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## SML 170

## BELTANA

## PROGRESS REPORTS TO LICENCE EXPIRY/RENEWAL FOR THE PERIOD 18/12/1967 TO 17/12/1969

Submitted by
Carpentaria Exploration Co. Pty Ltd
1970



**Enquiries:** Customer Services Branch
Minerals and Energy Resources
7th Floor
101 Grenfell Street, Adelaide 5000

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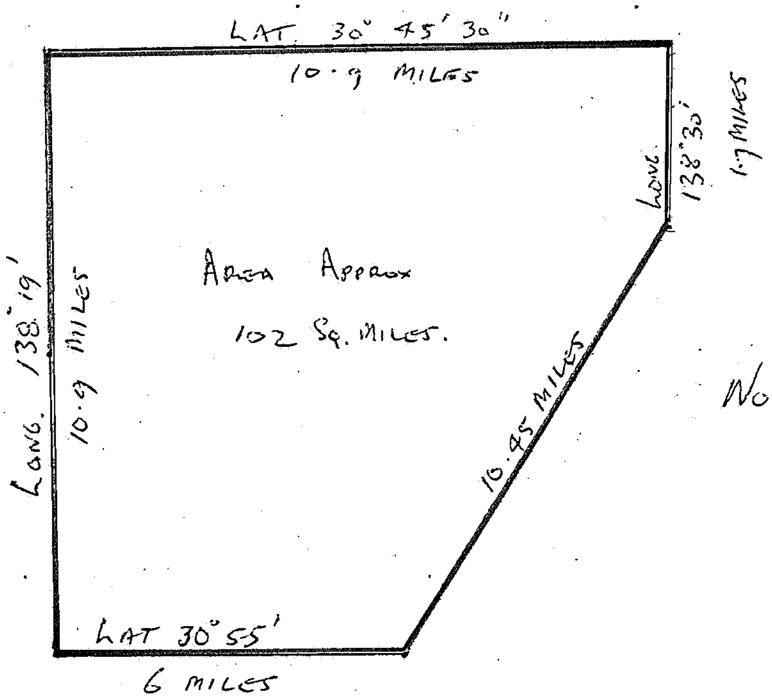
Facsimile: (08) 8204 1880

Government of South Australia
Primary Industries and Resources SA

APPLICATION FOR SPECIAL MINING LEASE "BELTANA"

THE GEOGRAPHICAL DETAILS OF THE S. M. L. HERE BEING APPLIED FOR ARE AS INDICATED BELOW.

THEY ARE ALSO SHOWN ON A SEPARATE BELTANA ONE MILE GEOLOGICAL SHEET.




NOT TO SCALE.

SIGNED J. RUSSELL LORD

J. Russell Lord

MT. ISA MINES LTD..

Copley

D.M. 1867/67

S.M.L. 170

TENEMENT: S.M.L. 170

TENEMENT HOLDER: MT. Isa Mines Ltd.

REPORTS:

SMITH,, D.W. 1968 Report for quarter ended 18/9/68 for S.M.L. 170 (No Plans) (pgs. 5-6)

SMITH W.D. 1969 Report for quarter ended 18/12/68 for s.M.L. 170 (No Plans) (pgs. 7-8)

SMITH W.D. 1968 REmarks concerning the Beltana Complex included with report for quarter ended 18/12/68 above (pgs 9-27)

Plans:

Map of the Beltana complex showing igneous outcrops 1-38 (N.B. 1162-8 is drafted version of 927-1) (1162-8)

REPORTS:

SMITH W.D. 1969 REport for quarter ended 18/3/69 for S.M.L. 170 (pgs. 28-30)

Plans:

| | | |
|---|---|---|
| Figure 1 | Copper results in soil samples. | (927-3) |
| Figure 1A | Soil sample numbers and locations. | (927-2) |
| Figure 2 | Lead results in soil samples. | (927-4) |
| Figure 3 | Zinc results in soil samples. | (927-5) |
| Figure 4 | Plot of poles to bedding Beltana complex | (927-6) |

REPORTS:

SMITH, W.D. 1969 Report for quarter ended 18/6/69 for S.M.L. 170 (pgs. 31-32)

Plans:

| | | |
|---|---|---|
| Diagram 1 | Soil sample copper values Black Feathers Group | (927-10) |

CONTENTS ENVELOPE 1162 Cont.

## PLANS:



## REPORTS:



## Plans.

ENV 927



005

567 South Road,
Everard Park,
S.A. 5035.

30th September, 1968

The Director of Mines,
Department of Mines,
Box 38 Rundle Street P.O.,
Adelaide,
S.A. 5001.

**Report for Quarter ended 18-9-68**

**for SML 170**

Dear Sir,

Work on SML 170 so far has been concentrated chiefly within the complex zone mapped as the Beltana Diapir. This is so because preliminary examinations showed the existence of considerably more igneous material than was previously known, and also that the relative proportions of diapiric breccia to raft were much lower than expected.

Forty two outcrops of igneous rock have been located, and more would be found if specifically searched for. However, the extras to be found would probably not alter the pattern already recognised so this work will be discontinued at this stage. The igneous rocks are chiefly medium grained basic varieties with some coarse grained more acid examples and several examples of fragmental rocks (tuff and agglomerate). The distribution of the igneous rocks is broadly parallel to the general shape of the complex and entirely within it, with a concentration near the long (faulted) axis. Several collinear outcrops of gneiss occur along the axis.

All of the igneous outcrops are believed to be intrusive, though in most cases it is not possible to prove this by field relationships as the outcrops are surrounded by alluvium.

Much of the breccia within the complex is thought to have originated by subaqueous slumping. A further proportion is attributed to caving over sink holes and less clear cut examples of settling due to weathering. It is felt that recognition of "diapiric breccia" and discrimination between this and the two main kinds of breccia mentioned above must be relatively interpretive.

Having regard to the prevalence of intrusive ? igneous rocks, the large size of the rafts, the relatively small amount of interstitial breccia, the difficulty of recognising "diapiric breccia," the marginal effects suggestive of erosion and redistribution of core material, it is thought preferable to refer to the complex zone simply as a complex until a clear case for the diapiric model or an alternative one is indicated. At the present time, consideration is being given to the possibility that the complex was initiated as a penecontemporaneous fault block bounded by basement fractures, and that this was subsequently deformed and intruded during the Lower Palaeozoic. Such an origin would conceivably produce effects rather similar to those attributed to diapirism, and might explain the individual characteristics of this particular complex a little better.

Yours faithfully,
for and on behalf of
Mount Isa Mines Ltd.,

Walter D. Smith

Walter D. Smith
Party Leader (S.A)
<u>Carpentaria Exploration Co.Pty.Ltd.</u>

567 South Road,
Everard Park,
S.A. 5035.

2nd January, 1969

The Director of Mines,
Department of Mines,
Box 38, Rundle Street P.O.,
Adelaide,
S.A. 5001.



ENV 927

Dear Sir,

**Report for Quarter ended 18.12.68**
**for SML 170**

Work completed during the quarter has been mostly in the nature of visual examinations intended to suggest exploration methods and possibilities. Considerable attention was given to the Beltana Diapir because the absence of a suitable flowage medium and a large fragment - matrix ratio appeared to pose interpretational difficulties for the diapiric (salt diapirism) model though there seemed no doubt that a piercement structure was involved. This work led to development of an alternative hypothesis, and it emphasised that it is merely an alternative hypothesis or another interpretation which is being considered, rather than a firm conclusion held with any feeling of finality.

Some new data and the interpretation are outlined in the notes herewith entitled Remarks Concerning the Beltana Complex.

The new data and interpretation from the Beltana Complex have not so far been recognised as having any direct relevance to ore search, but will probably influence sampling activities to some extent, and guide selection of areas for more detailed attention.

A statement of expenditure is attached hereto.

Yours faithfully,

For and on behalf of MT. ISA MINES LTD.

Walter D. Smith

WALTER D. SMITH

Party Leader (S.A)

CARPENTARIA EXPLORATION COMPANY PTY.LTD.

ENV ~~928~~ 1162

# REMARKS CONCERNING THE BELTANA COMPLEX

By Walter D. Smith

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## INTRODUCTION

Examination of the feature mapped as the Beltana Diapir (Leeson (1966a and 1966b)) revealed some new data and suggested that an alternative interpretation was possible. The facts and arguments supporting this conclusion are outlined below. As it is possible that some workers will not agree with the preferred interpretation, and in order to preserve clarity in nomenclature and anticipate future discussion, it appears best to my mind to refer to Leeson's Beltana Diapir by the non genetic term Beltana Complex.

For clarity of presentation, the chief evidence and argument supporting certain points is assembled in appendices referred to by matching superscripts.

The word diapir is used in the sense envisaged by Leeson for the Beltana Diapir, namely a piercement feature produced by a plastic medium flowing laterally from a particular stratum to a certain point and emerging there in intrusive fashion carrying fragments of older rock with it and leaving them in positions relatively higher stratigraphically than their normal levels. The word piercement is used in a much more general sense for any process responsible for relative uplift of older rocks amongst younger ones involving structural disturbance.

Most of the outcrops (210) were examined individually except where it was readily recognisable that zones of essentially similar kind were present. This resulted in a number of conclusions enumerated below.

## CONCLUSIONS ARISING FROM MAPPING

1. Certain peripheral outcrops appear to represent fringing sedimentary debris rather than intrusive core material. (1)

2. Most of the breccia and nearly all of it that is describable as having a carbonate matrix occurs towards the margin of the complex. (2)

CONCLUSIONS ARISING FROM MAPPING (Cont.)

3. Rocks in the central zone appear to be representatives of units lower in the sequence than the rim rocks, and the apparent degree of structural deformation is greater, implying some sort of piercement feature. (3)

4. The complex can be resolved fairly realistically into a central piercement zone and a fringing debris zone. (4)

5. Certain lithologically and structurally continuous exposures are extremely large in relation to the central piercement zone. (5)

6. The reality of the matrix-fragment relationship implied by Leeson is questionable, especially within the central piercement zone, and at least it may be said that the fragment to matrix ratio must be very large. (6)

7. Long continued recurrent movements influenced sedimentation in units ranging from the Brachina Formation to the Pound Quartzite. (7)

8. Despite early initiation of the Beltana Complex, most of the stratigraphic displacement evident across it appears to be the result of late differential deformation across a pre-existing fault surface. (8)

9. There are a substantial number (about 40) of igneous rocks regarded as intrusives within the complex but none have been recognised outside it. (9)

INTERPRETATION OF THE BELTANA COMPLEX

Having regard to the fact that the interpretation of the Beltana Complex must satisfy at least the nine conclusions listed above, I prefer to interpret the complex as a central piercement zone plus a fringing

INTERPRETATION OF THE BELTANA COMPLEX (Cont.)

debris zone, and not to regard the central piercement zone as a diapir in the sense envisaged by Leeson.

The interpretation which in my opinion best fits the facts is that of an emergent penecontemporaneous fault block, partly mantled and fringed by disturbed cover rocks, later deformed and intruded by younger igneous rocks.

The important differences in interpretation are that :

1. The emplacement of Callana Beds and other Lower Adelaidean rocks is believed to have involved less brecciation and interstitial breccia than implied by Leeson.

2. Disturbances of cover and fringe rocks, with sedimentary breccias and irregularities due to gravity sliding, are believed to have occurred to a greater degree than envisaged by Leeson.

3. Penecontemporaneous block faulting is invoked as an important factor in the development of the piercement feature - this would largely replace the role formerly attributed to a mechanism analogous to salt diapirism.

   Certain aspects of the hypothetical fault block are enlarged upon in appendices 10 and 11.

A summary comparison of the nine points listed above with the two different models, i.e. Leeson's diapiric one and the preferred distorted Horst model, is given below (see Table).

<table>
<tr><th rowspan="2">CONCLUSION<br>(Points 1 to 9 listed above)</th><th colspan="2">FIT OF CONCLUSION WITH</th></tr>
<tr><th>Leeson's Diapiric Concept</th><th>Distorted Horst Concept</th></tr>
<tr><td rowspan="2">1. Presence of peripheral sedimentary debris.</td><td>Poorer</td><td>Better</td></tr>
<tr><td colspan="2">- but this is only a detail in relation to the overall feature.</td></tr>
<tr><td>2. Most of breccia, especially carbonate breccia, in or near the margins of the feature.</td><td>Poorer</td><td>Better</td></tr>
<tr><td rowspan="2">3. Core material comprised of older more disturbed rocks from lower in sequence compared with the rim rocks.</td><td>Better</td><td>Poorer</td></tr>
<tr><td colspan="2">- due to the extraordinary degree of disturbance which has no fully satisfactory explanation in terms of the distorted Horst concept.</td></tr>
<tr><td rowspan="2">4. Presence of central piercement and fringing debris zones.</td><td>Poorer</td><td>Better</td></tr>
<tr><td colspan="2">- but this is only a detail in relation to the overall feature.</td></tr>
<tr><td>5. Large size of certain exposures.</td><td>Poorer</td><td>Better</td></tr>
<tr><td>6. Questionable aspect of the matrix fragment relationship and relative proportions.</td><td>Poorer</td><td>Better</td></tr>
<tr><td rowspan="2">7. Long duration of recurrent movements.</td><td>Poorer</td><td>Better</td></tr>
<tr><td colspan="2">- but difference here very small to negligible.</td></tr>
</table>

| CONCLUSION (Points 1 to 9 listed above) | FIT OF CONCLUSION WITH | |
|---|---|---|
| | Leeson's Diapiric Concept | Distorted Horst Concept |
| 8. Early initiation of the Beltana Complex axial fault and the fact that the present repetition is due to differential deformation across it. | No preference for either model. | |
| 9. Preferential intrusion of Beltana Complex. | Poorer | Better |

## APPENDIX 1

Examination of Leeson's Beltana Diapir indicated that certain parts of it could plausibly be regarded as fringing debris rather than intrusive core material. This comment applies particularly to outcrops containing water worn pebbles of core material suggestive of sedimentary redistributive processes, e.g. those outcrops indicated on the map in the B6, B8, J10, K9 and F7 areas. The B8 exposure in particular was formerly regarded as intrusive in character in common with the whole feature. (See Leeson 1966b, Figure 5). Since fringing sedimentary material is not indicated within the Beltana Diapir on the map or in the text, it appears desirable to discriminate between core and fringing debris, and this creates the need for new terminology to preserve clarity.

Thus :

| Leeson's Term | Term Adopted Herein |
| --- | --- |
| Beltana Diapir | Beltana Complex |
| | Central Piercement Zone; Fringing Debris Zone |

- oOo -

## APPENDIX 2

Ignoring water worn gravels etc. of post Adelaidean age which mask substantial parts of some marginal areas mapped as the Beltana Diapir, three genetically different kinds of breccia have been recognised or suspected, and these must include "diapiric breccia" which I was unable to discriminate by inherent characteristics. I believe that recognition of this kind of breccia in the Beltana Complex is interpretive.

The three kinds of breccias recognised or suspected are :

1. Fault breccias.

2. Breccias due to weathering effects (in part at least).

3. Sedimentary breccias.

Concerning (1) above, fault breccias are areally unimportant, and they are unlikely to be interpreted differently by different personnel.

Concerning (2) above, there is a definite degree of uncertainty, not so much in recognition of weathering effects, but in knowing whether or not the brecciation due to weathering was preceded and facilitated by an earlier primary brecciation. There is a major possibility of superimposition of genetically different effects in this case. Some of the breccias that I regard as due at least partly to weathering are quite spectacular in appearance and it is possible that they had undue influence concerning interpretation of breccias in relation to the diapiric model. The most striking examples within the Beltana Complex occur in Sliding Rock Creek (see map). (See also figures 8 and 9 in Coats (1964), which illustrate breccias consisting of highly weathered material. These may represent subsidence breccias due to weathering, although even if this is so, it does not preclude the possibility that an earlier brecciation of a different sort preceded and facilitated the subsidence effects.)

Concerning (3) above, I believe that sedimentary breccias are by far the most common for the entire complex. There are a variety of different kinds. Three major generalisations may be made. Firstly, the vast majority of breccias within the central piercement zone occurs within sandstone-quartzite lithologies. Secondly, nearly all the breccia that could be described as having a carbonate matrix occurs in the fringing debris zone.

Thirdly, the textures of both groups mentioned above suggest stretching and jostling and slumping effects which I prefer to interpret as responses to submarine rather than subterranean processes of formation. If there is any important amount of "diapiric breccia" within the Beltana Diapir it must be included within this group.

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# APPENDIX 3

The conclusion that the core rocks of the Beltana Complex represent units older, more deformed, and relatively uplifted with respect to the rim rocks is not new. Leeson recognised this in the individual case of the Beltana Complex, and the conclusion appears to be shared with a number of other piercement features throughout the Adelaide Geosyncline.

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# APPENDIX 4

Exact boundaries between the two zones do not exist, and the two zones are not entirely mutually exclusive. Nevertheless I believe they are realistic, and that other personnel would recognise the same zones though their boundary lines would probably vary a little. It is only the principle and not the positions of the zones that is important here.

The central piercement zone is characterised by large exposures of relatively persistent lithology and structure, comparatively little breccia, sandstone breccias rather than carbonate breccia, and a number of younger igneous intrusives.

The fringing debris zone is distinguished by smaller exposures, non persistence of lithology and structure, comparatively more breccia, carbonate breccia as well as sandstone breccia, absence of younger igneous intrusives, and especially by the presence of obviously water worn debris in conglomerates suggesting sedimentary redistribution of eroded core material.

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# APPENDIX 5

The prominent quartzite outcrop (see Frontispiece Leeson 1966b) is about 1½ miles in length, and several other outcrops are nearly as large. Moreover these several very large outcrops which dominate most of the central piercement zone could be interpreted as approximating to their true stratigraphic positions with respect to each other. The point cannot be proved because of alluvium which masks the relationships. But as good a case could be argued that the individual large outcrops are nearly in their true stratigraphic relationships with respect to each other as that they are essentially distinct and separated from each other by a matrix of "diapiric breccia with carbonate matrix". At least it may be said that this latter interpretation would require virtually all of the "diapiric breccia with carbonate matrix" to occur only in the areas of no outcrop.

The size of the fragments becomes more critical because of reduction of the overall piercement zone from Leeson's Beltana Diapir to only the central piercement zone of the Beltana Complex. So also does the existence and amount of interstitial breccia become of critical importance for the same reason. (See Appendix 6).

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# APPENDIX 6

Owing to the recognition of a fringing debris zone as well as a central piercement zone, it is clear that the brecciation evident in the former is not admissible as evidence in support of the role implied by Leeson for the breccia in relation to the feature as a whole. Isolated patches of breccia of very small size do occur here and there throughout the central piercement zone, but not so generally, nor in such a way as to support unquestionably the matrix-fragment relationship implied by Leeson, and upon which the diapiric interpretation relies very heavily. Even if the matrix-fragment relationship is real, I believe the nature and texture of the breccia suggests a submarine rather than a subterranean process of formation. Thus I believe that the matrix-fragment relationship is questionable in fact and also in interpretation.

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# APPENDIX 7

Leeson (1966b) lists eight stratigraphic irregularities indicative of an influence by the Beltana Complex on sedimentation in units adjacent to it ranging from the Brachina Formation to the Pound Quartzite. Thus it seems that the complex was initiated at least as early as Brachina Formation time and that (probably intermittent) movements persisted penecontemporaneous with sedimentation until Pound Quartzite time. Various satellite occurrences of water worn material provide additional examples not recognised by Leeson.

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## APPENDIX 8

The relative positions of corresponding units in sequence north and south of the Beltana Complex indicate a displacement of over 5,000 feet across a surface approximating the long axis of the complex with a north block up sense. The complex (and presumably its axial fault) is believed to have been initiated at least as early as Brachina Formation time. However, although local changes in thickness and character within individual units near the complex are common, the overall thickness of the sequence ABC Quartzite to Pound Quartzite inclusive is about the same on both sides of the complex (about 8,000 feet). Since the known movement on the fault is very large compared with the thickness of sediment accumulating during the penecontemporaneous movements of the complex, it seems likely that most of the movement post-dated deposition of the sequence up to and including the Pound Quartzite. Therefore it is likely that the climactic deformation in the Lower Palaeozoic was responsible for the stratigraphic repetition evident across the complex. Thus the Beltana Complex axial fault preceded deformation of the Wilpena Group, and may be expected to have been warped in the same sense by the movements. Some measure of independent support may be found for this in the fact that the Beltana Complex axial fault must follow a curved path. It is recognisable in the north east and south west ends of the complex, but must follow a curved path around certain large intact exposures within the complex. (See the inferred position shown on the map).

Note that Leeson (1966b) supports a path following the northern limit of the main mass of the Beltana Diapir which implies an even more curved path.

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# APPENDIX 9

About 40 separate well distributed outcrops of igneous rock (regarded as intrusive) occur within the Beltana Complex. Since there are about 40 inside and none known outside the complex, it is clear that there is a fundamental relationship of some sort between the complex and intrusive igneous rocks.

It could be disputed whether all of the igneous outcrops are intrusive rather than rafts of old igneous rocks referable to the Callana Beds. However the intrusive character of some is quite clear, and most outcrops are very similar or identical in appearance. Thus, if not all of the outcrops are intrusive, I believe most of them are, and the fundamental implications will be the same.

The igneous intrusives all fall within the Beltana Complex, mostly in the north eastern part near the axial fault. They all fall (partly by definition of course) within the central piercement zone.

Most of the igneous outcrops are doleritic in appearance with coarser and more acid varieties, and several collinear occurrences of gneiss near the axial fault. (See map). In a number of instances altered sediments are exposed adjacent to the igneous rocks.

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## TABLE TO ACCOMPANY APPENDIX 9

| Outcrop Number | Macroscopic Identification | Microscopic Identification | Slide No. |
|---|---|---|---|
| 1 | Dolerite | | |
| 2 | Dolerite | | |
| 3 | Dolerite | | |
| 4 | Dolerite | | |
| 5 | Leucocratic Gneiss | | |
| 6 | Foliated Dolerite | Plagioclase Hornblende Gneiss | A2072 |
| 7 | Dolerite | | |
| 8 | Dolerite | Altered Dolerite Gneiss | A2059 |
| 9 | Gneiss | | |
| 10 | Dolerite | | |
| 11 | Dolerite | | |
| 12 | Dolerite | | |
| 13 | Dolerite? | Reconstituted carbonitised Argillaceous sediment | A2064 |
| 15 | Gneiss | | |
| 16 | Dolerite | | |
| 17 | Dolerite | | |
| 18 | Dolerite | | |
| 19 | Dolerite | | |
| 20 | Dolerite | | |
| 21 | Dolerite | | |
| 22 | Dolerite | | |
| 23 | Dolerite | | |
| 24 | Dolerite | | |
| 25 | Dolerite | | |
| 26 | Granophyre | Granophyre | A2068 |
| 27 | Dolerite and Metasomatised sediment | Impure Arkose | A2069* |
| 28 | Dolerite | | |
| 29 | Diorite? | | |
| 30 | Dolerite | Scapolitised Dolerite | A2073 |
| 31 | Dolerite | | |
| 32 | Dolerite | | |
| 33 | Dolerite | | |
| 34 | Dolerite | | |
| 35 | Dolerite | | |
| 36 | Dolerite | | |
| 37 | Dolerite | | |
| 38 | Dolerite? | K-Metasomatised impure Arkose | A2070 |

* A2069 refers to the metasomatised sediment.

# APPENDIX 10

## Aspects of the Original Fault Block Model

It appears plausible in theory that the boundary faults of a piercement block might well be masked by disturbances in the sediment adjacent to the moving block and in the rocks above it which may have been dislodged and re-orientated by processes of gravitational sliding and sedimentary redistribution. Accordingly the hypothesis of a piercement fault block is not weakened by the fact that its boundary faults cannot be mapped directly but can only be guessed at in a hypothetical way. Note that the Beltana Complex axial fault is recognisable directly only at the north east and south west ends of the complex and not in between, despite the fact that an obvious stratigraphic repetition of over 5,000 feet provides complete confidence in its continuity in depth between these extremities.

Since definite evidence can be adduced to support a central piercement zone and a fringing debris zone in the case of the Beltana Complex, it is hypothesised that the core represents a deformed penecontemporaneous block bounded by hypothetical faults approximately in the positions shown in the map. Penecontemporaneous faulting has occurred rather generally throughout the Adelaide Geosyncline, and variably emergent blocks with associated stratigraphic effects are a logical corollary.

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# APPENDIX 11

## The Piercement - Intrusive Relationship

It is well established that gravity (normal) faulting such as is responsible for the development of horst and graben relationships, is closely associated with basic igneous activity, both features representing effects of the same cause, namely the appropriate stress condition. It is difficult to envisage major gravity faulting without compensating redistribution of plastic material (potentially molten magma) in the subcrust. Consequently if the presence of (chiefly basic) intrusives in piercement zones is not actually accepted as indicative of involvement of early block faulting in the piercement process, at least it may be said that the association is very plausible, and to be expected rather than remarked upon, in relation to a piercement process initiated by penecontemporaneous block faulting. Despite this, it is not suggested that piercement by fault block emergence explains all or even any of the piercement features of the Adelaide Geosyncline in toto. However it is suggested that fault block emergence together with associated penecontemporaneous stratigraphic irregularities may explain most of the characteristics of the Beltana Complex, and may have some significance in relation to the initiation of some of the other piercement features.

- oOo -

## REFERENCES

LEESON, B., 1966a : Beltana 1:63360 Map Sheet. S.A. Mines Department (published).

LEESON, B., 1966b : Geology of the Beltana 1:63360 Map Area. S.A. Mines Department. Report No.63/58 (unpublished).

- oOo -


LEGEND

Leeson's Beltana Diapir

IGNEOUS OUTCROPS

- x Equigranular
- Δ Gneissic
- Ⓐ Peripheral conglomerate occurrences
- Possible subsidence breccias

FAULTS

- Definite
- Inferred

HYPOTHETICAL ZONES

- A Central piercement zone
- B Fringing debris zone

N

CARPENTARIA EXPLORATION COMPANY PTY LTD.

SML 170 BELTANA

(SOUTH AUSTRALIA)

MAP OF THE BELTANA COMPLEX SHOWING
Igneous Outcrops 1-38
Peripheral Conglomerate Occurrences
Inferred Approximate Faults
Approximate Zone Boundaries

| | | |
|---|---|---|
| SCALE: 1" = 1 mile | GEOL.: W.D.S. | DATE: December 1968 |
| CHECKED | DRAWN: R.C.T. | 3814 |

1162-8

ENV 121

028

CARPENTARIA EXPLORATION COMPANY PTY.LTD.
567 South Road,
Everard Park,
S.A. 5035

31st March, 1969

RECEIVED
- 2 APR 1969
DEPT. OF MINES
REGISTRY

The Director of Mines,
Department of Mines,
Box 38,
Rundle Street P.O.
Adelaide,
S.A. 5001.

NOTED
Director of Mines

Dear Sir,

**Report for Quarter ended 18.3.69**
**for SML 170**

Student labour was used during the quarter to soil sample selected parts of the lease chosen according to natural lithological divisions. This included lines within the Beltana Complex and some outside it.

Some of the data collected is shown on figures 1, 2, and 3 herewith. Sampling was also carried out on the Red Range Fault and on the Black Feather Group of mines but the results are not collated at this time.

Owing to preoccupation with supervising the actual sampling, interpretation of the data is lagging but will be caught up in due course.

A stereogram showing poles to bedding within the Beltana Complex is provided in Figure 4. This was prepared from measurements made during earlier examinations of the Beltana Complex.

Yours faithfully,
For and on behalf of MT. ISA MINES LTD.,

Walter D. Smith

WALTER D. SMITH
Party Leader (S.A.)

ENV 927 029

SAMPEY EXPLORATION SERVICES
327 Great Eastern Highway, Midland,
Western Australia, 6056
P.O. Box 134, Midland
Phone: 74 2088
74 1062
Cables: Exserv
Perth

Field Sheet No:—

Line No.:—

Project/Charge/Despatch Note No.:—

Date:— 1/9/69

See figure 1A for sample sites

Any queries please quote Lab. Sheet Number:— 2161

RECEIVED 6 OCT 1969 DEPT. OF MINES REGISTRY

| SAMPLE | CU | PB | ZN | AG | | |
|---|---|---|---|---|---|---|
| 1 | 30 | 30 | 70 | BLD | | |
| 2 | 30 | 30 | 60 | BLD | | |
| 3 | 30 | 25 | 65 | BLD | | |
| 4 | 40 | 20 | 90 | BLD | | |
| 5 | 25 | 20 | 55 | BLD | | |
| 6 | 30 | 20 | 40 | BLD | | |
| 7 | 30 | 20 | 45 | BLD | | |
| 8 | 40 | 250 | 300 | BLD | | |
| 9 | 50 | 30 | 150 | BLD | | |
| 10 | 50 | 30 | 110 | BLD | | |
| 11 | 30 | 30 | 100 | BLD | | |
| 12 | 20 | 25 | 80 | BLD | | |
| 13 | 80 | 170 | 270 | BLD | | |
| 14 | 35 | 150 | 225 | BLD | | |
| 15 | 20 | 55 | 140 | BLD | | |
| 16 | 40 | 100 | 175 | BLD | | |
| 17 | 25 | 40 | 95 | BLD | | |
| 18 | 10 | 30 | 35 | BLD | | |
| 19 | 20 | 35 | 80 | BLD | | |
| 20 | 20 | 30 | 120 | BLD | | |
| 21 | 15 | 40 | 45 | BLD | | |
| 22 | 30 | 30 | 55 | BLD | | |
| 23 | 25 | 40 | 40 | BLD | | |
| 24 | 15 | 30 | 65 | BLD | | |
| 25 | 10 | 35 | 75 | BLD | | |
| 26 | 20 | 35 | 75 | BLD | | |
| 27 | 20 | 35 | 55 | BLD | | |
| 28 | 20 | 30 | 45 | BLD | | |
| 29 | 25 | 30 | 85 | BLD | | |
| 30 | 15 | 45 | 50 | BLD | | |
| 31 | 40 | 35 | 60 | BLD | | |
| 32 | 35 | 35 | 55 | BLD | | |
| 33 | 35 | 35 | 55 | BLD | | |
| 34 | 30 | 30 | 40 | BLD | | |
| 35 | 40 | 45 | 55 | BLD | | |
| 36 | 20 | 40 | 30 | BLD | | |
| 37 | 20 | 25 | 35 | BLD | | |
| 38 | 30 | 30 | 40 | BLD | | |
| 39 | 110 | 40 | 50 | BLD | | |
| 40 | 30 | 35 | 40 | BLD | | |
| 41 | 30 | 35 | 65 | BLD | | |
| 42 | 35 | 35 | 50 | BLD | | |
| 43 | 20 | 35 | 40 | BLD | | |
| 44 | 40 | 35 | 75 | BLD | | |
| 45 | 30 | 25 | 60 | BLD | | |
| 46 | 35 | 30 | 50 | BLD | | |
| 47 | 40 | 25 | 50 | BLD | | |
| 48 | 30 | 25 | 50 | BLD | | |
| METHOD | 101B | 101B | 101B | 10LB | | |

FOR METHOD DETAILS SEE PRICE LIST

"S'MPEY EXPLORATION SERVICES
2?/? Great Eastern Highway, Midland,
Western Australia, 6056
P.O. Box 134, Midland
Phone: 74 2088
74 1062
Cables: Exserv
Perth

