PHOTOGEOLICAL AND GEOPHYSICAL
INTERPRETATIONS
E.L. Nos. 1386, 1388, 1389, 1463
and 1804
TENNANT CREEK
NORTHERN TERRITORY

MINES BRANCH
GEOLOGICAL LIBRARY
The Exploration Manager
Marathon Petroleum Australia, Ltd.
G.P.O Box 687
BRISBANE, Qld 4001

Attention: Mr. J Clavarino

Dear Sir,

LETTER REPORT : PHOTO GEOLOGICAL STUDY
TENNANT CREEK, QUEENSLAND (JOB GA. 45/78)

A photogeological study of the eastern part of Tennant Creek mineral field including the 756 sq km Tennant Creek Project (EL's 1386, 1388, 1389; ELA's 1463 and 1804), using black and white vertical panchromatic aerial photographs, was carried out during the period August-October 1978 by M. Coupard of R.F. Loxton, Hunting and Associates Pty. Limited on behalf of Marathon Petroleum Australia, Ltd.

The study-area is located in the centre of the Northern Territory some 500 km north of Alice Springs, and covers approximately 3200 sq km of arid country. No permanent streams exist and the vegetation is often adapted to desert conditions with porcupine bush, spinifex, turpentine bush, small eucalypts and mulga. The following geomorphic units occur across the area from north to south:

- a series of strike ridges, forming the Short Range with a maximum relief of the order of 60-100 m;

- low-lying plains, coinciding with the Phillip Creek drainage system, and a few isolated low hills;

.../...
- a belt, approximately 15 km wide and trending 120° consisting of flat-topped hills with a maximum relief of 80 m and narrow low-lying corridors;

- low-lying plains with scarce, very low outcrops.

To date, the overall area, being a gold and copper field, has received a fair degree of attention and is dealt abundantly with in the literature. It has been comprehensively mapped by geologists of the Bureau of Mineral Resources at scales of 1:250 000 (Tennant Creek SE 53-14 sheet), and 1:63 360 (Mount Woodcock 228 Zone 5 and Tennant Creek 238 Zone 5 sheets). It is noteworthy here that the geological mapping of the Mount Woodcock sheet was carried out on large-scale aerial photographs (1:12 000) as well as on small-scale photographs (1:46 000 and 1:83 000).

Exploration work so far has been intensive and has put an emphasis on geophysical targets such as magnetic anomalies, because almost all the known mines are associated with quartz-hematite and magnetite lodes. Geochemistry has also been carried out throughout the mineral field to help define anomalies of residual copper on leached outcrops, and was successful at the Orlando mine. Production has been recorded from about 115 mines and prospects including seven major mines. To date only two mines are in production, namely Warrego (Cu, Bi, Se, Ag, Au) and Nobles Nob (Au, Ag), whilst the mining operations at two other mines (Peko and Juno) have been temporarily suspended pending a more favourable economic climate.

Field checks were made during 3½ days at the end of the annotation phase, using a vehicle. A total of 43 localities of particular interest were visited and have been indicated on the work-sheets.

The results of the photogeological mapping are incorporated in two work-sheets at the nominal photo-scale of 1:83 000. This letter report is presented to supplement the work-sheets which are considered to represent the most important outcome of the study. One coloured set is enclosed with this letter report.

The aims of the photogeological interpretation are to provide as detailed a lithostratigraphic and structural map as possible, on which to base a subsequent field exploration program designed to test exploration targets for base metals and uranium. A close link between photogeology and geophysical work was maintained after the field checking phase in order to upgrade the mutual interpretation.
The photogeological mapping involved a total of 117 black and white aerial photographs at the scale of 1:83,000. These were interpreted under a Zeiss N2 mirror stereoscope with 1x and 6x magnification. Annotation of photogeological detail was done in ink directly onto two acetate drainage bases compiled from the photographically enlarged Tennant Creek (1973 edition) topographic map. Topographic detail was amended during the annotation. Re-annotation was done after the field checking period and took account of the findings in the field. Reference was made to four bands of four LANDSAT scenes at the scale of 1:1,000,000, in order to evaluate some very large structural features. A list of the aerial photographs and LANDSAT scenes is included in the appendix.

Comprehensive reviews of the regional geology and mineralisation have been given by Crohn (1965), Large (1975b) and Black (1977). A brief resume will be given here.

