SSCL-SR-1092

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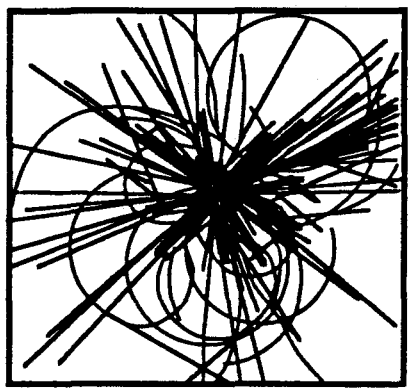
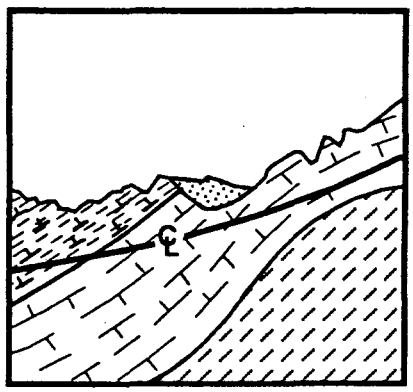
Project No. 87-888-0017

Report No. SSC-GR-33

August 1990

Data Report for Interaction Region 5 and Coreholes BIR 51, BIR 52, BIR 53, and BIR 54





Prepared by: The Earth Technology Corporation
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Prepared for: RTK a joint venture
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FOREWORD

The goal of the geotechnical studies at the Texas Superconducting Super Collider (SSC) site is to allow the geologist and engineer to build their level of knowledge and confidence about the geologic structures and geotechnical properties of the site materials to the point at which there remains only a realistically small risk of encountering geotechnical conditions during construction that would significantly increase construction costs or delay construction schedules. To do this, a characterization program has been designed to meet the following objectives:

- To confirm the site's suitability and optimize the ring location (the "footprint") and hall positions on the ring
- To provide data for a preliminary structural design
- To provide a rational framework within which construction contracts and schedules can be formulated
- To maximize the use of the site-specific data already gathered by the proposer.

The geotechnical program to meet these objectives has been divided into the following three phases of study:

- Footprint location data
- Structure-specific data
- Global data.

This is one in a series of data reports prepared for the structure-specific phase of geotechnical characterization at the SSC site. Data collection for this study phase focused on drillhole-based geological, geohydrological, geophysical, and geotechnical tests at the locations of experimental halls and the injector. In combination with data from the other phases, these data will allow conceptual designs of construction methods and structural supports for key underground structures. Each data report includes the results of both field and laboratory tests for specific drilling and sampling site(s).

DATA REPORT

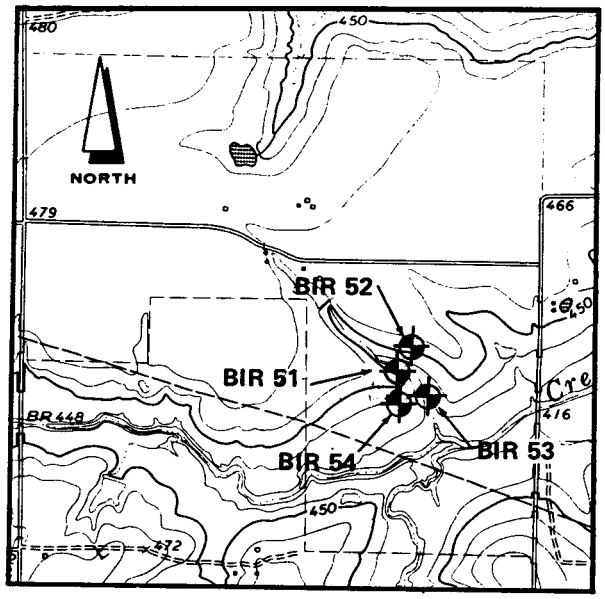
Site Designator: Interaction Region (IR) 5

Objective: Drill coreholes, three vertical and one inclined approximately 45° from horizontal; excavate one trench to a maximum depth of 4.5 feet; characterize fractures; and obtain samples for geomechanical testing; do in situ geohydrological and geophysical testing to characterize the conditions at the IR.

Interaction Region 5 is located on the eastern side of the ring, approximately 3.8 miles southwest of Palmer, Texas.

BIR 51, 52, and 54 are vertical coreholes.

BIR 53 is an angled boring with a bearing of approximately S80°W, angled 50° from horizontal.



SCALE 1:24,000

0 1000 2000 3000 4000 Feet

CONTOUR INTERVAL 10 FEET

Boring Locations:

Boring	Northing (feet)	Easting (feet)	Surface Elevation (feet)
BIR 51	266,170	2,250,529	449.0
BIR 52	266,420	2,250,682	447.8
BIR 53	266,088	2,250,927	438.7
BIR 54	265,911	2,250,528	440.3

Scope and Schedule:

- Borings

Boring	Coring (full depth)	Wire-Line Logging	Hydrologic Testing	Laboratory Testing	Well Construction or Plugging
BIR 51	Nov. 14 to 16, 1989	Nov. 16, 1989	Not done	Nov. 14, 1989 to Jan. 30, 1990	Nov. 17, 1989 (Plugging)
BIR 52	Nov. 17 to 20, 1989	Nov. 21, 1989	Not done	Nov. 18, 1989 to Jan. 30, 1990	Nov. 21, 1989 (Plugging)
BIR 53	Nov. 14 to 16, 1989	Nov. 17, 1989	Nov. 20, 1989	Nov. 15 to Dec. 9, 1989	Nov. 20, 1989 (Plugging)
BIR 54	Sept. 22 to 29, 1989	Sept. 29, 1989	Oct. 2 and 3, 1989	Sept. 24, 1989 to Jan. 17, 1990	Oct. 11, 1989 (Well*)

* Water level was measured at 449.8 feet above MSL on April 7, 1990.

- Geologic mapping - October 6 to October 11, 1989
- Trenching - October 6, 1989
- Downhole velocity surveys (in boring BIR 54 only) - November 30, 1989

Conditions Encountered: (see Lithologic Logs, Appendix A)

Boring No.	Total Depth (feet)	Soil (feet)	Weathered Taylor Marl (feet)	Fresh Taylor Marl (feet)	Austin Chalk (feet)
BIR 51	200.0	0.0 to 20.0	20.0 to 24.5	24.5 to 180.7	180.7 to 200.0
BIR 52	205.0	0.0 to 24.5	Not encountered	24.5 to 186.3	186.3 to 205.0
BIR 53 (Angle Hole)	285.5 (inclined)	0.0 to 16.5	16.5 to 20.5	20.5 to 238.7	238.7 to 285.5
	218.1 (vertical)	0.0 to 13.9	13.9 to 16.9	16.9 to 182.4	182.4 to 218.1
BIR 54	421.5	0.0 to 17.0	17.0 to 22.0	22.0 to 187.5	187.5 to 421.5

Geophysical Logging: (see Wire-line Logs, Appendix B)

Boring No.	Spontaneous Potential (SP)	Normal Resistivity (Short and Long)	Guard Resistivity	Point Resistance	Natural Gamma	Short and Long Gamma	Compensated Density (Caliper)	Sonic Velocity (Full Wave)	Other
BIR 51	X	X	X	X	X	X	X	X	
BIR 52	X	X	X	X	X	X	X	X	Neutron
BIR 53	X	X	X	X	X	X	X	X	Deviation
BIR 54	X	X	X	X	X	X	X	X	Neutron

Geologic Mapping Results and Trenching Summary: (see also Appendix C)

Geologic Mapping: Field mapping identified exposed bedrock approximately 1,900 feet southwest of the IR. This exposure was large enough to provide representative fracture data in the area of the IR. Analysis of boring logs for BIR 51, BIR 52, BIR 53, and BIR 54 indicates that no major faults cross IR 5. See Appendix C and Drawings GP-3 and GS-7 (in pocket).

Trenching: One "L"-shaped trench, with each arm approximately 30 feet in length, was excavated to further characterize the fractures at the IR (see Drawing GP-3).

Straddle Packer Test Results Summary: BIR 53 was hydrotested on November 20, 1989; BIR 54 was hydrotested on October 2 and 3, 1989 (see Appendix D).

Boring	Vertical Test Depth (ft)	Packer Pressure (psi)	Gauge Pressure (psi)	Formation/ Lithology	Hydraulic Conductivity (cm/sec)
BIR 53	135.0-151.8	200	20	Taylor Marl	$<5.0 \times 10^{-7}$
BIR 54	163.0-183.0	200	20	Taylor Marl	$<6.0 \times 10^{-8}$
BIR 53	174.2-191.0	200	19.5	Taylor/Austin Contact	$<5.1 \times 10^{-7}$
BIR 54	183.0-203.0	200	20	Taylor/Austin Contact	$<6.0 \times 10^{-8}$

Bulk and Clay Mineralogy Test Results Summary: (see also Appendix E)

Formation: Taylor Marl

Whole Rock Composition:		Relative Clay Abundance:	
Mineral	Percent	Mineral	Percent
quartz	23-24	illite	10-18
K feldspar	1-3	kaolinite	14-17
plagioclase	3-5	mixed layer	
calcite	30-32	(illite/smectite)	68-75
dolomite	3-4		
siderite	0-4		
pyrite	2-3		
total clay	28-41		

Laboratory Geomechanical Test Results Summary: (see also Appendix E)

Vertical Depth (ft)	Formation/ Lithology	Moisture Content (%)	Dry Density (pcf)	Uniaxial Compressive Strength (psi)	Tangent Young's Modulus E_{50} (psi x 10^5)	Brazil Tensile Strength (psi)
2-14	Residual Soil	20.9-28.7	94.7-105.9			
20-22.1	Taylor Marl	19.8-20.9	107.8	166		57
42-46.5	Taylor Marl	16.8-17.4	114.0-115.8	303	0.4	89
66.5-67.4	Taylor Marl	15.9-16.2	116.8			84
87.8-88.5	Taylor Marl	16.1-16.9	115.2-116.9	453-559		
113.2-122.9	Taylor Marl	14.9-16.4	118.1-119.1	708-742	0.9-1.4	98
131.4-135.9	Taylor Marl	15.2-16.3	117.5-118.1	558	1.0-1.3	
153.5-165.2	Taylor Marl	13.6-16.8	115.9-122.4	495-648	1.1-1.7	
176.7-178.0	Taylor Marl	15.4-16.1	118.4-122.4	618		
182.6-186.0	Taylor Marl	15.3-16.2	116.4-118.1	667	0.9	
189.1-196.4	Austin Chalk	10.0-12.8	129.0-131.2	1962-2411	2.6-3.1	271
238.3-287.6	Austin Chalk	9.9-11.4	128.4-129.4	3213		
413.3-414.4	Austin Chalk	6.9-8.0	140.3	3169		

Downhole Velocity Survey Summary: in boring BIR 54 (see Appendix F)

Depth (feet)	Vp (feet/second)	Vs (feet/second)	Poisson's Ratio	Shear Modulus (x 10^5 psi)	Constrained Modulus (x 10^5 psi)
Taylor Marl					
0-19	2100	840	0.41	0.18	1.15
19-184	6100	1530	0.47	0.68	10.81
Austin Chalk					
184-410	9500	4250	0.38	5.7	28.19

Hole Status: An observation well was installed in Boring BIR 54. Borings BIR 51 through BIR 53 were plugged with cement grout and abandoned (see also Appendix G).

APPENDIX A

LITHOLOGIC LOGS

LITHOLOGIC LOG

BORING BIR 51

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 51 PG 1 OF 5

LOCATION: N 266,170 feet
E 2,250,529 feet

GROUND EL: 449.0 feet

DATE: 11/14/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Begin drilling with water from ground surface.

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
5, 10									CLAY, silty, tan and brown (13.0)
15, 20									CLAY, shaly, mottled, tan and gray (20.0)
25									CALCAREOUS SHALE (Taylor Marl) soft, severely weathered, tan and gray with occasional thin tan clay layers (24.5)
30		C1	25.0	35.0	91	91			CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, moderately calcareous, dark gray.
35, 40		C2	35.0		92	92			

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.:16

BORING NO: BIR 51PG 2 OF 5

LOCATION: N 266,170 feet
E 2,250,529 feet

GROUND EL: 449.0 feet

DATE: 11/14/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 5

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray
45									
		C3	45.0	55.0	100	100			
50									
55									
		C4	55.0	65.0	100	100			
60									
65									
		C5	65.0	75.0	95	95			
70									
75									
		C6	75.0		100	100			
80									

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 51 PG 3 OF 5

LOCATION: N 266,170 feet
E 2,250,529 feet

GROUND EL: 449.0 feet

DATE: 11-15-89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 5

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray with traces of thin carbonate seams
85									
		C7	85.0	95.0	100	100			
90									
95									95'-105' Core catcher allowed core to slip. Unable to pick up 1.6'. Core destroyed during secondary recovery attempt
		C8	95.0	105.0	84	84			
100									
105									
		C9	105.0	115.0	95	95			-carbonate seam, very thin, light gray at 114.2' and 114.8'
110									
115									
		C10	115.0		87	87			
120									

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CB 12/21/89

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 51 PG 4 OF 5

LOCATION: N 266,170 feet
E 2,250,529 feet

GROUND EL: 449.0 feet

DATE: 11/15/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 5

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray with occasional thin carbonate seams and fossil partings
125									
		C11	125.0		98	98			
130									
135				135.0					
		C12	135.0		58	58			
140									
145				145.0					
		C13	145.0		99	99			-very thin, carbonate seams, light gray at 151.5', 151.8', 151.9', and 152.1'
150									
155				155.0					
		C14	155.0		99	99			-fossil parting at 156.1' -thin carbonate seams, light gray at 159.5', 161.4', and 161.6'
160									

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

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LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 51 PG 5 OF 5

LOCATION: N 266,170 feet
E 2,250,529 feet

GROUND EL: 449.0 feet

DATE: 11/16/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 5

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray with occasional thin carbonate layers up to 0.3' thick and medium angle fractures.
165									-thin carbonate seams, light gray from 165.2' to 165.5'
		C15	165.0		99	99			-fossil parting at 167.5' -carbonate nodules, light gray at 167.7', 168.5' and 168.7' -50° smooth, clean, healed slickened fracture at 169.4' -thin carbonate seam, light gray at 169.7'
170									-40° smooth, clean, tight slickensided fracture at 170.0' -40° smooth, clean, tight slickensided fracture at 170.5', 170.9' and 171.2'. (All fractures oriented in same direction.)
175				175.0					
		C16	175.0		100	100			-sharp contact, trace of pyrite along contact zone 180.7'
180									LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light gray to dark gray with 1' thick very fossiliferous limestone interbeds. Also medium angle fractures.
185				185.0					
		C17	185.0		99	99			-45° smooth, clean, tight, slickensided fracture at 187.1' -very fossiliferous from 191.4'-192.5'
190									
195				195.0					-45° open, healed, calcite filled ($\frac{1}{4}$") fracture at 196.2' -60° smooth, clean, tight slickensided fracture at 197.2'
		C18	195.0		61	61			
200				200.0					
									Bottom of Exploration at 200.0' Boring grouted upon completion

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LITHOLOGIC LOG

BORING BIR 52

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 52 PG 1 OF 6

LOCATION: N 266,420 feet
E 2,250,682 feet

GROUND EL: 447.8 feet

DATE: 11/17/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Begin drilling with rotary wash method from ground surface

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
5, 10, 15									CLAY, silty, jointed, tan and light brown
									19.5'
20									CLAY, stiff, jointed, mottled tan and gray
									24.5'
25, 30, 35		C1	25.0	35.0	97	97			CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray with traces of thin tan clay layers and fossil partings -weathered tan clay layers (¼") at 26.0', 26.5' and 26.6' -fossil parting at 33.3'
40		C2	35.0	45.0	73	73			

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 52 PG 2 OF 6

LOCATION: N 266,420 feet
E 2,250,682 feet

GROUND EL: 447.8 feet

DATE: 11/17-18/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 6

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, moderately calcareous, dark gray
45									
		C3	45.0	55.0	90	90			
50									
55									
		C4	55.0	65.0	96	96			
60									
65									
		C5	65.0	75.0	100	100			
70									
75									
		C6	75.0		94	94			
80									

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

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(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 52 PG 3 OF 6

LOCATION:

GROUND EL: N 266,420 feet
E 2,250,682 feet
447.8 feet

DATE: 11/18/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 6

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, moderately calcareous, dark gray
85				85.0					
		C7	85.0		100	100			
90									
95				95.0					
		C8	95.0		96	96			
100									
105				105.0					
		C9	105.0		99	99			-becoming gradationally more calcareous below 107.0'
110									
115				115.0					
		C10	115.0		97	97			
120									
				125.0					

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

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LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 52 PG 4 OF 6

LOCATION: N 266,420 feet
E 2,250,682 feet

GROUND EL: 447.8 feet

DATE: 11/18/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 6

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, moderately calcareous, dark gray with occasional thin interbedded carbonate seams and shale layers 0.8' thick.
125				125.0					
		C11	125.0		100	100			
130									
135				135.0					
		C12	135.0		97	97			
140									
145				145.0					
		C13	145.0		98	98			-thin carbonate seams, light gray at 150.5', 151.9', 152.7' and 153.8'
150									
155				155.0					
		C14	155.0		99	99			-thin carbonate seams, light gray at 157.8', 158.0' and 158.5' -very soft, shale layer with interbedded carbonate layers from 160.0'-160.8' -thin carbonate seams, light gray at 163.5', 164.4' and 164.7'
160									
				165.0					

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 52 PG 5 OF 6

LOCATION: N 266,420 feet
E 2,250,682 feet

GROUND EL: 447.8 feet

DATE: 11/20/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 6

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
				165.0					CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, moderately calcareous, dark gray with thin interbedded harder carbonate layers.
165			165.0						
170		C15			98	98			-carbonate layer, hard, light gray at 171.7'-171.8'
				175.0					
175			175.0						
180		C16			89	89			-carbonate seam, thin, light gray at 186.1'
				185.0					
185			185.0						186.3' sharp contact
190		C17			97	97			LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light to dark gray with 0.4' to 1' thick moderately to extremely argillaceous limestone interbeds 0.5 to 1' apart. Also fossil partings. -slightly fossiliferous, moderately argillaceous layer from 187.1'-187.5', 188.6'-189.2'. 190.0'-191.1', 191.6'-192.4' -fossil parting at 190.4' -very argillaceous layer, gradationally from 193.8'-194.7' -very fossiliferous layer at 196.2'-198.6' -fossil parting at 197.5'
				195.0					
195			195.0						
200		C18			96	96			-thick bedding, very argillaceous layer from 202.4'-204.6'
				205.0					

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Texas SSC Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 52 PG 6 OF 6

LOCATION: N 266,420 feet
E 2,250,682 feet

GROUND EL: 447.8 feet

DATE: 11/20/89 TYPE: Nx Core CASED TO: 10.0' CONTRACTOR: SwL (89-192)

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
									LIMESTONE (Austin Chalk) medium hard, fresh, light to dark gray, medium to thickly bedded
				205.0					
205									Bottom of Exploration at 205.0'
									Boring grouted upon completion
210									
215									
220									
225									
230									
235									
240									

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See Page 1 of 6

DRILLING GEOLOGIST Shawn Wood ASSISTANT Wayne Cowan CHECKED BY Clem Bommarito

CB 12/21/89

Shawn Wood
(2-1-90)

LITHOLOGIC LOG

BORING BIR 53

LOG OF BORING

BORING NO: BIR 53 PG 1 OF 8

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

LOCATION: ~N 266,088 feet
~E 2,250,927 feet

GROUND EL: ~438.7 feet

DATE: 11-14-89 TYPE: Nx Angle Core (1) CASED TO: 19.0' CONTRACTOR: MJA

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Wet Rotary Core Hole
Water level not determinable

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
5, 10, 15									CLAY (Residual Soil), v. fine grained, calcareous, brownish-gray (CH)
									16.5g SHALE (Taylor Marl), sli. to faintly weathered, soft to very soft, v. fine grained, calcareous, gray with a thin, v. soft, completely wea., tan interbed from 19.0 to 20.5
20.5s									SHALE (Taylor Marl), fresh, soft, v. fine grained, v. thinly bedded, dark gray, sli. fossiliferous. calcareous, w/v. thin (< 1/8") mod. hd. $CaCO_3$ laminations
20		C1	19.0	25.5	100	100			
25		C2	25.5	35.5	100	100			26.3 70° Insipient fracture, planar Strike N25°W, Dip 80°SW 32.6 70° Insipient fracture, planar Strike N50°E, Dip 85°NW
30, 35									
40		C3	35.5		100	100			39.0 65° Fracture, closed, sli. rough, fresh surface, clean, planar

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 53 PG 2 OF 8

LOCATION: ~N 266,088 feet
~E 2,250,927 feet

GROUND EL: ~438.7 feet

DATE: 11-14-89 TYPE: Nx Angle Core(1) CASED TO: 19.0' CONTRACTOR: MJA

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
45		C3		45.5	100	100				SHALE (Taylor Marl), fresh, soft, v. fine grained, v. thinly bedded, dark gray, sli. fossiliferous, calcareous, w/v. thin (< 1/8") mod. hard $CaCO_3$ laminations
50		C4	45.5	55.5	100	100				
60		C5	55.5	65.5	100	100				
70		C6	65.5	75.5	100	100				
80		C7	75.5		100	100				

SAMPLE LEGEND
S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION
Wet Rotary Core Hole
Water level not determinable

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BER 53 PG 3 OF 8

LOCATION: ~N 266,088 feet
~E 2,250,927 feet

GROUND EL: ~438.7 feet

DATE: 11-14-89 TYPE: Nx Angle Core(1) CASED TO: 19.0' CONTRACTOR: MJA

SAMPLE LEGEND
S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION
Wet Rotary Core Hole
Water level not determinable

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
		C7		85.5	100	100				SHALE (Taylor Marl), fresh, soft, v. fine grained, v. thinly bedded, dark gray, sli. fossiliferous, calcareous, w/v. thin (<1/8") mod. hard $CaCO_3$ laminations
85										
		C8	85.5	95.5	100	100	Stopped Drilling 11-14-89			88.8 63° Fracture, closed, sli. rough, fresh, clean surface, planar Strike N10°E, Dip 20°NW
90										
95										
		C9	95.5	105.5	100	100	Started Drilling 11-15-89			
100										
105										
		C10	105.5	115.5	100	100				
110										
115										
		C11	115.5		100	100				
120										

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 53 PG 4 OF 8

LOCATION: ~N 266,088 feet
~E 2,250,927 feet

GROUND EL: ~438.7 feet

DATE: 11-15-89 TYPE: Nx Angle Core(1) CASED TO: 19.0' CONTRACTOR: MJA

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Wet Rotary Core Hole
Water level not determinable

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
125		C11		125.5	100	100				SHALE (Taylor Marl), fresh, soft, v. fine grained, v. thinly bedded, dark gray, sli. fossiliferous, calcareous w/v. thin (up to 1/4") mod. hard $CaCO_3$ laminations 125.9 Very thin (~1/4") mod. hard, lt. gray $CaCO_3$ bed, sharp upper and sharp lower contacts
130		C12	125.5	135.5	100	100				
140		C13	135.5	145.5	100	100				
150		C14	145.5	155.5	100	100				
160		C15	155.5		100	100				

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 53 PG 5 OF 8

LOCATION: ~N 266,088 feet
~E 2,250,927 feet

GROUND EL: ~438.7 feet

DATE: 11-15-89 TYPE: Nx Angle Core(1) CASED TO: 19.0' CONTRACTOR: MJA

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Wet Rotary Core Hole
Water level not determinable

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
		C15		165.5	100	100			SHALE (Taylor Marl), fresh, soft, v. fine grained, v. thinly bedded, dark gray, sli. fossiliferous, calcareous, w/v. thin (≤ 1/8") mod. hard $CaCO_3$ laminations, increasing in frequency
165									
		C16	165.5	175.5	100	100			
170									
175									177.6-177.7 (3-4) very thin (~1/8") med. hard, $CaCO_3$ beds
		C17	175.5	185.5	100	100			179.6-179.7 (3-4) very thin (~1/8") med. hard, $CaCO_3$ beds
180									
185									
		C18	185.5	195.5	100	100	Stopped Drilling 11-15-89		
190									
195									
		C19	195.5		100	100	Started Drilling 11-16-89		
200									

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR53 PG 6 OF 8

LOCATION: N 266,088 feet
E 2,250,927 feet

GROUND EL: 438.7 feet

DATE: 11-16-89 TYPE: Nx Angle Core(1) CASED TO: 19.0' CONTRACTOR: MJA

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Wet Rotary Core Hole
Water level not determinable

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
		C19		205.5	100	100				SHALE (Taylor Marl), fresh, soft, v. fine grained, v. thinly bedded, dark gray, sli. fossiliferous, calcareous w/v. thin (~1/8") mod. hard $CaCO_3$ laminations increasing in frequency
205										
		C20	205.5	215.5	100	100				213.0 Very thin (1/4") mod. hd., lt. gray $CaCO_3$ lamination 215.0 Very thin (1/4") mod. hd., lt. gray $CaCO_3$ lamination
210										
215										
		C21	215.5	225.5	100	100				218.8 Very thin (1/4") mod. hd., lt. gray $CaCO_3$ lamination 219.3s-219.6s Thin (3") mod. hard, lt. gray $CaCO_3$ bed 223.9 Very thin (1/2") mod. hard, lt. gray $CaCO_3$ bed
220										
225										
		C22	225.5	235.5	100	100				226.0s-226.1 Very thin (1") mod. hard, lt. gray $CaCO_3$ bed 231.3 30° fracture, slks., closed, sli. rough, fresh surface, clean, planar Strike N10°W, Dip 55°NE
230										
235										
		C23	235.5		100	100				238.6s-238.7s Transition Zone, v. thin (1") med. hd., dk. gray, fossil., arenaceous 238.7 LIMESTONE (Austin Chalk), fresh, med. to mod. hard, med. to thickly bedded, sli. fossil., lt. gray
240										

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 53 PG 7 OF 8

LOCATION: N 266,088 feet
E 2,250,927 feet

GROUND EL: 438.7 feet

DATE: 11-16-89 TYPE: Nx Angle Core (1) CASED TO: 19.0' CONTRACTOR: MJA

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.
		C23		245.5	100	100			
245									
		C24	245.5	255.5	100	100			
250									
255									
		C25	255.5	265.5	100	100			
260									
265									
		C26	265.5	275.5	99	99			
270									
275									
		C27	275.5		100	100			
280									

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Wet Rotary Core Hole
Water level not determinable

DESCRIPTION OF STRATUM

LIMESTONE (Austin Chalk), fresh, med. to mod. hard, lt. gray, sli. fossiliferous w/0.45 to 5.5 ft. thick mod. argill. to shaly and bentonitic interbeds 1.35 to 8.4 ft. apart

242.4g-244.3g Med. thick very argill./shaly, soft, sli. fissile, dk. gray bed

252.2s-252.65g Thin shaly, soft, sli. bentonitic, dk. gray bed

252.3 85° fracture, slks., closed, sli. rough, fresh, clean surface, planar
Strike N45°E, Dip 45°NW

254.0g-255.0g Med. thick mod. argill., soft, dk. gray bed

258.4 52° fracture, slks., sli. rough, fresh, clean surface, planar
Strike N80°E, Dip 50°SE

258.4s-261.0g Med. thick mod. argill., dk. gray bed

263.5g-269.0g Thick mod. argill., dk. gray bed

272.5g-273.8g Med. thick very argill./shaly, soft, dk. gray bed

275.9 55° fracture, slks., sli. rough, fresh, clean surface, closed, planar
Strike N25°W, Dip 87°NE

278.8-278.9 Intersecting fractures

278.8 50° fracture, slks., rough to very rough, 1/4" calcite filling, planar
Strike N25°W, Dip 70°NE

278.9 40° fracture, slks., sli. rough, clean surface, closed, planar
Strike N20°W, Dip 60°NE

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LOG OF BORING

BORING NO: BIR 53 PG 8 OF 8

PROJECT: SSC - Texas Site

CLIENT: The Earth Technology Corporation

TASK NO.: 16

LOCATION: N 266,088 feet
E 2,250,927 feet

GROUND EL: 438.7 feet

DATE: 11-16-89 TYPE: Nx Angle Core(1) CASED TO: 19.0' CONTRACTOR: MJA

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Wet Rotary Core Hole
Water level not determinable

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
		C27			100	100				LIMESTONE (Austin Chalk), fresh, med. to mod. hard, lt. gray, sli. fossil., w/a 3.3 ft. thick mod. argill. interbed
										282.2g-285.5 Mod. argill., med. hard, dk. gray bed
285				285.5						
										Total Depth: 285.5' 11-16-89
										(1) Angle hole field azimuth: N85°W, Dip: 45°
										(2) Wireline logged 11-17-89
										(3) Hydrotested 11-20-89
290										(4) Nx Angle Boring Plugged 11-20-89
295										
300										
305										
310										
315										
320										

DRILLING GEOLOGIST Scott Lesikar ASSISTANT Gary Kincaid CHECKED BY W. D. Flanigan

LITHOLOGIC LOG

BORING BIR 54

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 1 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

Drilled with air rotary to 20.0', no ground water encountered. Cored with water rotary from 20.0' to bottom of exploration

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
5, 10, 15										CLAY, silty to shaly, jointed, tan
17.0										CALCAREOUS SHALE (Taylor Marl), soft, moderately weathered, fissile, slightly calcareous, dark gray with low to high angle fractures.
20		C1	20.0		100	100				-20° and 80° smooth, tight transverse slickensided fractures at 21.0'
22.0'										CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray.
25		C1			38	38				
30				30.0						
		C2	30.0							
35		C2			100	100				
40				40.0						

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 2 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
45		C3	40.0	50.0	100	100				CALCAREOUS SHALE (Taylor Marl), soft, fresh, fissile, slightly calcareous and dark gray.
50		C4	50.0	60.0	96	96				
55										
60		C5	60.0	70.0	100	100				
65										
70		C6	70.0	80.0	100	100				
75										
80			80.0							

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 3 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0 CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
85		C7	80.0	90.0	100	100				CALCAREOUS SHALE (Taylor Marl), soft, fresh, fissile, slightly calcareous, dark gray with very calcareous layers and low angle fractures. -very calcareous layer at 84.0'-84.1'
90		C8	90.0	100.0	98	98				-low angle, slickensided fracture zone from 94.2'-95.3'. All fractures smooth, tight
95										
100		C9	100.0	110.0	100	100				
105										
110		C10	110.0	120.0	96	96				
115										
120			120.0							

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 4 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
			120.0							CALCAREOUS SHALE (Taylor Marl), soft, fresh, fissile, slightly calcareous, dark gray with occasional silt seams.
125		C11			99	99				
130				130.0						
			130.0							
135		C12			73	73				
140				140.0						
			140.0							
145		C13			93	93				
				150.0						-occasional thin cemented silt seams below 150.0'
150										
			150.0							
155		C14			65	65				
160				160.0						
			160.0							

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 5 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: CASED TO: 21.0' CONTRACTOR: SWL (89-19

SAMPLE LEGEND
S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION
See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
			160.0							CALCAREOUS SHALE (Taylor Marl) soft, fresh, fissile, slightly calcareous, dark gray with shale layers and fossil partings.
165		C15			91	91				
170				170.0						
			170.0							
175		C16			100	100				-fossil parting at 176.1'
180				180.0						
			180.0							
185		C17			96	96				-1" shell fragments and soft shale at 187.4'
										187.5' LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light to dark gray with medium to high angle fractures.
190				190.0						
			190.0							
195		C18			100	100				-45° smooth, tight slickensided fracture at 195.6' and 196.4' -70° smooth, tight slickensided fracture at 197.5'
200				200.0						
			200.0							

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG6 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
		C19	200.0	210.0	100	100				LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light gray to dark gray with 1' thick extremely argillaceous limestone interbeds. Also shale layers 0.2' thick, and fossil partings. -fossil parting at 204.1'
205										
210		C20	210.0	220.0	100	100				-very argillaceous layer at 213.5'-214.5' -fossil parting at 219.0'
215										
220		C21	220.0	230.0	100	100				-broken fossil layer at 222.6'-222.8' -fossil partings at 224.1', 224.7', 225.9' and 226.0'
225										
230		C22	230.0	240.0	100	100				-fossil partings at 231.0', 233.1', 234.6' -shale layer, soft, dark gray at 237.0'-237.2'
235										
240			240.0							

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 7 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
245, 250		C23	240.0	250.0	100	100				LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light gray to dark gray with 0.6' thick extremely argillaceous limestone interbeds. Also shale layers 0.2' thick, and low to medium angle fractures.
255, 260		C24	250.0	260.0	100	100				-shale layer, soft, dark gray at 254.4'-254.6' -45° smooth, tight slickensided fracture at 256.2' -shale layer, soft, dark gray at 256.4'
265, 270		C25	260.0	270.0	100	100				-very argillaceous at 265.0'-265.6' -45° smooth, tight slickensided fracture at 265.3' -30° smooth, tight slickensided fracture at 268.0'
275, 280		C26	270.0	280.0	100	100				
			280.0							

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 8 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
285		C27	280.0	290.0	99	99				LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light to dark gray with 0.5' thick shaley limestone interbeds 10' apart. Also fossiliferous layers 1' thick. fossil partings, and low, medium, high angle fractures. -20° smooth, tight slickensided fracture at 283.7' -60° smooth, tight slickensided fracture at 289.5'
290		C28	290.0	295.0	80	40				-20° smooth, tight slickensided fracture at 291.1' -60° smooth, tight slickensided fractre at 292.1' -85° smooth, tight slickensided fracture at 292.2' -60° smooth, tight slickensided fracture at 295.5'
295		C29	295.0	305.0	100	96				-45° smooth, tight slickensided fractures at 297.8', 302.0' and 302.3' -very fossiliferous layer at 304.4'-305.5'
300		C30	305.0	315.0	100	100				-shaly layer, soft, dark gray at 307.5'-308.0' -very fossiliferous layer at 311.1'-312.5'
305		C31	315.0		97	97				-fossil parting at 316.2', 321.8' -shaly layer, soft, dark gray at 318.8'-319.3' -very fossiliferous layer at 321.8'-322.3'
310										
315										
320										

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 9 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES	HAND PEN. TSF.	DESCRIPTION OF STRATUM
				325.0					LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light to dark gray with 0.4' to 1' thick extremely argillaceous limestone interbeds 6' to 9' apart. Also fossil partings, and low angle fractures.
325		C32	325.0	335.0	100	100			-fossil partings at 326.0', 328.5', 329.2', 329.8', 331.6', 333.2', 334.0' -very argillaceous layers at 326.3'-327.6', 333.2'-333.9' -30° smooth, tight slickesnided fracture at 330.6'
330									
335		C33	335.0	345.0	100	100			-very argillaceous layer at 342.6'-343.0'
340									
345		C34	345.0	355.0	100	100			-fossil partings at 346.1', 348.9', 350.8', 352.1', and 354.2'
350									
355		C35	355.0		100	100			
360									

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

BORING NO: BIR 54 PG 10 OF 11

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
				365.0						LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light to dark gray with 1' to 2' thick extremely argillaceous to shaly limestone interbeds 3' to 17' apart. Also fossil partings, and traces of bentonite.
365		C36	365.0	375.0	100	100				-fossil partings at 366.8', 367.9', 368.3', 369.9', and 374.0'
370										
375		C37	375.0	385.0	100	100				-very argillaceous layer at 377.2'-378.2' -fossil partings at 378.2', 379.0', 379.8', 380.0', 380.5', 380.8', 382.4'
380										-very argillaceous layer at 381.5'-382.5'
385		C38	385.0	395.0	100	100				
390										
395		C39	395.0		100	100				-fossil partings at 396.9', 403.5', 404.0', 404.5' -shaly layer, soft, dark gray, trace bentonite at 399.4'-401.1'
400										

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

LOG OF BORING

PROJECT: Superconducting Supercollider

CLIENT: The Earth Technology Corporation

TASK NO.: 16

BORING NO: BIR 54 PG 11 OF 11

LOCATION: N 265,911 feet
E 2,250,528 feet

GROUND EL: 440.3 feet

DATE: 9/22-9/29/89 TYPE: Nx Core CASED TO: 21.0' CONTRACTOR: SWL (89-192)

SAMPLE LEGEND

S= SPLIT SPOON
T= 2" THIN WALL TUBE
U= 3" THIN WALL TUBE
C= NX ROCK CORE

WATER INFORMATION

See p. 1 of 11

DEPTH IN FEET	SYMBOL	SAMPLE TYPE & NUMBER	DEPTH RANGE TOP	DEPTH RANGE BOT.	PERCENT REC.	PERCENT RQD.	STANDARD PENETRATION TEST PER 6 INCHES		HAND PEN. TSF.	DESCRIPTION OF STRATUM
				405.0						LIMESTONE (Austin Chalk), moderately to medium hard, fresh, light to dark gray with 0.5' to 0.7' thick extremely argillaceous limestone interbeds 2' apart. Also shale layers, fossiliferous layers, and fossil partings.
405			405.0							-fossil partings at 405.4', 409.2', 413.2', 414.9'
410		C40			100	100				-very argillaceous with shale layers at 408.0'-408.7', 410.8'-411.3'
				415.0						
415			415.0							
420		C41			100	100				-cemented fossiliferous layers between 417.0'-420.0'
				421.5						
425										Bottom of Exploration at 421.5'
										NOTE: Observation well installed upon completion
430										
435										
440										

DRILLING GEOLOGIST R. Randall ASSISTANT S. Stevens CHECKED BY C. Bommarito

Shawn Wood
(2-1-90)

APPENDIX B

WIRE-LINE LOGS

WIRE-LINE LOGGING PARAMETERS

Hole No. BIR 51 **Log Measured From:** Ground Level

Drilling Parameters

Depth 200.0 feet

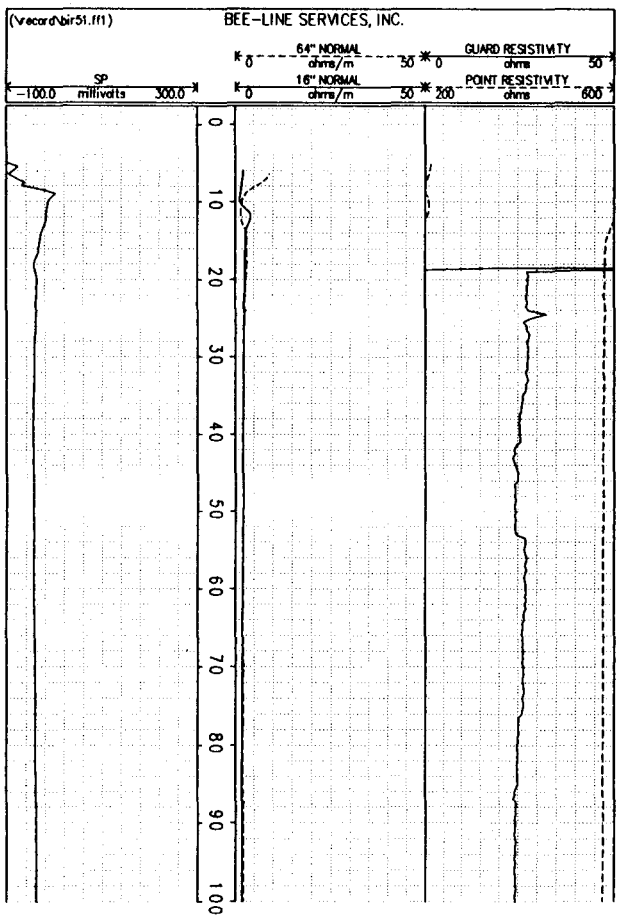
Bit Diameter 4.0 inches

Logging Parameters	Electrical Log	Gamma Log	Sonic Log
Date	November 16, 1989	November 16, 1989	November 16, 1989
Bottom Log Interval	203.0 feet	201.0 feet	197.5 feet
Top Log Interval	surface	surface	surface
Type of Fluid in Hole	drilling mud	drilling mud	drilling mud
Time Since Circulation Stop	45 minutes	45 minutes	45 minutes
Probe Type/S.N.	ALP-4979	XAP-4383	CLP-4877A
Module Type/S.N.	ALM-4979	XAM-4383	CLM-4877A
Logging Speed	40 feet/min.	20 feet/min.	20 feet/min.
Sample Interval	0.5 foot	0.5 foot	0.5 foot

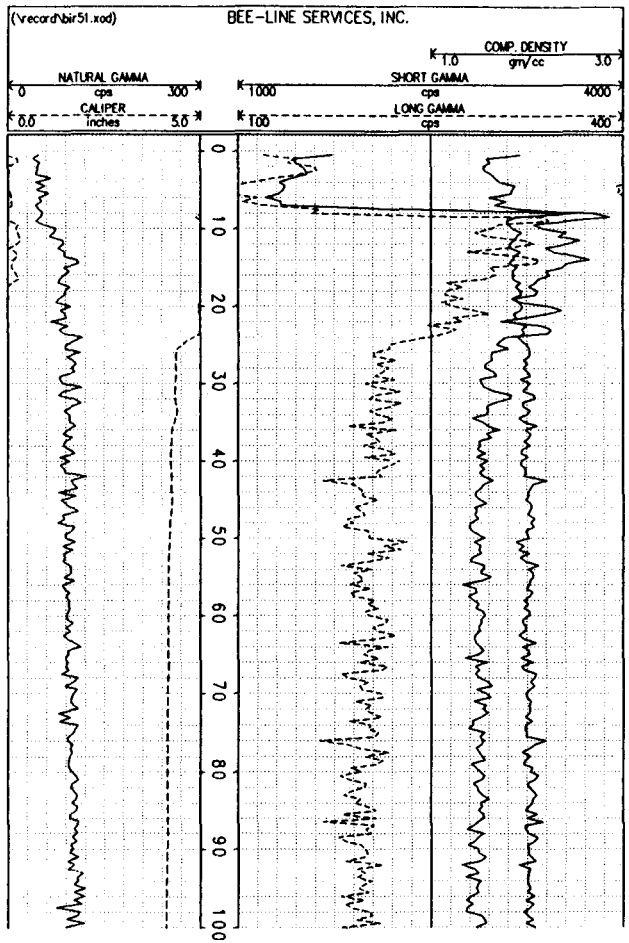
Logged by: BEE-LINE SERVICES, INC.
P. O. Box 2096
Corsicana, TX 75151

BIR 51 Wire-line logs run November 16, 1989. Surface elevation approximately 449 feet.

