Sample History

Drill stem 70007 is the third section from the top of the Apollo 17 drill string and contains approximately 30.5 cm. of core. The top of this section of core is from 62.7 cm. below the lunar surface.

This core was only partly filled. A void of about 10 cm. at the top allowed slumping to disturb natural stratification down another 8 cm. according to the X-radiograph interpretation. The exact cause of the void cannot be determined, but it is thought to be related to a partly uncoupled joint between 70007 and 70008. The lower 2 cm. of 70008 was also void. The poor sorting and coarseness of 70008 may have provided plug resistance during extraction on the moon, while the finer soil of 70007 allowed movement.

Before the drill stem was opened by milling, the soil was confined by inserting a hollow teflon plug and aluminum foil stay at the upper end. For this operation, the drill stem was oriented vertically. The plug was pushed in until moderate resistance was felt at 9.5 cm. below the tube opening.

The lower end of the tube was capped by a hollow teflon flight cap. It was necessary to replace this cap by an internal-fitting teflon tube plug. Although the soil in the flight cap was loosely packed, the solid tube plug penetrated the tube only about 5 or 6 mm. of the required 26 mm. The 20 mm. or so of soil obstructing the proper placement of the plug was pushed into the tube by screw compression during mounting of the drill stem in the milling machine. It was felt that the soil was very loosely packed by the upper plug emplacement, and that more compaction was desirable for the rigors of milling. The soil in the lower end was also loosely packed due to the 26 mm. void created when the male end of 70006 was uncoupled from the lower end of 70007. The flight cap, being hollow, did not fill this void.

On August 1, 1975, drill stem 70007 was longitudinally split on a milling machine. After being affixed in a troughed dissection table, the upper half of the tube was lifted off and set aside. Soil remained in the upper split half along the lower 4 cm. and tapering up another 2.5 cm. This soil was tightly compacted by insertion of a tube plug. Reference scales were mounted so that the lower plug/soil interface was aligned with the 40 cm. mark and that the upper end of the tube was aligned with the zero cm. mark. The upper plug/soil interface then became established at 9.5 cm.

Dissection and Handling

Dissection of 70007 took place between 23 July and 6 October, 1975, according to the standard drill stem procedures outlined in Chapter 1, and data were analyzed as described on pp. 17-15 through 17-18. Location of all dissection splits is documented in Fig. 17-8. The uppermost dissection interval (9.5-10.5 cm.) was taken at twice standard width because soil from the affected area became mixed during extraction of a large metal shaving. Red light and lead-free samples were taken from 33.0-34.5 and 19.0-20.5 cm. after
<table>
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the outer millimeter of soil had been removed. Unusual or large particles were set aside as separate samples; their occurrence is detailed in Fig.17-8, column 3.

Designation and Description of Stratigraphic Units

Distinctive aspects of the seven stratigraphic units recognized in 70007 are summarized in the Fig. 17-9; additional details are listed below. Grain size changes form the basis of nearly all the units, because the compositional variation is small. Units 2 (35.0-38.0 cm.), V (21.5-27.5 cm) and VI (15.5-21.5 cm) below the top of the drill stem are relatively coarse-grained; units III and IV (30.0-35.0 cm and 27.5-30.0 cm. respectively) are fine-grained, and units I (30.0-40.0 and VII (9.5-15.5 cm) are moderately coarse. A textural change, at 2.5 cm., is marked by a transverse fracture, and separates soils of differing cohesiveness. Between 9.5 and 21.5 cm., the surface is a nearly unfissured, continuous rind with pockets of relatively coarse, shiny particles. The overall appearance is speckled. At 21.5 cm., a transverse crack is the overlap formed by reconfinement.

Only minor compositional changes could be seen in the exposed coarse particles, none of which were larger than 2 mm in mean diameter. The matrix material is in the silt size range with a mean grain diameter estimated to be 5.5 phi units of about .02 mm.

Detailed textural changes found during dissection were also recognized in the X-radiographs, although units were designated differently. X-ray units in 70007 include at least part of units 55-59. Top of unit 55 corresponds to the large rock fragments in unit II of dissection, and dissection units III and IV correspond fairly closely to X-ray units 56 and 57. Units V - VII are included in X-ray units 58 and 59, with base of unit V corresponding to the base of rock fragment 70007,78, which lies in the middle of dissection unit V. X-ray unit 59 is extremely coarse-grained throughout; compositional changes found during dissection enabled subdivision of the lower part of unit 59 into units V, VI, and VII.

Brief Description of Dissection Units

Unit I (38.0 - 40.0 cm below top of the core) is mostly fine-grained (approximately 91% matrix) but it is moderately poorly sorted, containing some 2-4mm rock fragments. Low to medium-grade breccias - soil breccia and recrystallized melt breccia - are the major coarse components, with anorthositic rock fragments and basalts present only in small quantities. Glass is most abundant at the top of the unit, where there are coincident peaks in vesicular and partially crystallized glass. The lowest 0.5 cm. contains an unusually low concentration of coarse fragments; vibration during the lunar return flight may have caused particles to migrate from this zone.

