1980/2. Summary of chromite investigations in the Beaconsfield area

T.G. Summons

Abstract

Investigations by the Tasmania Department of Mines into the occurrence of chromite deposits outside the Barnes Hill mine near Beaconsfield began in August 1978 with seismic and percussion drilling programs.

Following the discovery of two chromite prospects in the Rifle Range area, detailed investigations into the physical (size distributions *etc.*)and chemical properties of the chromite deposits were carried out in the Department's Launceston laboratory. The laboratory results, in conjunction with the probable ore reserve data, indicate the South Rifle Range prospect to be of similar size, but higher grade than the pre-mining reserve of the Barnes Hill mine.

These results suggest a commercially viable mining operation could be established on the South Rifle Range prospect.

Insufficient drilling at the North Rifle Range prospect precludes calculation of ore reserves, but a possible ore figure suggests a similar tonneage, but a lower grade to the pre-mining reserve of the Barnes Hill mine. Further exploration in the Rifle Range area should substantially increase the known resources of chromite, particularly in the area between the two prospects.

INTRODUCTION

Northern Chromite Pty Ltd commenced investigation of the Barnes Hill chromite deposit 4 km west of Beaconsfield in 1969, and from 1971 to 1977 the Tasmania Department of Mines laboratory in Launceston was engaged in metallurgical investigations of the chromite orebody.

Other Tasmanian Government assistance has been in the form of financial aid, following the joint recommendation of the Director of Planning and Development and Director of Mines in June 1977. This recommendation resulted in Northern Chromite Pty Ltd being loaned $150,000 under the Industrial Development Act 1954; a further loan of $25,000 was made in November 1977.

Following considerable delays in the development of a satisfactory chromite concentrate, irregular production of 99% chromite commenced in November 1977. In July 1978, Northern Chromite Pty Ltd became a subsidiary of Amalgamated Metal Corporation Ltd, through the actions of its wholly owned Australian subsidiary companies (Consolidated Tin Smelters (Aust.) Pty Ltd and Amalgamet Aust. Ltd); subsequently in September 1978, Amalgamated Metal Corporation Ltd became a subsidiary of Preussag A.G.

Following the initial takeover of Northern Chromite, Amalgamet, having initiated certain improvements in the techniques of chromite extraction from the ore at the Barnes Hill mine, found the reserves of chromite at the mine to be inadequate to support a stable mining operation. Consequently Amalgamet approached the Tasmanian Government for assistance in locating further chromite deposits in the Beaconsfield area, and accordingly the Tasmania Department of Mines commenced investigations in the Rifle Range area north of Barnes Hill in August 1978.

This report summarises the significant economic data gained from the investigation, which terminated in December 1979.

GEOLOGY

The stratigraphy of the Cainozoic sequence, capped by gravel/conglomerate, and the modes of occurrence and genesis of the chromite deposits, will be described in detail in a forthcoming Tasmania Department of Mines publication. The complete Cainozoic sequence commences with the Lower Clay member (Tc-1), and generally youngs upward through the Beach/Channel Bar Placer (Tbp), the Second Clay (Tc-2), the Lower Sand (Ts), the Third Clay (Tc-3), the Older Conglomerate with a basal conglomerate unit (Cg-1), an intermediate sand unit (Cs), an upper clay unit (Cc), and the Younger Conglomerate (Cg-2) members.

In summary, chromite bearing sediments, derived from the laterite formed over the Andersons Creek Ultramafic Complex, were deposited in a marginal marine environment. Probably concurrently with this depositional event, significant concentrations of chromite were formed in the transitional environment represented by both fluviatile and marine processes during the early Tertiary.

Anomalous chromite concentrations occur in the Tc-1, Tbp, Tc-2 and Ts members in the area.

METHOD OF INVESTIGATION

The Rifle Range area selected for investigation is covered by at least 15 m of Cainozoic gravel/conglomerate (Cg-1, Cs, Cc and Cg-2 members) with minimal exposures of the Tertiary rock sequence between these gravels and the underlying Palaeozoic basement.

A seismic refraction program (using a Texas Geospace Instruments GT-2 refraction seismograph) showed the basement to have the form of an inclined peneplain, strongly dissected by pre-Cainozoic gravel streams.

Percussion drilling (using a Keystone Star Drill 55 rig) was initially aimed at the potential deep lead situations located in the topographic 'lows' in the basement. However, these features were found to be barren with regard to chromite and the drilling was then focussed on the remnant sedimentary sequences located on the elevated portions of the basement. Significant chromite intersections were obtained from most of these areas, and culminated in the discovery of the South Rifle Range prospect.

'Blind' drilling (*i.e.* drilling with no seismic control on basement topography) approximately one kilometre north of the South Rifle Range prospect, resulted in the discovery of the North Rifle Range prospect, which appears to have had an appreciable fluviatile component during its formation, and probably represents a deep lead deposit.

The North Rifle Range drill holes were positioned along a major, north-east trending, pre-gravel photolineament, on the premise that such structural features would have controlled early drainage systems, and would consequently represent sites for potential deep lead deposits. A total of 16 holes was drilled in the Rifle Range area, the locations of which are shown on Figure 1.

Costeaning along a west-east traverse across Tattersalls Hill (immediately east of the Barnes Hill mine) encountered anomalous chromite values in the laterised Tc-1 member. Similar chromite values were obtained

in grab samples from the same sedimentary member, beneath the current ore horizon at the Barnes Hill mine.

Percussion (churn) drill samples were collected initially in a rectangular steel sludge box; samples for assay were taken along its long axis using a small spade.

