60014 - 60013

Double Drive Tube

ALSEP Site

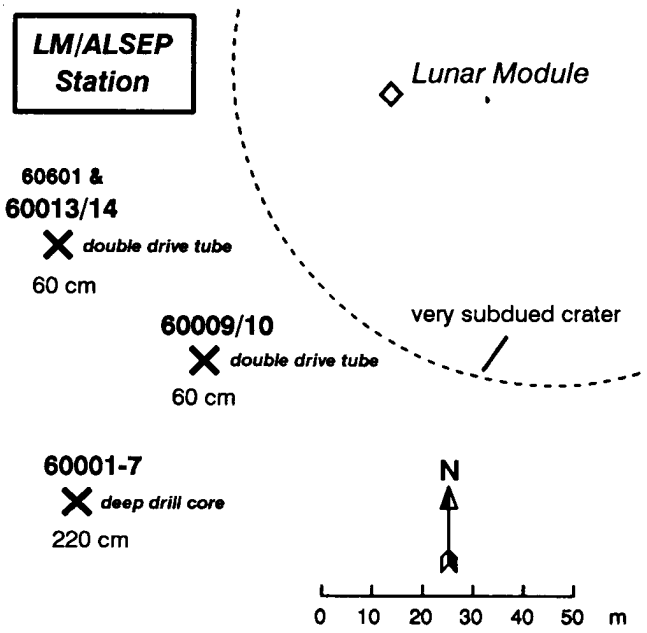


Figure 1: Map of ALSEP site at Apollo 16 (from Korotev 1991).

Introduction

60014 – 60013 is one of the three cores that were collected close to one another (about 50 m apart) at the ALSEP site at Apollo 16 (figure 1). It wasn't extruded and dissected until 1991 and has not been well studied. However, enough has been learned to establish has three basic units: A (0 to 44 cm), B (44 to 59 cm) and C (59 to 62 cm) (Korotev and Morris 1993).

Petrography

Basu et al. (1992, 1993) performed a grain size analysis and determined the percentage of glass, mineral and rock types in about 5 cm intervals (table 2). Basu et al. were not able to find any fragments or glasses of mare basalt composition, nor did they confirm the description based on X-rays.

Korotev and Morris (1993) determined the maturity along the core by magnetic resonance (figure 2). The top 44 cm is mature, but below a depth of about 44 cm the core samples are submature. Basu et al. (1993) also found fewer agglutinates at this depth.

Jolliff et al. (1993) reported on the composition and mineralogy of a small (0.1 mg) iron meteorite that they found in 60014. It was surrounded by agglutinate glass, but included tiny grains of low-Ca pyroxene (En_{83}), olivine (Fo_{80}), albitic and potassic feldspar, oldhamite(?) and hercynite(?). they even discuss whether this is a residual piece of the impactor responsible for the formation of the impact rocks at Apollo 16!

The continuous set of polished thin sections remains unstudied. A view of the epoxy encapsulated core segment is included herein (note the chunk at 44.5 cm).

Chemistry

Korotev and Morris (1993) dutifully analyzed 124 splits (every 0.5 cm) of the double drive tube and ended up publishing averages for the three units (A, B, C)(table1). But, generally, one would have to conclude that the core is relatively homogeneous (figure 2).

