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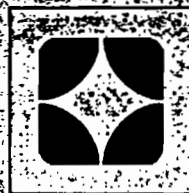
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**GEOTECHNICAL INVESTIGATION  
BORING 3, KOPANOAR  
BEAUFORT SEA**

*Report to*

**CANADIAN MARINE DRILLING LTD  
Calgary, Canada**



**McClelland engineers**

**geotechnical consultants**

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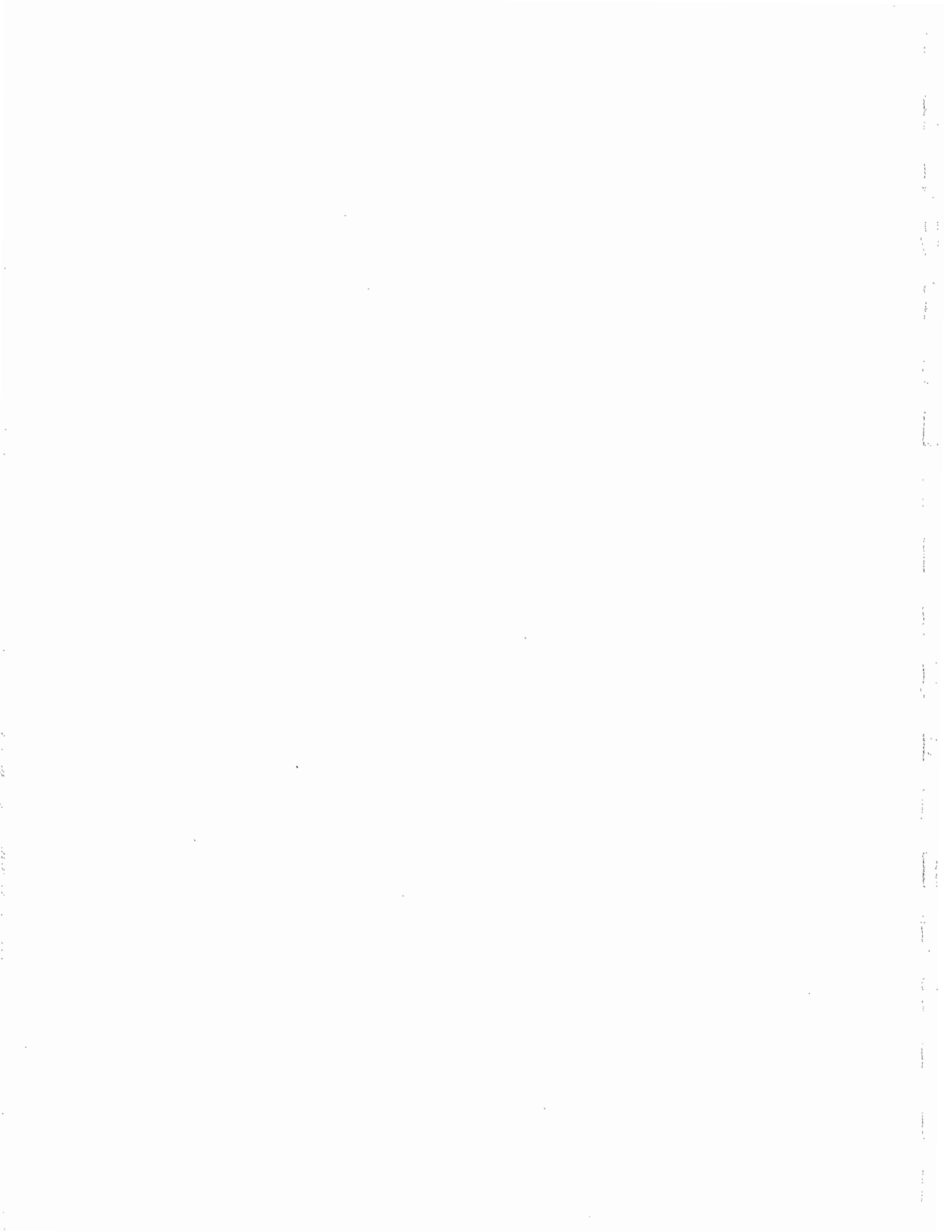
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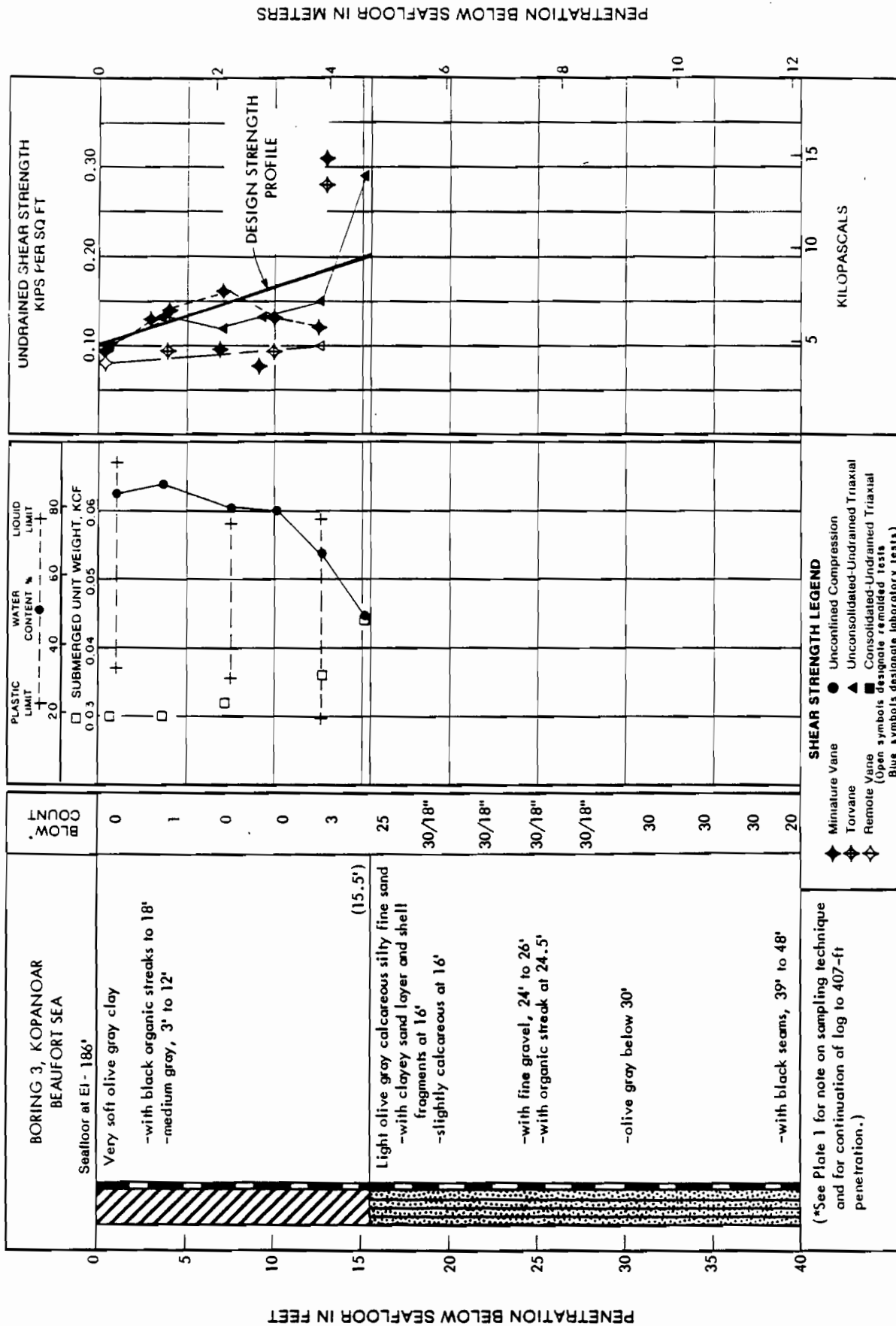
SOIL STRATIGRAPHY

A generalized summary of the major soil strata at KOPANOAR based on the log of the boring presented on Plates 1 and 2 is given in the following tabulation:

<u>Stratum</u>	<u>Penetration, ft</u>		<u>Description</u>
	<u>From</u>	<u>To</u>	
I	0	15.5	Very soft to soft olive gray clay
II	15.5	81	Light olive gray calcareous silty fine sand
III	81	138	Frozen olive gray calcareous fine sand
IV	138	156	Frozen laminated silt, sand, and clay
V	156	193	Frozen olive gray fine sand, slightly calcareous
VI	193	207	Frozen olive gray laminated sand, silt, and clay
VII	207	255	Frozen olive gray laminated calcareous sand and silt
VIII	255	317	Frozen olive gray laminated silty clay and silt
IX	317	407+	Very stiff olive gray calcareous clay

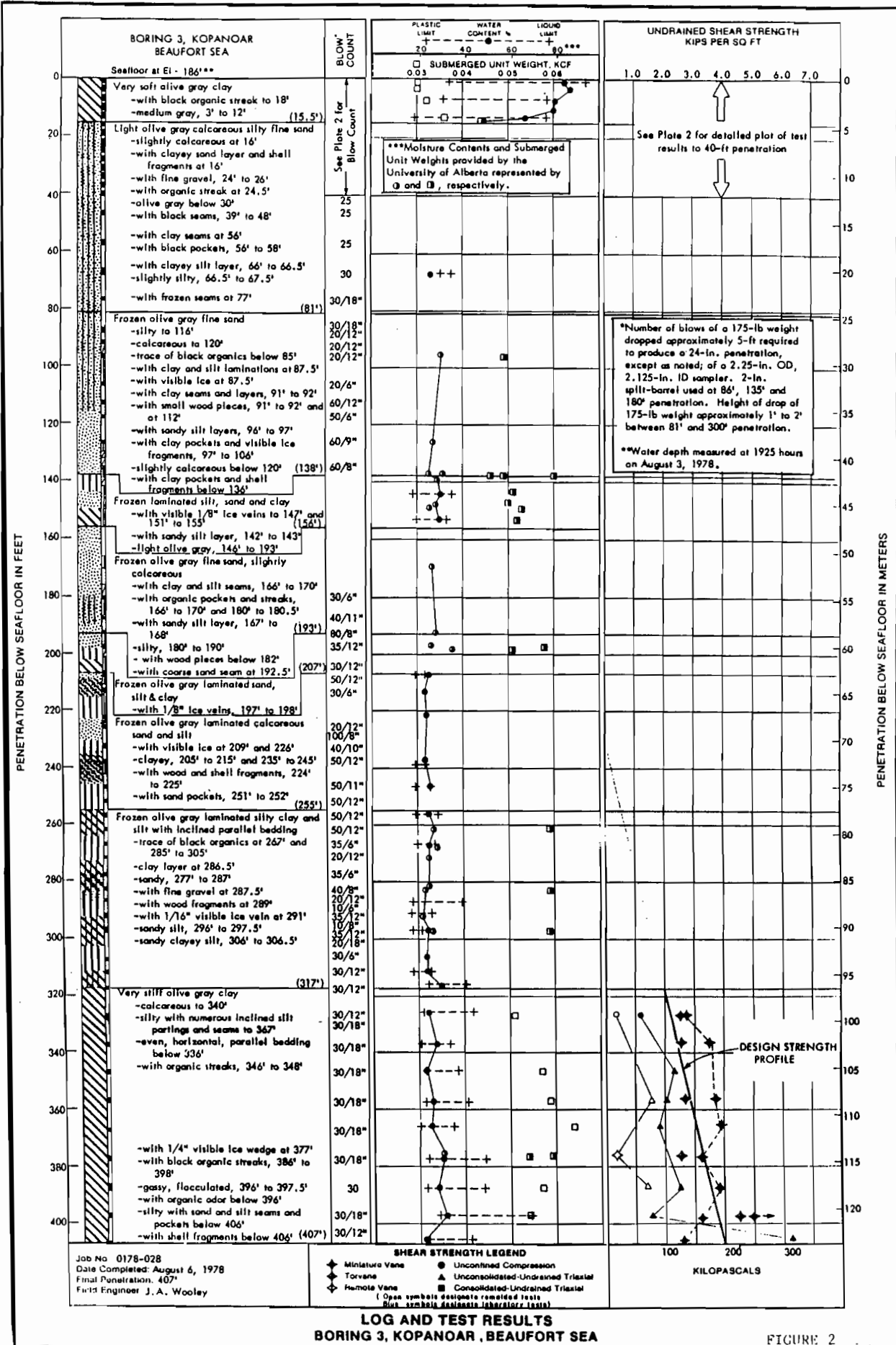
TABLE 1

FIGURE 1



**LOG AND TEST RESULTS TO 40-FT PENETRATION**  
**BORING 3, KOPANOAR**  
**BEAUFORT SEA**

(\*See Plate 1 for note on sampling technique and for continuation of log to 407-ft penetration.)







