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Preliminary Assessment of the 'Welbourn Hill' and 'Cadny Park' Magnetic Anomalies.

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Summary

Magnetic and gravity data over the 'Welbourn Hill' and 'Cadny Park' anomalies have been assessed to determine the potential for Roxby Downs type mineralisation.

The Welbourn Hill magnetic anomaly is most likely due to an intrusive at depth of $\sim$ 1800m; a residual gravity anomaly of $\sim$ 6mgals occurs over the magnetic source; from estimates of density and susceptibility it is inferred the source is ultramafic in composition and could be a carbonatite. However it is considered important to adequately define the residual gravity anomaly and recommendations are made for additional gravity survey.

The Cadny Park anomaly is attributed to a fault-bounded? zone of gneisses or granulites. A partially defined gravity high occurs adjacent to the anomaly over a zone of subdued magnetic relief. The latter could indicate a zone of hydrothermal alteration. It is recommended that the gravity coverage be extended to determine if a residual gravity high coincides with this 'alteration' zone.

1. Introduction

A preliminary assessment has been made of two magnetic anomalies, located by the Comalco Marla aeromagnetic survey, in terms of their potential for 'Roxby Downs' mineralisation. Some gravity data have been acquired over these features by Comalco and are included in this assessment.

The magnetic anomalies, 'Welbourn Hill' and 'Cadny Park' are shown on the magnetic contour map of Fig 1.

Both areas are covered by recent deposits; subsurface data are available in the vicinity of Welbourn Hill from drillholes Nicholson 2 and Manya 5; the nearest drillholes to the 'Cadny Park' anomaly are on the Manya 3-4 section about 30km to the SW.

Seismic data were obtained by SADME on two short refraction profiles about 10km N and S of Welbourn Hill and on a N-S section through Mt.Willoughby/Wintinna H.S's 15km east of Cadny Park.

The Comalco gravity surveys have been reported by Cucuzza and he has discussed the comparison of these data (and the magnetic data) with the Roxby Downs signatures.

Modelling of the magnetic data has been carried out along one profile over each anomaly; gravity data over the same profile across the Welbourn Hill anomaly have also been modelled; results are shown in Figs 3, 4 and 7. Contour maps of the Comalco gravity data are presented in Figs 2 and 6 and interpretation plans are given in Figs 5 and 8.

2. Discussion

2.1. The 'Roxby Downs' Geophysical Signature

The magnetic anomaly at Roxby Downs, as defined by the BMR regional aeromagnetic survey, is near-circular and has amplitude, relative to local background, of 800nT and half-width (width at half-maximum amplitude) of ~7km (E-W). The peak of the anomaly is close to the northern margin of the Olympic Dam deposit but the source of the anomaly (at depth ±1500m?) is below the mineralisation. To the writer's knowledge the nature of the source rocks is unknown.

A gravity anomaly of ~16mgals occurs over the mineralisation; the peak of the gravity anomaly is about 2km south of the magnetic anomaly peak; half-width of the gravity anomaly is ~3km (N-S). The density of the hematite-breccias (from data on drillhole RD16) is ~4.0t/m^3; a 'canoe' shaped body of such rocks of 3km x 2km in plan and extending from 350-600m at the margins and from 350-900m in the centre would produce a 16mgal anomaly (assuming a density contrast of 1.3t/m^3). There may, however, be some contribution to this gravity anomaly from the source of the magnetic anomaly which extends, at least partly, below the zone of mineralisation.

The proximity of the magnetic anomaly to the mineralisation suggests a genetic relationship between the magnetic source and the mineralisation e.g. either as a heat source or in ground preparation.

East of the deposit the magnetic basement is relatively shallow (~500m?) and it is believed that the deposit occurs within a NNW? graben structure.

2.2. The 'Welbourn Hill' Anomaly

The Welbourn Hill magnetic anomaly is similar in amplitude and areal extent to that at Roxby Downs. Estimates of magnetic basement depths (Cucuzza) are ~1800m over the anomaly and a basement 'high' is defined extending to the SW and shallowing to ~1000m at ~20km to the SW.

