CORES - EN-024

COO-2689-10

CORE

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

by

G. Ross Heath and Edward P. Laine

EN-024

U.S. DEPARTMENT OF ENERGY CONTRACT EY76-5-02-2689
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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.

INTRODUCTION

R/V Endeavor left Narraganett, 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 $35^{o}10$'N $61^{o}15$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 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.

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 of "transparent" material. The core barrels were standard GPC barrels adapted to a 3000 lb. weightstand. Our success with 15m barrel strings on two occasions supports the feasibility of large-diameter coring using 1/2" wire from "Oceanus"-class vessels. The LPC's recovered excellent samples. They were extruded and the first two were heavily sampled for engineering properties (under D. Calnan's direction) on board.

Large diameter gravity cores were less successful than our other samplers (Table 1). Two barrels broke, either on impact or pullout, and two short cores (low impact velocity) intended for pore-water studies washed out through the core catchers before they could be retrieved. The five good cores yielded excellent samples.

5. Sediment Dredging (R. Morin)

Two sediment dredges (Table 1) each recovered 80-100 gall of stiff, buff, foram-bearing clay. These bulk samples will be used for laboratory studies associated with ISHTE.

6. Camera Lowerings (E. Laine)

Two lowerings were made, one in the area of laminated sediments near PC-01 and 02 (35°01.0'N, 61°37.4-37.8'W, 2120-2212Z, 7/6/78) and the other on the erosional slope sampled by PC-03 and 04 (34°54.7-54.9'N 61°51.9-52.0'W, 1145-1230Z, 7/6/78). Figures 7 and 8 show typical frames from the two runs.

7. Pore Waters (D. Heggie)

85 samples from 4 cores most of which were centrifuged and analyzed at sea, were collected to establish the Eh conditions of the sediments. (Appendix I). In all cases, downcore reduction of oxygen, followed by nitrate, goes to completion. Shore-based analyses will determine whether significant sulphate reduction also takes place.

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.

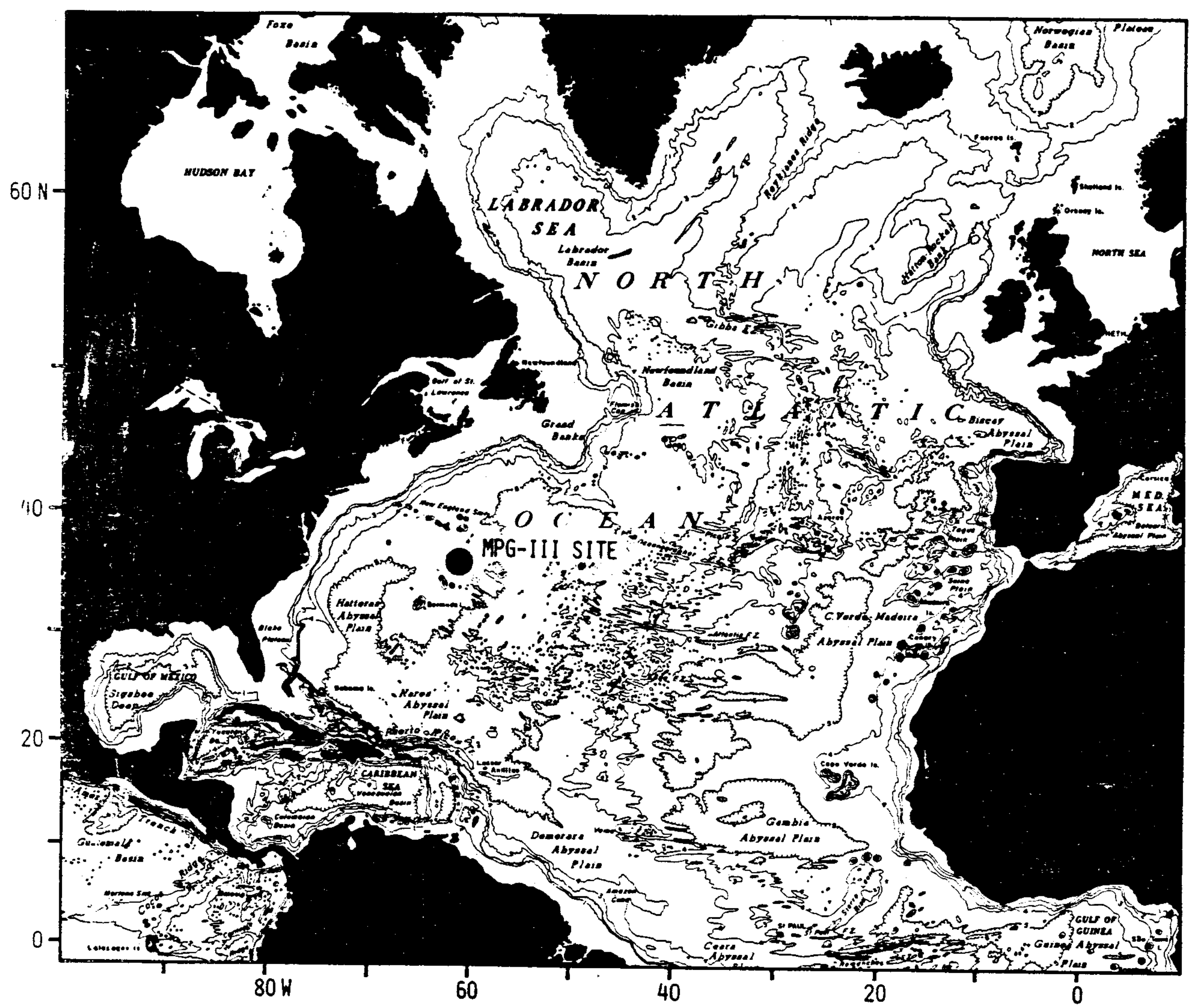


Figure 1. Location of MPG-III relative to the general bathymetry of the North Atlantic. Isobath interval 1 km (from Chase et al., 1975)

