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THE ANDERSONS CREEK CHROMITE PROJECT, NEAR BEACONSFIELD, TASMANIA. EXPLORATION LICENCE NO. 17/85.

FINAL REPORT

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1. SUMMARY

Exploration Licence 17/85 was granted to AUSTAMAX Operations Pty Ltd on 20th August 1985 with a committment to spend not less than $41,000 on investigations in the first two years. The Licence was renewable annually subject to satisfactory work performance. Pro-rata work and expenditure for the first year of tenure has been exceeded but after discouraging results the Company applied for relinquishment of the Licence as from 20th August 1986.

The objectives of the first years investigations were:-

(i) To review and evaluate all available data on previous exploration and mining of secondary (reworked) chromite deposits in the area.

(ii) To determine through new field observations, the true nature of deposition of the secondary chromite deposits in order to critically evaluate existing data and to plan an appropriate testing programme should such further testing be warranted.

(iii) To examine the chromite marketing scene to determine whether a ready market existed for the entire chromite product. The previous operator had aimed to produce only foundry sand with strict size specifications (- 40 + 140 B.S. mesh). This precluded more than 50% of total available chromite which was either discarded with tailings or stockpiled and later dispersed.

Briefly, investigations over the twelve month period have led to the following conclusions:-

(i) Previous testing tended to overestimate the mineable reserves of secondary chromite at Barnes Hill and in the Rifle Range area primarily because all Cr reported in analyses was attributed to chromite when, in fact, much of the Cr, particularly in lateritic clay matrix deposits, is associated with limonite and clay minerals. Such non-chromite Cr has been derived from primary and secondary chromite by acid leaching during prolonged weathering and is now fixed in limonite and clay minerals.

(ii) In the Rifle Range area, the reliance on percussion drilling for both quantitative and qualitative data, combined with the non-chromite Cr problem, seriously undermines confidence in the estimated secondary chromite reserves there.

(iii) Observations in the mined areas at Barnes Hill indicate that the secondary chromite concentrations are not planar sedimentary deposits in the normally accepted sense and that lateral extrapolation using shoreline or other conventional stratigraphic models is not justifiable. This applies particularly to the Rifle Range area.

(iv) The deposits are now interpreted as residual

chromite concentrations formed by the chemical and hydraulic flushing of limonite from the upper part of a pre-Tertiary ultramafic laterite profile. The active agent in this process is acid groundwater percolating through Tertiary quartz gravels with peaty interbeds. The leaching and flushing action of acid groundwater on ultramafic laterite proceeds rapidly only after the groundwater table falls below the quartz gravel/ultramafic laterite contact. Barnes Hill where a small quartz gravel cap overlies ultramafic laterite in a simple mesa-like prominence provides an ideal situation for the envisaged leaching and flushing process.

(v) The high grade residual concentrations of chromite and silica platelets at Barnes Hill accumulated in a system of solution channels in the laterite immediately below the gravel and in narrow steep-sided, spring-fed gutters in laterite on the flanks of the hill below the surface trace of the gravel/laterite contact. The complexity and irregularity of such deposits precludes rational lateral extrapolation of data from drilling or pitting for ore reserve estimation and would inhibit selective mining of the high grade chromite concentrations. The chaotic distribution of the high grade chromite concentrations was a significant factor in the demise of the operations of Northern Chromite Ltd.

(vi) Chromite from the Andersons Creek deposits could not compete in the international metallurgical chromite market because reserves are too small to warrant local reduction to ferrochrome which is a necessary requirement to reduce overseas freight costs.

(vii) The Andersons Creek chromite is both physically and chemically unsuitable as refractory chromite other than foundry sand for which Australian demand is small and shrinking. The strict size specifications for foundry sand are such that at least half the chromite from the Andersons Creek deposits would not qualify.

(ix) Interest has been shown in high quality chromite ($Cr_2O_3 > 60\%$, $SiO_2 < 1\%$) by chrome chemical manufacturers in Japan and the U.S.A. This presumably would be used for blending and upgrading of lower quality chrome ore from other sources. However, despite the high Cr_2O_3 and low SiO_2 contents of samples and small parcels of foundry sand chromite produced by the previous operator, it is most unlikely that this quality of product could be maintained in any large scale operation. The previous operator selectively mined small pockets of high grade chromite sand which had been residually enriched in Cr_2O_3 by the partial leaching of alumina and iron from some of the chromite by acid groundwater. Any larger scale operation would necessarily have to include lower grade clay matrix chromite bearing material in which the chromite has not been enriched by groundwater leaching. All chrome chemicals used in Australia are currently imported, mostly from U.S.A. If a chrome chemical plant were to be built in Australia then the higher quality chromite from the Andersons Creek deposits could probably be used at the rate of a few thousand tonnes a year to blend with other readily accessible but lower quality Australian chromite. However, at this time, there are no known plans to establish a chrome chemical plant in Australia. This aspect may be worthy of further investigation for later exploitation of the small quantity of near-surface high quality chromite left at Barnes Hill.

(x) Having regard to the low size potential, erratic distribution, and the lack of a local market for chemical grade chromite, the prospect does not appear to warrant further investigation and accordingly surrender of the Exploration Licence was recommended.

2. LOCATION

The Exploration Licence covers approximately 40 square kilometres in an area about 2km wide (E-W) at its northern end, 11km long (N-S) and five kilometres wide at its southern end.

It includes the head of the West Arm estuary of the Tamar River, the valley of Andersons Creek and the hills to the east between Anderson's Creek and the adjacent drainage, Middle Arm Creek, which flows into the Middle Arm estuary of the Tamar River.

The principal prospects are in the hills between these two drainages many of which are capped by Tertiary quartzose gravel which is quarried sporadically for road surfacing material.

The centre of the area is approximately 3.5 kilometres west of Beaconsfield which is a significant former gold mining town close to the western shore of the Tamar Estuary.

3. <u>TENURE</u>

AUSTAMAX Operations Pty Ltd applied for an Exploration Licence over an area of approximately 40 square kilometres on 19th December 1984. The application area was designed to include all known outcrops of Cambrian ultramafic rocks in the Andersons Creek region and those areas where ultramafic rocks may be covered by Tertiary quartz gravels. The Exploration Licence was granted on 20th August 1985 for two years, exclusive of three pre-existing Mineral Leases totalling 63 hectares and an area of 26 hectares under application by the Beaconsfield Shire Council for a Stone Lease. This latter application covered existing quartz gravel quarries in the Rifle Range area which adjoin and overlap areas where Mines Department drilling (1979-81) had indicated chromite-bearing sand and lateritic clay. The Stone Lease application was subsequently granted but assurance was received from the Beaconsfield Shire Council that chromite exploration could be conducted on the Stone Lease and, should this prove encouraging, they would then grant permission to mine chromite bearing materials but retain the right to the overlying gravels.

Permission was obtained from landowners and the Department of Forestry for access to properties for the exploration purposes. Special arrangements were made with Mr. M. Tattersal, the lessee of the property containing Barnes Hill which had been stripped by previous surface mining.

