COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1964/110

COBAR EXPERIMENTAL AEROMAGNETIC SURVEY,

NEW SOUTH WALES

1963

by

P.E. GOODEVE and F.E.M. LILLEY

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ILLUSTRATIONS

SUMMARY

From March to May 1963, the Bureau of Mineral Resources carried out an experimental aeromagnetic survey at Cobar, New South Wales. The purpose of the survey was to field test a proton-precession magnetometer installation in the Cessna aircraft VH-GEO. The Cobar area was chosen as considerable information was already held on the Earth's magnetic field there, which was known to provide a range of anomalous areas that are not excessively disturbed. Seven separate areas were surveyed which offered a useful range of magnetic anomaly characteristics for testing the new equipment.

A procedure for survey flying and methods for processing data were developed during the survey; contour maps of the aeromagnetic results were produced in the field.

The experimental survey was successful in outlining magnetic anomalies in detail.

1. INTRODUCTION

Since 1951 the Bureau of Mineral Resources, Geology and Geophysics has carried out airborne magnetometer surveys with a DC.3 aircraft carrying fluxgate magnetometer equipment. Recently a proton-precession magnetometer was developed by the Design and Development Group of the Geophysical Branch for observatory use. One unit, a modified MNZ1, was installed in the Cessna light aircraft, VH-GEO, for the purpose of testing the installation for detailed aeromagnetic surveying at low level.

This Record deals with the first Cessna survey, which was made in the Cobar area, NSW. The Cobar area was selected because previous detailed ground magnetic and regional airborne magnetic surveys had shown the area to be free from steep magnetic gradients and provided magnetic data suitable for comparison with the results of the Cessna survey. This Record describes the technical performance of the MNZ1 and the feasibility of detailed magnetometer surveys by light aircraft.

The survey was made from March to May 1963. The survey party included the following officers :

F.E.M. Lilley (party leader), B.A. Dockery, J.S. Milsom, A. Crowder, A.S. Scherl and G.B. Litchfield (T.A.A.).

2. EQUIPMENT

Cessna 180 B aircraft

The following structural modifications have been made to the Cessna to adapt it for aeromagnetic surveying:

(a) Installation of bird cradle and cable winch,

(b) Installation of camera hatch through cockpit floor and external skin, to hold navigation camera,

(c) Installation of the following units:

- (i) magnetometer assembly
- (ii) power and timing unit, and
- (iii) vertical camera.

Magnetometer assembly

The primary unit installed in the aircraft is the magnetometer. It consists of bird, cable, MNZ1 electronic unit, and Westronic chart recorder.

The bird is streamed on 60 ft of coaxial cable where it is clear of the disturbing effects of the magnetic field associated with the aircraft. The bird consists of a fibreglass aerodynamic shell holding a coil of aluminium wire wound around a perspex bottle filled with kerosene.

The MNZ1 unit controls the electronic operation of the bird. The full cycle takes 2 sec and comprises:

(a) A polarising period of 1 sec, during which a strong current (approximately 4A) is fed through the bird coil, causing a strong axial magnetic field which polarises the free protons in the kerosene,

(b) A period of 1 sec, for which the polarising current is removed, the free protons precess around the Earth's field, and the frequency of the precession is measured. This measurement normally occupies about the initial 0.6 sec of the 'counting' period.

The chart-recorder is fed by the memory unit of the MNZ1, which 'remembers' the value of a precession frequency estimation until it is reset by the next estimation 2 sec later. Hence the chart trace is in the form of steps, each lasting for 2 sec. At Cobar, the recorder was calibrated to 100 gammas full-scale deflection. As the aircraft surveys at speeds of about 110 knots, a reading every 2 sec gives in effect a station separation of about 370 feet.

Power and timing unit, CTP1

The CTP1 unit is fed by the aircraft 28V D.C. supply. It produces the correct sequence of co-ordinating timing pulses for the system, and the variety of power supplies needed.

Radio-altimeter

An APN1 radio-altimeter recorded on chart during survey flying and also controlled limit lights on the pilot's instrument panel.

Vertical camera

A Vinten camera, fitted with an 187° field-of-view lens, was employed to reeord the flight paths of the aircraft; 35-mm film was used, and a frame was exposed every 4 sec.

Magnetic storm warning device (SWD)

Pending the availability of a second proton magnetometer, the Cobar party was equipped with a fluxgate model MFD3 for magnetic storm detection. The MFD3 was still in the developmental stage and was found to drift with ambient temperature. Therefore it could not be used to give an accurate measurement of diurnal change in the Earth's magnetic field, although it indicated sharp irregular disturbances which could be seen superimposed upon the normally smooth trace.

3. SURVEY FLIGHT PROCEDURE

Rectangular areas of interest were chosen, normally several square miles in extent. Standard aerial photographs enlarged to a scale of approximately 2000 ft to 1-in were used for navigation. Line starting points for an ideal grid were marked on the photographs at a separation equivalent to 10 lines per mile.

On survey flights the crew comprised pilot and operator-observer. The main duties of the operator-observer consisted of operating the equipment during the flights and assisting in navigation during the flying of lines. The pilot flew each line straight by maintaining a constant bearing on the directional-gyro instrument. A constant height above ground level was maintained as closely as practicable with the aid of the radio-altimeter.

Before starting on the grid, it became practice for the pilot to first carry out a 'dummy run' to estimate aircraft drift correction. For each flight it was also practice to fly at the start of surveying a short traverse that could be repeated at the end of the flight. Comparison of the 'before' and 'after' traverses gave an estimate, in the reduction process, of diurnal change in magnetic field during survey.

4. DATA PROCESSING METHODS

Film processing

The navigation film, (Ilford HP3 and FP3), was processed in a Microrecord tank. Normal developing chemicals and a combination developer-fixer were used. It was found that the combination developer-fixer gave excellent results with much greater simplicity of operation.

Plotting

The path of the aircraft was plotted on the navigation photos by the vertical camera record, which exposed one frame every 4 sec, i.e. at approximately 740-ft intervals. It was found sufficiently accurate at Cobar to plot only every fifth or tenth frame, interpolating a straight line in between; the error introduced in this way had an estimated standard deviation of 25 ft.

Correction for diurnal change

Because the SWD drifted with temperature, an estimation of the diurnal change during a survey flight was made by comparison of the records for the traverse flown at the beginning and repeated at the end. The change measured this way was treated as linear, unless the SWD record showed a magnetic storm pattern superimposed upon the smooth curve due to the normal diurnal change and temperature drift.

The absence of an accurate continuous record of diurnal change introduced the greatest error into the reduction of data and contour map compilation.

Contour cut determination

The trace of the magnetometer chart was in 2-sec steps, which were not smoothed for reduction purposes except in the case of very obvious noise spikes. For each area surveyed an arbitrary value of magnetic field datum was selected; for each flight-line the datum was adjusted for the diurnal change, and contour levels marked on the chart at five-gamma intervals. The fiducial coordinates of the intersection of the magnetometer trace with the contour levels were then listed, and marked on a transparency overlying the flight-path pattern. Contour lines joining points of equal strength were then drawn on the overlay. In some cases it was more convenient to draw the contours at 10-gammas intervals, rather than at five-gammas intervals.

Time taken to process data

The time taken to process the data recorded on a typical flight of 60 line miles is as follows:

		Time (hr)
Processing of film	:	1½
Plotting of flight path (interpolating between every 5th-10th frame)	:	8
Drawing of overlay	:	2
Annotation of charts	:	4
Compiling list of contour cuts (at 5-gammas intervals)	:	4
Marking contour cuts on overlay	:	3
Contouring	:	3

5. SURVEY ERRORS

A 25-mile section of road, between Hermidale and Canbelego was flown four times at a height of 280 ft to determine the precision with which the magnetometer could record the magnetic field over known positions. A standard deviation (SD) of two gammas in the recorded values was estimated by comparing the profiles.

A study of the overall error in final plotted position of magnetic data established an estimated SD of 50 ft. The resultant error in gammas will clearly increase as the gradient of the magnetic field increases and dominate the total error in field measurement where the gradients are high.

Occasionally large noise spikes occurred on the chart trace. These are thought to be due to interference generated in the cable or in one of the electronic current relays.

A heading error was present in the bird core during the Cobar survey. This was due to a magnetic vector always acting in the direction of the polarising field. It amounted to a difference in reading of $4\frac{1}{2}$ gammas between north and south headings, and so the areas at Cobar were flown east-west making heading error negligible. The east-west direction was also generally across the strike of the rocks.

Flights were made at several levels over the road traverse to study depth computations made from proton-magnetometer records with a 2-sec interval between readings. Depth estimates were made on a selected anomaly using the 'half-maximum slope' method (Peters, 1949). The anomaly profile had previously been corrected for regional gradient and smoothed. The results of the estimates are tabulated below, where the estimates are the mean of two computations - one on each flank of the anomaly.

(a)	Aircraft height (ft) above ground level	230	280	330	380	500	750	1000
(b)	Estimated distance (ft) between aircraft and anomaly source	980	1300	1170	1260	1270	1490	1350
(b)-(a)	Estimated depth (ft) of anomaly source below ground level	650	1020	840	880	770	740	350

Flights were also made at heights of 1280 and 2030 ft but the profiles obtained did not define the anomaly clearly enough to allow depths to be estimated. The figures show a maximum error of about 25 percent of estimated distance between aircraft and source. There is no evidence that smoothing of the stepped profile has contributed to the error, but the quantity of data available for the study is insufficient to make a satisfactory study of error.

6. NOTES ON AREAS SURVEYED

Plates 2 to 8, present the results of the surveys over seven small areas where anomalies were known to exist and where information from previous surveys was available for comparison purposes. Plate 1 shows the location of the surveyed areas. All the seven areas had been covered by an aeromagnetic survey (Spence, 1961) made by the Bureau's DC.3 aircraft flying traverses spaced one mile apart. In Plates 2 to 8, where a map of part of a DC3 survey is shown, the boundary of the corresponding Cessna survey is indicated on the DC.3 map.

Three of the seven areas, viz. Peak, Nurri, and Spotted Leopard, had also been covered by an aeromagnetic survey with flight-lines spaced a quarter mile apart. This survey was performed by a private company under contract to Cobar Mines Pty Ltd and the results have not been generally published although data relating to these three areas were made available to the Bureau and are shown in Plates 2, 3, and 8.

It will be seen that the planimetry shown on the aeromagnetic maps supplied by Cobar Mines (Plates 2, 3, 8) is slightly different from that on corresponding maps of the light aircraft surveys. This is unavoidable but does not prevent comparison between the two sets of data to be made.

Plates 2, 3, 5, and 6 show, in addition to aeromagnetic data, the results of ground surveys, but no planimetric data appear on the ground maps. The ground and airborne maps can thus be related to each other only by matching the magnetic data. It should be noted that the results of the ground surveys are in the form of contours of vertical force as distinct from the contours of total force for the aeromagnetic surveys. The ground maps of the Peak and Spotted Leopard areas are from surveys made in 1947-49 (Richardson, 1948; Thomson, 1950) and those for Budgery and Girilambone from a survey made in 1949 (Barlow, 1950).

Peak

Prior to the survey, the Peak-Coronation area had been flown at heights of 500 and 300 ft. Ground work also had been done with a vertical force magnetometer. The results of the four surveys are shown for comparison in Plate 2. The map compiled from the results of the Cessna survey has been contoured at five-gamma intervals, thus giving more detail than the others which have been contoured at 10-gamma intervals.

It can be seen that the Cessna map closely follows the ground survey map and is more informative than the DC.3 maps. The geology of the Peak area is also shown in Plate 2, and while no outstanding correlation is present between geology and magnetic pattern, the north-north-west trend of the anomalies is seen to conform with the general north-north-west strike of the shear pattern in the area.

Drilling of the Peak anomaly has disclosed pyrrhotite which explains the strong magnetic pattern.

An important advantage of the airborne method over the ground method is illustrated by the results in the Peak area. Irregularities in ground measurements owing to disturbances from local sources at or near the surface are common, being due to natural or artificial material. These irregularities make contouring impossible in regions of otherwise low magnetic relief. The blank space west of the main Peak anomaly on the map showing the results of the ground survey is such a region. The corresponding part of the map of the light aircraft survey has been contoured without difficulty.

