

SEISMIC EXPERIMENTS IN THE CARIBBEAN SEA

Onboard Cruise Report

Hawaii Institute of Geophysics Cruise MW-77-10-20

Ft. Lauderdale, Florida (20 Oct. 1977) to

Ft. Lauderdale, Florida (7 Dec. 1977)

Submitted by:

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ONBOARD CRUISE REPORT, MW-77-10-20

R/V MOANA WAVE

Ft. Lauderdale, Florida (20 Oct. 1977) to
Ft. Lauderdale, Florida (7 Dec. 1977)

The various exploration seismic experiments conducted in the Caribbean Sea on board the R/V MOANA WAVE during late 1977 had the following three basic objectives:

- (1) to resolve the poorly defined, but apparently anomalous, velocity structure of the crust and uppermost mantle in the Venezuela Basin;
- (2) to study the fossil (?) subduction or transform plate margin near the Curcao Ridge and Los Rocques Trough on the southern margin of the Venezuela basin; and
- (3) to determine the large scale, deep structure of the northern continental margin of Venezuela.

To meet these objectives the MOANA WAVE participated in two-ship wide-angle, deep crustal common depth point reflection profiles as well as constant offset wide-angle reflection profiles with the R/V CONRAD of the Lamont-Doherty Geological Observatory. The MOANA WAVE also deployed bottom seismometers (OBS) for detection of low-level natural seismic events, shot explosion refraction lines to the OBS's, and detonated large explosions for simultaneous detection by the OBS array and portable land stations deployed in Venezuela. All of these experiments were successful, and apparent high-quality data was collected during all phases of the cruise.

Narrative

The MOANA WAVE departed Port Everglades (port of Ft. Lauderdale), Florida late in the afternoon of 20 October, 1977. The scientific crew on board this and subsequent legs are listed in Table 1. Scientific personnel had been aboard the MOANA WAVE since 10 October installing scientific equipment while in port. Personnel from the U.S. Navy and their contractors were also working on the ship during the entire 10-20 October port period.

The following morning the ship pulled in to the U.S. Navy Ordinance Test Unit port facility at Cape Canaveral, Florida, and loaded approximately 20 tons of Tovex explosives for seismic shooting, and three tons of Superseis (NCN) charges for the Maxipulse system. The ship departed for San Juan that same afternoon.

TABLE I: Scientific Crew, MW-77-10-20

Leg 1	Leg 2	Leg 3	Leg 4
Ft. Lauderdale, Fla. to San Juan, Puerto Rico 20 October 1977 to 26 October 1977	San Juan to La Guaira, Venezuela 1 November 1977 to 6 November 1977	La Guaira to La Guaira 8 November 1977 to 24 November 1977	Barbados to Ft. Lauderdale 29 November 1977 to 7 December 1977
D. Hussong, Chief Scientist			↑
P. Pozzi, OBS Tech.			↑
P. Jubinski, Computer Tech			↑
T. Jordan, Deck Tech			↑
J. Sinton, Student			↑
G. Fryer, Student			↑
R. Mitiguy, Seismic Tech			↑
L. Smith, Senior Electr. Tech			↑
G. Natonek, Electr. Tech			↑
	H. Van Santford Seismic Tech J. Nunez P. Baldy	La Guaira to Barbados 24 November 1977 to 26 November 1977	Barbados to Ft. Lauderdale 29 November 1977 to 7 December 1977

The transit to San Juan, Puerto Rico, was uneventful. All personnel were occupied with installing and testing the scientific gear. No scientific data were collected.

During the in-port period in San Juan the digital tape drive formatter failed. A replacement unit was sent from Honolulu. The ship was forced to delay sailing from San Juan for two days while waiting for delivery of the replacement formatter.

After departing San Juan deep reflection profile across Muertos Trough (see sketch of track lines, Figure 1) was made. Digital seismic data from two single-channel hydrophone arrays were recorded, using the Maxipulse repetitive explosive sound source. The low-resolution monitor record obtained during this 60 n. mile run indicate that several deep reflectors were detected beneath the apparent trench-like structure of Muertos Trough.

