



# 1984 OFFSHORE GEOTECHNICAL SITE INVESTIGATION

**AMAULIGAK (A-23) SITE  
AND  
AMAULIGAK (F-65) SITE  
BEAUFORT SEA**

Submitted to

**GULF CANADA RESOURCES INC.  
CALGARY, ALBERTA**

**JANUARY, 1985**



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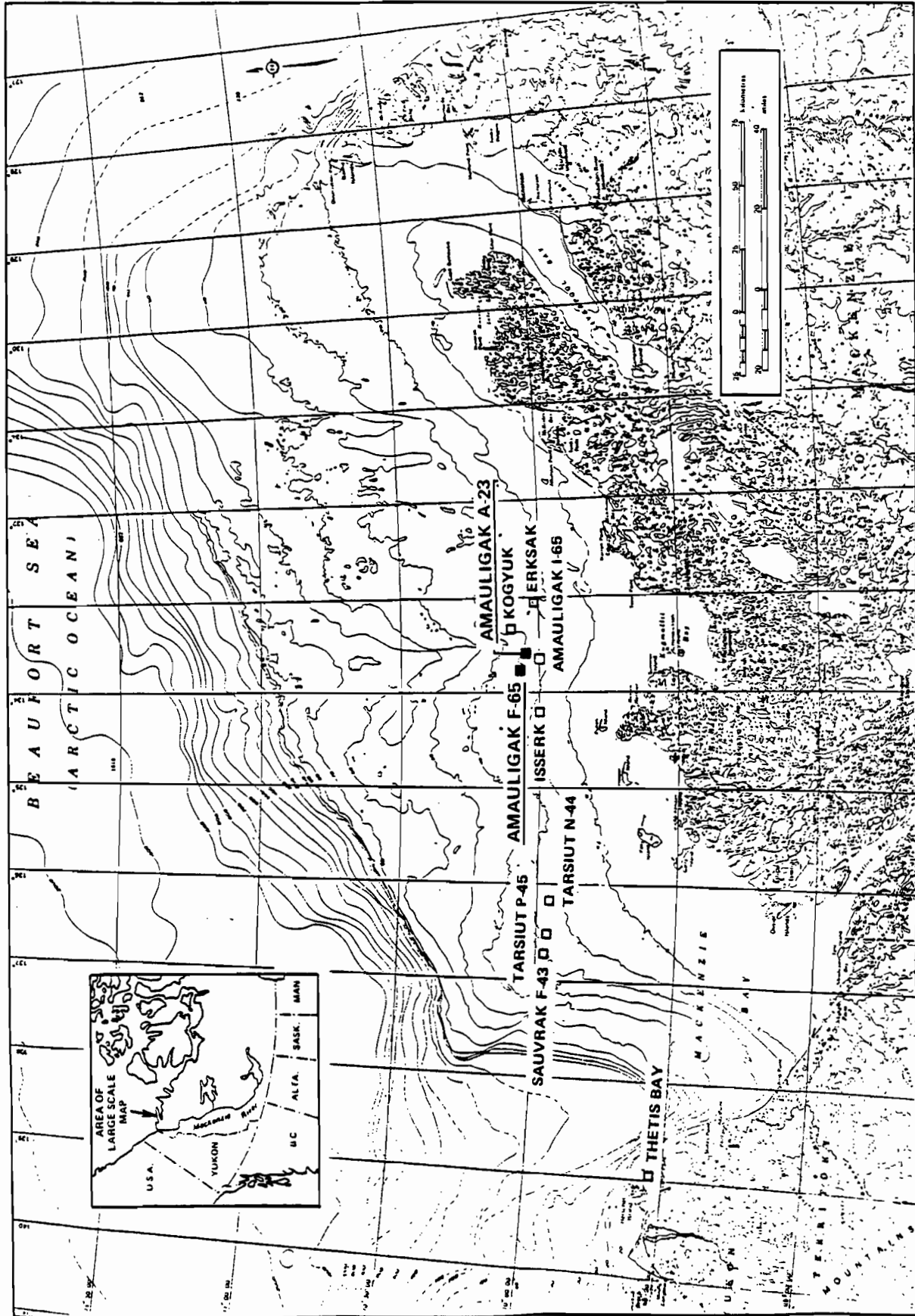


FIGURE 1 GENERAL LOCATION MAP

January, 1985

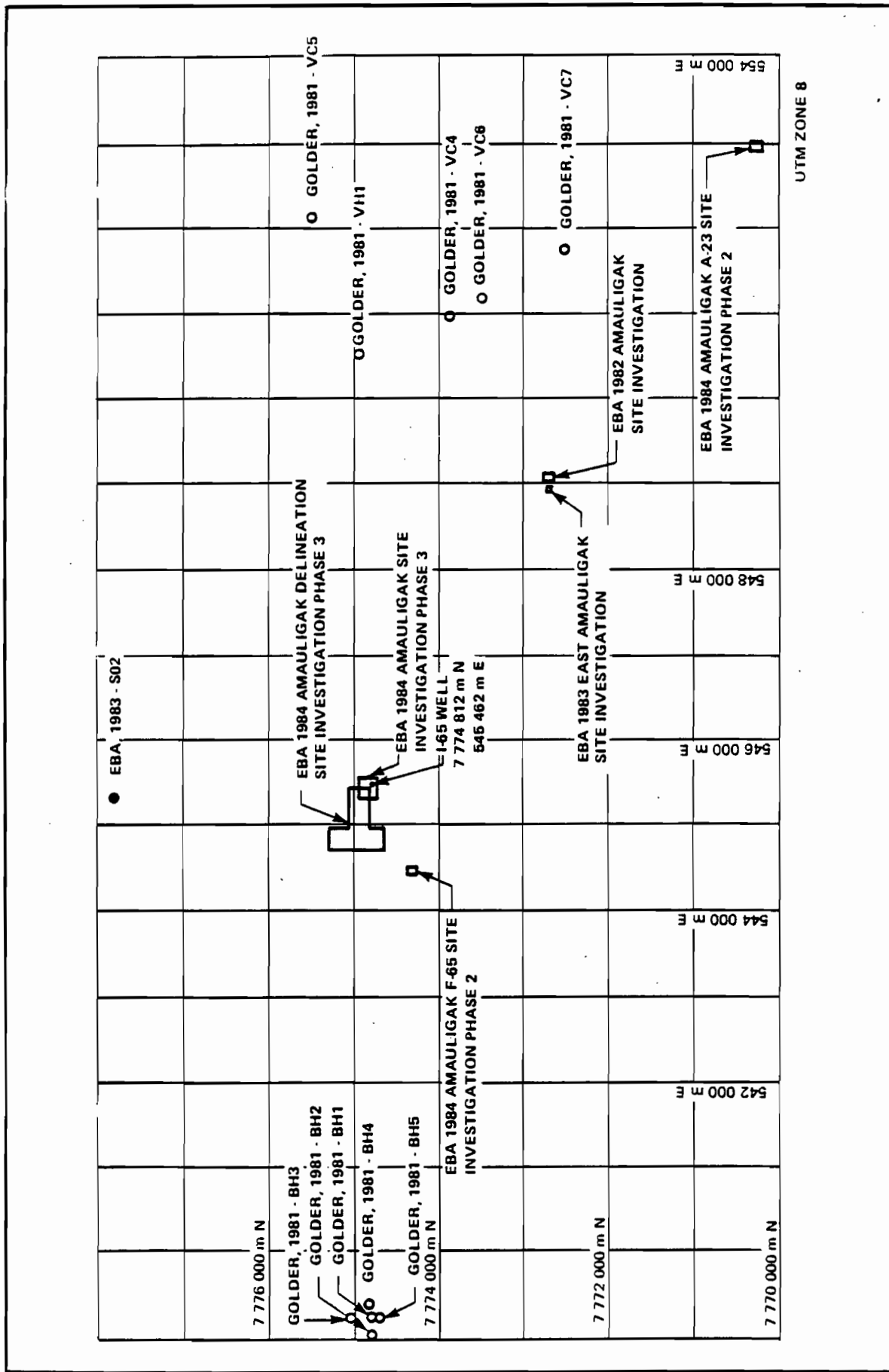


FIGURE 2 DETAILED BOREHOLE AND PROBEHOLE LOCATION MAP FOR ALL SITE INVESTIGATIONS ON THE AMAULIGAK BLOCK



TABLE 1 BOREHOLE AND PROBEHOLE LOCATIONS

BOREHOLE OR PROBEHOLE	UTM COORDINATES (ZONE 8)	GEOGRAPHIC COORDINATES		DATE (completed)	SEABED PENETRATION (metres)
		LATITUDE	LONGITUDE		
<b>AMAULIGAK A-23</b>					
AE84CI01	N 7 770 220	E 552 965	70° 02' 06.5"	133° 36' 36.4"	84-09-10 13.3
AE84CI02	N 7 770 270	E 552 965	70° 02' 08.1"	133° 36' 36.2"	84-09-10 13.3
AE84CI03	N 7 770 210	E 552 920	70° 02' 06.2"	133° 36' 40.8"	84-09-10 14.2
AE84CI04	N 7 770 330	E 552 950	70° 02' 10.0"	133° 36' 37.3"	84-09-10 14.0
AE84CI05	N 7 770 225	E 553 010	70° 02' 06.7"	133° 36' 32.2"	84-09-10 12.3
AE84PI01	N 7 770 220	E 555 950	70° 02' 04.2"	133° 31' 54.3"	84-09-08 14.0
AE84PI02	N 7 770 265	E 552 960	70° 02' 07.9"	133° 36' 36.6"	84-09-10 13.6
AE84PI03	N 7 770 225	E 552 910	70° 02' 06.6"	133° 36' 41.3"	84-09-09 14.0
AE84PI04	N 7 770 330	E 552 955	70° 02' 10.1"	133° 36' 36.8"	84-09-10 13.4
AE84PI05	N 7 770 220	E 553 005	70° 02' 06.4"	133° 36' 32.3"	84-09-09 13.1
AE84SI01	N 7 770 220	E 552 955	70° 02' 06.5"	133° 36' 37.0"	84-09-08 51.0
<b>AMAULIGAK F-65</b>					
AW84CI01	N 7 774 270	E 544 480	70° 04' 23.0"	133° 49' 50.0"	84-09-11 13.2
AW84CI02	N 7 774 320	E 544 480	70° 04' 24.5"	133° 49' 50.1"	84-09-11 12.2
AW84CI03	N 7 774 265	E 544 440	70° 04' 22.7"	133° 49' 54.0"	84-09-11 13.2
AW84CI04	N 7 774 395	E 544 480	70° 04' 26.9"	133° 49' 49.8"	84-09-11 13.3
AW84CI05	N 7 774 270	E 544 520	70° 04' 22.8"	133° 49' 46.3"	84-09-11 14.1
AW84PI01	N 7 774 275	E 544 455	70° 04' 23.1"	133° 49' 52.7"	84-09-12 13.9
AW84SI01	N 7 774 275	E 544 475	70° 04' 23.0"	133° 49' 50.7"	84-09-12 48.5

NOTE: 1. All coordinates supplied by C.E.S.

2. "AE84" or "AW84" denotes a borehole or probehole at the AMAULIGAK A-23 or AMAULIGAK F-65 sites, respectively, drilled or tested in 1984. "SI" refers to "sample investigation", "CI" refers to "static cone investigation", and "PI" refers to "pressuremeter investigation". The number following the latter designation is the borehole or probehole number.





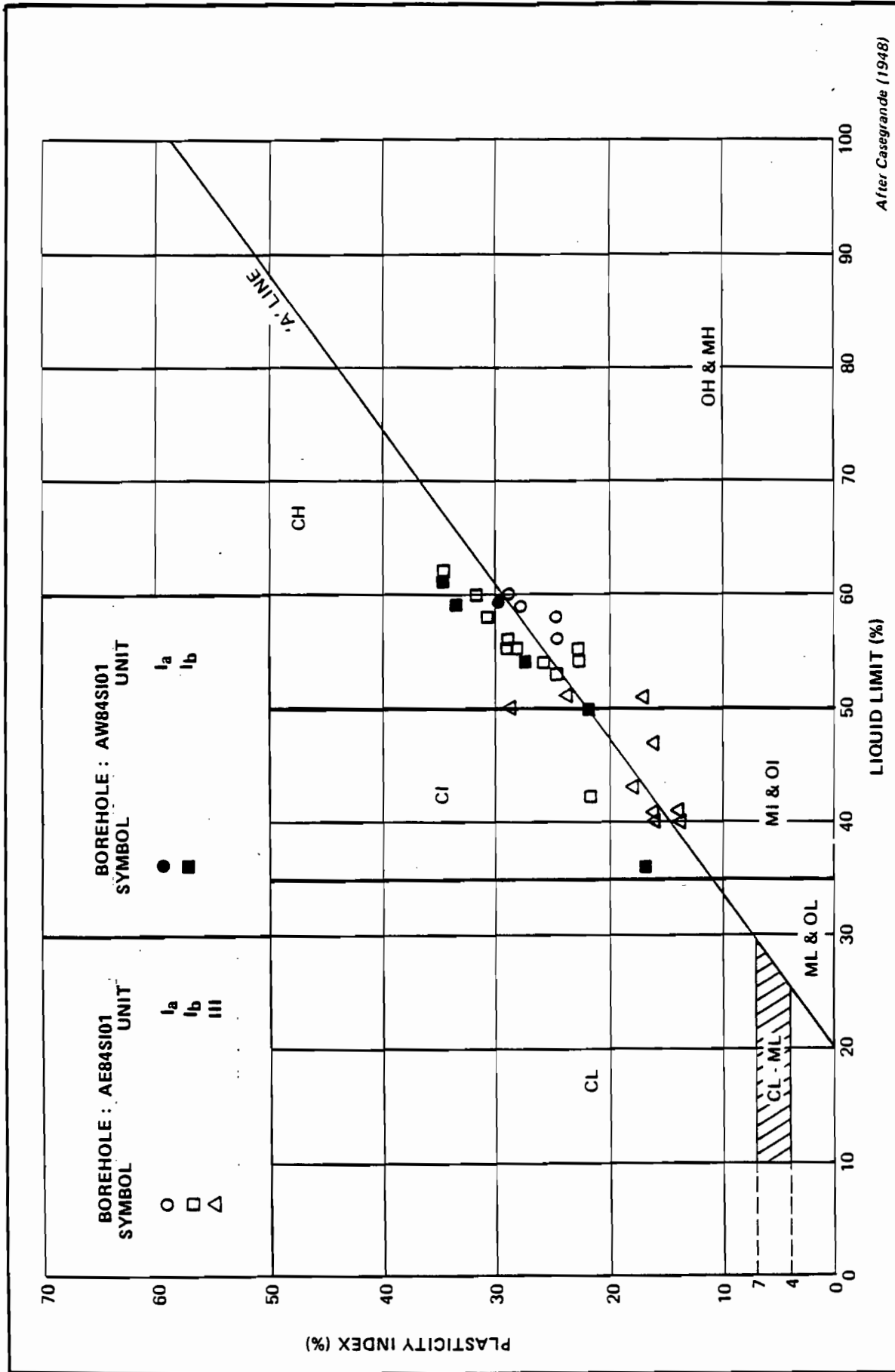
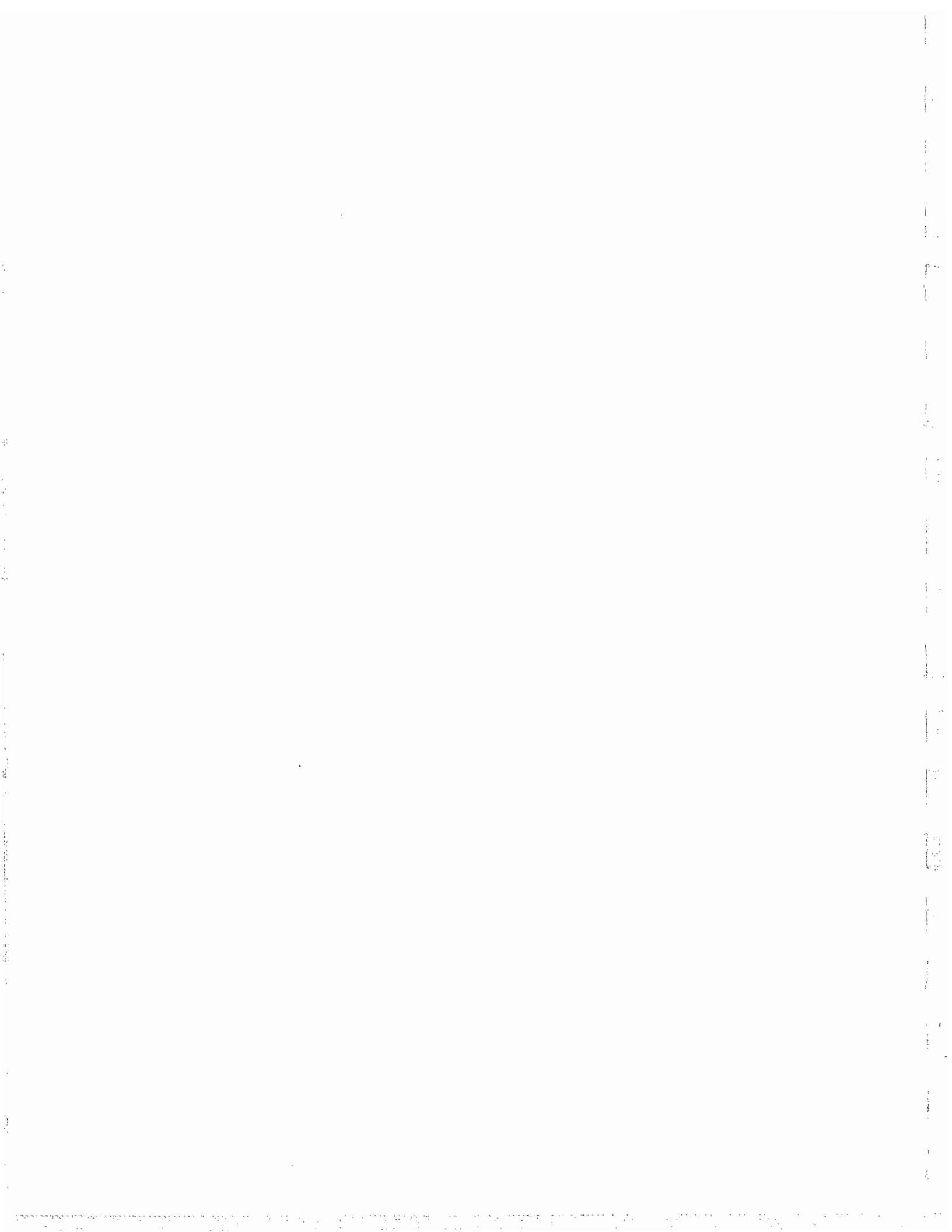


FIGURE 4 PLASTICITY CHART



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
<b>SI UNITS</b>				
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		
<b>SI SUPPLEMENTARY UNITS</b>				
plane angle	radian	rad		
solid angle	steradian	sr		
<b>EXAMPLES OF SI DERIVED UNITS WITH SPECIAL NAMES</b>				
frequency	hertz	Hz	1/s	s <sup>-1</sup>
force	newton	N	m · kg/s <sup>2</sup>	m · kg · s <sup>-2</sup>
pressure, stress	pascal	Pa	N/m <sup>2</sup>	m <sup>-1</sup> · kg · s <sup>-2</sup>
energy, work, quantity of heat	joule	J	N · m	m <sup>2</sup> · kg · s <sup>-2</sup>
power, radiant flux	watt	W	J/s	m <sup>2</sup> · kg · s <sup>-3</sup>
<b>EXAMPLES OF SI DERIVED UNITS WITHOUT SPECIAL NAMES</b>				
velocity - linear	metre per second	m/s		m · s <sup>-1</sup>
velocity - angular	(radian per second)	rad/s		rad · s <sup>-1</sup>
acceleration - linear	(metre per second) per second	m/s <sup>2</sup>		m · s <sup>-2</sup>
acceleration - angular	(radian per second) per second	rad/s <sup>2</sup>		rad · s <sup>-2</sup>
concentration (of amount of substance)	mole per cubic metre	mol/m <sup>3</sup>		mol · m <sup>-3</sup>
dynamic viscosity	pascal second	Pa · s		m <sup>-1</sup> · kg · s <sup>-1</sup>
moment of force	newton metre	N · m		m <sup>2</sup> · kg · s <sup>-2</sup>
surface tension	newton per metre	N/m		kg · s <sup>-2</sup>
heat flux density, irradiance	watt per square metre	W/m <sup>2</sup>		kg · s <sup>-3</sup>
heat capacity, entropy	joule per kelvin	J/K		m <sup>2</sup> · s <sup>-2</sup> · K <sup>-1</sup>
specific heat capacity, specific entropy	joule per kilogram kelvin	J/(kg · K)		m <sup>2</sup> · s <sup>-2</sup> · K <sup>-1</sup>
specific energy	joule per kilogram	J/kg		m <sup>2</sup> · s <sup>-2</sup>
thermal conductivity	watt per metre kelvin	W/(m · K)		m · kg · s <sup>-3</sup> · K <sup>-1</sup>

## 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	°
area	hectare	ha	1 ha = 10,000 m <sup>2</sup>
	volume	L	1,000 L = 1 m <sup>3</sup>
	temperature	degree Celsius	°C
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 <sup>18</sup>	exa	E	0.1 = 10 <sup>-1</sup>	deci*	d
1,000,000,000,000,000 = 10 <sup>15</sup>	peta	P	0.01 = 10 <sup>-2</sup>	centi*	c
1,000,000,000,000 = 10 <sup>12</sup>	tetra	T	0.001 = 10 <sup>-3</sup>	milli	m
1,000,000,000 = 10 <sup>9</sup>	giga	G	0.000,001 = 10 <sup>-6</sup>	micro	μ
1,000,000 = 10 <sup>6</sup>	mega	M	0.000,000,001 = 10 <sup>-9</sup>	nano	n
1,000 = 10 <sup>3</sup>	kilo	k	0.000,000,000,001 = 10 <sup>-12</sup>	pico	p
100 = 10 <sup>2</sup>	hecto*	h	0.000,000,000,000,001 = 10 <sup>-15</sup>	femto	f
10 = 10 <sup>1</sup>	deca*	da	0.000,000,000,000,000,001 = 10 <sup>-18</sup>	atto	a

\* to be avoided where possible

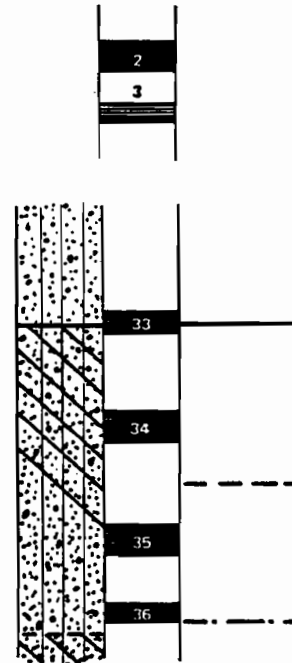
## SYMBOLS AND ABBREVIATIONS USED ON BOREHOLE LOGS

### 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  $\pm 0.5$  m of the marked level and is probably gradational between the two samples
- stratum boundary assumed to occur within  $\pm 1.0$  m of the marked level
- stratum boundary notation for both depth below seabed (41.5 m) and elevation below sealevel (uncorrected for tides) (-64.6 m. Elevation)



41.5 (-64.6 El.)