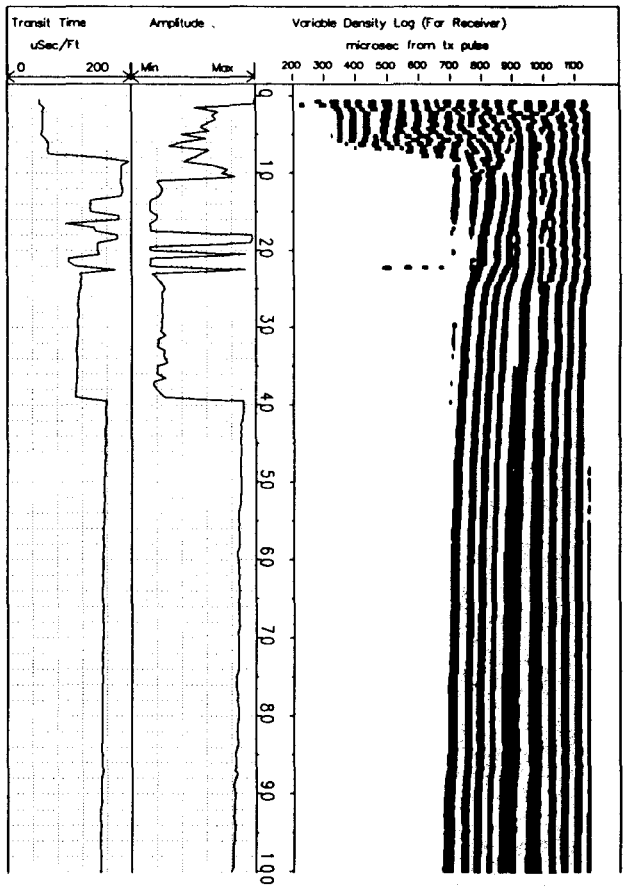
ELECTRICAL LOG



GAMMA LOG

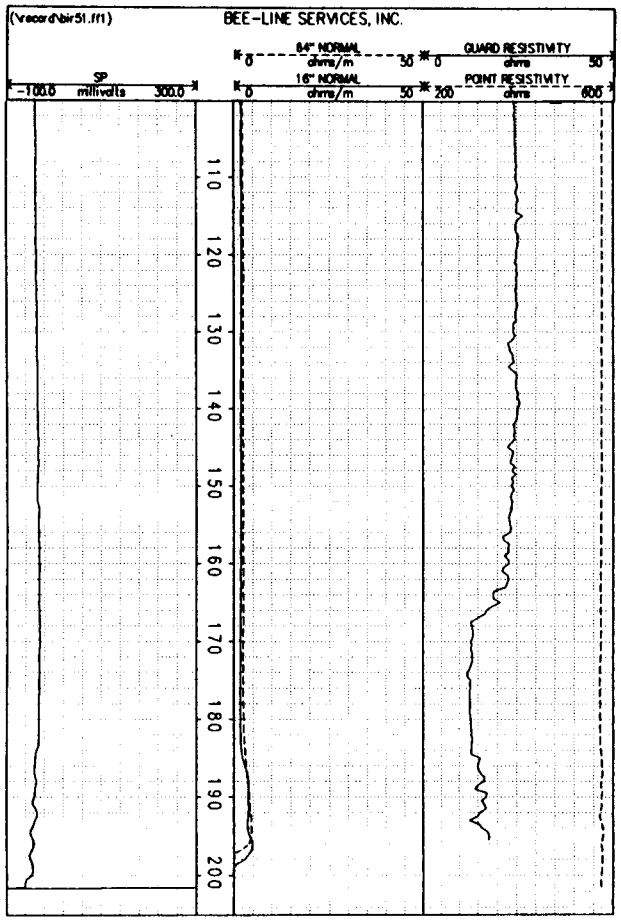


SONIC LOG

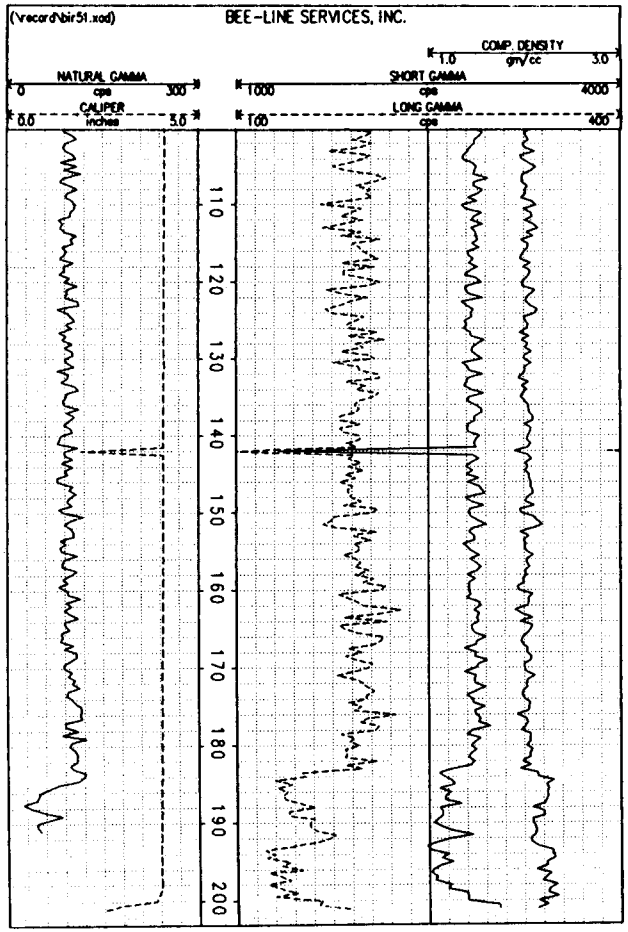


BIR 51 Wire-line logs run November 16, 1989 (Continued). Surface elevation approximately 449 feet.

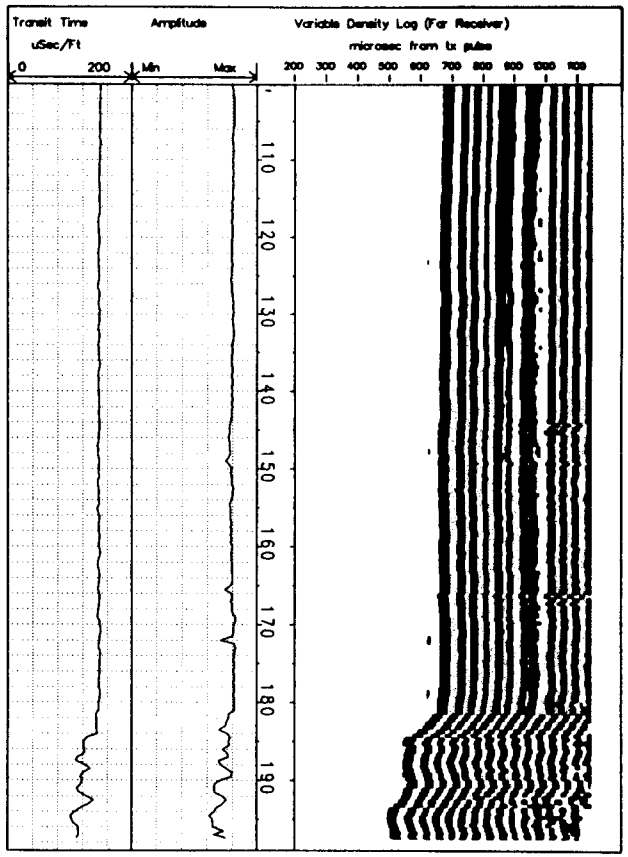
ELECTRICAL LOG CONTINUED



GAMMA LOG CONTINUED



SONIC LOG CONTINUED



WIRE-LINE LOGGING PARAMETERS

Hole No. BIR 52 **Log Measured From:** Ground Level

Drilling Parameters

Depth 205.0 feet

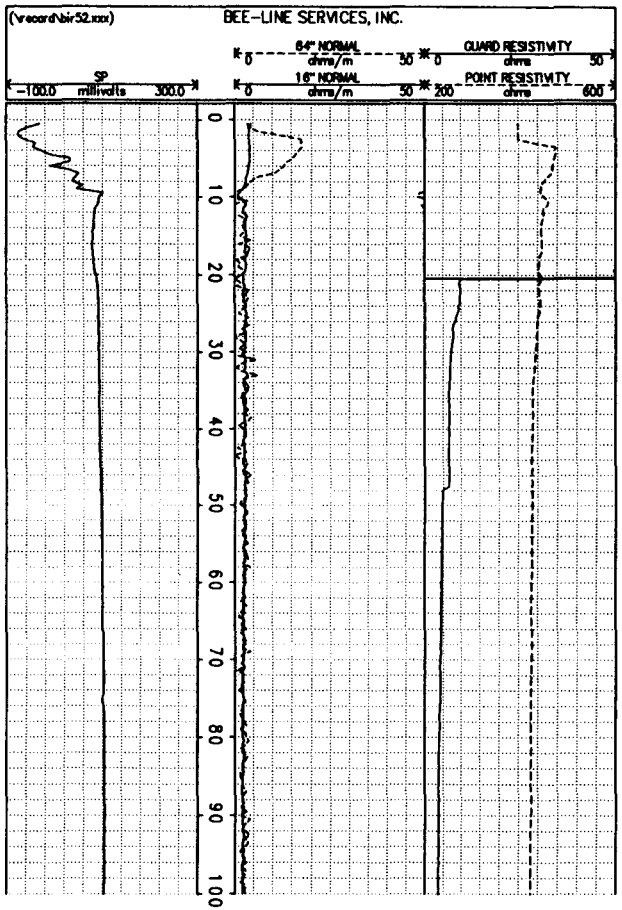
Bit Diameter 4.75 inches

Logging Parameters	Electrical Log	Gamma and Neutron Logs	Sonic Log
Date	November 21, 1989	November 21, 1989	November 21, 1989
Bottom Log Interval	205.5 feet	206.5 feet	200.7 feet
Top Log Interval	surface	surface	surface
Type of Fluid in Hole	drilling mud	drilling mud	drilling mud
Time Since Circulation Stop	16 hours	16 hours	16 hours
Probe Type/S.N.	ALP-4979	XAP-4383	CLP-4877A
Module Type/S.N.	ALM-4979	XAM-4383	CLM-4877A
Logging Speed	40 feet/min.	20 feet/min.	20 feet/min.
Sample Interval	0.5 foot	0.5 foot	0.5 foot

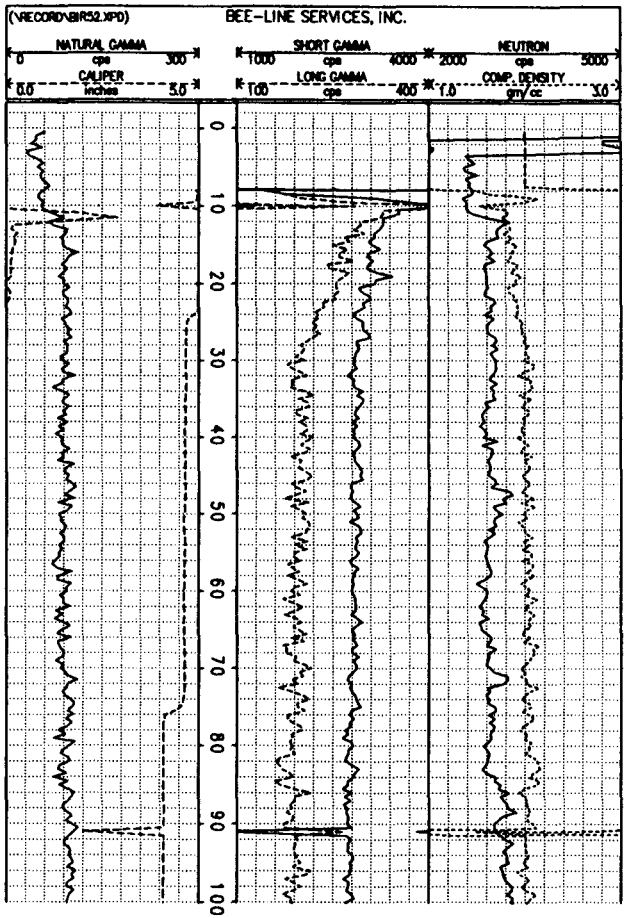
Logged by: BEE-LINE SERVICES, INC.
P. O. Box 2096
Corsicana, TX 75151

BIR 52 Wire-line logs run November 21, 1989. Surface elevation approximately 447.8 feet.

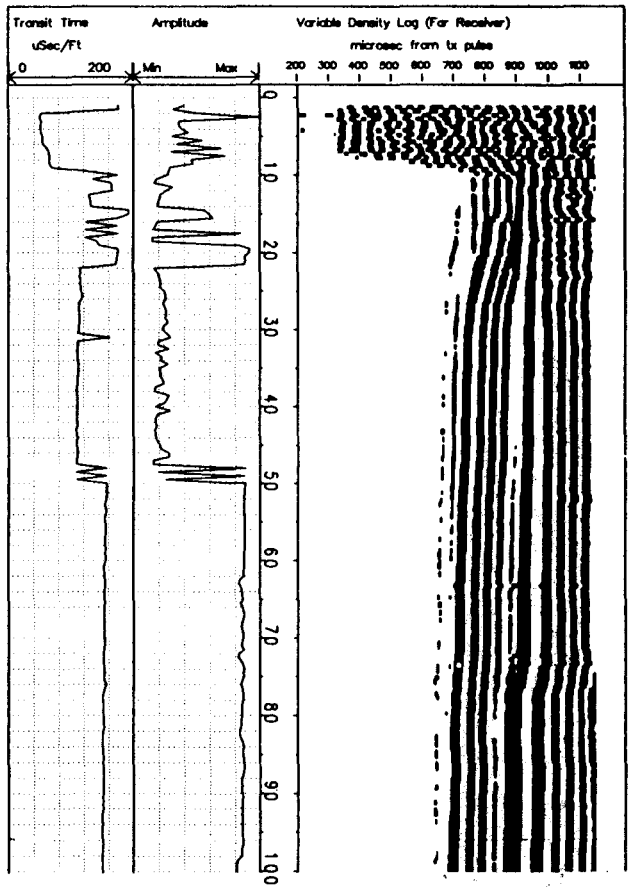
ELECTRICAL LOG



GAMMA AND NEUTRON LOGS

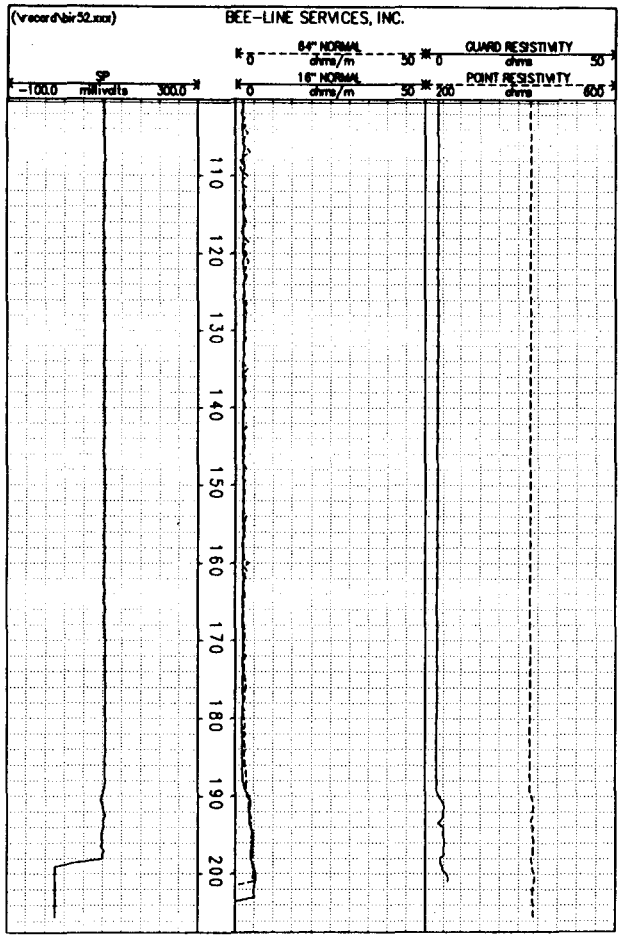


SONIC LOG

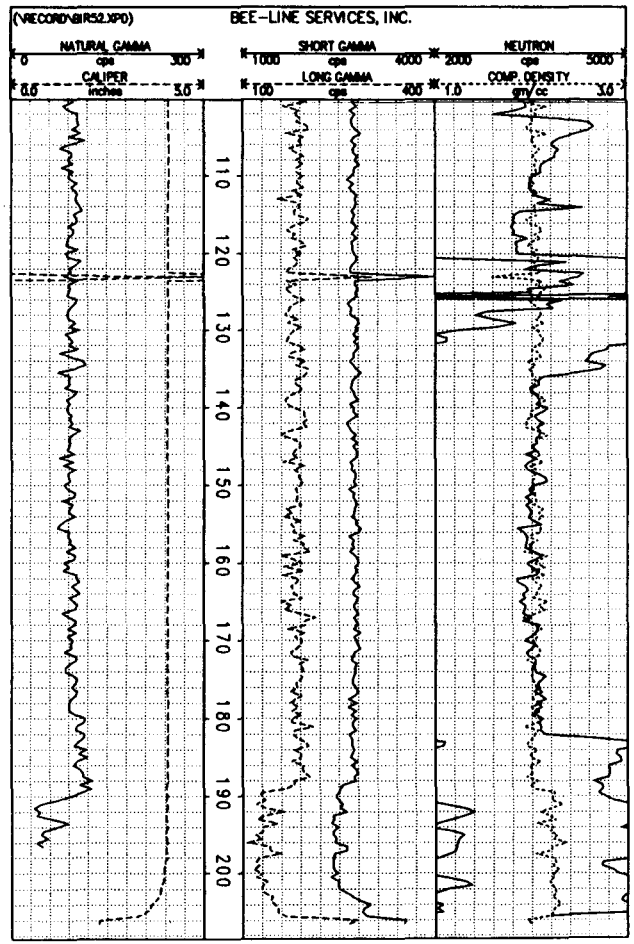


BIR 52 Wire-line logs run November 21, 1989 (Continued). Surface elevation approximately 447.8 feet.

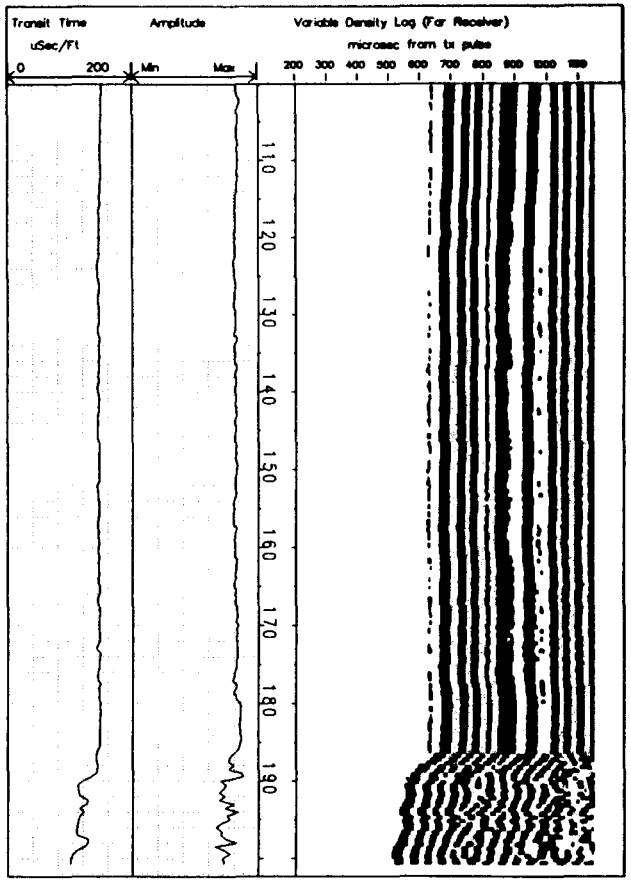
ELECTRICAL LOG CONTINUED



GAMMA AND NEUTRON LOGS CONTINUED



SONIC LOG CONTINUED



WIRE-LINE LOGGING PARAMETERS

Hole No. BIR 53 **Log Measured From:** Ground Level

Drilling Parameters

Depth 285.5 feet

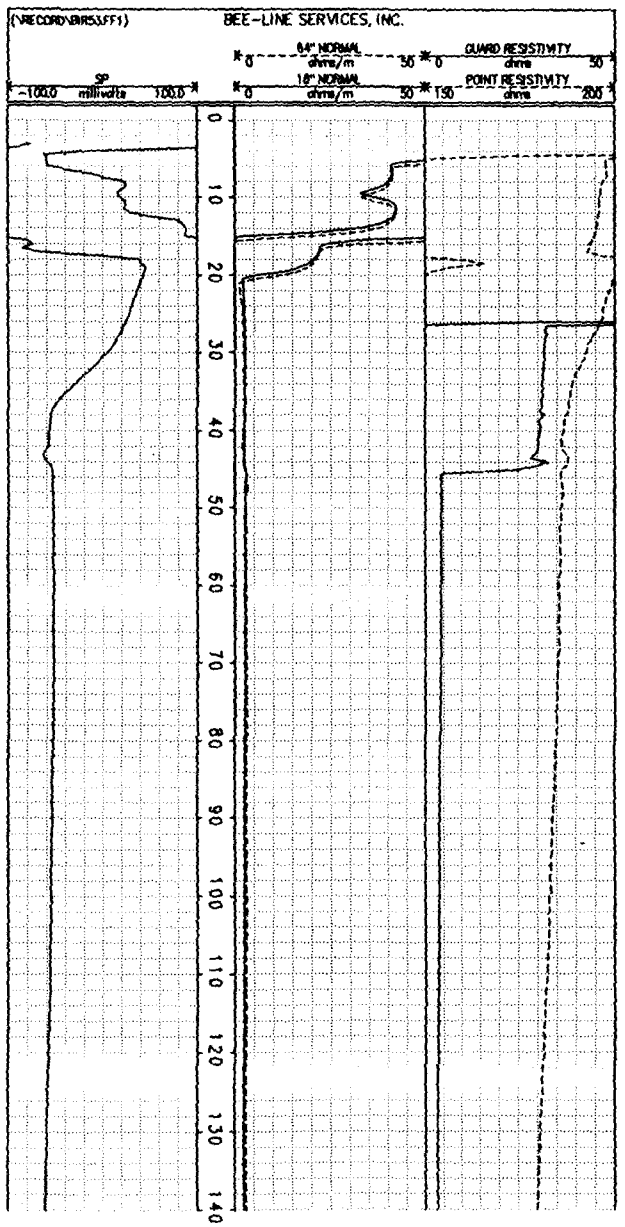
Bit Diameter 3.125 inches

Logging Parameters	Electrical Log	Gamma Log	Sonic Log	Deviation Log
Date	November 17, 1989	November 17, 1989	November 17, 1989	November 17, 1989
Bottom Log Interval	279.0 feet	274.0 feet	270.4 feet	274.0 feet
Top Log Interval	surface	surface	surface	surface
Type of Fluid in Hole	drilling fluid	drilling fluid	drilling fluid	drilling fluid
Time Since Circulation Stop	20 hours	20 hours	20 hours	20 hours
Probe Type/S.N.	ALP-4979	XAP-4383	CLP-4877A	9055A/135
Module Type/S.N.	ALM-4979	XAM-4383	CLM-4877A	COMPU-LOG
Logging Speed	40 feet/min.	20 feet/min.	20 feet/min.	60 feet/min.
Sample Interval	0.5 foot	0.5 foot	0.5 foot	0.1 foot

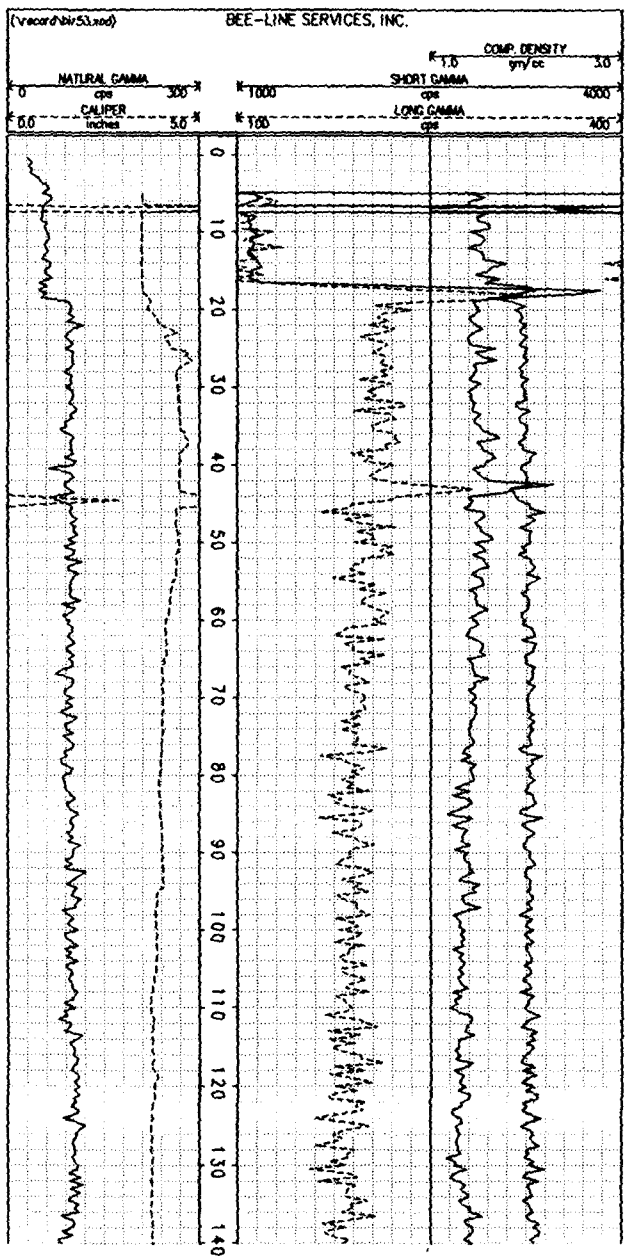
Logged by: BEE-LINE SERVICES, INC.
P. O. Box 2096
Corsicana, TX 75151

BIR 53 Wire-line logs run November 17, 1990. Surface elevation approximately 438.7 feet.

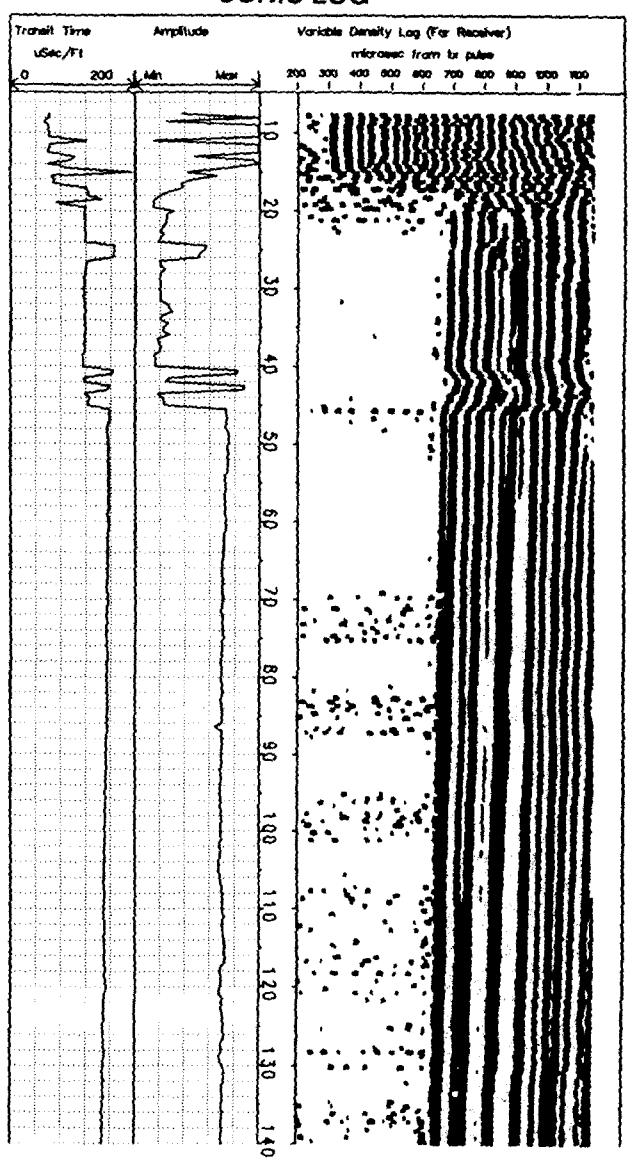
ELECTRICAL LOG



GAMMA LOG

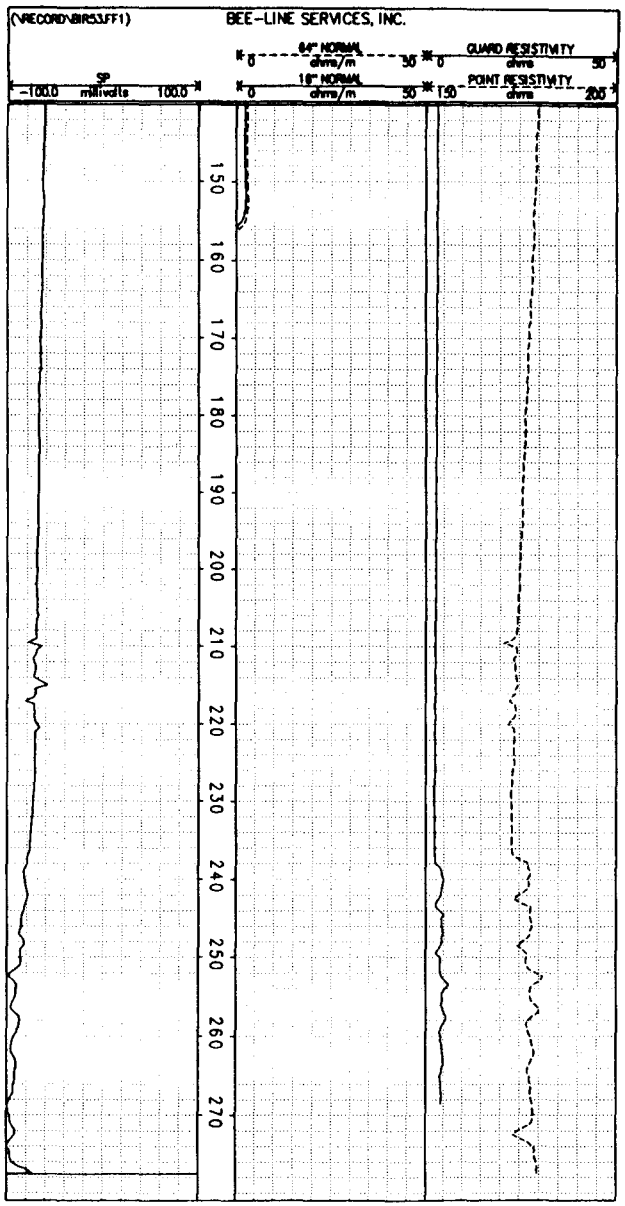


SONIC LOG

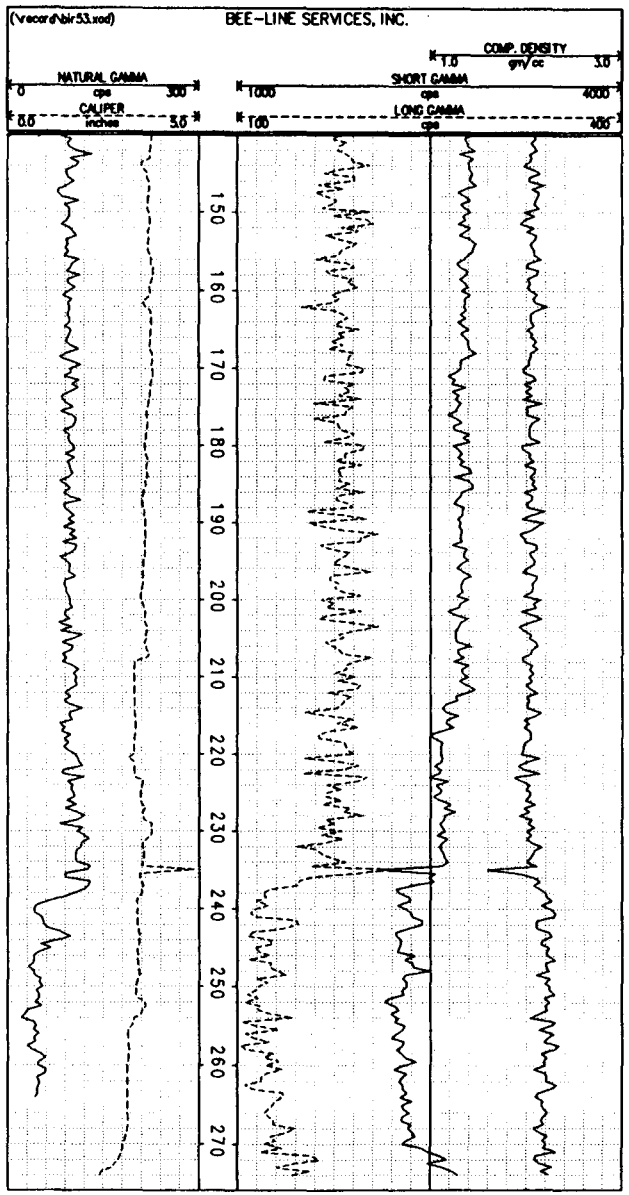


BI R 53 Wire-line logs run November 17, 1990 (Continued). Surface elevation 438.7 feet.

