CONTENTS ENVELOPE 5233

TENEMENT: E.L. 1142 - Mt. Gawler.

TENEMENT HOLDER: Pancontinental Mining Company.

Tenement:	Exploration Licence 1142 - Eyre Peninsula
Holder:	Pancontinental Mining Limited
Date Granted:	May 27th, 1983
Area:	296 sq.km.
Term:	One Year
Expenditure Commitment:	$25,000
Report Period:	May 27th to August 26th, 1983
Work Completed:	A series of samples were collected from the old workings of the Koppio Mine. Samples were forwarded to Graphitwerk Kropfmuhl in Germany for analysis.
Proposed Work:	Work is to commence in November on mapping the E.L. in detail.
Expenditure:	Expenditure during the quarter has amounted to $4911 comprising the following costs:-

Salaries and oncosts	$ 3,045
Sydney Office Expenses	461
Travel & Accommodation	1,405
Total	$ 4,911

Tenement:	E.L. 1142 - Eyre Peninsula
Holder:	Pancontinental Mining Limited
Date Granted:	May 27th, 1983
Area:	296 sq. km.
Term:	12 months
Expenditure Commitment:	$25,000
Report Period:	August 27th to November 26th, 1983
Work Completed:	A review of previous exploration has been completed. Field reconnaissance geologic mapping and sampling has been conducted.
Proposed Work:	An E.M. survey is to be conducted. Trenching is to follow this survey.
Expenditure:	Expenditure during the quarter has amounted to $2,107 comprising the following costs:

Salaries	$ 669
Contractors services	500
Travel & accommodation	596
Field & other expenses	134
Sydney office expenses	208
	$2,107

Tenement:	E.L. 1142 - Eyre Peninsula
Holder:	Pancontinental Mining Limited
Date Granted:	May 27, 1983
Area:	296 sq.km
Term:	12 months
Expenditure Commitment:	$25,000
Report Period:	November 27, 1983 to February 26, 1984
Work Completed:	A programme of geological mapping and sampling was completed. An E-M survey was conducted over a total of 9km at the Koppio and Kookaburra Gully Prospects.
Proposed Work:	Trenching at Koppio and Kookaburra Gully Prospects, then mapping of the trenches and bulk sampling for graphite content.
Expenditure:	Expenditure during the quarter has amounted to $8,733 comprising the following:

Salaries (oncosted)	$ 2,930
Travel and Accommodation	1,261
Contractors Services	2,939
Field and Other Expenses	1,439
Sydney Office Expenses	164
	$ 8,733

E.L. 1142, MOUNT GAWLER AREA, SOUTH AUSTRALIA

Annual Report for the Period Ended

27 May, 1983 - 26 May, 1984

PANCONTINENTAL MINING LIMITED

Angus Collins
Chief Geologist

Sydney, N.S.W.
June, 1984

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1. INTRODUCTION

This report summarises the results of the exploration work for flake graphite carried out by Pancontinental Mining Limited in E.L. 1142 during the period 27 May, 1983 to 26 May, 1984. The following was completed:-

1. preliminary investigation of graphite samples in Germany
2. review of previous exploration in the area
3. geological mapping of the exploration licence at 1:25,000 scale
4. rock chip sampling during regional mapping
5. gridding of the Koppio Mine and Kookaburra Gully areas
6. an electromagnetic survey of the Koppio Mine and Kookaburra Gully areas
7. trenching and channel sampling
8. preliminary evaluation of the graphite content, flake size and gangue minerals at Kookaburra Gully.

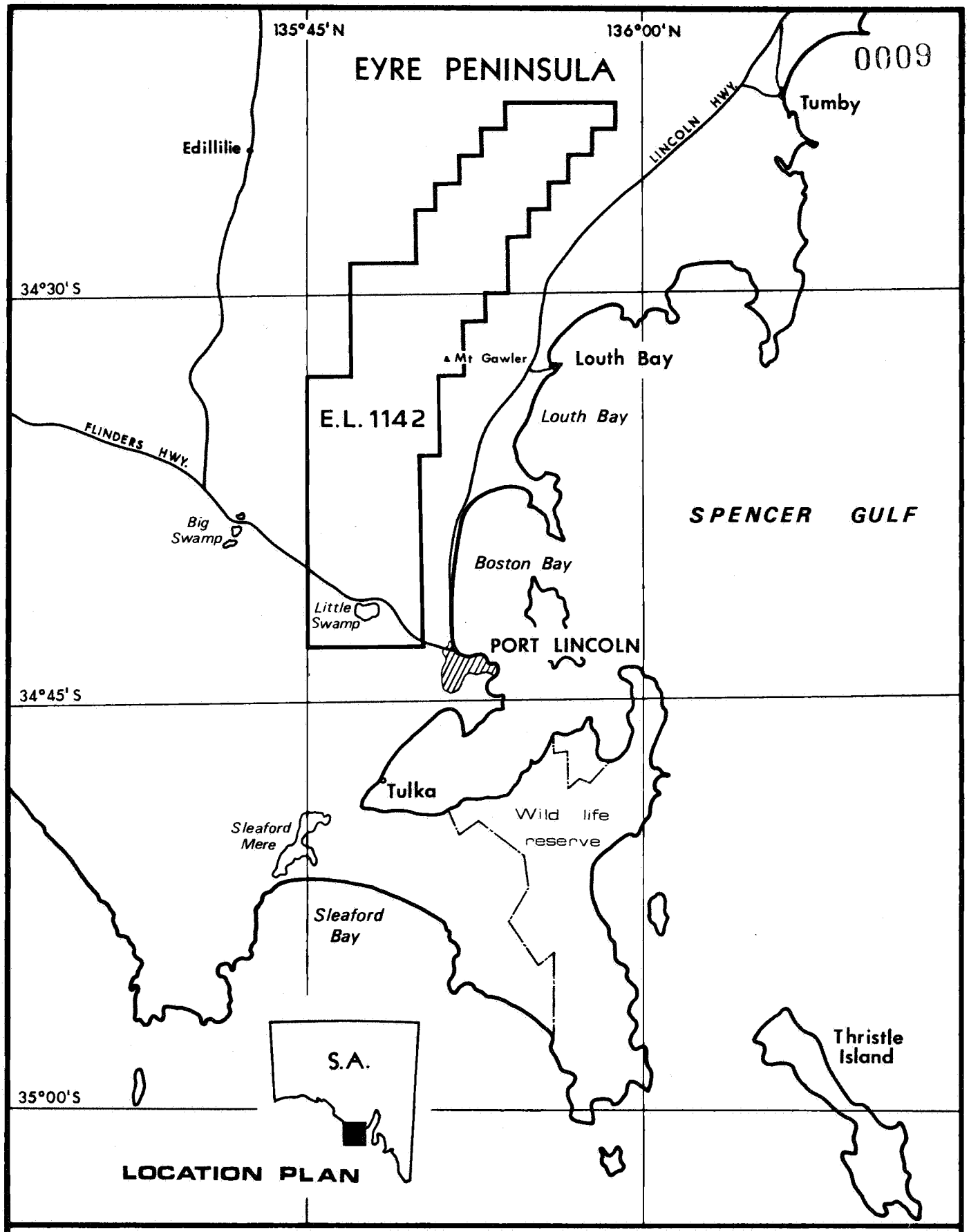
2. LOCATION AND ACCESS

The E.L. is located on the Eyre Peninsula to the north and northwest of Port Lincoln (See Figure 1). Access is adequate with numerous secondary roads and farm tracks throughout the E.L.

3. PRELIMINARY INVESTIGATION

Seven channel samples from the abandoned Koppio mine were sent to Graphitwerke Kropmühl A.G. in Hauzenberg, Germany for chemical analysis and determination of flake characteristics. The results were:-

Sample No.	Ash %	Volatile Matter %	C Content %
4271	21.8	6.6	15.2
4272	24.6	7.7	16.9
4273	22.4	5.5	16.9
4274	36.5	2.8	33.7
4275	36.4	4.7	31.7
4282	32.5	7.0	25.5
4283	28.6	2.5	26.1



EYRE PENINSULA - E.L. 1142

LOCATION PLAN

0 5 10 15 km

Scale 1:250 000

REPORT No.: 84/15

FIG. 1

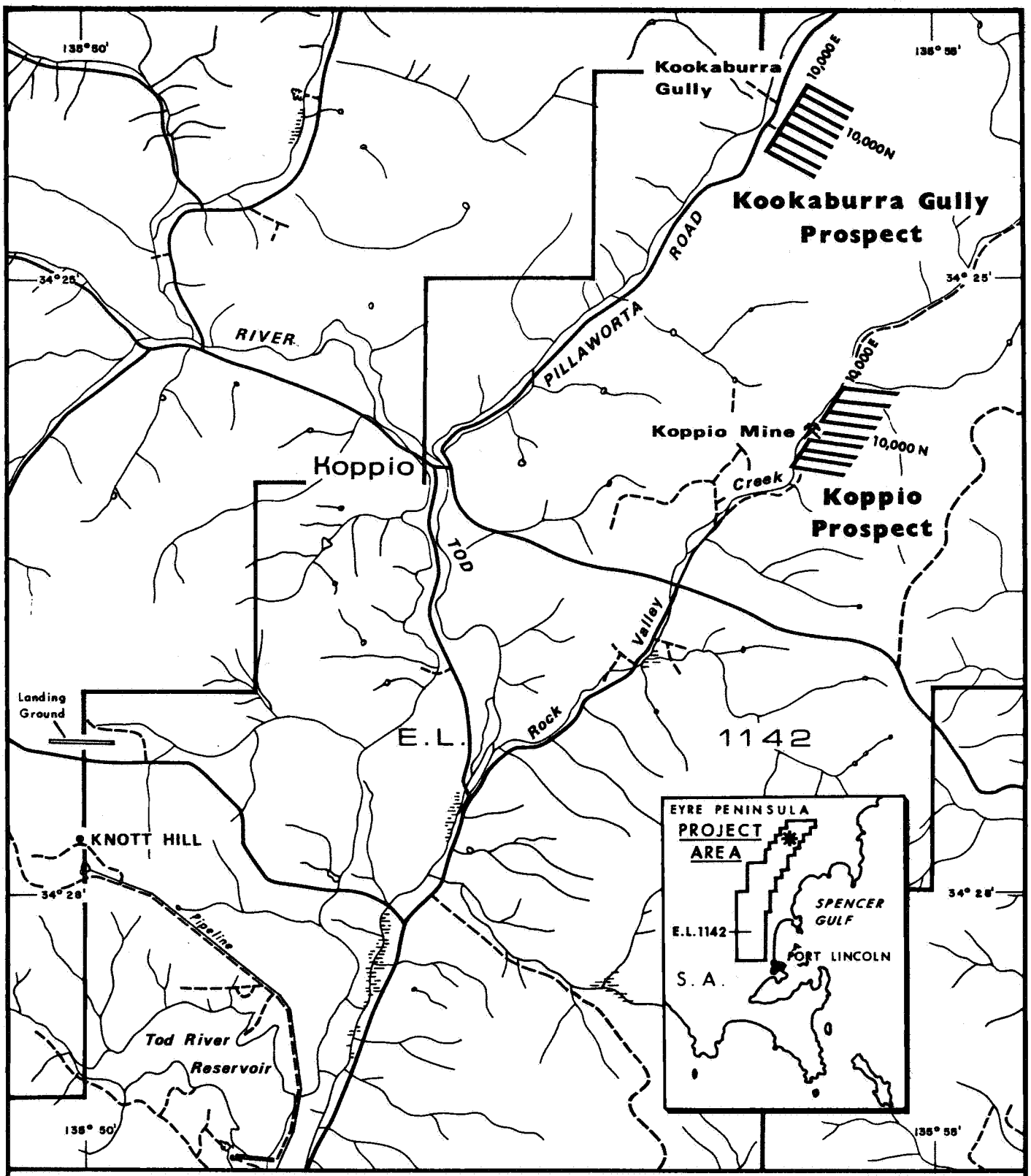


FIGURE 2

KOPPIO AND KOOKABURRA GULLY PROSPECTS

E.L.1142 - SOUTH AUSTRALIA

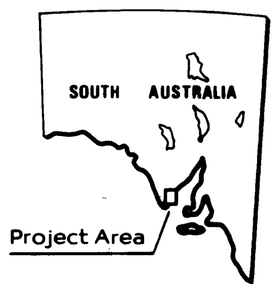
E.M. GRID LOCALITY

SCALE 1 : 50,000

0 50 100 150 200 250

METRES

21/E/20



135°45' 135°50' 135°55' 136°00'

34°25' 34°30' 34°35' 34°40'

"Koppio"
Koppio
Koppio Mine
TOD
TOD RIVER RESERVOIR
"Pillaworta"
"Kookaburra Gully"
Old Mount Liverpool Mine
New Mount Liverpool Mine
Pillaworta Hill
PIL 40
PIL 21
PIL 22
PIL 1
S1
S2
S3
S4-8
K 1-10
K11-16
K17-19
K 20
K 21-23
EYRE PENINSULA HIGHWAY
PL 31
PL 32
PL 30
PL 35
PL 36
PL 37
PL 38
TBD1
TBD2
TBD3
S9-12
S14-17
White Flat
Mount Gawler
GULLY
CHARLTON
RIVER
LOUTH BAY
Port Lincoln Airport
LINCOLN
North Shields
Point Boston
BOSTON BAY
"Coomunga Springs"
FLINDERS
THEVENARD-PORT LINCOLN RAILWAY
HIGHWAY
Little Swamp
Winter Hill
PORT LINCOLN
BOSTON ISLAND
E.L. 1142

LEGEND

- Tl — Tertiary terrestrial iron rich peneplain sediments and laterites. (Tl)
- Tls — Tertiary marine limestone, fossil bearing in places (Tls)
- Ez — Post tectonic quartz-plagioclase ± muscovite ± tourmaline granites and pegmatites.
- PhC2 — Biotite feldspar quartz schist (PhC_2)
- Phb — with minor gneiss (Phb)
- Pha — and amphibolite (Pha)
- Phi — Banded iron formation (Phi) haematite-limonite units with layers of chert, grading through to ferruginous quartzite and quartzite.
- PhC1 — Muscovite-feldspar-quartz-garnet schist (PhC_1) with interbeds of
- Phg — graphite schist (Phg),
- Phm — dolomite (Phk) and rare calcsilicates (Phm)
- Phw — Feldspathic quartzite-equivalent to Warrow quartzite.
- Ap — Sleaford Complex gneisses.
- El — Late tectonic Lincoln Complex intrusive gneisses
- Area of float
- Rock outcrop
- M ⊙ — Anglo-American point E.M Anomaly
- PL 31 □ — Anglo-American zone E.M. Anomaly
- × TBD1 — Afmeco Diamond Drill Hole
- PIL40 ⊢ PIL22 — Afmeco R.A.B. Drill Hole projection
- S3 — Geochemical sample location

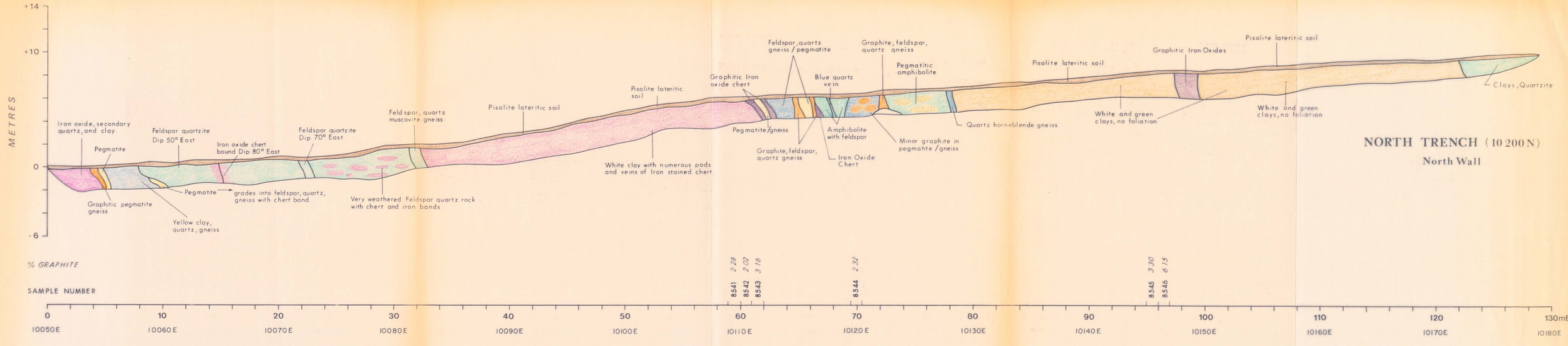
PANCONTINENTAL MINING LIMITED
PANCON EXPLORATION DIVISION

E L 1142, KOPPIO GRAPHITE PROSPECT
EYRE PENINSULA - S.AUST.
GEOLOGY PLAN

SCALE 1:50,000
0 1000 2000 3000 4000 5000
METRES

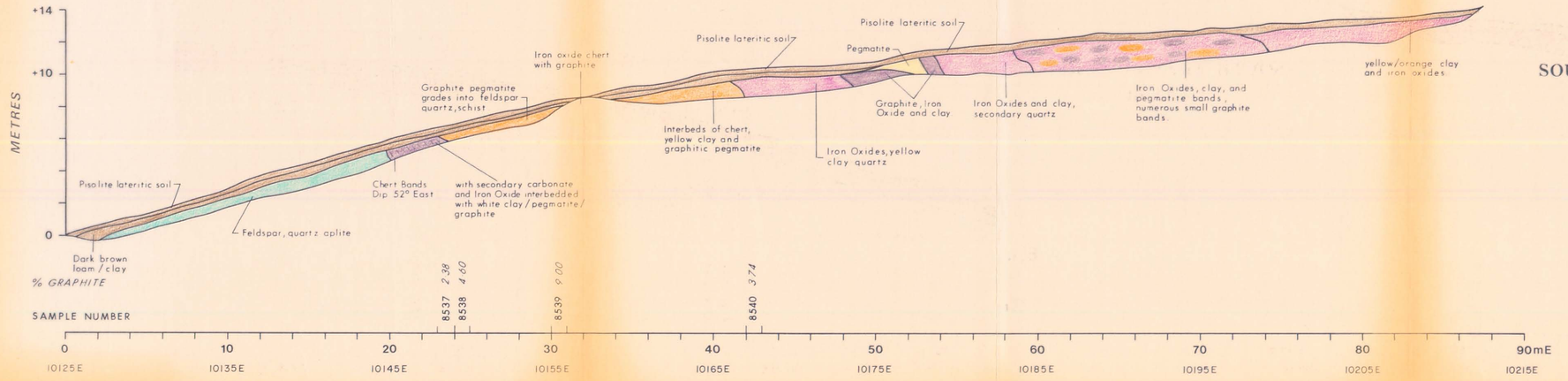
Compiled J. Poole	Date December, 1983	Dwg. Nº 21/D/2
Report Nº 84/3	Map Ref. SI 53-11	PLATE 1

5233-



NORTH TRENCH (10200N)

North Wall



SOUTH TRENCH (9800N)

North Wall

5233-2

E.L.1142, KOPPIO GRAPHITE PROJECT

South Australia

Geology of North and South Trench

KOPPIO

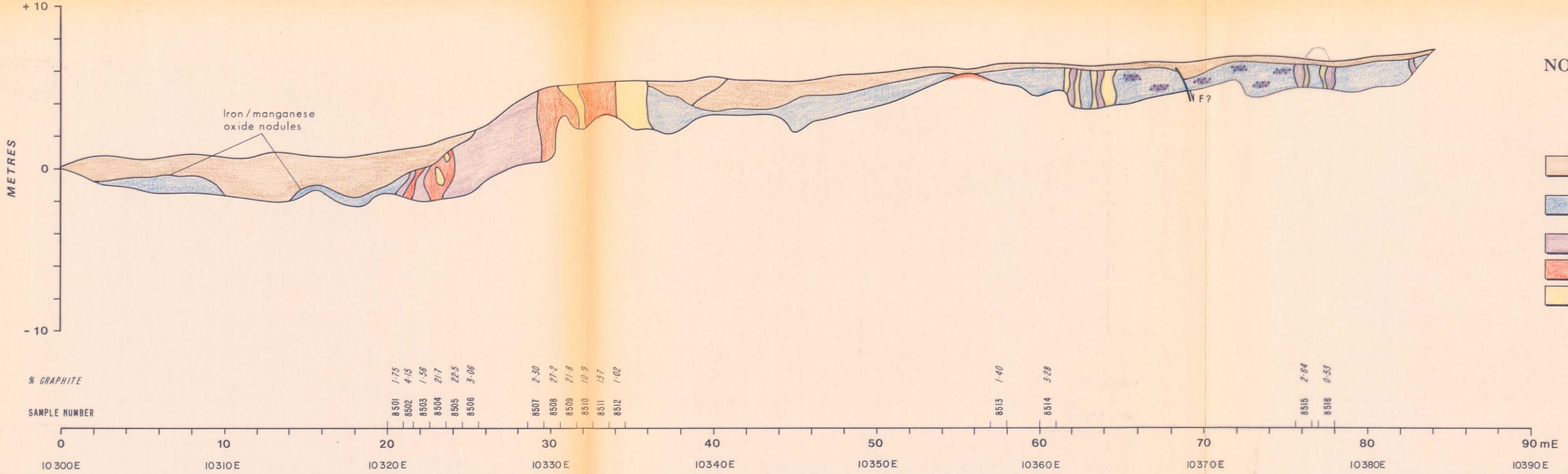
DWG. Nº 21/D/3

March, 1984

0 5 10

1:200 METRES

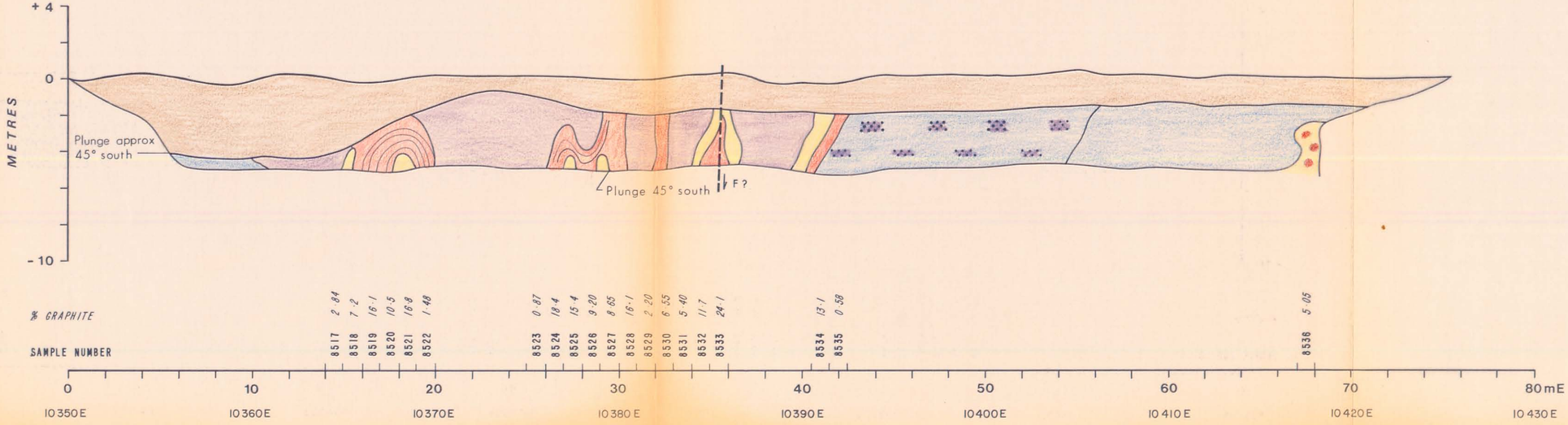
PLAT



NORTH TRENCH (10030N)
North Wall

LEGEND

- Soil - brown, clay rich with variable graphite content.
- Quartz feldspar muscovite gneiss. (trace garnet and graphite)
- Quartz feldspar graphitic gneiss.
- Graphitic schist.
- Pegmatite (quartz, feldspar ± graphite).



SOUTH TRENCH (9785N)
North Wall

5233-3

E.L. 1142, KOPPIO GRAPHITE PROJECT
South Australia
Geology of North and South Trench
KOOKABURRA GULLY

DWG. Nº 21/D/4
March, 1984

0 5 10
1:200 METRES

PLATE 3

In addition, sample 4282 was tested for flotation behaviour and grain size analysis of the concentrate. The results were:-

Sample 4282	Ash Content %	Volatile Matter %	C Content %
Total concentrate	57.6	6.8	50.8
Size fractions			
+ 315 - concentrate			50.2
- original rock			15.6
+ 160 - concentrate			50.1
- original rock			32.3
+ 125 - concentrate			12.1
+ 100 - "			8.9
+ 71 - "			9.7
- 71 - "			21.4

Microscope study showed that the material greater than 160 comprised almost completely aggregates of finer flakes that had not been separated by the preliminary milling.

4. REVIEW OF PREVIOUS EXPLORATION

The aerial electro-magnetic survey flown by Anglo American in October 1973 was reviewed and the large zone anomalies and several point anomalies which occur within E.L. 1142 were examined in the field to establish if there was any correlation with graphite occurrences. Unfortunately, neither the Koppio nor Kookaburra Gully occurrences are on flight lines, but surprisingly no extensions of the graphite horizons appear on the charts. However, these may be evident if the original six channel data profiles were examined and compared with the edited data supplied in the open file record.

There is a point anomaly of medium conductance located a few hundred metres south of the Koppio mine in an area with no outcrop or float (See Plate 1). Further south, in the White Flat-Charlton Gully area, there are six zone anomalies in close proximity and in related geological environments.

Of these E.M. anomalies, PL31 was R.A.B. drilled by Afmeco as part of a stratigraphic profile in 1980. This drilling intersected schists and gneiss within the anomaly and a graphite unit approximately 200 metres outside the zone.

PL30 is situated 3.5km to the south/southwest of PL31 and is designated as anomaly K in Anglo American's report. It lies on the contact zone and contains an intrusive granite. Anglo obtained one value of 500ppm for zinc from a surface sample, but no encouragement from their auger drilling.

Anomalies PL35 (F), PL36 (H), PL37 and PL38 (G), are all located in close proximity to each other, 2.4km south of PL30 (K), in an area with limited outcrop. As with PL30 (K), PL38 (G) overlies the contact area and Afmeco tested the anomaly with a stratigraphic diamond drill hole. This hole, drilled towards the west, finished in a serpentine/olivine marble with minor (1%) pyrite, apparently before it reached the E.M. anomaly.

PL36 (H) is on a lateritic hill 200-300 metres west of PL38 (G), with granitised gneiss cropping out in the valley between them and one small weathered granite outcrop within the area. PL35 (F) and PL37 have no outcrop and limited float.

5. REGIONAL GEOLOGY

Geological mapping of the graphite horizons in E.L. 1142 was completed at a scale of 1:25,000 and has been transposed to a base map at a scale of 1:50,000 (Plate 1). The extent of Lower Proterozoic outcrop in the area is very limited, due to the abundance of iron-rich, Tertiary peneplain sedimentary cover and intense laterisation of such outcrops as do exist. As a result, most of the mapping has been confined to the northern two-thirds of the E.L., as the sedimentary cover increases to the south and grades from terrestrial, iron-rich sediments into marine limestones south of the Coonumga Springs - North ~~Shields Road. It~~ was also necessary to base some of the mapping on float, particularly over the graphite horizons.

Two graphite horizons have been defined within the E.L. area. Both occupy the same position in the stratigraphic column, as defined by Parker and Lemon (1982), and as such may be two limbs of the same horizon repeated by folding. Sparse evidence suggests the fold is synform, with the iron formation forming the core of the fold.

The eastern limb, which includes the old Koppio Mine, appears to thin rapidly away from the mine area to the north and south. To the north it can be traced out of the E.L. area along a series of small ferruginous outcrops, containing some flake graphite and several areas of limited float. The outcrops are too lateritised for the original rock types to be recognisable and are only distinguished from the surrounding ironstone by the presence of minor graphite. South of the mine, the graphite lenses out rapidly and is replaced in places by a silicified marble unit. In this zone, there is very little in the way of float or outcrop of the graphite unit, which may indicate that the unit is very thin to non-existent in this area.

0012

The western limb of the fold is much easier to trace by both float and outcrop of the graphitic unit. This horizon can be traced from outside the E.L. in the north southwards to the town of Koppio where it disappears beneath Tertiary cover. Along most of the strike length of this limb, pegmatitic float can be found in close proximity to the graphite.

One potentially prospective area was located at Kookaburra Gully during the mapping of the western limb. Here the graphite schist crops out as a ferruginous, lateritic unit on the side of a small hill. There is pegmatite closely associated with the graphite. Massive magnesite is also present in outcrop, as it apparently was originally at the Koppio mine.

6. REGIONAL SAMPLING

Reference samples of the graphitic schist horizon were collected during regional mapping as follows:-

TABLE 1 - GRAPHITIC ROCK SAMPLES FROM E.L. 1142

Sample No.	Location	Rock Type, Remarks
1	"Pillaworta" Sect. 125, Hd. Koppio 6195500mN, 586350mE (out of E.L.)	Laterised graphite schist, graphite is in small flakes ⩽0.5mm, little visible quartz
2	Sect. 123, Hd. Koppio 6194200mN, 584800mE	Heavily laterised graphitic schist, flake size appears larger than Sample No. 1. Rock more cemented by iron oxides, no quartz.
2a	Sect. 123, Hd. Koppio 6194300mN 584900mE	Ferruginous graphite schist, graphite up to >50% of rock. Flake size ⩽0.5mm, no quartz
3	Sect. 125, Hd. Koppio 6194250mN 586075mE	Ferruginous graphite schist, graphite >50% of rock, flake size ⩾0.5mm, no quartz
4	Sect. 129/122, Hd. Koppio 6192750mN 583350mE	Graphitic quartz (chert?) feldspar, iron oxide, schist, (B.I.F.?), some tourmaline up to 3.0mm, graphite flake size ⩽0.5mm

5	As for Sample No. 4	Graphitic quartz, feldspar schist, minor acid, intrusive and quartz veining, graphite flake size improves around acid and quartz veins
6	As for Sample No. 4	Massive globular magnesite
7	As for Sample No. 4	Ferruginous graphite schist. Graphite ≥50% of rock. Flake size ≤0.5mm
8	As for Sample No. 4	Fine flake to amorphous graphite schist, some muscovite and quartz, possible garnets. Iron and manganese oxides in shear planes

Another group of samples was collected for geochemical analysis. These were generally ferruginous, possibly gossanous and some appeared to have traces of sulphide. Assay results, however, as shown in Table 2, were quite disappointing, although samples 11 and 15 are weakly anomalous in base metals and arsenic.

7. GRIDDING

Grids totalling 9 line km were established in the Koppio Mine and Kookaburra Gully areas in preparation for detailed mapping, trenching and geophysics (see Figure 2 for locations).

8. ELECTROMAGNETIC SURVEY

A Max Min II electromagnetic survey totalling 9 line km was run over the Koppio Mine and Kookaburra Gully prospects. The main objectives were:-

a) to test its effectiveness over known graphite outcrops, and

b) to detect possible extensions along strike and up to 50 metres deep under laterite (Fe rich) soils subjected to extensive weathering.

The complete survey report is included in Annex 1. The Max Min II system successfully detected the graphitic horizons. Some surface conductivity is present but there were good low frequency responses indicating the presence of conductors at depth.

TABLE 2 - GEOCHEMICAL SAMPLES FROM E.L. 1142

SAMPLE NO.	LOCATION	ROCK TYPE, REMARKS	ASSAY RESULTS							
			Cu	Pb	Zn	Ag	Au	Co	Mn	As
9	Sect. 433, Hd. Louth 6179400mN, 575300mE.	Hematite/Limonite boxwork mass with minor ? graphite, ?sulphide and mica.	48	13	670	x	0.04	72	5520	8.0
10	As for Sample No. 9	As for Sample No. 9	16	8	680	x	0.01	67	5220	2.5
11	As for Sample No. 9	Hematite-cemented, altered ? dolomite, ? breccia with ? traces of bornite in stained vughs.	180	102	133	x	0.01	5	95	16
12	As for Sample No. 9	Hematite graphite schist, flake size <0.5mm.	150	49	475	x	0.01	23	175	1.5
13	Sect. 434, Hd. Louth 6178150mN, 575600mE.	Limonite-quartz, porous Tertiary rock (PL30).	19	19	15	x	x	3	86	1.0
14	Sect. 433, Hd. Louth 6179300mN, 575200mE.	Massive hematite rock with ? trace of bornite	85	45	170	x	0.01	15	160	0.5
15	As for Sample No. 14	Massive hematite/limonite rock	215	77	127	x	0.04	6	76	8.0
16	As for Sample No. 14	Silicified altered dolomite/	22	36	12	x	0.01	2	16	3.5
17	As for Sample No. 14	Silicified altered dolomite/ marble.	8	9	10	x	0.03	x	9	1.5

Results in ppm.
Analyses by AAS.

9. TRENCHING AND CHANNEL SAMPLING

Four trenches totalling 370 metres were excavated north and south of the Koppio Mine and in the Kookaburra Gully areas. The trenches have been mapped and channel sampled in the vicinity of the graphitic horizons (see Plates 2 and 3). In the Koppio Mine trenches, values up to 9% graphite over one metre were obtained but overall the thin graphite zones exposed in the trenches averaged less than 3% graphite over two metres.

At Kookaburra Gully both trenches returned good grade graphite over significant widths:-

Northern trench - two zones

a) 5.5 metres average 9.6% graphite (including 2.0 metres at 22.1%)

b) 4.0 metres average 18.6% graphite (maximum 1.0 metre at 27.2%)

Southern Trench - two zones

a) 4 metres average 12.7% graphite

b) 10 metres average 11.8% graphite (including 5 metres at 13.6%)

10. PRELIMINARY LABORATORY TESTING

A preliminary petrographical and mineralogical study was undertaken by Amdel of nine representative samples from the Kookaburra Gully trenches (see Annex 2). This indicated that graphite flakes ranged in length from 150 to 2,200 microns and averaged from 250 to 1000 microns. In general the samples containing greater than 10% graphite had average flake lengths greater than 500 microns. Gangue minerals are mostly quartz, kaolinite, muscovite with accessory or trace dolomite, calcite, feldspar, halite and iron oxides.

Much additional sampling, mapping and testwork remains to be undertaken before the commercial significance of the graphite occurrences can be determined.

11. EXPENDITURE

The expenditure for the final quarter of the year ending May 26, 1984, totalled $15,298 and was made up of the following:

Salaries	$ 4,441
Travel & accommodation	1,656
Contractors services	6,523
Field & other expenses	2,312
Sydney office expenses	366
	$15,298

The total expenditure on the E.L. for the twelve months was $31,049. The expenditure commitment was $25,000.

12. REFERENCE

Parker, A.J., and Lemon, N.M., 1982. Reconstruction of the Early Proterozoic Stratigraphy of the Gawler Craton, South Australia.
Jour. Geol. Soc. Australia, v. 29, pp. 221-328.

ANNEX 1

0018

SOUTH AUSTRALIA

E.L. 1142

E.M. ORIENTATION SURVEY

Pancontinental Mining Limited
50 Bridge Street
Sydney NSW 2000

L.S. Wynn
March, 1984

LIST OF FIGURES

Fig. No.	Title		Plan No.
1	Location Map		21/E/20
2	Summary of Koppio Max Min Profiles		21/E/1
3	Summary of Kookaburra Max Min Profiles		21/E/2
4	Line 9600N	Koppio Profiles	21/E/3
5	Line 9700N		21/E/4
6	Line 9800N		21/E/5
7	Line 9900N		21/E/6
8	Line 10,000N		21/E/7
9	Line 10,100N		21/E/8
10	Line 10,200N		21/E/9
11	Line 10,300N		21/E/10
12	Line 10,400		21/E/11
13	Line 9,500N	Kookaburra Profiles	21/E/12
14	Line 9600N		21/E/13
15	Line 9700N		21/E/14
16	Line 9800N		21/E/15
17	Line 9900N		21/E/16
18	Line 10,000		21/E/17
19	Line 10,100		21/E/18
20	Line 10,200		21/E/19

INTRODUCTION

An Orientation Electromagnetic (E.M.) Survey totalling nine km was conducted from 3.2.84 to 14.2.84 on two neighbouring graphite prospects in South Australia (Figure 1, Location Map).

The main objectives of the E.M. survey were:

a) to test its effectiveness over known graphite outcrops, and

b) to detect possible extensions along strike and up to 50 metres deep under lateritic (Fe rich) soils subjected to extensive weathering.

EQUIPMENT

The system used was an Apex Parametrics Max Min II, operated in the Horizontal Mode.

The Max Min II is a two-man continuously portable E.M. system designed to measure both the horizontal and vertical, In Phase (I.P.) and Ouadrature (O.P.) components of the anomalous field resulting from electrically conductive zones.

Principal features of the Max Min II include:

a) Five frequencies to effectively deal with a wide range of overburden and bedrock conductivities, 222, 444, 888, 1777, 3555 (Hz).

b) Four different Transmitter-Receiver separations (cable lengths) 50m, 100m, 150m and 200m, to investigate conductive zones ranging from 100m to surface in location.

As a general rule lower frequencies (444 Hz, 222 Hz) and larger cable separations 150m, 200m permit a deeper depth of investigation.

PROCEDURE

A preliminary survey was run over the abandoned Koppio Mine, utilizing all five frequencies and three Transmitter (Tx) - Receiver (Rx) separations 50m, 100m and 200m, to see which frequencies and cable separation would produce the best responses.

The depth of optimum investigation is approximately half the cable separation.

The 50 metre cable penetrated depths to 20m and the lower frequencies were masked out by the extensively weathered overburden.

200 metre separation revealed a weak anomaly on the 222hz channel, but the large Tx-Rx separation was far in excess of the anomaly width (approximately 30 metres).

100 metre separation indicated the graphite schist on all five frequencies, most importantly at the lower frequencies which are less influenced by surficial effects.

Accordingly 100 metre Tx-Rx separation was used throughout the survey.

KOPPIO PROSPECT

The general strike is 030° with near vertical dip. Host rocks for the graphite schist are quartz mica and garnet schist bounded by quartzite and iron-rich quartzite to the west.

Eight east-west lines orientation(100°), each 100 metres apart were surveyed, four north of the mine and four south. Readings were taken at 25 metres intervals with all frequencies recorded.

RESULTS

The survey indicated the major graphitic horizon extended to and was still open 400 metres north of the mine but diminished 200 metres to the south (Figure 2).

Traces of weaker conductors were located parallel to and east of the major conductor.

In some areas the lower frequencies gave an indication while the higher frequencies (3555 Hz, 1777 Hz) were masked out and failed to indicate the anomaly (Figures 9, 10). This occurrence was expected as the higher frequencies are largely influenced by weathering and geological noise, and again highlights the importance of the lower frequencies in determining "true" anomalies.

KOOKABURRA PROSPECT

The geology is similar to Koppio with the traverse lines at 120° magnetic east-west.

As with Koppio eight lines at 100 metres intervals were surveyed north and south of visible outcrops.

Again the lower frequencies produced the best indications of the graphite extensions (figures 18, 19). The conductor diminished 100 metres north of the outcrop on line 10,000N (figures 3, 20) but continued strongly southward into wheat fields 300 metres from the outcrop (figures 3, 15). South of 9700N the anomaly weakens (figure 3).

CONCLUSIONS AND RECOMMENDATIONS

The Max Min II proved effective in detecting the graphite schist down to a depth of 60 metres.

The near vertical dip interpreted at Koppio with the Max Min II conforms to the observed geology.

Areas showing a weak response such as lines 9600N and 9500N at Kookaburra Gully should be investigated with a larger Tx-Rx (cable) separation allowing deeper investigation to see if the conductor plunges or simply diminishes in conductivity.

The Max Min II proved successful on this exercise and at $50.00 per day is low cost as between 4 to 6 km may be surveyed per day, depending on terrain.

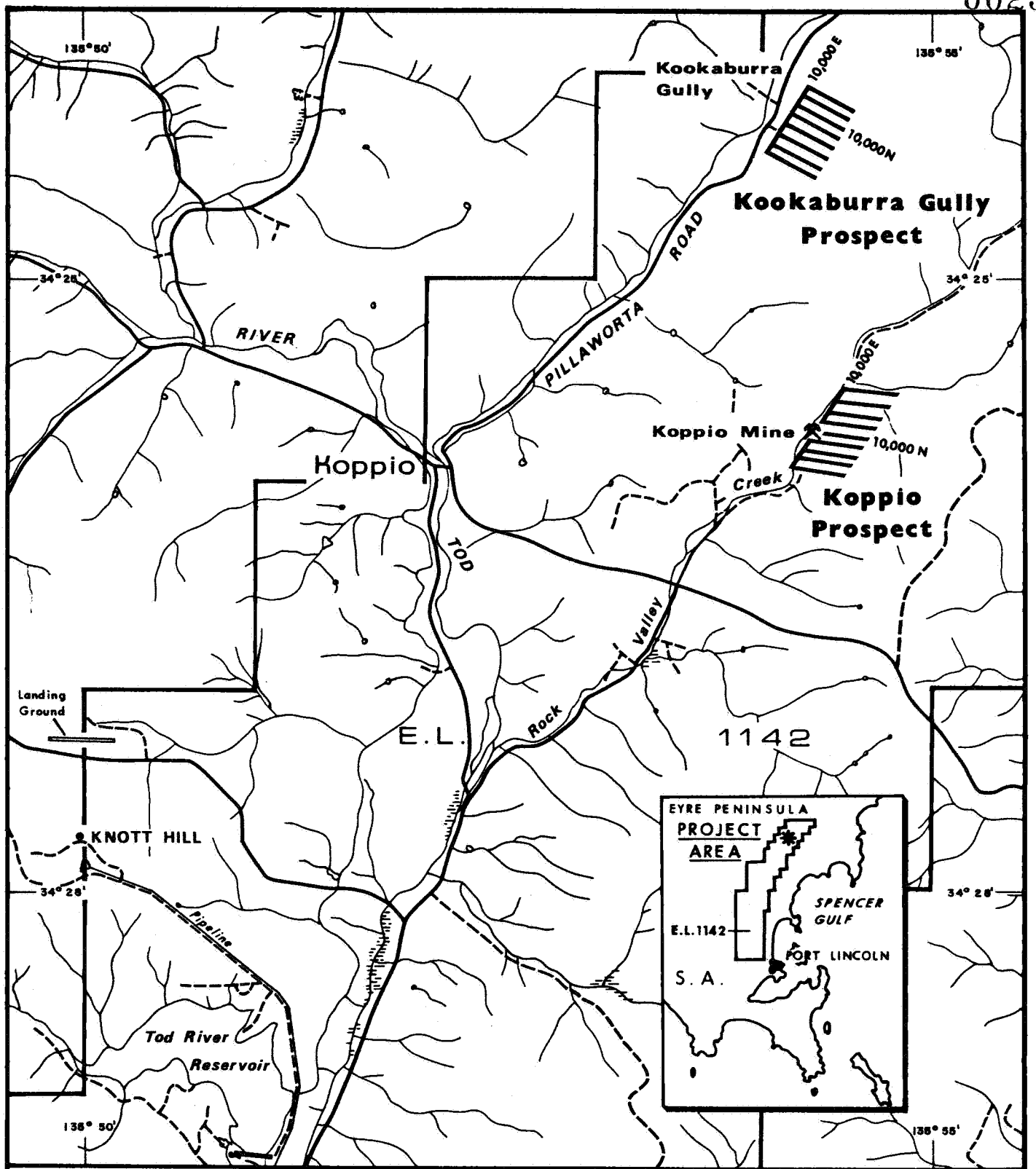


FIGURE 1

KOPPIO AND KOOKABURRA GULLY PROSPECTS

E.L.1142 - SOUTH AUSTRALIA

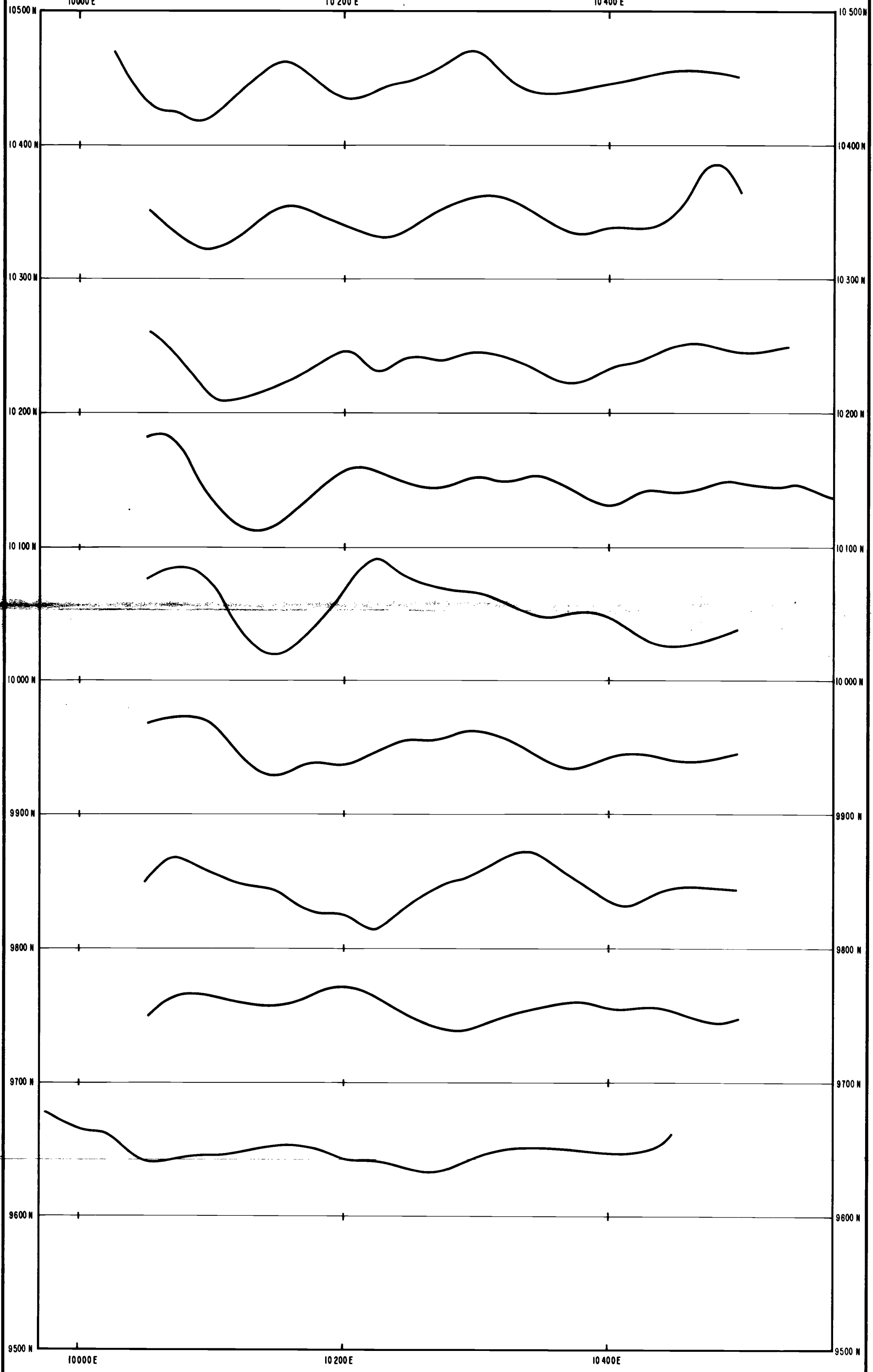
E.M. GRID LOCALITY

SCALE 1: 50,000

0 50 100 150 200 250

METRES

21/E/20



FREQUENCY..... 444 hz

SEPARATION..... 100 m

PANCONTINENTAL MINING LIMITED
EXPLORATION DIVISION

PANCON

KOPPIO GRAPHITE PROJECT
KOPPIO PROSPECT - E.L.1142

EM PROFILES

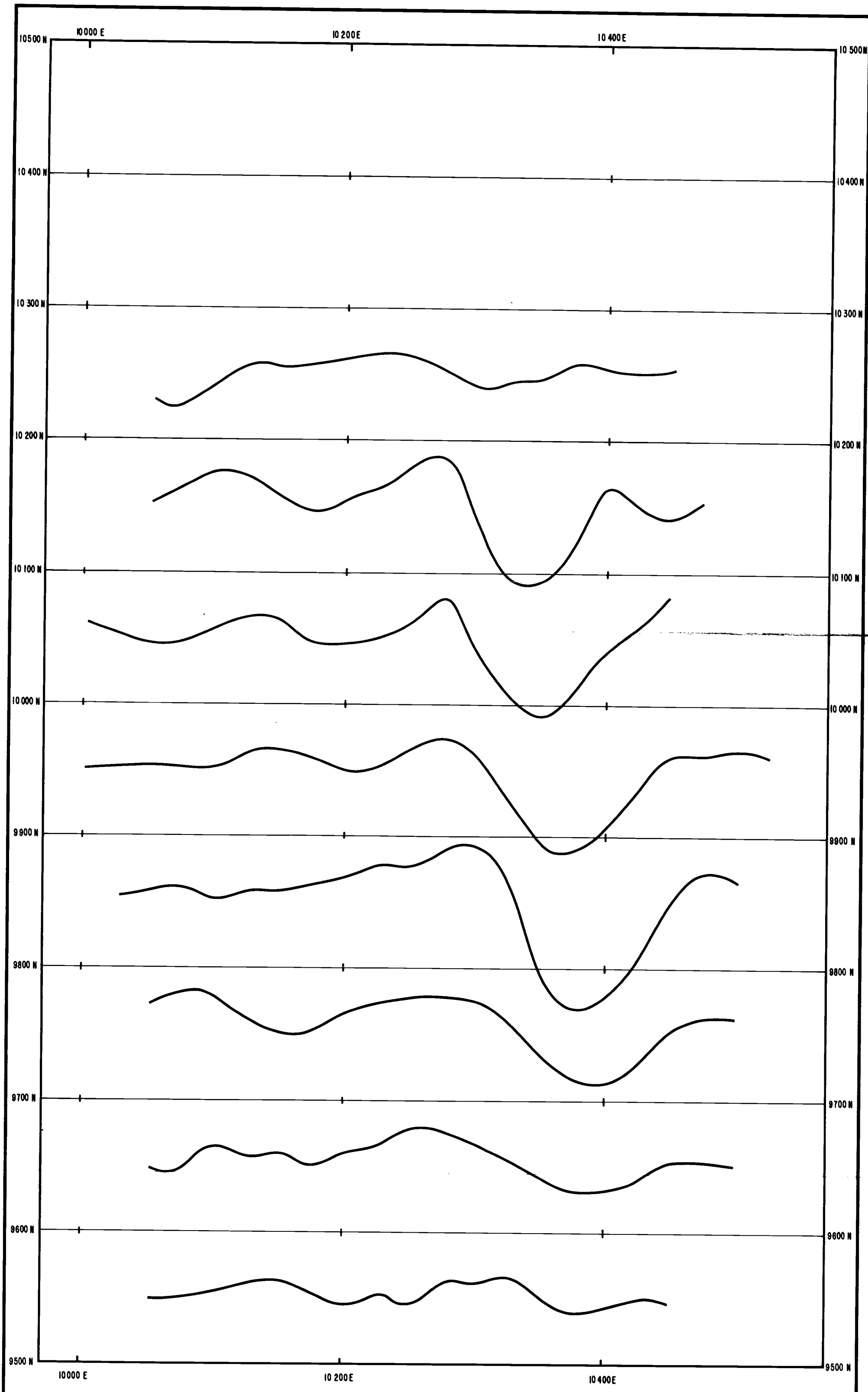
SCALE 1:2500

0 50 100 150 200

METRES

Compiled L.W	Date APRIL,1984	Dwg Nº 21/E/1
Report Nº 84/11	Map Ref S153/11	FIG. 2