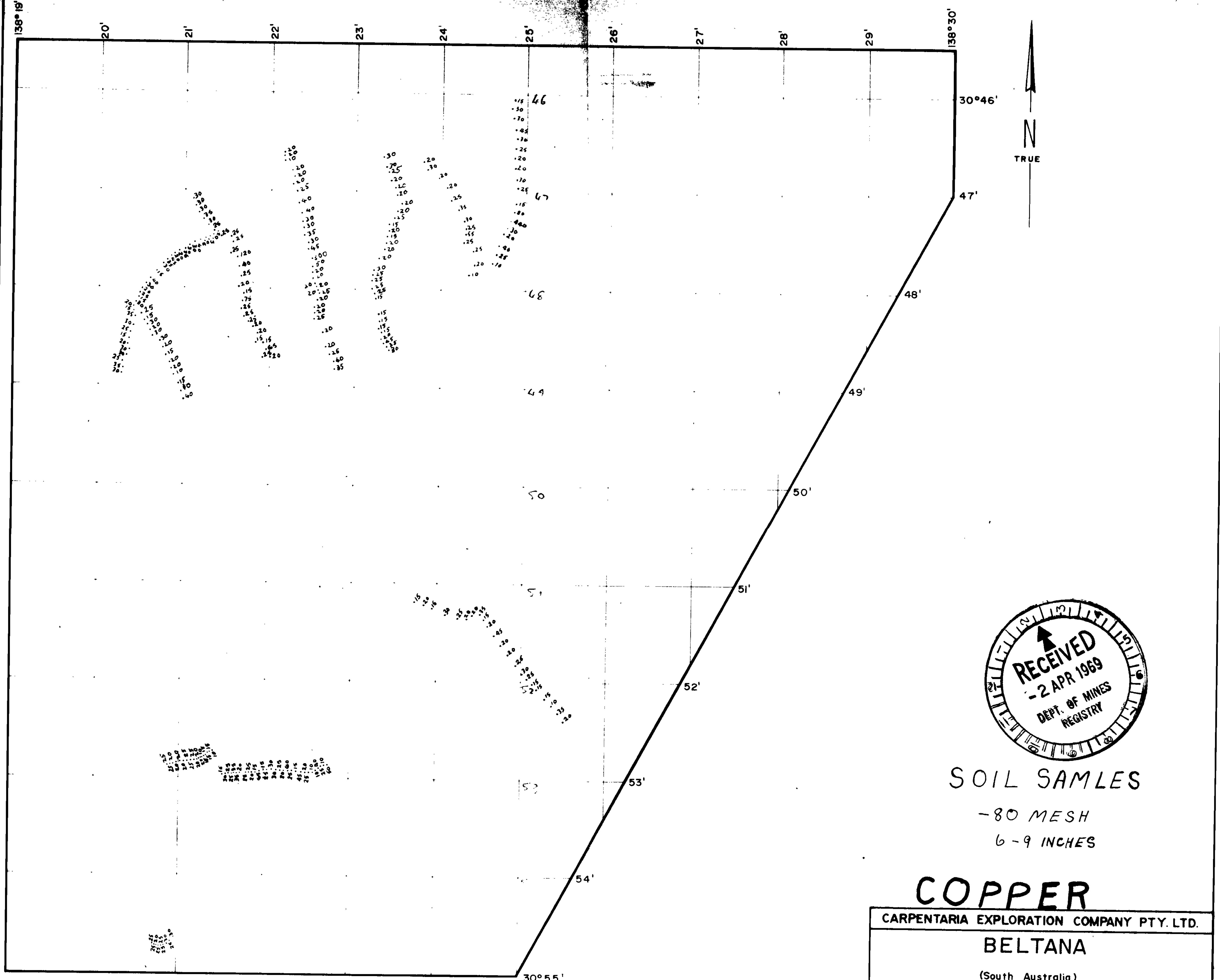
Field Sheet No:—
Line No.:—
Project/Charge/Despatch Note No:—
Date:— 1969 6- OCT 1969



Any queries please quote Lab. Sheet Number:—

| SAMPLE 3 | CU | PB | ZN | AG |
|---|---|---|---|---|
| 49 | 30 | 25 | 60 | BLD |
| 50 | 50 | 30 | 55 | BLD |
| 51 | 50 | 30 | 40 | BLD |
| 52 | 25 | 30 | 115 | BLD |
| 53 | 30 | 40 | 120 | 3 |
| 54 | 30 | 40 | 125 | BLD |
| 55 | 30 | 35 | 100 | BLD |
| 56 | 35 | 60 | 165 | BLD |
| 57 | 25 | 50 | 120 | BLD |
| 58 | 20 | 25 | 70 | BLD |
| 59 | 30 | 75 | 250 | BLD |
| 60 | 20 | 50 | 200 | BLD |
| 61 | 20 | 30 | 120 | BLD |
| 62 | 25 | 25 | 85 | BLD |
| 63 | 30 | 30 | 105 | BLD |
| 64 | 20 | 25 | 90 | BLD |
| 65 | 20 | 25 | 80 | BLD |
| 66 | 20 | 25 | 65 | BLD |
| 67 | 20 | 20 | 70 | BLD |
| 68 | 15 | 25 | 35 | 3 |
| 69 | 20 | 20 | 105 | BLD |
| 70 | 70 | 30 | 120 | BLD |
| 71 | 30 | 45 | 100 | BLD |
| 72 | 20 | 50 | 166 | BLD |
| 73 | 30 | 30 | 160 | 3 |
| 74 | 25 | 30 | 250 | 3 |
| 75 | 30 | 45 | 145 | 2 |
| 76 | 25 | 30 | 125 | 3 |
| 77 | 30 | 25 | 120 | BLD |
| 78 | 30 | 170 | 330 | BLD |
| 79 | 230 | 725 | 370 | BLD |
| 80 | 30 | 30 | 115 | BLD |
| 81 | 60 | 320 | 340 | BLD |
| 82 | 70 | 500 | 340 | BLD |
| 83 | 35 | 400 | 315 | BLD |
| 84 | 30 | 240 | 330 | BLD |
| 85 | 30 | 240 | 280 | BLD |
| 86 | 50 | 600 | 360 | BLD |
| 87 | 50 | 120 | 80 | BLD |
| METHOD | 101B | 101B | 101B | 101B |

FOR METHOD DETAILS SEE PRICE LIST




SOIL SAMLES

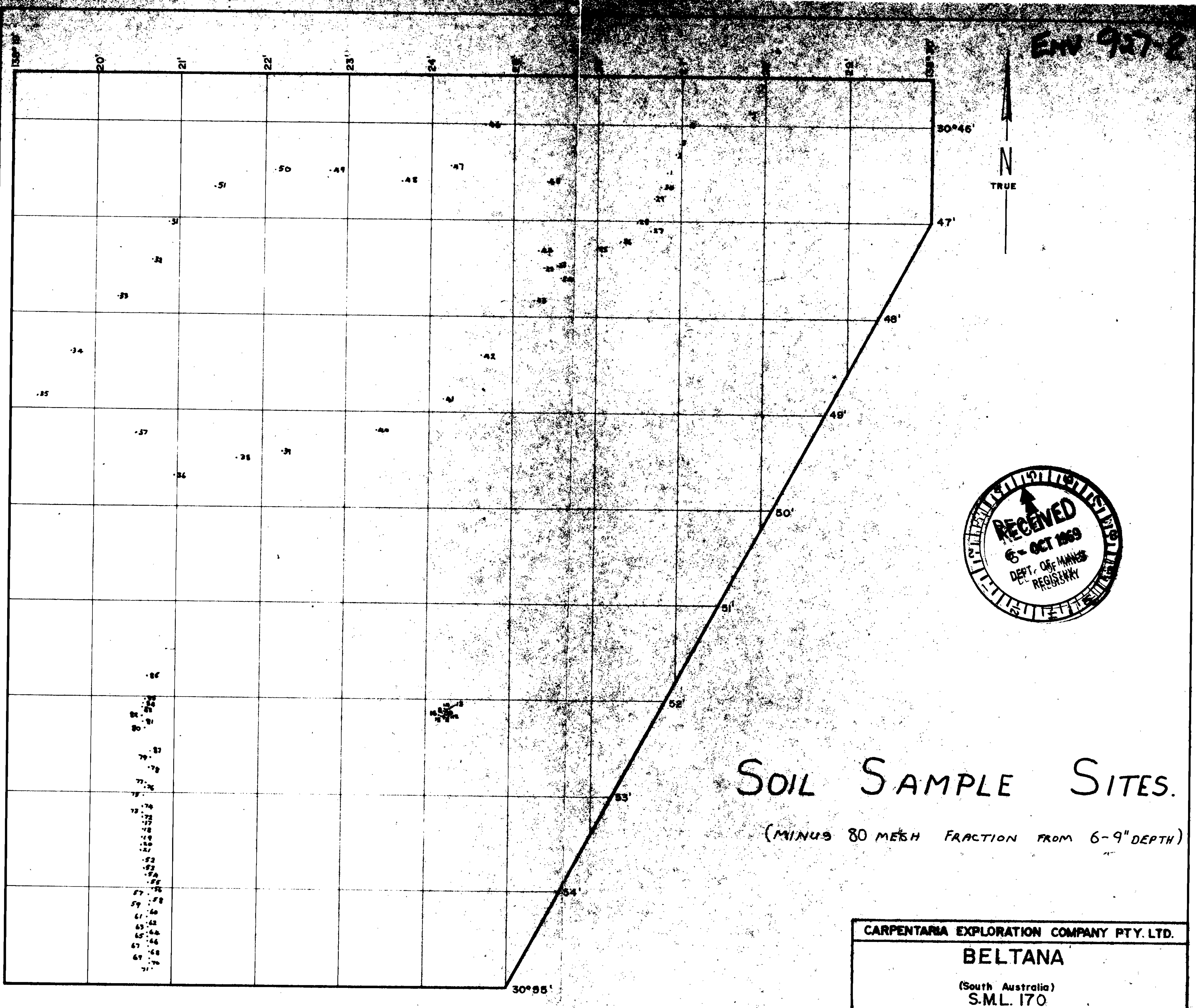
-80 MESH

6-9 INCHES

# COPPER

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| BELTANA<br>(South Australia)<br>S.M.L. 171<br>FIGURE 1 | | |
| SCALE 1"= 1mile | GEOL. W. D.S. | DATE: MARCH 69 |
| CHECKED | DRAWN: | |

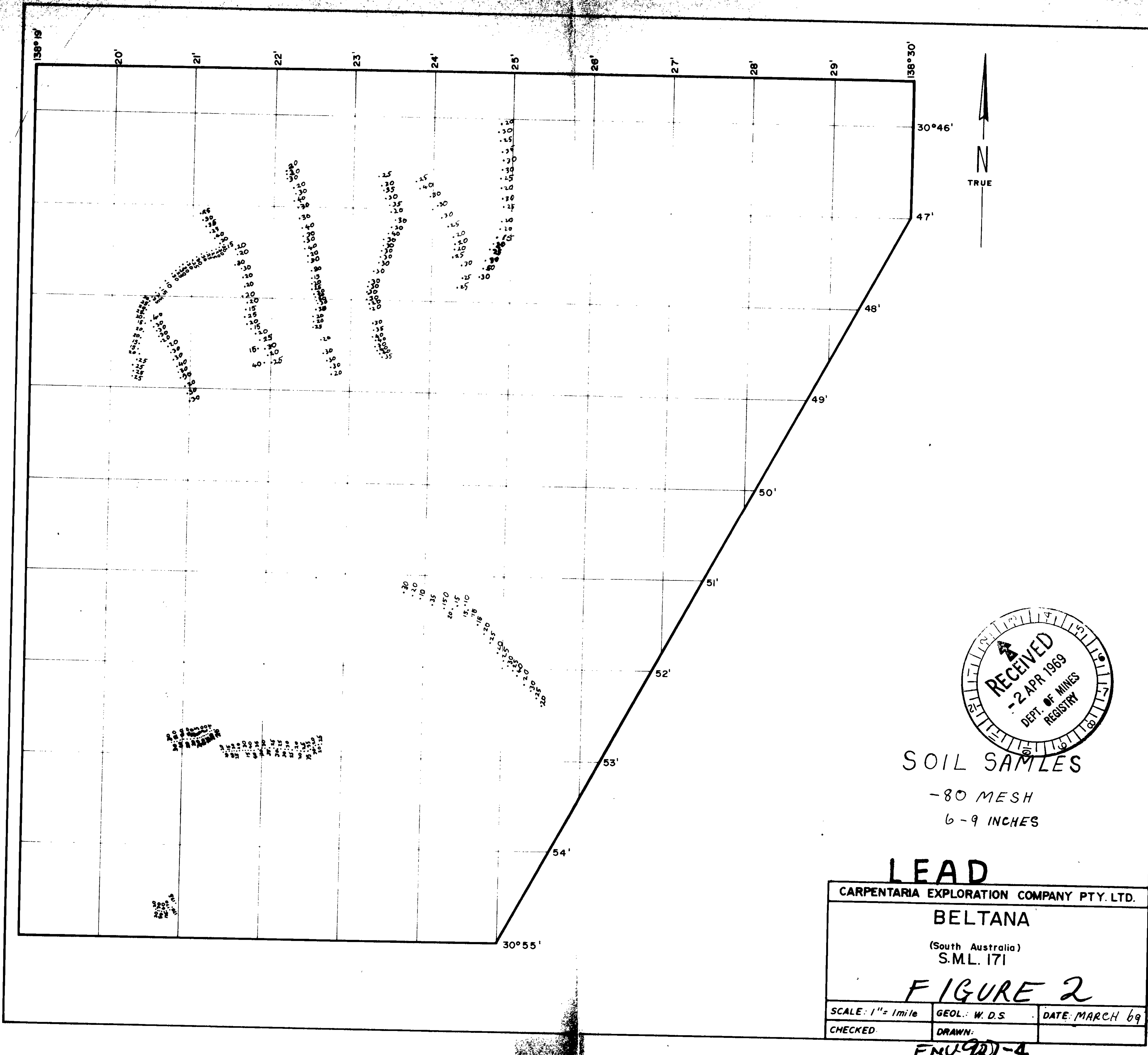
ENV 927-3

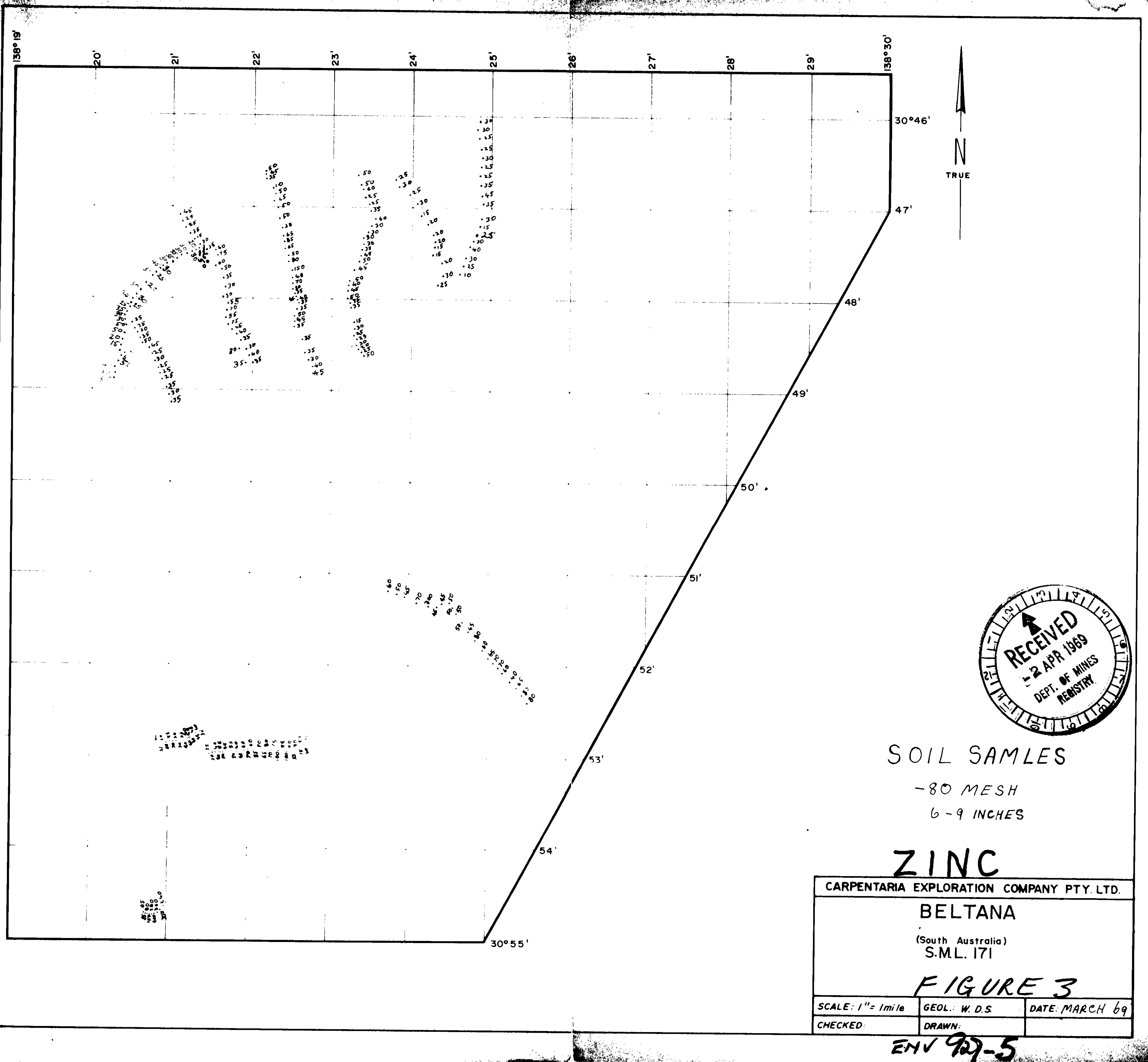



# SOIL SAMPLE SITES.

(MINUS 80 MESH FRACTION FROM 6-9" DEPTH)

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| BELTANA (South Australia) S.M.L. 170 FIGURE 1A | | |
| SCALE: 1" = 1 mile | GEOL.: | DATE: |
| CHECKED: | DRAWN: | |


138°19'
20'
21'
22'
23'
24'
25'
26'
27'
28'
29'
138°30'
30°46'
47'
48'
49'
50'
51'
52'
53'
54'
30°55'
N
TRUE
RECEIVED
- 2 APR 1969
DEPT. OF MINES
REGISTRY
SOIL SAMLES
-80 MESH
6-9 INCHES
LEAD
CARPENTARIA EXPLORATION COMPANY PTY. LTD.
BELTANA
(South Australia)
S.M.L. 171
FIGURE 2
SCALE: 1" = 1mile
GEOL.: W. D.S.
DATE: MARCH 69
CHECKED
DRAWN:
ENV 921-4


138°19'
20'
21'
22'
23'
24'
25'
26'
27'
28'
29'
138°30'
30°46'
47'
48'
49'
50'
51'
52'
53'
54'
30°55'
N
TRUE
RECEIVED
-2 APR 1969
DEPT. OF MINES
REGISTRY
SOIL SAMLES
-80 MESH
6-9 INCHES
ZINC
CARPENTARIA EXPLORATION COMPANY PTY. LTD.
BELTANA
(South Australia)
S.M.L. 171
FIGURE 3
SCALE: 1" = 1mile
GEOL.: W. D.S.
DATE: MARCH 69
CHECKED:
DRAWN:
ENV 929-5

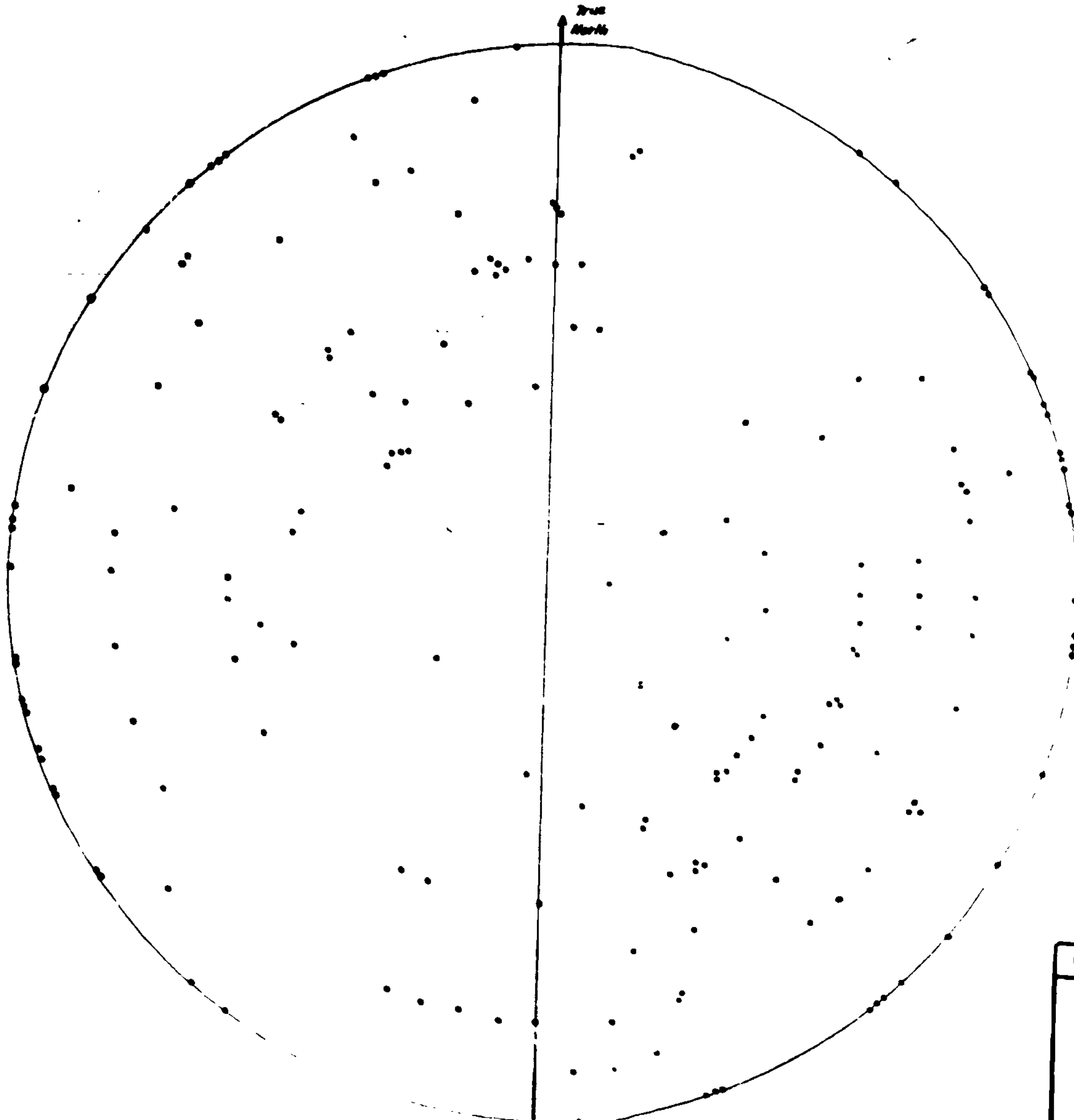



FIGURE 4

**CARPENTARIA EXPLORATION COMPANY PTY. LTD.**

PLOT OF POLES TO BEDDING

**BELTANA COMPLEX**

156 POLES

W.D SMITH AND REREAD

JANUARY, 1969

SCHMIDT NET

| SCALE. | GEOL. W.D.S. | DATE Feb 1969 |
|---|---|---|
| CHECKED | DRAWN. J C N | 3669 |



ENV 927-6

ENV 927

031



CARPENTARIA EXPLORATION COMPANY
PTY. LTD.

567 South Road,

Everard Park,

S.A. 5035

10th July, 1969

The Director of Mines,

Department of Mines,

Box 38,

Rundle Street P.O.

Adelaide,

S.A. 5001.



Dear Sir,

**Report for Quarter Ended 18.6.69**
**for SML 170**

Field work during the quarter was confined to further examination and limited mapping in the Black Feather and Red Range areas.

Six diagrams are appended showing results of geochemical sampling in these areas, namely:-

| | | |
|---|---|---|
| 1 Copper | ) | |
| 2 Lead | ) | Black Feather Area |
| 3 Zinc | ) | |
| 4 Copper | ) | |
| 5 Lead | ) | Red Range Area |
| 6 Zinc | ) | |

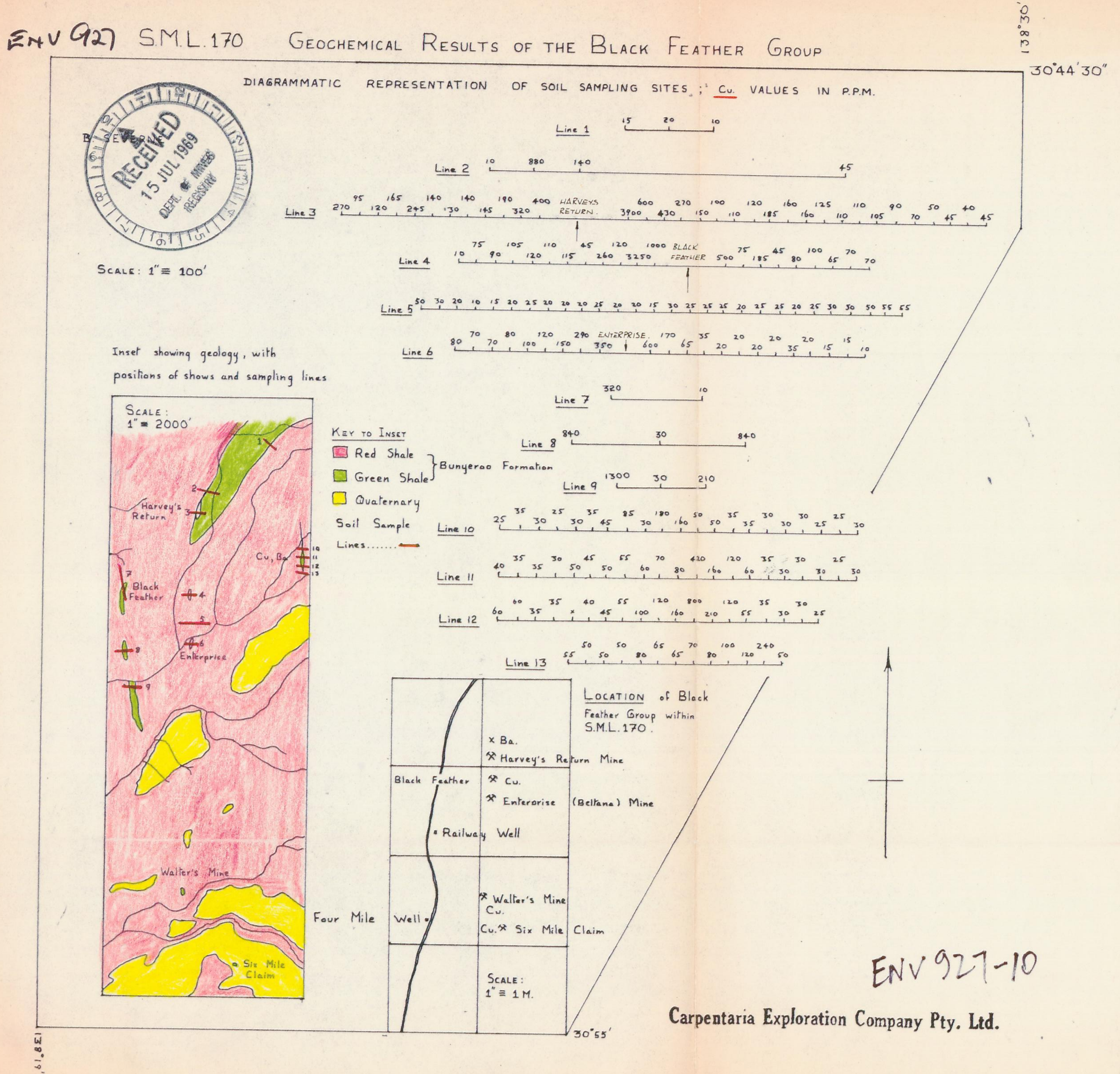
The area is currently thought to have no chance of a large orebody, and very little chance of a small ore. Present intentions are to drill a number of isolated airblast holes in a number of localities to improve confidence in this conclusion.

Yours faithfully,
for and on behalf of
MT. ISA MINES LIMITED

Walter D. Smith

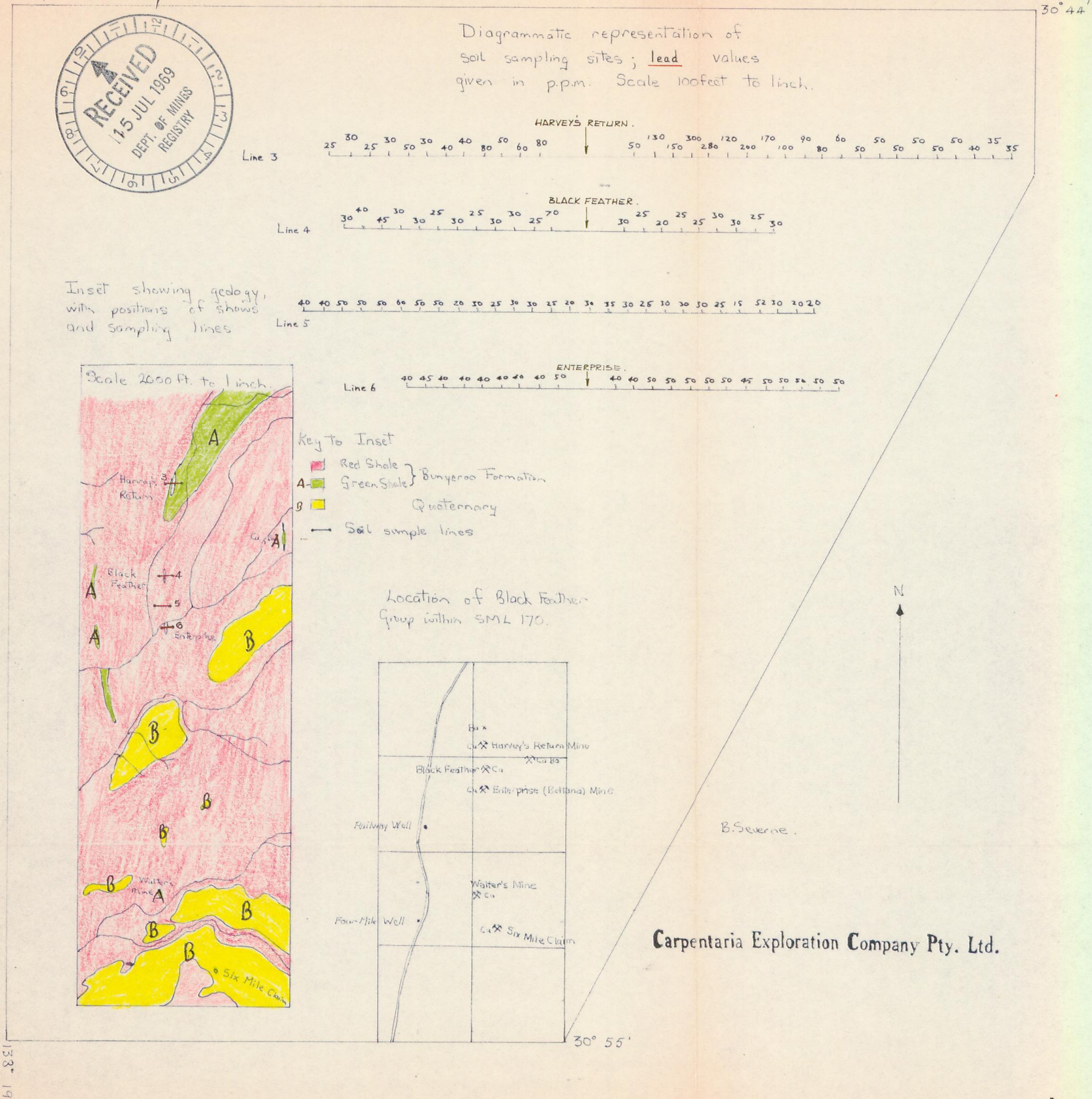
WALTER D. SMITH
Party Leader (S.A.)

