DEPARTMENT OF
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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Reconnaissance Helicopter Gravity Survey, Qld, 1964:

Compilation and Recomputation of Data

by

J. C. Allen and A. W. Waldron

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CONTENTS

PLATES

SUMMARY

In 1964 a reconnaissance helicopter gravity survey was carried out by Wongela Geophysical Pty Ltd under contract to the Bureau of Mineral Resources. 441 000 km^2 of southern Queensland were surveyed on an 11-km square grid covering thirty 1:250 000 Sheet areas. About 4300 stations were read and all results were then computed by hand. Contour maps were published showing Bouguer anomaly values.

The data from this survey, survey numbers 6402, 6403, and 6423, were assembled, and processed on the CSIRO CDC 3600 computer. Datum control used was the Isogal survey for gravity and the Australian Height Datum for elevation. Principal facts for all stations have been listed on magnetic tape in standard format.

Some errors in the hand computation were found and corrected but divergence of the revised maps from those already published was not great.

The file of principal facts for the 1964 reconnaissance helicopter gravity survey is now held by the Regional Gravity Group.

INTRODUCTION

The field operations of the 1964 reconnaissance helicopter gravity survey were carried out by a private geophysical contractor, Wongela Geophysical Pty Ltd for the Bureau of Mineral Resources (BMR). The method of operation used by the contractor was identical with procedures adopted by the BMR on previous helicopter gravity surveys (Vale, 1962). All traversing was done using the cell method described by Hastie & Walker, 1962.

The survey over 441 000 km^2 of southern Queensland on an 11-km square grid covered thirty 1:250 000 Sheet areas (Plate 1). About 4300 stations were read and survey numbers used were 6403 and 6423 for the helicopter work and 6402 for the road control survey.

Gravity readings were made at bench marks, using road transport, to provide gravity control for the helicopter work.

Results in 1964 were hand-computed and transcribed to maps which were published. Recomputation was carried out to create a file, on magnetic tape, of all the principal facts using modern computer techniques. Short descriptions of the computer programs used are given in the Appendix.

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OBJECTIVES

The main objectives of the recomputation were :

- To reprocess the original field data using programs written for use on the CSIRO CDC 3600 computer;
- To use as a datum control for gravity the Isogal network (Barlow, 1970) and for heighting the Australian Height Datum (AHD) (Roelse, Grainger, & Graham, 1971);
- To create a magnetic tape, in a format compatible with current BMR requirements, containing the principal facts for the survey, i.e. station number, latitude, longitude, meter height, observed gravity, and ground height.

COMPUTATIONAL TECHNIQUES

Recomputation was done in three stages :

Preparation - the sorting of the data into a form suitable for computer processing;

Processing - the reduction of basic data to give principal facts;

Checking - plotting the processed data, and correcting errors detected.

Brief descriptions of computer programs used are given in the Appendix. Plate 2 gives the processing flow diagram.

PREPARATION

All original field readings had to be reformatted on field sheets in current usage. These data were then punched on computer cards and a data file created on magnetic tape.

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The information from this file was then plotted at 1:1 000 000 scale, using program FLTMAP, and the resulting plots checked for errors in latitude, longitude, and duplicated station numbers. These errors were then corrected on the cards.

Using the criteria of at least one Isogal station per segment and as many fixed heights as possible the survey was then split into six helicopter segments and three road segments. Free nodes are defined as any multiply-read station and fixed nodes any station which has a known value assigned for either gravity or elevation. Segments were limited by the size of the available computer memory to a maximum of 160 nodes and 400 lines of network. Readings on road traverses in the survey were intended to provide control for the helicopter work; however owing to the incomplete network it was decided to give equal weight to both road and helicopter work.

All fixed nodes were located at this stage. The Isogal network providing gravity control and bench marks which have AHD values were used for height control. Where bench marks could not be reoccupied by Division of National Mapping surveyors and no correction could be made, those stations were deleted at a later stage.

Sorted gravity and height segments were written onto magnetic tape using program INFILE.

Free nodes for each segment were then extracted from this tape, using program FINDER, ready for input into program GRAVHTS in the next stage in processing.

PROCESSING

Program GRAVHTS (Whitworth, pers. comm.) was used in this phase to compute both gravity and height values from the field data. This was done in several stages. At each stage of processing the standard deviation, the measure of dispersion of adjustments from the normal, was calculated.

Internal Standard Deviations (ISD) were first calculated using one fixed node per segment to check the internal accuracy of the network. This was done using the Isogal value for gravity and one bench mark value for height.

In this phase, errors such as duplicate station numbers, mispunching, and some misreadings were edited out using the editing option in GRAVHTS.