The ship then proceeded directly to the southern margin of the Venezuela Basin. No data were collected during this transit. A five knot transit from the Venezuela Basin across the Curacao Ridge and Los Rocques Trough was made using only a 4.5 K-Joule sparker sound source. Although deep penetration was not possible with this small energy source, good definition of the upper portion (up to around 1 second two-way travel time) of the sediment section was obtained.

During the sparker profiling, repeated attempts to contact the land parties that were supposed to be installing seismometers in Venezuela were unsuccessful. As the time of a pre-arranged shooting schedule was approaching, the MOANA WAVE went ahead and began deployment of the six OBS's that were to monitor the big shots for the land-sea experiment. The particulars of all the OBS drops made during the cruise are contained in Table II. The OBS locations are included in Figure 2.

As the last of the first set of six OBS's was deployed, word was received from Honolulu that we could not begin shooting the large shots until after we had called at the Venezuelan port of La Guaira to take on Venezuelan scientists to participate in the experiments. The cruise schedule was then altered and we sailed directly for La Guaira, arriving on 6 November 1977.

After departing La Guaira a series of 46 large charges (200 to 1000 pounds) were fired along two lines extending from near the coast to the Venezuela Basin (see Figure 1). The shots were all recorded on the OBS array (except OBS #4, which was never recovered), and were apparently received by most of the

TABLE II: Ocean Bottom Seismometer Deployments, MW-77-10-20

Station No. Cruise	HIG	Unit	Preliminary Position		Depth (M)	Time and Drop Dates		Approximate Time/Date Recover	Comments	
			(N) Lat.	Long. (W)		GMT				
1	66	BOBS Q	12°27.6'	67°29.5'	4657	2009	4 Nov.	0636	13 Nov.	Acquired Data
2	67	POBS F	12°51.3'	67°30.1'	3202	0328	5 Nov.	0920	13 Nov.	Acquired Data
3	68	POBS M	13°22.3'	67°34.9'	5010	0630	5 Nov.	1232	13 Nov.	Acquired Data
4	69	BOBS O	12°32.0'	68°25.0'	3120	1606	5 Nov.		LOST	
5	70	POBS G	12°57.8'	68°08.9'	2325	1925	5 Nov.	1850	12 Nov.	Acquired Data
6	71	BOBS P	13°30.0'	67°53.6'	5010	2304	5 Nov.	2344	12 Nov.	Acquired Data
7	72	POBS G	12°42'	67°48'	4456	0447	13 Nov.	0215	24 Nov.	Acquired Data
8	73	BOBS P	13°30'	67°53.6'	5013	1606	13 Nov.	1952	23 Nov.	Acquired Data
9	74	BOBS Q	13°19'	67°10'	5006	2351	13 Nov.	1701	23 Nov.	Acquired Data
10	75	POBS F	13°30'	66°30.2'	~5000	2240	14 Nov.	2330	15 Nov.	Acquired Data, ESP 2
11	76	POBS M	14°32.2'	66°04'	~5000	1423	15 Nov.	1508	16 Nov.	Acquired Data, ESP 1
12	77	POBS M	14°56.2'	67°26.1'	~5000	2316	17 Nov.	1730	18 Nov.	Acquired Data, ESP 3
13	78	POBS F	13°53'	67°42'	5017	1113	20 Nov.	0815	21 Nov.	Acquired Data, ESP 4
14	79	POBS M	13°03'	68°19.2'	~3000	1428	21 Nov.	0231	22 Nov.	Acquired Data, ESP 5
15	80	POBS F	13°15.5'	67°48.5'	~5000	0821	22 Nov.	0910	22 Nov.	PRETRIGGER
16	81	POBS F	13°15'	67°49'	~5000	1013	22 Nov.	2151	23 Nov.	Acquired Data, ESP 6

twelve land stations. The farthest land station were some 360 kilometers inland, providing shot-to-receiver ranges of as much as 745 kilometers. It is hoped that these data will be useful for delineating the deep oceanic-continental margin in the area.

During a break in the land-sea shooting that was scheduled to permit relocation of the land stations, a crustal refraction line was shot through the OBS array. A total of 263 shots were fired. These data will be used to define the local crustal structure and will also provide the necessary upper crustal correction for interpreting the large land-sea shots.

