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Compagnie Générale de Géophysique

Bureau of Mineral Resources

marine geophysical survey, Gulf of Papua and Bismarck Sea, field report Sept. 1970 to Dec. 1970, survey 05

BUREAU OF MINERAL RESOURCES

MARINE GEOPHYSICAL SURVEY
GULF OF PAPUA AND BISMARCK SEA
FIELD REPORT
September 1970 to December 1970
SURVEY 05

COMPAGNIE GENERALE DE GEOPHYSIQUE
39 BOOROONDARA STREET REID, A.C.T.

Record 1974/45

FIELD REPORT OF MARINE GEOPHYSICAL SURVEY NO. 5 OF THE GULF OF PAPUA AND BISMARCK SEA

by

COMPAGNIE GENERALE DE GEOPHYSIQUE

SEPTEMBER TO DECEMBER, 1970

This report was written by the contractor, Compagnie Generale de Geophysique to record the progress of the survey in the Bismarck Sea and the Gulf of Papua. It represents his view of the operations, which is not necessarily that of the Bureau of Mineral Resources.

SUMMARY

A marine geophysical survey of the Bismarck Sea, part of the Gulf of Papua and contiguous waters was carried out by Compagnie Generale de Geophysique (C.G.G.) under contract to the Bureau of Mineral Resources, Geology and Geophysics (B.M.R.) between September and December, 1970. Gravity, magnetic and seismic reflection and refraction observations were recorded.

Geophysical equipment was installed on M.V. Hamme in Sydney during August 1970 and tests were carried out during the cruise to New Guinea and during a test cruise following arrival at Port Moresby. The survey itself comprised five cruises, with intervening port calls at Madang, Lae, Rabaul and Port Moresby. A total of 14 566 nautical miles of traversing was completed at an average cruising speed of nearly 9 knots.

All of the data, except seismic, was acquired in digital form on magnetic tape using small electronic computers to control and monitor the input. All important parameters were recorded also in analogue chart form, both for monitoring the measurements and for backup in case of failure of the digital system.

The primary navigation control was performed by a satellite Doppler system and continuous position was obtained by the use of sonar Doppler equipment to interpolate between the satellite fixes. For back-up support to the sonar Doppler, a Chernikeeff electromagnetic log and a pressure log were operated continuously and the outputs were recorded on the digital tape along with gyro compass bearings. A V.L.F. radio navigation system was operated as back-up to the satellite Doppler system.

Total magnetic field measurements were made using a proton precession magnetometer trailed about 200 m behind the ship. Gravity measurements were made with a La Coste and Romberg marine gravity

meter mounted on a gyro-stabilized platform near the centre of the ship. The seismic system comprised a six-channel hydrostreamer cable and a single channel cable both connected through a standard seismic amplifier bank to an analogue magnetic tape recorder and two analogue chart recorders. The seismic energy source was a 120 Kilojoule sparker. The use of Flexotir as the energy source for refraction recording was discontinued after the first cruise when it was found the sparker was more suited to the operation. Water depths were measured by two depth sounders, one designed for shallow water and the other for deep water.

Diurnal variations of the magnetic field and the V.L.F. transmissions were recorded at a shore station established at Port Moresby.

Note: Summary written by F.W. Brown, B.M.R.

BUREAU OF MINERAL RESOURCES

MARINE GEOPHYSICAL SURVEY

GULF OF PAPUA AND BISMARCK SEA

FIELD REPORT
September 1970 to December 1970

SURVEY 5

Compagnie Generale de Geophysique
39 Booroondara Street, REID, A.C.T.

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INTRODUCTION

According to Contract Acceptance and Purchase Order Q 560585, of the District Contract Board of Queensland, Compagnie Generale de Geophysique carried out, on behalf of the Bureau of Mineral Resources, a combined marine geophysical survey of the Gulf of Papua and the Bismark Sea. During this survey a shore station was located in Port Moresby.

The geographical limits of each cruise of this survey are:

	Limit North	Limit South	Limit East	Limit West
Cruise 1	02°30	11°20	152°00	145°40
Cruise 2	00°30	07°00	148°20	141°10
Cruise 3	00°40	05°00	155°00	144°10
Cruise 4	03°40	11°40	154°30	147°05
Cruise 5	08°00	11°30	147°30	144°00

This survey lasted from September 4th, 1970 to December 7th, 1970. Its B.M.R. name is survey 5.

BMR

Fig. 1

T. P. N. G.

MARINE GEOPHYSICAL SURVEY, 1970

LOCATION MAP

1st cruise	: lines	1	to	32
2nd	"	33	-	86
3rd	"	86	-	135
4th	"	136	-	188
5th	"	189	-	230

SCALE : 1 / 5,000,000

0 100 200 Km

CGG

141° 144° 147° 150° 153° 156°

0° 3° 6° 9° 12°

NINIGO GROUP

ADMIRALTY ISLANDS

MANUS Island

BISMARCK ARCHIPELAGO

BISMARCK SEA

ST MATTHIAS GROUP

NEW HANOVER

NEW IRELAND

PACIFIC OCEAN

RABAUL

WITU Islands

KARKAR I

LONG I

UMBOI I

MADANG

NEW BRITAIN

SOLOMON ISLANDS

BOUGAINVILLE ISLAND

IRIAN WEST

NEW GUINEA

PAPUA

LAE

SOLOMON SEA

TROBRIAND I

D'ENTRECASTEAUX ISLANDS

WOODLARK I

LOUISIADE ARCHIPELAGO

PORT MORESBY

LINE 1

LINE 2

LINE 230

THE GREAT BARRIER REEF

CORAL SEA

AUSTRALIA

PRELIMINARY TO START OF SURVEY

I Trip from Sydney to Port Moresby:

The equipment set up on board M/V Hamme in Sydney was tested at sea during the voyage to Port Moresby (15th to 26th August, 1970). Meanwhile the data acquisition programme was modified to meet the requirements of this survey:

* Addition of ten channels into the Data Acquisition System: 8 V.L.F. amplitudes, sine and cosine of the heading; 32 channels are now input.
* Ability, at any time, to calibrate the 20 analogue channels.
* Maintenance, via the computer, of three systems of deadreckoning between the times of Satellite fixes.
* The size of the acquisition blocks was reduced to 2.5 minutes.

The calibration of the gravitymeter was checked during four calls on the way to Port Moresby:

Port	Date	Meter zero
Sydney	13.08.70	971,161.0
Mackay	21.08.70	971,160.8
Cairns	23.08.70	971,160.4
Port Moresby	02.09.70	971,160.1

II Cruise in the Gulf of Papua

This cruise took place near the Fly River from August 30th to September 2nd, 1970. It was shortened by the loss of 2 seismic cables during the night of August 31st/ September 1st. Only one of them (main cable) could be recovered.

The Chernikeeff log was also damaged during the night. The sea becoming rough, the ship had to sail to Port Moresby to effect repairs in harbour.

The noise level of the main cable was of 40 microvolts for the first channel and 15 microvolts for the other five. Edgerton recorders provided better results than Esterline Angus recorders. Pinger was not put at sea, and generally, stack result was removed during refraction probes.

