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INFORMAL REPORT

HYDROGRAPHIC AND CARTOGRAPHIC
EFFORTS IN COLOMBIA
UNDER THE HARBOR SURVEY
ASSISTANCE PROGRAM

JANUARY 1969

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NAVAL OCEANOGRAPHIC OFFICE
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INFORMAL REPORT

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ABSTRACT

This report documents the events leading to the initiation of a cooperative surveying and charting program in which agencies of both the Colombian and the United States Governments are collaborating. It describes in detail the field training activities in hydrography which were carried out in Cartagena, Colombia in 1966, resulting in the first nautical chart published by a Colombian agency.

Participation by the U. S. Naval Oceanographic Office was provided for under an extension of an existing mapping agreement between the Colombian Government and the U. S. Army Inter-American Geodetic Survey.

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This report has been reviewed and is approved for release as an UNCLASSIFIED Information Report.



W. A. FOSTER, JR.
Director, Bathymetry Division

DATE: 4/15/69

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INTRODUCTION

The Bay of Cartagena in Colombia is the fifth harbor surveyed under the Harbor Survey Assistance Program (HARSAP). This program initiated by the U. S. Navy in 1964, provides host governments with engineers and equipment for conducting hydrographic surveys of harbors and approaches. This program has the dual purpose of (1) obtaining information for publishing more accurate Nautical Charts and Sailing Directions and (2) providing technical training and guidance to personnel of the various participating governments.

Cartagena, a city of approximately 300,000 people is located on the northern coast of Colombia. It is the second oldest city of the Americas, and is noted for its well protected harbor.

Cartagena is the major shipping port of the Caribbean Coast of Colombia. The main export is oil, the larger portion of which is brought into Cartagena by barge via the El Dique canal and the Magdalena River. The El Dique is an 80 mile canal connecting the bay of Cartagena and the Magdalena River, which in turn is navigable for some 600 miles. In addition to oil export items include coffee, cotton, and bananas. Cartagena has some small industry, and serves a large tourist trade.

Approximately 80 per cent of the Colombian Navy is based on Cartagena, the home of the Colombian Naval Academy.

There are two 600 foot piers at the civilian terminal and a 1200 foot pier at the Navy Base. Work in progress at the civilian terminal includes dredging, the construction of a new 1000 foot pier,

and the reclaiming of 25 per cent of the terminal area. There are also plans to construct several new warehouses, a customs building and an administration building.

The entrance to the Bay is at Boca Chica, some 10 miles to the south of the city. This is a 400 foot wide channel dredged to a depth of 40 feet. Pilotage is compulsory.

BACKGROUND AND RECONNAISSANCE

The Bay of Cartagena and its approaches were last surveyed in 1935 by the USS NOKOMIS in collaboration with the Instituto Geografico de Colombia. Due to silting in various parts of the bay, existing hydrographic data were considered inaccurate.

In June 1966 plans became firm for Cartagena to be the first harbor surveyed under the HARSAP Program for fiscal year 1967. In early July the author commenced a reconnaissance trip, first stopping in Panama and contacting the Inter-American Geodetic Survey (IAGS) and the United States Commander in Chief Southern Command (USCINCSO) personnel there. CDR James K. Athow, representing both IAGS and USCINCSO, proceeded with the author to Bogota, where the heads of various Colombian organizations were contacted.

These organizations were impressed with the type of operation conducted in Buenaventura by the USS MAURY (AGS-16) and the USS SERRANO (AGS-24) in 1965. They showed enthusiasm for this survey and indicated hopes of having a continuous hydrographic operation in Colombia. The Instituto Geografico Agustin Codazzi (IGAC) requested NAVOCEANO to assist and direct it in producing a hydrographic chart from the

collected data. While IGAC produces various types of charts, it has never produced a hydrographic chart.

The reconnaissance team, which was joined by Mr. Douglas Dean of IAGS, Bogota, was met in Cartagena by members of both the U. S. Navy Mission and the Colombian Navy. After meeting with officials of the Colombian Navy and the Colombian port authority, (Empresa Puerto de Colombia), a sounding craft was selected and a reconnaissance of the actual survey area was made.

After the program was discussed at length with each organization concerned, the following commitments were made:

1. EMPRESA PUERTO DE COLOMBIA PARTICIPATION

The Empresa agreed to provide:

- a. Engineer and necessary personnel to conduct the hydrographic survey, establish geodetic control and the process of data
- b. All local geodetic data
- c. Miscellaneous equipment and material for the construction of signals and station monuments
- d. Transits to be used for the positioning of the sounding launch
- e. Outboard launch to be used as necessary
- f. Current meter and bottom samplers.

2. COLOMBIA NAVY PARTICIPATION

The Colombian Navy agreed to provide:

- a. Necessary launches to perform the hydrographic survey, including crew

- b. Office and storage space
- c. Office tables and desks
- d. Necessary supplies for installing Raytheon depth recorder.

3. INTER-AMERICAN GEODETIC SURVEY PARTICIPATION

IAGS agreed to provide:

- a. Necessary photogrammetric control
- b. Vehicles as required

4. INSTITUTO GEOGRAFICE "AGUSTIN CODAZZI" PARTICIPATION

IGAC agreed to provide:

- a. All available geodetic data
- b. Personnel and equipment needed to publish a hydrographic chart.

5. U. S. NAVAL OCEANOGRAPHIC PARTICIPATION

NAVOCEANO agreed to provide:

- a. Necessary personnel to supervise the hydrographic operation and the production of a hydrographic chart
- b. Equipment and supplies needed to conduct geodetic and hydrographic operations.

The author returned to NAVOCEANO on 26 July 1966 for the purpose of writing survey specifications and shipping equipment to the survey area.

GEODETTIC OPERATION

On 7 August 1966 the author, accompanied by NAVOCEANO Engineer William W. Wallace, returned to Cartagena. A thorough geodetic reconnaissance revealed ten usable geodetic stations in the area. As

a result of the reconnaissance, NAVOCEANO engineers, assisted by the Empresa personnel, established sites for an addition six geodetic stations (Figure I). One of these stations was positioned immediately and soundboat operations commenced. The remaining stations were positioned on a time available basis by either triangulation or traverse. Seven additional prominent objects were positioned for use in sextant work. For good line of sight visibility it became necessary to perform a considerable amount of brush clearing, and to erect a semi-permanent survey tower. The erection of this tower is shown in Figure II.