After recovery of OBS's 1, 2, 3, 5, and 6, three OBS's (7, 8, and 9) were redeployed to monitor local micro-seismic activity near the Cuacao Ridge.

The ship then proceeded to rendezvous with the R/V CONRAD of Lamont-Doherty Geological Observatory to begin two-ship operations at expanded spread profile (ESP) number 2 (see Figure 2). This and subsequent ESP profiles are wide-angle reflection profiles obtained by two ships steaming in opposite directions away from an OBS site. During this portion of the cruise the primary task of the MOANA WAVE was to fire explosive charges on each ESP profile. Seismic returns from the shots were recorded on a 24-channel hydrophone array towed by the CONRAD. This maneuver produces a series of arrivals reflected off successively deeper interfaces beneath the OBS center point, as well as a short refraction profile from the OBS to the MOANA WAVE. A total of six ESP profiles were obtained on this cruise (see Figure 2).

A high resolution wide-angle reflection and refraction profile was also made over OBS #10 at ESP-2 using the Maxipulse sound source. During this station, a pair of constant-gain SSQ-57 sonobuoys were deployed near the OBS site to record seismic arrivals near the surface. Since the Maxipulse source is a carefully regulated explosive source (which is recorded at each shot for later deconvolution of the reflected and refracted arrivals), it is hoped that the arrivals on the OBS and SSQ-57 sonobuoys can be analyzed for phase and amplitude to determine the reflection and propagation characteristics of various crustal layers. This high-resolution, Maxipulse to OBS and sonobuoy, reflection profile was repeated at ESP-3.

While transitting between the ESP stations the two ships ran two long constant offset profiles (C05 and C06, Figure 2), in the Venezuela basin and, in the case of C06, up on to the Venezuela continental margin. These tracks were each run twice, each time with the ships steaming in the same direction, one

following the other, at ranges where shots from the MOANA WAVE to the CONRAD would travel in and reflect off specific interfaces in the crust. The experiments are designed to yield data on lateral variation in the seismic character of certain interfaces. During both the EDP and the CO experiments, range between the ships was measured using a Raydist system.

A total of 2500 shots, ranging in size from one to 120 pounds of explosives, were fired from the MOANA WAVE to the CONRAD.

At the completion of the two-ship work the MOANA WAVE conducted a 75 mile-long Maxipulse deep reflection profile across Los Rocques Trough, the Curacao Ridge, and part of the Venezuela Basin (see Figure 2). The OBS's at stations 7, 8, 9, and 16 were then retrieved.

On 24 November, 1977, the MOANA WAVE pulled in to La Guaira for several hours during which Venezuelan scientists disembarked and the equipment used by the seismic land parties was brought aboard.

The ship then sailed for Barbados, arriving in the evening on 26 November. No data were collected during this transit. At Barbados the HIG OBS system was unloaded and left for later use by the CONRAD. The L-DGO Raydist system was also offloaded for shipment back to New York.

The MOANA WAVE left Barbados on the morning of 29 November, 1977. On 1 December, an 85-mile Maxipulse deep reflection profile was made across the Puerto Rico trench just north of San Juan (Figure 1). This was the last data collection effort of the cruise. The remaining sea days were spent dismantling the scientific equipment on the MOANA WAVE and packing it for shipment back to Honolulu.

The MOANA WAVE ended this voyage, MW-77-10-20, upon arrival at Ft. Lauderdale, Florida, early in the morning of 7 December 1977.

DATA ACQUISITION SUMMARY

Most of the data collected during MW-77-10-20 were recorded only on digital tape, so that accurate appraisal of its quality was not possible at sea. Based on monitor records, we anticipate that the data quality will be very good.

All the OBS's which were recovered from the bottom pulled the proper amount of tape and recorded arrivals with good S/N levels.

The only data acquisition system that did not operate properly was the sonobuoy receiver, which had very poor sensitivity. The approximately 25 sonobuoys launched during the cruise could not be received at ranges greater than about 8 miles.

