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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1967/89

MANN - WOODROFFE AEROMAGNETIC SURVEY, SOUTH AUSTRALIA 1965

by

D.B. TIPPER

The information contained in this report has been obtained by the Department of National Development as part of the policy of the Commonwealth Governmment to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus or statement without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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CONTENTS

ILLUSTRATIONS

1967/89

SUMMARY

During November 1965, the Bureau of Mineral Resources flew a series of low-level aeromagnetic traverses across a narrow zone in the extreme north-western corner of South Australia. This work was requested by the South Australian Department of Mines to assist their search for possible extensions of nickeliferous laterites, which are known to be associated with ultrabasic intrusives of the Giles Complex. It was hoped to determine whether or not the localised groups of basic and ultrabasic outcrops within the survey area are continuous beneath Cainozoic cover.

This Record presents only the preliminary results. From this initial analysis, the aeromagnetic data are not expected to make as significant a contribution to the exploration programme as was originally hoped. Some basic rocks are correlated with a major magnetic 'ridge', whereas elsewhere they are virtually non-magnetic. This lack of magnetic uniformity of the Giles Complex hampers any attempt to demonstrate its continuity through the survey area by extrapolation of geologic/magnetic correlation. In addition, comparison of adjacent profiles is limited by the use of a 1-mile line-spacing.

1. INTRODUCTION

During the period 10th to 14th November 1965, the Bureau of Mineral Resources (BMR) flew sixty-three short low-level aeromagnetic traverses over part of the MANN and WOODROFFE 1:250,000 map areas in South Australia. The area surveyed forms an elongated strip, approximately 75 miles east-west and 5 to 10 miles north-south, in the extreme north-western corner of the State (Plate 1A).

This work was requested by the South Australian Department of Mines (SADM) to assist their exploration for possible extensions of the Claude Hills nickeliferous laterites. These laterites have been found to the west-north-west of the survey area, representing the weathered product of ultrabasic rocks intruded into metasediments. A number of groups of basic and ultrabasic outcrops have been mapped in the survey area, although in none of these has nickeliferous laterite yet been found. The extensive development of sand dunes in the region has prevented the determination as to whether or not the basic and ultrabasic rocks are continuous between the mapped outcrops. It was hoped that the aeromagnetic survey would provide data to supplement gravity traverses by the SADM and assist in resolving this uncertainty.

The original magnetic data have been plotted by the SADM and reproduced as reduced scale profiles and preliminary contours of total magnetic intensity at a scale of 1:47,520. The BMR has further reduced the profiles, and these are shown in Plate 1B, superimposed on the mapped geology. The original chart profiles have been retained by the SADM to assist their preparation of a report dealing with the combined investigations in the Mann-Woodroffe area (Rowan, 1967). The interpretation of the aeromagnetic data, included in this Record, was based on the reduced scale profiles and therefore represents a preliminary analysis only. The brief summary of the geology of the area is derived from mapping by the SADM The logistics of the airborne survey are given in an Appendix.

Gravity data were recorded by the SADM along a number of north-south traverses across the aeromagnetic survey area and along a closely knit grid in the Caroline 1:62,500 map area. In addition, four regional gravity traverses have been made; these are from Giles to Mulga Park, Mount Davies Camp to Emu, Musgrave Park to Ernabella, and Pitardi to the southern boundary of the MANN sheet. These data reveal three positive Bouguer anomalies over the Tomkinson Ranges, Hanging Knoll, and the outcrops of the Giles Complex in the Caroline 1:62,500 map area, and these anomalies are joined by a gravity 'saddle' which extends the length of the aeromagnetic survey area (Rowan, 1967).

A reconnaissance airborne magnetic and radiometric survey of the MANN area was flown by the BMR in 1960 (Wells, 1962). Although many magnetic anomalies were detected and tentatively ascribed to bodies at or near the surface, the line-spacing of five miles was not conducive to an accurate inter-correlation of anomalies from line to line.

