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Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

A Report to
GULF CANADA RESOURCES INC.
on
BEAUFORT SEA GEOTECHNICAL INVESTIGATION - 1981

EAST AMAULIGAK

DISTRIBUTION: 12 Copies - Gulf Canada Resources Inc., Calgary, Alberta
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812-2102

November, 1982

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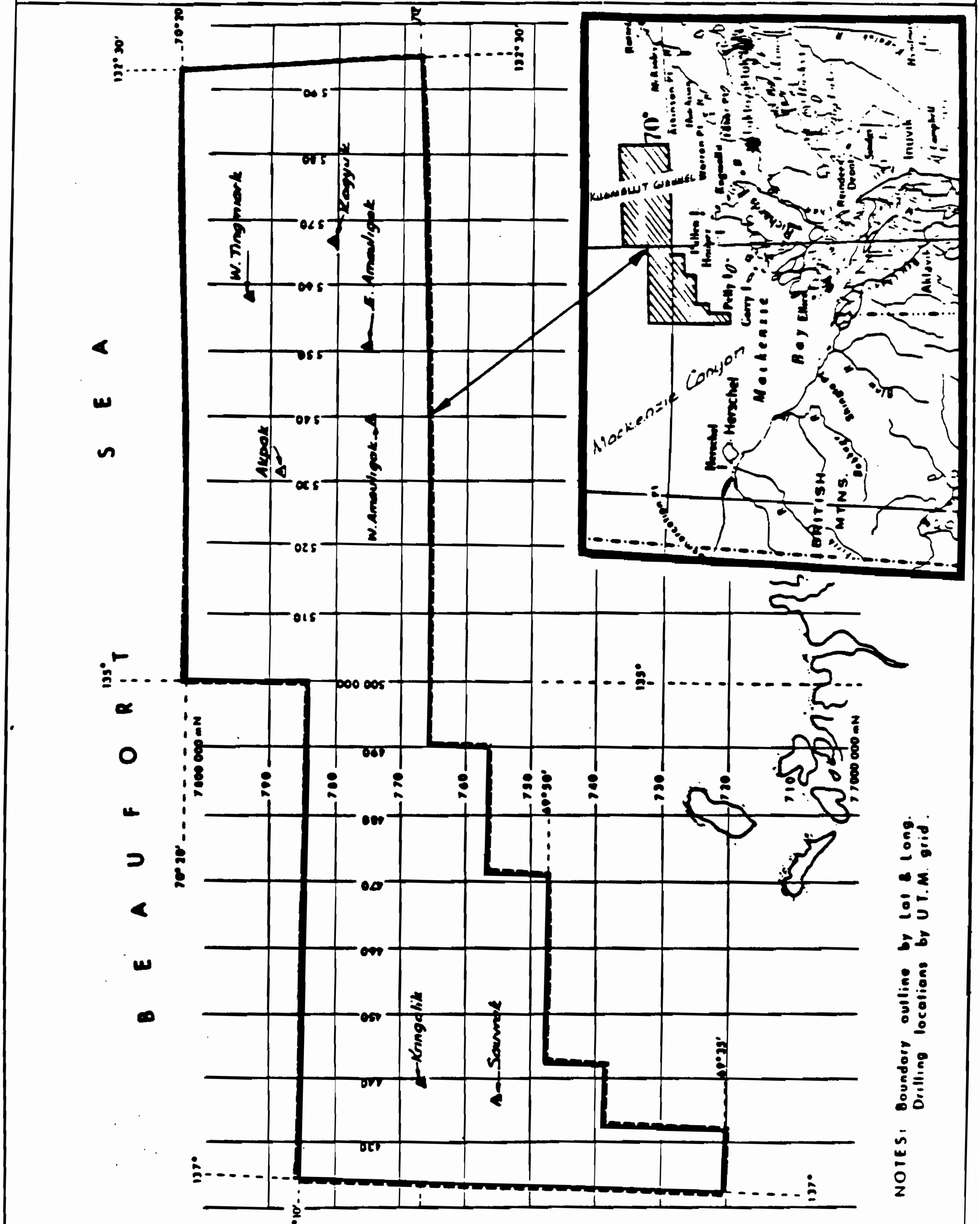

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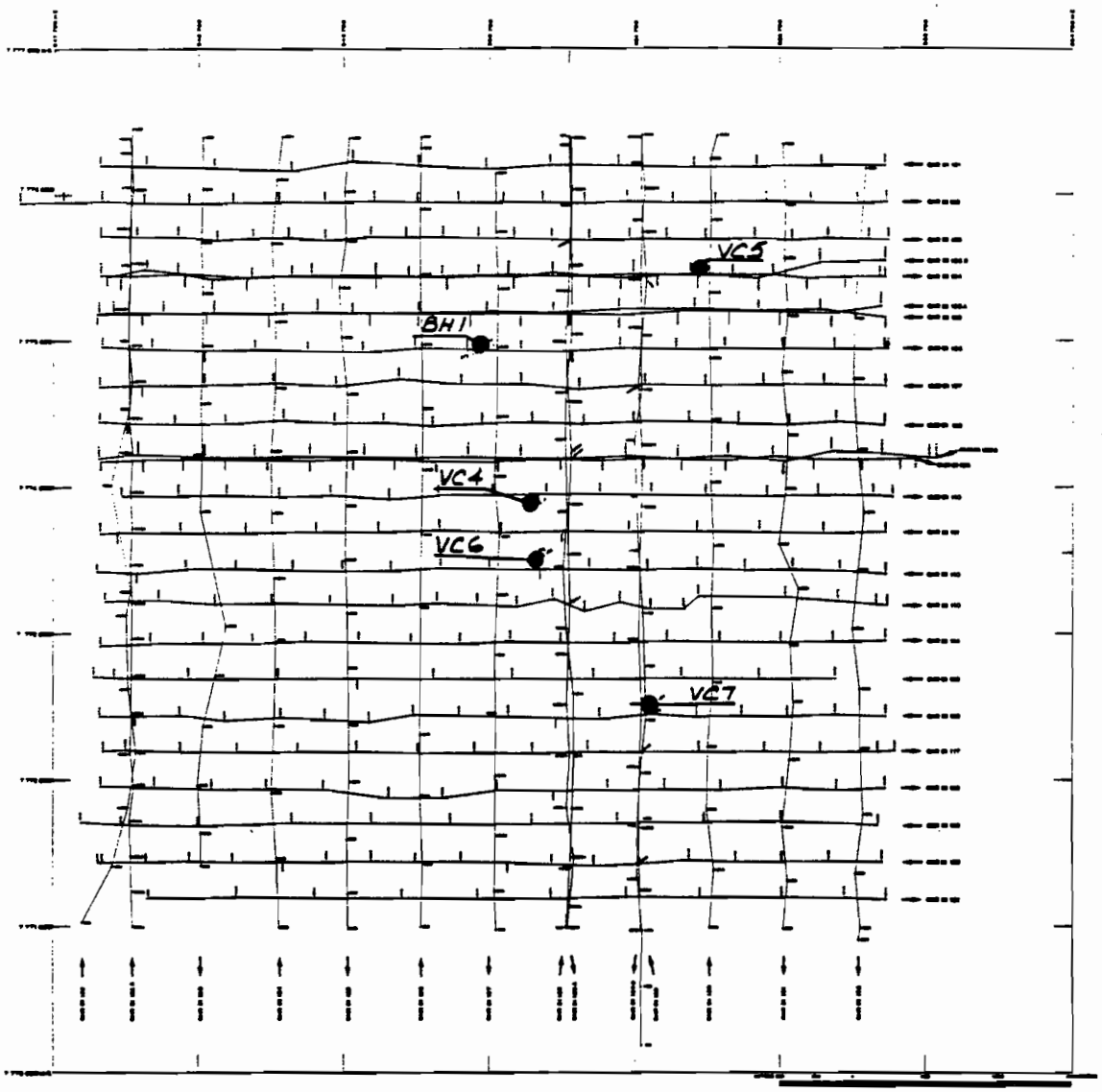
GEOPHYSICAL SURVEY LINES AND BOREHOLE LOCATIONS

Figure 2



EAST AMAULIGAK

Project No. 812-2102 Drawn RS Reviewed ' Date Nov 82

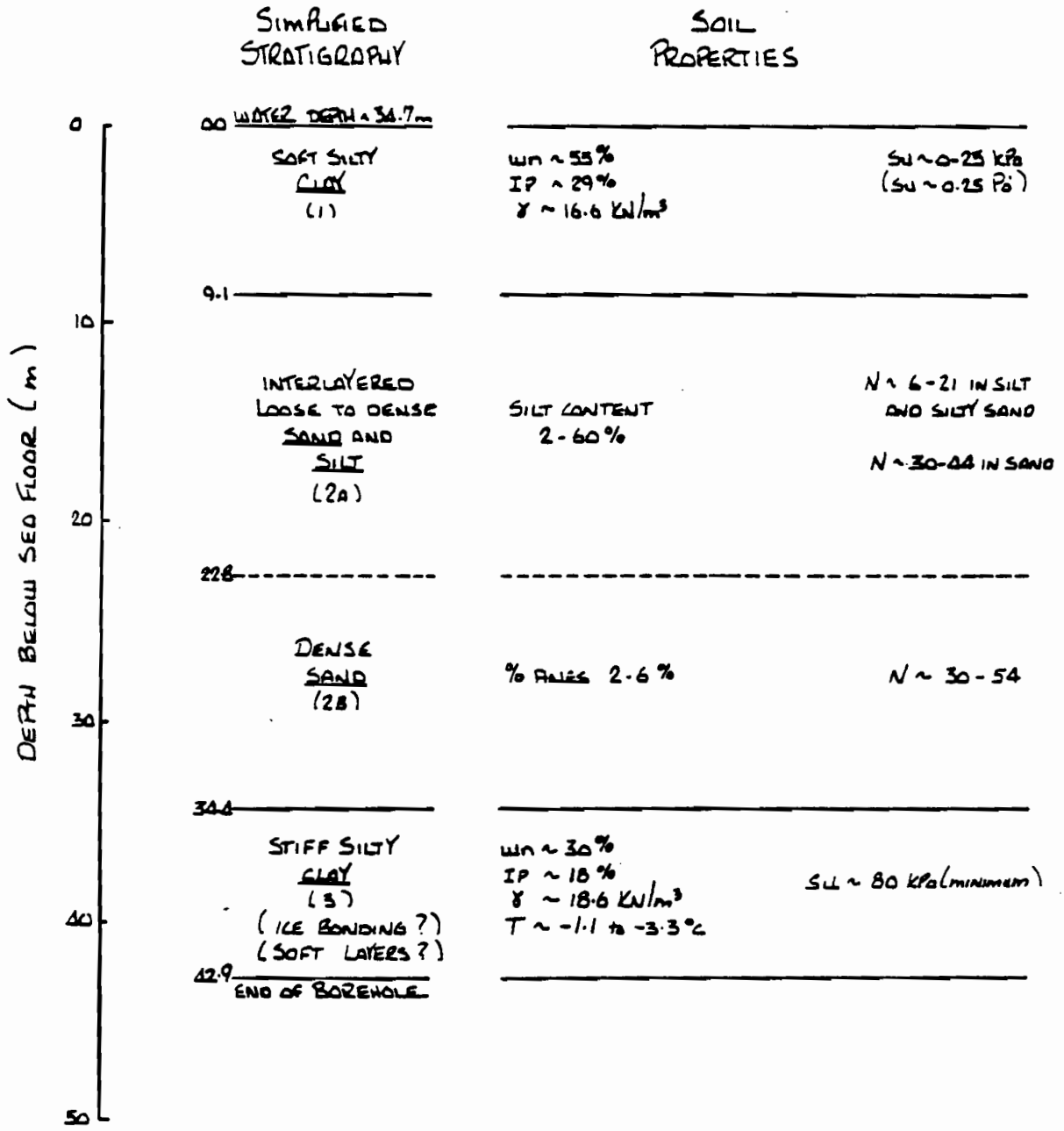
TABLE 1

Locations and Depths for East Amauligak VC Boreholes
(Locations in UTM Zone 8, WAD 72)

Hole #	VC4	VC5	VC6	VC7
Location N	7 773 868	7 775 491	7 773 502	7 772 506
E	550 995	552 146	551 137	551 797
Depth(m)	7.0	— 18.3	17.6	20.1

Summarized Stratigraphy and Engineering Properties for Preliminary Design East Amauligak Site

Figure 3



NOTE: Stratigraphy and Engineering Properties given on this figure are for preliminary design purposes only

Project No. 812-2102 Drawn BS Reviewed AI Date Nov 82

TABLE 2 SUMMARY OF LABORATORY TESTS, BOREHOLE #1

812-2102

Unit #	Description	Sample #	Depth (m)	Wn %	W_L %	W_P %	Plastic Index	Unit Wt. (kN/m^3)	GRAIN SIZE DISTRIBUTION Sand C M F	Fines* -	Silt C M F	Clay -	UNDRAINED SHEAR STRENGTH (kPa) Fall Cone	Pocket Penetrometer	Lab Vane Undist.	Lab Vane Rem.	Triaxial Tests
1	Soft, silty clay	1	1.5 - 2.1	55.1							1 5 26	68	10	5	10	5	
		2	4.6 - 5.3	59.1									26	11	14	2	
		3	6.1 - 6.7	57.6									21	9	13	3	
		4	7.6 - 8.2	46.7	62	23	39	16.6					25	9	20	5	CIU**
2A	Dense fine and medium sand, trace silt	5	9.1 - 9.6						1 59 38	2							
		6	9.6 - 9.8														
		7	10.8 - 11.3						2 42 54	2							
		8	13.0 - 13.4														
	Loose sand and silt	9	14.5 - 14.9						1 2 60	37							
		10	16.1 - 16.5														
	Dense sand, some silt	11	17.4 - 17.8						0/3 4/62 78/29	18/6							
		12	18.9 - 19.4														
	Compact silt and sand	13	20.4 - 20.9						7 33	60							
		14	21.9 - 22.4														
2B	Dense sand, trace silt	15	23.5 - 23.9						3 82 12	3							
		16	25.0 - 25.5														
		17	26.5 - 27.0						61 33	6							
		18	28.0 - 28.5														
		19	29.6 - 30.0						1 37 60	2							
		20	31.1 - 31.6														
		21	34.1 - 34.6	25.6					3 88 7	2							
3	Stiff silty, clay	22	35.7 - 36.3	33.3					2		1 17 32	48					
		23	36.3 - 36.9	33.1	40	25	15	18.5					129	120	82/45	21/9	CIU**
		24	37.8 - 38.4	28.8	47	23	24	18.7					>250/156	156	113	26	CIU**
		25	39.3 - 39.9	27.9	39	24	15						129/29	132/107/48	84/78	28/24	
		26	39.9 - 40.5	25.9							7 31 29	33	156/38	177/167/96	93	28	

* All material passing #200 sieve

**No pore pressure measurement

TABLE 3 EAST AMAULIGAK TRIAXIAL TESTS

Borehole No.	Sample No.	Depth (m)	Type of Test	Overburden Pressure, Po' (kPa)	Cell Pressure (kPa)	Back Pressure (kPa)	Effective Consolidation Pressure (kPa)	Rate of Strain (%/Hr)	Failure Deviator Stress (kPa)	Failure % Strain
1	4	7.6- 8.2	CU*	54	345	276	69	3.6	19	4.9
1	23	36.3-36.9	CU*	340	538	138	400	3.6	449	4.8
1	24	37.8-38.4	CU*	350	414	55	359	3.5	206	11.3

* Tests performed on Frank Broderick - Pore pressures not measured

APPENDIX 1

BOREHOLE,VIBRACORE LOGS AND GRAIN SIZE CURVES

LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance: The number of blows by a 63.5 kg hammer dropped 760 mm required to drive a 50 mm diameter, 60 degree cone 0.3 m , where the cone is attached to 'A' size drill rods and casing is not used.

Standard Penetration Resistance, *N*: The number of blows by a 63.5 kg hammer dropped 760 mm required to drive a 50 mm drive open sampler

WH sampler advanced by static weight—weight, hammer

PH sampler advanced by pressure—pressure, hydraulic

PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	*N, blows/0.3 m*
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	c_u, kPa
Very soft	Less than 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	over 200

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer[1]
Q undrained triaxial[2]
R consolidated undrained triaxial[2]
S drained triaxial
U unconfined compression
V field vane test
F fall cone
L lab vane
P pocket penetrometer

NOTES:

[1]Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.
[2]Undrained triaxial tests in which pore pressures are measured are shown as $\bar{Q}$ or $\bar{R}$.

LIST OF SYMBOLS

I. GENERAL

$\pi = 3.1416$

e = base of natural logarithms 2.7183

$\log_e a$ or $\ln a$, natural logarithm of a

$\log_{10} a$ or $\log a$, logarithm of a to base 10

t	time
g	acceleration due to gravity
V	volume
W	weight
M	moment
F	factor of safety

II. STRESS AND STRAIN

u	pore pressure
σ	normal stress
σ'	normal effective stress ($\bar{\sigma}$ is also used)
τ	shear stress
ϵ	linear strain
ϵ_{xy}	shear strain
ν	Poisson's ratio (μ is also used)
E	modulus of linear deformation (Young's modulus)
G	modulus of shear deformation
K	modulus of compressibility
η	coefficient of viscosity

III. SOIL PROPERTIES

(a) *Unit weight*

γ	unit weight of soil (bulk density)
γ_s	unit weight of solid particles
γ_w	unit weight of water
γ_d	unit dry weight of soil (dry density)
γ'	unit weight of submerged soil
G_s	specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
e	void ratio
n	porosity
w	water content
S_r	degree of saturation

(b) *Consistency*

w_L	liquid limit
w_P	plastic limit
I_P	plasticity index
w_s	shrinkage limit
I_L	liquidity index $= (w - w_P)/I_P$
I_C	consistency index $= (w_L - w)/I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
D_r	relative density $= (e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

h	hydraulic head or potential
q	rate of discharge
v	velocity of flow
i	hydraulic gradient
k	coefficient of permeability
j	seepage force per unit volume

(d) *Consolidation (one-dimensional)*

m_v	coefficient of volume change $= -\Delta e/(1+e)\Delta\sigma'$
C_c	compression index $= -\Delta e/\Delta \log_{10} \sigma'$
c_v	coefficient of consolidation
T_v	time factor $= c_v t/d^2$ (d, drainage path)
U	degree of consolidation

(e) *Shear strength*

τ_f	shear strength	
c'	effective cohesion intercept	in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	effective angle of shearing resistance, or friction	
c_u	apparent cohesion*	in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
ϕ_u	apparent angle of shearing resistance, or friction	
μ	coefficient of friction	
S_t	sensitivity	

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

SOIL CLASSIFICATION SYSTEM

GRAIN SIZE SCALE: M.I.T. STANDARD

BOULDERS	Larger than 200 mm
COBBLES	60 mm to 200 mm
GRAVEL	2 mm to 60 mm
SAND	0.06 mm to 2 mm
SILT	0.002 to 0.06 mm
CLAY	Smaller than 0.002 mm

COMPOSITION:

"and"	36 to 50%
"y" or "ey"	21 to 35%
"some"	11 to 20%
"trace"	0 to 10%

EXAMPLE:

Gravel 70% Sand 22%
Pass #200 Sieve 8%
Sandy Gravel, Trace of Silt

EXCEPTION:

Silt 70% Clay 30%
And plots above 'A' line
Silty clay not clayey silt

Summary of Ground Ice Descriptive System
(After Pihlainen and Johnston 1963, Lineil and Kaplar 1966)

A. ICE NOT VISIBLE[a]

Group Symbol	Subgroup Description	Subgroup Symbol	Field Identification
N	Poorly bonded or friable	Nf	To determine presence of excess ice, use procedure under note[b] and hand magnifying lens as necessary. For soils not fully saturated, estimate degree of ice saturation: medium, low. Note presence of crystals or of ice coatings around larger particles.
	No excess ice Well-bonded	Nbn Nb	
	Excess ice	Nbe	

B. VISIBLE ICE—LESS THAN 1 INCH THICK[a]

Group Symbol	Subgroup Description	Subgroup Symbol	Field Identification
V	Individual ice crystals or inclusions	Vx	For ice phase, record the following when applicable: Location, Orientation, Thickness, Length, Spacing, Hardness, Structure, Colour, Size, Shape, Pattern of arrangement (Hardness, Structure, Colour per Group C)
	Ice coatings on particles	Vc	
	Random or irregularly oriented ice formations	Vr	
	Stratified or distinctly oriented ice formations	Vs	Estimate volume of visible segregated ice present as percentage of total sample volume.

