SURVEY REPORT
ON
DEEPWATER PORT CONSTRUCTION PROJECT
OF THE REPUBLIC OF ARGENTINA

September, 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

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1. OBJECTIVES OF SURVEY

The survey team was dispatched in response to a request for technical cooperation in a deepwater port construction project of the Republic of Argentina in May, 1977.

The objectives of the team were:

(1) To set definite goals on cooperation for the experiments on a deepwater port and to discuss the method of cooperation.

(2) To discuss the survey project for determining natural conditions of the proposed site for the deepwater port.

(3) To discuss definite goals on the Pta. Indio Channel and the technical analysis method for the channel and, in addition, to arrange the method of cooperation.

2. RESULTS OF SURVEY

2.1 Deepwater Port Construction Project

This project is intended to construct a port which will have a maximum water depth of -15 meters in the waterway and anchorage in the vicinity of Buenos Aires for the purpose of shipping out agricultural produce, mainly grains.

To promote this project, the Government of the Republic of Argentina set up a deepwater port committee (C.O.P.U.A.P., Systema Complejo Portuario de Ultramar en Aguas Profundas) under the jurisdiction of the Ocean Bureau (S.E.I.M., Secreteria de Estardo de Intereses Maritima) to provide close coordination with the following three government agencies:

(1) Channel Division of the Department of Defence (S.H.N., Servicio Hidrografica Naval) in charge of field survey.

(2) Survey & Development Bureau of the Department of Defence (D.I.G.I.D., Direccion General de Investigation y Desarallo) in charge of economic surveys and facilities planning.

(3) Applied Hydraulics Laboratory, Hydraulic Science Laboratory, Water Resource Bureau of the Department of Economics (L.H.A., Laboratorio de Hidraulica Applica) in charge of hydraulic experiments.

The proposed site is located in a dune zone (Punta Medonos) 290 km southeast of Buenos Aires facing the Atlantic Ocean. The site was determined on the basis of conclusions seached by the "Coordinating Committee for Prefeasibility, Preliminary Investment and Preliminary-Plan Survey for Deepwater Port for Ocean-Going Vessels" conducted from 1969 to 1971. The general public was widely informed of the project.

Various investigations mainly by the COPUAP began to substantially function after 1973, and research into natural conditions and economic conditions will proceed depending on the establishment of the plan by the end of 1978.

2.2 Proposed Site for Deepwater Port Construction (Punta Medonos)

The proposed site is located at 30 degrees 50 minutes south latitude and 56 degrees 40 minutes west longitude where the end of the right bank of the La Plata River meets the Atlantic Ocean. As Indicated in Fig. 1, there are several existing ports in this vicinity, such as the Buenos Aires Port (maximum water depth: -7m), La Plata Port (maximum water depth: -8m), Mar del Plata Port (maximum water depth: -7m) and Bahia Blanca Port (maximum water depth: -12m).

There are two beach resorts in the vicinity of Punta Medonos. Mar de Aho is 15 km north of Punta Medonos and the other, Pinamar is 26 km south of Punta Medonos. The coastal area of about 40 km long between these two resorts is covered with wild dunes, and swampy land spreads starting at a point about 2 to 4 km inland from the beach.

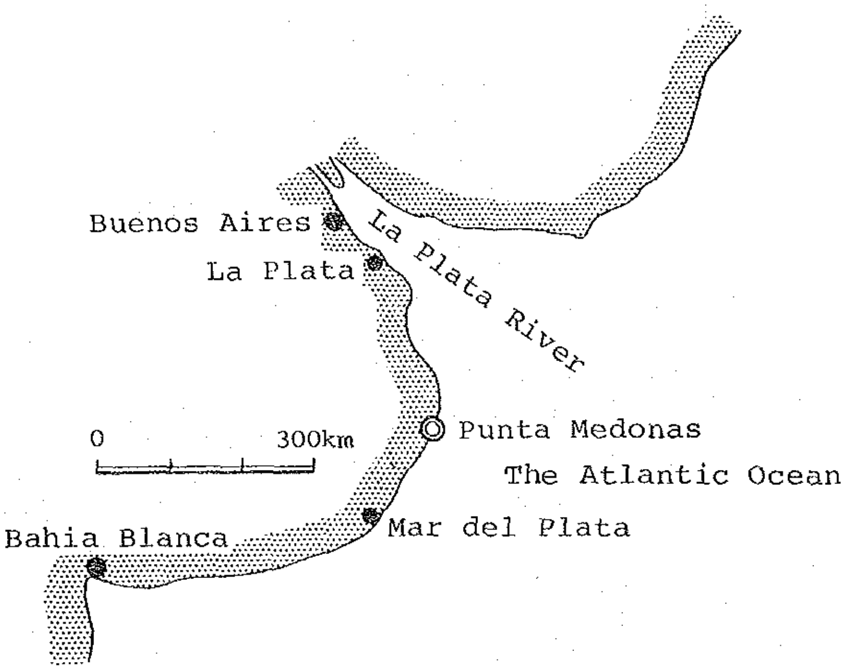


Fig. 1 Location of Punta Medonos and Other Major Ports in the Nearby Area

- Seabed Topography -

The general seabed topography of this area is shown in Fig. 2. As indicated in this figure, the water depth at the river-mouth of the Plata River is shallow due to a large amount of sediment discharged by the rivers. And in the area between Buenos Aires and San Antonio, the distance from the shoreline to a point where the water depth is -15m is extremely long, exceeding 30 km. However, a -15m depth contour line tends to gradually approach the shoreline in the ocean area after passing Cabo San Antonio, and it comes close to about 10 km from the shoreline at the front of Punta Medonos.

