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308001

NEWNHAM EXPLORATION AND MINING SERVICES

OPEN FILE

**MINERAL RESOURCE POTENTIAL ASSESSMENT
OF MINING LEASES HELD BY
MT. LYELL MINING AND RAILWAY COMPANY
LIMITED**

QUEENSTOWN, TASMANIA

30M/80

MINES		
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	- 4 MAR 1993	
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CAB		✓

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97-3995

MINERAL RESOURCE POTENTIAL
ASSESSMENT-MT LYELL - 30M/80
L.A.NEWNHAM

L. A. Newnham

**DEPARTMENT OF STATE DEVELOPMENT AND RESOURCES
DIVISION OF MINES**

308002

MEMORANDUM

TO: M.W.D. Ayre
FROM: Bill Baker
SUBJECT: MT LYELL - IN SITU LEACHING
DATE: 4 March 1993
FILE NO: WEB13.93:MP

MINES		
FILE NO.	2185	
	- 5 MAR 1993	
DOC. REF.	0425	
OFFICER	FOR ACTION	FOR INFO
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DopD		<i>[initials]</i>
TC		<i>[initials]</i>
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MWA		✓
WEB	DATE	✓
CAB		✓

See

all left

The Division of Mines has received proposals from Pasminco and Minproc for pre-feasibility study of in situ leaching of copper at Mt Lyell.

PASMINCO

STAGE 1: \$20 000

- (a) Small scale laboratory achievable extraction rates for copper.
- (b) Isolation of suitable bacteria and estimation of their nutrient requirements.
- (c) Preliminary flow sheet and process cost estimation.

STAGE 2: \$100 000 - \$150 000

- (a) Column testing of copper extraction to give reagent requirements and production rates.
- (b) Detailed testing of solvent extraction / electrowinning procedures.
- (c) Detailed costing of the process.

MINPROC

STAGE 1: \$32 000 + travel expenses

- (a) Large scale laboratory and column extraction studies.
- (b) Proven copper tolerant bacteria (Gunpowder, etc) available for study.

308003

- (c) Preliminary study underground at Mt Lyell to examine the problems of in situ leaching.

STAGES 2 & 3: \$54 000

- (a) Final investigations of bacterial leaching - flow sheets, mass balances, etc.
- (b) Detailed mine study - ore breakage, solution management and optimum scale of operation.

The Minproc proposal appears to have the greater merit for the following reasons:

1. The pre-feasibility study goes further than that of Pasminco in that it considers bulk ore problems and includes mining constraints.
2. Suitable bacteria are available to Minproc whilst they must be sought and cultured by Pasminco.
3. Although we are considering funding only the first stage of investigations the all up cost of the Minproc proposal is \$86 000 + travelling costs, compared with \$120 000 to \$170 000 for the Pasminco proposal.
4. Minproc has no ties to any major mining company and this would give us greater freedom of action should the investigations prove successful.

W. E. Baker

Bill Baker
MANAGER - LABORATORY SERVICES

c.c. Bob Callaghan
Chris Brooks
Brian McBride

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1. REPORT STATEMENT

Copper-gold-silver deposits at Queenstown are currently mined by the Mt. Lyell Mining and Railway Company Limited, a wholly owned subsidiary of Renison Goldfields Consolidated Limited.

R.G.C. has advised the Tasmanian Government that it will cease mining operations no later than June, 1995, and relinquish the Lease no later than June, 1996.

Because of the economic and social importance of the mine to Tasmania, Government has announced its desire to see operations continue beyond this planned withdrawal by R.G.C..

For this to happen, it will be necessary to demonstrate that mineral resources remain in the area, capable of profitably supporting a continuing operation, albeit of a technically different nature to the current operation.

Government has commissioned this report in order to highlight, and where possible, quantify, the potential for such resources. The report only deals with the resource potential on the current mining leases.

Acknowledgement:

I gratefully acknowledge the advice and assistance of the staff of the Mt. Lyell Mining and Railway Company Limited, which was openly and freely given at all times.

2. SUMMARY (Fig. 1, Table 1)

- (i) Current mining operations are confined to the 50 and 60 Series stopes on the Prince Lyell orebody. R.G.C. will cease operations when these two stoping series are completed - no later than June, 1995.
- (ii) **At that stage, identified resources of approximately 20 million tonnes of 1.65% copper, 0.6 g/tonne gold, and 2.5 g/tonne silver will remain on the mining lease, together with additional substantial mineral resource potential.**
- (iii) The majority of this resource and resource potential falls into five discrete geographical locations:
 - West Lyell (Prince Lyell, Royal Tharsis, and A Lens).
 - Western Tharsis (Cape Horn-Royal Tharsis).
 - Cape Horn-Lyell Comstock.
 - North Lyell.
 - Clays.

Based on mining and processing characteristics, the potential in these areas can be broadly grouped into:

- deep mineralisation amenable to underground mining
- shallow mineralisation amenable to open-cut mining
- waste dumps.

In all cases, this potential must be confirmed by further geological, mining and metallurgical studies.

- (iv) For each group, scope exists to innovate with mining and mineral processing technologies not previously implemented on a large scale at Lyell. Sub level caving of deep resources, in situ solvent extraction, (both underground and on surface) and waste dump leaching, all require further investigation.
- (v) A thorough evaluation of all these opportunities is unrealistic. The resource potential of each area in each group should be ranked and further evaluation appropriately focused on the highest ranked areas in each group: see Table 1.
- (vi) Prominent in this Table is **Prince Lyell below 60 Series**. The orezone is showing no decrease in size with depth, and copper and gold grades appear to be increasing. The recently completed hole WL701, intersected true width of **37m of 2.73% copper, 0.98 g/tonne gold, and 18m of 1.62% copper, 0.3 g/tonne gold** in 90 Series, within a 200m wide copper anomalous zone.

This is arguably one of the best intersections ever obtained at Lyell and lies 250m beneath the planned closure level.

- (vii) In addition to Prince Lyell, substantial resource potential exists at depth in the Western Tharsis and Cape Horn areas. ?

Combined, these three areas provide scope for an **expanded underground operation** utilising different underground extraction methods such as sub-level caving.

Davies and Speechly pointed out the advantages of sub-level caving to a continuing Lyell operation and further detailed the current mining and processing constraints and solutions confronting an expanded underground operation.

- (viii) Areas such as Royal Tharsis, Crown Lyell, Cape Horn and Lyell Comstock have the potential to support **modest open-cut operations**. Each of these areas has a resource potential the range 1-5 million tonnes of 0.5-1.5% copper. ?
- (ix) The **copper clay deposits** could support one or more modest open-cut operations, but they would require their own processing plant which would produce a high grade copper concentrate. Some of the clays lie just outside the existing Lease.
- (x) Large tonnages of **low grade copper mineralisation** exist firstly as **in-situ remnants** around the former West Lyell open-cut and Prince Lyell orebodies and secondly as **waste dumps** adjacent to West Lyell. ?

R.G.C. has estimated the in-situ remnants between surface and 70 Series as 85 million tonnes of 0.95% copper.

Waste dumps are estimated to contain 45 million tonnes of 0.17% copper.

This material may be amenable to modern solvent extraction (SX-EW) technologies, either on an in situ or mined basis. The resultant product would be a high grade copper concentrate.

- (xi) The **North Lyell area**, because of its relatively high proportion of bornite mineralisation, easy underground access, altitude and geographical location, is recommended for trialling the effectiveness of SX-EW processes at Mt. Lyell. Any such trial should be preceded by a **quality collation of the extensive, but currently disparate, resource information on the area**.
- (xii) An **integrated operation** based on conventional underground and open-cut production, SX-EW and copper clay operations could provide an opportunity for **expanded output** at Lyell.

If this was so, then there would be a strong argument for on site, **downstream processing** of concentrates, utilising modern, clean, smelting technology, thereby reducing the current massive ex-mine costs. ✓

- (xiii) Alternatively the geographically and technically disparate nature of the potential resources may support **several commercially distinct operations**.
- (xiv) Considerable technical and financial studies remain to be completed to evaluate the resource potential at Lyell.

If a reasonable continuity of operations beyond 1995 is desirable, then these **evaluation studies must be commenced by the end of 1993, or earlier**. ✓

4.

A strategic plan embracing an evaluation critical path is necessary, and should commence with the drill evaluation of Prince Lyell 70 and 80 Series, drill testing of Royal Tharsis open-cut area, and SX-EW studies at North Lyell.

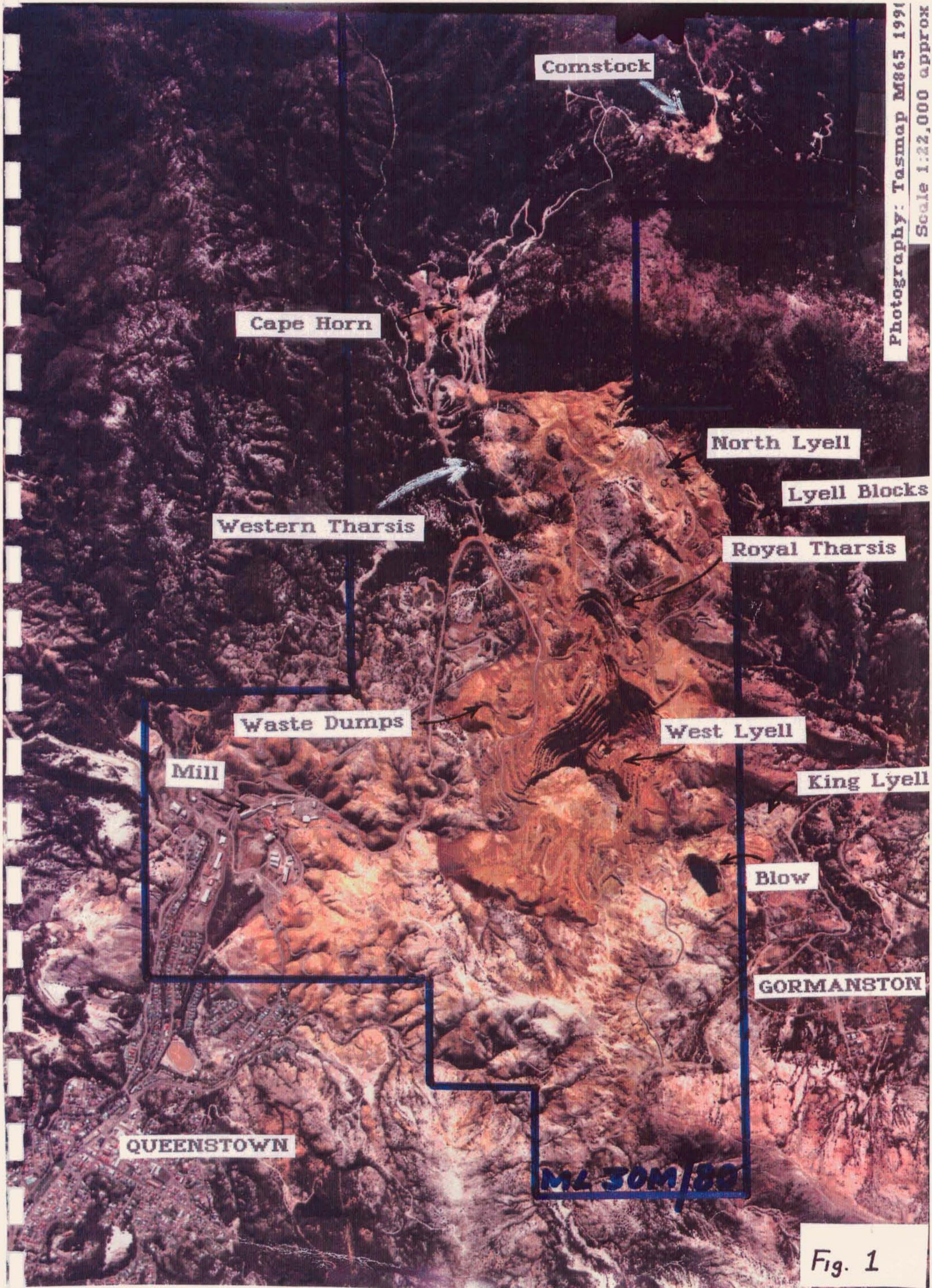


Fig. 1

Rank	Ore Type	Geographical Group	Resource Potential	Evaluation Required
1.	Underground: Prince Lyell *	West Lyell	11 Mt. 1.7 Cu, 0.67 Au.	Drilling, mine planning
2.	North Lyell - * Crown Lyell	North Lyell	1+ Mt. 2 + Cu ?	Data collation SX-EW testing.
3.	Western Tharsis	Western Tharsis	6 Mt. 1.56 Cu, 0.67 Au	Drilling, mine planning.
4.	Cape Horn	Cape Horn -	1+ Mt. ? 1-2 Cu ?	Drilling, mine planning.
5.	A-Lens	West Lyell	+0.2 Mt. 1-1.5 Cu	Drilling, mine planning.
1.	Open-cut: Royal Tharsis *	West Lyell	+1 Mt. 0.5-1.5 Cu	Drilling, mine planning.
2.	Crown Lyell	North Lyell	1-2 Mt. 1.5-1.7 Cu	Mine planning.
3.	Copper Clays	Copper Clays	2 Mt. 1-1.5 Cu	Drilling, mine planning.
4.	West Lyell Workshops	West Lyell	>1 Mt. 0.5-1.0 Cu?	Drilling, mine planning
5.	Cape Horn	Cape Horn - Lyell Comstock	>1 Mt. 0.5-1.0 Cu?	Drilling, mine planning.
6.	Large Low Grade W. Lyell Pit (or in-situ leach)	West Lyell	85 Mt. 0.95 Cu	SX-EW testing.
7.	Lyell Comstock	Cape Horn - Lyell Comstock	1 Mt. 0.5-1.0 Cu?	Drilling, mine planning.
1.	Waste Dumps West Lyell	West Lyell	45 Mt. 0.17 Cu.	Drilling; SX-EW testing.

Table 1: Mineral Resource Potential - Summary

NOTE: This is a table of resource potential, not identified resources.

3. INTRODUCTION

This report identifies the mineral resource potential on the Consolidated Mining Lease 30 M/80.

It is clear that the potential is collectively substantial, but is varied in technical nature and geographically disparate.

Without wanting to place inappropriate constraints on future exploration, mining or mineral processing technologies, it was considered important to make some attempt to rank the various resource potentials in a practical and logical sense, so that future technical and commercial evaluation of the field could be appropriately focused.

Hence, the report has placed the resource into five geographic categories considered to have the greatest potential:

- West Lyell (Prince Lyell and Royal Tharsis)
- Western Tharsis (Cape Horn to Royal Tharsis)
- Cape Horn - Lyell Comstock
- North Lyell
- Copper Clays.

Undoubtedly, additional potential lies outside these key areas, and may form the basis for longer term exploration programs.

Most of the potential resources require further technical evaluation (drilling, mine planning and metallurgical studies), before they can be reported as identified mineral resources and/or reserves, as per the Australasian Code for Reporting of Identified Mineral Resources and Ore Reserves.

Substantial technical data bases exist at Mt. Lyell which will afford interested parties the opportunities of more thoroughly assessing the resources in the five areas identified as having the maximum potential.

4. OPERATIONAL TENURE (Fig. 2)

Current operations are undertaken on mining leases 30M/80 and 28M/83 with a combined area of 1,236 hectares, issued under the Mining Act, 1929.

These Leases will expire at the cessation of operations in 1996.

The Lessee holds a Licence to Operate a Scheduled Premises issued under the Environment Protection Act, 1973, and operations are undertaken in accordance with an Environmental Rehabilitation and Management Plan, dated 1992, which details agreed environment management prescriptions, up to closure in June, 1996.

Overall conditions covering operations up to June, 1996, are subject to legislation, namely:

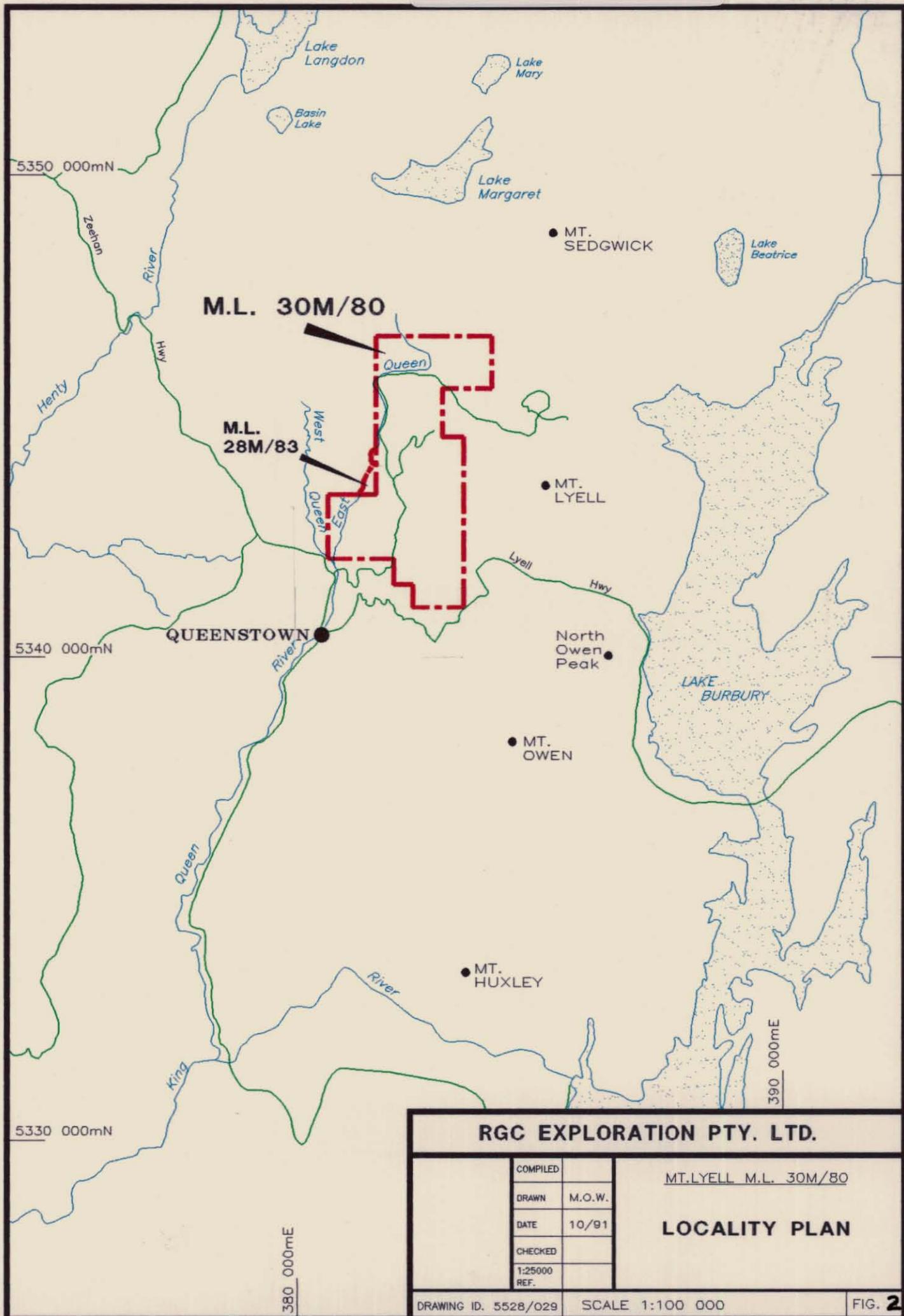
- (i) The Mt. Lyell Mining and Railway Company Limited (Continuation of Operations) Acts 1985 and 1987.
- (ii) The Mt. Lyell Mining and Railway Company Limited (Continuation of Operations) Act, 1992.

If R.G.C. locates a new operator prior to June, 1996, then all legislative conditions and obligations currently applying to the tenements will be assigned to the new operator, and any such arrangements would require Government approval.

If a new operator commences operations beyond 1996, it will start with a clean slate, requiring approval of the development and environmental management plans and the issuing of a new Mining Lease and a new Licence to Operate.

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MT. LYELL M.L. 30M/80

LOCALITY PLAN

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SCALE 1:100 000

FIG. 2

5. SPECIAL REFERENCES

Over a century of continuous mining operations at Mt. Lyell has resulted in an enormous data base of published and unpublished references on the mine.

Many of these were referenced in preparing this report and are listed in Section 16.

However, four recent internal Mt. Lyell Mining and Railway Company Ltd. reports are worthy of special reference for anyone contemplating a continuing interest in the longer term future of Mt. Lyell:

5.1 Davies and Speechly Report

"Preliminary Report to Mt. Lyell Copper Division of Renison Goldfields Consolidated Limited. Long Term Planning Strategies for Mt. Lyell Operations", by Edward Davies and Brian Speechly, 18 January, 1992.

This report addresses a range of technical matters confronting long term future operations at Mt. Lyell. The resource potential of the Lease and the mining options to utilise that resource are reviewed, including development of a large open-cut and a change of underground mining method.

Mining and milling constraints and remedies confronting an expanded operation are reviewed, including the desirability of downstream processing through the application of new smelting technologies.

The report also positively addresses environmental considerations and proposes options for acceptable environmental management.

5.2 Mt. Lyell - Technical Review

This report, written late 1991, is an excellent and in-depth technical review of the geology, mining and mineral processing functions of Mt. Lyell.

It provides an in-depth statement on current operational methods, equipment and performance.

5.3 Ore Potential Report (Dufty Report)

"Progress Report on the Assessment of the Ore Potential of the Mt. Lyell Copper Field" by M. Dufty, M. Flitcroft, and M. McKeown, 21st May, 1991.

This report reviews the geological setting, known resource and resource potential of the Mt. Lyell Consolidated Mining Lease and adjacent areas.

5.4 Old Mines - New Visions (O.M.N.V.)

"Old Mines - New Visions" by M. Flitcroft and M. McKeown, 29th January, 1992.

This substantial report is a visionary look at the potential remaining copper resource at Mt. Lyell.

9.

It specifically highlights the substantial resources that may exist on the Lease if a lower grade cut-off is applied and concludes that these resources might support a large tonnage open-cut operation, and possibly expanded underground operations.

Geostatistical modelling and application are heavily relied upon in support of these arguments.

6. MINE HISTORY

Descriptions of historical production at Mt. Lyell can be confusing because of the large number of individual deposits and the various names applied to these deposits.

Fig. 3 illustrates the spatial relationship between these various bodies, and the means by which they are accessed.

Historical production has largely come from five groups of individual ore sources:

- (a) The Blow - South Lyell.
- (b) West Lyell: including the various Prince Lyell lenses, Royal Tharsis, A-Lens, and Razorback.
- (c) North Lyell: including the North Lyell lenses, Crown Lyell lenses, 12 West and Lyell Tharsis.
- (d) Cape Horn: a group of lenses of which only one was mined. ?
- (e) Comstock: a group of four lenses.

All five groups of ore sources operated as both open-cuts and underground mines.

6.1 Summary

Mineralisation was discovered at Mt. Lyell in 1883. Early production was confined to the Blow area and high grade copper, gold and silver ores were smelted in nearby Zeehan. Smelting on site commenced in 1896.

Mining rapidly expanded to the adjacent high grade North Lyell orebodies and then to Lyell Comstock.

Recognition of the large low grade potential of the West Lyell area led to the development of the West Lyell open-cut which commenced in 1935. During its 37 year life, the open-cut produced 58 million tonnes of ore, at 0.72% copper, 0.25 g/tonne gold and 1.66 g/tonne silver, with a waste:ore ratio of 0.82.

Several significant events occurred during the 1960's. The refinery closed in 1965 and the smelter in 1969. Exploration at West Lyell defined substantial depth extensions of the open-cut ore lens and it was decided to mine these from underground. Further, a new major ore source was defined at Cape Horn.

During the early 1970's, production came from open-cut and underground operations on each of the Cape Horn, North Lyell and West Lyell areas. However, by 1978, all major open-cut work had ceased, the North Lyell Mine was closed and all ore was coming from underground sub-level open stoping operations at Cape Horn and Prince Lyell (including Royal Tharsis).

Cape Horn closed in 1987, leaving Prince Lyell and Royal Tharsis as the two dominant ore sources. Since 1992, all production has come from Prince Lyell.

6.2 Historical Production

Total estimated production since 1896 is 109 million tonnes of 1.19% copper, 0.4 g/tonne gold, 6.8 g/tonne silver, containing approximately 1.3 million tonnes of copper, 43 tonnes of gold and 740 tonnes of silver. Total production estimates for each of the five groups of ore sources are shown in Table 2.

Ore Source	Ore Tonnes (M)	Cu%	Au g/t	Ag (g/t)
West Lyell				
Open-Cut	58.3	0.72	0.25	1.66
Prince Lyell	28.5	1.29	0.40	2.91
Royal Tharsis	2.0	1.56	0.49	2.77
Razorback	0.2	1.10	0.24	1.48
North Lyell				
North Lyell	4.7	5.28	0.40	34.29
Crown Lyell & 12 West	4.0	1.62	0.37	6.67
Lyell Tharsis	0.7	0.94	0.27	4.85
Cape Horn	4.1	1.43	0.42	3.30
Blow				
Mt. Lyell & South Lyell	5.6	1.29	1.99	61.22
Lyell Comstock	1.3	2.38	0.67	5.23
Others	0.2			
	109.6	1.19	0.40	6.84

Table 2: Historical Production: 1896 - January, 1993.

6.3 Recent and Projected Production

The sixteen year period since the mid 1970's has been a particularly difficult time for Mt. Lyell due to the erratic and difficult to predict world copper markets (Fig. 4).

The effects of this market on Mt. Lyell's profitability and production performance are tabulated in Table 3, and illustrated in Fig. 5, both of which include production predictions through to the end of 1995, when R.G.C. plans to cease mining operations.

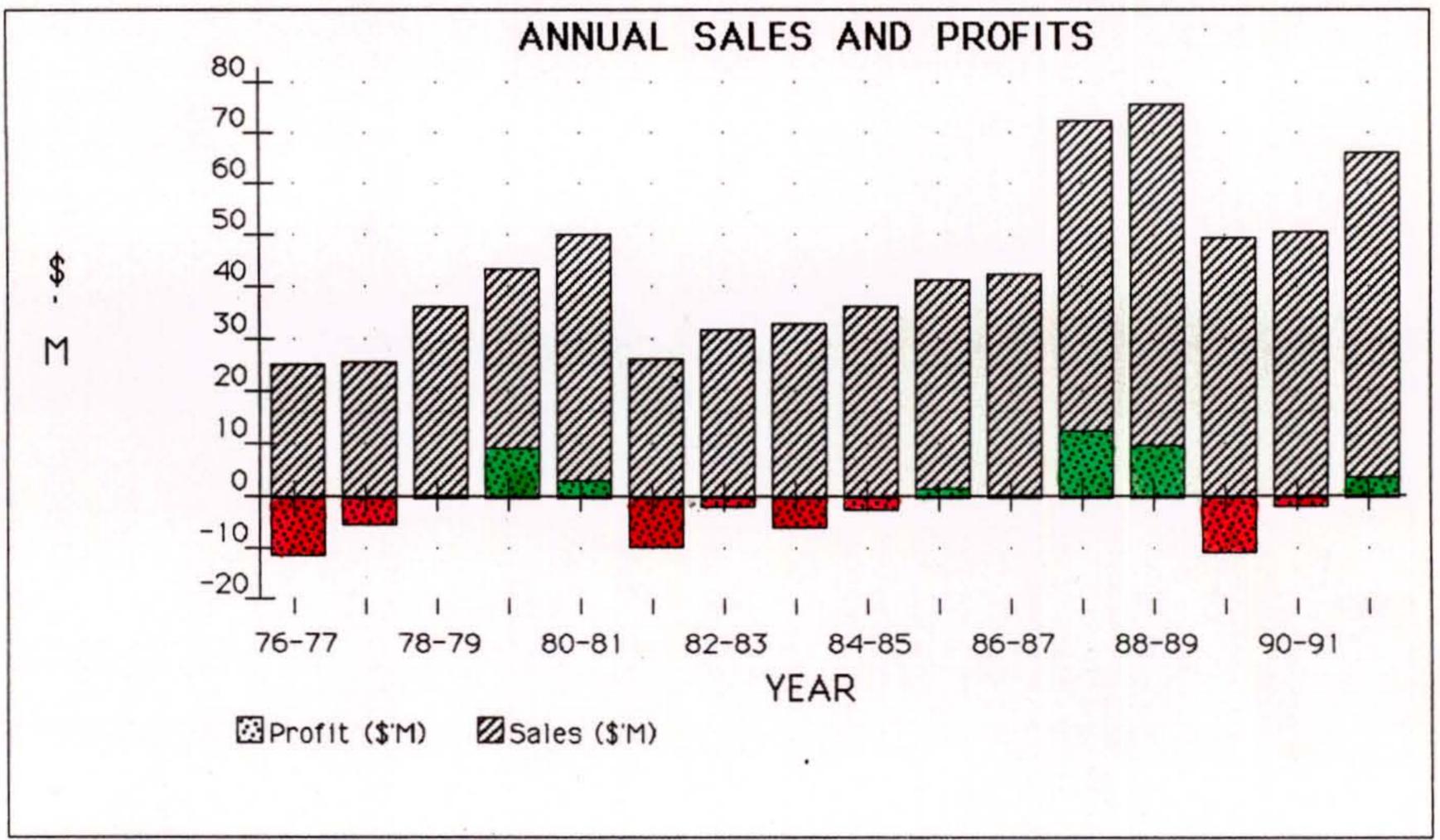
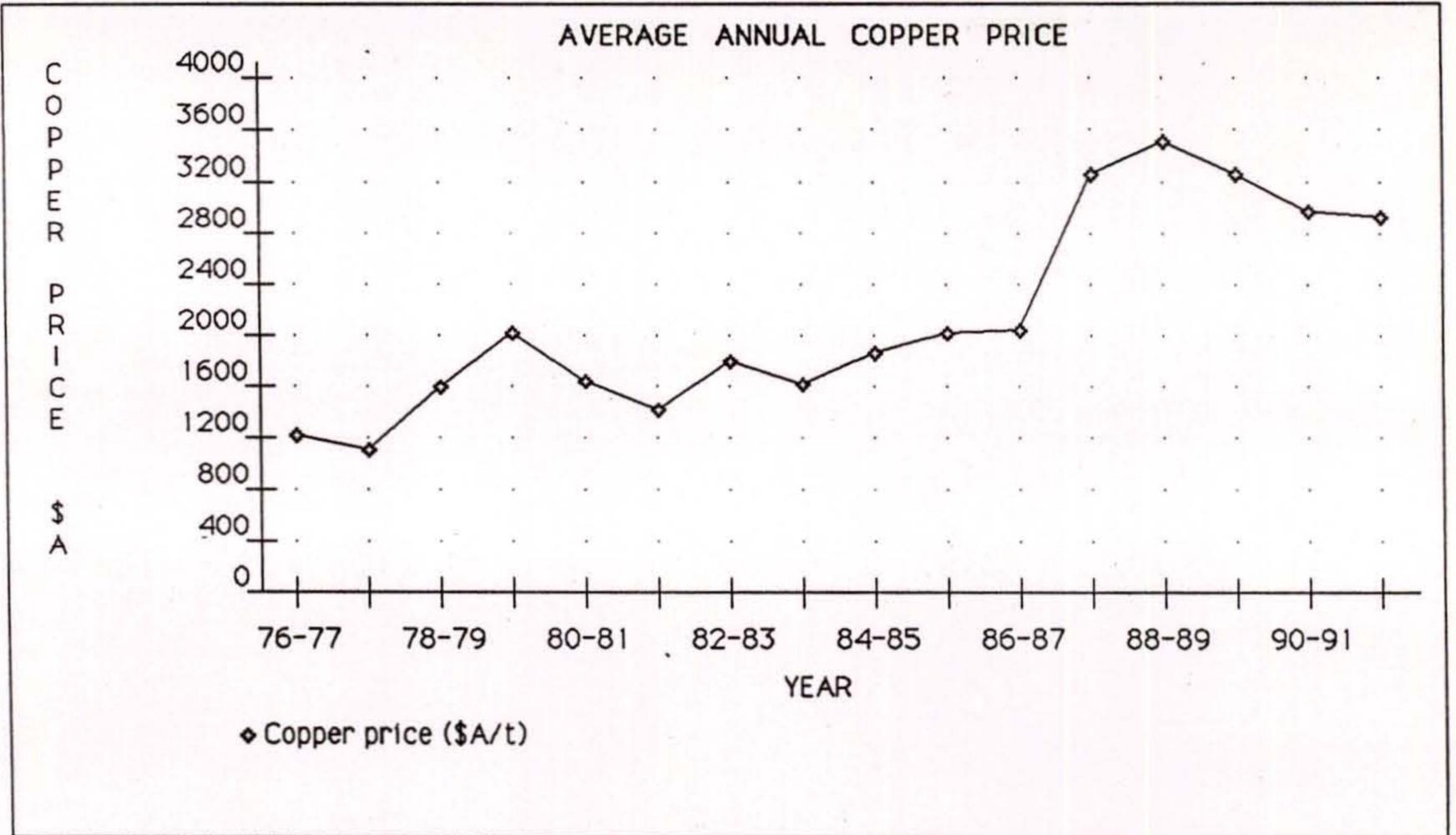


Figure 4.

