THE USE OF RAYDIST IN THE SURVEY OF A BANK OFFSHORE LOURENÇO MARQUES

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1. — Choice of Raydist equipment

The hydrographic survey of the Portuguese overseas province of Mozambique involves many difficulties, due to the great length of the coast (about 1 500 nautical miles), islands and coral reefs in the north, shoals and mangrove in the centre, extensive sand dunes which are difficult of access in the south, bad weather, strong currents, and so on.

For this survey we had installed in 1951 on the hydrographic ship *Almirante Lacerda* the Raydist equipment Type E, with one reference transmitter (2 642 Kc/s), one mobile transmitter (2 641 Kc/s), three slave shore stations, connected by high modulated frequency (36.1-36.9 and 38.7 Mc/s) and one master station.

This equipment was very useful in the survey of coastal waters and of the Sofala Bank, near Beira, giving accurate positions up to 80 miles offshore.

However, it was not very practical for the survey for the projected general charts on account of the small area covered by each group of shore stations, and the consequent need of frequent changes of sites, most of them being difficult of access.

This limited coverage, which is characteristic of the geometry of hyperbolic systems, was further decreased in our equipment by the bad conditions of propagation over land of the high frequency modulated transmissions between shore stations, whose distance was very seldom greater than 30 miles.

For these reasons it was advantageous to have a new electronic positioning system with the greatest possible coverage for each group of shore stations, and a two-range system would satisfy this requirement more efficiently.

We chose the DM Raydist system after visits to some manufacturers of electronic navigational equipment in France, England and the U.S.A., as we thought it was at that time the best solution to our problems in Mozambique connected with various characteristics of range, precision, coverage, lane identification, need of calibration, portability and others.

2. — General characteristics of Raydist DM and results obtained

This new Raydist DM equipment for the Hydrographic Mission of Mozambique, installed on the hydrographic ship *Almirante Lacerda* in 1960, consists of two shore stations, with completely independent circuits, two mobile transmitters and one Navigator on the ship.

The frequencies of the continuous wave transmitters of the shore stations are 3 484.345 Kc/s and 4 232.256 Kc/s, and those of the reference transmitters on board 1 741.983 Kc/s and 2 115.918 Kc/s giving heterodyne signals of 380 and 420 c/s which are received by the phasemeters. The output of all continuous wave transmitters is 100 watts, which theoretically gives ranges of 180 miles during the day and of 60 miles during the night, in the area of the Mozambique Channel.

We preferred this equipment with two independent red stations instead of one red and one green, slave of the former, normally supplied by Hastings Raydist Inc., in order to avoid radio links over land, always subject to attenuation and disturbance, and thus allowing complete freedom of choice in the sites of shore stations.

As the width of the lanes is different for the two stations, the position must be plotted on the boat sheets with a special protractor with two families of semicircles separated by a common diameter.

This equipment gave a satisfactory performance, and functioned about 300 hours during the field season of 1960 and about 600 hours during the field season of 1961, with few breakdowns, mostly due to the power generators of the shore stations.

The main difficulties due to electronic circuits were an effect of cross-modulation and over-modulation at one shore station and a breakdown of the high pass filter in the main station antenna loading box; these causes are being investigated.

Atmospherics and noise have little influence on the equipment, due to the great selectivity and sensibility of the phasemeters, although they may sometimes cause a loss of lanes in the counter. That is why we always use a Brush recorder, from which we are able to reset the position if the perturbation is not very long and especially if the ship follows a steady course with constant speed.

The maximum ranges observed during 1960 and 1961 were of 154 nautical miles by day and 101 nautical miles by night. This last is exceptional, as it greatly exceeds the normal night range of 60 miles.

3. — Normal procedure in the general chart soundings

The soundings for the general charts of Mozambique are to be carried out up to 120 nautical miles offshore. As a rule, shore stations are installed 60 nautical miles apart; this gives a coverage of about 11 000 square nautical miles with good lane intersections (between 30° and 150°).

The Raydist, being a differential system, must be set on an accurate position, generally obtained by sextant observations near the shore.

