Received
P.OSCOP 12/21/
Cr.d.f 12/17/

CRUISE REPORT

GYRE -81-14 LEG 1

#81033

By Deborah R. Hutchinson

VESSEL: R/V GYRE

CRUISE NUMBER: GY -81-14 - LEG 1

PROJECT: MID ATLANTIC (9840-01830)

LOCATION: LONG ISLAND PLATFORM

DATES: 15 - 26 September 1981

PORTS: Woods Hole, (15 Sept, 17-18 Sept)
New York City (21 Sept)
Atlantic City (26 Sept)

SCIENTIFIC CREW:

John Grow	(15-26 Sept)	Chief Scientist
Deborah Hutchinson	"	Co-Chief Scientist
Jim Dodd	"	Nav. watch
Barry Irwin	"	Nav. watch
Robin Bell	"	Nav/Seismic watch
Betsy Coward	"	Nav/Seismic watch
Ann Swift	"	Seismic watch
Bob Commeau	"	Seismic watch
Quad Wheeler	"	Seismic watch
Kathy Scanlon	"	Coring Tech.
Tom O'Brien	"(WHOI)	DFS V Tech.
John Godley	"	OBIPs
Dave Mason	"	Airgun/watergun Tech.
Dave Nichols	15-21 Sept	DFS V Tech
Dick Wise	"	DFS V Tech
Larry Lowe	"	Watergun Tech
Jim McCullough	"(WHOI)	LORAN C
Bruce Ambuter	21-26 Sept	OBIPs
Ray Davis	"	OBIPs
Jack Connell	"	DFS V Tech
Ed Harper	"(Benthos)	OBIPs

CRUISE OBJECTIVES:

(i) to define the extent and size of rift valleys identified in the basement surface of the L.I. Platform from USGS lines 24, 9 and 36 using the high resolution multichannel system.

(ii) to collect refraction velocity measurements within the rift structures and along undisturbed basement using the USGS OBIPs.

(iii) to collect gravity data in the N.Y. Bight, Raritan Bay and N.Y. Harbour to better define the shape and magnitude of the offshore extent of the Piedmont Gravity High.

(iv) to define the shape of the northern edge of the Baltimore Canyon Trough where it meets the L.I. Platform.

(v) to collect refraction velocity measurements along USGS line 34 (continental slope) for a proposed ocean margin drill site.

(vi) to test the resolution of the 240 m (12 channel) streamer with the 80 in^3 watergun compared to the 120 m (12 channel streamer) and 15 in^3 watergun.

(vii) to do signature tests for the 540 in^3 airgun, the 80 in^3 watergun, the 40 in^3 airgun and the 15 in^3 watergun.

SCIENTIFIC EQUIPMENT:

I <u>Acquisition</u> (Seismic reflection)

A. Hydrophones

12 channel USGS Fairfield Industries 240 m streamer
6 channel WHOI SEI 600 m streamer
Single channel 200 - element USGS streamer
Single channel USGS Sparker streamer

B. Sources

(2) 540 in^3 BOLT airguns with waveshaper chamber
(2) 80 in^3 MICA T SSI Waterguns

C. DFS V

SEI Depth Indicator panel
USGS 24 channel patch panel
BNC Model 7010 Digital delay generator
DFS V control module
DFS V analog module
2 Lamda regulated power supply boxes
2 DFS V Texas Instruments 9T tape drives
Mountain Systems extended header interface box
SIE, Inc Oscillograph Model R-10A

II <u>Playback</u> (Seismic reflection)

A. Amplifiers

2 channel seismic amplifier
Teledyne Model 300LF amplifier

B. Graphic Recorders
2 EPC Model 3200 recorders
1 EPC Model 4100 recorder

III Magnetic

Geometrics G-801G marine proton magnetometer
HP 7130A graphic recorder

IV Echosounder

3.5 kHz (hull mounted)
ORE Model 140 transceiver
EPC Model 4100 graphic recorder

V Seismic Refraction (Ambuter/Davis System)

A. Instruments
5 shallow water OBIP spheres
4 deep water OBIP spheres
6 2-channel OBIP etectronics
1 4-channel OBIP electonics

B. Time calibration
Efratom rubidium standard
9-Digit Hewlett Packard frequency counter
Tracor #527 phase meter
GOES satellite receiver
Cromenco System II computer

C. Test and Playback Equipment
INCOR 6-channel hot pen recorder
OBIP test rack
Tape head amplifier interface

VI Seismic Refraction (sonobuoy system)

1 calibrated Aquatronic reusable sonobuoy
2 Aquatronics Tech expendable sonobuoys
Aquatronics Telseis STR 70-2F sonobuoy receiver

VII Gravity

USGS Bell gravity system (tied to INS navigation)
Lacoste and Romberg gravity system (self contained)

