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REPORT ON MACQUARIE HARBOUR
WEST COAST TASMANIA
E.L. 37/70

FIMISTON MINERALS 1971:24

Including some information relative to areas:

E.L. 47/70 ?

and

S.P.L. 96

By: W.D. ROOTS
SYDNEY GEOLOGICAL AND GEOPHYSICAL SERVICES PTY. LIMITED

8th April, 1971.

AMG REFERENCE POINTS ADDED

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A. INTRODUCTION

Macquarie Harbour is the major feature in the 170 square mile EL 37/70, granted to the company on 30th June 1970. It is a large land-bound body of water lying near, and draining, several zones of known mineralisation, most important of which is the Mt. Lyell area.

The Harbour has a narrow (1/4 mile) entrance to the sea, behind which it forms a rough elongate rectangle approximately 21 miles long by 7 miles wide. The Harbour shore includes embayments, estuaries and inlets, the most important being Farm Cove, Kelly Basin and Birch Inlet. The two largest rivers draining into the Harbour are the Gordon and the King. Numerous other smaller but active streams also contribute to the drainage pattern, deriving from a total catchment area of 2,737 square miles. The rainfall over this catchment averages in excess of 100 inches per annum. The terrain is steep and rugged, with a general relief of over 3,000 ft.

The catchment area is very thickly vegetated, includes much rain-forest, and soils are heavily laden with composting organic material. As a result the ground and stream waters are unusually highly charged with humic acids. This is important in that humic acids act to very markedly increase the solubility of base metal ions in natural waters, so that, in the natural erosion of mineralised rocks, the mobility of the base metal content should be increased.

This framework of active physical and chemical erosion and deposition into the Harbour led to the idea of testing the harbour bottom sediments for possible economic concentrations of minerals.

B. THE GEOLOGY OF THE HINTERLAND AREAS

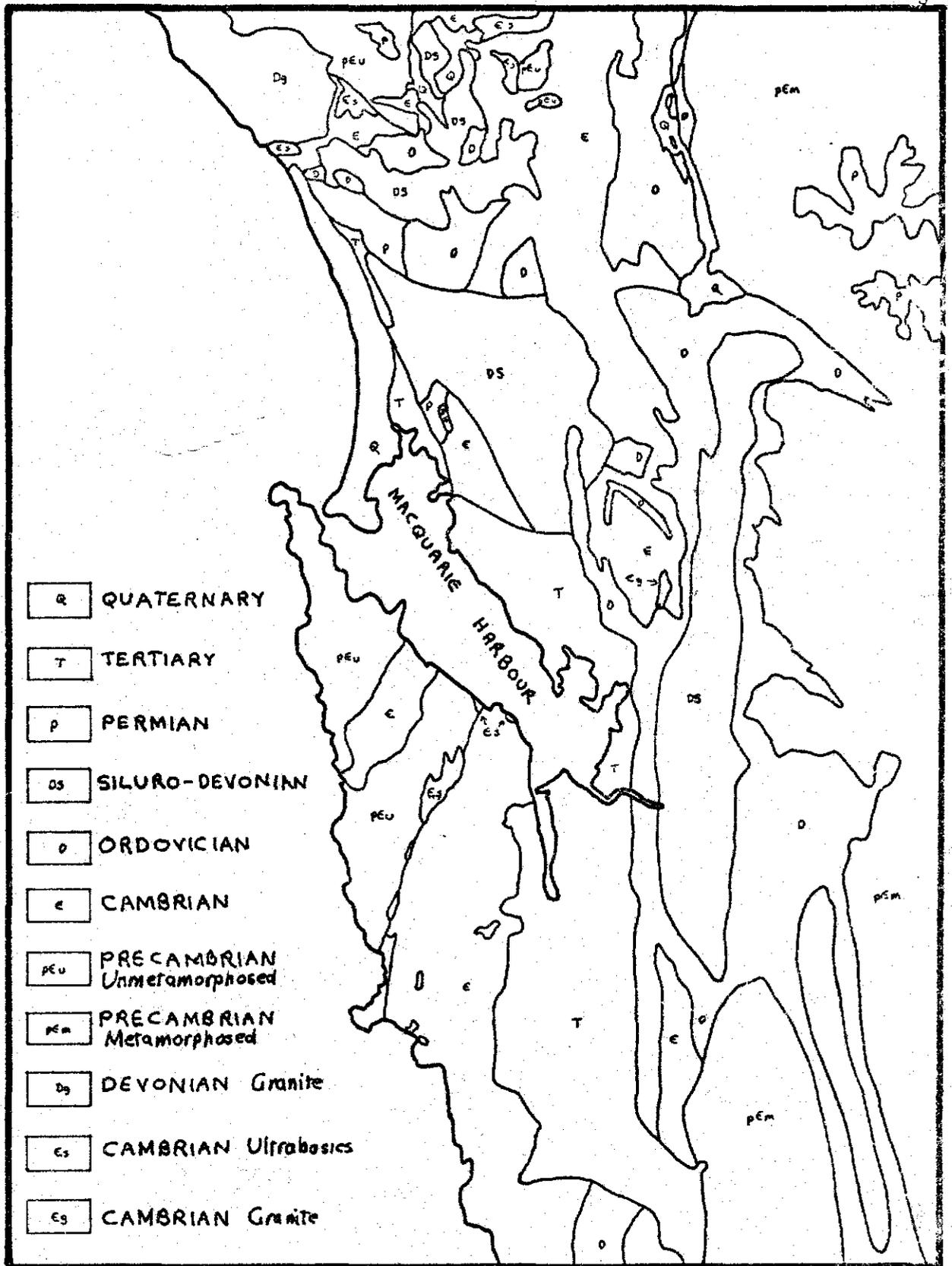
A complete literature survey relative to this area is concurrently being compiled by D.G. Morris. The following notes are adequate for an understanding of the results to date.

(i) Pre-Cambrian Rocks

These occur in the eastern limits of the hinterland, and also west of the Harbour, dividing the Cambrian belts there. The Pre-Cambrian rocks are not reported to be mineralised. They consist of strongly deformed metasediments with a low to moderate

REGIONAL

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Map 1

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grade of metamorphism. They are massive and schistose quartzites and phyllites, amphibolites and mica and garnet schists.

(ii) Palaeozoic Rocks

East of the Harbour a varied Palaeozoic assemblage occurs ranging from Cambrian to Devonian. There is a marked unconformity at the base of the Ordovician, above which the rocks are moderately deformed, with open regular folds and much faulting. The Cambrian rocks are more intensely deformed, with at least two fold histories about divergent axes.

The Cambrian rocks include large thicknesses of acid volcanics, generally slightly pyritic, and hosting significant economic base metal deposits at Mt. Lyell (copper) within the catchment, and at Rosebery (lead-zinc), north of the catchment. Two belts of Cambrian rocks occur running into the western shore of the Harbour, but most of the knowledge of the mineralisation here is confidential to the B.H.P. Company, who are currently exploring these tracts.

The other Palaeozoic rocks have reported mineral occurrences, but no mines within the catchment, whilst outside the catchment, at Zeehan they host the numerous small but workable epigenetic silver-lead deposits which comprised the Zeehan mining field. In these occurrences the country rocks include many types covering a range of sediments and limestone. There are no significant volcanic associations younger than the Cambrian.

(iii) Tertiary Rocks

On the north east shore of the Harbour, and south of it, a sequence of up to 700 feet of Tertiary non marine sediments occurs. These comprise gravels, sandstones, mudstones and lignite beds. Some of the mudstones are highly pyritic.

(iv) Igneous Rocks

(a) A small intrusion of pre-Ordovician granite occurs at Mt. Darwin. This is not related to the much larger Devonian Heemskirk granite to the north of the area. Although the larger granite is mineralised, the small body is not reported to be so.

(b) South-west of the Harbour, and outcropping up to the shoreline, occur a series of irregular serpentinised ultrabasic intrusives, roughly aligned south westerly. These are probably contemporaneous with the ultrabasics in the Zeehan region which

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are thought to be Cambrian in age. In the Zeehan bodies, copper-nickel occurrences are reported, but little is known of these near Macquarie Harbour. Again, recent exploration data relating to these will remain confidential to the B.H.P. Company, who hold title over them.

C. EXPLORATION AIMS

It will be seen from the foregoing that the hinterland could act as a source of both base metal and heavy minerals, and that sufficiently energetic erosional and transporting mechanisms are active on this source. The exploration target thus resolves to establishing whether the Harbour acts as a net concentrator of this widespread dilute supply.

This concentration could be by way of two differing systems:

(1) In deep still parts of the bottom, chemical or biochemical agencies could extract and fix base metal ions in the sludges. On present knowledge this action could occur in at least three ways:-

- (a) Attachment of base metal ions to clay particles;
- (b) Digestion of base metals from sulphide grains and other habits by bacteria, and subsequent death of these bacteria.
- (c) The precipitation, as metals, oxides or sulphides, of base metals in the highly reducing environment created by anaerobic bacteria.

(2) In active areas, and near river fans, heavy mineral concentration could occur.

Overall, it would provide most promise if the harbour was a net shedder of sediments. In this case the sands and silts lost to the sea would be analogous to a sifting out of the gangue and country rock of the primary deposit. This appears highly unlikely from a consideration of the Harbour's present floor shape. However, consideration must be given to the total Pleistocene and recent history of the Harbour, including its various eustatic states, and in this total picture net shedding seems possible. Study of this relationship, although somewhat hampered by lack of research in this area, is being kept in mind.

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The targets then can be tested by geochemically mapping the bottom sediments and by testing the heavy mineral content of the various sediment types.

The initial programmes must determine whether the hoped for elements and minerals are in fact reaching the Harbour. Thus a fairly exhaustive process of geochemical scanning is involved.

D. ARTIFICIAL FACTORS

(1) Pyritic tailings from the Mt. Lyell Mine

The Mt. Lyell field opened in 1883, and since that time, waste and tailings from milling operations have been dumped into tributaries of the King River, via which a very large amount of fine pyritic material has been fed into Macquarie Harbour. About 30 million tons are estimated to have been supplied to the Macquarie Harbour sediments in this way.

The Harbour sediment studies at present under way will determine whether this artificially supplied material has remained at, or near the King River delta fan, or whether it is discharging to other parts of the Harbour.

This is an important question, because the Harbour sediments elsewhere have relatively high pyrite content and give geochemical results which constitute significant anomalies if they are natural.

(2) The Crotty Line

This derelict tramway was constructed late last century, and runs from Linda to the Kelly Basin, where for a short period in the early history of the field, bulk ore was loaded. Ballast and spillage material along the line includes pyritic material, and occasionally rich sulphide ore, particularly bornite. Since this line runs parallel to the Nora and Bird Rivers for some eight miles, it is probable that artificial contamination of these streams is occurring. The extent of this effect needs to be checked, because the streams feed into the Kelly Basin, where some samples have yielded significantly high copper values. A geochemical orientation programme has been completed in this area (see report, W.D. Roots) and further work has been initiated to try and clarify the relationship between the Crotty Line and the Kelly Basin copper values.

These two effects should be kept in mind as a possible

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influence on the following results. The current exploration work is designed, amongst other purposes, to examine fully the influence of these contaminating factors.

E. BATHYMETRIC PROFILES

Profiles based on British Admiralty Chart No. 1629 are shown on diagram No. 2 . Locations of the profiles are shown on location map No. 3 .

The profiles show the trap-like nature of the central part of the harbour and reveal the deep holes occurring between Strahan and the harbour entrance.

It is apparent that all but the finest sediment is now retained within the harbour and that areas of heavy mineral buildup are most likely to be located along shore lines and adjacent to river mouths.

The presence of raised benches around the harbour shore line suggests that old sand banks in the above locations may have been reworked at least twice with consequent enrichment of more robust grain types.

F. SAMPLING

Apart from geophysical aspects, the complete exploration programme depends upon sampling, and therefore upon sampling procedures.

Three sampling tools have been used, namely - bucket, dredge and corer.

Bucket and dredge take only a shallow, and therefore recent, sample of the harbour floor sediments.