5233-4



FREQUENCY..... 444 hz

SEPARATION .....100 m

PANCONTINENTAL MINING LIMITED
PANCON
EXPLORATION DIVISION

KOPPIO GRAPHITE PROJECT
KOOKABURRA GULLY PROSPECT
E.L.1142

EM PROFILES

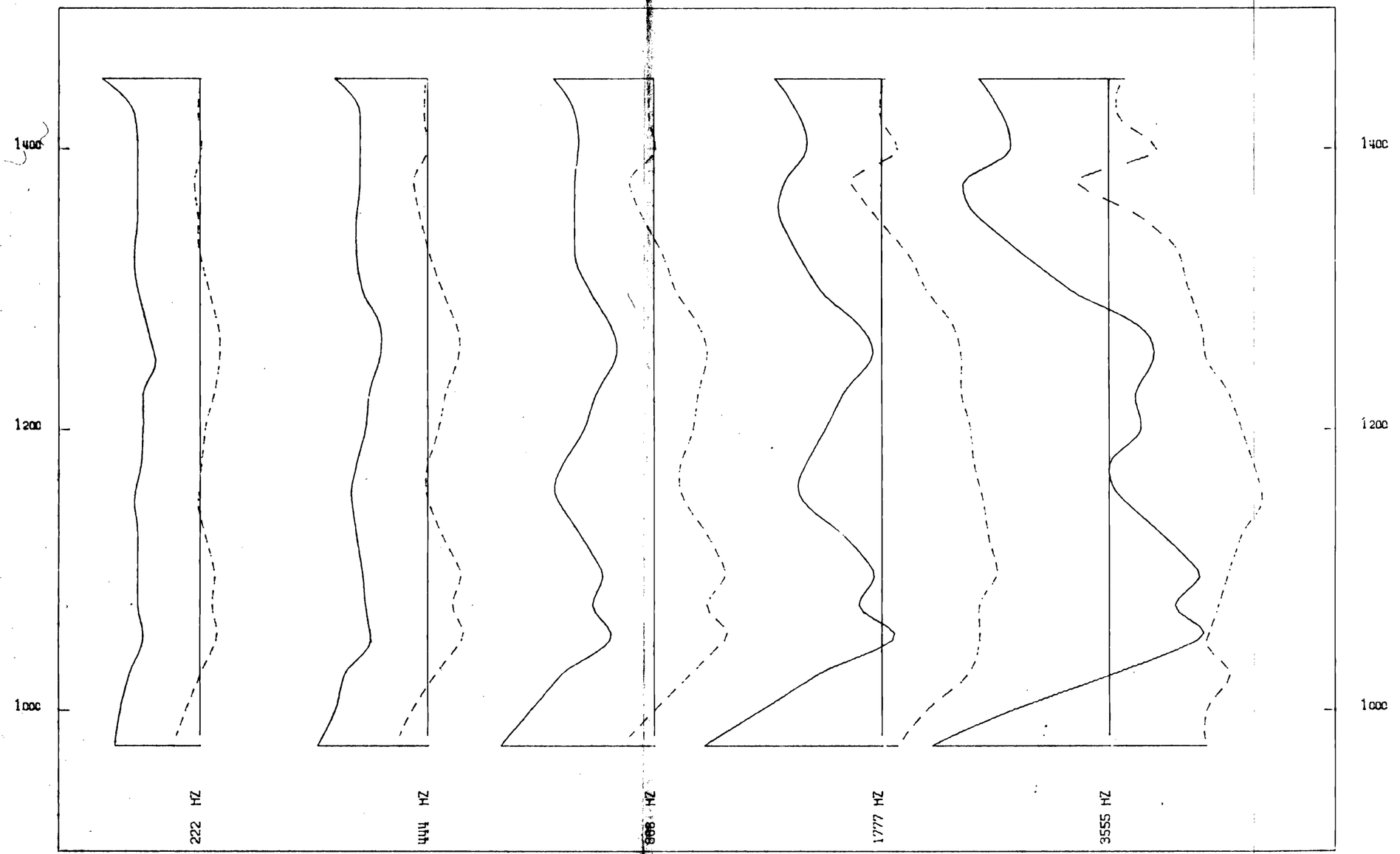
SCALE 1:2500

0 50 100 150 200

METRES

Compiled L.W	Date APRIL,1984	Dwg Nº 21/E/2
Report Nº 84/11	Map Ref S153/11	FIG. 3

5233-5



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS: 1CM = 20%

- - - OUT OF PHASE

SCALE

1:2500

0 10 20 30 40 50 60 70 80 90 100

M M

PANCONTINENTAL COMPUTING SERVICES

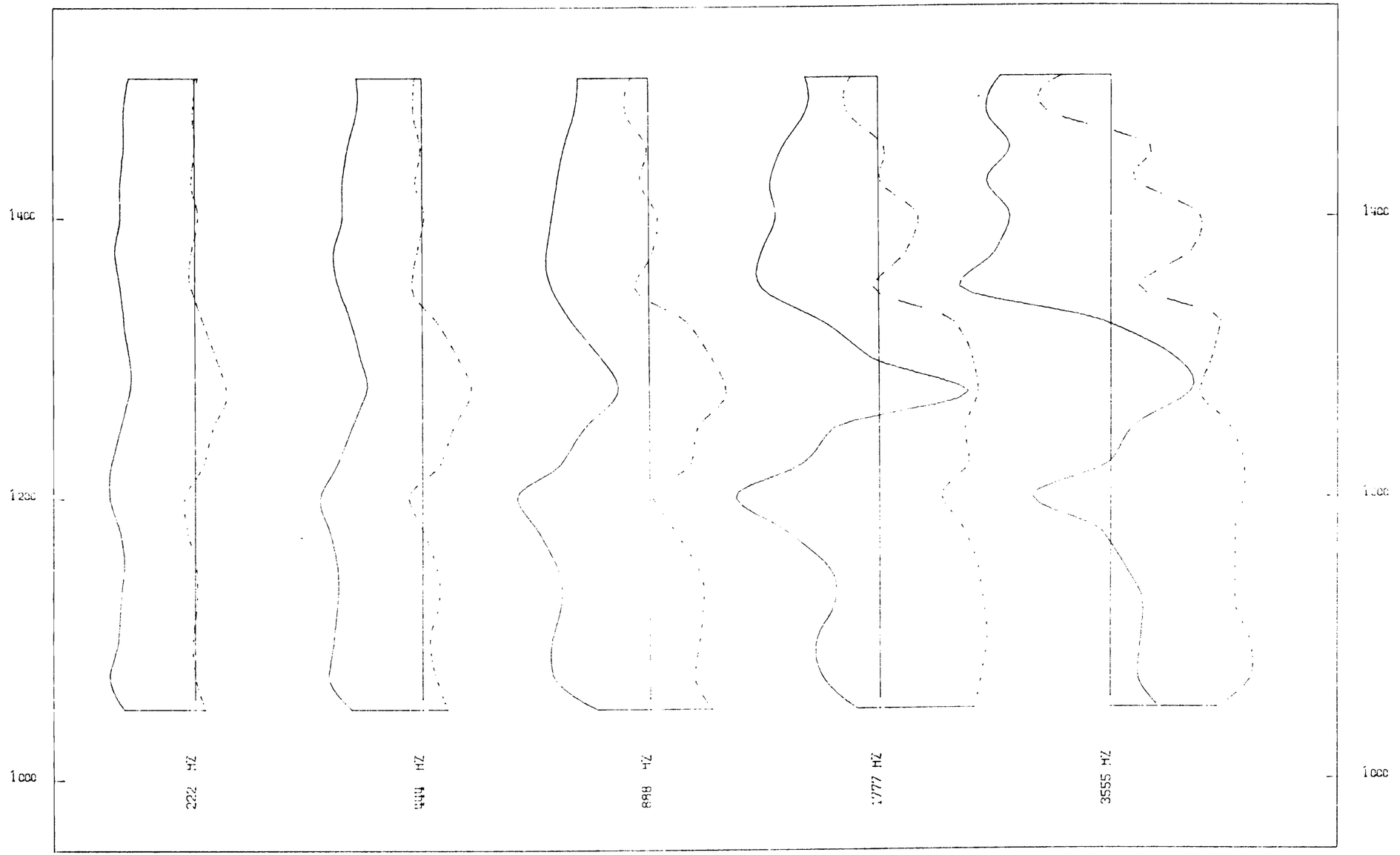
KOPPIO PROSPECT

9600N

21/E/3

5233-6

FIG.4



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

PANCONTINENTAL COMPUTING SERVICES

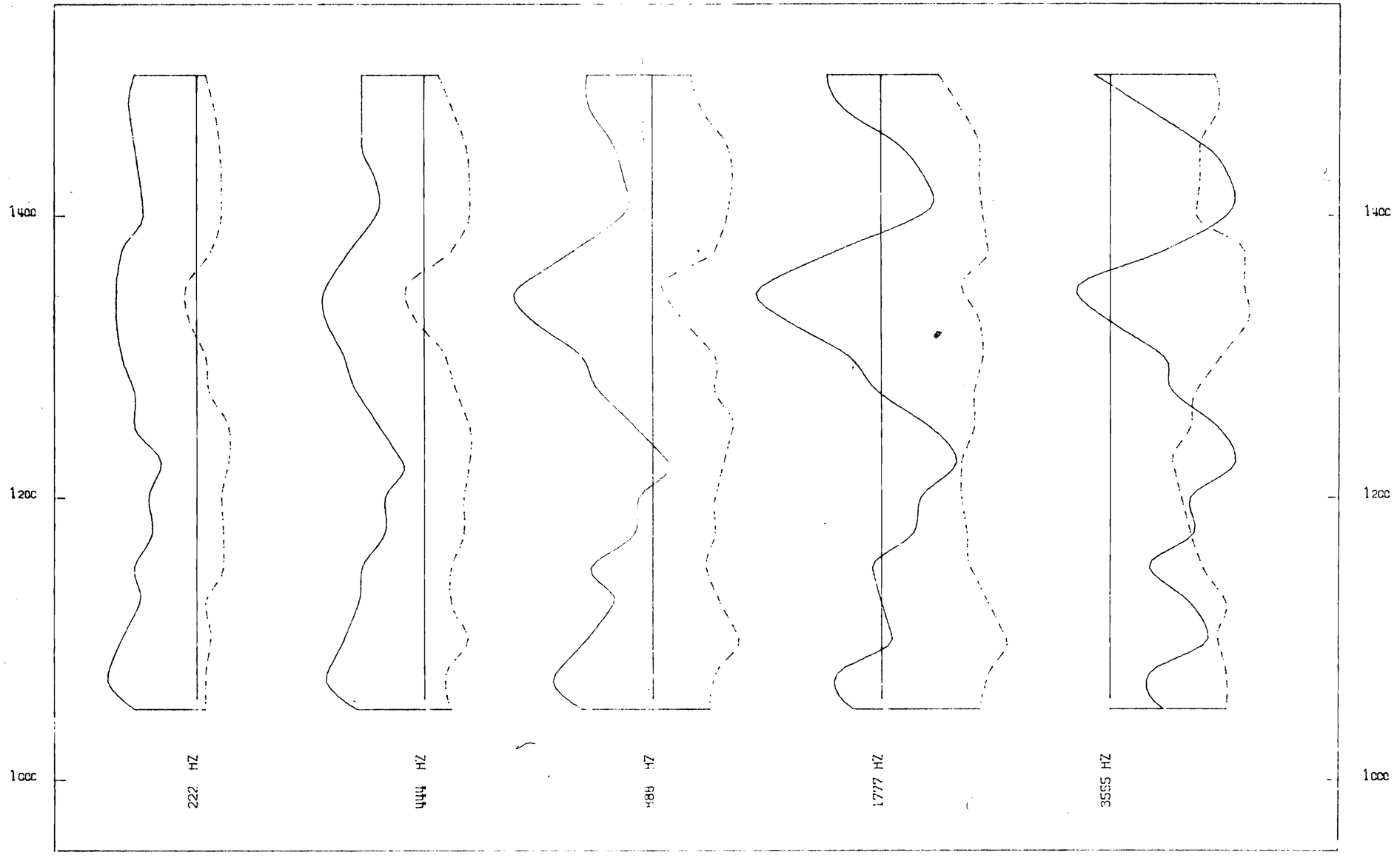
KOPPIO PROSPECT

9700N

21/E/4

FIG.5

5233-7



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 1CM = 20%
- - - OUT OF PHASE

SCALE
1:2500
0 10 20 30 40 50 60 70 80 90 100
M M

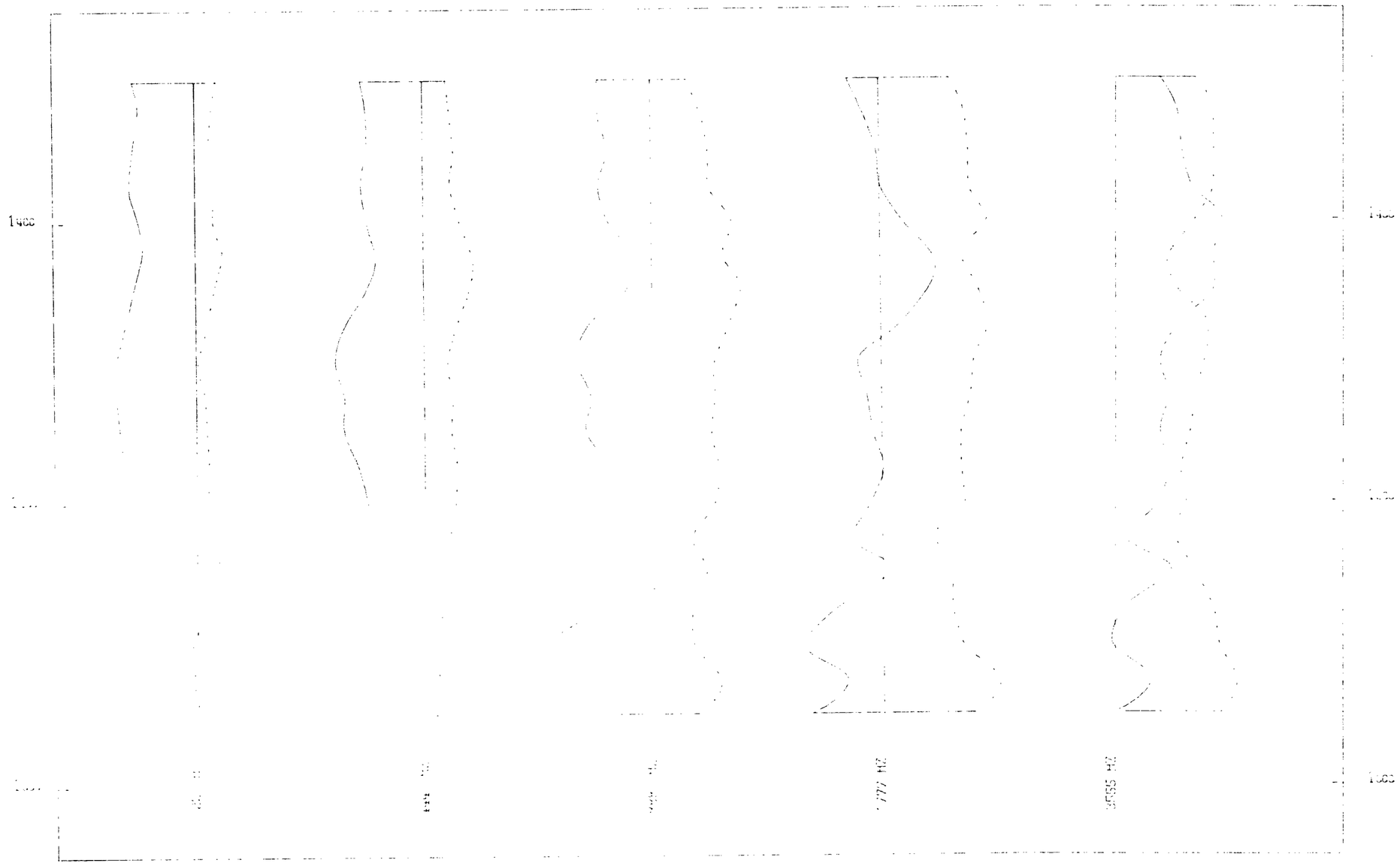
PANCONTINENTAL COMPUTING SERVICES

KOPPIO PROSPECT

9800N

21/E/5 FIG.6

5233-8



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

PANCONTINENTAL COMPUTING SERVICE

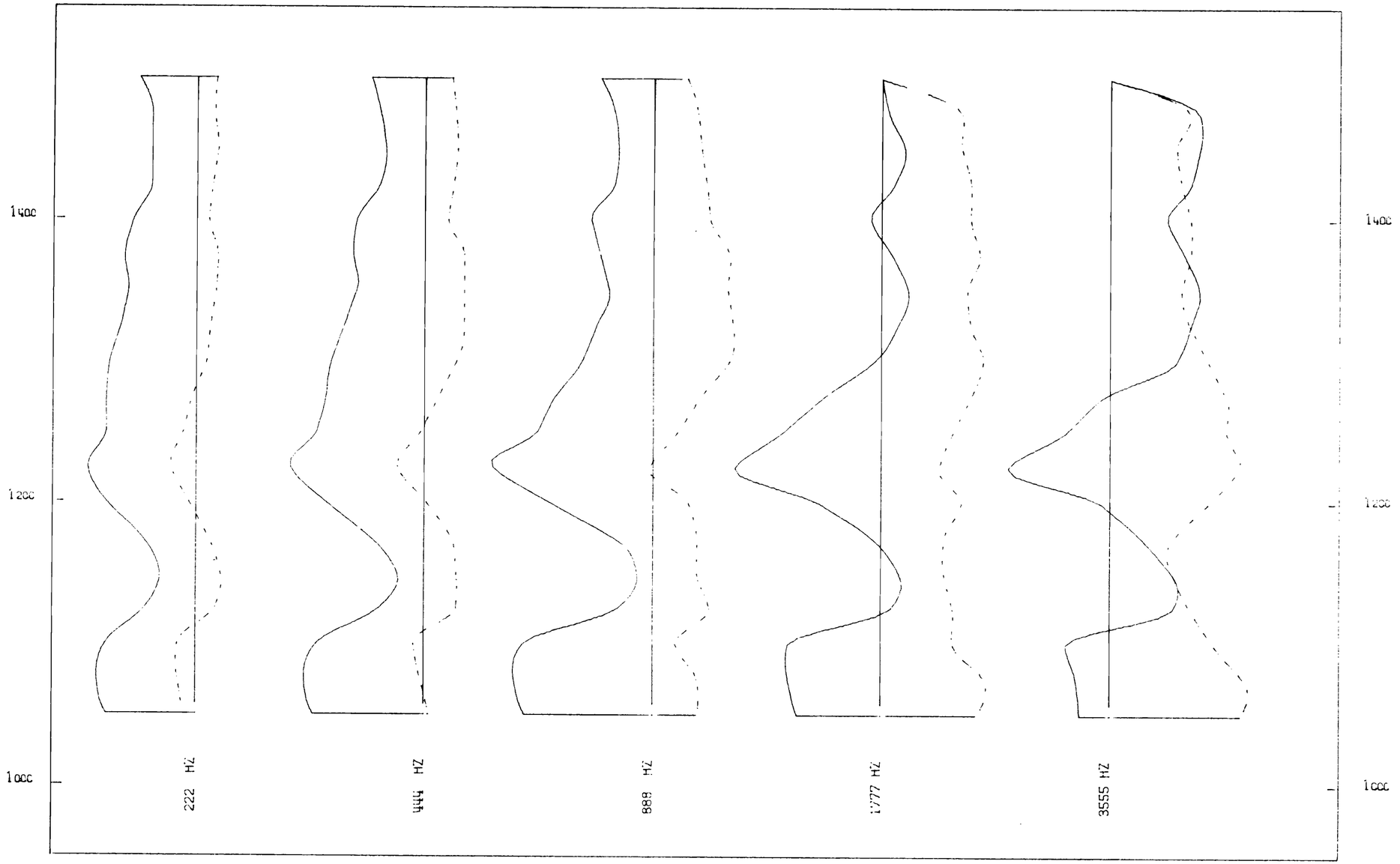
KOPPIO PROSPECT

9900N

21/E/ 6

FIG. 7

5233-9



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

V: 1CM = 20%
- - - OUT OF PHASE

PANCONTINENTAL COMPUTING SERVICES

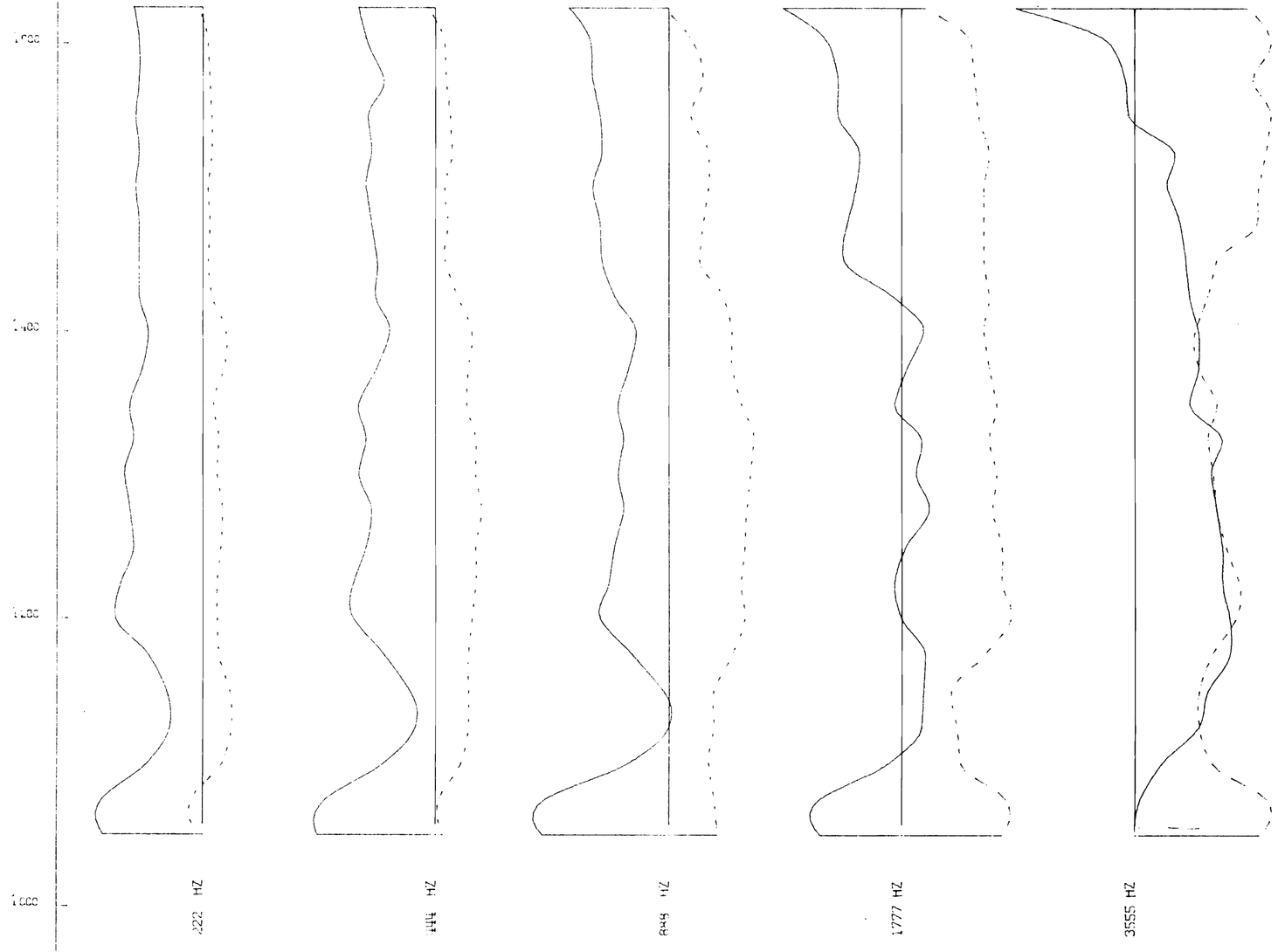
KOPPIO PROSPECT

10000N

21/E/7

FIG.8

PROJECT: 5233-10



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS: 1CM = 20%

- - - OUT OF PHASE

SCALE
1:2500

0 50 100 150 200 250
M M

PANCONTINENTAL COMPUTING SERVICES

KOPPIO PROSPECT

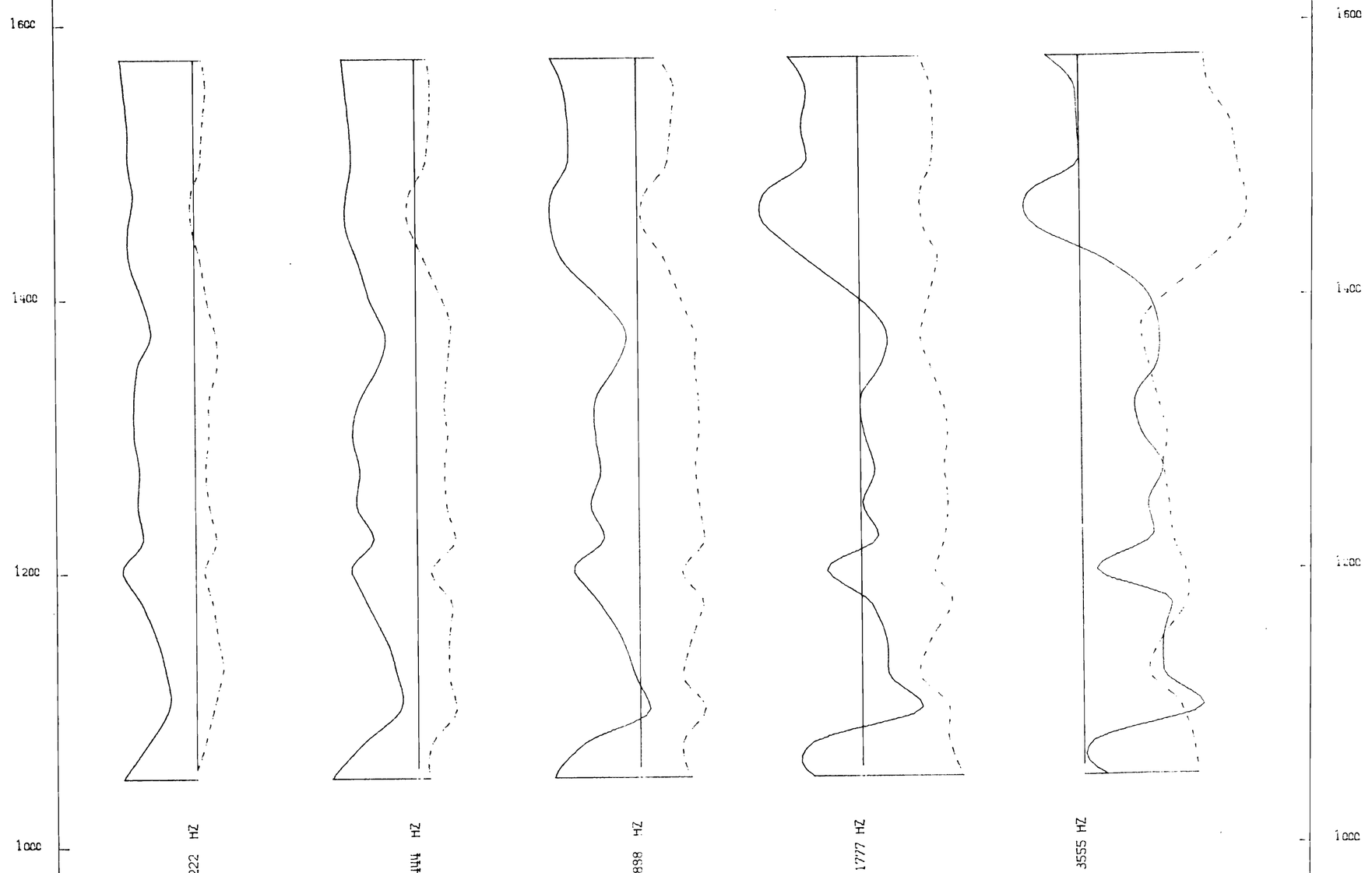
10100N

21/E/8

FIG.9

PROJECT: 5233-11

DATE: 23-APR-84



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS: 1CM = 20%

- - - OUT OF PHASE

SCALE
1:2500

0 50 100 150 200 250
M M

PANCONTINENTAL COMPUTING SERVICES

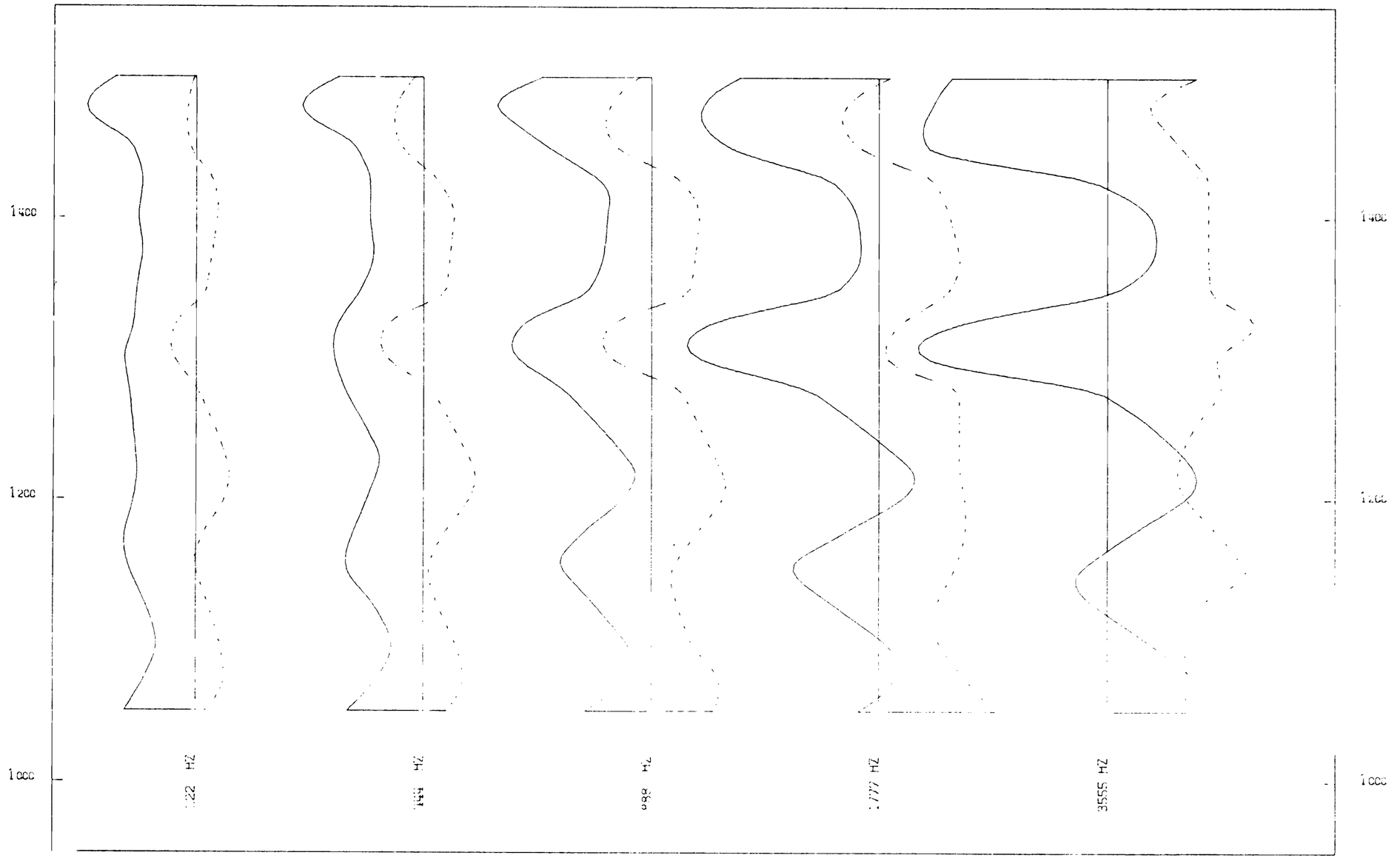
KOPPIO PROSPECT

10200N

21/E/9

FIG .10

PROFILE 5233-12



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 10M = 20%
- - - OUT OF PHASE

PANCONTINENTAL COMPUTING SERVICES

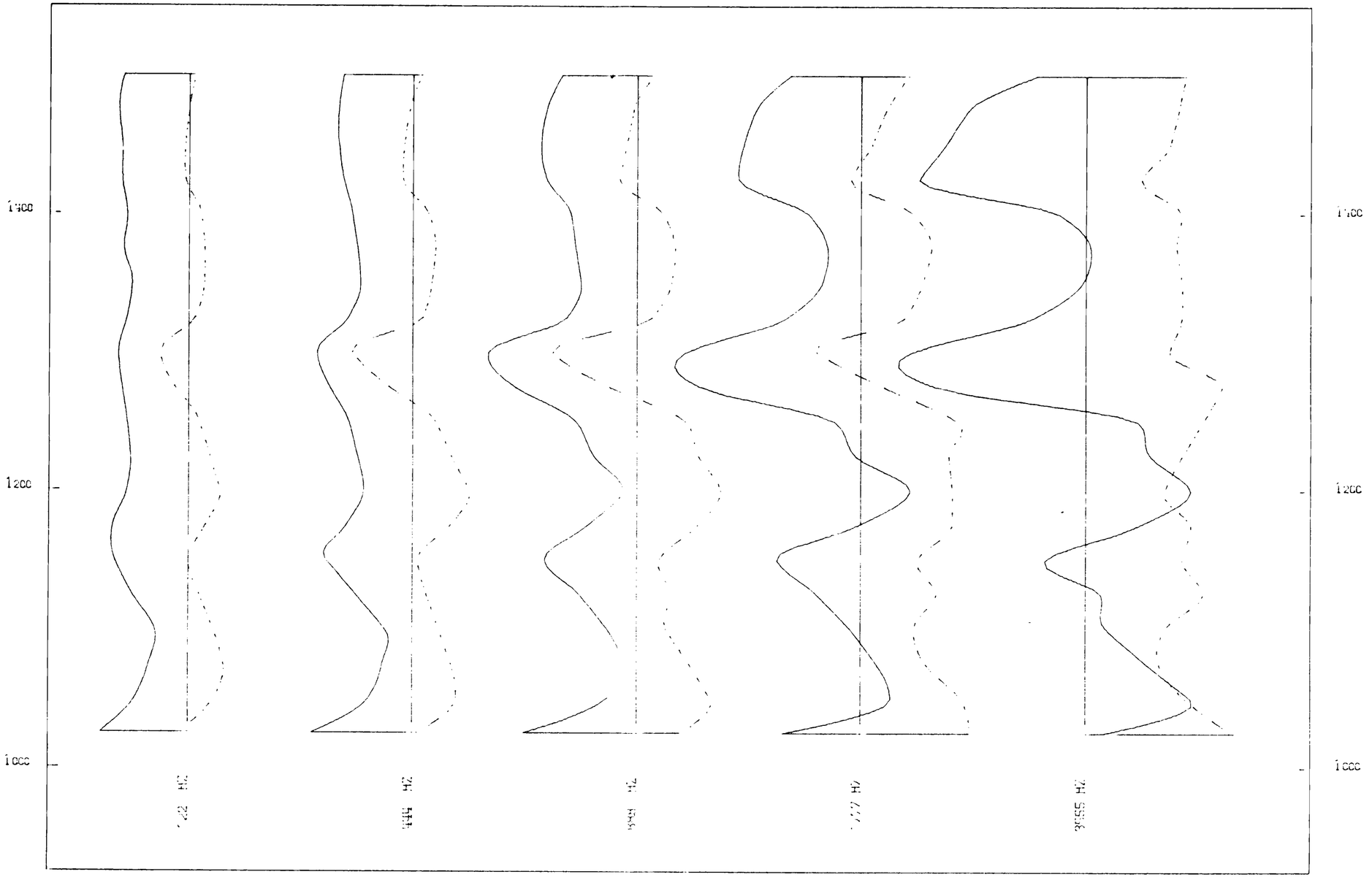
KOPPIO PROSPECT

10300N

21/E/10

FIG. 11

5233/13



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 1CM = 20%

- - - - OUT OF PHASE

SCALE

1:500

0 10 20 30 40 50 60 70 80 90 100

M M

PANCONTINENTAL COMPUTING SERVICES

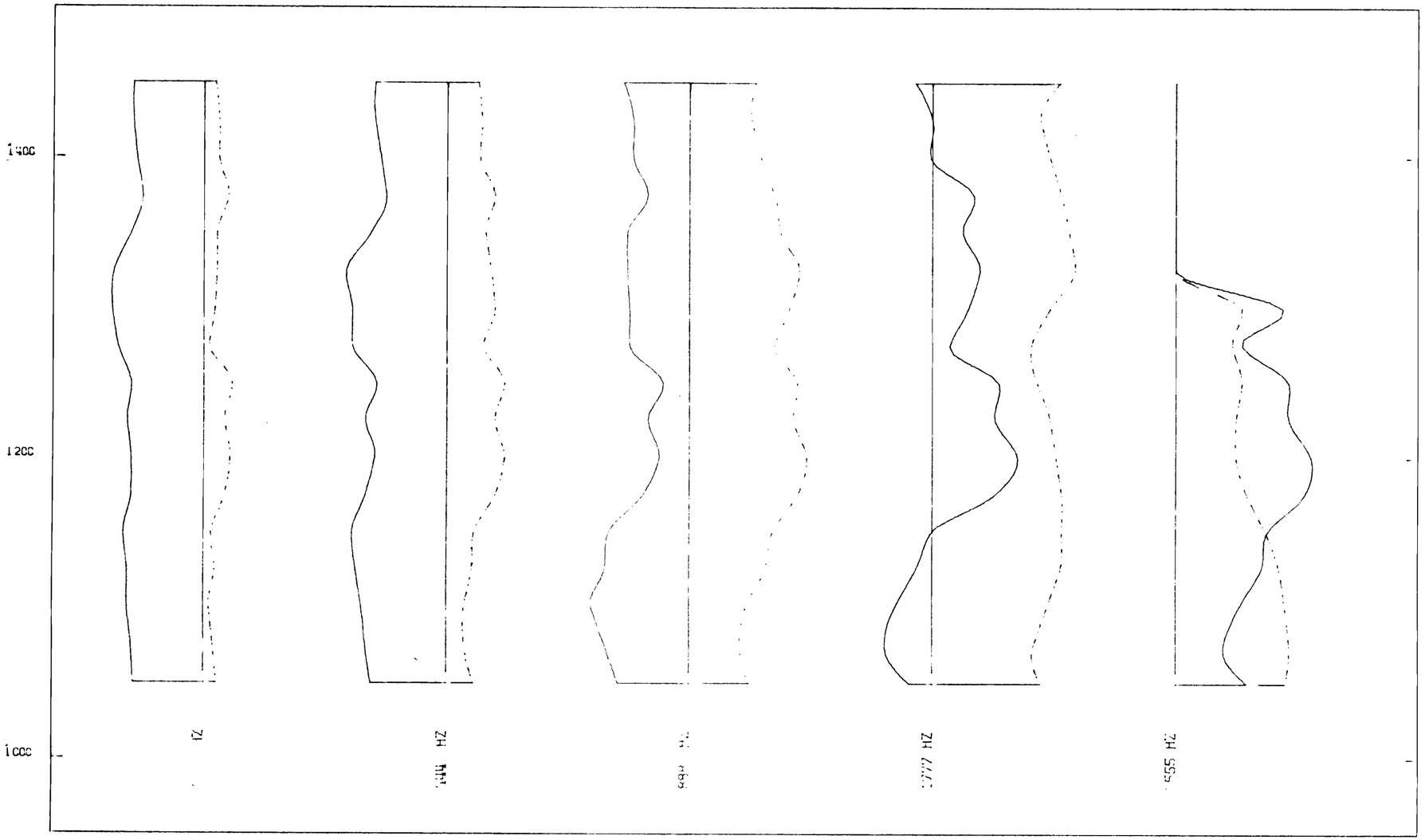
KOPPIO PROSPECT

10400N

21/E/11

FIG.12

5233/14



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 10M = 20%

- - - OUT OF PHASE

SCALE

1:500

0 10 20 30 40 50 60 70 80 90 100

M M

PANCONTINENTAL COMPUTING SERVICES

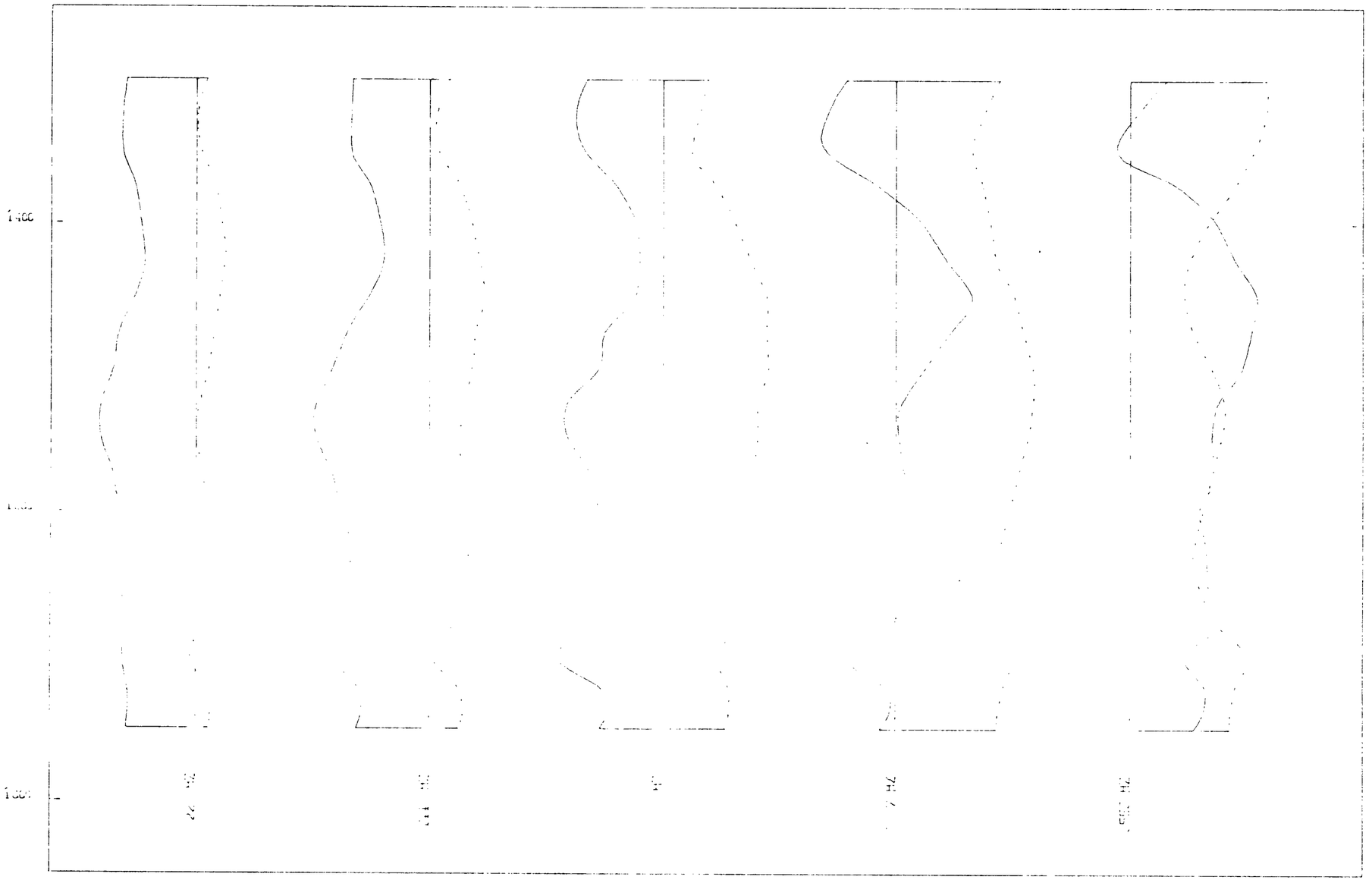
KOOKABURRA PROSPECT

9500N

21/E/12

FIG.13

5233/15



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

PANCONTINENTAL COMPUTING SERVICES

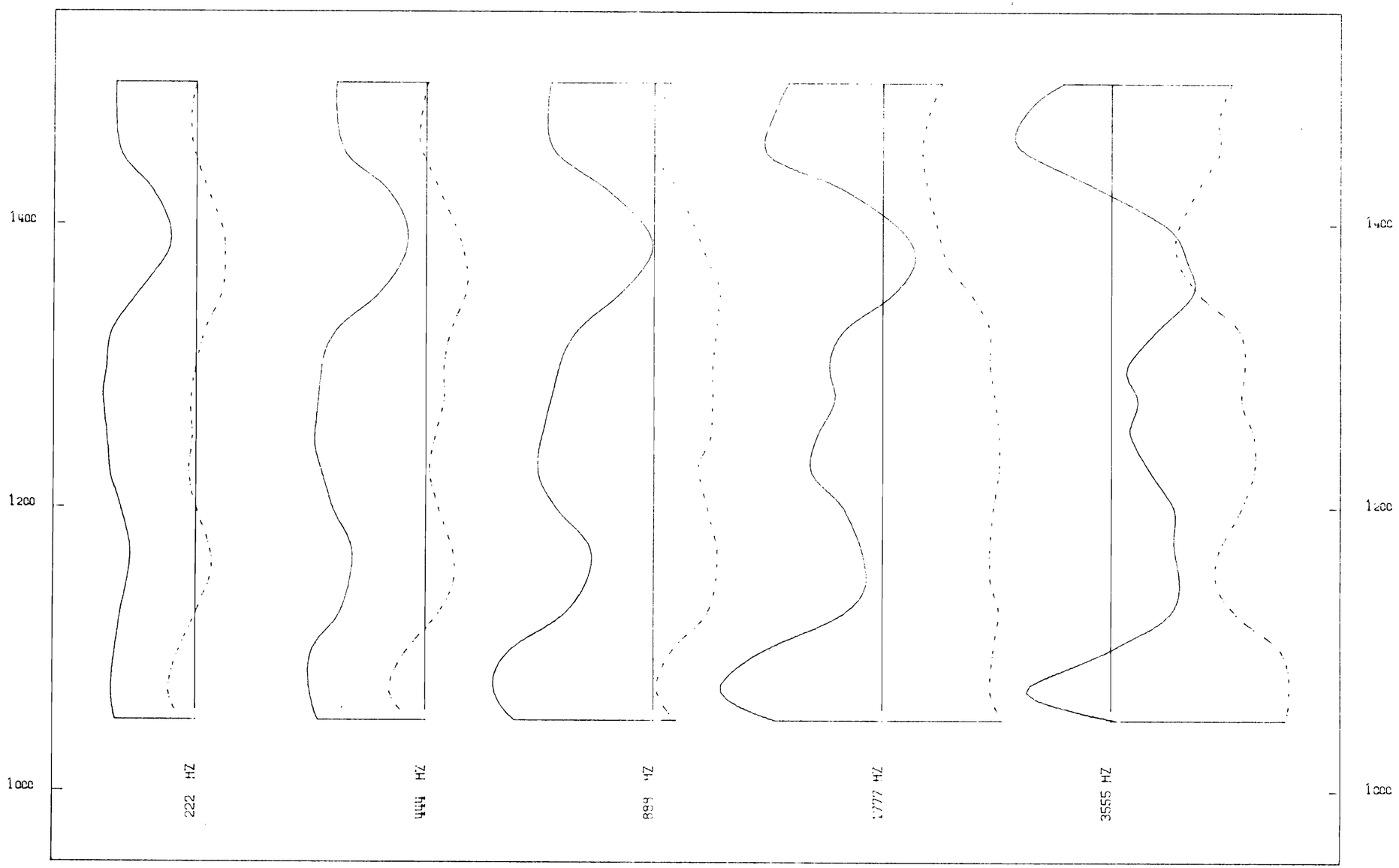
KOOKABURRA PROSPECT

9600N

21/E/13

FIG. 14

5233-16



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 1CM = 20%
- - - OUT OF PHASE