### SOIL DESCRIPTION

#### UNIFIED SOIL CLASSIFICATION

- determined in accordance with chart on following page

#### USC

#### TEXTURAL DESCRIPTION

- material named after its principal component
- name is modified by other components as follows:
 

Presence of Component "XXX"	Modifier
> - 35%	and XXX
21 - 35%	XXX-ey
11 - 20%	Some XXX
1 - 10%	Trace of XXX
- Modifiers are always recorded in order of decreasing amounts.
- Classification may be modified as information regarding plasticity, grain size distribution, etc., is made available from lab test results.

#### 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 ( $^{\circ}$ F) at that level
- see also definition of terms in text

e.g. FROZEN 28.1  $^{\circ}$ C  
- Nf - Nbn  
- poorly to slightly bonded  
SAND: Nbn 28.5  $^{\circ}$ C  
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 undrained shear strength, as indicated by cone penetrometer reading or miniature vane and triaxial test results.

Descriptive Term	Undrained Shear strength (kPa)
Very Soft	less than 12.5
Soft	12.5 to 25
Firm	25 to 50
Stiff	50 to 100
Very Stiff	100 to 200
Hard	200 and higher

##### 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
Very Loose	0 - 20%
Loose	20 - 40%
Compact or Medium	40 - 75%
Dense	75 - 90%
Very Dense	90 - 100%

#### PLASTICITY

Low - Liquid limit less than 35  
Medium - Liquid limit between 35 and 50  
High - Liquid limit greater than 50





LOCATION AMAULIGAK F 85		WATER DEPTH 30.7 m		UIM CUKIHHNAIES 7 774 273 m N 544 454 m E		(TIME MEASURED 0135 hrs)		
SYMBOL	SAMPLE	SOIL DESCRIPTION	GROUND ICE DESCRIPTION	BULK DENSITY		UNDRAINED SHEAR STRENGTH (kPa) Mc = 14	WATER CONTENT (%)	LABORATORY TESTS
				PLASTIC LIMIT	LIQUID LIMIT			
			UNFROZEN	20	40	60	80	
		CLAY (CH) - silty, trace of disseminated organic, homogeneous, very soft, high plasticity, dark olive grey						
		becoming soft						S = 2.0 %
		very thin (laminated), firm, low plasticity						
		trace of shell fragments, with occasional homogeneous layers up to 10 mm thick						
		becoming homogeneous						S = 3.4 %
		sand partings between homogeneous layer 10 - 20 mm thick						
		shell layer 10 mm thick at 13.8 m						S = 3.2 %
		14.2 m (46.9 m B.)						
		SAND (SM) - trace to some soft, fine-grained, uniform, homogeneous, compact to dense, dark grayish brown						PSA
		(clay interbeds noted by drifter)						
		clay layer 200 mm thick at 17.7 m						
		SAND (SP) - trace of silt with one pebble 18 mm diameter, fine grained, uniform homogeneous, compact to dense (testated), olive grey						
		10 mm thick clay lens at 20.9 m						
		trace of organics						
		several randomly oriented organic pebbles						
		(Drifter noted interbedding started at 31.8 m)						
		10 mm thick CLAY layers at 33.0 m and 33.3 m						PSA
		lens bedding apparent						S = 3.4 %
		becoming (SP)						
		trace of silt, fine grained but slightly coarse, uniform homogeneous, dark brown						
		trace of fine grained gravel						
		END OF BOREHOLE						
		48.8 m (159.2 m B.)						

PROJECT NUMBER 10IC-4118	SOIL SYMBOLS	SAMPLE TYPE	SHEAR STRENGTH	TEST IDENTIFICATION	BOREHOLE NUMBER
DRILLING COMPLETED 04-09-12	Sand Silt Clay	Thin Wall Tube Split Spoon Liner Core Disturbed No Recovery	Terzaghi Mead Vane Piezon Vane In Site Vane UW Triaxial Fall Cone	Compaction Flow Table Direct Shear DSS Direct Simple Shear Triaxial Shear P.M. Salinity Gas Analysis Particle Size Analysis	AWB45101

**CONE PENETRATION TEST DATA  
BOREHOLE LOG AND LABORATORY TEST RESULTS**



APPENDIX B

DIAGNOSTIC PROFILES

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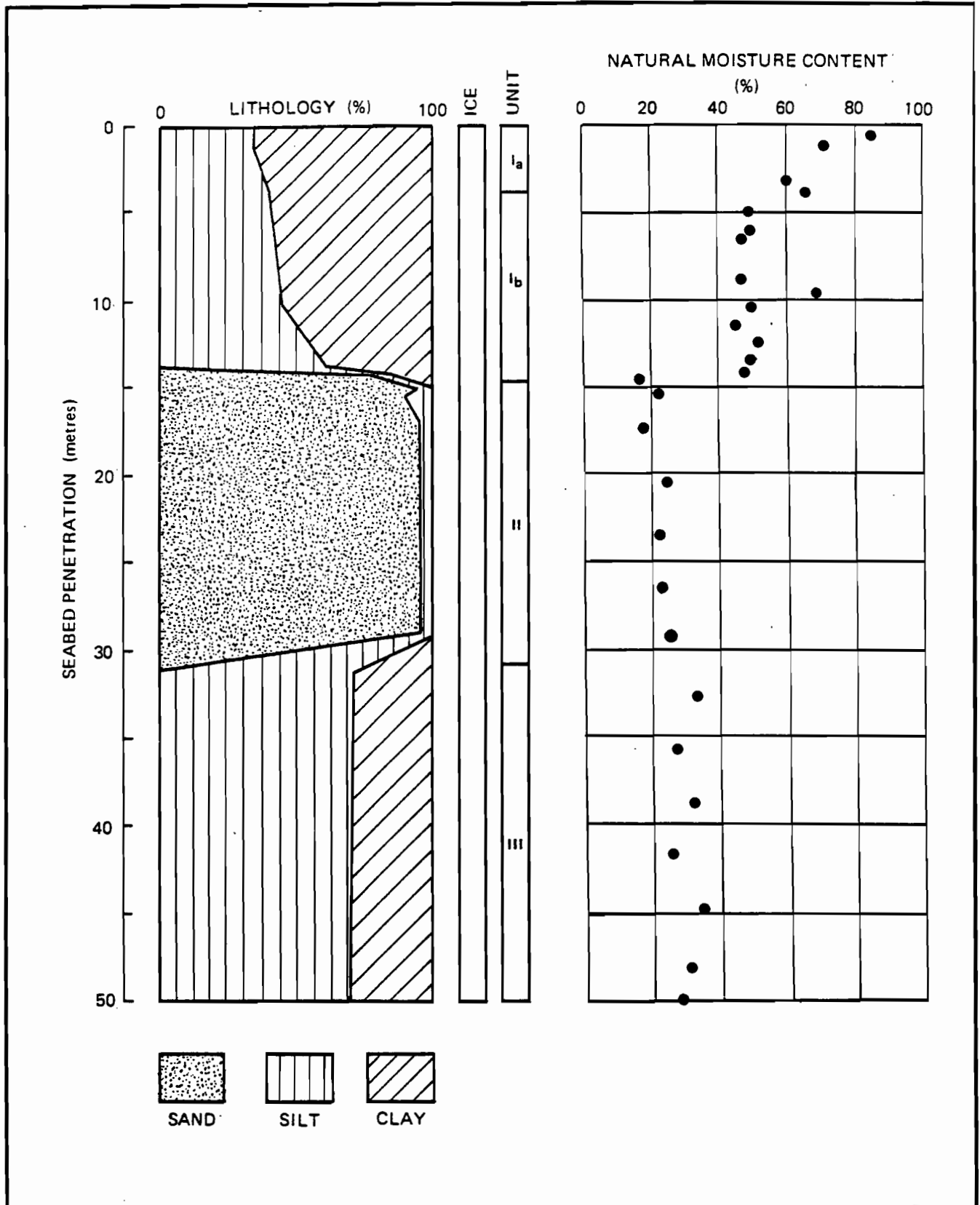


