MASTER

C00-2689-10

CRUISE REPORT

✓ R/V ENDEAVOR CRUISE EN-024.

SEABED DISPOSAL PROGRAM;

NORTH ATLANTIC STUDY AREA MPG-III

35°30'N 61°00'W,

JUNE 30 - JULY 11 1978

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by

G. Ross Heath and Edward P. Laine

FINAL REPORT

September 1978

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ABSTRACT

During 7 days in the vicinity of 35°30'N, 61°00'W (Seabed Disposal Program mid-late, mid-gyre study area MPG-III) we carried out 1830 km of subbottom acoustic profiling and 2 camera lowerings, and took 7 standard piston cores, 3 large diameter piston cores, 9 large diameter gravity cores and 2 dredge hauls of surface sediment. Pore fluids were extracted from 3 gravity cores and 1 piston core and on-board physical property measurements were made on 2 large diameter piston cores and 1 large diameter gravity core.

These data and samples will be used to assess the lateral homogeneity and recent geologic history of the area, as well as to compare the sorption and physical barrier properties of the sediments with deposits from the MPG I and II areas in the Pacific.

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INTRODUCTION

R/V Endeavor left Narragansett, Rhode Island at 0500 on June 30, 1978 to start cruise EN-024. Most of the scientific work - subbottom acoustic profiling and sediment sampling - was concentrated within about 60 km (35n.m) of 35°10'N 61°15'W, an area designated as MPG-III (third mid-plate, mid-gyre study area). The cruise ended in Narragansett at 0700 on July 11, 1978.

The general criteria for selection of the Seabed Disposal Program's study areas, and the general approach of the program are summarized in a recent issue of Oceanus (Vol.20, No.1, winter 1977).

The general setting of MPG-III is shown in Figure 1. The outline of the area relative to surrounding topographic and geographic features is shown in Figure 2. MPG-III was chosen for the following reasons:

- a. It lies beneath the relatively biologically unproductive North Atlantic gyre.
- b. It is far from the seismically active margins of the North American lithospheric plate.
- c. It lies in an area of thick pelagic sediments, but several hundred meters above the surrounding abyssal plains which likely contain sandy turbidites.
- d. The sediments (thick, mildly reduced, rapidly deposited) are quite different from those in the MPG-I and II areas (thin, strongly oxidized, very slowly deposited), allowing for a comparison of the effectiveness of the barrier properties of the two deposits to the migration of nuclides from buried waste.
- e. In terms of sediment thickness, lack of basement outcrops, and distance from known areas of bottom erosion, the MPG-III area was favored over other sites in the western North Atlantic.

Figure 1. Location of MPG-III relative to the general bathymetry of the North Atlantic. Isobath interval 1 km (from Chase et al., 1975)

Figure 2. Outline of MPG-III area relative to the bathymetry of the northwest Atlantic (Navoceano chart NA6, 200m isobaths), and to the 200-mile limit of Bermuda.

Figure 3 shows the defined limits of MPG-III (35°00'N 62°00'W, 34°40'N 60°50'W, 35°40'N, 60°25'W, 36°00'N, 61°35'W), bathymetry from the U.S.Navy compilation (Navoceano chart NA-6) and existing tracklines including those made by the French vessel Resolution during July, 1978.

SCIENTIFIC STAFF

G. Ross Heath	Co-Chief Scientist, coring
Edward P. Laine	Co-Chief Scientist, seismics
Alan Driscoll	Coring chief
David I. Calnan	Sediment-processing chief
David T. Heggie	Pore-waters chief
Steve Imms	Technician, seismics
Bob Knobel	Technician, camera
Ken Baldwin	Sediments, acoustics
Mike Bell	Coring, sediments
Elizabeth Ayer	Coring, sediments
Peter Chipello	Coring
Steve Criscenzo	Coring, sediments
Nancy Lindquist	Coring, data archival
Peter Lemmond	Sediments, dredging
Nile Luedtke	Pore waters
Roger Morin	Sediments, dredging

SCIENTIFIC PROGRAMS

1. Navigation

Position control was by Loran C with supplemental satellite fixes. Loran positions generally appear good to about 0.1n.m., but with excursions up to 5n.m. round sunrise/sunset.

