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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1962/99

TENNANT CREEK AREA AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY, NORTHERN TERRITORY 1960

by

A.G. Spence

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SUMMARY

Airborne magnetic and radiometric surveying in the Tennant Creek area was extended in 1960 to include all of the Tennant Creek four-mile area and part of the Green Swamp Well four-mile area.

Because of the association of mineral deposits with ironstone bodies in this region, magnetic prospecting has had considerable influence on the development of the Tennant Creek Mineral Field. The results of this survey, presented here in preliminary form, indicate areas of magnetic disturbance where further magnetic prospecting for mineral deposits may be warranted.

Six radiometric anomalies were detected.

1. INTRODUCTION

Airborne surveys in the Tennant Creek region were initiated by the Bureau of Mineral Resources to assist the development of the Tennant Creek Mineral Field. In 1956 an airborne magnetic and radiometric survey was made over an area which included all the known workings in the Field. The results were published in Bureau of Mineral Resources maps G110-25, G110-28, G110-29, and G110-30. In 1960 the survey was extended to cover the rest of the Tennant Creek four-mile area and part of the Green Swamp Well four-mile area.

The boundaries and location of the area surveyed are shown on Plate 1. The area surveyed was approximately 5400 sq. miles. The survey was made during the months of June to October 1960 using the Bureau's DC3 aircraft VH-MIN. The members of the survey party were: Bureau Officers A.G. Spence (Party Leader), G.A. Young, M.J.W. Duggin, K. Sears, W. Gerula, F. Clements, P. Turner, F.G. Walker, E.J. Lynne, K. Mort, D. Park, D. Upton, I. Parkinson, J. Slama, and D. Girvan, and Trans-Australia Airlines Officers G. Close, G.C. Greene, R. McNamee, and W. Briggs.

2. METHOD

The survey consisted of a systematic measurement of the total magnetic intensity and gamma radiation throughout the area. In the northern and western sections of the area this was done along north-south flight lines spaced one fifth of a mile apart using a Shoran radio navigation system to navigate the aircraft and to plot its track. In the eastern and southern sections, flight lines were one mile apart and aerial photographs were used for navigation; vertical strip film and air position data were used to plot the aircraft's position.

The height of the aircraft was maintained at 500 $\pm$ 100 ft above ground level.

A system of east-west tie-lines was flown to provide the information required to reduce individual flight lines to a common datum, and to remove systematic errors.

3. EQUIPMENT

The magnetometer used was a saturable core fluxgate magnetometer, type MFS-4. The detector head was mounted in a boom which was projecting from the tail of the aircraft to remove the detector head as far as possible from the disturbing fields of the aircraft's magnetism. The output of the magnetometer was recorded on a 'Speedomax' chart recorder.

Two separate scintillographs were carried. One was mounted within the aircraft and consisted of two MEL detectors, whose outputs were fed into a BMR-type ratemeter and presented on a Kelvin & Hughes chart recorder. The other scintillograph measured the radiation level at a height that was about 300 ft below the aircraft. The detector in this case was contained in a 'bird' which was towed by the aircraft on 500 ft of cable. The output of this detector was fed to a second BMR-type ratemeter and recorded on a Kelvin & Hughes chart recorder.

The altitude of the aircraft was continuously measured and recorded by an STR30B radio altimeter. The altitude profile so recorded was used to correct the radiometric data where necessary.

The Shoran radio navigation system consisted of an AN/APN-84 setinstalled in the aircraft and three AN/CPN-2A ground stations. The aircraft set is operated with two ground stations at one time to give a continuous triangulation fix of the aircraft's position. The ground stations were located on sites chosen to give line-of-sight coverage of the area being surveyed; the sites were as far as possible made to coincide with surveyed trigonometrical stations. The distances between aircraft and ground stations were continuously displayed on two sets of mileage counters. One set was used by the pilots to navigate the aircraft and the other set was photographed every ten seconds to provide data for plotting the aircraft's track.

The aircraft was also fitted with a straight-line flight-indicator. This instrument is operated in conjunction with the aircraft's Shoran set and indicates any deviation from a pre-selected straight line by movement of a meter pointer on the pilots' instrument panel.

