REPORT ON DRILL STEM 70002

GENERAL DESCRIPTION

Drill stem 70002 is the eighth and lowest stem in the Apollo 17 drill string. In order to accommodate the drill bit, the stem was shortened from a length of 39.9 cm to 36 cm. Calculations based on X-radiographs and previous dissections place the top of 70002 at 252.1 cm below the lunar surface. Due to various factors such as mechanical compaction, this figure is only a close approximation. The drill string, with a total length of about 294.5 cm, has three major stratigraphic units: an upper, coarse-grained, basaltic unit, 107 cm thick; a middle, fine-grained zone 56 cm thick, high in anorthosite; and a lower zone of alternating coarse and fine basaltic and breccia material, 131.5 cm thick. It is of the lower major unit which core 70002 is part. The Apollo 17 drill string was taken about 40 meters north of the ALSEP central station.

SAMPLE HISTORY

Upon extraction of the drill string from the drill hole, the string was separated into three segments for packing. Drill stem 70002 was the bottom stem of the deepest segment, but was not separated at either joint until it was received in the lab. Burrowed end samples were taken totaling slightly more than 7 grams. Based on a length of 36 cm and weight of 207.8 grams, the end samples are equivalent to about 13mm of soil column, which left 34.7 cm of soil column in the tube.

On December 1, 1976, the drill stem was longitudinally split on a milling machine. Previous to this operation, the drill stem was fitted with a special plug for a thermoconductivity experiment. This plug protruded ~10 mm from the tube opening and was subsequently forced further into the tube due to requirements of the milling operation.

The "upper" split half was lifted off the soil column after the "lower" split half was affixed in a troughed dissection table on December 2, 1976. As lifting began, it could be seen that soil in the higher (stratigraphically) half of the split half was remaining in that portion of the tube. This occurred on 60003 with favorable results and it was hoped that successful repetition on 70002 could be attained. Very close to 50% of the soil remained in the upper split half from 2.8 to 18 cm on the local datum scale.

The stratigraphically highest end of the tube was, by convention, set to the zero cm mark on the scale. The upper soil/plug interface thus became

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SAMPLE HISTORY (Cont'd)

established at the 2.8 cm mark and the lower interface at 36.2 cm. The length of soil column is 33.4 cm, which indicates that 2.6 cm of column was "lost" by compaction and early sampling.

PREDISSECTION DESCRIPTIONS

From X-radiographs of core 70002, twelve units were interpreted on the basis of size distributions and inferred compositions. (See attached chart.) Examination of the exposed surface revealed at least five tonal units. No tonal differences could be detected on that portion of the drill stem which did not split into each part of the split tube. The overall color was 10 YR 3/1 on Munsell's Color Chart.

Variations in the gross surface texture as seen in the development of a rind of compacted soil, give some indication of changes in physical properties of the underlying soil. This information, integrated with the x-ray data, is the sole basis for establishing preliminary units on that portion of the core which no tonal differences are apparent. The soil matrix is about 6 phi or 16 microns.

PROCESSING PROCEDURES

Certain departures from the standard dissection procedure was necessary in order to process this drill stem. In accordance with the precedent set by drill stem 60003, that portion of the soil remaining in the upper split half was stored away for future dissection. Dissection of the soil in the lower half was begun at the upper end. Standard 5 mm intervals were taken except where breaks in tonal contrast were well-defined. At these contacts, effort was taken to keep from mixing soil types. Special samples were taken in the 13 to 14 cm area, due to the sloping contact and interfingering nature of the zone. Red light samples were taken at 21 and 33 cm and a lead-free sample was taken at 21 cm. More red light samples will be taken in the dissection of the upper half. This is necessary due to the sample size differences. Unusual or large particles transcending interval boundaries were set aside as special samples. Where possible, large particles were located on a diagram of the interval in order to record orientations. All particles not passing through a 1 mm sieve were classified, photographed, and separately containerized for each dissection interval. Voids created by extraction of large particles extending below standard dissection level were maintained if possible. It was necessary to remove these large particles in order to obtain a peel sample. After peeling, the soil remaining in the trough of the split drill stem was impregnated with epoxy under vacuum conditions. The impregnated core was then encapsulated with more epoxy in a mold. This mold provides for ease of handling in making thin sections from the impregnated core.

ANALYSIS OF DATA

The collected quantitative data consists of the weights of the fine fraction and coarse fraction of each interval, plus the weights of special samples. In addition, frequency counts of particles in the coarse fraction were taken in three size ranges — 1-2 mm, 2-4 mm, and greater than 4 mm. Each size range is also divided into seven compositional types. Frequencies are computer-normalized to the standard interval width and average weight. Graphs of normalized frequencies versus depth are plotted in eight groupings: by compositional type for each of the three size ranges; by compositional type for the combined sizes; by combined compositions for each of the three sizes; and by combined compositions for the combined size ranges. When combining sizes, scale factors are used. In addition to the frequency graphs, a weight percent coarseness indicator is plotted. The percentages are computed by dividing the weight of material greater than 1 mm in size by the weight of all the material per unit.

