EXPLORATION LICENCE 7140

ANNUAL REPORT ON EXPLORATION

7 January 1991 - 6 January 1992

Limbunya 1:250,000 sheet SE52/7

R. SOWERBY
January 1992

Report No NT92/285
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SUMMARY

Exploration Licence 7140 located 560 km South of Darwin was granted to Geokeko on 7/1/91 for a period of 6 years. The EL was acquired to explore for stratiform base metal deposits, after regional correlations suggested a similar age and lithologies for Limbunya Group sediments to the McArthur River Group.

Work carried out on EL 7140 during the first tenure year included:

- compilation of previous company exploration data
- reconnaissance mapping and rock chipping
- detailed photo-geologic interpretation

In addition to this work a reconnaissance Sirotom survey and an airborne geophysical survey were completed on the adjacent EL 7141. Information from these surveys will be used to evaluate the potential of EL 7140.

Total expenditure for the 12 month period was $38 518.

An exploration expenditure of $30 000 is proposed for the second year to include:

- stream sediment sampling
- detailed mapping and rock chip sampling
- reconnaissance Sirotom surveys
- depending on the results of EM results, some stratigraphic drilling may be undertaken
1.0 INTRODUCTION

Exploration Licence 7140 is located approximately 110 km west of Wave Hill and covers an area of 1256 sq km on the Limbunya and Inverway cattle stations. It is contained within the Limbunya SE 52-7 1:250 000 sheet.

The licence area was granted to Geoeko on 7 January 1991 for a period of six years. The licence was taken out to explore for sediment hosted stratiform base metal deposits. Broad correlations of stratigraphy throughout the Northern Territory indicate a Carpentarian age for Limbunya Group rocks as well as lithologies similar to those of the McArthur River Group.

Exploration during the first year was aimed at defining stratigraphy and following up areas of interest from previous exploration in the region.

2.0 REGIONAL GEOLOGY AND STRUCTURE

2.1 GEOLOGY

Exploration Licence 7140 occurs in the southern part of the Carpentarian/Adelaidean Victoria River Basin. The main rocks of interest are those of the Limbunya Group which occur as the basal portion of the Victoria River Basin sequence. Broad correlations indicate Limbunya Group rocks to be of mid-Carpentarian age.

The Limbunya Group is dominated by shallow dipping dolomites and siltstones with lesser sandstone deposited in shallow marine and sabkha environments. These sediments unconformably overlie the lower Proterozoic Inverway Metamorphics. Regionally, the Limbunya Group is unconformably over lain by Adelaidean sediments of the Wattie and Auvergne Groups while locally it is overlain by the extensive Antrim Plateau Volcanics. The stratigraphy of the Limbunya Group is summarised in Table 1.
**TABLE 1**

<table>
<thead>
<tr>
<th>Formation</th>
<th>Thickness</th>
<th>Lithologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraynes Formation</td>
<td>- 120 m -</td>
<td>silty dolomite, siltstone, dolomite massive chert.</td>
</tr>
<tr>
<td>Campbell Springs Dolomite</td>
<td>- 300 m -</td>
<td>Stromatolitic dolomite, dolomite conglomerate.</td>
</tr>
<tr>
<td>Blue Hole Formation</td>
<td>- 150 to 300 m -</td>
<td>Silty dolomite, stromatolitic dolomite, siltstone</td>
</tr>
<tr>
<td>Farquharson Sandstone</td>
<td>- 40 to 165 m -</td>
<td>Grey and brown quartz sandstone, siltstone.</td>
</tr>
<tr>
<td>Kunja Siltstone</td>
<td>- 60 m -</td>
<td>Siltstone, silty dolomite</td>
</tr>
<tr>
<td>Mallabah Dolomite</td>
<td>- 15 m - 100 m -</td>
<td>Pink-buff dolomite siltstone, shale</td>
</tr>
<tr>
<td>Amos Knob Formation</td>
<td>- 50 m -</td>
<td>Dolomite, siltstone shale, sandstone.</td>
</tr>
<tr>
<td>Pear Tree Dolomite</td>
<td>+105 m -</td>
<td>Brown dolomite, dolarenite, chert stromatolitic chert</td>
</tr>
<tr>
<td>Margery Formation</td>
<td>- 120 m -</td>
<td>Siltstone, claystone, minor dolomite and chert</td>
</tr>
<tr>
<td>Stirling Sandstone</td>
<td>- 120 m -</td>
<td>Brown quartz sandstone grit, conglomerate.</td>
</tr>
</tbody>
</table>