SOUNDBOAT OPERATION

The launch selected for a sounding craft was 28-foot boat powered by twin diesel engines. The boat has a two foot draft. While geodetic work was being performed, a Raytheon 723-B Depth Recorder Unit was installed aboard.

In the southern part of the survey area many charted and non-charted shoals and pinnacles exist, appearing on the Raytheon sounding track with only limited warning. Thus, in spite of precautionary measures the transducer was sheared off the side mount frame on six different occasions. Fortunately, on all six occasions the transducer was recovered.

35'

75°30'

GEODETTIC CONTROL

POSITIONED BY IAGS / INSTITUTO GEOGRAFICO ▲

POSITIONED BY HARSAP SURVEY TEAM ●

UNIVERSIDAD

CARTAGENA

▲ POPA

PES

▲ CARIBE

NO. 5 ●

▲ ACUEDUCTO

NO. 6 ●

CLUB ● NO. 2 NAV

ARENA

▲ ALBORNOZ

ISLA TIERRA BOMBA

LORO

FARO ▲

ANGEL ▲

PIEDRA

JOS ●

CARTAGENA BAY

25'

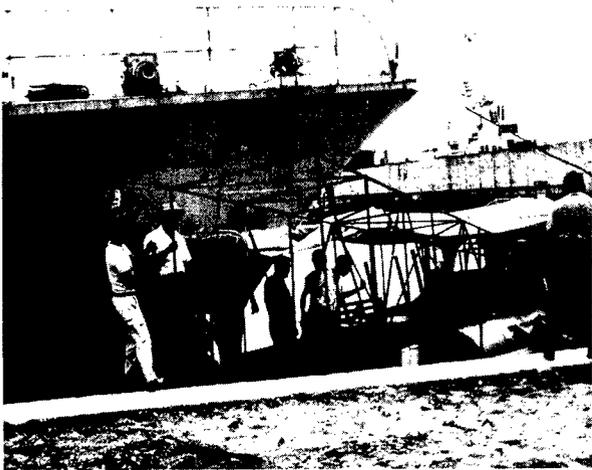
10°20'

FIGURE I

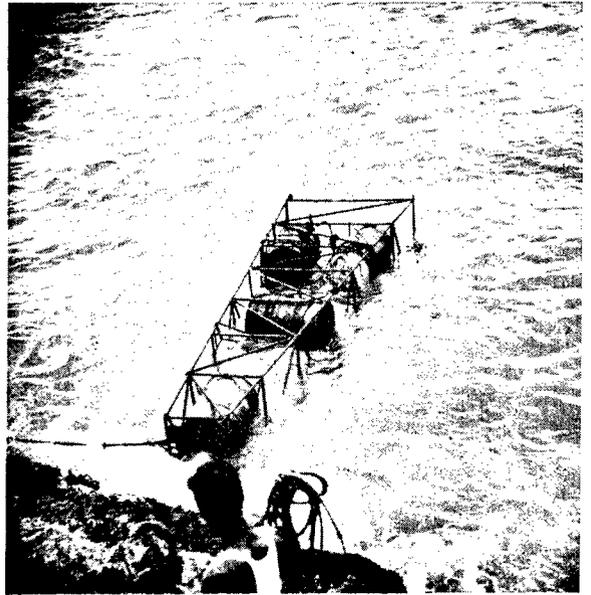
35'

6

75° 30'



Loading the tower aboard soundboat



Floating the tower ashore



Hoisting the tower up a 60 foot cliff



The tower as erected

Figure II - Supplementary control stations were established by triangulation and traverse. Semi-permanent towers were used for geodetic observation and left in place to serve as sextant signals.

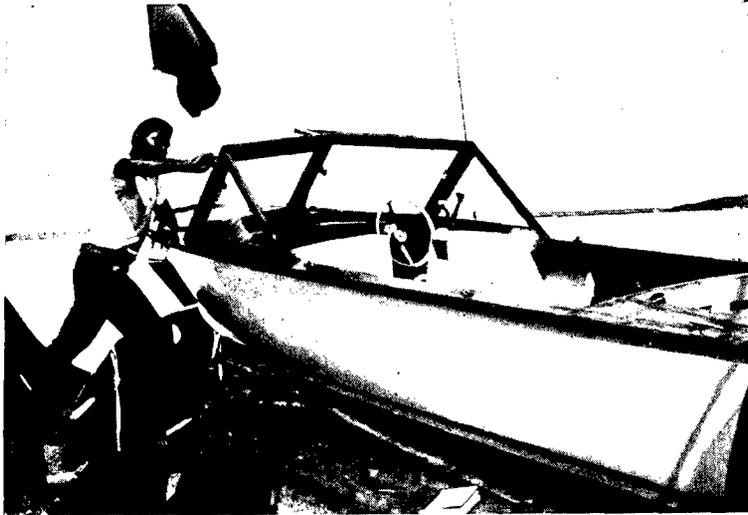


Figure III - Outboard motor boat furnished
by Empresa Puerto de Colombia

A fiber glass outboard motor boat (Figure III) was continually used in establishing geodetic control, taking hand lead line soundings, and assisting the soundboat.

During the night of 6 November the soundboat sank while tied up at the Naval pier. Photographs of the sunken soundboat are shown in Figure IV. The soundboat was in approximately six feet of water at the time, and completely submerged except for the canopy. The following morning the soundboat was raised (Figure V), and after ten days of repairs, the boat was again ready for sounding operations. The cause of the sinking was never determined.

All installation and repairs of the soundboat and Raytheon equipment were performed by the Colombian Navy.