Bias is introduced by the sampling size of the drill stem, in that the presen of a particle approaching tube diameter in size eliminates the possibility of occurence of other particles. Other statistical error is brought about by the discrete size categorization, rather than a continuous size measurement of each particle. This error is demonstrated by comparing the weight percent coarseness graph with the combined composition/ combined sizes graph. The lack of congruence that can be seen is partially due to this "pidgeonhole" effect and partially due to generalizing assumptions that had to be made in order to combine the discrete size categories. Other biases or errors include — sampling below standard dissection level, measurement error, assumptions of uniform density, and mis-classification of lithology. Bearing these limitations in mind, interpretation of the constructed graphs was not attempted at the order of resolution provided.

COMPOSITIONAL DESCRIPTIONS

Seven compositional categories were used to classify particles greater than 1 mm in grain size: anorthositic breccia (ANBX); agglutinates (AGGL); devitrified or partially-crystallized glasses (PXGL); recrystallized or high-grade breccia (RXBX); vesicular, droplet, or fresh glasses (VSGL); soil or low-grade breccia (SOBX); and basaltic or crystalline rock fragments (BSRF). Of these seven, SOBX is by far the most abundant.

The category "BSRF" includes any particle which is apparently no recrystallized material, but is polycrystalline and contains plagioclase and pyroxene. In practice, some of the smaller particles classified as BSRF's may be monomineralic. Also, many particles are soil or glass coated to the point of being barely recognizable. Some soil coated BSRF's may have been misclassified as SOBX's for this reason. Most occur as fairly equant chunks with coarsely-textured surfaces. When the rough pockets in the surface are filled with soil, they are easily mistaken for the equant, smooth-surfaced SOBX's. Effort was taken to remove as much loose soil as possible SOBX's without significantly damaging the normally friable SOBX's in the process. Some BSRF's have shocked plagioclase or anorthositic material. ANBX's may be derived directly from this source, in which case they are more likely to display some evidence of crystal structure. When found as clasts in SOBX's, they tend to be sugary in texture. Some particles classified as "ANBX" may either be soil coated ANBX's or anorthositic clasts from broken SOBX's. SOBX's therefore, exclude white, sugary masses of supposed anorthositic material, even though the only difference may be the color of the soil matrix in which it is formed. "SOBX" refers to a particle of welded, non-white soil matrix. Welding may have been brought about by heat, pressure, small amounts of molten glass, or some combination of these. When glass welding creates a more spindly particle, it is considered to be an "AGGL" rather than a more massive and rounded SOBX. SOBX's are usually friable and occasionally break open to reveal an interior of crystalline mash. Others simply disintegrate when broken. Certain SOBX's are distinguished as medium grade in that they are tougher and seemingly transitional to the category of RXBX. "RXBX" is an angular, waxy-appearing particle that would seem to be the high grade equivalents of SOBX or ANBX. "PXGL" is somewhat similar in appearance to RXBX, but readily distinguishable by a duller surface luster and glass fracture shape characteristics, as it is a devitrified form of VSGL. "VSGL" refers to fresh, vitreous glass which occurs as beads, shards, or coatings. It is often found as coatings on SOBX and causes some difficulty in classification, as SOBX may be glass welded.

DESCRIPTION OF PHYSICAL UNITS

Drill stem 70002 has seven distinct tonal units. Further subdivisions have been determined by minor variations in tonal appearances, corroborated by size and compositional frequency variations, plus a wettability or cohesivity factor as evidenced in the core peel. Severe bias may have occurred above the 19 cm mark due to a much smaller sampling size. Tonal variations are more heavily relied on above 19 cm for this reason.

Unit I (31.7 - 36.2) is moderately coarse, with about 78% matrix by weight. (References to "matrix" refer to that fraction of the soil less than 1 mm in size.) Large particles in the greater than 4 mm size range are common. Frequencies in the 2-4 mm size range are constant, while those of the 1-2 mm size range vary between sub-units. The crystalline (BSRF) material frequencies are quite high. Small clods of pure white anorthosite (ANBX) occur throughout. The overall tone is moderately light in a pronounced whitish or more neutral shade. This unit may continue downward with the drill bit units as sub-units.

Unit I-A (33.7 - 36.2) is 74% matrix. Cohesivity is high. A large peak in BSRF frequency marks the upper contact. The tone may be slightly lighter than in unit B.

Unit I-B (31.7 - 33.7) is 85% matrix. Cohesivity is somewhat low. BSRF and SOBX occur in about equal quantities . The basal portion contains a notable amount of glass.