Unit II (35.0-38.0 cm) is bimodally coarse-grained with a consistently high frequency of particles coarser than 4 mm, a relative scarcity of particles in the 1-4mm range, especially at the bottom of the unit, and an abundance (75%) of matrix, finer than 1 mm. Basalt and soil breccia are most abundant
### STRATIGRAPHIC SUMMARY, DRILL STEM 70007

**Apparent distance below Lunar Surface (cm):**

<table>
<thead>
<tr>
<th>Sample Interval</th>
<th>UNIT (Numeral)</th>
<th>Thickness Samples in unit</th>
<th>Characteristics</th>
<th>Sub-units</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.1</td>
<td>70007, VII</td>
<td>6.0 cm. thick -128 -132</td>
<td>Moderately crumbly, apparently mixed and slumped, gravelly silt soil, 85% finer than 1 mm, with a mixture of rock types. Shows as partially void in X-ray.</td>
<td>Not subdivided</td>
</tr>
<tr>
<td>69.1</td>
<td>70007, VI</td>
<td>6.0 cm. thick -96 -127</td>
<td>Moderately crumbly, coarse sandy silt soil, 83% finer than 1 mm, composition generally polymict, with a concentration of vesicular glass at top of unit.</td>
<td>C. Concentration of vesicular glass</td>
</tr>
<tr>
<td>75.1</td>
<td>70007, V</td>
<td>6.0 cm. thick -60 -95</td>
<td>Moderately crumbly gravelly silt soil, texturally immature with abundant very coarse basalt at top of unit, anorthosite breccia and soil breccia at base.</td>
<td>A. Maximum basalt and melt breccia</td>
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<tr>
<td>81.1</td>
<td>70007, IV</td>
<td>2.5 cm. thick -20 -39</td>
<td>Moderately fine sandy silt soil, 87% finer than 1 mm, polymict with both basalt and soil breccia in coarse fraction.</td>
<td>B. Very coarse-grained, maximum basalt</td>
</tr>
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<td>83.6</td>
<td>70007, III</td>
<td>5.0 cm. thick -32 -49</td>
<td>Cohesive, fine sandy silt soil, 94% finer than 1 mm, polymict with a mixture of fragment types.</td>
<td>A. Fine grained, maximum breccia</td>
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<tr>
<td>88.6</td>
<td>70007, II</td>
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<td>Moderately cohesive silt and gravelly sand soil, with 75% finer than 1 mm; very abundant basalt in coarse fraction.</td>
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<td>2.0 cm. thick -14 -30</td>
<td>Cohesive silt soil, with 95% finer than 1 mm, breccia fragments are prominent in coarse fraction, may be disturbed due to sampling.</td>
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in the coarse fraction throughout the unit, but there are other components in varying amounts. Vesicular glass decreases downward from the top of the unit, and anorthosite breccia increases downward. Medium grade recrystallized breccia is relatively uncommon, and is represented by large particles only.

Unit III (30.0-35.0 cm) is the finest-grained unit in the core, containing 94% matrix, and constant, low amounts of particles coarser than 2 mm. Although sorting is fair to good, there is a great fluctuation in abundance of 1-2 mm particles, which become moderately common in some intervals. Soil breccia and vesicular glass are the only coarser fragments present, with soil breccias most abundant at the base and vesicular glass most abundant at the top of the units.

Unit IV (27.5-30.0 cm) is fine-grained, but slightly coarser (87% matrix) than unit III, and is weakly bimodal, with a maximum of coarse particles near the middle of the units. Mineralogy of the coarse fraction differs notably from unit III; basalt rock fragments are most abundant, with medium grade anorthosite breccia, partially crystallized glass and recrystallized breccia present, but in lesser quantities toward the bottom. Soil breccia and vesicular glass fragments are common only at the top of the unit.

Unit V (21.5-27.5 cm) is coarse-grained and distinctly bimodal with a high abundance of material coarser than 4 mm, low to moderate abundances of 1-4 mm ranges, and 72% matrix. A mixture of rock types is found in this unit, with peaks in soil breccia, anorthosite breccia, recrystallized breccia, partially crystallized glass, and basalt rock fragments at various places through the unit. Vesicular glass is less common than in surrounding units, but there is an occurrence of orange glass at the top of Unit V.

Unit VI (15.5-21.5 cm) A transverse fracture and textural change marks the base of unit VI (15.5-21.5 cm). Unit VI is finer than Unit V, with 83% matrix, and is unimodal with respect to the coarse fraction, as the 1-2 mm fraction is relatively abundant, the coarser than 2 mm fraction variable, but notably less common than in Unit V. Most rock types, including basalt rock fragments, soil breccia, anorthosite breccia occur in moderate abundance throughout the unit, but there is a significant amount of recrystallized melt breccia at the very bottom of the unit, and a sharp and strong maximum in vesicular glass at the top of the unit.