Spotted Leopard

The Spotted Leopard anomaly is one of low strength. Comparison of the results of the four surveys of the area, in Plate 3 again emphasizes the improved resolution of the Cessna results compared to the DC3 results, and the extent to which the Cessna map correlates with the ground work. The Spotted Leopard map is presented exactly as it was produced in the field. There may be justification for rationalising some of the contour lines by smoothing.

The magnetic anomaly pattern again shows a north-north-west strike, conforming with the shear direction of the C.S.A. beds. To the west of the area, a very flat magnetic field was measured over the Amphitheatre group rocks. There is no evidence in the magnetic results of the postulated fault (Thomson, 1953) at the junction of the C.S.A. beds with the Amphitheatre group.

Weltie North

This area was flown to cover an anomaly which had been detected but only partly delineated by the DC.3 survey. Inspection of the Cessna survey results presented in Plate 4 shows the anomaly to resolve into two separate units. These could be associated with granite plugs thought to exist in the area.

Budgery

The Budgery area was flown to test the equipment over the known anomaly at the mine. The airborne anomaly was recorded accurately in position and has a strength of 80 gammas. On the ground, the anomaly is resolved into two peaks close together, of 180 gammas and 240 gammas. The ground measurements were made at stations 25 or 50 ft apart along traverses 400 ft apart. Plate 5 illustrates these anomalies.

Girilambone

The Girilambone anomaly is situated at the old mine, just south of a strong anomaly delineated by the DC.3 survey. This anomaly has a maximum amplitude of 60 gammas (vertical force) measured on the ground, and was flown to test the survey technique over weak, small anomalies. Inspection of Plate 6 shows the anomaly to have been detected in the correct position and orientation, and with a strength of 30 gammas.

Mount Boppy

Mount Boppy is a pronounced topographic feature and the area was therefore chosen to test the survey technique in an area with vertical relief.

Plate 7 shows satisfactory results over the area. The 60-gamma anomaly detected in the otherwise flat field resolves the feature shown by the flexure in the 980-gamma contour in the DC.3 map at that point.

Nurri

The Nurri area is another area showing topographical relief. Plate 8 demonstrates the correlation of the Cessna results with the previous survey at 300 ft height and with the DC.3 results.

7. CONCLUSIONS

The proton-precession magnetometer installed in VH-GEO is basically successful in performing detailed aeromagnetic surveys. As was expected, the resulting maps show the appropriate portion of the DC.3 map to be considerably resolved in each instance, and in some cases to the extent where ground follow-up would add little or no useful detail.

A more-satisfactory method of correcting for diurnal variation would improve the accuracy of the magnetic results. This must entail the replacement of the fluxgate magnetometer type of SWD with a drift-free magnetometer, and a study of the limitations involved in correcting aerial records for diurnal variations by reference to a ground SWD recording some distance from the aircraft.

A magnetometer which recorded more frequently than every 2 sec would be required on surveys over areas more magnetically disturbed than Cobar. Even at Cobar a higher recording frequency would have been required for a more-detailed record over some anomalies.

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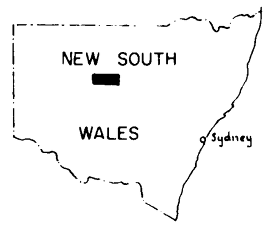
PLATE I

LOCATION DIAGRAM



AIRBORNE MAGNETOMETER SURVEY
(LIGHT AIRCRAFT)
COBAR REGION N S W
LOCATION OF SURVEYED AREAS

SCALE

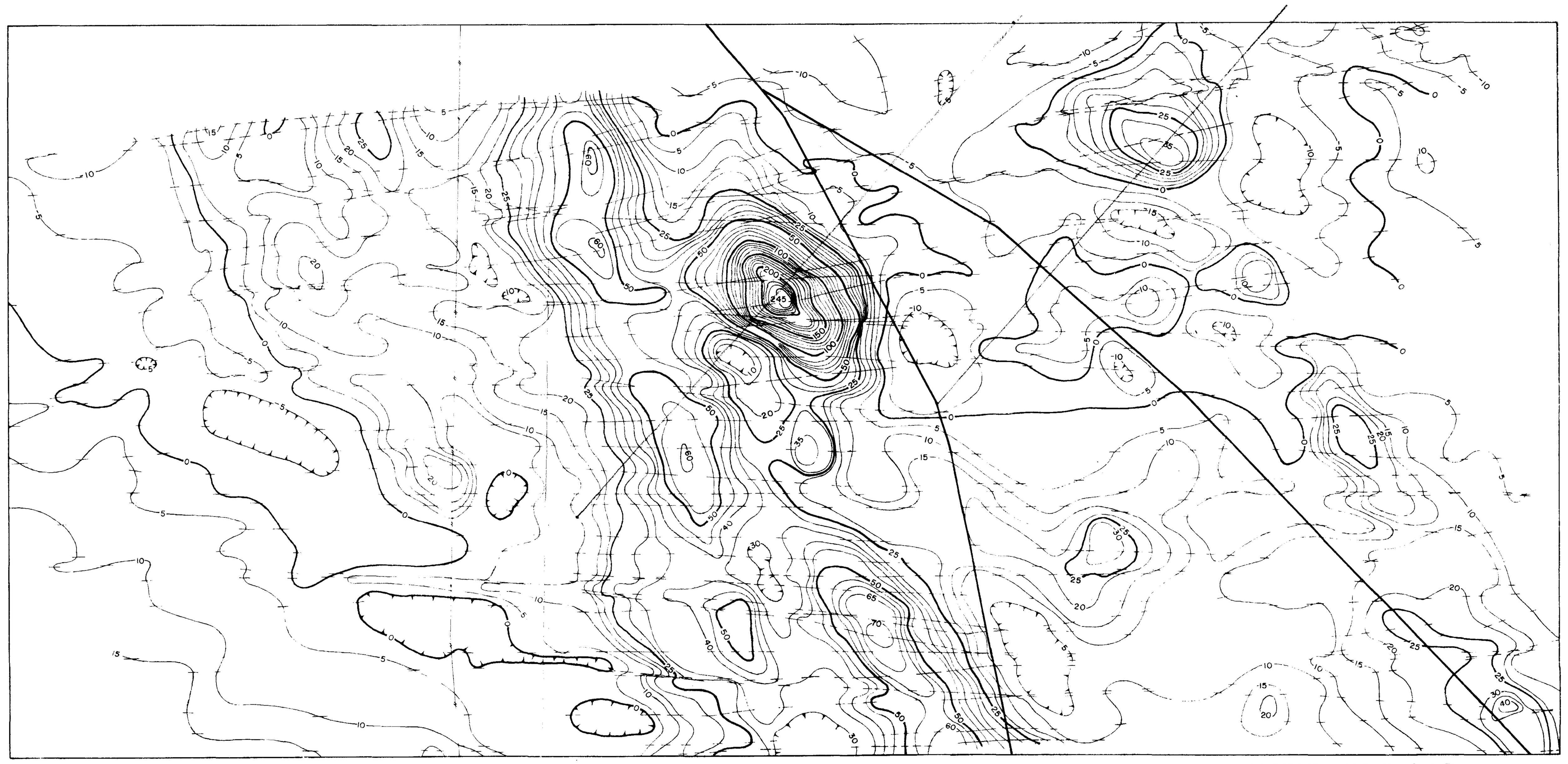
miles 2 1 0 2 4 6 8 10 miles

LEGEND

- River or creek
- Highway or road
- Track
- Railway
- Homestead
- Named place
- Aerodrome
- Mine
- Map boundary of surveyed areas

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS H55/B1-2

TO ACCOMPANY RECORD NO. 1964/110



LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

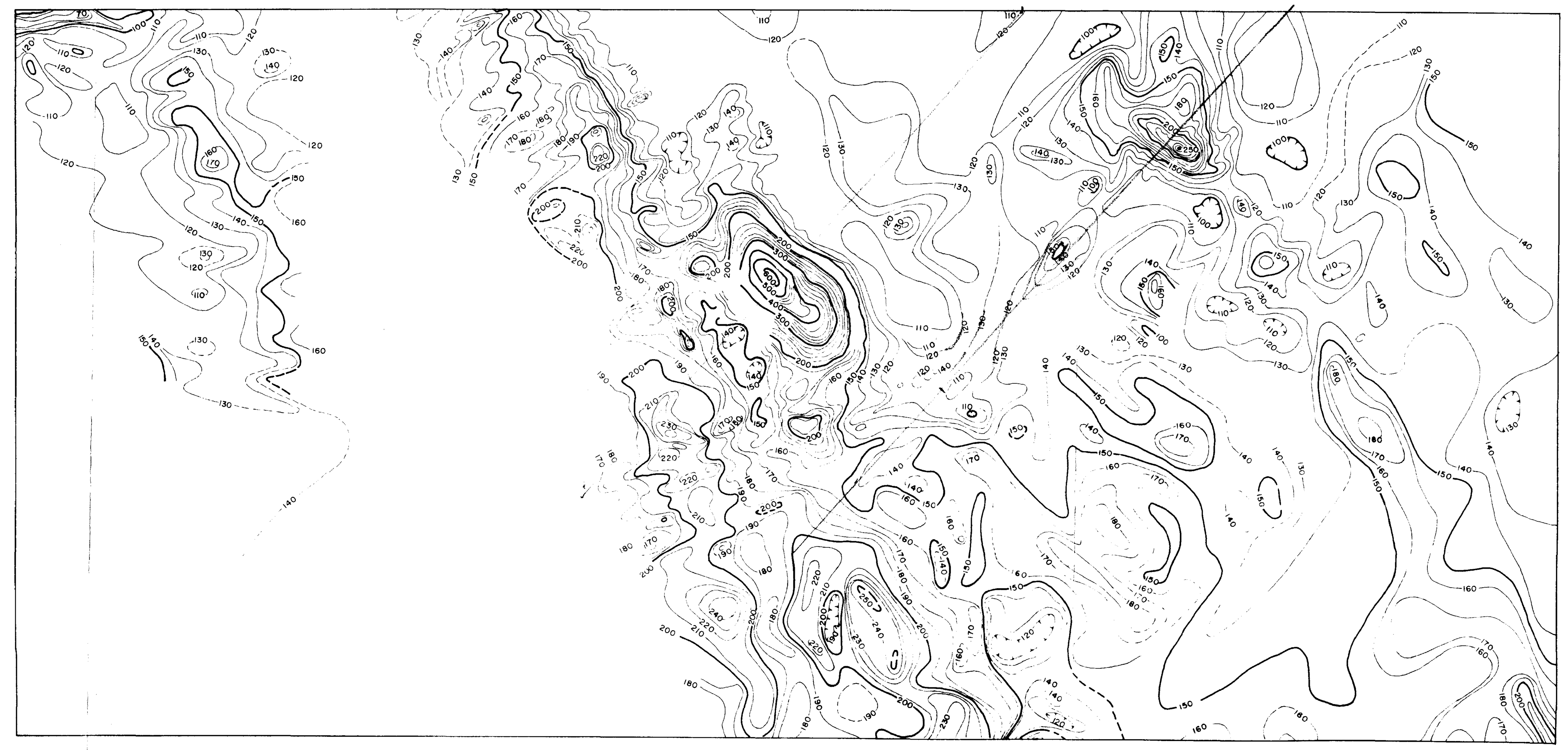
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 5 GAMMAS

