REPORT ON

BMR AIRBORNE GEOPHYSICAL DATA, LARRIMAH AND DALY WATERS AREAS, NORTHERN TERRITORY

by

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SALIENT GEOPHYSICS

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INTRODUCTION

An airborne geophysical survey was conducted by the Bureau of Mineral Resources, Geology and Geophysics, during 1987 over part of the Northern Territory of Australia. This was the 1:250 000 sheet areas of Larrimah, SD 53-13, and Daly Waters, SE 53-01, which are contained between latitudes 15° 00′ and 17° 00′ South and longitudes 132° 00′ and 133° 30′ East. It was undertaken as part of a nationwide programme of surveying the sedimentary basins and metallogenic provinces to assist petroleum and mineral exploration throughout Australia.

The radioactivity and the total intensity of the earth's magnetic field were measured at 1 second (approximately 60m) intervals along north-south flight lines spaced 1.5km apart. The measuring instruments were a Geometrics G813 proton precession magnetometer and a four channel gamma ray spectrometer accumulating counts from a NaI(Tl) crystal of 16 780 cubic centimetres volume. The nominal altitude for the Aero Commander aircraft was 150m above ground level. Readings from both instruments were recorded digitally for later presentation as maps.

The data was purchased in digital form on 9 track magnetic tape for reprocessing or computer interpretation. Copies of maps produced by the BMR were also purchased as they became available.

These were all on standard 1:250 000 scale map sheets. They consisted of stacked profile presentations of (i) the Total Magnetic Intensity corrected for diurnal variation and the International Geomagnetic Reference Field, (ii) the Total Count rate for the energy interval 0.4 to 3.0 MeV with correction for height and background variation, (iii) the Potassium count rate for the interval 1.35 to 1.57 MeV with correction for Compton scatter, height and background, (iv) the Uranium count rate for the interval 1.63 to 1.89 MeV with Compton scatter, height and background corrections, and (v) the Thorium count rate for the interval 2.42 to 2.82 MeV with height and background corrections.

There was also a contour map of the corrected Total Magnetic Intensity over the Larrimah sheet area with a contour interval of 5 nanoTeslas. The map was constructed from a subset of the original data by taking every fifth value (about 300m intervals) along each flight line. No such map was available for the Daly Waters sheet area at the time of preparing this report.

The aim in purchasing this data was to assess its significance in a petroleum exploration programme of parts of the Larrimah and Daly Waters sheet areas. Previously a detailed assessment had been made of data from the adjoining Tanumbirini sheet area. This is described in the "Report on Interpretation of Airborne Geophysical Data, 1:250 000 Sheet SE-53-02 Tanumbirini, Northern Territory" by B.A. Dockery, December 1988.

DISCUSSION OF RESULTS

A visual assessment of the data has been made by studying the maps produced by the BMR. No computer interpretation or other calculations have been performed on the survey data. A description of the assessment for each map sheet is given in the following sections.

(i) **Larrimah 1:250 000 sheet SD 53-13**

The profiles of the Total Magnetic Intensity displayed a broad background variation which had a wavelength of about 120km and an amplitude of about 200 nanoTeslas. This may arise from very deep mafic or ultramafic basement rocks of the order of 50km beneath the surface.

Superimposed on the background variation there was a number of shorter wavelength features. An intermediate response with a wavelength of about 5km occurred in a few places with an amplitude of 50 to 100 nanoTeslas. It may arise from a rock unit at a depth of about 1km. No similar response was noticed on either the Daly Waters or the Tanumbirini areas. The source could be a mafic rock unit of unknown origin.

The most prominent feature on the profiles had a wavelength of 1 to 3km and an amplitude of 50 to 300 nanoTeslas. Similar responses occurred throughout the Daly Waters and Tanumbirini sheet areas. The source is considered to be surface or near-surface volcanic flows equivalent to the Nutwood Downs Volcanics on the Tanumbirini sheet area and possibly the extensive Antrim Plateau Volcanics to the west. A series of parallel west-northwest striking trends cut across this response from the southern boundary of the sheet area. These must arise from a set of fractures crossing the volcanics presumably reflecting movement in the underlying rock units.

