Major-element composition:

Chemical analyses of 72161

SiO_2	42.12
Al_2O_3	14.22
FeO	14.86
MgO	10.54
CaO	11.17
Na_2O	.41
K_2O	.11
TiO_2	5.21
P^2O^5	.08
MnO	.22
Cr_2O_3	.42
Total	99.36

72161.6 (Rhodes and others, 1974).

STATION 2

LOCATION

Station 2 is at the foot of South Massif where it intersects the southeast rim of Nansen crater (fig. 7B); it is near the contact between the light mantle and the materials of the South Massif (pls. 1 and 2).

OBJECTIVES

The objectives at station 2 were to characterize South Massif bedrock and the light mantle and to investigate features indicative of the origin of the light mantle (Sevier, 1972).

GENERAL OBSERVATIONS

The station area includes the flat to gently rolling southeastern rim crest of Nansen crater and the lower slope of the South Massif (pans 14 and 15, pis. 5 and 6).

The smaller craters in the station area range in size from several centimeters to 20 m. Nansen crater is ap-

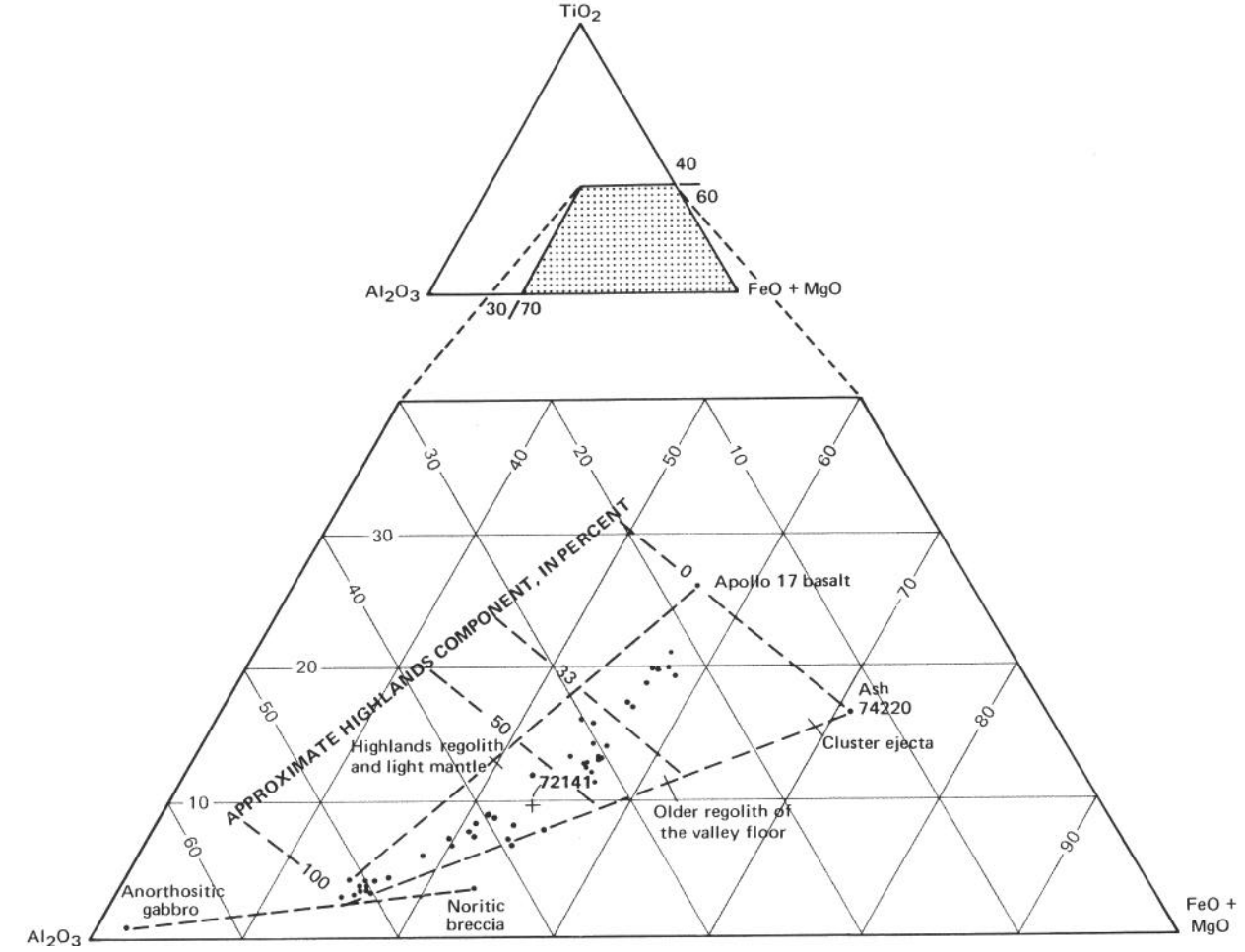

FIGURE 68.-Relative amounts of $Ti0_2$, $A10_3$, and FeO + MgO in sediment sample 72141 (cross), collected at station LRV-2, in comparison with sediment samples from rest of traverse region (dots). Apollo 17 basalt, anorthositic gabbro, and noritic breccia values from Rhodes and others (1974).

proximately I km long across its northwest-southeast axis and 0.5 km across its northeast-southwest axis. Craters near station 2 on the South Massif appear to have blockier and higher rims than those on the rim of Nansen, but overall the crater abundance in the two areas is similar.

Near the station, the area between craters on the South Massif is moderately blocky. The Nansen crater rim is less blocky in comparison, and the average block size is much smaller. Blocks on the South Massif range in size from a few centimeters to several meters, those on the Nansen crater rim from a few centimeters to 1m.

Fillets are well developed on the uphill sides of blocks on the massif slope and are not present on the downhill sides. Blocks on the Nansen rim have poorly developed fillet. The degree of block burial ranges from almost none to almost total burial.

The astronauts reported that lobes of unconsolidated material extend from the slopes of South Massif onto the light mantle and encroach onto the north wall of Nansen crater. The lobes suggest that downslope movement of South Massif materials has occurred. Visible lobes do not extend as far as the rake sample area (72735-38) in the light mantle on the southeast rim of Nansen crater (fig. 72).

Most of the rock samples collected from the lower slopes of South Massif were chipped front three boulders, two of which are about 2m across and the third about two-thirds meter across (fig. 72). Sediment was

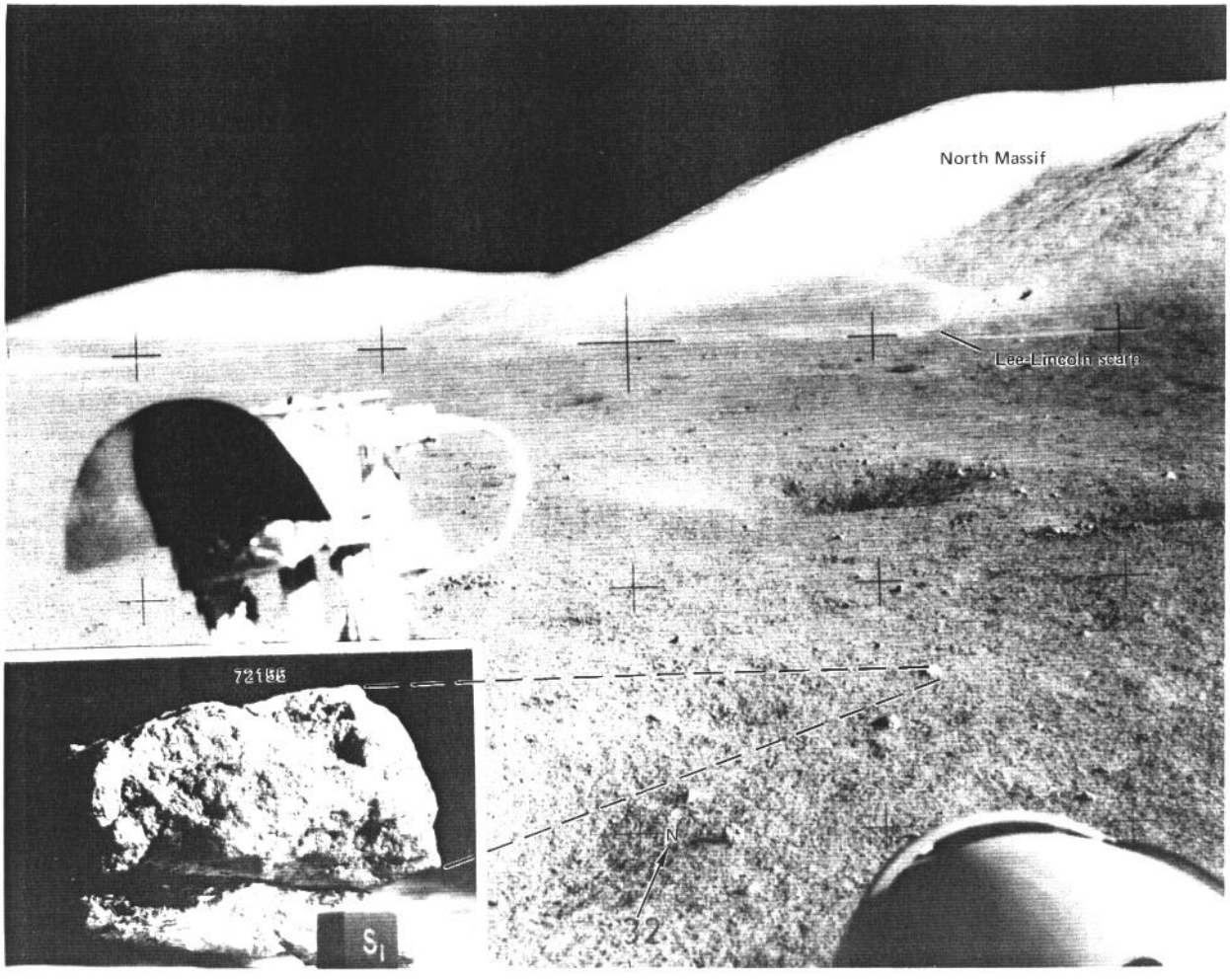

FIGURE 69. - Station LRV-3 sampling area, before sampling, and probable location of sample 72155. Inset shows 72155 with tentatively reconstructed lunar surface orientation and lighting. Sediment sample 72150 was collected with 72155. Sediment sample 72160-64 was collected in same general area (NASA photographs AS17-135-20649; S-73-18406.)

collected from beneath overhangs on the two larger boulders and from beneath the smaller boulder after it was rolled. Sediment was also collected from the fillet of the southernmost large boulder, and a rake sample was collected about 5 m to east of this boulder. Another rake sample was taken from the surface of the light mantle about 50 m north of the break in slope at the base of South Massif.

The three sampled boulders are in a field of boulders near the base of the massif (fig. 73). Most of the boulders may have rolled from a blocky area about two thirds of the way up the massif. Schmitt (1973) observed that in the upper part of the massif above station 2 blue-gray material overlies tan-gray material and that the hue of boulder 1 as seen from a distance resembled the blue-gray line seen near the top of the massif. Boulders 2 and 3 resembled the tan-gray hue of the upper massif. Some of the boulders, although not the sampled ones, are at the ends of visible tracks.

Boulder 1 is layered and foliated rock (fig. 74), the only one of this type seen by the crew. The boulder is approximately 2 m across and 1 m high as measured from the lunar surface. It has a well-developed fillet approximately 30 cm high on its uphill side and no fillet on its downhill side. The boulder appears to be highly eroded and has a hackly and knobby surface. The knobs range from less than 1 to about 15 cm across and were reported by the crew to be mostly finegrained clasts eroded from a more friable fine-grained matrix. The crew also reported dark elongate clasts parallel to the layering; however, these are not discernible in the photographs.

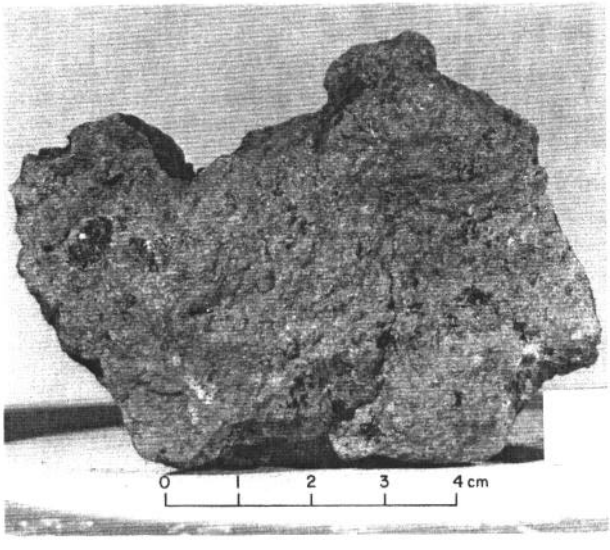

FIGURE 70.-Sample 72155. Fine-grained vesicular olivine basalt. (NASA photograph S-73-16918.)

Four samples. 72215, 72235, 72255, and 72275, were taken from boulder 1.

Boulder 2, a greenish-gray breccia, is approximately 2 m wide and 2 m high as measured from the lunar surface. It is rounded and smoother than boulder 1. Although several sets of fractures can be recognized (Muehlberger and others, 1973), no layering is visible. The boulder has a fillet about 25 cm high on its uphill side but overhangs the ground surface on its downhill side.

Five samples, 72315, 72335, 72355, 72375, and 72395, were taken from boulder 2.

Boulder 3 is an equant subangular breccia boulder about 40 cm across. Clasts as large as 10 cm are visible in lunar surface photographs. Three fractures transecting the boulder are recognized (Muehlberger and others, 1073), but no well-developed fracture or cleavage sets are visible. The boulder has a poorly developed fillet. Two samples, a metadunite clast (72415-18) and matrix material (72435), were collected from boulder 3.

GEOLOGIC DISCUSSION

The lower slopes of the South Massif' at station 2 are interpreted as the surface of a thick wedge of colluvium (fig. 242) onto which boulders from the upper part of the massif have rolled. The boulders are samples of feldspar-rich breccia emplaced as ejecta from the impact that formed the southern Serenitatis basin (Wolfe and Reed, 1976; Reed and Wolfe. 1975).

The four samples of boulder 1 are polymict breccia. Fragments of metaclastic rock with aphanitic to granoblastic matrix make up about 40 to 70 percent of the matrix materials of the four samples. Fragments of plagioclase, olivine, and pyroxene, with plagioclase about twice as abundant as olivine and pyroxene combined, make up about 20 to 45 percent of the matrix materials. Metagabbro and metatroctolite as well as small amounts of quartz-potassium feldspar rock occur in all four samples. Fragments of ophitic basalt and basalt cataclasite are present in 72275.

Petrographers of the boulder 1 consortium (Consortium Indomitabile) concluded that the boulder includes two lithologically distinct associations (Marvin, 1975; Ryder and others, 1975): (1) light-gray friable feldspar-rich matrix interfingered with crushed pigeonite basalt and (2) dark-gray to black competent microbreccia that is commonly interlayered with cataclastic anorthositic breccia. The competent microbreccia, represented according to the consortium interpretation by samples 72215 and 72255 and by clasts in 72235 and 72275, is interpreted as fragments of older impact breccia incorporated in the light-gray friable breccia matrix by a later impact. The matrix of the competent

breccia records thermal metamorphism and local partial melting not seen in the matrix of the light-gray friable breccia. Some grains of olivine in the competent breccia have equilibration rims 10 to 15 um wide, which also were not seen in the light-gray friable breccia. Hence, Ryder and others (1975) believe the competent breccia records older high-temperature thermal events to which the entire boulder was not subjected.