**2.2 STRUCTURE**

Limbuunya Group rocks are only slightly folded however they are extensively faulted, particularly immediately south of EL 7140. A major fault set trends west-northwest and is evident over 100 km. The timing and sense of movement on these faults is not yet clear.

-2-
3.0 PREVIOUS EXPLORATION

The Limbunya region has been explored sporadically over the last 20 years, principally for diamonds. Base metal exploration has been carried out by Amad N.L. (1968), Dampier Mining Company Limited (1977) and Western Mining Corporation (1979-1982).

3.1 Amad N.L.
Amad exploration was limited to a two day field trip involving regional traverses to inspect stratigraphy.

3.2 Dampier Mining Company Limited
Dampier mining undertook a program involving 96 line km of gravity and magnetics to investigate a magnetic and associated gravity anomaly. The target model was for a Zambian copper deposit. The tenure was surrendered due to the realisation that the geophysical anomalies were not associated with a basement high. A total of 6 stream sediment samples and 3 rock chip samples were taken.

3.3 Western Mining Corporation
WMC acquired tenure in the area after a regional stream sediment survey targeting stratiform Cu mineralisation located anomalous Pb and Zn in the Swan Yard region. These anomalies were pursued by blanket stream sediment sampling which located further interesting Pb, Zn and As anomalies. Ground follow up of these anomalies was limited before tenure was surrendered due to a general rationalisation of base metal exploration across Australia in favour of gold.

4.0 GEOPEKO EXPLORATION — FIRST TENURE YEAR

A program involving compilation of existing data, reconnaissance mapping and rock chip sampling and a detailed photo-geological interpretation was carried out during the first tenure year. In addition, reconnaissance Sirottem surveys, stratigraphic drilling and an extensive airborne E.M. survey were completed on the adjoining EL 7141 to the south where better access and more complete sections of stratigraphy are available. Data from this work will be used to assess the potential for mineralisation on EL 7140.
4.1 GEOLOGIC MAPPING AND ROCK CHIP SAMPLING

Geologic mapping for the first tenure year was of a reconnaissance nature. The aim of the mapping was to gain familiarity with the stratigraphy. Traverses were undertaken along station tracks. Selected samples were submitted for petrologic study. Copies of these descriptions are presented in Appendix I.

4.2 RECONNAISSANCE SIROTEM SURVEY

A reconnaissance Sirotém survey was conducted on the adjacent EL 7141. The aims of the survey were to:-

1) Evaluate the area for the suitability of airborne EM techniques.
2) Characterise the response of the stratigraphy

The survey was not designed to identify discrete anomalies.

A total of 6 line km of ground Sirotém was completed over 3 lines covering the stratigraphy from the Mallabah Dolomite to the Cambell Springs Dolomite. The responses from the survey indicated the area to be a resistive environment and amenable to airborne EM techniques.

4.3 QUESTEM SURVEY

A Questem survey involving 1806 line km over EL 7141 was flown in December 1991 (DWG No NLY 001089). Final results are not yet available however preliminary data suggests that black shale horizons may exist within the Blue Hole Formation. Depending on final results further EM surveys will be extended into EL 7140 over Blue Hole Formation sub-crop.

4.5 PHOTO GEOLOGICAL INTERPRETATION

A photo-geological interpretation at 1:50 000 scale is currently being undertaken by Australian Photogeological Consultants P/L on behalf of Geopeko. This exercise was not completed at the time of writing this report.
5.0 EXPLORATION EXPENDITURE

A total of $38 518 has been spent on exploration on EL7140 for the period 8.1.91 to 7.1.92. Expenditure figures include a proportion of some work carried out on EL 7141 where the work was considered to be directly relevant to evaluating EL 7140.