ENV 927 S.M.L. 170 GEOCHEMICAL RESULTS OF THE BLACK FEATHER GROUP



# S.M.L. 170 Geochemical Results of the Black Feather Group:

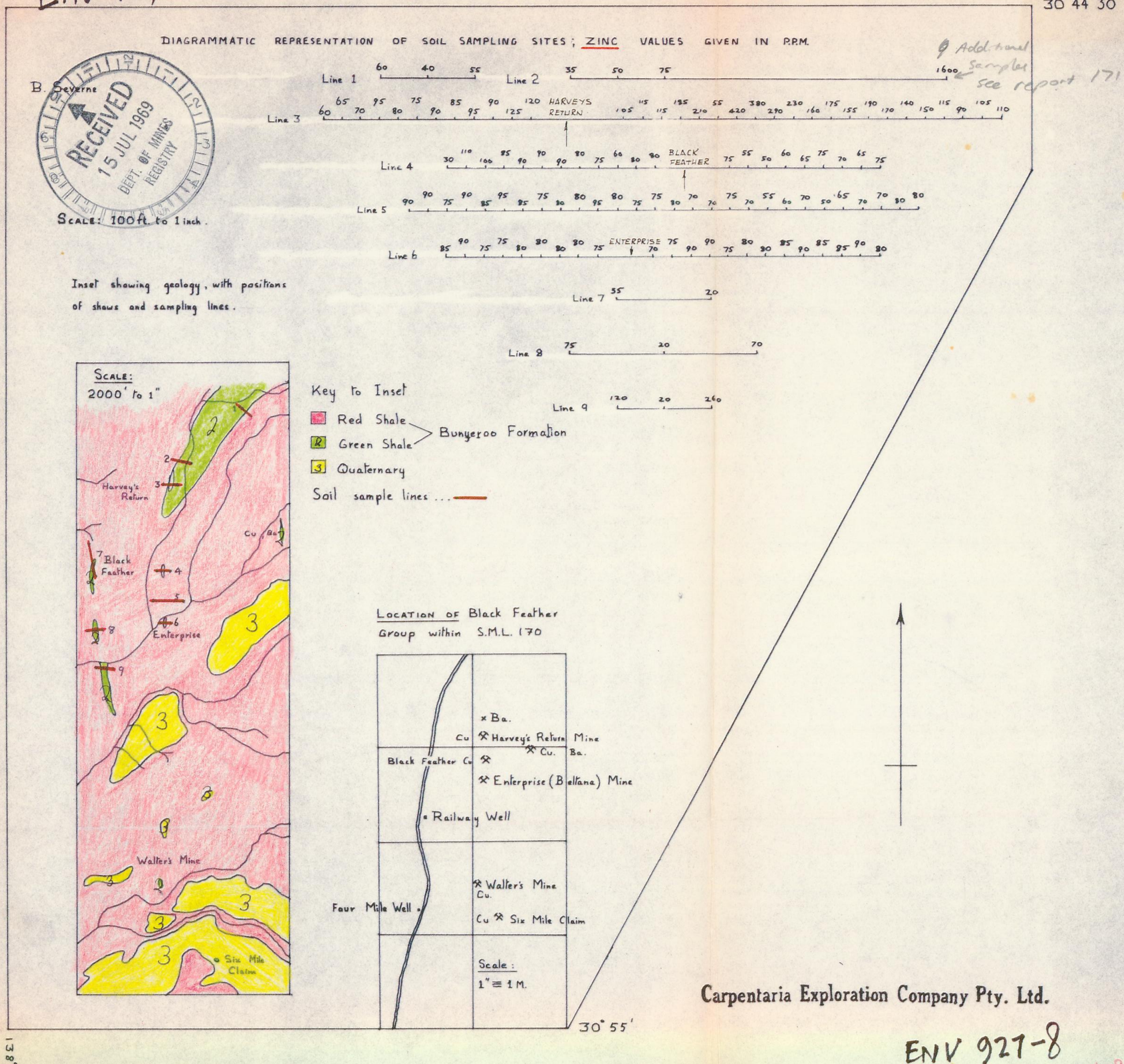
ENV 927




ENV 927-9

ENV 927

# S.M.L. 170 Geochemical Results of the Black Feather Group



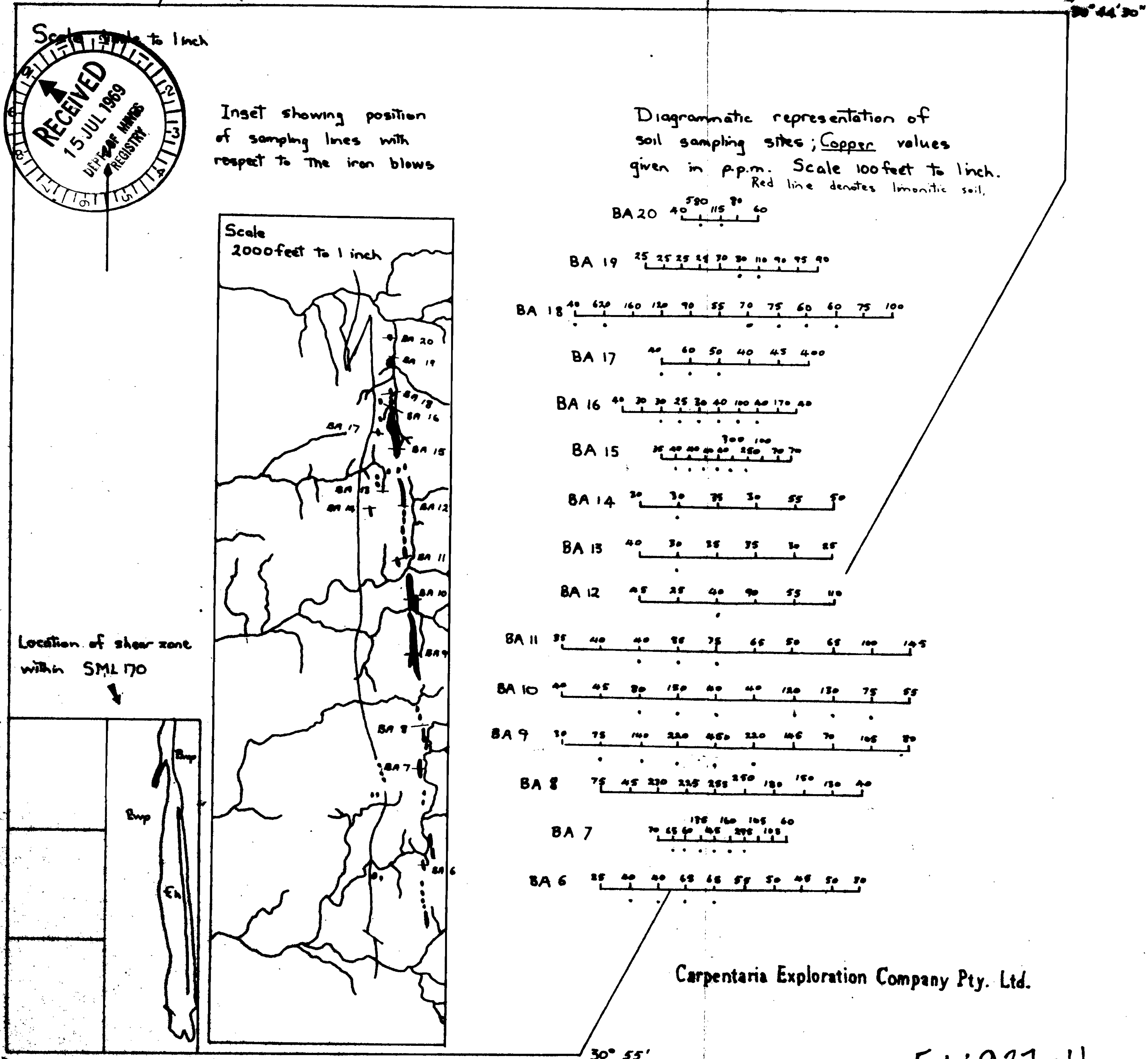

Carpentaria Exploration Company Pty. Ltd.

ENV 927-8

# SML170 Geochemical Results of the Red Range Area

ENV 927

B. Severne

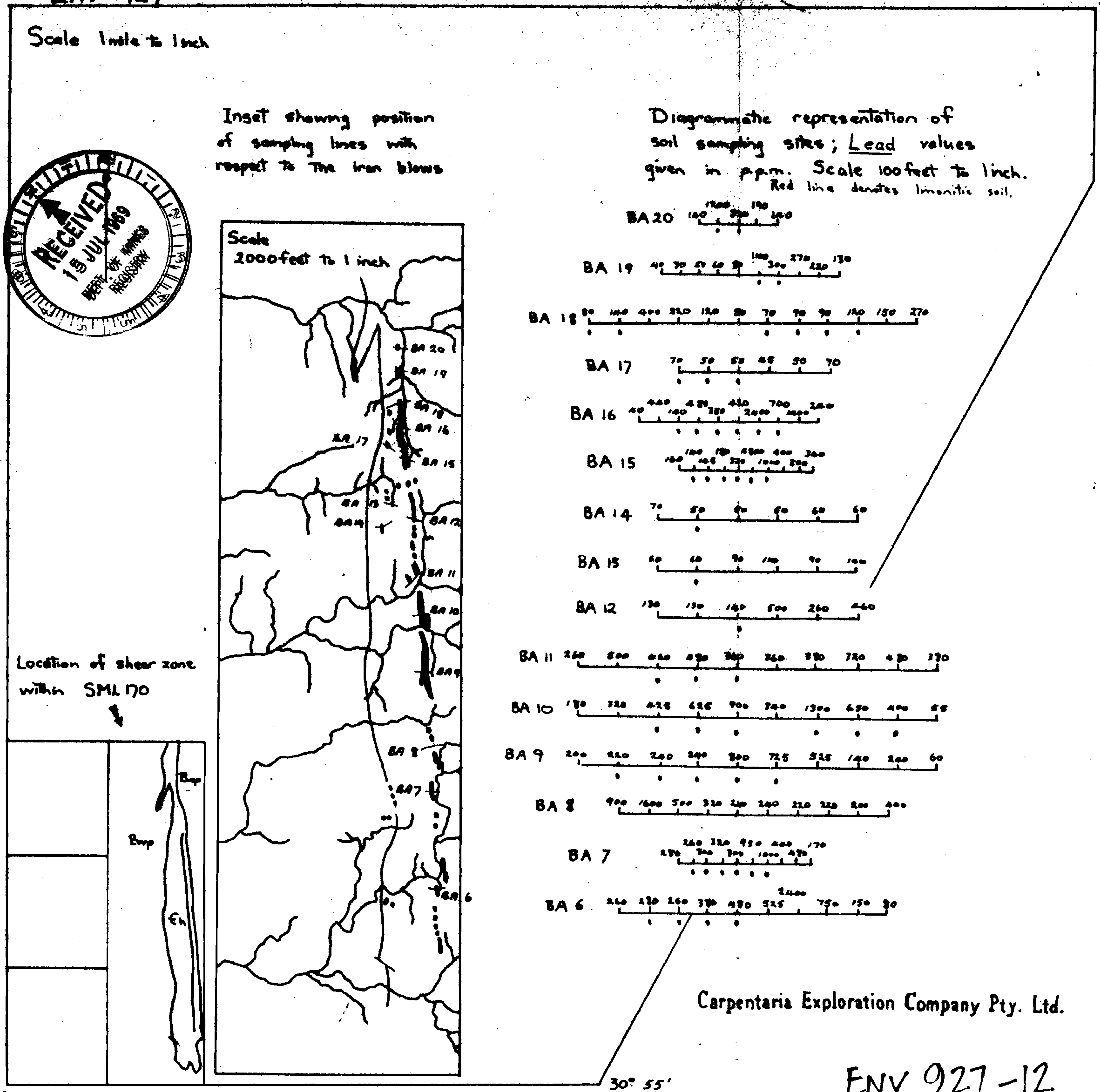



ENV 927-11

# SML 170 Geochemical Results of the Red Range Area

ENV 927.

B. Severne

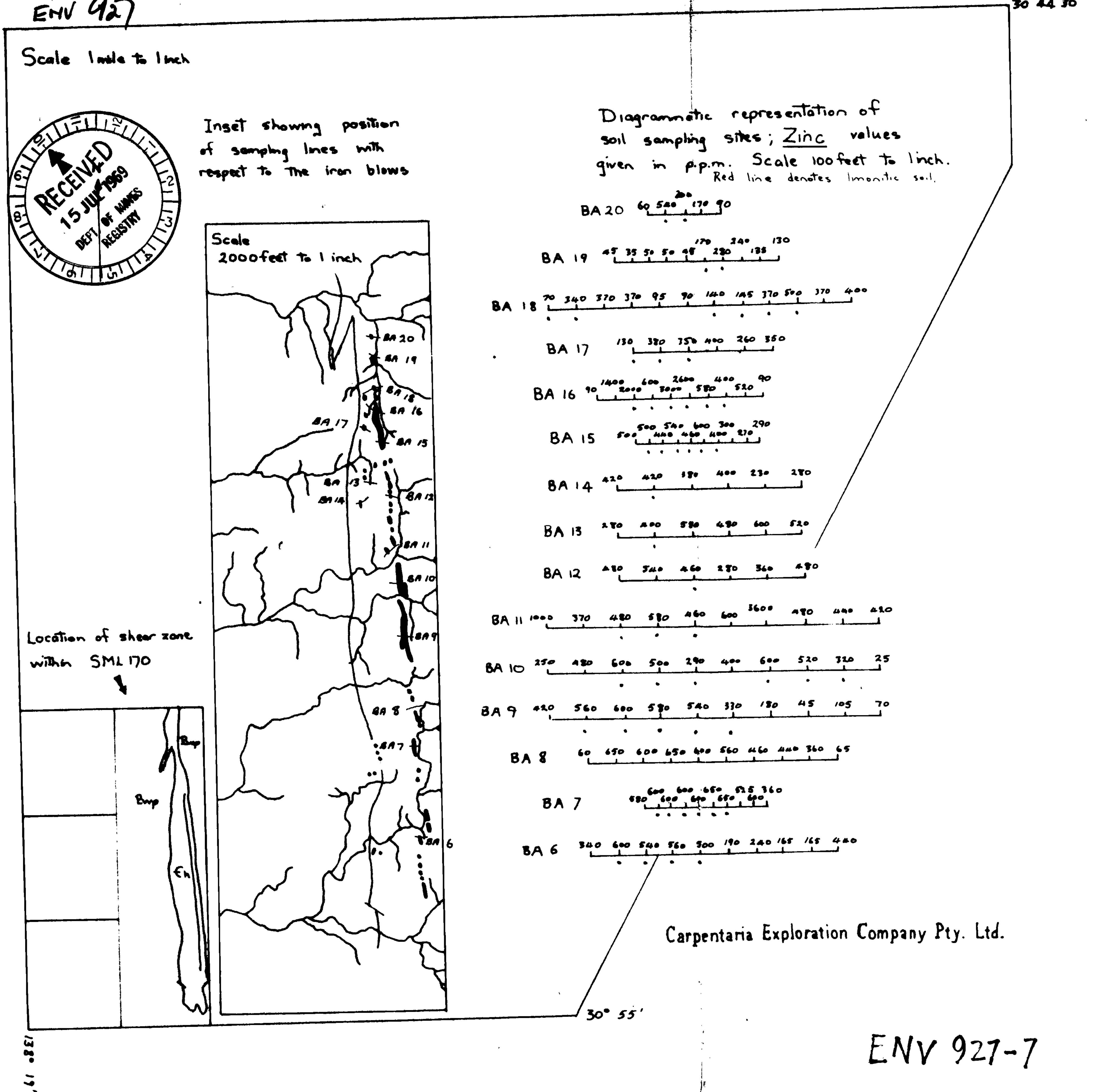



ENV 927-12

# SML170 Geochemical Results of the Red Range Area

B. Severne

ENV 927




ENV 927-7

C.E.C. 81

033

**CARPENTARIA EXPLORATION COMPANY PTY. LTD.**

# TECHNICAL REPORT No. 172

Title PROGRESS REPORT - BELTANA - SML 170

Author W.D. SMITH

Investigations Conducted By W.D. SMITH
B.C. SEVERNE

Submitted By W.D. SMITH

Date NOVEMBER 1969

5.12.69 1162

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TECHNICAL REPORT No. 172 - 036

# SUMMARY

Date November, 1969


OBJECT:

To evaluate S.M.L. 170 with respect to base metal mineralisation.

PRECIS:

Geological and geochemical investigations have suggested that the Beltana "Diapir" has no particular potential for major mineralisation. There is an association of minor mineralisation with the "diapir", as with many other S.A. "diapirs", but this association is more with the immediate rim rocks than with the core rocks. This is probably because the brecciated character of the "diapir" gave it greater porosity and permeability, it functioned as a conduit for hypogene mineralising influences, and precipitation occurred chiefly in the wall and roof rocks.

Owing to the proximity of rail and road facilities, several apparently small prospects are being drilled by airblast methods for a rough first appraisal.

CONCLUSIONS:

Initial drilling results should be appraised for Black Feather, Red Range, Iron Blow, and Copper Queen (under option), and further work and or ground reduction planned accordingly.

RECOMMENDATIONS:

Appraise initial drilling results, and if appropriate, plan immediate work to justify further reduction of area on a pro rata expenditure basis as soon as possible.


Walter D. Smith.

## 1.0 INTRODUCTION

Special Mining Lease 170 comprises about 100 square miles towards the western edge of the Central Flinder's Ranges. The centre of the lease is about 15 miles east of the well known Ediacara primary Ag-Pb-Zn mineralised zone, and about 8 miles south of the recently discovered Puttapa secondary zinc mineralisation.

The area was selected to permit evaluation of the Beltana Diapir, and the various, apparently small, showings of mineralisation nearby.

The position and boundaries of S.M.L. 170 are shown on Figure 1. A 40 acre claim surrounding the Copper Queen Mine is excluded from S.M.L. 170

This report covers work completed prior to drilling, which will be reported separately.

# 2.0 GEOLOGY

## 2.1 General Geology

The general geology of S.M.L. 170 is shown on the S.A. Mines Department one mile Beltana Sheet provided in this report as Figure 1. An explanatory text giving extra detail is also available (Leeson 1966 b).

In general, the lease area consists of sediments of the Wilpena and Hawker Group (see Plate 1) involved in fairly regular folds, together with the distinctly anomalous feature known as the Beltana Diapir, across which there is a fault repetition of about 5,000 feet of Wilpena Group sediments.

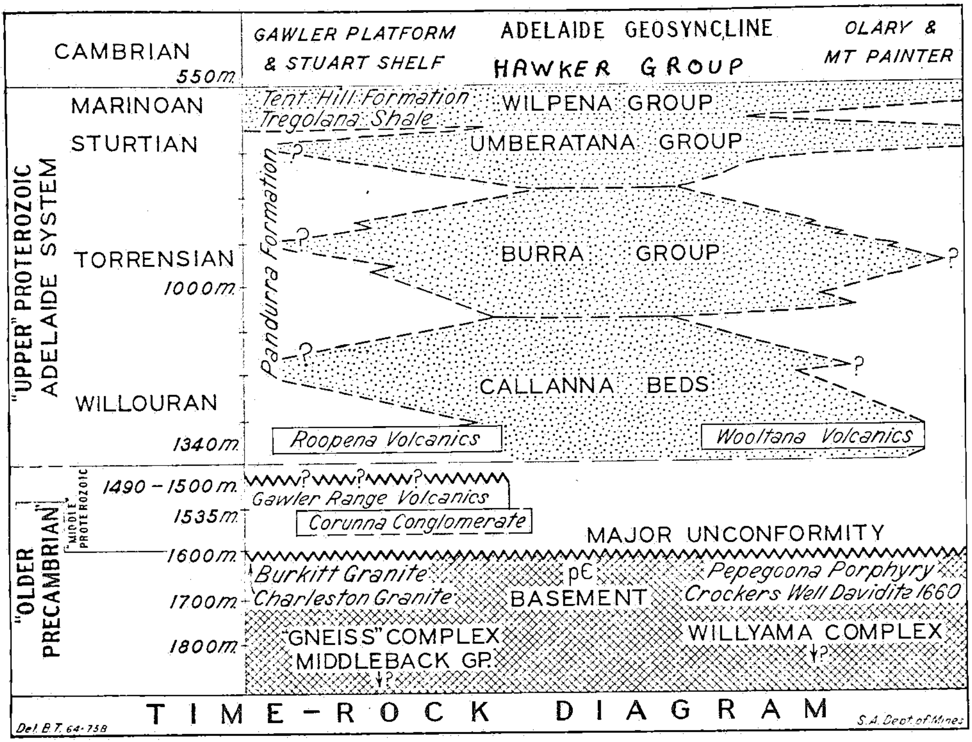
## 2.2 The Beltana Complex

The Beltana Diapir consists of highly disturbed representatives of the Callanna Beds and or the Burra Group (see Plate 1) and thus a piercement feature of some sort is indicated. Such features are common in the Adelaide Geosyncline, but are rather enigmatic in nature, especially with respect to the mechanism of emplacement.

The Beltana Diapir (Leeson 1966 a) was of particular interest because of the suggestion (Coats 1964) that there is "a close association of mineralisation with Willouran rocks and in particular with diapiric structures". Consequently it was examined in more detail than the remainder of the lease. As a result of this, the feature is given a different interpretation than the purely diapiric one advocated by Leeson (1966 a), (1966 b), Coats 1964), and others.

The Beltana Diapir is a complex feature, interpreted as having formed by a composite process extending over a very long interval of time, through three main stages, and through two dissimilar tectonic environments. For this reason, Leeson's (1966 a and 1966 b) Beltana

# PLATE I.




AFTER THOMPSON'S (1965) Fig. 6.

Diapir is referred to below as the Beltana Complex. The area mapped by Leeson as the Beltana Diapir does include effects attributable to diapirism,but it is also believed to include other effects of different origin.

Expressed rather briefly, the present interpretation of the Beltana Complex is that, it was initiated as a horst probably in the late Torrensian or early Sturtian, the Callanna Beds and Burra Group so elevated were disturbed by syntaphral tectonics during Sturtian and Marinoan times, and the disturbed zone so formed was mobilised in a diapiric manner by the orogeny closing the Adelaidean sedimentation in the Ordovician. Thus the third stage is regarded as diapiric, whereas the first and second are not, i.e. a non diapiric piercement feature existed during the Adelaidean, and this became diapiric during the Ordovician orogeny.

The interpretation above differs from those of previous workers, and probably also from those of other contemporary workers. The reader is referred to the literature, and to Addenda 1, 2, 3 and 4 of this report for more detail on this matter.

The composite piercement interpretation is summarised in Figure 2.

The general structural character of the Beltana Complex is shown by a bedding plane pole plot in Figure 3.

# GENERALIZED DIAGRAM
# SUMMARISING THE COMPOSITE THREE STAGE INTERPRETATION FAVOURED FOR THE BELTANA COMPLEX



| STAGE | HORIZONTAL COMPONENTS OF STRESS FIELD | BASIC PROCESS | EFFECTS | PRINCIPAL EVIDENCE | TIME TERM | TIME IN YEARS |
|---|---|---|---|---|---|---|
| THREE | COMPRESSIONAL | Deformation (diapric) of the complex already formed. | Additional folding and vertical diapric limited ejection of core rocks. | Upturned rim rocks, drags implying definite vertical relative movement of core rocks. | ORDOVICAN | |
| | | | | | | $500 \times 10^6$ |
| TWO | TENSIONAL | Syntaphral disordering of uplifted older sediments | Formation, movement, disorientation, and juxtaposition of fragments by gravitational gliding, slump folding, slump brecciation, and aqueous erosion and reworking. | Interpretation of the dominant breccia type as one formed by a lateral pull-apart mechanism, suggestion of a fringing zone of smaller relatively more disorded fragments, anomalously folded slump sheets of Callanna – Burra lithologies incorporated in the Wonoka Formation together with slump breccias, peripheral conglomerate occurrences together with slump breccias. | CAMBRIAN | |
| | | | | | | $550 \times 10^6$ |
| | | | | | MARINOAN | |
| | | | | | | $650 \times 10^6$ |
| ONE | | Fault block emergence | Elevation of older rocks amongst younger ones with minimal structural disturbance | Abundant regional evidence of contemporaneous faulting implying basement block movement, together with local absence of Sturtian rocks from the Beltana Complex. | STURTIAN | |
| | | | | | | $750 \times 10^6$ |
| | TENSIONAL | | | Relatively common regional evidence of contemporaneous faulting | TORRENSIAN | |
| | | | | | | $1050 \times 10^6$ |
| | | | | Evidence of contemporaneous faulting | WILLOURAN | |

FIGURE 2.

**N.B.** The stages shown in the first column refer principally to basic processes and effects rather than time. Thus it is not suggested that stage one was confined to the Sturtian, and stage two to the Marinoan and Cambrian, but that stage one preceded stage two, either once or repeatedly, and that this sort of activity probably began near the base of the Sturtian, and persisted into the Cambrian.

## 3.0 AEROMAGNETICS

### 3.1 Shallow Source Evidence

The Beltana Complex is not evident on aeromagnetic maps, except for a small knot of contours delineating a 100 $\gamma$ anomaly in the north-east corner of the feature. This correlates roughly with the cluster of igneous outcrops mapped within the Beltana Complex. Being a shallow source anomaly, it is regarded as due to the igneous rocks recorded, and or subjacent non-outcropping or undiscovered equivalents in the same general area (see Figure 4).

### 3.2 Deep Source Evidence

The aeromagnetic contours provide no support for the inferred horst, and this possibly poses a difficulty for the composite piercement interpretation outlined above. The magnitude of this difficulty is uncertain, chiefly because the size of the horst is unknown, and because the magnetic distinctiveness of basement relative to Adelaidean sediment is unknown. Further uncertainty exists because some piercements (e.g. Angepena) do show evidence of possible basement uplift in aero-magnetic contours, and many very large faults, including some contemporaneous ones, don't show evidence of basement uplift in aeromagnetic maps. Thus while the aeromagnetic contours do not support the inferred horst at Beltana, it seems that they do not necessarily preclude the possibility of its existence. Thus it is considered that the aeromagnetic evidence is inconclusive, and provides no firmer grounds against the composite piercement interpretation than the geological evidence for it. Moreover, the magnetic difficulties outlined above seem no greater than the mechanical difficulties of accounting for the Beltana Complex entirely by purely diapiric mechanisms.

Owing to the plausibility of the composite piercement interpretation in the context of the Adelaide geosyncline, it is preferred.

## 4.0 RECONNAISSANCE GEOCHEMISTRY

Thirteen lines of soil samples were taken in selected areas of the lease to permit comparison of the normal values of the different units with each other, and with irregular areas such as the Beltana Complex, and a number of mineralised zones. (See detailed Geochemistry below.) The sample sites, line numbers, sample numbers and values for copper, lead and zinc are shown in Figure 5. Results are summarised below for data inside the Beltana Complex, data outside the Beltana Complex, and for a comparison of these two areas, and the perimeter area.

### 4.1 Data Inside the Beltana Complex

Seven lines (lines 1 to 7) were run through the Complex in areas that were thought to be fairly natural subdivisions and or representative of particular parts of the Complex.

The raw data is given in Figure 5. The values are all rather ordinary with a few isolated low order anomalies. Some of these were examined in the field and were considered to be insignificant. (See Follow-up Work.)

Averages for lines 1 to 7 are shown below in Table 1.

As may be seen from the Table, there are no significant variations from one line to another with respect to lead and zinc. The same may be said of copper, except for Line 7, which is notably higher because of only one sample (Sample 313 of 440 p.p.m.). Lines 6 and 7, which represent the area of densest igneous outcrops, have marginally greater copper values, rather similar lead values, and smaller zinc values than the remainder of the Beltana Complex (Lines 1 to 5). Thus, while there is some suggestion that the igneous rocks might have functioned as mineralising influences, with respect to copper, the effect seems marginal, and rather erratic, since the suggestion is lost entirely with the elimination of only one sample. (See Tables 2 and 3.)

## 4.2 Data Outside the Beltana Complex

Line 8 was run around the periphery of the main body of the Beltana Complex to permit a broad comparison of the core, the rim rocks, and units more remote from the complex (lines 9 to 13). (See Comparison of the Beltana Complex and its wall rocks below.)

Lines 9, 10, 11, 12 and 13 were run across regular sections of the lease to indicate average values for different units. The raw data is given in Figure 5. The values are all rather ordinary, with a few isolated low order anomalies. Some of these were examined in the field and were considered to be insignificant. (See Follow-up Work)

The raw data for lines 9, 10, 11, 12 and 13 are summarised below in groups representing stratigraphic units (see Table 4). The average values for the different units are similar except for the Hawker Group which is distinctly higher with respect to lead and zinc.

## 4.3 Comparison of Core, Perimeter and Remote Samples

Comparison of all lines inside the Beltana Complex (lines 1 to 7) with line 8 around its perimeter, and lines 9 - 13 more remote from it shows that:

(1) Perimeter samples are higher with respect to copper, lead, and zinc, than core samples.

(2) Core samples are marginally higher with respect to copper than the remote samples.

(3) Core samples are lower with respect to lead and zinc than the remote samples.

The raw data are summarised in Table 5 with the Hawker Group (a distinct geochemical feature) included, and in Table 6 with the Hawker Group excluded.

The tendency for perimeter samples to be richer in all metals tested than the core samples was also noted at Angepena (S.M.L. 171).

Thus it might be a real and consistent feature of S.A. piercements in general. It is interpreted as indicating that the piercement functioned as a conduit because of its porosity and permeability, and thus most precipitation of metals from hypogene mineralising influences took place in the walls and roof rocks.

Owing to the small number and small order of anomalies arising from reconnaissance work, and the conclusion reached from the interpretation above, the Beltana Complex was considered to have little if any significance in relation to ore. Further work was of a more detailed nature in specific areas of interest, and of a follow up nature. This is reported below.

## 5.0 DETAILED WORK

046

### 5.1 The Black Feather Group of Mines

The Black Feather Group of mines includes Harvey's Return Mine, Black Feather Mine, and the Enterprise Mine. The mineralisation is transgressive in character, with mineralisation obviously associated with vertical faulting. Mineralisation occurs over a normal width of several feet and a maximum evident width of about 10 - 15 feet. These mines contrast with Walter's Mine and the Six Mile Claim shown on Figure 1 to the south. These two do not exhibit evidence of faulting having controlled mineralisation, which is probably bedded in nature. As the structure occupied by the Black Feather Group cuts the particular horizon mineralised at Walter's Mine and Six Mile Claim, it seems possible if not probable that the bedded copper provided the source for the Black Feather Group of mines.

Results of local soil sampling in the area of the Black Feather Group are given in Figure 6 (Cu), Figure 7 (Pb), and Figure 8 (Zn). These results show that appreciable copper values are confined to the mineralised structures, and thus width expectations are extremely limited. The mineralised structure pinches and swells along strike and thus offers very limited evidence of continuity. It seems very probable that the mineralisation mined in the past was significantly enriched by solution activity within the structure, and that the mineralisation will deteriorate in depth, and not persist below the mineralised horizon believed to have given rise to it.

Three airblast holes are recommended to check width and grade at Black Feather, Walter's Mine and Six Mile Claim.

### 5.2 The Red Range Fault

Mindful of the occurrence of marked secondary concentrations of zinc at Puttapa, the source of which is understood to be the Hawker Group, forty one soil samples were taken along the eastern side of the

Red Range Fault. This is a west block up strike fault repeating the Pound Quartzite west of the Ajax Limestone. (See Figure 1) Results for copper, lead, zinc, and silver are shown in Figure 9. None of these values are regarded as anomalous for this particular unit, except for several of the copper results towards the northern end which are probably only marginally anomalous. Lead and zinc are also higher in this area.

## 5.3 The Red Range Limonite Zone

Visible copper mineralisation occurs at several points along a relatively continuous, variably limonitic, zone near the base of the Ajax Limestone in Red Range (see Figure 1). The width of possible mineralisation varies from several feet to several hundred feet, and a possible length of about two miles is indicated.

Results of local soil sampling at various points along the limonite zone are given in Figure 10 (Cu), Figure 11 (Pb), and Figure 12 (Zn). The results are not regarded as anomalous for the particular unit in which they occur. See Table 7 below comparing average values for line 9 with those along the Red Range Fault, and those along the Red Range Limonite Zone. This table probably shows little more than the generally known tendency for best values to fall towards the base of the Hawker Group. It does not necessarily mean that the Red Range Limonite Zone is anomalous at all. The zones of visible copper mineralisation are considered to represent localised zones of enrichment by solution activity.

As the Red Range Limonite Zone has length and some continuity in its favour, two airblast holes are recommended to test for the possibility of grade increase with depth.

## 5.4 Puttapa Creek Sampling

Sixteen soil samples were taken adjacent to outcrops near the course of Puttapa Creek from Puttapa Spring to the eastern edge of the

Beltana Complex (See Figure 1). The locations are shown in Figure 13. The results are given in the Table 8 below from the north-eastern-most to the south-western-most in descending order. The results are all rather similar, and none are anomalous. All samples were assayed for silver also, and all results were below 1 p.p.m.

Four outcrops of breccia possibly or probably due to weathering near the boundary of the Beltana Complex were chip sampled. The locations and results of these samples are shown in Figure 13. All values were low and no further work of this sort seems warranted.

5.5 Miscellaneous Limonitic Zones

Four moderately sized, generally limonitic, zones were reconnaissance soil sampled. These have been named Read's Ridge, Limonite Valley, Siderite, and Harvey's Hollow. Their locations are shown in Figure 13. They generally tend to fall towards the edge of the Beltana Complex.

Results are given for each area separately in Tables 9, 10, 11 and 12.

All of the results are rather similar in value and of a low order. None of the results are considered anomalous and no further work is recommended.

5.6 Iron Blow

Iron Blow is an irregular but generally elongate zone of limonitic and highly leached rocks near the western edge of the Beltana Complex (see Figure 1). Copper mineralisation is evident in several places. There seems some chance of a mineralised length of 2,000 feet and a width of about 100 feet. Three lines of soil samples were run across the trend towards the southern end of the feature. Results are shown in Table 13.

In general results at Iron Blow are more variable and higher than in other areas such as the four miscellaneous limonitic zones mentioned above, and also the Red Range Limonite Zone. Iron Blow is clearly anomalous with respect to copper, and not with respect to lead and zinc.

Four airblast holes and a dependent fifth airblast hole are recommended to test for possible grade increase with depth.

## 5.7 Follow up Work

The following low order anomalies were inspected in the field, and are considered to be of no significance.

### Line 3 Sample 11

Six confirmatory samples in the same area gave results for copper as follows:- 40,25,30,40,40,95. Insignificant traces of chalcopyrite were identified.

### Line 7 Sample 313

Six confirmatory samples in the same area gave results for copper as follows: 15,15,20,110,320,20. No significant mineralisation was recognised.

### Line 12, Sample 105

Six confirmatory samples in the same area gave results for lead as follows: 150, 100, 80, 100, 140, 180, and for zinc as follows: 320, 250, 220, 240, 290, 350. These values occur in a green shale variation of the Bunyeroo Formation and are not considered significant.

### Black Feather Group Line 2,1600 p.p.m. (See Figure 8)

The isolated value of 1600 p.p.m. Zn occurs in a green shale variation of the Bunyeroo Formation. This was inspected in the field and no mineralisation was recognised. Nine samples from similar rock gave results for copper as follows: 40, 50, 50, 30, 20, 80, 35, 20, 40, and for lead as follows: 250, 30, 30, 30, 25, 170, 150, 55, 100, and for zinc as follows: 300, 150, 110, 100, 80, 270, 225, 140, 175. The samples were also assayed for silver and all results were less than 1 p.p.m. The 1600 p.p.m. Zn was not repeated, and is considered to be spurious or atypical. It is not regarded as significant.