C. VISIBLE ICE—GREATER THAN 1 INCH THICK

Group Symbol	Subgroup Description	Subgroup Symbol	Field Identification
ICE	Ice with soil inclusions	ICE + soil type	Designate material as ICE[c] and use descriptive terms as follows, usually one item from each group, when applicable:
	Ice without soil inclusions	ICE	*Hardness*: HARD, SOFT (of mass, not individual crystals). *Structure*[d]: CLEAR, CLOUDY, POROUS, CANDLED, GRANULAR, STRATIFIED. *Colour* (Examples): COLOURLESS, GRAY, BLUE. *Admixtures* (Examples): CONTAINS FEW THIN SILT INCLUSIONS

(a) Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group.

(b) When visual methods are inadequate, a simple field test to aid evaluation of volume of excess ice can be made by placing some frozen soil in a small jar, allowing it to melt, and observing the quantity of supernatant water as a percentage of total volume.

(c) Where special forms of ice such as hoarfrost can be distinguished, more explicit description should be given.

(d) Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

PROJECT No B12-2102 DRAWN D.S. REVIEWED KB DATE Nov 82

RECORD OF BOREHOLE BH 1

LOCATION (See Figure 1.2) N 7 774 969 E 550 638 East Amauligak
BORING DATE AUGUST 28-30 1981
BOREHOLE DIAMETER 10.2 cm
SAMPLE HAMMER WEIGHT 63.5 kg
DROP 0.76 metres
DATUM Sea Floor

BQ 'SAMPLING RODS ALL RODS FOR IN SITU VANE TEST
3½ in OD (117.5 mm) DRILL PIPE WITH CASING SHOE DRILL BIT MUD SUPPORTED HOLE **

Elev. Depth (m)	DESCRIPTION	Strat. Plot	Sample Number	Sample Type	Blows/300mm	Temperature °C
0.0	SEA FLOOR (WATER DEPTH 34.9 m)					
1	(1)		1	To		
2						
	SOFT, DARK GREY, SILTY CLAY, TRACE OF ORGANICS			To	No Recovery	
4			2	TP		
6			3	To		
8			4	To		
9.1	(2A)		5	To		
10	DENSE GREY FINE AND MEDIUM GRAINED SAND, TRACE OF SILT AND COARSE SAND		6	Do	(13?)	
12			7	Do	44	
13.8			8	Do	42	
	(2A) LOOSE, GREY, FINE SAND AND SILT		9	Do	6	
16			10	Do	10	
16.7	(2A) DENSE, BROWN MEDIUM TO FINE GRAINED SAND TRACE OF SILT AND COARSE SAND, OCCASIONAL SHELL FRAGMENTS.		11	Do	48	
18			12	Do	30	
	(2A) COMPACT GREY-BROWN SILT AND FINE SAND, TRACE OF SILT AND COARSE SAND		13	Do	17	
22			14	Do	21	
22.8	(2B)		15	Do	37	
			16	Do	39	
26	DENSE BROWN, MEDIUM TO FINE GRAINED SAND, TRACE OF SILT AND COARSE SAND		17	Do	45	
28			18	Do	54	
30			19	Do	46	
			20	Do	30	
32					LOOSE DRILLING RESISTANCE	
34.4			21	Do	46	-1.1
	(3) STIFF GREY SILTY CLAY OCCASIONAL SOFT TO VERY SOFT LAYERS; NO VISIBLE ICE PRESENT BUT TEMPERATURE AND DRILLING RECORDS INDICATE PRESENCE OF ICE BONDING BELOW 39 m.		22	To		-1.1
36			23	To		-2.8
38			24	To		-3.3
40			25	To		-2.8
			26	To		-2.8
42						
42.9	END OF BOREHOLE					
46						
50						

** CONDUCTOR STRING
a) 6⅝ in (168 mm) OD RISER CASING FROM 1.2 m BELOW SEA FLOOR TO MOON POOL
b) 8⅝ in (219 mm) OD OUTER CASING TO 29.9 m BELOW MOON POOL DECK
c) DRILLING MUD DISCHARGE ONTO SEABED THROUGH SLOTS IN 5⅝ m CASING

UNDRAINED SHEAR STRENGTH (kPa) FIELD VANE + NATURAL ⊕ REMOULDED
50 100 150 200

WATER CONTENT PERCENT W_p W W_l
20 40 60 80

INCREASE IN DRILLING RESISTANCE

ADDITIONAL LAB. TESTING: H; M; R γ = 16.6 kN/m³; MH R γ = 18.5 kN/m³; C γ = 18.7 kN/m³

PIEZOMETER OR STANDPIPE INSTALLATION

NOTE: ALL T.O. AND T.P. SAMPLES WERE 75 mm
ALL D.O. SAMPLES WERE 30 mm

NOTE: IN SITU VANE TESTS WERE CARRIED OUT AT A SEPARATE LOCATION, 17 m FROM BOREHOLE 1.

SCALE 1:200

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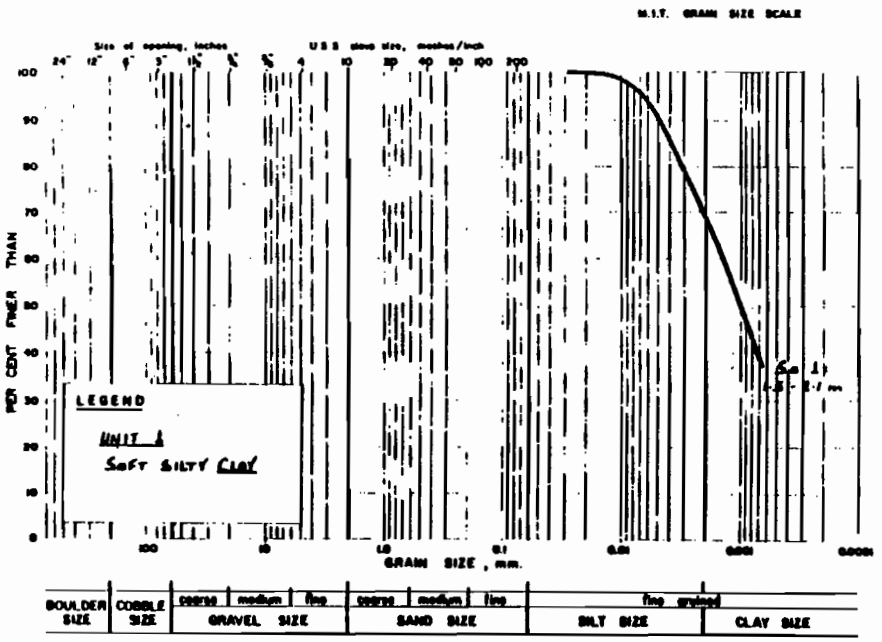
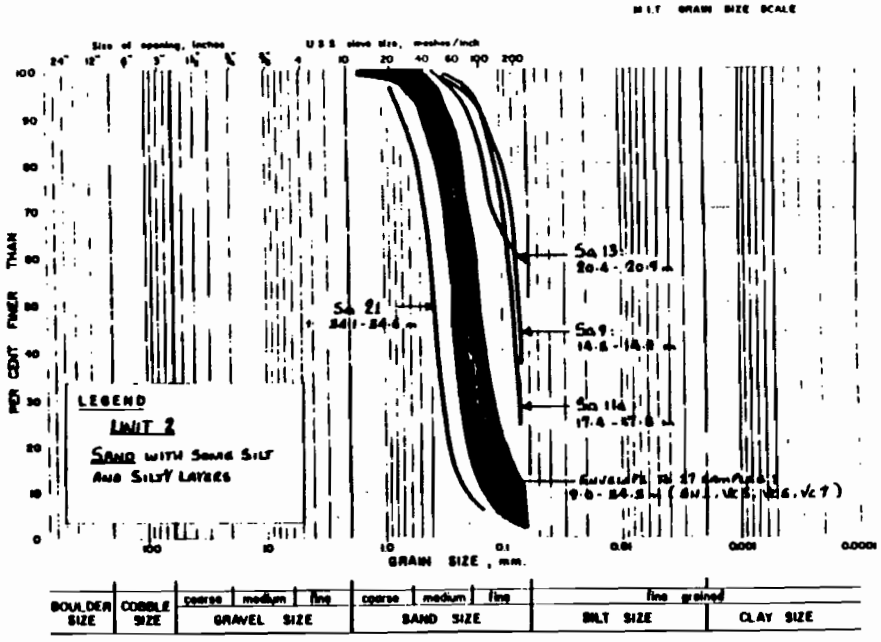
BOREHOLE No BH 1

Project No. B12-2102 Drawn D.S. Reviewed [illegible] Date Nov-82

GRAIN SIZE DISTRIBUTION





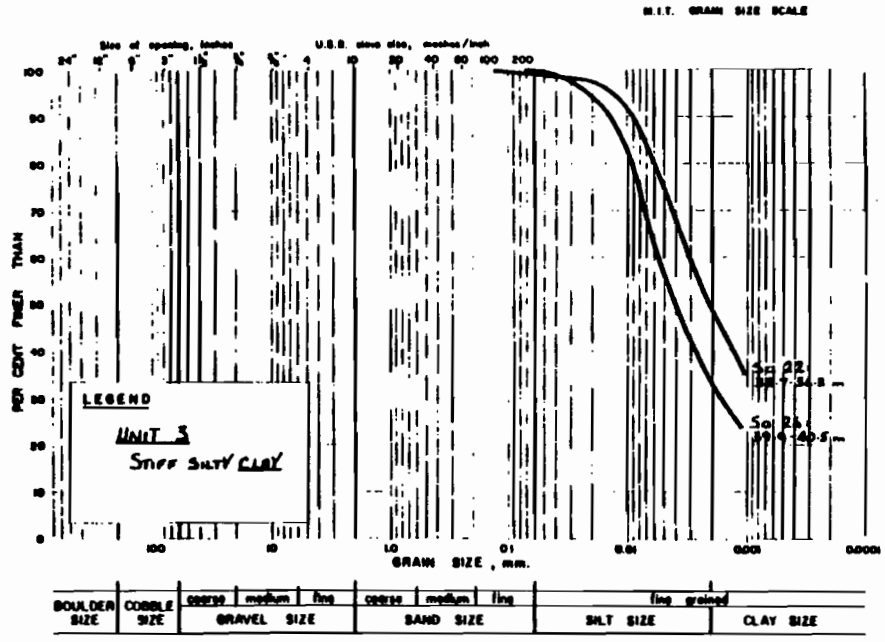


Figure 3

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RECORD OF BOREHOLE MC 04

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amauligak LOCATION CO-ORDS: N 7 773 868 E 550 995 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10-16cm BORING DATE: August 15, 1981 WATER DEPTH: 32.9 m.

DEPTH. 1:50(m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_p W W_L (20 40 60 80)	ADDITIONAL LAB. TESTING
	Sea Floor				
0.0	Lost				
0.9	Olive grey CLAY (or SILT) with thin black organic layers				
2.0					
4.0					
6.0					
7.0	End of Borehole				

PROJECT No. 812-2102 **Golder Associates** BORE HOLE No. MC 04

SHEET 1 OF 1

RECORD OF BOREHOLE VC 05

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amauligak LOCATION CO-ORDS: N 7 775 491 E 552 146 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10·16cm BORING DATE: August 15, 1981 WATER DEPTH: 35 m.

DEPTH. 1:50 (m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_p W W_L (20 40 60 80)	ADDITIONAL LAB. TESTING
	Sea Floor				
0.0					
2.0	Lost				
4.0					
5.1	Soft to firm, dark olive grey CLAY, local layers slightly silty, organic layers throughout, numerous shell fragments				
6.0					
8.0					
10.0					

PROJECT No. 812-2102 **Golder Associates** BORE HOLE No. VC 05

SHEET 1 OF 2

RECORD OF BOREHOLE YC 05

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amauligak LOCATION CO-ORDS: N 7 775 491 E 552 146 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10·16cm BORING DATE: August 15 1981 WATER DEPTH: 35 m.

DEPTH 1:50(m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_p W W_L (20 40 60 80)	ADDITIONAL LAB. TESTING
10.0	as above				
12.0					
12.8	Dark olive grey silty CLAY, thin black organic layers, calcareous, numerous shell fragments				
14.0					
14.6	Dense, greyish brown to grey, fine to medium SAND, trace of silt and organics, graded beds throughout, calcareous, occasional shell fragments		6		M
			7		M
			8		M
16.0			9		M
			10		M
18.0			11		M
18.3	End of Borehole				

PROJECT No. 812-2102 **Golder Associates** BORE HOLE No. YC 05

SHEET 2 OF 2

RECORD OF BOREHOLE VC 06

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amauligak LOCATION CO-ORDS: N 7 773 502 E 551 137 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10·16cm BORING DATE: August 19, 1981 WATER DEPTH: 33.2 m.

DEPTH 1:50(m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_p W W_l (20 40 60 80)	ADDITIONAL LAB TESTING
	Sea Floor				
0.0	Soft to firm, dark olive grey CLAY, locally silty, numerous thin organic layers, shell fragments, confined to individual layers, very disturbed				
2.0					
4.0					
4.2	as above, becomes calcareous				
6.0					
7.8					
8.0	Dark olive grey clayey SILT, trace of sand, calcareous				
8.8	Dense, brownish grey, medium to fine grained SAND, trace of silt, graded beds, calcareous, some shell fragments and organics		2		M
10.0					

PROJECT No 812-2102 **Golder Associates** BORE HOLE No. VC 06

SHEET 1 OF 2

RECORD OF BOREHOLE VC 06

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amaulicak LOCATION CO-ORDS: N 7 773 502 E 551 137 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10·16cm BORING DATE: August 19, 1981 WATER DEPTH: 33.2 m.

DEPTH. 1:50(m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_p W W_l (20 40 60 80)	ADDITIONAL LAB. TESTING
10.0			3		M
	as above		4		M
12.0					
			6		M
14.0					
14.2	Dense, olive, medium to fine SAND, trace of silt poorly graded.		7		M
			8		M
16.0			9		M
16.7	Greyish brown fine SAND, trace of silt, graded beds.		10		M
17.6	End of Borehole				
18.0					

PROJECT No. 812-2102 **Golder Associates** BORE HOLE No. VC 06

SHEET 2 OF 2

RECORD OF BOREHOLE VC 07

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amauligak LOCATION CO-ORDS: N 7 772 506 E 551 797 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10-16cm BORING DATE: August 19, 1981 WATER DEPTH: 32.9 m.

DEPTH. 1:50(m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_P W W_L (20 40 60 80)	ADDITIONAL LAB. TESTING
	Sea Floor				
0.0	Greenish grey CLAY, layered and mottled with organic material				
1.0	organic layer				
1.8	as above				
3.0	organic layer				
3.9	as above				
5.0	organic layer				
6.4	as above				
7.0					
10.0					

PROJECT No. 812-2102

Golder Associates

BORE HOLE No. VC 07

SHEET 1 OF 2

RECORD OF BOREHOLE MC 07

UTM GRID ZONE 8 WAD 72

SITE NAME: East Amauligak LOCATION CO-ORDS: N 7 772 506 E 551 797 DATUM: Sea floor

BOREHOLE TYPE: Sonic. DIAMETER: 10·16cm BORING DATE: August 19, 1981 WATER DEPTH: 32.9 m.