HYDROGRAPHIC PHASE

Four sounding sheets were developed, two at the scale of 1:5,000 and two at the scale of 1:10,000. The survey area and the scale of development are shown in Figure VI. Sounding operations were

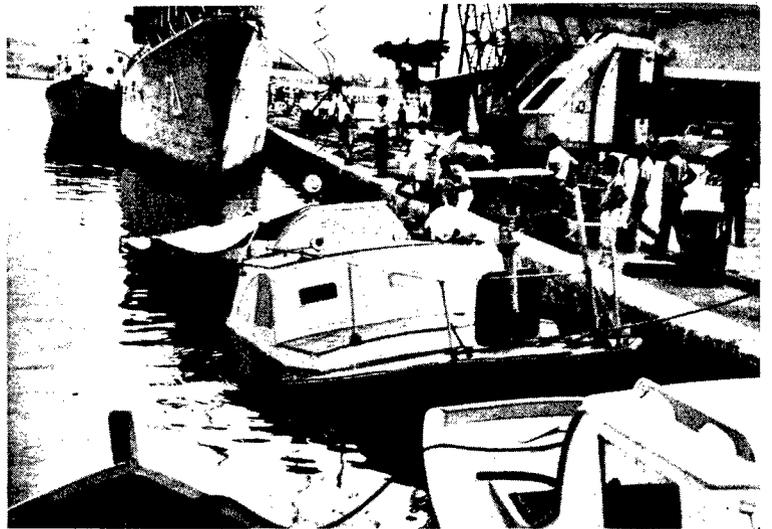
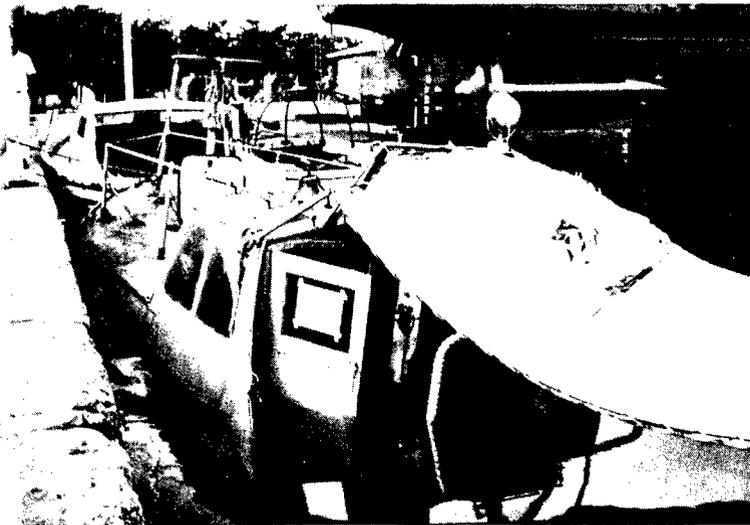
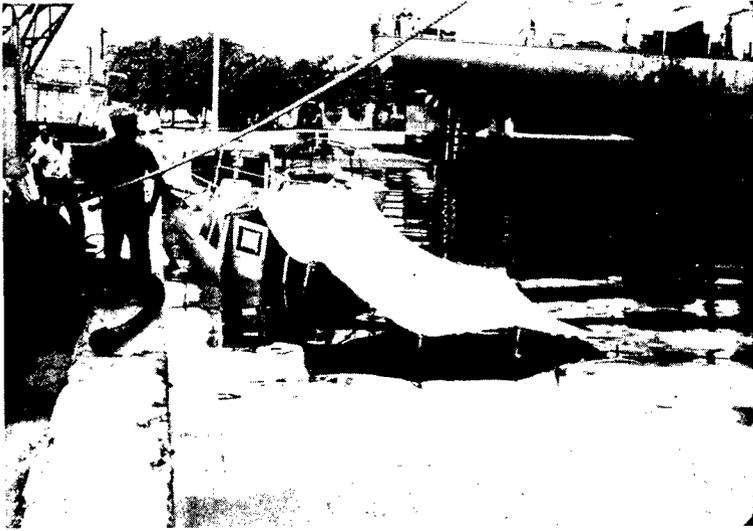


Figure IV - Photos of sunken soundboat.

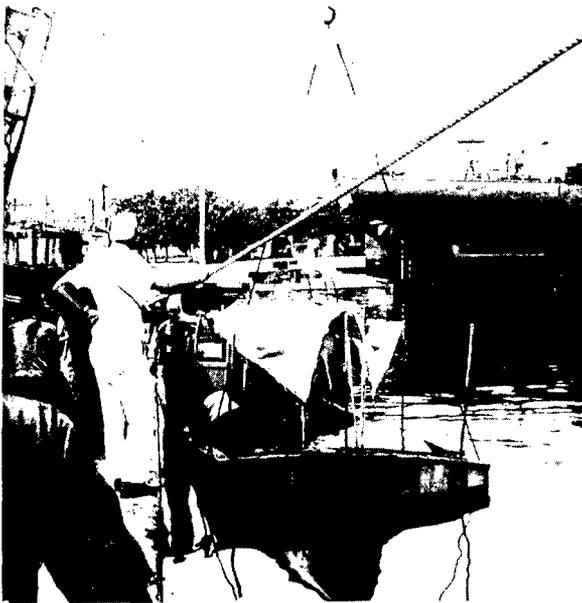
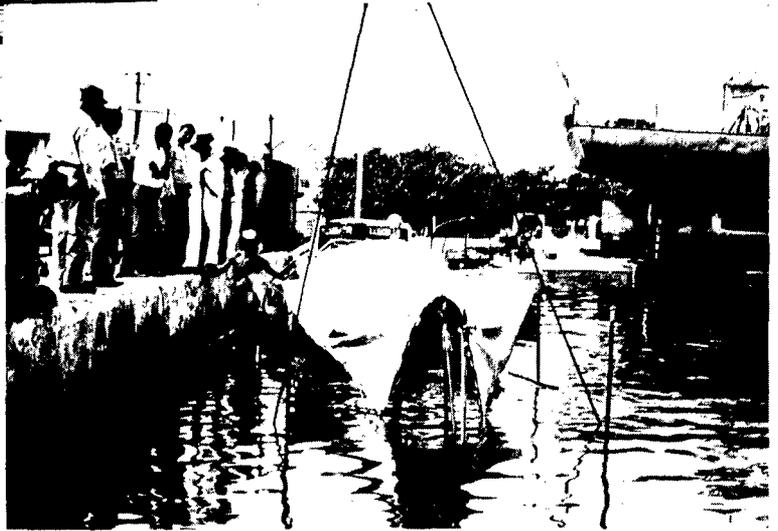


Figure V - Raising the sunken soundboat.

