70009 - 70001

Deep Drill Core

3 meters

Figure 1: There are no photos of the crew taking the Apollo 17 deep drill core, but this photo of the site, with the neutron probe in place, shows the effort that must have been expended to obtain the three (3) meter deep drill core. AS17-134-20505. The ALSEP site is just beyond.

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4 22 11 CDR Man, it didn't feel like this stuff was this hard. See if I can get it out. I may be jacking the treadle down into the surface. Come on baby. I'm going to get this thing out, now that I got it. I hope this core is appreciated. Man, I don't know what it's in.

4 22 15 LMP I was afraid that would happen – with all this rocks.

4 22 15 CDR Yes, but it didn't go in that hard.

4 22 27 CDR I've got a delicate core in one hand, and I'm trying to get some core caps on the other. You'd be glad to know it's full, Bob.

Introduction

The Apollo 17 deep drill was collected with great difficulty at the ALSEP site near Camelot Crater and within an area of many small craters known as the Central Cluster (figure 2). The drill core is a continuous section of the top of the regolith, 3 meters long, that represents an historic achievement *(and much appreciated by the science community)*. Drilling the lowest 20 cm was very difficult, because the basal material was very cohesive. Extraction was also very difficult, although for this mission it was facilitated by a specially designed "treadle". A neutron probe was successfully inserted into the open hole (figure 1). Two surface soils were collected nearby – 70180 and 70160.

The drill core "string" for Apollo 17 was broken down and returned in three segments (70009, 70008, 70007) (70006, 70005) and (70004, 70003, 70002, 70001) in a special beta-cloth bag. Apparently the plug inserted into the top of the drill did not function, because a void (10 – 12 cm) was found at the junction of 70008 and 70007 (which were not tightly connected) and core material slid along the core. Indeed, the transcript shows that the crew had difficulty placing the plug in the top of the core and ramming it home. However, it is believed that core recovery was ~100% (Duke and Nagle 1976).

The Apollo 17 deep drill core is not homogeneous along its length. It varies in nuclear track density, maturity, agglutinate content, modal mineralogy and in chemical composition. Vaniman et al. (1979) subdivide the drill string into 5 units A – E (bottom to top), while Taylor et al. (1979) subdivide it into 8 units A – H (top to bottom). The most obvious feature is a relatively coarse layer of immature mare material from about 22 cm to about 71 cm depth (called unit D by Vaniman et al. and unit B by Taylor et al.). *(This confusion can be attributed directly to the editors of the 10th Proceedings; Bogard, Horz and McKay)*

As soon as the drill string was returned to Houston, it was broken down into sections and a small amount was extracted from the tops of the bottom six segments to be put in a freezer where they have been kept cold all these years – see essay titled **70001**.

Interpretation

The data from the Apollo 17 deep drill core has been studied in detail by numerous investigators, who each give it their own interpretation based on their particular technique (Taylor et al. 1979, Morris et al. 1979, Vaniman et al. 1979, Goswami and Lal 1979). A synthesis of these models is given in Langevin and Nagle (1980) and McKay et al. (1992).

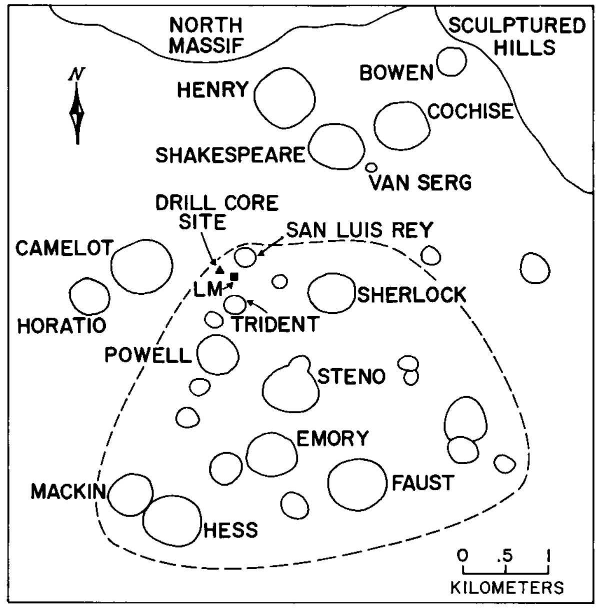

Figure 2: Location of Apollo 17 Deep Drill, about one crater diameter from Camelot, and near numerous craters in middle of mare surface (from Taylor et al. 1979). Note that it is several kilometers from surrounding highland areas.

Arvidson et al. (1977) make the connection between a site-wide "event" about 96 m.y. ago and the deposition of the deep drill core as part of a slab at about 100 m.y. (Curtis and Wasserburg 1975). Drozd et al. (1977) determined that many of the features at Apollo 17 (including the Central Cluster) can be dated at 109 ± 4 m.y. which they associate with the crater Tycho.

Fruchter et al. (1979) found that the Apollo 17 deep drill core had lower than expected values of ^{26}Al and ^{53}Mn at depth (figures 12 and 13) proving that there had been a recent crater at this location, which was filled in recently with previously irradiated surface material.

However, careful nuclear track studies indicate a long exposure and multiple episodes of deposition (Goswami and Lal 1979). A layer at about 240 cm is found to have a high dose of ^{15}N and ^{21}Ne indicating an ancient exposure to the sun (Thiemens and Clayton

Summary mode for A17 deep drill according to Vaniman et al. 1979.

Stratigraphic units	A	B	C	D	E
Mare basalt	7.5	11.4	9.2	24.3	19.7
Ant	3.4	3.5	2.8	2.0	1.4
RNB/poik	5.0	3.5	3.2	1.1	1.2
DMB	25.9	21.8	23.8	17.2	22.1
Agglutinate	20.8	15.7	23.8	15.9	20.1
Olivine	0.8	1.1	0.8	0.8	1.2
Pyroxene	9.0	7.9	7.8	18.3	15.2
Plagioclase	7.0	7.8	10.6	7.9	7.5
Opaque	2.6	2.7	2.5	3.0	4.0
Orange/black glass	14.6	13.8	10.6	6.9	5.0
Brown/grey glass	0.1	0.1	0.4	0.6	1.4
Clear glass	1.7	4.2	2.8	0.9	0.6
Yellow/green	1.6	6.5	1.9	1.0	0.8
	100.0	100.0	100.2	99.9	100.2
	256-284 cm	224-256 cm	71-224 cm	22-71 cm	0 - 22 cm

1980). Everyone agrees that the top 22 cm has been gardened by micrometeorite bombardment.

Petrography

A description of 70001 can be found in the Lunar Core Catalog (1976) pages 17-32 to 17-36. It was 5.5 cm long and was dissected top to bottom (0.5 cm at a time). Each unit was sieved into >1mm, 1-0.125 mm and <0.125 mm. A bottom portion (70001,5; 3.43 g) was placed in deep freeze! Descriptions of 70009, 70008 and 70007 are given by Duke and Nagle (1976). 70005 is described in newsletter #18. During dissection as many as 54 lithologic units were identified, but Nagle and Waltz (1979) eventually grouped these into 6 major units. These descriptions were soon superseded by petrographic study of thin sections.

Housley et al. (1976) showed that the maturity along the length of the deep drill is given by the proportion of agglutinates (figure 3) and the ferromagnetic resonance measurement Is/FeO (figure 4). Vaniman et al. (1979) tabulated the modal abundance of components for different size ranges, concluding that the Apollo 17 deep drill core was made up of 5 distinct units (see table). *"The upper unit E (0-22 cm depth) is marked by high content of fused soil, brown glass, and mare fragments. The underlying unit D (22-71 cm depth) has a low abundance of fused soil (i.e. low maturity) and is rich in coarse (>200 micron) mare fragments. A large section of the core, unit C (71-224 cm depth), is finer-grained, more mature (richer in agglutinates), more feldspathic and has more highland lithic, mineral and glass fragments than unit D. The next underlying unit, B (224-256 cm depth), has yellow/colorless KREEP glasses with a high-Si, low-alkali composition unlike the common Apollo 15 or Apollo 17 KREEP series. The deepest unit, A (256-284 cm depth), is marked by its relatively higher maturity and lower yellow/colorless KREEP glass content".* This description is an excellent starting point for a discussion of the core. However, Taylor et al. (1979) see a different set of layers, Morris et al. (1979) have found that the whole lower part of the drill string is mature to submature and Goswami and Lal (1979) have identified various units and events based on careful analysis of nuclear tracks. Thus there is no consensus on where the major subdivisions should be, but it is clear that the core is not well mixed (McKay et al. 1992).

Near the bottom of the core Vaniman and Papike (1977c) found fragments of very-low Ti (VLT) basalt, which is otherwise rare at the Apollo 17 site.

The coarse layer near the top (22 to 71 cm) is the least mature Apollo soil (only 6% agglutinate, Taylor et al. 1979) and is made up of coarse fragments and minerals of ilmenite basalt (Vaniman et al. 1979).

Mineralogical Mode

Detailed mineralogical modes based on petrographic analysis of thin sections were determined by Heiken and McKay (1974), Taylor et al. (1977), Vaniman and Papike (1977b), Taylor et al. (1979) and Vaniman et al. (1979). A summary of the mineralogical mode is given in Vaniman et al. (1979).

Glass: Warner et al. (1979) reported the composition of glass from the top of the drill core. Vaniman et al.

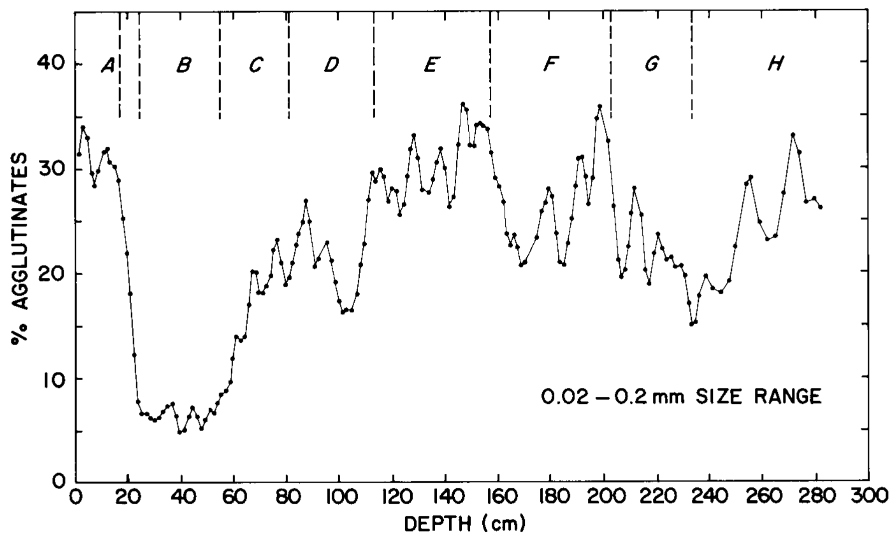

Figure 3: Percentage of agglutinate glass in fine fraction of Apollo 17 deep drill (from Taylor et al. 1979) and showing the lithologic units identified by Taylor et al. (A - H).

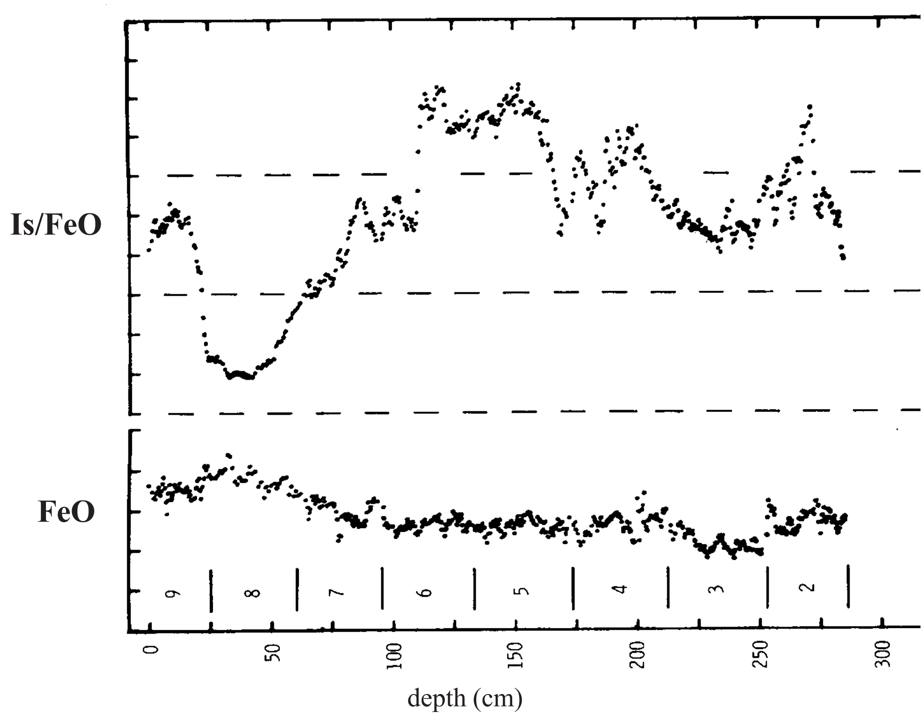

Figure 4: Maturity index (Is/FeO) as a function of depth in Apollo 17 deep drill core (Morris 1979).

(1979) reported that a lot of siliceous KREEP glass is to be found in their unit B (224-256 cm).

Chemistry

The chemical composition of the deep drill core has only been measured in gross detail (it is a long core). The main features found so far are a variation in TiO_2 content with depth (figure 7) and an enrichment in trace elements (especially the fines) at about 240 cm (figures 8, 9 and 10).

Ehmann and Ali (1977) measured the top of the core (70009 – 70007). They and others found there to be an abundance of Ti- and Fe-rich basalt in 70008.

Helmke et al. (1973), Laul et al. (1979) and Vaniman et al. (1979) each found a trace-element enriched layer at a depth of about 240 cm. Laul et al. found that the

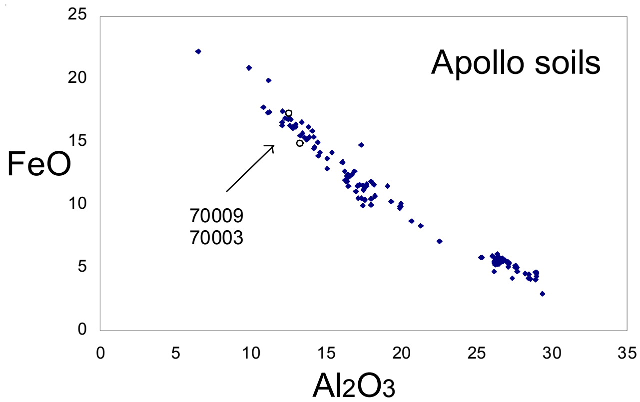

Figure 5: Chemical composition of deep drill samples for Apollo 17 compared with composition of all lunar soils.

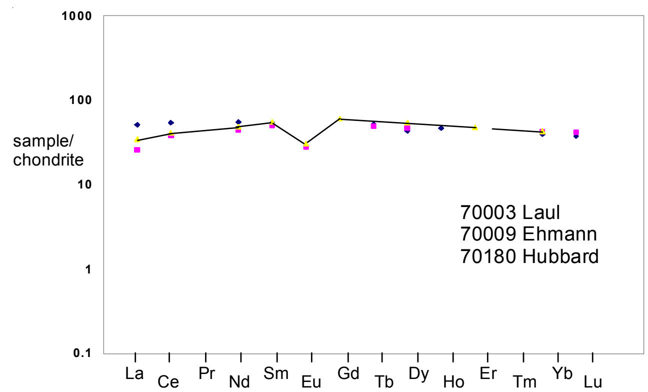

Figure 6: Normalized rare-earth-element pattern for Apollo 17 deep drill core compared with nearby reference soil (70180).

trace-element-enriched material (KREEP?) was especially enriched in the finest fraction (figure 10).

Laul et al. (1984) found that Zn was anticorrelated with agglutinate content. Zn was highest in the fine fraction indicating that it was surface correlated (figure 11).

Cosmogenic isotopes and exposure ages

The irradiation history and depositional history of this deep drill core is complicated. The material in the core with the least, and most ancient, surface exposure is near the surface (25 to 60 cm deep), and the soil with the greatest, and most recent, surface exposure is at a depth of 110 – 170 cm. The top 25 cm is like other soils at Apollo 17 (Thiemens and Clayton 1980). However, a region around 240 cm has correlated high ^{15}N, ^{21}Ne, ^{38}Ar and KREEP content. It needs to be studied in more detail.

Curtis and Wasserburg (1975) studied the neutron fluence of the core using Gd isotopes, consistent with a model where the core was laid down at a single, recent time (~100 m.y.). However, in a later paper they reported a single particle that has Gd isotopes inconsistent with that model (figure 17).

Rancitelli et al. (1975) and Fruchter et al. (1976 - 9) reported ^{22}Na and ^{26}Al for the entire Apollo 17 deep drill core. Nishiizumi et al. (1976) reported the activity of ^{53}Mn for samples of 70008 and Fruchter et al. (1979) determined the whole core (figures 12 and 13).

Other Studies

Rare gas contents were reported by Pepin et al. (1975) who found an enrichment of ^{21}Ne and ^{38}Ar at depth (figure 14). Elevated ^{15}N was reported by Thiemens and Clayton (1980) for about the same region. This indicates a long exposure to the Sun at an ancient time.

Crozaz et al. (1974), Crozaz and Plachy (1976), Crozaz and Dust (1977), Crozaz and Ross (1979), Goswami and Lal (1977 and 1979) studied nuclear tracks in silicates as a function of depth (figures 15 and 16). This data indicate a complicated exposure of particles along the core and is consistent with a long, multi-event deposition of the core.