Figure 3. MPG-III area ($35^{\circ}00'N$, $62^{\circ}00'W$; $34^{\circ}40'N$, $60^{\circ}50'W$; $35^{\circ}40'N$, $60^{\circ}25'W$; $36^{\circ}00'N$, $61^{\circ}35'W$) showing generalized bathymetry (Navoceano chart NA-6; 200m isobaths), existing U.S. tracklines (AII = Atlantis II, CH = Chain, EN = Endeavor, GC = Glomar Challenger), multichannel tracklines (BER = Resolution) and tracklines of EN-024.

2. Bathymetry/3.5 kHz Profiling (E. Laine)

The tracks of R/V Endeavour in the MPG-III area during EN-024 are shown on Figure 3. The 3.5 kHz system was operational and gave excellent records (up to 200m penetration) throughout the cruise. These records will be used to compile a new bathymetric map of the area, and to outline the distribution of near-surface acoustic units. Figures 4 and 5 show examples of well laminated Quaternary deposits and outcrops of ?Tertiary non-laminated ("transport") sediments.

3. Seismic Profiling (E. Laine)

The airgun system, using twin 40 cub. in. guns operated at 1500psi and a WHOI streamer/electronics system, gave excellent characterization of acoustic units above volcanic basement. The total sediment section ranges in thickness from less than 0.5 secs. (~380m) to more than 2 secs. (~1600m). These data, combined with existing profiles from D/V Glomar Challenger and R/V Resolution will be used to prepare isopach maps of MPG-III sediments and to form a basis for preparation of a complete geologic history of the area. Figure 6 illustrates the major acoustic units down to basement.

4. Coring Program (A. Driscoll, D. Calnan)

Details of the sediment cores taken during EN-024 are summarized in Table 1. Of the 7 conventional piston cores, 5 were taken in laminated deposits of presumed Quaternary and late Pliocene age, and two were taken in an area of outcrop of the underlying "transparent" deposits of presumed Tertiary age. All cores appear to be of high quality. They will be used to assess the vertical and lateral coherence of sediment properties as well as to decipher the recent geologic history of the region.

The 3 large piston cores (LPC's; 10cm diameter) were taken only in young laminated sediments, as we were concerned about the capacity of the 1/2" deep-sea wire to break out cores from the more consolidated outcrops

Figure 4. 3.5 kHz acoustic profiler record of typical laminated MPG-III sediments. Location $35^{\circ}17.6'N$, $61^{\circ}16.7'W$. Water depths in uncorrected meters (assumed velocity 1500 m/sec). Vertical exaggeration approximately 40:1.

Figure 5. 3.5 kHz acoustic profiler records of erosional slopes and irregular laminated sediments in MPG-III. Locations $34^{\circ}56.1'N$, $61^{\circ}45.1'W$ (upper) and $35^{\circ}12.1'N$, $61^{\circ}30.5'W$ (lower). Water depths in uncorrected meters (assumed velocity 1500 m/sec). Vertical exaggeration approximately 40:1.

Figure 6. Low frequency (airgun) acoustic profiler record of the full sedimentary section in MPG-III. Location $35^{\circ}18.8'N$, $60^{\circ}41.1'W$. Depth in uncorrected meters (assumed velocity 1500 m/sec). Vertical exaggeration approximately 10:1. Dark surface layer corresponds to laminations of Figures 4 and 5. Deepest irregular reflector is volcanic basement (basalt).