35'

75°30'

**SURVEY AREA &
SCALE OF DEVELOPMENT**

Scale 1:5,000



Scale 1:10,000



25'

25'

10°

20'

10°

20'

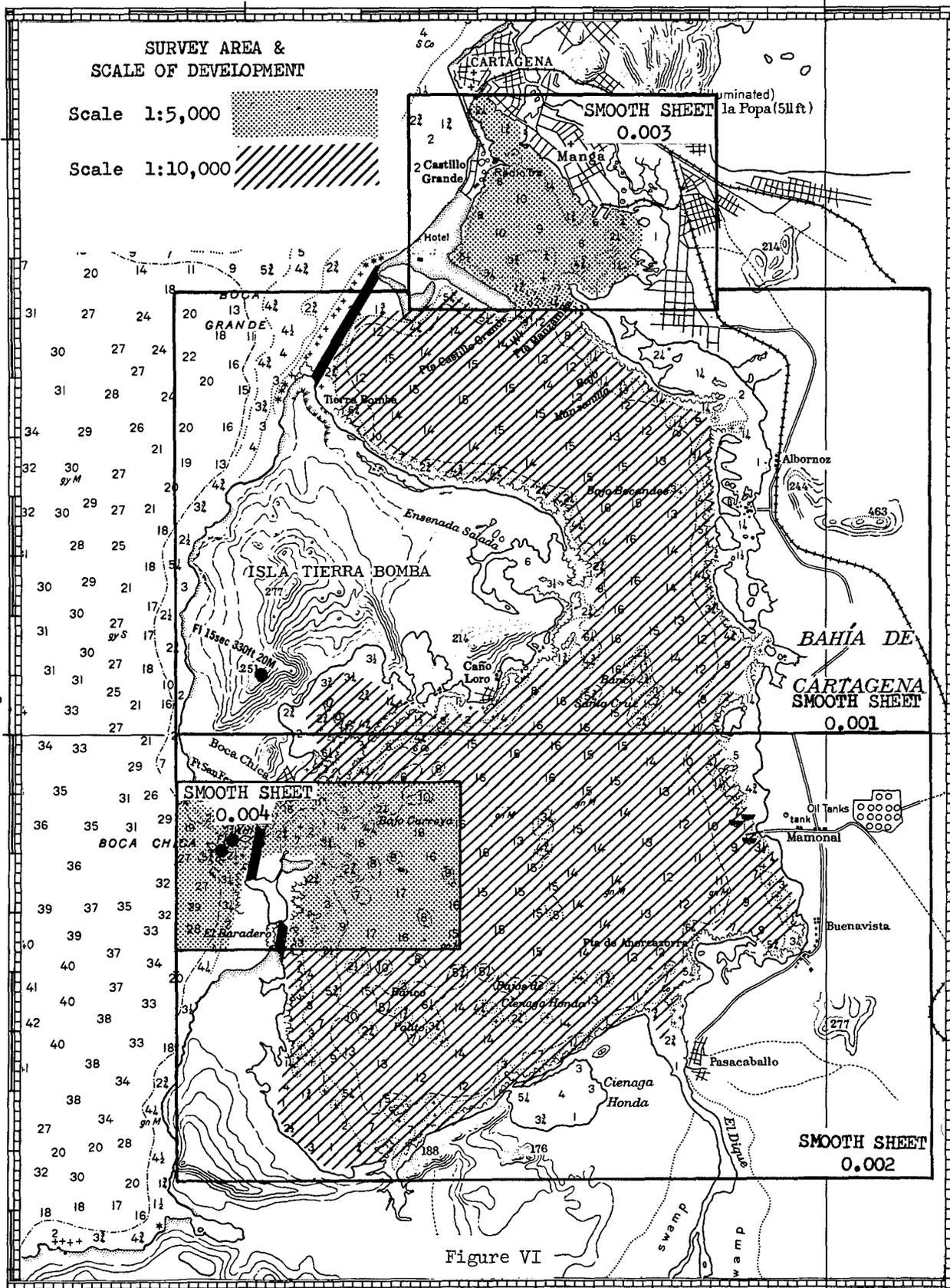


Figure VI

15'

35'

11

75°30'

15'

commenced on the western end of the northern 1:10,000 sheet as it was necessary to position only one geodetic station to sound this large area. It was determined during the reconnaissance trip that the method of positioning would be by transit angles from shore stations because this technique was familiar to the Empresa Puertos personnel. However, after two weeks of sounding operations with continuous radio communication difficulties, this method of positioning was changed to the three-point fix sextant method. The sextant method was utilized for the remainder of the survey. The use of these two methods are shown in Figure VII.

Hydrographic development was five lines to the inch, with position fixes taken every minute, and with scaled soundings at 15-second intervals. Cross check lines were run on all sheets; the line spacing varied according to the particular area and nature of the bottom topography.

Throughout the duration of the survey, dredging operations were conducted in and around the civilian terminal area, and were 80% completed at the completion of the survey. The entire terminal area is being dredged to a depth of 33 feet. Other dredging operations were conducted in El Dique.

Daily tide corrections were obtained from the permanent tide gage located at the Naval Officers Club; the gage, (maintained by IAGS) has been in existence for 18 years. The average tide range was approximately 0.5 foot, with a maximum range of 1.5 feet. All soundings were reduced to Mean Low Water Datum. On 4 and 5 November

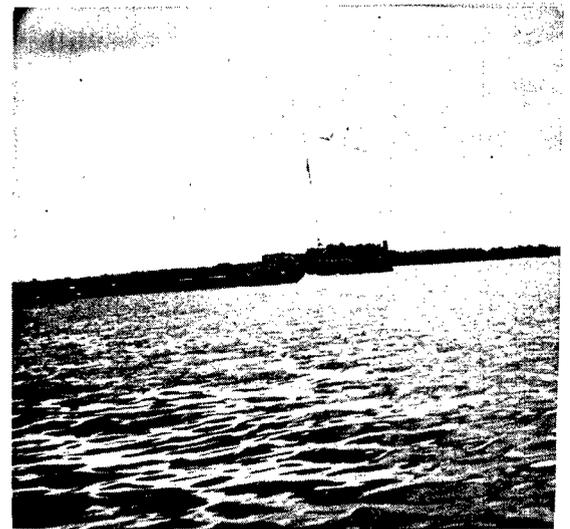


(left) Transit shore station for positioning sounding tracks

(right) Close-up of transitman with soundboat in background



Soundboat operation using sextant positioning



Sextant signal

Figure VII - Positioning the sounding craft.

most of the city was as much as three feet under water due to a tidal wave caused by an abnormal disturbance at sea. By 12 November the tide was back to normal. This was the first known occurrence of this type in Cartagena.