DEPTH. 1:50(m)	SOIL DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	WATER CONTENT PERCENT W_p W W_L (20 40 60 80)	ADDITIONAL LAB. TESTING
10.0	as above				
	organic layer ½" thick				
10.9	as above				
13.1	Compact greenish grey fine to medium SAND, calcareous		4		M
	organic layers at 13.5/14.1 and 14.5		5		M
15.1	Grey SAND				
15.5	PEAT				
15.7	SANDY PEAT ↓ Brownish black PEAT				
16.4	Black organic medium SAND		6		M
16.7	Grey organic medium SAND, calcareous		7		M
17.8	Greyish green fine SAND, trace of silt, non-calcareous		8		M
18.3	Greenish brown fine and medium grained SAND, graded bedding, layers of organic material		9		M
			10		M
20.1	End of Borehole →				

PROJECT No. 812-2102

Golder Associates

BORE HOLE No MC 07

SHEET 2 OF 2

TABLE 2

GRAIN SIZE DISTRIBUTION

BOREHOLE VC - 05 , 06,07 BOREHOLE TYPE: Sonic SITE NAME: East Amauligak

	Depth		Sample No.	Gravel	Sand			Fines	Silt			Clay
	From	To	—	—	C	M	F	—	C	M	F	—
VC - 05	10.4	10.7	6	0	0	77	17	6				
	10.8	11.0	7	0	1	75	21	3				
	11.0	11.6	8	0	1	59	32	8				
	11.6	12.2	9	0	1	68	28	3				
	12.5	13.1	10	0	0	73	25	2				
	13.4	14.0	11	0	0	69	27	4				
VC - 06	9.1	9.5	2	0	2	80	10	8				
	10.1	10.4	3	0	4	71	18	7				
	10.7	11.0	4	0	1	75	20	4				
	13.1	14.0	6	0	1	76	17	6				
	14.2	14.6	7	0	0	70	25	5				
	15.2	15.6	8	0	0	76	22	2				
	15.9	16.2	9	0	0	22	72	6				
	16.7	17.6	10	0	0	22	71	7				
VC - 07	13.1	14.0	4	0	0	72	27	1				
	14.3	14.6	5	0	0	77	23	0				
	16.4	16.7	6	0	0	66	30	4				
	17.1	17.4	7	0	1	85	8	6				
	17.7	18.0	8	0	1	36	53	10				
	18.6	18.9	9	0	1	50	42	7				
	19.5	19.8	10	0	0	47	45	8				

Project No. 812-2102

Golder Associates

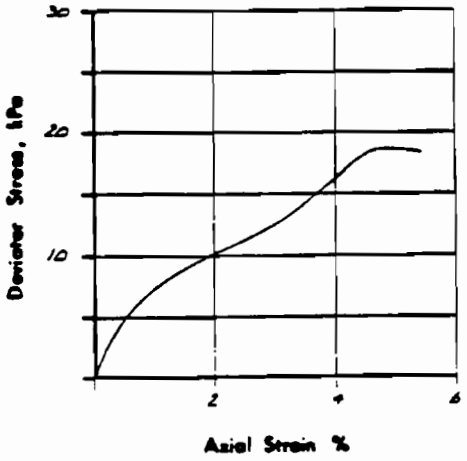
APPENDIX 2

UNDRAINED SHEAR STRENGTH TEST RESULTS AND PROFILES

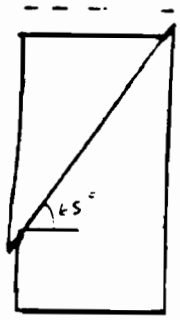
CONSOLIDATED UNDRAINED TRIAXIAL TESTS
EAST AMAULIGAK

Figure 4

Cell Pressure, kPa	345
Back Pressure, kPa	276
Rate of Strain % per hour	3.6
Deviator Stress at failure, kPa	19
% Strain at failure	4.9

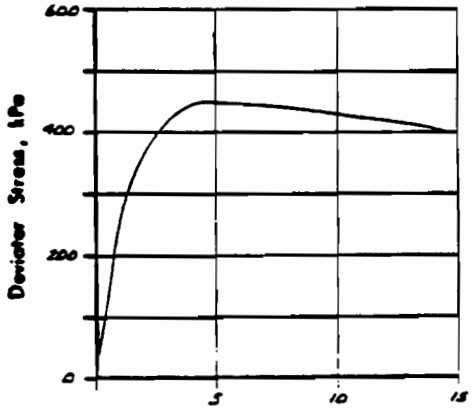


FAILURE SKETCHES



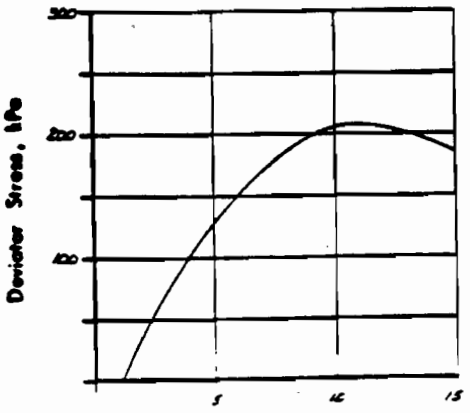
Sample No. 4 Depth 7.6 - 8.2 m

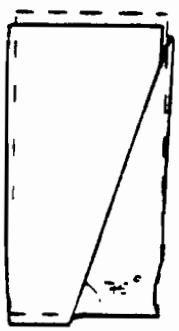
Cell Pressure, kPa	538
Back Pressure, kPa	138
Rate of Strain % per hour	3.6
Deviator Stress at failure, kPa	449
% Strain at failure	4.8



Sample No. 23 Depth 36.1 - 36.9 m

Cell Pressure, kPa	414
Back Pressure, kPa	55
Rate of Strain % per hour	3.5
Deviator Stress at failure, kPa	206
% Strain at failure	11.3





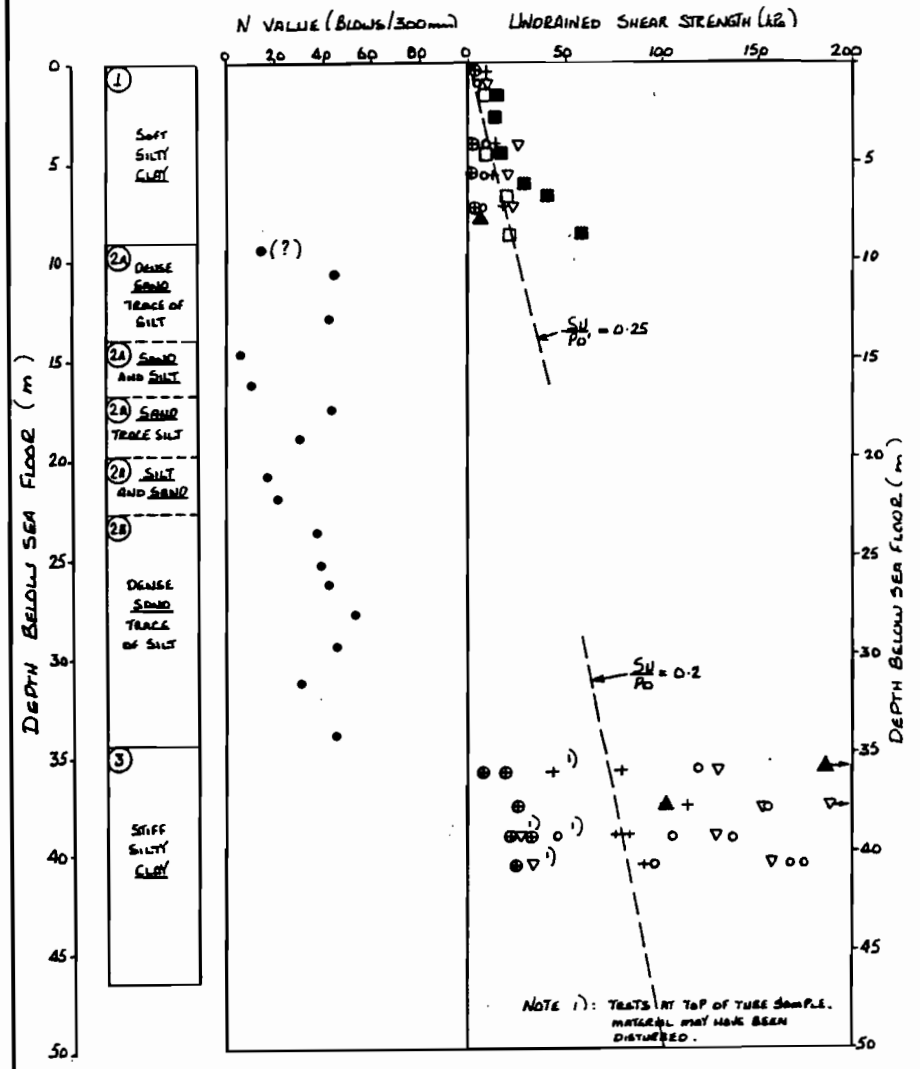
NOTE: NO PORE PRESSURE MEASUREMENTS.

Sample No. 24 Depth 37.8 - 38.4 m

Project No. 812-2102 Drawn RS Reviewed [illegible] Date Nov 82

UNDRAINED SHEAR STRENGTH AND N VALUE PROFILES.

FIGURE 5



LEGEND:

- ▽ FALL CONE
- ○ POCKET PENETROMETER
- ▲ C I U TRIAXIAL
- \+ UNDISTURBED — LABORATORY VAN.
- ⊕ REMOULDED — LABORATORY VAN.
- ■ UNDISTURBED — FIELD VANE
- □ REMOULDED — FIELD VANE

Golder Associates

DRAWN:	SCALE	PROJECT: 812-2102	DATE: NOV - 82	REVIEWED:

APPENDIX 3
FIELD PROGRAM PROCEDURES

The initial phase of the 1981 Field Program was to undertake geophysical traverses (by the Arctic Sounder) at the proposed site areas to determine, on a preliminary basis, the general stratigraphy at the sites. For calibration of the geophysical results and for the preliminary borrow search, a number of vibro-cored boreholes (VC series) were carried out from the same vessel. The vibra-coring carried out from the Arctic Sounder was not performed under the direction of Golder Associates, and details of these operations are therefore not included in this report. The geophysical and vibracore data was reviewed on site for selection of a potential MAC (Mobile Arctic Caisson) site within each site area. Potential MAC sites were selected based on water depth, thickness and consistency of surficial deposits, uniformity of stratigraphy and absence of permafrost.

Each selected MAC site was investigated by means of sampling and in situ testing from the Frank Broderick to verify the suitability of the chosen location from a geotechnical standpoint. Detailed sampled borings were put down from the Frank Broderick. This vessel was equipped with a diesel powered all hydraulic combined sonic/rotary top drive drillrig (modified Simco 5000 WS). The rig was mounted on rails to allow moving the rig and thereby to facilitate handling of casings and conductor pipes.

The casing system consisted of a conductor pipe and two different size casings. The conductor pipe, 203 mm (8") in diameter, was suspended from the moonpool cover to a maximum depth of approximately 27 m, to give additional lateral support to, and allow free vertical movement of, a 152 mm (6") casing, supported on the seafloor by means of a casing footing. The casing footing was equipped with longitudinal slots to allow discharge of the drilling mud onto the sea floor.

Inside the 152 mm (6") casing, 102 mm (4") casing was used for drilling and advanced by means of a wireline casing advancer. Sampling was carried out below the 102 mm (4") casing using split spoon sampling equipment and/or 76 mm (3") Shelby tubes attached to BQ drillrods.

In addition to conventional split spoon and Shelby tube sampling, the rig was also equipped for wireline Shelby tube sampling and down hole standard penetration testing. However, these options were not used due to time and weather constraints.

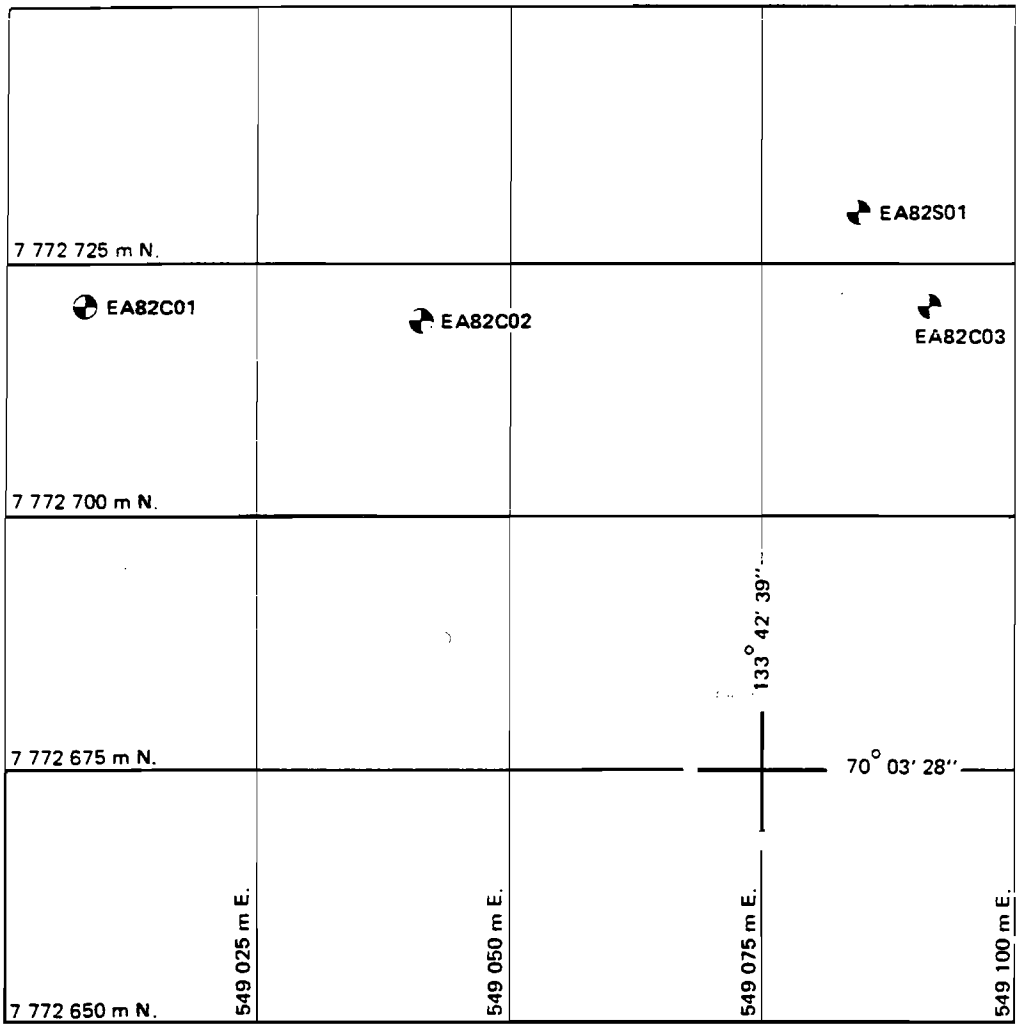
For the foundation investigation borehole, the sampling intervals were generally 1.5 m down to approximately 30 m below sea floor, 3.0 m between 30 m and 60 m and 4.6 m below 60 m. These sampling intervals applied to both split spoon and Shelby tube sampling.

Despite occasional difficulties in performing the standard penetration test in rough weather conditions, the 'N' values obtained are considered to be reliable. This is supported by the comparison between SPT 'N' value profiles where profiles were drilled within 300 m of one another. All tests were performed using a rope and cathead system for raising the drop-hammer, with BQ drill rod used for sampling.

In situ vane tests were performed with a Nilcon vane borer at selected depths in cohesive soils. This instrument has a limited twist slip coupling between the vane and rods, which allows the vane shear resistance to be distinguished from rod friction. In addition a continuous mechanical trace of torque against rotation is obtained. All tests were carried out using a 100 mm vane, with a rated capacity of 220 kPa. Remoulded tests were generally performed after measurement of peak (undisturbed) strengths. To ensure that the vane remained stationary in

the soil, the vane and vane rods were suspended from the 152 mm casing resting on the sea bed. Field vane strengths measured during this investigation have not been modified to account for effects such as strain rate or anisotropy.

In addition to the above techniques Static Cone Penetration Testing was attempted, but no results were obtained due to difficulties in handling the equipment on the ship. The equipment was however tried in shallow water and under ideal weather conditions.



Note: Locations provided by
Canadian Engineering Surveys Co. Ltd.

FIGURE 2 BOREHOLE LOCATION MAP
EAST AMAULIGAK AREA

TABLE 1 BOREHOLE/PROBEHOLE LOCATIONS

BOREHOLE/PROBEHOLE	UTM COORDINATES (ZONE 8)		DATE	SEABED PENETRATION (metres)
EA82S01	7 772 730N	549 085E	82-09-05	11.1
EA82C01	7 772 720N	549 019E	82-09-04	30.7
EA82C02	7 772 720N	549 040E	82-09-05	24.0
EA82C03	7 772 720N	549 090E	82-09-05	25.7

Note: 1. All coordinates supplied by CES Ltd.

2. EA82 denotes a borehole/probehole at the East Amauligak site drilled/tested in 1982. "S" refers to "sampled", "R" refers to "Remote Vane", "C" refers to "static cone", and "P" refers to "pressuremeter". The number following the latter designation is the borehole/probehole number.

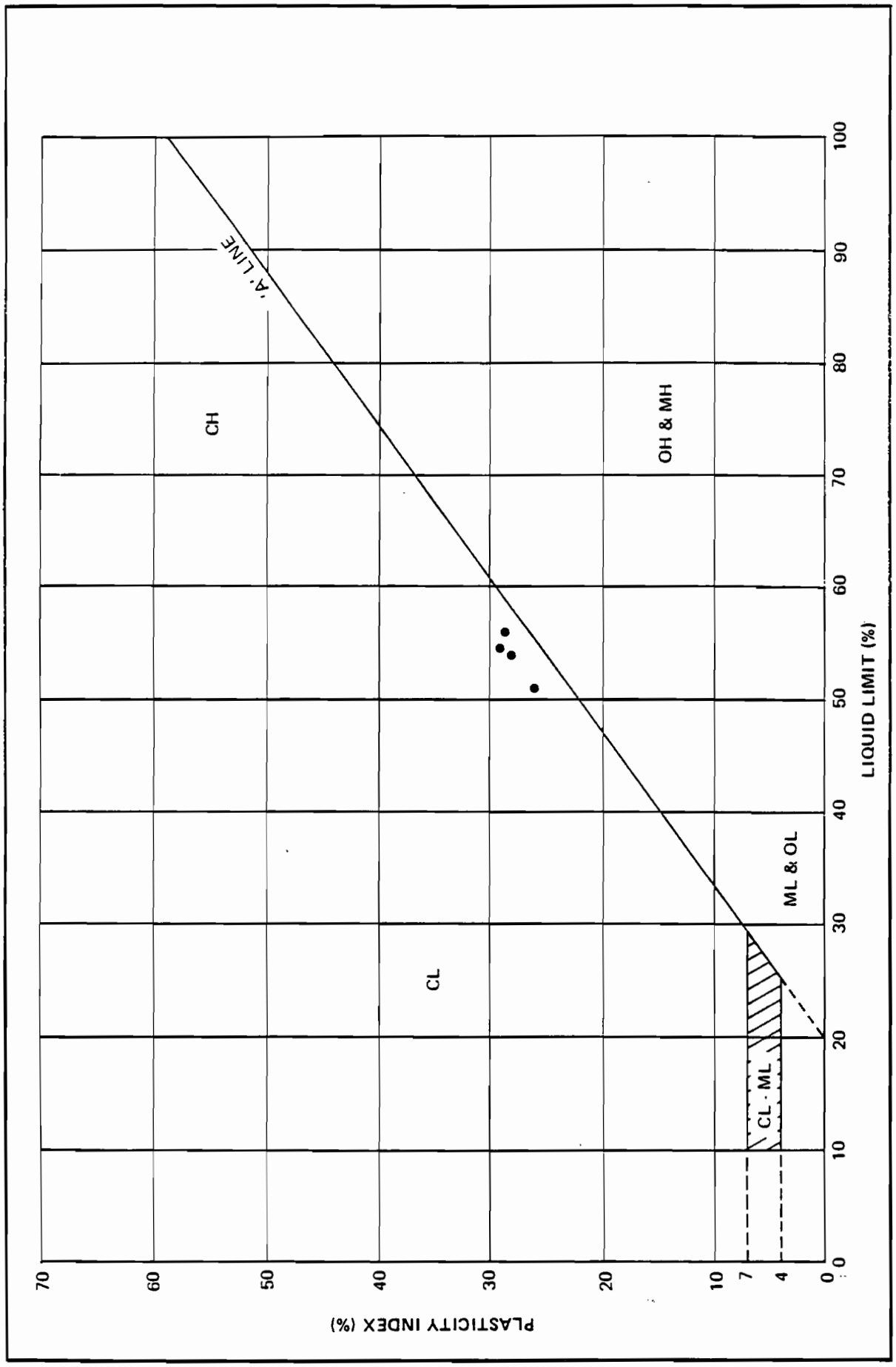


FIGURE 3 PLASTICITY CHART, EAST AMAULIGAK AREA

APPENDIX A

Borehole Logs

SYSTEM INTERNATIONAL UNITS

QUANTITY	NAME	SYMBOL	EXPRESSED IN TERMS OF OTHER SI UNITS	EXPRESSED IN TERMS OF BASE AND SUPPLEMENTARY UNITS
SI UNITS				
length	metre	m		
mass	kilogram	kg		
time	second	s		
electric current	ampere	A		
thermodynamic temperature	kelvin	K		
amount of substance	mole	mol		
luminous intensity	candela	cd		
SI SUPPLEMENTARY UNITS				
plane angle	radian	rad		
solid angle	steradian	sr		
EXAMPLES OF SI DERIVED UNITS WITH SPECIAL NAMES				
frequency	hertz	Hz	1/s	s^{-1}
force	newton	N	$m \cdot kg/s^2$	$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
EXAMPLES OF SI DERIVED UNITS WITHOUT SPECIAL NAMES				
velocity - linear	metre per second		m/s	$m \cdot s^{-1}$
- angular	(radian per second)		rad/s	$rad \cdot s^{-1}$
acceleration - linear	(metre per second) per second		m/s^2	$m \cdot s^{-2}$
- angular	(radian per second) per second		rad/s^2	$rad \cdot s^{-2}$
concentration (of amount of substance)	mole per cubic metre		mol/m^3	$mol \cdot m^{-3}$
dynamic viscosity	pascal second		$Pa \cdot s$	$m^{-1} \cdot kg \cdot s^{-1}$
moment of force	newton metre		$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
surface tension	newton per metre		N/m	$kg \cdot s^{-2}$
heat flux density, irradiance	watt per square metre		W/m^2	$kg \cdot s^{-3}$
heat capacity, entropy	joule per kelvin		J/K	$m^2 \cdot s^{-2} \cdot K^{-1}$
specific heat capacity, specific entropy	joule per kilogram kelvin		$J/(kg \cdot K)$	$m^2 \cdot s^{-2} \cdot K^{-1}$
specific energy	joule per kilogram		J/kg	$m^2 \cdot s^{-2}$
thermal conductivity	watt per metre kelvin		$W/(m \cdot K)$	$m \cdot kg \cdot s^{-3} \cdot K^{-1}$