SCALE
1:500
0 10 20 30 40 50 60 70 80 90 100
M M

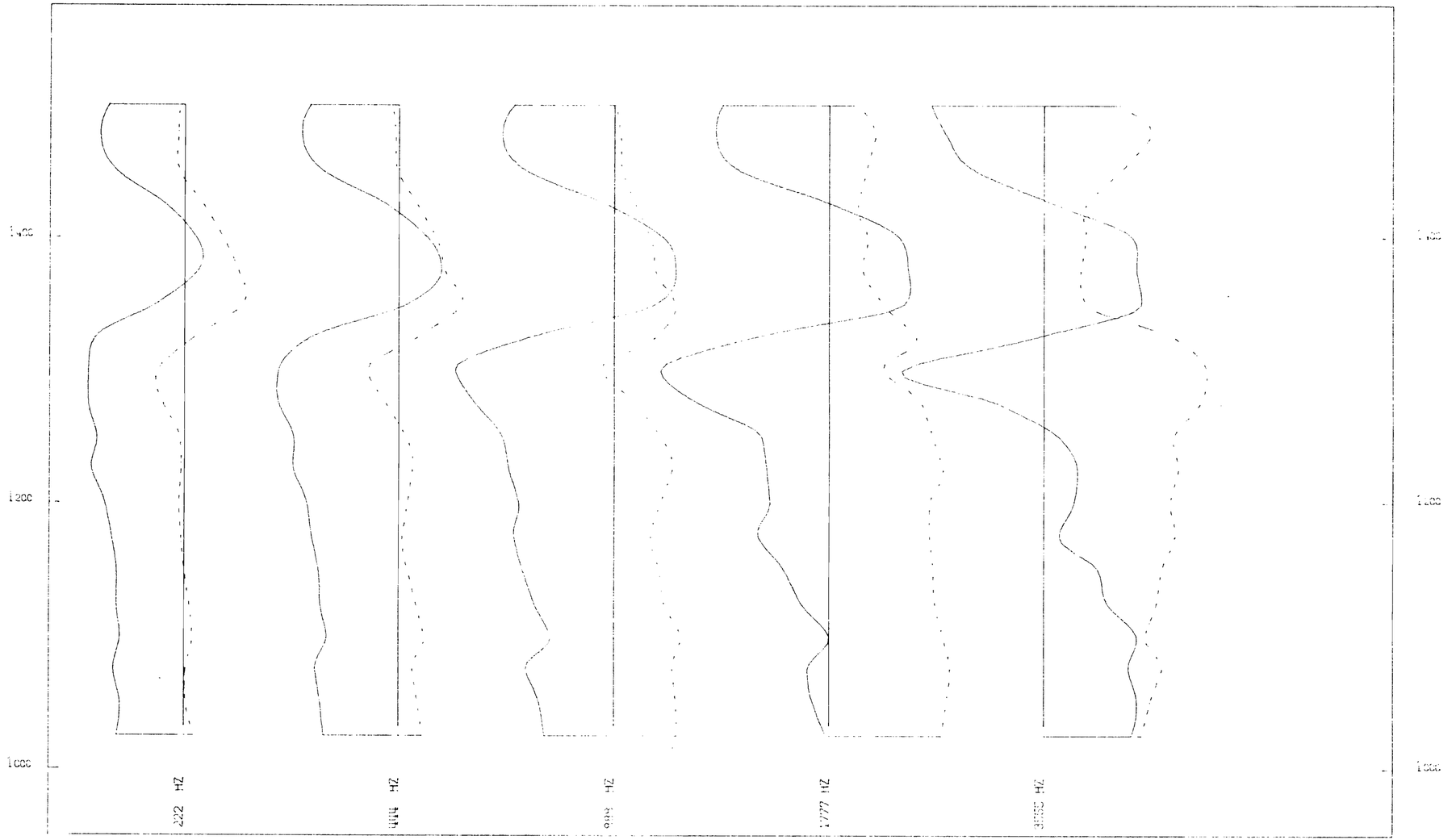
PANCONTINENTAL COMPUTING SERVICES

KOOKABURRA PROSPECT

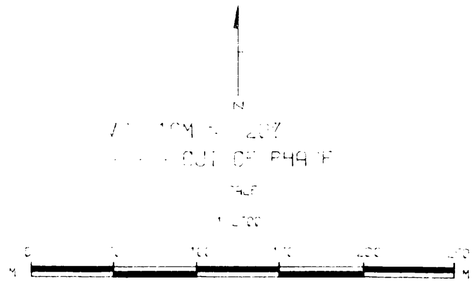
9700N

21/E/14 FIG.15

5233-17



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984



PANCONTINENTAL COMPUTING SERVICES

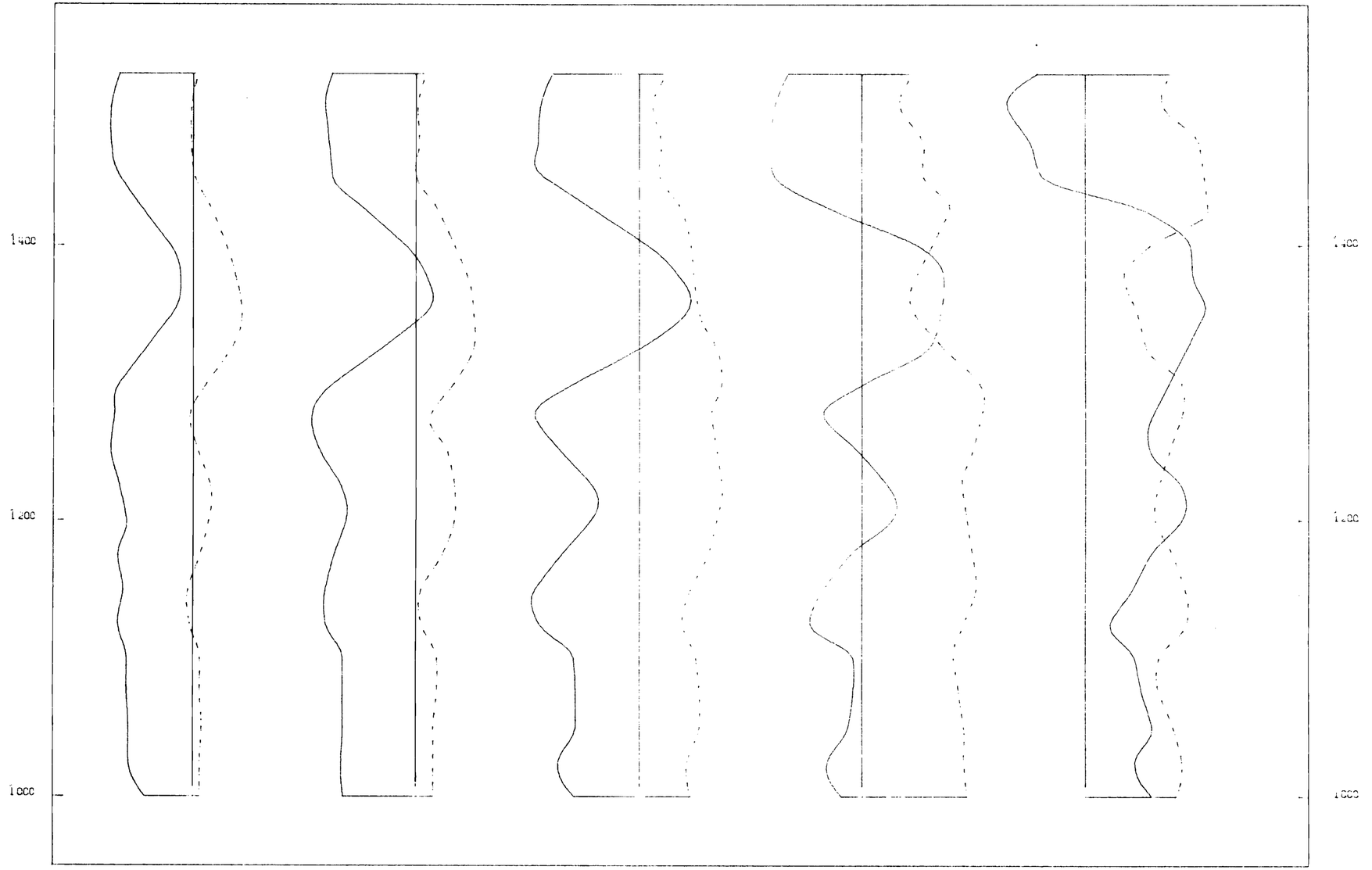
KOOKABURRA PROSPECT

9800N

21/E/15

FIG.16

5233-18



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

OUT OF PHASE

PANCONTINENTAL COMPUTING SERVICES

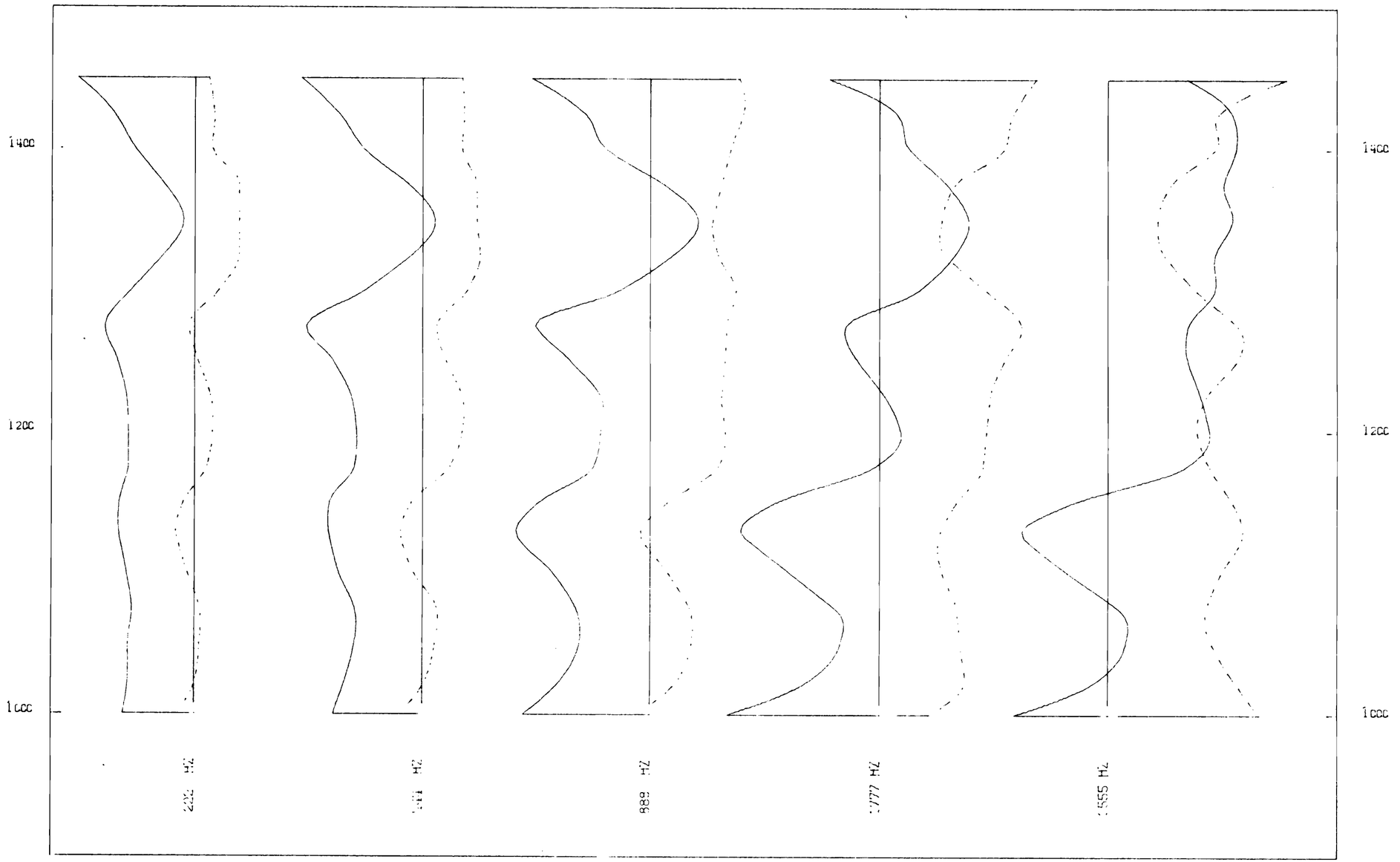
KOOKABURRA PROSPECT

9900N

21/E/16

FIG.17

5233-19



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 10M = 20%

- - - OUT OF PHASE

SCALE

1:2500

0 10 20 30 40 50 60 70 80 90 100

PANCONTINENTAL COMPUTING SERVICES

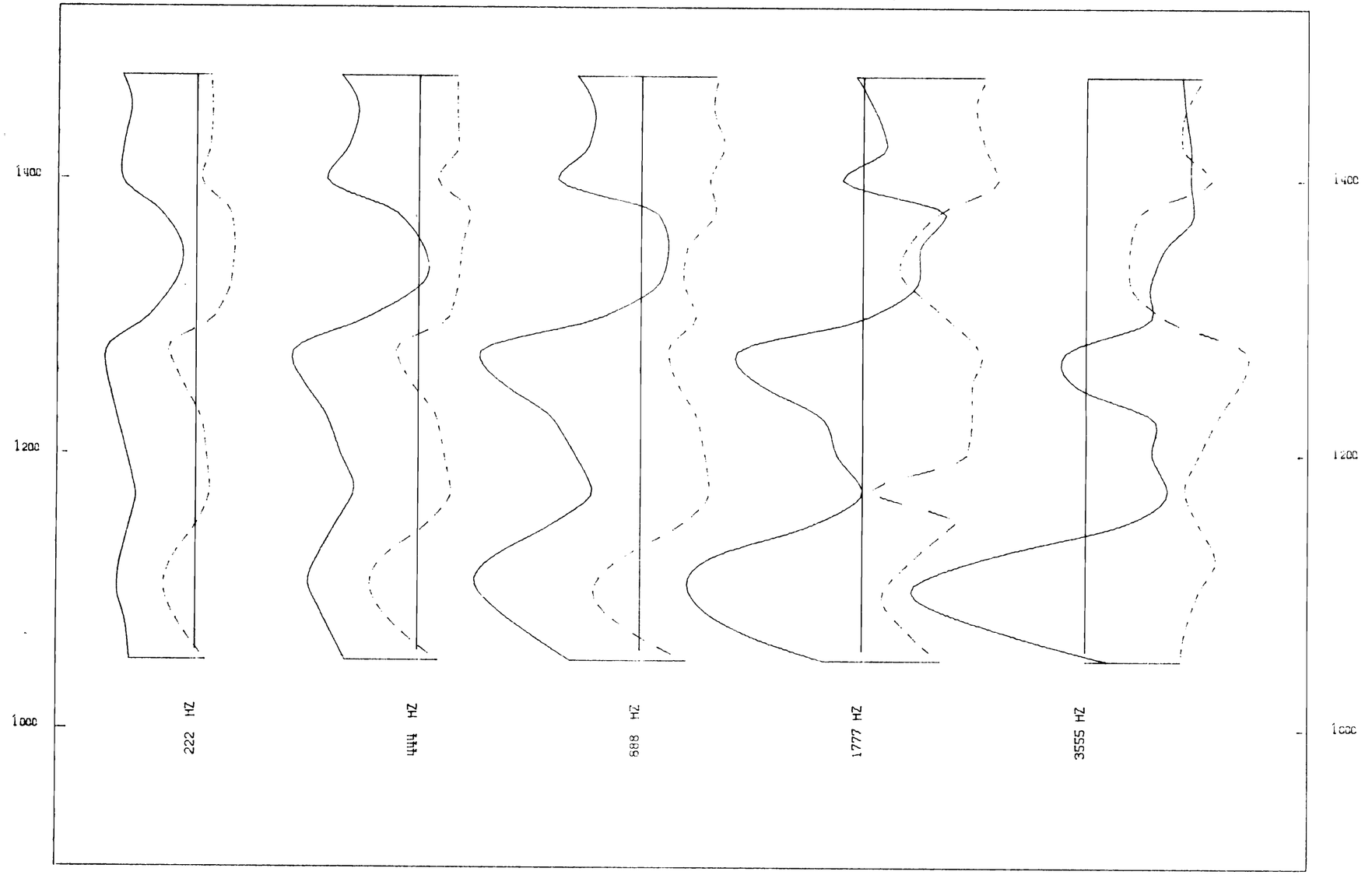
KOOKABURRA PROSPECT

10000N

21/E/17

FIG.18

PROJ. 5233-20



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS 1CM = 20%

- - - = OUT OF PHASE

SCALE

1:2000

0 50 100 150 200 250 M

PANCONTINENTAL COMPUTING SERVICES

KOOKABURRA PROSPECT

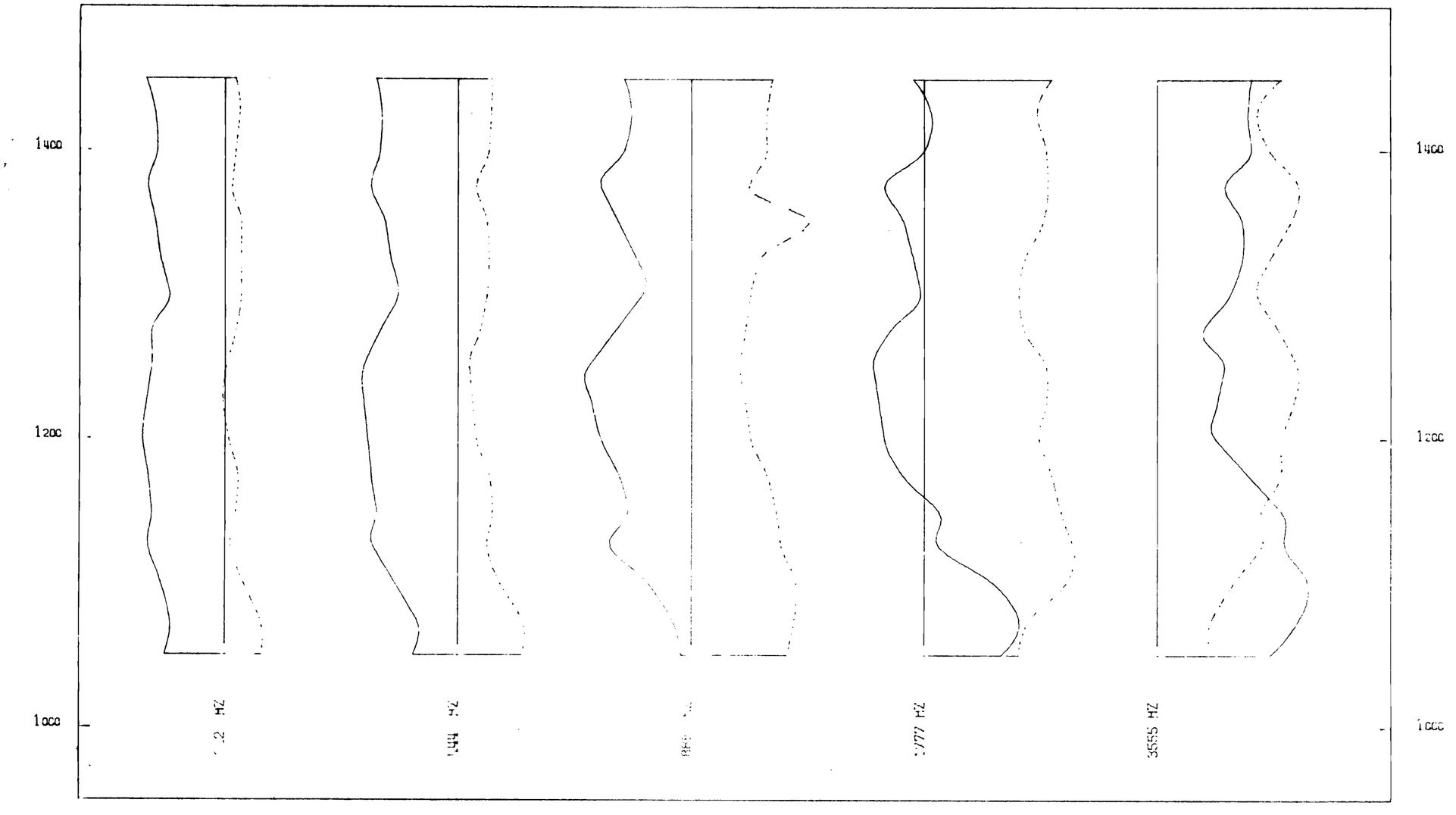
10100N

21/E/18

FIG. 19

PROJECT: 5233-21

DATE:



PANCONTINENTAL MINING LTD.
SOUTH AUSTRALIA
E.M SURVEY
1984

N

VS: 1CM = 20%
- - - OUT OF PHASE

SCALE
1:2500
0 20 40 60 80 100 120 140 160 180 200
M

PANCONTINENTAL COMPUTING SERVICES

KOOKABURRA PROSPECT

10200N

21/E/19

FIG.20

PROJECT 5233-22

DATE

ANNEX 2

0024

PRELIMINARY LABORATORY INVESTIGATION OF KOOKABURRA GULLY TRENCH SAMPLES CONDUCTED BY AMDEL

The Australian Mineral Development Laboratories

Flemington Street, Frewville
South Australia 5063
Phone Adelaide 79 1662
Telex AA82520

Please address all correspondence to
P.O. Box 114 Eastwood
SA 5063
In reply quote:

amdel

0025

31 May 1984

MD 3/698/0 - 6679/84

Pancontinental Mining Limited
AMP Centre
50 Bridge Street
SYDNEY NSW 2000

Attention Dr A Collins

REPORT MD 6679/84

YOUR REFERENCE	Purchase Order No. 3604.
TITLE	Testing of Graphite.
SAMPLE IDENTIFICATION	8501 - 8546.
LOCALITY	Kookaburra Gully.
DATE RECEIVED	9 April 1984.
WORK REQUIRED	Preliminary Evaluation.

Investigation and Report by: Lyn J. Day.

Chief, Materials Section: Philip J. Parry.

for Dr William G. Spencer
Manager
Mineral & Materials Sciences Division

Head Office:
Flemington Street, Frewville
South Australia 5063
Telephone (08) 79 1662
Telex: Amdel AA82520
Pilot Plant:
Osman Place
Thebarton, S.A.
Telephone (08) 43 5733
Branch Laboratories:
Melbourne, Vic.
Telephone (03) 645 3093
Perth, W.A.
Telephone (09) 325 7311
Telex: Amdel AA94893
Townsville
Queensland 4814
Telephone (077) 75 1377

1. INTRODUCTION

Forty six graphite-bearing trench channel samples from the Eyre Peninsula were submitted for preliminary evaluation. The samples were labelled 8501 - 8546. Duplicates of each sample were supplied.

2. PROCEDURES AND RESULTS

One complete set of samples was analysed using standard chemical techniques to determine their graphitic carbon content. Results are given in Table 1.

On the basis of the chemical analyses nine samples deemed to be representative of the range of samples from both trenches were selected and submitted to further testing. These samples were examined using X-ray diffraction to determine their mineralogy and hence indicate the types and amounts of gangue minerals present. These results are given in Table 2.

Polished sections were also made of these samples and examined using a bincoular microscope in order to measure the grainsize of the graphite flakes. Measurements of the lengths of the graphite flakes are given in Table 3. The flakes showed an elongated morphology.

Cross-sections of both trenches from which the samples were obtained are shown in Appendix A and B.

3. DISCUSSION

The samples tested showed a large variation in graphite content. The samples in the two trenches varied from negligible graphite to maximum contents of 27.2% and 24.1%. The average graphite values were 8.7% and 9.6% for Trenches A and B respectively. Overseas commercial graphite ventures are processing crude ore averaging 10-12% carbon.

The size range of the graphite flakes indicates that they are of sufficient size grading to be suitable for a number of uses. The graphite is associated with a large range of different gangue minerals.

In order to further evaluate the graphite it would be necessary to carry out beneficiation tests to determine how successfully the graphite may be liberated from the associated gangue minerals to yield a high-grade product. Most uses require a minimum carbon content of 85% or often a value well above this level. The graphite appears to meet basic requirements such as flake size and its economic potential will depend largely on how successfully it can be upgraded to the required standards.

dt.

TABLE 1: GRAPHITE CONTENT OF SAMPLES

Sample	Graphite Content %	Sample	Graphite Content %
8501	1.75	8524	18.4
8502	4.15	8525	15.4
8503	1.56	8526	9.20
8504	21.7	8527	8.65
8505	22.5	8528	16.1
8506	3.06	8529	2.20
8507	2.30	8530	6.55
8508	27.2	8531	5.40
8509	21.8	8532	11.7
8510	10.9	8533	24.1
8511	13.7	8534	13.1
8512	1.02	8535	0.58
8513	1.40	8536	5.05
8514	3.28	8537	2.38
8515	2.64	8538	4.60
8516	0.53	8539	9.00
8517	2.84	8540	3.74
8518	7.20	8541	2.28
8519	16.1	8542	2.02
8520	10.5	8543	3.16
8521	16.8	8544	2.32
8522	1.48	8545	3.30
8523	0.87	8546	6.15

TABLE 2: MINERALOGY OF SELECTED SAMPLES

	8505	8507	8508	8510	8513	8520	8525	8529	8533
Quartz	D	SD	D	SD	D	CD	D	D	CD
Kaolinite	SD	D	SD	D	A-SD	A-SD	A-SD	A-SD	A
Graphite	A-SD	A	SD	SD	SD	CD	SD	-	CD
Mica (muscovite)	A	A	A	A	A	A	A	Tr	A
Halite	Tr	Tr	Tr	Tr	-	-	-	-	-
Dolomite	-	A	-	A	A	-	A	-	Tr-A
Calcite	-	-	-	-	A	-	Tr-A	-	Tr-A
Feldspar	-	-	-	-	-	A-SD	-	A	-
Hematite	-	-	-	-	-	-	-	-	A
Goethite	-	-	-	-	-	-	-	-	A

Key

D	Dominant
CD	Co-dominant
SD	Sub-dominant (>20%)
A	Accessory (approx. 5-20%)
Tr	Trace (<5%)

TABLE 3: GRAINSIZE OF GRAPHITE FLAKES

Sample	Size Range* micrometres	Average Length
5	150 - 500	500
7	200 - 300	250
8	200 - 2 000	700
10	200 - 1 000	500
18	100 - 400	200
20	150 - 500	400
25	200 - 600	400
29	150 - 400	300
33	500 - 2 200	1 000

*Size range of the length of the majority of graphite flakes.

Tenement: EL 1142 - Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 296 sq.km.

Expenditure Commitment: $25,000

Report Period: May 27 to August 26, 1984

Work Completed: Kookaburra Gully Prospect

General: studies of the world market for crystalline flake graphite

Geology: detailed geological map of Kookaburra Gully prospect at 1:1000 scale

Gridding: 3000 metres of infill grid

Trenching: 154 metres of additional trenching and channel sampling

Sampling: 200kg of bulk samples taken for bench scale testing by AMDEL and potential consumers

What is the outlook? ?
Where is the report?
Pancon provide all info. in annuals.

Proposed Work: Depending on results of test of beneficiation, mineralogy and flake properties currently in progress, further work may comprise additional trenching, gridding, mapping, diamond drilling, bulk sampling for bench and pilot beneficiation and concentrate tests.

Expenditure: Expenditure on the E.L. for the quarter amounted to $17,102 being made up as follows:

Salaries	$ 6,110
Travel & Accommodation	2,581
Contractors Services	4,878
Field & Other Expenses	1,302
Operating Overheads	2,231
	$ 17,102

Tenement:	E.L. 1142 - Eyre Pensinsula
Holder:	Pancontinental Mining Limited
Area:	296 sq.km
Expenditure Commitment:	$25,000
Reporting Period:	August 27 to November 26, 1984
Work Completed:	Beneficiation testwork was the principal activity. AMDEL, Adelaide and some overseas consumers of flake graphite reported the results of their tests. These tests had been designed to determine if commercial grade concentrates of course flakes could be produced. They were partially successful but with low recovery.
Work Proposed:	Continuation of testwork and preliminary economic studies to determine the impact of low recovery.
Expenditure:	Expenditure on the E.L. for the quarter amounted to $10,555 being made up as follows:

Administration General	$ 3,624
Land Administration	41
Office Technical	844
Geological Investigation	495
Drilling	44
Mining, Metallurgy & Marketing	5,507
	$ 10,555

Tenement: E.L. 1142 - Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 296 sq.km.

Expenditure Commitment: $25,000

Reporting Period: November 27, 1984 - February 26, 1985

Work Completed: Evaluation continued by overseas consumers of graphite of trench samples from Kookaburra Gully. The conclusion was that the samples could be upgraded to produce concentrates having reasonable carbon content but with a high proportion of flakes less than 150 microns in size. To further investigate the market for these concentrates, a contract has been let to Warman International of Sydney to process a 250 kg bulk sample and produce concentrates with carbon contents as high as possible and flake sizes greater than 150 microns. The sample was taken and bench scale flotation and tabling process work was completed to define the parameters for producing the concentrates required.

Work Proposed: Completion of preparations of industrial grade concentrates. Market evaluation of the concentrates. Economic studies and reserve evaluation of market evaluation is favourable.

Expenditure: Expenditure on the E.L. for the quarter amounted to $4,592 being made up as follows:

Administration General	$3,034
Office Technical	566
Geological Investigation	791
Gridding, Surveying & Cartography	154
Geochemical Surveys	47
	$4,592

Tenement: E.L. 1142 - Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 296 sq. km

Expenditure Commitment: $25,000

Reporting Period: February 27 to May 26, 1985

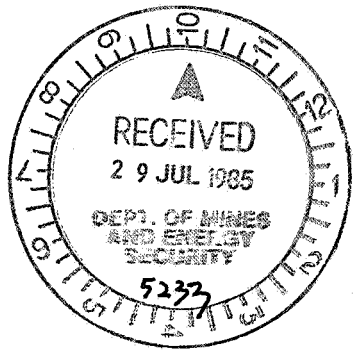
Work Completed: To further investigate the market for concentrates from samples taken from Kookaburra Gully, a contract was let to Warman International of Sydney to process a 250kg bulk sample and produce concentrates with carbon contents as high as possible and flake sizes greater than 150 microns. Warmans reported that the sample had a feed grade of 21.8% carbon. By a combination of screening, flotation and tabling, Warman produced a variety of products with a size cut-off at plus/minus 150 microns. When combined, the plus 150 micron concentrates have a grade of 93.6% carbon and represent recovery of 10% of the total carbon in the feed. The minus 150 micron fractions average 84.7% carbon but, after desliming, this will rise to about 90% carbon. Additional processing of the plus 570 micron fraction can be upgraded to give an additional 1.5% recovery of +150 micron graphite. Slight upgrading was achieved of some of the previously obtained concentrates by retabling and screening.

It was decided to produce two concentrates for submission to consumers: plus 150 microns at 92% carbon, and
minus 150 plus 75 microns at 90% carbon.
These were sent to companies in the United Kingdom, West Germany, Japan and U.S.A. The response to date has been sufficiently encouraging to proceed with the proving of reserves.

Work Proposed: Field work will be undertaken to prove the reserves, pilot plant beneficiation studies will be made and a preliminary feasibility study will be completed. In addition, reconnaissance mapping, geophysical surveys, sampling and diamond drilling will be undertaken on other graphite occurrences in the EL.

Expenditure: Expenditure for the EL for the quarter amounted to $10,345 being made up as follows:

Administration General	$ 1,676
Land Administration	841
Office Technical	1,511
Geological Investigation	369
Mining, Marketing and Metallurgy	5,948
	$ 10,345



85/25

0034

EL 1142 MT GAWLER AREA,
SOUTH AUSTRALIA

ANNUAL REPORT FOR THE PERIOD
27 May, 1984 to 26 May, 1985

A.R. Collins
Chief Geologist
PANCONTINENTAL MINING LTD

Distribution:

1. PML
2. PML
3. PML
4. Mines
5. PME
6. PME

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FIGURES

PLATES

ANNEXES

1. INTRODUCTION

This report summarises the results of the exploration for flake graphite carried out by Pancontinental Mining Limited in EL 1142 during the period 27 May, 1984 to 26 May, 1985. The following activities were completed:

1. 3000 metres of infill gridding on Kookaburra Gully
2. detailed geological mapping of the Kookaburra Gully prospect at 1:1000 scale
3. 154 metres of trenching and channel sampling
4. two programmes of bulk sampling and testing of the beneficiation characteristics and flake size distribution of Kookaburra Gully graphite
5. evaluation of small concentrate samples by overseas consumers of flake graphite
6. studies of the world market for crystalline flake graphite

2. LOCATION AND ACCESS

The E.L. is located on the Eyre Peninsula to the north and northwest of Port Lincoln (see Figure 1). Access is adequate with numerous secondary roads and farm tracks throughout the E.L.

3. GEOLOGY AND TRENCHING

The Kookaburra Gully prospect (see Figure 2) was mapped in detail at 1:1000 scale after infilling and extending the grid. The outcrop geology is shown on Plate 1. The main graphitic schist zone extends over a strike length of about 700 metres and appears to have closed off to the north. To the south outcrop is poor and continuity of the zone is possible.

Four additional trenches numbered 3, 4, 5 and 6 on Plate 1 were excavated to sample the graphitic zone and to provide structural information. Trench sections and graphite analyses are shown on Plate 2. The trenching confirmed the continuity of the zone and indicated considerable structural complexity, grade and thickness variation. Some of the grade variation is related to proximity to the lateritized surface (e.g. Trench 6). Analytical results of the trenching were:

Trench 3	9660N	12.5 metres at 8.75% graphite
Trench 4	10100N	14 metres at 20.09% graphite
Trench 6	9930N	7 metres at 9.83% graphite

Trench 5 contained only low grade graphitic schist. Analytical results are shown in Annex 1.

4. BENEFICIATION TESTING

4.1 AMDEL

Australian Mineral Development Laboratories of Adelaide were contracted to conduct a preliminary bench scale beneficiation test programme on 120 kg of material from Trench 4. They concluded that recovery of a +85% graphite concentrate with flake sizes greater than 150 microns would be very low. The full text of their report is included as Annex 2.

Similar trench samples were provided to several overseas graphite consumers. Though the details of their reporting of results were very limited, it was clear that all consumers found that reasonable grade concentrates could be produced but with poor recovery of coarse flakes.

4.2 WARMAN

To investigate the market for both coarse and fine flakes and to gain a better appreciation of the likely recovery of coarse flakes, a contract was let to Warman International Ltd of Sydney to produce at least 10 kg of plus 150 micron flake concentrate at better than 90% graphite. Warman's processed a 250 kg sample from trench 4 with head grade of 21.8% graphite. By a combination of crushing, screening, flotation, tabling and desliming they produced two concentrates:

(a) plus 150 microns at 92% graphite

(b) minus 150 plus 75 microns at 90% graphite

The Warman reports are included as Annex 3.

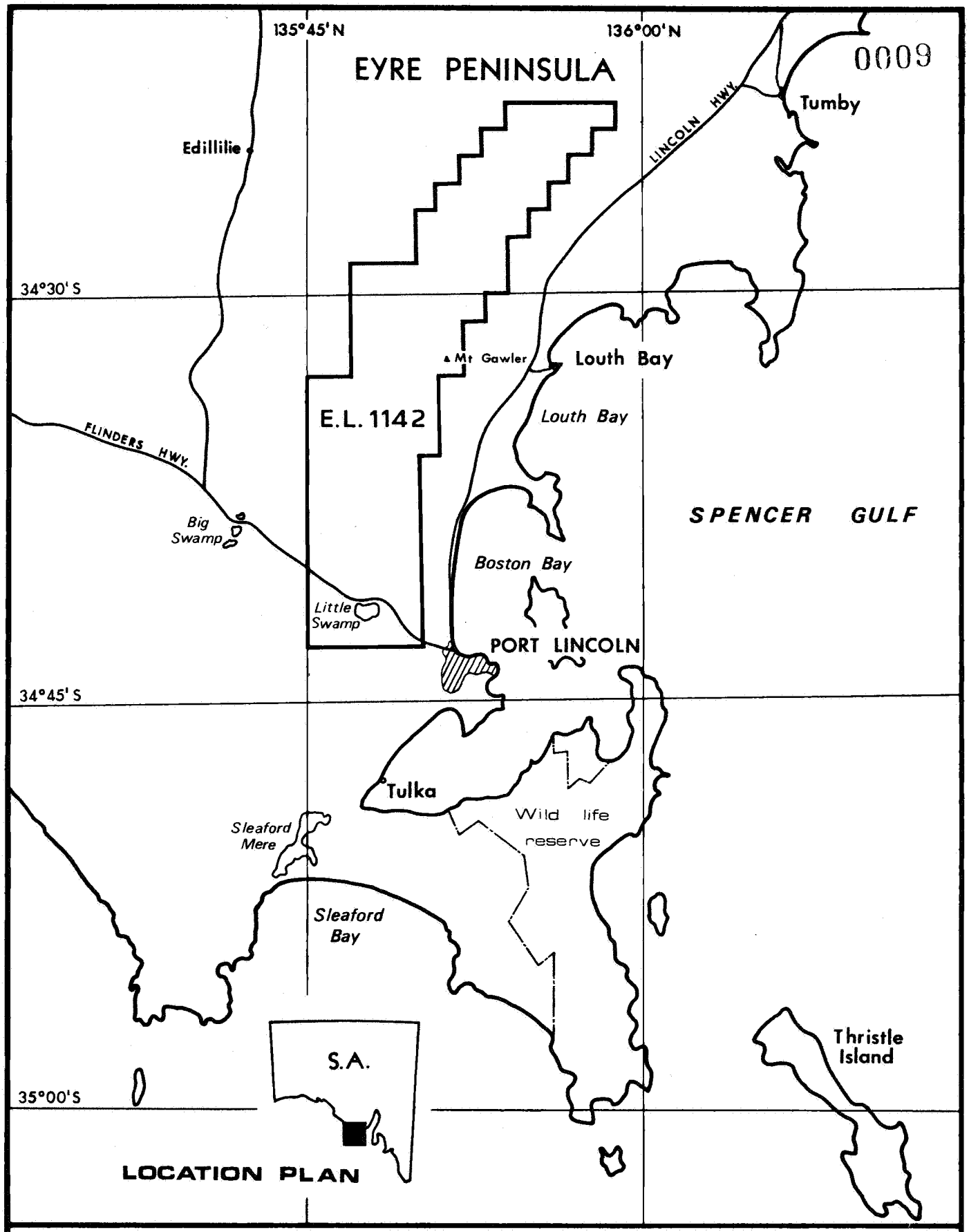
5. CONCENTRATE EVALUATION

At the conclusion of the year under review, samples of each concentrate had been sent to consumers in Europe, USA and Japan. The preliminary responses were sufficiently encouraging to plan for further beneficiation and consumer testing and for proving of the reserves.

6. EXPENDITURE

The expenditure for the year totalled $42,594 and was made up as follows:

	$
Admin General	7,657
Land Admin	1,101
Office Technical	4,000
Gridding, Surveying	2,970
Geological Investigations	9,208
Geochemistry	1,166
Drilling	354
Transport & Travel	1,014
Mining, Metallurgy & Marketing	15,124
	$42,594



EYRE PENINSULA - E.L. 1142

LOCATION PLAN

0 5 10 15 km

Scale 1:250 000

REPORT No.: 84/15

FIG. 1

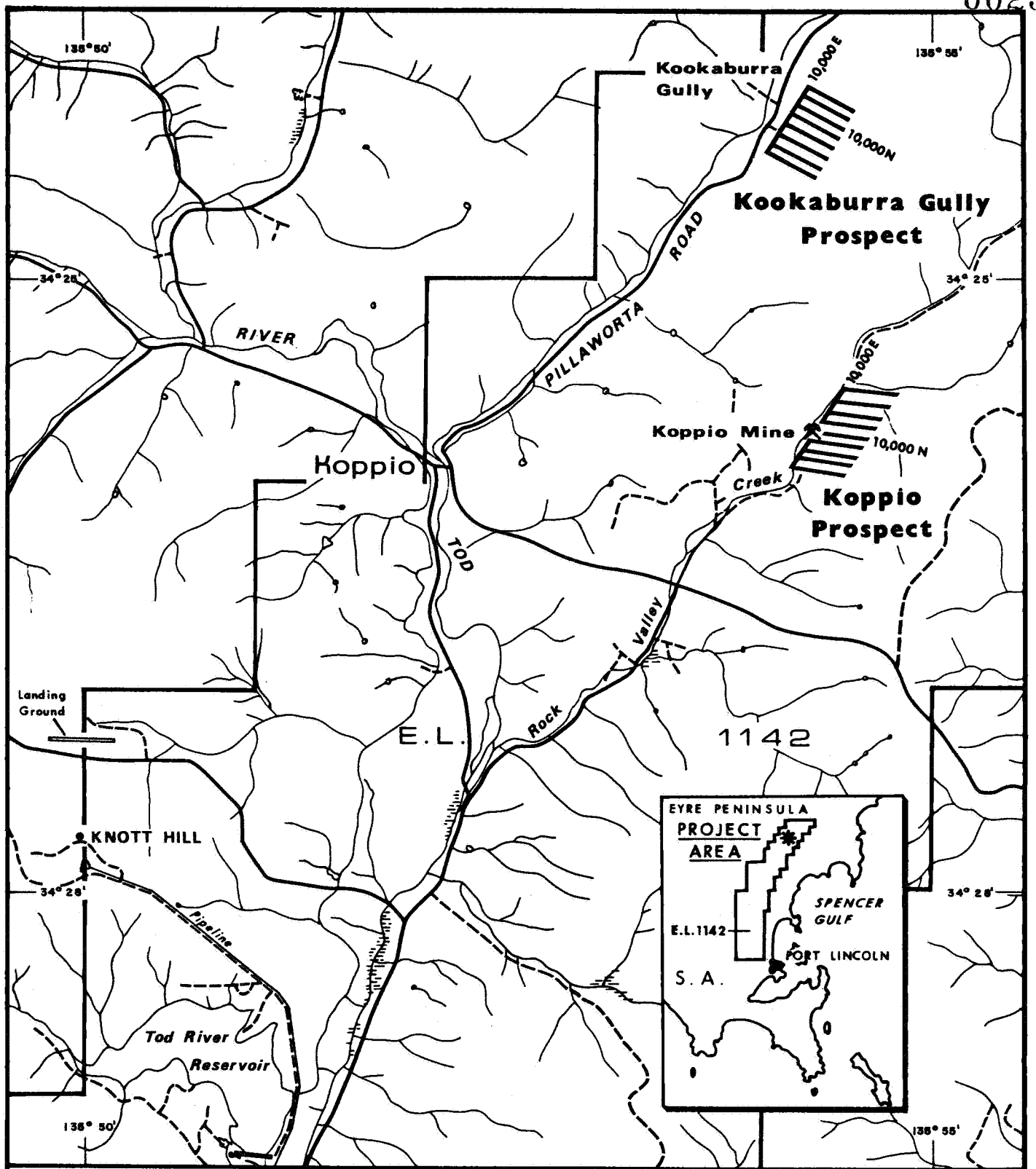


FIGURE 1

KOPPIO AND KOOKABURRA GULLY PROSPECTS

E.L.1142 - SOUTH AUSTRALIA

E.M. GRID LOCALITY

SCALE 1: 50,000

0 50 100 150 200 250

METRES

21/E/20

ANNEX 1

Analytical Results

COMLABS Pty. Ltd.
COMPUTERISED ANALYTICAL LABORATORIES

Head Office and
Central Laboratory
305 SOUTH ROAD,
MILE END SOUTH
STH. AUST. 5031
TEL.: (08) 43 5722
TELEX: AA89323

NATA REGISTERED No. 1526

0040

OUR REF.: COM 841432

YOUR REF.: Order No. 3206

Dr. A. Collins,
Pancontinental Mining Ltd.,
AMP Centre,
50 Bridge Street,
SYDNEY NSW 2000,

18.7.84

Dear Sir,

RE: JOB COM 841432

Enclosed are the assays for the samples delivered to cur laboratory on the 10th July 1984.

Yours sincerely,
COMLABS PTY LTD

per :

c.c.: Mr. J. Poole

COMLABS Pty. Ltd.
COMPUTERISED ANALYTICAL LABORATORIES

ANALYTICAL REPORT

0041

JOB COM841432 O/N : 3206

Results in %

SAMPLE	Graphitic Carbon	Trench	From (m)	To (m)
8547	0.63	10100N	15	16
8548	2.50		16	17
8549	15.5		17	18
8550	25.0		18	19
8551	25.7		19	20
8552	24.5		20	21
8553	22.1		21	22
8554	23.2		22	23
8555	23.2		23	24
8556	21.0		24	25
8557	12.8		25	26
8558	20.5		26	27
8559	25.3		27	28
8560	17.1		28	29
8561	14.2		29	30
8562	11.2		30	31
8563	1.50		31	32
8564	0.80		32	33
8565	26.0	duplicate of 8552	20	21
8566	19.3	" " 8558	26	27
8567	1.21	9930N	6	7
8568	10.7		7	8
8569	2.15		8	9
8570	2.10		9	9.5
8571	10.5		9.5	10.5

from 17 - 31 metres
14 metres 20.09% graphite.

FROM	TO	INT	% graphite
7.0	14.0	7	9.83%
9.5	14.0	4.5	12.20%

.../2

0042

ANALYTICAL REPORT

JOB COM841432 O/N : 3206

Results in %

SAMPLE	Graphitic Carbon	Trench	From(m)	To (m)
8572	16.8	9930N	10.5	11.5
8573	7.50		11.5	12.5
8574	12.7		12.5	13.5
8575	14.8		13.5	14.0
8576	1.75		14	15
8577	2.25	9660N	10	10.5
8578	7.55		10.5	11
8579	3.90		11	12
8580	8.15		12	13
8581	11.1		13	14
8582	3.85		14	15
8583	1.05		15	15.5
8584	16.4		15.5	16.5
8585	17.1	duplicate of 8584		
8586	11.4		16.5	17.0
8587	5.30		17	18
8588	4.55		18	19
8589	9.35		19	20
8590	8.75		20	21
8591	17.0		21	22
8592	11.0		22	23
8593	2.55		23	24

FROM	TO	INT	% Graphite
10.5	23.0	12.5	8.75
10.5	14.0	3.5	7.69.
15.5	23.0	7.5	10.41

Method of Analysis : C : GRAV

ANNEX 2

Report T 6017#1 by AMDEL on Mineralogical Assessment of Four Kookaburra Gully Graphite Samples - date 4 October 1984

The Australian
Mineral Development
Laboratories

Flemington Street, Frewville,
South Australia 5063
Phone Adelaide (08) 79 1662
Telex AA82520

Please address all
correspondence to
P.O. Box 114 Eastwood
SA 5063
In reply quote:

amdel

0044

4 October 1984

GS 3/698/0

AMDEL
Operations Division

Attention: Mr K.Y. Wong

REPORT T 6017#1

YOUR REFERENCE:	IWR 8709, dated 17 August 1984
IDENTIFICATION:	A, B, C, D
MATERIAL:	Four graphite-bearing ore samples
LOCALITY:	Kookaburra Gully, Eyre Peninsula, South Australia
DATE RECEIVED:	17 August 1984
WORK REQUIRED:	Mineralogical assessment

Investigation and Report by: Michael Till

Chief - Geological Services Section: Dr Keith J. Henley

for Dr William G. Spencer
Manager, Mineral and Materials Sciences Division

cap

Head Office:
Flemington Street, Frewville
South Australia 5063,
Telephone (08) 79 1662
Telex: Amdel AA82520
Pilot Plant:
Osman Place
Thebarton, S.A.
Telephone (08) 43 8053
Branch Laboratories:
Melbourne, Vic.
Telephone (03) 645 3093
Perth, W.A.
Telephone (09) 325 7311
Townsville
Queensland 4814
Telephone (077) 75 1377

MINERALOGICAL ASSESSMENT OF FOUR KOOKABURRA GULLY GRAPHITE SAMPLES

1. INTRODUCTION

Four samples of graphite ore from Pancontinental Mining Limited were received from Mr K. Wong of AMDEL's Operations Division with a request for mineralogical assessment and determination of liberation characteristics (Stage I investigation). The samples were labelled A, B, C and D, referring to different zones within a trench at Kookaburra Gully, Eyre Peninsula, South Australia.

2. PROCEDURE

The head samples and five size fractions (-2000 + 850 µm, -850 + 425 µm, -425 + 150 µm, -150 + 75 µm and -75 µm) of each sample were received. Riffled portions of the +75 µm fractions were separated statically in a mixture of tetrabromoethane and dimethyl formamide (sp.gr. 2.4). Polished sections (PS33486-33501) were prepared of the specific gravity products. The -850 + 75 µm <2.4 sp.gr. products were point-counted (500 points) using a 10 × 10 net graticule inserted into the eyepiece, to determine the liberation characteristics of the graphite. Subdivision was made during counting into particles consisting of 100%, 95-100%, 85-95% and <85% graphite (as estimated visually). Photomicrographs of typical textures were prepared. The head samples, specific gravity products and the -75 µm fraction were analysed for elemental and organic carbon (hereafter referred to as 'carbon' or 'C') and the head samples were analysed by X-ray powder diffractometry.

3. HEAD MINERALOGY

The following tabulation gives the C analyses for the head samples:

	Sample			
	A	B	C	D
% C (assay)	21.8	13.2	21.0	12.5
% C (calculated from sp.gr. data)	22.2	13.1	21.0	12.5

The head mineralogy, as calculated from assays and estimated from X-ray diffraction analysis, is as follows:

Sample A		Sample B		Sample C		Sample D	
Quartz	35-40	Hematite	25-30	Quartz	30-35	Quartz	30-35
Graphite	22	Goethite	20-25	Graphite	21	Kaolinite	25-30
Kaolinite	15-20	Quartz	15-20	Kaolinite	10-15	Muscovite	10-15
Muscovite	15-20	Kaolinite	15-20	Muscovite	5-10	Graphite	13
Goethite	3-5	Graphite	13	Dolomite	5-10	Hematite	5-10
Dolomite	3-5	Muscovite	5-10	Hematite	5-10	Goethite	5-10
Magnesite	3-5			Goethite	5-10	Dolomite	3-5

4. CARBON DISTRIBUTION WITH SPECIFIC GRAVITY AND PARTICLE SIZE

The heavy liquid separations at sp.gr. 2.4 were done to separate liberated and near-liberated graphite (sp.gr. ∿2.2) from graphite locked intimately with gangue and from liberated gangue (sp.gr. 2.6-5).

The distributions of carbon with specific gravity and in particle size in Sample A-D are given in Tables 1 to 4 respectively.

In interpreting these Tables the following points should be noted:

(1) In column 2 ('Spec. Grav. Fraction'), <2.4 refers to the <2.4 sp.gr. material and >2.4 refers to the >2.4 sp.gr. material.

(2) Columns 3-5 ('In Size Fractions') give the data for each size fraction - with weight and elemental distributions calculated to 100%. 'Totals for Above Size Fractions' refers to the total +75 μm material. 'Overall Totals' refers to the weight and element distributions between 'sands' (i.e. +75 μm material) and 'slimes' (-75 μm material).

(3) Columns 6-7 ('In Size Fractions') give the data on the basis of the head as 100%.

(4) Columns 8-10 ('Cumulative Data') give the cumulated totals by sp.gr. product. Thus, in the -850 + 425 μm size range for example, the <2.4 sp.gr. data refers to the total material with sp.gr. <2.4 in the +425 μm size fractions.

(5) The carbon distribution in the <2.4 sp.gr. product sets an upper limit to the percentage of liberated graphite in the size fraction; however some of the graphite in the <2.4 sp.gr. product is locked with gangue and the extent of this locking is quantified in Table 5.

The carbon distribution data in Tables 1-4 show broadly similar features for each sample, as follows:

(1) There is some preferential grinding of graphite as indicated by the increasing carbon content of the size fractions with decreasing particle size.

(2) The carbon assays of the <2.4 sp.gr. products increase with decreasing particle size from 25-35% carbon in the +850 μm fraction to 79-90% carbon in the -425 + 75 μm fractions due to increasing liberation of graphite from gangue.

(3) The carbon distribution in the <2.4 sp.gr. products increases from the -850 + 425 μm fraction to the -150 + 75 μm fraction due to increasing liberation of graphite from gangue. However, even in the -150 + 75 μm fraction only 50-79% of the carbon reports in the <2.4 sp.gr. product, the remainder being due to graphite locked with gangue minerals in the >2.4 sp.gr. product.

(4) The carbon assays of the >2.4 sp.gr. products show relatively little variation over the size range investigated (7-14% carbon) indicating that the graphite in these products is finely disseminated in gangue.

(5) On the basis of carbon assay and distribution in the -425 + 75 µm <2.4 sp.gr. products, the samples may be numbered in regard to liberation of graphite as follows:

(1)	(Best)	Sample A
(2)		Sample C
(3)		Sample B
(4)	(Worst)	Sample D

Samples A and C, which show the best liberation characteristics, also have the highest graphite contents (∿21%).

5. OVERALL LIBERATION/LOCKING CHARACTERISTICS

The microscopically-determined liberation/locking characteristics of graphite in the +75 µm <2.4 sp.gr. products are given in Table 5. These data have been combined with the heavy liquid separation data in Tables 1-4 to give the overall liberation of graphite in each of the +75 µm fractions (Table 6).

If it is assumed that graphite-bearing particles containing more than 85% graphite are effectively liberated, it can be seen from Table 6 that liberation is negligible in the +850 µm and -850 + 425 µm fractions and even in the -150 + 75 µm fraction is less than 40% for Samples B and D and 55-65% for Samples A and C.

6. GRAPHITE TEXTURAL CHARACTERISTICS

Photomicrographs of typical textural features of graphite in the <2.4 sp.gr. products are given in Figs. 1-16. Notes on particle shape are as follows:

Sample A

The estimated proportion of flakes (elongated particles) to equant particles and the estimated flake size in each is as follows:

Size Fraction (µm)	Particle Dist.			Length of Flakes in:	
	Flakes	:	Equant	Flaky Particles	Equant Particles
+ 850	0	:	100	-	100-500
-850 + 425	25	:	75	700-1000	100-250
-425 + 150	60	:	40	250- 500	100-250
-150 + 75	75	:	25	150- 300	100-200

Elongate particles with >95 vol. % graphite contain thin strips of fine-grained non-opaques between the flakes. In the +150 µm products the equant particles contain discrete areas of flakes and non-opaques, often with alternating bands of graphite and non-opaques.

Sample B

The estimated proportion of flakes and elongated particles and the estimated flake size in each is as follows:

Size Fraction (µm)	Particle Dist.			Length of Flakes in:	
	Flakes	:	Equant	Flaky Particles	Equant Particles
+ 850	0	:	100	-	100-600
-850 + 425	50	:	50	450-900	100-600
-425 + 150	60	:	40	300-700	100-300
-150 + 75	80	:	25	100-250	100-200

Elongate particles with >95 vol. % graphite contain thin strips of fine-grained non-opaques between the flakes. The equant particles in the -850 + 150 µm size range contain masses of sub-parallel graphite flakes, with alternating bands of graphite-poor non-opaques. In the +850 µm size range the masses of flakes are increasingly randomly oriented rather than possessing sub-parallel orientation.

Sample C

The estimated proportion of flakes and elongated particles and the estimated flake size in each is as follows:

Size Fraction (µm)	Particle Dist.			Length of Flakes in:	
	Flakes	:	Equant	Flaky Particles	Equant Particles
+ 850	0	:	100	-	100-400
-850 + 425	50	:	50	400-800	100-250
-425 + 150	60	:	40	200-500	100-200
-150 + 75	70	:	30	100-200	100-200

The elongate particles with >95 vol. % graphite contain thin strips of fine-grained non-opaques between the flakes. In the -150 + 75 µm size fraction the flake width is thinner than in the equivalent size range of Samples A, B and D. The equant particles contain masses of relatively short sub-parallel flakes. The graphite flakes are frequently fractured into segments and hence the flake length range in this sample is less than in the other samples.