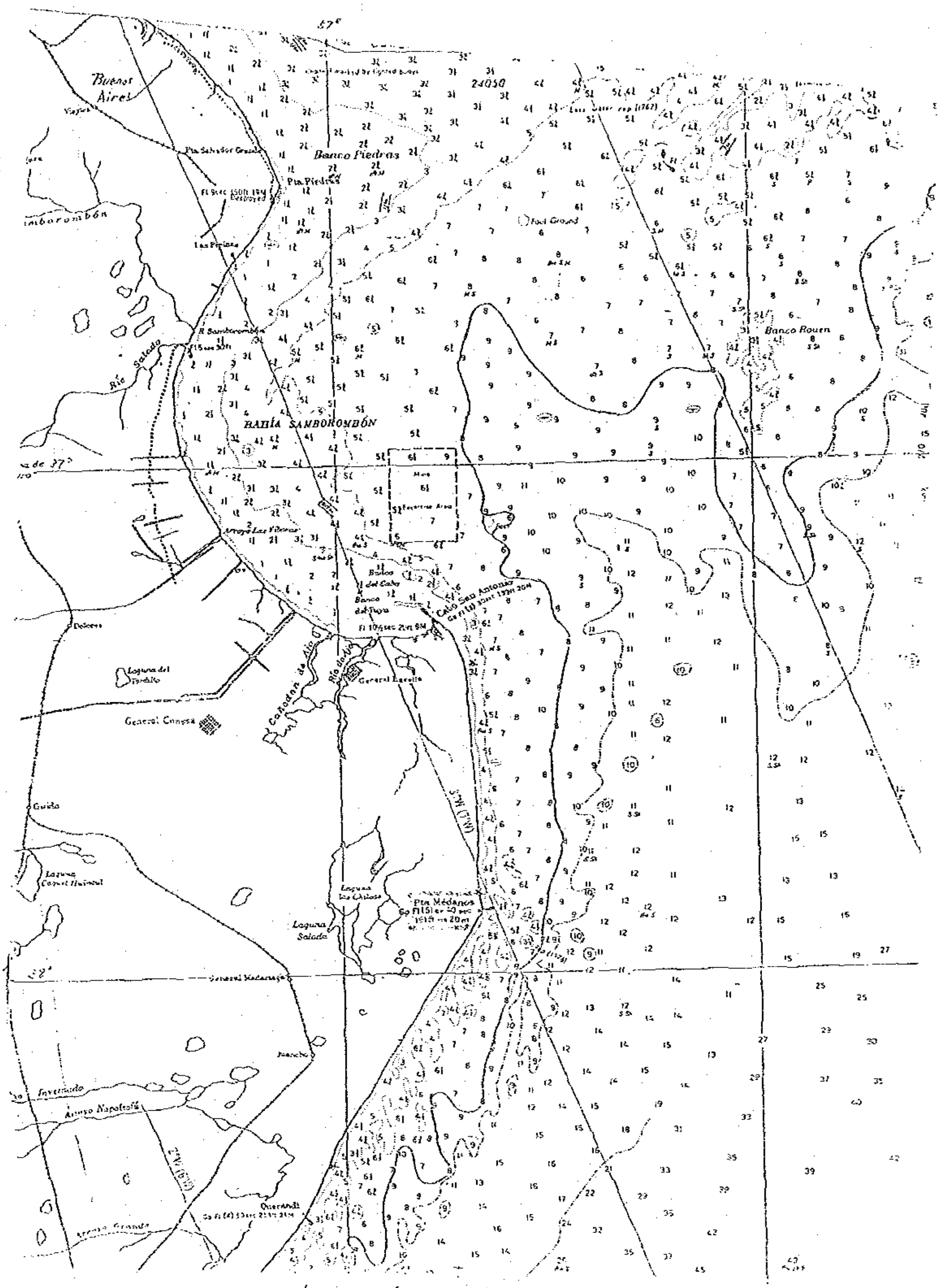


Fig. 2 Seabed Topography near Punta Medonos

Note: Unit of water depth: Fathoms (1 fathom = 1.8m)

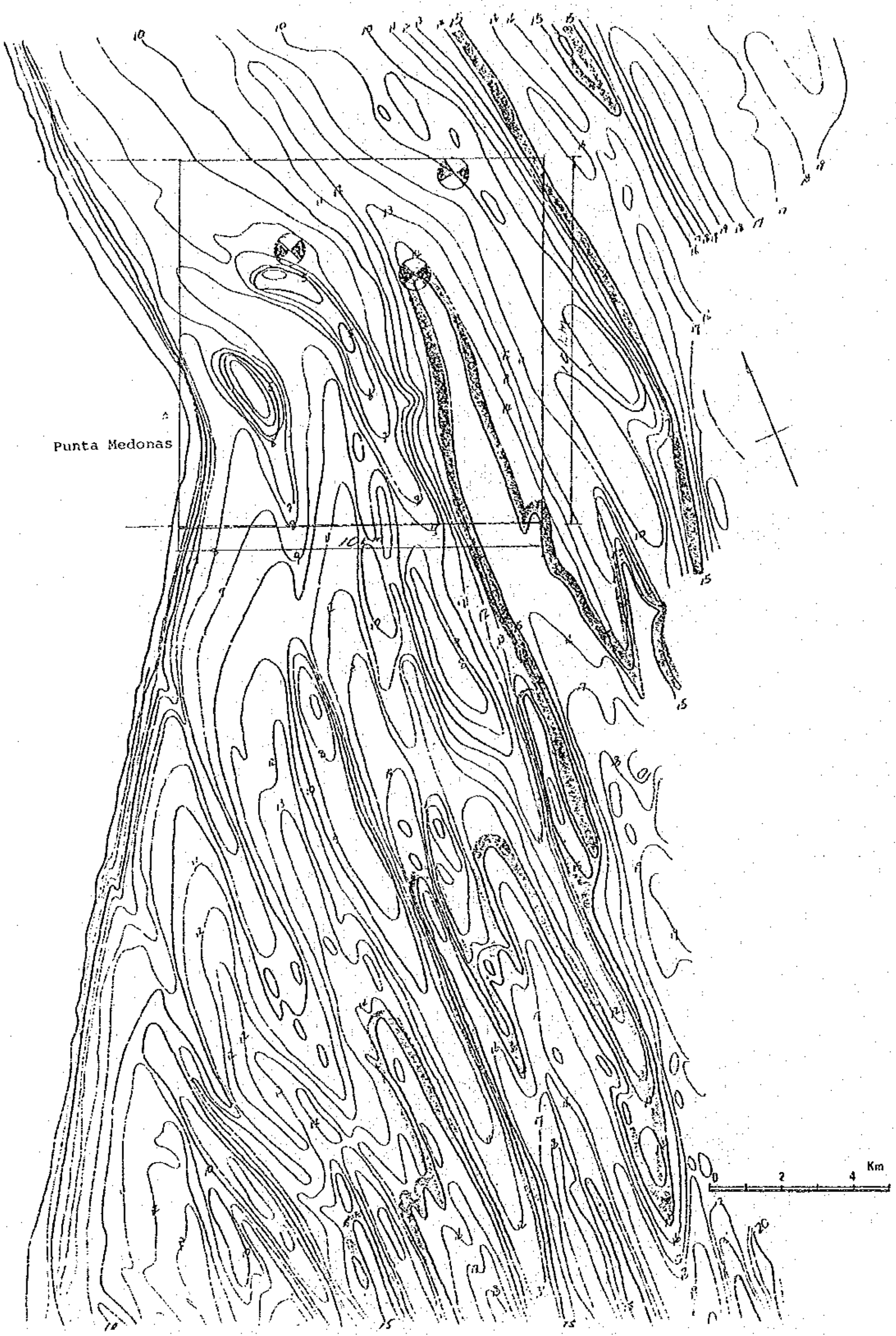


Fig. 3 Detail of Seabed Topography near Punta Medonos

In the area where the water depth is greater than -10m to -20m, an unusual topography is seen about 110 km south of Punta Medonos as shown on the -5 fathoms depth contour line of Fig. 2. That is, as shown in the detail of the area near Punta Medonos of Fig. 3, a group of shoals extend in the southeast direction at an angle of 30 to 40 degrees to the shoreline. (At some valleys of each shoal) a contour 15 meters in depth occasionally approaches less than 10 km from the shoreline. Government of the Republic of Argentina is presently considering using this valley section as an access waterway to the port. The spacing between two adjacent shoals reaches up to 3 to 5 km, and the difference in water depths between the crest and the valley of a sheal reaches up to about 5m.

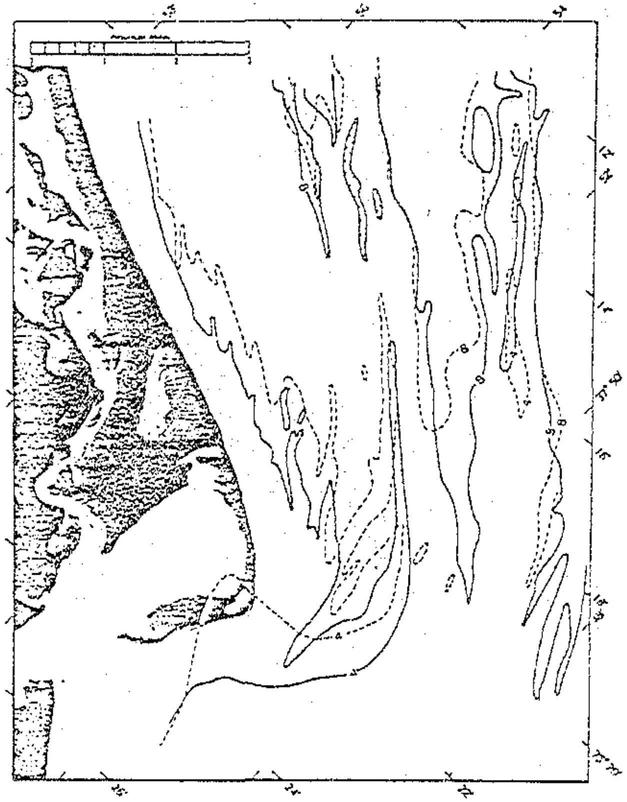
The underground structure of this shoal has not been clarified but the surface of the seabed is considered to consist of sandy material. Thus, it will be reasonable to consider that this topography belongs to the terrain known as the "shore-connected ridge" occasionally seen in the sea along the east coast of North America.