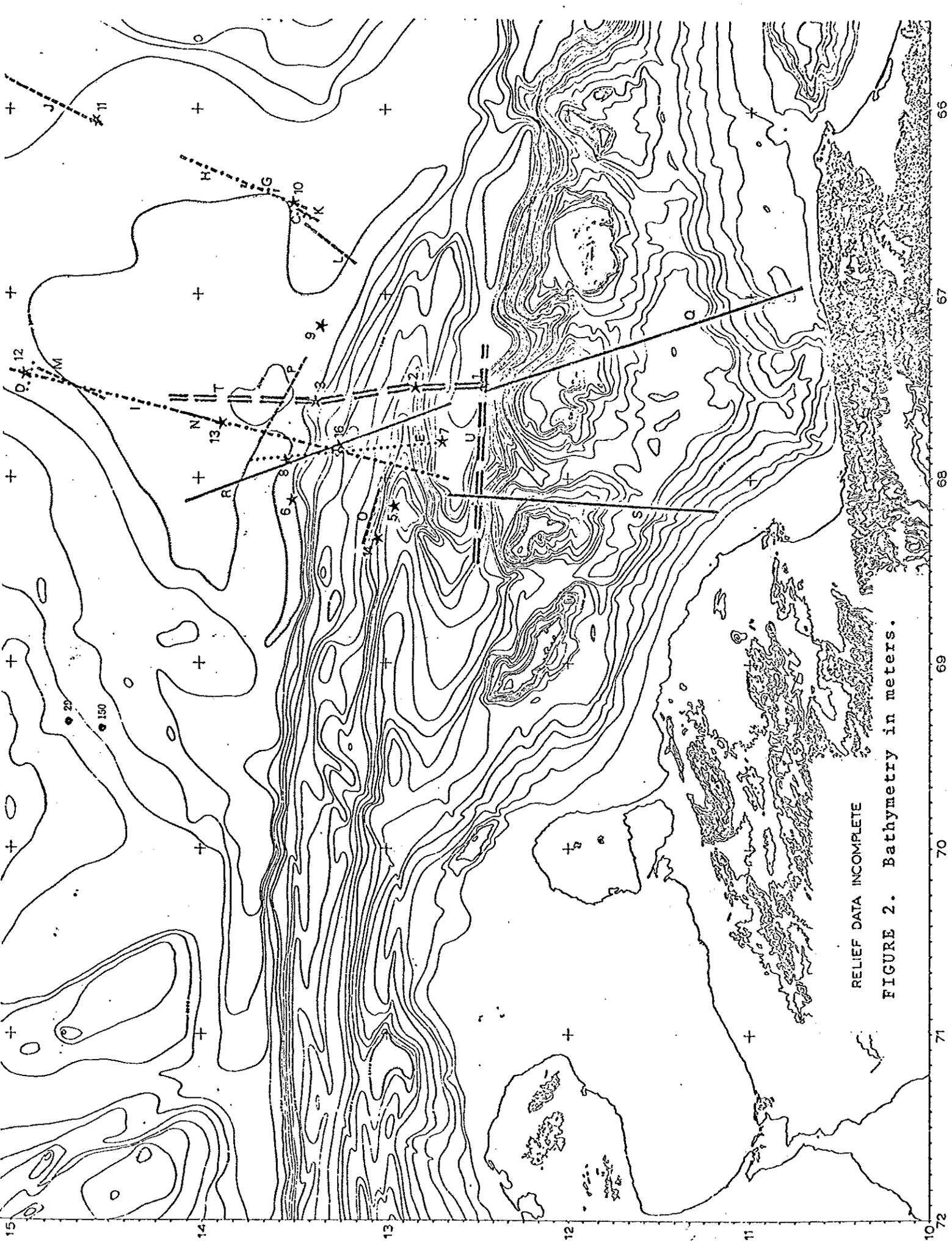
A UNOLS Research Cruise Report, containing an inventory of data collected on MW-77-10-20, and other pertinent information, is attached as Appendix A.