TABLE 1
Sediment Cores and Dredge Samples

Core No. EN-024	Date	Time on Bottom (GMT)	Lat. (N)	Long. (W)	Water Depth (corr. m)	Approx. Core Length (cm)	No. of Sections	Pore * Waters?	Eng. # Studies?	3.5kHz Record	Comments
LGC-01	7/2/78	1534	35°26.0'	60°59.5'	4722	20	0	no	no	LSR-1	Washed out at surface
LPC-01	7/2/78	2326	35°20.6'	60°56.6'	4618	902	9	no	yes	LSR-1	177cm. flow-in
LPG-01	7/2/78	2332	35°20.6'	60°56.6'	4618	180	1	no	no	LSR-1	
LGC-02	7/3/78	0320	35°19.8'	60°50.5'	4595	360	3	yes	no	LSR-1	
DR-01	7/4/78	0830	35°09.2'	61°36.4'	4690	-	2	no	no	UGR-2 LSR-1	Approx. 80 galls.
DR-02	7/4/78	1330	35°09.3'	61°30.0'	4646	-	2	no	no	UGR-3 LSR-2	Approx. 80 galls.
PC-01	7/4/78	2330	35° 5.6'	61°35.2'	4614	1200	8	no	no	UGR-3 LSR-2	
PG-01	7/4/78	2330	35° 5.6'	61°35.2'	4614	200	2	no	no	UGR-3 LSR-2	Overpenetrated
LGC-03	7/5/78	0600	35° 1.9'	61°35.9'	4631	0	0	no	no	UGR-3 LSR-2	Broken barrel
PC-02	7/5/78	1158	34°59.0'	61°41.2'	4569	1069	7	no	no	UGR-3 LSR-2	Piston on sediment
PG-02	7/5/78	1158	34°59.0'	61°41.2'	4569	76	2	no	no	UGR-3 LSR-2	0.76cm not in liner
LGC-04	7/5/78	1715	34°56.5'	61°43.2'	4544	0	0	no	no	UGR-4 LSR-2	Broken barrel
LGC-05	7/5/78	0050	34°49.5'	61°36.0'	4621	300	2	yes	no	UGR-4 LSR-2	
LPC-02	7/6/78	0455	34°58.8'	61°34.7'	4606	13	11	no	yes	UGR-4 LSR-2	No flow-in
LPG-02	7/6/78	0455	34°58.8'	61°34.7'	4606	0	0	no	no	UGR-4 LSR-2	Barrel lost
PC-03	7/6/78	1816	34°55.1'	61°50.5'	4556	850	6	no	yes	UGR-4 LSR-2	"Transparent" layer outcrop
PG-03	7/6/78	1816	34°55.1'	61°50.5'	4556	80	1	no	no	UGR-4 LSR-2	
LGC-06	7/6/78	2107	34°56.9'	61°51.2'	4598	300	2	no	no	UGR 4 LSR-2	Modules on top, sealed
PC-04	7/7/78	0228	34°54.3'	61°52.5'	4689	890	6	no	no	UGR-5 LSR-3	"Transparent" layer outcrop
PG-04	7/7/78	0228	34°54.3'	61°52.5'	4689	0	0	no	no	UGR-5 LSR-3	Barrel lost
PC-05	7/7/78	2312	35°18.4'	60°39.2'	4629	1200	8	yes	no	UGR-5 LSR-3	14cm taken between 1.5m sections
PG-05	7/7/78	2312	35°18.4'	60°39.2'	4629	120	1	yes	no	UGR 5 LSR-3	
LGC-07	7/8/78	0316	35°13.5'	60°37.0'	4516	10	0	no	no	UGR-5 LSR-3	Washed out at surface
PC-06	7/8/78	0610	35°10.7'	60°35.3'	4508	1200	8	no	no	UGR-5 LSR-3	
PG-06	7/8/78	0610	35°10.7'	60°35.3'	4508	80	1	no	no	UGR-5 LSR-3	Overpenetrated
PC-07	7/8/78	2155	35°34.8'	61°25.3'	4786	1250	8	no	no	UGR-6 LSR-3	
PG-07	7/8/78	2155	35°34.8'	61°25.3'	4786	0	0	no	no	UGR-6 LSR-3	Lost corer
LGC-08	7/9/78	0136	35°30.7'	61°21.6'	4817	300	2	no	yes	UGR-6	
LPC-03	7/9/78	0655	35°42.6'	61°30.9'	4866	1247	2	no	no	UGR-6	No flow-in
LGC-09	7/9/78	0946	35°42.8'	61°33.1'	4853	320	2	no	no	UGR-6	Sealed and stored

PC = Piston core, LPC - Large diameter piston core, PG = Pilot gravity core (trip weight), LGC = Large diameter gravity core, DR = Sediment dredge

* See Appendix I for details

See Appendix II for details. Cores LGC-06 and 07 and LPC-03 were sealed and processed on shore

Figure 7. Bottom photographs of the upper slope of the erosional valley forming the southwest margin of MPG-III ($35^{\circ}01.0'N$, $61^{\circ}37.4-37.8'W$). Bottom shows delicate biogenic features with no evidence of current activity. Scale: compass vane is 25 cm long.