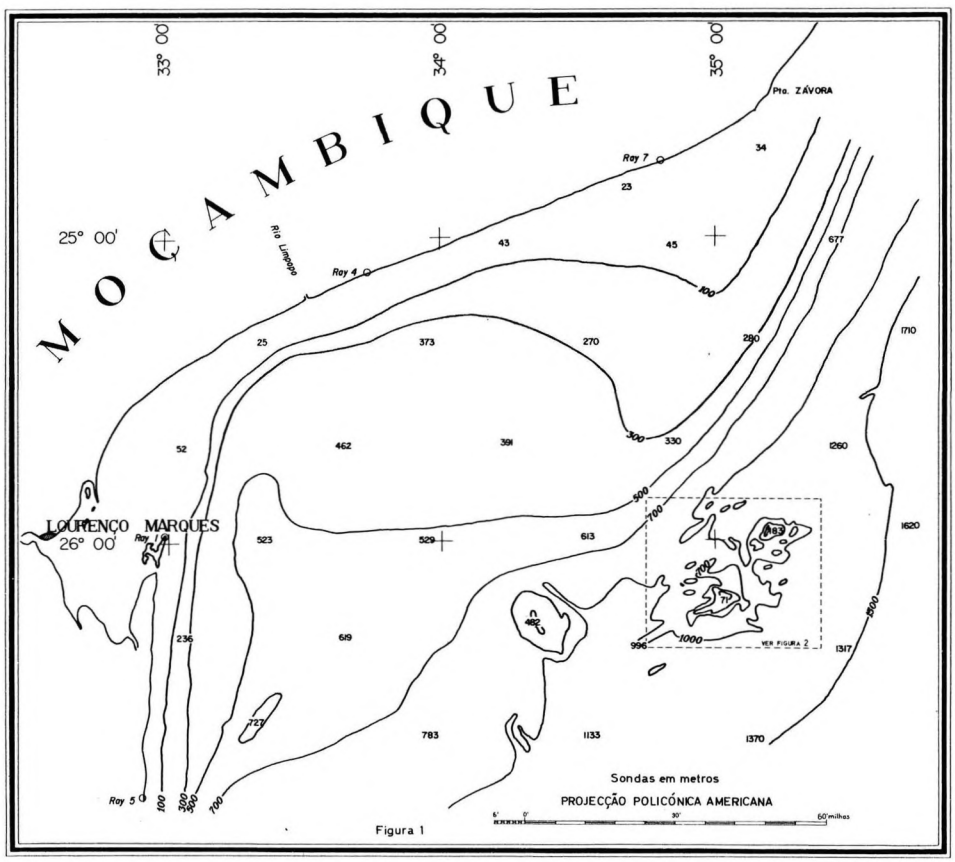


FIGURE 1

The planning of soundings must take into consideration the maximum ranges, day and night, in order not to lose the position. With the standard sounding speed of the ship (12 knots), the following procedure was normally used:

(*a*) Observation of a starting position, and setting of the phasemeter counters;

(*b*) Continuous sounding of the coastal area during the same day or night, within the maximum ranges, and arrival at sunrise at the limit of the range;

(*c*) Starting the long lines of soundings for the general chart at sunrise, arriving at their outward limit at noon; coming back through another line and arrival at a range less than 60 to 70 miles from the shore stations at sunset.

4. — Exploration of a bank, offshore Lourenço Marquès

The previous method was used in the 1961 field season from the southern limit of Mozambique to Ponta Zavora, a coastline of about 200 nautical miles with regular bathymetry outward from the 200-metre line