VIII Sampling

Anchor (gravity) corer with 225 lb weight stand and 4" inside diameter PVC pipe
Smith-McIntyre grab sampler

IX OTHER (J McCullough)
Loran C tracking and testing equipment

NAVIGATION: I. USGS Integrated Navigation System with:
Northstar 6000 LORAN C
Magnavox MX 702A-3 satelliter receiver
Sperry/Mark 29 gyro compass
Cesium vapor frequency standard
HP 2100 Mx series E computer
Sperry SRD 301 speed logs

II. Northstar 6000 LORAN C data recorded in duplicate on DFS V field tapes.

TOTAL KILOMETERS OF DATA:

(i) Geophysical Data:

Magnetic: 15
Gravity: 810

(ii) Reflection data:

12 channel (240m streamer): 15
6 channel (600m streamer): 247
Single channel: 279

(iii) Echo sounding:

3.5 kHz: 810

(iv) Refraction profiles:

Watergun: 20
Airgun: 94

TOTAL SAMPLES: 4

(i) Grab: 3
(ii) Core: 1

TOTAL OBIP DEPLOYMENTS: 13
TOTAL OBIP RECOVERIES: 12

TOTAL SONOBUOY DEPLOYMENTS: 4

(i) Calibrated buoy: 2
(ii) Expendable buoys: 2

TOTAL DAYS AT SEA: 10.1

15 Sept/1600z - 16 Sept/2300z: 1.2
18 Sept/0100z - 26 Sept/2200z: 8.9
10.1 days

ABBREVIATED CHRONOLOGICAL LOG:

15 Sept 1981/1600z	Depart Woods Hole
16 Sept 1981/0417z	Begin Line 1 (Fairfield 240 m streamer, 1x80 in^3 watergun)
0445z	Noise on all 12 channels, Begin tests changing tape transports
0530z	Shotpoints not synched (DFS V/INS)
0611z	Abandon line due to incoherent data Begin circling to troubleshoot, weather deteriorating
1200z	Call Woods Hole: to contact Fairfield Ind. Technician
1500z	Call Woods Hole: Fairfield Tech en route
2300z	Arrive Woods Hole
17 Sept 1981/All day	Trouble shoot streamer in Woods Hole Result: Streamer had not been properly repaired in July, Fairfield Tech. would take streamer and DSFS V interface box back to Texas to troubleshoot. Problem = pre-amps.
18 Sept 1981/0100z	Depart Woods Hole
1000z	Begin streaming WHOI/SEI streamer (last 6 channels of 10 channel streamer) Problem: birds not maintaining depth properly.
1600z	Streamer recovered to remove forward 400 m
2108z	Start line 2
19 Sept 1981/1601z	End line 2 in separation zone of Barneget light/Ambrose channel. Lobster pots everywhere
1701z	Clear water to turn out of separation zone and lobster pots
1808z	Start line 3
2130z	Weather deteriorating, slow speed to keep streamer noise down
20 Sept 1981/0530z	Abandon line 3 due to rough weather
1245z	Begin line 4 (along USGS line 36); gravity data only due to bad weather
2300z	Begin line 5 (single channel, 80 in^3 watergun), weather moderating
21 Sept 1981/1000z	End line 10 at entrance to N.Y. Harbour. Head to rendezvous north of Verranzano Bridge
1345z	Exchange personnel via launch
1400z	Begin Raritan Bay gravity traverses
1600z	End Raritan Bay gravity traverses
1730z	Begin line 11 (single channel, 80 in^3 watergun) to profile over fault identified on lines 2,3, and USGS line 24
22 Sept 1981/0735z	End line 16, Head to first refraction line
1128z	Deploy 2 OBIPS, 1 anchored sonobuoy

1642z	Start lines 101, 102, 103 (watergun-airgun-watergun)
2131z	Recover OBIPs, sonobuoy, take grab sample
23 Sept 1981/0623z	Deploy OBIPs for site #2
0740z	200 element single channel streamer lost around ships propellor
0743z	Start line 201
1021z	Recover 200 element streamer with airgun
1130z	Recover OBIPs, take grab sample
1657z	Deploy OBIPs for site #3, take grab sample
1730z	Start line 301 Deploy 2 (unusable) sonobuoys
2330z	Recover OBIPs, head to continental slope line
24 Sept 1981/1200z	Hove to in rough seas
25 Sept 1981/1145	Deploy OBIPs for site #4
1625z	Start line 401
2130z	2 Benthos transducers lost in ship's propellor; OBIP #A6 had no response to Benthos transducer
2200z	Recover 3 OBIPs and take core
26 Sept 1981/0318z	Commence search for lost OBIP (steaming circle around deployment location of radii 0.5 mi)
0817z	Start line 17 (Bathymetric Survey of Lindenkohl Canyon)
1004z	End line 18, Begin sonobuoy signature test
1256	Head to Atlantic City collecting gravity data long USGS line 25
2043	End Line 25
	Rendezvous off Atlantic City, personnel change
	End of Leg 1

COMMENTS:

I Scientific Objectives

A. The most significant discovery resulting from this cruise is the existance of a NNE - treading - growth fault in the N.Y. Bight area which offsets basement by up to 70 msec. Figures 1 and 2 show its location. Figure 3 shows a sample record from Line 2. Preliminary analysis shows the fault is about 30 km long and probably offsets Early Tertiary beds. Our data are insufficient to determine whether Quaternary sediments are disturbed. A preliminary report on these findings is being

prepared.