Processing

Although the core was allowed to sit in the sunlight (see figure 1 in 70180), and was warmed up for 7 – 10 days during transit to earth, portions were removed and placed in a freezer, where they have remained all these years (see section on 70001).

Continuous sets of thin sections and long epoxy encapsulated reference cores are available for the entire drill string (eight segments).

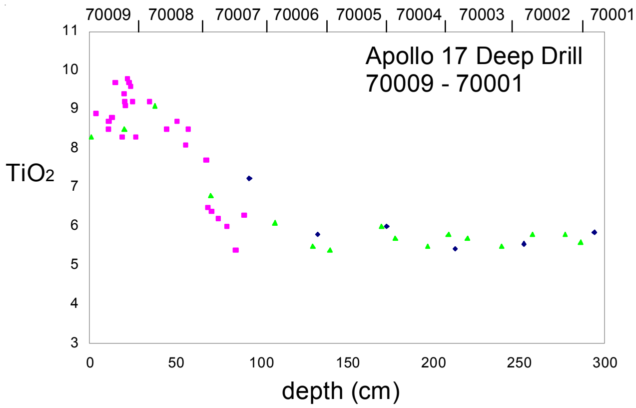

Figure 7: Bulk chemical composition of Apollo 17 deep drill as function of depth (with segments indicated at top). Data from Ehmann and Ali, Laul et al. and Helmke et al. - see tables.

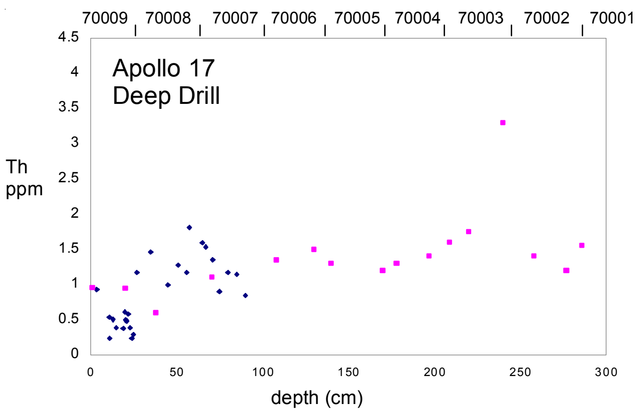

Figure 8: Bulk chemical composition of Apollo 17 deep drill as function of depth (with segments indicated at top). Data from Ehmann and Ali, Laul et al. and Helmke et al. - see tables.

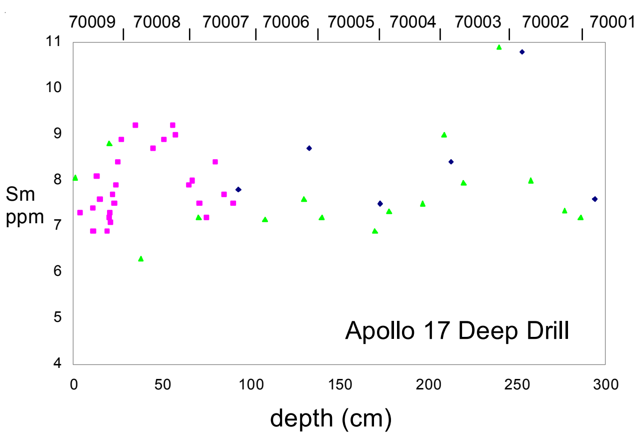

Figure 9: Bulk chemical composition of Apollo 17 deep drill as function of depth (with segments indicated at top). Data from Ehmann and Ali, Laul et al. and Helmke et al. - see tables.

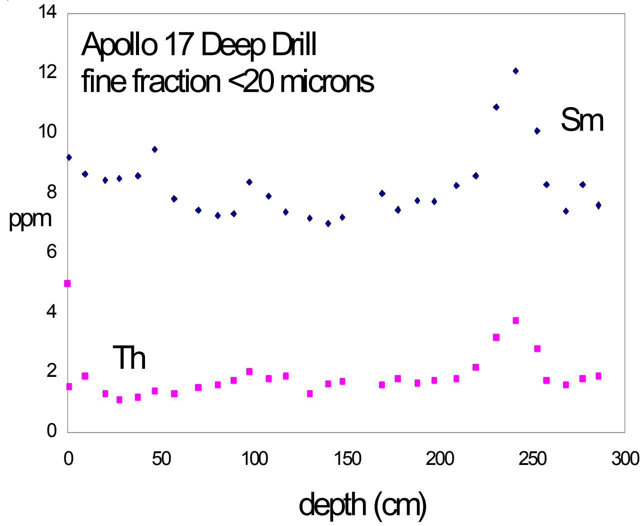

Figure 10: Laul et al. 1979, 1980 found that trace elements were enriched in the finest fraction and that this effect was pronounced at ~240 cm depth in the Apollo 17 deep drill.

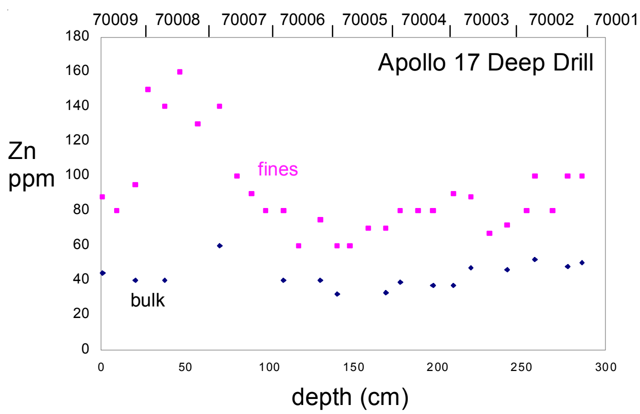

Figure 11: Laul et al. (1979, 1980) found that zinc (Zn) concentration is elevated in the top portion of the deep drill core, and anticorrelated with the agglutinate content. Notice that it is also enriched in the fines, indicating surface correlation.

Table 2. Chemical composition of A17 deep drill (representative samples). *

	70001	70002	70003	70004	70005	70006	70007	70008	70008	70009	70009	
reference	Laul + Papike80			Laul et al. 1979				Laul et al. 1978				
weight	4 mg	15 mg					>90	5.89	>90	3.65	top	
SiO2 %	42.3	42.3	42.6	42.2	42.1	42.1	41.7	39.5	39.9	40.7	40.4	(a)
TiO2	5.6	5.8	5.7	5.7	5.4	6.1	6	9.1	9.8	8.5	8.3	(a)
Al2O3	13.5	14	14.5	13.7	14.4	13	13.9	11.1	10	11.5	12.1	(a)
FeO	16	15.4	15.3	16.7	16	16.3	15.9	18.3	18.3	17.5	17.1	(a)
MnO	0.194	0.19	0.184	0.192	0.194	0.2	0.206	0.23	0.24	0.224	0.224	(a)
MgO	10.5	10.1	10	10.2	9.9	10.1	10.1	9.6	9	10	10.7	(a)
CaO	11.1	11.2	11	10.5	11.8	10.5	11.3	11.2	10.9	10	10.8	(a)
Na2O	0.45	0.46	0.44	0.41	0.41	0.43	0.39	0.43	0.4	0.41	0.39	(a)
K2O	0.12	0.12	0.14	0.11	0.11	0.11	0.087	0.068	0.078	0.085	0.085	(a)
P2O5												
S %	** note: there are many more analyses in these publication than can be presented here!*											
sum												
depth (cm)	286	258	220	178	140	108	81	38	28	20	1	
Sc ppm	47.5	47	43.5	51	48.9	50	49.3	63.6	72.1	60	56.6	(a)
V	80	80	80	85	90	90	85	100	100	100	100	(a)
Cr							3010	3147	2737	2874	2805	
Co	31.3	36	40	44	36.6	36.9	31.8	28.4	22.3	34.9	32.3	(a)
Ni	160	210	260	250	250	220	150	110	60	100	150	(a)
Cu												
Zn	50	52	47	39	32	40	40	40	30	40	44	(a)
Ga	7.4	9	8	7	6.6	6.6	5.5	9	5.2		6.3	(a)
Ge ppb												
As												
Se												
Rb												
Sr	170	170	170	150	170	190	170	150	160	180	210	(a)
Y												
Zr												
Nb												
Mo												
Ru												
Rh												
Pd ppb												
Ag ppb												
Cd ppb												
In ppb												
Sn ppb												
Sb ppb												
Te ppb												
Cs ppm												
Ba	130	140	170	120	120	120	100	80	100	110	120	(a)
La	9.5	10	12	9.5	9.23	9.36	6.65	5.4	6.54	8.3	7.9	(a)
Ce	29	30	33	28	27	28	23	20	25	29	28	(a)
Pr												
Nd	22	23	25	22	22	23	18	19	24	25	23	(a)
Sm	7.2	8	7.95	7.33	7.2	7.15	6.3	6.3	8.5	8.8	8.06	(a)
Eu	1.6	1.7	1.55	1.5	1.55	1.7	1.55	1.7	1.75	1.9	1.76	(a)
Gd												
Tb	1.8	1.9	1.9	1.9	1.8	1.9	1.6	1.8	2.2	2.1	1.9	(a)
Dy	10	10.9	10.5	11	10.5	10	9.6	10	12.6	12.5	11.4	(a)
Ho	2.5	2.5	2.6	2.6	2.6	2.4	2.4	2.5	2.6	2.8	2.9	(a)
Er												
Tm		1	1	1	0.96							(a)
Yb	6.1	6.7	6.4	6.25	6.21	6.1	6	6.64	8.21	7.4	7.11	(a)
Lu	0.9	0.97	0.91	0.92	0.88	0.9	0.84	0.95	1.16	1.1	1.07	(a)
Hf	5.7	6.4	6.27	6	6.05	6	5.45	5.56	6.5	6.6	6.6	(a)
Ta	1	1	1.1	1.14	1.02	1.05	1.2	1.3	1.44	1.35	1.2	(a)
W ppb												
Re ppb												
Os ppb												
Ir ppb	<10	15	13	16	<10	<15		<10	<10	<10	<10	(a)
Pt ppb												
Au ppb	3	4.4	3.5	2.8	5.2	3		2		2	3	(a)
Th ppm	1.5	1.4	1.75	1.3	1.3	1.35	0.95	0.6	0.4	0.94	0.95	(a)
U ppm	0.5	0.5	0.45	0.4	0.4	0.4					0.23	(a)

technique: (a) INAA

Table 3: Jovanovic and Reed (1974)

	depth cm	F ppm	Cl ppm res.	leach	Br ppm res.	leach	I ppm	Li ppm	U ppm
70181	surface	52	14	19	840	43	1.2	7.2	0.22
70006	94		13	5	190	60	3	9.4	0.29
70005	135		14	3.8	130	60	3	7.2	0.24
70002	256		21	7.9	190	90	9	9.8	0.51

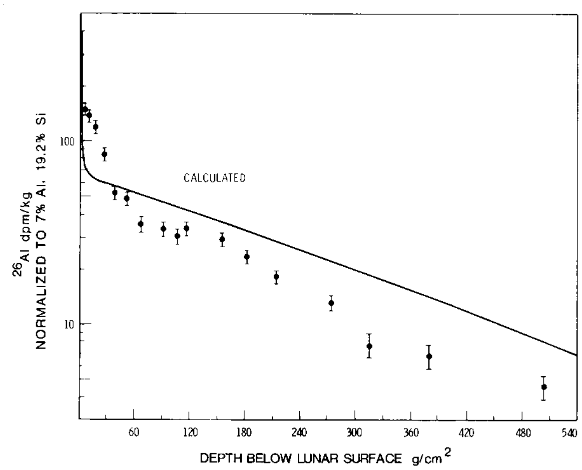

Figure 12: Depth profile for 26Al for A17 deep drill (measured and predicted)(from Fruchter et al. 1979).

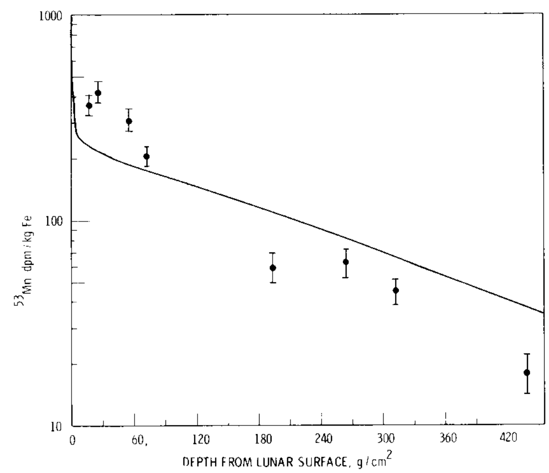

Figure 13: Depth profile for 53Mn for A17 deep drill (measured and predicted)(from Fruchter et al. 1979).

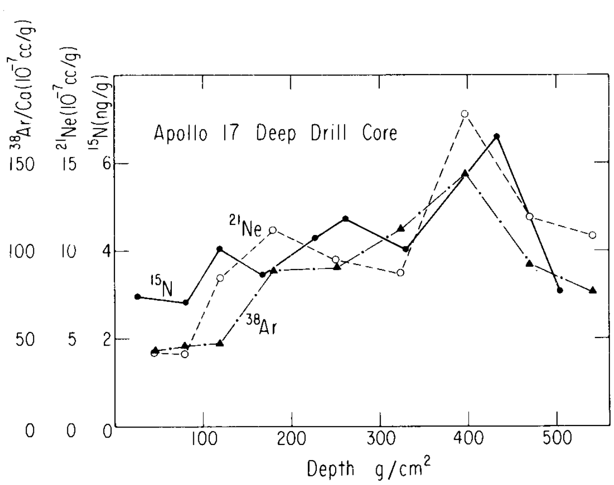

Figure 14: 15N, 21Ne and 38Ar are all enriched in Apollo 17 deep drill string (Pepin et al. 1975; Thiemens and Clayton 1980). The peak at 400 g/cm2 at the top of segment 70003 indicates an intense solar irradiation at an ancinct time .

Table 4. Chemical composition of A17 deep drill.

	70001	70002	70003	70004	70005	70006		70008	70008	70008	70008
reference	Helmke 73							Fruchter75			
depth	294	253	213	173	133	93	cm	30	40	50	60
SiO2 %	42.1	43.4	42.9	42.6	42.6	41.6	(a)				
TiO2	5.85	5.56	5.44	6	5.8	7.23	(a)				
Al2O3	14.1	14	13.9	13.7	14.1	13.3	(a)				
FeO	14.5	14.5	14.5	14.9	14.7	15.2	(a)				
MnO	0.2	0.199	0.203	0.209	0.207	0.213	(a)				
MgO	10.3	9.94	10.3	10.1	9.97	9.56	(a)				
CaO	11.2	10.9	11	11.2	11.2	10.9	(a)				
Na2O	0.43	0.48	0.46	0.44	0.42	0.46	(a)				
K2O	0.12	0.227	0.149	0.114	0.118	0.101	(a)	0.116	0.088	0.113	0.088
P2O5											
S %											
sum											
Sc ppm	47	43	43	46	46	52	(b)				
V											
Cr	2900	2770	2900	2800	2790	2930	(b)				
Co	34	36	39	34	37	30	(b)				
Ni											
Cu											
Zn											
Ga											
Ge ppb											
As											
Se											
Rb											
Sr											
Y											
Zr											
Nb											
Mo											
Ru											
Rh											
Pd ppb											
Ag ppb											
Cd ppb											
In ppb											
Sn ppb											
Sb ppb											
Te ppb											
Cs ppm											
Ba											
La	9.2	16.1	10.9	9.3	11.9	8.3	(b)				
Ce	25	54	35	28	36	29	(b)				
Pr											
Nd											
Sm	7.6	10.8	8.4	7.5	8.7	7.8	(b)				
Eu	2.1	2.4	2.1	2	2.1	2.2	(b)				
Gd											
Tb											
Dy											
Ho											
Er											
Tm											
Yb	6.4	8.5	6.6	6.2	7	6.6	(b)				
Lu	0.88	1.2	0.93	0.86	0.96	0.93	(b)				
Hf	6.2	8.6	6.6	6	6.5	6.3	(b)				
Ta											
W ppb											
Re ppb											
Os ppb											
Ir ppb											
Pt ppb											
Au ppb											
Th ppm								0.84	1.16	0.75	0.97
U ppm								0.19	0.27	0.21	

technique: (a) AA, (b) INAA

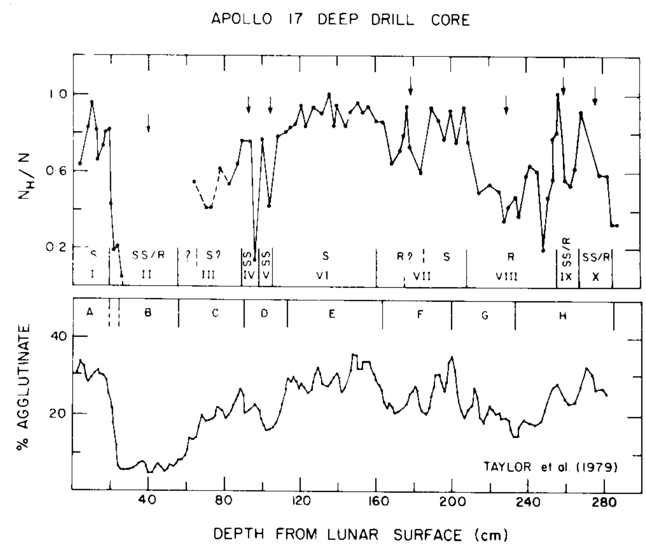

Figure 15: Track densities in feldspar and pyroxene grains in 80 samples along the length of the Apollo 17 deep drill (Goswami and Lal 1979). S stands for slow and R for rapid accretion, SS is for a soil slab deposit. Arrows indicated where material has been added in quick succession (nearby cratering event). Taylor et als measure of agglutinate content and litholgoical subdivision is given for comparison.