Unit II (24.5 - 31.7) is moderately fine, with about 87% matrix. Large particles are not as common as in Unit I, but occurrence is still regular. Frequencies of the 2-4 mm particles are low but constant in the two lower sub-units, then abruptly increase and gradually decrease to a low level at the top. The 1-2 mm frequencies are considerably variable, but generally occur in fewer at sub-unit contact zones. SOBX dominates all other compositional categories. The overall tone is moderately dark with a slightly browner or oranger color than in Unit I.

Unit II-A (30.2-31.7) is 83% matrix. Cohesivity is quite low. Occassional lenses of dark soil are seen. All size ranges have stable frequencies. SOBX is dominant with minor amounts of BSRF and ANBX. Tone is fairly even.

Unit II-B (29.2 - 30.2) is 91% matrix. Cohesivity is low. No large particles are present in the greater than 4 mm size range. Peaks in both the 1-2 mm particles and VSGL occur at the top. The tone is slightly darker.

Unit II-C (27.0 - 29.2) is 81% matrix. Cohesivity is moderately high. The top portion is coarser due to increases in both the 1-2 mm and greater than 4 mm frequencies. The tone is lighter. A strong VSGL peak is found at the top.

Unit II-D (24.5 - 27.0) is 92% matrix. Cohesivity is low. The lithology is varied, but SOBX is dominant. Blebs of white soil seems to be sprinkled in. The tone is slightly darker.

Unit III (16.1 - 24.5) is fine-grained, with about 93% matrix. Very few particles are greater than 4 mm in size. The frequencies of the 2-4 mm group are variable from interval to interval, but gradually increase upward. The 1-2 mm frequencies are similar. The lithology is varied with SOBX only slightly dominant. BSRF is uncommon except near the top where ANBX is also notable. The overall tone is dark with a lightening near the top due to stringers of white ANBX. Cohesivity is low throughout.

Unit III-A (23.5 - 24.5) is 97% matrix. This is a mixing zone between Units II and III. The tone is mottled. A significant peak in VSGL occurs at the top.

Unit III-B (20.9 - 23.5) is 97% matrix. Frequencies are very low. No compositional trends are evident. Tone is homogenously dark.

Unit III-C (18.2-20.9) is 92% matrix. Frequencies broadly peak at mid-unit due to contributions from SOBX and VSGL. The tone is dark with faint lines of lighter material.

Unit III-D (17.7 - 18.2) is 92% matrix. ANBX frequencies are high and are seen in the prominent lenses of white soil. The tone is lighter due to these lenses.

Unit III-E (16.8 - 17.7) is 92% matrix. ANBX lenses are not as prominent. ANBX frequencies are still relatively high.

Unit III-F (16.1 - 16.8) is 94% matrix. ANBX is not found. BSRF and SOBX occur evenly. The tone is evenly dark.

Unit IV (14.0 - 16.1) is moderately fine to moderat ly coarse with about 81% matrix. Frequencies are highly variable, possibly due to the small sample size in this portion of the core. BSRF, VSGL, and SOBX are common. Cohesivity is moderately low. The tone is light with one lens of orange soil.

Unit IV-A (15.2 - 16.1) is 88% matrix. This sub-unit contains the bleb of orange soil. The composition of the sub-unit is mostly VSGL and SOBX. The tone is evenly light.

Unit IV-B (14.0 - 15.2) is 75% matrix. The upper part contains a large particle which may be either a SOBX or a BSRF. The coarseness index is very high due to this one particle and the small sample size. The tone is slightly darker and cohesivity slightly higher than in IV-A.

Unit V (6.6 - 14.0) is fine-grained with about 92% matrix. Both the 1-2 and 2-4 mm groups are stronger at the bottom, while the 1-2 is stronger than the 2-4 at the top. The reverse is true in the middle. Lithology is varied with a notable consistency of ANBX. Cohesivity increases upward as the tone lightens.

Unit V-A (12.4 - 14.0) is 89% matrix. This sub-unit is an interfingered zone of mixing between units IV and V. It differs from sub-unit III-A in that the lenses are well-defined and either light or dark with definite boundaries. Some evidence suggests a sloping contact. Cohesivity is low.

Unit V-B (8.9 - 12.4) is 94% matrix. The 1-2 mm frequencies increase upward and the 2-4 mm have a broad peak in the middle. SOBX is dominant with ANBX an accessory. Tone and cohesivity are both medium.

Unit V-C (6.6 - 8.9) is 91% matrix. Frequencies in the 1-2 mm size range show a broad central peak. VSGL and ANBX peak at the top. Some orange-tinted SOBX is present. The tone is very light with one large, pure white lens. Cohesivity is very high.