B. A graben structure identified south of central Long Island on USGS lines 9 and 36 appears to coalesce with the Baltimore Canyon Trough, based on the results of this cruise and those of GY-81-13. Other graben structures were often obscured on the monitor record by multiples or diffractions. The processed data should improve the strength and clarity of basement and subbasement events.

C. The Raritan Bay gravity traverses show the free-air gravity anomaly has unusually large relief (40 mgal) over a short distance (40 km). The fault mentioned in A (above) lies on the axis of a second gravity high approximately 20 km east of the Raritan Bay anomaly. Preliminary gravity models show relief on the crust/mantle interface cannot cause the Raritan Bay anomaly, and hence it must be related to a shallower body within the crust.

D. Preliminary analysis of the OBIP refraction data shows first arrivals are weak or non-existent beyond 5 km range. Hence, refractors deeper than the basement refractor have not been identified. The records suggest the 540 in^3 airgun source with waveshaper chamber had insufficient energy.

E. The signature tests are of dubious value for two reasons: (i) Playback of the data shows that the signal was "analog" clipped in the receiver prior to A/D conversion for the near shots. Hence, only those shots at far ranges (where the signal was travelling essentially horizontally rather than vertically) are usable. (ii) The recorded signal was inadvertantly filtered at OUT-62 Hz rather than OUT to 256 Hz.

II. Equipment Performance

A. The largest disappointment of the cruise was the malfunction of the Fiarfield Industries 240 m, 12-channel streamer. Many of the scientific

objectives depended on the performance of this system and hence its failure meant that the actual data collected were a compromise in quality and resolution. most of the faults identified in A (above) will have to be resurveyed with the high-resolution multichannel streamer.

B. The 80-in^3 watergun is a major improvement over the airgun for reflection profiling in shallow water. The cleaner, non-reverberatory source makes a sharper monitor record than previously obtained with airguns. The processed data have not yet been compared.

C. Equipment losses included one deep water OBIP and two Benthos transducers. The 200-element streamer which wrapped around the props was recovered in the airgun harness and repaired.

D. Equipment malfunction included one OBIP tape drive, all OBIP radio beacons and two dead battery packs in two disposable sonobuoys.

III. Logistics

Operating a multichannel seismic vessel in areas of heavy ship traffic such as the N.Y. Bight requires well prepared ship tracks (to minimize opposing the general flow patterns) and a cooperative captain. Even with these two conditions satisfied, the unexpected can happen, such as crossing a field of lobster buoys, or encountering a tuna tournament. In the future for work which requires near-shore or inner shelf multichannel work, it may be logistically easier to deal with a vessel that is midway in size between the GYRE and the NEECHO, in order to maximize manueverability and visibility without sacrificing safety. No vessels threatened to cross the 600 m streamer during our operation (rightly so since vessels should not in general pass that close). However, we also encountered some recreational boaters who might be the ones most likely to approach closely.