A check on the loss of chromite due to overflow from the sludge box showed the analytical results for total chromite from one hole to be approximately 90% of the actual *in situ* chromite value.

Analyses received from the Department of Mines Launceston laboratory were expressed as Cr mass %, and were converted to chromite mass % by multiplying by a factor of 2.40. The chromite conversion factor was calculated from 16 electron probe microanalyses of chromite concentrate produced from the Barnes Hill mine, and is accurate to ± 6.0%.

Drill hole intersections were taken to approximate true widths because:

(i) all the holes were drilled vertically into a flat lying (< 5°) sedimentary sequence; and

(ii) of the error involved in estimating sedimentary unit boundaries in percussion drill holes.

Density factors were determined by the Launceston laboratory using samples of varying chromite grade from the Barnes Hill mine; these results were plotted on a graph of density versus mass % chromite, and are adequately represented by a straight line passing through 1.77 t/m^3 at 0 mass % chromite, and 2.76 t/m^3 at 100 mass % chromite.

Recoverable (or mineable) chromite was determined in the Launceston laboratory by screening and cyclosizing 13 composite samples from drill holes PBRR-7, 8, 9, 10, 11 (South Rifle Range prospect), and PBRR-4, 14 and 15 (North Rifle Range prospect). Recoverable chromite is arbitrarily defined as the chromite grains occurring in the 18-600 µm size interval, although inspection of grain size distribution data and grain size frequency diagrams indicates that > 90% of the mass of the samples occurs in the 34-600 µm size interval.

RESULTS

Summarised percussion drill hole logs are presented in Appendix I. All percussion drill hole intersection data for both total and recoverable (18-600 µm) chromite are shown respectively in Tables 1 and 2.

As discussed previously, the investigations in the Rifle Range area resulted in the discovery of two chromite prospects, the North Rifle Range prospect, and the South Rifle Range prospect, for which possible ore and a probable ore reserve have been calculated respectively.

Probable total chromite ore reserves are shown in Table 3 for the South Rifle Range prospect, for both 4 and 6.5 mass % chromite cut off grades. Probable recoverable (18-600 µm) chromite ore reserves are shown in Table 4 for the South Rifle Range prospect, with the same chromite cut off grades. The ore reserves were calculated using the polygonal method, with reserve blocks centered on drill holes; these reserve blocks are shown on Figure 1.

The estimated recovery grades for chromite in the South Rifle Range prospect are given in Table 5. As mentioned previously, > 90% of the mass

of the chromite bearing samples from this prospect are > 34 μm in size, and the estimated figure of 76% recovery for the 18-600 μm size range, can be modified to approximately 70% recovery for the 34-600 μm size range.

Probable ore reserve data, for both total and recoverable chromite at the Barnes Hill mine and at the South Rifle Range prospect, are shown in Table 6.

Possible ore (not an ore reserve), based on holes PBRR-4, 14 and 15 at the North Rifle Range prospect, amounts to approximately 200 000 tonnes at a grade of 7.5 mass % chromite.

CHROMITE POTENTIAL IN THE BEACONSFIELD AREA

The current investigations into chromite in the Barnes Hill-Tattersalls Hill-Rifle Range area, have indicated three broad modes of occurrence for the chromite:

(1) as a primary constituent of the ultramafic lithologies;

(2) as a secondary constituent in the Tertiary sediments;

(3) as a tertiary constituent in the Quaternary deposits.

Ultramafic lithologies

The potential for locating significant chromite reserves in the original host rocks would appear to be low, since the average background concentration of chromite in serpentinised peridotite is approximately 2 mass %, with only minor segregations (< 50 mm diameter) of chromite observed at Barnes Hill.

Tertiary sediments

As mentioned previously, there are four sedimentary members known to contain anomalous chromite concentrations in the area:

(a) *The Lower Clay member (Tc-1)*; - this has a high resource potential, based on data from several sources (Anthony, 1969; Gebert, 1967; and the Tasmania Department of Mines) which was obtained from Barnes and Tattersalls Hills, and the Rifle Range area. The main outcropping occurrences of this member are at Barnes, Tattersalls and Scotts Hills and Mt Vulcan.

(b) *The Beach/Channel Bar Placer (Tbp) and the Second Clay (Tc-2) member*; - these members have a proven high resource potential, and contain the majority of the probable chromite ore reserves in the South Rifle Range prospect, with the former representing the current ore horizon at the Barnes Hill mine. Because the Tertiary sequences intersected in the two Rifle Range prospects are similar, the interval separating them (approximately one kilometre) is considered as highly prospective for locating further significant chromite deposits.

(c) *The Lower Sand member (Ts)*; - this member (being fluviatile in origin) has a moderate resource potential in the form of deep lead concentrations of chromite, such as the upper portion of the North Rifle Range prospect. Although it crops out extensively in the Beaconsfield area, exploration work should be directed at locating early Tertiary (post Tc-1, Tbp, Tc-2 members) drainage pattern, a task complicated by those drainage patterns associated with the late Tertiary-early Quaternary gravel (the Older and Younger Conglomerates).

Quaternary deposits

These range from surficial gravel and sand to river alluvium, and have been derived from the Tertiary sediments; they are considered to have a low to moderate resource potential. The principal areas of interest occur in the immediate vicinity of Andersons Creek, where it has been dammed by differential dip slip movement along the late Tertiary block faults.

RECOMMENDATIONS

It is recommended further exploration for chromite in the Beaconsfield area should be directed at the following:

(1) Locating further occurrences of remnant Tc-1, Tbp, Tc-2 members, particularly in the Rifle Range area, and also in the area to the north, lying south-east of Badger Beach and bounded by the Asbestos Range and Stockyard Hills to the west and east respectively; the area between Peaked Hill and Cabbage Tree Hill-Salisbury Hill is of similar exploration priority.