SCALE

2000 FEET 0 2000 4000 6000 FEET



GEOPHYSICAL GROUND SURVEY

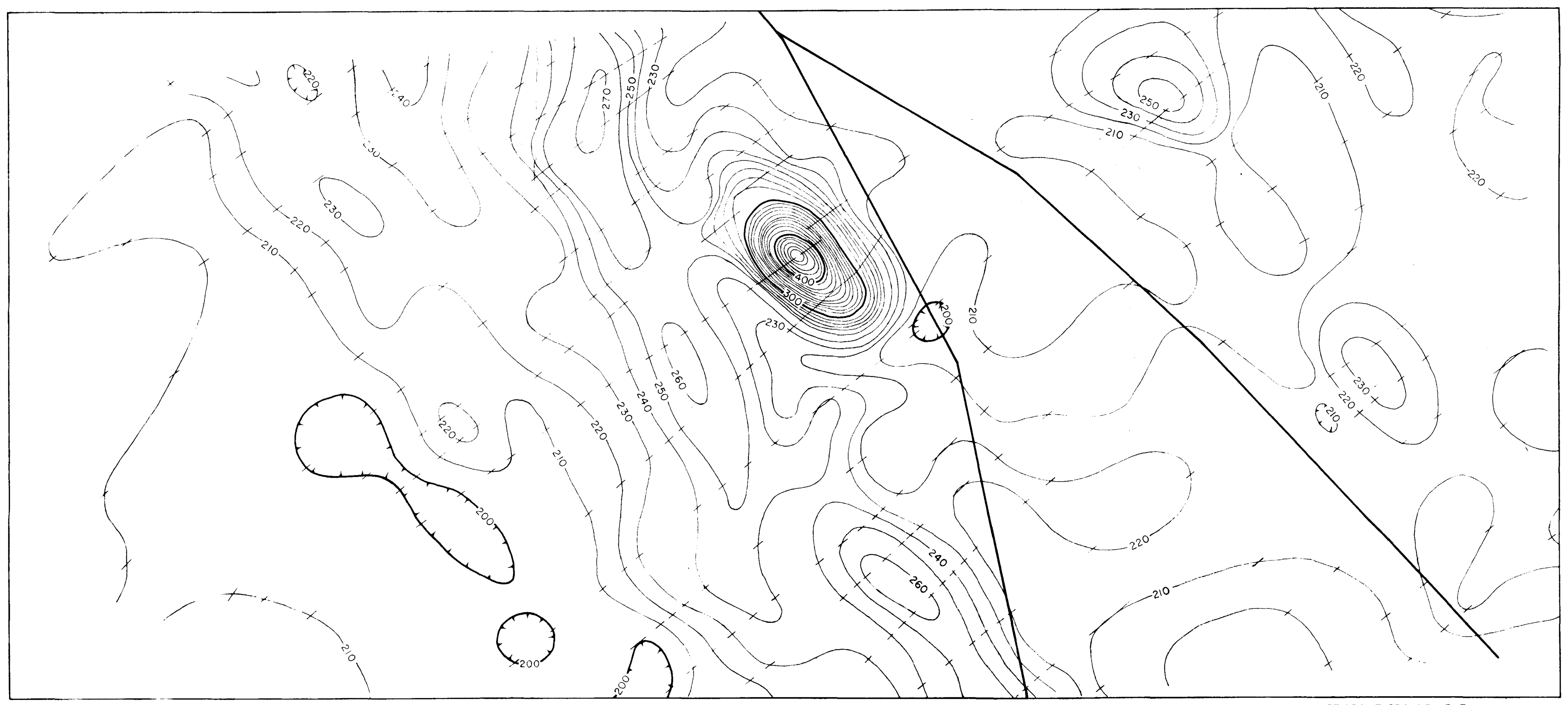
GEOMAGNETIC VERTICAL FORCE CONTOURS PREPARED FROM SMOOTHED PROFILES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

CONTOUR INTERVAL 10 GAMMAS

SCALE

2000 FEET 0 2000 4000 6000 FEET



AEROMAGNETIC SURVEY

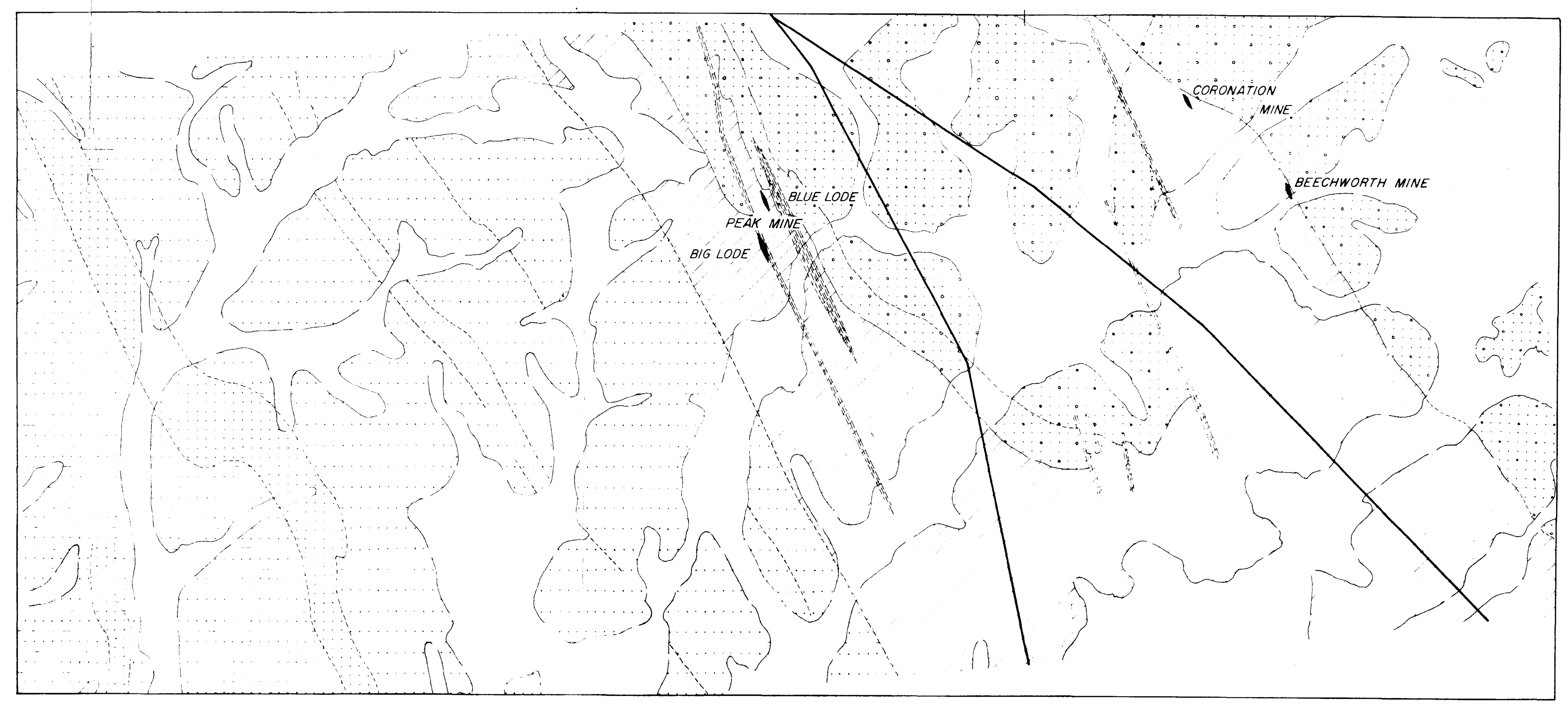
INFORMATION SUPPLIED BY COBAR MINES PTY LTD

MEAN DETECTOR HEIGHT 300 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 10 GAMMAS

SCALE

2000 FEET 0 2000 4000 6000 FEET



GEOLOGY

INFORMATION SUPPLIED BY COBAR MINES PTY LTD

SCALE

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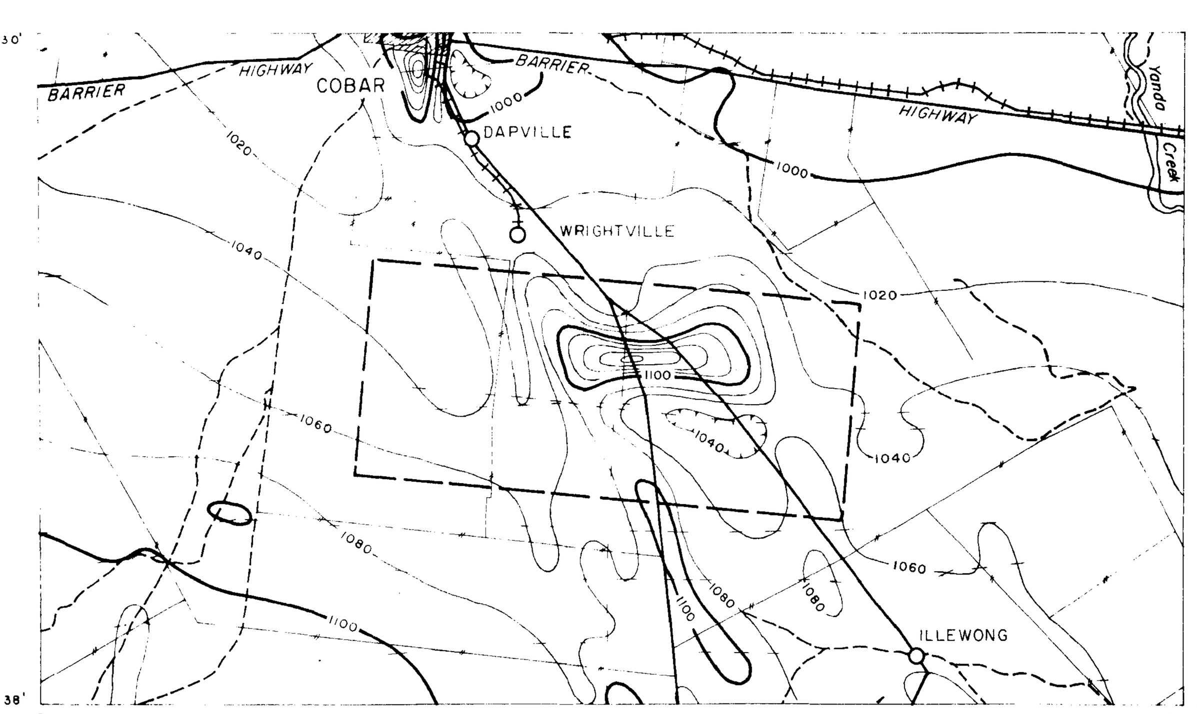


DC.3 AEROMAGNETIC SURVEY, 1957

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2 MILES 0 2 4 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS

TOPOGRAPHICAL LEGEND

- *River or creek*
- *Highway*
- *Road or track*
- *Railway*
- *Fence*
- *Named place*

GEOPHYSICAL LEGEND

- *Magnetic contours with flight-line intersections*
- *Magnetic low*
- *Map boundary of the 1963 light-aircraft aeromagnetic survey*