OTHER UNITS PERMITTED FOR USE WITH SI

QUANTITY	NAME	SYMBOL	DEFINITION
time	minute	min	1 min = 60 s
	hour	h	1 h = 3,600 s
	day	d	1 d = 86,400 s
	year	a	
plane angle	degree	°	$1° = (\pi/180)$ rad
	minute	′	$1′ = (\pi/10{,}800)$ rad
	second	″	$1″ = (\pi/648{,}000)$ rad
area	hectare	ha	1 ha = 10,000 m^2
volume	litre	L	1,000 L = 1 m^3
temperature	degree Celsius	°C	$0° C = 273.15° K$
			temperature interval $1 C° \equiv 1 K°$
mass	tonne	t	1 t = 1,000 kg = 1 Mg

MULTIPLYING FACTOR	PREFIX	SYMBOL	MULTIPLYING FACTOR	PREFIX	SYMBOL
$1{,}000{,}000{,}000{,}000{,}000{,}000 = 10^{18}$	exa	E	$0.1 = 10^{-1}$	deci*	d
$1{,}000{,}000{,}000{,}000{,}000 = 10^{15}$	peta	P	$0.01 = 10^{-2}$	centi*	c
$1{,}000{,}000{,}000{,}000 = 10^{12}$	tera	T	$0.001 = 10^{-3}$	milli	m
$1{,}000{,}000{,}000 = 10^{9}$	giga	G	$0.000{,}001 = 10^{-6}$	micro	μ
$1{,}000{,}000 = 10^{6}$	mega	M	$0.000{,}000{,}001 = 10^{-9}$	nano	n
$1{,}000 = 10^{3}$	kilo	k	$0.000{,}000{,}000{,}001 = 10^{-12}$	pico	p
$100 = 10^{2}$	hecto*	h	$0.000{,}000{,}000{,}000{,}001 = 10^{-15}$	femto	f
$10 = 10^{1}$	deca*	da	$0.000{,}000{,}000{,}000{,}000{,}001 = 10^{-18}$	atto	a

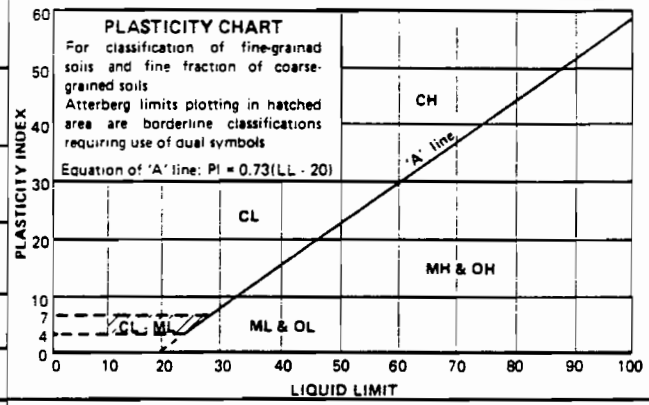
* to be avoided where possible

UNIFIED SOIL CLASSIFICATION†

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES	CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve*	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly-graded gravels and gravel-sand mixtures, little or no fines	Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand clay mixtures	Atterberg limits plot above 'A' line and plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly-graded sands and gravelly sands, little or no fines	Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures	Atterberg limits plot below 'A' line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits plot above 'A' line and plasticity index greater than 7	

Classification on basis of percentage of fines
Less than 5% pass No. 200 sieve: GW, GP, SW, SP
More than 12% pass No. 200 sieve: GM, GC, SM, SC
5% to 12% pass No. 200 sieve: Borderline classification requiring use of dual symbols

FINE-GRAINED SOILS 50% or more passes No. 200 sieve*				
SILTS AND CLAYS Liquid limit 50% or less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands	
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		OL	Organic silts and organic silty clays of low plasticity	
SILTS AND CLAYS Liquid limit greater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	
		CH	Inorganic clays of high plasticity, fat clays	
		OH	Organic clays of medium to high plasticity	
HIGHLY ORGANIC SOILS		PT	Peat, muck and other highly organic soils	



*Based on the material passing the 3 in. (75 mm) sieve
†ASTM Designation D 2487, for identification procedure see D 2488

GROUND ICE DESCRIPTION

ICE NOT VISIBLE

GROUP SYMBOLS	SYMBOLS	SUBGROUP DESCRIPTION	
N	Nf	Poorly-bonded or friable	
	Nbn	No excess ice, well-bonded	
	Nbe	Excess ice, well-bonded	

VISIBLE ICE LESS THAN 50% BY VOLUME

GROUP SYMBOLS	SYMBOLS	SUBGROUP DESCRIPTION	
V	Vx	Individual ice crystals or inclusions	
	Vc	Ice coatings on particles	
	Vr	Random or irregularly oriented ice formations	
	Vs	Stratified or distinctly oriented ice formations	

VISIBLE ICE GREATER THAN 50% BY VOLUME

ICE	ICE + Soil Type	Ice with soil inclusions	
	ICE	Ice without soil inclusions (greater than 25 mm (1 in.) thick)	

NOTE:

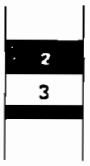
1. *Dual symbols are used to indicate borderline or mixed ice classifications*
2. *Visual estimates of ice contents indicated on borehole logs ± 5%*
3. *This system of ground ice description has been modified from NRC Technical Memo 79, Guide to the Field Description of Permafrost for Engineering Purposes*

LEGEND
Soil ☐ ice ■

SYMBOLS AND ABBREVIATIONS USED ON BOREHOLE LOGS

SOIL SAMPLE

- represented by sample identification number which increase sequentially from the top of the hole; thickness of block is equivalent to sample recovery



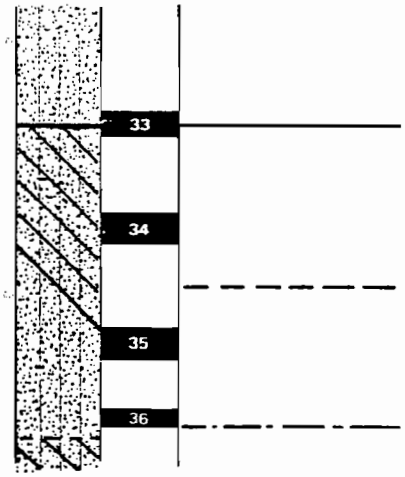
SOIL BOUNDARIES

- have been indicated using the following system

- stratum boundary observed within sample

- stratum boundary assumed to occur within ± 0.5m of the marked level and is probably gradational between the two samples

- stratum boundary assumed to occur within ± 1.0m of the marked level



- stratum boundary notation for both depth below seabed (41.5 metres) and elevation below sealevel (uncorrected for tides) (-64.6 metres El.)

41.5 (-64.6 El.)

SOIL DESCRIPTION

UNIFIED SOIL CLASSIFICATION — USC

- determined in accordance with chart on following page

TEXTURAL DESCRIPTION

- determined in accordance with attached sheet and used to augment Unified Soil Classification

Special terms used include:

e.g. - "becoming trace of/with some CLAY" indicating an overall change in a feature of the stratum not sufficient to change the total description

- "trace of/with some CLAY" indicating small feature displayed in that sample only

MUNSELL COLOUR DESIGNATION

- describing wet grey soil, e.g. (5Y 4/2)

- describing dry grey soil, e.g. (10YR 6/1)

GROUND ICE DESCRIPTION

- determined in accordance with chart on following page: extra effort has been made to better describe the degree and extent of soil bonding and also a value of core temperature (°C) at that level

- see also definition of terms in text

e.g. FROZEN - 2.3
- Nf - Nbn
- poorly to slightly bonded

SAND: Nbn - 2.8
CLAY: not frozen

TEST RESULTS

- see legend at bottom of borehole log

CONSISTENCY

Fine-Grained Soils

Major portion passing No. 200 Sieve. Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silt. Consistency is rated according to shear strength, as indicated by penetrometer readings or vane shear readings.

Descriptive Term	Unconfined Compressive Strength kPa	Equivalent Blows per Foot (N)
Very Soft	less than 25	0 - 2
Soft	25 to 50	2 - 4
Firm	50 to 100	4 - 8
Stiff	100 to 200	8 - 16
Very Stiff	200 to 400	15 - 50
Hard	400 and higher	>50

Coarse-Grained Soils

Major portion retained in No. 200 Sieve. Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

Descriptive Term	Relative Density	Equivalent Blows per foot (N)
Very Loose	0 - 20%	0 - 4
Loose	20 - 40%	4 - 10
Compact or Medium	40 - 75%	10 - 30
Dense	75 - 90%	30 - 50
Very Dense	90 - 100%	50 +

The number of blows (N) on a 2" O.D. split spoon sampler by a 140 lbs. weight falling 30" required to drive the sample a distance of 1' (in accordance with ASTM D1586).

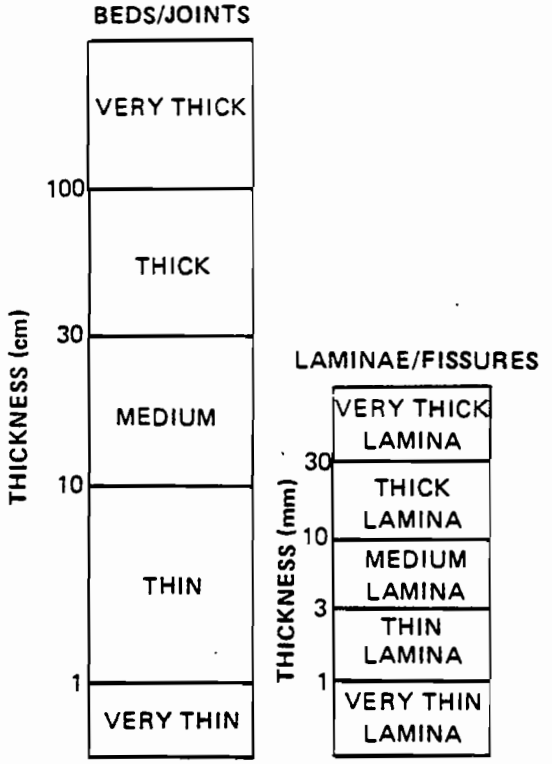
PLASTICITY

Low - Liquid limit less than 50
High - Liquid limit greater than 50

DESCRIPTION OF SEDIMENTARY STRUCTURES

BEDS SEDIMENTATION UNITS DEPOSITED UNDER ESSENTIALLY CONSTANT PHYSICAL CONDITIONS, SEPARATED BY BEDDING PLANES WHICH ARE RECOGNIZABLE BY TEXTURAL OR COMPOSITIONAL CHANGES RESULTING FROM PERIODS OF NON-DEPOSITION OR EROSION, OR ABRUPT CHANGES IN DEPOSITIONAL CONDITIONS. BEDS MAY BE INTERNALLY HOMOGENEOUS, OR COMPOSED OF SMALLER UNITS-LAMINAE

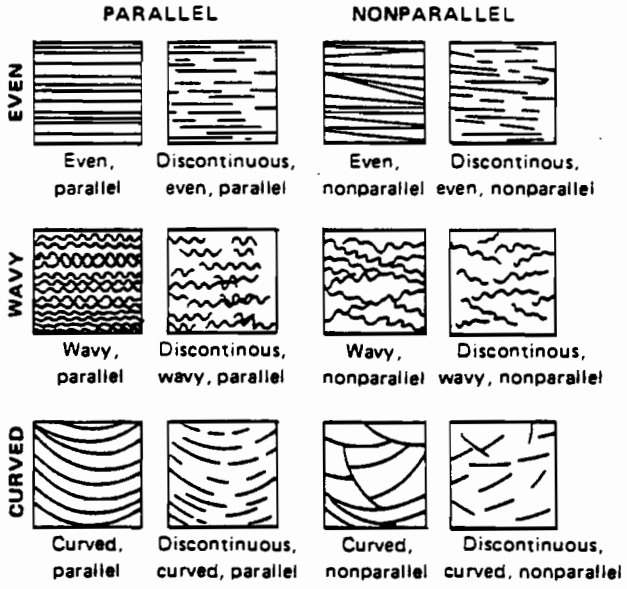
LAMINAE THE SMALLEST MEGASCOPIC LAYERS IN A SEDIMENTARY SEQUENCE, REPRESENTING MINOR FLUCTUATIONS IN PHYSICAL CONDITIONS DURING THE DEPOSITION OF BEDS. LAMINAE ARE RELATIVELY UNIFORM IN TEXTURE AND COMPOSITION AND GENERALLY LACK MEGASCOPIC INTERNAL LAYERING.



e.g. Thick bed
Thickly spaced joint

e.g. Thin lamina
Thinly spaced fissures

(Modified after Ingram, 1954 and Campbell, 1967)



(After Campbell, 1967)

LOCATION: EAST AMAULIGAK
UTM COORDINATES: 7 772 730 m. N. 549 085 m. E. WATER DEPTH: 33.5 m

DEPTH BELOW SEABED (metres)

SYM.	NO.	SOIL DESCRIPTION	GROUND ICE
	1	SILTY CLAY (CL) - trace of silt, occasional trace of shells, occasional zones with thin discontinuous horizontal laminations and occasional thin black beds, very soft becoming soft, high plasticity, dark grey	NOT FROZEN +2.1
	2		
	3		+3.5
	4		+2.6
	5		-0.7
	6		
	7		+1.1
	8		+2.1
	9	11.0 m (-44.5 m El.) SAND (SC) - fine-grained, clayey, with trace of silt, dense (estimated) dark grey becoming: at 11.1 m SAND (SM) - fine-grained, silty, dark olive grey	+1.3
		END OF BOREHOLE 11.1 (-44.6 m El.)	

NOTE: Hole terminated after gas erupted from base of hole. Pressure sufficient to blow sand up to 50 metres above sand/clay interface. Gas continued to bubble at water surface 8 hours after initial discharge.

BULK DENSITY (Mg m⁻³) ▲ 1.4 1.6 1.8 2.0
PLASTIC LIMIT — WATER CONTENT (%) — LIQUID LIMIT
20 40 60 80

UNDRAINED SHEAR STRENGTH (kiloPascals)
10 20 30

SPECIALIZED TESTS
TD
TD
TD,T,C,S
TD, S
TD
TD, T, C, S
TD, T, S,
TD
TD

eba

JOB No.: 101 - 3685
DRILLING COMPLETED: 82/09/05
BOREHOLE DEPTH: 11.1 (-44.6 m El.)
DRILLING RIG: S/5000 MV/BRODERICK
LOG COMPILED BY: JPR

LEGEND

SOIL SYMBOLS: SAND, SILT, CLAY

SHEAR STRENGTH
+ Torvane
× Mtn. Vane
• Pilcon Vane
○ Halibut Vane
● Fall Cone
▲ UU Triaxial
■ CU Triaxial

TEST IDENTIFICATION
C Consolidation
DS Direct Shear
TD TDR
Ca Calorimetry
T Triaxial Shear
S P W Salinity
G Gas Analysis

BOREHOLE NUMBER EA 82 S01

PAGE 1 OF 1

BOREHOLE LOG AND LABORATORY TEST RESULTS

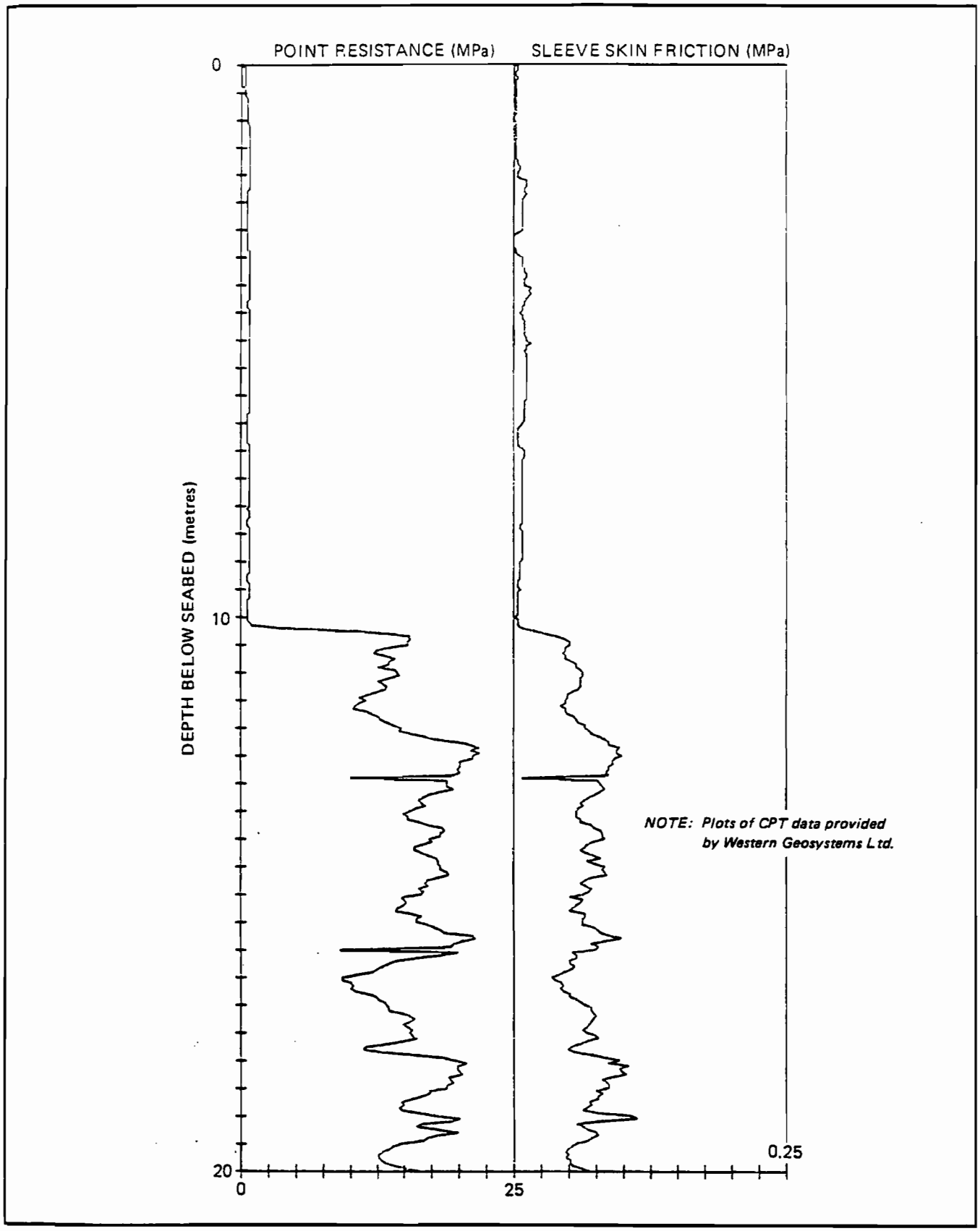


FIGURE A.1 CONE PENETRATION TEST PROFILE
TEST EA82C01- EAST AMAULIGAK
82/09/04 (Part 1)