<table>
<thead>
<tr>
<th>Category</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries</td>
<td>9,571</td>
</tr>
<tr>
<td>Wages</td>
<td>6,574</td>
</tr>
<tr>
<td>Tenement Expenses</td>
<td>55</td>
</tr>
<tr>
<td>Base support costs</td>
<td>7,181</td>
</tr>
<tr>
<td>Vehicles</td>
<td>3,317</td>
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<tr>
<td>Travel and accommodation</td>
<td>2,393</td>
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<tr>
<td>Field supplies</td>
<td>3,329</td>
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<tr>
<td>Other Costs</td>
<td>931</td>
</tr>
<tr>
<td>Maps</td>
<td>114</td>
</tr>
<tr>
<td>Analytical costs</td>
<td>211</td>
</tr>
<tr>
<td>Management charges</td>
<td>4,842</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>38,518</strong></td>
</tr>
</tbody>
</table>

The total of $38 518 compares with the covenant of $22 000 proposed for the first tenure year.

6.0 CONCLUSIONS

The following conclusions can be made after the first year of exploration on EL 7140:

- The Limbunya group shows broad age and geologic similarities with the McArthur River Group rocks. These similarities make the area a reasonable target for sediment hosted base metal deposits.

- The majority of the licence area consists of flat lying Cambell Springs Dolomite and Fraynes Formation which are not considered likely host units.

- The most prospective area is considered to be areas of outcropping Blue Hole Formation which may host black shale horizons.

- Results from a reconnaissance Sirotom survey indicates the area is suitable for aerial EM surveys.
7.0 PROPOSED WORK PROGRAM AND EXPENDITURE - 2ND TENURE YEAR

An expenditure of $30,000 is proposed for the second tenure year involving the following work:

- All data to be collated and detailed geologic interpretations completed
- Sirotim to identify Blackshale horizons.
- Some stratigraphic drilling to be performed to determine the stratigraphy of the Blue Hole formation and possible presence of black shale horizons.

<table>
<thead>
<tr>
<th>Category</th>
<th>Expenditure</th>
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<tbody>
<tr>
<td>Salaries and Wages</td>
<td>10,000</td>
</tr>
<tr>
<td>Field Supplies</td>
<td>2,000</td>
</tr>
<tr>
<td>Vehicles</td>
<td>2,000</td>
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<tr>
<td>Drilling</td>
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<tr>
<td>Analytical Costs</td>
<td>2,000</td>
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<tr>
<td>Tenement Expenses</td>
<td>4,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>30,000</strong></td>
</tr>
</tbody>
</table>

8.0 REFERENCES

1) "The Geology of the Southern Victoria River Region, Northern Territory"
   I.P. Sweet, J.R. Mendum, R.J. Bultitude, C.M. Morgan.
APPENDIX 1

PETROLOGY REPORTS
MINERALOGICAL REPORT NO. 5859
by A.C. Purvis, PhD.

April 30th 1991

TO: Mr R. Sowerby
Geopeko
Unit 1A, 390 Stuart Highway
DARWIN NT 0820

YOUR REFERENCE: Your covering letter 11/3/91
Order No. D33664

MATERIAL: Rock samples

IDENTIFICATION: A to H inclusive (note Sample H received 18/4/91, after the others).

WORK REQUESTED: Thin section preparation and description, with comments as specified.

SAMPLES & SECTIONS: Returned to you with this report.

PONTIFEX & ASSOCIATES PTY. LTD.

MINERALOGY — PETROLOGY ● SECTION PREPARATION
SUMMARY COMMENTS

This report discussed eight rock samples submitted from the Darwin office of Geopeko. Seven of these were made into normal thin sections, and one sample, (labelled ‘F’) into a polished thin section to enable examination of the abundant (opaque) manganese oxide(s) in that sample. Comments as requested follow below.