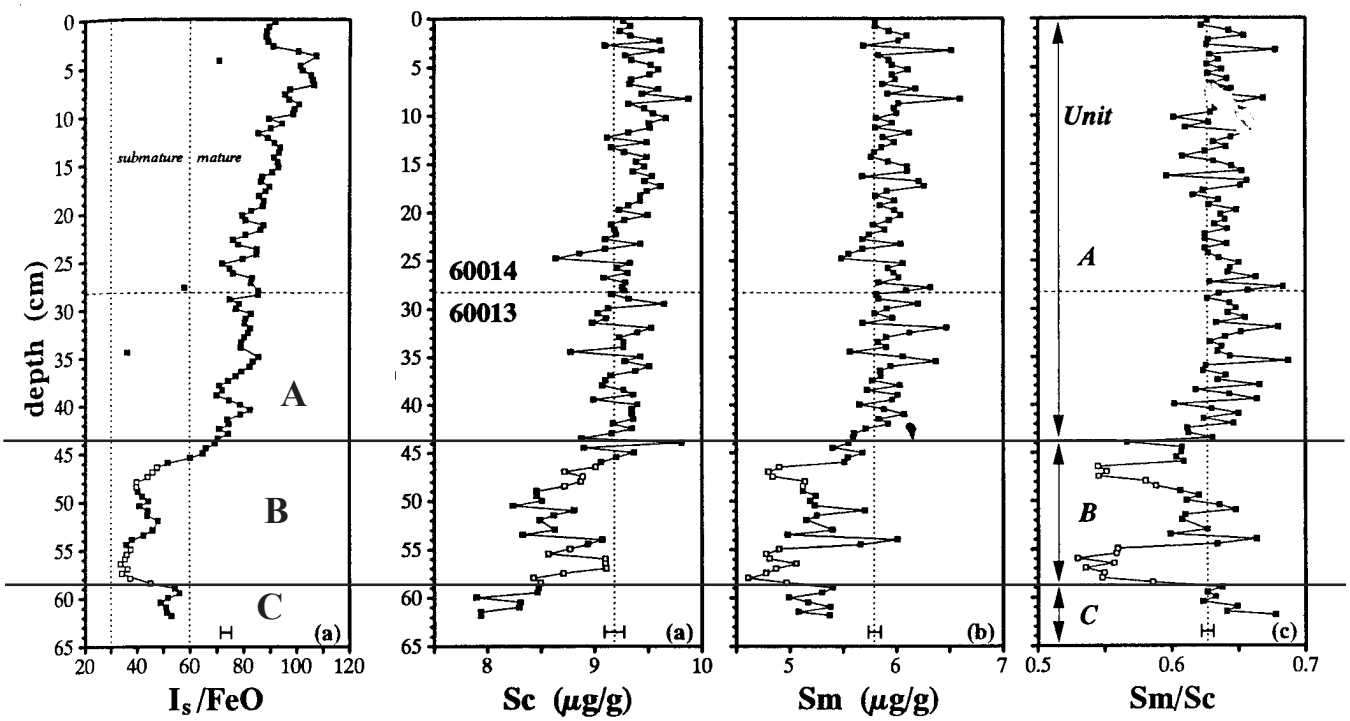


Figure 2: Maturity index and chemical composition for 60014 - 60013 (from Korotev and Morris 1993). Chemical units A, B, C defined by the variation in Sm/Sc ratio also match the variation in maturity index.

Table 2: Petrographic mode 60014 and 60013 (90 - 150 micron).
From Basu et al. 1992, 1993.

depth cm	0.75	4.25	12.25	20.25	25.75	28.1	33.5	41	43	48.5	54.5	61.5
%												
Agglutinate	31.2	40.8	35	39.9	35	31.6	28.7	33.2	25.7	18.3	19.8	21.2
Reg Bx.	7	7.9	10.6	11.4	5.4	5.2	16	11	13.3	8.5	4.4	9.4
FF Bx.	1.9	2.6	6.1	4.5	1.9	4.2	3.9	4.5	2.2	2.2	2.2	1.3
Xl. Bx.	41.4	31.3	27.7	29.5	38.5	38.4	24.2	25.7	32.5	39.8	40.5	29.4
Felds	12.2	14.5	17.4	12.3	10.7	16	19.6	17.9	18.8	24.6	24.2	32
Pyrox.	1.6	1	1.3	0	1.9	1.3	2.9	2.2	2.6	1.8	2.2	2.6
Or. glass	0.6	0	0	0	0.3	0	0	0.3	0	0	0.9	0
Gr. glass	0	0	0	0.3	0.3	0	0.6	0.3	0	0.3	0.9	0
Y glass	0.6	0.3	0.6	1	2.5	1	0.9	0.9	0.3	0.6	0.9	0.3
clear gl.	1.6	1.6	1	1	1.9	1	2.2	2.6	3.5	2.2	1.5	1.6
Kbasalt	0.3	0	0.3	0	0	0.7	0	0	0.3	0	0	0
Mbasalt							0	0	0	0	0	0
other	1.6	0	0	0	1.6	1.7	0.6	0.9	0.3	1.2	1.9	2
				A						B		C
				mature						submature		

Processing

Horz et al. (1972) gave the first description – based on X-rays of the core. They originally subdivide the core into nine units. *Unit 9 (from 0 – 18.5 cm) is a massive fine-grained unit with sparse equant rock fragments, with a concentration of rock fragments at 12 cm. Unit 8 (from 18.5 to38.5 cm) is also massive fine-grained - - -. Unit 7 (36.5 -38.5 cm) has a concentration of cm-sized rock fragments - - . Unit 6 (38.5 to 44.5 cm) is fine-grained - - . Unit 5 (44.5 to 50.5 cm) has large*

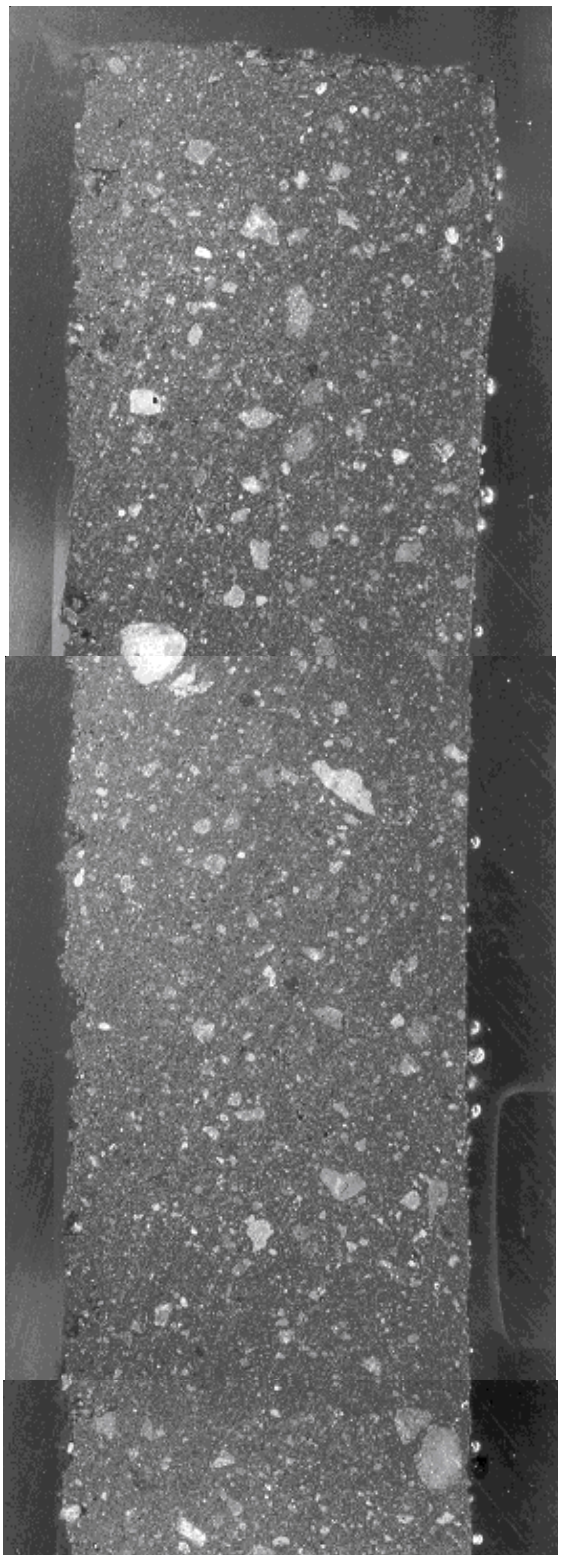
Table 1. Chemical composition of 60013/14.