TABLE I: TABULATED START/END POINT INFORMATION 1

Line No	START OF LINE YRMODA/TIME	SP	LAT (N)	LONG.(W)	END OF LINE YRMODA/TIME	SP	LAT (N)	LONG.(W)	TOTAL KM
	RELECTION	PROFILES						SUBTOTAL	(633)
1	810916/0417	001	40°56.14′	71°25.72′	810916/0611	1247	40°53.66′	71°35.54′	15
2	810918/2108	001	40°46.16′	72°01.68′	810919/1601	6359	40°17.36′	73°48.49′	163
3	810919/1808	001	40°11.61′	73°41.78′	810920/0555	3475	40°27.51′	72°44.02′	84
4	810920/1245		40°15.61′	72°59.70′	810920/2134		40°00.07′	73°57.03′	87
5	810920/2324	001	40°07.78′	73°52.54′	810921/0153	897	40°12.03′	73°40.13′	15
6	810921/0153	898	40°12.03′	73°40.13′	810921/0328	1460	40°18.95′	73°42.93′	13
7	810921/0328	1461	40°18.95′	73°42.93′	810921/0537	2242	40°15.96′	73°53.93′	17
8	810921/0544	2280	40°16.08′	73°54.50′	810921/0641	2622	40°19.42′	73°57.89′	8
9	810921/0647	2656	40°19.55′	73°57.43′	810921/0804	3117	40°19.01′	73°50.36′	11
10	810921/0810	3172	40°19.31′	73°50.48′	810921/1000	3813	40°25.73′	73°55.99′	15
11	810921/1730	001	40°26.17′	73°52.22′	810921/2116	1358	40°24.80′	73°29.79′	30
12	810921/2119	1360	40°24.98′	73°29.70′	810921/2210	1678	40°28.94′	73°29.22′	7
13	810921/2215	1710	40°28.97′	73°29.64′	810922/0039	2570	40°27.82′	73°41.80′	18
14	810922/0039	2571	40°27.82′	73°41.80′	810922/0257	3401	40°31.24′	73°53.98′	18
15	810922/0304	3402	40°31.42′	73°53.80′	810922/0443	4037	40°30.80′	73°45.51′	12
16	810922/0445	4038	40°30.78′	73°45.32′	810922/0735	5069	40°31.97′	73°29.17′	22
17	810926/0817		38°42.79′	72°51.14′	810926/0859		38°40.14′	72°54.27′	7
18	810926/0909		38°39.49′	72°53.58′	810926/1004		38°42.78′	72°49.52′	8
25	810926/1607		39°02.45	73°19.80′	810926/2043		39°22.16′	74°09.20′	83
	REFRACTION	PROFILES						SUBTOTAL	(114)
101	810922/1642	001	40°18.42′	72°52.65′	810922/1742	262	40°23.45′	72°52.13′	10
102	810922/1801	263	40°23.37′	72°52.21′	810922/1959	708	40°13.40′	72°53.10′	20
103	810922/2010	744	40°13.61′	72°53.04′	810922/2101	936	40°18.40′	72°52.57′	10
201	810923/0743	461	40°22.53′	72°17.43′	810923/1020	1054	40°33.49′	72°14.51′	21
301	810923/1855	552	40°27.89′	72°33.47′	810923/2137	1162	40°16.74′	72°35.60′	21
401	810925/1625	805	38°53.03′	72°41.11′	810925/2024	1675	38°39.68′	72°56.78′	32
	N. Y. CITY GRAVITY PROFILES							SUBTOTAL	(63)
NY1	810921/1140		40°28.90′	73°53.75′	810921/1230		40°31.55′	74°00.57′	11
NY2	810921/1245		40°32.34′	74°01.43′	810921/1325		40°36.22′	74°02.88′	7
NY3	810921/1355		40°35.19′	74°02.61′	810921/1433		40°28.62′	74°03.06′	12
RB1	810921/1433		40°28.62′	74°03.06′	810921/1512		40°30.50′	74°11.58′	12
RB2	810921/1516		40°30.42′	74°11.12′	810921/1600		40°28.47′	74°02.31′	13
NY4	810921/1617		40°28.97′	73°59.32′	810921/1645		40°26.41′	73°55.10′	8
								TOTAL:	810

TABLE II: TABULATED REFLECTION DATA

LINE NO.	MAG	GRAV	3.5 kHz	SOURCE[1]	HYDROPHONE[2]	CHANNELS	SHOT INTERVAL	FOLD	SAMPLE INTERVAL	RECORD LENGTH	DFS V TAPES
1	X	X	X	1-80 WG	240m	12	10m	6	1ms	2s	1-2
2		X	X	2-80 WG	600m	6	25m	6	"	"	5-21
3		X	X	"	"	"	"	"	"	"	22-31
4		X	X								
5		X	X	1-80 WG	200e	1	10s	1	"	"	32-34
6		X	X	"	"	"	"	"	"	"	34-35
7		X	X	"	"	"	"	"	"	"	35-37
8		X	X	"	"	"	"	"	"	"	37-38
9		X	X	"	"	"	"	"	"	"	38-40
10		X	X	"	"	"	"	"	"	"	40-41
11		X	X	"	"	"	"	"	"	"	42-45
12		X	X	"	"	"	"	"	"	"	45-46
13		X	X	"	"	"	"	"	"	"	46-48
14		X	X	"	"	"	"	"	"	"	48-50
15		X	X	2-80 WG	"	"	"	"	"	"	50-52
16		X	X	"	"	"	"	"	"	"	52-55
17		X	X								
18		X	X								
25		X	X								
01		X	X	1-80 WG	200e	1	16s	1	1ms	2s	56
02		X	X	1-540 AG	"	"	"	"	"	"	56-61
03		X	X	1-80 WG	"	"	"	"	"	"	61-63
01		X	X								
01		X	X	1-540 AG	SS	"	"	"	"	"	64-65
01				"	200e	"	"	"	"	4s	66-69
Y1		X	X								
Y2		X	X								
Y3		X	X								
Y4		X	X								
B1		X	X								
B2		X	X								

