SHIP UT… …ON DATA

SHIP NAME R/V ROBERT D. CONRAD

OPERATING INST. Lamont-Doherty Geological Observatory

CRUISE (LEG) NO. 2103

DATES 11/10/77 - 12/16/77

AREA OF OPERATIONS:
Venezuela Basin, Colombian & Venezuelan Margins.

DAYS AT SEA 35

DAYS IN PORT 2

PORT CALLS:

PLACE	DATES
La Guaira, Venezuela	11/10/~~78~~77
Cartagena, Colombia	12/1/~~78~~77
Bridgetown, Barbados, W.I.	12/15-16/~~78~~77

PARTICIPATING PERSONNEL

CODE	NAME	TITLE	AFFILIATION
1.	*Buhl, Peter	Chief Scientist	L-DGO
2.	**Kan, Tze-Kong	Co-Chief Scientist	"
3.	Truchan, Marek	" "	"
4.	Robinson, William	Electronics Tech.	"
5.	Rottier, Ross	" "	"

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)
Multi-channel seismic survey of the southern margin of the Caribbean Talwani/Stoffa	NSF	OCE 76-82328	All, except 10, 11, 12, 13, 14

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 Pat Buhl
CHIEF SCIENTIST

DATE 3/20/78

(Continue personnel and project listings on reverse if additional space needed)

ATTACH PAGE SIZE CRUISE TRACK

COST ALLOCATION DATA

DAYS CHARGED	AGENCY OR ACTIVITY CHARGED	GRANT OR CONTRACT NO.
37	NSF	OCE 76-00060

SIGNATURE D E Hayes
Institution Official

DATE 16/3/78

Lamont - Doherty Geological Observatory of Columbia University | *Palisades, N.Y. 10964*

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CRUISE REPORT

Ship Name: R/V CONRAD   Cruise No.: 2103

Departure: November 10, 1977 (Date) from La Guaira, Venezuela (Port)

Arrival: November 30, 1977 (Date) at Cartagena, Colombia (Port)

Departure: December 1, 1977 (Date) from Cartagena, Colombia (Port)

Arrival: December 14, 1977 (Date) at Barbados, W.I. (Port)

Days at Sea: 34   Days Foreign Port: 3 4 (No. of days in arrival port)

Area of Operation: Venezuela Basin, Colombian and Venezuelan Margins.

Program Description: Multi-Channel Seismic and Two-Ship Experiments (Constant Offset and Expanded Spread Profiles).

Participants: (All L-DGO unless otherwise specified)

Buhl, Peter	Chief Scientist
Kan, Tze-Kong	Co-Chief Scientist
Truchan, Marek	Co-Chief Scientist
Robinson, William	Electronics Technician
Rottier, Ross	" "
Gutierrez, Carlos	" "
Robertson, Wayne	" "
Hutchison, daniel	" "
Medlicott, David	Computer Technician
Rueda, Dario de la Torre	Colombian Observer
Lazzari, Armando	Venezuelan Observer
Soto, Tarcisio	" "
Fonseca, Angel	" "
Hernandez, Ali	" "
Iltzsche, M.	Airgun Eng.
Crimmins, Robert	Core Bosun
Mardones, Ernesto	Airgun Assist.

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Arrival: December 14, 1977 (Date) at Barbados, W.I. (Port)

Days at Sea: 34   Days Foreign Port: 43
No. of days in arrival port

Area of Operation: Venezuela Basin, Colombian and Venezuelan Margins.

Program Description: Multi-Channel Seismic and Two-Ship Experiments (Constant Offset and Expanded Spread Profiles).