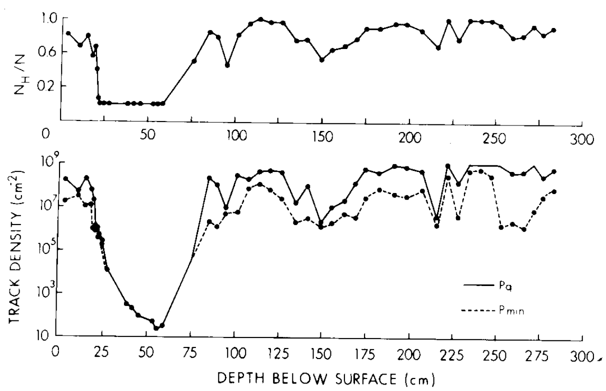

Figure !6: Track densities in feldspar grains from 49 individual layers in the Apollo 17 deep drill (Crozaz and Ross 1979).

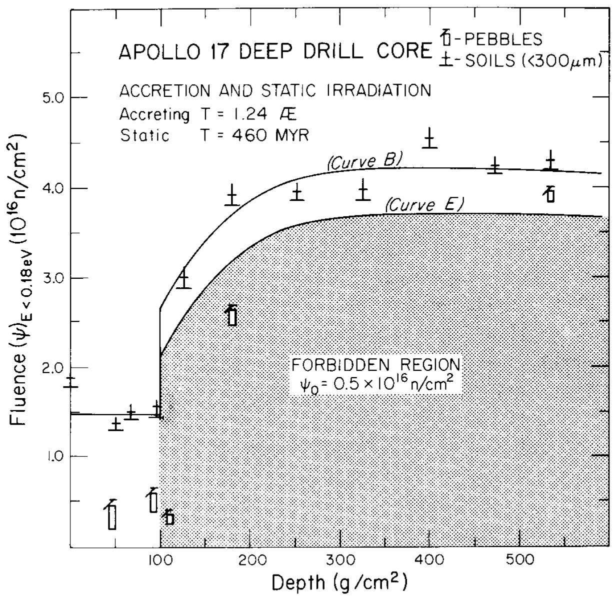

Figure 17: Gd isotopes of an individual particle violate the neutron flux model of Curtis and Wasserburg (1977b).

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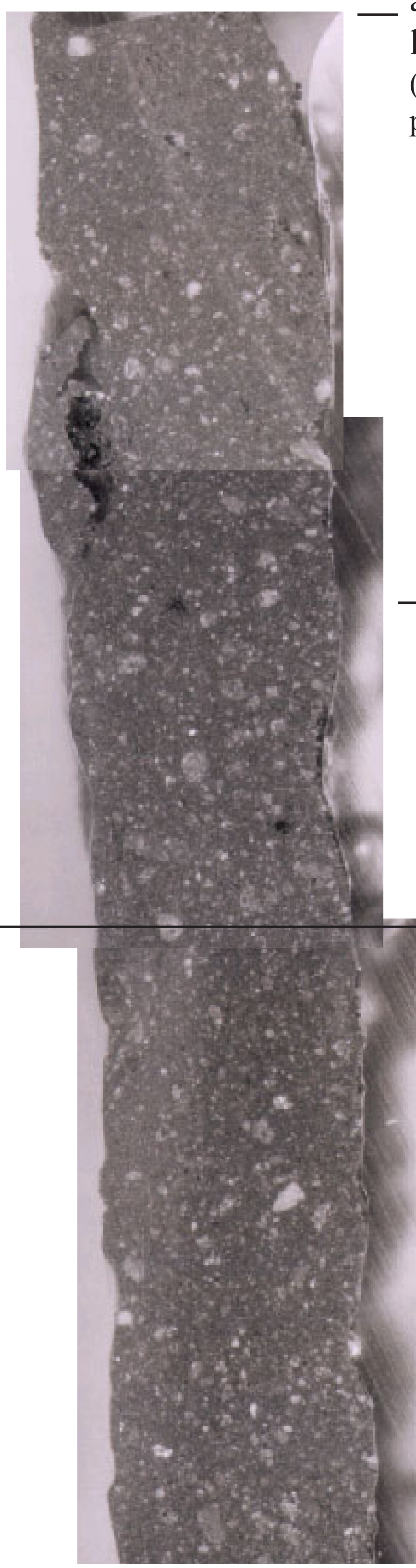
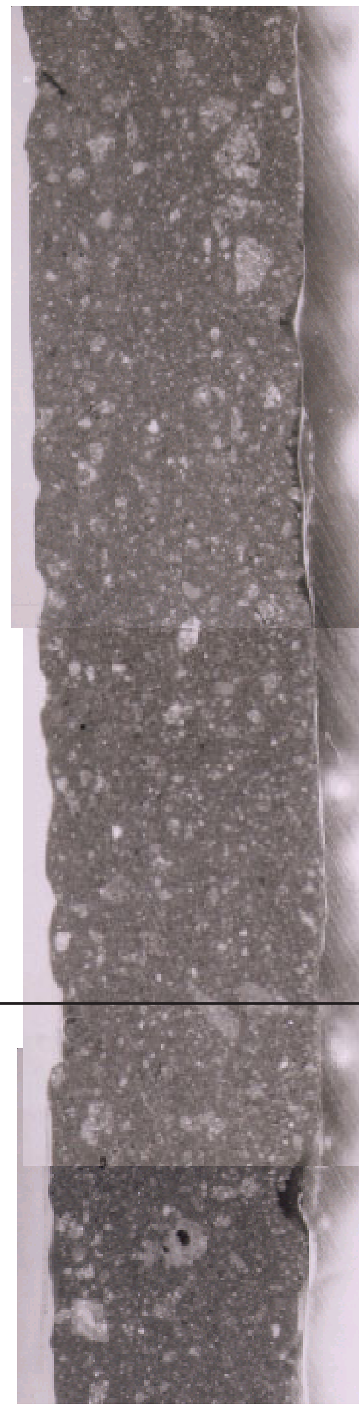
Table of calculated depth, densities and overburden mass of drill stem segments for Apollo 17 deep drill (Allton and Waltz 1980).

Core section	Depth below surface of top of core section (cm)	Core section length (cm)[a]	Core section weight (g)	Density (g/cm^3)[b]	Wt. of overburden at top of section (g/cm^2)
70009	0.0	25.1	143.3	1.75	0.0
70008	25.1	37.8	255.8[c]	2.07	43.84
70007	62.9	30.5	179.4	1.80	122.11
70006	93.4	38.8	234.2	1.85	176.99
70005	132.2	40.3[d]	240.7	1.83	248.65
70004	172.5	39.2	238.8	1.86	322.29
70003	211.7	39.5	237.8	1.84	395.35
70002	251.2	34.5[e]	207.8	1.84	468.10
joint between 70002-70001		0.6[f]			
70001	286.3	5.5	29.8	1.66	531.68
Totals		291.8 ± 1.6	1767.6 ± 7.2	1.85 (average)	540.80 ± 2.2