Two samples of sandstone (‘A’ and ‘B’) are dominated by rounded quartz grains (bimodal in ‘B’) and with abundant silty mudstone to very fine sandstone intraclasts also in sample B. Sample A includes minor detritus derived from silicified volcanics and cherty to chalcedonic siliceous rock fragments. Stable heavy minerals (zircon and leucoxene) occur in both sandstones. Authigenic quartz overgrowths of silica on the quartz grains are extensive, in sample A, filling almost all intergranular porosity. Sample B has an extensive intergranular cement of opal but has only rare authigenic quartz overgrowths.

These sandstone facies appear to represent a stable cratonic depositional environment; the abundance of well rounded grains indicates a mature sediment, which had considerable transport and/or multiple reworked grains. The intraclasts indicate that finer intercalated sediments in the sequence were subsequently reworked, probable due to fluctuating current velocities, but there is no evidence as to whether these sandstones were marine or fluvial. [Similar lithologies occur in fluviatile sandstone sequences, such as the Hawkesbury Sandstone, near Sydney, NSW for example].

The provenance for samples A and B is partly intraformational, but largely derived from a deeply weathered or sand/sandstone covered terrane, incorporating some siliceous and/or silicified lithologies ‘chert’ and volcanics. The extensive authigenic silicification is post deposition, but exactly when this occurred is not certain.

Differences in minor detrital components, and in the nature of the cement/matrix, suggest the possibility of two different sandstone ‘units’, but this could not be confirmed by petrography alone.
A pelitic facies is represented in the suite by 'C', 'D' and 'E', essentially as sericitic and silty shales but with a cleavage more obvious in hand specimen (particularly 'C') than in thin section. Minor random stringers of hematite ± chalcedony, opal, and sericite occur in sample C, also there are minor extremely thin shredded foliae of limonite along the cleavage in this sample. The samples D and E are extensively microfractured with minor very localised dislocation of angular breccia blocks mostly 1 to 10mm size, certainly in D, but nil or negligible disruption in E.

The fracturing at least in D, appears to be tectonic and disruptive. Fracturing in E is of a similar type to that in D, ut no displacement or rotation of blocks can be demonstrated. The extensive crazed networks of fractures in E and (between breccia blocks in D), have been permeated by extremely fine micaceous hematite, also locally (and later) by supergene opal ± limonite. The hematite in samples C, D and E was deposited from fluids of hydrothermal origin, chanelled either along fractures nearly parallel to bedding (C), or along the networks of fractures (D & E). The fractures in D and E were later partly filledy by supergene opal.

Sample E is dominated by a fractured mass of manganese oxides composite with highly irregular domains of structure-less partly limonitised silty mudstone. The mudstone is also cut by fractures, and encloses small fragments of the manganese oxide. All fractures have been extensively permeated by opal (which forms rims around the fragments), and a generally later and more extensive filling of chalcedony. Only minor manganese oxide occurs actually in this infilling vein network.

Samples 'G' and 'H' are dolerite and basalt respectively. Sample 'H' is possibly the chilled margin of the same body, or a similar body to that from which 'C' was taken. The mineralogy is plagioclase > augite > pigeonite > oxides > apatite. Accessory small grains of native copper are scattered through rock 'G', apparently as an indigenous component.
INDIVIDUAL DESCRIPTIONS

A  Pebbly quartz-rich sandstone, including possible intraclasts of very fine sandstone, minor grains of chert and silicified volcanic; trace leucoxene, zircon. Limonite-lined porosity which is almost completely filled by extensive authigenic quartz overgrowths ('silicified').

This sample is dominated by an originally loose-packed aggregate of rounded single crystal quartz grains, from 0.2 to 1.2mm in size, (fine to very coarse sand). Most of these grains are rimmed by limonitic dust, then later by extensive optically continuous overgrowths of authigenic quartz, which largely fill the original intergranular porosity.

Minor pebbles to 4mm long, consist largely of a very fine grained quartz-rich sandstone (or quartzite) with angular quartz grains to 0.1mm in size, with minor leucoxene, and a limonite stained siliceous matrix. Quartz veins occur in some of these pebbles, which appear to be intraclasts.