Data along a N-S profile (flight line 10830) through the centre of the anomaly have been modelled and results are shown in Fig 3.

Models 2,3,4 are included to account for the local 'regional' anomaly and have arbitrary strike lengths of 20km, 20km and 5km respectively. Model 1 is a 'prism' extending 1700m N-S and 2000m E-W at depth 1800m. The susceptibility is 0.026cgsu which suggests the source rocks are ultramafic in composition.

A contour map of the Comalco gravity data is shown in Fig 2. 27 mgals of relief occur between the gravity 'low' in the north and the 'high' in the south. The magnetic anomaly is located over the gradient between the 'low' and 'high'. A N-S profile, coincident with the magnetic model profile, has been modelled and results are given in Fig 4.

Density data (Comalco) are available below 337m in drillhole Nicholson 2; mean density from 337-370m is $2.49 t/m^3$ and from 370 to 812m is $2.66 t/m^3$.

A summary geological log for Nicholson 2 is given in Appendix 4.1. The density change at 370m is within Adelaidean rocks at a possible disconformity within a sequence of sandstones and shales.

The Permian and younger sediments are likely to have mean density of less than $2.49 t/m^3$ and for modelling a density contrast of $0.2 t/m^3$ between rocks above and below 370m has been assumed.

Relatively dense rocks occur in Manya 5 below 1075m (i.e. the Cambrian volcanics and Adelaidean carbonate) - such rocks are included as model 4 (Fig 4) of density $2.87 t/m^3$ and strike length 5000m.

Most ($\sim$25mgals) of the observed gravity relief can be attributed to a density contrast of $0.13 t/m^3$ within the magnetic basement (i.e. model 2, which represents models 3 and 4 of the magnetic interpretation). The regional gravity data indicate an anomaly of this shape and magnitude striking ESE from Welbourn Hill for a distance of $\sim$40km. The inferred basement densities are 2.67

t/m^3 and 2.80t/m^3 i.e. consistent with the contrast between granite and gneiss. The Adelaidean sediments below 370m in Nicholson 2 are indistinguishable from granitic rocks so that the area of 'lighter' basement may include a thick Adelaidean sequence.

Model 1 is the magnetic 'intrusive' which, with a density of 3.27t/m^3 (contrast of 0.6t/m^3), completes a satisfactory fit to the observed data.

The inferred density for the 'intrusive' is quite high e.g. it is towards the upper end of the density range for ultramafic rocks. The inferred susceptibility is also high but the magnetite content could be only a few per cent if remanent magnetisation, with appropriate direction, is present. It is therefore conceivable that the intrusive has acidic-intermediate composition and a lower density than 3.27t/m^3; for comparison a computed profile is given to Fig 4 for an 'intrusive' density of 2.8t/m^3. The residual anomaly, ~6mgals, is considered an estimate of the maximum gravity anomaly 'available' for the Roxby Downs type of mineralisation.

This residual anomaly does not correlate with the residual anomalies in the processed BMR data (centred at R1, R2 on Fig 5). The discrepancy is evident when the BMR Bouguer profile is compared with the Comalco Bouguer profile in Fig 4. It appears that there are errors in the BMR data between coordinates 10000 and 30000.

2.3. The 'Cadny Park' Anomaly

The magnetic anomaly, of amplitude ~600nT, is part of a semi-continuous magnetic 'ridge' which extends ~20km to the WSW/SW and ~60km to the ENE/NE.

The anomaly has been modelled on a N-S flight line (10761/10762) through its centre; results are presented in Fig 7 (allowance has been made in the modelling for the strike of the magnetic rocks relative to the flight line i.e. widths of models shown in Fig 7 are not true widths).

Model 1 has strike length of 15km and susceptibility contrast of .0053cgsu; magnetic rocks are required to the south to 'eliminate' the polarisation 'low' due to model 1. The 'sharp', linear, anomaly at coord.6000 requires a depth limited source, assuming induced magnetisation only, to account for the relative amplitudes of the anomaly 'high' and 'low'.