Hand leadline soundings were taken in the water area adjacent to the piers at both the civilian and Navy terminals. Depths at 20 foot intervals were obtained along the face of the piers and along lines parallel to the piers at distances of 20, 40 and 60 feet. Minimum depths of 31 and 16 feet were found at the civilian and Naval terminals, respectively. One vacant area remained in the vicinity of the Naval pier due to continuous berthing of vessels.

All survey sheets, when completed, were compared with the original survey sheets of the USS NOKOMIS. No greater differences were detected. A few shoals were discovered on the southern end of the southern 1:10,000 sheet. The sandbar at the entrance at Boca Grande was found to be approximately 50% the size it was in 1935. Changes were found in the land configuration at the entrance to the port area; the area in the southwest part of the port area has filled-in as much as two fathoms (this is in agreement with H. O. Chart No. 978 notation of 'Less Water rep 1964').

All smooth plotting was completed at the Naval Base office; this included inking of soundings, contouring, investigation of any critical area, incorporation of new shoreline, and selection of soundings. The shoreline which was compiled from 1962 photography was provided by IAGS.

CURRENT OBSERVATION AND BOTTOM SAMPLES

From 30 November through 4 December the "Boca de Ceniza", Colombia's sole hydrographic survey ship, was at sea conducting oceanographic observations, (Figure VIII).

Two current stations were occupied, one at Boca Chica and the other at the entrance to El Dique. It did not seem necessary to observe the entrance to the port area as the current there is negligible. A Gemware-Ekman current meter was used for all observations. Thirty-two bottom samples were obtained in the survey area. An orange-peel type sampler was used when soft muddy bottom occurred while a snapper type sampler was used for hard bottom area. All samples were field classified according to the 'Rock-Color Chart' distributed by the Geological Society of America. Then all samples were forwarded to NAVOCEANO for further evaluation. Location of oceanographic observations is shown in Figure IX.

METEOROLOGICAL CONDITIONS

The Cartagena area receives approximately 35 inches of rainfall annually. From the beginning of the survey through mid-November, the area received intermittent rain; from mid-November through mid-December, the area received showers almost daily, usually beginning around mid-day. After mid-December there was no rain for the remainder of the survey.

From August through mid-January, only light breezes occurred; they were usually at night. For the remainder of the survey, constant

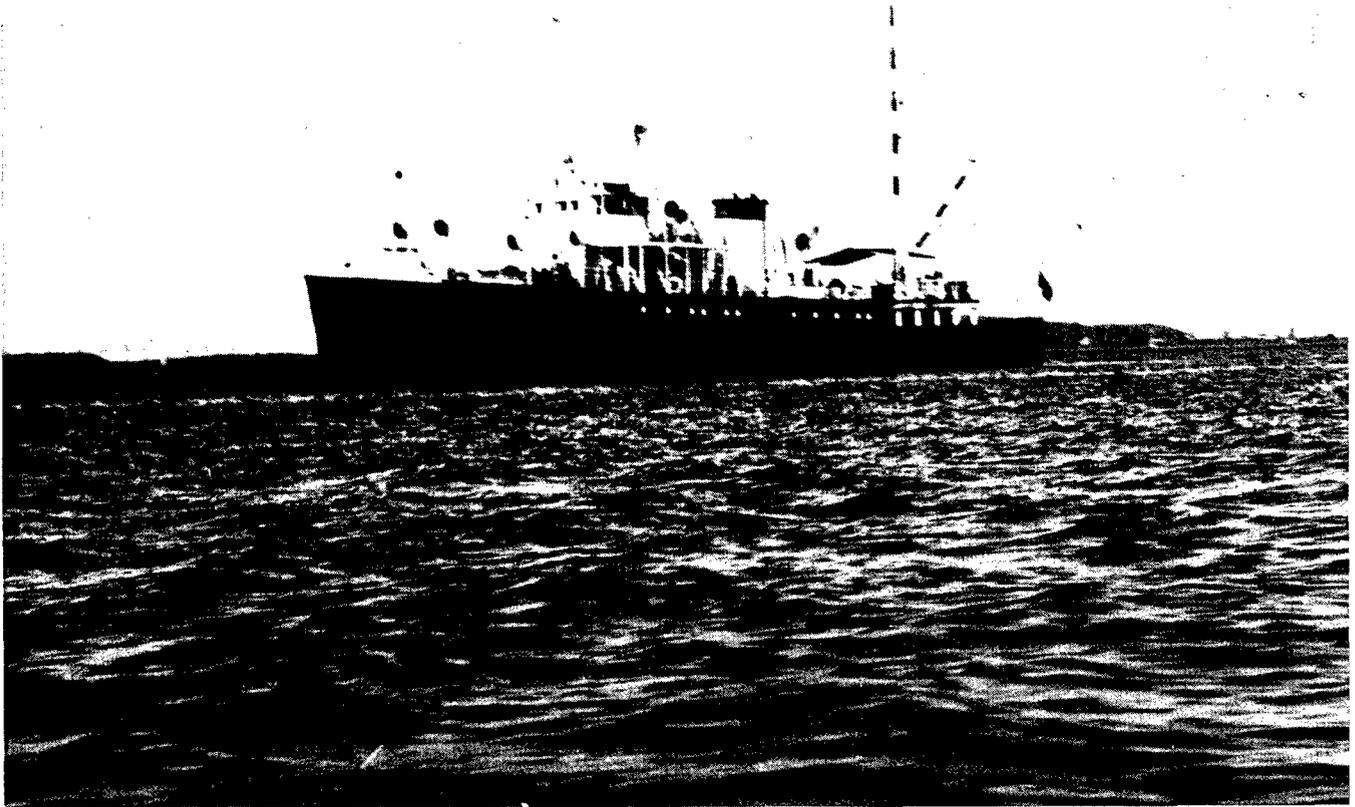
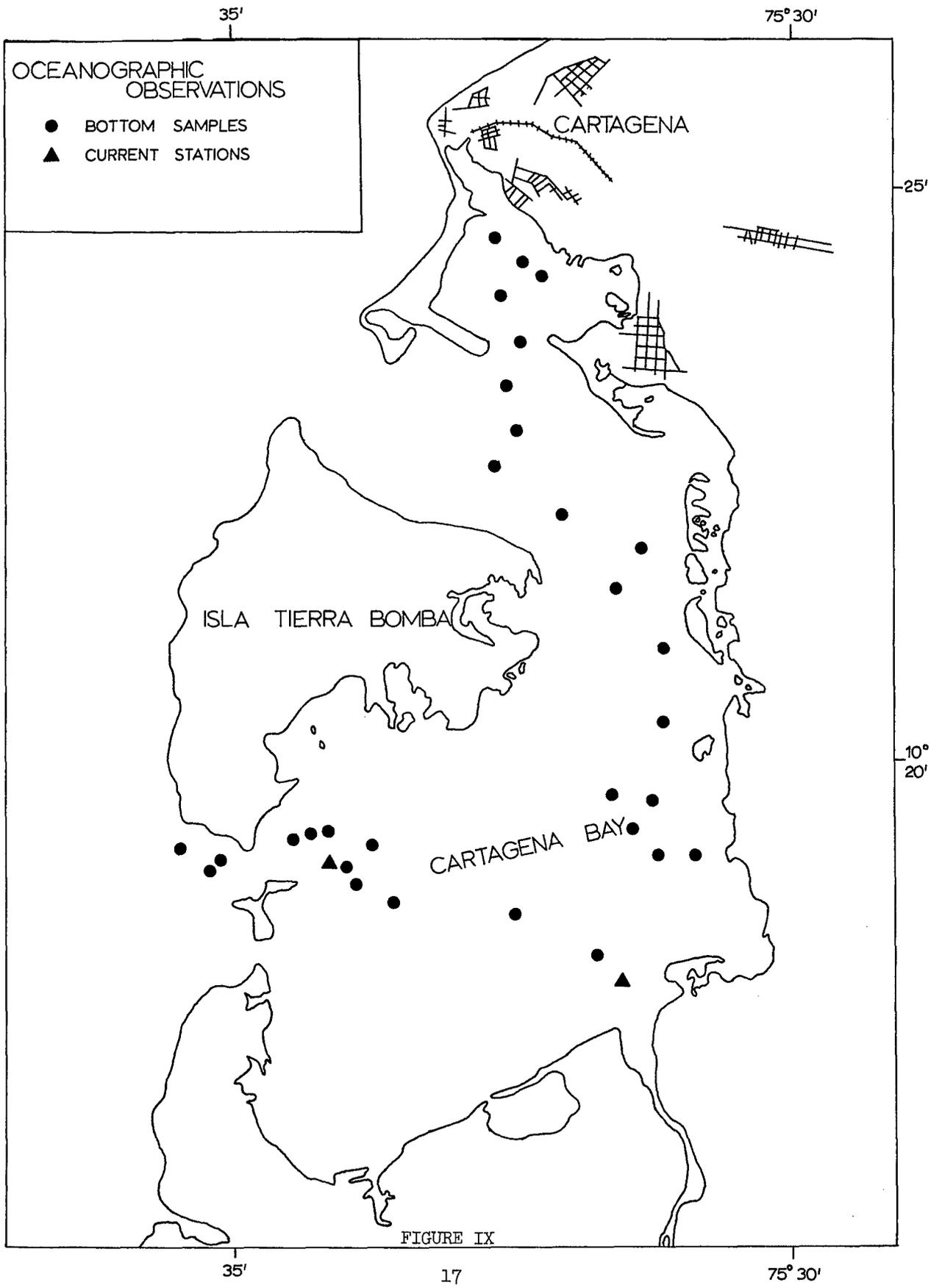


