrometer scans for sample 12057-1 are shown in figure B-12.

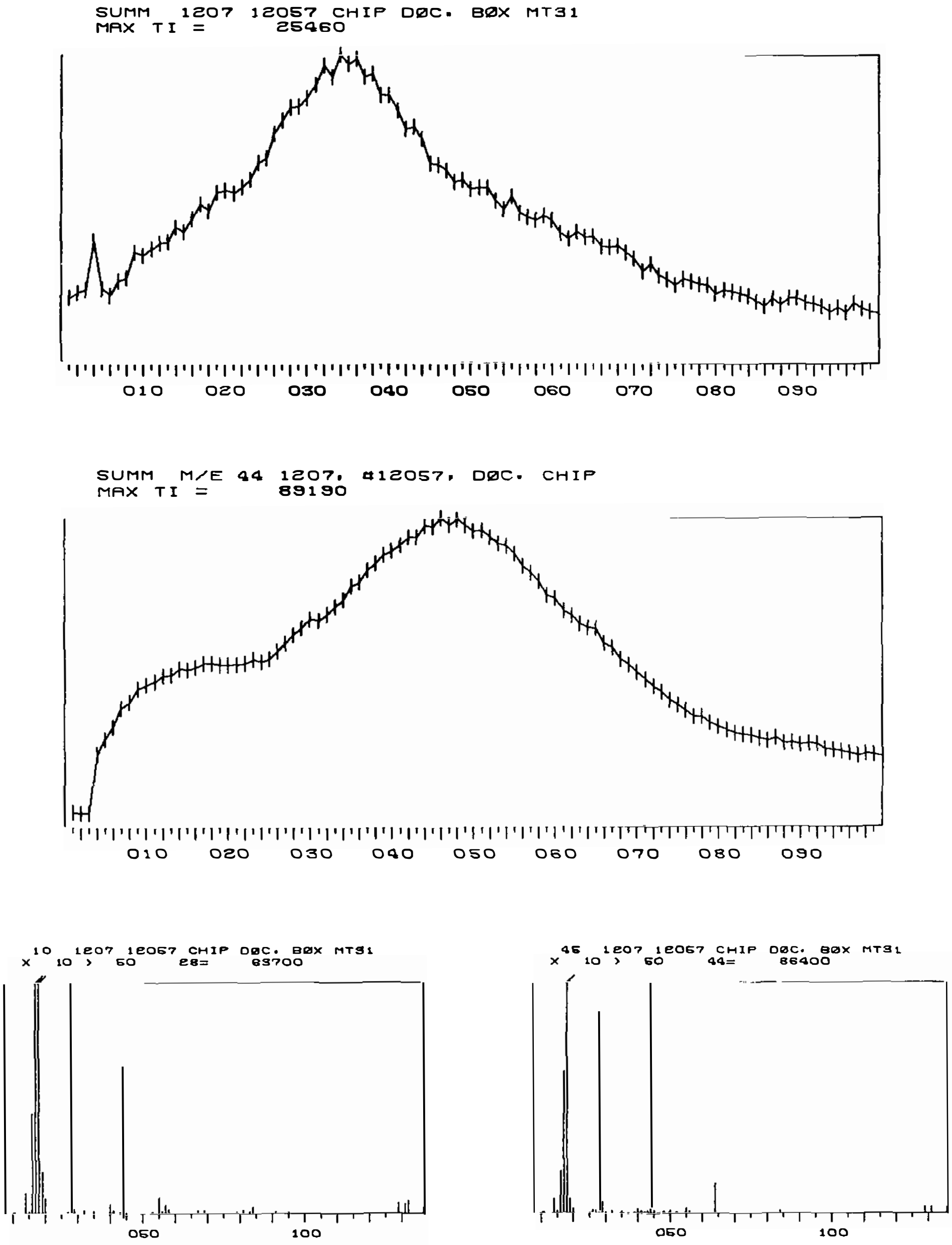

Figure B-12. - Mass spectrometer scans for sample 12057-1.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12059-1 2. Weight: 460.2 milligrams

3. Sample Description (from original description)

Rock type: D

Physical appearance: Fines and some small (10 to 15 milligram) chips

4. Sample History

Return container: D-ALSRC and documented sample bags

Schematic processing diagram: D-ALSRC⟶Bioprep⟶GAL glove box

Storage container sequence: D-ALSRC ⟶stainless steel can⟶Wasserburg container

Processing comments: Material was dusted from the loose rocks and the Teflon sample bags into a stainless steel pan. The material was exposed to cabinet atmosphere for 25 hours before sampling for carbon analysis. The rocks were dusted by a gas stream blown from a polyethylene squeeze bottle.

Control sample numbers: 1201 and 1202

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.1270	240 ± 25
2	.1336	120 ± 15

6. Organic Analysis Results

Maximum total ionization: 1.9×10^6

Total ionization: 4.2×10^7

Estimated organic content (total of indigenous and contamination): >2 ppm

7. Remarks

Sample 12059-1 was contaminated severely compared to the other samples that were run. Scan 40 (fig. B-13) is representative of one type of contaminant; Teflon (scan 92) is the other contaminant. The excess contamination was probably caused by flaking of the Teflon bag, blowing N from the polyethylene bottle, and extra handling. The second run contained a chip mixed in with the fines. The high C content correlates with the higher organic content.

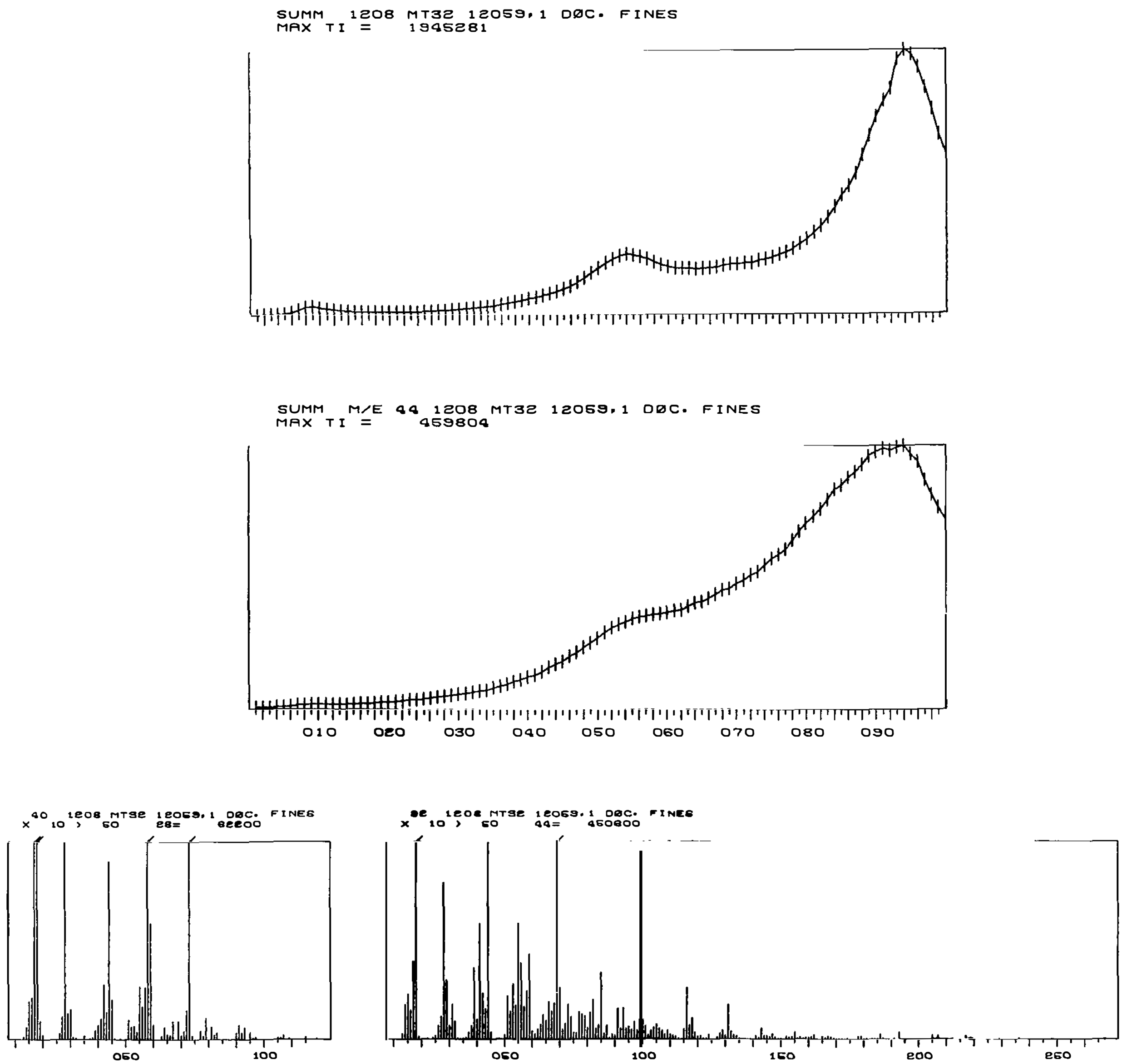

Figure B-13. - Mass spectrometer scans for sample 12059-1.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12063   2. Weight: 2416 grams

3. Sample Description (from original description)

Rock type: A

Physical appearance: Light to medium gray with many darker spots caused by glass in small pits and shadowed vugs

4. Sample History

Return container: Tote bag

Schematic processing diagram: Tote bag ⟶ LM ⟶ CM ⟶ CRA ⟶ PCTL

Storage container sequence: Tote bag ⟶ CDR's gloved (?) hand ⟶ aluminum foil ⟶ copper-flanged stainless steel container

Processing comments: Sample 12063 was subjected to considerable handling and to the LM, CM, and terrestrial atmospheres. The copper-flanged container was cleaned by ultrasonication in benzene/methanol and by vacuum bakeout. The rock chip was taken in the PCTL and sterilized at 160° C.

Control sample number: None

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.2755	35 ± 10

6. Organic Analysis Results: Not available

7. Remarks

Excessive handling and exposure to atmosphere apparently has not increased the contamination, which could be explained if the sample were an interior surface.

TOTAL CARBON AND ORGANIC ANALYSIS

1. Sample Number: 12065 2. Weight:

3. Sample Description (from original description)

   Rock type: AB

   Physical appearance: Pigeonite porphyry

4. Sample History

   Return container: Tote bag

   Schematic processing diagram: Tote bag⟶LM⟶CM⟶CRA⟶PCTL

   Storage container sequence: Tote bag⟶CDR's gloved (?) hand⟶aluminum foil⟶copper-flanged stainless steel container

   Processing comments: The processing comments are the same as for sample 12063.

   Control sample number: None

5. Total Carbon Analysis Results

Run no.	Sample weight, g	Carbon content, ppm
1	0.4920	29 ± 4
2	.1438	38 ± 10

6. Organic Analysis Results: Not available

7. Remarks

   The remarks are the same as for sample 12063.

APPENDIX C

ORGANIC-MONITOR DATA SHEETS

OTTAWA-SAND ORGANIC MONITORS

Baked Ottawa sand was used to monitor the background levels in the various LRL sample-processing cabinetry. Standard Ottawa sand is sieved to pass 20 to 30 mesh, which calculates to an average spherical grain volume of 5.2×10^{-4} cubic centimeters and an average grain weight of 1.4 milligrams. Thus, the surface area was approximately 22.6 cm^2/g of sand.

Two batches of sand were prepared: one to monitor the F201 vacuum system and one to monitor the nitrogen processing in the Bioprep cabinet. The F201 OM was prepared by washing the sand with water and firing it at 1000° C overnight. The Bioprep OM was prepared at ARC by washing the reagent-grade Ottawa sand with acid and firing it at 1000° C for 30 hours. Samples of both batches were analyzed using benzene/methanol extraction and high-resolution mass spectrometry at UCB and pyrolysis mass spectrometry at the LRL; the results of these analyses served as the control data. Approximately 200 grams of both the control and the exposed portions of each of these monitors were available for distribution to the Group D Principal Investigators.

The F201 OM control (Teflon bagged) yielded 3.08 $\mu g/g$ of extractables, which calculated to 0.136 $\mu g/cm^2$; the Bioprep OM control yielded 2.32 $\mu g/g$ of extractables, which calculated to 0.103 $\mu g/cm^2$. A second extraction of this sample yielded only background. The high-resolution mass-spectral data indicated mainly hydrocarbons from C_4 to C_{25} of as much as 6° of unsaturation and octoil (dioctyl phthalate). Oxygenated species were found in minor amounts (cyclic ketones, low-weight carboxylic acids, and an oxygenated compound with the composition $C_{23}H_{32}0_2$, after loss of one $C_{10}H_{20}$ group).

The results of the pyrolysis mass-spectrometer analyses for the control samples are given in appendix B. The mass spectrometer scans for the Ottawa-sand organic monitors are shown in figure C-1.

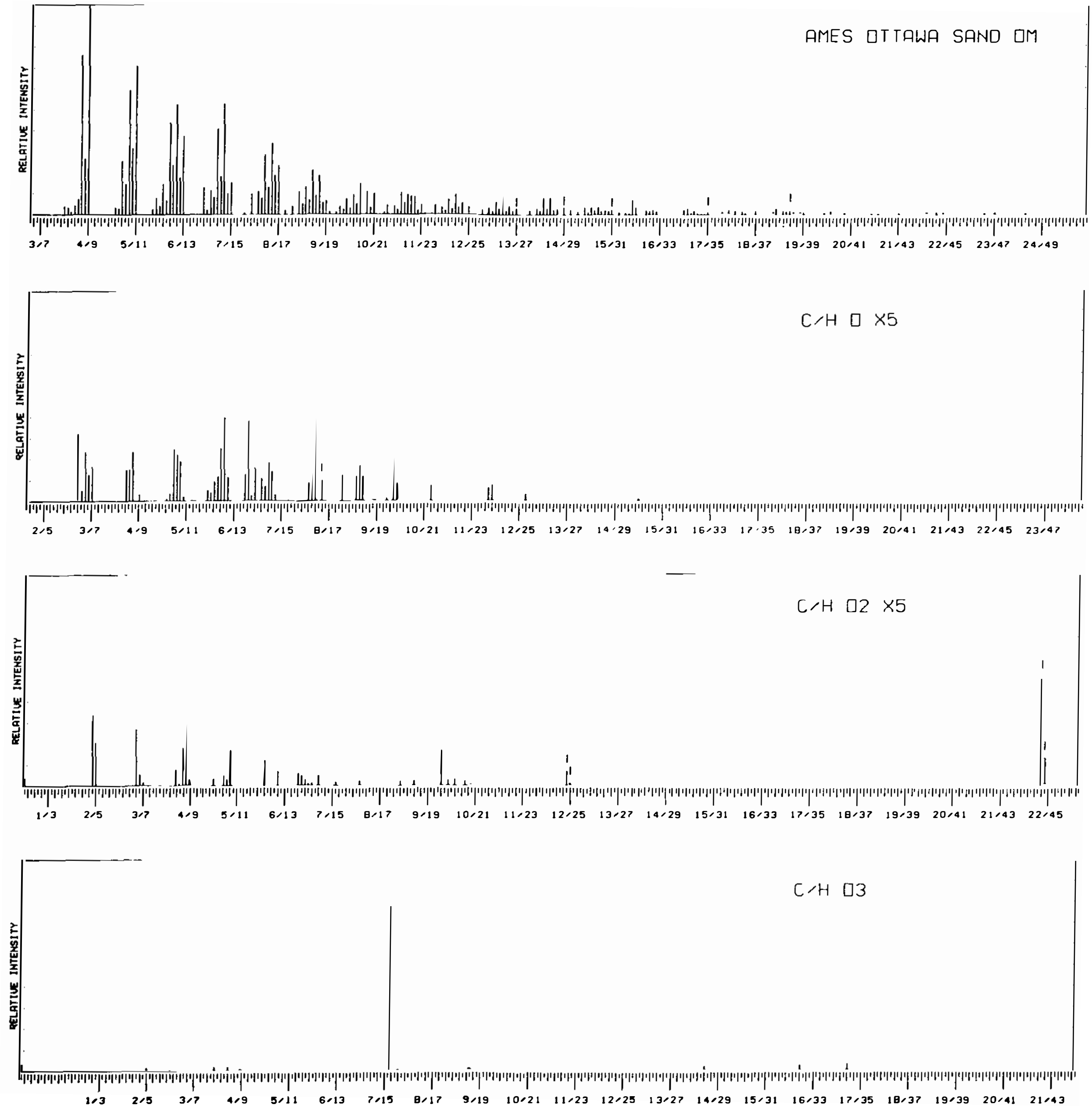

Figure C-1. - Mass spectrometer scans for Ottawa-sand organic monitors.

ORGANIC MONITOR 1007-2

Organic monitor 1007-2 was cleaned by the ALSRC-1574 cleaning procedure together with the contents of ALSRC 1009 (the S-ALSRC). The sample weighed 49.96 grams and yielded a benzene/methanol (3: 1) extract residue of 0.2 milligram. Assuming a York-mesh surface area of 60 cm^2/g, the residue was equivalent to 0.05 $\mu g/cm^2$ of extractable organics. The gas chromatogram (GC) showed only trace peaks above the background level, and the high-resolution mass-spectral data (one of the scans is illustrated in fig. C-2) indicated the presence of a more diverse suite of organic compounds. The major constituents were octoil (C/H 0_3 plot, fig. C-2), which was substantiated by the GC run, and hydrocarbons ranging from C_4 to C_{12}. Traces of carboxylic acids to C_8 were found.

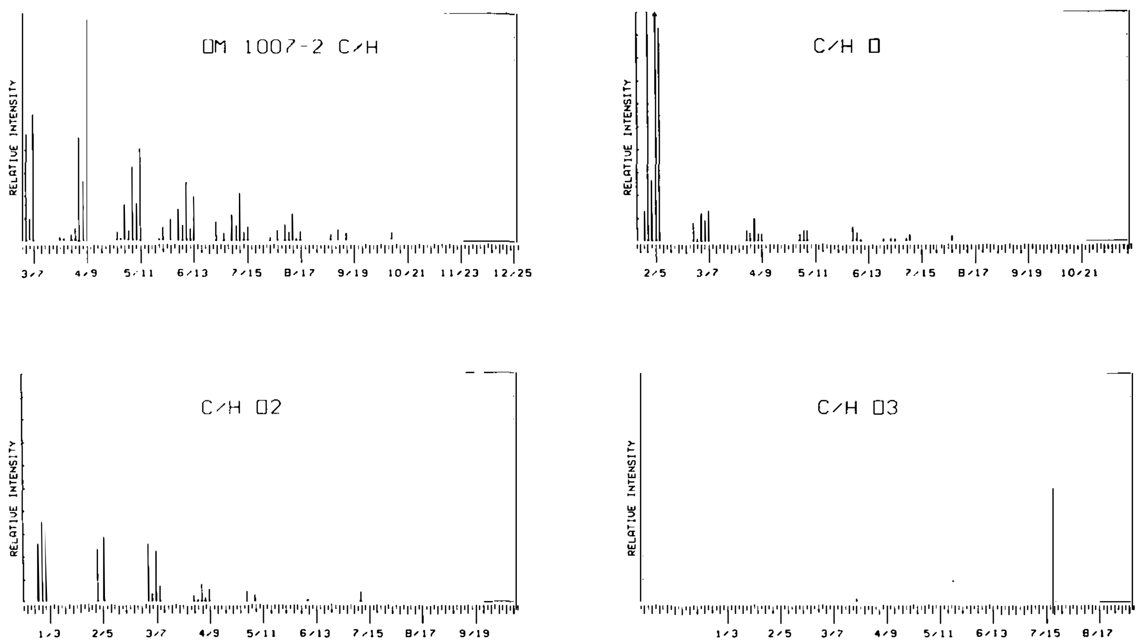

Figure C-2. - Mass spectrometer scans for organic monitor 1007-2.

ORGANIC MONITOR 1007-4

Organic monitor 1007-4 was cleaned by the ALSRC-1574 cleaning procedure together with the ALSRC 1009 box, the temperature sensor, and the seal protectors. The sample weighed 40.92 grams and yielded a benzene/methanol (3:1) extract residue of 0.25 milligram, which was equivalent to 0.12 $\mu g/cm^2$. This high value was the result of some fine AlO_2 passing through the filtering grit. The GC trace showed no peaks, and the high-resolution mass-spectral data indicated only trace hydrocarbons that were barely above the solvent background.

The mass spectrometer scans for OM 1007-4 are shown in figure C-3.

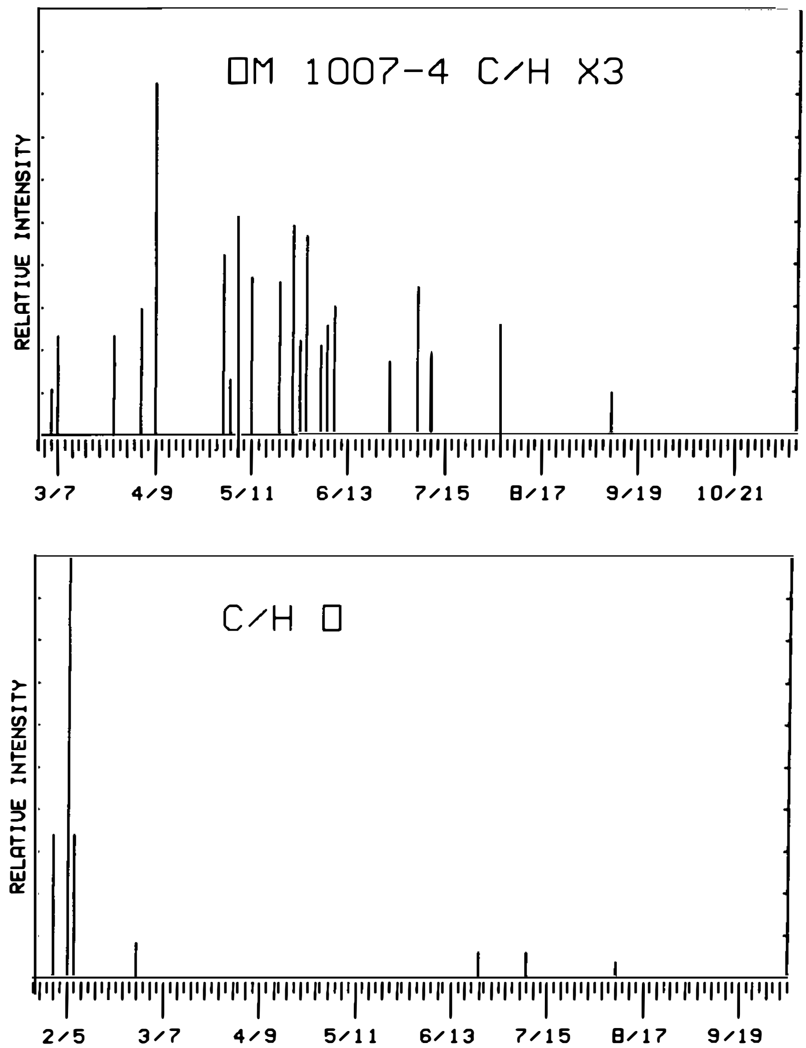

Figure C-3. - Mass spectrometer scans for organic monitor 1007-4.

ORGANIC MONITOR 1008

Organic monitor 1008 was cleaned by the ALSRC-1574 cleaning procedure together with the contents of ALSRC 1008 (the D-ALSRC) and then baked under vacuum conditions at 160° C in the LRL F250 conditioning chamber. The sample of York mesh weighed 11.02 grams, and the benzene/methanol (3:1) extract residue was 0.05 milligram above the solvent background, which corresponded to 0.08 $\mu g/cm^2$ of extractables. No GC trace was run, but the high-resolution mass-spectral data indicated carboxylic acids to approximately C_{12} as the major components, with octoil and hydrocarbons as minor constituents.

The mass spectrometer scans for OM 1008 are shown in figure C-4.

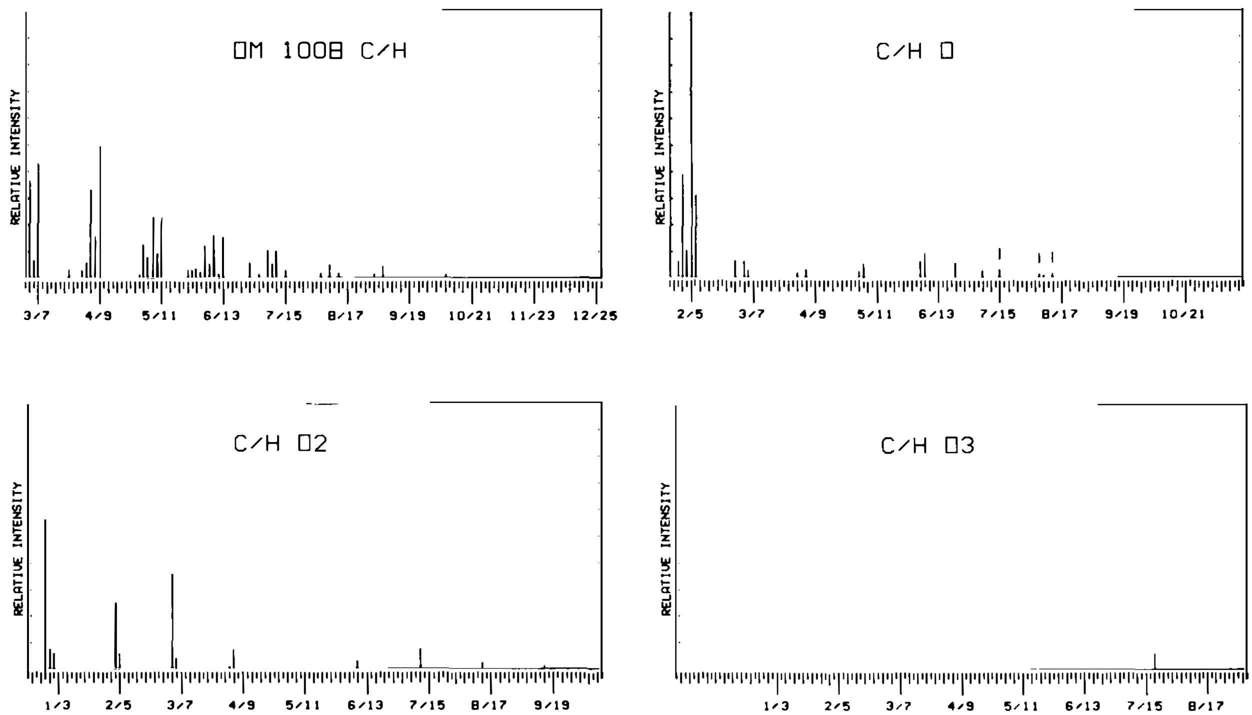

Figure C-4. - Mass spectrometer scans for organic monitor 1008.

ORGANIC MONITOR 1009

Organic monitor 1009 was cleaned by the ALSRC-1574 cleaning procedure together with the ALSRC 1009 contents and then baked under vacuum conditions at 160° C with ALSRC 1009 in the LRL F250 conditioning chamber. The sample weighed 12.31 grams, and the benzene/methanol (3:1) extract residue was 0.06 milligram above the solvent background, which corresponded to 0.08 $\mu g/cm^2$ of extractables. The GC trace indicated no peaks at the highest attenuation. The high-resolution mass-spectral data indicated mainly a suite of hydrocarbons from C_4 to C_{16} of varying degrees of unsaturation and octoil. Oxygenated compounds also were present in significant amounts; for example, cyclohexanone, cyclopentanone, butyric acid, and tetrahydronaphthol.

The mass spectrometer scans for OM 1009 are shown in figure C-5.

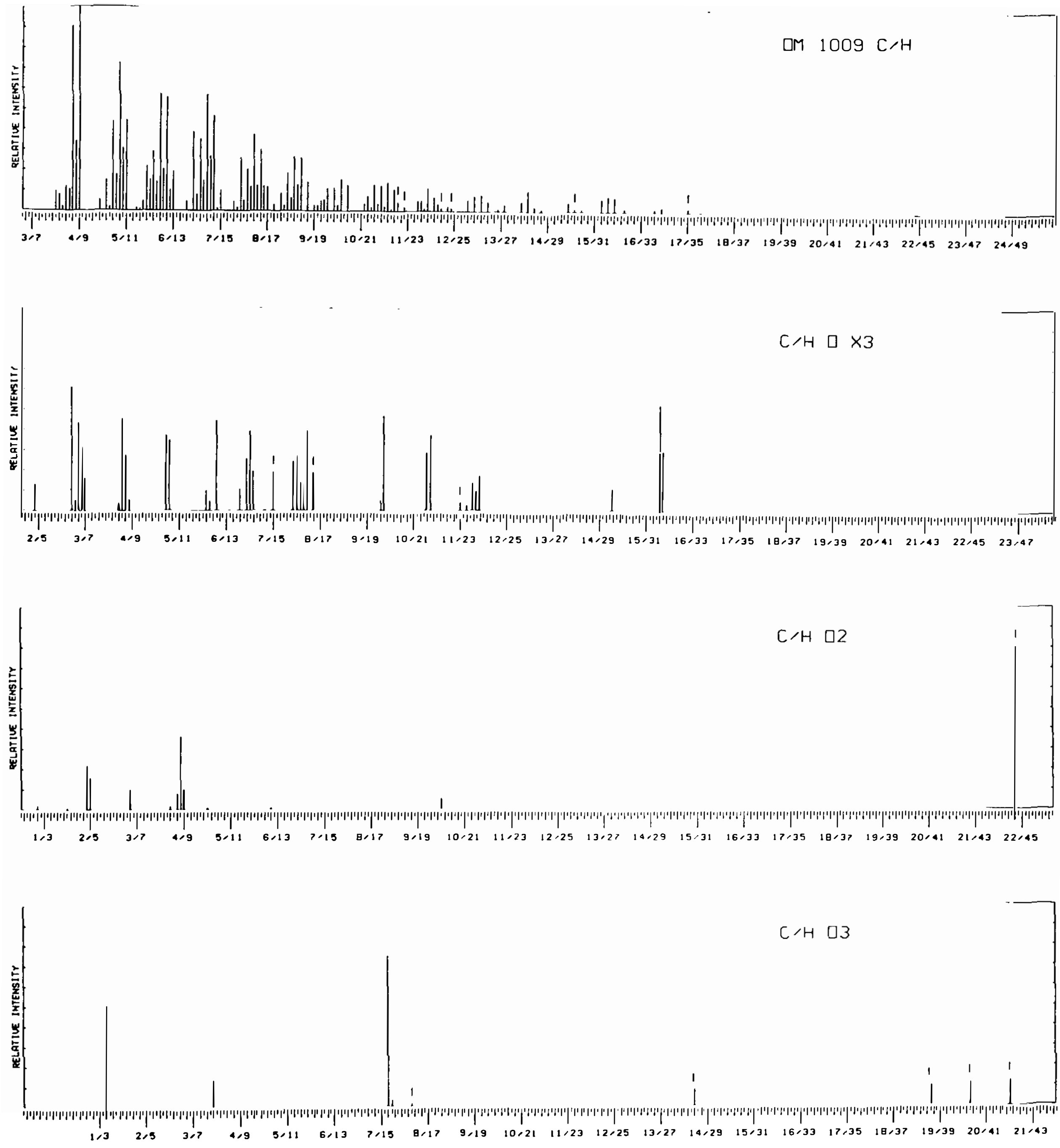

Figure C-5. - Mass spectrometer scans for organic monitor 1009.

EXTRACTION SOLVENTS

One liter each of benzene and methanol (both nanograde purity) were evaporated. This amount represents a tenfold larger quantity of solvent than was used for the extraction. The GC traces were run and showed no detectable peaks. The benzene background consisted mainly of hydrocarbons ranging from C_4 to C_{18} of varying degrees of unsaturation and minor amounts of octoil and carboxylic acids from C_4 to C_{15}. The methanol background consisted mainly of dissolved inorganics, traces of hydrocarbons, and low-weight carboxylic acids.

The high-resolution mass-spectral data for methanol are shown in figure C-6 and for benzene in figure C-7.

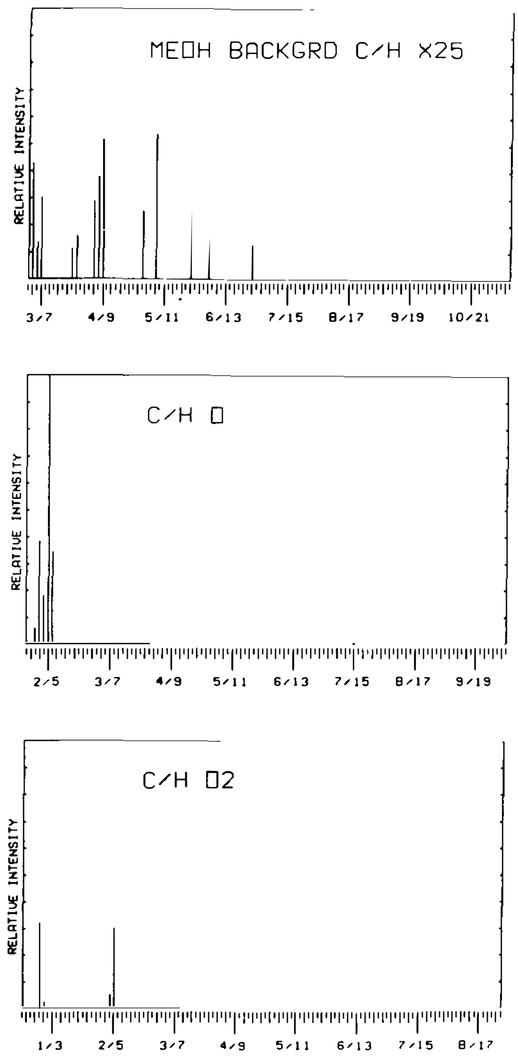

Figure C-6. - High-resolution mass-spectral data for methanol.

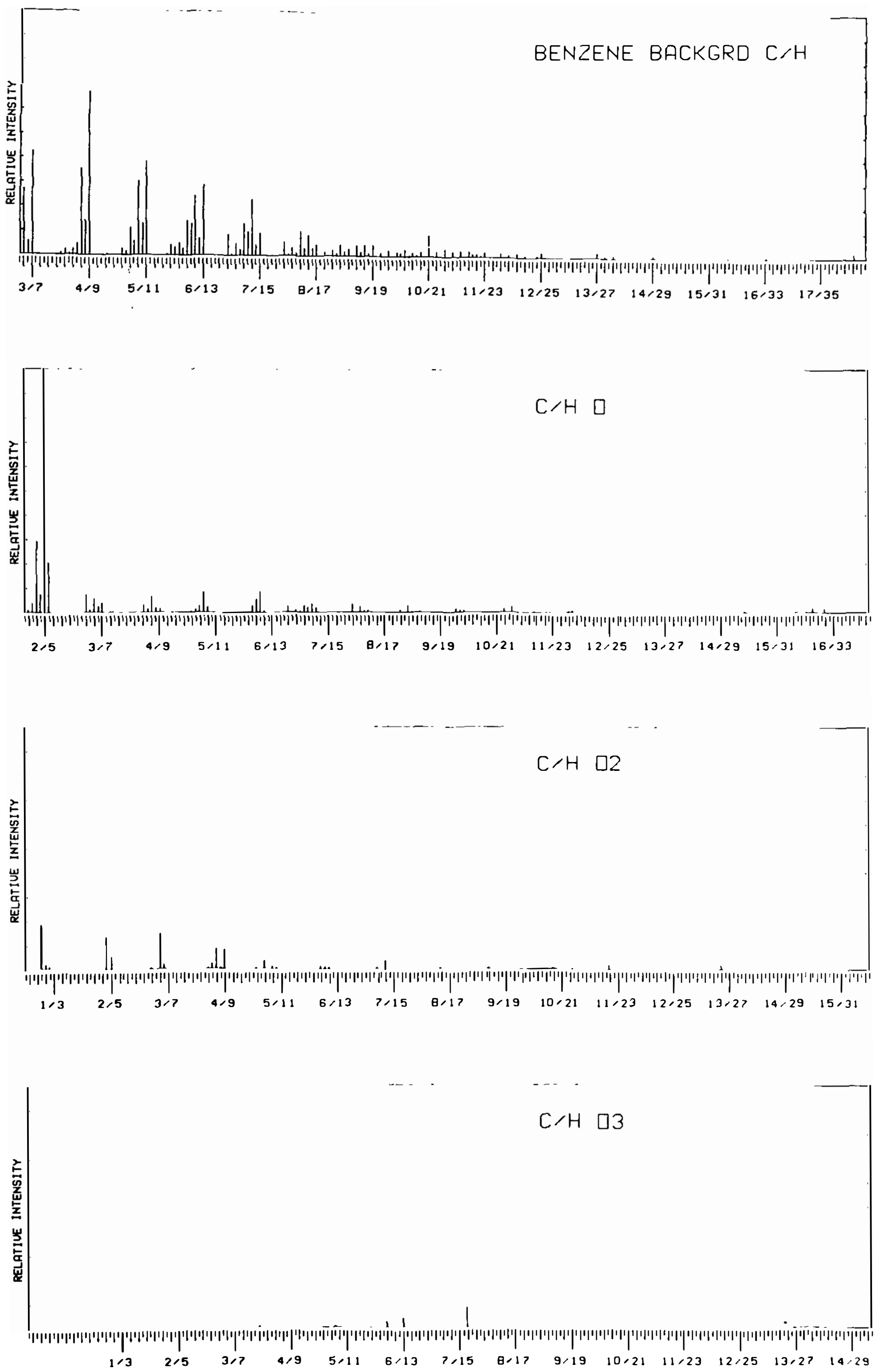

Figure C-7. - High-resolution mass-spectral data for benzene.

ALSRC 1008 LID

The ALSRC 1008 lid sample was the residue from the cleaning solution used to clean the LESC and GASC lid hardware that was stowed in ALSRC 1008 during the Apollo 12 mission. The cleaning procedure consisted of washing both the inside and the outside of the lid of the prime organic container. The extractable portion of the solution weighed 5.0 milligrams after solvent evaporation. The GC of the extract (the heptane solubles) is shown in figure C-8. The high-resolution mass-spectral data indicated dioctyladipate and octoil as the major components. The presence of dioctyladipate was substantiated by the series of peaks in figure C-8. Hydrocarbons and the free acids C_4, C_5, C_{12}, and C_{13} were found as minor components.

The mass spectrometer scans for the ALSRC 1008 lid are shown in figure C-9.

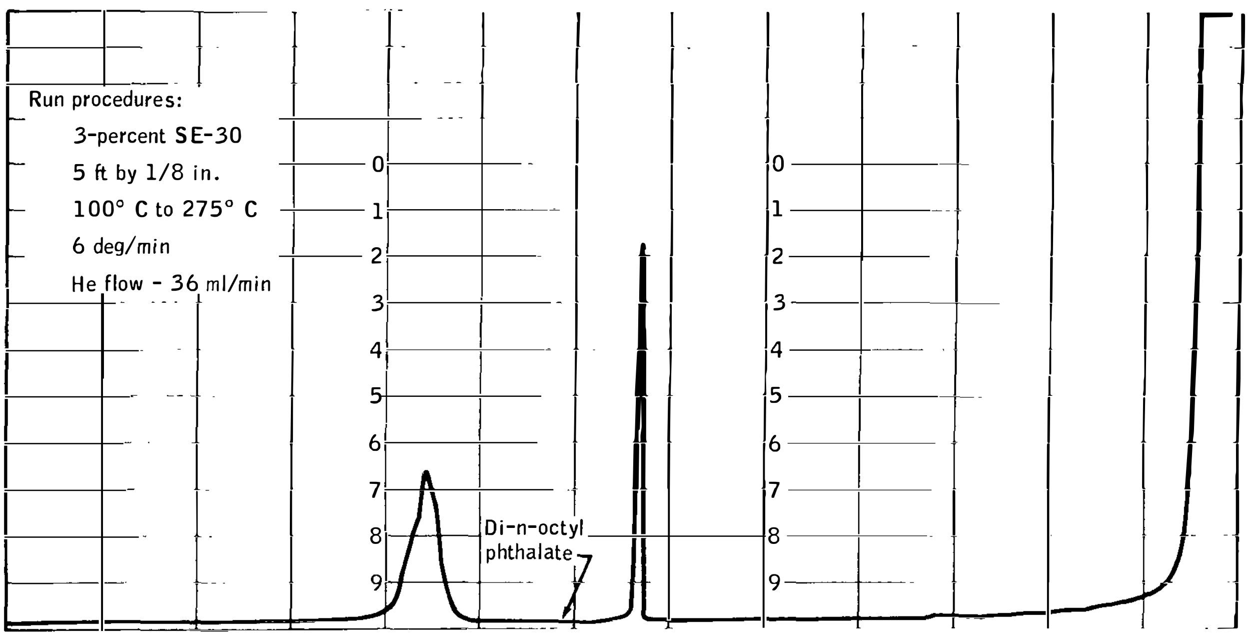

Figure C-8. - Data plot of ALSRC 1008 lid wash.