Sample D

The estimated proportion of flakes and elongated particles and the estimated flake size in each is as follows:

Size Fraction (μm)	Particles Dist. Flakes : Equant	Length of Flake in: Flaky Particles	Equant Particles
+ 850	0 : 100	-	100-300
-850 + 425	5 : 95	300-700	100-300
-425 + 150	30 : 70	200-500	100-200
-150 + 75	50 : 50	100-200	100- 75

The graphite flakes in this sample are less well-liberated than in the other samples, and typically contain attachments of non-opaque grains, as well as thin strips between the individual flakes. In the equant particles, the flake masses exhibit sub-parallel to random orientation and the proportion of graphite to non-opaques is considerably lower than in the other samples.

7. DISCUSSION

If it is assumed that a commercial graphite product should contain at least 85% graphite, the results of the present investigation indicate that maximum possible recoveries at this grade are likely to be as follows for the various size ranges:

Sample	Size Fraction (μm)	Approximate Maximum Recovery (%) at 85% Graphite Grade (±5%)
A	+ 850	-
	-850 + 425	15
	-425 + 150	65
	-150 + 75	80
B	+ 850	-
	-850 + 425	3
	-425 + 150	35
	-150 + 75	50
C	+ 850	-
	-850 + 425	5
	-425 + 150	40
	-150 + 75	65
D	+ 850	-
	-850 + 425	3
	-425 + 150	25
	-150 + 75	40

These figures are based on the data in Table 6 and assume virtually perfect separation of liberated and near-liberated graphite from gangue. In practice, however, such separation is unlikely to be possible and consequently concentrate grades are likely be be lowered.

Excellent liberation of graphite from gangue would only take place at particle sizes less than 75 μm and this aspect would warrant further investigation if graphite concentrates of such fine grain size are likely to be saleable.

TABLE 1. CARBON DISTRIBUTION IN SAMPLE A.

SIZE FRACTION (MICRONS)	SPEC GRAV FRACTION	--- IN SIZE FRACTIONS --- WT %	CARBON ASSAY %	CARBON DISTN %	IN HEAD SAMPLE WT %	CARBON DISTN %	CUMULATIVE DATA WEIGHT %	ASSAY %	DISTN %
+ 850.	< 2.40	33.5	28.80	63.9	4.45	5.76	4.45	28.80	5.76
	> 2.40	66.5	8.20	36.1	8.82	3.25	8.82	8.20	3.25
	TOTAL	100.0(	15.11)	100.0	13.27	9.02	13.27	15.11	9.02
- 850. + 425.	< 2.40	8.2	73.30	32.8	0.91	3.00	5.36	36.36	8.76
	> 2.40	91.8	13.40	67.2	10.19	6.14	19.01	10.99	9.39
	TOTAL	100.0(	18.31)	100.0	11.10	9.14	24.37	16.57	18.16
- 425. + 150.	< 2.40	18.9	84.70	66.8	4.82	18.38	10.18	59.26	27.14
	> 2.40	81.1	9.80	33.2	20.72	9.13	39.73	10.37	18.53
	TOTAL	100.0(	23.95)	100.0	25.54	27.51	49.91	20.34	45.67
- 150. + 75.	< 2.40	23.4	89.70	79.2	4.58	18.48	14.76	68.70	45.62
	> 2.40	76.6	7.20	20.8	15.02	4.86	54.75	9.50	23.39
	TOTAL	100.0(	26.48)	100.0	19.60	23.34	69.51	22.07	69.01
TOTALS FOR ABOVE SIZE FRACTIONS	< 2.40	21.2(	68.70)	66.1					
	> 2.40	78.8(	9.50)	33.9					
OVERALL TOTALS..	SANDS	69.5(	22.07)	69.0					
	SLIMES	30.5	22.60	31.0					
	TOTAL	100.0(	22.23)	100.0					

CALCULATED HEAD ASSAY= 22.23 %

TABLE 2. CARBON DISTRIBUTION IN SAMPLE B.

SIZE FRACTION (MICRONS)	SPEC GRAV FRACTION	--- IN SIZE FRACTIONS --- WT %	CARBON ASSAY %	CARBON DISTN %	IN HEAD SAMPLE WT %	CARBON DISTN %	CUMULATIVE DATA WEIGHT %	ASSAY %	DISTN %
+ 850.	< 2.40	5.3	26.40	12.1	1.69	3.41	1.69	26.40	3.41
	> 2.40	94.7	10.70	87.9	30.20	24.75	30.20	10.70	24.75
	TOTAL	100.0(	11.53)	100.0	31.89	28.16	31.89	11.53	28.16
- 850. + 425.	< 2.40	0.9	71.40	5.9	0.17	0.92	1.86	30.50	4.34
	> 2.40	99.1	10.90	94.1	17.82	14.88	48.02	10.77	39.63
	TOTAL	100.0(	11.47)	100.0	17.99	15.80	49.88	11.51	43.97
- 425. + 150.	< 2.40	6.2	86.00	35.3	1.22	8.07	3.08	52.56	12.41
	> 2.40	93.8	10.40	64.7	18.60	14.81	66.62	10.67	54.44
	TOTAL	100.0(	15.07)	100.0	19.82	22.88	69.70	12.52	66.85
- 150. + 75.	< 2.40	11.0	84.60	50.4	1.14	7.40	4.22	61.22	19.81
	> 2.40	89.0	10.30	49.6	9.23	7.28	75.85	10.62	61.72
	TOTAL	100.0(	18.48)	100.0	10.37	14.68	80.07	13.29	81.53
TOTALS FOR ABOVE SIZE FRACTIONS	< 2.40	5.3(	61.22)	24.3					
	> 2.40	94.7(	10.62)	75.7					
OVERALL TOTALS..	SANDS	80.1(	13.29)	81.5					
	SLIMES	19.9	12.10	18.5					
	TOTAL	100.0(	13.06)	100.0					

CALCULATED HEAD ASSAY= 13.06 %

TABLE 3. CARBON DISTRIBUTION IN SAMPLE C.

SIZE FRACTION (MICRONS)	SPEC GRAV FRACTION	IN SIZE FRACTIONS WT %	IN SIZE FRACTIONS CARBON ASSAY %	IN SIZE FRACTIONS CARBON DISTN %	IN HEAD SAMPLE WT %	IN HEAD SAMPLE CARBON DISTN %	CUMULATIVE DATA WEIGHT %	CUMULATIVE DATA ASSAY %	CUMULATIVE DATA DISTN %
+ 850.	< 2.40	23.8	33.40	45.9	8.27	13.17	8.27	33.40	13.17
	> 2.40	76.2	12.30	54.1	26.47	15.51	26.47	12.30	15.51
	TOTAL	100.0(	17.33)	100.0	34.74	28.69	34.74	17.33	28.69
- 850. + 425.	< 2.40	7.9	63.60	28.0	1.24	3.77	9.52	37.35	16.94
	> 2.40	92.1	14.00	72.0	14.54	9.70	41.00	12.90	25.21
	TOTAL	100.0(	17.91)	100.0	15.78	13.47	50.52	17.51	42.15
- 425. + 150.	< 2.40	15.4	81.40	57.3	3.19	12.37	12.71	48.40	29.31
	> 2.40	84.6	11.10	42.7	17.45	9.23	58.45	12.36	34.44
	TOTAL	100.0(	21.96)	100.0	20.64	21.60	71.16	18.80	63.75
- 150. + 75.	< 2.40	23.3	82.60	73.3	2.81	11.06	15.52	54.59	40.37
	> 2.40	76.7	9.10	26.7	9.27	4.02	67.72	11.92	38.46
	TOTAL	100.0(	26.19)	100.0	12.08	15.08	83.24	19.87	78.83
TOTALS FOR ABOVE SIZE FRACTIONS	< 2.40	18.6(	54.59)	51.2					
	> 2.40	81.4(	11.92)	48.8					
OVERALL TOTALS..	SANDS	83.2(	19.87)	78.8					
	SLIMES	16.8	26.50	21.2					
	TOTAL	100.0(	20.98)	100.0					

CALCULATED HEAD ASSAY= 20.98 %

TABLE 4. CARBON DISTRIBUTION IN SAMPLE D.

SIZE FRACTION (MICRONS)	SPEC GRAV FRACTION	--- IN SIZE FRACTIONS --- WT %	CARBON ASSAY %	CARBON DISTN %	IN HEAD SAMPLE WT %	CARBON DISTN %	CUMULATIVE DATA WEIGHT %	ASSAY %	DISTN %
+ 850.	< 2.40	7.4	32.40	21.3	1.44	3.75	1.44	32.40	3.75
	> 2.40	92.6	9.60	78.7	18.02	13.89	18.02	9.60	13.89
	TOTAL	100.0(	11.29)	100.0	19.46	17.64	19.46	11.29	17.64
- 850. + 425.	< 2.40	2.0	62.70	11.6	0.32	1.62	1.76	37.92	5.37
	> 2.40	98.0	9.90	88.4	15.46	12.29	33.48	9.74	26.18
	TOTAL	100.0(	10.98)	100.0	15.78	13.91	35.24	11.15	31.55
- 425. + 150.	< 2.40	5.2	78.90	35.2	1.16	7.38	2.93	54.22	12.75
	> 2.40	94.8	7.95	64.8	21.33	13.62	54.80	9.04	39.80
	TOTAL	100.0(	11.62)	100.0	22.49	21.00	57.73	11.33	52.55
- 150. + 75.	< 2.40	9.4	80.70	50.9	1.19	7.71	4.12	61.87	20.46
	> 2.40	90.6	8.05	49.1	11.51	7.44	66.31	8.87	47.24
	TOTAL	100.0(	14.86)	100.0	12.70	15.15	70.43	11.97	67.70
TOTALS FOR ABOVE SIZE FRACTIONS	< 2.40	5.8(	61.87)	30.2					
	> 2.40	94.2(	8.87)	69.8					
OVERALL TOTALS..	SANDS	70.4(	11.97)	67.7					
	SLIMES	29.6	13.60	32.3					
	TOTAL	100.0(	12.45)	100.0					

CALCULATED HEAD ASSAY= 12.45 %

PHOTOMICROGRAPHS

Photomicrographs of typical textures of graphite in the <2.4 sp.gr. products are shown in Figs. 1-16. One photomicrograph of each size fraction is given. (+850 μm, -850 + 425 μm, -425 + 150 μm, -150 + 75 μm). Graphite is the light flaky mineral. Non-opaque gangue is mainly quartz (grey, smooth polish) and clay (grey, rough polish).

TABLE 5: LIBERATION/LOCKING CHARACTERISTICS OF GRAPHITE IN THE -850 + 75 µm <2.4 SP.GR. PRODUCTS OF SAMPLES A, B, C AND D

Sample	Size Fraction (µm)	Vol. % Graphite in Particle			
		100	100-95	95-85	<85
A	+ 850	-	-	-	100
	-850 + 425	5	10	20	65
	-425 + 150	20	30	15	35
	-150 + 75	40	25	15	20
B	+ 850	-	-	<5	>95
	-850 + 425	5	15	15	65
	-425 + 150	15	30	20	35
	-150 + 75	35	25	15	25
C	+ 850	-	-	-	100
	-850 + 425	<1	5	10	85
	-425 + 150	10	30	15	45
	-150 + 75	30	30	15	25
D	+ 850	-	-	-	100
	-850 + 425	-	2	8	90
	-425 + 150	15	15	15	55
	-150 + 75	20	35	10	35

TABLE 6: OVERALL LIBERATION/LOCKING OF GRAPHITE IN THE +75 μm SIZE FRACTIONS

Sample	Size Fraction (μm)	Carbon Assay of <2.4 Sp.Gr. Product[3]	Carbon Distribution (%) in Size Fraction							
			<2.4 Sp.Gr. Product						>2.4 Sp.Gr. Prod.	
			Volume % Graphite in Particle					Total[3]	Total[4]	Total
			100[1]	100-95	95-85	(100-85)[2]	<85			
A	+ 850	28.8	-	-	-	(-)	64	64	36	100
	-850 + 425	73.3	2	3	7	(12)	21	33	67	100
	-425 + 150	84.7	13	20	10	(43)	23	67	33	100
	-150 + 75	89.7	32	20	12	(63)	16	79	21	100
B	+ 850	26.4	-	-	-	(-)	12	12	88	100
	-850 + 425	71.4	-	1	1	(2)	4	6	94	100
	-425 + 150	86.0	5	11	7	(23)	12	35	65	100
	-150 + 75	84.6	18	13	8	(38)	13	50	50	100
C	+ 850	33.4	-	-	-	(-)	46	46	54	100
	-850 + 425	63.6	-	1	3	(4)	24	28	72	100
	-425 + 150	81.4	6	17	9	(32)	26	57	43	100
	-150 + 75	82.6	22	22	11	(55)	18	73	27	100
D	+ 850	32.4	-	-	-	(-)	21	21	79	100
	-850 + 425	62.7	-	-	1	(1)	10	12	88	100
	-425 + 150	78.9	5	5	5	(16)	19	35	65	100
	-150 + 75	80.7	10	18	5	(33)	18	51	49	100

(1) Completely liberated graphite (as seen in polished section).

(2) Graphite in particles containing 85-100% graphite (0-15% gangue).

(3) Data from Tables 1-4.

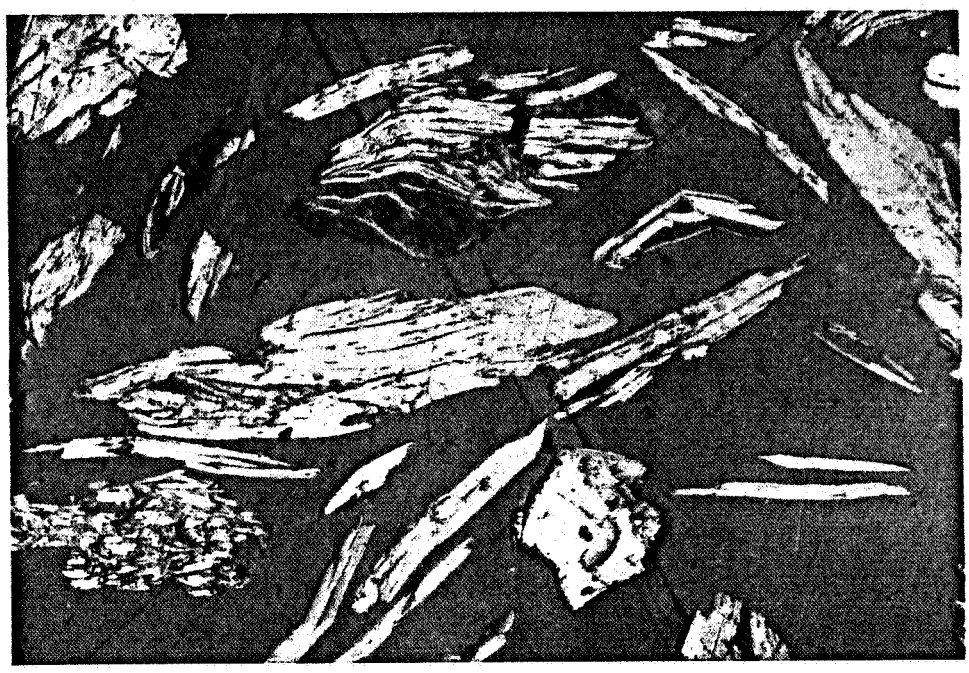
(4) Data from Tables 1-4, graphite in these products is locked with gangue.

500 µm

FIG. 1: Sample A, +850 µm <2.4 sp.gr.
Sub-parallel orientation of graphite flakes separated by bands of non-opaque gangue. ×5, 10

500 µm

FIG. 2: Sample A, -850 µm + 425 µm, <2.4 sp.gr.
Graphite with minor interstitial quartz (smooth polish non-opaque grains) and clay (rough polish non-opaque grains).
×5, 6

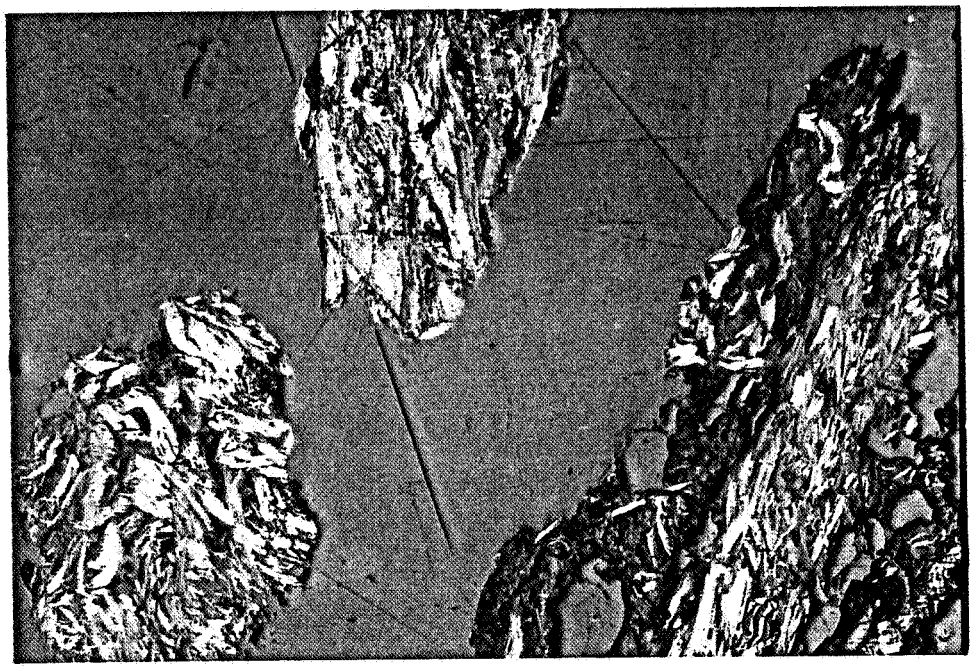


200 µm

FIG. 3: Sample A, -425 µm + 150 µm, <2.4 sp.gr.
Elongated and equant particles.
×10, 4

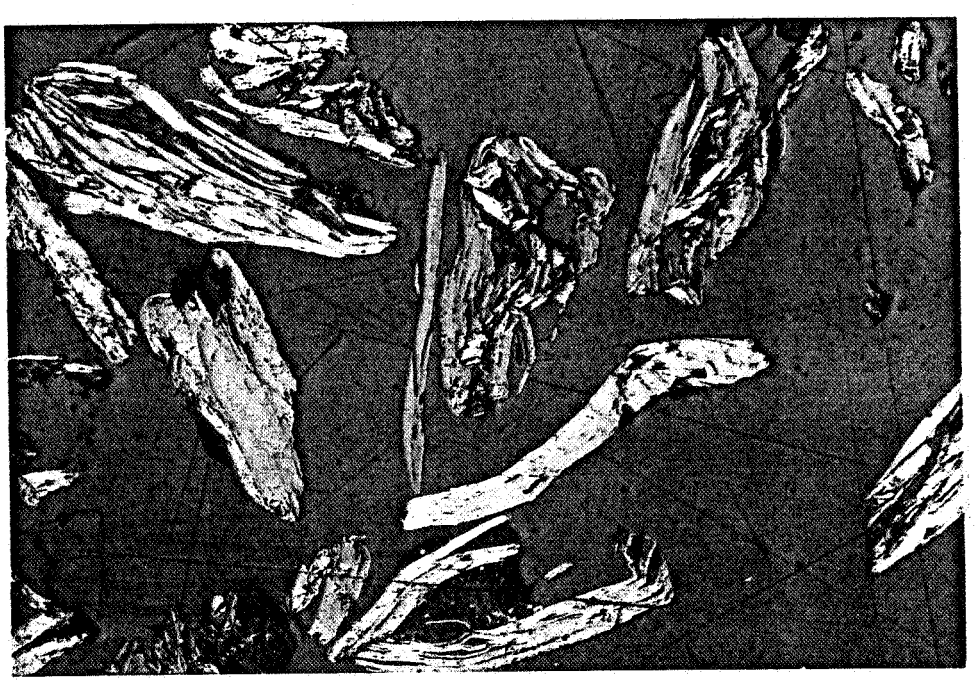
100 µm

FIG. 4: Sample A, -150 µm + 75 µm, <2.4 sp.gr.
Graphite flakes, some with thin strips of interstitial fine-grained non-opaque gangue.
×20, 2



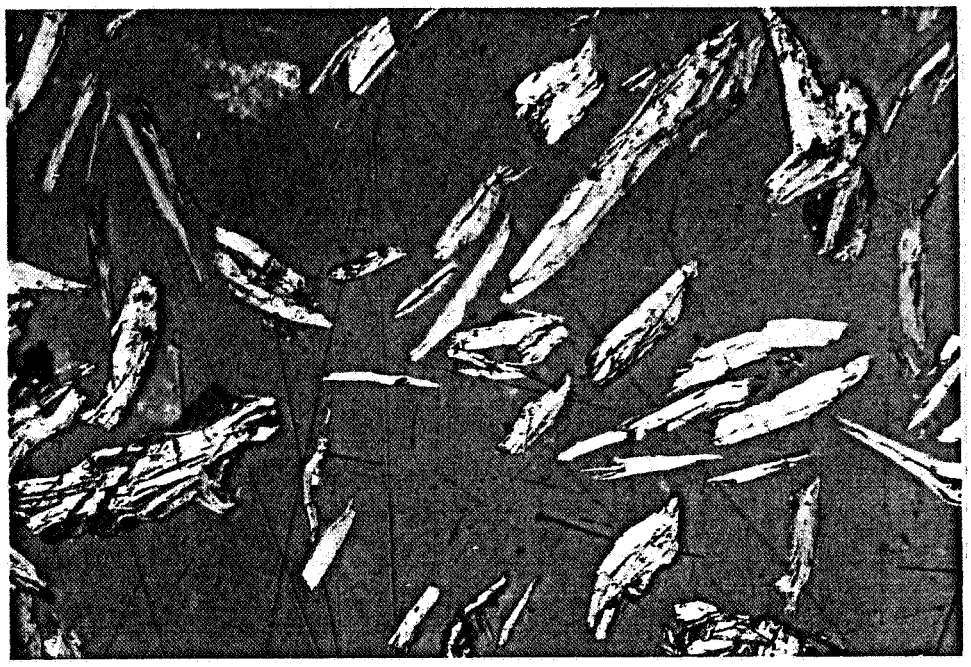
500 µm

FIG. 5: Sample B, +850 µm <2.4 sp.gr.
Sub-parallel and randomly oriented graphite flakes in equant particles with non-opaque gangue.
×5, 17



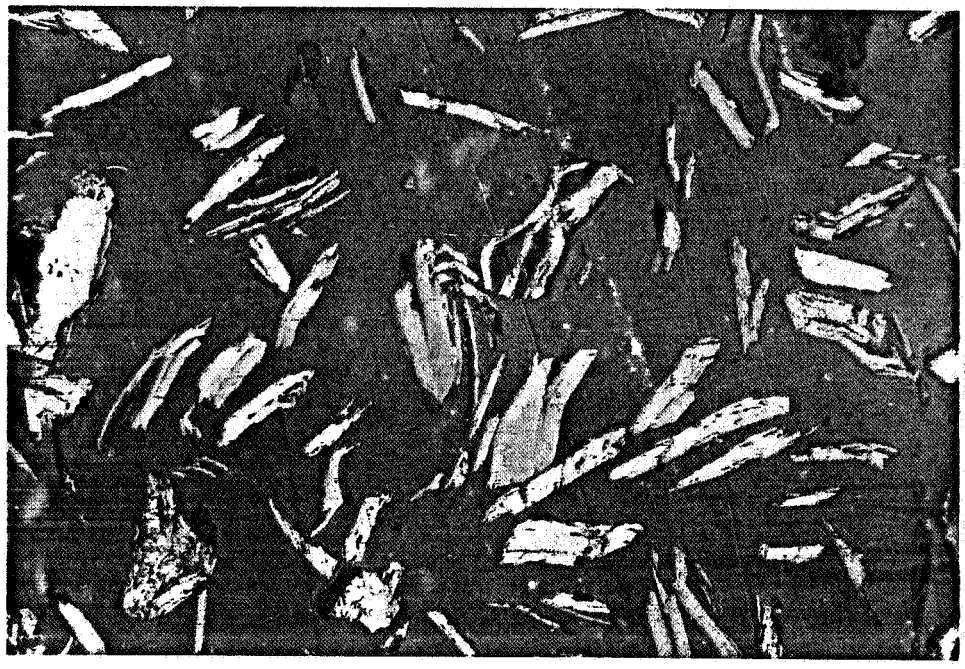
500 µm

FIG. 6: Sample B, -850 µm + 425 µm, ≤2.4 sp.gr.
Graphite flakes, generally intergrown with non-opaque gangue. Note smaller flake size in composite particles.
×5, 16



500 µm

FIG. 7: Sample B, -425 µm + 150 µm, <2.4 sp.gr.
Graphite flakes.
×5, 14



200 µm

FIG. 8: Sample B, -150 µm + 75 µm, <2.4 sp.gr.
Graphite flakes.
×10, 12

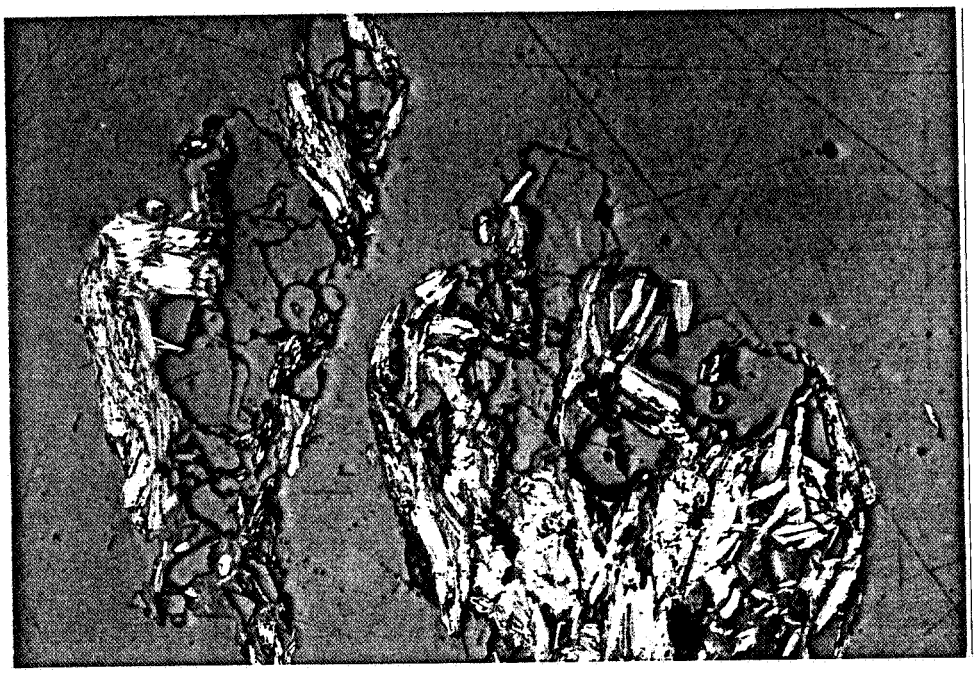


FIG. 9: Sample C, +850 µm <2.4 sp.gr.
Sub-parallel graphite flakes. Separated by quartz (equant crystals, smooth polish) and clay (rough polish).
×5, 24

FIG. 10: Sample C, -850 µm + 425 µm, <2.4 sp.gr.
Equant particles containing masses of sub-parallel graphite flakes intergrown with quartz and clay.
×5, 22

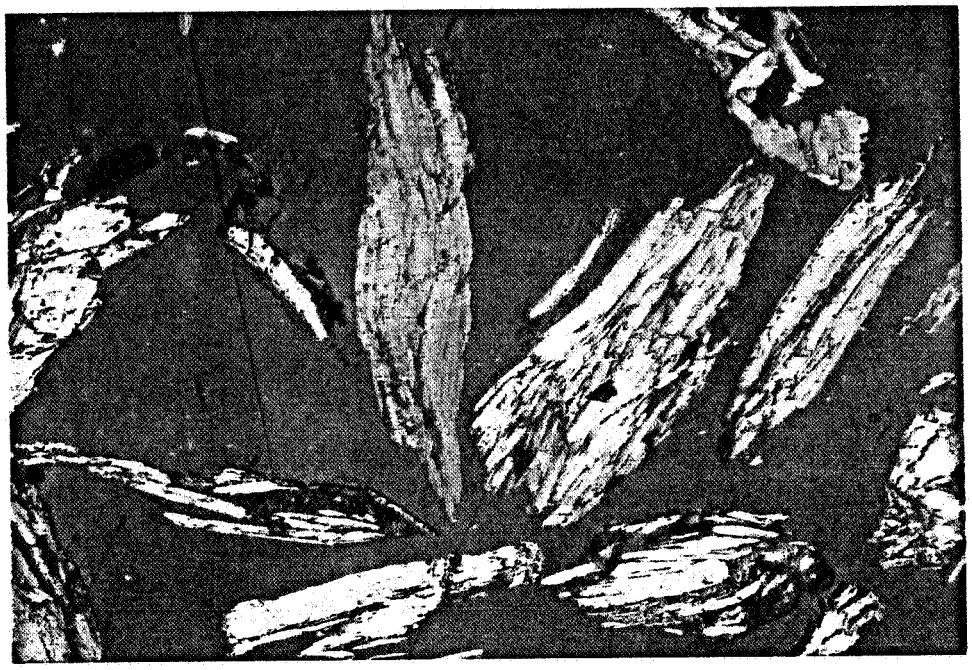
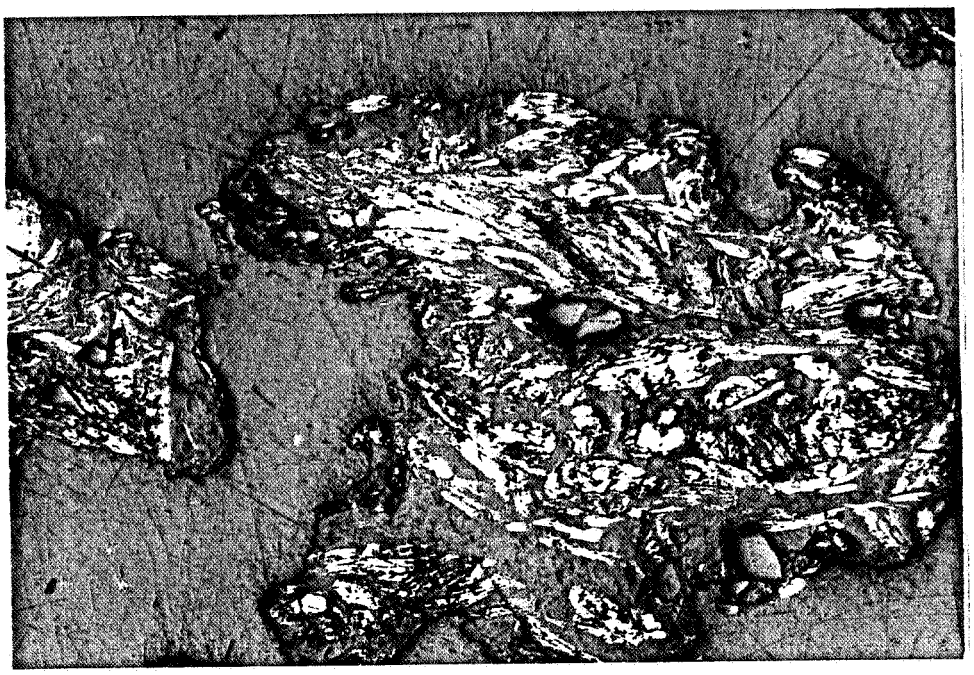


FIG. 11: Sample C, -425 µm + 150 µm, <2.4 sp.gr.
Graphite flakes. Note the fracturing of some flakes into segments.
×10, 20

FIG. 12: Sample C, -150 µm + 75 µm, <2.4 sp.gr.
Graphite flakes with interstitial thin strips of fine-grained non-opaque gangue.
×20, 19



500 µm

FIG. 13: Sample D, +850 µm <2.4 sp.gr.
Graphite flakes in a composite particle with clay and quartz (equant grains, smooth polish).
×5, 33

500 µm

FIG. 14: Sample D, -850 µm + 425 µm, <2.4 sp.gr.
Equant particles containing graphite flakes in sub-parallel to random orientations with interstitial quartz/clay
×5, 35

200 µm

FIG. 15: Sample D, -425 µm + 150 µm, <2.4 sp.gr.
Graphite flakes with interstitial non-opaque gangue.
×10, 30

100 µm

FIG. 16: Sample D, -150 µm + 75 µm, <2.4 sp.gr.
Graphite with attachments of non-opaque gangue.
×20, 26

ANNEX 3

Reports 85/171169 and 85/172474 by Warman International Ltd on Preliminary Testing of Kookaburra Gully Graphite Ore

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85/578

RESEARCH & DEVELOPMENT DIVISION REPORT

Report 85/171169

Preliminary Metallurgical Testing

of

Kookaburra Gully Graphite Ore

for

Pancontinental Mining Limited

S.F. Rayner

March 12, 1985

CONTENTS

SUMMARY

Some 230 kg of 20% grade graphite ore from the Kookaburra Gully prospect in South Australia has been processed in the laboratory with the objectives of;

a) preparing 10 kg of plus 150 μm flake size graphite grading better than 90%

b) developing a formative concentration process to treat the ore.

On the surface of it the test objective was met with 8-9 kg of product prepared from 230 kg of ore at 92% graphite grade. This represented just under 20% graphite recovery with the bulk of the graphite reporting to a fine grade concentrate of greater than 80% carbon. The rougher tailings typically assayed 1.5% graphite.

Concentration techniques were a combination of size classification, flotation and Wilfley tabling with the plus 150 μm fraction being treated separately to the minus fraction. The products were assessed on a size basis which revealed some 70% of the plus 150 μm premium product to be less than 150 μm, continued breakdown apparently occurring during processing. Speculation into the nature of this breakdown leans towards separation of interleaved graphite flakes of a larger screen size to finer individual grain sizes.

This final observation must severely effect the viability of the prospect and should be resolved beyond the speculative stage.

1. INTRODUCTION

Following on from a preliminary mineralogical examination of Kookaburra Gully graphite ore samples by Amdel, Warman were asked to carry out a metallurgical test program with the objective of producing 10 kg of premium grade (90% carbon) graphite in the plus 150 μm flake size. The 10 kg was intended for use as sellers samples with the processing data being used to formulate a conceptual mill treatment method.

The Amdel work had established the gangue constituents to be mainly quartz, kaolinite and muscovite with accessory to trace dolomite, calcite, feldspar, hematite, goethite and halite. Flake size tended to be predominantly in the fine (minus 150 μm) range and there was doubt expressed about the ability to produce a high grade product.

A review of the available reference data on treating graphitic ore indicated most success via flotation and gravity concentration techniques. After discussion with Pancontinental it was agreed that the above methods would form the basis of testing, not losing the objective of working mainly on the plus 150 μm material. A preliminary series of small-scale tests was proposed and if successful graduating to treating all of the 250 kg of ore supplied.

2. SAMPLE TESTED

Two samples A and C from the bulk sampling of trench 10100N were supplied for testing. Being readily broken up each was reduced by jaw crushing to nominally minus 6 mm, blended and a 5 kg head sample cut out for analysis and reference purposes as shown in Figure 1. Weights and assays were;

sample	kg	% graphitic carbon
A	200	22.8
C	50	18.5

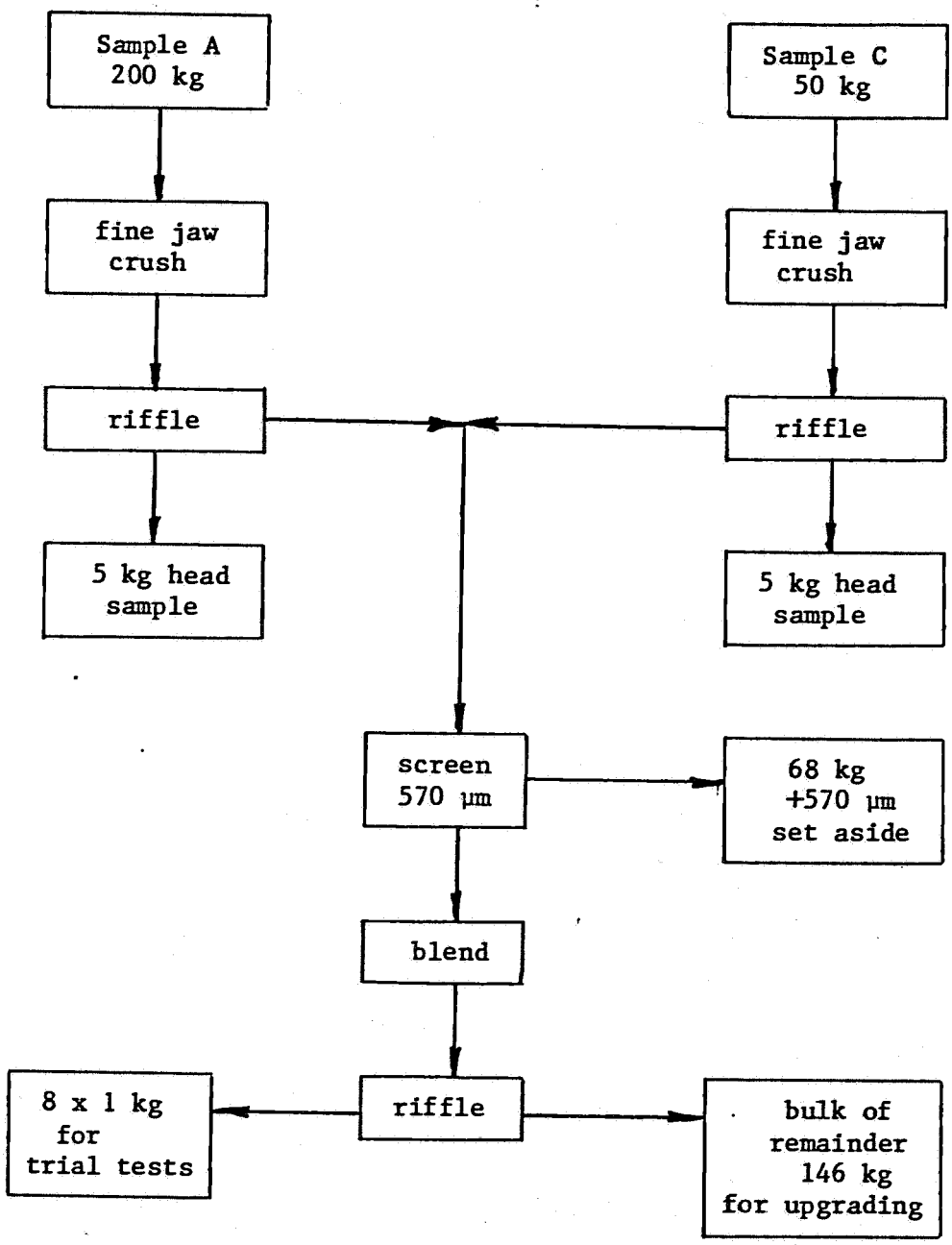
After combining to form a 240 kg composite the sample was screened at 570 µm with additional breakdown and liberation of graphite flake occurring by lightly pushing the oversize through the screen, i.e. by putting a little work into the screening. The oversize looked to be reasonably competent with graphite flakes embedded in a gangue matrix. If further crushed one could imagine producing predominantly unliberated graphite unless going to a fine crushed size and a decision was made to omit the oversize from further work at this stage to give every chance of success. Assays indicated the following grades and distribution.

fraction (µm)	weight		% graphitic carbon	dist % carbon
	kg	%		
+570	68	29.6	18.0	24
-570	162	70.4	23.8	76
total	230	100	(21.8)	100

From the -570 µm bulk, 8 x 1 kg working samples were split out for the preliminary tests.

FIGURE 1

Division of sample for test



3. PRELIMINARY TESTS

3.1 Conceptual Approach

In order to arrive at a logically developed treatment scheme and in light of our own inexperience with graphitic ore deposits, it was decided to utilise flotation in the first instance to treat the bulk of the ore. This would be followed by gravity treatment of the reduced quantity of float concentrate, via a Wilfley table if necessary, to make grade. If grade could not be produced it was then proposed to examine chemical treatments as a final upgrading. Techniques proposed were;

a) a mild acid leach to dissolve carbonates

b) a hot alkaline pressure leach to dissolve siliceous impurities.

3.2 Float 1 - prepared minus 570 µm ore

Little was known of the flotation reagent system required, although in one reference it was deduced that the organic tendency of the graphite could be relatively successfully exploited by use of a light organic (kerosene) and frother system. Shellsol 2046, a commercial organic, was selected in the first instance in combination with MIBC frother and applied to 1 kg of minus 570 µm composite feed at 25% solids in a Wemco laboratory float cell using induced air flotation. The response as shown in Table 1 was at first slow but improved when the kerosene dose built up and the frother changed for a stronger one. Slimes interfered initially floating with the concentrate while fine graphite tended to float first. The final result however was a promising 97% graphite recovery at 50% grade with tailings assaying 1.75% carbon.

Three gangue depressants were introduced into cleaner stages as shown in Table 1 with sodium silicate and carboxy methyl cellulose equally successful giving 70^{+}% grade graphite while guar gum depressed graphite and gangue.

0074

TABLE 1

Flotation trial on 1 kg of -570 µm ore

ROUGHER FLOAT - stage addition of Shellsol 2046 and frother

CONDITIONS	COMMENTS
stage 1 : 0.2 kg/t Shellsol 0.15 kg/t MIBC condition 2 minutes float 1 minute	A fine bubbled yet voluminous and persistent froth was obtained. Graphite in the concentrate represented only a small proportion of the total graphite and appeared to have carried over fine silicates. The tailing graphite was coarser and contained multilayer flake. Remedy? more kerosene.
stage 2 : 0.2 kg/t Shellsol 0.10 kg/t MIBC condition 2 minutes float 1 minute	Concentrate after desliming consisted of fine graphite plus quartz and composites while the tailings were still high in coarse graphite. Action → try stronger frother, i.e. Teric 410.
stage 3 : 0.05 kg/t Teric float 10 minutes	A slow but persistent float resulted with a better weight percent of graphite floating including coarse graphite. Still free graphite in tails.
stage 4 : 0.4 kg/t Shellsol condition 4 minutes float 5 minutes	Much better looking, heavily laden froth, almost barren after 5 minutes.
stage 5 : 0.2 kg/t Shellsol 0.1 kg/t Teric float 5 minutes	Scavenger yet high grade float concentrate with coarse graphite flakes.

CLEANER FLOAT - combined rougher concentrate was filtered and divided into three portions to try sodium silicate, carboxy methyl cellulose (CMC) and guar gum as gangue depressants.

sodium silicate cleaner : 400 g/t N40 grade ICI silicate
condition 2 minutes
Shellsol 0.2 kg/t
condition 3 minutes
Teric 0.01 kg/t

carboxy methyl cellulose : 500 g/t Tall Bennett CMC
float as above

Guar Gum : 500 g/t technical grade guar ex Tall Bennett
float as above

NOTE no concentrate taken as guar depressed all and may have been added excessively.

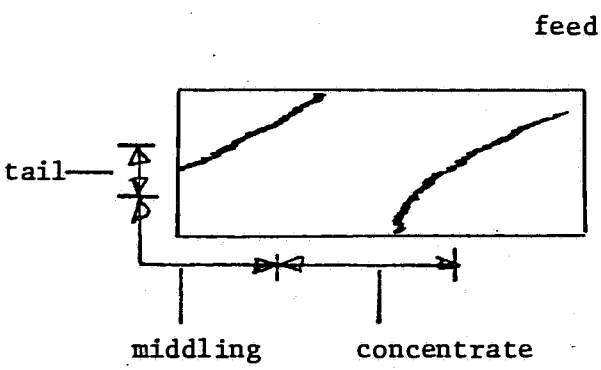
fraction	weight g	weight %	graphite %	graphite dist %
rougher concentrate	(511)	52.4	(49.5)	96.9
rougher tail	497	47.6	1.75	3.1
total	1045	100	(26.8)	100
sodium silicate cleaner				
cleaner concentrate	88	29.7	74.6	82.6
cleaner tail	67	22.7	16.9	14.3
total	155	52.4	(49.6)	96.9
CMC cleaner				
cleaner concentrate	78	25.1	70.4	67.1
cleaner tail	85	27.3	28.7	29.8
total	163	52.4	(48.7)	96.9
Guar cleaner				
(no response)	193	52.4	50.1	96.9

3.3 Float 2 - prescreened +150 µm feed

Based on the encouraging first result and the recognition of possible improvements if fines and slimes were removed, a second float trial was carried out concentrating on a wet screened plus 150 µm float feed. The reagent system was as for Test 1, i.e. Shellsol promoter and Teric frother. In this instance however the demand for reagents was much reduced, having removed the fines and as shown by the results in Table 2 was quite positive with 97% graphite recovery at 63% grade.

A cleaner stage introduced to further upgrade the rougher concentrate was unsuccessful, mainly because the contaminant gangue was in composite with graphite flakes and could not be preferentially depressed.

It was decided to try a gravity upgrading with the 129 grams of cleaner float concentrate fed over a quarter size Wilfley table. The division of sample on the table was the reverse of normal operation, the graphite being the low specific gravity product, i.e.,



Under the microscope the concentrate appeared as high grade graphite grading through middlings to the tail which was predominantly graphite with some free coarse flake observed. The setting of the cutter to divide concentrate, middling and tail was arbitrary, not being definitive

by observation and would require steady state operation in practice to be efficient. These comments and the success of tabling are shown in Table 2 with the concentrate grading 96% graphite at 20% recovery with the middlings going 82% graphite for another 63% recovery.

Note that to be put in true perspective the above recoveries need to be corrected for the 24% carbon distribution to the plus 570 µm reject, and the 62% reject of minus 150 µm material in preliminary screening.

TABLE 2

Flotation trial on -570 +150 µm feed

ROUGHER FLOAT	COMMENTS
stage 1 : 0.2 kg/t Shellsol 0.01 kg/t Teric condition 5 minutes float 3 minutes	heavily laden clean froth
stage 2 : 0.1 kg/t Shellsol condition 1 minute float 2 minutes	flotation apparently complete
CLEANER FLOAT	
0.2 kg/t CMC condition 2 minutes 0.2 kg/t Shellsol	all the rougher concentrate floated again leaving very little cleaner tail.

TABLING - under the microscope large gangue grains many of them composite with graphite were observed so it was decided to try tabling to finally upgrade

fraction	weight		graphite	
	g	%	%	dist %
rougher concentrate	179	44.3	(63.0)	97
rougher tail	225	55.7	1.60	3
total	404	100	(28.8)	100
cleaner concentrate	129	35.9	(73.2)	91
cleaner tail	30	8.4	19.3	6
total	159	44.3	(63.0)	97
table tail	28	7.8	30.9	8.4
table middling	79	22.0	81.9	62.6
table concentrate	22	6.1	96.1	20.3
total	129	35.9	(73.2)	91.3

3.4 Float 3 - prescreened -150 µm feed

Prescreening to prepare sample for float 2 had rejected -150 µm fines as shown below;

wet screen size µm	weight g	weight %	graphite %	graphite dist %
+150	404	38	28.8	22.7
-150	660	62	27.1	77.3
total	1064	100	(27.7)	100

Following the success in upgrading the plus 150 µm it was logical to proceed with the minus 150 µm to see if similar success could be achieved. Flotation as the first step required a lot more Shellsol before flotation commenced, apparently in deference to the slimes content which also collected in the froth giving a low grade concentrate with fine graphite initially. The coarser graphite did not float until the slimes had almost gone. The natural progression was therefore to a cleaner float where we employed sodium silicate as a gangue and slimes depressant. The results shown in Table 3 again reflected the observations with the rougher concentrate going 57% grade for 95% recovery and the cleaner concentrate going 71% graphite for 57% recovery, although this latter figure could probably be improved. We were tentative in floating too much for fear of reducing the grade. Tabling was not attempted as the product appeared too fine, and in insufficient quantity to set the table.

TABLE 3

Float trial on -150 μm feed

ROUGHER FLOAT	COMMENTS
stage 1 : 0.4 kg/t Shellsol 0.01 kg/t Teric condition 3 minutes float 2 minutes	low grade but persistent froth
stage 2 : 0.2 kg/t Shellsol condition 2 minutes float 1 minute	similar response to above.
stage 3 : 0.4 kg/t Shellsol condition 1 minute float 2 minutes	relatively good grade graphite still floating, obviously considerable Shellsol still required
stage 4 & 5 : as for stage 3.	
CLEANER FLOAT	
500 g/t sodium silicate frother 0.005 kg/t float 10 minutes	flotation was arbitrarily stopped at 10 minutes

fraction	weight		graphite	
	g	%	%	dist %
rougher concentrate	(300)	45.4	(56.8)	95
rougher tail	360	54.6	2.45	5
total	660	100	(27.1)	100
cleaner concentrate	141	21.6	71.4	56.9
cleaner tail	155	23.8	43.5	38.1
total	296	45.4	(56.8)	95.0

3.5 Summation of Trial Tests

An encouraging report was given at this stage of testing as (1) we were making grade despite initial pessimism and (2) we had achieved good results virtually on our first attempt.

The following points had been made;

* flotation followed by tabling as a final concentrate dressing step appeared a viable and relatively straight forward process route

* a light organic kerosene (Shellsol 2046) as promoter in conjunction with a frother of intermediate strength (between MIBC and Teric 410) is required

* it was obvious that desliming would benefit both product grade and reagent consumption and as plus 150 µm flake was premium product this fraction should be treated separately

* the float tends to be slow and more responsive to stage additions

* flotation cleaning of the plus 150 µm rougher float concentrate was not very effective

* flotation cleaning of the minus 150 µm rougher concentrate was more effective if a gangue depressant such as sodium silicate were introduced.

A calculation as shown in Table 4 below was made to try and relate the grade and recovery of plus 150 µm graphite back to the feed. For evaluative purposes it was assumed that graphite in the untreated plus 570 µm fraction would not yield any product. The results indicate 11% recovery of premium product at 96% grade and a further 34% recovery at 82% grade. By combining these fractions and adjusting the Wilfley table cut points, a prediction of 20% recovery at better than 90% grade would appear practicable.

TABLE 4

Summation of trial tests

fraction	weight kg	weight %	graphite %	graphite dist %
+570 µm	68	27.2	18.0	22.0
-570 µm	182	72.8	23.8	78.0
total	350	100	(22.2)	100
-570 +150 µm				
table tail		2.9	30.9	4.4
table middling		8.4	81.9	33.8
table concentrate		2.3	96.1	10.8
float cleaner tail		3.2	19.3	3.0
float rougher conc		21.2	1.60	1.7
total		38.0	(28.8)	(53.7)
-150 µm				
float cleaner conc		7.5	71.4	13.8
float cleaner tail		8.3	43.5	9.3
float rougher tail		19.0	2.45	1.2
total		34.8	(27.1)	(24.3)

4. PROCESSING TO PREPARE 10 kg PRODUCT

4.1 Sample Preparation

Based on the lessons of the trial tests it was decided to prescreen at 150 µm and treat only the plus 150 µm fraction to achieve the test objective of 10 kg of plus 150 µm flake at 90^{+}% graphitic carbon grade. Only the minus 570 µm crushed product was treated so that together with the prescreening to remove fines the major percentage of graphite (63%) was rejected before starting concentration. All these distributions are shown in Table 5. The screening at 150 µm was carried out first dry and then wet to remove nearsize material, adhering flakes and slimes. Surprisingly the second wet screening removed nearly as much weight as the dry screening and in retrospect it seems that a good percentage of this may have been due to separation of foliated flakes which when interleaved appeared as coarse flake, but when liberated were individually fine.

4.2 Processing of plus 150 µm

The 67 kg of plus 150 µm material was treated in six batch floats in a Warman 45 cm continuous flow cell converted to a batch unit. The only reagents were Shellsol and Teric frother added in doses as shown in the schedule below.

flotation fraction	Shellsol kg/t	Teric kg/t	condition mins	float mins
rougher conc	0.3	0.1	5	5
	0.3	0.02	2	3
	0.3	0.04	1	5
scavenger conc	0.3	0.04	1	3

The response was good with fine graphite floating first grading to coarser graphite, finally grading into composites in the scavenger as

observed under the microscope. All of the rougher stages were combined although grab samples from each stage were assayed as follows:

rougher float stage	1	79.1%	graphite
"	2	77.9%	"
"	3	70.7%	"

This, compared to the scavenger concentrate at 39% graphite, reflects the comments above. The scavenger concentrate was obviously a recycle product and was set aside for analysis. Tailings at 1.5% graphite were considered excellent at the treatment size, the graphite occurring only as composites.