Unit VI (3.8 - 6.6) is fine-grained with 91% matrix. The 2-4 mm particles occur only in the upper part. Lithology is variable. The tone is evenly dark with a few small pure white blebs. Cohesivity is very low.

Unit VII (1.5 - 3.8) is very fine-grained with 95% matrix. Frequencies of the 1-2 mm particles are fairly high however. The lower contact is slightly coarser with a few 2-4 mm particles. Composition is mostly VSGL and SOBX. The tone is light with an interfingering contact zone between 3.3 and 3.8 cm. The cohesivity is high.

DRILL STEM 70002 SAMPLE LOCATION INFORMATION

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PHYSICAL UNIT	LUNAR DEPTH (cm)	THICK-NESS (cm)	PLUG		INTERVAL Location Notation	FINE FRACTION Sample Number	FINE FRACTION Weight (mg)	COARSE FRACTION Sample Number	COARSE FRACTION Weight (mg)	SPECIAL SAMPLES Location Notation	SPECIAL SAMPLES Sample Number	SPECIAL SAMPLES Weight (mg)	Compositional Description	Note
70002 VII	252.1	2.3	P.E.T. Samples		022-15	3	3026	4	235					Bulk
					028-22	5	3005							
					033-28	25	1456	26	102					
70002 VI	254.4	2.8			038-33	27	1165	28	91					
					043-38	29	797	30	14					
				5	048-43	31	787	32	68					
					053-48	33	850	34	73					
					058-53	35	940	36	38					
					063-58	37	878	38	17					
70002 V	257.2	7.4	81		069-63	39	1194	40	55	071-67	41	81	ANEK	
					074-69	42	818	43	103					
					079-74	44	795	45	126					
					084-79	46	1034	47	100					
					089-84	48	915	49	76					
					094-89	50	912	51	50					
				10	099-94	52	857	53	64					
					104-99	54	972	55	90					
					109-04	56	840	57	71					
					114-09	58	961	59	92					
					119-14	60	737	61	27					
					124-19	62	818	63	17					
					129-24	64	754	65	84					
					135-29	66	524	67	150					Dark Soil
					138-32	68	451	69	35					Light Soil
					139-35	70	69	71	2					Dark Soil
70002 IV	264.6	2.1	78		142-35	72	607	73	46					
				15	147-42	74	407	75	30	149-41	78	342	SOEK	
					152-47	76	586	77	15	156-54	79	25	Orange Soil	
					157-52	80	600	81	92					
70002 III	266.7	8.4			162-57	82	637	83	78					
					167-62	84	738	85	38					
					172-67	86	666	87	59					
					177-72	88	730	89	57					
					182-77	90	952	91	88					
					187-82	92	1327	93	255					
					192-87	94	1475	95	97					
				20	197-92	96	1788	97	213					
					202-97	98	2015	99	132					
					217-02	102	4724	103	209	217-02 217-02	100 101	270 1040	Red Light Lead-Free	
					222-17	104	2197	105	66					
					227-22	106	2010	107	127					
					232-27	108	1975	109	25					
					237-32	110	1995	111	26					
					242-37	112	2183	113	73					
					247-42	114	2015	115	67					
70002 II	275.1	7.2		25	252-47	116	2031	117	156					
					257-52	118	2266	119	130					
					262-57	120	2115	121	241					
					267-62	122	2259	123	250					
			128		272-67	124	1989	125	197	274-70	128	237	SOEK	
			129		277-72	126	1719	127	476					
					282-77	129	1846	130	286	281-75	133	242	SOEK	
					287-82	131	1880	132	363					
			136		292-87	134	1934	135	114	295-86	136	244	SOEK	
					297-92	137	1973	138	153					
				30	302-97	139	2094	140	171					
					307-02	141	1920	142	215	312-04	145	183	SOEK	
			146, 145, 147		312-07	143	2065	144	133	315-06	146	153	ANEK	
70002 I	282.3	4.5			317-12	148	1694	149	294	314-11	147	187	BSRF	
					322-17	150	2128	151	366					
					327-22	152	1897	153	310					
					332-27	154	1688	155	276	332-27	156	250	Red Light	
			164, 161		337-32	157	2120	158	185	340-33	161	355	BSRF	
					342-37	159	1839	160	344	339-35	162	197	BSRF	
			167		347-42	163	1720	164	270	350-42	167	430	SOEK	
				35	352-47	165	1782	166	321					
			174		357-52	168	1437	169	310	361-52	172	573	BSRF	
					362-57	170	2130	171	690					
Soil should fill tube from 0.0 to 36.0 cm.-- Entire column was shifted down 0.2 cm and 1.3 cm was lost by compression.			PLUG		362-28	173	240							Funnel Misc.
					362-28	174	1000	175	29					Table Misc.
					362-28	176	5							Floor Misc.

(For explanation of compositional descriptions, see text of report.)