Cost of Sales 36.1 29.6 30.4 20.9 34.9 34.8 38.0 37.2 37.1 37.5 40.7 46.5 53.0 58.9 51.0 57.7

Year	76-77	77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95
Sales (\$M)	24.4	25.1	35.2	33.4	38.5	25.8	30.9	32.3	35.4	39	41.3	59.1	65.2	48.8	49.8	61.8			
Profit (\$M)	-10.7	-4.4	0.8	9.5	3.6	-9	-1.1	-4.9	-1.7	1.5	0.6	12.9	10.2	-10.1	-1.2	4.1			
Ore Production																			
Tonnes (Mt)	1.8	1.6	1.6	1.4	1.7	1.7	1.4	1.8	1.8	1.7	1.6	1.5	1.6	1.3	1.4	1.7	1.7	1.7	1.7
Grade (%Cu)	1.12	1.25	1.34	1.3	1.35	1.16	1.33	1.45	1.37	1.42	1.59	1.55	1.24	1.28	1.56	1.52	1.6	1.7	1.6
Metal Production																			
Copper ('000t)	18.4	18.5	20.2	16.9	21.1	17.9	17.8	23.5	22.3	22.1	23.5	21.6	18.7	15.7	20	23.5	25.3	26.8	25.3
Gold (kg.)				400	467	419	405	571	505	514	516	511	435	360	446	566			
Silver (t)				2.9	3.9	2.7	3	4.8	4.6	3.3	3.7	2.8	2.9	2	2.6	3.5			
Concentrates																			
Pyrite ('000t)																			
Copper ('000t)	70.2	70.7	77	64.8	80.8	68.7	68.4	90.7	85.5	85.4	91.5	83.7	68.3	59.2	76.7	68.5			
Copper price (\$A/t)	1212	1104	1591	2012	1645	1421	1811	1631	1870	2031	2036	3271	3518	3266	2983	2940			
Employees	727	699	708	727	742	715	706	689	533	525	536	556	553	475	449	454			

Current Cu Recovery 93%
 Cu concentrate grade 27% Cu
 Pyrite concentrate grade 40% S
 Operating costs \$30/tonne

Table 3: Mt. Lyell Operating Statistics

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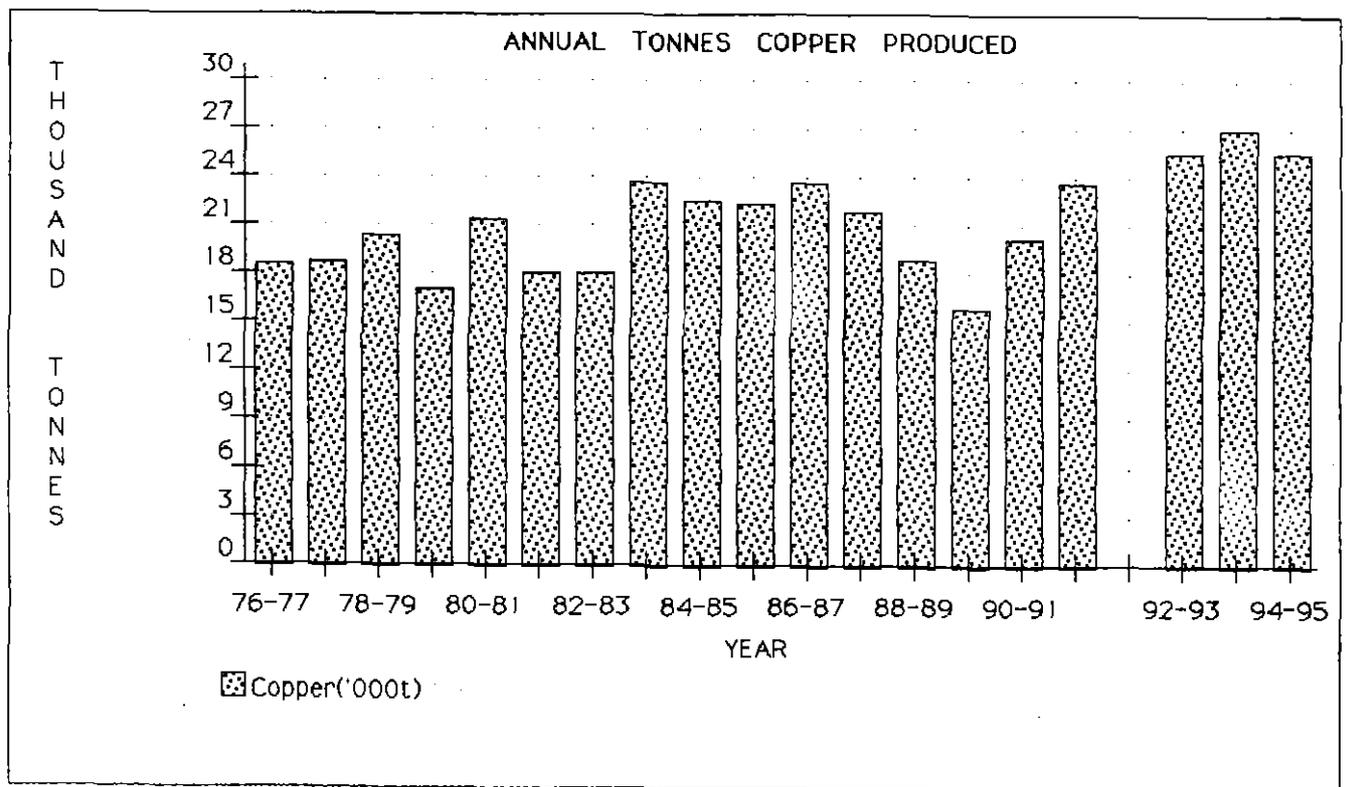
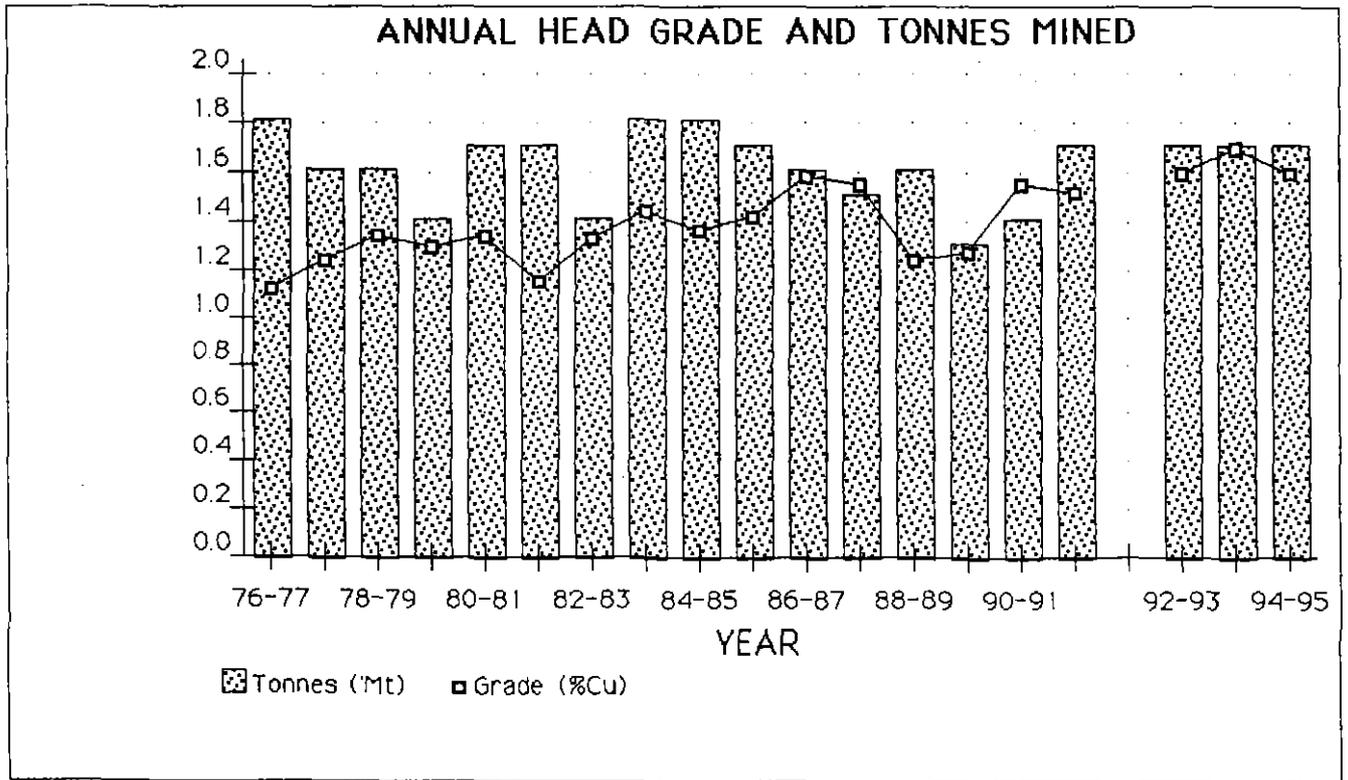


Figure 5.

The significant increase in grade of the underground mine since 1986 can be attributed to an increase in cut-off grade and the selective mining of ore lenses in the Prince Lyell mineralised zone, rather than changes in the inherent nature of the ore bodies.

6.4 Mine Data Conventions

Mt. Lyell mine data is presented on a local mine grid. Mine North lies approximately 8° 30' East of AMG. North.

Sea level = 00 R.L., hence there are positive and negative R.Ls.

One hundred metre R.L. slices are known as "series" to reflect the sub-level open stoping blocks. Hence

200 to 100 R.L. = 20 Series
100 to 00 R.L. = 30 Series
00 to -100 R.L. = 40 Series, etc.

The old 11 Level (Tunnel Level) equates approximately to 200 R.L.

7. CURRENT IDENTIFIED RESOURCES

Mt. Lyell estimates its identified resources at least on an annual basis. The most recent report is:

"Statement of Ore Reserve Estimate and Reconciliation, June 1992" by M.J. Flitcroft and M. House, July, 1992.

The report quantifies **identified** resources, but does not address the resource **potential** of the Lease, in terms of either exploration potential or the application of lower cut-off grades. This is discussed further below in this report.

Identified resources are subdivided into:

- (a) Measured - drilling and exposures sufficient to confirm continuity of mineralisation.
- (b) Indicated - some drilling and exposures but continuity not yet confirmed.
- (c) Inferred - inferred from existing geological knowledge. Drilling and exposure insufficient to classify higher.

Proven ore reserves are defined as measured resources on which mine planning has been completed and mine dilution provided for. In the case of Mt. Lyell, all measured resources are also proven ore resources and include the remaining ore in 50 Series, together with some 60 Series material.

Probable ore reserves are defined as indicated resources on which all drilling has been completed, but where mine planning is incomplete and dilution has not been provided for. Part of 60 Series is classified as probable ore. That part of 60 Series which is neither a proven nor probable reserve is classified as an Indicated Resource.

The June, 1992, resource estimates are shown in Table 4.

Category	Location	Tonnes ('M)	Cu%	Au g/t	Ag g/t
Measured Resource (Proven Reserves)	Prince 50 and part Prince 60 Series	3.01	1.78	0.51	3.05
Indicated Resource	Part of Prince 60 Series	3.48	1.60	0.48	2.98
	Western Tharsis 10-60 Series	6.00	1.56	0.54	1.70
	A-Lens 50 Series	0.20	1.50	0.20	1.50
	Crown III Pillars	1.20	1.60	0.40	4.00
Total Indicated		10.88	1.58	0.5	2.36
Inferred Resource	Prince 70 Series	5.5	1.73	0.67	3.0
	Prince 80 Series	5.5	1.73	0.67	3.0
	Western Tharsis 70 Series	1.6	1.56	0.54	1.7
Total Inferred		12.6	1.71	0.65	2.83
Total Identified Resources		26.49	1.66	0.57	2.66

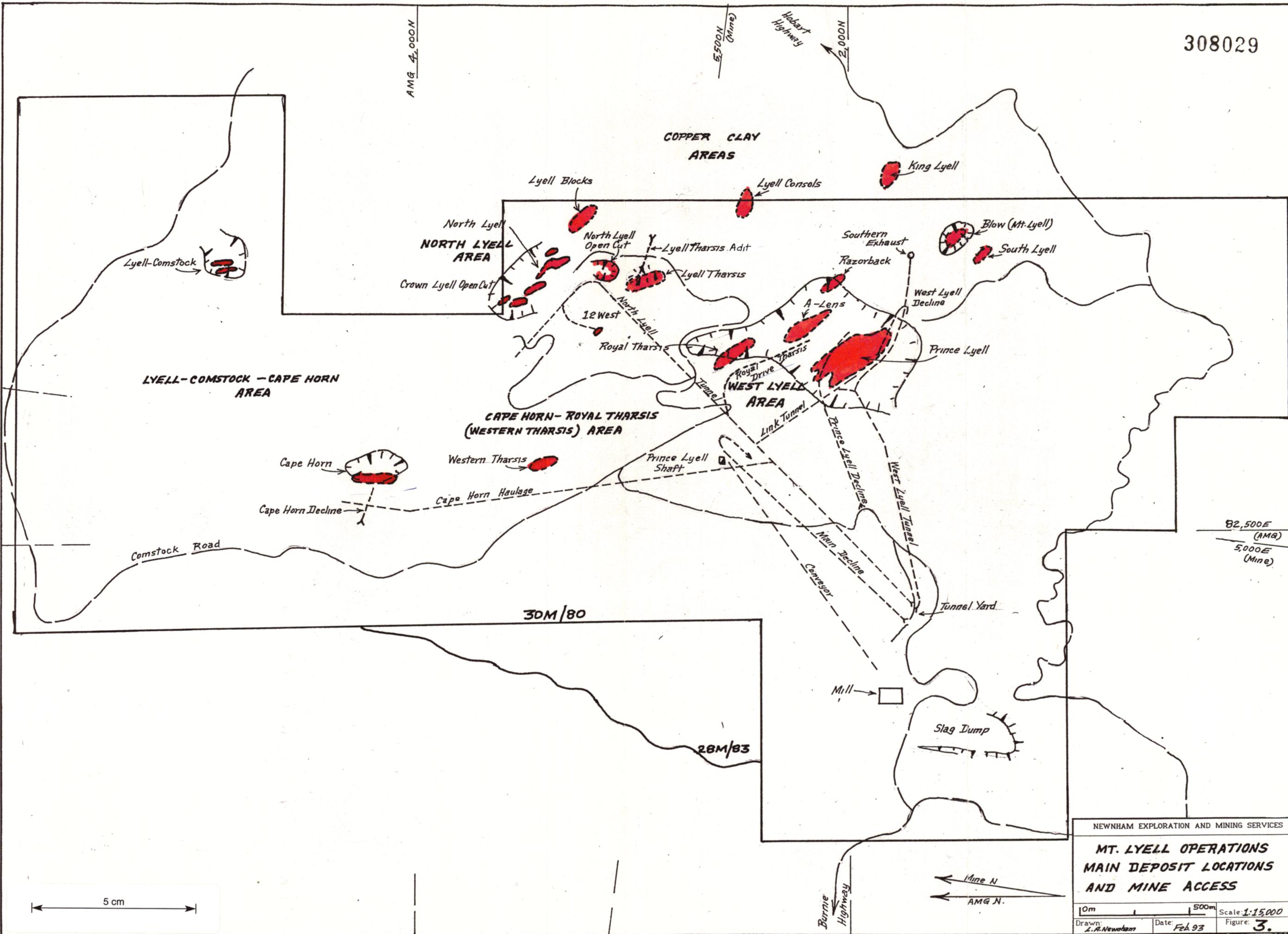
Table 4: Identified Resources - June, 1992.

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15.

By June, 1995, all the current measured resources and Prince Lyell 60 Series indicated resource will have been mined.

Identified resources remaining at that stage, when R.G.C. ceases mining, will be approximately 20 million tonnes of 1.65% copper and 0.6 g/tonne gold, as shown in Table 5.



NEWNHAM EXPLORATION AND MINING SERVICES

**MT. LYELL OPERATIONS
MAIN DEPOSIT LOCATIONS
AND MINE ACCESS**

0m 500m Scale: 1:15,000

Drawn: L.A. Newham Date: Feb 93 Figure: 3.

Location	Category	Tonnes ('M)	Cu%	Au g/t	Ag g/t
Prince Lyell					
70 Series	Inferred	5.5	1.73	0.67	3.0
80 Series	Inferred	5.5	1.73	0.67	3.0
Total Prince Lyell		11.0	1.73	0.67	3.0
Western Tharsis					
10-60 Series	Indicated	6.0	1.56	0.54	1.70
70 Series	Inferred	1.6	1.56	0.54	1.70
Total Western Tharsis		7.6	1.56	0.54	1.70
Crown III Pillars Indicated		1.2	1.6	0.40	4.0
Total Identified Resources		19.8	1.65	0.60	2.56

Table 5: Estimated Identified Resource - June, 1995.

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8. GEOLOGY

8.1 General Comments

Despite the large amount of exploration that has taken place on the Mt. Lyell field and the plethora of geological studies completed over a 100 year period, there remains a strong diversity of opinion as to the origin of the Mt. Lyell mineralisation and the factors responsible for shaping this mineralisation into ore bodies and controlling the distribution of those ore bodies.

Much of the geological thinking reflects, in a general sense, the geological theories popular at the time, the cyclicity of those theories, and the fields of specialisation of the geologists. Hence, if a structural geologist is working on the field, everything tends to be interpreted structurally; if a volcanogenic geologist is involved, everything tends to be interpreted volcanogenically, etc.

This report is not intended to be a geological report on Mt. Lyell, but rather an overview of the mineral resource potential of the field. Hence, geological factors are only dwelt upon where they may have some direct influence on ore discovery and definition.

A selection of references is attached (Section 16) for readers wishing to read further on the geology of Mt. Lyell.

Several features of Mt. Lyell geology and exploration are worth noting:

- (a) Most geological studies of Lyell have concentrated on either the geological setting of the field, or details of specific ore bodies. Few have stood back and in the practical sense asked the question why is Mt. Lyell where it is. In the whole of western Tasmania, nothing else looks geologically like Mt. Lyell in terms of setting, deformation, mineralisation or size. Why is this so? What is special about the Mt. Lyell area, and is that important in terms of future ore discovery?
- (b) Most of the genetic and mineralisation control theories have evolved with a somewhat myopic concentration on the Mt. Lyell area, with little regional overview of available information on new discoveries which are tending to indicate that base and precious metal deposits were forming in Palaeozoic rocks in a continuum from early Cambrian to mid Devonian. This fact should influence long-term future exploration directions in the Mt. Lyell area. X
- (c) No substantial mineralisation has been discovered at Mt. Lyell on the basis of geological modelling. All known orebodies were discovered by early surface prospecting and trenching, followed by either pattern drilling or a combination of geophysics and drilling. Does this mean that geological studies are an ineffective tool for discovery at Lyell, or that such studies may play a part in discovering deeper concealed deposits in the future?

8.2 Regional Geology (Fig. 6 - From Corbett)

The principal Mt. Lyell deposits occur in a 4 km. long x 2 km. wide zone of Cambrian volcanics (Mt. Read Volcanics) and Cambrian-Ordovician sediments, occurring at the intersection of the north-south Great Lyell Fault and the east-west Firewood Siding Fault, both of which are regarded as deep seated, thrust structures, active from the Precambrian to the Devonian.

The Mt. Read Volcanics are dominated by feldspar phyrlic dacites and rhyolitic lavas of the Central Volcanic Sequence, overlain in the North near Comstock by andesitic volcanoclastics and sediments of the Tyndall Group.

The Mt. Read Volcanics are in faulted contact with the Upper Cambrian - Lower Ordovician Owen Conglomerate. Unconformably overlying the Owen Conglomerate is a thin sandstone unit known as the Pioneer Beds which in turn is overlain by Lower Ordovician Gordon Limestone.

The region has been severely deformed on a number of occasions from the Cambrian to Devonian, resulting in greenschist metamorphism with accompanying strong cleavage development of the Central Volcanic Sequence and a complex faulting pattern.

It is instructive to note firstly that deformation in the Lyell area is more severe than anywhere else in the Palaeozoic Dundas Trough in Tasmania, and secondly that the Central Volcanic Sequence is more intensely sheared and deformed than the overlying volcanoclastic and sedimentary formations.

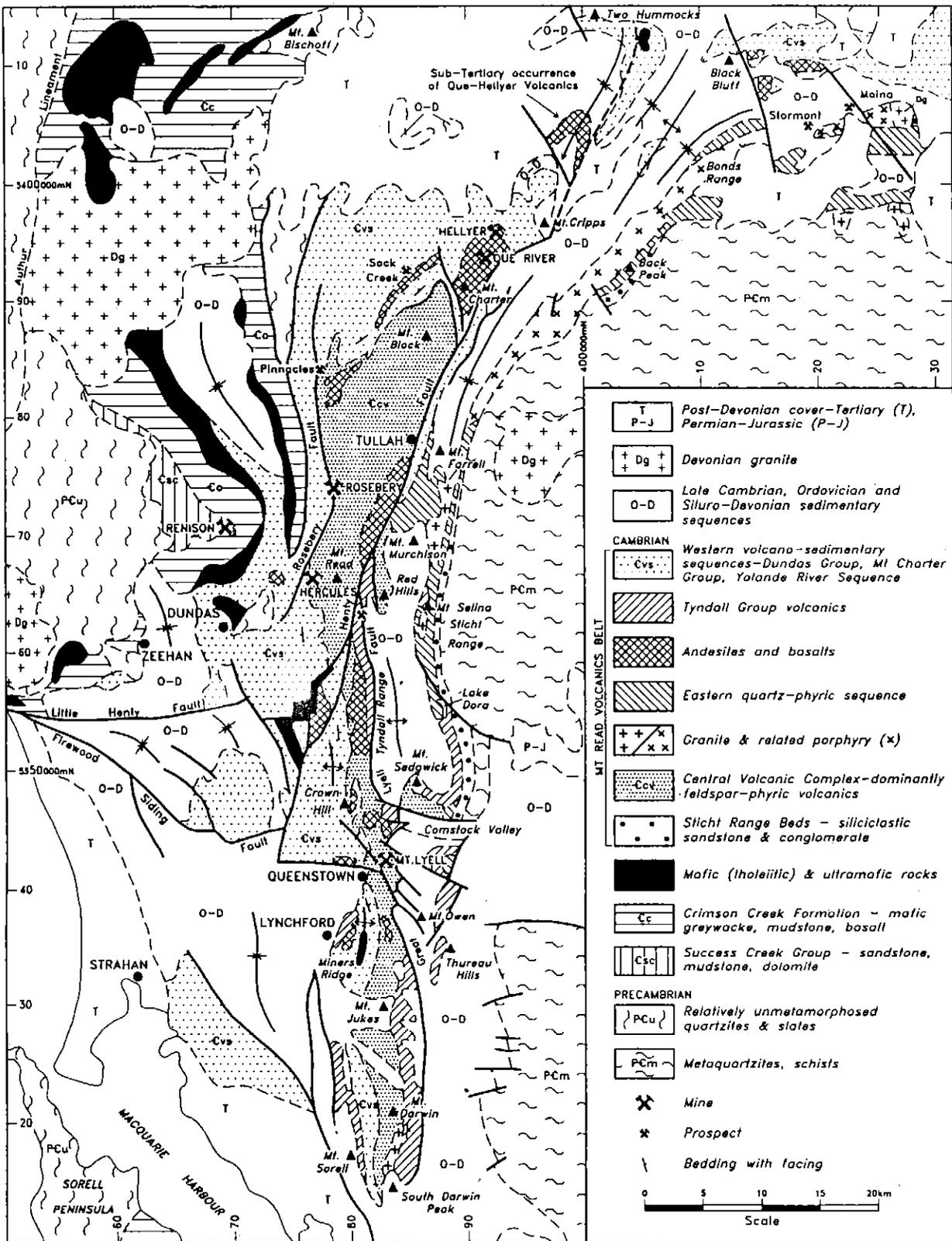
8.3 Local Geology (Fig. 7, 8 - after Hills)

The principal Mt. Lyell deposits occur in either Central Volcanic Sequence felsic and mafic tuffs (Prince Lyell - Western Tharsis, Cape Horn) or near the contact of the Central Volcanic Sequence - Tyndall Group (Lyell Comstock) or near the contact of the Central Volcanic Sequence and Cambrian-Ordovician sediments (North Lyell - Lyell Blocks).

The area has suffered severe structural deformation dominated by early major East-West faults, such as the Firewood Siding Fault - Owen Fault and the North Lyell Fault, later regional thrust faults such as the Great Lyell Fault, and late stage NNW faults such as Glen Lyell Fault.

There is little agreement in contemporary literature on the structural history of Mt. Lyell, including the sequence of faulting, the relative impact of each phase of faulting on the previous stage, and the relevance of faulting to ore genesis and ore location.

Alteration is widespread. Sericite-pyrite alteration is pervasive, particularly in the volcanic sequences but also in the Owen Conglomerate, Pioneer Beds and Gordon Limestone. Hematite-barite and silica-hematite-barite alteration is common in the Central Volcanic Sequence and the overlying sediments at North Lyell, and in the Central Volcanic Sequence and Tyndall Group at Comstock.



- T Post-Devonian cover-Tertiary (T), Permian-Jurassic (P-J)
 - + Dg + Devonian granite
 - O-D Late Cambrian, Ordovician and Siluro-Devonian sedimentary sequences
 - CAMBRIAN
 - Cvs Western volcano-sedimentary sequences-Dundas Group, Mt Charter Group, Yalonde River Sequence
 - Tyndall Group volcanics
 - Andesites and basalts
 - Eastern quartz-phyric sequence
 - + + x Granite & related porphyry (x)
 - Ccv Central Volcanic Complex-dominantly feldspar-phyric volcanics
 - Sticht Range Beds - siliciclastic sandstone & conglomerate
 - Mafic (tholeiitic) & ultramafic rocks
 - Cc Crimson Creek Formation - mafic greywacke, mudstone, basalt
 - Csc Success Creek Group - sandstone, mudstone, dolomite
 - PRECAMBRIAN
 - PCu Relatively unmetamorphosed quartzites & slates
 - PCm Metaquartzites, schists
 - x Mine
 - * Prospect
 - Bedding with facing
- 0 5 10 15 20km
Scale

Geology of the central part of the Dundas trough from Mount Darwin to Moina, showing distribution of major lithologic associations of the Mount Read Volcanics belt and associated Cambrian and Proterozoic sequences. Based on published maps of the Mount Read Volcanics Project and Geological Survey.