FIGURE C.1 NATURAL MOISTURE CONTENT PROFILE - AMAULIGAK A-23

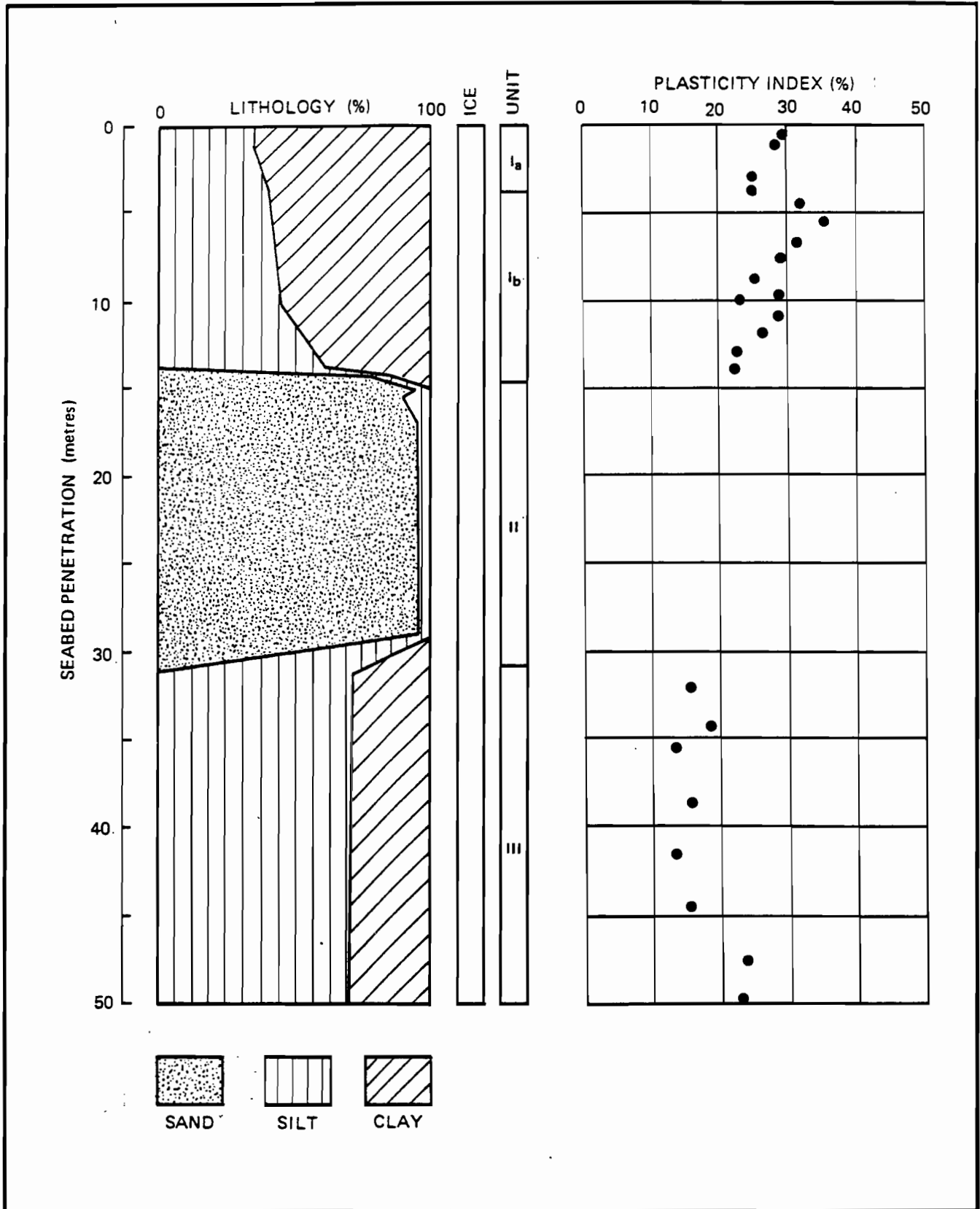


FIGURE C.2 PLASTICITY INDEX PROFILE -  
 AMAULIGAK A-23

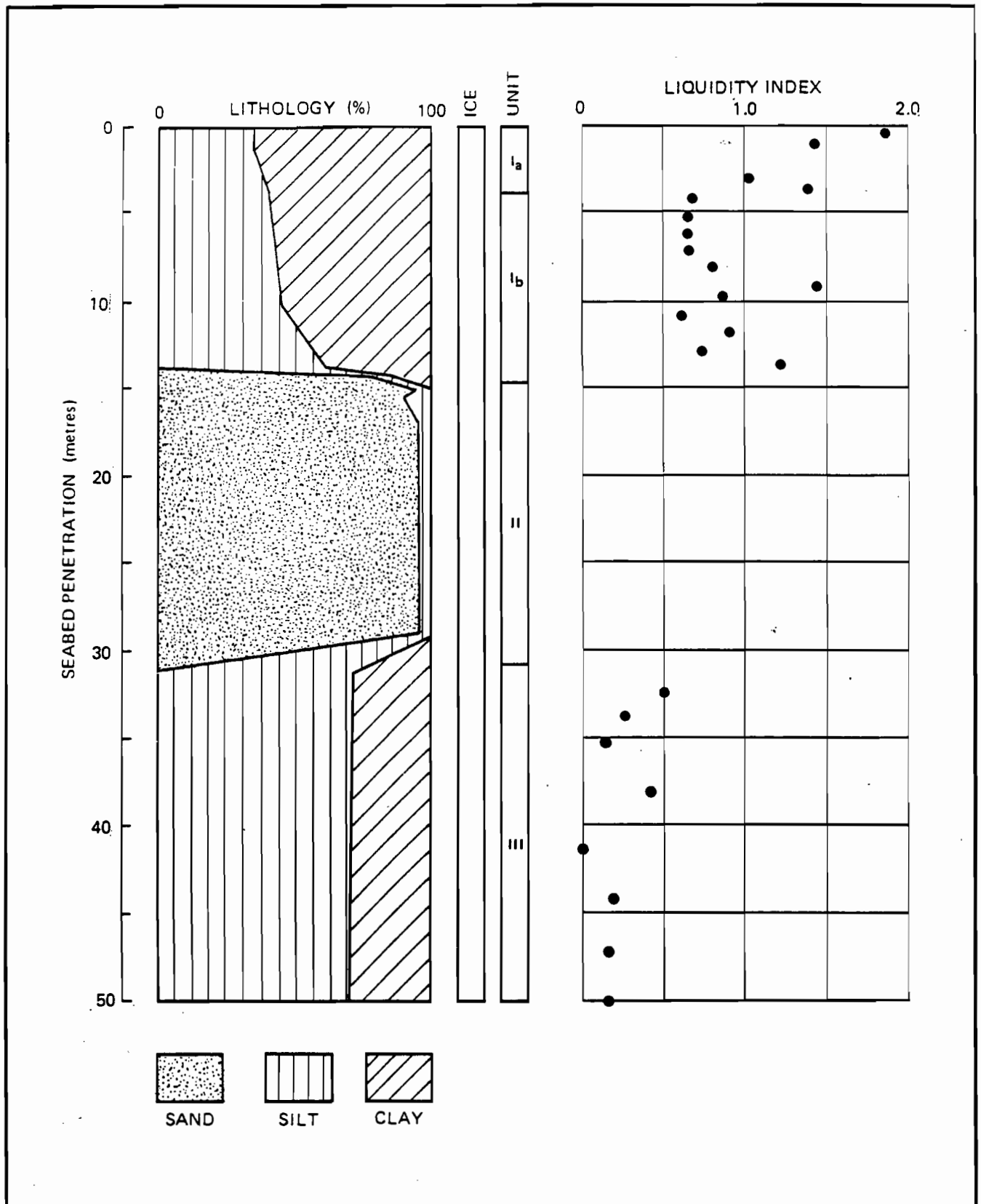


FIGURE C.3 LIQUIDITY INDEX PROFILE - AMAULIGAK A-23

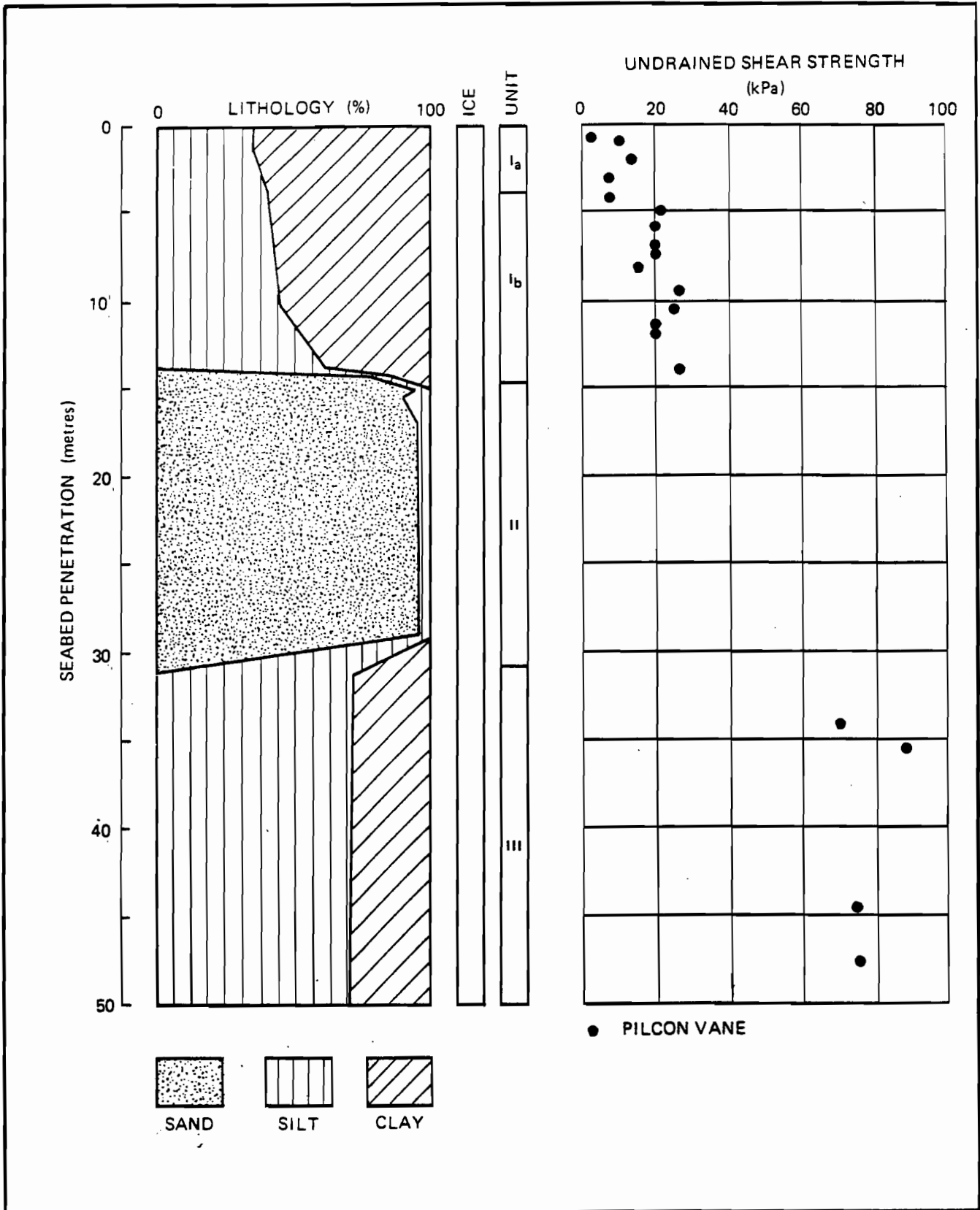


FIGURE C.4 UNDRAINED SHEAR STRENGTH PROFILE - AMAULIGAK A-23



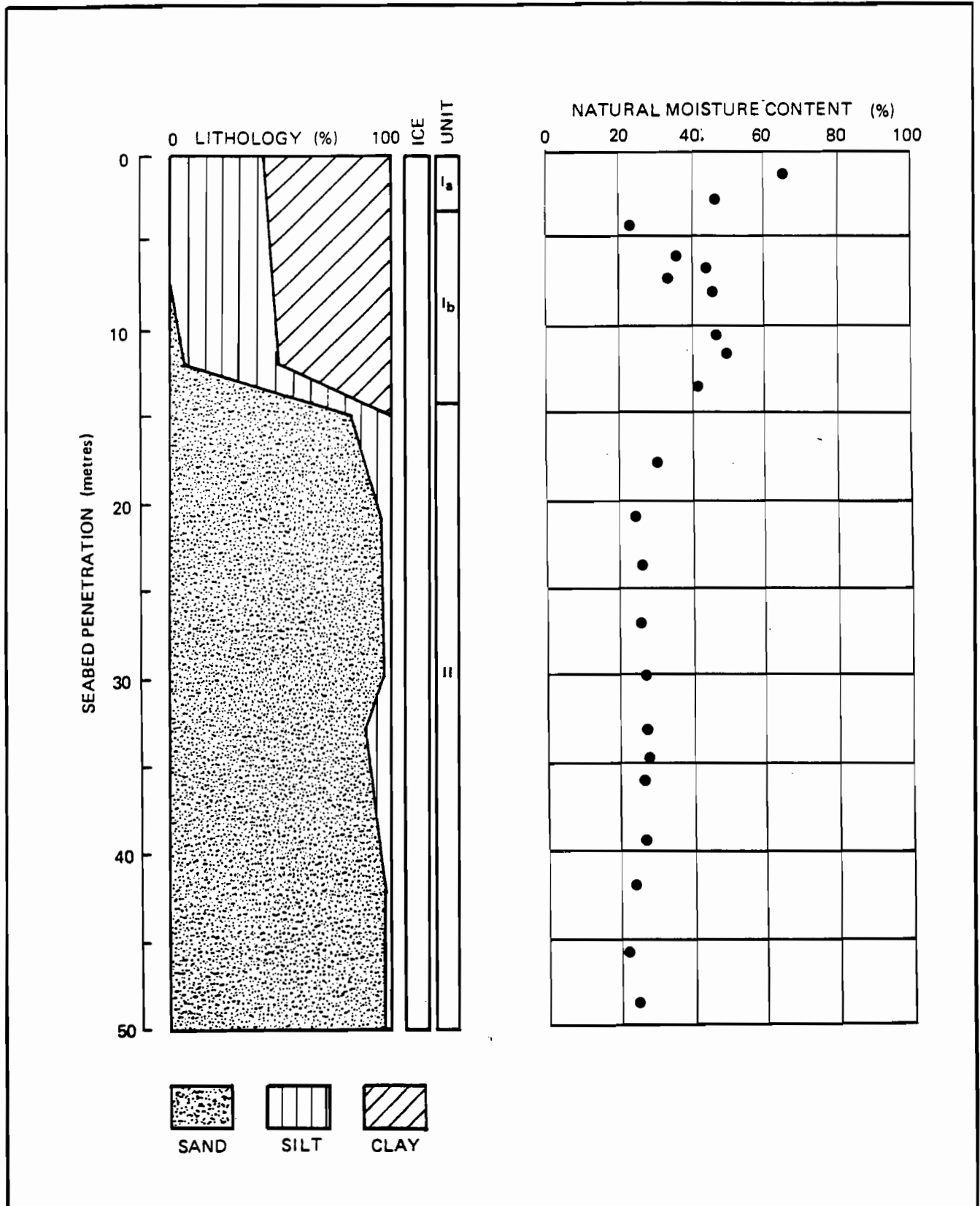


FIGURE C.5 NATURAL MOISTURE CONTENT PROFILE - AMAULIGAK F-65

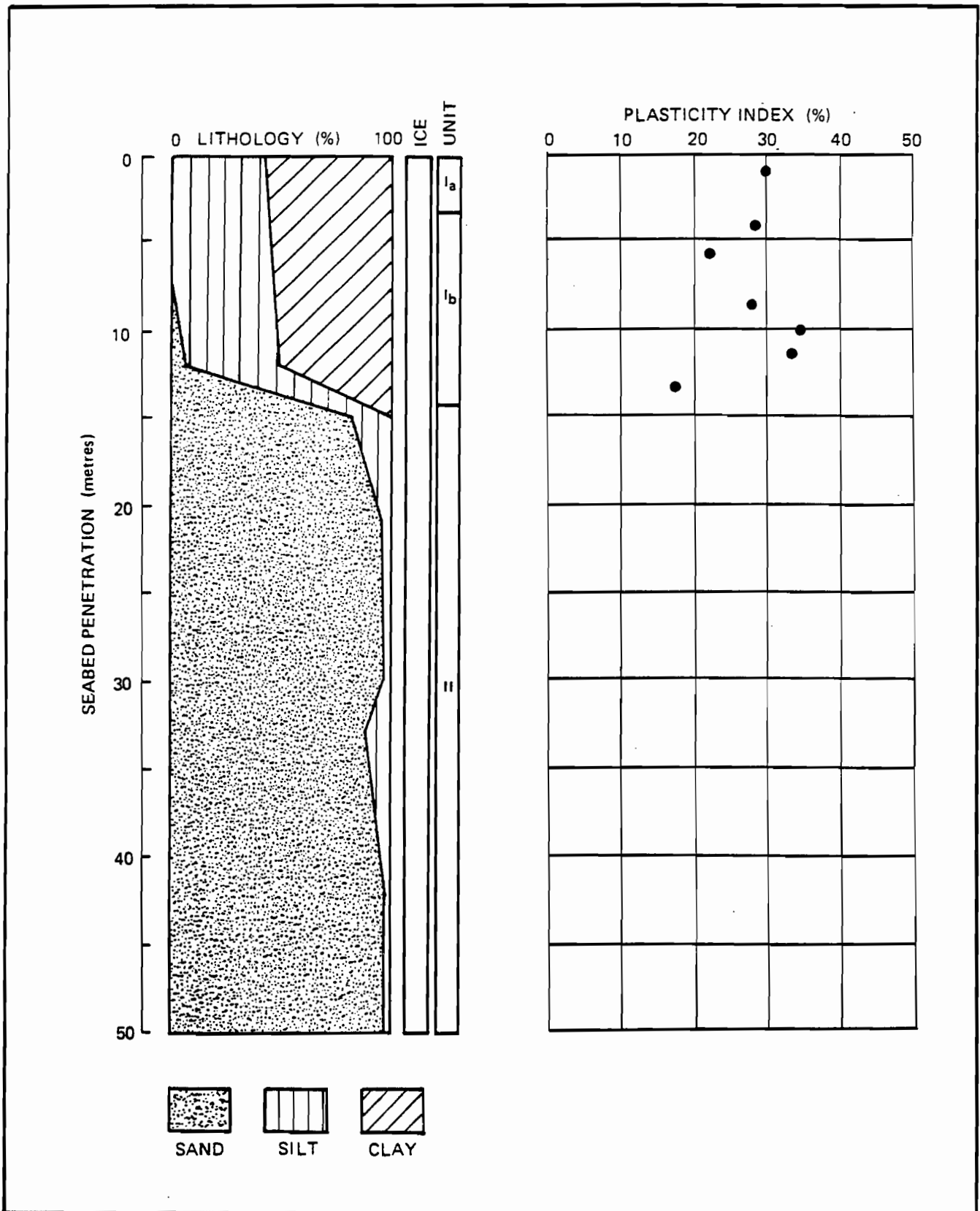


FIGURE C.6 PLASTICITY INDEX PROFILE - AMAULIGAK F-65

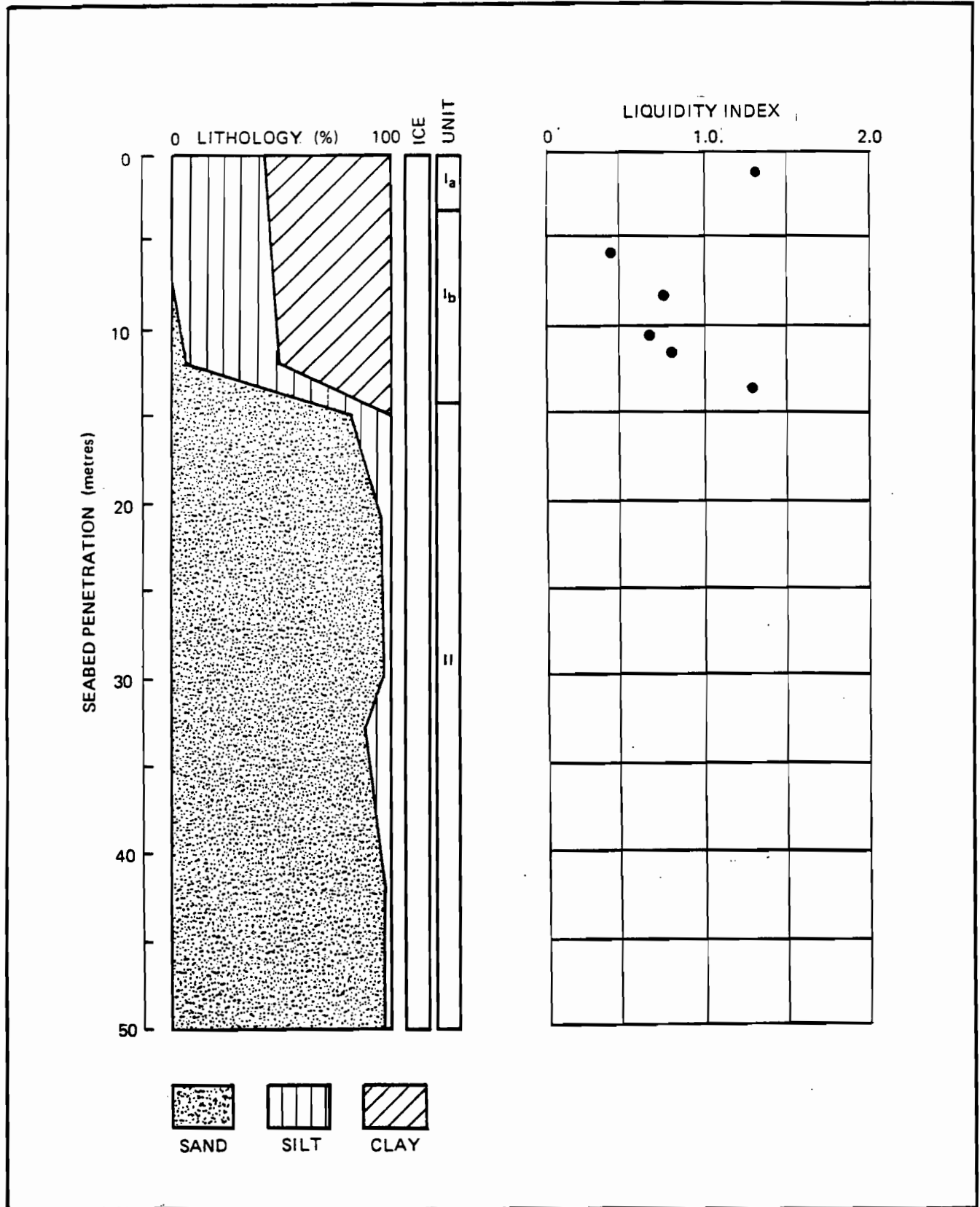


FIGURE C.7 LIQUIDITY INDEX PROFILE -  
 AMAULIGAK F-65

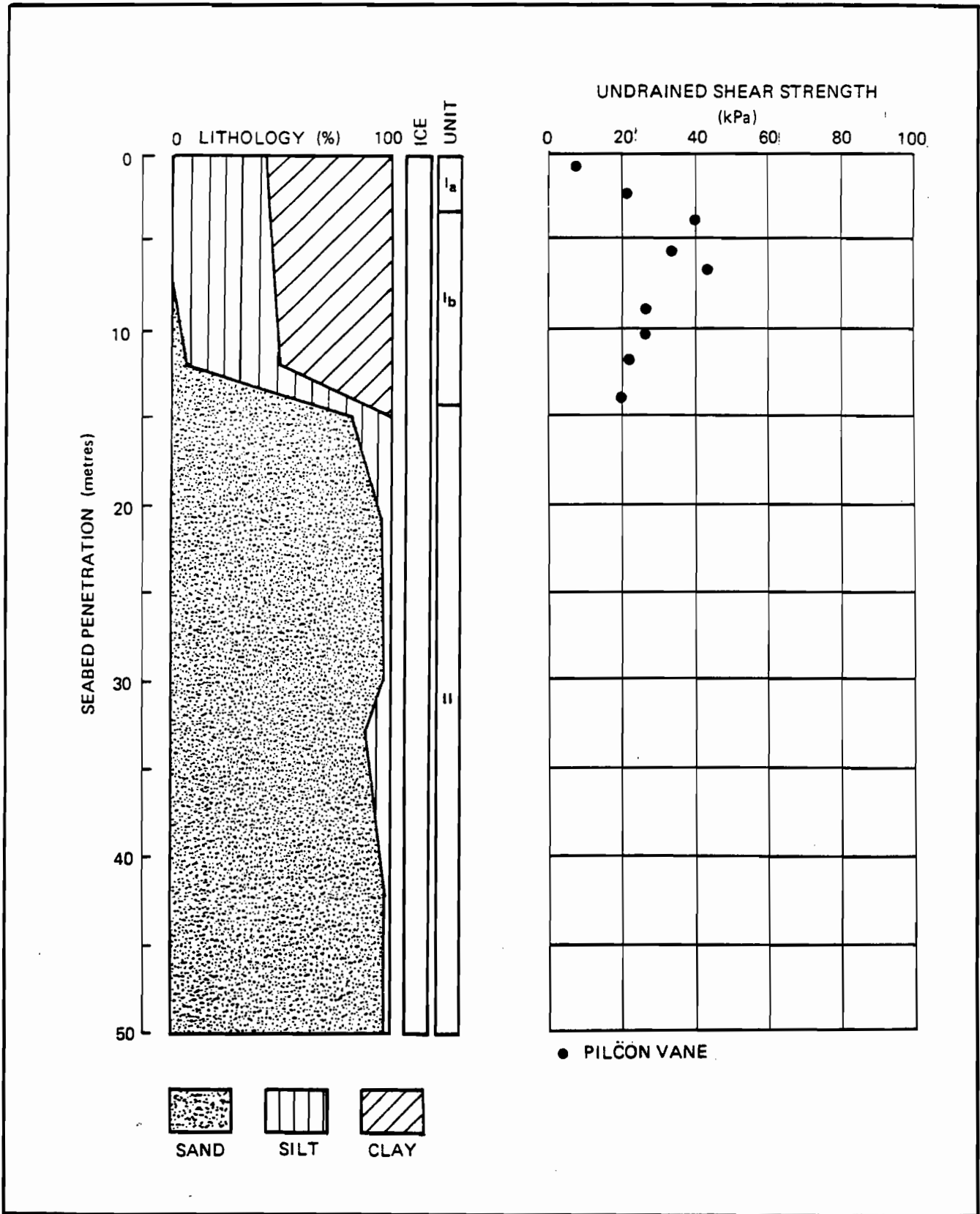


FIGURE C.8    UNDRAINED SHEAR STRENGTH PROFILE - AMAULIGAK F-65

APPENDIX C

SUMMARY OF LABORATORY TESTING

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**SUMMARY OF TEST RESULTS**

Borehole Number		Depth (metres) * Sample Photographed	Unified Soil Classification	Ground for Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm <sup>-3</sup> )	GRAIN SIZE DISTRIBUTION					SHEAR STRENGTH			CONSOLIDATION CHARACTERISTICS			TEST RESULTS TABULATED SEPARATELY			
Sample Number	Type								Liquid Limit (%)	Plastic Limit (%)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D <sub>50</sub> (µm)	T <sub>max</sub>	Shear Strength (kPa)	Failure Strain (%)	Consistency		P <sub>o</sub> (kPa)	P <sub>e</sub> (kPa)	C <sub>c</sub>
8A	T	6.25 - 6.95			-1.00	48								PV	20		Soft						
8B	B	6.25 - 6.95	CH																				S=3.2%
9A	T	7.16 - 7.66																					
9B	B	7.16 - 7.66	CH			46																	
10A	T	8.08 - 8.73																					
10B	B	8.08 - 8.73	CH			48																	
11A	T	9.00 - 9.65			-0.01																		
11B	B	9.00 - 9.65	CH			69																	
12A	T	9.91 - 10.46			-0.79																		
12B	B	9.91 - 10.46	OH & MH			51																	
12C	G	9.91 - 10.46																					
13A	T	10.82 - 11.42																					
13B	B	10.82 - 11.42	CH			44																	
14A	T	11.73 - 12.28			-0.43																		
14B	B	11.73 - 12.28	CH			53																	

**GULF 1984 OFFSHORE GEOTECHNICAL SITE INVESTIGATION**  
**AMAULIGAK A-23 SITE**

**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 : Mixzone  
FC : Fall Cone  
TV : Torvane  
PV : Picon Vane  
RV : Remote Vane

UU : Unconsolidated Undrained Triaxial Pressure Measurements  
CU : Consolidated Undrained Triaxial Pressure Measurements  
CD : Consolidated Drained Triaxial Pressure Measurements

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

Reviewed By: \_\_\_\_\_ P. Eng.

