DEPARTMENT OF MINES
SOUTH AUSTRALIA

PRELIMINARY GEOCHEMICAL REPORT ON THE YUDNAMUTANA AREA

Umberatana - 1 Mile Sheet

by

W.A. FAIRBURN
ASSISTANT SENIOR GEOLOGIST
METALLIC MINERALS SECTION

CONTENTS

PLANS

Plan No.	Title	Scale
67-783	Yudnamutana - Contour Plan of Copper Content in Soil	1" = 200ft.
67-784	Yudnamutana - Geological Plan in the Region of the Smelters Site	1" = 100ft.
67-824	Yudnamutana - Frequency Distribution Diagrams of Copper, Lead, Zinc and Vanadium in Soils	-
S6242	Yudnamutana - Comparison of Copper and Vanadium Content in Soils	-

17th January, 1968.

Rept.Bk.No. 66/19
G.S. No. 3881
D.M. 1486/66

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. 66/19
G.S. No. 3881
D.M. 1486/66

PRELIMINARY GEOCHEMICAL REPORT ON THE YUDNAMUTANA AREA

Umberatana - 1 Mile Sheet

ABSTRACT

Geochemical soil sampling in the Yudnamutana area, between the smelters site and the Cockscomb mine, has outlined two distinct copper anomalies. One anomaly lies within the boundary of the Wywyana Formation, while the other lies along the contact between the Wywyana Formation and the Paralana Quartzite. The source for the copper in these anomalies is not known.

Induced polarization surveys near the smelters site have produced anomalies on several traverse lines. Two of the most promising of these anomalies have been proposed for drilling.

It is recommended that additional geophysical surveys be carried out over the area covered by geochemical sampling, and that the geochemical soil sampling be extended over the remainder of the Wywyana Formation exposed within the reserve.

INTRODUCTION

General

The report by A.H. Blissett (Rept.Bk. 59/140) on the geology and mineralisation of the Daly-Yudnamutana field recommended geophysical surveys over the faulted anticline in the Willouran Callanna beds at Yudnamutana, between the Pinnacles mine and the Black Queen (East) workings. This request for geophysical surveys was later directed to the Exploration Services Division by Blissett in September, 1966.

An initial survey of the area using self potential, resistivity, radiometric, electromagnetic and induced polarization methods was made by the Senior Geophysicist, Exploration Geophysics Section, during October, 1966. It was recommended at

the conclusion of this work, that more detailed geophysical exploration would be justified.

Early in 1967, further geophysical work in the area was undertaken (See D. McPharlin, 1967) using magnetic and electrical methods. Additional I.P. coverage of some of the anomalies recorded by McPharlin is described by B.J. Taylor in an appendix to McPharlin's report.

To evaluate the geophysical anomalies, particularly the I.P. anomalies and a zone of high conductivity (see plan No. 67-784), in terms of bedrock geology and geochemistry, some detailed geological mapping was undertaken between the Yudnamutana mine and the Black Queen (West) mine, along with geochemical soil sampling on lines parallel to the geophysical grid.

This report includes a detailed geological map of the region near the smelters site (Plan No. 67-784) and also a geochemical plan showing the exposed outcrop of the Wywyana dolomite (Plan No. 67-783)

Size

The Yudnamutana area, as reserved from the operation of the Mining Act in September, 1966, is a rectangular area six miles long by two miles wide, whose northeastern corner and southwestern corner are Mt. Macdonnell and Yudnamutana Hill respectively.

During the present investigation only a small part of this reserve was examined. The reduced area being in the vicinity of Yerelina Creek, between the Yudnamutana and Cockscomb mines.

Location and Access

The area examined forms part of the pastoral property of Mt. Freeling Station and lies about six miles northwesterly from Mt. Painter. It is accessible by gravel road from Copley

to Umberatana Homestead via Mt. Serle and Yankaninna, and then by fourteen miles of fairly rough track to the Yudnamutana mining area on Yerelina Creek.

Previous Geological and Geophysical Investigations

The geology and mineralisation of the Yudnamutana area has been described in detail by A.H. Blissett (1964) who also lists (pp. 3-4) geological investigations prior to his work. Additional work by Blissett in this area, since 1964, will be incorporated in a bulletin on "The Regional and Economic Geology of the Mount Painter Province".

Geophysical investigations in the area, previous to the recent work of McPharlin and Taylor, have been summarised by McPharlin (1967, p.2)

GEOLOGY

Detailed geological mapping over a small area between the Yudnamutana mine and the Black Queen (West) mine and including the smelters site (see plan No. 67-784) was undertaken in an attempt to relate the geology to the I.P. anomalies. This area lies within the boundaries of an actinolite marble (mapped by Blissett, 1964) of Willouran age, which has been named the Wywyana Formation by R.P. Coats in the Mt. Painter Bulletin. The Wywyana Formation is underlain by the Paralana Quartzite and overlain by the Wooltana Volcanics, both of which are also of Willouran age.