Key to Figures 1 and 2

- 1-16 OBS Stations
- A Maxipulse 1
- B Maxipulse 2, aborted at outset, not shown
- C Maxipulse 3
- D Maxipulse 4
- E Maxipulse 5
- F Maxipulse 6
- G Constant Offset 5a
- H Constant Offset 5b
- I Constant Offset 6
- J Expanded Spread Profile 1
- K Expanded Spread Profile 2a
- L Expanded Spread Profile 2b
- M Expanded Spread Profile 3
- N Expanded Spread Profile 4
- O Expanded Spread Profile 5
- P Expanded Spread Profile 6
- Q Oceanic-Continental Explosion Refraction Line 1a
- R Oceanic-Continental Explosion Refraction Line 1b
- S Oceanic-Continental Explosion Refraction Line 2
- T Oceanic Explosion Refraction Line 1
- U Oceanic Explosion Refraction Line 2

FIGURE 1 Bathymetry in meters.





RELIEF DATA INCOMPLETE

FIGURE 2. Bathymetry in meters.

15
14
13
12
11
10
72
71
70
69
68
67
66

APPENDIX A



University of Hawaii at Manoa

January 17, 1978

Hawaii Institute of Geophysics
2525 Correa Road • Honolulu, Hawaii 96822
Cable Address: UNIHAW

RESEARCH CRUISE REPORT

SHIP NAME: R/V MOANA WAVE OPERATING INSTITUTION: Hawaii Institute of Geophysics

CRUISE NO: 77-10-20 DATES: 20 Oct 1977 to 7 Dec 1977

AREA OF OPERATION: Caribbean Sea PORT CALLS: Depart Ft. Lauderdale 20 Oct.
26 Oct. to 1 Nov. San Juan, Puerto Rico
6-8 Nov La Guira, Venezuela; 26-29 Nov. Barbados

PROJECT TITLE(S): (1) Seismic Study of the Crustal Structure of the Southern Margin of the Caribbean Sea. (2) Investigation of Crust-Mantle Structure in Northern Venezuela-Southern Caribbean Sea. SENIOR SCIENTIST: Dr. Donald M. Hussong

SCIENTIFIC PARTICIPANTS, TITLE AND AFFILIATION:

D. Hussong	Chief Scientist	HIG	G. Natonek	Electr Tech	HIG
P. Pozzi	OBS Technician	HIG	H. Van Santford	Seismic Tech	Venezuela
P. Jubinski	Computer Technician	HIG	J. Nunez	Scientist	"
T. Jordan	Marine Technician	HIG	P. Baldy	"	"
J. Sinton	Student	HIG			
G. Fryer	Student	HIG			
R. Mitiguy	Seismic Technician	HIG			
L. Smith	Sr. Electr. Techn.	HIG			

DESCRIPTION OF SCIENTIFIC PROGRAM:

The various exploration seismic experiments had the following three basic objectives: (1) to resolve the poorly defined, but apparently anomalous, velocity structure of the crust and uppermost mantle in the Venezuela Basin; (2) to study the fossil (?) subduction or transform plate margin near the Curcao Ridge and Los Rocques Trough on the southern margin of the Venezuela Basin; and (3) to determine the large scale, deep structure of the northern continental margin of Venezuela. To meet these objectives the MOANA WAVE participated in two-ship wide-angle, deep crustal common depth point reflection profiles as well as constant offset wide-angle reflection profiles with the R/V CONRAD of the Lamont-Doherty Geological Obs. The MOANA WAVE also deployed bottom seismometers (OBS) for detection of low-level natural seismic events, shot explosion refraction lines to the OBS's, and detonated large explosions for simultaneous detection by the OBS array and portable land stations deployed in Venezuela.

OBSERVATIONS AND SAMPLES (TYPE, LOCATION, CUSTODIAN):

Seismic reflection and refraction data recorded on digital tape, with associated navigation and bathymetric data.

ADDRESS OF CONTACT TO WHOM INQUIRIES REGARDING CRUISE SHOULD BE MADE:

Dr. Donald M. Hussong
Hawaii Institute of Geophysics
University of Hawaii
2525 Correa Road
Honolulu, Hawaii 96822