Participants: (All L-DGO unless otherwise specified)

Buhl, Peter	Chief Scientist
Kan, Tze-Kong	Co-Chief Scientist
Truchan, Marek	Co-Chief Scientist
Robinson, William	Electronics Technician
Rottier, Ross	" "
Gutierrez, Carlos	" "
Robertson, Wayne	" "
Hutchison, daniel	" "
Medlicott, David	Computer Technician
Rueda, Dario de la Torre - Colombian Observer	
Lazzari, Armando - Venezuelan Observer	
Soto, Tarcisio	" "
Fonseca, Angel	" "
Hernandez, Ali	" "
Iltzche, Martin	Airgun Engineer
Crimmins, Robert	Core Bosun

<u>CRUISE REPORT</u>

R/V CONRAD 2103

November 10 to December 14, 1977

Scientific Objectives and Areas

The Multi-Channel Seismic cruise in the Caribbean was divided into two phases: a) two-ship field experiments to resolve the velocity structure of the crust and upper mantle in the Venezuela Basin and b) a survey of the "deformed sediment belt" along the Colombian and Venezuelan margins.

The first project was carried out with the R/V MOANA WAVE of the Hawaii Institute of Geophysics as the shooting ship, and the R/V CONRAD as the receiving ship. Two types of field experiments were employed: 1) the Expanding Spread Profile (ESP) and b) Constant Offset Profile (COP). The accuracy of both methods is critically dependent upon the precision of distance determination between ships. Our experience with the Teledyne-Hastings Raydist ranging system is thus discussed at length, including methods of calibration at sea involving two ship maneuvers (see Addendum).

After completion of the two-ship work, the following objectives had to be carried out on the way to Cartagena, Colombia. The first to correlate the Venezuelan Basin crust with Beata Ridge (Line 119, Figure 1), traverse the Aruba Gap (Line 121) where at least one sonobuoy measurement was planned and then to trace the continuity of the Colombian Basin crust to the Nicaragua Rise (Line 122). Finally, we wanted to run a line as far to the west as time allowed to define the western limit of the "deformed sediment belt" and, hopefully, traverse the possible extension of Oca Fault (Line 123, Figure 1).

The second phase of the southern Caribbean study (Cartagena, Colombia to Barbados) was of considerable importance as it was planned to clarify the structure of the "deformed sediment belt", establish the location of the southern boundary of the Caribbean plate, and observe east-west variations in the style of deformation -- all of which reflect the history of plate motions.

Please note that although the R/V CONRAD made a stop in Cartagena, Colombia, the voyage is labeled as a single leg. The brief stop in Cartagena was made to deposit the Venezuelan observers who joined us in La Guaira and to pick up Colombian observers required to be on board during the study of the Colombian margin.

Accomplishments and Cruise Narrative

Although the R/V CONRAD departed November 10, 1977 from La Guaira, the rendezvous with the MOANA WAVE was not scheduled until a few days later. After consultation with the Venezuelan scientists, we decided to employ the extra time to investigate the seaward extension of the three great tectonic lineaments: the Oco, Bocono and San Sebastian Faults, see Figures 1, 2 and 3. A single channel profiler survey was carried out. From Figure 3 it is evident that sediment deformation has been intense; correlations of offsets between survey lines indicate lineations corresponding to the prolongation of Bocono Fault zone. The tectonic pattern is probably more complex, however, and a much more detailed survey will be needed to resolve the relationship of the Oca, Bocono and San Sebastian lineaments.

After completion of the near shore survey, we streamed the 24-channel array and started multi-channel recording using the 4 large air guns with waveshape kits, and both compressors. Line 97 crosses the Bonaire Basin, Los Roches Trough, Curacao Ridge, and joins with Line 8 in the Venezuelan Basin and provides a southern extension of this Line. Lines 8 and 10 had formed the basis for planning the two-ship work. Marked differences were noted between these two lines. On Line 10, weak discontinuous M-reflections were seen. The velocity below this horizon obtained from sonobuoys appeared to decrease from 8.1 km/sec in the basin to 7.3 km/sec as the Curacao Ridge was approached. We, therefore, planned 2 ESP's each along Lines 8 (ESP B + 4) and Line 10 (ESP 1 + 2). The Caracao Ridge appears to be largely a sedimentary feature. To accurately determine its velocity structure, 2 ESP's (5 + 6) were run on it. To complement the ESP data in the Venezuelan Basin, COP's were run along Lines * and 10. These are designed to profile, by recording refractions, Layer 3 which does not yield near vertical reflections and mantle. These refractions observed across the 24-channel streamer give the velocity of Layer 3 and its intercept time which can be converted to depth.