This map is reproduced directly from Corbett(1992)

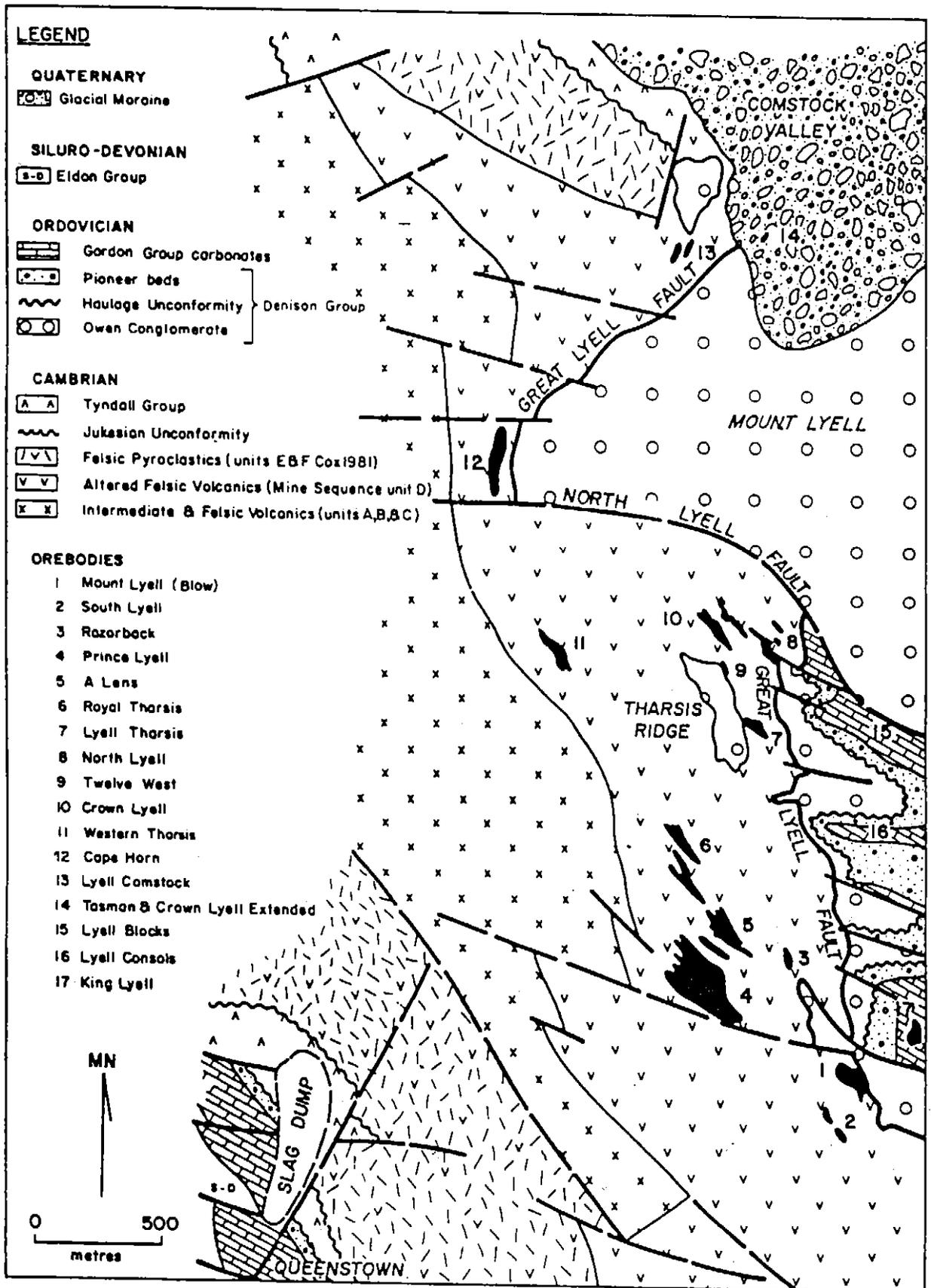
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NEWHAM EXPLORATION AND MINING SERVICES

**MOUNT LYELL DEPOSITS
REGIONAL GEOLOGICAL
SETTING** (From Corbett 1992)

Drawn: _____ Date: _____ Scale: _____

Figure: 6.



—Local geological map of Mount Lyell, after Cox (1979, 1981) and Walshe and Solomon (1981).

Reproduced directly from Hills (1990)

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Fig. 7

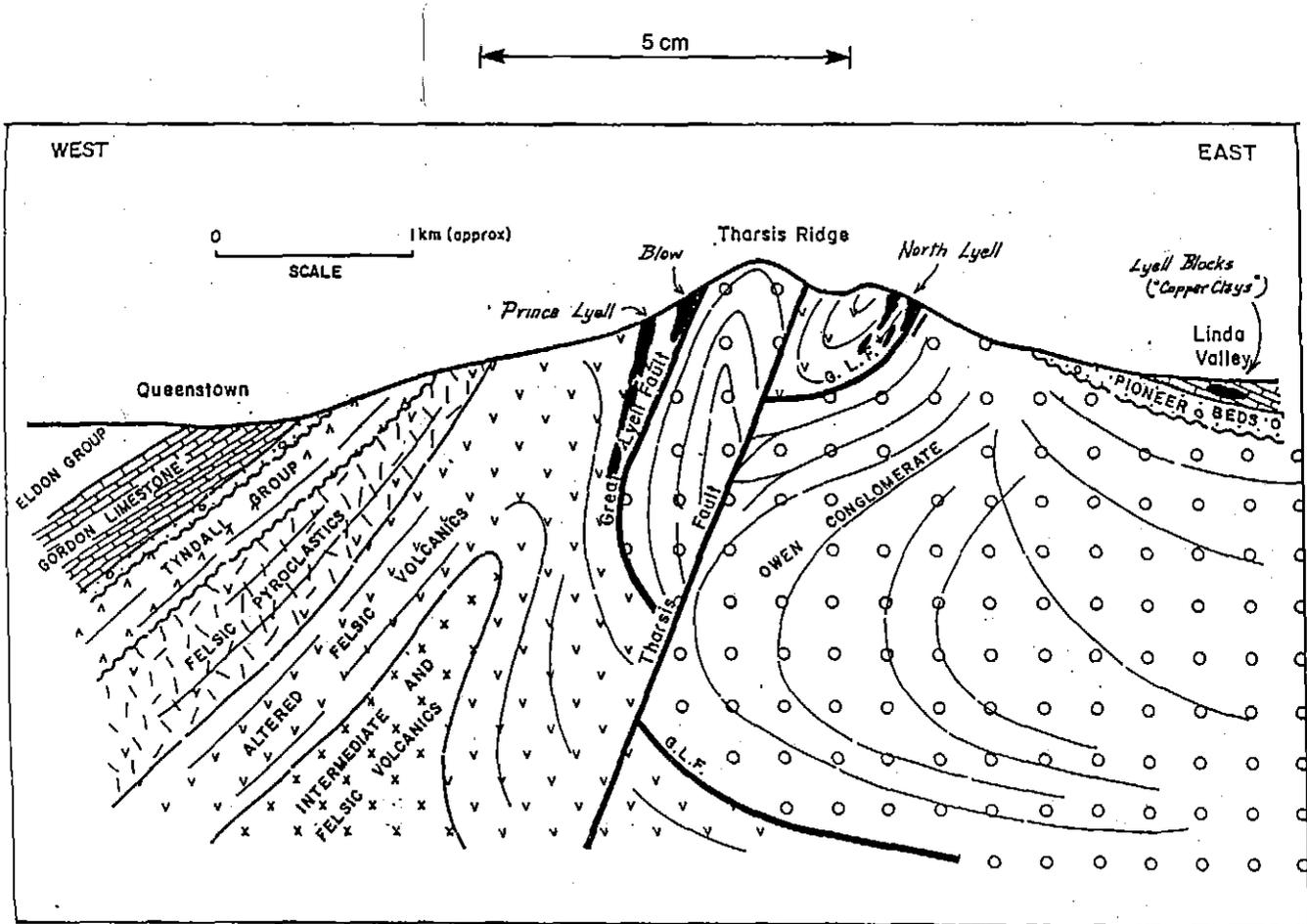
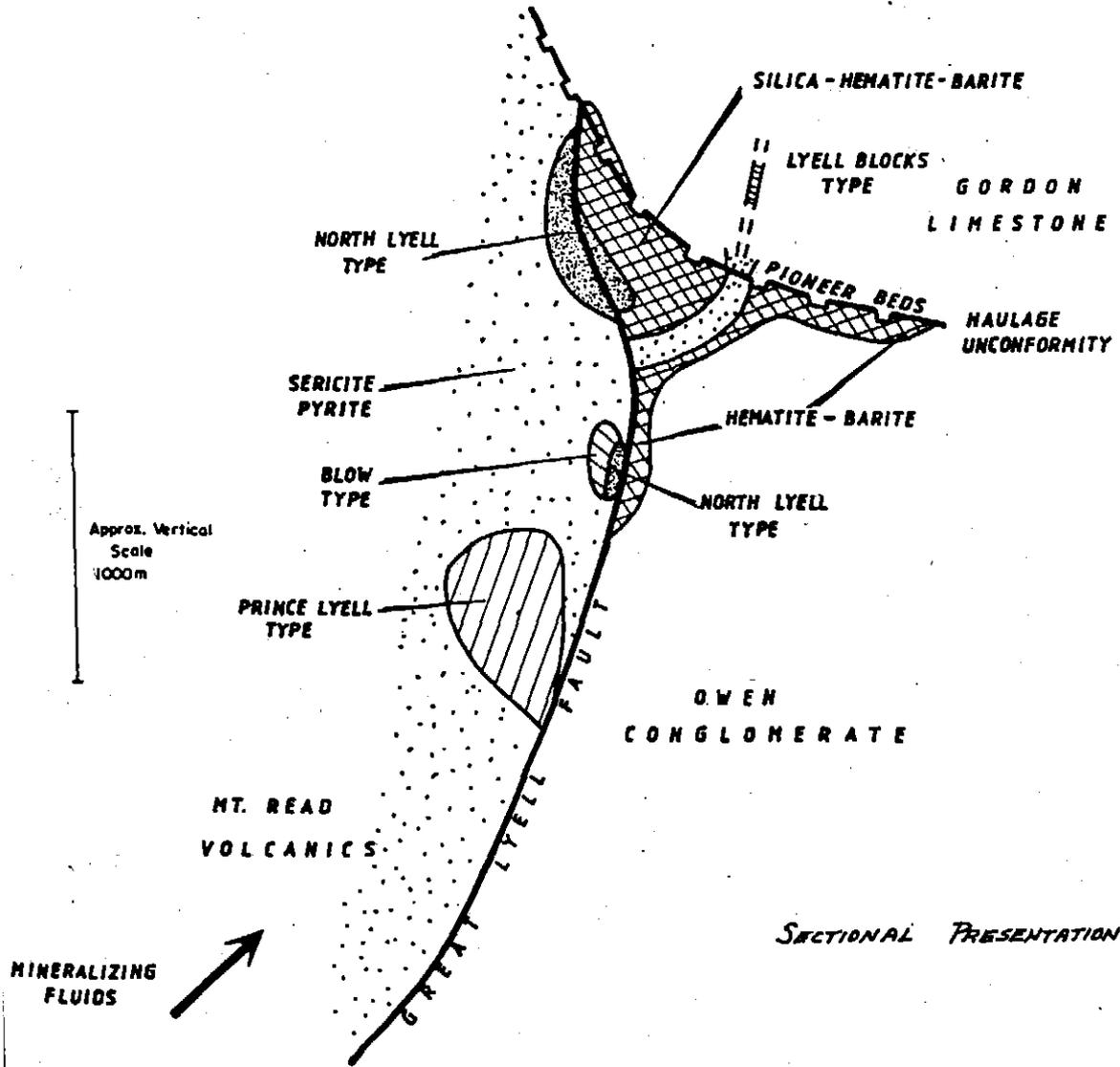


Fig 8. Schematic cross section - Mt. Lyell area. (After Hills 1990; deposit locations added by L.A.N.)

Mineralisation occurs in five basic styles:

- (a) large disseminated pyrite-chalcopryite bodies such as West Lyell, Royal Tharsis, and Cape Horn;
- (b) bornite-chalcopryite, for example, North Lyell and Crown Lyell (in part);
- (c) massive pyrite-chalcopryite (Mt. Lyell and South Lyell);
- (d) massive pyrite-galena-sphalerite-chalcopryite (Tasman and Crown Lyell);
- (e) native copper-cupryite-chalcocite in Gordon limestone (Lyell Blocks, King Lyell, and Lyell Consols).

The ore bodies are very elongate, with depth:strike length ratios typically >4:1. They generally dip steeply 70-90°, and high grade lenses tend to occur in clusters within a broader lower grade halo.



SECTIONAL PRESENTATION

MINERALIZING FLUIDS

This drawing is taken directly from Sillitoe (1985) report for RGC.

In the 1980s, a substantial body of evidence was gathered in support of post Mt. Read Volcanism development of Mt. Lyell orebodies - the basic concept is encapsulated in this schematised section

NEWNHAM EXPLORATION AND MINING SERVICES

SCHEMATIC SETTINGS OF MT. LYELL ORE BODIES AND ASSOCIATED ALTERATION (from Sillitoe 1985)

Drawn:	Date:	Scale:
		Figure: 9

Studies at both Prince Lyell and North Lyell clearly show that the distribution of mineralisation is not strictly lithologically controlled, with zones of continuous mineralisation commonly transversing formational and lithological boundaries. Pyrite is abundant. In fact, the whole Mt. Lyell field can be regarded as one very large pyritic system. Massive 10-20% pyrite zones in excess of 200m wide, 500m long and 1,000m deep extend through the Cape Horn - Western Tharsis - Royal Tharsis and West Lyell areas. There is a general, but not direct, relationship between pyrite and copper mineralisation. Most ore bodies occur within pyritic zones, although not necessarily in the most pyritic parts of these zones, and not all pyrite zones contain ore bodies.

8.4 Evolution of Geological Thinking

Geological thinking on the genesis of the Mt. Lyell ore bodies is continually changing and has an ominous cyclicity to it (Arnold).

Early this century, the ore bodies were generally considered to be replacement types, with fluids derived from some deep magmatic body.

During the 1920's - 50's, they were considered simply to be structurally controlled and probably Devonian age. In the 1960's and 70's they were widely regarded as volcanogenic accumulations formed during Cambrian Mt. Read Volcanism.

In the early 1980's, some Mt. Lyell geologists were recognising widespread mineralisation in post Mt. Read volcanic sediments (Owen Conglomerate, Pioneer Beds and Gordon Limestone) in the North Lyell area, and hence challenging the volcanogenic theories, in favour of structurally controlled hydrothermal replacement.

In 1984, Sillitoe, Brook and Bird, all noted extensive cupriferous mineralisation and associated silicification and hematite-barite alteration in post-Cambrian sediments at North Lyell, both on surface and in underground workings.

They considered mineralisation in both the volcanics and younger sediments to be attributable to channelling of hydrothermal fluids along the western faulted (Great Lyell Fault) margin of an Owen Conglomerate filled graben basin where it was cut and further deformed by the Linda graben (Fig. 9).

Sillitoe also regarded the copper clay deposits at Lyell Blocks to be structurally controlled hypogene mineralisation replacing Gordon Limestone. He pointed to the facts that the deposits were developed on a steep 10-15m wide structure and mineralisation changed to chalcocite at depth.

These workers regarded the geological setting at Lyell Comstock to be similar to North Lyell with extensive silica-barite-hematite alteration in the Tyndall Group above the Central Volcanic Sequence.

Sillitoe postulated several genetic models:

- a pre-Devonian stock at depth releasing fluids into both volcanics and sediments in a structurally prepared area;
- metamorphogenic fluids released from Mt. Read volcanics during early deformation;
- very late stage Mt. Read volcanic source which would require rapid accumulation of Gordon Limestone and Owen Conglomerate;
- connate brines generated by dewatering of an Ordovician-Silurian sedimentary basin west of Mt. Lyell with fluids structurally channelled and trapped in the Lyell area.

Arnold interpreted and further refined Sillitoe's structural comments and suggested the Great Lyell Fault was a strongly folded thrust plane, thereby explaining the structure of the Tharsis Ridge, which is an outlier of Owen Conglomerate.

More recently, Berry suggested the Owen Conglomerate accumulated in a confined basin whose margins were formed by significant structures such as the Great Lyell and Firewood Siding and North Lyell Faults. These basin bounding faults then acted as mineralisation conduits and trap sites where ore fluids reacted with cooler connate waters derived from Owen Conglomerate basin dewatering. This concept is not dissimilar to those of Sillitoe.

Brook further supported these general ideas of post Mt. Read volcanic ore forming processes.

Corbett, however, maintains that the Lyell Comstock orebodies and associated mineralisation are exhalative and hosted by andesitic volcanics near the Tyndall Group - Central Volcanic Sequence. He considered a precursor of the Great Lyell Fault controlled hydrothermal and mineralising processes and interpreted the Comstock chert as a sinter. His reconstruction of the pre-deformation sequence in the Comstock area is illustrated in Fig. 10 and contrasts starkly with the concepts of Sillitoe for this area.

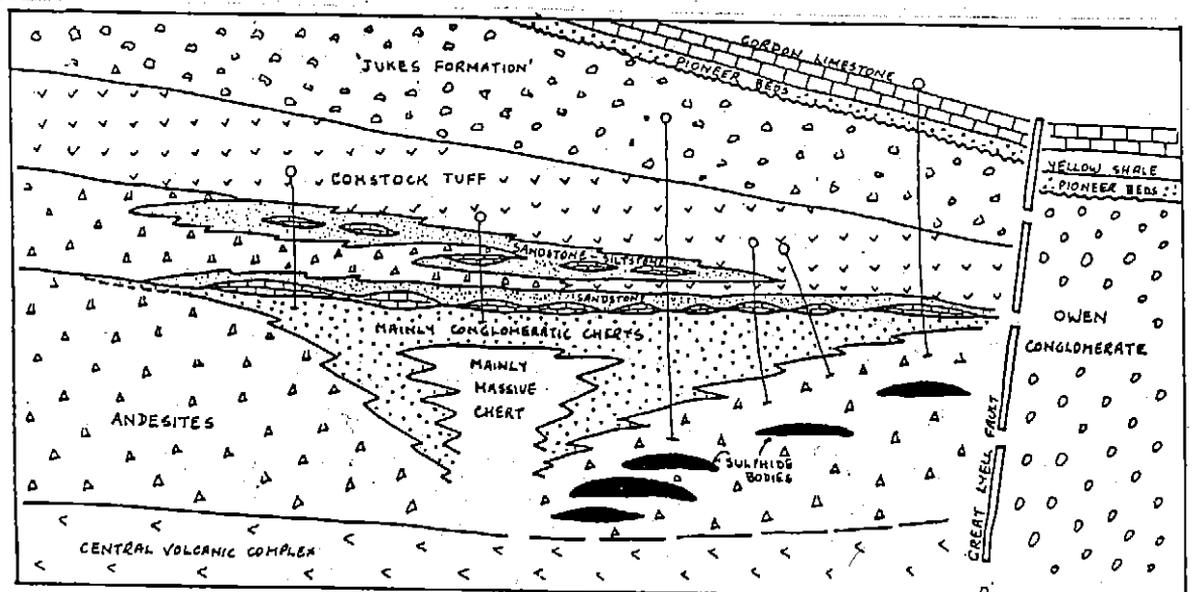


Fig. 10 . Facies setting of Lyell Comstock Orebodies : Taken directly from Corbett(1989)

In summary, these more recent genetic and ore forming models are suggesting that mineralisation was associated with Cambrian Mt. Read volcanism which itself may have been influenced by deep seated ancient structures.

A rapid accumulation of late Cambrian-early Ordovician sediments developed in a structurally controlled basin on top of these volcanics. Subsequent deformation of this basin and the underlying volcanics produced both considerable remobilisation of mineralisation and hydrothermal activity along major faults, resulting in the concentration of mineralisation into orebodies in the volcanics and overlying sediments.

Irrespective of the details of the model, several features of Mt. Lyell geology are noteworthy:

- (a) Mt. Lyell occurs at the intersection of a number of major faults and it is a very deformed area.
- (b) The accumulation of sulfides in this structural focus was large; probably at least 10 million tonnes of chalcopyrite, 100 tonnes of gold and 100+ million tonnes of pyrite.
- (c) The orebodies are not lithologically bound.

It is important to draw a distinction in the light of these conceptual models between genesis of mineralisation and factors controlling ore body formation. **The mineralisation may have had its genesis in the Cambrian volcanics, but the factors controlling the concentration of mineralisation such as major structures are more relevant to the discovery of future orebodies.**

Two important conclusions are:

- (a) The Tyndall Group, Owen Conglomerate, Pioneer Beds and Gordon Limestone may be important ore deposit hosts, and have been little explored to date.
- (b) Structure is probably a major factor in determining ore body location.

However, as Arnold points out, it is important at Lyell to avoid rigid models - an approach which has been conspicuous by its lack of ore discovery.

9. RESOURCE POTENTIAL - WEST LYELL AREA (Fig. 11)

9.1 Introduction

The West Lyell area refers to a closely spaced group of higher grade ore bodies occurring within a broad body of lower grade mineralisation.

The area includes the Prince Lyell, Royal Tharsis, Razorback, A-Lens and Intermediate Lens orebodies. Collectively they were mined near surface in the West Lyell open cut and underground as individual mines on the Prince Lyell, Royal Tharsis, and A-Lens mines.

Some literature refers to the West Lyell style of mineralisation (being disseminated chalcopyrite-pyrite) and in this context the term is used to describe a style of mineralisation rather than a physical location.

The West Lyell area is the most productive section of the Mt. Lyell field. The mineralisation occupies an area of 1,000m x 750m and has been variably mined over a vertical depth of 800m. Production has amounted to 89 million tonnes of 0.92% copper, 0.3 g/tonne gold, 2.1 g/tonne silver, which represents approximately 63% of the total value of metal output from the Mt. Lyell field (Table 6).

Ore Source	Tonnes ('M)	Cu%	Grade Au g/t	Ag g/t
Open cut	58.3	0.72	0.25	1.66
Underground -				
Prince Lyell	28.5	1.29	0.40	2.91
Royal Tharsis	2.0	1.56	0.49	2.77
Razorback	0.2	1.10	0.24	1.48
	89	0.92	0.3	2.1

Table 6: West Lyell Production (to December, 1992)

All current production is from Prince Lyell underground, and the bulk of Mt. Lyell's identified resources lie within that orebody. The most significant resource potential on the Lyell field is also considered to lie within this area.

9.2 Production

9.2.1 West Lyell Open-cut

The West Lyell Open-cut commenced operations in 1934 and remained in continuous production till 1978. Total production was 58.3 million tonnes, 0.72% copper, 0.25 g/tonne gold, 1.66 g/tonne silver at an average 1.3 million tonnes per annum, and a waste:ore ratio of 0.82.

Mining and drilling records indicate approx. 2Mt 1-2% Cu as native Cu and chalcocite in King Lyell, Lyell Blocks, Lyell Consols. May be opencuttable.

Limited drillings suggests scope exists to extend the Royal Tharsis Open Cut to the North and East.

Some potential exists in this area for shallow extensions of the Prince Lyell orebody North of original open cut

A very large tonnage (+100Mt) of moderate grade material remains adjacent to the Prince Lyell mined areas between 280 to -300 R.L. and may be amenable to solution mining.

The Prince Lyell orezone extends below -300RL (60 Series) and shows no sign of reducing in width or grade. Resource potential in this area is high.

- Og Gordon Limestone
- PB Pioneer Beds
- Oo Owen Conglomerate
- CVS Central Volcanic Sequence (Lyell Schists)

Plane of Longitudinal Projection

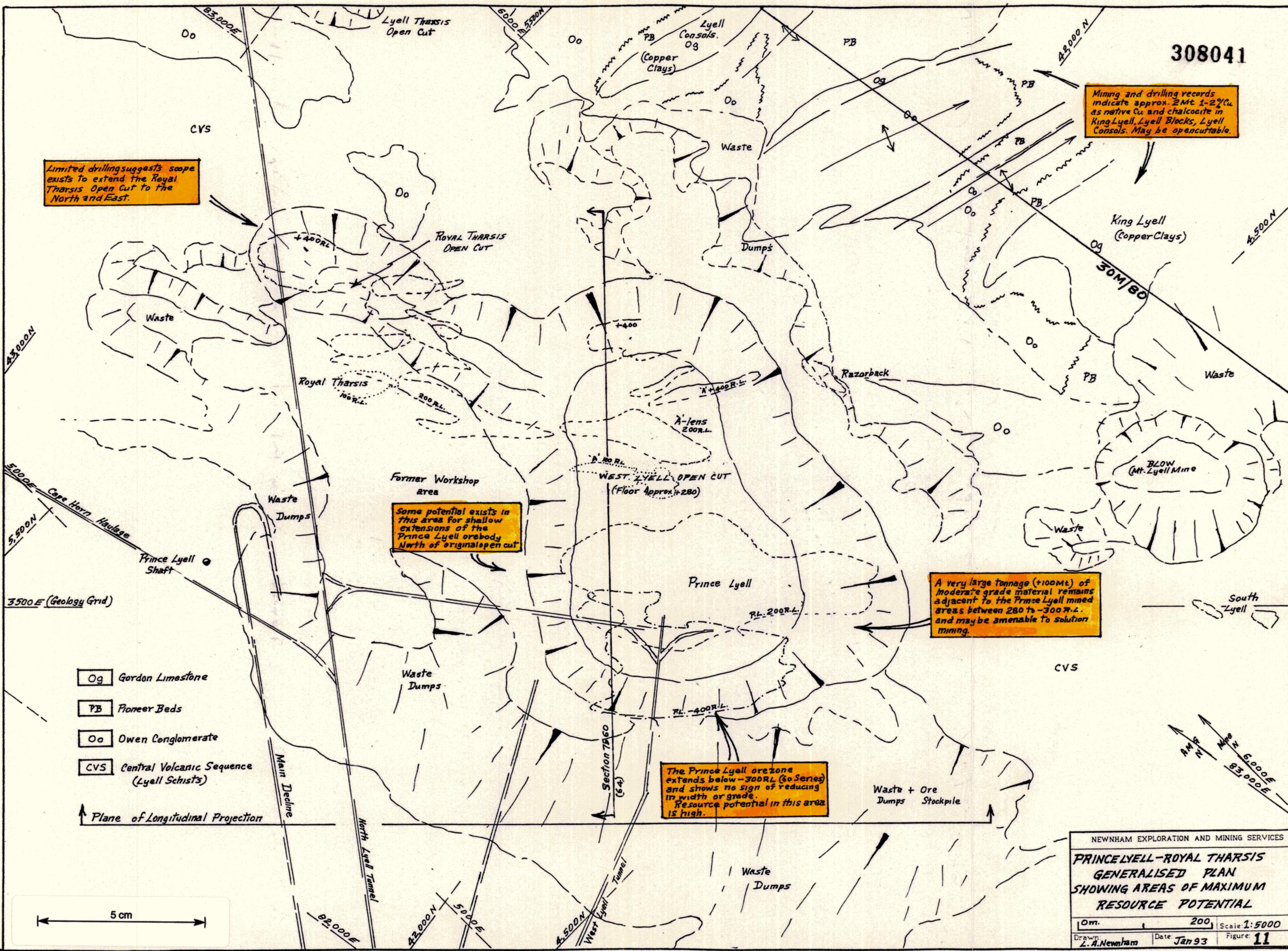
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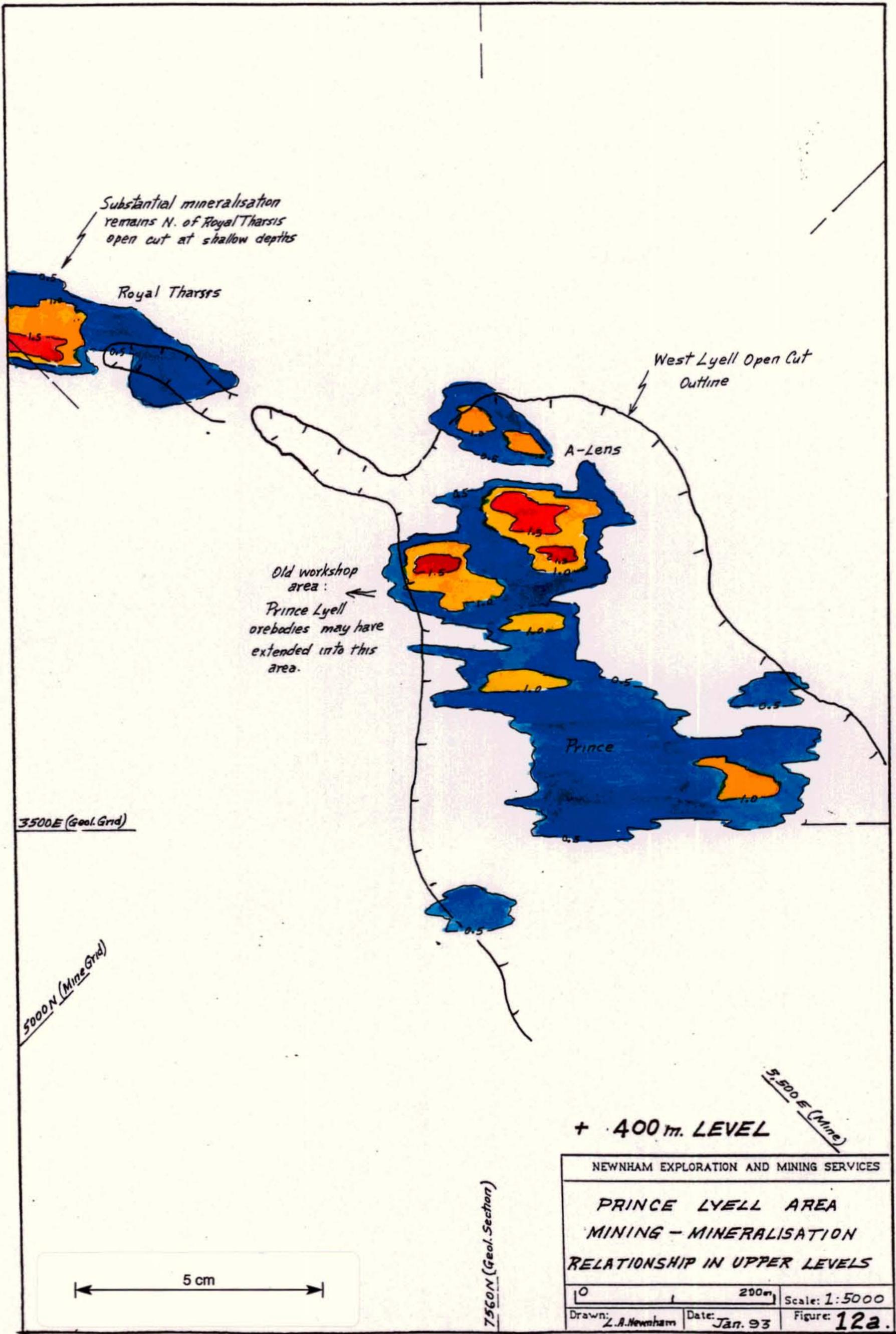
NEWNHAM EXPLORATION AND MINING SERVICES

PRINCE LYELL-ROYAL THARSIS GENERALISED PLAN SHOWING AREAS OF MAXIMUM RESOURCE POTENTIAL

0m 200 Scale 1:5000

Drawn L.A. Newham Date Jan 93 Figure 11





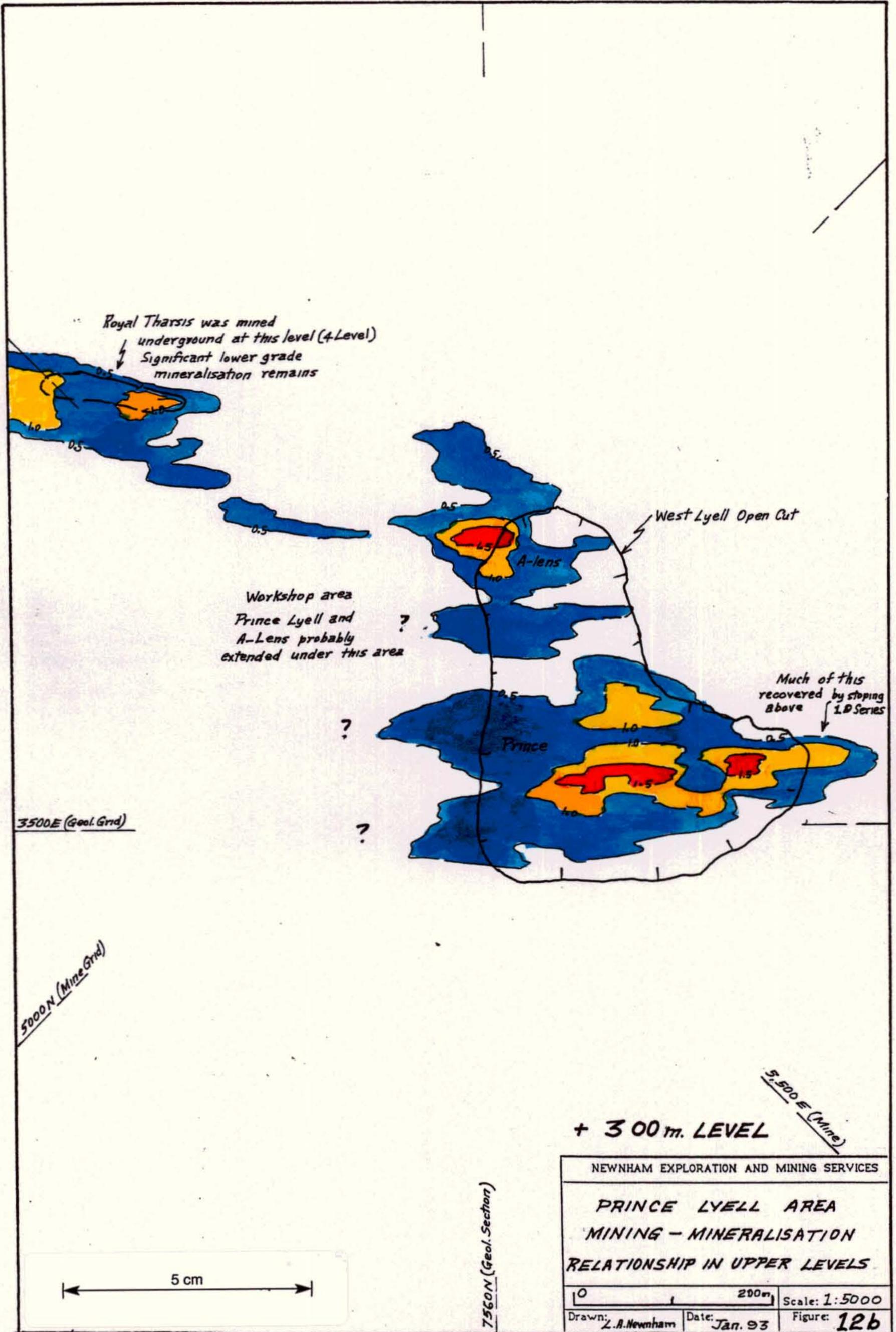
+ 400m. LEVEL

NEWNHAM EXPLORATION AND MINING SERVICES		
PRINCE LYELL AREA MINING - MINERALISATION RELATIONSHIP IN UPPER LEVELS		
		Scale: 1:5000
Drawn: Z.A. Newham	Date: Jan. 93	Figure: 12a.