4. OBJECTIVES

Past reports and production records indicate that chromite of exceptionally high quality ($Cr_2O_3 > 60\%$, $SiO_2 < 2\%$) had been produced from the Barnes Hill deposits. It was not clear from such reports whether the high quality of the produced chromite was attributable to selective sampling, selective mining and/or benefication or whether it was an inherent characteristic of all chromite derived from the Cambrian ultramafic rocks of the Andersons Creek area. If the latter was the case then potential could have existed for a resource of high quality chromite which might attract a sufficiently high price to offset freight costs to chrome chemical manufacturers in U.S.A. and Japan. All chrome chemicals are currently imported into Australia and there are no known plans to establish a domestic chrome chemical plant.

Before proceeding with costeaning and drilling, which would have disturbed reclamation measures already in place at Barnes Hill and in the Rifle Range area, reports of previous investigations were critically reviewed. It was inferred from these reports that a total resource of about 80,000 tonnes of recoverable chromite may be present in three separate deposits (Barnes Hill, Rifle Range South and Rifle Range North). This estimate was based mainly on Mines Department drilling at Rifle Range (North and South) and previous pitting and costeaning by various companies at Barnes Hill.

Several questionable assumptions and some significant omissions in the information used in this rough resource appraisal seriously downgrade the reliability of the estimate and imply a significant overstatement of the size of the resource.

Factors of particular concern in this regard are:

(1) The dubious conclusion that the high grade chromite sand concentrations were planar heavy mineral shoreline deposits with the implication that grade and "stratigraphy" could be interpolated and correlated laterally between control points (drill intersections and pit sections).

(2) The invalid assumption that assayed Cr was wholly attributable to chromite .

(3) The inherent unreliability of percussion drilling sludge samples, particularly for resistate minerals (chromite) in a clay (laterite) matrix, for grade and stratigraphic correlation purposes.

(4) The questionable assignment of subtle lithological boundaries in unconsolidated sediments and residual clays from percussion drilling sludge samples.

(5) No accounting for contained moisture in clays (probably up to 40% by weight) in volume to tonnage conversions and no clear indication as to whether grades, cut-off grades, volumes and tonnages relate to wet or dry "ore".

(6) No allowance was made (in grade estimation) for the difference in average chromite composition in the high grade chromite sand concentrations (Cr_2O_3 in the 55-62% range) and average chromite composition in the lower grade clay matrix material (Cr_2O_3 in the 42-48% range). The conclusion based on microprobe studies on primary chromite in various unweathered ultramafic rocks that all chromite in the secondary deposits (sand and lateritic clay) was of the high Cr_2O_3 variety could not be supported by metallurgical examination of secondary chromite recovered from various types of chromite-rich sediments and clays.

To gain further information on the problem areas indicated above, exposures around the partially mined flanks of Barnes Hill were carefully examined and different facies of chromite-bearing materials were sampled and submitted for metallurgical investigation by the Department of Mines Metallurgical Research Laboratory in Launceston. The main purpose of these investigations was to establish the compositional characteristics of chromite assemblages in both the sandy and clayey components of that part of the profile beneath the Tertiary gravels and above fresh ultramafic chromite source rocks which might be amenable to open-pit bulk mining.

Several tonnes of chromite sand were taken from a dump of chromite foundry sand product left by the previous operators. This was further up-graded by washing and separating into a coarse (-20 +100 BSS mesh) and fine (-100 BSS mesh) fraction using Sweco vibrating screens. These products were then cleaned on a Wilfley table and analysed by the Launceston Metallurgical Laboratory. The purpose of this work was to gain information on the average chromite composition and to provide a clean chromite product to support initial marketing investigations. For this latter purpose this sample had major shortcomings because its original locality and extent of benefication were not known and there were doubts as to whether the same degree of benefication could be achieved at a larger operating scale.

Because of early indications that some chromium was being leached and redeposited within the weathering profile, John Miedecke and Partners Pty Ltd were engaged to sample and analyse water, sediments and biota from a number of localities within and adjacent to the Exploration Licence boundaries to establish background levels for any elements which could be considered environmentally harmful. Their report is appended.

5. HISTORY

First reference to chromium in the area was in the 1870's as a deleterious component in the local lateritic iron deposits which made them unsuitable for steel making.

A Government investigation of the lateritic iron deposits in 1929 which included drilling also concluded that they were not exploitable for iron ore because of high chromium content (Nye, 1930). The average Cr_2O_3 content of drill core from lateritic iron ore from three localities was approximately 6.0%.

Exploration for nickel-bearing laterites in the Andersons Creek area seems to have been commenced in 1956 by the Ben Lomond Mining Company who were later joined by Enterprise Exploration Ltd (C.R.A). These companies noted the presence of chromite sand concentrations at Barnes Hill but were more interested in the nickeliferous laterite potential. They withdrew from the area in 1961 concluding that the nickel laterite potential was unattractive.

In 1958, Green (Green D.H., 1959) noted chromite sand deposits on the flanks of the hill now known as Barnes Hill. He considered these to be Quaternary raised beach deposits.

The first investigation specifically directed to secondary chromite deposits in the Andersons Creek area was by the Department of Mines in 1961-62. This included extensive sampling by pitting, costeaning and shallow drilling. Most of this work was done around the quartz gravel capped mesa now known as Barnes Hill. In a report on this investigation Noldart (1962) referred to the Barnes Hill Deposit as a small gravel capped hill south-west of the laterite capped Barnes Hill. This larger laterite capped hill has subsequently been called Tattersalls Hill and the smaller hill from which chromite was later mined became known as Barnes Hill. The results of this investigation were recorded by J.H. Noldart (1962) who concluded that the Barnes Hill Deposit contained about 7500 tons of chromite concentrate and that a further 6000 tons occur in four small deposits in the valley of Limestone Creek to the east and north-east of the Barnes Hill Deposit. He also drew attention to the possibility of additional chromite concentrations beneath Tertiary quartzose gravels in the Rifle Range area north-east of Barnes Hill (≡ Tattersalls Hill) and at Simmonds Hill and Leonardsburg.

Noldart's description of the distribution of chromite concentrations in the Barnes Hill Deposit is worth recording here because much of the original surface was subsequently removed by mining. He described the deposits thus:-

"The chromiferous concentrations occur immediately above the (lateritic) clay surface and extend upward into the lower gravel beds. Their thickness is not constant but ranges from zero to a maximum of 4.5 ft. Mineral concentration has been controlled to a large extent by the pre-existing surface contours of the clays ..... Local rolls, gutters, hollows, etc in the clay surface have caused local concentrations and heavy enrichments in small pockets resulting in extreme variations in thickness and grade".

This description is consistent with recent observations on remnants of the deposit now exposed on the partly reclaimed flanks of Barnes Hill. The description does not fit that of a palaeoshoreline deposit as previously proposed by Green (1959) and perpetuated later by Simmons et al (1981).