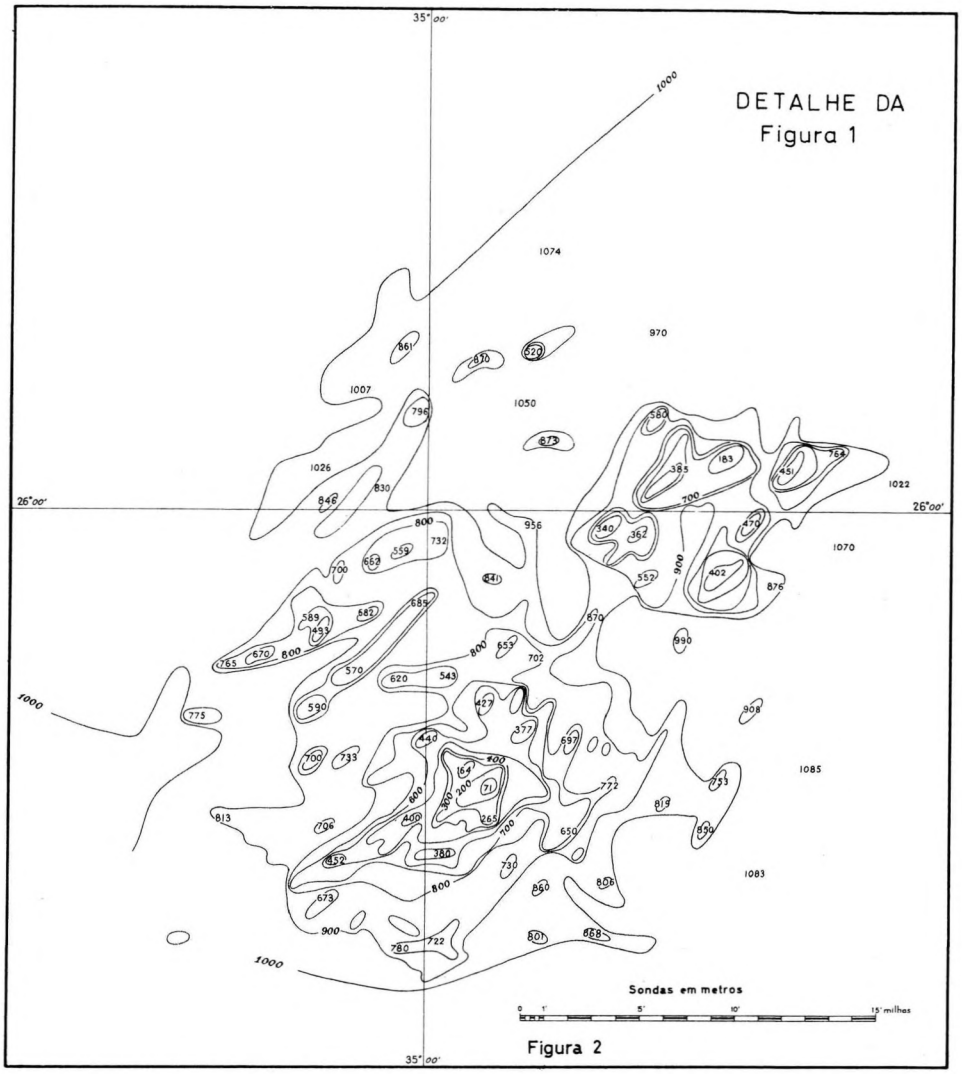


FIGURE 2

except near the position 26°11'.8 S and 35°02'.9 E, where a complex system of banks was found.

With an Elac echo sounder the hydrographic ship *Almirante Lacerda* discovered in this area a group of seamounts with exceptionally steep slopes, sometimes greater than 30 %, which rise from the 1 000-metre depths up to 100 or 200 metres. The graphs obtained by the echo sounder are very unusual as the depths vary sometimes by more than 100 metres per minute, and very irregularly (see reproduction of sounding profiles).

For the detailed exploration of this area we had to use a special procedure, as the normal one previously mentioned only allowed the ship to stay over the banks for a very short period each day without losing the position at sunset; this would result in a minimum delay of two days to go and reset the Raydist counters and return to the bank.

The problem was solved by anchoring a Fitzroy buoy over the bank at a depth of 80 metres, which position was defined accurately during the first day with the Raydist and was used the next morning to set the ship's position.

The first radar reflector used proved unsuccessful, and we had to manœuvre the ship all night, against wind and currents of one to two knots, trying not lose visual contact with the buoy, which was only possible during bright moonlight.

A new radar reflector of the type used by the firm AGA was installed in the buoy, and we repeated the operation, obtaining very good radar echoes. Even so, and to reduce manœuvering, the ship was anchored every night over the bank (about 90 metres deep), using a small anchor of 150 kg and 360 metres of wire cable.