5 cm

7500N (Geol. Section)

5500E (Mine)

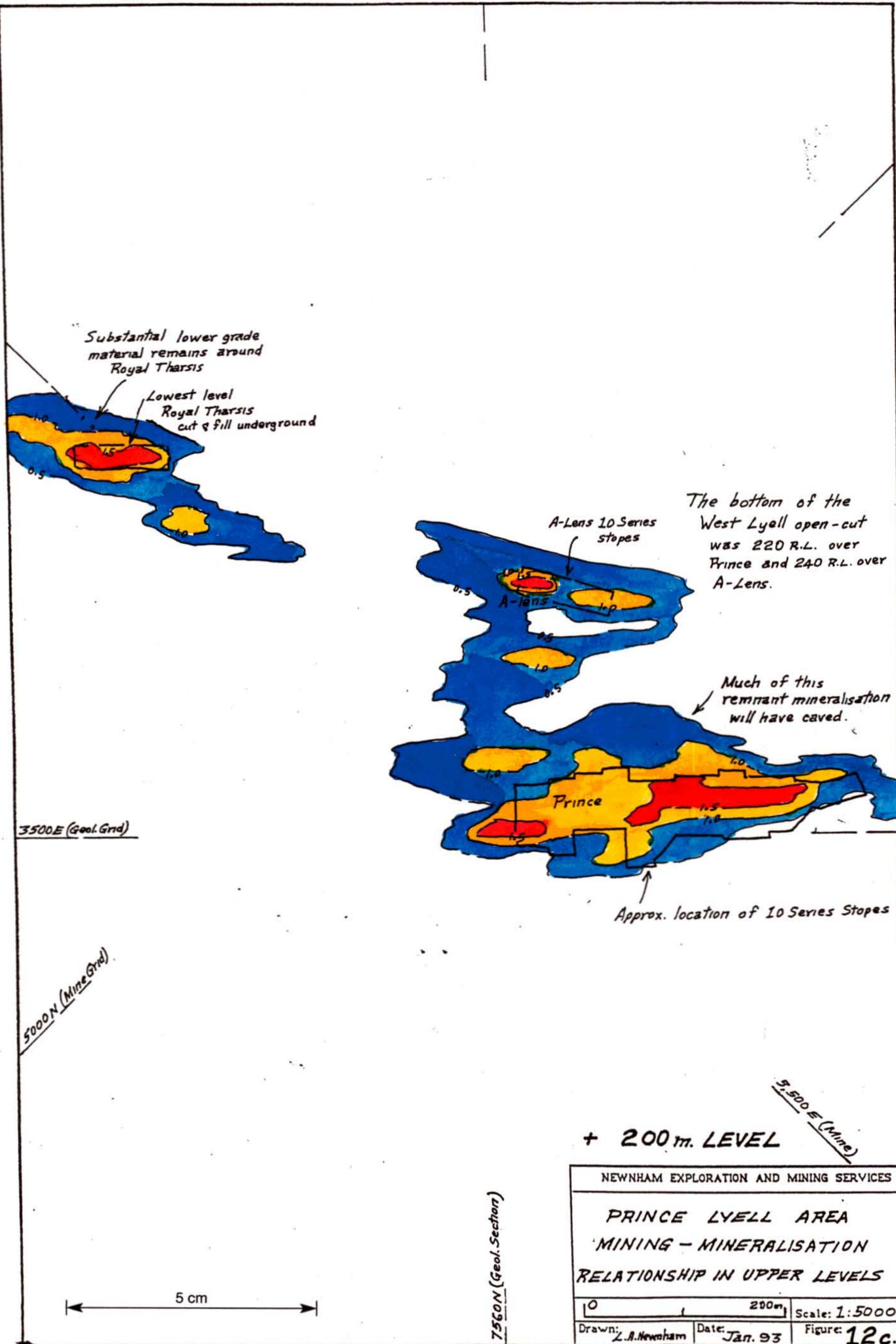


NEWHAM EXPLORATION AND MINING SERVICES

**PRINCE LYELL AREA
 MINING - MINERALISATION
 RELATIONSHIP IN UPPER LEVELS**

0 200m Scale: 1:5000

Drawn: L.A. Newham Date: Jan. 93 Figure: 12b



Substantial lower grade material remains around Royal Tharsis

Lowest level Royal Tharsis cut & fill underground

The bottom of the West Lyell open-cut was 220 R.L. over Prince and 240 R.L. over A-Lens.

Much of this remnant mineralisation will have caved.

Approx. location of 10 Series Stopes

3500E (Geol. Grid)

5000N (Mine Grid)

5500E (Mine)

+ 200m. LEVEL

5 cm

7560N (Geol. Section)

NEWHAM EXPLORATION AND MINING SERVICES		
PRINCE LYELL AREA MINING - MINERALISATION RELATIONSHIP IN UPPER LEVELS		
0	200m	Scale: 1:5000
Drawn: Z.A. Newham	Date: Jan. 93	Figure: 12c.

The maximum dimensions of the cut were 1,000m long x 500m wide and 200m deep.

Several individual high grade lenses were mined: Royal Tharsis, Razorback, A-Lens, Intermediate Lens and Prince Lyell, which itself consisted of a number of individual lenses. The material between these lenses was variably mineralised but typically contained some copper in the range of 0.1 - 0.5% copper. The whole West Lyell Open-cut area is heavily pyritic and probably averages 10 - 20% pyrite.

There is no close or strict relationship between rock type and mineralisation, that is, the mineralisation is not stratabound except to the extent that all known mineralisation occurs in Central Volcanic Sequence rocks.

The cut-off grade applied in the open-cut during its 45 years of operation undoubtedly varied. The 47 million tonnes of waste are generally considered to contain approximately 0.17% copper, and it is therefore reasonable to assume that the average cut off lay approximately midway between ore grade and waste grade - approximately 0.4 - 0.5% copper.

The major high grade ore lenses showed no decrease in either grade or size with depth. (Fig. 12(a), (b) and (c)). The life of the open-cut was limited and compromised by increasing waste:ore ratios, and the existence of mine infrastructure such as the Royal Tharsis shaft, the North Lyell tunnel and West Lyell workshops.

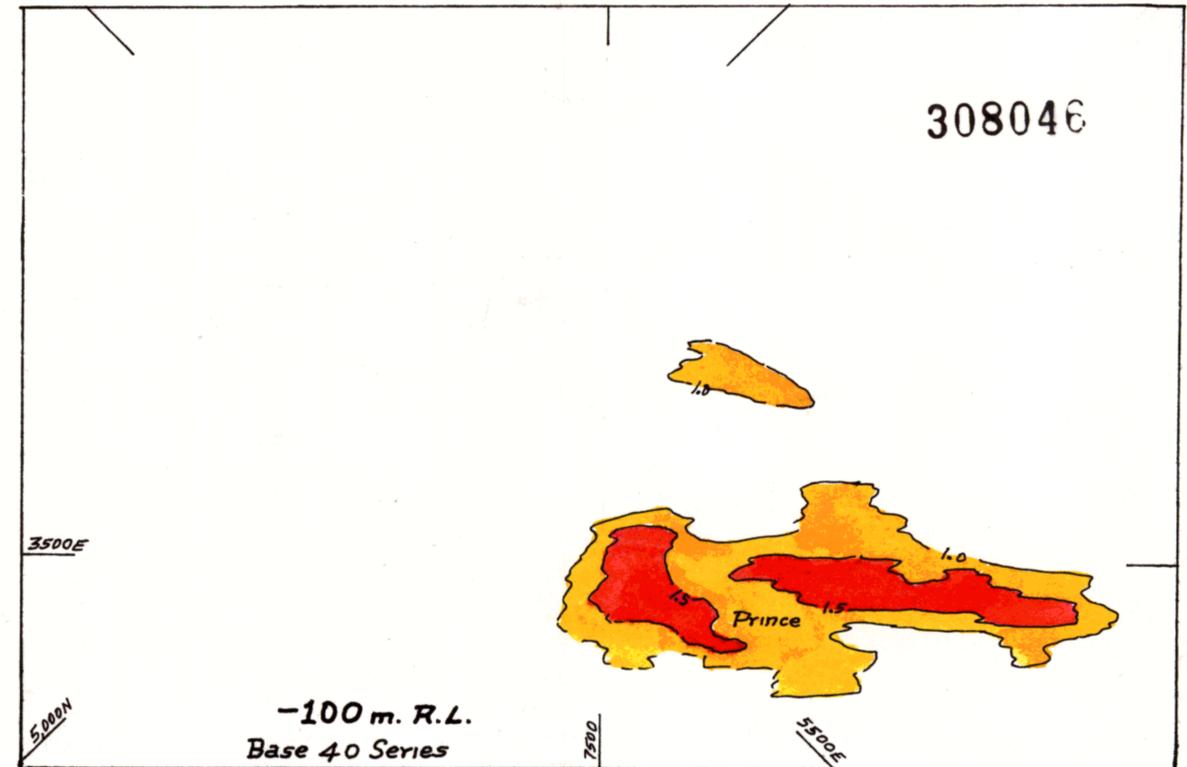
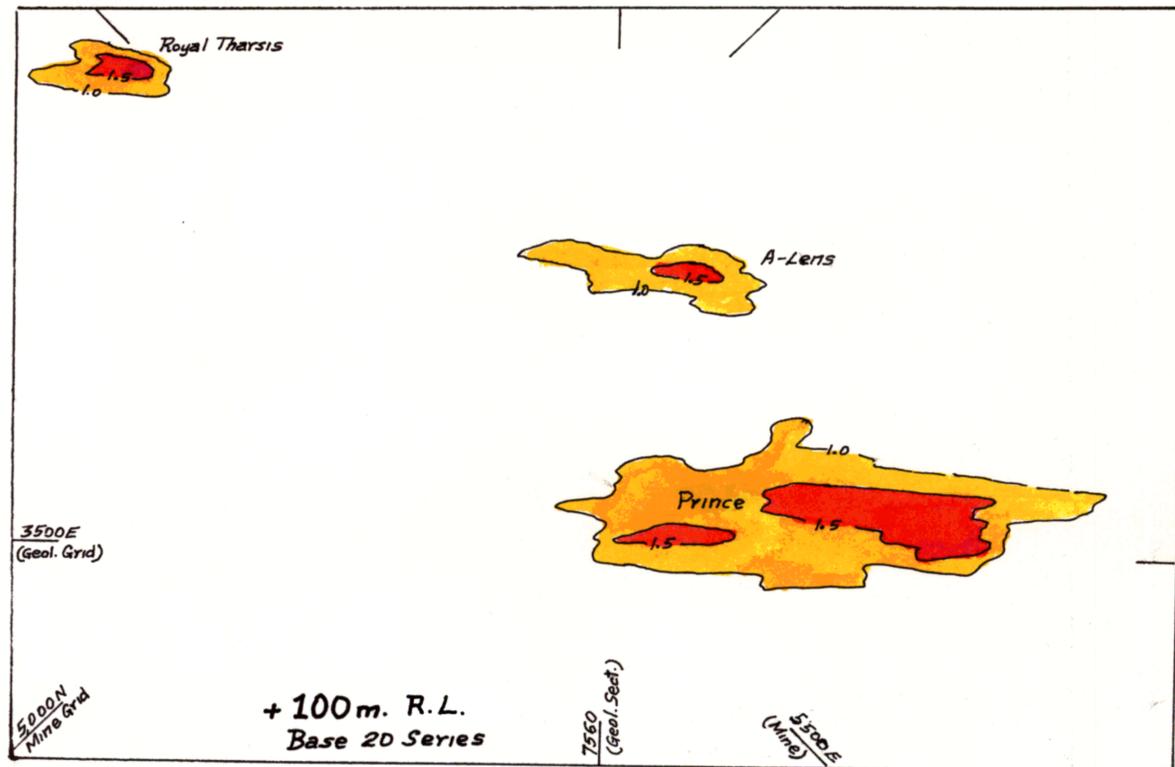
9.2.2 Prince Lyell Mine

The Prince Lyell orebody has been mined underground from the bottom of the open-cut at 280 R.L., to -300 R.L., a vertical distance of 580m.

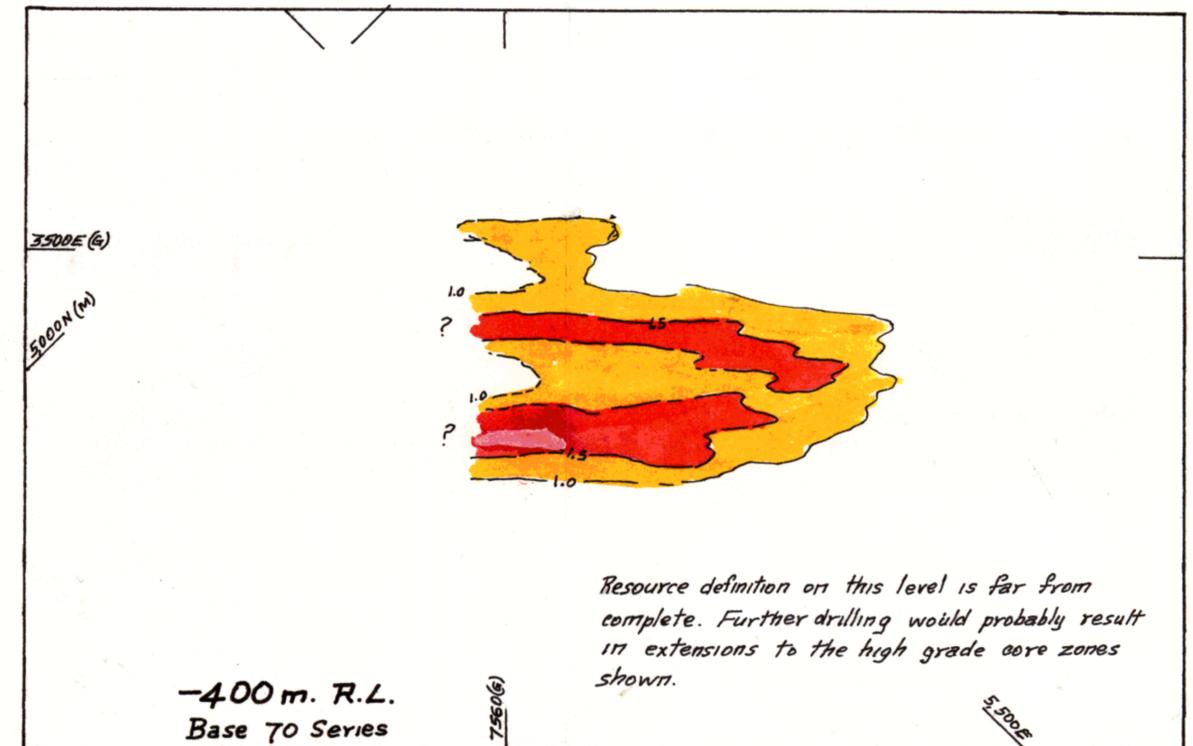
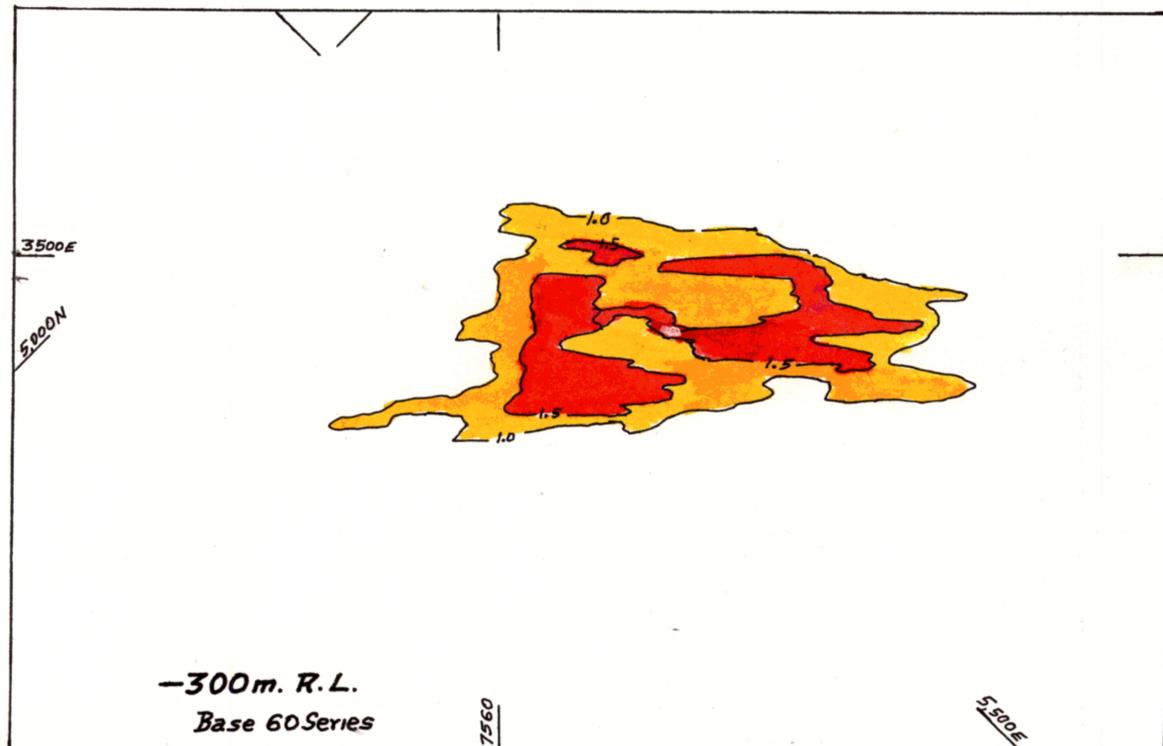
The mine has been developed on a mineralised body approximately 400 - 500m long by 200 - 250m wide. Within that broad zone, a number of higher grade lenses have been developed. In recent years, these lenses have generally been termed the North Lens, South Lens, North Footwall Lens, and South Footwall Lens. However, with depth, the shape and size of these individual lenses varies significantly - sometimes coalescing or splitting or disrupted by faulting. (Figure 13.)

The high grade lenses are surrounded by lower grade mineralisation. In the upper series of the mine, this lower grade material was generally mined at a cut-off around 1%, but with increasing depth, the cut-off has been steadily increased and is currently 1.5% copper in the 50 and 60 Series stopes.

The strict geostatistical application of this cut-off has resulted in the fragmentation at the mining stage of otherwise continuous zones of mineralisation. Hence, substantial tonnages of lower grade mineralisation remain adjacent to most stopes in Prince



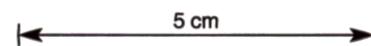
On these deeper levels only the high grade core zones (>1.0 Cu) are shown. However, as with the upper levels, these cores are surrounded by much greater volumes 0.1-1.0 Cu.



Resource definition on this level is far from complete. Further drilling would probably result in extensions to the high grade core zones shown.

PRODUCTION and RESOURCE ESTIMATES

10 + 20 Series (Actual Production) 11.2 Mt 1.19 Cu
 30 + 40 Series (Actual Production) 11.3 Mt 1.33 Cu
 50 + 60 Series (Resource) 9.5 Mt 1.70 Cu
 70 + 80 Series (Estimated Resource) 11 Mt 1.73 Cu
 Actual production from 50 + 60 Series will be less than the resource figure because of production decisions related to the closure plan.



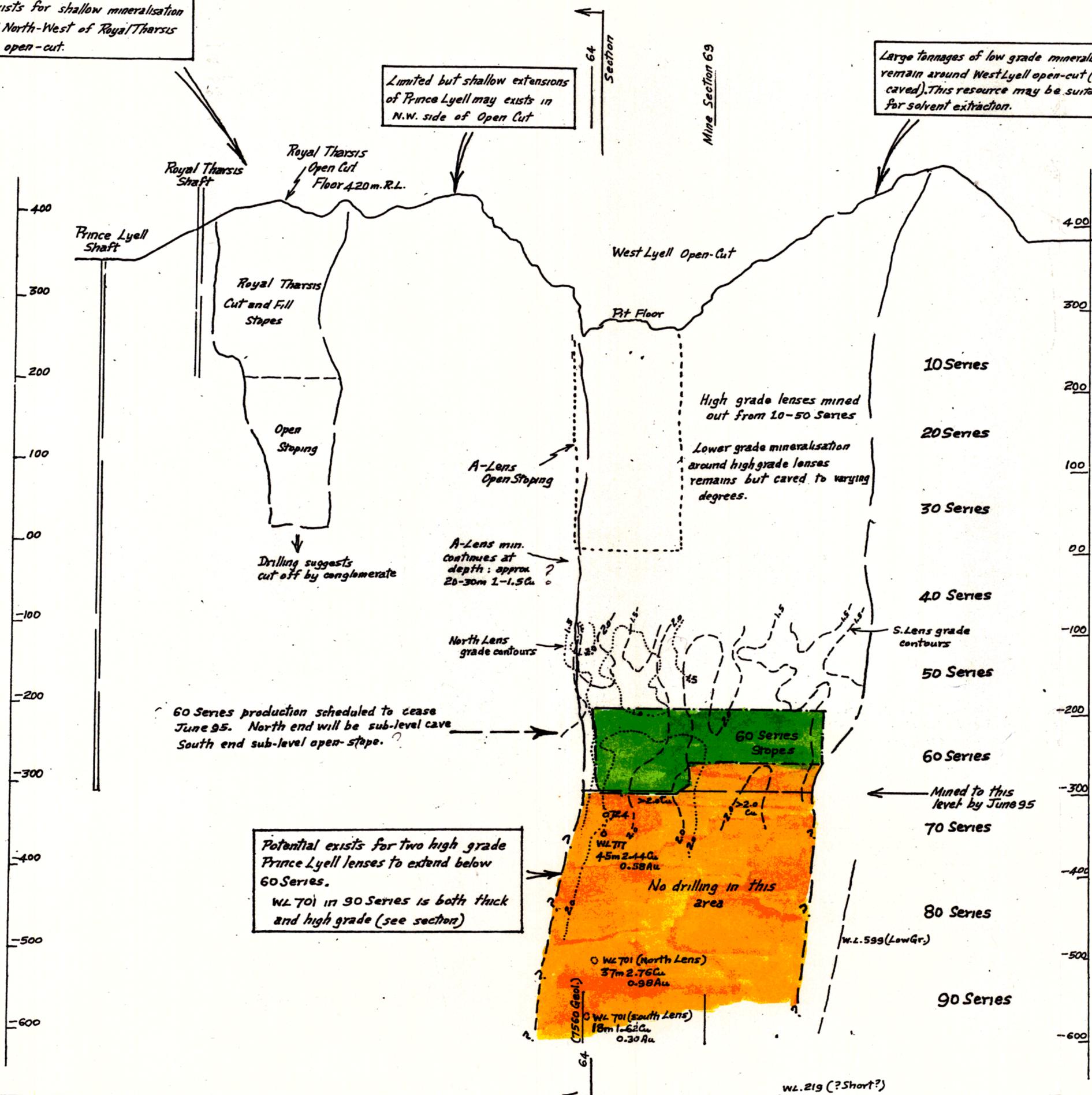
No evidence exists to suggest Prince Lyell is diminishing in either grade or tonnes with depth.
 In fact, preliminary drilling suggests both grade and tonnes may be increasing below 60 Series where production is planned to stop in 1995 cf. Drill hole WL 701 which intersected 37m. true width 2.76 Cu, 0.98 g/t Au within a 200m. true width zone averaging 1.13 Cu. at R.L. -500m.

NEWNHAM EXPLORATION AND MINING SERVICES		
PRINCE LYELL MINERALISATION OUTLINE TRENDS WITH DEPTH (Level Plans)		
0 m.	200	Scale: 1: 5000
Drawn: L. A. Newnham	Date: Jan. 93	Figure: 13

Potential exists for shallow mineralisation North and North-West of Royal Tharsis shaft and open-cut.

Limited but shallow extensions of Prince Lyell may exist in N.W. side of Open Cut

Large tonnages of low grade mineralisation remain around West Lyell open-cut (partly caved). This resource may be suitable for solvent extraction.



60 Series production scheduled to cease June 95. North end will be sub-level cave. South end sub-level open-stope.

Potential exists for two high grade Prince Lyell lenses to extend below 60 Series. WL 701 in 90 Series is both thick and high grade (see section)

5 cm

NEWMHAM EXPLORATION AND MINING SERVICES

ROYAL THARSIS- PRINCE LYELL
LONGITUDINAL- PROJECTION
 (Looking mine North-East)

0m 200m Scale: 1:5000

Drawn: L.A. Newham Date: Jan. 93 Figure: 14

Lyell. This is commented upon further in the section below on Mineral Resource Potential of the West Lyell area.

Mining has been by sub-level open stopes developed in 100m slices known as Series (Fig. 14).

The current phase of mining is planned to cease by June, 1995, at the base of 60 Series (-300 R.L.), where some production in the south end will be by sub-level caving.

At that time, total production from Prince Lyell will be approximately 31 million tonnes of 1.39% copper, and 0.45 g/tonne gold.

Production from the six stoping Series, including estimates of 50 and 60 Series is shown in Table 7.

Series	Tonnes ('M)	Grade Cu/%	Cu tonnes/v.m.
10	5.4	1.13	610
20	5.8	1.24	719
30	5.4	1.27	686 <i>557</i>
40	5.9	1.39	820
50) Production/	4.2	1.73	727
60) Resources	4.6	1.73	795
	31.3	1.39	

Table 7: Prince Lyell Resource.