Figure 8. Bottom photographs of the lower slope of the erosional valley forming the southwest margin of MPG-III ($34^{\circ}54.7-54.9'N$, $61^{\circ}51.9-52.0'W$). Bottom is covered with manganese nodules and evidence of strong current scour. Scale: compass vane is 25 cm long.

8. Engineering/Geotechnical Studies (D. Calnan)

Appendix II summarizes sampling for geotechnical measurements. Efforts were focused on the three large piston cores, and on three of the large gravity cores. Apart from some instrumentation problems with the acoustic probes, all systems appeared to collect good samples and data.

SUMMARY

MPG-III sediments are buff grading downcore to (and sometimes alternating with) grey to grey-green foram-bearing clay. They are poorly consolidated, judging by the weak pull-out forces for both standard and large piston cores (1000-4000 lb.). The underlying non-laminated grey foram-bearing clay that crops out in the area is much stiffer.

Our first impression, based largely on the 3.5 kHz records is that MPG-III is considerably more dynamic from a sedimentologic viewpoint than would be inferred from historical data or its oceanographic setting. Partial or complete erosion of the laminated sediments can be observed at several locations. The constructional nature of much of the surface topography (which does not mirror underlying basement features) provides further evidence of a geologically active bottom circulation.

Our initial impressions may be softened or changed by further analysis of the acoustic data and work on the cores. At present, however, MPG-III does not appear quiescent or predictable enough to rate highly as a potential disposal site. If this conclusion holds up, the western North Atlantic cannot be considered a strong prospect for future Seabed Program site selection fieldwork. Only the distal portions of the Sohm and Nares abyssal plains (which, however, are geologically young and therefore lack long-term predictability), and perhaps the southern Bermuda Rise appear to warrant additional study.

Appendix I

Interstitial Water Sampling

Nile A. Luedtke and David Heggie

Cores Sampled:

ENO24-LGC02

ENO24-LGC05

ENO24-PC05

ENO24-PG05

ENO24-LPC01 (sampled but insufficient water obtained by centrifuging)

Procedure:

Duplicate 50 ml centrifuge tubes of sample were collected under N_2 gas (when possible) and centrifuged. An average of 4 ml of water per tube was extracted, filtered through either a 0.2 μm or 0.45 μm Nucleopore filter, and analyzed for the following: NO_3 , NO_2 , PO_4 , SiO_2 , NH_3 , ECO_2 , SO_4 , alkalinity, major cations (Na, Ca, Mg, K), Mn, and Fe. Solid phases were preserved in the centrifuge tubes and labeled. The following tables indicate the samples taken, analyses completed on board and samples for which analyses are yet to be completed.

8. Engineering/Geotechnical Studies (D. Calnan,

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CORE: EN024-LGC02

50 cc centrifuge tubes collected in duplicate

Sample Depth (cm)	NO ₃	NO ₂	PO ₄	SiO ₂	NH ₃	ECO ₂ & SO ₄	Alk. & Major Cations	Mn/Fe	Solid Fraction
0 - 2	✓	✓	✓	-	✓	X	X	X	X
2 - 4	✓	✓	✓	-	✓	-	-	X	X
4 - 6	✓	✓	✓	X	✓	X	X	X	X
6 - 8	✓	✓	✓	X	✓	X	X	X	X
8 - 10	✓	✓	✓	-	✓	X	X	X	X
15-17	✓	✓	✓	-	✓	X	X	X	X
25-27	✓	✓	✓	-	✓	-	-	X	X
35-37	✓	✓	✓	-	-	-	-	X	X
45-47	✓	✓	✓	-	✓	X	X	X	X
55-57	✓	✓	✓	-	✓	X	X	X	X
65-67	✓	✓	✓	-	✓	X	X	X	X
87-97	✓	✓	✓	X	✓	X	X	X	X
106-116	✓	✓	✓	X	✓	X	X	X	X
129-139	✓	✓	✓	X	✓	X	X	X	X
169-179	✓	✓	✓	X	✓	X	X	X	X
195-205	✓	✓	✓	X	✓	X	X	X	X
242-255	✓	✓	✓	X	✓	X	-	X	X
286-299	✓	✓	✓	X	✓	-	-	X	X
330-343	✓	✓	✓	X	✓	X	X	X	X
375-385	✓	✓	✓	X	✓	X	X	X	X