70009,277 epoxy encapsulated core





— 6 cm

,280 PB
,291 TS
,292 TS

— 7 cm

— 8 cm

,281 PB
,293 TS
,294 TS

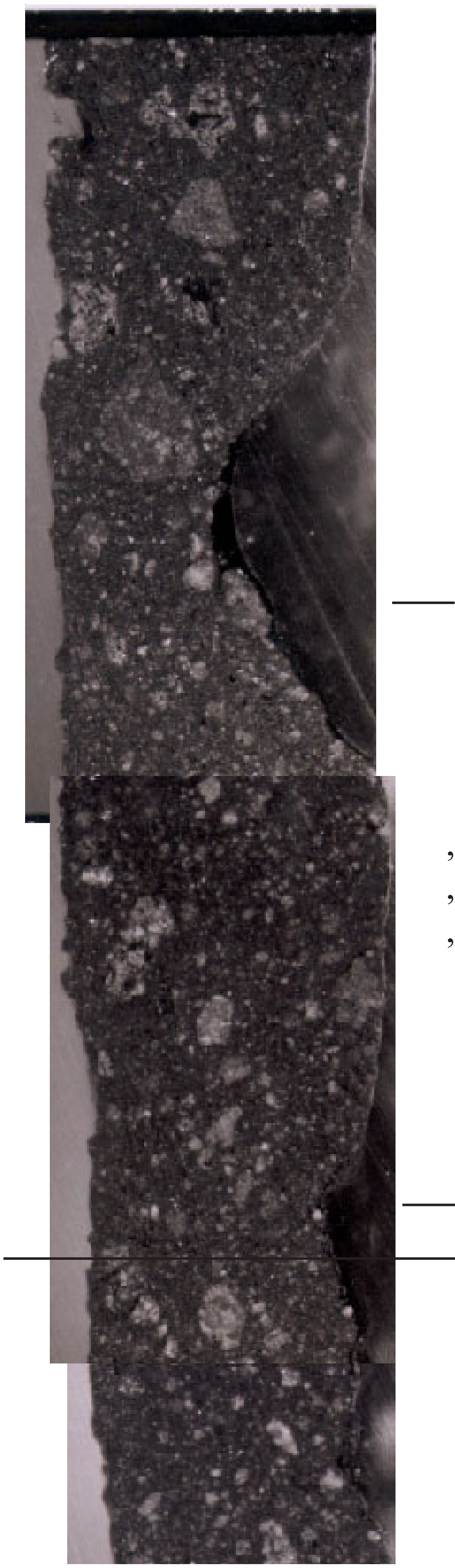
— 9 cm

—10 cm

—11 cm

70009

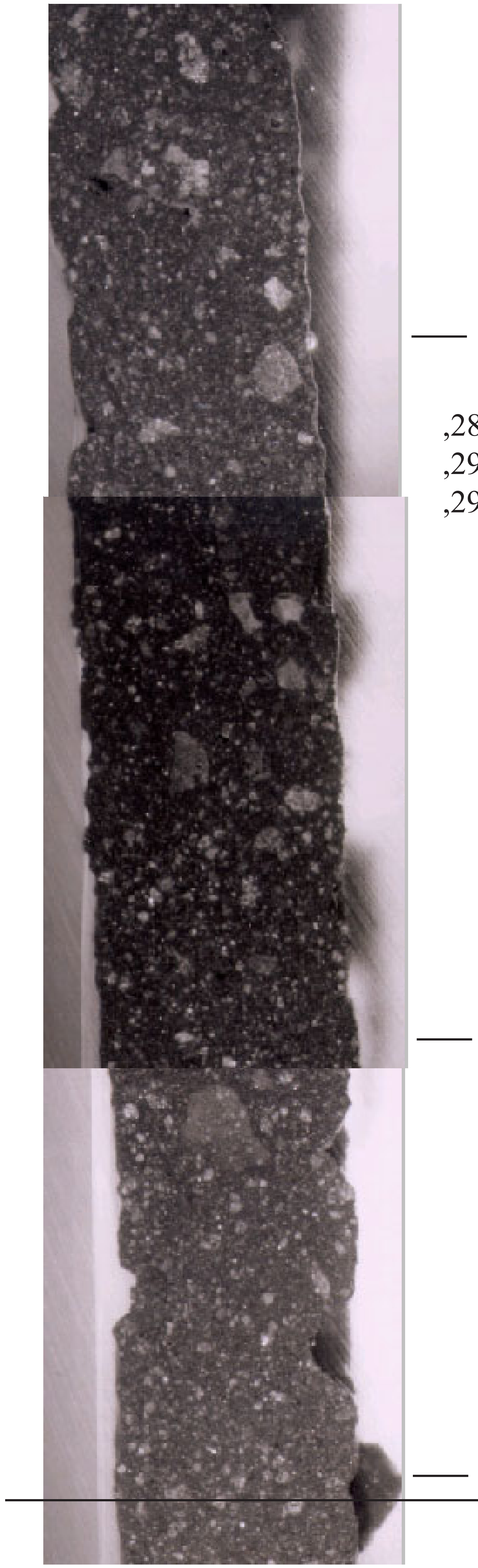
epoxy impregnated residual



12 cm

,282 PB
,295 TS
,296 TS

13 cm



14 cm

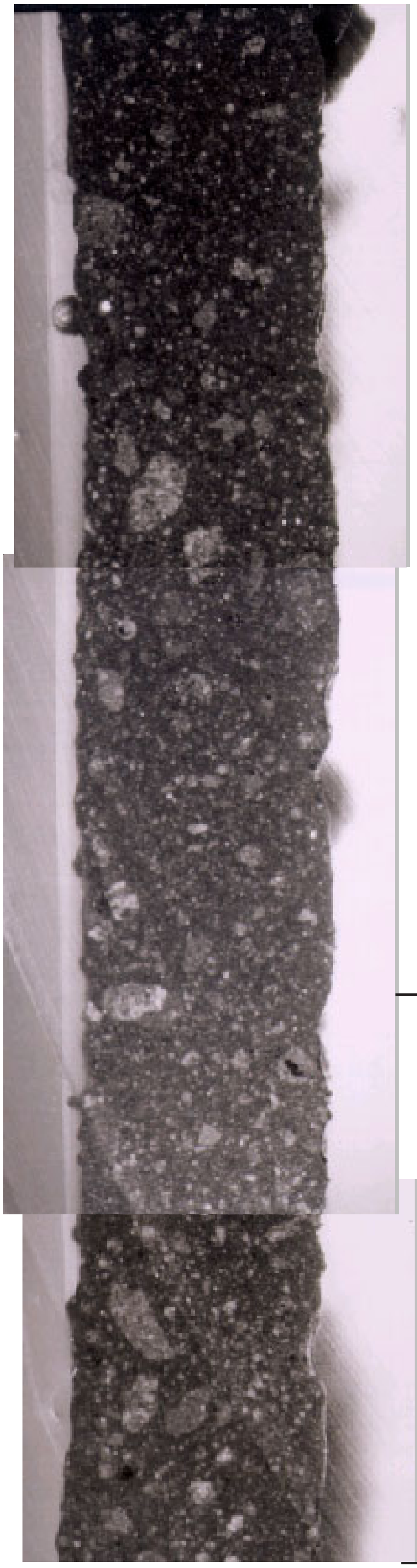
,283 PB
,297 TS
,298 TS

15 cm

16 cm

70009

epoxy impregnated residual



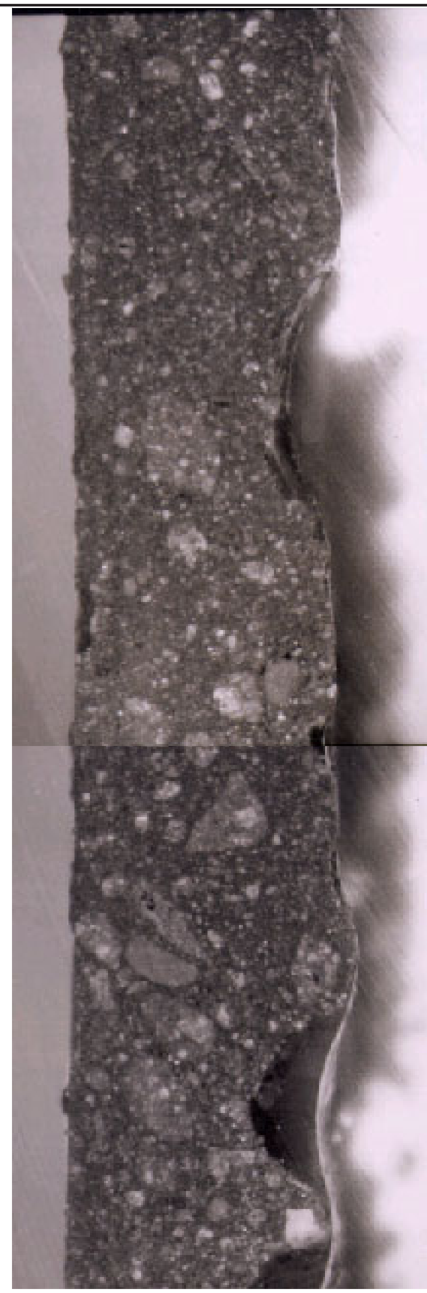
— 17 cm

,284 PB
,299 TS
,300 TS

— 18 cm

— 19 cm

19 cm

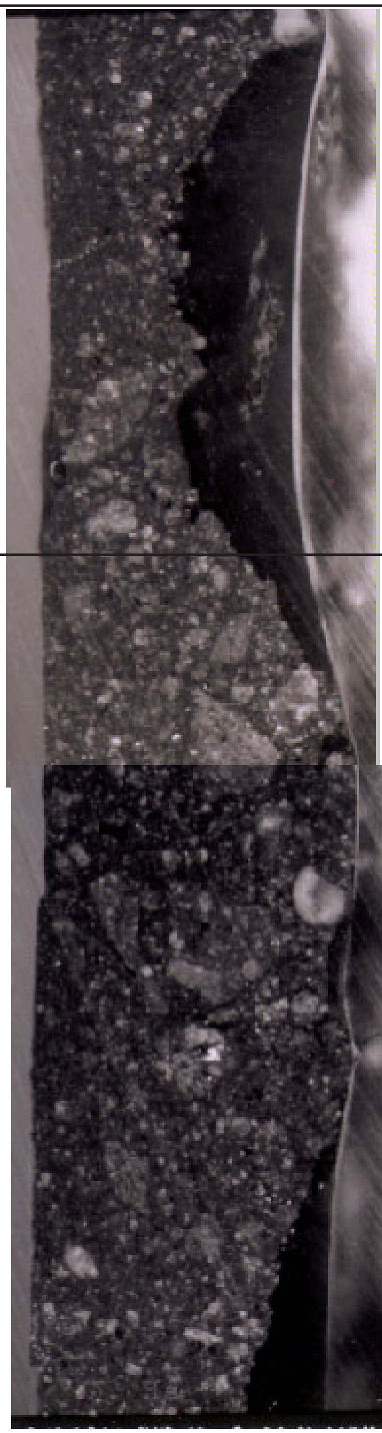


— 20 cm

,285 PB
,301 TS
,302 TS

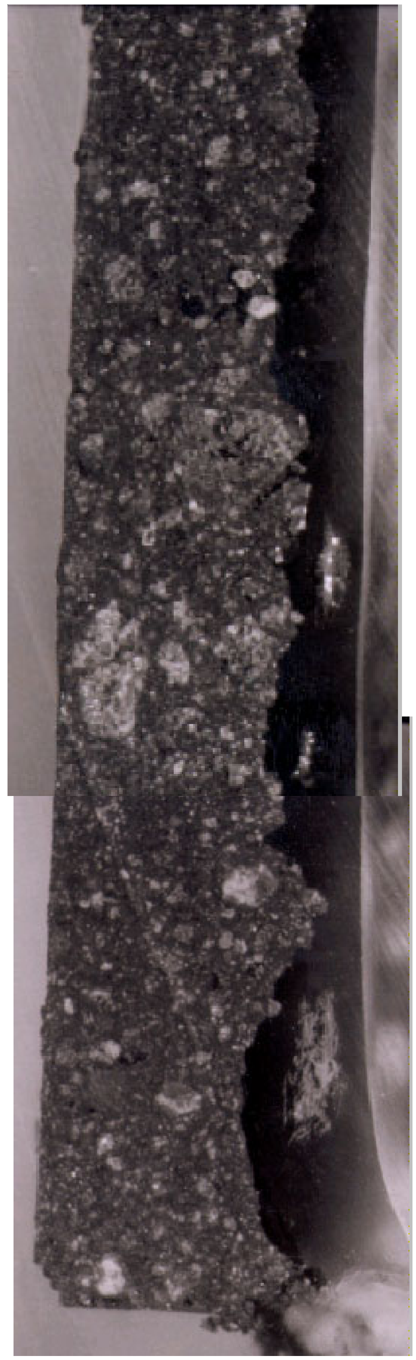
70009

epoxy impregnated residual



21 cm

22 cm



38 cm

,286 PB
,303 TS
,304 TS

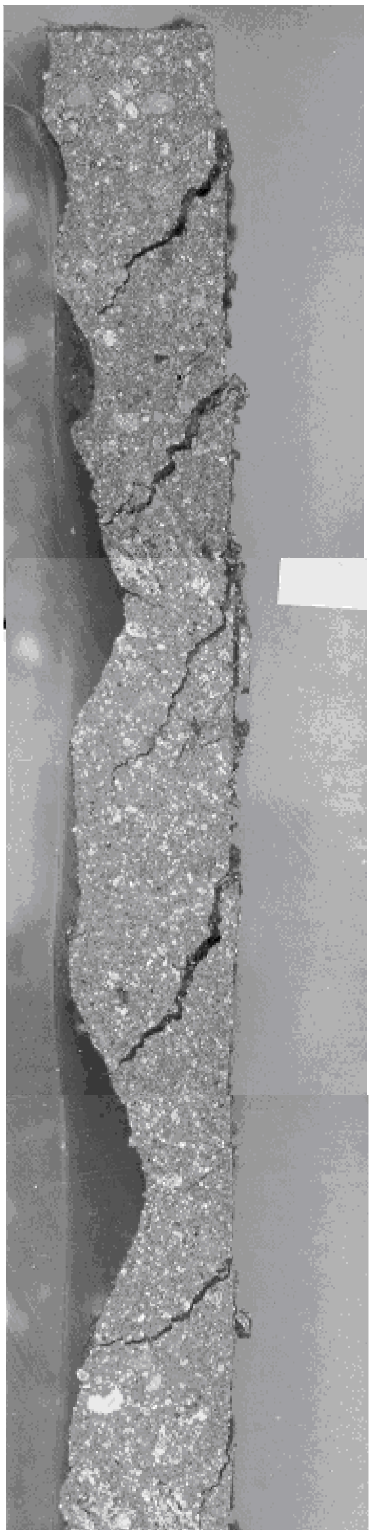
24 cm

25 cm

(note: presumably 5 mm was removed form the top of each segment)

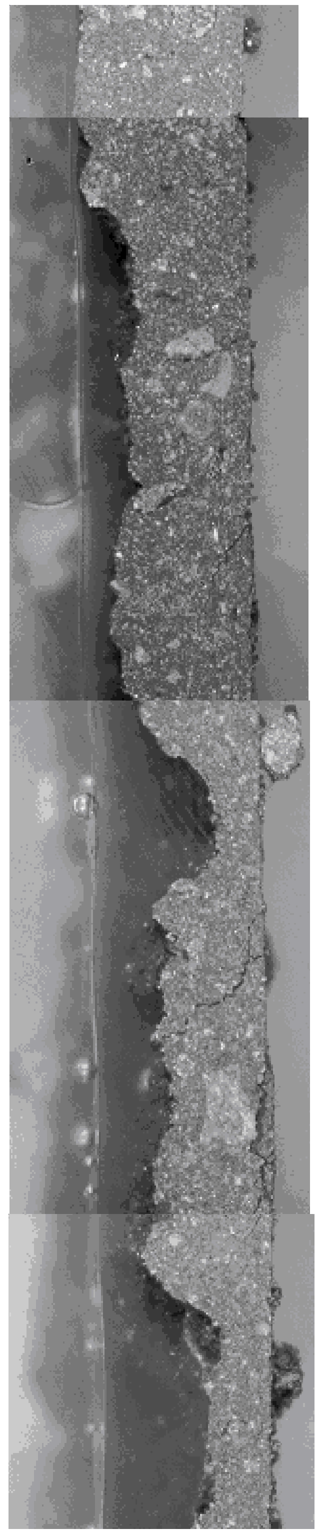
70008,264
epoxy
encapsulated
core

W1

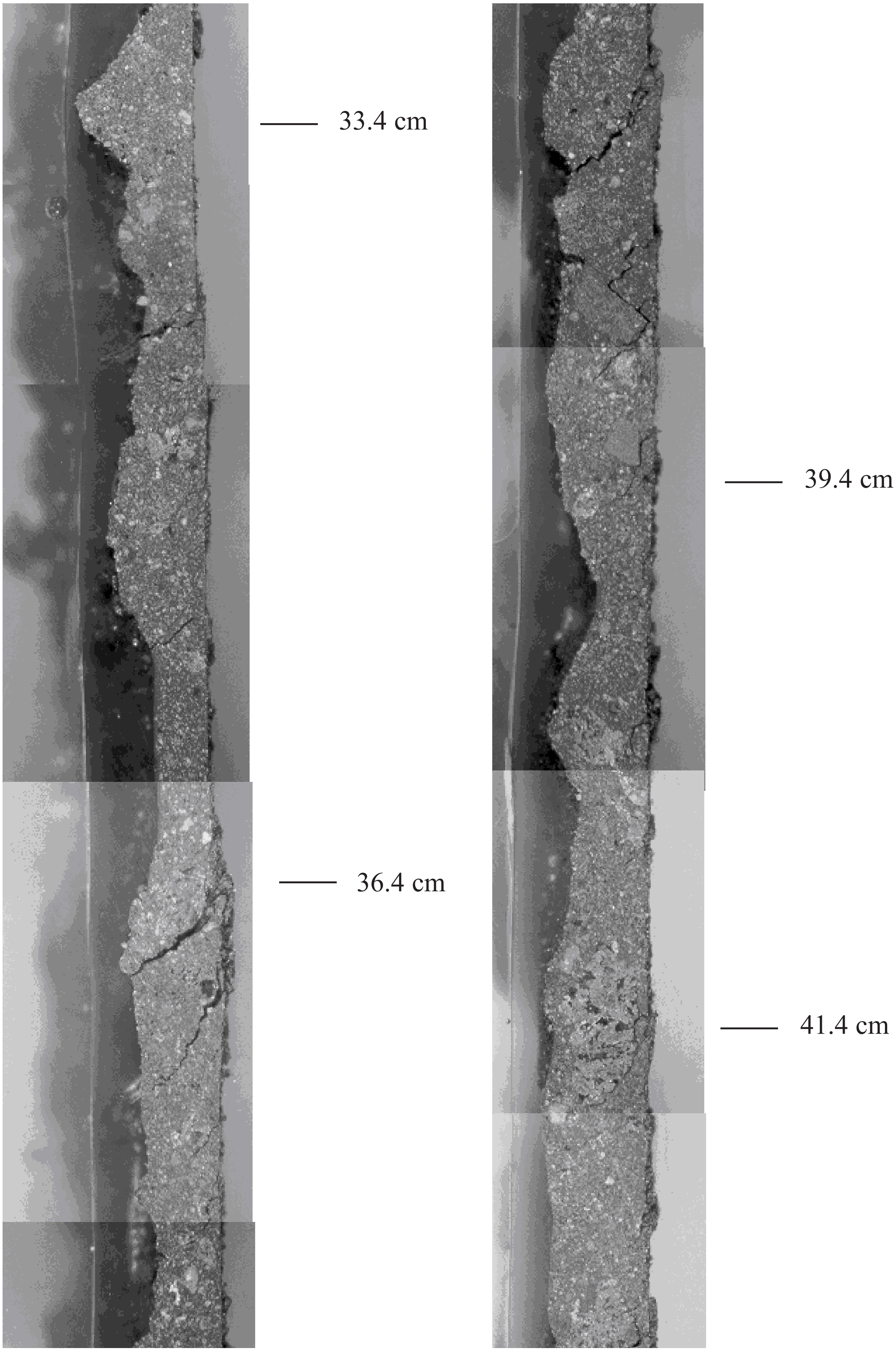


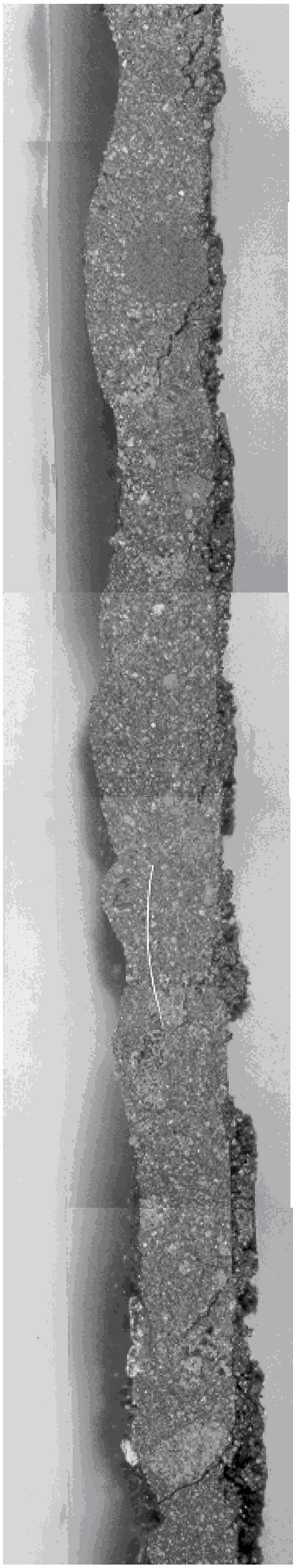
25.1 cm
(from
Allton and
Waltz)