9.2.3 Royal Tharsis

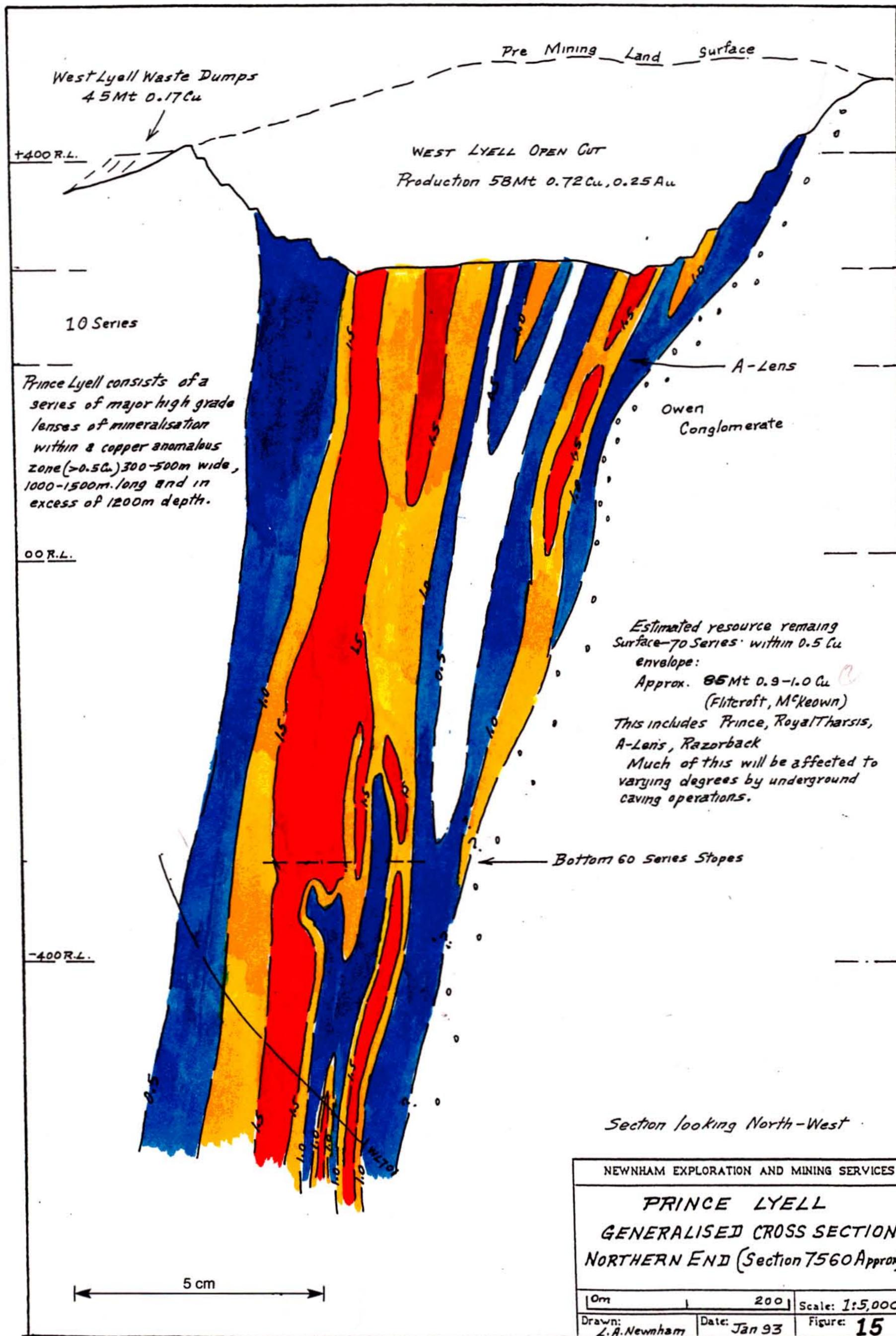
Royal Tharsis is a single lens of higher grade mineralisation, approximately 150m long by 30m wide, extending over a vertical depth of 450+m.

It was mined by open-cut to 420 R.L. and underground from 420 to 00 R.L. (base of 30 Series).

Mining to 200 R.L. was by cut and sand fill, using deslimed mill tailings as the principal fill. Ore was removed to the mill through the nearby North Lyell tunnel.

Below 200 R.L. stoping has been by sub-level open stoping. However, difficult ground conditions have limited underground production from this deposit.

Total production from the Royal Tharsis underground mine is 2 million tonnes of 1.56% copper, 0.49 g/tonne gold. Production from Royal Tharsis in the West Lyell open-cut is not known.



Grade contours above -350m.R.L. were derived from block model sections

Below -350 R.L. they were produced manually.

-400 R.L.

-500 R.L.

WL 701 and WL 717 drilled in 1990-91 into the northern margin of Prince Lyell indicated that two high grade lenses of mineralisation may extend at least 200m. below 60 Series, and possibly extend further North than previously thought. (see Long Proj.)

This limited drilling indicates that Prince Lyell is not reducing in size with depth, whilst gold and copper grades may be increasing.

This composite section incorporates data from mine sections 64-N (7560) and 65 (7530)

Base 60 Series
-300 R.L.

WL 378

70 SERIES

22m (True width)
1.78 Cu.

WL 602

-400 R.L.

NORTH LENS

NORTH FOOTWALL LENS
(SOUTH LENS)

80 SERIES

37m (True width)
2.76 Cu 0.98 Au

-500 R.L.

90 SERIES

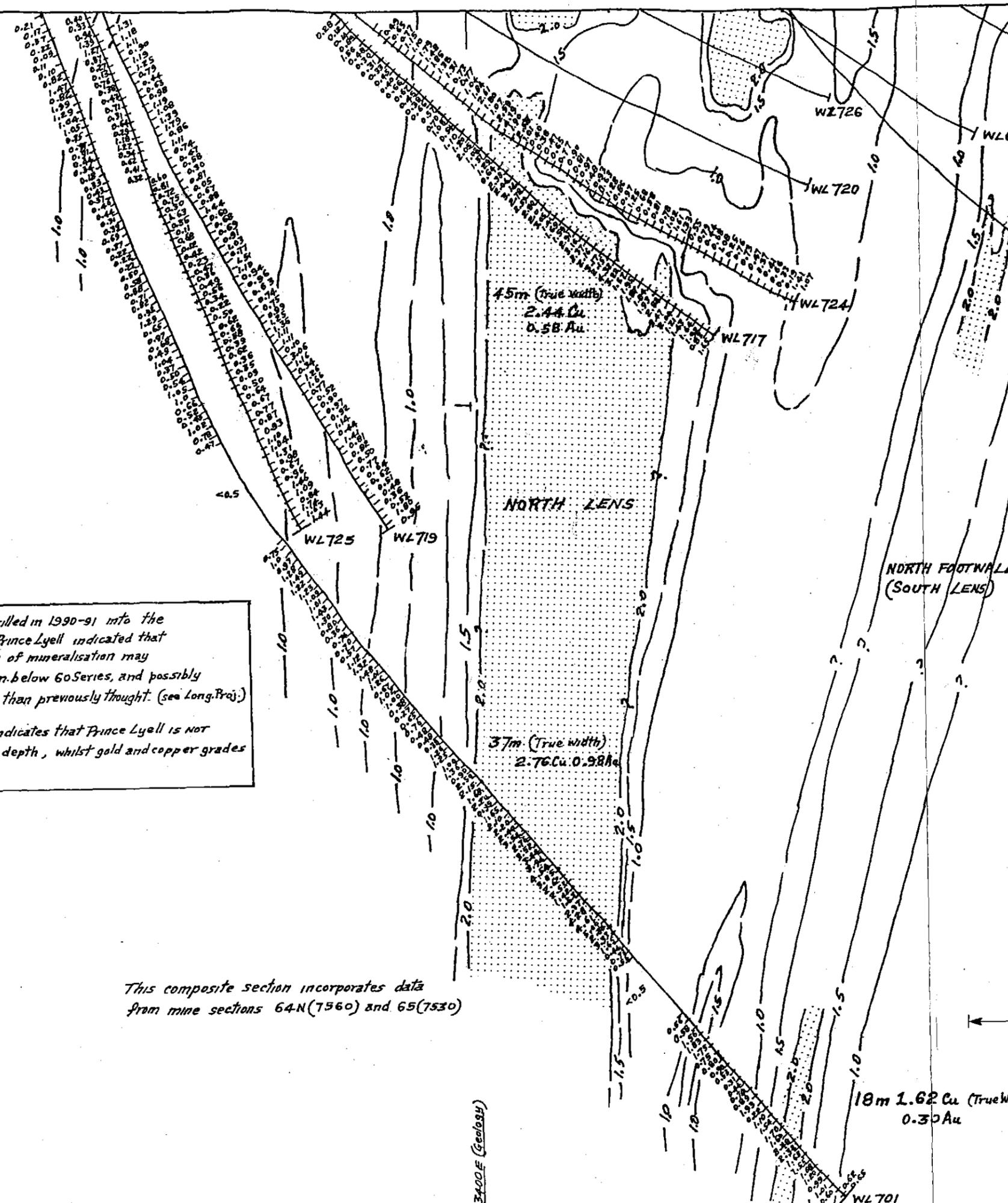
5 cm

18m 1.62 Cu (True Width)
0.30 Au

NEWHAM EXPLORATION AND MINING SERVICES			
PRINCE LYELL CROSS SECTION 70 and 80 SERIES NORTH END			
0m.	40	Scale: 1:1000	Figure: 16
Drawn: Z.A. Newbham	Date: JAN 93		

308050

3400E (celest)

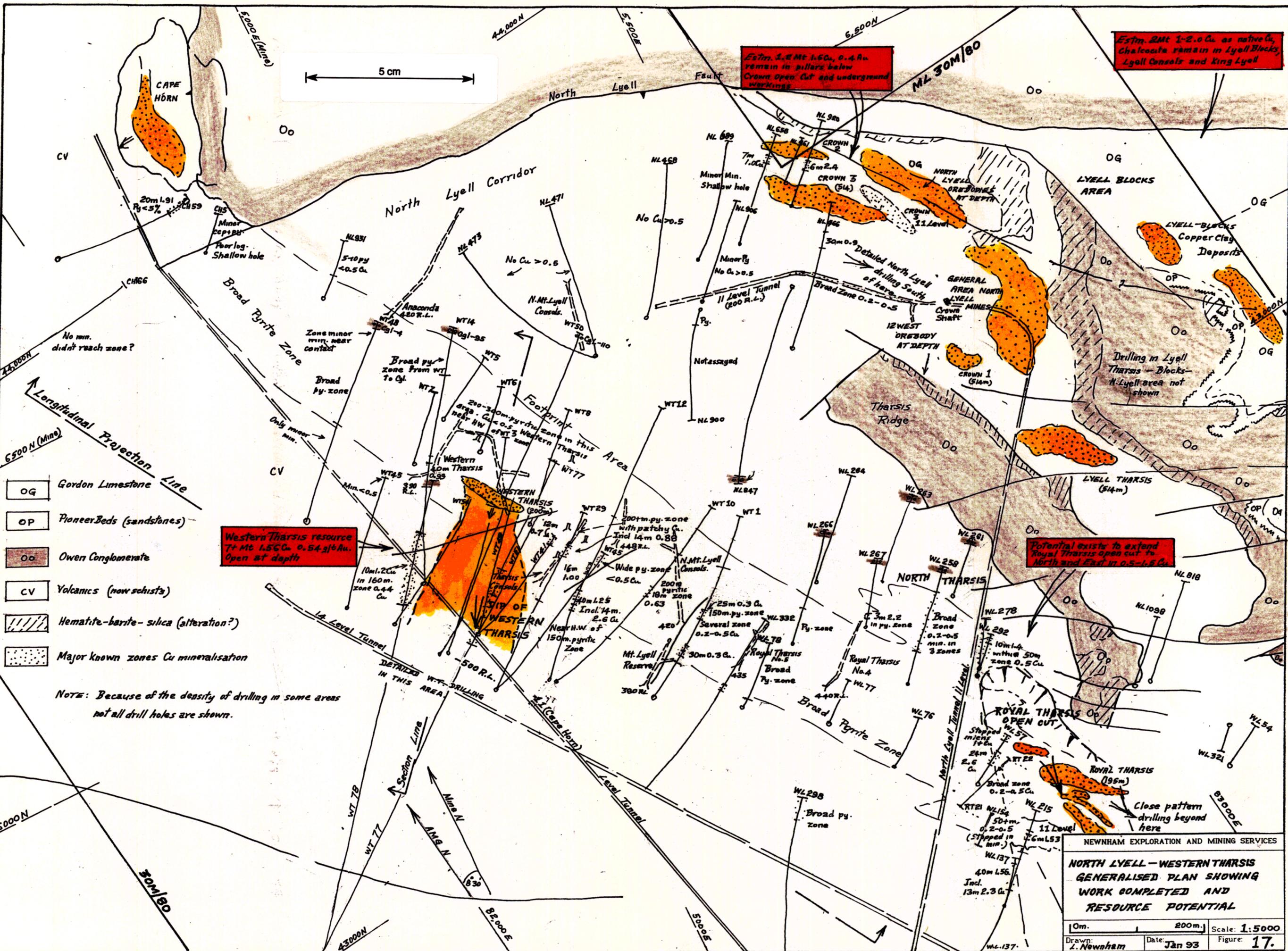


Estm. 1.2 Mt 1.6 Cu, 0.4 Au remain in pillars below Crown open cut and underground workings

Estm. 2Mt 1-2.0 Cu as native Cu, Chalcocite remain in Lyell Blocks, Lyell Consols and King Lyell

Western Tharsis resource 7+ Mt 1.56 Cu, 0.54 g/t Au. Open at depth

Potential exists to extend Royal Tharsis open cut to North and East in 0.5-1.5 Cu



NOTE: Because of the density of drilling in some areas not all drill holes are shown.

NEWNHAM EXPLORATION AND MINING SERVICES
NORTH LYELL - WESTERN THARSIS
GENERALISED PLAN SHOWING
WORK COMPLETED AND
RESOURCE POTENTIAL
0m. 200m. Scale: 1:5000
Drawn: L. Newnham Date: Jan 93 Figure: 17.

West byell W/shops not
established until 1954-5.
presumably in the Water
Tank area.

Pit design to existing
limits was done c 1949
I think & updated in 1954.

"Northern Roads" section
of pit was "pretty lean"
I doubt that extension
in this region is likely
- even though I always
wanted to come w. a
workshops!!

R.P.

R.T.

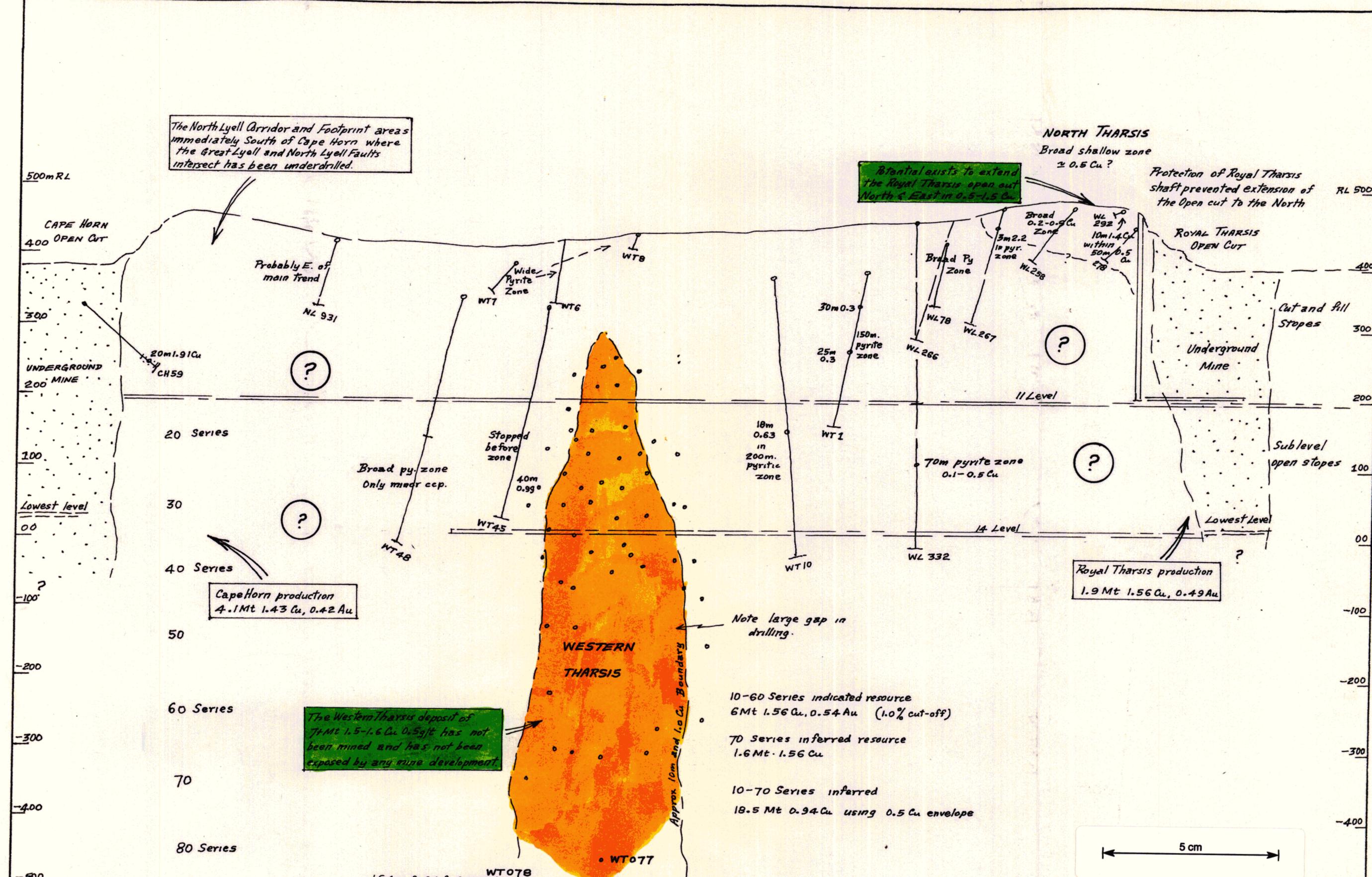
Drilling did not indicate
significant tonnage.

The North Lyell Corridor and Footprint areas immediately South of Cape Horn where the Great Lyell and North Lyell Faults intersect has been underdrilled.

Potential exists to extend the Royal Tharsis open cut North & East in 0.5-1.5 Cu

NORTH THARSIS
Broad shallow zone ≈ 0.5 Cu?

Protection of Royal Tharsis shaft prevented extension of the Open cut to the North



Cape Horn production
4.1 Mt 1.43 Cu, 0.42 Au

Royal Tharsis production
1.9 Mt 1.56 Cu, 0.49 Au

The Western Tharsis deposit of 7 Mt 1.5-1.6 Cu 0.5 g/t has not been mined and has not been exposed by any mine development.

Note large gap in drilling.

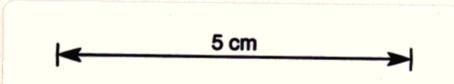
10-60 Series indicated resource
6 Mt 1.56 Cu, 0.54 Au (1.0% cut-off)

70 Series inferred resource
1.6 Mt 1.56 Cu

10-70 Series inferred
18.5 Mt 0.94 Cu using 0.5 Cu envelope

WT078
164 m. 0.44 Cu, 0.14 g/t Au
included several narrow higher grade zones. Probably just off northern limit of main zone.

WT077
51 m 1.48 Cu, 0.36 g/t Au,
within 128 m. 0.79 Cu, 0.23 Au



NEWHAM EXPLORATION AND MINING SERVICES			
WESTERN THARSIS AREA			
LONGITUDINAL PROJECTION			
Looking N.E.			
10	200m	Scale 1:5000	
Drawn	Date	Figure	
Z.A. Newham	Jan. 93	18.	

308053

9.2.4 A-Lens

A-Lens lies approximately 150m into the footwall of Prince Lyell and is separated from the latter by a zone of low grade mineralisation with occasional discontinuous higher grade lenses.

The lens is approximately 100 - 150m long by 20 - 30m wide. It was mined in the West Lyell open-cut to 280 R.L., then underground by sub-level open stope to 30 Series in parallel with Prince Lyell.

Separate production figures are not available for A-Lens. (?)

*SLC 10 Series
as they are from
stope production (mine record)*

9.3 Exploration

Exploration in the general West Lyell area has been quite intensive over the past 60 years, especially by way of core drilling. Various campaigns of mapping have been completed with a view to establishing the geological factors controlling and affecting West Lyell mineralisation. While surface geochemistry has been of limited value because of smelter and cultural contamination, lithochemical studies designed to characterise geochemical and alteration haloes around the main deposits have been more successful in understanding the mineralisation.

Geophysical exploration for nearby extensions of mineralisation have been of limited value. The West Lyell area is pervasively pyritised. The relationship between pyrite and copper mineralisation is variable. Copper mineralisation can occur in both high and low grade pyrite zones and not all pyritic zones carry significant copper.

Much early exploration of the area was by way of prospecting tunnels and trenches, and it is useful to note that all the significant high grade productive lenses in the West Lyell area were found by this method. Subsequent drilling has defined extensions of these lenses but no new, concealed lenses have yet been found.

Core drilling has been employed extensively in the West Lyell area to locate and define ore zones. However, most of this effort has been concentrated on known deposits and few holes have been drilled along the strike of the main mineralised zones searching for undiscovered ore zones. This is commented upon further in the Resource Potential section below.

9.4 Resource Potential

The more significant areas of mineral resource potential in the West Lyell area are considered to be:

- (i) depth extensions of Prince Lyell high grade lenses;
- (ii) depth extensions of Royal Tharsis and A-Lens;
- (iii) shallow extensions of moderate grade mineralisation adjacent to existing West Lyell - Royal Tharsis open-cut;
- (iv) low grade envelopes of mineralisation surrounding high grade lenses;

- (v) waste dumps.

9.4.1 Prince Lyell Depth Extensions

Production and resource estimation data demonstrate that there is no diminution of the Prince Lyell ore zone in either grade or size with depth. In fact, available data can be interpreted to suggest that copper and gold grades are increasing with depth.

Production from 50 Series is due to finish in June, 1993, and will total approximately 3.8 million tonnes of 1.63% copper.

Production from 60 Series has already commenced and is due for completion by June, 1995. Estimated total 60 Series production is 3.8 million tonnes of 1.67% copper.

The pre-mining resource figure for 50 and 60 Series combined was 9.5 million tonnes of 1.7% copper.

In July, 1992, Mt. Lyell estimated an inferred resource in each of 70 and 80 Series of 5.5 million tonnes of 1.73% copper, 0.67 g/tonne gold, 3.0 g/t silver, being a total of 11 million tonnes of those grades.

This estimate was based on detailed drilling information available in 60 Series and the top of 70 Series, and only a very few drill holes in the main part of 70 and 80 Series.

In fact, it may be that the resource potential of Prince Lyell below 60 Series is better than that shown in the June, 1992 inferred resource figure, because of an apparent increase in grades with depth.

Arguably, two of the best intersections on the whole Mt. Lyell field were recently obtained in deep drill holes below 60 Series:

- WL 701 intersected both a North and South Lens in 90 Series. In the North Lens, 200 m below 60 Series, it intersected a true width of 37m of 2.76% copper, 0.98 g/tonne gold, and in the South Lens, 275m below 60 Series, 18m of 1.62% copper, 0.3 g/tonne gold.
- WL 717, 50m below 60 Series, intersected 45m of 2.44% copper, 0.58 g/tonne gold in the North Lens and didn't reach the South Lens.

These are exciting intersections. Their locations are shown on longitudinal projection (Fig. 14), generalised section (Fig. 15) and detailed section (Fig. 16).

WL 701 confirms that both the main North and South Lenses continue to 90 Series (the bottom half of the hole was unfortunately not surveyed and a steady flattening of the hole is assumed in line with normal deviation patterns at Lyell).

28.

By not intersecting conglomerate, this hole points to the Prince Lyell North and South Lenses continuing at least to 100 Series.

The hole plots on the projected extreme Northern limit of the North Lens which either confirms that projected boundary or suggests the body plunges or widens to the North.

WL 717 occurs 25m beneath West Lyell 724 which carried only a narrow high grade zone in the North Lens, suggesting either close proximity to the Northern ore zone margin or the influence of a flat fault.

Traditional thinking at Lyell always had the Great Lyell Fault (Owen Conglomerate contact) terminating Prince Lyell with depth. However, intersections such as WL 701 and WL 219 indicate that if this is so, then the termination is below 100 Series. An alternative interpretation is of course that the Great Lyell Fault rolls back East at some depth and doesn't terminate Prince Lyell against conglomerate.

WL 701 and 717 suggest:

- the high grade Prince Lyell ore zones extend at least to 90 Series;
- they maintain their present size over that depth;
- grade may continue to increase below 60 Series.

Additional drilling is required to confirm and define this resource potential.

Clearly a most significant mineral resource potential at Mt. Lyell remains largely untested in the high grade Lenses in Prince Lyell below 60 Series.

In their recent report on long term planning strategies at Lyell, Davies and Speechly strongly recommended deeper mining on Prince Lyell should be by sub-level caving methods. The current mine plan at Lyell has all but enforced that recommendation, as there is now insufficient time to develop a sub-level open stope on 70 Series without a significant break in production.

9.4.2 Royal Tharsis and A-Lens Depth Extensions

Royal Tharsis has been partially mined to 30 Series. Current drilling below 30 Series suggests mineralisation weakens and may be terminated in 40 Series on the Great Lyell Fault - Owen Conglomerate contact.

Hence, the depth extension potential of high grade Royal Tharsis ore is not rated highly.

It is worth noting however, that extraction of 20 and 30 Series was not complete because of poor operating conditions. - *see over statement*

Also, considerable high grade mineralisation remains in cut and fill crown pillars between 200 R.L. and the open-cut, and possibly as a rib pillar around the Royal Tharsis shaft.

Mining of A-Lens ceased in 40 Series in 1990-91. Subsequent drilling has shown this Lens may continue to 60 Series over 100 - 150m strike length and 20 - 30m width. Grades tend to be in the 1 - 1.5% copper range.

Mt. Lyell has estimated an indicated resource in 50 Series A-Lens of 0.2 million tonnes of 1.50% copper, 0.2 g/tonne gold at a 1% copper cut off.

9.4.3 Shallow Open-Cut Extensions

This section considers the potential for shallow resources in the 0.5 - 1.5% copper range which may exist adjacent to the existing West Lyell open-cut and which may be amenable to mining by extension to that open-cut.

Two such areas have been identified:

- northerly extensions of the Royal Tharsis deposit;
- westerly extensions to Prince Lyell.

Royal Tharsis:

Mining records and existing drilling suggest that potential exists for mineralisation to extend north and north-east of the existing Royal Tharsis open-cut and underground mines.

The Royal Tharsis open-cut was severely limited by the presence of the Royal Tharsis shaft and the northern development of the pit was halted in +1% copper mineralisation in order to preserve a rib pillar around the shaft.

Drill hole WL 292 intersected 10m of 1.4% copper within a zone of 50m of 0.5% copper, whilst adjacent drill hole WL 278 intersected 69m of 0.37% copper. Both holes lie just north-east of the existing open-cut.

WL258, 100m north of the open-cut intersected a broad zone of low grade mineralisation with several intersections in the 0.2 - 0.5% copper range, whilst WL 267, 200m north of the open-cut intersected 3m of 2.2% copper in a broad pyritic zone.

The area east of the open-cut, between the open-cut and the conglomerate, remains essentially untested.

Hence, there is a broad area north and east of the Royal Tharsis open-cut, approximately 300m long by 150m wide, where the few existing drill holes and open-cut sampling suggest potential exists to define a modest open-cuttable resource of 0.5 - 1.5% copper mineralisation.

This area has been referred to in other reports as North Tharsis. Drilling would be required to determine this resource potential.

It is useful to note that this area is unaffected by caving associated with underground mining of Prince Lyell.

Prince Lyell:

The main Prince Lyell orebody strikes north-west - south-east across the overall trend of the West Lyell open-cut. In the early days of the open-cut, the major West Lyell Workshops were established in the general area where the north-west extension of Prince Lyell ore zone would lie.

Some early drilling was undertaken in this area, but was mainly aimed at testing the area between Prince Lyell and Royal Tharsis.

Potential remains for mineralisation associated with Prince Lyell to extend through the western wall of the cut into the former workshop area.

Any future mining in this region would be influenced by both cave subsidence adjacent to Prince Lyell and waste dumps to the west. Shallow drilling would be required to test the potential resource.

9.4.4 Low Grade Mineralised Envelope Potential

In their recent internal R.G.C. paper "Old Mines - New Visions", Flitcroft and McKeown exhaustively highlighted the effects on the West Lyell mineral resource of selectively mining the higher grade lenses from within a much larger copper mineralised body.

They estimated that the current practice of mining at 1.5% copper cut-off meant only 20% of the copper contained within a 0.5% copper envelope was recovered.

The overall Prince Lyell mineralised system is very large. In the open-cut, 58 million tonnes were mined from a pit 200m deep, i.e. approximately 30 million tonnes per 100m vertical series, using a 0.4% copper cut-off. Most of this came from Prince Lyell - say about 20 million tonnes per Series.

0.3%

This figure is reasonably consistent for the full known and projected vertical extent of Prince Lyell to 100 Series. Carrasco (internal R.G.C. Memo) estimated the average potential of each Series to 100 Series using a 0.5% copper cut-off as 14 million tonnes per series.

Production records show that actual tonnes extracted from Prince Lyell per series have gradually decreased with depth as cut-off has been steadily increased: 5-6 million tonnes per Series were extracted in 10 - 40 Series whilst 3 - 4 million tonnes per Series will be extracted in 50 - 60 Series.

Hence a very large amount of 0.5 - 1.5% copper material remains in and around the high grade lenses extracted.

Flitcroft and McKeown geostatistically estimated this remaining resource from 0 - 70 Series within a 0.5% copper envelope, allowing for cave, to be approximately 85 million tonnes of 0.95% copper.

If a 0.1% copper envelope was applied, the resource was increased to 354 million tonnes of 0.52% copper.

*This resource is
269 Mt @ 0.5%
copper envelope -
this is not consistent
with open cut*

Resource estimates of this magnitude of course entice thoughts of very large open-cut operations. Davies and Speechly considered this option at length, i.e. enlarging the West Lyell open-cut. However, at first glance, the stripping ratios to realise the resource would be prohibitive (approximately 18:1). The existing West Lyell open-cut, which is 200m deep, had a waste:ore ratio of 0.8, including the advantage of starting on a hill. To go deeper to say 400m (bottom of 20 Series) would seem unrealistic.

Difficulties associated with high stripping ratios would be compounded firstly by ground control problems associated with the underlying cave operation which has significantly destabilised ground adjacent to the West Lyell cut, and secondly by the need to reposition the 45 million tonnes of waste adjacent to the pit.