Project Number: **101C-4118**

Page **2** of **5**





AEMAS101		SUMMARY OF TEST RESULTS														TEST RESULTS						
Borehole Number	Sample Number	Depth (metres)	Unified Soil Classification	Ground Ice Description (%)	Temp. (°C)	Moisture Content (%)	Frozen Moisture Content (%)	Bulk Density (Mgm <sup>-3</sup> )	GRAIN SIZE DISTRIBUTION				SHEAR STRENGTH			CONSOLIDATION CHARACTERISTICS						
		*Sample Photographed							Clay (%)	Silt (%)	Sand (%)	Gravel (%)	D <sub>50</sub> (µm)	Test	Shear Strength (kPa)	Failure Strain (%)	Consistency	P <sub>o</sub> (kPa)	P <sub>c</sub> (kPa)	C <sub>c</sub>	TEST RESULTS	
23A	B	29.00 - 29.30	SP			26			--	3	97	--										
24A	B	32.16 - 32.56	CI			33								PV	44		Firm					
25A	B	33.68 - 34.13	CI											PV	70		Stiff					
25B	G	33.68 - 34.13																				
26A	B	35.20 - 35.50	CI			28								PV	88		Stiff					
27A	T	38.25 - 38.60			-0.9																	
27B	B	38.25 - 38.60	CI			31																
28A	T	41.30 - 41.60			-0.6																	
28B	B	41.30 - 41.60	ML & OL			27																
29A	T	44.35 - 44.80			-0.7																	
29B	B	44.35 - 44.80	ML & OL			34								PV	76		Stiff					
30A	T	47.40 - 47.95			-0.1																	
30B	B	47.40 - 47.95	CH			31								PV	76		Stiff					
30C	G	47.40 - 47.95																				

GULF 1984 OFFSHORE GEOTECHNICAL  
SITE INVESTIGATION  
AMAILIGAK A-23 SITE

LEGEND AND NOTES  
 B - Bag Sample  
 G - Gas Sample  
 L - Limer 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 - Pilon Vane  
 RV - Remote Vane  
 UU - Unconsolidated Undrained Triaxial  
 UU<sub>p</sub> - UU Triaxial with Pore Pressure Measurements  
 CU - Consolidated Undrained Triaxial  
 CU<sub>p</sub> - CU Triaxial with Pore Pressure Measurements  
 CD - Consolidated Drained Triaxial  
 O - Organic Content  
 S - Salinity  
 TS - Thaw Strain  
 SG - Specific Gravity







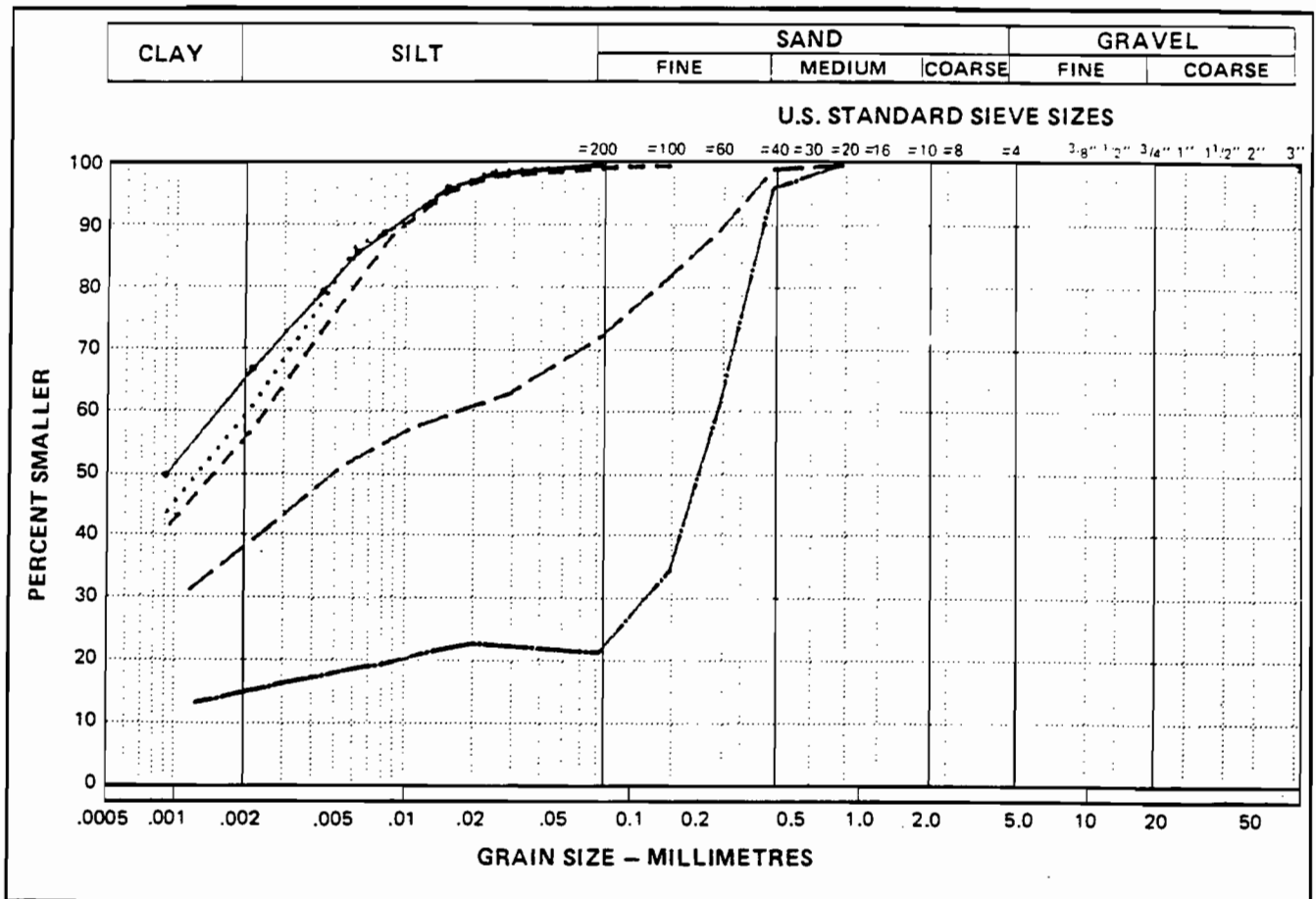


APPENDIX E  
PARTICLE SIZE ANALYSES

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PARTICLE - SIZE ANALYSIS OF SOILS

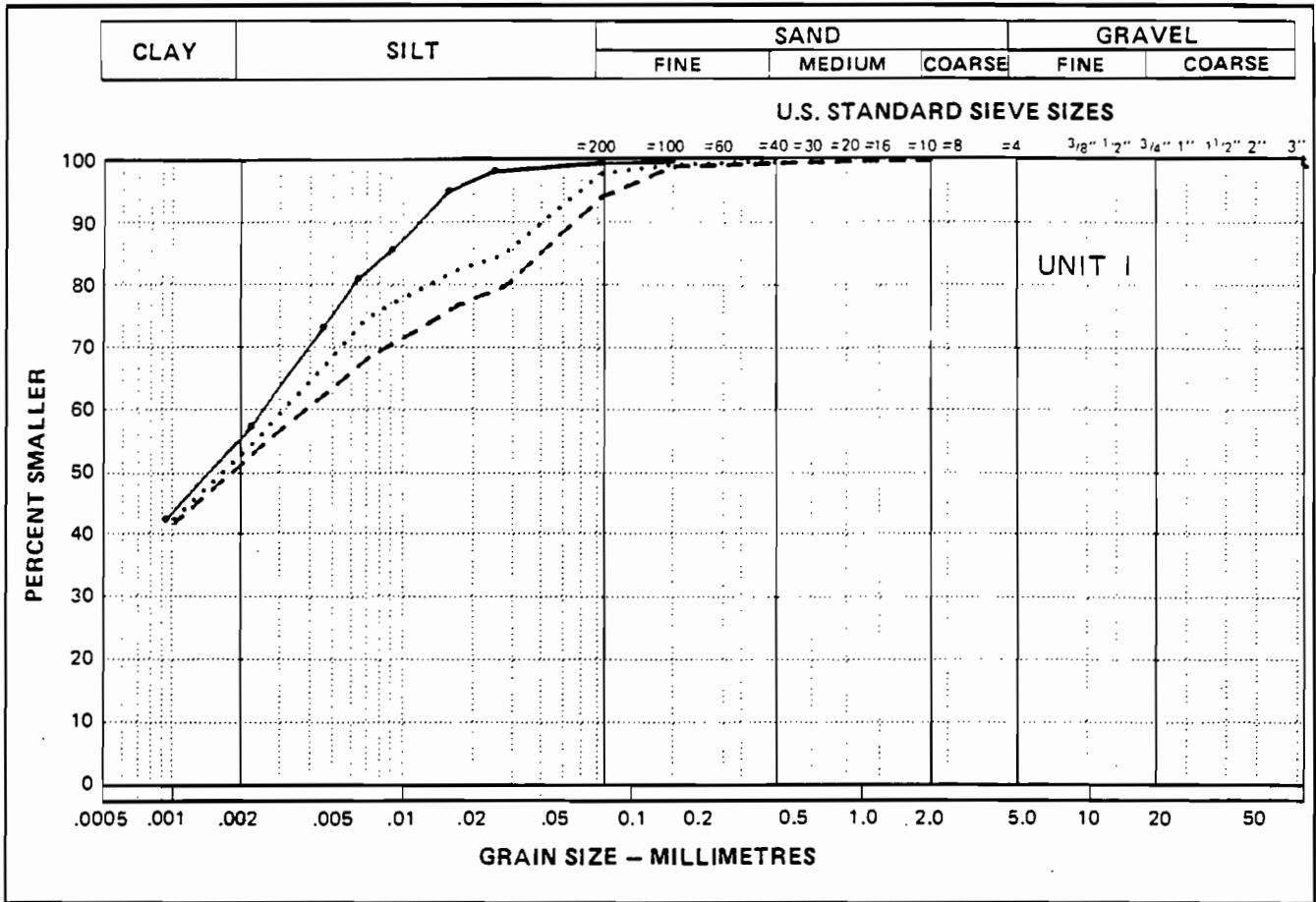


SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	UNIT
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
—	AE84SI01	.76 - 1.31	64.4	35.6	0.0	0.0	-	-	- Ia
.....	AE84SI01	3.51 - 3.81	58.7	41.1	.2	0.0	-	-	- Ia
- - -	AE84SI01	9.91 - 10.46	55.0	44.4	.6	0.0	-	-	- Ib
— —	AE84SI01	13.56 - 13.91	37.6	34.3	28.1	0.0	-	-	- Ib
— — —	AE84SI01	13.91 - 14.26	14.3	6.3	79.4	0.0	-	-	- II

JOB NO. 101 -4118

DATE 84-10-19

**PARTICLE - SIZE ANALYSIS OF SOILS**



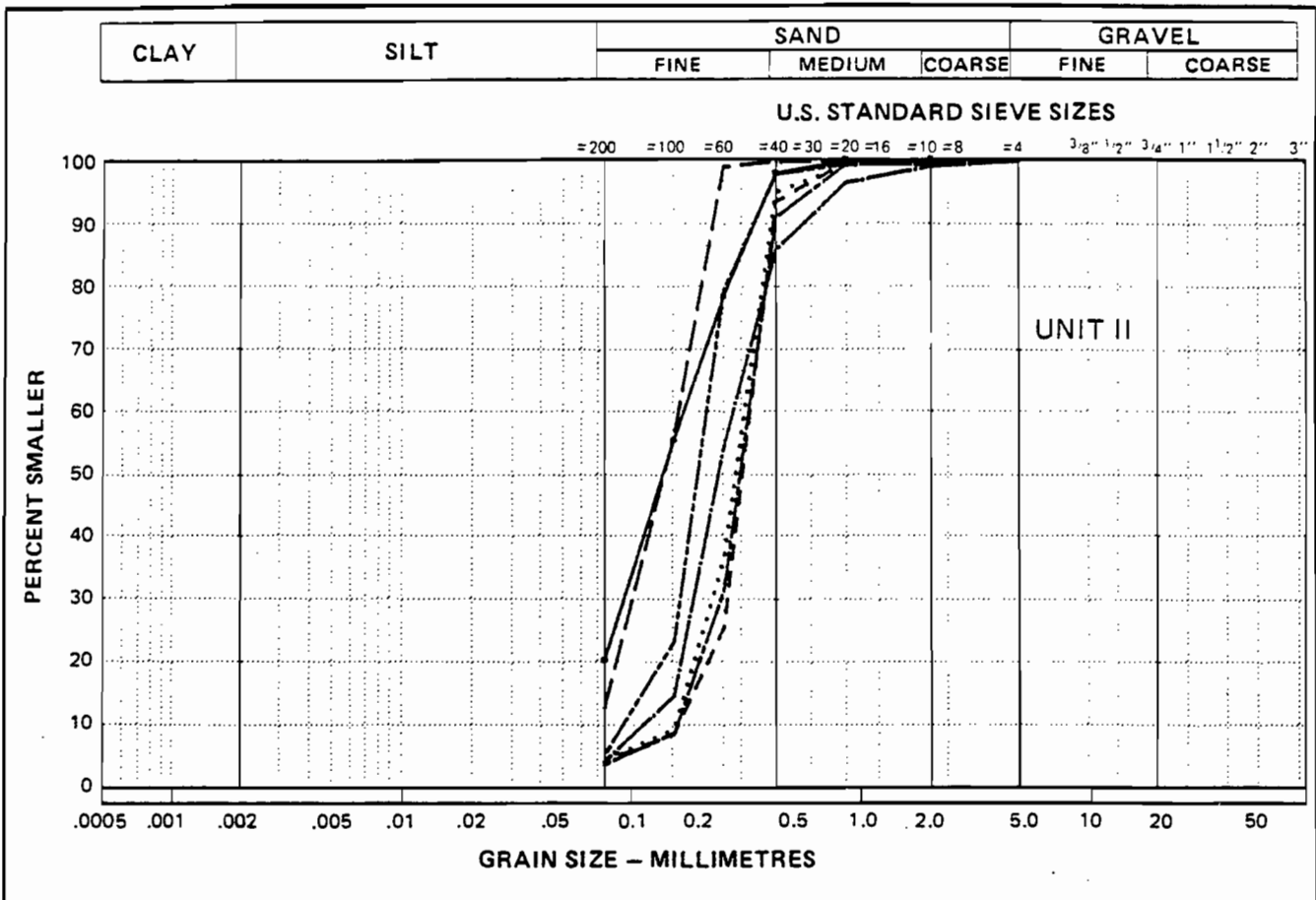
SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
_____	AW84SI01	4.00 - 4.35	55.2	44.6	.2	0.0	-	-	-
.....	AW84SI01	8.50 - 8.90	52.7	45.5	1.8	0.0	-	-	-
---	AW84SI01	11.60 - 11.95	51.1	43.2	5.7	0.0	-	-	-

**JOB NO. 101 -4118**

**DATE 84-10-19**



PARTICLE - SIZE ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (m)	DESCRIPTION				Cu	Cc	U.S.C.
			CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)			
_____	AW84SI01	14.60 - 14.90	-	19.2	80.8	0.0	-	-	-
.....	AW84SI01	20.73 - 21.33	-	3.5	96.5	0.0	2.0	1.0	SP
___	AW84SI01	29.81 - 30.37	-	3.1	96.9	0.0	2.0	1.3	SP
___	AW84SI01	32.91 - 33.40	-	11.5	88.5	0.0	-	-	-
___	AW84SI01	42.06 - 42.46	-	3.0	97.0	0.0	2.3	1.0	SP
___	AW84SI01	45.11 - 45.11	-	2.5	97.5	0.0	2.0	1.2	SP
___	AW84SI01	48.16 - 48.50	-	4.0	96.0	0.0	2.3	1.3	SP

JOB NO. 101 -4118

DATE 84-09-14

APPENDIX D

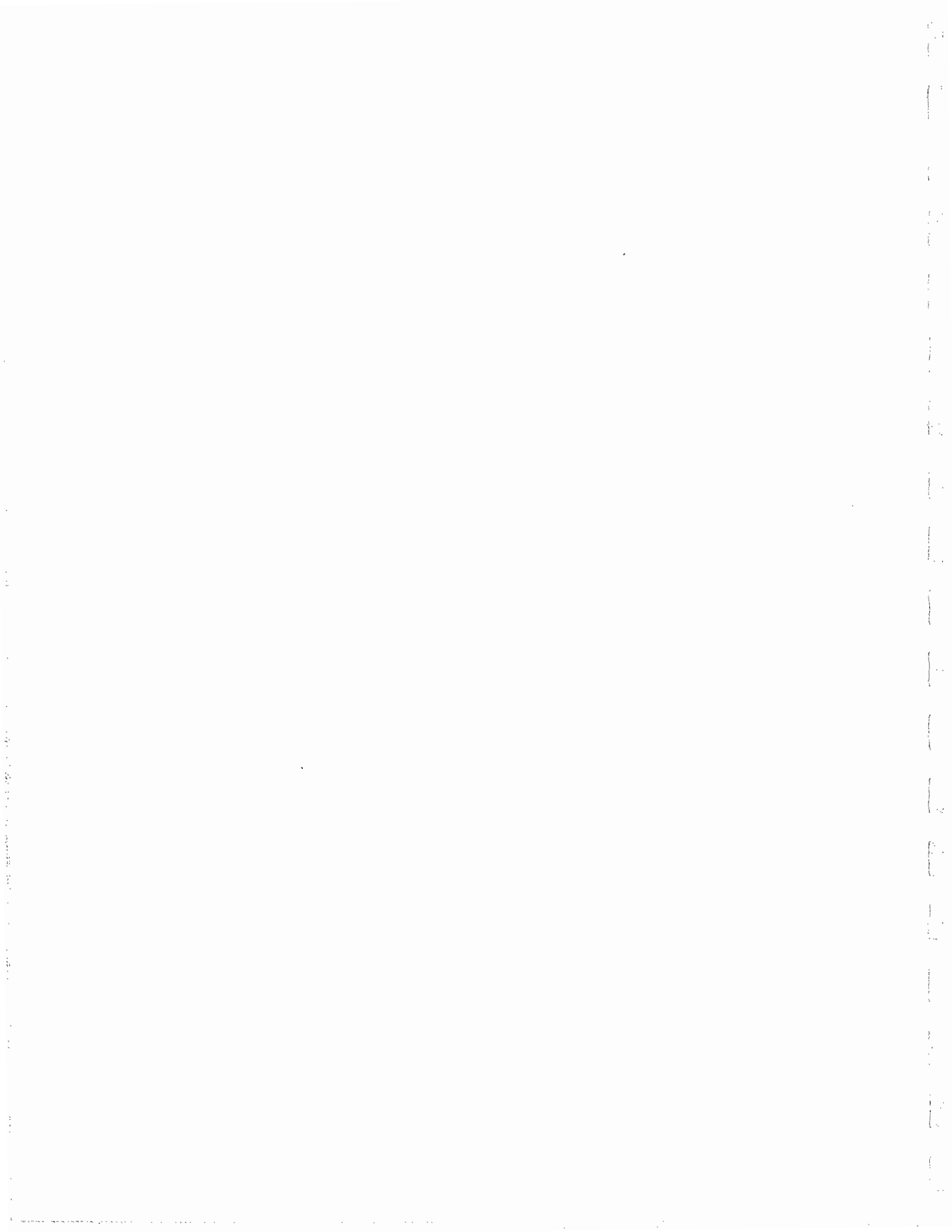
HYDROCARBON GAS ANALYSIS RESULTS

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## ANALYTICAL METHOD

### HYDROCARBON GAS ANALYSES

Sediment samples for hydrocarbon gas analysis were sealed in cans in a brine solution at the drill site. In the laboratory, a volume of brine equivalent to the sediment volume was removed and replaced with helium. The cans were then mechanically agitated for one hour to displace the hydrocarbon gases into the head space. The head space gas was analyzed for methane, ethane, propane, ethylene and propylene. Results are reported as gas volume hydrocarbon component per  $10^6$  volumes of wet sediment (ppm vol/vol). This method of reporting is the same as that used in past reports.





EBA ENGINEERING LTD.  
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EDMONTON, ALTA.  
T5L 2M7

NOV. 8, 1984.

EBAE148-0202-84-1659-2

GULF GAS ANALYSIS

EBA JOB NO.: 101C-4118

<u>BOREHOLE NO.</u>	<u>SAMPLE NO.</u>	<u>INTERVAL (metres)</u>	<u>CONCENTRATION (PPM)</u>				
			<u>METHANE</u>	<u>ETHANE</u>	<u>PROPANE</u>	<u>ETHYLENE</u>	<u>PROPYLENE</u>
AE84SI01	7C	5.33-5.93	N.D.	N.D.	N.D.	N.D.	N.D.
AE84SI01	25B	33.68-34.13	77900	N.D.	N.D.	N.D.	N.D.
AE84SI01	30C	47.4-47.95	63900	10	N.D.	N.D.	N.D.
101C-4082 AW84SI01	7C	10.10-10.55	120	N.D.	N.D.	N.D.	N.D.



APPENDIX E  
IN SITU TESTING

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APPENDIX G  
GLOSSARY OF EQUATIONS USED IN CONE PENETRATION  
TEST INTERPRETATION

G.1 Undrained Shear Strength

$$q_c = N_c C_u + \sigma$$

where:  $q_c$  = instantaneous cone tip resistance (MPa)

$C_u$  = undrained shear strength of the material (MPa)

$N_c$  = a cone bearing capacity factor based on site-specific correlation between the cone and an in situ measurement of undrained shear strength, usually a vane shear apparatus.

and,  $\sigma$  = a representation of total vertical in situ stress (MPa). This factor, for ease of calculation has been calculated by

$$\sigma = \gamma z$$

where:  $\gamma = 18 \text{ KN/m}^3$  (estimated "average" density for overlying soil)

and,  $z$  = depth of data point below seabed (m)

N.B. the effect of the overlying water column is ignored as the cone tip resistance is zeroed at seabed. This analysis will be ignored if the soil is likely to drain upon shear. The soil is classified in two ways for this purpose; if a mantle sleeve friction value is available, a friction ratio is calculated and compared with the instantaneous point resistance by the method suggested by Schmertmann (1977). Values falling outside those suggested for

pure clays are ignored. If pore pressure values are available soils exhibiting marked dilatant behavior are ignored for calculation purposes. As no concensus of opinion exists at present in the literature for a suitable classification system, pore pressure values less than 20% of hydrostatic pressure at the level in question are ignored.