PEAK AREA

MAGNETIC SURVEYS

COMPARISON OF RESULTS

GEOLOGICAL LEGEND

LOWER DEVONIAN — AMPHITHEATRE GROUP

- *Sandstone, claystone, slate, and shale.*
- *Quartzite and sandstone.*

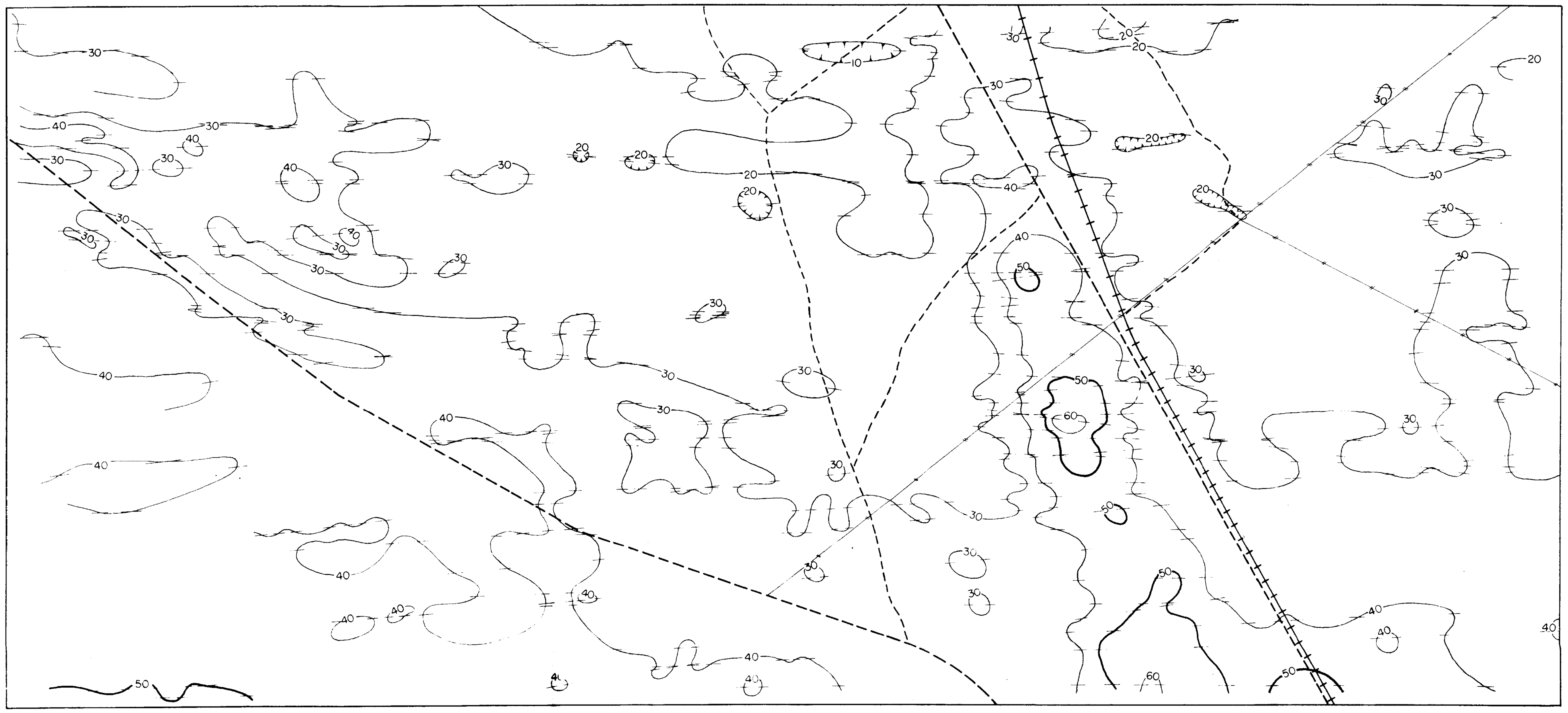
UPPER SILURIAN TO LOWER DEVONIAN

- C.S.A. BEDS — *Claystone, slate, and sandstone*
- COBAR FORMATION — *Slate*
- CHESNEY FORMATION — *Greywacke*

Shear

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS H55/B1-7

TO ACCOMPANY RECORD NO. 1964/110



LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

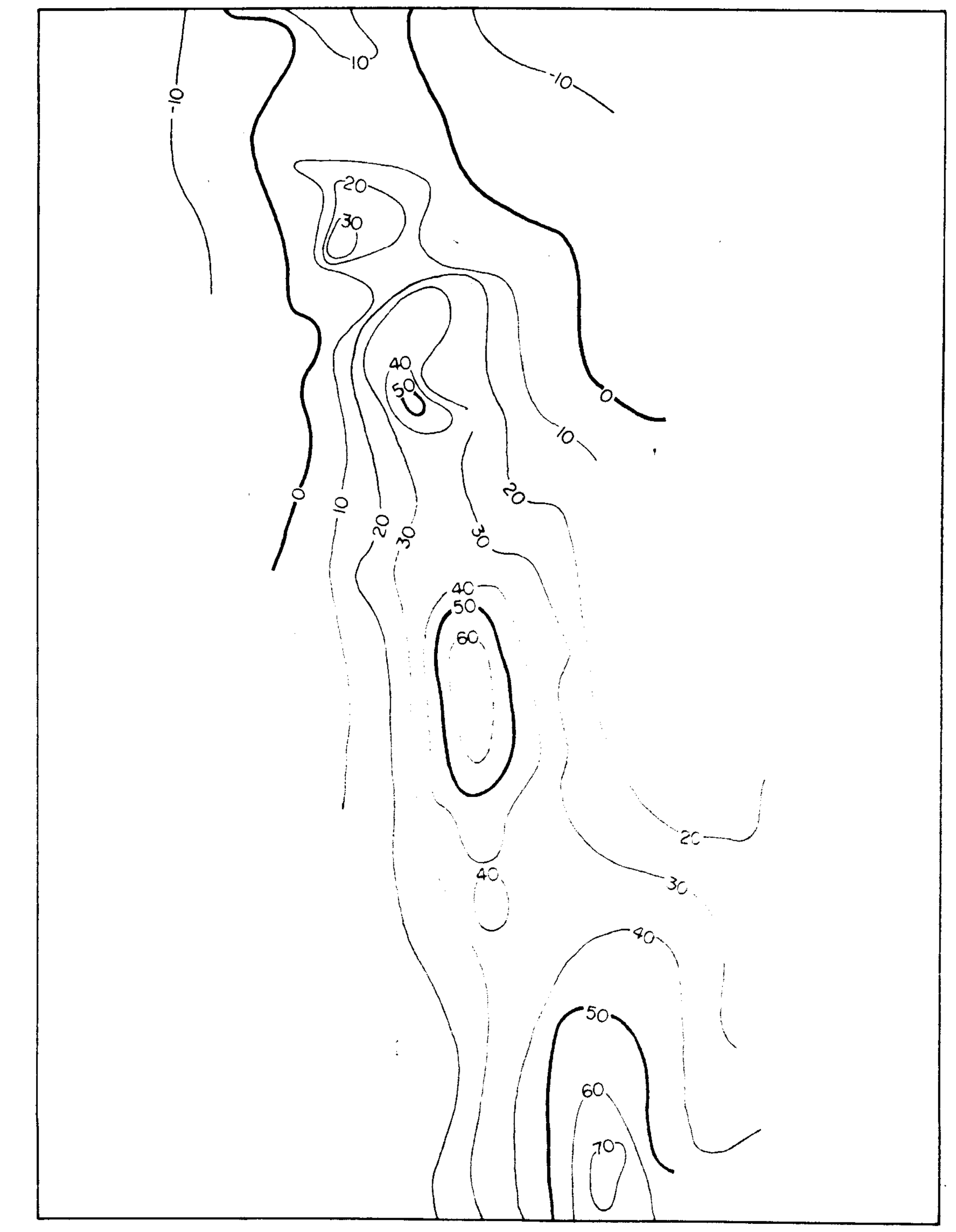
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2000 FEET 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 10 GAMMAS



GEOPHYSICAL GROUND SURVEY

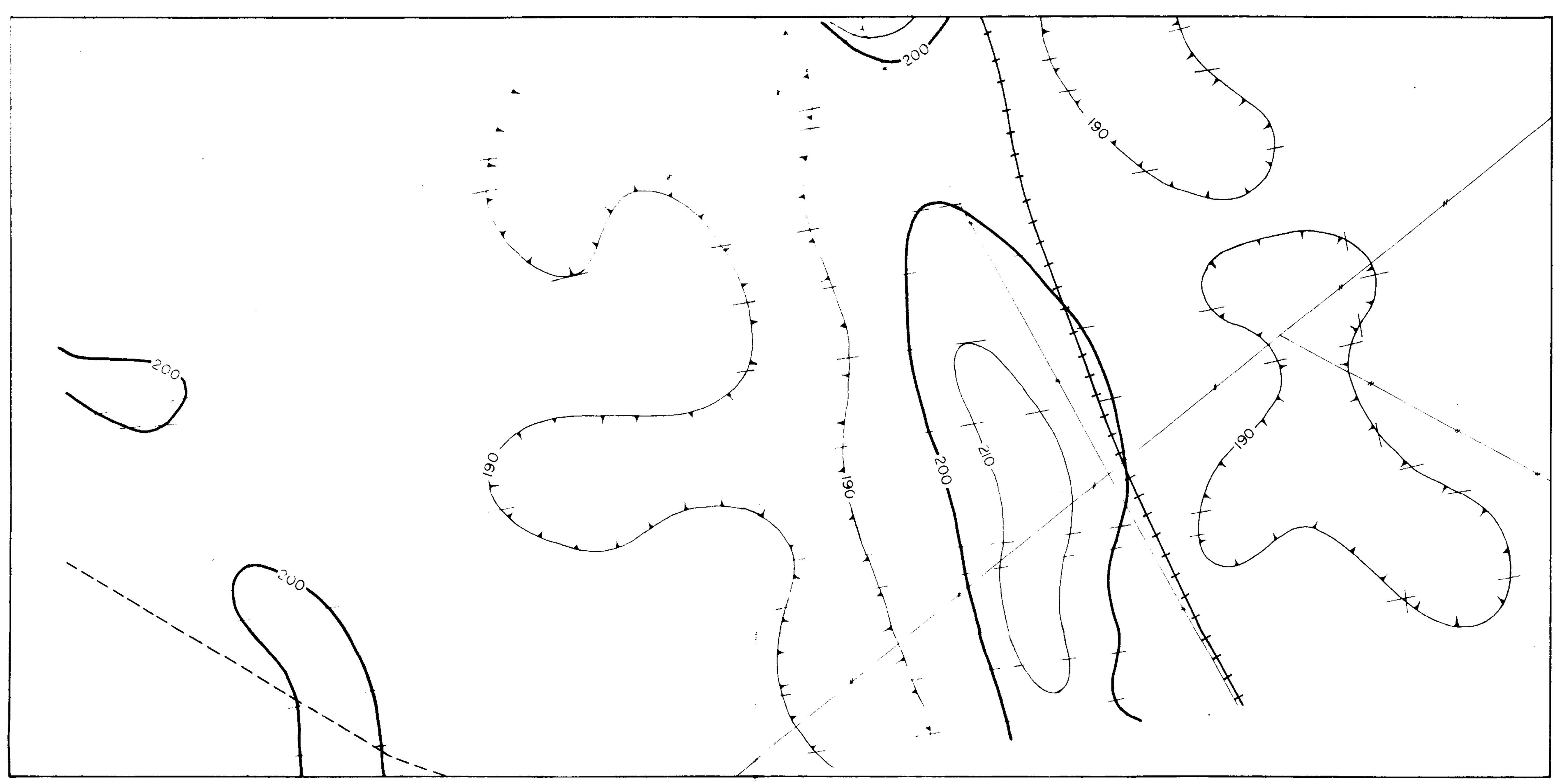
GEOMAGNETIC VERTICAL FORCE CONTOURS PREPARED FROM SMOOTHED PROFILES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2000 FEET 0 2000 4000 6000 FEET