Table 1 shows the standard deviations and maximum adjustments computed at this stage for each segment.

TABLE 1. INTERNAL STANDARD DEVIATION ADJUSTMENTS

SEGMENT		GRAVITY (mGal)		ELEVATION (m)	
		I.S.D.	Max. Adj.	I.S.D.	Max. Adj.
HELICOPTER	1	0.03	0.16	1.81	6.62
	2	0.04	0.25	2.20	9.19
	3	0.04	0.17	1.77	7.32
	4	0.04	0.15	1.71	7.46
	5	0.04	0.22	2.08	9.03
	6	0.04	0.10	1.34	4.01
ROAD	1	0.02	0.06		
	2	0.01	0.04		
	3	0.01	0.05		

External Standard Deviations (ESD) were computed with all known values together with mean values between segments, as computed at the ISD phase, being incorporated into their appropriate segments as fixed values. This gives the overall accuracy of the survey results.

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Table 2 shows the difference between segments of common helicopter stations.

TABLE 2. DIFFERENCE BETWEEN COMMON STATIONS

	GRAVITY (mGal)			ELEVATION (m)		
SEGMENT & STATION NO	A	B	DIFFERENCE (A-B)	A	B	DIFFERENCE (A-B)
SEGMENT 4. 6						
6403.8754	979141.74	979141.94	-0.20	FIXED	VALUE	
SEGMENT 4. 3						
6403.9151	978941.33	978941.53	-0.20	283.34	280.52	2.82
6402.2310	978945.18	978945.48	-0.30	303.86	303.86	0.0
6403.9189	978966.31	978966.62	-0.31	280.55	280.23	0.32
6403.9187	978970.90	978971.18	-0.28	314.84	311.11	3.73
6403.9188	978980.86	978981.12	-0.26	357.21	354.48	2.73
SEGMENT 4. 2						
6403.9312	978964.11	978963.92	0.19	397.47	398.71	-1.24
6403.9316	978956.58	978957.45	0.13	405.95	412.14	-6.19
SEGMENT 5. 1						
6402.5016	978905.59	978905.65	-0.06	36.28	42.03	-5.75
6403.9516	978883.84	978883.84	0.0	302.40	300.11	2.29
6402.9488	978951.25	978951.27	-0.02			
6403.9493	979001.30	979001.47	-0.17	183.67	185.30	-1.63
6402.1417	978975.34	978975.42	-0.08	358.63	358.63	0.0
6403.9577	978960.30	978960.37	-0.07	430.51	432.77	-2.26
6403.9601	978982.07	978981.85	0.22	484.11	489.97	-5.86
6403.9602	979072.48	979072.44	0.04	383.32	392.78	-9.46
6403.9122	979083.42	979083.25	0.17	417.25	424.56	-7.31
SEGMENT 5. 2						
6403.9336	978904.84	978905.09	-0.20	97.41	102.61	-5.20
6403.9510	978872.82	978872.99	-0.17	220.76	234.87	-6.13
6403.9514	978919.74	978919.91	-0.17	188.10	196.65	-8.55
6403.9487	978952.95	978953.04	-0.09	182.59	177.44	+5.15
6403.9481	978955.18	978955.13	-0.05	194.99	187.94	+3.05
6402.1016	978956.24	978956.24	0.0	226.92	226.92	0.0
6403.9385	978959.44	978959.44	0.0	240.48	238.71	+1.77
6403.9384	978944.08	978944.11	-0.03	292.09	296.58	-4.49
6003.0196	978934.54	978934.42	+0.12	365.92	363.20	+2.72
6403.9390	978995.83	978995.81	+0.02	301.61	303.81	-2.20
6403.9401	979021.29	979021.19	+0.10	288.98	288.75	+0.22

The ESD for helicopter segments were obtained by obtaining the mean values in Table 2 and using them with bench mark and Isogal values as fixed nodes. During the ESD stage the data were edited to further adjust gravity and height values where poor adjustments had been made. Values for stations which were multiply read but do not constitute a node for computational purposes were also checked and edited.

TABLE 3. MAXIMUM ADJUSTMENTS FOR HELICOPTER SEGMENTS AT ESD STAGE

SEGMENT	GRAVITY (mGal)	ELEVATION (m)
1	0.16	7.79
2	0.24	11.43
3	0.17	7.32
4	0.52	7.46
5	0.22	9.03
6	0.11	4.01

As all elevations in the road segments are fixed, the helicopter height segments were treated as final.

Mean values were obtained for common stations between helicopter and road segments as computed at the ESD phase. These values, together with all those for fixed nodes previously used, were then used to create the magnetic tape of principal facts.

Plate 3 shows the location and scale of high gravity adjustments as computed by mean values between road and helicopter segments. The height adjustments are shown in Plate 4.

