COMMONWEALTH OF AUSTRALIA

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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1961 No. 55

BOORABBIN AND NORSEMAN AIRBORNE MAGNETIC AND RADIOMETRIC SURVEYS, W.A. 1959

by

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ABSTRACT

An airborne magnetometer and scintillograph survey of the Norseman and Boorabbin 4-mile areas was conducted from May to July 1959. The operations are described and a preliminary analysis of the magnetic records is discussed.

Some interesting correlation between the magnetic field and the geology are demonstrated, particularly in the Norseman area where the geology is better known.

1. INTRODUCTION

The airborne magnetic and radiometric surveys of the Boorabbin and Norseman areas in Western Australia (Plate 1) were carried out by the Bureau of Mineral Resources, Geology and Geophysics at the request of the Western Australian Mines Department. They were a continuation of the survey programme commenced in 1956 and continued during 1957 and 1958. The survey programme comprised nine "4-mile" military map areas, and, of these, the Southern Cross area was surveyed during 1956 (Spence, 1958), the Kalgoorlie, Jackson, and Barlee areas during 1957 (Spence, 1958), and the Kurnalpi and Widgiemooltha areas during 1958 (Carter, 1959).

The surveys of the Boorabbin and Norseman areas were flown by the DC. 3 aircraft VH-MIN which operated from Kalgoorlie airport during May and June 1959 and from Norseman airport during June and July 1959. The Bureau of Mineral Resources personnel taking part in the survey operations were Messrs. W. A. L. Forsyth, A. G. Spence, J. R. Pollard, G. A. Young, F. S. Clements, J. E. Lynne, C. J. Braybrook, D. F. Upton and L. R. Geenen. The Trans-Australia Airlines staff concerned were Captain N. K. Pascoe, First Officer G. C. Greene, and Messrs. F. W. Milnes, F. W. McDonald and W.J. Briggs.

2. EQUIPMENT AND METHOD

The aircraft was equipped with a saturable-core fluxgate magnetometer, the detector head of which was mounted in the end of a 9-foot cylindrical boom projecting from the tail of the aircraft. This mounting arrangement reduces the disturbance of the magnetic field, at the detector head, by the magnetism of the aircraft. The residual disturbance was further reduced by means of compensating coils mounted in the boom. The output of the magnetometer, representing a continuous measurement of variations in the total intensity of the Earth's magnetic field, was recorded graphically on a "Speedomax" self-balancing potentiometric chart recorder.

The radiometric equipment consisted of two twin-crystal M.E.L. scintillation detector heads, mounted within the aircraft and feeding into an M.E.L. radiation monitor, together with a plastic-phosphor scintillation detector head suspended 200 feet below the aircraft in a towed "bird" and feeding into a second M.E.L. radiation monitor. The outputs of the two radiation monitors were recorded on a dual-channel "Recti-riter" chart recorder. The time constant of both radiation monitors was 1 second.

Terrain clearance was maintained at 500 feet, using an STR-30B frequency-modulated radio altimeter fitted with limit lights, and a continuous altitude profile was recorded on a "Recti-riter" chart recorder.

The track of the aircraft was recorded by means of an "Aeropath" 35-mm continuous-strip camera, the track being subsequently plotted on high-level vertical aerial photographs.

The aircraft was navigated by visual comparison of topographical detail with photographic detail on mosaics of high-level vertical aerial photographs on which were ruled parallel lines representing the proposed flight lines. Flight lines were oriented on east-west headings and spaced at one-mile intervals. A system of north-south magnetic tie lines was flown at approximately 15-mile intervals to enable the whole survey to be reduced to a contoured map of magnetic intensity.

The recorder charts and strip camera film were correlated by means of a system which printed fiducial marks and serial numbers on the strip film simultaneously with the inscription of fiducial marks on the recorder charts.

The "1-mile" military map areas of Norseman and Goodia, lying in the north-western corner of the Norseman "4-mile" area, were covered at $\frac{1}{4}$-mile intervals.

