JSC 12922

APOLLO 14 COARSE FINES (4-10MM) SAMPLE LOCATION AND CLASSIFICATION

BY F.E. KRAMER AND D.B. TWEDELL

JUNE, 1977

National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER
Houston, Texas

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INTRODUCTION

The information contained within this catalogue consists of the identification and description of the 4-10 mm sieve fraction (coarse fines) from the soil samples collected during the Apollo 14 mission. These soil samples were collected as part of the Contingency, Comprehensive, Bulk and Trench samples. Also, some of the residues from the weigh bags were sieved and the 4-10 mm fraction separated.

The soils were, for the most part, sieved during the PET phase of initial processing, but the coarse fines were not described in detail at that time. Recently, examination and description of the 4-10 mm fines were carried out in nitrogen-filled, stainless steel cabinets during a general re-examination of the Apollo 14 sample collection at the Lunar Curatorial Facility, Johnson Space Center. Each particle was held between forceps, dusted in a jet of N_2, and placed on a teflon-covered stage. They were examined with a binocular microscope, separated by lithology, and the lithologic types described.

Because of the relatively small quantity of 4-10 mm material returned by Apollo 14 (154 gm), it was possible to describe all such particles for inclusion in this document. Weights of individual particles in this fraction range from about 0.10 - 0.50 gm, large enough in size for several studies (age, chemistry, petrology).

ACKNOWLEDGMENTS

This catalogue was produced primarily by the efforts of Frank E. Kramer and David B. Twedell (Northrop Services, Inc.). The authors would like to thank Patrick Butler, Jr. and Charles Meyer, Jr. for their editorial assistance and continuing support. We would also like to thank all other curatorial personnel who assisted us in making this catalogue possible.

GEOLOGY OF THE LANDING SITE

Apollo 14 astronauts Alan Shepard and Edgar Mitchell landed at the Fra Mauro Site (coordinates 3°40'24" S. Latitude, 17°27'55" W. Longitude) on February 5, 1971. The lunar module (LM) landed in a broad, shallow valley, approximately 1100 meters west of Cone Crater and 500 kilometers from the edge of Mare Imbrium. The prime objective of the mission was to sample the Fra Mauro formation by collecting samples of the ejecta of Cone Crater.

The Fra Mauro formation is an extensive unit that is distributed radially around the Imbrium Basin. It is thought to be part of the ejecta blanket that resulted from the excavation of the Basin (Gilbert, 1893). Because of the size of the Basin, the pre-mission belief was that some ejecta may have come from deep (tens of kilometers) within the original crust. Stratigraphic relations around the margins of the Imbrium Basin indicate that a number of significant geologic events occurred after excavation of the Imbrium Basin and before or during the later filling by Mare material (Baldwin, 1963; Wilhelms, 1970). These included the formation of large craters such as Archimedes, emplacement of relatively light (pre-mare) plains materials and formation of the Orientale Basin. Materials from these post-Imbrium events may also be present at the Fra Mauro site (Schonfeld and Meyer, 1973). Samples from Apollo 14 site are, therefore, older than those taken at the Apollo 11 and Apollo 12 sites.

The ridges of Fra Mauro formation in the vicinity of the landing site are mostly 1-4 km wide, a few to several tens of meters high and 5-10 times as

long as they are wide. The ridges are slightly sinuous and roughly radial to the Imbrium Basin. These ridges are thought to have formed by material flow, probably fragmental rock debris, radially along the ground during excavation of the Basin (Swann et.al., 1971). Alternatively these ridges are thought to be caused by collisions of secondary ejecta during the Imbrium event (Morrison and Oberbeck, 1975). Cone Crater is situated on one of these ridges. It is a sharp rimmed, relatively young, crater approximately 340 meters in diameter. Ejecta material range up to 15 meters in size. Lunar orbital photographs indicate that Cone Crater penetrates below the fine grained lunar regolith into a blocky or bedrock substrate (Swann et.al., 1971). It was anticipated that this substrate would be Imbrium Basin ejecta material in its original form.

Analysis of photographs of the Cone Crater boulder field and comparison of these with returned samples indicate that the Fra Mauro formation is composed primarily of moderately coherent breccias in which dark lithic clasts, up to 50 cm across, and less abundant light clasts set in a light matrix (Swann, et.al., 1971).

The Apollo 14 astronauts traversed three photogeologic map units during the two EVA's: (1) a "smooth terrain" unit on which the LM landed that is relatively level over distances of one to a few kilometers, densely populated with subdued craters causing the surface to be undulating, (2) slopes of a cratered ridge of the Fra Mauro formation which has slope angles of at least 10° - 15°, and (3) the blocky rim deposit of Cone Crater which is densely strewn with blocky ejecta, 1-15 meters in size. It is presumed, using terrestrial crater analogs (Gault et.al., 1968), that ejecta closest to the rim of Cone Crater are derived from the greatest

depths and that a mixture of ejecta from different depths occurs in blocky rays that extend outward from the crater. Doublet and Triplet craters are situated between the landing site and Cone Crater. These craters have penetrated into the regolith into material that Sutton et.al. (1972) consider to be Fra Mauro. The ejecta from these craters may be represented by samples from Station G and G_1, as well as by the Comprehensive sample (see Figure 1).

The astronauts made two traverses from the LM. During the first EVA, they set up the Apollo Lunar surface experiment package (ALSEP), collected the Contingency, Comprehensive and Bulk samples, as well as two "football size" rocks. On the second EVA, they traversed to the rim of Cone Crater, taking cores and grab samples enroute, and returned to the LM, collecting additional grab samples, cores, and soils from a shallow trench.

Although the texture of the regolith of the Apollo 14 site is similar to those at the Apollo 11 and Apollo 12 landing sites, a greater variation exists in the characterization of the soil at depths of a few centimeters (Apollo Program Summary Report, 1975). No difficulty was encountered in digging the trench into the regolith. The layering of the trench showed a dark, fine grained material underlain by a thin, glassy layer that is, in turn, underlain by medium to coarse-grained sand size material. However, due to the low cohesion of the soil at the trench site, the walls of the trench caved in at shallow depths causing a mixed sampling of the layers.

TABLE I - Sample Listing, Showing Number and Type of Particles Present in the 4-10mm Fraction

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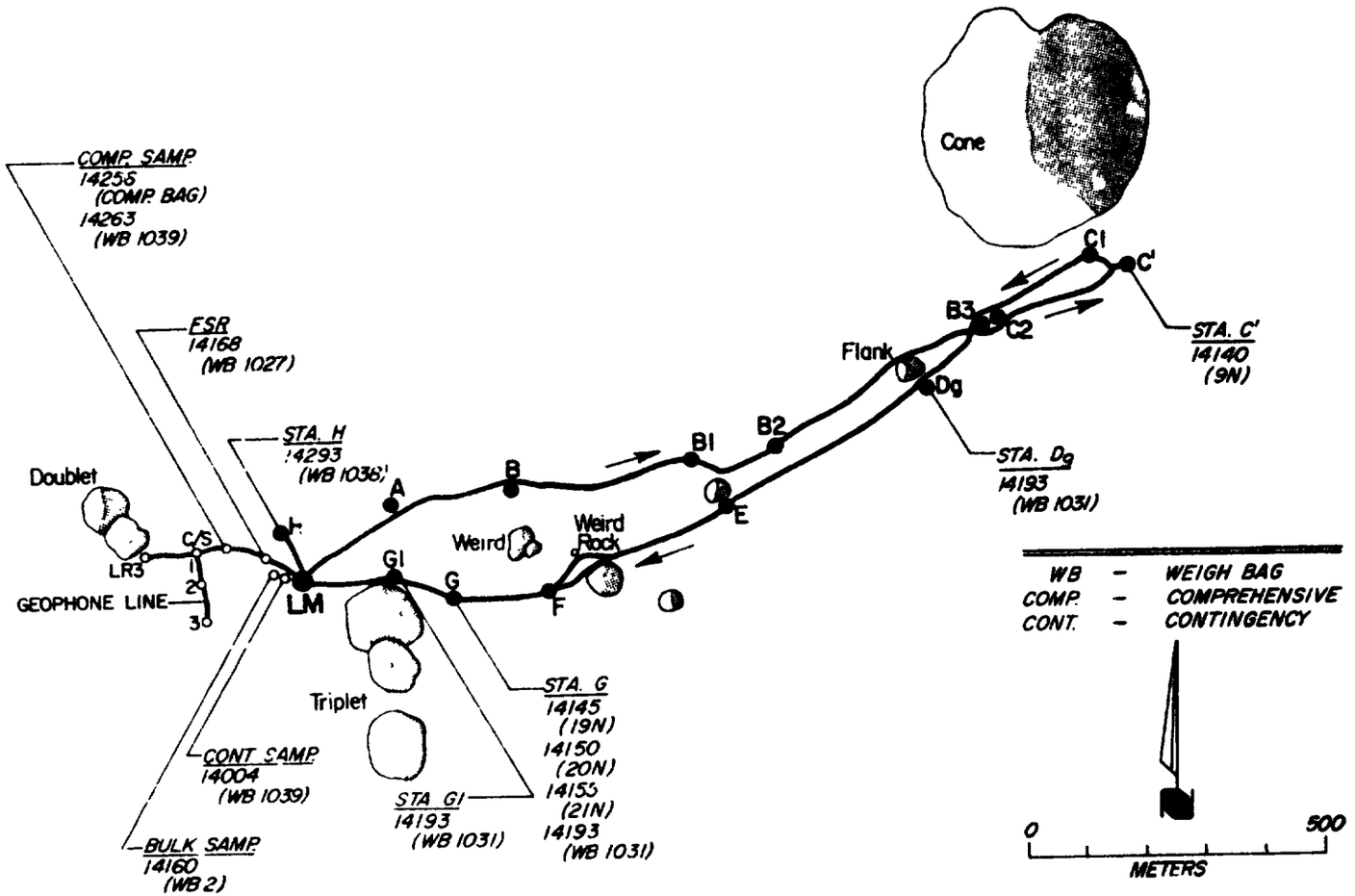
Sample Number	Total Weight	Light Matrix Breccia	Dark Matrix Breccia	Fine Grained Basalt	Coarse Grained Basalt	Anorthosite	Soil Breccias	Glass Matrix Breccias	Average Particle Weight	Station Number	Location and Type of Sample
14004	26.86 gm	31	36	12	4	1	81	29	.14	LM	Contingency Sample - Soil
14140	6.32 gm	14	7	1	2				.26	C'	Beneath Surface - Soil
14145	.88 gm		1	1					.44	G	Top of Trench - Soil
14150	11.01 gm	3	4		25	1			.33	G	Bottom of Trench - Soil
14155	2.77 gm	6	13						.15	G	Middle of Trench - Soil
14160	45.91 gm	13	14	25		2	50		.44	LM	Bulk Sample - Soil
14168	26.42 gm	49	5		2				.47	ALSEP	"Football Size Rocks" - Fines
14193	8.00 gm	24	13						.22	Dg	14301,306,308,310,311 Fines-Residue
14256	5.88 gm		2	1	1		25		.20	ALSEP	Comprehensive Fines - Soil
14263	15.61 gm	5	10	1	1		35		.30	ALSEP	From Comprehensive Rocks - Residue
14293	2.12 gm	12							.18	H	Residue, Bag 1038

Figure I. **APOLLO 14 EVA TRAVERSE**
COARSE FINES SAMPLE LOCATIONS, MAJOR CRATERS



The following is a list of terms used in the binocular descriptions of individual samples:

CHARACTERISTIC	TERM	DEFINITION AND COMMENT
Cavities		Not to include merely surface related features such as clast molds.
	vugs vesicles crystals	projecting or lining materials
Coherence		
Intergranular:		grain-to-grain coherence
	very friable	crumbles under manual pressure
	friable	crumbles under manual pressure
	coherent	must be struck to disaggregate grains
	tough	breaks across grains rather than around them
Fracturing:		terms combined as needed for a full description
	absent few numerous	
	non-penetrative penetrative	visible on opposing sides
Component		igneous rocks, breccia and fines is applicable
	plagioclase	light grey and white (if shocked)
	ilmenite	black opaque submetallic
	opaque	used when opaques other than ilmenite are present, but quantitatively inseparable
	pyroxene	amber to honey brown to dark brown
	clast	see clast descriptions for details of various clast lithologies
	glass	dark green to black noncrystalline silicate material
Surface		
	irregular granulated smooth hackly	generally a freshly broken surface

CHARACTERISTIC	TERM	DEFINITION AND COMMENT
	glass covered (%)	e.g., glass 30% of E and 10% of T
	grooved	for slickenside-like surfaces.
Zap Pit	none	none seen in quick scan
	few	$<10/cm^2$
	many	$>10/cm^2$

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14004

Contingency Sample Coarse Fines

The Contingency Sample was collected at the beginning of the first EVA 8-10 meters from the LM. The sample was scooped into the Contingency Sample Bag and placed on the ladder of the LM. After the first EVA the Contingency Sample was transferred into the LM. There is a possibility that some of the sample may have spilled out onto the floor of the LM.