[1] 80 WG = 80in^3 watergun
540 AG= 540in^3 airgun

[2] 240m = Fairfield Industries 240m streamer (20m/channel)
600m = WHOI SEI 600m streamer (50m/channel spacing)
200e = USGS 200 element streamer
SS = USGS sparker streamer

TABLE III: OBIP REFRACTION STATIONS

STN NO	DEPLOYMENT NO	SPHERE NO	LATITUDE (N)	LONGITUDE (W)	INSTRUMENT START-UP[1]	TAPE START TIME[2]	SAMPLE RATE	RECORDING MODE
1	1A:S-151	5	40° 18.361'	72° 52.597'	1427:00	1627:00	4ms	2 Ch continuous
	1B:S-150	4	40° 18.382'	72° 52.599'	1427:00		8ms	2 Ch continuous
	1C:S-152	1	40° 18.399'	72° 52.609'	1427:00		8ms	2 Ch buffer
2	2A:S-154	1	40° 27.979'	72° 15.868'	0540:00	0640:00	8ms	2 Ch buffer
	2B:S-153	5	40° 27.965'	72° 15.904'	0540:00		4ms	2 Ch continuous
	2C:S-155	A8	40° 27.958'	72° 15.943'	0540:00		4ms	4 Ch buffer
3	3A:S-158	4	40° 22.907'	72° 34.108'	1628:00	1828:00	8ms	2-Ch continuous
	3B:5-157	1	40° 22.868'	72° 34.118'	1628:00		8ms	2-Ch buffer
	3C:8-159	5	40° 22.861'	72° 34.117'	1628:00		4ms	2-Ch continuous
4	4A:S-161	A2	38° 43.906'	72° 51.741'	1256:00	1530:00	8ms	Loose take up reel
	4B:S-160	A6	38° 43.895'	72° 51.740'	1256:00		4ms	Lost at sea
	4C:S-163	A8	38° 48.665'	72° 46.271'	1256:00	1556:00	4ms	2 Ch continuous
	4D:S-162	A1	38° 48.742'	72° 46.268'	1256:00		8ms	2 Ch buffer

1. Time at which instruments are synched to the master clock.

2. Time at which tape is programmed to start recording.

TABLE IV: TABULATED REFRACTION LINES

LINE NO[1]	STN NO	SOURCE	SHOT PULSE	SHOT INTERVAL	WATER TEMP	SONOBUOY SAMPLE INTERVAL	INFORMATION[2] RECORD LENGTH	DFS V TAPES	TOTAL KM
101	1	80 WG	OBIP	16S	20°C	1ms	7S	56	10
102	1	540 WG	OBIP	16S		1ms	7S	56-61	20
103	1	80 WG	OBIP	16S		1ms	7S	61-63	10
201	2	540 AG	INS	16S	18°C				21
301	2	540 AG	INS	16S	18°C				21
401	2	540 AG	INS	16S	21°C				32
								TOTAL	114

[1] Same as reflection lines

[2] Lines 101-103: Tethered Ref-Tech calibrated sonobuoy
Line 301: 2 expendable sonobuoys launched (dead batteries)

TABLE V: SAMPLING INFORMATION

STATION[1]	YRMODA/TIME	LATITUDE	LONGITUDE	TYPE[2]	COMMENT
1	810923/0056	40°17.82′	72°52.53′	SM	sand
2	810923/1323	40°27.89′	72°16.36′	SM	sand
3	810923/1613	40°23.22′	72°34.43′	SM	sand
4	810926/0243	38°48.81′	72°46.56′	GC	mud