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CHECKING

The principal facts tape with missing values and stations to be deleted was updated using program SEGEDIT. Stations which were deleted were helicopter stations with no latitude and longitude and road stations for which no reliable height was available.

The tape was sorted, using program SEGSORT, into data blocks consisting of a 1:250 000 Sheet area with a 15 minute overlap.

Bouguer anomalies for each data block were plotted, using program PLOTANDCONTOUR, at a scale of 1:250 000 and using a density of 2.2 g /cm^3. These were checked against maps published in 1964 for errors and doubtful values, and appropriate updates were made to the principal facts tape.

Final computer-contoured maps were produced from this final corrected principal facts tape.

CONCLUSIONS

The results from the 1964 reconnaissance helicopter gravity survey, with survey numbers 6402, 6403, 6423, covering thirty 1:250 000 Sheet areas in southern Queensland have been recomputed. A principal facts file was created on magnetic tape in a format compatible with current BMR requirements. It includes station numbers, latitude, longitude, meter height, observed gravity, and ground height.

Discrepancies were found in some latitude and longitude values and a number of duplicate station numbers were detected. Two Sheets with the same numbers were detected, necessitating the introduction of this additional survey number 6423.

Final computed Bouguer anomaly values do not diverge greatly from those existing on the earlier published maps. This similarity is shown for the Monto map-sheet in Plates 5 and 6 drawn at a 5-mGal contour interval.

REFERENCES

BARLOW, B.C., 1970 - National report on gravity in Australia, July 1965 to June 1970. Bur. Miner. Resour. Aust. Rec. 1970/62 (unpubl.).

HASTIE, L.M., & WALKER, D.G., 1962 - Two methods of gravity traversing with helicopters. Bur. Miner. Resour. Aust. Rec. 1962/123 (unpubl.).

LONSDALE, G.F., 1965 - Southern Queensland contract reconnaissance gravity survey using helicopters 1964. Bur. Miner. Resour. Aust. Rec.1965/251 (unpubl.).

MURRAY, A.S., in prep. - The Australian National Gravity Repository computer system. Bur. Miner. Resour. Aust. Rec. (unpubl.).

ROELSE, A., GRAINGER, H., & GRAHAM, J., 1971 - Adjustment of Australian levelling survey, 1970-71. Div. Nat. Map. Tech. Rep. 12.

VALE, K.R., 1962 - Reconnaissance gravity surveys using helicopters, for oil search in Australia. Bur. Miner. Resour. Aust. Rec. 1962/130 (unpubl.).

APPENDIX

DESCRIPTION OF COMPUTER PROGRAMS

The following is a brief description of programs used on the CDC3600 computer in the 1964 recomputation work.

INFILE. This program is used to create a data file on magnetic tape containing all the basic data in a format which enables the data to be edited at a later stage.

FLTMAP. Using the file created by INFILE this program creates a tape for plotting which shows 'flights-as-flown'. There are two options

FLTPLOT - for plotting helicopter flights
TRAVPLOT - for plotting road traverses

Plots can be created at any scale within the limits of the plotting device.

FINDER. Reads a magnetic tape in card image format and locates all multiply-read stations which by definition should be nodes. The output is in the form of punched cards suitable for input to GRAVHTS.

GRAVHTS. This program is used to reduce gravity and height data and create a principal facts file.

SEGEDIT. This program is used to edit data on output files from GRAVHTS. It can be used to insert, amend, or delete stations, values, and informal station information.