Throughout the 1960's the ultramafic laterite areas were extensively prospected for nickel, firstly by the Broken Hill Pty Ltd and then by King Island Scheelite Ltd (Geopeko), with disappointing results. Routine assays for chromium during this phase of exploration confirmed chromium values up to several percent in most of the ferricreted laterite but in this association the chromium had no commercial significance.

The first commercial interest in chromite in the area was in 1969 by a local syndicate who acquired title over the chromite sand concentrations on the flanks of Barnes Hill which had been delineated by the Department of Mines (Noldart, 1962). This syndicate subsequently became (or sold out to) Northern Chromite Pty Ltd who during the period 1971 to 1977 received considerable technical and financial assistance from the Tasmanian Government. Production of chromite concentrate commenced at a low level in 1977.

By 1978 chromite sand and mould wash was being produced for use in Australian foundries. Production ceased in 1981 when the easily won chromite sand concentrations on the flanks of Barnes Hill had been mined out. The plant was unable to treat clay matrix ore, regardless of grade, and the company was obliged to selectively mine and treat the high grade chromite sand which was concentrated on the irregular, furrowed old lateritic clay surface. This ultimately led to insurmountable mining and treatment problems.

In mid-1978, Northern Chromite Ltd became a subsidiary of Amalgamated Metal Corporation (AMALGAMET) who later in the same year were acquired by Pruessag Ltd. During 1979 and 1980, AMALGAMET endeavoured unsuccessfully to extend the reserves of chromite sand at Barnes Hill.

In response to representations by AMALGAMET (Pruessag) the Department of Mines undertook a percussion drilling programme in the Rifle Range area to the north-east of Barnes Hill where Tertiary quartzose gravels overlie ultramafic laterite. AMALGAMET hoped to exploit both the near-surface quartz gravels and any underlying chromite sand. This drilling programme commenced in August 1978 and by December 1979 15 percussion drill holes had been completed and a chromite resource similar in tonnage but higher in grade than the pre-mining reserve at Barnes Hill was reported to have been indicated (Summons et al, 1980).

Infill drilling in 1980/81 comprising eleven percussion drill holes significantly reduced the indicated chromite resource. A review of this work by Castleden (1981) questioned the application of total Cr analyses in the calculation of recoverable chromite resource estimates. Attention had also been drawn to this previously by H. Wellington, Chief Metallurgist of the Department of Mines Launceston laboratory. Specifically, no acknowledgement was made for considerable acid-soluble (hot Hcl) Cr associated with lateritic limonite and clay minerals and for the Cr in very fine chromite which could not be recovered.

Costeaning and bulk sampling by AMALGAMET in 1980 and 1981 to check high grade chromite intersections in the South Rifle Range area revealed only chromite-rich clay and none of the preferred sand facies chromite. When processed, chromite bearing clay from this test yielded chromite with a much lower Cr_2O_3 content than that produced from the chromite sand mined from Barnes Hill. The average Cr_2O_3 content of chromite recovered from the South Rifle Range bulk sample was under the specified limits for foundry sand. Shortly after this test run the Barnes Hill mine and plant closed down and AMALGAMET relinquished all interests in the area.

There is no record of any further interest in the chromite potential of the area after the closure of the Barnes Hill mine though the area was included in subsequent Exploration Licences taken out primarily for gold.

6. REGIONAL GEOLOGY

The chromite deposits at Barnes Hill and in the Rifle Range area (Photos 1 & 2), are residual and alluvial concentrations derived from peridotitic portions of a fault-bounded segment of mafic and ultramafic rocks to which a Cambrian age of emplacement has been tentatively assigned. (Gee and Legge,1974).

This mafic-ultramafic Complex occupies an elongate, north-north-westerly aligned zone exposed discontinuously within an area about 5km long and 1.5km wide which corresponds approximately to the lower half of the valley of Andersons Creek.

The Complex comprises about 70% peridotite (harzburgite, dunite and pyroxenite) about 20% basic feldspathic rocks (gabbro, anorthosite and albitite) and 10% rafted segments of rodingite and dynamically metamorphosed sediments. These latter rocks are probably melange erratics within a thrust zone marginal to the mafic-ultramafic Complex.

Crude mineral and rock facies layering suggests regional transition from gabbroic facies along the western margin through pyroxenite and harzburgite to dunite along the eastern flank which implies a westerly dipping sequence of gabbro over pyroxenite/harzburgite over dunite. However, in detail, the outcrop pattern is confused by structural and topographic relief.

To the north and south, unconformable Permian and Tertiary sediments limit the outcrop of the mafic-ultramafic Complex, whereas on the east, faulted contact with steeply dipping Ordovician fine sandstone and shale (Cabbage Tree Formation) can be inferred from sporadic outcrops and some drill intersections in the Rifle Range area.

The western boundary of the Complex is almost certainly a major fault as inferred from intensely dynamically metamorphosed sediments and ultramafics. It is presumed to have been a thrust fault along which the mafic-ultramafic block has been thrust against and probably over the thick sequence of clastic sediments which forms the Dazzler and Asbestos Ranges. Away from the contact zone with the mafic-ultramafic Complex these sediments, which have turbidite affinity, have been tightly folded but only feebly metamorphosed. They were presumed by Gee and Legge (1974) to be of Precambrian age. However they may well be Palaeozoic trough sediments which have slumped and responded incompetently to thrusting of the mafic-ultramafic Complex from the east to produce a complexly folded and faulted imbricate package which from the aspect of its structural complexity alone was assigned to the Precambrian. If this is the case then emplacement of the mafic-ultramafic Complex may well have been an early Palaeozoic event. However, as this matter has no relevance to the occurrence of the secondary chromite deposits in the area it will not be pursued further.

7. LOCAL GEOLOGY AND SECONDARY CHROMITE OCCURRRENCES

Under this heading only the geology and geomorphic processes relating to the genesis and concentration of secondary chromite deposits will be discussed.

The primary source rocks for the various types of secondary chromite deposits in the area are the peridotites, mainly harzburgite and dunite, of the mafic-ultramafic Complex. Chromite is generally randomly disseminated as a euhedral accessory mineral throughout the peridotite, generally within the volume range of 0.2 to 0.5% (Photo 3). Most of the peridotite has been passively serpentinised without any drastic modification of the disseminated chromite. Locally, some serpentinised peridotite has been intensely sheared either by regional faulting or by minor movements to accommodate volume changes resulting from serpentinisation. In these serpentinised and sheared ultramafic rocks some chromite has been reduced to fine powder and smeared (together with magnetite) along shear planes. No massive lode chromite was seen in the area and none has been reliably recorded. A few small boulders containing primary concentrations of about 60% euhedral chromite in small sub-parallel lenticular segregations were found on the northern slope of Barnes Hill (Photo 4). At hand specimen scale these boulders might be compared with specimens of chromitite from a rhythmically differentiated mafic sill but this analogy cannot be extended beyond the hand specimen scale. However, the presence of a few chromite-rich serpentinite boulders at Barnes Hill does introduce the possibility that a higher than average concentration of primary chromite may have been a factor contributing to the unusually high concentration of secondary chromite at Barnes Hill.