CRUISE REPORT

UNOLS
REV. 5/76

SHIP UTILIZATION DATA

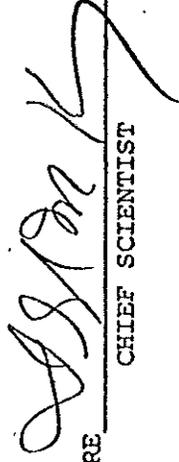
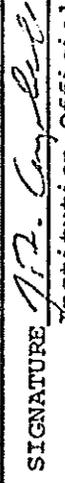
SHIP NAME	R/V MOANA WAVE	OPERATING INST.	HIG	PARTICIPATING PERSONNEL	AFFILIATION
CRUISE (LEG) NO.	77-10-20	DATES	Oct to 7 Dec 1977	NAME	TITLE
AREA OF OPERATIONS:		PORT CALLS:		CODE	
CARIBBEAN SEA		PLACE	DATES	1. D. Hussong	Chief Scientist
		San Juan, Puerto Rico	26 Oct-1 Nov	2. P. Pozzi	OBS Technician
DAYS AT SEA	41	La Guira Venezuela	6-8 Nov	3. P. Jubinski	Computer Technician
DAYS IN PORT	8	Barbados	26-29 Nov	4. T. Jordan	Marine Technician
				5. J. Sinton	Student
				6. R. Fryer	Student
				7. R. Mitiguy	Seismic Technician
				8. L. Smith	Sr. Electronics Techn.
				9. G. Natonek	Electronics Technician
				10. H. Van Santford	Seismic Tech. Venezuela
				11. J. Nunex	Scientist
				12. P. Baldy	"

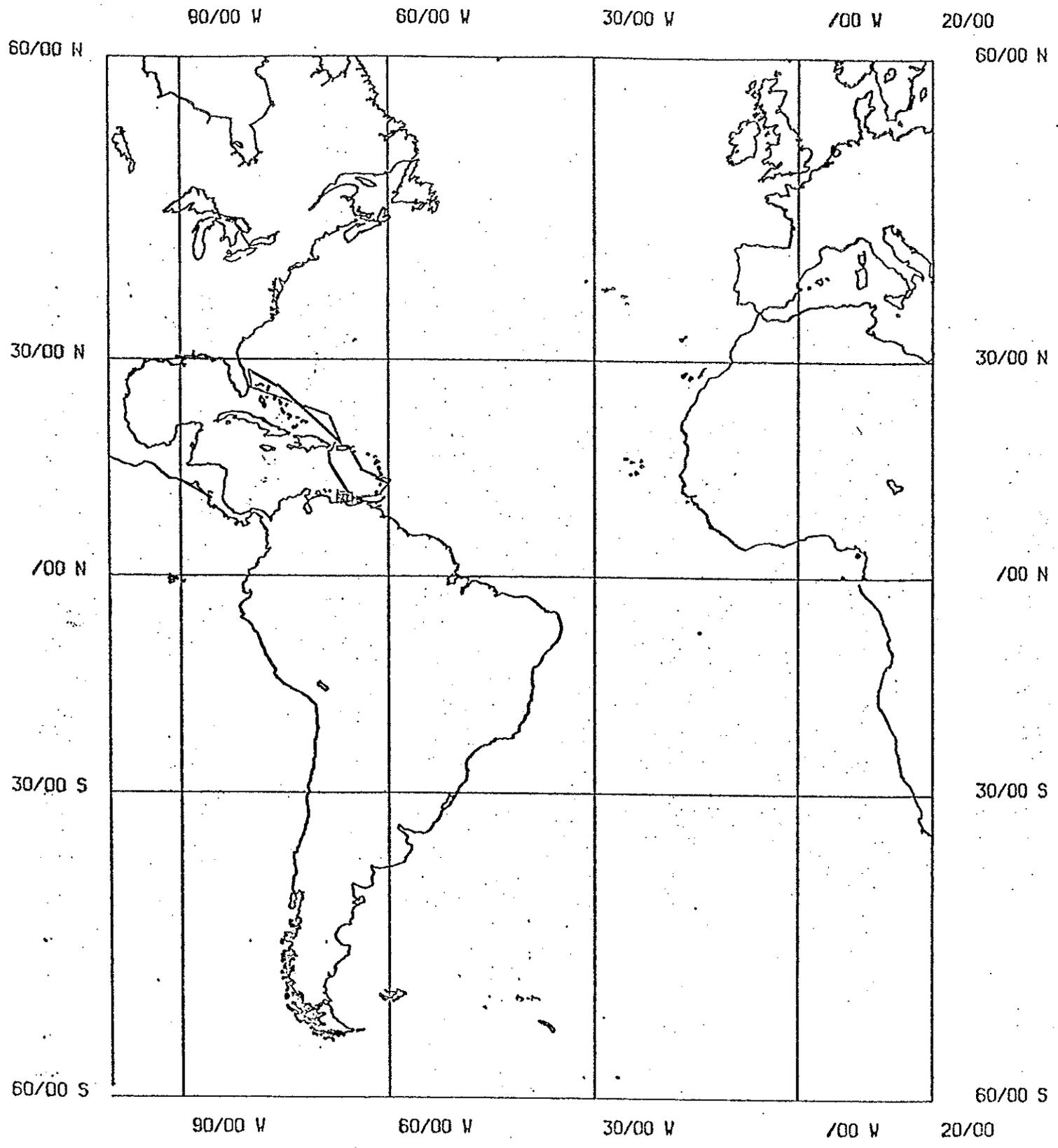
PRIMARY PROJECTS (those which govern the principal operations, area and movements of the ship)