Paralana Quartzite

This quartzite, according to Blissett (1964, p.7) is a poorly sorted, fairly coarse to medium grained, grey quartzite or quartzose sandstone, with bands of pebbly sandstone and fine conglomerate. It overlies unconformably rocks of the Mount Painter Complex. Also included within the quartzite are bands

of dark scapolite bearing rock.

Wywyana Formation

The Wywyana Formation is essentially an actinolite marble containing zones rich in magnetite, discontinuous bands of hornfels, thin quartz veins, and quartz fissure lodes. These separate units within the Wywyana Formation have been mapped near the smelters site (Plan No. 67-784). An outcrop map of the Wywyana Formation, between geochemical lines OOE and 5600E, is incorporated on Plan No. 67-783.

Magnetite - Dolomite

Magnetite is a fairly common accessory mineral in the actinolite marbles and at least one zone contains a high enough concentration to make a distinctive bed, with fairly sharp contacts. This bed has been mapped east and west of the Black Queen (West) mine dumps immediately north of a prominent band of hornfels. Some samples of the magnetite rich dolomite contain specks of copper sulphides.

Soil samples from over the magnetite-dolomite have copper contents greater than 1,000 p.p.m.

Hornfels

The hornfels bodies for the most part occur as small, discontinuous, irregularly shaped masses, showing fairly well pronounced bedding, which may be somewhat distorted and oblique to the general trend of bedding in the actinolite marble. In contrast to the smaller bodies, one fairly large band of hornfels, about 40 feet thick is exposed for a strike length of nearly 700ft. along the southern edge of the magnetite dolomite. A marked change in strike direction of the hornfels band near the Black Queen mine is probably due to faulting.

Quartz Veins

Quartz veins either show cross-cutting relationships or may be parallel, or near parallel to the general strike direction.

To the north of the smelters site and west of sample line 400E, the quartz veins are of the concordant type with slightly curved outcrop. Their spatial relationship suggests that they originated in tension fractures, bordering a sinistral wrench fault. This style of faulting is also suggested by the change in strike directions near the Black Queen (West) mine.

Geochemical soil samples, over or near several of the crosscutting north-westerly trending quartz veins, give highly anomalous copper contents.

Quartz Fissure Lodes

The quartz fissure lodes near the smelters site (Ridgway 1949, p. 160) are of uncertain origin, but could represent re-constituted quartz veins, which were emplaced prior to or during metamorphism. They are now represented by small jagged ridges or knolls, composed of masses of brownish, crystalline, finely granular and amorphous silica. Some of the quartz fissure lodes contain copper mineralisation. The structural controls for the location of the quartz fissure lodes is in most cases problematical.

The quartz fissure lodes, particularly those shown on plan 67-784, must be genetically related to the crystalline, quartz-ironstone-jasper replacement lodes of Ridgway (1949, p. 160), which they resemble closely.

Wooltana Volcanics

The northern exposed edge of the Wywyana Formation, between lines 1600E and 5600E (plan No. 67-783), is the contact between the Wywyana Formation and the overlying Wooltana Volcanics. This volcanic series is now represented by mica and chlorite schists, with bands containing scapolite, particularly in the lower part of the sequence.

Structural Geology

The structural geology of the Yudnamutana area has been

outlined by Blissett (1964, pp. 19-21) who gave details of folding, faulting, schistosity and cleavage.

Recent mapping has added very little new information, except for the possibility of a northwesterly trending, sinistral, wrench fault through the Black Queen (West) workings.

Mineralisation

All known mineralisation in the Daly-Yudnamutana copper field is presumed to be of epigenetic origin, being confined to faults, shear or breccia zones, stockworks and cross-cutting veins, veins parallel to cleavage and schistosity and zones of contact metasomatism (Blissett 1964, p.22)

Geochemical soil sampling, during the present investigation, has revealed the presence of copper anomalous zones within the Wywyana Formation and at the contact of the Wywyana Formation with the underlying Paralana Quartzite, in areas where mineralisation has not been previously recorded (see Plan No. 67-783).

Geochemical copper anomalies also occur in soil over some of the crosscutting quartz veins, which do not reveal any obvious copper mineralisation.

GEOCHEMISTRY

Geochemical sampling at Yudnamutana was initially undertaken in the area of geophysical exploration to investigate any abnormal metal contents in soils along I.P. lines. The work was later extended along strike eastward over the outcrop of the Wywyana Formation for a distance of about one mile.

All samples were tested for copper, lead and zinc by atomic absorption, and vanadium by emission spectrograph, the complete results being plotted on Plan No. 67-783. The sieved sample used in all determinations was the minus 80 mesh fraction.

A total of 227 soil samples and 24 stream sediment

samples were collected.

Soil Sampling

The soil sample lines, which cover a roughly rectangular area just over one mile long and about 1400 feet wide, were orientated north-south and approximately centred over the outcrop of the Wywyana Formation. Very few lines extend more than a few hundred feet on to the Paralana Quartzite or the Wooltana Volcanics. The lines were spaced 400 feet apart and samples were taken on these lines at intervals of 100 feet (Plan No. 67-783). Wherever possible all soil samples were taken at a depth of a few inches.