The co-operation of the Department of Mines in supplying accommodation for the 1965 survey party, as well as photographs, maps, and other assistance is acknowledged.

2. GEOLOGY

The geology of the MANN 1:250,000 map area (South Australia Geological Survey, 1962) and of the Caroline 1:62,500 map area has been mapped by the SADM and this mapping has been incorporated in the plate accompanying this Record. The following geological summary is based largely on the work of Mirams (1964). The nickel mineralisation has been described by Thomson (1963) and others, and the results of nickel-search programmes to date have been given by Thomson and Mirams (1961) and Miller (1966a, 1966b).

Most of the survey area is covered by a veneer of Cainozoic cover, but four distinct rock-types of Tertiary age have been recognised in the MANN area: chalcedonic cappings; ferruginous cappings; ochre, nickeliferous in part; and jasper. The ochre and jasper are associated with deep weathering of iron-rich ultrabasic rock. Ferruginous cappings near 'Jalukana' form the only mapped Tertiary outcrop within the survey area. Various Quaternary deposits, principally sand-dunes, cover the greater part of the area.

The pre-Cainozoic rocks may be classified into two major groups: Archaean metasediments (together with metasomatised variants); and intrusives (acid, basic, and ultrabasic). Although outcrops are sparse, most of the sand-dune country is believed to be underlain by metasediments of the granulite facies, of which, most outcrops are unmetasomatised. For mapping purposes these have been specified as being acid, intermediate, or basic. Magnetite is sometimes found as an accessory mineral. In places the granulites have been metasomatically altered to granitoid rocks and anorthositic rocks, but only in the western quarter of the survey area are there any appreciable outcrops of these variants. The metasedimentary sequence is tightly folded about easterly trending axes.

The most important intrusive rocks are the basics and ultrabasics of the Giles Complex. The outcrops are different lithologically, one from another, and individual masses are inhomogeneous. They are formed of fresh, coarse-grained norites and pyroxenites with some picrites, troctolites, and gabbros. The intrusive bodies are characterised by compositional banding, the origin of which is not fully known. Nesbitt and Kleeman (1964), in describing the outcrop east of Mount Davies camp, stated that the banding dips northerly at 70° to 80°. They also stated that there is an unusual deficiency of iron, and that magnetite is confined to the upper part of the intrusion. Within the survey area irregularly shaped outcrops have been mapped as localised groups. The two largest basic outcrops, each of about 2½ square miles, are found in the centre of the area. At Hanging Knoll, twenty miles to the east, both basic and ultrabasic rocks have been mapped, and in the extreme east, in the Caroline 1:62,500 map area, rocks of the Giles Complex form an arcuate string of small outcrops. In the western half of the survey area scattered ultrabasic outcrops are elongated east-west. The strike of the rocks in the individual outcrop groups is variable, generally being between north-east through east to south-east.

A younger suite of basic dykes striking west-north-west intrudes all other units. Outcrops are sparse within the survey area but a swarm of these dykes probably traverses the area west of 'Jalukana' beneath Cainozoic cover.

Granite has been mapped to the immediate east of the survey area in the Caroline 1:62,500 map area.

3. PRELIMINARY RESULTS

Plate 1B shows all magnetic profiles reduced to a scale of 1:95,040, superimposed on geological mapping by the SADM. The use of a 1-mile line-spacing, when flying at such low level over the complex geological environment of the survey area, has been found to hamper any accurate, detailed inter-correlation of magnetic features from line to line. A lack of significant detailed similarity between many adjacent profiles indicates that, in general, only major magnetic 'ridges' and 'troughs' may be delineated and contoured with reasonable confidence of unambiguity. The limited dimensions and apparently irregular shapes of many magnetic bodies, and the variations of rock-type along strike, would require flying at ½-mile spacing at the widest to determine more fully the geological structure of this region. The recognition of magnetic trends is further complicated in that, in places, lithologies appear to vary rapidly along a line normal to the strike; consequently the frequency of anomalies per mile can be quite high and many anomalies are themselves complex. Strong dissimilarity between adjacent profiles is likely to be due in part to north-westerly striking faults. The probable magnetic trends are shown in the plate.