F.2 Dynamic Pore Pressure Ratio

$$DPPR = \frac{q_c - p_o}{q_c - \sigma_v}$$

where: DPPR = dynamic pore pressure ratio (after Jefferies and Funegard, 1983)

$q_c$  = instantaneous cone tip resistance (MPa)

$p_o$  = hydrostatic pore pressure calculated at that level (MPa)

$$p_o = \gamma_w (z_w + z)$$

where:  $\gamma_w$  = density of water (9.81 KN/m<sup>3</sup>)

$z_w$  = depth of water at the site (metres)

and,  $z$  = depth below seabed (metres)

and,  $\sigma_v$  = the total vertical in situ stress (MPa). This factor, for ease of calculation, has been calculated by

$$\sigma_v = \gamma z + z_w \gamma_w$$

where:  $\gamma = 18 \text{ KN/m}^3$  = estimated "average" density for overlying soil

and,  $z$ ,  $z_w$  and  $\gamma_w$  are as above.

### G.3 Relative Density

The relative density of the soil is calculated from an algorithm based on the data provided by Baldi et al., (1979). Three solutions exist for the calculation of relative density. For the depths between 5 and 20 metres below seabed the calculation uses a linear function for the formula:

$$\text{Relative Density} = \frac{20q_c + 24 \sigma_v^2 - 54 \sigma_v + 71}{0.1 \sigma_v'^2 + 1.9 \sigma_v + 2.025}$$

where:  $q_c$  = instantaneous cone tip resistance (MPa)

and,  $\sigma_v$  = effective vertical stress at that level, calculated from:  $v = \gamma'z$

where:  $\gamma' = 10 \text{ KN/m}^3$  ("effective" density of overlying soil)

and,  $z$  = depth below seabed of that level (metres)

If this value of relative density is greater than 65% the parameter is recalculated using:

$$\text{Relative Density} = \frac{20q_c - 244 \sigma'_v{}^2 + 590 \sigma'_v + 94}{11 \sigma'_v - 3.6 \sigma'_v{}^2 + 2.6}$$

For depths less than 5 metres below seabed and for depths greater than 20 metres below seabed the function is fitted better by a power function. For 0 to 5 metres, the formula used is:

$$\text{Relative Density} = \frac{87.0 q_c}{\sigma'_v \exp 0.7} + 22.6$$

If the value of relative density is greater than 65%, the formula used is;

$$\text{Relative Density} = \frac{24.7 q_c}{\sigma'_v \exp 0.6} + 49.1$$

For the case of soil depths greater than 20 metres, the formula used is;

$$\text{Relative Density} = \frac{69.9 q_c}{\sigma'_v \exp 0.59} + 9.44$$



If the value of relative density is greater than 65% the formula used is;

$$\text{Relative Density} = \frac{45.0 q_c}{\sigma'_v \exp 0.59} + 29.2$$

This analysis will be ignored if the soil is not sand. The soil is classified in two ways for this purpose; if a mantle sleeve friction value is available, a friction ratio is calculated and compared with the instantaneous point resistance by the method suggested by Schmertmann (1977). Values falling outside those for SP sands are ignored. If pore pressure values are available, soils exhibiting dilatancy are ignored.

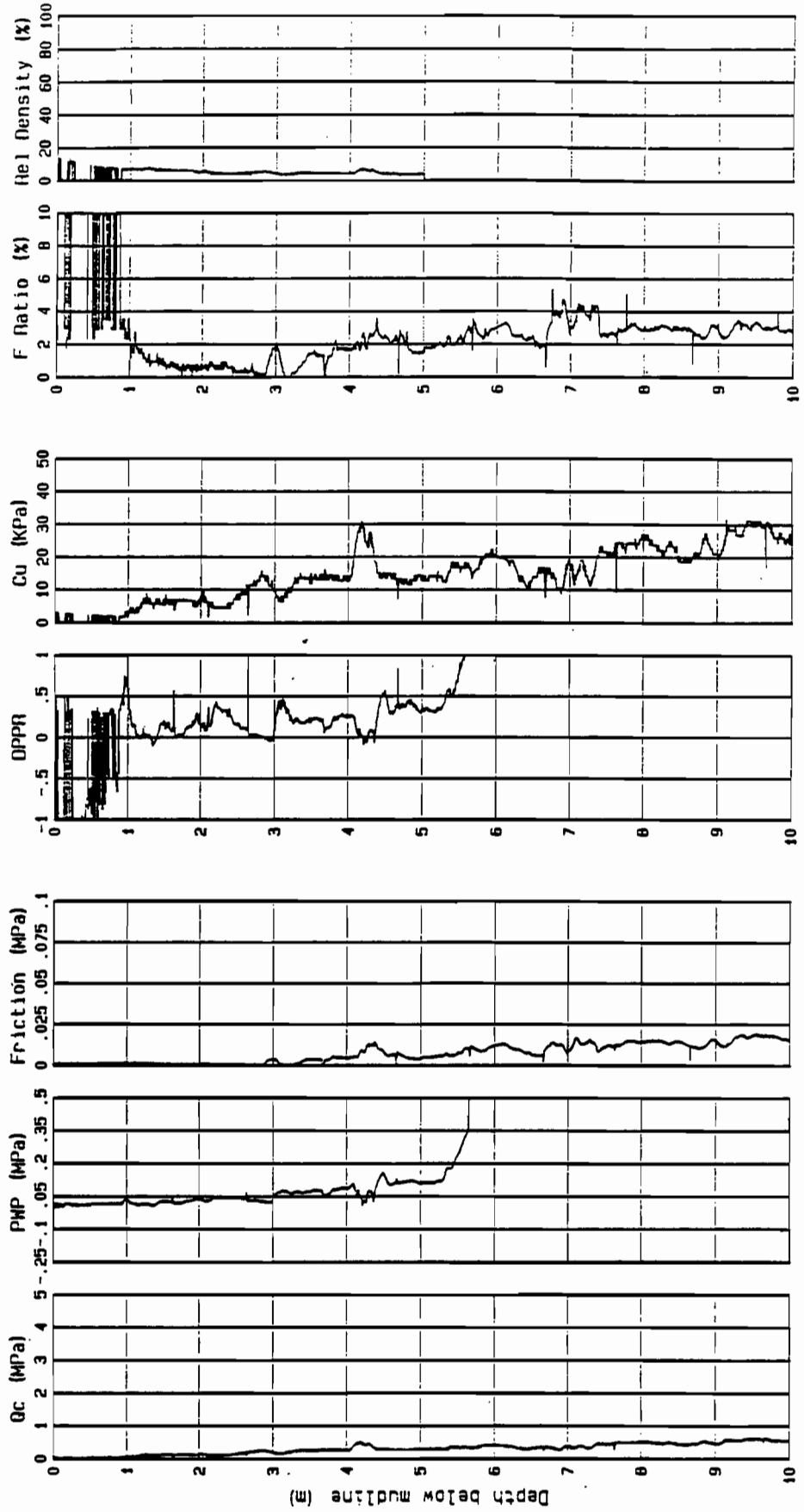
# GULF CANADA RESOURCES INC

Location: AMAULIGAK EAST

Water depth (m) : 29.4

CPT : AE84C101

PAGE 1 of 2

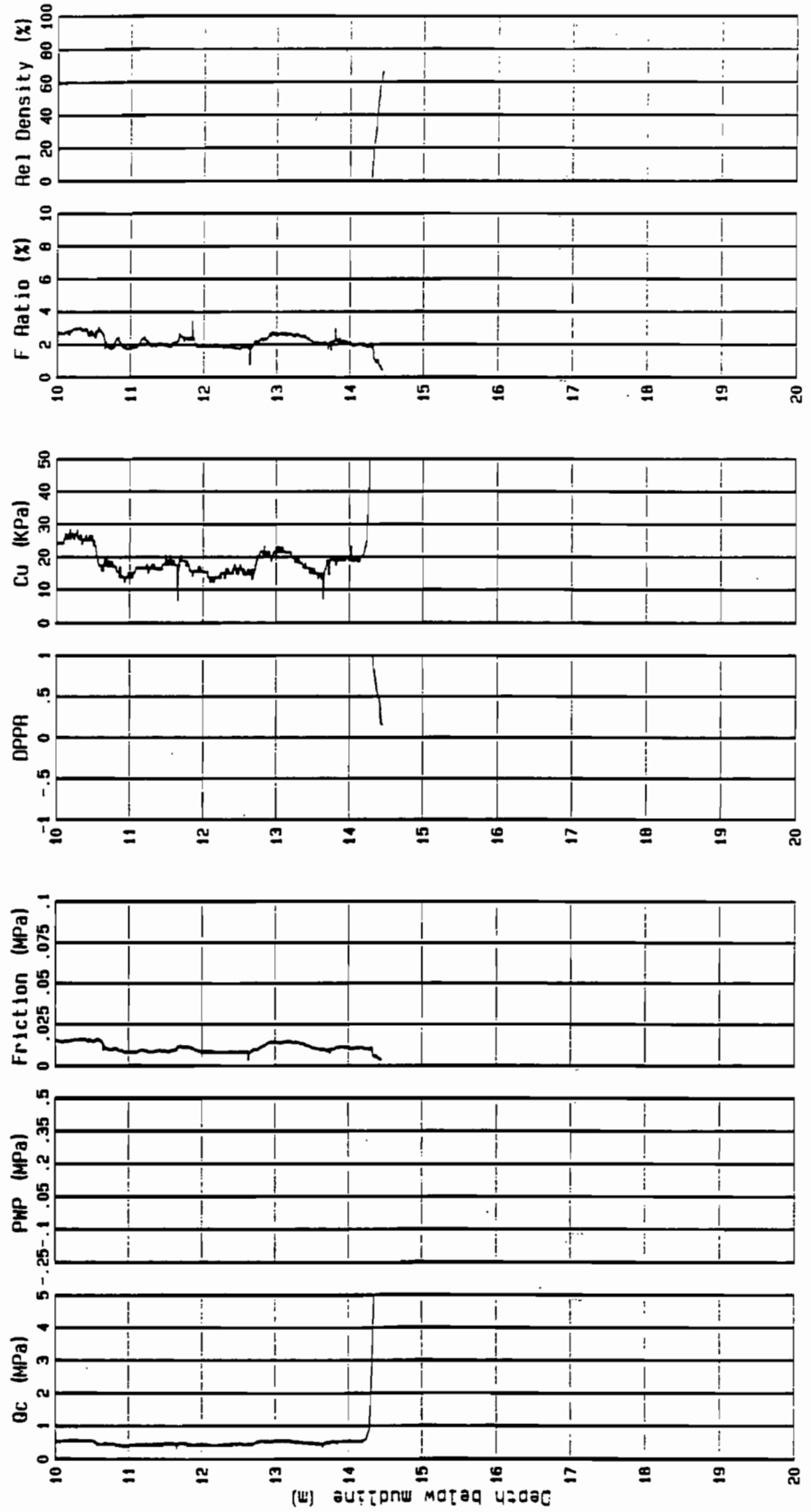


# GULF CANADA RESOURCES INC

Location: AMAULIGAK EAST  
Water depth (m) : 29.4

CPT : AEB4C101

PAGE 2 of 2



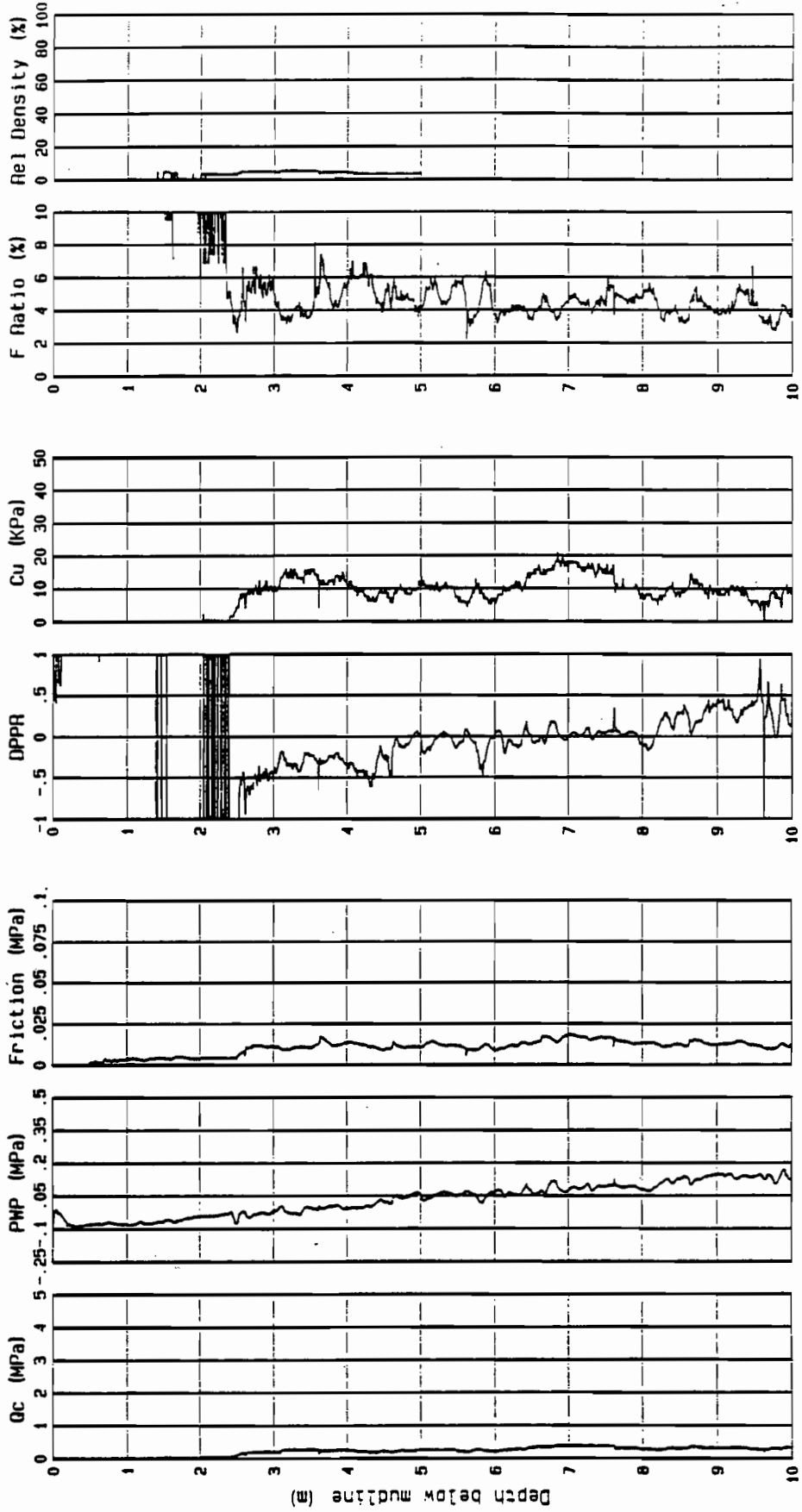
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (EAST)

CPT : AE84C102

PAGE 1 of 2

Water depth (m) : 30.7



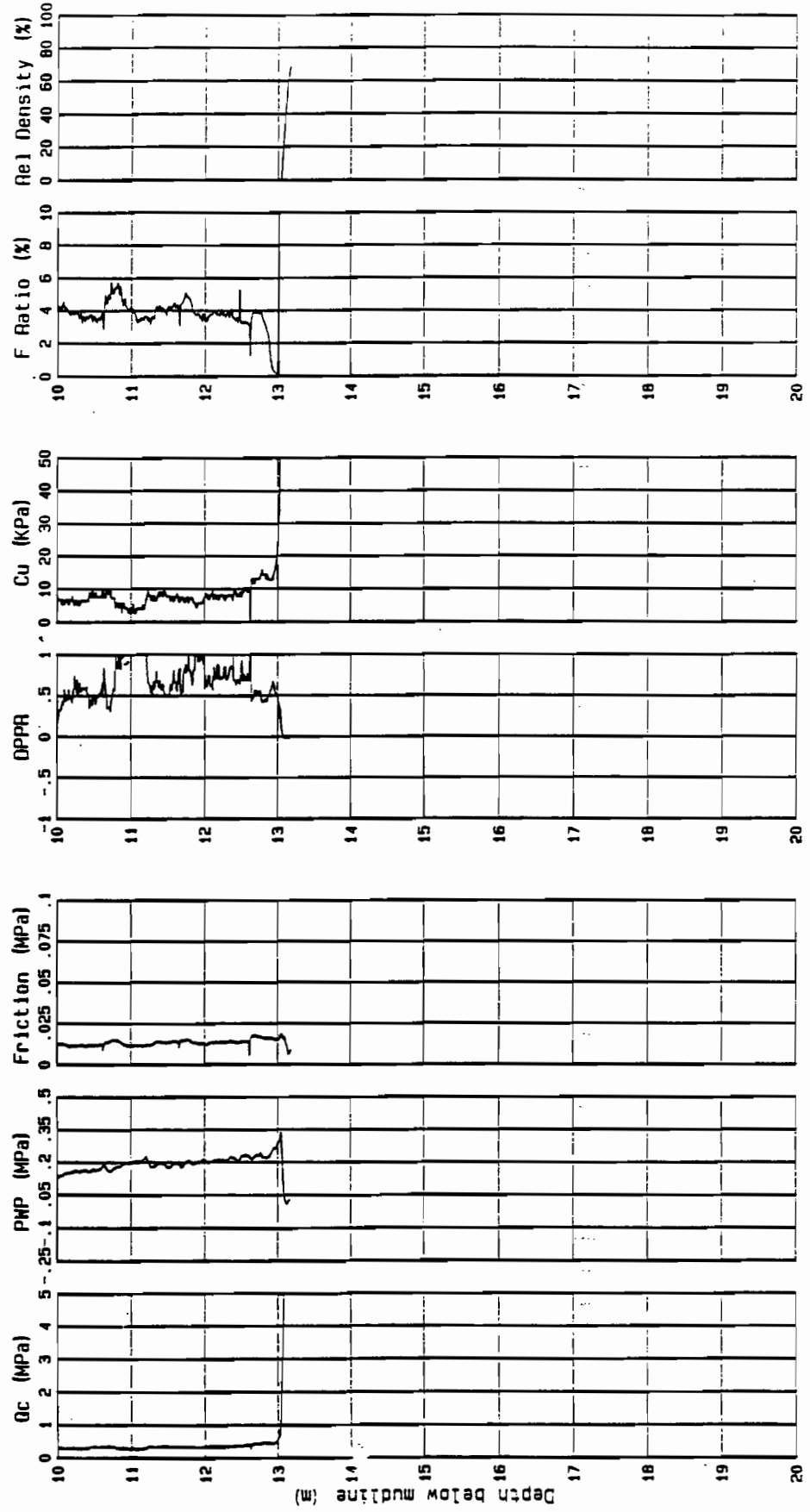
# GULF CANADA RESOURCES INC

Location: ANAULIGAK (EAST)