Details relevant to the geology, structure and mineralisation of individual mines are described in White (1962), Crohn (1965 and 1975), Crohn and Oldershaw (1965), Wright (1965), Dunnet and Harding (1967), Large (1975a and b) and Goulevitch (1975).

The oldest rocks in the Tennant Creek area are not exposed, but are thought to be represented by gneiss and amphibolite encountered in drill holes about 30 kms west-southwest of Tennant Creek, and are a possible correlative of similar rocks in the Mounta Complex farther south. The main part of the Tennant Creek area is underlain by the almost non-metamorphosed Proterozoic Warramunga Group, a series of interbedded sedimentary and volcanic rocks of eugeosynclinal origin. Recent isotopic studies (Black, 1977) indicated these rocks were deposited before a major deformation episode inferred to have occurred at about 1810 m.y. The Warramunga Group is overlain unconformably by clastic sedimentary rocks of shallow water facies, namely the Tomkinson Creek Group in the north and the Hatches Creek Group in the south, and has been intruded by various granites of Carpenterarian to Adelaidean age. The Proterozoic rocks are overlain by almost flat-lying Cambrian sedimentary and volcanic rocks. There is general agreement on the association of economic mineralisation (Cu, Au, Bi) with ironstones, but considerable controversy over the genesis and in particular the source of this mineralisation. The photogeological study has resulted in the empirical differentiation of eighteen discrete lithological units (see map, scale 1:83,000), nine of which correlate with the Proterozoic Warramunga Group.
The degree of confidence in the recognition of these units is generally fair to poor on the small-scale aerial photographs, owing to the paucity of outcrops, the poor lithological expression of individual outcrops and the sometimes fuzzy nature of the aerial photographs. In the field, it was often found that the deeply weathered sedimentary and volcanic rocks possess a similar geomorphic expression and alternate rapidly in the stratigraphy. Thus the lithological units as shown on the photogeological work-sheets consist of an association of rock types, in which shale and greywacke predominate.

This association forms a unique regional unit on the basis of the classical photogeological criteria of tone and expression. The previous mapping, particularly that at the scale of 1:63 360 (1 inch = 1 mile), has been slightly improved upon in certain areas with the addition of further details.

The stratigraphic succession of the Warramunga Group comprises three formations, namely the Whippet Formation (Pww), the Bernborough Formation (Pwb) and the Carraman Formation in order of decreasing age.

The Whippet Formation underlies the eastern part of the Tennant Creek area and consists of shallow water sandstone with subordinate amounts of greywacke and shale.

The Bernborough Formation consists of acid volcanic rocks, tuff, and tuffaceous greywacke that are interbedded with subordinate amounts of red shale and siltstone. The lower geological contact is gradational with the sedimentary rocks of the Whippet Formation, whilst the upper contact may represent a disconformity. Apart from areas occupied by resistant bedded chert, no marker horizon has been recognised throughout the volcanic sequence.

The Carraman Formation forms approximately 50 per cent of the outcrops in the study-area, and consists mainly of argillite, shale, siltstone and tuffaceous greywacke that form three units with features indicative of deposition by turbidity current. Isolated occurrences of dolomite have been reported at several localities (Dunnet and Harding, 1967, p. 48-49), including many mines (Peko, Juno, Orlando, Gecko, Northern Star) and in different lithological units (Pwg and Pwsh).
Felsic volcanism is present throughout the formation and forms lenses that have been variously named Warrego, Orlando and Gecko Volcanics on the previous geological maps (scales 1:63 360 and 1:250 000). In the field these volcanic rocks are indistinguishable from the Bernborough Volcanics; this supports an interpretation of a pulsating volcanism during the development and evolution of the Tennant Creek basin with peak periods of volcanic activity coinciding with the Bernborough Formation and the main lenses of Orlando-Warrego Volcanics. Volcanic rocks (Pwv) of a fissure type are indicated to the north of Tennant Creek, where they transgress several units.

Vent areas have not been recognised with certainty in the study-area and to which extent the vents are filled with outcrops of "porphyry" (Pp) is still a matter of speculation. Areas near the Tennant Creek airport and south of the Bernborough mine contain ignimbrites (Pp) that could qualify as pipe fillings (Crohn, 1965).