The baseline (300N), from which the sample lines were set out at right angles, was accurately surveyed and pegged, but individual sample points on these lines were located by taping.

Contamination of samples from old workings and dumps is thought to be negligible, except for a sample at 100N on line 800E.

During the course of geochemical sampling, an exposure map of the Wywyana Formation was prepared, as an added guide in the evaluation of the geochemistry, the boundary of the exposed area of the formation is shown on Plan No. 67-783.

In the statistical analysis of metal distribution in the soil samples it should be noted that the plots also include the results of the very limited stream sediment sampling.

Copper

The wide range of copper content in soils at Yudnamutana is revealed by the histogram in Fig. 1 (Plan No. 67-824), where the distribution of copper in 193 samples is illustrated (samples with copper contents greater than 260 p.p.m. have not been included). The histogram, due to the large proportion of samples with anomalous copper and lack of

a well defined mode, is markedly asymmetrical. As an approximation however, if the mode of background is taken as 50 p.p.m., by calculation, the arithmetic mean of background is 52 p.p.m., the standard deviation is 17 and the upper limit of background (arithmetic mean plus twice standard deviation) is 85 p.p.m. (c.f. U.L.B. of 50 p.p.m. in the Mt. Coffin diapir, Fairburn 1967, p. 13).

The copper content of all soil samples has been plotted on Plan No. 67-783 (upper right hand quarter), which is also a geological outcrop plan of the major rock units, and the values contoured at intervals of 100 p.p.m., 250 p.p.m., 500 p.p.m., and 1000 p.p.m. In choosing these contours, the upper limit of background was arbitrarily raised from 85 p.p.m. to 100 p.p.m. for mathematical simplicity. Values for stream sediment samples, also shown on this plan, have not been included in the contouring scheme.

The copper content in soil samples from lines 00, 400E, 800E, 1200E and 1600E has also been plotted on the detailed geological and geophysical plan.

It can be seen from the contoured plan, that two separate and well developed copper anomalies are present, (greater than 250 p.p.m.) with each anomaly broken into two parts by the area of alluvium bordering the small creek west of the Black Queen (East) mine. One anomaly is positioned in the middle of the Wywyana Formation, while the other, lies along the contact between the Wywyana Formation and the Paralana Quartzite. For both anomalies, some soil samples contain greater than 0.1% copper.

Plan 67-784 reveals that part of the copper anomaly on the Wywyana Formation coincides fairly closely with a zone through the dolomite, which has a high magnetite content.

The source of copper producing the soil anomalies on the Wywyana Formation and at the base of the Wywyana Formation is not known, but certain possibilities can be considered,

particularly in the case of the first mentioned anomaly.

That the anomalies are produced by local disseminations of malachite (which have been observed) or by increases in background copper near fault lines or quartz veins can largely be discounted due to the width of the anomalies and their repetition on all the sample lines where bedrock is not mantled by alluvium.

The association of anomalous copper with higher magnetite concentrations in bedrock near the Black Queen (West) mine suggests a possible source of the copper from magnetite. Available information on the trace element content in magnetite and haematite however, suggests that the copper that could be available in these minerals would be too low to produce a significant soil anomaly. Kisversanyi and Proctor (1967), in assaying 82 samples of purified iron ore from magnetite-haematite apatite and magnetite-copper sulphide deposits from southeastern Missouri, give a range of arithmetic means of copper contents for groups of the samples varying from 0.0001% copper to 0.174% copper. Details of values greater than the highest arithmetic mean of 0.174 per cent are not available.

Minute amounts of disseminated copper sulphide minerals have been noted in some samples of the magnetite dolomite but in insufficient quantities to cause major geochemical anomalies.

Lead and Zinc

The distributions of lead and zinc in the Yudnamutana area are considered to be normal, with no anomalous values. Histograms show that both distributions (Figs. 2 and 3, Plan No. 67-824) are clearly unimodal and fairly symmetrical.

The distribution of lead in 250 samples has an arithmetic mean of 15.1 p.p.m., a standard deviation of 4.7 and an upper limit of background of 24.5 p.p.m. Zinc like lead has a normal background distribution with very few if any anomalous values. The mode of distribution is similar to the arithmetic mean of nearly 32 p.p.m., the standard deviation of distribution

is 8.0 and the upper limit of background is 48 p.p.m.

Contouring of the plotted lead and zinc values on Plan No. 67-783 (upper left and lower left quarters) has not been thought necessary, due to the shortage of anomalous results.

Vanadium

The distribution of vanadium in soils at Yudnamutana is much more erratic than the distributions of the other metals, as is shown by Fig. 4, Plan No. 67-824. There would seem to be two populations present; a low range population with a mode of about 20 p.p.m., and a high range population with a mode of about 300 p.p.m. Some intermediate values exist between the two main populations.