Several other even lower order "anomalies" were inspected to ascertain the general character of copper mineralisation, and the impression was formed that this was structurally controlled and associated particularly with limey lithologies, except for the mineralisation near Walter's and Six Mile claims which is probably sedimentary.

TABLE 1

Showing Average Values for Lines 1 to 7 inside the Beltana Complex

| Line 1 | Line 2 | Line 3 | Line 4 | Line 5 | Line 6 | Line 7 |
|---|---|---|---|---|---|---|
| | | | COPPER (p.p.m.) | | | |
| 26 | 27 | 33 | 35 | 23 | 26 | 52 |
| | | | LEAD (p.p.m.) | | | |
| 24 | 29 | 24 | 29 | 31 | 27 | 27 |
| | | | ZINC (p.p.m.) | | | |
| 35 | 32 | 41 | 49 | 36 | 22 | 28 |

TABLE 2

Showing the Comparison of Lines 1 to 5 with Lines 6 & 7 (including Sample No. 313)

| Lines 1 to 5<br>Area of Fewer Igneous Outcrops | | Lines 6 & 7<br>Area of Densest Igneous Outcrops |
|---|---|---|
| | COPPER | |
| 29 | | 40 |
| | LEAD | |
| 28 | | 27 |
| | ZINC | |
| 40 | | 25 |

Note: Lines are weighted in accordance with their relative areas of influence as follows:-

| Line | | Weight |
|---|---|---|
| 1 | | 12 |
| 2 | | 9 |
| 3 | | 21 |
| 4 | | 22 |
| 5 | | 21 |
| 6 | | 15 |
| 7 | | 17 |
| | TOTAL | 117 |

# TABLE 3

## Showing the Comparison of Lines 1 to 5 with Lines 6 & 7 (excluding Sample No. 313 )

| Lines 1 to 5<br>Area of Fewer Igneous Outcrops | Lines 6 & 7<br>Area of Densest Igneous Outcrops |
|---|---|
| COPPER | |
| 29 | 28 |

Note: Lines are weighted in accordance with their relative areas of influence as follows:-

| Line | Weight |
|---|---|
| 1 | 12 |
| 2 | 9 |
| 3 | 21 |
| 4 | 22 |
| 5 | 21 |
| 6 | 15 |
| 7 | 17 |
| TOTAL | 117 |

TABLE 4

Showing Average Values for Stratigraphic Units outside the Beltana Complex

| STRATIGRAPHIC UNIT | Line No. | Sample Nos. | Cu (ppm) | Pb (ppm) | Zn (ppm) |
|---|---|---|---|---|---|
| Hawker Group | 9 | 601-609 | 26 | 97 | 223 |
| Pound Quartzite | 10<br>11 | 901-918<br>501-504 | 20 | 23 | 36 |
| Wonoka Formation | 11 | 505-528 | 28 | 29 | 66 |
| Bunyeroo Formation | 11<br>12 | 529-531<br>101-122 | 23 | 27 | 68 |
| ABC Quartzite | Representative composite sample | | 20 | 25 | 45 |
| Upper two members of Brachina Formation | 13 | 61-72 | 34 | 47 | 40 |

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TABLE 5

Showing Comparison of Core, Perimeter, and Remote Samples (Hawker Group Included)

| Element (ppm) | Core Samples (1) | Perimeter Samples (2) | Remote Samples (3) |
|---|---|---|---|
| Cu | 32 | 37 | 26 |
| Pb | 27 | 32 | 38 |
| Zn | 36 | 50 | 70 |

Notes:

(1) 163 samples - lines 1 to 7 weighted in accordance with their relative areas of influence.

(2) 21 samples - mean of line 8.

(3) 91 samples - lines 9 to 13 weighted in accordance with the relative stratigraphic thicknesses of the units taken to be as follows:-

| | |
|---|---|
| Hawker Group | 13 |
| Pound Quartzite | 30 |
| Wonoka Formation | 30 |
| Bunyeroo Formation | 16 |
| ABC Range Quartzite | 5 |
| Upper Brachina Formation | 22 |
| TOTAL | 116 |

## TABLE 6

**Showing Comparison of Core, Perimeter and Remote Samples (Hawker Group Excluded)**

| Element (ppm) | Core Samples (1) | Perimeter Samples (2) | Remote Samples (3) |
|---|---|---|---|
| Cu | 32 | 37 | 26 |
| Pb | 27 | 32 | 31 |
| Zn | 36 | 50 | 51 |

Notes:

(1) 163 samples - lines 1 to 7 weighted in accordance with their relative areas of influence.

(2) 21 samples - mean of line 8.

(3) 82 samples - lines 10 to 13 weighted in accordance with the relative stratigraphic thicknesses of the units taken to be as follows:-

| | |
|---|---|
| Pound Quartzite | 30 |
| Wonoka Formation | 30 |
| Bunyeroo Formation | 16 |
| ABC Range Quartzite | 5 |
| Upper Brachina Formation | 22 |
| TOTAL | 103 |

TABLE 7

Showing Comparison of Cu-Pb-Zn Values from Different Parts of the Hawker Group.

| Location of Samples | Number of Samples | Cu ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|
| Reconnaissance Line 9 | 9 | 26 | 97 | 223 |
| Red Range Fault | 41 | 34 | 108 | 157 |
| Red Range Limonite Zone | 131 | 92 | 387 | 461 |

TABLE 8

Showing Results of Soil Sampling along Puttapa Creek

| Sample Number | Unit Sampled | Cu ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|
| 6 | Pound Quartzite | 30 | 20 | 40 |
| 7 | Beltana Complex | 30 | 20 | 45 |
| 5 | Wonoka Formation | 25 | 20 | 55 |
| 4 | Wonoka Formation | 40 | 20 | 90 |
| 3 | Wonoka Formation | 30 | 25 | 65 |
| 2 | Wonoka Formation | 30 | 30 | 60 |
| 1 | Wonoka Formation | 30 | 30 | 70 |
| 30 | Wonoka Formation | 15 | 45 | 50 |
| 29 | Wonoka Formation | 25 | 30 | 85 |
| 28 | Wonoka Formation | 20 | 30 | 45 |
| 27 | Wonoka Formation | 20 | 35 | 55 |
| 26 | Wonoka Formation | 20 | 35 | 75 |
| 25 | Wonoka Formation | 10 | 35 | 75 |
| 23 | Wonoka Formation | 25 | 40 | 40 |
| 24 | Wonoka Formation | 15 | 30 | 65 |
| 22 | Wonoka Formation | 30 | 30 | 55 |

## TABLE 9

### Showing Results of Soil Sample Lines at Read's Ridge

| SW Line Sample No. | Cu ppm | Pb ppm | Zn ppm | Central Line Sample No. | Cu ppm | Pb ppm | Zn ppm | N.E. Line Sample No. | Cu ppm | Pb ppm | Zn ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BR3-1 | 25 | 30 | 35 | BR2-1 | 30 | 25 | 35 | BR1-1 | 10 | 20 | 25 |
| -2 | 20 | 30 | 30 | -2 | 30 | 20 | 25 | -2 | 20 | 30 | 25 |
| -3 | 25 | 25 | 25 | -3 | 25 | 25 | 20 | -3 | 25 | 25 | 25 |
| -4 | 20 | 25 | 25 | -4 | 25 | 25 | 25 | -4 | 35 | 20 | 35 |
| -5 | 15 | 25 | 20 | -5 | 30 | 25 | 30 | -5 | 25 | 20 | 45 |
| -6 | 20 | 20 | 20 | 06 | 25 | 20 | 25 | -6 | 25 | 25 | 30 |
| -7 | 25 | 25 | 25 | -7 | 25 | 20 | 25 | -7 | 15 | 25 | 20 |
| -8 | 25 | 20 | 25 | -8 | 25 | 20 | 30 | -8 | 40 | 25 | 25 |
| -9 | 45 | 20 | 30 | -9 | 40 | 20 | 25 | -9 | 45 | 25 | 25 |
| -10 | 35 | 20 | 30 | -10 | 35 | 25 | 30 | -10 | 55 | 20 | 30 |
| -11 | 30 | 20 | 20 | -11 | 40 | 25 | 35 | -11 | 60 | 20 | 25 |
| -12 | 30 | 20 | 20 | -12 | 50 | 20 | 40 | -12 | 55 | 25 | 20 |
| -13 | 20 | 20 | 25 | -13 | 40 | 25 | 35 | -13 | 30 | 20 | 15 |
| -14 | 25 | 25 | 20 | BR2-14 | 30 | 20 | 35 | -14 | 30 | 20 | 30 |
| BR3-15 | 20 | 30 | 25 | | | | | BR1-15 | 30 | 20 | 30 |
| Averages | 25 | 23 | 25 | | 32 | 22 | 29 | | 33 | 23 | 27 |

### Averages for all Lines

| Copper ppm | Lead ppm | Zinc ppm |
|---|---|---|
| 30 | 23 | 27 |

NOTES:

(1) All samples - 80 mesh fraction, 6-9" deep, 20 feet apart along 3 lines about 150 feet apart, numbered N.W. to S.E. in each line.

(2) All samples assayed for silver, and all values less than 8 ppm.

(3) All assays by Sampey Exploration Services - Method 101B.

## TABLE 10

### Showing Results of Soil Samples at Limonite Valley

| Non Ferruginous | | | | Ferruginous | | | |
|---|---|---|---|---|---|---|---|
| Sample No. | Cu ppm | Pb ppm | Zn ppm | Sample No. | Cu ppm | Pb ppm | Zn ppm |
| 7 | 10 | 25 | 15 | 1 | 15 | 40 | 20 |
| 8 | 10 | 20 | 40 | 2 | 15 | 20 | 30 |
| 9 | 25 | 20 | 55 | 3 | 25 | 20 | 35 |
| 10 | 10 | 20 | 30 | 4 | 10 | 30 | 40 |
| 11 | 25 | 20 | 50 | 5 | 25 | 30 | 25 |
| 12 | 20 | 20 | 40 | 6 | 50 | 30 | 40 |
| Averages | 17 | 21 | 38 | | 23 | 28 | 32 |

Averages - All Samples

| Copper ppm | Lead ppm | Zinc ppm |
|---|---|---|
| 20 | 24 | 35 |

NOTES:

(1) All samples - 80 mesh fraction, 6-9" deep.

(2) Each sample is a composite of six initial ones taken around evenly distributed outcrops which are either ferruginous or non ferruginous as shown.

(3) All assays by McPhar.

(4) All samples assayed for silver - all values less than 2 ppm.

## TABLE 11

### Showing Results of Soil Sample Lines at Siderite

| Sample No. | Cu ppm | Pb ppm | Zn ppM |
|---|---|---|---|
| 1 | 15 | 35 | 20 |
| 2 | 10 | 30 | 15 |
| 3 | 20 | 30 | 30 |
| 4 | 25 | 35 | 20 |
| 5 | 10 | 30 | 20 |
| 6 | 45 | 30 | 30 |
| 7 | 50 | 25 | 35 |
| 8 | 75 | 30 | 35 |
| Averages | 31 | 30 | 26 |

NOTES:

(1) All samples - 80 mesh fraction, 6-9" deep about 20 feet apart, along one line, across strike, through the centre of the leached limonitic and sideritic zone.

(2) All assays by McPhar

# TABLE 12

## Showing Results of Soil Samples at Harvey's Hollow

| Non Ferruginous | | | | Ferruginous | | | |
|---|---|---|---|---|---|---|---|
| Sample No. | Cu | Pb | Zn | Sample No. | Cu | Pb | Zn |
| 19 | 15 | 20 | 10 | 13 | 20 | 20 | 30 |
| 20 | 60 | 20 | 40 | 14 | 45 | 30 | 40 |
| 21 | 20 | 20 | 25 | 15 | 35 | 55 | 50 |
| 22 | 15 | 20 | 20 | 16 | 10 | 20 | 15 |
| 23 | 25 | 20 | 20 | 17 | 10 | 20 | 15 |
| 24 | 20 | 25 | 30 | 18 | 15 | 20 | 20 |
| Averages | 26 | 21 | 24 | | 22 | 27 | 28 |

Averages - All Samples

| Copper ppm | Lead ppm | Zinc ppm |
|---|---|---|
| 24 | 24 | 26 |

NOTES:

(1) All samples - 80 mesh fraction, 6-9" deep.

(2) Each sample is a composite of six initial ones taken around evenly distributed outcrops which are either ferruginous or non ferruginous as shown.

(3) All assays by McPhar.

(4) All samples assayed for silver - all values less than 2 ppm.

## TABLE 13

### Showing Results of Soil Sample Lines at Iron Blow

| Southern Line | | | | Central Line | | | | Northern Line | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample No. | Cu ppm | Pb ppm | Zn ppm | Sample No. | Cu ppm | Pb ppm | Zn ppm | Sample No. | Cu ppm | Pb ppm | Zn ppm |
| BA3-1 | 320 | 40 | 35 | BA2-1 | 290 | 30 | 35 | BA1-1 | 1200 | 80 | 25 |
| -2 | 360 | 30 | 25 | -2 | 410 | 30 | 40 | -2 | 265 | 30 | 10 |
| -3 | 250 | 30 | 20 | -3 | 380 | 40 | 40 | -3 | 600 | 30 | 10 |
| -4 | 150 | 25 | 15 | -4 | 155 | 40 | 60 | -4 | 95 | 30 | 15 |
| -5 | 35 | 40 | 20 | -5 | 40 | 40 | 20 | -5 | 130 | 30 | 110 |
| -6 | 25 | 40 | 25 | -6 | 20 | 30 | 30 | -6 | 45 | 30 | 15 |
| -7 | 35 | 40 | 20 | -7 | 15 | 30 | 20 | -7 | 450 | 40 | 100 |
| -8 | 140 | 30 | 15 | -8 | 25 | 40 | 35 | -8 | 100 | 40 | 70 |
| -9 | 1150 | 40 | 30 | -9 | 350 | 50 | 40 | -9 | 70 | 30 | 35 |
| BA3-10 | 45 | 40 | 15 | BA2-10 | 340 | 40 | 30 | BA1-10 | 60 | 30 | 25 |
| Averages | 251 | 35 | 22 | | 202 | 37 | 35 | | 261 | 37 | 41 |

### Averages for all Lines

| Copper ppm | Lead ppm | Zinc ppm |
|---|---|---|
| 238 | 36 | 33 |

NOTES:

(1) All samples - 80 mesh fraction, 6-9" deep, 20 feet apart along three lines about 200 feet apart, numbered west to east in each line.

(2) All samples assayed for silver - all values less than 1 ppm.

(3) All assays by Sampey Exploration Services - Method 101B.

## 6.0 REFERENCES

COATS, R.P. 1964. The Geology and Mineralisation of the Blinman Dome Diapir. Report of Investigations. Geological Survey of S.A. 26.

LEESON, B. 1966a. Geological Atlas of South Australia. Sheet Beltana - 1 inch to 1 mile. Geological Survey of South Australia.

LEESON, B. 1966b. Geology of the Beltana 1:63360 Map area. South Australian Mines Dept. Rept. Bk. 63/58 (unpublished).

## ADDENDUM I

During early examinations of the Beltana Diapir, certain observations seemed at variance with the diapiric interpretation understood from the Beltana 1 mile map, the explanatory report (especially Figure 5) by B. Leeson, and from other more general data available at that time. The main issues were communicated briefly to the Mines Dept. in the report for the Quarter ended 18-9-68 as follows:

"Much of the breccia within the complex is thought to have originated by subaqueous slumping. A further proportion is attributed to caving over sink holes and less clear cut examples of settling due to weathering. It is felt that recognition of "diapiric breccia" and discrimination between this and the two main kinds of breccia mentioned above must be relatively interpretive.

Having regard to the prevalence of intrusive ? igneous rocks, the large size of the rafts, the relatively small amount of interstitial breccia, the difficulty of recognising "diapiric breccia", the marginal effects suggestive of erosion and redistribution of core material, it is thought preferable to refer to the complex zone simply as a complex until a clear case for the diapiric model or an alternative one is indicated. At the present time, consideration is being given to the possibility that the complex was initiated as a penecontemporaneous fault block bounded by basement fractures, and that this was subsequently deformed and intruded during the Lower Palaeozoic. Such an origin would conceivably produce effects rather similar to those attributed to diapirism, and might explain the individual characteristics of this particular complex a little better."

Following a request for a map showing the distribution of igneous material, etc. some notes entitled "Remarks concerning the Beltana Complex" were prepared and issued with the report for the Quarter ended 18-12-68. These notes are included below as Addendum II.

In August, 1969, a report entitled "Remarks concerning Reinterpretation of the Beltana Diapir Structure" by B. Leeson was received from the Mines Dept. A copy of this is included below as Addendum III. This indicates that Leeson and myself are at considerable variance in what we regard as facts, and in what interpretations we give to these supposed facts.

Some final remarks are given in Addendum IV to clarify the important points of difference, and show why the composite interpretation is preferred.

# REMARKS CONCERNING THE BELTANA COMPLEX

By Walter D. Smith ADDENDUM II

067

## INTRODUCTION

Examination of the feature mapped as the Beltana Diapir (Leeson (1966a and 1966b)) revealed some new data and suggested that an alternative interpretation was possible. The facts and arguments supporting this conclusion are outlined below. As it is possible that some workers will not agree with the preferred interpretation, and in order to preserve clarity in nomenclature and anticipate future discussion, it appears best to my mind to refer to Leeson's Beltana Diapir by the non genetic term Beltana Complex.

For clarity of presentation, the chief evidence and argument supporting certain points is assembled in appendices referred to by matching superscripts.

The word diapir is used in the sense envisaged by Leeson for the Beltana Diapir, namely a piercement feature produced by a plastic medium flowing laterally from a particular stratum to a certain point and emerging there in intrusive fashion carrying fragments of older rock with it and leaving them in positions relatively higher stratigraphically than their normal levels. The word piercement is used in a much more general sense for any process responsible for relative uplift of older rocks amongst younger ones involving structural disturbance.

Most of the outcrops (210) were examined individually except where it was readily recognisable that zones of essentially similar kind were present. This resulted in a number of conclusions enumerated below.

## CONCLUSIONS ARISING FROM MAPPING

1. Certain peripheral outcrops appear to represent fringing sedimentary debris rather than intrusive core material. (1)

2. Most of the breccia and nearly all of it that is describable as having a carbonate matrix occurs towards the margin of the complex. (2)

CONCLUSIONS ARISING FROM MAPPING (Cont.)

3. Rocks in the central zone appear to be representatives of units lower in the sequence than the rim rocks, and the apparent degree of structural deformation is greater, implying some sort of piercement feature. (3)

4. The complex can be resolved fairly realistically into a central piercement zone and a fringing debris zone. (4)

5. Certain lithologically and structurally continuous exposures are extremely large in relation to the central piercement zone. (5)

6. The reality of the matrix-fragment relationship implied by Leeson is questionable, especially within the central piercement zone, and at least it may be said that the fragment to matrix ratio must be very large. (6)

7. Long continued recurrent movements influenced sedimentation in units ranging from the Brachina Formation to the Pound Quartzite. (7)

8. Despite early initiation of the Beltana Complex, most of the stratigraphic displacement evident across it appears to be the result of late differential deformation across a pre-existing fault surface. (8)

9. There are a substantial number (about 40) of igneous rocks regarded as intrusives within the complex but none have been recognised outside it. (9)

INTERPRETATION OF THE BELTANA COMPLEX

Having regard to the fact that the interpretation of the Beltana Complex must satisfy at least the nine conclusions listed above, I prefer to interpret the complex as a central piercement zone plus a fringing

INTERPRETATION OF THE BELTANA COMPLEX (Cont.)

debris zone, and not to regard the central piercement zone as a diapir in the sense envisaged by Leeson.

The interpretation which in my opinion best fits the facts is that of an emergent penecontemporaneous fault block, partly mantled and fringed by disturbed cover rocks, later deformed and intruded by younger igneous rocks.

The important differences in interpretation are that :

1. The emplacement of Callana Beds and other Lower Adelaidean rocks is believed to have involved less brecciation and interstitial breccia than implied by Leeson.

2. Disturbances of cover and fringe rocks, with sedimentary breccias and irregularities due to gravity sliding, are believed to have occurred to a greater degree than envisaged by Leeson.

3. Penecontemporaneous block faulting is invoked as an important factor in the development of the piercement feature - this would largely replace the role formerly attributed to a mechanism analogous to salt diapirism.

   Certain aspects of the hypothetical fault block are enlarged upon in appendices 10 and 11.

A summary comparison of the nine points listed above with the two different models, i.e. Leeson's diapiric one and the preferred distorted Horst model, is given below (see Table).

<table>
<tr><th rowspan="2">CONCLUSION<br>(Points 1 to 9 listed above)</th><th colspan="2">FIT OF CONCLUSION WITH</th></tr>
<tr><th>Leeson's Diapiric Concept</th><th>Distorted Horst Concept</th></tr>
<tr><td rowspan="2">1. Presence of peripheral sedimentary debris.</td><td>Poorer</td><td>Better</td></tr>
<tr><td colspan="2">- but this is only a detail in relation to the overall feature.</td></tr>
<tr><td>2. Most of breccia, especially carbonate breccia, in or near the margins of the feature.</td><td>Poorer</td><td>Better</td></tr>
<tr><td rowspan="2">3. Core material comprised of older more disturbed rocks from lower in sequence compared with the rim rocks.</td><td>Better</td><td>Poorer</td></tr>
<tr><td colspan="2">- due to the extraordinary degree of disturbance which has no fully satisfactory explanation in terms of the distorted Horst concept.</td></tr>
<tr><td rowspan="2">4. Presence of central piercement and fringing debris zones.</td><td>Poorer</td><td>Better</td></tr>
<tr><td colspan="2">- but this is only a detail in relation to the overall feature.</td></tr>
<tr><td>5. Large size of certain exposures.</td><td>Poorer</td><td>Better</td></tr>
<tr><td>6. Questionable aspect of the matrix fragment relationship and relative proportions.</td><td>Poorer</td><td>Better</td></tr>
<tr><td rowspan="2">7. Long duration of recurrent movements.</td><td>Poorer</td><td>Better</td></tr>
<tr><td colspan="2">- but difference here very small to negligible.</td></tr>
</table>

| CONCLUSION (Points 1 to 9 listed above) | FIT OF CONCLUSION WITH | |
|---|---|---|
| | Leeson's Diapiric Concept | Distorted Horst Concept |
| 8. Early initiation of the Beltana Complex axial fault and the fact that the present repetition is due to differential deformation across it. | No preference for either model. | |
| 9. Preferential intrusion of Beltana Complex. | Poorer | Better |

# APPENDIX 1

Examination of Leeson's Beltana Diapir indicated that certain parts of it could plausibly be regarded as fringing debris rather than intrusive core material. This comment applies particularly to outcrops containing water worn pebbles of core material suggestive of sedimentary redistributive processes, e.g. those outcrops indicated on the map in the B6, B8, J10, K9 and F7 areas. The B8 exposure in particular was formerly regarded as intrusive in character in common with the whole feature. (See Leeson 1966b, Figure 5). Since fringing sedimentary material is not indicated within the Beltana Diapir on the map or in the text, it appears desirable to discriminate between core and fringing debris, and this creates the need for new terminology to preserve clarity.

Thus :

| Leeson's Term | Term Adopted Herein |
|---|---|
| Beltana Diapir | Beltana Complex: Central Piercement Zone; Fringing Debris Zone |

- oOo -

Ignoring water worn gravels etc. of post Adelaidean age which mask substantial parts of some marginal areas mapped as the Beltana Diapir, three genetically different kinds of breccia have been recognised or suspected, and these must include "diapiric breccia" which I was unable to discriminate by inherent characteristics. I believe that recognition of this kind of breccia in the Beltana Complex is interpretive.

The three kinds of breccias recognised or suspected are :

1. Fault breccias.

2. Breccias due to weathering effects (in part at least).

3. Sedimentary breccias.

Concerning (1) above, fault breccias are areally unimportant, and they are unlikely to be interpreted differently by different personnel.

Concerning (2) above, there is a definite degree of uncertainty, not so much in recognition of weathering effects, but in knowing whether or not the brecciation due to weathering was preceded and facilitated by an earlier primary brecciation. There is a major possibility of superimposition of genetically different effects in this case. Some of the breccias that I regard as due at least partly to weathering are quite spectacular in appearance and it is possible that they had undue influence concerning interpretation of breccias in relation to the diapiric model. The most striking examples within the Beltana Complex occur in Sliding Rock Creek (see map). (See also figures 8 and 9 in Coats (1964), which illustrate breccias consisting of highly weathered material. These may represent subsidence breccias due to weathering, although even if this is so, it does not preclude the possibility that an earlier brecciation of a different sort preceded and facilitated the subsidence effects.)

Concerning (3) above, I believe that sedimentary breccias are by far the most common for the entire complex. There are a variety of different kinds. Three major generalisations may be made. Firstly, the vast majority of breccias within the central piercement zone occurs within sandstone-quartzite lithologies. Secondly, nearly all the breccia that could be described as having a carbonate matrix occurs in the fringing debris zone.

Thirdly, the textures of both groups mentioned above suggest stretching and jostling and slumping effects which I prefer to interpret as responses to submarine rather than subterranean processes of formation. If there is any important amount of "diapiric breccia" within the Beltana Diapir it must be included within this group.

- oOo -

## APPENDIX 3



The conclusion that the core rocks of the Beltana Complex represent units older, more deformed, and relatively uplifted with respect to the rim rocks is not new. Leeson recognised this in the individual case of the Beltana Complex, and the conclusion appears to be shared with a number of other piercement features throughout the Adelaide Geosyncline.

## APPENDIX 4

Exact boundaries between the two zones do not exist, and the two zones are not entirely mutually exclusive. Nevertheless I believe they are realistic, and that other personnel would recognise the same zones though their boundary lines would probably vary a little. It is only the principle and not the positions of the zones that is important here.

The central piercement zone is characterised by large exposures of relatively persistent lithology and structure, comparatively little breccia, sandstone breccias rather than carbonate breccia, and a number of younger igneous intrusives.

The fringing debris zone is distinguished by smaller exposures, non persistence of lithology and structure, comparatively more breccia, carbonate breccia as well as sandstone breccia, absence of younger igneous intrusives, and especially by the presence of obviously water worn debris in conglomerates suggesting sedimentary redistribution of eroded core material.

## APPENDIX 5

The prominent quartzite outcrop (see Frontispiece Leeson 1966b) is about $1\frac{1}{2}$ miles in length, and several other outcrops are nearly as large. Moreover these several very large outcrops which dominate most of the central piercement zone could be interpreted as approximating to their true stratigraphic positions with respect to each other. The point cannot be proved because of alluvium which masks the relationships. But as good a case could be argued that the individual large outcrops are nearly in their true stratigraphic relationships with respect to each other as that they are essentially distinct and separated from each other by a matrix of "diapiric breccia with carbonate matrix". At least it may be said that this latter interpretation would require virtually all of the "diapiric breccia with carbonate matrix" to occur only in the areas of no outcrop.

The size of the fragments becomes more critical because of reduction of the overall piercement zone from Leeson's Beltana Diapir to only the central piercement zone of the Beltana Complex. So also does the existence and amount of interstitial breccia become of critical importance for the same reason. (See Appendix 6).

## APPENDIX 6

Owing to the recognition of a fringing debris zone as well as a central piercement zone, it is clear that the brecciation evident in the former is not admissible as evidence in support of the role implied by Leeson for the breccia in relation to the feature as a whole. Isolated patches of breccia of very small size do occur here and there throughout the central piercement zone, but not so generally, nor in such a way as to support unquestionably the matrix-fragment relationship implied by Leeson, and upon which the diapiric interpretation relies very heavily. Even if the matrix-fragment relationship is real, I believe the nature and texture of the breccia suggests a submarine rather than a subterranean process of formation. Thus I believe that the matrix-fragment relationship is questionable in fact and also in interpretation.

- oOo -

## APPENDIX 7

Leeson (1966b) lists eight stratigraphic irregularities indicative of an influence by the Beltana Complex on sedimentation in units adjacent to it ranging from the Brachina Formation to the Pound Quartzite. Thus it seems that the complex was initiated at least as early as Brachina Formation time and that (probably intermittent) movements persisted penecontemporaneous with sedimentation until Pound Quartzite time. Various satellite occurrences of water worn material provide additional examples not recognised by Leeson.

## APPENDIX 8

The relative positions of corresponding units in sequence north and south of the Beltana Complex indicate a displacement of over 5,000 feet across a surface approximating the long axis of the complex with a north block up sense. The complex (and presumably its axial fault) is believed to have been initiated at least as early as Brachina Formation time. However, although local changes in thickness and character within individual units near the complex are common, the overall thickness of the sequence ABC Quartzite to Pound Quartzite inclusive is about the same on both sides of the complex (about 8,000 feet). Since the known movement on the fault is very large compared with the thickness of sediment accumulating during the penecontemporaneous movements of the complex, it seems likely that most of the movement post-dated deposition of the sequence up to and including the Pound Quartzite. Therefore it is likely that the climactic deformation in the Lower Palaeozoic was responsible for the stratigraphic repetition evident across the complex. Thus the Beltana Complex axial fault preceded deformation of the Wilpena Group, and may be expected to have been warped in the same sense by the movements. Some measure of independent support may be found for this in the fact that the Beltana Complex axial fault must follow a curved path. It is recognisable in the north east and south west ends of the complex, but must follow a curved path around certain large intact exposures within the complex. (See the inferred position shown on the map).

Note that Leeson (1966b) supports a path following the northern limit of the main mass of the Beltana Diapir which implies an even more curved path.

# APPENDIX 9

About 40 separate well distributed outcrops of igneous rock (regarded as intrusive) occur within the Beltana Complex. Since there are about 40 inside and none known outside the complex, it is clear that there is a fundamental relationship of some sort between the complex and intrusive igneous rocks.

It could be disputed whether all of the igneous outcrops are intrusive rather than rafts of old igneous rocks referable to the Callana Beds. However the intrusive character of some is quite clear, and most outcrops are very similar or identical in appearance. Thus, if not all of the outcrops are intrusive, I believe most of them are, and the fundamental implications will be the same.

The igneous intrusives all fall within the Beltana Complex, mostly in the north eastern part near the axial fault. They all fall (partly by definition of course) within the central piercement zone.

Most of the igneous outcrops are doleritic in appearance with coarser and more acid varieties, and several collinear occurrences of gneiss near the axial fault. (See map). In a number of instances altered sediments are exposed adjacent to the igneous rocks.

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TABLE TO ACCOMPANY APPENDIX 9

| Outcrop Number | Macroscopic Identification | Microscopic Identification | Slide No. |
|---|---|---|---|
| 1 | Dolerite | | |
| 2 | Dolerite | | |
| 3 | Dolerite | | |
| 4 | Dolerite | | |
| 5 | Leucocratic Gneiss | | |
| 6 | Foliated Dolerite | Plagioclase Hornblende Gneiss | A2072 |
| 7 | Dolerite | | |
| 8 | Dolerite | Altered Dolerite | A2059 |
| 9 | Gneiss | Gneiss | |
| 10 | Dolerite | | |
| 11 | Dolerite | | |
| 12 | Dolerite | | |
| 13 | Dolerite? | Reconstituted carbonitised Argillaceous sediment | A2064 |
| 15 | Gneiss | | |
| 16 | Dolerite | | |
| 17 | Dolerite | | |
| 18 | Dolerite | | |
| 19 | Dolerite | | |
| 20 | Dolerite | | |
| 21 | Dolerite | | |
| 22 | Dolerite | | |
| 23 | Dolerite | | |
| 24 | Dolerite | | |
| 25 | Dolerite | | |
| 26 | Granophyre | Granophyre | A2068 |
| 27 | Dolerite and Metasomatised sediment | Impure Arkose | A2069* |
| 28 | Dolerite | | |
| 29 | Diorite? | | |
| 30 | Dolerite | Scapolitised Dolerite | A2073 |
| 31 | Dolerite | | |
| 32 | Dolerite | | |
| 33 | Dolerite | | |
| 34 | Dolerite | | |
| 35 | Dolerite | | |
| 36 | Dolerite | | |
| 37 | Dolerite | | |
| 38 | Dolerite? | K-Metasomatised impure Arkose | A2070 |

* A2069 refers to the metasomatised sediment.

## Aspects of the Original Fault Block Model

It appears plausible in theory that the boundary faults of a piercement block might well be masked by disturbances in the sediment adjacent to the moving block and in the rocks above it which may have been dislodged and re-orientated by processes of gravitational sliding and sedimentary redistribution. Accordingly the hypothesis of a piercement fault block is not weakened by the fact that its boundary faults cannot be mapped directly but can only be guessed at in a hypothetical way. Note that the Beltana Complex axial fault is recognisable directly only at the north east and south west ends of the complex and not in between, despite the fact that an obvious stratigraphic repetition of over 5,000 feet provides complete confidence in its continuity in depth between these extremities.