27.4 cm

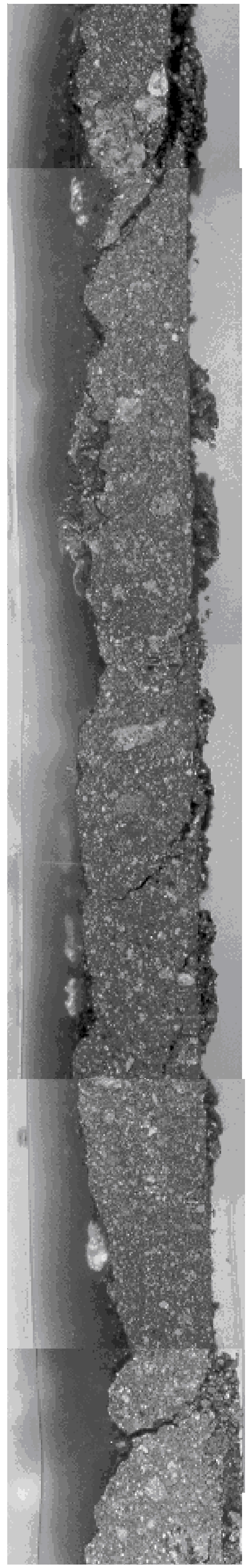


31.4 cm


33.4 cm
36.4 cm
39.4 cm
41.4 cm

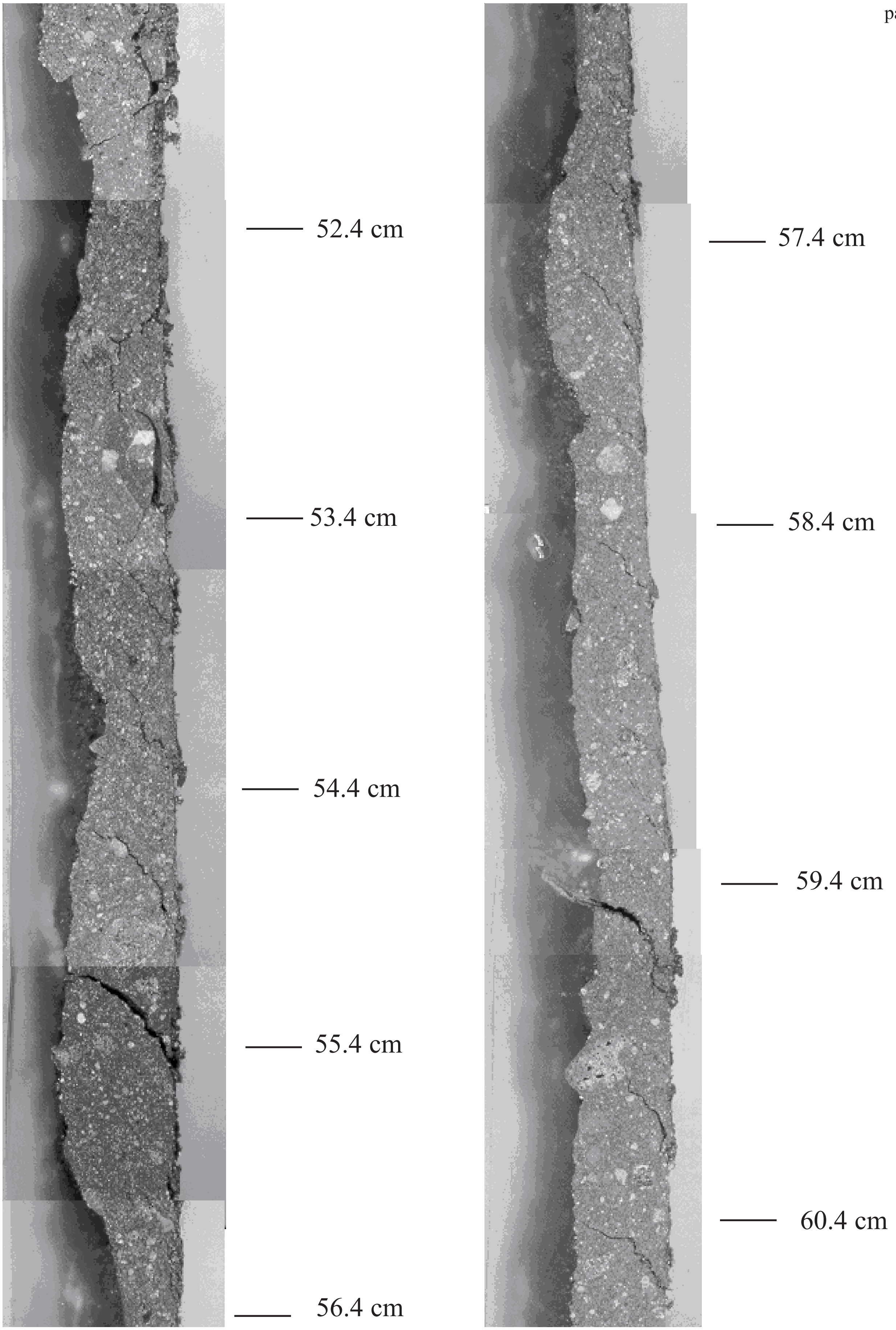


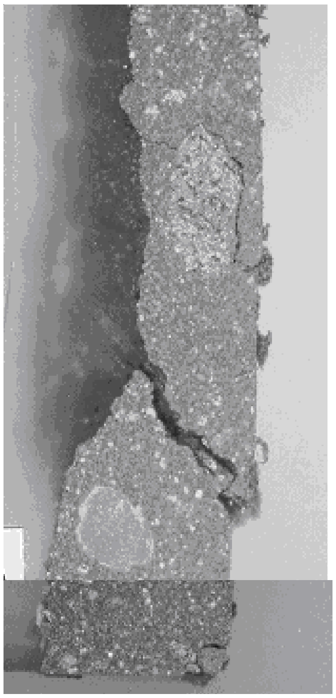
43.4 cm



47.4 cm

51.4 cm


52.4 cm
53.4 cm
54.4 cm
55.4 cm
56.4 cm
57.4 cm
58.4 cm
59.4 cm
60.4 cm



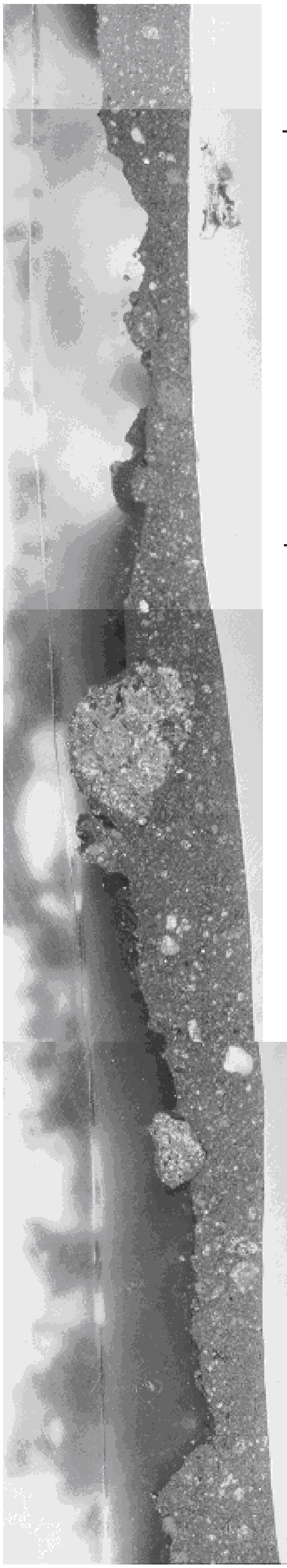
61.4 cm

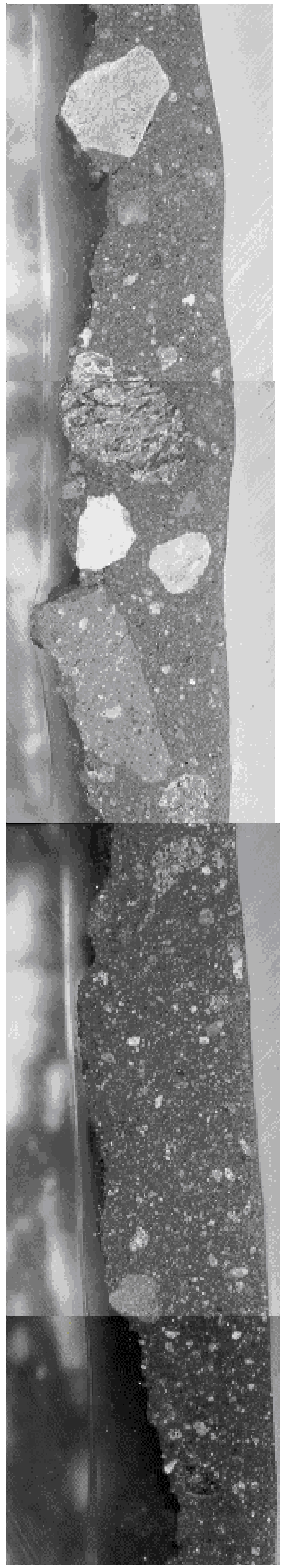
62.8 cm

(note: presumably 5 mm was removed form the top of each segment)

70007,157
epoxy
encapsulated
core

62.9 cm
(a la
Allton and
Waltz)


64.8 cm
65.8 cm
66.8 cm
67.8 cm

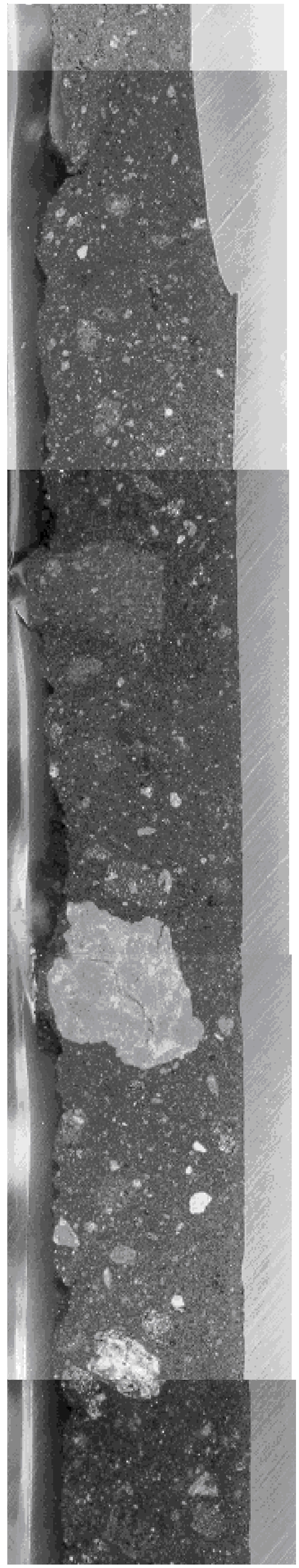

68.8 cm
69.8 cm
70.8 cm
71.8 cm

72.8 cm

73.8 cm

74.8 cm

75.8 cm

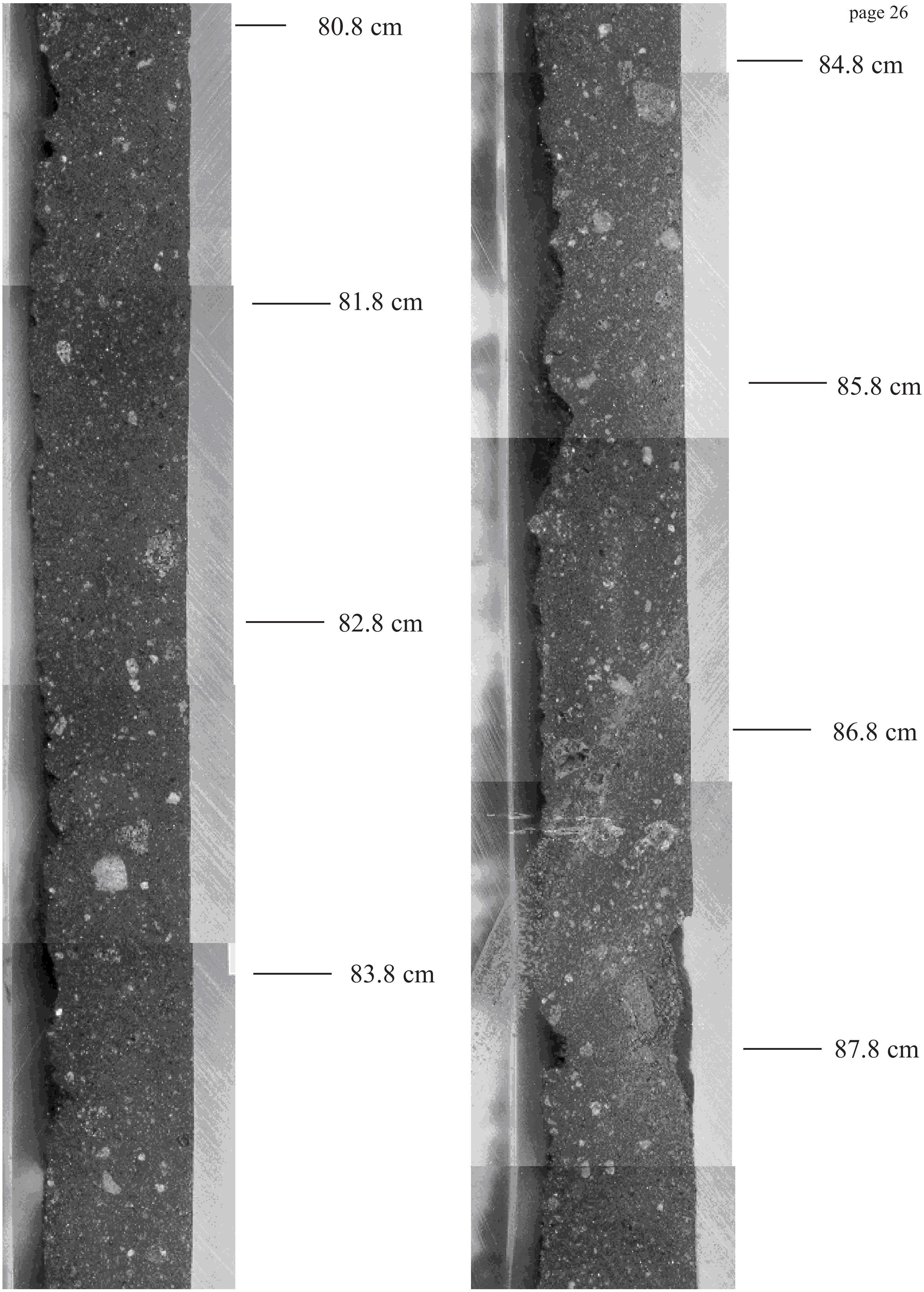


76.8 cm

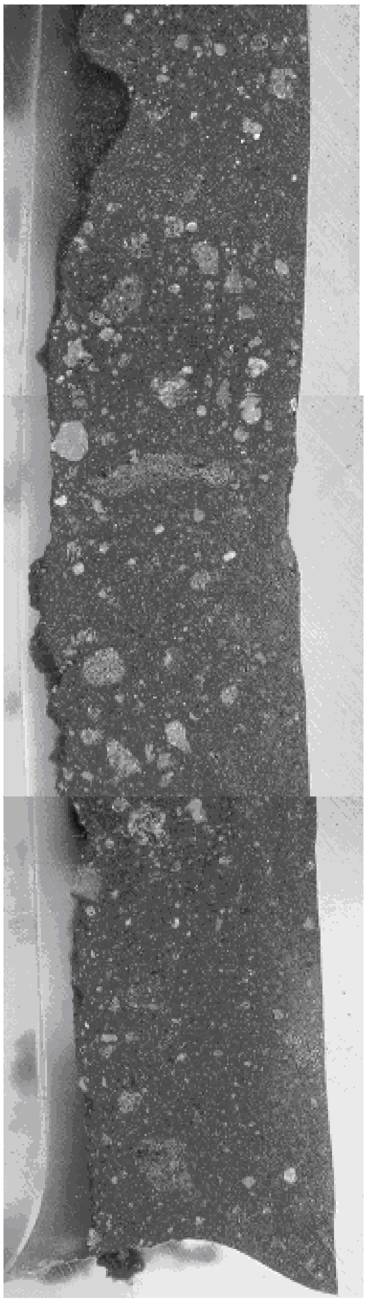
77.8 cm

78.8 cm

79.8 cm


80.8 cm
81.8 cm
82.8 cm
83.8 cm
84.8 cm
85.8 cm
86.8 cm
87.8 cm

70006, epoxy encapsulated core (continued)



88.8 cm

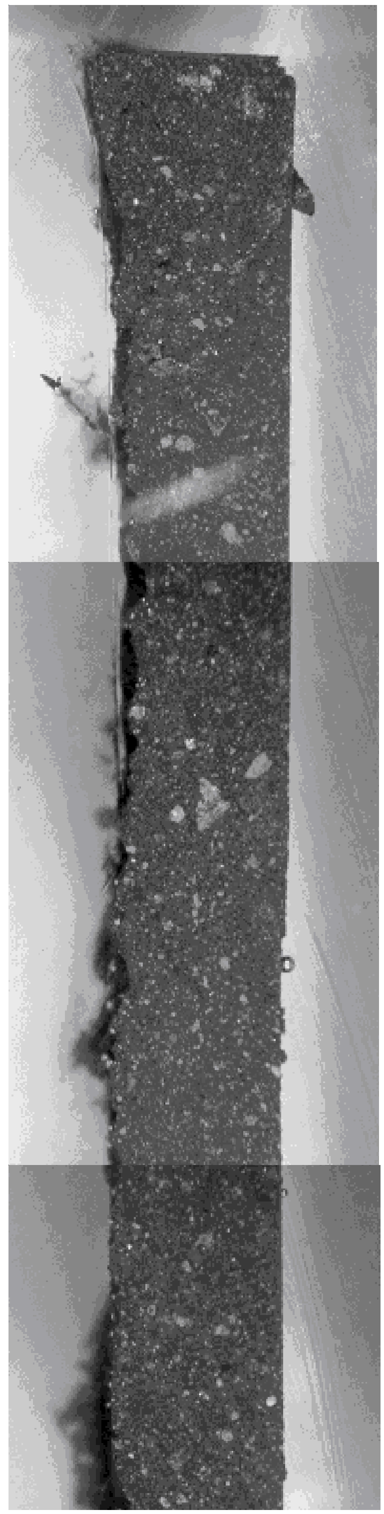
89.8 cm

90.8 cm

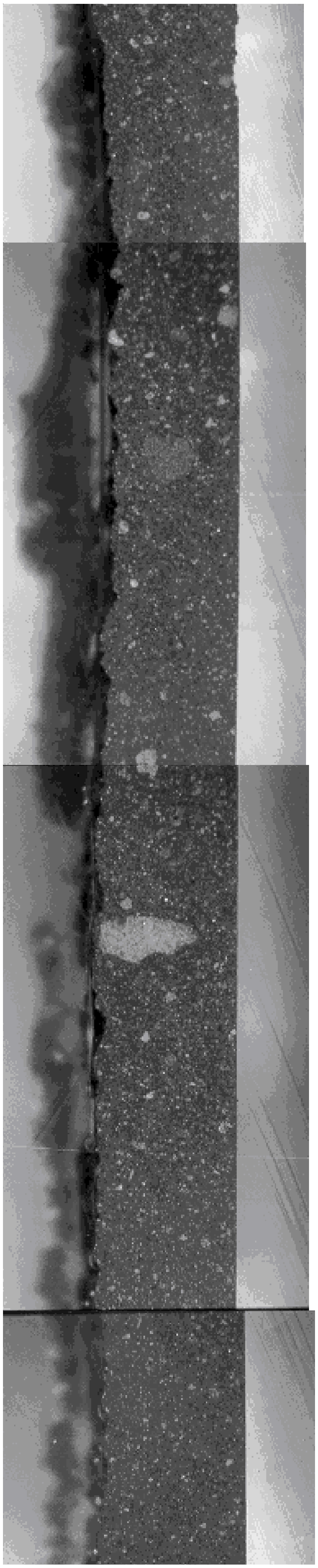
91.8 cm

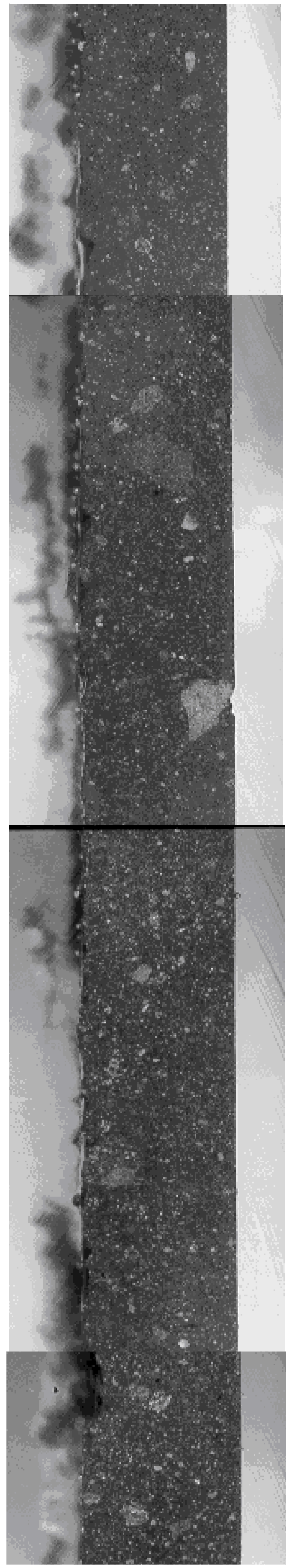
bottom of 70007

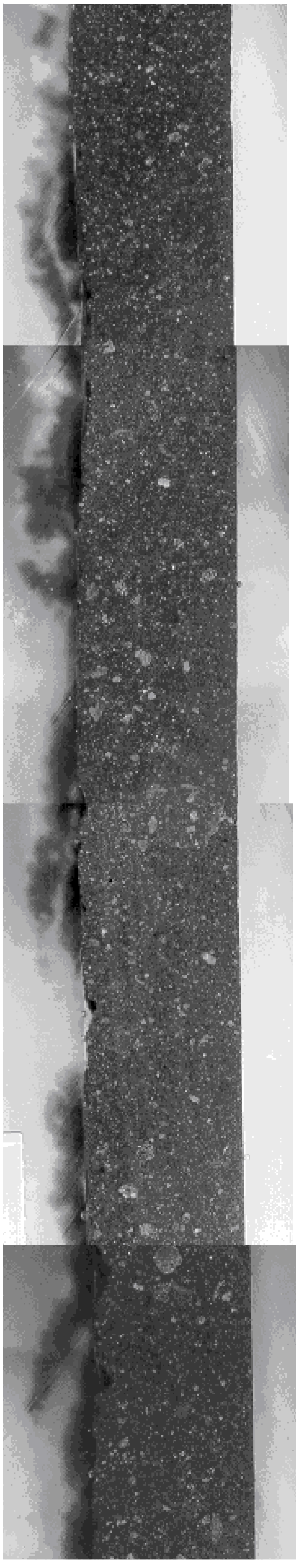
(note: presumably 5 mm was removed form the top of each segment)