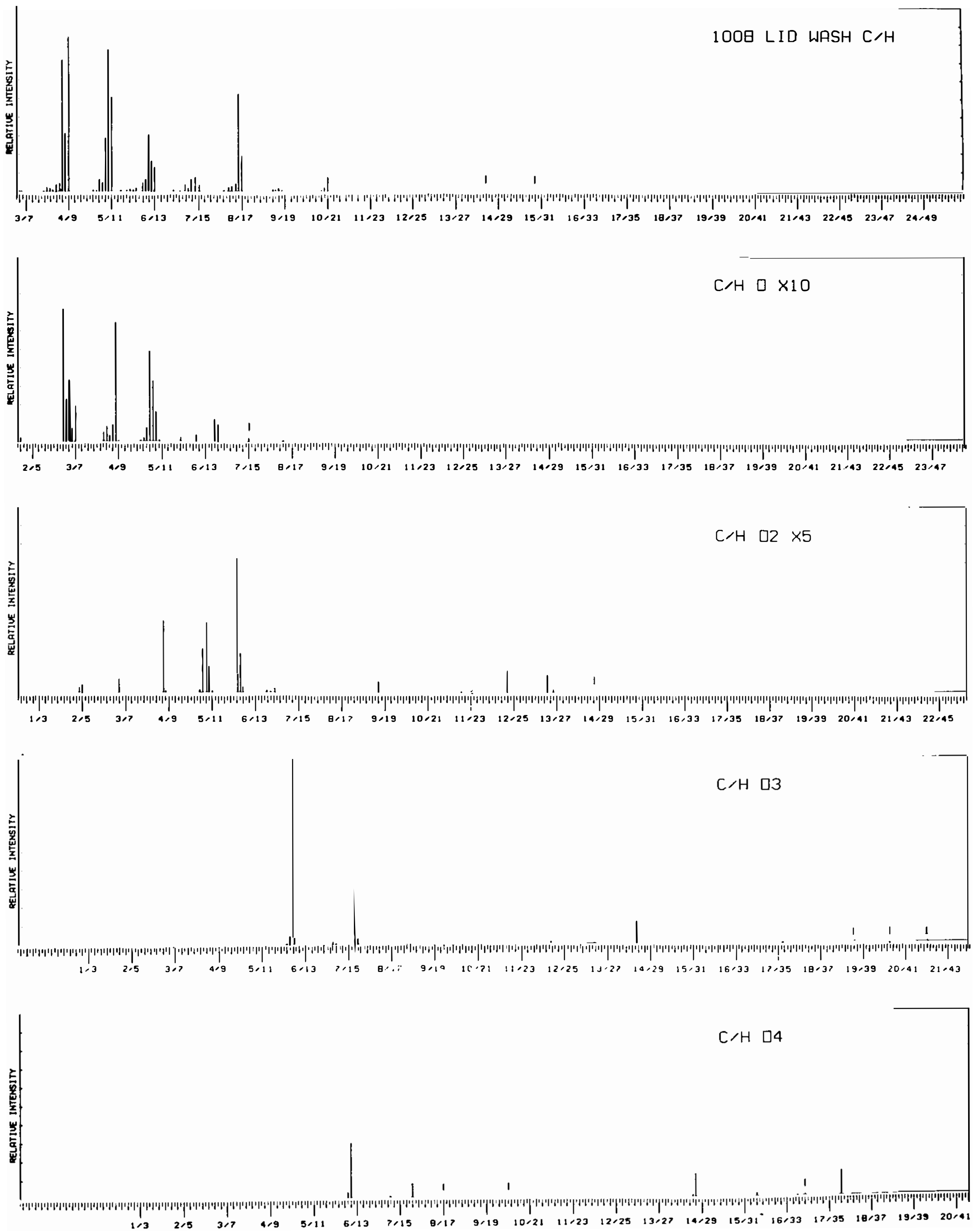

Figure C-9. - Mass spectrometer scans for ALSRC 1008 lid.

APPENDIX D

PHOTOGRAPHIC INDICES

The photographs of the Apollo 12 lunar samples have been indexed in the following ways: (1) a log of all photographs taken, (2) an index of photographs by sample number and an index of samples by photograph number, and (3) a cross-reference of samples with the lunar-surface collection location, photographs, and chronological sequence.

PHOTOGRAPHIC LOG

Effective use of 70-millimeter photographs taken on the Apollo 12 EVA requires extensive information about the camera parameters and camera location and orientation at the time each photograph was taken. The amount of such data that are being derived for each picture is too extensive to include concisely in one listing. The log has therefore been divided into two versions. The first version, which is presented here, is designed primarily to support general photographic interpretation. Two complete photographic listings are presented in this version. The first listing (table D-I) is a listing of all the photographs in chronological sequence and is useful for understanding the context of each photograph taken during the EVA traverses. The second listing (table D-II) is a sequential listing of photographs from each individual magazine and is useful for locating information about any given photograph. The second version, which is still in preparation, contains detailed geometric information required for precise mensuration of surface features from the photographs.

The two cameras used for primary lunar-surface scientific and engineering documentation during the Apollo 12 lunar stay were 70-millimeter Hasselblad cameras with automatic electric-film-advance and shutter-cocking mechanisms. Each camera was equipped with a specially designed f/5.6 Biogon lens and a reseau plate at the film plane that imprinted a five-by-five array of crosses on each photograph at the time of exposure. Although the focus settings on each camera were continuously variable, three detents were provided in the focusing ring to provide a finite number of repeatable focus settings. The conventional set of detents was available at 0.5 f-stop intervals on the adjusting ring for the iris. Shutter speeds of 1 to 1/500th second were available; however, with few exceptions, the exposure setting used on the lunar surface was 1/250th second. Both cameras were calibrated prior to launch for photometric and photogrammetric data reduction.

During the first EVA, color film was used in magazines Y and V. Magazines X and Z, used during the second EVA, contained black-and-white film.

Three main types of analyses were used to prepare this part of the log: (1) comparison of images on the Hasselblad photographs with those on Lunar Orbiter photographs, (2) comparison of photographs of geological sample sites with those taken of returned samples in the LRL, and (3) comparison of image data with data transmitted verbally during the EVA.

An explanation of the boxheads used in tables D-I and D-II is given in the following paragraphs.

PHOTO: The last six digits of the official NASA number assigned to each photograph shortly after processing. Each number is prefixed by "AS12." The last four digits of each number are unique, but numbers are sequential within a given film magazine only. The numbers do not represent a chronological order because two magazines were used simultaneously.

MAG: The letter designation assigned to the film magazine.

SEQ: The chronological sequence in which each picture was taken, as nearly as can be determined.

REMARKS: Comments about each picture that may refer to objects in the picture, to something the crew said about their reasons for taking the picture, to some unusual aspect of the subject of the picture, to number designations of samples appearing in the picture, or to the inferred reason for taking the picture. Descriptions of the photographic surveys and definitions of acronyms and abbreviations referred to in this column are given in the following two sections.

GET: Ground elapsed time, which is the time since lift-off, in hours and minutes, when the picture was taken, as nearly as can be determined from voice transmissions.

BY: Crewmember who took the picture. Discussion by the crew of subject matter in several pictures was sufficient to identify the photographer.

DIST and AZLM: Distance and azimuth of camera stations from the center of the LM (clockwise from north). These were determined by identifying features on both Lunar Orbiter and Apollo 12 EVA photographs and by computing photograph location using the standard surveying technique of resection. The distances given are not the same as those given in some of the remarks, which simply refer to the shortest distance to any part of the LM.

AZ: Azimuth (clockwise from north) along which the camera was aimed. This was also determined during resection. When the photograph was part of a panorama, the azimuths of other photographs in the panorama were measured from photomosaics of the panorama.

Photographic Surveys

Three basic types of photographic surveys were made by the Apollo 12 astronauts specifically for lunar-surface interpretation: (1) panoramas, (2) sample surveys, and (3) a polarimetric survey. These surveys are described in the following paragraphs.

Panoramas. - A total of 23 panoramas was taken during the Apollo 12 lunar stay. These include partial panoramas from inside the LM taken through both windows, complete 360° panoramas taken from the surface at intervals throughout the traverse, and partial panoramas frequently taken in pairs for stereoscopic average of large features of particular interest.

Panoramas taken from the LM windows are useful because of their high vantage point, even though their azimuthal field of view is little more than 180°. The view from the windows of the area in the vicinity of the LM is not often occulted by local topography, as photographs from the surface are. This lack of occultation permits detailed examination of continuous views of the surface.

Complete panoramas are taken to record as much lunar-surface detail as possible with a lunar-surface-based camera. Comparison of the appearance of surface features in pictures taken from orbit and in pictures taken from the lunar surface is useful in geological interpretation. Panoramic photographs also augment crew discussions of the area. When joined together as mosaics, the panoramas provide accurate map control data in the form of horizontal angles. This can be done analytically, with high precision, from measurements of glass-plate reproductions of the photographs, or graphically, with moderate precision, by measuring the mosaics themselves. Complete panoramas are more useful than broken or partial panoramas in the sense that they provide an immediate check of error accumulation in measuring horizontal angles, and because lunar directions can be determined accurately and independently of any other data from the locations of the image of the sun and the image of the astronaut's shadow. This was one of the reasons that the crew was requested to take pictures into the sun, even though poor picture quality was anticipated.

Partial panoramas produce some of the same data as complete panoramas at a considerable saving of film. They are useful for photographic documentation of large features of geological interest. When two partial panoramas are taken of the same feature from slightly different vantage points, pairs of pictures from the adjacent panoramas can be viewed stereoscopically, and precise photogrammetric measurements of the feature can be made.

Sample surveys. - The sample surveys were taken to illustrate the *in situ* characteristics of samples of lunar material returned to earth and to aid identification of sampling locations along the traverse. Most of the sample pictures were taken in stereoscopic pairs to aid in interpretation and photogrammetric measurement of the sample area. Many contain a self-righting wand, or gnomon, which serves as a scale, a vertical reference, and, by casting a shadow, a lunar azimuth indicator.

Polarimetric survey. - A polarimetric survey was made only once, early in the second EVA, with a polarizing filter attached to the camera. This type of survey was made to study the polarizing properties of lunar material. A series of pictures of the same area was taken from different locations and with different orientations of the polarizing filter.

Glossary of Acronyms and Abbreviations Used in the Photographic Log

ALSEP	Apollo lunar-surface experiments package
AUX	Auxiliary
BOT	Bottom or underside
CAM	Camera
CDR	Commander (Astronaut Charles C. Conrad)
CENT STA	Central station of ALSEP
CH	Changed
COMP A	One of two compartments on the Surveyor III spacecraft containing electronic components
CONT	Contingency sample
CSM	Command and service module
CT	Core tube
CTR	Crater
DN SUN	Camera was aimed directly away from the sun when the picture was taken.
DPS	Descent propulsion system, i. e., the exhaust cone under the descent stage of the LM
E	East
EVA	Extravehicular activity, i. e., astronaut activity outside the LM
FLD SPL	A number designation on sample bags carried by the astronauts. One or more samples in the same bag were designated by the same "field" sample number.
IDENT	Identification
IN	Inch
L	Left
LESC	Lunar-environment sample container
LM	Lunar module

LMP	Lunar module pilot (Astronaut Alan Bean)
LRL SPL	A number given in the LRL to a sample of lunar material. More than one LRL sample may have the same field sample number.
LTR	Lighter
MAG	Film magazine
N	North
OMNI	Omnidirectional antenna. The Surveyor III spacecraft has two such antennas, designated "Omni A" and "Omni B."
PSE	Passive-seismic-experiment instrument
R	Right
RADVS	Radar altimeter and Doppler velocity sensor — part of the automatic landing system on the Surveyor III spacecraft
RK	Rock
RTG	Radioisotope thermoelectric generator — the power source for ALSEP instruments
RTND	Returned
S	South
SEQ BAY	Scientific equipment bay — a storage compartment on the descent stage of the LM
SMSS	Soil mechanics surface sampler — the scoop on the Surveyor III spacecraft
SPL	Sample (of lunar material)
SWC	Solar-wind-composition measuring device
SWE	Solar-wind-experiment instrument
TRN	Trench
W	West
X-SUN	Camera was aimed across the direction of illumination.

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
46-6715	Y	40	CDR ON PORCH	115 13	LMP			300.0
46-6716	Y	41	CDR ON PORCH	115 13	LMP			300.0
46-6717	Y	42	CDR ON PORCH	115 13	LMP			300.0
46-6718	Y	43	CDR ON PORCH	115 13	LMP			300.0
46-6719	Y	44	CONT SPL AREA	115 47	CDR	14.6	307.5	350.0
46-6720	Y	45	CONT SPL AREA	115 47	CDR	14.6	307.5	340.0
46-6721	Y	46	CONT SPL AREA	115 47	CDR	14.6	307.5	335.0
46-6722	Y	47	CONT SPL AREA	115 47	CDR	14.6	307.5	0.0
46-6723	Y	48	CONT SPL AREA	115 47	CDR	14.6	307.5	0.0
46-6724	Y	49	LMP ON PORCH	115 50	CDR	6.1	323.7	135.0
46-6725	Y	50	LMP ON PORCH		CDR	6.1	323.7	135.0
46-6726	Y	51	LMP ON LADDER	115 50	CDR	6.1	323.7	135.0
46-6727	Y	52	LMP ON LADDER	115 50	CDR	6.1	323.7	135.0
46-6728	Y	53	LMP ON LADDER	115 50	CDR	6.1	323.7	135.0
46-6729	Y	54	LMP ON SURFACE	115 50	CDR	6.1	323.7	135.0
46-6730	Y	75	PANORAMA 2, 11 METERS W OF LM	116 22	CDR	14.9	281.2	251.5
46-6731	Y	76	PAN 2	116 22	CDR	14.9	281.2	276.0
46-6732	Y	77	PAN 2	116 22	CDR	14.9	281.2	294.6
46-6733	Y	78	PAN 2	116 22	CDR	14.9	281.2	313.0
46-6734	Y	79	PAN 2	116 22	CDR	14.9	281.2	339.2
46-6735	Y	80	PAN 2	116 22	CDR	14.9	281.2	350.9
46-6736	Y	81	PAN 2	116 22	CDR	14.9	281.2	10.7
46-6737	Y	82	PAN 2	116 23	CDR	14.9	281.2	34.3
46-6738	Y	83	PAN 2	116 23	CDR	14.9	281.2	57.8
46-6739	Y	84	PAN 2	116 23	CDR	14.9	281.2	81.1
46-6740	Y	85	PAN 2	116 23	CDR	14.9	281.2	118.4
46-6741	Y	86	PAN 2	116 23	CDR	14.9	281.2	144.4
46-6742	Y	87	PAN 2	116 23	CDR	14.9	281.2	165.9
46-6743	Y	88	PAN 2	116 23	CDR	14.9	281.2	164.4
46-6744	Y	89	PAN 2	116 23	CDR	14.9	281.2	191.5
46-6745	Y	90	PAN 2	116 24	CDR	14.9	281.2	215.5
46-6746	Y	91	PANORAMA 3, 11 METERS NE OF LM	116 24	CDR	15.4	33.1	144.0
46-6747	Y	92	PAN 3	116 24	CDR	15.4	33.1	168.4
46-6748	Y	93	PAN 3	116 24	CDR	15.4	33.1	187.6
46-6749	Y	94	PAN 3	116 24	CDR	15.4	33.1	211.9
46-6750	Y	95	PAN 3	116 24	CDR	15.4	33.1	237.0
46-6751	Y	96	PAN 3	116 24	CDR	15.4	33.1	257.0
46-6752	Y	97	PAN 3	116 24	CDR	15.4	33.1	269.7
46-6753	Y	98	PAN 3	116 24	CDR	15.4	33.1	290.5
46-6754	Y	99	PAN 3	116 24	CDR	15.4	33.1	304.1
46-6755	Y	100	PAN 3	116 24	CDR	15.4	33.1	319.9
46-6756	Y	101	PAN 3	116 24	CDR	15.4	33.1	335.2
46-6757	Y	102	PAN 3	116 24	CDR	15.4	33.1	350.6
46-6758	Y	103	PAN 3	116 24	CDR	15.4	33.1	5.0
46-6759	Y	104	PAN 3	116 24	CDR	15.4	33.1	21.9
46-6760	Y	105	PAN 3	116 24	CDR	15.4	33.1	41.2
46-6761	Y	106	PAN 3	116 24	CDR	15.4	33.1	61.5
46-6762	Y	107	PAN 3	116 24	CDR	15.4	33.1	83.8

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
46-6763	Y	108	PAN 3	116 24	CDR	15.4	33.1	109.2
46-6764	Y	109	PANORAMA 4, 6 METERS SE OF LM	116 25	CDR	9.7	146.3	66.7
46-6765	Y	110	PAN 4	116 25	CDR	9.7	146.3	89.0
46-6766	Y	111	PAN 4	116 25	CDR	9.7	146.3	82.8
46-6767	Y	112	PAN 4	116 25	CDR	9.7	146.3	82.8
46-6768	Y	113	PAN 4	116 25	CDR	9.7	146.3	112.1
46-6769	Y	114	PAN 4	116 25	CDR	9.7	146.3	128.1
46-6770	Y	115	PAN 4	116 26	CDR	9.7	146.3	157.6
46-6771	Y	116	PAN 4	116 26	CDR	9.7	146.3	160.1
46-6772	Y	117	PAN 4	116 26	CDR	9.7	146.3	191.3
46-6773	Y	118	PAN 4	116 26	CDR	9.7	146.3	200.9
46-6774	Y	119	PAN 4	116 26	CDR	9.7	146.3	232.7
46-6775	Y	120	PAN 4	116 26	CDR	9.7	146.3	261.0
46-6776	Y	121	PAN 4	116 26	CDR	9.7	146.3	287.4
46-6777	Y	122	PAN 4	116 26	CDR	9.7	146.3	319.2
46-6778	Y	123	PAN 4	116 26	CDR	9.7	146.3	292.9
46-6779	Y	124	PAN 4	116 26	CDR	9.7	146.3	344.4
46-6780	Y	125	PAN 4	116 26	CDR	9.7	146.3	6.7
46-6781	Y	126	PAN 4	116 26	CDR	9.7	146.3	25.5
46-6782	Y	127	PAN 4	116 26	CDR	9.7	146.3	54.8
46-6783	Y	128	UNLOADING ALSEP FROM LM		CDR	7.6	122.6	285.0
46-6784	Y	129	SOLAR WIND SPECTROMETER		CDR	7.6	122.6	250.0
46-6785	Y	130	RTG		CDR	7.6	122.6	285.0
46-6786	Y	131	FUEL CAPSULE REMOVAL		CDR	6.0	133.0	330.0
46-6787	Y	132	FUEL CAPSULE REMOVAL		CDR	7.2	168.8	350.0
46-6788	Y	133	FUEL CAPSULE REMOVAL		CDR	7.2	168.8	350.0
46-6789	Y	134	FUEL CAPSULE REMOVAL		CDR	8.0	112.7	295.0
46-6790	Y	135	FUEL CAPSULE REMOVAL		CDR	8.0	112.7	295.0
46-6791	Y	136	PREP TO CARRY ALSEP		CDR	10.2	172.1	5.0
46-6792	Y	137	PREP TO CARRY ALSEP		CDR	10.2	172.1	5.0
46-6793	Y	138	LARGE MOUND,DOWN-SUN	116 55	CDR	93.5	296.6	274.0
46-6794	Y	139	LARGE MOUND, STEREO (L)	116 55	CDR	106.0	295.6	237.0
46-6795	Y	140	LARGE MOUND, STEREO (R)	116 55	CDR	107.8	296.4	250.0
46-6796	Y	141	PANORAMA 5, ALSEP AREA	116 55	CDR	116.4	305.7	248.1
46-6797	Y	142	PAN 5	116 55	CDR	116.4	305.7	274.6
46-6798	Y	143	PAN 5	116 55	CDR	116.4	305.7	299.1
46-6799	Y	144	PAN 5	116 55	CDR	116.4	305.7	326.2
46-6800	Y	145	PAN 5	116 55	CDR	116.4	305.7	347.5
46-6801	Y	146	PAN 5	116 55	CDR	116.4	305.7	13.6
46-6802	Y	147	PAN 5	116 55	CDR	116.4	305.7	30.7
46-6803	Y	148	PAN 5	116 55	CDR	116.4	305.7	50.6
46-6804	Y	149	PAN 5	116 55	CDR	116.4	305.7	72.5
46-6805	Y	150	PAN 5	116 55	CDR	116.4	305.7	89.0
46-6806	Y	151	PAN 5	116 55	CDR	116.4	305.7	110.5
46-6807	Y	152	PAN 5	116 55	CDR	116.4	305.7	138.7
46-6808	Y	153	PAN 5	116 55	CDR	116.4	305.7	163.7
46-6809	Y	154	PAN 5	116 55	CDR	116.4	305.7	181.7
46-6810	Y	155	PAN 5	116 55	CDR	116.4	305.7	210.3
46-6811	Y	156	PAN 5	116 55	CDR	116.4	305.7	233.3

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	SET	BY	DIST	AZLM	AZ
46-6812	Y	157	SOLAR WIND EXP IN PLACE		CDR	122.9	311.8	310.0
46-6813	Y	158	MAGNETOMETER,LMP,AND LM		CDR	128.3	314.5	152.0
46-6814	Y	159	CENTRAL STATION		CDR	129.1	314.1	158.0
46-6815	Y	160	CENTRAL STATION		CDR	129.1	314.1	170.0
46-6816	Y	161	CENTRAL STATION		CDR	129.8	314.5	180.0
46-6817	Y	162	ALSEP IN PLACE		CDR	131.2	314.5	159.0
46-6818	Y	163	LMP AT ION DETECTOR		CDR	129.9	312.6	225.0
46-6819	Y	164	GLARE		CDR			
46-6820	Y	165	ALSEP IN PLACE		CDR	128.9	305.0	346.0
46-6821	Y	166	LMP AND ION DETECTOR		CDR	128.0	303.6	39.0
46-6822	Y	167	SMALL MOUND START OF SELECTED SAMPLE TRAVERSE	118 1	CDR	155.6	319.2	304.0
46-6823	Y	168	SMALL MOUND	118 1	CDR	156.5	320.0	294.0
46-6824	Y	169	SMALL MOUND	118 2	CDR	157.7	318.9	304.0
46-6825	Y	170	SMALL MOUND	118 2	CDR	157.8	319.4	295.0
46-6826	Y	171	LMP AT ALSEP	118 4	CDR	152.1	319.1	162.0
46-6827	Y	188	APPROACHING LARGE MOUND	118 6	CDR	120.3	296.6	173.0
46-6828	Y	189	APPROACHING LARGE MOUND	118 6	CDR	121.3	295.3	165.0
46-6829	Y	190	'BIG ROCK' NW OF LARGE MOUND	118 6	CDR	121.3	295.3	197.0
46-6830	Y	191	'BIG ROCK' NW OF LARGE MOUND	118 6	CDR	121.3	294.3	187.0
46-6831	Y	193	LARGE MOUND, SPL 12008. SPL IDENT. TENTATIVE	118 9	CDR	113.2	291.2	337.0
46-6832	Y	194	LARGE MOUND, SPL 12008 SPL IDENT. TENTATIVE	118 9	CDR	112.3	291.3	337.0
46-6833	Y	200	LRL SPLS 12010,12013, 12019 SPL IDENT TENTATIVE	118 16	CDR	140.8	307.6	180.0
46-6834	Y	202		118 16	CDR			0.0
46-6835	Y	203		118 16	CDR			
46-6836	Y	204	PANORAMA 6, STEREO (R) MIDDLE CRESCENT CTR	118 18	CDR	280.9	309.5	348.7
46-6837	Y	205	PAN 6	118 18	CDR	280.9	309.5	334.8
46-6838	Y	206	PAN 6	118 18	CDR	280.9	309.5	319.5
46-6839	Y	207	PAN 6	118 18	CDR	280.9	309.5	306.5
46-6840	Y	208	PAN 6	118 18	CDR	280.9	309.5	300.2
46-6841	Y	209	PAN 6	118 18	CDR	280.9	309.5	281.5
46-6842	Y	210	PAN 6	118 18	CDR	280.9	309.5	266.6
46-6843	Y	211	PAN 6	118 18	CDR	280.9	309.5	254.1
46-6844	Y	212	PAN 6	118 18	CDR	280.9	309.5	240.8
46-6845	Y	213	PANORAMA 7, STEREO (L) MIDDLE CRESCENT CTR	118 19	CDR	285.2	307.1	229.4
46-6846	Y	214	PAN 7	118 19	CDR	285.2	307.1	253.3
46-6847	Y	215	PAN 7	118 19	CDR	285.2	307.1	272.8
46-6848	Y	216	PAN 7	118 19	CDR	285.2	307.1	287.5
46-6849	Y	217	PAN 7	118 19	CDR	285.2	307.1	297.3
46-6850	Y	218	PAN 7	118 19	CDR	285.2	307.1	311.2
46-6851	Y	219	PAN 7	118 19	CDR	285.2	307.1	324.3
46-6852	Y	220	PAN 7	118 19	CDR	285.2	307.1	343.9

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
46-6853	Y	304	PANORAMA 11, L WINDOW		CDR	1.6	266.4	289.0
46-6854	Y	305	PAN 11		CDR	1.6	266.4	271.0
46-6855	Y	306	PAN 11		CDR	1.6	266.4	243.6
46-6856	Y	307	PAN 11		CDR	1.6	266.4	284.2
46-6857	Y	308	PAN 11		CDR	1.6	266.4	262.5
46-6858	Y	309	PAN 11		CDR	1.6	266.4	235.3
46-6859	Y	310	PAN 11		CDR	1.6	266.4	223.1
46-6860	Y	311	PAN 11		CDR	1.6	266.4	290.5
46-6861	Y	312	PANORAMA 11, R WINDOW		LMP	1.8	299.3	343.0
46-6862	Y	313	PAN 11		LMP	1.8	299.3	320.5
46-6863	Y	314	PAN 11		LMP	1.8	299.3	302.5
46-6864	Y	315	PAN 11		LMP	1.8	299.3	299.3
46-6865	Y	316	PAN 11		LMP	1.8	299.3	348.5
46-6866	Y	317	PAN 11		LMP	1.8	299.3	304.0
46-6867	Y	318	PAN 11		LMP	1.8	299.3	315.0
46-6868	Y	319	PAN 11		LMP	1.8	299.3	306.5
47-6869	V	1	TSIOLKOVSKY		CDR			
47-6870	V	2	TSIOLKOVSKY	107 23	CDR			
47-6871	V	3	EARTHRISE	107 38	LMP			
47-6872	V	4	EARTHRISE	107 38	LMP			
47-6873	V	5	EARTHRISE	107 38	LMP			
47-6874	V	6	EARTHRISE	107 38	LMP			
47-6875	V	7	COPERNICUS	108 8	LMP			
47-6876	V	8	COPERNICUS	108 8	LMP			
47-6877	V	9	CSM AFTER UNDOCKING	108 8	CDR			
47-6878	V	10	CSM AFTER UNDOCKING	108 8	CDR			
47-6879	V	11	EARTHRISE	109 38	LMP			
47-6880	V	12	EARTHRISE	109 38	LMP			
47-6881	V	13	EARTHRISE	109 38	LMP			
47-6882	V	14	EARTHRISE	109 38	LMP			
47-6883	V	15	EARTHRISE	109 38	LMP			
47-6884	V	16	EARTHRISE	109 38	LMP			
47-6885	V	17	EARTHRISE	109 38	LMP			
47-6886	V	18	EARTHRISE	109 38	LMP			
47-6887	V	19	EARTHRISE	109 38	LMP			
47-6888	V	20	EARTHRISE	109 38	LMP			
47-6889	V	21	EARTHRISE	109 38	LMP			
47-6890	V	22	EARTHRISE	109 38	LMP			
47-6891	V	23	EARTHRISE	109 38	LMP			
47-6892	V	24	EARTHRISE	109 38	LMP			
47-6893	V	25	EARTHRISE	109 38	LMP			
47-6894	V	26	EARTHRISE	109 38	LMP			
47-6895	V	27	EARTHRISE	109 38	LMP			
47-6896	V	55	SETTING UP FLAG	116 21	LMP	14.3	13.7	260.0
47-6897	V	56	SETTING UP FLAG	116 21	LMP	17.9	1.3	220.0
47-6898	V	57	SOLAR WIND COMP EXP	116 21	LMP	38.0	340.7	320.0
47-6899	V	58	SOLAR WIND COMP EXP, LM	116 21	LMP	43.1	341.6	165.0
47-6900	V	59	-Y PAD AREA	116 21	LMP	6.1	185.6	10.0
47-6901	V	60	-Y PAD AREA	116 21	LMP	7.1	210.6	10.0
47-6902	V	61	+Z PAD AREA (IN SHADOW)	116 21	LMP	6.8	304.8	180.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER

PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
47-6903	V	62	+Z PAD AREA (IN SHADOW)	116 21	LMP	5.3	317.3	180.0
47-6904	V	63	FRAMES 6904THRU 6907 ARE A STEREO 'FLIGHT LINE' OF THE +Y FOOT PAD AND ITS FIRST IMPACT POINT.	116 23	LMP	5.1	15.9	200.0
47-6905	V	64	+Y PAD AREA	116 23	LMP	5.2	41.1	200.0
47-6906	V	65	+Y PAD AREA	116 23	LMP	5.9	48.5	200.0
47-6907	V	66	+Y PAD AREA	116 23	LMP	6.1	61.8	200.0
47-6908	V	67	-Z PAD AREA	116 23	LMP	6.5	99.7	290.0
47-6909	V	68	-Z PAD AREA	116 23	LMP	5.8	111.2	290.0
47-6910	V	69	DPS AREA (WEAK STEREO)R	116 26	LMP	6.0	133.0	320.0
47-6911	V	70	DPS AREA (WEAK STEREO)L	116 26	LMP	5.6	154.8	320.0
47-6912	V	71	OPENING SEQ BAY	116 26	LMP	4.0	121.7	190.0
47-6913	V	72	OPENING SEQ BAY	116 26	LMP	4.0	121.7	190.0
47-6914	V	73	OPENING SEQ BAY	116 26	LMP	4.0	121.7	190.0
47-6915	V	74	-Z PAD AREA	116 26	LMP	4.1	174.4	55.0
47-6916	V	172	PASSIVE SEISMOMETER	118 4	LMP	126.9	315.7	180.0
47-6917	V	173	PASSIVE SEISMOMETER		LMP	123.4	315.4	330.0
47-6918	V	174	PSE,CENT.STA.,AND SWE		LMP	121.3	315.1	285.0
47-6919	V	175	CDR NEAR MAGNETOMETER		LMP	119.9	315.1	265.0
47-6920	V	176	MAGNETOMETER IN PLACE		LMP	109.5	311.0	335.0
47-6921	V	177	DEPLOYED ALSEP		LMP	102.6	310.0	335.0
47-6922	V	178	ION DET.(RT STEREO)		LMP	127.1	311.9	0.0
47-6923	V	179	ION DET.(LEFT STEREO)		LMP	127.9	311.6	0.0
47-6924	V	180	TOP OF ION DETECTOR		LMP	127.8	312.2	0.0
47-6925	V	181	TOP OF CENTRAL STATION		LMP	128.3	314.5	190.0
47-6926	V	182	CENTRAL STATION		LMP	128.3	314.5	190.0
47-6927	V	183	CENTRAL STATION		LMP	127.6	315.4	240.0
47-6928	V	184	CENT.STA,LM IN DISTANCE		LMP	128.3	314.5	135.0
47-6929	V	185	CENT.STA, SWE, MOUND		LMP	130.5	312.9	172.0
47-6930	V	186	CENT.STA, ION DETECTOR		LMP	128.3	314.5	210.0
47-6931	V	187	PSE, MAGNETOMETER	118 6	LMP	127.7	316.0	165.0
47-6932	V	192	CDR REACHING FOR SPL 12021	118 8	LMP	116.4	294.8	180.0
47-6933	V	195	TAKING SPL 12022 FROM MOUND. SPL IDENT. TENTATIVE	118 10	LMP	115.1	293.5	180.0
47-6934	V	196	SAMPLING AT LARGE MOUND	118 10	LMP	114.7	293.0	180.0
47-6935	V	197	LARGE MOUND, SPL NOT IDENTIFIED	118 11	LMP	115.7	292.8	180.0
47-6936	V	198	FRESH SECONDARY CRATERS LRL SPL 12004, SPL IDENT TENTATIVE	118 15	LMP	158.6	305.8	5.0
47-6937	V	199	SHOWS HORIZON N OF 47-6936	118 15	LMP	158.1	305.5	5.0
47-6938	V	201	'VALENTINE'	118 16	LMP			330.0
47-6939	V	221	FRESH CRATER, LRL SPL 12016, SPL IDENT TENTATIVE	118 22	LMP	252.3	303.4	335.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
47-6940	V	222	TONGS, LRL SPL 12014		LMP			
47-6941	V	223	PANORAMA 8, 10 METERS W OF LM	118 27	LMP	13.9	282.0	270.3
47-6942	V	224	PAN 8	118 27	LMP	13.9	282.0	251.9
47-6943	V	225	PAN 8	118 27	LMP	13.9	282.0	234.9
47-6944	V	226	PAN 8	118 27	LMP	13.9	282.0	214.5
47-6945	V	227	PAN 8	118 27	LMP	13.9	282.0	194.1
47-6946	V	228	PAN 8	118 27	LMP	13.9	282.0	176.7
47-6947	V	229	PAN 8	118 27	LMP	13.9	282.0	158.9
47-6948	V	230	PAN 8	118 27	LMP	13.9	282.0	144.5
47-6949	V	231	PAN 8	118 27	LMP	13.9	282.0	130.5
47-6950	V	232	PAN 8	118 27	LMP	13.9	282.0	105.2
47-6951	V	233	PAN 8	118 27	LMP	13.9	282.0	83.2
47-6952	V	234	PAN 8	118 27	LMP	13.9	282.0	69.5
47-6953	V	235	PAN 8	118 28	LMP	13.9	282.0	47.4
47-6954	V	236	PAN 8	118 28	LMP	13.9	282.0	35.5
47-6955	V	237	PAN 8	118 28	LMP	13.9	282.0	18.0
47-6956	V	238	PAN 8	118 28	LMP	13.9	282.0	2.8
47-6957	V	239	PAN 8	118 28	LMP	13.9	282.0	340.4
47-6958	V	240	PAN 8	118 28	LMP	13.9	282.0	317.5
47-6959	V	241	PAN 8	118 28	LMP	13.9	282.0	300.8
47-6960	V	242	PAN 8	118 28	LMP	13.9	282.0	295.8
47-6961	V	243	PANORAMA 9, 8 METERS E OF LM	118 29	LMP	11.8	105.2	289.8
47-6962	V	244	PAN 9	118 29	LMP	11.8	105.2	263.3
47-6963	V	245	PAN 9	118 29	LMP	11.8	105.2	242.8
47-6964	V	246	PAN 9	118 29	LMP	11.8	105.2	218.9
47-6965	V	247	PAN 9	118 29	LMP	11.8	105.2	205.4
47-6966	V	248	PAN 9	118 29	LMP	11.8	105.2	184.1
47-6967	V	249	PAN 9	118 29	LMP	11.8	105.2	170.1
47-6968	V	250	PAN 9	118 29	LMP	11.8	105.2	155.2
47-6969	V	251	PAN 9	118 29	LMP	11.8	105.2	138.7
47-6970	V	252	PAN 9	118 29	LMP	11.8	105.2	123.6
47-6971	V	253	PAN 9	118 29	LMP	11.8	105.2	107.3
47-6972	V	254	PAN 9	118 29	LMP	11.8	105.2	81.5
47-6973	V	255	PAN 9	118 30	LMP	11.8	105.2	62.1
47-6974	V	256	PAN 9	118 30	LMP	11.8	105.2	46.5
47-6975	V	257	PAN 9	118 30	LMP	11.8	105.2	36.8
47-6976	V	258	PAN 9	118 30	LMP	11.8	105.2	10.6
47-6977	V	259	PAN 9	118 30	LMP	11.8	105.2	356.4
47-6978	V	260	PAN 9	118 30	LMP	11.8	105.2	341.8
47-6979	V	261	PAN 9	118 30	LMP	11.8	105.2	327.8
47-6980	V	262	PAN 9	118 30	LMP	11.8	105.2	314.2
47-6981	V	263	PAN 9	118 30	LMP	11.8	105.2	302.0
47-6982	V	264	PANORAMA 10, 9 METERS NE OF LM	118 31	LMP	12.7	20.3	305.9
47-6983	V	265	PAN 10	118 31	LMP	12.7	20.3	291.7
47-6984	V	266	PAN 10	118 31	LMP	12.7	20.3	281.5
47-6985	V	267	PAN 10	118 31	LMP	12.7	20.3	268.0
47-6986	V	268	PAN 10	118 31	LMP	12.7	20.3	253.9

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
47-6987	V	269	PAN 10	118 31	LMP	12.7	20.3	239.0
47-6988	V	270	PAN 10	118 31	LMP	12.7	20.3	221.4
47-6989	V	271	PAN 10	118 31	LMP	12.7	20.3	206.7
47-6990	V	272	PAN 10	118 31	LMP	12.7	20.3	186.8
47-6991	V	273	PAN 10	118 31	LMP	12.7	20.3	166.5
47-6992	V	274	PAN 10	118 31	LMP	12.7	20.3	147.6
47-6993	V	275	PAN 10	118 31	LMP	12.7	20.3	141.9
47-6994	V	276	PAN 10	118 31	LMP	12.7	20.3	129.5
47-6995	V	277	PAN 10	118 31	LMP	12.7	20.3	113.1
47-6996	V	278	PAN 10	118 31	LMP	12.7	20.3	105.8
47-6997	V	279	PAN 10	118 31	LMP	12.7	20.3	87.9
47-6998	V	280	PAN 10	118 31	LMP	12.7	20.3	75.6
47-6999	V	281	PAN 10	118 31	LMP	12.7	20.3	55.7
47-7000	V	282	PAN 10	118 31	LMP	12.7	20.3	44.3
47-7001	V	283	PAN 10	118 31	LMP	12.7	20.3	30.2
47-7002	V	284	PAN 10	118 31	LMP	12.7	20.3	14.6
47-7003	V	285	PAN 10	118 31	LMP	12.7	20.3	4.3
47-7004	V	286	PAN 10	118 31	LMP	12.7	20.3	355.3
47-7005	V	287	PAN 10	118 31	LMP	12.7	20.3	338.4
47-7006	V	288	PAN 10	118 31	LMP	12.7	20.3	325.2
47-7007	V	289	LRL SPL 12026, CT 2013	118 36	LMP	19.0	33.2	20.0
47-7008	V	290	LRL SPL 12026, CT 2013	118 36	LMP	19.6	35.6	0.0
47-7009	V	291	CDR ENTERING LM	119 5	LMP			
47-7010	V	292	CDR ENTERING LM	119 5	LMP			
47-7011	V	293	PANORAMA 11, R WINDOW		LMP	1.8	299.3	286.0
47-7012	V	294	PAN 11		LMP	1.8	299.3	295.8
47-7013	V	295	PAN 11		LMP	1.8	299.3	306.6
47-7014	V	296	PAN 11		LMP	1.8	299.3	326.8
47-7015	V	297	PAN 11		LMP	1.8	299.3	347.2
47-7016	V	298	PAN 11		LMP	1.8	299.3	10.4
47-7017	V	299	PAN 11, (UNDEREXPOSED)		LMP	1.8	299.3	
47-7018	V	300	PAN 11		LMP	1.8	299.3	354.2
47-7019	V	301	PAN 11		LMP	1.8	299.3	333.8
47-7020	V	302	PAN 11		LMP	1.8	299.3	287.4
47-7021	V	303	PAN 11 (PARTIAL FRAME)		LMP	1.8	299.3	
48-7022	X	28	PANORAMA 1, L WINDOW (FOGGED)		CDR	1.6	266.4	216.2
48-7023	X	29	PAN 1		CDR	1.6	266.4	238.2
48-7024	X	30	PAN 1		CDR	1.6	266.4	270.5
48-7025	X	31	PAN 1		CDR	1.6	266.4	242.4
48-7026	X	32	PAN 1		CDR	1.6	266.4	264.5
48-7027	X	33	PAN 1		CDR	1.6	266.4	239.0
48-7028	X	34	PANORAMA 1, R WINDOW		LMP	1.8	299.3	295.5
48-7029	X	35	PAN 1		LMP	1.8	299.3	319.3
48-7030	X	36	PAN 1		LMP	1.8	299.3	350.2
48-7031	X	37	PAN 1		LMP	1.8	299.3	342.0
48-7032	X	38	PAN 1		LMP	1.8	299.3	324.0
48-7033	X	39	PAN 1		LMP	1.8	299.3	328.0
48-7034	X	320	'3.5 X 3.5'' ROCK'(DPS)	131 57	LMP	6.1	176.2	0.0
48-7035	X	321	NEAR DPS ENGINE	131 57	LMP	3.3	231.1	60.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
48-7036	X	322	STEP WEDGE DN SUN	131 57	LMP	30.3	351.3	292.0
48-7037	X	323	STEP WEDGE DN SUN	131 58	LMP	30.3	351.3	293.0
48-7038	X	324	STEP WEDGE IN SHADOW	131 58	LMP			
48-7039	X	325	STEP WEDGE IN SHADOW	131 58	LMP			
48-7040	X	326	STEP WEDGE IN SHADOW	131 58	LMP			
48-7041	X	327	SWC	131 59	LMP	38.7	342.5	294.0
48-7042	X	328	SWC	131 59	LMP	41.8	342.5	209.0
48-7043	X	334	GLASS IN CTR,N RIM HEAD LRL SPL 12030, FLD SPL 1D	132 13	LMP			
48-7044	X	335	GLASS IN CTR,N RIM HEAD LRL SPL 12030, FLD SPL 1D	132 13	LMP			
48-7045	X	336	GLASS IN CTR,N RIM HEAD LRL SPL 12030, FLD SPL 1D	132 13	LMP			
48-7046	X	340	N RIM OF HEAD CTR	132 15	LMP	150.9	273.4	252.0
48-7047	X	341	N RIM OF HEAD CTR	132 15	LMP	150.9	273.4	252.0
48-7048	X	351	'LIGHT COLOR WHEN DISTURBED', LRL SPL 12031,FLD SPL 3D	132 19	LMP			
48-7049	X	354	SHOWS PART OF TRENCH	132 19	LMP			
48-7050	X	355	POST SPL SHOT LRL SPL 12031, FLD SPL 3D	132 19	LMP			
48-7051	X	362	N RIM OF HEAD CTR LRL SPL 12033, FLD SPL 5D, LRL SPL 12034, FLD SPL 6D	132 26	LMP			
48-7052	X	363	N RIM OF HEAD CTR LRL SPL 12033, FLD SPL 5D	132 26	LMP			
48-7053	X	368	N RIM OF HEAD CTR DOWN-SUN,MOVED ROCK	132 27	LMP	185.8	272.7	250.0
48-7054	X	369	N RIM OF HEAD CTR DOWN-SUN,MOVED ROCK	132 27	LMP	185.8	272.7	255.0
48-7055	X	370	N RIM OF HEAD CTR DOWN-SUN,MOVED ROCK	132 27	LMP	185.8	272.7	255.0
48-7056	X	371	PANORAMA 12, E RIM OF TRIPLE CRATER	132 31	LMP	210.7	268.1	258.5
48-7057	X	372	PAN 12	132 31	LMP	210.7	268.1	280.3
48-7058	X	373	PAN 12	132 31	LMP	210.7	268.1	302.3
48-7059	X	390	'SHARP EDGE RK-TYPICAL' LRL SPL 12052 MOVED	132 33	LMP	222.1	255.1	225.0
48-7060	X	393	'FILLETS ON ALL SIDES'	132 35	LMP	232.7	248.6	255.0
48-7061	X	394	'FILLETS ON ALL SIDES'	132 35	LMP	233.1	248.3	240.0
48-7062	X	398	'FILLETS ON ALL SIDES'	132 35	LMP	236.7	249.5	170.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
48-7063	X	411	NW RIM OF BENCH CTR LRL SPL 12053 DOWN-SUN,MOVED	132 41	LMP	294.6	231.8	255.0
48-7064	X	414			LMP	310.8	232.5	
48-7065	X	442	'BLAST EFFECT' AT SHARP CTR,GNOMON AT TRENCH & CORE SITE	132 53	LMP	439.9	235.5	
48-7066	X	443	'BLAST EFFECT' AT SHARP CTR, GNOMON AT TRENCH & CORE SITE	132 53	LMP	439.9	235.5	
48-7067	X	444	DN-SUN OF TRENCH	132 53	LMP	439.9	235.5	
48-7068	X	460	DN-SUN CORE TUBE IN TRN LRL SPL 12027	132 56	LMP	439.9	235.5	
48-7069	X	461	DN-SUN CORE TUBE IN TRN LRL SPL 12027	132 56	LMP	439.9	235.5	
48-7070	X	465	DN-SUN,CT GONE (SHARP)	132 58	LMP	439.9	235.5	
48-7071	X	466	CONRAD (LM IN BACKGRND)	133 3	LMP	259.7	216.0	
48-7072	X	468	SW OF SURVEYOR CTR	133 8	LMP	186.5	198.3	210.0
48-7073	X	469	SW OF SURVEYOR CTR	133 8	LMP	186.5	198.3	205.0
48-7074	X	473	'NEW UNIT' (AREA OF LRL SPL 12042 FLD SPL 12D)	133 19	LMP	185.6	198.4	200.0
48-7075	X	474	'NEW UNIT' (AREA OF LRL SPL 12042 FLD SPL 12D)	133 20	LMP	185.6	198.4	170.0
48-7076	X	475	'NEW UNIT' (AREA OF LRL SPL 12042 FLD SPL 12D)	133 20	LMP	185.6	198.4	165.0
48-7077	X	478	LAST PHOTO FROM 1016 DOUBLE CT 1/3	133 33	LMP	244.5	183.4	220.0
48-7078	X	479	CAM FAILURE, FOGGED		LMP			
48-7079	X	480	FOGGED		LMP			
48-7080	X	481	FOGGED		LMP			
48-7081	X	482	FOGGED		LMP			
48-7082	X	521	MAG FROM 1016 CH TO 1002, LRL SPLS 12043 & 12044, FLD SPL 14D	133 46	LMP			
48-7083	X	522	'GLASS DUMBELL' LRL SPL 12043, FLD SPL 14D	133 53	LMP			
48-7084	X	523	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	7.0
48-7085	X	524	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	1.5
48-7086	X	525	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	357.5
48-7087	X	526	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	6.5
48-7088	X	527	30M S OF SURVEYOR	133 54	LMP	189.7	139.4	346.0
48-7089	X	528	30M S OF SURVEYOR	133 54	LMP	189.7	139.4	351.0
48-7090	X	529	30M S OF SURVEYOR	133 54	LMP	189.7	139.4	340.0
48-7091	X	530	SURVEYOR AND LM	133 55	LMP	188.5	134.5	322.0
48-7092	X	531	SURVEYOR AND LM	133 55	LMP	188.1	131.3	305.0
48-7093	X	532	SURVEYOR DOWN SUN	133 55	LMP	180.0	127.7	282.0
48-7094	X	533	SMSS,LM,AND BLOCK CTR	133 56	LMP	165.4	131.7	334.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER

PHOTOGRAPHS - Continued

PHOTO NO.		SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
48-7095	X	534	SURVEYOR	133 56	LMP	165.4	131.7	318.0
48-7096	X	535	SURVEYOR	133 56	LMP	165.4	131.7	290.0
48-7097	X	536	BLOCK CRATER	133 56	LMP	165.4	131.7	342.0
48-7098	X	537	ACCIDENTAL?	133 57	LMP			
48-7099	X	538	SURVEYOR AND LM	133 58	LMP	161.0	132.7	307.0
48-7100	X	539	SURVEYOR AND LM	133 58	LMP	161.0	132.7	309.0
48-7101	X	540	PANORAMA 20, NEAR SURVEYOR	134 2	LMP	158.1	133.1	38.1
48-7102	X	541	PAN 20	134 2	LMP	158.1	133.1	18.9
48-7103	X	542	PAN 20	134 2	LMP	158.1	133.1	1.6
48-7104	X	543	PAN 20	134 6	LMP	158.1	133.1	345.0
48-7105	X	544	PAN 20	134 6	LMP	158.1	133.1	340.4
48-7106	X	545	PHOTOS 7106 THRU 7109 SHOW THE SOIL MECH-ANICS SCOOP (SMSS) AND TRENCHED AREA. THEY CAN BE VIEWED STEREOSCOPICALLY IN VARIOUS COMBINATIONS	134 6	LMP	158.1	133.1	10.0
48-7107	X	546		134 6	LMP	158.1	133.1	12.0
48-7108	X	547		134 6	LMP	158.1	133.1	357.0
48-7109	X	548		134 7	LMP	158.1	133.1	1.0
48-7110	X	549	LEFT STEREO OF SURV-EYOR FOOTPAD 2 AREA.	134 7	LMP	158.8	133.4	
48-7111	X	550	RT STEREO OF PAD 2 AREA	134 7	LMP	158.8	133.4	
48-7112	X	551	LEFT STEREO AFTER OBL-ITERATING PAD 2 IMPRINT.	134 9	LMP	158.8	133.4	
48-7113	X	552	RT STEREO OF 7112	134 9	LMP	158.8	133.4	
48-7114	X	553	RADVS,COMP.A,FUEL TANK, VERNIER ENGINE 2,AND BASE OF LEG 2.	134 13	LMP	157.4	133.4	333.0
48-7115	X	554	LEFT STEREO OF ABOVE.	134 13	LMP	157.4	133.4	325.0
48-7116	X	555	LEFT STEREO OF 7115	134 13	LMP	157.4	133.4	322.0
48-7117	X	556	COMPARTMENT A	134 13	LMP	156.7	133.1	320.0
48-7118	X	557	COMP.A,RADVS,BASE OF LEG 1 AND OMNI A	134 13	LMP	156.0	133.4	342.0
48-7119	X	558	RT STEREO,PAD 1 AREA	134 14	LMP	155.3	133.6	342.0
48-7120	X	559	LEFT STEREO,PAD 1 AREA	134 14	LMP	155.3	133.6	42.0
48-7121	X	560	SURVEYOR	134 14	LMP	158.7	135.4	13.0
48-7122	X	561	SURVEYOR	134 14	LMP	158.7	135.4	7.0
48-7123	X	562	SURVEYOR	134 14	LMP	155.2	134.7	31.0
48-7124	X	563	W. SIDE OF PAD 3	134 14	LMP	153.2	132.8	80.0
48-7125	X	564	CANOPUS SENSOR	134 14	LMP	153.2	132.8	170.0
48-7126	X	565	R.STEREO,SMSS TRENCHES	134 14	LMP	156.8	132.1	180.0
48-7127	X	566	L. STEREO OF 7126	134 14	LMP	156.8	132.1	180.0
48-7128	X	567	R. STEREO,SMSS TRENCHES	134 15	LMP	156.8	132.1	180.0
48-7129	X	568	L.STEREO OF 7128	134 15	LMP	156.8	132.1	180.0
48-7130	X	569	SURVEYOR TV CAMERA	134 15	LMP	156.8	132.1	250.0
48-7131	X	570	STREAK IN DUST ON SUR-VEYOR CAMERA MIRROR.	134 15	LMP	156.8	132.1	244.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

[illegible]	MAG	SEQ	REMARKS	GET	BY	DIST	AZIM	AZ
48-7132	X	571	SIMILAR TO 7131	134 15	LMP	156.8	132.1	277.0
48-7133	X	572	CDR, SURVEYOR, AND LM	134 16	LMP	161.7	132.4	305.0
48-7134	X	573	R. STEREO OF 7133	134 16	LMP	161.7	132.4	307.0
48-7135	X	574	CDR, SURVEYOR, AND LM	134 16	LMP	158.2	132.1	297.0
48-7136	X	575	SAME AS 7135	134 16	LMP	158.2	132.1	298.0
48-7137	X	576	COMP.A WITH BENT HEAT REFLECTOR	134 28	LMP	156.8	132.6	237.0
48-7138	X	577	AUX. BATTERY WITH MARKS IN DUST	134 29	LMP	155.4	132.0	213.0
48-7139	X	578	VICINITY OF SURVEYOR LRL SPL 12062 SPL IDENT QUESTION- ABLE	134 33	LMP			
48-7140	X	579	PANORAMA 21, NEAR BLOCK CTR	134 39	LMP	113.8	95.1	202.4
48-7141	X	580	PAN 21	134 39	LMP	113.8	95.1	200.6
48-7142	X	581	PAN 21	134 39	LMP	113.8	95.1	227.4
48-7143	X	582	PAN 21	134 39	LMP	113.8	95.1	256.3
48-7144	X	583	PANORAMA 22, NEAR BLOCK CTR	134 39	LMP	109.8	94.7	173.2
48-7145	X	584	PAN 22	134 39	LMP	109.8	94.7	193.5
48-7146	X	585	PAN 22	134 39	LMP	109.8	94.7	217.9
48-7147	X	586	PAN 22	134 39	LMP	109.8	94.7	244.2
48-7148	X	587	N RIM OF BLOCK CTR LRL SPL 12045, FLD SPL 15D	134 40	LMP			
48-7149	X	588	N RIM OF BLOCK CTR LRL SPL 12045, FLD SPL 15D	134 40	LMP			
48-7150	X	589	N RIM OF BLOCK CTR LRL SPL 12045, 12046 & 12047, FLD SPL 15D	134 40	LMP			
48-7151	X	590	N RIM OF SURVEYOR CTR	134 43	LMP	116.4	141.5	262.0
48-7152	X	591	N RIM OF SURVEYOR CTR	134 43	LMP	116.4	141.5	268.0
48-7153	X	592	PANORAMA 23, L WINDOW		CDR	1.6	266.4	231.0
48-7154	X	593	PAN 23		CDR	1.6	266.4	243.2
48-7155	X	594	PAN 23		CDR	1.6	266.4	283.5
48-7156	X	595	PAN 23		CDR	1.6	266.4	252.0
48-7157	X	596	PAN 23		CDR	1.6	266.4	273.0
48-7158	X	597	PAN 23		CDR	1.6	266.4	259.0
48-7159	X	598	PANORAMA 23, R WINDOW		LMP	1.8	299.3	303.5
48-7160	X	599	PAN 23		LMP	1.8	299.3	337.5
48-7161	X	600	PAN 23		LMP	1.8	299.3	308.0
48-7162	X	601	PAN 23		LMP	1.8	299.3	1.5
48-7163	X	602	PAN 23		LMP	1.8	299.3	336.0
48-7164	X	603	PAN 23		LMP	1.8	299.3	4.5
48-7165	X	604	PAN 23		LMP	1.8	299.3	7.5
48-7166	X	605	PAN 23		LMP	1.8	299.3	347.3
48-7167	X	606	PAN 23		LMP	1.8	299.3	329.5
48-7168	X	607	PAN 23		LMP	1.8	299.3	315.3

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
48-7169	X	608	PAN 23		LMP	1.8	299.3	302.0
48-7170	X	609	PAN 23		LMP	1.8	299.3	291.6
48-7171	X	610	PAN 23		LMP	1.8	299.3	
49-7172	Z	329	FOGGED		CDR			
49-7173	Z	330	N RIM OF HEAD CTR, POLARIMETRY SURVEY	132 12	CDR	148.8	277.3	206.0
49-7174	Z	331	HEAD CTR POLAR SURVEY	132 12	CDR	148.8	277.3	206.0
49-7175	Z	332	HEAD CTR POLAR SURVEY	132 13	CDR	148.8	277.3	209.0
49-7176	Z	333	HEAD CTR POLAR SURVEY	132 13	CDR	148.8	277.3	209.0
49-7177	Z	337	HEAD CTR POLAR SURVEY	132 12	CDR	152.3	278.6	194.0
49-7178	Z	338	HEAD CTR POLAR SURVEY	132 14	CDR	152.3	278.6	196.0
49-7179	Z	339	HEAD CTR POLAR SURVEY	132 14	CDR	152.3	278.6	196.0
49-7180	Z	342	HEAD CTR POLAR SURVEY	132 15	CDR	152.3	278.6	195.0
49-7181	Z	343	HEAD CTR POLAR SURVEY	132 15	CDR	152.3	278.6	196.0
49-7182	Z	344	HEAD CTR POLAR SURVEY	132 15	CDR	152.3	278.6	196.0
49-7183	Z	345	HEAD CTR POLAR SURVEY	132 16	CDR	159.3	278.3	174.0
49-7184	Z	346	HEAD CTR POLAR SURVEY	132 16	CDR	159.3	278.3	175.0
49-7185	Z	347	HEAD CTR POLAR SURVEY	132 17	CDR	159.3	278.3	175.0
49-7186	Z	348	HEAD CTR POLAR SURVEY	132 17	CDR	163.7	276.6	149.0
49-7187	Z	349	HEAD CTR POLAR SURVEY	132 18	CDR	163.7	276.6	151.0
49-7188	Z	350	HEAD CTR POLAR SURVEY	132 18	CDR	163.7	276.6	150.0
49-7189	Z	352	N RIM OF HEAD CTR LRL SPL 12031, FLD SPL 3D	132 19	CDR			
49-7190	Z	353	N RIM OF HEAD CTR LRL SPL 12031, FLD SPL 3D	132 19	CDR			
49-7191	Z	356	TRENCH,X-SUN,HEAD CTR	132 20	CDR			
49-7192	Z	357	TRENCH,X-SUN LRL SPL 12033, FLD SPL 5D	132 20	CDR			
49-7193	Z	358	TRENCH,HEAD CTR		CDR			
49-7194	Z	359	N RIM OF HEAD CTR LRL SPL 12033, FLD SPL 5D	132 23	CDR			
49-7195	Z	360	N RIM OF HEAD CTR LRL SPL 12034, FLD SPL 6D	132 24	CDR			
49-7196	Z	361	N RIM OF HEAD CTR LRL SPL 12034, FLD SPL 6D	132 25	CDR			
49-7197	Z	364	'6 IN RK,LTR GRAY BOT' LRL SPL 12055 UNMOVED	132 27	CDR	185.8	272.7	140.0
49-7198	Z	365	'6 IN RK,LTR GRAY BOT' LRL SPL 12055 UNMOVED	132 27	CDR	185.8	272.7	130.0
49-7199	Z	366	N RIM OF HEAD CTR MOVED ROCK	132 27	CDR	185.8	272.7	180.0
49-7200	Z	367	N RIM OF HEAD CTR MOVED ROCK	132 27	CDR	185.8	272.7	170.0

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER

PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
49-7201	Z	374	PANORAMA 13,W RIM OF HEAD CRATER	132 32	CDR	222.2	254.1	133.5
49-7202	Z	375	PAN 13	132 32	CDR	222.2	254.1	158.2
49-7203	Z	376	PAN 13	132 32	CDR	222.2	254.1	178.4
49-7204	Z	377	PAN 13	132 32	CDR	222.2	254.1	204.2
49-7205	Z	378	PAN 13	132 32	CDR	222.2	254.1	226.6
49-7206	Z	379	PAN 13	132 32	CDR	222.2	254.1	246.8
49-7207	Z	380	PAN 13	132 32	CDR	222.2	254.1	267.8
49-7208	Z	381	PAN 13	132 32	CDR	222.2	254.1	293.9
49-7209	Z	382	PAN 13	132 32	CDR	222.2	254.1	309.9
49-7210	Z	383	PAN 13	132 32	CDR	222.2	254.1	341.0
49-7211	Z	384	PAN 13	132 32	CDR	222.2	254.1	3.1
49-7212	Z	385	PAN 13	132 32	CDR	222.2	254.1	19.3
49-7213	Z	386	PAN 13	132 32	CDR	222.2	254.1	53.3
49-7214	Z	387	PAN 13	132 32	CDR	222.2	254.1	71.5
49-7215	Z	388	PAN 13	132 32	CDR	222.2	254.1	91.0
49-7216	Z	389	PAN 13	132 33	CDR	222.2	254.1	115.2
49-7217	Z	391	'SHARP EDGE RK-TYPICAL' LRL SPL 12052 MOVED	132 33	CDR	224.0	255.2	328.0
49-7218	Z	392	'SHARP EDGE RK-TYPICAL' LRL SPL 12052	132 33	CDR	224.0	255.2	325.0
49-7219	Z	395	'FILLETS ON ALL SIDES'	132 35	CDR	239.4	248.4	340.0
49-7220	Z	396	'FILLETS ON ALL SIDES'	132 35	CDR	238.5	248.3	335.0
49-7221	Z	397	'FILLETS ON ALL SIDES'	132 35	CDR	239.4	247.1	346.0
49-7222	Z	399	'FILLETS ON ALL SIDES'	132 35	CDR	237.2	247.2	339.0
49-7223	Z	400	PANORAMA 14, N RIM OF BENCH CRATER	132 37	CDR	295.8	232.5	148.3
49-7224	Z	401	PAN 14	132 37	CDR	295.8	232.5	166.7
49-7225	Z	402	PAN 14	132 37	CDR	295.8	232.5	180.6
49-7226	Z	403	PAN 14	132 37	CDR	295.8	232.5	198.8
49-7227	Z	404	PAN 14	132 37	CDR	295.8	232.5	215.5
49-7228	Z	405	PAN 14	132 37	CDR	295.8	232.5	233.1
49-7229	Z	406	PANORAMA 15, N RIM OF BENCH CRATER	132 38	CDR	305.2	232.7	211.9
49-7230	Z	407	PAN 15	132 38	CDR	305.2	232.7	190.8
49-7231	Z	408	PAN 15	132 38	CDR	305.2	232.7	174.7
49-7232	Z	409	PAN 15	132 38	CDR	305.2	232.7	161.4
49-7233	Z	410	PAN 15	132 38	CDR	305.2	232.7	146.5
49-7234	Z	412	NW RIM OF BENCH CTR LRL SPL 12053 MOVED	132 41	CDR	294.0	232.0	180.0
49-7235	Z	413	NW RIM OF BENCH CTR LRL SPL 12053 MOVED	132 41	CDR	294.0	232.0	175.0
49-7236	Z	415	NW RIM OF BENCH CTR LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 43	CDR	310.8	232.5	

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER

PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
49-7237	Z	416	NW RIM OF BENCH CTR FRACTURED ROCK LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 43	CDR	310.8	232.5	
49-7238	Z	417	NW RIM OF BENCH CTR FRACTURED ROCK LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 45	CDR	310.8	232.5	
49-7239	Z	418	NW RIM OF BENCH CTR LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 45	CDR	310.8	232.5	
49-7240	Z	419	NW RIM OF BENCH CTR (AREA OF LRL SPLS 12038 FLD SPL 9D, LRL SPL 12039 FLD SPL 10D,LRL SPL 12040 FLD SPL 10D)	132 46	CDR	322.6	232.1	
49-7241	Z	420	NW RIM OF BENCH CTR (AREA OF LRL SPLS 12038 FLD SPL 90, LRL SPL 12039 FLD SPL 10D,LRL SPL 12040 FLD SPL 10D)	132 46	CDR	322.6	232.1	
49-7242	Z	421	BENCH CTR,SPLS MOVED LRL SPLS 12039 & 12040, FLD SPL 10D	132 48	CDR	322.6	232.1	
49-7243	Z	422	SCOOP MOVED LRL SPLS 12039 & 12040, FLD SPL 10D	132 48	CDR	322.6	232.1	
49-7244	Z	423	PANORAMA 16, NE OF SHARP CRATER	132 52	CDR	410.4	230.5	117.5
49-7245	Z	424	PAN 16	132 52	CDR	410.4	230.5	89.4
49-7246	Z	425	PAN 16	132 52	CDR	410.4	230.5	66.8
49-7247	Z	426	PAN 16	132 52	CDR	410.4	230.5	55.0
49-7248	Z	427	PAN 16	132 52	CDR	410.4	230.5	48.4
49-7249	Z	428	PAN 16	132 52	CDR	410.4	230.5	31.2
49-7250	Z	429	PAN 16	132 52	CDR	410.4	230.5	19.2
49-7251	Z	430	PAN 16	132 52	CDR	410.4	230.5	7.2
49-7252	Z	431	PAN 16	132 52	CDR	410.4	230.5	348.1
49-7253	Z	432	PAN 16	132 52	CDR	410.4	230.5	326.6
49-7254	Z	433	PAN 16	132 52	CDR	410.4	230.5	304.6
49-7255	Z	434	PAN 16	132 53	CDR	410.4	230.5	277.4
49-7256	Z	435	PAN 16	132 53	CDR	410.4	230.5	260.8
49-7257	Z	436	PAN 16	132 53	CDR	410.4	230.5	249.2

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER

PHOTOGRAPHS - Continued

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
49-7258	Z	437	PAN 16	132 53	CDR	410.4	230.5	218.3
49-7259	Z	438	PAN 16	132 53	CDR	410.4	230.5	200.1
49-7260	Z	439	PAN 16	132 53	CDR	410.4	230.5	179.0
49-7261	Z	440	PAN 16	132 53	CDR	410.4	230.5	157.2
49-7262	Z	441	PAN 16	132 53	CDR	410.4	230.5	138.2
49-7263	Z	445	PANORAMA 17, E RIM OF SHARP CRATER	132 54	CDR	441.4	235.0	311.3
49-7264	Z	446	PAN 17	132 54	CDR	441.4	235.0	299.6
49-7265	Z	447	PAN 17	132 54	CDR	441.4	235.0	289.9
49-7266	Z	448	PAN 17	132 54	CDR	441.4	235.0	272.3
49-7267	Z	449	PAN 17	132 54	CDR	441.4	235.0	254.2
49-7268	Z	450	PAN 17	132 54	CDR	441.4	235.0	243.4
49-7269	Z	451	PAN 17	132 54	CDR	441.4	235.0	224.0
49-7270	Z	452	PANORAMA 18, E RIM OF SHARP CRATER	132 54	CDR	443.9	234.8	238.0
49-7271	Z	453	PAN 18	132 54	CDR	443.9	234.8	251.4
49-7272	Z	454	PAN 18	132 54	CDR	443.9	234.8	260.8
49-7273	Z	455	PAN 18	132 54	CDR	443.9	234.8	285.3
49-7274	Z	456	PAN 18	132 54	CDR	443.9	234.8	305.2
49-7275	Z	457	PAN 18	132 54	CDR	443.9	234.8	322.2
49-7276	Z	458	X-SUN STEREO OF TRENCH	132 56	CDR	439.9	235.5	
49-7277	Z	459	X-SUN STEREO OF TRENCH	132 56	CDR	439.9	235.5	
49-7278	Z	462	LMP WITH LESC LRL SPL 12023	132 57	CDR	439.9	235.5	
49-7279	Z	463	X-SUN, CT2 IN TRN LRL SPL 12027	132 57	CDR	439.9	235.5	
49-7280	Z	464	X-SUN, CT2 IN TRN LRL SPL 12027	132 57	CDR	439.9	235.5	
49-7281	Z	467	BEAN	133 3	CDR	174.2	241.2	
49-7282	Z	470	SW OF SURVEYOR CTR	133 8	CDR	187.5	198.2	164.0
49-7283	Z	471	SW OF SURVEYOR CTR	133 8	CDR	187.5	198.2	164.0
49-7284	Z	472	SW OF SURVEYOR CTR	133 8	CDR	187.5	198.2	170.0
49-7285	Z	476	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 25	CDR	244.5	183.4	180.0
49-7286	Z	477	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 28	CDR	244.5	183.4	190.0
49-7287	Z	483	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 33	LMP	244.5	183.4	180.0
49-7288	Z	484	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 33	LMP	244.5	183.4	160.0
49-7289	Z	485	PANORAMA 19, SW OF SURVEYOR CRATER	133 35	LMP	239.5	183.3	254.2
49-7290	Z	486	PAN 19	133 35	LMP	239.5	183.3	232.2
49-7291	Z	487	PAN 19	133 35	LMP	239.5	183.3	209.7
49-7292	Z	488	PAN 19	133 35	LMP	239.5	183.3	186.9
49-7293	Z	489	PAN 19		LMP	239.5	183.3	165.0
49-7294	Z	490	PAN 19	133 35	LMP	239.5	183.3	143.1
49-7295	Z	491	PAN 19	133 35	LMP	239.5	183.3	133.4
49-7296	Z	492	PAN 19	133 35	LMP	239.5	183.3	116.7
49-7297	Z	493	PAN 19	133 35	LMP	239.5	183.3	100.7

TABLE D-I. - CHRONOLOGICAL SEQUENCE OF 70-MILLIMETER PHOTOGRAPHS - Concluded

PHOTO	MAG	SEQ	REMARKS	GET	BY	DIST	AZLM	AZ
49-7298	Z	494	PAN 19	133 35	LMP	239.5	183.3	83.1
49-7299	Z	495	PAN 19	133 36	LMP	239.5	183.3	65.1
49-7300	Z	496	PAN 19	133 36	LMP	239.5	183.3	48.0
49-7301	Z	497	PAN 19	133 36	LMP	239.5	183.3	31.3
49-7302	Z	498	PAN 19	133 36	LMP	239.5	183.3	19.7
49-7303	Z	499	PAN 19	133 36	LMP	239.5	183.3	9.5
49-7304	Z	500	PAN 19	133 36	LMP	239.5	183.3	353.0
49-7305	Z	501	PAN 19	133 36	LMP	239.5	183.3	337.1
49-7306	Z	502	PAN 19	133 36	LMP	239.5	183.3	325.0
49-7307	Z	503	PAN 19		LMP	239.5	183.3	308.6
49-7308	Z	504	PAN 19	133 36	LMP	239.5	183.3	290.4
49-7309	Z	505	PAN 19	133 36	LMP	239.5	183.3	283.7
49-7310	Z	506	PAN 19	133 36	LMP	239.5	183.3	265.5
49-7311	Z	507	PAN 19	133 36	LMP	239.5	183.3	257.5
49-7312	Z	508	SW OF SURVEYOR CTR FLD SPL 13D NOT RTND	133 39	LMP			
49-7313	Z	509	SW OF SURVEYOR CTR LRL SPL 12054	133 39	LMP			
49-7314	Z	510	SW OF SURVEYOR CTR LRL SPL 12054	133 39	LMP			
49-7315	Z	511	SW OF SURVEYOR CTR	133 39	LMP			
49-7316	Z	512	SW OF SURVEYOR CTR	133 39	LMP	191.1	181.1	1.0
49-7317	Z	513	SW OF SURVEYOR CTR	133 45	LMP	191.1	181.1	0.0
49-7318	Z	514	SW OF SURVEYOR CTR LRL SPL 12051	133 45	LMP	191.1	181.1	172.0
49-7319	Z	515	SW OF SURVEYOR CTR LRL SPL 12051	133 45	LMP	191.1	181.1	165.0
49-7320	Z	516	SW OF SURVEYOR CTR AFTER LRL SPL 12051	133 45	LMP	197.2	181.3	150.0
49-7321	Z	517	S RIM OF SURVEYOR CTR FOGGED		LMP	194.2	181.4	72.0
49-7322	Z	518	S RIM OF SURVEYOR CTR		LMP	194.2	181.4	66.0
49-7323	Z	519	S RIM OF SURVEYOR CTR FOGGED		LMP	194.2	181.4	52.0
49-7324	Z	520	S RIM OF SURVEYOR CTR FOGGED		LMP	194.2	181.4	59.0

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
1	47-6869	V	TSIOLKOVSKY		CDR			
2	47-6870	V	TSIOLKOVSKY	107 23	CDR			
3	47-6871	V	EARTHRISE	107 38	LMP			
4	47-6872	V	EARTHRISE	107 38	LMP			
5	47-6873	V	EARTHRISE	107 38	LMP			
6	47-6874	V	EARTHRISE	107 38	LMP			
7	47-6875	V	COPERNICUS	108 8	LMP			
8	47-6876	V	COPERNICUS	108 8	LMP			
9	47-6877	V	CSM AFTER UNDOCKING	108 8	CDR			
10	47-6878	V	CSM AFTER UNDOCKING	108 8	CDR			
11	47-6879	V	EARTHRISE	109 38	LMP			
12	47-6880	V	EARTHRISE	109 38	LMP			
13	47-6881	V	EARTHRISE	109 38	LMP			
14	47-6882	V	EARTHRISE	109 38	LMP			
15	47-6883	V	EARTHRISE	109 38	LMP			
16	47 6884	V	EARTHRISE	109 38	LMP			
17	47-6885	V	EARTHRISE	109 38	LMP			
18	47-6886	V	EARTHRISE	109 38	LMP			
19	47-6887	V	EARTHRISE	109 38	LMP			
20	47-6888	V	EARTHRISE	109 38	LMP			
21	47-6889	V	EARTHRISE	109 38	LMP			
22	47-6890	V	EARTHRISE	109 38	LMP			
23	47-6891	V	EARTHRISE	109 38	LMP			
24	47-6892	V	EARTHRISE	109 38	LMP			
25	47-6893	V	EARTHRISE	109 38	LMP			
26	47-6894	V	EARTHRISE	109 38	LMP			
27	47-6895	V	EARTHRISE	109 38	LMP			
28	48-7022	X	PANORAMA 1, L WINDOW (FOGGED)		CDR	1.6	266.4	216.2
29	48-7023	X	PAN 1		CDR	1.6	266.4	238.2
30	48-7024	X	PAN 1		CDR	1.6	266.4	270.5
31	48-7025	X	PAN 1		CDR	1.6	266.4	242.4
32	48-7026	X	PAN 1		CDR	1.6	266.4	264.5
33	48-7027	X	PAN 1		CDR	1.6	266.4	239.0
34	48-7028	X	PANORAMA 1, R WINDOW		LMP	1.8	299.3	295.5
35	48-7029	X	PAN 1		LMP	1.8	299.3	319.3
36	48-7030	X	PAN 1		LMP	1.8	299.3	350.2
37	48-7031	X	PAN 1		LMP	1.8	299.3	342.0
38	48-7032	X	PAN 1		LMP	1.8	299.3	324.0
39	48-7033	X	PAN 1		LMP	1.8	299.3	328.0
40	46-6715	Y	CDR ON PORCH	115 13	LMP			300.0
41	46-6716	Y	CDR ON PORCH	115 13	LMP			300.0
42	46-6717	Y	CDR ON PORCH	115 13	LMP			300.0
43	46-6718	Y	CDR ON PORCH	115 13	LMP			300.0
44	46-6719	Y	CONT SPL AREA	115 47	CDR	14.6	307.5	350.0
45	46-6720	Y	CONT SPL AREA	115 47	CDR	14.6	307.5	340.0
46	46-6721	Y	CONT SPL AREA	115 47	CDR	14.6	307.5	335.0
47	46-6722	Y	CONT SPL AREA	115 47	CDR	14.6	307.5	0.0
48	46-6723	Y	CONT SPL AREA	115 47	CDR	14.6	307.5	0.0
49	46-6724	Y	LMP ON PORCH	115 50	CDR	6.1	323.7	135.0
50	46-6725	Y	LMP ON PORCH		CDR	6.1	323.7	135.0

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
51	46-6726	Y	LMP ON LADDER	115 50	CDR	6.1	323.7	135.0
52	46-6727	Y	LMP ON LADDER	115 50	CDR	6.1	323.7	135.0
53	46-6728	Y	LMP ON LADDER	115 50	CDR	6.1	323.7	135.0
54	46-6729	Y	LMP ON SURFACE	115 50	CDR	6.1	323.7	135.0
55	47-6896	V	SETTING UP FLAG	116 21	LMP	14.3	13.7	260.0
56	47-6897	V	SETTING UP FLAG	116 21	LMP	17.9	1.3	220.0
57	47-6898	V	SOLAR WIND COMP EXP	116 21	LMP	38.0	340.7	320.0
58	47-6899	V	SOLAR WIND COMP EXP, LM	116 21	LMP	43.1	341.6	165.0
59	47-6900	V	-Y PAD AREA	116 21	LMP	6.1	185.6	10.0
60	47-6901	V	-Y PAD AREA	116 21	LMP	7.1	210.6	10.0
61	47-6902	V	+Z PAD AREA (IN SHADOW)	116 21	LMP	6.8	304.8	180.0
62	47-6903	V	+Z PAD AREA (IN SHADOW)	116 21	LMP	5.3	317.3	180.0
63	47-6904	V	FRAMES 6904THRU 6907 ARE A STEREO 'FLIGHT LINE' OF THE +Y FOOT PAD AND ITS FIRST IMPACT POINT.	116 23	LMP	5.1	15.9	200.0
64	47-6905	V	+Y PAD AREA	116 23	LMP	5.2	41.1	200.0
65	47-6906	V	+Y PAD AREA	116 23	LMP	5.9	48.5	200.0
66	47-6907	V	+Y PAD AREA	116 23	LMP	6.1	61.8	200.0
67	47-6908	V	-Z PAD AREA	116 23	LMP	6.5	99.7	290.0
68	47-6909	V	-Z PAD AREA	116 23	LMP	5.8	111.2	290.0
69	47-6910	V	DPS AREA (WEAK STEREO)R	116 26	LMP	6.0	133.0	320.0
70	47-6911	V	DPS AREA (WEAK STEREO)L	116 26	LMP	5.6	154.8	320.0
71	47-6912	V	OPENING SEQ BAY	116 26	LMP	4.0	121.7	190.0
72	47-6913	V	OPENING SEQ BAY	116 26	LMP	4.0	121.7	190.0
73	47-6914	V	OPENING SEQ BAY	116 26	LMP	4.0	121.7	190.0
74	47-6915	V	-Z PAD AREA	116 26	LMP	4.1	174.4	55.0
75	46-6730	Y	PANORAMA 2, 11 METERS W OF LM	116 22	CDR	14.9	281.2	251.5
76	46-6731	Y	PAN 2	116 22	CDR	14.9	281.2	276.0
77	46-6732	Y	PAN 2	116 22	CDR	14.9	281.2	294.6
78	46-6733	Y	PAN 2	116 22	CDR	14.9	281.2	313.0
79	46-6734	Y	PAN 2	116 22	CDR	14.9	281.2	339.2
80	46-6735	Y	PAN 2	116 22	CDR	14.9	281.2	350.9
81	46-6736	Y	PAN 2	116 22	CDR	14.9	281.2	10.7
82	46-6737	Y	PAN 2	116 23	CDR	14.9	281.2	34.3
83	46-6738	Y	PAN 2	116 23	CDR	14.9	281.2	57.8
84	46-6739	Y	PAN 2	116 23	CDR	14.9	281.2	81.1
85	46-6740	Y	PAN 2	116 23	CDR	14.9	281.2	118.4
86	46-6741	Y	PAN 2	116 23	CDR	14.9	281.2	144.4
87	46-6742	Y	PAN 2	116 23	CDR	14.9	281.2	165.9
88	46-6743	Y	PAN 2	116 23	CDR	14.9	281.2	164.4
89	46-6744	Y	PAN 2	116 23	CDR	14.9	281.2	191.5
90	46-6745	Y	PAN 2	116 24	CDR	14.9	281.2	215.5
91	46-6746	Y	PANORAMA 3, 11 METERS NE OF LM	116 24	CDR	15.4	33.1	144.0
92	46-6747	Y	PAN 3	116 24	CDR	15.4	33.1	168.4
93	46-6748	Y	PAN 3	116 24	CDR	15.4	33.1	187.6
94	46-6749	Y	PAN 3	116 24	CDR	15.4	33.1	211.9

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GFT	BY	DIST	AZLM	AZ
95	46-6750	Y	PAN 3	116 24	CDR	15.4	33.1	237.0
96	46-6751	Y	PAN 3	116 24	CDR	15.4	33.1	257.0
97	46-6752	Y	PAN 3	116 24	CDR	15.4	33.1	269.7
98	46-6753	Y	PAN 3	116 24	CDR	15.4	33.1	290.5
99	46-6754	Y	PAN 3	116 24	CDR	15.4	33.1	304.1
100	46-6755	Y	PAN 3	116 24	CDR	15.4	33.1	319.9
101	46-6756	Y	PAN 3	116 24	CDR	15.4	33.1	335.2
102	46-6757	Y	PAN 3	116 24	CDR	15.4	33.1	350.6
103	46-6758	Y	PAN 3	116 24	CDR	15.4	33.1	5.0
104	46-6759	Y	PAN 3	116 24	CDR	15.4	33.1	21.9
105	46-6760	Y	PAN 3	116 24	CDR	15.4	33.1	41.2
106	46-6761	Y	PAN 3	116 24	CDR	15.4	33.1	61.5
107	46-6762	Y	PAN 3	116 24	CDR	15.4	33.1	83.8
108	46-6763	Y	PAN 3	116 24	CDR	15.4	33.1	109.2
109	46-6764	Y	PANORAMA 4, 6 METERS SE OF LM	116 25	CDR	9.7	146.3	66.7
110	46-6765	Y	PAN 4	116 25	CDR	9.7	146.3	89.0
111	46-6766	Y	PAN 4	116 25	CDR	9.7	146.3	82.8
112	46-6767	Y	PAN 4	116 25	CDR	9.7	146.3	82.8
113	46-6768	Y	PAN 4	116 25	CDR	9.7	146.3	112.1
114	46-6769	Y	PAN 4	116 25	CDR	9.7	146.3	128.1
115	46-6770	Y	PAN 4	116 26	CDR	9.7	146.3	157.6
116	46-6771	Y	PAN 4	116 26	CDR	9.7	146.3	160.1
117	46-6772	Y	PAN 4	116 26	CDR	9.7	146.3	191.3
118	46-6773	Y	PAN 4	116 26	CDR	9.7	146.3	200.9
119	46-6774	Y	PAN 4	116 26	CDR	9.7	146.3	232.7
120	46-6775	Y	PAN 4	116 26	CDR	9.7	146.3	261.0
121	46-6776	Y	PAN 4	116 26	CDR	9.7	146.3	287.4
122	46-6777	Y	PAN 4	116 26	CDR	9.7	146.3	319.2
123	46-6778	Y	PAN 4	116 26	CDR	9.7	146.3	292.9
124	46-6779	Y	PAN 4	116 26	CDR	9.7	146.3	344.4
125	46-6780	Y	PAN 4	116 26	CDR	9.7	146.3	6.7
126	46-6781	Y	PAN 4	116 26	CDR	9.7	146.3	25.5
127	46-6782	Y	PAN 4	116 26	CDR	9.7	146.3	54.8
128	46-6783	Y	UNLOADING ALSEP FROM LM		CDR	7.6	122.6	285.0
129	46-6784	Y	SOLAR WIND SPECTROMETER		CDR	7.6	122.6	250.0
130	46-6785	Y	RTG		CDR	7.6	122.6	285.0
131	46-6786	Y	FUEL CAPSULE REMOVAL		CDR	6.0	133.0	330.0
132	46-6787	Y	FUEL CAPSULE REMOVAL		CDR	7.2	168.8	350.0
133	46-6788	Y	FUEL CAPSULE REMOVAL		CDR	7.2	168.8	350.0
134	46-6789	Y	FUEL CAPSULE REMOVAL		CDR	8.0	112.7	295.0
135	46-6790	Y	FUEL CAPSULE REMOVAL		CDR	8.0	112.7	295.0
136	46-6791	Y	PREP TO CARRY ALSEP		CDR	10.2	172.1	5.0
137	46-6792	Y	PREP TO CARRY ALSEP		CDR	10.2	172.1	5.0
138	46-6793	Y	LARGE MOUND,DOWN-SUN	116 55	CDR	93.5	296.6	274.0
139	46-6794	Y	LARGE MOUND, STEREO (L)	116 55	CDR	106.0	295.6	237.0
140	46-6795	Y	LARGE MOUND, STEREO (R)	116 55	CDR	107.8	296.4	250.0
141	46-6796	Y	PANORAMA 5, ALSEP AREA	116 55	CDR	116.4	305.7	248.1
142	46-6797	Y	PAN 5	116 55	CDR	116.4	305.7	274.6
143	46-6798	Y	PAN 5	116 55	CDR	116.4	305.7	299.1

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
144	46-6799	Y	PAN 5	116 55	CDR	116.4	305.7	326.2
145	46-6800	Y	PAN 5	116 55	CDR	116.4	305.7	347.5
146	46-6801	Y	PAN 5	116 55	CDR	116.4	305.7	13.6
147	46-6802	Y	PAN 5	116 55	CDR	116.4	305.7	30.7
148	46-6803	Y	PAN 5	116 55	CDR	116.4	305.7	50.6
149	46-6804	Y	PAN 5	116 55	CDR	116.4	305.7	72.5
150	46-6805	Y	PAN 5	116 55	CDR	116.4	305.7	89.0
151	46-6806	Y	PAN 5	116 55	CDR	116.4	305.7	110.5
152	46-6807	Y	PAN 5	116 55	CDR	116.4	305.7	138.7
153	46-6808	Y	PAN 5	116 55	CDR	116.4	305.7	163.7
154	46-6809	Y	PAN 5	116 55	CDR	116.4	305.7	181.7
155	46-6810	Y	PAN 5	116 55	CDR	116.4	305.7	210.3
156	46-6811	Y	PAN 5	116 55	CDR	116.4	305.7	233.3
157	46-6812	Y	SOLAR WIND EXP IN PLACE		CDR	122.9	311.8	310.0
158	46-6813	Y	MAGNETOMETER,LMP,AND LM		CDR	128.3	314.5	152.0
159	46-6814	Y	CENTRAL STATION		CDR	129.1	314.1	158.0
160	46-6815	Y	CENTRAL STATION		CDR	129.1	314.1	170.0
161	46-6816	Y	CENTRAL STATION		CDR	129.8	314.5	180.0
162	46-6817	Y	ALSEP IN PLACE		CDR	131.2	314.5	159.0
163	46-6818	Y	LMP AT ION DETECTOR		CDR	129.9	312.6	225.0
164	46-6819	Y	GLARE		CDR			
165	46-6820	Y	ALSEP IN PLACE		CDR	128.9	305.0	346.0
166	46-6821	Y	LMP AND ION DETECTOR		CDR	128.0	303.6	39.0
167	46-6822	Y	SMALL MOUND START OF SELECTED SAMPLE TRAVERSE	118 1	CDR	155.6	319.2	304.0
168	46-6823	Y	SMALL MOUND	118 1	CDR	156.5	320.0	294.0
169	46-6824	Y	SMALL MOUND	118 2	CDR	157.7	318.9	304.0
170	46-6825	Y	SMALL MOUND	118 2	CDR	157.8	319.4	295.0
171	46-6826	Y	LMP AT ALSEP	118 4	CDR	152.1	319.1	162.0
172	47-6916	V	PASSIVE SEISMOMETER	118 4	LMP	126.9	315.7	180.0
173	47-6917	V	PASSIVE SEISMOMETER		LMP	123.4	315.4	330.0
174	47-6918	V	PSE,CENT.STA.,AND SWE		LMP	121.3	315.1	285.0
175	47-6919	V	CDR NEAR MAGNETOMETER		LMP	119.9	315.1	265.0
176	47-6920	V	MAGNETOMETER IN PLACE		LMP	109.5	311.0	335.0
177	47-6921	V	DEPLOYED ALSEP		LMP	102.6	310.0	335.0
178	47-6922	V	ION DET.(RT STEREO)		LMP	127.1	311.9	0.0
179	47-6923	V	ION DET.(LEFT STEREO)		LMP	127.9	311.6	0.0
180	47-6924	V	TOP OF ION DETECTOR		LMP	127.8	312.2	0.0
181	47-6925	V	TOP OF CENTRAL STATION		LMP	128.3	314.5	190.0
182	47-6926	V	CENTRAL STATION		LMP	128.3	314.5	190.0
183	47-6927	V	CENTRAL STATION		LMP	127.6	315.4	240.0
184	47-6928	V	CENT.STA,LM IN DISTANCE		LMP	128.3	314.5	135.0
185	47-6929	V	CENT.STA, SWE, MOUND		LMP	130.5	312.9	172.0
186	47-6930	V	CENT.STA, ION DETECTOR		LMP	128.3	314.5	210.0
187	47-6931	V	PSE, MAGNETOMETER	118 6	LMP	127.7	316.0	165.0
188	46-6827	Y	APPROACHING LARGE MOUND	118 6	CDR	120.3	296.6	173.0
189	46-6828	Y	APPROACHING LARGE MOUND	118 6	CDR	121.3	295.3	165.0
190	46-6829	Y	'BIG ROCK' NW OF LARGE MOUND	118 6	CDR	121.3	295.3	197.0