✓ = analysis completed on board

X = sample collected for future analysis

Sample Depth (cm)	NO ₃	NO ₂	PO ₄	SiO ₂	NH ₃	ΣCO ₂ & SO ₄	Alk. & Major Cations	Mn/Fe	Solid Fraction
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Temperature Effect Samples

65-67	✓	✓	✓	X	✓	X	-	X	X
87-97	✓	✓	✓	X	✓	X	X	X	X
195-205	✓	✓	✓	-	✓	X	X	X	X
286-299	✓	✓	✓	-	✓	-	-	X	X

Air Exposure Effect Samples

87-97	✓	✓	✓	X	✓	X	X	X	X
129-139	✓	✓	✓	-	✓	-	-	X	X

Additional Large Samples Collected (Not Centrifuged)

10-15	250 cc centrifuge tube
20-25	"
50-55	"
87-97	"
197-205	"

✓ = analysis completed on board

X = sample collected for future analysis

CORE: EN024-PC05

Sample Depth (cm)	NO ₃	NO ₂	PO ₄	SiO ₂	NH ₃	ΣCO ₂ & SO ₄	Alk. & Major Cations	Mn/Fe	Solid Fraction
128-143	-	-	-	-		-	-	X	X
293-308	✓	✓	✓	X	✓	X	X	X	X
583-598	✓	✓	✓	-	-	X	-	X	X
748-763	-	✓	✓	X	✓	X	X	X	X
866-881	✓	✓	✓	X	✓	X	X	X	X
1031-1046	-	✓	✓	X	✓	X	X	X	X
1196-1216	✓	✓	✓	X	✓	X	X	X	X

✓ = analysis completed on board

X = sample collected for future analysis

Sample Depth (cm)	NO ₃	NO ₂	PO ₄	SiO ₂	NH ₃	ΣCO ₂ & SO ₄	Alk. & Major Cations	Mn/Fe	Solid Fraction
1-10	✓	✓	✓	X	✓	X	X	X	X
10-12	✓	✓	✓	X	✓	X	X	X	X
12-14	✓	✓	✓	X	✓	X	X	X	X
14-16	✓	✓	✓	X	✓	X	X	X	X
16-18	✓	✓	✓	X	✓	X	-	X	X
18-20	✓	✓	✓	-	✓	X	-	X	X
23-25	✓	✓	✓	X	✓	X	X	X	X
28-30	✓	✓	✓	X	✓	X	X	X	X
33-35	✓	✓	✓	-	✓	X	-	X	X
40-42	✓	✓	✓	X	✓	-	X	X	X
47-49	✓	✓	✓	X	✓	X	X	X	X
59-61	✓	✓	✓	X	✓	X	X	X	X
83-93	✓	✓	✓	X	✓	X	X	X	X
105-110	✓	✓	✓	X	✓	X	X	X	X
130-140	✓	✓	✓	X	✓	X	X	X	X
160-164	✓	✓	✓	X	✓	X	X	X	X
190-200	✓	✓	✓	X	✓	X	X	X	X
220-230	✓	✓	✓	X	✓	X	X	X	X
250-260	✓	✓	✓	X	✓	X	X	X	X

Additional Large Samples Collected (Not centrifuged)