> "04 18 32 01 LMP: Oh, oh; All of the contingency -- the disposal containers just fell out on the floor. Just a minute ..." (Apollo 14 Voice Transcript)

It was discovered that the Contingency Sample Bag had ruptured and was leaking. The crew then placed the Contingency Sample Bag into Weigh Bag 1039 which contained the Comprehensive Sample rocks.

Later, the Contingency Sample was sieved and the 4-10 mm fraction numbered 14004.

14004,1

Light Matrix Breccia

4 particles, 0.62 grams

Coherence: Tough

Shape: Angular and sub-angular

Surface: No pits, minute vugs

Color: Light gray

Mineralogy: Aphanitic, probably 70% plagioclase

Remarks: Annealed glass matrix, no visible clasts

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14004,2

Glass Matrix Breccia
2 particles, 0.66 grams

Coherence: Tough
Shape: Angular
Surface: No pits, no vugs
Color: Dark gray
Mineralogy: Aphanitic, about 5% is small clasts.
Remarks: Probably devitrified glass

14004,3

Dark Matrix Breccia

3 particles, 0.96 grams

Coherence: Tough

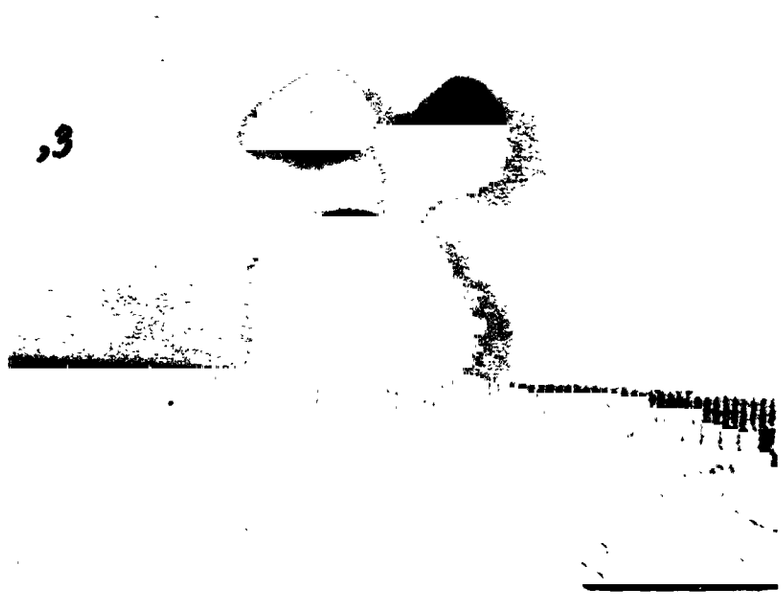
Shape: Angular

Surface: Sugary

Color: Light tan

Mineralogy: 80% feldspar; 18% orthopyroxene; 2% opaque.

Remarks: Grain size = 0.2mm
Equigranular texture



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14004,4

Glass Matrix Breccia

4 particles, 0.52 grams

Coherence: Tough

Shape: Subrounded

Surface: Dust covered

Color: Very light gray

Mineralogy: 80-90% glass, 10-20% clasts

Remarks: Lighter in color than most breccias

14004,5

Glass Matrix Breccia

5 particles, 1.35 grams

Coherence: Tough

Shape: Subrounded

Surface: Dust covered

Color: Light gray to tan

Mineralogy: 80-90% glass; 10-20% mineral inclusions.

Remarks: Similar to 14004,4

14004,6

Coarse Grained Basalt

4 particles, 0.61 grams

Coherence: Moderately coherent

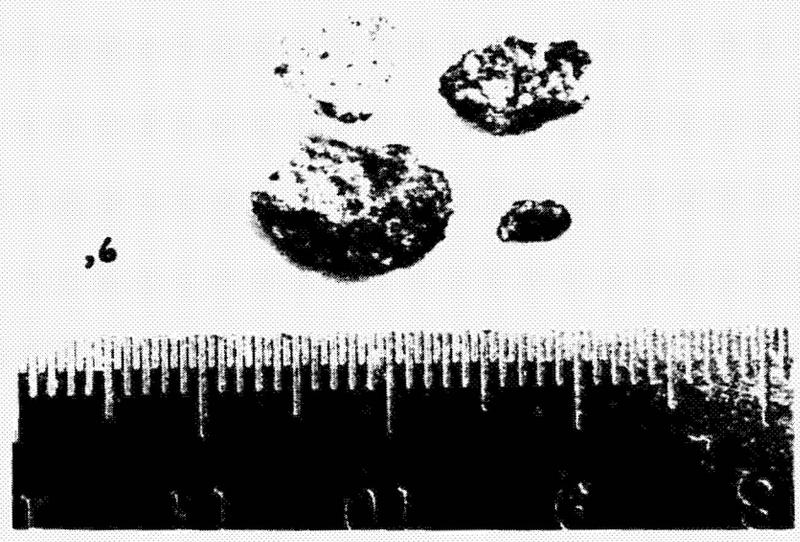
Shape: Angular

Surface: Hackly, freshly broken

Color: Tan

Mineralogy: 60% chalky plagioclase; 15-20% light brown pyroxene; 5-10% light green (olivine); 5% opaque.

Remarks: Texture = Equigranular, grain size = 1mm
These 4 particles are different from each other, but they are each clearly igneous (basaltic) in origin.



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14004,7

Fine Grained Basalt

1 particle, 0.11 grams

Coherence: Moderately coherent

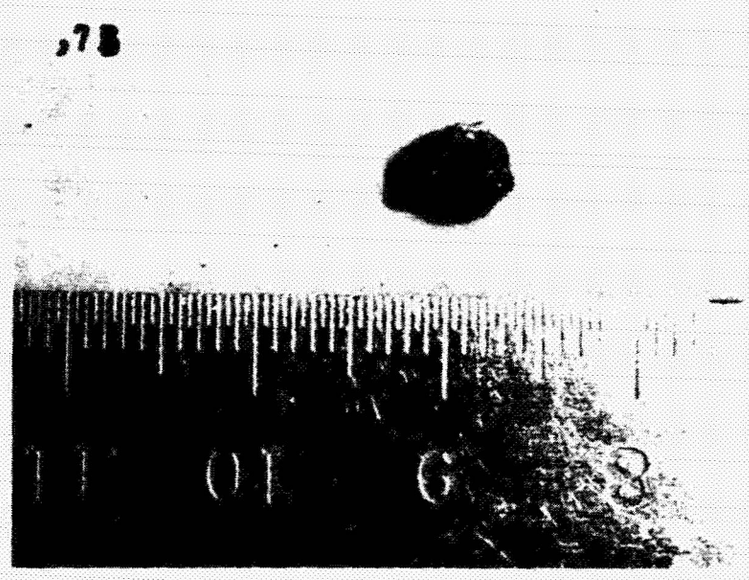
Shape: Angular

Surface: One side coated with devitrified black glass or microbreccia.

Color: Tan

Mineralogy: 60% chalky white plagioclase; 40% honey brown pyroxene, no opaques. Texture - equigranular. Grain size = 1-2mm.

Remarks: Probably was originally a clast in a breccia



14004,8

Light Matrix Breccia

3 particles, 0.39 grams

Coherence: Soft and friable

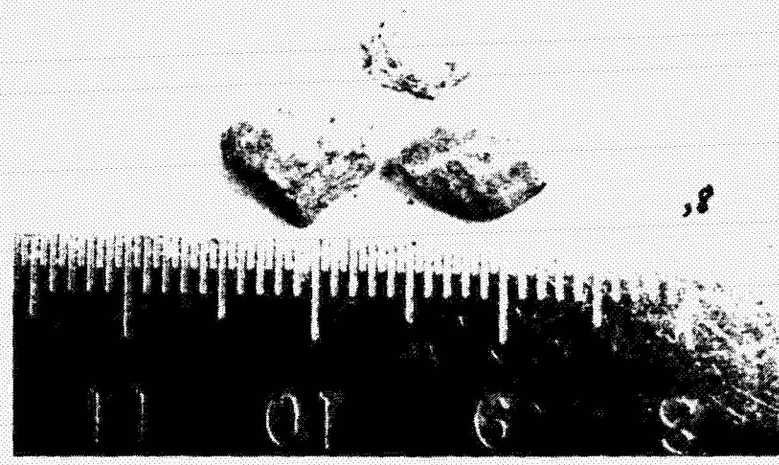
Shape: Subangular

Surface: 2 particles contain cavities

Color: White

Mineralogy: 90% chalky white plagioclase; 5-10% specks of opaque mineral.

Remarks: Fragmental texture



14004,9

Fine Grained Basalt

1 particle, 0.16 grams

Coherence: Poorly coherent

Shape: Angular

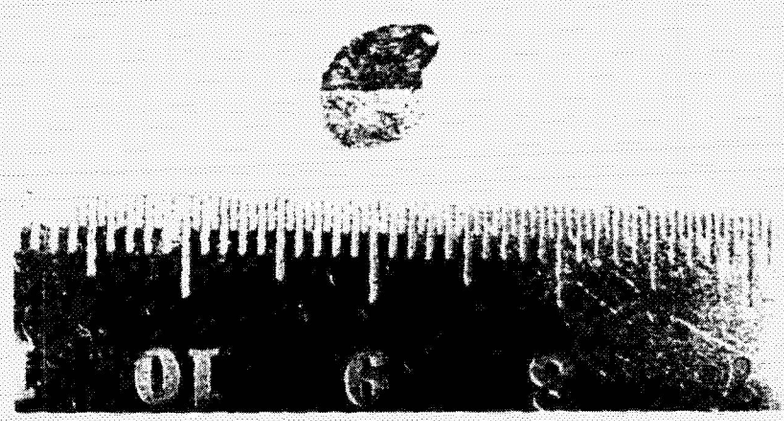
Surface: Freshly broken

Color: Black and white

Mineralogy: 60-70% chalky white plagioclase; 25-30% light gray pyroxene; 5% opaque. Grain size = 1-2mm, texture- subophitic.

Remarks: Half of particle is dark matrix microbreccia.

,9



14004,10

Fine Grained Basalt

5 particles, 0.67 grams

Coherence: Tough

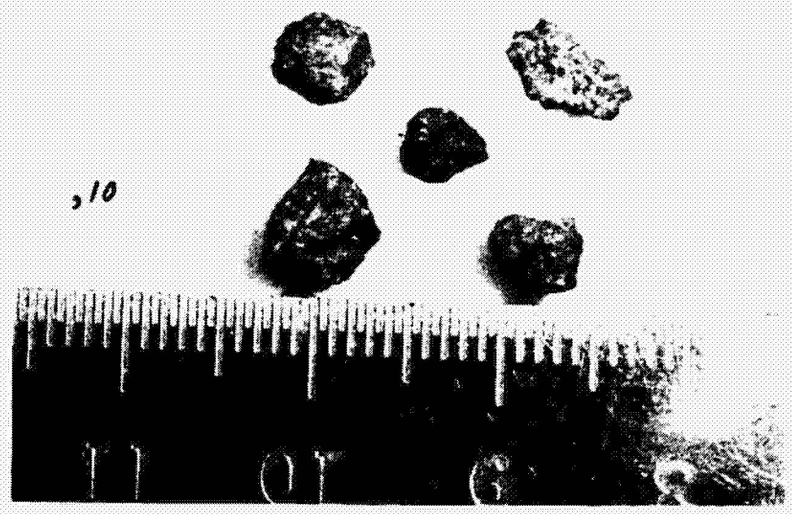
Shape: Rounded

Surface: Mottly

Color: Light grayish brown

Mineralogy: 60% plagioclase; 40% greenish brown pyroxene. One particle has 5% opaque and 5% vugs.

Remarks: These particles are probably clasts from breccia. They are different from each other, somewhat annealed in appearance and could be either KREEP or Aluminous Mare Basalts.