The group of responses which had the smallest discernable amplitude, namely about 10 nanoTeslas or less, exhibited a wavelength of 500 to 1000m. It must be generated by a surface source which could be laterite ridges as these were thought to be the source for the same type of feature in the Tanumbirini sheet area.

The shortest wavelength responses were not apparent in the contour map presentation of the data. Nor were the prominent responses from

the predicted volcanic flows adequately represented by the contour map. This was because the sample interval of about 300m along the flight lines and 1.5km between the lines does not provide sufficient information for the contouring process. The west-northwest striking trends were apparent as a series of contour closures crossing the map sheet. They are shown as faults on the Interpretation Diagram accompanying this report.

The intermediate wavelength features are only partly discernible on the contour map in the vicinity of latitude 15° 15′ South longitude 133° 00′ East. The broad background response was the main element of the contour map.

A magnetic field maximum occurred along the southern boundary of the sheet area reflecting a discontinuity in the basement rocks at great depth. Another maximum gave rise to a ridge striking northwest across the sheet slightly to the east of centre. It was truncated at its northern end by a proposed west-northwest fault and the position of its northeast contact was interpreted from the contour map. The composition and depth of its source is unknown.

The magnetic intensity increased towards the northwest corner of the sheet from a minimum striking east-west across the central west of the sheet. Another minimum occurred in the central east of the sheet area.

The profile presentation of the Total Count rate was difficult to follow due to the frequent overlapping of profiles from adjacent flight lines. The most active area appeared to be in the northwest corner of the sheet as shown on the Interpretation Diagram. Much of the remainder of the sheet displayed high frequency responses of sufficient amplitude to obscure the changes in background level. Some parts of the sheet area did display high frequency responses of low amplitude, once again marked on the Interpretation Diagram.

There were some clear trends of minima and maxima between adjoining lines superimposed on a background level of about 500 counts per second. As the radioactivity emanates from the surface material, the sheet area must contain a number of soil types or exposed rock units of contrasting radioelement composition. A contour map of the Total Count rate may assist in defining the extent of soil types or some rock outcrops.

The profile presentation of the Potassium response was obscure with high frequency variations of sufficient amplitude to overlap those of adjoining lines. No trends could be discerned other than an indication of the higher amplitude responses in the northwest corner of the sheet. Because of the number of corrections applied to the count rate, the variation may be largely due to the combined error in those corrections rather than a measure of the actual Potassium concentration. An indication of this error was the fact that the response was often less than zero which is not a valid representation of the Potassium abundance.

The profiles for the Uranium response were clear. They displayed a peak to peak amplitude of about 30 counts per second with the minima often less than zero. There was no distinct maximum or obvious trend but an overall uniformity of response. Once again the combined errors in the corrections may be a significant factor in the final profiles.

The Thorium profiles were also clear with amplitudes ranging from 0 to about 60 counts per second. The responses were similar to those for the Total Count but with less amplitude contrast and width. They are expected to be a reasonable reflection of the variation in Thorium concentration throughout the area.

There were only two places for which there was a correlation between the magnetic and the radiometric results. One of these was in the northwest corner of the sheet where the zone of higher

radioactivity corresponded with increasing background magnetic field and an absence of the prominent magnetic response attributed to near-surface volcanic flows. The other was a lineation in the Total Count and the Thorium profiles striking northwest from 10 km north of the southeast corner of the sheet and aligned with the northeastern edge of the contact for the northwest striking magnetic ridge in the centre-east of the sheet.

No correlation was noticed between the magnetic features and either the Uranium or the Potassium responses.

The Interpretation Diagram accompanying this report illustrates some of the major features detected by the airborne survey.

(ii) **Daly Waters 1:250 000 sheet SE 53-01**

Background variation for the Total Magnetic Intensity profiles had a wavelength of 40 to 80 km with the shorter wavelength in the southwest quadrant of the sheet. The amplitude was in the range 100 to 400 nanoTeslas. Possibly the basement is shallower than in the Larrimah sheet area and rising towards the southwest corner where it may be less than 10 km deep.