(2) Locating further deep lead occurrences of chromite in the Ts member in broadly similar areas to those described above.

(3) Investigating the Quaternary alluvial deposits immediately adjacent to Andersons Creek.

REFERENCES

ANTHONY, P.J. 1969. Beaconsfield nickel prospect, Tasmania. A progress report. *Unpubl.Rep. P.J. Anthony and Associates.*

GEBERT, H. 1967. Report on exploration licences 3/65 and 14/65, Beaconsfield, Tasmania. *Unpubl.Rep. Broken Hill Prop.Co.Ltd.*

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Table 1. ASSAY DATA (TOTAL CHROMITE), BEACONSFIELD (RIFLE RANGE) CHROMITE DRILLING

Hole	Depth (m)	Width (m)	Cr (mass %)	Chromite (mass %)	Bulking	
					4 mass % chromite cut off	6.5 mass % chromite cut off
PBRR-1	22.0 - 23.0	1.0	< 0.10	< 0.24		
	23.0 - 24.0	1.0	1.30	3.12		
PBRR-2	10 - 21.0	11.0	< 0.10	< 0.24		
	21.0 - 22.0	1.0	0.20	0.48		
PBRR-3	0 - 20.0	20.0	< 0.10	< 0.24		
	20.0 - 21.0	1.0	0.10	0.24		
	21.0 - 22.0	1.0	0.90	2.16		
	22.0 - 22.5	0.5	1.10	2.64		
PBRR-4	7.0 - 8.0	1.0	0.10	0.24		
	8.0 - 9.0	1.0	0.35	0.84		
	9.0 - 9.7	0.7	1.20	2.88		
	9.7 - 11.0	1.3	3.20	7.68)		) 1.3 m @ 7.7% chromite
	11.0 - 11.3	0.3	0.80	1.92)	2.3 m @ 6.2%	
	11.3 - 12.0	0.7	2.20	5.28)	chromite	
	12.0 - 13.0	1.0	0.60	1.44		
PBRR-5	10.0 - 11.0	1.0	0.26	0.62		
	11.0 - 12.0	1.0	0.31	0.74		
	12.0 - 13.0	1.0	0.11	0.26		
	13.0 - 14.0	1.0	0.12	0.29		
	14.0 - 15.0	1.0	0.16	0.38		
	15.0 - 16.0	1.0	0.27	0.65		
	16.0 - 17.0	1.0	0.16	0.38		
	17.0 - 18.0	1.0	0.08	0.19		
	18.0 - 19.0	1.0	0.26	0.62		
	19.0 - 20.0	1.0	0.07	0.17		
	20.0 - 21.0	1.0	0.04	0.10		
	21.0 - 22.0	1.0	0.08	0.19		
	22.0 - 23.0	1.0	0.08	0.19		
	23.0 - 24.0	1.0	0.10	0.24		
	24.0 - 25.0	1.0	0.16	0.38		

Table 1. (Continued)

Hole	Depth (m)	Width (m)	Cr (mass %)	Chromite (mass %)	Bulking	
					4 mass % chromite cut off	6.5 mass % chromite cut off
PBRR-6	5.0 - 6.0	1.0	0.20	0.48		
	6.0 - 7.0	1.0	0.30	0.72		
	7.0 - 8.0	1.0	0.50	1.20		
	8.0 - 9.0	1.0	0.60	1.44		
	9.0 - 10.0	1.0	0.30	0.72		
	10.0 - 11.0	1.0	0.30	0.72		
	11.0 - 12.0	1.0	0.20	0.48		
	12.0 - 13.0	1.0	0.30	0.72		
	13.0 - 14.0	1.0	0.20	0.48		
	14.0 - 15.0	1.0	0.20	0.48		
PBRR-7	5.0 - 6.0	1.0	0.40	0.96		
	6.0 - 7.0	1.0	0.30	0.72		
	7.0 - 8.0	1.0	0.20	0.48		
	8.0 - 9.0	1.0	1.50	3.60	2.25 m @ 10.70% chromite	1.25 m @ 16.30% chromite
	9.0 - 10.0	1.0	6.10	14.64		
	10.0 - 10.25	0.25	9.60	23.04		
PBRR-8	10.0 - 11.0	1.0	0.20	0.48		
	11.0 - 12.0	1.0	2.80	6.72	3 m @ 8.00% chromite	2 m @ 9.10% chromite
	12.0 - 13.0	1.0	4.80	11.52		
	13.0 - 14.0	1.0	2.40	5.76		
PBRR-9	5.0 - 6.0	1.0	0.18	0.43		
	6.0 - 7.0	1.0	0.20	0.48		
	7.0 - 8.0	1.0	0.23	0.55		
	8.0 - 9.0	1.0	0.22	0.53		
	9.0 - 9.8	0.8	0.20	0.48		
	9.8 - 10.0	0.2	7.20	17.28	2.95 m @ 16.30% chromite	2.2 m @ 20.20% chromite
	10.0 - 11.0	1.0	14.3	34.32		
	11.0 - 12.0	1.0	2.8	6.72		
	12.0 - 12.75	0.75	2.0	4.80		
PBRR-10	11.0 - 12.0	1.0	0.30	0.72		
	12.0 - 13.0	1.0	0.20	0.48		
	13.0 - 14.0	1.0	0.20	0.48		
	14.0 - 14.5	0.5	0.20	0.48		

Table 1. (Continued)