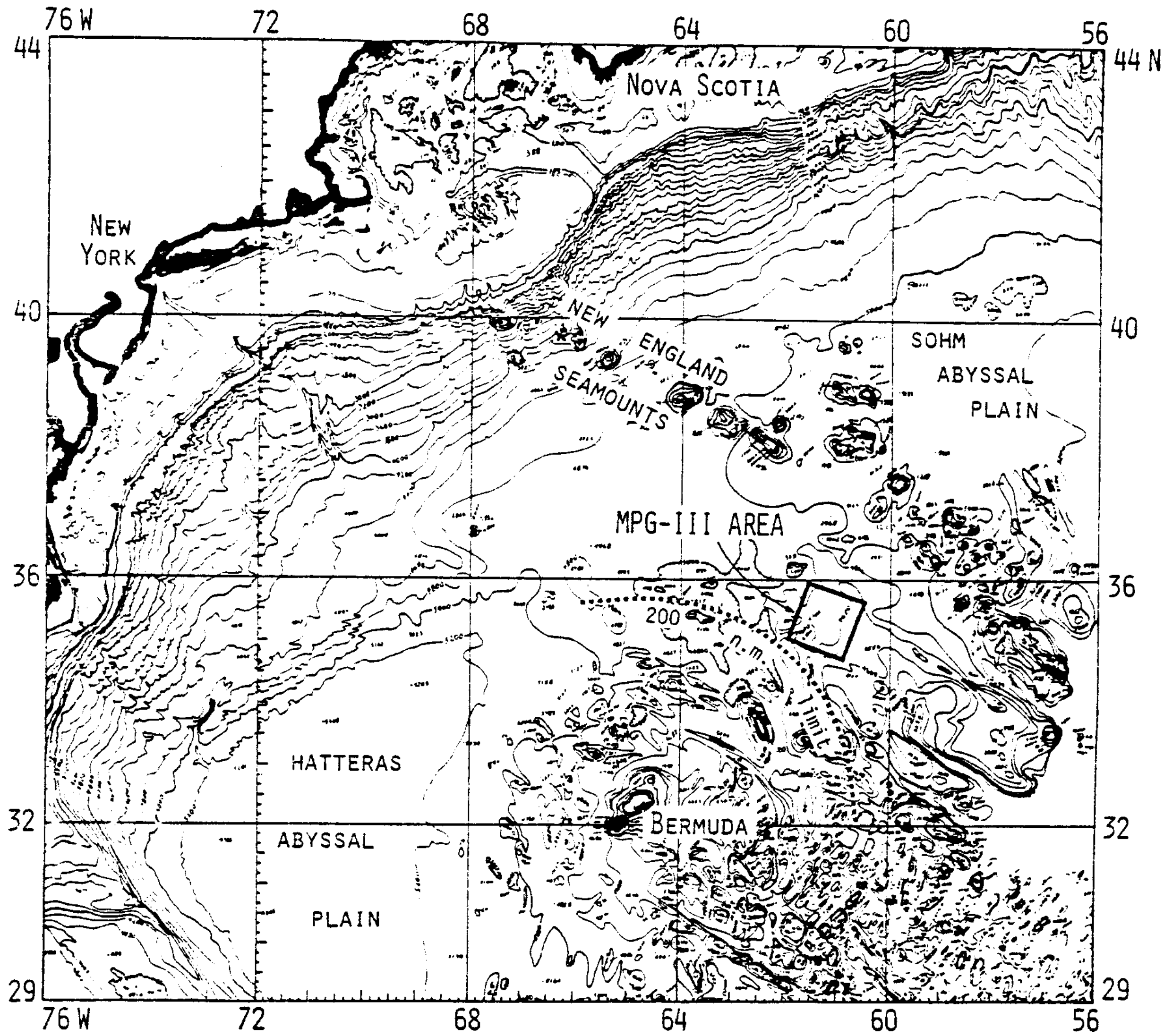


Figure 2. Outline of MPG-III area relative to the bathymetry of the northwest Atlantic (Navoceano chart NA6, 200 m isobaths), and to the 200-mile limit of Bermuda.