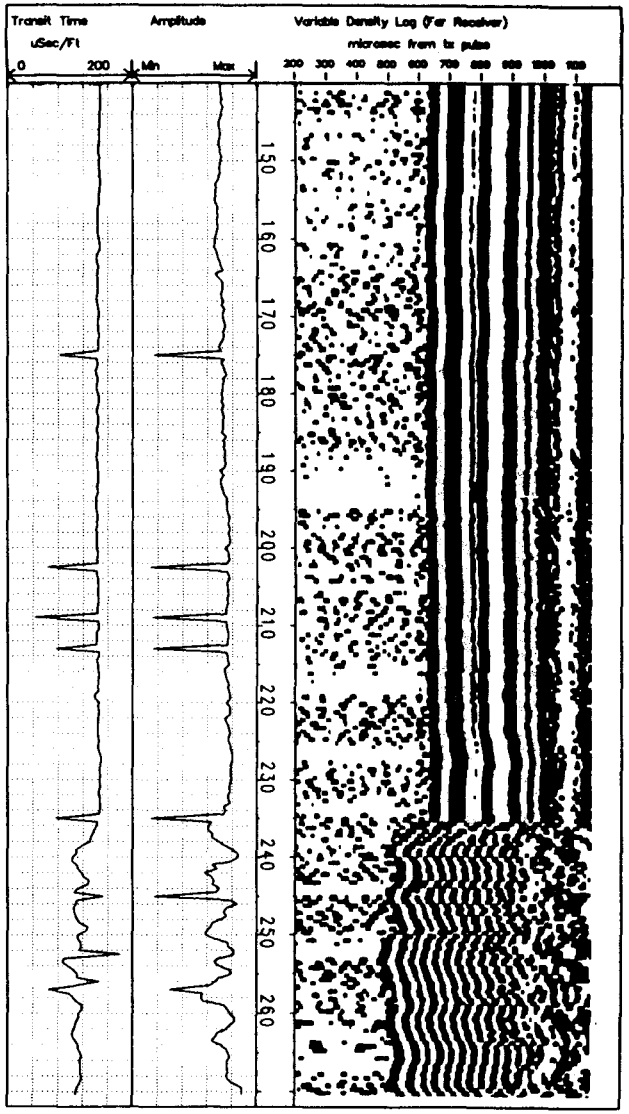
ELECTRICAL LOG CONTINUED



GAMMA LOG CONTINUED



SONIC LOG CONTINUED



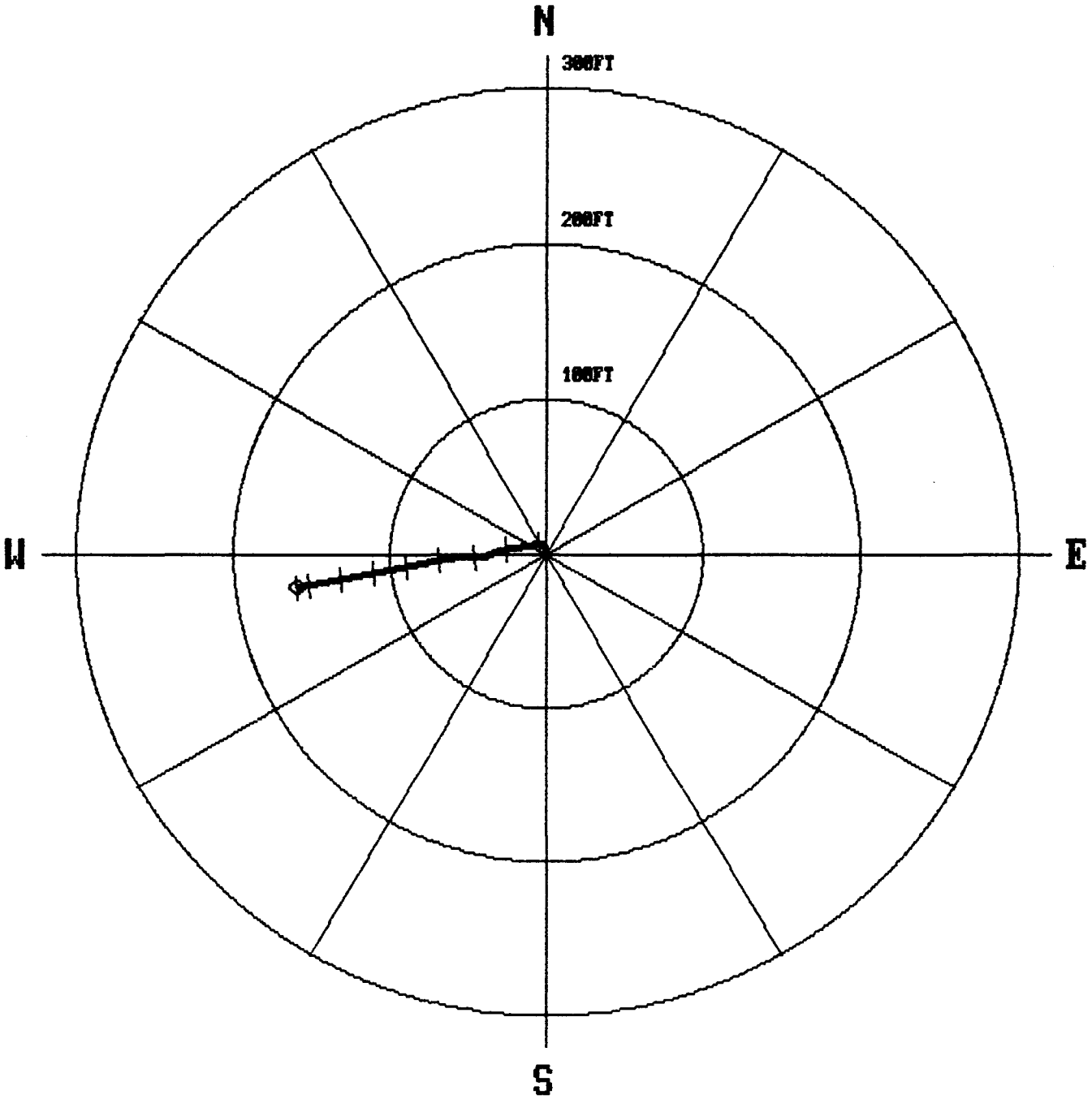
PLAN VIEW

COMPU-LOG DEVIATION

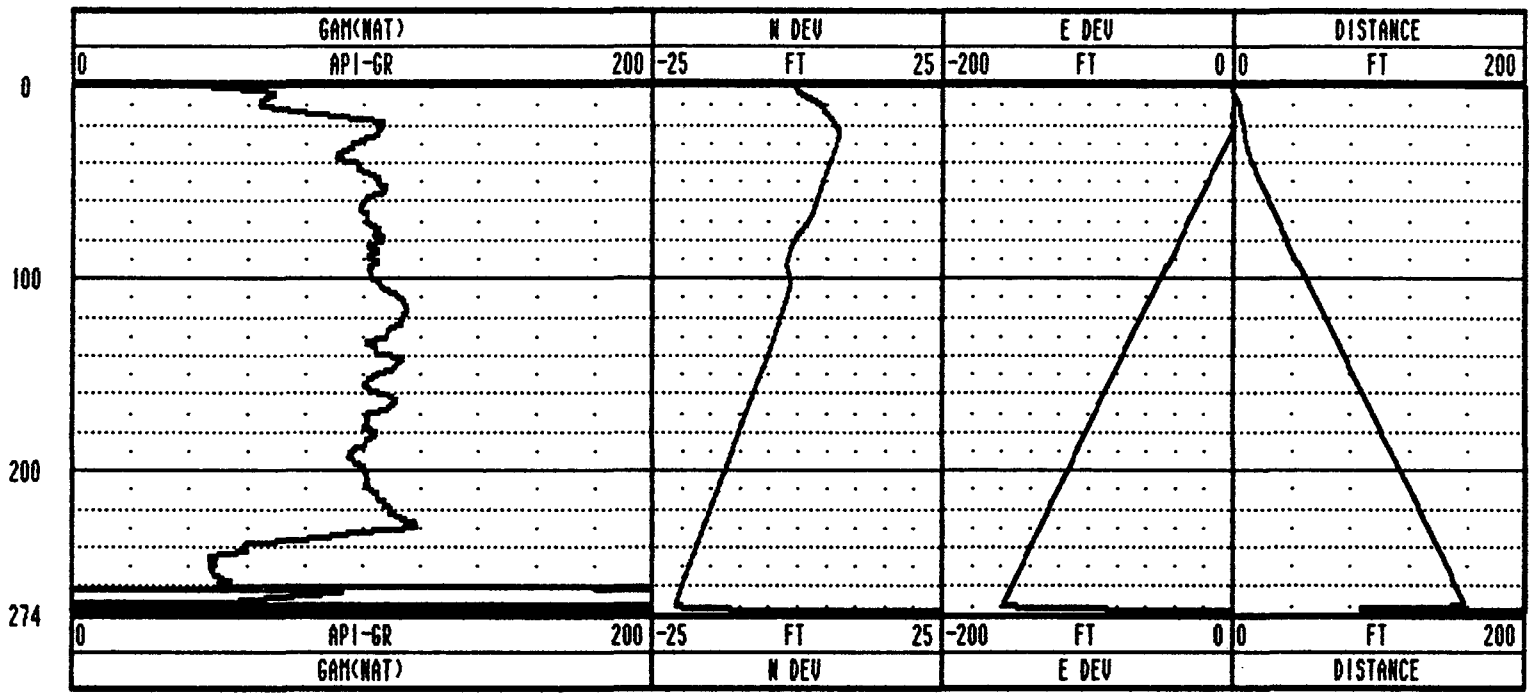
CLIENT: TSSC
LOCATION: TEXAS SSC SITE
HOLE ID: BIR - 53 TASK 16
DATE OF LOG: 11/17/89
PROBE: 9055A 135

MAG DECL: 7.0

SCALE: 100 FT/IN
TRUE DEPTH: 269.07 FT
AZIMUTH: 262.4
DISTANCE: 160.2 FT
+ = 25 FT INCR
O = BOTTOM OF HOLE



Profile View
Compu-Log Deviation
BIR 53



* * * * * * * COMPU-LOG - VERTICAL DEVIATION * * * * * * *

CLIENT : TSSC
FIELD OFFICE : CORSICANA
DATA FROM :
MAG. DECL. : 7.000

HOLE ID. : BIR - 53 TASK
DATE OF LOG : 11/17/89
PROBE : 9055A , 135
DEPTH UNITS : FEET LOG 5

CABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
6.0	5.83	0.41	0.03	0.4	4.2	40.4	349.3
7.0	6.60	1.03	0.11	1.0	6.4	40.2	19.2
8.0	7.36	1.59	-0.02	1.6	359.3	40.3	19.6
9.0	8.12	2.18	0.18	2.2	4.6	40.3	2.6
10.0	8.89	2.81	0.12	2.8	2.5	40.1	21.1
11.0	9.65	3.42	0.03	3.4	0.5	40.2	351.8
12.0	10.41	4.05	0.13	4.1	1.8	40.2	6.4
13.0	11.18	4.64	0.26	4.6	3.2	40.1	43.3
14.0	11.94	4.76	0.23	4.8	2.8	40.2	205.4
15.0	12.70	4.55	-0.10	4.6	358.7	40.4	335.8
16.0	13.47	5.16	-0.02	5.2	359.8	40.3	11.2
17.0	14.24	5.07	-0.22	5.1	357.6	40.0	355.2
18.0	15.00	5.70	-0.09	5.7	359.1	40.0	7.6
19.0	15.77	5.57	-0.20	5.6	358.0	39.9	314.4
20.0	16.53	6.19	-0.25	6.2	357.6	40.3	5.0
21.0	17.29	6.06	-0.26	6.1	357.5	40.2	191.7
22.0	18.06	6.56	-0.14	6.6	358.8	39.8	34.1
23.0	18.83	6.52	-0.03	6.5	359.7	40.0	207.6
24.0	19.59	6.61	0.07	6.6	0.6	39.7	29.8
25.0	20.36	7.13	-0.14	7.1	358.9	41.1	319.7
26.0	21.12	7.32	-0.75	7.4	354.1	40.1	277.7
27.0	21.88	7.31	-1.39	7.4	349.2	40.2	267.1
28.0	22.65	7.25	-2.03	7.5	344.3	39.9	263.6
29.0	23.41	7.18	-2.67	7.7	339.6	40.0	262.8
30.0	24.18	7.09	-3.31	7.8	335.0	40.1	262.3
31.0	24.94	7.00	-3.94	8.0	330.6	40.0	262.2
32.0	25.71	6.89	-4.58	8.3	326.4	39.7	260.4
33.0	26.48	6.78	-5.21	8.6	322.5	40.2	261.5
34.0	27.25	6.69	-5.84	8.9	318.9	40.0	261.4
35.0	28.01	6.58	-6.48	9.2	315.5	40.2	260.7
36.0	28.78	6.47	-7.11	9.6	312.3	40.1	260.5
37.0	29.54	6.36	-7.74	10.0	309.4	39.9	259.6
38.0	30.31	6.24	-8.38	10.4	306.7	40.3	259.9
39.0	31.07	6.13	-9.01	10.9	304.2	40.0	259.1
40.0	31.84	6.01	-9.65	11.4	301.9	40.0	259.4
41.0	32.60	5.89	-10.28	11.8	299.8	40.1	258.6
42.0	33.37	5.77	-10.91	12.3	297.9	40.4	259.9
43.0	34.13	5.65	-11.55	12.9	296.1	39.7	253.8
44.0	34.89	5.50	-12.17	13.4	294.3	39.6	254.0
45.0	35.66	5.36	-12.80	13.9	292.7	40.6	256.1
46.0	36.42	5.23	-13.44	14.4	291.3	40.5	257.5
47.0	37.18	5.12	-14.08	15.0	290.0	40.4	260.1
48.0	37.94	5.02	-14.72	15.6	288.8	41.4	258.5
49.0	38.69	4.90	-15.37	16.1	287.7	40.8	259.6
50.0	39.44	4.79	-16.01	16.7	286.6	41.3	256.6
51.0	40.20	4.67	-16.66	17.3	285.7	41.8	257.0
52.0	40.94	4.56	-17.32	17.9	284.7	41.3	260.9
53.0	41.70	4.45	-17.97	18.5	283.9	41.4	260.0
54.0	42.45	4.34	-18.62	19.1	283.1	41.3	260.6
55.0	43.20	4.23	-19.27	19.7	282.4	41.3	260.3
56.0	43.95	4.12	-19.92	20.3	281.7	41.3	260.4
57.0	44.70	4.01	-20.57	21.0	281.0	41.2	260.6

* * * * * * * COMPU-LOG - VERTICAL DEVIATION * * * * * * *

CLIENT : TSSC
FIELD OFFICE : CORSICANA
DATA FROM :
MAG. DECL. : 7.000

HOLE ID. : BIR - 53 TASK
DATE OF LOG : 11/17/89
PROBE : 9055A , 135
DEPTH UNITS : FEET LOG 5

CABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
58.0	45.45	3.90	-21.22	21.6	280.4	41.2	260.8
59.0	46.21	3.79	-21.87	22.2	279.8	41.2	260.5
60.0	46.96	3.69	-22.52	22.8	279.3	41.2	260.2
61.0	47.71	3.58	-23.17	23.4	278.8	41.3	260.1
62.0	48.46	3.47	-23.82	24.1	278.3	41.2	260.6
63.0	49.21	3.36	-24.47	24.7	277.8	41.2	260.6
64.0	49.97	3.25	-25.12	25.3	277.4	41.2	259.8
65.0	50.72	3.13	-25.77	26.0	276.9	41.3	259.2
66.0	51.47	3.02	-26.41	26.6	276.5	41.2	259.7
67.0	52.23	2.91	-27.06	27.2	276.1	41.1	259.3
68.0	52.98	2.79	-27.71	27.8	275.8	41.0	259.4
69.0	53.74	2.67	-28.35	28.5	275.4	40.8	259.0
70.0	54.50	2.55	-28.99	29.1	275.0	40.4	257.5
71.0	55.26	2.41	-29.62	29.7	274.7	40.4	254.8
72.0	56.03	2.25	-30.23	30.3	274.3	40.4	245.5
73.0	56.80	2.07	-30.84	30.9	273.8	38.7	251.8
74.0	57.59	1.86	-31.42	31.5	273.4	37.8	248.4
75.0	58.38	1.63	-31.98	32.0	272.9	37.0	245.8
76.0	59.18	1.38	-32.52	32.6	272.4	36.1	242.2
77.0	59.99	1.09	-33.03	33.1	271.9	35.6	239.4
78.0	60.81	0.80	-33.53	33.5	271.4	35.4	238.7
79.0	61.62	0.50	-34.03	34.0	270.8	35.8	239.4
80.0	62.43	0.21	-34.55	34.5	270.4	36.5	242.4
81.0	63.23	-0.04	-35.09	35.1	269.9	37.4	247.5
82.0	64.02	-0.26	-35.66	35.7	269.6	38.4	250.8
83.0	64.80	-0.46	-36.25	36.3	269.3	39.1	253.7
84.0	65.58	-0.63	-36.86	36.9	269.0	39.5	255.5
85.0	66.35	-0.78	-37.48	37.5	268.8	40.0	256.9
86.0	67.11	-0.93	-38.11	38.1	268.6	40.3	257.9
87.0	67.87	-1.06	-38.75	38.8	268.4	40.8	259.0
88.0	68.62	-1.18	-39.39	39.4	268.3	41.2	260.0
89.0	69.38	-1.29	-40.04	40.1	268.2	41.5	261.0
90.0	70.12	-1.38	-40.70	40.7	268.1	42.0	261.9
91.0	70.86	-1.47	-41.37	41.4	268.0	42.5	263.6
92.0	71.60	-1.54	-42.04	42.1	267.9	43.1	263.5
93.0	72.33	-1.59	-42.72	42.8	267.9	43.3	266.3
94.0	73.05	-1.62	-43.41	43.4	267.9	44.0	268.0
95.0	73.77	-1.64	-44.11	44.1	267.9	44.8	269.3
96.0	74.47	-1.64	-44.82	44.8	267.9	45.1	270.3
97.0	75.18	-1.62	-45.53	45.6	268.0	45.9	272.3
98.0	75.86	-1.58	-46.26	46.3	268.0	46.9	274.4
99.0	76.54	-1.50	-46.99	47.0	268.2	48.3	277.1
100.0	77.19	-1.39	-47.74	47.8	268.3	49.3	278.5
101.0	77.85	-1.29	-48.48	48.5	268.5	48.7	277.7
102.0	78.52	-1.21	-49.22	49.2	268.6	47.1	274.7
103.0	79.21	-1.17	-49.94	50.0	268.7	46.1	272.8
104.0	79.90	-1.13	-50.67	50.7	268.7	46.4	273.4
105.0	80.59	-1.09	-51.39	51.4	268.8	46.0	272.5
106.0	81.31	-1.11	-52.08	52.1	268.8	43.3	266.2
107.0	82.05	-1.19	-52.75	52.8	268.7	42.1	262.9
108.0	82.79	-1.27	-53.41	53.4	268.6	41.6	262.1
109.0	83.54	-1.37	-54.07	54.1	268.5	41.6	261.5

* * * * * * * COMPU-LOG - VERTICAL DEVIATION * * * * * * *

CLIENT : TSSC
FIELD OFFICE : CORSICANA
DATA FROM :
MAG. DECL. : 7.000

HOLE ID. : BIR - 53 TASK
DATE OF LOG : 11/17/89
PROBE : 9055A , 135
DEPTH UNITS : FEET LOG 5

CABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
110.0	84.29	-1.47	-54.73	54.7	268.5	41.5	261.7
111.0	85.04	-1.56	-55.38	55.4	268.4	41.6	261.8
112.0	85.79	-1.66	-56.04	56.1	268.3	41.5	261.4
113.0	86.54	-1.77	-56.69	56.7	268.2	41.5	262.0
114.0	87.29	-1.87	-57.35	57.4	268.1	41.4	261.4
115.0	88.04	-1.97	-58.00	58.0	268.1	41.3	260.8
116.0	88.79	-2.08	-58.65	58.7	268.0	41.3	261.1
117.0	89.54	-2.18	-59.30	59.3	267.9	41.2	260.6
118.0	90.29	-2.29	-59.95	60.0	267.8	41.2	260.8
119.0	91.05	-2.40	-60.60	60.6	267.7	41.1	260.4
120.0	91.80	-2.51	-61.25	61.3	267.7	41.2	260.9
121.0	92.55	-2.61	-61.90	62.0	267.6	41.2	260.7
122.0	93.31	-2.72	-62.55	62.6	267.5	41.2	260.8
123.0	94.06	-2.83	-63.20	63.3	267.4	41.2	260.8
124.0	94.81	-2.94	-63.84	63.9	267.4	41.1	260.6
125.0	95.57	-3.05	-64.49	64.6	267.3	41.1	260.4
126.0	96.32	-3.15	-65.14	65.2	267.2	41.1	260.4
127.0	97.07	-3.26	-65.79	65.9	267.2	41.1	260.4
128.0	97.83	-3.37	-66.44	66.5	267.1	41.1	260.4
129.0	98.58	-3.48	-67.08	67.2	267.0	41.1	260.5
130.0	99.33	-3.59	-67.73	67.8	267.0	41.1	260.4
131.0	100.09	-3.70	-68.38	68.5	266.9	41.1	260.5
132.0	100.84	-3.80	-69.03	69.1	266.8	41.1	260.3
133.0	101.59	-3.91	-69.68	69.8	266.8	41.1	260.5
134.0	102.35	-4.02	-70.33	70.4	266.7	41.1	260.6
135.0	103.10	-4.13	-70.97	71.1	266.7	41.1	260.5
136.0	103.85	-4.24	-71.62	71.7	266.6	41.2	261.9
137.0	104.61	-4.35	-72.27	72.4	266.6	41.2	261.9
138.0	105.37	-4.48	-72.91	73.1	266.5	41.2	262.3
139.0	106.12	-4.59	-73.56	73.7	266.4	40.9	260.7
140.0	106.88	-4.71	-74.20	74.3	266.4	40.8	260.7
141.0	107.64	-4.83	-74.84	75.0	266.3	40.8	261.1
142.0	108.40	-4.95	-75.48	75.6	266.2	40.7	261.6
143.0	109.16	-5.08	-76.11	76.3	266.2	40.6	260.3
144.0	109.92	-5.20	-76.75	76.9	266.1	40.4	260.2
145.0	110.68	-5.32	-77.39	77.6	266.1	40.3	259.2
146.0	111.44	-5.45	-78.02	78.2	266.0	40.4	259.2
147.0	112.21	-5.57	-78.66	78.9	266.0	40.4	259.1
148.0	112.97	-5.69	-79.29	79.5	265.9	40.3	259.2
149.0	113.73	-5.81	-79.93	80.1	265.8	40.4	259.8
150.0	114.49	-5.94	-80.56	80.8	265.8	40.3	260.0
151.0	115.26	-6.06	-81.20	81.4	265.7	40.3	259.2
152.0	116.02	-6.19	-81.83	82.1	265.7	40.2	259.1
153.0	116.78	-6.32	-82.46	82.7	265.6	40.2	259.2
154.0	117.55	-6.45	-83.10	83.3	265.6	40.2	258.8
155.0	118.31	-6.57	-83.73	84.0	265.5	40.1	259.0
156.0	119.08	-6.70	-84.36	84.6	265.5	40.1	258.8
157.0	119.84	-6.83	-84.99	85.3	265.4	40.1	258.5
158.0	120.61	-6.95	-85.62	85.9	265.4	40.1	258.5
159.0	121.37	-7.08	-86.25	86.5	265.3	40.1	258.7
160.0	122.14	-7.21	-86.89	87.2	265.3	40.1	258.7
161.0	122.90	-7.33	-87.52	87.8	265.2	40.0	258.6

* * * * * * * COMPU-LOG - VERTICAL DEVIATION * * * * * * *

CLIENT : TSSC
FIELD OFFICE : CORSICANA
DATA FROM :
MAG. DECL. : 7.000

HOLE ID. : BIR - 53 TASK
DATE OF LOG : 11/17/89
PROBE : 9055A , 135
DEPTH UNITS : FEET LOG 5

ABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
162.0	123.67	-7.46	-88.15	88.5	265.2	40.1	258.8
163.0	124.43	-7.58	-88.78	89.1	265.1	40.0	259.2
164.0	125.20	-7.71	-89.41	89.7	265.1	40.1	258.2
165.0	125.96	-7.83	-90.05	90.4	265.0	40.1	258.2
166.0	126.73	-7.95	-90.68	91.0	265.0	40.1	259.1
167.0	127.49	-8.08	-91.31	91.7	264.9	40.1	259.2
168.0	128.26	-8.21	-91.94	92.3	264.9	40.1	259.2
169.0	129.02	-8.34	-92.57	92.9	264.9	40.0	258.8
170.0	129.79	-8.46	-93.20	93.6	264.8	40.0	258.8
171.0	130.55	-8.59	-93.83	94.2	264.8	40.0	259.1
172.0	131.32	-8.72	-94.46	94.9	264.7	40.0	258.6
173.0	132.09	-8.84	-95.09	95.5	264.7	40.0	258.6
174.0	132.85	-8.96	-95.72	96.1	264.7	40.0	259.2
175.0	133.62	-9.08	-96.35	96.8	264.6	40.0	258.6
176.0	134.38	-9.21	-96.98	97.4	264.6	40.0	258.9
177.0	135.15	-9.33	-97.62	98.1	264.5	40.1	259.1
178.0	135.92	-9.46	-98.25	98.7	264.5	40.0	258.8
179.0	136.68	-9.58	-98.88	99.3	264.5	40.0	259.7
180.0	137.45	-9.71	-99.51	100.0	264.4	39.9	259.4
181.0	138.21	-9.84	-100.14	100.6	264.4	40.0	258.5
182.0	138.98	-9.96	-100.77	101.3	264.4	40.0	258.9
183.0	139.75	-10.08	-101.40	101.9	264.3	40.0	258.7
184.0	140.51	-10.21	-102.03	102.5	264.3	40.0	258.4
185.0	141.28	-10.32	-102.66	103.2	264.3	40.0	259.9
186.0	142.04	-10.45	-103.29	103.8	264.2	40.0	258.7
187.0	142.81	-10.57	-103.92	104.5	264.2	40.0	258.8
188.0	143.58	-10.70	-104.55	105.1	264.2	40.0	258.7
189.0	144.34	-10.82	-105.18	105.7	264.1	40.1	258.7
190.0	145.11	-10.95	-105.81	106.4	264.1	40.1	258.6
191.0	145.87	-11.07	-106.45	107.0	264.1	40.1	258.9
192.0	146.64	-11.19	-107.08	107.7	264.0	40.1	258.9
193.0	147.40	-11.31	-107.71	108.3	264.0	40.1	258.8
194.0	148.17	-11.44	-108.34	108.9	264.0	40.1	259.2
195.0	148.93	-11.56	-108.98	109.6	263.9	40.1	258.9
196.0	149.70	-11.68	-109.61	110.2	263.9	40.2	259.3
197.0	150.46	-11.80	-110.24	110.9	263.9	40.1	258.2
198.0	151.23	-11.93	-110.87	111.5	263.9	40.0	259.1
199.0	151.99	-12.06	-111.50	112.2	263.8	40.1	258.2
200.0	152.76	-12.19	-112.13	112.8	263.8	40.1	259.0
201.0	153.52	-12.31	-112.76	113.4	263.8	40.1	258.2
202.0	154.29	-12.44	-113.39	114.1	263.7	40.0	258.6
203.0	155.06	-12.57	-114.02	114.7	263.7	39.7	258.9
204.0	155.82	-12.69	-114.65	115.4	263.7	39.8	259.4
205.0	156.59	-12.81	-115.28	116.0	263.7	40.0	260.7
206.0	157.35	-12.92	-115.92	116.6	263.6	40.2	259.5
207.0	158.12	-13.04	-116.56	117.3	263.6	40.3	259.4
208.0	158.88	-13.16	-117.19	117.9	263.6	40.2	259.0
209.0	159.64	-13.28	-117.82	118.6	263.6	40.2	259.2
210.0	160.41	-13.41	-118.46	119.2	263.5	40.3	259.2
211.0	161.17	-13.53	-119.09	119.9	263.5	40.3	259.0
212.0	161.93	-13.65	-119.73	120.5	263.5	40.3	259.6
213.0	162.70	-13.77	-120.36	121.1	263.5	40.3	259.6

* * * * * * * COMPU-LOG - VERTICAL DEVIATION * * * * * * *

CLIENT : TSSC
FIELD OFFICE : CORSICANA
DATA FROM :
MAG. DECL. : 7.000

HOLE ID. : BIR - 53 TASK
DATE OF LOG : 11/17/89
PROBE : 9055A , 135
DEPTH UNITS : FEET LOG 5

CABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
214.0	163.46	-13.89	-121.00	121.8	263.5	40.2	258.8
215.0	164.22	-14.01	-121.63	122.4	263.4	40.2	259.2
216.0	164.99	-14.13	-122.27	123.1	263.4	40.2	259.7
217.0	165.75	-14.25	-122.90	123.7	263.4	40.3	259.8
218.0	166.51	-14.36	-123.54	124.4	263.4	40.3	259.9
219.0	167.27	-14.48	-124.18	125.0	263.3	40.4	260.0
220.0	168.03	-14.60	-124.81	125.7	263.3	40.5	260.4
221.0	168.80	-14.71	-125.45	126.3	263.3	40.5	258.6
222.0	169.56	-14.83	-126.09	127.0	263.3	40.2	257.8
223.0	170.32	-14.96	-126.72	127.6	263.3	40.1	258.7
224.0	171.09	-15.08	-127.35	128.2	263.2	40.2	259.1
225.0	171.85	-15.20	-127.99	128.9	263.2	40.0	258.8
226.0	172.62	-15.32	-128.62	129.5	263.2	40.0	258.5
227.0	173.38	-15.45	-129.25	130.2	263.2	40.0	258.8
228.0	174.15	-15.57	-129.88	130.8	263.2	39.9	258.5
229.0	174.92	-15.70	-130.51	131.4	263.1	39.9	258.5
230.0	175.68	-15.83	-131.14	132.1	263.1	39.7	256.6
231.0	176.45	-15.96	-131.76	132.7	263.1	39.9	258.5
232.0	177.22	-16.09	-132.39	133.4	263.1	39.9	258.1
233.0	177.99	-16.22	-133.02	134.0	263.0	39.8	258.6
234.0	178.76	-16.35	-133.64	134.6	263.0	39.9	259.1
235.0	179.52	-16.47	-134.27	135.3	263.0	39.9	259.0
236.0	180.29	-16.60	-134.90	135.9	263.0	39.9	259.0
237.0	181.06	-16.72	-135.53	136.6	263.0	39.9	258.8
238.0	181.82	-16.83	-136.16	137.2	263.0	40.1	262.0
239.0	182.59	-16.95	-136.80	137.8	262.9	40.1	258.8
240.0	183.35	-17.07	-137.43	138.5	262.9	40.2	259.6
241.0	184.12	-17.20	-138.06	139.1	262.9	39.9	257.5
242.0	184.88	-17.34	-138.69	139.8	262.9	40.2	258.3
243.0	185.65	-17.46	-139.32	140.4	262.9	40.1	258.6
244.0	186.41	-17.58	-139.95	141.1	262.8	40.0	258.5
245.0	187.18	-17.70	-140.59	141.7	262.8	40.1	259.8
246.0	187.94	-17.83	-141.22	142.3	262.8	40.0	258.7
247.0	188.71	-17.96	-141.85	143.0	262.8	40.1	258.4
248.0	189.48	-18.08	-142.48	143.6	262.8	40.0	258.8
249.0	190.24	-18.21	-143.11	144.3	262.7	40.0	258.0
250.0	191.01	-18.34	-143.74	144.9	262.7	40.0	258.5
251.0	191.77	-18.46	-144.37	145.5	262.7	40.0	259.3
252.0	192.54	-18.58	-145.00	146.2	262.7	40.1	258.6
253.0	193.30	-18.71	-145.63	146.8	262.7	40.1	259.1
254.0	194.07	-18.83	-146.27	147.5	262.7	40.1	259.2
255.0	194.83	-18.95	-146.90	148.1	262.6	40.2	259.2
256.0	195.60	-19.07	-147.53	148.8	262.6	40.2	259.0
257.0	196.36	-19.18	-148.17	149.4	262.6	40.3	259.4
258.0	197.12	-19.30	-148.80	150.1	262.6	40.2	259.0
259.0	197.89	-19.42	-149.44	150.7	262.6	40.4	259.7
260.0	198.65	-19.53	-150.08	151.3	262.6	40.3	258.7
261.0	199.41	-19.64	-150.72	152.0	262.6	40.4	259.1
262.0	200.17	-19.76	-151.36	152.6	262.6	40.7	261.1
263.0	200.93	-19.87	-152.00	153.3	262.6	40.7	262.1
264.0	201.69	-19.99	-152.64	153.9	262.5	40.4	259.4
265.0	202.45	-20.11	-153.28	154.6	262.5	40.3	259.5

* * * * * * * COMPU-LOG - VERTICAL DEVIATION * * * * * * *

CLIENT	: TSSC	HOLE ID.	: BIR - 53 TASK
FIELD OFFICE	: CORSICANA	DATE OF LOG	: 11/17/89
DATA FROM	:	PROBE	: 9055A , 135
MAG. DECL.	: 7.000	DEPTH UNITS	: FEET LOG 5

CABLE DEPTH	TRUE DEPTH	NORTH DEV.	EAST DEV.	DISTANCE	AZIMUTH	SANG	SANGB
266.0	203.21	-20.23	-153.91	155.2	262.5	40.7	260.7
267.0	203.97	-20.34	-154.55	155.9	262.5	40.5	260.4
268.0	204.73	-20.45	-155.19	156.5	262.5	40.4	259.5
269.0	205.49	-20.57	-155.83	157.2	262.5	40.5	259.5
270.0	206.25	-20.69	-156.47	157.8	262.5	40.5	259.5
271.0	207.01	-20.80	-157.11	158.5	262.5	40.4	259.3
272.0	207.77	-20.93	-157.75	159.1	262.4	40.6	258.8
273.0	208.53	-21.04	-158.38	159.8	262.4	40.3	257.8
274.0	209.17	-21.12	-158.83	160.2	262.4	0.0	14.0
274.0	209.17	-21.12	-158.83	160.2	262.4	0.0	14.0

WIRE-LINE LOGGING PARAMETERS

Hole No. BIR 54 **Log Measured From:** Ground Level

Drilling Parameters

Depth 422.0 feet

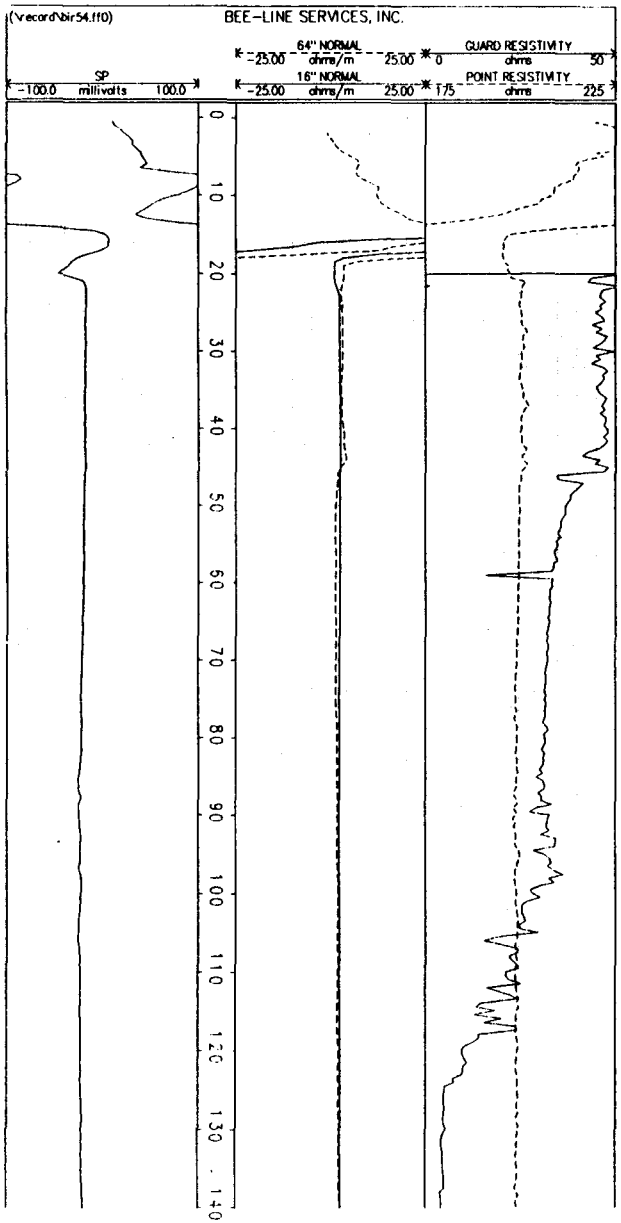
Bit Diameter 4.75 inches

Logging Parameters	Electrical Log	Gamma and Neutron Logs	Sonic Log
Date	October 2, 1990	October 2, 1990	October 2, 1990
Bottom Log Interval	419.0 feet	419.0 feet	415.0 feet
Top Log Interval	surface	surface	surface
Type of Fluid in Hole	drilling mud	drilling mud	drilling mud
Time Since Circulation Stop	45 minutes	45 minutes	45 minutes
Probe Type/S.N.	ALP-4979	XAP-4383	CLP-4877A
Module Type/S.N.	ALM-4979	XAM-4383	CLM-4877A
Logging Speed	40 feet/min.	20 feet/min.	20 feet/min.
Sample Interval	0.5 foot	0.5 foot	0.5 foot

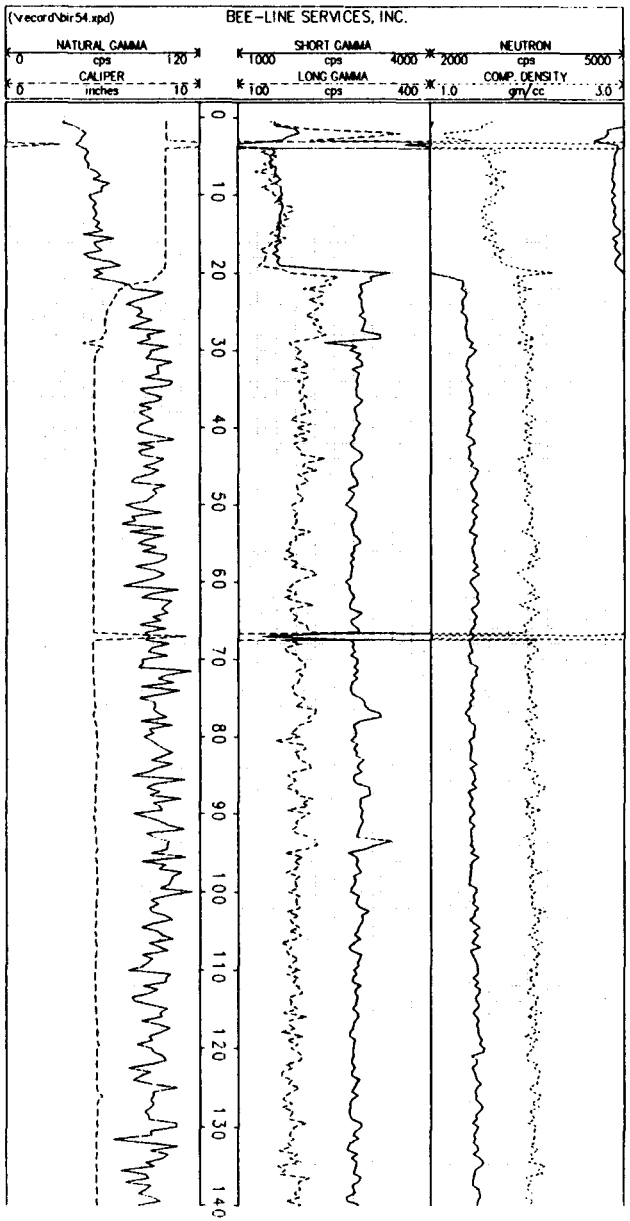
Logged by: BEE-LINE SERVICES, INC.
P. O. Box 2096
Corsicana, TX 75151

BIR 54 Wire-line logs run October 2, 1989. Surface elevation 440.3 feet.

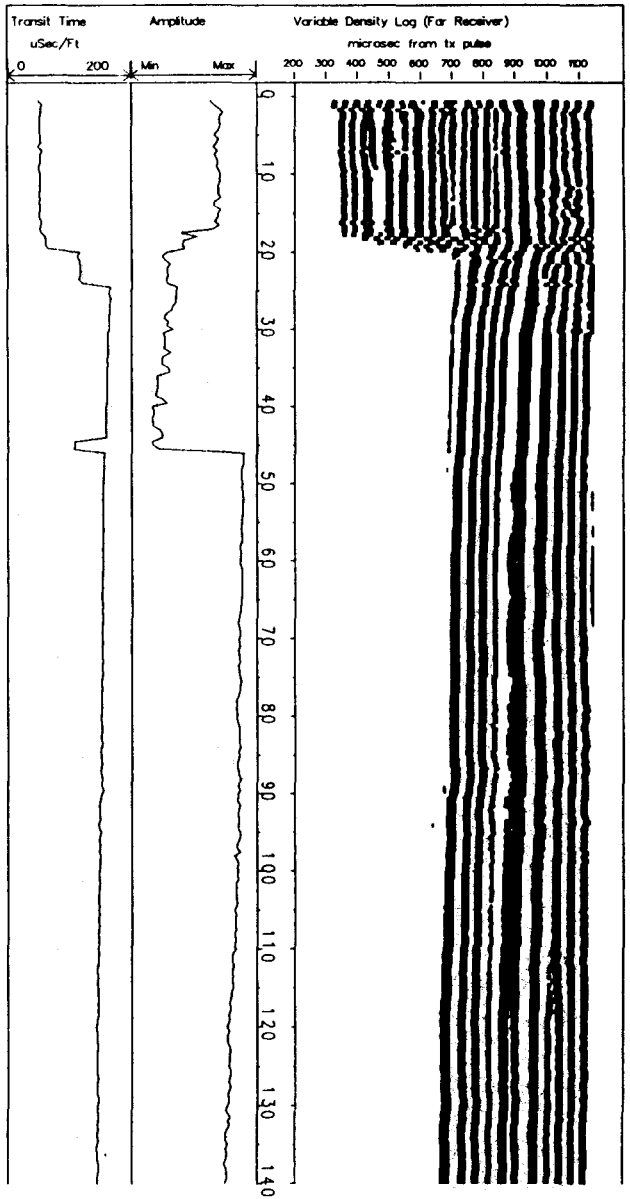
ELECTRICAL LOG



GAMMA AND NEUTRON LOGS

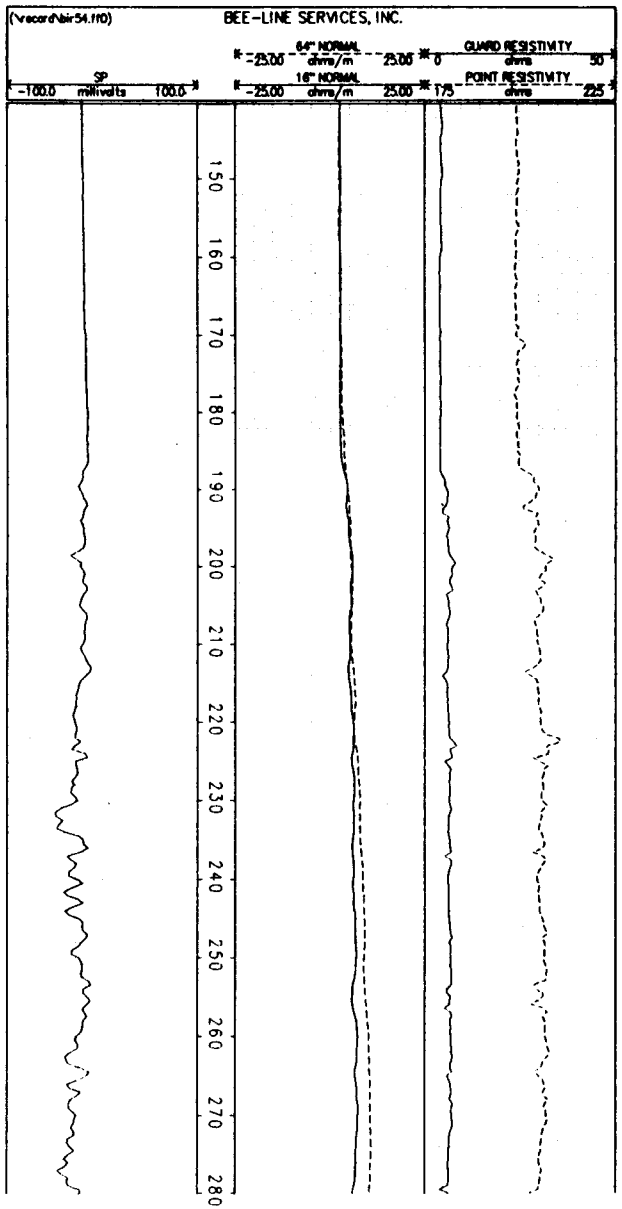


SONIC LOG

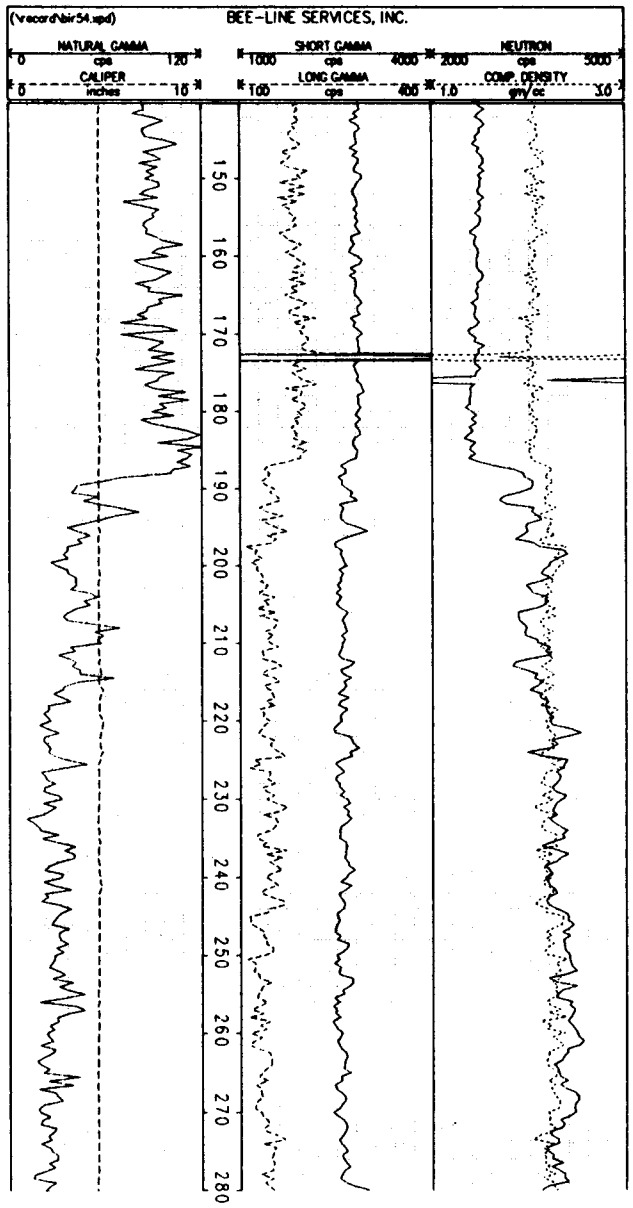


BIR 54 Wire-line logs run October 2, 1989 (Continued). Surface elevation 440.3 feet.