In order to reduce contamination by the effluent from the Mt. Lyell mine, and also to average the effects of local facies changes close to stream mouths, most sampling has been carried out with a corer capable of taking a four foot core.

Except in locations close to the King River mouth, this length of core should reduce contamination effects to a negligible amount.

This four foot corer will not be suitable for all testing, or for correlations of seismic information, but for initial heavy mineral analysis a 4 ft. sample is adequate.

G. EXPLORATION PROGRAMME TO DATE

STAGE 1

(1) SAMPLE TREATMENT

Thirteen samples were taken from locations marked on map No. 3, by numbers A1 to A11 and C1, C2. Samples A1 to A11 were bucket samples. Core samples C1 and C2 were not taken by us, but are from small sections of core made available to the company by Pickands Mather.

(2) RESULTS

Results from Stage 1 are given on the next page, and also in the attached result chart.

(3) COMMENT ON RESULTS

These results confirm that traces or small concentrations of both heavy minerals and base metals are present in the selected areas. They raise the question of the mineral, size, and specific gravity location of the elements shown.

The percentage heavy mineral content was determined from samples after pulverising and centrifuging to provide total liberation. Recoveries by free settling after pulverisation are shown in brackets.

These heavy mineral separations are interesting in that the results derived from T.B.E. gravity and T.B.E. centrifugal separations are so different. Examination of the iron and pyrite-rich King River sediments indicates that a heavy mineral content of between 1.7% and 3.72% (Gravity Method) is not acceptable. The centrifugal method gives more reasonable figures around 17% and these figures have been used in preference to the gravity method results.

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RESULTSStage 1

Sample No.		% Heavy Mineral		X Ray Fluorescence Scan			Trace	Atomic Absorption Analysis (for copper)
				>1%	0.1% - 1%	0.01% - 0.1%		
King River 1000 yds	A1	17.67	(1.76)	Fe	Ba	Mn, Sr, Rb, Zr, Pb	I	% Cu - 0.066
King River 500 yds - coarse	A2	17.58	(3.72)	Fe	Mn, Ba	Sr, Rb, Zr, Ti	Pb	0.070
King River 500 yds - fine	A3	N.A.	(3.38)	Fe	Mn, Ba	Sr, Rb, Zr,	Ti, Pb	0.087
Phillip Island	A4	4.88	(1.21)	Fe		Zr, Ti	Mn	0.004
Kelly's Basin Interior C	A5	5.20	(2.61)	Fe		Sr, Rb, Zr, Ti, Pb, Br	Mn, I	0.012
Kelly's Basin Interior F	A6	Tr.	(2.56)	Fe		Sr, Rb, Zr, Ti, Pb, Br, Ba	Mn	0.055
Kelly's Basin Warf C	A7	6.69	(2.42)	Fe	Zr	Sr, Rb, Ti, Pb, Br, Ba	Mn	0.012
Kelly's Basin Warf F	A8	9.80	(2.88)	Fe		Sr, Rb, Zr, Ti, Pb, Br, Ba	Mn, I	0.025
Birch Inlet Channel	A9	5.70	(2.03)	Fe		Sr, Zr, Ti, Pb, Sr	Rb	0.003
Birch Inlet Interior	A10	3.21	(3.22)	Fe		Sr, Rb, Zr, Ti, Pb, Br, Ba, Nb	Mn	0.027
Settlement Island	A11	5.61	(3.03)		Fe	Sr, Zr, Ti, Pb	Mn, Br	0.004
Core Sample	C1	18.16	(4.72)	Fe		Sr, Rb, Zr, Ti, Pb, Bn, Sn	I	
Core Sample	C2	N.A.	N.A.	Fe		Mn, Sr, Rb, Zr, Ti, Pb		

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On this basis the heavy mineral content of the harbour sediments generally is much higher than usually expected in stream sediments, although normally the gravity method is used to obtain the value.

Many grains have oxide coatings and a study will have to be made of the effect of heavy coatings on the specific gravity determinations.

A further discussion of these results in association with Stage 11 results occurs later.

STAGE 11

(1) OBJECT OF STAGE 11

To determine the physical nature and composition of sediment entering the harbour from streams.

(2) SAMPLE COLLECTION AND TREATMENT

94 samples were collected by coring to a depth of up to four feet across major stream mouths and along shores adjacent to interesting geological outcrop.

Samples were bagged, or retained in plastic core liners.

These were split, physical descriptions recorded and then submitted to Warman Equipment International Limited for analysis along the lines of the correspondence on pages 7a, b and c.

The basis suggested was not followed in that X.R.F. and A.A. scans were made on 25 samples chosen at random rather than representative of all environments as outlined in the correspondence. The actual results submitted follow on pages 7d to 8a?

H. RESULTS - STAGE I AND STAGE 11

STAGE 1

X.R.F. and A.A. analyses, together with heavy mineral percentages determined by the centrifugal method, are shown in the attached result table.

WARMAN EQUIPMENT (INTERNATIONAL) LTD.

(INCORPORATED IN W.A.)

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RAAS:RC.
70-6368.

1st October, 1970.

Sydney Geological & Geophysical Services Pty. Ltd.,
74 Pitt Street,
SYDNEY. 2000.

ATTENTION: MR. DAVID ROOTS.

Dear Sir,

RE: TESTWORK - MUD SAMPLES.

We confirm receipt of 94 samples for testwork and confirm our discussion on testwork procedure as follows:

1. Thoroughly mix sample and split out representative samples for moisture determination and head sample (100 grams).
2. Weigh remainder of sample and wet screen on 200 mesh B.S.S.
3. Settle undersize, decant clear liquor and retain remainder as a slurry sample.
4. Dry oversize and weigh.
5. Dry screen portion of oversize and weigh fractions (N.B. If amount of oversize is small the total sample may be used for screen analysis and then the fractions recombined for further work).
6. Do heavy liquid separation on plus 200 mesh fraction using tetrabromoethane at 2.91 S.G.
7. Wash, weigh and retain light fractions.
8. Wash and weigh heavy mineral fraction and split 50:50.
9. Separate one half of heavy mineral on Frantz Magnetic Separator to give three fractions of low, medium and high magnetic susceptibility.

- 10. Use other half of heavy mineral fraction to determine copper by Atomic Adsorption method and provide a semi-quantitative scan by X-Ray Fluorescence method for Pb, Zn, Ag, Au, Sn, W, Cr, Ti, Zr, Nb, Ta, Ni, Pt, rare earths etc.
- 11. Use head sample from (1) for fine assay for Ag, Au and Platinum Group.

Charges for the above work are as follows:

Stages 1 to 9	..	\$18.00 each less 10% quantity discount \$16.20 each
Stage 10	..	\$17.00 each nett.
Stage 11	..	\$12.00 each nett.

We trust this meets with your approval.

Yours faithfully,

WARMAN EQUIPMENT (INTERNATIONAL) LTD.

.....
 ROGER A.A. SMITH,
Chief Mineral Engineer.

- 7c -

6th October, 1970.

Warman Equipment (International) Ltd.,
24 Dickson Avenue,
ARTARMON. N.S.W.

Attention Roger A.A. Smith

Dear Roger,

We would like you to proceed immediately to process the 94 samples which we have delivered to you through stages 1 to 9, see your letter 1st October 1970.

We would also like stages 10 and 11 carried out on the following sample numbers - 6, 15, 25, 28, 30, 31, 37, 41, 47, 51, 56, 61, 66, 72, 81, 96, 98, 100, 112, 118, 123, 158, 167, 168, 170, and 190.

We thank you for your suggested modifications to our flow sheet for these mud samples and we would look forward to hearing the results of the work shortly.

Yours faithfully,



W.D. ROOTS.

Note: These analyses were made on whole mud samples, unseparated in any way.

STAGE 11

X.R.F. and A.A. analyses, grain size analyses, and heavy mineral percentages determined on the -10 to +200 size fraction only are shown in the attached results (pages 8a to 8g). These results for the 25 samples analysed are also shown in the attached result table.

Note: Comparison between the Stage 1 results, which are from whole mud samples, and the Stage 11 results, which are from a very small fraction of the whole mud sample, should only be made in the light of these treatment differences.

I. PHYSICAL EXAMINATION OF STAGE 11 SAMPLES

A physical examination of Stage 11 samples has been made and the results are tabled on pages 8h to 8o.

Colour, size range, smell, humic content were noted and listed. The size analyses from the contract laboratory and this visual examination do not always agree due to the difficulty in estimating the silt and sand size content of these generally thick tacky muds.

The visual descriptions have been corrected by the size analysis from the contract laboratory and used to plot the sedimentary zones shown in map No. 4. Not all areas of the harbour are covered as the Stage 11 programme was intended to reveal sediment supply information only.

This map will be superceeded and extensively upgraded when the results from the current Stage 11 bathymetric and sediment sampling programme are interpreted.

Condensed physical descriptions of those samples which have been analysed by the contract laboratory are included on the result table.

J. DISCUSSION OF SEDIMENT DISTRIBUTION

The overall picture within the harbour is one of deep euxinic basins containing fine muds and oozes, grading up through well sorted silty-sandy sediments at depths of less than 30 feet to pebbly - coarse sandy beached and rocky head lands.

WARMAN EQUIPMENT (INTERNATIONAL) LTD.

RESEARCH AND DEVELOPMENT DIVISION

LABORATORY REPORT

No. 70/A4015

EVALUATION OF MUD SAMPLES

LABORATORY SAMPLE No(s): 8152

SAMPLE SUBMITTED BY: Sydney Geological & Geophysical
Services Pty. Limited,
74 Pitt Street,
SYDNEY. 2000.

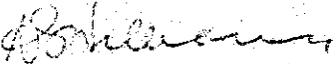
DATE RECEIVED: 1st October, 1970.

QUANTITY AND DESCRIPTION: 95 Mud Samples

SAMPLE MARK: As indicated on the attached sheets.

OBJECT OF TESTWORK: To perform test work as set out in
our memo dated 1st October, 1970.

SUMMARY OF RESULTS: See attached lists.


A.G. WILLIAMS.
Senior Analyst.

AGW:SH 71-1110.
1st March, 1971.

It is important to note that the results reported herein refer only to the sample tested. Although, to the best of our knowledge the information conveyed by this report is correct, no legal responsibility will be accepted for its use.

WARMAN EQUIPMENT (INTERNATIONAL) LTD.

LABORATORY REPORT 70/A4015.....

PAGE 2.....

Introduction.

A total of ninety five samples of mud were received on 1st October, 1970 for evaluation as a source of minerals. The scope of the work was as outlined in a memo from our Mr. R.A.A. Smith on the above date, with the following exceptions.

1. Only twenty-three of the samples were subjected to chemical analysis as set down in point 10 of the above memo.
2. No samples were submitted for Fine Assay for Silver, Gold and Platinum group as set down in point 11.

Procedure.Part A - Physical Testing.

Representative samples were taken and portions set aside for moisture determination and sizing analysis.

Material less than 200 mesh was separated and the oversize was subjected to heavy liquid separations using Tetrabromoethane as the medium.

The heavy fraction from this operation was then separated into fractions of low medium and high magnetic susceptibility using a Frantz Magnetic Separator.

Table 1 contains a summary of the results obtained.

Magnetic Separations were conducted at 0.01 amps, 0.5 amps and 2.6 amps (max) using the Frantz Iso-Dynamic Separator. Less than 0.005% is recorded as 0.00%.

Finally the magnetic fractions for each sample were combined and a selection of samples of the heavy minerals submitted for chemical analysis.

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LABORATORY REPORT 70/A4015.

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TABLE 1.