14004,11

Light Matrix Breccia

2 particles, 0.18 grams

Coherence: Moderately coherent

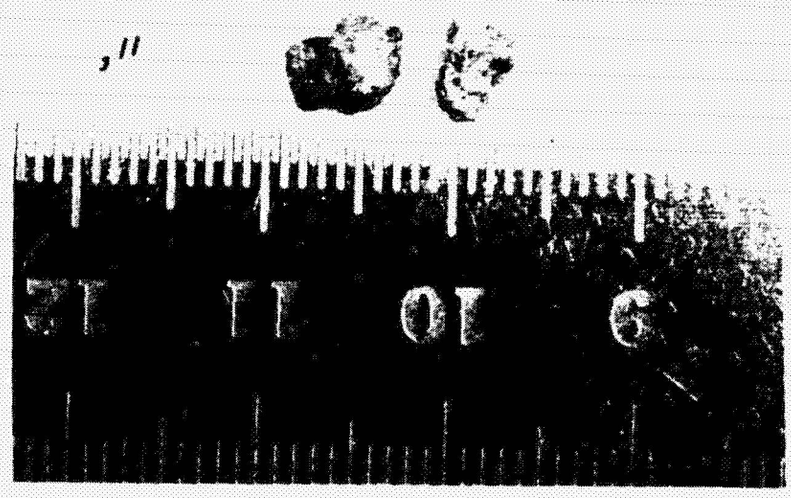
Shape: Angular

Surface: Rough with outline of large vugs.

Color: White

Mineralogy: 60% chalky white plagioclase; 40% dark gray matrix.

Remarks: Clast size 1-2mm.



14004,12

Fine Grained Basalt

1 particle, 0.43 grams

Coherence: Tough, with fractures

Shape: Subrounded with 5% vugs 1mm

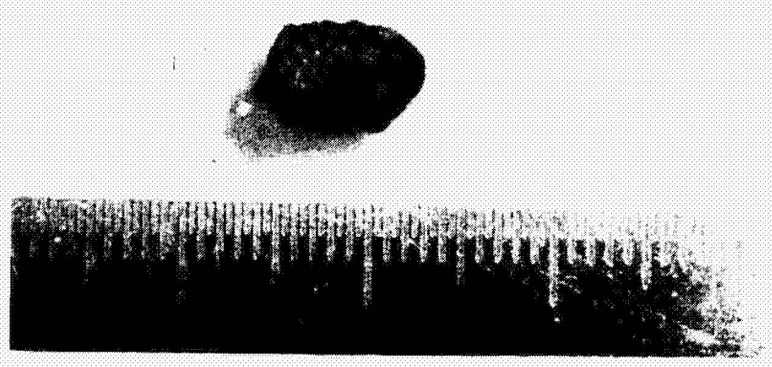
Surface: Bumpy, abraded

Color: Dark gray, greasy luster

Mineralogy: 50% light gray mineral(probably plagioclase)
50% dark gray mineral (probably pyroxene)
Texture is equigranular
Grain size - 1mm

Remarks: Poikolitic texture

,12



14004,13

Dark Matrix Breccia

9 particles, 3.03 grams

Coherence: Tough

Shape: Angular to subrounded

Sur[illegible] Some are zap pits

Col[illegible] Gray

Mine[illegible]y: Aphanitic

Remarks: These are not all exactly the same, there is some variety. Some particles are small white clasts (1mm) and others have vugs. These are similar to 14321, 14305 etc.

14004,14

Dark Matrix Breccia

20 particles, 2.72 grams

Coherence: Tough

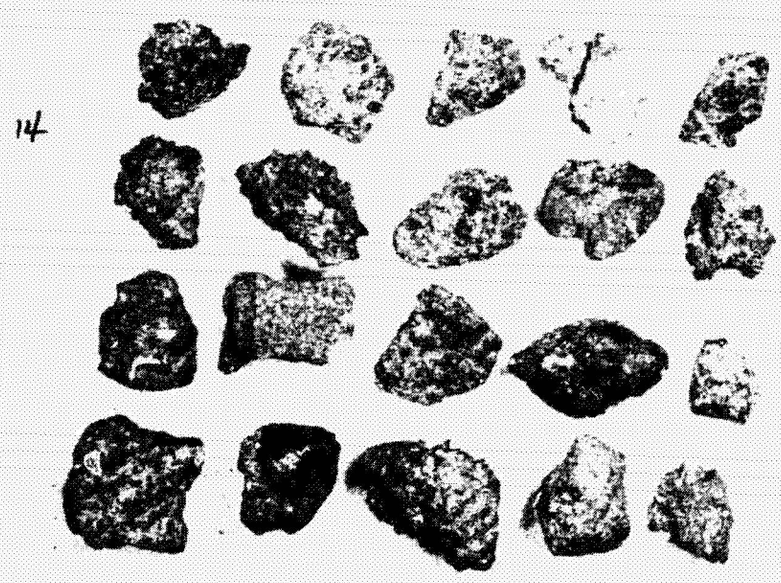
Shape: [illegible] r to subrounded

Surface: Some are zap pits

Color: Gray

Mineralogy: Aphanitic

Remarks: These are not all exactly the same, there is some variety. Some particles are small white clasts (1mm) and others have vugs. These are similar to 14321, 14305 etc.



14004,15

Dark Matrix Breccia

4 particles, 2.93 grams

Coherence: Tough

Shape: Angular to subrounded

Surface: Some are zap pits

Color: Gray

Mineralogy: Aphanitic

Remarks: These are not all exactly the same, there is some variety. Some particles are small white clasts (1mm) and others have vugs. These are similar to 14321, 14305 etc.

·15

14004,16

Soil Breccia

13 particles, 1.09 grams

Coherence: Delicate

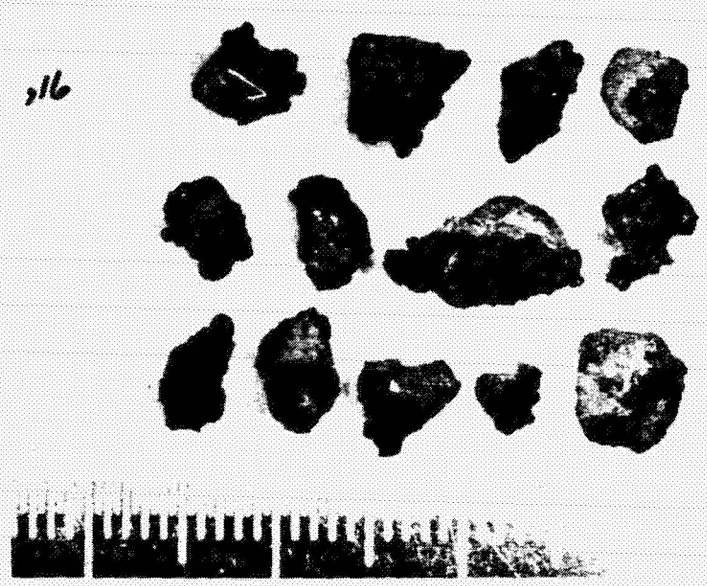
Shape: Irregular

Surface: Glass covered on one side

Color: Medium dark gray

Mineralogy: 95% aphanitic dark matrix; 5% plagioclase clasts

Remarks: Similar to 14004,17 and 14004,18



14004,17

Light Matrix Breccia

3 particles, 1.31 grams

Coherence: Tough

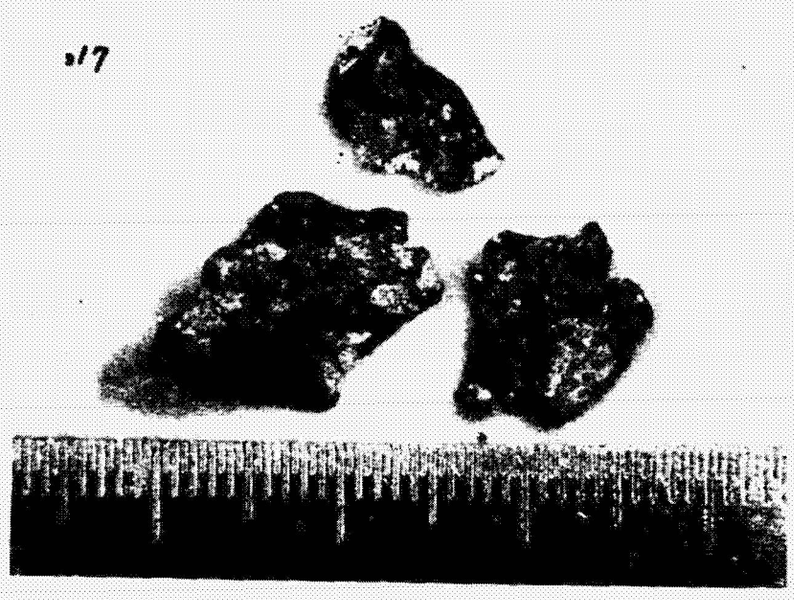
Shape: Angular

Surface: Freshly broken

Color: Dark Gray

Mineralogy: Aphanitic dark gray matrix (50-70%) with light colored clasts of various types (30-50%)

Remarks: Clast size 1-4 mm. Some of the larger clasts appear to be basalts. Most clasts are chalky white plagioclase.



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14004,18

Light Matrix Breccia

19 particles, 2.31 grams

Coherence: Tough

Shape: Angular

Surface: Freshly broken

Color: Dark Gray

Mineralogy: Aphanitic dark gray matrix (50-70%) with light colored clasts of various types(30-50%)

Remarks: Clast size 1-4 mm. Some of the larger clasts appear to be basalts. Most clasts are chalky white plagioclase.

14004,19

Soil Breccia

10 particles, 1.99 grams

Coherence: Friable

Shape: Rounded

Surface: Rough, abraded

Color: Gray

Mineralogy: Both light and dark clasts is very fine light gray matrix. Clasts >1mm = 20-40%.

Remarks: Compressed soil clods.

14004,20

Soil Breccia

18 particles, 1.22 grams

Coherence: Friable

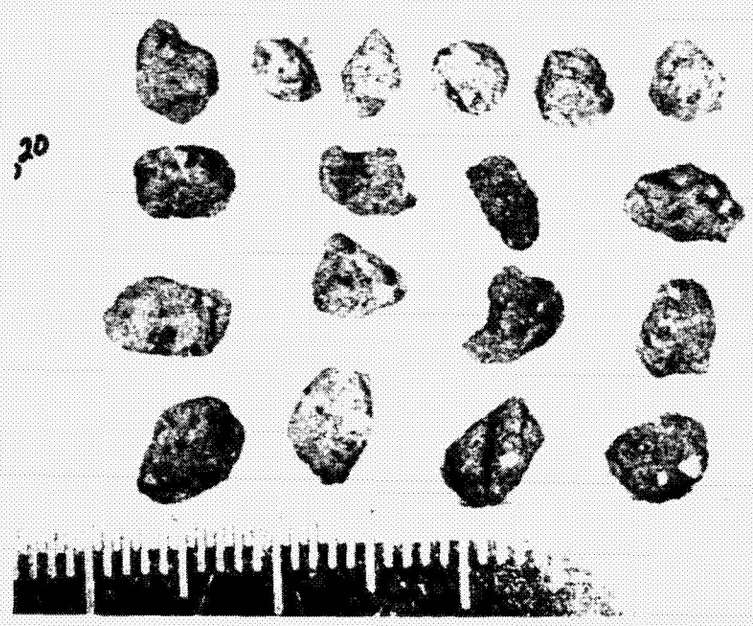
Shape: Rounded

Surface: Rough, abraded

Color: Gray

Mineralogy: Both light and dark clasts is very fine light gray matrix. Clasts >1mm - 20-40%.

Remarks: Compressed soil clods.



14004,21

Soil Breccia

40 particles, 0.62 grams

Coherence: Friable

Shape Rounded

Surface: Rough, abraded

Color: Gray

Mineralogy: Both light and dark clasts is very fine light gray matrix. Clasts >1mm = 20-40%.

Remarks: Compressed soil clods.

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14004,22

Fine grained Basalt

4 particles, 0.03 grams

Coherence: Tough

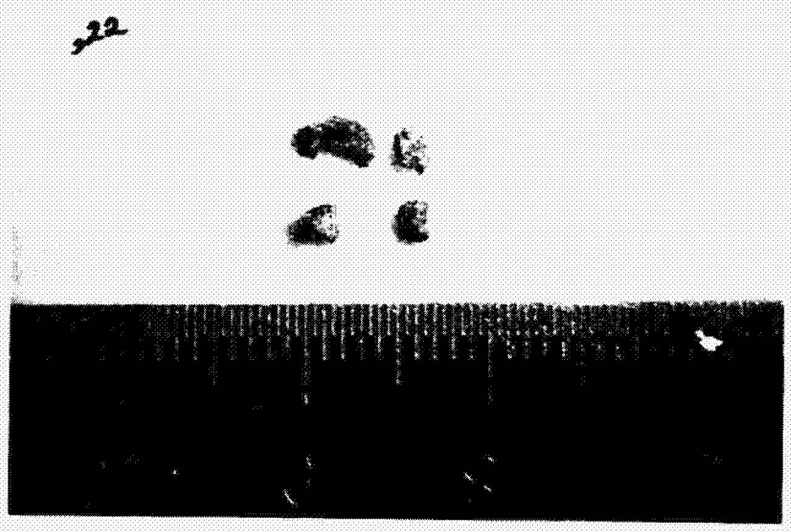
Shape: Irregular

Surface: Freshly broken

Color: Light brownish gray

Mineralogy: 2 particles are 70% plagioclase,30% orthopyroxene
2 particles are 60% plagioclase, 40% clinopyroxene

Remarks: All may have been clasts in breccias.