If this group of shoals is equal to the shore-connected ridge, this topography is a deposited terrain caused by hydraulic factors as confirmed in the United States by the results of past research. Thus, it has a tendency to naturally deform in a long period of time so that it is very difficult to avoid the deformation of the seabed topography that may be triggered by the change of hydraulic conditions as a result of the construction of a new port. However, if the speed of this terrain deformation is extremely slow, the possibility of utilizing the valley section of the shoal as an access waterway to the port cannot be completely denied from the economic and technical viewpoints.

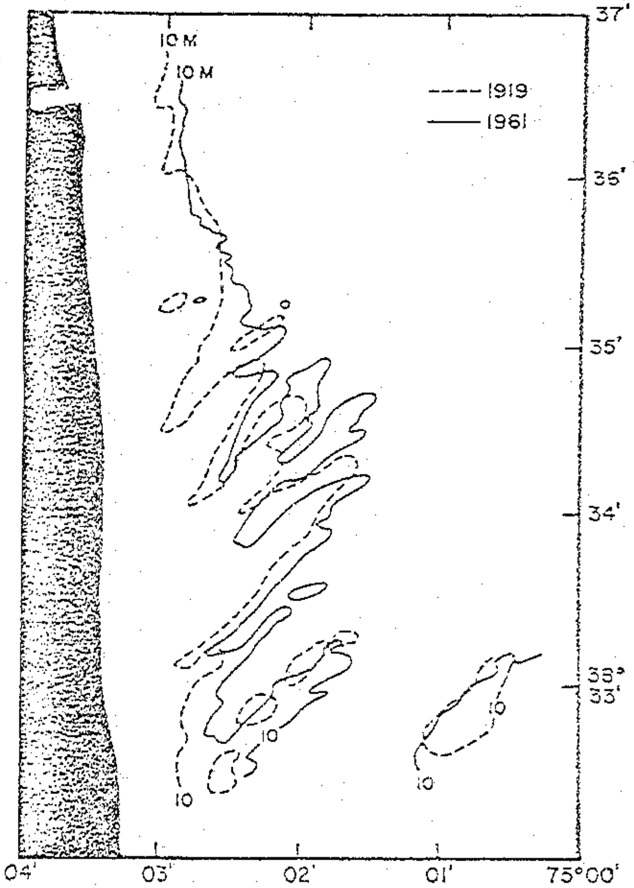
Examples of stability of the group of shoals, which is considered to be a shore-connected ridge, are indicated in Fig. 4 and Fig. 5. Fig. 4 shows a long-term variation of the ridge in which changes of the ridge are indicated at the left covering 51 years from 1881 to 1934 and at the right covering 42 years from 1919 to 1961. By comparing the solid lines with the broken lines in the figure, it is apparent that the ridge had been deformed. However, it also strongly suggests that the basic pattern of the terrain has been little changed contrary to expectation in consideration of the accuracy of sounding techniques in the early years of the 1900's.

On the other hand, Fig. 5 shows an example of short-term deformation less than 3 months at a beach in South Virginia. It indicates a drastic deformation of the ridge in three months. However, the sea area which is shallower than -7m in depth normally is subject to topographic deformation drastically even in a regular beach having no shore-connected ridge. Thus, as in the example, it cannot be proven that drastic deformation of the sea floor terrain is peculiar to the shore-connected ridge.

For stability of the ridge in a sea area deeper than -10m water depth which is currently being considered by us, it seems that there is a lack of reliable data at the present time.



Bathmetric time series of Chincoteague shoals, Delmarva (Delaware-Maryland-Virginia) coastal compartment. Ridges have migrated slightly offshore, and have extended their crestlines markedly to the south between the Coast and Geodetic surveys of 1881 (dashed line) and 1934 (solid line) From Duane et al. (1972)



Bathymetric time series from the Bathany Beach ridgefield, Delaware, between 1919 and 1961. From Moody(1964)

Fig. 4

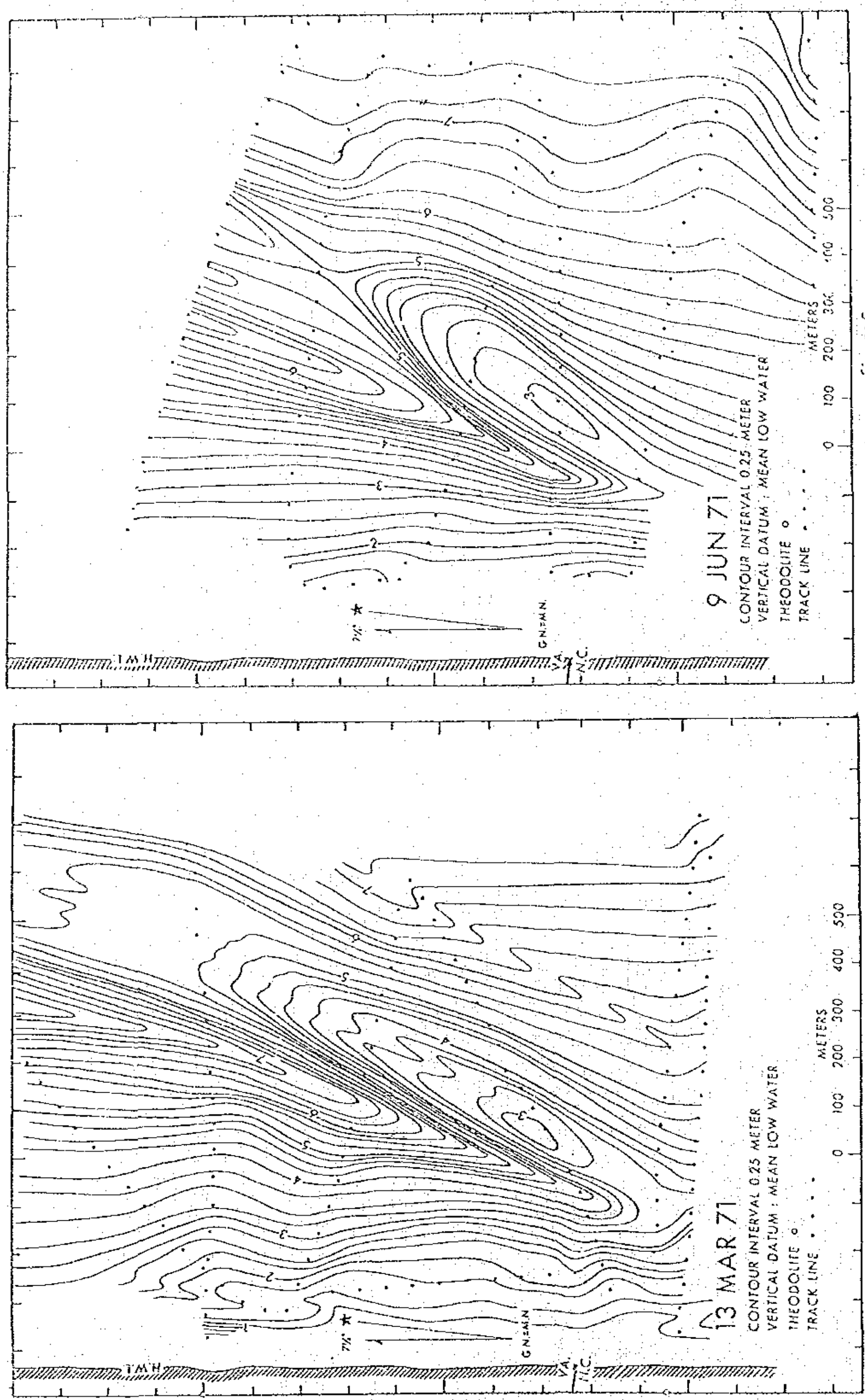


Fig. 5 Example of Deformation of Shore-Connected Ridge

Some results of studies on hydraulic phenomena near the ridge topography have been reported. They indicate that the coast parallel helical flows, as shown in Fig. 6, formed at the ridge valley as a result of mass transport by wind waves and wind-driven currents are supporting and maintaining the ridge topography. However, this conclusion was assumed from measured values of plane currents at a certain point and from tracing floats so that it was not supported by reliable data. The possibility of the formation of this helical flow after the ridge formation can be considered but this does not answer the question regarding the hydraulic mechanism that originally formed the first ridge.