Water depth (m) : 30.7

CPT : AEB4CI02

PAGE 2 of 2

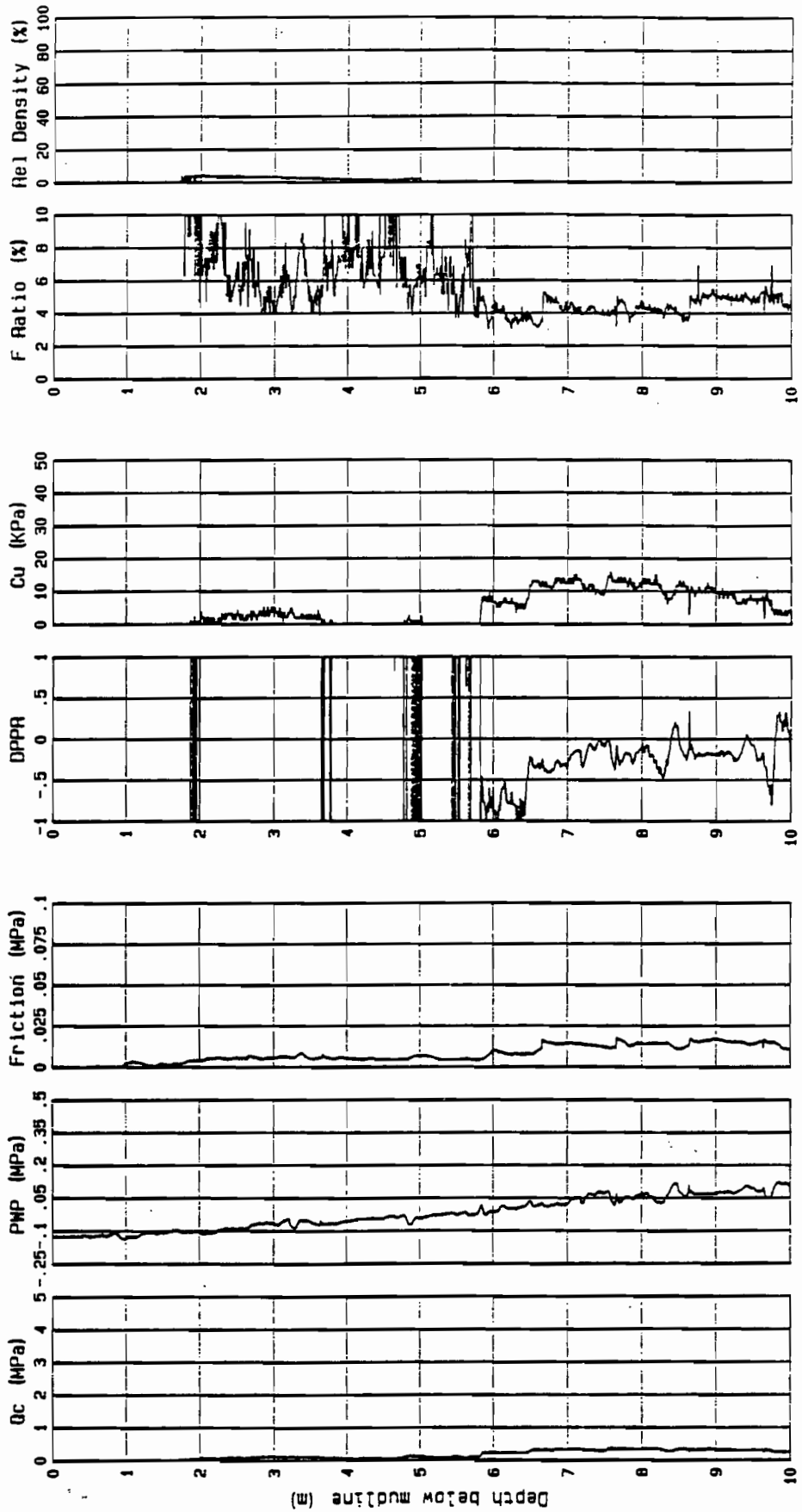


# GULF CANADA RESOURCES INC

Location: AMAULIGAK EAST  
Water depth (m) : 29.2

CPT : AEB4CI03

PAGE 1 of 2



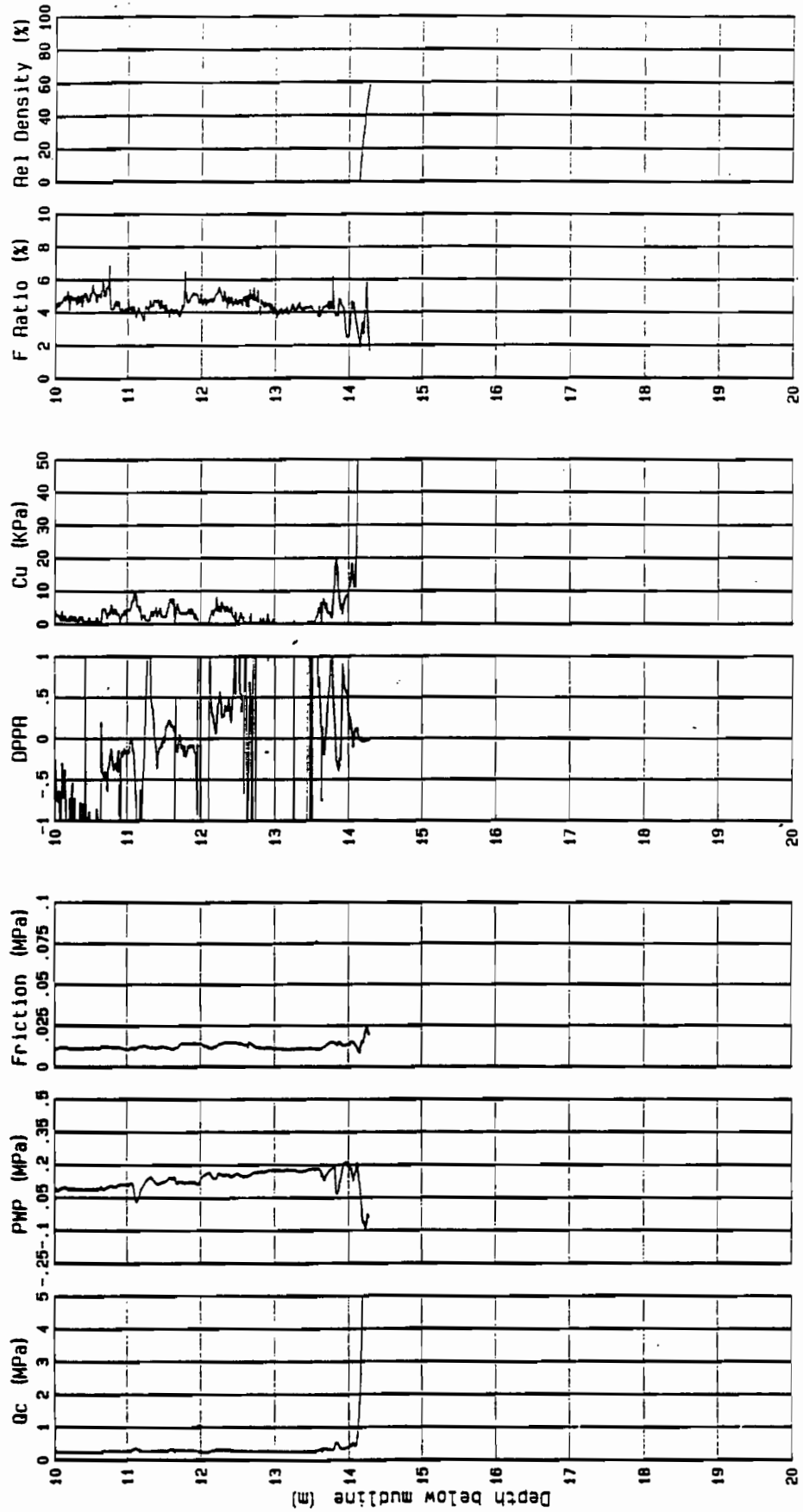
# GULF CANADA RESOURCES INC

Location: AMAULIGAK EAST

Water depth (m) : 29.2

CPT : AEB4C103

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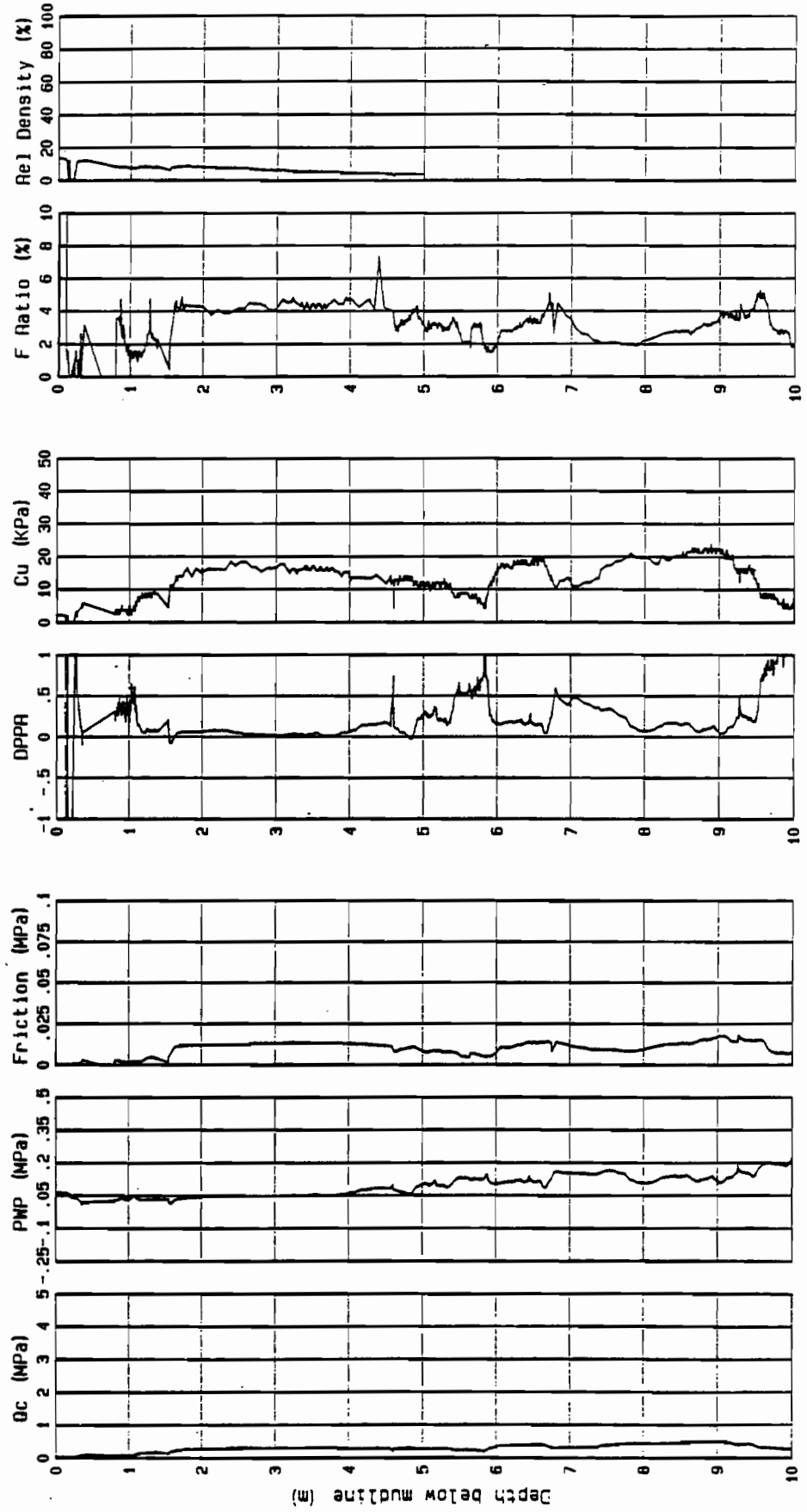
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (EAST)

Water depth (m) : 30.5

CPT : AE84CI04

PAGE 1 of 2





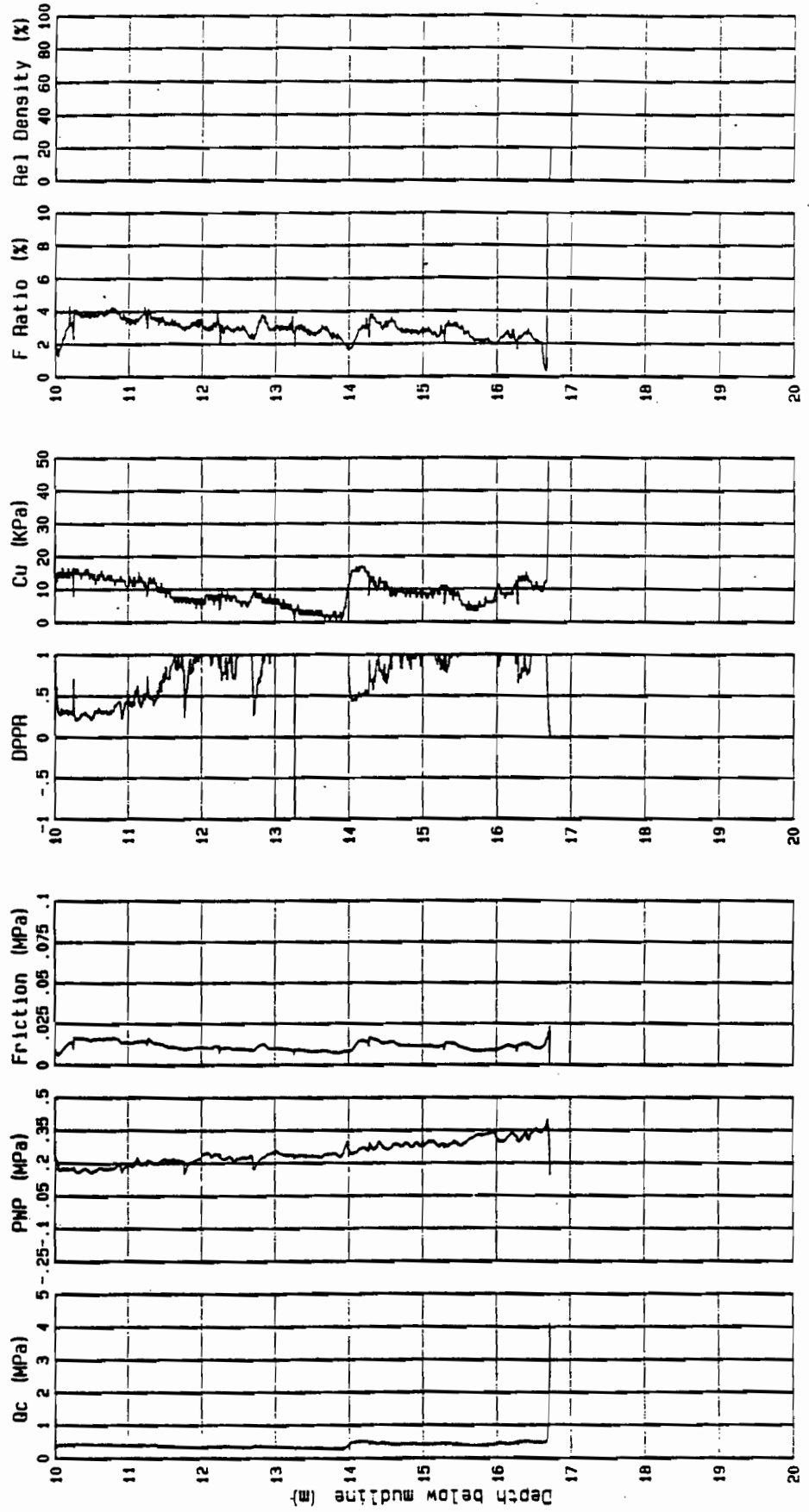
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (EAST)