Based on shipboard monitors, the ESP's were successful as we recorded arrivals out to 70 km. Computer processing must be carried out before the data will be ready for interpretation. Shipboard monitors indicate that the COP's were less successful. Good coverage of Layer 3 was recorded, but mantle arrivals were difficult to obtain.

New timing equipment designed by Bill Robinson was used on this Leg. To obtain accurate shot-break timing, two high-precision clocks were used, one on MOANA WAVE and one on CONRAD. Clock radings accurate to 1 millisec were made on MOANA WAVE for each shot instant. The shot instant causes the transmission of a series of tones to CONRAD. Detection of the first tone on CONRAD started the DSF IV recording sequence and caused the CONRAD clock to be read. Thus, by comparing the two clock readings, the true recording delay could be determined to an accuracy of 1 millisecond regardless of any transmission delays. Except for a short time at the beginning of two-ship operations, this timing system worked as desired. We had hoped to transmit the MOANA WAVE clock reading and shot number to CONRAD via the tone series, but this was only partially successful.

Operations with MOANA WAVE went very smoothly. The heavy shooting schedule put a burden on Don Hussong and his crew on MOANA WAVE, but they admirably carried out their part of the two-ship work. The frequent calibrations of the Raydist required close maneuvering of the ships, which was carried out successfully by the ships' captains. Harry Van Santford, Bill Robinson, Carlos Gutierrez and Martin Iltche made life easier for the Co-Chief Scientist.

Highlights and Cruise Overview

All of the MCS work planned was successfully accomplished for both phases of the southern Caribbean study. The data collected during the two-ship work in the Venezuelan Basin represents one of the most detailed studies of the crust and upper mantle undertaken in an ocean basin using two state-of-the-art approaches (ESP and COP), supplemented by a large number of sonobuoy measurements.

The second phase of the work, the survey of the "deformed sediment belt" is especially exciting. The data collected is important not only in being critical to the unraveling of the history of plate motions but in what it may reveal as to the economic potential of the southern Caribbean margin.

We are grateful to the scientific observers (four from Venezuela and one from Colombia) for their very active participation in all aspects of shipboard work and their camaraderie towards the L-DGO personnel. Our scientific members made available to them all technical data on shipboard instrumentation and continuously discussed the results and scientific objectives. In addition, Captain James P. Olander demonstrated the ship's satellite navigation system and reduction of the navigation data.

Much interest in future co-operative work was expressed by the Venezuelan scientists who prepared a preliminary report (in Spanish) based upon their interpretation of our geophysical survey (see Figure 1) between La Guaira, Puerto Cabello and Golfo Triste.