The rougher float concentrate was next fed over the quarter size Wilfley table with two concentrate fractions taken, a middling and tailing. Set points of the cutters were arbitrary but roughly the splits corresponded to the following:

concentrate 1 - fine high grade graphite plus all the entrapped slimes from flotation.

concentrate 2 - a coarser high grade graphite product possibly including fine free quartz which could possibly be removed by fine screening or hydraulic classification later.

middlings - a fraction of indeterminate nature containing valuable high grade coarse graphite flakes mixed with graphite flakes showing adhering silicate films, some fine silicates and 50/50 composite grains.

tailings - mostly composites equivalent in appearance to the flotation scavenger concentrate needing remilling to liberate graphite before further concentration could be achieved.

Dry weights and analysis of the products are shown in Table 5 and on the surface of it indicate that by combining the table concentrate fraction we had achieved our test objective of 10 kg of product at 88% graphite grade or if only concentrate 2 were used, 8.2 kg of product at 92% graphite grade.

TABLE 5

Results of processing 230 kg ore

treatment fraction	weight		graphite		
	kg	%	%C	units	dist %
crushed +570 µm	68	29.6	18.0	5.328	24.4
crushed -570 µm	162	70.4	23.8	16.474	75.6
total	230	100	(21.8)	21.802	100
dry screened -150 µm	41	19.8	(21.9)	4.329	26.3
wet screened -150 µm	(38)	18.3	(22.9)	4.191	12.8
wet screened +150 µm	67	32.3	(24.6)	7.954	36.5
total	146	70.4	23.8	16.474	75.6
PLUS 150 MICRON					
flotation scavenger tail	43.4	21.1	1.48	0.312	1.4
flotation scavenger conc	3.1	1.5	38.9	0.584	2.7
table tail	7.1	3.5	46.0	1.610	7.4
table middling	2.7	1.3	86.5	1.124	5.1
table concentrate 1	1.8	0.9	72.3	0.651	3.0
table concentrate 2	8.2	4.0	91.8	3.672	16.9
total	66.3	32.3	(24.6)	7.954	36.5
MINUS 150 MICRON (WET)					
-75 µm slimes	15.68	11.9	19.04	2.266	6.9
+75 µm fines	8.37	6.4	(30.10)	1.926	5.9
total	24.05	18.3	(22.9)	4.192	12.8
FLOTATION OF +75 µm FINES					
cleaner concentrate	1.07	1.7	80.82	1.374	3.6
cleaner tail	0.73	1.1	63.66	0.700	1.9
rougher tail	2.35	3.6	4.14	0.149	0.4
total	4.15	6.4	(34.7)	2.223	5.9
TABLING OF +75 µm FINES					
table concentrate 1	1.27	2.3	30.36	0.698	2.5
table concentrate 2	0.27	0.5	62.64	0.313	1.1
table middling	0.63	1.1	43.20	0.475	1.7
table tail	1.42	2.5	5.97	0.149	5.3
total	3.59	6.4	(25.5)	1.635	5.9

4.3 Size Analysis of plus 150 µm Products

Based on the observations of fine graphite segregation during tabling and fine silicate in the table concentrate 2 fraction, we were encouraged to assay the products by screen size fractions. This revealed a rather disturbing situation shown in Table 6 of excess fine graphite flake in the high grade product fractions and in effect making them a less desirable product.

A review of the physical observations and analysis for each fraction listed is presented to understand the picture;

Table concentrate 1 - this fraction screened 90% minus 150 µm and contained fine high grade graphite plus all the slimes, the latter severely affecting the overall grade achieved. If deslimed the total fraction would probably assay close to 90%. Desliming would be difficult by any means because of the low specific gravity and flake nature of the graphite with elution being the most likely to succeed. Despite these comments the plus 150 µm fractions obtained by wet screening would produce 0.16 kg at 92.6% grade from the work.

Table concentrate 2 - this was the most disappointing product in terms of size grading with 63% finer than 150 µm so that all that could be recovered for a saleable product sample at plus 150 µm would be 1.96 kg at 95.9% graphite.

Table middlings - the high grade coarse graphite is evident in this sample although the grade rapidly reduces to around 86% due to composites, i.e. graphite flakes with gangue attachment. Combining the plus 150 µm fractions would give 1.38 kg at 84.1% graphite.

Combining the above fractions would give only 3.5 kg of premium plus 150 µm product at 91% graphite grade.

Table tail and scavenger float concentrate - both these fractions went about 40% graphite and as mentioned previously would require regrinding to liberate graphite.

TABLE 6

Screen assay of treatment products (+150 μm)

screen aperture μm	weight % retained	% passing	graphite %	dist %
	TABLE CONCENTRATE 1			
425	trace	100.0		
300	0.4	99.6	95.72	0.5
212	2.6	97.0	86.88	3.1
150	6.8	90.2	94.42	8.9
-150	90.2		70.06	87.5
total	100.0		(72.3)	100.0
	TABLE CONCENTRATE 2			
425	0.1	99.9		
300	2.6	97.3	97.76	2.8
212	10.8	86.5	97.32	11.4
150	23.7	62.8	97.24	25.1
-150	62.8		88.70	60.7
total	100.0		(91.8)	100.0
	TABLE MIDDLINGS			
425	0.4	99.6	94.86	0.4
300	6.9	92.7	88.56	7.0
212	16.6	76.1	82.16	15.7
150	27.1	49.0	86.82	27.1
-150	49.0		87.42	49.8
total	100.0		(86.5)	100.0
	TABLE TAILS			
425	1.1	98.9	37.96	0.9
300	11.4	87.5	43.38	10.8
212	23.6	63.9	42.34	21.7
150	28.2	35.7	46.74	28.7
-150	35.7		48.92	37.9
total	100.0		(46.0)	100.0
	FLOTATION SCAVENGER CONCENTRATE			
425	4.3	95.7	41.92	4.6
300	22.4	73.3	40.64	23.4
212	30.0	43.3	36.34	28.0
150	25.4	17.9	35.02	22.8
-150	17.9		46.06	21.2
total	100.0		(38.9)	100.0

4.4 Processing of minus 150 μm

Treating the minus 150 μm fraction was beyond the work brief at this stage, however having made a quantity of wet screened product it was decided to make an attempt at upgrading this while leaving the dry screened material aside.

As shown in Table 5 there was some 38 kg of this material which on our first attempt at flotation was completely unsuccessful as the high proportion of fines adsorbed reagents and then floated as a slime bubble coating. There was a lesson to be learnt from this result, i.e. desliming would be a prerequisite to further treatment. For convenience we performed this function on a screen at 75 μm rejecting about 60% of the weight as shown in Table 5. The -150 +75 μm fraction was then divided into two with one fraction put directly over the Wilfley table and the other floated for comparison.

The results also shown in Table 5 indicate flotation to be a more successful operation making a product of 65-80% graphite. No attempt was made to further upgrade this on the table but it could be successful. Direct tabling suffered from the light specific gravity, flake nature and fine size of the graphite, although 60% grade was obtained. The concentrate 1 fraction (30% graphite) included all the fines and if deslimed would probably exceed 60% graphite in grade.

5. CONCLUSION

The testwork has shown that the Kookaburra Gully graphite ore is readily amenable to concentration by unit processes incorporating size classification, flotation and gravity concentration.

Premium product plus 150 μm flake graphite can be produced at grades in excess of 90% without having to revert to chemical leaching. Fine graphite can also be made at grades in excess of 80%.

The real area of concern exposed was the apparent continued breakdown of the plus 150 μm material during processing so that the final recovery of premium product was only 6-10% of the feed graphite. The source of the breakdown was either mechanical in the float cell and pumping (peristaltic pump) to the table or liberation of inter-leaved or foliated flakes from an apparent large flake size to individual fine flake sizes. We have no proof but feel the latter situation may exist.

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85/903

RESEARCH & DEVELOPMENT DIVISION REPORT

Report 85/172474

Further Testing of Kookaburra Gully Graphite Ore

Addendum to Report 85/171169

for

Pancontinental Mining Limited

S.F. Rayner

April 11, 1985

C O N T E N T S

SUMMARY

Processing of a crushed plus 570 micron fraction of graphite ore originating from testwork described in Warman Report 85/171169 has indicated that the 30% by weight fraction at 18% graphite can be upgraded, however

* concentrate grades produced tended to be lower than those previously obtained

* the best fraction obtained assayed 89% graphite for a recovery of less than 5% by weight, i.e. an improvement of only 1.5% recovery overall

* after the above grade, other concentrate fractions were 84% and 70% graphite

* the lower grades are consistent with unliberated gangue remaining with the graphite flake, a situation which could be improved with a ball mill grind rather than our laboratory simulation.

Additional fractions further assessed from the previous report were;

a) plus 150 micron table middlings from which 90% was recovered at 89% graphite grade by retabling

b) plus 150 micron concentrate 1 fraction from which 67% was recovered at a grade of 89% graphite by screening at 75 microns.

1. INTRODUCTION

The previous report (85/171169) demonstrated that alhtough acceptable grades of graphite could be produced from the ore the recovery of premium grade plus 150 µm graphite was low, leaving a situation that was far from decisive in favour of a mineable deposit. The fineness of the final graphite flake deposit compared to the apparent good initial recovery was attributed to further parting of composite flakes to their natural size but which when composited made a larger flake.

Two areas were targeted by Pancontinental for further examination. The first was to seek more information on buyers specifications for the size gradings of premium produce and the second was to look at boosting the recovery of graphite from fractions not fully exploited in the first report. In particular three were isolated;

- the untreated plus 570 µm
- the plus 150 µm table middlings
- the plus 150 µm table concentrate 1.

(see Table 5 in 85/171169 for identification).

This report describes the results of the further investigation.

2. PLUS 150 MICRON TABLE MIDDLINGS

This fraction which accounted for 1.3% of the ore and assayed 86.5% graphite carbon was noted as containing 50% coarse (+150 µm) graphite with a significant amount of graphite/gangue composites lowering the grade. An attempt was made to improve this grade on 100 gram fractions submitted to a 10% hydrochloric and 10% caustic agitation respectively, the object being to weaken the bond between graphite and gangue and achieve liberation. The results when viewed under the microscope were negative but it was observed that there was a significant amount of free graphite mixed with the composite grains, i.e. the fraction was a true middling, covering the range of coarse free graphite and graphite-containing gangue. It was decided to treat it as middlings and return it to another tabling operation, a manoeuver that proved partially successful as shown in Table 1. A concentrate of 89% graphite at 90% recovery was obtained, the tails assaying 77% graphite and obviously requiring regrinding to break up the composites.

TABLE 1

Analysis of retable products from
+150 µm table middling

fraction	weight		graphite	
	kg	%	%	dist %
table conc 1	0.387	17.2	88.7	17.3
table conc 2	1.612	71.5	89.9	72.9
tails	0.255	11.3	76.7	9.8
total	2.254	100	(88.2)	100

3. PLUS 150 MICRON TABLE CONCENTRATE NO 1

This fraction, accounting for 0.9% by weight of the ore assayed 72% graphitic carbon but was heavily influenced by the slimes which gathered in this fraction as it discharged from the Wilfley table. Screen sizing had shown that only 10% of the fraction was coarser than 150 µm and these fractions were high grade.

Further processing was requested incorporating wet screening all of the sample into fractions at 150, 75 µm and desliming the minus 75 µm. The results shown below were 20% recovery (90% grade) at plus 150 µm or 52% recovery (89% grade) at plus 75 µm. The minus 75 µm fractions were low grade.

TABLE 2

screen aperture µm	weight		graphite	
	kg	%	%	dist %
150	0.279	19.3	90.3	25.1
75	0.477	33.0	88.8	42.2
-75 +slimes	0.660	45.6	49.5	32.5
slimes	0.031	2.1	83.0	0.2
total	1.446	100	(69.5)	100

4. CRUSHED PLUS 150 MICRON FRACTION

Nothing was done with this fraction in the previous investigation to exploit this 30% by weight residual from initial crushing other than to observe that it consisted of silicious residuals impregnated with graphite flakes. With the request to assess what quantity of saleable graphite it might contain the first problem was how to mill it, as the quantity of sample (≈60 kg) was insufficient for our large mill and too much for the small (4 kg) batch mills. As a compromise the sample was processed through roll crushing and attritioning, a process which was obviously only partially successful. It was decided to continue with the processing through screening, flotation and tabling, making allowance for the unliberated graphite portion in the final assessment.

After attritioning the sample was wet screened at 150 µm with the undersize being deslimed. The two fine fractions were assayed and set aside while the plus 150 µm was processed through flotation and tabling as previously established. The products were each dried, weighed and assayed at ±150 µm gradings. The table concentrate 1 fraction was deslimed before analysis as established in Section 3 and the table middling was repassed as in Section 2. The results obtained are presented in Table 3 and show that only one concentrate fraction (table conc 2) reached 89% grade for a recovery of 2.5%. If allowance is made for the still unliberated graphite, which reported to the flotation scavenger tail, it is likely that this figure would be boosted to more than 3.5%.

After the concentrate above grades obtained fell drastically as summarised below;

table	conc	3	84%	graphite	@	6%	recovery
"	"	4	70%	"	"	1.5%	"
"	"	1	70%	"	"	1.9%	"

Each concentrate was assessed individually at 150 µm as shown in Table 4 but offers little scope for improving grades based on size classification.

The conclusion reached is that the products obtained in treating the harder silicious fraction of the ore tended to give products of slightly lower grade, consistent with the concept of adhering gangue remaining attached to the graphite flake. A ball mill grind rather than our simulation may improve this situation.

TABLE 3

Results of processing 68 kg of plus 570 μm ore

treatment fraction	weight		graphite		
	kg	%	%	units	dist %
-150 μm	27.33	49.1	14.4	7.082	38.8
-150 + slimes	12.56	22.6	22.0	4.972	27.2
slimes	15.80	28.3	21.9	6.198	34.0
total	55.69	100	(18.2)	18.252	100
PLUS 150 MICRON					
float scavenger tail	19.40	34.9	3.75	1.309	7.2
float scavenger conc	1.47	2.6	16.4	0.426	2.3
float rougher conc	6.46	11.6	(46.1)	5.347	29.3
total	27.33	49.1	(14.4)	7.082	38.8
table conc 1 deslimed	0.25	0.5	70.2	0.351	1.9
table conc 1 slimes	0.11	0.2	57.5	0.115	0.6
table conc 2	1.36	2.4	88.6	2.126	11.6
table tail 1	3.19	5.7	16.7	0.952	5.2
table conc 3	0.70	1.3	83.9	1.091	6.0
table conc 4	0.25	0.4	69.9	0.280	1.5
table tail 2	0.60	1.1	39.3	0.432	2.5
total	6.46	11.6	(46.1)	5.347	29.3

TABLE 4

Evaluation of Wilfley table products

screen aperture µm	weight % retained	weight % passing	graphite %	graphite dist %
		TABLE CONCENTRATE 1		
+212	11.6	88.4	72.4	33.0
+150	20.4	68.0		
-150 + slimes	68.0		69.2	67.0
		TABLE CONCENTRATE 2		
+212	13.2	87.0	89.5	42.1
+150	28.5	58.3		
-150	58.3		88.0	57.9
		TABLE CONCENTRATE 3		
+212	48.9	51.0	84.6	77.2
+150	27.7	23.4		
-150	23.4		81.8	22.8
		TABLE CONCENTRATE 4		
+212	51.7	48.3	68.9	76.0
+150	25.4	22.9		
-150	22.9		73.2	24.0
		TABLE TAIL 1		
+212	56.8	43.2	16.6	80.0
+150	23.6	19.6		
-150	19.6		17.0	20.0
		TABLE TAIL 2		
+425	32.7	57.3		
+300	25.0	32.3	36.9	79.7
+212	15.1	17.2		
+150	12.1	15.1		
-150	15.1		52.8	20.3

G.N.
M.N.
030° MAG.
30°

LEGEND

Fence
Track

ABBREVIATIONS

gs Graphitic schist
gn Gneiss
bn Banded
Boundary of geological outcrop

PANCONTINENTAL MINING LIMITED
EXPLORATION DIVISION
PANCON

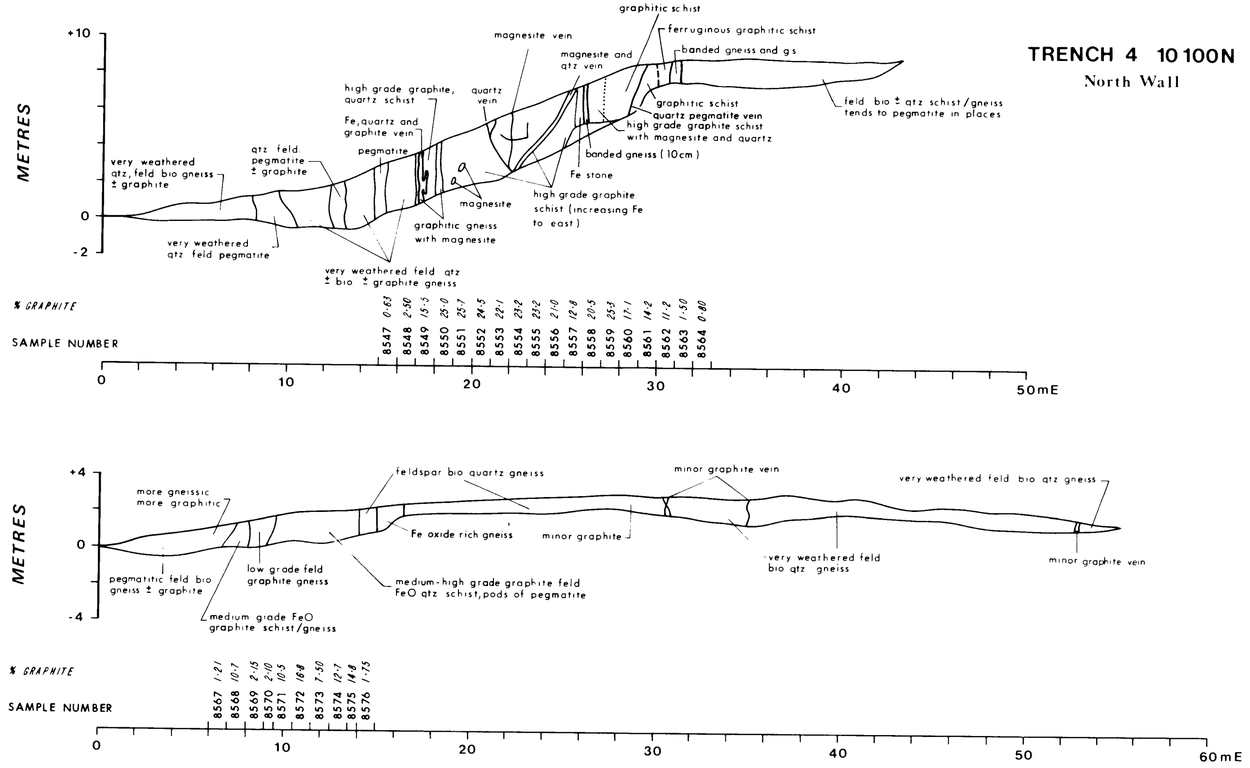
KOPPIO GRAPHITE PROJECT
E.L. 1142-SOUTH AUSTRALIA
KOOKABURRA GULLY PROSPECT

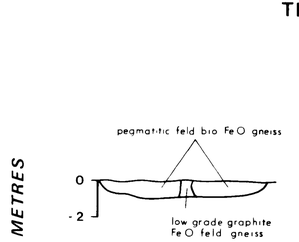
OUTCROP GEOLOGY

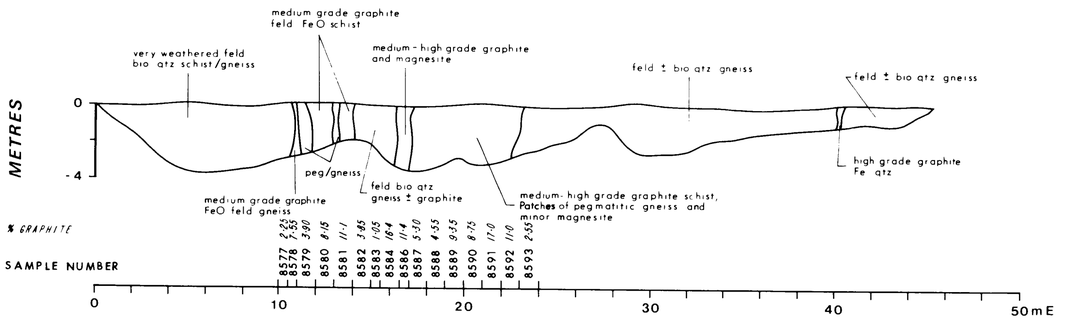
SCALE 1:1000
0 20 40 60 80 100
METRES

Compiled A.R.C.	Date MAY, 1985	Dwg. Nº 21/G/1
Report Nº 85/25	Map Ref. 5153-11	PLATE 1

5233-23







E.L. 1142, KOPPIO GRAPHITE PROJECT
South Australia
Trench Sections 3,4,5,6
KOOKABURRA GULLY

DWG. N° 21/D/5
March, 1984

0 5 10
1:200 METRES

Compiled: J P/AR.C.

5233-24 PLATE 2

Tenement: EL 1142 - Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 296 sq. km

Expenditure Commitment: $25,000

Reporting Period: May 27, 1985 to August 26, 1985

Work Completed: During the quarter, a field program of gridding, mapping, trenching and sampling was completed at the Kookaburra Gully prospect. The main objective was to more clearly define the extent, and quality of the main graphite zone.

381 metres of trenching was completed which involved the construction of 8 new trenches (trenches 8,9,10,11,12,13,14 and 15) and the extension of a pre-existing trench (trench 7). A total of 56 horizontal channel samples were collected from 4 trenches (trenches 8,9,12 and 14) which exposed signficant graphite zones. Most samples were collected at 1 metre intervals.

The trenching and sampling has indicated that graphite mineralisation of economic significance forms a zone with a strike extent of approximately 500 metres and an average width of approximately 16 metres.

The best intervals of economically significant graphite mineralisation were predectably obtained from trenches 8 and 14. In trench 8, a section measuring 10.25 metres (12.00 to 22.25m) averaged 15.72% C. Alternatively the section can be diluted by using geological cut-offs to produce an interval of 15.50 metres averaging 13.0% C. The highest result was 1 metre of 20.8% C between 13 and 14 metres. In trench 14 a section measuring 17.5m (5.00 to 22.50m) averaged 16.1% C between geological cut-off positions.

The graphite mineralisation occurs within weathered schists and gneisses which appear to form a discrete tabular body dipping steeply to the east. Geological controls are inconclusive, however the graphitic horizons are thought to represent the over-turned limbs of a tightly folded anticlinal structure which plunges to the south.

The northern surface extensions of the graphite mineralisation are probably disrupted by down faulting and the southern surface extensions are limited by either facies change or plunge effects.

The possibility of fold repetitions of the graphite horizon on the western side of the gridded area or a fold closure to the north were not substantiated by surface investigation. Trenching in this area did not reveal any additional zones of significant graphite mineralisation.

The trenching has outlined a graphite resource of approximately 770,000 tonnnes to a depth of 50 metres. A grade estimate can only be provided after sample results have been assessed.

The necessity for further evaluation work at Kookaburra Gully will depend on the economic implication of the tonnage and grade characteristics. If positive deposit potential is recognised then further metallurgical studies of the graphite ore should be undertaken prior to committing to drill testing and reserve delineations.

Expenditure:

The expenditure for the quarter totalled $24,870 being made up as follows:

Administration General	$ 4,574
Land Administration	86
Office Technical	4,678
Gridding, Surveying & Cartography	583
Geological Investigation	11,496
Drilling	186
Mining, Metallurgy & Marketing	98
	$ 24,870

Tenement: E.L. 1142, Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 296 sq. km

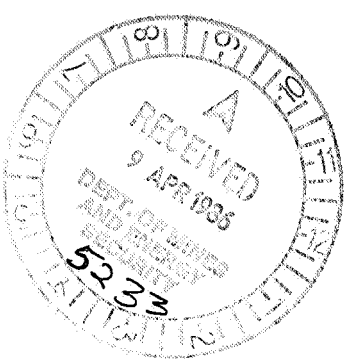
Reporting Period: August 27 to November 26, 1985

Work Completed: A field trip was made during the reporting period by a senior geologist and geophysical technician. It had been planned to run traverses over previously run EM lines at Kookaburra Gully and Koppio mine, however the Scintrex "Genie" EM system was found to be in an inoperable condition upon arrival and was returned to the owners for repairs. The opportunity was taken while in the area to inspect several other graphite mines and exposures.

Expenditure: The expenditure for the period totalled $5,781 which was made up as follows:

Administration General	$ 844
Land Administration	295
Office Technical	2,244
Gridding, Surveying & Cartography	417
Geophysical Surveys	1,101
Mining, Metallurgy & Marketing	880
	$ 5,781

Tenement:	E.L. 1142, Eyre Peninsula
Holder:	Pancontinental Mining Limited
Area:	296 sq.km
Reporting Period:	November 27, 1985, to February 26, 1986.
Work Completed:	No field work was undertaken during the reporting period. Previously trenched areas were inspected by the Land Manager to determine compensation and arrange for the restoration of the sites.
Expenditure:	The expenditure total for the quarter was $549.



Report No. 86/16

EL 1142
KOPPIO PROJECT
SOUTH AUSTRALIA

ANNUAL REPORT FOR THE PERIOD
27th May 1985 to 26th May 1986

BY J.M. GRAHAM
PANCONTINENTAL MINING LIMITED
JUNE 1986

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0104

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1.0 INTRODUCTION

During July 1985, a field program comprised of gridding, mapping, trenching and sampling was completed at the Kookaburra Gully prospect.

The primary objectives of the field program were as follows:

1. To establish the lateral extent of the main zone of graphite mineralisation by treching and to evaluate the tenor of the mineralisation by sampling.

2. To determine geological controls on the graphite mineralisation.

3. If warranted by results, to design a drilling program to test the geometry of the graphite mineralisation, the grade and the metallurgical characteristics.

In April 1986, a 500 kg bulk sample was collected by channel sampling Trenches 4 and 14 at the Kookaburra Gully prospect. The sample has been forwarded to Warman International for detailed metallurgical evaluation.

2.0 LOCATION AND ACCESS

EL 1142 is located on the Eyre Peninsula to the north and northwest of Port Lincoln. Access is adequate with numerous secondary roads and farm tracks throughout the EL area. The location of EL 1142 is shown in Figure 1. The location of the Kookaburra Gully prospect at the north end of the EL is shown in Figure 2.

3.0 GRIDDING

Rehabilitation of the grid system was undertaken to provide survey control for both check and in-fill geological mapping.

Approximately one kilometre of additional grid was installed to the north and south-east for mapping purposes.

The east-west grid lines were profiled to provide slope corrections and topographic control. Similarly, north-south lines 10,000E, 10,350E and 10,500E were also profiled.

The grid system has been located with respect to the local land boundary system.

Profiling along grid line 10,350E has shown that the central hill area through which the graphite zone trends has a topographic relief of approximately 50 metres.

4.0 TRENCHING

381 metres of trench construction was completed. Eight new trenches were excavated and one pre-existing trench was extended. Most trenches were orientated grid east-west whilst some have oblique orientations.

A Hastings-Deering 310B backhoe with a 3 feet wide bucket was used to excavate 7 of the trenches. Two trenches, Trench 14 and Trench 7 extended, were completed with a 2 feet wide bucket. Maximum reach by the backhoe was 4 vertical metres. Other trench depths varied down to 5 metres.

All trenches have been fenced to protect livestock and back-filling will be undertaken in due course.

Trench details are as follows:

Trench	Grid Line	Location From-To	Orientation	Length	Depth	Samples
7 ext'd	9900N	10175E-10250E	parallel E-W	38.3m (total 67m)	1.0-2.0m	Nil
8	9750N	10325E-10425E	oblique to E-W	55m	0.5-5m	21
9	9590N	10375E-10400E	parallel E-W	27m	2m	3
10	9575N	10325E-10350E	parallel E-W	25.2m	0.5-2.0m	Nil
11	9590N	10160E-10190E	parallel E-W	25m	2.0-3.0m	Nil
12	10200N	10275E-10375E	oblique to E-W	99m	0.5-3.0m	9
13	10300N	10255E-10300E	oblique to E-W	30m	0-1.5m	Nil
14	10125N	10325E-10350E	oblique to E-W	28m	1.0-3.0m	23
15	10250N	10175E-10250E	parallel E-W	53m	0.5-2.0m	Nil

Locations of all the trenches are shown on Plate 1.

5.0 SAMPLING

56 samples were collected from 4 trenches (Trench 8, 9, 12 and 14) in which significant zones of graphite mineralisation were revealed.

An electric-powered "Kango" percussion hammer was used to excavate horizontal channel samples from the north walls of the trenches (south wall in the case of Trench 8). A majority of the samples were collected at one metre intervals with sample boundaries determined by either geological or grade changes. Sample weights varied from approximately 2 to 5 kilograms.

All samples were submitted to Comlabs Pty Ltd in Adelaide for analyses of total carbon content using method GRAV III B.

All assay results are provided in Appendix 1, and individual sample results are recorded on Plates 2 and 3.

A summary of the economically significant results obtained from the trenching is shown in the following Table:

Trench No.	Zone of Sampling (m) From	To	Interval	Average Grade (% C.)
Trench 8	12.0	27.50	15.5	13.0
Trench 14	5.0	22.5	17.5	16.1

To provide a comparison, a summary of the economically significant results obtained from an earlier phase of trench sampling (1984) is setout in the following Table:

Trench No.	Zone of Sampling (m) From	To	Interval	Average Grade (% C.)
Trench 1	14.0	20.0	6.0	9.15
	26.0	36.0	10.0	11.77
	14.0	36.0	22.0	7.85
Trench 2	20.0	25.5	5.5	9.57
	28.5	34.5	6.0	12.82
	20.0	34.5	14.5	8.93
Trench 3	10.0	24.0	14.0	8.07
Trench 4	16.0	32.0	16.0	17.83
Trench 6	6.0	15.0	9.0	7.97

Using the average grades of the individual graphite zones exposed by trenching, an overall average surface grade of 11.57% C has been calculated for the zone of graphite mineralisation extending approximately 500 metres northwards from Trench 3 to Trench 14.

A 500 kg bulk sample was collected from Trenches 4 and 14 by channel sampling with a percussion hammer. Additional metallurgical studies are in progress and the results are pending.

6.0 GEOLOGY

Trenching at Kookaburra Gully has confirmed the persistence of a discrete zone of graphite mineralisation hosted by banded schists and gneisses over a strike interval of approximately 700 metres between grid lines 9500N and 10300N.

An apparently concordant pegmatite exposed in Trenches 14, 12 and 13 intrudes the northern limits of the graphitic zone forming a sharp contact boundary to the west. In Trenches 12 and 14, narrow zones of nodular magnesite are characteristically associated with high grade graphite sections centrally located within the graphite zones. The magnesite is thought to occupy the core zone of a tightly folded anticlinal structure.

Throughout the trench exposures, graphite flake size is generally fine and flakes rarely exceed one millimetre in diameter. Coarse clots or books of graphite flakes were noted in a narrow zone of gneissic host rocks in Trench 14.

Dips measured on S2 compositional bands within the host and wall-rock schists along the strike length of the graphite zone are persistently in the range 60-80° in the direction of grid east. Strike directions on compositional banding in the same rocks varies from 0-30°m.

Similar dip measurements made in gneissic rocks 150 metres to the west of the graphite zone are shallower and are of the order of 50° in a grid east direction.

The graphite zone is presumed to be associated with the nose of a tight anticlinal fold, however, this assumption remains unsubstantiated due to the lack of exposure.

Measurements made on the closure of a tight anticlinal fold exposed in Trench 14 indicate the fold plunges at 30° in a grid south direction. The fold was overturned to the west with the west limb dipping at 60° to grid east and the east limb dipping at 50° to grid east.

The true nature and geometry of folding in the area remains obscure. Visual impressions suggest that the graphite zone dips steeply to grid east and plunges in a grid south direction.

The graphite zone bifurcates and diminishes markedly in overall width at both the northern and southern limits. At the north end a probable fault between Trenches 14 and 12 has produced likely down faulting and disruption to the northern continuity of the graphite zone. At the southern end, the graphite zone attenuates due to either a facies change or plunge effects.

Within the overall strike extent of the graphite mineralisation, a zone lying between 9650N and 10,150N has the best economic characteristics. This zone measures 500 metres in strike length and has a width which varies from 9 metres (Trench 6) to 22 metres (Trench 1). Details of individual zones of graphite mineralisation are as follows:

New Trenches

Trench	Extent	Interval
7 extended	Nil	Nil
8	9.0 - 28.5m	19.5m
9	at 9.5m	0.5m
	at 13.5m	0.3m
	at 20m	1.5m
10	Nil	Nil
11	Nil	Nil
12	36.5 - 37.5m	1.0m
	45.9 - 46.1m	0.2m
	46.5 - 46.6	0.1m
	47.5 - 47.7	0.2m
	48 - 49m	1.0m
	50 - 51m	1.0m
13	23.5 - 24.0m	0.5m
	24.0 - 24.9m	0.9m
	24.9m - 25.1m	0.2m
14	4.0 - 22.5m	18.5m
15	Nil	Nil

Previous Trenches

1	14 - 20m and 25 - 36m	6m and 11m
2	20 - 34.5m	14.5m
3	10 - 24m	14m
4	15 - 33m	18m
5	Nil	Nil
6	6 - 15m	9m
7	Nil	Nil

If it is assumed that the graphite zone plunges in a grid south direction, then the 9 metre interval of graphite in Trench 6 may become wider with depth. Trench 6 is located at a higher topographic elevation than adjacent trenches (1 and 2) where wider graphite zones have been intersected.

Details of the geology of the Kookaburra Gully prospect are shown on Plate 1.

7.0 PETROLOGY

10 graphitic rock samples collected from Trench 8 and Trench 14 were submitted to Consulting Petrologist, Dr. Jane Barron, for petrological examination.

Information concerning the graphite flake characteristics, gangue minerals and host rock type was requested in order to design a metallurgical test program to maximise coarse flake recovery.

The rock samples were identified as follows:

Trench No.	Sample No.	Sample Interval	Assay Result % Graphitic Carbon
Trench 8	8597	12.0 - 13.0	8.3
	8602	16.5 - 17.5	16.8
	8605	19.5 - 20.5	14.9
	8609	23.0 - 27.5	12.3
	8612	26.5 - 27.5	9.5
Trench 14	8620	5.0 - 6.0	24.2
	8626	10.5 - 12.0	3.1
	8630	15.0 - 16.0	9.65
	8632	17.0 - 18.0	21.1
	8634	19.0 - 20.0	17.5

Average lengths of graphite flakes in all samples exceeded 100μm.

Samples from Trench 8 contained flakes mostly in the size range 150μm to 250μm by length. Flake size for samples from Trench 14 tended to be coarser and average flake length was in the 200μm to 400μm range.

The rock samples were all identified as weathered graphitic gneiss.

A petrological report with further details is provided in Appendix 2.

8.0 DEPOSIT SIZE POTENTIAL

Trenching has demonstrated that a graphite resource with the following parameters can be envisaged at Kookaburra Gully.

Strike extent of graphite zone with economic potential = 500m
Average width of zone = 16m
Attitude of zone = steeply dipping to east
Deposit size = 880,000 tonnes

(Assuming (a) SG = 2.2
(b) depth or ore= 50m)

As no drilling has been undertaken to date, the grade of graphitic carbon can not be calculated. However, an average value of 11.47% C has been calculated from assay results of those trench samples which define the extent of the graphite zone with economic potential.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Results of mapping and trenching at Kookaburra Gully have outlined an inferred graphite resource of approximately 880,000 tonnes to a depth of 50 metres.

The resource occurs as a steeply dipping tabular body with an outcrop expression.

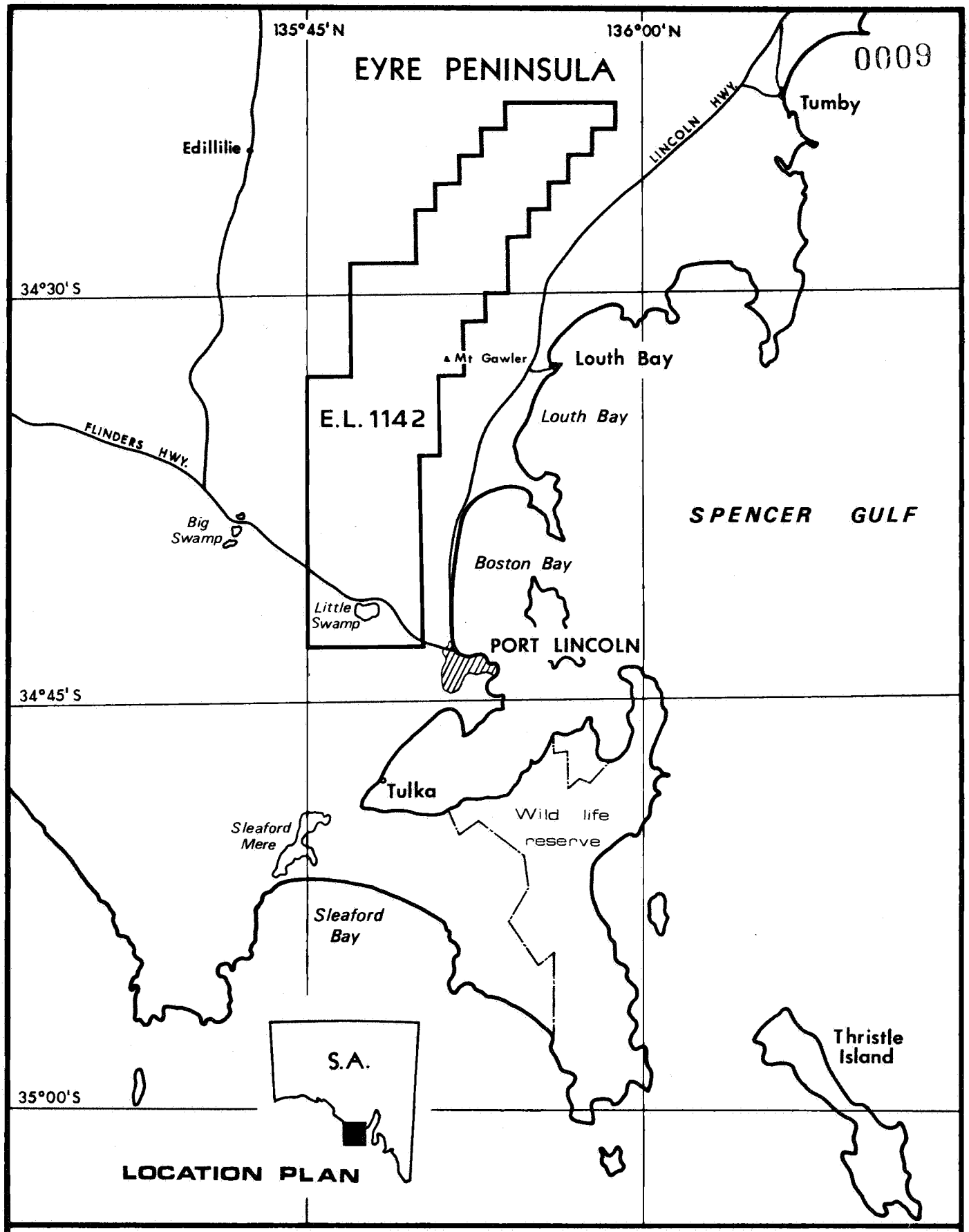
An average surface grade based on assay results from trench samples has been estimated at 11.47% C (graphitic carbon).

It is recommended that diamond drilling to test the economic potential of the graphite deposit be deferred until the results of the metallurgical test work on bulk ore samples have been received and assessed.

10.0 EXPENDITURE

The expenditure for the year ended 26th May 1986, totalled $33,761 and was made up as follows:

Administration General	$ 6,231
Land Administration	1,095
Office Technical	7,057
Gridding, Surveying and Cartography	911
Geological Investigation	11,700
Geochemical Surveys	3,019
Geophysical Surveys	1,645
Drilling	186
Mining, Marketing and Metallurgy	1,917
Total	$33,761



EYRE PENINSULA - E.L. 1142

LOCATION PLAN

0 5 10 15 km

Scale 1:250 000

REPORT No.: 84/15

FIG. 1

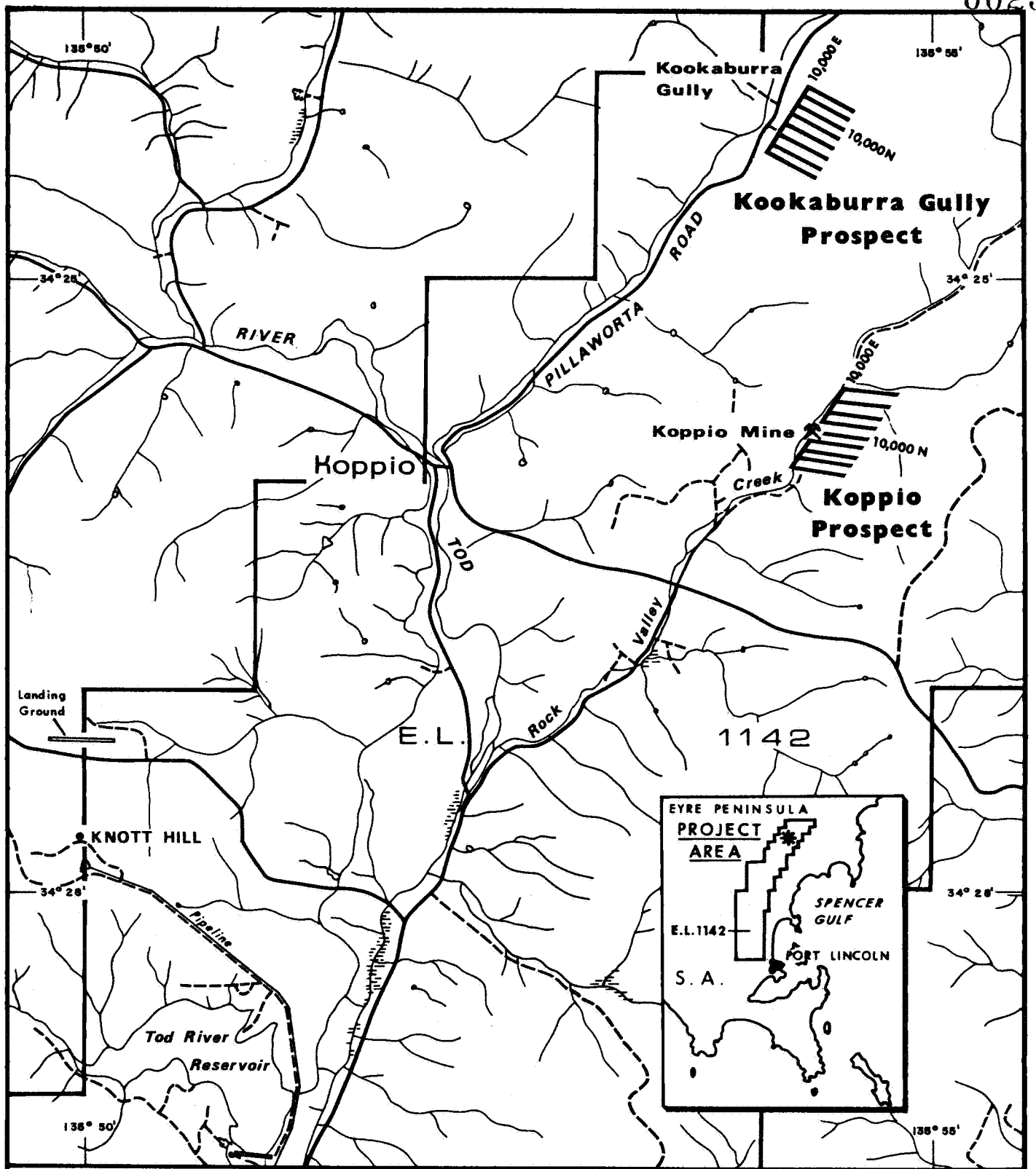


FIGURE 1

KOPPIO AND KOOKABURRA GULLY PROSPECTS

E.L.1142 - SOUTH AUSTRALIA

E.M. GRID LOCALITY

SCALE 1: 50,000

0 50 100 150 200 250

METRES

21/E/20

APPENDIX 1

Analytical Results by Comlabs Pty Ltd

COMLABS Pty. Ltd.
COMPUTERISED ANALYTICAL LABORATORIES

Head Office and Central Laboratory
305 South Road,
Mile End South,
Sth. Aust. 5031.
Tel: (08) 43 5722
Telex: AA89323

NATA REGISTERED No. 1526

OUR REF.:

YOUR REF.: COM 851301

0113

Mr. A. Collins,
Pancontinental Mining Ltd.,
50 Bridge Street,
SYDNEY NSW 2000,

August 16, 1985

Dear Angus,

RE: JOB COM 851301

Enclosed are the assays for the samples delivered to our laboratory on the 26th July, 1985.

Yours sincerely,
COMLABS PTY LTD

per :

c.c.: Mr. J.S. Poole - Pancontinental

Report Length : 3 Pages

COMLABS Pty. Ltd.
COMPUTERISED ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB COM851301

Results in %

0114

	SAMPLE	Graphitic Carbon	
	8594	1.70	
	8595	0.75	
	8596	1.90	
	8597	8.30	
	8598	20.8	
	8599	19.7	
	8600	20.1	
	8601	10.5	
	8602	16.8	15.5m @ 13.0% C
TRENCH 8	8603	15.8	
	8604	17.2	
	8605	14.9	
	8606	13.6	
	8607	18.0	
	8608	2.50	
	8609	12.3	
	8610	2.25	
	8611	12.8	
	8612	9.50	
	8613	1.70	
	8614	0.10	
	8615	2.65	
TRENCH 9	8616	6.35	
	8617	0.55	
TRENCH 14 ↓	8618	0.55	

.../2

ANALYTICAL REPORT

JOB COM851301

Results in %

0115

	SAMPLE	Graphitic Carbon
	8619	3.60
	8620	24.2
	8621	23.8
	8622	25.0
	8623	20.5
	8624	22.2
	8625	20.1
TRENCH 14	8626	3.10
	8627	12.1
	8628	15.4
	8629	1.55
	8630	9.65
	8631	9.25
	8632	21.1
	8633	22.3
	8634	17.5
	8635	21.0
	8636	18.9
	8637	0.50
	8638	0.50
	8639	10.2
	8640	1.30
TRENCH 12	8641	0.45
	8642	2.95
	8643	5.60

17.5m
16.09% C

.../ 3

ANALYTICAL REPORT

JOB COM851301

0116

Results in %

	SAMPLE	Graphitic Carbon
TRENCH 12	8644	11.8
	8645	1.55
	8646	11.3
	8647	1.15
	8648	0.95
	8649	13.4

Method of Analysis : GRAV3B

APPENDIX 2

Petrological Report by Dr. Jane Barron

B.J. BARRON, B.Sc., Ph.D., (Sydney)
PETROLOGIST

7 Fairview Ave.,
St. Ives,
SYDNEY NSW 2075
Tel. (02) 449 5839

0118

Our ref: P6/82/323a

Your ref: Letter dated 11th October, 1985.

DETAILED PETROGRAPHIC EXAMINATION INCLUDING PHOTOMICROGRAPHS OF TWELVE GRAPHITIC ROCK SAMPLES FROM KOOKABURRA GULLY, PORT LINCOLN SOUTH AUSTRALIA.

Report No: P6/82/323a 21st October, 1985.

For: Pancontinental Mining Limited.

J. Barron.

Dr B.J. Barron,
Consulting Petrologist.

SUMMARY AND CONCLUSIONS

A summary table of the textural characteristics of graphite in twelve rock samples are presented in the following table. It may be concluded that the average lengths of flakes in all the samples exceeds 100μ. The samples 8597, 8602 and 8605 from Trench 8 Kookaburra Gully contain flakes mostly within the size range 150μ to 250μ long and 20μ wide (medium sized flakes), while the sample 8609 and 8612 contain mainly smaller wispy flakes 150μ long and only 10μ wide. Sparse coarse flakes 600μ to 900μ long and up to 80μ wide are also present in most of these samples.

The graphite flakes from Trench 14 Kookaburra Gully tend to be coarser than those from Trench 8 Kookaburra Gully and in samples 8620, 8632 and 8634 the average lengths of flakes are within the range 200μ to 400μ and from 20μ to 30μ wide (medium to coarse flakes). The graphite flakes in samples 8630 and 8626 have very variable lengths (130μ to 1200μ) but in the sample 8626 the sparse flakes are generally less than 15μ thick.

Graphite flakes in the comparison samples 15106 and 15107, from the Strawberry Hill Prospect and Uley Graphite Mine respectively, have straight elongate consistently less deformed shapes than those in samples from Kookaburra Gully, with coarse average flake lengths of 500μ, and thickness of 20μ from both localities. The maximum flake length in both these samples is 900μ and thickness of flakes varies up to 50μ.

0120

SUMMARY OF GRAPHITE CHARACTERISTICS

TRENCH 8 KOOKABURRA GULLY

SAMPLE NO.	% GRAPHITE	DISTRIBUTION AND SHAPES OF FLAKES	AGGREGATION SIZE AND SHAPE	SIZE RANGE OF FLAKES IN AGGREGATES	MAXIMUM SIZE OF INDIVIDUAL FLAKES
8597	14	Patchy. ragged flakes many have bent deformed and tapered laminae	Lenses and irregular "clots" up to 6 mm long, 2.5 mm wide.	170μ to 300μ long and 30μ to 50μ wide.	600μ long 50μ wide.
8602	18	Even distribution of elongate lenses. Elongate narrow flakes, some deformed and bent lensed flakes.	Lenses and elongate aggregates up to 5 mm wide 1.8 mm wide.	Smaller flakes 150μ to 200μ long and 15μ to 30μ. Larger flakes average size 250μ long 50μ wide.	600μ long and 50μ wide.
8605	15	Uneven distribution with several dense patches. Elongate narrow tapered flakes and fewer deformed bent flakes.	Irregular shaped decussate clusters up to more than 5mm across.	Average length 120μ, 30μ wide (up to 230μ long).	400μ to 900μ long and 20μ to 100μ wide.
8609	12	Sparse clusters of wispy flakes.	Irregular clusters of partly foliated, partly decussate flakes.	150μ to 350μ long and 10μ (to 30μ) wide.	900μ long, 100μ wide.
8612	10	Patchy deformed clusters up to 2 mm across and 5 mm long defining a wavy foliation.	Tapered wispy delaminated flakes.	Average length of 150μ, average width of 10μ.	300μ to 700μ long, 80μ wide..

TRENCH 14 KOOKABURRA GULLY

0121

SAMPLE NO.	% GRAPHITE	DISTRIBUTION AND SHAPES OF FLAKES	AGGREGATION SIZE & SHAPE	SIZE RANGE OF FLAKES IN AGGREGATES	MAXIMUM SIZE OF INDIVIDUAL FLAKES
8620	25	Fairly even in wavy trails and lensed clusters. Ragged flakes many of which are bent and deformed.	Elongate lensed aggregates up to 2 mm long and 0.65 mm wide define a wavy foliation.	300μ to 500μ long and 30μ wide.	750μ long, 70μ wide.
8626	3	Sparse wispy bent and deformed flakes with almost even distribution.	Most flakes occur in sparse wispy clusters with variable foliation directions.	Average is 400μ long and 15μ wide.	700μ long, 15μ to 20μ wide.
8630	15	Very patchy distribution and very variable size of ragged flakes.	Small aggregates bands and lenses. Bands reach 2 cm long, 0.5 cm wide.	Average is 130μ long 20μ wide.	1200μ long and 40μ wide.
8632	20	More or less even distribution of ragged flakes. Many are bent, deformed and delaminated.	Lensed, foliated to decussate aggregates up to 3.5 mm long and 0.5 mm wide.	200μ to 400μ long and 50μ to 100μ wide.	700μ long and 45μ wide.
8634	20	More or less even distribution of ragged flakes.	Elongate lensed and foliated aggregates up to 5mm long and 1.8 mm wide.	120μ to 350μ long and 20μ to 40μ wide.	450μ to 1600μ long and 100μ thick.