There is little apparent pattern in the configuration of magnetic ridges and troughs. In plan, individual anomalous regions are irregularly shaped though having, in general, long axes that tend towards an east-west orientation. The dominant feature of the area is an arcuate region of high magnetic intensities in the extreme east, where the trough-to-peak amplitudes exceeds 3600 gammas. Twin magnetic ridges parallel the arcuate string of basic and ultrabasic outcrops, the source of much of the magnetic disturbance. The positions of the major ridge axis and the associated trough suggest that magnetic rocks are continuous southwards under Cainozoic cover for about one mile from the basic outcrops. Rowan (1967) has stated that holes have been drilled near the magnetic 'highs' south of the Giles Complex band; this drilling shows that the anomalies are most likely caused by anorthosite with varying magnetite content. High magnetic intensities were detected in the vicinity of Hanging Knoll, but the highest amplitude anomalies were recorded over Cainozoic cover. The basic outcrops produced a relatively small magnetic response whereas the effect of the ultrabasic outcrop was insignificant. Along flight line 17E, in fact, the highest magnetic anomalies are attributed to intermediate granulite.

The basic outcrops in the centre of the survey area are located within a magnetic trough, and in this region the granulites are at least as magnetic as the intrusives and probably much more so. The same relationship, though less conclusive, appears to be true in the extreme west of the area.

This disappointingly low-order correlation between the aeromagnetic data and mapped geology could be due to a number of factors but principally to the probably wide range of rock types which have, during mapping, been grouped into a single mapping unit; and the possibility that some of the magnetic features may reflect horizons beneath the pre-Cainozoic outcrops. No determinations of depth (or other parameters) have been quantitatively made, owing to the lack of confidence in delineating magnetic trends and the loss of detail introduced by the reduction in scale of the profiles. At least some of the apparently large depth values, as observed by inspection, would be considerably reduced if the correction for strike direction could be applied.

4. CONCLUSIONS

It is unlikely that the magnetic data will contribute as much to the problem of the continuity of the intrusives as was hoped. The intrusives do not have a specific, recognisable magnetic character, and a number of outcrop groups have virtually no obvious magnetic effect. Extrapolation of any geologic/magnetic correlation beyond the limits of any one outcrop is strongly hampered by lithological variations and by the use of the 1-mile line-spacing. This latter is considered too coarse for anything more than the locating of regional magnetic 'highs' and 'lows', and the determination of strikes and other parameters of the major magnetic bodies, again only on a regional basis. However, it would be profitable to review these results if at a later stage the area is reflown as part of a systematic regional aeromagnetic survey.

5. REFERENCES

MILLER, P.G. 1966a Report on nickel exploration, Northwest Province 1965. S. Aust. Dept. Mines Rept. Bk. 62/73.

1966b Nickel exploration, Claude Hills extension, Northern Territory. S. Aust. Dept. Mines Rept. Bk. 63/119.

MIRAMS, R.C. 1964 Geology of the Mann 4-mile sheet. Rept. Invest. Geol. Surv. S. Aust. 25.

NESBITT, R.W. and KLEEMAN, A.W. 1964 Layered intrusions of the Giles Complex, Central Australia. Nature 203 (4943).

ROWAN, I.S. 1967 Regional gravity survey of Mann and Woodroffe 1:250,000 sheet areas. S. Aust. Dept. Mines Rept. Bk. 64/33.

SOUTH AUSTRALIA GEOLOGICAL SURVEY 1962 Mann 1:250,000 area geological map, Sheet G52-11.