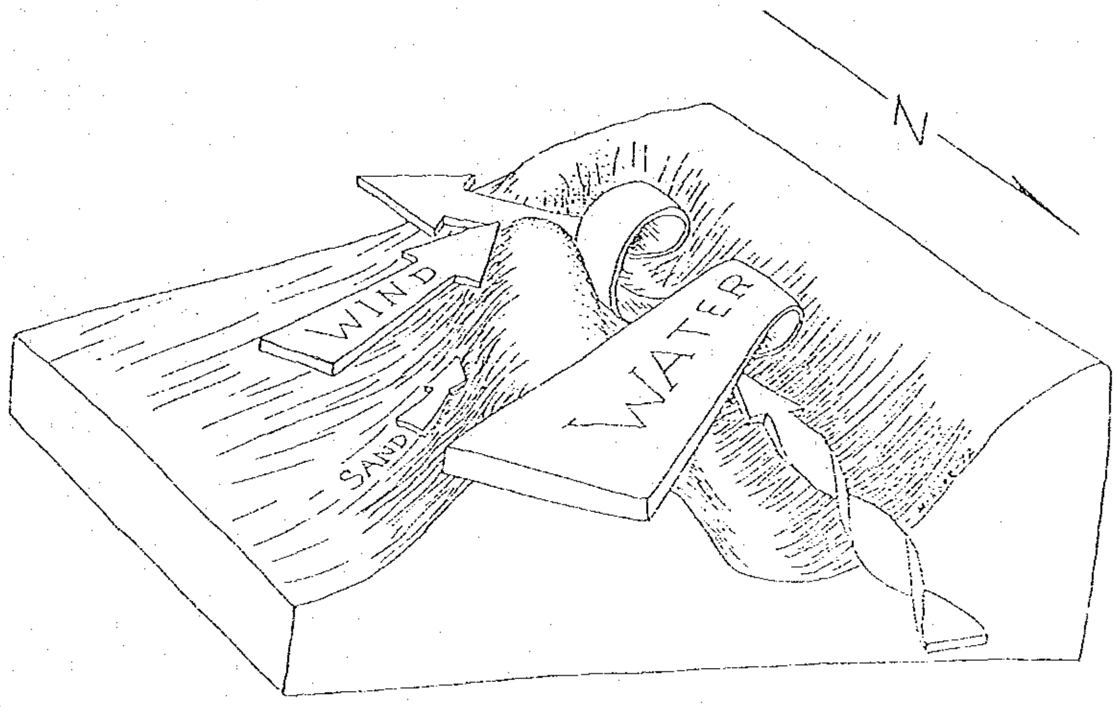


Fig. 6 Helical Flow Formed Near Shore-Connected Ridge

- Beach Topography near Punta Medonos -

According to the results of seashore observations conducted on July 26th and 27th in 1977, a considerable difference in characteristics of the beach was noticed between the southern and northern sections with its boundary at Punta Medonos. That is, the slope of the beach is extremely gentle (foreshore beach slope is about 1/30), height of the beach is low (height of back-shore is about +2m), and bottom materials are very fine in the northern beach.

On the other hand, in the southern section, the beach topography has a periodicity in response to the ridge mentioned before. There is a gentle slope at the base of the ridge similar to the northern beach, and the beach slope is relatively steep (foreshore slope is about 1/15) and the beach is higher at the section where the valleys are interlaced. The beach width is approximately 50m at the south end of Mar de Aho, but the beach gradually widens as it goes south, with the widest part reaching up to approximately 200m near the area 4 km from the lighthouse to the south.

- Waves near Punta Medonos -

Principal waves in this area are swells accompanied by cyclones moving to the east near the 50 degree south latitude line in the winter season (July and August) and wind waves accompanied by cyclones which move to the south along the La Plata River or grows in the Pacific Ocean near 35 degrees south latitude and moves to the east across the continent of South America. The waves measured in this sea area from past observations were not necessarily deepwater waves in view of the observed conditions. But the results of the observations indicate the following facts:

(1) Records for 8 months from July, 1974 to September, 1975 indicate that the maximum significant wave height is 2.6 to 2.8m in the southern part and 2.2 to 2.4m in the northern coast, and the former occurred in September while the latter in November and December.

(2) Values of wave height measured in the south coast are about 20% higher than those of the north coast on an average.

(3) The direction of waves exceeding 1.8m in height is mostly in the SE direction followed by a SSE direction in the south coast and only ESE and E directions in the north seashore.

(4) The results of short-term observations indicate that the wave height of 10-years probability is about 3.6m in the south coast and about 3.1m in the north coast. These values of probable wave height are considerably smaller than the ones in Mar del Plata 200 km south of Punta Medonos. But, it is difficult to find reasons for this fact because of the short observation period.

(5) The dominant direction of flux of transport energy of waves along the seashore is northward.

- Tide and Tidal Current near Punta Medonos -

Double day tides are clearly seen and the tidal range is from approximately 0.8m to 1.5m. There is a delay of the tide of about 1.4 hours between Mar de Ajo at the north end of the area and Pinamar at the south end of the area.

Currents observed at a point -9m in mean water depth are northward currents of 50cm per second in maximum during rising tide in the north coast and southward currents (September 2 to 13, 1975) of 70 to 40 cm per second during falling tide. However, currents in the relatively shallow mean water depth area is greatly affected by the seabed topography, and it seems that there is a difference in current patterns between the crost and valley of the ridge. For example, according to observations made form September 9 to 11 in 1975, the distribution of current direction has two peaks in the southward direction and northward direction parallel to the shoreline statistically but their relation with tides is not clear. Also according to observations made from September 1 to 11 in 1975, only the current moving southward in parallel to the shoreline is dominant but its regularity was not determined. The value of current speed in the south coast is generally high, about two times compared to the north coast.

- Littoral Drift near Punta Medonos -

Near Punta Medonos, particularly in the seashore zone, the littoral drift moving to the north is dominant for the following reasons:

(1) The energy of waves from the south is dominant resulting in littoral drift moving to the north.

(2) The bottom materials of the beach are course in the south coast and gradually become fine in the north coast.

(3) Judging from the results of borings, it is considered that the dune zone of Punta Medonos has been developed from the south and to the north. (Explained by Dr. Parkar.)

(4) The shore-connected ridge has a tendency to extend in the direction of the dominant littoral drift.

(5) The sand bars of Cabo San Antonio extend toward the north.

(6) In the coast of Mar del Plata located 200 km to the south of the proposed site, the littoral drift moving to the north is dominant as clearly testified by the sand deposition pattern near the breakwater.

The littoral drift moving to the north supplies the sand to the shoals during its movement, reaches Punta Medonos where the sands are heavily deposited, and further moves to the north suddenly changing the amount of sand movement. This situation of sand movement is shown in Fig. 7. Thus, the vicinity of Punta Medonos can be called a "grave of sand" since sands are deposited there in large quantities.