Unit VII (9.5-15.5 cm) is 85% matrix, and is moderately coarse-grained with a variable mix of size frequencies. The X-radiograph showed this unit to be extensively slumped, and the variability in size frequencies may be attributed to disturbance and re-compaction during preparation. A large agglutinate occurs at the bottom of the unit; otherwise the soil contains a mixture of basalt, medium grade partially crystalline glass, anorthosite breccia, and low grade soil breccia fragments, but vesicular glass fragments are not common.
### LIST OF PHOTOS

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</table>
Although the section at the top of 70007 is slumped and there appears to be partial void, the coarse grain size and occurrence of mixed rock types dominated by low grade breccias resembles the bottom of 70008, and gives evidence for stratigraphic continuity between the two cores. Because the total void in the upper three sections of the Apollo 17 drill string is approximately equal to the amount of drill string exposed on the surface after drilling, it appears that the section is continuous and not slumped, with no material missing from the section at the top of 70007. The void apparently was formed by the movement of a coherent slug of material upward in 70008 and 70009.

A minimum of three phases of accumulation are represented in 70007. The coarse, polymict material at the base of the core differs from soil in overlying units, and represents a separate event. More studies of composition and history are needed to determine if the fine-grained interval represented in units II and III; is garnered from the top of Unit I, or represents a separate event (s). The coarse material in the upper half of the core appears to be continuous with the thick deposit in 70009 and 70008.

**DRILL STEM 70004**

Section 70004 is the sixth section below the top of the Apollo 17 drill string, and contains 39.2 cm. of soil column. After extraction of the drill string from the hole, the string was separated on the lunar surface into three segments. Drill stem 70004 was the top stem of the deepest segment, and its upper end was covered by flight cap F. A negligible amount of soil was reported to have been lost in separation. The opening of the upper end to the tube, in January, 1973, revealed that the core was essentially completely filled (photo S-73-15047), confirming the lunar surface observation that little soil was lost in uncoupling and handling. P.E.T. and cold storage samples totalling nearly 7 gm. were extracted from the top of the core, and the remaining soil was confined with a hollow teflon plug. Based on a length of 39.9 cm. and a weight of 238.8 gm., seven grams is equivalent to about twelve millimeters of soil column extracted for P.E.T. studies. X-radiographs were prepared according to standard procedure and described in P.E.T. The drill stem was longitudinally split on the LCL drill stem milling machine, on 8 October, 1975. The sample was transferred to the dissection cabinet on 11 October 1975, and dissection was completed by 30 April 1976. Peeling and impregnation was completed by 18 May 1976, all activities being accomplished according to standard procedures described in the beginning of this catalogue.

In preparation for milling, the hollow tube plug at the upper end of the stem was pushed further into the tube, resulting in a small amount of compaction. After the core was affixed in the dissection table, the upper half of the split tube was lifted off and set aside. Reference scales were mounted so that the upper end of the stem was aligned with the zero cm. mark, and the lower soil/plug interface with the 40 cm. mark. The upper soil/plug interface then became established at the 2 cm. mark. From these figures it can be calculated that compaction by mechanical compression amounted to a maximum of seven millimeters.
PREDISSECTION DESCRIPTION

From X-radiographs of drill stem 70004, ten units were interpreted on the basis of size distributions and inferred compositions. (Fig.17-2) Examination of the exposed surface of the core brought out no color or tonal differences. Consequently, no layering could be identified based on that parameter. The overall color was between 10YR 3/1 and 5Y 3/1 on Munsell's color chart. Variations in the gross surface texture (development of a rind of compacted soil) give some indication of changes in physical properties of the underlying soil. Unfortunately, many other factors may affect the preservation of this rind and confuse interpretation. After dissection, it was clear that the smeared rind was very thin along the fine-grained portions of the core and did not fracture at unit boundaries as well as it did in the coarser sections.

SAMPLING

Except for P.E.T. samples, the core was dissected in standard 0.5 cm. increments, as explained in chapter 1. Redlight and lead-free samples were taken at 4.5-6 cm. and 33-34.5 cm., and redlight samples accompanied by lead-free samples at 12-12.5 and 25-25.5 cm. Many large rock fragments were extracted and documented separately: their occurrence is listed in Fig. 17-9.

STRATIGRAPHIC SUMMARY

Soil in drill stem 70004 was found to be much coarser-grained than reported in descriptions of the X-radiographs, but most of the coarse fraction occurs as soil breccia, which shows up poorly or not at all in X-radiography. The most important factor by which 70004 differs from previously dissected cores which lie higher in the drill string is the general scarcity of all rocks but soil breccia. Crystalline basalts and medium to high grade breccias of the higher sections are almost totally lacking in the coarse fraction of 70004.