SUMMARY OF OPERATIONS

* Cruise 1

Survey 5 began on 4th of September 1970, at 10.00 L.T. (BMR day 01.00.00), M/V Hamme being berthed in Port Moresby. Work began on day 01.04.40 and lasted until day 12.04.10.

At the end of this cruise, the ship berthed in Madang (15.09.1970) and left this port (18.09.1970) for Lae where she arrived on the 19th of September at 12.30 (ship being anchored until next day at 11.00 L.T., berthed later). This change of port is due to the insufficient supplies available in Madang for the ship (water and food being brought aboard from Lae).

* Cruise 2

M/V Hamme left Lae on 21st of September 1970 at 15.15 L.T. (BMR day 18).

The working period were -

- from 18.07.40 to 25.21.20: stoppage for D.A.S. troubles
- from 26.04.30 to 33.07.10: End of cruise - Sail to Madang

The ship arrived at Madang on 7th of October, 1970 at 17.00 L.T.

* Cruise 3

M/V Hamme left Madang on 09th of October at 22.00 L.T. (BMR day 36).. The working period lasted from 37.16.20 to 53.19.35 without any stoppage. The ship arrived in Rabaul on 27th Of October at 15.00 L.T. (BMR day 54)

* Cruise 4

M/V Hamme left Rabaul on 3]st of October at 20.15 L.T. (BMR day 58). The Working periods were:

- from 58.18.00 to 62.20.20: Stoppage for D.A.S. trouble
  Sail to Lae
- from 64.11.40 to 72.11.20: End of cruise; Sail to Port Moresby.

The Ship arrived in Port Moresby on 15th of November (BMR day 73)

* Cruise 5

M/V Hamme left Port Moresby on the 23rd November at 04.00 (GMT)(BMR day 81).

The working period lasted from day 81.12.00 to 95.14.00, without any stoppage.

The ship sailed to Port Moresby for the end of the survey.

* STATISTICAL ANALYSIS

Figure 2 gives statistical results for all cruises of survey 5. On this table a mean travel time of about 4 hours

STATISTICS

Survey / Cruise	Total time at sea TTS	Working time	Travel time	Supply boat	Bad weather	Major breakdown	Port	Total time TT
05 / 1	268·05	263·25	04·40				156·15	424·20
05 / 2	376·00	364·50	04·00			07·10	80·00	456·00
05 / 3	391·15	387·15	04·00				114·25	505·00
05 / 4	333·20	290·00	04·00			39·20	212·40	546·00
05 / 05	342·00	338·00	04·00				102·00	444·00
TOTAL	1710·40	1643·30	20·40	0	0	46·30	665·20	2376·00
MONTHES	2.376	2.283	0.029	0	0	0.064	0.924	3.3
REDUCED TO **1 MONTH**	0.720	0.692	0.009	0	0	0.019	0.280	1
DAY / MONTH	21.6	20.76	0.27	0	0	0.570	8.4	30
TTS = 100%	100%	96.11%	1.25%	0	0	2.64%	–	–
TT = 100 %	72% TTS + PORT = TT	69.2%	0.9%	0	0	1.9%	28.0%	100%

FIG. 2

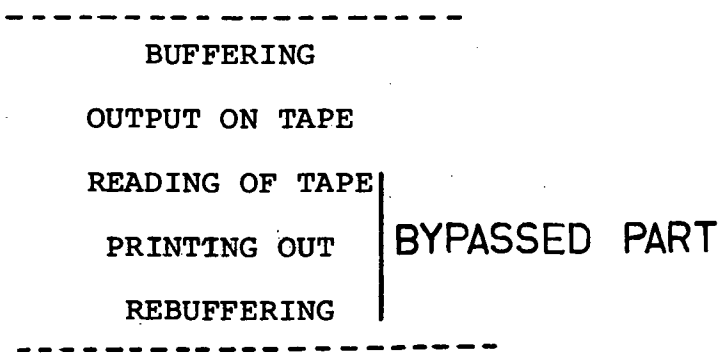
has been assumed for each cruise, accurate data for travelling not being available. The breakdown of this survey, in relation to working and stoppage times appears very satisfactory. A total of 14566 nautical miles has been surveyed in 1643 hours 40 minutes with a working speed of 8.86 knots.

FIELD OPERATIONS

I DATA ACQUISITION SYSTEM

From 1st of October, the dead reckoning was not working; the system output dollars sign ($) instead of values; On 2nd of October, the magnetic tape recorder emitted abnormal noises, and consequently the magnetic tape had to be changed and the heads cleared; on 6th of October the running of the tape recorder became abnormal; operations had to be stopped and the ship sailed to Madang. Two checks carried out with an interval of 12 hours did not show any parts wrong in the system. Perhaps it was due to the temperature in the navigation room.

During the call between cruises 2 and 3, a thorough check was carried out on the whole data acquisition system showing no abnormality. Despite this, dollar signs reappeared on listings. So, it was decided to bypass the following part of the programme:



The rebuffering was suspect; incorrect values were used for the dead reckoning calculations, the results being out of range. With the above modification, dead reckoning appeared correct, but writing of the magnetic tape was not checked any more. It cannot be said whether it is a hardware

or software problem, Hewlett-Packard test not showing any anomaly.

At the beginning of cruise 4 (days 58 and 59), a new version of the Data Acquisition programme with two back spaces was used. However, after three identical breakdowns (tape recorder staying on forward and programme destroyed), the original programme was again used (only one backspace). Loss of data during each of these breakdowns was approximately 50 minutes. As for the previous cruise, output from this programme was not satisfactory (printed out dollars and bad cycle "writing-back", "space-reading") the same solution was adopted to get reasonable data.

A Hewlett-Packard representative was called and came on board in Lae (day 63). On day 64, Data Acquisition System was restarted (using original programme) and worked satisfactorily until day 69 when troubles started again. (H.P. representative had left the ship on day 66). Troubles were similar to the previous ones and lasted until the end of the cruise.

Between cruises 4 and 5, the Hewlett-Packard representative was recalled and worked again upon the tape recorder 2020B. Behaviour of this system was better than during the last cruise. However it must be pointed out that 04.45 hours of data were lost due to:

- Navigation clock (bad contact).
- Sercel interface
- Format error in the computer
- Tape recorder (cleaning of the magnetic heads)
- Difficulties in calibrating V.L.F. channels coming from the multiverter (repairs carried out on day 97 during Port Moresby call).

II SEISMIC SYSTEM

II.I Seismic container:

The survey uses a 6-channel cable designed to receive deep reflections of seismic data. Shooting is performed every 50 meters providing four six-fold coverages which are processed on board as exploration proceeds. The data are converted to digital form through a Hewlett-Packard multiverter corrected for normal move out and stored onto a disc memory awaiting the corresponding common depth point (CDP) traces. When four consecutive CDP's are available, the four stacks are processed and mixed. Basic parameters, (velocity function, distances, mutes) are introduced via teleprinter.