CONTOUR INTERVAL 10 GAMMAS



AEROMAGNETIC SURVEY

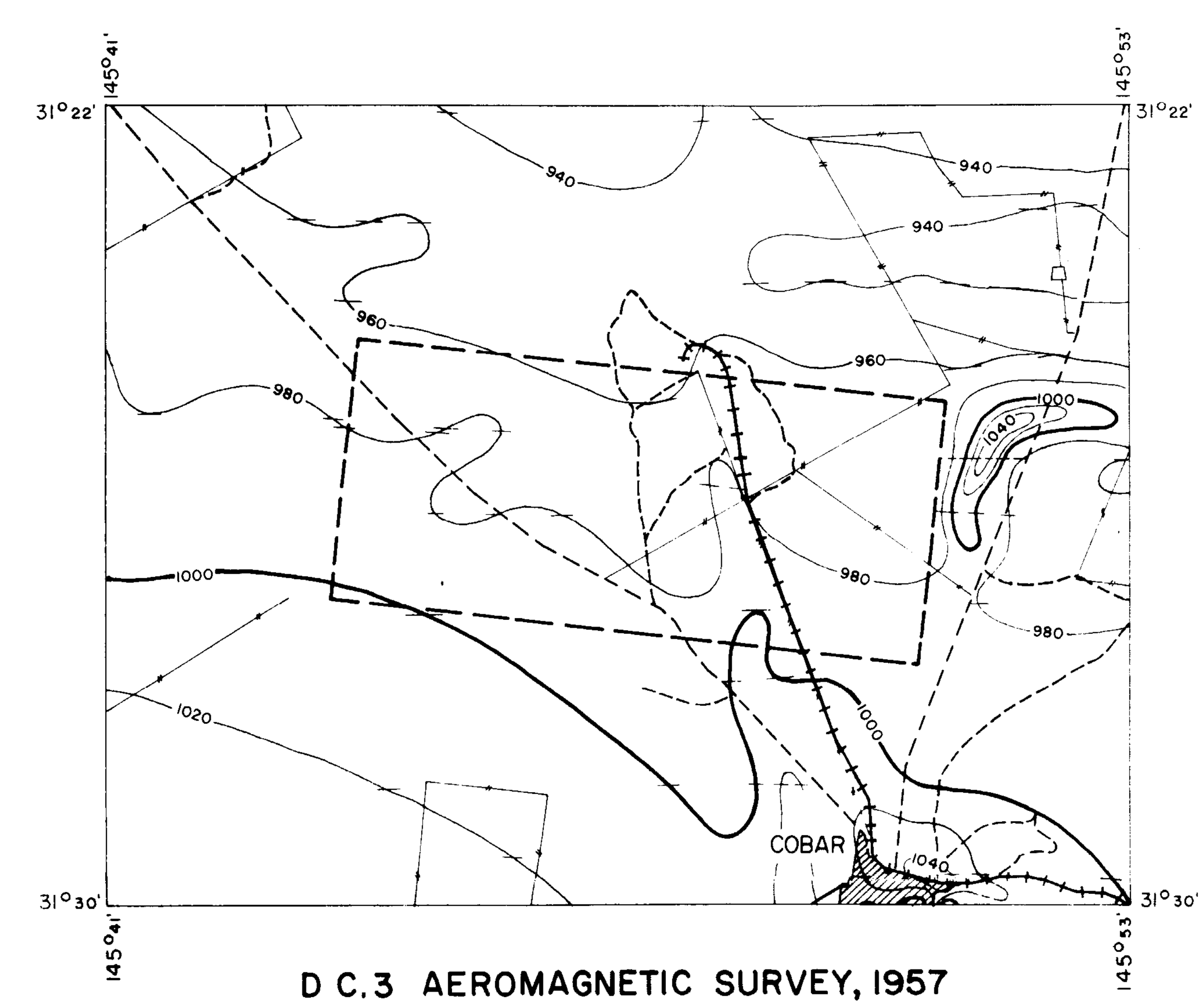
INFORMATION SUPPLIED BY COBAR MINES PTY LTD

SCALE

2000 FEET 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 300 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 10 GAMMAS



D C.3 AEROMAGNETIC SURVEY, 1957

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2 MILES 0 2 4 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS

SPOTTED LEOPARD AREA

MAGNETIC SURVEYS

COMPARISON OF RESULTS

TOPOGRAPHICAL LEGEND

Highway — Railway

Road or track — Fence

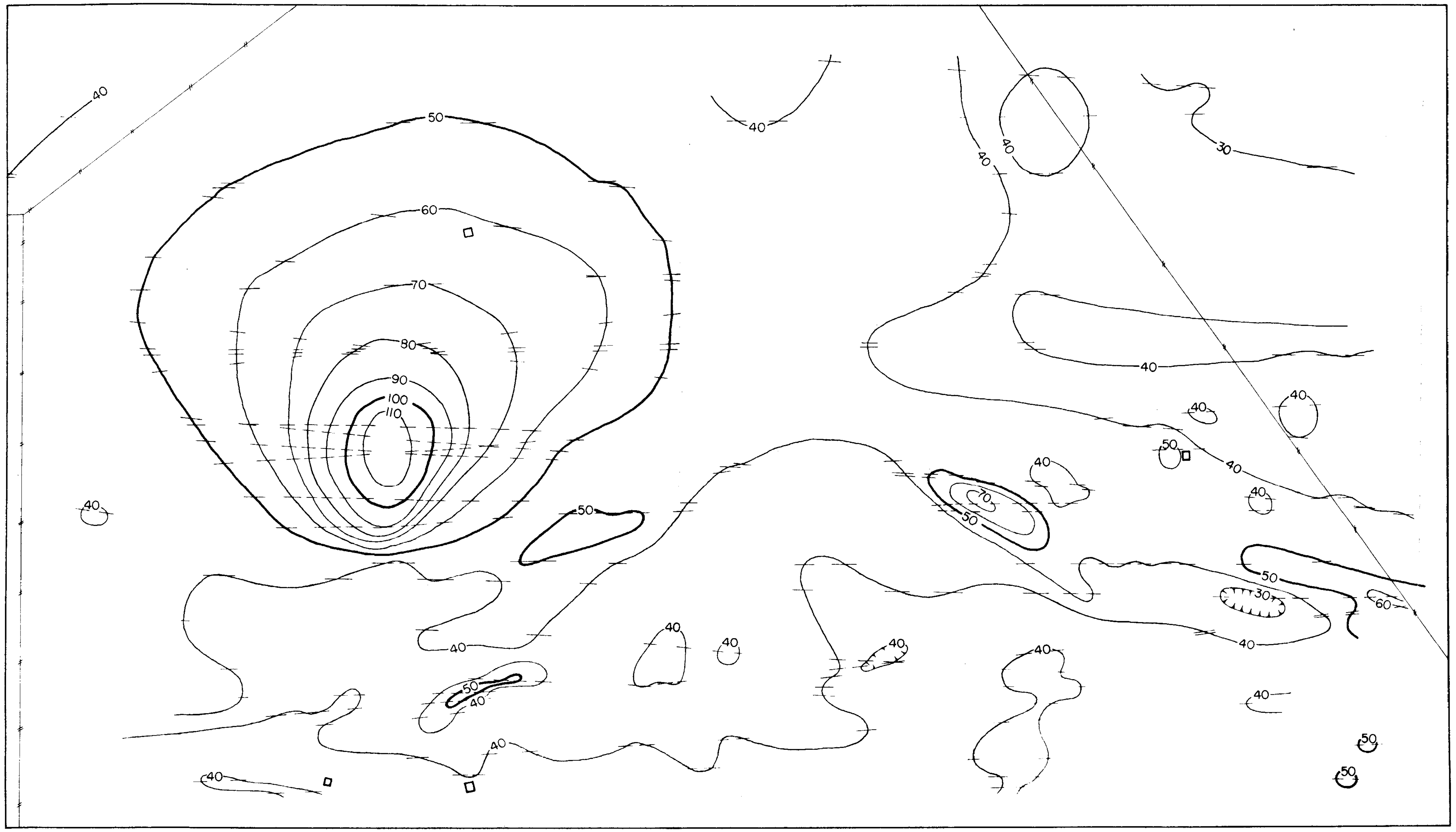
GEOPHYSICAL LEGEND

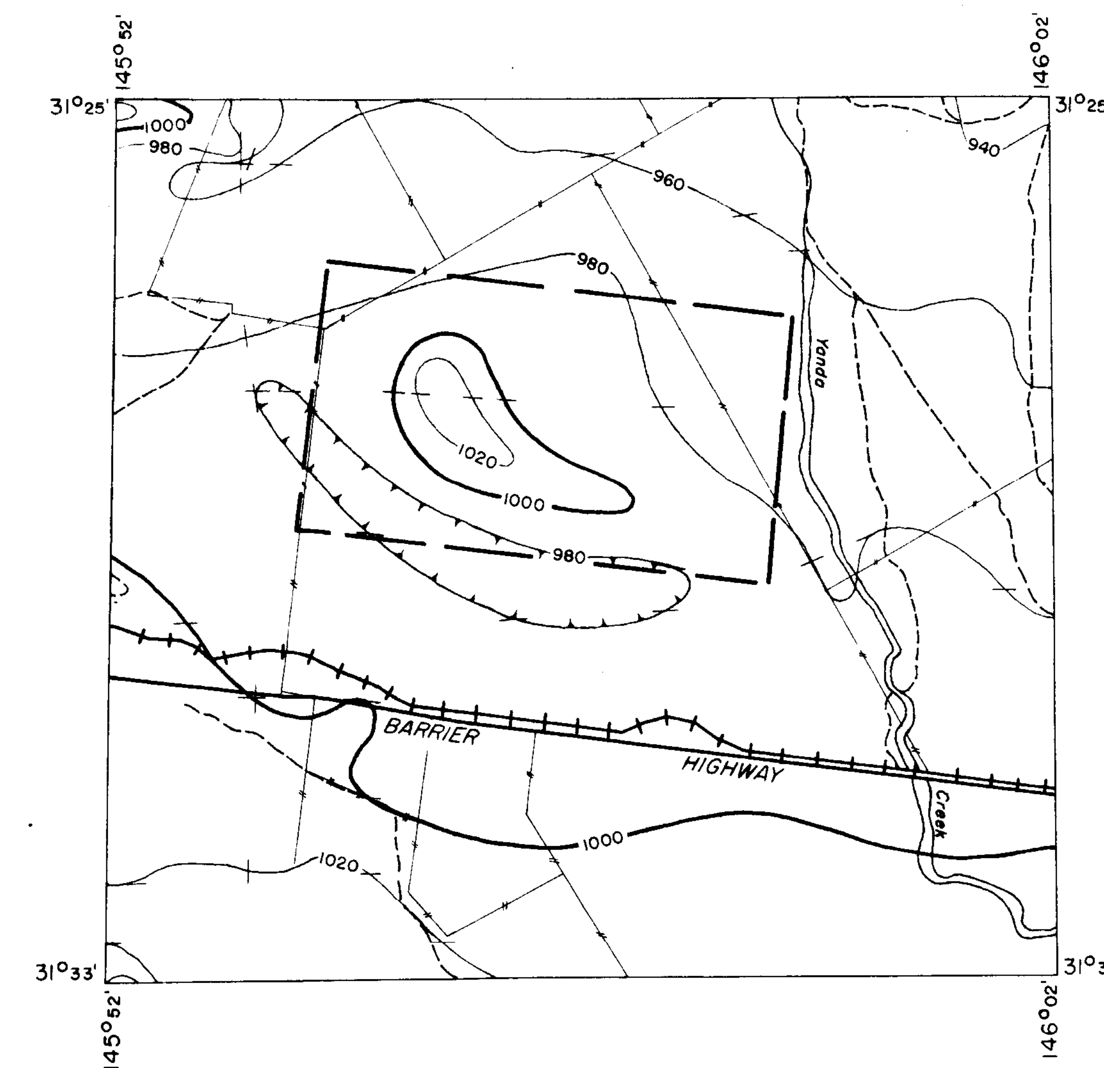
Magnetic contours with flight-line intersections