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET		BY	DIST	AZLM	A7
191	46-6830	Y	'BIG ROCK' NW OF LARGE MOUND	118	6	CDR	121.3	294.3	187.0
192	47-6932	V	CDR REACHING FOR SPL 12021	118	8	LMP	116.4	294.8	180.0
193	46-6831	Y	LARGE MOUND, SPL 12008. SPL IDENT. TENTATIVE	118	9	CDR	113.2	291.2	337.0
194	46-6832	Y	LARGE MOUND, SPL 12008 SPL IDENT. TENTATIVE	118	9	CDR	112.3	291.3	337.0
195	47-6933	V	TAKING SPL 12022 FROM MOUND. SPL IDENT. TENTATIVE	118	10	LMP	115.1	293.5	180.0
196	47-6934	V	SAMPLING AT LARGE MOUND	118	10	LMP	114.7	293.0	180.0
197	47-6935	V	LARGE MOUND, SPL NOT IDENTIFIED	118	11	LMP	115.7	292.8	180.0
198	47-6936	V	FRESH SECONDARY CRATERS LRL SPL 12004, SPL IDENT TENTATIVE	118	15	LMP	158.6	305.8	5.0
199	47-6937	V	SHOWS HORIZON N OF 47-6936	118	15	LMP	158.1	305.5	5.0
200	46-6833	Y	LRL SPLS 12010,12013, 12019 SPL IDENT TENTATIVE	118	16	CDR	140.8	307.6	180.0
201	47-6938	V	'VALENTINE'	118	16	LMP			330.0
202	46-6834	Y		118	16	CDR			0.0
203	46-6835	Y		118	16	CDR			
204	46-6836	Y	PANORAMA 6, STEREO (R) MIDDLE CRESCENT CTR	118	18	CDR	280.9	309.5	348.7
205	46-6837	Y	PAN 6	118	18	CDR	280.9	309.5	334.8
206	46-6838	Y	PAN 6	118	18	CDR	280.9	309.5	319.5
207	46-6839	Y	PAN 6	118	18	CDR	280.9	309.5	306.5
208	46-6840	Y	PAN 6	118	18	CDR	280.9	309.5	300.2
209	46-6841	Y	PAN 6	118	18	CDR	280.9	309.5	281.5
210	46-6842	Y	PAN 6	118	18	CDR	280.9	309.5	266.6
211	46-6843	Y	PAN 6	118	18	CDR	280.9	309.5	254.1
212	46-6844	Y	PAN 6	118	18	CDR	280.9	309.5	240.8
213	46-6845	Y	PANORAMA 7, STEREO (L) MIDDLE CRESCENT CTR	118	19	CDR	285.2	307.1	229.4
214	46-6846	Y	PAN 7	118	19	CDR	285.2	307.1	253.3
215	46-6847	Y	PAN 7	118	19	CDR	285.2	307.1	272.8
216	46-6848	Y	PAN 7	118	19	CDR	285.2	307.1	287.5
217	46-6849	Y	PAN 7	118	19	CDR	285.2	307.1	297.3
218	46-6850	Y	PAN 7	118	19	CDR	285.2	307.1	311.2
219	46-6851	Y	PAN 7	118	19	CDR	285.2	307.1	324.3
220	46-6852	Y	PAN 7	118	19	CDR	285.2	307.1	343.9
221	47-6939	V	FRESH CRATER, LRL SPL 12016, SPL IDENT TENTATIVE	118	22	LMP	252.3	303.4	335.0
222	47-6940	V	TONGS, LRL SPL 12014			LMP			
223	47-6941	V	PANORAMA 8, 10 METERS W OF LM	118	27	LMP	13.9	282.0	270.3

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
224	47-6942	V	PAN 8	118 27	LMP	13.9	282.0	251.9
225	47-6943	V	PAN 8	118 27	LMP	13.9	282.0	234.9
226	47-6944	V	PAN 8	118 27	LMP	13.9	282.0	214.5
227	47-6945	V	PAN 8	118 27	LMP	13.9	282.0	194.1
228	• 47-6946	V	PAN 8	118 27	LMP	13.9	282.0	176.7
229	47-6947	V	PAN 8	118 27	LMP	13.9	282.0	158.9
230	47-6948	V	PAN 8	118 27	LMP	13.9	282.0	144.5
231	47-6949	V	PAN 8	118 27	LMP	13.9	282.0	130.5
232	47-6950	V	PAN 8	118 27	LMP	13.9	282.0	105.2
233	47-6951	V	PAN 8	118 27	LMP	13.9	282.0	83.2
234	47-6952	V	PAN 8	118 27	LMP	13.9	282.0	69.5
235	47-6953	V	PAN 8	118 28	LMP	13.9	282.0	47.4
236	47-6954	V	PAN 8	118 28	LMP	13.9	282.0	35.5
237	47-6955	V	PAN 8	118 28	LMP	13.9	282.0	18.0
238	47-6956	V	PAN 8	118 28	LMP	13.9	282.0	2.8
239	47-6957	V	PAN 8	118 28	LMP	13.9	282.0	340.4
240	47-6958	V	PAN 8	118 28	LMP	13.9	282.0	317.5
241	47-6959	V	PAN 8	118 28	LMP	13.9	282.0	300.8
242	47-6960	V	PAN 8	118 28	LMP	13.9	282.0	295.8
243	47-6961	V	PANORAMA 9, 8 METERS E OF LM	118 29	LMP	11.8	105.2	289.8
244	47-6962	V	PAN 9	118 29	LMP	11.8	105.2	263.3
245	47-6963	V	PAN 9	118 29	LMP	11.8	105.2	242.8
246	47-6964	V	PAN 9	118 29	LMP	11.8	105.2	218.9
247	47-6965	V	PAN 9	118 29	LMP	11.8	105.2	205.4
248	47-6966	V	PAN 9	118 29	LMP	11.8	105.2	184.1
249	47-6967	V	PAN 9	118 29	LMP	11.8	105.2	170.1
250	47-6968	V	PAN 9	118 29	LMP	11.8	105.2	155.2
251	47-6969	V	PAN 9	118 29	LMP	11.8	105.2	138.7
252	47-6970	V	PAN 9	118 29	LMP	11.8	105.2	123.6
253	47-6971	V	PAN 9	118 29	LMP	11.8	105.2	107.3
254	47-6972	V	PAN 9	118 29	LMP	11.8	105.2	81.5
255	47-6973	V	PAN 9	118 30	LMP	11.8	105.2	62.1
256	47-6974	V	PAN 9	118 30	LMP	11.8	105.2	46.5
257	47-6975	V	PAN 9	118 30	LMP	11.8	105.2	36.8
258	47-6976	V	PAN 9	118 30	LMP	11.8	105.2	10.6
259	47-6977	V	PAN 9	118 30	LMP	11.8	105.2	356.4
260	47-6978	V	PAN 9	118 30	LMP	11.8	105.2	341.8
261	47-6979	V	PAN 9	118 30	LMP	11.8	105.2	327.8
262	47-6980	V	PAN 9	118 30	LMP	11.8	105.2	314.2
263	47-6981	V	PAN 9	118 30	LMP	11.8	105.2	302.0
264	47-6982	V	PANORAMA 10, 9 METERS NE OF LM	118 31	LMP	12.7	20.3	305.9
265	47-6983	V	PAN 10	118 31	LMP	12.7	20.3	291.7
266	47-6984	V	PAN 10	118 31	LMP	12.7	20.3	281.5
267	47-6985	V	PAN 10	118 31	LMP	12.7	20.3	268.0
268	47-6986	V	PAN 10	118 31	LMP	12.7	20.3	253.9
269	47-6987	V	PAN 10	118 31	LMP	12.7	20.3	239.0
270	47-6988	V	PAN 10	118 31	LMP	12.7	20.3	221.4
271	47-6989	V	PAN 10	118 31	LMP	12.7	20.3	206.7

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
272	47-6990	V	PAN 10	118 31	LMP	12.7	20.3	166.8
273	47-6991	V	PAN 10	118 31	LMP	12.7	20.3	166.5
274	47-6992	V	PAN 10	118 31	LMP	12.7	20.3	147.6
275	47-6993	V	PAN 10	118 31	LMP	12.7	20.3	141.9
276	47-6994	V	PAN 10	118 31	LMP	12.7	20.3	129.5
277	47-6995	V	PAN 10	118 31	LMP	12.7	20.3	113.1
278	47-6996	V	PAN 10	118 31	LMP	12.7	20.3	105.8
279	47-6997	V	PAN 10	118 31	LMP	12.7	20.3	87.9
280	47-6998	V	PAN 10	118 31	LMP	12.7	20.3	75.6
281	47-6999	V	PAN 10	118 31	LMP	12.7	20.3	55.7
282	47-7000	V	PAN 10	118 31	LMP	12.7	20.3	44.3
283	47-7001	V	PAN 10	118 31	LMP	12.7	20.3	30.2
284	47-7002	V	PAN 10	118 31	LMP	12.7	20.3	14.6
285	47-7003	V	PAN 10	118 31	LMP	12.7	20.3	4.3
286	47-7004	V	PAN 10	118 31	LMP	12.7	20.3	355.3
287	47-7005	V	PAN 10	118 31	LMP	12.7	20.3	338.4
288	47-7006	V	PAN 10	118 31	LMP	12.7	20.3	325.2
289	47-7007	V	LRL SPL 12026, CT 2013	118 36	LMP	19.0	33.2	20.0
290	47-7008	V	LRL SPL 12026, CT 2013	118 36	LMP	19.6	35.6	0.0
291	47-7009	V	CDR ENTERING LM	119 5	LMP			
292	47-7010	V	CDR ENTERING LM	119 5	LMP			
293	47-7011	V	PANORAMA 11, R WINDOW		LMP	1.8	299.3	286.0
294	47-7012	V	PAN 11		LMP	1.8	299.3	295.8
295	47-7013	V	PAN 11		LMP	1.8	299.3	306.6
296	47-7014	V	PAN 11		LMP	1.8	299.3	326.8
297	47-7015	V	PAN 11		LMP	1.8	299.3	347.2
298	47-7016	V	PAN 11		LMP	1.8	299.3	10.4
299	47-7017	V	PAN 11, (UNDEREXPOSED)		LMP	1.8	299.3	
300	47-7018	V	PAN 11		LMP	1.8	299.3	354.2
301	47-7019	V	PAN 11		LMP	1.8	299.3	333.8
302	47-7020	V	PAN 11		LMP	1.8	299.3	287.4
303	47-7021	V	PAN 11 (PARTIAL FRAME)		LMP	1.8	299.3	
304	46-6853	Y	PANORAMA 11, L WINDOW		CDR	1.6	266.4	289.0
305	46-6854	Y	PAN 11		CDR	1.6	266.4	271.0
306	46-6855	Y	PAN 11		CDR	1.6	266.4	243.6
307	46-6856	Y	PAN 11		CDR	1.6	266.4	284.2
308	46-6857	Y	PAN 11		CDR	1.6	266.4	262.5
309	46-6858	Y	PAN 11		CDR	1.6	266.4	235.3
310	46-6859	Y	PAN 11		CDR	1.6	266.4	223.1
311	46-6860	Y	PAN 11		CDR	1.6	266.4	290.5
312	46-6861	Y	PANORAMA 11, R WINDOW		LMP	1.8	299.3	343.0
313	46-6862	Y	PAN 11		LMP	1.8	299.3	320.5
314	46-6863	Y	PAN 11		LMP	1.8	299.3	302.5
315	46-6864	Y	PAN 11		LMP	1.8	299.3	299.3
316	46-6865	Y	PAN 11		LMP	1.8	299.3	348.5
317	46-6866	Y	PAN 11		LMP	1.8	299.3	304.0
318	46-6867	Y	PAN 11		LMP	1.8	299.3	315.0
319	46-6868	Y	PAN 11		LMP	1.8	299.3	306.5

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
320	48-7034	X	'3.5 X 3.5'' ROCK'(DPS)	131 57	LMP	6.1	176.2	0.0
321	48-7035	X	NEAR DPS ENGINE	131 57	LMP	3.3	231.1	60.0
322	48-7036	X	STEP WEDGE ON SUN	131 57	LMP	30.3	351.3	292.0
323	48-7037	X	STEP WEDGE ON SUN	131 58	LMP	30.3	351.3	293.0
324	48-7038	X	STEP WEDGE IN SHADOW	131 58	LMP			
325	48-7039	X	STEP WEDGE IN SHADOW	131 58	LMP			
326	48-7040	X	STEP WEDGE IN SHADOW	131 58	LMP			
327	48-7041	X	SWC	131 59	LMP	38.7	342.5	294.0
328	48-7042	X	SWC	131 59	LMP	41.8	342.5	209.0
329	49-7172	Z	FOGGED		CDR			
330	49-7173	Z	N RIM OF HEAD CTR, POLARIMETRY SURVEY	132 12	CDR	148.8	277.3	206.0
331	49-7174	Z	HEAD CTR POLAR SURVEY	132 12	CDR	148.8	277.3	206.0
332	49-7175	Z	HEAD CTR POLAR SURVEY	132 13	CDR	148.8	277.3	209.0
333	49-7176	Z	HEAD CTR POLAR SURVEY	132 13	CDR	148.8	277.3	209.0
334	48-7043	X	GLASS IN CTR,N RIM HEAD LRL SPL 12030, FLD SPL 1D	132 13	LMP			
335	48-7044	X	GLASS IN CTR,N RIM HEAD LRL SPL 12030, FLD SPL 1D	132 13	LMP			
336	48-7045	X	GLASS IN CTR,N RIM HEAD LRL SPL 12030, FLD SPL 1D	132 13	LMP			
337	49-7177	Z	HEAD CTR POLAR SURVEY	132 12	CDR	152.3	278.6	194.0
338	49-7178	Z	HEAD CTR POLAR SURVEY	132 14	CDR	152.3	278.6	196.0
339	49-7179	Z	HEAD CTR POLAR SURVEY	132 14	CDR	152.3	278.6	196.0
340	48-7046	X	N RIM OF HEAD CTR	132 15	LMP	150.9	273.4	252.0
341	48-7047	X	N RIM OF HEAD CTR	132 15	LMP	150.9	273.4	252.0
342	49-7180	Z	HEAD CTR POLAR SURVEY	132 15	CDR	152.3	278.6	195.0
343	49-7181	Z	HEAD CTR POLAR SURVEY	132 15	CDR	152.3	278.6	196.0
344	49-7182	Z	HEAD CTR POLAR SURVEY	132 15	CDR	152.3	278.6	196.0
345	49-7183	Z	HEAD CTR POLAR SURVEY	132 16	CDR	159.3	278.3	174.0
346	49-7184	Z	HEAD CTR POLAR SURVEY	132 16	CDR	159.3	278.3	175.0
347	49-7185	Z	HEAD CTR POLAR SURVEY	132 17	CDR	159.3	278.3	175.0
348	49-7186	Z	HEAD CTR POLAR SURVEY	132 17	CDR	163.7	276.6	149.0
349	49-7187	Z	HEAD CTR POLAR SURVEY	132 18	CDR	163.7	276.6	151.0
350	49-7188	Z	HEAD CTR POLAR SURVEY	132 18	CDR	163.7	276.6	150.0
351	48-7048	X	'LIGHT COLOR WHEN DISTURBED', LRL SPL 12031,FLD SPL 3D	132 19	LMP			
352	49-7189	Z	N RIM OF HEAD CTR LRL SPL 12031, FLD SPL 3D	132 19	CDR			
353	49-7190	Z	N RIM OF HEAD CTR LRL SPL 12031, FLD SPL 3D	132 19	CDR			
354	48-7049	X	SHOWS PART OF TRENCH	132 19	LMP			
355	48-7050	X	POST SPL SHOT LRL SPL 12031, FLD SPL 3D	132 19	LMP			

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
356	49-7191	Z	TRENCH, X-SUN, HEAD CTR	132 20	CDR			
357	49-7192	Z	TRENCH, X-SUN LRL SPL 12033, FLD SPL 5D	132 20	CDR			
358	49-7193	Z	TRENCH, HEAD CTR		CDR			
359	49-7194	Z	N RIM OF HEAD CTR LRL SPL 12033, FLD SPL 5D	132 23	CDR			
360	49-7195	Z	N RIM OF HEAD CTR LRL SPL 12034, FLD SPL 6D	132 24	CDR			
361	49-7196	Z	N RIM OF HEAD CTR LRL SPL 12034, FLD SPL 6D	132 25	CDR			
362	48-7051	X	N RIM OF HEAD CTR LRL SPL 12033, FLD SPL 5D, LRL SPL 12034, FLD SPL 6D	132 26	LMP			
363	48-7052	X	N RIM OF HEAD CTR LRL SPL 12033, FLD SPL 5D	132 26	LMP			
364	49-7197	Z	'6 IN RK, LTR GRAY BOT' LRL SPL 12055 UNMOVED	132 27	CDR	185.8	272.7	140.0
365	49-7198	Z	'6 IN RK, LTR GRAY BOT' LRL SPL 12055 UNMOVED	132 27	CDR	185.8	272.7	130.0
366	49-7199	Z	N RIM OF HEAD CTR MOVED ROCK	132 27	CDR	185.8	272.7	180.0
367	49-7200	Z	N RIM OF HEAD CTR MOVED ROCK	132 27	CDR	185.8	272.7	170.0
368	48-7053	X	N RIM OF HEAD CTR DOWN-SUN, MOVED ROCK	132 27	LMP	185.8	272.7	250.0
369	48-7054	X	N RIM OF HEAD CTR DOWN-SUN, MOVED ROCK	132 27	LMP	185.8	272.7	255.0
370	48-7055	X	N RIM OF HEAD CTR DOWN-SUN, MOVED ROCK	132 27	LMP	185.8	272.7	255.0
371	48-7056	X	PANORAMA 12, E RIM OF TRIPLE CRATER	132 31	LMP	210.7	268.1	258.5
372	48-7057	X	PAN 12	132 31	LMP	210.7	263.1	280.3
373	48-7058	X	PAN 12	132 31	LMP	210.7	268.1	302.3
374	49-7201	Z	PANORAMA 13, W RIM OF HEAD CRATER	132 32	CDR	222.2	254.1	133.5
375	49-7202	Z	PAN 13	132 32	CDR	222.2	254.1	158.2
376	49-7203	Z	PAN 13	132 32	CDR	222.2	254.1	178.4
377	49-7204	Z	PAN 13	132 32	CDR	222.2	254.1	204.2
378	49-7205	Z	PAN 13	132 32	CDR	222.2	254.1	226.6
379	49-7206	Z	PAN 13	132 32	CDR	222.2	254.1	246.8
380	49-7207	Z	PAN 13	132 32	CDR	222.2	254.1	267.8
381	49-7208	Z	PAN 13	132 32	CDR	222.2	254.1	293.9

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
382	49-7209	Z	PAN 13	132 32	CDR	222.2	254.1	309.9
383	49-7210	Z	PAN 13	132 32	CDR	222.2	254.1	341.0
384	49-7211	Z	PAN 13	132 32	CDR	222.2	254.1	3.1
385	49-7212	Z	PAN 13	132 32	CDR	222.2	254.1	19.3
386	49-7213	Z	PAN 13	132 32	CDR	222.2	254.1	53.3
387	49-7214	Z	PAN 13	132 32	CDR	222.2	254.1	71.5
388	49-7215	Z	PAN 13	132 32	CDR	222.2	254.1	91.0
389	49-7216	Z	PAN 13	132 33	CDR	222.2	254.1	115.2
390	48-7059	X	'SHARP EDGE RK-TYPICAL' LRL SPL 12052 MOVED	132 33	LMP	222.1	255.1	225.0
391	49-7217	Z	'SHARP EDGE RK-TYPICAL' LRL SPL 12052 MOVED	132 33	CDR	224.0	255.2	328.0
392	49-7218	Z	'SHARP EDGE RK-TYPICAL' LRL SPL 12052	132 33	CDR	224.0	255.2	325.0
393	48-7060	X	'FILLETS ON ALL SIDES'	132 35	LMP	232.7	248.6	255.0
3[illegible]	48-7061	X	'FILLETS ON ALL SIDES'	132 35	LMP	233.1	248.3	240.0
3[illegible]	49-7219	Z	'FILLETS ON ALL SIDES'	132 35	CDR	239.4	248.4	340.0
396	49-7220	Z	'FILLETS ON ALL SIDES'	132 35	CDR	238.5	248.3	335.0
397	49-7221	Z	'FILLETS ON ALL SIDES'	132 35	CDR	239.4	247.1	346.0
398	48-7062	X	'FILLETS ON ALL SIDES'	132 35	LMP	236.7	249.5	170.0
399	49-7222	Z	'FILLETS ON ALL SIDES'	132 35	CDR	237.2	247.2	339.0
400	49-7223	Z	PANORAMA 14, N RIM OF BENCH CRATER	132 37	CDR	295.8	232.5	148.3
401	49-7224	Z	PAN 14	132 37	CDR	295.8	232.5	166.7
402	49-7225	Z	PAN 14	132 37	CDR	295.8	232.5	180.6
403	49-7226	Z	PAN 14	132 37	CDR	295.8	232.5	198.8
404	49-7227	Z	PAN 14	132 37	CDR	295.8	232.5	215.5
405	49-7228	Z	PAN 14	132 37	CDR	295.8	232.5	233.1
406	49-7229	Z	PANORAMA 15, N RIM OF BENCH CRATER	132 38	CDR	305.2	232.7	211.9
	49-7230	Z	PAN 15	132 38	CDR	305.2	232.7	190.8
408	49-7231	Z	PAN 15	132 38	CDR	305.2	232.7	174.7
409	49-7232	Z	PAN 15	132 38	CDR	305.2	232.7	161.4
410	49-7233	Z	PAN 15	132 38	CDR	305.2	232.7	146.5
411	48-7063	X	NW RIM OF BENCH CTR LRL SPL 12053 DOWN-SUN,MOVED	132 41	LMP	294.6	231.8	255.0
412	49-7234	Z	NW RIM OF BENCH CTR LRL SPL 12053 MOVED	132 41	CDR	294.0	232.0	180.0
413	49-7235	Z	NW RIM OF BENCH CTR LRL SPL 12053 MOVED	132 41	CDR	294.0	232.0	175.0
414	48-7064	X			LMP	310.8	232.5	
415	49-7236	Z	NW RIM OF BENCH CTR LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 43	CDR	310.8	232.5	

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
416	49-7237	Z	NW RIM OF BENCH CTR FRACTURED ROCK LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 43	CDR	310.8	232.5	
417	49-7238	Z	NW RIM OF BENCH CTR FRACTURED ROCK LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 45	CDR	310.8	232.5	
418	49-7239	Z	NW RIM OF BENCH CTR LRL SPL 12035, FLD SPL 7D, LRL SPLS 12036 & 12037, FLD SPL 8D	132 45	CDR	310.8	232.5	
419	49-7240	Z	NW RIM OF BENCH CTR (AREA OF LRL SPLS 12038 FLD SPL 9D, LRL SPL 12039 FLD SPL 10D,LRL SPL 12040 FLD SPL 10D)	132 46	CDR	322.6	232.1	
420	49-7241	Z	NW RIM OF BENCH CTR (AREA OF LRL SPLS 12038 FLD SPL 9D, LRL SPL 12039 FLD SPL 10D,LRL SPL 12040 FLD SPL 10D)	132 46	CDR	322.6	232.1	
421	49-7242	Z	BENCH CTR,SPLS MOVED LRL SPLS 12039 & 12040, FLD SPL 10D	132 48	CDR	322.6	232.1	
422	49-7243	Z	SCOOP MOVED LRL SPLS 12039 & 12040, FLD SPL 10D	132 48	CDR	322.6	232.1	
423	49-7244	Z	PANORAMA 16, NE OF SHARP CRATER	132 52	CDR	410.4	230.5	117.5
424	49-7245	Z	PAN 16	132 52	CDR	410.4	230.5	89.4
425	49-7246	Z	PAN 16	132 52	CDR	410.4	230.5	66.8
426	49-7247	Z	PAN 16	132 52	CDR	410.4	230.5	55.0
427	49-7248	Z	PAN 16	132 52	CDR	410.4	230.5	48.4
428	49-7249	Z	PAN 16	132 52	CDR	410.4	230.5	31.2
429	49-7250	Z	PAN 16	132 52	CDR	410.4	230.5	19.2
430	49-7251	Z	PAN 16	132 52	CDR	410.4	230.5	7.2
431	49-7252	Z	PAN 16	132 52	CDR	410.4	230.5	348.1
432	49-7253	Z	PAN 16	132 52	CDR	410.4	230.5	326.6
433	49-7254	Z	PAN 16	132 52	CDR	410.4	230.5	304.6
434	49-7255	Z	PAN 16	132 53	CDR	410.4	230.5	277.4
435	49-7256	Z	PAN 16	132 53	CDR	410.4	230.5	260.8
436	49-7257	Z	PAN 16	132 53	CDR	410.4	230.5	249.2

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
437	49-7258	Z	PAN 16	132 53	CDR	410.4	230.5	218.3
438	49-7259	Z	PAN 16	132 53	CDR	410.4	230.5	200.1
439	49-7260	Z	PAN 16	132 53	CDR	410.4	230.5	179.0
440	49-7261	Z	PAN 16	132 53	CDR	410.4	230.5	157.2
441	49-7262	Z	PAN 16	132 53	CDR	410.4	230.5	138.2
442	48-7065	X	'BLAST EFFECT' AT SHARP CTR,GNOMON AT TRENCH & CORE SITE	132 53	LMP	439.9	235.5	
443	48-7066	X	'BLAST EFFECT' AT SHARP CTR, GNOMON AT TRENCH & CORE SITE	132 53	LMP	439.9	235.5	
444	48-7067	X	DN-SUN OF TRENCH	132 53	LMP	439.9	235.5	
445	49-7263	Z	PANORAMA 17, E RIM OF SHARP CRATER	132 54	CDR	441.4	235.0	311.3
446	49-7264	Z	PAN 17	132 54	CDR	441.4	235.0	299.6
447	49-7265	Z	PAN 17	132 54	CDR	441.4	235.0	289.9
448	49-7266	Z	PAN 17	132 54	CDR	441.4	235.0	272.3
449	49-7267	Z	PAN 17	132 54	CDR	441.4	235.0	254.2
450	49-7268	Z	PAN 17	132 54	CDR	441.4	235.0	243.4
451	49-7269	Z	PAN 17	132 54	CDR	441.4	235.0	224.0
452	49-7270	Z	PANORAMA 18, E RIM OF SHARP CRATER	132 54	CDR	443.9	234.8	238.0
453	49-7271	Z	PAN 18	132 54	CDR	443.9	234.8	251.4
454	49-7272	Z	PAN 18	132 54	CDR	443.9	234.8	260.8
455	49-7273	Z	PAN 18	132 54	CDR	443.9	234.8	285.3
456	49-7274	Z	PAN 18	132 54	CDR	443.9	234.8	305.2
457	49-7275	Z	PAN 18	132 54	CDR	443.9	234.8	322.2
458	49-7276	Z	X-SUN STEREO OF TRENCH	132 56	CDR	439.9	235.5	
459	49-7277	Z	X-SUN STEREO OF TRENCH	132 56	CDR	439.9	235.5	
460	48-7068	X	DN-SUN CORE TUBE IN TRN LRL SPL 12027	132 56	LMP	439.9	235.5	
461	48-7069	X	DN-SUN CORE TUBE IN TRN LRL SPL 12027	132 56	LMP	439.9	235.5	
462	49-7278	Z	LMP WITH LESC LRL SPL 12023	132 57	CDR	439.9	235.5	
463	49-7279	Z	X-SUN, CT2 IN TRN LRL SPL 12027	132 57	CDR	439.9	235.5	
464	49-7280	Z	X-SUN, CT2 IN TRN LRL SPL 12027	132 57	CDR	439.9	235.5	
465	48-7070	X	DN-SUN,CT GONE (SHARP)	132 58	LMP	439.9	235.5	
466	48-7071	X	CONRAD (LM IN BACKGRND)	133 3	LMP	259.7	216.0	
467	49-7281	Z	BEAN	133 3	CDR	174.2	241.2	
468	48-7072	X	SW OF SURVEYOR CTR	133 8	LMP	186.5	198.3	210.0
469	48-7073	X	SW OF SURVEYOR CTR	133 8	LMP	186.5	198.3	205.0
470	49-7282	Z	SW OF SURVEYOR CTR	133 8	CDR	187.5	198.2	164.0
471	49-7283	Z	SW OF SURVEYOR CTR	133 8	CDR	187.5	198.2	164.0
472	49-7284	Z	SW OF SURVEYOR CTR	133 8	CDR	187.5	198.2	170.0
473	48-7074	X	'NEW UNIT' (AREA OF LRL SPL 12042 FLD SPL 12D)	133 19	LMP	185.6	198.4	200.0

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
474	48-7075	X	'NEW UNIT' (AREA OF LRL SPL 12042 FLD SPL 12D)	133 20	LMP	185.6	198.4	170.0
475	48-7076	X	'NEW UNIT' (AREA OF LRL SPL 12042 FLD SPL 12D)	133 20	LMP	185.6	198.4	165.0
476	49-7285	Z	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 25	CDR	244.5	183.4	180.0
477	49-7286	Z	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 28	CDR	244.5	183.4	190.0
478	48-7077	X	LAST PHOTO FROM 1016 DOUBLE CT 1/3	133 33	LMP	244.5	183.4	220.0
479	48-7078	X	CAM FAILURE, FOGGED		LMP			
480	48-7079	X	FOGGED		LMP			
481	48-7080	X	FOGGED		LMP			
482	48-7081	X	FOGGED		LMP			
483	49-7287	Z	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 33	LMP	244.5	183.4	180.0
484	49-7288	Z	CT1(LRL SPL 12025)/ CT3(LRL SPL 12028)	133 33	LMP	244.5	183.4	160.0
485	49-7289	Z	PANORAMA 19, SW OF SURVEYOR CRATER	133 35	LMP	239.5	183.3	254.2
486	49-7290	Z	PAN 19	133 35	LMP	239.5	183.3	232.2
487	49-7291	Z	PAN 19	133 35	LMP	239.5	183.3	209.7
488	49-7292	Z	PAN 19	133 35	LMP	239.5	183.3	186.9
489	49-7293	Z	PAN 19		LMP	239.5	183.3	165.0
490	49-7294	Z	PAN 19	133 35	LMP	239.5	183.3	143.1
491	49-7295	Z	PAN 19	133 35	LMP	239.5	183.3	133.4
492	49-7296	Z	PAN 19	133 35	LMP	239.5	183.3	116.7
493	49-7297	Z	PAN 19	133 35	LMP	239.5	183.3	100.7
494	49-7298	Z	PAN 19	133 35	LMP	239.5	183.3	83.1
495	49-7299	Z	PAN 19	133 36	LMP	239.5	183.3	65.1
496	49-7300	Z	PAN 19	133 36	LMP	239.5	183.3	48.0
497	49-7301	Z	PAN 19	133 36	LMP	239.5	183.3	31.3
498	49-7302	Z	PAN 19	133 36	LMP	239.5	183.3	19.7
499	49-7303	Z	PAN 19	133 36	LMP	239.5	183.3	9.5
500	49-7304	Z	PAN 19	133 36	LMP	239.5	183.3	353.0
501	49-7305	Z	PAN 19	133 36	LMP	239.5	183.3	337.1
502	49-7306	Z	PAN 19	133 36	LMP	239.5	183.3	325.0
503	49-7307	Z	PAN 19		LMP	239.5	183.3	308.6
504	49-7308	Z	PAN 19	133 36	LMP	239.5	183.3	290.4
505	49-7309	Z	PAN 19	133 36	LMP	239.5	183.3	283.7
506	49-7310	Z	PAN 19	133 36	LMP	239.5	183.3	265.5
507	49-7311	Z	PAN 19	133 36	LMP	239.5	183.3	257.[illegible]
508	49-7312	Z	SW OF SURVEYOR CTR FLD SPL 13D NOT RTND	133 39	LMP			
509	49-7313	Z	SW OF SURVEYOR CTR LRL SPL 12054	133 39	LMP			
510	49-7314	Z	SW OF SURVEYOR CTR LRL SPL 12054	133 39	LMP			

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
511	49-7315	Z	SW OF SURVEYOR CTR	133 39	LMP			
512	49-7316	Z	SW OF SURVEYOR CTR	133 39	LMP	191.1	181.1	1.0
513	49-7317	Z	SW OF SURVEYOR CTR	133 45	LMP	191.1	181.1	0.0
514	49-7318	Z	SW OF SURVEYOR CTR LRL SPL 12051	133 45	LMP	191.1	181.1	172.0
515	49-7319	Z	SW OF SURVEYOR CTR LRL SPL 12051	133 45	LMP	191.1	181.1	165.0
516	49-7320	Z	SW OF SURVEYOR CTR AFTER LRL SPL 12051	133 45	LMP	197.2	181.3	150.0
517	49-7321	Z	S RIM OF SURVEYOR CTR FOGGED		LMP	194.2	181.4	72.0
518	49-7322	Z	S RIM OF SURVEYOR CTR		LMP	194.2	181.4	66.0
519	49-7323	Z	S RIM OF SURVEYOR CTR FOGGED		LMP	194.2	181.4	52.0
520	49-7324	Z	S RIM OF SURVEYOR CTR FOGGED		LMP	194.2	181.4	59.0
521	48-7082	X	MAG FROM 1016 CH TO 1002, LRL SPLS 12043 & 12044, FLD SPL 14D	133 46	LMP			
522	48-7083	X	'GLASS DUMBELL' LRL SPL 12043, FLD SPL 14D	133 53	LMP			
523	48-7084	X	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	7.0
524	48-7085	X	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	1.5
525	48-7086	X	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	357.5
526	48-7087	X	40M S OF SURVEYOR	133 54	LMP	179.5	142.8	6.5
527	48-7088	X	30M S OF SURVEYOR	133 54	LMP	189.7	139.4	346.0
528	48-7089	X	30M S OF SURVEYOR	133 54	LMP	189.7	139.4	351.0
529	48-7090	X	30M S OF SURVEYOR	133 54	LMP	189.7	139.4	340.0
530	48-7091	X	SURVEYOR AND LM	133 55	LMP	188.5	134.5	322.0
531	48-7092	X	SURVEYOR AND LM	133 55	LMP	188.1	131.3	305.0
532	48-7093	X	SURVEYOR DOWN SUN	133 55	LMP	180.0	127.7	282.0
533	48-7094	X	SMSS,LM,AND BLOCK CTR	133 56	LMP	165.4	131.7	334.0
534	48-7095	X	SURVEYOR	133 56	LMP	165.4	131.7	318.0
535	48-7096	X	SURVEYOR	133 56	LMP	165.4	131.7	290.0
536	48-7097	X	BLOCK CRATER	133 56	LMP	165.4	131.7	342.0
537	48-7098	X	ACCIDENTAL?	133 57	LMP			
538	48-7099	X	SURVEYOR AND LM	133 58	LMP	161.0	132.7	307.0
539	48-7100	X	SURVEYOR AND LM	133 58	LMP	161.0	132.7	309.0
540	48-7101	X	PANORAMA 20, NEAR SURVEYOR	134 2	LMP	158.1	133.1	38.1
541	48-7102	X	PAN 20	134 2	LMP	158.1	133.1	18.9
542	48-7103	X	PAN 20	134 2	LMP	158.1	133.1	1.6
543	48-7104	X	PAN 20	134 6	LMP	158.1	133.1	345.0
544	48-7105	X	PAN 20	134 6	LMP	158.1	133.1	340.4
545	48-7106	X	PHOTOS 7106 THRU 7109 SHOW THE SOIL MECH-ANICS SCOOP (SMSS) AND TRENCHED AREA. THEY CAN BE VIEWED STEREOSCOPICALLY IN VARIOUS COMBINATIONS	134 6	LMP	158.1	133.1	10.0

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Continued

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
546	48-7107	X		134 6	LMP	158.1	133.1	12.0
547	48-7108	X		134 6	LMP	158.1	133.1	357.0
548	48-7109	X		134 7	LMP	158.1	133.1	1.0
549	48-7110	X	LEFT STEREO OF SURVEYOR FOOTPAD 2 AREA.	134 7	LMP	158.8	133.4	
550	48-7111	X	RT STEREO OF PAD 2 AREA	134 7	LMP	158.8	133.4	
551	48-7112	X	LEFT STEREO AFTER OBLITERATING PAD 2 IMPRINT.	134 9	LMP	158.8	133.4	
552	48-7113	X	RT STEREO OF 7112	134 9	LMP	158.8	133.4	
553	48-7114	X	RADVS,COMP.A,FUEL TANK, VERNIER ENGINE 2,AND BASE OF LEG 2.	134 13	LMP	157.4	133.4	333.0
554	48-7115	X	LEFT STEREO OF ABOVE.	134 13	LMP	157.4	133.4	325.0
555	48-7116	X	LEFT STEREO OF 7115	134 13	LMP	157.4	133.4	322.0
556	48-7117	X	COMPARTMENT A	134 13	LMP	156.7	133.1	320.0
557	48-7118	X	COMP.A,RADVS,BASE OF LEG 1 AND OMNI A	134 13	LMP	156.0	133.4	342.0
558	48-7119	X	RT STEREO,PAD 1 AREA	134 14	LMP	155.3	133.6	342.0
559	48-7120	X	LEFT STEREO,PAD 1 AREA	134 14	LMP	155.3	133.6	42.0
560	48-7121	X	SURVEYOR	134 14	LMP	158.7	135.4	13.0
561	48-7122	X	SURVEYOR	134 14	LMP	158.7	135.4	7.0
562	48-7123	X	SURVEYOR	134 14	LMP	155.2	134.7	31.0
563	48-7124	X	[illegible]. SIDE OF PAD 3	134 14	LMP	153.2	132.8	80.0
564	48-7125	X	CANOPUS SENSOR	134 14	LMP	153.2	132.8	170.0
565	48-7126	X	R.STEREO,SMSS TRENCHES	134 14	LMP	156.8	132.1	180.0
566	48-7127	X	L. STEREO OF 7126	134 14	LMP	156.8	132.1	180.0
567	48-7128	X	R. STEREO,SMSS TRENCHES	134 15	LMP	156.8	132.1	180.0
568	48-7129	X	L.STEREO OF 7128	134 15	LMP	156.8	132.1	180.0
569	48-7130	X	SURVEYOR TV CAMERA	134 15	LMP	156.8	132.1	250.0
570	48-7131	X	STREAK IN DUST ON SURVEYOR CAMERA MIRROR.	134 15	LMP	156.8	132.1	244.0
571	48-7132	X	SIMILAR TO 7131	134 15	LMP	156.8	132.1	277.0
572	48-7133	X	CDR,SURVEYOR,AND LM	134 16	LMP	161.7	132.4	305.0
573	48-7134	X	R.STEREO OF 7133	134 16	LMP	161.7	132.4	307.0
574	48-7135	X	CDR,SURVEYOR,AND LM	134 16	LMP	158.2	132.1	297.0
575	48-7136	X	SAME AS 7135	134 16	LMP	158.2	132.1	298.0
576	48-7137	X	COMP.A WITH BENT HEAT REFLECTOR	134 28	LMP	156.8	132.6	237.0
577	48-7138	X	AUX.BATTERY WITH MARKS IN DUST	134 29	LMP	155.4	132.0	213.0
578	48-7139	X	VICINITY OF SURVEYOR LRL SPL 12062 SPL IDENT QUESTIONABLE	134 33	LMP			
579	48-7140	X	PANORAMA 21, NEAR BLOCK CTR	134 39	LMP	113.8	95.1	202.4
580	48-7141	X	PAN 21	134 39	LMP	113.8	95.1	200.6
581	48-7142	X	PAN 21	134 39	LMP	113.8	95.1	227.4

TABLE D-II. - SEQUENTIAL LISTING OF 70-MILLIMETER PHOTOGRAPHS FROM EACH CAMERA MAGAZINE - Concluded

SEQ	PHOTO	MAG	REMARKS	GET	BY	DIST	AZLM	AZ
582	48-7143	X	PAN 21	134 39	LMP	113.8	95.1	256.3
583	48-7144	X	PANORAMA 22, NEAR BLOCK CTR	134 39	LMP	109.8	94.7	173.2
584	48-7145	X	PAN 22	134 39	LMP	109.8	94.7	193.5
585	48-7146	X	PAN 22	134 39	LMP	109.8	94.7	217.9
586	48-7147	X	PAN 22	134 39	LMP	109.8	94.7	244.2
587	48-7148	X	N RIM OF BLOCK CTR LRL SPL 12045, FLD SPL 15D	134 40	LMP			
588	48-7149	X	N RIM OF BLOCK CTR LRL SPL 12045, FLD SPL 15D	134 40	LMP			
589	48-7150	X	N RIM OF BLOCK CTR LRL SPL 12045, 12046 & 12047, FLD SPL 15D	134 40	LMP			
590	48-7151	X	N RIM OF SURVEYOR CTR	134 43	LMP	116.4	141.5	262.0
591	48-7152	X	N RIM OF SURVEYOR CTR	134 43	LMP	116.4	141.5	268.0
592	48-7153	X	PANORAMA 23, L WINDOW		CDR	1.6	266.4	231.0
593	48-7154	X	PAN 23		CDR	1.6	266.4	243.2
594	48-7155	X	PAN 23		CDR	1.6	266.4	283.5
595	48-7156	X	PAN 23		CDR	1.6	266.4	252.0
596	48-7157	X	PAN 23		CDR	1.6	266.4	273.0
597	48-7158	X	PAN 23		CDR	1.6	266.4	259.0
598	48-7159	X	PANORAMA 23, R WINDOW		LMP	1.8	299.3	303.5
599	48-7160	X	PAN 23		LMP	1.8	299.3	337.5
600	48-7161	X	PAN 23		LMP	1.8	299.3	308.0
601	48-7162	X	PAN 23		LMP	1.8	299.3	1.5
602	48-7163	X	PAN 23		LMP	1.8	299.3	336.0
603	48-7164	X	PAN 23		LMP	1.8	299.3	4.5
604	48-7165	X	PAN 23		LMP	1.8	299.3	7.5
605	48-7166	X	PAN 23		LMP	1.8	299.3	347.3
606	48-7167	X	PAN 23		LMP	1.8	299.3	329.5
607	48-7168	X	PAN 23		LMP	1.8	299.3	315.3
608	48-7169	X	PAN 23		LMP	1.8	299.3	302.0
609	48-7170	X	PAN 23		LMP	1.8	299.3	291.6
610	48-7171	X	PAN 23		LMP	1.8	299.3	

PHOTOGRAPHIC INDICES BY SAMPLE AND PHOTOGRAPH NUMBERS

The index of photographs by sample number (table D-III) is designed to help locate photographs that show part or all of any specific Apollo 12 lunar sample. Conversely, the index of samples by photograph number (table D-IV) is designed to help locate photographs that are not listed by sample number. The latter index is more complete and contains more explanatory information.