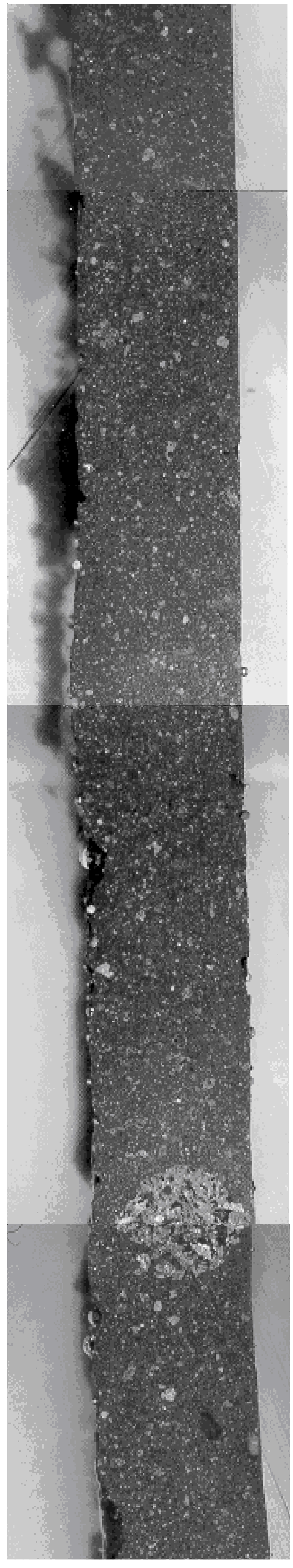


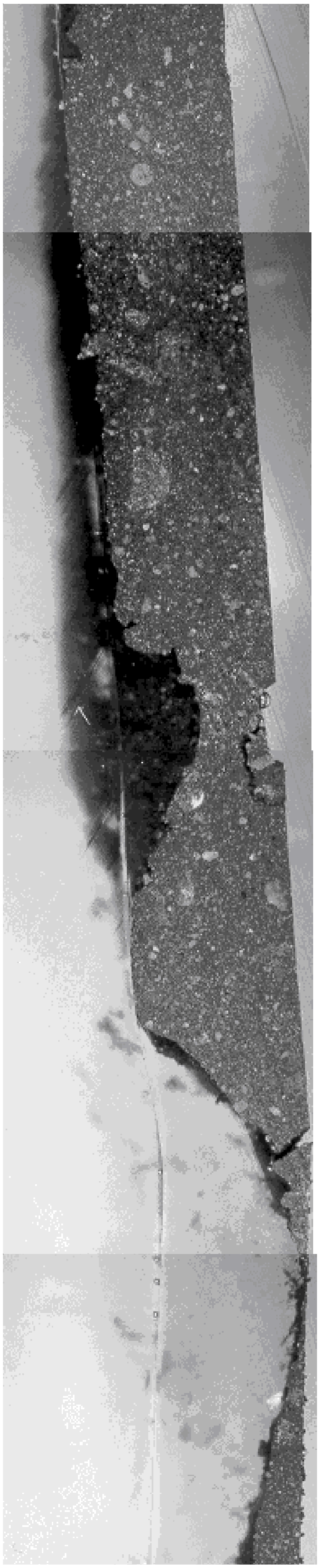
depth 93.4 cm (a la Allton and Waltz)

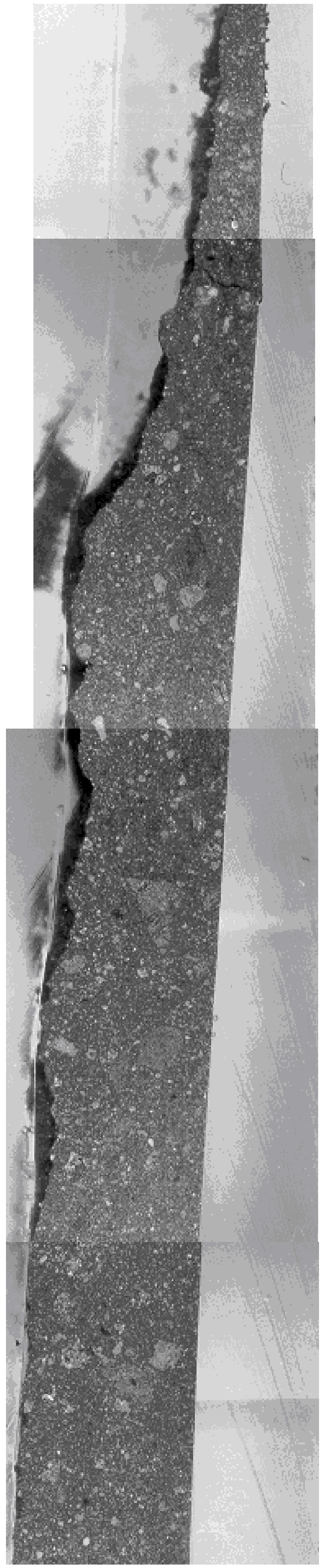


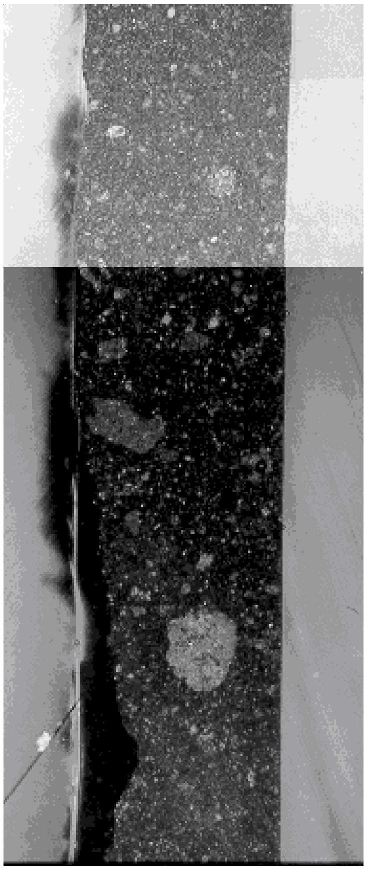


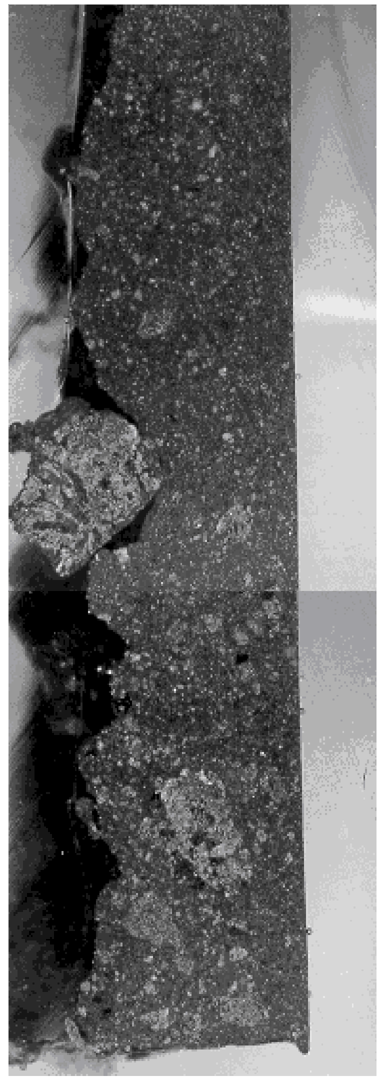






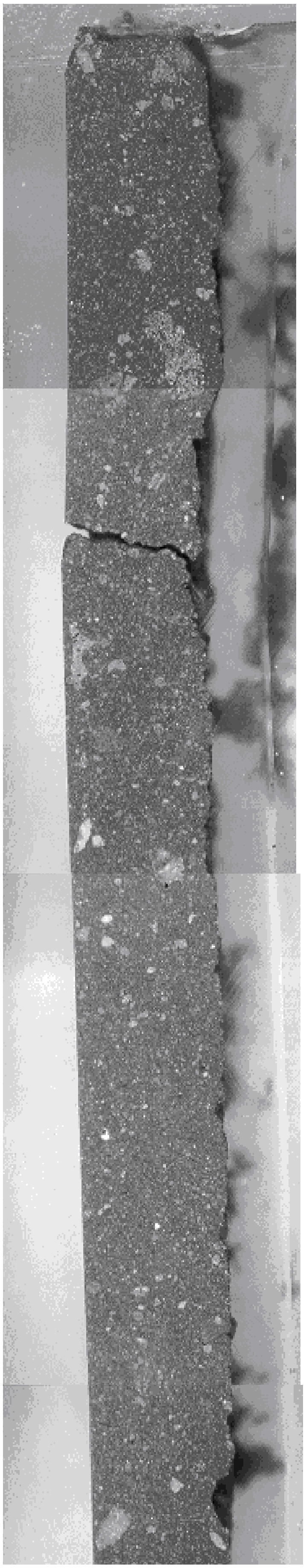






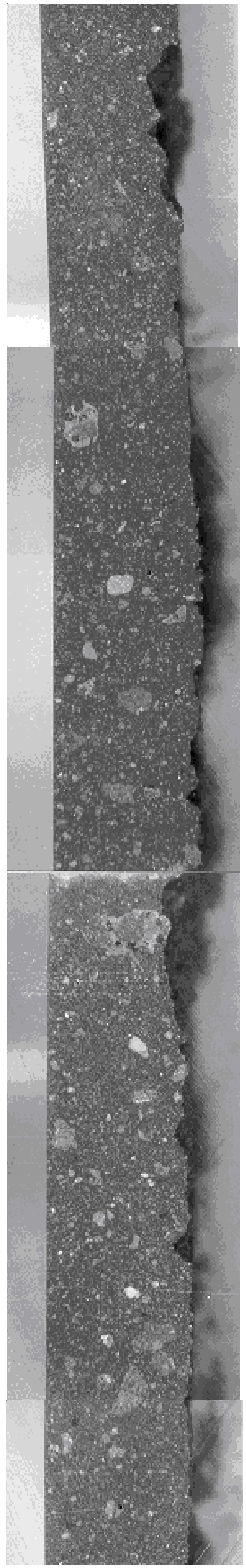
bottom of 70006,

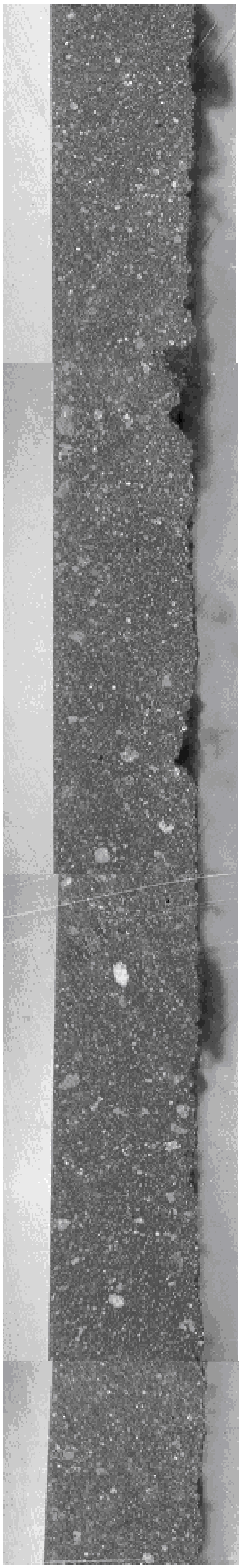
(note: presumably 5 mm was removed form the top of each segment)

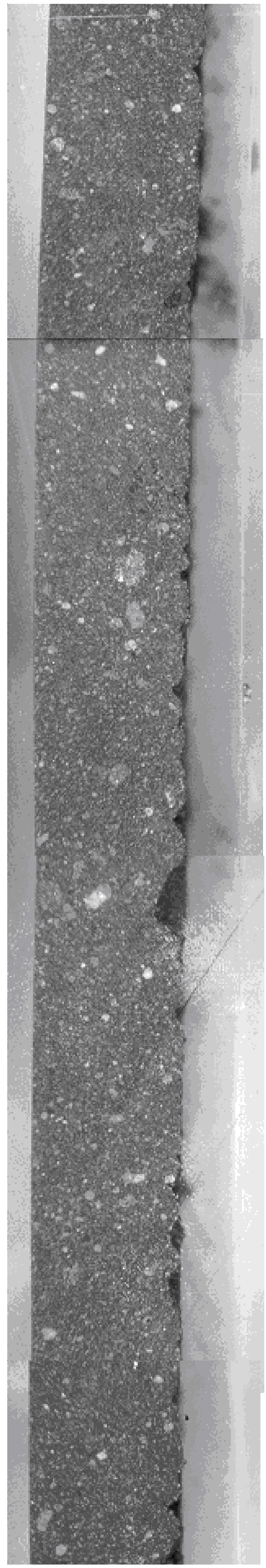


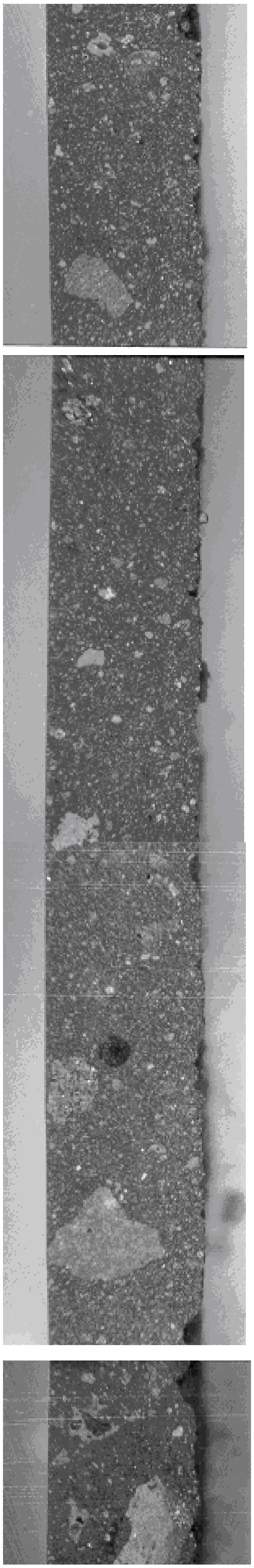
depth 132.2 cm
(a la Allton and Waltz)

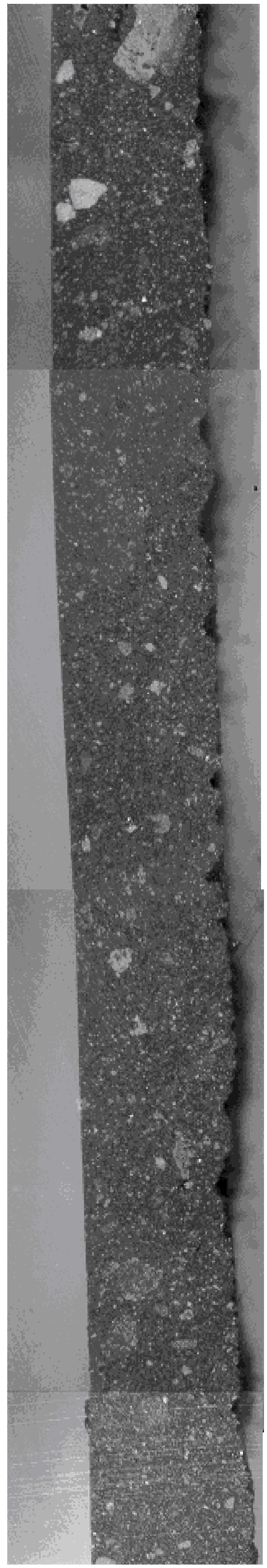
70005, epoxy encapsulated core (continued)