Magnetic low

Map boundary of the 1963 light-aircraft aeromagnetic survey

PLATE 4





D C.3 AEROMAGNETIC SURVEY, 1957

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

MILES 2 0 2 4 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS

LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

FEET 2000 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 10 GAMMAS

TOPOGRAPHICAL LEGEND

River or creek

Highway

Road or track

Railway

Fence

Dam or water tank

GEOPHYSICAL LEGEND

100 *Magnetic contours with flight-line intersections*

Magnetic low

Map boundary of the 1963 light-aircraft aeromagnetic survey

WELTIE NORTH AREA

MAGNETIC SURVEYS

COMPARISON OF RESULTS

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS H55/B1-13

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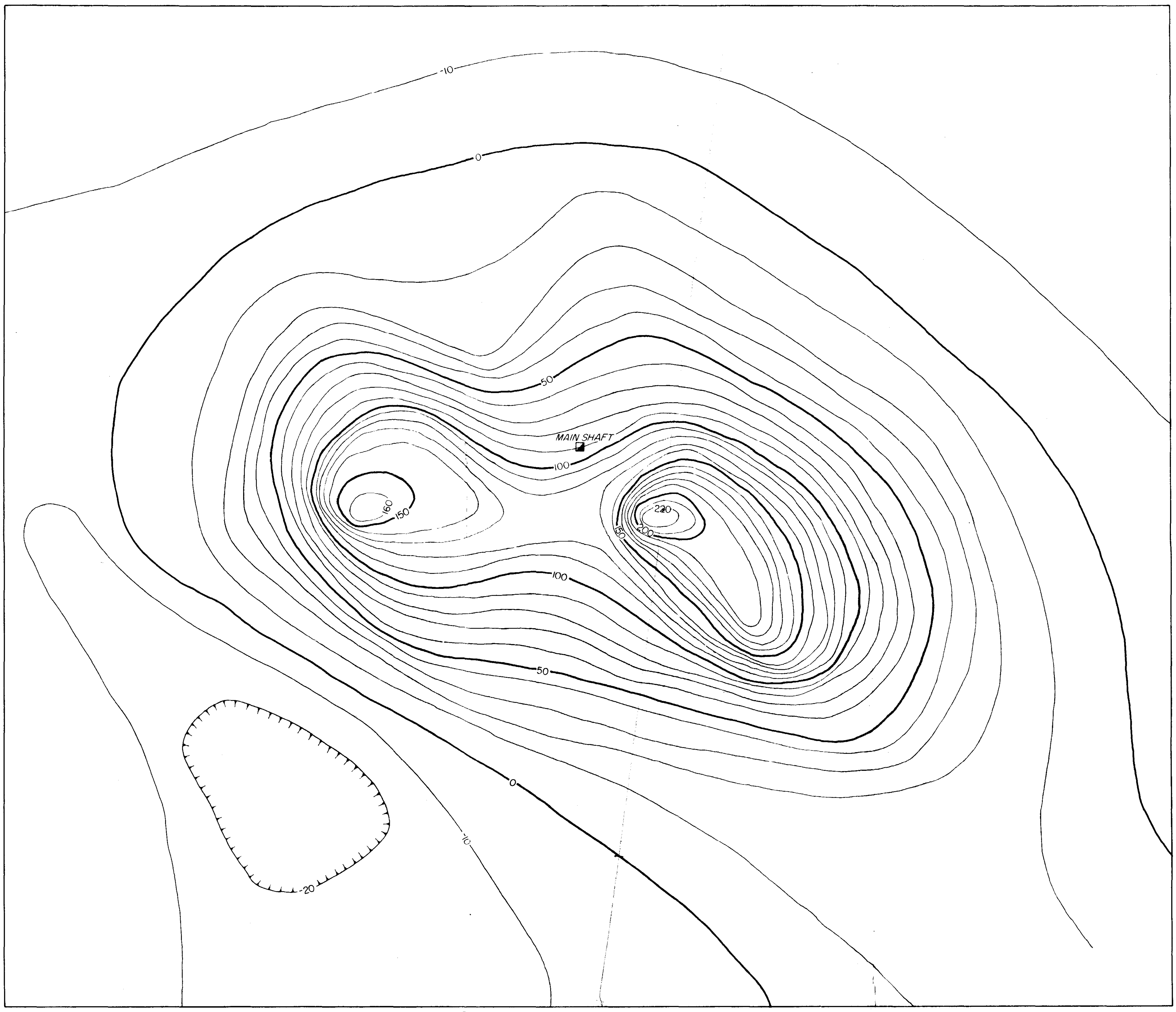


GEOPHYSICAL GROUND SURVEY

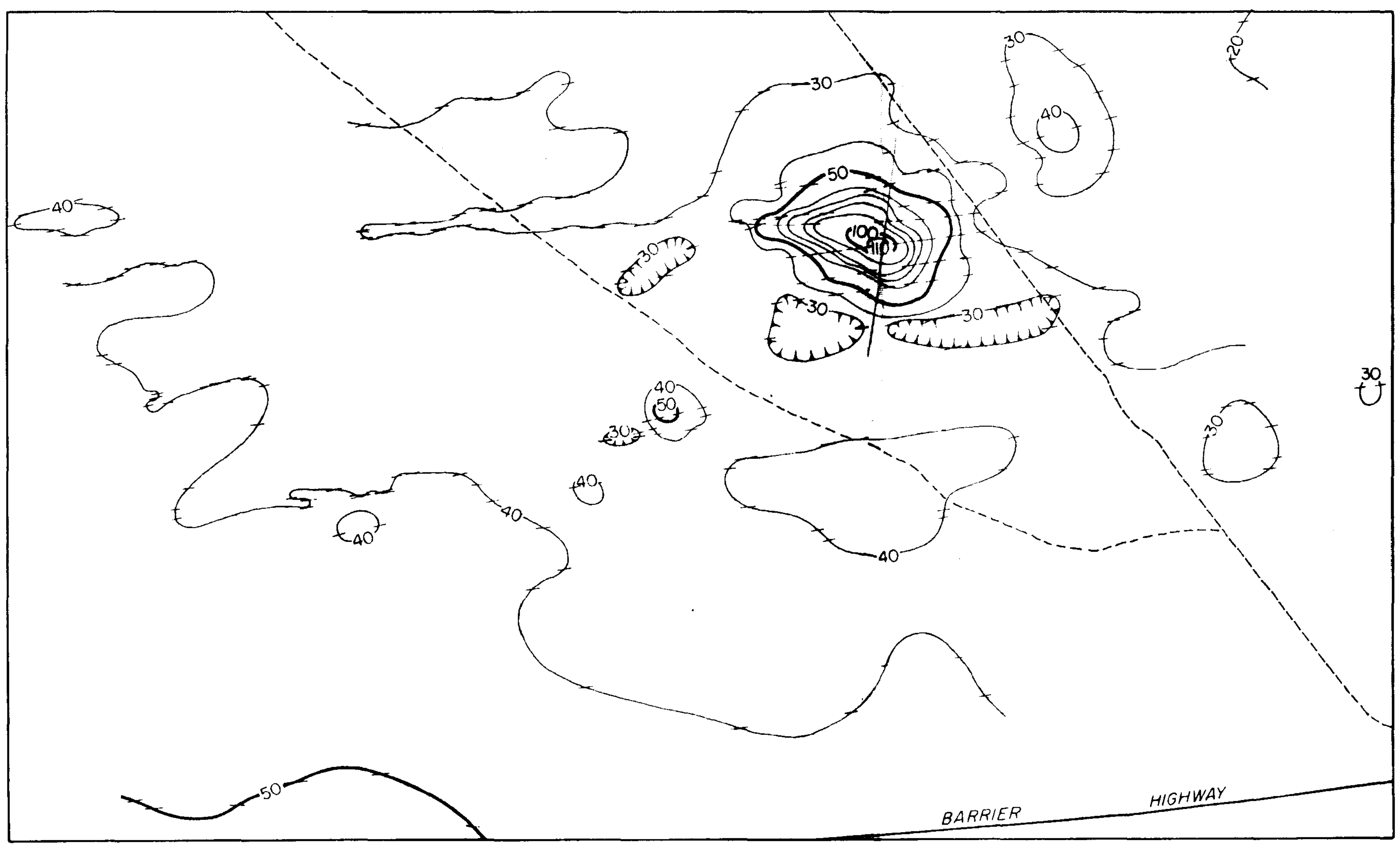
GEOMAGNETIC VERTICAL FORCE CONTOURS

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

FEET 200 0 200 400 600 FEET

CONTOUR INTERVAL 10 GAMMAS



LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

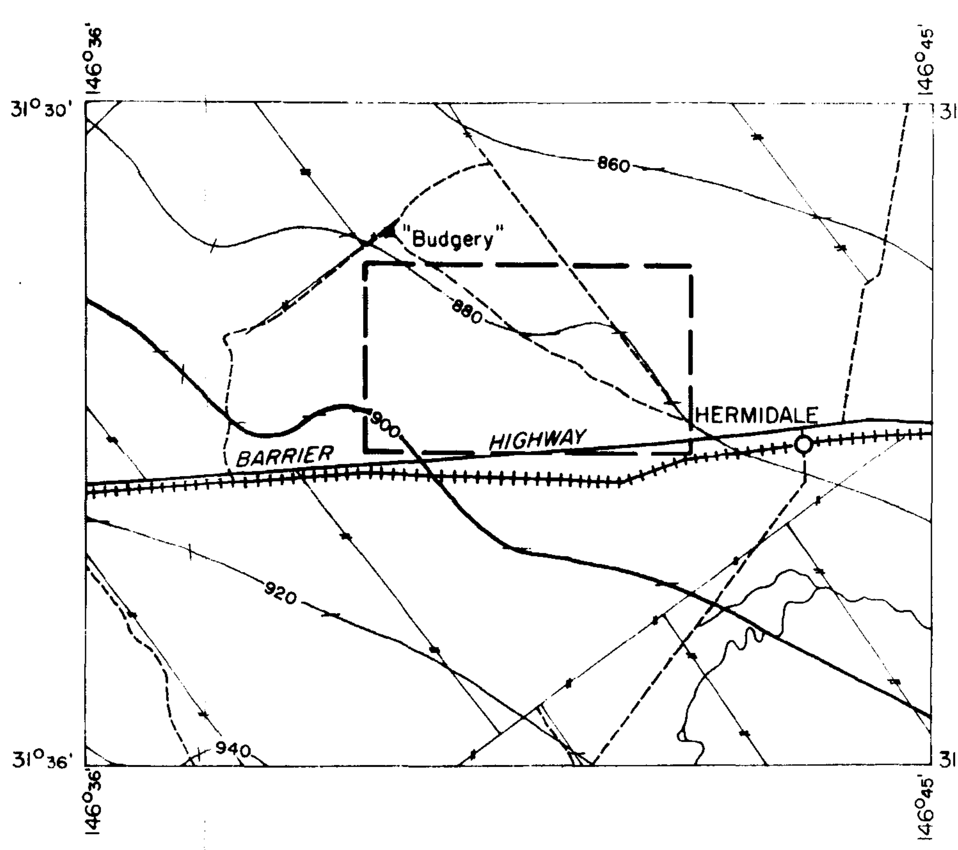
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

FEET 2000 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 10 GAMMAS



DC.3 AEROMAGNETIC SURVEY, 1957

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

MILES 2 0 2 4 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS

GEOPHYSICAL LEGEND

- Magnetic contours with flight-line intersections
- Magnetic low
- Map boundary of the 1963 light-aircraft aeromagnetic survey