The lower unit (Pwsh) of the Carraman Formation consists mainly of argillite, shale and siltstone interbedded with subordinate amounts of greywacke, acid volcanic rock and ironstones (banded iron formation and/or gossan). The ironstones in this lower unit are often magnetic and well developed close to and above the contact with an underlying volcanic unit or lens as at the Northern Star, the Queen of Sheba and Orlando mines; this implies a genetic relation of the ironstones to the volcanic rocks. The lower unit forms generally very low hills, with occasional razorback ridges of volcanic rocks or ironstones, the latter imparting a very dark tone on the aerial photographs. A dendritic drainage pattern is not usually well developed, except over an area approximately 7 km north of Tennant Creek.

The intermediate unit (Pwg) of the Carraman Formation forms a belt of low flat-topped hills trending east-west and surrounding the town of Tennant Creek. It consists mainly of greywacke with varying grain sizes and subordinate amounts of shale, including black shale with finely disseminated pyrite. Volcanic rocks, mostly tuffs, form scattered stratiform lenses, which do not appear to be as abundant as in the lower unit (Pwsh). A thin hematite shale horizon forms an almost continuous "marker" bed in the lower part of the unit, and is associated with a few gold mines. It is not known at this stage whether the above hematite shale can be equated through repeated folding with the hematite shale found in the Mt. Samuel to Nobles Nob area.
The upper unit (Pwss) of the Carraman Formation forms the northernmost outcrops of the Warramunga Group, just below the unconformity with the Tomkinson Creek Group. This unit consists of sandstone, greywacke and subordinate shale forming very low rises. No visible ironstone or acid volcanic unit occurs in this unit.

The above units forming the Carraman Formation may be equated with the chemical breakdown of magnetite, hematite and iron-free facies, proposed by Large (1975b) in order of decreasing age.

Granites (Pg) have intruded the Warramunga Group, but have not been found to intrude the Tomkinson Creek Group. Granite ages range from 1798 m.y., which may represent maximum time of emplacement, to 1738 m.y. The main outcrops of Tennant Creek granite are in the areas of Station Hill, White Hill and north of the Barkly Highway. A narrow zone of contact metamorphism has been reported (Dunnet and Harding, 1967) to outcrop in the Owen Hills with andalusite spotted shale, and may be the source of the slight anomaly that surrounds the granite, on the aeromagnetic map (scale 1:250 000). The photogeological worksheets indicate a different igneous phase (Pgb) in the vicinity of White Hill and Station Hill, where big boulders of a granitoid with large round pinkish porphyroblasts and a pronounced metamorphic foliation were observed. The writer believes that this porphyroblastic granitoid represents a basement, which was remobilised during the first period of deformation dated at about 1810 m.y. minimum (Black, 1977).

The cover rocks include the well-exposed Carpentarian to Lower Proterozoic Tomkinson Creek Group (which forms strike ridges of sandstone, quartzite and conglomerate), the Rising Sun Conglomerate of undifferentiated age and Cambrian formations consisting of acid and basic volcanic rocks overlain by calcareous siltstone, chert and grit.

The structural features identified in the study-area during the photogeological mapping indicate that the Tennant Creek area was subjected to at least two main periods of deformation.

The first period of deformation, termed F1, produced a slaty cleavage S1 with invariably steep dips either to the north or south. It is better developed in the shale than in the greywacke. The strike of the cleavage ranges from N80°E to N110°E and coincides with the axial planes of large flexural-slip folds in the Peko-Juno mines area and north-west of the Barkly Highway.
Metamorphism has been assumed by previous workers (Black, 1977) to have occurred during this period of deformation. The field evidence indicates however that the rocks are essentially unmetamorphosed, although subjected locally to dynamic and diagenetic processes.

Shear zones parallel the S1 cleavage throughout the area; their width ranges from a few centimeters to over 30 metres, as at the Orlando Mines (Dunnet and Harding, 1967). The Mary Ann Shear Zone probably correlates with the F1 phase and is parallel to the axial plane of the major anticlinal structure.

Recent age dating of the orebodies (Black, 1977), indicates a minimum age of 1810 m.y. for the F1 period since the orebodies are localised along F1 structures. Goulevitch (1975) provides a strong case in favour of the folding being pre-mineralisation; but it can be argued that the folding and slumping were caused by this period of the deformation.