We suggest that boulder 1 is a fragment of the ejecta from the impact that created the southern Serenitatis basin. The target, as represented by the materials of the boulder, was heterogeneous. It included gabbroic, noritic, troctolitic, and anorthositic plutonic rocks and their coarsely metamorphosed equivalents, and rocks of "granitic" composition. Although preexisting impact breccia was undoubtedly present near the surface in the target region, much of the target material was probably excavated for the first time by the southern Serenitatis impact. The clasts of pigeonite basalt in sample 72275 may represent a lava flow in the target area or a fragment of pigeonite basalt introduced to the target by some distant earlier impact. An alternate hypothesis is that they came from local subsurface partial melt zones formed in the target plutonic rocks by some earlier impact but not previously excavated. The spectrum of dynamic and thermal metamorphism-pulverization, heating, melting-represented by various phases in both clasts and matrix of the four samples were the product of a continuous complex process of impact, excavation, and deposition as outlined by Wilshire and Moore (1974). At the depositional stage the mass consisted of relics of the target rock and variously fused, quenched, and pulverized rock debris undergoing cataclastic flow. When it came to rest, the

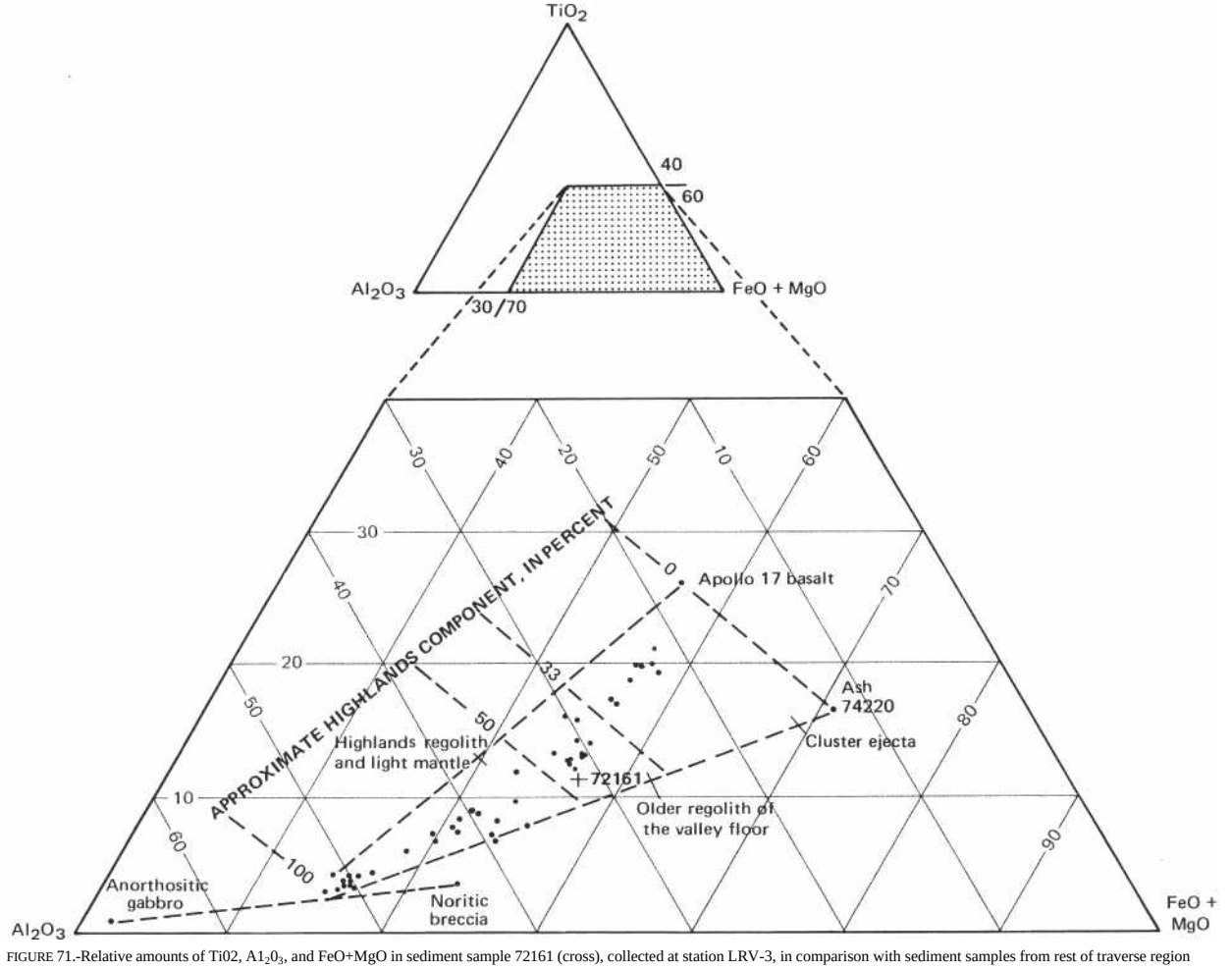

FIGURE 71.-Relative amounts of Ti02, $A1_20_3$, and FeO+MgO in sediment sample 72161 (cross), collected at station LRV-3, in comparison with sediment samples from rest of traverse region (dots). Apollo 17 basalt, anorthositic gabbro, and noritic breccia values from Rhodes and others (1974).

heterogeneous distribution of strongly heated to fused material and colder pulverized material dictated whether the final product had a granoblastic-melt matrix (for example, samples 72215, 72255) or a friable matrix (for example, sample 72275). In this view, the dominant clast type-polymict breccia with very fine grained matrix-was assembled by the same event that excavated its components and the components of the groundmass that encloses it and does not necessarily represent earlier impact brecciation as is commonly held.

Ryder and others (1975) suggested that the lightgray friable breccia had a provenance different at least in part from that of the competent breccia (that is, the friable breccia is not simply the crushed equivalent of the competent breccia). They cite two lines of evidence: (1) the occurrence of distinctive pigeonite basalt clasts in the friable breccia but not in the competent breccia and (2) chemical differences, particularly in meteoritic materials, between their two breccia types.

The pigeonite basalt clasts have been found only in friable breccia sample 72275 (Ryder and others, 1975). Variation diagrams of major elements (fig. 75) show that the compositions of the matrix and of some clast samples of 72275 diverge from the nearly linear trend characteristic of Apollo 17 highlands rocks toward the composition of the iron-rich pigeonite basalt. We infer from these data that the boulder 1 breccia, except for mechanical admixture of pigeonite basalt, is compositionally like the rest of the Apollo 17 highlands suite.

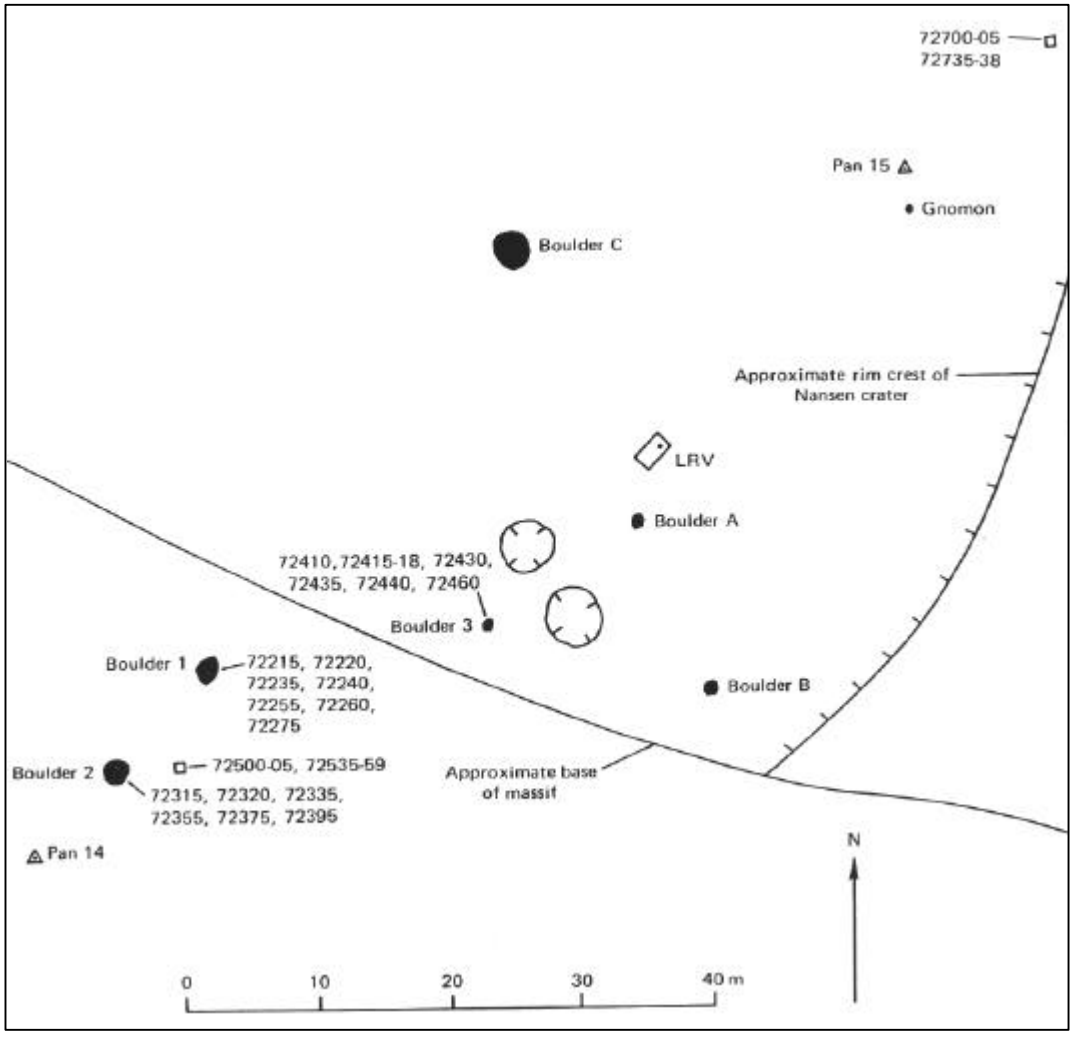

FIGURE 72.-Planimetric map of station 2.

The restricted occurrence of pigeonite basalt in 72275 reflects the inhomogeneous distribution of the basalt within the target area.

Chemical data (fig. 75) suggest that pigeonite basalt has been incorporated in the dark rind of the so-called Marble Cake clast, described by Ryder and others as a 3-cm clast consisting of "cataclastic gabbroic anorthosite crudely interlayered with gray breccia and [vesicular] dark rim material***. The rim and core have been fluidized and interlayered in a rather complex manner to form a 'marble cake' pattern." We suggest that the dark rim material with its pigeonite basalt component was formed simultaneously with the 72275 matrix in a local zone within the mobilized ejecta where more intense cataclasis and perhaps partial melting occurred. Similar relations have been described by Wilshire and Moore (1974) for the large clast in sample 72235 (fig. 79) as well as a model for cataclasis and mobilization

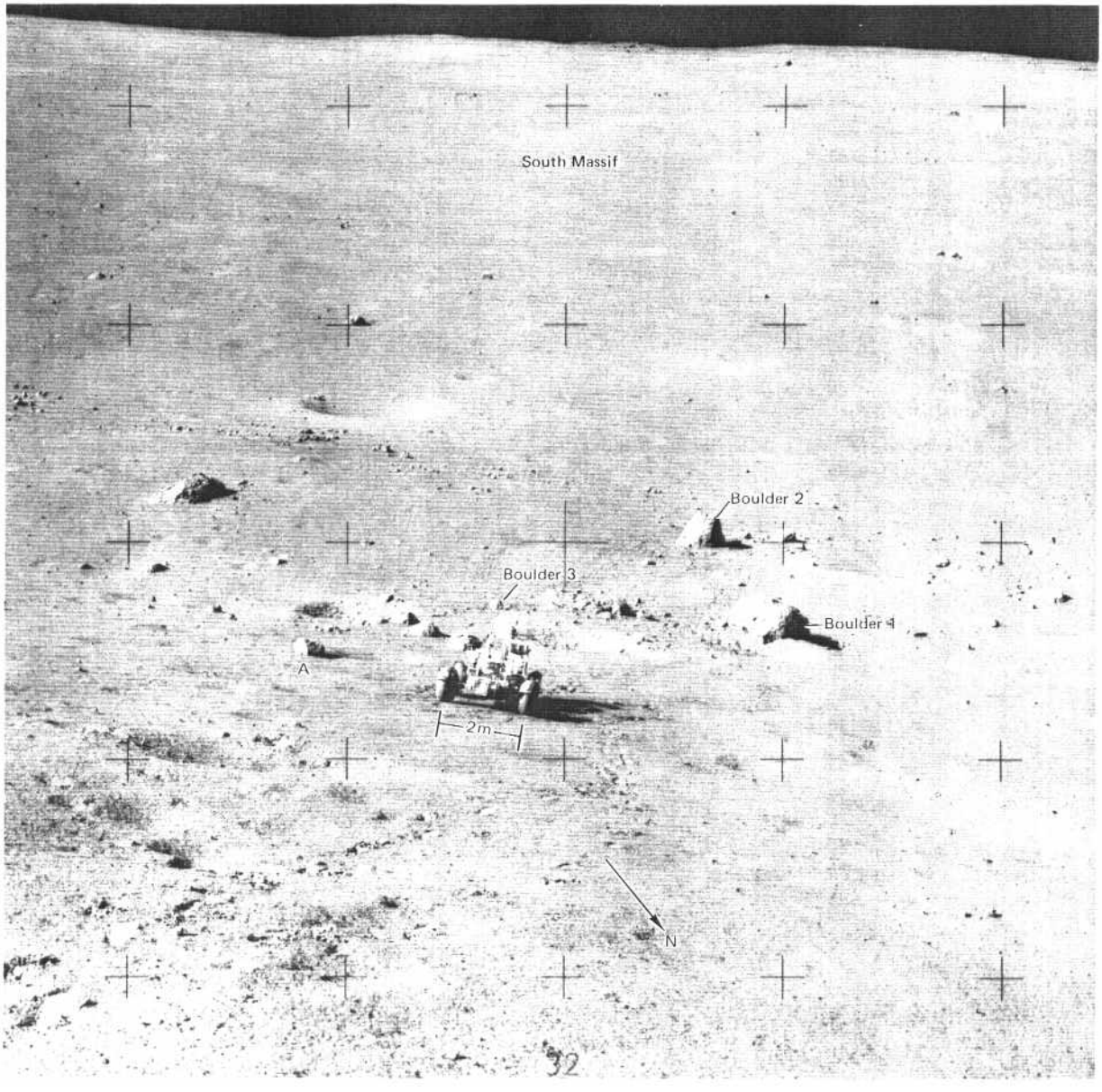

FIGURE 73.-Station 2 area. Distance from LRV to boulder 2 is about 50 m. A denotes boulder identified on station map (fig. 72) and in pans 14 and 15 (pls. 5 and 6). (NASA photograph AS17-138-21072.)

of ejecta in impacts to produce such layered and coated clasts.

Samples of both matrix and clasts of boulder 1, excluding the pigeonite basalt and a few clasts interpreted as plutonic fragments, are characterized by a distinctive meteoritic trace-element distribution (group 3) that is different from the equally distinctive pattern (group 2) shared by most of the Apollo 17 highlands breccia (Morgan and others, 1975). The data suggest that differences between the 72275 tracelement distribution and that of the other boulder 1 samples are due at least in part to the admixture of pigeonite basalt in 72275. Because of the predominance of the group 2 pattern in the Apollo 17 highlands breccia, Morgan and others (1975) concluded that it represents the trace-element signature of the projectile that formed the Serenitatis Basin (southern Serenitatis basin of this report). They suggested that the boulder 1 materials were excavated in the same impact but that they came from a position in the basin distant enough from the projectile itself to avoid detectable admixture of materials of the projectile. Supporting evidence that the trace-element distributions of groups 2 and 3 may each represent ejecta of the same basin impact comes from station 3. Two of three matrix samples from rock 73215 contain the group 2 meteoritic component. The third matrix sample, taken about a centimeter from the first two and not visibly different, contains the group 3

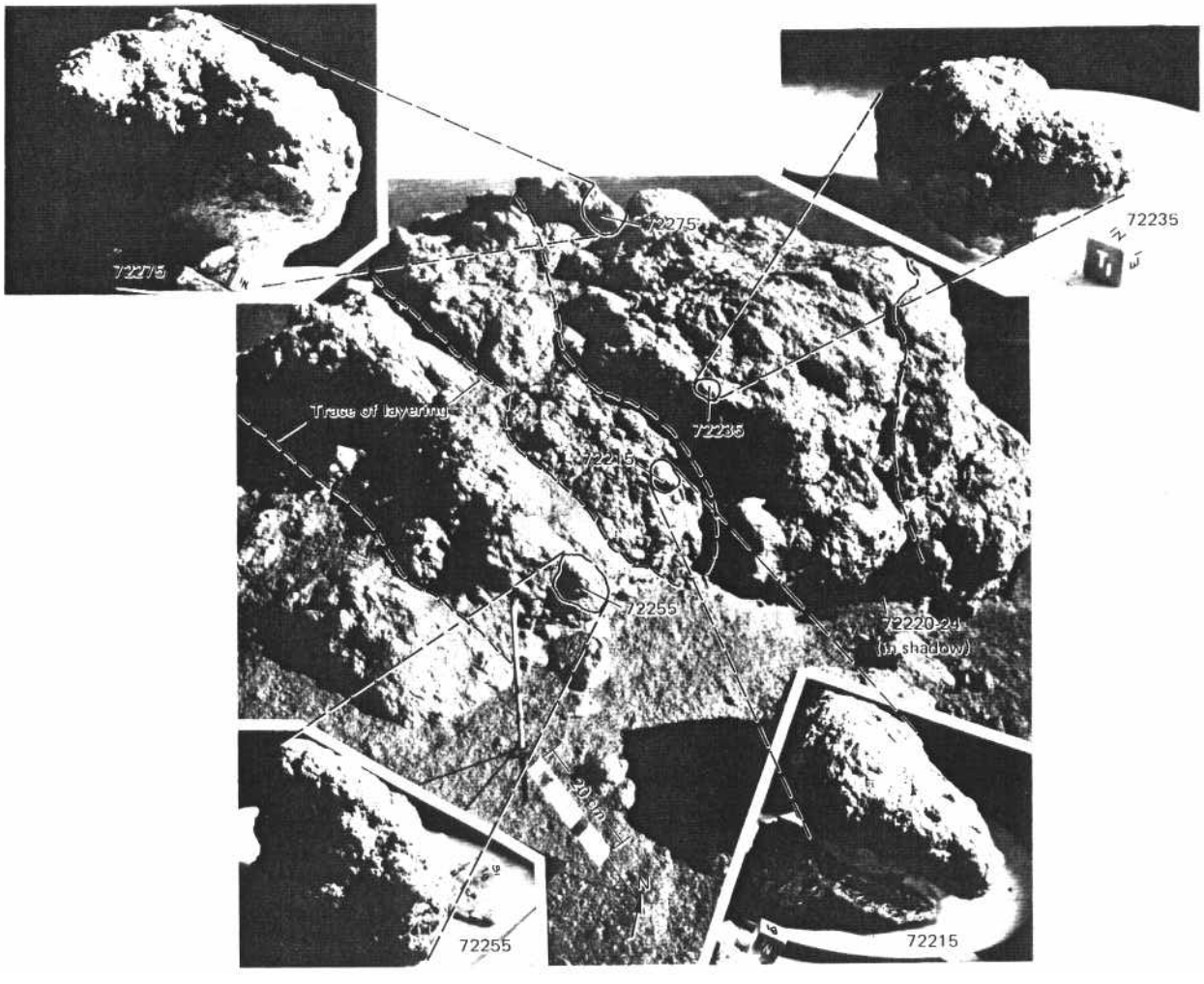

FIGURE 74. Boulder 1 at station 2 before sampling, showing locations of rock samples 72215, 72235, 72255, and 72275, and sediment sample 72220-24. Boulder is about 2 m across and 1 m high. Insets are laboratory photographs showing four rock samples with reconstructed lunar surface orientations and lighting. (NASA photographs AS17-137-20901; S-73-17987 (72215), S-73-17963 (72235), S-73-17989 (72255), and S-73-17988 (72275).)