Figure VIII - The BOCA DE CENIZA, a 90 foot wooden hull ship, is owned and operated by the Empresa Puertos de Colombia and is Colombia's sole hydrographic/oceanographic survey ship. The ship berths 30 men - all civilian; the complement includes a hydrographic engineer, a topographer, and a draftsman. The ship has a small drafting room and its equipment includes two depth recorders, sextants, transits, bottom samplers, current meter, barometers, outboard motor boat, and miscellaneous supplies and equipment. Besides providing equipment and personnel, the 12 foot draft ship assisted this survey in taking oceanographic observations, and, when in Cartagena, berthed Empresa Puertos and Instituto Geografico personnel. During the period of this survey, she assisted in the Boca De Ceniza survey, (the river for which the ship was named) and commenced the geodetic phase of the Santa Martha survey.

NAVOCEANO was first associated with the BOCA DE CENIZA in 1965 when she assisted in establishing the geodetic control for the Buenaventura survey.



strong breezes occurred; those breezes were stronger from mid-afternoon until early morning hours. During these hours the sea was too choppy for soundboat operations.

The temperature is usually 85 to 90 degrees and some 10 degrees cooler during the windy season.

NAVIGATIONAL AIDS

All buoys are well attended; and their positions are reliable. H. O. Chart 978 was in bad need of being up-dated. All new and/or useful navigational aids were incorporated on the new smooth sheets.

CARTOGRAPHIC PHASE

Under the provision of the basic HARSAP agreement, IGAC received the smooth sheets in manuscript form for use in compiling a final nautical chart. This was the first nautical chart to be published in Colombia by IGAC. In February 1967, at a meeting between IGAC officials, and staff, personnel of the Empresa Puertos de Colombia, and others, Mr. William H. Atwood of NAVOCEANO presented a plan for integrating the services and facilities of the agencies concerned to produce nautical charts. His recommendations were accepted in principle, and cartographic work commenced. The plan basically set forth the responsibilities for each agency and defined the work flow and work processes necessary to ensure coordination of chart production, from survey phase through printing and distribution. This aspect of the program had not been considered in depth and lead to considerable speculation about individual agency responsibilities.

This situation was resolved on 28 February 1967 at a meeting of all parties to the agreement. At that time the basis for projecting a plan for establishment of a central hydrographic authority in Colombia was suggested.

The format of the charts to be produced in Colombia differs from those produced at NAVOCEANO but follows the basic standards for portrayal of navigation information as recognized by the International Hydrographic Bureau. With Mr. Atwood's assistance, actual cartographic processes for translating the survey data and topographic source materials into a finished chart were adapted to the technical facilities and talents available in IGAC. Chart production was under the technical guidance of NAVOCEANO's Mr. Lionel Hardison who advised IGAC from June to September and again from November to December 1967 on production of the first nautical chart. Figure X is a copy of a portion of the prototype chart of the inner bay of Cartagena as produced by IGAC. The actual nautical chart which is to be in color is scheduled for publication in December 1968.