Hole	Depth (m)	Width (m)	Cr (mass %)	Chromite (mass %)	Bulking	
					4 mass % chromite cut off	6.5 mass % chromite cut off
PBRR-10	14.5 - 15.0	0.5	1.60	3.84	2.5 m @ 4.00% chromite	
	15.0 - 16.0	1.0	1.20	2.88		
	16.0 - 17.0	1.0	2.10	5.04		
PBRR-11	2.0 - 3.0	1.0	0.40	0.96		
	3.0 - 4.0	1.0	0.30	0.72		
	4.0 - 5.0	1.0	0.10	0.24		
	5.0 - 6.0	1.0	0.10	0.24		
	6.0 - 7.0	1.0	0.10	0.24		
	7.0 - 8.0	1.0	0.60	1.44		
	8.0 - 9.0	1.0	5.20	12.48	6.0 m @ 9.60 % chromite	3.0 m @ 15.60% chromite
	9.0 - 10.0	1.0	8.30	19.92		
	10.0 - 11.0	1.0	6.0	14.40		
	11.0 - 12.0	1.0	1.20	2.88		
	12.0 - 13.0	1.0	1.70	4.08		
	13.0 - 14.0	1.0	1.70	4.08		
PBRR-12	28.5 - 29.0	0.5	0.60	1.44		
	29.0 - 30.0	1.0	1.10	2.64		
PBRR-13	No samples submitted for analysis					
PBRR-14	8.0 - 9.0	1.0	1.40	3.36		
	9.0 - 10.0	1.0	4.00	9.60	5.0 m @ 7.70% chromite	5.0 m @ 7.70% chromite
	10.0 - 11.0	1.0	1.80	4.32		
	11.0 - 12.0	1.0	3.20	7.68		
	12.0 - 13.0	1.0	1.60	3.84		
	13.0 - 14.0	1.0	5.40	12.96		
	14.0 - 14.90	0.90	0.80	1.92		
PBRR-15	21.0 - 22.0	1.0	0.60	1.44	2 m @ 5.3% chromite	
	22.0 - 23.0	1.0	3.80	9.12		
PBRR-16	10.0 - 11.0	1.0	0.40	0.96		
	11.0 - 12.0	1.0	0.60	1.44		
	12.0 - 13.0	1.0	0.80	1.92		
	13.0 - 14.0	1.0	0.60	1.44		

Table 2. ASSAY DATA (RECOVERABLE CHROMITE 18 - 600 μm), BEACONSFIELD (RIFLE RANGE) CHROMITE DRILLING

Hole	Depth (m)	Width (m)	Cr (mass %)	Chromite (mass %)	Bulking	
					4 mass % chromite cut off	6.5 mass % chromite cut off
SOUTH RIFLE RANGE PROSPECT						
PBRR-7	8.0 - 10.0	2.0	3.16	7.58	2.25 m @ 9.30% chromite	2.25 m @ 9.30% chromite
	10.0 - 10.25	0.25	9.60	23.04		
PBRR-8	11.0 - 14.0	3.0	2.08	5.00	3 m @ 5.0% chromite	
PBRR-9	9.80 - 10.0	0.20	7.20	17.28	2.95 m @ 13.5% chromite	2.20 m @ 16.70% chromite
	10.0 - 12.0	2.0	6.95	16.68		
	12.0 - 12.75	0.75	1.60	3.84		
PBRR-10	14.5 - 15.0	0.50	1.46	3.50	2.50 m @ 3.4% chromite	
	15.0 - 17.0	2.0	1.38	3.31		
PBRR-11	8.0 - 9.0	1.0	3.56	8.54	6.0 m @ 7.50% chromite	3.0 m @ 11.30% chromite
	9.0 - 10.0	1.0	6.35	15.24		
	10.0 - 11.0	1.0	4.22	10.13		
	11.0 - 12.0	1.0	1.20	2.88		
	12.0 - 13.0	1.0	1.70	4.08		
	13.0 - 14.0	1.0	1.70	4.08		
NORTH RIFLE RANGE PROSPECT						
PBRR-4	9.7 - 12.0	2.30	≈ 2.00	4.80	2.3 m @ 4.80% chromite	
PBRR-14	8.0 - 14.0	6.0	2.52	6.05	6.0 m @ 6.0% chromite	
PBRR-15	22.0 - 23.0	1.0	2.62	6.29	1.0 m @ 6.3% chromite	

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Table 3. PROBABLE TOTAL CHROMITE ORE RESERVES, SOUTH RIFLE RANGE PROSPECT

Percussion drill hole	Intersection data		Area of influence (m^2)	Volume of influence (m^3)	Density factor (t/m^3)	Tonnes
	Width (m)	Weighted chromite grade (mass %)				
4 mass % chromite cut off						
PBRR-7	2.25	10.70	11 197	25 193	1.88	47 363
PBRR-8	3.0	8.00	19 497	58 491	1.86	108 793
PBRR-9	2.95	16.30	16 334	48 185	1.93	92 997
PBRR-10	2.50	4.00	13 257	33 142	1.81	59 987
PBRR-11	6.00	9.60	10 754	64 524	1.87	120 660
					Total =	429 800

The total probable ore reserve, weighting grades by block tonneages is 429 800t @10.00 mass % chromite

6.50 mass % chromite cut off						
PBRR-7	1.25	16.30	11 197	13 996	1.93	27 012
PBRR-8	2.00	9.10	19 497	38 994	1.86	72 529
PBRR-9	2.20	20.20	16 334	35 935	1.98	72 151
PBRR-11	3.00	15.60	10 754	32 262	1.92	61 943
					Total =	232 635

The total probable ore reserve, weighting grades by block tonneages is 232 635t @15.10 mass % chromite