20-23 cm; 25-28 cm; 30-33 cm; 35-40 cm; 42-47 cm

✓ = analysis completed on board

X = sample collected for future analysis

CORE: EN024-PG05

Sample Depth (cm)	NO ₃	NO ₂	PO ₄	SiO ₂	NH ₃	ΣCO ₂ & SO ₄	Alk. & Major Cations	Mn/Fe	Solid Fraction
0-2	✓	✓	✓	X	✓	X	X	X	X
2-4	✓	✓	✓	-	✓	X	X	X	X
4-6	✓	✓	✓	-	✓	X	X	X	X
6-8.5	✓	✓	✓	X	✓	X	X	X	X
8.5-11	-	-	-	-	-	-	-	X	X
11-13.5	-	-	-	-	-	-	-	X	X
13.5-16	✓	✓	✓	X	✓	-	-	X	X
16-18.5	✓	✓	✓	X	✓	X	X	X	X
18.5-21	✓	✓	✓	-	-	-	-	X	X
26-28.5	✓	✓	✓	-	-	-	-	X	X
33.5-36	-	-	-	-	✓	X	-	X	X
41-43.5	✓	-	-	-	-	-	-	X	X
48.5-51	-	-	-	-	-	-	-	X	X
60-62.5	-	✓	✓	-	✓	-	-	X	X
70-72.5	✓	-	-	-	-	-	X	X	X
80-82.5	-	-	-	-	-	-	-	X	X

Additional Large Samples (Not Centrifuged)

21-26 cm; 28.5-33.5 cm; 36-41 cm; 43.5-48.5 cm; 51-60 cm; 62.5-70 cm; 72.5-80 cm

✓ = analysis completed on board

X = sample collected for future analysis

Appendix II
Geotechnical Sampling

David I. Calnan

WATER CONTENT

<u>LPC-01</u>	<u>LPC-02</u>	<u>LPC-03</u>
5cm - 335cm @ 5cm	16 - 111	0 - 275
340	130 - 185	282
350	235 - 265	285 - 290
360	275 - 330	297
375	370 - 390	365 - 505
380	405 - 475	305 - 350
390 - 465	500 - 790	515 - 1215
485 - 495	801	
540 - 565	810 - 820	<u>LGC-08</u>
585 - 605	826	10 - 30
615 - 635	835 - 960	37
675 - 750	968	45 - 115
790 - 915	975 - 1065	115 - 290
930	1075 - 1235	297
955	1242	
980	1250 - 1290	<u>LGC-09</u>
1005	1296	
	1300 - 1375	
<u>LGC-06</u>		
65 - 200		
270 - 280		

CLASSIFICATION

LPC-01	LPC-02	LPC-03	LPC-03
5-10	40-50	0-5	805-810
25-30	72-77	20-25	817-825
49-58	116-126	46-50	825-835
70-75	130-135	55-60	835-845
95-100	155-160	80-90	846-856
109-117	160-165	105-115	870-875
119-124	190-197	120-125	890-895
135-140	200-202	130-133	900-905
160-165	209-218	135-143	915-925
185-190	220-228	180-190	932-940
208-214	263-268	190-202	976-980
214-219	272-282	248-255	1010-1020
219-228	298-303	257-260	1035-1045
229-238	334-342	259-270	1050-1060
239-245	343-348	270-280	1064-1077
260-265	352-357	284-295	1080-1090
277-282	358-367	300-305	1100-1110
280-285	393-398	322-327	1115-1125
305-310	476-487	348-355	1130-1140
332-336	493-498	357-367	1155-1165
350	503-508	370-375	1175-1185
370-375	511-518	400-405	1190-1200
395-405	560-567	420-424	1210-1220
433-443	617-621	440-444	
470-475	633-640	470-480	
493-498	680-689	480-490	
500-505	722-730	502-510	
505-512	768-780	510-517	
517-525	797-800	530-535	
529-537	808-816	560-565	
570-576	821-829	590-598	
577-581	849-851	595-600	
606-613	880-888	600-610	
630-635	892-897	612-624	
646-654	943-949	635-640	
654-663	965-970	645-655	
666-671	982-987	675-680	
698-708	1012-1017	710-715	
728-737	1043-1048	715-720	
810-815	1076-1088	726-735	
838-842	1090-1096	740-745	
865-870	1135-1144	740-747	
906	1210-1216	755-760	
920-926	1234-1239	780-785	
938-943	1241-1246		
999-1004	1292-1296		
N. C.	1326-1330		
	1371-1376		
	N. C.		