This writer considers a more realistic approach to utilising this substantial low grade resource may be to investigate its potential for in-situ solvent extraction (leaching), possibly in tandem with selective high grade hard rock mining below 60 Series.

Both the 85 million tonnes of 0.95% copper within the 0.5% copper envelope and the 354 million tonnes of 0.52% copper within the 0.1 copper envelope are reasonably well defined by drilling and mine excavation and no immediate drilling is required to confirm the resource.

However, its suitability and viability to in-situ solvent extraction requires verification.

9.4.5 Waste Dumps (Fig. 11)

R.G.C. estimates the waste dumps surrounding the West Lyell open-cut contain 45 million tonnes of 0.17% copper, i.e. 76,000 tonnes of copper. These dumps do not represent an attractive mining and treatment option using conventional flotation techniques. However, they may be amenable to heap leaching techniques.

The dumps have already been leached by natural acidic ground waters. R.G.C. estimates approximately 700 tonnes of copper per annum leave the lease area annually in acid mine drainage. The majority of this (say, 400 tonnes per annum) possibly comes from the West Lyell dump.

If this was so, then over a 30 year period, some 12,000 tonnes of copper would have been leached from the dumps, leaving approximately 64,000 tonnes of contained copper.

If it could be demonstrated that the dumps were amenable to accelerated copper leaching, then they could become a useful supplementary source of high grade copper concentrate production whilst at the same time allowing the problem of acid mine drainage to be reduced and efficiently controlled.

The production of copper precipitates from mine drainage is not a new concept at Mt. Lyell. Up to 150 tonnes per annum copper precipitates were produced from the 1930's until the late 1960's.

In 1967, an investigation was also completed into the viability of leaching the West Lyell waste dumps, with reported encouraging results.

The resource potential of the dumps would need to be confirmed by air-core hammer drilling, and the metallurgical feasibility of leaching and recovering the copper would require testing.

Any dump leaching operation would nicely complement an adjacent in-situ leaching operation on low grade West Lyell mineralisation.

9.5 West Lyell Area Summary

Considerable mineral resource potential exists adjacent to and beneath the former West Lyell open-cut which was developed on a cluster of steeply dipping high grade lenses enveloped within a much larger lower grade mineralised zone.

In a practical sense, this potential can be subdivided into:

- (a) Continuation of high grade lenses of mineralisation beneath the Prince Lyell 60 Series which may be amenable to underground mining by sub-level caving methods. A limited amount of drilling suggests firstly the tonnage potential of this area is at least as good as in higher series (5+ million tonnes/100 vertical metres), secondly, copper and gold grades may be increasing with depth, and thirdly, mineralisation should extend at least to 90 Series (300m below 60 Series) and probably deeper.

Drilling is required to confirm this resource.

- (b) Shallow moderate grade (0.5 - 1.5% copper) mineralisation which may be amenable to conventional open-cut mining by extending the existing open-cut. The most attractive of these areas is a northern and eastern extension of the Royal Tharsis orebody.

Drilling is required to confirm this resource.

- (c) Moderate grade mineralisation surrounding Prince Lyell, and waste dumps, which may be amenable to in-situ and heap leaching technologies respectively.

Drilling and metallurgical test work is required to confirm this resource.

Combined, these resources present substantial scope for the integrated application of new underground and surface mining and metal recovery procedures at Mt. Lyell.

10. CAPE HORN - ROYAL THARSIS AREA - (WESTERN THARSIS)

10.1 Introduction

Sparse core drilling indicates a 200 - 300m wide zone of pyritic felsic volcanics stretches 1,500m between Cape Horn and the Royal Tharsis - West Lyell areas. Contained within this zone is the major Western Tharsis mineral deposit (Fig. 17).

Geologically, the setting of this area is complex. An outlying ridge of Owen Conglomerate (Tharsis Ridge) lies to the east of Western Tharsis and this has been interpreted either as an erosional remnant beneath a folded Great Lyell Fault, or a simple fault block. The North Lyell Fault cuts through the zone to the north near Cape Horn. Recent R.G.C. drawings show the faulted contact between volcanics and Owen Conglomerate in the footwall of Western Tharsis as the North Lyell Fault. However, it is more likely to be the Great Lyell Fault, close to that complex area where a folded, crumpled Great Lyell Fault intersects the North Lyell Fault. An area of such intense structural deformation may explain why the Western Tharsis orebody formed in this particular location, i.e. the Western Tharsis orebody may be structurally controlled near the intersection of the Great Lyell Fault and North Lyell Fault.

10.2 Known Deposits

The Cape Horn and Royal Tharsis Mines (described elsewhere) occur at either end of this pyritic zone.

The Western Tharsis deposit occurs approximately half way along the zone, 700m north of Royal Tharsis and 700m south of Cape Horn.

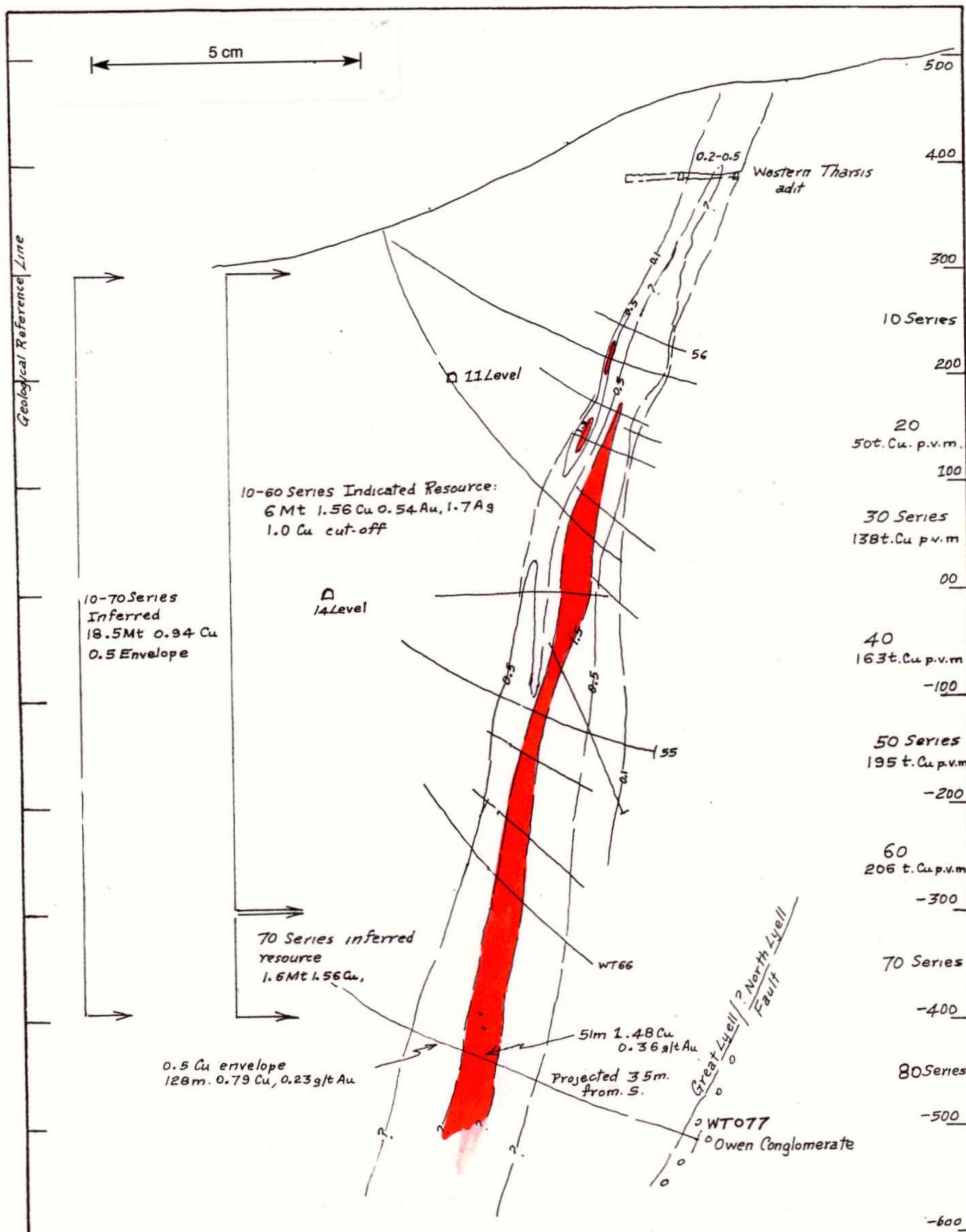
Apart from a series of old shallow exploration tunnels, no production has been achieved.

The Western Tharsis area is currently accessed underground via the 11 and 14 level tunnels, driven in the hangingwall of Western Tharsis on their way to Cape Horn.

Surface and underground core drilling suggest Western Tharsis is a vertically elongated finger of mineralisation which essentially tapers out within 70m of surface (Fig. 18), but expands over a 800+m. vertical distance to a zone of significant copper - gold mineralisation, approximately 400m long by 150m wide. Mineralisation is disseminated chalcopyrite-pyrite contained within a felsic volcanic sequence. As with the Cape Horn and West Lyell orezones, Western Tharsis consists of a higher grade lens of mineralisation contained within a much larger zone of copper mineralisation. To date, only one major such high grade lens has been defined (Fig. 19).

Mineralisation boundaries transgress lithological boundaries, and mineralisation controls appear to be other than lithologic.

In June, 1992, R.G.C. reported an indicated resource in Western Tharsis in 10 - 60 Series (200 - -300 RL.) of 6 million tonnes of 1.56% copper, 0.54 g/tonne gold and 1.7 g/tonne silver, using a 1% cut-off, and an inferred resource in 70 Series of 1.4 million tonnes of the same grades.



Recently completed WT077 indicated that a high grade core of mineralisation approx. 50m. wide, 150m-200m. long and averaging approx. 1.5 Cu, 0.4 g/t Au persisted below 60 Series, with a productive capacity of 200-250 t. Cu per vertical metre.

NEWHAM EXPLORATION AND MINING SERVICES		
WESTERN THARSIS		
CROSS-SECTION 21		
Looking North		
0	200m	Scale: 1:5000
Drawn: L.A. Newham	Date: Jan 93	Figure: 19.

However, R.G.C. (O.M.N.V.) has shown that within a 0.5% copper envelope, the 10 - 70 Series resource is 18 million tonnes of 0.94% copper, and that both tonnes per vertical metre and grade appear to be increasing with depth.

10.3 Previous Exploration

This strongly pyritic zone was extensively prospected early this century by way of shallow tunnels. Little encouragement was derived from this work.

In the 1950-60's, E.M. geophysical surveys completed over much of the area north of West Lyell, defined several strong anomalies commonly known as the footprint anomalies, and further north-west between Cape Horn and North Lyell as the corridor anomalies.

Some core drilling completed to test these anomalies, generally intersected broad 10-20% pyrite zones. The only exceptions to this were a few holes which intersected the weak copper mineralisation in the top of Western Tharsis. Subsequent follow up drilling from underground and surface confirmed the Western Tharsis deposit and highlighted its increasing potential with depth.

The E.M. surveys and subsequent drilling programmes through this area highlighted several important aspects of geophysics applied at Lyell:

- very large zones of strong (semi-massive) pyrite mineralisation are developed within a broad pyritic alteration zone which encompasses most of the Mt. Lyell field;
- the relatively small orebodies may or may not be closely associated with these stronger pyritic zones;
- hence, the magnitude of geophysical response over the strong pyritic zones may be a red herring in diverting drilling attention from potential orezones which lie in weaker pyritised rocks, e.g. North Lyell;
- substantial and persistent drilling for orezones is required in both strongly and weakly pyritic zones.

In regard to this latter point, the general Cape Horn to Royal Tharsis area is under-drilled, especially north of Royal Tharsis and immediately south-east of Cape Horn (Fig. 18).

10.4 Resource Potential

Several features of the known Western Tharsis orebody are noted:

- only one high grade lens within a broader low grade zone is indicated and the grade of this lens is somewhat lower than those at similar depths at West Lyell and Cape Horn;

- average vertical productivity potential of Western Tharsis from 10-60 Series is 156 tonnes of copper per vertical metre, compared with 130 tonnes at Cape Horn and 700-800 tonnes at Prince Lyell and North Lyell;
- recently completed drill holes WT077 and WT078 indicate Western Tharsis may continue to improve in grade with depth and will probably extend to at least 100+ Series.

Results of drill holes WT077 and WT078 justify additional comment. Both holes intersected broad 100-150m wide copper anomalous zones:

WT077: 120m (estimated true thickness) 0.79% copper;
WT078: 160m (estimated true thickness) 0.44% copper.

WT078 intersected the mineralised zone north of the anticipated high grade lens and the broad zone of low grade mineralisation is somewhat stronger than that in similar situated holes at higher levels.

WT077 intersected 50m (estimated true thickness) of 1.48% copper and 0.36 g/tonne gold in a high grade lens in 80 Series, approximately 250m below the deepest previous drilling.

Hence, data from these holes combined with geostatistical trends from higher levels suggest that potential for defining significant tonnages of 1.5-2% copper ore below 60 Series is high.

It should be noted that a significant 200m x 100m gap occurs in the drilling pattern on Western Tharsis in 50 and 60 Series.

Drilling is required to both infill this gap and to test the deeper potential below 60 Series.

Elsewhere in this 1,500m pyritic zone between Cape Horn and Royal Tharsis exploration has been sparse. In the 700m zone between Cape Horn and Western Tharsis, only six holes have been drilled and the deepest of these was 400m below surface (Fig. 18).

In the 700m zone between Western Tharsis and Royal Tharsis, only eight holes have been drilled and the deepest of these was 350m below surface.

These two areas are essentially unexplored and present significant scope for future ore discovery.

10.5 Resource Potential Summary

The Western Tharsis deposit contains an identified resource of 7.6 million tonnes of 1.56% copper, 0.54 g/tonne gold, between 10-70 Series, with a productive capacity of 156 tonnes of copper per vertical metre, using a 1.0% copper cut-off.

Grade and tonnage and therefore copper productivity appear to be increasing with depth and recent drilling confirms potential remains to define substantially more 1.5-2.0% copper mineralisation below 60 Series (-300 RL).

Within a 0.5% copper envelope, R.G.C. has estimated an identified resource of 18 million tonnes of 0.94% copper.

Western Tharsis mineralisation is generally of a lower grade than either Cape Horn and Prince Lyell and has a lower productive capacity than Prince Lyell. However, because it lies only 850m north of the Prince Lyell shaft and the Prince Lyell Decline, it could represent a significant auxiliary underground ore source to continued mining of Prince Lyell below 60 Series, thereby supporting an expanded mining operation.

The areas between Western Tharsis-Royal Tharsis and Western Tharsis - Cape Horn have attracted little drilling attention and both areas contain potential for the discovery of new deposits. They should be included for drill testing in any strategic plan aimed at more fully testing the mineral resource potential of the Mt. Lyell area.

11. LYELL COMSTOCK - CAPE HORN AREA

11.1 Introduction

The Lyell Comstock - Cape Horn area is a 1,500m long north-east trending sheared and pyritised belt of volcanics near the northern end of the mining lease (Fig. 20).

The belt abuts the Great Lyell Fault which separates it from the Owen Conglomerate to the east.

Significant production has come from the Lyell Comstock mine near the northern end of the belt and the Cape Horn mine on the southern end. The pyritised volcanics between these two mines has been extensively prospected by shallow pits and adits. A small lead-zinc occurrence north of Comstock was prospected by development of the Tasman Crown mine.

11.2 Production

The Lyell Comstock deposit is developed at the top of the Central Volcanic Sequence close to its contact with the overlying Tyndall Group sediments and volcanics. A silicified body (chert) occurs near the hangingwall. Sillitoe and Brook regarded the hematized chert as silicification associated with mineralisation, and regarded the area as similar in geology and mineralogy to the high grade North Lyell area. Corbett however regarded the chert as a sinter deposit associated with exhalative mineralisation.

The Great Lyell Fault east of the mine dips 75° from surface to 460 RL then flattens to 33° at 375 RL, then steepens to 65° below that, i.e. the fault appears to be folded. Wade believed the fault would continue to steepen with depth and roll under the Owen Conglomerate to the east, just below 11 Level.

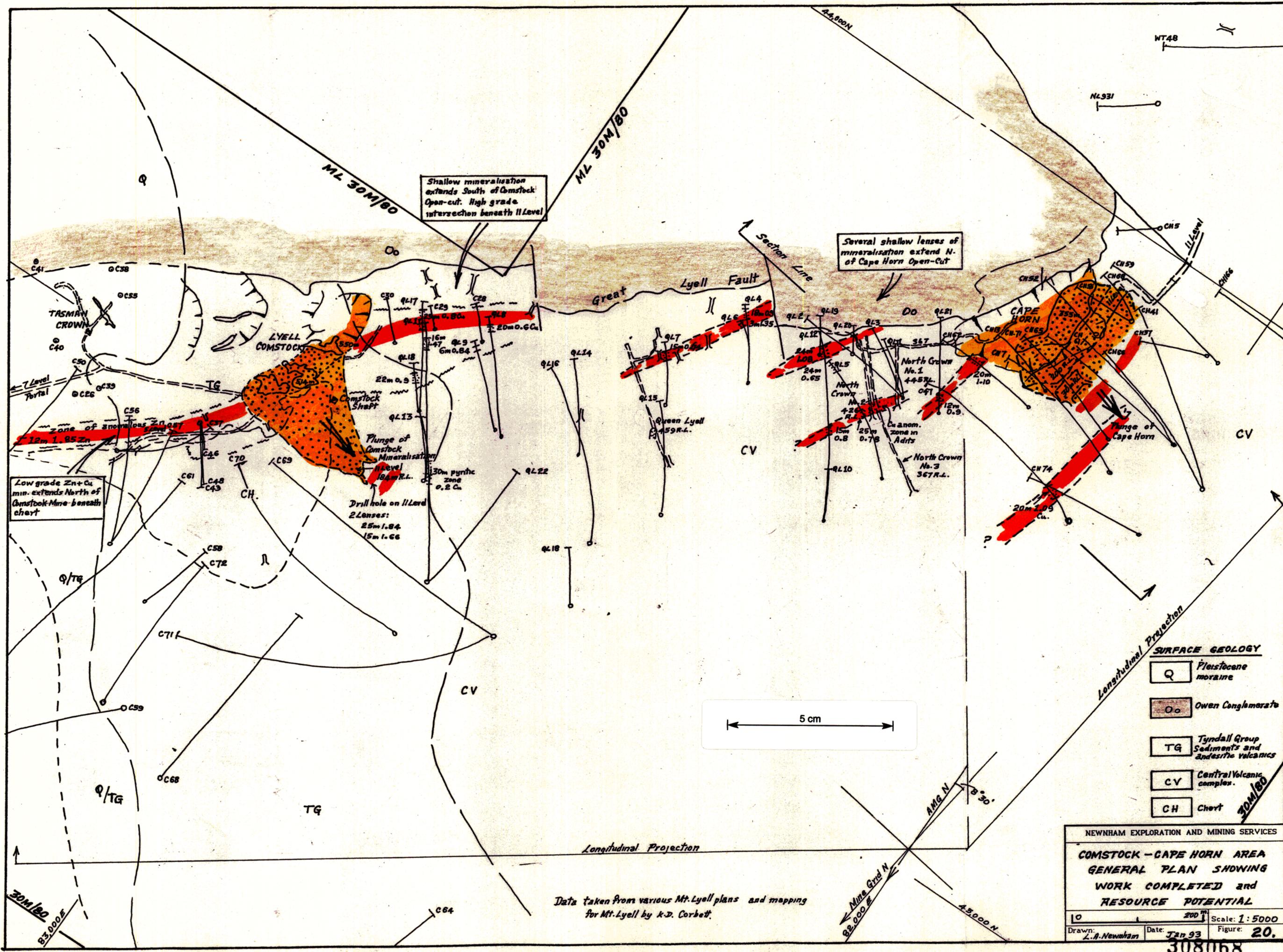
Production came from four high grade lenses of pyrite-chalcopyrite-bornite mineralisation within a lower grade body 210m long, 165m wide and 360m deep. This body lay between the Comstock Chert and the Owen Conglomerate and dipped steeply west, parallel to schistosity.

The Lyell Comstock mine produced 1.34 million tonnes of 2.38% copper, 0.67 g/tonne gold, 5 g/tonne silver, from an open-cut and eleven underground levels over a vertical distance of 360m. The underground mine was accessed by shaft and two adits. Mine production from the four high grade lenses was approximately 100 tonnes of copper per vertical metre.

The No. 1 and No. 2 lenses died out above 5 Level.

No. 3 lens was the largest - 50-100m long, 15-30m wide and still well developed on 11 Level.

No. 4 lens extended from 7 Level to 11 Level, where it attained its maximum width of 42 x 22m.



Shallow mineralisation extends South of Comstock Open-cut. High grade intersection beneath II Level

Several shallow lenses of mineralisation extend N. of Cape Horn Open-Cut

Low grade Zn+Cu min. extends North of Comstock Mine beneath chert

Plunge of Comstock Mineralisation 11 level 184m R.L. 30m pyritic zone 0.2 Cu

Drill hole on II Level 2 Lenses: 25m 1.84 15m 1.66

Data taken from various Mt. Lyell plans and mapping for Mt. Lyell by K.D. Corbett.

SURFACE GEOLOGY

Q	Pleistocene moraine
Oo	Owen Conglomerate
TG	Tyndall Group Sediments and andesitic volcanics
CV	Central Volcanic complex.
CH	Chert

NEWNHAM EXPLORATION AND MINING SERVICES

COMSTOCK - CAPE HORN AREA
GENERAL PLAN SHOWING
WORK COMPLETED and
RESOURCE POTENTIAL

Scale: 1:5000
 Figure: 20.
 Date: Jan 93
 Drawn: L.A. Newnham

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Production grade on 11 Level was 1.94% copper.

Drilling suggested No. 3 and No. 4 lenses continued below 11 Level and a reserve of 0.4 million tonnes of 2.25% copper was estimated on closure. Records suggest closure was largely due to manpower shortages in 1942.

The Cape Horn Mine was developed on a high grade lens of pyrite-chalcopyrite mineralisation 250m long x 50m wide, dipping 80° south-west, developed in sheared Central Volcanic Sequence rocks approximately 50-80m from the Great Lyell Fault near its intersection with the North Lyell Fault. ^{low (1.47%)}

It produced 4.1 million tonnes of 1.43% copper, 0.42 g/tonne gold, 3.3 g/tonne silver, from an open-cut and sub-level open stope mine over a vertical distance of 400m. Mine productivity was therefore 130 tonnes of copper per vertical metre.

Access to the underground mine was via both rail haulage on 11 Level (200 RL) and a decline. The lowest level was 30 RL (equivalent to 30 Series in Prince Lyell).

The Tasman Crown and Crown Lyell Extended Mines were developed to test two occurrences of copper and galena-sphalerite north of Lyell Comstock. The latter body was approximately 33m long x 2m wide. The mineralisation is hosted by Tyndall Group volcanoclastics and contains narrow fine-grained sedimentary interbeds.

No commercial production was obtained from the mine but it proved useful as an access to 11 Level on the Lyell Comstock Mine.

North Crown and Queen Lyell:

The broad pyritic zone between Cape Horn and Lyell Comstock was prospected at shallow depths by four major tunnels known as North Crown 1, 2, 3 and Queen Lyell (Fig. 20).

Several narrow zones of +0.5% copper were intersected, being best developed in North Crown 2 and 3.

11.3 Exploration

Early prospecting along the Cape Horn-Lyell Comstock zone was by way of tunnelling and trenching the broad outcropping pyritic zone. The shallow Lyell Comstock and Tasman Crown deposits were soon located and developed. However, the potential of the Cape Horn area was not recognised.

E.M. surveys completed in the 1930-40's highlighted several anomalies and these were tested by shallow drilling programs south of the Comstock Mine and in the Cape Horn area. In the former, holes C 24, 28, 29, 30 (Fig. 20) located a 50m wide zone of approximately 0.5% copper near surface.

Following further geophysical surveys, deeper drilling was completed between Lyell Comstock and Cape Horn during the 1960's and defined

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I did have a cursory
look at microscopic
cuts in the area.

The major problem in
stability of the pit walls -
it would be necessary to
mine a fair chunk of
Mt Keyell to maintain
a decent pit - wide the
Crown Hill & Hill of Losses
"disaster" areas.

several zones of mineralisation, including the Cape Horn deposit which was subsequently developed.

During this period, the Lyell Comstock deposit was interpreted as occurring in a similar geological environment to the high grade North Lyell orebodies and some drilling was undertaken around the Comstock chert to test this

concept without success. However, a zone of significant copper-zinc mineralisation was located, trending north-east (grid) of the Lyell Comstock Mine in the foot wall of the chert.

During the 1980's, the general environs of the chert were further mapped, sampled and drilled to evaluate the area's gold potential, without significant success.

More recently, R.G.C. has been conducting exploration north-west of Lyell Comstock, searching for volcanogenic zinc deposits in the Tyndall Group volcanoclastics, following the intersection of broad zinc enriched zones in several drill holes in that region.

No drilling has been undertaken in the zone between Lyell Comstock and Cape Horn apart from Cape Horn ore delineation drilling during the past twenty years.

11.4 Resource Potential (Figs. 20, 21, 22)

Previous exploration and mining indicates potential exists for significant copper-gold mineralisation to remain in the following areas:

- (i) depth extensions of the Cape Horn orebody below the lowest level of previous mining; *See sketch of a conglomerate*
- (ii) moderate grade remnants adjacent to Cape Horn stopes;
- (iii) additional ore lenses in the hanging wall of Cape Horn;
- (iv) a series of discreet shallow lenses immediately north of the Cape Horn Mine;
- (v) shallow southern extensions of the Lyell Comstock Mine;
- (vi) depth extensions of the Lyell Comstock Mine;
- (vii) other areas.

11.4.1 Cape Horn Remnants

Cape Horn was mined by open-cut from surface to 170 RL and from underground to 30m RL where drilling indicated it maintained grade but diminished dramatically in size.

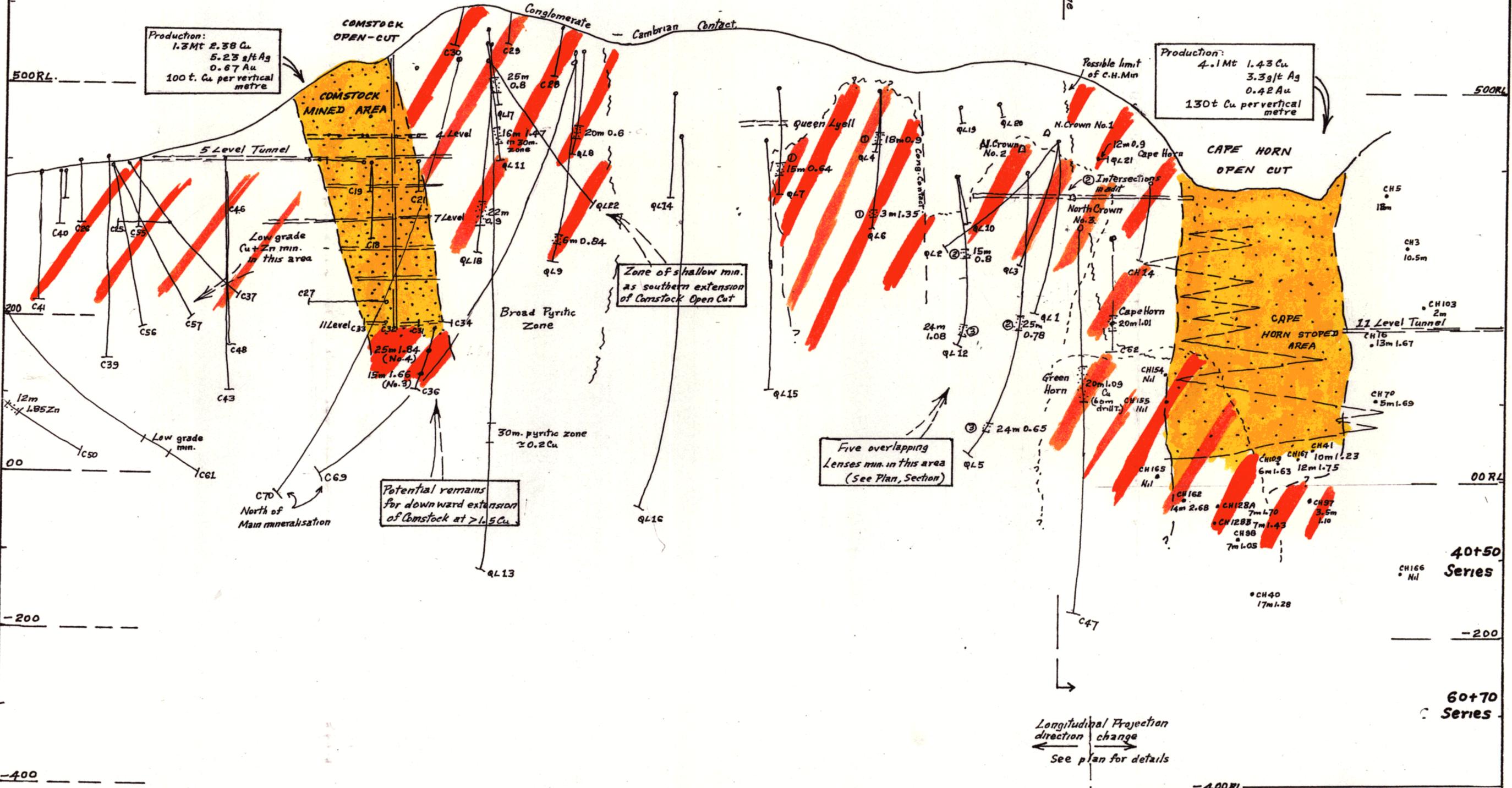
Production during the last four years averaged >2% copper.

However, very little drilling exists below 00 RL, i.e. below 30 Series equivalent and results from those few holes are not all that

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S.W.