Table 4. PROBABLE RECOVERABLE CHROMITE ORE RESERVES, SOUTH RIFLE RANGE PROSPECT

Percussion drill hole	Intersection data		Area of influence (m^2)	Volume of influence (m^2)	Density factor (t/m^3)	Tonnes
	Width (m)	Weighted chromite grade (mass %)				
4 mass % chromite cut off						
PBRR-7	2.25	9.30	11 197	25 193	1.87	47 111
PBRR-8	3.0	5.00	19 497	58 491	1.82	106 454
PBRR-9	2.95	13.50	16 334	48 185	1.91	92 033
PBRR-10	2.50	3.40	13 257	33 142	1.81	59 987
PBRR-11	6.0	7.50	10 754	64 524	1.85	119 369
					Total =	424 954

The probable recoverable ore reserve, weighting grades by block tonneages is:
424 954t @7.80 mass % chromite
364 967t @8.50 mass % chromite (excluding PBRR-10)

6.5 mass % chromite cut off						
PBRR-7	2.25	9.30	11 197	25 193	1.87	47 111
PBRR-9	2.20	16.70	16 334	35 935	1.94	69 714
PBRR-11	3.0	11.30	10 754	32 262	1.89	60 975
					Total =	177 800

The probable recoverable ore reserve, weighting grades by block tonneages is 177 800t @12.90 mass % chromite

Table 5. ESTIMATION OF RECOVERY GRADES FOR CHROMITE, SOUTH RIFLE RANGE PROSPECT, USING 4 MASS % CHROMITE CUT OFF

Ore reserve block	Recoverable tonneage	Chromite mineral content in respective ore reserve blocks (t)		Ratio $R/_T$ (%)
		Total (T)	Recoverable (R)	
PBRR-7	47 111	5 068	4 381	86
PBRR-8	106 454	8 703	5 323	61
PBRR-9	92 033	15 158	12 424	82
PBRR-10	59 987	2 400	2 039	85
PBRR-11	119 369	11 583	8 953	77

The average recovery grade (weighted by recoverable tonneages) of chromite in the South Rifle Range prospect is 76%

Table 6. CHROMITE ORE RESERVE SUMMARY, ANDERSONS CREEK AREA, BEACONSFIELD

Probable ore reserve category	Cut off grade (mass %)			Tonnes	Grade (mass %)			Comments
	Cr	Cr_2O_3	Chromite		Cr	Cr_2O_3	Chromite	
Barnes Hill mine (P.M.R.)								
Total	2.71	4.00	6.50	234 000	5.16	7.54	12.38	
18-600 µm	"	"	"	≈ 188 000	3.92	5.73	9.41	*
South Rifle Range prospect								
Total	1.67	2.44	4.00	430 000	4.17	6.09	10.00	
18-600 µm	"	"	"	425 000	3.25	4.75	7.80	incl.PBRR-10
" "	"	"	"	365 000	3.54	5.17	8.50	excl.PBRR-10
Total	2.71	4.00	6.50	233 000	6.29	9.19	15.10	excl.PBRR-10
18-600 µm	"	"	"	178 000	5.37	7.85	12.90	excl.PBRR-8, 10

P.M.R. - Pre mining reserve

* These data were not determined during the initial investigations of the Barnes Hill mine. The tonneages have been estimated from the average of the recoverable tonneages in the South Rifle Range prospect for both 4 and 6.5 mass % chromite cut off grades.

The grade of recoverable chromite has been estimated from the recovery data shown in Table 5.

APPENDIX I

Summary drill logs, Rifle Range prospects, Beaconsfield

Depth (m)	*Description*
PBRR-1	
0 - 22.8	Quartz/quartzite cobble-pebble-granule gravel and sand; humic acid precipitate (HAP) staining from 8-10 m, white/orange clay from 12-20 m; trace chromite over entire interval (Cg-2).
22.8 - 23.1	White kaolinitic clay, with < 2 vol % chromite (Tc-2).
23.1 - 24.0	Pale blue secondary silica platelets with nickeliferous salt coating (70 vol %), quartz sand (28 vol %) and chromite (2 vol %) (Tbp).
24.0 - 26.0	Olive and chrysoprase green serpentinite gradational to dark green glassy partly silicified serpentinite; minor cross fibre asbestos, and spinel 5 vol % (chromite > magnetite).
PBRR-2	
0 - 14.0	Quartz/quartzite cobble-pebble-granule gravel and sand; HAP staining from 4-7 m, pink and green coloured quartzite clasts from 10-14 m; trace of chromite over entire interval (Cg-2).
14.0 - 16.0	Orange kaolinitic clay, trace chromite (Cc).
16.0 - 18.0	White kaolinitic quartz/quartzite sand, (clay > 20 vol %), with trace chromite (Cs).
18.0 - 19.5	Orange kaolinitic clay (30 vol %) and cobble-pebble gravel composed predominantly of schistose clasts, trace chromite (Cg-1).
19.5 - 21.5	Grey and green/brown ? smectitic clay, with chromite ≈ 1 vol % (Tc-2).
21.5 - 25.0	Moderately weathered serpentinite and green "clay rock" (? possibly Tc-1) to 23 m, followed by slightly weathered green-brown serpentinite with minor slip fibre asbestos. Spinel < 5 vol %, with chromite ≈ ½ vol %.
PBRR-3	
0 - 2.9	Quartz/quartzite cobble-pebble-granule gravel and sand (Cg-2).
2.9 - 5.5	Orange kaolinitic clay (50 vol %), fine quartz sand (40 vol %) and minor quartzite gravel; trace chromite (Cc).
5.5 - 21.0	Quartzite cobble-pebble-granule gravel with white/red/brown kaolinitic clay; HAP staining from 7-9 m and trace chromite (Cg-1).
21.0 - 21.6	Organic brown clay (? smectitic), trace chromite (Tc-2).
21.6 - 22.5	Translucent secondary silica platelets, quartz sand and minor limonite fragments; chromite ≈ 2 vol % (Tbp).
22.5 - 24.0	Moderately weathered "metallic green" serpentinite, secondary silica platelets and minor bright green "clay rock" (? Tc-1), gradational into green-brown serpentinite with secondary silica veining. Spinel 2 vol %, chromite < 1 vol %.