The second phase of deformation, termed F2, produced both a fracture and crenulation cleavage S2-S3 leading to chevron folds and kink bands. Partial or complete transposition of earlier S surfaces has been reported (Dunnet and Harding, 1967) in intensely deformed areas, such as near the Quartz Hill Fault. Three conjugate sets of faults were produced by the F2 phase and trend 060°, 120° and 165°. The first trend is the North Star Shear Zone, whilst the second trend is that of the Quartz Hill Fault. It is noteworthy to mention that the trends of 060° and 120°, coinciding with S2-S3 structures, are bisected by the S1 structures. Faults striking N150°W (165° trend) are well developed east of Tennant Creek, but were found in the field at several other localities to equate with a fracture cleavage; these faults are slightly rotated north of the Quartz Hill Fault. Minor structures related to the F2 period of deformation include mullions, rodding, parasitic folding on the limbs of the large structures and thrust faulting which interrupts small ore shoots at the Peko Mine (Wright, 1965). Recent isotopic data (Black, 1977) suggests that the F2 phase occurred at about 1735 m.y. and was coeval with the emplacement of some granites and part of the Bernborough Formation.

Later and less intense periods of deformation are inferred to have taken place from isotopic age dating. The emplacement of granites west and south-west of Tennant Creek and the dykes of lamprophyre throughout the area may well represent one such episode at 1660 m.y.
Concerning the regional features of mineralisation, economic concentrations of gold, copper, and bismuth in the Tennant Creek mineral field are not unique and are spatially related to distinct lithological and structural features, which affect the Warramunga Group and are listed below. These features have been selected from the description of the mines and prospects available in the literature and from observations in the field:

1. The mineralisation always forms lenticular, ellipsoidal or pipe-like ore shoots rich in magnetite and/or hematite. The shoots are discordant to the bedding, because they have been remobilised into transgressive positions, i.e. they follow the cleavage, as a result of a main deformation period. All the mineralised specimen seen on the dumps of Orlando, Ivanhoe and Juno mines indicate that the ore is bedded, i.e. stratabound.

2. Lithological controls of mineralised ore are as follows:

(a) within sediments adjacent to acid volcanic rocks, often a rhyolite crystal tuff (Peko, Warrego mines);

(b) within sediments exhibiting soft-sediment deformation structures, such as mudflow- and breccia-conglomerates (Peko, Gecko, Orlando mines);

(c) in close proximity or adjoining an ironstone or banded iron formation (Nobles Nob, Juno, Orlando and Eldorado mines);

(d) in close proximity to bedded dolomite (Juno and Gecko mines).

3. Structural controls of the mineralised bodies are mostly contemporaneous with the F1 phase of deformation and include:

(a) fault and shears (Warrego, Orlando, Ivanhoe mines);

(b) anticlinal (Warrego, Eldorado mines) or synclinal (Peko mine) folds;

(c) the attitude of the mineralised bodies is mainly controlled by either the intersection of the slaty cleavage with shearing or follows the axis of a fold structure.

.../...
Other features relevant to mineralisation, although not necessarily economic, include the following:

1. Gold seems to be exclusively concentrated in the near-surface zone with a frequent sharp cut-off at water level. This feature is linked with the chemistry of gold and specifically its precipitation from complexes (with selenium) under higher potential of oxygen (Marakushev, 1977);

2. Uranium/thorium mineralisation is reported from several mines, as uraninite at the Juno mine (Large, 1975b) and monazite at the Warrego mine (Goulevitch, 1975).

The regional features of mineralisation mentioned above are not unique to the Tennant Creek area and have a great deal in common with the Cobar mineral field in New South Wales, despite the relative difference of age. It is quite conceivable that many orebodies at Tennant Creek, traditionally regarded as epigenetic mineralisation resulting from hydrothermal activity and consequent metasomatic zonation, could represent stratabound and stratiform sulphide deposits.

Suggestions for further work include the following:

1. Ground traverses should be made in E.L. 1388, to improve upon the existing mapping south of the Butchers Waterhole and to investigate the presence of dolomite west-southwest of the Northern Star mine.