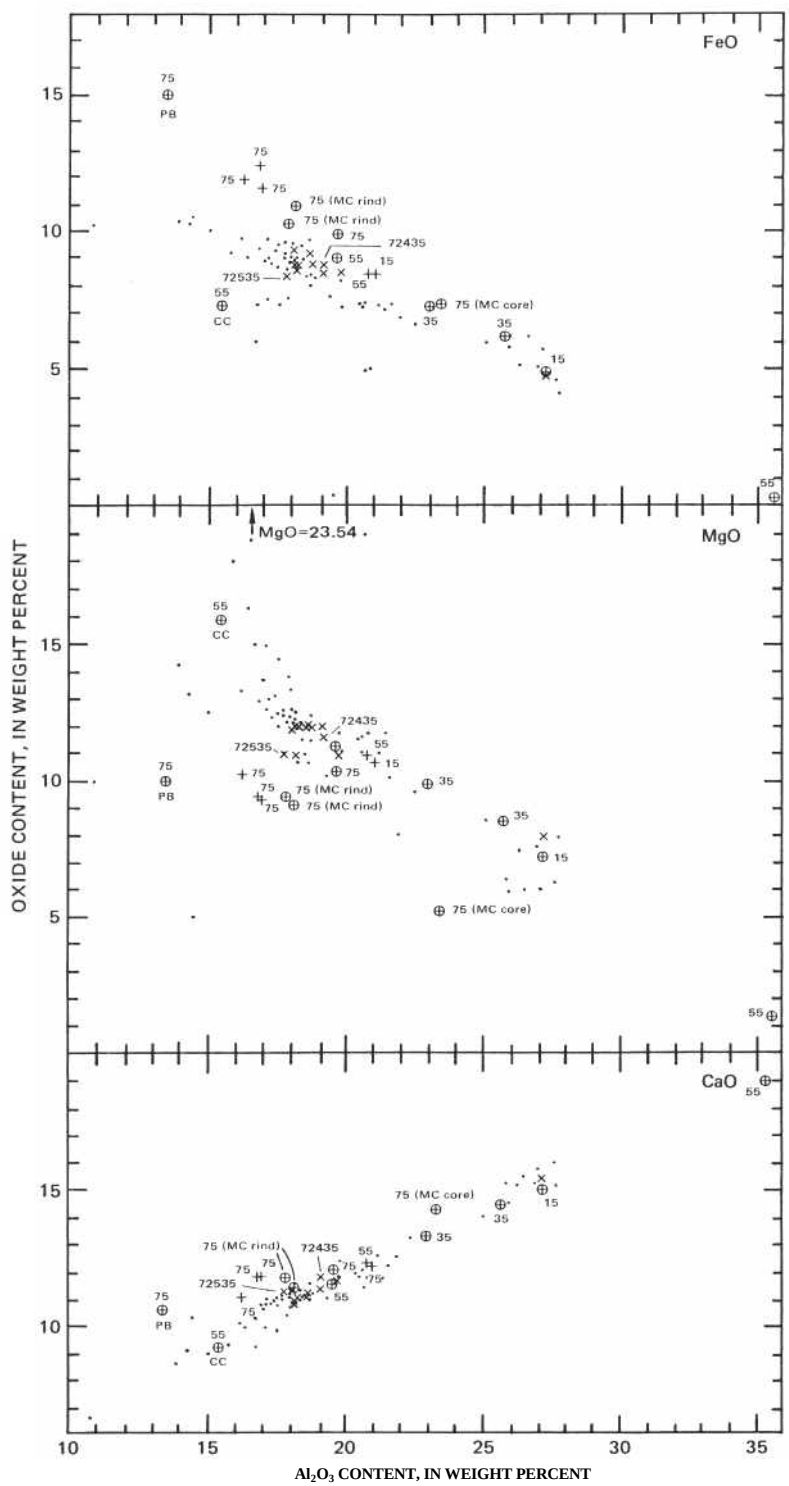

FIGURE 75.-Plots of FeO, MgO, and CaO contents in relation to Al_2O_3 content for analyzed rocks from station 2 (excluding metadunite 72415-18) in comparison with all analyzed Apollo 17 highlands rocks. Cross, boulder 1 matrix sample; circled cross, boulder 1 clast sample (those with $A1_2O_3$ contents ranging from 17.9 through 23.1 percent are competent breccia from distinct clasts within individual samples); 15, 35, 55, 75 identify last two digits of boulder 1 sample numbers; PB, pigeonite basalt; MC, Marble Cake clast; CC, Civet Cat norite clast; x, sample from boulder 2 except where identified as 72435 (boulder 3) and 72535 (rake fragment).

meteoritic component (James and others, 1975a).

Boulder 2 samples and sample 72435, which represents the matrix material of boulder 3, are polymict breccia. Modal analyses by Wilshire (this report) show that the matrix, in the 0.1-1.0-mm size range, is dominated by clasts of plagioclase (49-65 percent), with smaller amounts of olivine (6-28 percent) and pyroxene (1-4 percent). Metagabbroid fragments (10-21 percent) are the dominant lithic type in this size range. Larger lithic clasts, up to about 2 cm in diameter, have been classified by Dymek and others (1976b) as members of the dunite-anorthosite-norite-troctolite suite.

Matrix textures in boulders 2 and 3 are described by Wilshire (this report) as aphanitic to granoblastic to poikilitic, implying that thermal metamorphism in an ejecta blanket at least in part recrystallized a matrix that may have ranged initially from fragmental to partly melted. In contrast, Dymek and others (1976b) have described no textures indicative of thermal metamorphism; they have interpreted the matrices of boulders 2 and 3 as aggregates of abundant microclasts within a poikilitic to subophitic groundmass that crystallized from a melt. In their model, the breccia was formed by violent mixing of predominantly unshocked cold clasts with impact melt generated in the formation of a lunar basin.

Analyzed subsamples from boulders 2 and 3 show a high degree of chemical homogeneity (fig. 75). Except for a single clast that is unusually rich in plagioclase (72335,2; Al_2O_3=27.3 percent), all of the analyzed samples are tightly clustered ($A1_2O_3$ values between 18 and 20 percent) within the compositionally restricted Apollo 17 breccia suite. However, Dymek and others (1976b) have reported on the basis of microprobe analyses that the "igneous" groundmass in boulders 2 and 3 differs from the bulk breccia compositions. In addition, the dominant plagioclase in the clasts is significantly more calcic than that in the groundmass, and olivine and pyroxene clasts tend to be more magnesian than their groundmass counterparts. Hence they have concluded that the groundmass melt and the clasts were derived from slightly different sources; that is, the groundmass was not produced by crushing, grinding, melting, or recrystallization of the observed clast assemblage.

Sample 72415-18, the clast of metadunite from boulder 3, has been interpreted as a sample of a cumulate igneous rock (Albee and others, 1975); its relict granoblastic fabric may represent prolonged deepseated thermal metamorphism. Snee and Ahrens (1975) found evidence of shock deformation from which they inferred shock pressures in the range of 330-440 kb. Before or during incorporation into the ejecta of which boulder 3 is a sample, the metadunite fragment underwent cataclasis. Papanastassiou and Wasserburg (1975) inferred a crystallization age of 4.55±0.10 b.y. and suggested that the metadunite clast was derived from an early lunar differentiate; its mineralogy is appropriate for it to be related by fractional crystallization to norite 78235 and metatroctolite 76535 (Dymek and others, 1975).

Both the chemical composition (fig. 76) and the petrography of sediment samples from station 2 reflect their derivation from the feldspar-rich rocks of the South Massif. All are samples of unconsolidated colluvium derived from impact-generated regolith on the surface of the massif. Sample 72700-04, collected more than 50 m out from the base of the South Massif, is the most likely sample from station 2 to represent pure light mantle material. However, the other analyzed samples (fig. 76), from the lowest part of the massif slope, are indistinguishable from 72700-04 in figure 76; they could all represent light mantle material.

The boulders near the base of the massif probably rolled to their present positions after emplacement of the light mantle. Some, although not the three sampled boulders, are at the ends of tracks that probably would have been obliterated by subsequent deposition of light mantle, and all would probably have been buried by the boulder-poor light mantle if they had been there first. Evaluating exposure ages determined for boulder 1, Leich and others (1975) concluded that the boulder has been in its present position at the base of the massif for about 42 m.y.

SUMMARY OF SAMPLING

Sample 72215

Type: Polymict breccia with an aphanitic matrix.
Size: 9.7X6.6X5.0 cm.
Weight: 379.2 g.
Location: From 2-m boulder 1 on lower slopes of South Massif approximately 35 m southwest of the LRV.
Illustrations: Pans 14,15, figures 73, 74, 77 (LRL).
Comments: Boulder 1 represents bedrock from the upper part of the South Massif.
Petrographic description: Polymict breccia with an aphanitic matrix. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 32 percent plagioclase, 3 percent pyroxene, 12 percent olivine, 33 percent dark metaclastic rocks with aphanitic matrices, 5 percent light metaclastic rocks with granoblastic matrices, 5 percent quartz-potassium feldspar fragments, 6 percent metagabbro, 1 percent metatroctolite, 2 percent recrystallized olivine, and 8 percent recrystallized plagioclase. The dominant source rock is probably troctolite-metatroctolite.

In the classification of the boulder 1 consortium

(Consortium Indomitabile), sample 72215 is dominantly gray competent breccia, interpreted as representing the matrix of many of the clasts that are themselves incorporated within the light-gray friable breccia of sample 72275 (Marvin, 1975).

Major- element composition:

Chemical analyses of 72215

	1	2
SiO_2	45.2	44.7
Al_2O_3	21.1	27.3
FeO	8.43	4.80
MgO	10.7	7.19
CaO	12.1	14.9
Na_2O	.52	.48
K_2O	.25	.11
TiO_2	.9	.5
P_2O_5	--	--
MnO	.128	.067
Cr_2O_3	.25	.126
Total	99.578	100.18

1. Average of 4 analyses of gray competent breccia matrix (Blanchard and others, 1975). Original analyses (72215,47; 60; 64; 92) in Blanchard and others, 1974).
2. 72215, 76 anorthostic breccia clast (Blanchard and others, 1975).

Age: Rb-Sr: 4.03±0.03 b.y. determined for Rb-rich microgranite clasts in competent breccia matrices of 72215,104 and 72255,59 (Compston and others, 1975). Microgranite fragments show reaction-rim relation to enclosing breccia, and some have been partially melted; hence, they predate the high

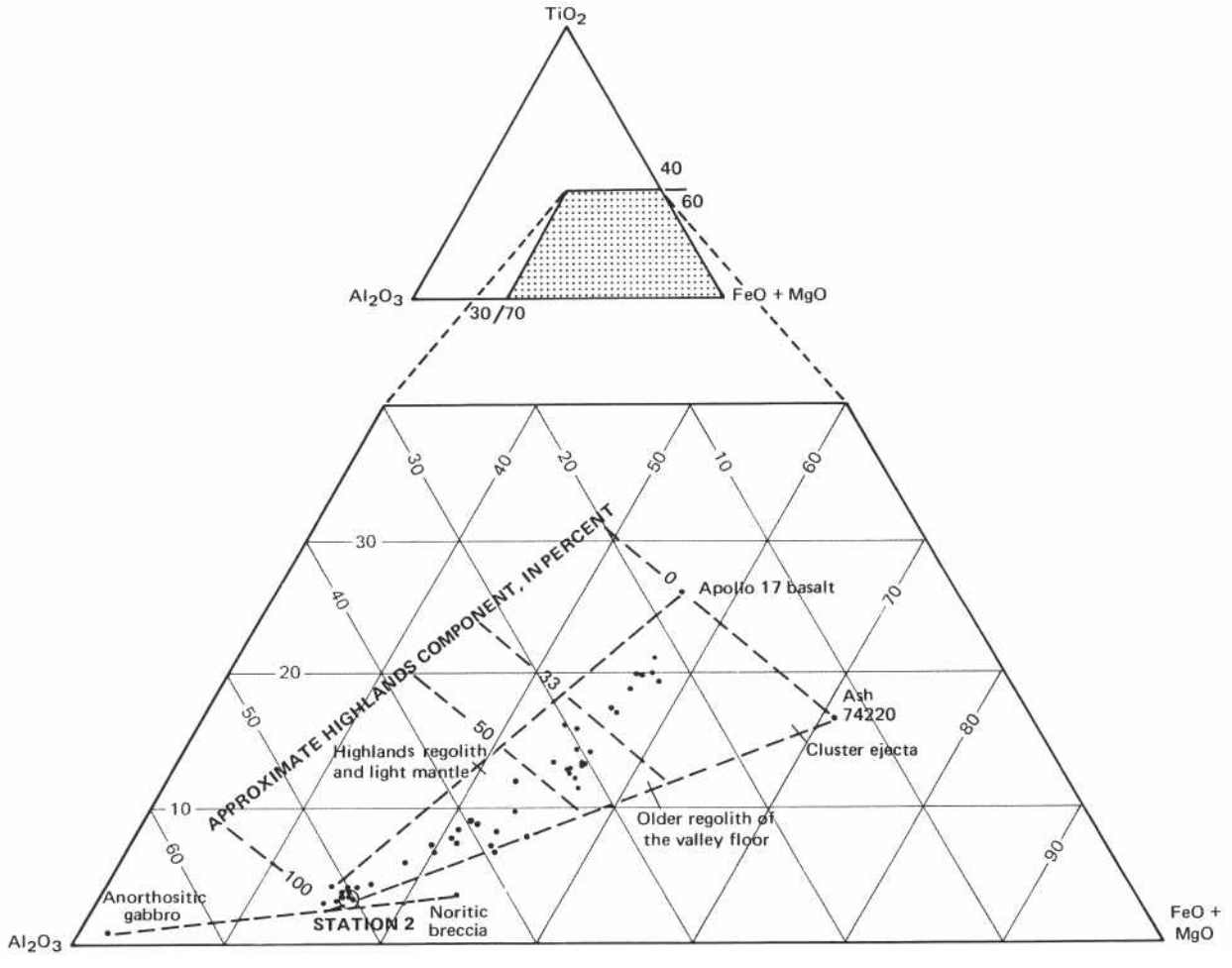

FIGURE 76.-Relative amounts of $Ti0_2$, $A1_2O_3$, and FeO+MgO in sediment samples 72321, 72441, 72461, 72501, and 72701 (circled) from station 2, in comparison with sediment samples from rest of traverse region. Apollo 17 basalt, anorthositic gabbro, and noritic breccia values from Rhodes and others (1974).

temperature high-pressure assembly of the matrix inferred by Stoeser and others (1974a). Rb-Sr age of microgranite clasts is an older limit for consolidation of the competent breccia matrix and may be the crystallization age of the microgranite.