In the photo-navigated section of the area, an 'Aeropath' vertical strip camera was used to photograph the track of the aircraft. In addition, an air position indicator (API) was used to record the air position of the aircraft. The co-ordinates of the air position, referred to an arbitrary datum, were displayed on mileage counters, which were photographed every ten seconds. The air position was also recorded in the form of a continuous plot by means of a chart recorder. In plotting the positions of the flight lines on the base maps, the data provided by the API facilitated interpolation between photo-identified positions.

A fiducial marker system provided the correlation between the various chart and film records. A magnetic-base-monitor was operated during the survey to supply information on diurnal variation and occurrence of magnetic storms.

4. GEOLOGY

The history of the field and geological investigations up to 1954 are discussed by Ivanac (1954). Subsequent geological work is described in a report by Crohn, Oldershaw, and Ryan (1959). The two major companies operating on the field, Australian Development N.L. and Peko Mines N.L., have carried out geological and geophysical exploration within their leases.

Geochemical prospecting has been carried out by McMillan and Debnam (1961) and magnetic prospecting in the area has been summarised and discussed by Daly (1957). Petrological examinations of rocks from Tennant Creek have been made by Oldershaw (1961).

Most of the work referred to above has been confined to the area about the workings. No geological investigations have been made of the area covered by the present survey. The following notes are based on information of a regional nature contained in the above reports and on an article by Noakes (1953). The geological boundaries shown on Plate 1 of this Record were taken from the 'Tectonic Map of Australia' published by the Bureau of Mineral Resources in 1960.

The area surveyed falls within the continental Precambrian Shield which underlies almost the whole of Western Australia and the Northern Territory. The basic structural feature of the area is the Warramunga Geosyncline. The area has been comparatively stable since the orogeny, about the end of the Lower Proterozoic Era, which terminated geosynclinal sedimentation and introduced most of the mineral deposits together with the granite and porphyry.

The major rock units mapped to date are the Warramunga Group and the younger Ashburton Sandstone. The area to the east and west of these formations is little known geologically. It is shown on the BMR Tectonic Map as middle Devonian to Cambrian shale, conglomerate, sandstone, chert, etc.

The Warramunga Group is the name given to the sedimentary succession, which consists of greywacke, siltstone, and shale, and which includes the gold-bearing quartz-haematite lodes. It crops out as sub-parallel lines of flat-topped and pinnacled hills separated by large flat areas of soil and alluvium. The dominant structural features are folds with roughly east-west axes. Shearing and faulting are very widespread. Numerous quartz-feldspar porphyry bodies have intruded the sediments.

The Ashburton Sandstone is the succession of quartzite, conglomerate, and sandstone which crops out in the northern section of the area surveyed. It is regarded by Ivanac (1954) as conformably overlying the Warramunga Group, although some doubt about this is suggested by Crohn et al. (1959, p.10). The Ashburton sandstone is not mineralised.

The geological feature of most interest in magnetic prospecting in the Tennant Creek area is the wide-spread occurrence of massive ironstone bodies. As a rule the iron oxide in these bodies is haematite at the surface and magnetite below the water-table but some occurrences still carry significant amounts of magnetite even in the oxidised zone (Crohn et al., 1959, p.13). The magnetite content is considered to be the source of the magnetic anomalies. However, since the ironstone bodies occur at various depths and are in various stages of oxidation some of them may produce only a small anomaly or no anomaly at all. Furthermore not all the ironstones carry gold or sulphide deposits, and gold and sulphide deposits are not necessarily associated with ironstone (Crohn et al., 1959, p.19). No magnetic criterion is known for distinguishing mineralised ironstone bodies from barren ones.

5. RESULTS

Magnetic results

The preliminary presentation of results given on Plate 1 shows the peak values of magnetic anomalies relative to the surrounding field level. The accuracy of positioning is within one fifth of a mile in the northern and western sections and within half a mile in the eastern and southern sections.

The main feature revealed by the 1956 results (BMR map G110-30) was a rhombic-shaped area of magnetic relief with its long axis trending east-south-east; this area corresponds with the main area of Warramunga outcrop. This feature terminates fairly abruptly at its south-eastern end along a north-north-east line through Rocky Range. There appears to be no disruption in the trend of geological features in this vicinity that could account for this abrupt termination (Crohn, 1961) and it was hoped that the present extension of the survey might throw some light on the problem. The present survey did not reveal any similar magnetic feature here or elsewhere in the area surveyed. However, it did delineate an extensive feature of low magnetic relief in the south-eastern sector whose trend is mainly to the north. The significance of this feature is not clear.