PETER BUHL, Chief Scientist
La Guaira to Cartagena

TZE-KONG KAN, Co-Chief Scientist

MAREK TRUCHAN, Co-Chief Scientist
Cartagena to Barbados

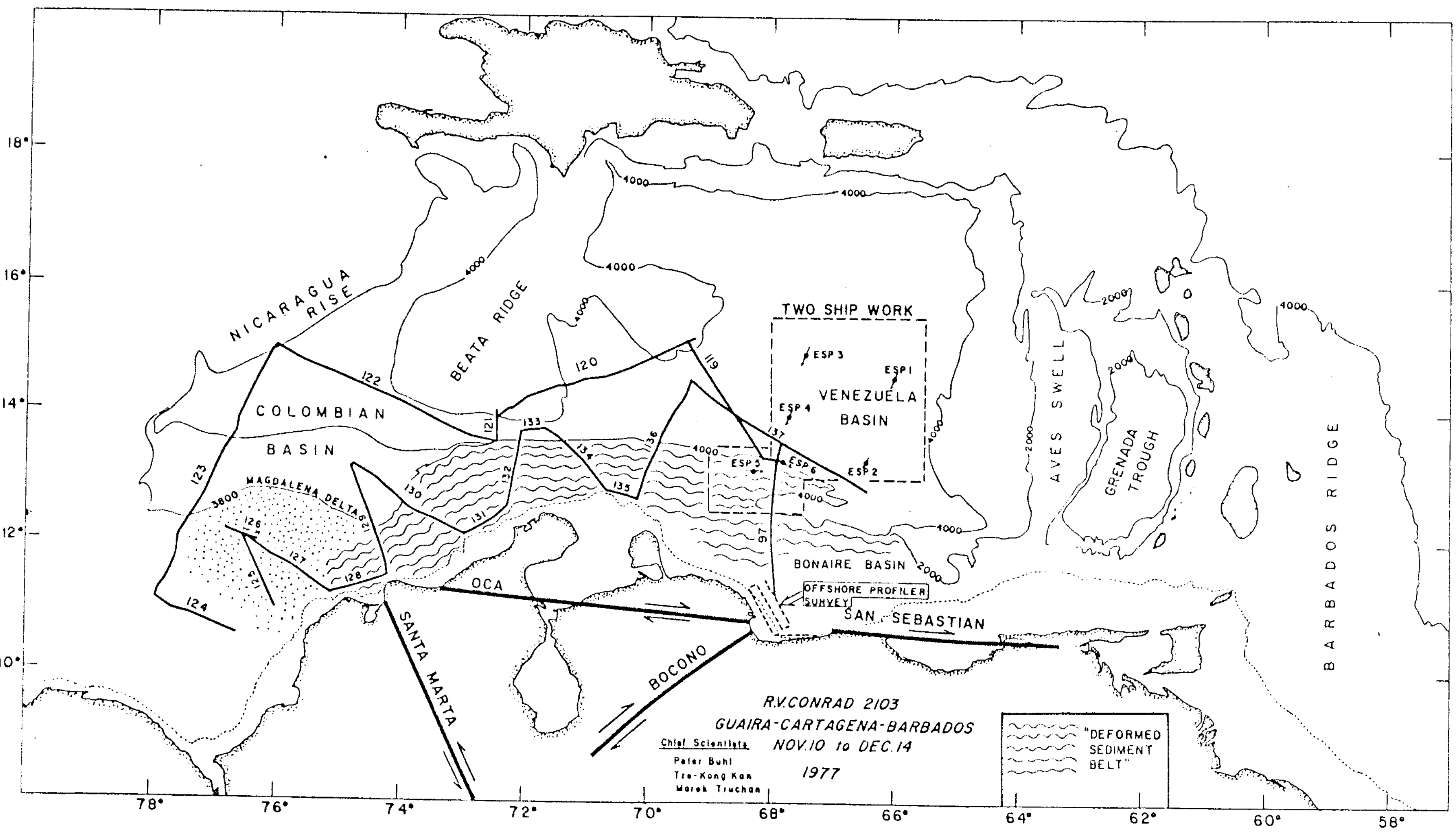

TWO SHIP WORK
VENEZUELA BASIN
ESP 1
ESP 2
ESP 3
ESP 4
ESP 5
ESP 6
NICARAGUA RISE
BEATA RIDGE
COLOMBIAN BASIN
MAGDALENA DELTA
BONAIRE BASIN
AVES SWELL
GRENADA TROUGH
BARBADOS RIDGE
OCA
SANTA MARTA
BOCONO
SAN SEBASTIAN
OFFSHORE PROFILER SURVEY
R.V.CONRAD 2103
GUAIRA-CARTAGENA-BARBADOS
NOV.10 to DEC.14
1977
Chief Scientists
Peter Buhl
Tze-Kong Kan
Marek Truchan
"DEFORMED SEDIMENT BELT"