Drill stem 70004 contains three textural sequences, each of which is further subdivided into units on minor textural or compositional grounds,(Fig.17-10). The upper sequence is fine to moderately fine with a varied lithology among the coarse fragments. It ranges from the top of the stem to a depth of 7.5 cm. and is subdivided into units VIII and IX. It may extend into 70005, the drill stem above in the drill string. The middle sequence is thick (26.5cm), very coarse, and almost all fragments are SOBX. Many large particles are freshly fractured, suggesting drilling action breakage. Units III,IV,V,VI, and VII are included in this larger unit. The lower sequence is similar to the upper sequence except that the content of ANBX is noticeably greater and the glass content lesser. Its six centimeters of thickness is subdivided into units I and II. Stem 70003, the one below in the drill string, may contain a continuation of this sequence. The rock fragments in drill stem 70004 are predominantly SOBX with small amounts of VSGL, ANBX, and traces of PXGL, RXBX, and BSRF.

Unit I (38.0-40.0) is unimodal, fine-grained, fairly well sorted, with 93% matrix finer than 1mm, a moderate amount of 1-2 mm fragments and a few
fragments coarser than 2mm. Lithology is varied, yet dominated by SOBX. More BSRF occurs in this than in other units. Vesicular glass (VSGL) is notable only at the top of the unit.

Unit II is relatively fine-grained, and is unimodal, with few particles coarser than 4mm, but moderate abundances of 1-2 and 2-4mm fines and 83% matrix. The increase in 2-4mm particles corresponds to an increased dominance of SOBX. The upper part of the unit is relatively rich in ANBX in association with BSRF.

Units I and II together form a larger unit which may extend into drill stem 70003.

Unit III (31.0-34.0) is coarse-grained silt soil, with a considerable soil breccia fragments greater than 4mm; there is only 62% matrix, and fair amounts of 1-2 and 2-4mm material. Nearly all fragments are soil breccia.

Unit IV (24.5-31.0 cm) is slightly finer than unit III because the abundance of coarse fragments decreases by 50%. There is a rise in the 2-4mm frequencies and 1-2mm frequencies, but there is some variability, attributed to sampling size bias due to the very large particles. Soil breccia is extremely abundant, and ANBX and some other types are present in very small quantities.

Unit V (8.0-24.0) is very coarse-grained, with a large number of soil breccia fragments greater than 4mm in size which appear to be pieces of a rock or rocks larger than the drill stem diameter. Frequencies in the other coarse size ranges are also high and matrix is only 46%. SOBX makes up over 99% of the coarser fraction.

Unit VI (10.0-18.0) is 55% matrix. Frequencies of the greater than 4mm size range decrease slightly on the average. The average frequencies in the 1-2mm and 2-4mm size ranges remain high. The variability is high, again due to sampling size bias. The coarseness, on the other hand, is fairly constant. Aside from the overwhelming abundance of SOBX, small amounts of PXGL are found, especially near the top of the unit. RXBX also occurs with some regularity, primarily in the bottom half. The upper centimeter contains many medium grade SOBX fragments in the smaller size ranges. Medium grade SOBX is a more coherent type of SOBX, darker in matrix, apparently due to a higher glass content, with inclusions of chalky white anorthositic clasts and an occasional bleb of orange soil. The upper contact is marked by a distinct tonal shift to lighter material in Unit VII, as seen after peeling. The medium grade SOBX fragments transcend this boundary and continue in higher units. The main concentration is at this boundary, however.

Unit VII (7.5-10.0) is 75% matrix. Size range frequencies increase downwards in stages. At 8.0 cm, the 1-2mm's show a sharp increase, the 2-4's at 8.5 cm. While the greater than 4mm's do not show a sharp increase, they are concentrated towards the bottom of the unit. The bottom centimeter contains a large number of medium grade SOBX fragments in the smaller size ranges, along with the low grade counterpart. The top of this unit is marked by a relatively vague tonal shift and somewhat large amounts of VSGL.
<table>
<thead>
<tr>
<th>Unit thickness Samples</th>
<th>Apparent distance below lunar surface (cm)</th>
<th>Sample Interval (LCL Inventory)</th>
<th>Sample Vial No.</th>
<th>Sample Vial No.</th>
<th>Sample Vial No.</th>
<th>Sample Vial No.</th>
<th>Sample Interval</th>
<th>Sample Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>70004. IV</td>
<td>3.7 cm thick</td>
<td>.75-.36</td>
<td>176.7</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. V</td>
<td>3.0 cm thick</td>
<td>.37-.46</td>
<td>176.7</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. VI</td>
<td>2.5 cm thick</td>
<td>.47-.64</td>
<td>182.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. VII</td>
<td>2.0 cm thick</td>
<td>.55-.118</td>
<td>190.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. VIII</td>
<td>1.5 cm thick</td>
<td>.119-.154</td>
<td>196.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. IX</td>
<td>1.5 cm thick</td>
<td>.165-.187</td>
<td>203.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. X</td>
<td>1.0 cm thick</td>
<td>.188-.201</td>
<td>206.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. XI</td>
<td>0.75 cm thick</td>
<td>.202-.206</td>
<td>210.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
<tr>
<td>70004. XII</td>
<td>0.5 cm thick</td>
<td>.207-.209</td>
<td>210.2</td>
<td>2.0</td>
<td>.198</td>
<td>.018</td>
<td>.252</td>
<td>1.860</td>
</tr>
</tbody>
</table>