[1]same as refraction stations

[2]SM = Smith-McIntyre grab sample

GC = Gravity core

TABLE VI: SIGNATURE TEST INFORMATION

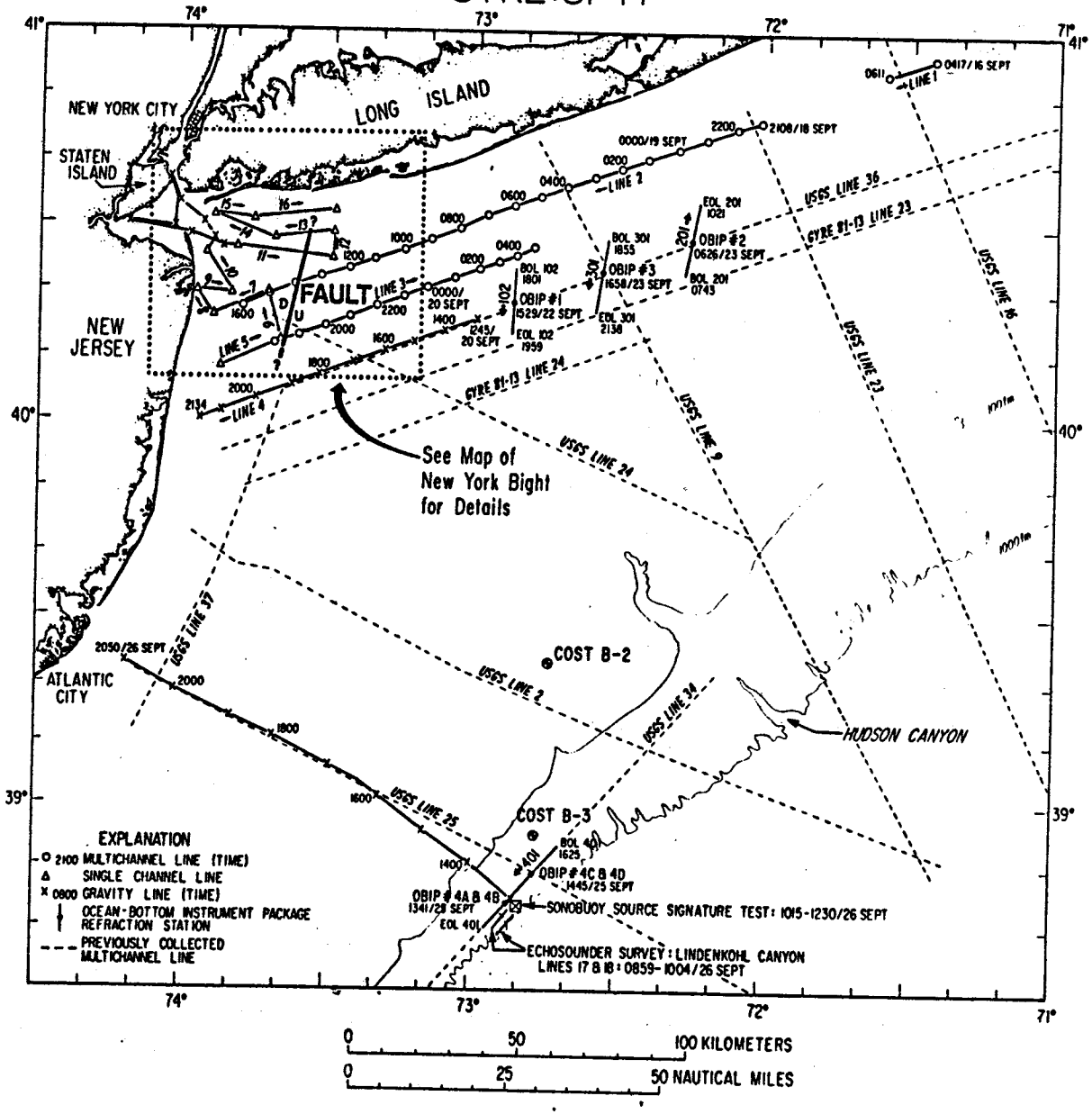
SOURCE[1]	RECEIVER[2]	SAMPLE INTERVAL	RECORD LENGTH	DFSV TAPE	FILE NO.
80WG	CAL SBY	1ms	2s	71	1-20
					91-108
540AG	CAL SBY	1ms	2s	71	21-69