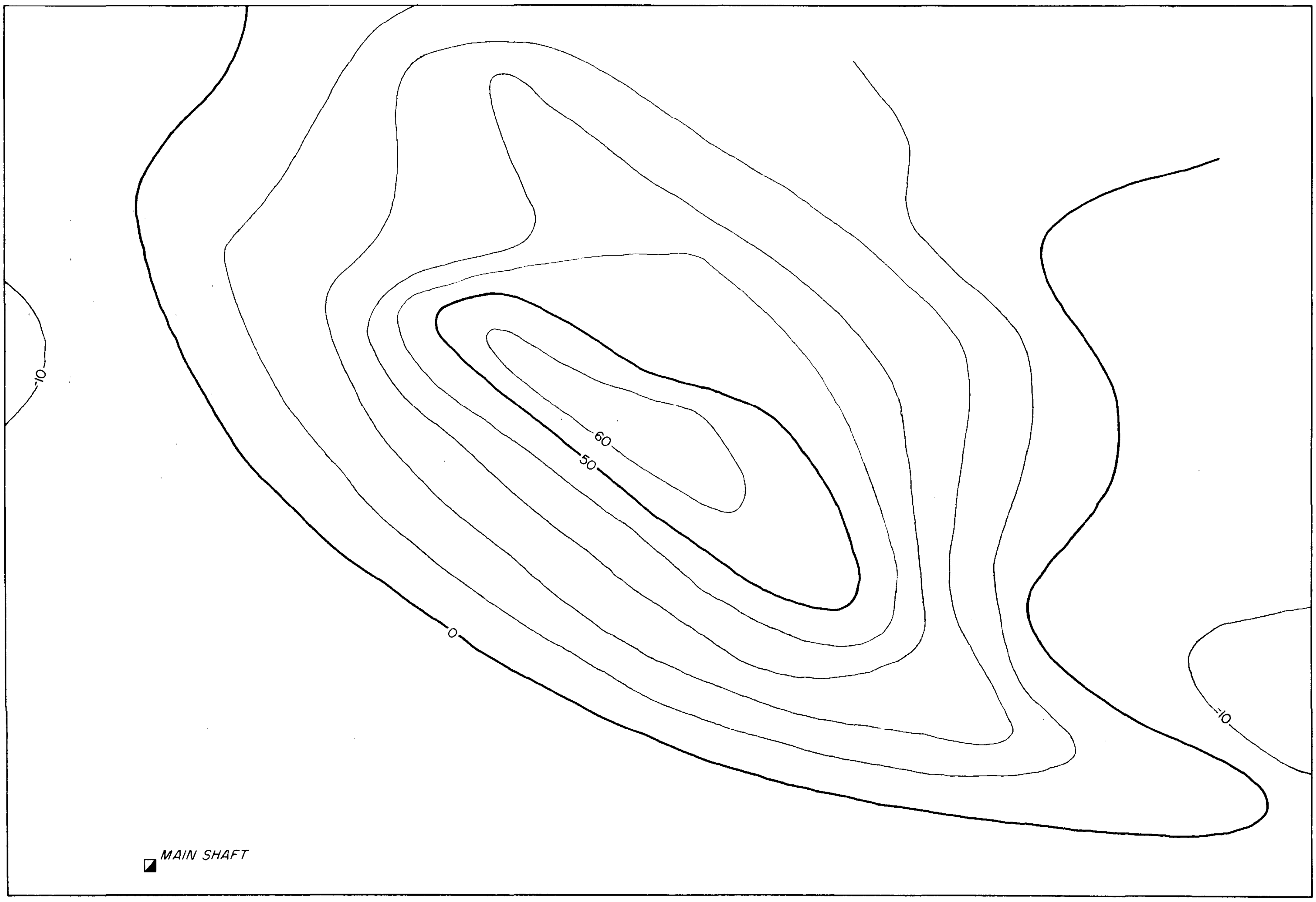
BUDGERY AREA

MAGNETIC SURVEYS

COMPARISON OF RESULTS

TOPOGRAPHICAL LEGEND

- River or creek
- Highway
- Road or track
- Railway
- Fence
- Homestead
- Named place
- Mine shaft



GEOPHYSICAL GROUND SURVEY

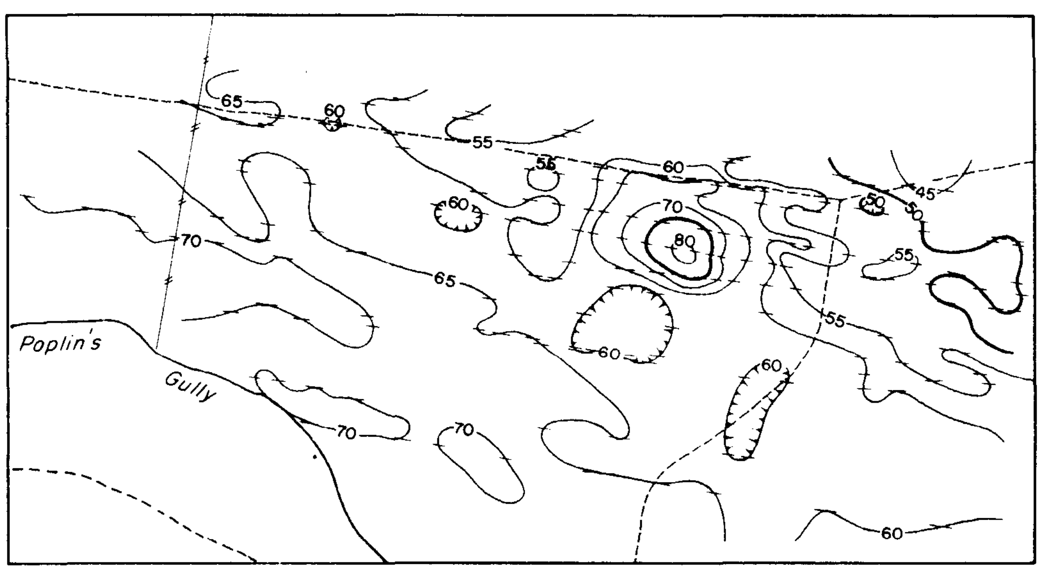
GEOMAGNETIC VERTICAL FORCE CONTOURS

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

200 FEET — 0 — 200 — 400 — 600 FEET

CONTOUR INTERVAL 10 GAMMAS



LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

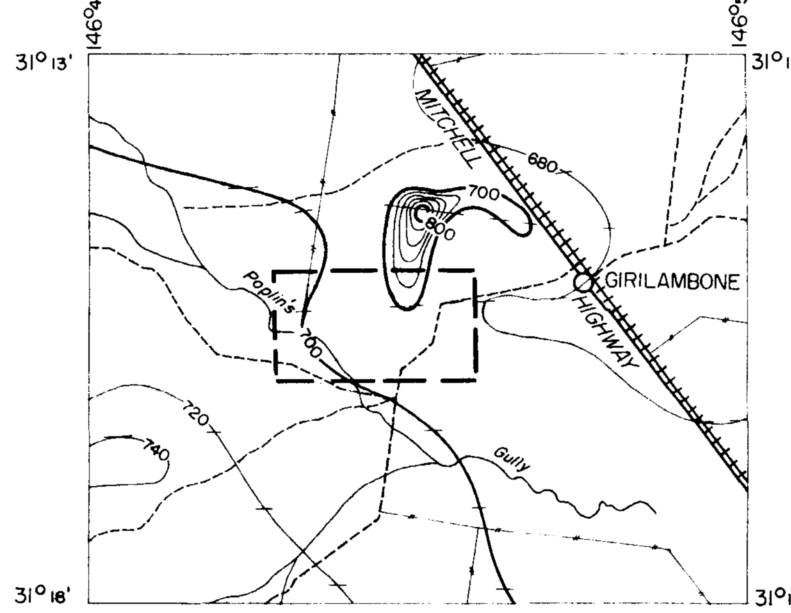
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2000 FEET — 0 — 2000 — 4000 — 6000 FEET

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 5 GAMMAS



D C.3 AEROMAGNETIC SURVEY, 1957

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2 MILES — 0 — 2 — 4 — 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS

TOPOGRAPHICAL LEGEND

- *River or creek*
- *Railway*
- *Highway*
- *Fence*
- *Road or track*
- *Named place*
- *Mine shaft*

GIRILAMBONE AREA

MAGNETIC SURVEYS

COMPARISON OF RESULTS

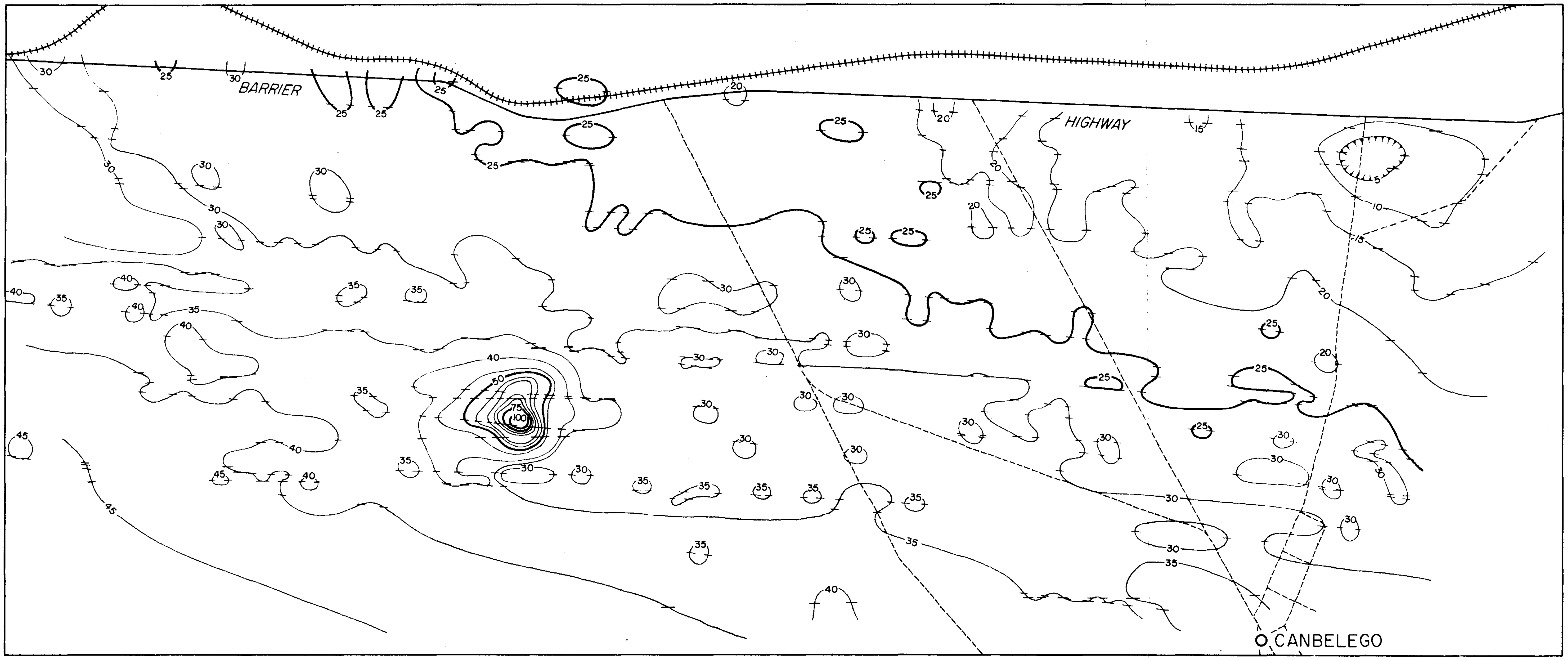
GEOPHYSICAL LEGEND

- 100 — *Magnetic contours with flight-line intersections*
- *Magnetic low*
- *Map boundary of the 1963 light-aircraft aeromagnetic survey*

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS H55/B1-11

PLATE 6

TO ACCOMPANY RECORD NO. 1964/110



LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

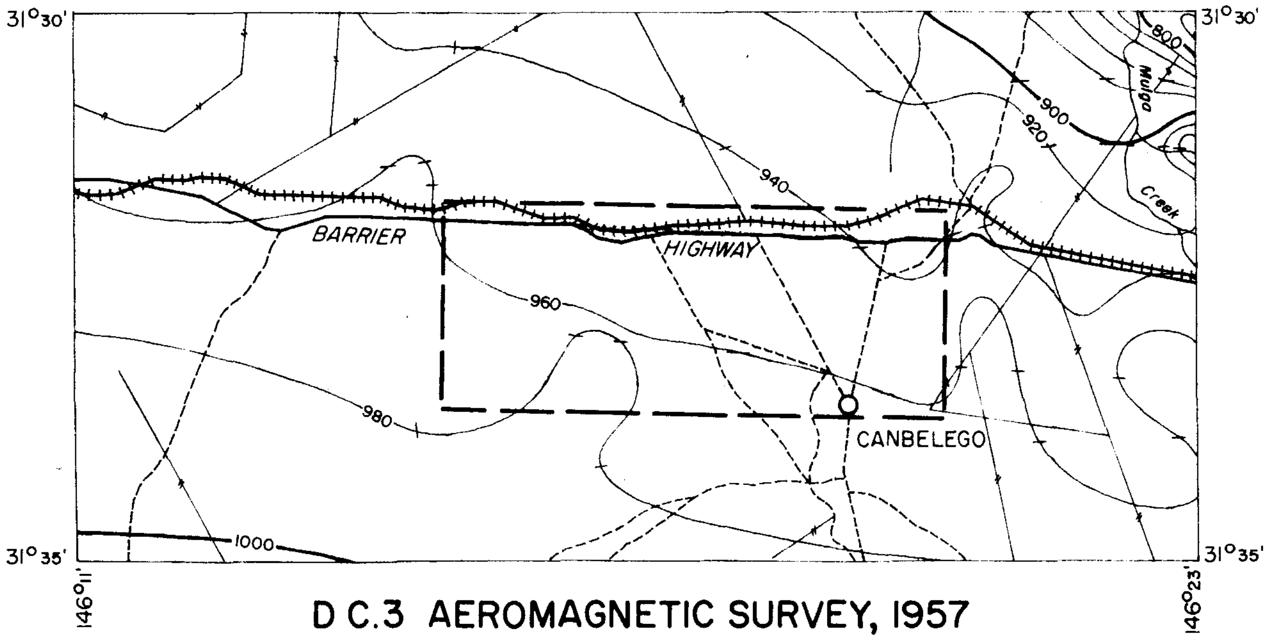
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