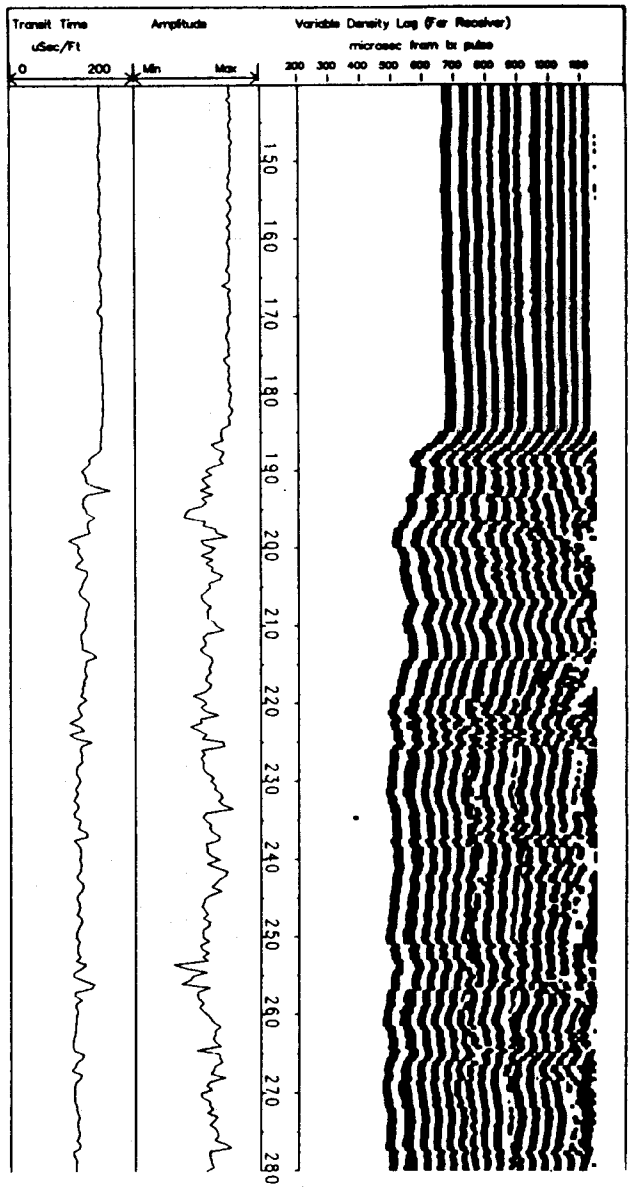
ELECTRICAL LOG CONTINUED



GAMMA AND NEUTRON LOGS CONTINUED

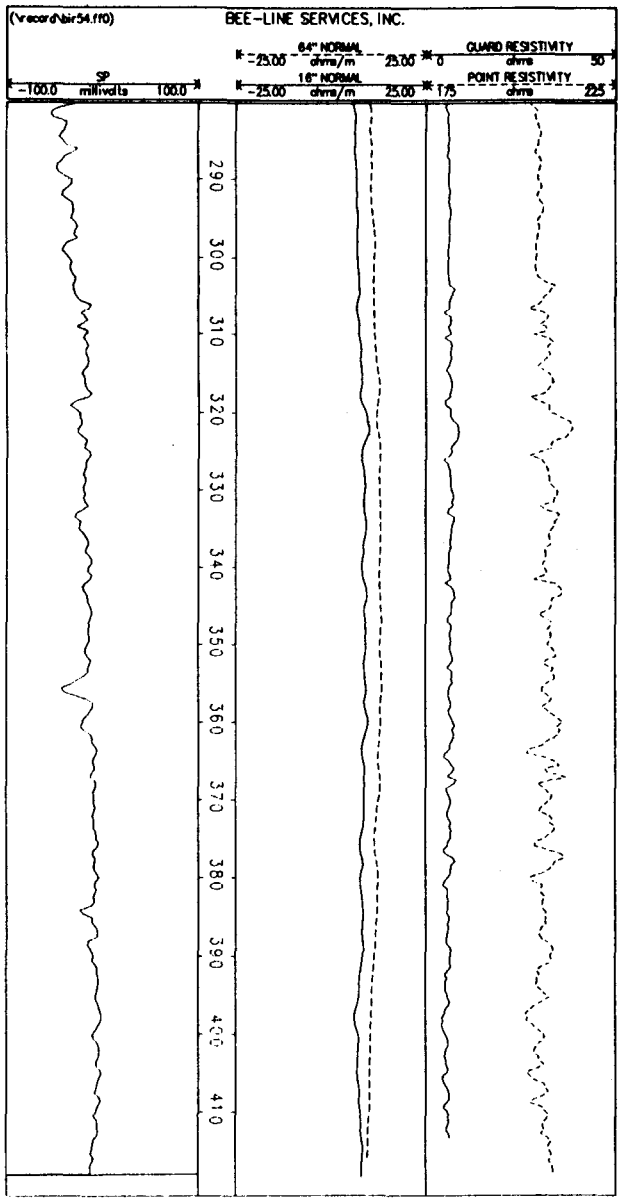


SONIC LOG CONTINUED

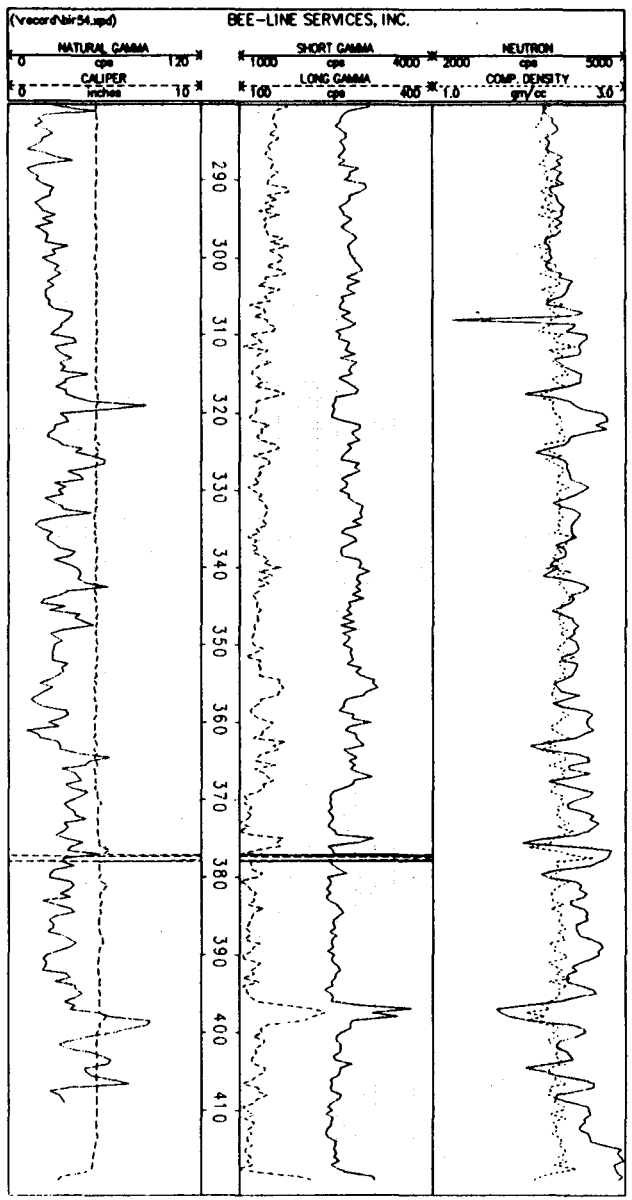


BIR 54 Wire-line logs run October 2, 1989 (Continued). Surface elevation 440.3 feet.

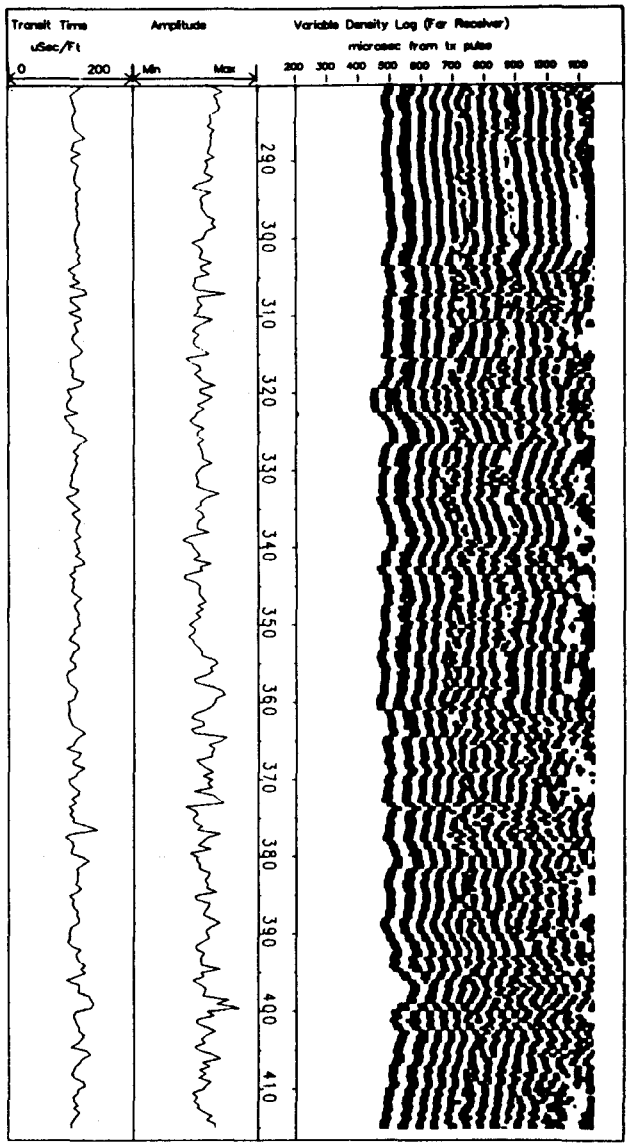
ELECTRICAL LOG CONTINUED



GAMMA AND NEUTRON LOGS CONTINUED



SONIC LOG CONTINUED



APPENDIX C

SITE GEOLOGY

SITE GEOLOGY - INTERACTION REGION 5

Field mapping at IR 5 consisted primarily of locating and measuring the bearing of joints and locating and identifying the presence of faults within the area. Over 100 joints were measured along a nearby drainage and in an L-shaped trench excavated at the site. Two joint sets were recognized and each was characterized according to roughness of the joint surfaces and the degree of alteration. Faults were identified by photo interpretation and review of boring logs. Because the Taylor Marl is severely weathered, physical evidence of faulting at the surface was difficult to determine in the field.

- **Setting** - See Drawing GP-3 (in pocket).
- **Location and Topographic Setting:** IR 5 is approximately 3.8 miles southwest of Palmer, Texas, on gently sloping, slightly undulating topography.
- **Surface Slope:** Approximately 1 to 2 degrees to the south.
- **Current and Prior Use:** Current use is pastureland; prior use was probably cultivated cropland and pastureland.
- **Cultural Features and Structures within 50 feet of the IR:** See Drawing GP-3 in pocket. IR 5 is in a large pasture approximately 1,500 feet from the nearest road and overhead power lines. The site is situated astride two large livestock tanks (ponds) with the nearest spillway approximately 200 feet east of boring BIR 54.
- **Surface Soil Type:** The topsoil at the trench is approximately 3.5 feet thick and consists of medium to dark brown silty clay with medium to high plasticity and showing iron oxidation. Desiccation cracks 0.25 inch to 2 inches wide are common throughout the site and extend to a depth of approximately 3.5 feet (top of weathered Taylor Marl).
- **Erosional Drainage Features:** One primary drainage is located approximately 720 feet south of the site. The IR lies on top of an existing livestock watering tank, which consists of a dam (elevation 452.1) and a spillway south of the IR.
- **Vegetation:** Vegetation is dominated by short grasses and wildflowers. There are a few scattered trees in the fields and along portions of drainages.
- **Surface Geology:** IR 5 is in the Taylor Marl. Bedrock is exposed in a drainage 1,900 feet southwest of the IR, and consists of bluish gray to dark gray, slightly fossiliferous, slightly calcareous shale. Bedding is typically irregular to undulating and bedding planes and fractures are commonly filled with gypsum crystals. Surface exposures of the Taylor Marl are severely weathered and typically require removing 2 to 3 feet of soil before bedrock can be described.

- **Subsurface Geology:** Drawing GS-7 (Geologic Profiles, in pocket) illustrates the subsurface geologic conditions that are expected to be encountered at the IR. These profiles were compiled using the data collected from the borings around the IR.

- **Joint Characterization (in Austin Chalk):**

Joint Set	I	II
Orientation[1]	N70° W to N62°E subvertical dips 70°SW to 64°NE	N19°W to Due East, subhorizontal dips 2°NW to 17°SW
Joint Spacing[2]	2.5 ft (± 1.9) n = 29	0.16 ft (± 0.06) n = 20
Joint Roughness[3]	Smooth, planar to smooth undulating JRC[4] = 8-20	Rough planar to rough undulating JRC[4] = 4-14
Joint Alteration	Wall rock to wall rock contact; unaltered, surface staining only	Wall rock to wall rock contact; unaltered, surface staining only
Comments		Bedding

1. See stereographic plot of poles to fractures on Drawing GP-3, in pocket.
2. n = the number of fracture spacing measurements made in the field for that fracture set.
3. Descriptions refer to small-scale features and intermediate-scale features, in that order.
4. JRC =Joint Roughness Coefficient.

APPENDIX D

HYDROLOGIC TEST RESULTS

APPENDIX D

The objectives of the hydrogeologic (packer) tests were to provide estimates of the hydraulic conductivity at the Taylor Marl/Austin Chalk or Austin Chalk/Eagle Ford Shale contacts and within fractured or other suspected water-bearing zones. Intervals within boreholes were selected for packer testing based on visual inspections of rock cores and the results of borehole geophysical testing. Sections of a borehole that exhibited increased frequency of fractures or bedding plane parting were commonly packer tested.

Standard procedures used to conduct these tests included lowering a pair of pneumatically operated rubber packers (in straddle-packer configuration) separated by a known length of perforated pipe into the drill hole to a predetermined depth. The packer interval was approximately 20 feet. The packers were then inflated to a precalculated pressure to seal against the rock side walls and water was pumped into the test interval at a selected pressure while the flow rate was measured with a cumulative flow meter. To improve the accuracy of measurements at the low flow rates encountered in most of these tests, the water was often pumped from a large container (e.g., a drum or section of casing) and the volume removed was recorded. In addition to monitoring the water pressure and flow rate at appropriate intervals, the height of the water pressure gauge above ground surface, as well as the diameter and length of water pipe used, was recorded. The tests were continued until five consecutive readings indicated a stabilization of the flow rate but for a minimum of at least 10 minutes. Standard forms were used for data records and the hydraulic conductivity was calculated using standard Bureau of Reclamation procedures.

STRADDLE PACKER TEST RESULTS

Boring	Test Depth (feet)	Packer Pressure (psi)	Gauge Pressure (psi)	Formation/ Lithology	Hydraulic Conductivity* (cm/sec)
BIR 53	176.8-198.8 (vertical depth 135.0-151.8)	200	20	Taylor Marl	$<5.0 \times 10^{-7}$
	228.0-250.0 (vertical depth 174.2-191.0)	200	19.5	Taylor Marl/ Austin Chalk Contact	$<5.1 \times 10^{-7}$
BIR 54	163.0-183.0	200	20	Taylor Marl	$<6.0 \times 10^{-8}$
	183.0-203.0	200	20	Taylor Marl/ Austin Chalk Contact	$<6.0 \times 10^{-8}$

* Based on approximate static water level of 9.5 feet above ground surface.

At boring BIR 53 (an angled boring), two test intervals were selected based on an inspection of the rock core and review of the boring and wire-line logs. The first interval (Test 1) was from 228.0 to 250.0 feet (vertical depth 174.2 to 191.0 feet) and encompassed the contact between the Taylor Marl and the Austin Chalk. The second interval (Test 2) was from 176.8 to 198.8 feet (vertical depth 135.0 to 151.8 feet) and represented typical Taylor Marl lithology. No other fractures or other indicators of potentially increased permeability were noted in this boring. Hydrogeologic (packer) testing are listed in the table above. Flow volumes were derived from flow meter readings.

At boring BIR 54, two intervals were selected based on an inspection of the rock core and review of the boring and wire-line logs. The first interval (Test 1) selected was from 183.0 to 203.0 feet and encompassed the contact between the Taylor Marl and Austin Chalk. The second interval (Test 2) was from 163.0 to 183.0 feet and represented typical Taylor Marl lithology. No fractures or other indicators of potentially increased premeability were noted. Hydrogeologic (packer) testing in BIR 54 followed the standard procedures as outlined above. The deeper zone was tested first (Test 1) followed by the shallower zone (Test 2). Packer and gauge pressures are listed in the table above. Flow volumes were derived from flow meter reading and beginning/end readings from a calibrated container (approximately 3-foot length of 8-inch diameter steel casing).

APPENDIX E

LABORATORY RESULTS

BULK AND CLAY MINERALOGY

TEST RESULTS

TABLE E-1. BULK AND CLAY MINERALOGY TEST RESULTS - BIR 54

Formation: Taylor Marl **Depth:** 20.1 ft.

Whole Rock Composition:

Mineral	Percent
quartz	23
K feldspar	3
plagioclase	3
calcite	32
dolomite	4
siderite	4
pyrite	3
total clay	28
Total	100

Relative Clay Abundance:

Mineral	Percent
illite	18
kaolinite	14
mixed layer (illite/smectite)	68
Total	100

Formation: Taylor Marl **Depth:** 117.1 ft

Whole Rock Composition:

Mineral	Percent
quartz	24
K-feldspar	1
plagioclase	5
calcite	30
dolomite	3
pyrite	2
total clay	35
Total	100

Relative Clay Abundance:

Mineral	Percent
illite	11
kaolinite	17
mixed layer (illite/smectite)	72
Total	100

Formation: Taylor Marl **Depth:** 166.5 ft

Whole Rock Composition:

Mineral	Percent
non-clay minerals	59
total clay	41
Total	100

Relative Clay Abundance:

Mineral	Percent
illite	10
kaolinite	15
mixed layer (illite/smectite)	75
Total	100

GEOMECHANICAL TEST RESULTS

GEOMECHANICAL TEST RESULTS

BORING BIR 51

TABLE E-2. GEOMECHANICAL TEST RESULTS - BIR 51

Geologic Formation and General Lithology	Vertical Depth	Moisture Content	Dry Density	Specific Gravity	Atterberg Limits		Sample Dimension Ratio L/D	Sample Failure Mode	Uniaxial Compressive Strength	Triaxial Compression		Failure Strain	Tangent Young's Modulus		Brazil Tensile Strength	Carbonate Content
					Liquid Limit	Plasticity Index				σ_c	$\sigma_1 - \sigma_3$		E_{50}	σ_3		
	feet	percent	pcf						psi	psi	psi	percent	psi x 10^5	psi	psi	percent
R. Soil	2.0	20.9	105.9													
R. Soil	4.0	22.6			55	33										
R. Soil	4.3	22.8	104.3													
R. Soil	6.0	22.7	101.0													
R. Soil	8.0	24.5			60	37										
R. Soil	8.0	24.3	101.5													
R. Soil	10.3	23.3	102.3													
R. Soil	12.0	25.5	100.4													
R. Soil	14.3	25.7			69	42										
R. Soil	14.3	25.6	99.8													
Taylor Marl	44.4	17.4	114.0													
Taylor Marl	87.3	16.9														
Taylor Marl	87.3															
Taylor Marl	88.2			2.68												
Taylor Marl	88.2	16.1	116.9				2.0	D	559			1.2				
Taylor Marl	88.5				89	57										
Taylor Marl	113.2	16.4														31.0
Taylor Marl	113.2															
Taylor Marl	113.4	15.5	118.1				2.1	D	742							
Taylor Marl	113.8				87	56										
Taylor Marl	115.0	15.8														
Taylor Marl	115.2	14.9	119.7				2.4	B-1/30°		50	713	0.8	1.0			
Taylor Marl	115.2															32.1
Taylor Marl	115.6	15.9														
Taylor Marl	115.7	14.9	119.1				2.3	B-1/45°		200	900	1.0	1.4			
Taylor Marl	162.4	16.8														
Taylor Marl	162.7			2.71												
Taylor Marl	162.7															31.6
Taylor Marl	162.9	16.3	115.9				2.0	C	648			1.1				
Taylor Marl	163.3				92	58										
Taylor Marl	164.0	16.8														
Taylor Marl	164.2	16.3	116.7				2.3	B-1/41°		100	652	0.8				
Taylor Marl	164.2												1.1			25.2
Taylor Marl	165.0	15.4														
Taylor Marl	165.2	13.6	122.4				2.3	B-1/29°		300	847	0.7	1.7			
Taylor Marl	176.7	16.1														
Taylor Marl	176.8															24.4
Taylor Marl	177.0				84	53										
Taylor Marl	178.0	15.4	118.4				1.9	B-1/35°	618			1.0				
Austin Chalk	189.3	12.8														
Austin Chalk	189.4	10.6													271	
Austin Chalk	189.5	10.6	130.7				2.0	D	1962			1.1				
Procedure		ASTM-D2216		ASTM-D854	ASTM-D4318				ASTM-D2938	ASTM-D2664			ASTM-D3148		ASTM-D3967	

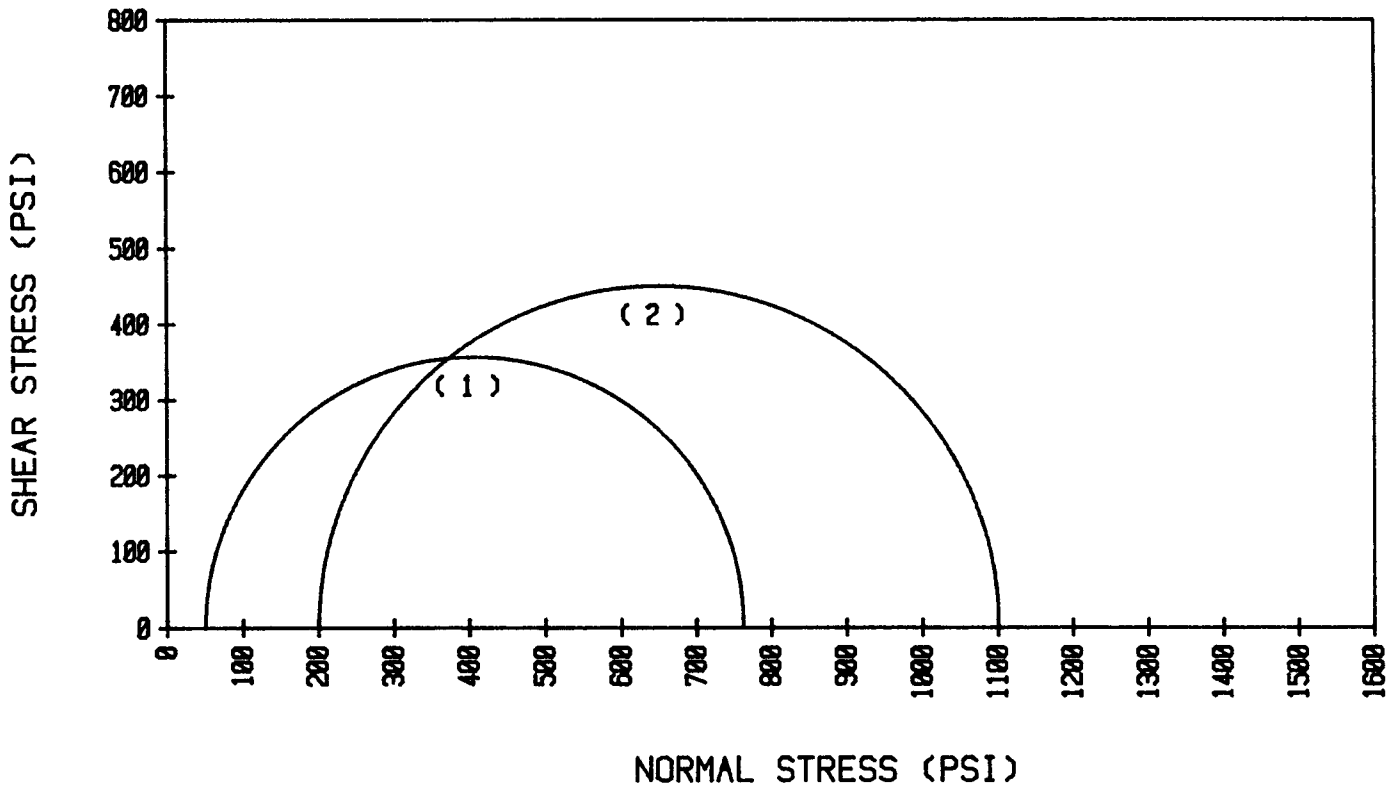
Symbol	Failure Type
A	No discernible failure plane
(B)	Well defined shear plane @ X angle (deg) to vertical or to long axis of core
B-1	Shear plane
B-2	Bedding plane shear
B-3	Shear plane along preexisting fracture, shear zone, etc.
B-4	Combination
C	Barreling/Bulging
D	Longitudinal (axial) splitting
E	Conical
F	No information

PRELIMINARY (Subject to Revision)

Note: Some values in this table may be revised based on reviews of test procedures and individual test results. The reader should refer to the latest revision of the gINT geotechnical data base (geotechnical report GR-70).

BORING NO.: BIR51
DEPTH RANGE (FT): 115.2-116.1
TAYLOR MARL

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 115.2
(2) DEPTH (FT) : 115.7

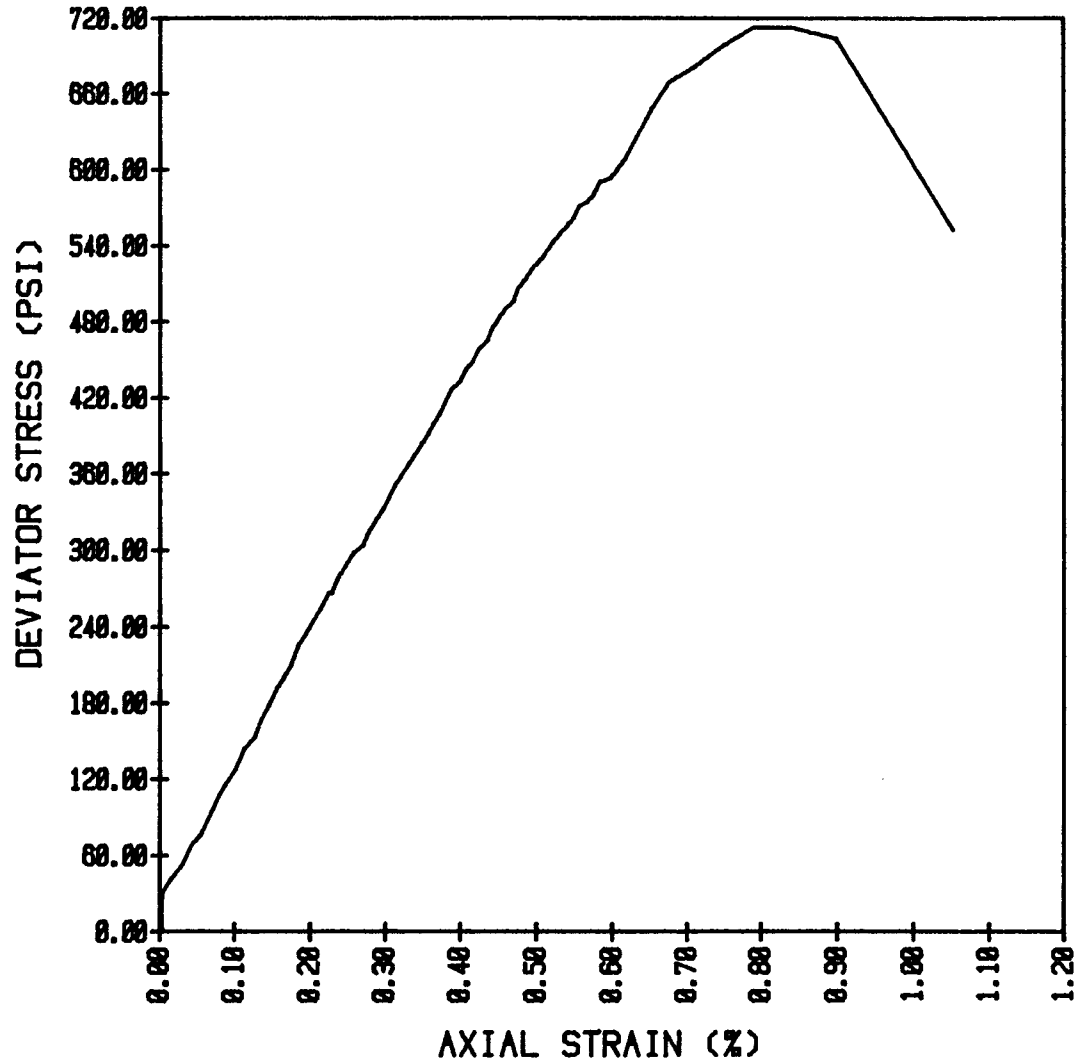
TEXAS SSC SITE

MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR51
DEPTH (FT): 115.2
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =14.9
DRY UNIT WEIGHT (PCF) =119.7
DEG. OF SATURATION (%) = 99.0
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 50
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.984 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 30 DEG

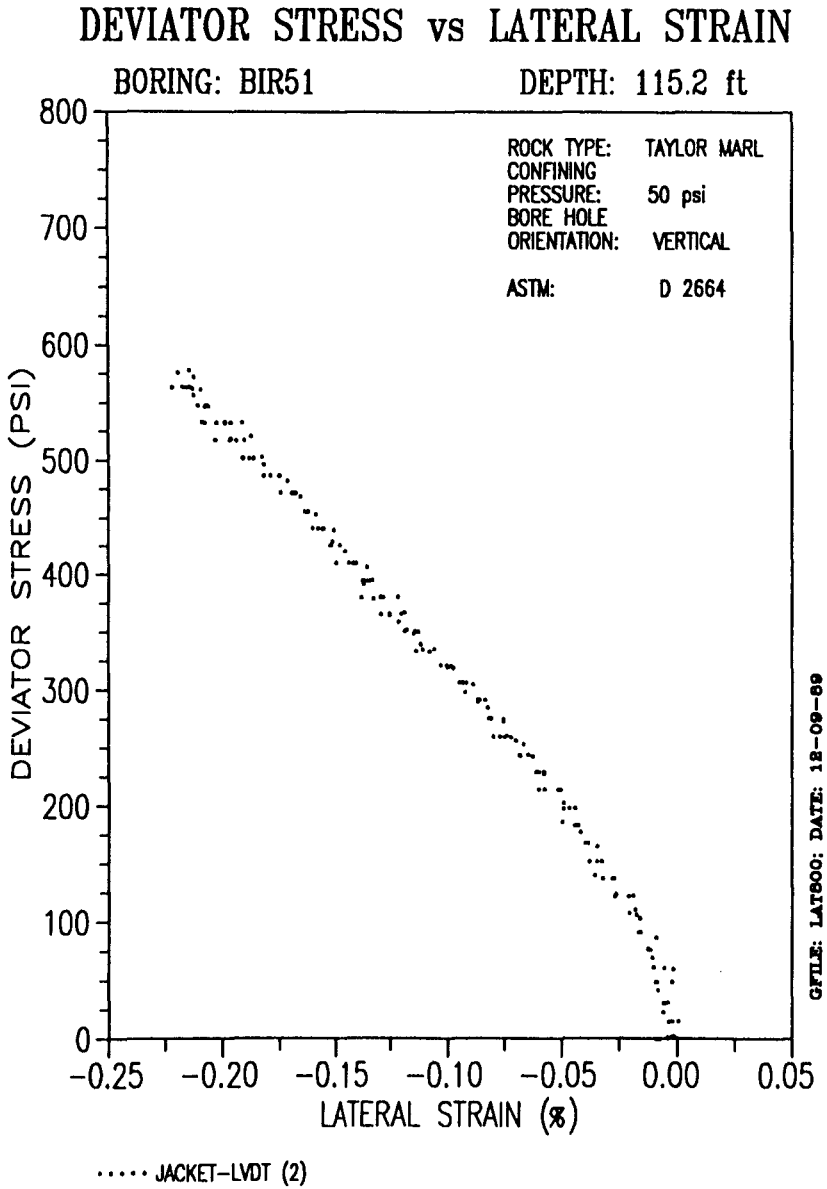
TEXAS SSC SITE

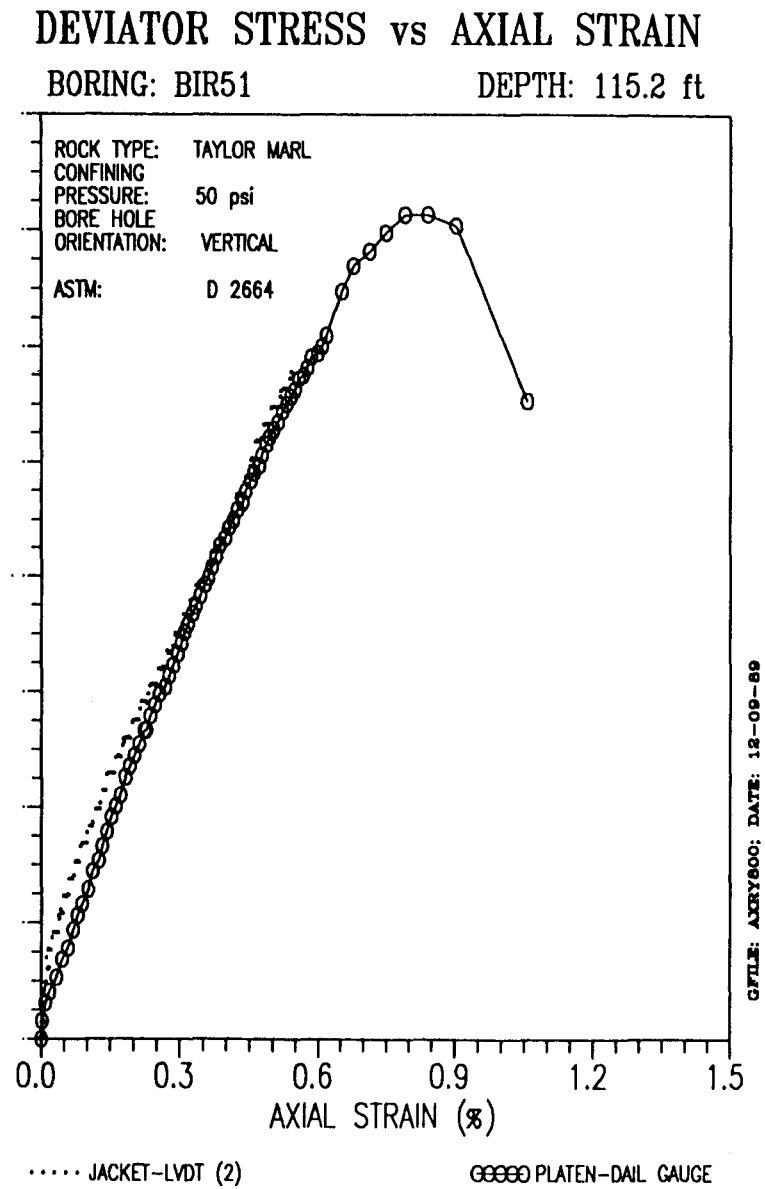
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

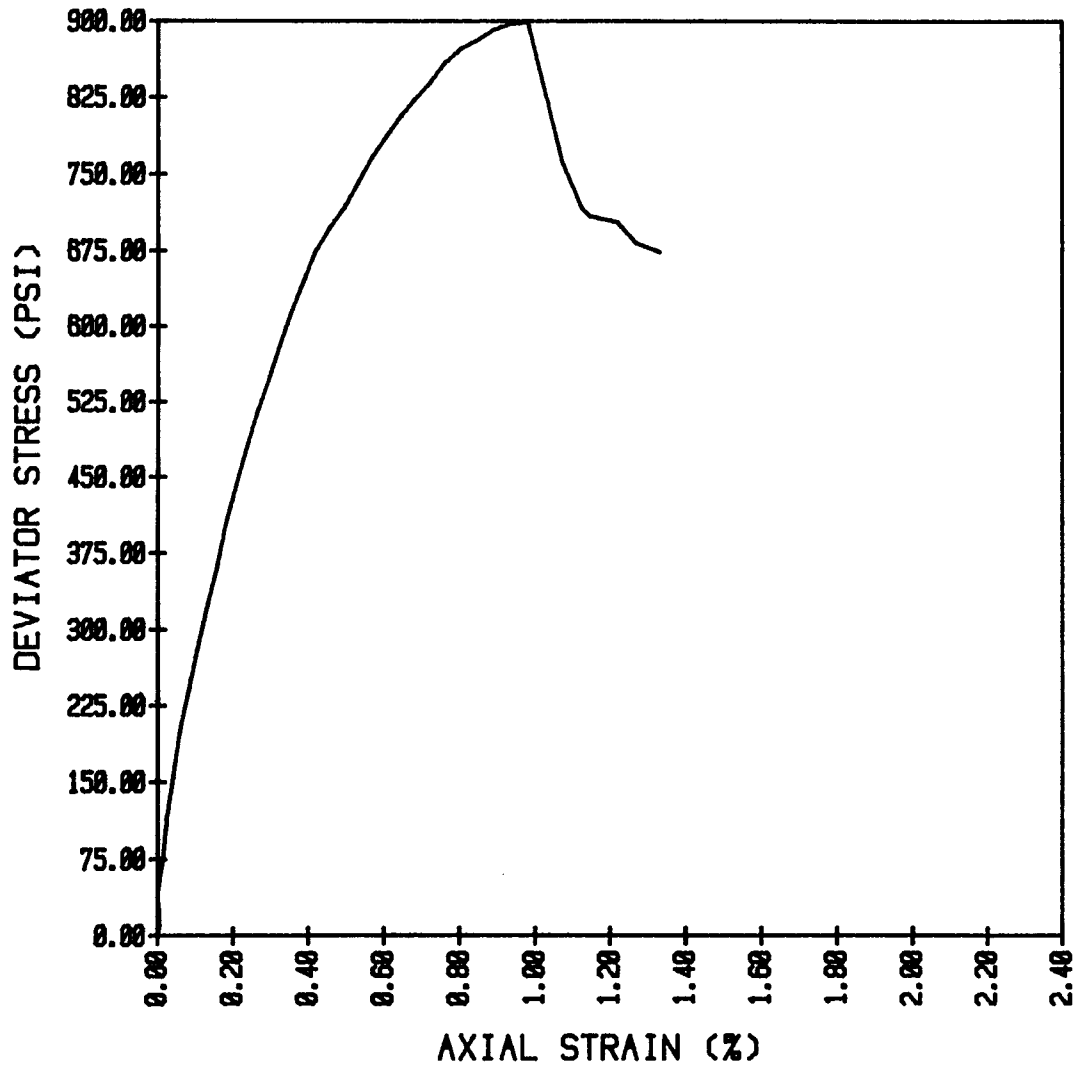
JOB NO.: 5530.16

FIGURE


DEVIATOR STRESS vs LATERAL STRAIN
BORING: BIR51
DEPTH: 115.2 ft
ROCK TYPE: TAYLOR MARL
CONFINING PRESSURE: 50 psi
BORE HOLE ORIENTATION: VERTICAL
ASTM: D 2664
DEVIATOR STRESS (PSI)
LATERAL STRAIN (%)
GFILE: LAT600; DATE: 12-09-89
JACKET-LVDT (2)


DEVIATOR STRESS vs AXIAL STRAIN
BORING: BIR51
DEPTH: 115.2 ft
ROCK TYPE: TAYLOR MARL
CONFINING PRESSURE: 50 psi
BORE HOLE ORIENTATION: VERTICAL
ASTM: D 2664
AXIAL STRAIN (%)
GFILE: AXRY600; DATE: 12-09-89
JACKET-LVDT (2)
PLATEN-DAIL GAUGE