3. GEOLOGY

The nine "4-mile" map areas lie within the Precambrian Shield of Western Australia; this consists of granite, granite gneiss, and highly metamorphosed sedimentary and igneous rocks of Archaean age. Mineralisation has occurred at many places within the Precambrian Shield, principally within the metamorphosed sedimentary and igneous rocks or in areas of granitised rocks adjacent to them. This localisation of mineralisation has led to the concentration of geological investigation in selected areas, and the granitic areas have been relatively neglected. The resultant lack of geological information is particularly apparent in the case of the Boorabbin and Norseman areas, where detailed geological mapping has been done only in the immediate vicinity of the Norseman goldfields.

Forman (1953) classifies the basic igneous and sedimentary rocks of the Precambrian Shield into three series :-

(1) The Older Greenstones

(2) The Whitestones

(3) The Younger Greenstones

The Older Greenstones are the oldest recognisable beds, and consist of basic volcanic flows, with subordinate agglomerate and tuff, and a minor development of banded iron formation or jaspilites.

The Whitestones are beds overlying the Older Greenstones and comprising agglomerate, tuffs, greywacke, and quartzite, with subordinate basic lava flows and minor bands of jaspilite.

These bedded formations are tightly folded and have been intruded at various periods by basic and acidic sills and dykes, and at a late stage by granitic intrusions of batholithic extent. The most important of the basic intrusions are sills of quartz dolerite greenstone and associated types, which have a special importance owing to their being the host rocks of the gold deposits in the Kalgoorlie district. They are referred to as the Younger Greenstones.

Geological information on the Boorabbin area is almost non-existent. The Geological Sketch Map of Western Australia (1950) classifies 90 percent of the area as "mainly acid rocks", the remaining 10 percent, which lies in the north-eastern corner of the area, being mapped as Greenstone Series and Whitestone Series. The following notes on the geology of the Norseman "4-mile" area are based on information supplied by Western Mining Corporation (Hall, 1959)

The Norseman goldfield lies in a pocket of Precambrian greenstone in the broad inland granite plateau. The productive section occupies a belt of hilly country several miles wide extending slightly east of north between two large dried-out claypans. The greenstones consist of folded basaltic lava, pillow lava, tuff, and sediments, invaded by many dykes of quartz porphyry, felspar porphyry, and dolerite and other intrusions. Low-grade regional metamorphism has changed the volcanics and basic intrusives to amphibolites, and has induced characteristic slaty cleavages in many of the tuffs and sediments. The regional dip is steeply west, as indicated by the banded iron formations and meta-sediments to the east of the producing area and by pillow lavas and slate bands within the volcanics. The producing area lies on the western limb of a large anticlinal structure which pitches flatly north over a length of more than 20 miles. Within the volcanics are series of gold-bearing quartz reefs dipping E45° and striking slightly west of north.

Lower in sequence than the greenstones is a series of metamorphosed sediments lying on the eastern side of the producing area and averaging $2\frac{1}{2}$ miles in width. These consist of 5 banded iron formations, varying in width from 50 to 400 feet, interbedded with conglomerate, sandstone, and other sedimentary material. Between the two uppermost banded iron formations an amphibolite sill has been intruded. The banded iron formations have been traced from the old Dundas town site, 14 miles south of Norseman, almost continuously along the eastern margin of the field and across the norite dyke to a place 11 miles north-east, where they are lost beneath the soil.

Younger than the stratified Precambrian is a norite dyke, up to 1 mile in width, which crosses the field from east to west over a distance of some 38 miles. It is thought to be of Late Precambrian age and is now seen to intrude the granites.

Higher in the Precambrian succession are the western sediments about which little detailed information is available. The chief member is a bed of banded iron formation which outcrops for several miles along the western shores of Lake Cowan, then crosses the norite dyke without apparent displacement, and disappears beneath the silted lake floor. Banded iron formation on the two islands to the north, as well as folded exposures in the Peninsula area farther north, suggest that the upper sediments swing slowly to the north-east in a large arc corresponding with the structure shown by the lower beds.