A P P E N D I X A  
FIELD AND LABORATORY SOIL TEST RESULTS

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APPENDIX A  
FIELD AND LABORATORY SOIL TEST RESULTS  
Appendix-Illustrations

	<u>Plate</u>
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Stress-Strain Curves, Unconsolidated- Undrained Triaxial Compression Tests . . . . .	A-9 and A-10
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Results of Microscopic Analysis . . . . .	A-15
Results of HCl Solubility Tests . . . . .	A-16



SUMMARY OF TEST RESULTS

SAMPLE NUMBER	PENETRATION, FEET	CLASSIFICATION TESTS					TORVANE	MINIATURE VANE		COMPRESSION TESTS								
		LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	UNIT WEIGHT, LB/CU FT	PERCENT PASSING NO. 200 SIEVE	SHEAR STRENGTH, KIPS/50 FT	TYPE OF TEST	SHEAR STRENGTH, KIPS/50 FT	TYPE OF TEST	WATER CONTENT, %		UNIT DRY WEIGHT, LB/CU FT	SHEAR STRENGTH, KIPS/50 FT	VOLUME CHANGE, %	LATERAL PRESSURE, KIPS/50 FT	FAILURE STRAIN, %	TYPE OF FAILURE
											INITIAL	FINAL						
2	1.0				94			U	0.092	2-Ub	86		50	0.10		0.29	12.2	A
3	1.5	94	34	85														
4	4.0				94			U	0.13	2-Ub	87		50	0.13		0.24	14.6	A
6	5.0				88		0.092*	U	0.14*									
8	7.5				96			U	0.16	2-Ub	78		54	0.12		10.43	19.1	A
9	8.0	77	31	81				U	0.095*									
10	9.5							U	0.078	2-Ub				0.13		10.58	20.8	A
11	10.0				80		0.096*	U	0.13*									
13	12.0	77	19		100			U	0.12	2-Ub	67		60	0.15		10.79	14.8	A
										2-R	65		62	0.10		10.79	11.2	A
14	13.5				71		0.28*	U	0.31*									
15	15.5				108					2-Ub	49		72	0.29		10.94	16.8	A
17	16.5					18												
19	19.0					21a												
20	21.5					14												
22	24.5					33				Consolidated-Drained Triaxial, Sieve Analysis, See Plate A-10 Stress-Strain Curves, See Plate A-11								
24	28.0					42												
27	32.0					28												
29	34.5					26a												
31	37.5					40												
32	40.0					17a												
35	47.5					26												
37	57.5					15				Consolidated-Drained Triaxial, Sieve Analysis, See Plate A-12 Stress-Strain Curves, See Plate A-13								
38	66.5	35	30	26														
39	67.5					10a												
41	77.5					18a												
42	86.0					45												
45	95.0					72a												
47	101.0					29												
50	117.0					5a												
51	126.0					7a												
58	136.0					4												
59	142.0					82a												
63	144.0	35	18	30														

(Continued on Plate A-1b)

\*Denotes tests run in field

LEGEND & NOTES

- | TYPE OF TEST   | TYPE OF FAILURE          |
|--|--------------------------|
| 1 UNCONFINED COMPRESSION                               | A = BULGE                |
| 2 UNCONSOLIDATED-UNDRAINED TRIAXIAL                    | B = SINGLE SHEAR PLANE   |
| 3 CONSOLIDATED-UNDRAINED TRIAXIAL                      | C = MULTIPLE SHEAR PLANE |
| U = UNDISTURBED R = REMOLDED                           | D = VERTICAL FRACTURE    |
| (1) GRAIN-SIZE DISTRIBUTION CURVE PRESENTED SEPARATELY |                          |
| (2) STRESS-STRAIN CURVE PRESENTED SEPARATELY           |                          |

BORING 3, KOPANOAR  
BEAUFORT SEA

Seafloor at El - 186'

**SUMMARY OF TEST RESULTS**

SAMPLE NUMBER	PENETRATION, FEET	CLASSIFICATION TESTS						TOP VANE		MINIATURE VANE		COMPRESSION TESTS						
		LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	UNIT WEIGHT, LB/CU FT	PERCENT PASSING NO. 200 SIEVE	SHEAR STRENGTH, KIPS/SQ FT	TYPE OF TEST	SHEAR STRENGTH, KIPS/SQ FT	TYPE OF TEST	WATER CONTENT, %		INITIAL DRY WEIGHT, LB/CU FT	SHEAR STRENGTH, KIPS/SQ FT	VOLUME CHANGE, %	LATERAL PRESSURE, KIPS/SQ FT	FAILURE STRAIN, %	TYPE OF FAILURE
											INITIAL	FINAL						
(Continued from Plate A-1a)																		
71	152.0	33	20	31														
74	166.0					7a												
75	167.0					58a												
79	180.5					79a												
80	186.0					48												
83	192.5					5												
84	197.0					95a												
86	206.0			30														
90	208.0	23	19	25														
91	212.0			23		85a												
93	222.0			24														
98	240.0	23	19			95a												
101	246.0	25	19	26														
102	251.0					62a												
105	256.5	29	19	25														
108	266.5	27	20	25														
112	277.5					84a												
116	286.5	39	18			70a												
119	291.5	26	17															
120	296.0	22	18	24														
123	306.5			23		84a												
126	312.0	25	18	24														
128	317.0	41	24	30		99a												
129	326.0	44	22	24			2.50*	U	2.74*									
131	327.5				115					1-U 22	94	1.27			7.9	A, C		
132	336.5	33	21	27						1-R 22	100	0.45			4.6	C		
133	337.0			24			2.55*	U	3.52*									
134	346.5	37	23		121					2-U 23	98	2.47		20.7 <sup>a</sup>	17.5	A		
137	357.0	42	23		123		2.75*	U	3.74*	2-U 26	98	2.24		21.46	20.6	A		
138	356.5				128					2-R 23	100	1.75		21.46	19.6	A, C		
139	367.0	35	20	25			1.75*	U	3.91*	2-U 26	102	2.07		22.03	12.4	A		
140	376.0	49	23	20			2.50*	U	3.22*									
								R	0.57									

(Continued on Plate A-1c)

\*Denotes tests run in field

**LEGEND & NOTES**

- |  |   |
|--|---|
| <p><u>TYPE OF TEST</u></p> <p>1 UNCONFINED COMPRESSION<br/>                 2 UNCONSOLIDATED-UNDRAINED TRIAXIAL<br/>                 3 CONSOLIDATED-UNDRAINED TRIAXIAL<br/>                 U=UNDISTURBED R=REMOLDED<br/>                 (G) GRAIN-SIZE DISTRIBUTION CURVE PRESENTED SEPARATELY<br/>                 (D) STRESS-STRAIN CURVE PRESENTED SEPARATELY</p> | <p><u>TYPE OF FAILURE</u></p> <p>A= BULGE<br/>                 B= SINGLE SHEAR PLANE<br/>                 C= MULTIPLE SHEAR PLANE<br/>                 D= VERTICAL FRACTURE</p> |
|--|---|

BORING 3, KOPANOAR  
BEAUFORT SEA

Seafloor at El - 186'

SUMMARY OF TEST RESULTS

SAMPLE NUMBER	PENETRATION, FEET	CLASSIFICATION TESTS					TORVANE		MINIATURE VANE		COMPRESSION TESTS							
		LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	UNIT WEIGHT, LB/CU FT	PERCENT PASSING NO. 200 SIEVE	SHEAR STRENGTH, KIPS/SQ FT	TYPE OF TEST	SHEAR STRENGTH, KIPS/SQ FT	TYPE OF TEST	WATER CONTENT, %		UNIT DRY WEIGHT, LB/CU FT	SHEAR STRENGTH, KIPS/SQ FT	VOLUME CHANGE, %	LATERAL PRESSURE, KIPS/SQ FT	FAILURE STRAIN, %	TYPE OF FAILURE
											INITIAL	FINAL						
(Continued from Plate A-1b)																		
143	387.5				121					2-U	30	92	2.63	23.18	16.5	A		
										2-R	28	92	1.51	23.18	19.6	A, B		
144	388.0	48	23	28		2.50*	U	3.82*										
145	396.5	59	28		118		U	3.33	2-U	31		90	1.68	23.76	3.3	B		
147	397.5			28		4.50*	U	4.99*										
149	406.5	42	23		123		U	2.71	2-U	22		100	6.52	24.48	9.0	A		

\*Denotes tests run in field

**LEGEND & NOTES**

TYPE OF TEST

- 1 UNCONFINED COMPRESSION
- 2 UNCONSOLIDATED-UNDRAINED TRIAXIAL
- 3 CONSOLIDATED-UNDRAINED TRIAXIAL
- U UNDISTURBED P= REMOLDED

TYPE OF FAILURE

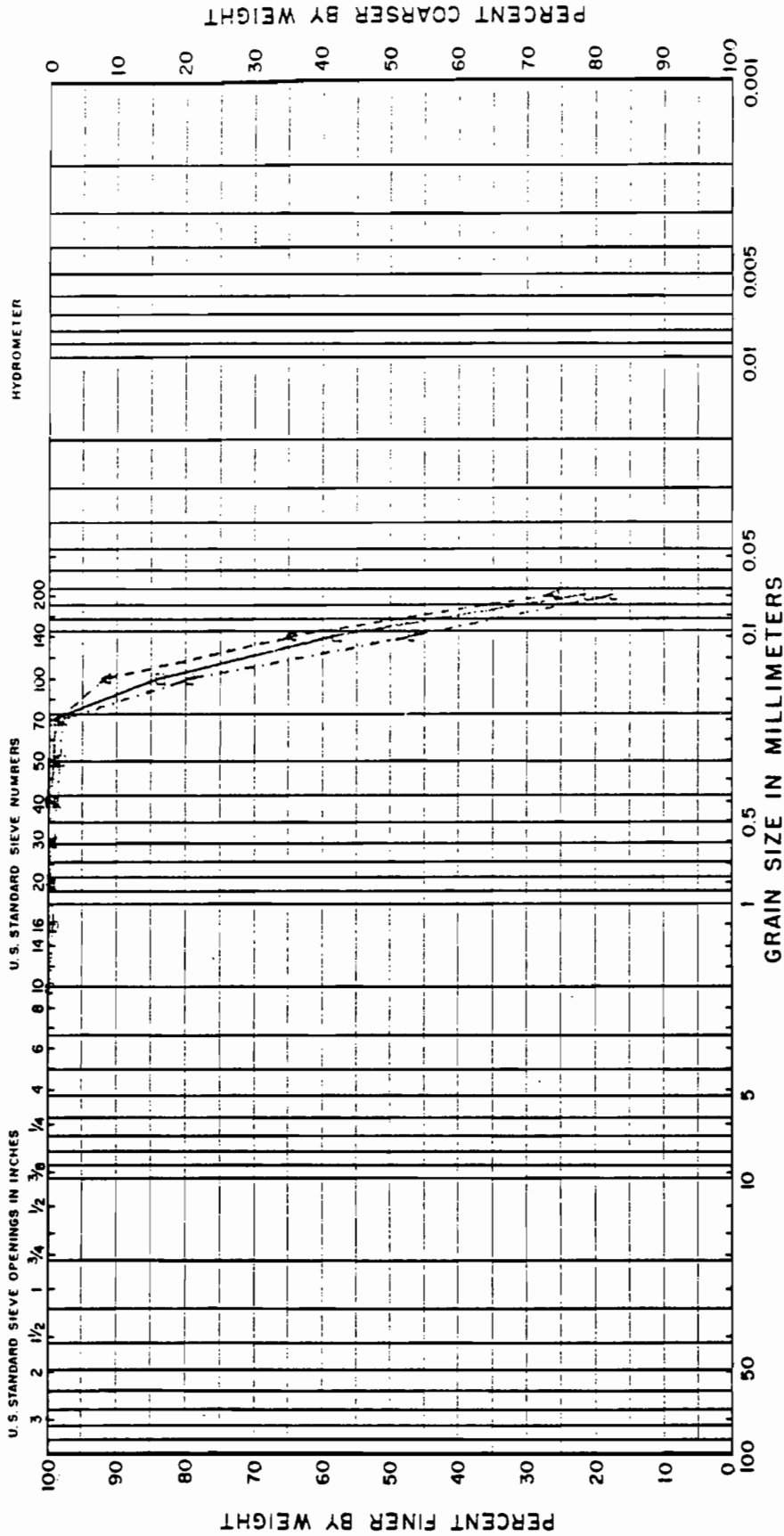
- A= BULGE
- B= SINGLE SHEAR PLANE
- C= MULTIPLE SHEAR PLANE
- D= VERTICAL FRACTURE