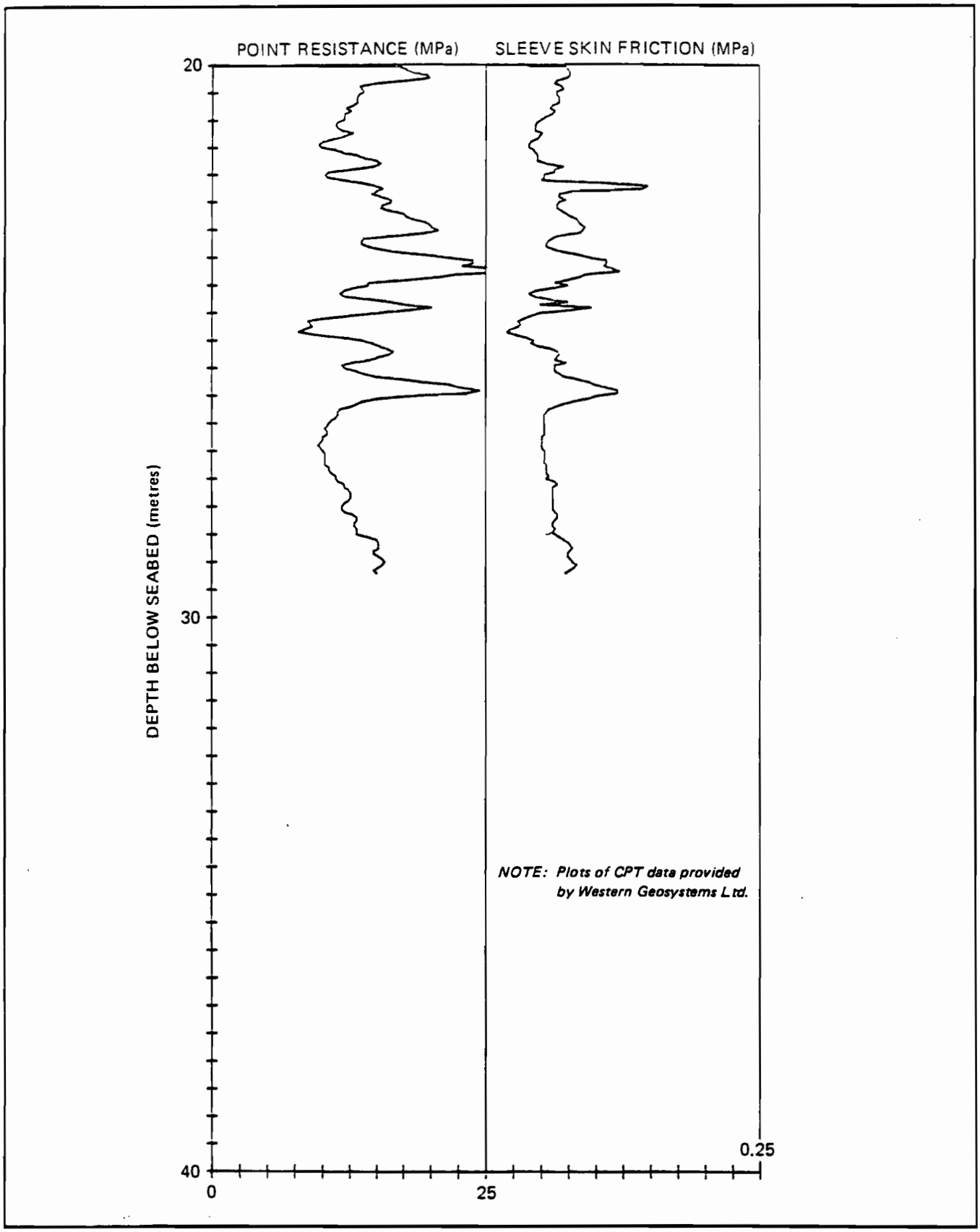


FIGURE A.1 CONE PENETRATION TEST PROFILE
TEST EA82C01 - EAST AMAULIGAK
82/09/04 (Part 2)

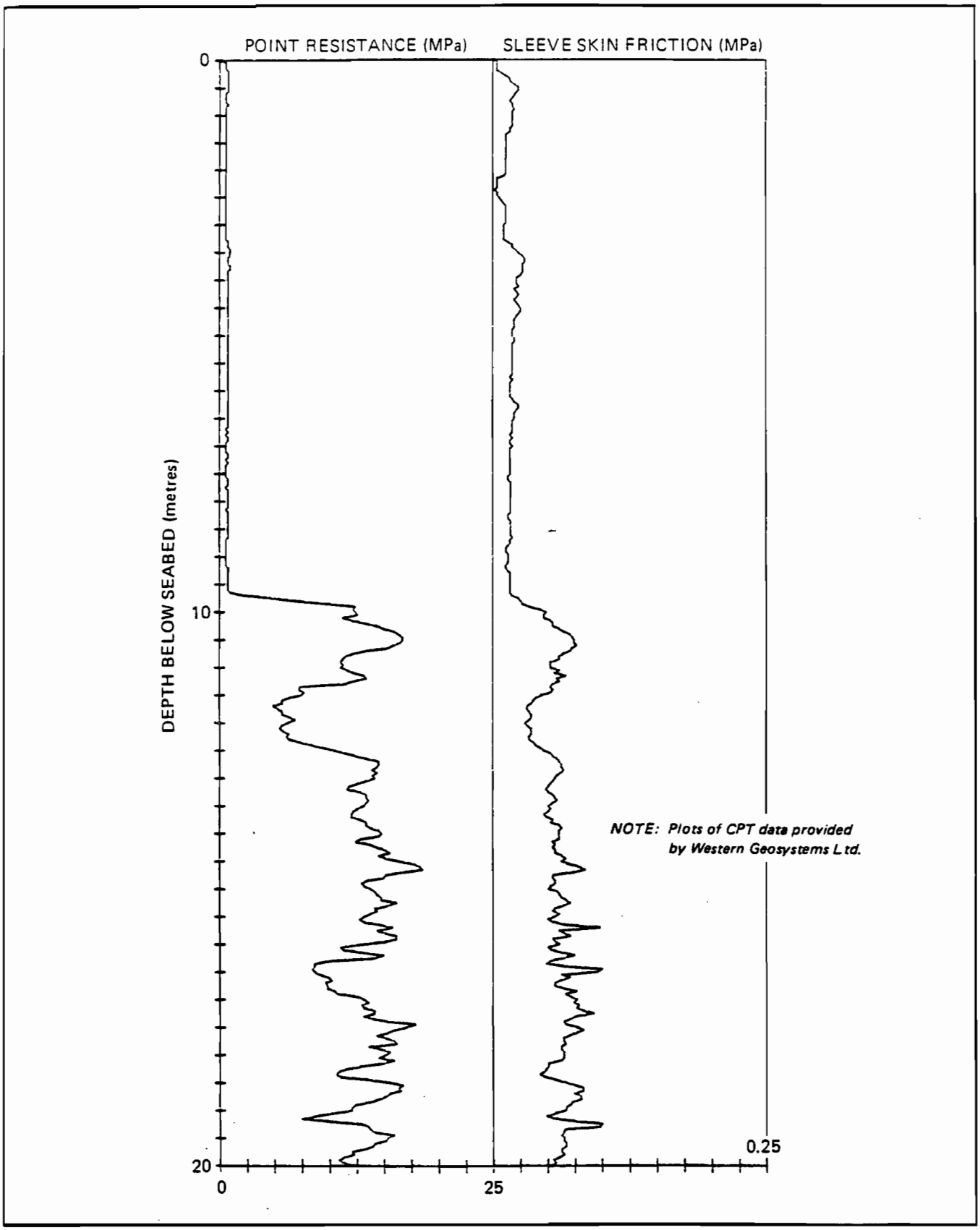


FIGURE A.2 CONE PENETRATION TEST PROFILE
TEST EA82C02 - EAST AMAULIGAK
82/09/05 (Part 1)

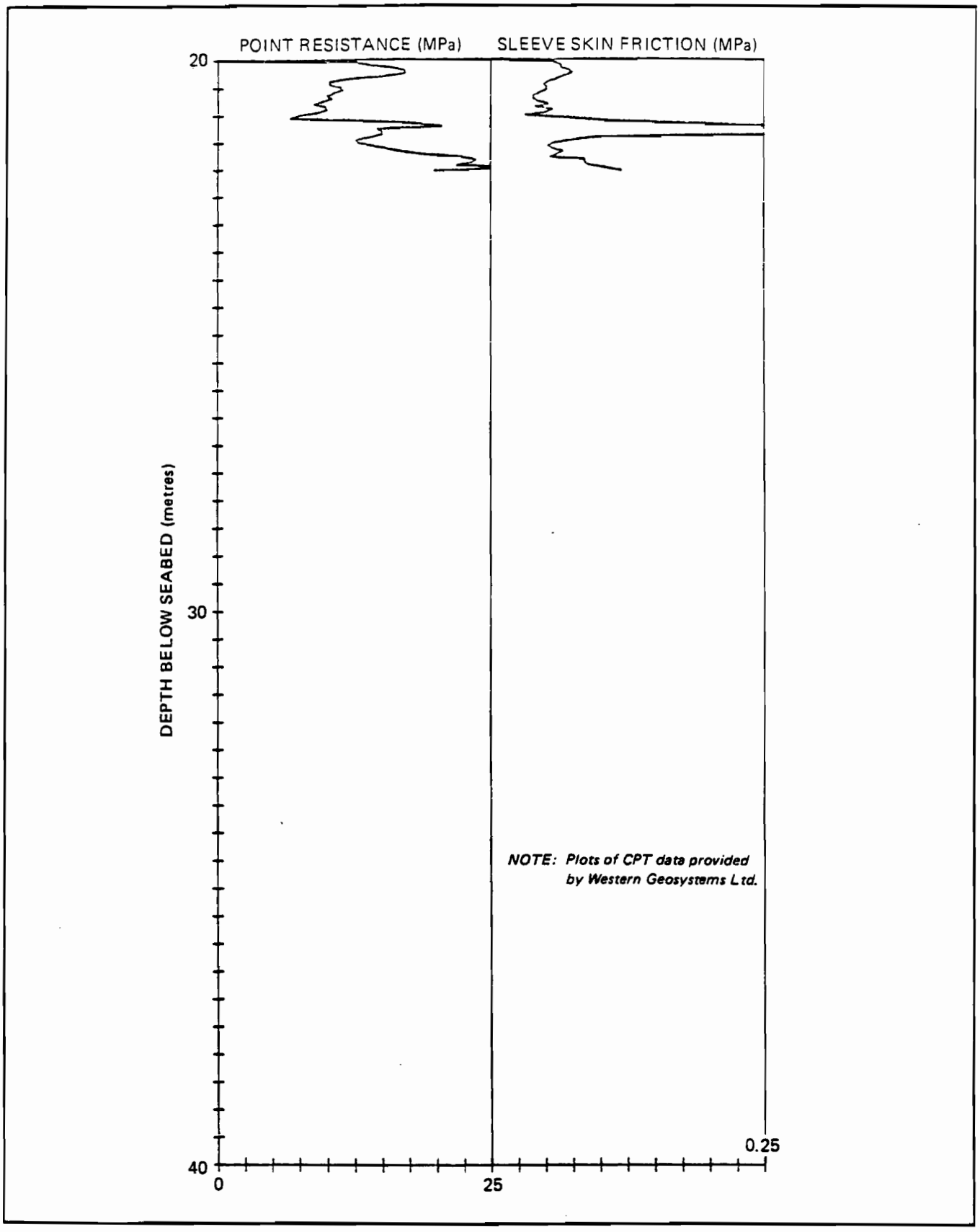


FIGURE A.2 CONE PENETRATION TEST PROFILE
TEST EA82C02 - EAST AMAULIGAK
82/09/05 (Part 2)

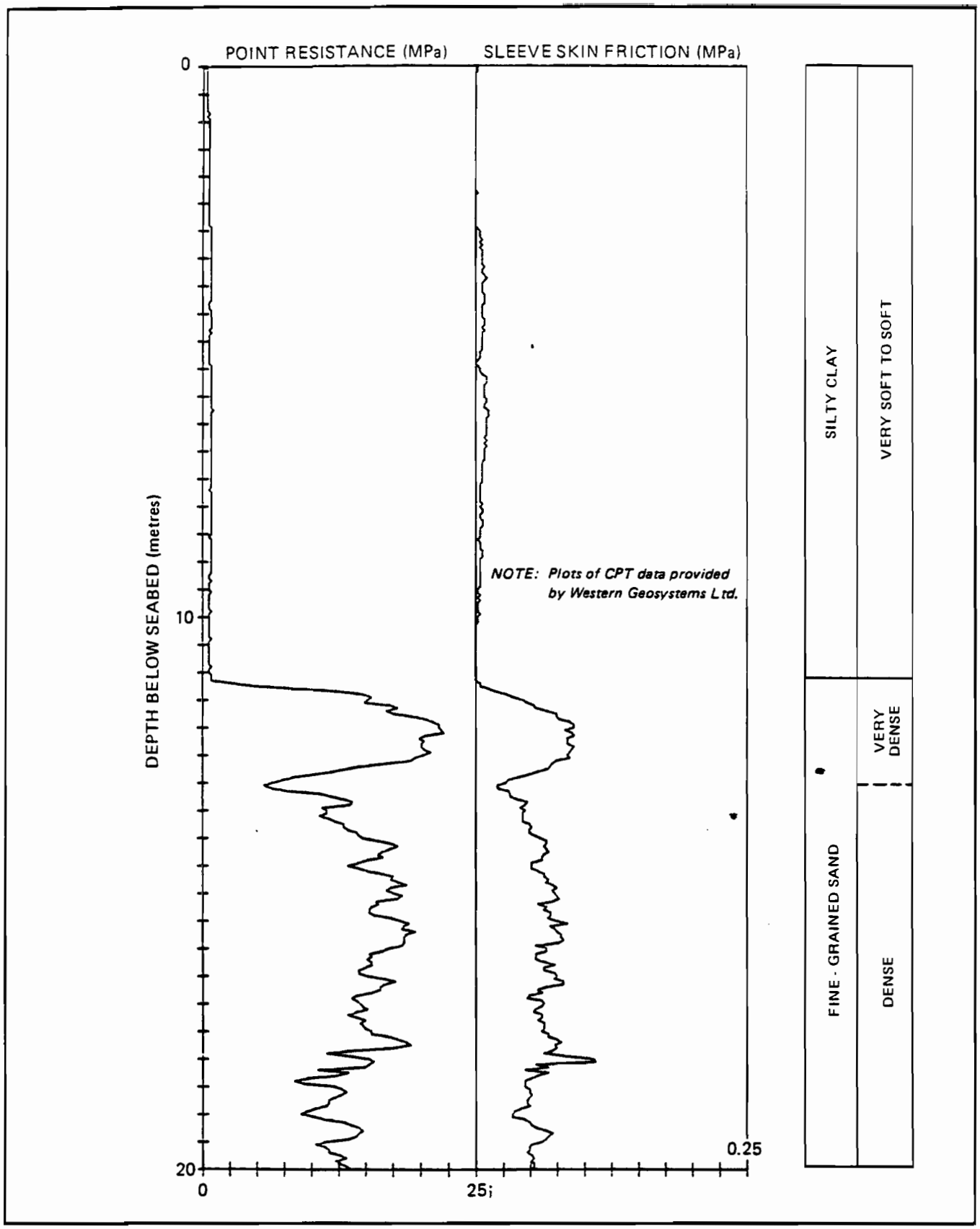


FIGURE A.3 CONE PENETRATION TEST PROFILE
TEST EA82C03 - EAST AMAULIGAK
82/09/05 (Part 1)

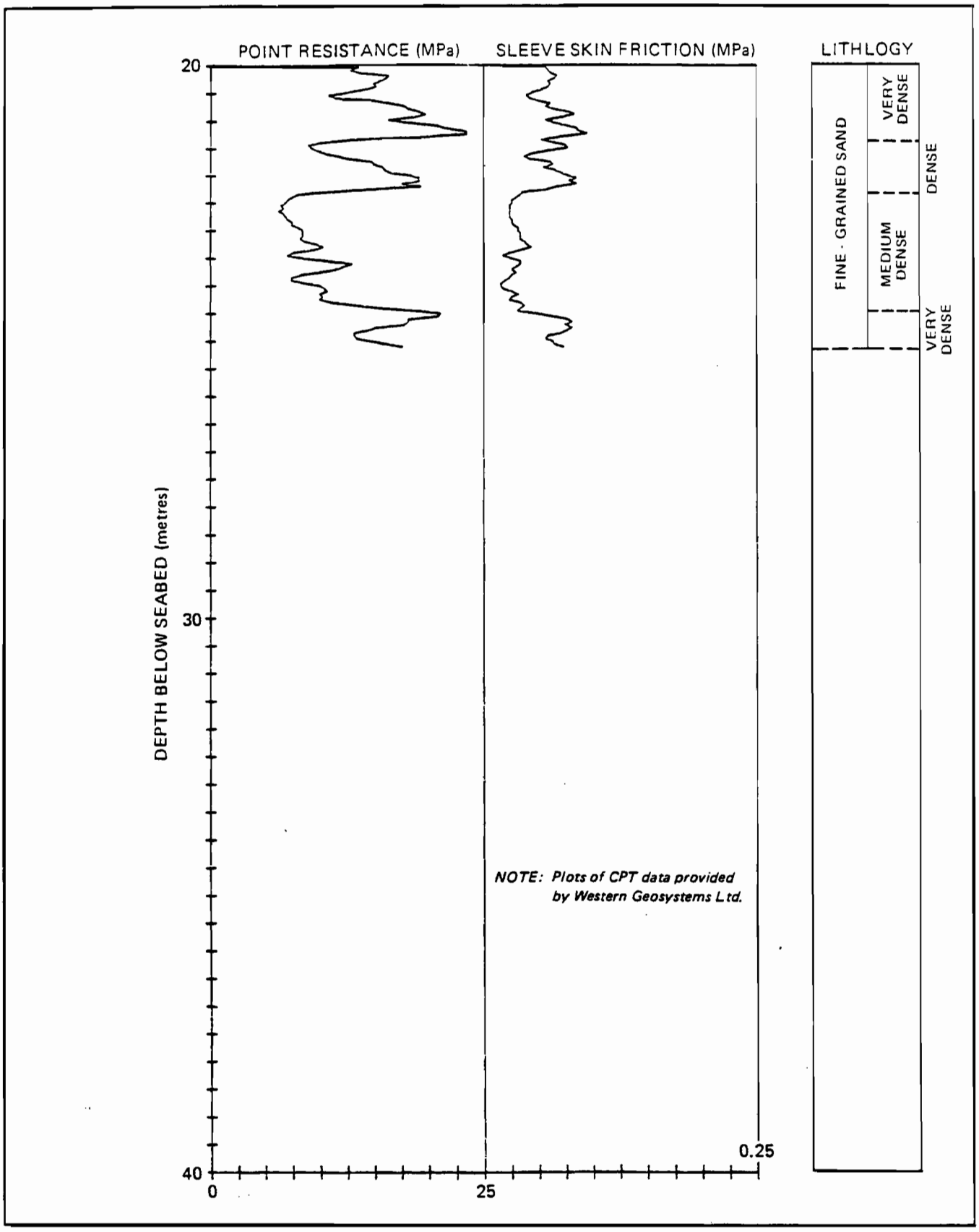


FIGURE A.3 CONE PENETRATION TEST PROFILE
TEST EA82C03 - EAST AMAULIGAK
82/09/05 (Part 2)