PROJECT TITLE AND PRINCIPAL INVESTIGATOR	SPONSORING ACTIVITY	GRANT OR CONTRACT NUMBER	PARTICIPATING PERSONNEL (AS CODED ABOVE)
1) Seismic Study of the Crustal Structure of the Southern Margin of the Caribbean Sea D. M. Hussong	NSF	OCE 76-82148	I - 12
2) Investigation of Crust-Mantle Structure in Northern Venezuela-Southern Gettrust/Hussong	NSF Caribbean Sea	EAR77-13635	

ANCILLARY PROJECTS (which are accomplished on a not-to-interfere basis and contribute to the overall effectiveness of the cruise)

PROJECT TITLE AND PRINCIPAL INVESTIGATOR	SPONSORING ACTIVITY	GRANT OR CONTRACT NUMBER	PARTICIPATING PERSONNEL (AS CODED ABOVE)

SIGNATURE  CHIEF SCIENTIST	DATE	
(Continue personnel and project listings on reverse if additional space needed)	COST ALLOCATION DATA	
	DAYS CHARGED	AGENCY OR ACTIVITY CHARGED
49	ONR	GRANT OR CONTRACT NO.
		N00014-77-C-0074
ATTACH PAGE SIZE CRUISE TRACK	SIGNATURE  Institution Official	
	DATE 19 Jan 78	



Cruise Track: R/V MOANA WAVE 20 October to 7 December 1977

NOAA FORM 24-23
(1-76)

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA SERVICE
NATIONAL OCEANOGRAPHIC DATA CENTER

A00 DATA CENTER

OCEANOGRAPHY - GENERAL CRUISE INVENTORY
(ROSCOP - II)

A40 REFERENCE NUMBER

A01 EXPEDITION/PROJECT
SEISMIC STUDIES / CARIBBEAN SEA

YES	NO	PART	
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A11 CRUISE NUMBER OR NAME
MW 77-10-20

A91 Declared national program?

A02 SHIP OR PLATFORM
R/V MOANA WAVE

WZE 3929

A81 Exchange restricted?

A12 PLATFORM TYPE
01

A92 Co-operative program?

A72 NAME
L-D G. O.
Venezuela

A82 Co-ordinated internationally?

A62 BY WHOM?

A03 COUNTRY
USA

A04 ORGANIZATION
Hawaii Institute of Geophysics
University of Hawaii

A05 CHIEF SCIENTIST(S)
Dr. Donald M. Hussong

A06 NAME AND ADDRESSES OF ORGANIZATIONS AND PERSONS
WHOM TO QUERY

FINAL DISPOSITION OF DATA

A1 Donald M. Hussong

A2 Hawaii Institute of Geophysics, 2525
Correa Road, Honolulu, Hawaii 96822

B1

B2

C1

C2

D1

D2

E1

E2

DATE	DAY	MONTH	YEAR
A07 FROM	2	0	1 0 7 7
A17 TO	0	7	1 2 7 7

A08 GENERAL OCEAN AREAS
27

A09 TYPE(S) OF MARINE ZONE(S)
06, 08

GEOGRAPHIC AREA

If all data were collected at a fixed station, fill in the co-ordinates

A10 LATITUDE

A20 LONGITUDE

N/S

E/W

A15 FEDERAL SUPPORT
NSF

A25 REMARKS

See attached cruise report.