14004,23

Anorthosite

1 particle, .01 gram

Coherence: Soft

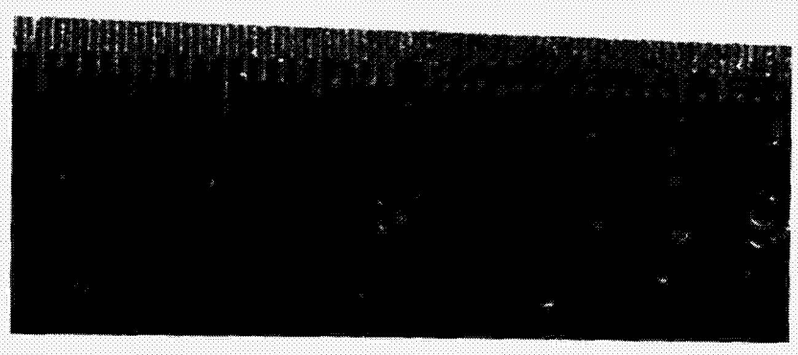
Shape: Subangular

Surface: Freshly broken

Color: Chalky white

Mineralogy: 100% plagioclase

,23



14004,24

Glass Matrix Breccia
3 particles, 0.49 grams

Coherence: Tough
Shape: Irregular
Surface: Shiny black glass
Color: Black
Mineralogy: 100 % glass

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,24

14004,25

Glass Matrix Breccia

15 particles, 1.69 grams

Coherence: Delicate

Shape: Irregular

Surface: Shiny black glass

Color: Black and gray

Mineralogy: 30% black glass attached to 70% dark matrix breccia

Remarks: Not true agglutinates

14140

Station C' Soil - Coarse Fines

Shepard attempted to core the regolith at Station C' but the surface material was apparently very granular and would not remain in the core tube upon withdrawal. He then decided to scoop material into a bag.

> "05 13 35 48 CDR: ... Right now I'm sampling a layer that is sort of a light grey just under the regolith ... it looks like kind of a secondary impact that has disrupted the surface regolith and gone down into the grey area."

The soil was placed in documented bag 9N. It was later sieved and the 4-10 mm fraction numbered 14140.

REPRODUCIBILITY OF THE
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14140,1

Light Matrix Breccia

1 particles, .10 grams

Coherence: Moderately friable

Shape: Angular

Surface: Vuggy black glass to lithic white material. Adhering dust on all surfaces.

Color: Dark gray to white

Mineralogy: 50% glass coating; 50% light matrix breccia. Small % of white plagioclase clasts.

14140,2

Coarse Grained Basalt

1 particle, .08 grams

Coherence: Tough

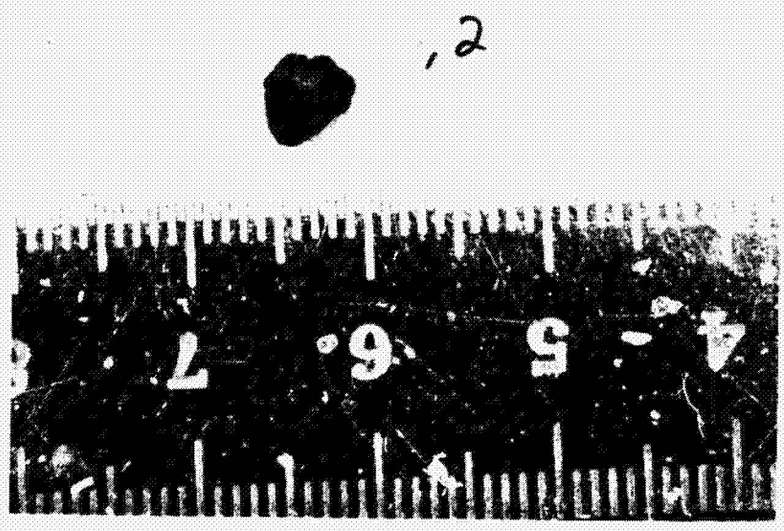
Shape: Sub-rounded

Surface: No pits or patina

Color: Dark gray

Mineralogy: 60% dark brown pyroxene; 40% translucent plagioclase crystals; <1% platy ilmenite.

Remarks: Crystal size ranges from <.1 - .6 mm



14140,3

Light Matrix Breccia

3 particles, .36 grams

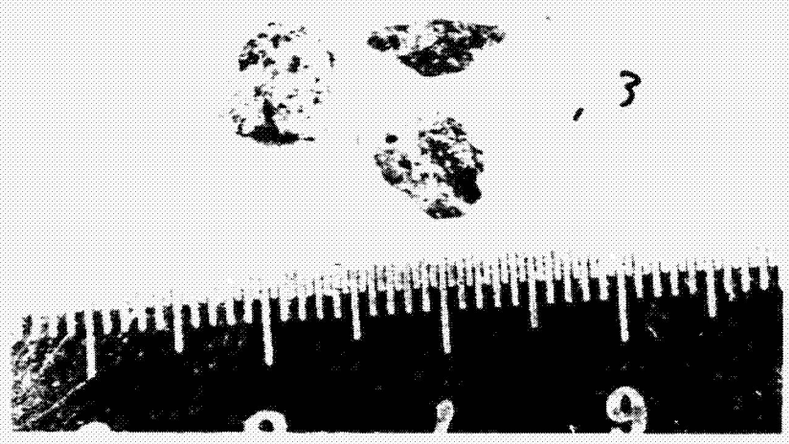
Coherence: Moderately tough

Shape: Rounded to sub-rounded

Surface: Chalky in appearance

Color: White with dark clast material

Mineralogy: 60% crushed chalky plagioclase; 40% aphanitic dark gray clast material.



14140,4

Dark Matrix Breccia

5 particles, 2.62 grams

Coherence: Tough

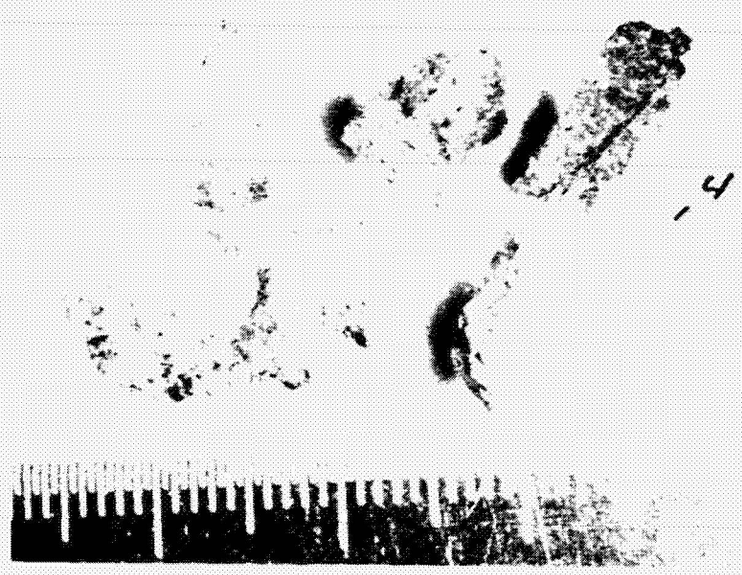
Shape: Angular to sub-angular

Surface: No pits, small amount of dust cover

Color: Medium dark gray

Mineralogy: 75% aphanitic matrix; 25% crushed white plagioclase clasts.

Remarks: Possibly devitrified glass matrix breccia or annealed basaltic material that were clast in previous breccias.



14140,5

Coarse Grained Basalt

1 particle, .84 grams

Coherence: Moderately tough

Shape: Sub-angular

Surface: No pits and a small amount of patina.

Color: Light gray

Mineralogy: 60% semi crushed plagioclase; 40% pyroxene with other dark minerals.

Remarks: Grain size ranges from .1 - .8 mm. Grain size is slightly larger than 14140,4.

REPRODUCIBILITY OF THE
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14140,6

Fine Grained Basalt

1 particle, .10 grams

Coherence: Tough

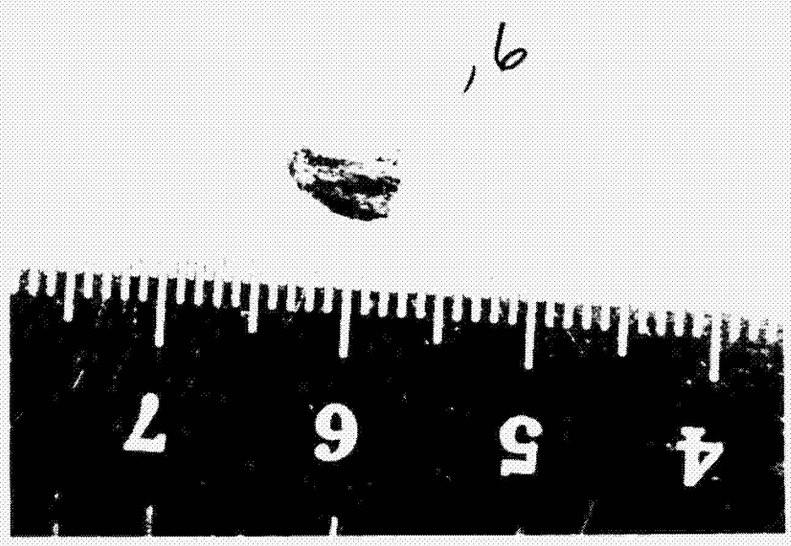
Shape: Angular

Surface: No pits with a small amount of patina

Color: Medium dark gray

Mineralogy: 99% aphanitic gray; 1% crushed plagioclase in isolated areas.

Remarks: Finer grained than 14140,5



14140,7

Light Matrix Breccia

8 particles, .98 grams

Coherence: Tough

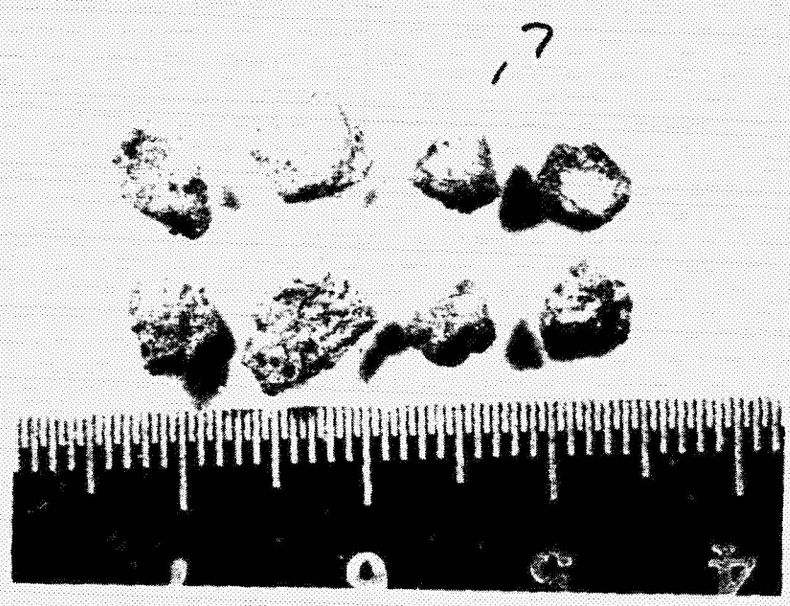
Shape: Angular to sub-angular

Surface: Few pits on one small piece. Small amount of patina.

Color: Medium light gray

Mineralogy: 90% aphanitic light material; 10% aphanitic dark material.

Remarks: Some small pyroxene crystals present. Mostly crushed plagioclase.



14140,8

Dark Matrix Breccia

2 particles, 1.24 grams

Coherence: Tough

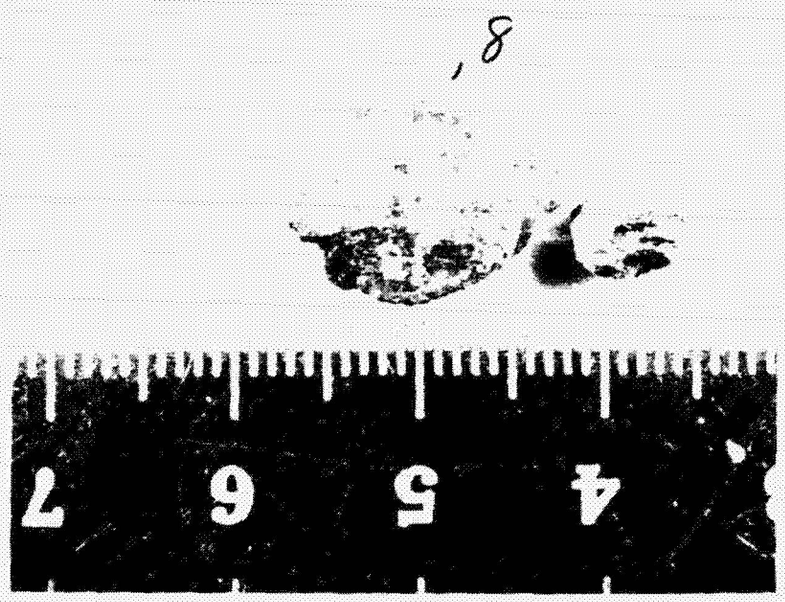
Shape: Sub-angular

Surface: No pits, small amount of adhering dust

Color: Medium dark gray

Mineralogy: Mostly crushed white material with a coating of dark glass. Some unaltered plagioclase crystals on the smaller piece.