STRAWBERRY HILL PROSPECT

SAMPLE NO.	% GRAPHITE	DISTRIBUTION AND SHAPES OF FLAKES	AGGREGATION SIZE & SHAPE	SIZE RANGE OF FLAKES IN AGGREGATES	MAXIMUM SIZE OF INDIVIDUAL FLAKES
15106	15	More or less even distribution with straight to gently curving flakes.	Elongate well foliated lensed clusters.	Average length is 500μ, and width is 20μ. Other flakes are 250μ long and 15μ thick.	900μ long and 20μ wide.

ULEY GRAPHITE MINE

15107	25	Fairly even distribution of fairly straight to slightly curved flakes. Sparse kinked flakes.	Bundles of fairly straight flakes defining a wavy deformed foliation.	Average length 500μ, width 20μ.	900μ long and 50μ wide.

TRENCH 8 KOOKABURRA GULLY

Sample No. 8597

Rock Type. Partly degraded (weathered and oxidised), partly foliated patchy quartz-(?feldspar) -graphite-muscovite gneiss.

Thin Section A patchy, partly foliated and partly granular texture of this rock reflects a wide variation in grain sizes and shapes. It has undergone partial strong foliation and metamorphic recrystallisation, as well as partial alteration and oxidation in a near surface weathering environment. This complex sample therefore may be described in terms of several separate textural domains controlled by distinct sets of simple assemblages. Firstly are developed somewhat elongate lensed to irregular shaped "clots" up to 6 mm long and 2.5 mm across, comprising foliated to decussate dense graphite flakes, intergrown with relatively minor quartz, muscovite ± stained "sericite". The lensed and deformed "clots" are set in a granular quartz-rich matrix comprising mainly a mosaic of highly irregular shaped interlocking quartz grains and subordinate altered sites that once may have contained feldspar, a little of which remains. A third fraction comprises a strongly degraded argillic zone with relict primary phases and aggregates "suspended" in an abundant fine grained, stained and oxidised argillic matrix, clearly of near surface weathering origin. An approximate modal composition for the rock is as follows; quartz 40%; graphite 14%; muscovite 10%; sericite (?illite) and "clay" 20%; limonitic oxides 12%; accessory phases (including tourmaline and fresh ?feldspar) <4%.

The quartz-rich domains in this rock generally do not exhibit recrystallised granoblastic textures, but appear as interlocking aggregates of strained anhedral grains with a variable grain size mostly within the range 0.15 mm up to 0.6 mm. These quartz aggregates which are clouded by trails of dense fluid inclusions, are intergrown with sparse, barely recognisable relict grains of "sericite"-altered untwinned calcic plagioclase (very high negative optic axial angle).

The graphite of the distinct aggregates described above comprises partly foliated and partly decussate laminae or flakes with an average length of about 0.1 mm (100μ) to 0.15 mm (150μ) and average thickness of about 0.02 mm (20μ). Smaller masses and individual graphite flakes tend to have a coarser grain size with certain narrow bent flakes reaching 0.4 mm (400μ) long and 0.05 mm (50μ) wide. Still other aggregates comprise bent and deformed tapered laminae with individual strands reaching 0.6 mm (600μ) long and 0.03 mm (30μ) wide. In one part of the rock is an "open" cluster of flakes which have an average length of about 0.07 mm to 0.1 mm (70μ to 100μ) defining a microfolded (or rotated) structure. These flakes are enclosed within relatively coarse partly decussate "muscovite" flakes. Thus about 70% of graphite in this sample is present in the elongate "clots" with an average flake size of 0.1 mm to 0.15 mm (100μ to 150μ). Elsewhere lengths of flakes range up to about 0.6 mm (600μ). Most flakes lie within the size range 0.10 mm (100μ) to 0.30 mm (300μ) long.

Muscovite flakes have ragged shapes and commonly reach more than 1 mm long. The larger flakes enclose decussate clusters of the graphite flakes.

Degraded patches of the sample now comprise pale brown stained and oxidised birefringent clay ?montmorillonite ± sericite, enclosing unoriented graphite flakes, angular quartz chips and rare grains of yellow-brown pleochroic tourmaline.

Deformation of the incompetent graphite-rich fraction in this rock has produced a patchy, partly foliated texture with possible rootless microfolds, set in a somewhat "granitic" quartzo-feldspathic matrix fraction. The rock may be described as a partly degraded (weathered and oxidised), partly foliated, patchy quartz-(?feldspar)-graphite-muscovite gneiss.

commonly reach 5 mm (5000μ) long and 1.8 mm (1800μ) wide (at the widest part of the lens). Such lenses contain in the order of 70% graphite in narrow wispy flakes aligned subparallel to the foliation. Individual flakes have an average length of about 0.25 mm (250μ) but commonly reach 0.6 mm (600μ) long. The flakes are generally about 0.05 mm (50μ) wide, and sparse cleavage plates parallel to the thin section plane have irregular but somewhat equant shapes and reach 0.4 mm (400μ) across. The lensed clusters of graphite flakes are intergrown with fine grained granular patches of quartz, sericite, sparse wispy muscovite flakes and aggregates of minute rounded ?concretionary opaque to translucent red-brown oxides, (mostly hematite ± goethite), with an average grain size of only 0.02 mm. Oxides also coat cleavage surfaces and delaminate individual flakes.

The muscovite forms as rather sparse coarse ragged but narrow flakes intergrown with graphite flakes, and individual muscovite flakes commonly reach 0.6 mm long.

On the other hand, the "sericite" (or illite) in this sample is restricted to pseudomorphed granular sites of possible previous ?feldspars that are intergrown with quartz-rich patches. Thus "sericite" is an exceptionally fine grained phase clouded by brown translucent staining and possibly intergrown with some ?montmorillonite.

This rock may be described only in terms of its present recrystallised metamorphic assemblage as a distinctly foliated quartz ?feldspar-graphite-(muscovite-"sericite") ?gneiss that has been partly altered, and oxidised in a near surface weathering environment.

Sample No. 8605

Rock Type. Fine grained carbonate rock of low grade secondary origin enclosing patches of a graphite-quartz-tourmaline-(muscovite) relict primary ?gneissic assemblage.

Thin Section. This is an intensely carbonated, fine grained rock in which are preserved only sparse relict patches or "islands" of the original graphite, quartz and tourmaline-bearing host lithology. An approximate modal mineralogy is as follows: carbonate 70%; graphite 15%; quartz 10%; tourmaline 3%; and muscovite 2%.

The ubiquitous carbonate in this sample is fine grained (0.15 mm maximum)to microgranular, and it is possible that two separate phases are represented. The latter could include a clouded carbonate and a microgranular carbonate clear of inclusions. Elsewhere are developed veinlets and subradiating to banded clusters of fine grained secondary carbonate.

Graphite has a rather uneven distribution throughout the carbonate, with several quite dense patches of flakes oriented subparallel to a previous wavy foliation. These patches suggest the presence of previous irregular shaped ?fragments reaching more than 5 mm across. Elsewhere the graphite flakes occur in "delaminated" clusters with the carbonate penetrating along cleavage surfaces of this mineral, while sparse unoriented individual graphite flakes are scattered throughout the greater proportion of the carbonate. Graphite flakes in the dense clusters of this sample, have unoriented decussate to partly foliated textures, and flake shapes tend to be elongate narrow and tapered. The average length of flakes is about 0.12 mm (120μ) and 0.03 mm (30μ thick), with sparse laminae reaching 0.23 mm (230μ) long. Flakes in the "delaminated" clusters also are extremely narrow with gently curving to bent and deformed shapes. These flakes also have an average length of about 0.12 mm (or 120μ) and an average width of about 0.2 mm (20μ), but in certain aggregates individual narrow laminae reach 0.4 mm (400μ) long and about 0.2 mm (20μ) wide. Throughout the massive carbonate sparsely disseminated flakes tend to have somewhat ragged shapes with an average size of about 0.12 mm (120μ) long and 0.04 mm (40μ) thick. Sparse bent flakes reach a maximum size of about 0.9 mm (900μ) long and 0.1 mm (100μ) wide.

The quartz grains in this sample have irregular to angular shapes, and mostly lie within the size range 0.13 mm and 0.30 mm. Sparse grains up to 0.7 mm are present. The quartz invariably occurs as isolated angular grains and granular aggregates. In one part of the

rock the quartz grains are associated with similar isolated angular chips of strongly pleochroic yellow-brown tourmaline reaching 0.5 mm across.

Sparse small ragged flakes of a colourless birefringent layer silicate (probably ?muscovite) are accessory, as are patches of a pale yellow-brown ?clay with moderate but anomalous birefringence. A single almost opaque to dark brown translucent crystal 0.23 mm across is also accessory.

Pervasive carbonate alteration has affected this rock but abundant isolated phases and clusters are preserved, suggesting a parent with a partly foliated patchy graphite distribution, and abundant granular quartz, as well as significant tourmaline somewhat similar to that of the previous sample 8597. The sample thus may be described as a fine grained carbonate rock of low grade secondary origin, enclosing patches of a graphite-quartz-tourmaline-(muscovite) relict ?gneissic primary assemblage.

Sample No. 8609

Rock Type. Quartz-tourmaline-graphite-(muscovite) gneiss that has undergone very significant fine grained carbonate alteration.

Thin Section. This sample is somewhat similar to the previous sample 8605. It also has undergone intense very fine grained carbonate alteration with preservation of relict "islands" of an earlier graphite-quartz-tourmaline-?muscovite assemblage. The present approximate modal composition is as follows: carbonate 73%; graphite 12%; quartz 5%; tourmaline 8%; and muscovite 2%. The ubiquitous carbonate is extremely fine grained to microgranular and shadowy concentric banded and colloform textures confirm a secondary origin. Several small voids are lined with the colloform carbonate.

The graphite flakes, in contrast are relatively coarse, and are more or less evenly distributed throughout the rock in

somewhat wavy foliated domains that enclose relict patches of the coarse grained quartz-tourmaline-rich host. As in the previous sample, the graphite flakes are "suspended" in the fine grained carbonate matrix and individual ragged flakes are interlayered with secondary carbonate. Clusters of flakes in these domains have a partly foliated, partly decussate texture, and most flakes in these clusters lie within the size range 0.15 mm (150μ) and 0.35 mm (350μ) long, and 0.01 (10μ) to 0.3 mm (30μ) wide. Elsewhere are partly deformed and delaminated flakes reaching 0.9 mm long (900μ) and 0.1 mm wide (100μ). The average flake size is about 0.25 mm (250μ) long and 0.02 mm (20μ) wide. Flake shapes vary considerably, most comprising distinctly ragged, tapered laminae that are commonly deformed and bent.

Quartz and tourmaline in this sample are present as clusters of relict angular grains in optical continuity suggesting the presence of original individual crystals 1 mm to 3 mm across. The quartz grains are not recrystallised but are distinctly strained and enclose sparse trails of minute fluid inclusions. The quartz once was intergrown with the coarse crystals of a strongly pleochroic yellow-brown to pale yellow-brown tourmaline. Minor accessory phases in this rock include a dark brown to opaque weakly pleochroic phase with very high relief (uniaxial positive or biaxial with a very small optic axial angle, and traces of a pale brown stained birefringent clay (?montmorillonite).

A patchy coarse grained granular to partly foliated relict texture is defined by lensed aggregates of quartz and tourmaline enclosed within dense wavy patches and trails of deformed and foliated graphite. This texture is partly overprinted by pervasive fine grained very low grade carbonate exhibiting colloform and banded structures consistent with deposition from a fluid phase. This rock may be described as a quartz-tourmaline-graphite-(muscovite) gneiss that has undergone very substantial fine grained carbonate alteration.

* Note: Small accessory grains (rutile or ?strueverite) in several samples could be of interest as a Ta, Cb-bearing phase.

Sample No. 8612

Rock Type. Quartz-(muscovite)-graphite ?gneiss which is largely pseudomorphed by microgranular secondary carbonate.

Thin Section. Fine grained pervasive carbonate alteration similar to the previous two samples 8605 and 8609 has affected this rock and only sparse patches of the original mineralogy remain. The original mineralogy now accounts for only about 20% of the total thin section area and an approximate modal composition is as follows: carbonate 65%; quartz 15%; graphite 10%; muscovite and/or sericite ∿3%; stained argillic material 2%; and voids 5%. The ubiquitous carbonate that replaces most of this sample is extremely fine grained with vague outlines of previous nodular, partly concentric structures defined by alternating layers of clouded and relatively clear microgranular carbonate. Angular quartz chips remain as clusters of angular strained grains, mostly within the size range 0.3 mm up to 0.5 mm across. Narrow quartz bands about 0.1 mm to 0.3 mm thick in this rock are discontinuous and define wavy folds parallel to the deformed graphite-defined foliation.

The graphite fraction in this rock has a patchy overall distribution with sparse deformed domains reaching 2 mm across and up to 5 mm wide, of fairly dense graphite flakes, while much smaller clusters of flakes up to 3 mm long and 1 mm to 2 mm wide are sparsely distributed throughout the remainder of the host rock. The flakes have somewhat lensed or tapered wispy narrow shapes and the ubiquitous secondary carbonate has penetrated along cleavage surfaces of this phase with the result that the "delaminated" flakes have an average length of about 0.15 mm (105μ) and average width of only about 0.01 mm (10μ) to 0.02 mm (20μ). Sparse patches of partly bent and deformed coarser grained flakes have a variable grain size of about 0.30 mm (300μ) up to 0.70 mm (700μ) and 0.08 mm thick (80μ). The graphite flakes thus occur in clusters of flakes defining a wavy deformed foliation.

Discontinuous accessory patches of ragged wispy ?muscovite (a colourless birefringent layer silicate) together with patches of sericite also define the deformed foliation. Accessory grains are

of an almost opaque dark brown phase with high relief, and elongate voids and fracture surfaces are coated with accessory yellow-brown limonitic oxide-stained carbonate.

The intense pervasive carbonate alteration has largely obscured relict textural features of this rock and granular quartz-rich domains now are represented by "islands" of angular grains while strongly foliated and deformed graphite-rich domains also are dissociated by the ubiquitous secondary carbonate. The parent rock may be only tentatively identified as a quartz-(muscovite)-graphite ?gneiss which is now largely pseudomorphed by microgranular secondary carbonate.

TRENCH 14 KOOKABURRA GULLY

Sample No. 8620

Rock Type. Quartz-plagioclase-(?K-feldspar)-sillimanite-graphite gneiss.

Thin Section. As in previous samples the present rock exhibits a partly granular and partly deformed foliated texture consistent with a metamorphic gneissic parent. Lensed and discontinuous augen shaped quartz-rich domains alternate with and are enclosed by wavy trails of graphite flakes well oriented parallel to the strongly deformed and kinked foliation. A rather simple approximate modal mineralogy is as follows; quartz 50%; graphite 25%; patches of low birefringent argillic material 15%; dusty limonitic oxides 5%; patches of fine grained sericite 3%; and accessory phases 2%, including small relict crystals of sillimanite, plagioclase and minute red-brown ?biotite (or phlogopite) flakes.

The quartz-rich domains comprise anhedral interlocking aggregates of this phase with somewhat variable grain size ranging up to 2 mm. The coarse grains are distinctly strained, have sutured quartz/quartz grain boundaries, and enclose sparse small flakes of strongly pleochroic biotite (or phlogopite). Certain quartz grains exhibit marginal development of small equant strain free recrystallised quartz grains.

The anhedral quartz aggregates more commonly have an average grain size of about 0.2 mm to 0.3 mm, and are intergrown with sparse anhedral crystal sites, now pseudomorphed by low birefringent, very fine grained argillic material (?kaolinite). These sites almost certainly once contained feldspar, a little of which remains as relict 'islands' of weakly zoned finely twinned calcic plagioclase.

Elsewhere in the distinctly foliated fraction of the rock are elongate narrow prismatic shaped crystal sites now pseudomorphed by a birefringent layer silicate. These crystals once reached 1.5 mm long (maximum), and partial relict "islands" of this phase confirm the presence of substantial previous sillimanite. The latter occurs particularly in patches of well foliated graphite-bearing material that is relatively poor in quartz. Such domains commonly define strongly deformed rootless microfolds in the folded foliation.

The graphite in this rock is distinctly coarser grained than in previous samples and individual flakes commonly have lengths of about 0.3 mm (300μ) to 0.5 mm (500μ), and thickness of about 0.03 mm (30μ). In addition, the wavy trails and lensed clusters of these flakes are more or less evenly distributed throughout the sample. Smaller somewhat decussate wispy flakes are characteristic of certain elongate lensed clusters, while many of the very ragged coarser flakes are bent and deformed. The lenses reach 2 mm long and 0.65 mm wide.

The accessory red-brown limonitic oxide dust of near surface weathering origin, stains clay-altered feldspar sites, some of which could have contained K-feldspar.

The relict mineralogy of this sample indicates a parent of high metamorphic grade (most likely granulite facies), and its texture clearly indicates multiple deformation. Granular textures of the quartzofeldspathic fraction most likely represent microsegregations rather than simple recrystallisation. The rock may be classed as a quartz-plagioclase-(?K-feldspar)-sillimanite-graphite gneiss.

Sample No. 8626

Rock Type. Quartz-(?feldspar-?sillimanite)-graphite gneiss that has undergone intense pervasive alteration and weathering to a fine grained argillic secondary assemblage.

Thin Section. Intense argillic alteration (most likely a near surface weathering effect) has pseudomorphed about 70% of the primary mineralogy of this sample. In spite of this, however, vague outlines of a gneissic metamorphic texture suggest the dominant presence of a coarse granular ?feldspathic fraction comprising deformed augen-shaped patches up to 5 mm long and 3 mm wide intergrown with discontinuous wavy bands and patches of granular quartz. An approximate modal mineralogy is as follows: quartz 15%; argillically altered crystal sites 70%; graphite 3%; wispy sericite and/or montmorillonite 3%; clouded and stained yellow-brown ?sphene dust including ?leucoxene 8%; and 4% of accessory phases including trace proportions of yellow-brown tourmaline, rare grains and clusters of weakly pleochroic yellow-brown to dark brown and opaque uniaxial positive ?strueverite, rare grains of zircon, and patches of microgranular secondary carbonate coating narrow fractures and partial voids.

The quartz grains have irregular interlocking shapes and a variable grain size ranging up to about 0.6 mm. The elongate quartz aggregates are crossed by narrow trails of fluid inclusions mostly oriented normal to the foliation direction. Lensed bundles of an acicular to fibrous phase defining a somewhat wavy foliation tend to alternate with the altered once-granular layers and it is almost certain that the altered fibres once comprised sillimanite. These crystal sites now are converted to a moderately birefringent fine grained layer silicate phase, together with redistributed secondary quartz. Elsewhere a wispy fibrous phase (?fibrolite) is converted to low birefringent equally wispy clay (possibly kaolinite)

The graphite in this sample occurs as sparse wispy narrow flakes more or less evenly distributed throughout the rock.

The flakes commonly have bent and deformed shapes, with an average length of about 0.4 mm and average width of only about 0.015 mm. The maximum length of flakes in this sample is about 0.7 mm, and most flakes are quite well aligned parallel to the wavy gneissic foliation or else are themselves quite strongly deformed.

The original mineralogy of this sample is largely masked by its intense pervasive argillic alteration due to near surface weathering effects. Pseudomorphous replacement has, however, preserved a distinctly gneissic texture with lensed wavy discontinuous deformed bands of alternating granular quartzofeldspathic to strongly foliated ?sillimanite-bearing assemblages. Quartz and graphite now are the sole remaining primary essential phases. The rock may be only tentatively described as a quartz-(?feldspar-?sillimanite)-graphite gneiss that has undergone intense pervasive alteration and weathering to a fine grained argillic secondary assemblage.

Sample No. 8630

Rock Type. Patchy and irregularly deformed quartz-graphite (?sillimanite-?feldspar) gneiss that is strongly altered to abundant microcrystalline carbonate, argillic products and limonitic oxide dust.

Thin Section. This sample is similar to other samples in this suite,and exhibits a distinct gneissic metamorphic relict texture in spite of intense but patchy fine grained argillic and carbonate alteration possibly associated with weathering and circulation of near surface groundwater. Vein-like lensed to irregular shaped granular patches contain clusters of anhedral interlocking quartz grains and possible feldspar crystal sites, while strongly foliated and deformed domains comprise abundant well oriented graphite flakes ± kink folded domains of fine wispy "sericite", most likely replacing previous sillimanite and fibrolite. The approximate modal composition of this rock is as follows: quartz 33%; graphite 15%; carbonate 25%; "sericite" 12%; limonitic oxides 3%; low birefringent argillic material 10%; accessory phases (2%) include

tourmaline, zircon and an almost opaque pleochroic oxide (uniaxial positive) ?stueverite.

The quartz in this rock has an uneven distribution in small patches, as well as in somewhat lensed domains of anhedral interlocking grains. Several individual grains reach more than 3 mm across but mostly the grain size of quartz lies within the range 0.7 mm up to 1.3 mm. In a heavily carbonated part of the rock sparse angular "islands" of quartz are present, together with sparse similar chips of yellow-brown tourmaline and clusters of wispy graphite flakes. In the quartz-rich granular domains the rock almost certainly also once contained feldspar(s), the crystal sites of which are now pseudomorphed by dense, very fine grained argillic material including "sericite" and a moderately birefringent clay. In addition the argillic material is crammed with fine dusty red-brown limonitic oxides.

the graphite flakes have a very patchy distribution and distinctly variable flake size. Dense concentrations of fairly small flakes oriented subparallel to the foliation occur in bands more than 2 cm long and 0.5 cm wide, as well as smaller irregular shaped patches and wispy lensed aggregates. In the aggregates the small flakes have an average length of about 0.13 mm (130μ) and average thickness of 0.02 mm (20μ). Elsewhere are sparse smaller clusters of graphite flakes, (particularly in quartz aggregates, or else enclosed within fine grained carbonate ± sericite), that reach up to 1.2 mm long (1200μ) and 0.04 mm (40μ) thick.

Carbonate and argillic alteration products obscure the primary mineralogy of this sample, with relict quartz and graphite partly defining the original gneissic texture. The original mineralogy also most likely included sillimanite in patches of foliated wispy fibres, and granular aggregates of ?feldspar(s) intergrown with quartz. The rock thus may be described as a patchy and irregularly defomred quartz-graphite-(?sillimanite-?feldspar) gneiss that is strongly altered to abundant microcrystalline carbonate, argillic products and limonitic oxide dust.

Sample No. 8632

Rock Type. Quartz-graphite-(?feldspar-??cordierite-?sillimanite) gneiss, which has undergone intense argillic alteration, mostly due to near surface weathering effects.

Thin Section. The texture of this metamorphic rock is distinctly gneissic with abundant elongate narrow graphite-rich lenses well aligned parallel to a somewhat wavy foliation. The lenses are enclosed within a granular quartz-rich mosaic intergrown with altered anhedral crystal sites that almost certainly once contained feldspar(s). The modal composition of the rock is approximately as follows; quartz 40%; argillically altered ?feldspar crystal sites 35%; graphite 20%; ragged flakes of a colourless birefringent layer silicate (?muscovite) <3%; and trace proportions (<2%) of accessory grains including zircon, secondary epidote, and rare grains of a high relief highly birefringent pleochroic brown to opaque phase, (?streuverite).

As in previous samples the quartz occurs in aggregates of anhedral interlocking grains that exhibit distinct strain shadows and enclose discontinuous trails of fluid inclusions. Larger grains tend to be elongate and lensed parallel to the foliation direction. There is a distinct variation in grain size, mostly within the range 0.1 mm up to 0.6 mm and a composite vein-like band more than 1 cm thick contains strained anhedral quartz grains, certain of which reach 7 mm across.

No relict ?feldspar(or?cordierite) is preserved in argillically altered anhedral crystal sites intergrown with the granular quartz layers, and these sites mostly lie within the range 0.3 mm to 0.6 mm. Rare quartz grains exhibit a relict intergrowth texture comprising graphic cuneiform shaped altered ?feldspar crystal sites enclosed within individual quartz grains. The ubiquitous very fine argillic alteration most likely is a montmorillonite-like clay ± ?kaolinite, and is commonly stained by red-brown limonitic oxide dust.

The distinctly foliated lensed clusters of

graphite flakes are more or less evenly distributed throughout this sample, and generally these reach 2 mm to 4 mm long and 0.5 mm to 1 mm wide. Shapes of individual flakes again are quite ragged, with numerous bent and deformed flakes within aggregates. Individual flakes tend to be delaminated along cleavage surfaces and much smaller flakes tend to be characteristic of the denser aggregates. In these domains the flakes have an average length of about 0.25 mm (250μ) and thickness of 0.015 mm (15μ), while elsewhere in the rock numerous flakes reach 0.45 mm (450μ) long and 0.04 mm (40μ) wide. Sparse graphite flakes set in the vein-like quartz-rich domain are grain-boundary located and are quite coarse grained reaching more than 0.7 mm (700μ) long and 0.045 mm (45μ) wide.

Accessory aggregates of relatively coarse ragged ?muscovite flakes (up to 1 mm long), help define the foliation in graphite-rich lenses. Several clusters of quite ragged flakes retain textures suggesting replacement of previous sillimanite.

The gneissic texture of this sample indicates a metamorphic parent of fairly high grade, but argillic alteration including partial oxidation (mostly near surface weathering), has obsucred its exact primary mineralogy. Quartz and graphite are the sole remaining essential relict phases and the rock may be described tentatively as a quartz-graphite-(?feldspar-??cordierite-?sillimanite) gneiss, which has undergone intense argillic alteration and partial oxidation, mostly due to near surface weathering effects.

Sample No. 8634

Rock Type. Partly argillically altered and carbonated (oxidised and weathered) quartz-graphite-(?feldspar-??cordierite-?sillimanite) gneiss.

Thin Section. This partly altered gneissic sample texturally is similar to the previous sample 8632, comprising graphite-defined lensed and foliated domains (most likely including micro-boudins), set in a granular quartz-rich matrix fraction with a distinctly variable

grain size. The modal mineralogy of this rock is as follows; quartz 35%; argillically altered ?feldspar crystal sites 30%; graphite 20%; carbonate nodules and patches 10%; <5% of ragged ?muscovite; and accessory phases including tourmaline, zircon and rare minute red-brown pleochroic biotite flakes enclosed in quartz grains.

The quartz predominates in quite coarse lens shaped to anhedral grains with distinct strain shadows. The quartz grain size is widely variable, sparse grains reaching 3 mm across, but most grains lie within the size range 0.4 mm up to 0.9 mm. In addition there are aggregates of more equant grains, with an average size of about 0.15 mm, that appear to represent zones of finer recrystallisation. The granular quartz-rich domains also contain numerous similar sized anhedral crystal sites that almost certainly once contained ?feldspar(s) ± ?cordierite. Such sites now are pseudomorphed by exceptionally fine grained, moderately birefringent argillic material that is very heavily stained by red-brown limonitic oxide dust. This selective alteration appears largely to be due to near surface effects of weathering. Rare anhedral grains of yellow-brown to pale yellow pleochroic tourmaline which reach 1 mm across are located in the granular quartzofeldspathic fraction.

Graphite in this rock occurs mainly in elongate lensed ragged aggregates ranging in size up to more than 5 mm long and 1.8 mm wide, and defining a wavy foliation. Certain more equant patches 3 mm long and 2 mm wide contain less well oriented decussate flakes or flakes oriented around rootless folds (?boudins). Single flakes and aggregates of a few flakes tend to be quartz/quartz grain boundary-located. The size of ragged decussate to deformed flakes in relatively dense aggregates tends to lie within the range 0.12 mm (120μ) to 0.35 mm (350μ) long and 0.02 mm (20μ) to 0.04 mm (40μ) wide. Elsewhere are developed bent and deformed flakes 0.45 mm (450μ) long and 0.06 mm (60μ) wide. Sparse graphite flakes in small aggregates located in granular quartz reach 1.6 mm (1600μ) long and individual laminae in the well cleaved flakes commonly reach 0.1 mm (100μ) thick. Small clusters of ragged ?muscovite flakes and sericite form wavy trails, certain of which suggest the presence of previous sillimanite.

The alteration of this rock is advanced, and rounded to irregular shaped weakly zoned nodules of clouded microcrystalline carbonate are unevenly distributed throughout the rock. These are mostly 0.5 mm to 1 mm across and are generally not selectively located in previous crystal sites. Several are partly rimmed with limonitic oxides.

This sample may be described as a metamorphic rock in terms of its clearly preserved relict gneissic textural features but only tentatively in terms of its probable primary assemblage as a partly argillically altered and carbonated (oxidised and weathered), -quartz-graphite-(?feldspar-??cordierite-?sillimanite) gneiss.

STRAWBERRY HILL PROSPECT

Sample No. 15106

Rock Type. Strongly foliated and recrystallised quartz-graphite rock (?gneiss), that contains substantial patchy limonitic oxides and yellow-brown stained argillic patches due to weathering.

Thin Section. Strong metamorphic foliation is a dominant textural element in this metamorphic rock, and gneissic textural features are less well developed than in most of the preceeding samples. The rock has been affected by patchy partial alteration and oxidation in a near surface weathering environment, and the present relict mineralogy is quite simple. An approximate modal composition is as follows; quartz 40%; graphite 15%; limonitic oxides 30%; voids and yellow-brown stained argillic material 15%.

Unlike the quartz in previous samples the quartz in the present rock is more or less even grained with an average grain size of about 0.3 mm, and narrow lensed aggregates of quartz generally are in the order of 0.8 mm to 2 mm long and one grain (0.3 mm) wide. The quartz grains exhibit strain shadows, and rarely they also show fine deformation lamellae. Sparse quartz grains enclose small domains of fine polygonised strain-free grains. Certain voids and clay-altered

patches once may have contained ?feldspar, but these sites are not clearly intergrown with the quartz and again contrast with the previous samples in this respect.

The graphite in this sample is less deformed and less ragged than in previous samples, and tends to occur in fairly straight to gently curving flakes in ubiquitous lensed clusters and small aggregates more or less evenly distributed throughout the rock. Several well foliated graphite clusters comprise distinct tight rootless folds in the dominant foliation, similar to those in previous samples. The flakes in this sample are narrow and elongate with an average length of about 0.5 mm (500μ) and average width of only about 0.02 mm (20μ). The maximum length of several "shredded" narrow flakes in several lensed aggregates is 0.9 mm (900μ) and individual laminae are 0.02 mm (20μ) thick. Elsewhere are aggregates of well foliated narrow wispy flakes set in dense limonitic oxides. These wispy flakes have average lengths of about 0.25 mm (250μ) and average widths of only 0.01 to 0.015 mm (or 10μ to 15μ) and the limonitic oxides have formed narrow continuous rims around certain of the flakes. Dense limonitic oxides stain quartz/quartz grain boundaries and graphite flakes are also commonly grain boundary located.

This sample exhibits significant textural and mineralogical differences compared with previous samples. It is a very well foliated rock in which graphite flakes define a fairly consistent foliation direction. The graphite flakes tend to be straighter, less ragged and less deformed than in previous samples, and are more evenly distributed throughout the rock. The granular quartz is fairly even grained and there is no clear evidence of its intergrowth with possible feldspar crystal sites, and no evidence of previous sillimanite fibres. The sample may be described simply as a strongly foliated, deformed and recrystallised quartz-graphite rock (?gneiss), that contains substantial patchy limonitic oxides and yellow-brown stained argillic patches due to the effects of near surface weathering.

0141

ULEY GRAPHITE MINE

Sample No. 15107

Rock Type. Oxidised, stained and weathered, strongly foliated, partly deformed and recrystallised quartz-graphite rock (or ?gneiss).

Thin Section. This metamorphic sample is texturally and mineralogically similar to the previous sample 15106. It is a strongly foliated rock with a simple quartz-graphite relict primary mineralogy that has been considerably oxidised (weathered) and stained by red-brown limonitic oxides. Dense graphite flakes define the somewhat wavy but nevertheless excellent foliation and elongate lensed bundles of flakes are very common or else are mutually impinging. Granular quartz-rich domains also tend to be lensed but ubiquitous limonitic oxide staining of quartz/quartz grain boundaries and development of similar oxides as narrow rims around individual flakes partly obscures original textural features. An approximate modal composition is as follows; quartz 35%; graphite 25%; limonitic oxides 30%; carbonate and stained argillic products 5%; and voids 5%.

The quartz occurs as individual angular shaped grains with heavily stained quartz/quartz grain boundaries and microfractures, and most grians lie within the range 0.13 mm and 0.5 mm. Sparse lensed aggregates and single coarse elongate augen shaped quartz grains with strain shadows reach a maximum of 3 mm long and 1 mm wide. There are relatively few quartz grains with patchy fine grained polygonised domains, and there is little textural evidence of previous feldspar crystal sites.

The very abundant graphite flakes are well oriented, defining a wavy deformed foliation, and tend to occur mostly in bundles of fairly straight to slightly curved flakes. Kinked flakes are sparse. The bundles comprise flakes with an average length of about 0.5 mm (500μ), and average thickness of individual laminae is about 0.02 mm (20μ), whereas individual isolated flakes and in smaller groups of flakes, sizes increase with many reaching 0.9 mm (900μ) long and 0.05 mm (50μ) wide. A somewhat decussate aggregate of coarse ragged flakes with an average size of 0.8 mm long and 0.5 mm thick now comprise alternating fine layers of graphite and secondary very fine grianed carbonate.

The latter is not present in the remainder of the host rock, but patchy translucent red-brown limonitic oxides are common. Yellow-brown stained, poorly defined argillic products partly fill irregular shaped voids.

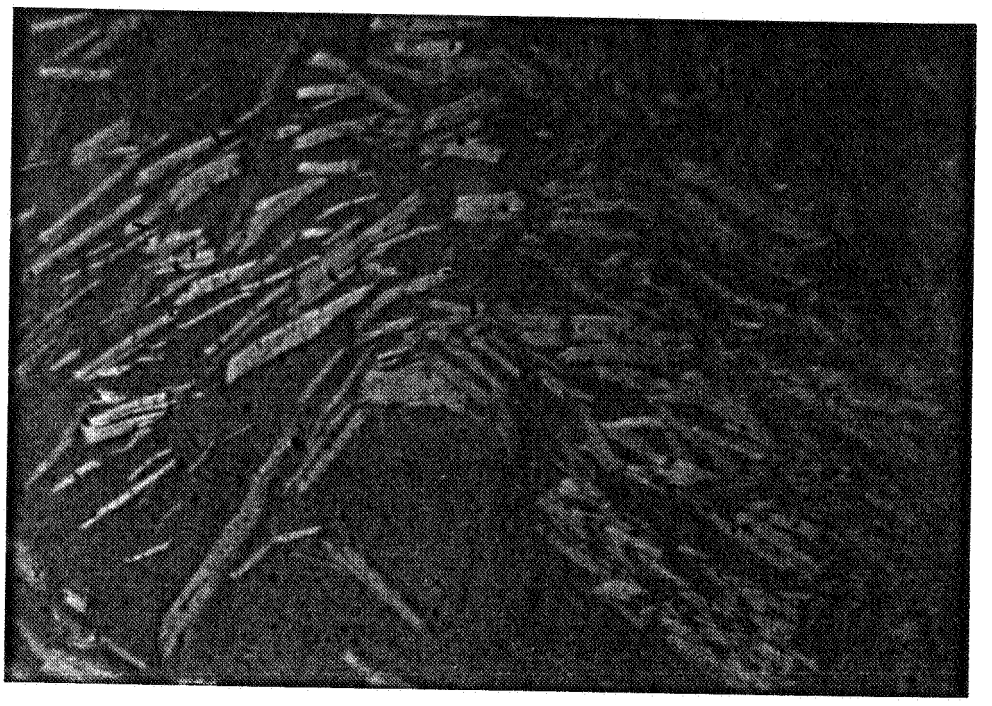
A high proportion of coarse graphite flakes and lensed bundles of flakes, well oriented parallel to a wavy deformed foliation, are characteristic of this rock. The graphite is intergrown with lensed patches and trails of granular quartz, but the presence of quartzofeldspathic segregations, characteristic of previous gneissic samples, is not demonstrated in the present rock. This sample is an oxidised, stained and weathered, strongly foliated, partly deformed and recrystallised quartz-graphite rock or ?gneiss.

0143

PHOTOMICROGRAPHS

TRENCH 8 : KOOKABURRA GULLY

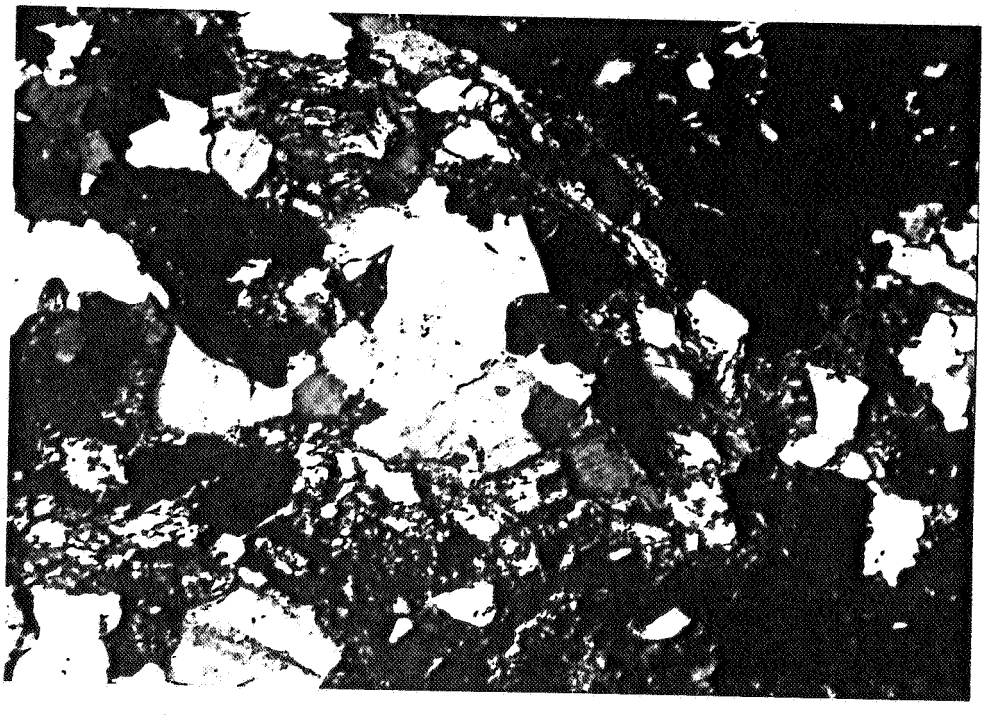
NOTE: All photomicrographs taken in reflected light are at the same magnification for visual size comparison of graphite flakes.



Sample No. : 8597

0.5 mm (500μ)

Graphite flakes which define a microfold are enclosed in an aggregate of coarse muscovite and quartz. Reflected light.



Sample No. : 8597

0.5 mm

Patchy granular quartz with fluid inclusions intergrown with argillically altered ?feldspar crystal sites. Crossed nicols, transmitted light.

Sample No. : 8602

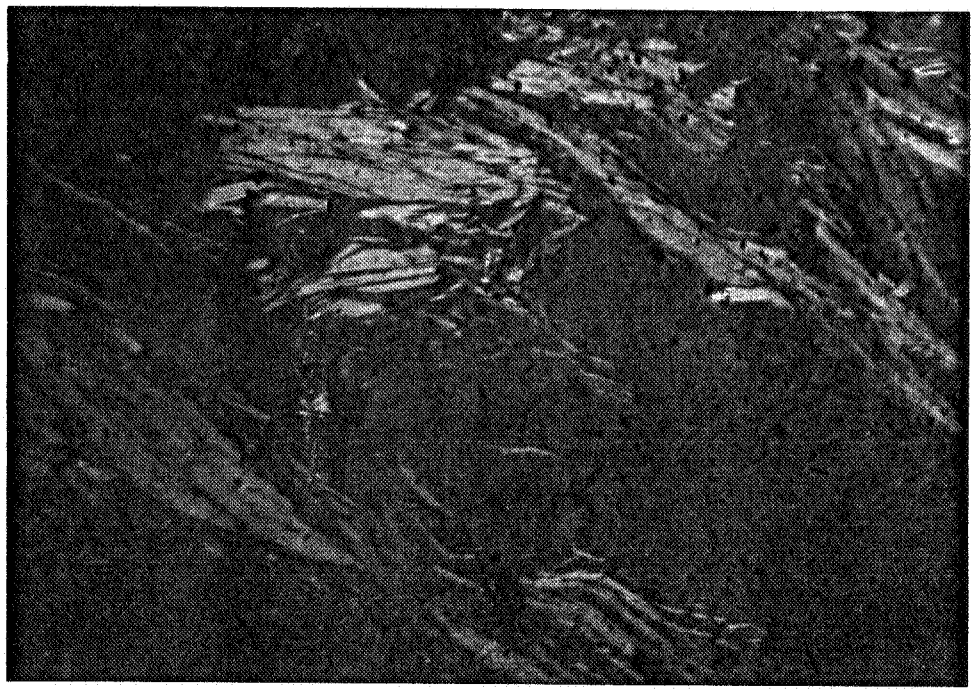
0.5 mm (500μ)

Foliation oriented clusters of graphite flakes and larger individual quartz/quartz grain boundary-located flakes. Abundant secondary limonitic oxides comprise masses of small rounded nodules. Reflected light.

Sample No. : 8602

0.5 mm (500μ)

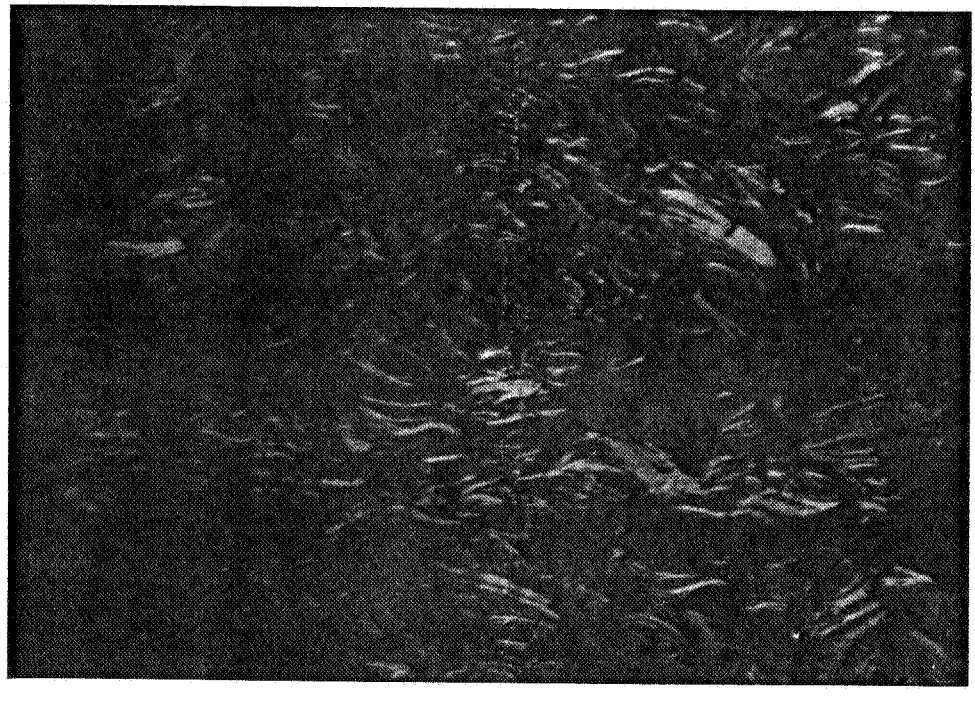
Elongate lens shaped quartz grains showing strain shadows intergrown with degraded ?feldspar crystal sites, opaque limonitic oxides and graphite flakes. Crossed nicols, transmitted light.



Sample No. : 8605

0.5 mm (500μ)

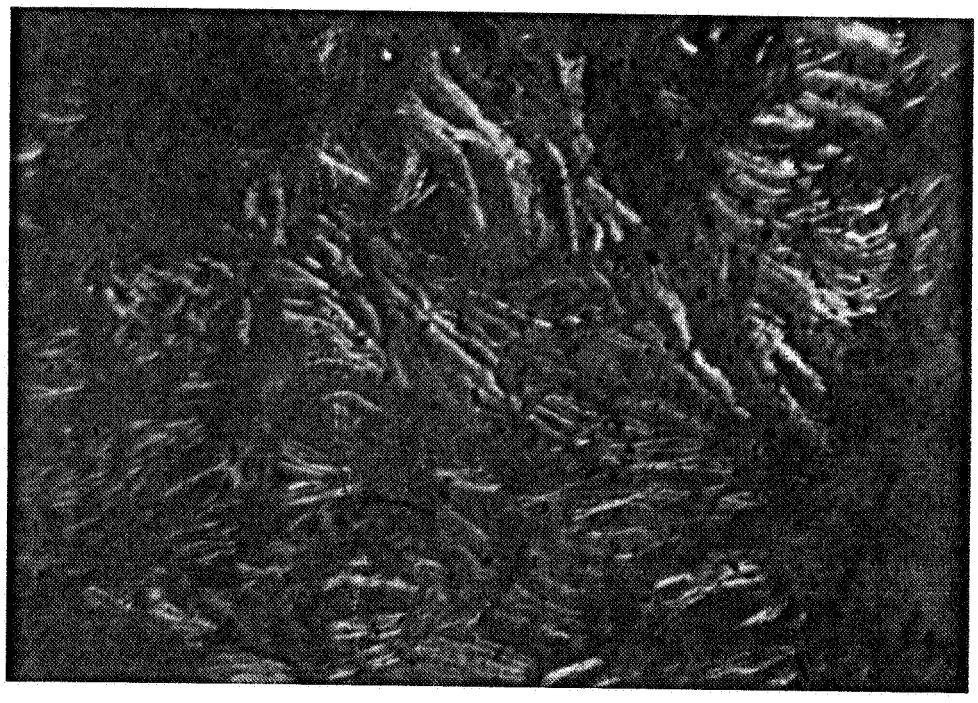
Aggregates of well cleaved, tapered and bent graphite flakes set in a dense matrix of secondary carbonate. Crossed nicols.



Sample No.: 8609

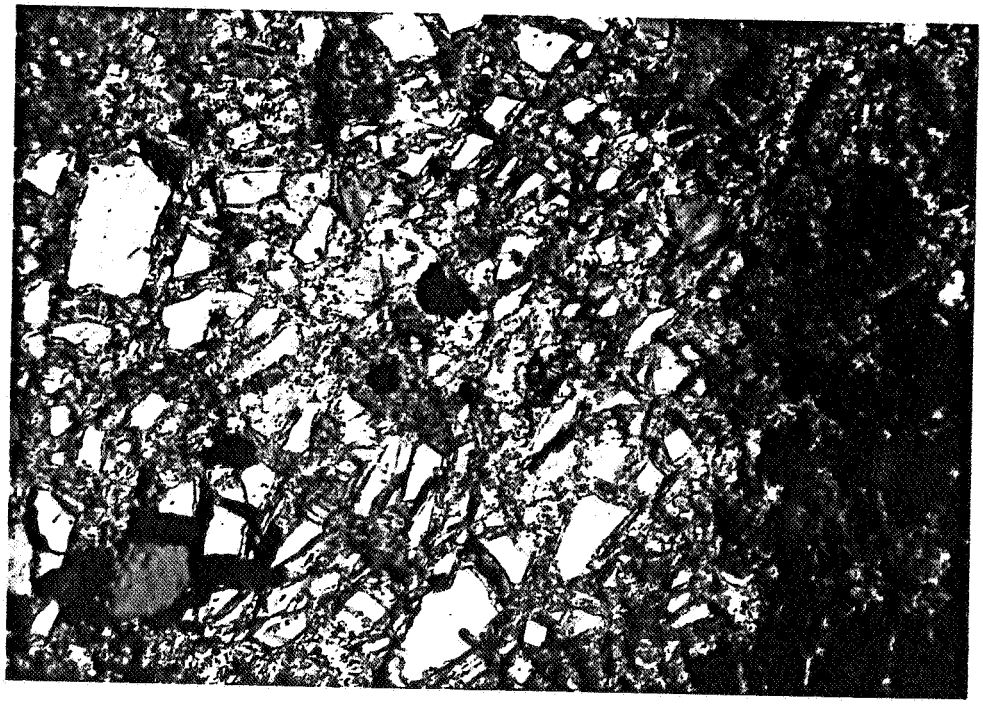
0.5 mm (500μ)

Patch of small wispy and mostly bent graphite flakes set in dense, very fine grained secondary carbonate. Crossed nicols.



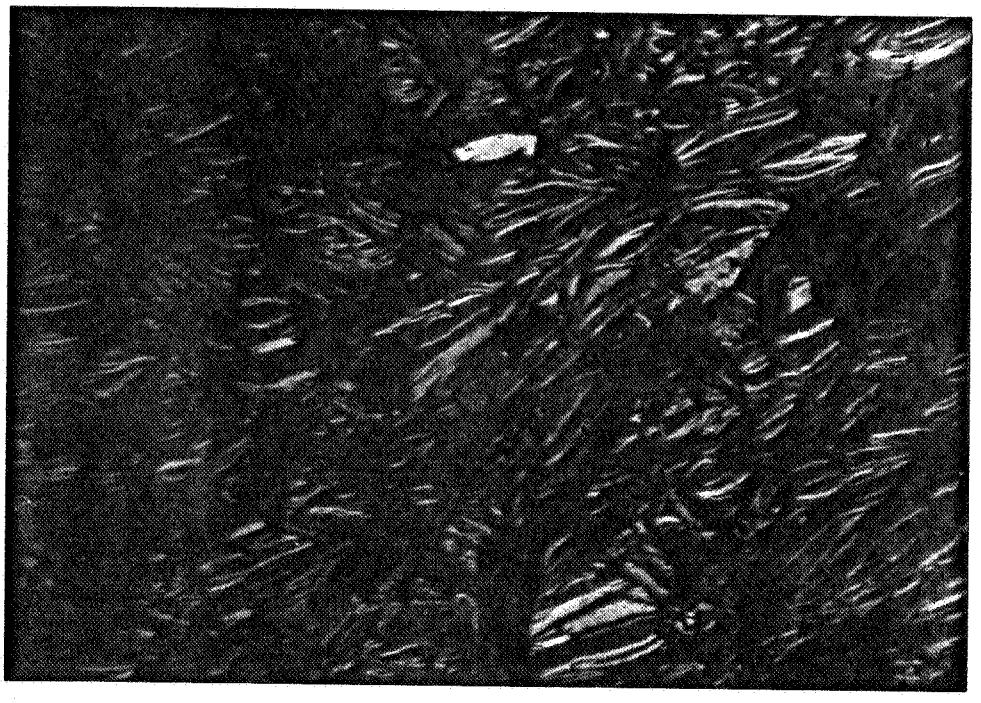
Sample No. : 8609 0.5 mm (500μ)

Aggregates of wispy bent graphite flakes are aligned subparallel to variable wavy deformed foliation directions. Reflected light.