SYDNEY GEOLOGICAL - TABLE OF TESTWORK RESULTS

PART A - PHYSICAL TESTING

SAMPLE IDENTIFICATION	+10	SIZE DIST. % WT.		% SOLIDS AS REC'D.	% WT. HEAVY MIN.		% WT. DISTRIBUTION HM MAG. FRCTN			
		-10+200	-200		IN -10+200	REL. HEAD	MAGS PRIM.	MAGS SEC.	MAGS TERT.	NON-MAGS.
1	0.0	95.9	4.1	78.9	1.60	1.54	0.40	62.65	10.44	26.51
2	0.0	95.7	4.3	76.0	0.55	0.53	0.00	59.57	12.77	27.66
3	0.0	60.2	39.8	50.0	0.57	0.34	0.00	45.00	27.50	27.50
4	0.0	38.4	61.6	30.0	0.56	0.21	0.00	25.00	25.00	50.00
5	0.0	7.2	92.8	27.0	0.50	0.03	CLIENT	RETAINED	H.M.	SAMPLE
6	0.0	79.6	20.4	80.0	0.25	0.20	0.00	47.06	18.38	34.56
7	0.0	79.2	20.8	72.0	0.47	0.38	1.39	65.97	20.83	11.81
8	0.0	37.2	62.8	28.0	0.43	0.16	NOT SEPARATED.			
9	0.0	90.3	9.7	72.0	0.48	0.43	0.60	46.39	31.93	21.08
10	0.8	23.7	75.5	35.0	0.16	0.04	1.1	11.1	22.22	55.56
11	9.8	76.7	13.5	84.0	1.23	0.94	0.00	52.14	22.22	25.64
12	0.2	47.9	51.9	43.0	0.20	0.42	1.12	39.33	31.46	28.09
13	0.0	16.8	83.2	28.6	1.99	0.33	0.00	16.67	0.00	83.33
14	78.9	16.8	4.3	82.4	3.69	0.62	0.00	80.00	4.44	15.56
15	11.3	65.1	23.6	67.0	1.88	1.23	0.00	79.43	17.14	3.43
16	18.4	67.2	14.4	57.0	1.01	0.68	0.51	73.33	5.64	20.52
17	56.5	31.7	11.8	84.0	2.17	0.69	3.23	90.32	4.84	1.61
18	0.0	81.1	18.9	60.0	1.46	1.19	0.74	81.48	13.33	4.45
19	0.0	50.0	50.0	56.0	2.23	1.11	0.52	59.68	12.57	27.23
20	58.6	31.3	10.4	80.0	19.92	6.24	0.48	97.62	1.90	0.00
21	6.1	88.0	5.9	75.0	4.62	4.06	0.50	88.50	4.00	7.00
24	47.9	35.6	16.5	73.0	1.21	0.43	0.00	75.00	8.33	16.67
25	7.7	76.5	15.8	47.0	0.49	0.37	0.68	50.00	24.66	24.66
26	0.0	96.6	3.4	66.6	0.56	0.54	2.94	44.11	23.53	29.42
27	43.8	52.8	3.4	80.0	36.13	19.08	0.60	91.80	3.50	4.10
28	0.0	99.4	0.6	77.0	0.20	0.20	0.00	74.80	13.40	11.80
29	37.3	59.4	3.3	80.0	0.75	0.45	1.72	87.12	9.44	1.72
30	0.0	99.7	0.3	78.0	0.42	0.42	8.60	55.00	26.80	9.60
31	0.0	96.3	3.7	75.0	0.51	0.49	0.50	60.40	16.90	22.20
32	0.0	93.4	6.6	80.0	0.83	0.77	0.40	60.80	14.80	24.00
33	0.0	99.5	0.5	75.0	0.61	0.61	0.00	67.20	15.60	17.20
34	0.0	98.5	1.5	77.0	0.32	0.32	0.00	63.20	18.40	18.40
36	0.0	92.5	7.5	56.0	1.06	0.98	1.90	6.70	25.20	66.20
37	0.0	99.5	0.5	76.0	0.50	0.50	0.00	56.30	16.80	26.90
38	0.0	99.5	0.5	17.0	1.22	1.22	0.00	73.30	6.70	20.00
40	0.9	59.3	39.8	36.0	0.34	0.20	3.70	40.74	11.11	44.45
41	0.0	17.8	82.2	33.6	0.55	0.10	0.00	80.00	0.00	20.00
42	2.5	37.4	60.1	23.8	2.53	0.09	0.00	55.60	11.10	33.30
43	0.0	84.4	15.6	72.5	0.63	0.54	0.00	32.50	15.70	51.80
44	0.0	99.0	1.0	72.9	0.36	0.36	0.00	54.10	14.80	31.10
45	0.0	99.0	1.0	77.2	0.30	0.29	0.60	55.80	17.00	26.60

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PAGE 4.

SAMPLE IDENTIFICATION	SIZE DIST. % WT.			% SOLIDS AS REC'D.	% WT. HEAVY MIN.		% WT. DISTRIBUTION HM MAG. FR.			
	+10	-10+200	-200		IN -10 +200	IN HEAD	MAGS PRIM.	MAGS SEC.	MAGS TERT.	NON-MAGS.
46	0.0	82.9	17.1	78.4	0.32	0.27	2.70	51.40	8.10	37.80
47	0.0	96.8	3.2	76.2	0.09	0.09	0.00	60.00	14.30	25.70
48	0.0	86.2	13.8	72.3	0.27	0.23	0.00	71.10	11.10	17.80
49	0.0	90.0	10.0	70.0	0.66	0.60	0.00	75.50	7.50	17.00
50	0.0	99.3	0.7	74.9	0.77	0.76	0.00	87.40	5.50	7.10
51	0.0	98.5	1.5	73.6	0.85	0.84	5.90	68.30	7.60	18.20
52	0.0	96.9	3.1	74.2	0.70	0.67	1.30	65.40	11.50	21.80
53	0.0	98.7	1.3	69.8	0.49	0.48	12.30	43.90	24.20	19.60
54	0.0	90.1	9.9	78.0	0.30	0.27	1.80	74.60	10.90	12.70
55	0.0	32.2	67.8	22.5	0.89	0.29	0.00	66.70	0.00	33.30
56	0.0	84.3	15.7	80.0	0.81	0.68	0.00	83.30	8.60	8.10
57	0.0	67.5	32.5	60.0	0.59	0.40	0.00	72.50	12.50	15.00
58	0.0	12.2	87.8	38.0	0.28	0.03	0.00	66.60	16.70	16.70
59	0.0	11.5	88.5	32.0	0.10	0.01	0.00	25.00	25.00	50.00
60	0.0	33.9	66.1	27.0	0.61	0.21	0.00	71.20	18.60	10.20
61	0.0	11.4	88.6	30.0	0.51	0.06	0.00	62.50	0.00	37.50
63	14.4	65.6	20.0	77.7	0.22	0.15	0.00	61.50	7.70	30.80
64	0.0	31.3	68.7	25.0	0.24	0.07	0.00	50.00	16.70	33.30
65	0.0	4.4	95.6	17.0	0.35	0.02	0.00	71.40	3.60	25.00
66	7.5	32.5	60.0	20.0	12.13	3.94	38.90	50.10	9.60	1.40
67	0.0	8.6	91.4	26.0	1.80	0.15	2.50	12.50	75.00	10.00
69	0.8	35.3	63.9	42.0	0.39	0.14	0.00	63.60	14.30	22.10
70	0.0	22.0	78.0	30.0	0.22	0.05	2.20	32.60	21.70	43.50
72	0.5	80.9	18.6	83.0	1.79	1.44	0.75	76.49	15.67	7.09
73	0.0	83.6	16.4	92.0	14.26	11.92	1.60	55.90	10.80	31.70
74	0.0	59.8	40.2	87.0	21.37	12.78	1.10	36.90	12.60	49.40
75	6.5	86.9	6.6	80.0	22.54	19.59	1.60	50.53	12.23	35.64
76	2.5	83.8	14.7	82.0	3.82	3.21	9.30	73.20	7.80	9.70
78	0.0	93.8	6.2	80.0	9.84	9.23	2.40	65.60	9.00	23.00
80	4.6	75.3	20.1	82.0	4.07	3.06	12.10	71.50	9.30	7.10
81	5.1	70.6	24.3	75.0	7.58	5.35	5.30	78.80	6.70	9.20
82	1.6	80.1	18.3	65.0	0.30	0.24	0.00	75.40	11.50	13.10
83	3.3	67.2	29.5	57.0	0.27	0.18	1.50	73.20	10.40	14.90
84	1.3	45.6	53.1	60.0	0.35	0.16	1.20	71.70	14.80	12.30
85	0.0	65.4	34.6	65.0	0.26	0.17	0.00	75.00	12.50	12.50
86	1.4	46.4	52.2	50.0	0.23	0.11	0.00	55.60	25.00	19.40
88	3.0	65.7	31.3	64.0	2.58	1.69	0.00	60.00	27.50	12.50
89	65.7	7.2	27.1	24.0	3.77	0.27	7.10	78.60	3.60	10.70
91	16.3	79.6	4.1	73.0	0.06	0.05	3.70	59.30	18.50	18.50
92	14.2	80.7	5.1	74.0	0.03	0.02	12.50	37.50	12.50	37.50
93	0.0	94.5	5.5	75.0	0.19	0.18	1.00	62.00	15.00	22.00
94	44.8	39.8	15.4	68.0	4.38	3.71	0.40	94.40	4.30	0.90
95	55.5	20.5	24.0	70.0	3.91	0.80	0.00	90.50	8.60	0.60
96	20.7	17.5	61.8	60.0	15.58	2.73	3.60	62.30	33.30	0.80
97	20.3	26.8	52.9	62.0	18.66	4.99	7.00	60.80	29.10	3.10
98	0.0	98.7	1.3	73.0	0.21	0.20	1.00	51.00	17.40	30.60
99	6.0	71.9	22.1	70.0	0.61	0.46	0.40	66.80	21.30	11.50

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SAMPLE IDENTIFICATION	SIZE +10	DIST. % WT.		% SOLIDS AS REC'D.	% WT. HEAVY MIN		% WT. DISTRIBUTION HM MAG.			
		-10	+200		-200	IN -10+200	IN HEAD	MAGS PRIM.	MAGS SEC.	MAGS TERT.
100	21.3	28.9	49.8	43.0	0.28	0.08	0.00	77.10	8.60	14.30
122	53.9	15.5	30.6	80.0	1.94	0.30	0.40	36.50	57.10	6.00
123	0.9	70.1	29.0	70.0	0.70	0.49	0.40	43.20	42.90	13.50
168	2.0	67.0	31.0	62.0	0.12	0.08	0.00	65.90	14.60	19.50
179	0.0	4.5	95.5	35.0	0.12	0.01	20.00	40.00	30.00	10.00
187	0.0	1.8	98.2	37.0	0.33	0.01	5.90	5.80	47.10	41.20
190	0.0	21.7	78.3	37.0	0.37	0.01	3.90	54.90	33.30	7.90

TOTAL OF 95 SAMPLES LISTED.

PART B - CHEMICAL ANALYSES OF HEAVY MINERAL FRACTIONS

1. Geochemical type analyses were performed on twenty-three of the heavy mineral fractions using atomic absorption methods for Copper, Lead and Zinc.

SAMPLE	PARTS PER MILLION		
	COPPER	LEAD	ZINC
1	61	52	89
15	168	79	257
16	197	64	301
18	103	83	282
19	113	60	206
20	163	128	353
21	120	67	320
27	84	41	154
29	139	83	212
72	364	157	331
73	3555	60	347
74	2388	45	150
75	4219	111	598
76	1532	944	2794
78	1632	67	371
80	2816	865	1664
81	3656	514	1664
88	246	509	243
94	209	34	110
96	950	52	315
97	549	113	281
99	360	63	438
123	286	63	298

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2. X.R.F. Scans for Heavy elements were performed on twenty-three samples. (89)

The results are summarised on a separate sheet.

The following coding has been used:

N.D. = not detected

+ = greater than

- = less than.