Fig. 1

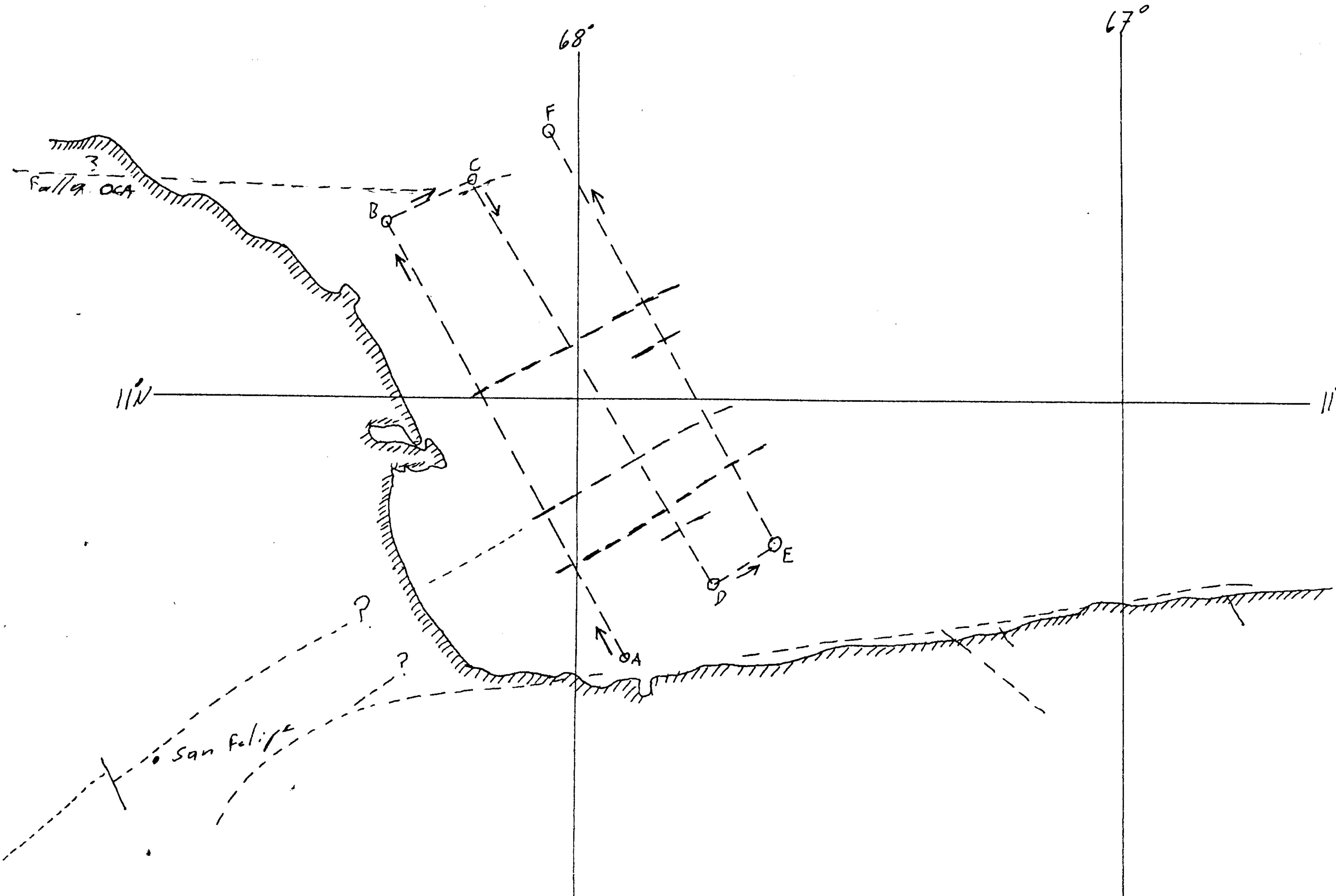