Remarks: Resembles 14063 and 14083



Sample Trench At Station G

While Mitche [1] was coring the regolith, Shepard dug a trench in the wall of a small crater:

"05 14 20 40 CDR: I've got a trench here. It's going fairly easily, but I need the extension handle to get it deeper, so I'll wait until Ed's through with that. I'm cutting into the rim of a crater which is approximately six meters in diameter, has a depth of about three quarters of a meter. And we're back in about one diameter away from the north rim of Triplet. The trench is going through at least three layers that I can see. The fine grain surface, dark browns; then a layer of what appears to be quite a bit of black; and then, a third layer of some very light material. And we should be able to sample all three of these .... I know that we did not mention this white layer down in this area before that was so obvious to us just below the surface up near the flank of Cone. But it appears as though it is quite a bit - well it's relatively deep, as far as visual observation is concerned. And certainly not any that would be picked up by the footprints or MET tracks or the like. But there appears to be some of that here in this trench."

After excavating the trench, Shepard described the sampling:

"05 14 29 19 CDR: Bag 19 for the sample of the surface fines , that is, from the surface layer of the trench. ... I am unable to take from the walls of the

trench -- the blocky type of material that I could see when I was digging, so I'll just get a shovel full of that, and we'll mix the surface with the second layer."

This combined sample was placed into Bag 19N. The 4-10mm sieve fraction was later numbered 14145.

Shepard then collected from the middle of the trench. This material was unavoidably admixed with surface material due to slumping in the trench. The sample was placed into Bag 21N. The 4-10mm sieve fraction was later numbered 14155.

Shepard then collected material from the bottom of the trench:

"05 14 32 10 CDR: ... and the last bag will be pebbles from the bottom layer ... in bag 20, we'll fill a sample of the bottom material; also -- some of the surface material has fallen down on top of it. And that's about -- call it 18 inches below the surface."

The 4-10mm material in Bag 20N was later numbered 14150.

14145,2

Fine Grained Basalt

1 particle, .49 grams

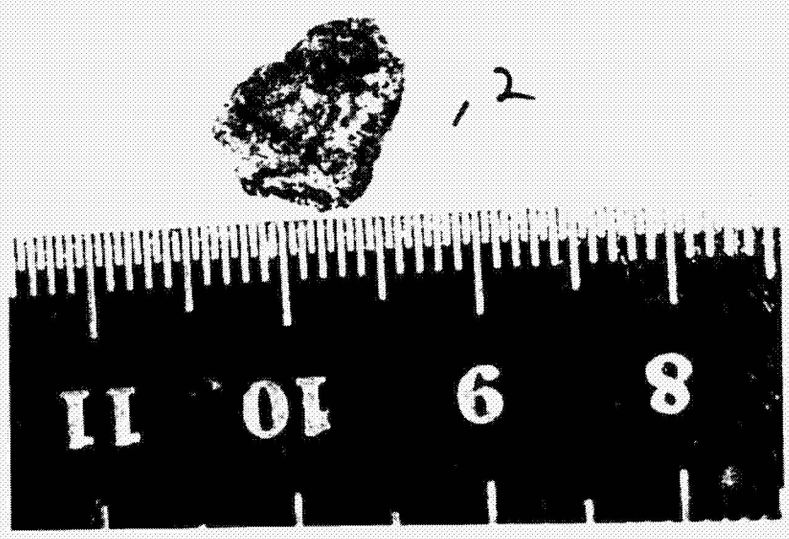
Coherence: Tough

Shape: Rounded to sub-rounded

Surface: Pitted on several surfaces with a thin layer of patina on some faces. Small number of vesicles.

Color: Medium light gray

Mineralogy: 40% crushed white material; 40% translucent mineral (grain size .3 - .5 mm); 20% opaques.



14145,1

Dark Matrix Breccia

1 particle, .39 grams

Coherence: Moderately tough

Shape: Angular to sub-angular

Surface: No pits or patina

Color: Medium dark gray

Mineralogh: 60% dark gray matrix; 10% crushed white plagioclase clasts; 30% aphanitic light gray clast.

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14150,1

Coarse Grained Basalt

1 particle, 1.05 grams

Coherence: Medium tough

Shape: Angular to sub-angular

Surface: No pits or patina present. Some small 1-2 mm vugs on all surfaces.

Color: Medium light gray

Mineralogy: 40% white aphanitic plagioclase; 30% light green aphanitic material; 30% dark aphanitic material.

Remarks: Light green could be orthopyroxene and dark could be ilmenite and glass and pyroxene.

14150,2

Coarse Grained Basalt

24 particles, 7.31 grams

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Coherence: Tough

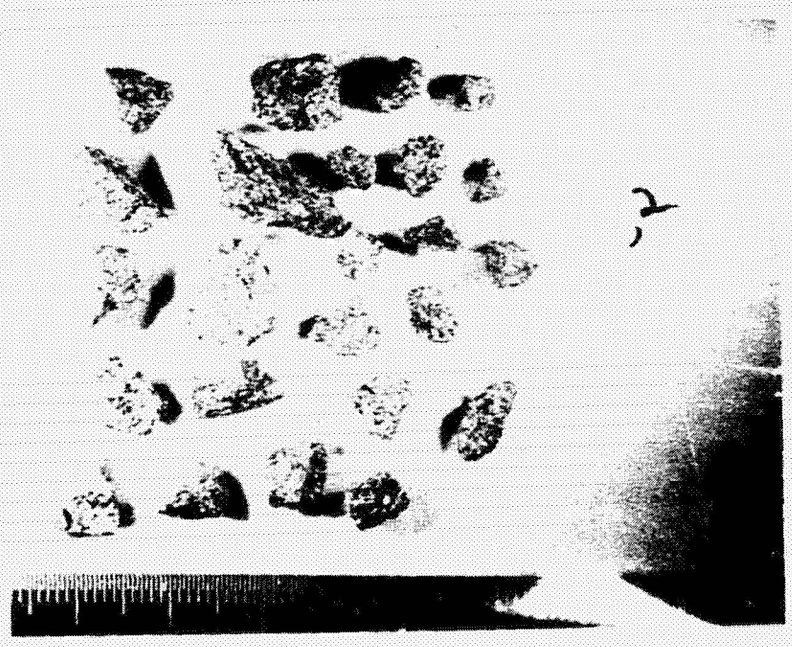
Shape: Rounded to sub-rounded

Surface: Small amount of patina on several pieces.

Color: Medium light gray

Mineralogy: 30% light green crystalline orthopyroxene; 40% translucent white crystalline plagioclase; 30% aphanitic dark material.

Remarks: Grain size is approximately .1 - .3 mm.



14150,3

Dark Matrix Breccia

4 particles, 1.71 grams

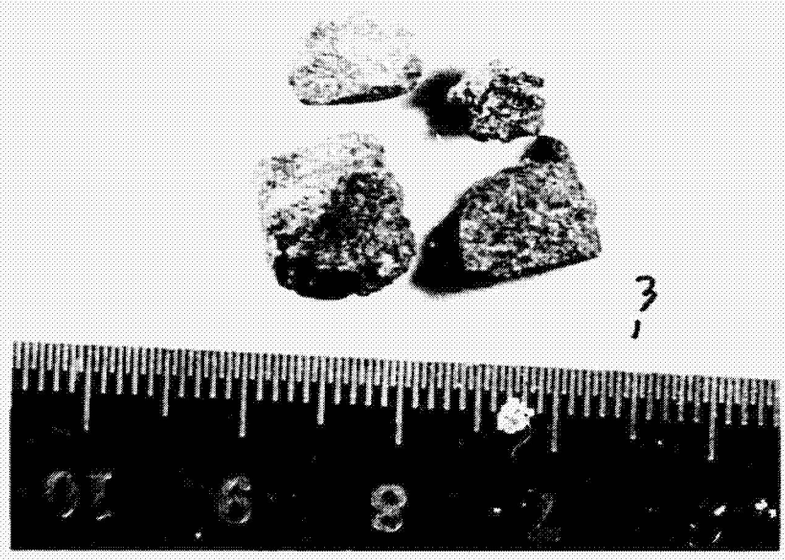
Coherence: Tough

Shape: Sub-rounded to sub-angular

Surface: Patina on all pieces, few pits on the three larger pieces.

Color: Dark gray

Mineralogy: 90% aphanitic dark gray; 10% aphanitic white material.



14150,4

Light Matrix Breccia

3 particles, .60 grams

Coherence: Friable

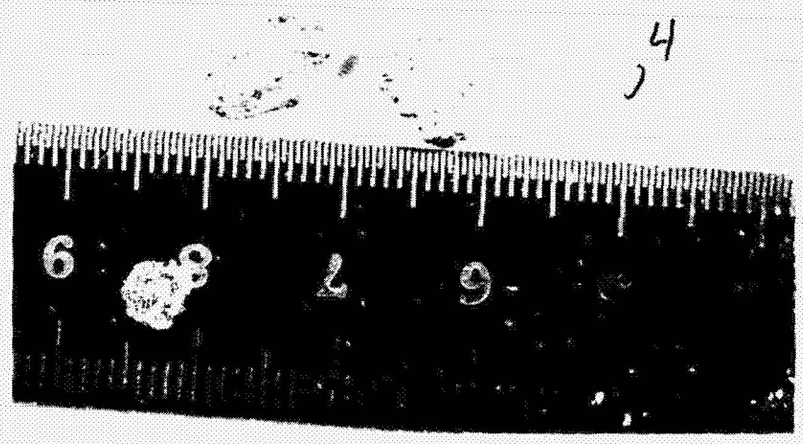
Shape: Rounded

Surface: No pits or patina, powdery texture

Color: Light gray

Mineralogy: 85% aphanitic light gray matrix; 15% <1 mm dark gray aphanitic clasts.

Remarks: Some small pyroxene and plagioclase present



14150,5

Anorthosite

1 particle, .36 grams

Coherence: Tough

Shape: Rounded

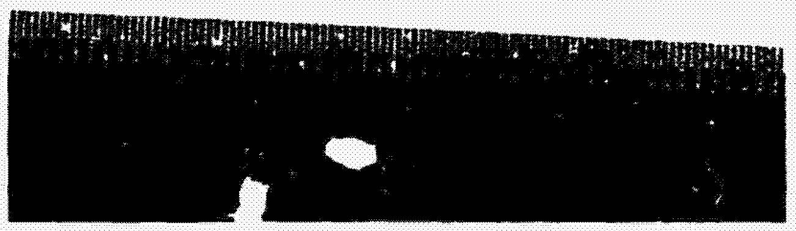
Surface: Pits on one face, patina on all other

Color. White

Mineralogy: 40% translucent material with elongated platy ilmenite within; 60% crushed white material.

Remarks: Crushed white material appears to serve as a matrix to the translucent material.

5



14155,1

Dark Matrix Breccia

13 particles, 2.11 grams

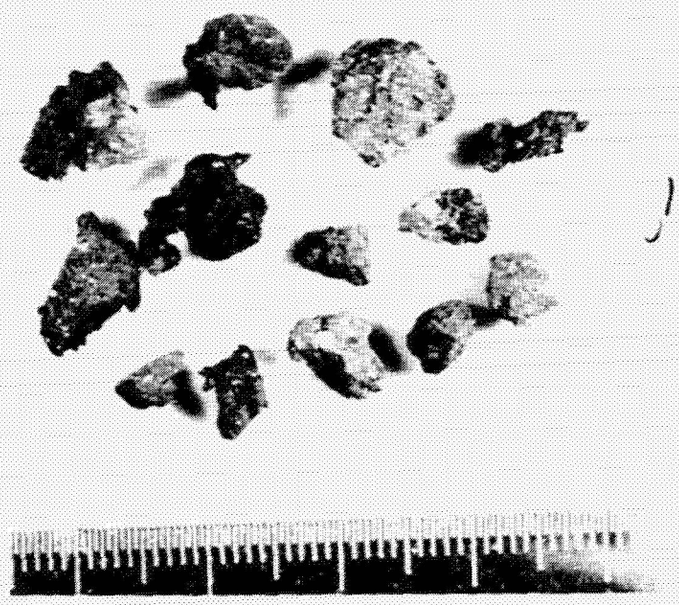
Coherence: Moderately friable

Shape: Angular on glassy surfaces, smooth on matrix

Surface: No patina on any surface, small pits on several of the larger pieces.