Projection Looking SE and E

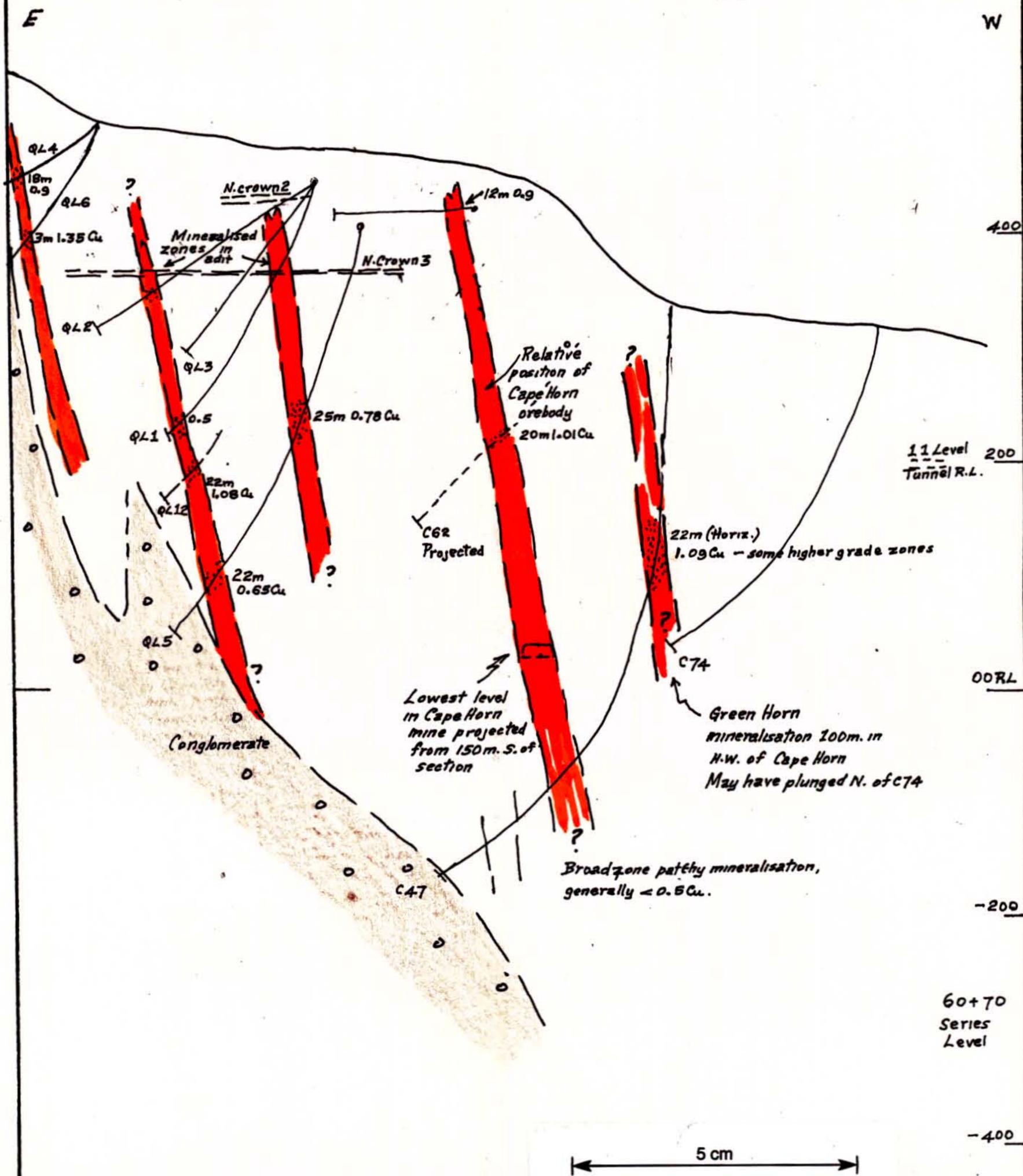


NEWHAM EXPLORATION AND MINING SERVICES

**COMSTOCK-CAPE HORN AREA
LONGITUDINAL PROJECTION
WORK COMPLETED and
RESOURCE POTENTIAL**

0	200 m	Scale: 1:5000
Drawn: L. A. Newham	Date: Jan 93	Figure: 21

Section Looking Grid South



This semi-schematic section is a collation of data designed to illustrate the presence of several mineralised lenses North of the Cape Horn mine which may form the basis of an open-cuttable resource.

Further drilling would be required to confirm that potential

NEWNHAM EXPLORATION AND MINING SERVICES		
COMSTOCK - CAPE HORN AREA		
SEMI-SCHEMATIC SECTION		
MINERALISED LENSES NORTH		
OF CAPE HORN		
		Scale: 1:5000
Drawn: L.A. Newton	Date: Jan 93	Figure: 22.

discouraging. The deepest hole is CH40 which intersected 17m of 1.28% copper at RL -150 (approximately).

Potential certainly exists for the Cape Horn orebody to continue below 00RL. This potential would require testing by surface core drilling.

Any deeper resource so defined could be used to supplement underground production from Prince Lyell and Western Tharsis in an expanded underground operation.

11.4.2 Moderate Grade Cape Horn Remnants

Mining at Cape Horn involved the selective extraction of a high grade core from within a much broader, lower grade envelope of mineralisation.

R.G.C. estimated that approximately 12 million tonnes of 1.12% copper originally existed in a 0.5% copper envelope down to -200 RL. Of this 4 million tonnes of 1.43% copper has been extracted, and 8 million tonnes of 0.97% copper remains. ? *unlikely*

This moderate grade envelope could therefore contribute to either an expanded Cape Horn open-cut, or a deeper underground mine based on mining at lower grades over greater widths, or to an underground in situ solvent extraction operation.

11.4.3 Additional Hanging Wall Lenses

Drilling has indicated that an additional lens of mineralisation is developed approximately 100m into the hangingwall of the main Cape Horn orebody, below 200 RL and slightly to the north.

Hole CH47 intersected 22m (horizontal) of 1.09% copper, including several higher grade zones. R.G.C. refers to this lens as Green Horn.

The potential for this lens to extend further north and at depth remains untested.

The development of such additional, parallel lenses is attractive because it dramatically improves the vertical productivity of the resource.

11.4.4 Lenses North of Cape Horn (Fig. 22)

Drilling and shallow tunnelling to the immediate north of Cape Horn has indicated the presence of four lenses of mineralisation. One of these is possibly the northern extension of the main Cape Horn orebody. Individually they average 15-20m horizontal width and have been drill indicated to extend (discontinuously?) 500m north of Cape Horn. The deepest intersection is in QL5 at 50 RL. Grades are generally in the range 0.6-1.0% copper.

Such a resource if confirmed by drilling and appropriately modelled, could form the basis of a substantially enlarged open-cut

operation which might include these four lenses, plus the remnant envelope material at Cape Horn.

11.4.5 Shallow Southern Extensions of Lyell Comstock

Drilling programs completed in the 1940's and 1960's have defined a 15-25m wide zone of mineralisation within a broader pyritic zone extending 250m south of the Comstock Mine. The zone extends from near surface over a vertical distance of 300m to 250 RL. Grades range from 0.6-1.4% copper and average approximately 0.9% copper.

Such a deposit if confirmed might support a modest open-cut operation in this area.

Drilling is required to further evaluate this potential.

11.4.6 Depth Continuation of Comstock

The Comstock Mine was worked to 11 Level (200 RL). Where the No. 3 and No. 4. lenses were mined. On closure, it was estimated that 0.4 million tonnes, 2.25% copper and 0.6 g/tonne gold remained below 11 Level. Production grade at the close of mining was 1.94% copper.

Drill hole C36 completed to test these lenses 50m below 11 Level intersected 15m of 1.66% copper in No. 3 and 25m of 1.84% copper in No. 4, which suggested No. 3 was thinning in depth and No. 4 thickening.

QL13 passed 150m beneath 11 Level and intersected minor copper in a 30m pyritic zone. However, it is probable that this hole passed just south of the down-dip extension of the lenses.

Potential for additional resources below 11 Level does exist and would require further drilling to confirm.

11.4.7 Other Potential

A broad zone of significant copper-lead-zinc mineralisation extends along strike north-east of the Comstock Mine in grey quartzitic schists and altered cherts.

Hole C42 was drilled north-west into the hanging wall of chert and intersected 21m of 0.44% copper, 2% zinc.

Approximately 100m north-east of the mine C43 intersected 200m drill length of 0.2-0.4% copper and 1.94% zinc, whilst holes C46 and C48 on the same section intersected a 100m drill length interval of similar copper but 0.2-0.3% zinc.

All of these holes were drilled from the 5 Level access tunnel. Further north-east along strike C56 and C57 intersected a 70-80m wide pyritic zone which carried 0.1-0.5% copper, including 3m of 1.8% copper in each hole. C50 intersected 12m of 1.85% zinc,

43.

approximately 350m north of the mine and C61 intersected 15m of 0.4% copper and 0.33% zinc in the same zone.

Potential certainly exists in this copper-zinc pyritic zone which extends north-east of Comstock for the development of further mineralisation and additional drill testing is warranted, particularly in the area north-east of C50.

R.G.C. is currently testing another base metal rich zone in Tyndall Group sediments and volcanics to the north and north-west of Comstock, and several broad intersections of low grade mineralisation have been obtained to date.

11.5 Summary

Resource potential exists at both the Cape Horn and Lyell Comstock Mines for depth extension and shallow strike extensions of previously mined orebodies.

Such resources could provide a basis for the development of modest sized open-cut operations, or expanded underground operations utilising either conventional or SX techniques.

The 1,000m zone between Cape Horn and Lyell Comstock is only superficially drill tested and any future long term operation at Lyell should plan to further test this area.

Significant copper-zinc mineralisation has been drill intersected in two zones north-east and north of Lyell Comstock. The former, which is adjacent to the Great Lyell Fault, is considered to have the higher potential and further testing along strike and at depth is warranted.

12. NORTH LYELL AREA

12.1 Introduction

The North Lyell area refers to a cluster of high grade orebodies which occurs in a structurally complex area adjacent to the North Lyell Fault (Fig. 17).

Mineralisation consists of chalcopyrite-bornite in a silicious-hematite-barite alteration zone which overprints both volcanic schists and the overlying conglomerates, sandstones and limestones.

Interpretations of the genesis of mineralisation and its structural setting are numerous and the area has become the type location for the ongoing controversy on the volcanogenic/non-volcanogenic origin of Mt. Lyell mineralisation.

The basic geological elements and the relative physical location of deposits are illustrated on Figs. 23(a) and (b), and 24 (from R.G.C.). The North Lyell deposits essentially occur in an east-west structural pendant of Cambrian volcanics and Ordovician sediments. This pendant is generally referred to as the North Lyell Corridor. The Lyell Blocks copper clay deposits lie within this corridor to the east of North Lyell and are discussed separately in Section 13.

The main North Lyell orebodies differed significantly from other Mt. Lyell deposits on several accounts:

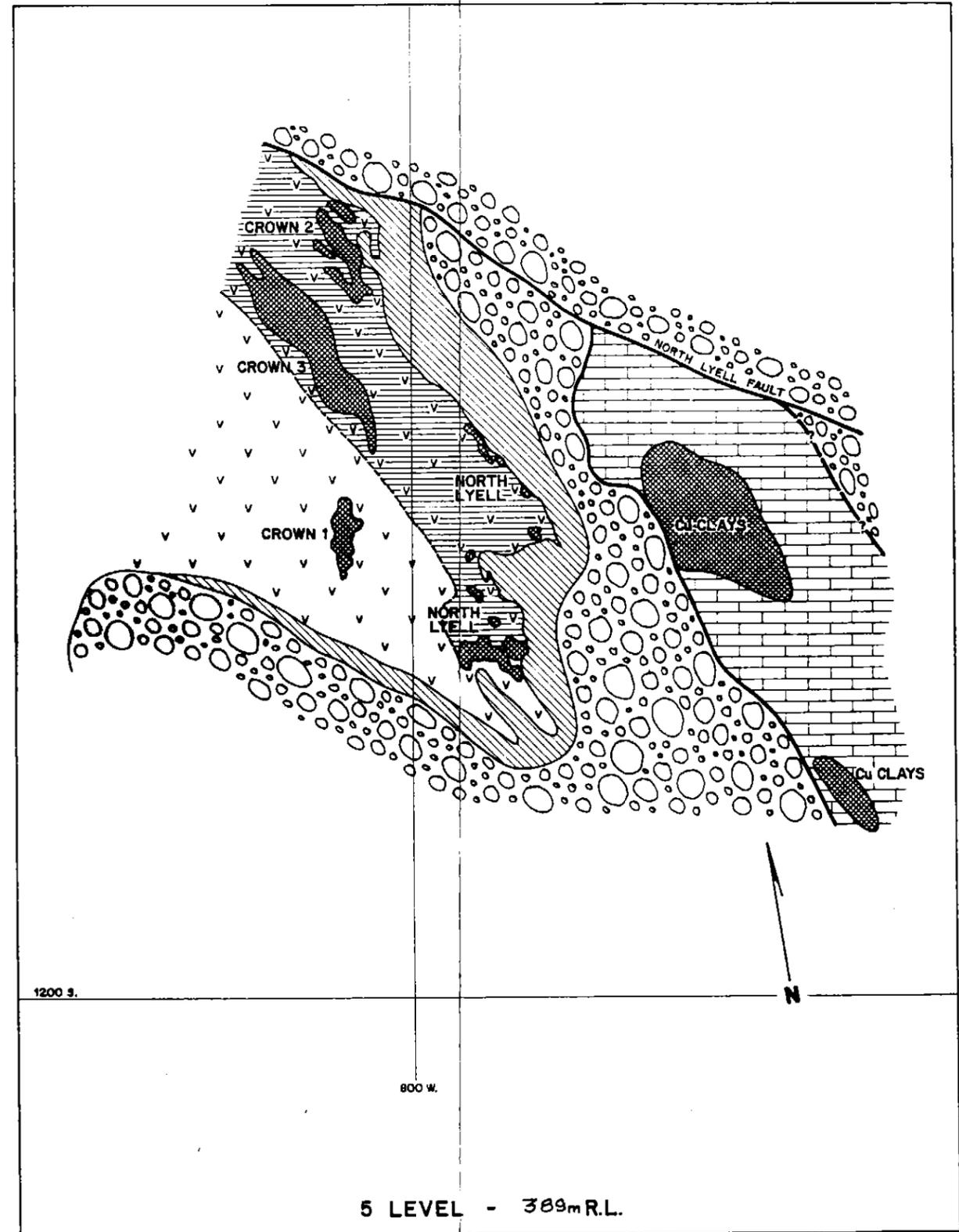
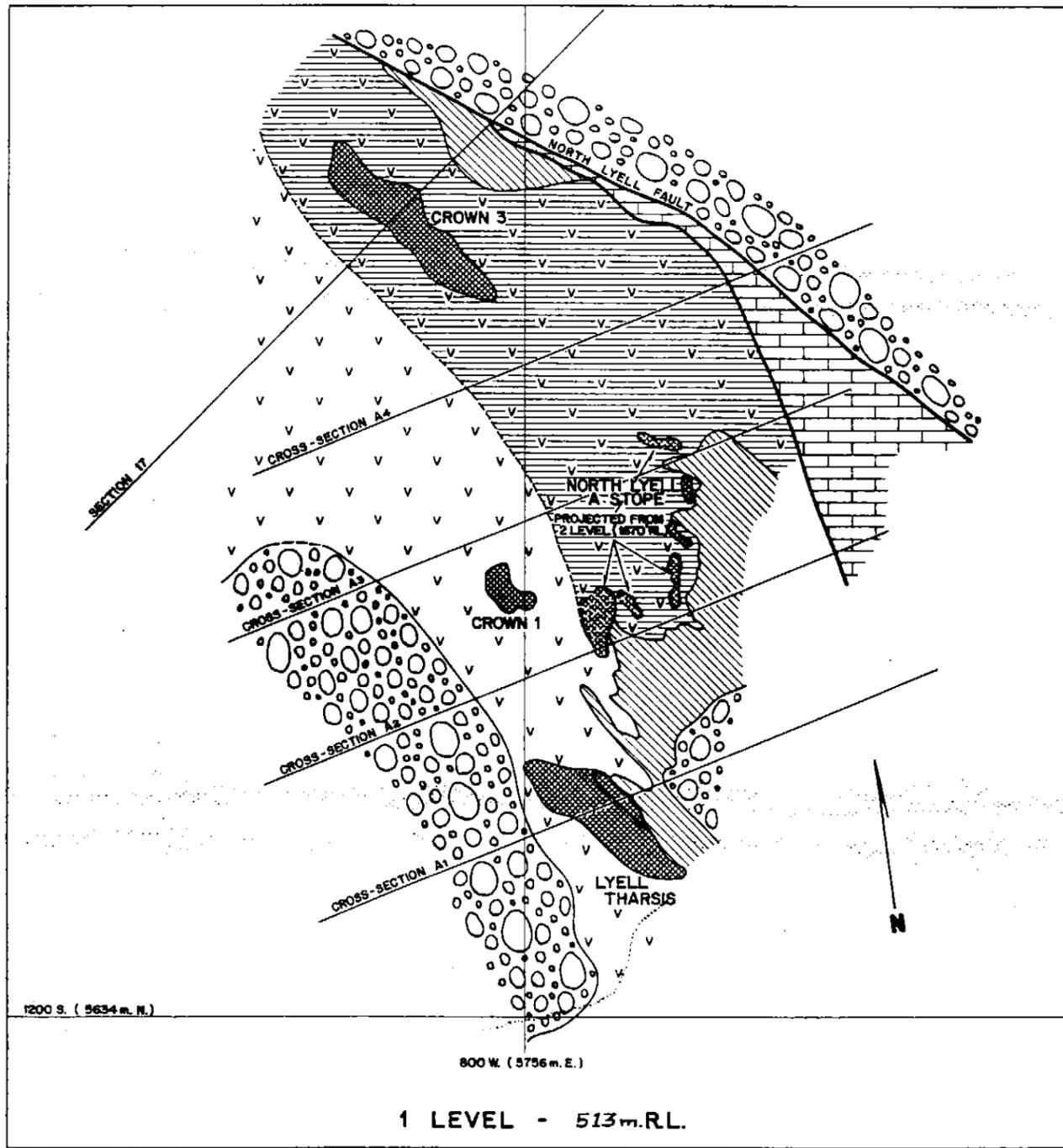
- the lenses were very discrete and relatively low in sulfur;
- mineralisation was common in the adjacent Ordovician conglomerates and sandstones;
- some of the lenses were very high grade in both copper and silver;
- much of the copper was present as bornite;
- extensive silica-barite-hematite alteration was associated with the mineralisation, and it affected both the volcanics and the overlying sediments.

12.2 Production

The North Lyell orebodies were some of the earliest mined and highest grade orebodies on the Mt. Lyell field.

In this report, the term North Lyell is used to collectively include the North Lyell, Crown Lyell, Lyell Tharsis and 12 West orebodies which occur as close spaced, steeply dipping interconnected lenses within a 600m x 500m area.

Production between 1896-1985 was 9.4 million tonnes of 3.41% copper, 0.38 g/tonne gold and 20.5 g/tonne silver. This production came from four separate operations (Table 8). However, these lenses are so closely related geologically, that it seems more appropriate to regard them as one productive unit, similar to the various Prince Lyell lenses.



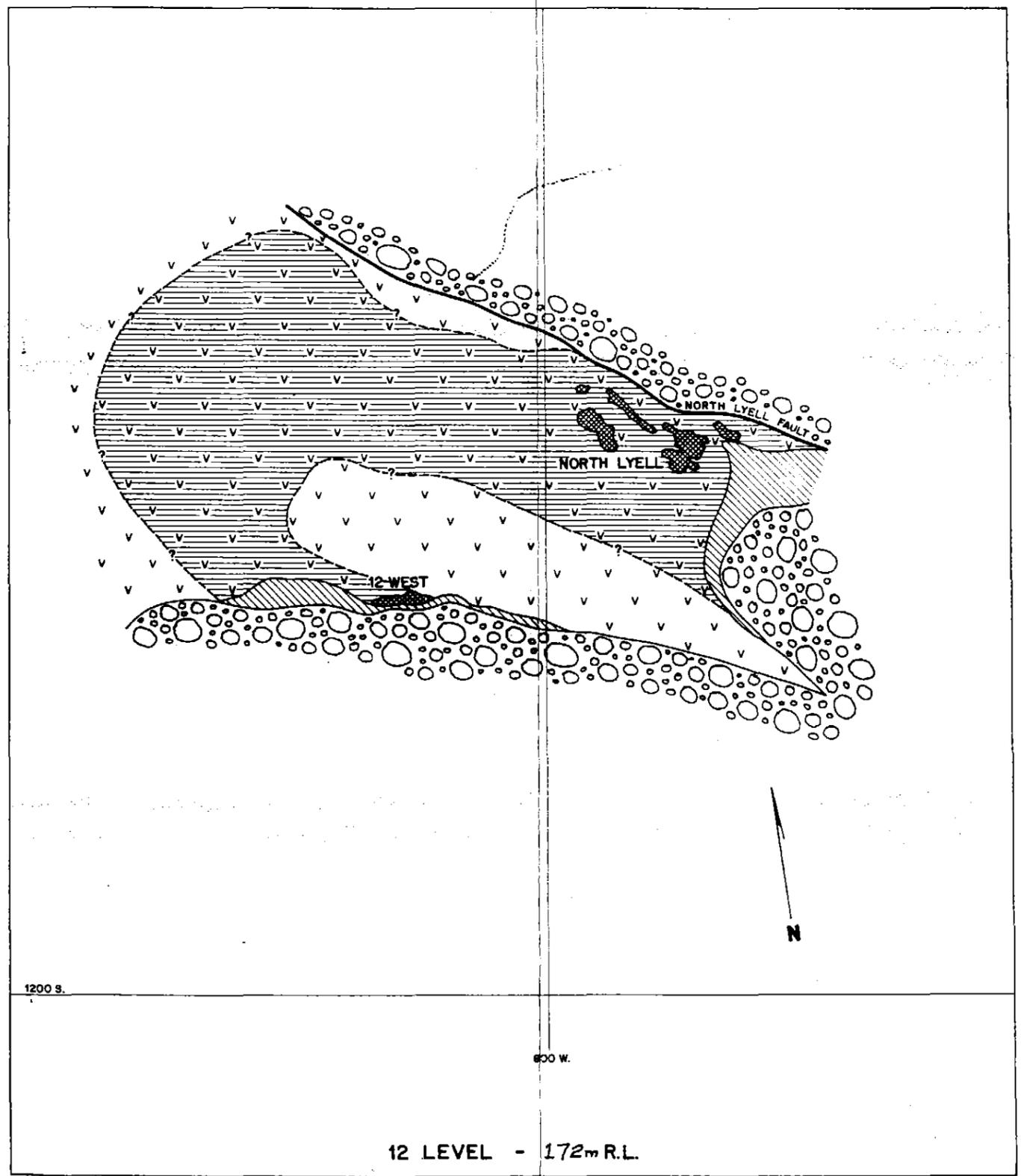
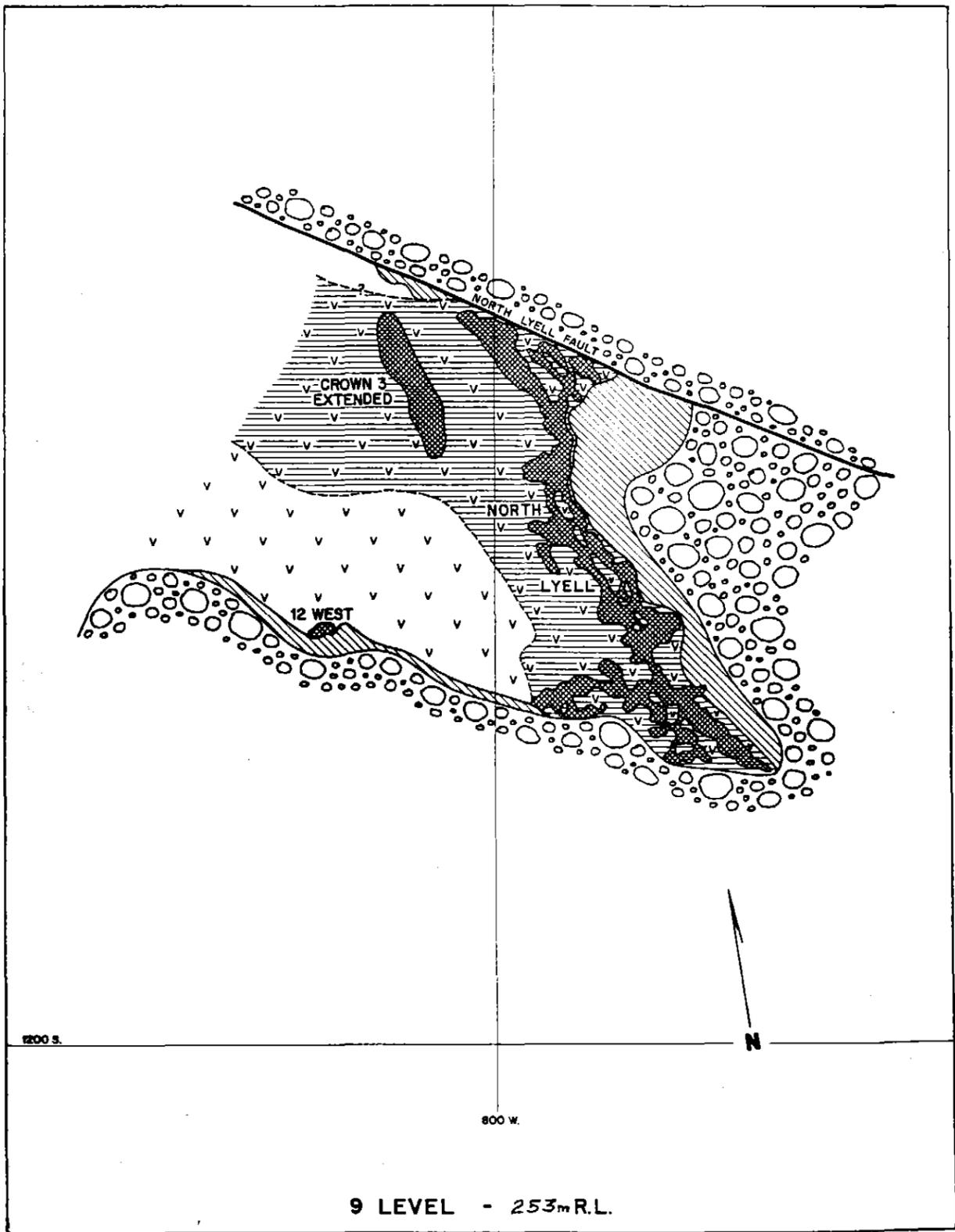
KEY: See accompanying
North Lyell Section

These Level plans illustrate the spatial relationship between North Lyell, Crown Lyell, Lyell Blocks, Lyell Tharsis, 12 West Orebodies and how that relationship varies with depth (see following Fig. also)

5 cm

Data source: RGC plan dated July 85.

NEWHAM EXPLORATION AND MINING SERVICES		
NORTH LYELL MINE AREA		
LEVEL PLANS (1 and 5)		
0	200	Scale: 1:5,000
Drawn:	Date: Jan 93	Figure: 23a



KEY: See accompanying North Lyell Section

5 cm

These Level plans illustrate the spatial relationship between North Lyell, Crown Lyell, Lyell Blocks, Lyell Tharsis, 12 West Orebodies and how that relationship varies with depth (see also previous Figs.)

Data Source: RGC Plan dated July 85

NEWHAM EXPLORATION AND MINING SERVICES

NORTH LYELL MINE AREA

LEVEL PLANS (9 and 12)

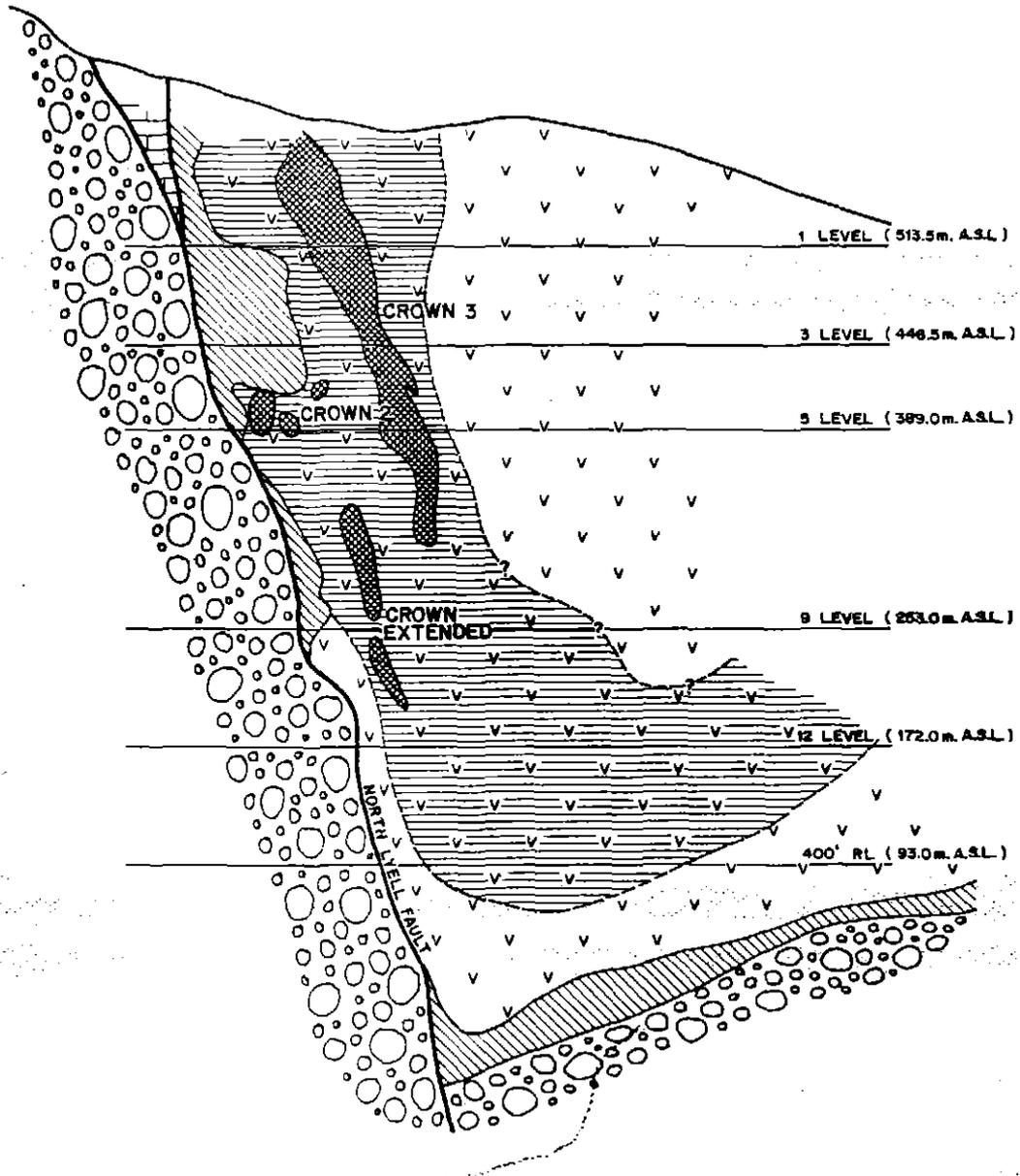
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Figure: 236

Date: Jan 93

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SW



SECTION 17

-  Gordon Limestone
-  Owen Conglomerate
-  Schists
-  Schists with Si-Py alteration
-  Hematite-barite-silica alteration
-  Orebodies

Data source: RGC Plan dated July 85

NEWHAM EXPLORATION AND MINING SERVICES

**NORTH LYELL MINE AREA
CROSS SECTION**

5 cm

0  200 m		Scale: 1:5,000
Drawn:	Date: Jan 93	Figure: 24

Mine	Tonnes ('M)	% Cu	g/t Au	g/t Ag
North Lyell	4.72	5.28	0.40	34.29
Crown Lyell	3.83	1.60	0.37	6.67
12 West	0.13	7.59	0.37	39.00
Lyell Tharsis	0.69	0.94	0.27	4.85
Total	9.37	3.41	0.38	20.5

Table 8: North Lyell Area - Production.