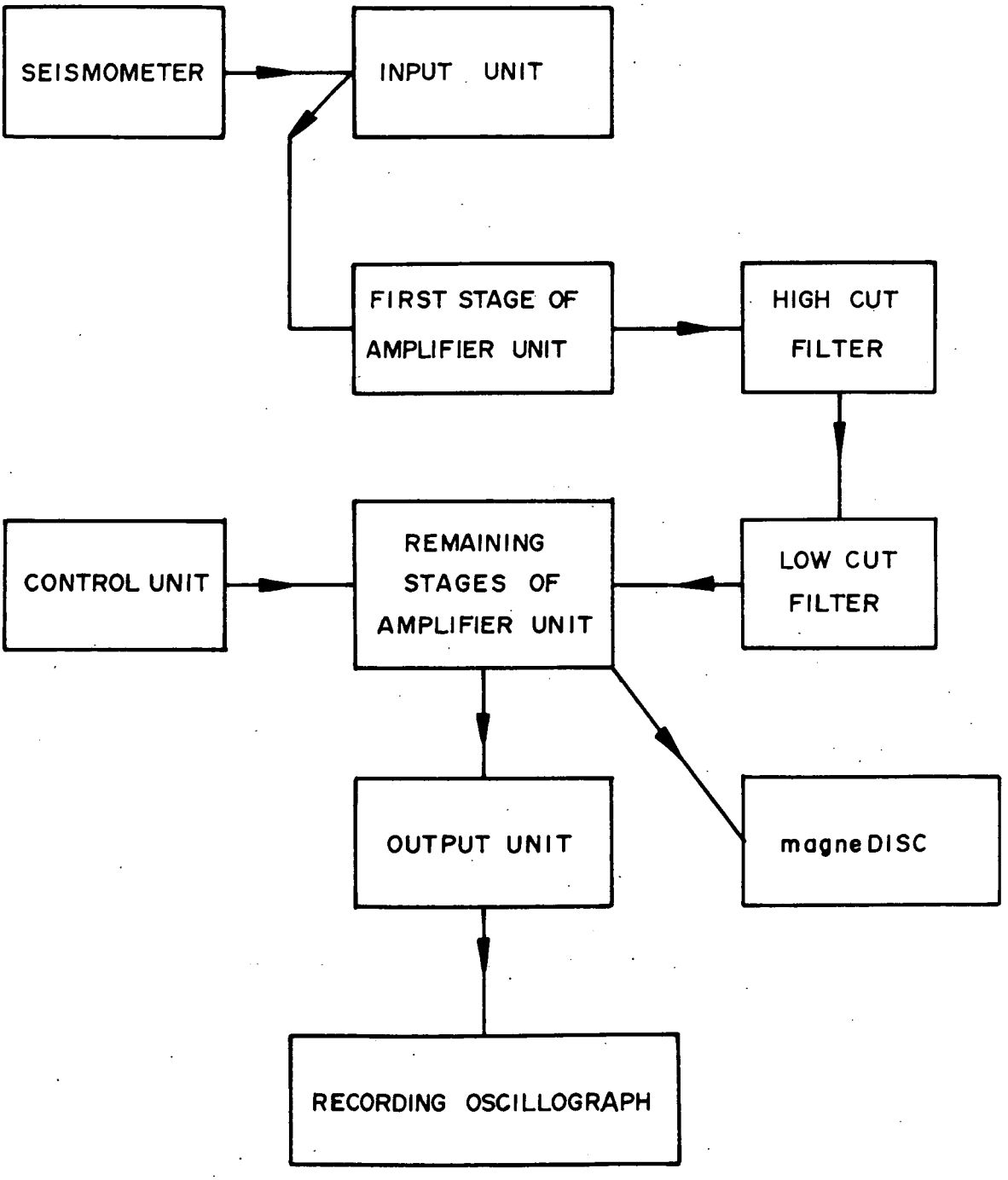
In C.D.P. technique, the normal move-out correction is essential and needs permanent watching. The velocity function can be adjusted according to water depths and the residual deformations observed on spit-outs. Pinger is used to bring a very high resolution of the sea-bottom. Refractions tests were carried out with SONOBUOYS, energy source being either Sparker or Flexotir.

As the ESTERLINE ANGUS E1101S recorders were not available, the remaining recorders were used in the following way:

- Elimination of the pinger
- Recording of the single channel on ESTERLINE ANGUS and transferring onto EGG recorder in case of shallow water.
- Recording on EGG recorder of one trace of the long cable and of the result of the stack.
- Elimination of the stack, in the case of a refraction test,
- Elimination of the spit-out.

FIG. 3

HTL 7000B
FLOW DIAGRAM



The amplifier used was a 7000B portable seismic system of Texas Instrument Inc.; its main characteristics were (fig. 3)

- The inputs go to the input unit for metering and paralleling. For a normal shot, the input unit is not a part of the circuit.
- For a normal shot, the inputs are fed directly to the amplifier units. After the first stage of amplification which is not affected by A.G.C. the signals are filtered by the high and low cut filter units.
- After filtering, the signals return to the remaining stages of the amplifiers where the A.G.C. control signal from the control unit limits the gain to a pre-determined level.
- The outputs of the amplifiers go to the output unit for mixing, if desired, and then to the recording oscilloscope.

The main problem encountered was due to the insufficient air conditioning of the seismic cab restricting cooling of the system.

Seismic Processing system operation

Cruise 1 The Hewlett-Packard computer was unserviceable for 99 hours during this cruise. It seems that a malfunctioning of the air conditioning of the seismic cab is the main cause of the H.P. troubles. The second cause of these troubles consists of difficulties with the hardware of the system. Assistance of Hewlett-Packard technician was called at Madang.

Cruise 4 The Hewlett-Packard computer was not working during the whole cruise. The trouble was found to be in the multiverter and was impossible to repair on-board. The Hewlett-Packard technician, onboard the ship, took away the circuit-board to be fixed up by RAYTHEON in Sydney.

Cruise 5 The repaired circuit board, was received on day 81 after set up in the multiverter on day 82, the system began again to run.

Seismic recorders

Two main kinds of recorders were used during this survey : ESTERLINE ANGUS and EDGERTON. Channel 2 of main cable, shallow cable and stack were recorded permanently; Refraction probes were recorded on EDGERTON recorders.

On cruise 5, a RAYTHEON Recorder was received and began to work on day 84 till day 95 when the absence of space parts did not allow repairs.

II.2 Sparker container and electrodes

* On cruise 1, the electrode gear worked satisfactorily. However, the port side boom broke down when the speed was reduced to fix the Chernikeef Log (4th of September). A couple of stronger booms were ordered in Port Moresby for delivery in Madang. Nevertheless, the electrodes appear to be heavily trimmed with regard to their insulation and ballast. The use of a lightly insulated cable would increase the electrode consumption

but make operations easier and reduce time spent for maintenance (about 2 hours per day).

* On cruise 2, apart from time used for electrode maintenance (1.5 hours per day), running of the system was satisfactory.
* On cruise 3, the change to light electrodes and a better trimming of the system reduced maintenance time to 11 minutes per day.
* On cruise 4, working quite satisfactory
* On cruise 5, violent storm caused short circuit in sparker room. Repairs stopped seismic work from 81.16.30 to 81.17.20.