The higher vanadium contents are mainly in soils from over the Wooltana Volcanics, but high values are also present in soils derived from the other formations. Perhaps the only marked areas where vanadium is low are where the Wywyana Formation gives rise to highly anomalous copper contents in the soils. The apparent antipathy of vanadium for copper can be illustrated by graphically plotting together vanadium and copper values for each line (see Plan No. S6242), and marking the extent of the exposure of the Wywyana Formation. On line 400E, where high copper values in soils coincide with low vanadium (100M and 200M), the bedrock dolomite contains a high proportion of magnetite, which would normally be considered a carrier of vanadium. Thus, many of the low vanadium contents are somewhat anomalous and not readily explained.

Turekian and Wedephohl (Table 2, 1961), in listing the distribution of elements in the earth's crust, give the vanadium content of basaltic rocks as 250 p.p.m. and of sedimentary sandstones and carbonates as 20 p.p.m. Thus, the high vanadium contents (100 p.p.m. - 1000 p.p.m.) in soils over the Wooltana Volcanics is probably not anomalous, but the high contents in some of the soils over the Wywyana Formation and Paralana Quartzite must be considered highly anomalous,

particularly as a lower range population is also present. The variations in vanadium over the Wywyana Formation could be due to variations in the magnetite content of the Wywyana dolomites; zones in the dolomite high in magnetite giving rise to soils with anomalous vanadium. As however, high vanadium generally coincides with low copper, the above suggestion is contrary to an earlier discussion (p. 9) that the copper anomalies occur over the magnetite rich dolomites.

Stream Sediment Sampling

Stream sediment samples were collected at intervals of 100ft., where the soil sample lines crossed Yerelina Creek. On most lines this involved the taking of two samples as shown on Plan No. 67-783. A total of 24 samples were collected, sieved to minus 80 mesh and assayed for copper, lead, zinc and vanadium.

Copper values are distinctly anomalous, being mainly in excess of 100 p.p.m. with a quite good reproducibility for the creek bed samples on each line. Some variations are noted for samples taken from alluvial terraces, within the creek bed.

Lead and zinc contents in the stream sediments are normal background and similar to the contents of these metals in the soil samples.

The vanadium contents of the sediments are in the upper ranges (see p. 10), being similar to the vanadium values in soil samples over the Wooltana Volcanics.

GEOPHYSICS

Accounts of induced polarization, magnetic, potential distribution and self potential investigations over the Yudnamutana area have been given in reports by McPharlin (1967) and Taylor (1967).

Induced Polarization

A total of eleven I.P. Lines were laid out at Yudnamutana mainly between the Black Queen (East) mine and the Yudnamutana mine. The position of seven of these lines with their deduced anomalies are shown on Plan No. 67-784. It is apparent from this plan, that the cause of the I.P. anomalies lie in a variety of geological settings as shown below:-

Geological Location of Anomaly	I.P. Line
Yudnamutana mine Code	Line 'D' and 'L'
Hornfels and/or magnetite dolomite	Line 'E'
Quartz lodes	Line 'J' (200N.E.)
Magnetite dolomite	Line 'B' (300-600E)
Unknown	Line 'J' and (200-400 S.W.) Line 'B' (300W)

It should also be noted that a small anomaly occurs on line 'K' in the region of the magnetite dolomite.

In conclusion it may be said, concerning the I.P. investigation, that the unit within the Wywyana Formation producing the best I.P. effects is the magnetite dolomite, which as has been noted earlier (p. 4) can be overlain by soil containing anomalous copper values (up to 0.1%).

Magnetic

Magnetic anomalies indicated by the contoured plan (McPharlin, 1967, Plan No. 67-160) of total magnetic intensity do not markedly coincide with any particular rock unit. A magnetic 'high' in the region of the smelters site occurs north, or down dip, from the main area of magnetite bearing rocks.

Potential Distribution

Potential distribution and induced polarization resistivity measurements have revealed a zone of high conductivity near the Black Queen (west) mine.

This zone in general lies fairly close to the magnetite dolomites.

Self Potential

The self potential recordings were regarded as being unreliable due to high resistivity conditions.

CONCLUSIONS AND RECOMMENDATIONS

Geochemical soil sampling near Yudnamutana has outlined two distinct copper anomalies in the area between the smelters site and the Cockscomb mine. One anomaly is situated over part of the Wywyana Formation, while the other is centred roughly along the line of the contact between the Wywyana Formation and the Paralana Quartzite. The source for the copper producing these anomalies has not been proved, but in the case of one of the anomalies, could be derived from magnetite, which is an important accessory mineral in some of the dolomites of the Wywyana Formation.

The geophysical data is not conclusive, particularly as regards the I.P. results, as a variety of sources for the anomalies are possible (see p. 12). Some of the best I.P. anomalies seem to be caused by the magnetite dolomite, a not unexpected reaction as magnetite can give appreciable frequency effects.

As a result of the geochemical and geophysical investigations, two diamond drill holes have been proposed in the area covered by the induced polarization survey. One hole will be on the I.P. anomaly on traverse 'E' while the other will be on the I.P. anomaly on traverse 'L' (see Plan No. 67-784).

Extension of the induced polarization survey to cover the geochemical anomalies east of sample line 2000E has been recommended to the Exploration Services Division, prior to the completion of this report.