CLIENT'S SAMPLE No.	Ba	Zr	Sb	Y	Rb*	As	Ni	Fe	Cr	Mn	Ti	Sn	Nb	La	Ce	Th
<i>North Braddock</i> 1	TRACE	+10000	ND	-10000	ND	n.d.	-500	+10000	+10000	-10,000	+10000	-500	-10000	-1000	-1000	-500
6 KB	-1000	+10000	TRACE	-10000	T.C.E.	ND	-500	+10000	-10000	-10000	+10000	ND	-10000	ND	ND	T.C.E.
9 KB	+10000	+10000	TRACE	-1000	T.C.E.	ND	ND	+10000	-10000	-10000	+10000	-500	-1000	-	-	ND
15 SMHa	-1000	-10000	n.d.	-1000	n.d.	n.d.	-500	+10000	-10000	-10000	10000	n.d.	-1000	-	-	ND
16 SMHa	-1000	-10000	n.d.	-1000	n.d.	n.d.	-500	+10000	+10000	-10000	10000	n.d.	TRACE	-	-	ND
18 SMHa	-1000	-10000	ND	TRACE	ND	ND	-500	+10000	-10000	-10000	+10000	n.d.	-1000	-	-	ND
19 SMHa	-1000	-10000	TRACE	n.d.	n.d.	ND	-500	+10000	-10000	-10000	-10000	n.d.	TRACE	-	-	ND
20	TRACE	-1000	ND	ND	ND	ND	ND	+10000	-10000	-10000	-1000	ND	TRACE	-	-	ND
21	-1000	-1000	TRACE	ND	ND	ND	TRACE	+10000	-10000	-10000	-10000	ND	ND	-	-	ND
27	-1000	-1000	ND	ND	ND	ND	ND	+10000	-10000	-1000	-10000	ND	ND	-	-	ND
29	-1000	-1000	TRACE	ND	ND	ND	TRACE	+10000	-1000	-1000	-10000	-500	ND	-	-	ND
72	-10000	-10000	ND	TRACE	TRACE	ND	-1000	+10000	-10000	-10000	10000	ND	-1000	-	-	ND
73	-10000	-1000	ND	TRACE	ND	ND	TRACE	+10000	ND	-1000	-1000	ND	-1000	-	-	ND
74	-10000	-1000	ND	ND	ND	ND	TRACE	+10000	ND	ND	-1000	ND	-1000	-	-	ND
75	-10000	-1000	ND	ND	ND	ND	ND	+10000	ND	-10000	-1000	ND	ND	-	-	ND
76	-10000	-10000	TRACE	ND	TRACE	ND	ND	+10000	-1000	-1000	-10000	-500	TRACE	-	-	ND
78	-10000	-1000	ND	ND	TRACE	ND	ND	+10000	n.d.	-1000	-10000	-500	TRACE	-	-	ND
80	+10000	-10000	TRACE	ND	TRACE	ND	ND	+10000	-10000	-1000	-10000	-500	-1000	-	-	ND
81	-10000	-10000	TRACE	ND	TRACE	ND	ND	+10000	-1000	-1000	-10000	TRACE	TRACE	-	-	ND
88	-1000	-10000	ND	ND	ND	ND	-500	+10000	-10000	-10000	+10000	ND	-1000	-	-	ND
94 DGovc	TRACE	-10000	ND	-1000	ND	ND	-1000	+10000	-10000	-1000	-10000	ND	TRACE	-	-	ND
96	-1000	-1000	n.d.	n.d.	n.d.	ND	-1000	+10000	-10000	-10000	10000	ND	ND	-	-	ND
97	TRACE	-1000	ND	ND	ND	ND	-500	+10000	-10000	+10000	+10000	ND	ND	-	-	ND
99	-10000	+10000	TRACE	-1000	n.d.	ND	-500	+10000	-1000	-1000	+10000	ND	TRACE	-	-	ND
123	-1000	-10000	ND	-1000	n.d.	ND	TRACE	+10000	-1000	-10000	+10000	ND	-1000	-	-	ND

89

889021

INTERFERENCE IN RUBIDIUM DETERMINATIONS FROM BROMINE.

13 elements above atomic number 22. Estimates recorded as parts per million. Average limit of detection 50 p.p.m.

No.	Colour	Humic	Description (Particle Sizes, etc.)	H ₂ S	Mica	Remarks
1	Med brown	No	Well sorted sand, majority 0.3 m.m. range 0.1m.m. to fine sand.	L	L	
2	Med brown	-	Well sorted sand, 0.1m.m. to 0.3 m.m.	-	L	
3	Med grey brown	H	Sample 50% leaves and rest majority is fine grey sand well sorted, average 0.2 m.m. Sand has high lithic content. Some mud is suspension.	H	-	
4	Choc. brown	L	Mud sample majority in suspension, 10% fine sand in wash.	L	-	
5	Black	L	Majority is mud in suspension, wash contains small percentage fine silt.	L	-	
6	Black-brown	L	Sand well sorted, majority 0.3 m.m.	L	L	
7	Choc. brown	-	Fine silt and mud in suspension, majority sand range 0.3m.m. to 3m.m., larger grains coated.	L	-	
8	Black	L	Majority is mud in suspension, 10% fine sand in wash.	H	-	
9	Black	L	High mud and silt content, sand particles to 1 m.m., average 0.3 m.m.	L	L	
10	Choc. brown	L	10% mud in suspension, rest well graded sand average 0.1 m.m. 15% to 2 m.m.	L	-	
11	Lt. brown	-	Sand average 0.5 m.m., some larger angular lithic fragments, some rounded quartz grains.	-	-	
12	Dk. brown	H	Majority mud and silt, mud in suspension, silt average size 0.1 m.m.	L	-	
13	Black	L	High mud content in suspension, rest silt, average size 0.1m.m.	L	-	

84

No.	Colour	Humic	Description	H ₂ S	Mica	Remarks
14	Lt. brown	H	Mainly fine silt, little mud in suspension, average 0.1m.m. Some quartz pebbles to 1/2"	L	-	
15	Dk. brown	-	Sample mainly silt to fine sand size, some larger grains 1.5 m.m. - 3 m.m. rounded quartz.	-	-	
16	Dk. brown	M	High mud content, mostly fine silt, some sand to 0.2 m.m.	L	-	
17	Med. brown	M	Some mud in suspension, majority fine sand size 0.1 m.m. some shell fragments.	L	-	
18	Choc. brown	L	Generally silty mud, some fine sand size with lithic grains few larger angular grains 5 m.m. x 2 m.m.	L	-	
19	Black-brown	-	Mud and silt mainly some sand to 0.2 m.m. few larger particles to 3 m.m.	L	-	
20	Med brown	L	Some mud, bulk fine sand containing well rounded quartz pebbles 1/4" to 1" Siltstone fragments to 4 m.m.	L	-	
21	Dk. brown	-	Some mud and silt, majority sand, fine sand size to 3 m.m. 20% quartz, platy grains and lithic	H	-	
22	Black	-	Fine mud in suspension.	L	-	
(1) 22	Grey-brown	-	Quartz and lithic fragments to 4 m.m. Some larger slightly rounded to 3 c.m.	-	-	
(1) 23	Lt. brown	L	Majority well sorted coarse silt and mud, 5% fine sand size.	-	-	
24			No sample			
25	Choc. brown	-	10% mud in suspension, rest well sorted fine sand about 0.2 m.m. some angular quartz and rock fragments.	H	-	
26	Dk. brown	H	Some mud in suspension, majority sand size 0.2 - 1 m.m., lithic few angular quartz grains to 2 m.m.	L	L	

Fi

889023

No.	Colour	Humic	Description	H ₂ S	Mica	Remarks
27	Med. brown	L	Small percentage mud in suspension, majority quartz pebbles 5 m.m. - 1", some greenish stones to 1/2", siltstones, smaller grains black coated and furriginous, some quartz sand and black grains sand size.	L	L	
28	Lt. brown	-	Well sorted moderate sand to 0.3 m.m.	-	-	
29	Med. brown	-	Coarse pebbly beach sand, lithic and angular.	-	-	
30	Lt. brown	-	Well sorted sand to 0.2 m.m.	-	L	
31	Lt. brown-black	M	Majority sand grains to 0.3 m.m., some lithic fragments to 3 m.m.	H	L	
32	Med. brown	-	Well sorted sand to 0.3 m.m.	-	L	
33	Med. brown	-	Well sorted sand, majority 0.1 m.m. ranges to 0.5 m.m.	-	L	
34	Med. brown	-	Well sorted sand, average 0.3 m.m.	-	-	
35			No sample			
36	Black	H	Humic content is peat layers interbedded, some mud is peat, majority well sorted sand to 1 m.m.	L	-	
37	Med. brown	-	Well sorted fine sand to 0.3 m.m.	-	-	
38	Grey-brown	-	Majority of sample mud in suspension, some fine silt.	-	-	
39			No sample			
40	Black	H	50% mud in suspension and fine silt, 50% well sorted sand to 0.1 m.m.	H	-	
41	Black	H	Fine mud in suspension, majority fine silt to sand size 0.2m.m. well sorted.	L	-	

8 j

No.	Colour	Humic	Description	H ₂ S	Mica	Remarks
42	Choc. brown	H	Humic content sticks and leaves, rest fine silt to sand 2 m.m. mostly lithic and angular.	L	-	
43	Lt. grey, brown & black grains	L	Some mud, average light grey sand 0.1 m.m., some grains to 2 m.m.	L	-	
44	Brown	-	Well sorted sand mainly 0.2 m.m., some grains 0.3 m.m.	-	-	
45	Black, brown	L	Well sorted sand, average 0.2 m.m., occasional grains to 2 m.m.	L	-	
46	Brown	H	Humic content, many small hairlike roots, some silt, mud in suspension. Mainly sand well sorted to 0.2 m.m.	M	L	
47	Med. brown	-	Well sorted fine sand size 0.1 to 0.5 m.m., occasional grains to 2 m.m.	-	-	
48	Black, brown	H	Humic, many hairlike roots. Some mud, silt to coarse sand to 4 m.m., mostly quartz.	M	M	
49	Med. brown	L	Well sorted fine silt sand to 0.1 m.m.	-	L	
50	Grey, brown	-	Well sorted sand to 0.3 m.m.	-	H	
51	Light brown	L	Well sorted fine sand to 0.1 m.m.	L	H	
52	Light brown	L	Well sorted sand 0.1 - 0.2 m.m., contains mica flakes to 0.1 m.m.	L	H	
53	Med. brown	L	Well sorted fine sand 0.2 m.m. contains mica flakes 0.1 - 0.2 m.m.	L	H	
54	Grey, brown	-	Well sorted sand 0.2 - 0.5 m.m.	-	H	
55			No sample			
56	Brown, grey	H	Well sorted sand to 0.3 m.m., humic - leafy material.	L	H	

8k

889025

No.	Colour	Humic	Description	H ₂ S	Mica	Remark
57	Grey, brown	M	Well sorted 0.1 sand, contains mica flakes to 0.1 m.m.	L	H	
58	Choc. brown	M	90% mud in suspension, 10% fine quartz sand.	M		
59	Choc. brown	M	Silty mud in suspension, no grains over 0.1 m.m.	L	-	
60	Choc. brown	L	Silty mud, majority in suspension, some grains 0.3 m.m. - 2 m.m.	L	-	
61	Choc. brown	L	Muddy silt, majority in suspension, fine silt residue with quartz grains to 2 m.m.	H	-	
62	Choc. brown	L	Majority in suspension, residue fine silt.	M	-	
63	Brown	-	Some mud in suspension, 50% black coated grains and angular quartz grains 1 m.m. - 3 m.m., 40% sand to 0.3 m.m.	L	-	
64	Black	L	Some mud in suspension, majority fine silt to 0.1 m.m.	L	-	
65	Choc. brown	M	Humic leafy material. Majority mud in suspension, rest grains to fine sand size.	H	-	
66	Red ochre	L	Majority mud in suspension, some rounded pebbles to 1", iron encrusted siltstone.	L	-	
67	Choc. brown to black		Majority is mud in suspension, small percentage to fine sand size.	H	-	
68	Black and light grey		Humic material is small roots and high leaf content, grey mud in suspension, rest ranges from fine silt to quartz grains to 3 m.m.			
69	Black-brown	M	Humic material is fine strands. Majority is fine silt in suspension. Some sand size grains 0.1 to 0.5 m.m.	H	-	
70	Black	L	Majority is mud in suspension. Some fine silt, occasional grains to 1 m.m.	L	-	