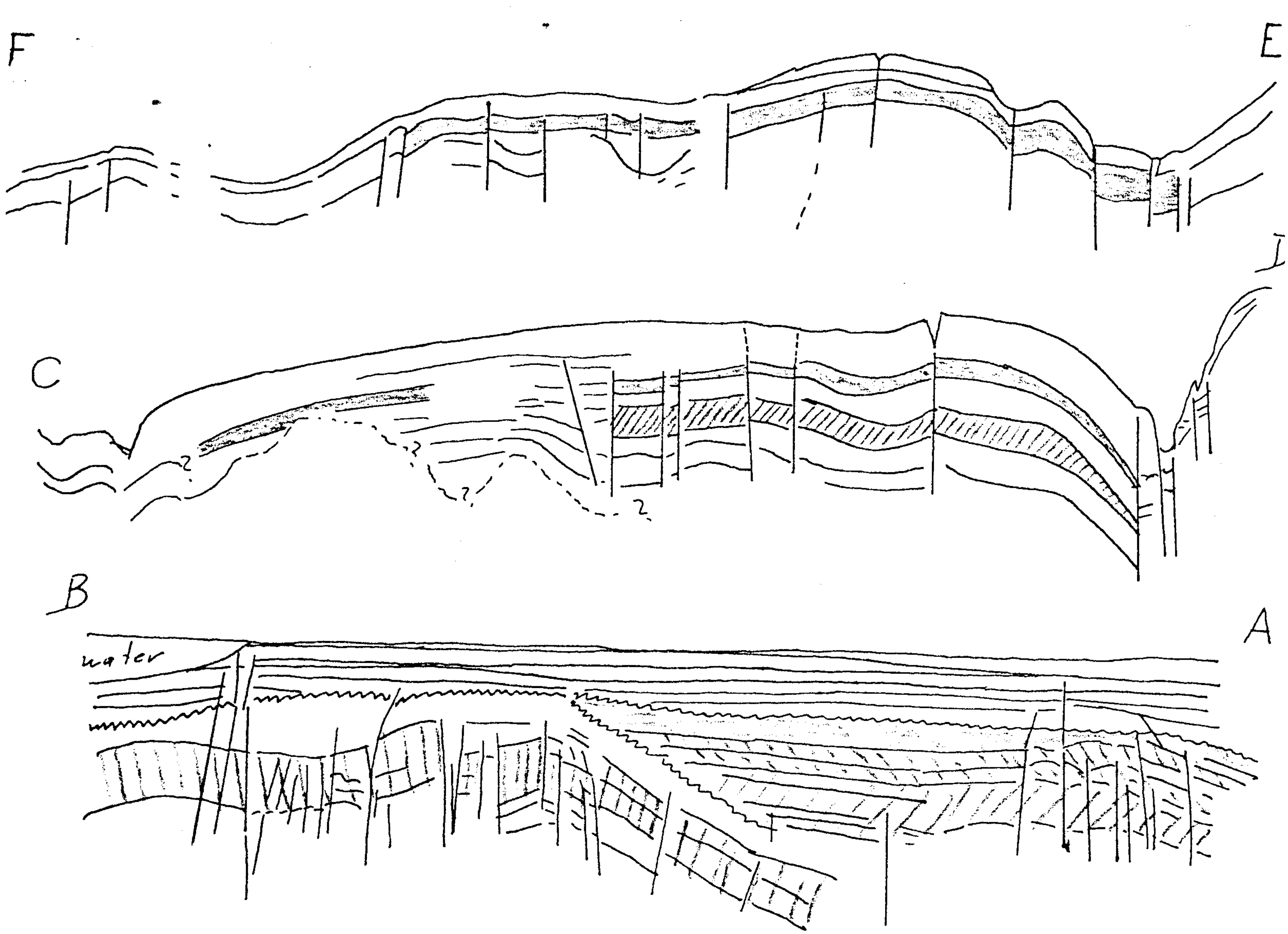