The intermediate response was identical to the prominent response on the Larrimah sheet. Its wavelength was between 1 and 3 km and its amplitude ranged from 20 to 250 nanoTeslas. It is attributed to the same source, namely surface or near-surface volcanic flows. A pronounced zone of this response extended from the northwest corner to the central-north of the eastern edge of the sheet area. It displayed continuations of the west-northwest trends present on the Larrimah sheet and attributed to faults.

The low amplitude response was again of the same nature as that on the Larrimah sheet, namely an amplitude of about 10 nanoTeslas and wavelength between 500m and 1000m. It is also attributed to the same type of source, being ridges of surface laterite.

No contour map of the Total Magnetic Intensity over the Daly Waters sheet was viewed for the preparation of this report nor is any Interpretation Diagram presented.

The Total Count radiometric profiles for the Daly Waters sheet were clearer than those for the Larrimah sheet. Moderate activity with variations of 200 to 300 counts per second was prevalent. There was a similar area of intermediate activity at around 100 counts per second variation but a lesser area of low activity at below 50 counts per second variation. Some obvious trends or zones of maxima and minima were evident. As before these are attributed to the presence of different soil types or rock outcrop in the sheet area.

The description of the profile presentation for both Potassium and Uranium is the same as that given above for the Larrimah sheet. One exception was an indication that the Uranium response was lower along the southern boundary of the Daly Waters sheet than elsewhere.

The Thorium profiles generally matched those of Total Count but with less amplitude contrast and width. The amplitude ranged from 0 to about 60 counts per second.

A zone of decreasing magnetic field along the southern edge of sheet corresponded with an area of undisturbed, low levels of Total Count, Uranium and Thorium. Another section of low, undisturbed Total Count in east side of the southeast quadrant correlated with undisturbed Total Magnetic Intensity, that is, no near surface volcanics. Otherwise no other trend or correlation between the various data sets was recognised.

CONCLUSIONS AND RECOMMENDATIONS

A magnetic basement of mafic or ultramafic rocks underlies the Larrimah and Daly Waters sheet areas. It may be of the order of 50km beneath the surface of the Larrimah area and rise to a depth of about 10km below the southwest quadrant of the Daly Waters area.

Both areas have an extensive near-surface layer of volcanic rock of the same nature as attributed to the Nutwood Downs Volcanics on the Tanumbirini sheet area. It displays a set of west-northwest striking faults in the vicinity of latitude 16° 00′ South. There may also be a blanket cover of laterite ridges.

A number of different types of response were evident in the Total Count and Thorium radiometric profiles. These could be used to divide the area into zones of different soil type or rock outcrop. The Potassium and Uranium profiles may reflect variations in the error involved in calculating the values rather than variations in the abundance of these radioactive elements.

The response attributed to near-surface volcanics dominated the magnetic data. Because of this, there is probably little to be gained about the depth to magnetic basement from wholesale processing of the digital data. Some computer modelling of selected profiles may achieve useful depth indications as this was the case in dealing with the same type of data for the Tanumbirini sheet area.

The Interpretation Diagram for the Larrimah area shows the predicted extent of the volcanic flows. It may be useful to undertake stratigraphic drilling away from these flows in order to avoid the cost of drilling through hard basalt.

An interesting view of the regional setting for the Larrimah, Daly Waters and Tanumbirini sheets could be obtained by image processing

the magnetic data from the sixteen 1:250 000 sheet areas contained between latitudes 14° and 18° South and longitudes 130° 30′ and 136° 30′ East. This is equivalent to the area of a standard 1:1 000 000 sheet. Similar images have been produced by the BMR for the 1:1 000 000 areas of Adelaide, Albany and Roper River. They show major structural lineaments, indicate basin features and show domains of magnetic response for different rock units. Whether the cost of such a study is warranted will depend on the overall expenditure contemplated for the project.

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