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889026

No.	Colour	Humic	Description	H ₂ S	Mica	Remarks
71			No Sample			
72	Light rusty brown	L	King River Pyrite Sample. Some silt, fine, rest Med. sand 0.5 - 1 m.m., pyrite in sand. Some black grains.	L		
73	Rusty yellow brown	-	Some fine silt in suspension, majority well graded sand to 1 m.m. containing considerable pyrite, black grains.	L		
74	Rusty yellow brown	-	Some fine silt, majority well sorted sand to 1 m.m. containing much pyrite. Many black grains.	L		
75	Rusty brown	-	Mainly well sorted sand to 0.5 m.m., some angular siltstone particles to 4 m.m. pyrite approx. 5% of sample.	L		
76	Rusty brown	H	Some mud and silt in suspension, rest coarse sand 1 m.m. - 2 m.m., little pyrite in sand, rusty compacted sand particles to 1".	M		
77			No Sample			
78	Med. brown	-	King River Pyrite. Rusty brown sand, well sorted to 1 m.m. contains some pyrite, many black grains.	L		
79	Black, brown	L	90% mud in suspension, rest sand size 0.2 m.m. to 0.5 m.m.	L		
80	Red, brown		King River Pyrite. Well sorted sand to 1 m.m. Many large pieces of wood in sample. Some angular siltstone to 1" little pyrite.	L		
81	Med. brown	L	Some fine muds, silt rusty and pyritic. Some sand, size 0.3 m.m., also contains siltstone particles with rusty encrustations.	L		
82	Med. brown	H	Humic - 10% of sample is leaves, rest light brown well sorted sand 0.1 - 0.3 m.m.	L		
83	Med. brown	H	50% of sample sticks and leaves. Some mud 10% in suspension rest washes to light brown, well sorted sand 0.1 - 0.3 m.m.	H		

fm

889027

No.	Colour	Humic	Description	H ₂ S	Mica
84	Med. brown	H	Humic content 20% of sample, majority mud and silt in suspension, residue light brown, well sorted sand 0.1 0 0.2 m.m.	L	
85	Med. brown	L	Majority of sample silt and mud in suspension, residue light brown, well sorted fine sand 0.1 m.m.-0.3 m.m.	L	
86	Choc. brown	L	Silt and sand to 2 m.m.		
87	Black, brown		Majority mud in suspension, with small percentage silt size.	M	
88	Choc. brown	L	Majority mud and silt, also some lithic quartz and sandstone to 6 m.m.	L	
89			No sample		
90	Med. brown	L	Mostly mud and silt in suspension, few sand size to 0.1 m.m.	H	
91	Brown	H	Coarse sand 0.5 - 2 m.m., few larger to 5 m.m.	H	
92	Light grey	H	Low mud content, majority coarse sand well sorted average 0.5m.m.	L	
93	Light brown	-	Well sorted brown sand, average 0.2 m.m., some to 2 m.m.	-	
94	Med. brown	H	Sand average 0.5 m.m. also some larger, well rounded to 1 c.m. some angular lithic fragments.	M	
95	Light brown	H	High mud content in suspension, rest fine sand to 0.1 m.m., some pebbles to 1"	M	
96	Mustard ochre	-	Some mud and silt, rest sandstone bedrock particles to 1" some angular quartz.	L	
97	Light brown	-	Mostly mud in suspension, 20% sand to 1.0 m.m. few pebbles to 1" quartz.	L	
98	Black	M	Humic-hair like roots. Small mud content, majority well sorted sand to 0.3 m.m. with bi-valves.	L	L

52

889028

029

No.	Colour	Humic	Description	H ₂ S	Mica
99	Med. brown	M	Humic - hair like roots. well sorted sand to 0.3 m.m. few angular quartz grains to 3 m.m.	L	
100	Choc. brown	L	Majority silty mud in suspension, 10% fine sand to 0.1 m.m.	L	

88

889029

030

Generally, sampling has revealed mapable sediment zones which relate to sediment supply and water energy provinces.

Based on current data, the following preliminary patterns can be recognised.

Harbour Mouth. Southerly longshore drift has built up a substantial bar and dune system which has all but closed the mouth of Macquarie Harbour. Although no sub-bottom seismic evidence is available, field observation and air photo geo-morphological observations suggest that the harbour mouth has been wider and deeper at some previous time.

The presence of a submarine canyon type structure adjacent to the present harbour mouth suggests that south drifting sand is being drained off at this point and that little, if any, sediment moves south past the harbour mouth. See map 5.

The west stepping nature of the coastal profile would seem sufficient reason for the presence of the canyon at this point. It is likely that at times of lower relative sea level, the harbour was a major supplier of sediment to this canyon. This theory could be tested by a sub-bottom morphology study of the Cape Sorell area, and, if found to be sound, would suggest that the history of the harbour as a sediment trap may only date from the last major rise in sea level.

Existing charts show a deep depression in the harbour bottom adjacent to Strahan in line roughly with the present King River mouth. This suggests that an additional harbour mouth may have existed through Long Bay, cut originally by the King River and now closed by dune encroachment.

The presence of extensive shallow sand banks at the western end of the harbour, isolating deep depressions in the harbour from the sea indicates that the harbour is a collector of all but the finest incoming stream sediments. (Refer to the attached bathymetric cross-sections) Diagram No. 2.

Birches Inlet Birches Inlet contains humic muds along its axis, almost up to the shore line. These muds are modified by humic sands near streams mouths, particularly at the southern end where the Sorell River enters. Wave action is generally subdued and currents weak.

031

The environment is ideal for euxinic sulphide buildup but heavy mineral concentration is not expected.

The Sorell River drains Tertiary sediments so that concentrations of heavy minerals are likely at its mouth.

Kelly Basin The Kelly Basin contains humic muds at its northern end, and along its axis almost up to the shoreline. There is a rapid gradation to silty muds, silts, and sands close to the shore line. The eastern shore is marked by coarse sandy deposits where the most energetic waves from the harbour refract into the basin and impinge upon the shoreline.

South East Shore The south east shore of the harbour (from Birches Inlet to the Kelly Basin) reflects the inter play of the Gordon River sediment supply and the high wave energy generated by the prevailing N.E. winds.

This shoreline is marked by a size increase from coarse sandy sediments in Kelly Basin to quartzite cobbles near the Gordon River mouth and then by a size decrease towards the mouth of Birches Inlet where the shore is masked by Settlement Island and Rum Point, from strong wave action.

Below the depth of the strongest wave action, sand bars have built up around the mouth of the Gordon River.

With increasing water depth away from the S.E shore, euxinic muds, locally high in silts and sands become pronounced.

Sounding with a greased lead weight has revealed a clean harbour floor at a position between the Gordon River mouth and Condemned Island. (Marked Rk. on the Sample Location Chart)

This suggests that the Gordon River scours a path to bedrock at this location. This should be confirmed by the bathymetric programme at present in progress.

The bed gradient of the Gordon River is very low for several miles before it enters the harbour. This, together with its depth (up to 90 feet) and moderate velocity, appears to select sediments of predominantly 0.1 m.m. to 0.3 m.m. for transport into the harbour.

Farm Cove Farm Cove is semi-isolated from the harbour proper by

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rocky sand banks across much of its entrance. The bottom sediments obtained so far would seem to have a higher content of silt and sand size grains than would seem reasonable for this relatively protected area. This is due to bias in sampling as all the samples treated so far were cored by hand in shallow water. At low tides and rough weather all locations would be within range of energetic surface waves, and the finer muds would be winnowed out. Deeper areas in Farm Cove are expected to be similar to Birches Inlet, mostly humic muds.

The Southern Harbour Shore, Liberty Point to Rum Point

This shore is lashed by high energy waves whenever the wind blows from its prevailing direction, the N.E. to N.N.E. As a result a distinct trend can be observed away from the shore line. Gravelly-cobbly beaches giving way to sparsely covered bedrock at depths up to six feet in places, then increasing thicknesses of sand occur at up to 20 feet water depth, after which silt then mud become predominant. This pattern is locally modified by many rocky projections into the harbour which are bare of sediment.

The North Shore of the Harbour from Gould Point to Sophia Point

This shore is less active than the opposite shore but has many characteristics in common. Beaches are pebbly and the near shore sediments to a depth of some 20 feet are well sorted, fine, grey brown micaceous sands. Areas of exposed or thinly covered bedrock were not noted except where rocky projections occur.

Beyond the 30 ft. water depth mark, mud is predominant.

The Central Harbour Axis. As suggested by the flanking shores, fine muds with a low silt content are the sole sediment type so far detected in this area.

Philip Island. A considerable sand bank has been built up between the shore and Philip Island. The source of this material is the Braddon River which enters the harbour adjacent to the island. The surface sediments on these banks are well sorted fine sands, with muddy silts more prominent at depth.

Settlement Island. A shoal exists around Settlement Island but this appears to be a reflection of bedrock shape rather than sediment buildup. This may not be true on the eastern side of the Island, where the bottom contours are smoother than elsewhere around the Island.

Liberty Point Area The area west of a line drawn north through Liberty Point shows a marked difference in sediment type. This is due to the influence of sands entering the harbour from the ocean due to wind, wave and current action.

No results have yet been processed from this area except the two cores C1 and C2.

The cores and drilling residues obtained from Pickands Mather appear to be fine clean sands, (some shelly) and interbedded black muds. Many are well sorted as would be expected from an active channel.

Local deep euxinic depressions exist in this area and these, together with the Pickands Mather samples suggest a history of facies alternations between active sand banks and euxinic depressions during the buildup of these sediments.

Swan Bay Sediments in the Swan Bay area are fine euxinic muds but these have been swept from the bottom at some places between Magazine Island - Neck Island.

Pine Cove - Lettes Bay Area Sediments in this area are contaminated by the pyritic effluent carried down the King River from the Mt. Lyell mine at Queenstown. A substantial delta has been built up and is extending out into the harbour around the King River mouth. The fine pyritic muds can be observed travelling for miles and give the water the appearance of a thick metallic particle soup.

Although the King River delta is held under S.P.L. by the Mt. Lyell company it should be noted that the fines are carried well clear of the delta. This may constitute a concentration process of economic importance as the recovery of copper from the fines could well be less efficient than from the run-of-mill average sizes.

Analysis of Stage 111 samples will test this theory.

There is a deep depression in the harbour floor adjacent to Strahan which could well be a repository for much of this fine material.

034

ANALYSIS OF RESULTS

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INTRODUCTION

Patterns can be detected in the distribution of metallic elements around the shores of the harbour.

A reasonable correlation can be made between source rocks, with their associated minerals and metallic elements, and the locations sampled in the harbour. Concentration of elements can be related to the size range sampled and the sampling location relative to stream mouths, depth of water and, generally energy considerations.

The comparison of analyses from whole mud samples with those from heavy mineral concentrates from specific size fractions reveals the size distribution/specific gravity range of the minerals containing the elements under study. This is a somewhat woolly comparison but it does reveal some useful information.

Most samples contain a high proportion of iron coated grains, and mineral identifications may have to be proceeded by an acid wash to remove this coating.

It is expected that in some locations this coating will have increased the specific gravity of many grains and some heavy mineral separations on acid washed samples will be necessary to test the validity of the present results.

The matrix in which the elements are located affects the accuracy of X.R.F. analyses. For accurate interpretation, the results must be calibrated by comparison with chemically analysed samples from the same locations. No such calibration has been conducted on the present results which may, therefore, indicate less than the actual amounts of each element present.

Heavy iron coatings may mask the presence of some elements or bias the X.R.F. results due to matrix effect even though the grains are powdered before analysis. This should be tested by submitting known samples for further X.R.F. analysis after acid washing.

In examining the X.R.F. and A.A. analyses it should be remembered that these only reveal elements of atomic number greater than 21 in the case of X.R.F. and only those elements requested in the case of A.A. These results are a numerical atomic count of each element relative to the total number of atoms present.

Thus a 1% count of Zr equals a 5% count of zircon, assuming that all the Zr is present in the form of zircon. The remaining 4% is

035
is uncounted SiO₄.