Exposure age: Kr: 41.4±1.4 m.y. (Leich and others, 1975).

Sample 72220-24

Type: Sedimentary, unconsolidated.
Weight: 388.56 g.
Depth: 0-3 cm.
Location: From fillet underneath the east-facing overhang on boulder 1.
Illustrations: Pans 14, 15; figures 73, 74, 78.
Petrographic description: 72220-24, dominantly breccia, some agglutinate, some feldspar fragments.

Sample 72235

Type: Polymict breccia with a cataclastic matrix.
Size: 7X4X3 cm.
Weight: 61.91 g.
Location: From boulder 1 on lower slopes of South Massif approximately 35 m southwest of the LRV.
Illustration: Pans 14,15; figures 73, 74, 79.
Comments: Boulder 1 represents bedrock from the upper part of the South Massif.
Petrographic description: Polymict breccia with a cataclastic matrix. The specimen is dominated by a 2.5X4 cm clast (fig. 79) of interlayered troctolitic(?) cataclasite and dark finely pulverized material. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 15 percent plagioclase, 9 percent pyroxene, 1 percent olivine, 1 percent opaque minerals, 57 percent dark metaclastic rocks with aphanitic matrix, 3 percent light metaclastic rocks with granoblastic matrix, 1 percent quartzpotassium feldspar rocks, 11 percent metagabbro, 2 percent recrystallized plagioclase.

The boulder 1 consortium described 72235 as a coherent knob (the large 2.5X4 cm clast) of interlayered black competent breccia and anorthositic breccia with an adhering matrix of light-gray friable breccia similar to the matrix of 72275 (Marvin, 1975).

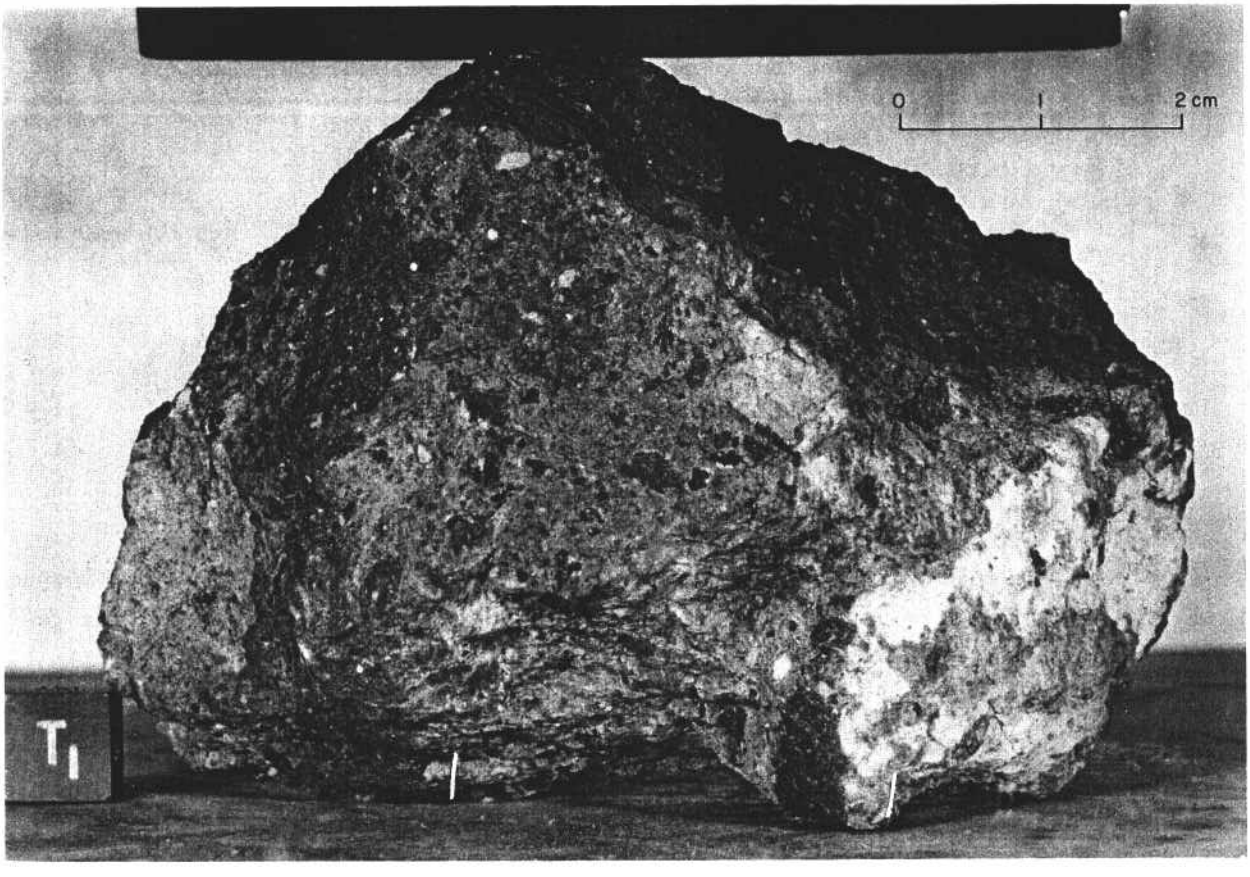

FIGURE 77.-Sample 72215. Polymict breccia with aphanitic matrix. (NASA photograph S-73-16661.)

Major-element composition:

Chemical analyses of 72235

	1	2
SiO_2	44.6	44.5
Al_2O_3	23.1	25.8
FeO	7.28	6.19
MgO	9.9	8.52
CaO	13.2	14.4
Na_2O	.514	.42
K_2O	.20	.11
TiO_2	.8	.8
P_2O_5	.--	--
MnO	.111	.080
Cr_2O_3	.21	.146
Total	99.92	100.97

1. 72235, 46, competent breccia matrix of 72235. Composition, intermediate between the more typical competent breccia matrix of the boulder (for example, average matrix of 72255) and anorthositic breccia clasts (for example 72215, 76 and 72235, 36), is interpreted as a mechanical mixture of components that were abundant at the source region and that are identifiable in the boulder 1 samples (Blanchard and others, 1975).
2. 722335, 36, anorthositic breccia clast (Blanchard and others, 1975).
Additional analyses, by defocused beam microprobe, have been published by Stoeser and others (1974a) and Ryder and others (1975).

Sample 72240-44

Type: Sedimentary, unconsolidated.
Weight: 322.42 g.
Depth: 0-5 cm.
Location: From fillet on east of boulder 1 on lower slopes of South Massif, approximately 35 m southwest of LRV.
Illustrations: Pans 14, 15; figures 73, 78.
Comments: Sample 72240-44 represents regolith developed on the talus at the base of South Massif.
Petrographic description: 72240-44, dominantly breccia and agglutinate.

Sample 72255

Type: Polymict breccia with an aphanitic matrix.
Size: 10.5x9x2.5 cm.
Weight: 461.2 g.
Location: From boulder 1 on lower slopes of South Massif approximately 35 m southwest of LRV.
Illustrations: Pans 14, 15; figures 73, 74, 80 (LRV).
Comments: Source rock (boulder 1) is from high on the slope of South Massif.
Petrographic description: Polymict breccia with an aphanitic matrix. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 19 percent plagioclase, 2 percent olivine, 8 percent pyroxene, 60 percent dark metaclastic rocks with aphanitic matrices, 3 percent light metaclastic rocks with granoblastic matrices, 1 percent quartz-potassium feldspar rocks, 4 percent metagabbro, 1 percent metatroctolite, 1 percent recrystallized olivine, 2 percent recrystallized plagioclase, trace noritic cataclasite.

The boulder 1 consortium has interpreted 72255 as a polymict breccia with a competent matrix (in contrast to the friable-matrix breccia of 72275 type). Hence they believe it may represent a clast within boulder 1. Numerous clasts within 72255 include some described as gray aphanitic microbreccia, white anorthosite with and without black rims, crystalline gabbroic clasts, and the particularly conspicuous 2-cm "Civet Cat" clast (fig. 80) interpreted as a norite fragment with relict plutonic texture visible through shock features (Marvin, 1975).

Major - element composition:

Chemical analyses of 72255

	1	2	3	4
SiO_2	45.0	52.0	43.0	46.0
Al_2O_3	20.9	15.5	35.8	19.7
FeO	8.45	7.4	0.13	9.05
MgO	11.0	15.9	1.43	11.3
CaO	12.2	9.1	18.9	11.5
Na_2O	.51	.33	.63	.54
K_2O	.25	.08	.12	.28
TiO_2	.8	.3	.7	1.2
P_2O_5	--	--	--	--
MnO	.122	.122	.003	.136
Cr_2O_3	.25	.16	.003	.263
Total	99.482	100.89	100.72	99.77

1. Average of four analyses of gray competent breccia matrix (Blanchard and others, 1975); original analyses (72255,52 64, 69, 79) from Blanchard and others (1974).
2. Coarse norite clast ("Civet Cat") 72255, 42 (Blanchard and others, 1975).
3, 4. 72255,45, clast of interlayered white anorthositic breccia (column 3) and black competent breccia (cloumn 4) (Blanchard and others, 1975).
Additional analyses by defocused beam microprobe have been published by Stoeser and others (1974a) and Ryder and others (1975).

Age:

$^{40-39}$Ar:72255,42, 3.99±0.03 b.y., Civet Cat norite clast;72255,52, 4.01±0.03 b.y., matrix adjacent to Civet Cat clast (Leich and others, 1975). Mean value of 4.00±0.03 is interpreted as an accurate measure of the time that 72255 began retention of argon and as the time when the competent breccias, such as the 72255 matrix, were assembled. It may represent an older limit for the formation of the Serenitatis basin (Leich and others, 1975).

Rb-Sr isochron: 72255,41, 4.17±0.05 (2_o) b.y., Civet Cat norite clast; may represent original igneous age or at least a younger limit on original crystallization (Compston and others, 1975). Data also show a Rb-Sr disturbance at ~3.9±0.1 b.y., which may represent the high-temperature event in which the competent breccia of boulder 1 was formed.

Fission track: Whitlockite crystal in 72255,30, 3.96+0.04/-0.07 b.y., interpreted as representing the last high-temperature metamorphic event

experienced by the boulder I materials (Goswami and Hutcheon, 1975).

Exposure age:

Kr: 44.1 +/-3.3 m.y. (Leich and others, 1975).

Track age: ~40 m.y. (Goswami and Hutcheon, 1975) apparently supersedes an earlier track age determination of 19±2 m.y. by Hutcheon and others (1974b).

Sample 72260-64

Type: Sedimentary, unconsolidated.

Weight: 279.0 g.

Depth: 0 - 1 cm.

Location: From fillet on east side of boulder 1 on lower slopes of South Massif, approximately 35 m southwest of LRV.

Illustrations: Pans 14, 15; figures 73, 78.

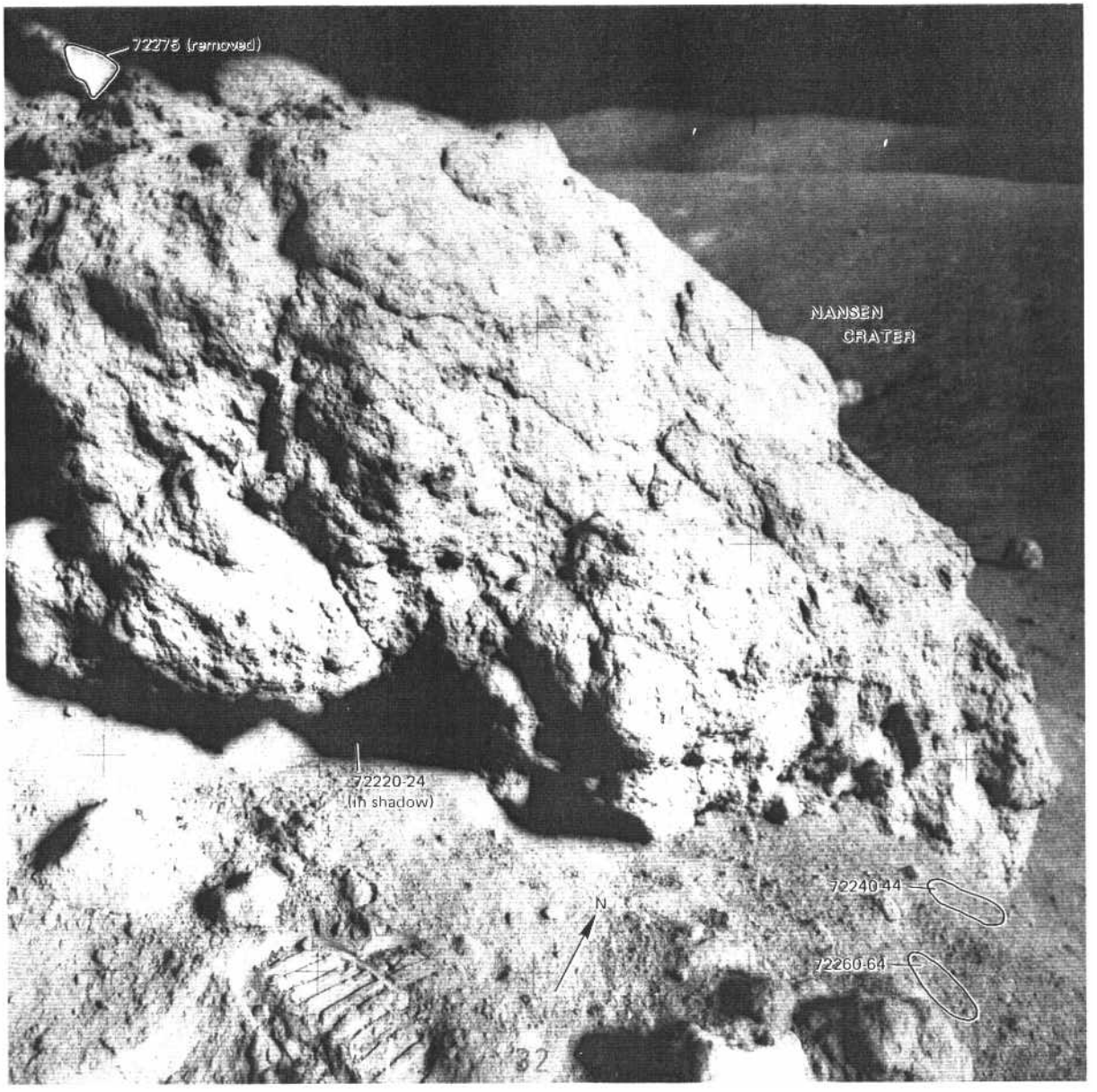

FIGURE 78.-Boulder 1 of station 2 showing 72275 after collection and 72220-24, 72240-44, and 72260-64 before collection. (NASA photograph AS 17-138-21031.)

Comments: Skim sample 72260-64 represents regolith developed on the talus at the base of South Massif.

Sample 72275

Type: Polymict breccia with cataclastic matrix.
Size: 17X14X12 cm.
Weight: 3,640 g
Location: From boulder 1 on lower slopes of South Massif

Illustrations: Pans 14, 15; figures 73, 74, 78, 81 (LRL).
Comments: Source rock (boulder 1) is from upper part of South Massif.

Petrographic description: Polymict breccia with a fine grained cataclastic matrix. Clast types in the size range 0.1 to 1.0 mm are in the approximate proportions: 13 percent plagioclase, 2 percent olivine, 5 percent pyroxene, 65 percent dark metaclastic rocks with aphanitic matrix, 5 percent light metaclastic rocks with granoblastic matrix, 1 percent ophitic basaltic rock. 1 percent anorthosite, 4 percent metagabbro, 1 percent in metatroctolite, 3 percent recrystallized plagioclase, 1 percent anorthosite cataclasite, 1 percent basalt cataclasite, trace quartzpotassium feldspar rock.

The boulder 1 consortium has described 72275 as predominantly light-gray friable matrix material in which the most conspicuous clast types are (1) gray, and black competent breccia; (2) anorthositic breccia, commonly cataclastic, sometimes with rims of black competent breccia as in the 2 cm "Marble Cake" clast from 72275 (3) felty pigeonite basalt clast that occur as clots of basalt within lenses and bands of basaltic debris interfingering with the light-gray friable matrix. Pigeonite basalt occurs only within the light friable matrix. never within the clasts of gray or black competent breccia (Marvin, 1975) .