	unit A	unit B	unit C	
reference	Korotev 93			
depth	0 - 43.7 cm	43.7 - 58.7	58.7 - 62 cm	
SiO2 %				
TiO2				
Al2O3				
FeO	5.48	5.05	4.76	(a)
MnO				
MgO				
CaO	15.2	15.5	15.6	(a)
Na2O	0.453	0.432	0.44	(a)
K2O				
P2O5				
S %				
sum				
Sc ppm	9.32	8.81	8.19	(a)
V				
Cr	762	723	670	(a)
Co	34.6	29.3	27.6	(a)
Ni	510	396	386	(a)
Cu				
Zn	26	15	20	(a)
Ga				
Ge ppb				
As				
Se				
Rb				
Sr	179	175	176	(a)
Y				
Zr	183	154	153	(a)
Nb				
Mo				
Ru				
Rh				
Pd ppb				
Ag ppb				
Cd ppb				
In ppb				
Sn ppb				
Sb ppb				
Te ppb				
Cs ppm	0.14	0.12	0.12	(a)
Ba	138	117	118	(a)
La	12.9	11.2	11.3	(a)
Ce				
Pr				
Nd	19.9	17.3	17.1	(a)
Sm	5.94	5.19	5.25	(a)
Eu	1.19	1.13	1.13	(a)
Gd				
Tb	1.24	1.06	1.06	(a)
Dy				
Ho				
Er				
Tm				
Yb	4.23	3.69	3.68	(a)
Lu	0.586	0.513	0.518	(a)
Hf	4.5	3.87	3.83	(a)
Ta	0.54	0.45	0.45	(a)
W ppb				
Re ppb				
Os ppb				
Ir ppb	16	12.5	12.5	(a)
Pt ppb				
Au ppb	10	7.4	8.9	(a)
Th ppm	2.11	1.84	1.84	(a)
U ppm	0.57	0.5	0.48	(a)
technique:	*(a) INAA*			

rock fragments - - -. Unit 4 (50.5 to 53 cm) has 80% matix - - . Unit 3 (53 to 58 cm) has 85 % matrix - - -. Unit 2 (58 – 59 cm) has rock fragments with 50 % matrix - - -. Unit 1 (59 to 67 cm) is dense and has 95% matrix.

Schwarz (1991, 1992) documents the dissection of the core.