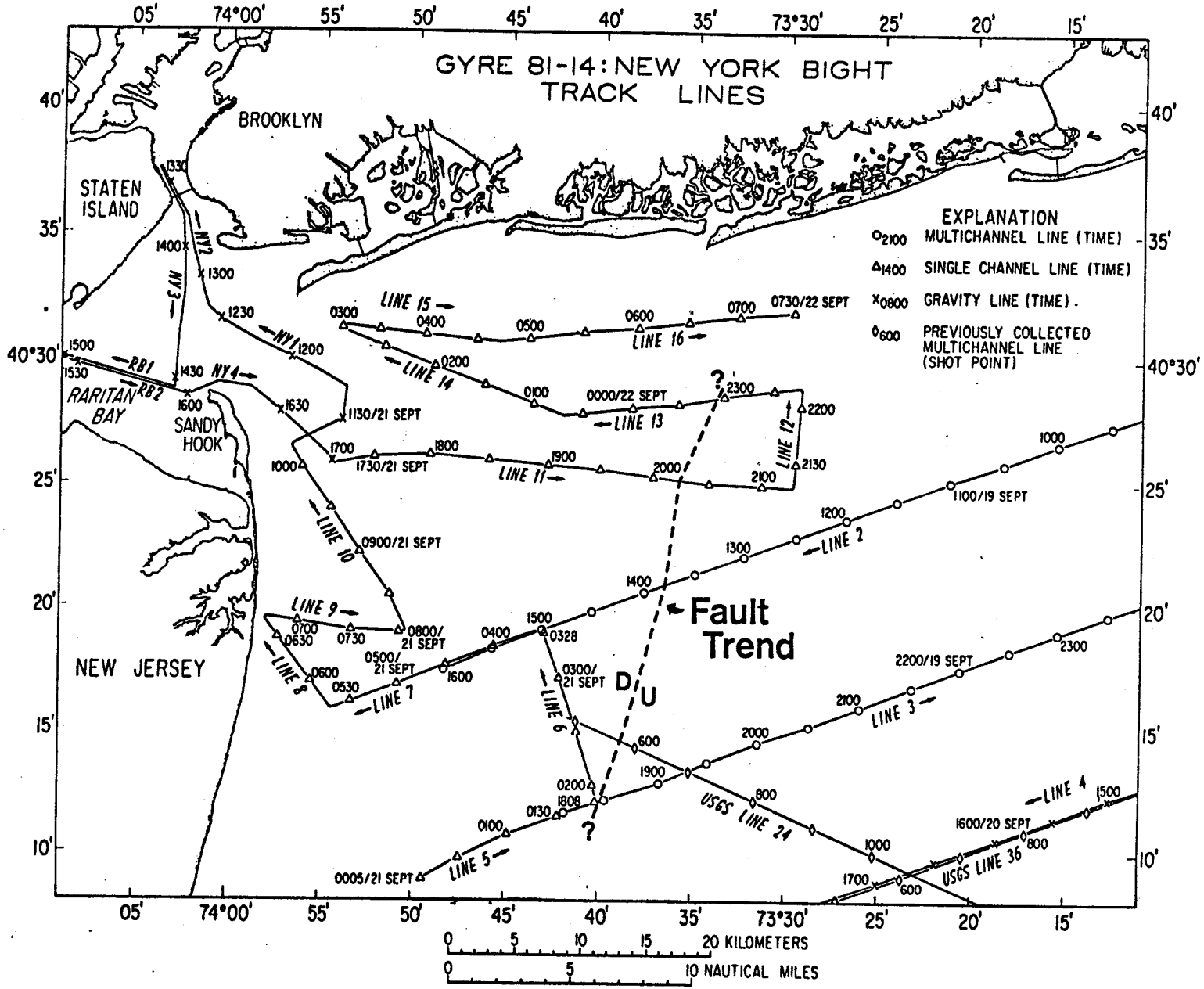
[1] 80 WG = 90 in ^{3} watergun

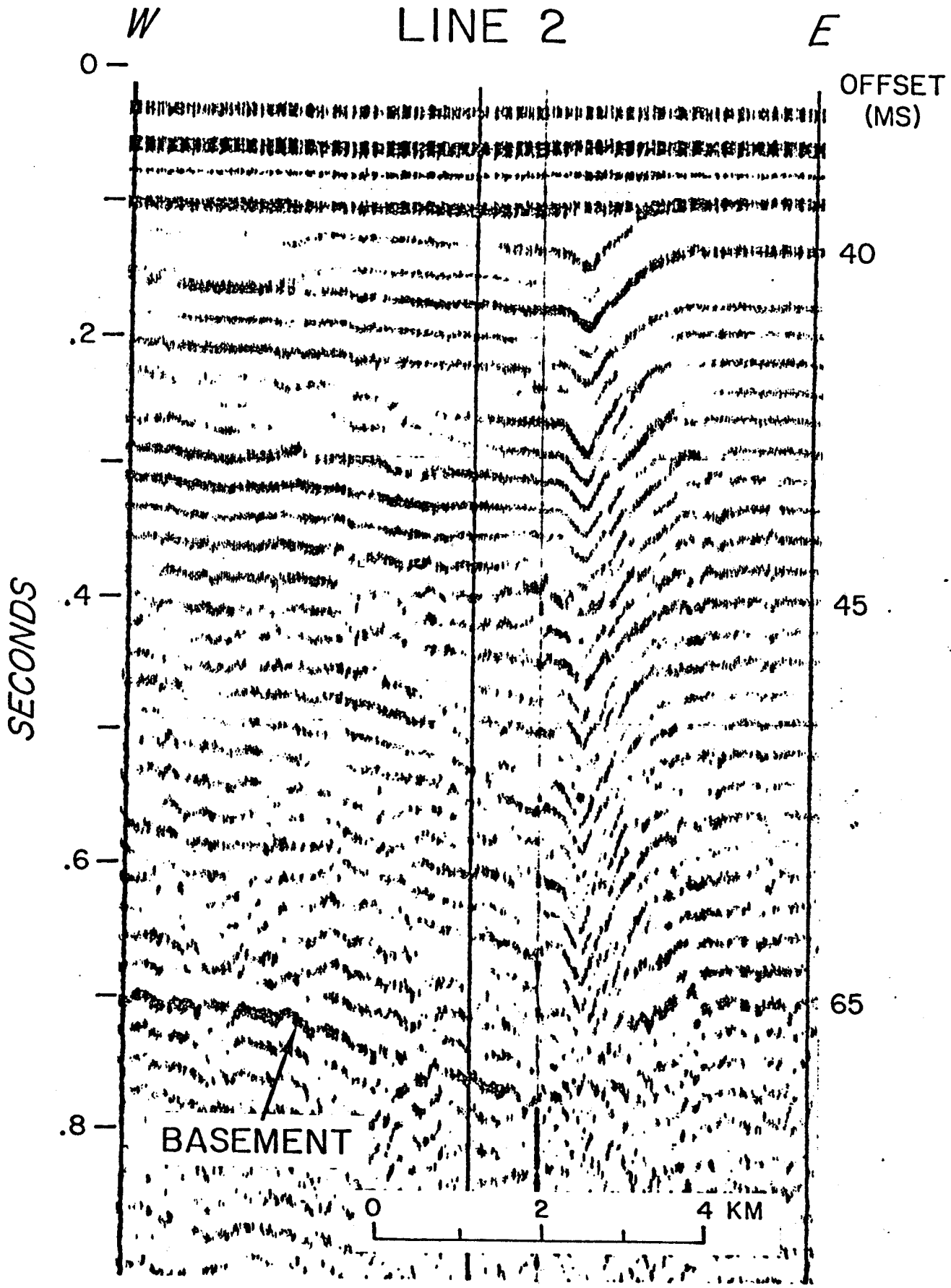
540AG = 540 in ^{3} airgun

[2] CAL SBY = calibrated sonobuoy

GYRE:81-14


NEW YORK CITY
STATEN ISLAND
LONG ISLAND
NEW JERSEY
ATLANTIC CITY
FAULT
D
U
LINE 1
LINE 2
LINE 3
LINE 4
LINE 5
0611
0417/16 SEPT
0000/19 SEPT
2108/18 SEPT
0000/20 SEPT
1245/20 SEPT
2134
2050/26 SEPT
USGS LINE 36
GYRE 81-13 LINE 23
USGS LINE 16
USGS LINE 23
USGS LINE 9
USGS LINE 24
GYRE 81-13 LINE 24
USGS LINE 37
USGS LINE 2
USGS LINE 34
USGS LINE 25
BOL 102 1801
OBIP #1 1529/22 SEPT
EOL 102 1959
BOL 301 1855
OBIP #3 1658/23 SEPT
EOL 301 2138
EOL 201 1021
OBIP #2 0626/23 SEPT
BOL 201 0743
See Map of New York Bight for Details
COST B-2
COST B-3
HUDSON CANYON
BOL 401 1625
OBIP #4C & 4D 1445/25 SEPT
OBIP #4A & 4B 1341/25 SEPT
EOL 401
SONOBUOY SOURCE SIGNATURE TEST: 1015-1230/26 SEPT
ECHOSOUNDER SURVEY: LINDENKOHL CANYON LINES 17 & 18: 0859-1004/26 SEPT