(1) GRAIN-SIZE DISTRIBUTION CURVE PRESENTED SEPARATELY  
 (2) STRESS-STRAIN CURVE PRESENTED SEPARATELY

BORING 3, KOPANOAR  
 BEAUFORT SEA

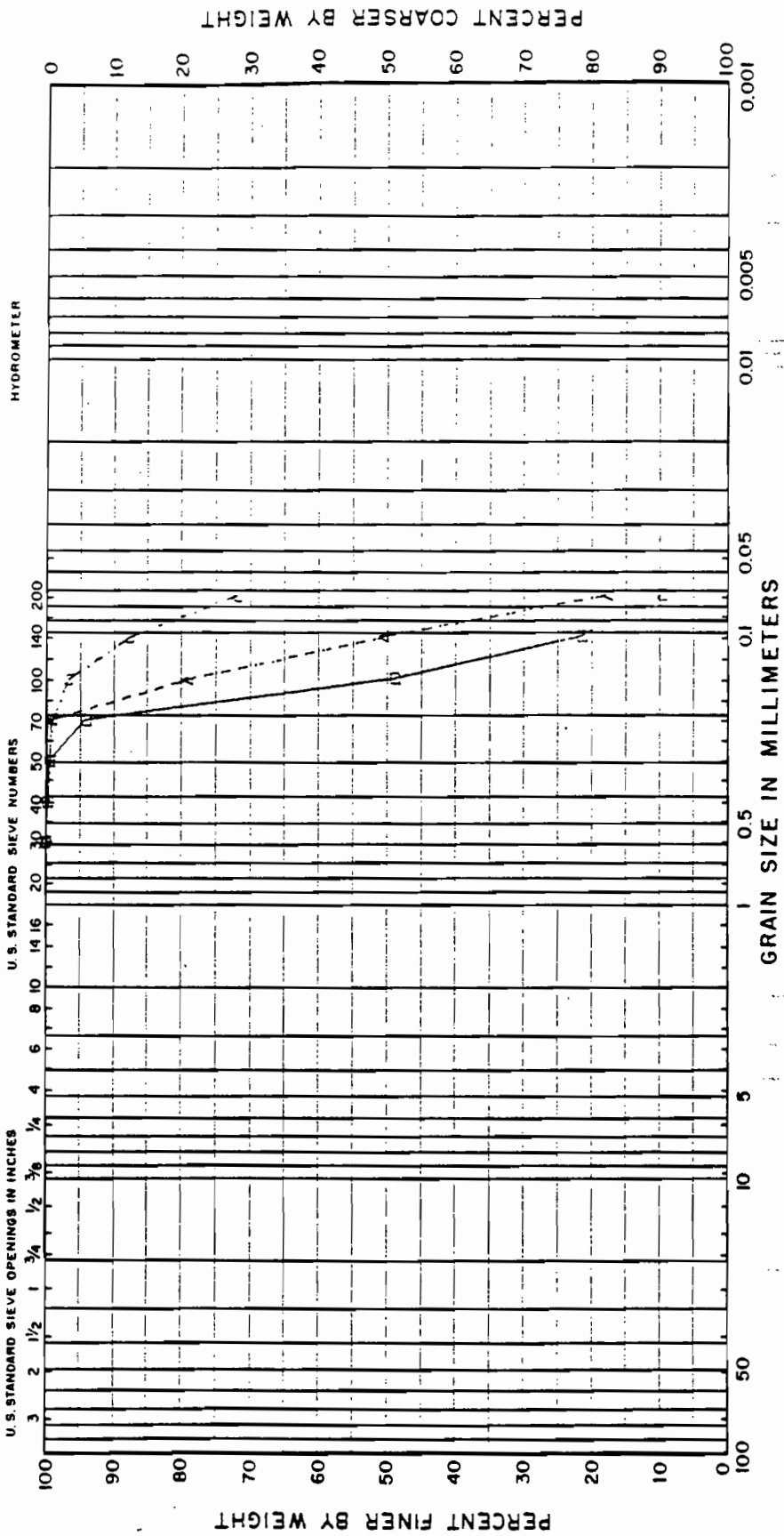
Seafloor at El - 186'

# GRAIN SIZE CURVES



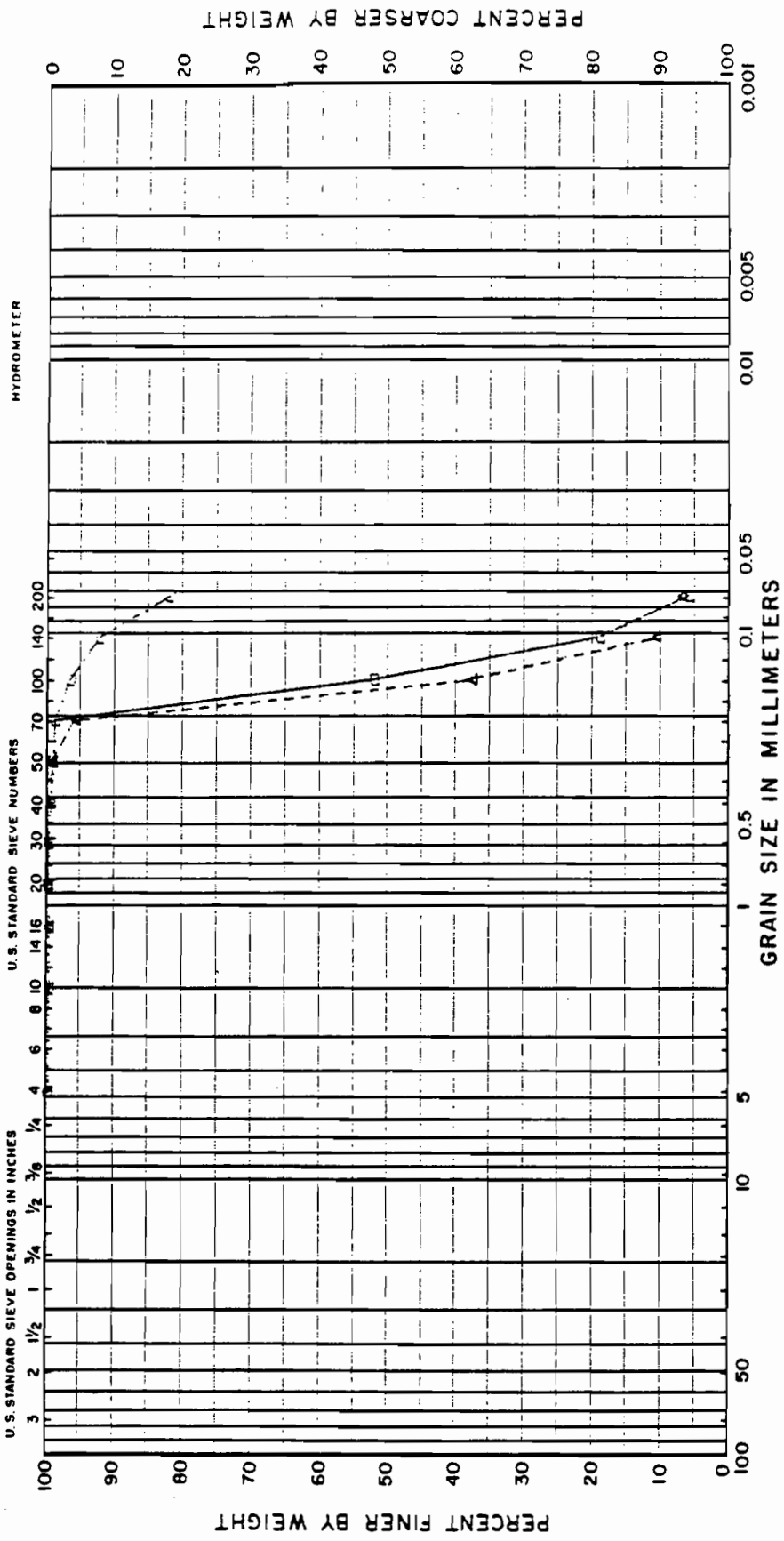


# GRAIN SIZE CURVES



CURVE	GRAVEL		SAND		BORING	DEPTH, FT.	MATERIAL
	Coarse	Fine	Medium	Fine			
1					KOPANOAR	67.5	OLIVE GRAY FINE SAND (SL SILTY)
2					KOPANOAR	77.5	OLIVE GRAY SILTY FINE SAND
3					KOPANOAR	96.0	OLIVE GRAY SANDY SILT

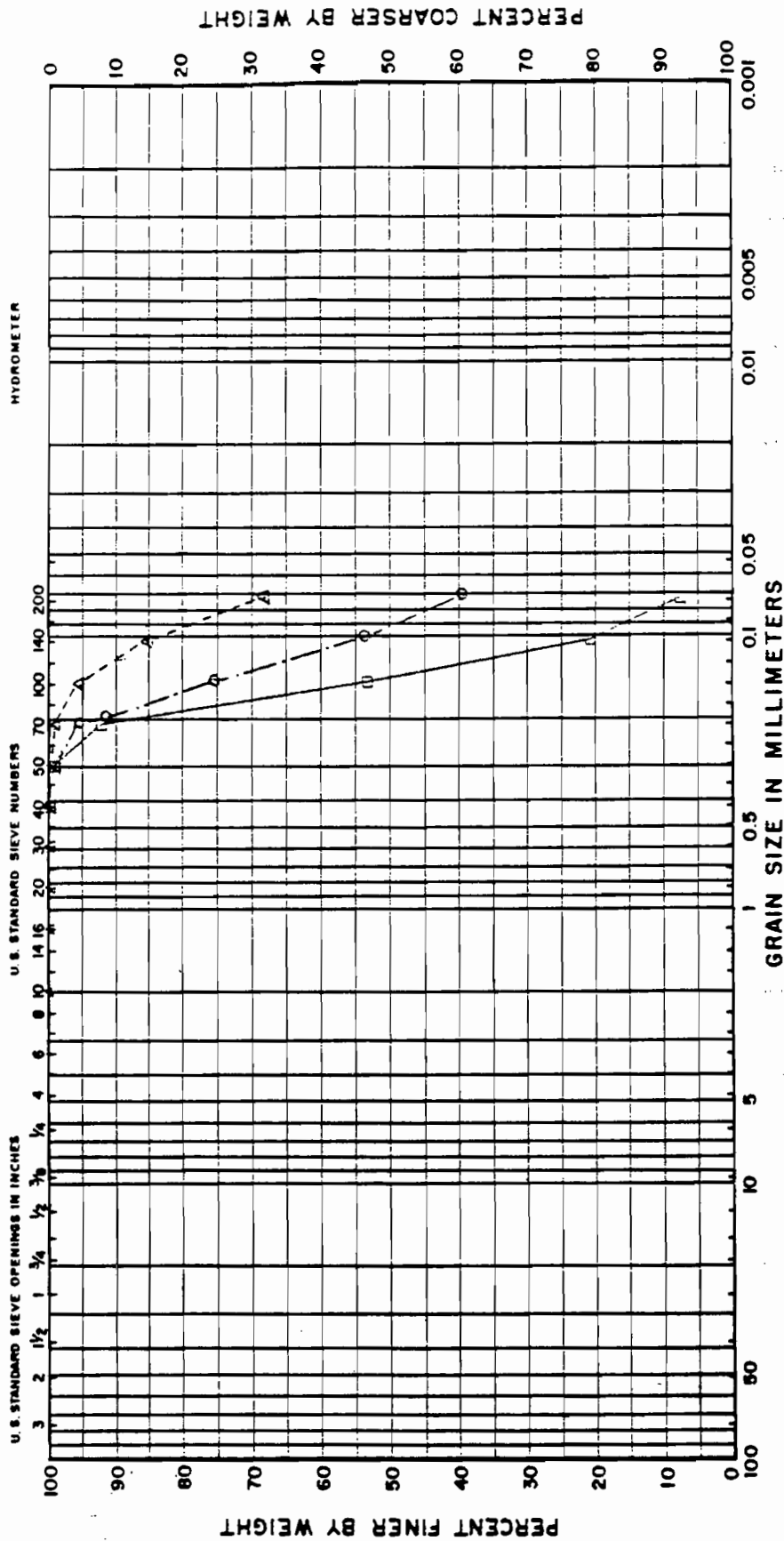
# GRAIN SIZE CURVES



CURVE	GRAVEL		SAND			SILT or CLAY		MATERIAL
	Coarse	Fine	Coarse	Medium	Fine	Coarse	Fine	
—●—								OLIVE GRAY FINE SAND
—▲—								OLIVE GRAY FINE SAND
—◻—								OLIVE GRAY SANDY SILT