Color: Medium dark gray

Mineralogy: All chips have small areas of glassy splatter. These pieces could be classified as agglutinates. Matrix is dark gray aphanitic, approximately 90%; 10% plagioclase and pyroxene mineral clasts.



14155,2

Light Matrix Breccia

6 particles, .66 grams

Coherence: Tough

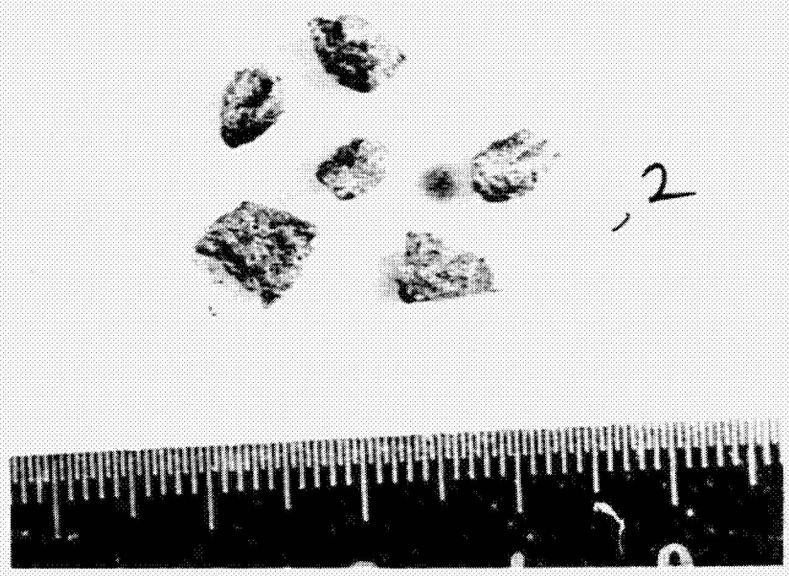
Shape: Angular to sub-angular

Surface: No pits on patina observed on any piece. Some small cavities on all pieces, <1 mm in diameter.

Color: Medium light gray

Mineralogy: 75% light gray crystalline plagioclase; 25% crystalline translucent white material.

Remarks: Crystal size .1 - .3 mm. Some .1 - .9 mm crystals present in the larger pieces.



14160

Bulk Sample Coarse Fines

The Bulk Sample was collected approximately 20 meters northwest of the LM just before the end of the first EVA. The sample was taken at the bottom of a small crater. The sample was collected in Weigh Bag #2. The 4-10mm sieve fraction from this soil sample was later numbered 14160.

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14160,87

Soil Breccia

50 particles, 18.36 grams

Coherence: Moderately friable

Shape: Angular to rounded

Surface: Few pits and patina on some surfaces. Glass coating on several pieces.

Color: Medium dark gray

Mineralogy: 95% aphanitic dark gray matrix; 5% white crushed plagioclase.

14160,88

Anorthosite

2 particles, .20 grams

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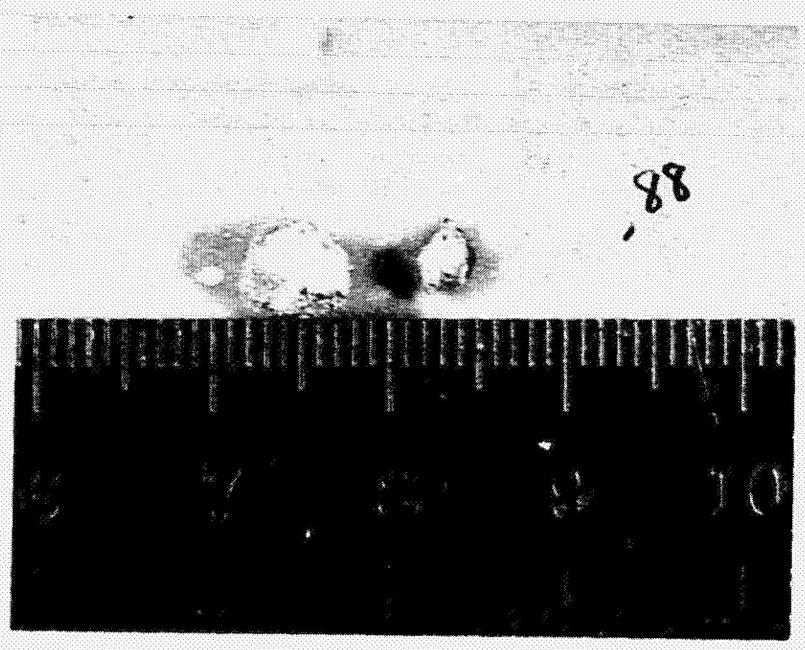
Coherence: Tough

Shape: Sub-angular to sub-rounded

Surface: Small amount of patina, no pits.

Color: White

Mineralogy: 100% aphanitic white



14160,89

Light Matrix Breccia

13 particles, 2.03 grams

Coherence: Friable

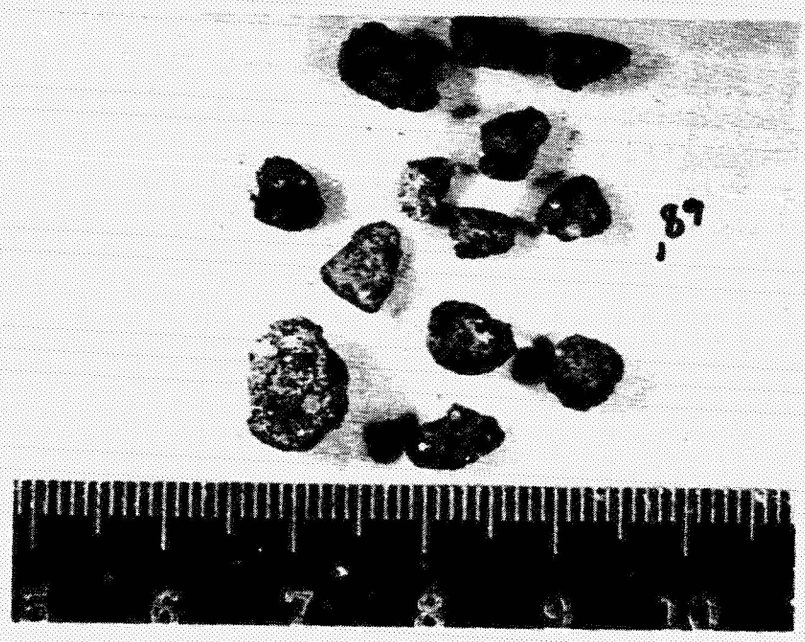
Shape: Rounded to sub-rounded

Surface: No pits but a small amount of patina on some chips.

Color: Medium light gray

Mineralogy: 95% light matrix; 5% dark gray clasts

Remarks: One small chip has a large crushed plagioclase clast.



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14160,90

Fine Grained Basalt

24 particles, 6.61 grams

Coherence: Tough

Shape: Angular to sub-angular

Surface: Highly patinated, few pits. <10% surface vesicle coverage.

Color: Medium dark gray

Mineralogy: 100% aphanitic dark gray

14160,91

Fine Grained Basalt

37 particles, 9.74 grams

Coherence: Tough

Shape: Angular to sub-angular

Surface: < 5% surface vesicle coverage. Few pits and a small amount of patina on some pieces.

Color: Medium light gray

Mineralogy: 100% aphanitic gray

Remarks: Slightly coarser grained than 14160,90

14160,92

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

Dark Matrix Breccia

14 particles, 3.54 grams

Coherence: Moderately tough

Shape: Angular

Surface: No pits. Small amount of glass on some pieces. Patina on all pieces.

Color: Dark gray

Mineralogy: 80% aphanitic dark gray matrix. 20% crushed plagioclase clasts and minor amount of glass.

14160,93

Fine Grained Basalt

2 particles, 1.57 grams

Coherence: Tough

Shape: Angular

Surface: Small number of vugs. Large amount of patina on one chip. No pits.

Color: Dark gray

Mineralogy: 100% dark gray aphanitic

14160,94

Fine Grained Basalt

10 particles, 2.20 grained

Coherence: Tough

Shape: Angular to sub-angular

Surface: Small vugs on some chips. Patina on some chips, no pits observed.

Color: Medium light gray

Mineralogy: 100% aphanitic material

Remarks: Lighter in color than 14160,95

14160,95

Fine Grained Basalt

2 particles, 1.66 grams

Coherence: Friable

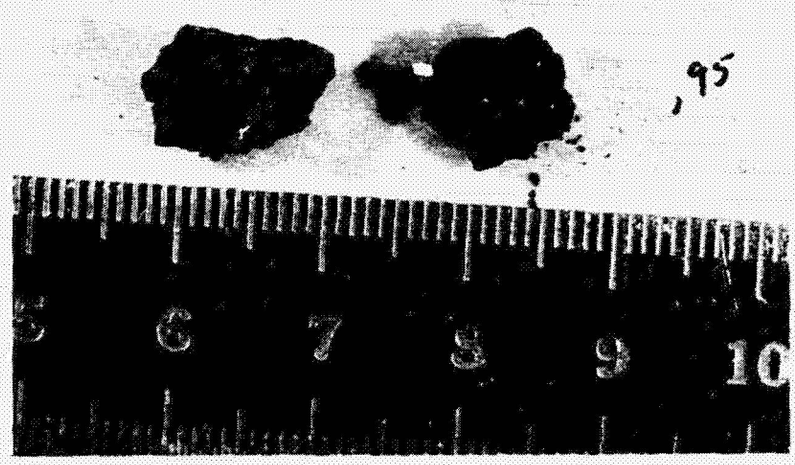
Shape: Angular

Surface: Small amount of patina. 25% surface coverage of vesicles

Color: Dark gray

Mineralogy: 100% aphanitic dark gray

Remarks: Much darker than previous fine grained basalts in this group.



14168

4-10mm Residue From Football-Sized Rocks

14168 consists of the 4-10mm sieve fraction of the residue left in Weigh Bag 1027. This bag contained the two football-sized rocks 14304 and 14305, both breccias. The residue represents the spallation products from these rocks.

REPRODUCIBILITY OF THE
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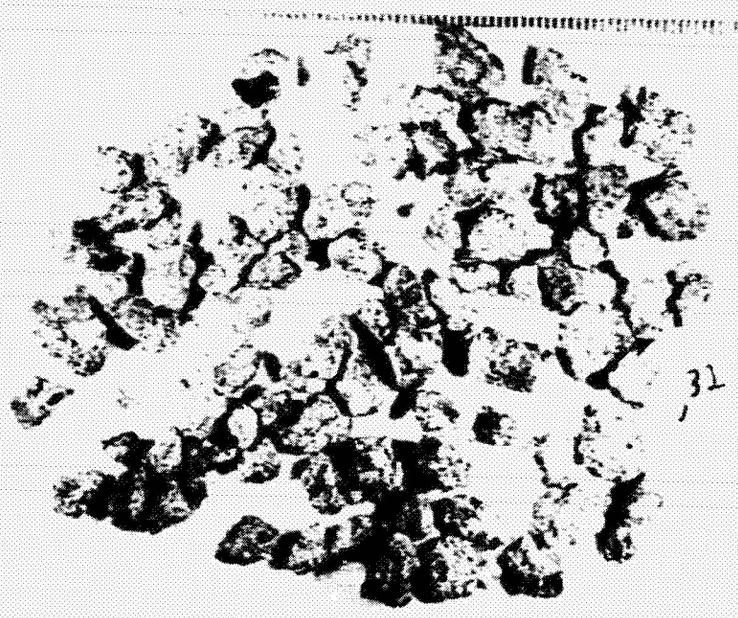
14168,32

Light Matrix Breccia
45 particles, 21.71 grams

Coherence: Moderately tough
Shape: Angular to rounded
Surface: Few pits on some pieces; patina on all pieces
Color: Medium light gray
Mineralogy: 90% aphanitic matrix; 10% light aphanitic clasts



14168,33

Coarse Grained Basalt
2 particles, .94 grams

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Coherence: Moderately friable

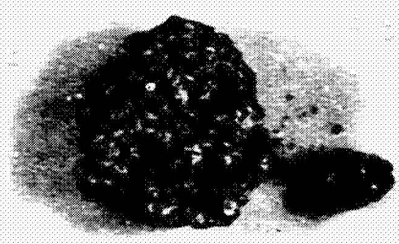
Shape: Rounded to sub-rounded

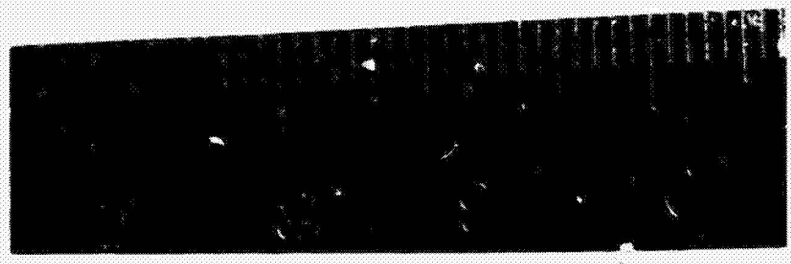
Surface: No pits or patina

Color: Medium light gray

Mineralogy: 40% aphanitic plagioclase; 45% green material; 10% opaques

Remarks: Crystal size .1 - .3 mm





14168,34

Dark Matrix Breccia

5 particles, 1.95 grams

Coherence: Tough

Shape: Angular to sub-angular

Surface: No pits but a small amount of patina

Color: Dark gray

Mineralogy: 99% aphanitic matrix; 1% crystalline plagioclase

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14168,35

Light Matrix Breccia

4 particles, 1.82 grams

Coherence: Moderately tough

Shape: Rounded to sub-rounded

Surface: Small number of pits and patina

Color: Medium light gray

Mineralogy: 60% aphanitic light gray matrix; 40% aphanitic dark gray

Remarks: Small amount of crushed plagioclase on one chip.