APPENDIX B

Diagnostic Profiles

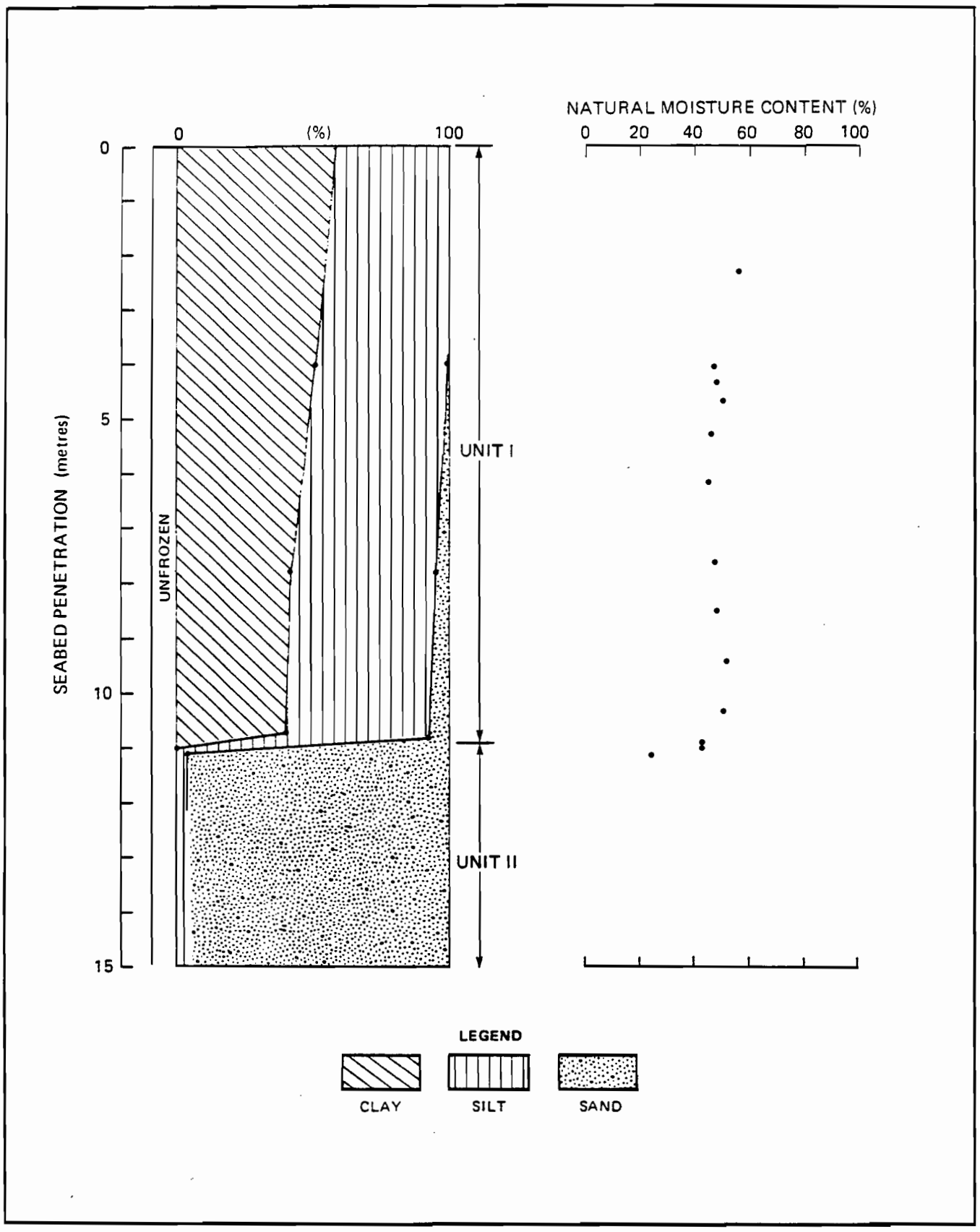


FIGURE B.1 NATURAL MOISTURE CONTENT PROFILE, EAST AMAULIGAK SITE

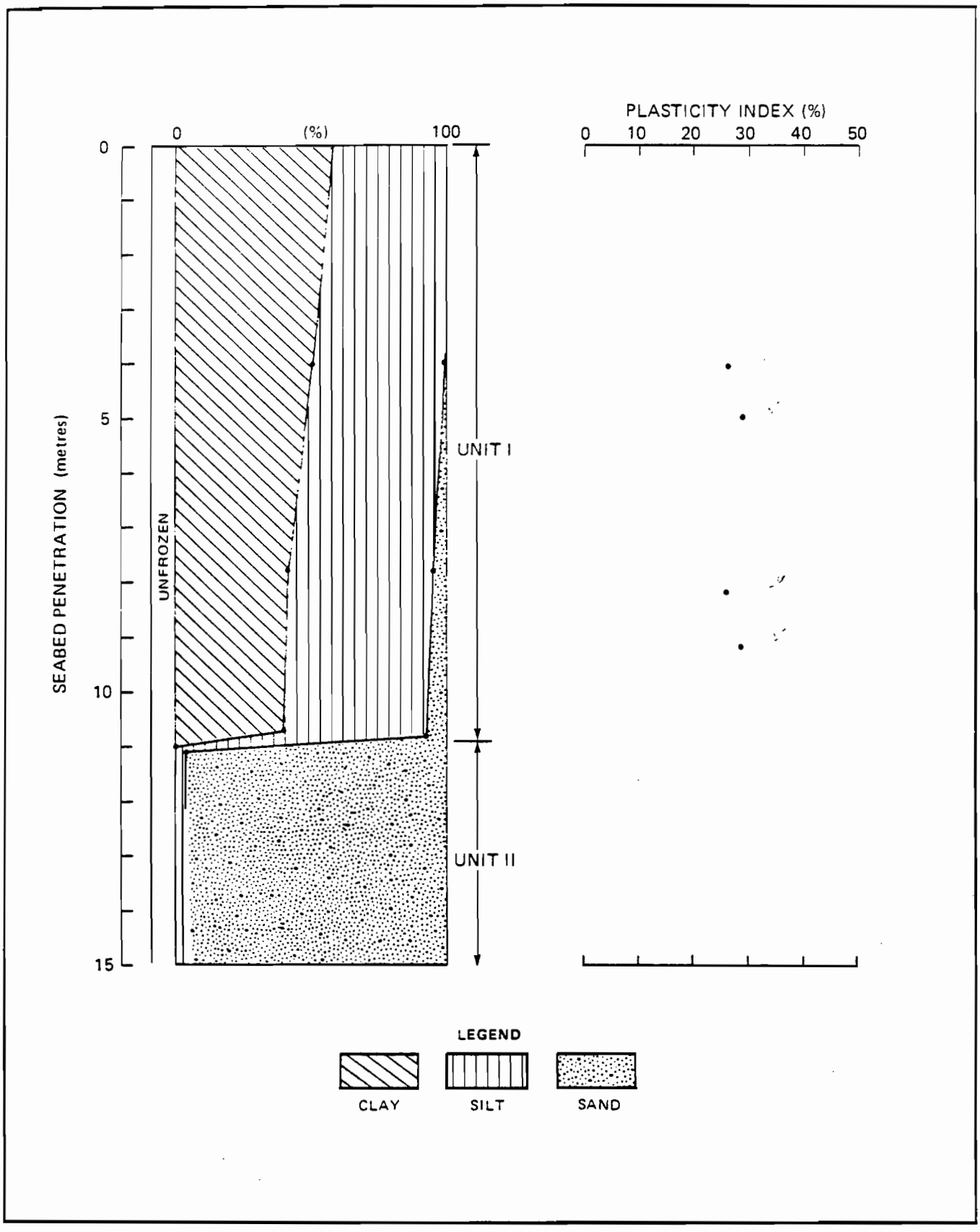


FIGURE B.2 PLASTICITY INDEX PROFILE, EAST AMAULIGAK SITE

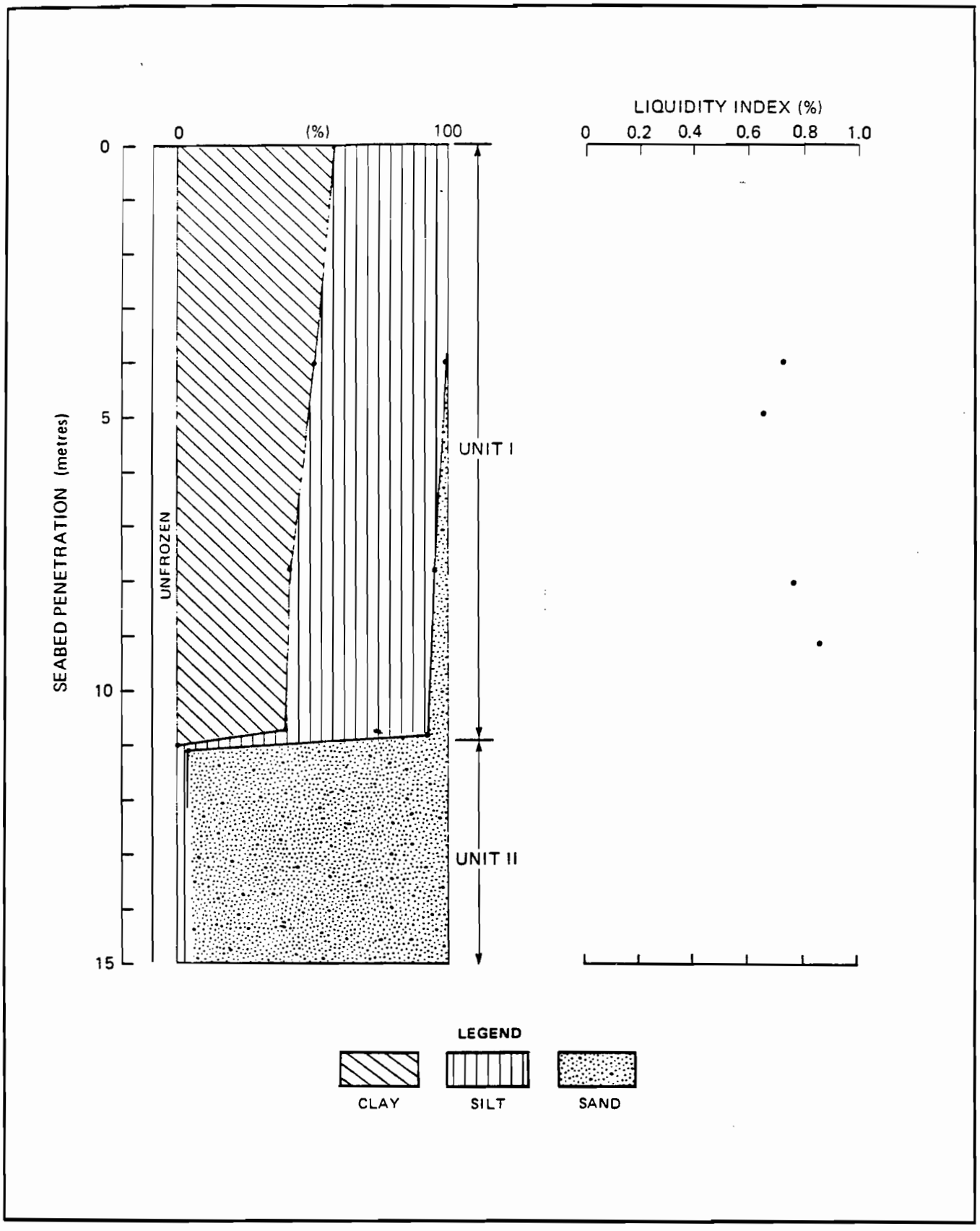


FIGURE B.3 LIQUIDITY INDEX PROFILE, EAST AMAULIGAK SITE

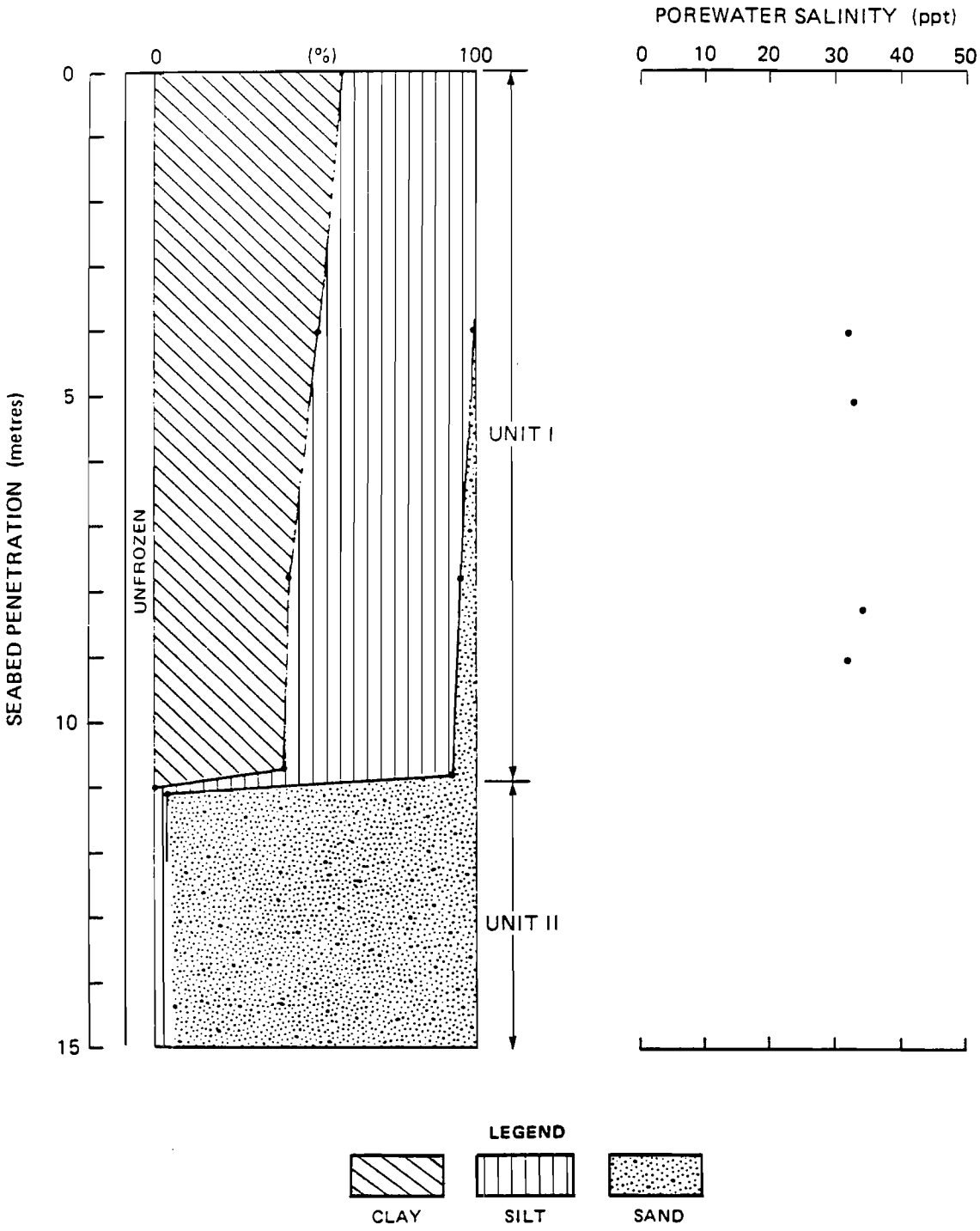


FIGURE B.4 SALINITY PROFILE,
EAST AMAULIGAK AREA

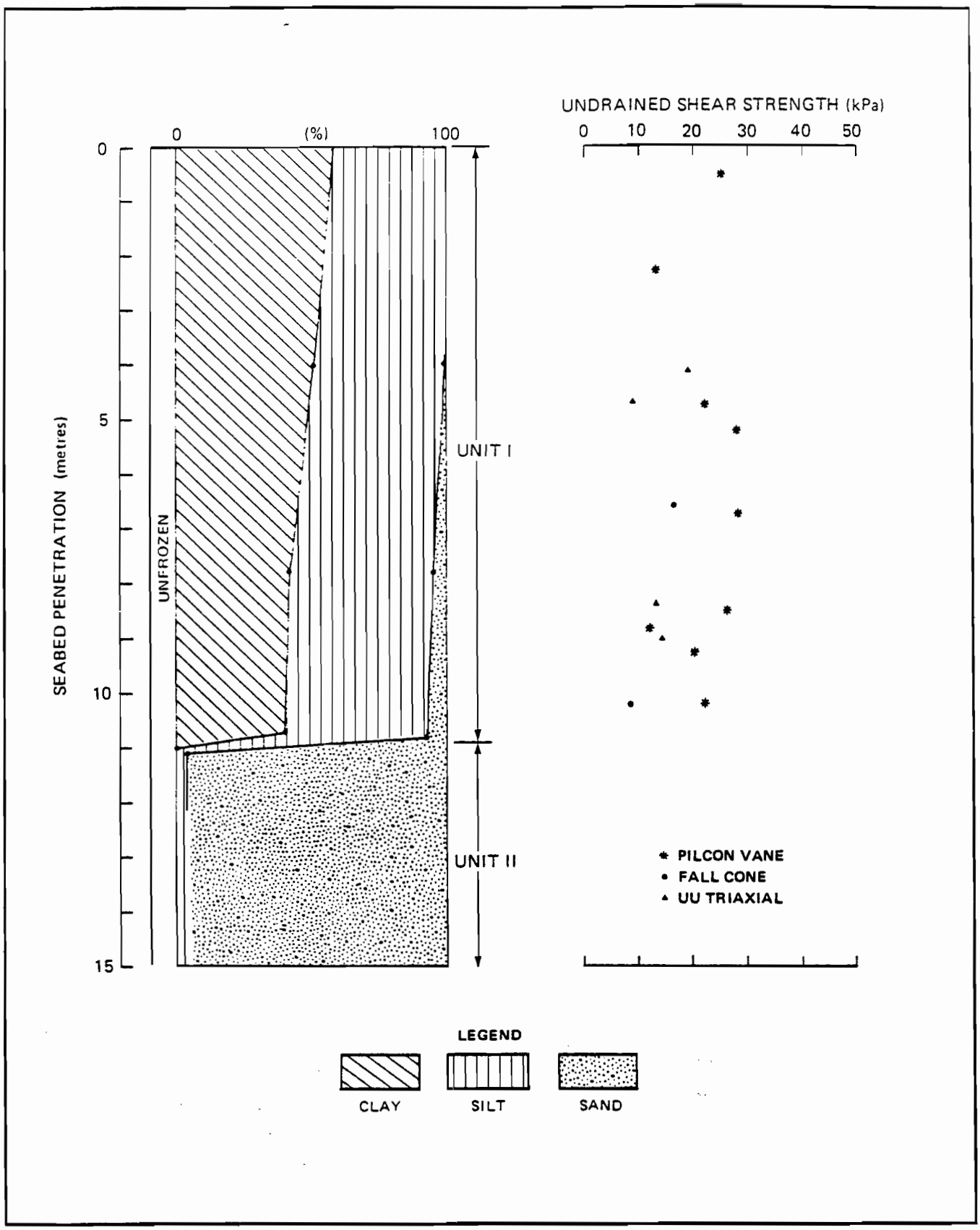


FIGURE B.5 UNDRAINED SHEAR STRENGTH PROFILE, EAST AMAULIGAK SITE

APPENDIX C

Classification and Index Test Results

SUMMARY OF TEST RESULTS

LA82S01 Sample Number	Sample Type	Depth (metres) Sample Depth Interpreted	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	ATTERBERG LIMITS: Liquid Limit (%)	ATTERBERG LIMITS: Plastic Limit (%)	GRAIN SIZE DISTRIBUTION: Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	SHEAR STRENGTH: Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	CONSOLIDATION CHARACTERISTICS: P_o (kPa)	P_c (kPa)	C_c	TEST RESULTS TABULATED SEPARATELY
1A	B	* 0.00 - 0.45	CL		2.1											PV	25		soft				
1B	NS	0.43 - 0.45				46																	
2A	NS	2.30 - 2.32	CL			56										PV	13		V.soft				
2B	B	1.52 - 1.92																					
		1.92 - 2.32																					
3A	NS	4.72 - 4.75	CL		3.5	50										PV/UU	22/9	23	V.soft				
P3B	T	3.96 - 4.72				47			54	29	51	48	1			UU	19	24	soft	35	35	0.27	2.745G
4A	NS	5.35 - 5.37	CL		2.6	46										PV	28		soft				3.2 S
4B	T	4.75 - 5.35							56	27													3.3 S
5A	NS	6.72 - 6.75	CL		-0.7	45										PV/Fc	28/16		soft				
5B	B	6.10 - 6.68																					
5C	S	6.68 - 6.70																					
5D	G	6.70 - 6.72																					
6A	NS	8.45 - 8.47	CL		1.1	48										PV	26		soft				
P6B	T	7.77 - 8.45				44			51	25	42	53	5			UU	13	16	soft	75	80	0.25	2.695G
7A	NS	9.34 - 9.36	CL		2.1	51										PV	20		V.soft				3.4 S
7B	T	8.69 - 9.34							55	26						PV/UU	12/14	20	soft				3.2 S
8A	NS	10.28 - 10.30	CL		1.3	51										PV/Fc	22/8		V.soft				
8B	B	9.60 - 10.28																					
9A	B	10.93 - 11.04	SC			43																	
9B	B	11.04 - 11.09				24																	

LEGEND AND NOTES

B Bag Sample
G Gas Sample
L Liner Sample
P Piston Sample
NR No Recovery
NS No Sample Remaining

PF · Permafrost Sample
PW · Porewater Sample
T · Sample Stored in Tube
W · Waxed Sample
RC · Radiocarbon Sample

MV · Minivane
FC · Fall Cone
TV · Torvane
PV · Pilcon Vane
RV · Remote Vane

UU · Unconsolidated Undrained Triaxial
UUp · UU Triaxial with Pore Pressure Measurements
CU · Consolidated Undrained Triaxial
CUp · CU Triaxial with Pore Pressure Measurements
CD · Consolidated Drained Triaxial

O · Organic Content
S · Salinity
TS Thaw Strain
SG · Specific Gravity

Project Number: 101-3685

Reviewed By: _____ P Eng.

SUMMARY OF TEST RESULTS

EA82S01

Sample Number	Sample Type	Depth (metres) Top to Bottom of Core Sample	Unified Soil Classification	Ground Ice Description (%)	Temp (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm^{-3})	ATTERBERG LIMITS		GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH				CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY
									Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D_{50} (μm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P_o (kPa)	P_c (kPa)	C_c	
10		Below 11.1	SM								4	96											

LEGEND AND NOTES

B	Bag Sample	PF	Permafrost Sample	MV	Minivane	UU	Unconsolidated Undrained Triaxial
G	Gas Sample	PW	Porewater Sample	FC	Fall Cone	UUp	UU Triaxial with Pore Pressure Measurements