In the north-western part of the area, south and east of West Point, there is a group of distinct easterly-trending anomalies. This feature can be followed through the 1956 survey area; it finally merges into the disturbed zone in the central-northern section of the area. This feature is possibly related to the Ashburton-Warramunga contact zone, which has not been firmly positioned to date. The absence of anomalies over most of the Ashburton Sandstone in this area indicates that these sediments are weakly magnetic and contain less intrusive material than the Warramunga Group.

The area about, and to the east of, the Stuart Highway in the central-northern section of the area appears on Ivanac's map (1954) as Ashburton Sandstone, but shows considerably more magnetic relief than the rest of the Ashburton Sandstone surveyed. It is possible that the anomalies in this area are associated with igneous intrusions along a system of faults trending 30 degrees east of north. These faults can be verified only by further detailed geological mapping. These anomalies may possibly be significant as an indication of correlation between this area and the Davenport Range area, where some of the major structural trends appear to be parallel to the trend of these anomalies. Crohn (1961) supports this possibility on the basis of personal impressions gained while working in this region, adding that it is not possible to prove it conclusively as the Davenport Group and the Ashburton Sandstone have no contact anywhere.

In the central-southern sector of the area near the Stuart Highway there is a magnetic feature whose position is probably related to the northern boundary of the Hatches Creek Group which has been mapped as far north as the southern boundary of the airborne survey area. (Smith, Stewart, and Smith, 1960).

The geology of the south-western part of the area is insufficiently known to establish any correlation between the geology and the low magnetic relief, which here trends mainly east.

The most intense anomaly encountered is south-west of Red Bluff near the western edge of the 1956 survey area. It extends east-west over a length of about $2\frac{1}{2}$ miles; the anomaly partly delineated in the 1956 area in this vicinity is part of the same feature. It appears from the aeromagnetic profiles that this anomaly is not of the type usually encountered in the Warramunga zone and is not likely to be due to a massive ironstone body.

Radiometric results

Six radiometric anomalies were detected. Four are in an area of low topographic relief in the north-eastern section of the survey area. The remaining two are in the central-western section.

Changes in level of radioactive intensity are shown on Plate 1. In many cases they are associated with the watercourse patterns where, apparently, locally disseminated radioactive material has become concentrated. Until more geological information becomes available, it is not possible to comment on the significance of the distribution of radioactivity indicated by the data.