14193

4-10mm Residue From Weigh Bag 1031

14193 is the number given to the 4-10mm sieve fraction of the residue from Weigh Bag 1031. This bag contained the following samples:

14301 - Station G1 - Tough breccia
14306 - Station G - Tough breccia
14307 - Station G - Coherent breccia
14309 - Unresolved - Tough breccia
14310 - Station G - Tough fine-grained basalt
14311 - Station D - Tough breccia

The residue is undoubtedly the spallation product of these rock samples.

14193,7

Light Matrix Breccia

20 particles, 3.74 grams

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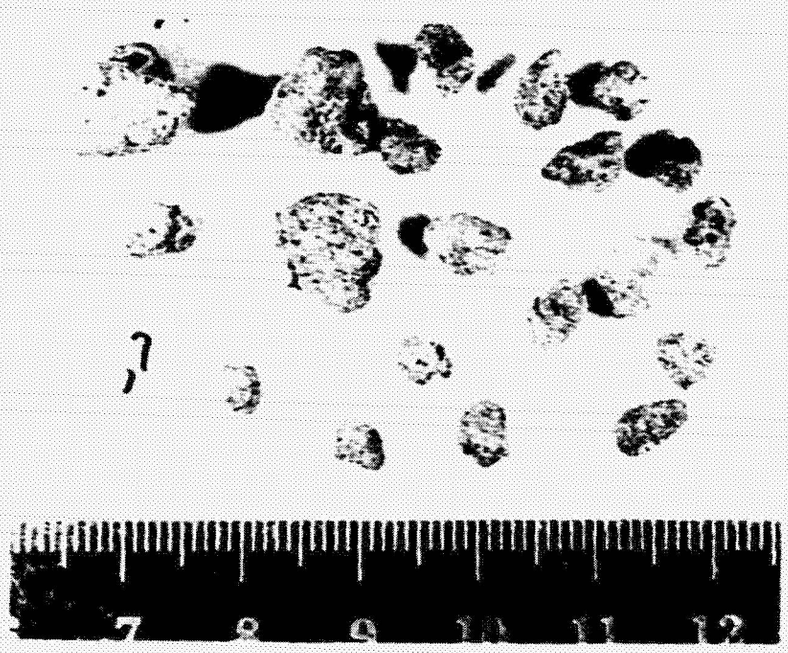
Coherence: Moderately Friable

Shape: Rounded to sub-rounded

Surface: Pits noted on larger pieces; Glass splatter on 1 smaller piece; Patina on few pieces.

Color: Light gray

Mineralogy: 98% aphanitic light gray matrix; 2% crushed to crystalline white plagioclase clasts.



14193,9

Dark Matrix Breccia

11 particles, 2.32 grams

Coherence: Tough

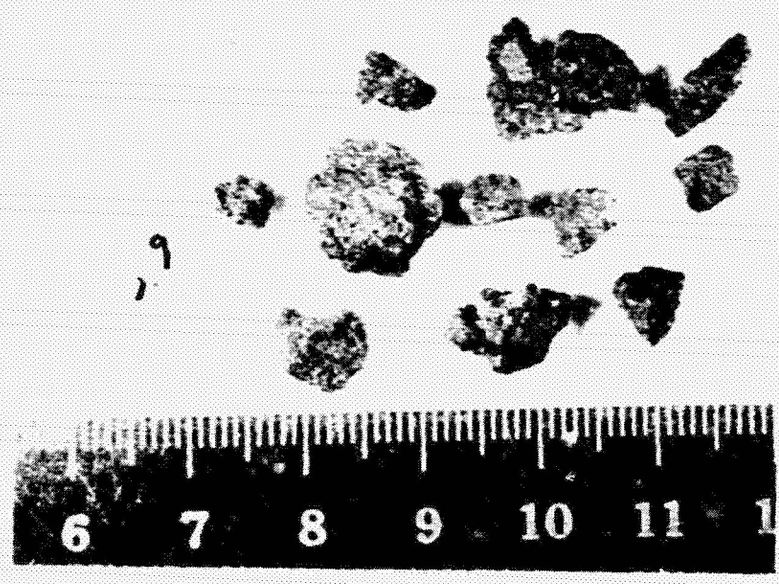
Shape: Angular to sub-angular

Surface: <10% surface vug coverage. Pits and patina on all surfaces.

Color: Medium dark gray

Mineralogy: 99% aphanitic matrix; 1% crystalline plagioclase. Small % of green mineral clasts.

Remarks: Large piece has a small mare basalt clast with pyroxene plagioclase and ilmenite.



14193,10

Dark Matrix Breccia

2 particles, .56 grams

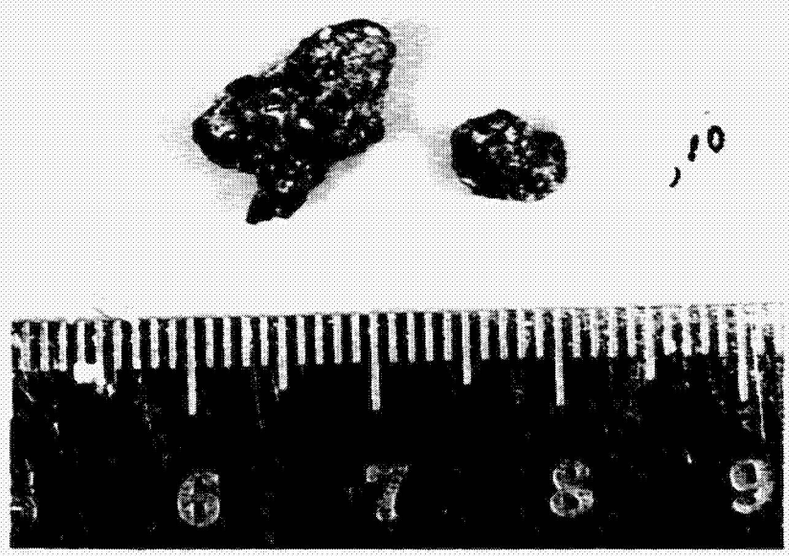
Coherence: Tough

Shape: Angular to sub-angular

Surface: 10% surface coverage of vesicles. Small number of pits and small amount of patina present.

Color: Dark gray

Mineralogy: 50% aphanitic matrix; 50% chalky white plagioclase



14193,11

Light Matrix Breccia

4 particles, 1.38 grams

Coherence: Tough

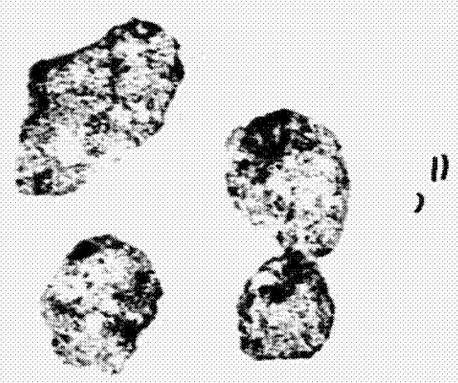
Shape: Rounded to sub-rounded

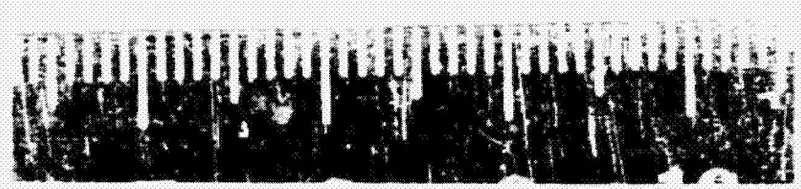
Surface: <10 surface vesicle coverage. Small amount of pits and patina on all pieces.

Color: Light gray

Mineralogy: 80% aphanitic light gray material; 20% aphanitic white material.

Remarks: Some small plagioclase crystals present in isolated clusters.





14256

Comprehensive Soil - Coarse Fines

The Comprehensive Soil sample was collected 150 meters WNW of the LM. Shepard drew a 2 meter-radius circle and scooped fines from the area. Mitchell collected rocks from within the circle for the comprehensive rock sample. The 4-10mm sieve fraction from the soil was later numbered 14256.

14256,4

Fine Grained Basalt

4 particles, .69 grams

Coherence: Tough

Shape: Sub-rounded to rounded

Surface: Pits on several pieces, patina and a 15% surface coverage of vesicles are also present.

Color: Medium light grey

Mineralogy: 100% aphanitic gray material

15256,5

Coarse Grained Basalt

1 particle, .42 grams

Coherence: Tough

Shape: Angular to sub-angular

Surface: Pits on one surface, patina on all others.

Color: Medium light gray

Mineralogy: 60% crystalline green material; 30% translucent white plagioclase; 10% black glass and opaques.

Remarks: Crystal size is .1 - .2 mm

14256,6

Dark Matrix Breccia

2 particles, .69 grams

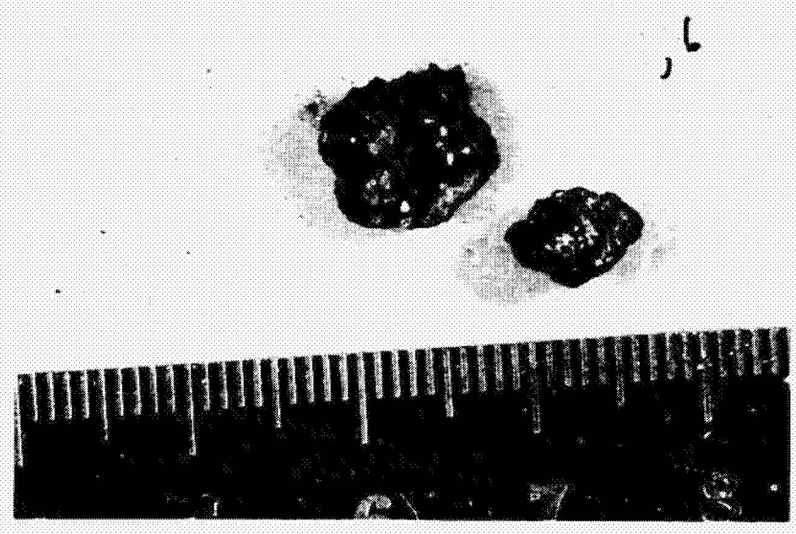
Coherence: Tough

Shape: Angular to sub-angular

Surface: Few pits on the larger piece, small amount of patina on both pieces.

Color: Medium dark gray

Mineralogy: 50% white crushed plagioclase clasts in a glassy matrix.