DISCIPLINE AND TYPE
OF MEASUREMENTS

Index 10° x 10°
Qc L G G

INDEX 1° x 1°

DISCIPLINE AND TYPE
OF MEASUREMENTS

Index 10° x 10°
Qc L G G

INDEX 1° x 1°

A G10, G25, G26B

7 1 0 6

A B

A B

A B

A B

A B

A B

A B

A B

A B

A B

A B

A B

A B

B - BIOLOGY

	NUMBER	i	l	FORMAT		NUMBER	i	l	FORMAT
B01 Primary productivity					B31 Vitamin concentrations				
B02 Phytoplankton pigments					B32 Amino acid concentration				
B03 Seston					B33 Hydrocarbon concentrations				
B04 Particulate organic carbon					B34 Lipid concentrations				
B05 Particulate organic nitrogen					B35 ATP-ADP-AMP concentrations				
B06 Dissolved organic matter					B36 DNA-RNA concentrations				
B07 Bacterial and pelagic micro-organisms					B37 Taggings				
B08 Phytoplankton					B80 Other measurements				
B09 Zooplankton									
B10 Neuston					BS TYPES OF STUDIES				
B11 Nekton					B51 Identification				
B12 Invertebrate nekton					B52 Spatial and temporal distribution				
B13 Pelagic eggs and larvae					B53 Monitoring and surveillance				
B14 Pelagic fish					B54 Biomass determination				
B15 Amphibians					B55 Description of communities				
B16 Benthic bacteria and micro-organisms					B56 Food chains energy transfers				
B17 Phytobenthos					B57 Population and environments				
B18 Zoobenthos					B58 Population structures				
B19 Commercial demersal fish					B59 Taxonomy, systematics, classification				
B20 Commercial benthic molluscs					B60 Physiology				
B21 Commercial benthic crustacean					B61 Behaviour				
B22 Attached plants and algae					B62 Pathology, parasitology				
B23 Intertidal organisms					B63 Toxicology				
B24 Borers and foulers					B64 Gear research				
B25 Birds					B65 Exploratory fishing				
B26 Mammals and reptiles					B66 Commercial fishing				
B27 Deep scattering layers					B67 Aquaculture				
B28 Acoustical reflections on marine organisms					B90 Other measurements				
B29 Biologic sounds									
B30 Bioluminescence									

H - HYDROGRAPHY

HS SURFACE				NUMBER	i	I	FORMAT	HC CHEMICAL				NUMBER	i	I	FORMAT
H01 Continuous temperature recording								H26 Silicates							
H02 Continuous salinity recording								H27 Alkalinity							
H03 Discrete temperature measurements								H28 pH							
H04 Discrete salinity measurements								H29 Chlorinity							
NEAR SEA FLOOR (≤ 10 m)								H30 Trace elements							
H05 Continuous temperature recording								H31 Radioactivity							
H06 Continuous salinity recording								H32 Isotopes							
H07 Discrete temperature measurements								H33 Dissolved gases							
H08 Discrete salinity measurements								H90 Other measurements							
HP PHYSICAL															
H09 Classical oceanographic stations															
H10 Vertical profiles (STD/CTD)								P - POLLUTION							
H11 Sub-surface measurements underway								P01 Suspended solids							
H12 Mechanical bathythermograph (No. of drops)								P02 Heavy metals							
H13 Bathythermograph-expendable (No. of drops)								P03 Petroleum residues							
H14 Sound velocity stations								P04 Chlorinated hydrocarbons							
H15 Acoustic stations								P05 Other dissolved substances							
H16 Transparency								P06 Thermal pollution							
H17 Optics								P07 Waste water: BOD							
H18 Diffusion (Dynamic)								P08 Waste water: Nitrates							
H80 Other measurements								P09 Waste water: Microbiology							
								P10 Waste water: Other							
								P11 Discolored water							
								P12 Bottom deposits							
HC CHEMICAL								P13 Contaminated organisms							
H21 Oxygen								P90 Other measurements							
H22 Phosphates															
H23 Total-P															
H24 Nitrates															
H25 Nitrites															