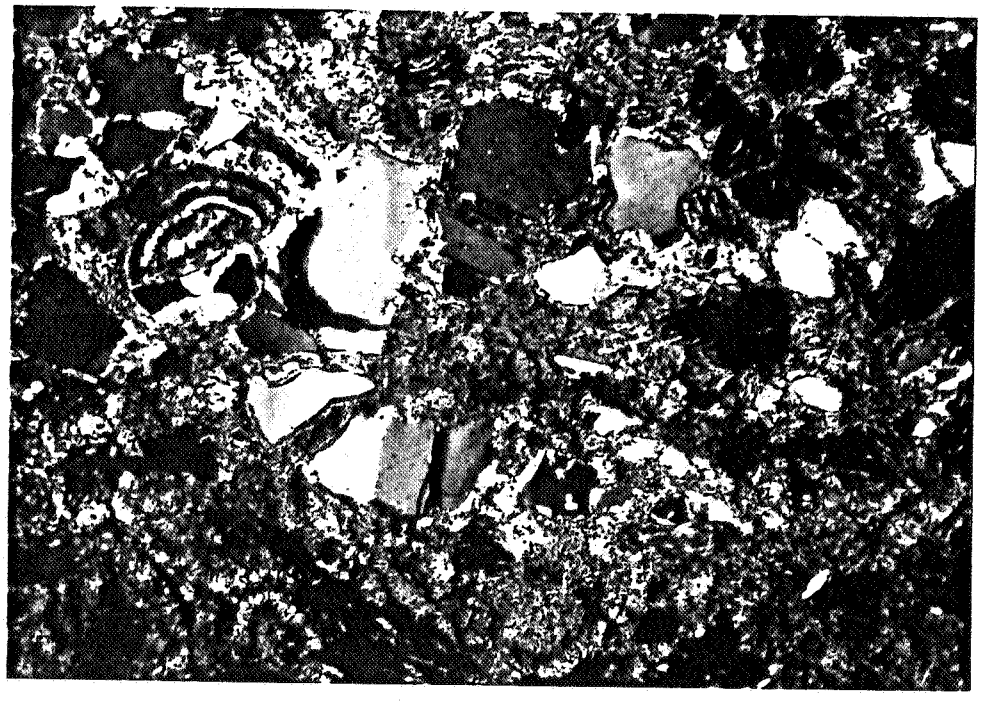
Sample No. : 8609 0.5 mm (500μ)

Angular chips of relict tourmaline are set in a matrix of fine grained secondary carbonate. Large lensed aggregates of coarse grained tourmaline and quartz crystals were present in the parent rock. Crossed nicols, transmitted light.



Sample No. : 8612 0.5 mm (500μ)

Narrow wispy ragged flakes of graphite with secondary carbonate penetration along cleavage surfaces. Reflected light.



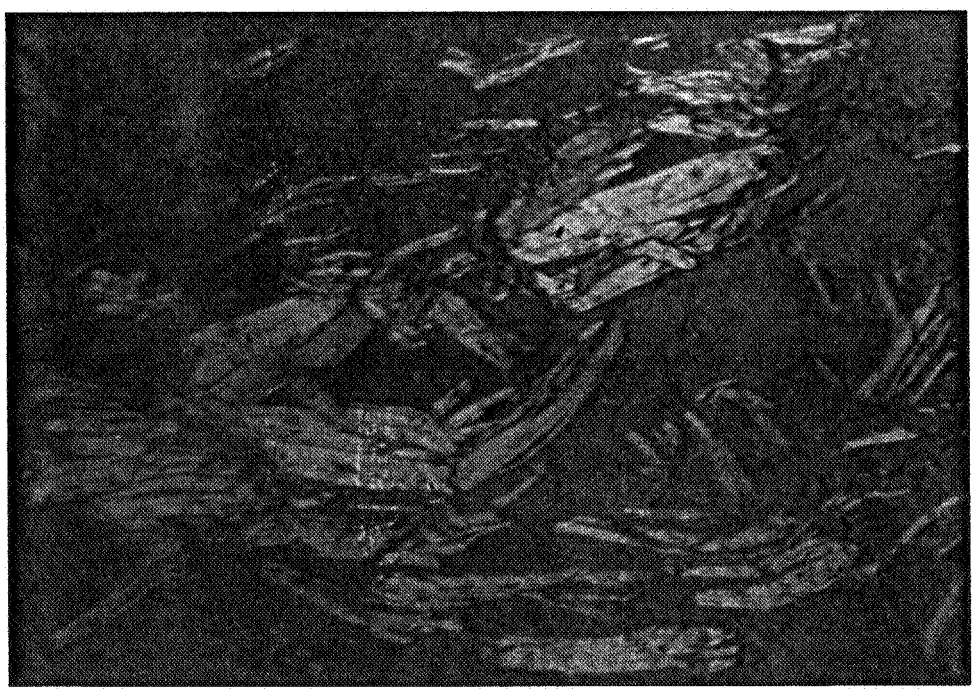
Sample No. : 8612 0.5 mm (500μ)

Relict "islands" of anhedral granular quartz set in a dense matrix of fine grained carbonate. Note concentric zoned patch of secondary carbonate upper left of photomicrograph. Crossed nicols, transmitted light.

TRENCH 14 : KOOKABURRA GULLY

Sample No. : 8620 — 0.5 mm (500μ)

"Shredded" coarse flakes of graphite that are partly bent and delaminated along cleavage surfaces. Reflected light.

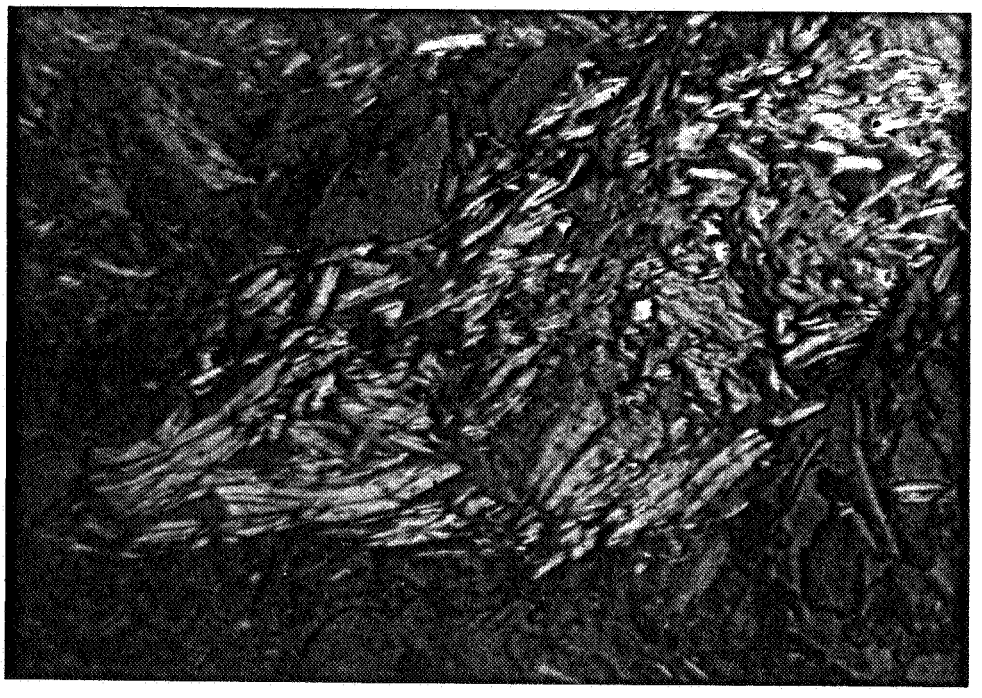


Sample No. : 8620 — 0.5 mm (500μ)

Irregular cluster of coarse ragged graphite flakes bent around lensed aggregates of granular quartz and partly degraded feldspar crystal sites.

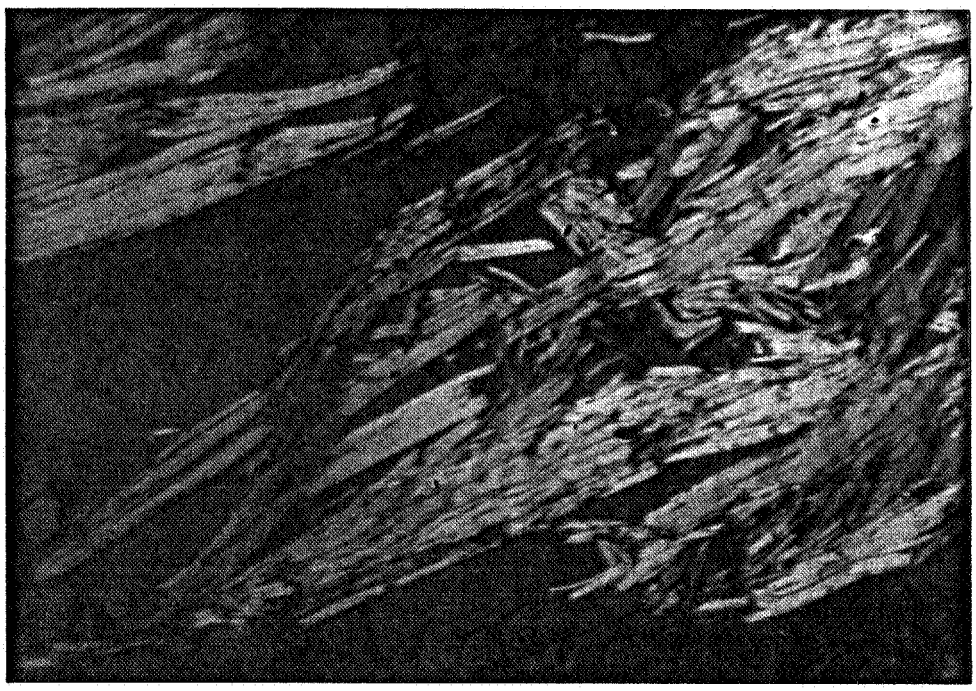
Sample No. : 8626 — 0.5 mm (500μ)

Very sparse wispy deformed graphite flakes that are delaminated along cleavage surfaces by penetration of ubiquitous secondary argillic products. Reflected light.



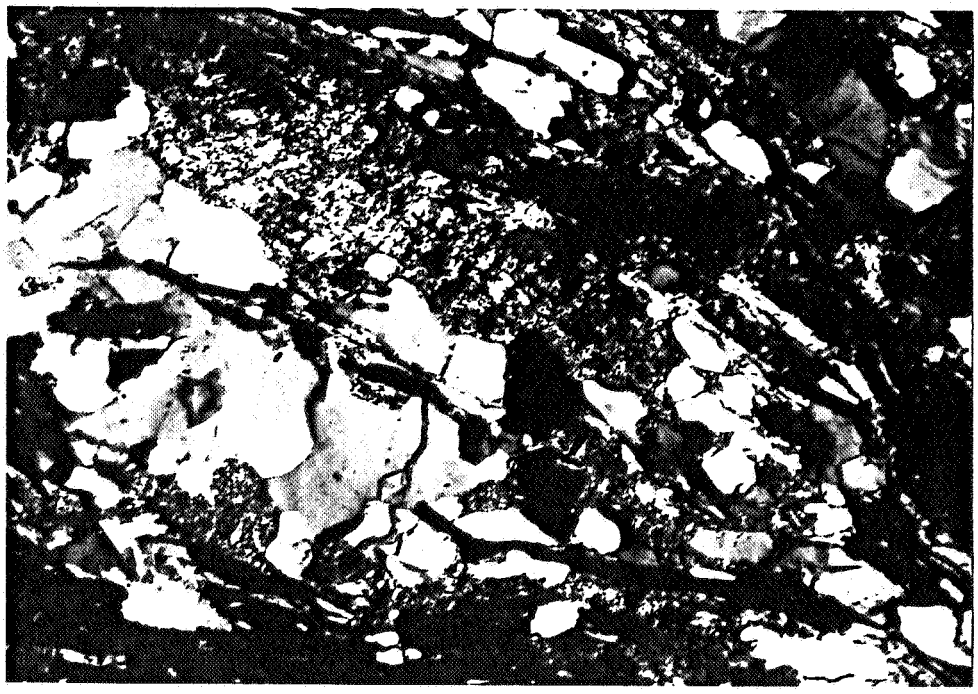
Sample No. : 8630 — 0.5 mm (500μ)

Lensed cluster of small ragged somewhat decussate graphite flakes associated with relict "islands" of angular quartz and ubiquitous fine carbonate sericite alteration. Reflected light.



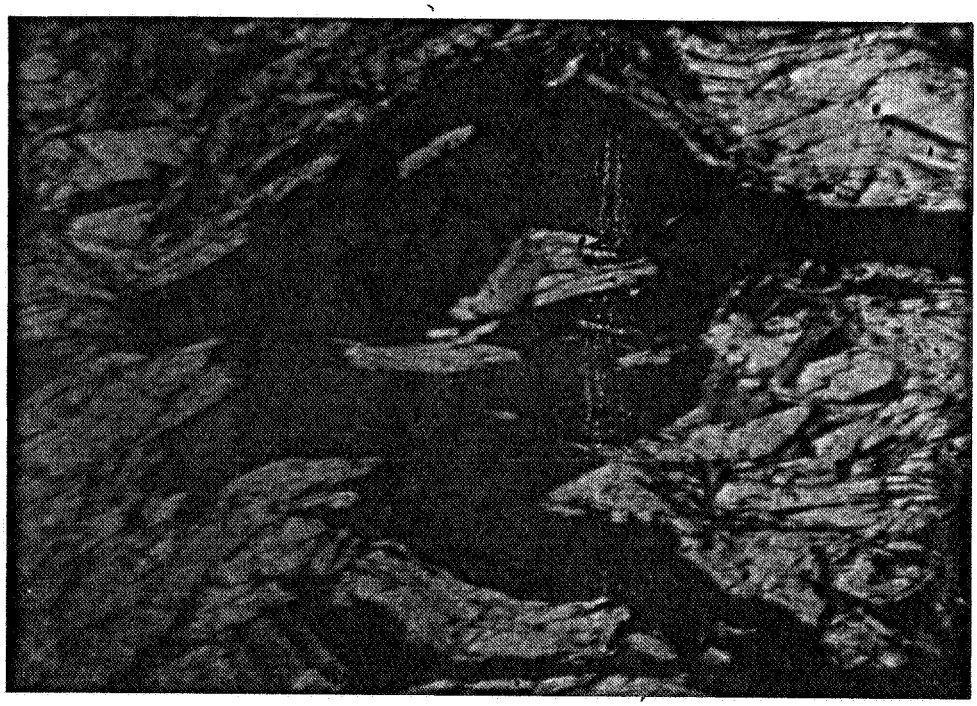
Sample No. : 8632 0.5 mm (500μ)

Foliation-oriented coarse ragged graphite flakes with decussate patches of smaller deformed wispy flakes. Coarse flake size in this sample is similar to that of the previous sample 8620.



Sample No. : 8632 0.5 mm (500μ)

Gneissic texture is well demonstrated in this sample with lenses (or segregations) of granular quartz-degraded feldspar sites separated by wavy trails of foliation-oriented grpahite flakes. Crossed nicols, transmitted light.



Sample No. : 8634

0.5 mm (500μ)

Lensed patches of deformed ragged graphite flakes are intergrown with the altered quartzofeldspathic "segregations". Reflected light.

Sample No. : 8634

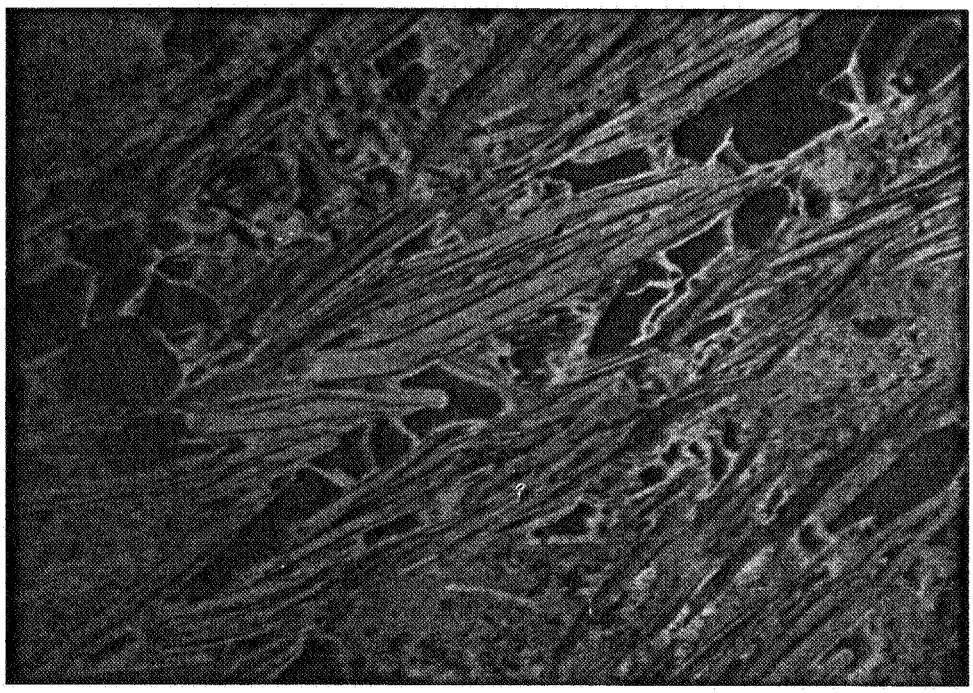
0.5 mm (500μ)

Bent and deformed coarse graphite flake showing fracturing along kinks and disruption of cleavage lamellae. Reflected light.

Nat Kodaburra Gully
10.

STRAWBERRY HILL PROSPECT

0152



Sample No. : 15106 0.5 mm (500μ)

Relatively straight narrow graphite flakes well aligned parallel to a gently curving foliation. Reflected light.

ULEY GRAPHITE MINE

Sample No. : 15107 0.5 mm (500μ)

These flakes are somewhat similar to those in the previous sample 15106. The flakes are dominantly straight and tend to be slightly thicker than in the previous sample. Reflected light.

PLATES

10 000 E | 10 100 E | 10 200 E | 10 300 E | 10 400 E | 10 500 E | 10 600 E

10 400 N | 10 300 N | 10 200 N | 10 100 N | 10 000 N | 9 900 N | 9 800 N | 9 700 N | 9 600 N | 9 500 N

G.N. | M.N. | 030° MAG. | 3.0°

LEGEND

— I — Fence

Track

ABBREVIATIONS

gs Graphitic schist

gn Gneiss

bn Banded

Boundary of geological outcrop

PLOUGHED FIELD | SCRUB | TEA TREE SCRUB | PLOUGHED FIELDS | SCATTERED FLOAT IN PLOUGHED FIELD | PLOUGHED FIELD TRACE FLOAT | OPEN FIELD | STEEP SLOPE SOIL COVERED | GULLY | DAM | BREAN CREEK | HILL TOP | TREELINE

TRENCH 1 | TRENCH 2 | TRENCH 3 | TRENCH 4 | TRENCH 5 | TRENCH 6 | TRENCH 7 | TRENCH 8 | TRENCH 9 | TRENCH 10 | TRENCH 11 | TRENCH 12 | TRENCH 13 (not sampled) | TRENCH 15 (not sampled)

PANCONTINENTAL MINING LIMITED
PANCON EXPLORATION DIVISION

KOPPIO GRAPHITE PROJECT
E.L. 1142 - SOUTH AUSTRALIA
KOOKABURRA GULLY PROSPECT

OUTCROP GEOLOGY

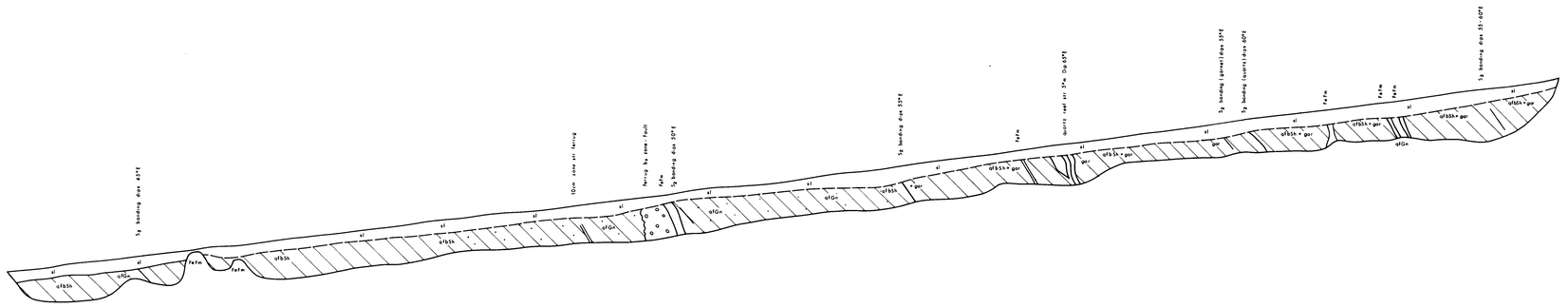
SCALE 1:1000

0 20 40 60 80 100 METRES

Compiled A.R.C.	Date JULY, 1984	Dwg. No 21/D/6
Report No 86/16	Map Ref. 5153-11	PLATE 1

5233-25

TRENCH 7 AND EXTENSION (9900N)
North Wall



% GRAPHITE

SAMPLE NUMBER

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70

TRENCH 11 (9600N)
North Wall

% GRAPHITE

SAMPLE NUMBER

0 5 10 15 20 24

TRENCH 8
South Wall

0.10 1.70 9.50 12.80 2.25 12.3 2.50 18.0 13.5 14.9 17.2 15.8 16.8 10.5 20.1 19.7 20.8 8.30 1.90 0.75 1.70

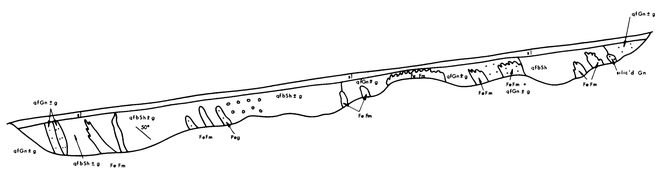
8614 8613 8612 8611 8610 8609 8608 8607 8606 8605 8604 8603 8602 8601 8600 8599 8598 8597 8596 8595 8594

55 50 45 40 35 30 25 20 15 10 5 0

% GRAPHITE

SAMPLE NUMBER

TRENCH 10 (9575N)
North Wall

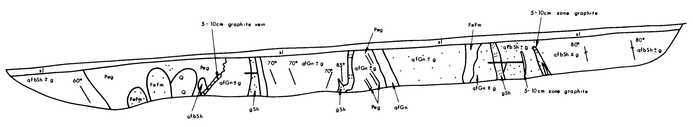


% GRAPHITE

SAMPLE NUMBER

0 5 10 15 20 25

TRENCH 9 (9590N)
North Wall



0.35 0.55

8616 8617

% GRAPHITE

SAMPLE NUMBER

0 5 10 15 20 25

LEGEND

- sl — Soil
- FeTOB — Ferruginised transported overburden on Laterite
- sfbShtg — Thin banded Qtz-feld-biot schist ± graphite
- gSh — Graphitic schist
- sfGn ± g — Poorly banded Qtz-feld gneiss ± graphite
- gGn — Graphitic gneiss
- Peg ± g — Pegmatite ± graphite
- FeFm — Iron formation or intense pervasive ferruginisation
- Q — Quartz segregation
- · — Lower ( )
- ·· — Medium (10-20 Vol%)
- ∴ — High (20-30 Vol%) — concentrations of graphite
- Xm — Magnesite nodules
- gar — Garnet
- Brecciation/pebbley effect
- Gradational change
- 8614 — Channel sample
- 60° — Apparent dip of S_2 compositional bands

PANCONTINENTAL MINING LIMITED
PANCON EXPLORATION DIVISION

KOPPIO GRAPHITE PROJECT
E.L.1142 - SOUTH AUSTRALIA
GEOLOGY OF TRENCHES
7, 8, 9, 10 AND 11

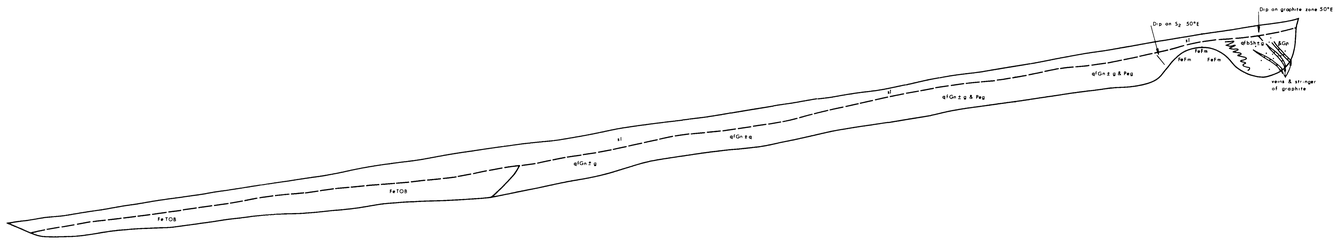
SCALE 1:100

0 2 4 6 8 10
METRES

Compiled J.G.	Date AUGUST, 1985	Dwg. Nº 21/D/9
Report Nº 86/16	Map Ref. SI 53-11	PLATE 2

5233-26

TRENCH 15 (10 250 N)
North Wall

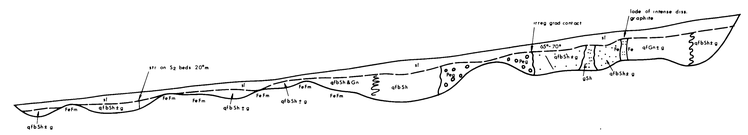


% GRAPHITE

SAMPLE NUMBER

0 5 10 15 20 25 30 35 40 45 50 54

TRENCH 13 (10 300 N)
North Wall

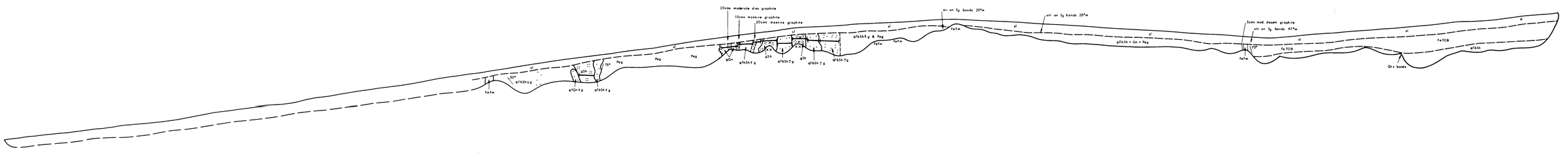


% GRAPHITE

SAMPLE NUMBER

0 5 10 15 20 25 30 35

TRENCH 12 (10 200 N)
North Wall



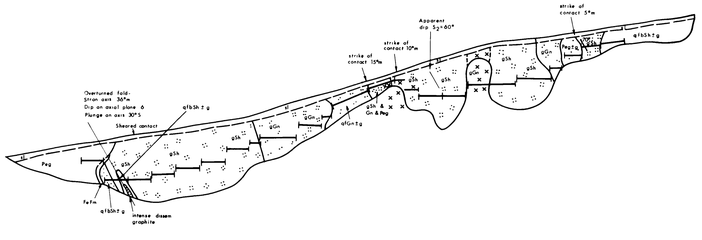
% GRAPHITE

SAMPLE NUMBER

8649	8641	8642	8643	8644	8645	8646	8647	8648
13·4	0·45	2·95	5·60	11·8	1·55	11·3	1·15	0·95

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

TRENCH 14 (10 125 N)
North Wall



% GRAPHITE

SAMPLE NUMBER

8618	8619	8620	8621	8622	8623	8624	8625	8626	8627	8628	8629	8630	8631	8632	8633	8634	8635	8636	8637	8638	8639	8640
0·55	3·60	24·2	23·8	25·0	20·5	22·2	20·1	3·10	12·1	13·4	1·55	9·65	9·25	21·1	22·3	17·5	21·0	18·9	0·50	0·50	10·2	1·30

0 5 10 15 20 25 28·5

LEGEND

- sl — Soil
- FeTOB — Ferruginsed transported overburden on Laterite
- qfbsh±g — Thin banded Qtz-feld-biot schst ± graphite
- gsh — Graphitic schist
- qfGn±g — Poorly banded Qtz-feld gneiss ± graphite
- qGn — Graphitic gneiss
- Peg±g — Pegmatite ± graphite
- fefm — Iron formation or intense pervasive ferruginisation
- Q — Quartz segregation
- · — Lower ( )
- ·· — Medium (10-20 Vol%)
- ∴ — High (20-30 Vol%) } concentrations of graphite
- ×,× — Magnesite nodules
- grt — Garnet
- Brecciation/pebbley effect
- Gradational change
- 8614 — Channel sample
- 50° — Apparent dip of S_2 compositional bands

PANCONTINENTAL MINING LIMITED
PANCON EXPLORATION DIVISION

KOPPIO GRAPHITE PROJECT
E.L.1142 - SOUTH AUSTRALIA

GEOLOGY OF TRENCHES 12, 13, 14 AND 15

SCALE 1:100

0 2 4 6 8 10
METRES

Compiled J.G.	Date AUGUST, 1985	Dwg. Nº 21/D/8
Report Nº 86/16	Map Ref. SI 53-11	PLATE 3

5233-27

Tenement:	E.L. 1142, Eyre Peninsula
Holder:	Pancontinental Mining Limited
Area:	296 sq.km
Reporting Period:	May 27 to August 26, 1986
Work Completed:	Metallurgical evaluation of bulk samples of graphite mineralisation from Kookaburra Gully continue to be undertaken at Warman International. Results to date indicate that, while it is possible to obtain high carbon (greater than 90%) relatively coarse flake, the total recovery of such flake is very low and would not be sufficient to make the project economic. Further test work is now being conducted to determine whether it is possible at a reasonable cost to increase the recovery of the coarser flake.
Expenditure:	The expenditure for the quarter totalled $2,133.

Tenement: EL 1142, Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 296 sq.km

Reporting Period: August 27, to November 26, 1986

Work Completed: Metallurgical evaluation of bulk samples of graphite mineralisation from Kookaburra Gully was undertaken by Warman International. The recent test work was conducted to determine whether it was possible, at a reasonable cost, to increase the recovery of the coarser flake. However, it was found that there appears to be no advantage gained in treating coarser crushed material. A petrological study was conducted with the following comments:

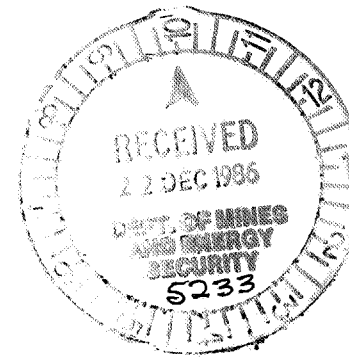
a) Contaminants of calcite could possibly be leached out using HCl.

b) The graphite is generally long and narrow.

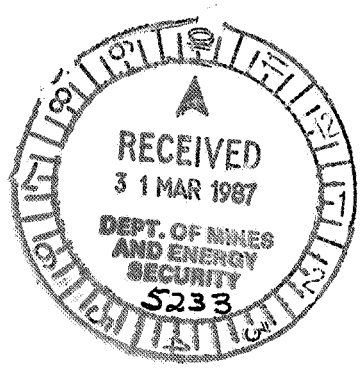
c) Some contamination occurs with muscovite, quartz and limonite.

d) About half the graphite is deformed and not regular in shape.

Expenditure: The expenditure for the quarter totalled $10,470.



Tenement:	EL 1142, Eyre Peninsula
Holder:	Pancontinental Mining Limited
Area:	296 sq.km
Reporting Period:	November 27, 1986 to ? February January 26, 1987
Work Completed:	No field work was conducted during the reporting period. A review of the recent metallurgical test work was conducted and contact was maintained with international graphite consumers.
Expenditure:	The expenditure for the quarter totalled $2,031.00



Report No. 87/84

0157

PANCONTINENTAL MINING LIMITED

EL 1142
KOPPIO PROJECT
SOUTH AUSTRALIA

ANNUAL REPORT FOR THE PERIOD
27 MAY 1986 TO 26 MAY 1987

By R.M.D. Meares

Distribution

Original
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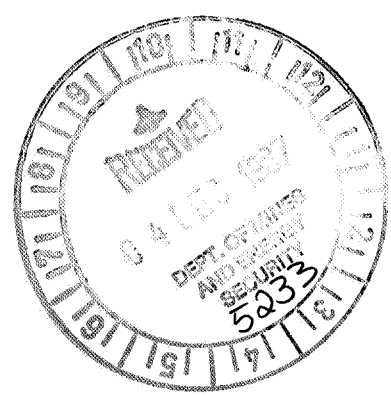
Copy 2: PML File 8542
Copy 3: Department of Minerals and Energy



CONTENTS

FIGURES

APPENDIX

1. INTRODUCTION

EL 1142 in the Eyre Peninsula of South Australia is the subject of on-going exploration programs to evaluate the graphite potential of the Proterozoic metamorphic sequences in the area.

This report details exploration activities conducted in the twelve month period to 26 May 1987.

2. TENURE

EL 1142 was granted to Pancontinental Mining Limited over an area of 296 sq km on 27 May 1983. The licence was renewed on 27 may 1987 over a reduced area of 91 sq km.

3. WORK COMPLETED

Following the extensive trenching program conducted in 1985-86, the principal activities completed in the reporting period have focused on the mineralogy and metallurgical recoveries of the bulk samples of graphite mineralisation collected from the trenches at Kookaburra Gully. This has been necessary for although an indicated resource of approximately 800,000 tonnes of graphitic mineralisation can be envisaged to a depth of 50m at an average grade of 11.4% carbon, previous mineralogical studies indicated that concentrates grading +85% carbon have an average flake size of less than 150 microns. This is below the average flake size required (150-200 microns) for the deposit to be considered of commercial value.

The metallurgical testwork during the reporting period was conducted on a 200 kg representative bulk sample collected from the trenches. Warman International crushed the sample to minus 3mm, and then riffle split off 60kg which was further split into four 15kg representative samples for floatation concentration and sizing analysis (refer Appendixes 1 and 2).

In addition, splits of two Warmans samples were sent to Radex in Austria for further metallurgical evaluation (refer Appendix 3). Radex was selected as they are a major processor and marketer of graphite products on the international scene.

A review of the Warman testwork and associated mineralogical studies by Pancontinental's Group metallurgist is included as Appendix 4.

4. CONCLUSIONS AND RECOMMENDATIONS

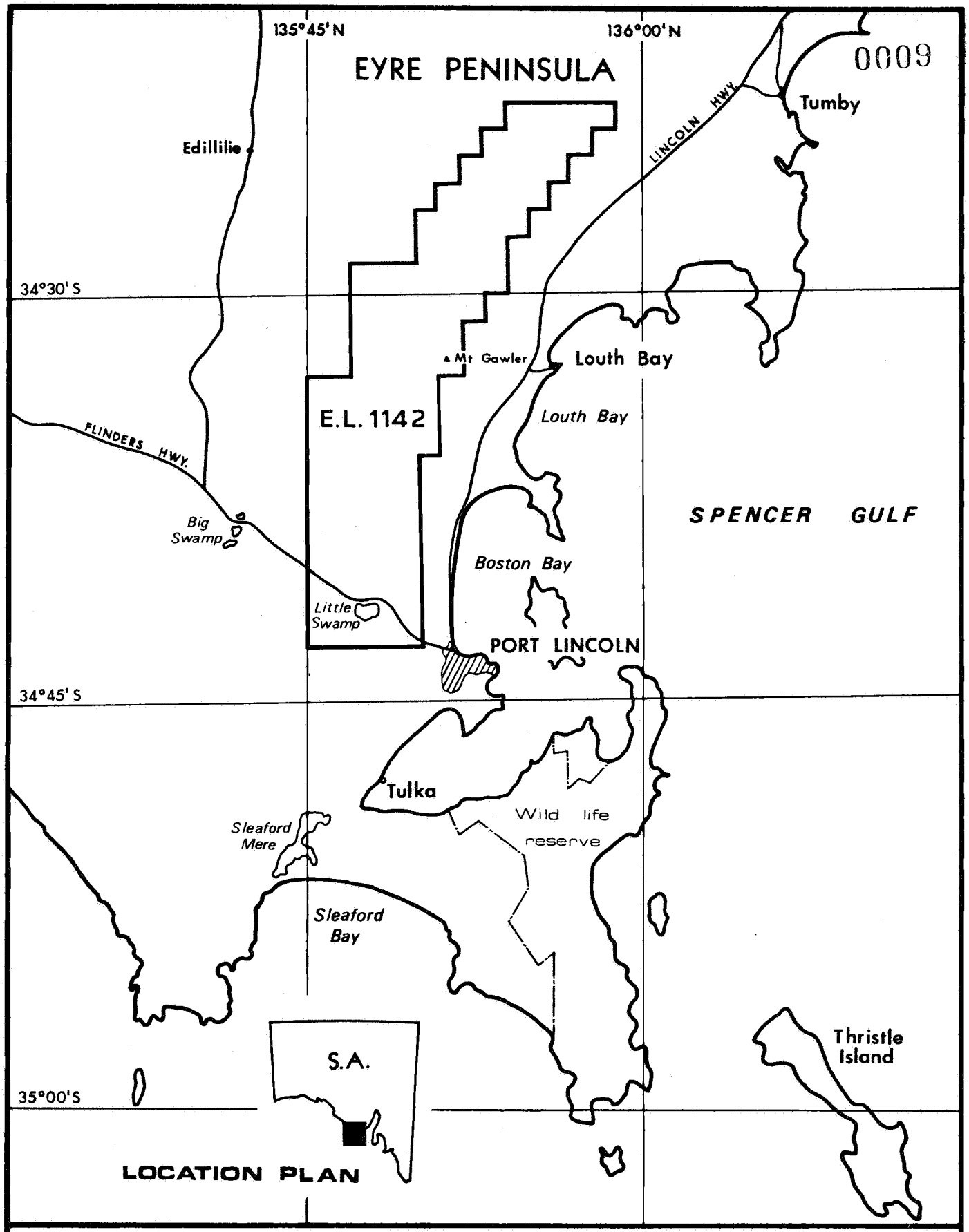
Metallurgical testwork conducted during the reporting period has confirmed that the graphite flakes are generally long and narrow, with average flake size less than 150 microns. If a plus 150 micron product was produced in a mining operation, this is likely to have a grade of +90% carbon, recovery of only 12-15%, and the resultant product would comprise 2-3% of the mill feed.

The proposed work program during the extension period will include further on-going metallurgical testwork aimed at optimising the recovery of coarse flake graphite, continuing marketing studies including liaison with potential consumers, and further reconnaissance geological mapping and outcrop rock chip/channel sampling to evaluate the grade and mineralogical character of other zones of flake graphite on EL 1142.

5. EXPENDITURE

	$
Manning	642
Material & Supplies	101
Assaying	7,375
Consultants & Contractors	3,735
Travel, Freight & Equipment	522
Administration	423
Overheads	1,836
TOTAL	$14,634

Total Project expenditure to 26 May 1987 amounted to $159,099.



EYRE PENINSULA - E.L. 1142

LOCATION PLAN

0 5 10 15 km

Scale 1:250 000

REPORT No.: 84/15

FIG. 1

APPENDIX 1

B.J. BARRON, B.Sc., Ph.D., (Sydney)
PETROLOGIST

7 Fairview Ave.,
St. Ives,
SYDNEY NSW 2075
Tel. (02) 449 5839

Our ref: P6/82/365a

Your ref: Letter of 1st September 1986 from Warman International Ltd.

DETAILED PETROGRAPHIC EXAMINATION OF GRAPHITE CONCENTRATES FROM KOOKABURRA GULLY, PORT LINCOLN, SOUTH AUSTRALIA.

Report No: P6/82/365a

19th September, 1986.

For: Pancontinental Mining Limited.

J. Barron.

Dr. B.J. Barron,
Consulting Petrologist.

Sample No. Product 1 0163

Type Graphite concentrate. — Ore type Grade #1

Description of Concentrate

A mid-grey medium grained concentrate containing visible red-brown (?ferric oxide) and white contaminant grains. On stereo-binocular microscope examination numerous grains reacted strongly with cold dilute HCl indicating the presence of significant calcite. The sample is not magnetic.

Polished Thin Section In this sample of graphite concentrate there is an overall grain size range from less than 0.1 mm up to 0.9 mm (and 0.3 mm across) for certain elongate grains. Most grains however, are within the size range 0.2 mm up to 0.4 mm across. The sample has the following approximate modal composition;

carbonate (calcite)	45%
quartz	25%
graphite	10-12%
muscovite (or sericite)	5%
limonitic oxides and degraded ?titaniferous opaque oxides	8%
tourmaline	5%

The carbonate is present as irregular shaped to angular aggregates of exceptionally fine grain size, and several aggregates show concentric and radial structures consistent with deposition from solution. The carbonate aggregates very commonly enclose aggregates of graphite flakes of very variable size from less than 0.02 mm up to more than 0.2 mm long. Many of the latter are wispy foliated plates and aggregates less than 0.01 mm thick.

Quartz grains are angular and broken and commonly occur in aggregates. The average grain size for this phase is about 0.15 mm with a range from 0.07 mm to 0.5 mm. The granular quartz is strained and fractured and many grains are intergrown with graphite flakes and carbonate.

Graphite flakes have a very variable size, ranging up to a maximum length of about 0.45 mm (450μ) and 0.7 mm (70μ) thick, although individual cleavage laminae within these flakes are in the order of 0.1 mm (100μ) to 0.15 mm (150μ) thick. Sparse aggregates of flakes reach 1 mm (1000μ) long by 0.5 (500μ) mm wide, but individual flakes within these aggregates have a variable but average length of only about 0.16 mm (160μ) and width of about 0.1 mm (100μ). Individual flakes and small aggregates of graphite that are not enclosed within carbonate ± quartz aggregates, have an average length of about 0.2 mm (200μ) and thickness of about 0.04 mm (40μ). Shapes of graphite flakes are generally lensed and gently curved defining a somewhat wavy foliation. There are almost equally numerous flakes that are essentially straight. Minor aggregates of graphite flakes are intergrown with chlorite.

Sparse ragged flakes of muscovite and sericite, as well as rare partly degraded and clouded biotite flakes range in size from only 0.15 mm long and 0.3 mm wide up to 0.55 m long and 0.2 mm wide. Several muscovite flakes are intergrown or interlayered with graphite.

Red-brown limonitic oxides stain lithic aggregates of carbonate, graphite and quartz and also occur as individual grains of red- and yellow-brown translucent to almost opaque limonite, hematite ± goethite.

Strongly pleochroic dark yellow-brown to pale yellow-brown accessory tourmaline grains tend not to enclose graphite flakes.

Sample No. Product 2

Type Graphite concentrate

Description of Concentrate

A medium grained mid-grey concentrate containing sparse red-brown and pale grey to white grains. Stereo-binocular

examination of the concentrate reveals a strong reaction of many grains with cold dilute HCl indicating the presence of significant calcite. There are no magnetic grains present.

Polished Thin Section The observed grain size range for this concentrate is within the limits of less than 0.06 mm up to more than 1.0 mm (length) and 0.4 mm (width). Most grains however, are within the range 0.3 mm up to 0.5 mm across. An approximate modal composition for the sample is as follows;

carbonate (calcite)	38%
graphite	25-27%
quartz	18%
sericite (or muscovite etc.)	7%
limonitic oxides	7%
accessory fibrolitic sillimanite and tourmaline 3%	3%

The carbonate is similar to that in the previous sample (Product 1). It is exceptionally fine grained (individual grains are generally less than 0.01 mm across), and dense aggregates enclose grains and aggregates of quartz, graphite, and rarely muscovite. The carbonate aggregates comprise mostly calcite (see strong reaction with cold dilute HCl above). The carbonate aggregates have angular to irregular shapes, and certain of these exhibit subradiating as well as banded colloform textures.

Graphite in this sample occurs both as isolated flakes and aggregates, as well as intergrown with carbonate, quartz and rarely "sericite" or muscovite. The graphite flakes once again exhibit a very variable grain size with wispy flakes less than 0.02 mm (20μ) long, ranging up to substantial flakes more than 0.5 mm (500μ) long and 0.1 mm (100μ) wide. Most flakes have gently curved shapes, an average length of about 0.3 mm (300μ) and widths generally less than 0.05 mm (50μ). Dense aggregates of graphite in this sample comprise lensed and tapered flakes and laminae with an average length of about 0. 2mm (200μ), and width of about 0.02 mm (20μ).

The quartz occurs as medium to coarse angular grains and aggregates with a grain size reaching more than 0.5 mm across. The grains show strain shadows and are densely fractured with sparse graphite flakes (generally less than 0.2 mm (200μ) long and 0.03 mm (30μ) wide), located along grain boundaries.

Sparse muscovite (and/or sericite) flakes commonly enclose small graphite flakes subparallel to the direction of kink folds in the muscovite. The partly deformed stout muscovite flakes range in size up to 0.6 mm long and 1.3 mm across with wispy narrow lensed interlayer inclusions of graphite.

Yellow- and red-brown dusty limonitic oxides stain carbonate aggregates, and also comprise dense translucent to opaque aggregates of these oxides, including ?goethite. Some aggregates of graphite flakes are interlayered with, or else enclose interstitial patches of limonitic oxides ± quartz ± carbonate.

Accessory aggregates of very fine grained but clouded wispy fibrolitic sillimanite are partly converted to sericite ± minor graphite.

Sample No. Product 3

Type Graphite Concentrate Gravity Product #3

Description of Concentrate

A dark grey medium grained concentrate containing sparse pale yellow-brown limonitic oxide stained grains and pale grey to white grains that react strongly with cold dilute HCl indicating the presence of significant calcite.

Polished Thin Section This is a slightly coarser grained concentrate than the previous sample Product 2. Its grain size ranges up to a maximum of about 1.5 mm (1500μ) for elongate graphite flakes about 0.4 mm (400μ) thick. However the average grain size for the sample lies within the

range 0.35 mm and 0.6 mm. The approximate modal composition for the sample is as follows;

graphite	55%
carbonate	18%
quartz	10%
muscovite (including sericite and degraded fibrolitic sillimanite)	5%
limonitic oxides	4%
very fine grained aggregates of low birefringent clay	3%

Graphite flakes in this sample have ragged but fairly straight to gently curving shapes with irregular outlines parallel to the cleavage surfaces. Many of these are in the order of 0.65 mm (650μ) x 0.5 mm (500μ) across, and these plates have a somewhat variable thickness mostly in the range 0.05 mm (50μ) up to 0.1 mm (100μ). About a third of the graphite flakes occur in lithic aggregates intergrown with carbonate ± granular quartz ± muscovite (or sericite), as well as degraded fibrolitic sillimanite. Red- and yellow-brown dusty limonitic oxides heavily stain certain carbonate aggregates and coat sparse quartz/graphite grain boundaries. Graphite flakes in this sample are generally coarser grained than those in the previous two samples, with certain flakes reaching more than 1 mm (1000μ) long and more than 0.06 mm (60μ) wide.

As in the previous samples Product 1 and Product 2), the carbonate is extremely fine grained and reacts strongly with cold dilute HCl indicating the presence of dominant calcite. The carbonate occurs in lithic aggregates enclosing wispy graphite flakes ± angular quartz chips, and is variously stained by dusty limonitic oxides.

Quartz grains mostly are present in granular lithic aggregates intergrown with "matted" clusters of unoriented wispy graphite flakes or else in granular aggregates (with an average grain size of about 0.2 mm), with fine grained carbonate developed along quartz/quartz grain boundaries.

Sparse ragged muscovite flakes that reach 0.5 mm long and 0.25 mm wide commonly enclose numerous small unoriented graphite flakes. Small lithic fragments comprise graphite intergrown with quartz and degraded wispy sericite. Elsewhere are elongate straight pale brown briefringent layer silicate flakes with interlayered narrow graphite flakes.

Small irregular aggregates of limonitic oxides include finely banded colloform deposits but mostly this phase occurs as red-brown limonitic oxide dust staining carbonate-rich and other lithic aggregates.

Sparse accessory low birefringent clay is present in dense wispy unoriented fibrous aggregates intergrown with small clusters (up to 0.2 mm across) of minute graphite flakes. Rare relict "islands" of fresh sillimanite are set in certain of the clay aggregates.

Sample No. Table/float concentrate 4

Type Graphite Concentrate

Description of Concentration

A dark grey medium grained sample containing numerous small pale grey to white, as well as yellow-brown oxidised grains. As in previous samples the pale grey to white grains react strongly with cold dilute HCl indicating the presence of significant calcite.

Polished Thin Section Grain size in this sample of graphite concentrate ranges up to a maximum of about 1 mm across, with sparse flakes measuring 1 mm (1000μ) x 0.7 mm (700μ) and of variable thickness (mainly in the order of 0.15 mm to 0.20 mm). The sample comprises the following approximate proportions of phases;

graphite	60%
carbonate	20%
quartz	15%
limonitic oxides	
accessory phases (including tourmaline, sericite, and low birefringent clay).	5%

The graphite in this sample occurs as fairly straight to gently curving well cleaved ragged flakes with an average length of about 0.6 mm (600μ) and average thickness of about 0.05 mm (50μ). The flakes are quite ragged and commonly exhibit narrow lensed interlayer development of very fine grained silicate phases and aggregates. At least 20% of the graphite in this concentrate is attached to or enclosed within aggregates of host lithology including dominant, extremely fine grained carbonate, as well as almost equally abundant aggregates of granular quartz. Accessory aggregates of "sericite", coarse flakes of muscovite and oxide stained carbonate ± clay also partly enclose graphite flakes. The aggregates of flakes associated with host material are generally much finer grained than the individual ragged flakes (see micro-photographs), with individual lengths of wispy narrow flakes less than 0.15 mm (150μ).

Once again the carbonate is invariably extremely fine grained calicte (see above strong reaction with cold dilute HCl). The aggregates of this phase are intergrown with sparse small quartz grains, graphite flakes and rarely sericite.

Quartz grains tend to occur in granular aggregates with an average grain size of about 0.25 mm. Several aggregates are intergrown with fibrous wispy sillimanite sites (now converted to sericite), that are well oriented parallel to and defining the foliation. Elsewhere are quartz aggregates enclosing sparse graphite flakes; while others include accessory tourmaline. Only very few grains and aggregates of quartz are monomineralic.

Dusty limonitic oxides mostly stain oxidised carbonate aggregates and layer silicates, but several translucent to almost opaque limonitic oxide grains are also present.

Sample No. Graphite Concentrate 5 Final Product.

Type Graphite Concentrate

Description of Concentrate

A dark grey concentrate of medium grained flakes

in which only sparse pale grey grains and even fewer pale yellow-brown grains and aggregates are observed using stereo-binocular microscope. The sparse pale grey grains react strongly with cold dilute HCl indicating the presence of calcite.

Polished Thin Section Only about 10% of this sample consists of material other than graphite. The contaminant grains include approximately equal proportions of quartz and aggregates of extremely fine grained carbonate. Such grains are in the order of 0.15 mm up to 1 mm across, (mainly about 0.4 mm) and have highly irregular to angular shapes. The carbonate aggregates are almost certainly calcite (see above reaction with cold dilute HCl), and several of these enclose abundant unoriented flakes of graphite (mostly less than 0.25 mm), while others enclose small angular quartz chips. Several carbonate aggregates show colloform banding and subradial grain growth.

The quartz grains however, have an individual grain size of about 0.2 mm to 0.3 mm and occur as granular aggregates as well as individual angular grains. The coarser quartz grains and aggregates generally are not associated with or intergrown with graphite flakes.