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It is not possible to convert this numerical count to either a volume or weight percentage without knowing such information as total atomic population and atomic weights, and molecular volumes of all elements and minerals present.

The data, then, indicates the presence of elements, gives an indication of percentages present, but cannot be directly related to expected economic yields.

Economic yields are best determined by mineral identifications and counts, and by calculations of weight or volume percentages from these counts. A reasonable correlation between X.R.F./A.A. analyses and economic potential may be possible later when sufficient grain counts have been made to permit the establishment of a conversion scale.

The detailed treatment of samples C1 and C2 is not known so caution should be used in the interpretation of results from these samples.

ELEMENT BY ELEMENT DISCUSSION OF ANALYSES

This section is to be read in conjunction with the result table. Untreated muds are hereafter referred to as blue samples, and heavy mineral concentration of -10 to +200 size fraction are referred to as red samples. They are shaded to indicate this on the result table.

Iron (Fe)

Iron occurs in almost all samples in amounts greater than 1%. The X.R.F. method does not reveal the actual quantity present when this exceeds 1%. With heavy mineral yields averaging, say, 10%, a ten fold increase in Fe content should be observed between untreated mud samples and heavy mineral concentrates. Fe content of whole muds therefore probably exceeds 10%.

As iron will not be economic here, no further direct enquiry into Fe concentration will be made.

The iron occurs in magnetite, pyrite and grain coatings.

Barium (Ba)

Barium is present in all samples from the King River. Both blue samples and red samples yield the same percentage of Ba. As this element is most certainly present in the mineral form barytes, (S.G.-4.5), all that passed the sieving should be located in the heavy concentrates.

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Greater than 70% of sediment from the King River falls within the -10 to +200 size fraction, suggesting that a 13 fold increase in Ba content should be observable from the blue to red samples. This is observed in the case of samples 76 and 80, but the remaining samples must have contained their predominant baryte content in the -200 size fraction. Analysis of the -200 size fraction is suggested to determine the Ba content, with an eye to the drilling mud market.

Barytes occur in the Cambrian rocks of the Dukes-Darwin Mining Field. It is also a major gangue mineral in the Mt. Lyell mine and this is considered the source of Ba in the King River samples.

In the Kelly Basin, Ba is present in equal quantities in all blue samples, and two of the red samples. Sample 9 shows at least a hundred fold increase over the blue samples suggesting that size discrimination has occurred here also.

The Clarke River and Bird River drain Cambrian rocks on the side of Mt. Darwin, and this is considered the source of the Ba in the Kelly Basin.

Birches Inlet contains Barium in one location, adjacent to Cambrian rock outcrops on the west side of the Inlet. More analyses will reveal the extent of its occurrence.

The Double Cove - Settlement Island samples all contain Ba, except blue sample All. This sample, from the Settlement Island wharf is under the influence of the Gordon River outlet and is atypical of the rest.

Ba values in this area fluctuate in a pattern which has no clear meaning yet, but these observations can be made.

Samples 96 and 99 were adjacent to Cambrian rock outcrop, close to shore and have Ba values of, say, 0.5%.

Samples 94 and 97 were adjacent to Cambrian rock outcrop, close to shore but had only traces of Ba.

Samples 15, 16 and 88 were in deeper water adjacent to Precambrian rocks and had values of, say, 0.05%.

Samples 18, 19, 21 and 22 were from deeper water, adjacent to Cambrian rocks and had values of, say, 0.05%.

Sample 20 was similarly located but showed a trace only.

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It is considered that the prevailing winds, impinging on this dissected shore create local currents which distribute grains according to size. The present sampling programme, being more widely spaced than the projecting reefs, has failed to resolve this pattern. The pattern is further masked by the choice of the 200 sieve as the fine limit of sediment analysed.

Philip Island and Coal Head The Braddon River drains some Cambrian rocks but mostly flows in Tertiary sediment which is derived in part also from the same Cambrian rocks. These contribute barytes to the sediment at the river mouth. The creek adjacent to sample 29 near Coal Head is similarly fed.

Harbour Entrance No Ba occurs in the sediments so far tested from the Harbour entrance.

The absence of Ba is noted from the sediments at the Harbour entrance, although this element is present at all other locations tested. This suggests a different source for the harbour mouth sediments.

This is apparently contradicted by the similarity otherwise of, say, the Birches Inlet samples and the Harbour mouth samples, eg. Zr, Ti, Sr, Rb, Pb present in similar quantities in both locations.

It is noted that Zr and Ti are present in sediments from the ocean beach (see attached analysis). It is expected that Sr, Rb and Pb will be eventually located absorbed on clay size particles and able to travel across the deep depressions in the harbour floor. The Ba, however, present in the mineral form Barytes cannot cross such depressions and thus the original suggestion of two separate provenances seems valid.

Zirconium (Zr), Chromium (Cr) Titanium (Ti)

These three elements are considered together as the five minerals in which they normally occur have similar hardness and specific gravity, and tend to collect together.

These elements are present in amounts up to 1% in red samples from the King River, and the Double Cove/Settlement Island area. The blue samples from the King River delta and the one blue sample from the Settlement Island wharf all show lower percentages as would be expected in whole mud samples. The fact that the red samples are not higher than indicated suggests that the minerals containing these elements occur outside the -10 to +200 size range.

The Philip Island samples have a high percentage of these elements in red sample 1 and it is noted that 95.9% of this sample falls

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GEOCHEMICAL AND MINERALOGICAL LABORATORIES PTY. LTD.

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76 McLACHLAN AVENUE,
RUSHCUTTERS BAY,
N.S.W., 2011

8927/LD

9th June, 1970.

Sydney Geological & Geophysical Services,
Suite 107,
74 Pitt Street,
SYDNEY. N.S.W. 2000.

QUANTITATIVE MINERAL ESTIMATE

Ocean Beach
Strahan

Sample No. : 8927/1

Heavy Mineral Content : 11.8%

Composition of heavy mineral concentrate :

Cassiterite	nil
Wolframite	nil
Magnetite	½%
Ilmenite	2
Zircon	trace
Rutile	1½
(plus leucoxene)	2½
Monazite	nil
Osmiridium	nil

Sample consists mainly of tourmaline and garnet.

039

within the -10 to +200 size range. Blue sample A4 reveals by comparison the expected dilution of Zr and Ti but Cr is absent.

Kelly Basin results show similar trends, again with the absence of Cr in the blue samples.

Birches Inlet has similar values to Kelly Basin in the whole mud samples. Its sediment supply is also derived from Tertiary rocks, so analyses of samples from the south end should show a trend to higher Ti, Cr and Zr values in heavy concentrates.

Harbour mouth samples should be treated with caution due to the uncertainty of prior treatment.

Detrital chromite occurs in the Owen Conglomerate on the north side of the harbour and probably also in the Tertiary Macquarie Harbour Beds also. The presence of ultra basic rocks on the south side of the harbour and possibly under the harbour as well probably accounts for the values of Cr there.

Manganese (Mn) Manganese is present in most of the King River, Double Cove - Settlement Island, Philip Island samples in amounts between 1% and 0.01%. Samples from Kelly Basin and Birches Inlet generally contain traces only in whole muds - more in the heavy fractions.

As the Mn is probably present as grain coating, and this will be checked by grain identification, it is unlikely to be economic to extract.

Tin (Sn)

Tin is present in six locations in amounts less than 0.05% in red samples.

One other sample C1 has less than 0.1% in a whole (?) mud sample, and this should be further investigated.

No tin was found on the south side of the harbour and this reduces the number of possible source rocks by excluding Precambrian and Cambrian rocks.

The most likely sources of the tin appear to be the Owen Conglomerate (Ordovician) and the Tertiary Macquarie Beds.

The source of the tin in sample C1 is considered to be the staniferous Heemskirk Granite north of the harbour.

how?
||

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Nickel (Ni)

Nickel is present in three of the King River bank samples but was not detected in the whole mud samples at the King River mouth.

All but two of the samples from the Settlement Island - Double Cove area contain nickel in amounts which indicate the proximity of ultra basic rocks behind Asbestos Point, and possibly under the harbour as well.

Coal Head and Philip Island samples indicate nickel in small amounts.

The mineral location and size range of the nickel must be determined, before a definite statement of economic importance can be made. The south shore does have consistent values and warrants this further investigation.

Platinoid Minerals

No platinoid minerals have been determined in the harbour although Osmiridium has been washed in streams along the south shore of the harbour. In view of the wide distribution of nickel along this shore, selected samples should be submitted for fire assay to determine whether platinoid minerals are present in economic quantities too small for X.R.F. to detect.

Yttrium (Y)

Yttrium is present in trace amounts in red samples from the King River but is not expected to be economic in this location. The Double Cove - Settlement Island area samples show greater values, but the areas of greatest interest are the Braddon River mouth and the Kelly Basin, where values are between 0.1% and 1.0% in red samples.

Further work is necessary to locate the Yttrium containing minerals.

Both the Braddon River and the Clarke River drain Tertiary Macquarie Beds so it appears likely these are the source rocks for the Yttrium. The absence of Yttrium from the coal head samples casts doubt on this observation, as does its absence from Birches Inlet. The two samples analysed from Birches Inlet are from the north end, away from the inlet of the Tertiary draining Sorell River, and both are whole mud samples. Increases in Yttrium are expected to be noted in analyses from the south end.

Niobium (Nb) (Also called Columbium)

Niobium is present in most red samples from the King River and Settlement Island - Double Cove areas, in amounts not exceeding 0.1%. Niobium is present in values up to 1% in the mouth of the Braddon River, and in one sample from in the Kelly Basin. Both these are red samples. Heavy concentrates from these areas should yield significant amounts of Nb.

Rubidium (Rb)

Rubidium is present in trace quantity in heavy concentrates from the King River banks, but in larger quantities from the whole muds at the King River mouth. This indicates that the Rb is concentrating with either the finest fractions and/or mostly in the light fractions. This same pattern is repeated in the Kelly Basin.

Birches Inlet whole muds contain similar percentages to other locations, but no red samples are available here for comparison.

No Rb was located on the south side of the harbour.

Rb is not expected to be an economic mineral, unless it can be concentrated by simple means or occurs as a byproduct of other processes.

Antimony (Sb)

Five red samples from widely distributed points contain traces of antimony, but these are not expected to be an economic mineral here. No pattern of source rock or particle size distribution can be gleaned from this group of samples, but other work may reveal this in time.

Bromine (Br) and Iodine (I)

These elements occur only in whole mud samples in generally euxinic areas. Neither element will be economic and they are not considered further.

Thorium (Th), Lanthanum (La) and Cerium (Ce)

Thorium occurs as a trace in one red Kelly Basin sample.

The red sample from the Braddon River mouth contains between 0.1% and 0.01% of Th, La and Ce. This suggests the presence of monazite in the heavy mineral fraction in amounts which are significant.

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Copper (Cu)

The copper content of the sediments on the banks of the King River is high, as would be expected.

Whole mud samples from the King River Mouth show copper generally 1/6 less than the river banks, agreeing with the 6 times reduction to value to obtain the red samples. These samples were collected by bucket from the delta top and front and, if they are any indication of the bulk Cu content of the delta material, then the delta heavies are on the threshold of being economic.

It was thought that the copper content of King River sediments would increase with depth reflecting the increase in efficiency of the Mt. Lyell plant with time. The delta may therefore increase in Cu content with depth. Since the change over from pyritic smelting, considerable volumes of mill tailings have extended the delta and it is unlikely to pay the Mt. Lyell Company, who hold a S.P.L. over the delta, to process the underlying material for copper unless the top material is economic also.

Three five foot cores were taken along the King River in locations where only flood material is deposited. The top and bottom 30" sections were treated separately to record, if possible, an increase in grade with depth. This was observed in one core but the reverse was noted in the other two cores, and no conclusion is drawn from this result.

Examinations of the copper content of fine muds carried far from the King River mouth should be conducted to determine if the fines are more cupiferous than the coarser material.

Copper values in other locations range up to 950 p.p.m. (red samples 96) at Double Cove. Blue values are lower generally, indicating that the copper is largely located in the heavy, mid grain size fractions.