Since definite evidence can be adduced to support a central piercement zone and a fringing debris zone in the case of the Beltana Complex, it is hypothesised that the core represents a deformed penecontemporaneous block bounded by hypothetical faults approximately in the positions shown in the map. Penecontemporaneous faulting has occurred rather generally throughout the Adelaide Geosyncline, and variably emergent blocks with associated stratigraphic effects are a logical corollary.

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## APPENDIX 11



### The Piercement - Intrusive Relationship

It is well established that gravity (normal) faulting such as is responsible for the development of horst and graben relationships, is closely associated with basic igneous activity, both features representing effects of the same cause, namely the appropriate stress condition. It is difficult to envisage major gravity faulting without compensating redistribution of plastic material (potentially molten magma) in the subcrust. Consequently if the presence of (chiefly basic) intrusives in piercement zones is not actually accepted as indicative of involvement of early block faulting in the piercement process, at least it may be said that the association is very plausible, and to be expected rather than remarked upon, in relation to a piercement process initiated by penecontemporaneous block faulting. Despite this, it is not suggested that piercement by fault block emergence explains all or even any of the piercement features of the Adelaide Geosyncline in toto. However it is suggested that fault block emergence together with associated penecontemporaneous stratigraphic irregularities may explain most of the characteristics of the Beltana Complex, and may have some significance in relation to the initiation of some of the other piercement features.

- oOo -

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ADDENDUM III



Rept.Bk.No. 68/83
G.S. No. 4232
D.M. No. 1867/67

## REMARKS CONCERNING REINTERPRETATION OF THE BELTANA DIAPIR STRUCTURE

These notes should be read in conjunction with the report by Carpentaria Exploration Coy Pty Ltd. on S.M.L. 170 for the quarter ended 18.12.68. Mr. Smith's report concerns the interpretation of a complex inlier of rocks of Willouran age in the north of the Beltana map area which I regarded as being of diapiric origin (Leeson, 1966a and b.).

In his report (Smith, 1969) Mr. Smith lists nine points which he considers are better explained by an alternative structural model. The proposed model consists of a central horst fault-block surrounded by a zone of slump breccia. I have listed below Mr. Smith's nine conclusions together with my comments. These notes should be read in conjunction with the Appendices 1-9 of Mr. Smith's report.

1. "Certain peripheral outcrops appear to represent fringing sedimentary debris rather than intrusive core material". - W.D.S.

   Unfortunately I cannot comment without a field review of the particular outcrops. I might add, however, that I did not place this interpretation upon any of the outcrops I saw during my field-mapping programme (1964-1965). Submarine slumping is not incompatible with a diapiric model, since there is independent evidence of the periodic emergence of the diapir during the Pre-Cambrian.

2. Most of the breccia and nearly all of it that is describable as having a carbonate matrix occurs towards the margin of the complex." - W.D.S.

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One would anticipate a greater degree of brecciation towards the margin of a diapir because of the drag-effect of the walls. I think that there is sufficient fine carbonate-type breccia throughout the diapir, both exposed and covered by superficial debris, to be compatible with the diapiricmodel. The type and amount of matrix



required to permit diapiric movement (if indeed it acts as a lubricant) are unsolved problems (see Addendum, point 3).

3. "Rocks in the central zone appear to be representatives of units lower in the sequence than the rim rocks, and the apparent degree of structural deformation is greater, implying some sort of piercement feature.". - W.D.S.

This is compatible with the diapiric model.

4. "The complex can be resolved fairly realistically into a central piercement zone and a fringing debris zone". - W.D.S.

This is essentially a statement of the final model rather than supporting evidence for the model. Appendix 4 of Mr. Smith's report offers supporting descriptive evidence based on the juxtaposition of a central zone characterized by large blocks, igneous material, and only a little breccia dominantly of a sandstone type, with a peripheral zone characterized by a smaller exposures, a greater percentage of breccia (particularly of the carbonate type), the absence of younger igneous rocks, and the presence of conglomerates.

These individual points are dealt with elsewhere in these notes.

5. "Certain lithologically and structurally continuous exposures are extremely large in relation to the central piercement zone". - W.D.S.



Blocks of similar size have been recorded from other South Australian diapirs which have been mapped in detail eg. Blinman Dome Diapir, Lyndhurst Diapir, and from evaporite type diapirs in other parts of the world eg. the Upheaval Dome Diapir, Utah; and the Isaachson Dome, Canada.

The space problem in the Beltana structure is not acute if one adopts the diapir model.

I do not think that there is sufficient correlation to regard the larger blocks in the Beltana structure asbeing in approximately correct stratigraphical relationships. But this is a minor point and does not affect the diapiric model. The retention of original relationships is a function of plasticity and the space problem.



In evaporite-type diapirs there is a less chaotic mixing of elements.

The distribution of large blocks is not confined to the central area of the structure. Quite large blocks of siltstone (admittedly unspectacular in appearance) occur within Smith's peripheral zone eg. a large block of siltstone in the narrow northern apophysis to the east of the Beltana - Copley road.

With respect to the distribution of fine breccia within the structure (Smith, Appendix 5), it must be emphasised that this type of breccia does occur in outcrop in the central part of the structur Moreover,I think it is likely that, because of its relatively low resistance to weathering, this breccia would occupy low ground an could be present in greater amount beneath the widespread recent alluvium.

6. "The reality of the matrix-fragment relationship implied by Leeson is questionable, especially within the central piercement zone, and at least it may be said that the fragment to matrix ratio must be very large". - W.D.S. 086

Since it is a matter of field-interpretation, no observation can be made here upon the nature and texture of the breccia, except to record that I regard it to be largely a tectonic-type of breccia compatible with a diapiric origin. It is invalid to preclude as evidence of a diapiric mechanism of intrusion for the whole structure that breccia which lies within Smith's "fringing debris zone" (Appendix 6 of Mr. Smith's report).

There is possibly a question of terminology being somewhat at fault. The phrase "Undifferentiated diapiric b reccia with carbonate matrix" (Legend; Beltana 1:63,360 Sheet) is in part a convenience to cover areas which (1) have not been mapped in detail; (2) could not be mapped in detail either because of complexity, superficial cover, or cartographic limitations. Its use here includes disoriented blocks of too small a size to be cartographically represented. Breccia is not a very specific term unless qualified, and to my knowledge, there is no limitation by definition to the size of the breccia elements. There is, moreover, no implication in the



above phrase of the relative proportions of blocks and fragments to matrix.

I do not think that the fragment to matrix ratio is critical. It is a function of the space problem and of the plasticity of the diapiric mass, and will vary from diapir to diapir according to regional variations in those factors. (See Addendum 3).

7. "Long continued recurrent movements influenced sedimentation in units ranging from the Brachina Formation to the Pound Quartzite". - W.D.S.



I believe there is sufficient evidence for this statement. It appears to be a common feature of diapirs, both of the South Australian type and the more widely occurring evaporite type.

8. "Despite early initiation of the Beltana Complex, most of the stratigraphic displacement evident across it appears to be the result of late differential deformation across a pre-existing fault surface". - W.D.S.

I agree with this and with most of Appendix 8, although I consider that there is a single axial fault along the northern boundary of the whole complex. There does not seem to be any supporting evidence from the aeromagnetic map to postulate that this fault affects the basement, although I think that this is possibly an essential feature for the initiation of the diapiric mechanism.

9. "There are a substantial number (about 40) of igneous rocks regarded as intrusives within the complex but none have been recognised outside it". - W.D.S.

I regarded many of the smaller occurrences of igneous rock as being blocks of Willouran volcanics, although I accept that at least two in the northereastern part of the complex do show intrusive characteristics. I did not attach a great deal of importance to those occurrences which I regarded as detached blocks of older volcanics, and since they were below the size for strict cartographic representation I did not record their positions.

Perhaps intrusive characteristics exist in other blocks. However in regional mapping it is not possible to record the position of all occurrences on a sketch map in the way that Mr. Smith has done.

With regard to the absence of igneous material from the peripheral zone, I do not know of any igneous occurrences outside the limits of the Central Zone as designated by Mr. Smith. Igneous bodies do however occur in other diapiric structures adjacent to wall-rocks viz. the Nilpena Diapir, Beltana 1:63,360 sheet. I do not preclude the possibility that similar occurrences would be found by detailed search in the areas shown as peripheral on Smith's map. It is of interest to note in this context that in the east-central part of the diapir where the greatest number of occurrences are shown, the northern limit of the central horst (and of the igneous occurrences) is coincident with the boundary of the diapir.

1. Smith's model incorporates an uplifted central horst block involving, one assumes, a portion of the basement. The Willouran sequence in the Beltana area is probably no more than 5,000 feet thick with a sequence of 25,000 to 30,000 feet of Adelaidean rocks above it. The horst model implies that there is a difference to basement across the horst of the order of 20,000 to 25,000 feet. One would expect this difference to have some reflection on the pattern of aeromagnetic contours. However the only unusual pattern of contours over the Beltana Complex is a small, roughly circular "high" which is probably related to a large subsurface development of the small igneous intrusion shown on the published geological map in the northeastern part of the Complex.

There seems to be no specific aeromagnetic characteristic of the Flinder Ranges diapirs. Some diapirs show a strong, irregular pattern of aeromagnetic contours, (eg. Oraparinna Diapir), while others show no magnetic response (eg. Worumba and Arkaba Diapirs).



This variability may be related to the amount of intrusive igneous material present in the structures.

2. The narrow eastern extension of the Beltana Complex in the vicinity of Puttapa Spring, where it contains blocks of Willouran sediments, is less easily explained in terms of Smith's model, than in terms of a diapiric mechanism. Linear diapiric injections of this type are common in the Central Flinders Ranges (cf. Nuccaleena Dome, Beltana and Cadnia 1:63,360 geological sheets), and in areas of salt domes in other parts of the world. Similar linear structures have been reproduced in model experiments (Tanner and Williams, 1968).

3. Severe brecciation does not seem to play an important role in the more widespread evaporite diapirs. In the symposium "Diapirism and Diapirs" (Braunstein and O'Brien, 1968) brecciation is remarked upon only once (in connection with the Spanish salt-diapirs). It would appear that this phenomenon is a function of 1) the plasticity of the diapiric material, and 2) the space problem. With respect to the latter, some authors have postulated that stress conditions are essential to diapir initiation (eg. Tanner and Williams, op.cit.). The greater the degree of stress, the smaller the space problem would become, and, one assumes, the lesser the degree of brecciation. A variability in the stress pattern over a region would result in varying degrees of space problem between individual diapirs, and variability in the severity of the brecciation.

The mobility of the type of diapiric material present in South Australian diapirs is an unresolved problem. It is assumed that brecciation is essential to the mobility of the mass. Tanner and Williams (op.cit.) consider that under suitable conditions of plasticity (governed by temperature and pressure?) sandstone would flow in the same manner as salt. Gussow (1968) considers that plasticity (sufficient for diapiric injection) occurs for solids at only half their melting temperatures. With a depth of burial of 15,000 to 20,000 feet a high background temperature would be regional, while igneous activity (perhaps governed itself by the pattern of basement faults) would provide localized centres of critical temperature conditions to initiate plastic diapirism. The rock would ascend plastically until cooling restored its brittleness. Further upward movement would result in brecciation; the degree of brecciation being governed by the space problem.

4. While I am unable to comment upon the validity of Mr. Smith's field-interpretation of certain outcrops as representing sedimentary and slump breccia, the presence of such material would not preclude a diapiric origin for the structure as a whole. A prolonged exposure at the land surface (or sea bottom) while the diapiric column was still active would result in the sub-aerial or sub-marine erosion and slumping of the rising mound. The "mushroom" effect produced by a thick mantle of this type of material stretching away from the edges of diapirs, has been noted from salt diapirs (eg. the Eienhausen Salt Dome, N.W. Germany). Whether this "mushrooming" took place to any great extent with the Beltana Diapir during the Lower Cambrian can be implied from 1) a study of slump and sedimentary breccia, and 2) a study of the nature of contacts with the rim-rocks, and the steepness of the rim-rocks. Except along a part of the southern margin where the contact is largely masked by Recent creek alluvium, the country rock rimming the Beltana Diapir show steep to overturned dips compatible with diapiric movement rather than mantling with slump debris.

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6.6.69

ADDENDUM 1V

Leeson's comments do not negate any of the facts or difficulties presented by me, nor alter any interpretations. There are many points with which I do not agree but these issues are such as will not be resolved in writing in Adelaide. Consequently the comments below are confined to general matters, and not points of detail.

Leeson's comments seem most valuable as an expression of his opinion that the complexity of the Beltana Complex can be accounted for by one diapiric process. It seems to be on this point that the most significant difference of opinion exists. My proposal is a composite one, consisting of three main stages, namely:-

(1) Initiation of a piercement feature by an emergent fault block.

(2) Disturbance of cover rocks by processes including gravity sliding and sedimentary re-distribution of ~~core~~ cover rocks.

(3) Deformation of the complex already formed, causing diapiric remobilisation of sediment brecciated chiefly by the earlier fragmentary processes due to gravitational instability.

The composite interpretation relies upon three different mechanisms. Each is plausible independently, and the combination is plausible collectively. All three mechanisms (and especially the first two) are plausible in the context of the Adelaide Geosyncline. There is definite supporting evidence for all three mechanisms.

The composite interpretation considerably reduces problems related to motivation, lubrication and room.

Most of the brecciation is attributed to lateral sliding effects causing unstressed pull-apart type breccias, or more advanced varieties with fragments scattered throughout a reslurried dolomitic matrix.

Most of the uplift of older rocks amongst younger ones is attributed to contemporaneous block faulting during Adeladean sedimentation, augmented by relatively limited diapiric injection during the Ordovician orogeny.

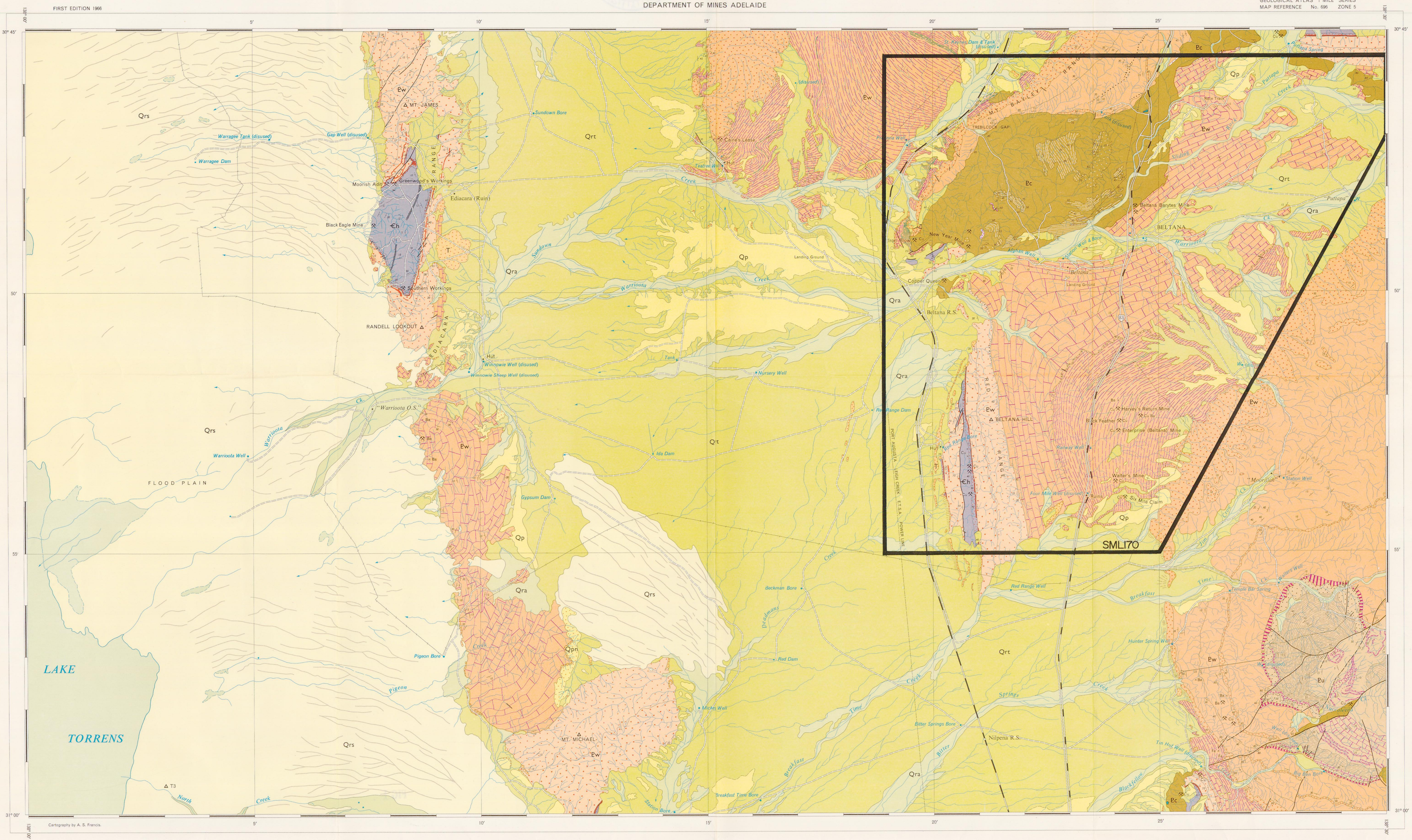
The drags evident around the Beltana complex are attributed to diapiric movement during the Ordovician orogeny.

# BELTANA

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

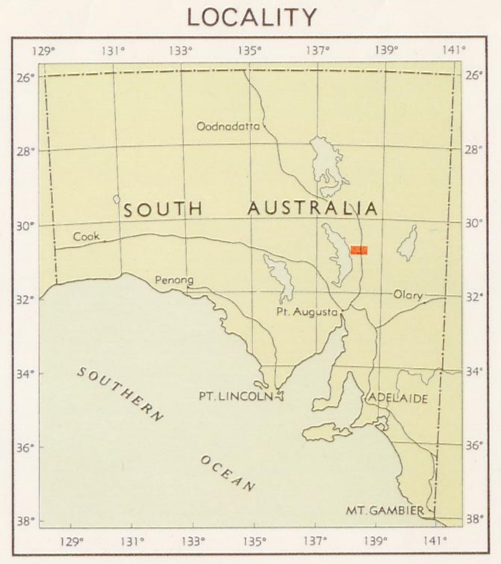
FIRST EDITION 1966

GEOLOGICAL ATLAS 1 MILE SERIES
MAP REFERENCE No. 696 ZONE 5




Cartography by A. S. Francis.

## LOCALITY




## INDEX TO ADJOINING SHEETS

| | | |
|---|---|---|
| SCOTT | COPLEY | ANGEPENA |
| MURDIE | BELTANA | CADNIA |
| CARRAPATEENA | PARACHILNA | BLINMAN |

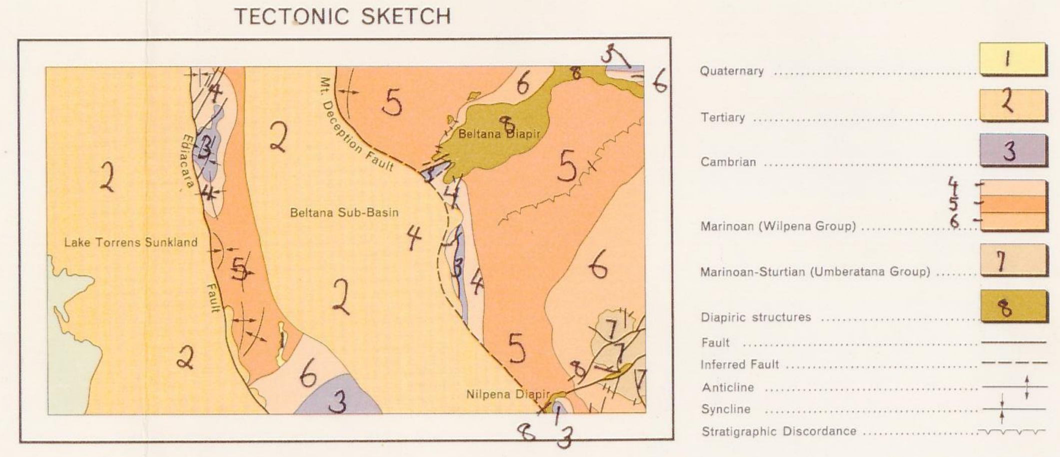
SCALE: 1 : 63,360 — 1 INCH TO 1 MILE

CHAINS 80 60 40 20 0 1 2 3 4 5 6 7 8 9 MILES

METRES 1000 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 KILOMETRES

H. J. WALL, GOVERNMENT PHOTOLITHOGRAPHER, ADELAIDE.

## TECTONIC SKETCH




## REFERENCE

CAINOZOIC — QUATERNARY — RECENT

Lake deposits. Gypseous clays, saline silts, and quartz sands.

Qra — Alluvium of drainage channels and flood plains.

Qrt — Low angle slope deposits.

Scree deposits on high angle slopes.

Qrs — Sand spread and sand dunes.

PLEISTOCENE

Qp — High-level dissected piedmont gravels. Upper limit defined by old erosion surface.

Qpn — Nilpena Limestone. Non-marine limestone with gastropods.

TERTIARY

T — Silcrete and laterite. Red and yellow clays in bores.

PALAEOZOIC — CAMBRIAN — LOWER CAMBRIAN — HAWKER GROUP

€h — AJAX LIMESTONE (includes Wilkawillina Limestone): Cross-bedded sandy dolomite passes laterally and vertically into algal and oolitic dolomite, overlain by cherty dolomite with Archaeocyatha.

PARACHILNA FORMATION: Argillaceous sandstone and shale with limestone lenses. Worm-burrow bed at base.

UPPER PROTEROZOIC — ADELAIDE SYSTEM — MARINOAN — WILPENA GROUP

Ew

POUND QUARTZITE:
Upper Member: Massive to flaggy, resistant white orthoquartzite with ripple-marks and heavy mineral laminations. Numerous clay-galls. Ediacara fauna near top.
Lower Member: Feldspathic sandstone with interbedded red siltstones and sandstones overlie red-bed sequence of cross-bedded red sandstones and micaceous red siltstones. Local conglomerate at base in northern part of Red Range.

WONOKA FORMATION: Thin interbedded blue-grey limestone and siltstone with flute-casts and ripple-marks. Slump brecciolas throughout, particularly in the region of Beltana Diapir. Local sedimentary discordance with Bunyeroo Formation marked by slump brecciola.

BUNYEROO FORMATION: Dark red, finely-laminated dolomitic shales with flute-casts and mud cracks. Thin interbedded dolomites in upper part. Thin interbedded grey-green shales occasionally cupriferous. Local conglomerate at base near Trebilcock's Gap.

A.B.C. RANGE QUARTZITE: Ripple-marked and cross-bedded heavy mineral banded feldspathic sandstone with minor siltstones. Thick, massive to flaggy orthoquartzite at base.

BRACHINA FORMATION:
BAYLEY RANGE SILTSTONE MEMBER: Drab olive-green siltstones with occasional interbeds of hard feldspathic siltstone.
MOORILLAH SILTSTONE MEMBER: Banded and unbanded purple and dark red coarse-grained siltstone with two thin lenses of conglomerate. Basal lens of buff, fine-grained sandstone grading into local conglomerate near Diapir.
MOOLOOLOO SILTSTONE MEMBER: Drab olive-green siltstones with ripple-marks near top. Red siltstone at base.

NUCCALEENA FORMATION: Well-bedded, cream-weathering pink dolomite overlain by purple shales with interbedded thin dolomites.

STURTIAN — UMBERATANA GROUP

Eu

ELATINA FORMATION: Pink to reddish, coarse-grained orthoquartzite with well-rounded quartz and red chert granules. Rare pebbles.

TREZONA FORMATION: Grey calcareous shales with several bands of red brecciola dolomite.

ENORAMA SHALE: Thinly bedded, unbanded grey-green shales overlain by drab grey shale with slumping near top. Thin purple siltstone at base.

ETINA FORMATION: Massive blue-grey and grey siltstones with three thin dolomite bands; lowest band sandy with lenses of quartz grit. Underlain by yellow-brown weathering sandy dolomite. Minor interbeds of soft, coarse-grained red siltstone. Thin quartzite at base.

AMBEROONA FORMATION EQUIVALENTS

TAPLEY HILL FORMATION: Thick, flaggy dark blue-grey well laminated siltstone. Coarser in upper part. Thin dolomite near top.

WILLOURAN — CALLANNA BEDS

Ec — Undifferentiated diapiric breccia with carbonate matrix.

Massive quartzites with heavy mineral laminations.

Brown and blue-grey siltstones with halite pseudomorphs.

Sandstones and siltstones with halite pseudomorphs. Prominent interbedded bands of yellow-brown weathering dolomite.

Bedded yellow-brown weathering dolomites.

Scapolitized hornblende quartz rock (?basic igneous).

GEOLOGICAL BOUNDARIES
- OBSERVED
- APPROXIMATE
- SUB SURFACE BOUNDARY

FAULTS
- OBSERVED
- INFERRED

CRUSH ZONE

BEDDING
- INCLINED — 30
- VERTICAL
- HORIZONTAL
- TREND OF BEDDING

TYPE SECTION
MAIN ROAD
SECONDARY ROAD
TRACK
NATIONAL ROUTE NUMBER — 83
RAILWAY
DISUSED RAILWAY
VERMIN PROOF FENCE
HOMESTEAD
TRIANGULATION STATION
EPHEMERAL STREAM
CLAYPANS

WATER FEATURES
- BORE
- SPRING — S
- WELL — W
- EARTH TANK OR DAM

MACRO FOSSIL LOCALITY
MINE
MINERAL OCCURRENCE — ×
COPPER — Cu
LEAD — Pb
IRON — Fe
BARYTES — Ba


Geology by B. LEESON, B.Sc.,(Hons.)
L. G. Nixon, B.Sc. (Ediacara Mineral Field).

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Director of Mines.

Issued under the authority of the Honourable
S. C. Bevan, M.L.C., Minister of Mines.
Published 1966


BELTANA

1162-9

FIGURE 1


LEGEND

Leeson's Beltana Diapir

IGNEOUS OUTCROPS

x Equigranular

Δ Gneissic

Ⓐ Peripheral conglomerate occurrences

Possible subsidence breccias

FAULTS

Definite

Inferred

HYPOTHETICAL ZONES

A Central piercement zone

B Fringing debris zone

N

CARPENTARIA EXPLORATION COMPANY PTY LTD.

SML 170 BELTANA
(SOUTH AUSTRALIA)

MAP OF THE BELTANA COMPLEX SHOWING
Igneous Outcrops 1-38
Peripheral Conglomerate Occurrences
Inferred Approximate Faults
Approximate Zone Boundaries

| | | |
|---|---|---|
| SCALE: 1"= 1mile | GEOL.: W.D.S. | DATE December 1968 |
| CHECKED | DRAWN R.C.T. | 3814 |

1162-8

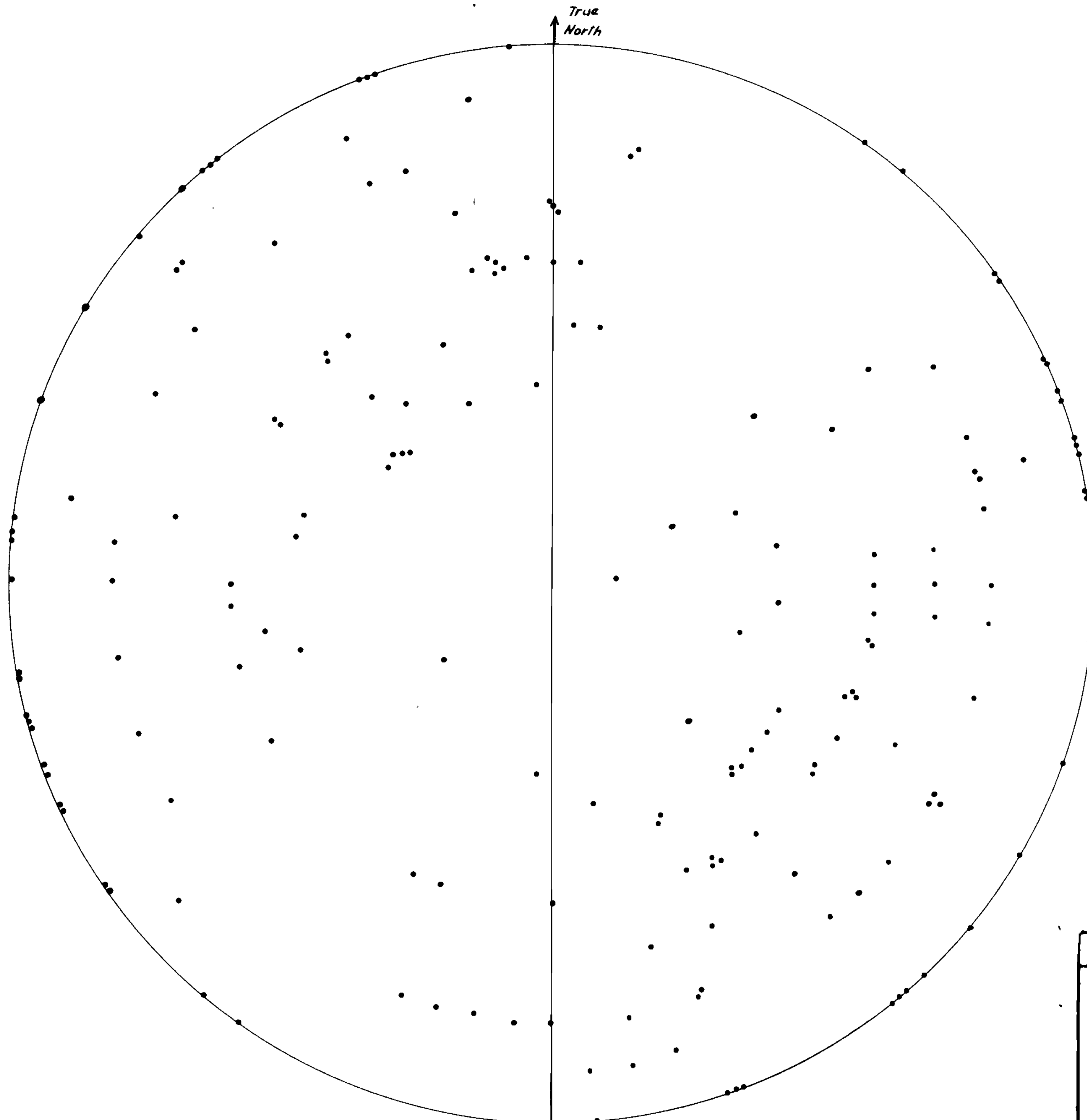





FIGURE 3

**CARPENTARIA EXPLORATION COMPANY PTY. LTD.**

PLOT OF POLES TO BEDDING

**BELTANA COMPLEX**

156 POLES

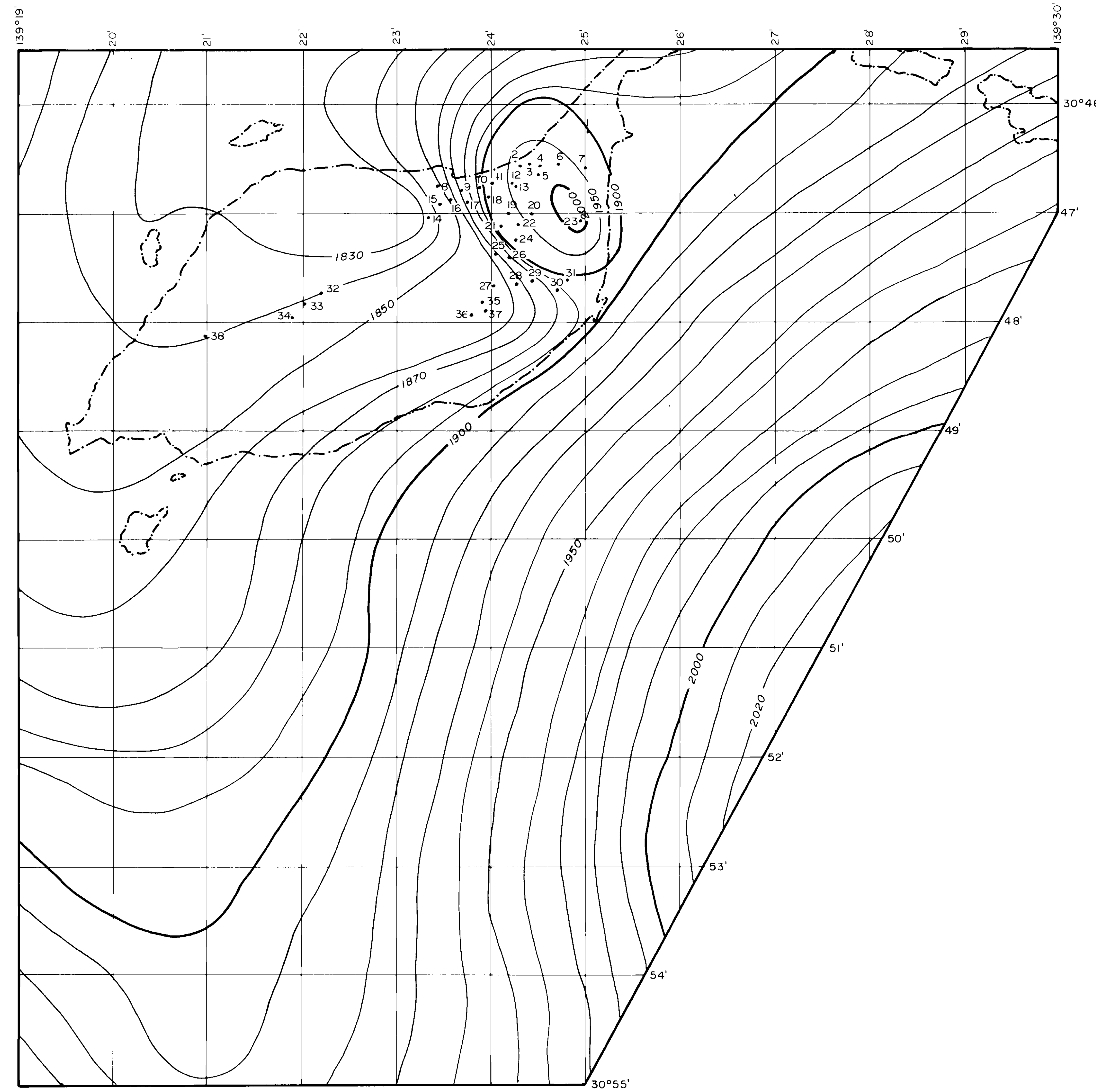
W. D. SMITH AND R.E. READ

JANUARY, 1969

SCHMIDT NET

| | | |
|---|---|---|
| SCALE: | GEOL.: W.D.S. | DATE: Feb. 1969. |
| CHECKED: | DRAWN: J.C.N. | 3669 |

1162-14




# LEGEND

Outline of Beltana Diapir (From Leeson 1965)