EXPLANATION
2100 MULTICHANNEL LINE (TIME)
SINGLE CHANNEL LINE
0800 GRAVITY LINE (TIME)
OCEAN-BOTTOM INSTRUMENT PACKAGE
REFRACTION STATION
PREVIOUSLY COLLECTED MULTICHANNEL LINE
74°
73°
72°
71°
41°
40°
39°
0 50 100 KILOMETERS
0 25 50 NAUTICAL MILES


GYRE 81-14: NEW YORK BIGHT
TRACK LINES
EXPLANATION
MULTICHANNEL LINE (TIME)
SINGLE CHANNEL LINE (TIME)
GRAVITY LINE (TIME).
PREVIOUSLY COLLECTED MULTICHANNEL LINE (SHOT POINT)
BROOKLYN
STATEN ISLAND
RARITAN BAY
SANDY HOOK
NEW JERSEY
Fault Trend
D
U
LINE 15
LINE 16
LINE 14
LINE 13
LINE 12
LINE 11
LINE 10
LINE 9
LINE 8
LINE 7
LINE 6
LINE 5
LINE 4
LINE 3
LINE 2
USGS LINE 24
USGS LINE 36
NY1
NY2
NY3
NY4
RB1
RB2
0730/22 SEPT
0000/22 SEPT
1130/21 SEPT
1730/21 SEPT
0900/21 SEPT
0800/21 SEPT
0500/21 SEPT
0300/21 SEPT
0005/21 SEPT
1100/19 SEPT
2200/19 SEPT
1600/20 SEPT
0 5 10 15 20 KILOMETERS
0 5 10 NAUTICAL MILES


W
LINE 2
E
0
.2
.4
.6
.8
SECONDS
OFFSET
(MS)
40
45
65
BASEMENT
0
2
4 KM