Appendix I (Continued)

Depth (m)	*Description*
PBRR-4	
0 - 7.0	Quartz/quartzite boulder-cobble-pebble gravel and sand, with HAP staining from 3-7 m (Cg-2).
7.0 - 8.0	White kaolinitic clay and quartz sand, chromite 0.5 vol % (Tc-3).
8.0 - 9.0	Quartz/quartzite granule gravel and sand, chromite 1 vol % (Ts).
9.0 - 9.7	Brown ? smectitic clay, lignite and trace marcasite, chromite $\leq$ 2 vol % (Tc-1).
9.7 - 11.0	Quartz/quartzite pebble-granule gravel and sand, lignite/brown coal and chromite $\approx$ 5 vol % (Ts).
11.0 - 11.3	Grey clay (? smectitic) and minor quartz sand, chromite $\approx$ 1 vol % (Tc-2).
11.3 - 12.0	Quartz and magnesitic silica pebble-granule gravel and sand, with secondary silica platelets and marcasite cement, chromite $\approx$ 5 vol %, trace lignite (Tbp).
12.0 - 13.0	Pale green grey (? smectitic) clay, pale brown secondary silica platelets and massive fragments, chromite $\approx$ 1 vol % (Tc-1).
13.0 - 17.0	Turquoise green, slightly silicified serpentinite, with slip fibre asbestos; spinel $\leq$ 5 vol %, (magnetite > chromite).
PBRR-5	
0 - 14.0	Quartz/quartzite boulder-cobble-pebble-granule gravel and sand, HAP staining from 1-6 m, trace chromite (Cg-2).
14.0 - 19.0	Orange kaolinitic clay, quartz/quartzite sand, trace chromite (Cc).
19.0 - 23.0	Quartz/quartzite granule gravel and sand, minor orange and pale green clay (kaolinitic); trace chromite (Cs).
23.0 - 24.9	Quartzite cobble-pebble-granule gravel and white/pale green kaolinitic clay (matrix); 0.5 vol % chromite (Cg-1).
24.9 - 25.2	Brown ? smectitic clay, trace chromite (Tc-2).
25.2 - 27.0	Slightly weathered to fresh dark green serpentinite.
PBRR-6	
0 - 6.0	Quartz/quartzite boulder-cobble-pebble-granule gravel and sand, with minor pale brown (? HAP) clay; trace chromite (Cg-2).
6.0 - 9.0	Orange/red kaolinitic clay and fine quartz sand (Cc).
9.0 - 11.0	Quartz sand with minor tan clay, chromite $\leq$ 1 vol % (Cs).
11.0 - 13.0	Quartzite pebble-granule gravel and coarse sand, chromite 0.5 vol % (Cg-1).
13.0 - 14.0	Orange coloured medium-coarse quartz sand, chromite 0.5 vol % (Ts).
14.0 - 15.0	Bright green and khaki brown clay (? smectitic), with chromite $\leq$ 0.5 vol % (Tc-1).
15.0 - 17.0	Slightly weathered chloritic serpentinite, probably derived from pyroxenite from 16-17 m.

Appendix I (Continued)

Depth (m)	*Description*
PBRR-7	
0 - 7.0	Quartz/quartzite cobble-pebble-granule gravel and sand, with < 25 vol % kaolinitic clay, minor HAP staining from 2-5 m, trace of coarse chromite (< 100 µm) (Cg-2).
7.0 - 7.5	Pale brown ? smectitic clay, trace chromite (Tc-2).
7.5 - 8.0	Quartz sand, trace chromite (Ts).
8.0 - 8.6	Organic brown ? smectitic clay, minor lignite 5 vol % chromite (Tc-2).
8.6 - 9.0	Fine quartz sand, ≤ 5 vol % chromite, ± lignite (Ts).
9.0 - 9.6	Pale brown ? smectitic clay, ≈ 15 vol % chromite (100 µm - 0.5 mm) (Tc-2).
9.6 - 10.25	Pale blue, green, brown and black secondary silica platelets < 10 mm in size, 20 vol % chromite, (100 µm - 0.5 mm), trace marcasite (Tbp).
10.25 - 11.7	Moderately to highly weathered serpentinite, with black obsidian like secondary silica forming cellular boxworks.
PBRR-8	
0 - 3.0	Quartz/quartzite cobble-pebble-granule gravel and sand, minor HAP staining from 2-3 m, trace - 0.5 vol % of chromite (Cg-2).
3.0 - 5.0	White kaolinitic clay, minor quartz sand, trace chromite (Cc).
5.0 - 12.0	Quartz/quartzite sand with lignite from 7-10 m, and pale brown ? smectitic clay from 10-12 m, probably indicating a transition to the underlying unit. Chromite increases from trace to ≈ 5 vol % from 11-12 m (Ts).
12.0 - 13.0	Medium brown ? smectitic clay, minor lignite (?UHC), and pale brown to translucent secondary silica platelets; chromite ≈ 10 vol %, (100 µm - 0.5 mm) (Tc-2).
13.0 - 14.0	Translucent/blue/green/brown secondary silica platelets, partly magnesitic, brown ? smectitic clay (< 25 vol %), traces of marcasite, chromite ≈ 5 vol % (100 µm - 0.5 mm) (Tbp).
14.0 - 16.0	Moderately weathered serpentinite.
PBRR-9	
0 - 5.0	Quartz/quartzite sand and silt which is HAP stained from 2-4 m, coarse (0.5 - 1 mm) chromite ≤ 0.5 vol % (Cs).
5.0 - 8.0	Quartzite/quartz boulder-cobble-pebble gravel and sand, minor kaolinitic clay, HAP staining, trace chromite (Cg-1).
8.0 - 9.8	Quartz limonite sand, well rounded and sorted, chromite 0.5 vol % (100 µm - 0.5 mm) (Ts).
9.8 - 10.5	Pale brown and green ? smectitic clay, chromite < 30 vol % (Tc-2).
10.5 - 11.9	Green/pale blue/glassy and brown obsidian like secondary silica platelets (< 10 mm), chromite 5 - 30 vol % (100 µm - 1 mm) (Tbp).