2. A narrow zone located south-west of the geological contact with the Bernborough Formation in E.L. 1389 constitutes a favourable environment for stratiform sulphide deposits. Geochemistry carried out by the Bureau of Mineral Resources disclosed anomalous values for Cu-Pb-Zn-Bi in ironstones 1.5 km southwest of Bishop Bore that correlate with the suite of ironstones at Orlando and Northern Star. Further geochemical sampling should be envisaged.

3. The unit (Pp) located 6.5 km west of the Three Ways Roadhouse should be investigated because it may represent a volcanic vent area and contain disseminated chalcopyrite as in the "porphyry" adjacent to the airport.
4. Detailed photogeological mapping using colour photography at scales of 1:25 000 or 1:12 000 (1" = 1000') would definitely improve the existing mapping over areas selected from the integration of geophysical, geochemical and field investigations.

All radiometric anomalies should be sampled (geochemically) when located on the ground (Juno type).

Yours faithfully,

R. F. LOXTON, HUNTING AND ASSOCIATES PTY. LIMITED

[Signature]

M.M. Coupard

Attach:
REFERENCES CITED


LARGE, R R., (1975b) Zonation of Hydrothermal Minerals at the Juno Mine, Tennant Creek Goldfield, Central Australia, Econ Geol., 70, 1387-1413.


Black and White Panchromatic Photographs at the Scale of 1:83 000 (80% overlap)

Source: Commonwealth of Australia, Division of National Mapping

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Single weight, glossy, non-flattened prints

List of Non Digitally Enhanced Scenes prints at the scale of 1:1 000 000.

Source: NASA, Sioux Falls, USA.

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The Exploration Manager
Marathon Petroleum Australia Ltd.
G P.O. Box 687
BRISBANE, Qld. 4001

Attention: Mr. J. Clavarino

Dear Sir,

LETTER REPORT: GEOPHYSICAL INTERPRETATION
TENNANT CREEK, NORTHERN TERRITORY (GA. 46/78).

Introduction:

This letter-report presents the findings of the interpretation of an airborne magnetic and spectrometer survey in an area comprising three Exploration Licences (Nos. 1386, 1388 and 1389) immediately north of Tennant Creek.

A total of approximately 1150 line kilometres of aeromagnetic and high sensitivity spectrometer data were recorded at a nominal height of 90 metres along flight lines 500 metres apart. The data are presented in the form of corrected profiles and contoured maps at a scale of approximately 1:25 000.

The interpretation has been carried out in conjunction with a photo-geological study also undertaken by R. F. Loxton, Hunting and Associates. Throughout the project reference has been made to the results of the photo-geological study which have provided a valuable geological basis for the interpretation of the geophysical data.

.../...
Aims of the Interpretation:

Within the project area exploration targets are threefold:

(i) Base metals of the Tennant Creek type, i.e. Cu/Au;

(ii) Uranium associated with base metal deposits;

(iii) Uranium deposits of the Alligator Rivers type.

In the development of the Tennant Creek mineral field geophysical techniques and in particular the magnetic method have played an important part. The primary success of the magnetic method is due to the presence of magnetite lodes in association with the base metal mineralisation. This has resulted in the direct discovery of mineralisation following the drilling of both aeromagnetic and ground magnetometer survey results frequently in areas of little or no outcrops. The magnetic method has also provided structural information such as the location of major faults which appear to be important in relation to mineralisation.

Uranium mineralisation is also known to occur in association with the copper/gold mineralisation at the North Star Mine. Airborne spectrometer surveys in conjunction with magnetometer surveys therefore also offer the possibility of the direct location of uranium mineralisation.

With these facts in mind the aims of the geophysical interpretation have been as follows:

(i) to interpret the magnetic data with particular regard for the classic Tennant Creek type base metal mineralisation;

(ii) to interpret the spectrometer data with a view to the selection of potential uranium target areas and also as an aid to the geological mapping.
Discussion of Results:

(a) Regional Survey Data

Prior to interpreting the detailed geophysical survey results all available regional aeromagnetic and spectrometer data were studied in order to determine the possible influences of regional structures on the local geology. Regional geophysical contoured maps frequently contain information regarding the presence of major regional faults and lineaments which may be important in relation to mineralisation.

In recent times the significance of lineaments in relation to mineralisation has been given serious consideration and although very much in its infancy appears to offer some potential.