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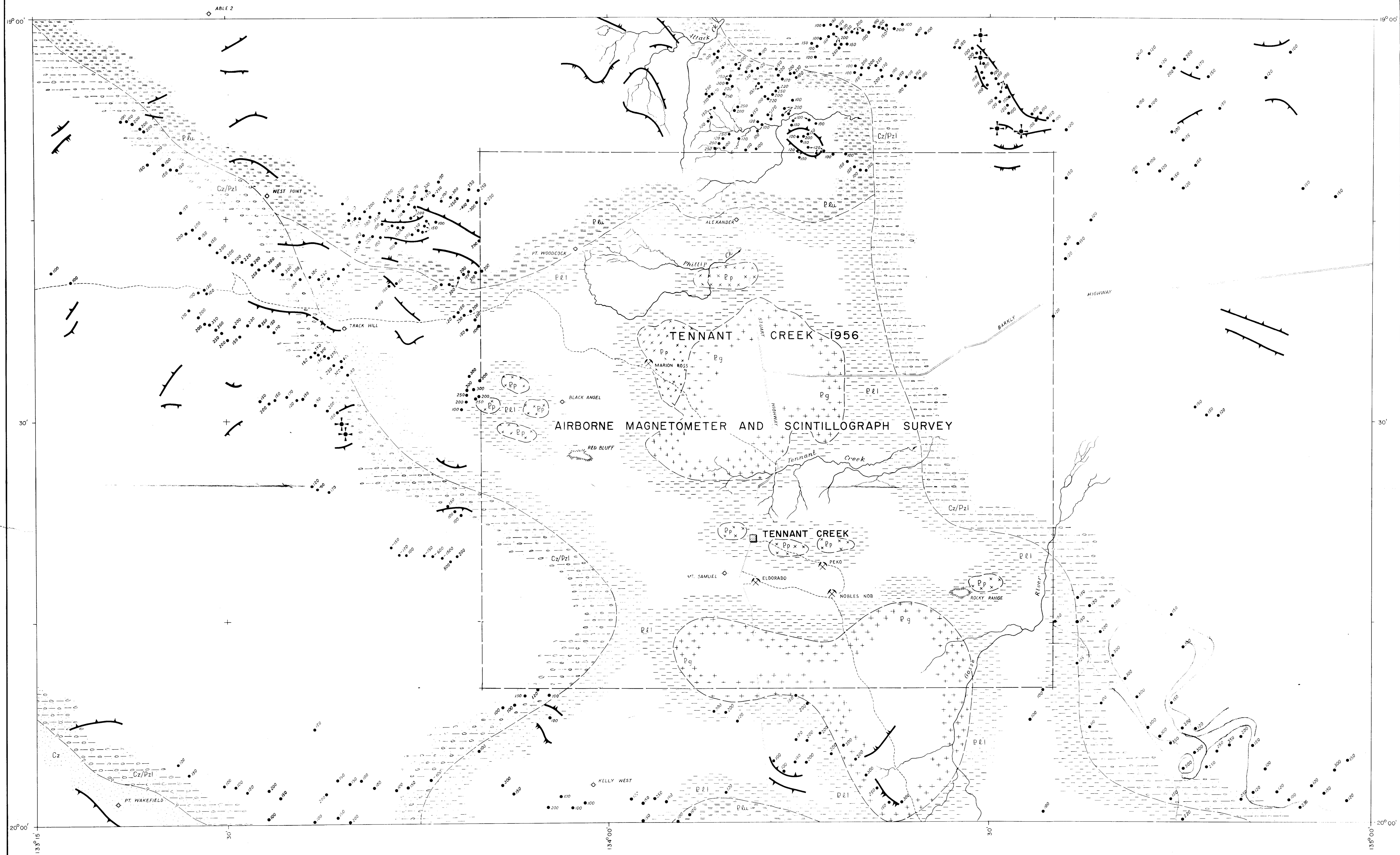
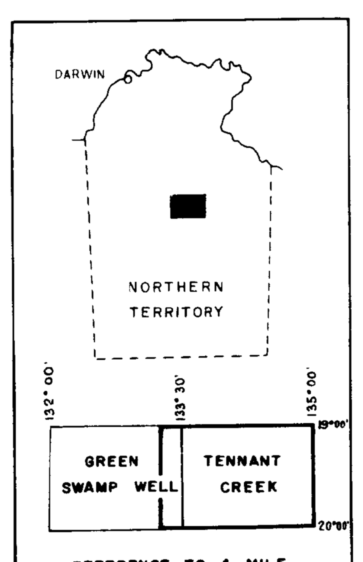


LOCATION DIAGRAM



REFERENCE TO 4-MILE AUSTRALIAN NATIONAL MAP SERIES

LEGEND

CAINOZOIC	UNDIFFERENTIATEC	Cz	Mainly Quaternary sand, alluvium, and residual soil.
PALAEOZOIC	LOWER	Cz/Pzl	Shale, sandstone and conglomerate with areas of undifferentiated Cainozcic sand, alluvium, and residual soil.
PROTEROZOIC	LOWER, UPPER	Plu	Arenaceous quartz, greywacke, sandstone, and shale.
	PRINCIPALLY LOWER	Pg Pp	Intrusive igneous rocks.
	LOWER, LOWER	Pll	Folded geosynclinal sediments, mainly greywacke, siltstone, and shale.

NORTHERN TERRITORY

TENNANT CREEK

GEOLOGY, MAGNETIC AND RADIOMETRIC ANOMALIES

1960 AIRBORNE SURVEY

SCALE

MILES 4 0 4 8 12 MILES

4°30'

LEGEND

- 100 — MAGNETIC ANOMALY SHOWING APPROXIMATE INTENSITY IN GAMMAS ABOVE OR (-) BELOW MEAN FIELD LEVEL IN VICINITY OF ANOMALY
- RADIOMETRIC ANOMALY
- RADIOACTIVE INTENSITY CHANGE BETWEEN HALF AND ONE TIMES BACKGROUND
- " " " ONE " TWO " "

THE BARBED EDGE IS ON THE SIDE OF LOWER INTENSITY

- GEOLOGICAL BOUNDARY
- MINE
- SHORAN BEACON SITE

GEOLOGY AFTER TECTONIC MAP OF AUSTRALIA 1960, BY GEOLOGICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

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