FEET 2000 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 5 GAMMAS



D C.3 AEROMAGNETIC SURVEY, 1957

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

MILES 2 0 2 4 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS

TOPOGRAPHICAL LEGEND

- *River or creek*
- *Highway*
- *Road or track*
- *Railway*
- *Fence*
- *Named place*

GEOPHYSICAL LEGEND

- 100 — *Magnetic contours with flight-line intersections*
- *Magnetic low*
- *Map boundary of the 1963 light-aircraft aeromagnetic survey*

MT BOPPY AREA

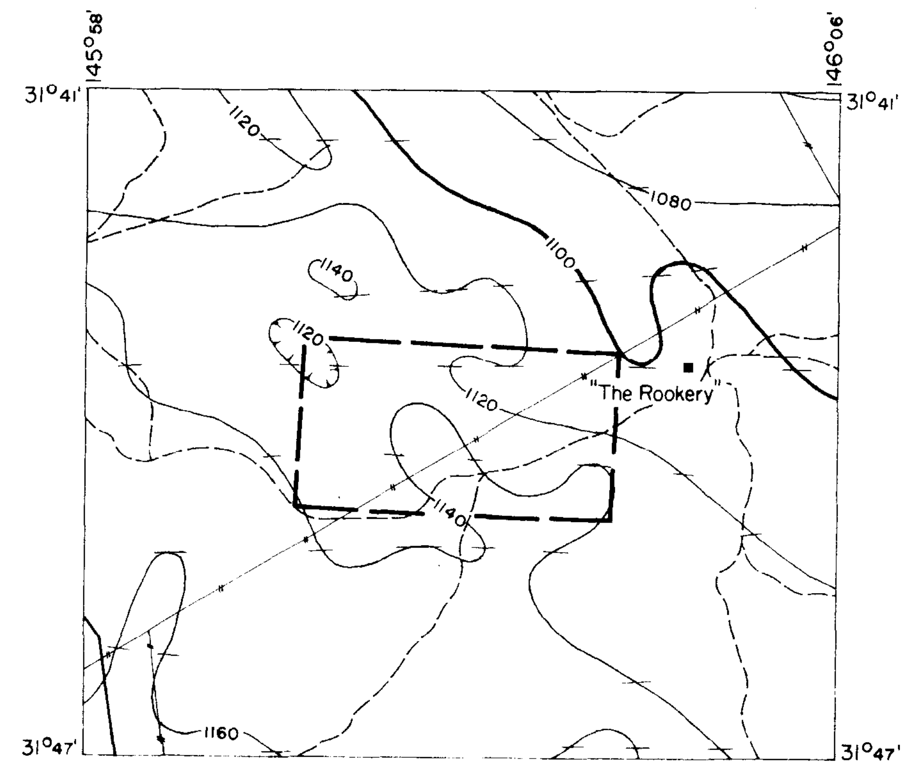
MAGNETIC SURVEYS

COMPARISON OF RESULTS

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS H55/B1-12.

TO ACCOMPANY RECORD NO. 1964/110

PLATE 8



D C.3 AEROMAGNETIC SURVEY, 1957

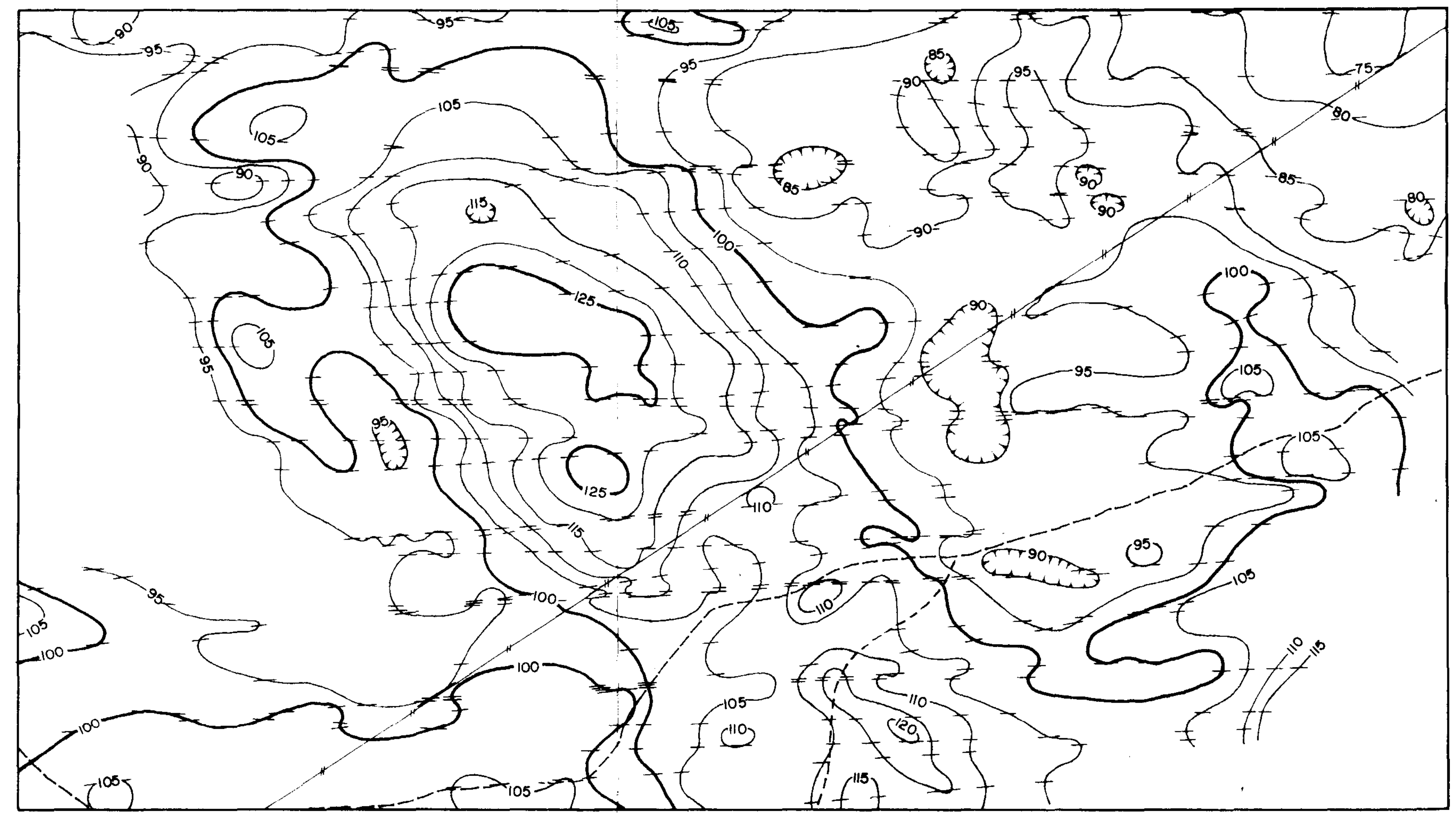
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2 0 2 4 6 MILES

MEAN DETECTOR HEIGHT 500 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 20 GAMMAS



LIGHT-AIRCRAFT DETAILED AEROMAGNETIC SURVEY, 1963

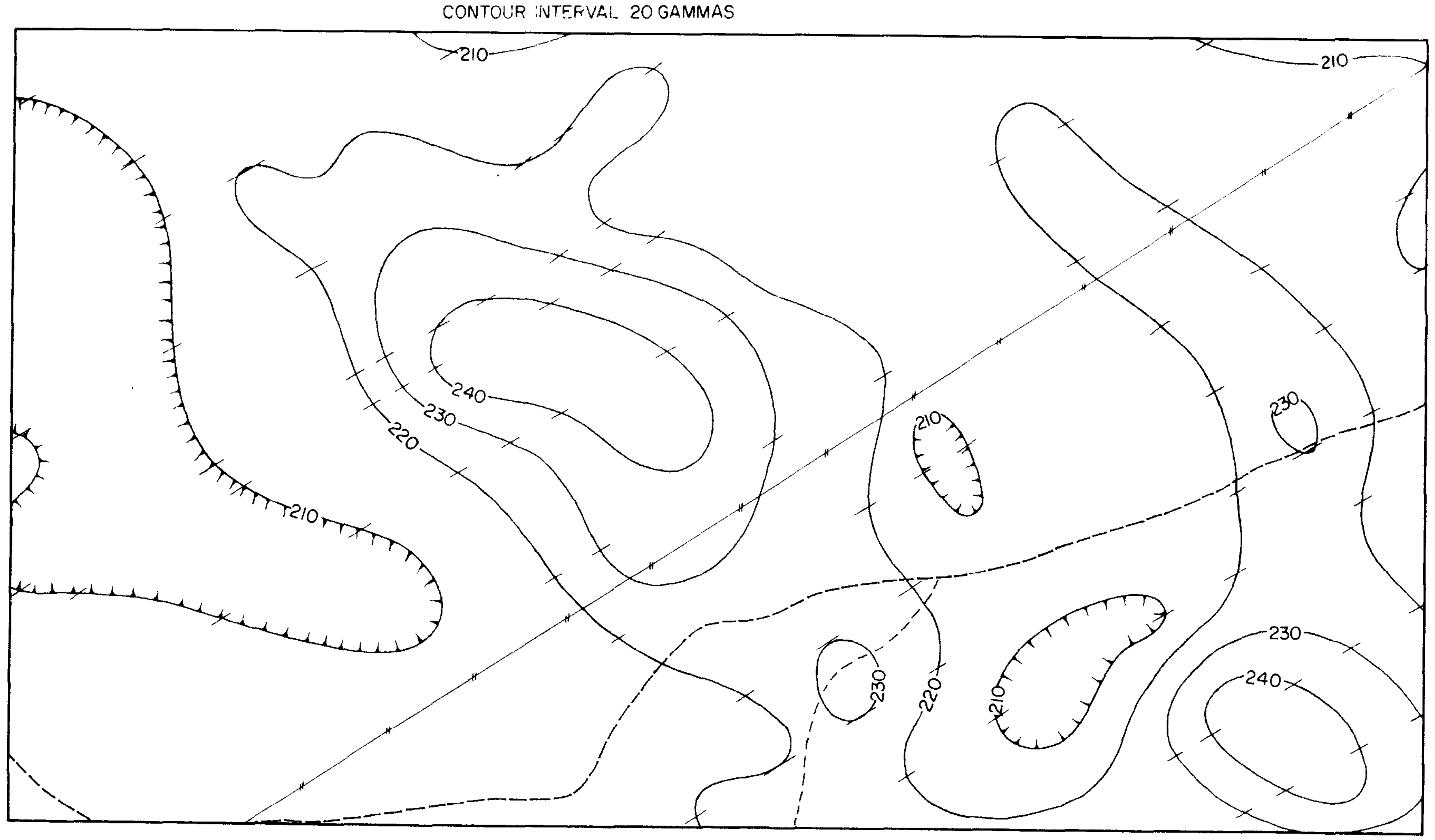
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

SCALE

2000 FEET 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 250 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 5 GAMMAS



AEROMAGNETIC SURVEY

INFORMATION SUPPLIED BY COBAR MINES PTY LTD

SCALE

2000 FEET 0 2000 4000 6000 FEET

MEAN DETECTOR HEIGHT 300 FEET ABOVE GROUND LEVEL

CONTOUR INTERVAL 10 GAMMAS

NURRI AREA

MAGNETIC SURVEYS

COMPARISON OF RESULTS

GEOPHYSICAL LEGEND

- 100 — *Magnetic contours with flight-line intersections*
- *Magnetic low*
- *Map boundary of the 1963 light-aircraft aeromagnetic survey*

TOPOGRAPHICAL LEGEND

- *Highway*
- *Fence*
- *Road or track*
- *Homestead*

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS H55/B1-6

TO ACCOMPANY RECORD NO. 1964/110