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14256,7

Soil Breccia

25 particles, 4.08 grams

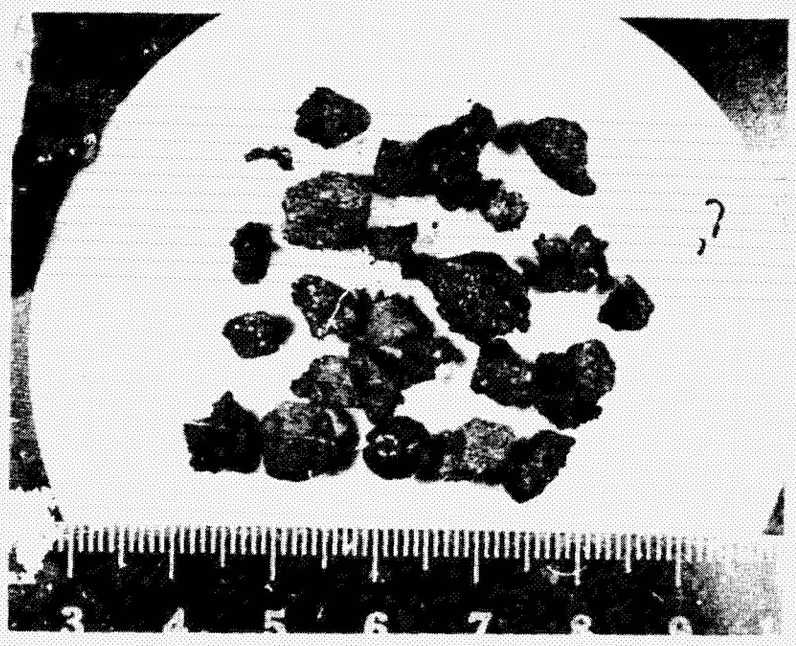
Coherence: Moderately friable

Shape: Rounded to angular

Surface: Glass coating on all pieces. Some small amounts of patina on a few pieces.

Color: Dark gray

Mineralogy: 98% dark matrix; 2% white plagioclase clasts



14263

Comprehensive Rock Sample - Coarse Fines

The Comprehensive Sample consisted of one soil sample and one sample of small rocks. Both were collected 150 meters WNW of the LM from within a 2 meter-radius circle drawn in the regolith.

The bag containing the Contingency Sample ruptured and was placed into the weigh bag (1039) containing the Comprehensive Rocks. As a result, the 4-10mm sieve fraction from this bag may contain any fines which leaked from the Contingency Sample bag.

Loose rocks collected in Weigh Bag 1039 are:

14264 - Tough breccia
14265 - Tough breccia
14266 - Tough breccia
14267 - Tough breccia
14268 - Coherent breccia
14269 - Coherent breccia
14270 - Tough basalt
14271 - Coherent breccia
14272 - Tough breccia
14273 - Coherent breccia
14274 - Tough breccia
14275 - Coherent breccia
14276 - Tough basalt
14277 - Tough breccia
14278 - Coherent breccia
14279 - Coherent breccia
14280 - Tough breccia
14281 - Tough breccia
14282 - Friable breccia
14283 - Tough breccia
14284 - Friable breccia
14285 - Tough breccia
14286 - Tough breccia
14287 - Friable breccia
14288 - Tough breccia

The 4-10mm sieve fraction contains spallation products of the above rocks plus any leaked Contingency Sample fines.

14263,1

Soil Breccia

35 particles, 9.86 grams

Coherence: Moderate

Shape: Angular to sub-rounded

Surface: Pits and glass coating on several pieces. No patina observed.

Color: Medium dark gray

Mineralogy: 90-98% aphanitic matrix; 1-10% mineral clasts, such as plagioclase, pyroxene.

14263,2

Light Matrix Breccia

5 particles, 1.34 grams

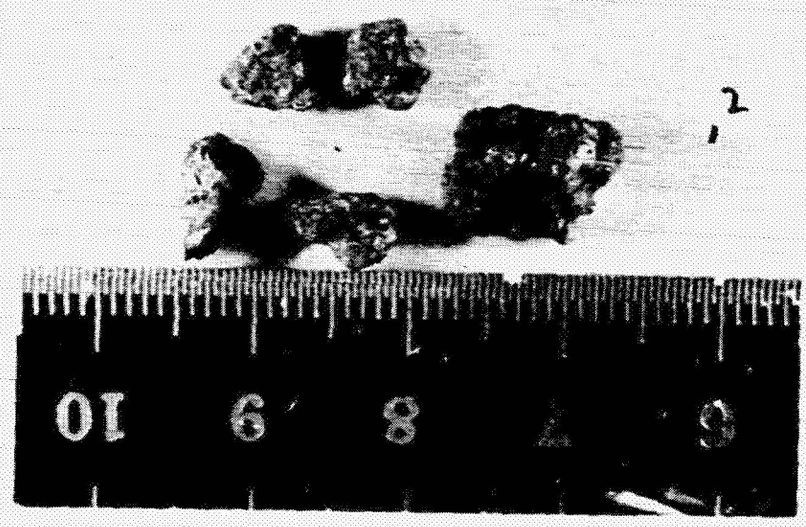
Coherence: Moderately tough

Shape: Angular to sub-angular

Surface: Few pits and a small amount of patina on all pieces.

Color: Medium light gray

Mineralogy: 95% aphanitic matrix; 5% white plagioclase clasts.



14263,3

Dark Matrix Breccia

8 particles, 2.58 grams

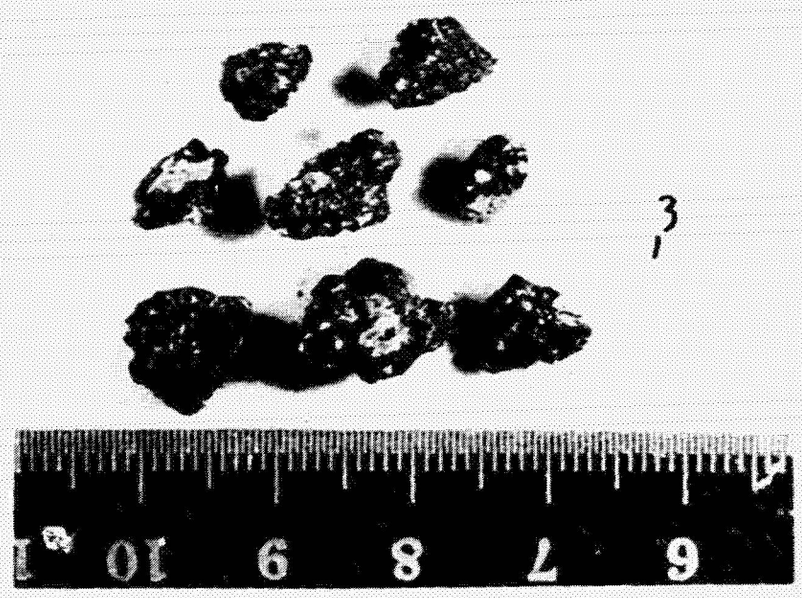
Coherence: Tough

Shape: Angular-subangular

Surface: No pits or patina observed

Color: Dark gray

Mineralogy: 90-95% aphanitic matrix; 5-10% mineral clasts including pyroxene, but predominately plagioclase.



14263,4

Dark Matrix Breccia

2 particles, .80 grams

Coherence: Tough

Shape: Angular-subangular

Surface: Pits and patina on both pieces. 15% surface coverage of small vesicles.

Color: Dark gray

Mineralogy: 95% aphanitic dark material; 5% aphanitic white material.

,4

14263,5

Fine Grained Basalt

1 particle, .68 grams

Coherence: Tough

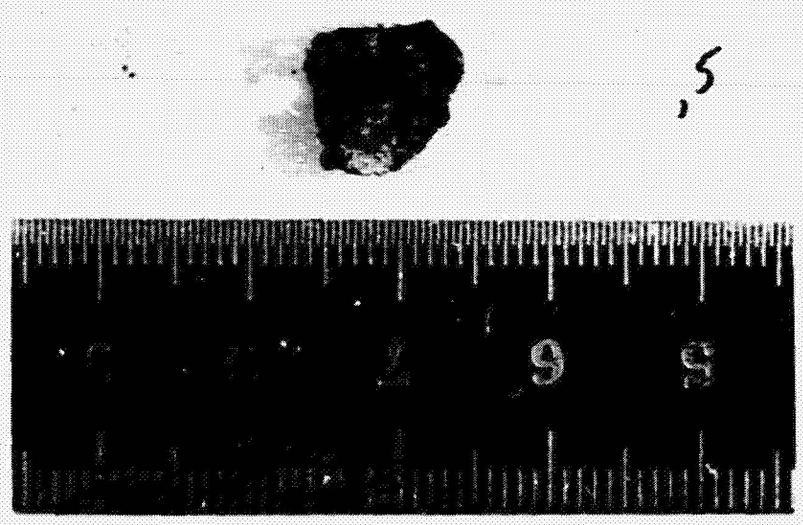
Shape: Subangular

Surface: No pits; large amount of patina noted.

Color: Dark gray

Mineralogy: 100% aphanitic material

Remarks: Texture is slightly coarser than 14263,4, but still aphanitic.



14263,6

Coarse Grained Basalt

1 particles, .35 grams

Coherence: Moderately friable

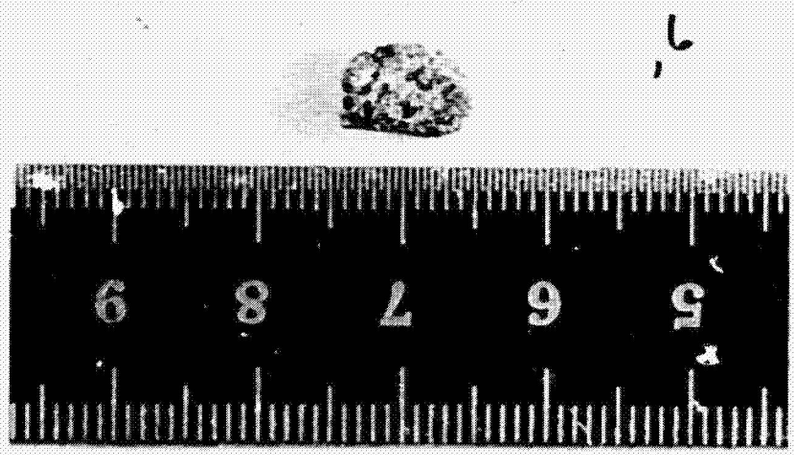
Shape: Sub-angular,sub-rounded

Surface: Saturated with small glass-lined pits. <10% surface coverage of vesicles. Small amount of patina present.

Color: Light gray

Mineralogy: 60% crystalline to crushed plagioclase; 30% dark brown pyroxene; 10% opaques and glass.

Remarks: Grain size approximately .3 - .5 mm



14293

4-10mm Residue From Station H Rocks

The rocks collected at Station H were placed into Weigh Bag 1038. The rocks contained in this bag are:

14312 - Tough breccia
14314 - Friable breccia
14315 - Tough breccia
14316 - Tough breccia
14317 - Tough breccia
14318 - Tough breccia
14319 - Coherent breccia
14320 - Tough breccia

The 4-10mm sieve fraction of the residue from this bag was numbered 14293. This residue consists of the spallation products from the rocks.

14293,7

Light Matrix Breccia

10 particles, 1.56 grams

Coherence: Moderately tough

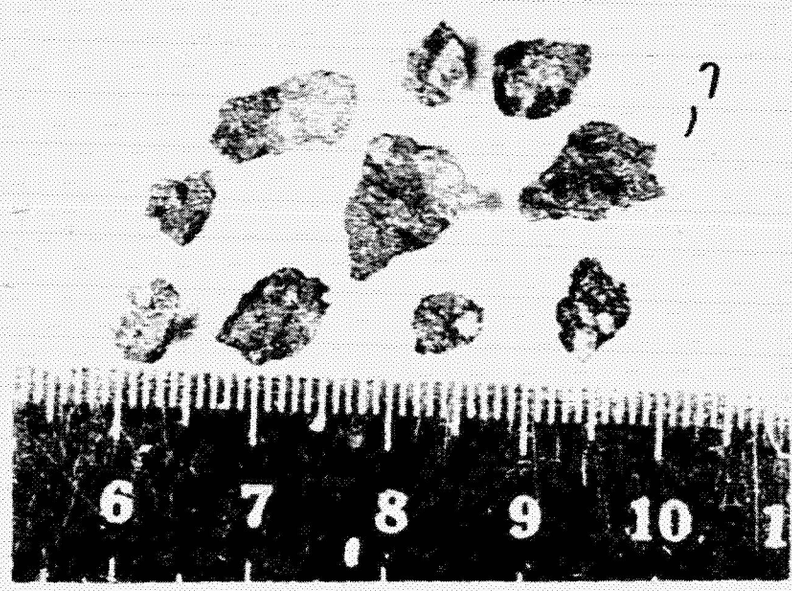
Shape: Angular to sub-angular

Surface: Abundant unexposed surface. Some pits and patina on larger pieces. Small patches of glass coating noted on some pieces.

Color: Medium light gray

Mineralogy: 60% aphanitic matrix; 30% crushed to crystalline plagioclase clasts; 10% mineral clasts.

Remarks: Mineral clasts include a honey brown pyroxene and a light green mineral.



14293,9

Light Matrix Breccia

2 particles, .56 grams

Coherence: Moderatley friable

Shape: Sub-rounded to sub-angular

Surface: Rough, no pits or patina

Color: Medium light gray

Mineralogy: 60% aphanitic white matrix; 35% dark ophanitic clasts; 5% mineral clasts

Remarks: Contact between light and dark material is poorly defined.

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