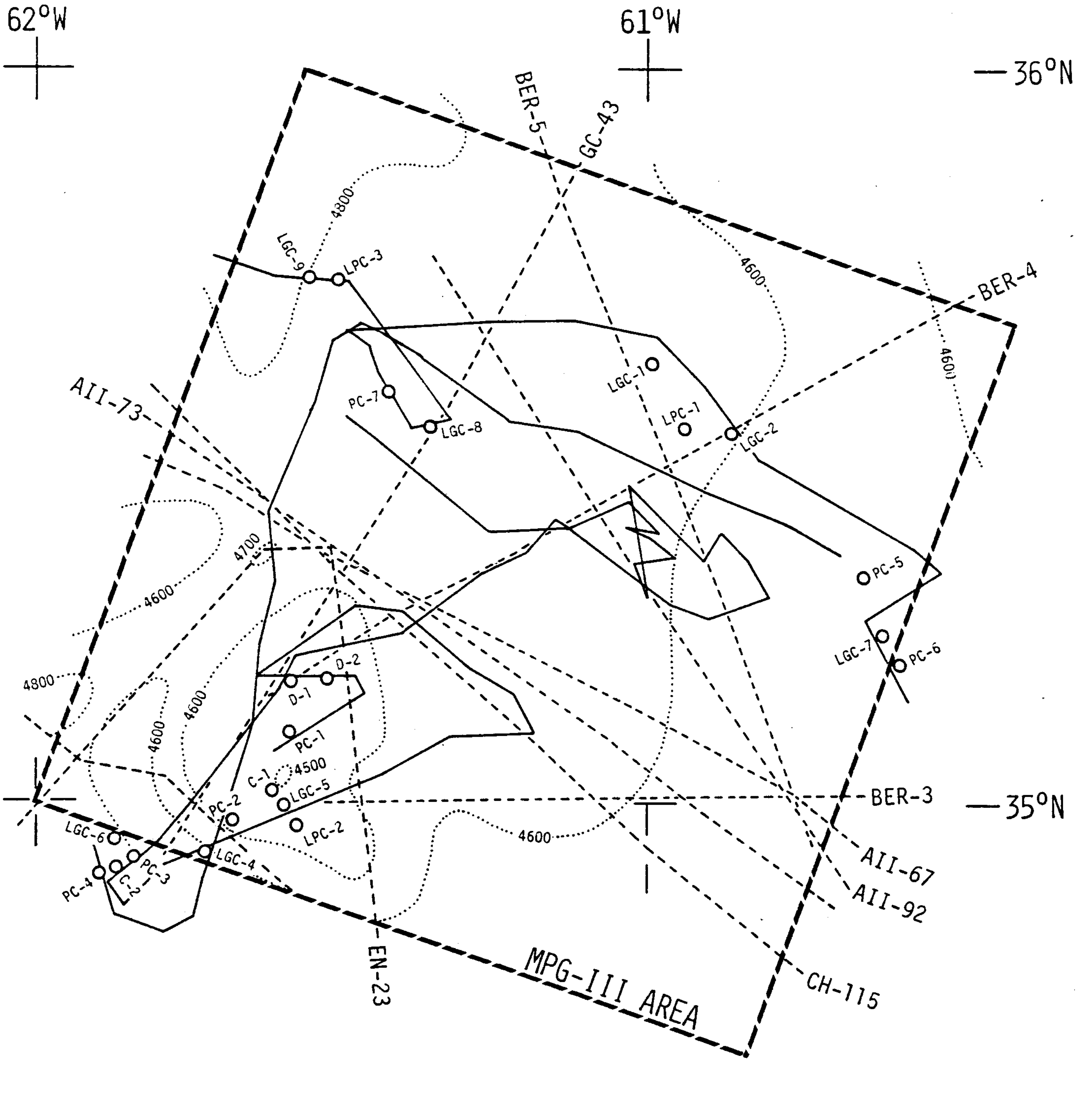


Figure 3. MPG-III area (35°00'N, 62°00'W; 34°40'N, 60°50'W; 35°40'N, 60°25'W; 36°00'N, 61°35'W) showing generalized bathymetry (Navoceano chart NA-6; 200 m isobaths), existing U.S. tracklines (AII = Atlantis II, CH = Chain, EN = Endeavor, GC = Glomar Challenger), multichannel tracklines (BER = Resolution)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