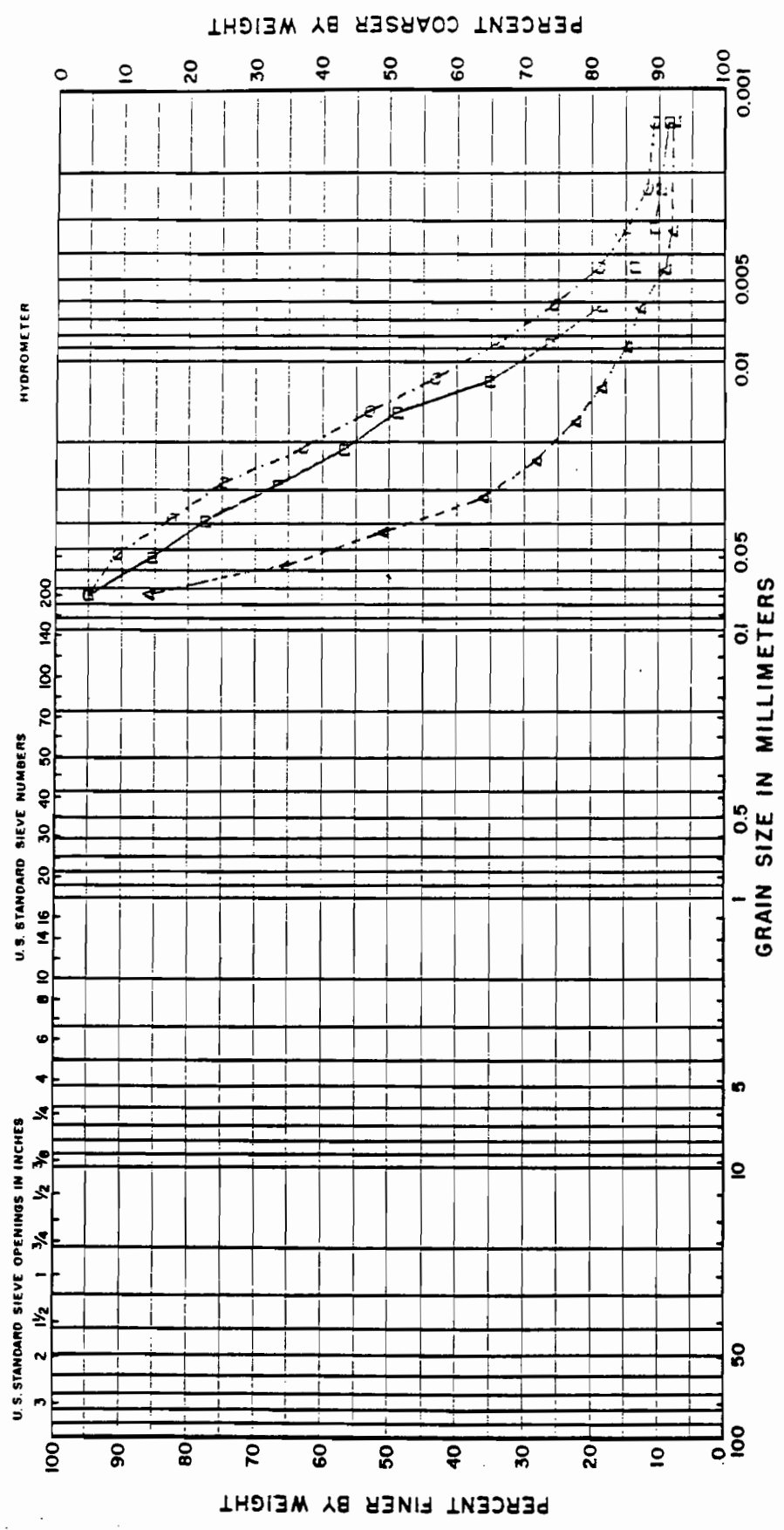
BORING	DEPTH, FT.
KOPANGAR	117.0
KOPANGAR	126.0
KOPANGAR	142.0

### GRAIN SIZE CURVES



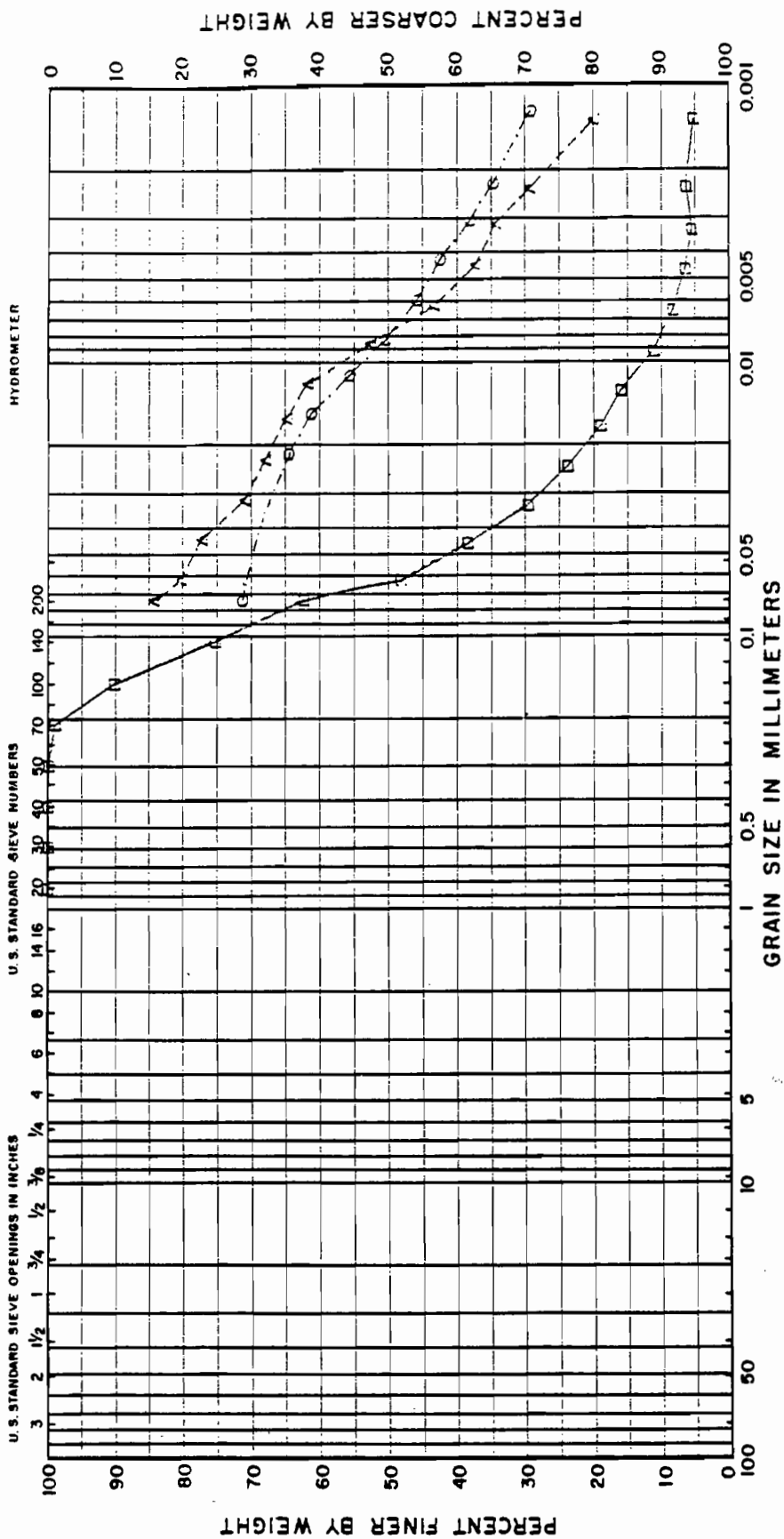
CURVE	GRAVEL		SAND		DEPTH, FT.	MATERIAL
	Coarse	Fine	Coarse	Fine		
—●—					166.0	GRAY FINE SAND
-▲-					167.0	OLIVE GRAY SANDY SILT
-□-					180.5	OLIVE GRAY SILTY FINE SAND

# GRAIN SIZE CURVES



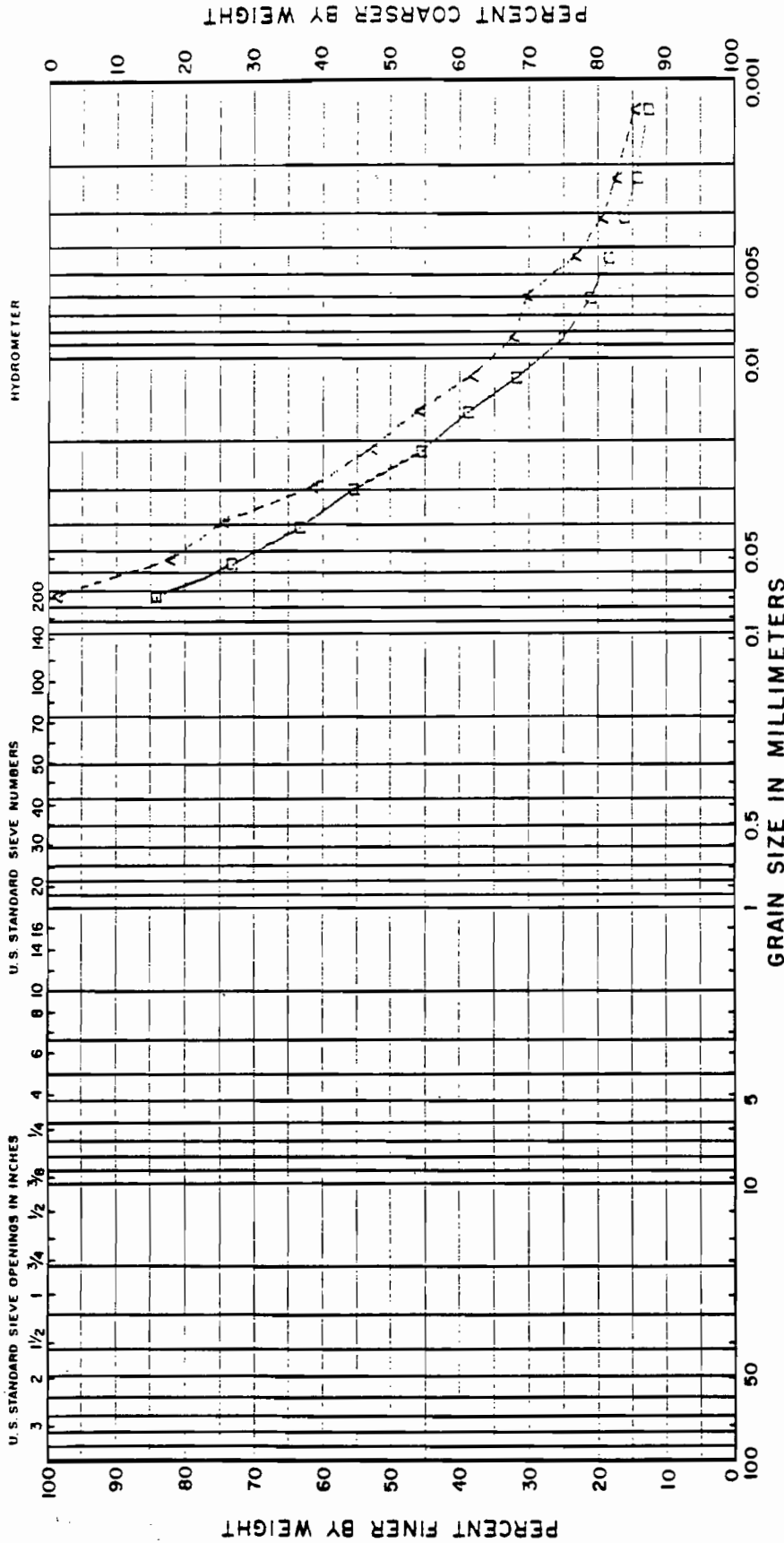
CURVE	GRAVEL		SAND			DEPTH, FT.	MATERIAL
	Coarse	Fine	Coarse	Medium	Fine		
—●—●—●—						197.0	OLIVE GRAY CLAYEY SILT
-▲-▲-▲-						212.0	OLIVE GRAY SANDY SILT
-○-○-○-						240.0	OLIVE GRAY CLAYEY SILT