Rarer volcanic grains to 1mm in size has been silicified (apparently prior to deposition) also limonitised, with sparse leucoxene. Chert grains to 2mm are scattered and there are rare grains of spherulitic chalcedony.

A minor porosity is present partly lined by limonite, in spite of the authigenic silification.

Accessory heavy mineral grains include leucoxene and zircon. A single grain of quartz contains a flake of dark brown to nearly black biotite.
Bimodal quartz sandstone, incorporating locally abundant intraclasts of silty mudstone. Only rare authigenic quartz overgrowths but an extensive intergranular cement of opal. Rare detrital zircon, microcline. Opal also occupies partly leached out clasts.

At least 70% of this sample consists of a reasonably tightly packed aggregate of sandgrains, unsorted but with apparently two size populations (i.e. bimodal). Most abundant are small subrounded grains 0.1 to 0.2 mm in size (fine sand), incorporating lesser scattered well rounded grains 0.5 - 1.25 mm in size (coarse to very coarse sand). These coarser grains compare with the most abundant grains in sample A, however unlike Sample A, there are very few optically continuous overgrowths on the quartz. There is however, an extensive, intergranular cement of limonite-stained partly porous opal.

Intraclasts of silty mudstone are scattered, with those <2 mm long locally clustered together in aggregates about 10 mm across. The clasts about 5 mm long occur singly. Some alteration to opal and chalcedony is apparent, in these intraclasts, and a secondary porosity has developed in some.

The siltstones and silty mudstone intraclasts are quartz rich, the quartz grains are angular and mostly <0.05 mm in size.

Accessory zircon grains occur in the sandstone, and in some of the siltstone fragments, and rare grains of microcline are present in the sandstone.
C Sericitic (muddy) shale, minor limonitic foliae along cleavage, minor random microfractures occupied by stringers of extremely fine micaceous hematite ± quartz ± illite or ?sericite.

This is a clay-rich shale with a fairly strong bedding foliation/cleavage (more obvious in hand specimen than in thin section). Minor silt to very fine sand sized quartz grains and small grains of leucoxene and limonite are scattered, more or less bedded.

Microfractures oriented at 0-20° to the foliation are common and now mostly filled by stringers of extremely fine micaceous hematite ± limonite. Minor quartz and sericite (+ illite) occur along these stringers.

No carbonaceous matter is currently present in this rock. If such material was originally present in this rock, it would have been destroyed by weathering due to oxidation to CO₂ plus water.
Muddy shale and siltstone; extensive chaotic network of fine fractures between locally dislocated angular blocks (?tectonic breccia); permeated by microcrystalline micaceous hematite limonite ± opal.

The main lithology in this sample is shale similar to sample ‘C’, but with quartz-silt to very fine quartz sand grains in slightly better defined beds 0.5 to 2mm thick. Minor fine grains are also weakly disseminated.

This shale-siltstone unit has been brecciated, apparently tectonically, into angular fragments from 0.5 to 8mm in maximum dimension. The layering has been locally disrupted although some groups of fragments show an interrupted continuity of fabric between them. These groups are partly bounded by parallel through-going fractures, possibly parallel to the breccia zone as a whole.

Microcrystalline hematite and lesser associated limonite extensively permeate the fracture network to form up to 10% of the whole rock. There are areas of porosity to 2mm long.

Some of the fragments appear to have been flooded by opal and converted to ‘porcellanite’, and minor opal also occurs as an inner lining to some porosity within the fine micaceous hematite.
Fractured shale, with extensive microfracture networks permeated by very fine micaceous hematite and/or opal.

This is an extensively microfractured shale, with extensive alteration to opal but with sufficient clays retained to demonstrate a more or less continuous foliation parallel throughout the sample. This means that the brecciation has occurred without dislocation or rotation of the individual fragments. Minor quartz silt grains are disseminated in this facies, but do not form bedding planes as in sample D.