II.3 Refraction probes - Sonobuoys - Flexotir

Cruise 1 On 7th of September (BMR day 4) a failure of the receiver was fixed, but some troubles were still present. On 8th of September (BMR day 5) a bad contact was found in the connection of the ship sonobuoy-aerial. With regard to the FLEXOTIR system, it can be said that the results of its use during this cruise were not satisfactory: The emitted signal appeared good even when the guns were towed at 4 meters depth, but many shot stoppages occurred, apparently due to the plastic explosives; cartridges often jam in the firing head when sailing at 10 knots.

On 11th of September (BMR day 11), refraction probe was cancelled, because two guns were jammed and fuse lines broken. It must be noted-

- Use of Flexotir requires the sparker system stopped.
- Use of sparker (15th of September) as refraction source gives comparable results to the Flexotir.

* Cruise 2

Sparker was used satisfactorily as a refraction source. Seven sonobuoys have not worked for the following reasons:

- Insufficient protection against humidity.
- Geophone not released
- Breakage of antenna wire when antenna released
- Inadequate frequency
- Deficient battery

13 Sonobuoys were damaged when water flooded the hold in which they were stored; this was due to a misuse of water - gate.

* Cruise 3

Six sonobuoys did not work correctly for the same reasons as during cruise 2.

* Cruise 4

Refraction test carried out near Egum Atoll (day 67) showed that optimum operating conditions are:

- Ship's speed: 6 knots
- Shot interval: 10 seconds
- Sweep (recording): 3.2 seconds
- Record through the Aquatronix receiver, the KROHN-HITE filters (HP 200 x 100, LP 40 x 1, on band reject) the E.G.G. recorder (filters by-passed)
- Shifting of the aerial on the top of the rear mast

* Cruise 5

Several sonobuoys failed for the reason already expressed above (cruise 1) and one of them because of the failure of the coaxial cable from the antenna to the receiver.

For the whole survey, 68 sonobuoys were used, 38 being good.

III Sounders

* ATLAS performances were limited to 20 metres only. It seems that the transducer was damaged at the beginning of operations while work was carried out to set up equipment on board the ship for this survey.

* ELAC echo sounder provided an analogue record up to 4000 meters. Digitization of this record has to be made later, this system not having any digital output.

* DIGITRACK system was operational on day 89, but the data provided are not reliable. The real reason of this malfunctioning is not well known.

IV MAGNETISM

Main problem was coming from interference between the magnetometer and the sparker system, once interference coming from SSB transceiver was suppressed. To do it, the magnetometer cable was set up in the portside FLEXOTIR

Faraday cage at the beginning of cruise 2.

V GRAVITY

At the beginning of the survey (first sixty hours) a large cross-coupling effect, with a noteworthy correlation between cross-coupling and gravity is shown on the recordings. This phenomena disappeared after Jomard entrance when sea conditions improved.

G.A.I. was asked the reason of the behaviour of the meter. Reply was received at the next call: terms AX and AX^2 of the cross-coupling were responsible. Their influence was expected to be of the fourth order and the suggestion from G.A.I. and Lacoste and Romberg was to switch them off; which was done on 25th of September (BMR day 21). AX was recorded in analogue form on a WW601 recorder.

The variations of AX are generally small; when they become noteworthy, no correlation between AX and G (without AX) appears.

WW601 recorder was replaced by Westronics recorder on BMR day 47.

During fourth cruise, as suggested by Lacoste-Romberg, an extra resistor was set up in parallel in the AX circuit. No improvement can really be seen, due to the sea state.

VI NAVIGATION

Main systems worked satisfactorily throughout the survey. Failures of Chernikeeff or Pressure Log were generally small and never disturbed dead reckoning, except during

cruise 4 (day 66) when a general power failure stopped all navigation systems for several hours.

Satellite system worked satisfactorily throughout the cruise.

VII CABLES

Two cables are towed, a single channel and a six channel. The first one is designed for high frequency shallow reflections. It should have been a GEOTECH cable with a 50 feet long active section, but this cable was lost during a preliminary test - cruise and replaced by a spare trace of the main cable. The second one (fig 4) is designed to receive deep reflections.

- Operations:

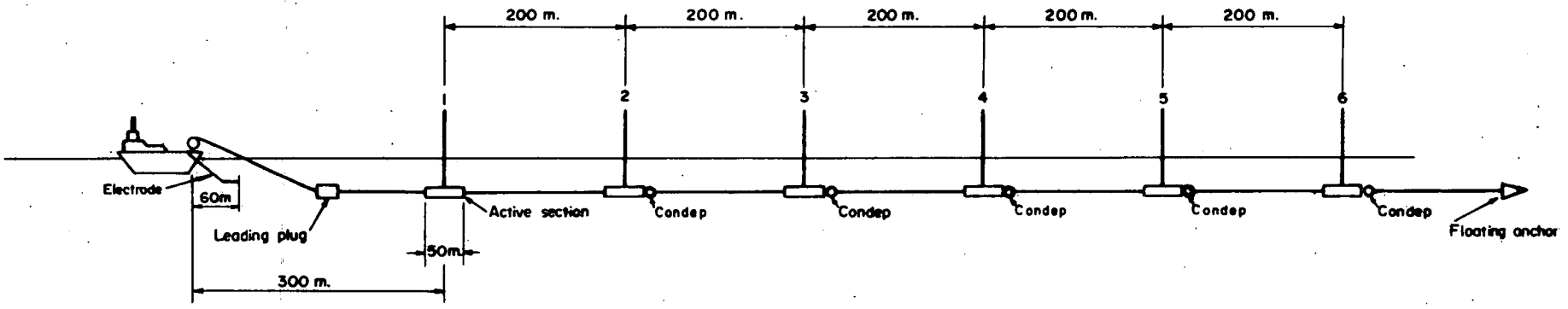
On day 38, the main cable was lost, because of the breaking of the shock absorber portion. It was found again and pulled on board after 2 hours. A new cable was refitted and operations began again day 39 at 01.20.

On day 92, the main cable was pulled in at 00.10, and once again the shock absorber was removed and replaced by a new one. The repair lasted 2 hours, ship recording all data except seismic.

Noise level on main cable appeared to be 40 microvolts for channel 1 and 15 microvolts for the other five channels.

CGG STREAMER CABLE - 6 CHANNELS

1000 metres 48 hydrophones per trace



TRACE DIAGRAM 48 hydrophones HC 301 (2 sensors per phone)

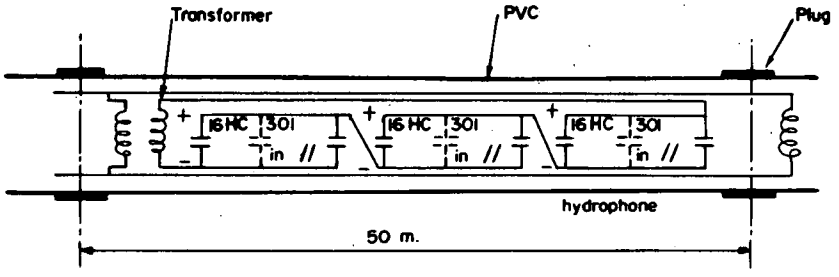


FIG. 4

- On cruise 5 a CHESAPEAKE cable was used as the record cable. To get satisfactory data, it has been necessary to rebuild the stabilizer weight. Recording of seismic data from this cable were made from day 93.