Water depth (m) : 30.5

CPT : AEB4CI04

PAGE 2 of 2

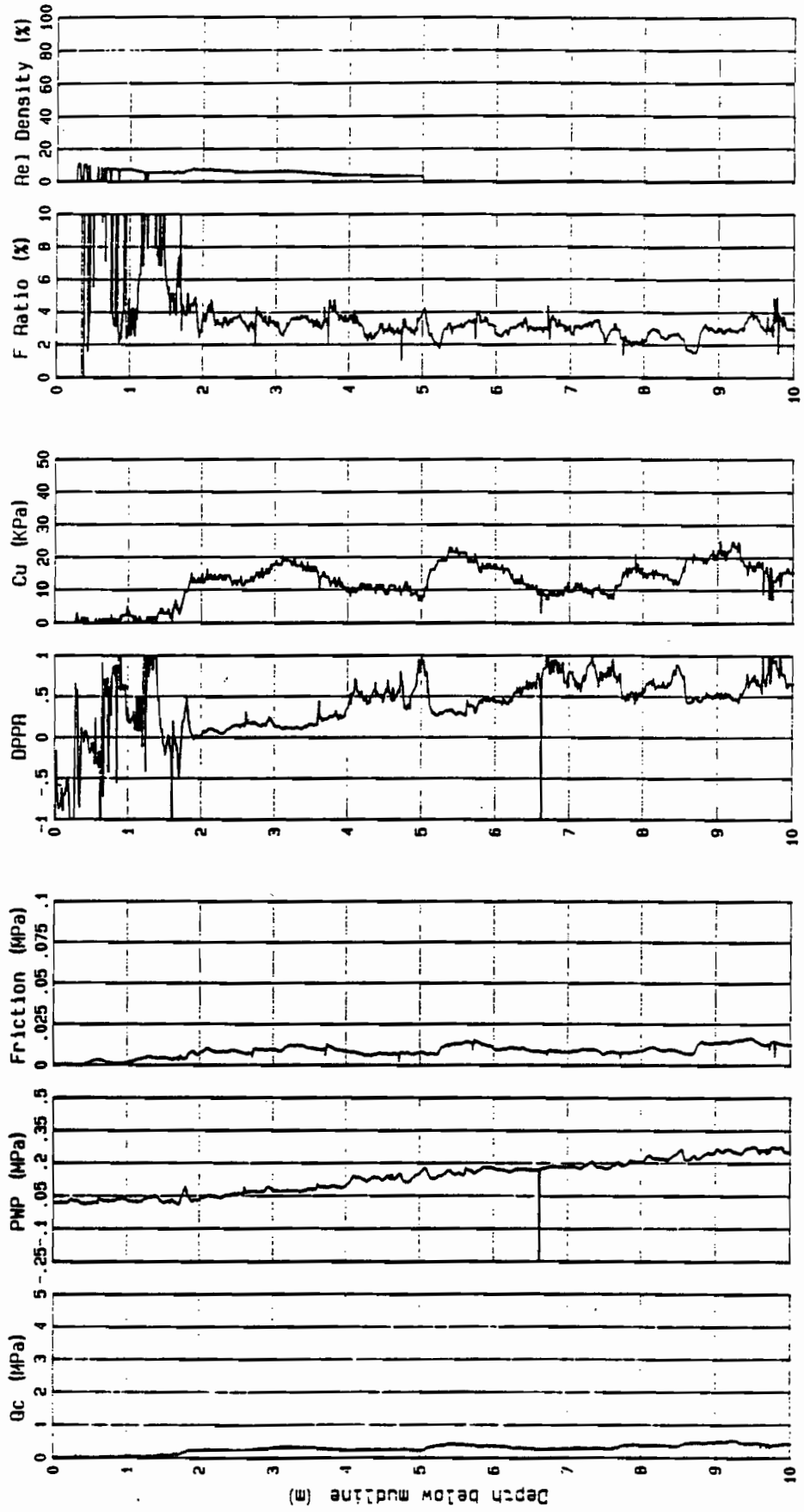


# GULF CANADA RESOURCES INC

Location: AMALIGAK EAST  
Water depth (m) : 30.7

CPT : AEB4CI05

PAGE 1 of 2

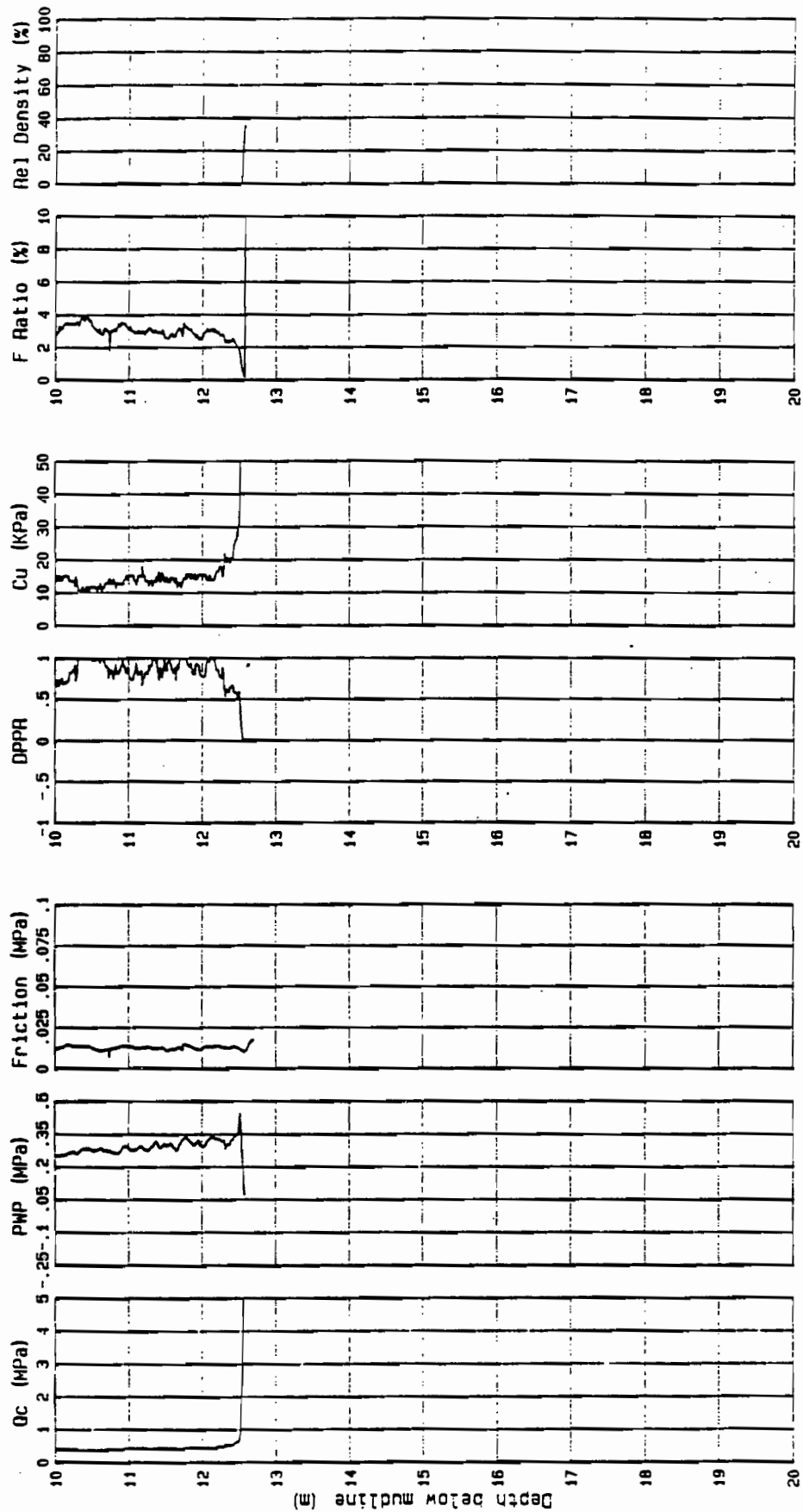


# GULF CANADA RESOURCES INC

Location: AMAULIGAK EAST  
Water depth (m) : 30.7

CPT : AEB4CI05

PAGE 2 of 2



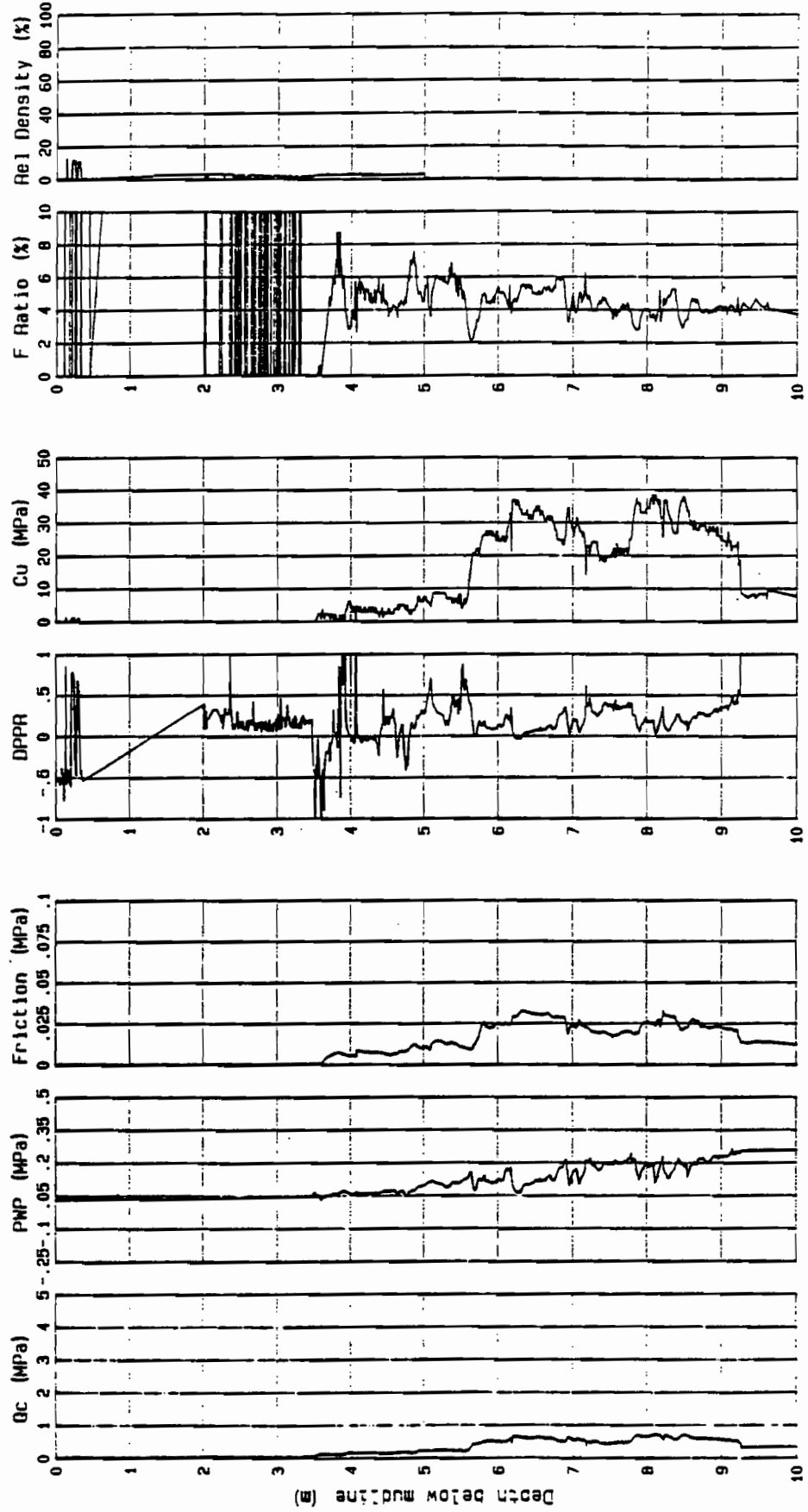
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Location: AMAULIGAK (NEST)

Water depth (m) : 30.7

CPT : AMB4CI01

PAGE 1 of 2



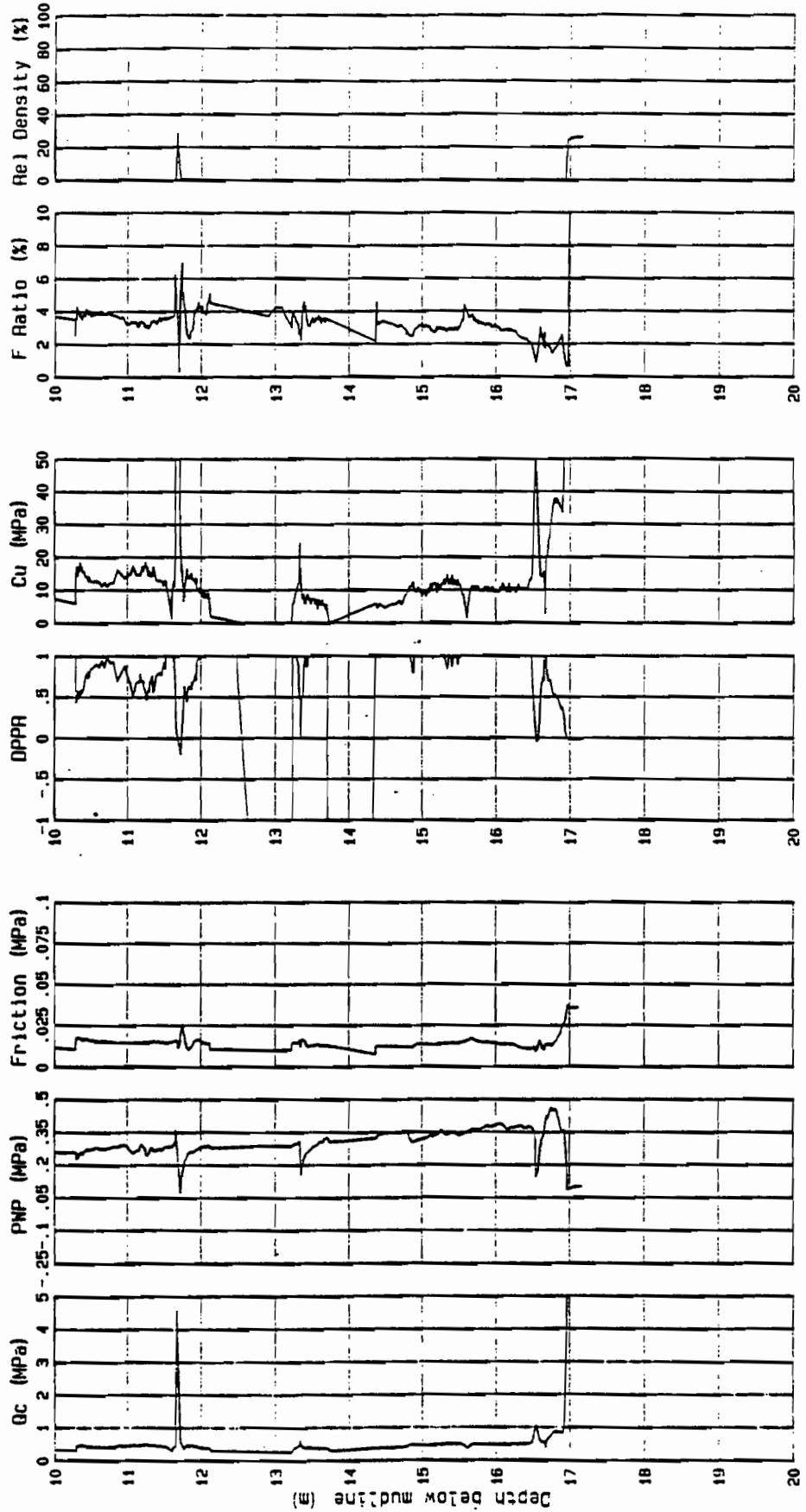
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (WEST)

Water depth (m) : 30.7

CPT : AMB4C101

PAGE 2 of 2

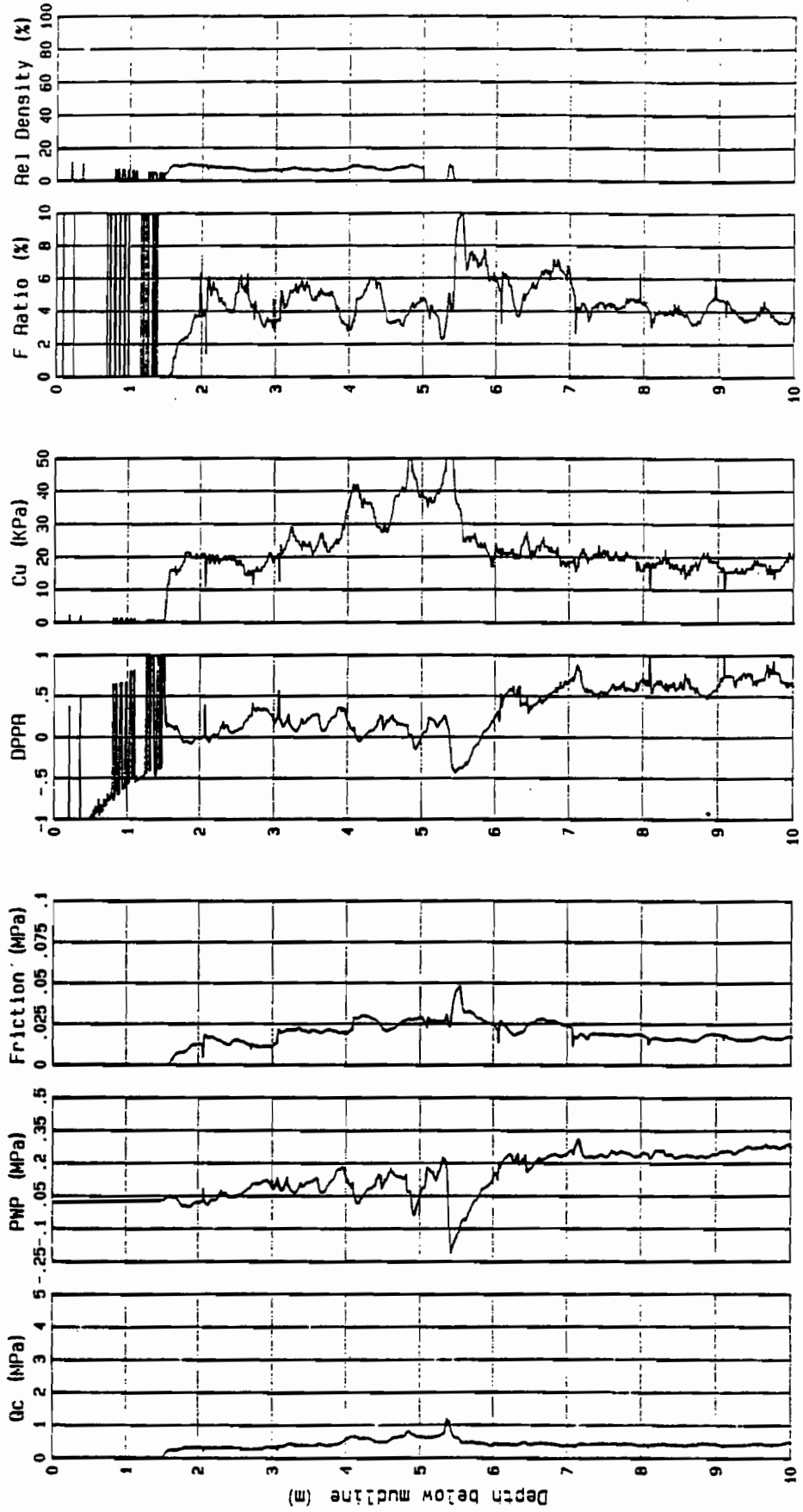


# GULF CANADA RESOURCES INC

Location: ANAULIGAK (WEST)  
Water depth (m) : 31.4

CPT : ANB4CI02

PAGE 1 of 2



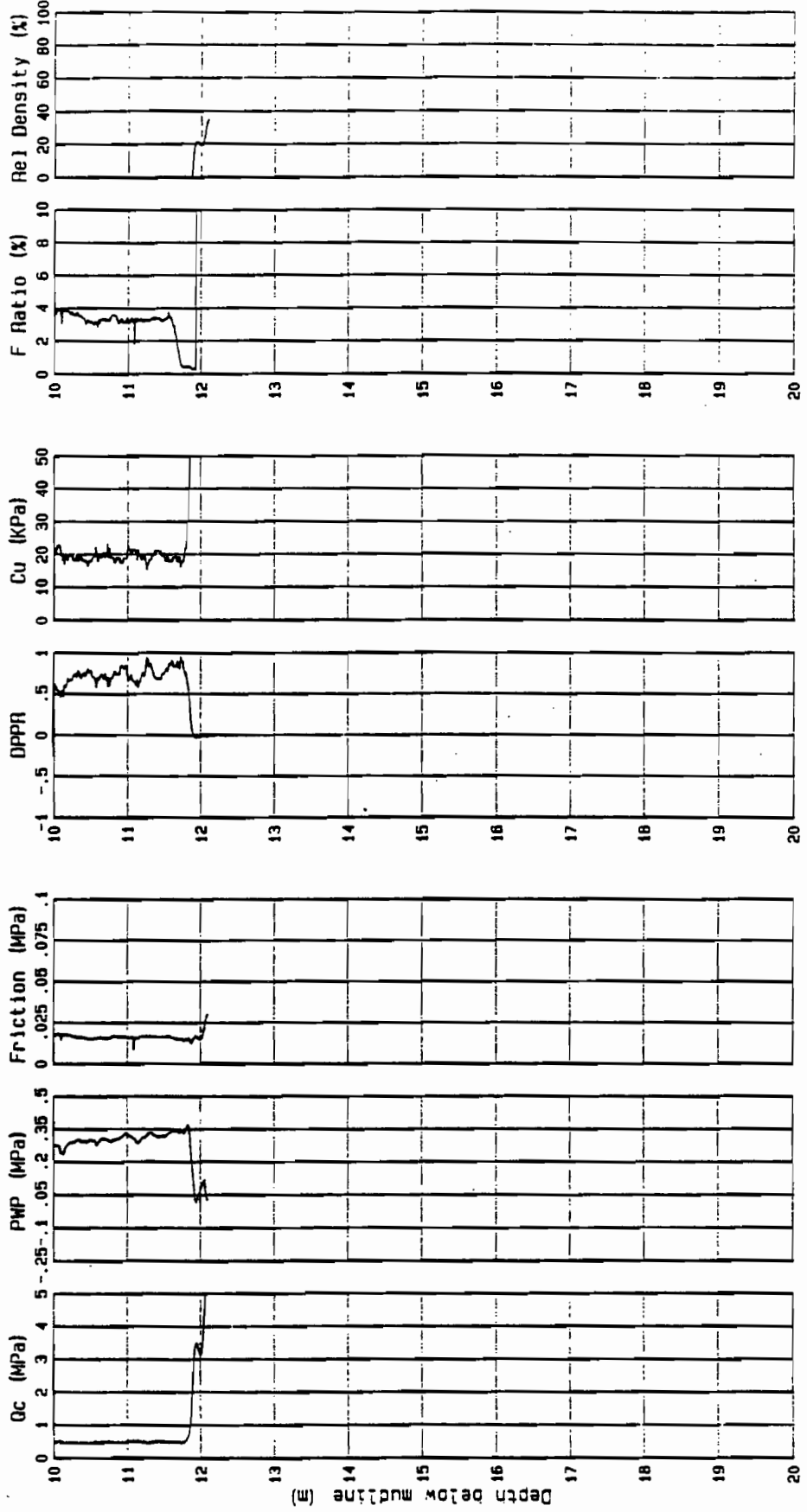
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (WEST)

Water depth (m) : 31.4

CPT : AMB4C102

PAGE 2 of 2



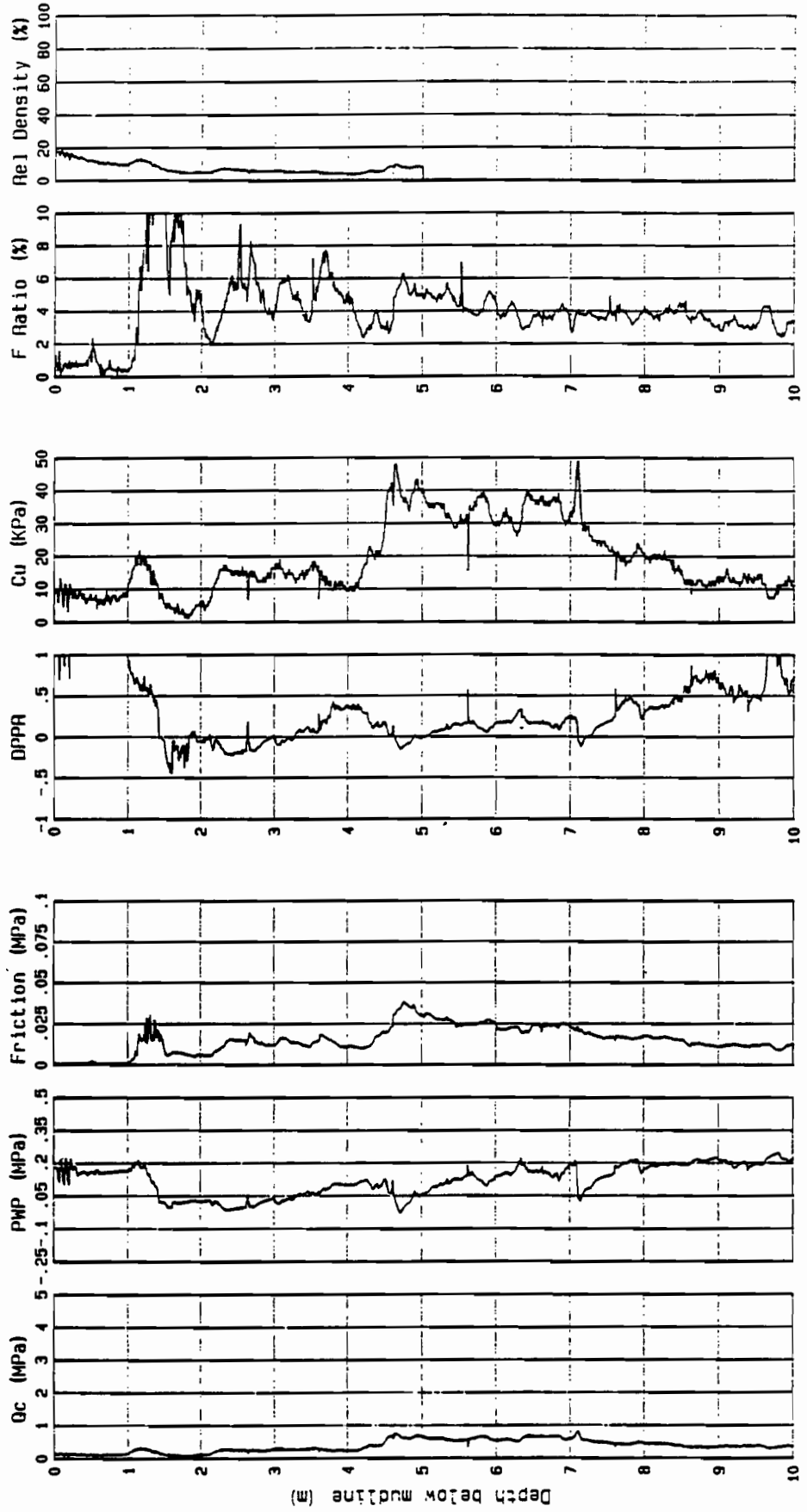
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (WEST)