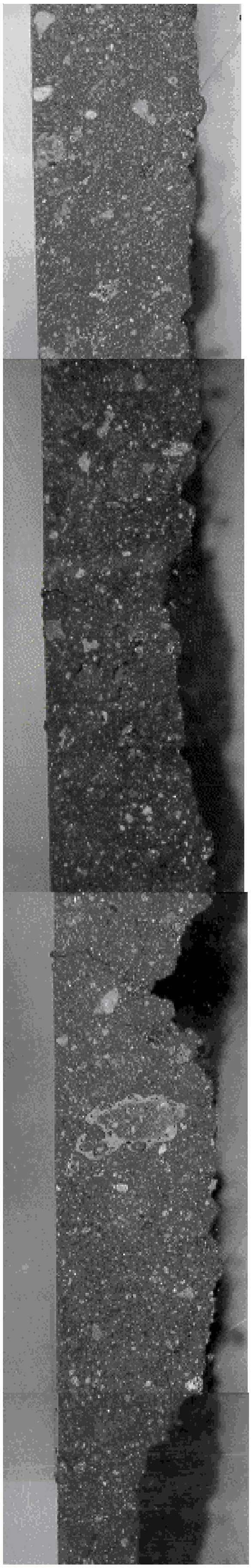


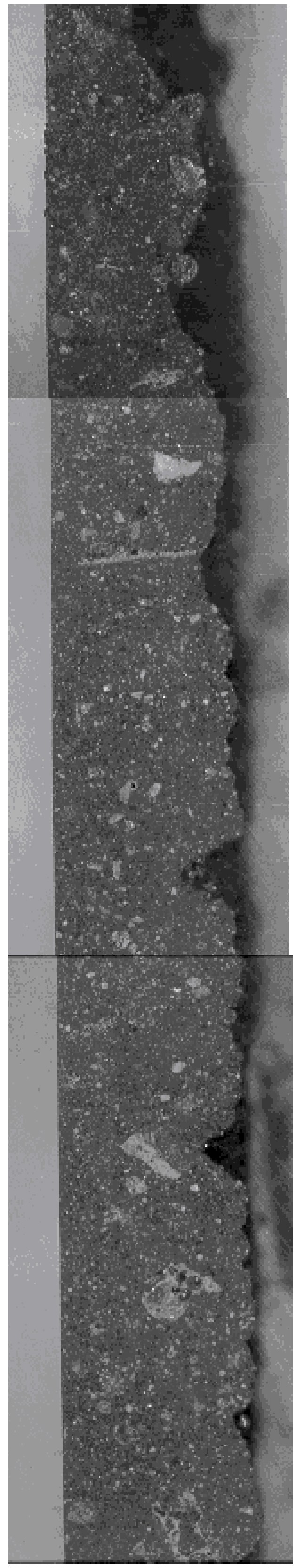


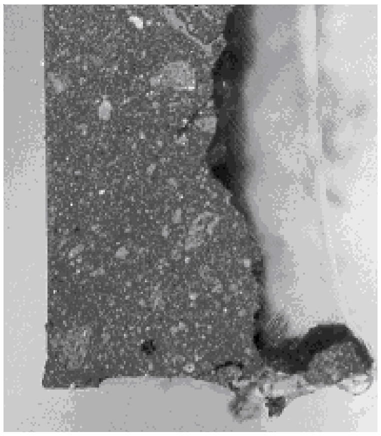






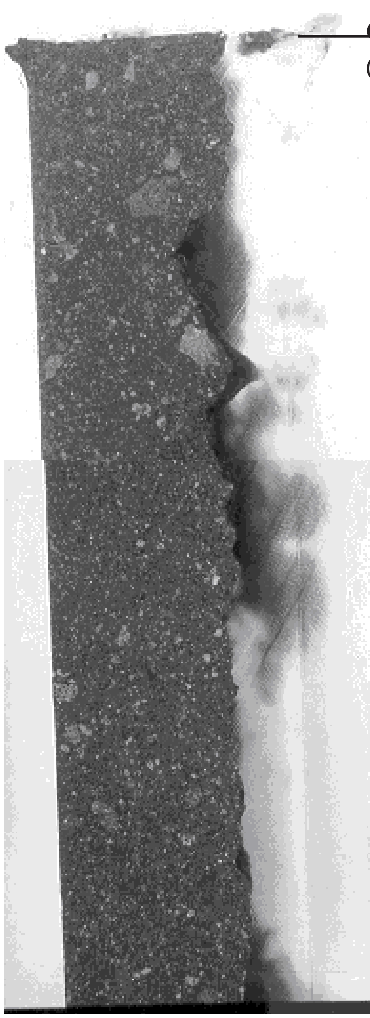






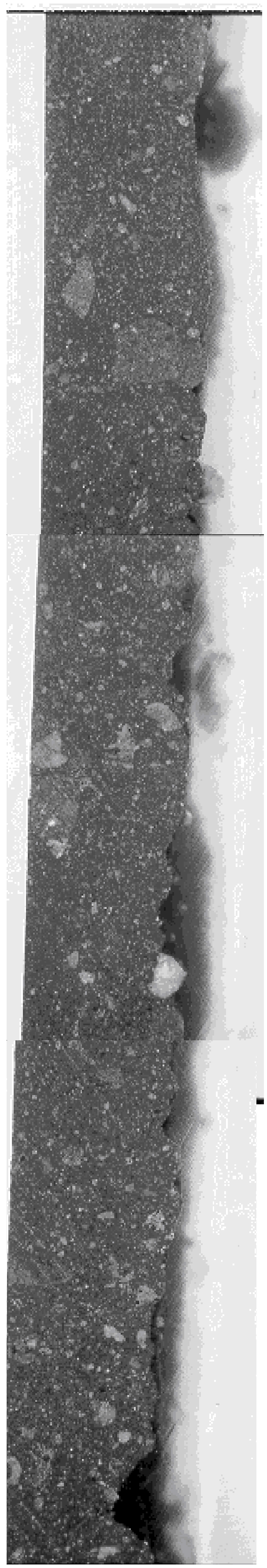
bottom of 70005

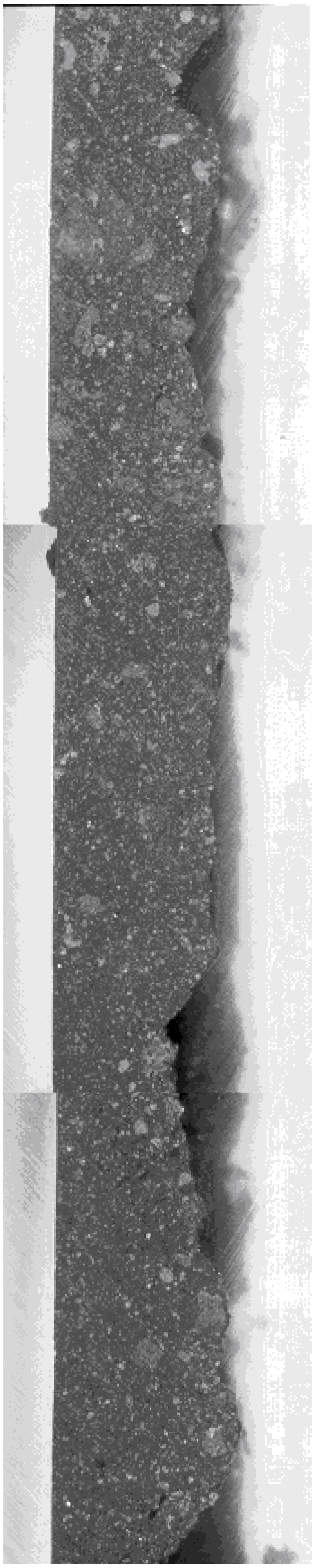
(note: presumably 5 mm was removed form the top of each segment)

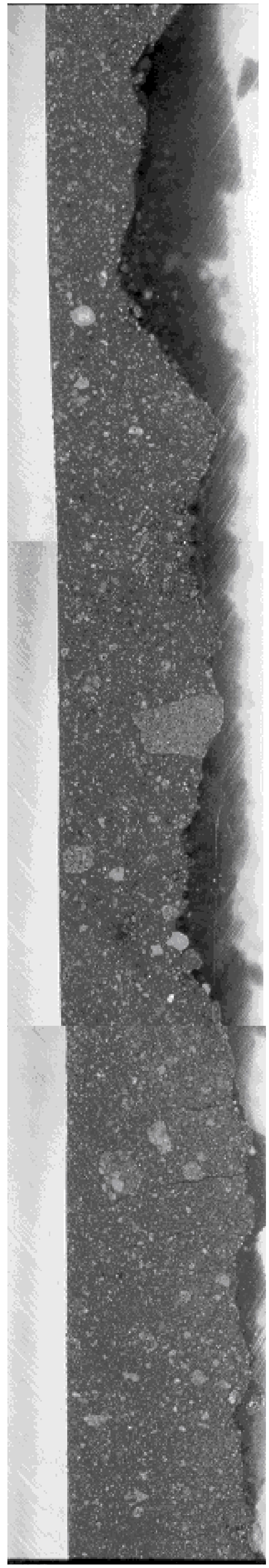


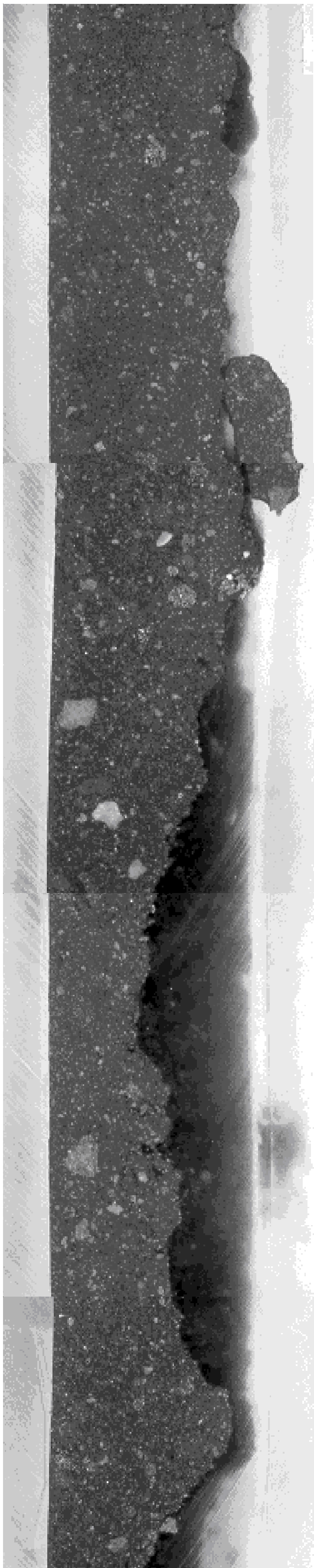
depth 172.5 cm
(a la Allton and Waltz)

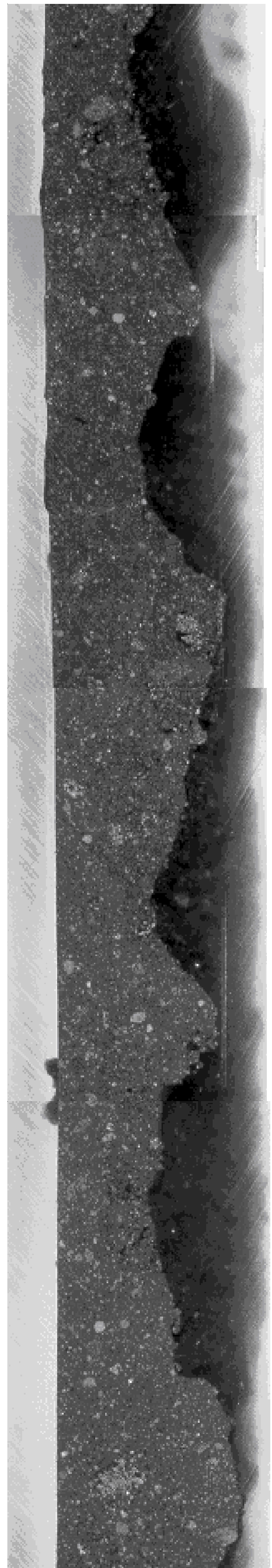
70004,
epoxy
encapsulated
core

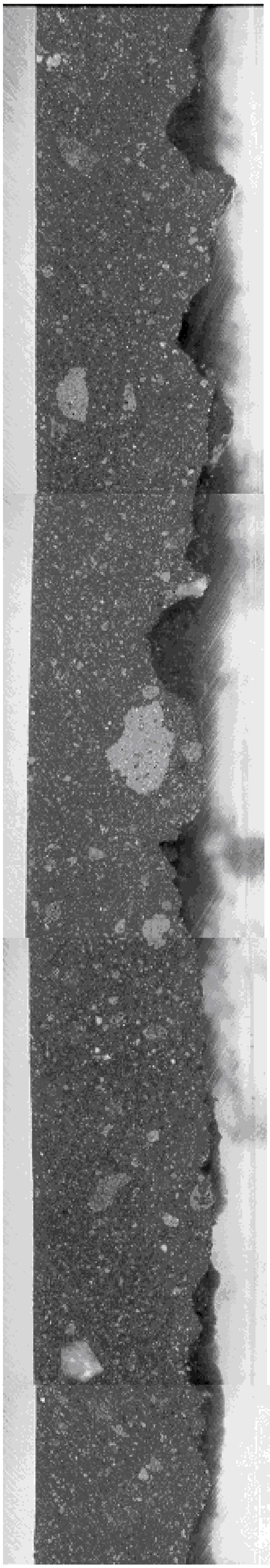


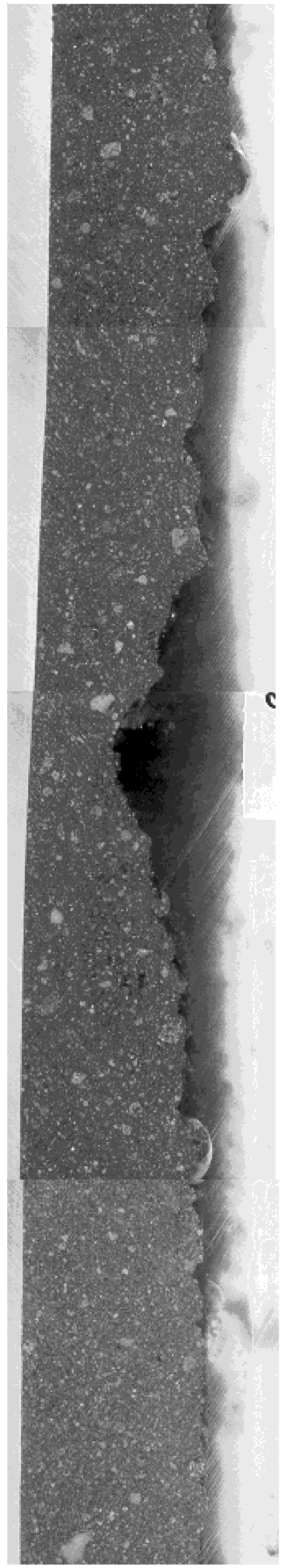


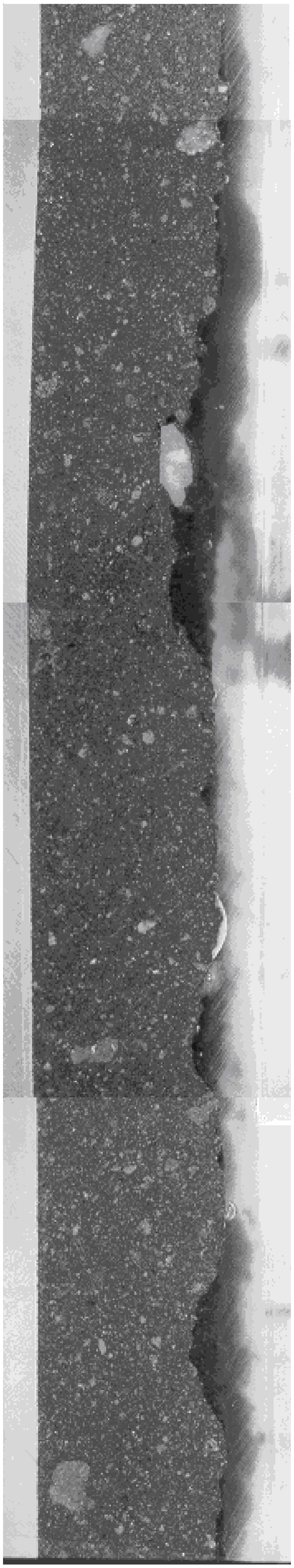


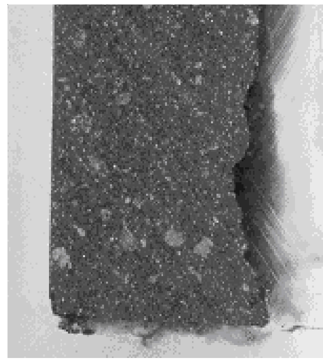






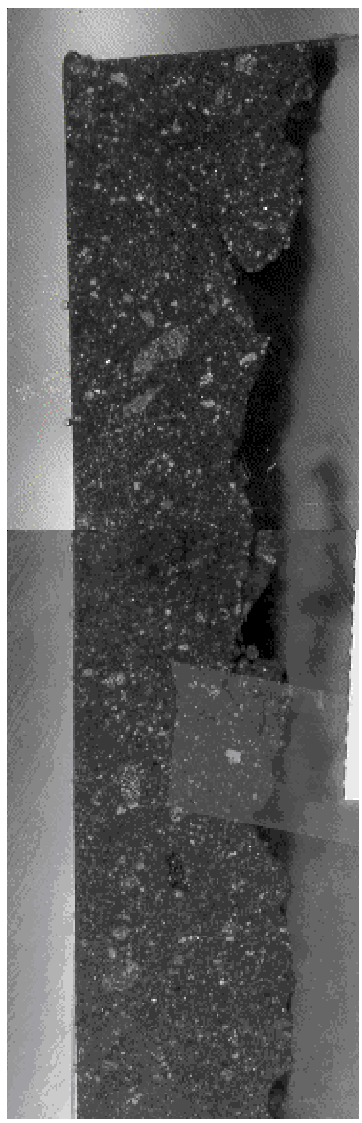






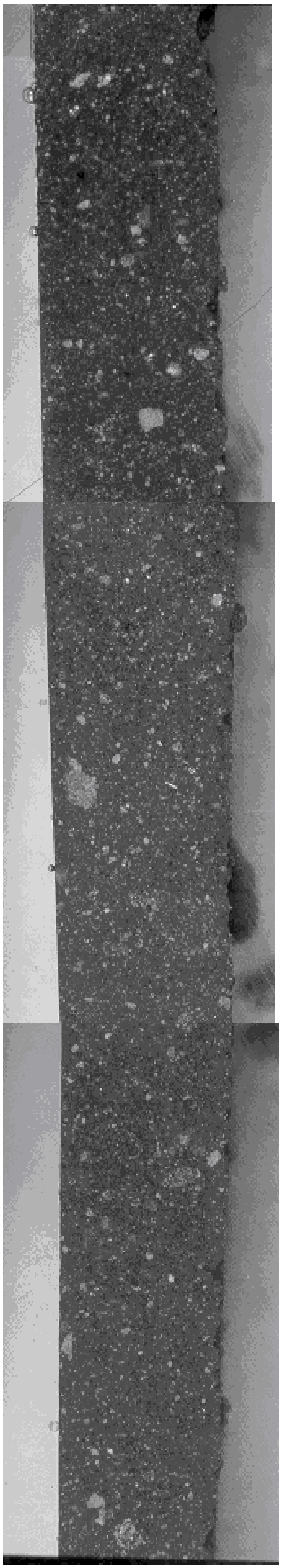
bottom of 70004

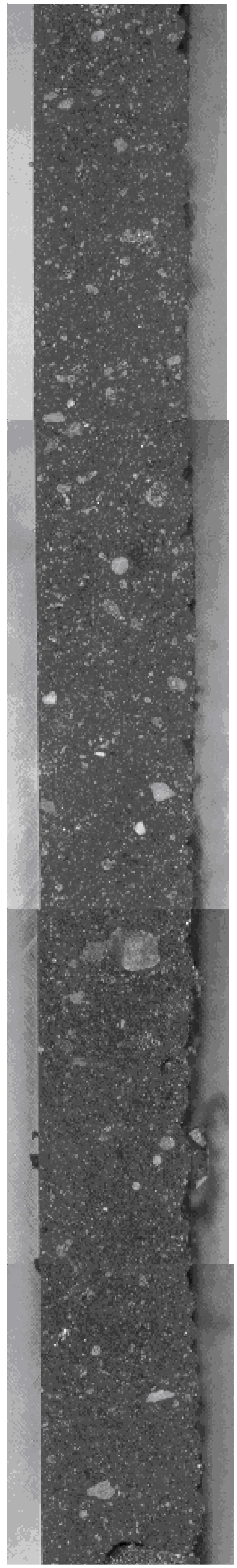
(note: presumably 5 mm was removed form the top of each segment)