Major – element composition:

Chemical analyses of 72275

	1	2	3	4	5	6	7	8	9
SiO_2 ……..	47.54	47.31	48.3	48.0	47.0	47.0	47.0	46.0	47.7
Al_2O_3……..	17.01	16.90	16.3	13.5	17.9	18.2	23.5	19.7	16.7
FeO…….	11.58	12.45	11.9	15.0	10.3	10.9	7.4	9.9	12.0
MgO……..	9.35	9.47	10.3	10.0	9.43	9.14	5.24	10.4	9.7
CaO……	11.71	11.72	11.0	10.5	11.7	11.2	14.2	12.0	11.5
Na_2O……..	.38	.35	.44	.29	.39	.63	.36	.30	.39
K_2O……	.28	.22	.25	.25	.47	.49	.32	.25	.25
TiO_2 ……..	.91	.94	1.0	1.4	1.8	1.1	1.8	.8	1.0
P_2O_5 ……..	.35	.38	--	--	--	--	--	--	.36
MnO……..	.18	.19	.17	.156	.104	.167	.077	.111	.18
Cr_2O_3……	.36	.34	.35	.46	.46	.27	.20	.24	.35
Total	99.65	100.27	100.01	99.56	99.55	99.41	100.10	99.70	100.13

Note: - Additional analyses by defocused beam microprobe have been published by Stoesser and others (1974a, b) and Ryder and others (1975).

1. 72275, 2, representitive nortic breccia from 72275 (Apollo 17 PET, 1973).
2. 72275, 90, matrix (Rose and others, 1974).
3. 72275, 57, light gray friable breccia matrix (Blanchard and others, 1975).
4. 72275, 91, pigeonite basalt clast (Blanchard and others, 1975).
5. 72275, 80, black competent breccia rind of Marble Cake clast (Blanchard and others, 1975).
6. 72275, 166, black competent breccia rind of Marble Cake clast (Blanchard and others 1975).
7. 72275, 76, anorthositic breccia core of Marble Cake clast (Blanchard and others, 1975).
8. 72275, 83, gray competent breccia clast (Blanchard and others, 1975).
9. Average matrix composition (average of columns 1, 2, and 3).

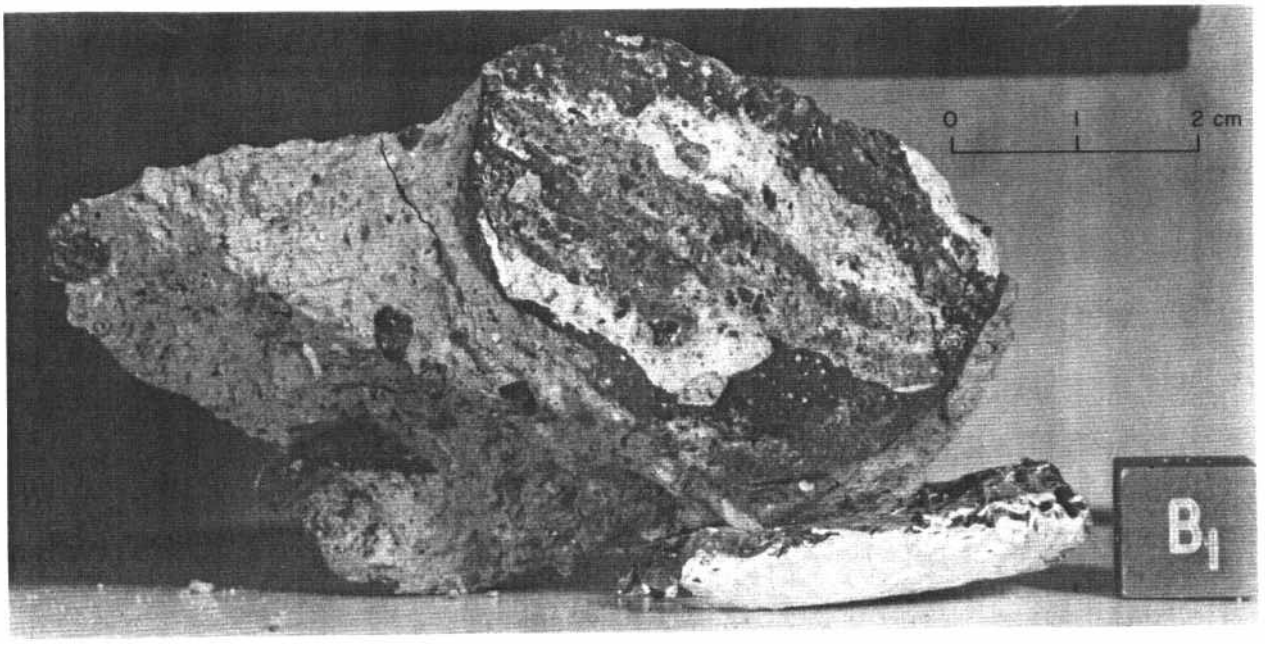

FIGURE 79. - Sample 72235. Polymict breccia with cataclastic matrix. At right is large (2.5X4 cm) clast of interlayered troctolitic(?) cataclastic and dark finely pulverized material. (NASA photograph S-73-16772.1

Age:

$^{40-39}$Ar: 72275,80. 3.99 +/- 0.03 b.y., black competent breccis rim of Marble Cake clast 1 Leich and others. 1975).

Rb-Sr isochron: 72275,171, 4.01 +/-0.04 b.y., pigeonite basalt clast; interpreted as age of original crystallization because of absence of petrographic evidence for either thermal metamorphism or extensive shock effects on the pigeonite basalt fragments (Compston and others, 1975).

Fission track: Whitlockite crystal in 72275, 3.98 +0.04/-0.06 b.y. (Goswami and others. 1976b).

Exposure age:

Kr: 52.5 +/-l .4 m.y. (Leich and others. 1975). This exposure age may represent. the time since first exposure of boulder 1 material to irradiation, perhaps while the sampled material was still in place high on the South Massif. Slightly younger Kr ages determined for 72215 and 72275 give a mean value of 41.8 +/- 1.3 m.y., which may represent the time of emplacement of the boulders in its present position (Leich and others, 1975). The ~40-m.y. track age of 72255 (Goswami and Hutcheon. 1975) is compatible with the suggested ~42-m.y. life of the boulder at the base of the massif.

Sample 72315

Type: Polymict breccia with granoblastic matrix.
Size: l0x5.5x2 cm.
Weight: 131.4 g.
Location: From boulder 2 on lower slopes of South Massif approximately 50 m southwest of LRV.

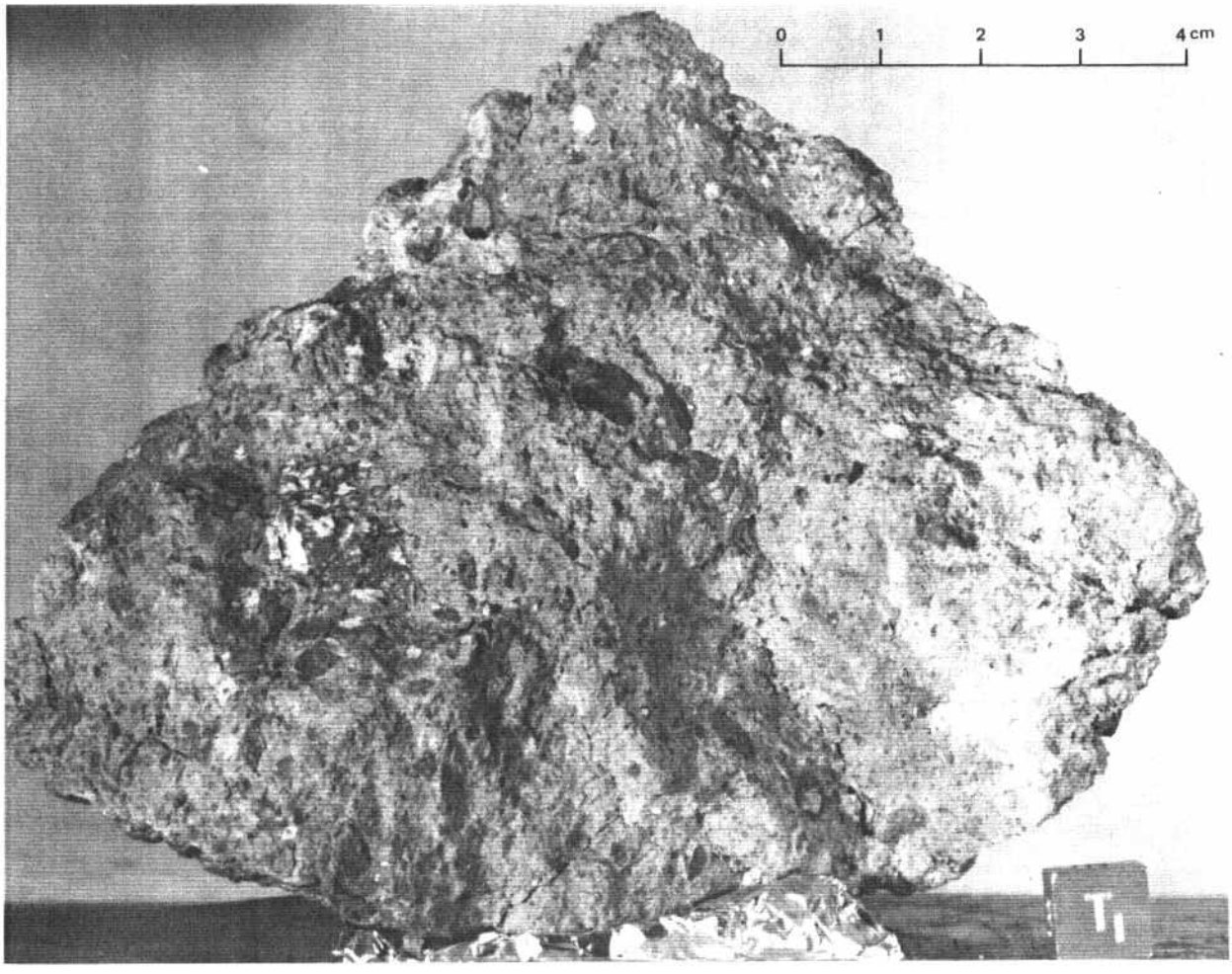

FIGURE 80. - Sample 72255. Polymict breccia with aphanitic matrix. Conspicuous black and white clast at left center is the 2-cm norite "Civet Cat" clast (Marvin. 1975). (NASA photograph S-73-16010.)

Illustrations: Pans 14, 15; Figures 73, 82, 83, (LRL).

Comments: Boulder 2 represents bedrock from high on the South Massif

Petrographic description: Polylllict breccia with a granoblastic matrix Locally vuggy with vug linings of coarse plagioclase and brown pyroxene; similar minerals occurs as clasts in the breccia. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 63 percent plagioclase. 7 percent olivine, 2 percent pyroxene, 27 percent metagabroid rock, 1 percent metatroctolite, 4 percent recrystallized olivine, 2 percent recrystallized plagioclase.

Dymek and others (1976b) have interpreted the matrix as an aggregate of microclasts with a very fine interstitial groundmass that crystallized from a melt.

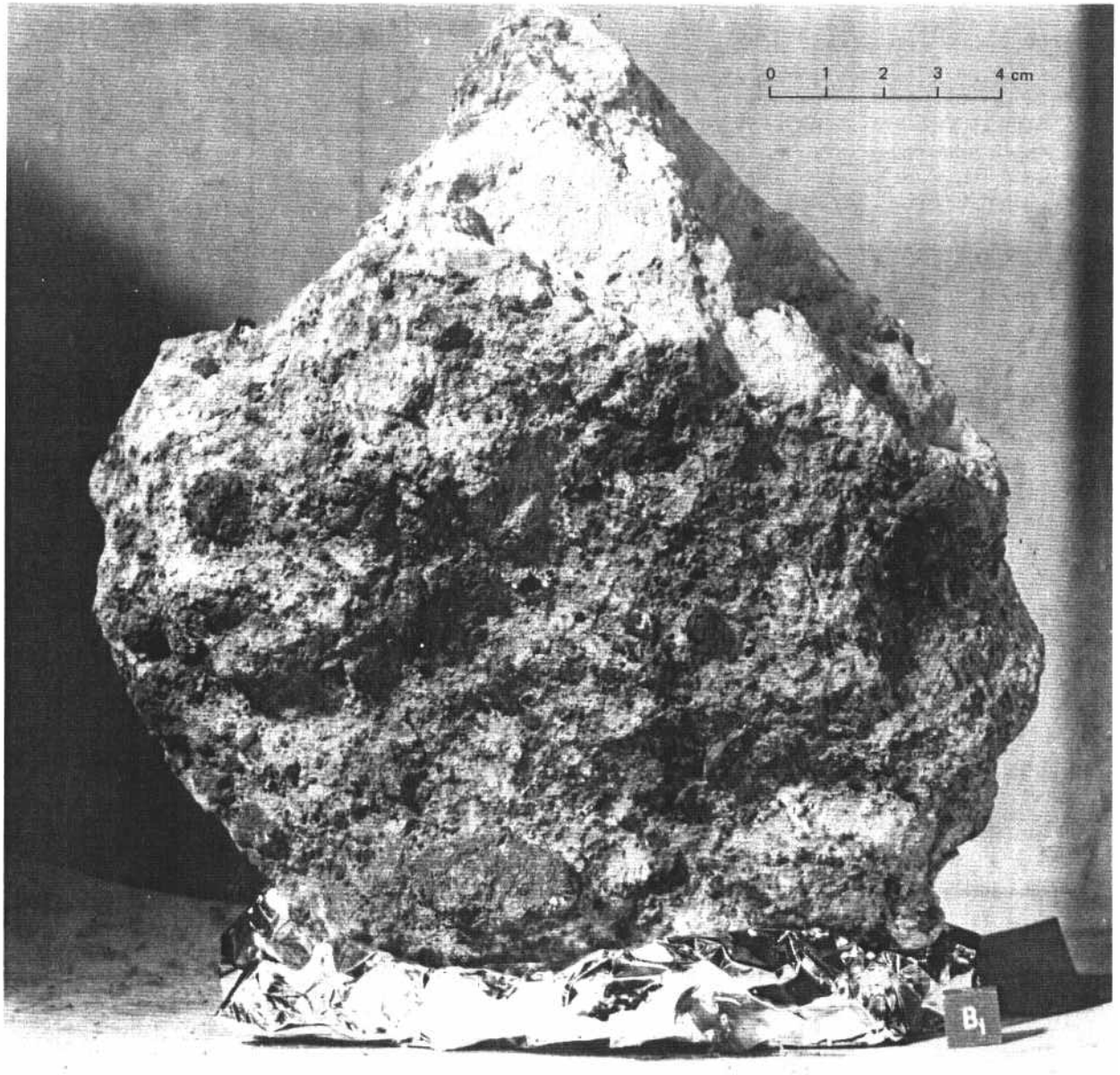

FIGURE 81. - Sample 72275. Polymict breccia with cataclastic matrix. (NASA photograph S-73-16056.)