Magnetic contours, values in gammas (From S.A. Mines Dept)

Igneous outcrop as recorded by W. D. Smith

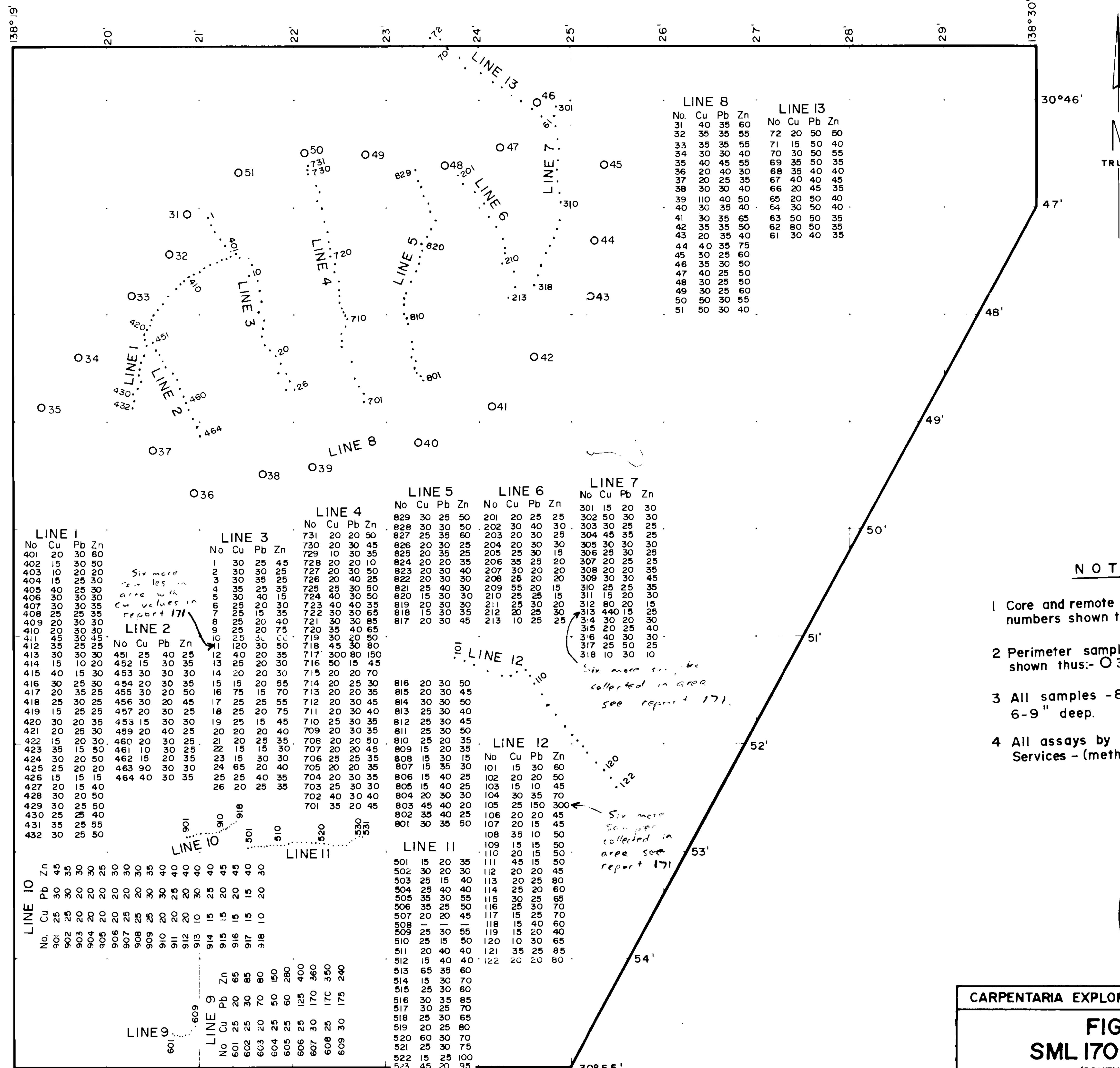
N

CARPENTARIA EXPLORATION COMPANY PTY LTD.

SML 170 BELTANA
(SOUTH AUSTRALIA)
FIGURE 4
SHOWING
OUTLINE OF BELTANA DIAPIR
AEROMAGNETIC CONTOURS
IGNEOUS OUTCROPS RECORDED

| SCALE: 1"= 1mile | GEOL.: W.D.S. | DATE November 1969 |
|---|---|---|
| CHECKED | DRAWN R.C.T. | 3827 |

1162-13




LINE 1

| No | Cu | Pb | Zn |
|---|---|---|---|
| 401 | 20 | 30 | 60 |
| 402 | 15 | 30 | 50 |
| 403 | 10 | 20 | 20 |
| 404 | 15 | 25 | 30 |
| 405 | 40 | 25 | 30 |
| 406 | 30 | 30 | 30 |
| 407 | 30 | 30 | 35 |
| 408 | 25 | 25 | 35 |
| 409 | 20 | 30 | 30 |
| 410 | 20 | 30 | 30 |
| 411 | 45 | 30 | 45 |
| 412 | 35 | 25 | 25 |
| 413 | 30 | 30 | 30 |
| 414 | 15 | 10 | 20 |
| 415 | 40 | 15 | 30 |
| 416 | 30 | 25 | 30 |
| 417 | 20 | 35 | 25 |
| 418 | 25 | 30 | 25 |
| 419 | 15 | 25 | 25 |
| 420 | 30 | 20 | 35 |
| 421 | 20 | 25 | 30 |
| 422 | 15 | 20 | 30 |
| 423 | 35 | 15 | 50 |
| 424 | 30 | 20 | 50 |
| 425 | 25 | 20 | 20 |
| 426 | 15 | 15 | 15 |
| 427 | 20 | 15 | 40 |
| 428 | 30 | 20 | 50 |
| 429 | 30 | 25 | 50 |
| 430 | 25 | 25 | 40 |
| 431 | 35 | 25 | 55 |
| 432 | 30 | 25 | 50 |

LINE 2

| No | Cu | Pb | Zn |
|---|---|---|---|
| 451 | 25 | 40 | 25 |
| 452 | 15 | 30 | 35 |
| 453 | 30 | 30 | 30 |
| 454 | 20 | 30 | 35 |
| 455 | 30 | 20 | 50 |
| 456 | 30 | 20 | 45 |
| 457 | 20 | 30 | 25 |
| 458 | 15 | 30 | 30 |
| 459 | 20 | 40 | 25 |
| 460 | 20 | 30 | 25 |
| 461 | 10 | 30 | 25 |
| 462 | 15 | 20 | 35 |
| 463 | 90 | 30 | 30 |
| 464 | 40 | 30 | 35 |

Six more samples in area with Cu values in report 171

LINE 3

| No | Cu | Pb | Zn |
|---|---|---|---|
| 1 | 30 | 25 | 45 |
| 2 | 30 | 30 | 25 |
| 3 | 30 | 35 | 25 |
| 4 | 35 | 25 | 35 |
| 5 | 30 | 40 | 15 |
| 6 | 25 | 20 | 30 |
| 7 | 25 | 15 | 35 |
| 8 | 25 | 20 | 40 |
| 9 | 25 | 20 | 75 |
| 10 | 25 | 30 | [illegible] |
| 11 | 120 | 30 | 50 |
| 12 | 40 | 20 | 35 |
| 13 | 25 | 20 | 30 |
| 14 | 20 | 20 | 30 |
| 15 | 15 | 20 | 55 |
| 16 | 75 | 15 | 70 |
| 17 | 25 | 25 | 55 |
| 18 | 25 | 20 | 75 |
| 19 | 25 | 15 | 45 |
| 20 | 20 | 20 | 40 |
| 21 | 20 | 25 | 35 |
| 22 | 15 | 15 | 30 |
| 23 | 15 | 30 | 30 |
| 24 | 65 | 20 | 40 |
| 25 | 25 | 40 | 35 |
| 26 | 20 | 25 | 35 |

LINE 4

| No | Cu | Pb | Zn |
|---|---|---|---|
| 731 | 20 | 20 | 50 |
| 730 | 20 | 30 | 45 |
| 729 | 10 | 30 | 35 |
| 728 | 20 | 20 | 10 |
| 727 | 20 | 30 | 50 |
| 726 | 20 | 40 | 25 |
| 725 | 25 | 30 | 50 |
| 724 | 40 | 30 | 50 |
| 723 | 40 | 40 | 35 |
| 722 | 30 | 30 | 65 |
| 721 | 30 | 30 | 85 |
| 720 | 35 | 40 | 65 |
| 719 | 30 | 20 | 50 |
| 718 | 45 | 30 | 80 |
| 717 | 300 | 80 | 150 |
| 716 | 50 | 15 | 45 |
| 715 | 20 | 20 | 70 |
| 714 | 20 | 25 | 30 |
| 713 | 20 | 20 | 35 |
| 712 | 20 | 30 | 45 |
| 711 | 20 | 30 | 40 |
| 710 | 25 | 30 | 35 |
| 709 | 20 | 30 | 35 |
| 708 | 20 | 20 | 50 |
| 707 | 20 | 20 | 45 |
| 706 | 25 | 25 | 35 |
| 705 | 20 | 20 | 35 |
| 704 | 20 | 30 | 35 |
| 703 | 25 | 30 | 30 |
| 702 | 40 | 30 | 40 |
| 701 | 35 | 20 | 45 |

LINE 5

| No | Cu | Pb | Zn |
|---|---|---|---|
| 829 | 30 | 25 | 50 |
| 828 | 30 | 30 | 50 |
| 827 | 25 | 35 | 60 |
| 826 | 20 | 30 | 25 |
| 825 | 20 | 35 | 25 |
| 824 | 20 | 20 | 35 |
| 823 | 20 | 30 | 40 |
| 822 | 20 | 30 | 30 |
| 821 | 25 | 40 | 30 |
| 820 | 15 | 30 | 30 |
| 819 | 20 | 30 | 30 |
| 818 | 15 | 30 | 35 |
| 817 | 20 | 30 | 45 |
| 816 | 20 | 30 | 50 |
| 815 | 20 | 30 | 45 |
| 814 | 30 | 30 | 50 |
| 813 | 25 | 30 | 40 |
| 812 | 25 | 30 | 45 |
| 811 | 25 | 30 | 50 |
| 810 | 25 | 20 | 35 |
| 809 | 15 | 20 | 35 |
| 808 | 15 | 30 | 15 |
| 807 | 15 | 35 | 30 |
| 806 | 15 | 40 | 25 |
| 805 | 15 | 40 | 25 |
| 804 | 20 | 30 | 30 |
| 803 | 45 | 40 | 20 |
| 802 | 35 | 40 | 25 |
| 801 | 30 | 35 | 50 |

LINE 6

| No | Cu | Pb | Zn |
|---|---|---|---|
| 201 | 20 | 25 | 25 |
| 202 | 30 | 40 | 30 |
| 203 | 20 | 30 | 25 |
| 204 | 20 | 30 | 30 |
| 205 | 25 | 30 | 15 |
| 206 | 35 | 25 | 20 |
| 207 | 30 | 20 | 20 |
| 208 | 25 | 20 | 20 |
| 209 | 55 | 20 | 15 |
| 210 | 25 | 25 | 15 |
| 211 | 25 | 30 | 20 |
| 212 | 20 | 25 | 30 |
| 213 | 10 | 25 | 25 |

LINE 7

| No | Cu | Pb | Zn |
|---|---|---|---|
| 301 | 15 | 20 | 30 |
| 302 | 50 | 30 | 30 |
| 303 | 30 | 25 | 25 |
| 304 | 45 | 35 | 25 |
| 305 | 30 | 30 | 30 |
| 306 | 25 | 30 | 25 |
| 307 | 20 | 25 | 25 |
| 308 | 20 | 20 | 35 |
| 309 | 30 | 30 | 45 |
| 310 | 25 | 25 | 35 |
| 311 | 15 | 20 | 30 |
| 312 | 80 | 20 | 15 |
| 313 | 440 | 15 | 25 |
| 314 | 30 | 20 | 30 |
| 315 | 20 | 25 | 40 |
| 316 | 40 | 30 | 30 |
| 317 | 25 | 50 | 25 |
| 318 | 10 | 30 | 10 |

Six more samples collected in area see report 171.

LINE 8

| No. | Cu | Pb | Zn |
|---|---|---|---|
| 31 | 40 | 35 | 60 |
| 32 | 35 | 35 | 55 |
| 33 | 35 | 35 | 55 |
| 34 | 30 | 30 | 40 |
| 35 | 40 | 45 | 55 |
| 36 | 20 | 40 | 30 |
| 37 | 20 | 25 | 35 |
| 38 | 30 | 30 | 40 |
| 39 | 110 | 40 | 50 |
| 40 | 30 | 35 | 40 |
| 41 | 30 | 35 | 65 |
| 42 | 35 | 35 | 50 |
| 43 | 20 | 35 | 40 |
| 44 | 40 | 35 | 75 |
| 45 | 30 | 25 | 60 |
| 46 | 35 | 30 | 50 |
| 47 | 40 | 25 | 50 |
| 48 | 30 | 25 | 50 |
| 49 | 30 | 25 | 60 |
| 50 | 50 | 30 | 55 |
| 51 | 50 | 30 | 40 |

LINE 13

| No | Cu | Pb | Zn |
|---|---|---|---|
| 72 | 20 | 50 | 50 |
| 71 | 15 | 50 | 40 |
| 70 | 30 | 50 | 55 |
| 69 | 35 | 50 | 35 |
| 68 | 35 | 40 | 40 |
| 67 | 40 | 40 | 45 |
| 66 | 20 | 45 | 35 |
| 65 | 20 | 50 | 40 |
| 64 | 30 | 50 | 40 |
| 63 | 50 | 50 | 35 |
| 62 | 80 | 50 | 35 |
| 61 | 30 | 40 | 35 |

LINE 9

| No | Cu | Pb | Zn |
|---|---|---|---|
| 601 | 25 | 20 | 65 |
| 602 | 25 | 30 | 85 |
| 603 | 20 | 70 | 80 |
| 604 | 25 | 50 | 150 |
| 605 | 25 | 60 | 280 |
| 606 | 25 | 125 | 400 |
| 607 | 30 | 170 | 360 |
| 608 | 25 | 170 | 350 |
| 609 | 30 | 175 | 240 |

LINE 10

| No. | Cu | Pb | Zn |
|---|---|---|---|
| 901 | 25 | 30 | 45 |
| 902 | 25 | 30 | 35 |
| 903 | 20 | 20 | 30 |
| 904 | 20 | 20 | 30 |
| 905 | 20 | 20 | 25 |
| 906 | 20 | 20 | 30 |
| 907 | 25 | 20 | 30 |
| 908 | 25 | 20 | 30 |
| 909 | 25 | 30 | 35 |
| 910 | 20 | 30 | 40 |
| 911 | 20 | 25 | 40 |
| 912 | 20 | 20 | 40 |
| 913 | 10 | 30 | 40 |
| 914 | 15 | 25 | 40 |
| 915 | 15 | 20 | 45 |
| 916 | 15 | 20 | 45 |
| 917 | 15 | 15 | 40 |
| 918 | 10 | 20 | 30 |

LINE 11

| | | | |
|---|---|---|---|
| 501 | 15 | 20 | 35 |
| 502 | 30 | 20 | 30 |
| 503 | 25 | 15 | 40 |
| 504 | 25 | 40 | 40 |
| 505 | 35 | 30 | 55 |
| 506 | 35 | 25 | 50 |
| 507 | 20 | 20 | 45 |
| 508 | — | — | — |
| 509 | 25 | 30 | 55 |
| 510 | 25 | 15 | 50 |
| 511 | 20 | 40 | 40 |
| 512 | 15 | 40 | 40 |
| 513 | 65 | 35 | 60 |
| 514 | 15 | 30 | 70 |
| 515 | 25 | 30 | 60 |
| 516 | 30 | 35 | 85 |
| 517 | 30 | 25 | 70 |
| 518 | 25 | 30 | 65 |
| 519 | 20 | 25 | 80 |
| 520 | 60 | 30 | 70 |
| 521 | 25 | 30 | 75 |
| 522 | 15 | 25 | 100 |
| 523 | 45 | 20 | 95 |
| 524 | 20 | 20 | 100 |
| 525 | 25 | 25 | 70 |
| 526 | 10 | 35 | 55 |
| 527 | 10 | 35 | 50 |
| 528 | 40 | 30 | 75 |
| 529 | 25 | 20 | 55 |
| 530 | 10 | 20 | 40 |
| 531 | 50 | 25 | 70 |

LINE 12

| No | Cu | Pb | Zn |
|---|---|---|---|
| 101 | 15 | 30 | 60 |
| 102 | 20 | 20 | 50 |
| 103 | 15 | 10 | 45 |
| 104 | 30 | 35 | 70 |
| 105 | 25 | 150 | 300 |
| 106 | 20 | 20 | 45 |
| 107 | 20 | 15 | 45 |
| 108 | 35 | 10 | 50 |
| 109 | 15 | 15 | 50 |
| 110 | 20 | 15 | 50 |
| 111 | 45 | 15 | 50 |
| 112 | 20 | 20 | 45 |
| 113 | 20 | 25 | 80 |
| 114 | 25 | 20 | 60 |
| 115 | 30 | 25 | 65 |
| 116 | 25 | 30 | 70 |
| 117 | 15 | 25 | 70 |
| 118 | 15 | 40 | 60 |
| 119 | 15 | 20 | 40 |
| 120 | 10 | 30 | 65 |
| 121 | 35 | 25 | 85 |
| 122 | 20 | 20 | 80 |

Six more samples collected in area see report 171

## NOTES

1. Core and remote sample sites and numbers shown thus:- •901
2. Perimeter sample sites and numbers shown thus:- O 31
3. All samples -80 mesh fraction, 6-9" deep.
4. All assays by Sampey Exploration Services - (method 101B) - values in p.p.m.

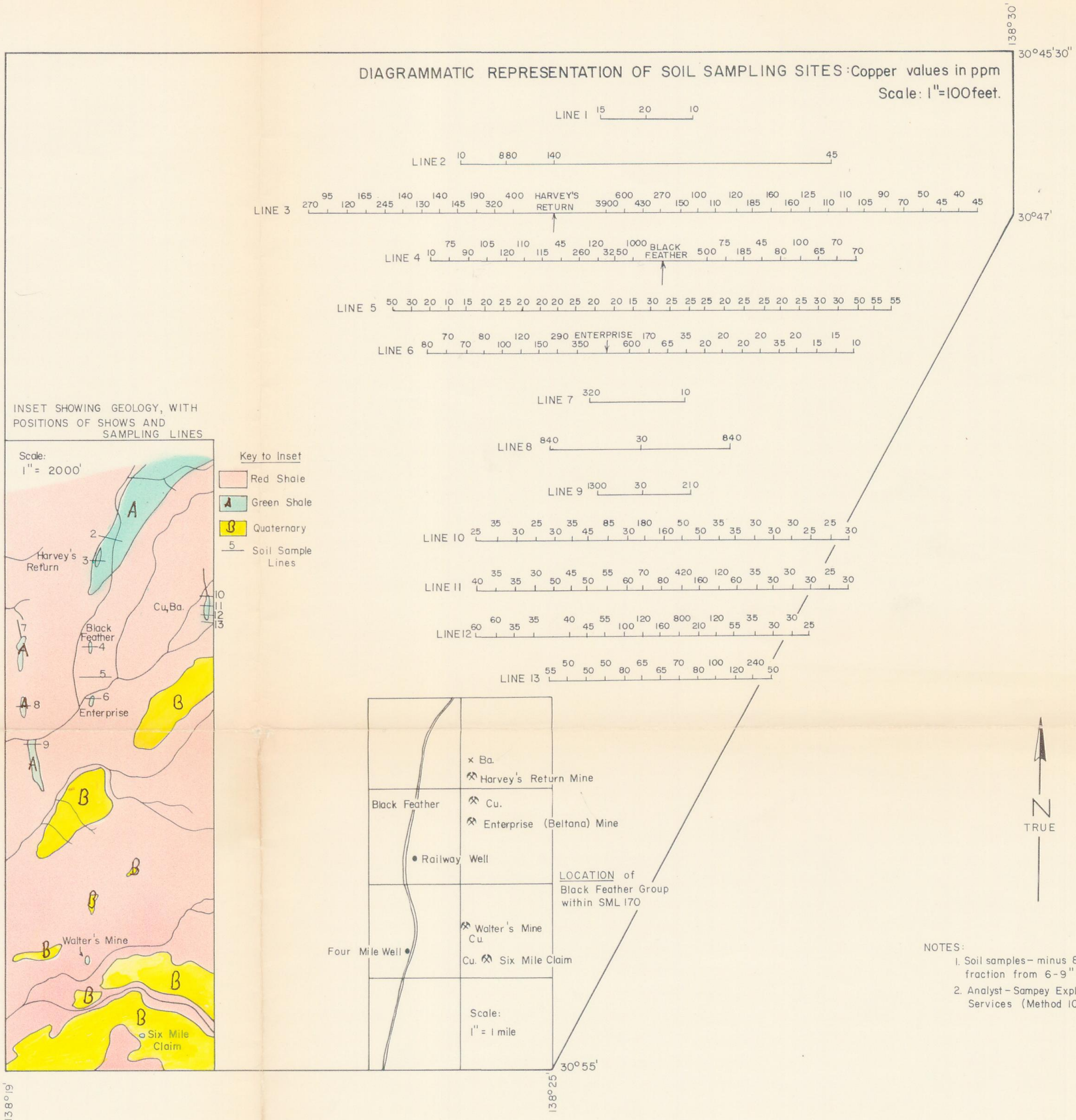


CARPENTARIA EXPLORATION COMPANY PTY. LTD.

# FIGURE 5
# SML 170 BELTANA
(SOUTH AUSTRALIA)
## SHOWING RAW DATA FOR RECONNAISSANCE SOIL SAMPLING

| SCALE: 1" = 1mile | GEOL.: W. D. S. | DATE: OCT 1969 |
|---|---|---|
| CHECKED | DRAWN: R.T. | 3976 |

1162-12

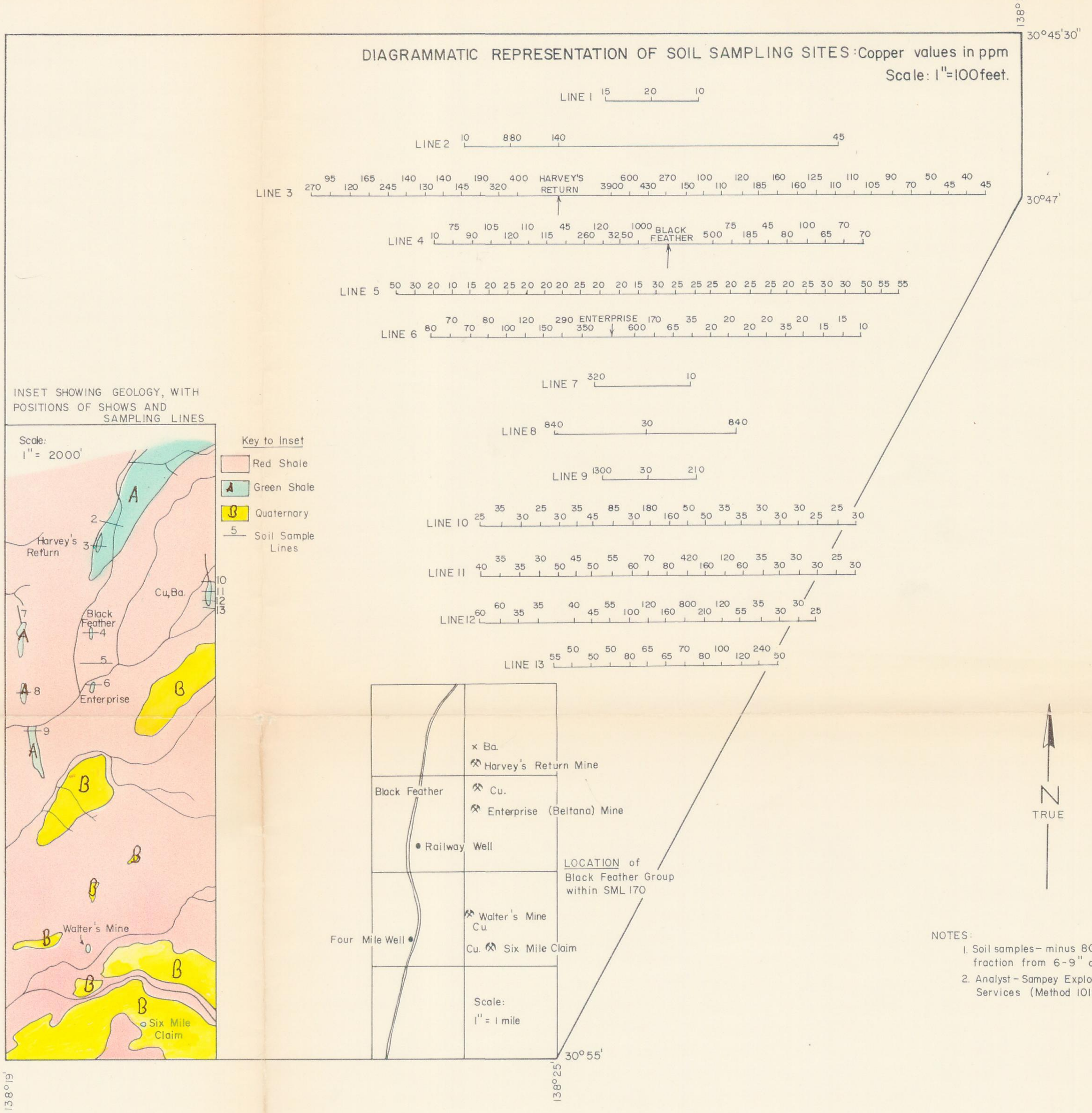



NOTES:
1. Soil samples – minus 80 mesh fraction from 6-9" depth
2. Analyst – Sampey Exploration Services (Method 101B)



1162-7

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| FIGURE 6<br>SML 170 BELTANA (S.A)<br>SOIL SAMPLING<br>BLACK FEATHER GROUP<br>COPPER | | |
| SCALE: As shown | GEOL.: B.C.S. | DATE: NOV. 1969 |
| …CKED | DRAWN: D.F./J.N./R.T. | 4006 |




NOTES:
1. Soil samples – minus 80 mesh fraction from 6-9" depth
2. Analyst – Sampey Exploration Services (Method 101B)

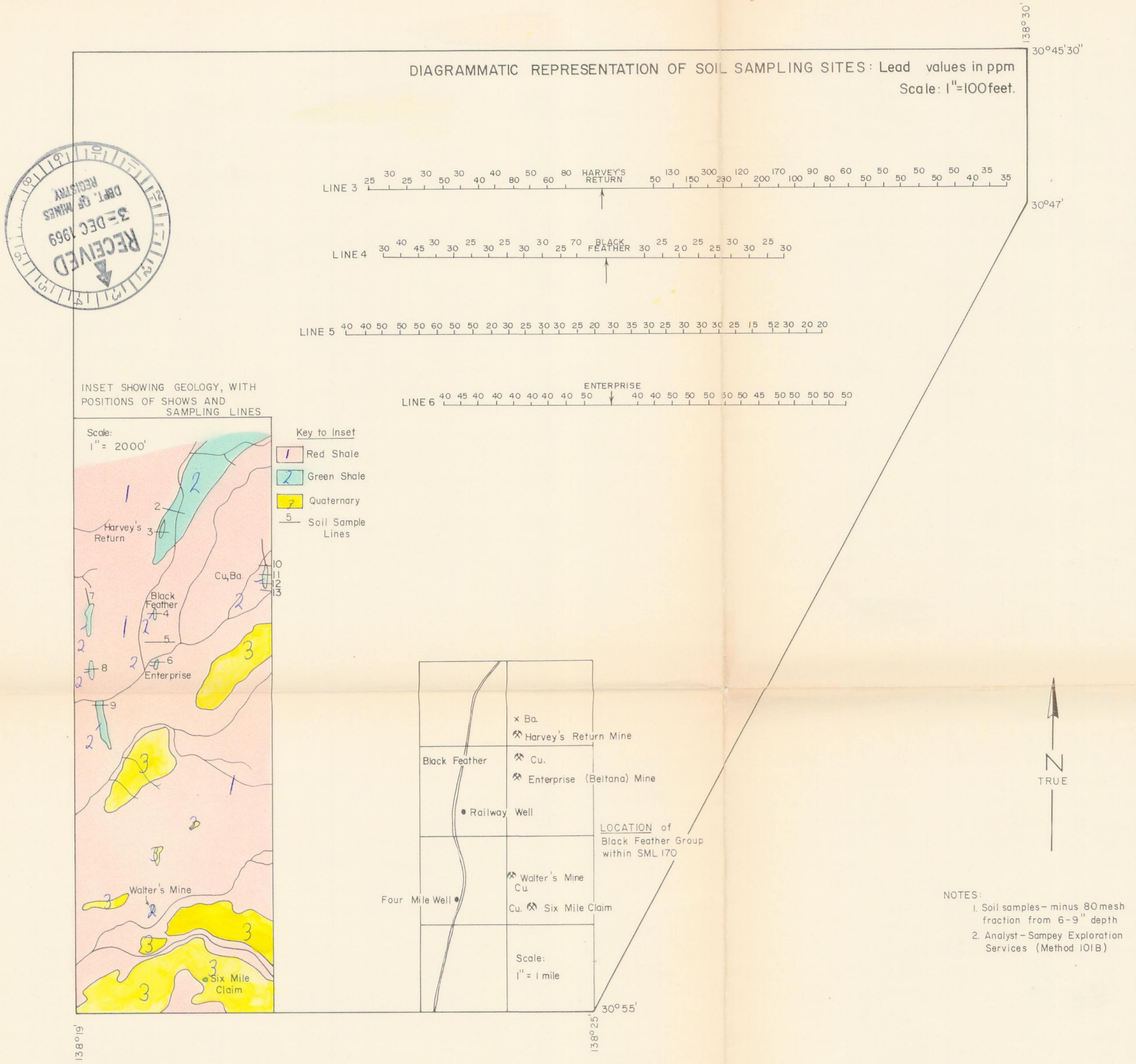


1162-7

CARPENTARIA EXPLORATION COMPANY PTY. LTD.