Blue sample A6 from Kelly Basin is high, at 550 p.p.m. and this warrants further investigation.

Lead (Pb)

Lead was detected by X.R.F. scan in all of the blue samples. Values generally are less than 1,000 p.p.m. If all the lead was in the heavy fractions, red samples should yield values of greater than 1,000 p.p.m. However, red values are equal to, or less than 1,000 p.p.m., so the lead is concentrating in the light fraction or in some cases, evenly in both fractions. Further work should reveal the location of the

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lead and the possibility of its upgrading and extraction.

Zinc (Zn)

Zinc is present in all samples in values up to 2794 p.p.m., although the majority of values are below 500 p.p.m.

No zinc was located in any of the blue samples so it appears to be concentrating in the heavy fraction. It is hoped that grain identifications will locate the zinc bearing heavy minerals and consequently their economic potential. The lowest value of zinc recorded is 89 p.p.m. at Philip Island.

Here also were recorded low values of copper and lead. No A.A. analyses for copper, lead and zinc were returned from the Kelly Basin or Birch Inlet blue samples. This would have allowed a correlation of base metal content and drainage from Tertiary rocks.

From the results in hand it would appear that low base metal values can be expected from these areas.

This is contradicted by the previously mentioned high copper values from the Kelly Basin muds and more analyses are needed to resolve this doubt.

CONCLUSION

Efforts to date have been biased toward the study of the heavy mineral population of the harbour. This is a simpler and more usual path to economic evaluations than a study of possible syngenetic sulphide buildup, involving as it does a study to greater sediment depth than has so far been achieved.

Surface sampling has, however, revealed anomalous values of base metals in fine euxinic muds and this suggests that deep coring in locations of high surface values should be conducted. Some locations such as Kelly Basin and Birch Inlet would lend themselves to deep coring with simple equipment. It is suggested that a number of cores to 30 ft. or 40 ft. depth be taken and the variation of base metal concentration with depth be studied to determine whether a general programme along these lines is warranted.

The object of the analytical work undertaken to date was to provide a list of all elements likely to be encountered in the harbour, together with typical environments for all elements.

This object has not been fully achieved due to the analysis

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by Warman Industries of the wrong group of samples. The list of elements is not likely to be much extended by the additional analyses necessary to correct this mistake, so complete X.R.F. scans could now be superseded by A.A.S. analysis for the eighteen possible elements which could prove economic. A saving of some \$12.50 per sample will result from this change.

The samples which have been wrongly analysed permit a more complete analysis of some areas than was intended. The scatter of results in these areas, i.e. the King River and Settlement Island areas, indicates that at least three samples from each location should be analysed before it can be assumed that all elements have had a reasonable chance of being located. In areas where only one sample has been scanned - all elements found in other locations should be checked for in future A.A. work.

The next steps in the study of the heavy mineral potential of the harbour should be along these lines:-

(1) Grain identification and counts of the heavy mineral fractions now held, to give mineral locations for those economic elements known to be in each sample.

(2) Re sieving of some of the whole muds already analysed using the following sieves:-

- 2,000 micron
- 1,000 "
- 500 "
- 250 "
- 125 "
- 63 "
- 31 "
- 15 "

This should be followed by A.A. analyses of these size splits for specific elements, as a guide to the possibility of upgrading specific elements by sieving.

(3) A general programme of size analysis by sieving, heavy mineral separation, and grain identification should be undertaken on all samples held, to be completed before the start of next summer.

(4) Specific problems noted in this report should be resolved, including fire assays for platinoid minerals in the areas adjacent to Asbestos Point.

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The setting up of our Margaret Lane store and laboratory giving us facilities for drying, splitting, sieving, weighing, crushing and heavy mineral separation will be completed before the end of March.

This will permit us to process the backlog of work caused by the holdups we have suffered at the hands of Warman Industries.

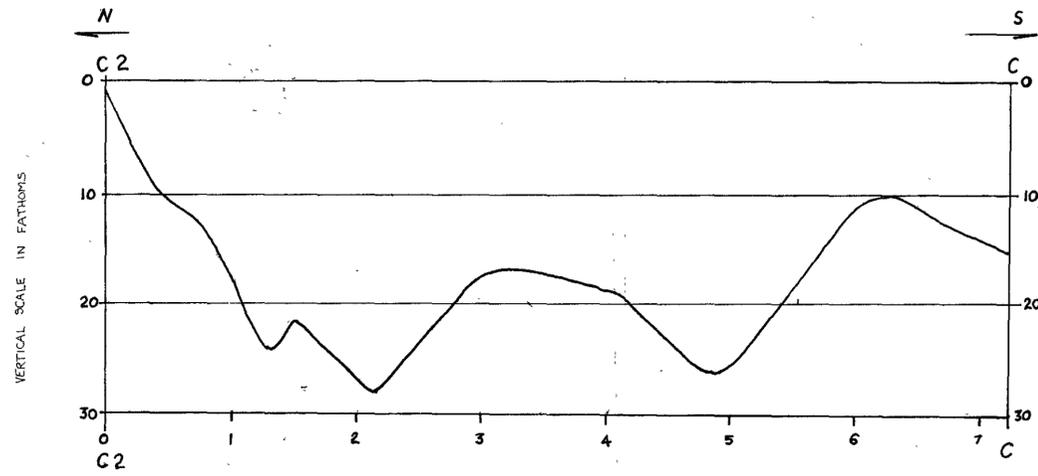
It is anticipated that at least six months of processing, plotting and interpretation of existing results and samples lies ahead of us before a logical evaluation of the project can be made.

No field work is warranted until then, unless it is to resolve problems bearing on the planned analytical work.

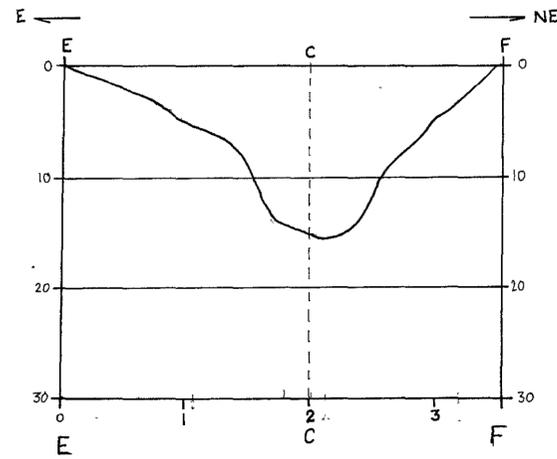
Maps:

1. Regional Geology (In Text)
2. Macquarie Harbour Hydrographic Section Lines
3. Location map
4. Result Chart Stages 1 & 2
5. Offshore Bathymetric Interpretation

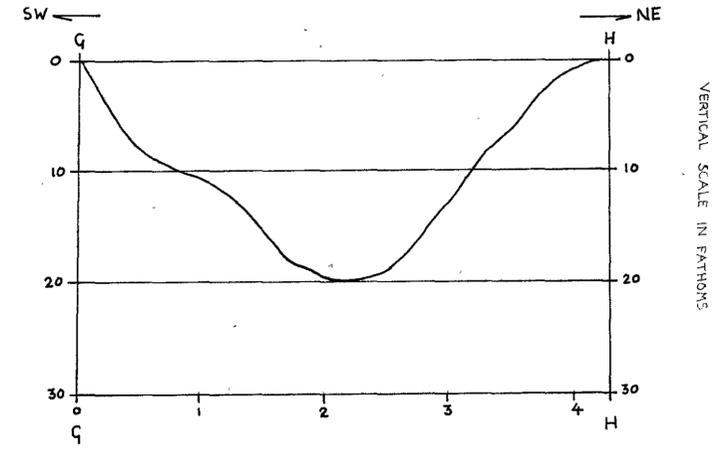
SECTION C2-C



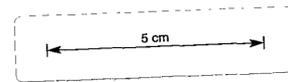
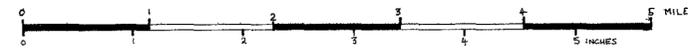
SECTION E-F



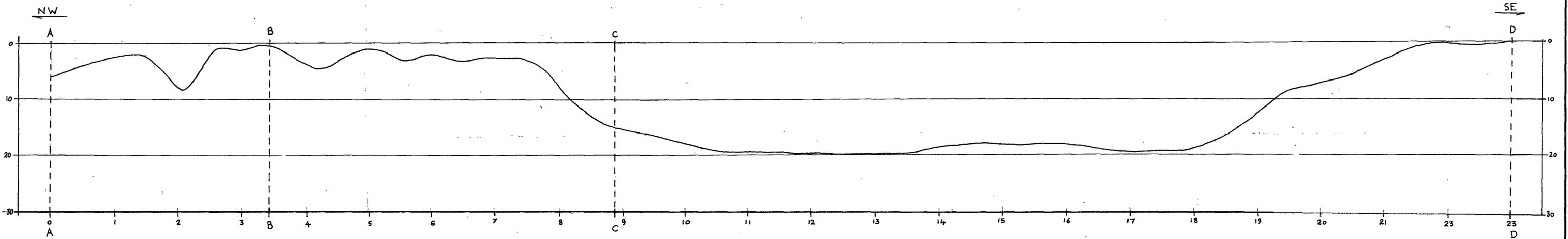
SECTION G-H



HORIZONTAL SCALE



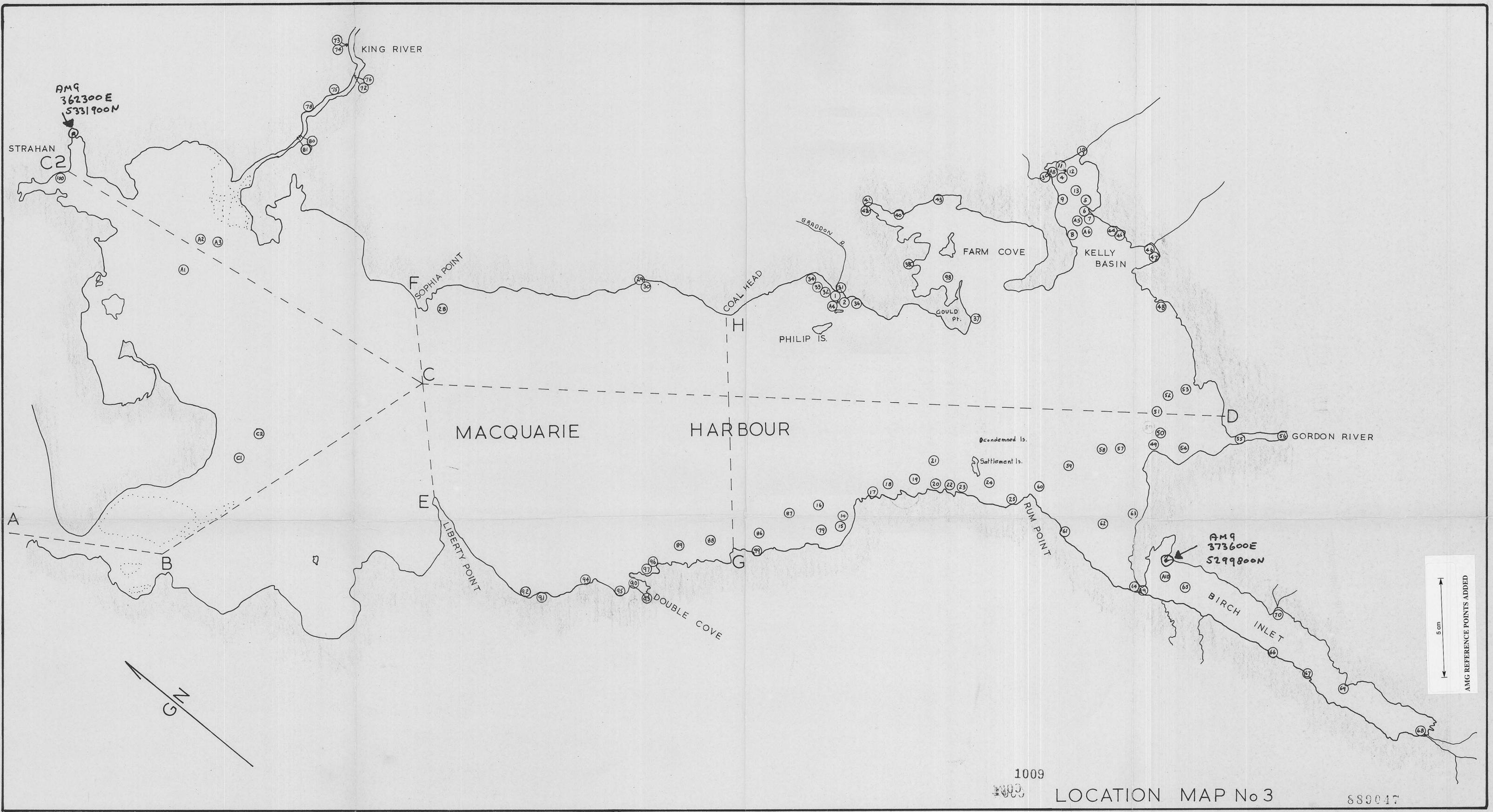
COMPOSITE SECTION A-B, B-C, C-D.