Peridotites weather to ferruginous laterite very readily with vertical and lateral redistribution of the principal component elements magnesium, silica and iron. In regions of low to moderate relief, weathering releases magnesia and silica in solution. They migrate downwards in the profile and may be either deposited in the lower part of the profile as hydrous oxides and silicates or flushed from the profile and dispersed into surface waters. Iron released by the weathering of peridotite redeposits in the upper part of the weathering profile either as a finely porous and permeable plastic clay-like aggregation of hydrated iron oxides if the profile is perpetually wet under high rainfall/low evaporation conditions (e.g. rainforest) or as a welded ferricrete in arid or seasonally dry environments. The high-iron clay-like laterite can transform to ferricrete in response to changes in climate, evaporation rate or subsurface drainage. In normal ultramafic laterites the trace elements, nickel and cobalt segregate chemically and concentrate into specific zones in accordance with Eh/pH relationships.

Chromite is chemically resistant to normal lateritic weathering and concentrates residually in the upper iron-rich part of the profile consequent on the reduction in volume of the parent peridotite due to the removal of magnesia and silica during lateritisation. Clean chromite may be further concentrated residually on the eroding surface of non-ferricreted laterite by rainfall flushing of the lighter materials from the laterite surface. More vigorous erosion of soft laterite may lead to the concentration of clean chromite in gutters cut into the laterite profile and to the shedding of some clean chromite into the alluvial deposits of adjacent drainages.

Where ultramafic laterite has been "ferricreted", chromite becomes physically bonded into the erosion-resistant, welded, hydrated iron oxide mass. Such chromite which may be released from "ferricreted" laterite by erosion is usually too contaminated by coatings of hydrated iron oxides to be of economic interest.

It is important in the context of the secondary chromite deposits in the Andersons Creek area to recognise that eroding soft spongy clay-like laterite and saprolite is an ideal source of clean chromite grains whereas eroding ferricreted chromite is not.

All significant outcrops of ultramafic laterite in the Licence area which are not on the flanks of hills capped by Tertiary gravels have been "ferricreted" to varying degrees. In some places (e.g. Mt. Vulcan, Scots Hill, Tattersalls Hill) ferricrete is so well developed that attempts were made to mine it as iron ore in the 1880's, but the high Cr content made it unacceptable. In other places a thin ferricreted laterite profile overlies serpentinised peridotite with little or no intervening saprolite. These ferricreted laterites do not contribute any clean chromite to alluvial deposits though they do contain considerable chromium both as chromite and as Cr complexed with hydrated iron oxides which is not metallurgically recoverable.

On the flanks of Tertiary gravel-capped hills and in percussion drill intersections, costeans and pits through Tertiary gravels, sections of soft spongy ultramafic laterite and saprolite up to 20 metres thick have been recorded. Part of this profile is well exposed in erosion gutters on the flanks of Barnes Hill which were cleared for mining. It is also exposed in old costeans at the southern margin of the Rifle Range dissected plateau. This profile contains abundant clean euhedral chromite which is concentrating in run-off gutters in the present-day surface. The transition zones between laterite, saprolite and serpentinised peridotite can also be observed in exposures at Barnes Hill. The transition zone between saprolite and serpentinised peridotite is characterised by an intricate mesh of fragile secondary silica fracture fillings which are released as thin flakes and sheets as the saprolite erodes (Photos 5 & 6). These are the "silica plates" and "platelets" which invariably occur in the high grade chromite concentrations at Barnes Hill (Photos 7 & 8). The base of weathering at Barnes Hill is extremely irregular and large blocks of peridotite are frequently suspended in saprolite.

It is inferred from these observations, that the ultramafic laterite on which the Tertiary quartzose gravel was deposited was maturely developed, but not ferricreted, having an upper iron-rich finely porous and permeable zone over a soft saprolite zone which merged downwards through a bouldery, secondary silica-rich, transition zone into unweathered serpentinised peridotite. Within the iron-rich zone there was some concentration of chromite due to volume reduction of the parent rock and in the saprolite and transition zones the chromite content was about the same as in the parent rock, but secondary silica fracture fillings were abundant. The chromite throughout this profile is uncontaminated by iron oxide coatings. It is presumed that just before deposition of the Tertiary gravel, the laterite terrain had low relief and that erosion had truncated the laterite profile on the higher parts of the landscape. This erosion would have produced localised eluvial and colluvial concentrations of resistate minerals, mainly clean chromite, from the upper iron-rich zone and clean chromite plus secondary silica "platelets" from the saprolite zone and basal transition zone.

The original cause and extent of Tertiary gravel deposition is unknown but clast characteristics (size, angularity, composition, lack of sorting), total thickness (+ 30 metres) and wide lateral spread, as evidenced by remnant cappings, suggest a repetitive high energy transfer of erosional detritus off an emerging fault block on to adjacent lowlands. A possible scenario for this style of deposition could be spasmodic uplift of the (?) Precambrian metasediments comprising the fault-bounded Dazzler and Asbestos Ranges in isostatic response to previous thrusting from the east giving rise to an outward spread of piedmont fans over adjacent non-emergent terrain. In such a scheme, the Andersons Creek ultramafic Complex would have been immediately adjacent to the emerging and eroding fault block where thickest development of the gravel deposits would be expected. This style of tectonism and depositional response commonly occurs in contemporary obduction terranes around the Pacific margin.

The quarrying of Tertiary quartzose gravels in the Rifle Range area has exposed peaty interbeds and much black organic staining from ground water seepage draining peaty layers, particularly near the base of the gravelly sequence. On the north-eastern flank of Barnes Hill, stripping has exposed a basal peat bed about 0.5 metres thick (Photo 9). Because of near-total oxidation, these peaty interbeds are not recognisable in natural outcrops or old quarry faces. They are represented by recessive, crumbly, extremely porous siliceous siltstone and fine sandstone layers. The abundant vegetal matter, presumably swamp vegetation, interbedded in the gravelly sequence was a significant source of organic acids which, as erosion progressed and the water table was lowered severely, leached the underlying sediments, thereby residually upgrading their silica content, and reacted with the underlying ferruginous laterite by dissolution of iron oxides. As the upper layer of the laterite was virtually mono-mineralic hydrated iron oxide except for disseminated chromite, subsurface solution openings and channels were formed within which chromite and fine silica sand and silt which had been flushed through the overlying gravels was deposited. Under the special set of circumstances prevailing at Barnes Hill where, as erosion progressed, the water table dropped below the gravel/laterite interface, drainage through the permeable peaty gravel capping moved rapidly to the base of the gravels, thence by way of underground solution channels in the soft spongy laterite to emerge on the hill slope as springs around which small outwash fans of chromite, silica platelets, fine sand and clay were deposited. Remnants of these deposits are still exposed on the slopes of Barnes Hill (Photo 10). They do not exhibit lateral continuity and occur at different levels around the hill slope. This inferred mode of origin for the chromite concentrations differs drastically from the palaeoshoreline concept proposed initially by Green (1959) and perpetuated by Summons et al (1980) but is consistent with the early descriptions by Noldart (1961) before mining commenced at Barnes Hill.