Information concerning the amount of sand transport which can be obtained for us at this time are the estimated values derived from equations of wave energy, the amount of deposited sediment to be obtained by comparing topographic maps in the vicinity of Punta

Medonos, and the assumed values for Mar del Plata Port. These values are indicated below.

(1) The values assumed from wave energy

These are shown in the table below.

Table 1. Rate of Littoral Transport Calculated from Wave Energy

Period of Time	South Coastal Area	North Coastal Area
Sept. ∿ Dec. 1974	(to north) 121,000 m^3 (1,700 m^3/day)	(to north) 36,600 m^3 (600 m^3/day)
Apl. ∿ May, 1975	(to south) 9,000 m^3 (300 m^3/day)	12,000 m^3 (380 m^3/day)

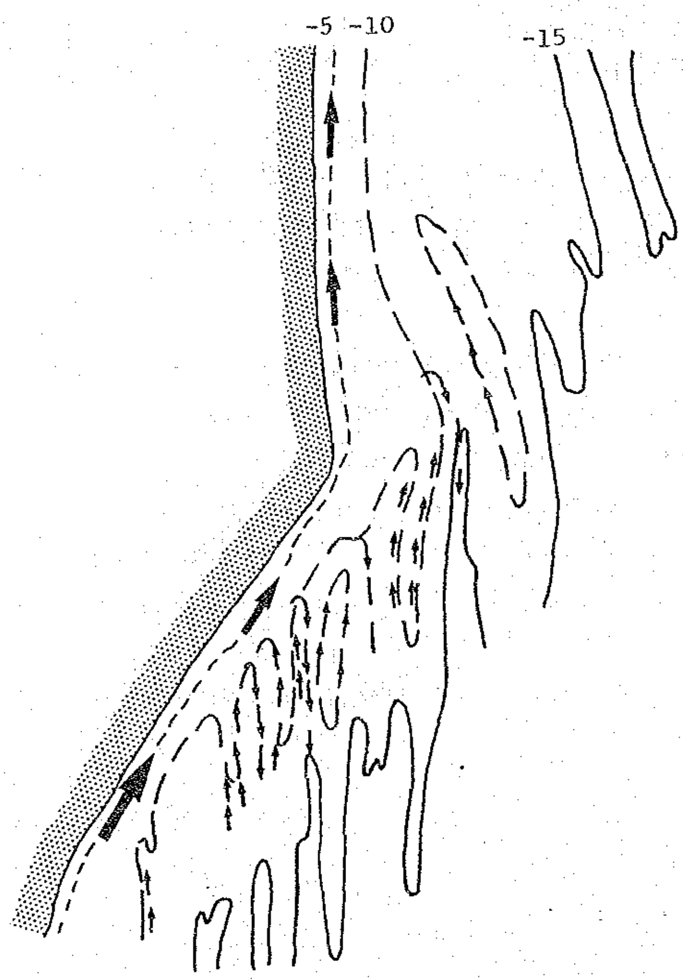


Fig. 7 Dominant Direction of Littoral Drift

(2) The values assumed from the amount of sand deposit in the vicinity of Punta Medonos: The amount of sediment deposited in the area of 209 km^2 in front of Punta Medonos for 7 years from 1966 to 1974 is 103 x 10^{-3} km^3. This is equal to 15,000,000 m^3/year which is a tremendous amount of volume. When converting this volume to water depth, the rate of deposition will be 7 cm/year.

(3) Value assumed for Mar del Plata Port:
It is assumed that the rate of littoral transport to the north passing by the tip of the south breakwater of Mar del Plata Port is 400,000 to 600,000 m^3/year.

Of the information shown above, the data during midsummer and midwinter when the waves are large, are not available for those values derived from the wave energy equation. But it will be about 500,000 m^3/ year considering, the mean net value of 1,400 m^3/day from 1,700 m^3/day to the north in autumn and 300 m^3/ day to the south in spring. This is almost equal to the assumed value for Mar del Plata.

On the other hand, the values obtained by comparing two different topographic maps are unreasonably high and their order is doubtful. Thus, the reliability of the survey data particularly for the purpose of sediment estimation is very doubtful since surveys were not conducted for an unified objective and by an unified method. Thus the yearly rate of not littoral transport in this area is estimated to be about 500,000 m^3/year to the north.

2.3 Present Situation of The Organization L.H.A. Working on Model Experiments

L.H.A. was established in 1969 as a sub-laboratory under the National Hydraulic Science & Engineering Laboratory (I.N.C.Y.T.H., Institute National de Ciencias y Tecnica Hidricos). Construction of its research facilities and training of researchers were mainly conducted from 1969 to 1974, and actual research activities by the laboratory began after 1974. However, most of the research activities conducted by the laboratory concerned river problems, dam problems and researches on river systems and only few achievements on coastal area and port problems were reported.

The organization of the laboratory at the present time is shown in Fig. 8, but the ocean model section in charge of deepwater problems owns only one outdoor plane tank and one wave channel and an indoor plane tank was being constructed for handling the deepwater port problem. Staff members are presently being trained at M.I.T. in the United States and at the University of Berlin.

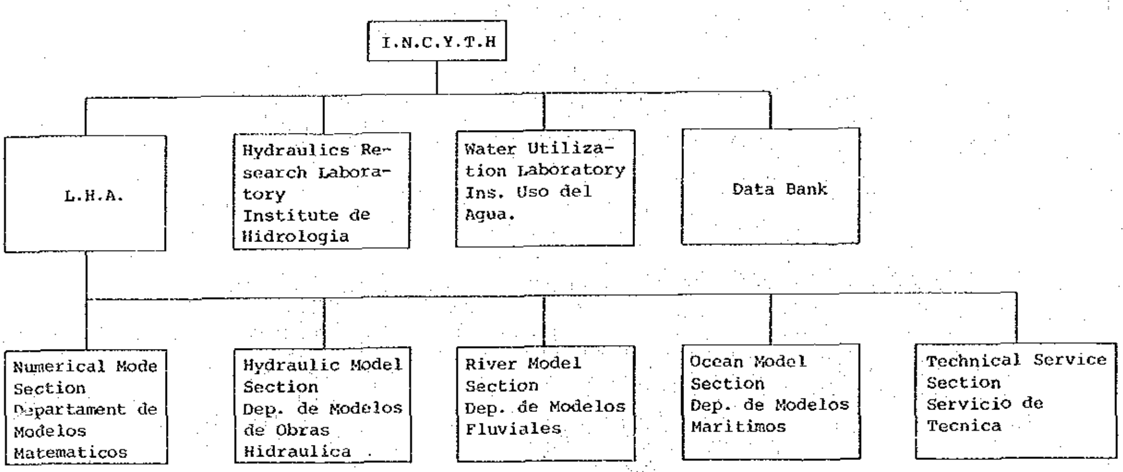


Fig. 8 Organization Diagram of L.H.A.

Thus, in the organization of L.H.A. which will be in charge of field surveys required for hydraulic experiments and related works as a member of C.O.P.U.A.P in the future, urgent problems to be solved are the improvement of facilities and equipment for model experiments and training of engineers in charge. And positive cooperation of Japan is being requested for solving these urgent problems.

Dr. Barchillon, director of L.H.A., and young researchers are very desirous of absorbing new knowledge on actual methods of experiment and field observation and observation equipment. While the survey team was in Argentina, they frequently wanted to exchange opinions up to midnight spending a considerable time particularly on discussing these problems.

Such discussions were conducted based upon the catalogs and related reports prepared by the survey team in conformity with Form A-4 presented by the Government of the Republic of Argentina in advance.

2.4 Situation of Field Survey Operations

Field surveys are conducted mainly by the Oceanography Department of S.H.N. and supplementary surveys required for achieving hydraulic experiments are being conducted also by L.H.A.

The Oceanography Department of S.H.N. is comprised of the ocean physics, ocean geology, ocean chemistryy and ocean biology (Departamento Oceanografia) sections, and close coordination is being maintained between these sections for inter-disciplinary research, but the leadership of surveys for deepwater port problems is undertaken by the ocean physics section.