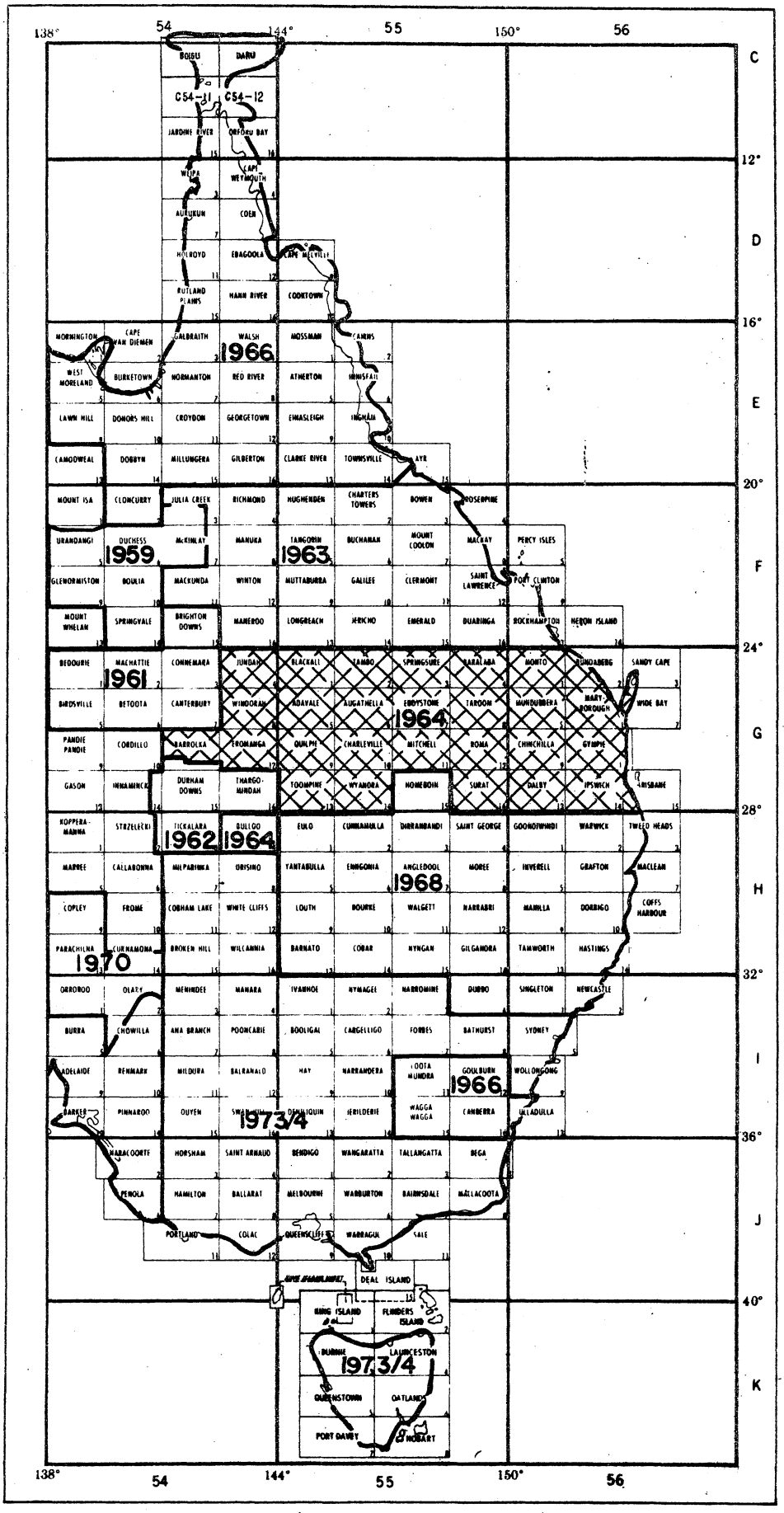
SEGBA. SEGBA is used to obtain a Bouguer anomaly print-out of the principal facts file at specified densities.

SEGSORT. This program sorts a principal facts file into a desired format, e.g. 1:250 000 map sheets with 15 minute overlaps. The output is normally a new principal facts file.

PLOTANDCONTOUR. This program is used to plot stations from the principal facts file, label them with station numbers, Bouguer anomaly values, and heights, and then contours these data at a designated contour interval and rock density.

A detailed description of this program is given by Murray (in prep).