The relationship of the ore lenses and the Crown Lyell mining system are illustrated in the isometric drawing, Fig. 25.

Ore was extracted from both open-cuts and underground over a combined vertical distance of 400m. The lowest level was 13 Level (150m RL) where the ore was considered to cut out against Owen Conglomerate.

The vertical productivity was approximately 800 tonnes of copper per vertical metre - comparable to Prince Lyell.

The **North Lyell Mine**, which closed in 1953, was accessed by both shaft and the North Lyell tunnel on 11 Level. Ore was railed 2.5 km. along this tunnel to the concentrator.

Commencing in 1967, the main **Crown Lyell III** orebody was mined by sub-level open stoping. Ore extraction was along the North Lyell Tunnel. The primary stopes only extracted 44% of the mineralised body and mining ceased in 1976 due to the combination of difficult ground and access conditions.

The **12 West Orebody** south-west of the Crown Shaft was a small, very high grade bornite orebody tucked into a fold in the steeply dipping faulted contact between volcanics and Owen Conglomerate.

Lyell Tharsis is a relatively low grade (0.94% copper) shallow open-cut and underground operation immediately south of North Lyell. The underground operation was accessed via a short adit.

12.3 Exploration

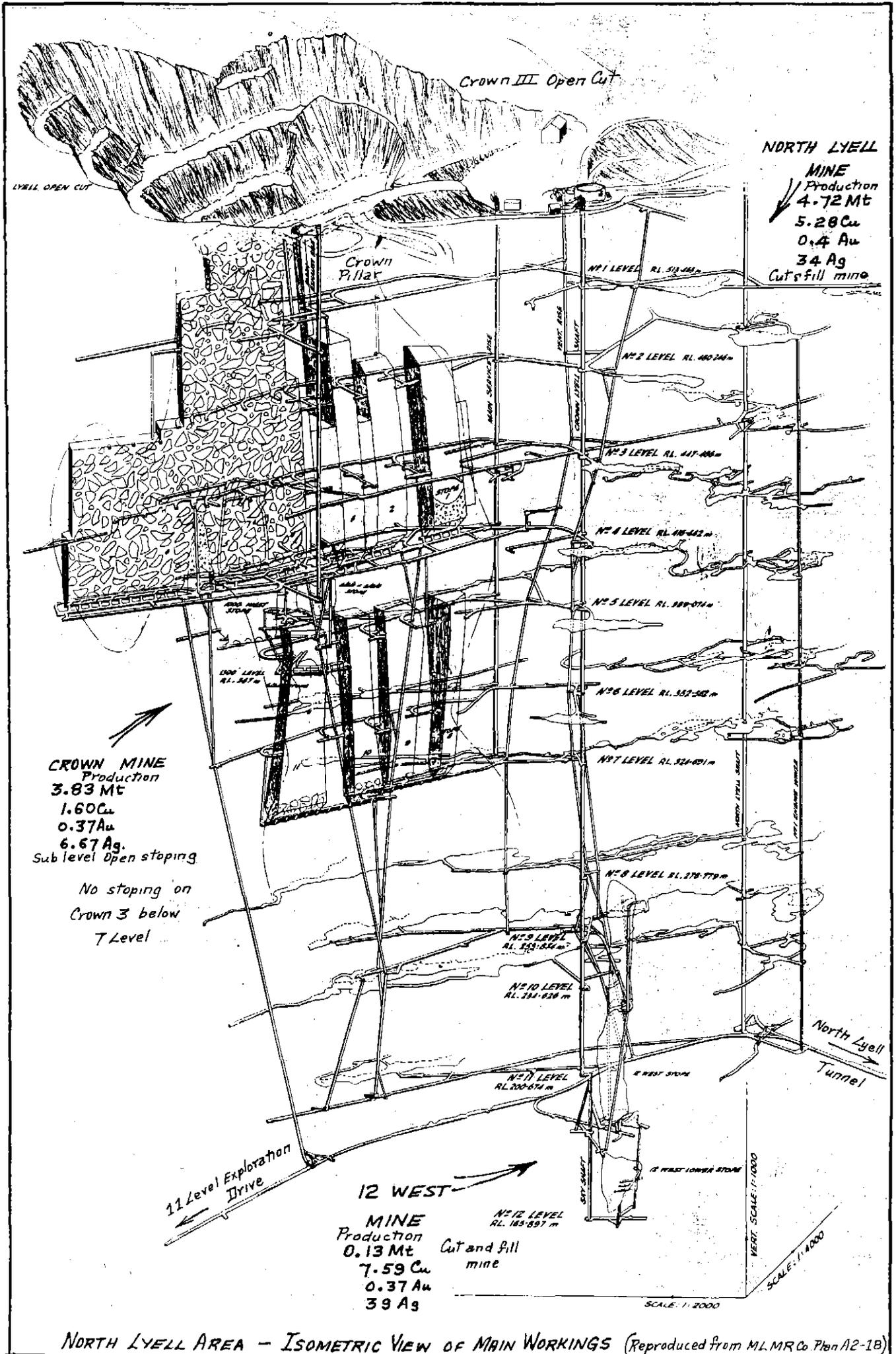
The North Lyell-Crown Lyell orebodies lie at the eastern end of the North Lyell Corridor, a 1,000m long, fault bounded pendant of sheared volcanics and sediments extending along the North Lyell Fault to the Cape Horn area.

The main North Lyell area has been intensively drilled and explored by underground mine development.

West of the Crown Lyell Mine, the Corridor has not been so exhaustively examined.

5 cm

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NORTH LYELL AREA - ISOMETRIC VIEW OF MAIN WORKINGS (Reproduced from ML MRC Plan A2-1B)

An exploration drive was developed on 11 Level north-west of the Crown Shaft (Fig. 17) and whilst drilling from this drive together with drive exposures located substantial low grade mineralisation, no significant higher grade mineralisation was located.

The remainder of the Corridor has been prospected at shallow depth by the North Lyell Consolidated and Anaconda Tunnels. Following E.M. surveys in the 1960's, six cored holes were completed into a pyritic sourced anomalous zone (Fig. 17). Results were not encouraging.

In the mid 1980's, some drilling was undertaken in the North Lyell area, firstly to test for extensions of shallow ore which could be open-cut, and secondly for mineralisation in Ordovician sediments.

Significant shallow mineralisation was outlined around the North Lyell and Crown Lyell open-cuts and some of this was mined to supplement underground production from Prince Lyell.

Drill holes NL1101 and NL1102 completed immediately east of North Lyell intersected broad barite-hematite-silica alteration zones in Ordovician sediments. The latter intersected 26m of 0.7% copper, 8 g/tonne silver, including 6m of 1.48% copper, 15 g/tonne silver, in altered sandstones.

12.4 Resource Potential

Opportunities exist for relatively small extensions of the Crown, North Lyell and Lyell Tharsis orebodies.

The most prospective areas for additional mineralisation area:

- crown pillars below Crown III open-cut;
- beneath 7 Level in the Crown Lyell Mine;
- beneath 13 Level in North Lyell Mine;
- above 12 West stopes.

In June, 1992, R.G.C. identified an indicated resource of 1.2 million tonnes of 1.6% copper, 0.4 g/tonne gold remaining as crown pillars beneath the open-cut. Potential for additional open-cut ore around the existing cut is limited and the mineability of the crown pillars requires investigation. The existing steep batters and underlying workings may present complications.

Core drilling from surface would be required to better determine the magnitude of the mineralisation potential in the other three areas. Existing drilling indicates that the potential below Crown Lyell and North Lyell is limited because of the underlying Ordovician Owen Conglomerate.

Dufty et al., and Flitcroft and McKeown point to additional resource potential in the North Lyell area (Table 9).

Area	Potential Resource	Mining
Crown Lyell 1	0.2 Mt 1.48 Cu	Underground
Crown Lyell 3	1.6 Mt 1.4 Cu	Underground and open-cut
Crown Lyell - Extended	0.7 Mt 1.1 Cu	Underground
Lyell Tharsis	0.3 Mt 1.2 Cu	Underground and open-cut
North Lyell	2.7 Mt 0.94 Cu	Underground

Table 9: Resource Potential - North Lyell Area.

This potential may exist and could present scope for either extensions of open-cut operations around the North Lyell and Lyell Tharsis areas or development of underground mining, based on small high grade extensions of North Lyell and Crown Lyell lenses, accessed by a short decline driven from east of the Mine where the topography falls rapidly towards current quarrying operations.

North Lyell mineralisation contains a significantly higher proportion of bornite than other Mt. Lyell ores.

This feature, combined with easy decline access, high altitude and geographical separation from other operational areas, highlights the potential for this area to support an in-situ solvent extraction operation.

In a rudimentary sense, such an operation is currently in progress, because surface waters have been prevented from discharging into the Linda Valley by diverting them down the North Lyell mine workings, presumably into the North Lyell tunnel.

If SX-EW operations appear viable at Lyell, it is recommended that the process be trialled in the North Lyell-Crown Lyell area.

Testing of the area between the Crown and Cape Horn Mines along the North Lyell Fault is inadequate. Many workers believe the North Lyell Fault is an important structural element in the development of Mt. Lyell orebodies and certainly this zone requires more drilling as a component of a longer term program to assess the mineral resource potential of the Lyell field.

12.5 Summary

Approximately 25% of the total production on the Mt. Lyell field has come from high grade deposits beneath a 30 hectare area at North Lyell.

Naturally, this immediate area has been intensively explored. However, potential remains for firstly shallow resources capable of supporting a modest open-cut operation, and secondly deeper high grade remnants which could be accessed with a short decline from the Linda Valley.

Collectively these resources, which contain significant bornite, may be amenable to a solvent extraction operation. A thorough assessment of the North Lyell area requires a quality collation of existing data.

The area west of North Lyell between the Crown Lyell and Cape Horn Mines adjacent to the North Lyell Fault has been only superficially tested (6 drill holes) for further North Lyell type deposits, and presents an excellent exploration opportunity.

13. COPPER CLAYS (Figs. 3, 11, 17)

13.1 Introduction

Deposits of copper bearing clays occur in three east dipping synclinal troughs east of the main Mt. Lyell operations at the western end of the Linda Valley:

- Lyell Blocks
- Lyell Consols
- King Lyell

The King Lyell deposit lies just outside ML30M/80 lease.

The copper occurs as native copper, cuprite and chalcocite in intensely weathered sandy beds of the lower Gordon Limestone, immediately above the Pioneer Beds (sandstones). The red and yellow copper bearing clays are generally overlain by black clays developed by either weathering Gordon Limestone, or hydrothermal alteration resulting in decarbonisation of the limestone.

A controversy exists as to the origin of the deposits. Some workers regard them as secondary deposits derived from mineralisation in the nearby volcanics and accumulated in weathered Ordovician sediments. However, a more thorough examination of mine workings and geological records appear to favour a process of hydrothermal replacement of limestones followed at a much later stage by deep weathering.

Sillitoe (1984) cited the Lyell Blocks Mine which was developed in clays adjacent to a steep 10-15m wide structure, and the changing nature of mineralisation from native copper and cuprite to chalcocite at depth as evidence of fracture controlled hypogene mineralisation which was later modified by karstic weathering. He and others consider the original copper deposits to be post-Cambrian mineralisation.

13.2 Production

Attempts were made to mine all three clay deposits by underground methods which understandably suffered from poor ground conditions.

Core drill testing was also attempted but results are unreliable because of poor core recoveries.

The Blocks Mine was developed in a clay filled trough 120m wide, 180m deep adjacent to the North Lyell Fault. The main shaft serviced development to the 135m level and prospecting to 165m level. Production between 1900-1907 was approximately 200,000 tonnes for a recovered 2,500 tonnes of copper, i.e. a recovered grade of 1.2% copper.

A considerable amount of development work had been undertaken when the shaft collapsed and the Mine was abandoned.

The Lyell Consols deposit lies in a trough 180m long, 12m wide, 45m deep adjacent to the Whaleback Fault with probable extensions to the west and east.

Between 1907-1910 approximately 300 tonnes of copper were recovered from 25,000 tonnes of ore for a recovered grade of 1.2% copper. Again the Mine was abandoned when the shaft collapsed. An in-situ grade of 3% is attributed to Lyell Consols' mineralisation.

The King Lyell deposit (which lies just outside 30M/80) was developed in 90-120m thick east dipping brown-grey-orange clays and mudstones. Initially it was sluiced and later mined and prospected underground.

Again mining was abandoned following subsidence and water problems. The known King Lyell deposit is 45m long, 34m wide and 43m deep.

Part of King Lyell is now covered by the toe of the West Lyell waste dumps.

Two other small deposits occur between King Lyell and Lyell Consols.

13.3 Resource Potential

Remaining resources may be in the vicinity of:

Blocks:	1.6 million tonnes of 1.5-2% copper;
Consols:	0.25 million tonnes of 3% copper?
King Lyell:	0.15 million tonnes of 2% copper.

2MT @ +1.5% Cu.

A possible total of 2 million tonnes of 1-1.5% copper. Potential for the definition of additional resources appears reasonable.

Whilst these deposits are not large, they have three attractive features:

- amenable to open-cut mining;
- simple processing;
- high grade copper concentrate.

In the past, great difficulty has been experienced in establishing reliable resource estimates on the clays because of poor drilling conditions and core recoveries. This problem would be overcome efficiently and economically by air-core drilling.

The copper clay resources are considered to represent scope for a medium sized operation which because of its unique character could either supplement larger adjacent hard rock mining operations or stand alone as a separate operation with its own specialised treatment facility.

14. OTHER POTENTIAL RESOURCES

14.1 Blow - South Lyell Area

These two adjacent deposits occur south of Prince Lyell. The Blow (Iron Blow or Mt. Lyell Mine) was the first discovered deposit on the Mt. Lyell Field. From 1893-96 it was mined for gold alone and from 1896-1929 as a copper ore for pyritic smelting. Mining was by both open-cut and underground methods, and total production was 5.5 million tonnes of 1.3% copper, 1.99 g/tonne of gold, 61 g/tonne of silver.

The high gold and silver values set it aside in type from other deposits at Mt. Lyell. The open-cut today represents a significant tourist attraction.

The last resource estimate was in 1924: 1.6 million tonnes of 0.5% copper, 1.3 g/tonne gold.

The adjacent South Lyell deposit consisted of two non-outcropping lenses of massive pyrite with low chalcopyrite, mined specifically for feed to the pyritic smelters and the production of sulfuric acid.

Production between 1899-1922 was 324,000 tonnes of 50% sulfur, 0.4% copper, 1.1 g/tonne gold, 6 g/tonne silver, consisting of 205,000 tonnes of 0.51 copper, 1.2 g/tonne gold from the Main Lens and 119,000 tonnes of 0.26 copper, 1 g/tonne gold from the North Lens.

Bird (1984) interpreted the lenses as strongly fault controlled with the higher grade gold zones (5-8 g/tonne) occurring near the intersection of the Proprietary and Owen Spur Faults. He considered the depth potential of the deposits to be structurally limited and estimated total resources of 0.6 million tonnes of low copper grades.

However, Wade and Solomon (1958) reported a resource potential of approximately 0.3 million tonnes and considered the deposit had substantial depth potential.

14.2 Precious Metals

The mines of the Mt. Lyell field have produced approximately 44 tonnes of gold and 740 tonnes of silver over a 110 year life.

Precious metal production in 1991-92 was 0.566 tonnes of gold and 3.46 tonnes of silver, contained within the copper concentrate which averages approximately 6.4 g/tonne gold and 39 g/tonne silver.

Gold and silver are present to varying degrees in all Mt. Lyell deposits. The upper part of the Blow was initially mined for gold, and total production averaged 1.99 g/tonne gold and 61 g/tonne silver. The North Lyell orebodies were high in silver (34 g/tonne average) and significant silver was also reported from the Lyell Blocks deposit. Elevated gold was reported in the South Lyell and Lyell Comstock Mines and in the chert body in the hanging wall of that Mine.

Precious metal content in Prince Lyell appears to be increasing steadily with depth and currently averages 0.51 g/tonne gold, 3.05 g/tonne silver. It is important to note this trend may continue below 60 Series. Drill hole

WL701 intersected 37m true width of 2.75% copper and 0.98 g/tonne gold in the North Lens, including one 2m interval of 6.1 g/tonne gold.

The controls and associations of precious metals are not particularly clear. They appear to be associated with copper mineralisation and to be concentrated close to fault zones.

In the 1980's, R.G.C. undertook studies of the Mt. Lyell field exploring for stand alone gold deposits based on various gold deposit models. This intermittent programme failed to highlight any significantly encouraging areas and was perhaps prematurely terminated. *

However, the Cambrian volcanics of the Mt. Lyell region are pervasively gold anomalous and regional anecdotal evidence suggests that gold may have been remobilised and concentrated by subsequent tectonism both within the Cambrian volcanics and the younger Palaeozoic sediments.

Hence, whilst immediate opportunities for stand alone gold deposits have not yet been indicated on ML30M/80, gold and silver do represent a valuable by-product in the known copper orebodies and longer term potential certainly exists for the discovery of stand alone precious metal deposits.

14.3 Other Base Metals

No production of base metals other than copper, e.g. lead and zinc has occurred on the Mt. Lyell field. Most exploration encouragement to date has occurred near the northern end of the field where early underground development at the Tasman Crown Mine prospected a small occurrence of massive pyrite-galena-sphalerite mineralisation in Tyndall Group volcanoclastics and exploration in the Lyell Comstock area has drill indicated the existence of two base-metal enriched zones.

The first of these zones may represent a north-north-east continuation of Lyell Comstock where anomalous copper and zinc values have been obtained in volcanics in the footwall of the Comstock Chert (C50: 12m of 1.8% zinc). See Section 11 for more details on this zone.

The second is a broad zone of anomalous lead and zinc in andesitic volcanoclastics and sediments north-west of Lyell Comstock. This mixed volcanic-sedimentary sequence is interpreted by R.G.C. as being near the base of the Tyndall Group, stratigraphically equivalent to the Hellyer-Que River deposits and overlain by the Comstock Chert, interpreted as a volcanic hot spring sinter deposit. Other workers (Sillitoe, Brook, Bird) regarded the chert as silicious alteration associated with the formation of the Lyell Comstock deposit.

Holes C64, C68, C69, C70 and C71 have all recorded broad zones of low grade mineralisation:

- C69: 13m 0.17 copper, 0.34 lead, 0.24 zinc, 0.26 gold including 8m of 0.12 copper 0.12 lead, 0.04 zinc, and 0.39 lead and 0.22 gold.
- C70: 14m 0.66 lead, 1.16 zinc, 244 silver.
- C71: 137m 0.17 lead, 0.25 zinc, 5.4 silver.

14.4 Miscellaneous

This report has so far addressed the mineral resource potential which exists as either extensions to areas which have already been mined or in areas tested only by drilling.

On the basis of geological modelling, geophysical and lithogeochemical studies, there are other areas that have longer term resource potential which have either not yet reached the drilling stage, or which have been inadequately drilled.

In the last ten years a significant amount of research and non-drilling exploration has taken place at Lyell but for various reasons associated with difficult operating conditions, very little exploration drilling away from known orezones has occurred - averaging only 1,000m of such drilling per annum.

In this context, the saying: "IQ is fine but BQ finds the mine", is appropriate.

Given an environment of long term confidence in copper and the current remaining identified and potential resources at Lyell, a greater and more consistent drilling effort on untested or under-tested anomalous areas and exploration concepts is warranted.

The last significant drilling of this nature was NL1102 designed to test for gold and copper mineralisation in Ordovician sediments in a structurally complex setting at North Lyell. The hole intersected 26m of 0.7% copper, 8 g/tonne silver, in a zone of intensely altered sandstones. That was a significant and exciting result for such a new concept but has not been followed up. *

Further, much of the exploration undertaken in the last 25 years has been based on volcanogenic models. It is now clear that whilst some or all of the mineralisation may have a volcanogenic origin, it was remobilised and concentrated into **orebodies** by later structural events and there is thus a strong argument in support of drilling structurally disturbed zones such as:

- (a) the North Lyell Corridor where the North Lyell Fault intersects the Great Lyell Fault, i.e. east of Cape Horn, where to date there is only one shallow hole;
- (b) the North Lyell Fault zone east of the North Lyell area where it intersects the Great Lyell Fault.

In terms of modern exploration philosophy which supports persistent drilling in known mineralised areas, the Mt. Lyell field is seriously under-drilled in areas away from known deposits, all of which either outcropped or had surface expressions, i.e. exploration for blind orebodies has been minimal.

The Mt. Lyell area represents, by several orders of magnitude, the largest accumulation of non-ferrous mineralisation in Tasmania, and justifies more intense exploration for non-outcropping, structurally controlled deposits in both conventional and non-conventional host rocks. *

Any strategic plan to continue operations at Lyell should have the confidence and optimism to include an on-going drilling program aimed at assessing this unquantified resource potential.

16. RESOURCE EVALUATION STRATEGIES

15.1 Evaluation Requirements

There are major technical and social factors which support the concept of any future mining operation at Lyell commencing as soon as possible after the planned cessation of operations by R.G.C. in June, 1995, i.e. avoidance of significant breaks in operation. To achieve this, a considerable amount of technical work would be required over the next two years.

A strategic resource assessment plan is urgently required.

This paper has identified a substantial number of areas which are considered to have a high chance of containing resources which might support one or more continuing major mining operations at Queenstown.

The potential in all of these areas is only inferred or indicated. In all cases, the level of technical knowledge is insufficient for the purpose of preparing final development and business plans to evaluate their commercial viability.

Various geological, mining and processing investigations are required prior to the preparation of such plans.

Clearly neither the time nor commercial justification exists to fully test all the areas of significant resource potential.

The assessment plan should therefore rank the areas, schedule and cost their assessment, and establish a critical assessment path.

A single plan is not possible, because different potential investors will have differing objectives. However, no matter what these objectives are, all plans should be focused and driven along a critical path, otherwise valuable resources will become rapidly disseminated and ineffective.

Table 1 represents but one manner of **grouping** and **ranking** these areas. The potential resource shown in this table is meant to give the reader only a broad order of magnitude assessment of the potential of individual areas. These assessments should not be treated in the same way as resources and reserves as defined by the Australasian Institute of Mining and Metallurgy, and certainly they should not be totalled or bulked.

Brief comments on the likely evaluation of work required on each of the areas is presented below:

15.1.1 Open-Cut Potential

- (a) Royal Tharsis -
Shallow pattern core drilling followed by pit optimisation studies. Access is excellent and this would be an easy task.
- (b) Crown Lyell -
Minor additional drilling; main considerations are the practicalities of mining the remnants.

- (c) Copper Clays -
Air-core drilling of 2-3 areas followed by metallurgical test work and pit design studies.
- (d) West Lyell Workshop Area -
Shallow pattern core drilling followed by geotechnical and pit design studies.
- (e) Cape Horn Extension -
Core drilling and mine planning.
- (f) Large Low Grade West Lyell Pit -
In-situ leaching leaching studies in conjunction with similar studies on adjacent waste dumps.
- (g) Lyell Comstock -
Core drilling and mine planning.

All of the above could be undertaken without interference to the current operations.

15.1.2 Underground Potential

- (a) Prince Lyell -
Core drilling 70, 80, 90 series, mainly from underground, some from surface; sub-level cave mine planning.
- (b) North Lyell -
Data collation; minor drilling; SX-EW test work.
- (c) Western Tharsis -
Infill core drilling from underground (?), sub-level cave mine planning.
- (d) Cape Horn -
Depth extension core drilling; mine planning.
- (e) A-Lens -
Depth extension core drilling (? underground).

15.1.3 Waste Dumps

- (a) West Lyell -
Air core drilling and leaching studies.

15.2 Evaluation Methodologies

15.2.1 Drilling

In all cases where drilling is necessary, it should be core drilling. Exceptions are air-core drilling of the copper clays and waste dumps.

Reverse circulation drilling is not recommended because of very high rainfall, high water table and large quantities of ground water, and hole deviation.

Traditionally, NQ-BQ or 56/46TT has proved adequate at Mt. Lyell.

15.2.2 Geophysics

Geophysics is not considered appropriate for evaluating the resource potential of any of the above areas. The evaluation work is down to mine scale in strongly sheared and pyritic rocks.

15.2.3 Solvent Extraction Metallurgy

Considerable data already exists at Lyell on the various past attempts at SX-EW. This data should be reviewed prior to ongoing tests with contemporary technology.

15.2.4 Mine Planning

Alternative underground mining methods should be investigated. Davies and Speechly recommended sub-level caving and provided detailed layouts, costs and benefits on lower Prince Lyell.

If drilling confirms open-cut resources, computerised pit optimisation studies should be undertaken on such areas.

15.3 Critical Path Evaluation (Table 10)

Conceivably in future operations, ore could be drawn concurrently from four supply bases, either by one or more operators:

- underground (conventional)
- open-cut (conventional)
- copper clays
- in situ leaching.

The four groupings are determined principally by processing requirements. Realistically, conventional underground production will probably be in the grade range 1.5-2.5% copper and 0.5-0.75 g/tonne gold, whereas conventional open-cut ore will be about half these grades. The desirability of blending these ores in one concentrator requires investigation.

Any future major underground operation would appear to depend critically on confirmation of the 70 and 80 Series Prince Lyell resource potential.

If that potential could not be confirmed, then the chances of a Western Tharsis or Cape Horn being developed underground would diminish dramatically.

If the Prince Lyell resource potential was confirmed, then further testing of both Cape Horn and Western Tharsis would be justified. The combined resources of Prince Lyell, Western Tharsis, Cape Horn could justify an expanded underground operation of 2+ million tonnes per annum. The commercial advantages of such an expanded underground operation were enunciated recently by Davies and Speechly. They further

detailed the current mine and mill infrastructure constraints on such an expansion and recommended ways of removing these constraints.

Clearly, either continuing or expanding underground operations beyond 1995 would benefit from the availability of the current Prince Lyell shaft and decline system. Hence, it will be very important to confirm the Prince Lyell resource below 60 Series well in advance of 1995.

The **open-cut resources** could be considered as either part of an integrated and expanded open-cut and underground mining operation, or as a stand alone operation. Either way, if advantage is to be taken of the existing processing infrastructure, the resource potential of several of the higher ranked areas should be further tested by drilling and mine studies prior to 1995, e.g. Royal Tharsis, Crown Lyell, and West Lyell Workshop areas.

The **copper clay resources** would require their own processing plant and separate open-cut operations. Hence, from a technical infrastructure point of view, the same urgency to confirm the resources does not exist. However, if a continuation of production is seen as desirable from other points of view, then confirmatory drill testing, mine planning and metallurgical test work would need to start soon.

Leaching operations based on waste dumps and in-situ ores similarly would require their own treatment plants and mine operations. If such an operation was to take place whilst either conventional underground or open-cut mining was in progress, it is likely that all operations would have to be under the control of one operator - otherwise there would be arguments!

Leaching of in-situ ores (underground and surface) and dumps is very much a technologically unknown process at Lyell. Hence, substantial metallurgical and mine design studies would have to commence soon, if such operations were to play a role in continuing operations beyond 1995.

The benefits of undertaking SX-EW trials on the North Lyell area were outlined in greater detail in Section 12.

Given a substantial resource and a 5-10 year minimum life of mine, **downstream processing** of copper concentrates, using Isasmelt/Austmelt technology, should be investigated as a means of dramatically reducing the current high ex-mine charges on a low valued concentrate.

Other factors important in establishing a critical path resource evaluation strategy are firstly that any new operation beyond 1995 will require a tailings dam and secondly the new operator will be required to prepare development and environment management plans for Government approval.

Table 10 represents one resource evaluation strategy and highlights the importance of time and effort with respect to testing of the mineral resource potential if a reasonable continuation of operations is to be achieved.

Project	Jul 93	Dec 93	Jan 94	Jun 94	Jul 94	Dec 94	Jan 95	Jun 95
Identify Investors	→							
Agreements with RGC	→							
Prince Lyell Drilling		→	→	→				
Western Tharsis Drilling					→	→		
Open Cut Drilling		→	→	→				
Copper Clays Drilling			→					
Copper Clays Metallurgical testing				→				
Solvent Extraction Studies		→	→	→				
Feasibility Studies					→	→	→	
Environment Management Plan						→	→	
Government Approvals								→
Tailings Dam construction								→

Table 10: Resource Assessment Plan

15.4 Resource Assessment Program and Costs

It was not within the scope of this report to design and cost programs to test the various potential mineral resources listed.

However, once an evaluation plan has been devised, it is a relatively simple task to detail the plan, using the very adequate data base held on the Mt. Lyell Mine.

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