The fragments are mostly elongate parallel to the foliation and from 0.2 to 4 mm long. They have spots within them which may be reduction spots and there are extremely rare, localised quartz stringers.

The fractures have been extensively permeated by microcrystalline micaceous hematite, with a porosity largely occupied by later opal. This is the same ‘mineralisation’ as in sample D, and to a lesser extent in sample C, and it is concluded that this hematite (± quartz and sericite) are of hydrothermal (?epithermal) origin. The later opal is considered to be supergene.
Heterogeneous, massive extremely fine manganese oxide, incorporating minor relicts of fine sandstone (also permeated by Mn-O); and composite with structureless silty mudstone. Later extensive (desiccation) fracture network filled by opal, chalcedony, minor colloform, and botryoidal Mn-O.

At least 75% of this sample consists of massive, extremely compact, micocrystalline to cryptocrystalline (opaque) manganese oxide. The exact species forming the great bulk of this material is uncertain (because of the overlapping optical properties of many of the manganese-oxides), but it seems most likely to be cryptomelane or psilomelane.

This manganese oxide is aggregated with, more or less incorporates, irregular domains of fine quartz mosaic (apparently sandstone), forming up to 5% of the sample. Intergranular spaces in this sandstone are completely permeated by manganese oxide, but apparently a different species from the bulk massive material.

An extensive irregular network of fractures, possibly desiccation fractures, up to 2mm wide, are filled by microcolloform opal, as an initial lining, then chalcedony as the final infilling. These silicified networks incorporate minor colloform laminae, and botryoids of manganese oxide at irregular (zoned) intervals.

Minor irregular domains of structureless silty mudstone, partly limonitised, appear to be essentially supergene. These are however also cut by fractures filled by opal, some continuous with those in the massive manganese oxides.

The entire aggregate in interpreted to have a supergene, accretionary genesis, with several stages of mobilisation and cementation. Perhaps the best evidence of a ‘primary’ bedrock, is the local small relicts of fine quartz sandstone (permeated by manganese oxide).
Massive medium grained dolerite, including fresh primary augite and pigeonite, but with albited/sericitised plagioclase and minor nontronite-chlorite alteration. Sparse small scattered grains of native-Cu.

The mineralogy of this rock is:

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sericite ± albite after plagioclase</td>
<td>55-66%</td>
</tr>
<tr>
<td>Augite</td>
<td>25-30%</td>
</tr>
<tr>
<td>Pigeonite + nontronite</td>
<td>10%</td>
</tr>
<tr>
<td>Opaque oxides</td>
<td>5%</td>
</tr>
<tr>
<td>Clays</td>
<td>2-3%</td>
</tr>
<tr>
<td>Apatite</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Native copper</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

This mineralogy, together with an ophitic texture and medium grain size, characterise this rock as a dolerite, although the plagioclase laths, 0.5 - 1.5mm long, have been totally altered to sericite ± albite.

Pigeonite in this rock is easily recognisable as it is partly altered to nontronite, and is prismatic to subophitic, compared with the more ophitic augite crystals. The scattered opaque oxides appear to be variably fresh or oxidised titaniferous magnetite ± ilmenite with a grain size of 0.2 to 1mm. Sparse minute grains of apatite are present and there are patches of interstitial clays (chlorite ± smectites).

Small grains of native copper to 1mm size are seen sparsely scattered on cut surfaces of this ample, and even more rarely in the thin section. These appear to be indigenous (primary) to the dolerite.
H Basalt, with altered pigeonite, sparse plagioclase phenocrysts and rare vesicles. Possibly a chilled margin of the dolerite sample G.

This is a finer grained equivalent of ‘G’, with a similar gross, primary mineralogy. The plagioclase in this rock however, is mostly fresh, and this includes rather sparse phenocrysts 1 to 3mm long, but mostly as groundmass plagioclase laths about 0.2mm in size. As in ‘G’, pigeonite is a minor component and altered to smectites, with more abundant largely fresh augite.

Accessory opaque oxide grains to 0.2mm are scattered. Rare vesicles to 1mm long contain chalcedony or opal.