# FIGURE 6
## SML 170 BELTANA (S.A)
SOIL SAMPLING
BLACK FEATHER GROUP
**COPPER**

| SCALE: As shown | GEOL.: B.C.S. | DATE: NOV. 1969 |
|---|---|---|
| [CHEC]KED: | DRAWN: D.F./J.N./R.T. | 4006 |





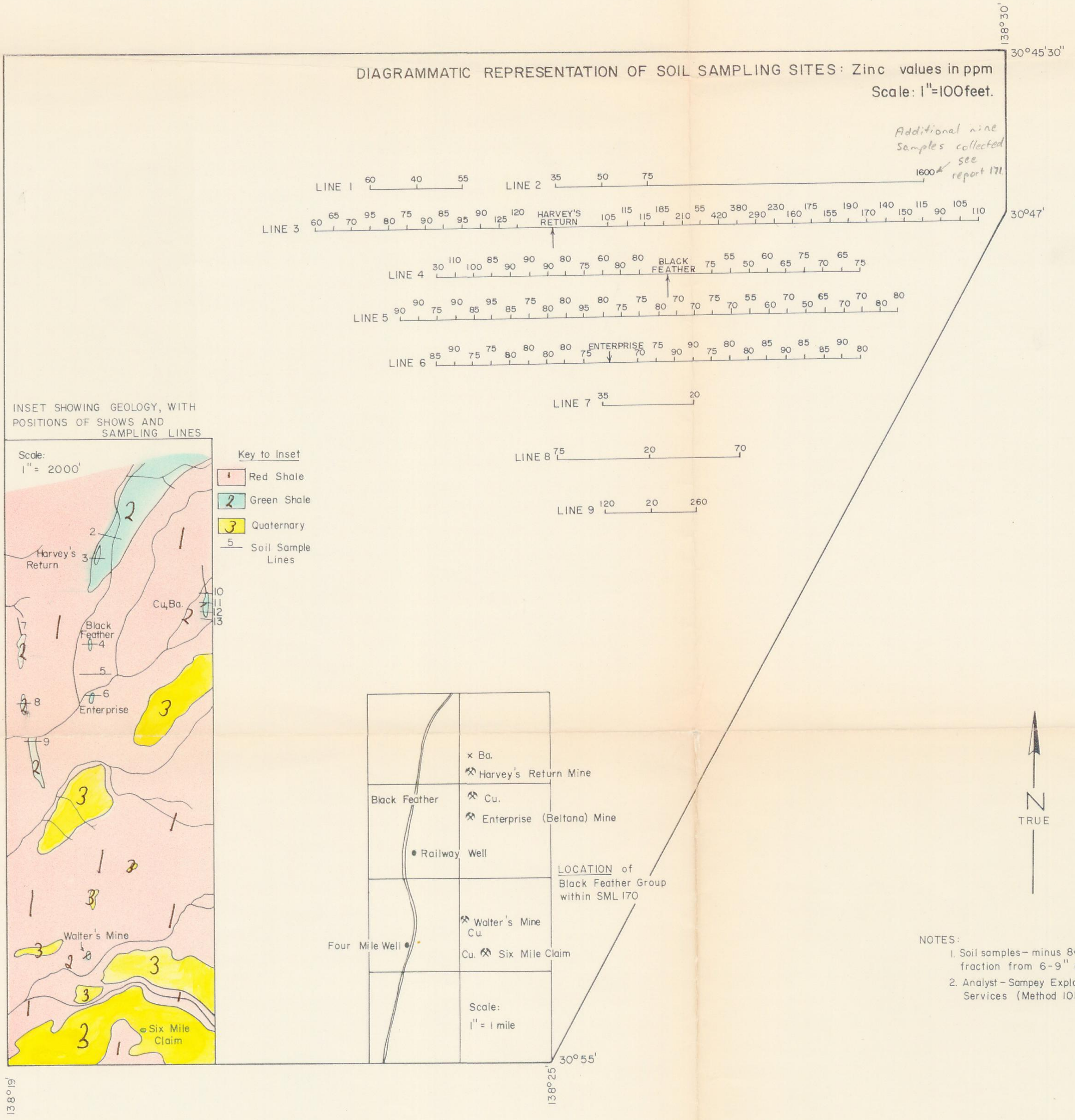

NOTES:
1. Soil samples – minus 80 mesh fraction from 6-9" depth
2. Analyst – Sampey Exploration Services (Method 101B)

CARPENTARIA EXPLORATION COMPANY PTY. LTD.

# FIGURE 7
## SML 170 BELTANA (S.A)
SOIL SAMPLING
BLACK FEATHER GROUP
## LEAD

| | | |
|---|---|---|
| SCALE: As shown | GEOL.: B.C.S. | DATE: NOV. 1969 |
| CHECKED: | DRAWN: D.F./J.N./R.T. | 4007 |

1162-6




NOTES:
1. Soil samples – minus 80 mesh fraction from 6-9" depth
2. Analyst – Sampey Exploration Services (Method 101B)

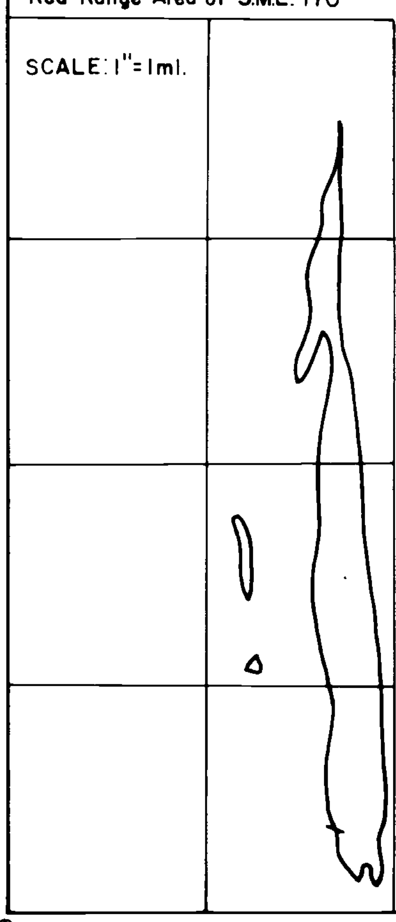
**CARPENTARIA EXPLORATION COMPANY PTY. LTD.**

# FIGURE 8
# SML 170 BELTANA (S.A)
## SOIL SAMPLING
## BLACK FEATHER GROUP
## ZINC

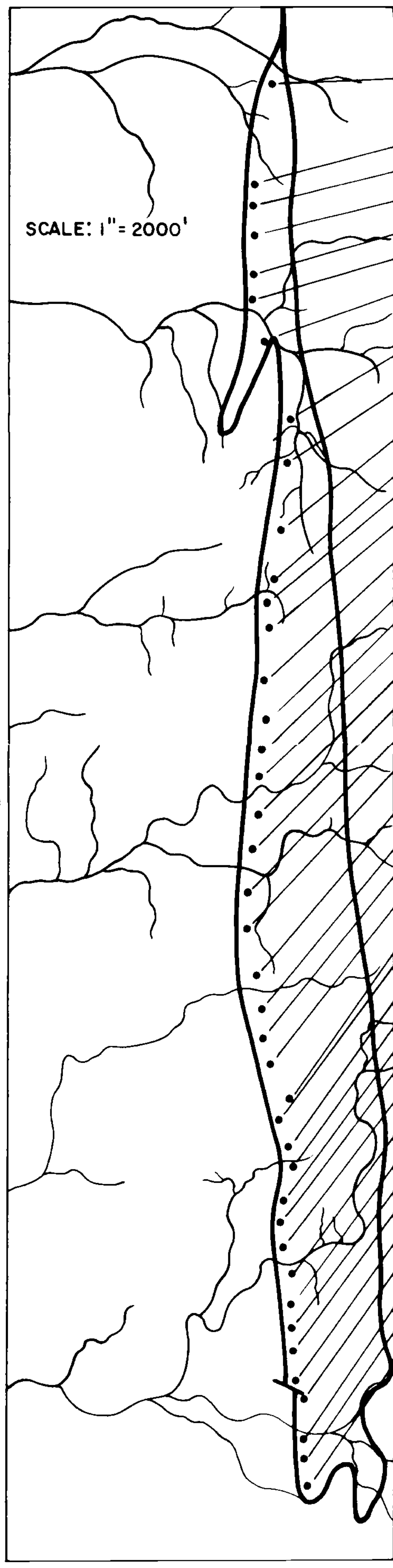
| SCALE: As shown | GEOL.: B.C.S. | DATE: NOV. 1969 |
|---|---|---|
| CHECKED: | DRAWN: D.F./J.N./R.T. | 4008 |

1162-5

Location of the Hawker Group in the Red Range Area of S.M.L. 170




Inset showing soil sample sites within the Hawker Group




RESULTS OF SOIL SAMPLING IN THE HAWKER GROUP - METAL VALUES GIVEN IN P.P.M.

| COPPER | LEAD | ZINC | SAMPLE NO. |
|---|---|---|---|
| 50 | 600 | 360 | 86 |
| 30 | 240 | 280 | 85 |
| 30 | 240 | 330 | 84 |
| 35 | 400 | 315 | 83 |
| 70 | 500 | 340 | 82 |
| 60 | 320 | 340 | 81 |
| 30 | 30 | 115 | 80 |
| 50 | 120 | 80 | 87 |
| 230 | 725 | 370 | 79 |
| 30 | 170 | 330 | 78 |
| 30 | 25 | 120 | 77 |
| 25 | 30 | 125 | 76 |
| 30 | 45 | 145 | 75 |
| 25 | 30 | 250 | 74 |
| 30 | 30 | 160 | 73 |
| 20 | 50 | 160 | 72 |
| 25 | 40 | 95 | 17 |
| 10 | 30 | 35 | 18 |
| 20 | 35 | 80 | 19 |
| 20 | 30 | 120 | 20 |
| 15 | 40 | 45 | 21 |
| 25 | 30 | 115 | 52 |
| 30 | 40 | 120 | 53 |
| 30 | 40 | 125 | 54 |
| 30 | 35 | 100 | 55 |
| 35 | 60 | 165 | 56 |
| 25 | 50 | 120 | 57 |
| 20 | 25 | 70 | 58 |
| 30 | 75 | 250 | 59 |
| 20 | 50 | 200 | 60 |
| 20 | 30 | 120 | 61 |
| 25 | 25 | 85 | 62 |
| 30 | 30 | 105 | 63 |
| 20 | 25 | 90 | 64 |
| 20 | 25 | 80 | 65 |
| 20 | 25 | 65 | 66 |
| 20 | 20 | 70 | 67 |
| 15 | 25 | 35 | 68 |
| 20 | 20 | 105 | 69 |
| 70 | 30 | 120 | 70 |
| 30 | 45 | 100 | 71 |

TRUE N

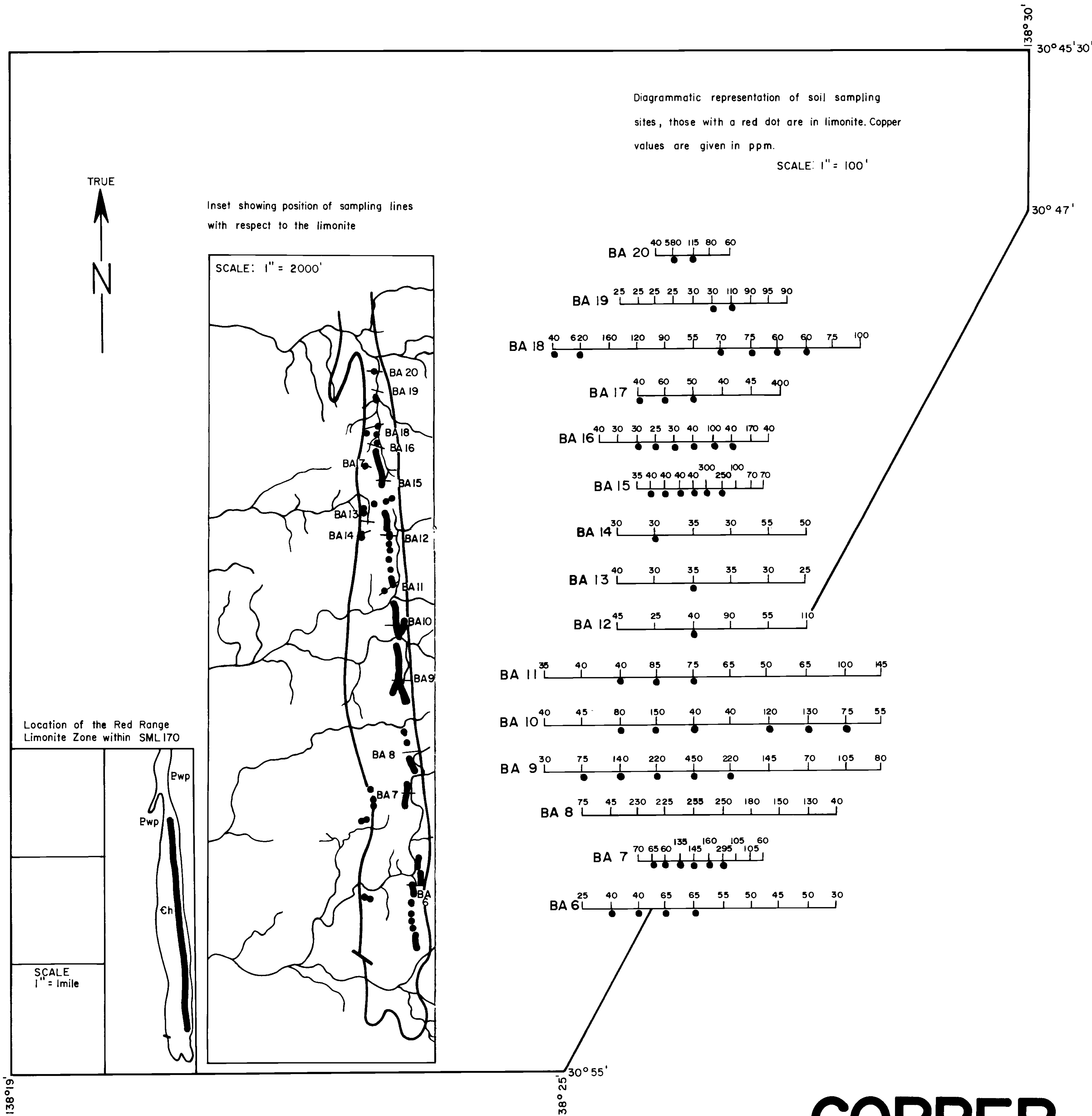
138°19' 138°25' 138°30' 30°45'30" 30°47' 30°55'

NOTES

1. Soil samples minus 80 mesh fraction from 6-9" depth
2. Analyst Sampey Exploration Services (Method 101B)
3. All samples assayed for silver - all results less than 3 p.p.m.

1162-4

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| FIGURE 9 BELTANA S.M.L. 170 (SOUTH AUSTRALIA) SOIL SAMPLING HAWKER GROUP COPPER, LEAD, ZINC, SILVER. | | |
| SCALE: AS SHOWN | GEOL.: B.C.S. | DATE: NOV. 1969 |
| CHECKED: [illegible] | DRAWN: D.J.F. | 3922 |




# COPPER

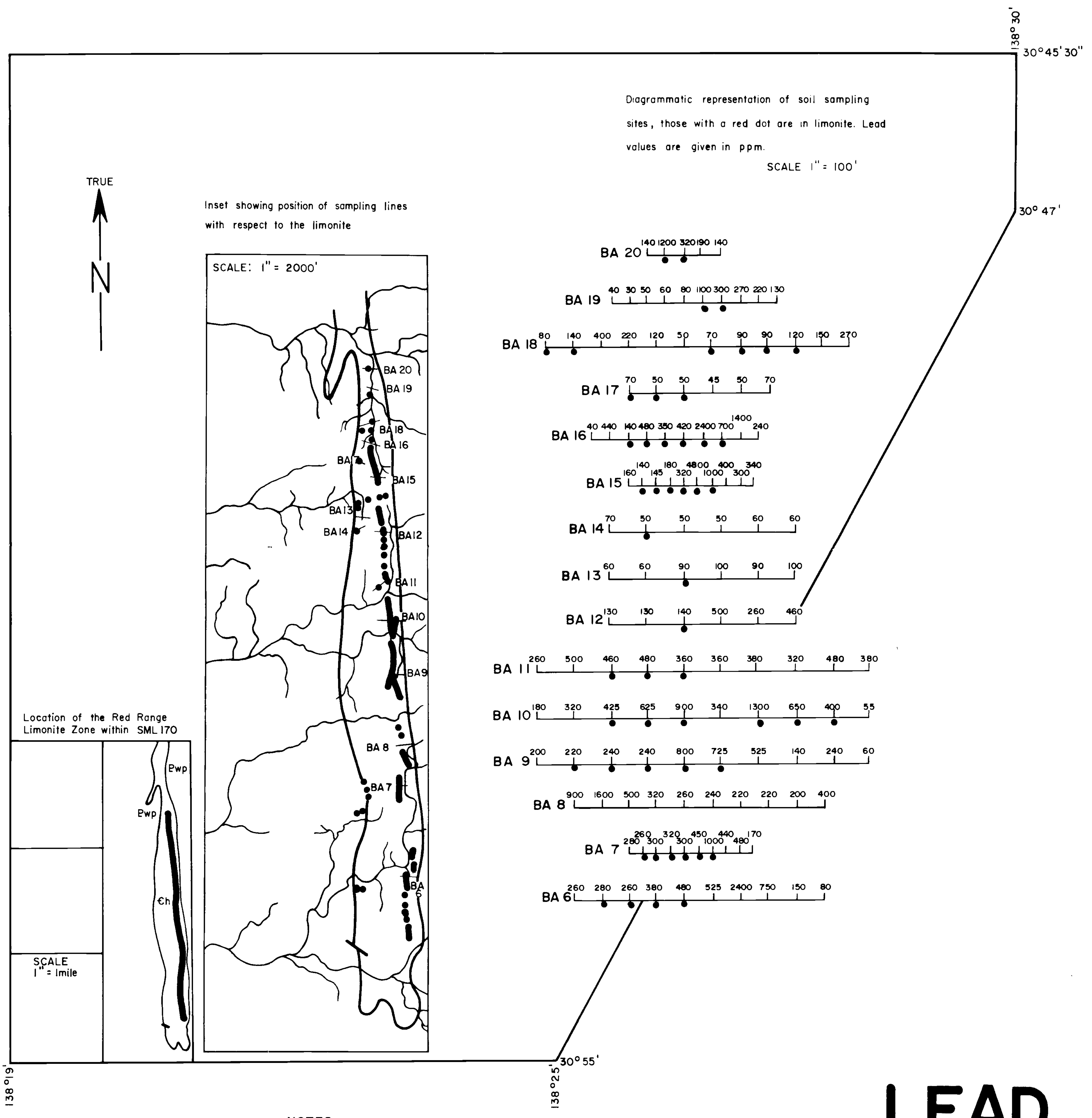
NOTES

1. Soil samples minus 80 mesh fraction from 6" - 9" depth

2. Analyst - Sampey Exploration Services (method 101B)

1162-3

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| FIGURE 10<br>SML 170 BELTANA<br>(SOUTH AUSTRALIA)<br>SOIL SAMPLING<br>RED RANGE LIMONITE ZONE<br>COPPER | | |
| SCALE: AS SHOWN | GEOL.: B C S. | DATE: NOV 1969 |
| CHECKED | DRAWN: D J F | 3880 |




# LEAD

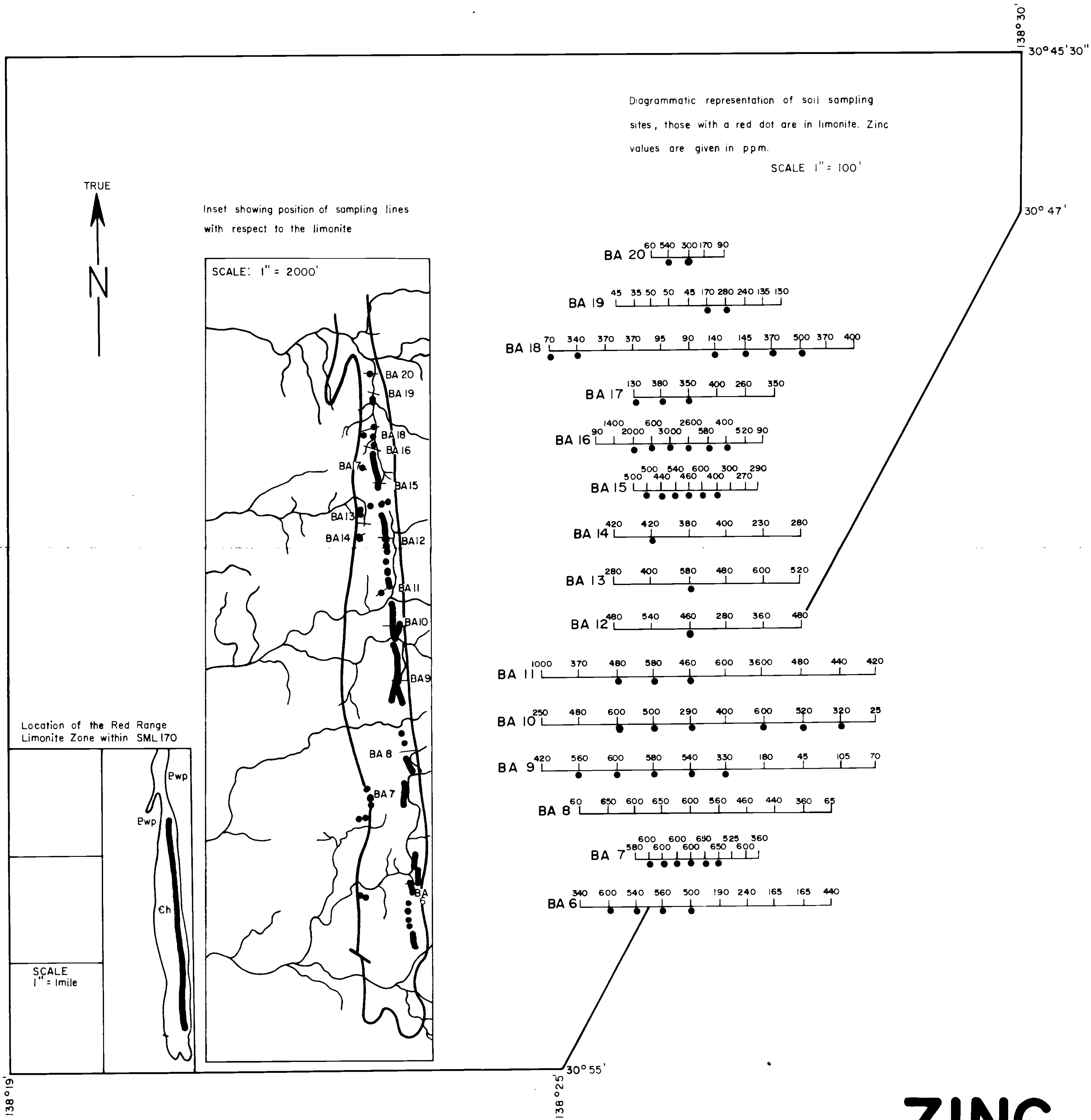
## NOTES

1. Soil samples minus 80 mesh fraction from 6" - 9" depth

2. Analyst - Sampey Exploration Services (method 101B)

1162-2

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| FIGURE 11<br>SML 170 BELTANA<br>(SOUTH AUSTRALIA)<br>SOIL SAMPLING<br>RED RANGE LIMONITE ZONE<br>LEAD | | |
| SCALE: AS SHOWN | GEOL.: B C S. | DATE: NOV 1969 |
| CHECKED: [signature] | DRAWN: D.J.F. | 3879 |



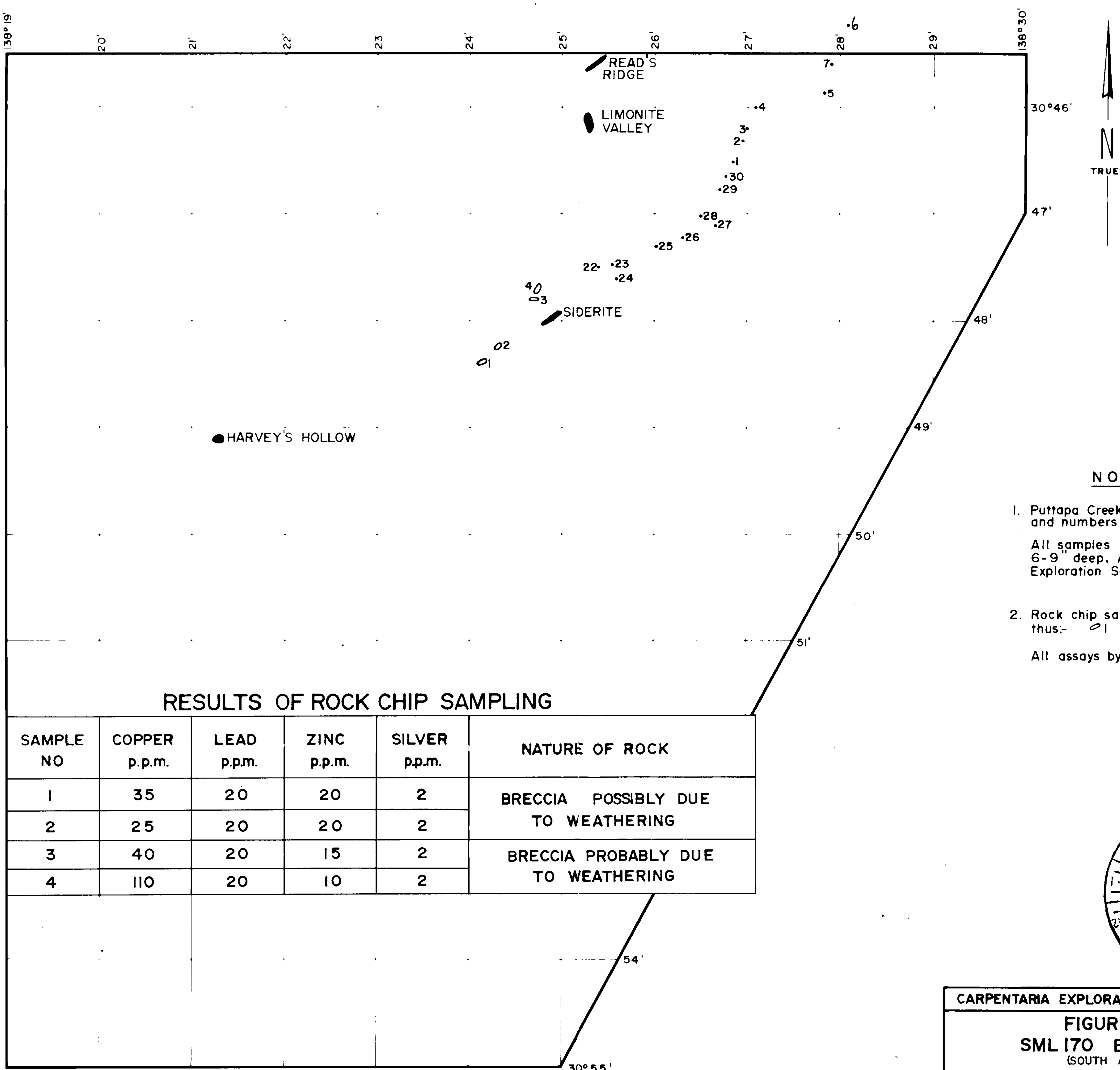

# ZINC

NOTES

1. Soil samples minus 80 mesh fraction from 6" - 9" depth
2. Analyst - Sampey Exploration Services (method 101B)

| CARPENTARIA EXPLORATION COMPANY PTY. LTD. | | |
|---|---|---|
| FIGURE 12<br>SML 170 BELTANA<br>(SOUTH AUSTRALIA)<br>SOIL SAMPLING<br>RED RANGE LIMONITE ZONE<br>ZINC | | |
| SCALE: AS SHOWN | GEOL.: B.C.S. | DATE: NOV 1969 |
| CHECKED: [signature] | DRAWN: D.J.F. | 3878 |

1162-1




# RESULTS OF ROCK CHIP SAMPLING

| SAMPLE NO | COPPER p.p.m. | LEAD p.p.m. | ZINC p.p.m. | SILVER p.p.m. | NATURE OF ROCK |
|---|---|---|---|---|---|
| 1 | 35 | 20 | 20 | 2 | BRECCIA POSSIBLY DUE TO WEATHERING |
| 2 | 25 | 20 | 20 | 2 | |
| 3 | 40 | 20 | 15 | 2 | BRECCIA PROBABLY DUE TO WEATHERING |
| 4 | 110 | 20 | 10 | 2 | |

## NOTES

1. Puttapa Creek soil sample locations and numbers shown thus:- •5

   All samples -80 mesh fraction 6-9" deep. All assays by Sampey Exploration Services (method 101B)

2. Rock chip sample locations shown thus:- ⌀1

   All assays by McPhar.



CARPENTARIA EXPLORATION COMPANY PTY. LTD.

FIGURE 13
SML 170 BELTANA
(SOUTH AUSTRALIA)
LOCATIONS FOR PUTTAPA CREEK SAMPLING
LOCATIONS OF MISCELLANEOUS LIMONITE ZONES
LOCATIONS & RESULTS OF ROCK CHIP SAMPLES

| | | |
|---|---|---|
| SCALE: 1" = 1mile | GEOL. W. D. S. | DATE OCT 1969 |
| CHECKED | DRAWN D. F. | 3968 |

1162-11

CARPENTARIA EXPLORATION COMPANY PTY. LTD.

TECHNICAL REPORT NO. 176

**TITLE:** ROTARY PERCUSSION DRILLING - BELTANA - S.M.L. 170

**AUTHOR:** W.A. FAIRBURN

**INVESTIGATIONS CONDUCTED BY:** B.C. SEVERNE

**SUBMITTED BY:** W.D. SMITH

**DATE:** JANUARY 1970.

28-1-70 1162

## DISTRIBUTION

1. CARPENTARIA EXPLORATION COMPANY PTY.LTD., BRISBANE

2. CARPENTARIA EXPLORATION COMPANY PTY.LTD., ADELAIDE

3. DEPARTMENT OF MINES - SOUTH AUSTRALIA

4. SPARE

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## ILLUSTRATIONS

# SUMMARY

## OBJECT:

TO EVALUATE BASE METAL MINERALISATION AT IRON BLOW, RED RANGE AND BLACK FEATHER ON S.M.L. 170 AS RECOMMENDED IN TECHNICAL REPORT NO. 172

## PRECIS:

Thirteen holes totalling 1458 feet were drilled to test for base metal mineralisation in Proterozoic and Cambrian Sediments on S.M.L. 170 in the Beltana area. Assays of drill samples were completed in all cases for copper and in some cases for lead and zinc.

## CONCLUSIONS:

Although most of the holes drilled, particularly those at Red Range and Black Feather failed to reach full target depth due to water or soft clay being encountered in the drill hole causing either jamming of the drill rods or a considerable decrease in the recovery of drill cuttings, the drilling has probably been adequate for initial testing.

No mineralisation of economic significance was encountered in any of the holes drilled, the best intersection being 10 feet of 1.1% copper or 25 feet of 0.76% copper in Iron Blow Centre West. At Red Range the highest zinc contents were over 1.0% andthe highest lead contents over 0.5%

## RECOMMENDATIONS:

No additional drilling on this property can be recommended at this time although further mapping might be justified at the Iron Blow to augment the drilling results.

W. L. Fairburn

## 1-0 INTRODUCTION

As a consequence of recommendations made by W.D. Smith in Technical Report No. 172, thirteen rotary percussion holes totalling 1,458 feet were drilled in the Iron Blow, Red Range and Black Feather localities on S.M.L. 170. Drilling was performed by either an Ingersoll-Rand or Gardner-Denver air-track mounted hammer drill cutting a 2½ inch diameter hole. Splitting of drill cuttings was carried out on site at usually 10 ft. intervals with a small sample being taken and bagged for initial assaying by A.A.S. at the laboratories of McPhar Geophysics. All samples were tested for copper but only those from Red Range were examined for lead and zinc.

Logging of the drill cuttings was performed after the completion of the drilling by washing a small sample from each interval and storing the residue in clear plastic tubes.

Details of the drilling and assaying along with a locality plan of the drilling are included at the end of this report.

## 2-0 IRON BLOW

Five holes were drilled at Iron Blow in a zone of highly leached limonitic rocks at the western edge of the Beltana complex. Two of the holes reached target depth. All holes were probably completed in clay just above the water table.

Assays results for the drill cuttings apart from one intersection in Iron Blow Centre West were anomalous for copper (c.f. Soil Sampling Technical Report No. 172, Table 13) but at grades well below economic interest.

### 2-1 IRON BLOW FAR NORTH

This hole was drilled to a depth of 168 feet before stopping in wet clay. Assay values for copper are anomalous only and show a slight overall increase with depth.

### 2-2 IRON BLOW NORTH

Drilling of this hole ceased at 95 feet when water in the hole prevented an adequate recovery of drill cuttings. Assay values essentially range from 85 p.p.m. to 620 p.p.m. copper, except for higher values in the first twenty feet probably due to surface secondary enrichment.

### 2-3 IRON BLOW CENTRE WEST

Assay values in the hole which was drilled to 110 feet are considerably higher than for the other holes at Iron Blow. One 10 ft. intersection assayed 1.10% copper inside a broader zone of mineralisation averaging 0.76% copper over 25 feet or 0.58% copper over 35 feet. The final ten feet in the hole averaged 0.18% copper.

### 2-4 IRON BLOW CENTRE EAST

Slight surface enrichment in this hole is indicated by an assay value of 0.18% copper in the first ten feet.

### 2-5 IRON BLOW SOUTH

Assay results for this hole are background only, apart from some slightly anomalous values in the first thirty feet.

## 3-0 RED RANGE

Two holes were drilled at Red Range to test a limonitic (gossanous) zone near the base of the Ajax Limestone. Although some visible copper mineralisation occurs along this zone, assays for copper, lead and zinc from soil samples were not considered anomalous.

Both holes reached only just over 100 feet which is below target depth. Assay values are average for this unit or only slightly above average.