Because of resource size implications, (particularly the risks of extrapolation of quantifiable data from drill holes, pits and costeans), the mode of origin of the known chromite concentrations at Barnes Hill and those inferred from percussion drilling at Rifle Range, are discussed further in the following section.

8. ORIGIN OF CHROMITE CONCENTRATIONS

The previous operators at Barnes Hill do not seem to have concerned themselves with the mode of origin and distribution of the chromite sand which was the only ore type their plant could treat. In 1980, when readily mineable reserves of chromite sand were obviously being rapidly depleted, an extensive costeaning/pitting programme was initiated. Most of this effort was directed to the laterite profile from which the Tertiary gravels and most of the high grade chromite sand had been eroded, stripped or mined; in most cases this sampling was taken down to serpentinised peridotite bedrock. The gravel capping on the crest of Barnes Hill was only penetrated by a few pits because of digging difficulties. Not surprisingly this work did not significantly add to the reserve of the high grade chromite sand acceptable to the plant but, predictably, indicated a large quantity (about 200,000 tonnes) of clayey laterite and saprolite containing approximately 5% Cr_2O_3, not all of which should be attributed to chromite. (These figures are vague because plans only were made available at the office of Pruessag Australia Ltd. and there is no report on this work in the Department of Mines). Had the mode of deposition been understood, this work would probably not have been undertaken.

At that time (1980) it seems to have been accepted without question that the favoured chromite-rich sand facies was a remnant of an early Tertiary marine heavy mineral strandline deposit and that the associated bedded organic clays with high chromite content were low energy littoral deposits adjacent to the beach deposits. This concept stems from suggestions by Green (1959) and from a "sedimentological analysis" of twenty samples reported by Summons et al (1980). Neither of these investigations addressed several important contradictions in field data to the marine strandline concept.
These contradictions include:-

1. The absence of fossil marine or estuarine fauna in the chromite-rich sands or in associated fine sediments.
2. The predominance of chromite and the relatively low contents of magnetite and ilmenite. The latter are essential constituents of the gabbroic facies of the Andersons Creek Ultramafic Complex which would have been exposed and eroding nearby and at the same time as the peridotitic source rocks for the chromite.
3. The soft, readily erodible laterite basement to the chromite sand concentrations could not have survived erosion on a shoreline with the necessary energy to concentrate heavy minerals.
4. The coexistence of equant chromite grains and fragile silica "platelets" of contrasting hydraulic equivalence and abrasion resistance implies weathering and deposition with

minimal transport.

5. The observed occurrence at Barnes Hill of chromite-rich sand and "silica platelets" in narrow steep-sided gutters deeply incised in soft laterite and ultramafic saprolite is incompatible with strandline deposition.

6. The intricate depositional interplay between chromite rich sand and grey, brown and olive-green bedded clays, visible in outcrop at Barnes Hill (see Figure 4 in Summons et al, 1981) is inconsistent with heavy mineral strandline deposition.

7. Tertiary marine deposits have not been recorded elsewhere in the district in the same stratigraphic position or at a comparable elevation, as might be expected had there been marine transgression before deposition of the Tertiary quartz gravels.

The conclusion by Summons et al (1981) from a "sedimentalogical analysis" of twenty samples that the chromite concentrations are littoral marine deposits is unconvincing as is the lateral extrapolation of this concept (see Figure 9. Summons et al, 1981) implying two chromite-rich sand beds extending beneath Tertiary gravel cover in the Rifle Range area. The prospect of substantially increasing chromite sand reserves by further drill testing following this concept is considered remote.

Observations on good exposures at Barnes Hill and in a costean at the southern edge of the Rifle Range gravel cap strongly suggest that the chromite-rich sand and associated fine sediments have been deposited in underground channels at or just below the buried ultramafic laterite surface (Photos 11 & 12). The subsurface channels seem to have been formed by the dissolution of limonite in the upper part of the laterite profile by groundwater charged with organic acids derived from peat beds interspersed through the overlying gravel sequence. Subsequent flushing and resistate mineral concentration occurred when the water table dropped below the gravel/laterite interface. Rainwater percolating through the overlying gravels has flushed some fine silt and clay, including heavy minerals of non-ultramafic provenance, into the sub-surface drainage channels in the underlying laterite. The chromite and secondary silica platelets which form the bulk of the deposits is residue from the dissolution of the soft (non-ferricreted) laterite in which the channels have formed. Exposures on Barnes Hill show steep-sided sediment-filled (chromite plus silica platelets) channels cut deeply into the lower saprolitic part of the weathering profile almost to serpentinite bedrock. Some deposits of chromite and silica platelets on the northern flank of Barnes Hill have features suggestive of small alluvial fans at spring outlets.

In situ shrinkage of the laterite profile by dissolution of limonite can be inferred from some exposures where there is progressive rotation of secondary silica fracture fillings from original high angle attitudes low in the weathering profile through medium to sub-horizontal bedding-like layering high in the profile. This progressive flattening of secondary silica plates and platelets is accompanied by a gradual increase in chromite so that in some places interlayered silica platelets, chromite and olive green clay, which looks like a bedded sediment has been formed by shrinkage in situ without any lateral transport or reworking by moving groundwater.

For optimum concentration and preservation of residual chromite under the conditions outlined above the following critical factors probably prevailed.

1. Burial of a thick mature, non-ferricreted ultramafic laterite profile. Any pre-burial erosional stripping of the upper limonite rich zone would severely reduce the supply of chromite for later concentration. Complete stripping of the upper limonite-rich zone by erosion before burial would remove two essential ingredients for subsequent chromite concentrations, namely, reactive limonite and a large part of the chromite supply.

2. Inclusion of peaty beds (swamp vegetation) in the overlying gravel sequence. This provided organic acids which dissolve the limonite in the underlying laterite causing a residual concentration of chromite and silica platelets.

3. Uplift, erosion, and lowering of the water table below the gravel/laterite interface. This provides the hydraulic gradients necessary for the interaction of acid groundwaters with lateritic limonite and promotes solution channelling in the upper part of the buried laterite.

4. The retention of a gravel capping to protect the underlying loosely bonded chromite/secondary silica residual enrichments from dispersion by erosion or partial incorporation into ferricrete formed as the exhumed laterite profile was exposed to a new weathering cycle. This may have happened at Tattersall's Hill between Barnes Hill and Rifle Range where Tertiary gravel cover has been eroded and ferricreted laterite with an unusually high Cr content now occurs at the surface.

Barnes Hill uniquely fits all the above requirements envisaged for the formation and preservation of this unusual, essentially residual, type of secondary chromite.