**Interval Samples**

<table>
<thead>
<tr>
<th>Coarse fraction</th>
<th>Special Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Interval</td>
<td>Sample Interval</td>
</tr>
<tr>
<td>Sample Interval (L.L. Inventory)</td>
<td>UNIT (Numeral)</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>70004, IX</td>
<td>3.7 cm thick</td>
</tr>
<tr>
<td>70004, VIII</td>
<td>3.0 cm thick</td>
</tr>
<tr>
<td>70004, VI</td>
<td>8.0 cm thick</td>
</tr>
<tr>
<td>70004, IV</td>
<td>6.5 cm thick</td>
</tr>
<tr>
<td>70004, III</td>
<td>3.0 cm thick</td>
</tr>
<tr>
<td>70004, II</td>
<td>2.0 cm thick</td>
</tr>
</tbody>
</table>
overshadowing even the abundant SOBX. It is believed that this unit represents a mixing or gardening zone.

Units III through VII make up a larger unit characterized by its coarseness and overwhelming abundance of SOBX.

Unit VIII (4.5-7.5) is much finer than underlying units, with the only occurrence of particles greater than 4mm in size in the 6.0-6.5 cm interval. The other sizes are at moderate to low levels and presence of 92% matrix makes this interval moderately sorted. SOBX is the most common constituent at about 70%, but VSGL is plentiful. In association with the VSGL is an occasional AGGL. A few medium grade SOBX's are found. The top of the unit is marked by another vague tonal shift.

Unit IX (0.8-4.5) is 85% matrix. A few large particles at the bottom of the unit increase the overall coarseness. One large SOBX fragment is orange-stained. Large VSGL, RXBX, and BSRF fragments occur throughout this diverse unit. SOBX is common but not dominant.

Units VIII and IX form a larger, generally fine-grained, lithologically diverse unit which may extend into drill stem 70005.
The sample numbered 70001 was generated on 22 December, 1972, when the drill string was disassembled into individual subsamples. After photography of the open end (NASA Photos S-73-15051 and 15052) and description of the material therein, the core was bagged and X-rayed on 22 December, according to standard procedures described in Chapter 2 of this catalog. On 3 January, 1973, splits 3 and 5 were removed for early allocation and time-critical deep freeze storage, and on 16-17 January, the bit was dissected. The following information details the results of the dissection.

Dissection and Sampling Procedure

Soil was excavated in approximately 1/2 cm. intervals; each interval contained approximately 2 gms. of material. The lowest half cm. equivalent, 5.5-4.7 cm. from bottom Fig 17-12 was first extracted for allocation and scientific study. Because of shifting during transport, both ends of the bit were decompacted and less cohesive than the middle of the core, and hence, this sample was removed according to weight rather than thickness of the interval. The next 0.7 cm. from 4.7 - 4.0 cm., a bulk sample of 3.431 gm. was placed in deep freeze storage to preserve temperature-critical properties. Succeeding intervals were dissected in 0.5 cm. increments, with each increment passed through a 125 micron sieve. The finer-than 125 micron fraction was combined to make up the biomedical prime samples. The coarser fraction, remaining in the sieve, was further sized and scrutinized. Fragments larger than 1 mm. were picked out and described, and the fraction between .25 and 1 mm. described under the binocular microscope. Because each size fraction was weighed, it is possible to roughly assess size distribution; this information will be presented under "texture" and "composition."

Physical Properties

Color of all samples from the drill bit was found to be a medium neutral drab, 5 Y 5/1 on the Munsell Chart of colors.

Textural information was gained both from examination of X-radiographs, direct observation of the bulk sample during dissection, and as a result of sieving samples for biomedical allocation. Grain size results are presented in Table 17-5.