# GRAIN SIZE CURVES



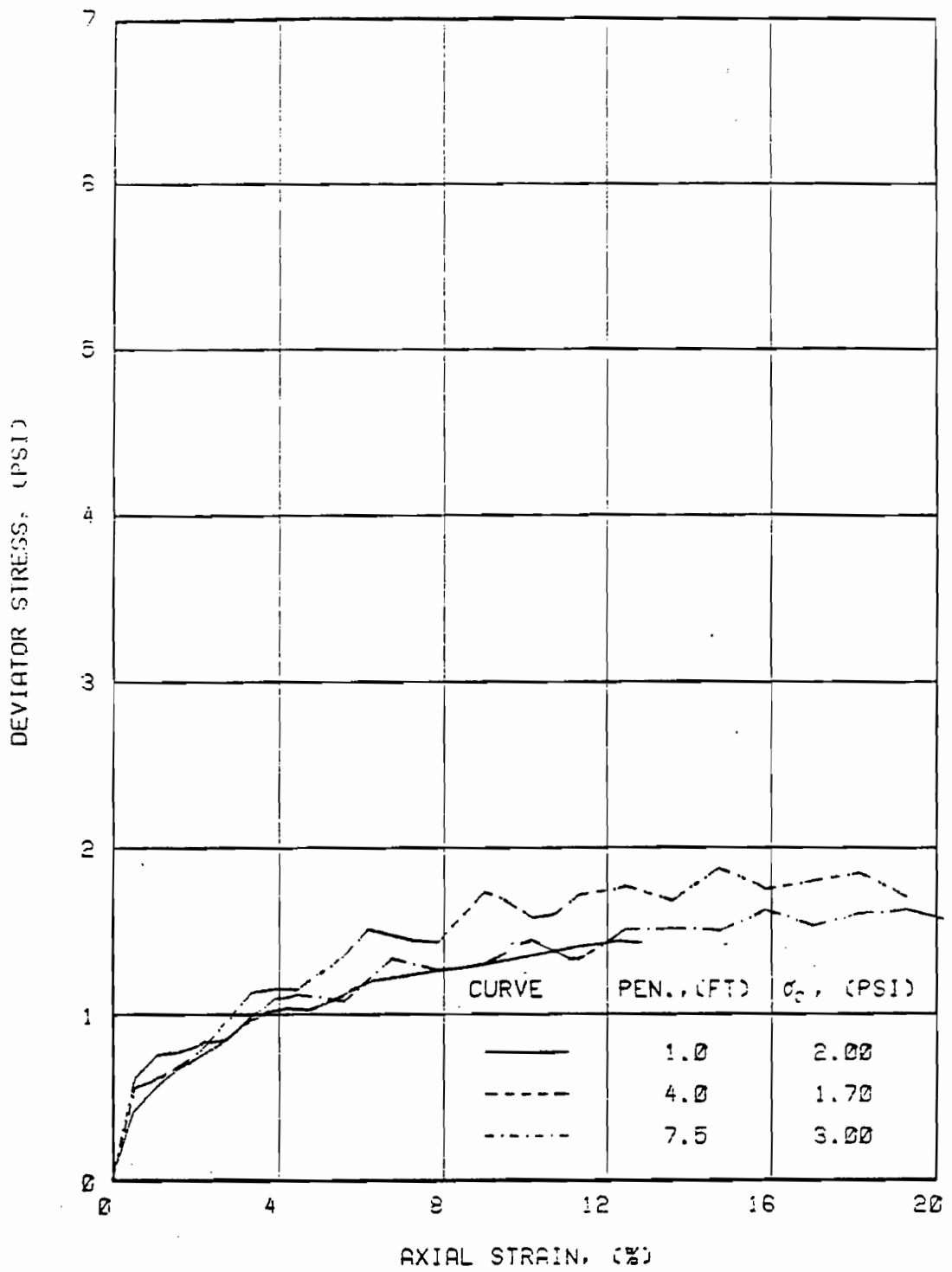
CURVE	GRAVEL		SAND			DEPTH, FT.	MATERIAL
	Coarse	Fine	Coarse	Medium	Fine		
—B—B—B—						251.0	OLIVE GRAY SANDY SILT
—A—A—A—A—						277.5	OLIVE GRAY SILTY CLAY
—C—C—C—C—						286.5	OLIVE GRAY SILTY CLAY

# GRAIN SIZE CURVES

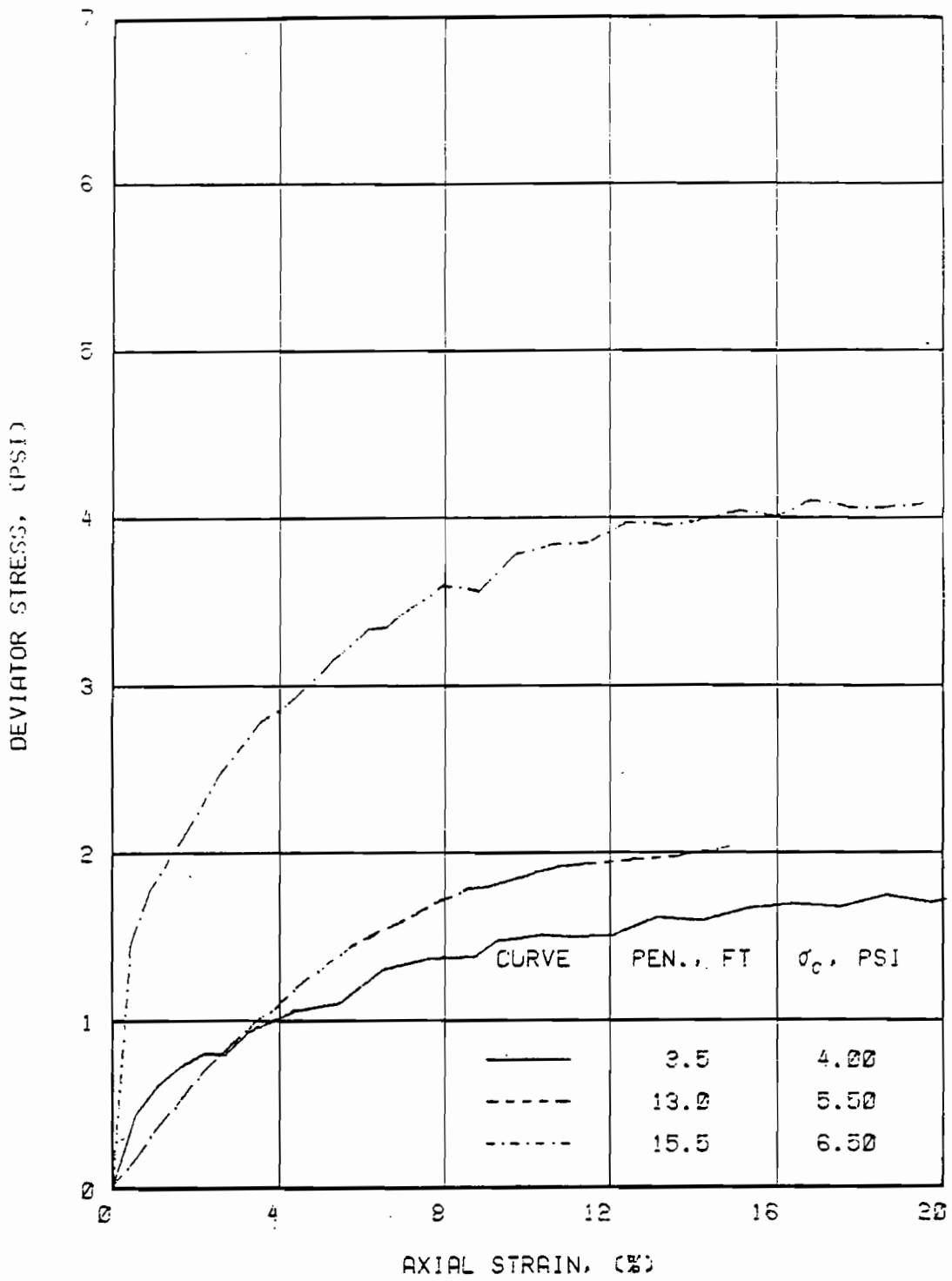


CURVE	GRAVEL		SAND			SILT or CLAY		MATERIAL
	Coarse	Fine	Coarse	Medium	Fine	SILT or CLAY		
-A-								OLIVE GRAY SANDY CLAYEY SILT
-B-								OLIVE GRAY SILTY CLAY

BORING	DEPTH, FT.
KOPANOAR	306.5
KOPANOAR	317.2

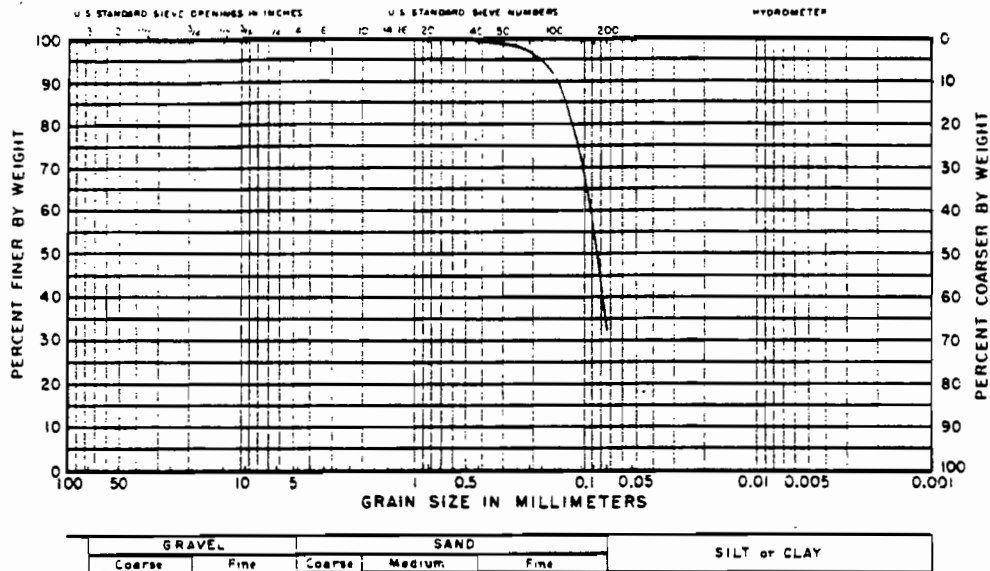


STRESS-STRAIN CURVES  
 UNCONSOLIDATED UNDRAINED TRIAXIAL TEST  
 BORING KOPANGAR



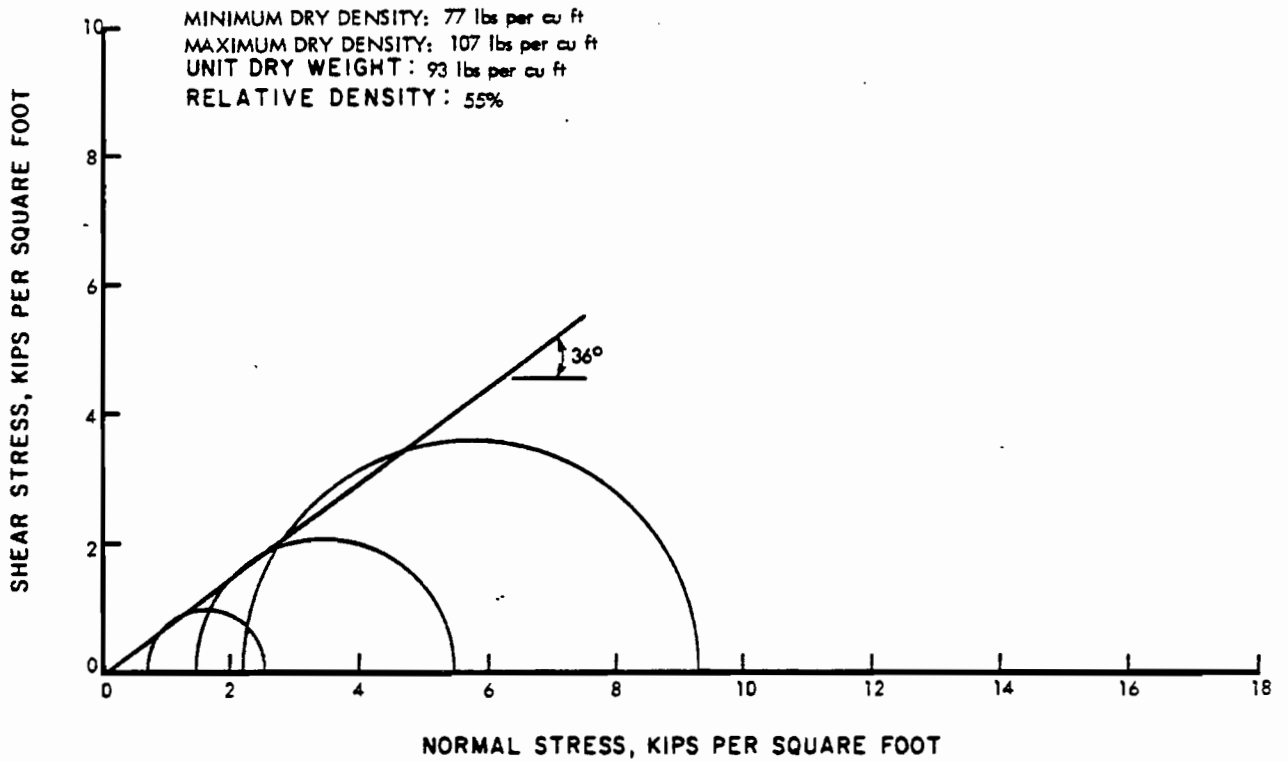
STRESS-STRAIN CURVES  
 UNCONSOLIDATED UNDRAINED TRIAXIAL TEST  
 BORING KOPANOAR