THOMSON, B.P. and MIRAMS, R.C. 1961 Nickel exploration, special mining lease No. 33. Tomkinson Ranges. S. Aust. Dept. Mines Rept. 659(b).

THOMSON, B.P. 1963 Nickel mineralisation and the Giles Complex in the Tomkinson Ranges. Quart. Geol. Notes Geol. Surv. S. Aust. 8.

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APPENDIX

Operational details

Staff

D.B. Tipper	:	Geophysicist
I. Heath	:	Senior Technician (Radio)
J. Lord	:	First Officer (Trans Australia Airlines)

Survey Specifications

Ground clearance of aircraft	:	Nominally 280 ft
Ground clearance of detector	:	Nominally 250 ft
Line spacing	:	Nominally 1 mile
Line orientation	:	North-westerly and north-easterly
Number of traverses	:	63
Length of traverses	:	1.5 to 15 miles
Magnetometer sensitivity	:	1000 gammas f.s.d.

Equipment

Aircraft	:	Cessna 180
Magnetometer	:	MNS-1 proton precession type of BMR design
Recorder	:	Moseley Autograph
Camera	:	Modified Vinten, frame type, 35-mm, with 186° fish-eye lens
Radio altimeter	:	AN/APN-1 (visual aid only)

REDUCTION OF DATA (by the BMR)

Film development; chart annotation; profile smoothing, necessary as the magnetometer chart record is by nature a step function, and because the instrument noise level was increased by the unfavourable flight direction.

Reduction of Data (by SADM)

Film plotting, production of flight-line plot, reduction of profiles.

Diurnal Variation

The technique of reflying base traverses showed that the diurnal variation was negligible by comparison with the amplitudes of recorded anomalies. Diurnal corrections were therefore not applied.