Generally, soils from the bit appear to be very sparingly to sparingly rock fragmental siltsoils, evidently unimodal in composition. The upper half cm. and the lowest 2.0 cm. were extremely crumbly and loose, probably because of de-densification through handling. The remainder of the core was compact and moderately resistant to crumbling. When disturbed by the spatula, soils from this interval fractured into 0.5 to 2.0 mm. equant, even-sized, somewhat blocky (rather than prismatic, rounded, or jaggedly crumb-like) fragments and there was nearly 50% single-grain disaggregation. Sorting is moderately poor to poor, and size distribution appears to be unimodal, as opposed to the strong bimodality of the upper coarse interval
**APOLLO 17 DRILL BIT (70001) SAMPLE LOCATION INFORMATION**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Sample No.</th>
<th>Container No.</th>
<th>Sample Wt.</th>
<th>1.0 - 0.125mm FRACTION</th>
<th>Sample No.</th>
<th>Container No.</th>
<th>Sample Wt.</th>
<th>COARSER THAN 1mm FRACTION</th>
<th>Sample No.</th>
<th>Container No.</th>
<th>Sample Wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>35</td>
<td>8-2654</td>
<td>1.580</td>
<td>36</td>
<td>8-2663</td>
<td>0.525</td>
<td>37</td>
<td>8-2665</td>
<td>0.111</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>*3</td>
<td>0.951</td>
<td>33</td>
<td>8-2652</td>
<td>0.307</td>
<td>34</td>
<td>8-2653</td>
<td>0.168</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>*2</td>
<td>1.941</td>
<td>30</td>
<td>8-2643</td>
<td>0.669</td>
<td>31</td>
<td>8-2645</td>
<td>0.331</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>*2</td>
<td>3.030</td>
<td>27</td>
<td>8-2635</td>
<td>1.070</td>
<td>28</td>
<td>8-2638</td>
<td>0.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>*2</td>
<td>1.878</td>
<td>24</td>
<td>8-2617</td>
<td>0.692</td>
<td>25</td>
<td>8-2632</td>
<td>0.134</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>*2</td>
<td>2.068</td>
<td>21</td>
<td>8-2611</td>
<td>0.710</td>
<td>22</td>
<td>8-2613</td>
<td>0.093</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>*2</td>
<td>1.257</td>
<td>18</td>
<td>8-2604</td>
<td>0.432</td>
<td>19</td>
<td>8-2610</td>
<td>0.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>*2</td>
<td>1.006</td>
<td>15</td>
<td>8-2586</td>
<td>0.341</td>
<td>16</td>
<td>8-2600</td>
<td>0.051</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>8-2573</td>
<td></td>
<td>3.431</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Bulk sample, placed in deep freeze)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8-2562</td>
<td></td>
<td>2.662</td>
<td>*1</td>
<td>4</td>
<td>8-2562</td>
<td>0.167</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Attrition: 70001,6 0.497
70001,40 0.148

*1 Weight listed is original weight; approximately 0.950 gms removed from this sample in allocations 70001,7-13, 70001,42.

*2 This sample combined into 70008,38, bioprim sample, total of 12.005 gms.

*3 0.866 gm of fines allocated in bioprim sample, remaining 0.085 gms of fines retained in Container #8-2649 as Sample 70001,39.
of 70007-70009. Rock fragments coarser than 1 mm. comprise slightly less than 5% of the total in the lower part of the bit (Table 17-5) then increase abruptly to slightly less than 10% near the top. Although the .125 to 1 mm. fraction comprises 24 ± 2% of the total, the bulk of all subsamples from the bit are finer than .125 mm. (66 - 72%). Most rock fragments are angular to subangular, and are sparingly distributed through the core; nowhere was there packing of rock fragments.

Two tentative units can be separated texturally at 1.5 cm. from the top of the bit. Rock fragments larger than 1 mm. comprise less than 5% of the lower unit, and abruptly increase to approximately 10% (by weight) in the upper. Similarly, rock fragments appear to be more abundant near the top of the bit, as seen in X-radiograph, although the thick walls of the bit obscure details (Fig. 17-3).

**TABLE 5. GRAIN-SIZE TRENDS, APOLLO 17 DRILL BIT**

<table>
<thead>
<tr>
<th>DEPTH FROM TOP OF BIT</th>
<th>% FINER THAN .125MM</th>
<th>% .125-MM</th>
<th>% COARSER THAN 1MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.5 cm.</td>
<td>71%</td>
<td>24%</td>
<td>5%</td>
</tr>
<tr>
<td>0.5 - 1 cm.</td>
<td>67%</td>
<td>22%</td>
<td>12%</td>
</tr>
<tr>
<td>1 - 1.5 cm.</td>
<td>66%</td>
<td>23%</td>
<td>11%</td>
</tr>
<tr>
<td>1.5 - 2 cm.</td>
<td>71%</td>
<td>25%</td>
<td>3%</td>
</tr>
<tr>
<td>2 - 2.5 cm.</td>
<td>69%</td>
<td>26%</td>
<td>5%</td>
</tr>
<tr>
<td>2.5 - 3 cm.</td>
<td>72%</td>
<td>24%</td>
<td>3%</td>
</tr>
<tr>
<td>3 - 3.5 cm.</td>
<td>69%</td>
<td>24%</td>
<td>8%</td>
</tr>
<tr>
<td>3.5 - 4 cm.</td>
<td>72%</td>
<td>24%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Composition