RECENT DEVELOPMENTS AND FUTURE PLANS

In early 1968 the Colombian Navy with the administrative and technical assistance from NAVOCEANO, established a Hydrographic/Oceanographic Department presently known as "Departamento de Litorales." The newly created department, which is headed by NAVOCEANO graduate LCDR J. Pablo Rairan H., is also responsible for the establishment and maintenance of all the navigational aids in Colombia.

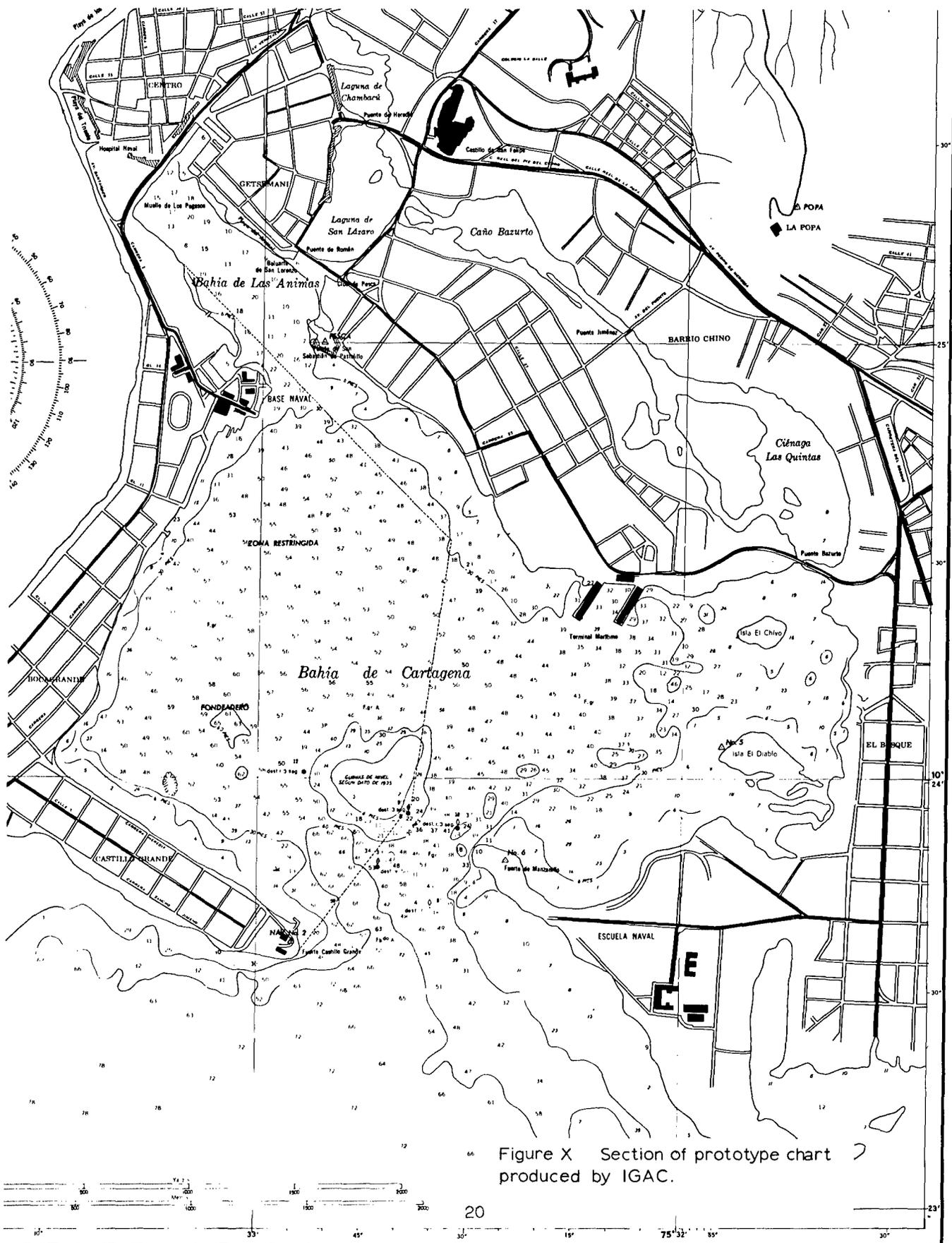


Figure X Section of prototype chart produced by IGAC.

A recently converted vessel, the ARC QUINDIO, has been assigned to the department for the sole purpose of conducting surveys of both Atlantic and Pacific coasts of Colombia. Presently, the QUINDIO is engaged in a hydrographic survey of Tumaco Harbor which is the first survey to be conducted by the new Hydrographic Department. This survey is expected to be completed in December 1968. (See Figure XI)

The establishment of the Hydrographic Department creates, within Colombia, a central agency which facilitates the planning and execution of the much-needed marine surveys. With input requirements from agencies such as the Empresa Puertos de Colombia, private shipping companies and the Colombian Navy itself, a comprehensive survey program can now become a reality.

Future plans include hydrographic surveys to be conducted in San Andres and Turbo Harbors, and, in addition, an oceanographic survey to be conducted in the area between Tumaco and Buenaventura.

It is evident that as a result of the Cartagena assistance project and the follow-up by NAVOCEANO representatives, Colombia now has a complete assessment of their hydrographic surveying and nautical charting needs to meet their own national requirements. Through efforts which have continued since the completion of the Cartagena survey, and which have grown in scope and mission, a nucleus of a nautical charting capability exists which shows much promise of becoming an established, continuing program utilizing local resources entirely.

PARTICIPATING PERSONNEL

Three NAVOCEANO Civil Engineers of Code 8550 participated in the hydrographic phase of the survey. The author was in Cartagena for the full duration of the survey, 7 August 1966 to 1 March 1967. Mr. William W. Wallace, was in Cartagena for the complete survey except for the period of 14 December 1967 through 7 February 1968. In February Mr. William H. Atwood, visited the Cartagena survey as investigator and made a reconnaissance trip to Santa Marta for the survey there.

The Empresa Puerto de Colombia provided from three to seven personnel throughout the duration of the survey.