Appendix I (Continued)

Depth (m)	*Description*
PBRR-9 (Continued)	
11.9 - 12.75	Green clay with Mn staining, minor quartz sand and granule gravel, chromite ≃ 5 vol % (Tc-1).
12.75 - 13.0	Moderately to highly weathered serpentinite.
PBRR-10	
0 - 2.0	Quartz/quartzite cobble-pebble-granule gravel and sand (Cg-2).
2.0 - 7.0	White/orange kaolinitic clay and very fine quartz sand, with trace chromite (Cc).
7.0 - 14.5	Quartzite sand, organic brown (? lignitic) staining 7-11 m, lignite from 12 - 13 m, proportion of Oct quartzite increases down the interval; trace chromite (Ts).
14.5 - 17.0	Translucent/pale blue/magnesitic secondary silica platelets, (< 10 mm) minor brown ? smectitic clay, ≃ 5 vol % chromite; (100 μm - 1 mm) (Tbp).
17.0 - 18.0	Moderately to highly weathered serpentinite, with brown glassy secondary silica veinlets and boxworks.
PBRR-11	
0 - 2.0	Quartz/quartzite cobble-pebble gravel and sand, with minor ferruginous cement binding the fine sand; trace chromite (Cg-2).
2.0 - 8.0	Quartz/quartzite sand and silt with white kaolinitic clay increasing down the interval, chromite 0.5 - 1 vol %, (100 μm - 0.5 mm) (Ts).
8.0 - 10.8	White/brown/green/grey clay (? kaolinitic), with disseminated chromite ≥ 15 vol %, increasing from < 100 μm to ≤ 1 mm down the interval (Tc-2).
10.8 - 12.8	Secondary silica platelets, box works and massive fragments, with subordinate limonite fragments; chromite ≤ 5 vol % (Tbp).
12.8 - 14.0	Bright green "clay rock", chromite ≤ 5 vol % (Tc-1).
14.0 - 15.0	Moderately weathered serpentinite, with minor silicification.
PBRR-12	
0 - 2.5	Quartz granule gravel and sand, trace chromite (Cg-2).
2.5 - 5.0	Orange kaolinitic clay (Cc).
5.0 - 23.0	Quartzite/quartz cobble-pebble-granule gravel and sand, with white/yellow/organic brown kaolinitic clay (< 30 vol %); heavy minerals include rutile, zircon, garnet, magnetite, and chromite, (all in trace amounts) (Cg-1).
23.0 - 28.5	White kaolinitic clay and quartz sand (25 vol %) (Tc-3).
28.5 - 30.0	Brown to khaki ? smectitic clay, chromite ≃ 2 vol % (Tc-2).
30.0 - 31.0	Slightly to moderately weathered serpentinite.

Appendix I (Continued)

Depth (m)	*Description*
PBRR-13	
0 - 7.0	Quartz/quartzite boulder-cobble-pebble-granule gravel and sand, minor kaolinitic clay, HAP staining 2 - 3 m (Cg-2).
7.0 - 9.0	Quartz/quartzite sand, minor kaolinitic clay, trace chromite (Ts).
9.0 - 12.5	Grey sericitic clay (? kaolinitic) and medium to fine quartz sand; from 11 - 12 m, alternate white and black (? organic) clays occur in fine laminations apparently representing bedding (Tc-2).
12.5 - 14.0	Quartzite (silicified sandstone), sericite schist and vein quartz fragments - representing slightly weathered Cabbage Tree Formation (Oct.).
PBRR-14	
0 - 8.0	Quartz/quartzite cobble-pebble-granule gravel and sand, with HAP staining from 2 - 8 m; trace chromite (Cg-2).
8.0 - 9.0	Medium brown ? smectitic clay subordinate quartz sand and minor lignite/brown coal, chromite ≈ 2 vol % (Tc-2).
9.0 - 10.0	Quartz/quartzite sand, brown clay, lignite/brown coal, and chromite > 5 vol % (Ts).
10.0 - 11.0	Medium brown ? smectitic clay, chromite ≈ 2 vol % (Tc-2).
11.0 - 12.0	Grey micaceous quartzite and white-vein quartz granule gravel and sand, chromite > 5 vol % (Ts).
12.0 - 13.0	Grey/brown ? smectitic clay, minor quartz sand and chromite ≈ 2 vol % (Tc-2).
13.0 - 14.0	Secondary silica platelets and grey massive fragments in part magnesitic, minor brown ? smectitic clay, chromite > 10 vol % and traces of emerald green clay (derived from Tc-1) (Tbp-2).
14.0 - 14.9	Ferruginous secondary silica platelets, with minor pale brown clay and chromite ≈ 2 vol % (Tbp-1).
14.9 - 15.0	Highly weathered serpentinite, including ferruginous silicified material ex serpentinite.
PBRR-15	
0 - 10.0	Quartz/quartzite cobble-pebble-granule gravel and sand, HAP staining from 6.5 - 9 m (Cg-2).
10.0 - 11.0	White kaolinitic clay, minor quartz sand (Cc).
11.0 - 17.0	Pale pink/green quartzite and white vein quartz pebble gravel, minor kaolinitic clay (Cg-1).
17.0 - 21.9	White kaolinitic clay, accessory quartzite granule gravel and sand, trace chromite (Tc-3).
21.9 - 22.2	Grey ? kaolinitic clay, and chromite 2 vol % (Tc-2).
22.2 - 23.0	Pale-emerald green/yellow/grey clay, minor hematite/ limonite, secondary silica platelets, quartz sand, and chromite > 5 vol % (Tc-1).
23.0 - 25.5	Grey/green/blue highly weathered serpentinite, with some minor slip fibre asbestos, trace marcasite.