CLASSIFICATION

LGC-08

26-31
33-38
51-59
103-108
135-140
148-153
155-164
166-175
173-178
176-185
288-293
292-297
370-375

LGC-06

0-10
8-13
15-19
15-26
24-33
35-40
40-45
47-52
60-65
64-73
70-75
85-90
94-102
103-108
120-127
127-135
135-147
143-148
150-162
163-175
165-170
185-190
192-202
210-215
215-220
228-235
230-240
250-255
253-262
262-275
272-282
282-287
290-300
308-319
338-343
355-365
391-396
397-400
400-410
N. C.

LGC-09

10-15
40-50
65-77
205-210
225-240
240-250
247-255

ACOUSTIC PROPERTIES

<u>LPC-01</u> *		<u>LPC-02</u>		<u>LPC-03</u>		<u>LGC-06</u>
15	16	695	1325	5	800	15
30	31	710	1340	20	880	40
40	56	725	1355	70	895	55
70	71	740		85	910	80
85	86	755		100	950	110
100	101	840		150	965	185
135	130	855		165	980	205
390	145	870		180	995	220
410	160	885		205	1110	245
430	175	900		220	1125	260
450	240	915		235	1135	
480	255	930		305	1150	
545	270	980		320	1165	<u>LGC-08</u>
560	285	995		335	1180	15
590	300	1010		365		65
620	315	1025		380		80
635	375	1040		395		95
675	405	1055		425		120
690	420	1070		440		200
705	435	1105		455		220
720	450	1120		525		235
735	465	1155		540		250
750	530	1170		555		265
795	545	1185		570		280
810	560	1200		585		
825	575	1215		628		
840	590	1250		680		<u>LGC-09</u>
855	605	1265		695		20
870	650	1280		710		40
885	665	1295		755		55
900	680	1310		770		90
				785		

* Mechanical failure between 135 cm and 390 cm

MINI VANE

<u>LPC-01</u>		<u>LPC-02</u>		<u>LPC-03</u>		<u>LGC-08</u>
270	850	25	610 1225	10	795	65 210
285	865	40	645 1250	20	785	80 225
300	880	55	660 1265	30	775	95 240
315	900	70	675 1280	65	765	175 255
325	910	85	690 1295	75	900	130 270
340	930	100	705 1310	85	910	190 285
400	960	110	720 1325	95	890	195
410	1010	130	735 1340	105	755	
420		145	750 1355	155	955	<u>LGC-06</u>
430		160	762 1370	165	970	15
444		175	835	175	980	40
448		185	850	205	990	55
460		235	865	215	1005	80
480		250	880	225	1030	105
490		265	895	235	1105	120
540		280	910	305	1115	188
555		295	925	315	1125	208
565		310	938	325	1135	220
590		325	975	335	1178	240
605		370	990	345		250
620		385	1005	525		
635		405	1020	535		<u>LGC-09</u>
675		420	1035	545		20
680		435	1050	555		40
695		450	1065	565		60
710		465	1100	575		95
725		474	1113	585		180
740		520	1130	665		165
755		535	1150	675		150
790		550	1165	685		140
805		565	1180	695		
820		580	1195	705		
835		595	1210	805		