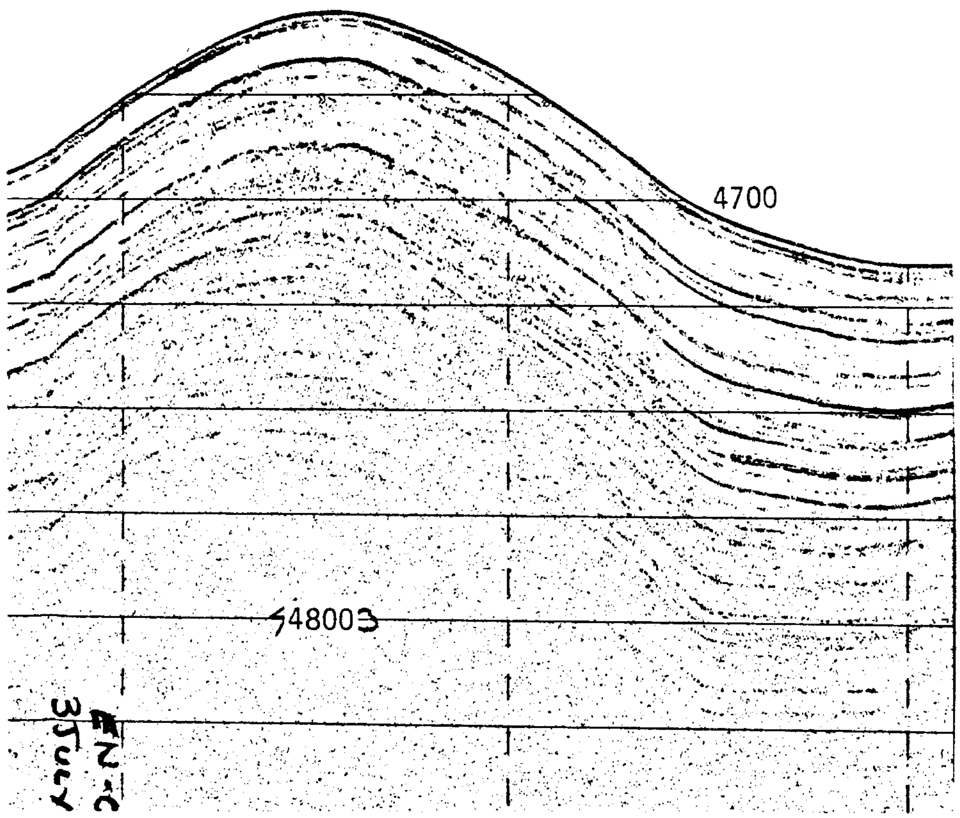


Figure 4. 3.5 kHz acoustic profiler record of typical laminated MPG-III sediments. Location 35°17.6'N, 61°16.7'W. Water depths in uncorrected meters (assumed velocity 1500 m/sec). Vertical exaggeration approximately 40:1.

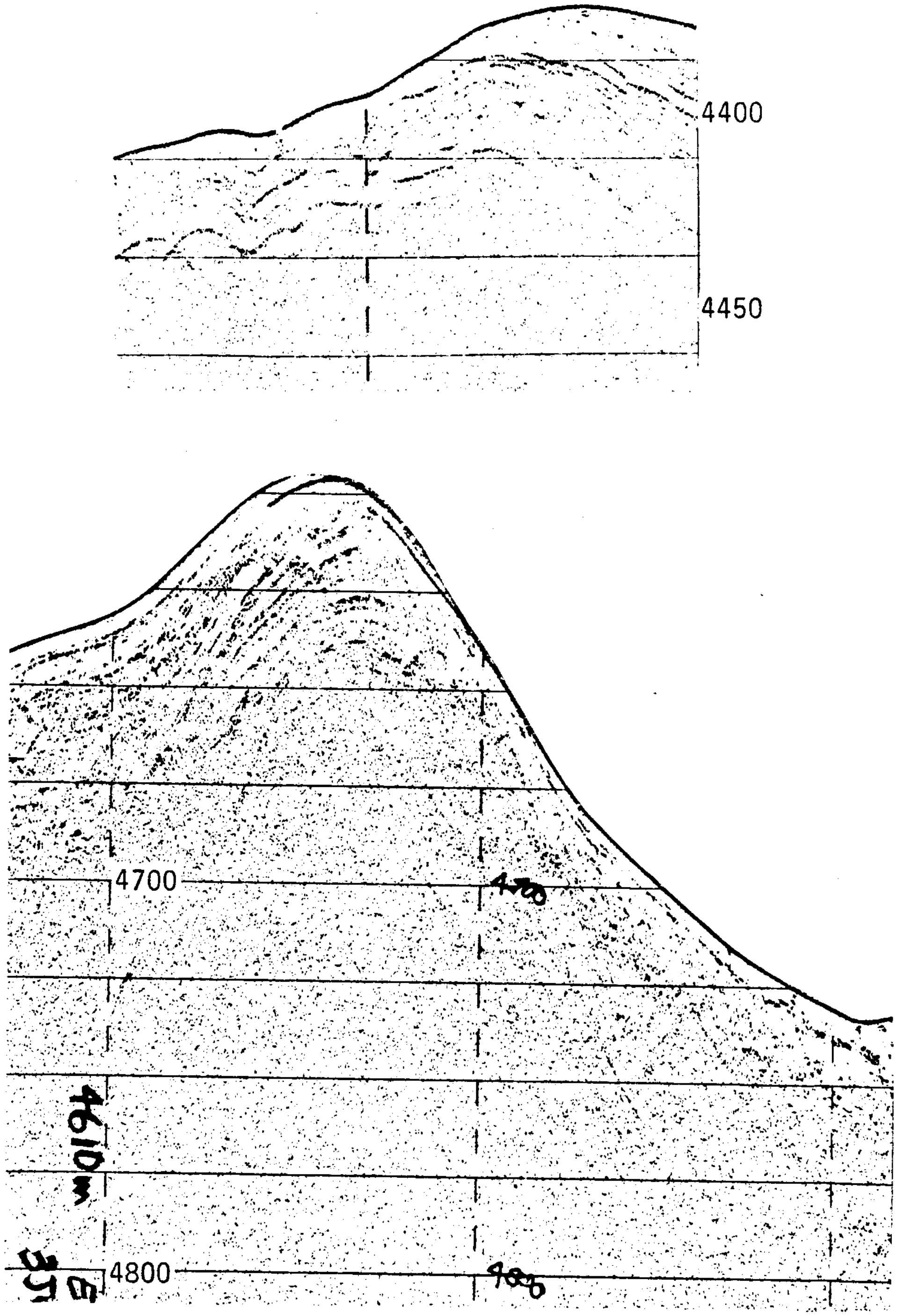


Figure 5. 3.5 kHz acoustic profiler records of erosional slopes and irregular laminated sediments in MPG-III. Locations $34^{o}56.1'N$, $61^{o}45.1'W$ (upper) and $35^{o}12.1'N$, $61^{o}30.5'W$ (lower). Water depths in uncorrected meters (assumed velocity 1500 m/sec). Vertical exaggeration approximately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