S.H.N. has a well-experienced staff in addition to a complete organization and mobilization force, and it is considered to have considerable ability in field surveys. A field survey was conducted for the area shown in Fig. 9 and the items and method of survey are:

(1) Survey for seabed and ocean topography; Survey was conducted from December of 1973 to March of 1974. A second survey is being planned in 1978. The survey was done by using an echo-sounder and radio navigation.

(2) Wave observation; Waves were observed three times a day using a wave rider (acceleration type wavemeter) in addition to visual observation of wave direction by the direction board method in Mar de Ajo and Pinamar. Observations conducted in the past were one point each (-10m water depth) at both the south and north coastal areas from July, 1974 to September, 1975, one point each at both the south and north coastal areas (-14m water depth) from August to October in 1976, and one is being made after January of 1977 at the offshore area (-10m water depth) of Punta Medonos. One additional point will be made as planned after August, 1977 in the south coastal area.

(3) Current Observation; Observation of tidal currents was conducted using five current meters in September, 1975. And many observations of beach currents can be made at any time using floats.

(4) Tidal level observation; This has been conducted at two points in Mar de Ajo and Pinamar using float-type tide gauges since July of 1974. Records are made in the form of analog data and digital data taken at 3 minutes interval.

(5) Survey for change of beach section; Sections of four survey lines each were taken at both the south and north areas with an interval of about 10 to 15 days in 1974 and from August to November of 1975.

(6) Bottom material survey; Grain sizes of beach materials of the foreshore were measured in both the south and north areas from September, 1974 to May, 1975.

(7) Also, boring on land, a floating sand survey, tracing of fluorescent sand, survey by R.I. tracer, water quality (salt) and temperature surveys were conducted.

LABORATORIO DE HIDRAULICA APLICADA

ESTUDIO PUERTO DE AGUAS PROFUNDAS

CAMPAÑA PUNTA MEDANOS 1974/75

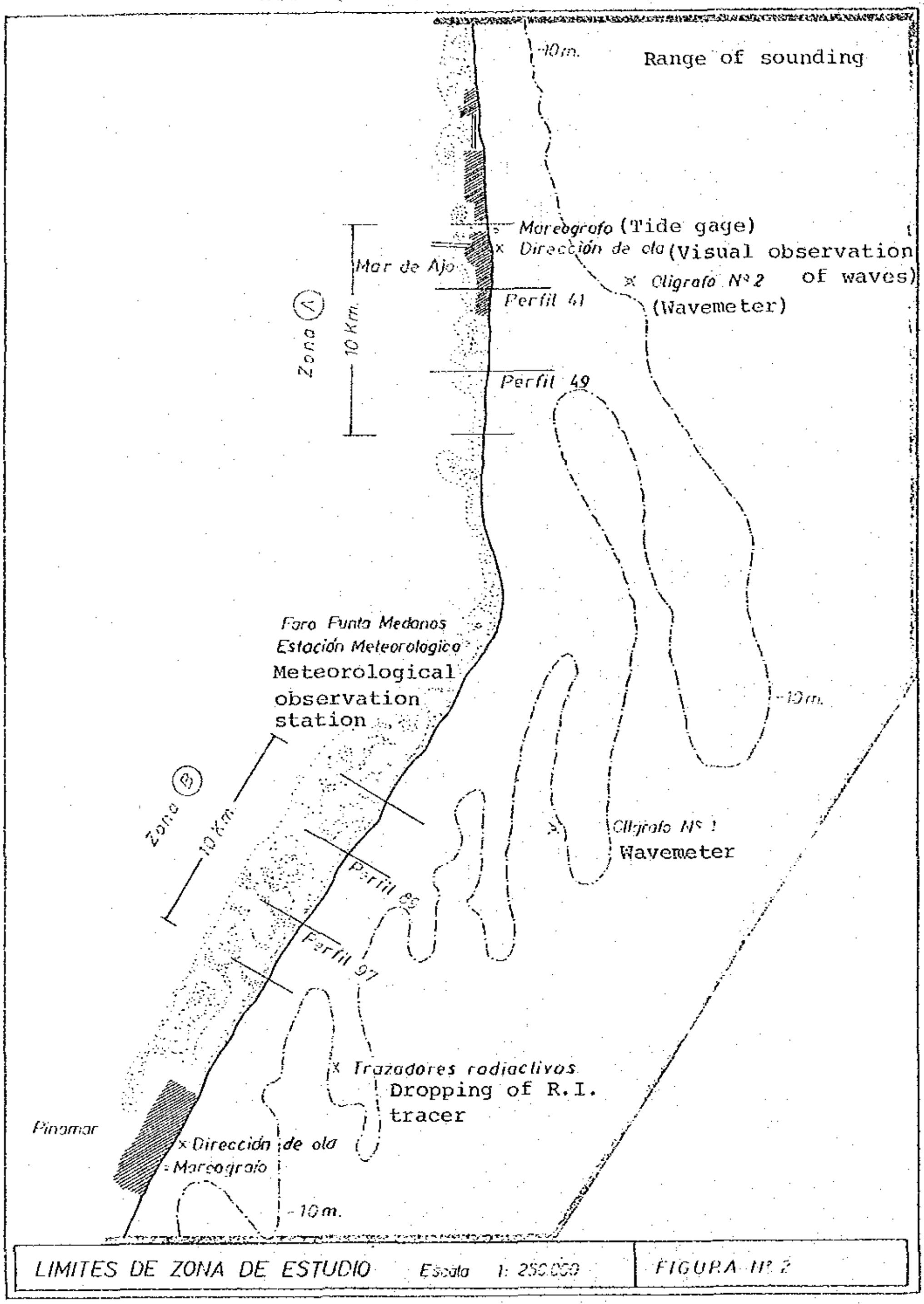


Fig. 9 Survey Area and Points of Principle Surveys

3. Conclusions

3.1 Opinion of Survey Team

In response to the request for technical cooperation presented by the Government of the Republic of Argentina, the survey team will make the following recommendations. However, the main outlines of the recommendations were already explained to COPUAP on July 29th, 1977 after consulting with officials of the Japanese Embassy in Argentina, and the survey team stressed in the explanation that the contents were reflecting only the opinion of the survey team so that final decision would naturally be made by the Ministry of Foreign Affairs and financial authorities.

(1) Dispatch of top class engineers for guiding the hydraulic experiment of littoral drift along the coastal area:

One engineer engaged in the survey of Kashima Port and model experiments with sufficient field experience will be dispatched. Period of his stay will be about two months. It is desirable to dispatch this engineer after trainees stated in the subsequent provision go home and when model experiments of the deepwater port begin.

(2) Receiving of trainees engaged in hydraulic experiments:

It is more desirable to accept more than one person for individual training. However, the period of training should be about 6 months eliminating academic study. (Two trainees have been accepted already from November, 1977 to July, 1978.)

(3) Giving of equipment for hydraulic experiments:

Total amount of equipment requested will exceed several 100 million yen. Thus, we think that it is difficult to give equipment of this amount as a single donation. However, in view of the present situation of L.H.A. in Argentina, we think that the giving of important items of equipment shown below should be positively considered as equipment to be brought to Argentina by the specialist to be dispatched. These items are: small-type propeller current meter, multi-element analog recorder, and high-speed analog recorder.

(4) Dispaching of international level engineers for examining deepwater port engineering and economic feasibility of the port:

As far as technical problems are concerned, the presence of technical problems were pointed out. The report also clearly indicates the presence of extremely difficult technical problems in the proposed construction site. Thus, we think that the dispatch of a new survey team for economic feasibility surveys including the study of technical problems pointed out in this report should be considered.