LCDR Juan P. Rairan Hernandez, who had just completed a one year hydrographic training course at NAVOCEANO, made provisions for Navy LT Hector Porras to assist in the survey. Two Navy enlisted men intermittently assisted in the survey from 29 September to 20 October.

The Instituto Geografico provided two men to assist in the survey from 7 October to 14 December.

APPRECIATION

The author expresses his special appreciation to LT COL R. T. Bennett, Mr. Jack Staples and Mr. Douglas Deane, members of IAGS Staff, Bogota, for their invaluable liaison work, interests, and continuous assistance throughout this survey.

Special appreciation is also expressed to Dr. Reyland Paskast, Chief of Dry-Dock Operations of the Colombia Navy, through whose efforts the soundboat was kept in continuous operating condition. He rendered many extra services in various situations.

Special appreciation is expressed to LT Hector Porras of the Colombia Navy who diligently worked daily with soundboat operation and data processing from 23 November to 4 January. He further demonstrated his ability by becoming temporary captain of the "Boca de Ceniza" during the five days of oceanographic observation.

Appreciation is extended to Dr. Saul Granadas, Hydrographic Engineer of the "Boca de Ceniza," for his assistance throughout the survey. Continuous invaluable workmanship was rendered by Srs. Francisco Cabrera A. and Herando Victoria O., crew members of the "Boca de Ceniza." These men are to be commended for their conscientiousness and alertness.

Appreciation is also expressed to the following:

Captain Vasques	Director of Navy School (Navy Liaison Officer for this operation)
Dr. Arnolando Martines Emilian	Chief of Dredging Operations, Cartagena
Dr. Jorge Noel Rodriguez	Chief of Cartographic Branch Instituto Geografico
Dr. Rafael Roa	Chief of Engineering Division Empresa Puertos de Colombia Cartagena
Dr. Alfonso Villera	Manager, Civilian Terminal Empresa Puertos de Colombia, Cartagena

The Colombian Navy Electronic Officers and their staff for their "well done" job in keeping Raytheon continuously working, and especially, for the outstanding job they performed after the Raytheon equipment was submerged overnight in salt water.

The members of the "Boca de Ceniza," members of the Colombian Navy (both military and civilian) and members of the Instituto Geografico who assisted in the survey and the U. S. Navy Mission, Bogota and Cartagena.

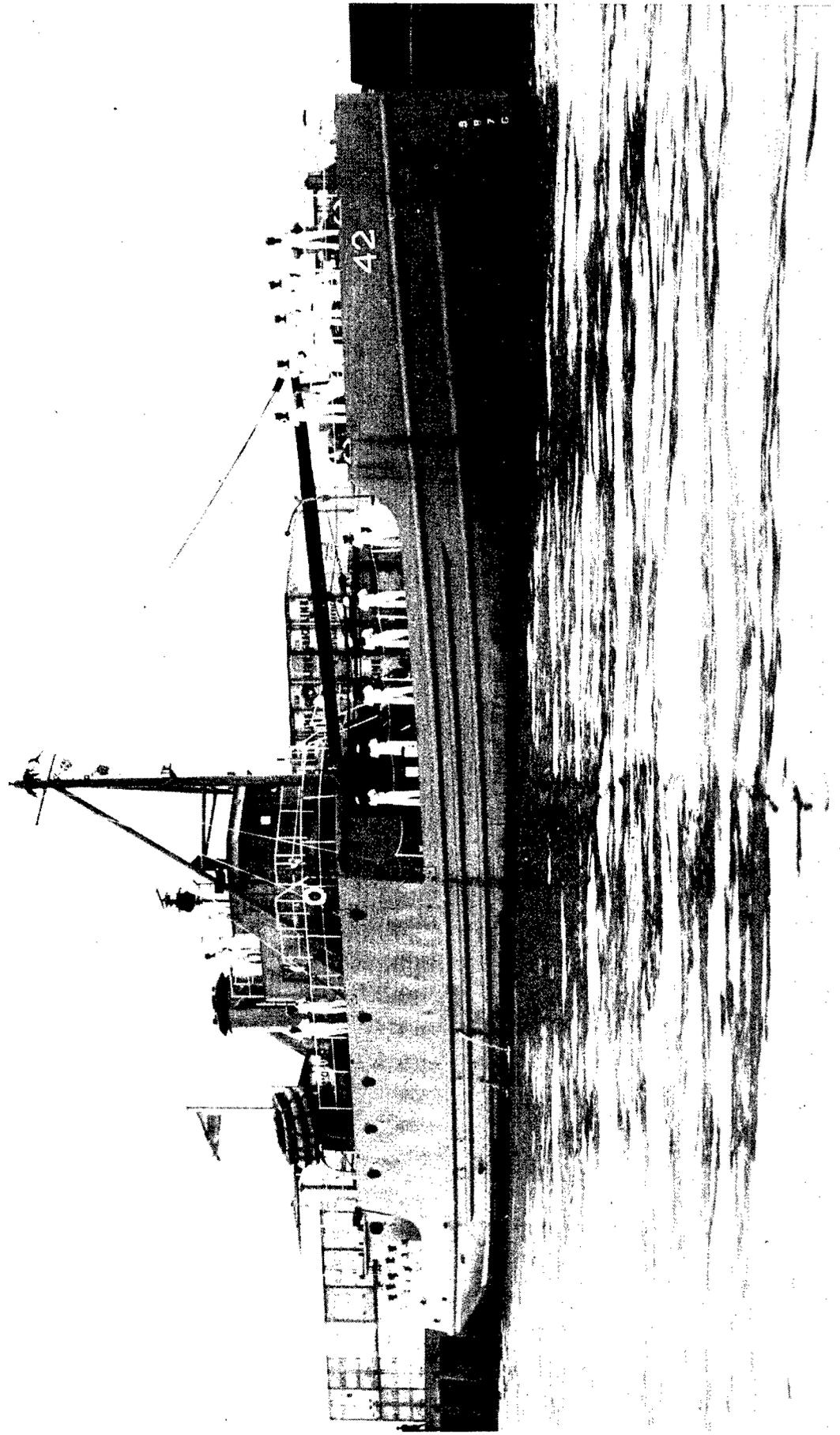


Figure XI - The ARC QUINTIO, the hydrographic/oceanographic survey ship of the Colombian Navy.

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