The basement surface dips to the NW; the fault at coord.6000 is probably real and model 1 may also be fault bounded.

Magnetic rocks probably also are present to the north of model 1 in which case the inferred susceptibilities of the models are minimum values; such rocks are not likely to be strongly magnetic and the susceptibility of model 1 is probably less than .008cgsu i.e. the rocks may be mafic granulites or mafic gneisses.

The Comalco gravity data are shown in the contour map of Fig 6. A closure is partly defined in the SW i.e. west of coord.11000 of the magnetic model. On the regional scale a zone of gravity 'high' coincides closely with the extensive magnetic 'high' which includes the Cadny Park anomaly. On the local scale the gravity closure is not over the source of the Cadny Park magnetic anomaly but coincides with a zone of subdued magnetic relief to the immediate SW; the latter may indicate a zone of alteration within the basement.

Several faults can be inferred from the magnetic data and are shown on the interpretation map of Fig 8. A small magnetic intrusive, I1, is adjacent to the inferred fault F1. Depth estimate on I1 is ~600m and, by comparison with the basement map of Cucuzza, it has intruded the sediments above the basement; it may be a volcanic plug or a kimberlite.

3. Conclusions

3.1. The 'Welbourn Hill' Anomaly

The simplest interpretation of the magnetic anomaly indicates a depth extensive plug-like source of diameter $\sim$ 2km at depth $\sim$ 1800m. Its susceptibility is $\sim$ 0.026cgsu which implies a magnetite content of $\sim$ 8 vol.%; if the source is remanently magnetised then the magnetite content could be much lower.

Gravity data show that the magnetic body occurs on or close to an ESE trending contact (fault contact?) between granite? to the N and gneisses? to the S. There may be no density contrast between Adelaidean rocks and granitic basement and a thick sequence of Adelaidean rocks could occur N of the contact.

A residual gravity anomaly of $\sim$ 6mgals is defined over the magnetic body; this can be accounted for if the density of the body is $\sim 3.27 t/m^3$.

These data suggest that the source rocks are ultramafic in composition - the body could be a carbonatite.

It is possible however that the density of the source is lower than $3.27 t/m^3$ and that the residual anomaly is related to a shallower source e.g. Roxby Downs type mineralisation. It is also conceivable that the magnetic anomaly could be caused by a shallower laccolith-like source of higher magnetisation e.g. skarn mineralisation.

The current gravity coverage does not adequately allow definition of the residual anomaly. It is suggested that the survey be extended to cover the area outlined in Fig 5; this area could be surveyed on, say, a 1.5km grid using a helicopter with levelling by barometers - subsequently one or two additional ground, optically levelled, lines may be appropriate.

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3.2. The 'Cadny Park' Anomaly

The magnetic anomaly is interpreted to be due to a fault-bounded? zone of gneisses or granulites at depth 1800-2400m.

Gravity data indicate a gravity high over a zone of locally subdued magnetic relief to the immediate SW of the magnetic anomaly. The reduction in magnetic relief could be due to hydrothermal alteration of the basement rocks which, in conjunction with the inferred faulting, suggests the possibility of mineralisation within the overlying sediments. Confirmation of a coincident residual gravity anomaly would upgrade the zone and it is suggested that this be carried out over the area outlined in Fig 8 in the same manner as for the Welbourn Hill anomaly.

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4. Appendices

4.1. Summary Drillhole Logs

Manya 5

0 - 134m	Mesozoic (sst, shale)
134 - 453	Permo-Carboniferous (sst)
453 - 1075	Cambro-Ordovician (sst)
----------	Unconformity
1075-1139	Cambrian (Volcs - equivalent of Table Hill Volcs)
----------	Unconformity
1139-1333	Adelaidean (Carbonate)

Nicholson 2

0 - 120	Cretaceous (Bulldog shale)
120 - 200	Permo-Jurassic (sst)
200 - 814	Adelaidean (sst, shale, tillite)