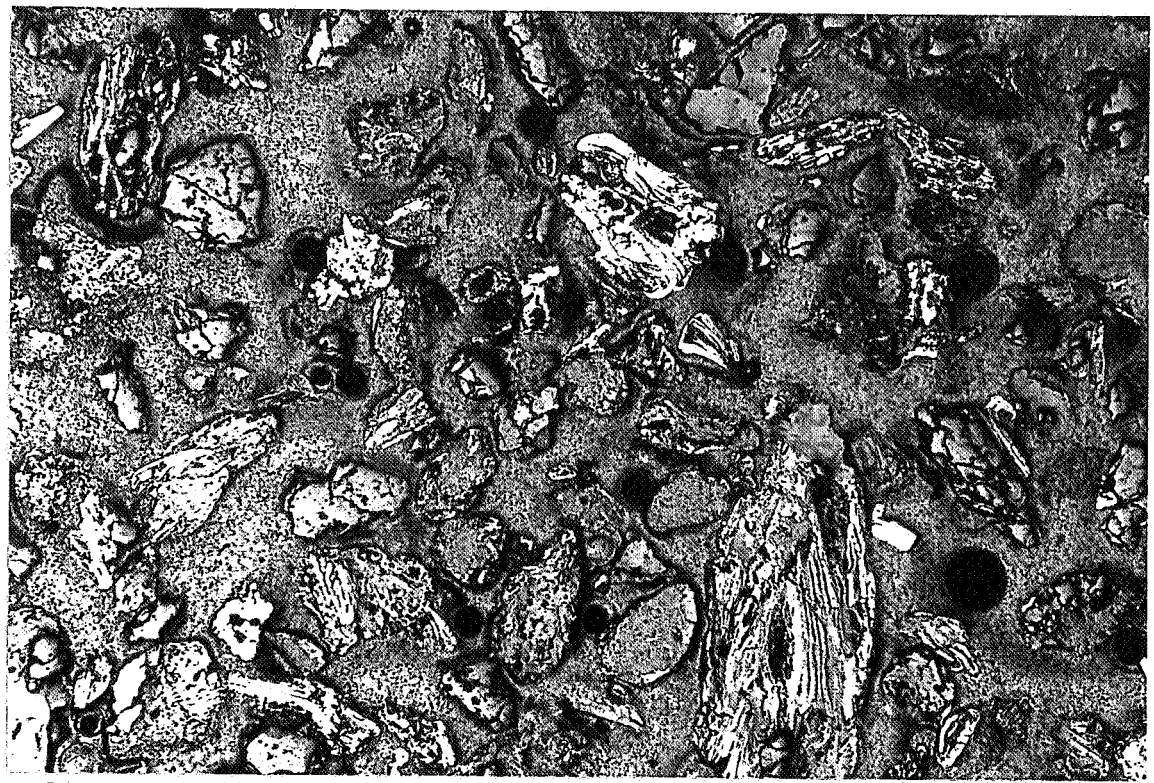
Sparse accessory contaminants include sericite flakes, several of which are intergrown with graphite flakes, rare, very fine grained (?carbonate) aggregates that are heavily stained by yellow-brown limonitic oxides, and several well foliated aggregates of degraded ?fibrolitic sillimanite now converted to birefringent clay ± limonitic oxide dust.

The graphite in this sample consists mainly of fairly straight or gently curved but well cleaved flakes with an average size of about 0.5 mm (500μ) long and 0.05 mm (50μ) thick. Aggregates of flakes reach up to 1.5 mm long (1500μ) and 0.7 mm (70μ) across, but the average length for individual flakes in the aggregates is mainly less than 0.3 mm (300μ), with variable widths up to 0.06 mm (60μ). Where aggregates of flakes are attached to or associated with host rock, the latter is mostly fine grained carbonate with subordinate granular quartz, muscovite (or sericite), traces of degraded sillimanite and minor limonitic oxide dust.

PHOTOMICROGRAPHS

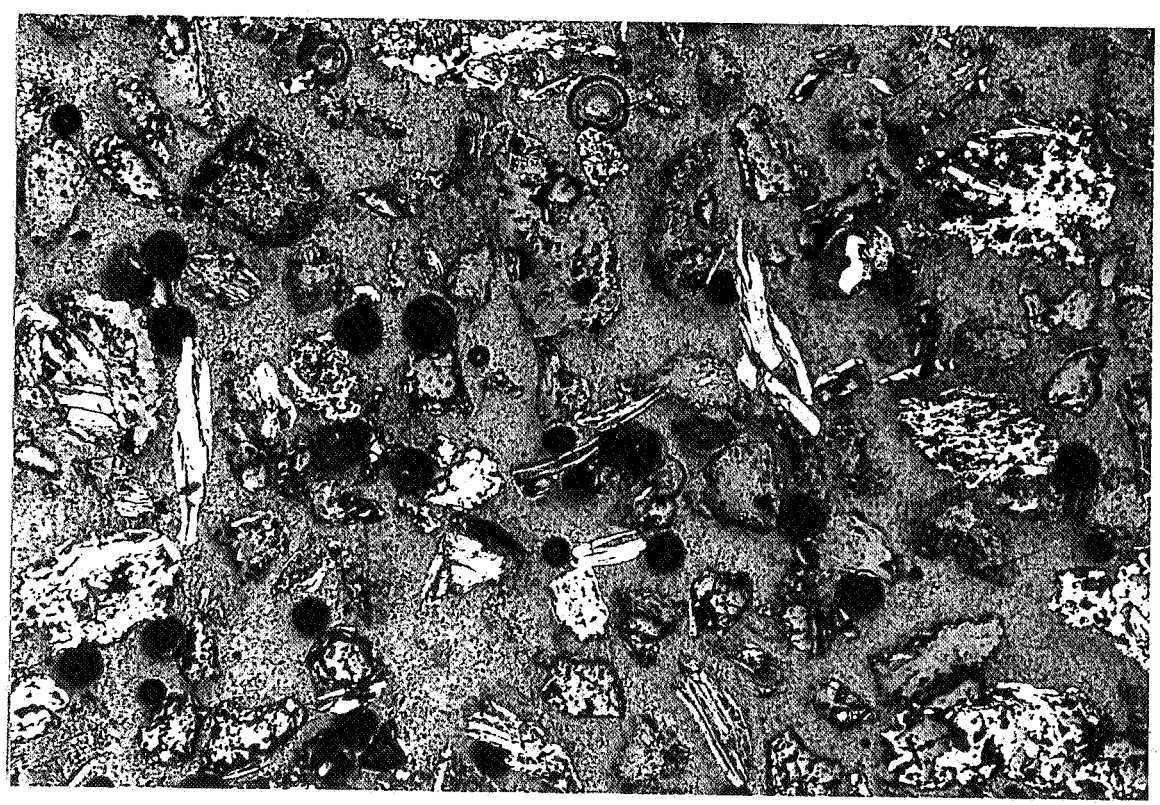
All photomicrographs are taken in reflected light at a scale of 6 cm = 1 mm (1000μ).

1 mm (1000μ).



Sample No.: Product 1

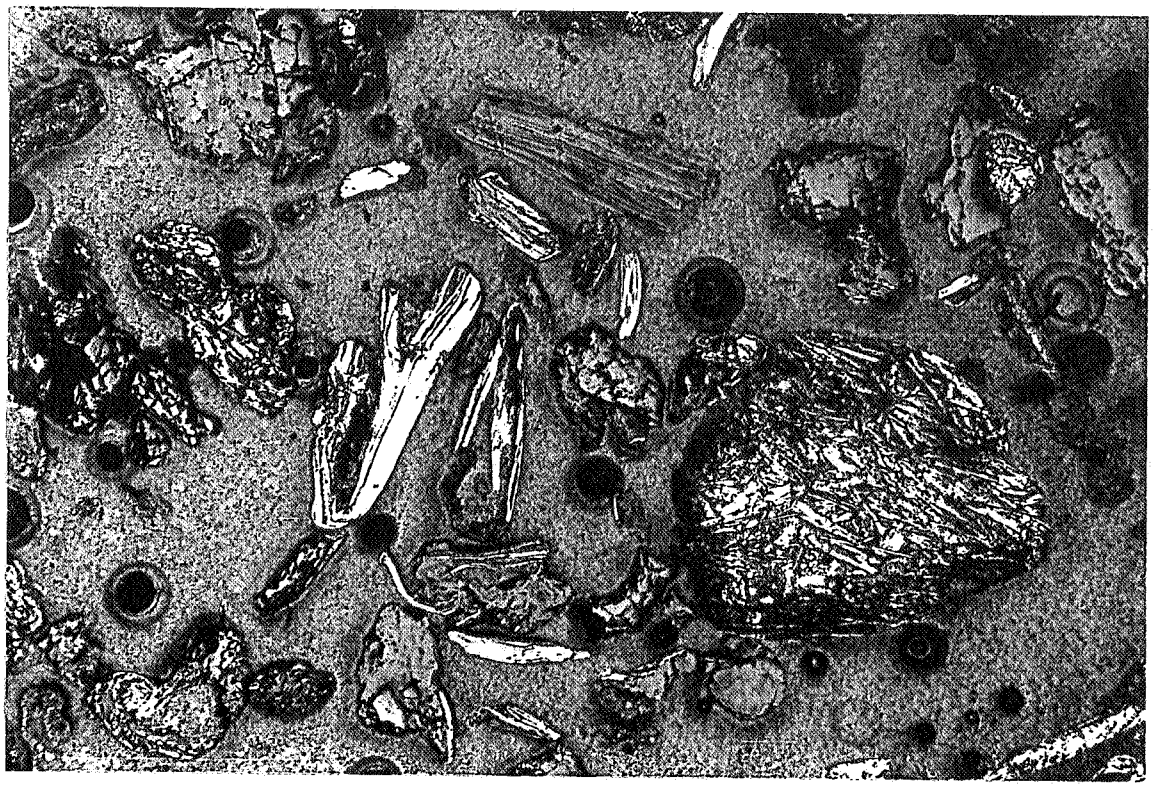
Wispy graphite flakes are in aggregates intergrown with host rock material as well as sparse individual flakes.



Sample No. Product 1

Wispy individual graphite flakes show partly deformed and separated cleavage laminae.

Scale: 1 mm (1000μ)



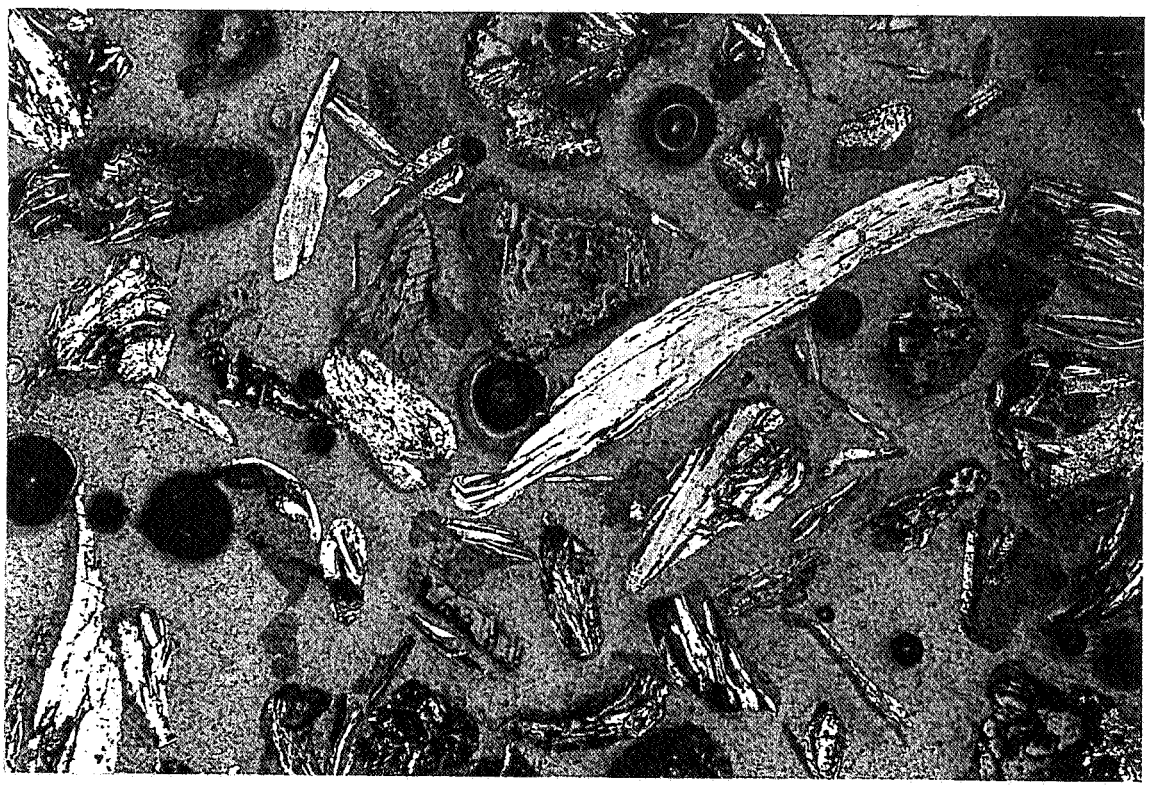
Sample No.: Product 2

Aggregates of unoriented graphite flakes are much finer grained than individual well cleaved graphite flakes.

Sample No.: Product 2

Certain large graphite "flakes" appear to be aggregates of much finer wispy flakes, while others are coarse flakes with cleavage surfaces possibly disrupted by thin section preparation. Much smaller flakes are intergrown with host rock material.

Scale: 1 mm (1000μ)



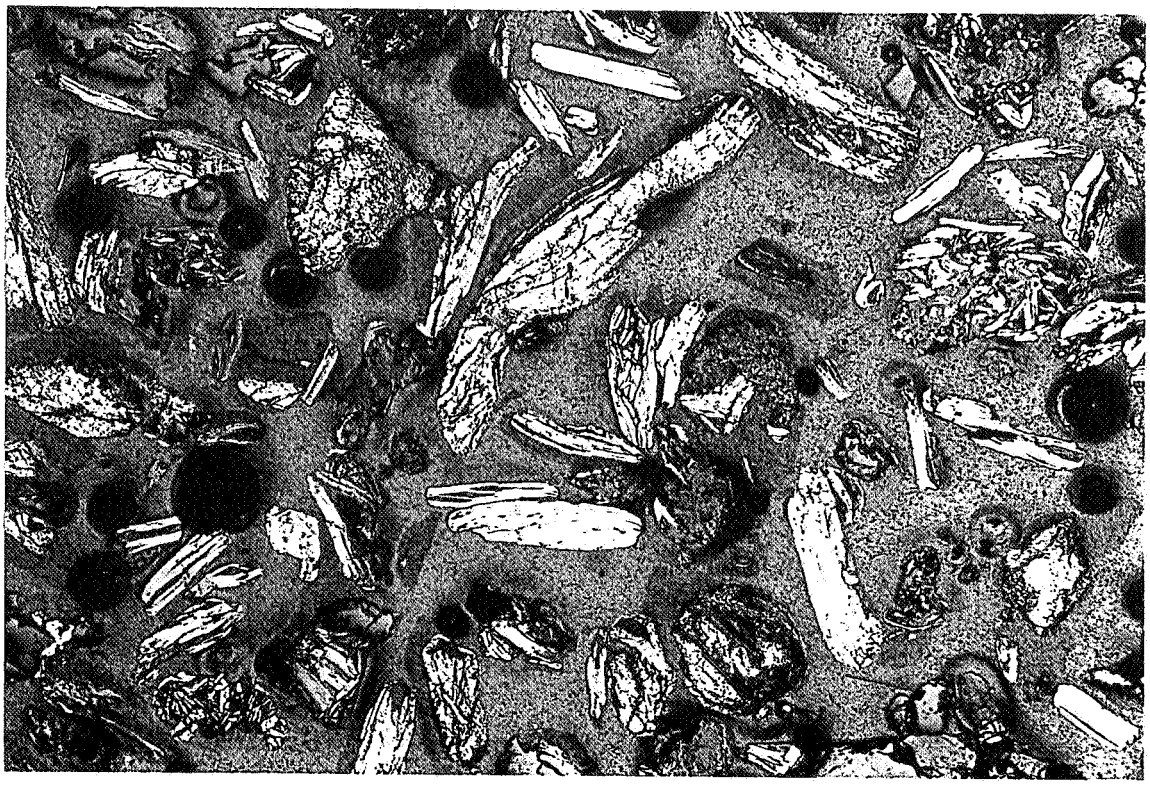
Sample No.: Product 3

Flakes vary in length up to 1 mm (1000μ) but most are smaller than this, especially where they occur in aggregates intergrown with original host rock matrix.

Sample No.: Product 3

About a third of all graphite flakes are attached to or intergrown with fine grained host material.

Scale: 1 mm (1000μ)



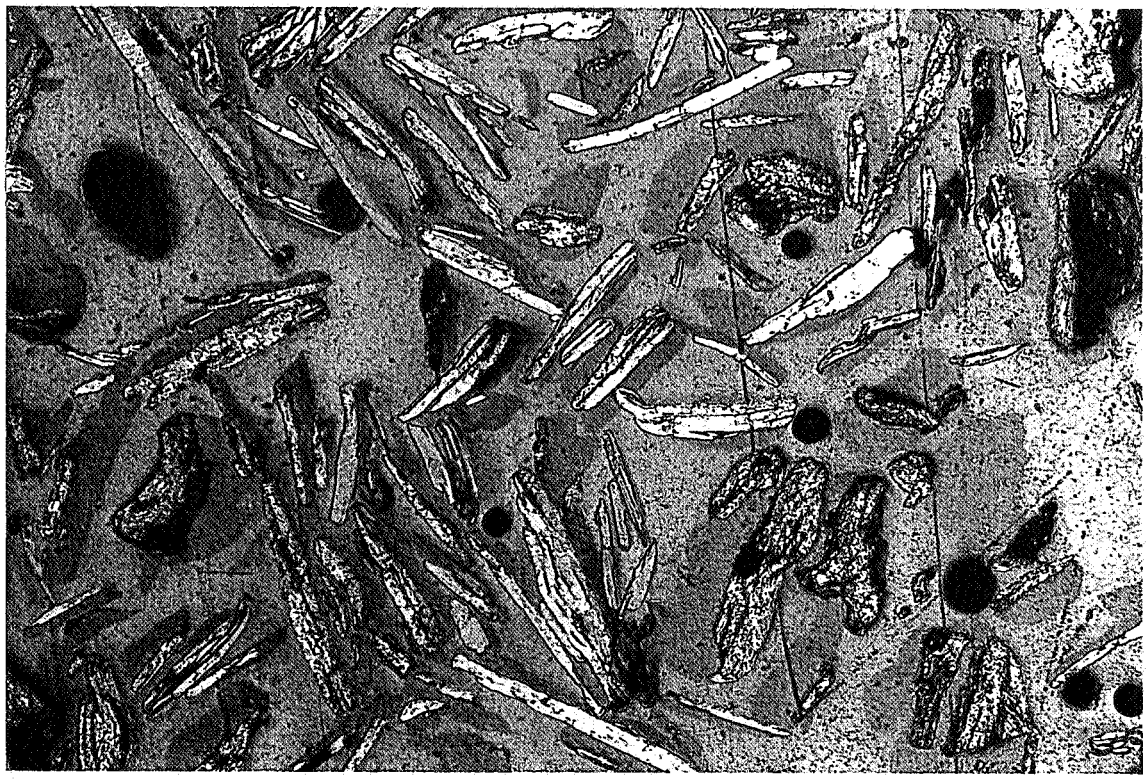
Sample No.: Table/float Concentrate 4

Some coarse straight flakes are present of variable lengths (c.f. scale above), while aggregates tend to be much finer grained.

Sample No.: Table/float Concentrate 4

Fairly straight flakes are characteristic, but still about a third to half of the flakes occur in dense clusters or else are attached to or intergrown with fine grained host rock.

Scale: 1 mm (1000μ)



Sample No.: Graphite Concentrate 5

Straight and gently curved well cleaved graphite flakes with an average length of about 0.5 mm (500μ) are dominant, with subordinate finer grained aggregates.

Sample No: Graphite Concentrate 5

Several aggregates of unoriented narrow flakes are intergrown with host rock, while individual flakes vary in width (up to 0.8 mm (80μ)), and length up to 0.6 mm (600μ).

Note: Extra photographs of the samples are numbered on reverse side of photograph.

APPENDIX 2

WARMAN INTERNATIONAL LTD.
A member of the WARMAN INTERNATIONAL GROUP Incorporated in Queensland

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SFR:sh
86/2527

RESEARCH & DEVELOPMENT DIVISION

September 1, 1986

MEMO TO: MR. R. NICE
PANCONTINENTAL MINING LTD

FROM: S.F. RAYNER

SUBJECT: KOOKABURRA GULLY GRAPHITE

We have processed 30 kg of material after first crushing to minus 3 mm as shown in the schematic attached.

Despite the coarser feedstock we have still only made a 5% by weight high grade (87.5%) product. This equates to the recovery obtained in the 1985 program and that on the 15 kg batch test reported by telex on June 25. The only improvement is that this time 65% of the product is at +150 µm compared to 50% previously. Not really a great success.

Attempts at recovering more graphite at grade by remilling the initial flotation tailing produced only another 1.8% by weight product at 58% graphite. This is similar to previously and hardly seems worth it.

Attempts at recovering coarse flake from the initial coarse low grade table product by re-flotation could only produce another 0.7% by weight at 57% grade.

The weight % referred to relates to the total ore weight as shown in the attached table. Recovery of graphite to the main 87.5% grade product above was 22.7%. Some 56% of the graphite was rejected as minus 150 µm from screening leaving 20% not recovered.

I have today sent some fractions to Dr. Barron for examination as described in the attached letter. Despite indications to the opposite in her report on the untreated material, I am convinced that much of the graphite is fine when liberated from the gangue and is not due to excessive work from milling.

S.F. Rayner

S.F. Rayner

Encls.

WARMAN INTERNATIONAL LTD.

(INCORPORATED IN QLD.)

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RESEARCH & DEVELOPMENT DIVISION

SFR:sh
86/2526

September 1, 1986

Dr. B.J. Barron
Consulting Petrologist
7 Fairview Avenue
ST IVES NSW 2075

Dear Joan,

re: KOOKABURRA GULLY GRAPHITE

Please find enclosed three sets of samples for mineralogical examination with an overview of describing the natural flake size, the nature of the contaminant and the association of the contaminants with the graphite. The fractions represent the best that we have been able to produce but with a target of 90+% grade at +150 µm size you will see by the descriptions below we are struggling a little.

1. Graphite concentrate - this is the premium product representing 5% by weight of the original feed. It assays 87.5% graphite. When assessed by sizing and analysis it had the following make up:

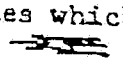
size	weight %	% graphite
+300 µm	10	85.5
+150 µm	55	89.8
-150 µm	35	83.6

2. Table/float concentrate - this fractions at 0.8% by weight, assaying 57% graphite contains some of the coarse, potentially premium quality graphite. We have attempted to upgrade it without resorting to further milling which could destroy the flake size. It grades 80% plus 150 µm.

3. Second stage gravity products - there are three fractions here which represent losses of plus 150 µm graphite (much of the other graphite loss has been as minus 150 µm material which is not economically as valuable). The fractions assay as follows;

product	1	10% graphite
	2	22% "
	3	58% "

.../2

Another factor that I would like you to comment on if possible, is the natural flake size, particularly in the graphite concentrate. I am of the opinion that much of what we are calling coarse graphite is in fact made up of booklets of smaller flakes which when overlapping give the impression of a larger flake, i.e.  . The overlapping flakes may contain or be attached to contaminant grains and as we process the material to liberate the grains we also separate flakes making only minus 150 µm product which we then throw away.

Your comments together with our mineral processing attempts are liable to influence greatly the viability of this development, so I am keen to present a factual case, be it positive or negative and would be pleased to discuss any point with you.

Another point on which I cannot throw a great deal of light on is the acceptability of flakes of graphite that are more than 150 µm long yet may not be very wide, i.e. needle-like flakes. These all have the potential of passing a 150 µm screen and in our processing have been rejected. I don't expect you to have any real comment on this aspect but you might note if the remaining flakes as spherical or elongated.

Please send your report and invoice to Angus Collins of Pancontinental with a copy to me.

Yours sincerely,

S.F. Rayner

S.F. Rayner
Senior Metallurgist - Process Testing

Encls.

p.c. R.W. Nice, A.R. Collins, Pancontinental Mining Ltd

WARMAN INTERNATIONAL LTD.

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86/2534

RESEARCH & DEVELOPMENT DIVISION REPORT

Report 86/184841

Developmental Metallurgical Testing

of

Kookaburra Gully Graphite Ore

for

Pancontinental Mining Limited

S.F. Rayner
P.J. Christison

September 5, 1986

C O N T E N T S

SUMMARY

Three parcels of 18% grade graphite ore from Kookaburra Gully have been processed along the same lines as previously (Warman report 85/171169). The process incorporated crushing, screening, flotation and Wilfley table upgrading. Despite modifications mainly to the initial crushed size the recovery of plus 150 µm graphite grading 90^{+}% was similar, i.e. 20-25% of the total graphite in 5% by weight.

Distribution of the graphite was as follows;

minus 150 µm reject fractions	56%
product	22%
low grade 57% products	5%
slimes from processing	13%
other fractions	4%

As shown the major loss is as minus 150 µm screen reject. The material seems to break down readily releasing the graphite into its natural flake size which although put at predominantly longer than 150 µm by the petrologist seems to be elongated, thus allowing it to pass the screen. Thus the definition of 150 µm graphite might need clarification if recoveries are to be improved.

Product and process fractions have been sent independently to Dr. B.J. Barron for examination to describe flake size, the nature of the contaminant and the association of the contaminants with graphite.

1. INTRODUCTION

In March 1985 Warman reported on the processing of Kookaburra Gully graphite for Pancontinental using a combination of flotation, gravity concentration and sizing with the objective of producing premium quality graphite of 90^{+}% grade in the plus 150 µm size range. A tabulation of the results obtained is reproduced in the Appendix. In terms of processing, the results were encouraging with a relatively inexpensive set of unit operations producing 92% grade product. On the debit side only 17% of the contained graphite was recovered to this fraction, most of the remainder being rejected in the minus 150 µm screening operations.

In this second attempt at treating the material, the same process route was proposed with modifications, the most significant being to start with coarser feed to minimise breakage of graphite flakes. About 500 kg of new feed was supplied being taken from Trenches 4 and 14 grading about 16% graphite.

Petrographic exmaination of the Trench 14 material identified the graphite as being within the range 200-400 µm long and 20-30 µm wide. Being a little selective in the extractions from the above report, the graphite seems to be evenly dispersed in wavy trails and lensed clusters in a granular host rock approximated at 50% quartz, 25% graphite, 15% argillic material, 5% dusty limonitic oxides plus 5% accessory phases.

2. PREPARATION OF TEST SAMPLE

The total 500 kg of sample received in April 1986 in 15 x 25 litre drums plus 4 boxes was stage crushed to pass a 6 mm screen, blended and riffle divided to give equivalent portions suitable for testing. Some 60 kg was further roll crushed to minus 1.4 mm and riffled into 15 kg test portions. One of these was sampled and assayed as follows;

head grade 18.1% graphitic carbon.

3. TESTING AT MINUS 1.4 MM CRUSHED SIZE

3.1 Physical Processing

The prepared size at 1.4 mm was roughly twice that previously used and it was hoped that this manoeuvre in itself would improve the recovery of plus 150 µm flake appreciably.

Two batches of 15 kg each were processed in this first stage of testing as shown in Figures 1 and 2. The operations with the first batch comprised;

- prescreening wet at 150 µm on a Kason vibroscreen separator rejecting undersize from further treatment
- flotation using kerosene promoter with Teric frother as required
- tabling to recover three fractions;
  1) from what would normally be the concentrate fraction comprising coarse flake, some free, some as clusters and some unliberated along with gangue carried over with voluminous float
  2) from what would normally be the middling, a high grade fraction with some fine gangue representing a non decisive cut point between products

3) a slimes fraction containing also some fine graphite.

- remilling of the flotation tails and coarse low grade table product
- repeating the screen, float, table sequence above.

As shown in Table 1, two products were obtained,

* high grade representing 24% of the graphite at 90% grade
* low grade representing 3% of the graphite at 36% grade.

The second product does not meet specification and would questionably recover the extra cost of processing. The high grade product was screened and assayed as follows;

.... see page 9

FIGURE 1

Schematic of treatment of 15 kg of -1.4 mm feed

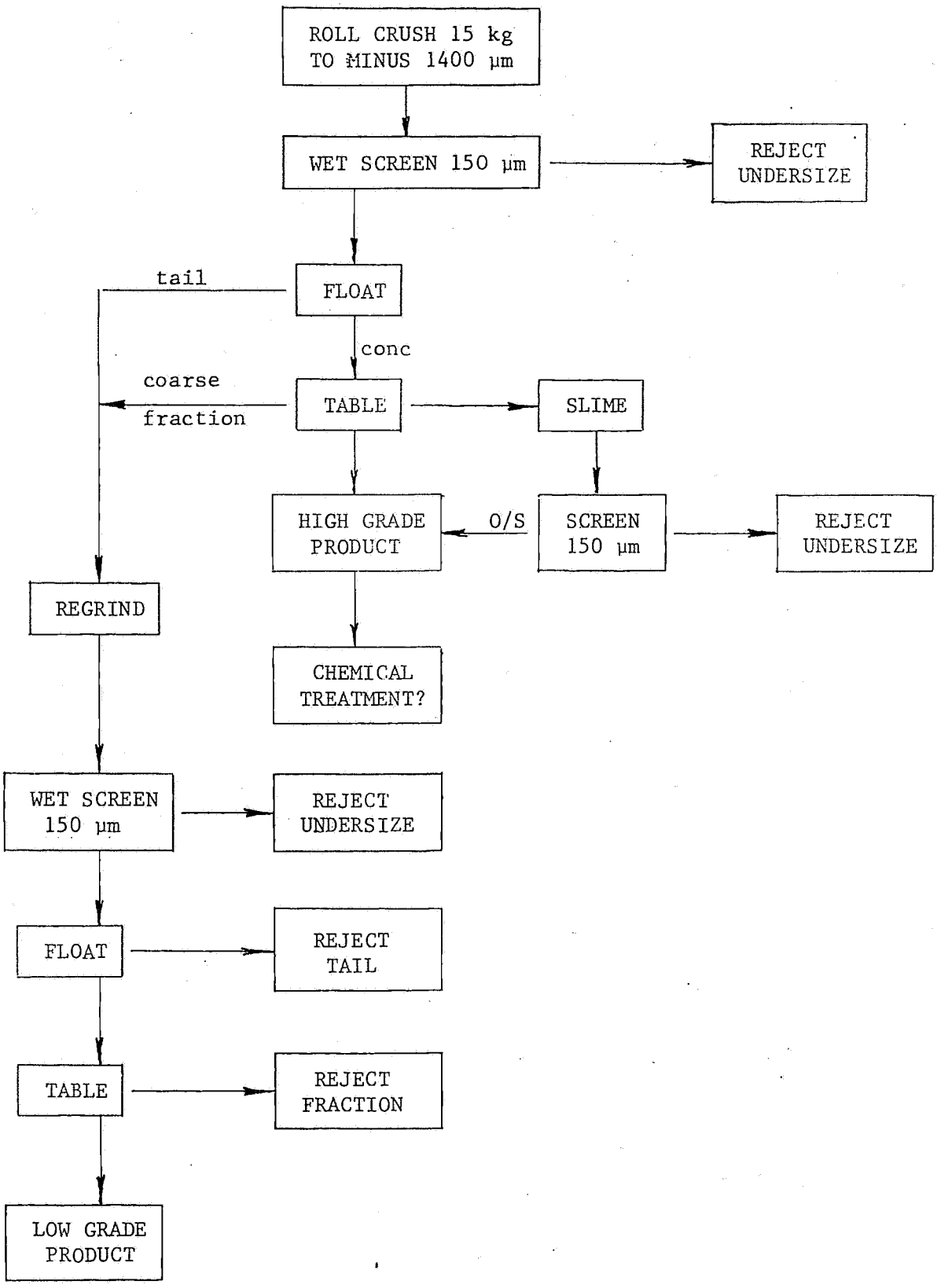


FIGURE 2

Schematic of treatment of 30 kg of -3 mm feed

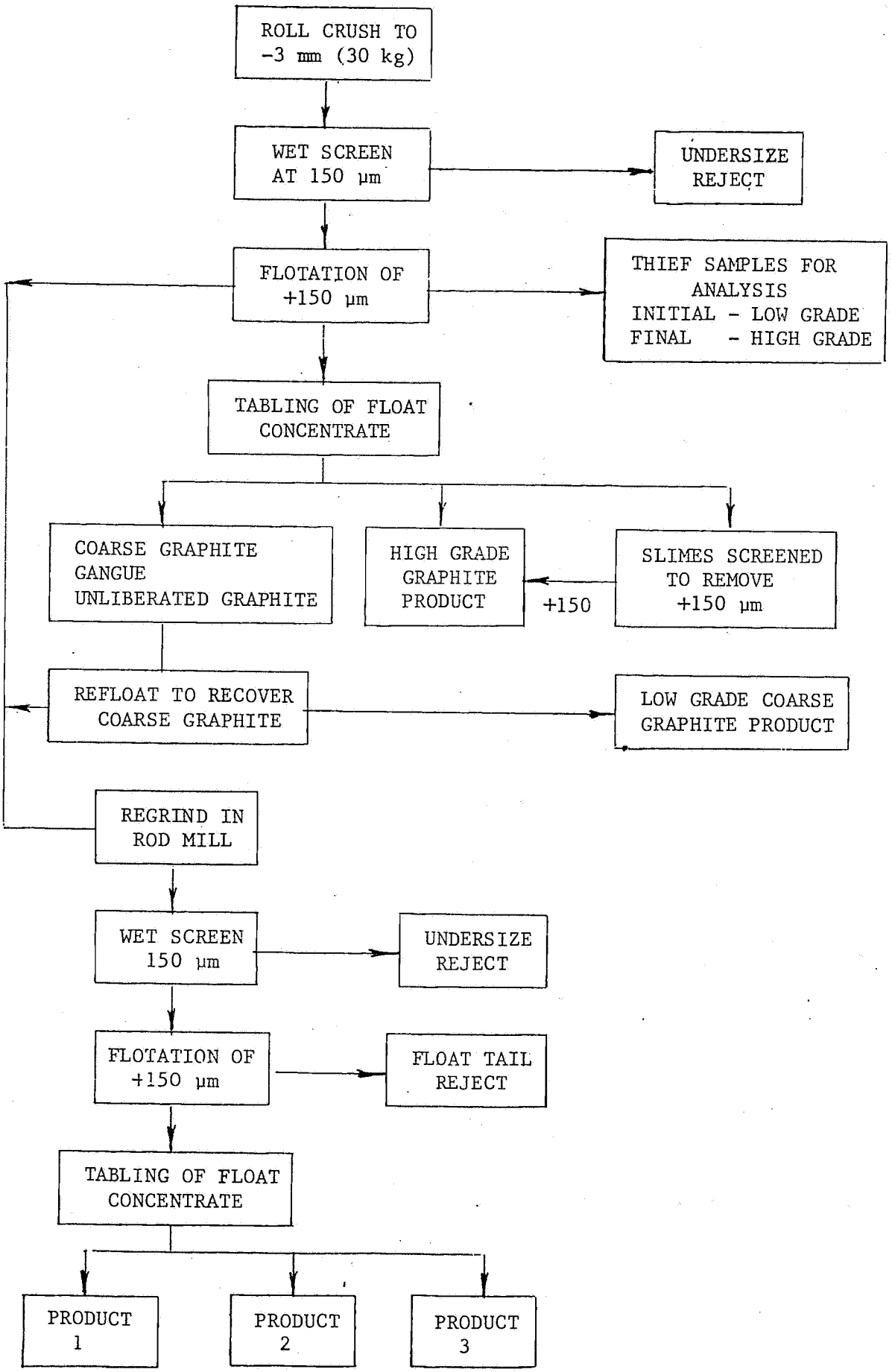


TABLE 1

Processing of -1.4 mm feed

fraction	weight %	graphite %	graphite dist %
FIRST PASS		BATCH 1	
minus 150 µm reject	50.7	19.0	51
high grade table product	5.1	90.5	24
slime screen U/S	7.7	38.8	16
SECOND (REGRIND) PASS			
minus 150 µm reject	16.9	4.1	3.8
float tail	12.6	0.25	0.2
table reject	5.6	7.57	2.2
low grade table product	1.4	36.5	2.8
TOTALS	100	(18.9)	100
FIRST PASS		BATCH 2	
minus 150 µm reject	34.0	19.1	36
high grade table product	4.4	91.8	22.5
slime screen O/S	0.2	88.9	1
slime screen U/F	5.9	36.7	12
SECOND PASS			
minus 150 µm reject	32.8	12.5	22.7
float tail	15.2	0.27	0.2
table reject	5.8	5.94	1.9
low grade table product	1.8	37.2	3.7
TOTALS	100	(18.0)	100

50% + 150 µm = 22% total wgt = 51% Graphite Dist (≡ 12.5%)

screen size µm	weight %	graphite %	graphite dist %
425	1.6	73.1	1.3
300	6.4	90.9	6.5
212	15.9	93.3	16.4
150	26.1	96.0	27.7
-150	50.0	87.2	48.1
		(90.5)	

i.e. 50% of it graded less than 150 µm, having broken up during processing.

Batch 2 was essentially a repeat of the first batch although minor modifications were made to the screening, flotation and tabling with a view to improving graphite recovery, but as shown in Table 1 almost identical results were obtained.

3.2 Chemical Upgrading

Attempts were made to upgrade the graphite concentrates above by retabling, but were visibly unsuccessful, as was re-flotation. The contaminant was seen under the microscope, sometimes free and sometimes attached to graphite flakes.

One option suggested was chemical treatment, particularly if the contaminant grains were carbonaceous. As a first trial, 100 g portions of high grade product from batch 1 were conditioned with 100 ml HCl and NaOH respectively.

From a 90.5% grade initially the leach fractions assayed;

acid leach 91.2% graphite, green leach liquor
alkaline leach 89.2% graphite.

Thus only the acid route showed any positive result at this stage. Leach temperature was 60°C. For alkaline leaching to have any effect more aggressive leach conditions would probably be required.

Upgrading by elutriation in an upflow water column was also attempted with some success though being able to introduce it on a commercial scale must be questioned, i.e.,

floats	87.7% graphite
sinks	82.0% graphite (12% by weight)

Note there is a differential between assays but both are below the feed grade suggesting loss of fine high grade graphite in the elutriation testing.

4. TESTING AT MINUS 3 MM CRUSHED SIZE

After reviewing the above results it was suggested by Pancontinental that improvement may be achieved by reducing the amount of crushing even further while still following the general process in Figure 1. To this end 30 kg of feed was screened/crushed to pass 3 mm. This was then processed as shown in Figure 2 by first wet screening at 150 µm. The oversize was floated with similar response to that reported in detail in the first report, i.e. slimes floating first, followed by graphite. An attempt was made to quantify this effect as shown in Table 2, grab samples assaying first 33 then 60% graphite.

Wilfley tabling progressed much as before though with a distinct low grade coarse flake product taken from the top of the table. In recognition of this, attempts were made to recover a product by reflotation, without resorting to any milling. A fraction representing 2.5% of the graphite at 57% grade was obtained. The float tails progressed to the regrind.

The second stage processing was much the same as the previous batches with a low grade table concentrate at 58% graphite obtained representing 2% of the graphite. Both the high grade product and coarse flotation products above were sized and assayed as shown in Table 2.

TABLE 2

Processing of -3 mm feed

Identification of test fraction	Sub Fractions	weight kg	weight %	graphite %	graphite dist %
Feed		30.01	100	18.1	100
Initial Screen (1)					
Undersize -150 µm		13.33	45	20.2	50
Flotation (1)	low grade concentrate	-	-	32.7	-
	high grade concentrate	-	-	59.5	-
	combined concentrate	4.59	15	(47.4)	40
	tail	12.08	40	(4.6)	10
	total	16.67	55	(16.4)	50
Wilfley Table (1)	coarse low grade product	0.74	2.4	31.2	4.2
Products	highgrade product	1.42	4.6	87.5 (A)	22.7
	slimes	2.43	8.0	29.0	13.1
	total	4.59	15	(47.4)	40
Refloat of Coarse	concentrate	0.23	0.7	(57.2) (B)	2.5
Low Grade Table	tail	0.46	1.7	(19.6)	1.7
Product	total	0.69	2.4	31.2	4.2
Regrind Screen (2)					
Undersize -150 µm		4.86	16.0	5.09	6.5
Flotation (2)	concentrate	0.64	10.0	(24.2)	4.9
	tail	4.80	15.7	0.91	0.3
	total	5.44	25.7	(3.7)	5.2
Wilfley Table (2)	product 1	0.26	4.1	10.5	0.9
Products	product 2	0.26	4.1	22.4	1.9
	product 3	0.12	1.8	58.3	2.1
	total	0.64	10.0	(24.2)	4.9

Sizing/Assay of Product Fractions

screen fraction µm	Wilfley Table 1 High Grade Product (A)			Wilfley Table 1 Refloat of Coarse Product (B)		
	wt %	% graphite C	dist %	wt %	% graphite C	dist %
+300	10.0	85.5	10	19.2	57.9	19
+150	55.3	89.8	57	60.0	58.6	61
-150	34.7	83.6	33	20.8	52.6	20
total	100	(87.2)	100	100	(57.2)	100

o +150 = 65% wgt (x 9.6 = 3% wgt)
o = 67% (combined) (x 22.7 = 15.2)

APPENDIX

Page 19 Report 85/171169

TABLE 5

Results of processing 230 kg ore

treatment fraction	weight kg	weight %	graphite %	graphite units	graphite dist %
crushed +570 µm	68	29.6	18.0	5.328	24.4
crushed -570 µm	162	70.4	23.8	16.474	75.6
total	230	100	(21.8)	21.802	100
dry screened -150 µm	41	19.8	(21.9)	4.329	26.3
wet screened -150 µm	(38)	18.3	(22.9)	4.191	12.8
wet screened +150 µm	67	32.3	(24.6)	7.954	36.5
total	146	70.4	23.8	16.474	75.6
PLUS 150 MICRON					
flotation scavenger tail	43.4	21.1	1.48	0.312	1.4
flotation scavenger conc	3.1	1.5	38.9	0.584	2.7
table tail	7.1	3.5	46.0	1.610	7.4
table middling	2.7	1.3	86.5	1.124	5.1
table concentrate 1	1.8	0.9	72.3	0.651	3.0
table concentrate 2	8.2	4.0	91.8	3.672	16.9
total	66.3	32.3	(24.6)	7.954	36.5
MINUS 150 MICRON (WET)					
-75 µm slimes	15.68	11.9	19.04	2.266	6.9
+75 µm fines	8.37	6.4	(30.10)	1.926	5.9
total	24.05	18.3	(22.9)	4.192	12.8
FLOTATION OF +75 µm FINES					
cleaner concentrate	1.07	1.7	80.82	1.374	3.6
cleaner tail	0.73	1.1	63.66	0.700	1.9
rougher tail	2.35	3.6	4.14	0.149	0.4
total	4.15	6.4	(34.7)	2.223	5.9
TABLING OF +75 µm FINES					
table concentrate 1	1.27	2.3	30.36	0.698	2.5
table concentrate 2	0.27	0.5	62.64	0.313	1.1
table middling	0.63	1.1	43.20	0.475	1.7
table tail	1.42	2.5	5.97	0.149	5.3
total	3.59	6.4	(25.5)	1.635	5.9

APPENDIX 3

INTER OFFICE MEMORANDUM

TO: B. C. J. Lloyd cc: Angus Collins/Andrew Firek

FROM: K. G. Robb

SUBJECT: RADEX GRAPHITE ANAYLSIS

DATE: April 15, 1987

Attached is a translation of Radex's results after analysing two Kookaburra Gully samples.

K.G.R.

EXPLORATION DIVISION

Date Rec'd. 16.4.87

	ORIGINAL		COPY	
	TO	SIG	TO	SENT
GGL	X			
ARC	X	AC		
RMDM	X	KM		
TPR				
RWN			X	21/4
KAL				
PERTH				
ISA				
FILE	3	5+2		9

Translation (by Andrew Firek) of analytical work done by Radex on two Kookaburra Gully graphite samples.

From Mr Freuhauf we have obtained samples of Australian graphite described as +150 microns and -150 microns. We have analysed both samples by screen analysis for carbon and ash content. We have also carried out specific surface analysis of the -150 micron sample.

Results

Description:	Australian Graphite, Kookaburra Gully	
Screen analysis %	+ 150 microns	- 150 microns
<0.063mm	1.6	21.6
0.063 - 0.09	1.9	18.7
0.09 - 0.12	7.5	40.2
0.12 - 0.16	29.7	19.2
0.16 - 0.2	32.5	0.3
0.2 - 0.3	22.2	
0.3 - 0.4	3.6	
0.4 - 0.5	0.7	
> 0.5	0.3	
< 0.16	40.7	
Carbon content %	92.12	89.17
Ash content %	7.88	10.83

Ash Chemical Analysis %	+ 150 microns	- 150 microns
SiO_2	51.37	49.21
Fe_2O_3	4.38	4.19
Al_2O_3	31.74	33.34
Mn_3O_4	0.10	0.09
Cr_2O_3	0.01	0.01
CaO	2.57	1.59
MgO	2.53	2.20
TiO_2	0.79	0.69
Na_2O	0.24	0.30
K_2O	3.05	3.85
P_2O_5	0.11	0.12
V_2O_5	0.07	0.07
SO_3	0.06	0.05

Specific surface area using BET technique 2.984 m^2/gm

Both graphite samples were treated as concentrate which differ between themselves in flake size and carbon content. The +150 micron sample classifies as a Group A or B (specification 85%C min) from a carbon content point of view but would not qualify for Group E (specification 94%C min) because of its carbon content of 92.12%. What the screen analysis shows is that they fall steeply from +150 microns to a very fine material of 47% below 0.16 mm and are not up to our specification for A, B and E graphite is 20% max less than 0.16mm is still not a substitute for A, B or E graphite.

The ash analysis shows that the Australian graphite presents itself in comparison with our A or B graphite substitutes from China and Madagasca because of its extremely low Fe_2O_3 and higher Al_2O_3 content.

The -150 micron sample corresponds directly to screen analysis and specific surface analysis of crystalline graphite which we at this time regard as equivalent to Group F. With its carbon content of 89.17%C it falls well under our specification of F graphite which is characterised by 94%C so we don't see a possibility of using this as a substitute classification.

We will inform you later of the mineralogical studies of both samples.

Enclosed is a table of our inhouse graphite specifications.

Gruppe	Bisherige Spezifikation	Neue Spezifikation
A	max. 10 % kl. 0,16 mm (+80 % +50 mesh) min. 85 % C	Gruppe A wird ersatzlos gestrichen
B Grafittyp 888 (885, 585)	10-20 % kl. 0,16 mm min. 85 % C	min. 88 % C, falls nicht verfügbar, min. 85 % C. Max. 20 % kl. 0,16 mm (+80 % +80 mesh)
C	außerhalb jeder Spezifikation und darf nur nach Rücksprache mit FQ im Verschnitt eingesetzt werden	
D	Sondergrafit für Versuchszwecke (wird von FQ festgelegt)	
E Grafittyp 894	max. 20 % kl. 0,16 mm min. 94 % C	min. 94 % C max. 20 % kl. 0,16 mm (+80 % +80 mesh)
F Grafittyp 198 (194)	100 % kl. 0,16 mm (100 % kl. 100 mesh) min. 98 % C	min. 98 % C, falls nicht verfügbar, min. 94 % C. 100 % kl. 0,16 mm, ca. 50 % gr. 0,063 mm (100 % kl. 100 mesh) BET: kl. 3 m^2/g

Erläuterung der Grafit-Typenbezeichnungen:

Die erste Ziffer der Typenbezeichnung drückt die Korngröße in mesh aus, die beiden folgenden Ziffern geben den C-Gehalt an; z. B.

894 bedeutet: +80 % +80 mesh und +94 % C
888 bedeutet: +80 % +80 mesh und +88 % C
198 bedeutet: 100 % -100 mesh und +98 % C
585 bedeutet: +80 % +50 mesh und +85 % C

APPENDIX 4

PANCONTINENTAL GOLDMINING AREAS PTY. LTD.

0201

MEMORANDUM

TO: A.R. Collins c.c. C.W. Fuchatel

FROM: R.W. Nice

FILE No.: RWN:SLB:1987 Kookaburra.

DATE: November 6, 1986

SUBJECT: Kookaburra Gully Project
- Review of Sept. Test Report and Sept. Mineralogy Report

After some delay, I have finally had the opportunity to review the latest results of testing on the Kookaburra Gully material. The two reports reviewed were:-

- Developmental Metallurgical Testwork of Kookaburra Gully Graphite Ore
  - Warman International, September 5, 1986
- Detailed Petrographic Examination of Graphite Concentrates from Kookaburra Gully
  - Dr. B.J. Barron, September 19, 1986

Summary:

The best results obtained were:

Table Product (A) 90.5%C in 5.1% (w/w) of feed with 24% Recovery of Graphite.

(B) 87.5%C in 4.6% of feed with 22.7% Recovery.

This compares with the treatment of the bulk sample in 1985.

Combined Table Cone 2 + Middling

90.5%C in 5.3% of feed for 22% Recovery.

Of Table Products A and B further +150 micron screening gave -

A - 93.8%C in 2.2% of feed for 12.5% carbon recovery.

B - 91.9%C in 3% of feed for 15.2% carbon recovery.

Thus, it can be concluded that a final product at +150 micron would have the following criteria:

Grade	-	>90%C
Recovery	-	12 - 15%
Production	-	2 - 3% of feed

Thus, for a 200,000 tpy mining operation about 4,000 tonnes of product would be produced grading 90%C or better.

Very simplistically, if operating costs run $20/t of ore and revenue at $1,000/t product, the operating costs equal revenue.

Discussion:

Upon reviewing the Warman report, some statements can be made:

- There appears to be no advantage gained in treating coarser crushed material i.e. -1.4mm versus 3.0mm
- Leaching is only marginally successful using HCl which confirms Barron's comments regarding calcite.
- Elutriation helps but may be expensive.

Reviewing Barron's report suggests:

- Contaminants of calcite could possibly be leached out simply using HCl.
- The graphite is generally long and narrow. This prompts the question that the purchasers have to be asked - what dimensions L vs W do they require on +150 micron product.
- Some contamination occurs with muscovite, quartz and limonite.
- About half the graphite is deformed and not rectangular in shape.

Please advise if any further discussions or work is required.

Rolly W. Nice

QUARTERLY REPORT FOR PERIOD

27 MAY TO 26 AUGUST, 1987

0203

Tenement: EL 1142, Eyre Peninsula

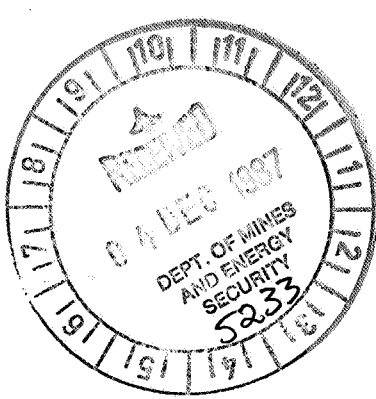
Holder: Pancontinental Mining Limited

Area: 91 square kms

Work Completed: No field work was completed during the quarter.

Expenditure:

Manning	$ 302.00
Consultants	$1,249.00
Administration	$ 251,00
	$1,802.00



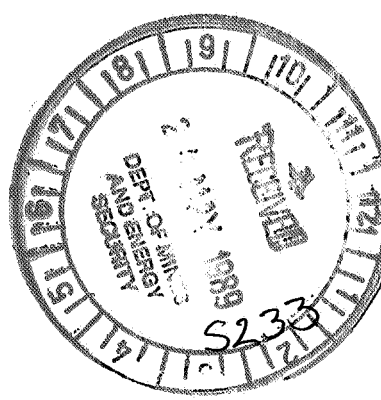
EXPLORATION LICENCE 1142

QUARTERLY REPORT FOR PERIOD

TO 26 MAY 1988

1. No active field work was conducted during the quarter.

2. All open trenches on EL 1142 were filled-in and contoured in co-operation with the landowners? ans.



QUARTERLY REPORT FOR PERIOD 27 AUGUST TO 26 NOVEMBER, 1987

Tenement: EL 1142, Eyre Peninsula

Holder: Pancontinental Mining Limited

Area: 91 square kms

Work Completed: During the reporting period, discussions were held with overseas consumers of flake graphite to evaluate the market for flake size products of less than 150 microns. British brick manufacturers are now using 50 micron graphite flakes in their products.

In addition the use of the Koppio graphite in the downstream processing of Pancontinental's Kunwarara (Qld) magnesite deposit is under evaluation.

Expenditure:

Manning	$172.00
Administration	$ 26.00
	$198.00

QUARTERLY REPORT FOR PERIOD

27TH NOVEMBER TO 26TH FEBRUARY 1988

Tenement:	EL 1142, Eyre Peninsula
Holder:	Pancontinental Mining Limited
Area:	91 square kms
Work Completed:	No field work was conducted during the Quarter.

Expenditure:

Manning	$276.00
Administration	$ 6.00
Overheads	$ 42.00
	$324.00