top

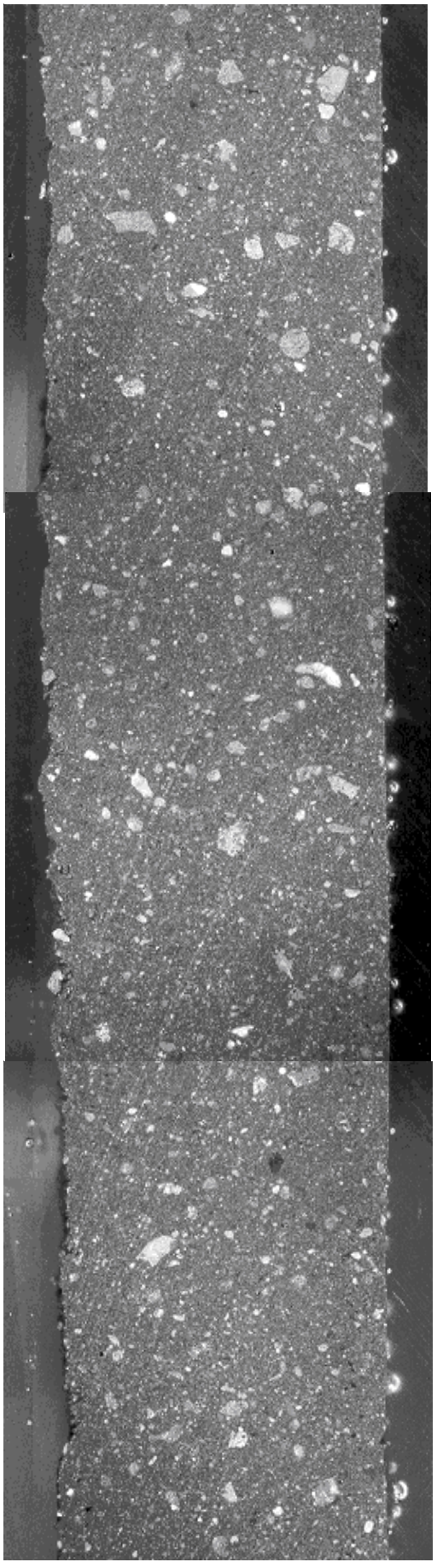


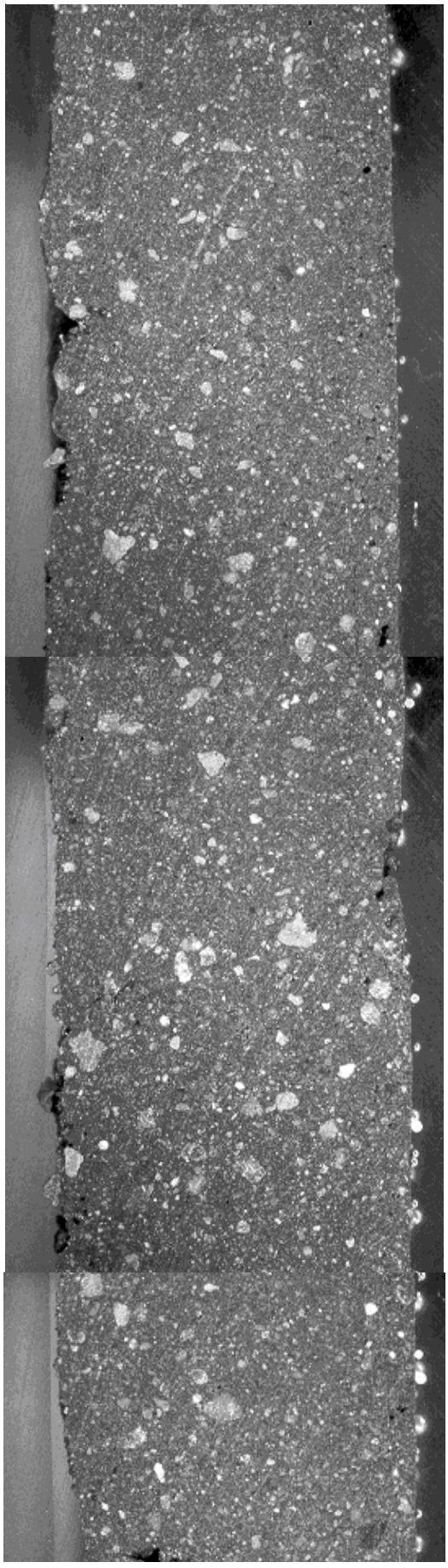
0.0 cm

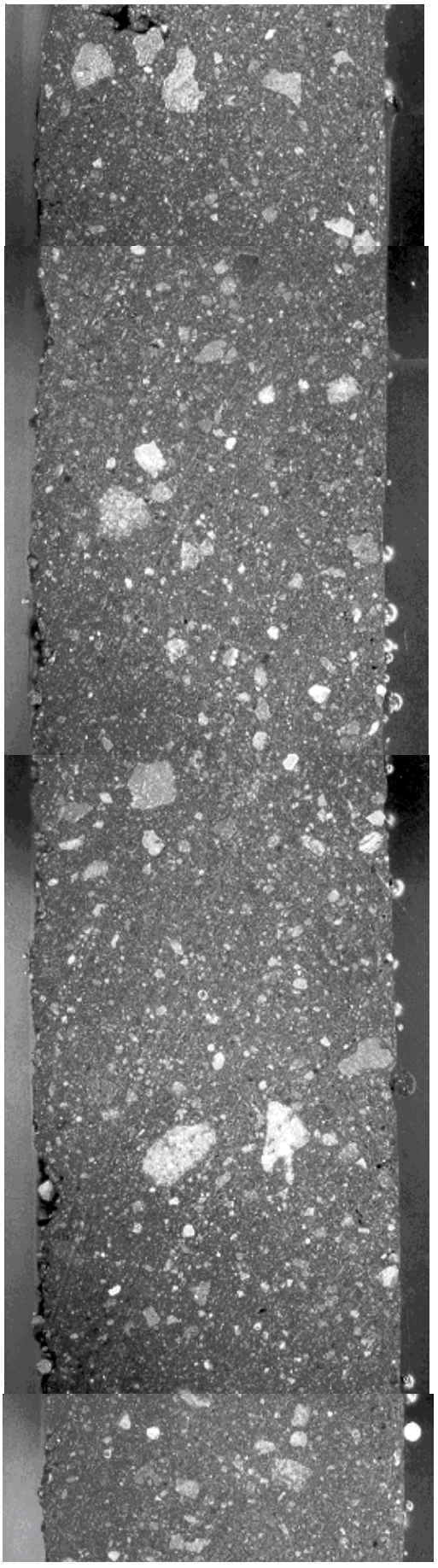
60014,6001
epoxy
encapsulated
core

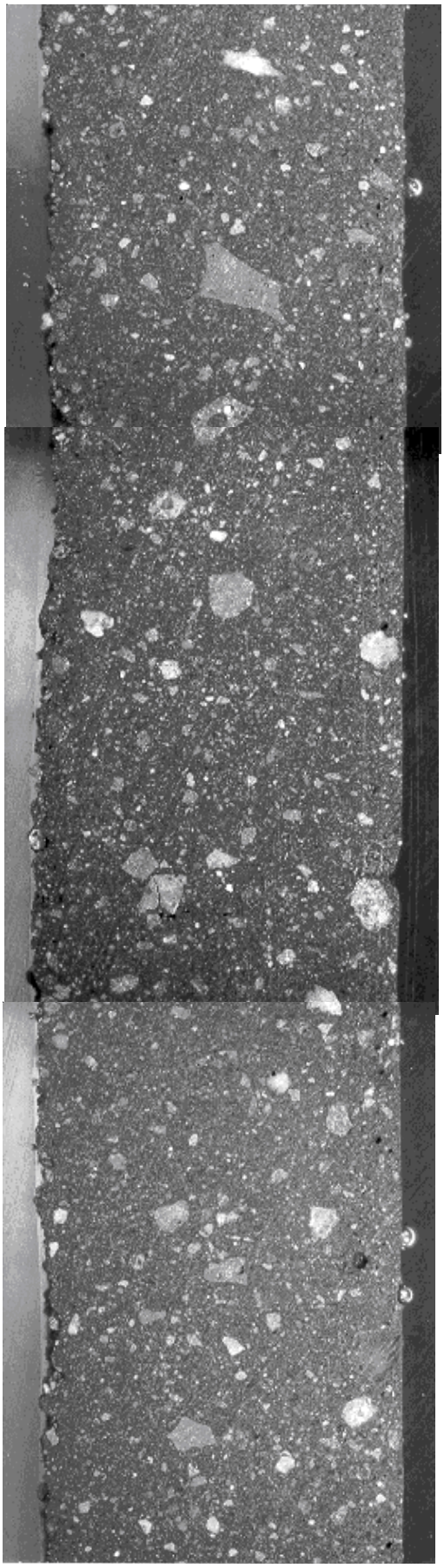
2.0 cm