Fig. 2



TRANSECT PARALLEL TO COASTLINE

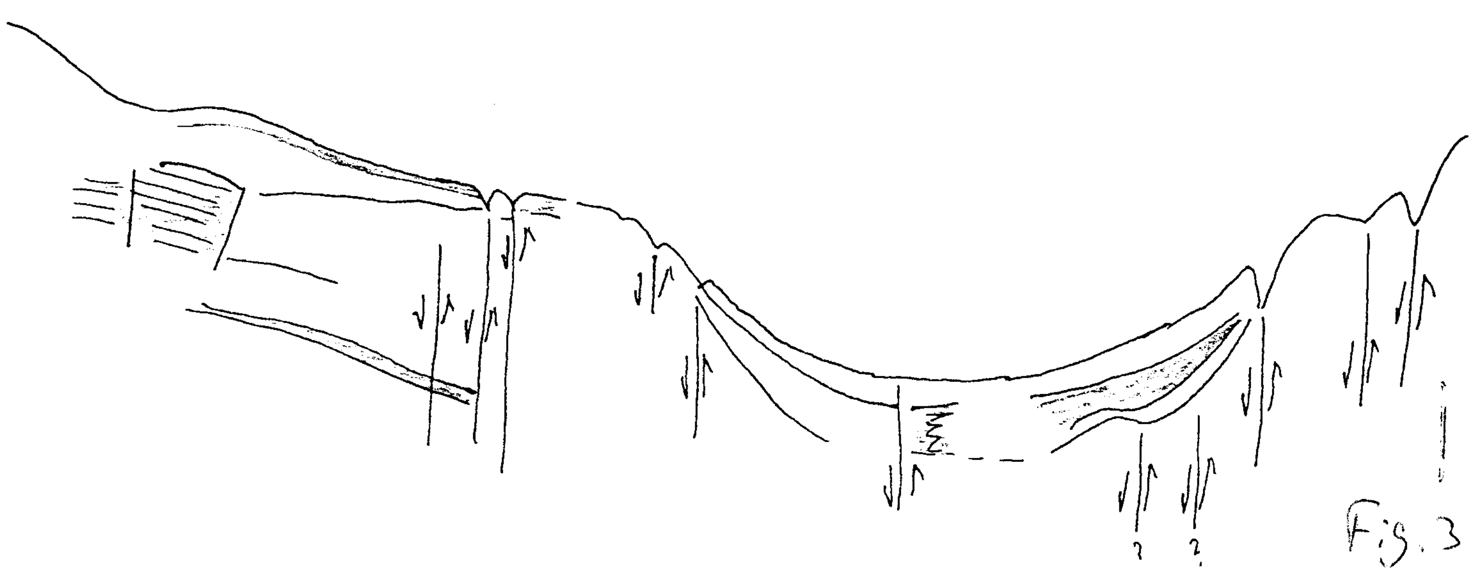


Fig. 3

Addendum

RAYDIST OPERATIONS FOR TWO-SHIP WORK

Our ability to properly interpret the results of two-ship seismic experiments crucially depends upon accurate knowledge of the experimental parameters. In particular, one needs to know precisely the horizontal distance between source and receiver. Distance inaccuracies in past work were largely due to error in estimating how far apart the ships were at the time of each shot. Use of the Teledyne-Hastings Raydist System reduces this uncertainty by about two orders of magnitude (5 m. vs. 500 m.). Raydist range measurements coupled with digital recording of the shots and accurate shot break timing allow great confidence to be placed in the field data. The following report discusses operational techniques necessary to preserve the inherent accuracy of the Raydist measurements.

An initial calibration (lane check)of the Raydist must be made before the start of operations. This calibration should be checked every time the ships are near to one another. A relatively simple procedure for checking is outlined below and should take no more than half an hour, depending on sea conditions and the boldness of the ships' captains. This report is based on our experiences on the CONRAD in working with the University of Hawaii's R/V MOANA WAVE on the Caribbean during November, 1977. Our initial experience with Raydist was during CONRAD-VEMA operations off Japan in October, 1976.

The master unit was installed on CONRAD. All of the electronics and one of the strip chart recorders were in the dog house. CONRAD's starboard aft stack antenna was used with the antenna coupler mounted on top of the stack close to the antenna base. The second strip chart recorder was located in the chart room. The slave unit was mounted on the MOANA WAVE. The slave has no position readout and the only controls are those for antenna loading and a high-low power switch. Both the master and slave units radiate a considerable amount of R. F. energy ($\sim$ 3 Mhz) and this may interfere with other shipboard electronics, especially if they lack proper shielding in their cables. The Raydist R. F. did not cause any major problems on CONRAD.

Since Raydist readings were only available on CONRAD, the speed of both ships was specified from the CONRAD. The MOANA WAVE has direct diesel drive and, therefore, could not make small speed adjustments.

CONRAD, with diesel-electric drive, has finer control. While towing the MCS streamer, however, CONRAD's speed range is only 4 to 6 knots. Course adjustments were made by MOANA WAVE and fine adjustments were made by CONRAD. The strip chart recorder in the chart room allowed the ship's officers to maintain a fixed separation during constant offset profiles (COP).