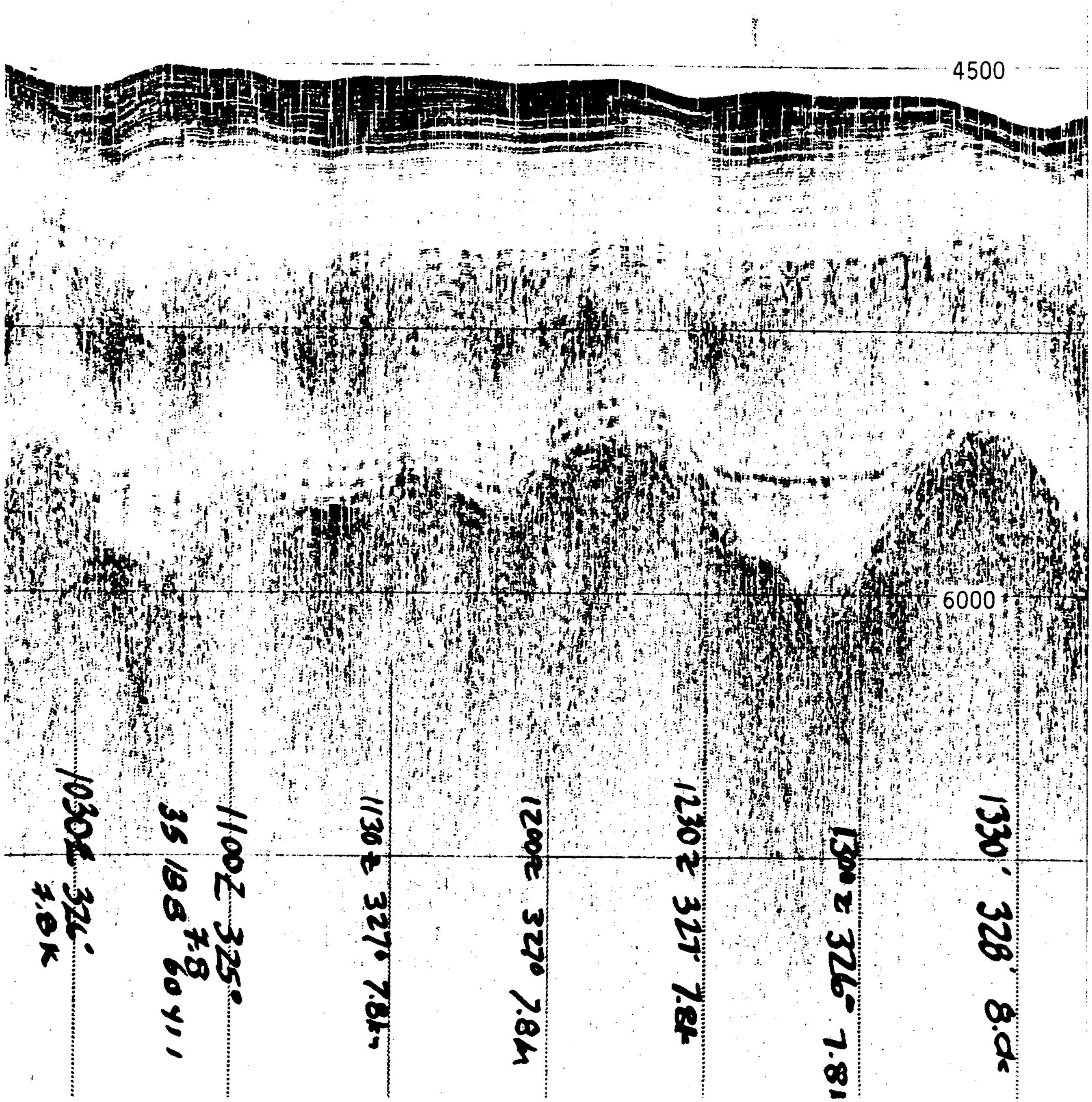
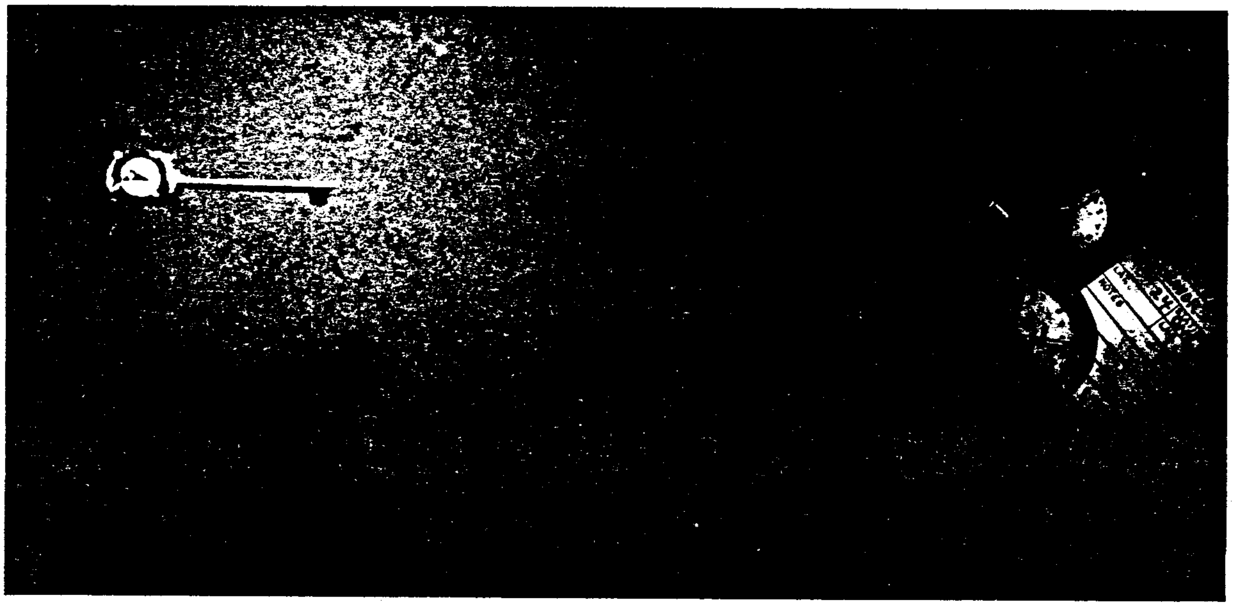