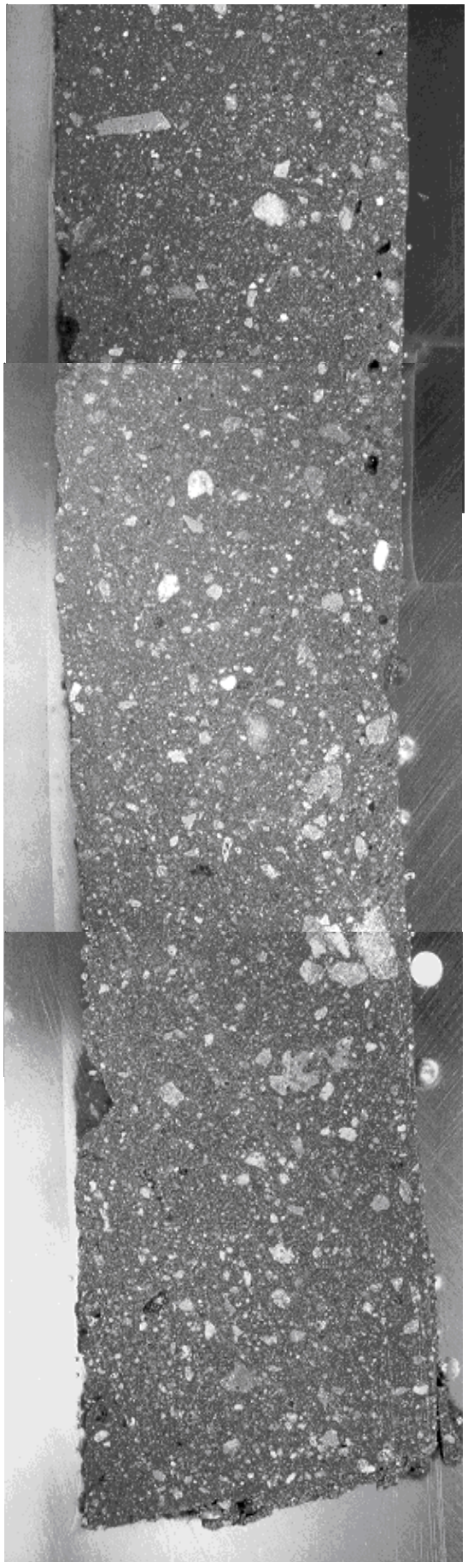
4.0 cm


5.0 cm
6.0 cm
8.0 cm


10.0 cm
11.0 cm
12.0 cm
13.0 cm


14.0 cm
15.0 cm
16.0 cm
17.0 cm
18.0 cm


19.0 cm
20.0 cm
21.0 cm
22.0 cm

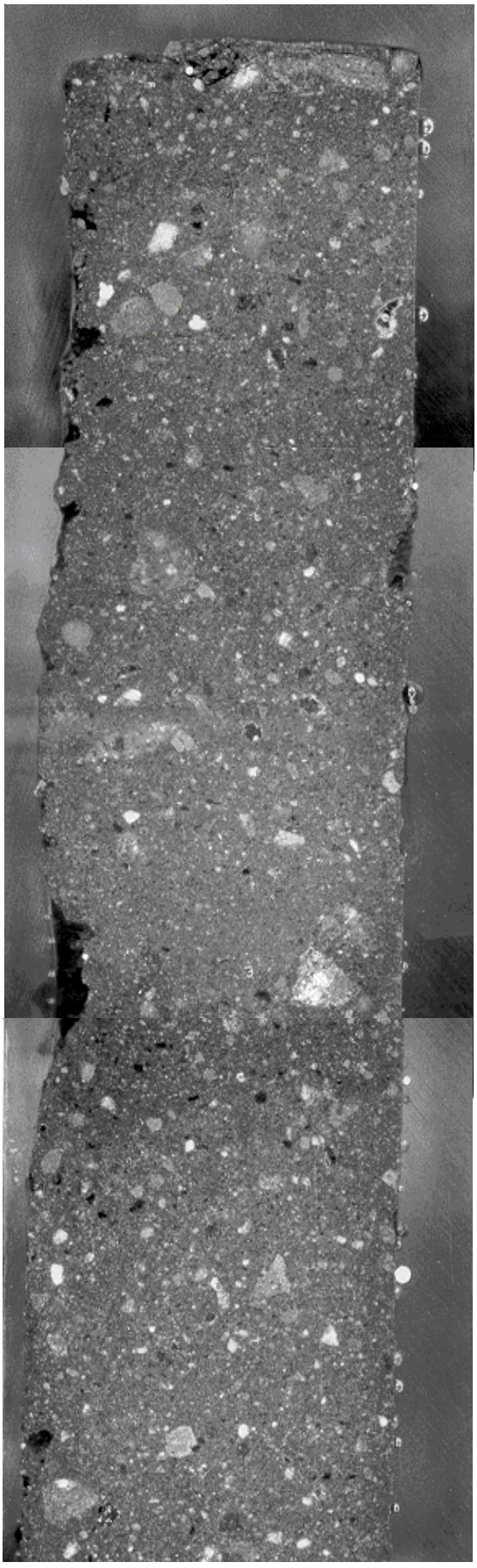


24.0 cm