VIII SHORE STATION

It was located near Port Moresby from the beginning to the end of the survey.

Latitude 09°25'

Longitude 147°09'

IGRF 43082

Both magnetic and VLF data were recorded at the shore station. In relation with magnetic recording, malfunctioning of recorder used must be pointed out: jump of 10 to 20 γ occurred frequently on the analogue recording chart. Besides, there was no automatic change of scale.

IX V.L.F.

Shore and ship stations received the following stations ALDRA, HAIKU, TRINIDAD and GBR of Omega and VLF network.

X SHIP SHORE COMMUNICATION

These radio-communications were very difficult due to the large distance between ship and shore station. Geophysical information (VLF and shore magnetic diunal) was transmitted by radio telegrams, at the beginning of the survey.

GENERAL COMMENTS AND CONCLUSIONS

1 Navigation:

Generally of good quality; the good behaviour of Sonar Doppler even in deep water must be pointed out. It seems that in such areas, the echo reflect on water-back scatter. Other systems (Pressure and Chernikeeff Log) worked satisfactorily.

2. Echo-Sounders

Elac analogue records are satisfactory till 4000 meters. Atlas system recorded until 20 meters. This is probably due to a malfunctioning of the transducer.

3 Gravitymeter

The three first days of recording show a large correlation between Gravity and cross-coupling. A further processing - cross correlation - should get rid of this imperfection. Apart from theses recordings, the whole survey provided satisfactory data.

4 Magnetometer

A further processing should eliminate all the spikes due to the interferences between magnetometer sensor and sparker. Apart from this problem, data recorded are of good quality.

5 Data Acquisition System

The malfunction of the tape recorder had a hardware origin: a bad contact in a circuit-board caused intermittent failure of the internal clock. This generally results in extra records before completion of the block of 15 scans Elimination of these extra records can be done whilst tape is converted from Hewlett-Packard to Control Data format in Canberra processing center.

6 Production

A very high percentage of working time at sea is the main characteristic of this survey; few stoppages have to be pointed. General good weather and supply boat was always available by rendez-vous without stopping the operations are the reasons.

FIELD RESULTS

Field results are established on an hourly basis as the work proceeds. On board, plotting and contouring are carried out at a scale of 1/1000,000. Reductions at a scale of 40 miles to the inch are presented in this report. (Encl. 3 to 6).

A. Location Map (Encl 3)

The first order network is based on satellite fixes computed via the PDP 8, following the usual criteria of reliability, elimination of bad Doppler counts and rejection of satellites out of range in elevation.

In case of a straight line sailed at a constant speed, hourly positions are interpolated between two consecutive fixes. When heading or speed have changed, the dead-reckoning of the line is plotted after the ten minute print-out of the Data Acquisition System and the mistie compensated for graphically.

B. Water Depth Map (Encl 4)

Hourly values are read on the Elac strip chart.

C. Bouguer Anomaly Map (Encl 5)

The Bouguer Anomaly is computed according to the following formula:

$$B = G - Go + kH + 7.5 \frac{\Delta E}{\Delta T} \text{ Cos } L$$

(mgals) (metres) (Knots)

where

- G is the value of gravity measured by the meter
- Go is the normal gravity depending on the latitude
- kH is the reduction of the water section (H) to a fixed density d. With H expressed in metres and a density of 2.2, we have

  $k = .04]9\ (d - 1) = .05$ approx.

- the last term is the EOTVOS correction reduced to the first order. L is the latitude. $\frac{\Delta E}{\Delta T}$ is the eastward component of the speed in knots.

Tide correction is ommited.

C.1 Gravity

Ties along the Sydney, Mackay, Cairns, Port Moresby chain indicate that, depending on the range, the calibration factors provided with the meter are good. Adjustment of range is given by the reading in Port Moresby.

By adopting a mean calibration factor for the survey, a simple linear formula converts counter readings into milligals.

C.2 Normal Gravity

Tables are available giving values for every minute of latitude according to the formula;

$$G0=978,049\ (1+0.0052884\ \mathrm{Sin}^2L-0.0000059\ \mathrm{Sin}^2 2L)$$

Hourly latitudes are read from the D.A.S. print-outs and the corresponding normal gravities interpolated between the values of the tables. The Sonar Doppler dead-reckoning is used.

C.3 EOTVOS correction

The values of eastings and northings from an arbitrary origin are given correctly in nautical miles by the Sonar Doppler. The determination of the eastward component of the speed is obtained by triplicating the difference of eastings 10 minutes before and after the considered hour

D. MAGNETIC ANOMALY MAP (Encl. 6)

Magnetic anomaly values are given by the formula:

$$m = M - Mo - D$$

where

- m is the magnetic anomaly value
- M is the reading of the meter directly available in gammas
- Mo is the normal IGRF value obtained by double interpolation in precalculated tables provided by B.M.R. using the dead-reckoning positions.
- D is the diurnal variation recorded at the shore station and relayed to the ship by radio.

E. PRECISION OF THE RESULTS

Statistics of misties and misclosures are presented on Figure 5 and Enclosure 7 respectively.

They have been established as follows:

- Plotting of the location map gives an estimation within a minute of the respective intersection times of two crossing lines.
- corresponding gravity and magnetism values are adopted as a result of linear interpolation between flanking ten minute out-puts - Eotvos and diurnal corrections are applied. Water depths are read on the charts.
- Differences at intersections are misties - Their sum according to the trigonemetric direction along a loop is a misclosure.

Standard deviations of misties are:

Gravity	-	4 milligals
Magnetic	-	35 gammas
Water depth	-	12 metres

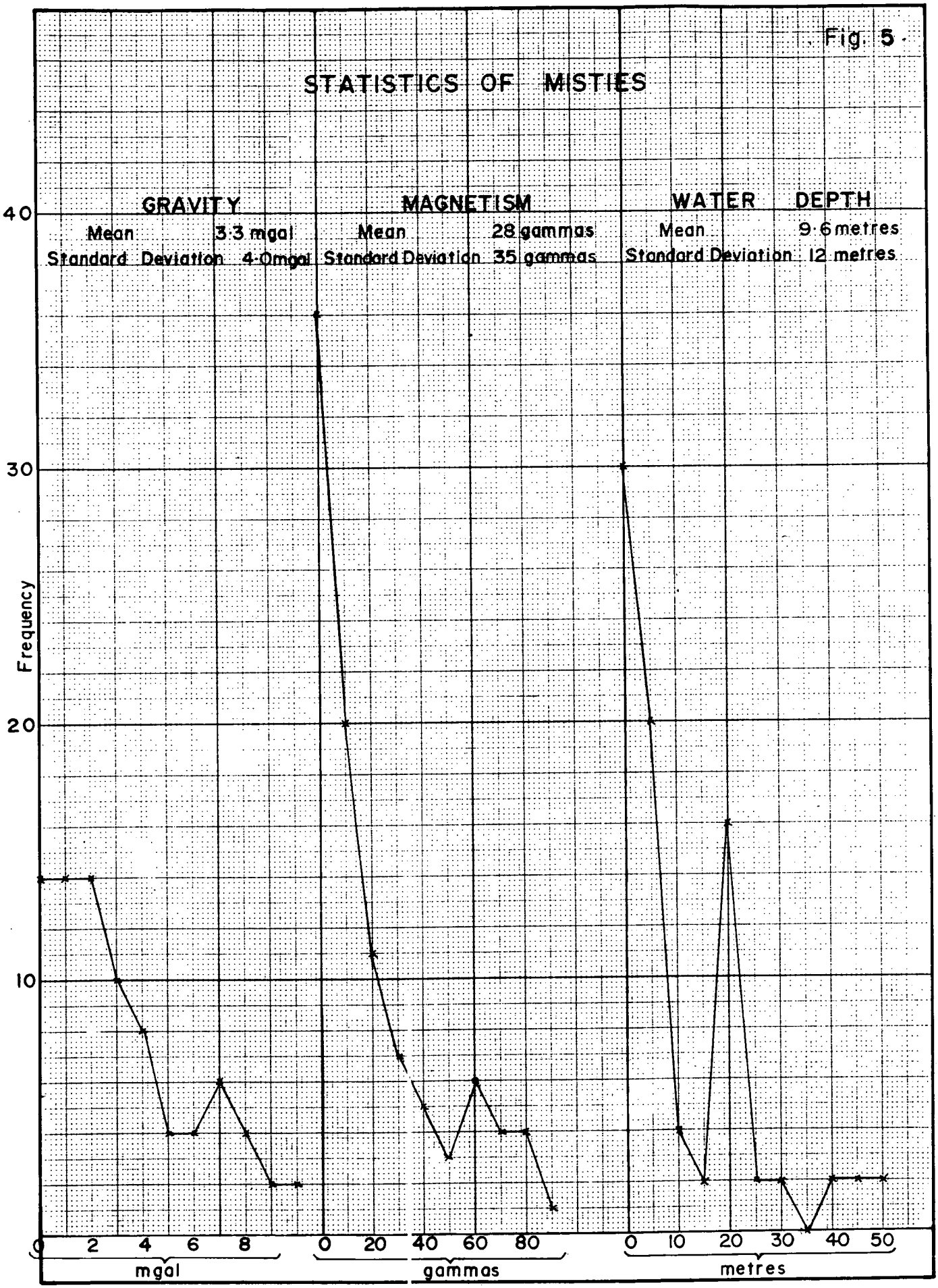
If this last value appears reasonable, the other two are higher than expected, i.e. 2 milligals for gravity and 4 gammas for magnetics.

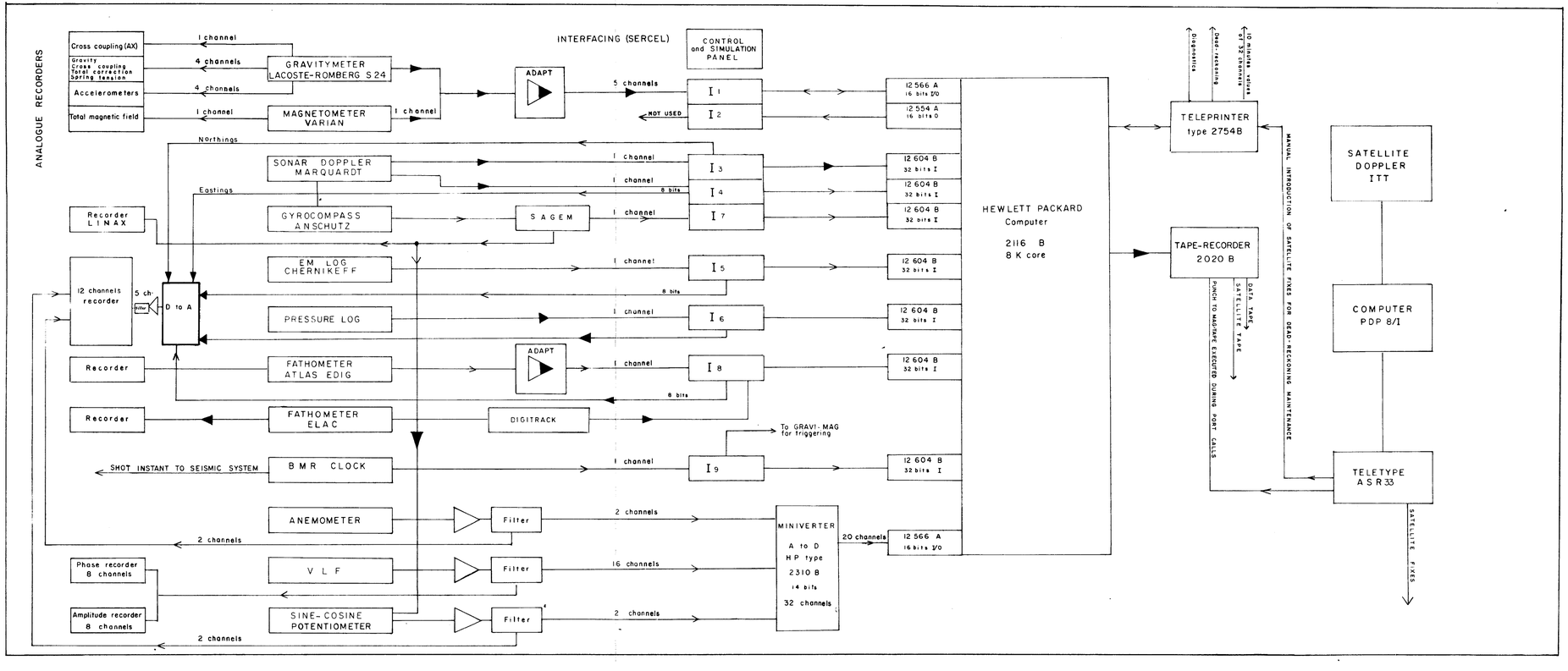
But they appear normal when the steep gradients observed during the survey are taken into account.

Magnetism misties in the Gulf of Papua emphasize this. Enclosure 6 shows a smooth magnetic struction in the area. The average of 20 local misties goes down to 2.2 gammas, equivalent to the 4 gammas expected for standard deviation. In any case, anomalies contoured are intense enough for being unaffected by a low absolute accuracy.

Gravity and depth contours have been merged with previous results.

Fig. 5.