In regard to Tennant Creek the regional gravity map of Australia indicates the presence of a major lineament striking NNW-SSE which can be traced from South Australia through Tennant Creek to the northernmost part of the Northern Territory (see Figure 3). The significance of this "lineament" with regard to mineralisation is no means clear but the following observations can be made:

(i) A number of major mineral occurrences lie on or near this feature, notably Roxby Downs, the Alligator Rivers uranium deposits and also the Tennant Creek deposits.

(ii) Common to all these are uranium, copper and gold.

(iii) The presence of rare earths and other less common minerals such as bismuth, etc.

In associating these occurrences with this linear feature it is not suggested that the controls of mineralisation are the same; simply the possibility that the source of the primary mineralisation may in some form or other be related to this mega feature.

The B.M.R. 1:250 000 aeromagnetic compilation confirms the presence of NNW faults or discontinuities within the Tennant Creek area and also substantiates the photogeological evidence for major ENE-, ESE- and NW-trending faults and shears.
In addition to outlining major faults such as the Quartz Hill Fault and Mary Ann Shear Zone the regional aeromagnetic data also indicates the presence of distinct magnetic zones which may or may not be important in relation to areas of mineralisation. Figure 2 indicates some of these major subdivisions but it is stressed that this interpretation of the regional magnetic data is extremely coarse and subject to revision.

Zone A forms a very distinctive unit characterised by a number of linear magnetic anomalies superimposed upon a higher magnetic background than the adjoining areas to the north and south. Geologically this zone correlates with unit Pw6 of the Warramunga Group (Reference B. M. R. 1:250 000 geological series map of Tennant Creek).

A number of significant mineral deposits occur within this zone, including Peko and Nobles Nob. With regard to the mineralisation the following observations can be made:

(i) A number of mines including Eldorado, Nobles Nob and Mt. Samuel lie on or close to the southern margin of Zone A.

(ii) Lone Star lies on a major shear zone along the northern margin of Zone A.

(iii) Peko and Golden Forty lie along or close to a magnetic gradient which appears to reflect a possible geological contact within Zone A. Golden Forty also lies along a major NE-trending fault which displaces the northern and southern margins of Zone A.

(iv) The western margin of Zone A is marked by a series of parallel discontinuities or faults striking ENE to NE. It appears that a number of the gold occurrences lie along one of these faults.

(v) To the north of the Quartz Hill Fault/Mary Ann Shear Zone although geological unit Pw6 is present, magnetically it appears to be different and mineralisation is confined to gold along the extension of the ENE- to NE fault which marks the western margin of Zone A.

Zone B is poorly defined and very much more complex than indicated in Figure 2. Essentially there appears to be distinct magnetic units along the northern and southern margins which converge on both the western and eastern sides which may reflect regional folding and/or faulting. Ivanhoe lies within Zone B and close to the intersection of major ESE and NE-trending faults.
Zone C is essentially an area of low magnetic response and correlates broadly with areas of granitic intrusion.

Zone D represents a highly complex zone and a subdivision has been attempted. With regard to the known mineralisation the following observations are possible:

(a) The Warrego Cu/Au deposit lies on a major NNW discontinuity which can be traced both to the north and south for up to 20 kilometres.

(b) Orlando appears to lie on an extension of the Quartz Hill Fault.

(c) At Gecko a NNW-trending discontinuity or fault may be important.

(d) The Queen of Sheba mine lies on or near to a marked magnetic gradient which is possibly related to a NNW-trending basement fault.

The remaining zones with the exception of Zone E which includes the North Star Mine contain little or no mineralisation. The North Star Mine lies along a major gravity gradient which corresponds to the North Star Shear Zone. This feature is not however very apparent on the contoured aeromagnetic data.

(b) Detailed Survey Data

For purposes of cross reference between the geophysical interpretation and photogeological study the contoured aeromagnetic and spectrometer maps were reduced to a scale of approximately 1:83 000 and the results of the interpretation are presented at this common scale.

Within the project area two mineral occurrences are known, namely Ivanhoe and the Queen of Sheba. Both are characterised by the distinctive magnetic anomaly typical of the Tennant Creek type base metal mineralisation. Within the remainder of the study area only one very distinctive anomaly is present east of Bishops Bore. This feature has however been drilled by the B.M.R. which indicated the presence of a "magnetite chlorite rock in a host of volcanic rocks (porphyry)".