In the eastern portion of the survey area are the Fraser Range rocks, a metamorphosed sedimentary series, now appearing as granulites. This series of rocks has been strongly cross-jointed, as is very evident from aerial photographs. Examination of the aerial photographs indicates NE-SW bedding, which has been confirmed by ground observation.

4. RESULTS

(1) Magnetic

The accompanying maps (Plates 2 and 3) show the positions of magnetic anomalies of amplitude greater than 250 gammas relative to the mean intensity of the Earth's magnetic field in the vicinity of the anomaly. The anomalies have been graded according to intensity into three classifications : 250-500, 500-1000, and greater than 1000 gammas. The positions plotted are those of the points at which the maximum amplitude of the anomaly occurs, and in many places the anomalies extend for considerable distances on either side of the plotted positions. The positions of the anomaly peaks were plotted on Plates 2 and 3 with an accuracy of about 200 yards. No attempt was made to plot anomaly peaks recorded on lines flown at $\frac{1}{4}$-mile spacing in the 1-mile areas of Norseman and Goodia.

Indicated on the accompanying maps are the approximate positions of boundaries between the various rock types. The information shown in the Boorabbin area is taken from the Geological Sketch Map of Western Australia (1950) compiled by the Geological Survey of Western Australia, and that shown in the Norseman area is published by courtesy of Western Mining Corporation Ltd.

(2) Radiometric

135 radiometric anomalies were located in the Boorabbin area and 42 in the Norseman area. Further investigation of the radiometric records to determine the changes of level of radioactive intensity is to be undertaken at a later date. The results of this investigation and the positions of the radiometric anomalies will be shown in the final published maps. The radiometric results are not included in the maps accompanying this Record.

5. CONCLUSIONS

(1) Magnetic Results

(a) Boorabbin Area (Plate 2)

At several places within the survey area, the magnetic anomalies occur in linear groups. In the north-eastern corner of the area these lines of anomalies tend to occur within or near the boundaries of the greenstones, but the relatively low proportion of greenstones in the survey area does not allow correlation to be as conclusive as in other areas previously surveyed (Spence, 1958).

Many anomalies of small amplitude, some of which form linear patterns, occur within the area mapped as "mainly acid rocks", but no conclusion as to the source of these anomalies can yet be drawn owing to lack of geological information.

(b) Norseman Area (Plate 3)

There is a strong correlation between the plotted magnetic anomalies and the known geology in the vicinity of the Norseman goldfield. The main banded iron formations (B.I.F.) immediately east of the producing area have given rise to a continuous line of anomalies greater than 500 gammas over the full length of the known extent of the B.I.F. southwards from the Norite dyke to beyond Dundas. The short extension of the B.I.F. north of the norite dyke also gives rise to an anomalous zone, but of relatively lower intensity. The only anomalies associated with the western B.I.F. were two anomalies between 250 and 500 gammas in the vicinity of the more southerly of the two islands in Lake Cowan.

Immediately west of Lake Cowan, two anomalous zones follow the strike of the greenstones over a distance of approximately eight miles. The more westerly of these anomalous zones appears to be a continuation of a magnetic feature detected in the Widgiemooltha area and supports the suggestion of the beds swinging in an arc to the north-east (Hall, 1959).

A strong anomaly, extending for four miles and striking north, lies along the shore of Lake Dundas immediately south of the southern limit of the main B.I.F. and is displaced approximately two miles east of the projected strike of the main B.I.F.

In the eastern and south-eastern portions of the survey area, lines of anomalies tend to follow the trends of the Fraser Range rocks, as indicated by examination of aerial photographs and by visual observations from the air (Hall, 1959). Most of the anomalies in the Fraser Range area lie within the lowest classification plotted (250 to 500 gammas). The magnetic contour maps, to be published shortly, will include information from anomalies below the arbitrary minimum scaling limit of 250 gammas, and will probably yield further information on the structure of this portion of the survey area.