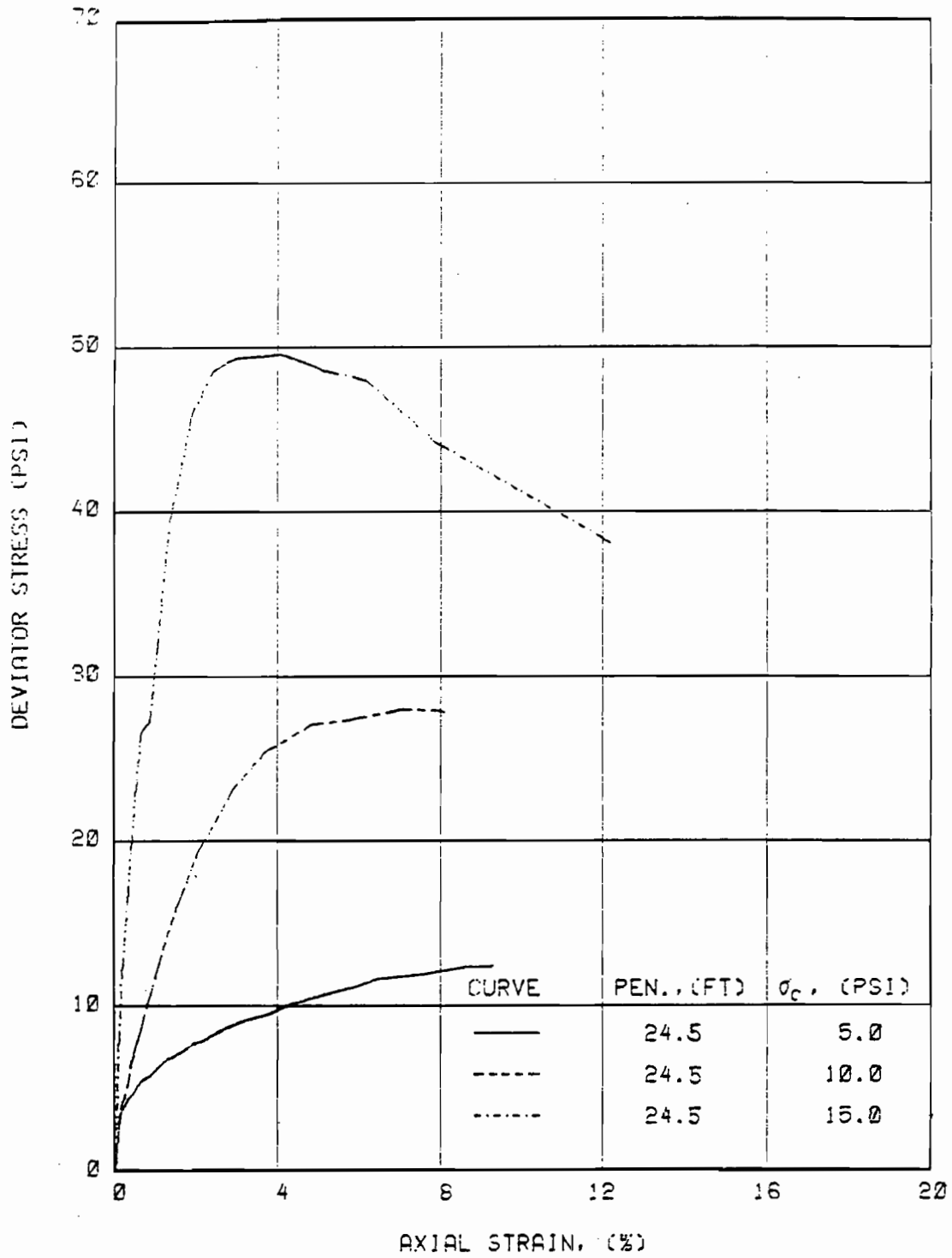


**GRADATION OF TEST SPECIMEN**

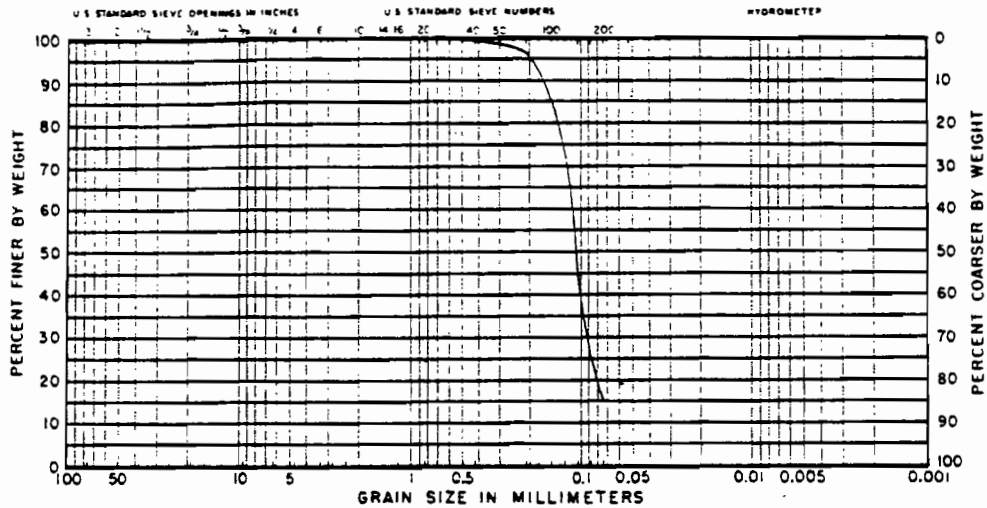
**BORING:** KOPANOAR    **PENETRATION:** 24.5'    **MATERIAL:** Light olive gray silty fine sand



**TRIAxIAL COMPRESSION TEST RESULTS**  
**CONSOLIDATED-DRAINED, MULTIPLE-STAGE TYPE**



STRESS-STRAIN CURVES  
 CONSOLIDATED DRAINED TRIAXIAL TEST  
 BORING KOPANOAR

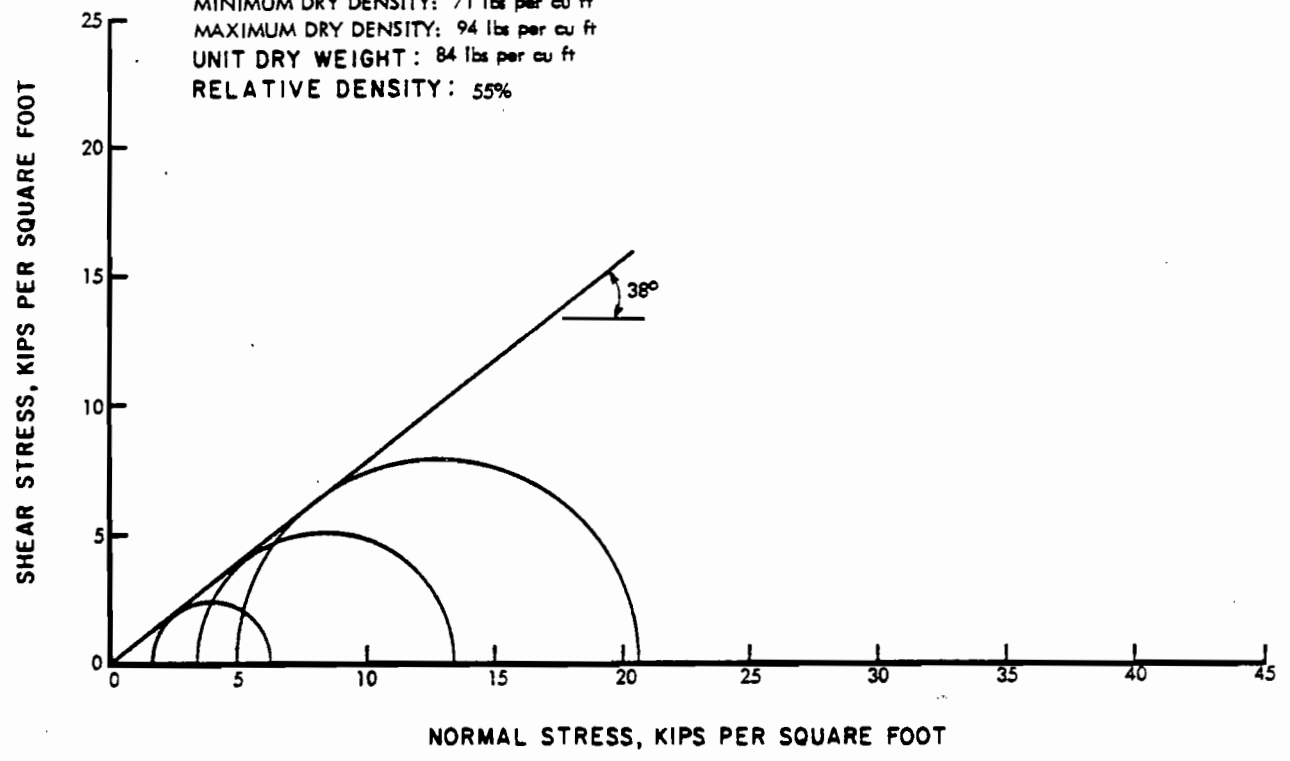


GRAVEL		SAND			SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine		

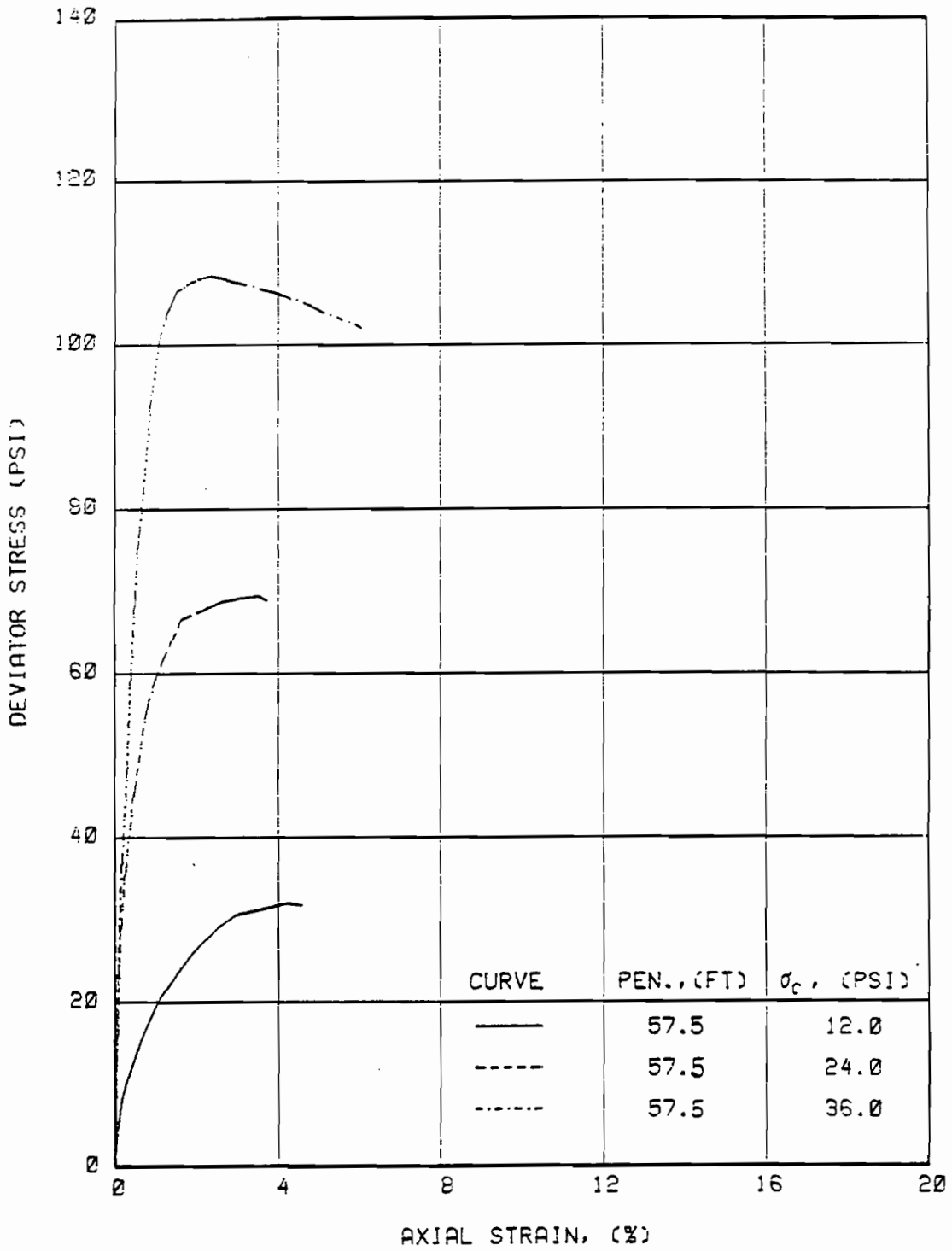
**GRADATION OF TEST SPECIMEN**

**BORING:** KOPANOAR     **PENETRATION:** 57.5'     **MATERIAL:** Olive gray silty fine sand

MINIMUM DRY DENSITY: 71 lbs per cu ft  
 MAXIMUM DRY DENSITY: 94 lbs per cu ft  
 UNIT DRY WEIGHT: 84 lbs per cu ft  
 RELATIVE DENSITY: 55%