L	Liner Sample	T	Sample Stored in Tube	TV	Torvane	CU	Consolidated Undrained Triaxial
P	Piston Sample	W	Waxed Sample	PV	Pilcon Vane	CUp	CU Triaxial with Pore Pressure Measurements
NR	No Recovery	RC	Radiocarbon Sample	RV	Remote Vane	CD	Consolidated Drained Triaxial
NS	No Sample Remaining						

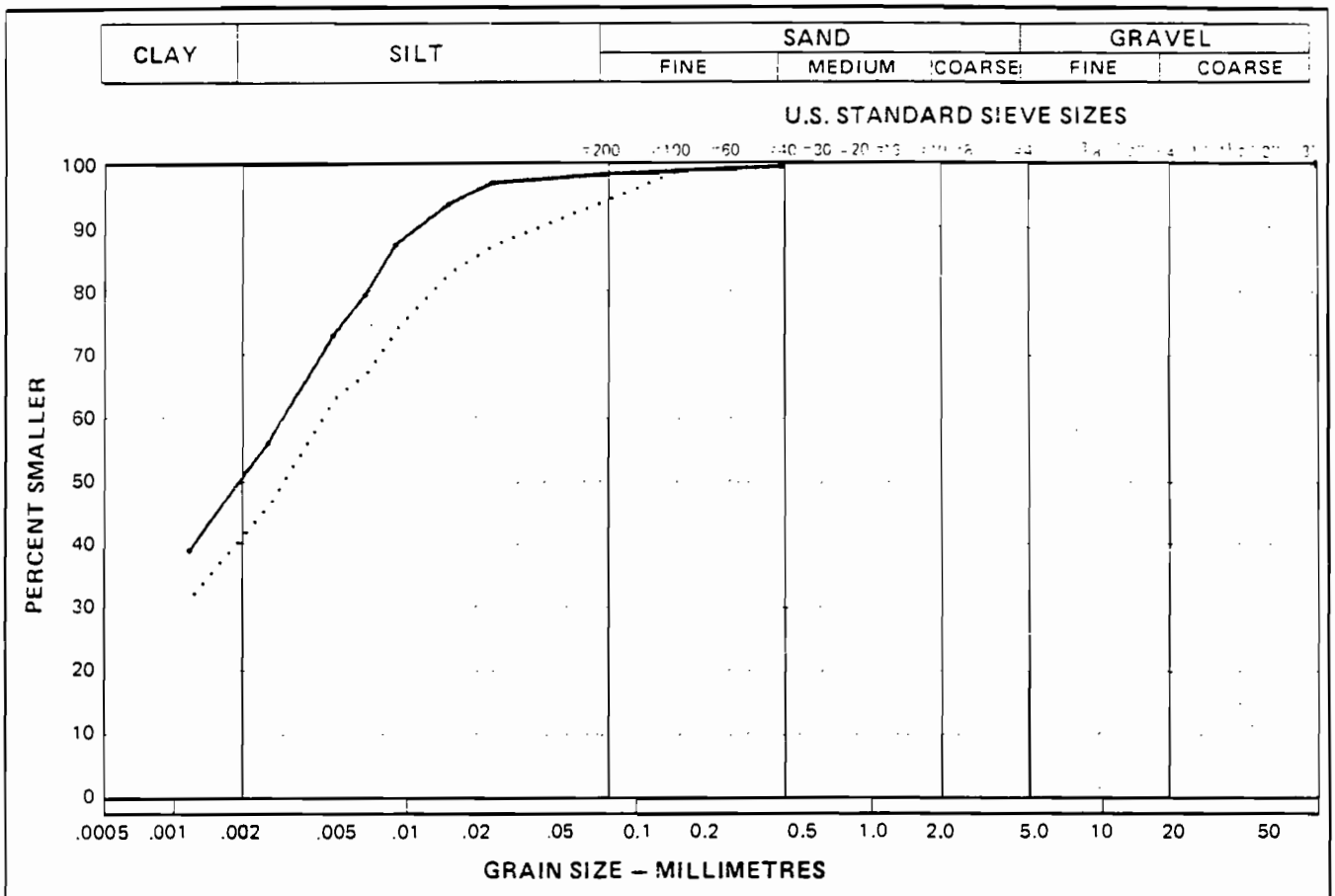
O	Organic Content	
S	Salinity	
TS	Thaw Strain	
SG	Specific Gravity	

Project Number: 101-3685

Reviewed By: _____ P Eng.

7141

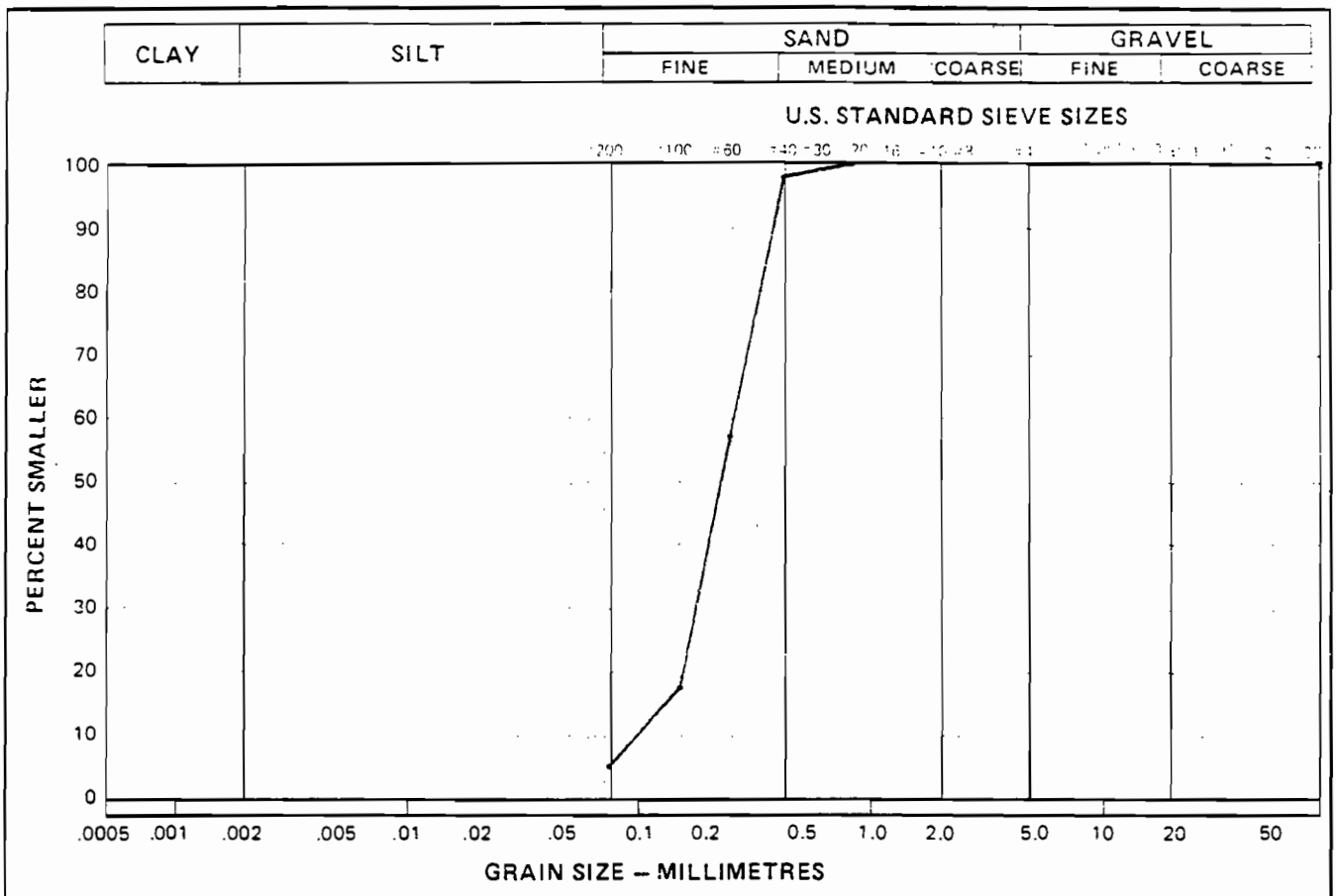
PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
_____	EA82S01	3.96 - 4.76	51.1	48.1	.8	0.0	-	-	
. . . . .	EA82S01	7.77 - 8.45	41.7	53.1	5.2	0.0	-	-	

JOB NO. 101 -3685 DATE 82-11-16

PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
_____	EA82S01	11.11 - 11.11	-	4.2	95.8	0.0	2.5	1.2	SP

JOB NO. 101 -3685 DATE 82-11-08

APPENDIX D

Shear Strength Test Results

APPENDIX D

GLOSSARY OF TERMS RELATED TO SHEAR STRENGTH

Axial Stress	:	Vertical stress applied to a sample (Force/X-Sectional Area)
B	:	The ratio of pore pressure response to a change in isotropic pressure. Indicative of the degree of saturation.
Back Pressure	:	An increase in pore pressure applied to a sample for the purpose of increasing saturation.
c'	:	Effective value of cohesion.
Cell Pressure	:	Isotropic confining pressure to which a sample is subjected during triaxial testing.
Consolidation	:	Volumetric change in soil with time resulting from loading under drained condition.
Deviator Stress	:	The net applied axial stress during triaxial testing. Mathematically, the difference between the major and minor principal stresses (sigma $_1$'-sigma $_3$').
Effective Stress	:	The net stress present in a saturated soil after the pore pressure has been subtracted. The stress difference between the total and measured pore pressure.
Epore	:	Computer output heading for excess pore pressure
Excess Pore Pressure	:	The pore pressure generated or developed during shear.
Jacketed	:	A sample is enclosed in a thin, impermeable, latex membrane.
Ko	:	The ratio of the effective horizontal stress to the effective vertical stress. sigma $_3$'/ sigma $_1$'
ParA	:	Computer output heading for Skempton's pore pressure parameter A. A is the ratio of change in excess pore pressure to change in deviator stress.
Peak Strength	:	The maximum deviator stress that can be applied to a sample.

GLOSSARY (continued)

Ø'	:	Internal angle of friction under effective stress conditions.
Pore Pressure Response	:	A change in pore pressure resulting from a change in stress condition.
Reshaped Strength	:	Analogous to remoulded strength. Shear strength measured after soil structure completely removed.
Strain	:	Ratio of deformation over a fixed reference length to the initial reference length. Expressed as a percent.
s1	:	Computer output heading for the effective major principal stress, sigma $_1$'. In triaxial testing this represents the total vertical stress.
s3	:	Computer output heading for the effective minor principal stress, sigma $_3$'. In triaxial testing, this represents the cell pressure.
Tpore	:	Computer output heading for total pore pressure.
VolCh	:	Computer output heading for the volume changes a sample undergoes during loading.
Wet Density	:	Mass of the soil particles and water in a unit volume of soil.
Dry Density	:	Mass of the dry soil particles in a unit volume of soil.

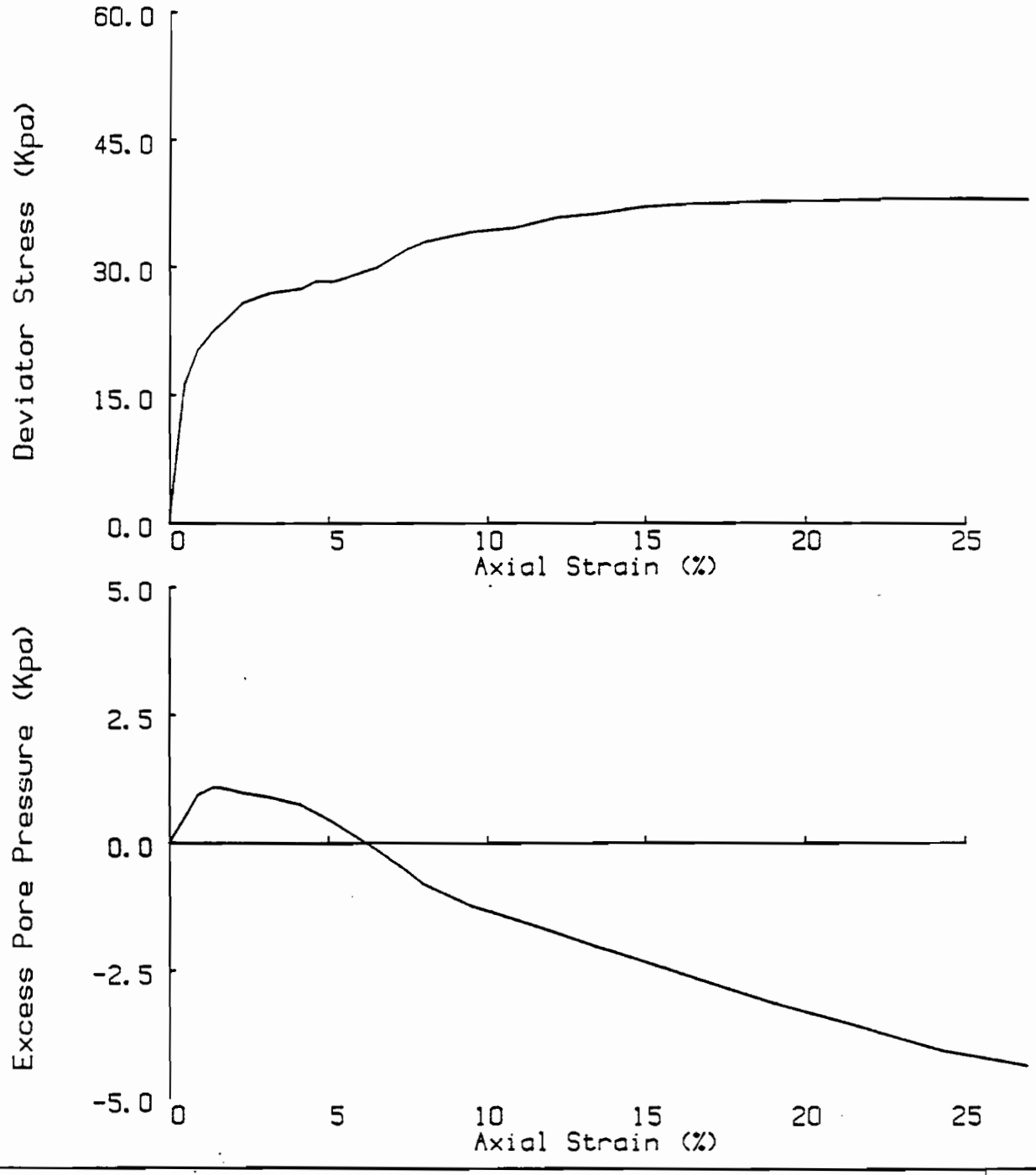
Test Hole..... EA82S01 38
Depth..... 3.98-4.72 m
Test Number..... 1
Cell Pressure..(Kpa).. 390.9
Back Pressure..(Kpa).. 373.7
Parameter B..... .95