BORING NO. : BIR51
DEPTH (FT): 115.7
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =14.9
DRY UNIT WEIGHT (PCF) =119.1
DEG. OF SATURATION (%) = 96.7
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :200
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.429 x1E5 PSI

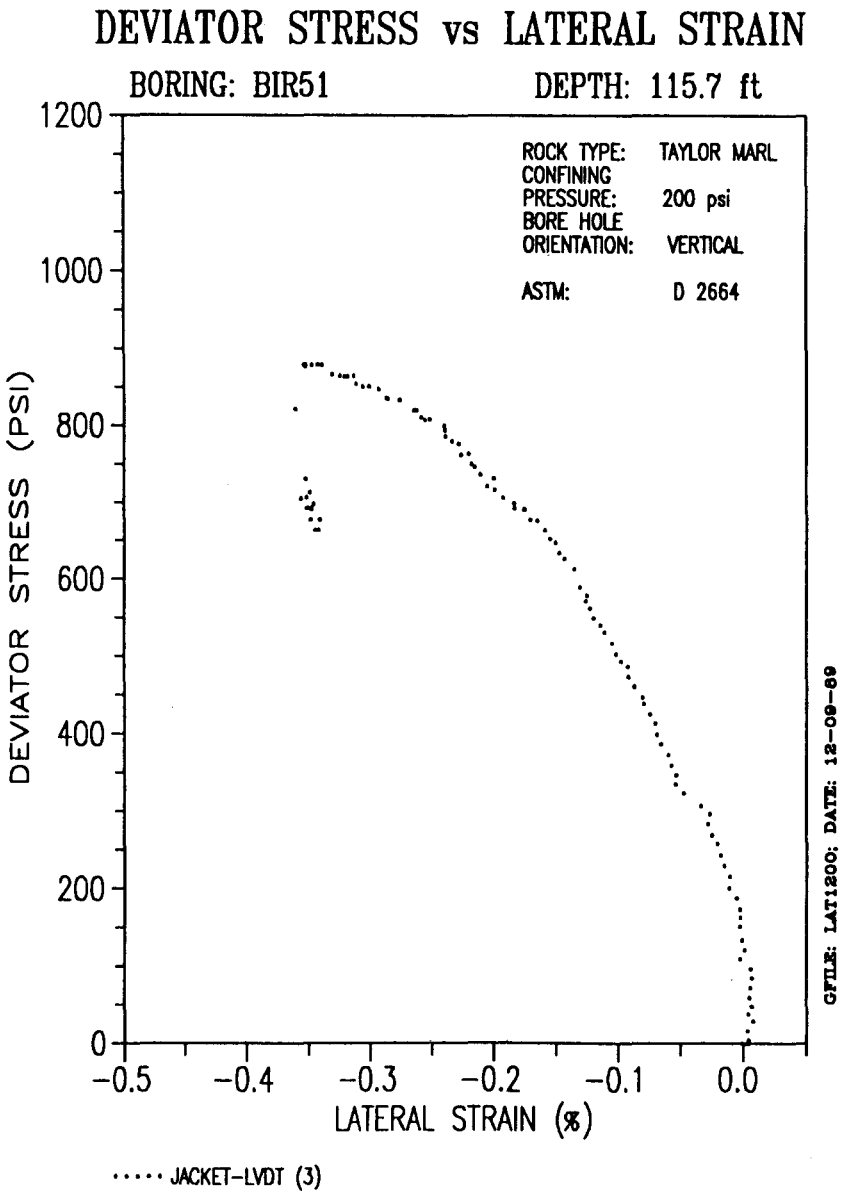
FAILURE MODE :
SHEAR PLANES AT 45 DEG

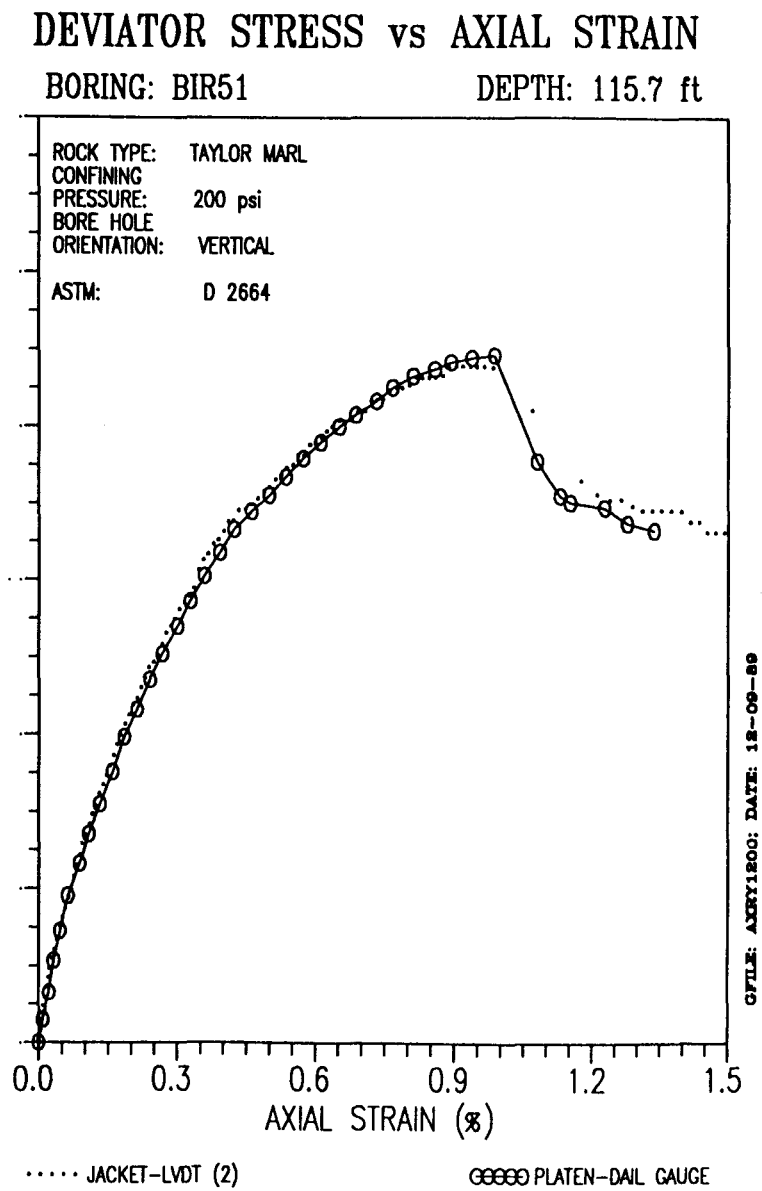
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

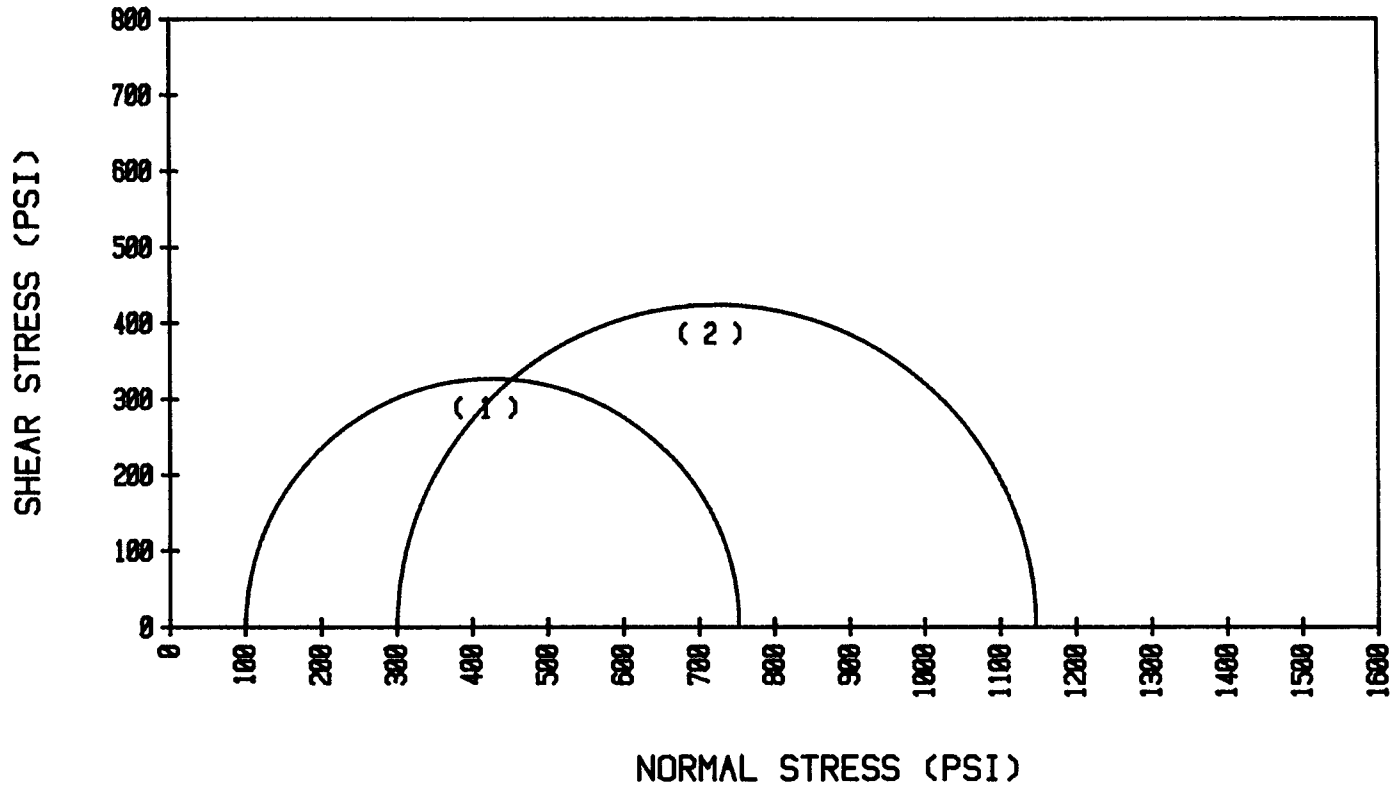
JOB NO.: 5530.16 | FIGURE


DEVIATOR STRESS vs LATERAL STRAIN
BORING: BIR51
DEPTH: 115.7 ft
ROCK TYPE: TAYLOR MARL
CONFINING PRESSURE: 200 psi
BORE HOLE ORIENTATION: VERTICAL
ASTM: D 2664
DEVIATOR STRESS (PSI)
1200
1000
800
600
400
200
0
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
LATERAL STRAIN (%)
GFILE: LAT1200; DATE: 12-09-89
JACKET-LVDT (3)


DEVIATOR STRESS vs AXIAL STRAIN
BORING: BIR51
DEPTH: 115.7 ft
ROCK TYPE: TAYLOR MARL
CONFINING PRESSURE: 200 psi
BORE HOLE ORIENTATION: VERTICAL
ASTM: D 2664
0.0
0.3
0.6
0.9
1.2
1.5
AXIAL STRAIN (%)
GFILE: AXRY1200; DATE: 12-09-89
JACKET-LVDT (2)
PLATEN-DAIL GAUGE

BORING NO.: BIR51
DEPTH RANGE (FT): 164.2-165.6
TAYLOR MARL

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 164.2
(2) DEPTH (FT) : 165.2

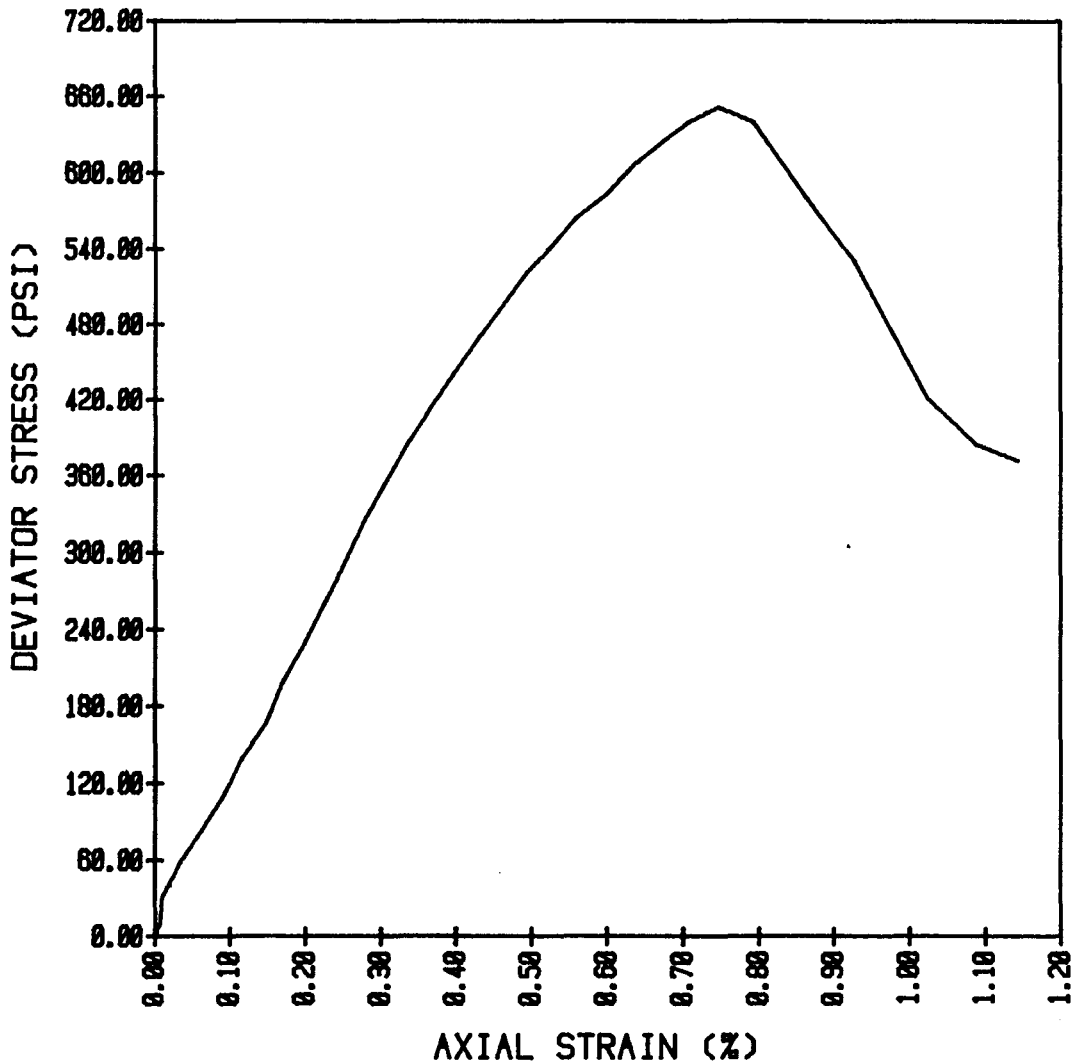
TEXAS SSC SITE

MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR51
DEPTH (FT): 164.2
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =16.3
DRY UNIT WEIGHT (PCF) =116.7
DEG. OF SATURATION (%) = 99.4
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :100
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.143 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 41 DEG.

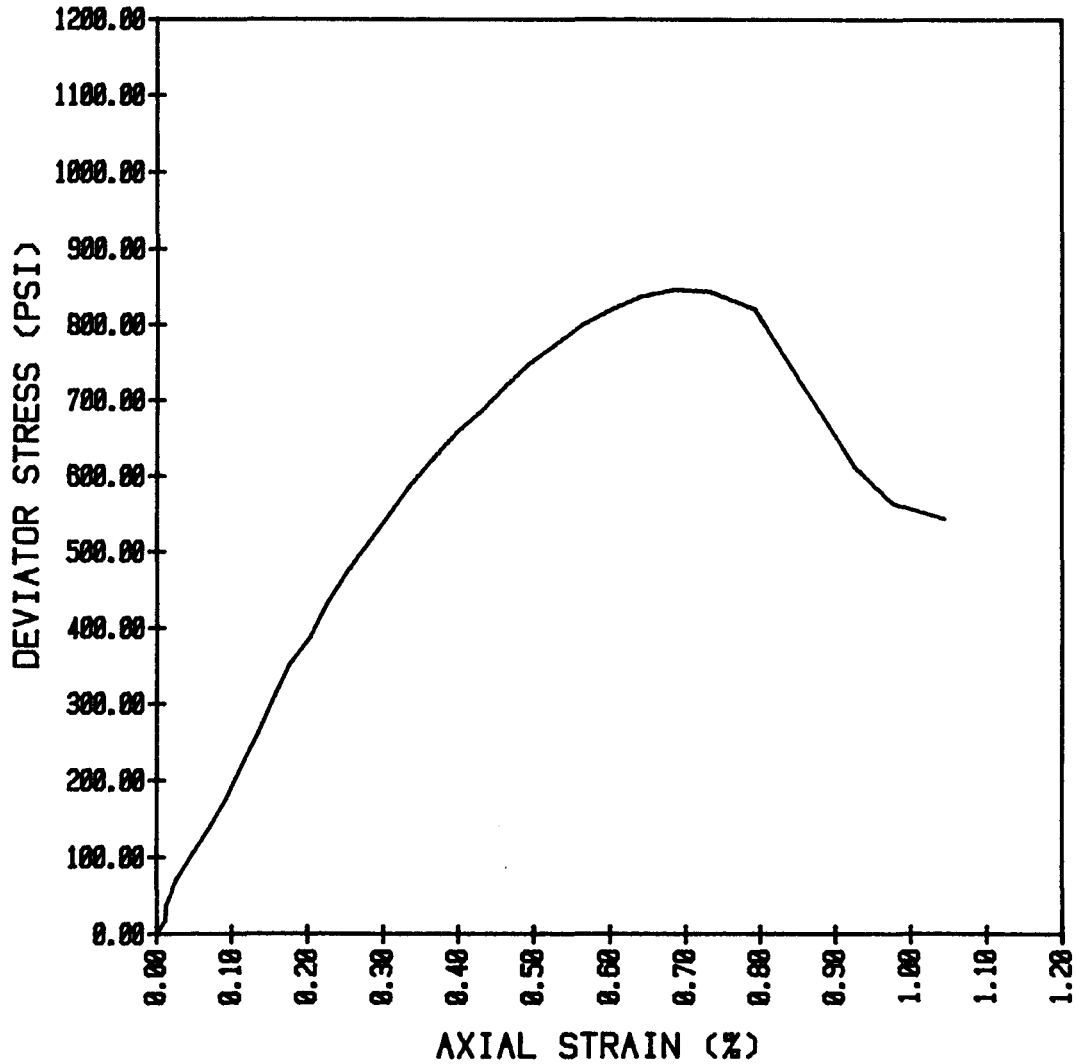
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR51
DEPTH (FT): 165.2
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =13.6
DRY UNIT WEIGHT (PCF) =122.4
DEG. OF SATURATION (%) = 97.3
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :300
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.667 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 29 DEG.

TEXAS SSC SITE	
STRESS - STRAIN PLOT	
MASON-JOHNSTON & ASSOCIATES, INC. GEOLOGISTS-ENGINEERS	
JOB NO.: 5530.16	FIGURE

GEOMECHANICAL TEST RESULTS

BORING BIR 52

TABLE E-3. GEOMECHANICAL TEST RESULTS - BIR 52

Geologic Formation and General Lithology	Vertical Depth	Moisture Content	Dry Density	Specific Gravity	Atterberg Limits		Sample Dimension Ratio	Sample Failure Mode	Uniaxial Compressive Strength	Triaxial Compression		Failure Strain	Tangent Young's Modulus		2nd Cycle Slake-Durability Index	Modified Tabor Abrasion/ Hardness Index	Carbonate Content
					Liquid Limit	Plasticity Index	L/D			σ_c	$\sigma_1 - \sigma_3$		E_{50}	σ_3			
	feet	percent	pcf						psi	psi	psi	percent	psi x 10^5	psi	percent		percent
R. Soil	2.0	26.7	96.7														
R. Soil	4.0	21.6	105.9														
R. Soil	4.0	21.5			59	36											
R. Soil	6.0	28.7	94.7														
R. Soil	8.0	24.0			61	37											
R. Soil	8.0	24.9	100.8														
R. Soil	10.0	24.3	102.0														
R. Soil	12.0	23.8	102.3														
R. Soil	14.0	26.5			68	43											
R. Soil	14.0	26.2	99.3														
Taylor Marl	87.8	16.9															
Taylor Marl	87.9	16.6	115.2				2.2	E	453			1.3					
Taylor Marl	88.3				86	55											
Taylor Marl	88.5																29.6
Taylor Marl	131.4	16.1															
Taylor Marl	131.5	15.8	118.6				2.1	D/C	558			1.2					
Taylor Marl	132.0				85	54											
Taylor Marl	132.0														54.6		
Taylor Marl	132.1																34.4
Taylor Marl	132.3																
Taylor Marl	135.3	16.3															
Taylor Marl	135.4	15.3	118.1				0.4	B-1/20°		50	653	0.6	1.3				
Taylor Marl	135.9	15.2	117.5				0.4	B-1/25°		200	722	1.0	1.0				
Taylor Marl	135.9																28.1
Taylor Marl	135.9			2.71													
Taylor Marl	136.3	15.5															
Taylor Marl	153.5	16.8															
Taylor Marl	153.6				84	54											
Taylor Marl	153.8																30.6
Taylor Marl	153.9	16.0	117.3				2.2	E	495			1.1					
Taylor Marl	160.0	16.3															
Taylor Marl	160.1	16.3			99	65											
Taylor Marl	195.0	10.6															
Taylor Marl	195.1	10.1	131.2				2.0	D	2211			1.7					
Austin Chalk	197.2															0.7	
Procedure		ASTM-D2216		ASTM-D854	ASTM-D4318				ASTM-D2938	ASTM-D2664			ASTM-D3148		ISRM	ISRM	

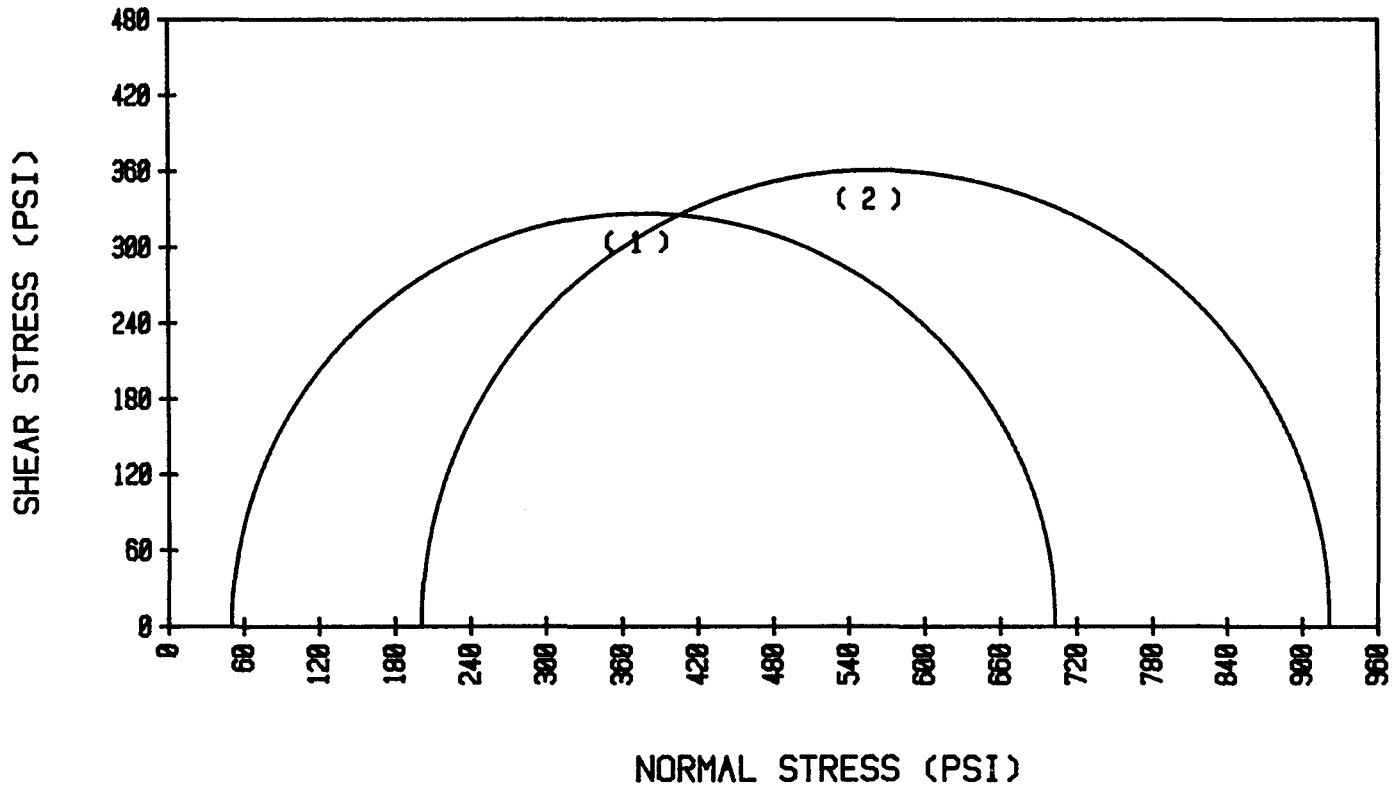
Symbol	Failure Type	Symbol	Failure Type
A	No discernible failure plane	B-4	Combination
(B)	Well defined shear plane @ X angle (deg) to vertical or to long axis of core	C	Barreling/Bulging
B-1	Shear plane	D	Longitudinal (axial) splitting
B-2	Bedding plane shear	E	Conical
B-3	Shear plane along preexisting fracture, shear zone, etc.	F	No information

Note: Some values in this table may be revised based on reviews of test procedures and individual test results. The reader should refer to the latest revision of the gINT geotechnical data base (geotechnical report GR-70).

PRELIMINARY (Subject to Revision)

BORING NO.: BIR52
DEPTH RANGE (FT): 135.4-136.3
TAYLOR MARL

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 135.4
(2) DEPTH (FT) : 135.9

TEXAS SSC SITE

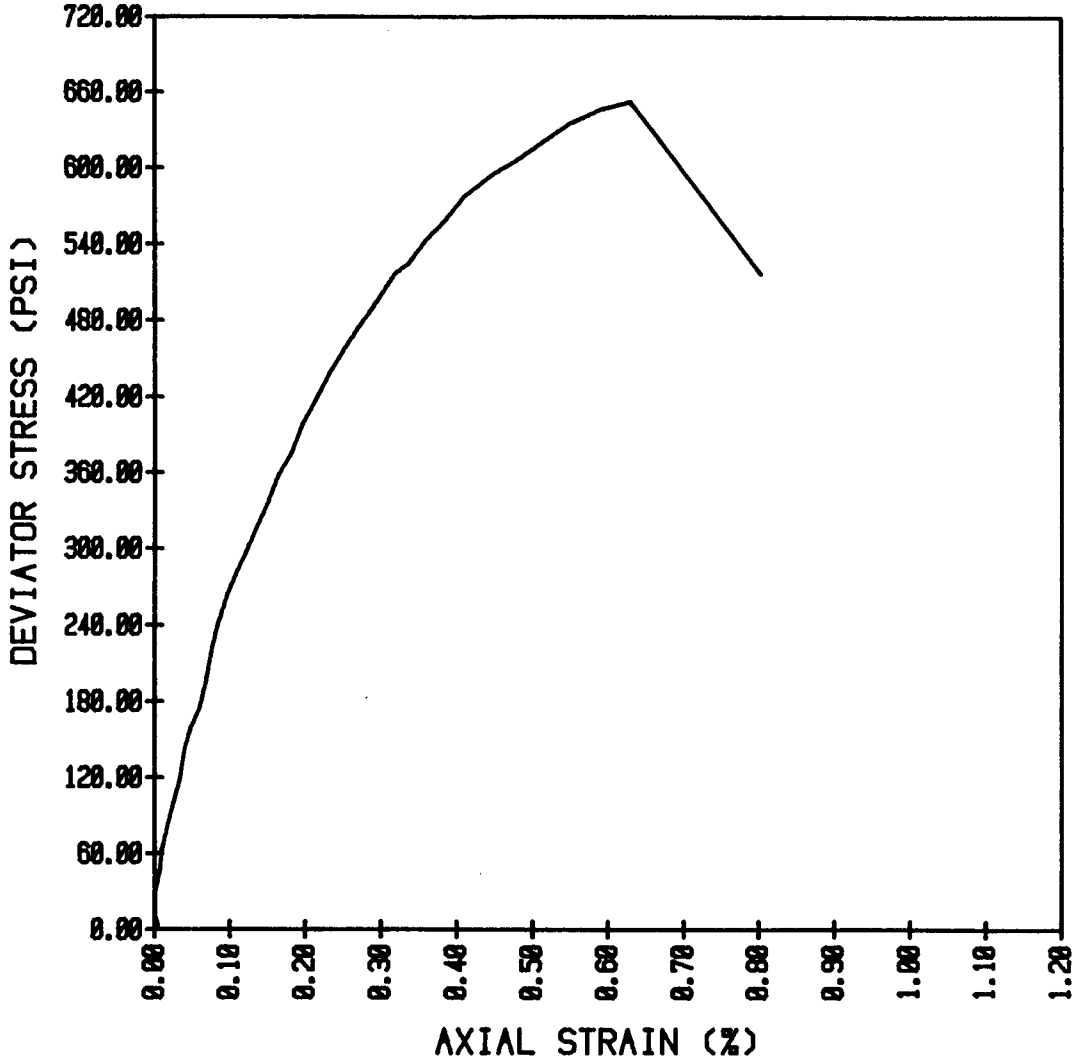
MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR52
DEPTH (FT): 135.4
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =15.3
DRY UNIT WEIGHT (PCF) =118.1
DEG. OF SATURATION (%) = 96.8
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 50
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.319 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 20 DEG.

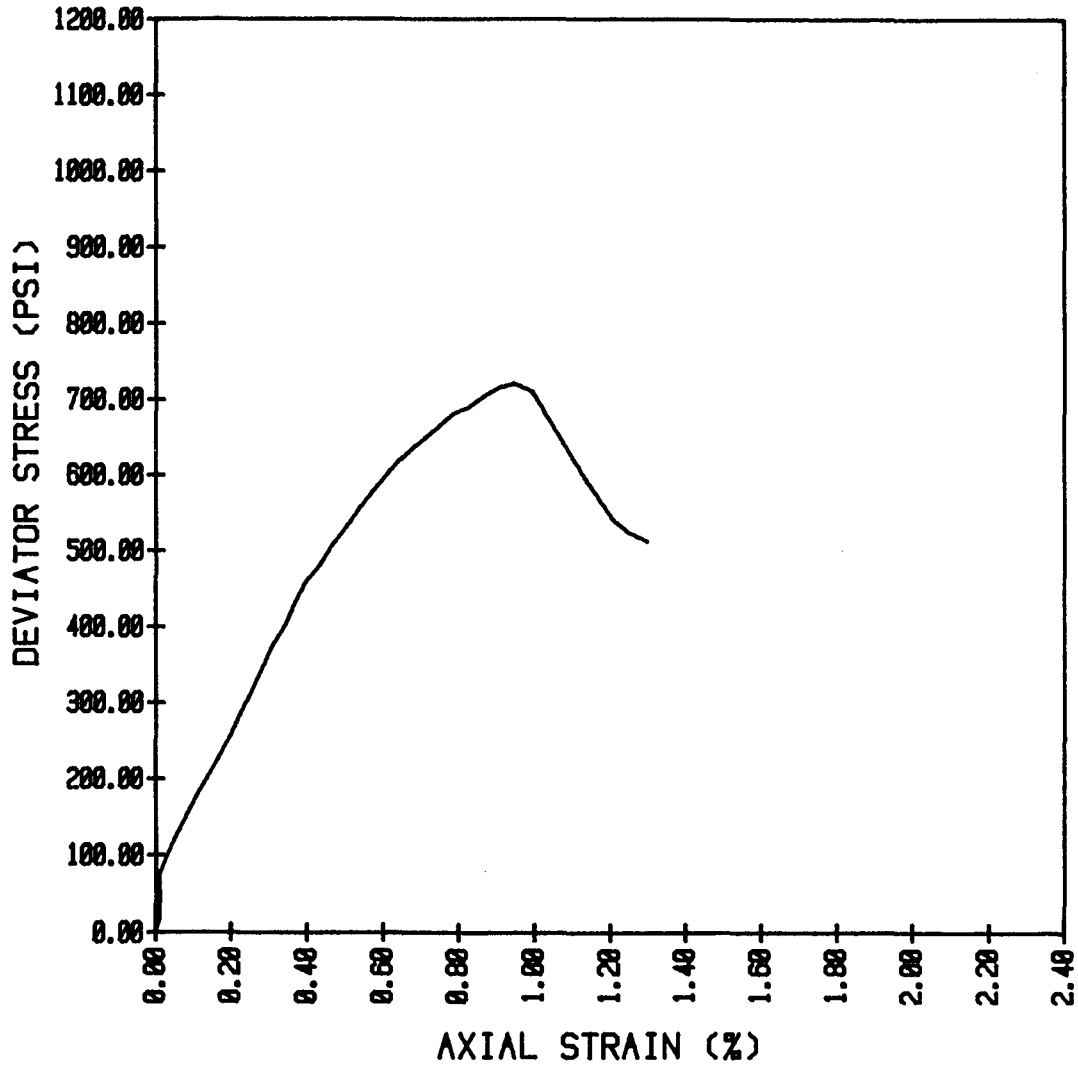
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR52
DEPTH (FT): 135.9
TAYLOR MARL

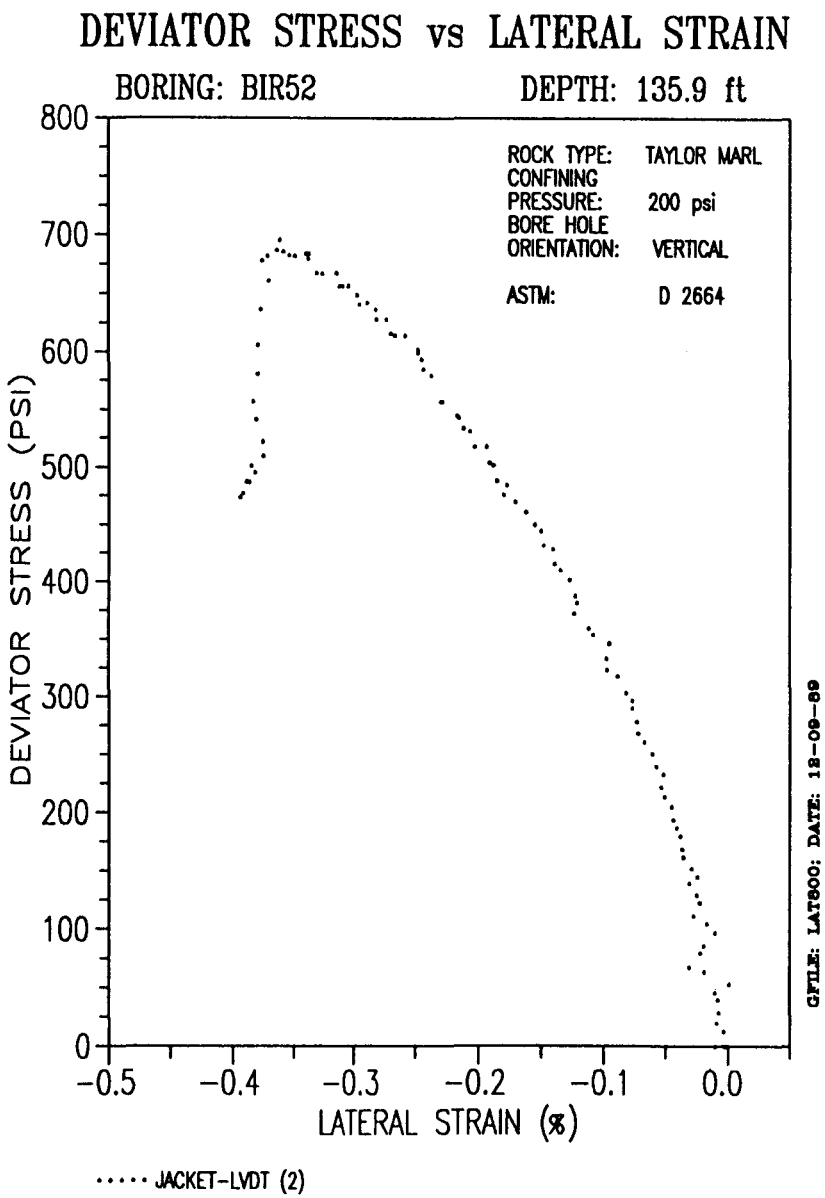


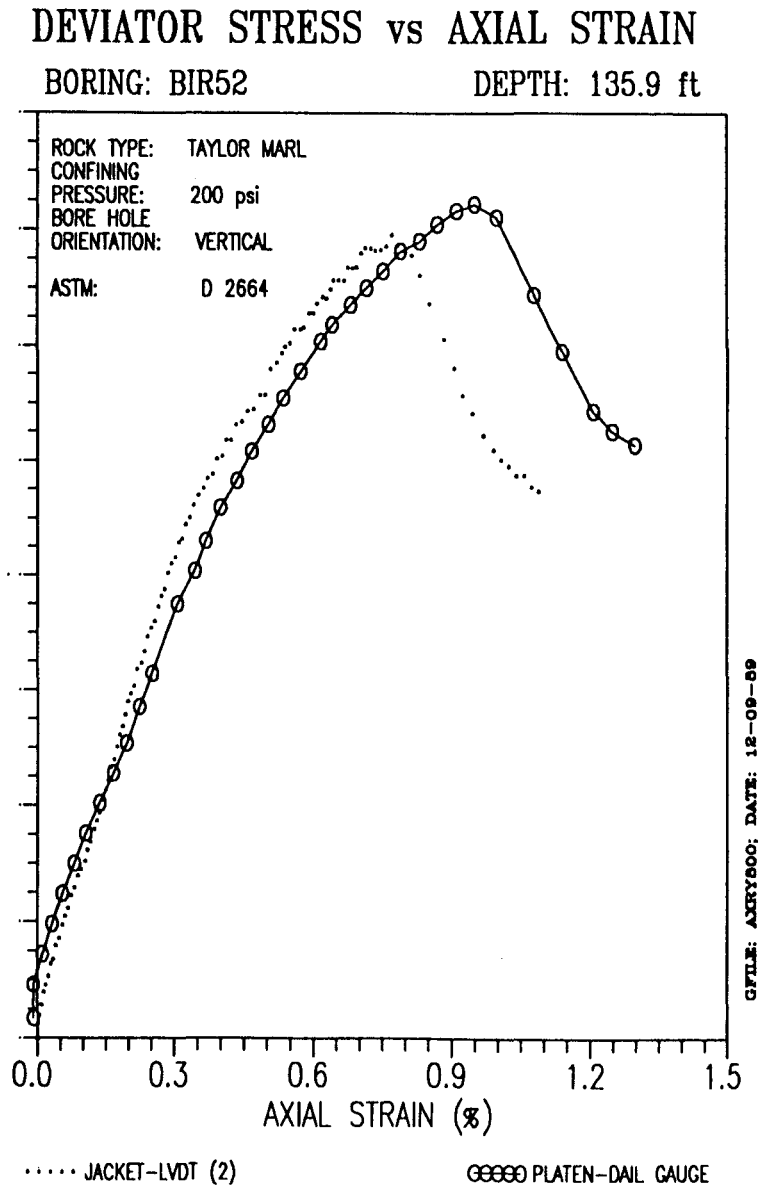
INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =15.2
DRY UNIT WEIGHT (PCF) =117.5
DEG. OF SATURATION (%) = 94.3
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :200
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.000 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 25 DEG

TEXAS SSC SITE	
STRESS - STRAIN PLOT	
MASON-JOHNSTON & ASSOCIATES, INC. GEOLOGISTS-ENGINEERS	
JOB NO.: 5530.16	FIGURE


DEVIATOR STRESS vs LATERAL STRAIN
BORING: BIR52
DEPTH: 135.9 ft
ROCK TYPE: TAYLOR MARL
CONFINING PRESSURE: 200 psi
BORE HOLE ORIENTATION: VERTICAL
ASTM: D 2664
DEVIATOR STRESS (PSI)
800
700
600
500
400
300
200
100
0
-0.5
-0.4
-0.3
-0.2
-0.1
0.0
LATERAL STRAIN (%)
GFILE: LAT800; DATE: 12-09-89
····· JACKET-LVDT (2)


DEVIATOR STRESS vs AXIAL STRAIN
BORING: BIR52
DEPTH: 135.9 ft
ROCK TYPE: TAYLOR MARL
CONFINING PRESSURE: 200 psi
BORE HOLE ORIENTATION: VERTICAL
ASTM: D 2664
0.0
0.3
0.6
0.9
1.2
1.5
AXIAL STRAIN (%)
GFILE: AXRY800; DATE: 12-09-89
····· JACKET-LVDT (2)
ooooo PLATEN-DAIL GAUGE