Percussion drilling in the Rifle Range area as described by Summons (1980) and Castleden (1981) has shown that within this dissected plateau a large part of the critical gravel/laterite interface lies below the present-day watertable. Thus, it is unlikely that there has been widespread interaction between acid groundwater and lateritic limonite which is the initial step in the proposed chromite concentrating process. Further, the drilling results seem to indicate that over a large part of the Rifle Range area the ultramafic laterite profile had been erosionally truncated before deposition of the Tertiary gravel.

Doubts concerning lateral continuity together with the obvious overburden factor, sample recovery difficulties, problems in apportioning analysed Cr between chromite and unidentified, chrome-bearing, supergene minerals and the questionable chromite quality, all downgraded the Rifle Range prospect to such an extent that further investigations could not be justified.

Without support from the Rifle Range prospect, Barnes Hill and other more obscure small prospects in the area were not considered worthy of further investigation.

9. METALLURGICAL TESTING

It was recognised early in our investigations that the reserve of readily available chromite sand from which the foundry sand product had formerly been won was very limited. Further, it was not known whether the high quality (+55% Cr_2O_3) of the chromite produced as foundry sand was the result of beneficiation to achieve the foundry sand grainsize specifications or, a feature peculiar to the sand facies chromite resulting from the natural processes which concentrated the chromite, or whether it was an inherent feature of the primary chromite in the Andersons Creek Ultramafic Complex. Resolution of these questions at an early stage was necessary to determine whether the chromite-containing clay facies, both sedimentary and residual, occurring adjacent and subjacent to the higher grade, but largely depleted, chromite sand bodies, could have potential as low grade ore from which a high quality chromite product might be produced.

To these ends large samples from four contrasting sample types readily available at surface at Barnes Hill were collected and subjected to a range of metallurgical investigations and concentrate product analyses by the Mines Department Metallurgical Laboratory in Launceston.

These investigations, which are detailed below, showed conclusively that the high quality chromite was restricted to the naturally occurring chromite sand concentrations and was neither the result of beneficiation during the preparation of the foundry sand product nor was it a regional feature peculiar to chromite in the Anderson's Creek ultramafic body. The composition of chromite concentrates produced from residual clayey laterite and saprolite underlying the chromite sand deposits were in the 40% to 45% contained Cr_2O_3 range which is consistent with disseminated chromite occurring world-wide in "alpine-type" serpentinites and their lateritic derivatives. This conclusion removed the previously perceived possibility that the reserves of high quality chromite might be extended by the inclusion of clay-matrix chromite-bearing ground with the remnants of the high grade, high quality chromite sand bodies.

The reason for the marked improvement in chromite quality in the sand facies was not conclusively determined but it is suspected that iron-rich chromite and chromite-magnetite composites (chromite rimmed with high-iron chromite or magnetite) may have been preferentially leached by acid groundwater flowing through the underground channels in which the chromite sand (and silica platelets) accummulated. It had been noted previously (Summons et al, 1981) that chromite in laterite and mill products from Barnes Hill did not include highly aluminous chromite determined by microprobe in primary serpentinite or chromite with "alteration rims" (presumably high-iron) seen in primary serpentinite and secondary silica-encased grains. It was presumed by them that during lateritisation the high-alumina chromite and the alteration rims were removed and that the released chromium contributed to the chromium in geothite in the laterite which had caused errors in the conversion of Cr assays of geothite-bearing samples and concentrates to contained chromite equivalents. This latter aspect was further investigated by Everard and Green (1980) who concluded that the transfer of considerable Cr_2O_3 from chromite to geothite and chamosite during lateritisation would be of concern to the operators of the Barnes Hill refractory sand/wash plant as "bulk Cr_2O_3 analyses will consistently over estimate the amount of chromite available". This statement would likewise apply to all Cr_2O_3 analyses of samples and concentrates in all previous investigations, including, particularly, the Mines Department drilling in the Rifle Range areas.

Whereas Everard and Green (1980) attributed the dissolution of aluminous chromite and (ferruginous) alteration rims on chromite to the lateritisation process, our observations suggest that post-lateritisation leaching by acid groundwater has been the dominant factor.

The four sample types collected for metallurgical investigation were:-

1. Stockpiled fine chromite sand originally thought to be "mould wash" product dumped because no viable market could be found (our Sample No. 62514). (Photo 13).
2. Naturally occurring high-grade chromite sand believed to be typical of the sandy ore from which the foundry sand product had been produced (our Sample No. 62515).
3. Naturally occurring chromite-rich bedded (or laminated) "clays" underlying and interfingering with the high grade chromite sand (our Sample No. 62517). This material had not been mined presumably because the plant had not been designed to process clay matrix material.
4. Naturally occurring, "clayey", palaeo-laterite grading downwards into saprolite from below the level of post-burial residual chromite concentration by the erosion, leaching and flushing action of acidic groundwater (our Sample No. 62516).

Approximately 400kg of each sample was wet screened at Beaconsfield through a bank of "Sweco" vibrating screens to remove all vegetal and "earthy" matter, (amorphous geothite and chamosite, smectitic clays and fine organic debris and organic precipitates) and to produce three size fractions (+20, -20+100, -100+300 BSS mesh) of clean concentrate suitable for gravity (Wilfley table) and magnetic separation. Sub-samples were submitted to the Mines Department metallurgical laboratory in Launceston.

The "Sweco" screening operation was not quantitatively monitored because its purpose was merely to produce clean mineral concentrates. It is likely that some very fine clean chromite, much geothite and most chrome-bearing hydrated iron oxides and clays were lost at this stage. This should be borne in mind when assessing the results of subsequent tabling, magnetic separations and analyses done by the Mines Department on these concentrates.

Where apparently clean spinel concentrates were produced, either from gravity or magnetic separations, analyses for Cr_2O_3, FeO, Al_2O_3, MgO, CaO and SiO_2 were requested.

On several products, the amount of Cr_2O_3 extracted by a 10 hour digest in hot concentrated hydrochloric acid was determined ("HCl soluble Cr_2O_3) as an indicator of the presence of chrome-bearing minerals other than chromite, notably aluminous geothite, either as coatings on chromite or as discrete nodular grains. These "HCl soluble Cr_2O_3" contents cannot be related quantitatively to the original samples because most of the geothite (and any chrome-bearing clays) would have been disaggregated and discarded in slimes from the "Sweco" wet screening.

The results of work done on sub-samples of the "Sweco" concentrates at the Mines Department metallurgical laboratory are presented and discussed below, sample by sample:-

I. SAMPLE 62514

This sample was taken from a dump of chromite concentrate on the northern flank of Barnes Hill thought to be "mould wash" product, from the former operation, which could not be sold.

The minor amount of plus 20 mesh material from the Sweco screening was obviously foreign material (sticks, stones, paper, etc) which post-dated the dumping.

The -20+100 mesh and -100+300 mesh fractions contained a negligible content of magnetic minerals responsive to a hand magnet, so it was assumed that the concentrate had previously been subjected to a magnetic separation.