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER

Sample number	NASA photograph number
12002	S-69-60369 to S-69-60377
	S-69-64082
	S-69-64107
	S-70-25874
	S-70-25885
	S-70-27988 and S-70-27989
	S-70-28219 to S-70-28222
	S-70-30217
	S-70-30227
	S-70-30231
	S-70-30238 and S-70-30239
	S-70-30241
	S-70-30243
	S-70-30248
	S-70-30268
	S-70-30956
	S-70-31571 to S-70-31578
	S-70-31581
	S-70-31644 to S-70-31651
	S-70-33504 to S-70-33549
	S-70-36450 to S-70-36453
	S-70-36457 to S-70-36464
	S-70-36471
	S-70-36477
	S-70-37687 and S-70-37688
	S-70-38313 to S-70-38525
	S-70-40707 to S-70-40710
	S-70-40838
	S-70-40842
	S-70-44103
	S-70-44107 to S-70-44109
	S-70-44114 and S-70-44115
	S-70-44118
12004	S-69-62008 to S-69-62034
	S-69-62735 and S-69-62736
	S-69-64087 and S-69-64088
	S-69-64112 and S-69-64113
	S-70-27987
	S-70-28678
	S-70-28685
	S-70-30228

Sample number	NASA photograph number
12004 (Cont'd)	S-70-30240
	S-70-30245
	S-70-30259
	S-70-30272
	S-70-30960 and S-70-30961
	S-70-31569
	S-70-31582
	S-70-32739 to S-70-32746
	S-70-36455
	S-70-40688 to S-70-40706
	S-70-41199
	S-70-41216
	S-70-42738
	S-70-42740 and S-70-42741
	S-70-42744
	S-70-43440
	S-70-43444
	S-70-43458 and S-70-43459
	S-70-43461
	S-70-44112
	S-70-44121
12005	S-69-62294 and S-69-62295
	S-69-62297 and S-69-62298
	S-69-64089
	S-69-64114
12006	S-69-61907 to S-69-61929
	S-69-62330 to S-69-62353
	S-69-63086 to S-69-63109
	S-69-63853 to S-69-63858
	S-70-22504 to S-70-22507
12007	S-69-61788 to S-69-61810
	S-69-63134 to S-69-63157
12008	S-69-61668 to S-69-61691
	S-69-62651 to S-69-62674
	S-69-63190 to S-69-63213
	S-70-44088 to S-70-44093
	S-70-44529
	S-70-44557

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number
12008 (Cont'd)	S-70-44561
	S-70-44567
	S-70-44572
	S-70-44574
12009	S-69-62296
	S-69-62299 to S-69-62307
	S-69-62739 and S-69-62740
	S-69-62743
	S-69-64090 and S-69-64091
	S-69-64115 and S-69-64116
	S-70-25412
	S-70-25427
	S-70-25872
	S-70-30242
	S-70-30246
	S-70-31563
	S-70-31567 and S-70-31568
	S-70-31570
	S-70-31654 to S-70-31661
	S-70-33325 to S-70-33342
	S-70-36454
	S-70-36456
	S-70-36472
	S-70-36478
	S-70-37689
	S-70-37694
	S-70-40822
	S-70-43342
	S-70-43347
	S-70-43827
	S-70-43834
	S-70-44102
12010	S-69-62308 to S-69-62316
	S-69-62737 and S-69-62738
	S-69-64092
	S-69-64117
	S-70-25877
	S-70-25881
	S-70-27975
12010 (Cont'd)	S-70-27977
	S-70-27979
	S-70-28677
	S-70-28682
	S-70-43800 to S-70-43805
	S-70-44542 and S-70-44543
	S-70-44556
	S-70-44566
	S-70-44570
	S-70-45621
	S-70-45625
	S-70-45628
	S-70-45634
	S-70-45636
	S-70-45644
12011	S-69-63369 to S-69-63377
	S-69-63388 to S-69-63395
	S-69-64096 and S-69-64097
	S-69-64121 and S-69-64122
12012	S-69-24214
	S-69-24220
	S-69-63333 to S-69-63341
	S-69-63396 to S-69-63399
	S-69-63417 to S-69-63421
	S-69-64098 and S-69-64099
	S-69-64123 and S-69-64124
	S-70-20747
	S-70-20961
	S-70-25405
	S-70-25419 and S-70-25420
	S-70-25429 to S-70-25432
	S-70-25888
12013	S-69-24217
	S-69-24223
	S-69-63360 to S-69-63368
	S-69-63655 to S-69-63663
	S-69-64100
	S-69-64125

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number	Sample number	NASA photograph number
12013 (Cont'd)	S-70-25407	12017	S-69-63230 to S-69-63240
	S-70-25410		S-69-64093 to S-69-64095
	S-70-25423		S-69-64118 to S-69-64120
	S-70-25426		S-70-44096
	S-70-27993		S-70-44098 and S-70-44099
	S-70-28211		S-70-45306 to S-70-45312
	S-70-28228		
	S-70-33434 to S-70-33453	12018	S-69-61967 to S-69-61984
	S-70-40348 and S-70-40349		S-69-62741 and S-69-62742
	S-70-40673 to S-70-40687		S-69-64085 and S-69-64086
	S-70-40833 and S-70-40834		S-69-64110 and S-69-64111
	S-70-41204 and S-70-41205		S-70-27973
	S-70-41211		S-70-27978
	S-70-41390		S-70-27994
	S-70-41407 to S-70-41410		S-70-28212
	S-70-43632 to S-70-43637		S-70-28674
	S-70-43641		S-70-28681
			S-70-28688 and S-70-28689
12014	S-69-24210		S-70-30223 and S-70-30224
	S-69-24215		S-70-30226
	S-69-63351 to S-69-63359		S-70-30237
	S-69-63378 to S-69-63386		S-70-30244
	S-69-64101 and S-69-64102		S-70-30249
	S-69-64126 and S-69-64127		S-70-37692
	S-70-20964		S-70-37700
	S-70-25403 and S-70-25404		S-70-40736 to S-70-40739
	S-70-25883		S-70-43445 and S-70-43446
	S-70-28216		S-70-43526
	S-70-28218		S-70-43537
	S-70-30247		S-70-43833
			S-70-43836 and S-70-43837
12015	S-69-23391 and S-69-23392		S-70-43840
	S-69-62872 and S-69-62873		S-70-44544
	S-69-63342 to S-69-63350		S-70-44547
	S-69-64103		S-70-44564
	S-69-64128		S-70-44568
	S-70-24713 to S-70-24721		
		12019	S-69-63315 to S-69-63323
12016	S-69-60718 to S-69-60726		S-69-64104
	S-69-64081		S-69-64129
	S-69-64106		S-70-33460 to S-70-33503

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number	Sample number	NASA photograph number
12020	S-69-24213	12021 (Cont'd)	S-70-20749
	S-69-24225		S-70-20751 to S-70-20754
	S-69-63324 to S-69-63332		S-70-20957 to S-70-20960
	S-69-64105		S-70-25401 and S-70-25402
	S-69-64109		S-70-25878
	S-69-64130		S-70-25886
	S-70-25406		S-70-39758 to S-70-39798
	S-70-25408		S-70-42736
	S-70-25421 and S-70-25422		S-70-42742 and S-70-42743
	S-70-25424		S-70-43349
	S-70-25873		S-70-43351
	S-70-25882		S-70-43353 and S-70-43354
	S-70-25890 and S-70-25891		S-70-43356 and S-70-43357
	S-70-27983		S-70-43359
	S-70-27991		S-70-43362
	S-70-30229		S-70-43365
	S-70-30235		S-70-43421
	S-70-30251 to S-70-30254		S-70-43431 to S-70-43434
	S-70-30266		S-70-43517
	S-70-30957		S-70-43528 to S-70-43535
	S-70-31559		S-70-43828
	S-70-31566		S-70-43830
	S-70-31579		S-70-43838 and S-70-43839
	S-70-31652 and S-70-31653		S-70-44116
	S-70-32727 to S-70-32732		S-70-44122
	S-70-32734		S-70-45640
	S-70-43638 to S-70-43640		S-70-45642 and S-70-45643
	S-70-44528		
	S-70-44540	12022	S-69-23349
	S-70-44558		S-69-23369
	S-70-44573		S-69-24202
			S-69-24204
12021	S-69-23364 and S-69-23365		S-69-24208
	S-69-23372 and S-69-23373		S-69-24212
	S-69-24205 and S-69-24206		S-69-61999 to S-69-62007
	S-69-24219		S-69-63470 to S-69-63476
	S-69-61985 to S-69-61998		S-69-64083
	S-69-63464 to S-69-63469		S-69-64108
	S-69-64084		S-70-20739 and S-70-20740
	S-70-20741		S-70-20745
	S-70-20743		S-70-20755

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number	Sample number	NASA photograph number
12022 (Cont'd)	S-70-20757	12030	S-69-23379 to S-69-23390
	S-70-20956		S-69-64182 to S-69-64186
	S-70-24741 and S-70-24742		
	S-70-25875 and S-70-25876	12031	S-69-61811 to S-69-61834
	S-70-25889		S-69-63062 to S-69-63085
	S-70-28213 and S-70-28214		S-69-63631 to S-69-63654
	S-70-28226		S-70-24366 to S-70-24374
	S-70-28686 and S-70-28687		
	S-70-39799 to S-70-39829	12034	S-69-60932 to S-69-60955
	S-70-39850 and S-70-39851		S-69-62820 to S-69-62843
	S-70-40726 to S-70-40735		S-70-25413
	S-70-43518 to S-70-43521		S-70-25416
	S-70-43523		S-70-27990
	S-70-43543 to S-70-43546		S-70-28217
	S-70-43831 and S-70-43832		S-70-28676
	S-70-44104		S-70-28684
	S-70-44106		S-70-33842 to S-70-33877
	S-70-44120		S-70-40711 to S-70-40725
	S-70-44527		S-70-42737
	S-70-44541		S-70-42755
	S-70-44545		S-70-43348
	S-70-44565		S-70-43355
			S-70-43460
12025	S-69-23722 to S-69-23733		S-70-43524 and S-70-43525
	S-69-23803 to S-69-23818		S-70-43538 and S-70-43539
	S-70-20400		S-70-43829
	S-70-21302 to S-70-21309		S-70-43835
			S-70-44125
12026	S-69-60356 to S-69-60362		
	S-69-60477 to S-69-60481	12035	S-69-61249 to S-69-61256
	S-69-60488 to S-69-60493		S-69-63158 to S-69-63165
	S-69-61191 to S-69-61194		S-70-44174 to S-70-44179
	S-69-62744 to S-69-62762		S-70-44328 and S-70-44329
			S-70-45626 and S-70-45627
12028	S-69-23396 to S-69-23412		S-70-45630
	S-69-23734 to S-69-23757		S-70-45633
	S-69-60570 to S-69-60572		S-70-45635
	S-69-62763 to S-69-62765		S-70-45637
	S-69-64424		S-70-45639
	S-70-22669		

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number
12036	S-69-61586 to S-69-61609 S-69-62318 to S-69-62329 S-69-63847 to S-69-63852
12038	S-69-24203 S-69-60367 S-69-61538 to S-69-61561 S-69-62699 to S-69-62710 S-69-63819 to S-69-63822 S-70-20968 S-70-22428 to S-70-22439 S-70-24343 to S-70-24365 S-70-25425 S-70-25887 S-70-28679 S-70-28683 S-70-30215 S-70-44525 S-70-44550 S-70-44553 and S-70-44554 S-70-44562
12039	S-69-61466 to S-69-61489 S-69-63859 to S-69-63861 S-70-22440 to S-70-22451
12040	S-69-24211 S-69-24218 S-69-24222 S-69-60987 to S-69-61010 S-69-62317 S-69-63843 to S-69-63846 S-69-64822 S-69-64824 and S-69-64825 S-69-64829 S-70-20742 S-70-20750 S-70-20962 S-70-22452 to S-70-22459 S-70-44524 S-70-44548
12040 (Cont'd)	S-70-44551 and S-70-44552 S-70-44555 S-70-44569
12043	S-69-61562 to S-69-61585 S-69-63823 to S-69-63826 S-70-22460 to S-70-22467
12044	S-69-24207 S-69-61233 to S-69-61240 S-69-63241 to S-69-63288 S-70-25884 S-70-27992 S-70-28215
12046	S-69-60486 and S-69-60487 S-69-61883 to S-69-61906 S-69-63166 to S-69-63189
12047	S-69-61764 to S-69-61787 S-69-62711 to S-69-62734 S-69-63110 to S-69-63133
12051	S-69-61514 to S-69-61537 S-69-62675 to S-69-62686 S-69-63827 to S-69-63830 S-70-22468 to S-70-22475 S-70-22938 to S-70-22983 S-70-36904 to S-70-36917 S-70-36944 to S-70-36946 S-70-36987 to S-70-36992 S-70-40807 and S-70-40808 S-70-40811 and S-70-40812 S-70-40818 S-70-40820 S-70-40827 and S-70-40828 S-70-40835 and S-70-40836 S-70-40844 and S-70-40845 S-70-41403 S-70-41405 and S-70-41406 S-70-41197 and S-70-41198

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number
12051 (Cont'd)	S-70-41203
	S-70-41215
	S-70-41217
	S-70-42732
	S-70-42734
	S-70-42751 to S-70-42753
	S-70-43341
	S-70-43352
	S-70-43360 and S-70-43361
	S-70-43363
	S-70-43435 to S-70-43439
	S-70-43441 to S-70-43443
	S-70-44100
	S-70-44119
12052	S-69-24216
	S-69-24224
	S-69-60908 to S-69-60931
	S-69-61241 to S-69-61248
	S-69-61859 to S-69-61882
	S-69-62354 to S-69-62376
	S-69-62796 to S-69-62819
	S-69-63831 to S-69-63834
	S-70-20401 to S-70-20403
	S-70-21310 to S-70-21320
	S-70-22476 to S-70-22487
	S-70-22670 to S-70-22689
	S-70-24375 to S-70-24424
	S-70-25409
	S-70-25411
	S-70-25417 and S-70-25418
	S-70-27985 and S-70-27986
	S-70-28227
	S-70-30232
	S-70-30250
	S-70-31583
	S-70-44630 to S-70-44639
	S-70-44847 and S-70-44848
12053	S-69-60621 to S-69-60642
	S-69-60956 to S-69-60958
	S-70-23019 to S-70-23048
	S-70-36468 to S-70-36470
	S-70-36473 and S-70-36474
	S-70-36479 to S-70-36483
	S-70-36864 to S-70-36903
	S-70-36918 to S-70-36943
	S-70-36947 to S-70-36986
	S-70-37690 and S-70-37691
	S-70-37693
	S-70-37696
	S-70-37702
	S-70-40809 and S-70-40810
	S-70-40813 and S-70-40814
	S-70-40816 and S-70-40817
	S-70-40821
	S-70-40825 and S-70-40826
	S-70-40831 and S-70-40832
	S-70-40843
	S-70-41393
	S-70-41395 and S-70-41396
	S-70-41398
	S-70-41200 and S-70-41201
	S-70-41208
	S-70-41210
	S-70-41213 and S-70-41214
	S-70-43344 and S-70-43345
	S-70-43350
	S-70-43364
	S-70-43422 to S-70-43426
	S-70-43522
	S-70-43540 to S-70-43542
	S-70-44101
	S-70-44117
	S-70-44126
12054	S-69-60354 and S-69-60355
	S-69-60963 to S-69-60986
	S-69-62772 to S-69-62795
	S-70-22690 to S-70-22704
	S-70-22984 to S-70-23018

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number
12055	S-69-23394 and S-69-23395
	S-69-61011 to S-69-61034
	S-69-62690 to S-69-62698
	S-69-63835 to S-69-63838
	S-70-22488 to S-70-22499
	S-70-23123 to S-70-23155
12056	S-69-61035 to S-69-61058
	S-69-63839 to S-69-63842
	S-70-22500 to S-70-22503
	S-70-22508 to S-70-22511
	S-70-23112 to S-70-23122
12057	S-69-60959 to S-69-60962
	S-69-61387 to S-69-61390
	S-69-61403 to S-69-61408
	S-69-61411 and S-69-61412
12057-4	S-69-23354
	S-69-23356
	S-69-23366
	S-69-63415
	S-69-63427
	S-69-63454 to S-69-63463
	S-69-64831
12057-5	S-69-63492 to S-69-63494
12057-6	S-69-23374 and S-69-23375
	S-69-24201
	S-69-63403
	S-69-63408
	S-69-63412
	S-69-63416
	S-69-63449 and S-69-63450
	S-69-64882
	S-69-64884
	S-70-20967
12057-7	S-69-23352
	S-69-23357
12057-7 (Cont'd)	S-69-23368
	S-69-63405
	S-69-63411
	S-69-63414
	S-69-63440 to S-69-63445
	S-69-63451 to S-69-63453
	S-69-63495
	S-69-64823
	S-69-64828
	S-69-64830
	S-69-64886
	S-70-20746
	S-70-20758
12057-8	S-69-24221
	S-69-63490 and S-69-63491
	S-69-64827
	S-70-20954 and S-70-20955
12057-9	S-69-23358
	S-69-23367
	S-69-23371
	S-69-24226
	S-69-63406
	S-69-63409 and S-69-63410
	S-69-63428 to S-69-63430
	S-69-64740 and S-69-64741
	S-69-64832
	S-70-20738
	S-70-20966
12057-11	S-69-24209
	S-69-63404
	S-69-63407
	S-69-63413
	S-69-63446 to S-69-63448
	S-69-64826
	S-69-64881
	S-69-64883
	S-70-30221 and S-70-30222

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number
12058	S-69-62766 to S-69-62771
12061	S-69-61659
12062	S-69-60860 to S-69-60883
	S-69-61660 to S-69-61662
	S-69-63488 and S-69-63489
	S-70-24699 to S-70-24712
	S-70-27976
	S-70-28223 and S-70-28224
	S-70-30213
	S-70-30216
	S-70-30255 and S-70-30256
	S-70-36467
	S-70-36475
	S-70-37699
	S-70-45624
	S-70-45631
12063	S-69-23350 and S-69-23351
	S-69-23353
	S-69-23355
	S-69-23359 and S-69-23360
	S-69-23362
	S-69-23377
	S-69-60597 to S-69-60620
	S-69-61391
	S-69-61663 and S-69-61664
	S-70-20736
	S-70-20756
	S-70-20965
	S-70-25555 to S-70-25597
	S-70-26415 to S-70-26436
	S-70-26591 to S-70-26629
	S-70-26651 to S-70-26671
	S-70-26690 to S-70-26700
	S-70-27974
	S-70-27980 to S-70-27982
	S-70-27984
	S-70-28225
	S-70-28675
12063 (Cont'd)	S-70-28680
	S-70-30214
	S-70-30218
	S-70-30220
	S-70-30225
	S-70-30230
	S-70-30233 and S-70-30234
	S-70-30236
	S-70-30262 and S-70-30263
	S-70-30265
	S-70-30267
	S-70-30270 and S-70-30271
	S-70-30273 and S-70-30274
	S-70-30954 and S-70-30955
	S-70-30958 and S-70-30959
	S-70-31560 and S-70-31561
	S-70-31564
	S-70-31664 to S-70-31669
	S-70-32733
	S-70-32736
	S-70-37695
	S-70-39830 to S-70-39849
	S-70-39852 to S-70-39865
	S-70-40839
	S-70-43346
	S-70-43358
	S-70-44110
	S-70-44123 and S-70-44124
	S-70-44526
	S-70-45623
	S-70-45641
12064	S-69-60884 to S-69-60907
	S-69-63484 to S-69-63487
	S-70-24722 to S-70-24736
	S-70-30219
	S-70-30257 and S-70-30258
	S-70-30260 and S-70-30261
	S-70-30264
	S-70-30269
	S-70-31562

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Continued

Sample number	NASA photograph number	Sample number	NASA photograph number
12064 (Cont'd)	S-70-31580 S-70-44450 to S-70-44459	12065 (Cont'd)	S-70-43340 S-70-43343 S-70-43427 to S-70-43430
12065	S-69-23361 S-69-23363 S-69-23370 S-69-23376 S-69-23378 S-69-60573 to S-69-60596 S-69-61409 and S-69-61410		S-70-43447 to S-70-43457 S-70-44105 S-70-44111 S-70-44113 S-70-44127 S-70-44559 and S-70-44560
	S-69-61665 to S-69-61667 S-69-63431 to S-69-63439	12071	S-69-61218 to S-69-61222
	S-69-63630 S-69-64880	12072	S-69-61740 to S-69-61763
	S-70-20737 S-70-20963 S-70-25489 to S-70-25554 S-70-26630 to S-70-26650 S-70-26672 to S-70-26689 S-70-26701 to S-70-26721 S-70-37257 to S-70-37274 S-70-40815 S-70-40819 S-70-40823 and S-70-40824 S-70-40829 and S-70-40830 S-70-40840 S-70-41196 S-70-41202 S-70-41206 and S-70-41207 S-70-41209 S-70-41212 S-70-41218 S-70-41389 S-70-41391 and S-70-41392 S-70-41394 S-70-41397 S-70-41399 to S-70-41402 S-70-41404 S-70-42735 S-70-42745 S-70-42747 to S-70-42749	12073	S-69-60368 S-69-61059 to S-69-61082 S-69-61413 to S-69-61415 S-69-64885 S-70-20744 S-70-20748 S-70-24687 to S-70-24698 S-70-25414 and S-70-25415 S-70-25879 and S-70-25880 S-70-31565 S-70-31662 and S-70-31663 S-70-32735 S-70-32737 and S-70-32738 S-70-36465 and S-70-36466 S-70-36476 S-70-37697 and S-70-37698 S-70-37701 S-70-40837 S-70-40841 S-70-42733 S-70-42739 S-70-42746 S-70-42754 S-70-43527 S-70-43536 S-70-44094 and S-70-44095

TABLE D-III. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX

BY SAMPLE NUMBER - Concluded

Sample number	NASA photograph number	Sample number	NASA photograph number
12073 (Cont'd)	S-70-44097 S-70-44330 to S-70-44336	12075 (Cont'd)	S-70-44571 S-70-45622 S-70-45629 S-70-45632 S-70-45638
12075	S-69-61490 to S-69-61513 S-69-63477 to S-69-63483 S-70-33797 to S-70-33841 S-70-44014 to S-70-44023 S-70-44546 S-70-44549 S-70-44563	12076	S-69-61692 to S-69-61739
		12077	S-69-61835 to S-69-61838

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER

NASA photograph number	Sample number	Description
S-69-23349	12022	Chip in thin-section laboratory
S-69-23350 and S-69-23351	12063-9	Thin sections
S-69-23352	12057-33	Thin section
S-69-23353	12063-6	Thin section
S-69-23354	12057-31	Thin section
S-69-23355	12063-5	Thin section
S-69-23356	12057-31	Thin section
S-69-23357	12057-33	Thin section
S-69-23358	12057-35	Thin section
S-69-23359 and S-69-23360	12063-5	Thin sections
S-69-23361	12065-8	Thin section
S-69-23362	12063-6	Thin section
S-69-23363	12065-6	Thin section
S-69-23364 and S-69-23365	12021	Chips in thin-section laboratory
S-69-23366	12057-32	Thin section
S-69-23367	12057-35	Thin section
S-69-23368	12057-34	Thin section
S-69-23369	12022	Chip in thin-section laboratory
S-69-23370	12065-6	Thin section (closeup)
S-69-23371	12057-36	Thin section
S-69-23372 and S-69-23373	12021	Chips in thin-section laboratory
S-69-23374	12057-37	Thin section
S-69-23375	12057-39	Thin section
S-69-23376	12065-8	Thin section
S-69-23377	12063-9	Thin section
S-69-23378	12065-6	Thin section
S-69-23379 to S-69-23390	12030	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-23391 and S-69-23392	12015	Photographs in the PCTL
S-69-23394 and S-69-23395	12055	Photographs in the nitrogen processing laboratory
S-69-23396 to S-69-23412	12028	Bottom of double core tube
S-69-23722 to S-69-23733	12025	Color negatives
S-69-23734 to S-69-23757	12028	Color negatives
S-69-23803 to S-69-23818	12025	Color negative of the top of the double core tube
S-69-24201	12057-38	Thin section
S-69-24202	12022-10	Thin section
S-69-24203	12038-2	Thin section
S-69-24204	12022-10	Thin section
S-69-24205	12021-4	Thin section
S-69-24206	12021-5	Thin section
S-69-24207	12044-2	Thin section
S-69-24208	12022-10	Thin section
S-69-24209	12057-40	Thin section
S-69-24210	12014	Thin section
S-69-24211	12040-3	Thin section
S-69-24212	12022-7	Thin section
S-69-24213	12020-1	One view only
S-69-24214	12012-1	One view only
S-69-24215	12014-1	One view only
S-69-24216	12052	One view only
S-69-24217	12013-1	One view only

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-69-24218	12040-4	Thin section	S-69-60363 to S-69-60365		First view into D-ALSRC
S-69-24219	12021-5	Thin section	S-69-60366		GASC
S-69-24220	12012	Thin section	S-69-60367	12038	Documented sample bag 9-D containing sample 12038
S-69-24221	12057-27	Thin section	S-69-60368	12073	A breccia in the PCTL
S-69-24222	12040-4	Thin section	S-69-60369 to S-69-60377	12002	Record and stereoscopic photographs of the first RCL sample in F201 chamber (Note: Views from cameras 3, 4, 5, and 6 are printed left for right.)
S-69-24223	12013	Thin section	S-69-60477 to S-69-60481	12026	Core tube 2013
S-69-24224	12052	Thin section	S-69-60482 to S-69-60485		View of the contingency sample being opened in the PCTL
S-69-24225	12020	Thin section	S-69-60486 and S-69-60487	12046	A breccia from the contingency sample
S-69-24226	12057-43	Thin section	S-69-60488 to S-69-60493	12026	Core tube 2013 being split
S-69-60294		First view into S-ALSRC (1008) in F201 chamber	S-69-60540 and S-69-60541		Color version of S-69-60314; early view into S-ALSRC
S-69-60295 to S-69-60298		View of D-ALSRC (1009) in R-cabinets	S-69-60544		Color version of S-69-60340; rocks from S-ALSRC on floor of F201 chamber
S-69-60299 to S-69-60302		S-ALSRC being opened in F201 chamber	S-69-60570	12028	Core tube 2012
S-69-60303 to S-69-60313		View of LRL scientific staff waiting for S-ALSRC to be opened	S-69-60571 and S-69-60572	12028	Opened bottom of core tube 2012
S-69-60314		Second view into S-ALSRC (same as S-69-60294 except that one rock has been removed)	S-69-60573 to S-69-60596	12065	Record and stereoscopic photographs in the PCTL
S-69-60315 to S-69-60319		View of the ALSRC being brought into the vacuum laboratory and being weighed	S-69-60597 to S-69-60620	12063	Record and stereoscopic photographs in the PCTL
S-69-60320 and S-69-60321		Placing S-ALSRC into R-cabinets	S-69-60621 to S-69-60642	12053	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-60322 to S-69-60328		S-ALSRC in R-cabinets	S-69-60718 to S-69-60726	12016	Record and stereoscopic photographs in F201 chamber
S-69-60340		Last 12 rocks from S-ALSRC on floor of F201 chamber			
S-69-60354 and S-69-60355	12054	Sample being held in Teflon glove as it was removed from the D-ALSRC in the nitrogen processing laboratory			
S-69-60356 to S-69-60362	12026	Core tube 2013; the tube from the S-ALSRC being opened in the nitrogen laboratory			

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-69-60860 to S-69-60883	12062	Record and stereoscopic photographs in PCTL
S-69-60884 to S-69-60907	12064	Record and stereoscopic photographs in PCTL
S-69-60908 to S-69-60931	12052	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-60932 to S-69-60955	12034	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-60956 to S-69-60958	12053	Oblique views in the nitrogen processing laboratory
S-69-60959 to S-69-60962	12057	Chips and coarse fines on 1-mm sieve from bottom of D-ALSRC
S-69-60963 to S-69-60986	12054	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-60987 to S-69-61010	12040	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61011 to S-69-61034	12055	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61035 to S-69-61058	12056	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61059 to S-69-61082	12073	Record and stereoscopic photographs in the PCTL
S-69-61191 to S-69-61194	12026	Color views of core tube 2013
S-69-61218 to S-69-61222	12071	Record photographs of chips from contingency sample
S-69-61233 to S-69-61240	12044	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61241 to S-69-61244	12052-1	Record photographs
S-69-61245 to S-69-61248	12052-2	Record photographs
S-69-61249 to S-69-61256	12035	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61387 to S-69-61390	12057	Various views in the thin-section laboratory
S-69-61391	12063-1	View in the thin-section laboratory
S-69-61392 to S-69-61401	12057	Various views in the thin-section laboratory
S-69-61402	12063-1	View in the thin-section laboratory
S-69-61403 to S-69-61408	12057	Various views in the thin-section laboratory
S-69-61409 and S-69-61410	12065-1	Views in the thin-section laboratory
S-69-61411 and S-69-61412	12057	Various views in the thin-section laboratory
S-69-61413 to S-69-61415	12073-1	Views in the thin-section laboratory
S-69-61466 to S-69-61489	12039	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61490 to S-69-61513	12075	Record and stereoscopic photographs in the PCTL
S-69-61514 to S-69-61537	12051	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61538 to S-69-61561	12038	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61562 to S-69-61585	12043	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61586 to S-69-61609	12036	Record and stereoscopic photographs in the nitrogen processing laboratory

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-69-61659	12061	Chips in the PCTL
S-69-61660 to S-69-61662	12062	Three views in the PCTL
S-69-61663 and S-69-61664	12063	Two views in the PCTL
S-69-61665 to S-69-61667	12065	Three views in the PCTL
S-69-61668 to S-69-61691	12008	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61692 to S-69-61739	12076	Record and stereoscopic photographs in the PCTL
S-69-61740 to S-69-61763	12072	Record and stereoscopic photographs in the PCTL
S-69-61764 to S-69-61787	12047	View in the nitrogen processing laboratory
S-69-61788 to S-69-61810	12007	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61811 to S-69-61834	12031	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61835 to S-69-61858	12077	Record and stereoscopic photographs in the PCTL
S-69-61859 to S-69-61882	12052	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61883 to S-69-61906	12046	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61907 to S-69-61929	12006	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-61967 to S-69-61984	12018	Record and stereoscopic photographs; presplit and postsplit in F201 chamber
S-69-61985 to S-69-61998	12021	Record and stereoscopic photographs in F201 chamber (Note: One record for each camera as the sample was turned 180°)
S-69-61999 to S-69-62007	12022	Record and stereoscopic photographs in F201 chamber
S-69-62008 to S-69-62034	12004	Record and stereoscopic photographs in F201 chamber
S-69-62287 to S-69-62293		In CRA; color negatives
S-69-62294 and S-69-62295	12005	Record and stereoscopic photographs in F201 chamber
S-69-62296	12009	Record and stereoscopic photographs in F201 chamber
S-69-62297 and S-69-62298	12005	Record and stereoscopic photographs in F201 chamber
S-69-62299 to S-69-62307	12009	Record and stereoscopic photographs in F201 chamber
S-69-62308 to S-69-62316	12010	Record and stereoscopic photographs in F201 chamber
S-69-62317	12040	One view
S-69-62318 to S-69-62329	12036	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62330 to S-69-62353	12006	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62354 to S-69-62376	12052-1	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62651 to S-69-62674	12008	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62675 to S-69-62686	12051	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62690 to S-69-62698	12055	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62699 to S-69-62710	12038	Record and stereoscopic photographs in the nitrogen processing laboratory

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-69-62711 to S-69-62734	12047	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-62735 and S-69-62736	12004	Two views in panorama
S-69-62737 and S-69-62738	12010	Two views in panorama
S-69-62739 and S-69-62740	12009	Two views in panorama
S-69-62741 and S-69-62742	12018	Two views in panorama
S-69-62743	12009	One view, black and white
S-69-62744 to S-69-62762	12026	Color negatives
S-69-62763 to S-69-62765	12028	Color negatives
S-69-62766 to S-69-62771	12058	Color negatives
S-69-62772 to S-69-62795	12054	Color negatives
S-69-62796 to S-69-62819	12052	Color negatives
S-69-62820 to S-69-62843	12034	Color negatives
S-69-62872 and S-69-62873	12015	Two views in F201 chamber
S-69-63062 to S-69-63085	12031	Color negatives
S-69-63086 to S-69-63109	12006	Color negatives
S-69-63110 to S-69-63133	12047	Color negatives
S-69-63134 to S-69-63157	12007	Color negatives
S-69-63158 to S-69-63165	12035	Color negatives
S-69-63166 to S-69-63189	12046	Color negatives
S-69-63190 to S-69-63213	12008	Color negatives
S-69-63230 to S-69-63240	12017	Record and stereoscopic photographs in F201 chamber
S-69-63241 to S-69-63264	12044-2	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-63265 to S-69-63288	12044-1	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-63315 to S-69-63323	12019	Record and stereoscopic photographs in F201 chamber
S-69-63324 to S-69-63332	12020	Record and stereoscopic photographs in F201 chamber
S-69-63333 to S-69-63341	12012	Record and stereoscopic photographs in F201 chamber
S-69-63342 to S-69-63350	12015	Record and stereoscopic photographs in F201 chamber
S-69-63351 to S-69-63359	12014	Record and stereoscopic photographs in F201 chamber
S-69-63360 to S-69-63368	12013	Record and stereoscopic photographs in F201 chamber
S-69-63369 to S-69-63377	12011	Record and stereoscopic photographs in F201 chamber
S-69-63378 to S-69-63386	12014	Record and stereoscopic photographs in F201 chamber

NASA photograph number	Sample number	Description
S-69-63388 to S-69-63395	12011	Record and stereoscopic photographs in F201 chamber
S-69-63396 to S-69-63399	12012	Record and stereoscopic photographs in F201 chamber
S-69-63403	12057-39	Thin section
S-69-63404	12057-22	Thin section
S-69-63405	12057-7	Thin section
S-69-63406	12057-20	Thin section
S-69-63407	12057-23	Thin section
S-69-63408	12057-17	Thin section
S-69-63409 and S-69-63410	12057-21	Thin sections
S-69-63411	12057-18	Thin section
S-69-63412	12057-39	Thin section
S-69-63413	12057-22	Thin section
S-69-63414	12057-19	Thin section
S-69-63415	12057-14	Thin section
S-69-63416	12057-15	Thin section
S-69-63417 to S-69-63421	12012	Record and stereoscopic photographs in F201 chamber
S-69-63427	12057-15	Photomicrograph; color positive
S-69-63428 to S-69-63430	12057-21	Photomicrographs; color positives
S-69-63431 to S-69-63439	12065-7	Photomicrographs; color positives
S-69-63440 to S-69-63445	12057-18	Photomicrographs; color positives
S-69-63446 to S-69-63448	12057-23	Photomicrographs; color positives
S-69-63449 and S-69-63450	12057-17	Photomicrographs; color positives

NASA photograph number	Sample number	Description
S-69-63451 to S-69-63453	12057-19	Photomicrographs; color positives
S-69-63454 to S-69-63463	12057-14	Photomicrographs; color positives
S-69-63464 to S-69-63469	12021	Photomicrographs; color positives
S-69-63470 to S-69-63476	12022	Photomicrographs; color positives
S-69-63477 to S-69-63483	12075	Photomicrographs; color positives
S-69-63484 to S-69-63487	12064-a	Photomicrographs; color positives
S-69-63488 and S-69-63489	12062-1	Photomicrographs; color positives
S-69-63490 and S-69-63491	12057-8	Photomicrographs; color positives
S-69-63492 to S-69-63494	12057-5	Photomicrographs; color positives
S-69-63495	12057-13	Photomicrograph; color positive
S-69-63630	12065	One view only
S-69-63631 to S-69-63654	12031	Record and stereoscopic photographs in the nitrogen processing laboratory
S-69-63655 to S-69-63663	12013	Record and stereoscopic photographs in F201 chamber
S-69-63819 to S-69-63822	12038	Color negatives
S-69-63823 to S-69-63826	12043	Color negatives
S-69-63827 to S-69-63830	12051	Color negatives

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-69-63831 to S-69-63834	12052	Color negatives	S-69-64098 and S-69-64099	12012	Color positives
S-69-63835 to S-69-63838	12055	Color negatives	S-69-64100	12013	Color positive
			S-69-64101 and S-69-64102	12014	Color positives
S-69-63839 to S-69-63842	12056	Color negatives	S-69-64103	12015	Color positive
S-69-63843 to S-69-63846	12040	Color negatives	S-69-64104	12019	Color positive
			S-69-64105	12020	Color positive
S-69-63847 to S-69-63852	12036	Color negatives	S-69-64106	12016	Color positive
			S-69-64107	12002	Color positive
S-69-63853 to S-69-63858	12006	Color negatives	S-69-64108	12022	Color positive
			S-69-64109	12021	Color positive
S-69-63859 to S-69-63861	12039	Color negatives	S-69-64110 and S-69-64111	12018	Color positives
S-69-64081	12016	Color positive	S-69-64112 and S-69-64113	12004	Color positives
S-69-64082	12002	Color positive			
S-69-64083	12022	Color positive	S-69-64114	12005	Color positive
S-69-64084	12021	Color positive	S-69-64115 and S-69-64116	12009	Color positives
S-69-64085 and S-69-64086	12018	Color positives	S-69-64117	12010	Color positive
S-69-64087 and S-69-64088	12004	Color positives	S-69-64118 to S-69-64120	12017	Color positives
S-69-64098	12005	Color positive	S-69-64121 and S-69-64122	12011	Color positives
S-69-64090 and S-69-64091	12009	Color positives	S-69-64123 and S-69-64124	12012	Color positives
S-69-64092	12010	Color positive			
S-69-64093 to S-69-64095	12017	Color positives	S-69-64125	12013	Color positive
			S-69-64126 and S-69-64127	12014	Color positives
S-69-64096 and S-69-64097	12011	Color positives	S-69-64128	12015	Color positive

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-69-64129	12019	Color positive	S-70-20737	12065-12	Thin section
S-69-64130	12020	Color positive	S-70-20738	12057-42	Thin section
S-69-64182 to S-69-64186	12030	Color negatives	S-70-20739	12022-6	Thin section
			S-70-20740	12022-9	Thin section
S-69-64424	12028	Bottom of double core	S-70-20741	12021-4	Thin section
S-69-64740 and S-69-64741	12057-28	Thin sections	S-70-20742	12040-2	Thin section
			S-70-20743	12021-4	Thin section
S-69-64821	12040-2	Thin section	S-70-20744	12073-5	Thin section
S-69-64822	12041-2	Thin section	S-70-20745	12022-6	Thin section
S-69-64823	12057-25	Thin section	S-70-20746	12057-41	Thin section
S-69-64824	12040-2	Chip in thin-section laboratory	S-70-20747	12012-6	Thin section
S-69-64825	12040	Chip in thin-section laboratory	S-70-20748	12073-5	Thin section
S-69-64826	12057-29	Thin section	S-70-20749	12021-4	Thin section
S-69-64827	12057-27	Thin section	S-70-20750	12040-2	Thin section
S-69-64828	12057-25	Thin section	S-70-20751 to S-70-20754	12021-4	Thin sections
S-69-64829	12040-2	Chip in thin-section laboratory			
S-69-64830	12057-19	Thin section	S-70-20755	12022-12	Thin section
S-69-64831	12057-14	Thin section	S-70-20756	12063-11	Thin section
S-69-64832	12057-28	Thin section	S-70-20757	12022-6	Thin section
S-69-64880	12065-7	Thin section	S-70-20758	12057-41	Thin section
S-69-64881	12057-30	Thin section	S-70-20954 and S-70-20955	12057-27	Color thin sections
S-69-64882	12057-24	Thin section			
S-69-64883	12057-29	Thin section	S-70-20956	12022-6	Color thin section
S-69-64884	12057-38	Thin section	S-70-20957 to S-70-20960	12021-4	Color thin sections
S-69-64885	12073-7	Thin section			
S-69-64886	12057-26	Thin section	S-70-20961	12012-6	Color thin section
S-70-20400	12025	Core sample after splitting; color negative	S-70-20962	12040-2	Color thin section
			S-70-20963	12065-12	Color thin section
S-70-20401 to S-70-20403	12052	Closeups; color negatives	S-70-20964	12014-5	Color thin section
			S-70-20965	12063-6	Color thin section
S-70-20736	12063-11	Thin section	S-70-20966	12057-35	Color thin section