The crystalline component of the coarser fractions of the drill bit is dominated by basaltic fragments (Table 17-6) with crystalline anorthosite being of very minor importance Fig. 17-13. Basaltic fragments are medium to coarse grained, moderately to strongly crushed and internally pulverized, and most are too small to show vesiculation. Crystalline anorthosite fragments are distinguished from breccias in being only moderately crushed internally, and have a distinctive olivine component. In the .125 to 1 mm. fraction are many individual grains of clear to whitish plagioclase, reddish pyroxene, yellowish olivine, and dark opaques with cleavage faces; all of which are probably derived from basalt rock fragments. Both the basaltic and anorthositic components are probably of relatively local origin, with overall proportions (19% Basalt, 2% Anorthosite) reflecting the local basaltic subfloor source and the relatively distant anorthositic massif source. The subordinate abundance of crystallines (only 21% of the coarse fraction, and an average of approximately 30% of the .125 - 1 mm. fraction) indicates that this lower part of the core was subjected to extensive reworking or derived more from a glassy and brecciated source.

The glassy component is also relatively scarce, taking up approximately 25% of the sample. Dark to black, frothy to vesicular glass is slightly more abundant than the chips and splintery fragments of dark to blackish opaque
**COMPOSITION TRENDS, APOLLO 17 DRILL BIT**

**COARSER THAN 1 MM FRACTION**

**EXPLANATION**

**CRYSTALLINE ROCK FRAGMENTS**
- Basalt
- Plagioclase or anorthosite
- Reddish pyroxenes
- Misc. including olivine, dark fgs. w/cleavage faces

**GLASS FRAGMENTS**
- Frothy to green, amber, dark to black vesicular or orange glass
- Dark to black devitrified glass spheres

**BRECCIA FRAGMENTS**
- Anorthositic breccia, powdery to chalky appearance
- Soil-matrix breccia or lithified soil
### Table XVII - 6

**Compositional Trends, Apollo 17 Drill Bit**

**COARSER THAN 1 MM**

<table>
<thead>
<tr>
<th>Depth:</th>
<th>CRYSTALLINE ROCKS</th>
<th>GLASS FRAGMENTS</th>
<th>BRECCIAS</th>
<th>Total Particles Counted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basalt</td>
<td>Anorthosite</td>
<td>Vesicular</td>
<td>Devitrified</td>
</tr>
<tr>
<td>0-0.5cm</td>
<td>10%</td>
<td>10%</td>
<td>19%</td>
<td>10%</td>
</tr>
<tr>
<td>0.5-1cm</td>
<td>12.5%</td>
<td>---</td>
<td>---</td>
<td>12.5%</td>
</tr>
<tr>
<td>1-1.5cm</td>
<td>25%</td>
<td>---</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>1.502cm</td>
<td>21%</td>
<td>---</td>
<td>5%</td>
<td>11%</td>
</tr>
<tr>
<td>2-2.5cm</td>
<td>20%</td>
<td>---</td>
<td>13%</td>
<td>7%</td>
</tr>
<tr>
<td>2.5-3cm</td>
<td>23%</td>
<td>5%</td>
<td>14%</td>
<td>18%</td>
</tr>
<tr>
<td>3-3.5cm</td>
<td>10%</td>
<td>---</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>3.5-4cm</td>
<td>32%</td>
<td>---</td>
<td>26%</td>
<td>---</td>
</tr>
<tr>
<td>SUM:</td>
<td>19.1%</td>
<td>2.0%</td>
<td>12.2%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

**.125 - 1 MM FRACTION**

<table>
<thead>
<tr>
<th>Depth:</th>
<th>Basalt</th>
<th>Plag.</th>
<th>Pyrox.</th>
<th>Other¹</th>
<th>Vesicular</th>
<th>GLASS₂</th>
<th>Devitr.</th>
<th>Beads</th>
<th>BRECCIAS</th>
<th>Anorthosite</th>
<th>Soil</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.5cm</td>
<td>5%</td>
<td>15%</td>
<td>5%</td>
<td>3%</td>
<td>20%</td>
<td>2%</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>25%</td>
<td>5%</td>
<td>25%</td>
</tr>
<tr>
<td>0.5-1cm</td>
<td>5%</td>
<td>15%</td>
<td>7%</td>
<td>7%</td>
<td>10%</td>
<td>6%</td>
<td>15%</td>
<td>5%</td>
<td>5%</td>
<td>30%</td>
<td>5%</td>
<td>30%</td>
</tr>
<tr>
<td>1-1.5cm</td>
<td>5%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td>7%</td>
<td>6%</td>
<td>10%</td>
<td>7%</td>
<td>5%</td>
<td>40%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>1.5-2cm</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>3%</td>
<td>20%</td>
<td>7%</td>
<td>5%</td>
<td>40%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>2-2.5cm</td>
<td>10%</td>
<td>10%</td>
<td>7%</td>
<td>2%</td>
<td>---</td>
<td>1%</td>
<td>20%</td>
<td>2%</td>
<td>---</td>
<td>40%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>2.5-3cm</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td>Tr.</td>
<td>5%</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td>---</td>
<td>40%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>3-3.5cm</td>
<td>5%</td>
<td>10%</td>
<td>10%</td>
<td>8%</td>
<td>---</td>
<td>2%</td>
<td>20%</td>
<td>5%</td>
<td>---</td>
<td>40%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>3.5-4cm</td>
<td>15%</td>
<td>15%</td>
<td>5%</td>
<td>5%</td>
<td>---</td>
<td>5%</td>
<td>20%</td>
<td>5%</td>
<td>10%</td>
<td>25%</td>
<td>5%</td>
<td>25%</td>
</tr>
</tbody>
</table>