PLATE I

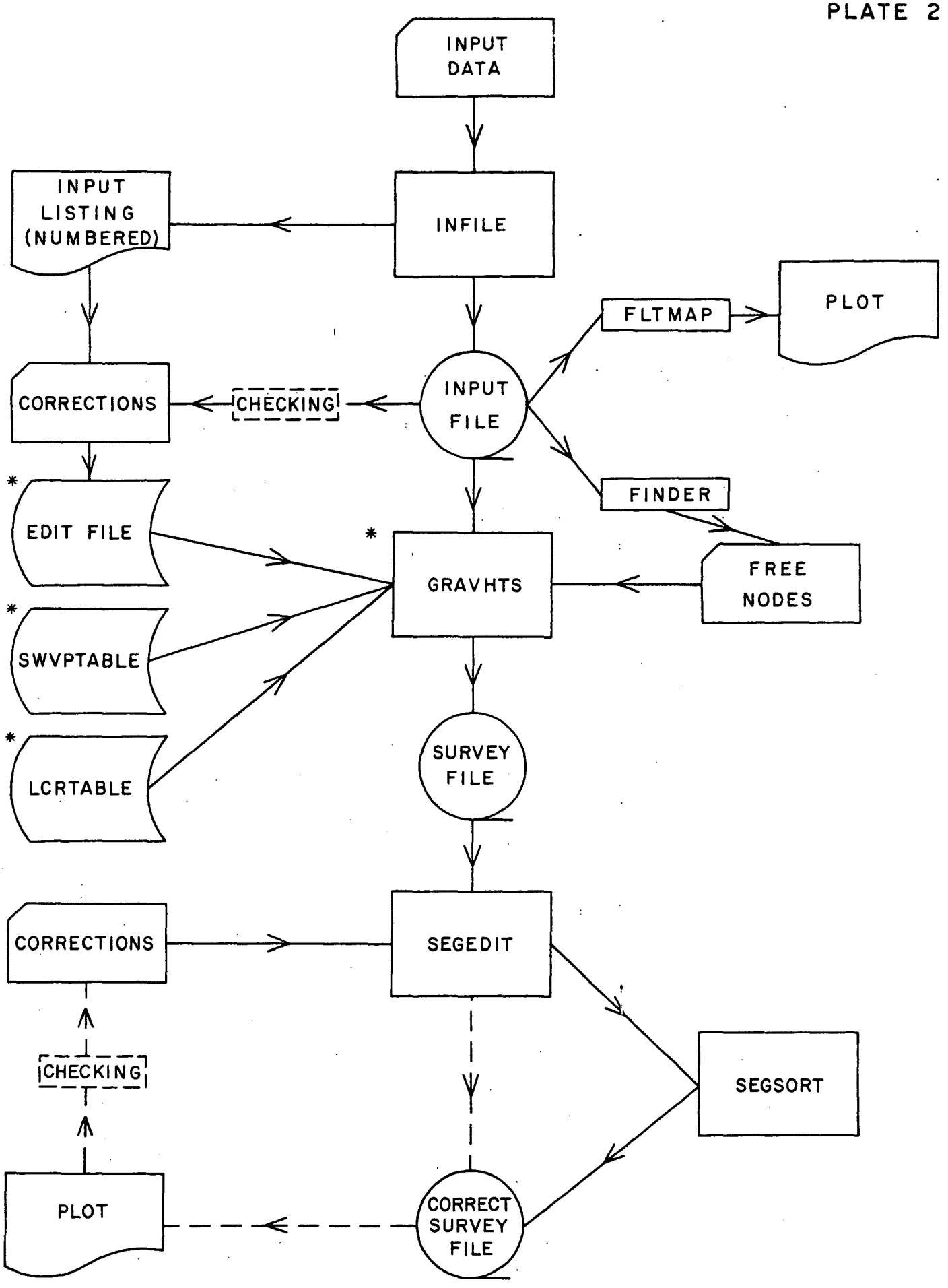


RECONNAISSANCE HELICOPTER GRAVITY SURVEY
QLD 1964, RECOMPUTATION OF DATA

LOCALITY MAP