Figure 6. Low frequency (airgun) acoustic profiler record of the full sedimentary section in MPG-III. Location 35°18.8'N, 60°41.1'W. Depth in uncorrected meters (assumed velocity 1500 m/sec). Vertical exaggeration approximately 10:1. Dark surface layer corresponds to laminations of Figures 4 and 5. Deepest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



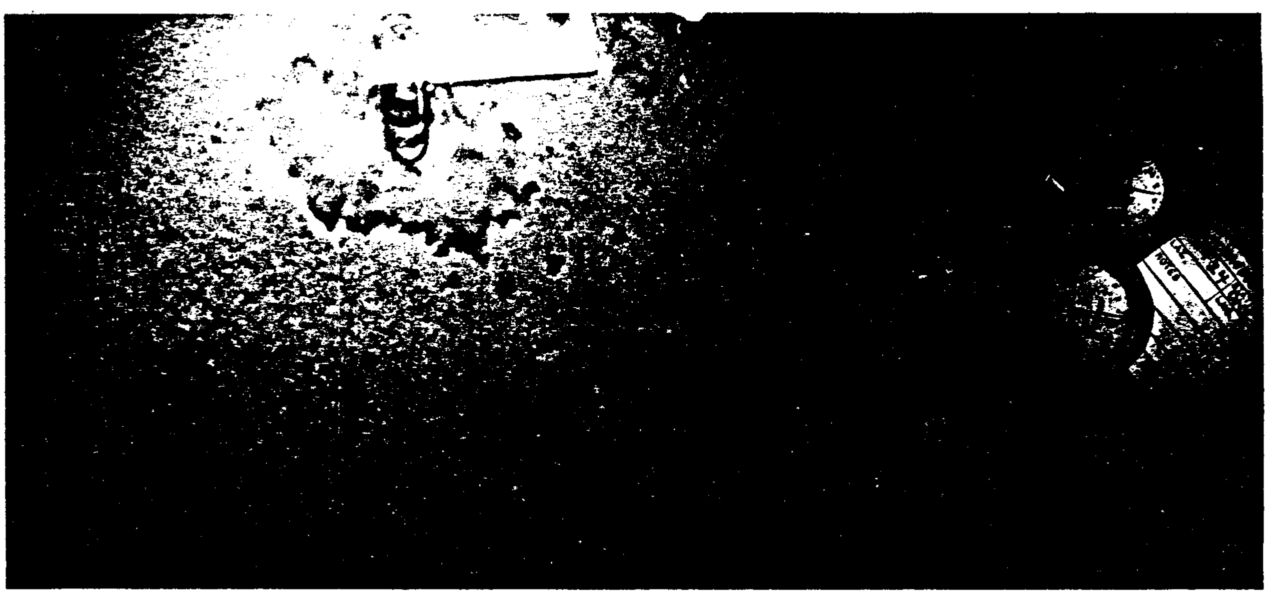


Figure 7. Bottom photographs of the upper slope of the erosional valley forming the southwest margin of MPG-III ($35^{o}01.0$'N, 61^{o} 37.4-37.8'W). Bottom shows delicate biogenic features with no evidence of current activity. Scale: compass vane is 25 cm long.