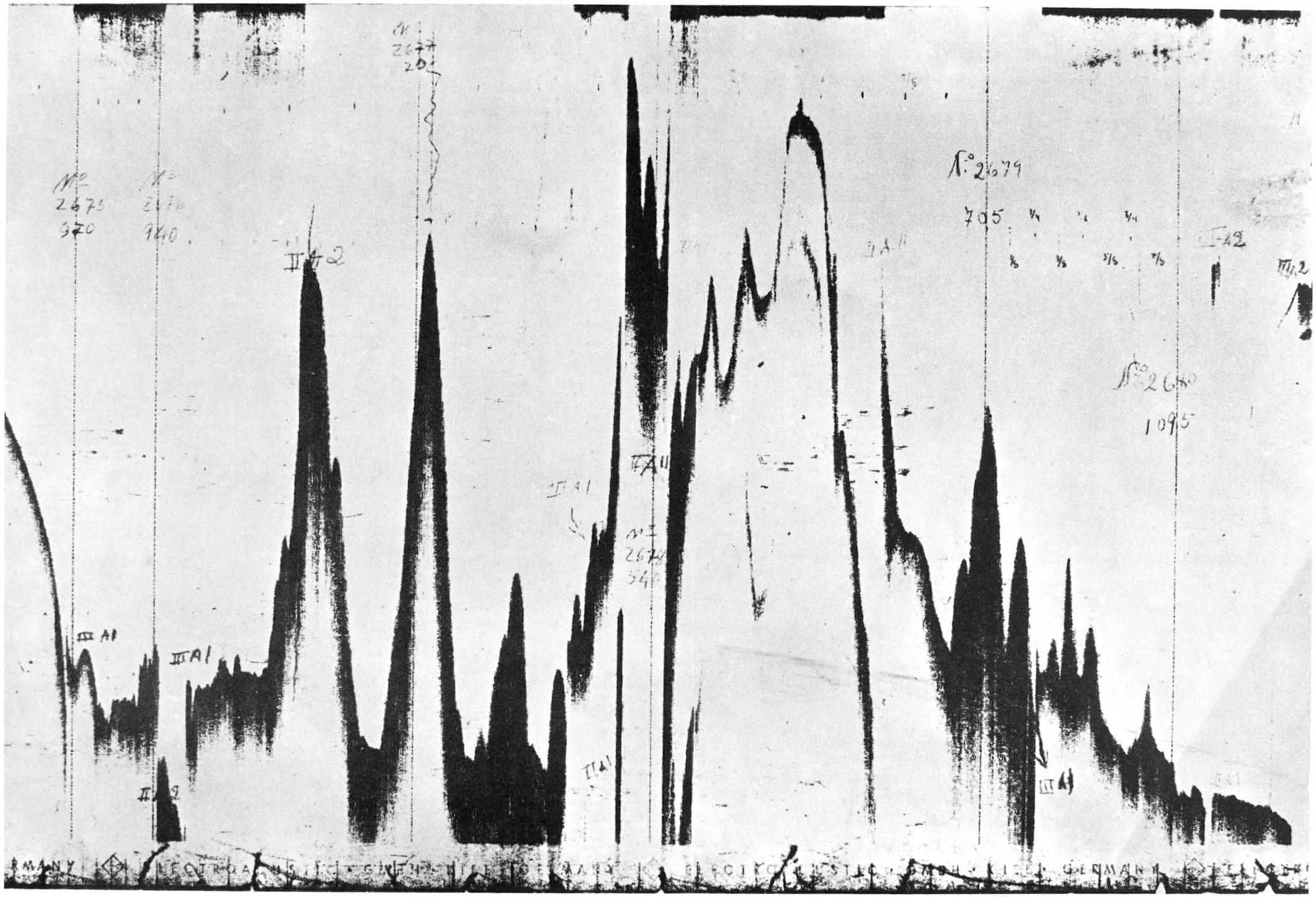
We were thus able to investigate the banks for six successive days, and to make a detailed survey at appropriate scales, up to 1/7 500.

The main features of these banks are shown in figures 1 and 2, and many seamounts separated by much greater depths are clearly visible. The smallest depth observed was of 71 metres, and this area seems to be a very rich fishing ground, as proved by some fishing trials, by clear echoes of large shoals of fish on the fathometer, and by the abundance of bird life, sharks and dolphins in this area.