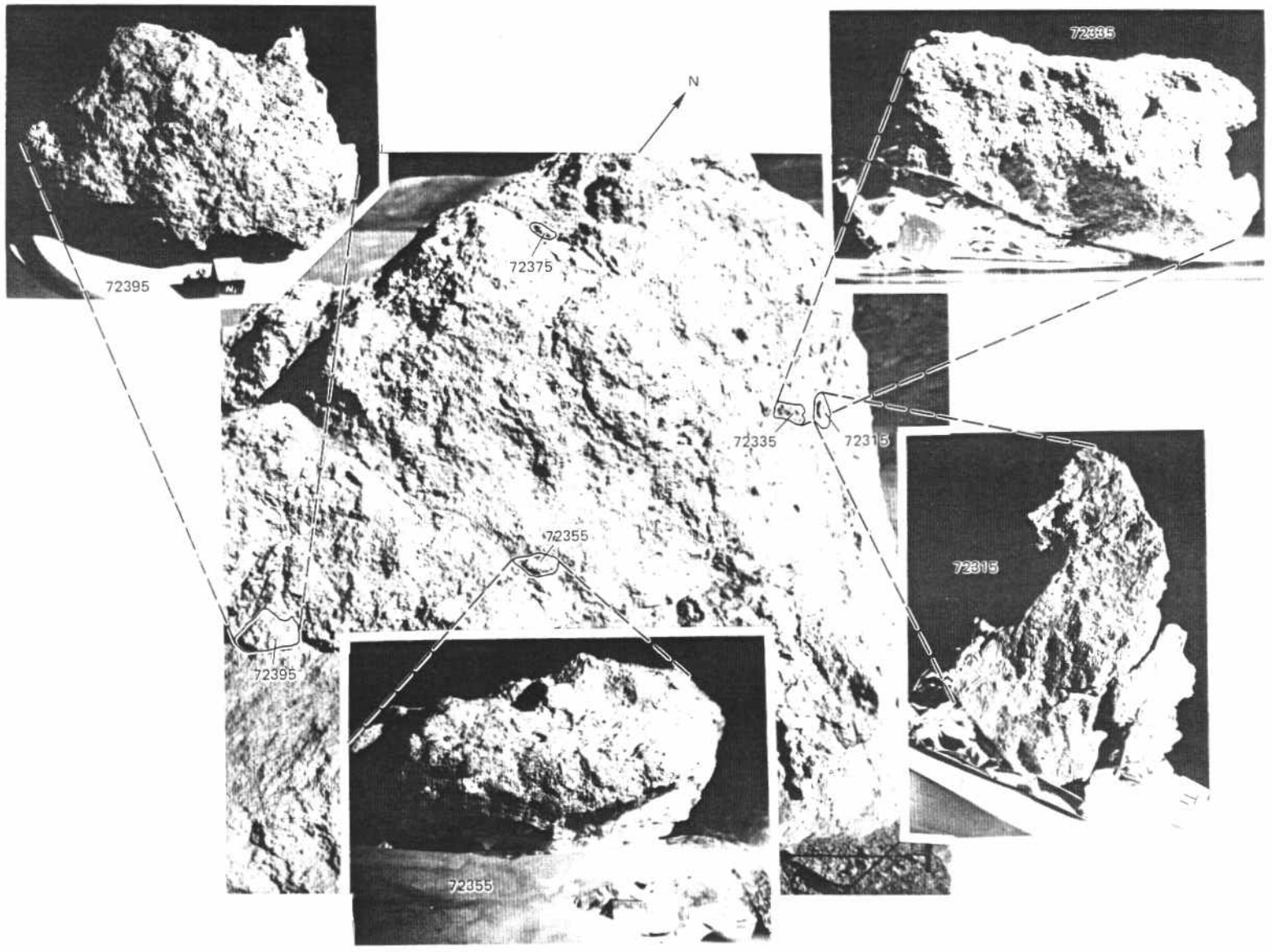

FIGURE 82. - Boulder 2, station 2, showing locations of samples 72315, 72335, 72355, 72375, and 72395 before collection. Boulder is approximately 2 m high. Insets show samples 72315, 72335, 72355, and 72395 with reconstructed lunar surface orientations and lighting. (NASA photographs AS17-137-20913; S-73-18408 (72315), S-73-21389 (72335), S-73-1 7799 (72355) and S-73-19586 (72395).) (Modified from Muehlberger and others. 1973.)

Major-element composition:

Chemical analyses of 72315

	1	2
SiO_2	--	--
Al_2O_3	19.8	19.2
FeO	8.5	8.5
MgO	11.0	12.0
CaO	11.6	11.3
Na_2O	.61	.70
K_2O	.32	.35
TiO_2	1.4	1.4
P_2O_5	--	--
MnO	.111	.111
Cr_2O_3	.186	.187

1. 72315, 3 (Laul and Schmitt, 1974).
1. 72315, 4 (Laul and Schmitt, 1974).

Exposure age: Track measurements and micrometeorite crater counts: ~10^5 years. The lighter (fresher) appearance of this part of the boulder surface, which presumably was exposed by local spalling ~10^5 years ago, may have been the cause for the crew's interpreting this part of boulder 2 as a clast (Hutcheon and others, 1974a).

Sample 72320

Tape: Sedimentary, unconsolidated.
Weight: 106.31 g.
Depth: Upper few centimeters.
Location: From about 20 cm under an east-west overhang on the southwest side of boulder 2.

Illustrations: Pans 14, 15.
Comments: Sediments accumulated by mass wasting from South Massif.
Petrographic description: 72320-24, dominantly agglutinate and fine grained breccia and (or) metaclastic rock.

Components of 90-150-um fraction of, 723217,7 (Heiken and McKay, 1974)

Components	*Volume Percent*
Agglutinate	45.3
Basalt, equigranular	2.3
Basalt, variolitic	.7
Breccia:	
Low grade[1] - brown	5.3
Low grade[1] - colorless	7.3
Medium to high grade[2]	15.6
Anorthosite	.7
Cataclastic anrthosite[3]	1.7
Norite	2.0
Gabbro	--
Plagioclase	9.3
Clinopyroxene	2.7
Orthopyroxene	.3
Olivine	.3
Ilmenite	Trace
Glass:	
Orange	Trace
"Black"	1.3
Colorless	1.0
Brown	2.0
Gray, "ropy"	.7
Other	--
Total number of grains	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

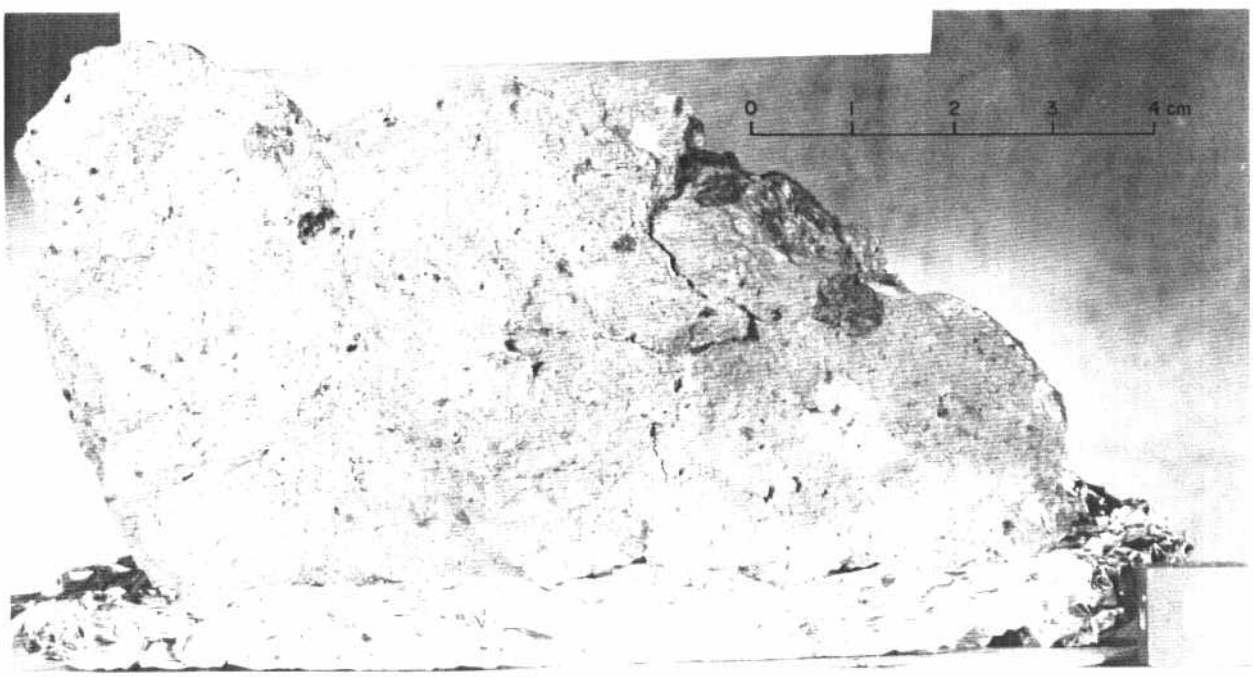

FIGURE 83, –Sample 72315, Polymict breccia with granoblastic matrix. (NASA photograph S-73-16657.)

Major - element composition:

Chemical analyses of 72321

SiO_2	44.91
Al_2O_3	20.57
FeO	8.65
MgO	9.84
CaO	12.82
Na_2O	.47
K_2O	.16
TiO_2	1.56
P_2O_5	.15
MnO	.13
Cr_2O_3	--
Total	99.26

72321, 5 (Rhodes and others, 1974).

Sample 72335

Type: Polymict breccia with a poikilitic (?) matrix.
Size: 8 X l.5 X l.5 cm.
Weight: 108.9 g.
Location: From boulder 2 on lower slopes of South Massif approximately 50 m southwest of the LRV.
Illustrations: Pans 14, 15; figures 73, 82, 84 (LRL).
Comments: Boulder 2 represents bedrock from the upper part of South Massif.
Petrographic description: Polymict breccia with a poikilitic (?) matrix. Clast types include plagioclase, olivine pyroxene, and fine-grained metaclastic rock.

Dymek and others (1976b) have interpreted the matrix as an aggregate of microclasts with a very fine interstitial groundmass that crystallized from a melt.

Major - element composition:

Chemical analyses of 70011

	1	2	3
SiO_2	--	--	--
Al_2O_3	27.3	18.2	18.3
FeO	4.8	8.6	8.8
MgO	8.0	11.0	12.0
CaO	15.4	10.7	11.0
Na_2O	.45	.61	.60
K_2O	.12	.27	.34
TiO_2	.60	1.6	1.6
P_2O_5	--	--	--
MnO	.060	.112	.114
Cr_2O_3	.100	.190	.200

1. 72335, 2 (Laul and Schmitt, 1974); analysis is of ~ 1 cm clast that has more plagioclase than normal 72335 breccia (Dymek and others, 1976a).
2. 72335,6 (Laul and Schmitt, 1975a).
3. 72335,7 (Laul and Schmitt, 1975a).

Columns 2 and 3 are representative of bulk of boulder 2 samples (Dymek and others 19756a); presumably the represent the boulder matrix.

Sample 72355

Type: Polymict breccia with a granoblastic matrix.
Size: 10 X 6.5 X 5.5 cm.
Weight: 367.4 g.
Location: From boulder 2 on lower slopes of South Massif approximately 50 m southwest of the LRV.
Illustrations: Pans *14, 15;* figures 73, 82, 85 (LRL).
Comments: Source rock (boulder 2) is from high on the slope of South Massif.
Petrographic description: Polymict breccia with a granoblastic matrix. Locally vuggy with vug linings distinctive spongy plagioclase and brown pyroxene; both minerals also occur as clasts in the breccia. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 62 percent plagioclase, 4 percent. pyroxene, 21 percent olivine, 10 percent metagabbroid rock, 1 percent metatroctolite, 2 percent recrystallized olivine, 1 percent recrystallized plagioclase.

Dymek and others (1976b) have interpreted the matrix as an aggregate of microclasts with a very fine interstitial groundmass that crystallized from a melt.

Major element composition:

Chemical analyses of 72355

SiO_2	--
Al_2O_3	18.8
FeO	8.7
MgO	12.0
CaO	11.1
Na_2O	.70
K_2O	.33
TiO_2	1.6

FIGURE 84. - Sample 723435. Polymict breccia with poikilitic (?) matrix. (NASA photograph S-73-16250.)

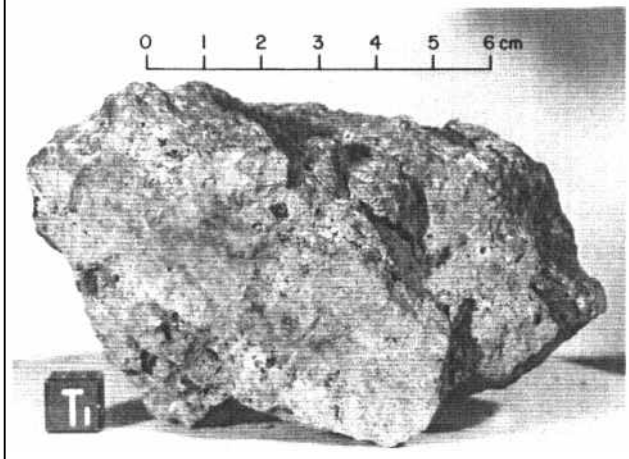

FIGURE 85. - Sample 72355. Polymict breccia with granoblastic matrix. (NASA photograph S-73-15352.)

Chemical analyses of 72355 - Continued

P_2O_5	--
MnO	.114
Cr_2O_3	.193

72355, 7 (Laul and Schmitt, 1974).

Sample 72375

Type: Polymict breccia with a poikilitic(?) matrix.
Size: 5X4X3 cm (estimated from LRL photos).
Weight: 18.16 g.
Location: From boulder 2 on lower slopes of South Massif approximately 50 m southwest of the LRV.
Illustrations: Pans 14, 15; figures 73, 82, 86 LRL).
Comments: Source rock (boulder 2) is from high on the slope of South Massif.
Petrographic description: Polymict breccia with a poikilitic (?) matrix. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 48 percent plagioclase, 5 percent olivine, 1 percent pyroxene, 1 percent brown pyroxene-plagioclase vug lining, 1 percent light metaclastic rock with granoblastic matrix, 19 percent metagabbroid rock, 1 percent recrystallized olivine, 1 percent recrystallized plagioclase.

Dymek and others (1976b) have intepreted the matrix as an aggregate of microclasts with a very fine interstitial groundmass that crystallized from a melt.

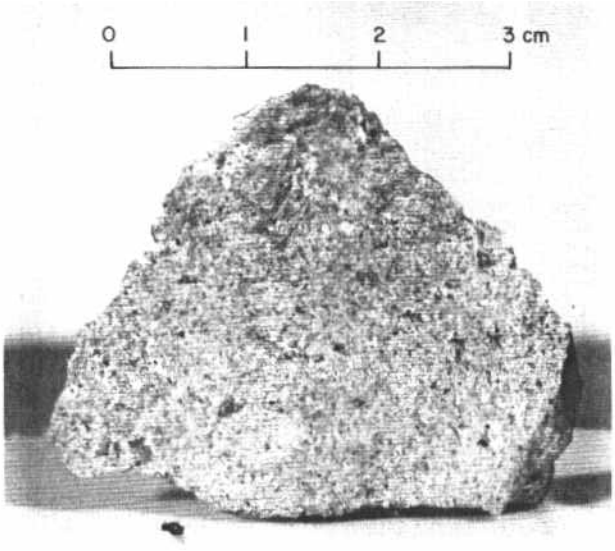

FIGURE 86.-Sample 72375. Polymict breccia with poikilitic (?) matrix. (NASA photograph S-73-15358.)

Major-element composition:

Chemical analyses of 72375

SiO_2	--
Al_2O_3	18.2
FeO	8.8
MgO	12.0
CaO	10.8
Na_2O	.67
K_2O	.27
TiO_2	1.5
P_2O_5	--
MnO	.112
Cr_2O_3	.178

72321, 5 (Rhodes and others, 1974).

Sample 72395

Type: Polymict breccia with an aphanitic matrix.
Size: 12 X 9 X 5.5 cm.
Weight: 536.4 g.
Location: From boulder 2 on lower slopes of South Massif approximately 50 m southwest of the LRV.
Illustrations: Pans 14, 15; figures 73, 82, 87 (LRL).
Comments: Boulder 2 represents bedrock from high on the slope of South Massif.
Petrographic description: Polymict breccia with an aphanitic matrix. Fragments of brown pyroxene from vug linings; scarce fragments of moderately dark metaclastic rocks. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 56 percent plagioclase, 27 percent olivine, 1 percent pyroxene, 15 percent metagabbroid rock, 1 percent metatroctolite, 1 percent recrystallized olivine, 3 percent recrystallized plagioclase.

Dymek and others (1976b) considered 72395 typical of' the samples from boulder 2 and described it as follows:

Sample 72395 is***a sugary-textured, light greenish-gray "metaclastic" rock with only a few clasts larger than a few mm. The most abundant clasts are clear white plagioclase and pale green olivine, although shocked, glassy plagioclase is also present. Each type occurs as subangular to rounded fragments 1-3 mm across. The few large lithic clasts are typically fine-grained "felsites," probably shocked anorthosite. The sample is highly vesicular, containing very small spherical vesicles (<50um), irregular vesicles, and "slit" vesicles.

In addition, they interpreted the matrix as an aggregate of microclasts with a very fine interstitial groundmass that crystallized from a melt.

Major-element composition:

Chemical analyses of 72395

	1	2
SiO_2	--	46.8
Al_2O_3	18.7	18.1
FeO	9.2	9.26
MgO	12.0	11.95
CaO	11.0	11.26
Na_2O	.67	.693

Chemical analyses of 72395 - Continued

	1	2
K_2O	.32	.287
TiO_2	1.7	1.75
P_2O_5	--	.325
MnO	.166	.120
Cr_2O_3	.210	.205
Total		100.75

1. 72395, 3 (Laul and Schmitt, 1974).
2. 72395,46 (Wanke and others, 1975).

Exposure age: Track age: ~27 m.y. Hutcheon and others, 1974b).

Sample 72410

Type: Sedimentary, unconsolidated.
Weight: 52.0 g.
Depth: 0-1 cm.
Location: From approximately one-half meter southeast of boulder 3.
Illustrations: Pans 14, 15; figures 73, 88.
Comments: Sediment collected with samples 72415-18.