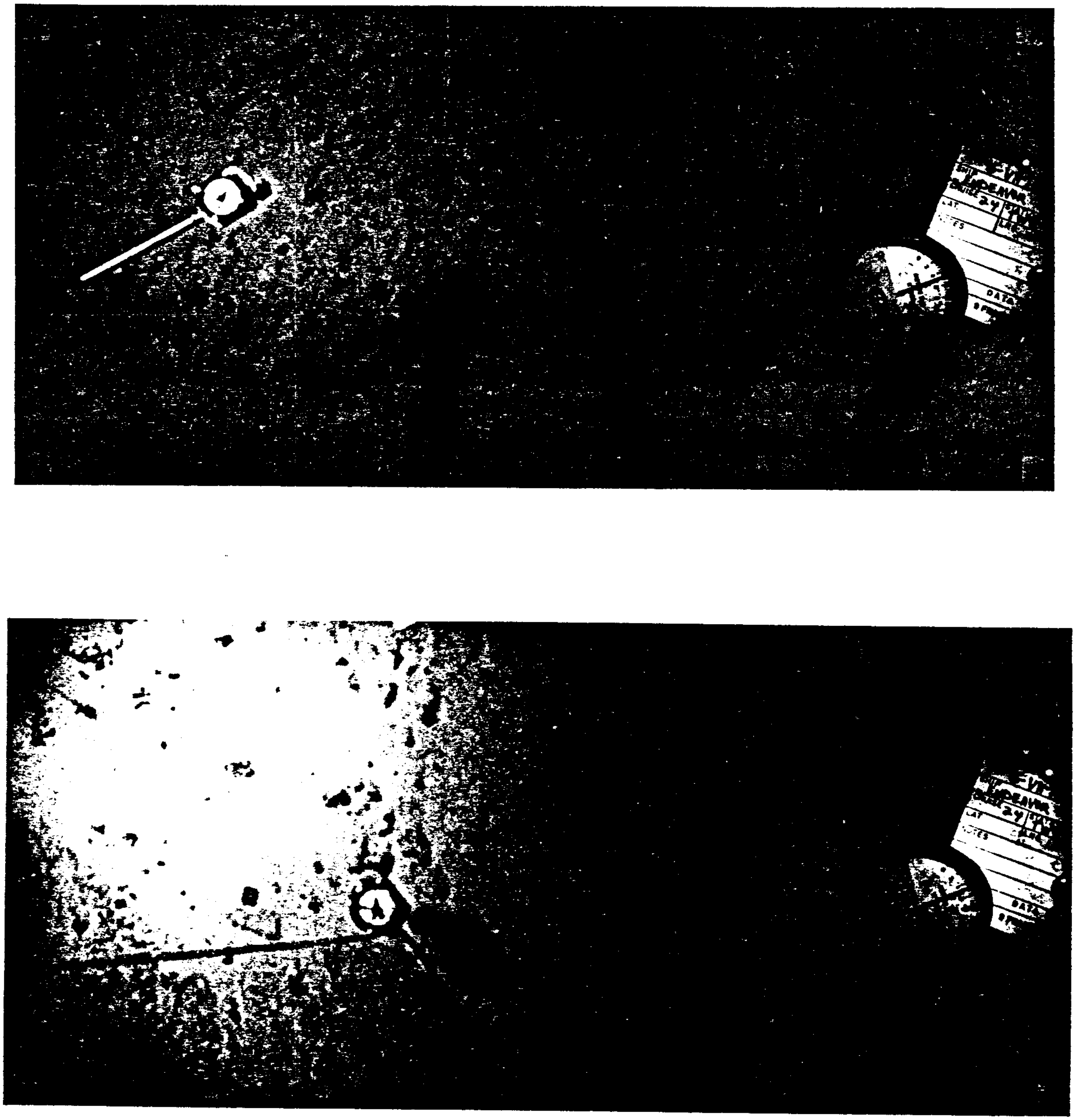


Figure 8. Bottom photographs of the lower slope of the erosional valley forming the southwest margin of MPG-III ($34^{o}54.7$-54.9'N, $61^{o}51.9$-52.0'W). Bottom is covered with manganese nodules and evidence of strong current scour. Scale: compass vane is 25 cm long.

Appendix I

Interstitial Water Sampling

Nile A. Luedtke and David Heggie

Cores Sampled:

EN024-LGC02
EN024-LGC05
EN024-PC05
EN024-PG05
EN024-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, ΣCO_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.

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

CORE: EN024-LGC05

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
103-110	✓	✓	✓	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-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 fur future analysis

CORE: EN024-LGC02

50 cc centrifuge tubes collected in duplicate

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
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

CORE: EN024-LGC02 (con't)

Sample Depth (cm)	NO_3	NO_2	PO_4	SiO_2	NH_3	ΣCO_2 & SO_4	Alk. & Major Cations	Mn/Fe	Solid Fraction
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

TABLE I

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	Nodules 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

Appendix II

Geotechnical Sampling

David I. Calnan

WATER CONTENT

LPC-01

5cm - 335cm @ 5cm
340
350
360
375
380
390 - 465
485 - 495
540 - 565
585 - 605
615 - 635
675 - 750
790 - 915
930
955
980
1005

LGC-06

65 - 200
270 - 280

LPC-02

16 - 111
130 - 185
235 - 265
275 - 330
370 - 390
405 - 475
500 - 790
801
810 - 820
826
835 - 960
968
975 - 1065
1075 - 1235
1242
1250 - 1290
1296
1300 - 1375

LPC-03

0 - 275
282
285 - 290
297
365 - 505
305 - 350
515 - 1215

LGC-08

10 - 30
37
45 - 115
115 - 290
297

LGC-09

MINI VANE

LPC-01

270	850
285	865
300	880
315	900
325	910
340	930
400	960
410	1010
420	
430	
444	
448	
460	
480	
490	
540	
555	
565	
590	
605	
620	
635	
675	
680	
695	
710	
725	
740	
755	
790	
805	
820	
835	

LPC-02

25	610	1225
40	645	1250
55	660	1265
70	675	1280
85	690	1295
100	705	1310
110	720	1325
130	735	1340
145	750	1355
160	762	1370
175	835	
185	850	
235	865	
250	880	
265	895	
280	910	
295	925	
310	938	
325	975	
370	990	
385	1005	
405	1020	
420	1035	
435	1050	
450	1065	
465	1100	
474	1113	
520	1130	
535	1150	
550	1165	
565	1180	
580	1195	
595	1210	

LPC-03

10	795
20	785
30	775
65	765
75	900
85	910
95	890
105	755
155	955
165	970
175	980
205	990
215	1005
225	1030
235	1105
305	1115
315	1125
325	1135
335	1178
345	
525	
535	
545	
555	
565	
575	
585	
665	
675	
685	
695	
705	
805	