It is also recommended that geochemical soil sampling over the Wywyana Formation should be completed to the limits of

the reserved area using a grid system similar to that already adopted.

WAF:OB:CC
17.1.68

W.A. FAIRBURN
ASSISTANT SENIOR GEOLOGIST
METALLIC MINERALS SECTION

REFERENCES

BLISSETT, A.H. 1964. The Geology and Mineralisation of the Daly-Yudnamutana Copper Field. Dept. of Mines, S.Aust., Rept.Bk.No. 59/140. (Unpub.).

COATS, R.P., and BLISSETT, A.H. The Regional and Economic Geology of the Mount Painter Province. Bull. geol. Surv. S.Aust., (In Preparation).

FAIRBURN, W.A. 1967. Second Geochemical and Geological Report on the Serle - Angepena Area. Dept. of Mines, S.Aust., Rept.Bk.No. 65/95. (Unpub.).

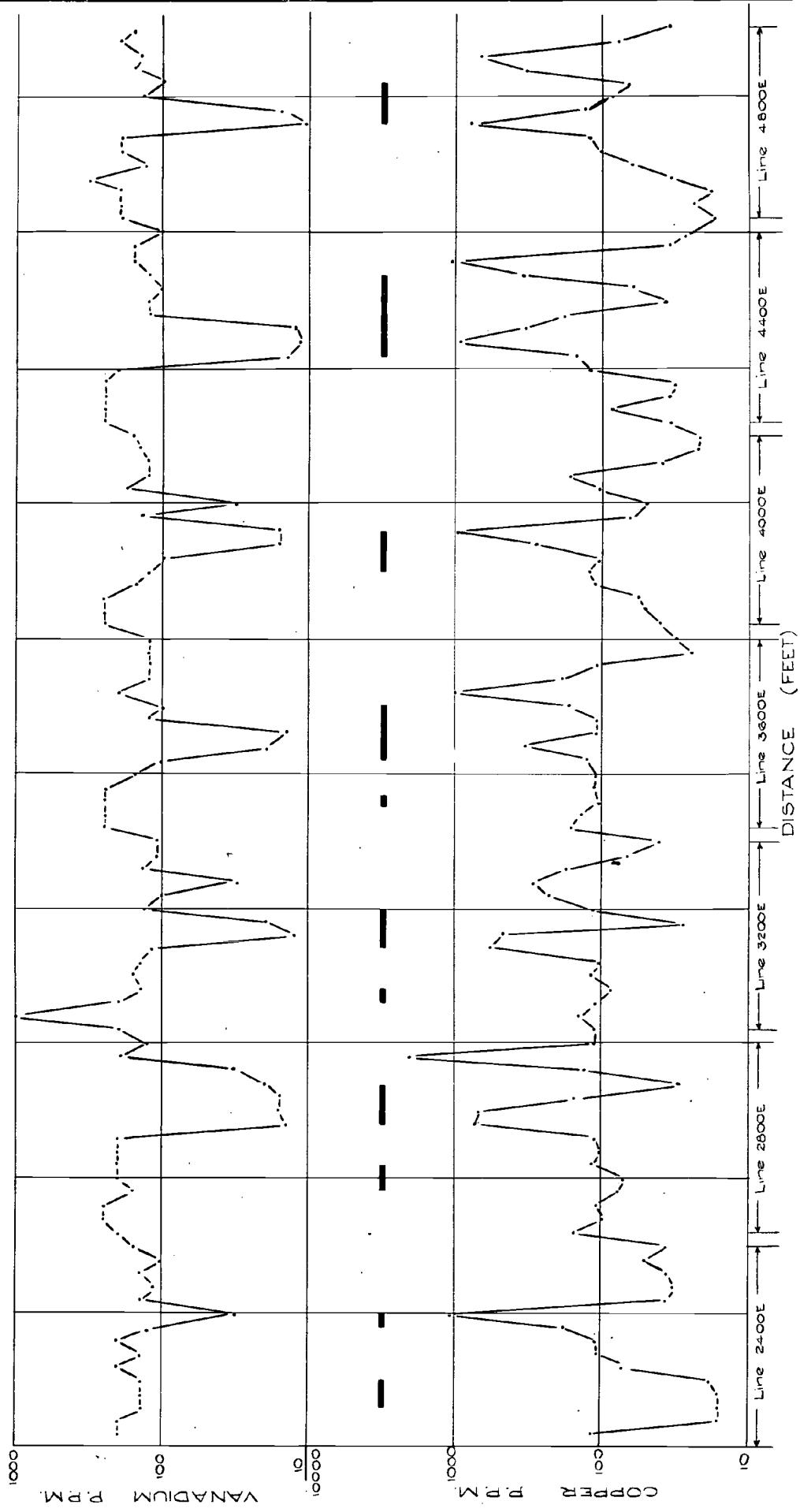
KISVARSANYI, G., and PROCTOR, P.D., 1967. Trace Element Content of Magnetites and Hematites, Southwest Missouri Iron Metallogenic Province, U.S.A. Econ. Geol. Vol. 62, No. 4, pp. 449-481.