Sample 72415-18

Type: Metadunite cataclasite.
Size: 72415, 4 x 2 x 0.8 cm; 72416, 2.1 x 1 .2 x 0.9 cm; 72417, 3.2 x 2.1 x1.2 cm; 72418, 4 x 2.5 x 1 cm.
Weight: 72415, 32.34 g; 72416, 11.53 g; 72417, 11.32 g; 72418, 3.55 g.
Location: From light clast in boulder 3 at base of South Massif approximately 15 m southwest of LRV.
Illustrations: Pans 14, 15; figures 73, 88, 89 (LRL).
Comments: Boulder 3 represents bedrock from the upper part of the South Massif.
Petrographic description: Metadunite cataclasite. Relict clasts have granoblastic-polygonal texture. One to 2 percent spinel-plagioclase-pyroxene intergrowths, the remainder partly recrystallized olivine.

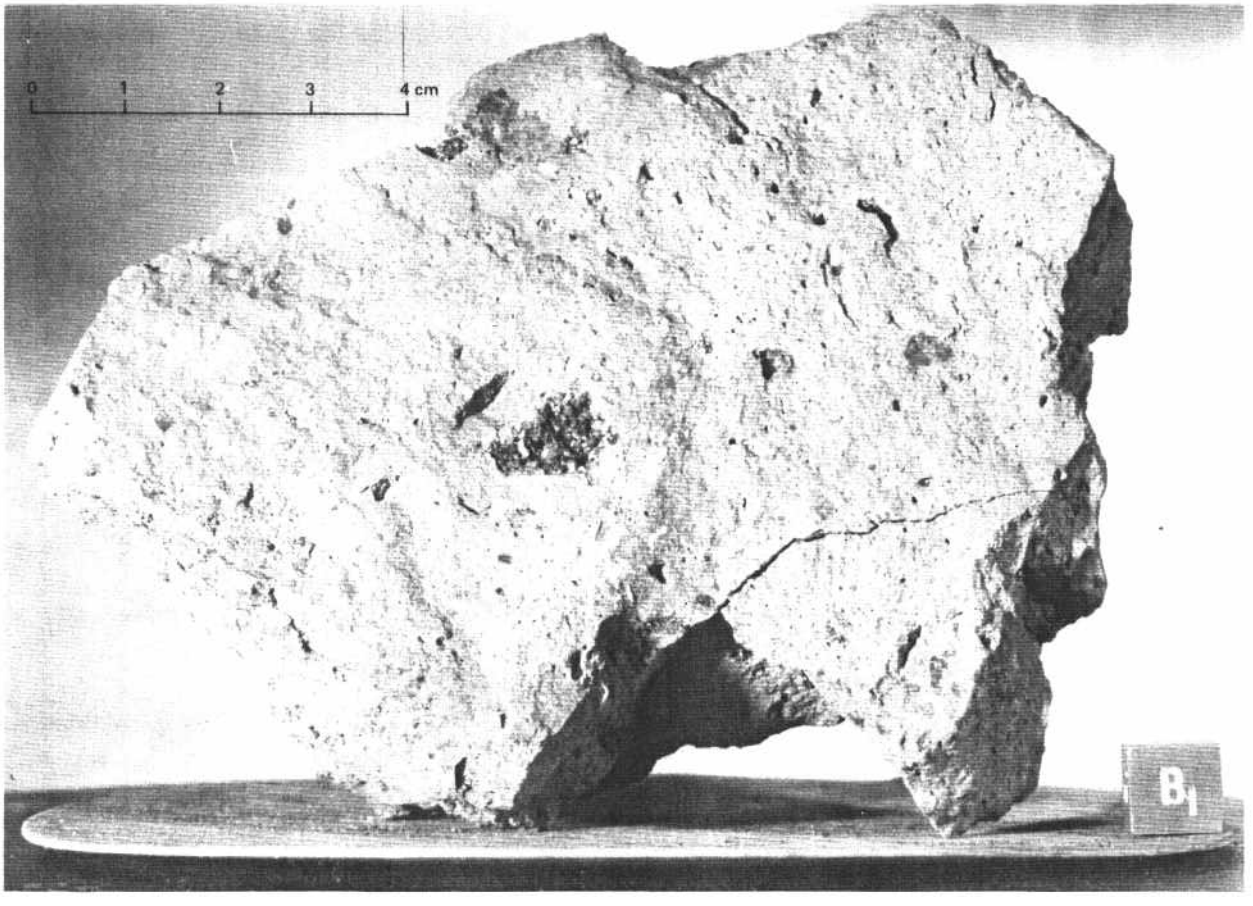

FIGURE 87. - Sample 72395. Polymict breccia with aphanitic matrix. (NASA photograph S-73-16052.)

Major element composition:

Chemical analyses of 72415 and 72417

	1	2
SiO_2	39.93	--
Al_2O_3	1.53	1.3
FeO	11.34	11.9
MgO	43.61	45.4
CaO	1.14	1.1
Na_2O	<.02	.013
K_2O	.00	.0024
TiO_2	.03	--
P_2O_5	.04	--
MnO	.13	.113
Cr_2O_3	.34	.34
Total	98.11	

1. 72415, 2 (Apollo 17 PET, 1973).
2. 72417 (Laul and Schmitt, 1975b).

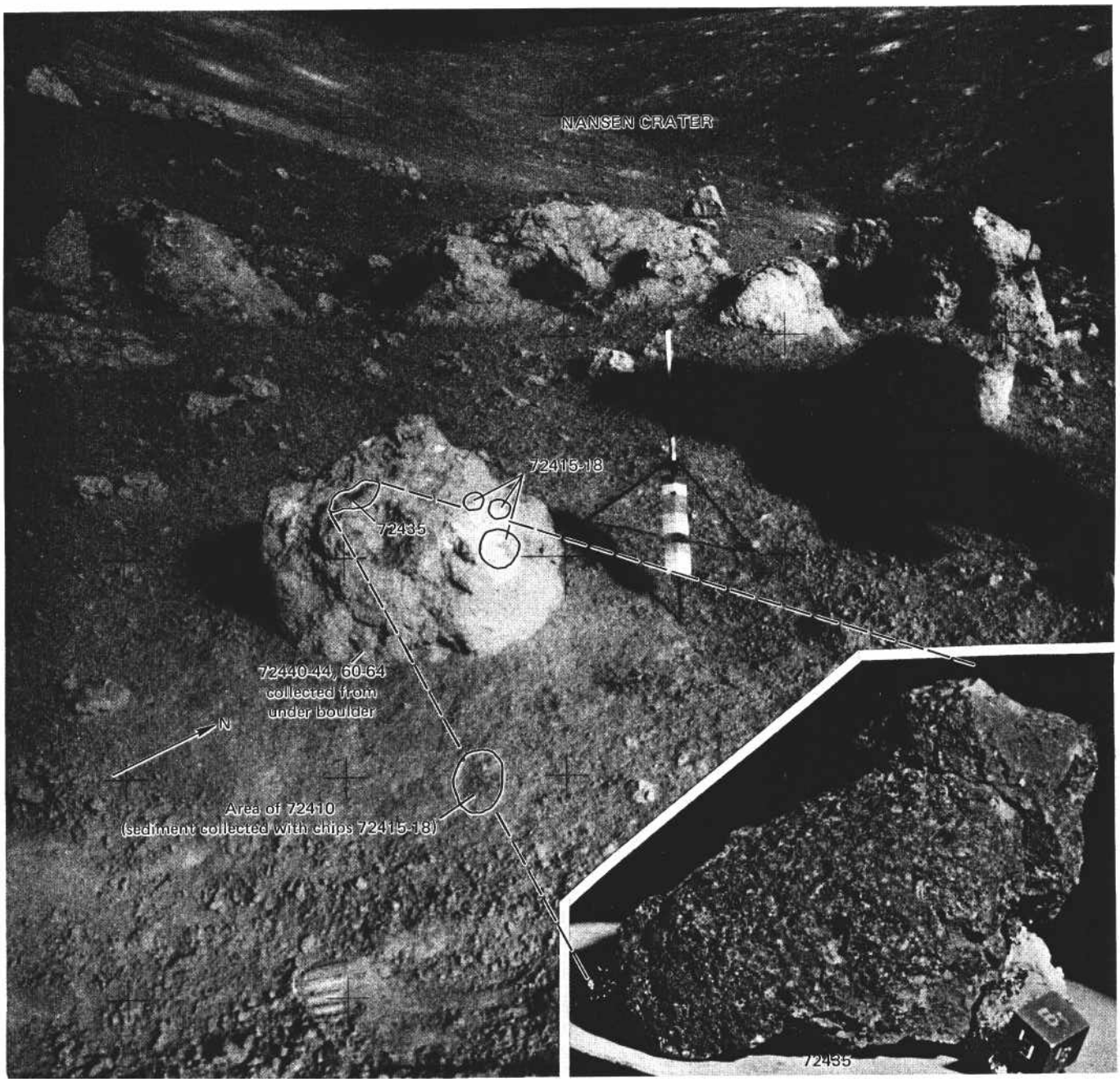

FIGURE 88.-Boulder 3 at station 2 showing locations of samples 72410, 72415-18, 72435, 72440-44, and 72460-64 before collection. Inset shows 72435 with reconstructed lunar surface orientation and lighting. (NASA photographs AS 17-138-21049; S-73-19389.)

Age:

Rb-Sr isochron: 72417, 4.55+/-0.10 (2 *o*) b.y. (Papanastassiou and Wasserburg, 1975).

$^{40-39}$Ar: 72417, ~3.95±0.01 b.y. $^{40-39}$Ar release pattern is complicated but indicates argon loss at about 3.95±0.01 b.y. (Dymek and others, 1975).

Sample 72430-34

Type: Sedimentary, unconsolidated.
Weight: 80.87 g.
Depth: Unknown-scooped up with sample 72435.
Location: In area of boulder 3.
Illustrations: Pans 14, 15, figures 73, 88.
Comments: Sediment derived from South Massif by mass wasting.
Petrographic description: 72430-34, dominantly breccia.

Sample 72435

Type: Polymict breccia with a poorly developed poikilitic matrix.
Size: 5X4X3 cm, 5X4X3 cm (2 mated pieces).
Weight: 160.6 g.
Location: From matrix of boulder 3.
Illustrations: Pans 14, 15; figures 73, 88, 90 (LRL).
Comments: Source rock (boulder 3) is from high on the slope of South Massif.
Petrographic description: Polymict breccia with a poorly developed poikilitic matrix. Probable local fusion in areas of vesicles; crystallization yielded intergrowths of brown pyroxene and spongy plagioclase that appear as clasts in samples 72355, 72375, 72395. Clasts in the size range 0.1 to 1.0 mm are in the approximate proportions: 53 percent plagioclase, 3 percent pyroxene, 24 percent olivine, 2 percent dark metaclastic rocks with aphanitic matrix, 1 percent light metaclastic rocks with granoblastic matrix, 1 percent troctolite, 13 percent metagabbroid rock, 1 percent recrystallized olivine, 4 percent recrystallized plagioclase.

Dymek and others (1976b) have described 72435 as similar to the samples from boulder 2. It consists of 5-10 percent megaclasts (1 mm-2 cm) set in an extremely fine grained partially clastic matrix that consists of microclasts (<1 mm) in a very fine grained (<50um) groundmass crystallized from a melt. They have identified the larger lithic clasts as anorthosite (predominant), dunite, and troctolite (?).

Major-element composition:

Chemical analyses of 72435

SiO_2	45.76
Al_2O_3	19.23
FeO	8.70
MgO	11.63
CaO	11.72
Na_2O	.52
K_2O	.23
TiO_2	1.54
P_2O_5	.27
MnO	.11
Cr_2O_3	.20
Total	99.91

72435, 1 (Apollo 17 PET, 1973).

Age:

Rb-Sr: <4.10 b.y.; lowest model age determined for any breccia component is 4.10±0.05 b.y. for a single clast; hence 4.10 b.y. is an older limit for breccia formation (Papanastassiou and Wasserburg, 1975).

Rb-Sr isochron: 3.85±0.18 (2*o*) b.y.; defined by five samples from interior of same clast as above; surrounding matrix, not equilibrated with clast, gives older Rb-Sr age (Papanastassiou and Wasserburg, 1975).

Fission track: <4.05 b.y.; tracks measured in plagioclase crystal from decay of Pu, U, and Th in the adjacent matrix suggest 4.05 b.y. is older limit for assembly of the breccia (Goswami and others, 1976a).

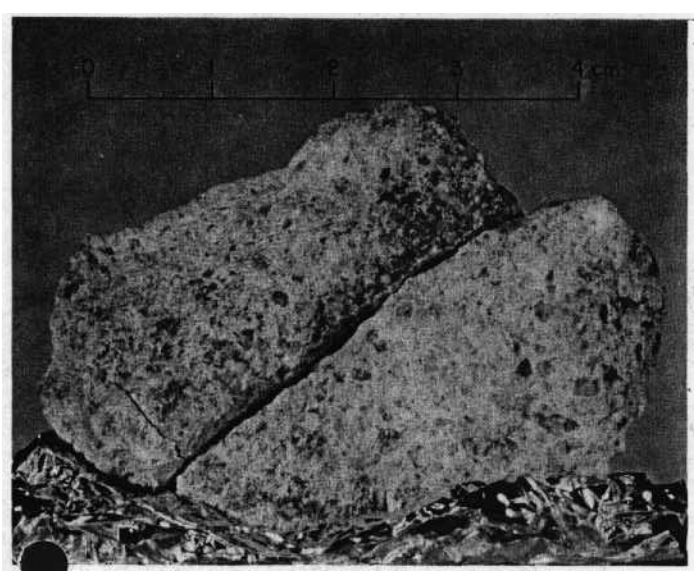

FIGURE 89.-Sample 72415. Metadunite cataclasite. (NASA photograph S-73-16199.)

Sample 72440-44

Type: Sedimentary, unconsolidated.
Weight: 450.39 g.
Depth: 0-4 cm.
Location: Collected from beneath boulder 3 after boulder was rolled.
Illustrations: Pans 14,15; figures 73, 88.
Comments: Material derived from South Massif by mass wasting.

Petrographic description: 72440-44, dominantly metaclastic rock and breccia, some agglutinate, minor feldspathic plutonic derivatives.

Components of 90-150-um fraction of 72441,7 (Heiken and McKay, 1974)

Components	*Volume Percent*
Agglutinate	41.7
Basalt, equigranular	1.3
Basalt, variolitic	1.3
Breccia:	
Low grade[1] - brown	9.3
Low grade[1] - colorless	6.3
Medium to high grade[2]	19.3
Anorthosite	1.0
Cataclastic anrthosite[3]	1.3
Norite	.7
Gabbro	--
Plagioclase	6.7
Clinopyroxene	3.0
Orthopyroxene	3.3
Olivine	.7
Ilmenite	.3
Glass:	
Orange	.3
"Black"	.3
Colorless	1.3
Brown	1.0
Gray, "ropy"	.3
Other	--
Total number of grains	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major-element composition:

Chemical analyses of 72441

	1	2	3	4
SiO_2	44.84	45.03	45.17	45.01
Al_2O_3	21.06	20.51	20.25	20.61
FeO	8.54	8.85	8.68	8.69
MgO	9.99	9.89	10.78	10.22
CaO	12.59	12.83	12.75	12.72
Na_2O	.34	.46	.40	.40
K_2O	.27	.17	.16	.20
TiO_2	1.42	1.53	1.53	1.49
P_2O_5	.20	.17	.15	.17
MnO	.18	.13	.11	.14
Cr_2O_3	.28	.22	.28	.26
Total	99.71	99.81	100.26	99.91

1. 72441 (Mason and others, 1974).
2. 72441, 3 (Rhodes and others, 1974).
3. 72441, 9 (Rose and others, 1974).
4. Average of 1 - 3.

Sample 72460-64

Type: Sedimentary, unconsolidated.
Weight: 125.01 g.
Depth: 0-1 cm (skim sample).
Location: Collected from beneath boulder 3 after boulder was rolled.
Illustrations: Pans 14, 15; figures 73, 88.
Comments: Material derived from South Massif by mass wasting.