25.0 cm

26.0 cm

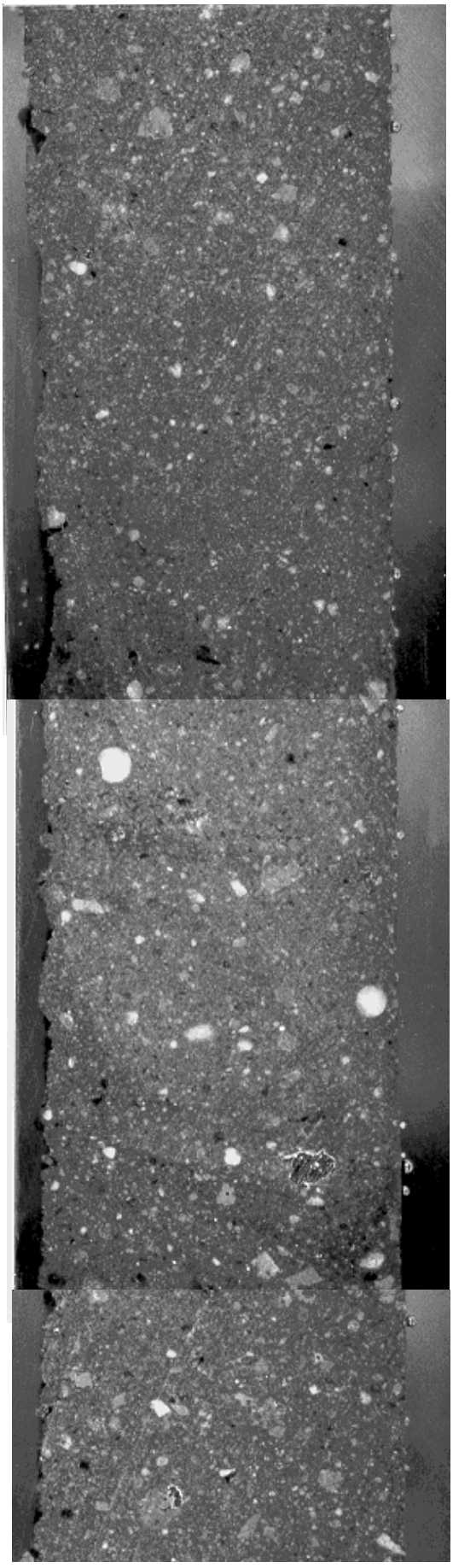
27.5 cm



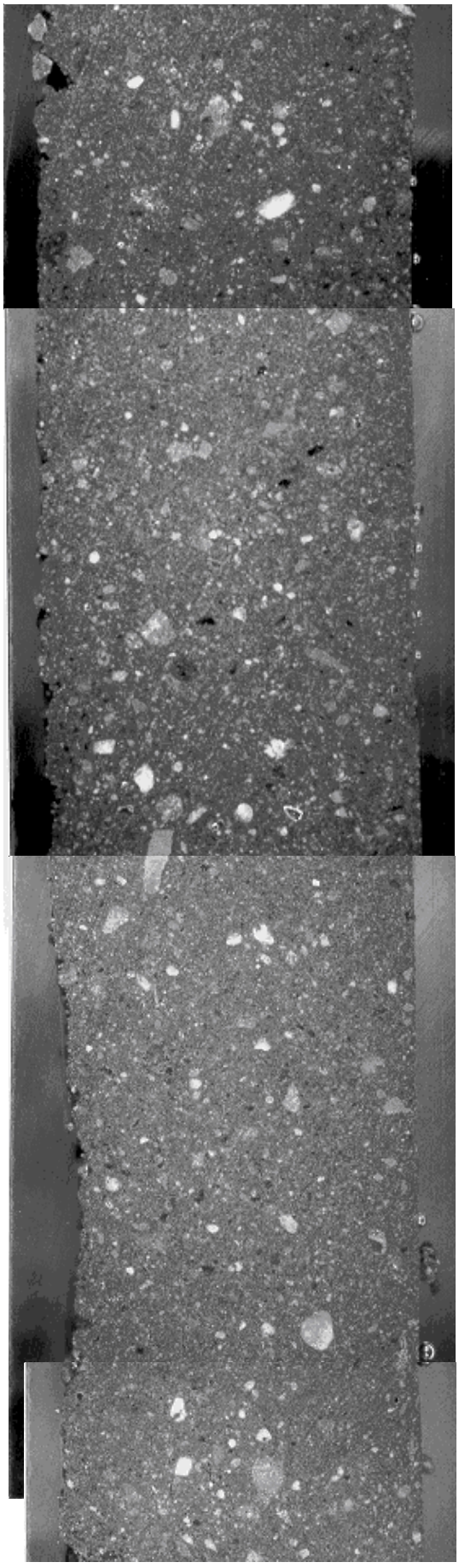
0.0 cm

60013,6004
epoxy
encapsulated
core

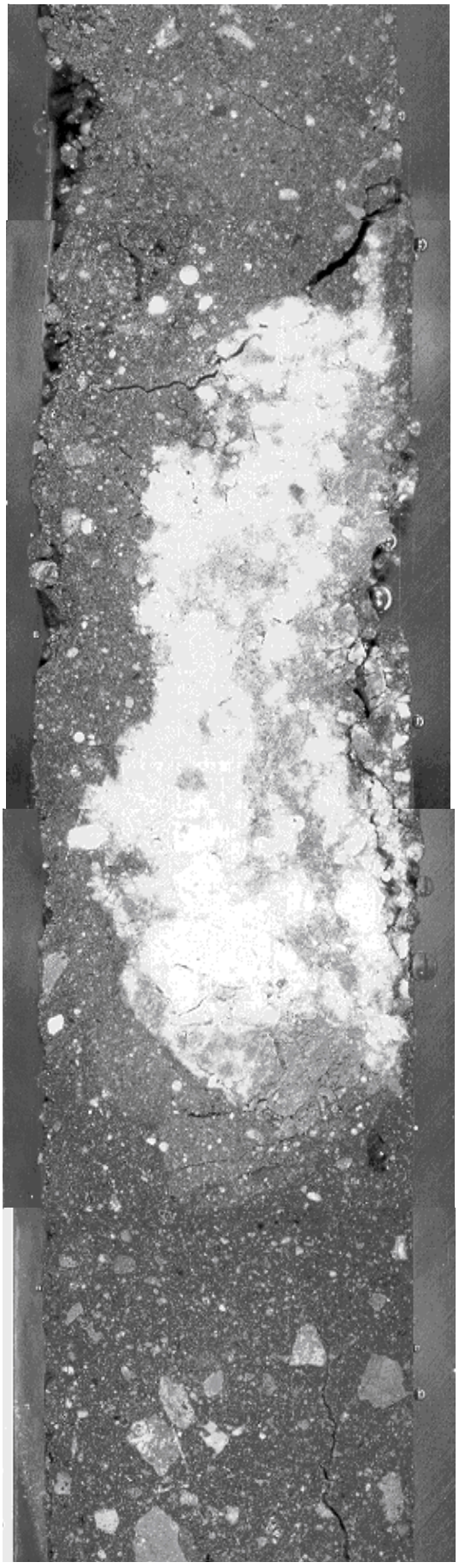
3.0 cm

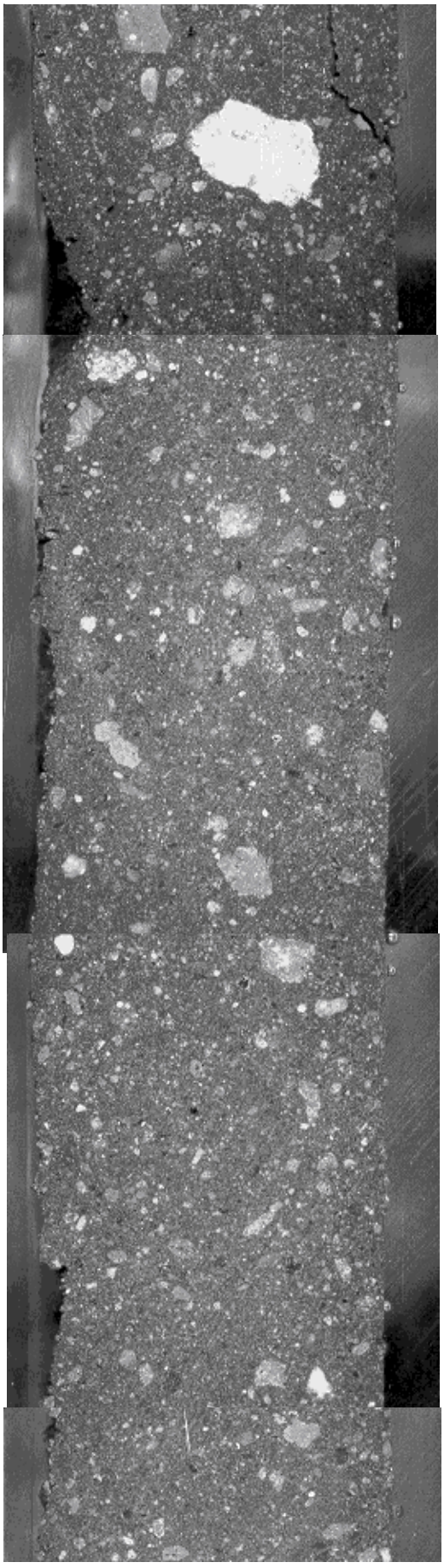