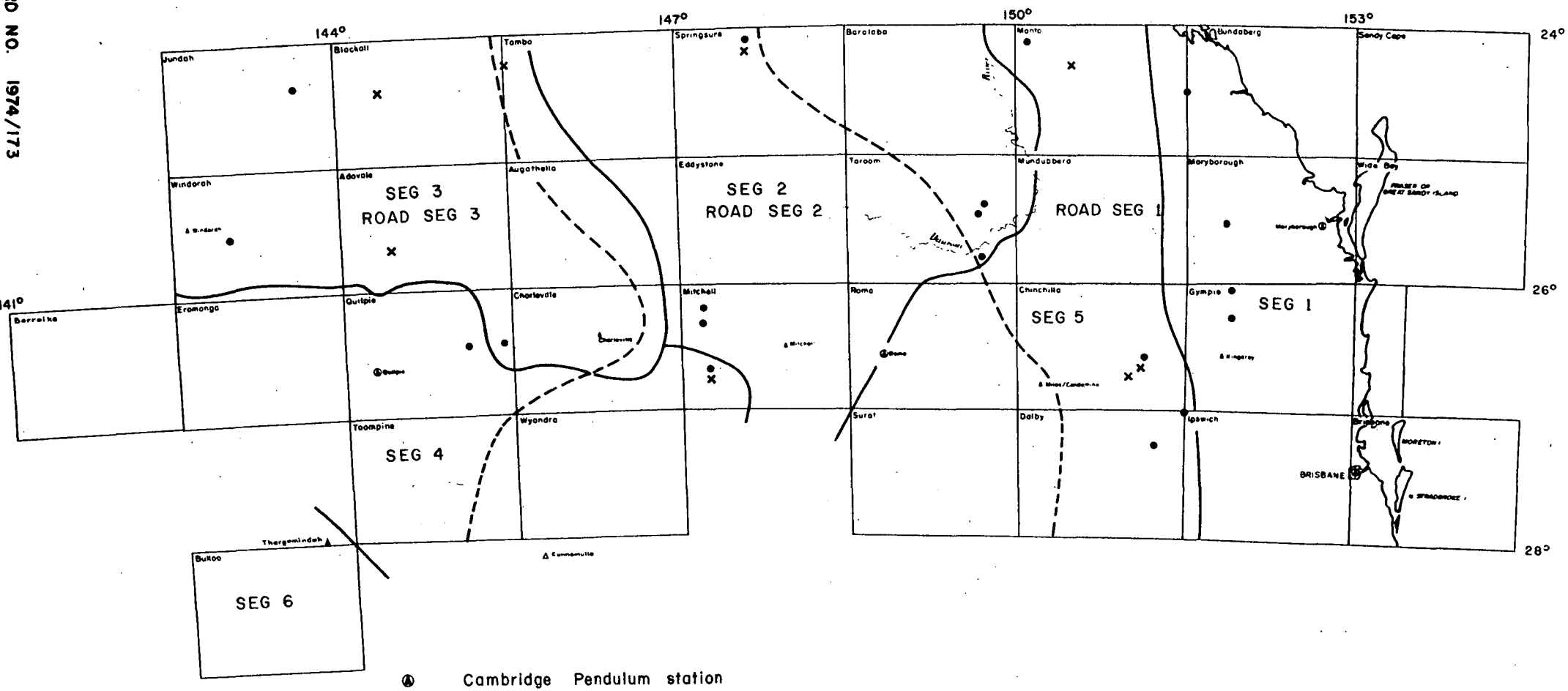
RECORD NO. 1974/173

A/B2-108A

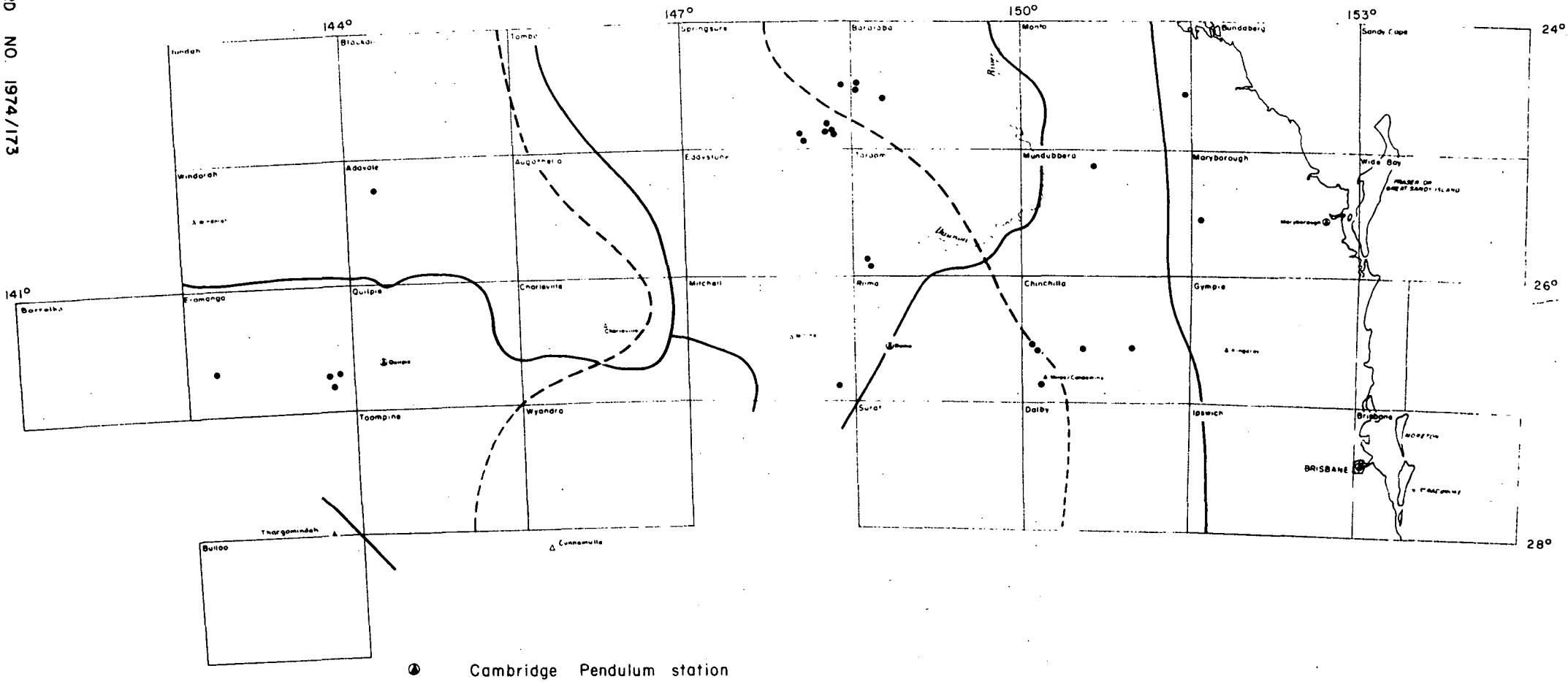


* Described by Whitworth (in prep.)