	INITIAL	FINAL
Water Content (%)	45.08	44.73
Wet Density (Mg/cu.m)	1.80	1.79
Dry Density (Mg/cu.m)	1.24	1.24

Strn	s1-s3	Tpore	Epore	ParA	VolCh	s1/s3	s-s/2	s+s/2
0.00	0.0	373.8	0.00	0.00	0.0	1.00	0.0	17.1
.47	16.3	374.2	.49	.03	0.0	1.98	8.2	24.9
.88	20.4	374.7	.85	.05	0.0	2.26	10.2	26.4
1.38	22.6	374.8	1.10	.05	0.0	2.41	11.3	27.4
1.80	24.0	374.7	1.06	.04	0.0	2.48	12.0	28.2
2.28	25.8	374.6	.98	.04	0.0	2.58	12.9	29.2
3.15	27.0	374.6	.90	.03	0.0	2.65	13.5	29.8
4.10	27.5	374.5	.75	.03	0.0	2.68	13.7	30.1
4.58	28.4	374.4	.60	.03	0.0	2.73	14.2	30.7
5.07	28.3	374.0	.43	.01	0.0	2.68	14.6	31.0
6.48	30.0	373.6	-.12	-.00	0.0	2.73	15.0	32.3
7.44	32.2	373.3	-.54	-.01	0.0	2.82	16.1	33.7
7.87	33.0	372.8	-.80	-.03	0.0	2.83	16.5	34.6
9.44	34.2	372.5	-1.22	-.04	0.0	2.86	17.1	35.5
10.86	34.7	372.2	-1.48	-.04	0.0	2.86	17.4	36.1
12.22	35.9	371.9	-1.76	-.05	0.0	2.89	17.9	36.9
13.53	36.3	371.7	-2.04	-.06	0.0	2.89	18.2	37.4
14.90	37.1	371.4	-2.31	-.06	0.0	2.90	18.5	38.0
16.23	37.4	371.1	-2.58	-.07	0.0	2.89	18.7	38.5
18.93	37.8	370.6	-3.12	-.08	0.0	2.86	18.9	39.2
21.60	38.0	370.1	-3.59	-.09	0.0	2.83	19.0	39.8
24.30	38.2	369.6	-4.06	-.11	0.0	2.79	19.1	40.3
26.89	38.0	368.3	-4.36	-.11	0.0	2.76	19.0	40.5
0.00	0.0	0.0	0.00	0.00	0.0	0.00	0.0	0.0
24.30	38.2	374.8	4.36	.11	0.0	2.90	19.1	40.5
24.30	60.0	500.0	5.00	.12	0.0	4.00	20.0	50.0
Strn	s1-s3	Tpore	Epore	ParA	VolCh	s1/s3	s-s/2	s+s/2

FIGURE D1 UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS
EAST AMAULIGAK AREA.

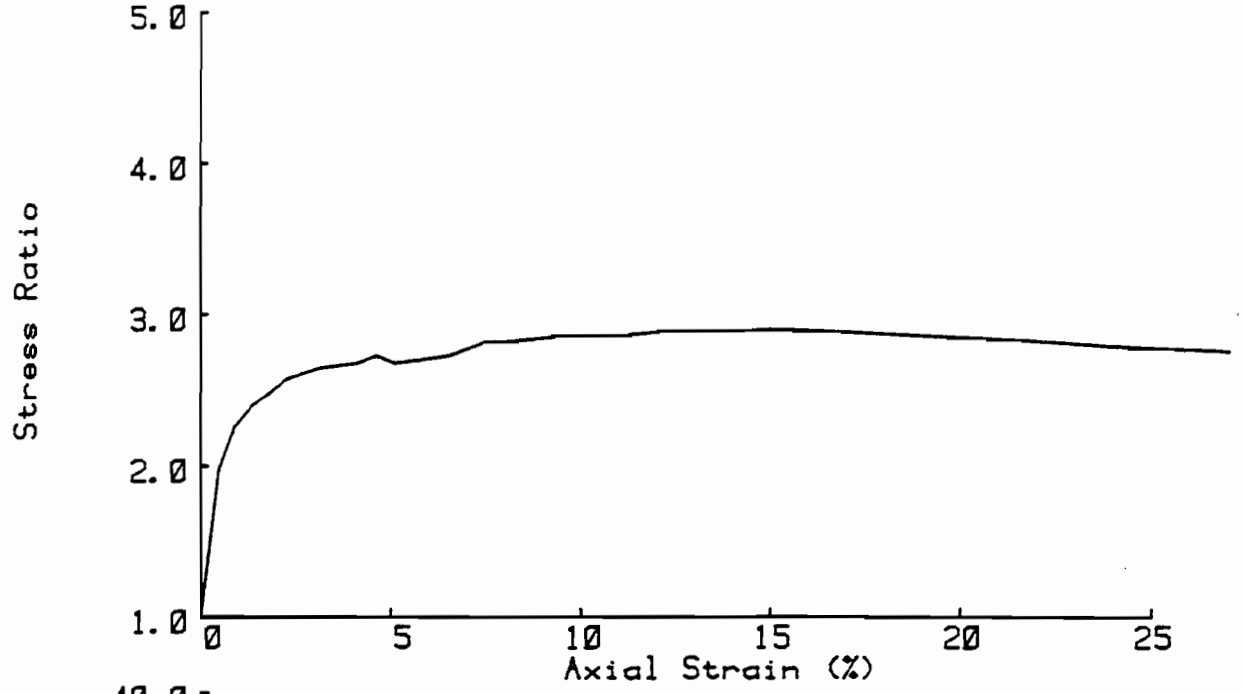
	Test no.	σ'_{3c} (kPa)	Dry dens. (Mg/cu. m)
———	1	17.2	1.24

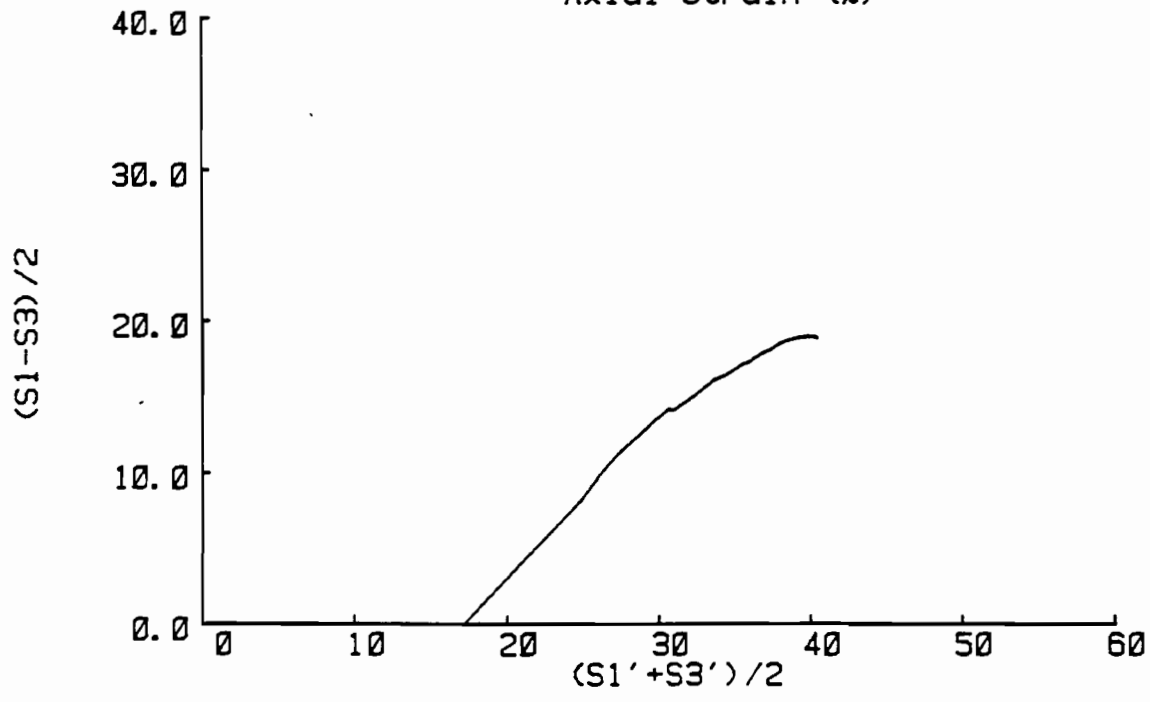


UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE WATER PRESSURE MEASUREMENTS

FIGURE
D.2

	Test no.	σ'_{3c} (kPa)	Dry dens. (Mg/cu. m)
———	1	17.2	1.24





UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE WATER PRESSURE MEASUREMENTS

FIGURE D.3

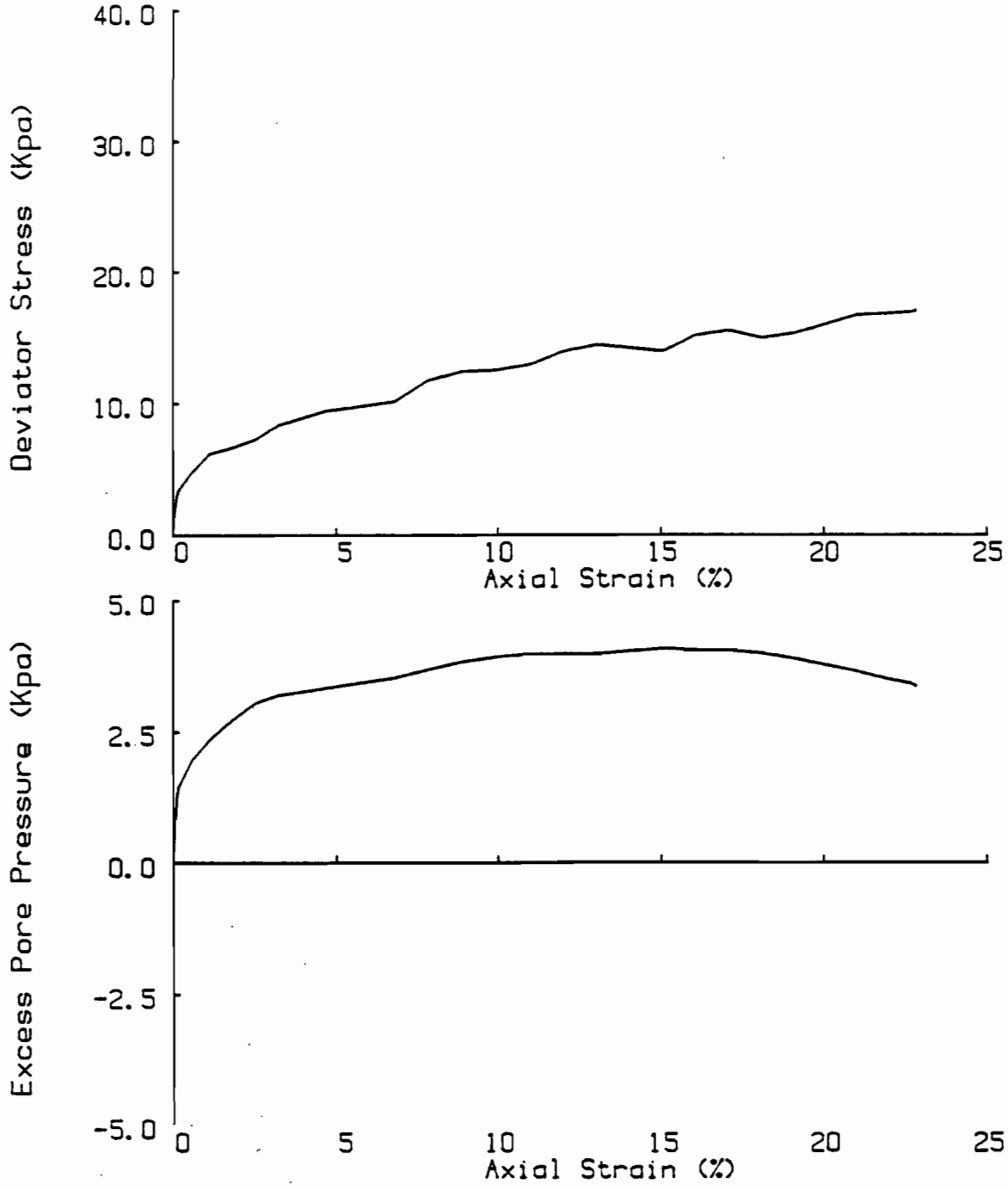
Test Hole..... EAB2S01 4B
Depth..... 4.75-5.37 m
Test Number..... 2
Cell Pressure..(Kpa).. 401.3
Back Pressure..(Kpa).. 384.0
Parameter B..... 1.00

	INITIAL	FINAL
Water Content (%)	45.67	45.58
Net Density (Mg/cu.m)	1.74	1.74
Dry Density (Mg/cu.m)	1.19	1.19

Strn	s1-s3	Tpore	Epore	ParA	VolCh	s1/s3	s-s/2	s+s/2
0.00	0.0	385.0	0.00	0.00	0.0	1.00	0.0	16.3
.14	3.0	385.3	1.29	.27	0.0	1.30	2.4	18.4
.19	3.4	385.4	1.44	.28	0.0	1.32	2.5	18.4
.63	4.9	386.2	1.99	.37	0.0	1.39	3.0	18.1
1.12	6.2	386.3	2.34	.37	0.0	1.42	3.1	18.1
1.86	6.7	386.5	2.74	.38	0.0	1.45	3.3	18.1
2.51	7.3	387.0	3.04	.42	0.0	1.51	3.6	17.9
3.23	8.4	387.2	3.19	.38	0.0	1.60	4.2	18.3
4.67	9.5	387.3	3.33	.35	0.0	1.68	4.8	18.7
6.80	10.2	387.5	3.53	.35	0.0	1.74	5.1	18.9
7.85	11.8	387.7	3.68	.31	0.0	1.87	5.8	19.5
8.89	12.5	387.8	3.83	.31	0.0	1.93	6.3	19.7
9.83	12.6	387.9	3.93	.31	0.0	1.94	6.3	19.6
10.97	13.0	388.0	3.98	.31	0.0	1.98	6.5	19.8
11.99	14.0	388.0	3.98	.28	0.0	2.05	7.0	20.3
13.01	14.5	388.0	3.98	.27	0.0	2.09	7.3	20.6
15.03	14.0	388.1	4.08	.29	0.0	2.06	7.0	20.2
16.04	15.2	388.0	4.03	.27	0.0	2.15	7.6	20.9
17.06	15.6	388.0	4.03	.26	0.0	2.18	7.8	21.1
18.07	15.0	388.0	3.98	.27	0.0	2.13	7.5	20.8
19.08	15.4	387.9	3.88	.25	0.0	2.15	7.7	21.1
21.06	16.8	387.6	3.63	.22	0.0	2.23	8.4	22.1
22.04	16.9	387.5	3.48	.21	0.0	2.23	8.5	22.3
22.68	17.0	387.6	3.40	.21	0.0	2.25	8.5	22.2
22.83	17.1	387.5	3.35	.21	0.0	2.24	8.5	22.3
0.00	0.0	0.0	0.00	0.00	0.0	0.00	0.0	0.0
20.07	19.3	388.1	4.08	.42	0.0	2.43	9.6	23.2
20.07	40.0	500.0	5.00	.46	0.0	4.00	20.0	25.0
Strn	s1-s3	Tpore	Epore	ParA	VolCh	s1/s3	s-s/2	s+s/2

FIGURE D.4 UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS
EAST AMAULIGAK AREA.

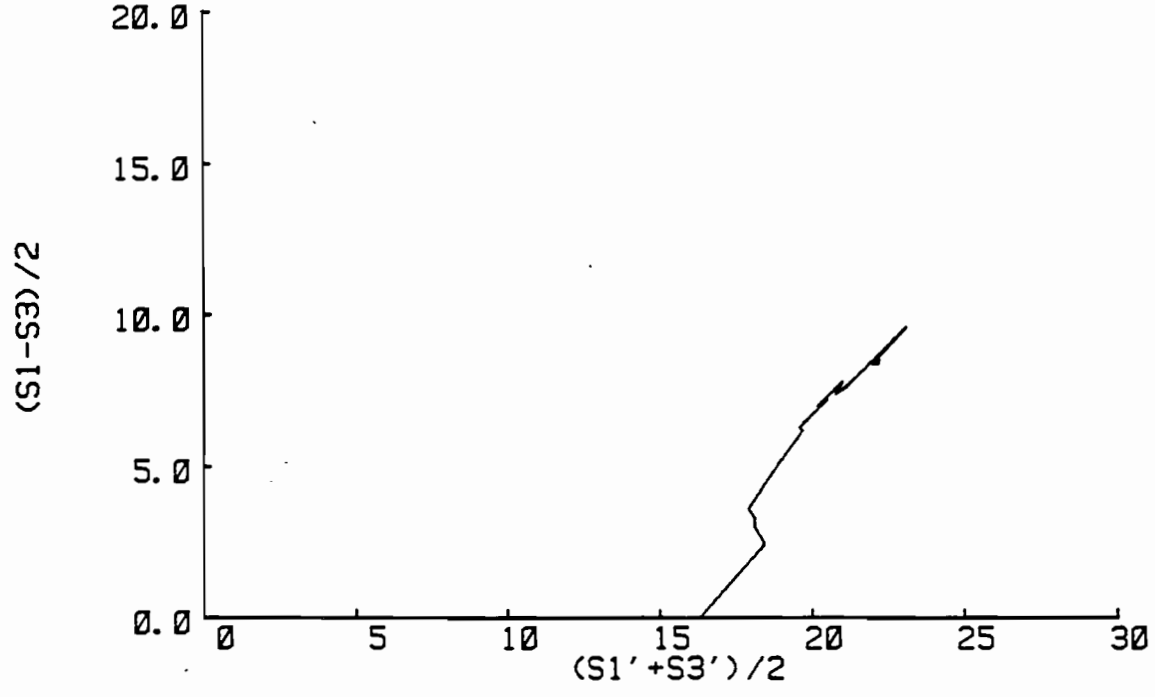
	Test no.	σ'_{3c} (kPa)	Dry dens. (Mg/cu. m)
———	2	17.3	1.19



UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE WATER PRESSURE MEASUREMENTS

FIGURE
D.5

	Test no.	σ'_{3_o} (kPa)	Dry dens. (Mg/cu. m)
———	2	17.3	1.19



UNCONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE WATER PRESSURE MEASUREMENTS

FIGURE D.6