Each fraction was passed over a Wilfley table to produce visibly clean chromite concentrates and the products were analysed to determine chromite quality with the following results:-

	% Cr_2O_3	FeO (total)	Al_2O_3	MgO	CaO	SiO_2
1. -20+100 mesh	56.8	18.3	10.3	8.5	<0.2	0.78
2. -100+300 mesh	58.0	18.3	10.1	8.4	<0.2	0.54

A cut from the -20+100 mesh fraction was subjected to both cold and hot concentrated HCl extraction (10 hours) with the following results (expressed as Cr).

Cold HCl 0.008% Cr.
Hot HCl 0.028% Cr.

The Cr_2O_3 contents of chromite in both fractions is somewhat lower than that reported from mould sand and mould wash produced from Barnes Hill and is considerably lower than that of the dominantly chromite magnetic fraction produced from naturally occurring chromite sand from Barnes Hill (see results for Sample No. 62515). The Cr_2O_3 difference between chromite from the dump and chromite from chromite sand ore at Barnes Hill may be due to more precise magnetic separation of samples of the latter or, as is considered more likely the dump represents a discarded concentrate from a bulk sample taken from the Rifle Range area just before the former operators plant was closed down. It now seems unlikely that it represents a typical mould wash product as originally assumed.

II. SAMPLE 62515

This sample was taken from a natural exposure of chromite-rich sand (estimated 50 to 70% chromite) in which the other principal component was secondary silica as chips and flakes derived locally from broken fracture fillings in saprolite and weathered serpentinite at the base of the ultramafic laterite profile.

Three size fractions from the "Sweco" screening were examined in the Launceston laboratory.

The +20 mesh fraction was further subdivided into plus and minus 2.36mm fractions; the coarser fraction being almost entirely secondary silica and the finer fraction being a mixture of silica chips, rock fragments and some chromite. The -2.36mm fraction was gravity concentrated on the Wilfley table to produce a predominantly chromite concentrate weighing 247.4gm. As this was only a minor portion of the total chromite, the majority of which occurred in the two minus 20 mesh fractions, no further work was requested on this sample.

The -20+100 mesh fraction was gravity separated to produce a table concentrate weighing 3165.6gm. This was then magnetically fractionated into three categories designated M/S M/A 1 + 2 + 3, M/S M/A 4 and M/S N which progress from strongly and moderately magnetic through weakly magnetic to virtually non-magnetic. As can be seen from the tabulation below. Most (+85%) of the chromite reported in the M/S M/A 4 (weakly magnetic) fraction:-

	Mass (gm)	Percent Mass
M/S M/A 1+2+3	318.4	10.1
M/S M/A 4	2738.5	86.5
M/S N	108.7	3.4
	3165.6	100.0

The M/S M/A 4 product which was apparently clean chromite assayed as follows:-

% Cr_2O_3	FeO (total)	Al_2O_3	MgO	CaO	SiO_2
63.2	18.3	7.4	9.7	$<$0.2	0.55

The -100+300 mesh Sweco screening fraction from this same sample (62515 - natural chromite sand) was processed in the manner described above for the -20+100 mesh fraction with the following results:-

Table concentrate 2956.4gm

Magnetic Fractions	Mass(gm)	Percent Mass
M/S M/A 1+2+3	58.7	2.0
M/S M/A 4	2684.2	90.8
M/S N	213.5	7.2
	2956.4	100.0

As for the coarser fraction the M/S M/A 4 (weakly magnetic) fraction contained the bulk (+90%) of the chromite which the following analyses show to be of very high quality.

The M/S M/A 4 fraction assayed thus:

% Cr_2O_3	FeO (total)	Al_2O_3	MgO	CaO	SiO_2
63.2	17.6	7.1	9.4	<0.2	0.49

The analyses of chromite extracted magnetically from this sample of naturally occurring chromite sand show not only that these deposits contain chromite of remarkably high quality (63% Cr_2O_3) but also that the gain in Cr_2O_3 has been at the expense of some Al_2O_3 (7.1% Al_2O_3). This is consistent with the earlier conclusion by Everden that aluminous chrome spinels are less stable in the weathering environment than the spinels with higher Cr_2O_3 to Al_2O_3 ratios. The small, highly magnetically susceptible (MS/MA 1+2+3), fraction in this sample (58.7gm) also suggests that residual enrichment in Cr_2O_3 may also have been caused by preferential supergene dissolution of magnetite and iron-rich chromite.

III. SAMPLE 62517

This sample represents layered fine silts and clays ranging in colour from putty grey through tan to olive green which lie below the chromite sand (Sample No. 62515) and above unmodified laterite/saprolite (Sample No. 62516). The sample mainly represents "pre-gravel" laterite which has been severely depleted of hydrated iron oxides by acid dissolution. Shrinkage, collapse and localised reworking by ground water in channels has produced a crude sub-horizontal layering in this unit which is emphasised by flat-lying accumulations ("beds") of secondary silica flakes. In the uppermost part of this layered unit some putty coloured clays with fine layers of silt-size chromite are thought to be a low-energy correlate of the chromite sand. However, the "bedding" throughout the greater part of this unit has been caused by compaction rather than aqueous reworking. The lower part of the unit is gradational into massive unmodified ultramafic saprolite in which secondary silica fracture fillings have not been rotated from their original steep attitudes.

The regional extent and thickness of this facies type is not known. On the north flank of Barnes Hill exposures up to 2 metres thick have been seen but, high on the western flank of the hill, chromite sand rests directly on unmodified laterite. This sample was selected for investigation because the obvious high content of fine grained chromite implied a potential resource which, if the chromite quality (Cr_2O_3 content) was high and the clay could be readily disaggregated, might augment the very limited reserve of high quality chromite in the overlying chromite sand.

This sample disaggregated readily when passed wet through the "Sweco" vibrating screens but a lot of black mineral, presumably chromite, was lost with the minus 300 mesh slimes. No analyses were done on the sample before processing but a visual estimate of chromite in the three "Sweco" fractions indicated that the sample probably contained 10 to 15% chromite (by volume).

The <u>+20 mesh fraction</u> which was, by far, the smallest of the three fractions, was screened at 2.36mm to remove coarse, mostly foreign, material (3.6% by volume containing 1.01% Cr_2O_3) before tabling. The table concentrate from the undersize material (8.9%) contained 34.9% total Cr_2O_3 and 0.76% hot HCl extractable Cr_2O_3. The table tails from this size fraction (91%) contained 1.31% total Cr_2O_3 and 0.66% hot HCl extractable Cr_2O_3. This table concentrate was not magnetically fractionated.

The <u>-20+100 mesh fraction</u> was also concentrated on the Wilfley table but the concentrates were not magnetically fractionated. The table concentrate, accounting for 33.6% contained 39.2% total Cr_2O_3 and 0.87% hot HCl extractable Cr_2O_3. These results are comparable with those obtained on the coarser fraction.

The <u>-100+300 mesh fraction</u> was both gravitationally concentrated and magnetically separated. The table concentrate (62.7%) contained 39.9% total Cr_2O_3 and 0.83% hot

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HCl extractable Cr_2O_3. On magnetic fractionation this concentrate behaved differently from previous samples; the greater part of the concentrate (81.5%) reported in a median magnetic fraction (M/S M/A 3) so this was chosen as representative of "average chromite" for the sample. The weakly magnetic fraction (M/S M/A 4), which in other samples had contained most of the chromite, contained only a minor amount of concentrate, so for analytical purposes it was bulked with the more magnetic fractions (M/S M/A 1 and M/S M/A 2).