Calibration is really just setting the initial lane count when the ships are at a known separation. Because of the metal superstructure of the ships, the effective antenna position will not, in general, coincide with the actual position. To determine both the master and slave antennas' effective locations, one would ideally first rotate one ship, noting the Raydist readings, and then rotate the other ship -- again taking readings. At sea, the only practical measurement is with one ship following in the wake of the other at a fixed distance.

Initially, we took readings first with MOANA WAVE in front, then with CONRAD in front. All subsequent lane count checks were made with MOANA WAVE in front. To determine the separation the lead ship would tow a measured length of 1/2" polypropylene line with a float attached to the end. MOANA WAVE used a sonobuoy case painted orange with a stroboscopic flasher attached for night operations. CONRAD used a large rubber balloon float. Polypropylene is preferable to nylon because it does not stretch. CONRAD's line was 670 ft. from stern to buoy and MOANA WAVE's was 576 ft. from antenna to buoy. For future work, a minimum of 1,000 ft. should be used. This will avoid saturation of the R. F. systems in the

Raydist. In addition, both the master and slave systems should be set to low power before lane checking. The switching between high and low power should be done while the ships are not changing range so that any shift in lane reading can be noted. The lane count occasionally oscillated rapidly when the ships were abeam at close range, so close approaches should be made only with the ships in fore and aft formation.

To lane check with MOANA WAVE in front, CONRAD would slow to 4 knots; MOANA WAVE would overtake CONRAD and pull directly in front of CONRAD at a range of ~ 1/4 mile. MOANA WAVE, with her calibration line deployed, would slow to 4-1/2 knots and CONRAD would increase speed to close range allowing the buoy to slide down the port side some 10 ft. off the side. When the buoy was abeam of the bridge and abeam of the antenna, lane counts were recorded. During the initial lane check the lane count was set to 3.89 lanes when the buoy was opposite the stack. 3.89 lane is the equivalent of 576 ft., the length of the MOANA WAVE calibration line. Subsequent lane checks were made with the buoy off the bridge with an expected lane count of 4.33.

After the initial calibration, the CONRAD slowed to 3 knots so that the streamer would sink to 100 ft. This allowed the MOANA WAVE to move directly on top of the streamer astern of CONRAD. With CONRAD's calibration buoy abeam of MOANA WAVE's antenna, the Raydist showed 4.99 lanes as opposed to an expected 5.09 lanes.

The COPs were normally run with MOANA WAVE in front, thus the initial setting of the lane count should be accurate for these profiles regardless of the effective antenna positions. The single lane check with MOANA WAVE aft of CONRAD should be adequate for those COPs run with CONRAD leading. For the expanding spread profiles (ESP), the ships steam on opposite courses along parallel tracks with an offset of 2 km. The ships initially steam towards each other, pass abeam, and continue away from each other. They thus present varying aspects to each other and the precise locations of the effective antenna positions is needed. However, one would be satisfied with a stern-to-stern calibration, as most of the data is recorded with this geometry. I know of no easy way to obtain this calibration, particularly with CONRAD's MCS streamer deployed as it was during the entire time of MOANA WAVE operations. Perhaps MOANA WAVE could back into position aft of CONRAD, making ~3 knots, but this was not tried. Several radar range checks were made when the ships passed abeam during ESPs, but this is probably not an adequate calibration.

There are some peculiarities of the Raydist system which should be noted. The readings which are printed on the grocery tape are not directly coupled to the dials on the receiver. The dials are the true reading. The printer can be set to the dial reading by entering the lane count in the number switches on the printer and at moment of coincidence, pushing the correct button on the front of the printer above the number switches. The printer must be correctly set because it is this reading that goes in the DSF IV tape header, not the dial readings.

The dials can be initially set to the approximate lane count by sliding each number wheel sideways to disengage it from the other wheels.

During calibration, the print button should be pressed on the printer when the calibration buoy is abeam of the bridge. This will give a hard copy of the calibration lane count.

Installation and checkout of the Raydist on both ships was done by Bill Robinson and Harry Van Santford.

Chief Scientist (La Guaira-Cartagena)

PETER BUHL