(5) Accepting of high class feasibility trainees for deepwater port:

We think that it is very meaningful for members of the Deepwater Port Committee to observe the deepwater ports in foreign countries to learn the method of carrying-out type project.

(6) Giving of equipment related to field surveys:

We believe that more than half of the contents of the request have been fulfilled by the current meter brought and given by the survey tea. However, we think that equipment such as an electromagnetic current meter should be further considered for the field in order to make it possible to do surveys based upon the field survey working guides stated in subsequent paragraphs.

(7) Request for references and papers:

The survey team brought with them a number of lists of references and papers and pamphlets. We are also able to cooperate in the future in this respect if concrete requests are made.

3.2 Recommendations to the Government of the Republic of Argentina

In regard to the construction of the deepwater port in Punta Medonos, the most important point for determining the actual construction site and the type of port such as an artificially excavated port or port-island type port, will be the problem of stability of the group of shoals. Depending upon the topography of the stable group of shoals and the possibility of utilization of the valley section as an access waterway to the port, the selection of both construction site and type of port will be affected and varied.

As stated before, presently available data indicate that it is more reasonable to consider that the group of shoals does not assure a stable topography. In addition, it is considered that there is quite a difference in marine conditions such as waves between the south and north coastal areas at both sides of the cape in the Punta Medonos area. Thus, because of this difference in marine conditions between both coastal areas, occurrence of a difference in functions of port utilization and scales of structures can be expected. Merits and demerits of both coastal areas and the possibility of shoal terrain utilization will act as important factors in determining the construction site. Thus, as a basic course of survey and study on natural conditions at the present time, the following two points should be fully taken into consideration:

(1) To pursue the stability of the group of shoals and the mechanism of maintaining the topography of the group of shoals.

(2) To fully grasp the difference in characteristics between the south and north coastal areas without having a fixed concept in selecting the construction site and port type.

Items and methods of survey and study to be made from now on in the research and study of the natural conditions are described below.

(1) Survey on changes of group of shoals

a) Repetitive sounding on typical 2 to 3 ridges;

For example, soundings of the area enclosed by the chain line in Fig. 3 should be made more than 4 times per year repeatedly. This survey should be continued for more than one year at least. For measuring the location of the boat during the survey, it should be done at least at one point per area of about 50m x 50m by a sufficiently accurate method.

b) Use of satellite photographs for finding changes in overall arrangement pattern of ridges;

In view of the scale and water depth, it is considered that the group of shoals taken by the satellite is very clearly photographed. Using several photographs taken on different days, there is a possibility of finding changes in the ridges.

(2) Survey on hydraulic mechanism in the vicinity of the group of shoals

a) Flow observation at each point corresponding to ridge topography;

As indicated in Fig. 10, it is desired to do simultaneous observations at several points along the traverse section of the ridge. If a helical flow stated before exists, the presence of this helical flow can be grasped from the distribution of the current directions derived from observed data.

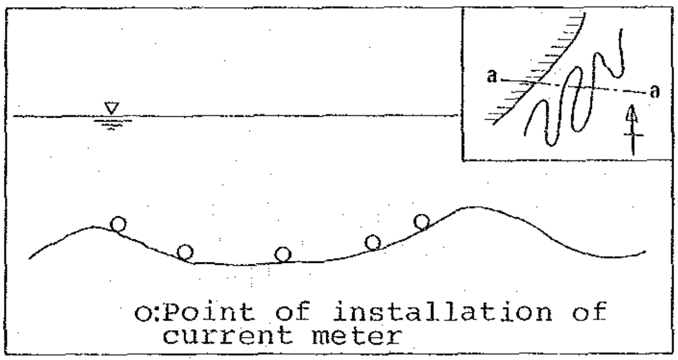


Fig. 10

More than five observation points should be provided at the same time, and observations should be continuously performed for two to three months in order to obtain the results for various wave conditions. And, if possible, it is more desirable to use a current meter such as the supersonic type or electro-magnetic type current meter which is capable of measuring three-dimensional flow directions of x, y and z and has a short averaging time for current speed.

b) Observation of littoral drift using tracer in the vicinity of ridge;

For example, a radio isotope of fluorescent tracer should be dropped at points shown by  in Fig. 3, and its movement should be traced.

As a tracer, the radio isotope is particularly excellent, but use of an isotope tracer is more desirable, if allowed.

c) Graspring of characteristics of bottom materials near the ridge;

It is desired to grasp the relation between characteristics of both ridge topography and grain size in detail for particular ridges properly selected.

(3) Grasping statistic characteristics of waves and wave distribution characteristics in the area

a) Installation of permanent wave observation station;

Information on the waves can be used for many purposes such as (a). determination of port location and facilities arrangement, (b). design of port structures, and (c) management of port construction work. For the purpose of (a), observation data continuously taken for at least one year are needed. For the purpose of (c), the data must be continuously obtained at least until external facilities of the port are completed.

In addition, for a large-scale port facing the ocean, continuation of wave observation is desirable even after the completion of the port. Thus, it is ideal to have a strong, stable observation station that is capable of obtaining wave information permanently. Construction of large-scale facilities such as a marine tower is desirable as a permanent wave station but, for the time being, every effort should be taken to sufficiently fix and secure the buoy type wave meter being used at the present time.

It should be installed at an offshore point with -20m water depth for both Pinamar and Mar de Ajo as a representative point for the south and north area, considering the presence of considerable difference in marine conditions between, the south and north sides of the cape in Punta Medonos, and it should be installed at an offshore point of the group of shoals for the south coastal area.

b) Calculating values of anomalous waves;

For the purpose of (b) using the wave information stated in above paragraph, information concerning the high waves which may govern the stability of port structures is needed. However, such high waves will occur through some kind of probability process from a long-term viewpoint so that grasping of such high wave data through several years of observation is impossible. Thus, this kind of information is normally obtained by hindcasting from weather data in the past. Data about 30 years in the past should be examined, several days of rough weather should be selected for each year, and the values for waves should be calculated for these weather conditions.

c) Numerical calculations for wave distribution and examination for verification;

Due to the presence of a group of shoals in Punta Medonos, complicated distribution of wave characteristics in the area is expected. Such complicated wave distribution characteristics cannot be grasped only by observation at the site. The use of a numerical model for the wave deformation must be considered. As a numerical model for the wave deformation, a model considering the phenomena such as diffraction and refraction of irregular waves (irregular in wave shape and direction), deformation in shallow water, and wave breaking has been utilized in Japan and other countries. However, the most important thing to be done in using this numerical model is to use the numerical model only after thoroughly verifying the estimated values with actually measured values.

(4) Grasping littoral drift characteristics in the area

a) Measuring of relative values of littoral drift intensity using a tracer or sediment trap;

From the results of measurements for the amount of suspended sediment using a tracer and sediment trap, relative values of littoral drift intensity at a number of points at the same period or relative values of littoral drift intensity due to the difference of marine conditions at the same point can be found. This information is very useful in port planning particularly when determining the port site.

b) Measurement of the rate of littoral transport using a tracer;

The rate of littoral transport can be assumed from the product of moving velocity of the center of gravity of the tracer distribution multiplied by the mixed thickness of the tracer in sand after complete measurement of the tracer distribution pattern. The mixed thickness of the tracer in sand can be found from the vertical distribution of the tracer in the thin-wall sample obtained from the sea bottom.