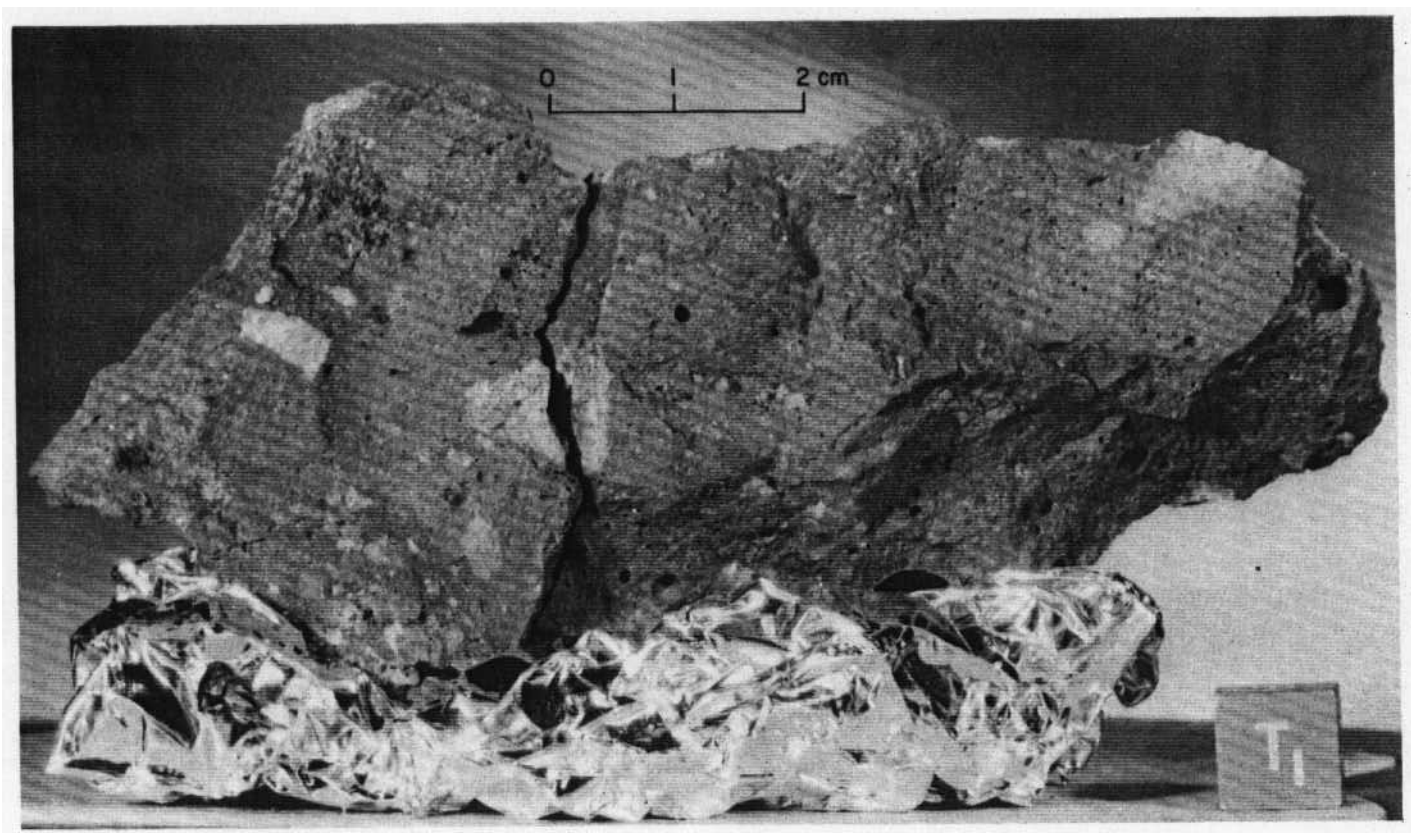

FIGURE 90. - Sample 72435. Polymict breccia with poorly developed poikilitic matrix. (NASA photograph S-73-16187.)

Petrographic description: 72460-64, dominantly metaclastic rock and breccia, some agglutinate, minor feldspathic plutonic derivatives.

Components of 90 – 150 um fraction of 72461, 5 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate	43.0
Basalt, equigranular	2.7
Basalt, variolitic	.3
Breccia:	
Low grade[1] - brown	8.3
Low grade[1] - colorless	5.7
Medium to high grade[2]	15.3
Anorthosite	2.0
Cataclastic anrthosite[3]	1.3
Norite	.3
Gabbro	--
Plagioclase	11.0
Clinopyroxene	3.0
Orthopyroxene	3.0
Olivine	.3
Ilmenite	.6
Glass:	
Orange	.7
"Black"	1.0
Colorless	1.0
Brown	1.3
Gray, "ropy"	--
Other	--
Total number of grains	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).

Major-element composition:

Chemical analyses of 72461

	1	2	3
SiO_2	44.98	44.79	44.88
Al_2O_3	20.87	20.63	20.75
FeO	8.58	8.61	8.60
MgO	9.69	10.52	10.10
CaO	12.97	12.87	12.92
Na_2O	.47	.43	.45
K_2O	.17	.17	.17
TiO_2	1.50	1.56	1.53
P_2O_5	.16	.16	.16
MnO	.12	.11	.12
Cr_2O_3	.12	.28	.24
Total	99.72	100.13	99.92

1. 72461, 3 (Rhodes and others, 1974).
2. 72461, 7 (Rose and others, 1974).
3. Average of 1 and 2.

Sample 72500-05

Type: Sedimentary, unconsolidated (72500-04) with breccia fragment (72505).

Weight: 72500-04, 1,057.73 g; 72505, 3.09 g.

Size: 72505,1.7X1.5X1 cm.

Depth: 0-4 cm.

Location: From lower slopes of South Massif approximately 45 m southwest of LRV.

Illustrations: Pans 14,15; figures 73, 91.

Comments: Material derived from South Massif by mass wasting; sediment sample to complement rake sample 72535-59.

Petrographic description: 72500-04, dominantly metaclastic rock and breccia, some agglutinate, minor basalt, and feldspathic plutonic derivatives.

Components of 90 – 150 um fraction of 72501, 1 (Heiken and McKay, 1974)

Components	Volume Percent
Agglutinate	48.0
Basalt, equigranular	3.3
Basalt, variolitic	--
Breccia:	
Low grade[1] - brown	8.3
Low grade[1] - colorless	8.7
Medium to high grade[2]	12.6
Anorthosite	.7
Cataclastic anrthosite[3]	1.7
Norite	.3
Gabbro	--
Plagioclase	6.3
Clinopyroxene	3.3
Orthopyroxene	2.0
Olivine	.7
Ilmenite	.3
Glass:	
Orange	1.0
"Black"	1.0
Colorless	.7
Brown	.7
Gray, "ropy"	--
Other	.3
Total number of grains	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3.. Includes crushed or shocked feldspar grains.

Major-element composition:

Chemical analyses of 72501

	1	2	3	4
SiO_2	45.12	45.17	45.52	45.27
Al_2O_3	20.64	20.63	20.52	20.60
FeO	8.77	8.74	8.98	8.83
MgO	10.08	9.87	9.90	9.95
CaO	12.86	12.84	12.69	12.80
Na_2O	.40	.46	.50	.45
K_2O	.16	.17	.17	.17
TiO_2	1.56	1.55	1.62	1.58
P_2O_5	.13	.15	.14	.14
MnO	.11	.13	.12	.12
Cr_2O_3	.23	.23	.17	.21
Total	100.06	99.94	100.33	100.12

1. 72501, 2 (Rhodes and others, 1974).
2. 72501, 22 (Rhodes and others, 1974).
3. 72501, 36 (Scoon, 1974).
4. Average of 1 - 3.

Age:

40-39Ar:

72503, 8, 12, 3.96±0.02 b.y. (Schaeffer and Husain, 1974); fragment from 2-4-mm fraction: recrystallized melt rock with plagioclase; olivine and lithic fragments in groundmass of plagioclase, poikilitic pigeonite, and opaque minerals (Bence and others, 1974).

72503, 8, 5, 3.974±0.011 b.y. (Schaeffer and others, 1976); fragment from 2-4-mm fraction; described as coarse-grained recrystallized noritic breccia with a troctolite clast.

72503,8 6, 3.982±0.006 b.y. (Schaeffer and others, 1976); fragment from 2-4-mm fraction, described as fine-grained recrystallized noritic breccia.

Sample 72535-39, 45-49, 55-59

Type: Fifteen breccia fragments from rake sample.
Size: Largest, 72535, is 7.6x6.8X5.9 cm; others are much smaller.
Weight: 417.901 g total (largest is 72535, 221.4 g).
Depth: 0-1 cm.
Location: From lower slopes of South Massif approximately 45m southwest of LRV.
Illustrations: Pans 14,15; figures 73, 91.
Comments: 72535-39, 45-48 are blue-gray breccia. 72549, 55-58 are green-gray breccia. 72559 is light-gray breccia.
Petrographic descriptions:

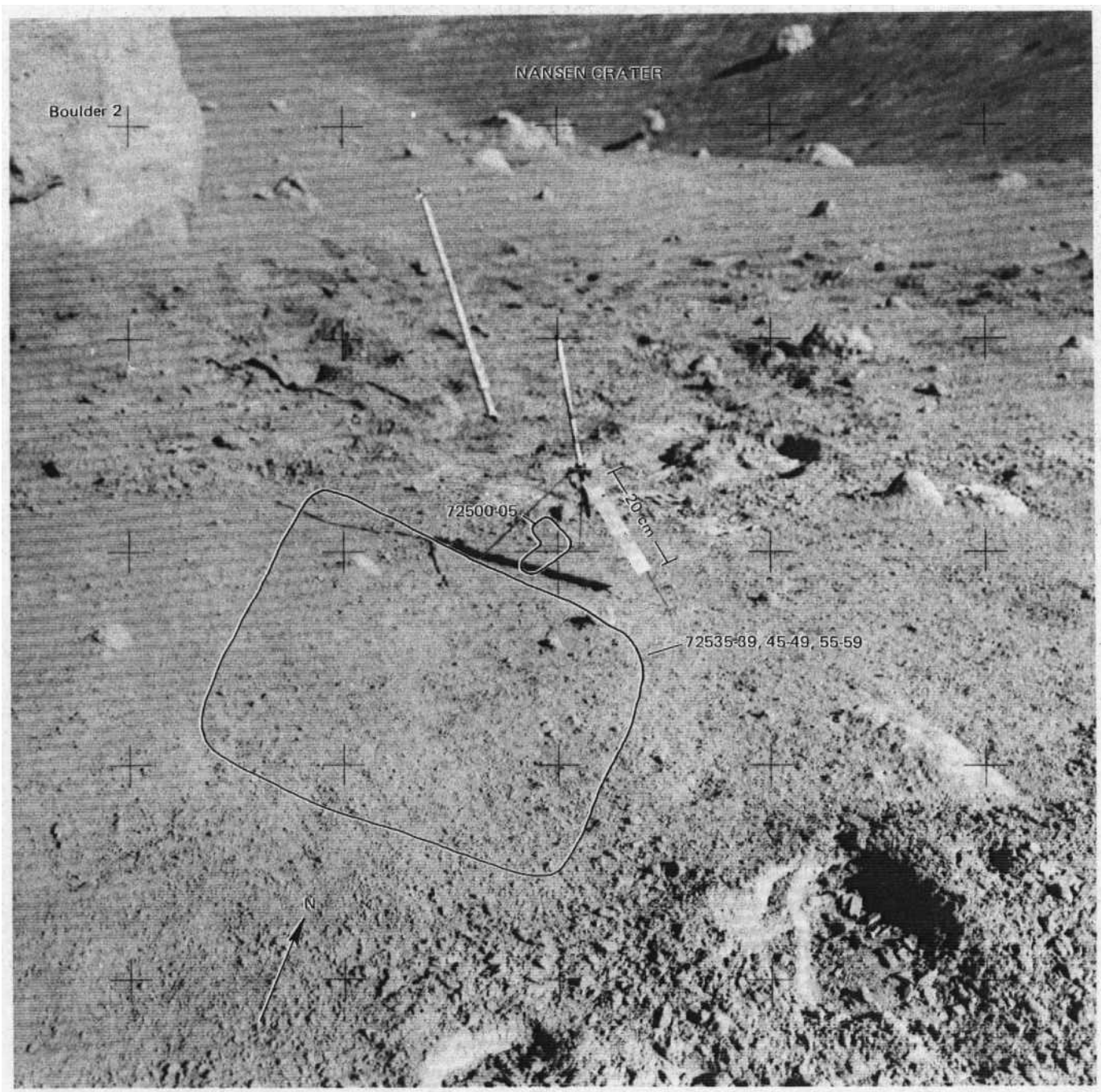

FIGURE 91.-First rake area at station 2 showing areas from which samples 72500-05 and 72535-59 were collected, before sampling.
(NASA photograph AS17-138-21045.)

72535, polymict breccia with an aphanitic matrix. Possible local fusion in areas of spherical vesicles. Cavity-rich zones contain angular clasts similar to the dominant rock type of the whole rock. Light metaclastic fragments with granoblastic(?) texture and mineral debris.

72536-39, same as 72535.

72547, like 72535, but cavities are lined or filled with intergrowths of brown pyroxene and spongy plagioclase.

72548, polymict(?) breccia with an aphanitic matrix. Skin of metagabbroid or gahbroid cataclasite on one side.

72549, metaclastic rock with a fine-grained poikilitic(?) 1 matrix. Mineral debris, no lithic clasts.

72555, metaclastic rock with a fine-grained poikilitic(?) 1 matrix. Mineral debris. no lithic clasts.

72558, metaclastic rock with a fine-grained poikilitic(?) matrix. No lithic clasts. Vugs lined by intergrowths of brown pyroxene and plagioclase. Mineral porphyroclasts

72559, metaclastic rock with an aphanitic matrix. No lithic clasts, scarce mineral clasts.

Major element composition.:

Chemical analyses of 72535

SiO_2	--
Al_2O_3	17.8
FeO	8.4
MgO	11.0
CaO	11.2
Na_2O	.58
K_2O	.13
TiO_2	1.4
P_2O_5	--
MnO	.099
Cr_2O_3	.190

72535, rake fragment, blue gray breccia (Laul and Schmitt, 1975a).

Exposure age: Kr-Kr: 107±4 m.y. (Arvidson and others, 1976b).

Sample 72700-05

Type: Sedimentary. unconsolidated (72700-041 and breccia fragment (721(1.51.

Size: 7270.5, 1.3x1 x1 cm.

Weight: 72700-114. 883.01 g; 72705, 2.39 g.

Depth: 0-5 cm.

Location: On southeast rim of Nansen crater approximately 42 m northeast of LRV.

Illustrations: Pans 14, 15: figure 92.

Comments: Collected from surface of light mantle adjacent to South Massif. Sediment sample to complement rake simple 72735-38.

Petrographic description: 72700-04, dominantly metaclastic rock and breccia, some agglutinate, minor feldspathic plutonic derivatives.

Components of 90-1.50 am (r *action of 72701,1 (Heiken and McKay, 1974)*

Components	*Volume Percent*
Agglutinate	43.6
Basalt, equigranular	1.7
Basalt, variolitic	--
Breccia:	
Low grade[1] - brown	12.6
Low grade[1] - colorless	9.7
Medium to high grade[2]	11.7
Anorthosite	1.3
Cataclastic anrthosite[3]	1.0
Norite	.3
Gabbro	--
Plagioclase	7.7
Clinopyroxene	3.0
Orthopyroxene	.7
Olivine	1.7
Ilmenite	--
Glass:	
Orange	1.0
"Black"	1.7
Colorless	.7
Brown	1.3
Gray, "ropy"	--
Other	--
Total number of grains	300

1. Metamorphic groups 1-3 of Warner (1972).
2. Metamorphic groups 4-8 of Warner (1972).
3. Includes crushed or shocked feldspar grains.

Major-element composition:

Chemical analyses of 72707

	1	2	3	4	5	6
SiO_2	44.87	45.24	45.45	45.45	45.8	45.3
Al2O3	20.60	20.70	20.55	20.70	21.0	20.7
FeO	8.65	8.78	8.94	8.99	8.6	8.8
MgO	9.97	9.99	9.98	9.86	9.98	9.96
CaO	12.80	12.74	12.83	12.69	12.3	12.7
Na_2O	.40	.44	.51	.49	.435	.46
K_2O	.16	.154	.17	.17	.132	.16
TiO_2	1.52	1.50	1.53	1.59	1.55	1.54
P^2O^5	.15	.153	.14	.14	--	.15
MnO	.12	.116	.13	.12	.110	.12
Cr_2O_3	.23	.229	.23	.18	.200	.21
Total	99.47	100.042	99.97	100.38	100.127	100.10

1. 72707, 2 (Rhodes and others, 1974).
2. 72707,12 (Duncan and others, 1974).
3. 72707, 21 (Rhodes and others, 1974).
4. 72707, 23 (Scoon, 1974).
5. 72707, 37 (Wanke and others, 1973).
6. Average of 1 through 5.

Sample 72735-38

Type: Four breccia fragments from rake sample.

Size: 72735, 5X3.5X2 cm: 72736, 5.5X2.5x2 cm; 72737, 1.5x1.1 x1.1 cm; 72738, 4x2.5X2.5 cm.

Weight: 72735, 51.11 g; 72736, 28.73 g; 72737, 3.33 g 72738, 23.75 g

Depth: 0-2 cm.

Location: Southeast rim of Nansen crater approximately 42 m northeast of LRV.

Illustrations: Pans 14, 15; figure 92.

Comments: Fragments were derived from the South