(2) Radiometric Results

No firm conclusions as to the significance of the radiometric results are offered. Radiometric anomalies are more numerous in the Boorabbin area than in the Norseman area. This may be due to the relatively widespread occurrence of granite in the Boorabbin area, as granite intrusions are often many times more radioactive than the surrounding rocks.

6. REFERENCES

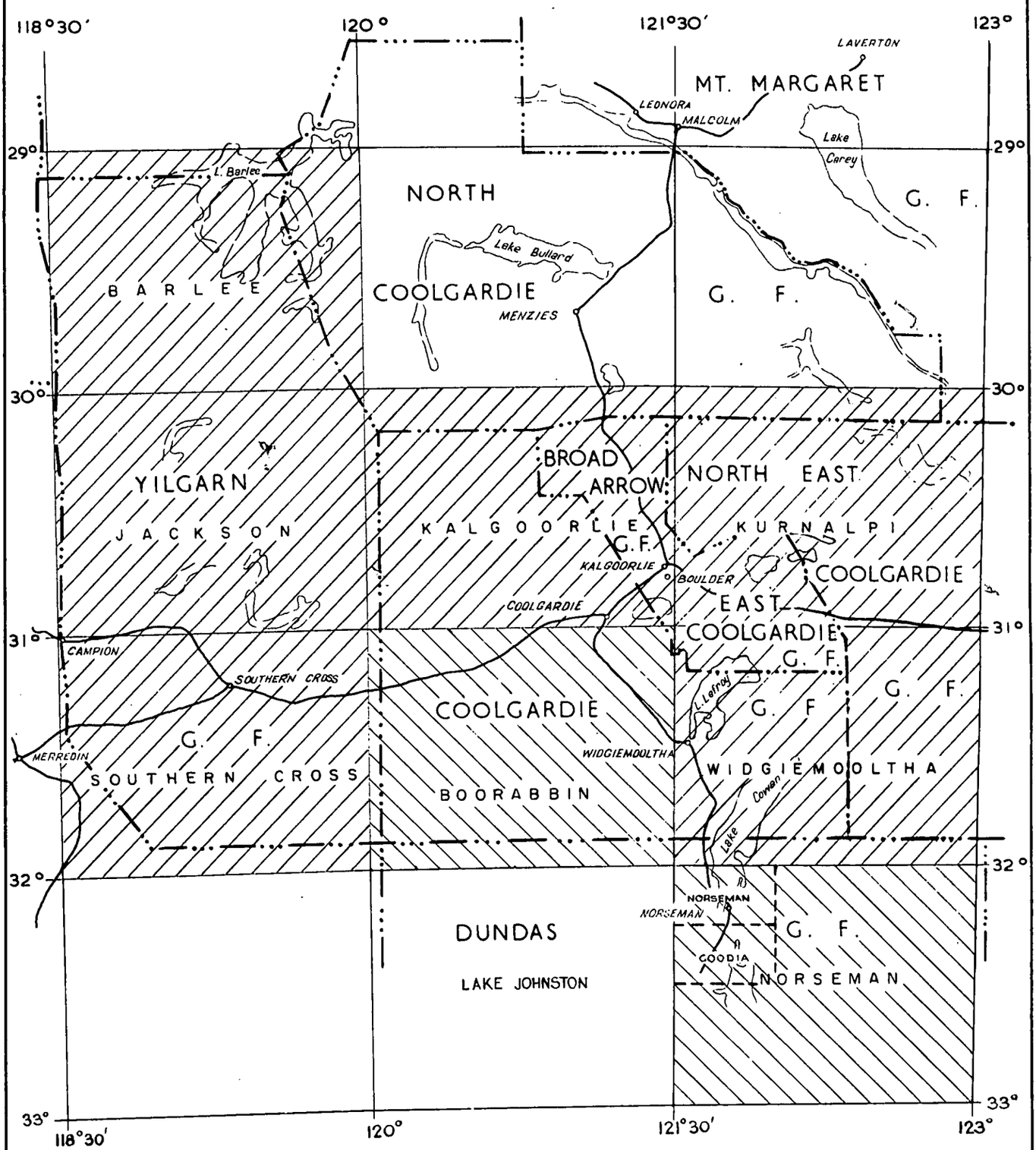
CARTER, R. M. 1959 A preliminary report of an airborne magnetic and radiometric survey of the Kurnalpi-Widgiemooltha areas, W.A. 1958. Bur. Min. Resour. Aust. Rec. 1959/137.