NASA photograph number	Sample number	Description
S-70-20967	12057-17	Color thin section
S-70-20968	12038-2	Color thin section
S-70-21302 to S-70-21309	12025	Lump in core tube
S-70-21310 to S-70-21320	12052	Surface closeups
S-70-22428 to S-70-22439	12038	Color negatives
S-70-22440 to S-70-22451	12039	Color negatives
S-70-22452 to S-70-22459	12040	Color negatives
S-70-22460 to S-70-22467	12043	Color negatives
S-70-22468 to S-70-22475	12051	Color negatives
S-70-22476 to S-70-22487	12052	Color negatives
S-70-22488 to S-70-22499	12055	Color negatives
S-70-22500 to S-70-22503	12056	Color negatives
S-70-22504 to S-70-22507	12006	Color negatives
S-70-22508 to S-70-22511	12056	Color negatives
S-70-22669	12028	Core-tube diagram
S-70-22670 to S-70-22689	12052	Surface simulations
S-70-22690 to S-70-22704	12054	Surface simulations

NASA photograph number	Sample number	Description
S-70-22938 to S-70-22983	12051	Surface closeups; color negatives
S-70-22984 to S-70-23018	12054	Surface closeups; color negatives
S-70-23019 to S-70-23048	12053	Surface closeups; color negatives
S-70-23112 to S-70-23122	12056	Surface closeups; color negatives
S-70-23123 to S-70-23155	12055	Surface closeups; color negatives
S-70-24343 to S-70-24365	12038	Surface closeups; color negatives
S-70-24366 to S-70-24374	12031	Surface closeups; color negatives
S-70-24375 to S-70-24424	12052	Surface closeups; color negatives
S-70-24687 to S-70-24698	12073	Stereopair; color
S-70-24699 to S-70-24712	12062	Stereopair; color
S-70-24713 to S-70-24721	12015	Stereopair; color
S-70-24722 to S-70-24736	12064	Stereopair; color
S-70-24741 and S-70-24742	12022-10	Enlargement of skeletal ilmenite in thin sections
S-70-25401	12021-3	Thin section
S-70-25402	12021-6	Thin section
S-70-25403	12014-7	Thin section
S-70-25404	12014-6	Thin section
S-70-25405	12012-7	Thin section

NASA photograph number	Sample number	Description
S-70-25406	12020-6	Thin section
S-70-25407	12013-5	Thin section
S-70-25408	12020-8	Thin section
S-70-25409	12052-6	Thin section
S-70-25410	12013-6	Thin section
S-70-25411	12052-5	Thin section
S-70-25412	12009-6	Thin section
S-70-25413	12034-2	Thin section
S-70-25414 and S-70-25415	12073-6	Thin sections
S-70-25416	12034-2	Thin section
S-70-25417	12052-6	Thin section
S-70-25418	12052-5	Thin section
S-70-25419 and S-70-25420	12012-7	Thin sections
S-70-25421 and S-70-25422	12020-8	Thin sections
S-70-25423	12013-6	Thin section
S-70-25424	12020-8	Thin section
S-70-25425	12038-3	Thin section
S-70-25426	12013-5	Thin section
S-70-25427 and S-70-25428	12009-7	Thin sections
S-70-25429 to S-70-25432	12012-8	Thin sections
S-70-25489 to S-70-25554	12065	Surface closeups; color
S-70-25555 to S-70-25597	12063	Surface closeups; color
S-70-25872	12009-7	Thin section; black and white
S-70-25873	12020-10	Thin section; black and white
S-70-25874	12002-2	Thin section; black and white
S-70-25875	12022-8	Thin section; black and white
S-70-25876	12022-11	Thin section; black and white
S-70-25877	12010-4	Thin section; black and white
S-70-25878	12021-7	Thin section; black and white
S-70-25879 and S-70-25880	12073-8	Thin sections; black and white
S-70-25881	12010-4	Thin section; black and white
S-70-25882	12020-12	Thin section; black and white
S-70-25883	12014-9	Thin section; black and white
S-70-25884	12044-3	Thin section; black and white
S-70-25885	12002-2	Thin section; black and white
S-70-25886	12021-7	Thin section; black and white
S-70-25887	12038-3	Thin section; black and white
S-70-25888	12012-8	Thin section; black and white
S-70-25889	12022-8	Thin section; black and white
S-70-25890	12020-11	Thin section; black and white
S-70-25891	12020-10	Thin section; black and white
S-70-26176		Apollo 11 and Apollo 12 modes
S-70-26177		Apollo 12 size graph; black and white
S-70-26178		Apollo 12 chemistry
S-70-26415 to S-70-26436	12063	Surface closeups; color negatives
S-70-26591 to S-70-26629	12063	Surface closeups; black and white
S-70-26630 to S-70-26650	12065	Surface closeups; black and white
S-70-26651 to S-70-26671	12063	Surface closeups; black and white
S-70-26672 to S-70-26689	12065	Surface closeups; black and white

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-70-26690 to S-70-26700	12063	Surface closeups; black and white	S-70-28216	12014-9	Thin section; black and white
			S-70-28217	12034-3	Thin section; black and white
S-70-26701 to S-70-26721	12065	Surface closeups; black and white	S-70-28218	12014-9	Thin section; black and white
			S-70-28219 and S-70-28220	12002-4	Thin sections; black and white
S-70-27973	12018-6	Thin section; black and white			
S-70-27974	12063-14	Thin section; black and white	S-70-28221 and S-70-28222	12002-5	Thin sections; black and white
S-70-27975	12010-5	Thin section; black and white			
S-70-27976	12062-7	Thin section; black and white	S-70-28223 and S-70-28224	12062-7	Thin sections; black and white
S-70-27977	12010-6	Thin section; black and white			
S-70-27978	12018-6	Thin section; black and white	S-70-28225	12063-16	Thin section; black and white
S-70-27979	12010-6	Thin section; black and white	S-70-28226	12022-11	Thin section; black and white
S-70-27980 and S-70-27981	12063-14	Thin sections; black and white	S-70-28227	12052-7	Thin section; black and white
			S-70-28228	12013-7	Thin section; black and white
S-70-27982	12063-15	Thin section; black and white	S-70-28674	12018-10	Thin section; black and white
S-70-27983	12020-11	Thin section; black and white	S-70-28675	12063-21	Thin section; black and white
S-70-27984	12063-16	Thin section; black and white	S-70-28676	12034-4	Thin section; black and white
S-70-27985	12052-7	Thin section; black and white	S-70-28677	12010-5	Thin section; black and white
S-70-27986	12052-8	Thin section; black and white	S-70-28678	12004-8	Thin section; black and white
S-70-27987	12004-8	Thin section; black and white	S-70-28679	12038-4	Thin section; black and white
S-70-27988	12002-4	Thin section; black and white	S-70-28680	12063-21	Thin section; black and white
S-70-27989	12002-5	Thin section; black and white	S-70-28681	12018-10	Thin section; black and white
S-70-27990	12034-3	Thin section; black and white	S-70-28682	12010-5	Thin section; black and white
S-70-27991	12020-9	Thin section; black and white	S-70-28683	12038-4	Thin section; black and white
S-70-27992	12044-4	Thin section; black and white	S-70-28684	12034-4	Thin section; black and white
S-70-27993	12013-7	Thin section; black and white	S-70-28685	12004-8	Thin section; black and white
S-70-27994	12018-8	Thin section; black and white	S-70-28686 and S-70-28687	12022-12	Thin sections; black and white
S-70-28211	12013-7	Thin section; black and white			
S-70-28212	12018-8	Thin section; black and white	S-70-28688 and S-70-28689	12018-7	Thin sections; black and white
S-70-28213 and S-70-28214	12022-11	Thin sections; black and white			
			S-70-30213	12062-9	Thin section
S-70-28215	12044-4	Thin section; black and white	S-70-30214	12063-25	Thin section

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-70-30215	12038-4	Thin section	S-70-30246	12009-9	Thin section
S-70-30216	12062-8	Thin section	S-70-30247	12014-8	Thin section
S-70-30217	12002-8	Thin section	S-70-30248	12002-6	Thin section
S-70-30218	12063-19	Thin section	S-70-30249	12018-11	Thin section
S-70-30219	12064-6	Thin section	S-70-30250	12052-9	Thin section
S-70-30220	12063-19	Thin section	S-70-30251	12020-14	Thin section
S-70-30221	12057-23	Thin section	S-70-30252	12020-11	Thin section
S-70-30222	12057-30	Thin section	S-70-30253	12020-9	Thin section
S-70-30223 and S-70-30224	12018-10	Thin sections	S-70-30254	12020-13	Thin section
			S-70-30255	12062-9	Thin section
S-70-30225	12063-15	Thin section	S-70-30256	12062-18	Thin section
S-70-30226	12018-9	Thin section	S-70-30257	12064-6	Thin section
S-70-30227	12002-10	Thin section	S-70-30258	12064-9	Thin section
S-70-30228	12004-9	Thin section	S-70-30259	12004-11	Thin section
S-70-30229	12020-13	Thin section	S-70-30260	12064-7	Thin section
S-70-30230	12063-24	Thin section	S-70-30261	12064-8	Thin section
S-70-30231	12002-9	Thin section	S-70-30262	12063-22	Thin section
S-70-30232	12052-9	Thin section	S-70-30263	12063-24	Thin section
S-70-30233 and S-70-30234	12063-22	Thin sections	S-70-30264	12064-9	Thin section
			S-70-30265	12063-20	Thin section
S-70-30235	12020-14	Thin section	S-70-30266	12020-13	Thin section
S-70-30236	12063-17	Thin section	S-70-30267	12063-19	Thin section
S-70-30237	12018-11	Thin section	S-70-30268	12002-6	Thin section
S-70-30238	12002-10	Thin section	S-70-30269	12064-8	Thin section
S-70-30239	12002-9	Thin section	S-70-30270	12063-17	Thin section
S-70-30240	12004-9	Thin section	S-70-30271	12063-18	Thin section
S-70-30241	12002-8	Thin section	S-70-30272	12004-11	Thin section
S-70-30242	12009-8	Thin section	S-70-30273 and S-70-30274	12063-25	Thin sections
S-70-30243	12002-7	Thin section			
S-70-30244	12018-9	Thin section	S-70-30954 and S-70-30955	12063-19	Thin sections
S-70-30245	12004-10	Thin section			

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-70-30956	12002-9	Thin section	S-70-31644 and S-70-31645	12002-158	Thin sections
S-70-30957	12020-4	Thin section			
S-70-30958 and S-70-30959	12063-19	Thin sections	S-70-31646	12002-157	Thin section
			S-70-31647	12002-158	Thin section
S-70-30960 and S-70-30961	12004-11	Thin sections	S-70-31648	12002-159	Thin section
			S-70-31649	12002-157	Thin section
S-70-31559	12020-16	Thin section	S-70-31650 and S-70-31651	12002-159	Thin sections
S-70-31560	12063-20	Thin section			
S-70-31561	12063-23	Thin section	S-70-31652 and S-70-31653	12020-15	Thin sections
S-70-31562	12064-7	Thin section			
S-70-31563	12009-10	Thin section	S-70-31654 and S-70-31655	12009-10	Thin sections
S-70-31564	12063-15	Thin section			
S-70-31565	12073-10	Thin section	S-70-31656 and S-70-31657	12009-8	Thin sections
S-70-31566	12020-15	Thin section			
S-70-31567	12009-9	Thin section	S-70-31658 and S-70-31659	12009-9	Thin sections
S-70-31568	12009-8	Thin section			
S-70-31569	12004-10	Thin section	S-70-31660 and S-70-31661	12009-11	Thin sections
S-70-31570	12009-11	Thin section			
S-70-31571	12002-157	Thin section	S-70-31662 and S-70-31663	12073-10	Thin sections
S-70-31572	12002-159	Thin section			
S-70-31573	12002-156	Thin section	S-70-31664 and S-70-31665	12063-15	Thin sections
S-70-31574	12002-158	Thin section			
S-70-31575	12002-156	Thin section	S-70-31666 and S-70-31667	12063-23	Thin sections
S-70-31576	12002-7	Thin section			
S-70-31577 and S-70-31578	12002-156	Thin sections	S-70-31668 and S-70-31669	12063-20	Thin sections
S-70-31579	12020-16	Thin section	S-70-32727 to S-70-32730	12020-9	Thin sections
S-70-31580	12064-7	Thin section			
S-70-31581	12002-7	Thin section	S-70-32731 and S-70-32732	12020-11	Thin sections
S-70-31582	12004-10	Thin section			
S-70-31583	12052-8	Thin section	S-70-32733	12063-18	Thin section

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-70-32734	12020-11	Thin section	S-70-36459 and S-70-36460	12002-161	Thin sections
S-70-32735	12073-10	Thin section	S-70-36461 and S-70-36462	12002-165	Thin sections
S-70-32736	12063-18	Thin section	S-70-36463 and S-70-36464	12002-164	Thin sections
S-70-32737 and S-70-32738	12073-10	Thin sections	S-70-36465 and S-70-36466	12073-12	Thin sections
S-70-32739 to S-70-32746	12004-2	Surface closeups; black and white	S-70-36467	12062-10	Thin section
S-70-33325 to S-70-33342	12009	Surface closeups by diagrams; black and white	S-70-36468 to S-70-36470	12053-76	Thin sections
S-70-33355 to S-70-33368	12010	Surface closeups by diagrams; black and white	S-70-36471	12002-166	Thin section
S-70-33434 to S-70-33453	12013-7	Thin sections	S-70-36472	12009-15	Thin section
S-70-33460 to S-70-33503	12019	1:1 closeups	S-70-36473	12053-75	Thin section
S-70-33504 to S-70-33549	12002	1:1 closeups	S-70-36474	12053-76	Thin section
S-70-33797 to S-70-33841	12075	1:1 closeups	S-70-36475	12062-10	Thin section
S-70-33842 to S-70-33877	12034	1:1 closeups	S-70-36476	12073-12	Thin section
S-70-36450	12002-161	Thin section	S-70-36477	12002-166	Thin section
S-70-36451	12002-164	Thin section	S-70-36478	12009-15	Thin section
S-70-36452	12002-160	Thin section	S-70-36479 and S-70-36480	12053-75	Thin sections
S-70-36453	12002-165	Thin section	S-70-36481	12053-76	Thin section
S-70-36454	12009-12	Thin section	S-70-36482 and S-70-36483	12053-75	Thin sections
S-70-36455	12004-48	Thin section	S-70-36864 to S-70-36903	12053	Sample-cutting photographs
S-70-36456	12009-12	Thin section	S-70-36904 to S-70-36917	12051	Sample-cutting photographs
S-70-36457 and S-70-36458	12002-160	Thin sections	S-70-36918 to S-70-36943	12053	Sample-cutting photographs

NASA photograph number	Sample number	Description	NASA photograph number	Sample number	Description
S-70-36944 to S-70-36946	12051	Sample-cutting photographs	S-70-39830 to S-70-39849	12063	Sample-cutting photographs
S-70-36947 to S-70-36986	12053	Sample-cutting photographs	S-70-39850 and S-70-39851	12022	Sample-cutting photographs
S-70-36987 to S-70-36992	12051	Sample-cutting photographs	S-70-39852 to S-70-39865	12063	Sample-cutting photographs
S-70-37257 to S-70-37274	12065	Sample-cutting photographs	S-70-40348 and S-70-40349	12013	Sample-cutting photographs
S-70-37687 and S-70-37688	12002-162	Thin sections	S-70-40673 to S-70-40687	12013	Sample-cutting photographs
S-70-37689	12009-13	Thin section	S-70-40688 to S-70-40706	12004	Sample-cutting photographs
S-70-37690 and S-70-37691	12053-77	Thin sections			
			S-70-40707 to S-70-40710	12002	Sample-cutting photographs
S-70-37692	12018-12	Thin section			
S-70-37693	12053-77	Thin section	S-70-40711 to S-70-40725	12034	Sample-cutting photographs
S-70-37694	12009-13	Thin section			
S-70-37695	12063-11	Thin section	S-70-40726 to S-70-40735	12022	Sample-cutting photographs
S-70-37696	12053-77	Thin section			
S-70-37697 and S-70-37698	12073-11	Thin sections	S-70-40736 to S-70-40739	12018	Sample-cutting photographs
S-70-37699	12062-11	Thin section	S-70-40807 and S-70-40808	12051-53	Thin sections
S-70-37700	12018-12	Thin section			
S-70-37701	12073-11	Thin section	S-70-40809	12053-84	Thin section
S-70-37702	12053-77	Thin section	S-70-40810	12053-54	Thin section
S-70-38313 to S-70-38525	12002	Sample-cutting photographs	S-70-40811	12051-55	Thin section
			S-70-40812	12051-54	Thin section
S-70-39758 to S-70-39798	12021	Sample-cutting photographs	S-70-40813 and S-70-40814	12053-54	Thin sections
S-70-39799 to S-70-39829	12022	Sample-cutting photographs	S-70-40815	12065-93	Thin section
			S-70-40816 and S-70-40817	12053-54	Thin sections

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-70-40818	12051-55	Thin section
S-70-40819	12065-93	Thin section
S-70-40820	12051-53	Thin section
S-70-40821	12053-84	Thin section
S-70-40822	12009-13	Thin section
S-70-40823 and S-70-40824	12065-92	Thin sections
S-70-40825	12053-84	Thin section
S-70-40826	12053-78	Thin section
S-70-40827	12051-53	Thin section
S-70-40828	12051-55	Thin section
S-70-40829 and S-70-40830	12065-92	Thin sections
S-70-40831 and S-70-40832	12053-84	Thin sections
S-70-40833 and S-70-40834	12013-9	Thin sections
S-70-40835 and S-70-40836	12051-55	Thin sections
S-70-40837	12073-14	Thin section
S-70-40838	12002-167	Thin section
S-70-40839	12063-12	Thin section
S-70-40840	12065-92	Thin section
S-70-40841	12073-14	Thin section
S-70-40842	12002-162	Thin section
S-70-40843	12053-54	Thin section
S-70-40844	12051-55	Thin section
S-70-40845	12051-53	Thin section
S-70-41196	12065-95	Thin section
S-70-41197 and S-70-41198	12051-59	Thin sections
S-70-41199	12004-50	Thin section
S-70-41200	12053-85	Thin section
S-70-41201	12053-83	Thin section
S-70-41202	12065-95	Thin section
S-70-41203	12051-58	Thin section
S-70-41204 and S-70-41205	12013-15	Thin sections
S-70-41206 and S-70-41207	12065-95	Thin sections
S-70-41208	12053-85	Thin section
S-70-41209	12065-95	Thin section
S-70-41210	12053-85	Thin section
S-70-41211	12013-15	Thin section
S-70-41212	12065-94	Thin section
S-70-41213 and S-70-41214	12053-85	Thin sections
S-70-41215	12051-59	Thin section
S-70-41216	12004-50	Thin section
S-70-41217	12051-59	Thin section
S-70-41218	12065-96	Thin section
S-70-41389	12065-93	Thin section
S-70-41390	12013-14	Thin section
S-70-41391 and S-70-41392	12065-93	Thin sections
S-70-41393	12053-83	Thin section
S-70-41394	12065-93	Thin section
S-70-41395 and S-70-41396	12053-83	Thin sections
S-70-41397	12065-94	Thin section
S-70-41398	12053-83	Thin section

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-70-41399 and S-70-41400	12065-94	Thin sections
S-70-41401	12065-96	Thin section
S-70-41402	12065-94	Thin section
S-70-41403	12051-58	Thin section
S-70-41404	12065-96	Thin section
S-70-41405 and S-70-41406	12051-58	Thin sections
S-70-41407	12013-13	Thin section
S-70-41408	12013-14	Thin section
S-70-41409 and S-70-41410	12013-13	Thin sections
S-70-42732	12051-57	Thin section
S-70-42733	12073-15	Thin section
S-70-42734	12051-56	Thin section
S-70-42735	12065-97	Thin section
S-70-42736	12021-124	Thin section
S-70-42737	12034-32	Thin section
S-70-42738	12004-51	Thin section
S-70-42739	12073-13	Thin section
S-70-42740	12004-55	Thin section
S-70-42741	12004-51	Thin section
S-70-42742 and S-70-42743	12021-132	Thin sections
S-70-42744	12004-55	Thin section
S-70-42745	12065-107	Thin section
S-70-42746	12073-13	Thin section
S-70-42747 to S-70-42749	12065-107	Thin sections
S-70-42751 to S-70-42753	12051-61	Thin sections
S-70-42754	12073-15	Thin section
S-70-42755	12034-32	Thin section
S-70-43340	12065-109	Thin section
S-70-43341	12051-60	Thin section
S-70-43342	12009-14	Thin section
S-70-43343	12065-108	Thin section
S-70-43344 and S-70-43345	12053-86	Thin sections
S-70-43346	12063-110	Thin section
S-70-43347	12009-14	Thin section
S-70-43348	12034-37	Thin section
S-70-43349	12021-136	Thin section
S-70-43350	12053-86	Thin section
S-70-43351	12021-135	Thin section
S-70-43352	12051-62	Thin section
S-70-43353 and S-70-43354	12021-141	Thin sections
S-70-43355	12034-37	Thin section
S-70-43356	12021-136	Thin section
S-70-43357	12021-141	Thin section
S-70-43358	12063-110	Thin section
S-70-43359	12021-136	Thin section
S-70-43360 and S-70-43361	12051-62	Thin sections
S-70-43362	12021-135	Thin section
S-70-43363	12051-62	Thin section
S-70-43364	12053-86	Thin section
S-70-43365	12021-135	Thin section
S-70-43421	12021-125	Thin section
S-70-43422 to S-70-43426	12053-87	Thin sections

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-70-43427 to S-70-43430	12065-97	Thin sections
S-70-43431 and S-70-43432	12021-125	Thin sections
S-70-43433 and S-70-43434	12021-124	Thin sections
S-70-43435 to S-70-43439	12051-56	Thin sections
S-70-43440	12004-57	Thin section
S-70-43441 to S-70-43443	12051-60	Thin sections
S-70-43444	12004-57	Thin section
S-70-43445 and S-70-43446	12018-74	Thin sections
S-70-43447 to S-70-43450	12065-109	Thin sections
S-70-43451 to S-70-43454	12065-106	Thin sections
S-70-43455 to S-70-43457	12065-108	Thin sections
S-70-43458 and S-70-43459	12004-56	Thin sections
S-70-43460	12034-36	Thin section
S-70-43461	12004-58	Thin section
S-70-43517	12021-139	Thin section
S-70-43518 and S-70-43519	12022-110	Thin sections
S-70-43520	12022-111	Thin section
S-70-43521	12022-110	Thin section
S-70-43522	12053-90	Thin section
S-70-43523	12022-113	Thin section
S-70-43524	12034-34	Thin section
S-70-43525	12034-33	Thin section
S-70-43526	12018-76	Thin section
S-70-43527	12073-16	Thin section
S-70-43528	12021-137	Thin section
S-70-43529	12021-134	Thin section
S-70-43530 and S-70-43531	12021-139	Thin sections
S-70-43532 and S-70-43533	12021-137	Thin sections
S-70-43534 and S-70-43535	12021-134	Thin sections
S-70-43536	12073-16	Thin section
S-70-43537	12018-76	Thin section
S-70-43538	12034-33	Thin section
S-70-43539	12034-34	Thin section
S-70-43540 to S-70-43542	12053-90	Thin sections
S-70-43543 and S-70-43544	12022-113	Thin sections
S-70-43545 and S-70-43546	12022-111	Thin sections
S-70-43632 and S-70-43633	12013-8	Color closeups
S-70-43634 to S-70-43637	12013-11	Color closeups
S-70-43638 to S-70-43640	12020	Color closeups
S-70-43641	12013	Color closeup
S-70-43800 to S-70-43805	12010-0	Color closeups

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Continued

NASA photograph number	Sample number	Description
S-70-43827	12009-16	Thin section
S-70-43828	12021-142	Thin section
S-70-43829	12034-35	Thin section
S-70-43830	12021-140	Thin section
S-70-43831	12022-116	Thin section
S-70-43832	12022-115	Thin section
S-70-43833	12018-75	Thin section
S-70-43834	12009-16	Thin section
S-70-43835	12034-35	Thin section
S-70-43836	12018-77	Thin section
S-70-43837	12018-75	Thin section
S-70-43838 and S-70-43839	12021-142	Thin sections
S-70-43840	12018-77	Thin section
S-70-44014 to S-70-44023	12075-4	Full-view color photographs
S-70-44088 to S-70-44093	12008	Color closeups
S-70-44094 and S-70-44095	12073-17	Color closeups
S-70-44096	12017	Color closeup
S-70-44097	12073-17	Color closeup
S-70-44098 and S-70-44099	12017	Color closeups
S-70-44100	12051	Artist's drawing of rock-cutting genealogy
S-70-44101	12053	Artist's drawing of rock-cutting genealogy
S-70-44102	12009	Artist's drawing of rock-cutting genealogy
S-70-44103	12002-33	Artist's drawing of rock-cutting genealogy
S-70-44104	12022-14	Artist's drawing of rock-cutting genealogy
S-70-44105	12065	Artist's drawing of rock-cutting genealogy
S-70-44106	12022-13	Artist's drawing of rock-cutting genealogy
S-70-44107	12002-27	Artist's drawing of rock-cutting genealogy
S-70-44108	12002-23	Artist's drawing of rock-cutting genealogy
S-70-44109	12002-48	Artist's drawing of rock-cutting genealogy
S-70-44110	12063	Artist's drawing of rock-cutting genealogy
S-70-44111	12065-21	Artist's drawing of rock-cutting genealogy
S-70-44112	12004-2	Artist's drawing of rock-cutting genealogy
S-70-44113	12065-16	Artist's drawing of rock-cutting genealogy
S-70-44114	12002	Artist's drawing of rock-cutting genealogy
S-70-44115	12002-26 and -28	Artist's drawing of rock-cutting genealogy
S-70-44116	12021-33	Artist's drawing of rock-cutting genealogy
S-70-44117	12053-4	Artist's drawing of rock-cutting genealogy
S-70-44118	12002-21	Artist's drawing of rock-cutting genealogy
S-70-44119	12051-2	Artist's drawing of rock-cutting genealogy
S-70-44120	12022-0	Artist's drawing of rock-cutting genealogy
S-70-44121	12004-15	Artist's drawing of rock-cutting genealogy
S-70-44122	12021	Artist's drawing of rock-cutting genealogy
S-70-44123	12063-31, -32, and -33	Artist's drawing of rock-cutting genealogy
S-70-44124	12063-28, -30, and -34	Artist's drawing of rock-cutting genealogy

NASA photograph number	Sample number	Description
S-70-44125	12034	Artist's drawing of rock-cutting genealogy
S-70-44126	12053-6	Artist's drawing of rock-cutting genealogy
S-70-44127	12065-20	Artist's drawing of rock-cutting genealogy
S-70-44174 to S-70-44179	12035-9	Color closeups
S-70-44328 and S-70-44329	12035-7	Color closeups
S-70-44330 to S-70-44336	12073-17	Color closeups
S-70-44450 to S-70-44459	12064-11	Color closeups
S-70-44524	12040-46	Thin section
S-70-44525	12038-68	Thin section
S-70-44526	12063-113	Thin section
S-70-44527	12022-118	Thin section
S-70-44528	12020-57	Thin section
S-70-44529	12008-19	Thin section
S-70-44540	12020-28	Thin section
S-70-44541	12022-119	Thin section
S-70-44542	12010-29	Thin section
S-70-44543	12010-30	Thin section
S-70-44544	12018-80	Thin section
S-70-44545	12022-118	Thin section
S-70-44546	12075-23	Thin section
S-70-44547	12018-79	Thin section
S-70-44548	12040-43	Thin section
S-70-44549	12075-22	Thin section
S-70-44550	12038-68	Thin section
S-70-44551 and S-70-44552	12040-44	Thin sections
S-70-44553	12038-67	Thin section
S-70-44554	12038-66	Thin section
S-70-44555	12040-46	Thin section
S-70-44556	12010-29	Thin section
S-70-44557	12008-14	Thin section
S-70-44558	12020-57	Thin section
S-70-44559 and S-70-44560	12065-112	Thin sections
S-70-44561	12008-14	Thin section
S-70-44562	12038-67	Thin section
S-70-44563	12075-22	Thin section
S-70-44564	12018-79	Thin section
S-70-44565	12022-119	Thin section
S-70-44566	12010-30	Thin section
S-70-44567	12008-19	Thin section
S-70-44568	12018-80	Thin section
S-70-44569	12040-43	Thin section
S-70-44570	12010-28	Thin section
S-70-44571	12075-23	Thin section
S-70-44572	12008-15	Thin section
S-70-44573	12020-56	Thin section
S-70-44574	12008-15	Thin section
S-70-44630 to S-70-44639	12052-10	Color closeups
S-70-44847 and S-70-44848	12052-1	Color closeups
S-70-45306 to S-70-45312	12017	Color closeups
S-70-45621	12010-31	Thin section
S-70-45622	12075-27	Thin section
S-70-45623	12063-115	Thin section

TABLE D-IV. - LUNAR-SAMPLE PHOTOGRAPHIC INDEX BY NASA PHOTOGRAPH NUMBER - Concluded

NASA photograph number	Sample number	Description
S-70-45624	12062-13	Thin section
S-70-45625	12010-31	Thin section
S-70-45626	12035-21	Thin section
S-70-45627	12035-24	Thin section
S-70-45628	12010-32	Thin section
S-70-45629	12075-27	Thin section
S-70-45630	12035-24	Thin section
S-70-45631	12062-13	Thin section
S-70-45632	12075-26	Thin section
S-70-45633	12035-22	Thin section
S-70-45634	12010-32	Thin section
S-70-45635	12035-22	Thin section
S-70-45636	12010-33	Thin section
S-70-45637	12035-21	Thin section
S-70-45638	12075-26	Thin section
S-70-45639	12035-25	Thin section
S-70-45640	12021-145	Thin section
S-70-45641	12063-115	Thin section
S-70-45642 and S-70-45643	12021-145	Thin sections
S-70-45644	12010-33	Thin section

SAMPLE CROSS-REFERENCE

The third index (table D-V) is a cross-reference of all samples collected during the EVA traverses with (1) the tentative lunar-surface locations, (2) the lunar-surface photographs in which the samples are shown, and (3) the chronological sequence (in ground-elapsed time) in which the samples were collected. The tentative identification of the samples is based on a combination of the astronauts' descriptions and a correlation of the sample characteristics as seen in the NASA and the surface photographs. Samples indicated in the first column of table D-V as "(?)" have not been identified; however, where the sample number is given with the "(?)," the reference to an actual sample is strongly suggested. Further study of the surface photographs may permit additional identification and orientation of the samples.

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Contingency sample						
12070 to 12077	Total contingency sample		All collected from the rim of a small crater 15 m northwest of LM.	AS12-48-7029 to AS12-48-7033 (sample area before sampling) (panorama 1, right-hand LM window)	04:19:26 to 04:19:28 (sampling)	CDR "... I'm going over to get my contingency sample, and I'll get one of the rocks — in the sample. And yes, as a matter of fact, it is built up on the side that the LM landed on. Let me get it. Well, there's one scoop. There 's another with some more rocks in it ... here's another good-looking rock ... there's another rock I want to get in it."
12070	D — fines	1102		16-mm sequence-camera photographs show sample area before and during sampling		"I think that's about enough, don't you? Except there's one big rock that's too pretty to pass up ... it won't fit. I'll go over and get this other one, though."
12071	E — chips	9.16				
12072	A — basalt	103.6				
12073	C — breccia	407.6	Identified and tentatively oriented in presampling photographs.	AS12-46-6719 to AS12-46-6723 (postsample photographs showing scoop marks)		CDR "One of the first things that I can see, by golly, is little glass beads. I got a piece about a quarter of an inch in sight, and I'm going to put it in the contingency sample bag, if I can get it. I got it ..."
12074	(Broken from sample 12073)	46.6				
12075	A — basalt	232.5	Identified and tentatively oriented in presampling photographs.		04:19:39	CDR "... I got the contingency sample in the bag." (Equipment transfer bag)
12076	A — basalt	54.55				
12077	A — basalt	22.63			04:19:43	CDR "That contingency sample is black."
						LMP "You'd better believe it."
Selected samples						
12017 [a](1)	AB — glass-coated basalt		Near the small mound. It is not clear whether the sample was picked up from the mound or from the debris apron nearby; however, the sample is probably associated with mound material. Identification is from the description only. Rock 12017 is the only selected sample that has a shiny glass coating. The sample is not identified in surface photographs, and the lunar orientation is not known; the glassy side was probably up, thus attracting attention as a specimen.	AS12-46-6822 to AS12-46-6825 (small mound photographs; sample not located)	04:22:02	LMP "Hey, here's a rock they'll be glad to see in Houston ... It's an interesting one[b]. It looks like a solid glass chunk. It's real shiny black ..."

[a]A total of 20 rocks is included in the selected sample. The numbers in parentheses indicate the sequence of rocks picked up, as inferred from a study of the mission transcript and the lunar-surface photographs.

[b]The Public Affairs Office (PAO) transcript has the remark here, "It's rather soft --"; however, this remark is not found in other transcripts.

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
			Selected samples - Continued			
Rock (?) (2)	Unidentified		Near the small mound. This is probably a rock picked up in addition to the glassy one. It is not identified by photographs or description.	AS12-46-6822 to AS12-46-6825 (small mound photographs; sample not located)	04:22:03 04:22:04	CDR "Put this rock in your pack." CDR "- - glass spatter on it. That's fantastic." (Probably refers to rock 12017, picked up by the LMP)
12021T (3)	B — gabbro pegmatite	1876.6	Approximately 10 m north of large mound, probably on an apron of debris derived from the mound. Sample can be identified and oriented in photograph AS12-47-6932. Sample area can be seen north of large mound in photographs AS12-46-6827 and AS12-46-6828.	AS12-47-6932 (closeup view of sample before collection; tongs and boot give scale) AS12-46-6827 and AS12-46-6828 (sample area before sampling)	04:22:08	LMP "Want to get a picture of that?" CDR "Sure do." LMP "Let me get it set up." CDR "Right." LMP "Try it at f/8. Okay. There you go. Grab her up, Pete."
12008T (4)	AB — olivine vitrophyre	58.4	Southeast side of large mound. Sample is tentatively identified and oriented in the surface photographs. Rock 12008 has a distinctively black color.	AS12-46-6831 and AS12-46-6832 (closeup stereopair of southeast side of large mound)	04:22:09	LMP "... you've already got pictures of the - this, Pete?" (Probably refers to the large mound) CDR "Yes, at 15 feet. I'm just taking it close up over here." LMP "Okay. Take that at about - -" CDR "... Look at this black rock here." LMP "Okay. Wait. Let me get close - Wait - Wait. Uh oh - That ruins it." (Apparently refers to a proposed photograph) CDR "I got it, I got it, I got it." LMP "Yes, but I didn't get a picture of it. Okay."
12022T (5)	B — olivine basalt	1864.3	Northeast side of large mound. Rock 12022 is tentatively identified and oriented in the surface photographs. (Not clear whether another photograph or another sample taken here.)	AS12-47-6933 AS12-47-6934(?)	04:22:09 04:22:10	CDR "Of that one? Yes. Okay?" (Probably pointing at a proposed sample with tongs) LMP "There's your old picture in there. Let's get another one from here ... this one - -"

TABLE D-V.- CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Selected samples - Continued						
12007(?) (6)	A — porphyritic basalt (pyroxene crystals to 3 cm long)	65.2	From the large mound. Identification is from description only; sample 12007 is small and angular and appears to be freshly broken. Texture could suggest microbreccia during sampling.	AS12-47-6933 to AS12-47-6935 (sample not recognized)	04:22:10	LMP "Let me see if I can chip some of that off, Pete, with this. Get my tool here. I know - -" CDR "... okay." LMP "Kind of knock a piece of that off." CDR " Got the feeling that when that crater was made, it just threw out a big blob of dirt. This is where it landed." LMP "Yes." CDR "Ain't any that big." LMP "Hey, you'd almost - I wouldn't be surprised to find this is that micro ... You haven't got any ..." (Sample bags?)
				AS12-47-6934 and/or AS12-47-6935	04:22:11	LMP "Hey, look at that picture." LMP "Okay. That'll be a goodie."
12004T (7)	A — olivine basalt	585.0	Sample is tentatively identified and oriented in the lunar-surface photographs that were taken to show the fresh-looking craters approximately 50 m north northwest from large mound in an area of north-south lineaments.	AS12-47-6936 and AS12-47-6937	04:22:15	(Nothing was said about samples at this time)
			Precise location not known but near the rim of Middle Crescent Crater. The sequence and numbers of photographs and samples taken at this time are difficult to determine. LMP photograph AS12-47-6938 shows the CDR at the location where he took photograph AS12-46-6834.	AS12-46-6833 to AS12-46-6835 AS12-47-6938	04:22:16 to 04:22:17	CDR "Yes. We're almost to the crater (Middle Crescent Crater). Okay, ... we're not getting very many rocks by going this far ..." LMP "Hey, ... when we start picking up, we'll try to get a larger sample - -" CDR "Hey, ... this looks like a brilliant sparking fresh impact crater. Look at that little fellow, huh?" LMP "Sure does, doesn't he?" CDR "Yes. Let's get some rocks right here; here's some. Here, get some pictures first. Get some pictures of that crater, and I'll get some over there. I'll get this one right here."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
			Selected samples - Continued			
12013T (8)	A — anorthosite breccia	82.3	Near rim of Middle Crescent Crater. Precise location not known. Sample identified and tentatively oriented from photographic interpretation only. Right-hand rock in foreground group.	AS12-46-6833	04:22:16	(Crew comments at this time are shown above)
12019T (9)	A — basalt	462.4	Tentatively identified and oriented from photographic interpretation only. Center rock in foreground group.	AS12-46-6833	04:22:16	(Crew comments at this time are shown above)
12010T (10)	A — microbreccia	360.0	Tentatively identified and oriented from photographic interpretation only. Shown in center foreground of lunar-surface photograph.	AS12-46-6835	04:22:17	CDR "There - there's a rock for you." LMP "Okay." CDR "Listen, we need to find a grapefruit, too, you know." LMP "Yes. There's a bunch around."
12015(?) (11)	A — olivine vitrophyre	191.2	Near the rim of Middle Crescent Crater. Sample not recognized in lunar-surface photographs. Questioned identification is based on the "dent"; rock 12015 has a spherical cavity approximately 3 cm in diameter.	AS12-46-6833 to AS12-46-6835	04:22:17	CDR "Made a dent in this rock. Whoops. Wait a minute; I dropped it. Hold it, move on a little bit . . ."
Rock (?)	Probably not sampled		On rim of Middle Crescent Crater. No comment about actually picking up a sample.		04:22:17	CDR ". . . Look at there; that crater's spectacular, isn't it? Wow, what a monster! Look at that rock! I'd like to . . ." LMP "Oh, . . . get some of this bedrock - -"
			(Panorama 6 taken at this time.)	AS12-46-6836 to AS12-46-6844	04:22:18	
Rock (?) (12)	Unidentified		Near site of panorama 6 (not recognized in lunar-surface photographs).		04:22:19	LMP "Got it. I was just looking over this rock down here. Looks like it came - -" CDR "Just a minute. Okay. Now, let me go over here, and I'll get one in stereo of this baby." (Stereopanorama of Middle Crescent Crater)
			(Panorama 7 taken at this time.)	AS12-46-6845 to AS12-46-6852	04:22:19	

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Selected samples - Continued						
Rock (13)	Unidentified		Near site of panorama 7 (not recognized in lunar-surface photographs).		04:22:20	LMP "We're picking up a couple right now, and we're on our way back. Just a minute. Boy, there's a big block over there."
						CDR "Why don't you get it? Got it? I can't get it with the tongs."
						LMP "Move ahead and I'll pick it up."
						CDR "Hey, wait a minute. How about this?"
						LMP "Get it?"
						CDR "Push it over here and I'll get it."
						LMP "Push her over here."
						CDR "Okay, ..."
						LMP "Drop it in my bag."
						CDR "Okay, ..."
Rock (?)	Unidentified — probably not a sample		Near site of panorama 7 (not recognized in lunar-surface photographs).		04:22:21	CDR "Okay. You got anything else you want to put in your bag? Got to push another one over here."
						LMP "Okay, in just a minute."
						CDR "Okay."
						LMP "A couple of big ones. Oh, I wish I could get this inside of that. I can't."
						CDR "Try that one."
						LMP "That's a good one."
						CDR "Huh?"
Rock (14)	Unidentified		Southeast rim of Middle Crescent Crater.		04:22:21	LMP "A couple of nice ones right here. Wait a minute. Get my ..."
						CDR "There you go. Oops."
						LMP "Okay, ..."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
			Selected samples - Continued			
Rock (15)	Unidentified		Southeast rim of Middle Crescent Crater.		04:22:21	LMP "... Wait a minute. Yes. Let's just - let's just get - get this real good one." CDR "Yes." LMP "Okay. We're getting you some of this rock and hope it's a ... Let's go back."
12016T (16)	AB — basalt	2028.3	Southeast rim of Middle Crescent Crater. Sample is tentatively identified and oriented in lunar-surface photograph, prominently perched on the rim of a 2-m crater approximately 40 m southeast from panorama 6 and 7 sites.	AS12-47-6939	04:22:22	LMP "That's interesting, isn't it?" CDR "What?" LMP "I was looking at that rock perched right over on top of the hill, there ... my distance here, because there's nothing but - -" (Taking a picture?) CDR "Here." (Giving LMP the sample?) LMP "- - all the same." CDR "Yes." LMP "... the same."
Rocks (?)	Unidentified rock		Near ALSEP, not certain that any rocks were actually picked up at this time.	No photographs	04:22:23	CDR "Listen. When I get this rock box, we've got to get some more rocks. Turned us all around and we didn't get any rocks." LMP "I'm getting some up here." CDR "We'll fill it. Just a minute."
12014T (17)	B — olivine basalt	159.4	Near ALSEP, possibly about halfway between ALSEP and the small mound. Tentatively identified and oriented in lunar-surface photograph, correlating with LRL sample photograph S-69-63382.	AS12-47-6940	04:22:23	CDR "Hey, Houston. We're approaching the ALSEP, headed back to the LM." LMP "Hey, ease over this way a little." CDR "Which way?" LMP "Over towards your left." CDR "What you want to do?" LMP "I thought there were a couple of good rocks over there. There." (Evidently, LMP had noted these during ALSEP deployment) CDR "Be about halfway - -" LMP "Why don't we grab a couple of rocks here?"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day:hr:min	Crew comments relating to samples
			Selected samples - Continued			
						CDR "All right. Here's one right here."
						LMP "Okay. Let me get a photograph of it. Hurry. We're on our way."
						LMP "Okay. There's a good one. Wait a minute. Eight. Step in and get the picture."
						CDR "Got it?"
						LMP "Got it. There you go."
						CDR "Good boy. Okay."
Rock (18)	Unidentified rock		Near ALSEP.	No photograph	04:22:24	LMP "Get another good one. Forget the picture."
						CDR "Okay. You're in the shadow. Step back just a little."
						LMP "I said forget the picture - -"
						CDR "Okay."
12020(?) (or) 12006(?) (19)	A — olivine basalt AB — olivine basalt	312.0 206.4	Between ALSEP and the LM. Using the "grinning" face as a clue to identity, rocks 12020 and 12006 both are vuggy and could have "faces" at certain orientations.	No photograph	04:22:25	CDR "Okay, We're within about 300 feet of the LM now, Houston."
						"There's a good rock."
						LMP "Halt, halt, halt."
						CDR "Look at that!"
						LMP "I swear there's a - -"
						CDR "Never saw one like that before. Look at that! ... That green, what is it?"
						LMP "- - see it."
						CDR "No, it was grinning at me. That's why I stopped."
						LMP "Okay."
						CDR "The heck with it. Put it in the bag."
Rock (20)	Unidentified rock		Between ALSEP and the LM. LMP reference to "gabbro" suggests relatively coarse texture of this sample.		04:22:26	LMP "Here, let's pick up a couple of these."
						CDR "Okay."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day: hr: min	Crew comments relating to samples
Selected samples - Continued						
						LMP "Hey, they're good. They're a little different. They're more the gabbro type. Yes - - Wait a second . . . "
						CDR "Get it in?" (One sample)
						LMP "Good show."
						CDR "Let's go."
12001	D — fines (< 1 cm) (glass bead)	2216.0	Near the LM on return from first EVA sample traverse. This glass bead is probably included in the sample of fines from the selected sample.	No photograph	04:22:26 to 04:22:27	CDR ". . . look at that, a pure bead of glass! . . ."
						LMP "Let's grab it. Oh, come on. Hold my hand."
						CDR "Okay."
						LMP "Oh, I'm losing it. Got it . . . it's one of those black beads, only this one's - about - -"
						CDR "All look green to me. Okay."
						LMP "- - three-eighths of an inch in diameter. And they're all - -"
12026	Core 2013 (No. 1)	101.4	Approximately 4 m east of television camera.	AS12-47-7007 and AS12-47-7008	04:22:35 to 04:22:36	LMP "Adios. I'll go for the core tube . . . over near the TV, and I'd come back by it." . . ., okay. I'm core-tubing it right now."
						CDR . . .
						LMP "Houston, we're getting the core tube in real good. It's down almost full length now. It's a little harder to drive in; you have to auger it a bit and then pound it, but now it's full length, and let me take a picture of it and that will be it."
12001 and 12003	D — fines D — fines and chips	2216.0 300.0	Near the LM. Filling SRC at end of the first EVA.	No photograph	04:22:35	CDR "You know, I wish we had more rocks."
						CC[c] "Pete, you can go ahead and fill up the remainder with the fines from that area."
						CDR "Okay, . . . Let's see. Scoop material. That a boy."