—— 7.0 cm



10.0 cm

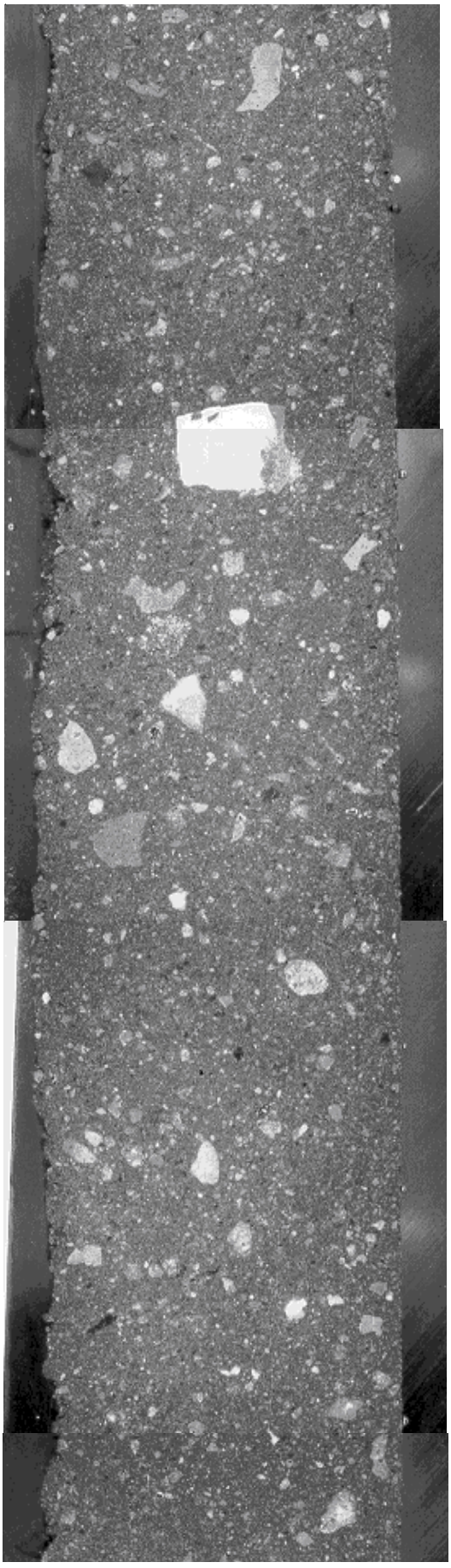

15.0 cm
17.0 cm
18.0 cm

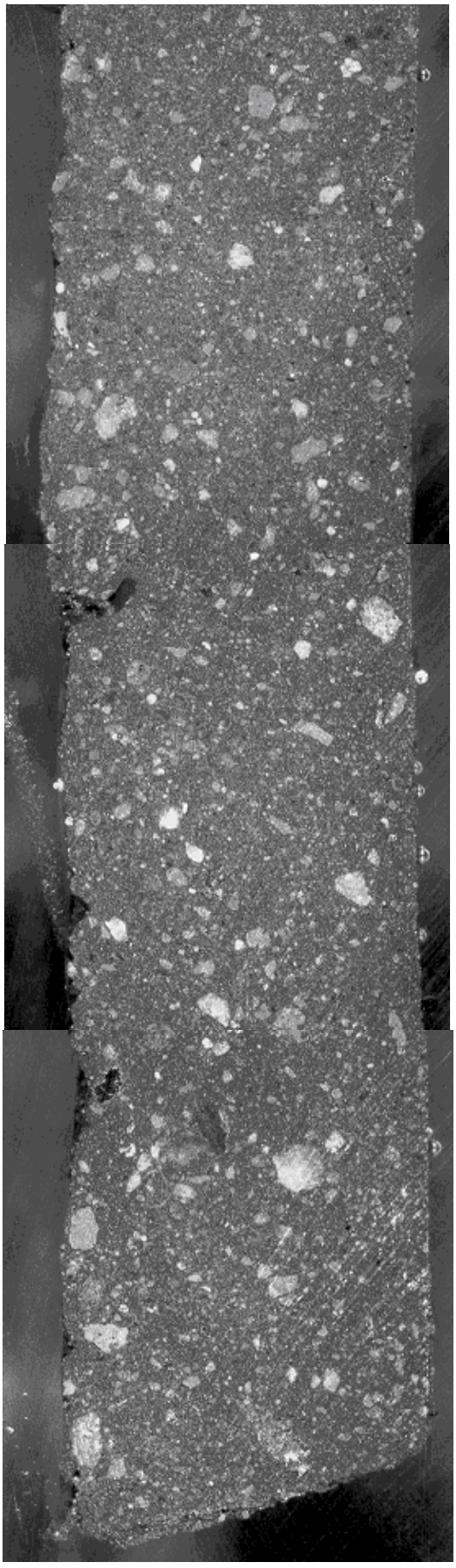


20.0 cm

22.0 cm

23.5 cm


25.0 cm
27.0 cm
28.0 cm



30.5 cm

32.0 cm

33.0 cm

bottom

Selected References for 60013-14

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Schwarz C. (1992) Preliminary description of 60013, bottom half of double drive tube 60014/60013. (abs) LPS XXIII, 1249-1250.