McPHARLIN, D. 1967. Report on Geophysical Investigations of Yudnamutana Copper Deposits. Dept. of Mines, S.Aust., Rept.Bk.No. 64/104 (Unpub.).

RIDGWAY, J.E. 1949. Yudnamutana Copper Deposits. Min. Rev. Adelaide, No. 88, pp. 146-151.

TAYLOR, B.J. 1967. Appendix to Report on Geophysical Investigations of Yudnamutana Copper Deposits (by McPharlin, D.). Dept. of Mines, S.Aust., Rept.Bk. No. 64/104. (Unpub.).

TAREKIAN, K.K., and WEDEPHOHL, K.H., 1961. Distribution of the Elements in Some Major Units of the Earth's Crust. Geol. Soc. America Bull. Vol. 72, pp. 175-191.



For location of samples lines. Drawing No. 67-783
To accompany report by W.A. Fairburn.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

	Drn. W.F	YUDNAMUTANA COMPARISON OF COPPER AND VANADIUM CONTENT IN SOILS LINES 2400E - 4800E	SCALE : 1"=1000ft. Horizontal
	Tcd. AMcD		S 6242 Cd
	Ckd. L.V.W.		
	Exd.		DATE : 10-1-68

00 400E 800E 1200E 1600E 2000E 2400E 2800E 3200E 3600E 4000E 4400E 4800E 5200E 5600E

1200N 800N 400N 00 400S 800S 1200S

N

YERELINA CREEK

BLACK QUEEN (WEST)

BLACK QUEEN (EAST)

SCALE

FEET 0 400 800 1200 1600 2000 FEET

LEGEND

Copper content in soils in p.p.m.
(Creek samples not included)

> 1000

500—1000

250—500

100—250

Edge of exposed area of Actinolite Marble (Wywyana Formation

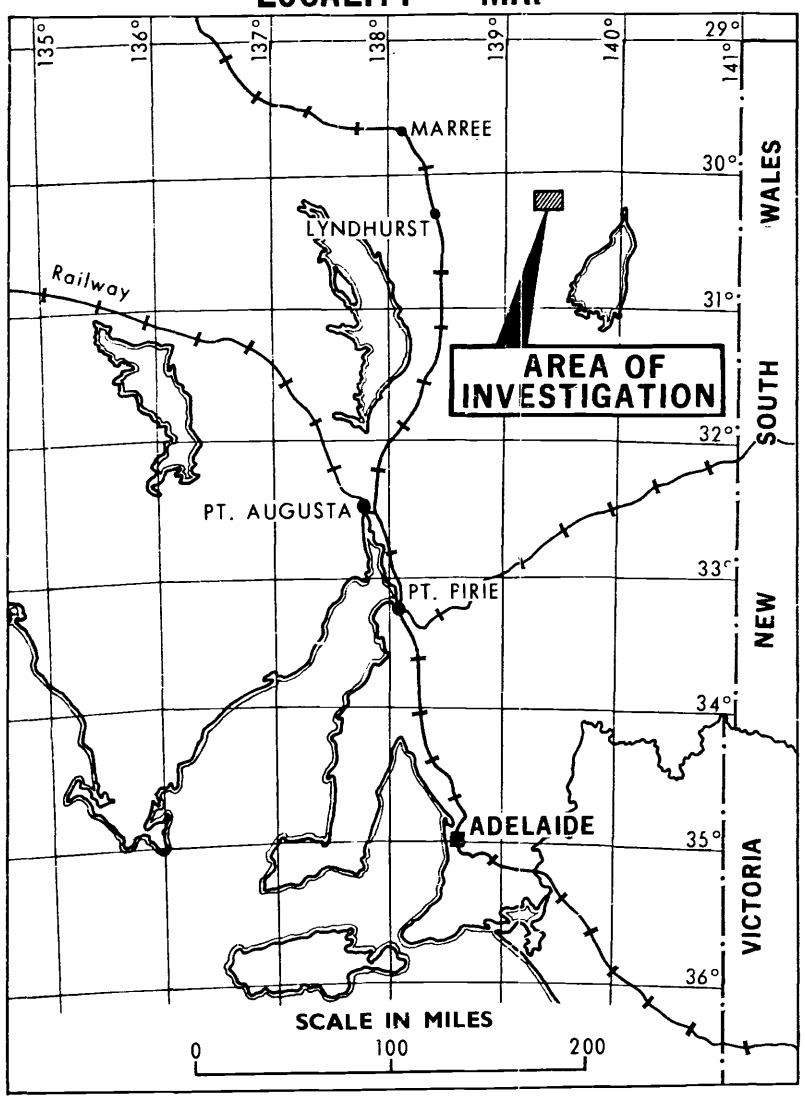
Northern edge of exposed Quartzite (Basal Callanna Quartzite)