CPT : ANB4CI03

PAGE 1 of 2

Water depth (m) : 30.8





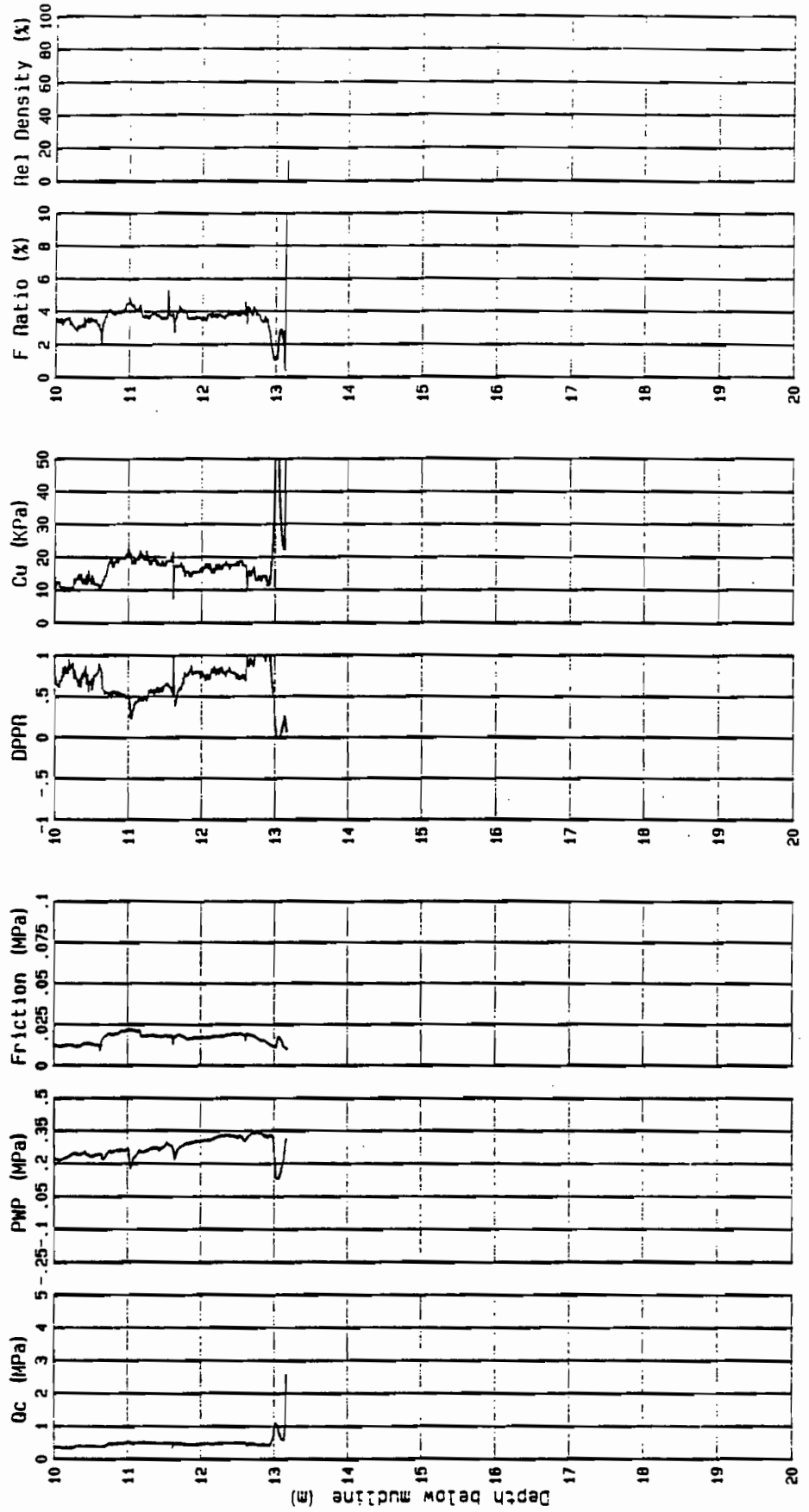
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (WEST)

Water depth (m) : 30.8

CPT : AMB4CI03

PAGE 2 of 2



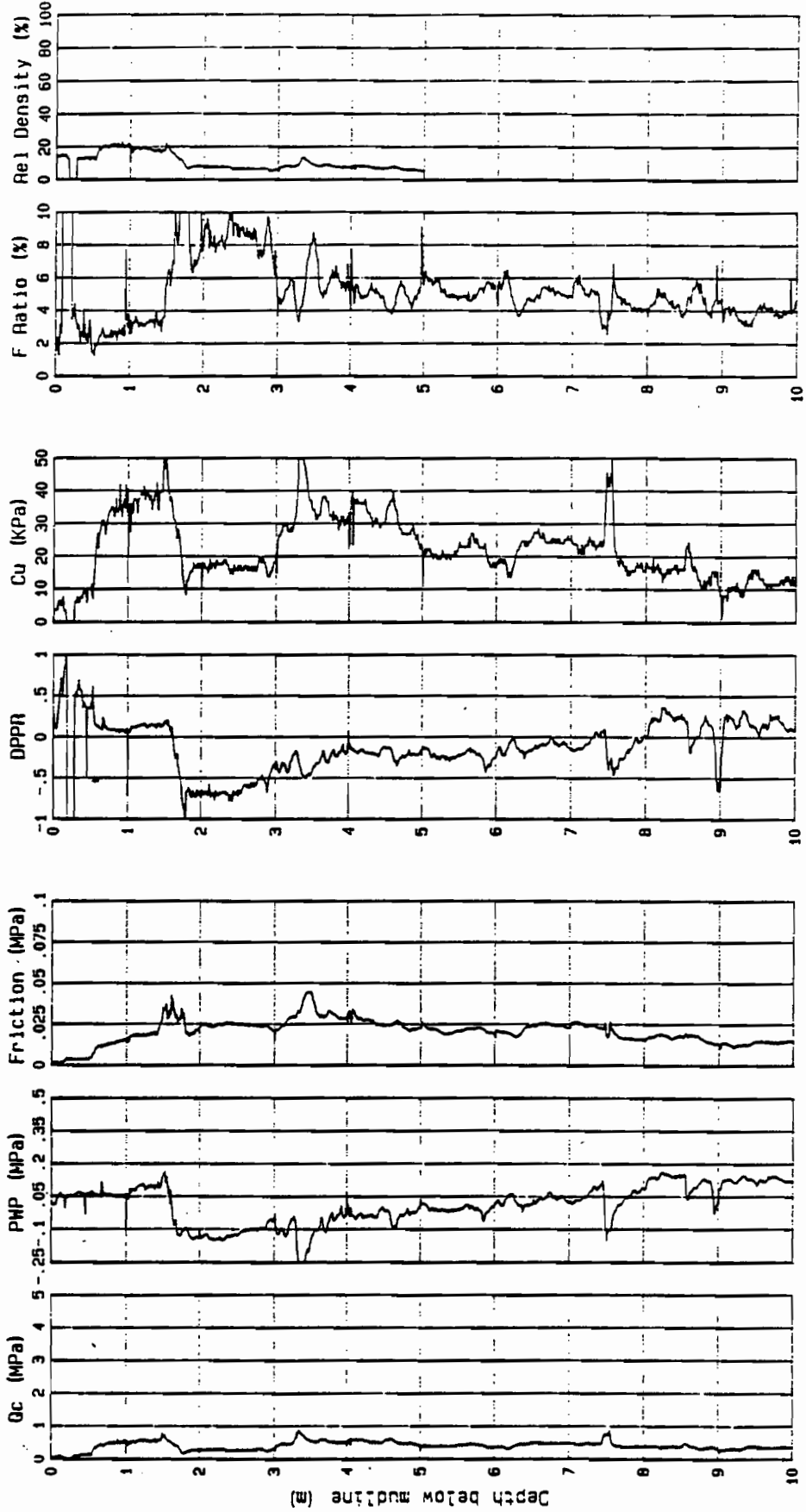
# GULF CANADA RESOURCES INC

Location: AMAULIGAK (WEST)

CPT : AM84CI04

PAGE 1 of 2

Water depth (m) : 31.8



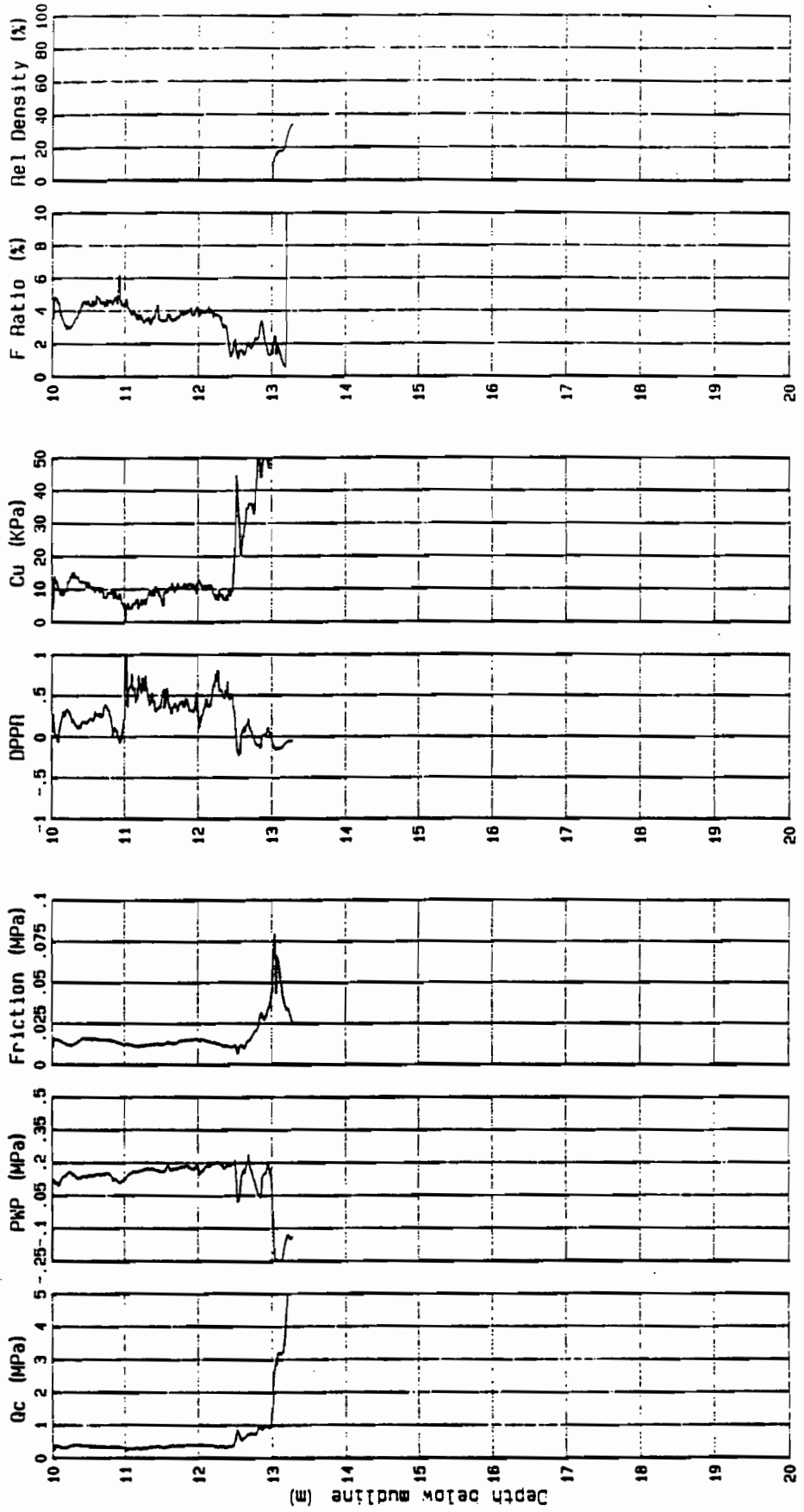
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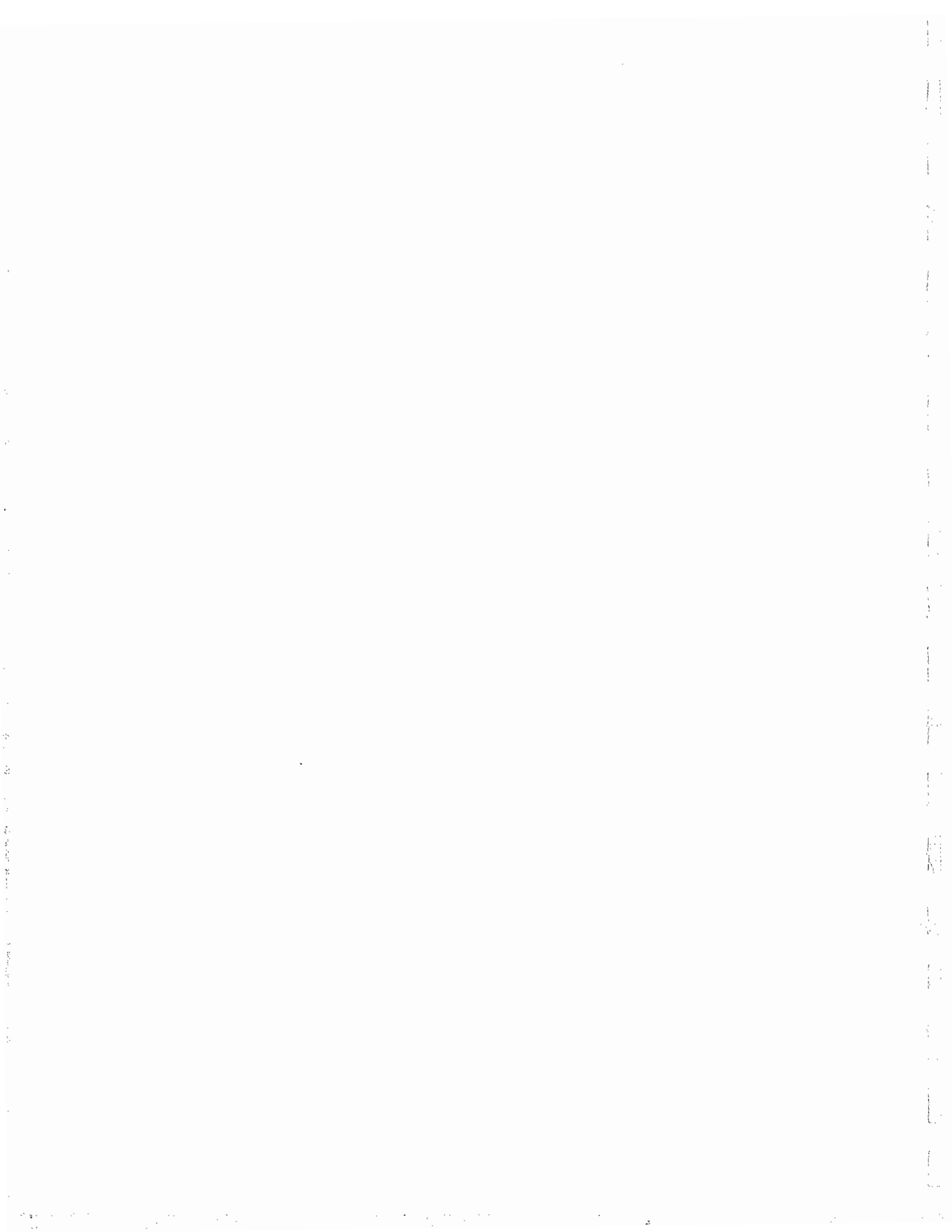
Location: AMAULIGAK (WEST)

Water depth (m) : 31.8

CPT : ANB4CI04

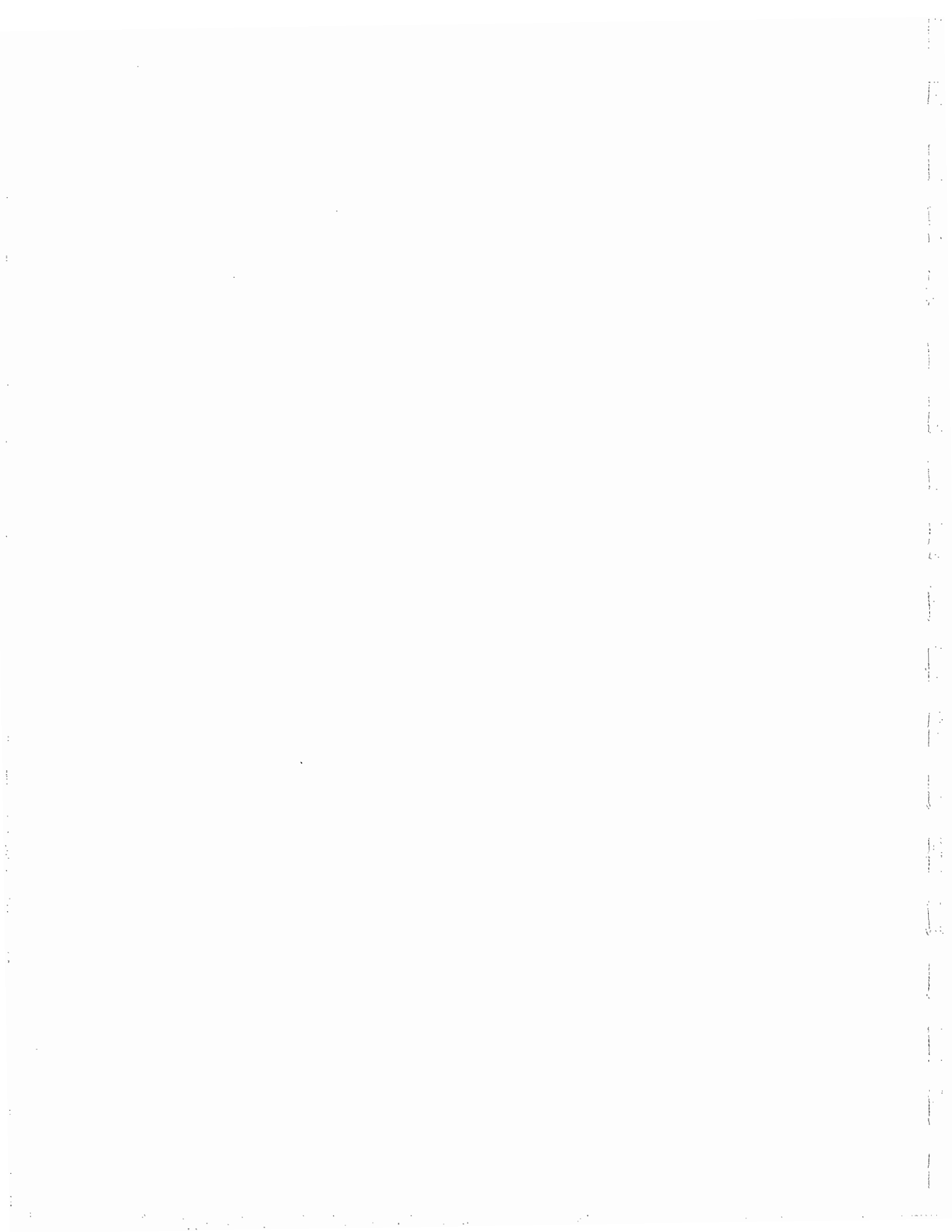
PAGE 2 of 2





APPENDIX F

LABORATORY TEST PROCEDURES



January, 1985

LABORATORY TEST PROCEDURES

Procedures Specified

1. Classification and Index Tests
2. Porewater Salinity Tests





LABORATORY TEST PROCEDURES

1. CLASSIFICATION AND INDEX TESTS

These tests are quite routine and the standard ASTM procedures employed are listed below:

<u>TEST</u>	<u>ASTM DESIGNATION</u>
Moisture Content	D 2216
Liquid Limit (1)	D 423
Plastic Limit and Plasticity Index	D 424
Grain Size	D 421 & 422
Specific Gravity	D 854
Relative Density	D 2049
Unified Soil Classification	D 2487

NOTE: 1. All liquid limits reported were obtained from 3 point determinations.

2. POREWATER SALINITY TESTS

Sample is trimmed to remove disturbed material. Porewater is extruded from thawed sample and filtered. The salinity content (NaCl) of the extruded porewater in % is determined using a hand-held refractometer. Several drops of porewater are placed on the reflecting plate and a reading is taken through the eyepiece. Results are reported to the nearest ppt.