**TRIAxIAL COMPRESSION TEST RESULTS  
 CONSOLIDATED-DRAINED, MULTIPLE-STAGE TYPE**



STRESS-STRAIN CURVES  
 CONSOLIDATED DRAINED TRIAXIAL TEST  
 BORING KOPANDAR

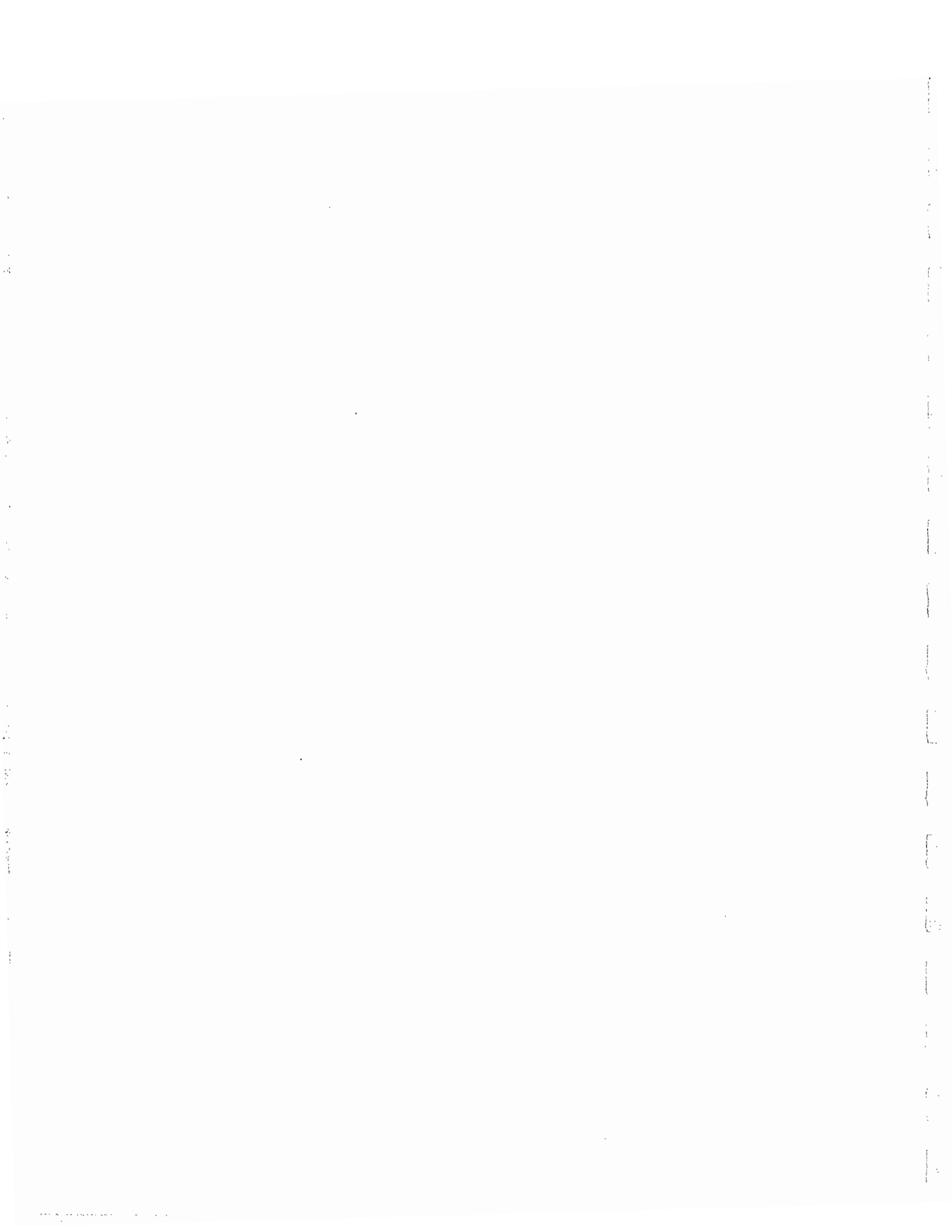
<u>Penetration, Ft</u>	<u>Description of Material</u>	<u>Grain Shape</u>
19.0	Silty fine sand 80% Quartz 10% Calcareous, mostly frosting 10% mafic	Subangular to subrounded; some platy mafic grains
40.0	Silty fine sand 70% Quartz 15% Calcareous 10% Mafic 5% Mica and organic	Subangular with some subrounded
77.5	Silty fine sand 70% Quartz 15% Calcareous 15% Mafic trace mica	Subangular with some angular quartz grains and subrounded mafics
97.0	Silty fine sand 70% Quartz 15% Calcareous 15% Mafic	Subrounded to subangular
142.0	Sandy silt 65% Silicate 20% Mafic 10% Calcareous 5% Mica and organic	Subrounded

\*Note: Percentage of constituents estimated

### RESULTS OF MICROSCOPIC ANALYSIS

Boring 3, KOPANOAR

Beaufort Sea



<u>Penetration, Ft</u>	<u>Description of Material</u>	<u>Solubility, %</u>
16.0	Clayey fine sand, slightly calcareous	10
40.5	Calcareous silty fine sand	14
76.5	Calcareous silty fine sand	16
117.0	Calcareous fine sand	13
136.0	Fine sand, slightly calcareous	10
192.5	Fine sand, slightly calcareous	9
241.0	Calcareous clayey silt	19
337.0	Calcareous clay	15
396.5	Clay, slightly calcareous	9

**RESULTS OF HCL SOLUBILITY TESTS**  
 Boring 3, KOPANOAR  
 Beaufort Sea

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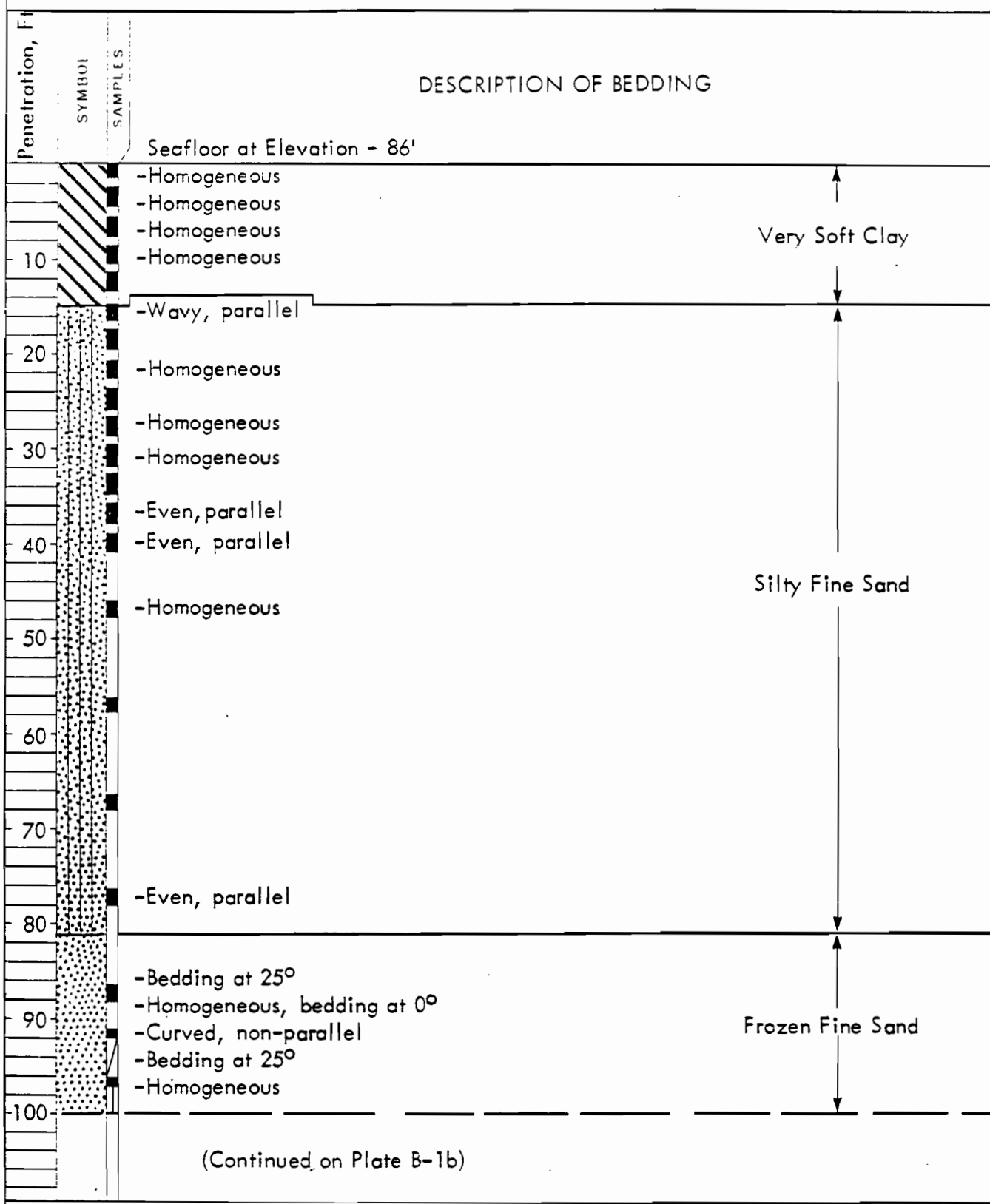
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APPENDIX B  
SUPPLEMENTAL FIELD DATA  
Appendix-Illustrations

	<u>Plate</u>
Log of Sedimentary Structure . . . . .	B-1
Log of Temperature . . . . .	B-2