UNDISTURBED SAMPLES

26

LPC-01			LPC-02		
<u>Depth</u>	<u>Type</u>	<u>Size</u>			
			40-45	Consolidation	2.0
			116-120	Consolidation	2.0
49-53	Consolidation	2.0	191-196	Consolidation	2.0
53-58	Consolidation	2.0	199-208	Triaxial	1.4
109-117	Triaxial	1.4	209-218	Triaxial	1.4
119-124	Consolidation	2.0	220-228	Triaxial	1.4
214-219	Consolidation	2.0	334-342	Triaxial	1.4
219-227	Triaxial	1.4	343-348	Consolidation	2.0
229-238	Triaxial	1.4	352-357	Consolidation	2.0
239-245	Triaxial	1.4	358-367	Triaxial	1.4
245-253	Triaxial	1.4	393-398	Consolidation	2.0
277-282	Consolidation	2.0	478-487	Triaxial	1.4
332-336	Consolidation	2.0	493-498	Consolidation	2.0
470-475	Consolidation	2.0	503-508	Consolidation	2.5
500-505	Consolidation	2.0	513-518	Consolidation	2.0
505-517	Triaxial	1.4	636-641	Consolidation	2.0
517-528	Triaxial	1.4	768-778	Triaxial	1.4
		(Disturbed)			
528-537	Triaxial	1.4	797-806	Triaxial	1.4
577-581	Consolidation	2.0	808-816	Triaxial	1.4
617-631	Triaxial	2.0	821-829	Triaxial	1.4
646-650	Consolidation	2.0	945-950	Consolidation	2.0
650-654	Consolidation	2.0	966-970	Consolidation	2.0
666-671	Consolidation	2.0	1076-1087	Triaxial	2.0
754-758	Consolidation	2.0	1092-1096	Consolidation	2.0
767-771	Consolidation	2.0	1135-1147	Triaxial	2.0
772-782	Triaxial	1.4	1234-1239	Consolidation	2.5
			1241-1246	Consolidation	2.5
			1371-1376	Consolidation	2.5

46-50	Consolidation	2.0	825-833	Triaxial	1.4
56-60	Consolidation	2.5	837-843	Triaxial	1.4
120-124	Consolidation	2.5	846-856	Triaxial	1.4
122-131	Triaxial	1.4	857-867	Triaxial	1.4
135-143	Triaxial	1.4	871-875	Consolidation	2.5
181-185	Consolidation	2.5	915-925	Triaxial	2.0
194-198	Consolidation	2.5	932-936	Consolidation	2.5
198-202	Consolidation	2.5	936-940	Consolidation	2.5
247-255	Triaxial	1.4	1010-1020	Triaxial	2.0
259-267	Triaxial	1.4	1035-1045	Triaxial	2.0
272-282	Triaxial	1.4	1050-1060	Triaxial	2.0
284-292	Triaxial	1.4	1064-1074	Triaxial	2.0
300-304	Consolidation	2.5	1084-1088	Consolidation	2.5
348-352	Consolidation	2.5	1090-1100	Triaxial	2.0
362-367	Consolidation	2.5	1190-1200	Triaxial	2.0
420-424	Consolidation	2.5	1210-1214	Consolidation	2.5
468-478	Triaxial	2.0	Nose Cone	Consolidation	2.0
480-490	Triaxial	2.0			
502-507	Consolidation	2.5			
512-517	Consolidation	2.5			
590-595	Consolidation	2.5			
600-610	Triaxial	2.0			
614-624	Triaxial	2.0			
646-650	Consolidation	2.5			
650-654	Consolidation	2.5			
717-721	Consolidation	2.5			
726-730	Consolidation	2.5			
817-821	Consolidation	2.5			

LGC-05

50-55	Consolidation	2.0
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LGC-06

5-10	Consolidation	2.5
27-32	Consolidation	2.5
64-69	Consolidation	2.5
96-101	Consolidation	2.5
130-135	Consolidation	2.5
137-147	Triaxial	2.0
150-160	Triaxial	2.0
165-175	Triaxial	2.0
195-200	Consolidation	2.5
230-235	Consolidation	2.5
272-277	Consolidation	2.5
Nose Cone	Consolidation	2.0

LGC-08

26-31	Consolidation	2.5
33-38	Consolidation	2.5
51-59	Triaxial	1.4
103-108	Consolidation	2.5
135-140	Consolidation	2.5
148-153	Consolidation	2.5
155-164	Triaxial	1.4
166-175	Triaxial	1.4
176-185	Triaxial	1.4
288-293	Consolidation	2.5
Nose Cone	Consolidation	2.5

LGC-09

10-15	Consolidation	2.5
65-77	Triaxial	2.0
102-106	Consolidation	2.5
106-110	Consolidation	2.5
206-210	Consolidation	2.5
210-220	Triaxial	1.4
227-237	Triaxial	1.4
240-250	Triaxial	1.4