### 3-1 RED RANGE NORTH

Copper values range from about 100 p.p.m. to about 500 p.p.m. with most values being in the range 100 to 300 p.p.m. Lead and zinc values vary from 450 p.p.m. to 5200 p.p.m. and 240 p.p.m. to 12,000 p.p.m. respectively.

These values do not vary greatly from those obtained in gossanous zones near the base of the Ajax Limestone elsewhere in the Flinders Ranges. For example, bulk samples collected from pits by Mines Exploration north of Bunyeroo Gorge assayed up to 9,500 p.p.m. zinc and 1500 p.p.m. lead.

### 3-2 RED RANGE SOUTH

Apart from an assay of 0.12% copper in the first ten feet of this hole, copper values are similar to Red Range North. The assay data for lead and zinc is of a similar order of magnitude although maximum values are not so great.

In both holes the lead-zinc content seems to be related to the abundance of manganese oxides in the dolomite. Presence of the oxides in the quartzite intersections is probably due to contamination.

# 4-0 BLACK FEATHER GROUP

All six holes drilled in this region failed to reach target depth due to difficulties encountered in drilling wet clay at depths of about 100 feet. Failure to reach target depth is probably of more significance in some holes than in others.

Mineralisation intersected was negligible apart from the Black Feather hole which averaged 0.62% copper over sixty five feet, suggesting surface enrichment from a low grade source.

Further assessment of the rather interpretive nature of the mineralisation in the Black Feather Group can probably be made as a result of the drilling. Mineralisation at Harvey's Return Mine, Black Feather and the Enterprise Mine is thought to be fault controlled while at Walter's and Six Mile Claim it could be stratiform or again structurally controlled.

## 4-1 HARVEY'S RETURN MINE

Drilling reached a depth of 120 feet and probably passed into the supposed fault zone. The highest assay value was however only 200 p.p.m. copper with most other values less than half the amount.

## 4-2 BLACK FEATHER

Although drilled to only 65 feet, which is well above target depth of about 150 feet, this hole averaged 0.62% copper.

## 4-3 ENTERPRISE MINE

Two holes were drilled at the Enterprise Mine and both reached a depth of only 90 feet which is about 60 feet above target depth. In both cases the bottom of the hole may just have reached the projected fault zone. Assay values in both holes were similar, averaging about 100 p.p.m.

## 4-4 WALTER'S MINE

The drill hole at Walter's Mine failed to intersect mineralisation of either stratiform or epigenetic origin. Assay values were mainly below 100 p.p.m. with a maximum of 300 p.p.m. copper.

## 4-5 SIX MILE CLAIM

Drilling at Six Mile Claim was again negative (c.f. Walter's Mine) with the highest assay values less than 100 p.p.m. copper.

**DRILL HOLE:** IRON BLOW FAR NORTH (IBFN)

**LOCATION:** NEAR THE IRON BLOW PROSPECT IN THE VICINITY OF LONG. 138° 20', LAT. 30° 49' (See plan)

138.33 30.82

**DEPTH AND DIRECTION:** 168 FEET AT -54° BEARING 098° M.

| QS SAMPLE NUMBER | Footage (ft.) From To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|
| 728 | 0 - 10 | 10 | 55 | 55 | Red-Brown Sandstone with Limonite |
| 9 | 10 - 20 | 10 | 65 | 40 | |
| 730 | 20 - 30 | 10 | 70 | 50 | Brown, yellow and red siltstones, some quartz grains and Limonite |
| 1 | 30 - 40 | 10 | 75 | 85 | |
| 2 | 40 - 50 | 10 | 70 | 120 | |
| 3 | 50 - 60 | 10 | 75 | 90 | |
| 4 | 60 - 70 | 10 | 70 | 180 | |
| 5 | 70 - 80 | 10 | 65 | 120 | |
| 6 | 80 - 90 | 10 | 65 | 95 | |
| 7 | 90 -100 | 10 | 70 | 100 | |
| 8 | 100 -110 | 10 | 70 | 150 | |
| 9 | 110 -120 | 10 | 70 | 150 | |
| 740 | 120 -130 | 10 | 65 | 480 | Brown and Yellow weathered Siltstones with a high proportion of Limonite |
| 1 | 130 -140 | 10 | 65 | 410 | |
| 2 | 140 -150 | 10 | 70 | 430 | |
| 3 | 150 -160 | 10 | 60 | 260 | |
| 4 | 160 -165 | 5 | 5 | 330 | |
| 745 | 165 -168 | 3 | 10 | 280 | |

**WATER:** Wet clay at bottom of hole

A3C

**DRILL HOLE:** IRON BLOW NORTH (I B N)

**LOCATION:** NEAR THE IRON BLOW PROSPECT IN THE VICINITY OF LONG. 138° 20', LAT. 30° 49' (See plan)

**DEPTH AND DIRECTION:** 95 FEET AT -54° BEARING 100° M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 746 | 0 | 10 | 10 | 65 | 1500 | Ferruginous Siltstone |
| 7 | 10 | 20 | 10 | 65 | 840 | |
| 8 | 20 | 30 | 10 | 65 | 110 | |
| 9 | 30 | 40 | 10 | 65 | 130 | |
| 750 | 40 | 45 | 5 | 55 | 85 | Purple or Cream |
| 1 | 45 | 50 | 5 | 55 | 120 | coloured Dolomite ? |
| 2 | 50 | 60 | 10 | 60 | 300 | Siltstones |
| 3 | 60 | 70 | 10 | 55 | 210 | Fragments of |
| 4 | 70 | 75 | 5 | 70 | 620 | Carbonate, quartz |
| 5 | 75 | 80 | 5 | 70 | 470 | and heavy minerals |
| 6 | 80 | 85 | 5 | 40 | 300 | |
| 7 | 85 | 90 | 5 | 65 | 170 | |
| 758 | 90 | 95 | 5 | 40 | 260 | |

**WATER:** Mud at 95 ft.

6r 3.

**DRILL HOLE:** IRON BLOW CENTRE WEST. (IBCW)

**LOCATION:** NEAR THE IRON BLOW PROSPECT IN THE VICINITY OF LONG. 138° 20', LAT. 30° 49' (See plan)

**DEPTH AND DIRECTION:** 110 FEET AT -59° BEARING 085°M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 759 | 0 | 10 | 10 | 50 | 230 | Purple Weathered Siltstones |
| 760 | 10 | 20 | 10 | 65 | 270 | |
| 1 | 20 | 30 | 10 | 70 | 6700 | Purple and pale Weathering Siltstones with Malachite |
| 2 | 30 | 40 | 10 | 70 | 11000 | |
| 3 | 40 | 45 | 5 | 55 | 2600 | |
| 4 | 45 | 50 | 5 | 55 | 1700 | |
| 5 | 50 | 55 | 5 | 70 | 1100 | Weathered cream, red, yellow, purple and brown Siltstones (Dolomitic ?) |
| 6 | 55 | 60 | 5 | 100 | 860 | |
| 7 | 60 | 70 | 10 | 60 | 760 | |
| 8 | 70 | 80 | 10 | 55 | 450 | |
| 9 | 80 | 90 | 10 | 60 | 520 | |
| 770 | 90 | 100 | 10 | 60 | 510 | |
| 771 | 100 | 110 | 10 | - | 1800 | Siltstones, Specks of Malachite |

**WATER:** Mud at 110 ft.

(0.76%)

7.6m

**DRILL HOLE:** IRON BLOW CENTRE EAST (IBCE)

**LOCATION:** NEAR THE IRON BLOW PROSPECT IN THE VICINITY OF LONG. 138° 20', LAT. 30° 49' (See plan)

**DEPTH AND DIRECTION:** 125 FEET AT -60° BEARING 101° M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 772 | 0 - | 10 | 10 | 45 | 1800 | ) Weathered iron |
| 3 | 10 - | 20 | 10 | 50 | 870 | ) stained siltstones |
| 4 | 20 - | 30 | 10 | 65 | 640 | ) and quartz sand. |
| 5 | 30 - | 40 | 10 | 65 | 670 | ) Minor iron and |
| 6 | 40 - | 50 | 10 | 70 | 1200 | ) Manganese oxides |
| 7 | 50 - | 60 | 10 | 75 | 560 | ) |
| 8 | 60 - | 70 | 10 | 70 | 60 | ) Mainly purple |
| 9 | 70 - | 80 | 10 | 70 | 65 | ) stained |
| 780 | 80 - | 90 | 10 | 75 | 50 | ) Dolomitic ?, Silt- |
| 1 | 90 - | 100 | 10 | 75 | 90 | ) stones and fine |
| 2 | 100 - | 110 | 10 | 65 | 50 | ) Sandstones. Quartz |
| 3 | 110 - | 120 | 10 | 70 | 70 | ) sand and minor |
| 784 | 120 - | 125 | 5 | 55 | 240 | ) Carbonate. |
| | | | | | | ) Rare Iron Oxides. |

18m

**WATER:** Wet clay at bottom of hole.

**DRILL HOLE:** IRON BLOW SOUTH (IBS)

**LOCATION:** NEAR THE IRON BLOW PROSPECT IN THE VICINITY OF LONG. 138° 20', LAT. 30° 49' (See plan)

**DEPTH AND DIRECTION:** 180 FEET AT -53° BEARING 098° M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 785 | 0 - | 10 | 10 | 60 | 260 | Iron stained quartz sand and fine sandstone. Re-cemented fragments. |
| 6 | 10 - | 20 | 10 | 70 | 410 | |
| 7 | 20 - | 30 | 10 | 80 | 310 | |
| 8 | 30 - | 40 | 10 | 95 | 70 | Purple coloured Dolomitic Siltstone with pink or brownish dolomite. Minor Quartz Sand |
| 9 | 40 - | 50 | 10 | 80 | 55 | |
| 790 | 50 - | 60 | 10 | 95 | 60 | |
| 1 | 60 - | 70 | 10 | 90 | 35 | |
| 2 | 70 - | 80 | 10 | 90 | 45 | |
| 3 | 80 - | 85 | 5 | 80 | 40 | |
| 4 | 85 - | 90 | 5 | 95 | 35 | |
| 5 | 90 - | 95 | 5 | 70 | 35 | |
| 6 | 95 - | 100 | 5 | 100 | 25 | |
| 7 | 100 - | 105 | 5 | 65 | 30 | |
| 8 | 105 - | 110 | 5 | 90 | 25 | |
| 9 | 110 - | 120 | 10 | 85 | 40 | |
| 800 | 120 - | 130 | 10 | 80 | 30 | |
| 1 | 130 - | 140 | 10 | 95 | 45 | |
| 2 | 140 - | 145 | 5 | 25 | 45 | |
| 3 | 145 - | 150 | 5 | 100 | 30 | |
| 4 | 150 - | 160 | 10 | 80 | 25 | |
| 5 | 160 - | 170 | 10 | 95 | 45 | |
| 806 | 170 - | 180 | 10 | 65 | 25 | |

**WATER:** Bottom of hole in wet clay.

Box 3

**DRILL HOLE:** RED RANGE NORTH (RRN)

**LOCATION:** IN THE VICINITY OF LONG. 138° 21' '35
LAT. 30° 53' (See plan) .083

**DEPTH AND DIRECTION OF HOLE:** 110 FEET AT -60° bearing 095°M.

| QS Sample Number | Footage (ft.) From | To | Interval | % Recovery | Assay Data p.p.m. Cu | Pb | Zn | Geological Log |
|---|---|---|---|---|---|---|---|---|
| 807 | 0 | -10 | 10 | 40 | 100 | 1200 | 9100 | Manganiferous Dolomite |
| 8 | 10 | -20 | 10 | 65 | 100 | 1400 | 12000 | |
| 9 | 20 | -30 | 10 | 80 | 200 | 1400 | 8000 | |
| 810 | 30 | -40 | 10 | 70 | 300 | 3400 | 5600 | Sandy Manganiferous Dolomite |
| 1 | 40 | -50 | 10 | 65 | 300 | 5200 | 3600 | |
| 2 | 50 | -60 | 10 | 50 | 500 | 3000 | 4800 | |
| 3 | 60 | -65 | 5 | 20 | 300 | 1500 | 5900 | |
| 4 | 65 | -70 | 5 | 65 | 500 | 3300 | 2900 | |
| 5 | 70 | -75 | 5 | 35 | 200 | 1900 | 830 | Manganiferous Quartz-Sand |
| 6 | 75 | -80 | 5 | 55 | 100 | 1100 | 440 | |
| 7 | 80 | -85 | 5 | 40 | 100 | 1000 | 350 | |
| 8 | 85 | -90 | 5 | 20 | 200 | 1200 | 310 | |
| 9 | 90 | -100 | 10 | 35 | 100 | 1200 | 390 | |
| 820 | 100 | -110 | 10 | 35 | *100 | 450 | 240 | |

21m

213

**WATER:** Wet clay at bottom of hole.

* Denotes less than.

Ajax

**DRILL HOLE:** RED RANGE SOUTH (R.R.S)

**LOCATION:** IN THE VICINITY OF LONG. 138° 21'
LAT. 30° 54' (See plan)

**DEPTH AND DIRECTION OF HOLE:** 105 FEET AT -60° bearing 090°M.

| QS Sample Number | Footage (ft.) From | To | Interval | % Recovery | Assay Data p.p.m. Cu | Pb | Zn | Geological Log |
|---|---|---|---|---|---|---|---|---|
| 821 | 0 - | 10 | 10 | 50 | 1200 | 900 | 5000) | Manganiferous |
| 2 | 10 - | 20 | 10 | 70 | 800 | 660 | 3800) | Dolomite |
| 3 | 20 - | 30 | 10 | 60 | 400 | 640 | 2300 ) | |
| 4 | 30 - | 40 | 10 | 45 | 600 | 1300 | 3000 ) | |
| 5 | 40 - | 50 | 10 | 85 | 500 | 1000 | 2900 | )Sandy |
| 6 | 50 - | 60 | 10 | 70 | 200 | 390 | 900 | )Manganiferous |
| 7 | 60 - | 70 | 10 | 70 | 100 | 370 | 550 | ) Dolomite |
| 8 | 70 - | 80 | 10 | 65 | *100 | 370 | 600) | |
| 9 | 80 - | 90 | 10 | 55 | *100 | 380 | 820) | Fine |
| 830 | 90 - | 100 | 10 | 50 | 200 | 440 | 2000) | Quartz |
| 831 | 100 - | 105 | 5 | 20 | 200 | 450 | 2100) | Sand. Some Manganese Oxides |

**WATER:** -

* Denotes less than.

**DRILL HOLE:** HARVEY'S RETURN MINE (H.R.)

**LOCATION:** IN THE VICINITY OF LONG. 138° 24' ·4
LAT. 30° 52' (See plan)
·97

**DEPTH AND DIRECTION OF DRILLING:** 120 FEET AT -60° bearing 093°M.

| QS Sample Number | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 1008 | 0 - | 10 | 10 | 50 | 0.02 | Pale Weathered Shales |
| 9 | 10 - | 20 | 10 | 70 | *0.01 | |
| 10 | 20 - | 30 | 10 | 75 | *0.01 | |
| 1 | 30 - | 40 | 10 | 80 | *0.01 | |
| 2 | 40 - | 50 | 10 | 80 | *0.01 | Blue-Grey Shales |
| 3 | 50 - | 60 | 10 | 85 | 0.02 | |
| 4 | 60 - | 70 | 10 | 80 | 0.01 | |
| 5 | 70 - | 80 | 10 | 80 | *0.01 | Purple Shales |
| 6 | 80 - | 90 | 10 | 90 | *0.01 | |
| 7 | 90 - | 100 | 10 | 85 | *0.01 | |
| 8 | 100 - | 110 | 10 | 85 | *0.01 | |
| 9 | 110 - | 120 | 10 | 65 | *0.01 | Purple Shale with vein Quartz |

**WATER:** Water at 115 feet.

* Denotes less than

Burgess

**DRILL HOLE:** BLACK FEATHER (B.F.)

**LOCATION:** IN THE VICINITY OF LONG. 138° 24'
LAT. 30° 53' (See plan)

.893

**DEPTH AND DIRECTION OF DRILLING:** 65 FEET AT -60° BEARING 092°M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 1020 | 0 | 10 | 10 | 65 | 0.03 | Purple Shale |
| 1 | 10 | 20 | 10 | 80 | 0.77 | Purple Shales with Dolomite vein quartz and traces of Malachite |
| 2 | 20 | 30 | 10 | 100 | 0.78 | |
| 3 | 30 | 40 | 10 | 100 | 0.78 | |
| 4 | 40 | 50 | 10 | 100 | 0.54 | |
| 5 | 50 | 60 | 10 | 100 | 0.58 | |
| 6 | 60 | 65 | 5 | 30 | 1.04 | |

**WATER:** Hole dry.

**AVERAGE** 0.62% Copper

**DRILL HOLE:** ENTERPRISE MINE NO. 2 (EM 2)

**LOCATION:** 25 FEET SOUTH OF ENTERPRISE MINE NO. 1.

**DEPTH AND DIRECTION OF DRILLING:** 90 FEET AT -60°BEARING 094°M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 1036 | 0 | 10 | 10 | 75 | *0.01 | Purple Shales |
| 7 | 10 | 20 | 10 | 90 | *0.01 | |
| 8 | 20 | 30 | 10 | 95 | 0.01 | |
| 9 | 30 | 40 | 10 | 100 | *0.01 | |
| 40 | 40 | 50 | 10 | 95 | 0.02 | |
| 1 | 50 | 60 | 10 | 95 | 0.02 | |
| 2 | 60 | 70 | 10 | 90 | *0.01 | |
| 3 | 70 | 80 | 10 | 95 | 0.02 | |
| 4 | 80 | 90 | 10 | 70 | 0.02 | |

**WATER:** Soft clay at bottom of hole.

Bergo

**DRILL HOLE:** ENTERPRISE MINE NO. 1 (EM1)

**LOCATION:** IN THE VICINITY OF LONG. 138° 24'
LAT. 30° 53' (See plan) .4

**DEPTH AND DIRECTION OF DRILLING:** 90 FEET AT -60° BEARING 094°M.

| QS Sample Number | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 1027 | 0 | 10 | 10 | 60 | *0.01 | Purple Shales |
| 8 | 10 | 20 | 10 | 80 | *0.01 | |
| 9 | 20 | 30 | 10 | 85 | 0.01 | |
| 30 | 30 | 40 | 10 | 85 | 0.02 | |
| 1 | 40 | 50 | 10 | 85 | 0.01 | |
| 2 | 50 | 60 | 10 | 80 | 0.05 | |
| 3 | 60 | 70 | 10 | 95 | *0.01 | |
| 4 | 70 | 80 | 10 | 80 | 0.02 | |
| 5 | 80 | 90 | 10 | 20 | *0.01 | |

**WATER:** Bottom of hole in soft clay.

* Denotes less than

Burgess

**DRILL HOLE:** WALTER'S MINE

**LOCATION:** IN THE VICINITY OF LONG. 138° 24'
LAT. 30° 54' (See plan).

**DEPTH AND DIRECTION OF DRILLING:** 90 FEET AT -60° BEARING 094°M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 1045 | 0 | 10 | 10 | 60 | *0.01 | Purple Shales |
| 6 | 10 | 15 | 5 | 85 | *0.01 | |
| 7 | 15 | 20 | 5 | 95 | *0.01 | |
| 8 | 20 | 25 | 5 | 75 | 0.01 | |
| 9 | 25 | 30 | 5 | 95 | 0.01 | |
| 50 | 30 | 40 | 10 | 80 | 0.02 | |
| 1 | 40 | 50 | 10 | 80 | 0.03 | |
| 2 | 50 | 60 | 10 | 75 | *0.01 | |
| 3 | 60 | 70 | 10 | 75 | *0.01 | |
| 4 | 70 | 80 | 10 | 75 | *0.01 | |
| 5 | 80 | 90 | 10 | 50 | *0.01 | |

**WATER:** Bottom of hole in soft clay.

* Denotes less than.

**DRILL HOLE:** SIX MILE CLAIM (SMC)

**LOCATION:** IN THE VICINITY OF LONG. 138° 24'
LAT. 30° 54' (See plan)

**DEPTH AND DIRECTION OF DRILLING:** 110 FT. AT -60° BEARING 093° M.

| QS SAMPLE NUMBER | Footage (ft.) From | To | Interval | % Recovery | Assay Data Cu p.p.m. | Geological Log |
|---|---|---|---|---|---|---|
| 1056 | 0 - | 10 | 10 | 40 | *0.01 | Purple Shales |
| 7 | 10 - | 20 | 10 | 75 | *0.01 | |
| 8 | 20 - | 30 | 10 | 80 | *0.01 | |
| 9 | 30 - | 40 | 10 | 80 | *0.01 | |
| 60 | 40 - | 50 | 10 | 85 | *0.01 | |
| 1 | 50 - | 60 | 10 | 80 | *0.01 | |
| 2 | 60 - | 70 | 10 | 80 | *0.01 | |
| 3 | 70 - | 80 | 10 | 85 | *0.01 | |
| 4 | 80 - | 90 | 10 | 85 | *0.01 | |
| 5 | 90 - | 100 | 10 | 80 | *0.01 | |
| 6 | 100 - | 110 | 10 | 70 | *0.01 | |

**WATER:** Water in hole at 110 ft.

* Denotes less than.

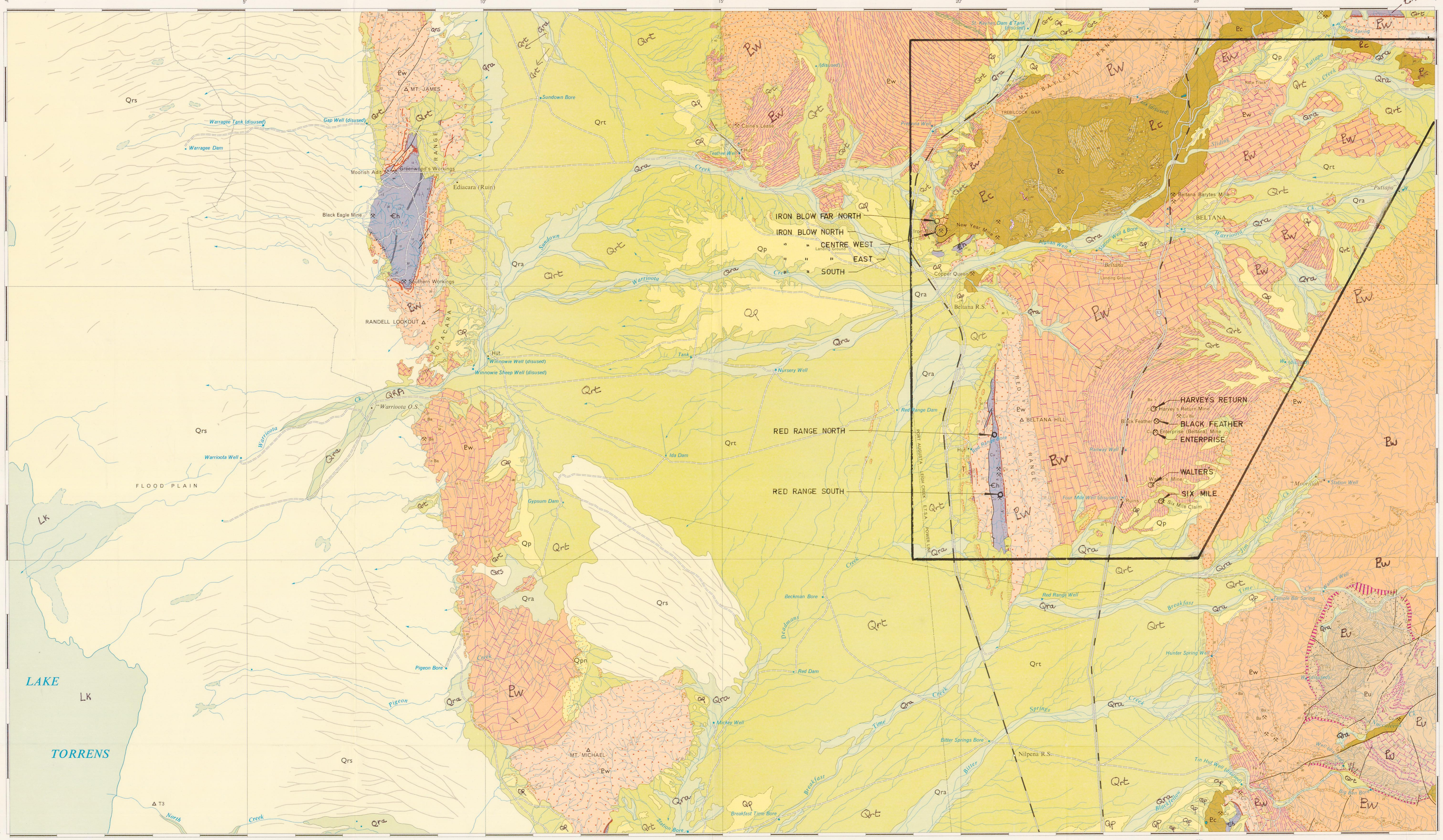
# PERCUSSION DRILL SITES. SML 170.

# BELTANA

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

FIRST EDITION 1966

GEOLOGICAL ATLAS 1 MILE SERIES
MAP REFERENCE No. 696 ZONE 5




Cartography by A. S. Francis.

## REFERENCE

| | |
|---|---|
| LK | Lake deposits. Gypseous clays, saline silts, and quartz sands. |
| Qra | Alluvium of drainage channels and flood plains. |
| Qrt | Low angle slope deposits. |
| | Scree deposits on high angle slopes. |
| Qrs | Sand spread and sand dunes. |
| Qp | High-level dissected piedmont gravels. Upper limit defined by old erosion surface. |
| Qpn | Nilpena Limestone. Non-marine limestone with gastropods. |
| T | Silcrete and laterite. Red and yellow clays in bores. |

CAINOZOIC — QUATERNARY — RECENT; PLEISTOCENE; TERTIARY

PALAEOZOIC — CAMBRIAN — LOWER CAMBRIAN — HAWKER GROUP (Ꞓh)

AJAX LIMESTONE (includes Wilkawillina Limestone): Cross-bedded sandy dolomite passes laterally and vertically into algal and oolitic dolomite, overlain by cherty dolomite with Archaeocyatha.

PARACHILNA FORMATION: Argillaceous sandstone and shale with limestone lenses. Worm-burrow bed at base.

UPPER PROTEROZOIC — ADELAIDE SYSTEM — MARINOAN — WILPENA GROUP (Pw)

POUND QUARTZITE:
Upper Member: Massive to flaggy, resistant white orthoquartzite with ripple-marks and heavy mineral laminations. Numerous clay-galls. Ediacara fauna near top.
Lower Member: Feldspathic sandstone with interbedded red siltstones and sandstones overlie red-bed sequence of cross-bedded red sandstones and micaceous red siltstones. Local conglomerate at base in northern part of Red Range.

WONOKA FORMATION: Thin interbedded blue-grey limestone and siltstone with flute-casts and ripple-marks. Slump brecciolas throughout, particularly in the region of Beltana Diapir. Local sedimentary discordance with Bunyeroo Formation marked by slump brecciola.

BUNYEROO FORMATION: Dark red, finely-laminated dolomitic shales with flute-casts and mud cracks. Thin interbedded dolomites in upper part. Thin interbedded grey-green shales occasionally cupriferous. Local conglomerate at base near Trebilcock's Gap.

A.B.C. RANGE QUARTZITE: Ripple-marked and cross-bedded heavy mineral banded feldspathic sandstone with minor siltstones. Thick, massive to flaggy orthoquartzite at base.

BRACHINA FORMATION:
BAYLEY RANGE SILTSTONE MEMBER: Drab olive-green siltstones with occasional interbeds of hard feldspathic siltstone.
MOORILLAH SILTSTONE MEMBER: Banded and unbanded purple and dark red coarse-grained siltstone with two thin lenses of conglomerate. Basal lens of buff, fine-grained sandstone grading into local conglomerate near Diapir.
MOOLOOLOO SILTSTONE MEMBER: Drab olive-green siltstones with ripple-marks near top. Red siltstone at base.

NUCCALEENA FORMATION: Well-bedded, cream-weathering pink dolomite overlain by purple shales with interbedded thin dolomites.

UMBERATANA GROUP (Pu) — MARINOAN / STURTIAN

ELATINA FORMATION: Pink to reddish, coarse-grained orthoquartzite with well-rounded quartz and red chert granules. Rare pebbles.

TREZONA FORMATION: Grey calcareous shales with several bands of red brecciola dolomite.

ENORAMA SHALE: Thinly bedded, unbanded grey-green shales overlain by drab grey shale with slumping near top. Thin purple siltstone at base.

ETINA FORMATION: Massive blue-grey and grey siltstones with three thin dolomite bands; lowest band sandy with lenses of quartz grit. Underlain by yellow-brown weathering sandy dolomite. Minor interbeds of soft, coarse-grained red siltstone. Thin quartzite at base.

AMBEROONA FORMATION EQUIVALENTS

TAPLEY HILL FORMATION: Thick, flaggy dark blue-grey well laminated siltstone. Coarser in upper part. Thin dolomite near top.

WILLOURAN — CALLANNA BEDS

| | |
|---|---|
| Pc | Undifferentiated diapiric breccia with carbonate matrix. |
| | Massive quartzites with heavy mineral laminations. |
| | Brown and blue-grey siltstones with halite pseudomorphs. |
| | Sandstones and siltstones with halite pseudomorphs. Prominent interbedded bands of yellow-brown weathering dolomite. |
| | Bedded yellow-brown weathering dolomites. |
| | Scapolitized hornblende quartz rock (?basic igneous). |

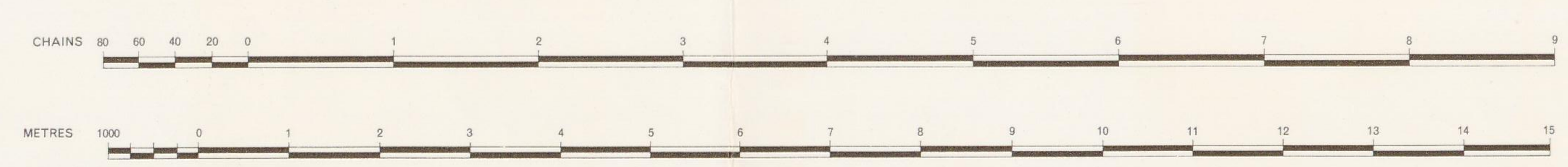
GEOLOGICAL BOUNDARIES
OBSERVED
APPROXIMATE
SUB SURFACE BOUNDARY
FAULTS
OBSERVED
INFERRED
CRUSH ZONE
BEDDING
INCLINED
VERTICAL
HORIZONTAL
TREND OF BEDDING
TYPE SECTION
MAIN ROAD
SECONDARY ROAD
TRACK
NATIONAL ROUTE NUMBER
RAILWAY
DISUSED RAILWAY
VERMIN PROOF FENCE
HOMESTEAD
TRIANGULATION STATION
EPHEMERAL STREAM
CLAYPANS
WATER FEATURES
BORE
SPRING
WELL
EARTH TANK OR DAM
MACRO FOSSIL LOCALITY
MINE
MINERAL OCCURRENCE
COPPER ... Cu
LEAD ... Pb
IRON ... Fe
BARYTES ... Ba

## LOCALITY


## INDEX TO ADJOINING SHEETS

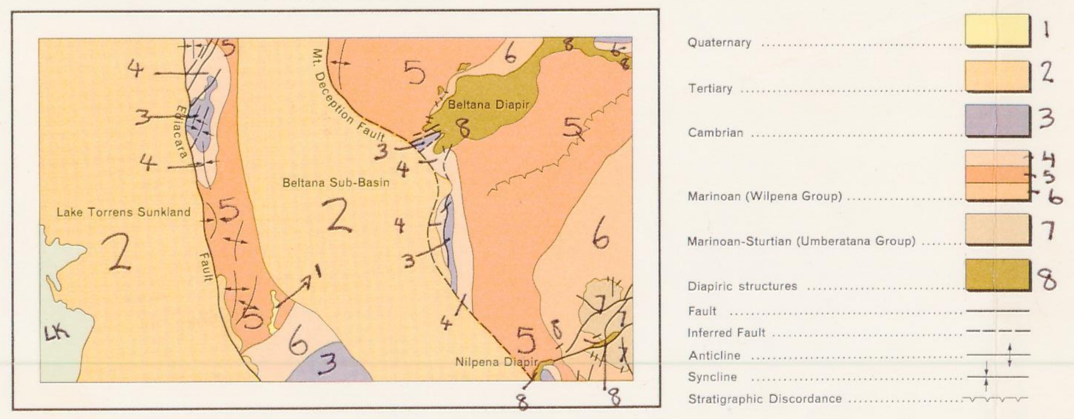
| | | |
|---|---|---|
| SCOTT | COPLEY | ANGEPENA |
| MURDIE | BELTANA | CAONIA |
| CARRAPATEENA | PARACHILNA | BLINMAN |

SCALE: 1 : 63,360 — 1 INCH TO 1 MILE




H. J. WALL, GOVERNMENT PHOTOLITHOGRAPHER, ADELAIDE.

## TECTONIC SKETCH

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BELTANA

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