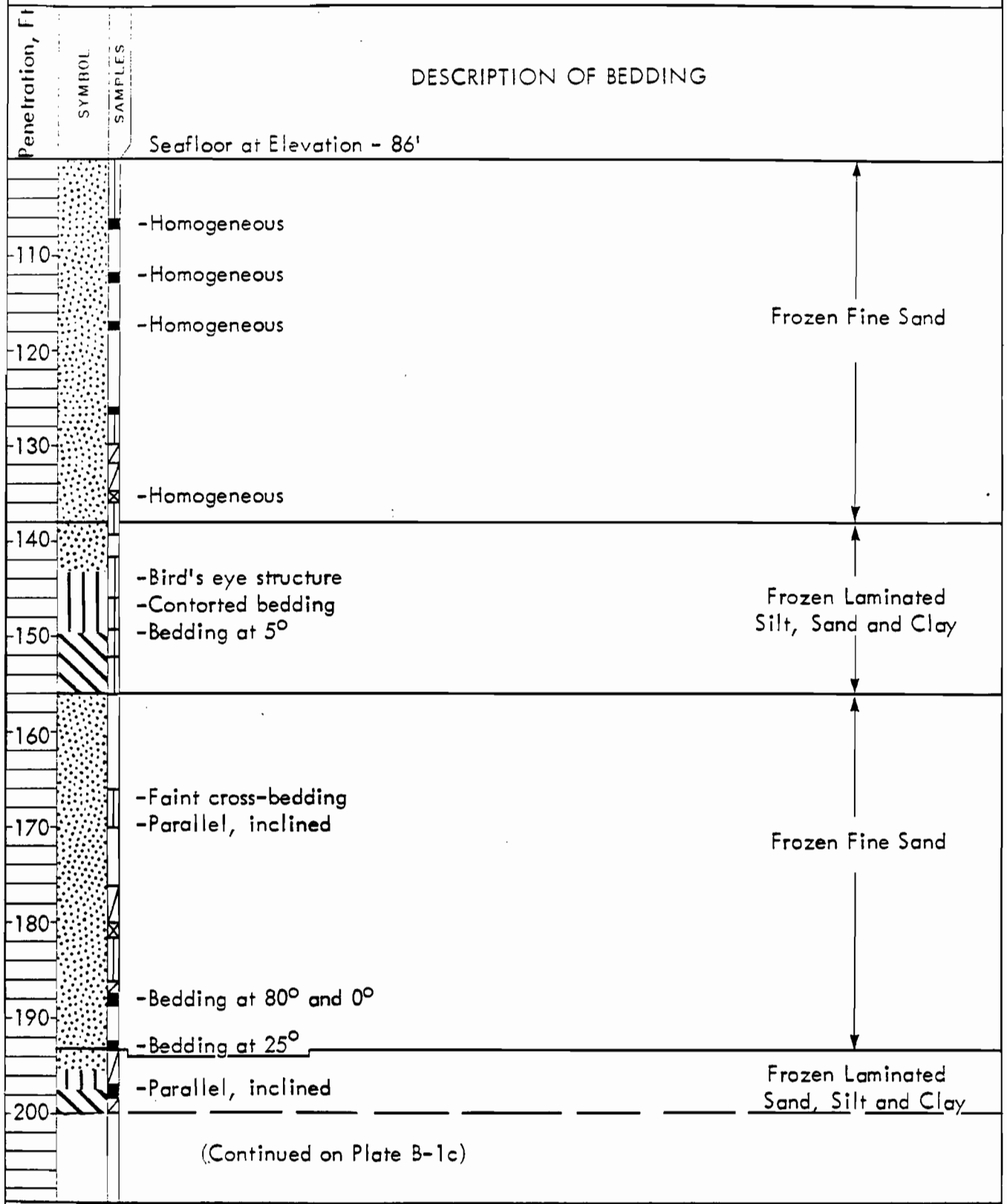


LOG OF SEDIMENTARY STRUCTURE  
BORING 3, KOPANOAR  
BEAUFORT SEA



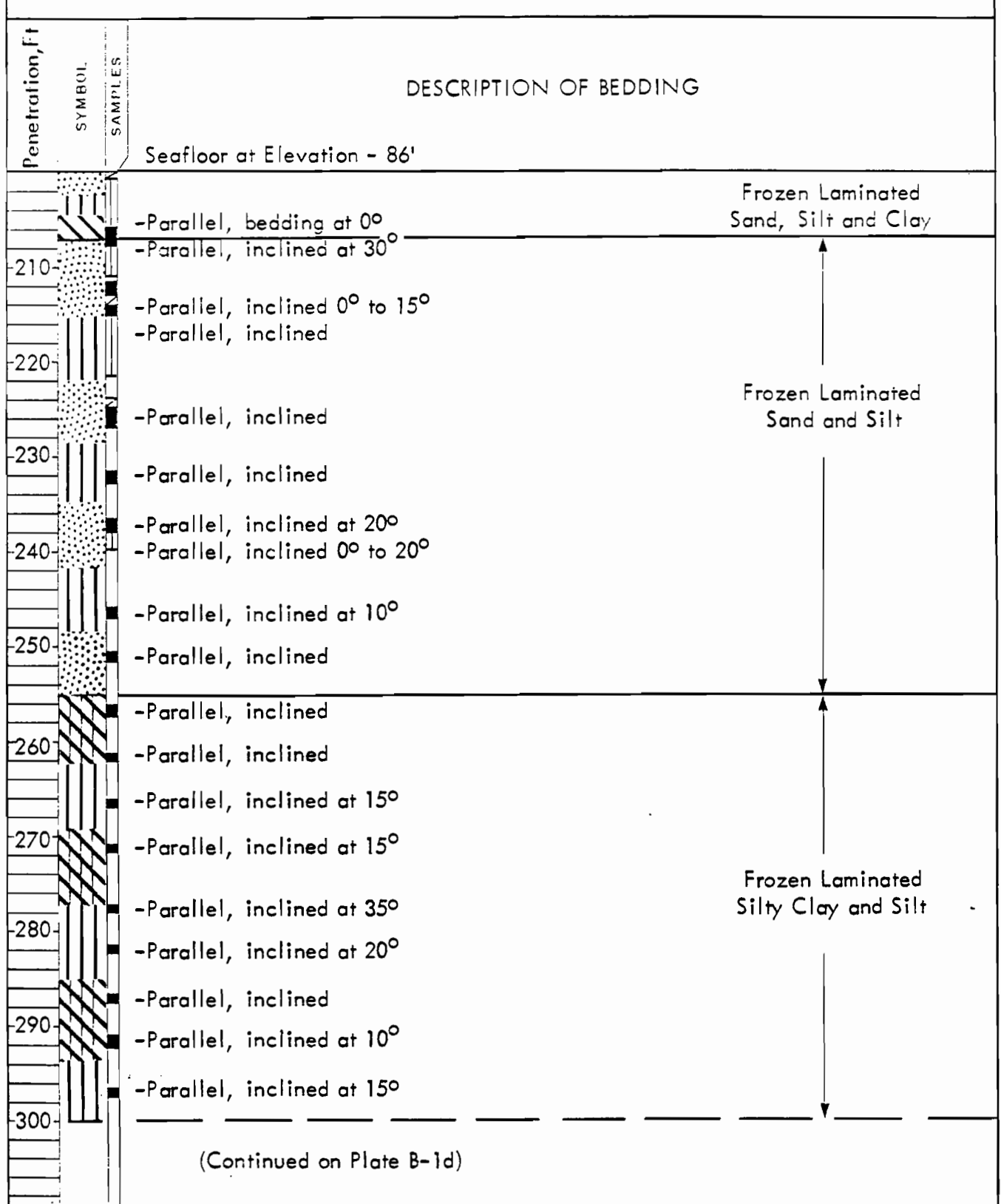
(Continued on Plate B-1b)

LOG OF SEDIMENTARY STRUCTURE  
BORING 3, KOPANOAR  
BEAUFORT SEA

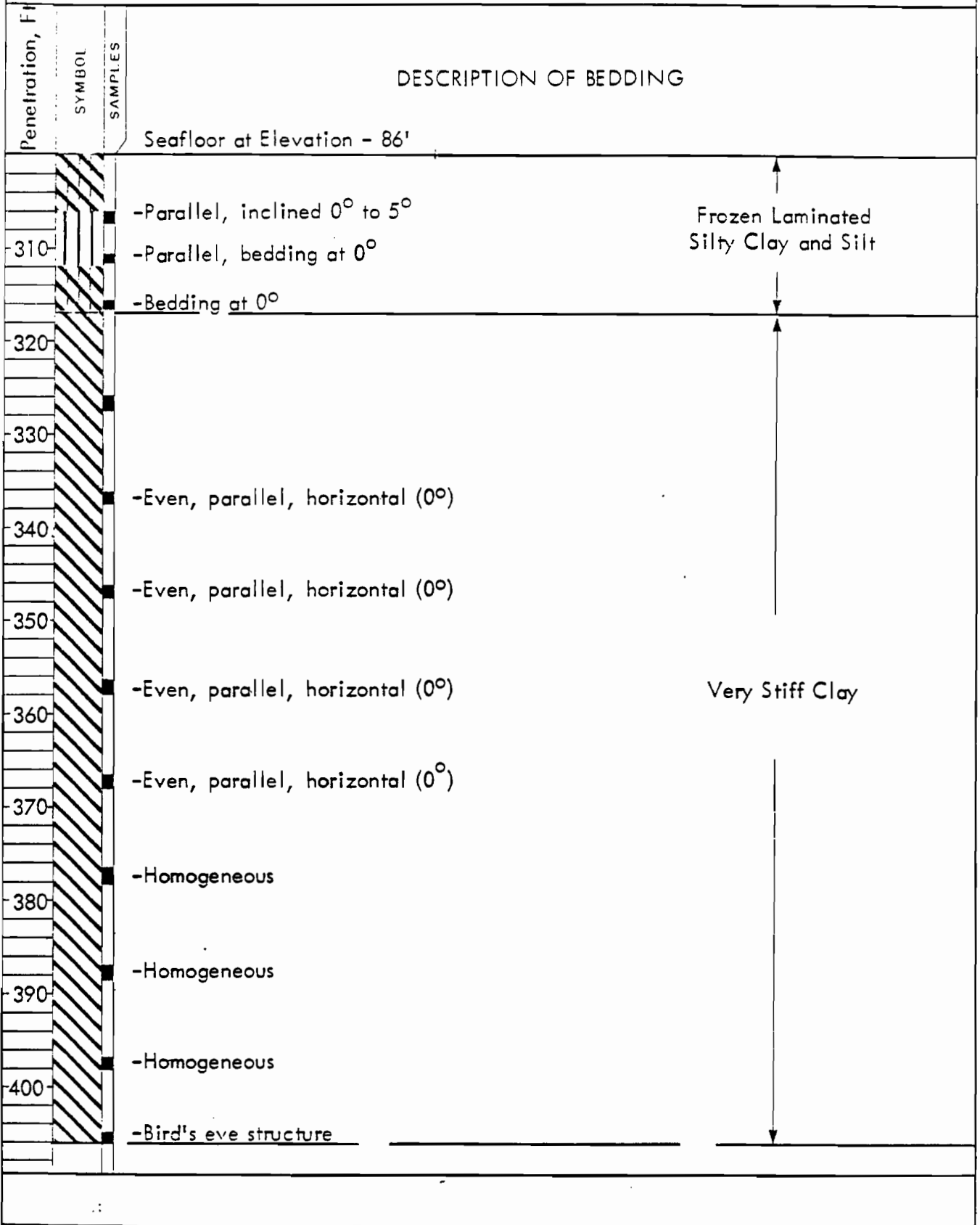


(Continued on Plate B-1c)

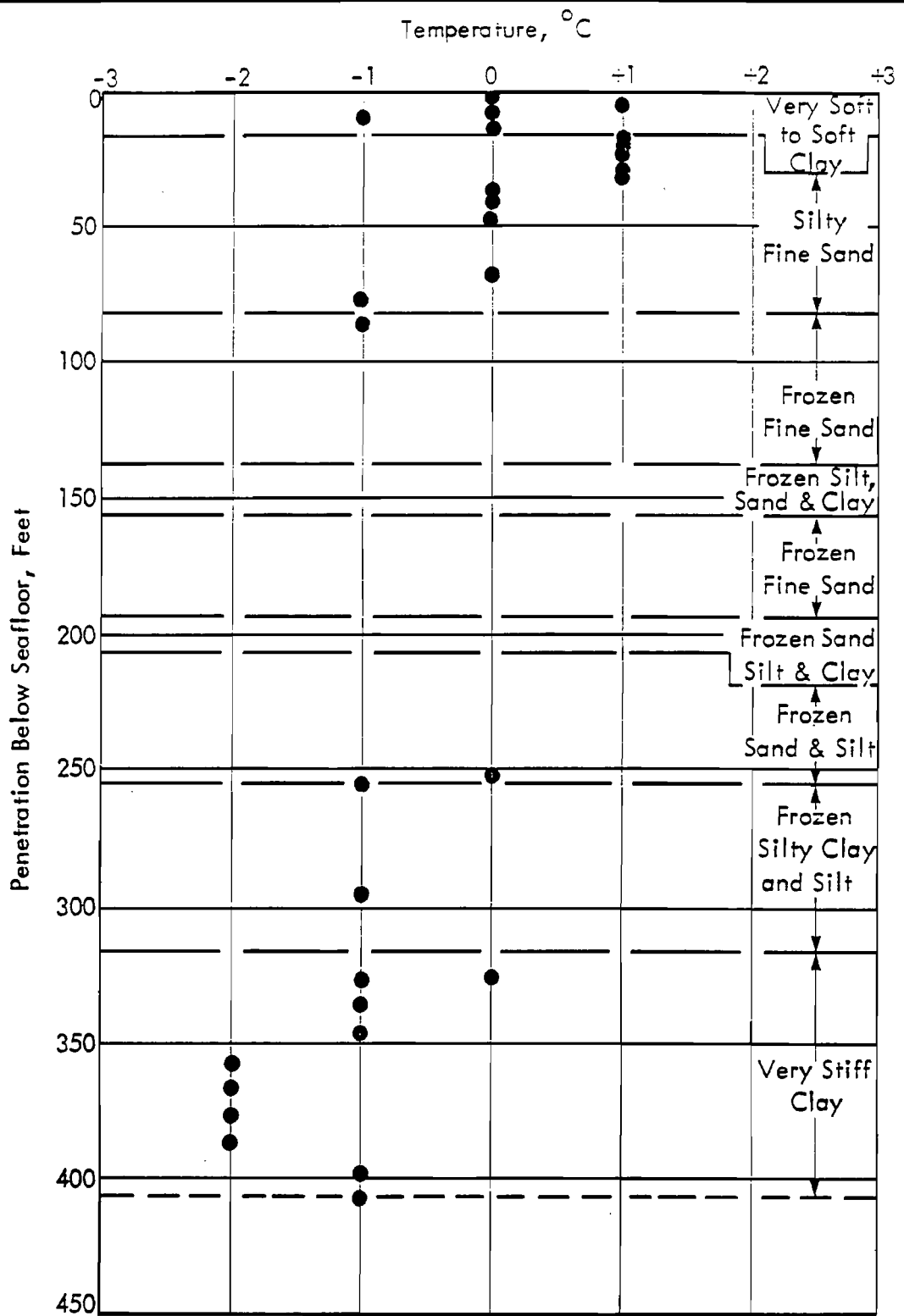
LOG OF SEDIMENTARY STRUCTURE  
BORING 3, KOPANOAR  
BEAUFORT SEA



LOG OF SEDIMENTARY STRUCTURE  
BORING 3, KOPANOAR  
BEAUFORT SEA







LOG OF TEMPERATURE  
Boring 3, KOPANOAR  
Beaufort Sea