Appendix I (Continued)

Depth (m)	*Description*
PBRR-16	
0 - 3.0	Quartz/quartzite cobble-pebble-granule gravel and sand, minor HAP staining, trace chromite (Cg-2).
3.0 - 4.0	Orange kaolinitic clay, trace chromite (Cc).
4.0 - 11.0	Quartzite cobble-pebble-granule gravel with white to pale brown kaolinitic clay, trace - 1 vol % chromite (Cg-1).
11.0 - 13.9	Cream/dun brown/orange clay (? kaolinite and illite), subordinate quartz sand, chromite ≈ 2 vol % (Tc-2).
13.9 - 16.5	Grey-pale brown clay (XRD : kaolinite > montmorillonite > illite), with white quartz/dark grey chert sand; interpreted as highly weathered argillaceous siltstone and pebble conglomerate (Oct).
16.5 - 17.0	Pale brown clay (XRD : montmorillonite > illite > kaolinite) with white quartz/grey chert pebble-granule gravel, chloritised ultramafic, and pale green amphibole-chlorite schist; interpreted as remobilised transition zone beds originally at the base of the Cabbage Tree Formation (Oct).
17.0 - 21.0	Pale brown to cream clay (XRD : montmorillonite > illite), pale brown quartzite "sand", encrusted with spherical concentric zoned secondary silica particles and dark grey chert fragments; the quartzite becomes grey/black in colour from 19 m, while the chert fragments contain pyrite; interpreted as moderately to highly weathered argillaceous siltstone, sandstone and pebble conglomerate (Oct).
21.0 - 21.9	Poorly consolidated sandstone, composed of spherical concentric silica grains (? siliceous sinter); (XRD : quartz); it has polygonal cavities 5 mm across, some of which contain relict pyrite, or hematite pseudomorphs, and a sulphurous residue; interpreted as a fault channel in Oct.
21.9 - 23.1	Lateritized sandstone and pebble conglomerate, including the ? siliceous sinter material, gradational to fresh grey/black quartzite with minor chert pebbles containing pyrite. Interpreted as Oct, with base of oxidation at ≈ 23.0 m.

5 cm

20/20

NORTH AND SOUTH RIFLE RANGE PROSPECTS - BEACONSFIELD

T. G. Summons. 1979.

0 50 100 150 200 m.

CAINOZOIC

QUATERNARY

- Qs — Sand derived from Cainozoic conglomerate (Cg).
- Qp — Boulder – cobble – gravel derived from Permian strata.
- Cg — Boulder – cobble – pebble conglomerate (undifferentiated into the older and younger members)

TERTIARY

- Tbp — Beach / channel bar placer, consisting of secondary silica platelet sand / gravel, heavy minerals (predominantly chromite), and quartz sand
- Tfl — Ferruginous laterite (rock enriched in limonite etc.) 'OLDER LATERITE'
- Tsl — Siliceous laterite (serpentinite replaced by skeletal and cellular textured secondary silica).

ORDOVICIAN

- Oct — Cabbage Tree Formation – quartz sandstone with chert and quartz conglomerate.

CAMBRAIN

- €p — Pyroxenite.
- €s — Serpentinite derived from either pyroxenite or peridotite.
- €s (Hw) — Highly weathered serpentinite occuring immediately beneath Tsl.
- €sl — Slate and greywacke.
- Qs/€s — Quaternary sand overlying Cambrian serpentinite.
- Qs/€s/€p — Quaternary sand overlying either Cambrian serpentinite or pyroxenite.
- Cg/Oct — Cainozoic conglomerate indirectly overlying Ordovicain Cabbage Tree Formation.
- Cg/€s — Cainozoic conglomerate indirectly overlying Cambrian serpentinite

Geological boundary – position accurate (surveyed boundary of conglomerate).

Geological boundary – position approximate.

Geological boundary – position inferred.

Photo lineament

94 — Seismic refraction traverse, with R.L. in (m)

PBRR7 (108) — Percussion drill hole collar (all holes vertical) with R.L. (m) shown in brackets.

Contours on the reminant early Tertiary? marine depositional surface (equivalent to the eroded Older laterite surface). Contour interval 2m South Prospect) and 1m (North Prospect).

Ore reserve polygonal block boundary (4% chromite cut off).

63.36 — Chromite factor (intersection width X chromite %) using 4% chromite cutoff.

5 cm

UR1980_02