GEOMECHANICAL TEST RESULTS

BORING BIR 53

Inclined Boring

Geologic Formation and General Lithology	Boring Depth	Vertical Depth	Moisture Content	Dry Density	Specific Gravity	Atterberg Limits		Sample Dimension Ratio L/D	Sample Failure Mode	Uniaxial Compressive Strength	Triaxial Compression		Failure Strain	Tangent Young's Modulus		Carbonate Content
						Liquid Limit	Plasticity Index				σ_c	$\sigma_1 - \sigma_3$		E_{50}	σ_3	
	feet	feet	percent	pcf						psi	psi	psi	percent	psi x 10^5	psi	percent
Taylor Marl	65.5	51.1	17.4													
Taylor Marl	65.6	51.2	16.5	115.7				2.1	B-2/44°	208			0.58	0.40		
Taylor Marl	67.1	52.3	16.4	116.9	2.73	70	41	2.2	B-1/22°		50	471	0.70	0.79		
Taylor Marl	67.1	52.3														28.9
Taylor Marl	67.1	52.3														
Taylor Marl	67.5	52.6	16.4	116.3				2.1	B-2/40°		200	507	0.88	0.77		
Taylor Marl	78.4	61.1	16.5													
Taylor Marl	78.5	61.2	15.5	117.9				2.4	B-2/43°	273			0.66	0.49		
Taylor Marl	78.5	61.2														28.5
Taylor Marl	78.5	61.2				81	53									
Taylor Marl	197.4	150.8	16.4													
Taylor Marl	197.6	150.9	14.6	119.2				2.3	B-2/47°		100	661	0.32	2.31		
Taylor Marl	197.6	150.9			2.73											31.1
Taylor Marl	197.6	150.9				75	47									
Taylor Marl	198.0	151.2	15.0	117.8				2.3	B-2/45°		300	780	0.42	2.13		
Taylor Marl	198.4	151.5	14.7	116.8				2.3	B-2/46°	270			0.61	0.88		
Taylor Marl	232.1	177.3	15.9													
Taylor Marl	232.2	177.4	14.7	119.4				2.3	B-2	356			0.48	1.09		
Taylor Marl	232.2	177.4														21.0
Taylor Marl	232.2	177.4				98	64									
Austin Chalk	248.0	189.5	10.4													
Austin Chalk	248.2	189.6	10.5	131.2				2.3	D	2875			0.53	7.37		
Procedure			ASTM-D2216		ASTM-D854	ASTM-D4318				ASTM-D2938	ASTM-D2664			ASTM-D3148		ASTM-D3148

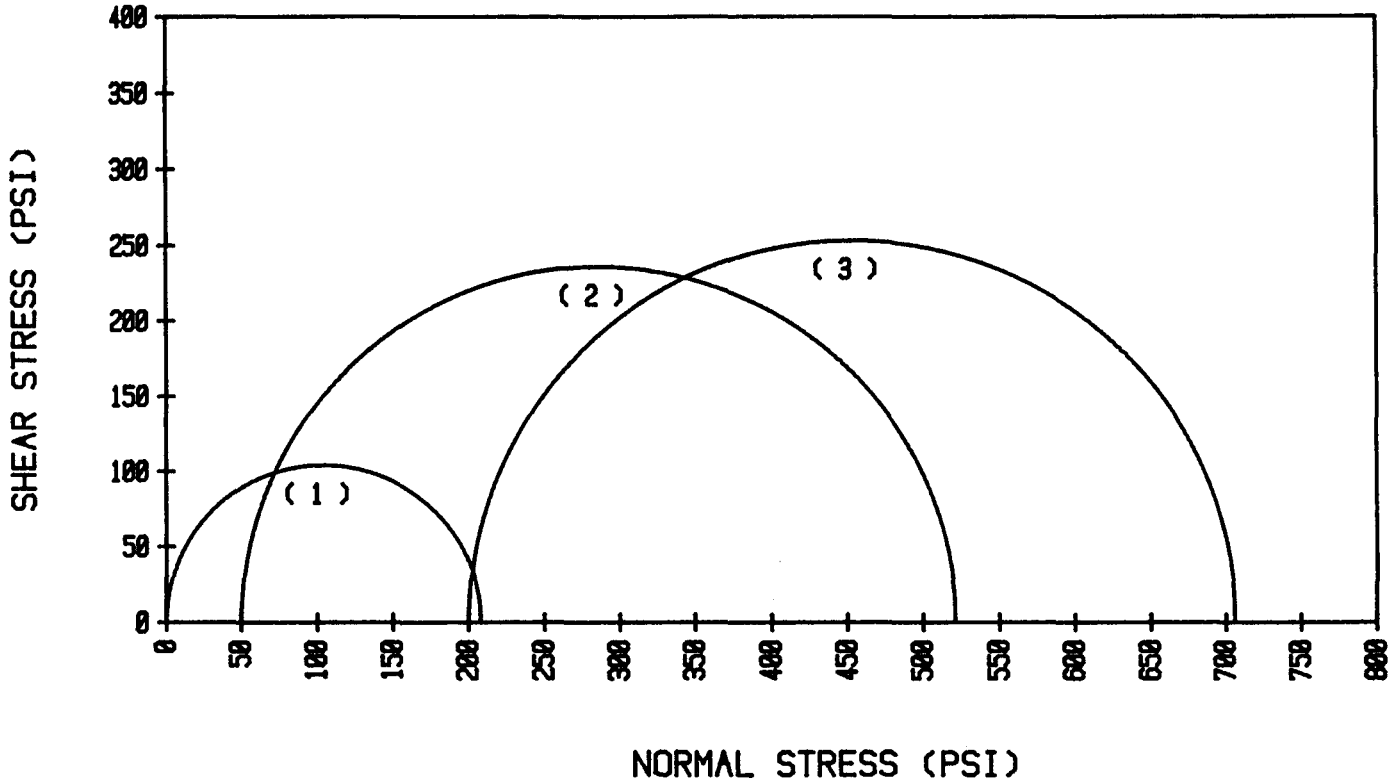
PRELIMINARY (Subject to Revision)

Symbol	Failure Type	Symbol	Failure Type
A	No discernible failure plane	B-4	Combination
(B)	Well defined shear plane @ X angle (deg) to vertical or to long axis of core	C	Barreling/Bulging
B-1	Shear plane	D	Longitudinal (axial) splitting
B-2	Bedding plane shear	E	Conical
B-3	Shear plane along preexisting fracture, shear zone, etc.	F	No information

Note: Some values in this table may be revised based on reviews of test procedures and individual test results. The reader should refer to the latest revision of the gINT geotechnical data base (geotechnical report GR-70).

BORING NO.: BIR53
DEPTH RANGE (FT): 65.6-67.9
TAYLOR MARL

BORING INCLINATION (DEG) : 45
TEST TYPE : UNCONFINED COMPRESSION (ASTM D2938)
TRIAXIAL COMPRESSION (ASTM D2664)

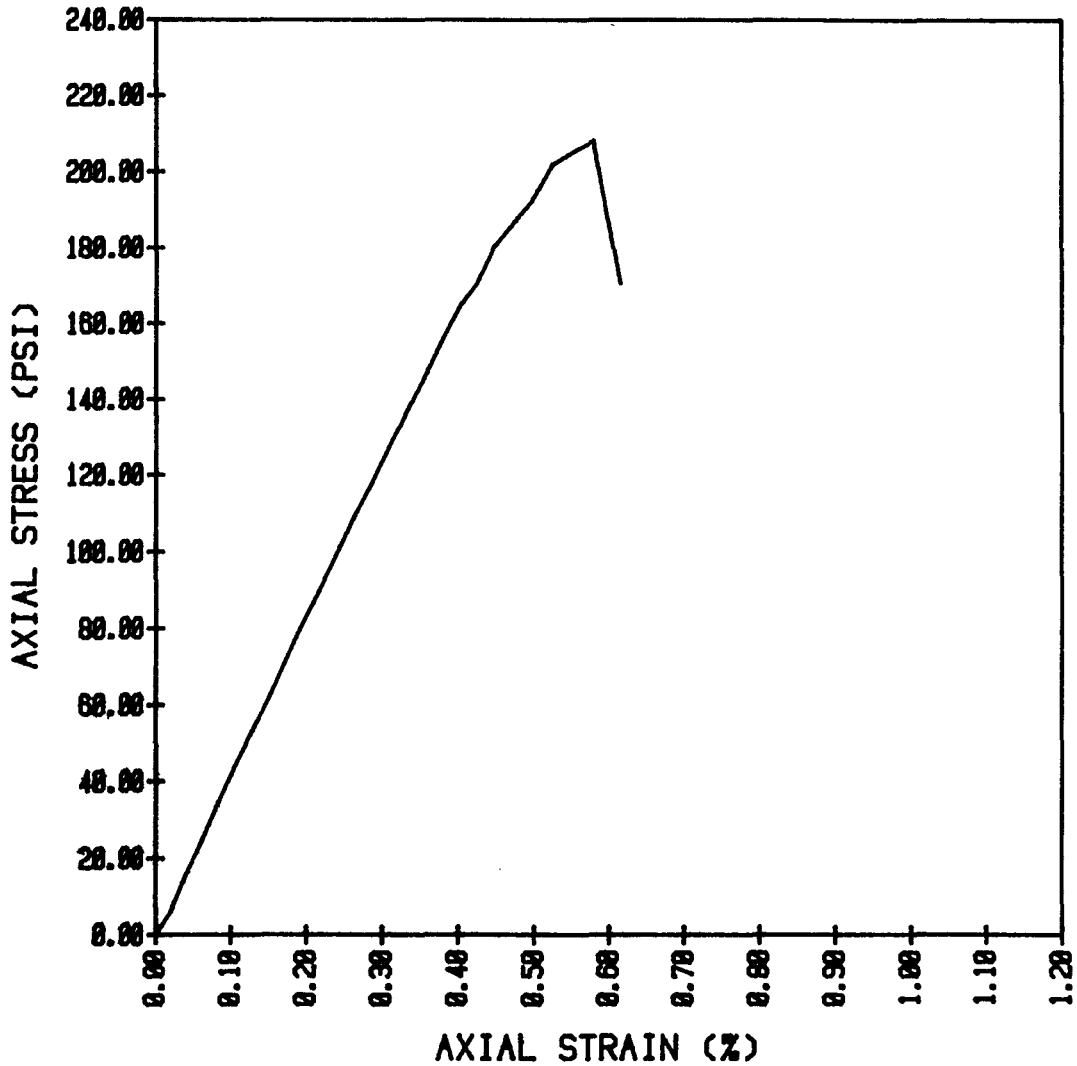


SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 65.6
(2) DEPTH (FT) : 67.1
(3) DEPTH (FT) : 67.5

TEXAS SSC SITE	
MOHR CIRCLE PLOT	
MASON-JOHNSTON & ASSOCIATES, INC. GEOLOGIST-ENGINEERS	
JOB NO.: 5530.16	FIGURE

BORING NO. : BIR53
DEPTH (FT): 65.6
TAYLOR MARL



INCLINATION (DEG): 45
MOISTURE CONTENT (%) = 16.5
DRY UNIT WEIGHT (PCF) = 115.7
DEG. OF SATURATION (%) = 97.4
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 0
TEST TYPE :UNCONFINED COMPRESSION
(ASTM D 2938)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.400 x1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR
AT 44 DEG.

TEXAS SSC SITE

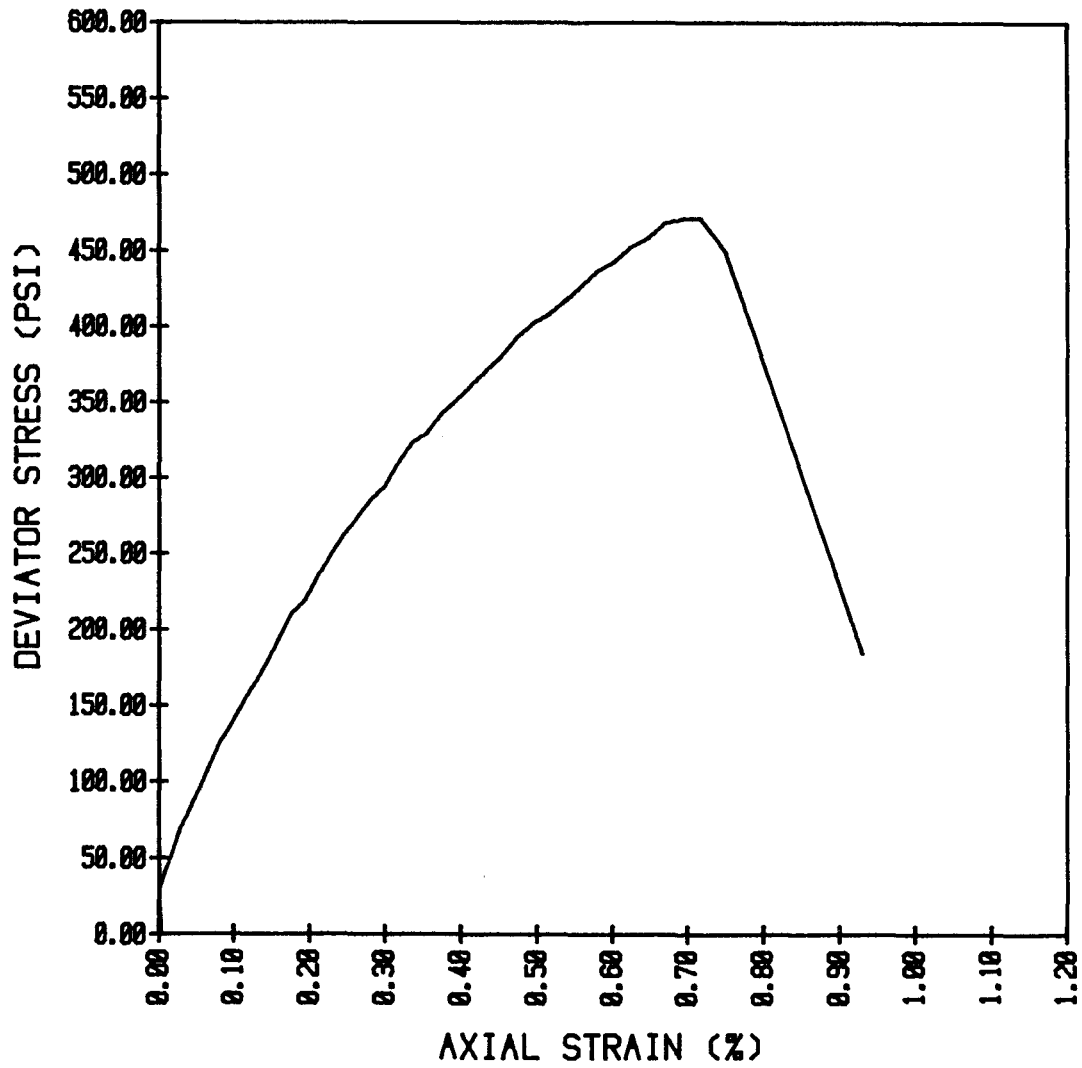
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR53
DEPTH (FT): 67.1
TAYLOR MARL



INCLINATION (DEG) : 45
MOISTURE CONTENT (%) =16.4
DRY UNIT WEIGHT (PCF) =116.9
DEG. OF SATURATION (%) =100.2
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 50
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.794 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 22 DEG

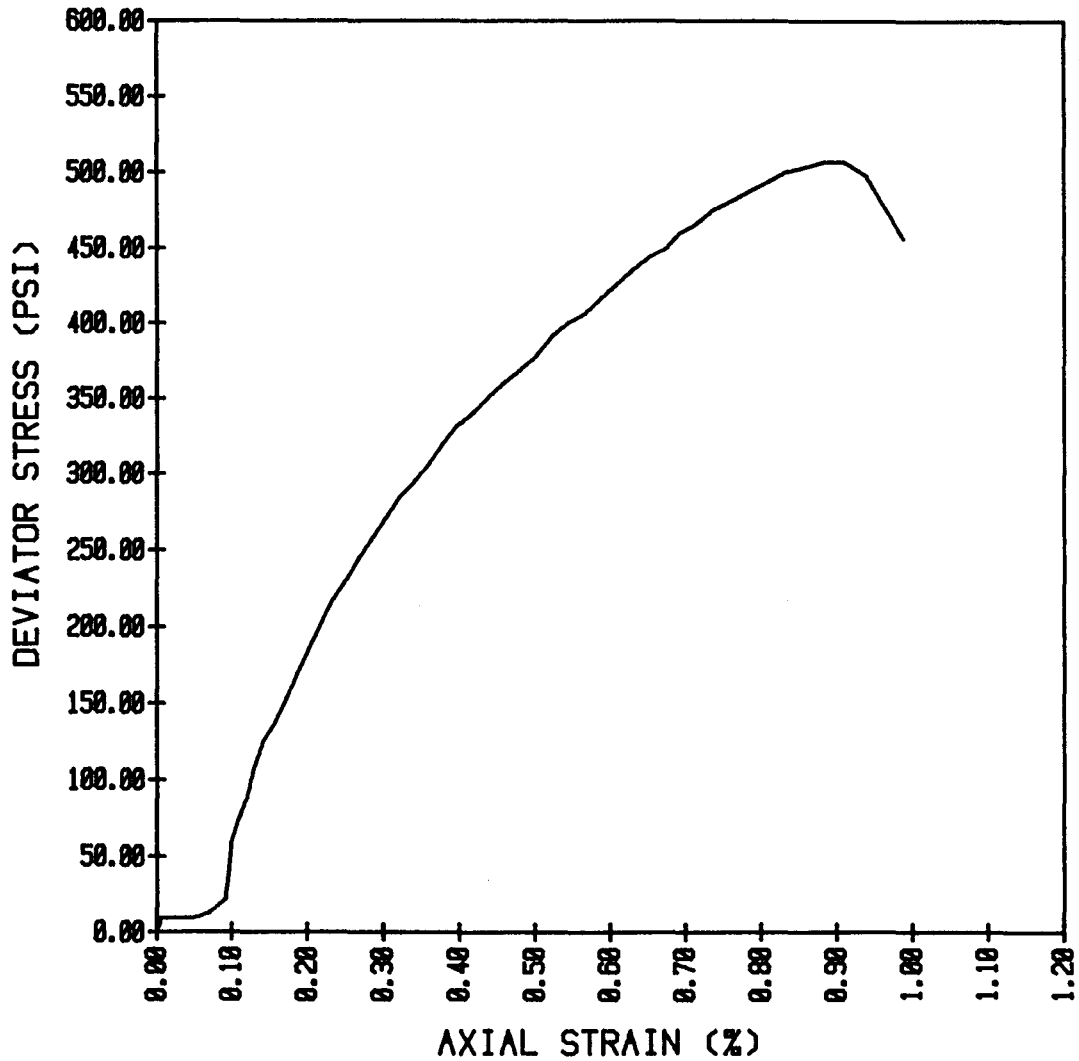
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR53
DEPTH (FT): 67.5
TAYLOR MARL



INCLINATION (DEG) : 45
MOISTURE CONTENT (%) =16.4
DRY UNIT WEIGHT (PCF) =116.3
DEG. OF SATURATION (%) = 98.8
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :200
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.769 x1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR
AT 40 DEG

TEXAS SSC SITE

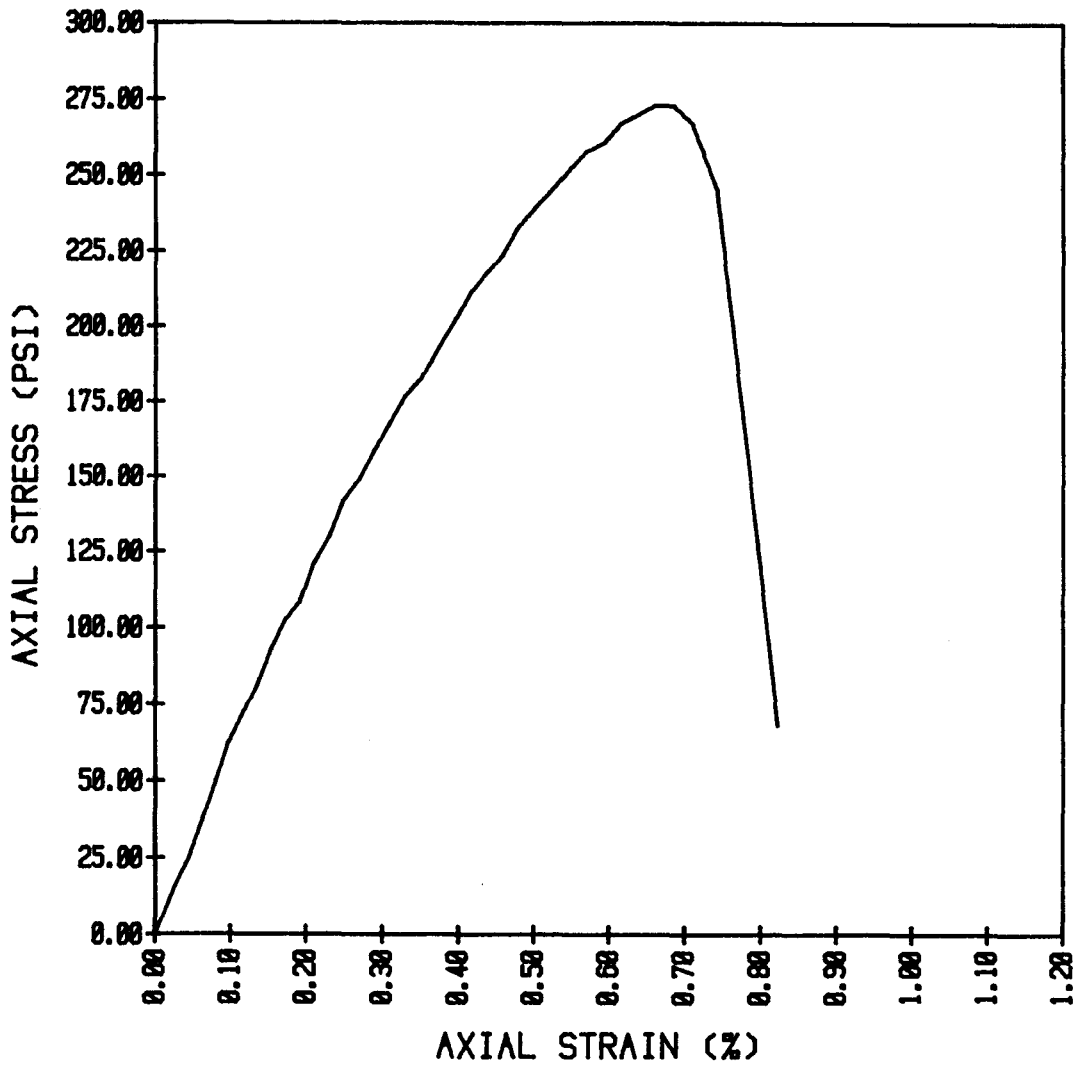
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR53
DEPTH (FT): 78.5
TAYLOR MARL



INCLINATION (DEG): 45
MOISTURE CONTENT (%) = 15.5
DRY UNIT WEIGHT (PCF) = 117.9
DEG. OF SATURATION (%) = 97.5
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 0
TEST TYPE :UNCONFINED COMPRESSION
(ASTM D 2938)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.485 x1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR
AT 43 DEG.

TEXAS SSC SITE

STRESS - STRAIN PLOT

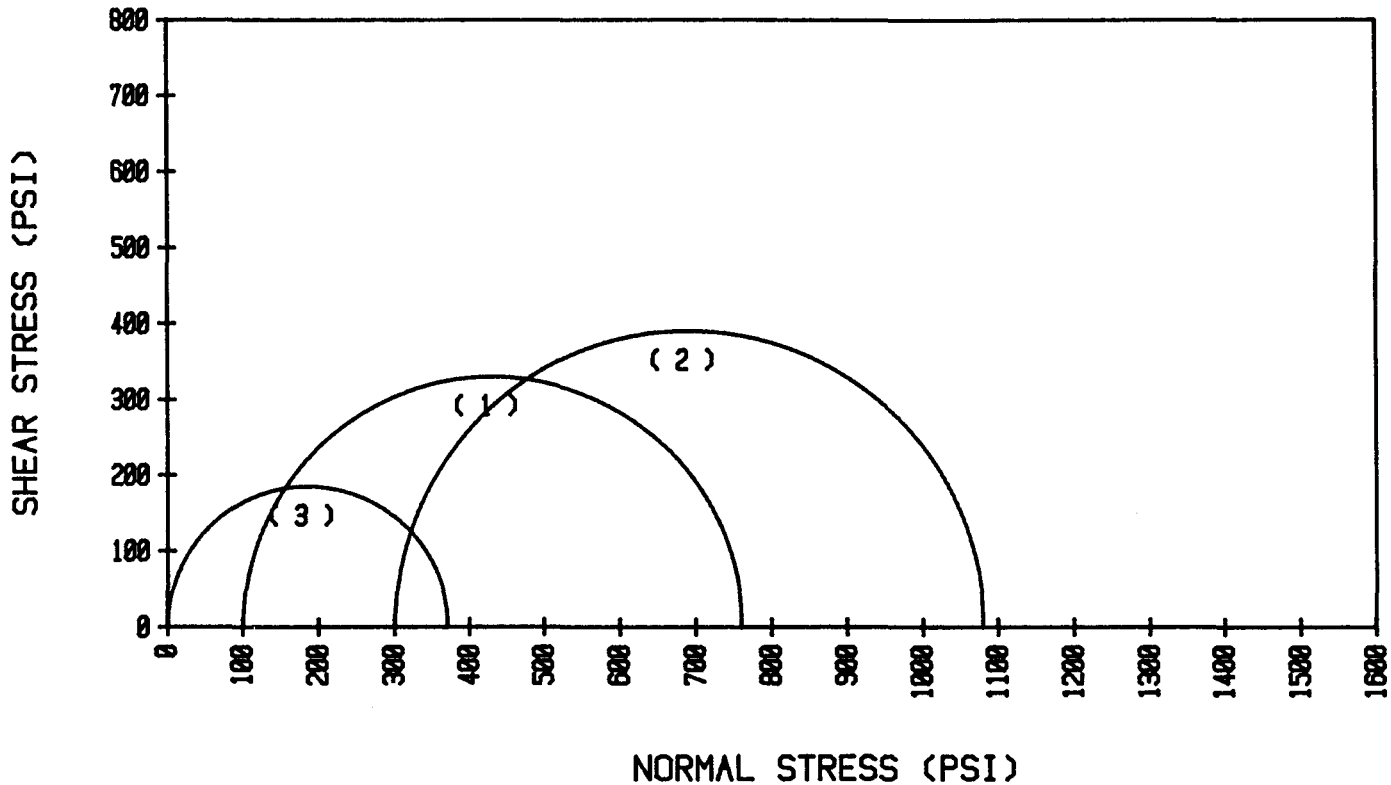
MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO.: BIR53
DEPTH RANGE (FT): 197.6-198.8
TAYLOR MARL

BORING INCLINATION (DEG) : 45
TEST TYPE : UNCONFINED COMPRESSION (ASTM D2938)
TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 197.6
(2) DEPTH (FT) : 198.0
(3) DEPTH (FT) : 198.4

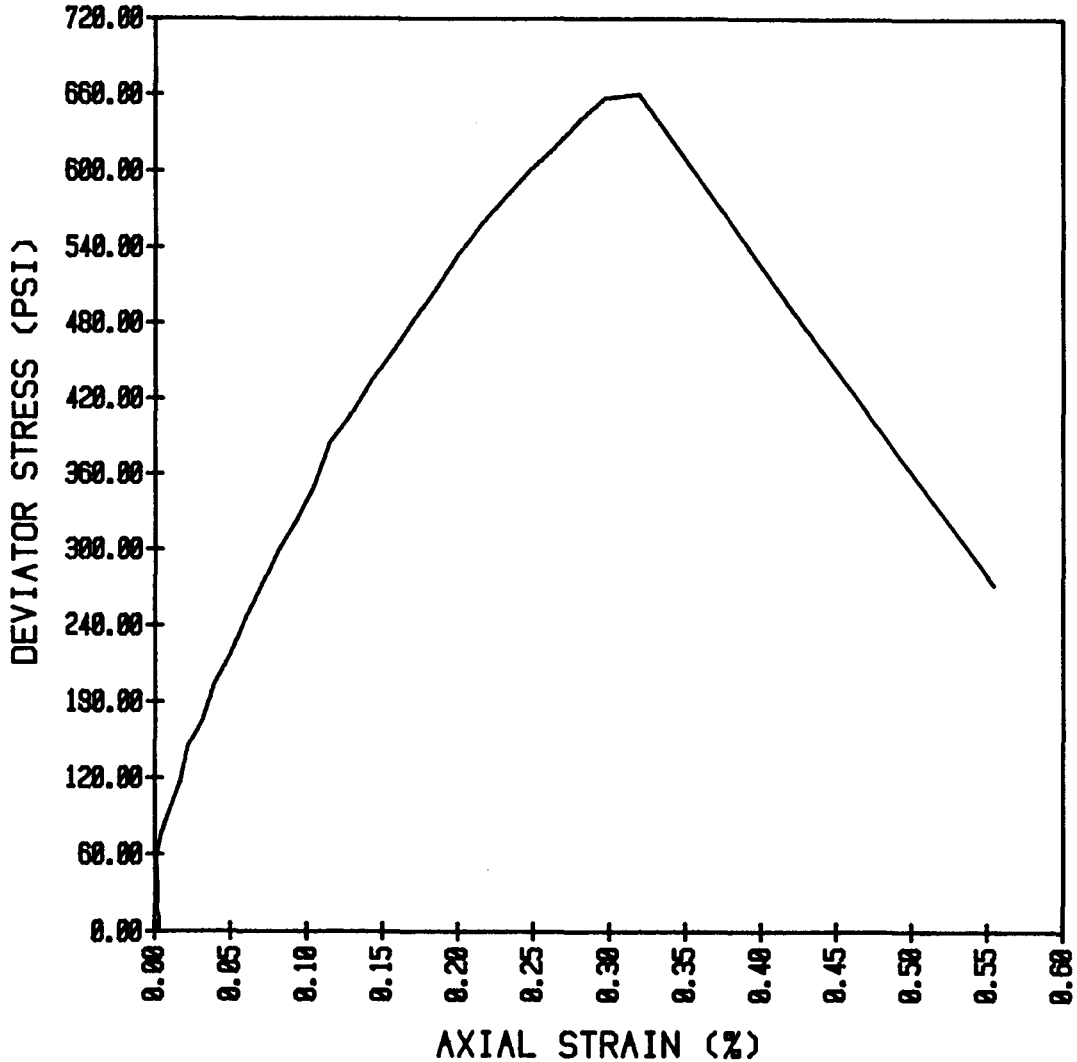
TEXAS SSC SITE

MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR53
DEPTH (FT): 197.6
TAYLOR MARL



INCLINATION (DEG) : 45
MOISTURE CONTENT (%) =14.6
DRY UNIT WEIGHT (PCF) =119.2
DEG. OF SATURATION (%) = 95.1
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :100
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
2.308 x1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR
AT 47 DEG

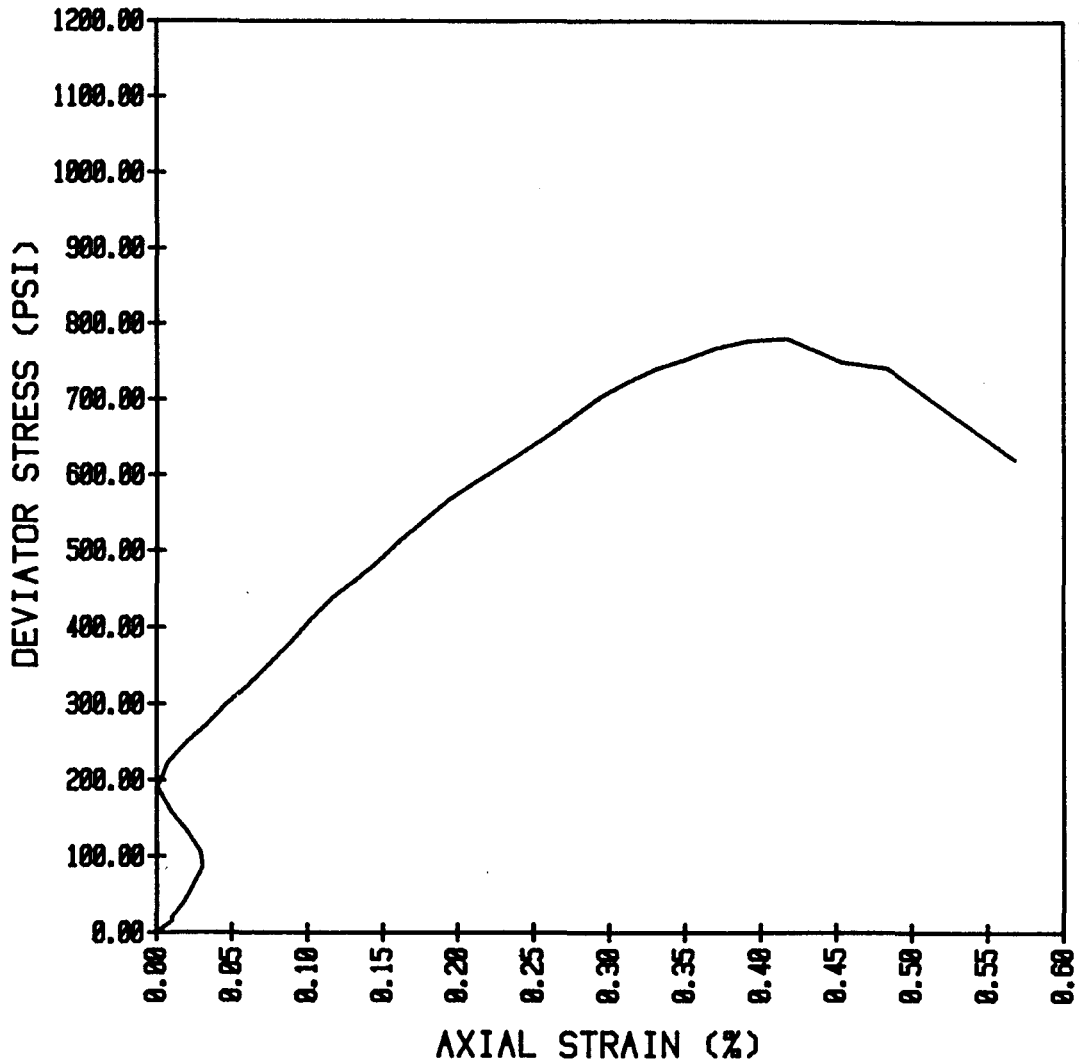
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR53
DEPTH (FT): 198.0
TAYLOR MARL



INCLINATION (DEG) : 45
MOISTURE CONTENT (%) =15.0
DRY UNIT WEIGHT (PCF) =117.8
DEG. OF SATURATION (%) = 93.7
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) :300
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
2.128 x1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR
AT 45 DEG

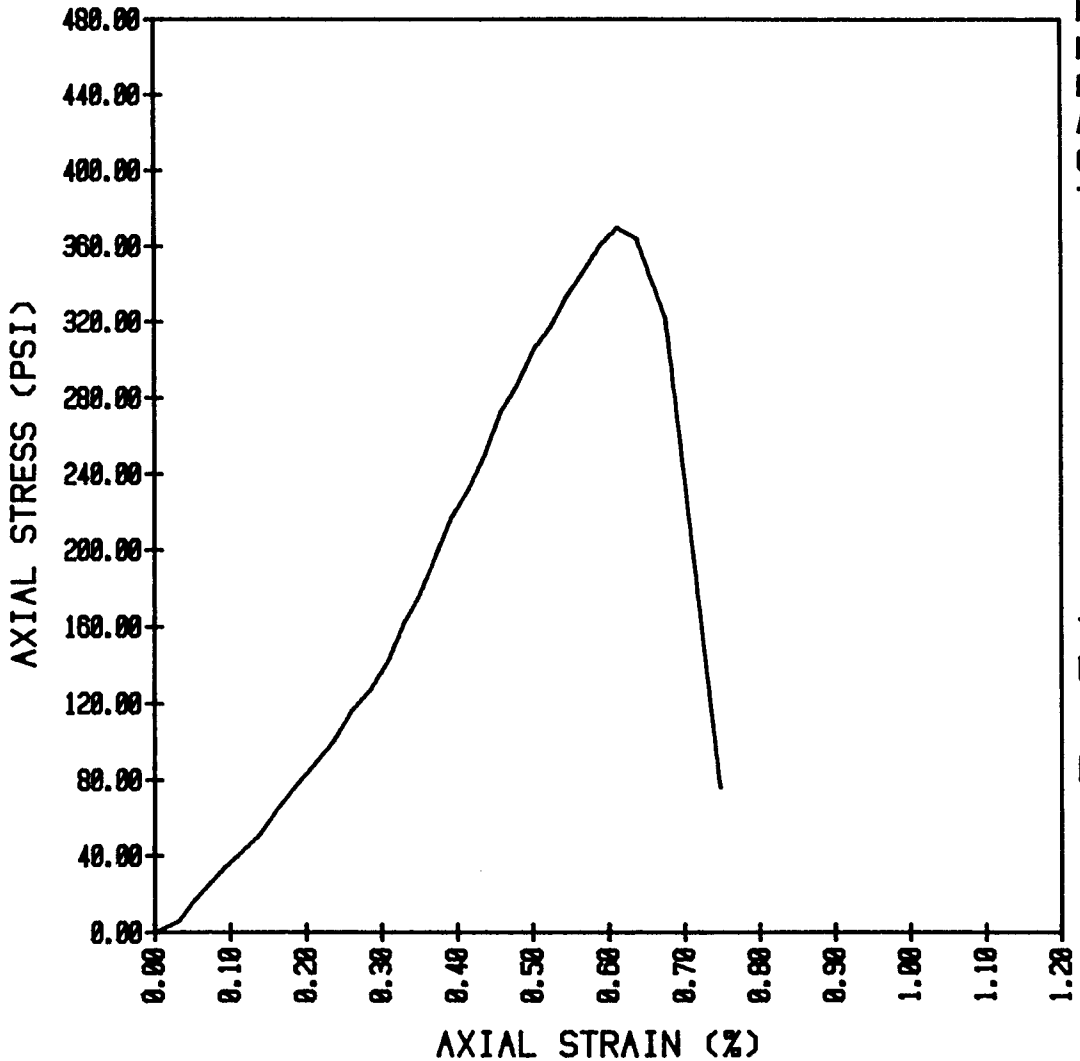
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR53
DEPTH (FT): 198.4
TAYLOR MARL



INCLINATION (DEG): 45
MOISTURE CONTENT (%) = 14.7
DRY UNIT WEIGHT (PCF) = 116.8
DEG. OF SATURATION (%) = 89.9
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 0
TEST TYPE :UNCONFINED COMPRESSION
(ASTM D 2938)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.875 ×1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR
AT 46 DEG.