[c]Capsule communicator.

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
Selected samples - Concluded						
					04: 22: 44	CDR "... dump some dirt in this bag." LMP "How much? When you say stop?" CDR "All right. ... Boy, that's dirt ... that's a good bag full."
Documented samples						
Rock	Not sampled		Between ALSEP and north rim of Head Crater. CDR apparently rolled this rock into Head Crater.	None	05:12:03	CDR "Oh, boy, is ... like I want that rock. Here's a dandy extra grapefruit-sized-type goody. Find a crater with a shadow in it first; there's one."
					05:12:04	CDR "Man, have I got the grapefruit rock of all grapefruit rocks. It's got to come home in the spacecraft; it'll never fit in the rock box. Okay, Houston, I'll tell you what I'm going to do. I'm going to wind up at the right place at Head Crater; and, while I'm waiting for Al, I'll roll a boulder for you. Okay, Houston?"
	No sample here		As LMP crosses area between LM and Head Crater. Description of rocks as given at the time by LMP.	None	05:12:11	LMP "I can see anything - everything from fine-grain basalt as I come running across the area here, to - coarse - coarse-grain ones; I see some - sort of light reddish-gray colored rock that I would call - I don't know really what I would call it - it looks almost like a granite, but of course it probably isn't, but it has the same sort of texture. The individual components - constituents, so to speak, are crystals but it still has that same appearance."
12030	D — fines (from bag 1-D)	75.0	Near northeast rim of Head Crater. Exact location not known.	AS12-48-7043, AS12-48-7044 (before collection), and AS12-48-7045 (after collection)	05:12:13	LMP "Okay, let me take something out of this crater hole, Pete. It's sort of unusual; it's got a lot of those little droplets on it, those blips. But ... the fragments in this crater look different from - the others. Take a couple of quick pictures, then I'll be right with you." "... this is a very small crater, Houston, probably about 3 feet in diameter and looks like it was made at - not very fast moving or energetic or heavy projectile. Yet, right in the middle of the hole is some of these glass-covered rock fragments. And, on some of the other rocks that seemed to be rested in the hole, I'm putting them all in a - sample bag 1 here, I mean - some of the others don't have any coating on them at all. I'm picking them up with the tongs, but ... they don't seem to hold together too well; they seem kind of weak. ..."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
					05:12:17	LMP "And, Houston, that sample bag that I put the fragments in that I mentioned earlier, that I found in the bottom of that small crater? - That's sample bag 1-D."
12031	B — olivine diabase (from bag 3-D)	185.0	Northwest rim of Head Crater; about 15 m inside the rim crest. Adjacent to the site where a trench was dug following collection of this sample.	AS12-48-7048, AS12-49-7189, AS12-49-7190 (before collection), and AS12-48-7050 (after collection)	05:12:20	LMP "Let me get over here and get the gnomon and - let's ... over this rock right here; this rock is very typical of all the fragments around here."
					05:12:21	LMP "Okay, I just put it into 3-D."
12032			See entry for sample 12032 at 05:12:40. Sample from bag 4-D (apparently collected after bag 6-D).			
12033	D — fines from bag 5-D	450.0	Trench 15 cm deep, approximately 15 m inside northwest rim of Head Crater.	AS12-49-7191 to AS12-49-7196, AS12-48-7049, AS12-48-7051, AS12-48-7052	05:12:21	LMP "... Houston, kind of interesting here. Pete walked across one edge of the rim here. We're about - oh, 50 feet inside the upper rim and he happened to scrape an area there with his foot. It's a much lighter colored soil - -"
						CDR "Like cement."
					05:12:24	CDR "There you go. Now let me trench it."
						LMP "... Okay. Where Pete digs up - sure enough, right underneath the surface, you find some much lighter gray - Boy, I don't exactly know what at this point, and you can look around now and see several places where we've walked. If the same thing's occurred, we never have seen this at all - Boy, that's going to make a good picture, Pete. Never seen this at all on the area we were before. Hey, that looks nice."
						CC "Roger, Al. We copy that; you think it could be the sun angle?"
						LMP "Listen. No, not at all. This is definitely a change to a light gray as you go down, and the deeper Pete goes - he's down about 4 inches now - it still remains this light gray. It's - this soil must be of a different makeup than that we were on outside the crater, because we have to - -"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
						CDR "Say, this is different than around the spacecraft, because we've kicked up all kinds of stuff around the spacecraft and it's all the same color - -"
					05:12:25	LMP "Yes, dig as deep as you can, then give me a sample right out of the bottom, because this will be something new. I'll put it in sample bag number 5-D."
					05:12:26	LMP "- - down about 6 inches and - looks just light gray down there. Now, in the bag, you'll find there's some darker gray material that fell in off the side."
12034	C — breccia (bag 6-D)	155.0	From bottom of trench dug at northwest rim of Head Crater.	AS12-49-7195 and AS12-49-7196 (before sampling); AS12-48-7051 and AS12-48-7052 (Shows trench site after bagging rock 12034)	05:12:26 to 05:12:27	CDR "Let's throw this little rock in that I dug up from deep down. ... get another sample bag." LMP "... Hey, that's a nice rock. Pete just handed me a rock from the bottom of the hole, and it's covered with gray; I can't see - anything in it other than just the gray dirt covering, soil covering. Let me get a final shot, Pete."
12055	B — basalt	912.0	Northwest rim of Head Crater between trench site and Triple Craters. Some confusion arises as to which of two rocks photographed was picked up. Correlation of lunar-surface photographs with returned rocks shows that sample 12055 best matches the upright rock beneath the gnomon in AS12-49-7197 and AS12-49-7198.	AS12-49-7197 and AS12-49-7198 (before sampling); AS12-49-7199 and AS12-49-7200; AS12-48-7053 to AS12-48-7055 (Shows overturned rock with light gray bottom)	05:12:27 to 05:12:30	LMP "... Hey, you kicked over a rock that had a white bottom - quite a bit different than the top. Right behind you; you might want to take a picture of that. It's quite a bit different than those others." "Okay, let me take a picture of this rock. I'm going - -" CDR "This isn't going to show much." (Taking photographs AS12-49-7197 and AS12-49-7198 at this time?) LMP "Let me use your shovel." CDR "Okay, now, let me see which side is which." LMP "Well, we've got it; turn over one of the rocks of the rim. The bottom part of the rock is gray, about a half of it; this rock happens to be about a 6-inch-diameter rock. That'll give you stereo on it. And the top is the same color as the - -" CDR "... You got it in your shadow."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
						LMP "Yes. I do. I'll take another one. Pete, maybe you want it."
						CDR "Even these rocks out in here - even the ones that are almost completely covered with the soil, if I look at them, I can see glints of crystals or something."
						LMP "Yes, every one of them."
						CDR "All right, let me have that."
12052	A — olivine basalt	1866.0	Site of panorama 13, west rim of Head Crater. Sample identified in photographs; apparently rolled into position before photography.	AS12-49-7217 and AS12-49-7218; AS12-48-7059	05:12:32 to 05:12:34	LMP "I'm kind of wondering, we're passing up these here - and they got to be bedrock from somewhere; we need to get a pretty large-sized one here, before we leave this area, Pete."
						"Because these rocks obviously came out of the crater, because they're scattered more uniformly around it. There's a bunch of them on the rim and there's not many far away. We probably ought to grab a big one of them."
						"There's an interesting rock; let's - Hey, that's all right; let's get it."
						CDR "... All right, Al, where do you want to grab the sample here?"
						LMP "Right here, I'd like to grab that rock right there, because it's got kind of a sharp edge on it and all the rest of them are - I don't know, it's got kind of a - an oblique edge on it, and you don't see many like that around here."
						CDR "Which one you mean?"
						LMP "This one right here, this gray one. It looks a little bit different than the rest."
						CDR "This one?"
						LMP "No, right there, a little bit further - that one right there. I'll just grab it and put it in the box, if we can pick it up."
						CDR "This one, the big one?"
						LMP "The big one."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day: hr: min	Crew comments relating to samples
Documented samples - Continued						
						CDR "... wait until I get the pictures."
						LMP "Okay. If we can do that, we can just put it in the bag. I think that's kind of a different-looking rock. This rock is different, Houston - just in the way it's shaped, and it's partly rounded and got some oblique angles on it. Maybe under all that dirt is something a little bit different."
						CDR "Okay. I got it."
						"... Picking it up; no sweat."
						LMP "Okay."
						CDR "That a boy. We know you got the rock; that's what counts."
						LMP "The thing that was giving it that unusual shape was the dirt that was adhering to it. That's okay; we'll take it back with us."
						CDR "Good rock."
Rock	Not sampled		A large rock approximately 3 ft in diameter and 2 ft high was described and photographed by the crew near the southwest rim of Head Crater. Fillets were noted on all sides of this rock.	AS12-48-7060 to AS12-48-7062; AS12-49-7219 to AS12-49-7222	05:12:35 to 05:12:37	LMP "If you look real closely at the rock, the surface of it is coarse pitted and there's some pits that are maybe even up to three-eights of an inch in diameter on it; however, most of them are small. It doesn't look like a basalt, although the grains are too small for me to see anything - identify any specific one. Some of the pits have glass in it, which is not too surprising; and many of them don't. That's about all we can say about that rock, Houston, and that's typical of the ones in this area."
						CC "Roger, Al. Could you give us a sample bag number and then press on?"
						LMP "Okay. Well, we didn't take a sample there. The couple that we did take a sample of previously are the same types, so the last couple of samples have been of the same type rocks that we're discussing."
12053	A — olivine basalt	879.0	Site of panorama 15, at the north rim of Bench Crater. Sample identified in photographs; apparently tilted slightly before photography.	AS12-48-7063, AS12-48-7064, AS12-49-7234, AS12-49-7235	05:12:39 to 05:12:41	CDR "What a fantastic sight. Al, look in the bottom of that crater." (Bench Crater) "Do you think that stuff melted or what? What's that look like to you?"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
						LMP "Well, ... what it looks to me like is we've got one of those central - little bitty central peaks, you know - little rebound there, like the - -" CDR "Yes. But don't they look melted on the top? Don't they look like they've been - they were molten? They're not - they're not completely jagged." LMP "No, they're not. It's hard to tell. I noticed when I was looking at that rock back there up real close that it had been hit by meteorites so much, I guess, it had given it a rounded appearance something like those in the hole, except there's a couple over there, like you say, that don't look that way. Hey, we ought to grab one of these pieces of rock." CDR "... Here's some good rock samples right here. Come on." LMP "All right." CDR "Look at that baby; that rock looks a little different." LMP "Okay. I don't think - ... it's going to fit. Let's put it in one of these bags. It'll fit in there, Pete." "No. It won't fit in there, Pete. The rock's too big." CDR "Let's just put it in here, and we've got a nice picture of it, so we can tell where it's from - -" LMP "That's a super rock."
12032	D — fines with rock fragments (from bag 4-D)	310.5	North rim of Bench Crater. (Same area as panorama 15 and sample 12053).	None	05:12:41 to 05:12:42	CDR "- - let's just pick up two or three others - little ones and put them in 64 here, from that same area. Here, all this - -" (There was no bag numbered 64. Apparently, the bag used was 4-D used out of sequence after bag 6-D) LMP "Hey, you notice that underneath this soil on the rim, too, it's the light gray."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
Documented samples - Continued						
						CDR "... Houston, there are a couple of small rocks that we just picked up from the area we have been discussing. It doesn't - I don't think they appeared in the photo, but that won't make any difference. It's just typical of the other rocks around here ..."
12035	B — granular basalt (from bag 7-D)	71.0	Northwest rim of Bench Crater. Sample not identified in surface photographs. Fragment was broken into pieces when it was opened in the LRL.	AS12-48-7064, AS12-49-7236, AS12-49-7237, AS12-49-7238, AS12-49-7239	05:12:42 to 05:12:43	LMP "... Here's something interesting, Houston. Hey, it looks like a surface - What we got is what looks like kind of a semiburied rock. Hey, there's a small piece of it over there to the left. See it, Pete? We'll be able to catch it and put it in the bag."
						"What it looks like is a - a buried rock, not unlike the others around here, except it appears to have some sort of coating on it that's very iridescent. Lot of crystals shining in it."
						CDR "I'll tell you what's happened is - it's been laying in the ground and it's been hit by another fragment."
						LMP "Think so?"
						CDR "Yes. Look at the glass beads, too. ... all over the place."
						"Okay, you want to - you want to catch that piece over there and I'll put it - Wait - let me get the - the sample of it."
						LMP "Okay."
						CDR "All right. Sample in sample bag 7-L." (7-D)
12036	B — gabbro or pigeonitic troctolite (from bag 8-D)	75.0	Same location as sample 12035.	AS12-48-7064, AS12-49-7236, AS12-49-7237, AS12-49-7238, AS12-49-7239	05:12:43 to 05:12:45	LMP "... Pete's picking up a small piece of this rock. Maybe you could get a piece that's fractured right off the middle."
and						
12037	D — fines (from bag 8-D)	145.0	Sample 12036 is tentatively identified in surface photographs as the fragment in center foreground in the stereopair AS12-49-7238 and AS12-49-7239. This fragment is approximately one-half m south of the gnomon.			CDR "That's what I wanted to do."
						"There it is right there."
						LMP "Okay. Got kind of an interesting coating on it. That's different from what we've seen. Maybe this is more newly exposed than the ... Is that all you want to put in that bag?"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day: hr: min	Crew comments relating to samples
Documented samples - Continued						
						CDR "Listen. Hand me the scoop. Let me get some of those glass beads and stuff there - -" LMP "All right. Let me get you the scoop." "Hey, I - I better not put that in there, that's what we wanted to show was the - -" CDR "Okay." LMP "Let me get you another sample bag." CDR "But ... I'm going to get you - we're going to get you some of the bedrock. It looked like it's up in the lip here. All of it looks the same - on the edge. That's 8-D." LMP "Ridiculous." CDR "I think." LMP "What happened to 1, 2, 3, 4, 5?" CDR "Get you another one. Okay." LMP "What we're putting in here now, Houston, is some soil that's right next to the rock that we previously described. In fact, Pete's got a nice fragment of that rock that's going to end up in this bag, too. Oh, catch that one. That's a beauty. That thing is barely - weak - it fractures right off - -" LMP "Okay. Put that in the bag. There you go." CDR "We need to put more, samples per - in the bag."
12038	A — basalt (from bag 9-D)	746. 0	Inside the west rim of Bench Crater. Sample is not identified in lunar-surface photographs. A large rock may also have been taken at this time, but the crew comments are somewhat cryptic.	AS12-49-7240 and AS12-49-7241	05: 12: 46 to 05: 12: 49	CDR "Okay. Let's go over here and get some of this good rock. Like bedrock to me."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
Rock (?)	Unidentified large rock		The large rock sample would probably be one of the following four: 12056, 12062, 12063, or 12065. Sample 12063 is the only one with a large glass spot on it.			LMP "Okay." CDR "Looks a lot like the fragments we've been seeing laying all over the place, but this stuff obviously - I'll bet you we have a total of about 3 pounds of rocks right now." LMP "Okay. I'm with you." CDR "Okay. We're going to have to grab some bigger ..." "Got to dip down in the side of the crater there see how it is going up and down - Boy, this is interesting. I want to get this area right here and see if I can't sample it - if I don't fall down in the crater. Go. That's a boy. Well, this is different; look at this, Al? This is different, we'll get some of this." LMP "... Look at the glass all over those rocks." CDR "Yes. I need to -" LMP "I want to bring this back; look at it." "Here, let me put this - put that in there." CDR "... It's going to fall." LMP "There you go." "Hold it ..." CDR "Let me get up here. Okay?" LMP "Watch it - it - You're going to -" CDR "Okay. Now you're going to help me get a bunch of these." LMP "Let's do; let's get a bunch of them and then they'll - have any rocks to bring back. ... There you go; there's a good one. Put that thing in here." CDR "I had to take that big piece right there. Look at it; it's got spattered glass or something all over it."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
			Documented samples - Continued			
						LMP "Let's take it. Why don't we take a big piece of it? And - sample bag." CDR "I'm ... these sample bags, whether they're the - the round ones, or the square ones - or the flat ones, they're all the same type. What you need are sample bags - little ones for these and some big ones for the bigger rocks. Okay; 9-B is the sample we just picked up and described, Houston."
12039 and 12040	B — olivine diabase or gabbro B — olivine diabase or gabbro (Both from bag 10-D)	255.0 319.0	Inside west rim of Bench Crater. Samples not identified in photographs. AS12-49-7240 and AS12-49-7241; both samples have been moved into position for photography in AS12-49-7242 and AS12-49-7243.	AS12-49-7240 and AS12-49-7241, AS12-49-7242 and AS12-49-7243 (Samples beside tool carrier)	05:12:49	LMP "Okay. Put this right in here, Pete." CDR "No. Wait a minute; here's a better one." LMP "Okay. Now we are working on sample bag - 10-B." CDR "- 10-B." "Okay. That's a good rock, and that one fills that one up."
12023	D — fines (from LESC)	269.3	Trench site on east rim of Sharp Crater.	AS12-49-7276, AS12-49-7277, AS12-48-7068, and AS12-49-7278 (Shows LMP holding container)	05:12:58 to 05:13:01	CDR "Dig in that stuff." LMP "Wow!" CDR "You could drive three core tubes down there." LMP "You sure could. It's soft." CDR "Yes. Got down about 8 inches." LMP "Yes. Pete, you're digging ... a nice clean trench." "... fine gray. Very fine soil here." CDR "Fill the big container with dirt." LMP "Well, you still need some more, although one more scoop ought to do it though." "Okay, that's it. Bag's full. And now let me put the lid on." "... Houston, this dirt came from about 8 inches down. ..."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
			Documented samples - Continued			
12027	Core 2011 (Core no. 2)	80.0	Bottom of 20-cm trench on east rim of Sharp Crater.	AS12-48-7068, AS12-48-7069, AS12-49-7279, AS12-49-7280 (core tube in trench), and AS12-48-7070 (trench after core no. 2 taken)	05:13:03 to 05:13:04	CDR "Okay. Now you need a core tube in the bottom of that trench. Is that right, Houston?" ". . . and this is core tube number 2." LMP ". . . Ought to be a good place, Pete. Relatively fresh stuff here. . . . you could almost drive it without a hammer; but, if you'll hand it to me, I'll get - -" CDR "It's driving in real easy, Houston." LMP " Go on . . . all the way. . . . we're driving it all the way in pretty easy." CDR "That a boy. Wait 1. Stop. That's it."
12024	D — fines (from GASC)	56.5	Near trench site, east rim of Sharp Crater. Surface photograph shows area of glassy material included in the gas-analysis sample.	AS12-48-7070	05:13:06 to 05:13:09	LMP "Okay. We need some little rock fragments from here, Pete. . . . hold on - -" CC "Roger. .That's surface rock fragments." CDR "Okay. Just a second. Yes. We're going to get it; hold the phone." "Some little rocks in here - -" LMP "Okay, little rocks . . ." CDR "We got the environmental sample, we got . . . core tube, and I'm trying to find a little rock. Little rock? There - there's a lot - -" LMP "There's a neat one. There it is right there." CDR "Ho-ho, just right for that little can." LMP "Give me a few. . . . See those bright shiny ones there?" CDR "Yes, yes, yes, yes." LMP "Wait. Let's get a shot of them. Just move - Just a second, Pete." CDR "Okay."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day: hr: min	Crew comments relating to samples
			Documented samples - Continued			
						LMP "Okay. Got a picture of them." "Careful. ... there. How about those right - right there? There. Right - there. See them shine?" CDR "The little ones?" LMP "No, no. Move over this way. This way. Up - you're near about - right there." CDR "No. Hey, that's a neat - oh, that's glass. Look at that." LMP "Right next to it." CDR "Yes, here. One at a time. Make a good sample for them." LMP "And that piece right next to it, right there." "Hey, we need some more, Pete. Give me a bigger rock. There's not enough to do anything with." CDR "Hey, come on, I'm getting tired of picking up those little things." LMP "There's nothing in there. Get a big one. There's one right there." CDR "Get a big what? Here, this one?" LMP "Yes." CDR "I don't think that will fit." LMP "Let's try it." CDR "No, that won't ... Okay. Come on, Al, we're wasting time. There you go." LMP "Okay. We got it."
12041	D — fines (from bag 11-D)	24.8	Between Bench Crater and Halo Crater during EMU check at 05:13:14.	None	05:13:14 to 05:13:15	CDR "... beautiful. Round glass ball they got to have, Al. Quarter of an inch. - And the sample bag." LMP "Coming. Coming."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
			Documented samples - Continued			
						CDR "Look at that."
						LMP "This is sample bag 11-D."
						CDR "I didn't take a picture. I just wanted to - -"
						"Okay. Watch that crater behind you. Don't step back."
						LMP "Wait a minute."
						CDR "This is glass beads."
12042	D — fines (from bag 12-D)	255.0	In "wrinkled texture" area approximately 20 m northwest of Halo Crater.	AS12-48-7074 to AS12-48-7076, AS12-49-7282 to AS12-49-7284	05:13:17 to 05:13:19	CDR "This is Halo - Let's take some pictures here."
						LMP "... We've run across a sort of a textural contact. We're suddenly on a - on an area that's quite - not so smooth; it's got dimples and wrinkles in it. You want me to take some pictures or what, Pete?"
						CDR "Yes. Why don't you come up here - and we will take a couple of good dirt bag samples of this stuff."
						LMP "Okay. It's interesting. You know, I think this looks like that material that we talked about the first day in front of the LM. Maybe it runs past the LM down into this area. But it's sure different than where we've been. It looks almost like it - like it's more - the material is more cohesive and forms clumps, instead of being so nice and smooth. ... around behind you."
						CDR "... I'm going to dig. Just get some sample bags and we'll - -"
						LMP "Okay, Pete."
						CDR "- - scoop this stuff."
						LMP "Okay."
						CDR "Let me - Boy, it sure is fine; it's kind of like over at the other - at Sharp Crater."
						LMP "Yes. Looks the same, except on the surface it just seems - -"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
						CDR "Except it looks almost finer."
						LMP "Yes."
						CDR "Wait a minute and I'll get you another bag - -"
						LMP "It's funny though. If you saw this on Earth, you would think it was a - a real soft dirt that it had just been rained on recently. ... Not hard rain, but just a sprinkle, so that the droplets - -"
						CDR "There you go."
						LMP "Now, that's a good sample bag full. That's 12-D, Houston, the sample bag number - -"
						CDR "... I think this is Halo Crater right here. ... We've actually got the soil sample from part of it."
	Double core, no. 1 over no. 3		North rim of 10-m crater approximately 25 m south of Halo Crater.	AS12-49-7285 to AS12-49-7288, AS12-48-7077	05:13:24 to 05:13:28	CDR "Double core tube. You can drive it. Give it a go."
12025 and 12028	Core 2010 (no. 1) Core 2012 (no. 3)	56.1 189.6				LMP "I'm going to hand you the hammer. I'm not sure that double core tube screws on as far as it should. Try it again. Okay. The lower core tube is number 3, I think. Yes."
						CDR "Three?"
						LMP "Three, and the upper one's 1."
						CDR "Ready to pound it."
						LMP "Where are you going to drive it?"
						CDR "Where would you recommend?"
						LMP "Well, let's go over to this crater right here. Where it's soft around those little ... craters. About right here."
						"I can shove it in that little - I hope this is a good soft place. It seems to be. Oh, I hit something solid there. Well, I shoved it in - I used all my weight, Houston, and shoved it in about 11 inches. Now, I'll just pound on it a while and see what we can do. It ... be going in okay. Yes. It's going in down."

TABLE D-V.- CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
Documented samples - Continued						
						"No. We've got a good spot. I don't think - really think this is the right place. Some of those things aren't so obvious."
						CDR "Got awful solid, didn't it?"
						LMP "Yes, it's going. Let me wiggle it a bit. It's got one core tube completely in now. Have to hit it harder."
						CDR "Okay. He's up to the bottom of the handgrip portion of the upper tube. He's really driving that baby. Hit something solid there, didn't you?"
						LMP "No. It's just getting down there, Pete."
						CDR "Hey, that baby is in the ground."
						LMP "We've got a double. Now the question is can we pull it out?"
			Problems with cameras interrupted the retrieval of the core.		05:13:32 to 05:13:36	CDR "It's coming up real easy."
						LMP "What?"
						CDR "I say it's coming up real easy."
						LMP "Looked for a minute like you were going down real easy. The core tube hangs in and your feet just sink down. Okay, hold."
						CDR "I think we dropped an end of the tube we shouldn't have dropped."
						LMP "No."
						CDR "Yes. We got to take them apart. Remember?"
						LMP "Okay. Well, what we'll have to do is pick it up, right over there."
						CDR "It's right back there. It's someplace buried in the dirt. I see it. Ha. Ha. Right here. Wait a minute. I'll get it with the - Here, you hold the core tube."
						LMP "Okay. Just a second. Just a second. Okay. I've got the core tube. I'll start unscrewing it. - -"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
			Documented samples - Continued			
						"Well, see the - Here, wait a minute. Reach inside the core tube. Wait. Which goes which - There you go. Beautiful. Right down in there. You got it? You got that one? Okay? Boy, I drove a nice core tube in there." CDR "Well, it doesn't look any different, though, from the eye - halfway down." LMP "Loan me the tweezers a moment. See that cap right there? The cap right there. Okay. Is this on there tight enough?" CDR "Yes." "Yes, sir. We got a double core tube, and all put together correctly."
(Rock)	Bag 13-D (Not returned)		At site of panorama 19, Halo Crater.	AS12-49-7312	05:13:38 to 05:13:39	LMP "That's it, Pete. PAN's complete. Probably ought to get rocks - one of these rocks here just throw it in the bag - -" CDR "Yes. I think we ought to." LMP "How about - You want to get this one? Let's sample a couple of these laying right over here." CDR "Good idea. That a boy." LMP "Okay. Here, take one quick picture so we can save some film." CDR "All right. Here it goes." LMP "- - where it came from." CDR "Okay. Just a second." LMP "Those little holders for this - for these sample bags are ridiculous, you know. In this light gravity up here, if you put anything in the holder and move, it flips it right out of it. Come out of there, sample bag. There you go. Funny how this one - Go in there. Go in - That a boy. Give me some of that dirt around there too, Pete. Drop it right in. This is going in sample bag 13-D, Houston."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
12054	B — shocked diabase with glass spatter	687.0	South rim of Surveyor Crater. Sample is definitely identified and oriented from lunar-surface photographs.	AS12-49-7313, AS12-49-7314, AS12-49-7315	05:13:41 to 05:13:42	CDR "Al, look at these rocks; they look a little bit different. Let's grab some." LMP "Yes, sir." CDR "Look at that glass in the bottom of that one. They look like granites, don't they?" LMP "They do; they look just like granite. Here's a beauty over - Here's a beauty." CDR "Where?" LMP "Right here. That is a nice rock. ... Let's get this one for sure. Right there." CDR "Okay." LMP "... in the bag, but it is sure different. It seems to have some - -" CDR "Got a big glass splotch on it." LMP "Yes. That's a good one. That's a real good rock. Get some pictures - -" CDR "- - Wait. Wait. Wait. Wait. Okay. ..." LMP "That's a beauty. ... Let me get the cross-suns too. Oops, got to get over where you are." "Okay. Okay. We will just put that in; that's a beautiful rock." CDR "Okay. You able to scoop it up? You know you need some tongs that will get bigger samples than we have got." LMP "All right. Watch that." CDR "You know seeing that, I just thought -" LMP "Hey, that's beautiful. It's got a lot of -" CDR "Don't drop it." LMP "Nearly dropped it. Tough to hold it."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
			Documented samples - Continued			
12051	AB — olivine basalt	1660.0	Rim of small 4-m Sharp Crater on south rim of Surveyor Crater. The sample has been definitely identified and oriented from lunar-surface photographs.	AS12-49-7318, AS12-49-7319 (before collection), and AS12-49-7320 (after collection)	05:13:43 to 05:13:45	CDR "Okay. Now I want some of these granites over here - looks like granite." LMP "Okay. Let's try that." CDR "Step across over there; photograph that rock right there - Wait until I drop the gnomon in - and do it in such a manner as to get this crater that it came out of." LMP "That's a good idea. Let me see if I can; I'll have to back - Let me get a 15-foot shot." "... Pete, let me reach back here and grab this strap." CDR "Okay, now?" LMP "Go. Okay. Let me roll a little bit over." CDR "That a boy. Back up. Now, if they had a strap like that, they could just hold the other guy while he leaned over and picked up a rock." LMP "Hey, that's a - -" CDR "It works pretty good. It sure saves time. Look at the shear face on that rock, something whistled by it or something." LMP "It's fractured a bit; it's got some pretty interesting fracture marks on it. It also has got some - what look like abrasion marks on it. Maybe that's just hard packed dirt. Boy, there is a lot of flashing crystals in that rock - crystal faces. It's a good rock. Okay. Let me take the - the picture of that where the rock was. Right there."
					05:13:50	LMP "... A few minutes ago, Pete wanted to pick up a rock, so I held onto a - that strap of the Surveyor bag and he leaned right over and picked it up and I helped him get back up. ..."
12043 and 12044	A — basalt (from bag 14-D) D — fines (from bag 14-D) (including a glass bead dumbbell 3 cm long)	60.0 92.0	South rim of Surveyor Crater before starting onto crater to Surveyor III. Sample 12043 is tentatively identified and oriented in surface photograph. The glass bead in sample 12044 is identified in surface photographs.	AS12-48-7082 and AS12-48-7083	05:13:50 to 05:13:52	CDR "Look at that glass ... Al, grab a shot of that beaded glass there and we'll bag it." LMP "Okay." CDR "That's better than the Hope diamond."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day: hr: min	Crew comments relating to samples
Documented samples - Continued						
						LMP "Okay. Set her up."
						CDR "Better take that."
						LMP "There you are in here. Okay. I got it, Pete."
						CDR "Got her?"
						LMP "Yes. Got a lot of those we've - Got too many of them."
						CDR "Oh, you did get a lot of these?"
						LMP "Yes. Why don't you get that? Pick it up - -"
						CDR "- - could get the rock with it. Look."
						LMP "Okay. Get some rocks with it. That's a good id - Hey, here's some rocks right here. There's a good rock. You know, we keep collecting a lot of the same type of rocks, because there just doesn't seem to be any other kinds around. I haven't seen any microbreccia the whole day; I've looked around for it. All I have seen is some basalt; I've seen nothing that looked vesicular at all, except on the surface."
						CDR "I haven't either."
						LMP "You know, that's real strange; it's - It's not at all like Neil's rocks. Why don't you give me a rock or two, Pete? And I will stick in there. Got any spares? There you go. Good rock. Good rock."
						"We just made a sample of - glass bead and some local rock on the south edge of the Surveyor Crater, Houston. And they are going into bag 14-D."
12060 and 12061	D — fines (from tote bag) E — chips (from tote bag)	20.7 9.5	Surveyor III scoop.	None	05:14:29	LMP "One scoop."
						CDR "That's dandy! It's even got dirt in it. Bring back some of the original dirt. Okay. Got an extra sample for you, Houston. The scoop's got dirt in it."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
Rock Rock 12064	Unidentified large rock Unidentified large rock B — diabase (from tote bag)	 1214.3	Surveyor III site. Comments by the crew indicate three large rock samples from this location. Description of the brick-like square rock fits the shape of sample 12064. Others are not identified, but are probably two of the following: 12056, 12062, 12063, or 12065.	None	05:14:30 to 05:14:34	CC "Okay, Pete. Now, before you leave there, also, would you get some of those geosamples which we've discussed, as well as some of the loose soil from that area?" CDR "Will do. We'll do it right now." LMP "Here's this rock right here. Let me give the Surveyor tool a heave." CDR "You've got you . . . rock right here. Okay. Let me go get the sample bags." LMP "Hey, that's a good one." CDR "I don't think the TV could see that one, though, I figure it was too close. How about this one?" LMP ". . . down with you." CDR "Okay. All right, now. Trying to remember where that - they got a . . . one." LMP "Here's a square one. I see one up there, right now." CDR "Where's the one that had the lines in it?" LMP "I think it's right over - right up here on the - There's a crater, right up - I'll show you. Looks like - -" CDR "Wait, wait! Let me get this in the bag, too." LMP "Sorry. Didn't know you had it, Pete." (Sample?) CDR "Look, is that the rock right there? You know, these rocks, as they showed in the Surveyor pictures, all have this soil built up around them." LMP "Yes, they all have fillets around them." CDR "I'm trying to remember where - I can't orient myself to the pictures, can you?" LMP "No, there's - I think it's about - -" CDR "Should we nab this one right here?"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS,

AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g.e.t., day:hr:min	Crew comments relating to samples
Documented samples - Continued						
						LMP "That's a good rock right there." CDR "I don't know whether I can get that or not. Let me see." LMP "We'll get it. That a boy. There you go." (Sample) CDR "Okay, let's head for blocky crater; pick up a couple of more of these enroute. Let's get that brick-looking one over there. I think that's one of them they saw there. Up the hill a little bit - ways. - -" LMP "Right here's the one, the square one, Pete." CDR "Where?" LMP "There." CDR "Okay. That's about enough rocks, pal." LMP "I think it is, that is, for here. Let me get it. Okay, you got it. Good show." (Sample 12064, from description) CDR "All those rocks are too big for sample bags - -" LMP "They are big rocks, Houston. They're all at least 6 inches in diameter, and I think these are some of the ones you wanted. It's kind of hard to tell without having a photograph on hand or something that's standing there and studying it for a lot longer than I think we care to do it, just which rocks are which."
12045 12046 12047	A — basalt A — basalt A — basalt (All from bag 15-D)	63.0 166.0 193.0	North rim of Block Crater. Sample 12046 is tentatively identified and oriented from lunar-surface photographs. Sample 12047 is definitely identified and oriented in photographs AS12-48-7148 and AS12-48-7149 as the rock standing upright in the foreground.	AS12-48-7148, AS12-48-7149, AS12-48-7150	05:14:37 to 05:14:42	CDR "... Okay, let's document up a sample here, and I think you ought to photo that whole blocky crater right there. That thing's spectacular." LMP "It is. What is it?" CDR "Bed - That's got to be bedrock there, babe. Yes. Let's get some samples of that. ... I'll tell you what we're going to do, Houston. We're going to get an EMU check here; we're going to pick up one sample out of this blocky crater; give you a partial PAN of it because it's a pretty fantastically interesting crater with a lot of bedrock. Big chunky rocks blown up out of it - -"

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Continued

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day: hr: min	Crew comments relating to samples
Documented samples - Continued						
						LMP "Very angular. Very sharp."
						CDR "- - and get a sample of the double craters on the side of the Surveyor Crater, and then my recommendation is, we've got so much gear and so many rocks, that we head for the LM and start packing it all up." "I'm beginning to think that these rocks that look red, if we'd just crack them open, we'd find they're plain old basalt rock on the inside. We just don't ever have any cracked. We ought to pound one of those things with a hammer in a minute."
						LMP ". . . This is probably the most spectacular crater we've come to, I think. The original craters took it down to bedrock and then, I guess, more recently then, this one, came in here and really banged it out. These blocks are a lot more sharp cornered than any we've seen anywhere else. I guess this must be the most recent one we've been around."
						CDR "No. I got the idea that the bedrock's not too deep, and that this was a big crater but it's very, very, very, very old. And then this thing came along and hit it - -"
						LMP "That's right."
						CDR "- - and broke into the side of the bedrock that's been sticking out into this . . . - -"
						LMP "Yes, and then threw it all out again."
						CDR "I think - Let's get a sample of that rock."
						LMP "Yes. Let's do. I think it's going to be the same - -"
						CDR "And then let's get out of here."
						LMP "Okay. Want to get a docu - we document and a couple of the big pieces. How's that?"
						CDR "Yes."

TABLE D-V. - CROSS-REFERENCE OF LUNAR SAMPLES WITH LOCATIONS, PHOTOGRAPHS, AND GROUND-ELAPSED TIMES - Concluded

Sample number	Sample type	Sample weight, g	Location and comments	Lunar-surface photographs	g. e. t., day: hr: min	Crew comments relating to samples
Documented samples - Concluded						
						LMP "That's a good idea. Let's see. What looks like all the same. Right here?" "Yes. Let me get a shot at it, Pete, cross-Sun." CDR "Okay. Get a stereopair right here. We don't need the gnomon; I'll put the - Get further back, Bean." LMP "Okay. Let me get some rocks. Okay. This is going to be sample bag number - number 15-D, Houston." CC "15-D, Al." LMP "Okay. Pete, you ought to put two or three rocks in here, just generally; and I'll photograph them, and we can see what you took. Couple of more. Those are good. Okay. You know, most of the rocks we've seen today is exactly like this. Going to pound one of these with a hammer in a minute."
Rock	Unidentified large rock		Rim of Bench Crater. Sample not identified by description or in lunar-surface photographs. Apparently one of the following rocks: 12056, 12062, 12063, or 12065.	Not photographed for documentation. May be present in AS12-48-7148 to AS12-48-7150	05:14:43	CDR "Hey, there's some of that light-colored undersoil." LMP "You're right. Okay. You want me to get another sample bag?" CDR "No. I want to start moving out." LMP "Okay. Go." CDR "All right." LMP "I'll just pick up this one big rock here, Pete, and stick it in the bag." (Loose in tote bag?) CDR "Okay." LMP "Good. That's a good rock."

APPENDIX E

MAJOR UPDATES AS OF JULY 31, 1970

The data contained in this appendix are considered to be of major significance in the preliminary description of the Apollo 12 lunar samples. The data are both new data and corrections and modifications of earlier data. No attempt has been made to update the main part of this document completely; rather, this appendix is included to correct only the most serious problems. The following five changes have been made to this document.

1. The photomicrographs of thin sections (figs. A-64 to A-95) have been expanded to include at least one photomicrograph of each sample that was sectioned.

2. Many photographs of the rocks have been replaced with more recent photographs that show greater detail.

3. Tables D-I and D-II have been recast.

4. The LRL photographic indices (tables D-III and D-IV) have been updated.

5. The cross-reference among the sample numbers, the lunar-surface photograph numbers, and the mission transcript (table D-V) has been updated.

The first part of this appendix is a list of errata that references the number of the page that is affected by more recent data. The second part is an Apollo 12 rock classification. The last two parts consist of a current list of the various samples that have lunar orientation or location data associated with them and a supplementary list of the sample locations and orientations.

ERRATA

Pages 1, 43, and 57:	Samples 12010, 12013, 12034, and 12073 are microbreccias.
Pages 75, 76, and 86:	Samples 12008, 12009, and 12015 are modally and texturally the same; slightly devitrified glass with approximately 10 percent olivine phenocrysts (some skeletal) and approximately 5 percent small skeletal trains of olivine.
Pages 47 and 82:	Sample 12013 is considerably more complex texturally than was previously thought. It consists of a mixture of at least four types of matrices and a wide variety of fragments. This sample is not a "late-stage differentiate."