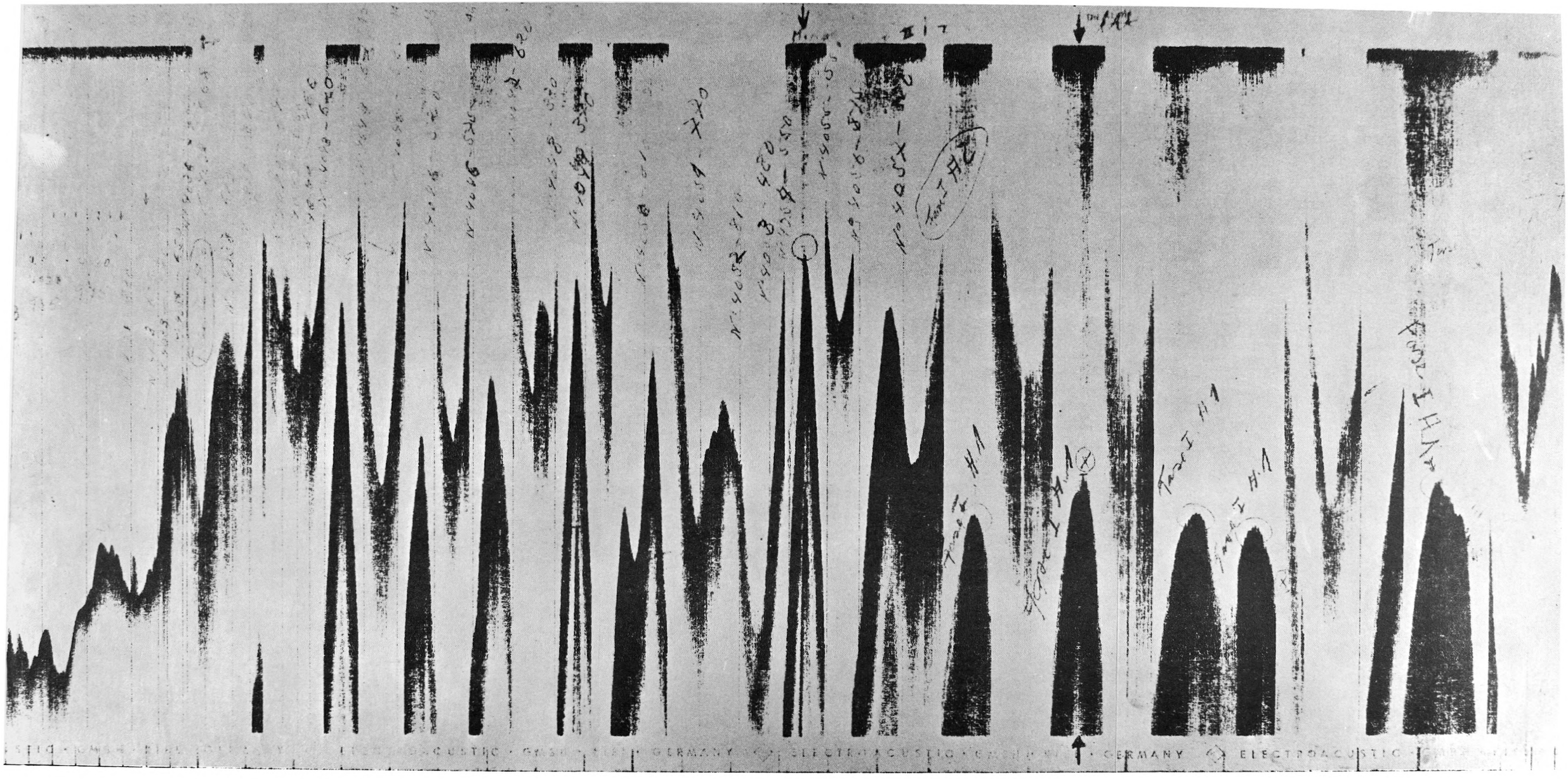
5. — Conclusions

The example shown is typical of a very accurate hydrographic survey offshore, only possible with modern methods of radio navigation, and represents an interesting contribution to the better knowledge of the Mozambique Channel.

Furthermore, the use of Raydist on the hydrographic ship *Almirante Lacerda* has provided as a result of the normal soundings a large number of current observations through the comparison of dead reckoning and Raydist positions. They show, at this stage, the very complex structure of the circulation in the Mozambique Channel, near Lourenço Marquès, with a main south-westerly current offshore, a nearshore north-easterly counter-current and several eddies in between.



Example of sounding profile.



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