67—783

W.A. Fairburn Assistant Senior Geologist

S.A. Dept. of Mines

LOCALITY MAP



500W 00 500E 1000E 1500E

1500N 1000N 500N 00 500S

YERELINA CREEK

1000NE 800NE 1200NE 800NE

H Q

D.D.H. 1

SMELTERS SITE

BLACK QUEEN (WEST) DUMP

D.D.H. 2

600E

800W 900W

TRAVERSE 'B'

TRAVERSE 'A'

YUDNAMUTANA MINE (Main Shaft)

D.D.H. 3

800W 0 TRAVERSE 'L' 1000E

TRAVERSE 'D' 1200SW

TRAVERSE 'J' 600SW

TRAVERSE 'E' 1200SW

TRAVERSE 'K' 1200SW

N

SCALE

FEET 0 200 400 600 800 1000 FEET

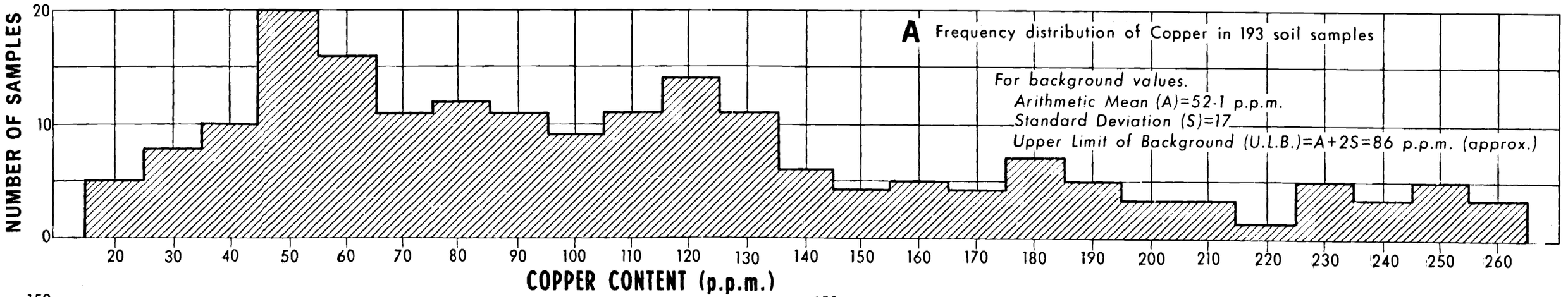
LEGEND

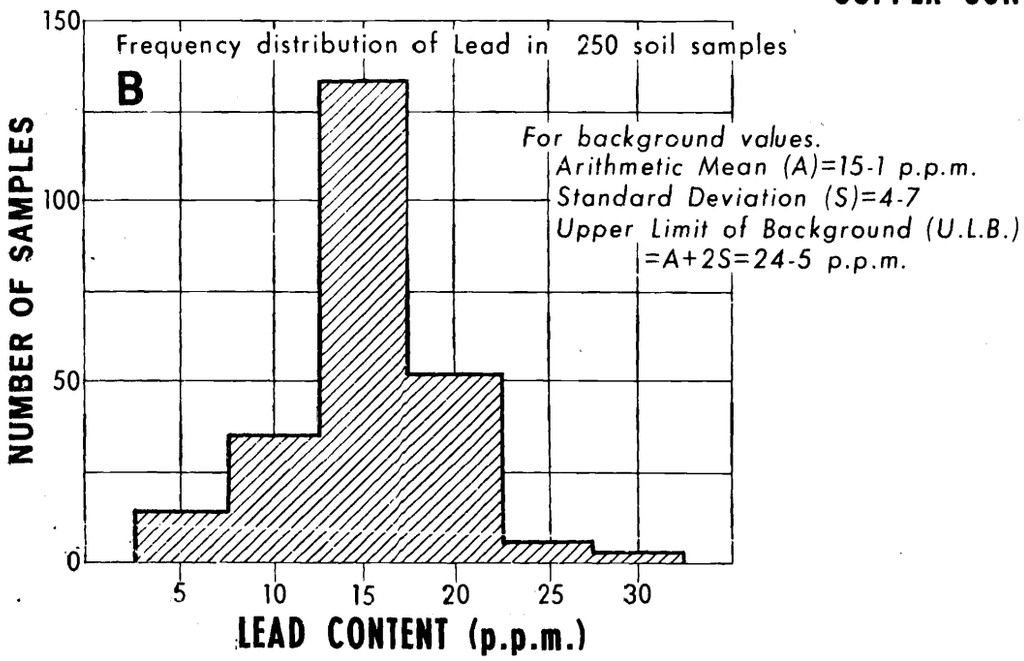
Hornfels	I.P. Anomaly
Quartz veins	I.P. Line — TRAVERSE 'K'
Magnetite rich actinolite dolomite	Fracture lines
Quartz lodes	Diamond Drill Hole (proposed) — D.D.H. 2
Breccia	High Conductivity Zone