.../...
The spectrometer survey does not indicate the presence of any significant uranium anomalies at least not at the surface. Taking into consideration the depth of weathering and the extreme solubility of uranium it is not altogether an unexpected result. Some low amplitude anomalies have been selected which warrant investigation. The spectrometer results in general reflect outcrop and considerable care is necessary in attaching significance to radiometric boundaries.

The following section summarizes the findings within the individual Exploration Licence areas :-

1. Exploration Licence 1388

The most distinctive magnetic anomaly is associated with the Queen of Sheba mineral occurrence at the contact between the volcanics of the Bernborough Formation and the shales of the Carraman Formation. It is understood that the leases are currently held by Geopeko. Lower amplitude anomalies to the south may however warrant investigation along the above mentioned contact. (Ref B1). The possibility of uranium mineralisation should also be considered as the volcanics are marked by a noticeable increase in uranium backgrounds.

A northeast-trending belt of magnetic anomalies (B2) extending from Butchers Waterhole are highly anomalous and are confined to areas of poor outcrop. In the northern part some low amplitude uranium anomalies (U1) are associated with these magnetic anomalies. Both the magnetic and spectrometer anomalies warrant investigation.

Three fault directions are interpreted, namely NW, N-S and ENE. The N-S feature lies along the eastern margin of the volcanics and possibly reflects a deep seated basement fault or contact. ENE faults appear to control the Queen of Sheba anomaly. A NW-trending fault possibly controls the uranium anomalies in Area U1.

2. Exploration Licence 1389

A very pronounced magnetic boundary is interpreted along the southern margin of the area which correlates in part with photogeological boundary between greywacke and shale. On the regional geological map the magnetic unit to the south corresponds with unit Pw6. The Ivanhoe Mine occurs within this unit and the interpreted B.I.F. to the east warrants investigation if stratiform mineralisation is considered likely in the Tennant Creek Field (B5).
The highly magnetic anomaly in the extreme north-east of the licence area which was discussed previously in connection with B.M.R. drilling certainly warrants further investigation as it coincides with an area mapped as shale south of the Bernborough Volcanics.

Area B3 is marked by a very low amplitude magnetic anomaly which is considered important as it lies close to the intersection of two faults including the Quartz Hill Fault. Area B4 is similarly a low amplitude anomaly which is coincident with a slight uranium response.

The volcanics and in places the greywackes have a significantly higher uranium background than the shales and structural traps close to these areas of higher background uranium may be prospective for uranium. Area U3 is one such area where low amplitude anomalies are present close to major faults.

The granites are generally radioactive but within the main granitic mass there is a pronounced high associated with a distinct magnetic anomaly. This possibly indicates a remobilised granite. Uranium background values are generally higher within the areas of higher radioactivity.

The high amplitude thorium anomaly at Ivanhoe is most likely due to the mine dumps which have been spread over a large area.

3. Exploration Licence 1386

A marked increase in uranium background values occurs along the southeast boundary of the area and a number of spot uranium anomalies are present (U2). Faults along a NE to ENE trend may be important in relation to the uranium anomalies and are possibly related to the faults which mark the western boundary of Zone A in Figure 2.

The granites are radioactive and the changes in background values may reflect areas of reworked granite as in Licence Area 1389. The magnetic results are difficult to correlate with the geology due to the extremely poor outcrop. The very marked linear magnetic low is either due to an intrusive permanently magnetised body or alternately an aureole effect along the contact between the shales and granite.
Summary:

Besides the known mineral occurrence at Ivanhoe and the Queen of Sheba no magnetic anomalies of the type associated with the Tennant Creek mineralisation are present.

Lower amplitude anomalies may however be important if the concept of stratiform mineralisation is correct. Five potential targets have been selected.

There are no major uranium anomalies recorded and the selected anomalies are of a very low amplitude. Three potential target areas have been selected which warrant further investigation. The volcanic horizons and parts of the granites indicate higher uranium backgrounds than the other units and may be potential sources of uranium.

A number of major faults have been interpreted from the geophysical data. The predominant trends are NNW-SSE, WNW to NW and ENE to NE.

Yours faithfully,

R. F. LOXTON, HUNTING AND ASSOCIATES PTY. LIMITED

[Signature: R.K. Jones]