TEXAS SSC SITE

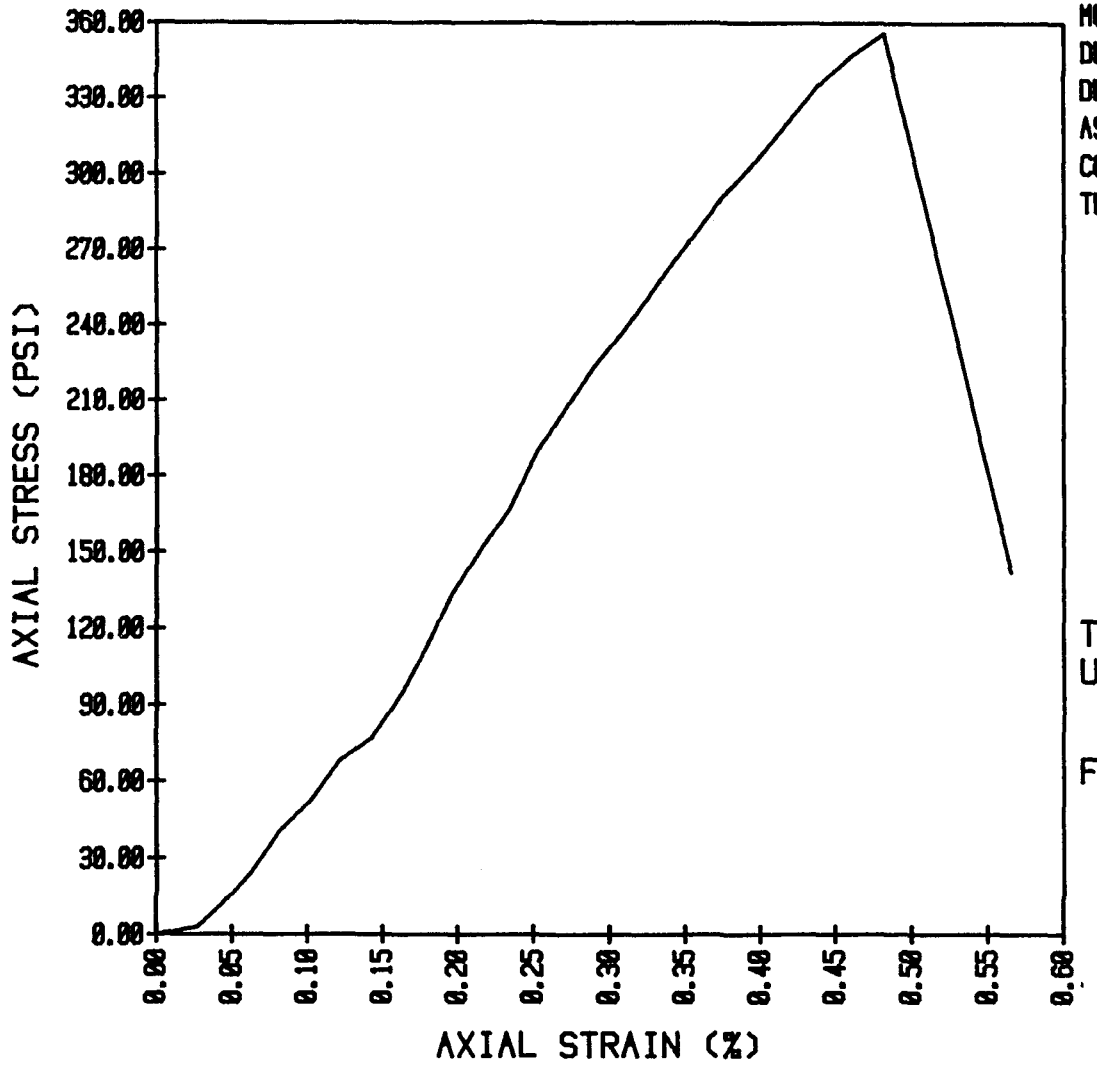
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR53
DEPTH (FT): 232.2
TAYLOR MARL



INCLINATION (DEG): 45
MOISTURE CONTENT (%) = 14.7
DRY UNIT WEIGHT (PCF) = 119.4
DEG. OF SATURATION (%) = 96.3
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 0
TEST TYPE :UNCONFINED COMPRESSION
(ASTM D 2938)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.091 x1E5 PSI

FAILURE MODE :
BEDDING PLANE SHEAR

TEXAS SSC SITE

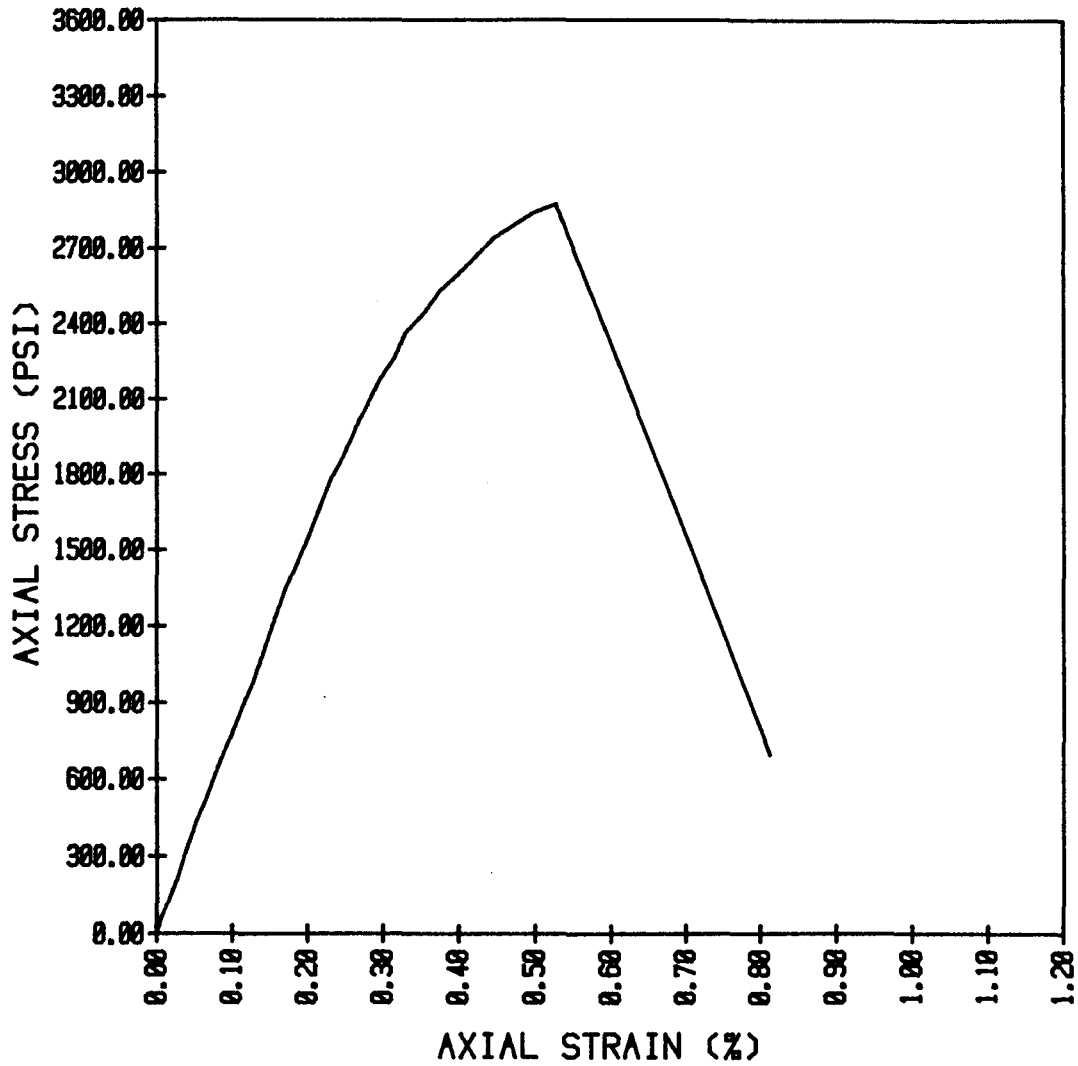
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR53
DEPTH (FT): 248.2
AUSTIN CHALK LIMESTONE



INCLINATION (DEG): 45
MOISTURE CONTENT (%) = 10.5
DRY UNIT WEIGHT (PCF) = 131.2
DEG. OF SATURATION (%) = 99.7
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 0
TEST TYPE :UNCONFINED COMPRESSION
(ASTM D 2938)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
7.368 x1E5 PSI

FAILURE MODE :
AXIAL SPLITTING

TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

GEOMECHANICAL TEST RESULTS

BORING BIR 54

Geologic Formation and General Lithology	Vertical Depth	Moisture Content	Dry Density	Specific Gravity	Atterberg Limits		Sample Dimension Ratio L/D	Sample Failure Mode	Uniaxial Compressive Strength	Triaxial Compression		Failure Strain	Tangent Young's Modulus		Brazil Tensile Strength	2nd Cycle Slake-Durability Index	Modified Tabor Abrasion/ Hardness Index	Swell Pressure Index	Carbonate Content	Comments
					Liquid Limit	Plasticity Index				σ_c	$\sigma_1 - \sigma_3$		E_{50}	σ_3						
	feet	percent	pcf						psi	psi	psi	percent	psi x 10^5	psi	psi	percent		psi	percent	
Taylor Marl	20.0	20.9																		
Taylor Marl	20.2																		21.6	
Taylor Marl	20.2	20.2	107.8				2.4	D	166			2.2								
Taylor Marl	21.0																			
Taylor Marl	22.0															72.4				
Taylor Marl	22.1	19.8													57					
Taylor Marl	42.0	17.2																		
Taylor Marl	42.2																		24.8	
Taylor Marl	42.2			2.73																
Taylor Marl	42.5															86.6				
Taylor Marl	43.2				70	44														
Taylor Marl	44.5	17.2	115.4															43		
Taylor Marl	44.8	17.4	115.8															43		
Taylor Marl	45.2	17.0													89					
Taylor Marl	45.3	16.9	114.5				2.3	D	303			1.4								
Taylor Marl	46.0	17.3																		
Taylor Marl	46.1	16.9	115.0				2.0	D		50	374	1.5	0.4							
Taylor Marl	46.5	16.8	115.5				2.0	B-1/40°		300	423	1.5	0.4							
Taylor Marl	66.5	15.9	116.8																	
Taylor Marl	66.7	16.2													84					
Taylor Marl	66.8																			Sample unsuitable
Taylor Marl	67.4															58.9				
Taylor Marl	117.0	14.9																		
Taylor Marl	117.3																		27.8	
Taylor Marl	117.3			2.68																
Taylor Marl	117.6				81	54														
Taylor Marl	118.0																			
Taylor Marl	118.5	15.4													98					
Taylor Marl	121.5	15.2	118.6				2.3	D	708			1.2								
Taylor Marl	122.0	15.4																		
Taylor Marl	122.1	15.0	118.4				2.0	B-1		100	706	1.1	0.9							
Taylor Marl	122.9	14.9	119.1				2.1	B-1/30°		500	774	0.9	1.1							
Taylor Marl	166.5	15.9	116.2																	
Taylor Marl	167.4																			Sample unsuitable
Procedure		ASTM-D2216		ASTM-D854	ASTM-D4318				ASTM-D2938	ASTM-D2664			ASTM-D3148		ASTM-D3967	ASTM-D3148	ISRM	ISRM		

PRELIMINARY (Subject to Revision)

Symbol	Failure Type	Symbol	Failure Type
A	No discernible failure plane	B-4	Combination
(B)	Well defined shear plane @ X angle (deg) to vertical or to long axis of core	C	Barreling/Bulging
B-1	Shear plane	D	Longitudinal (axial) splitting
B-2	Bedding plane shear	E	Conical
B-3	Shear plane along preexisting fracture, shear zone, etc.	F	No information

Note: Some values in this table may be revised based on reviews of test procedures and individual test results. The reader should refer to the latest revision of the gINT geotechnical data base (geotechnical report GR-70).

TABLE E-5. GEOMECHANICAL TEST RESULTS - BIR 54 (Cont'd)

Geologic Formation and General Lithology	Vertical Depth	Moisture Content	Dry Density	Specific Gravity	Atterberg Limits		Sample Dimension Ratio L/D	Sample Failure Mode	Uniaxial Compressive Strength	Triaxial Compression		Failure Strain	Tangent Young's Modulus		Brazil Tensile Strength	2nd Cycle Slake-Durability Index	Modified Tabor Abrasion/ Hardness Index	Swell Pressure Index	Carbonate Content	Comments
					Liquid Limit	Plasticity Index				σ_c	$\sigma_1 - \sigma_3$		E_{50}	σ_3						
	feet	percent	pcf						psi	psi	psi	percent	psi x 10^5	psi	psi	percent		psi	percent	
Taylor Marl	182.6	15.3																		
Taylor Marl	182.8			2.72																
Taylor Marl	183.0	16.2	116.4				2.3	D	667			1.5								
Taylor Marl	185.2	15.5	118.1				2.0	B-1/37°		100	557	1.0	0.9							
Taylor Marl	185.6	15.8	117.2				2.0	B-1		500	787	1.3	0.9							
Taylor Marl	186.0	16.2																		
Austin Chalk	193.0	11.5																		
Austin Chalk	193.2																0.400			
Austin Chalk	194.2	10.0													293					
Austin Chalk	194.3	10.4	129.0				2.3	D	2411			1.4								
Austin Chalk	194.5	10.7																		
Austin Chalk	195.7	10.5	129.8				0.1	D		100	2312	1.1	3.1							
Austin Chalk	196.4	10.4	131.0				0.1	B-1/30°		500	2865	1.2	2.6							
Austin Chalk	238.3	11.4																		
Austin Chalk	238.8	9.9	129.4				2.2	D	3213			1.9								
Austin Chalk	287.6	10.9	128.4																	
Austin Chalk	413.3	8.0																		
Austin Chalk	414.4	6.9	140.3				2.0	B-1/45°	3169			2.2								
Procedure		ASTM-D2216		ASTM-D854	ASTM-D4318				ASTM-D2938	ASTM-D2664			ASTM-D3148		ASTM-D3967	ISRM	ISRM	ISRM		

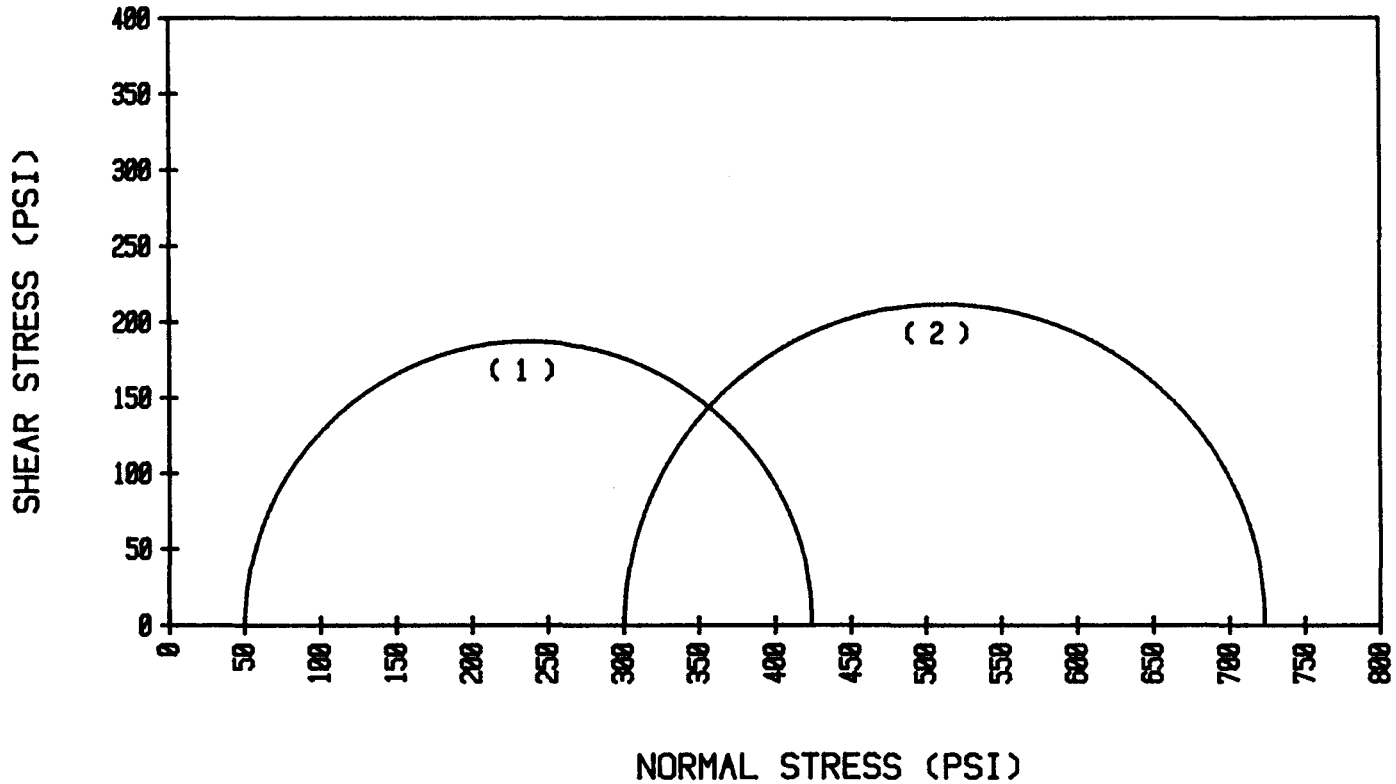
PRELIMINARY (Subject to Revision)

Symbol	Failure Type	Symbol	Failure Type
A	No discernible failure plane	B-4	Combination
(B)	Well defined shear plane @ X angle (deg) to vertical or to long axis of core	C	Barreling/Bulging
B-1	Shear plane	D	Longitudinal (axial) splitting
B-2	Bedding plane shear	E	Conical
B-3	Shear plane along preexisting fracture, shear zone, etc.	F	No information

Note: Some values in this table may be revised based on reviews of test procedures and individual test results. The reader should refer to the latest revision of the gINT geotechnical data base (geotechnical report GR-70).

BORING NO.: BIR54
DEPTH RANGE (FT): 46.1-46.9
TAYLOR MARL

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 46.1
(2) DEPTH (FT) : 46.5

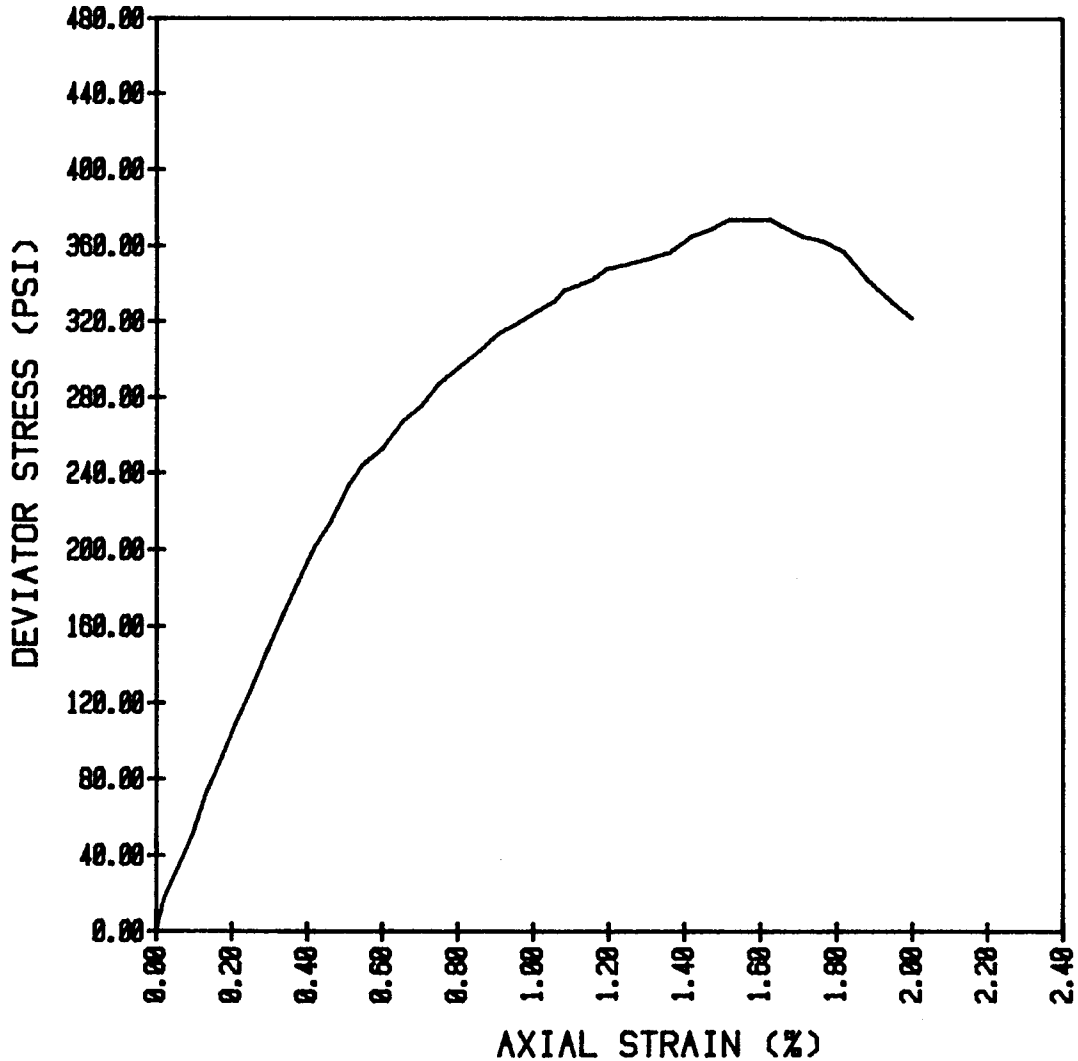
TEXAS SSC SITE

MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR54
DEPTH (FT): 46.1
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =16.9
DRY UNIT WEIGHT (PCF) = 115.0
DEG. OF SATURATION (%) = 98.0
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 50
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.426 x1E5 PSI

FAILURE MODE :
AXIAL SPLITTING

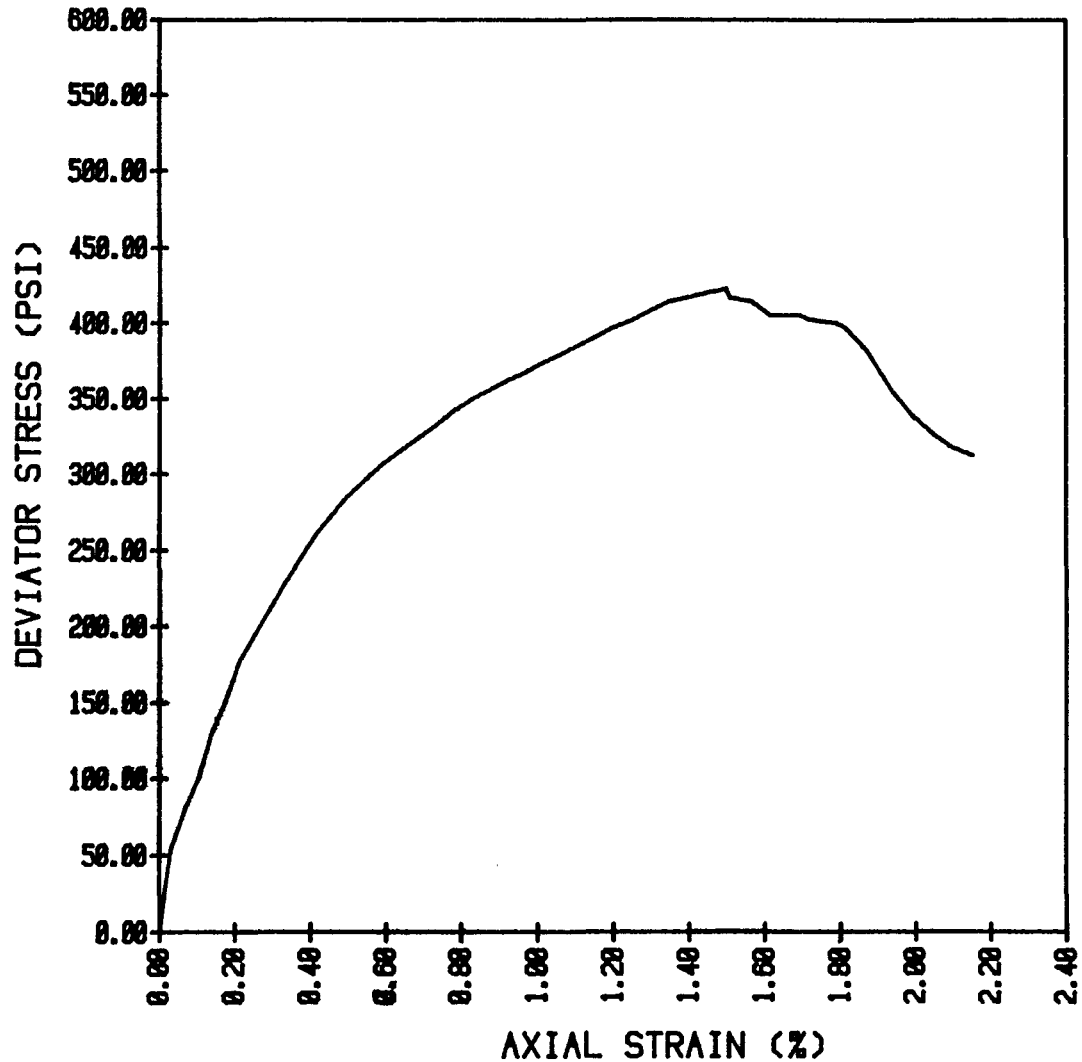
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR54
DEPTH (FT): 46.5
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =16.8
DRY UNIT WEIGHT (PCF) = 115.5
DEG. OF SATURATION (%) = 98.8
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 300
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.431 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 40 DEG

TEXAS SSC SITE

STRESS - STRAIN PLOT

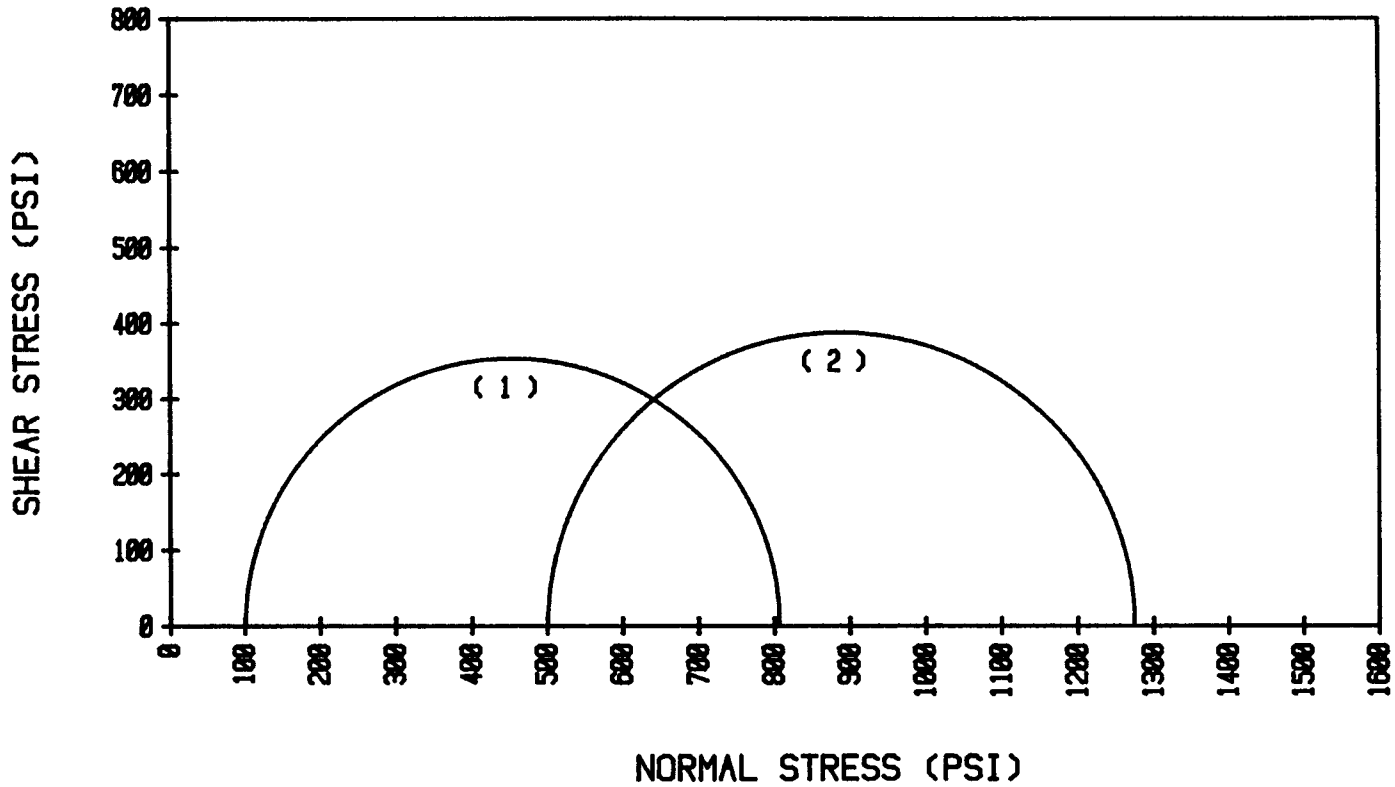
MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO. : 5530.16

FIGURE

BORING NO.: BIR54
DEPTH RANGE (FT): 122.1-123.3
TAYLOR MARL

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)

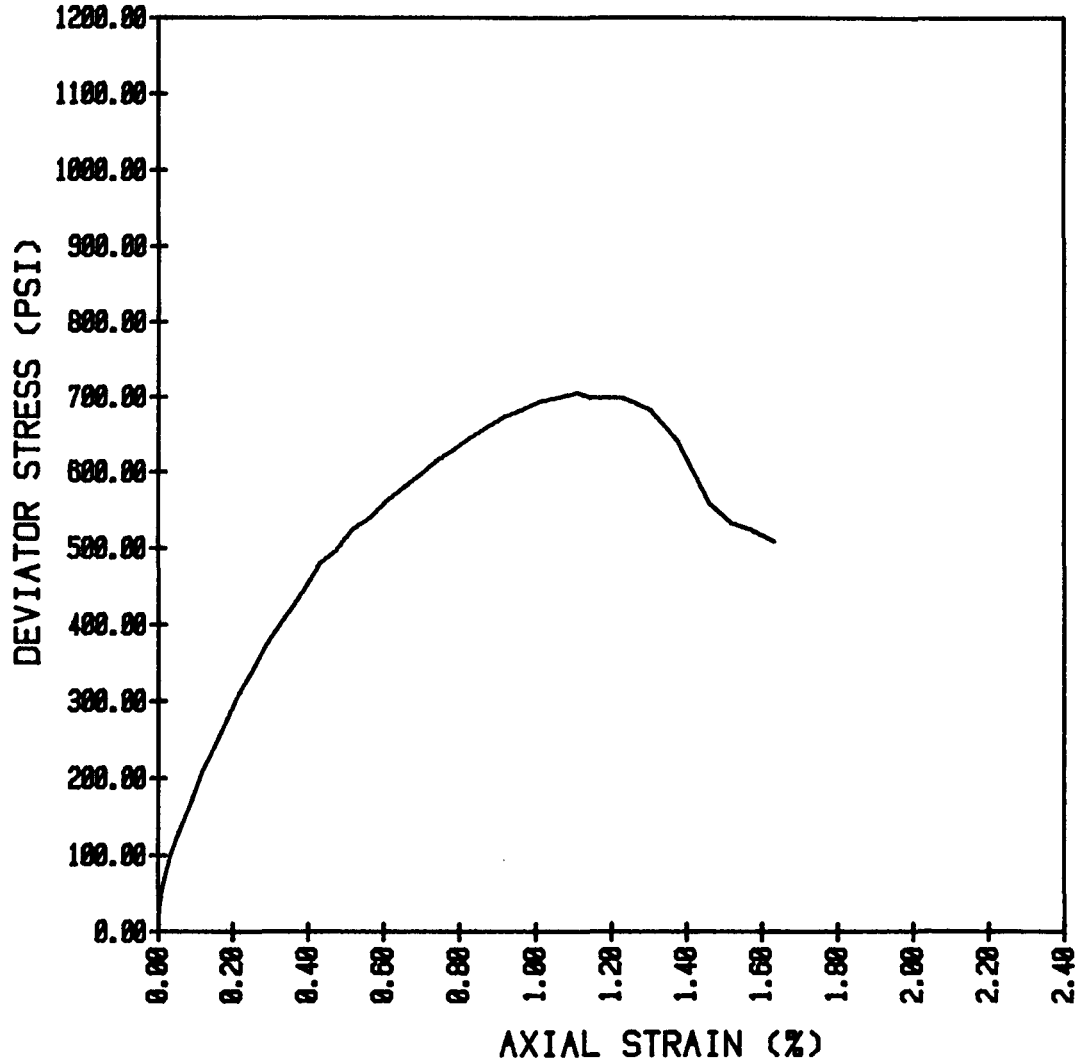


SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 122.1
(2) DEPTH (FT) : 122.9

TEXAS SSC SITE	
MOHR CIRCLE PLOT	
MASON-JOHNSTON & ASSOCIATES, INC. GEOLOGIST-ENGINEERS	
JOB NO.: 5530.16	FIGURE

BORING NO. : BIR54
DEPTH (FT): 122.1
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =15.0
DRY UNIT WEIGHT (PCF) = 118.4
DEG. OF SATURATION (%) = 96.1
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 100
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.855 x1E5 PSI

FAILURE MODE :
SHEAR PLANES

TEXAS SSC SITE

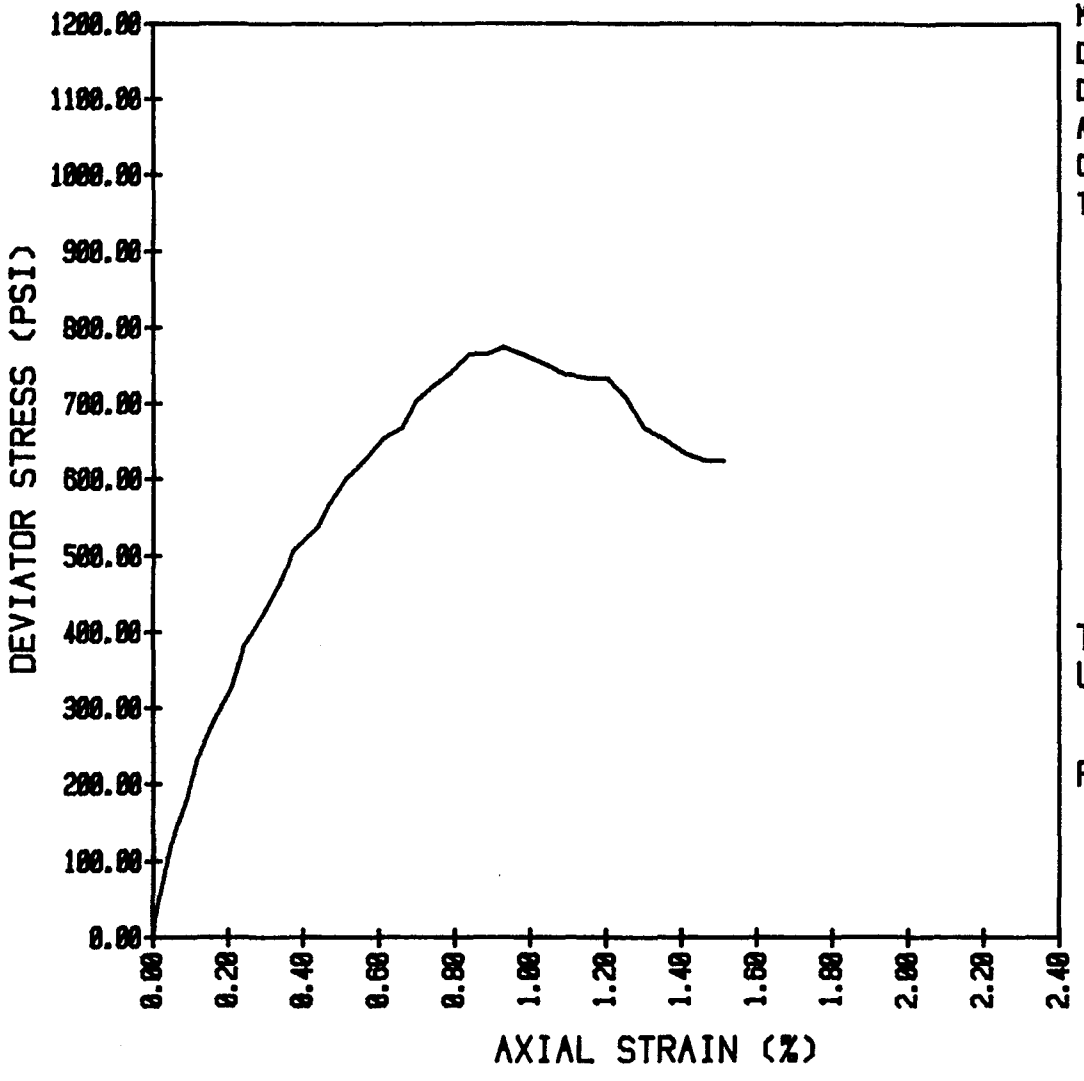
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR54
DEPTH (FT): 122.9
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =14.9
DRY UNIT WEIGHT (PCF) = 119.1
DEG. OF SATURATION (%) = 97.2
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 500
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
1.091 x1E5 PSI

FAILURE MODE :
SHEAR PLANE AT 30 DEG.

TEXAS SSC SITE

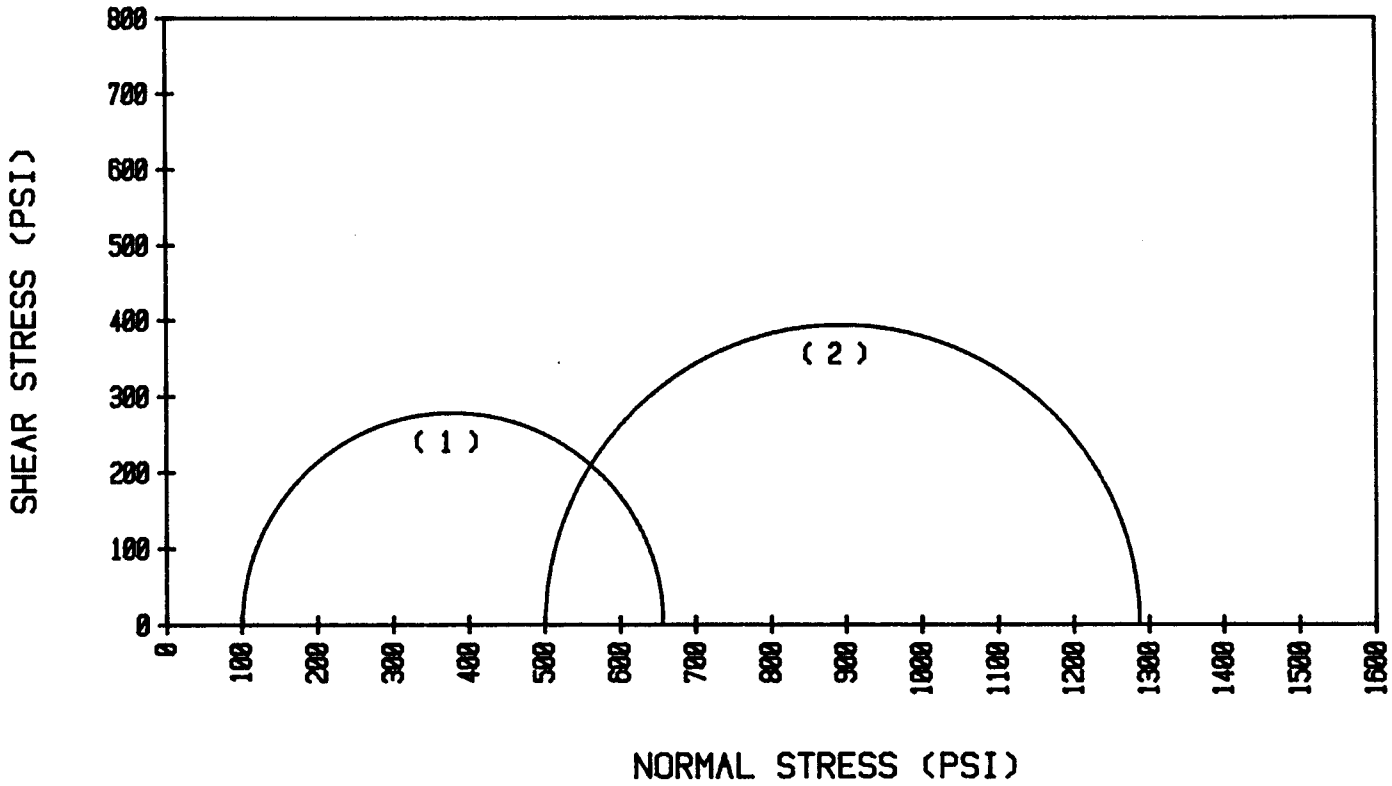
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO.: BIR54
DEPTH RANGE (FT): 185.2-186.0
TAYLOR MARL

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 185.2
(2) DEPTH (FT) : 185.6

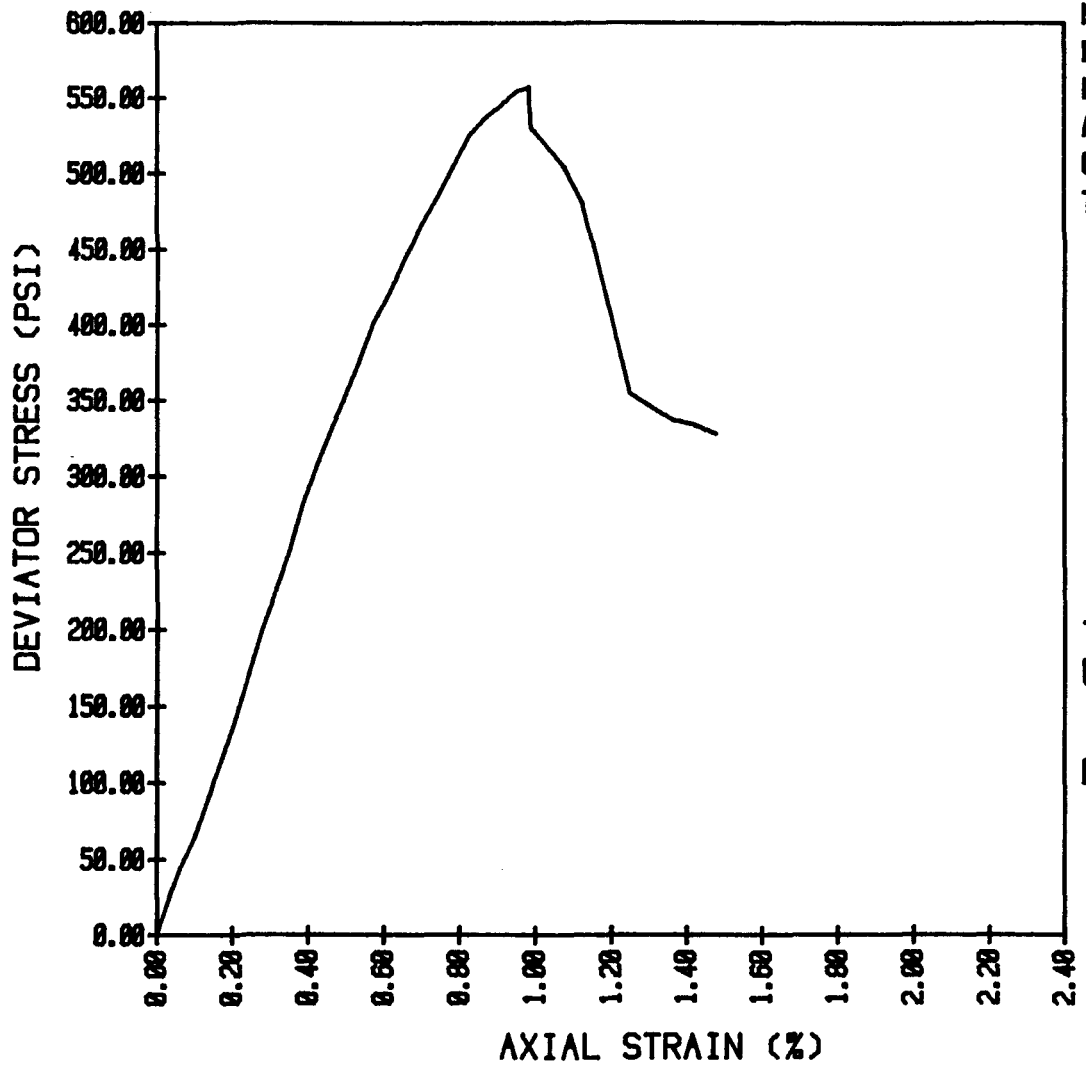
TEXAS SSC SITE

MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR54
DEPTH (FT): 185.2
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =15.5
DRY UNIT WEIGHT (PCF) = 118.1
DEG. OF SATURATION (%) = 97.8
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 100
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.889 x1E5 PSI

FAILURE MODE :
SHEAR PLANES AT 37 DEG.