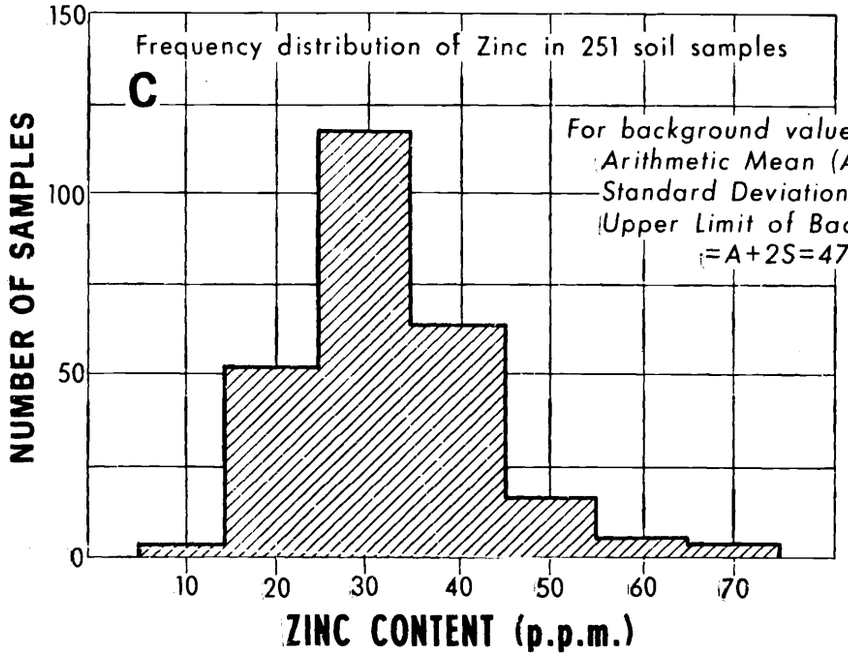
67--784

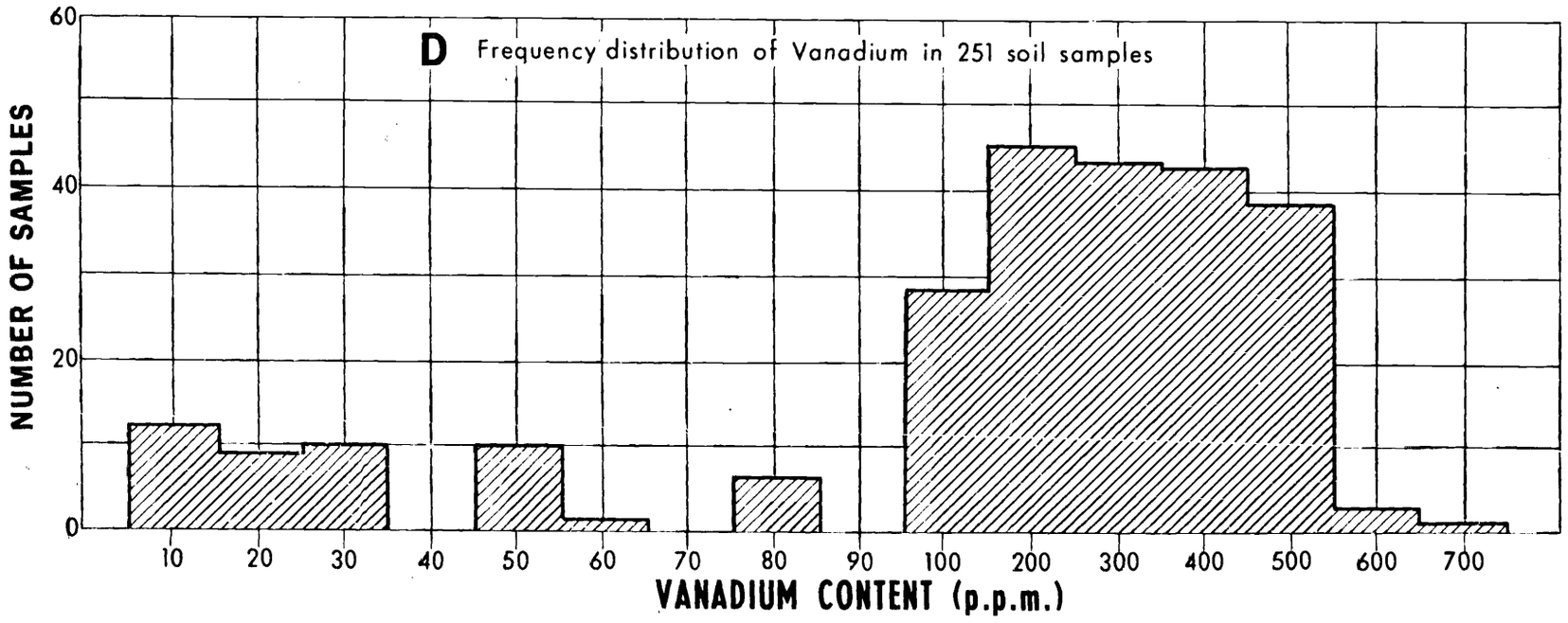
W.A. Fairburn Assistant Senior Geologist

S.A. Dept. of Mines









67—824

W.A. Fairburn Assistant Senior Geologist

S.A. Dept. of Mines