STATISTICS OF MISTIES
GRAVITY
Mean 3·3 mgal
Standard Deviation 4·0mgal
MAGNETISM
Mean 28 gammas
Standard Deviation 35 gammas
WATER DEPTH
Mean 9·6 metres
Standard Deviation 12 metres
Frequency
40
30
20
10
0 2 4 6 8
mgal
0 20 40 60 80
gammas
0 10 20 30 40 50
metres



COMPAGNIE GENERALE DE GEOPHYSIQUE

BUREAU OF MINERAL RESOURCES

DATA AQUISITION SYSTEM

BLOCK DIAGRAM

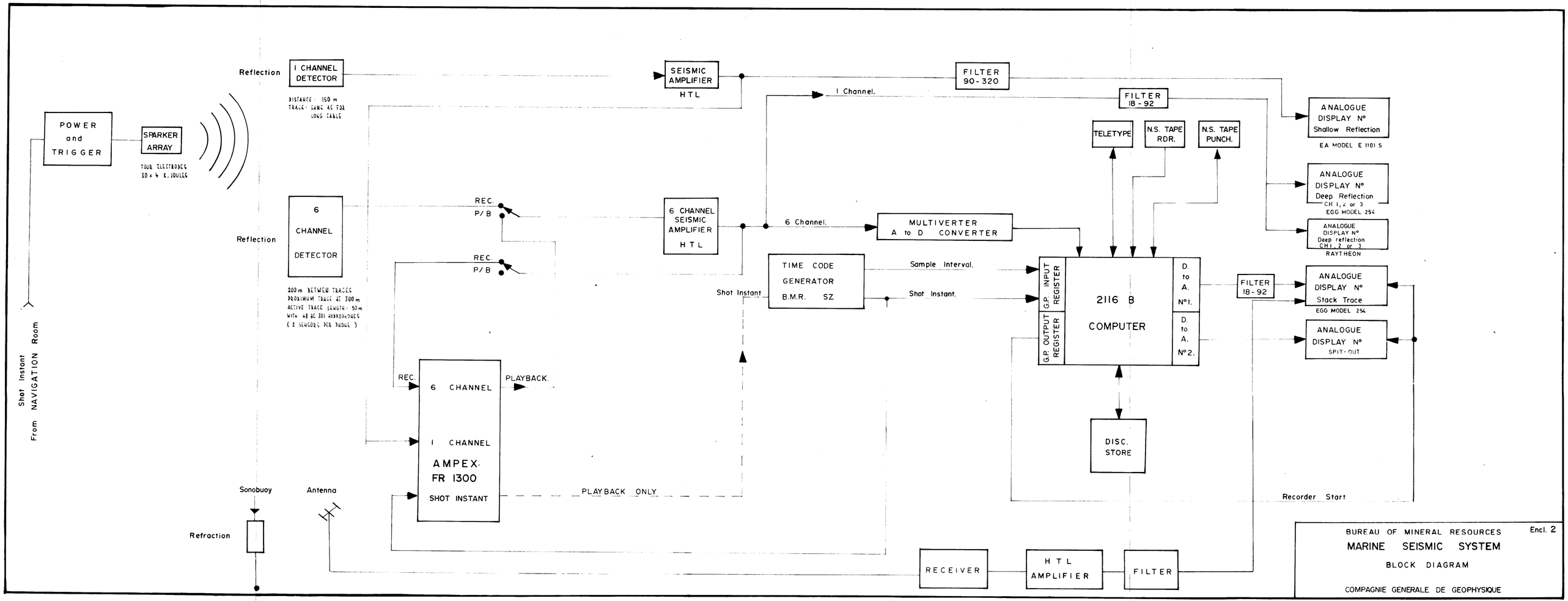
INFORMATION RECORDED ON MAGNETIC TAPE

Channel No.	Data	BCD digits	Units	Writing
1	Clock	8	Hours	XXXX, XXXX
2	Gravity	5	Milligals	XXXX, X
3	Cross Coupling	3	Milligals	XXX,
4	Total Correction	3	Milligals	XXX,
5	Spring Tension	5	Milligals	XXXX, X
6	Magnetism	5	Gammas	XXXXX,
7	Sonar Doppler Northings	6	Nautical Miles	XXX, XXX
8	Sonar Doppler Eastings	6	Nautical Miles	XXX, XXX
9	EM Log	6		XXXX, XX
10	Pressure Log	5		XXXX, X
11	Compass	3	Degrees	XXX,
12	Fathometer	5	Metres	XXX, XX
13-14	Anemometer	2	Metres/second	XX,
15-16	Sine Cosine potentiometer	2		, XX
17 to 24	VLF Phase	5	Cycles	XXX, XX
25 to 32	VLF Amplitude	2	Decibels	XX,

Sample Interval : 10 seconds,

Data recorded in Blocks of 2,5 minutes (15 Scrutations).

COMPAGNIE GENERALE DE GEOPHYSIQUE


Reflection
1 CHANNEL DETECTOR
DISTANCE : 150 m
TRACE : SAME AS FOR LONG CABLE
POWER and TRIGGER
SPARKER ARRAY
FOUR ELECTRODES
10 x 4 K. JOULES
Reflection
6 CHANNEL DETECTOR
200 m BETWEEN TRACES
PROXIMUM TRACE AT 300 m
ACTIVE TRACE LENGTH : 50 m
WITH 48 BC 301 HYDROPHONES
(8 SENSORS PER PHONE)
REC.
P/B
REC.
P/B
SEISMIC AMPLIFIER HTL
6 CHANNEL SEISMIC AMPLIFIER HTL
FILTER 90-320
1 Channel.
FILTER 18-92
6 Channel.
MULTIVERTER A to D CONVERTER
TELETYPE
N.S. TAPE RDR.
N.S. TAPE PUNCH.
ANALOGUE DISPLAY N° Shallow Reflection
EA MODEL E 1101 S
ANALOGUE DISPLAY N° Deep Reflection
CH 1, 2 or 3
EGG MODEL 254
ANALOGUE DISPLAY N° Deep reflection
CH 1, 2 or 3
RAYTHEON
TIME CODE GENERATOR B.M.R. SZ
Sample Interval.
Shot Instant.
Shot Instant
G.P. INPUT REGISTER
G.P. OUTPUT REGISTER
2116 B COMPUTER
D. to A. N°1.
D. to A. N°2.
FILTER 18-92
ANALOGUE DISPLAY N° Stack Trace
EGG MODEL 254
ANALOGUE DISPLAY N° SPIT-OUT
DISC. STORE
Shot Instant From NAVIGATION Room
REC.
PLAYBACK.
6 CHANNEL
1 CHANNEL
AMPEX FR 1300
SHOT INSTANT
PLAYBACK ONLY
Recorder Start
Sonobuoy
Antenna
Refraction
RECEIVER
H T L AMPLIFIER
FILTER
BUREAU OF MINERAL RESOURCES
MARINE SEISMIC SYSTEM
BLOCK DIAGRAM
COMPAGNIE GENERALE DE GEOPHYSIQUE
Encl. 2

BUREAU OF MINERAL RESOURCES ENCL. 3

GULF OF PAPUA AND BISMARCK SEA COMBINED MARINE SURVEY

LOCATION MAP

Scale - 40 miles to 1 inch

LEGEND :

- Hourly position
- R — Refraction test

ST MATTHIAS GROUP

Manus I.

ADMIRALTY Is.