¹ Includes olivine, dark opaques with cleavage faces evident, probably spinels.
² Includes orange and green glass, fresh-appearing dark chips and shards.
devitrified glass. Green, orange, or dark globules are present in the coarse fraction only in the top 1.5 cm. of the core, but comprise approximately 5% of the sample in the .125 - 1 mm. fraction. Large glass beads and small vesicular fragments are present only in the upper 1.5 cm. of the bit; otherwise no compositional trends are evident in the glass fraction of the bit (Fig. 17-9).

Breccias, in contrast, are much more abundant, making up over half of the sample studied. Most breccia fragments have the appearance of lithified soil, or appear as hardened and glassy soil that contains angular, crystalline or glassy rock fragments. A smaller percentage of breccia fragments (Fig. 17-9) is present in the .125 to 1 mm. fraction than in the coarse fraction, but abundance trends are parallel in both fractions. Anorthosite breccia, consisting of crushed anorthosite with a chalky appearance, is a minor component in both the coarser and finer than 1 mm. fractions, but is most abundant near the top of the bit.

**Stratigraphy**

Compositional trends, including an upward decrease in basalt and soil breccias, and an upward increase in crystalline anorthosite, vesicular glass, glass beads, and anorthosite breccias, roughly correspond to grain size trends noted earlier, but are more transitional. Trends tend to be internally consistent, allowing for separation of the bit into 2 units (Fig. 17-10) but with equal evidence for transitional and abrupt boundaries, there can be no exact placement of the contact between units. The separation point is placed at 1.5 cm. below the top of the bit, at the greatest change in grain size, between samples 70001,26 - ,28 and 70001,29 - ,31, but it must be emphasized that THERE IS NO SHARP CONTACT BETWEEN UNITS.

Greater abundance of crystalline rock fragments and soil breccia in the lower unit suggests that this bed was derived from a relatively local subfloor source, and finer grain size suggest more reworking.

In contrast, the massifs apparently contributed more material for the upper unit, especially the anorthosite and anorthosite breccia. The impact to bring in this relatively distant material was evidently more energetic as evidenced by the presence of largest grains and more melt material such as frothy, vesicular glass and glass beads.

Transitional nature of these units could be a result of mixing on the lunar surface, or it could be an artifact of handling.
Coarsest grains were relatively abundant, and ranged in size up to 7 mm. Vesicular glass, large dark glass beads, crystalline anorthosite fragments with olivine, and anorthosite breccias are especially abundant.

Coarsest grains were relatively sparse and generally less than 3 mm diameter. Basalt rock fragments and soil breccia fragments at maximum abundance.

Fig. 17-14  Stratigraphic Summary, Apollo 17 Drill Bit (Sample 70001).

Drive Tube 70012 (L52)

This core was hand driven to a hard layer at 28 cm depth 0.5 m inside the plus-Y footpad of the LM. The site lies on regolith developed on basaltic subfloor, near the center of the valley, approximately 750 m equidistant between the large (300 to 400 m) craters Camelot and Sherlock. The sample was collected in a relatively flat area with common, but subdued, 10 to 30 cm-diameter craters. Most of the surface appeared fine grained with particles near the limit of resolution of the surface photographs, but 1 to 2 percent of the surface was covered with particles as much as 3 or 4 cm in diameter. Similar material is in the core. Although this core was not disturbed by footprints (AS17-147-22517), the top 1 or 2 cm were probably depleted in fine soil by the LM descent propulsion engine. When the buddy secondary life-support system (BSLSS) bag was opened in the LRL, the bottom cap of the core was off and lying nearby, and soil was spilling from the bottom. A total of 47 g of slumped material were excavated from the base of the core to provide a fresh vertical face, which was then supported by a plug of aluminum foil. The upper follower was in place, and the X-radiograph indicated no serious cracking or slumping in the remainder of the core (Fig. 17-15).