FORMAN, F. G. 1953 The geological structure of the shield in southern Western Australia in relation to mineralisation. THE GEOLOGY OF AUSTRALIAN ORE DEPOSITS, 65-78; A.I.M.M., Melbourne.

HALL, H. E. 1959 Geology of the Norseman Area. Report for Western Mining Corporation (unpublished).

SPENCE, A.G. 1958 Preliminary report on airborne magnetic and radiometric surveys in Kalgoorlie-Southern Cross region, W.A. (1956/57). Bur. Min. Resour. Aust. Rec. 1958/45.

PLATE I



LOCALITY MAP

AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY, 1959

BOORABBIN AND NORSEMAN AREAS W.A.

SCALE IN MILES

40 0 40 80 120

AREA PREVIOUSLY SURVEYED

AREA SURVEYED MAY - JULY 1959

GOLDFIELDS BOUNDARIES

Geophysical Branch, Bureau of Mineral Resources Geology & Geophysics G.334 - 5

TO ACCOMPANY RECORDS 1961, No. 55

PLATE 2

120° 00'

121° 30'

31° 00'

32° 00'

TO COOLGARDIE

TO COOLGARDIE

FROM SOUTHERN CROSS

BOORABBIN

TO WIDGEMOOLTHA

Lake Barker

Lake Raeside

BOORABBIN AREA W. A.

AIRBORNE SURVEY, 1959

PRELIMINARY MAGNETIC RESULTS

LEGEND

- Greenstone Series
- Whitestone Series
- Mainly Acid Rocks

LEGEND

- Magnetic Anomalies between 250 and 500 gammas.
- " " " 500 and 1000 gammas.
- " " greater than 1000 gammas.

SCALE

MILES 4 0 4 8 12 MILES

Geological boundaries plotted from Geological Sketch Map of Western Australia, 1950, compiled by Geological Survey of Western Australia.

Geophysical Section, Bureau of Mineral Resources Geology & Geophysics. G 334 - 2

To Accompany Record 1961 No. 55

121°30'
123°00'
32°00'
33°00'

PENINSULA
LAKE
ISLAND
COWAN
ISLAND
EYRE
HIGHWAY
FRASER RANGE HS
SOUTHERN HILLS
NORSEMAN
DUNDAS
LAKE
DUNDAS
GRAHAM ROCKS
FRASER
RANGE
MT ANDREWS
LAKE
GILMORE
SALMON GUMS

LEGEND

- MAINLY ACID ROCKS
- GREENSTONE SERIES (SHOWING TREND LINES)
- BANDED IRON FORMATION
- NORITE DYKE
- FRASER RANGE COMPLEX (SHOWING TREND LINES)
- GRANITE OUTCROPS
- MAIN ROADS
- TRACKS
- RAILWAYS
- TELEGRAPH LINES
- GREENSTONE - GRANITE CONTACT (INFERRED)

GEOLOGY BY WESTERN MINING CORPORATION (BASED ON AERIAL PHOTOGRAPHY)

NORSEMAN AREA WA

AIRBORNE SURVEY 1959

PRELIMINARY MAGNETIC RESULTS

SCALE

4 0 4 8 12 MILES

- MAGNETIC ANOMALIES 250 - 500 gammas
- MAGNETIC ANOMALIES 500 - 1000 gammas
- MAGNETIC ANOMALIES over 1000 gammas

GEOPHYSICAL SECTION, BUREAU OF MINERAL RESOURCES GEOLOGY & GEOPHYSICS G 334-4

To Accompany Record 1961 No 55