PLATE 1B

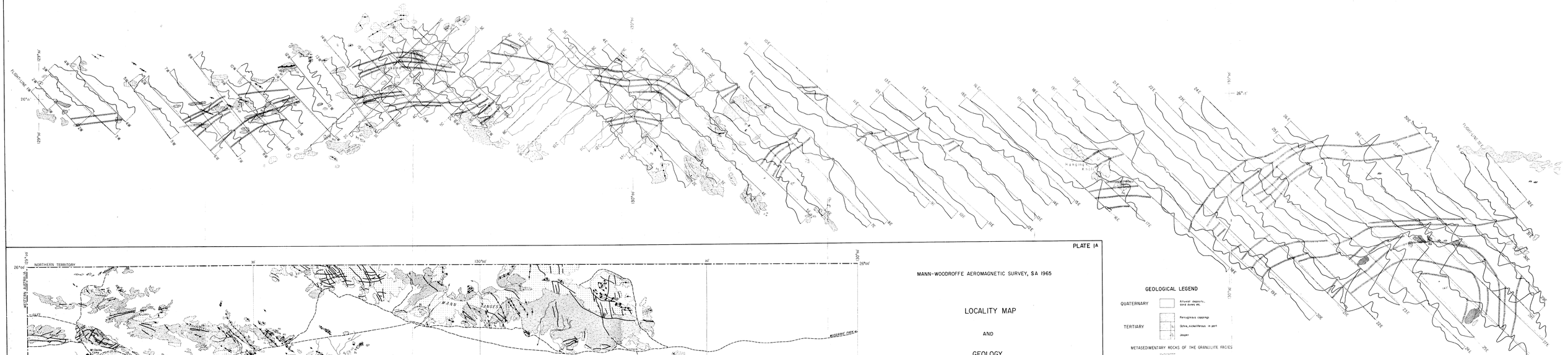


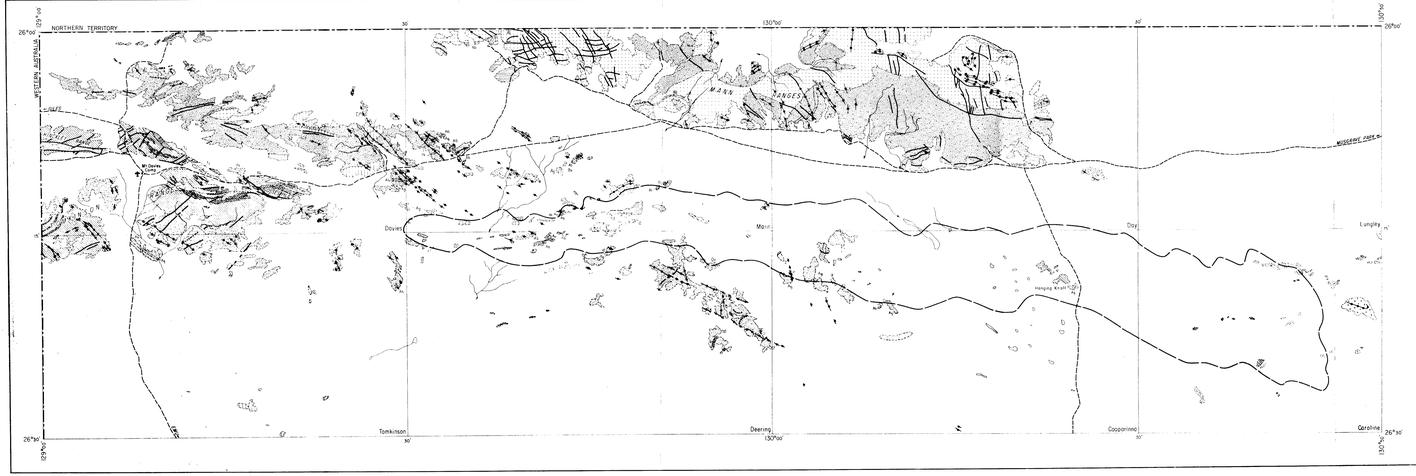
PLATE 1A

MANN-WOODROFFE AEROMAGNETIC SURVEY, SA 1965

LOCALITY MAP

AND

GEOLOGY

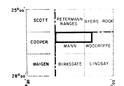


TOPOGRAPHICAL LEGEND

- River or creek
- Road or track
- Landing ground
- Survey boundary

LOCATION DIAGRAM

INDEX TO ADJOINING SHEETS



GEOLOGICAL LEGEND

QUATERNARY
- Alluvial deposits, sand dunes etc.

TERTIARY
- Ferruginous cappings
- Ochre, nickeliferous in part
- Jasper

METASEDIMENTARY ROCKS OF THE GRANULITE FACIES

ARCHAEAN
- Quartz granulite
- Acid granulite
- Intermediate granulite
- Basic granulite

METASOMATISED SEDIMENTS
- Granofels rocks
- Anorthositic rocks

INTRUSIVE ROCKS
- Granite

GILES COMPLEX
- Undifferentiated
- Basic
- Ultrabasic
- Basic dykes
- Fault
- Shear zone
- Dip and Strike of bedding in sedimentary rocks where not appearing on Giles Complex Trend line
- Plunge of minor fold
- Geological boundary

Geology after 1:250,000 SA Geological Atlas series sheet G52-11 Mann, first edition 1962, and preliminary geological map 1:63,360 sheet Caroline by Geological Survey of South Australia, Department of Mines, Adelaide

PROFILE SCALE

8000 gammas
6000
4000
2000
0

THE NORTH-EAST AND NORTH-WEST AEROMAGNETIC PROFILES HAVE DIFFERENT MAGNETIC DATUM LINES

MANN-WOODROFFE AEROMAGNETIC SURVEY, SA 1965

TOTAL MAGNETIC INTENSITY PROFILES, MAGNETIC TRENDS AND GEOLOGY

GEOPHYSICAL LEGEND

- 2E — Flight-line
- Magnetic intensity profile and base-line
- Magnetic trend-line

TO ACCOMPANY RECORD No. 1967/89

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics G52/81-34