PROCESSING FLOW CHART

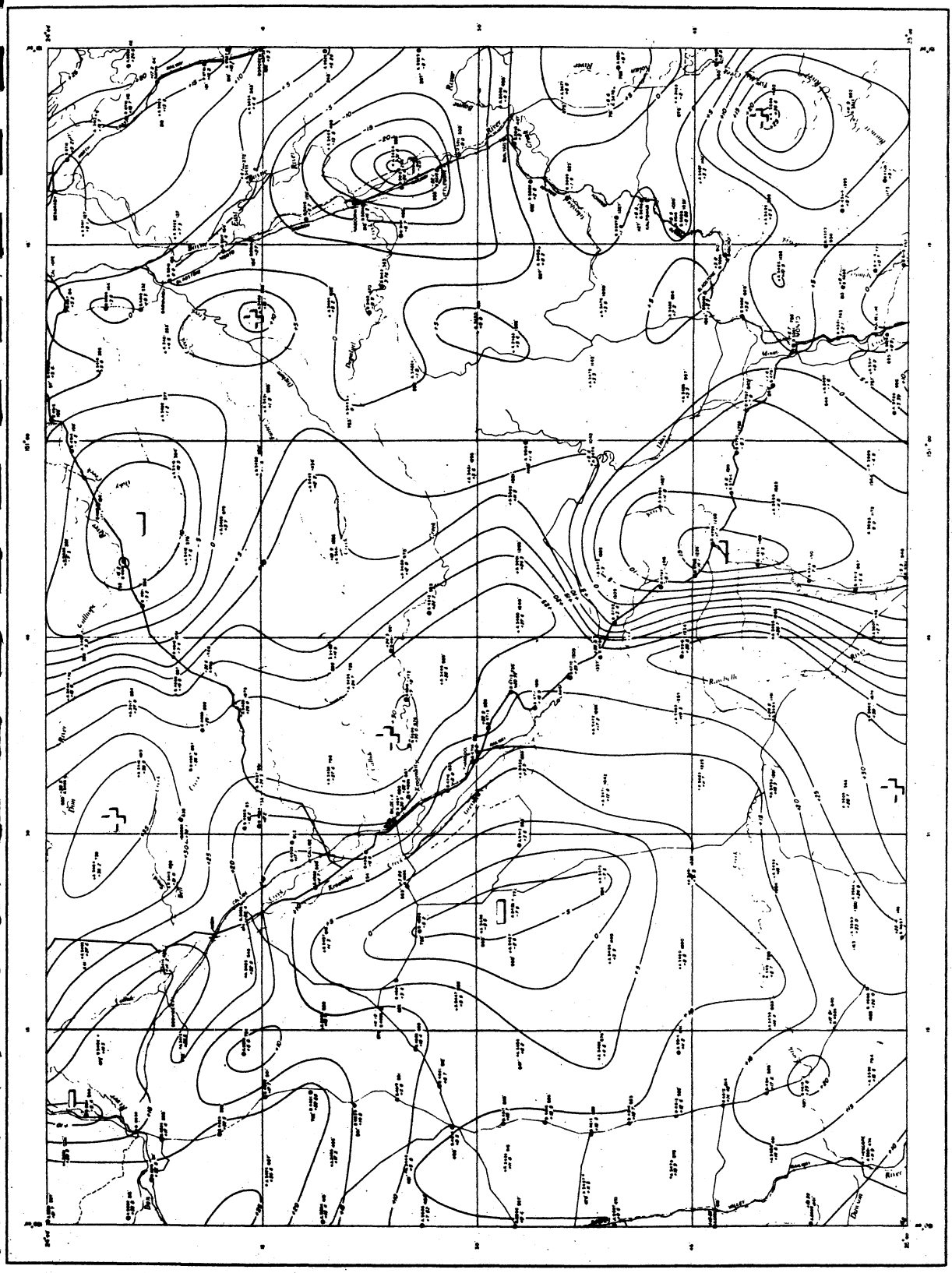


LOCATION OF HIGH GRAVITY ADJUSTMENTS



- Cambridge Pendulum station
- Primary Isogal station
- Secondary Isogal station
- Station with large height adjustment
- Road segment boundary
- Helicopter segment boundary