(5) Survey for forecasting influences after completion of the port plan

a) Hydraulic experiment and numerical calculations for wave distribution near the port and calmness in the port;

In the experiment for wave deformation, it is desirable to perform the wide-area small-scale experiment for analyzing the wave distribution of a wide area and flow conditions in the shoal area, and a narrow-area large-scale experiment for analyzing the calmness in the port. The former should be performed using a distorted model with a 1/500 to 1/700 horizontal scale and a 1/50 to 1/100 vertical scale, and the latter should be done by using an undistorted model with a 1/100 to 1/150 scale. A numerical forecasting model for wave deformation has been developed in recent years. This numerical model has the advantage of the ability to forecast the irregularity of waves.

b) Hydraulic experiment or numerical calculations for forecasting the change of tidal current;

The hydraulic experiment on the tidal current will be performed by using a distorted model with a 1/700 to 1/1000 scale. In giving the current, oscillatory currents, one directional unsteady current, or one directional steady current will be selected depending upon the conditions of the facilities. A numerical model for tidal current change has been widely utilized, and high reliability will be expected if sufficient verification is conducted by using field data.

c) Hydraulic experiment and numerical calculations on topographic change;

For the experiment on littoral drift using a movable bed, the law of similarity does not exist and this is a big problem. Therefore, the conditions are found by the trial and error method in order to simulate the existing conditions of the field within the model, and generally effects of structure installed within these conditions are examined.

For the phenomena in the inshore zone such as change of shoreline after the port construction, an experiment of the movable bed can be utilized using a similar method. However, for the stability of the group of shoals, the possibility of execution of the experiment cannot be discussed here since the phenomena in the field are unknown at the present time. The method of experiment must be found through the analysis of the results of field survey in the future and results of experiment on the fixed bed. On the other hand, a numerical model for the topographic change is presently being developed in many countries. There are two systems in the present numerical models for the topographic changes. One system deals mainly with changes of shoreline, and the other deals with changes of the offshoree sea bottom not influenced by the phenomena near the shoreline. However, integrating these two systems has not been successfully done as yet. Application of the model of the first system will be appropriate for the change near the shoreline resulting from the port construction, and the model of the second system will be suitable for the siltation of the access waterway excavated in the flat sea floor. The possibility of success of a numerical model for the phenomena in the group of shoals depends upon the possibility of numerical forecasting for the beach current near the group of shoals.

6) Analysis on stability of the port and related structures

The problems such as stability of breakwater and wave run-up to the bulkhead will be analyzed by the channel experiment in the wave channel.

APPENDICES

1) Members to the Survey Team

Dr. Chisato Tsuruta;
Director General, Port and Harbour Research Institute

Mr. Tomoharu Takahashi;
Chief of Littoral Drift Laboratory Institute

Mr. Morio Tanaka;
Chief of Coastal Observation Laboratory Institute

2) Itinerary of Survey Team in Argentine

Jul 16 (Set) * 09:00 Arrived at Buenos Aires via Flight AR-321.
Greeted by
Mr. Kimoto, Secretary, and
Mr. Yoshikawa, Secretary,
Japanese Embassy in Argentine;
Capt. Torti, and
Sr. Bergeot,
COPUAP:

* Arrangement together with Secretary Yoshikawa, including the schedule hereafter, interpreter service, etc.

* 16:30 To official Residence of Ambassador for curtsy visit.

Jul 16 (Sun) * 15:00 To Embassy. Check of the carried flow meter.

* 17:00 To Official Residence of Ambassador.

Jul 18 (Mon) * 11:00 Curtsy all on Cap. Guevara. Secretaria de Intereses Maritomos, accompanied by Ambassador Kondo and Secreatry Yoshikawa. Presented the flow meter and the documentary film of Kashima.

* 15:00 COPUAP Working Panel meeting with the presence of:
Japanese side: Leader Tsuruta, Takahashi, Tanaka, and Secretary Yoshikawa
Argentine side: Capt. Torti, Capt. Pantin (Copuap), Capt. Valdez (SHN), Dr. Barchilon,
AHe. Furlong, Ing. Garcia, Ing. Furlong, Ing. Schwarz, Ing. Escalante and Ing. Petroni (DIGID).

* 1930 Reception at Hotel Plaza (held by COPUAP).

Jul 19 (Tue) * 08:00 Called at the hotel, went to LHA.

* Inspected the facilities of LHA.

Jul 20 (Wed) * 08:50 To LHA.

Jul 21 (Thu) * Third day at LHA.

Jul 22 (Fri) * 09:00 Visited SHN, accompanied by Mr. Yoshikawa of the Embassy.

Paid respect to the Deputy Director, then received the explanation of the achievements of investigation, etc. of SHN.

* After the presentation, simple cocktail party with the presence of
Capt. Garrido, Capt. Paccioretti,
Capt. Torti, Capt. Valbez,
Capt. Buscallia, Capt. Nawratill,

Capt. Young, Capt. Paone,
Ing. Lanfredi, Dr. Parker and
Sra. Martorani.

* 16:00 The Kashima Port documentary film was projected in the COPUAP projection room.

Jul 23 (Sat)	*	09:00 Inspection of the Tigre area. Party on board the ship with attendants of: Japanese side - Kitamura, Ambassador Kimoto, Councilor Yoshikawa, Secretary Tsuruta, leader of the survey team Takahashi, member Tanaka, member Argentine side - Capt. Torti Capt. Buscallia Sr. Bergeot Ing. Gracia Dr. and Sri. Barchilon Mr. Kurokawa and and Mr. Kiuchi.
Jul 24 (Sun)	*	
Jul 25 (Mon)	*	In the morning, inspection of the Buenos Aires Port. Accompanied by Capt. Torti, Sr. Bergeot, Sr. M. R. Bottessi, Director of NABIGATION Dept., and Ing. L.A. Roura, Division Chief.
	*	12:00 Luncheon at the Secretaria de Estado de Intereses Maritimos.

Attendants:

Ambassador Kitamura, Secretary Yoshikawa, Leader Tsuruta, Takahashi and Tanaka;
Capt. Guevara, Capt. Torti,
Capt. Villanueva, Capt. Valdez,
Dr. Barchilon and Capt. Babino.

* 15:00 Went to SHN and discussed with Dr. Parker over the problems of the bank.

Jul 26 (Tue) * 08:00 Gathered at SHN for trip to Punta Medanos.

* Lodged in a hotel in Mar de Aja.
Participants:

Capt. Torti, Capt. Buscallia,
AHe. Furlong, Ing. Langredi,
Dr. Parker, Dr. Barchilon,
Ing. Castellano and Ing. Clavijo;
and Leader, Takahashi and Tanaka.

Additionally, personnel of the field camp joined the inspection.

Jul 27 (Wed) * 09:00 Departed for inspection of the south coast.

Jul 28 (Thu) * 09:00 Dr. Barchilon, Ing. Clavijo and Ing. Castellano came to the hotel. Answered to their questions concerning the experiment, field survey and machines and instruments

* 11:00 Curtsy visit to Ing. Camba, Secretaris de Estado de Transporte y Obras Publica, accompanied by Councilor Arao and Secretary Yoshikawa of the

Embassy and Dr. Barchilon.

* Luncheon meeting given by Dr. Barchilon.

* In the afternoon, discussion continued with the members of LHA.

* 16:00 At the Embassy, arrangement with the councilor (in charge of the policy) and Secretary Yoshikawa in the presence of the Ambassador with respect to the policy of technical cooperation.

Jul 29 (Fri) * 10:19 COPUAP Working Panel meeting.
Attendants:
Capt. Torti, Capt. Buscaria, Capt. Pautin, Img. Petroni, Ing. Schwarz, Ing. Garcia, Ing. Castellano, Ing. Lanfredi, Ing. Clavijo and Dr. Parker; and Leader, Takahashi and Tanaka, and Secretary Yoshikawa.

* 12:45 Talk with Capt. Guevara, Secretaria.

* 21:30 Supper meeting at the Official Residence of the Ambassador.
Attendants:
Ambassador Kondo, Councilor Secretary Yoshikawa, Secretaria Cuevara, Deputy Secretaria R. F. Bondoni, Channel Department Chief Villanueva, Capt. Valdez, Capt. Torti, Leader, Takahashi and Tanaka.

Jul 30 (Sat) * Departed Argentine via Flight AR380. Honored the send-off of Capt. Torti, Sr. Bergeot and Secretary Yoshikawa.