TEXAS SSC SITE

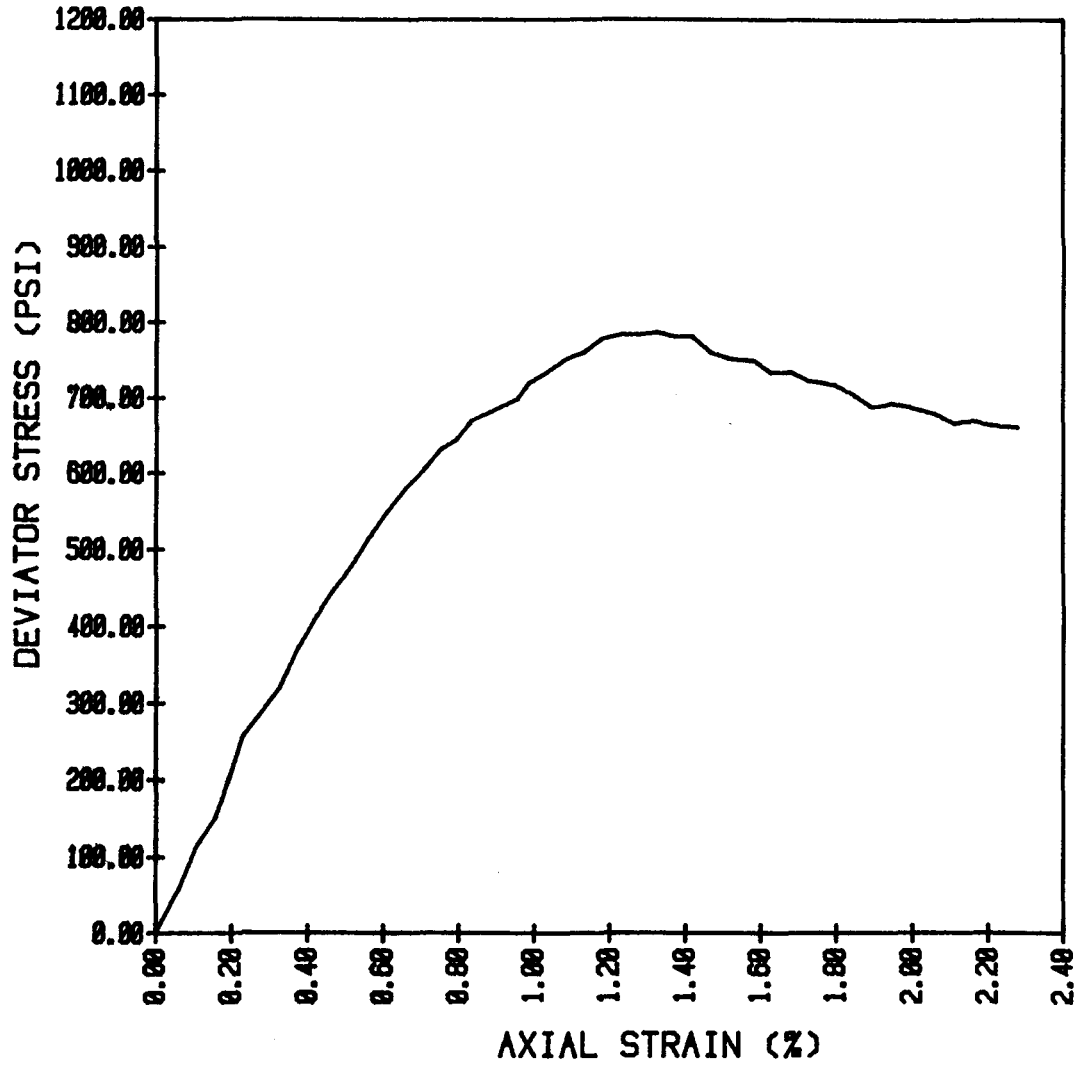
STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR54
DEPTH (FT): 185.6
TAYLOR MARL



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =15.8
DRY UNIT WEIGHT (PCF) = 117.2
DEG. OF SATURATION (%) = 97.8
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 500
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

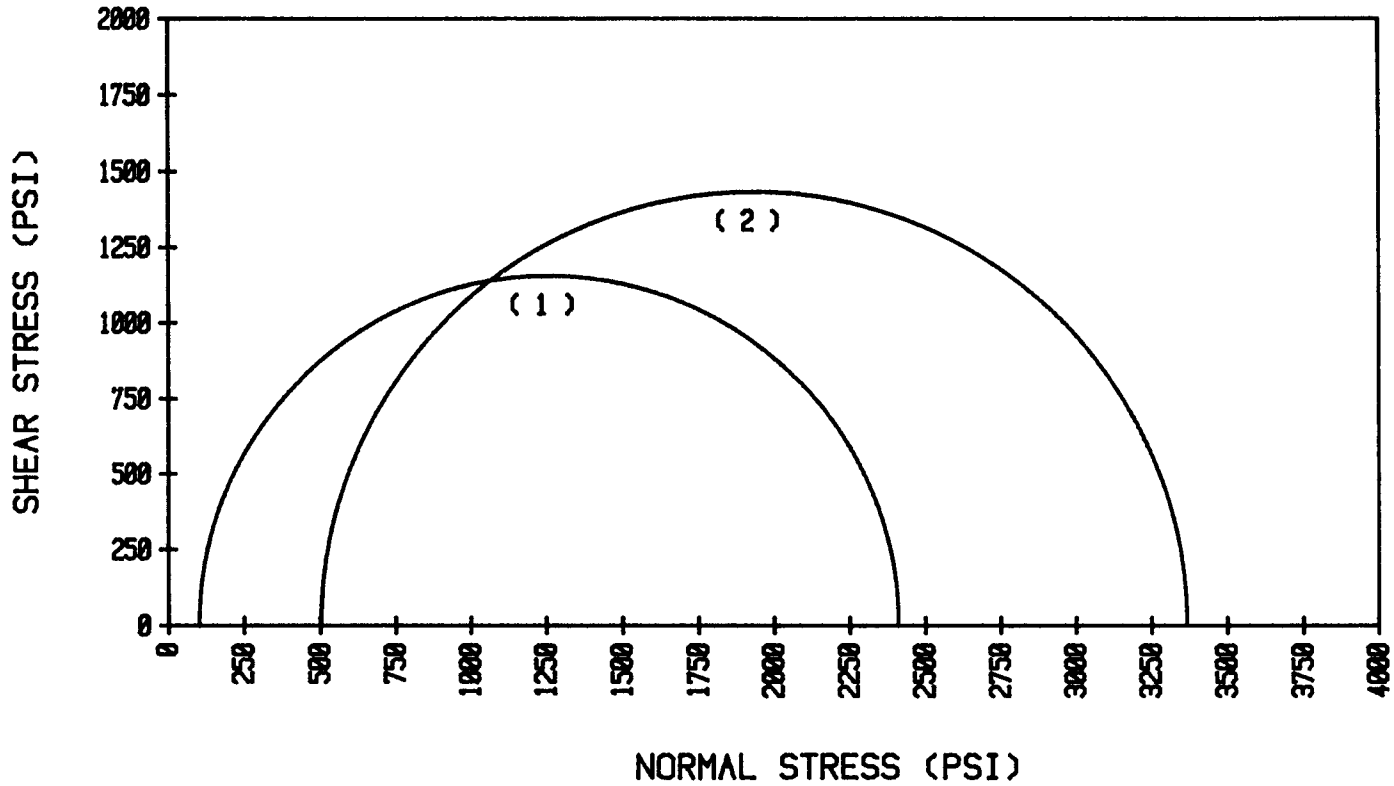
TANGENT MODULUS AT 50%
ULTIMATE STRESS:
0.882 x1E5 PSI

FAILURE MODE :
SHEAR PLANES

TEXAS SSC SITE	
STRESS - STRAIN PLOT	
MASON-JOHNSTON & ASSOCIATES, INC. GEOLOGISTS-ENGINEERS	
JOB NO.: 5530.16	FIGURE

BORING NO.: BIR54
DEPTH RANGE (FT): 195.7-196.8
AUSTIN CHALK LIMESTONE

BORING INCLINATION (DEG) : VERTICAL
TEST TYPE : TRIAXIAL COMPRESSION (ASTM D2664)



SEE STRESS STRAIN PLOTS
FOR INDIVIDUAL SAMPLE DATA

(1) DEPTH (FT) : 195.7
(2) DEPTH (FT) : 196.4

TEXAS SSC SITE

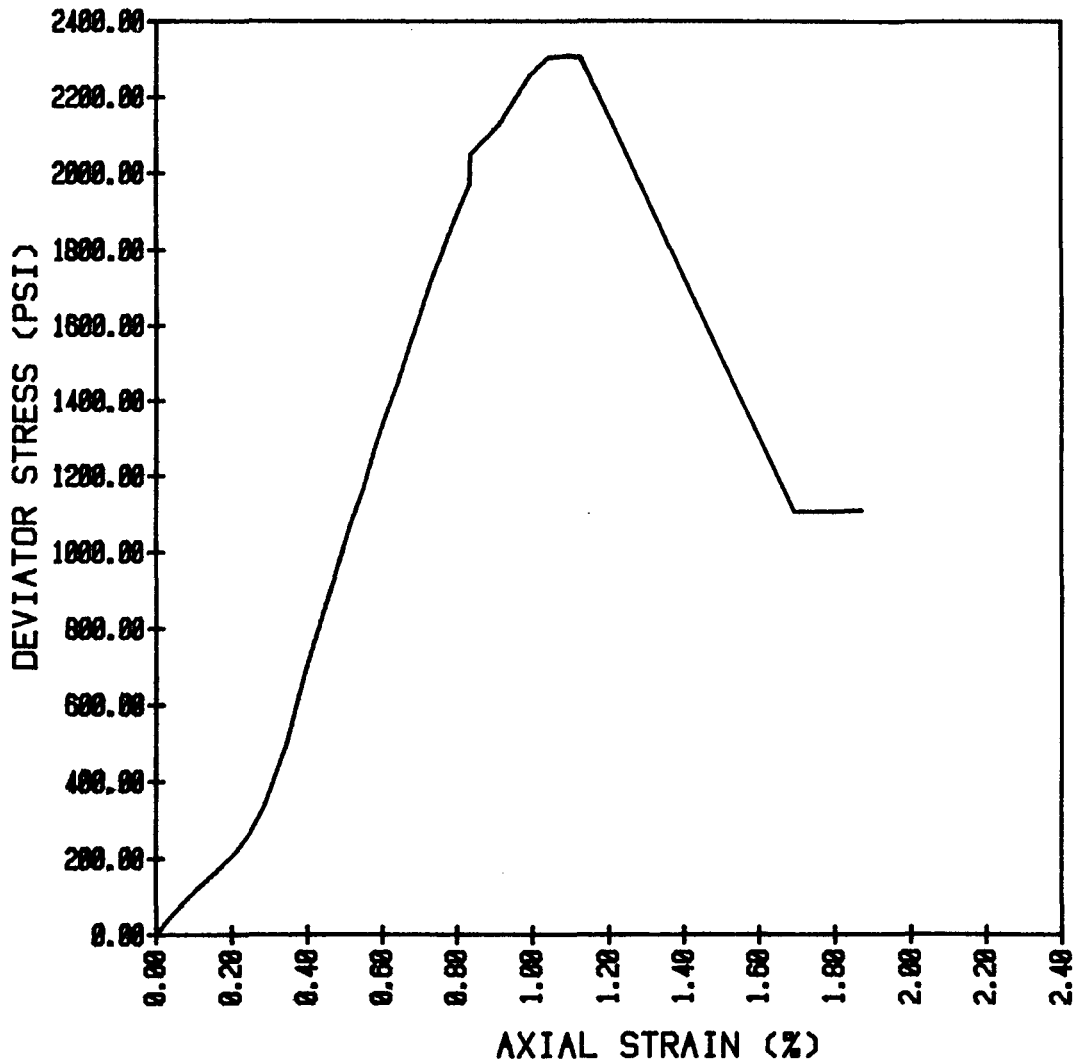
MOHR CIRCLE PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGIST-ENGINEERS

JOB NO.: 5530.16

FIGURE

BORING NO. : BIR54
DEPTH (FT): 195.7
AUSTIN CHALK LIMESTONE



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =10.5
DRY UNIT WEIGHT (PCF) = 129.8
DEG. OF SATURATION (%) = 94.9
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 100
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
3.103 x1E5 PSI

FAILURE MODE :
AXIAL SPLITTING

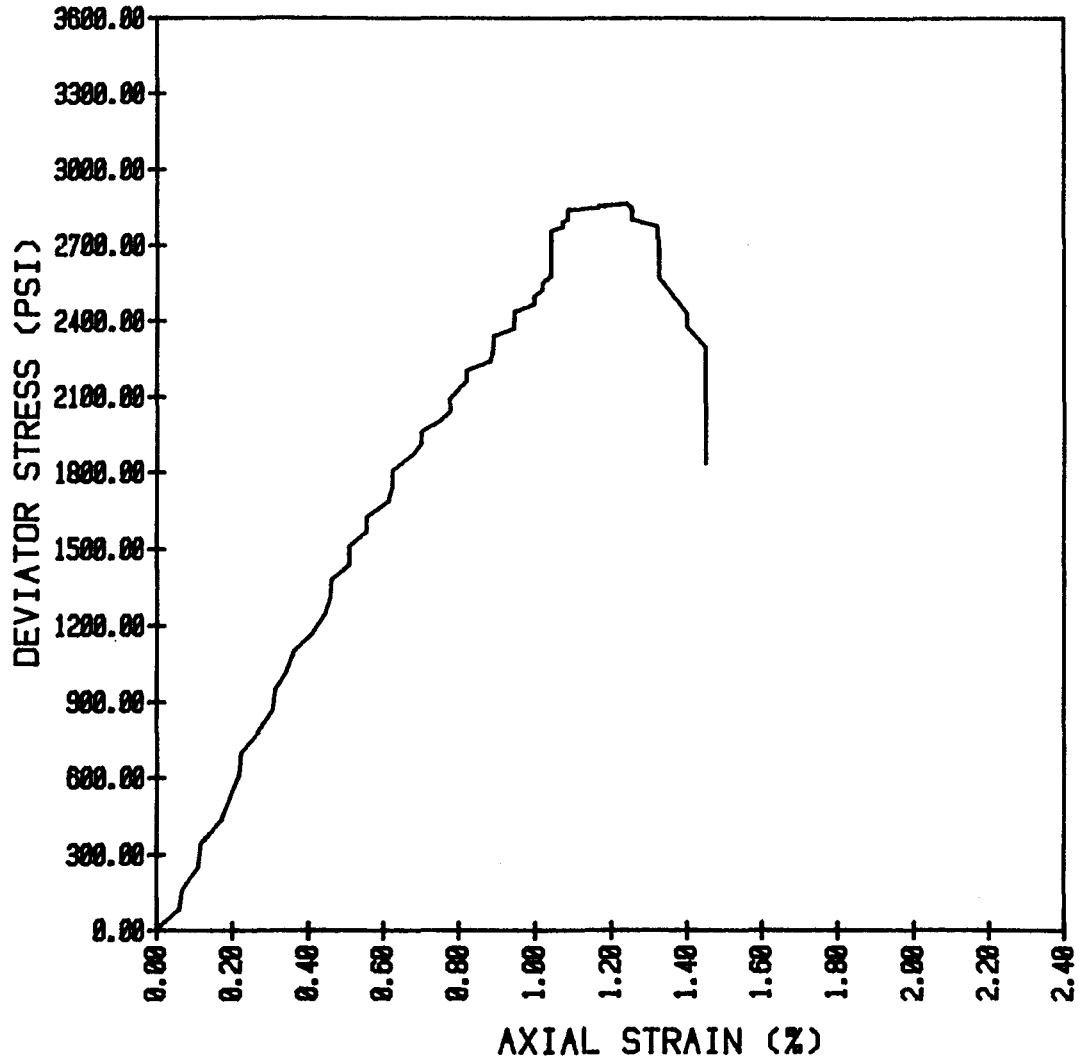
TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

BORING NO. : BIR54
DEPTH (FT): 196.4
AUSTIN CHALK LIMESTONE



INCLINATION (DEG) : VERTICAL
MOISTURE CONTENT (%) =10.4
DRY UNIT WEIGHT (PCF) = 131.0
DEG. OF SATURATION (%) = 98.4
ASSUMED SPECIFIC GRAVITY :2.7
CONFINING PRESSURE (PSI) : 500
TEST TYPE :TRIAXIAL COMPRESSION TEST
(ASTM D 2664)

TANGENT MODULUS AT 50%
ULTIMATE STRESS:
2.625 x1E5 PSI

FAILURE MODE :
SHEAR PLANES AT 30 DEG.

TEXAS SSC SITE

STRESS - STRAIN PLOT

MASON-JOHNSTON & ASSOCIATES, INC.
GEOLOGISTS-ENGINEERS

JOB NO.: 5530.16 | FIGURE

APPENDIX F

DOWNHOLE VELOCITY SURVEYS

APPENDIX F

MEASUREMENT

Downhole seismic velocity surveys at boring BIR 54 were completed on November 30 and December 1, 1989. The survey objectives were to determine the in-situ compressional (P) and shear (S) wave velocity profiles of subsurface materials. Dynamic elastic moduli were estimated from interpreted velocities and densities obtained from laboratory analysis of boring samples.

Seismic waves were generated at the surface and recorded at a number of depths in the boring. Seismic waves were detected with a downhole package of three mutually perpendicular geophones (Mark Products model L-10-3WD, 28 Hz resonant frequency) with one geophone vertically oriented. Spring-loaded steel wedges were used to press the geophone package against the casing.

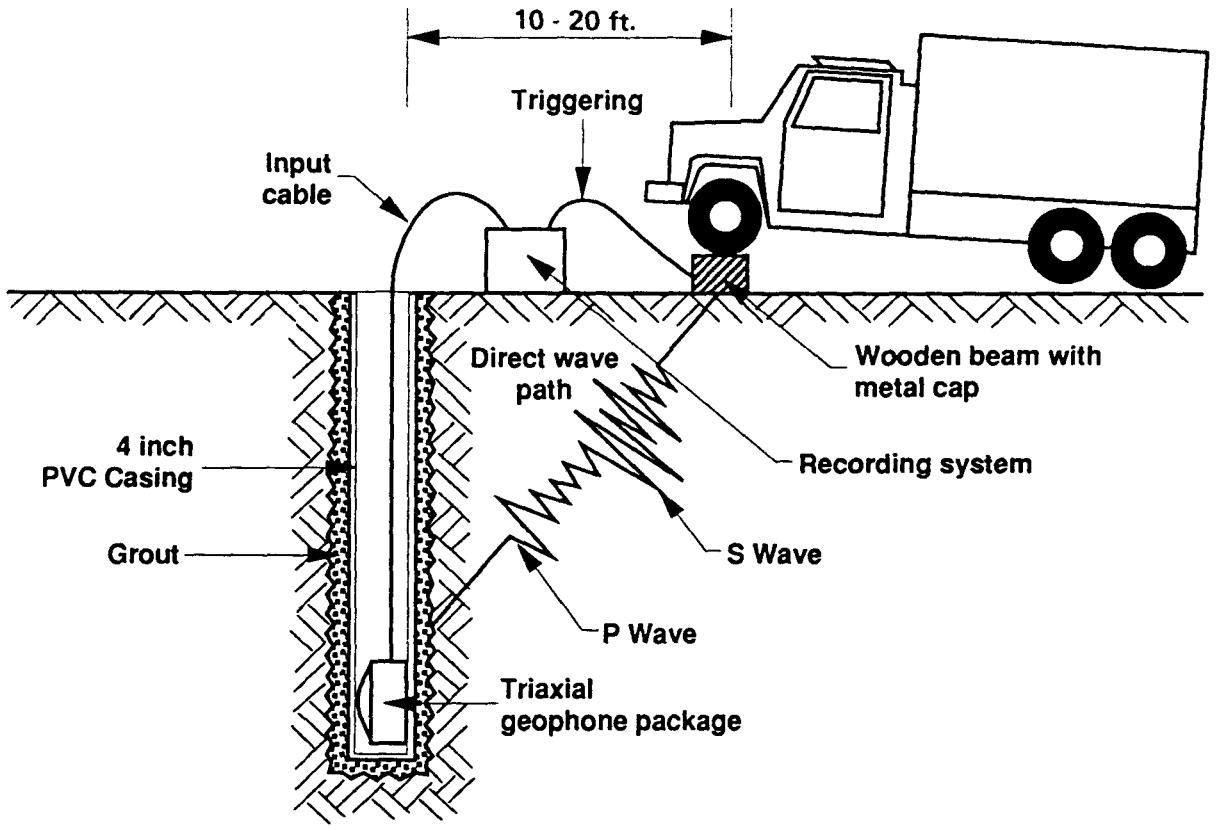
Geophone output signals were recorded with a twelve-channel, signal enhancement seismograph (EG&G Geometrics model ES-1210F, S/N 19186). The seismograph was triggered at the instant of energy generation by a transistor switch attached to the source. For a given measurement depth, waveforms from several impacts were stacked (added together) and the sum stored in memory. Often, stacking permits building a weak seismic waveform to a recognizable level even in 'noisy' environments. No filtering was used in recording the data. During acquisition, seismic waves were displayed on an oscilloscope. When the proper sequence of data traces was developed, a hard copy record was made with full-width timing lines (0.5 millisecond intervals). Travel times have an uncertainty of $\pm$0.25 milliseconds.

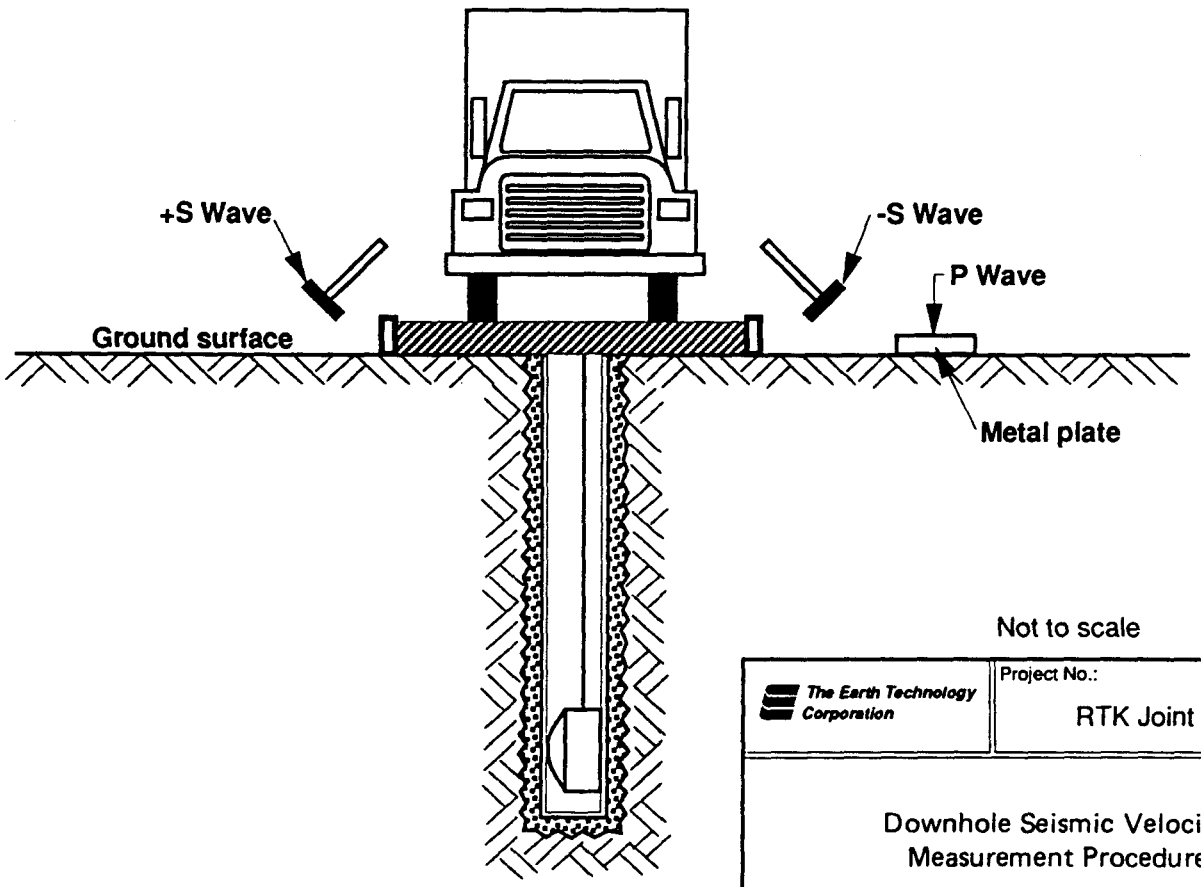
The layout for measuring seismic velocity is shown in Figure F-1. Measurement depths have an uncertainty of $\pm$ 0.1 foot. The quality of P and S wave arrivals was judged to be generally good to fair.

RESULTS

Downhole velocity survey results at boring BIR 54 (Figure F-2) agree well with conditions described by boring and wire-line logs. Dynamic elastic moduli and Poisson's ratio were calculated using the equations listed in the following table. Densities were measured in the laboratory on boring samples. All P wave arrivals are judged to be of good quality. All S wave arrivals are judged to be of only fair quality. No coherent S wave arrivals could be recorded between 70 and 110 feet. No data were recorded within the screened interval, at depths of 176 to 196 feet. The interpreted velocities and moduli are thought to have an uncertainty of $\pm$10 percent.

The boring log describes surficial clayey overburden (16 feet thick) underlain by weathered Taylor Marl (6 feet thick). Seismic velocities for the overburden are 2,100 fps (feet/second) and 840 fps for P and S waves, respectively. Taylor Marl was identified between depths of 22 and 188 feet. The average P velocity of the marl as interpreted from full-wave sonic logging is 6,550 fps (feet/second). The downhole





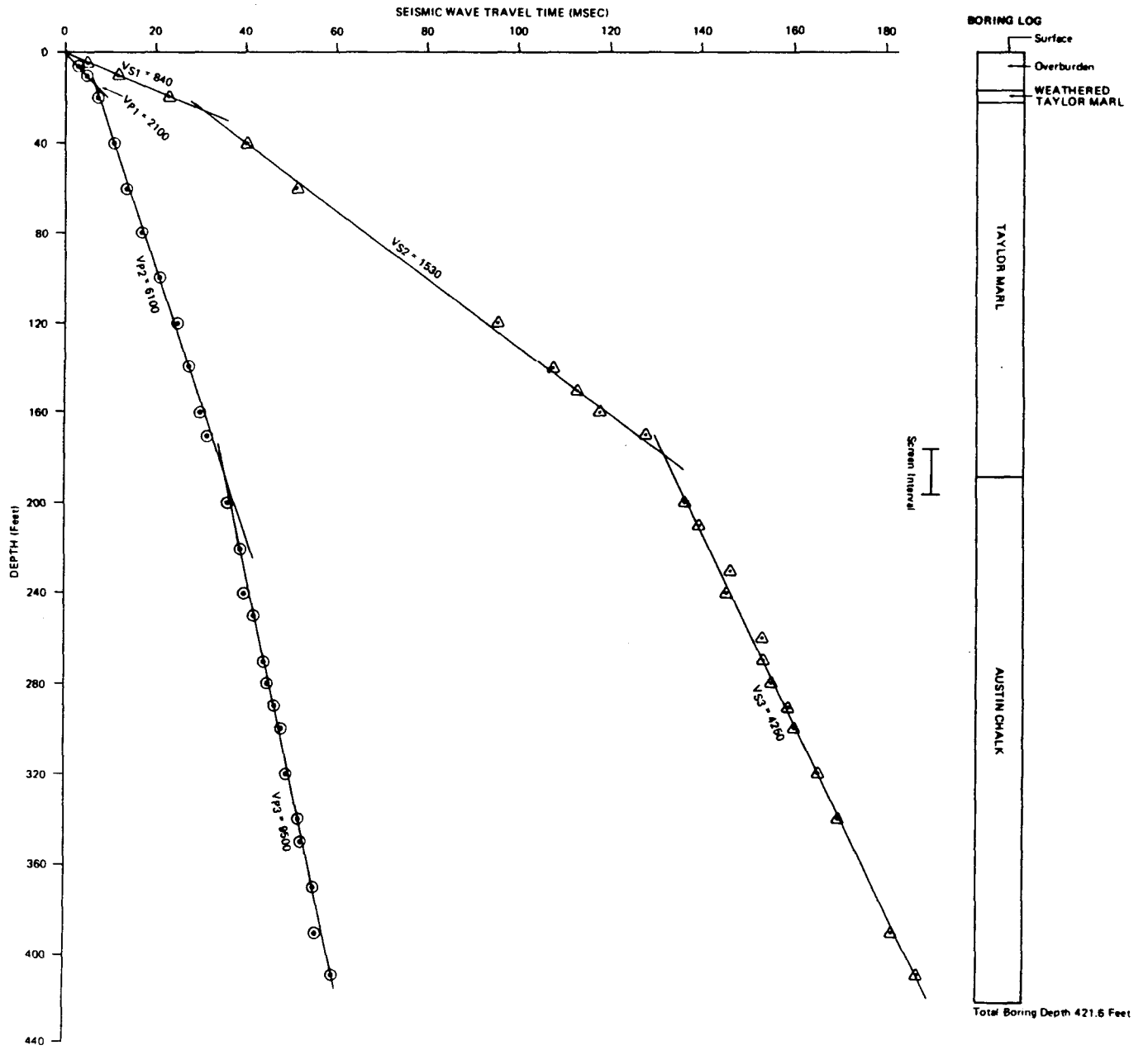
Not to scale

The Earth Technology Corporation	Project No.: 87-888-0015 RTK Joint Venture

Downhole Seismic Velocity Measurement Procedure

12-89

Figure F-1



EXPLANATION

⊙ P WAVE ARRIVAL TIMES

△ S WAVE ARRIVAL TIMES

ENERGY SOURC TO BORING DISTANCE IS 20 FEET

SEISMIC VELOCITIES IN FEET/SECOND

The Earth Technology Corporation

Project No 87 888 0016

RTK Joint Venture

BORING BIR 54
DOWNHOLE VELOCITY SURVEY
DATA and INTERPRETED RESULTS

1-90

Figure F 2

velocity survey identified a P velocity of 6,100 fps (7 percent less than the sonic logging value) and the S wave velocity is 1,530 fps.

The boring log describes Austin Chalk from depths of 188 to 421 feet (boring termination). The measured sonic logging P velocity for the chalk is 9,100 fps. The downhole velocity survey identified a large P and S wave velocity inversion below an average depth of 184 feet. The chalk P velocity is 9,500 fps (4 percent greater than the sonic logging value) and the S velocity is 4,250 fps. Both chalk velocities are at least 50 percent greater than velocities in the overlying Marl.

SUMMARY OF SEISMIC VELOCITIES AND ELASTIC MODULI FOR BORING BIR54

Depth (ft)	Vp (fps)	Vs (fps)	Average Bulk Density (pcf)	Poisson's Ratio*	Shear Modulus* ($x10^5$ psi)	Constrained Modulus* ($x10^5$ psi)	Young's Modulus* ($x10^5$ psi)	Bulk Modulus* ($x10^5$ psi)
0-19	2100	840	121.0**	0.41	0.18	1.15	0.52	0.91
19-184	6100	1530	134.8	0.47	0.68	10.81	2.00	9.93
184-410	9500	4250	144.9	0.38	5.7	28.19	15.55	20.71

** No sample tested, estimated.

*Equations used to calculate Poisson's ratio and dynamic elastic moduli are listed below.

Poisson's Ratio, u (dimensionless) $$u = \frac{Vp^2 - 2Vs^2}{2(Vp^2 - Vs^2)}$$

Shear Modulus, G (psi) $$G = CDVs^2$$

Constrained Modulus, M (psi) $$M = CDVp^2$$

Young's Modulus, E (psi) $$E = 2G(1 + u)$$

Bulk Modulus, K (psi) $$K = CD(Vp^2 - 4/3Vs^2)$$

where: Vp = P wave velocity (fps)
Vs = S wave velocity (fps)
D = Bulk (wet) density (pcf)
C = 2.156×10^{-4} (units conversion)

SSC BOREHOLE PLUGGING REPORT

Project No. 87-88-0017

Task No. 16

Boring No. BIR 51

Texas Coordinate Location: N 266,170 feet
E 2,250,529 feet

Surface Elevation: 449.0 feet

Total Boring Depth: 200.0 feet

Date Drilled: 11/14-11/16/89

Date Plugged: 11/17/89

Time Completed: 11:00 A.M.

Remarks:

204 gallons of grout (tremie placed) was used to completely cement boring from bottom to top. Water/cement ratio was approximately 7 gallons per sack.

Drilling geologist: Shawn Wood
Coordinator: Bruce Bailey
SwL Report No. 89-192

SSC BOREHOLE PLUGGING REPORT

Project No. 87-88-0017

Task No. 16

Boring No. BIR 52

Texas Coordinate Location: N 266,420 feet
E 2,250,682 feet

Surface Elevation: 447.8 feet

Total Boring Depth: 205.0 feet

Date Drilled: 11/17-11/20/89

Date Plugged: 11/21/89

Time Completed: 2:00 P.M.

Remarks:

185 gallons of grout (tremie placed) was used to completely cement boring from bottom to top. Water/cement ratio was approximately 7 gallons per sack.

Drilling geologist: Shawn Wood
Coordinator: Bruce Bailey
SwL Report No. 89-192

SSC BOREHOLE PLUGGING REPORT

TETC Project No. 87-888-0016

Task No. 16

Boring No. BIR-53

Texas Coordinate Location: N 266,088 feet E 2,250,927 feet

Surface Elevation: 438.7 feet

Total Boring Depth: 285.5 feet

Plugging Remarks:

Grout tube was placed into hole. Grout was mixed at a ratio of 35 gallons of water to 4 sacks of cement (9/1). Grout was placed down the hole through the grout tube (tremie pipe). A total of 12 sacks of cement were used.

Note: Approximately 12 lbs. of bentonite was mixed with each 4 sack batch of grout.

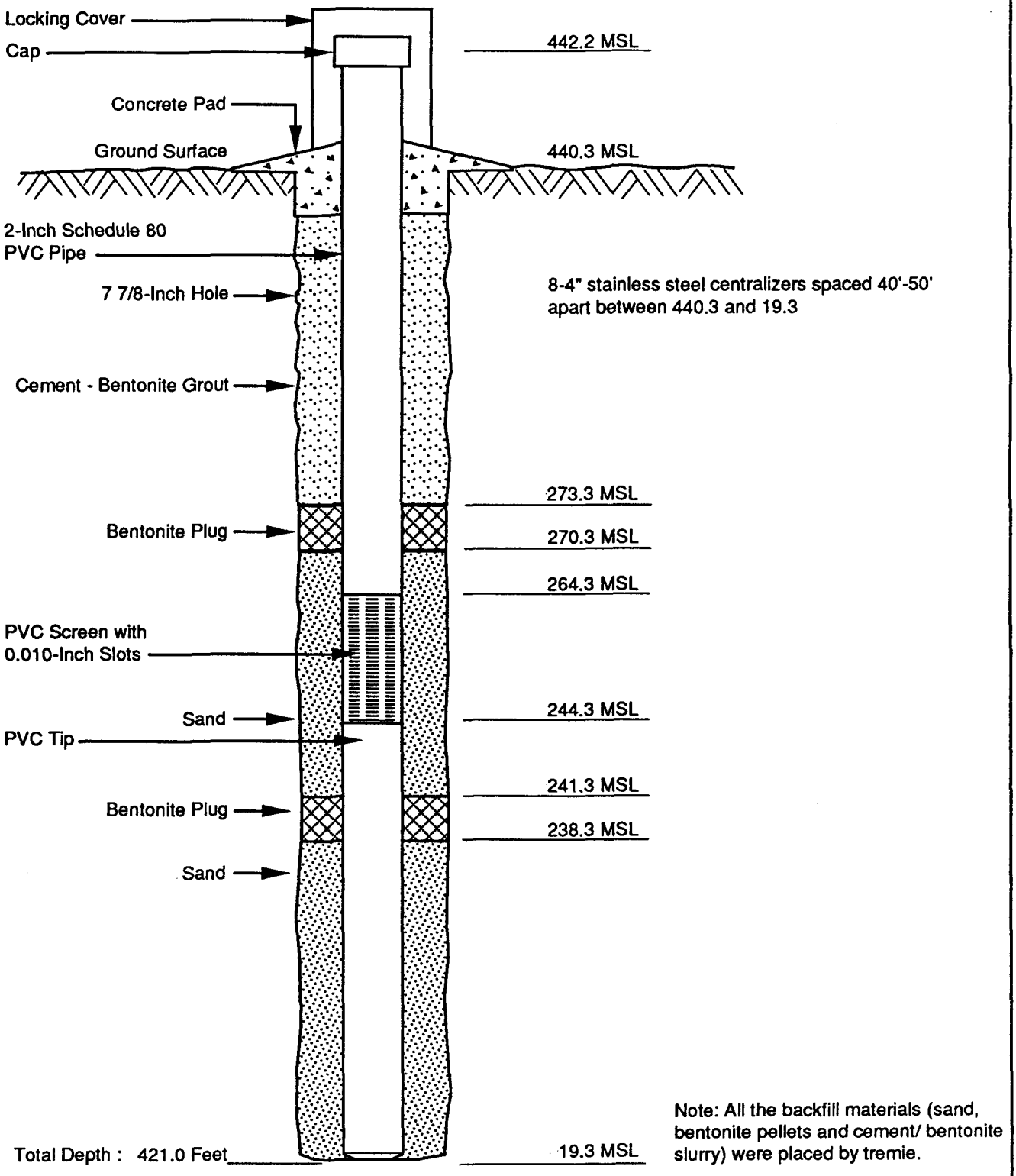
Date Plugged: 11-20-89

Time Completed: 2:45 pm

Drilling Geologist: H. C. Crowder

MJA Coordinator: W. D. Flanigan

MJA No.: 5530.16



Note: All the backfill materials (sand, bentonite pellets and cement/ bentonite slurry) were placed by tremie.

NOT TO SCALE

Boring: BIR 54
Location: N 265,911
E 2,250,528
Date(s) Installed: 10/10-10/11/90
Well Construction
Supervising Geologist: Ron Randall
Approved By: Shawn Wood **Date: 5/21/90**

"As Built"
Well Construction Diagram
Observation Well
No. BIR 54

5/90 Figure