LGC-08

65	210
80	225
95	240
175	255
130	270
190	285
195	

LGC-06

15
40
55
80
105
120
188
208
220
240
250

LGC-09

20
40
60
95
180
165
150
140

LGC-05

50-55	Consolidation	2.0

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

ACOUSTIC PROPERTIES

LPC-01*

15, 30, 40, 70, 85, 100, 135, 390, 410, 430, 450, 480, 545, 560, 590, 620, 635, 675, 690, 705, 720, 735, 750, 795, 810, 825, 840, 855, 870, 885, 900

LPC-02

16, 31, 56, 71, 86, 101, 130, 145, 160, 175, 240, 255, 270, 285, 300, 315, 375, 405, 420, 435, 450, 465, 530, 545, 560, 575, 590, 605, 650, 665, 680, 695, 710, 725, 740, 755, 840, 855, 870, 885, 900, 915, 930, 980, 995, 1010, 1025, 1040, 1055, 1070, 1105, 1120, 1155, 1170, 1185, 1200, 1215, 1250, 1265, 1280, 1295, 1310, 1325, 1340, 1355

LPC-03

5, 20, 70, 85, 100, 150, 165, 180, 205, 220, 235, 305, 320, 335, 365, 380, 395, 425, 440, 455, 525, 540, 555, 570, 585, 628, 680, 695, 710, 755, 770, 785, 800, 880, 895, 910, 950, 965, 980, 995, 1110, 1125, 1135, 1150, 1165, 1180

LGC-06

15, 40, 55, 80, 110, 185, 205, 220, 245, 260

LGC-08

15, 65, 80, 95, 120, 200, 220, 235, 250, 265, 280

LGC-09

20, 40, 55, 90

* Mechanical failure between 135 cm and 390 cm

CLASSIFICATION

LGC-08	LGC-06	LGC-09
26-31	0-10	10-15
33-38	8-13	40-50
51-59	15-19	65-77
103-108	15-26	205-210
135-140	24-33	225-240
148-153	35-40	240-250
155-164	40-45	247-255
166-175	47-52	
173-178	60-65	
176-185	64-73	
288-293	70-75	
292-297	85-90	
370-375	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.	

46-50	Consolidation	2.0
56-60	Consolidation	2.5
120-124	Consolidation	2.5
122-131	Triaxial	1.4
135-143	Triaxial	1.4
181-185	Consolidation	2.5
194-198	Consolidation	2.5
198-202	Consolidation	2.5
247-255	Triaxial	1.4
259-267	Triaxial	1.4
272-282	Triaxial	1.4
284-292	Triaxial	1.4
300-304	Consolidation	2.5
348-352	Consolidation	2.5
362-367	Consolidation	2.5
420-424	Consolidation	2.5
468-478	Triaxial	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
825-833	Triaxial	1.4
837-843	Triaxial	1.4
846-856	Triaxial	1.4
857-867	Triaxial	1.4
871-875	Consolidation	2.5
915-925	Triaxial	2.0
932-936	Consolidation	2.5
936-940	Consolidation	2.5
1010-1020	Triaxial	2.0
1035-1045	Triaxial	2.0
1050-1060	Triaxial	2.0
1064-1074	Triaxial	2.0
1084-1088	Consolidation	2.5
1090-1100	Triaxial	2.0
1190-1200	Triaxial	2.0
1210-1214	Consolidation	2.5
Nose Cone	Consolidation	2.0

UNDISTURBED SAMPLES

LPC-01

Depth	Type	Size
49-53	Consolidation	2.0
53-58	Consolidation	2.0
109-117	Triaxial	1.4
119-124	Consolidation	2.0
214-219	Consolidation	2.0
219-227	Triaxial	1.4
229-238	Triaxial	1.4
239-245	Triaxial	1.4
245-253	Triaxial	1.4
277-282	Consolidation	2.0
332-336	Consolidation	2.0
470-475	Consolidation	2.0
500-505	Consolidation	2.0
505-517	Triaxial	1.4
517-528	Triaxial	1.4 (Disturbed)
528-537	Triaxial	1.4
577-581	Consolidation	2.0
617-631	Triaxial	2.0
646-650	Consolidation	2.0
650-654	Consolidation	2.0
666-671	Consolidation	2.0
754-758	Consolidation	2.0
767-771	Consolidation	2.0
772-782	Triaxial	1.4

LPC-02

40-45	Consolidation	2.0
116-120	Consolidation	2.0
191-196	Consolidation	2.0
199-208	Triaxial	1.4
209-218	Triaxial	1.4
220-228	Triaxial	1.4
334-342	Triaxial	1.4
343-348	Consolidation	2.0
352-357	Consolidation	2.0
358-367	Triaxial	1.4
393-398	Consolidation	2.0
478-487	Triaxial	1.4
493-498	Consolidation	2.0
503-508	Consolidation	2.5
513-518	Consolidation	2.0
636-641	Consolidation	2.0
768-778	Triaxial	1.4
797-806	Triaxial	1.4
808-816	Triaxial	1.4
821-829	Triaxial	1.4
945-950	Consolidation	2.0
966-970	Consolidation	2.0
1076-1087	Triaxial	2.0
1092-1096	Consolidation	2.0
1135-1147	Triaxial	2.0
1234-1239	Consolidation	2.5
1241-1246	Consolidation	2.5
1371-1376	Consolidation	2.5

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.		