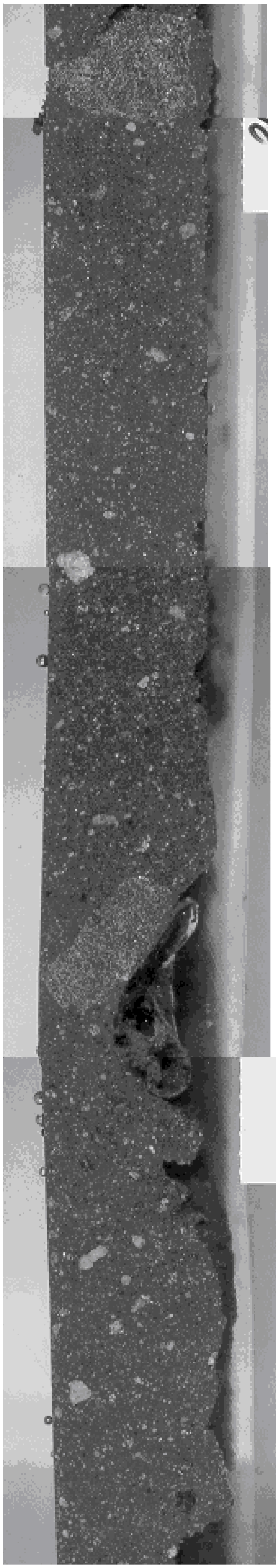


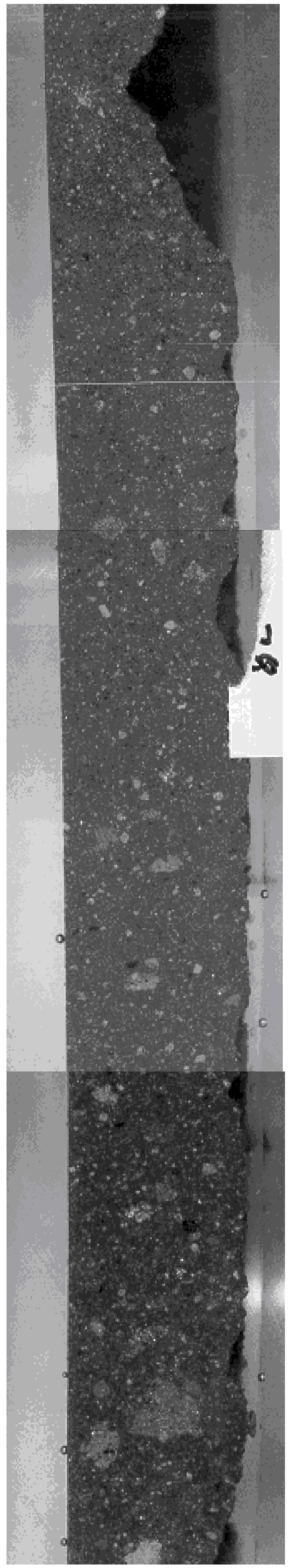
depth = 211.7 cm
(a la Allton and Waltz)

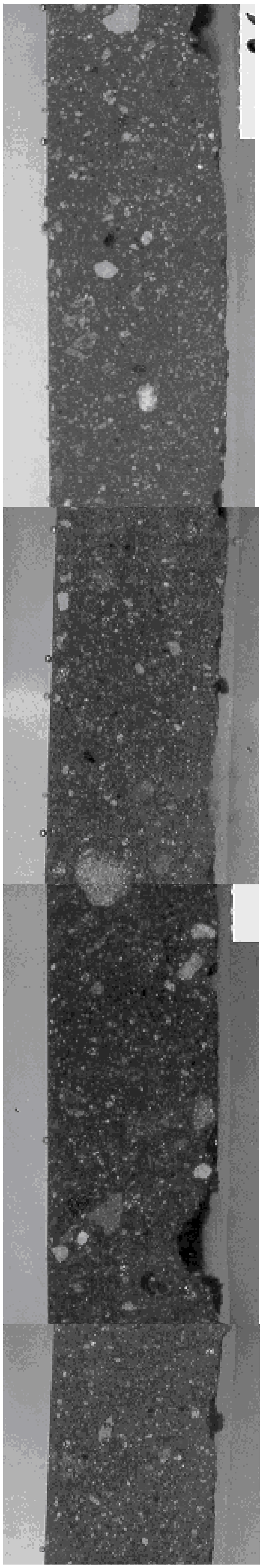
70003, epoxy encapsulated core

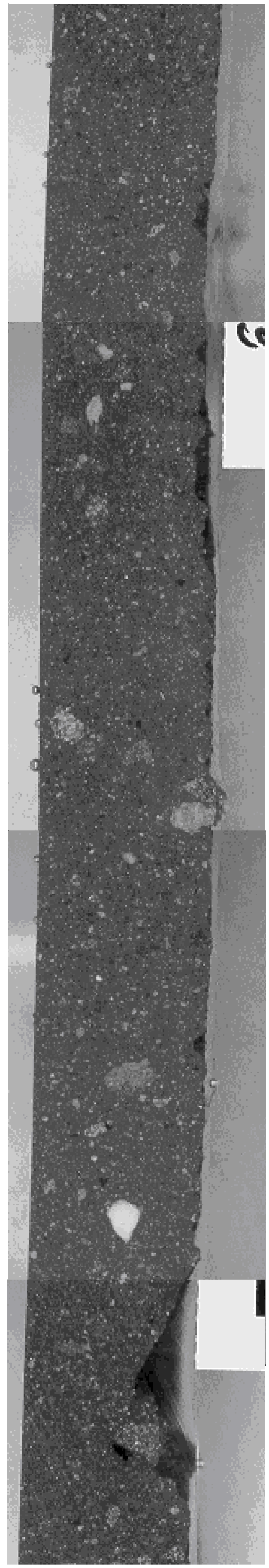


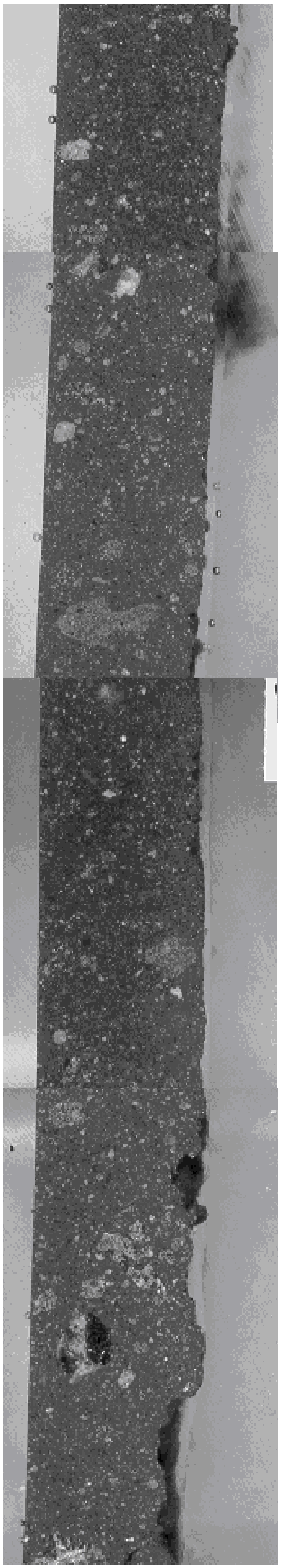


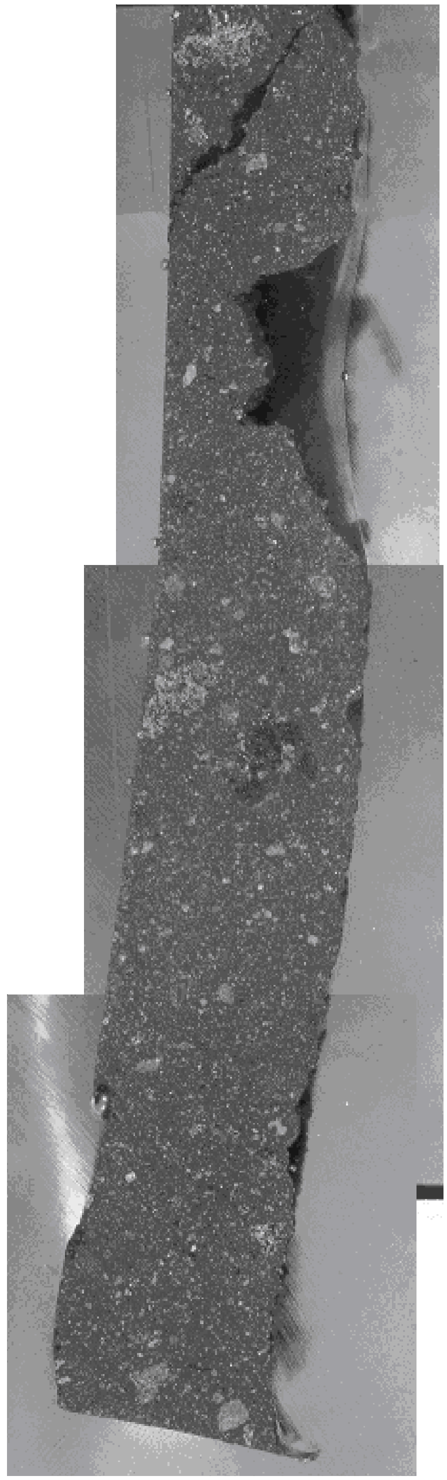




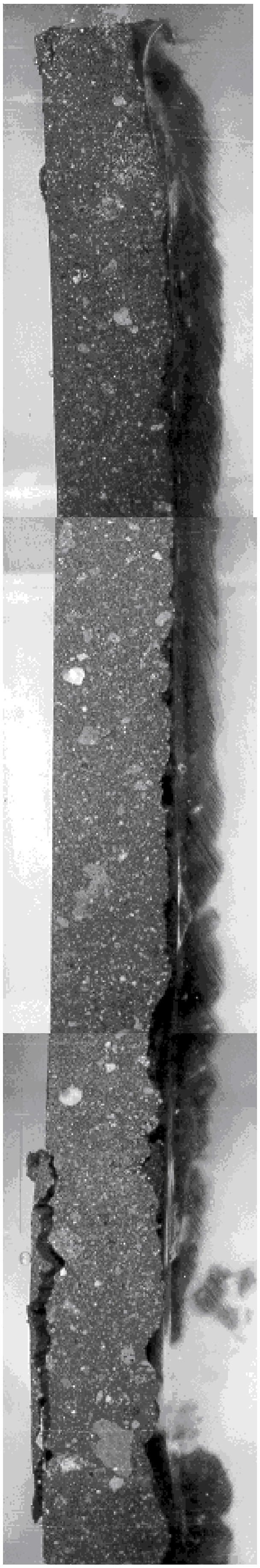






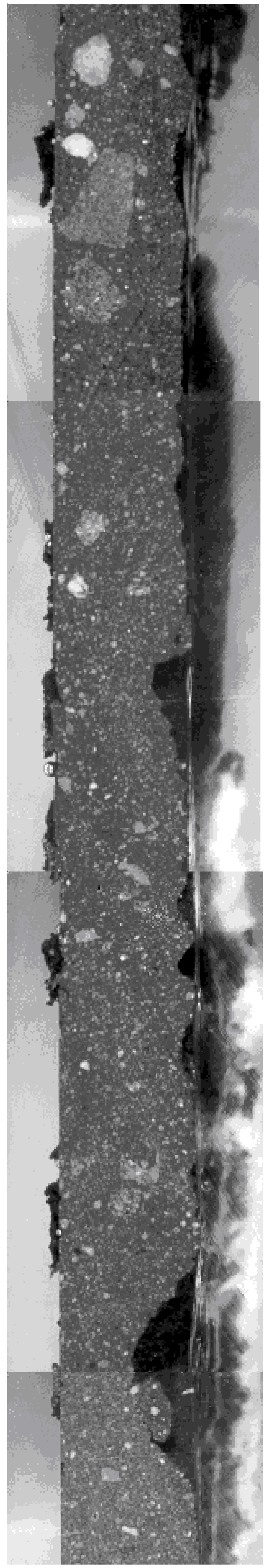


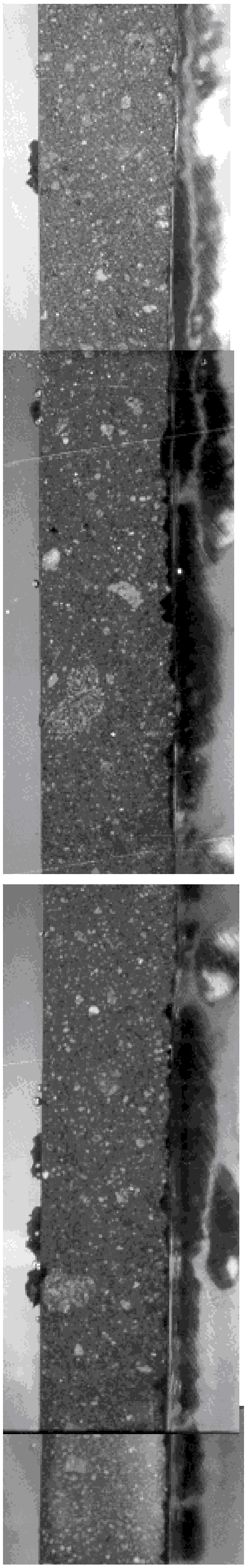
(note: presumably 5 mm was removed form the top of each segment)

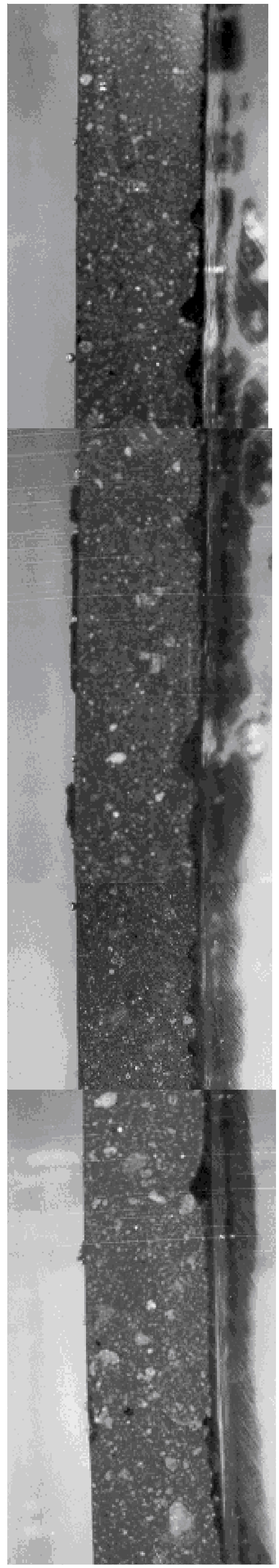


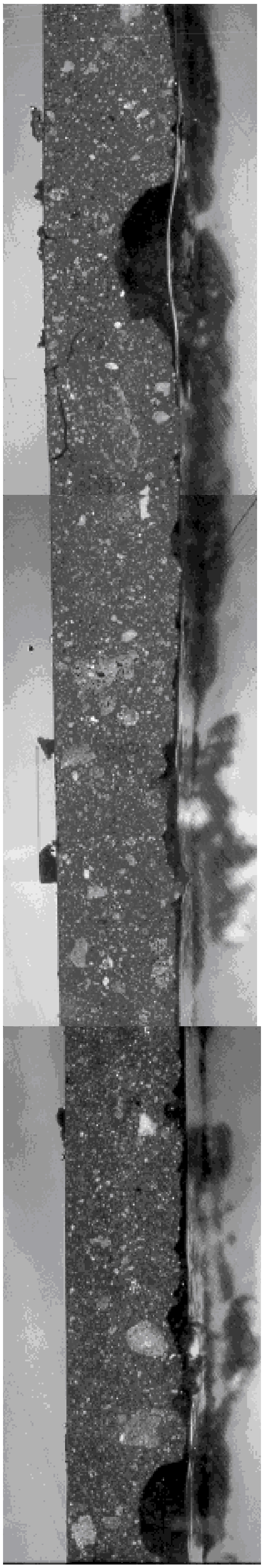
depth = 251.2 cm
(a la Allton and Waltz)

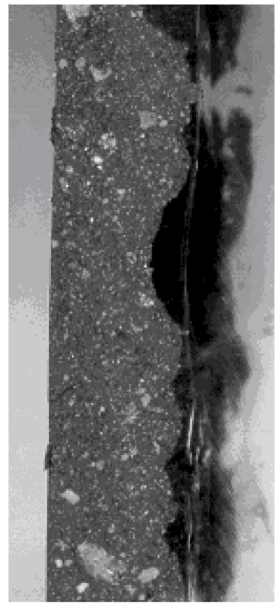
70002, epoxy encapsulated core

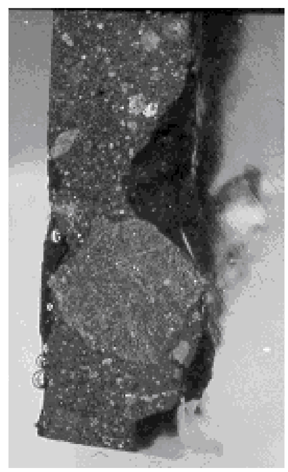












bottom of 70002

70001 was not dissected lengthwise
and there is no encapsulated portion