NEW HANOVER

NEW IRELAND

NEW BRITAIN

BOUGAINVILLE I.

Bougainville Island South

Samo

Rabaul

Cape St George

Karkar I.

Long I.

Ritter I.

Madang

Wewak

Boag

Manam

Mt Hagen

Karimui

Markham

Huon

Lae

Bulolo

Wau

Huon Gulf

Gasmata

Aitape

May River

Ambunti

Ramu

Wabag

Blucher Range

Raggi

Lake Kutubu

Lake Murray

Aworra River

Kikori

Buna

Fly River

Kiwai

Boigu

Daru

Port Moresby

Abau

Dyke Auckland Bay

Good Enough I.

Collingwood Bay

Ferguson I.

Normanby I.

Cape Vogel

Good Enough Bay

Jomard Entrance

Trobriand I.

Woodlark I.

Bwaggoia I.

Rossel I.

Tagula I.

100 50 0 100 200 MILES

100 50 0 100 200 KILOMETRES

(BASED ON PNG/BO-2)

PNG/BO-2

BUREAU OF MINERAL RESOURCES

ENCL. 4

GULF OF PAPUA AND BISMARCK SEA COMBINED MARINE SURVEY

BATHYMETRY

Scale - 40 miles to 1 inch

LEGEND :

Hourly position

Contour interval 200 metres

Mean speed 8.8 knots

From field values at one hour interval

ST MATTHIAS GROUP

NEW BRITAIN

BOUGAINVILLE

Samo

Rabaul

Cape St George

Gasmata

Bougainville Island South

Abau

Port Moresby

Buna

Wau

Lae

Bulolo

Mt Hagen

Karimui

Markham

Huon

Madang

Ramu

Wabag

Blucher Range

Lake Kutubu

Lake Murray

Aworra River

Kikori

Ragga

Kiwai

Fly River

Boigu

Daru

Ambunti

Baiga

May River

Aitape

0° 140° 144° 148° 152° 156° 0°

4° 4°

8° 8°

12° 140° 144° 148° 152° 156° 12°

100 50 0 100 200 MILES

100 50 0 100 200 KILOMETRES

(BASED ON PNG/BO-2)

PNG/BO-2

BUREAU OF MINERAL RESOURCES ENCL. 5

GULF OF PAPUA AND BISMARCK SEA COMBINED MARINE SURVEY

BOUGUER ANOMALIES

d = 2.2

Scale - 40 miles to 1 inch

LEGEND :

Hourly position

Contour Interval 20mg.

After field values at 1 hour intervals

ST MATTHIAS GROUP

BOUGAINVILLE I

Aitape
May River
Ambunti
Baag
Ramu
Blucher Range
Wabag
Madang
Markham
Mt Hagen
Karimui
Lake Kutubu
Rago
Lake Murray
Kikori
Wau
Bulolo
Buna
Kiwai
Fly River
Daru
Boigu
Port Moresby
Abau
Gasmata
Cape St George
Kabadi
Bougainville Island South

(BASED ON PNG/80-2)

PNG/80-2

100 50 0 100 200 MILES

100 50 0 100 200 KILOMETRES

BUREAU OF MINERAL RESOURCES ENCL. 6

GULF OF PAPUA AND BISMARCK SEA COMBINED MARINE SURVEY

MAGNETIC ANOMALIES

AFTER FIELD VALUES AT ONE HOUR INTERVALS

Scale = 40 miles to 1 inch

LEGEND :

Hourly position

Contour Interval: 100 γ

(+ or −)

100
200
300
400
500

ST MATTHIAS GROUP

Samo

Aitape

May River

Ambunti

Baag

Madang

Ramu

Wabag

Blucher Range

Mt Hagen

Karimui

Markham

Huon

Gasmata

Rabaul

Cape St.George

Pomio

Talasea

Bougainville Island North

Bougainville Island South

BOUGAINVILLE I

Raggi

Lake Kutubu

Lake Murray

Awarra River

Kikori

Wau

Bulolo

Lae

Buna

Kiwai

Fly River

Boigu

Daru

Port Moresby

Abau

PNG/80-2

(BASED ON PNG/80-2)

100 50 0 100 200 MILES

100 50 0 100 200 KILOMETRES

BUREAU OF MINERAL RESOURCES

ENCL. 7

GULF OF PAPUA AND BISMARCK SEA COMBINED MARINE SURVEY

GRAVITY AND MAGNETIC MISCLOSURES

Scale - 40 miles to 1 inch

LEGEND :

- Hourly position
- -1·2 (Gravity - Eötvos) misclosure in milligals
- +12 (Magnetic - Diurnal) misclosure in gammas
- Positive misclosure direction

ST MATTHIAS GROUP

BOUGAINVILLE I

Bougainville Island South

Bougainville Island North

Gasmata

Abau

Port Moresby

Buna

Wau

Bulolo

Lae

Mt Hagen

Karimui

Markham

Huon

Madang

Ramu

Wabag

Blucher Range

Lake Kutubu

Kikori

Aworra River

Lake Murray

Fly River

Kiwai

Daru

Boigu

Baiyer River

Ambunti

Bogia

Aitape

Rabaul

Cape St George

Samo

G-0·9 M-32

G-4·1 M-134

G+6·0 M-94

G+10·8 M-162

G+10·3 M-58

G-6·8 M-160

G-9·0 M-98

G+6·3 M-43

G+10·0 M-131

G+1·7 M+53

G-2·5 M-51

G+4·9 M-82

G-8·8 M+14

G-5·5 M-60

G-5·8 M+3

G-9·8 OM-22

G-8·1 M+17

G-9·6 M-45

G+9·6 M-36

G-8·1 M-46

G-5·0 M+7

G+10·8 M+24

G-3·2 M+1

G-6·2 M-104

G-2·9 M-17

G-6·9 G+121

G-5·4 M-29

G-2·4 M+128

G+1·9 M+133

G+1·7 M+129

G-3·7 M+55

G-2·2 M-87

G-2·6 M-27

G-0·6 M-131

G-0·3 M-80

G+5·2 M+121

G+10·5 M-137

G-11·6 M+7

G+12·6 M-17

G-5·6 M-59

G-13·6 M-5

G+1·9 M+26

G+21·6 M-52

G-0·3 M-8

G-0·2 M+2

G-1·0 M-14

G+5·6 M+19

G+5·4 M-35

G-1·9 M-52

G+10·3 M-58

G-1·1 M-4

G+5·6 M-5

G+5·6 M+16

G-0·7 M+24

G+1·4 M+26

G+1·7 M+14

G-3·5 M+33

G+4·7 M+44

G+3·2 M-4

G+21·7 M+32

G-22·6 M+28

G+8·5

G+18·5 M+28

G+3·3 M+4

G+4·6 M+13

G+11·5 M+4

G-2·5 M-9

G-1·2 M-8

G+18·3 M-6

G+12·9 M-5

G-9·4 M+119

G-13·5 M+126

G-8·1 M-5

100 50 0 100 200 MILES

100 50 0 100 200 KILOMETRES

(BASED ON PNG/BO-2)

PNG/BO-2