LOCATION OF HIGH HEIGHT ADJUSTMENTS



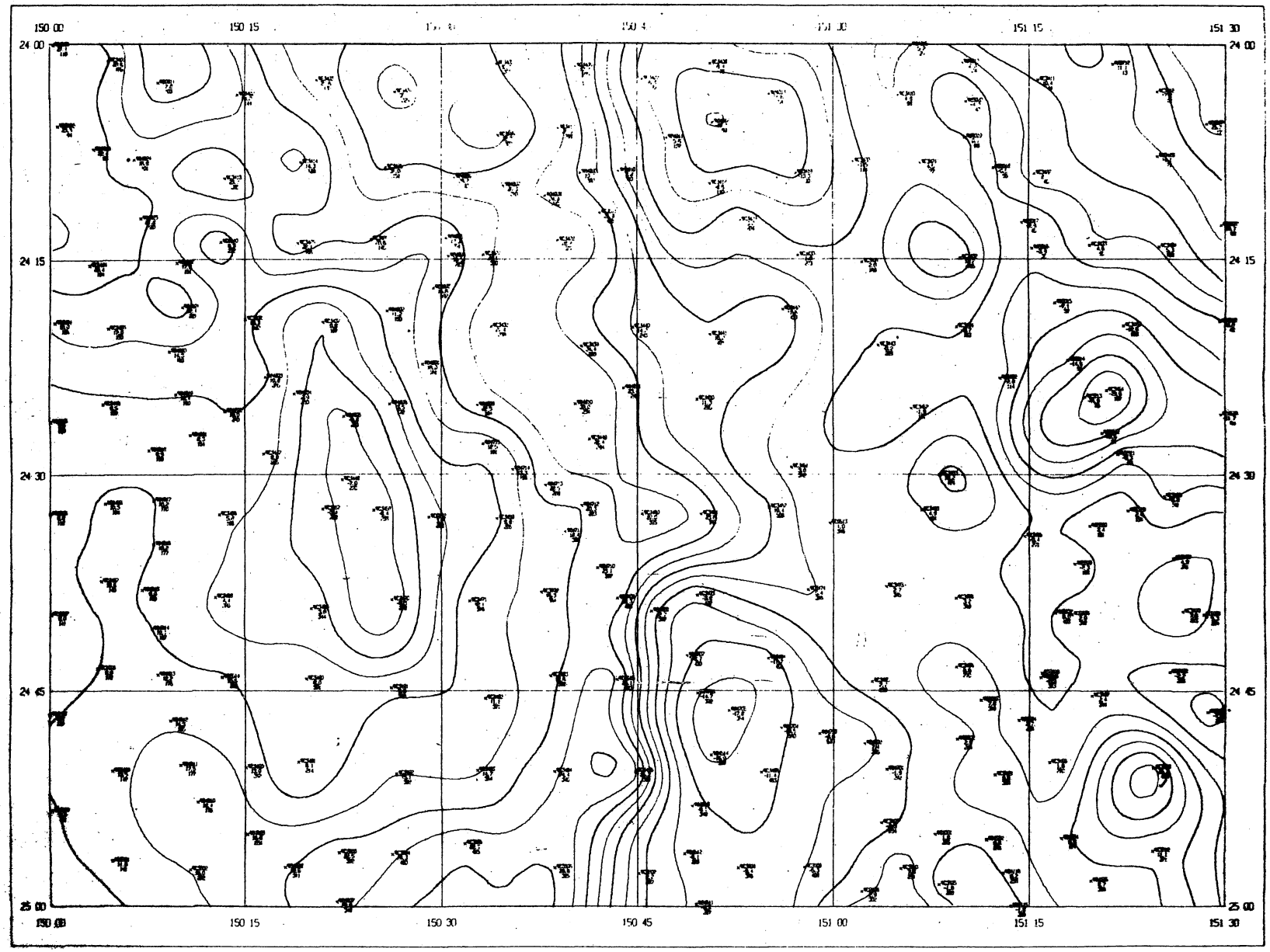
PUBLISHED BOUGUER ANOMALY MAP (1964)

PLOTTED 24/08/72

MØNTØ

QUEENSLAND

AUSTRALIA



COMPUTER - CONTOURED BOUGUER ANOMALY MAP

CLARKE 1858 SPHEROID × ϕA = 6003

TRANSVERSE MERCATOR PROJECTION × ϕB = 6402

ZONE 8 (AUSTRALIA SERIES) × ϕC = 6403

1964 HELICØPTER SURVEY

DENSITY = 2.20 GMS/CC

MØNTØ

QUEENSLAND

656/38

PLATE 6

RECORD NO. 1974/173

Q/B2-24A