Page 68:	Data on selected fragments of sample 12003	C. Meyer, MSC

Sample 12003-36, a polished thin section that contains three fragments of the coarse fines from this sample, was studied. The first fragment is a 5-millimeter porphyritic olivine basalt. The second fragment is a 4-millimeter breccia. The third fragment is a recrystallized anorthosite, perhaps containing a new mineral. The recrystallized anorthosite consists of a meshlike intergrowth of plagioclase microlites, including minor amounts of olivine, opaques, and the unidentified mineral.

The unidentified mineral (found by A. Ried of MSC) is a single, highly reflecting grain 0.2 by 0.1 millimeter. Other physical properties are high relief and medium birefringence, and the mineral is apparently pleochroic in yellow-green and brown. The outer margin of the mineral appears to be in reaction relation with the plagioclase groundmass.

Page 117: Sample 12035 is not a troctolite. It is a granular basalt containing less than 10 percent olivine and several percent of cristobalite.

APOLLO 12 ROCK CLASSIFICATION

As of July 31, 1970, thin sections are available for 36 of the 45 returned rocks. Also, there are thin sections of five large chips from sample 12057, which consists of a variety of rock fragments. Study of these thin sections provided the data for the following textural classification. The photographs of one unsectioned sample were clear enough to enable that sample to be classified.

This classification is not intended to be final. First, there are 9 rocks (approximately one-quarter of the collection) that have not been sectioned. Second, mineralogical and chemical data on all rocks are far from complete. A complete classification of any rocks demands a melding of textural, chemical, and mineralogical information.

The Apollo 12 rocks are broadly classified as crystalline rocks and microbreccias. The crystalline rocks are further classified as variolitic basalts, porphyritic olivine basalts, olivine vitrophyre, granular basalts and gabbros, ophitic and subophitic basalts, and porphyritic ophitic basalts. The granular basalts are similar to the Apollo 11 type B rocks, and the ophitic and subophitic basalts are similar to the Apollo 11 type A rocks.

In reading the following descriptions, the reader should refer to the photomicrographs of the various thin sections (figs. A-64 to A-95). An asterisk next to a sample number indicates that a thin section of that sample is not presently available.

Variolitic Basalts
Samples 12004, 12019, 12052, 12053, and 12065

The pyroxene in these rocks displays well-developed variolitic texture; that is, random pyroxene phenocrysts as long as 3 millimeters in a matrix consisting of a feathery intergrowth of pyroxene and plagioclase crystals. These rocks typically contain euhedral to rounded olivine phenocrysts and platelike ilmenite. A generalized mode of these rocks is as follows.

Plagioclase	15 to 25 percent
Pyroxene	55 to 70 percent
Olivine	5 to 15 percent
Opaques	5 to 10 percent
Silica	0 to 2 percent

Samples exist that fall between the variolitic basalts and the porphyritic olivine basalts.

Porphyritic Olivine Basalts and Peridotite
Samples 12002, 12012, 12014, 12018, 12020, 12022, 12045, 12075, and 12076

The olivine in these rocks forms euhedral to rounded phenocrysts as long as 1.5 millimeters across. The remainder of the rocks are similar to the variolitic basalts. Pyroxene phenocrysts are present. The matrix consists of lath-shaped plagioclase crystals in a more-or-less ophitic relation to matrix pyroxene prisms. The opaque phase forms as equant grains. In addition, platelike ilmenite crystals are found in some samples (especially well developed in samples 12022 and 12045). Unlike the variolitic rocks, matrix pyroxene does not form feathery masses. A generalized mode for these rocks is as follows.

Plagioclase	10 to 20 percent
Pyroxene	35 to 50 percent
Olivine	25 to 40 percent
Opaques	5 to 15 percent

Samples exist that fall between the variolitic basalts and the porphyritic olivine basalts.

Olivine Vitrophyre
Samples 12008, 12009, and 12015*

The matrix of these rocks consists of black glass and small (0.01 millimeter) crystals of silicates and opaques. Olivine phenocrysts form as euhedral, subhedral, and skeletal crystals as long as 1 millimeter across. A second generation of olivine forms stringers of optically continuous skeletal crystals that are 0.05 millimeter across. Modally, olivine comprises approximately 20 percent of these rocks, about equally divided between the phenocrysts and the stringers.

Granular Basalts and Gabbros
Samples 12035#, 12036#, 12039#, 12040#, 12044, 12056, 12057-4, 12057-9#, and 12064

The pyroxene and olivine in these rocks form subhedral crystals. The pyroxenes are 0.5 to 1 millimeter in size in the basalts and range to 5 millimeters in the gabbros. The gabbros are indicated by a "#." Pyrox-ferrite forms as separate crystals in at least one rock (12039). Plagioclase, opaques, and cristobalite form as anhedral crystals. In some rocks, tridymite forms as lathlike crystals as long as 1.5 millimeters. In most of these rocks, the pyroxene and olivine form with many pyroxene-pyroxene and pyroxene-olivine contacts, and plagioclase fills the interstices. This is interpreted as a cumulate texture. A generalized mode of these rocks is as follows.

Plagioclase	20 to 40 percent
Pyroxene	45 to 55 percent
Olivine	5 to 20 percent
Opaques	5 to 15 percent
Silica	0 to 10 percent

Samples exist that fall between the granular basalts and the ophitic basalts. These rocks are similar to the Apollo 11 type B rocks.

Ophitic and Subophitic Basalts
Samples 12006, 12038, 12046, 12047, 12051, 12057-6, 12057-7S, 12062, and 12063S

The plagioclase laths forming the ophitic texture in these rocks are as long as 2 millimeters. Ilmenite forms as platelike crystals that are slightly shorter than the plagioclase laths. Pyroxene forms as equant crystals and cristobalite fills the interstices. The samples marked with an "S" in the heading of this section have less well-defined ophitic texture and are considered subophitic. A generalized mode for these rocks is as follows.

Plagioclase	30 to 45 percent
Pyroxene	40 to 55 percent
Olivine	0 to 5 percent
Opaques	5 to 10 percent
Silica	0 to 5 percent

Samples exist that fall between the ophitic basalts and the granular basalts. These rocks are similar to the Apollo 11 type A rocks.

Porphyritic Ophitic Basalts
Samples 12017, 12021, and 12031*

The most distinguishing feature of these rocks is the pyroxene phenocrysts that are as long as 2.5 centimeters. The matrix of these rocks is similar to that of the ophitic or subophitic basalts. In sample 12017, there are small (0.5 millimeter) patches of matrix that are similar to the matrix of the variolitic basalts. A generalized mode for these rocks is as follows.

Plagioclase	30 to 35 percent
Pyroxene	55 to 60 percent
Opaques	5 to 7 percent
Silica	3 to 5 percent

Microbreccias
Samples 12010, 12013, 12034, 12057-11, and 12073

The microbreccias are a shock-lithified mixture of glass, mineral, and rock fragments. Glass spherules are commonly found. Fragments of breccia are found as components of these samples. These rocks are similar to the Apollo 11 type C rocks. Sample 12013 has many special features that will not be described here.

LOCATION AND ORIENTATION OF SAMPLES

The location of lunar rocks is determined by the Field Geology Team (FGT) on the basis of two types of primary information: the transcript of the astronauts' comments during the EVA traverses and the LRL and lunar-surface photographs.

The orientation of the lunar samples is derived from one or more of the following experiments.

1. Lunar-surface photographs — As described in the sample location and sample identification and orientation sections of this document, the lunar-surface photographs show the orientation of the sample when it was picked up by the astronaut. This orientation experiment is performed by the FGT and is the only orientation experiment that provides north-south-east-west data. The other experiments yield only "top" and "bottom" data.

2. Pit counting — Pit counting is performed by F. Horz at MSC. A "top" is obtained that is an integration of the entire lifetime of the rock on the lunar surface.

3. Gamma-ray counting — Gamma-ray counting is performed by E. Schonfeld at MSC and by R. W. Perkins at the Battelle Memorial Institute, Richland, Washington. Three types of "top" may be obtained from this work. Each type is derived by counting a different isotope and is thus an integration over a length of time that is dependent on the half life of the counted isotope. The three types are as follows.

Isotope	Approximate time of integration
Al^{26}	10^6 years
Na^{22}	10 years
Co^{56}	2 months

Those samples that have had orientation work performed on them are listed in table E-I. Most of the location results are given in figure 3 and in table D-V. Most of the orientation data of the FGT are given in the sample location section of this document; the rest of this information will be published later.

TABLE E-I. - ORIENTATION WORK PERFORMED ON THE APOLLO 12 LUNAR SAMPLES

Sample number	Method	Investigator	Status of orientation
12002	Gamma-ray counting	Schonfeld	Known
12004	Photographs	FGT	Tentative
12005	Gamma-ray counting	Perkins	In progress
12006	Pit counting	Horz	Inconclusive
12008	Photographs	FGT	Tentative
12010	Photographs	FGT	Tentative
12013	Photographs	FGT	Tentative
12014	Photographs	FGT	Tentative
12016	Photographs Gamma-ray counting	FGT Perkins	Tentative In progress
12017	Pit counting	Horz	Known
12019	Photographs	FGT	Tentative
12021	Photographs Pit counting Gamma-ray counting	FGT Horz Schonfeld	Known Known Known
12022	Photographs	FGT	Tentative
12031	Photographs	FGT	Known
12038	Pit counting	Horz	Known
12043	Photographs	FGT	Tentative
12044	Photographs	FGT	Known for glass dumbbell

TABLE E-I. - ORIENTATION WORK PERFORMED ON THE

APOLLO 12 LUNAR SAMPLES - Concluded

Sample number	Method	Investigator	Status of orientation
12046	Photographs	FGT	Known
12047	Pit counting Photographs	Horz FGT	Inconclusive Known
12051	Pit counting Gamma-ray counting Photographs	Horz Schonfeld FGT	Known Known Known
12052	Photographs	FGT	Rock moved before photographs taken
12053	Photographs	FGT	Rock moved before photographs taken
12054	Gamma-ray counting Photographs	Schonfeld FGT	Known Known
12055	Photographs	FGT	Known
12063	Gamma-ray counting	Perkins	Known
12065	Gamma-ray counting	Perkins	Known
12073	Photographs Pit counting	FGT Horz	Tentative Inconclusive
12075	Photographs	FGT	Tentative

SUPPLEMENTARY LIST OF APOLLO 12 SAMPLE LOCATIONS AND ORIENTATIONS

The following sections describe the Apollo 12 lunar samples that have been identified and oriented with various degrees of confidence between January 31 and July 31, 1970. The current status of all samples is summarized in table E-II.

All rock identifications from the selected sample are considered to be tentative, based solely on an LRL correlation of sample shapes, sizes, and shadow characteristics with photographs of rocks taken on the lunar surface by the astronauts. The status is considered tentative because, during the selected-sample traverse (the first EVA), the individual samples were not bagged and no specific indication was made of which samples were photographed before collection. Most lunar-surface photographs taken of rocks during this traverse show several fragments, any one or several (or none) of which may have been picked up. There was not a one-to-one relation between the lunar-surface photographs and the samples. Furthermore, no postsampling photographs were taken to indicate which rocks had been picked up.

Confidence in the identification and orientation of rocks in the documented sample is higher than for those in the selected sample for several reasons. Many of the samples were put into prenumbered bags indicating the locations of specific samples. Samples were, for the most part, photographed on the lunar surface together with a tripod gnomon, which, in addition to showing scale on a vertical-seeking weighted bar, pointed out the particular rock to be picked up.

Sample 12006

See the discussion for sample 12020.

Sample 12007

Sample 12007 has not been recognized in surface photographs; however, the small, angular, apparently freshly fractured piece of rock may have been taken from the large mound. At 04:22:10 g. e. t., the LMP made a comment about chipping off a fragment of a larger rock. The lack of surface pits in sample 12007 may be because this sample was embedded in the large mound.

Sample 12008

Sample 12008 has been tentatively identified on the southeast side of the large mound in Hasselblad photographs AS12-46-6831 and AS12-46-6832 (fig. E-1). The rock is seen on the side of the mound near the left edge of the photograph in figure E-1. Sample 12008 is shown in figure E-2 in the LRL with an approximate reconstruction of the lunar lighting.

TABLE E-II. - CURRENT STATUS OF THE IDENTIFICATION AND LOCATION OF THE APOLLO 12 SAMPLES

Samples identified in lunar-surface photographs		Samples located based on descriptions[a]		Samples not located
Definite	Tentative	Known	Tentative	
Selected samples				
None	12004	None	[b]12001	12002
	12008		[b]12003	12005
	12010		12007	12009
	12013		12015	12011
	12014		12017	12012
	12016		[c]12020 or 12006	12018
	12019			[c]12020 or 12006
	12021			
	12022			
Documented samples				
12031	12036	12035	[b]12030	[d]12056
[b]12033	[e]12039	12038	[b]12032	12062
[e, f]12034	[e]12040	12045	[b]12037	12065
[b]12037	12043		[b]12041	
[b]12042	12046		[b]12042	
12047			[b]12044	
12051			[g]12063	
[e]12052			[h]12064	
[e]12053				
12054				
12055				

[a]Location of the documented samples was also based on the bag numbers.

[b]Soil.

[c]One of these samples is the "grinning" rock described by the CDR; the location of the other sample is not known.

[d]Two of the documented samples not located are probably from the Surveyor III site; the third one is probably from Block Crater.

[e]Sample was moved before lunar-surface photography.

[f]From trench.

[g]Bench crater.

[h]Surveyor III site.

Figure E-1. - Photograph showing tentative identification of sample 12008 on the southeast side of the large mound (AS12-46-6832).

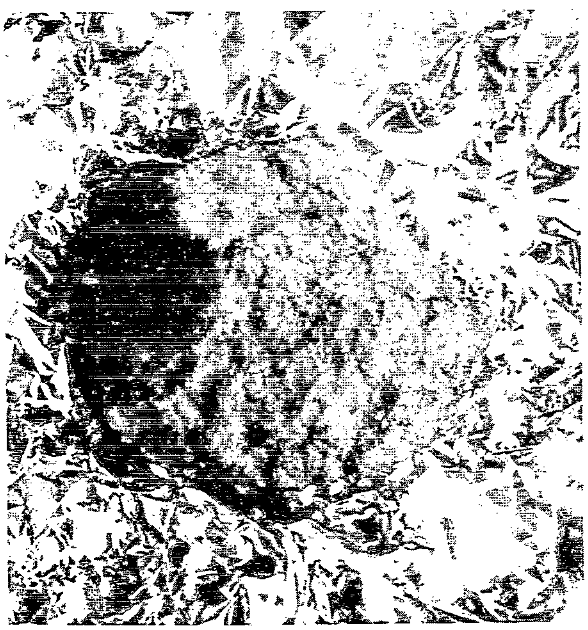

Figure E-2. - Approximate lunar orientation of sample 12008 in the LRL.

Sample 12010

Sample 12010 has been tentatively identified in Hasselblad photograph AS12-46-6835 (fig. E-3). This photograph was taken near the rim of Middle Crescent Crater. Figure E-4 shows sample 12010 in the LRL with an approximate reconstruction of the lunar lighting. The reconstructed orientation can be correlated most nearly with LRL photographs S-69-62309 and S-69-62310.

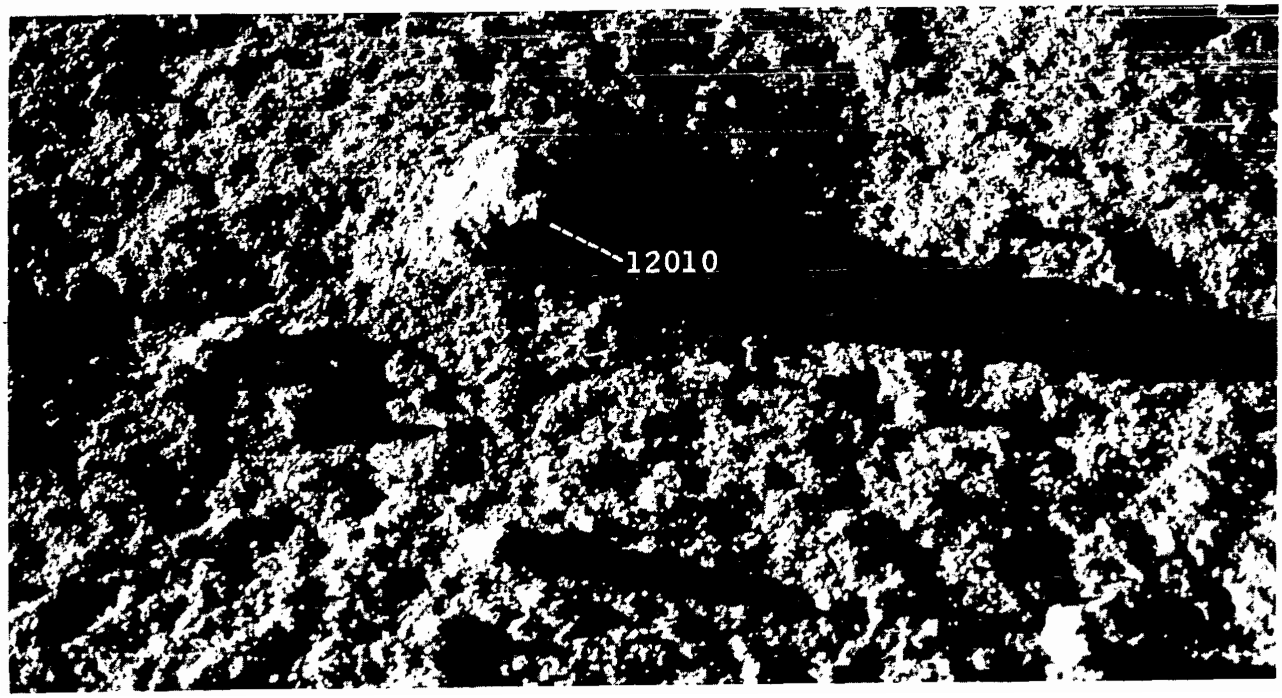

Figure E-3. - Enlargement of a portion of Hasselblad photograph AS12-46-6835 showing the tentative identification of sample 12010.

Figure E-4. - Approximate lunar orientation of sample 12010 in the LRL as correlated with Hasselblad photograph AS12-46-6835.

Sample 12013

Sample 12013 is tentatively identified in Hasselblad photograph AS12-46-6833 as the right-hand fragment in a group of three. This photograph was taken near or on the rim of Middle Crescent Crater. Sample 12013 is shown in figure E-5 before it was picked up. Sample 12013 is shown in figure E-6 in the LRL with an approximate reconstruction of the lunar lighting. The lunar orientation can be correlated most nearly with LRL photograph S-69-63360. In the Hasselblad photograph, the sample can be seen on the rim of a small crater from which it may have been recently ejected along with the other fragments in the field of view. The fragment lying in the center of the group of three shown in figure E-5 has been identified tentatively as sample 12019.

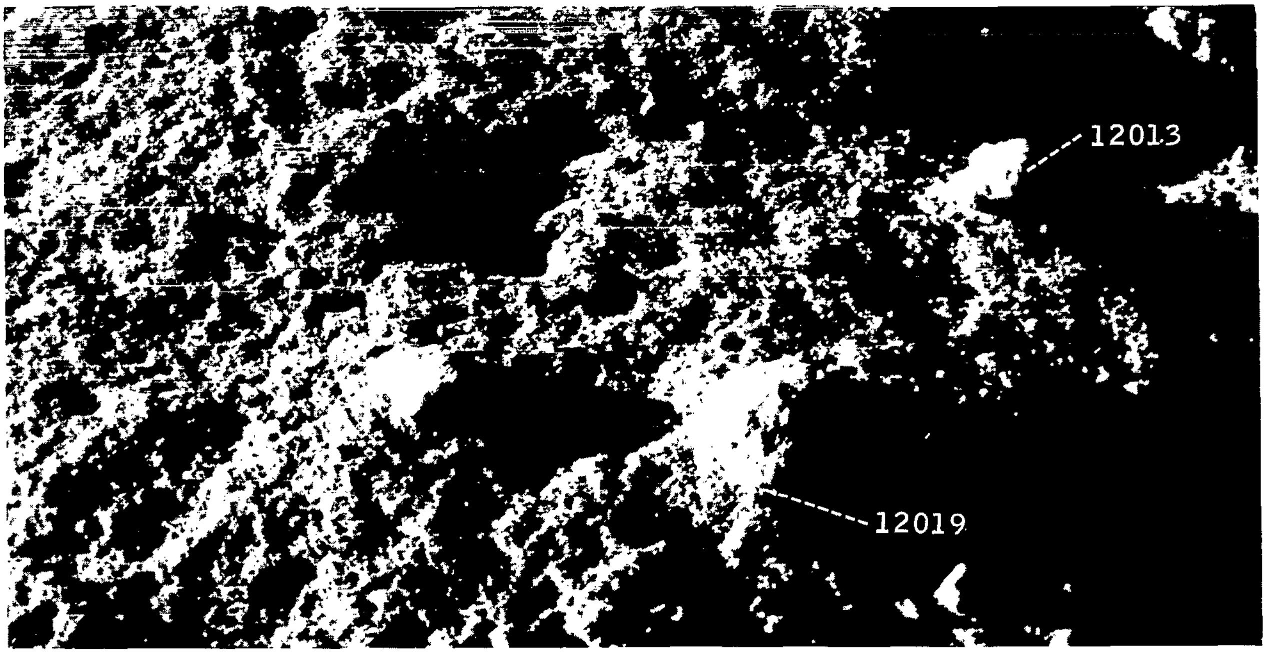

Figure E-5. - Enlargement of a portion of Hasselblad photograph AS12-46-6833 showing the tentative identification of samples 12013 and 12019 near the rim of Middle Crescent Crater.

Figure E-6. - Approximate lunar orientation of sample 12013 in the LRL. (Note that a slice has been removed for thin sections.)

Sample 12014

Sample 12014 is tentatively identified in Hasselblad photograph AS12-47-6940, taken by the LMP on the return trip to the LM from Middle Crescent Crater. Figure E-7 shows sample 12014 on the lunar surface before it was collected. Figure E-8 shows sample 12014 in the LRL in an approximate lunar orientation without a reconstruction of the details of lunar lighting.

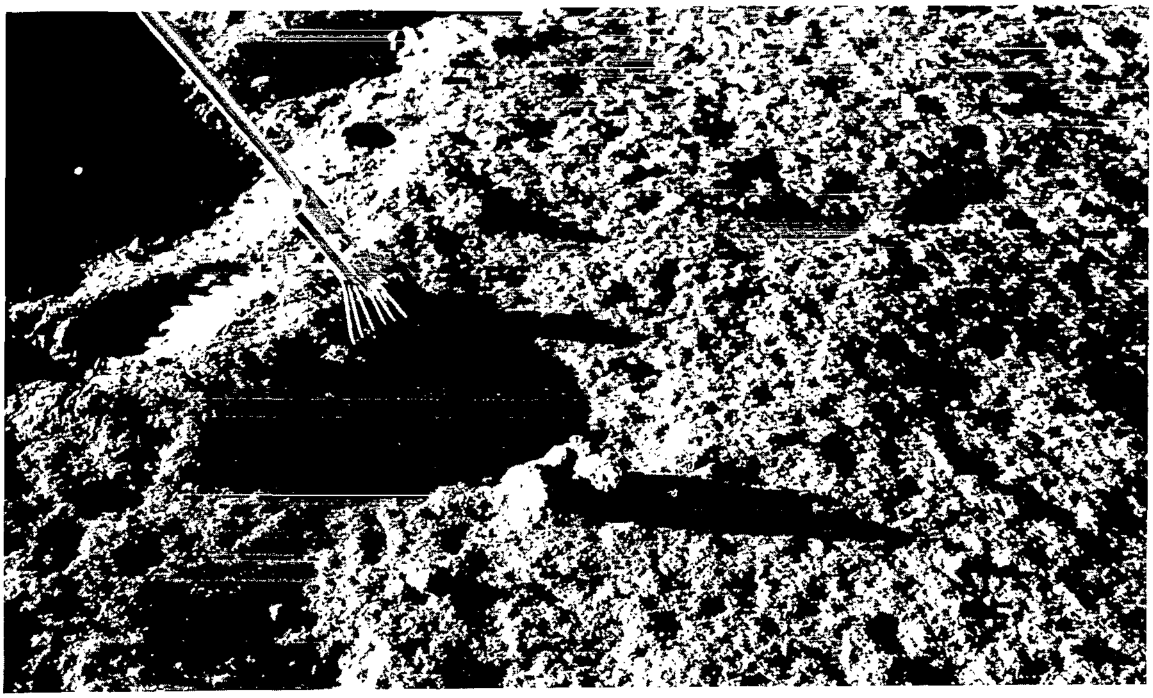

Figure E-7. - Photograph showing tentative identification of sample 12014 before it was picked up (AS12-47-6940).

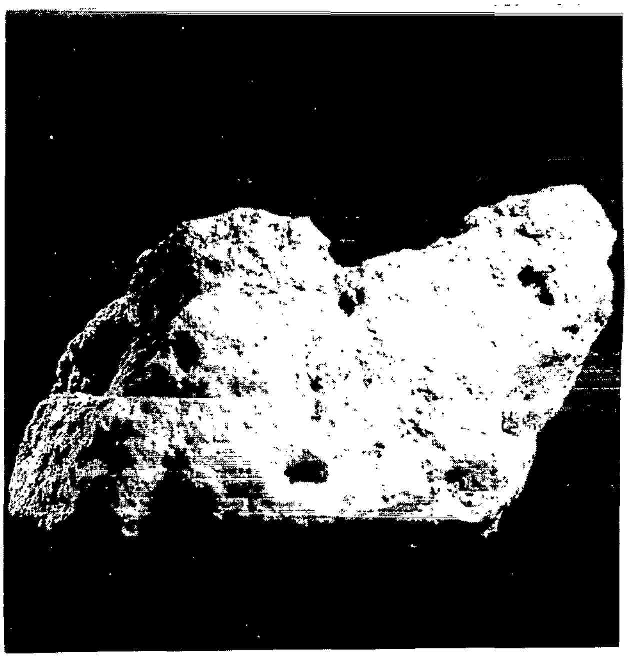

Figure E-8. - Approximate lunar orientation of sample 12014 in the LRL without reconstructed lunar lighting (NASA-S-69-63353).

Sample 12015

Sample 12015 has not been recognized in any lunar-surface photograph; however, a comment made by the CDR at 04:22:17 g. e. t. suggests that he picked up a rock that had a "dent" in it. Sample 12015 does have a large, single, nearly spherical cavity on one side. The location of sampling was on the rim of Middle Crescent Crater.

Sample 12016

Sample 12016 is tentatively identified in Hasselblad photograph AS12-47-6939, taken on the rim of Middle Crescent Crater by the LMP. Figure E-9, an enlargement of part of the Hasselblad photograph, shows sample 12016 half embedded in the ejecta on the rim of a 2-meter-diameter crater. Figure E-10 is an approximate reconstruction of the lunar orientation using an LRL model of sample 12016. It is interesting to note that approximately half of sample 12016 appears to be buried by other ejecta from the small crater in a manner similar to the burial of documented sample 12051.

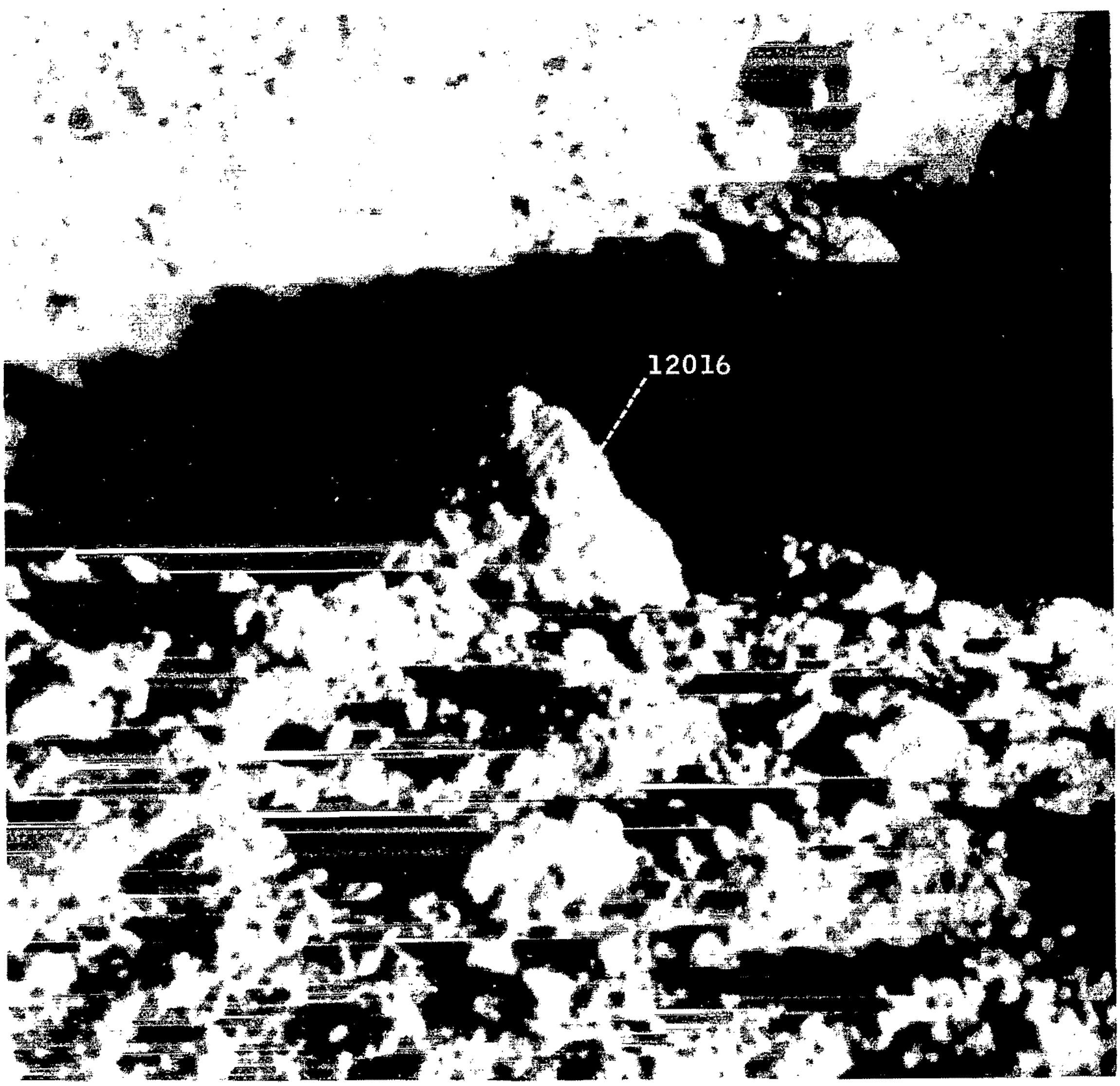

Figure E-9. - Enlargement of a portion of Hasselblad photograph AS12-47-6939 showing the tentative identification of sample 12016 embedded in the rim of a 2-meter-diameter crater.

Figure E-10. - Photograph of an LRL model of sample 12016 showing the approximate lunar orientation and lighting. The fine details of the surface of the rock are lost on the model. The holes are bubbles formed when the model was made.

Sample 12017

Sample 12017 has not been identified in any lunar-surface photograph; however, it is the only rock in the selected sample that had a significant coating of black glass. It is probable that sample 12017 came from the vicinity of the small mound that was the starting point for the selected-sample traverse. Although the sample was not specifically photographed and its lunar orientation at the time of sampling is unknown, it seems likely that the glassy side was up and exposed on the lunar surface so that it attracted attention and elicited the following comment from the LMP (04:22:02 g. e. t.): "Hey, here's a rock they'll be glad to see in Houston."

Sample 12019

Sample 12019 is tentatively identified in Hasselblad photograph AS12-46-6833 as the center fragment in a group of three resting on the rim of a small secondary crater. The photograph was taken on or near the rim of Middle Crescent Crater; the exact location is not known because the lunar horizon is not shown in the photograph. Figure E-5 is an enlargement of part of Hasselblad photograph AS12-46-6833 and shows sample 12019 before it was picked up. In the same field of view, sample 12013 is also tentatively identified. Figure E-11 shows an approximate reconstruction of the lunar orientation of sample 12019 in the LRL.

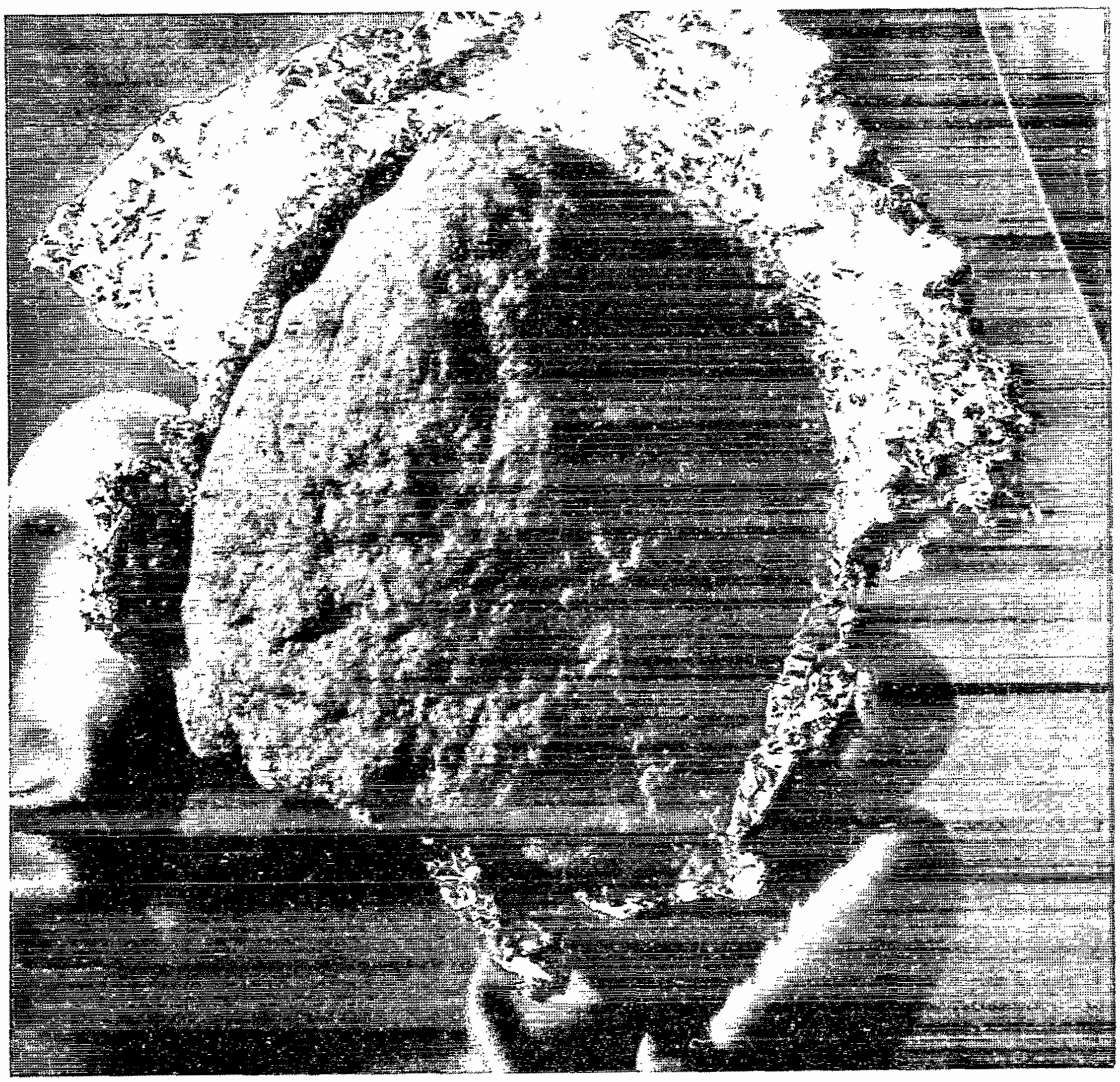

Figure E-11. - Approximate lunar orientation of sample 12019 in the LRL as correlated with Hasselblad photograph AS12-46-6833.

Sample 12020

Sample 12020 has not been identified in the lunar-surface photographs; however, the sample is one of two rocks likely to be the "grinning" rock mentioned by the CDR at 04:22:25 g. e. t. on the return trip to the LM from Middle Crescent Crater during the selected-sample traverse. The other possible contender for the "grinning" rock is sample 12006. Samples 12020 and 12006 both have vugs and vesicles that, at the proper lunar orientation and lighting, could have faces. Sample 12006 is shown in figure E-12 in the LRL in an orientation that includes a face. Figure E-13 shows sample 12020 in the LRL held in such a way that the shadows cast by the vugs and fractures produce a face.

Figure E-12. - Photograph of sample 12006 at an angle in which the vugs suggest a face, possibly the "grinning" rock sampled at 04:22:25 g. e. t. (NASA-S-69-61912).

Figure E-13. - Photograph of sample 12020 held in an orientation such that the vugs and fractures suggest a face, possibly the "grinning" rock.

Sample 12046

Sample 12046 is from the documented sample and was one of three fragments collected on the north rim of Block Crater and put into bag 15-D. Sample 12046 is tentatively identified with moderate assurance in Hasselblad photographs AS12-48-7148, AS12-48-7149, and AS12-48-7150. Figure E-14 is an enlargement of a portion of Hasselblad photograph AS12-48-7149 that shows samples 12046 and 12047 before they were picked up. Figure E-15 shows sample 12046 in the LRL with an approximate reconstruction of lunar lighting.

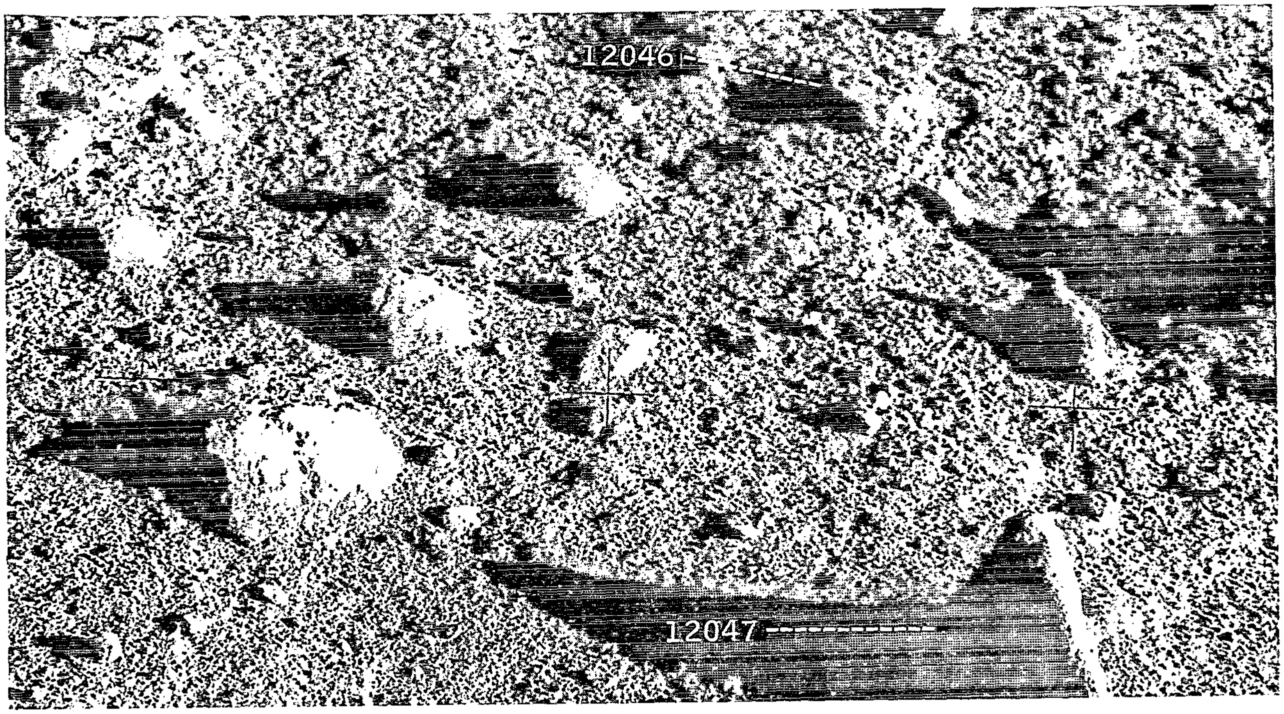

Figure E-14. - Enlargement of a portion of Hasselblad photograph AS12-48-7149 showing samples 12046 and 12047 before they were picked up and put into bag 15-D. Sample 12045, also included in bag 15-D, has not been identified in the lunar-surface photograph.

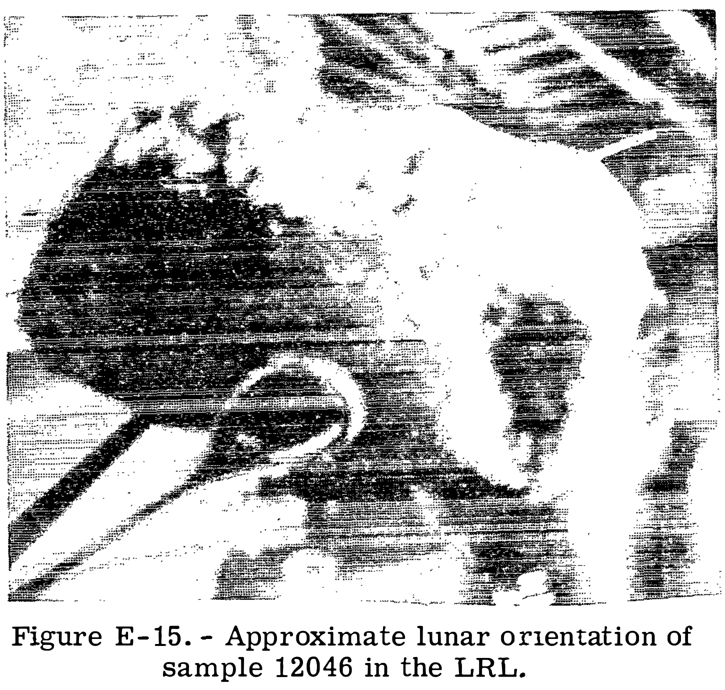

Figure E-15. - Approximate lunar orientation of sample 12046 in the LRL.

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