MACQUARIE HARBOUR HYDROGRAPHIC SECTION LINES

1008

DIAGRAM *Map* No. 2



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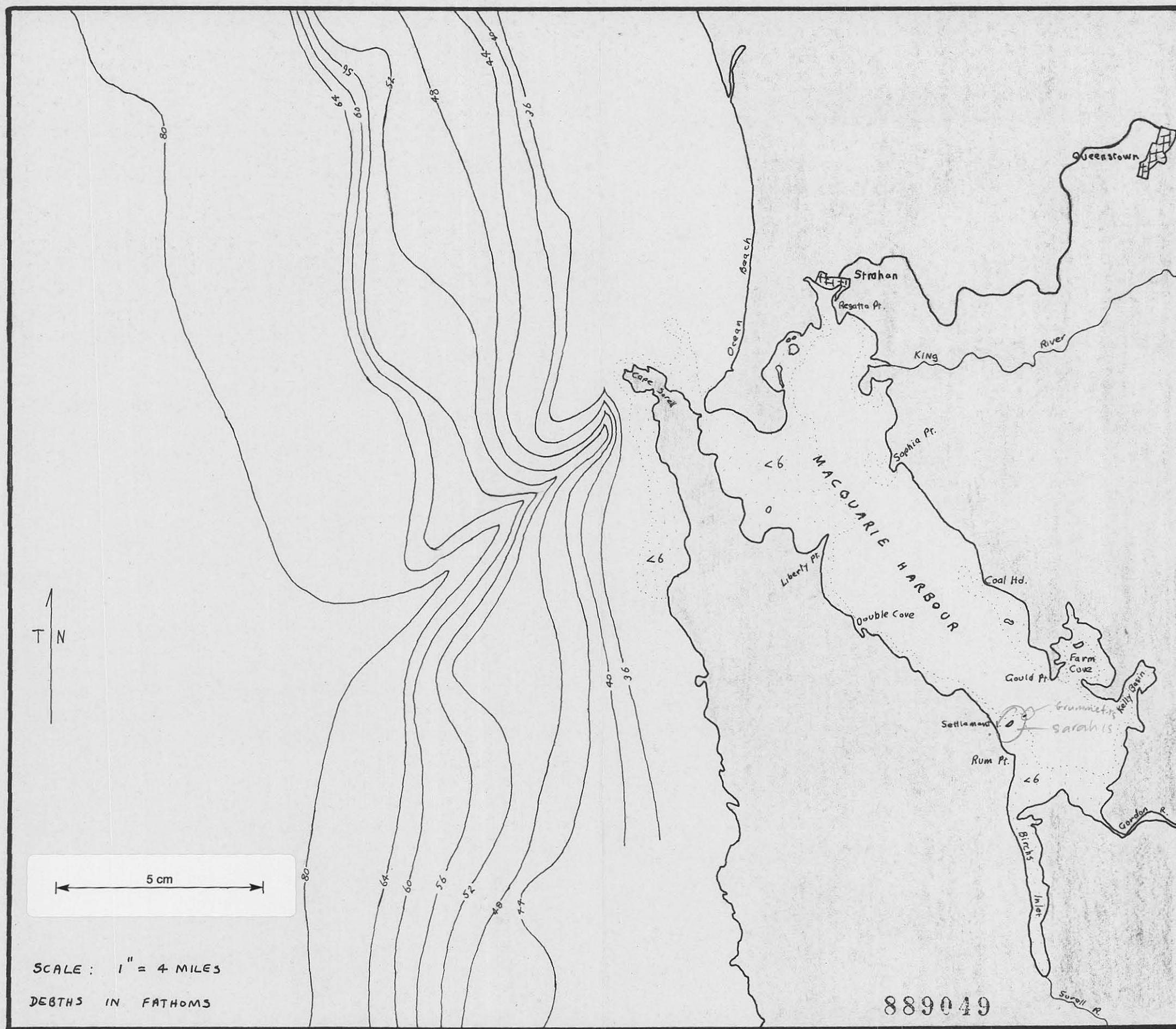
LOCATION MAP No 3

889047

Map 4

SAMPLE NUMBER	> 1%	1% - 0.1%	0.1% - 0.01%	TRACE	Cu	Pb	Zn	HEAVIES	SIZE +10 -200	DESCRIPTION OF UNTREATED SAMPLE
73	Fe	Ba	Zr Mn Ti Nb	Y Ni	3555	60	347	14.3%	0 83.6 16.4	High Pyrite Content and Iron Staining Masks True Nature of original Sediment Generally Well Sorted (Mode ~ 0.3 m.m.)
74	Fe	Ba	Zr Ti Nb	Ni	2388	46	150	21.4%	0 59.8 40.2	
72	Fe	Ba Zr Cr Ti Mn	Ni Nb	Y Rb	364	157	331	1.8%	0.5 80.9 18.6	
76	Fe Ba	Zr Ti	Cr Mn Sn	Sb Rb Nb	1532	944	2794	3.8%	2.5 83.8 14.7	
75	Fe	Ba Mn	Zr Ti		4219	111	598	22.5%	6.5 86.9 6.6	
78	Fe	Ba Ti	Zr Mn Sn	Rb Nb	1632	67	371	9.8%	0 93.8 6.2	
80	Fe Ba	Zr Cr Ti	Mn Sn Nb	Sb Rb Sn Nb	2816	865	1664	4.1%	4.6 75.3 20.1	
81	Fe	Ba Zr Ti	Cr Mn	Sb Rb Sn Nb	3656	514	1664	7.6%	5.1 70.6 24.3	
A1	Fe	Ba	Zr Mn Sr Rb Pb	I	700	NA	NA	17.7%	NA	
A2	Fe	Ba Mn	Zr Ti Sr Rb	Pb	710	NA	NA	17.9%	NA	
A3	Fe	Ba Mn	Zr Sr Rb	Pb Ti	710	NA	NA	NA	NA	
15	Fe	Zr Cr Ti Mn	Ni Nb Ba Y		168	78	257	1.9%	11.3 65.1 23.6	Choc. Br., Low Humic, Silty Sand + Rounded Quartz to 3 m.m.
16	Fe Cr	Zr Ti Mn	Ni Nb Ba Y	Nb	197	64	301	1.0%	18.4 67.2 14.4	Dk. Br., Humic, Muddy Fine Silt + Some Sand to 0.2 m.m.
88	Fe Ti	Zr Cr Mn	Ni Nb Ba		246	509	243	2.6%	3.0 65.7 31.3	Choc. Br., Low Humic, Muddy Silt + Lithic Fragments to 6 m.m.
96	Fe	Ba Cr Ti Mn	Zr Ni		950	52	315	NA	20.7 17.5 61.8	Mustard Br.
97	Fe Mn	Ba	Zr Ni	Ba	549	113	281	18.7%	20.3 26.8 52.9	Lt. Br., Low Humic, Mud, + 20% Sand to 1 mm. + Some Pebbles to 25 m.m.
99	Fe Ti Zr	Ba	Ni Cr Mn Y	Sb Nb	360	63	438	0.6%	6.0 71.9 22.1	Med. Br., Low Humic, Muddy Sand (Mode 0.3 m.m.) Few Grains to 3 m.m.
94	Fe	Zr Cr Ti	Ni Mn Y	Nb Ba	209	34	110	9.3%	44.8 39.8 15.4	Med. Br., Humic, Muddy Med Sand, (Mode 0.5 m.m.) + 10 mm. Pebbles.
23	Fe Ti	Zr Mn	Cr Nb Ba Y	Ni	286	63	298	0.7%	0.9 70.1 29.0	Lt. Br., Low Humic, Well Sorted Muddy Silt.
18	Fe Ti	Zr Cr Mn	Ni Nb Ba	Y	103	83	282	1.5%	0 81.1 18.9	Choc. Br., Low Humic, Muddy Silt, Lithic, Few Grains 2 mm. - 25 m.m.
19	Fe	Zr Cr Ti Mn	Ni Nb Ba	Sb? Nb	113	60	206	2.2%	0 66.4 33.6	Dk. Br., Low Humic, Muddy Silt, (Some Grains 0.2 - 3 m.m.)
20	Fe	Cr Ti Mn	Zr Nb Ba	Nb Ba	163	128	353	20.1%	65.1 24.5 10.4	Low Humic, Fine to Med. Sand, Low Mud, Some 25 m.m. Pebbles.
21	Fe	Cr Ti Mn	Zr Nb Ba	Sb Ni	120	67	320	4.6%	6.5 85.6 7.9	Dk. Br., No Humic, Muddy, Silty, Fine Sand, Some to 3 m.m.
All		Fe Zr Ti Sr Pb			40	NA	NA	3.0%	58.6 31.3 10.4	
1	Fe Ti Zr Cr	Mn Y Nb	Ni Sn La Ce Th	Ba	61	52	89	1.6%	0 95.9 4.1	Med. Br., No Humic, Well Sorted Sand (Mode 0.3 m.m.) Range 0.1 mm - 0.5.
A4	Fe		Zr Ti	Mn	40	NA	NA	1.2%	NA	
6	Fe Ti Zr	Cr Mn Y Nb	Ba	Sb Rb Th	NA	NA	NA	0.2%	0 79.6 20.4	Black Br., Low Humic, Well Sorted Med. Sand, Some Mud (Mode 0.3 m.m.)
9	Fe Ti Zr Ba	Cr	Mn Sn Nb Y	Sb Rb	NA	NA	NA	0.5%	0 90.3 9.7	Black, Low Humic, Well Sorted Silty Sand, Some Mud (Mode 0.3 m.m.)
11			Zr Ba		NA	NA	NA	1.2%	9.8 76.7 13.5	Lt. Br., Low Humic, Well Sorted Sand, Some Mud (Mode 0.5 m.m.)
A5	Fe		Zr Ti Sr Rb Pb	Br I Mn	120	NA	NA	2.6%	NA	
A6	Fe		Zr Ti Sr Rb Pb Ba	Br Mn	550	NA	NA	2.6%	NA	
A7	Fe	Zr	Ti Sr Rb Pb Ba	Br Mn	120	NA	NA	2.4%	NA	
A8	Fe		Zr Ti Sr Rb Pb Ba	Br I Mn	250	NA	NA	2.9%	NA	
29	Fe	Zr Ti	Cr Mn Sn Ba	Sb Ni	139	83	212	0.7%	37.3 57.4 3.3	Med. Br., Coarse Clean Beach Sand, No Humic.
A9	Fe		Zr Ti Sr Pb	Br Rb	30	NA	NA	2.0%	NA	
A10	Fe		Zr Ti Nb Sr Rb Pb Ba	Br Mn	270	NA	NA	3.2%	NA	
C1	Fe		Zr Ti Sn Sr Rb Pb	Br I	40	NA	NA	4.7%	NA	
C2	Fe		Zr Mn Ti Sr Rb Pb		NA	NA	NA		NA	

OFFSHORE BATHYMETRIC INTERPRETATION



W.O. ROOTS