The results of the magnetic separation and analyses on each magnetic fraction are tabulated below;

Mag Fraction	Mass (gm)	Mass % table conc.	$\%Cr_2O_3$	FeO	Al_2O_3	MgO	CaO	SiO_2	Hot HCl Sol Cr_2O_3
M/S M/A 1+2+4	7.0	11.16	35.4	14.4	21.9	9.2	<0.4	12.1	0.38
M/S M/A 3	51.1	81.5	42.8	17.3	23.9	12.2	<0.4	1.9	0.94
M/S N	4.6	7.34	14.6	5.7	9.9	4.2	<0.4	60.0	0.29

The notable aspects of these results are the lower Cr_2O_3 and higher Al_2O_3 contents for the "average" chromite (M/S M/A 3) as compared with average chromite extracted from the chromite concentrate dump sample (No. 62514) and the chromite sand sample (No. 62515).

It should be noted that "average" chromite (M/S M/A 3) in this sample has lower Cr_2O_3 and higher Al_2O_3 contents than "average" chromite in either the naturally occurring chromite sand (sample 62515) or in the chromite stockpile (sample 62514). A chromite product from this material would be difficult to market separately and, if mixed with chromite from the overlying small sand bodies, would tend to lower the quality and value of the average chromite product would be severely depressed. Two possible explanations for the marked change in Cr_2O_3/Al_2O_3 contents are:-

(1) aluminous chromite has not been leached from this material, or,

(2) alumina has by some means been enriched in the material consequent on its leaching from aluminous chromite in

the overlying sand bodies.

As the FeO content of the chromite has not been substantially increased it is unlikely that the latter explanation holds. Insufficient work has been done for a definitive resolution of this question.

IV. SAMPLE 62516

This sample was taken from an old excavation on the south-western flank of Barnes Hill over a vertical interval of about 2 metres commencing about 2 metres below the base of the Tertiary quartzose gravels and finishing about one metre above hard serpentinite bedrock. The lower two thirds of the sample is saprolitic (i.e has relict rock textures) and the upper third lateritic (amorphous). In the saprolitic part of the sample, secondary silica fracture fillings in both flat and steep attitudes are common. Chromite is sparsely (<1% by volume) and randomly disseminated through the sample as equant black shiny euhedra generally between 0.5 and 1mm across. At this locality, the layered silt and clay unit (sample 62517) is missing and the chromite sand unit, about 30cms thick, lies directly on massive puggy laterite. The sample was chosen to represent that part of the ultramafic palaeo-weathering profile (laterite plus saprolite) below the leaching and flushing influence of acid groundwater which has percolated through the Tertiary gravels and peaty interbeds.

This sample was the most difficult to wash through the "Sweco" vibrating screens because of continuous "balling" of the clay matrix. The three-way screening was quantitatively ineffective but, after prolonged recycling sufficient clean screenings in each size category were obtained for further investigation by the Launceston laboratory.

The <u>+20 mesh</u> fraction was screened at 2.36mm and the oversize (19.2%), which was mostly secondary silica and serpentinite fragments, was analysed for total Cr_2O_3 (0.24%) and hot HCl extractable Cr_2O_3 (0.05%). The remaining undersize (i.e. +20 mesh -2.36mm) was tabled to produce a concentrate (16.2% mass) which contained 10.5% Cr_2O_3 and 0.12% hot HCl extractable Cr_2O_3. The table tails (83.8% by mass) contained 0.89% total Cr_2O_3 and 0.49% hot HCl extractable Cr_2O_3. This fraction was not magnetically separated.

The <u>-20+100 mesh</u> fraction was tabled and concentrated. The table tailings were analysed for total Cr_2O_3 and hot HCl extractable Cr_2O_3 with the following results:

	Total Cr_2O_3	Hot HCl Soluble Cr_2O_3
T/C (13.5% mass)	42.6%	0.08%
T/T (86.5% mass)	1.05%	0.56%

It is notable that about half the Cr_2O_3 in the table tails, approximately 86% (mass) of this Sweco grainsize fraction, was present in an HCl soluble, probably non-chromite, form. This is indicative of the latitude for error in theoretical conversions of total Cr_2O_3 as assayed to contained, potentially recoverable, chromite. The potential for error is greater in clay matrix materials than in sand facies natural chromite concentrates suggesting that much of the Cr_2O_3 not attributable to chromite has been dissolved and dispersed by acid groundwater during the formation of the natural chromite sand deposits.

The -100+300 mesh "Sweco" fraction was tabled and magnetically fractionated so that the composition of the contained chromite could be compared with the composition of similarly extracted chromite from the same size fraction of the other three samples. The table concentrate (34.4%, mass) contained 49.9% total Cr_2O_3 and 0.18% hot HCl extractable Cr_2O_3, whereas the tailings (65.6% mass) contained only 1.42% total Cr_2O_3 but, relatively much more acid extractable Cr_2O_3 (0.39%). Three magnetic fractions were prepared from the table concentrate, namely M/S M/A 1+2+3 (strongly and moderately magnetic), M/S M/A 4 (weakly magnetic - almost exclusively chromite) and M/S N (non-magnetic - mainly silica and silicates). The distribution and composition of these magnetic separation products are shown below:-

Mag. Fraction	Mass % Table Concentrate	% Cr_2O_3 (total)	FeO (total)	Al_2O_3	M_gO	CaO	SiO_2	Hot HCl Sol. Cr_2O_3
M/S M/A 1+2+3	1.2	51.5	22.5	9.3	8.1	<0.4	2.7	0.17
M/S M/A 4	85.2	57.3	16.8	10.4	9.5	<0.4	1.3	0.20
M/S N	13.7	3.81	1.4	0.69	0.56	<0.4	91.5	0.05

Immediately obvious from these results is the remarkably low content of magnetite and magnetic (high-iron) chromite expressed both by the small, moderate to highly magnetic fraction and its high Cr_2O_3 content (51.5%). Also worthy of note are the very low hot HCl extractable Cr_2O_3 contents in all fractions. This is interpreted as being due to the lack of geothite coatings on chromite grains low in the laterite profile. However, as previously mentioned, considerable hot HCl extractable HCl does occur in the table tailings which were not magnetically separated. Further, a significant amount of hot HCl extractable Cr_2O_3 would have been contained in rejected slimes from the initial "Sweco" screening which were not analysed.

10. CONCLUSIONS FROM METALLURGICAL TESTS

It is acknowledged that neither the sampling nor the metallurgical testing has been exhaustive. However, progressive review of the results revealed trends, consistent with field observations, implying that the naturally concentrated chromite sand occurring as irregular lenticular pods and furrow fillings contained uniquely high quality chromite. This enhancement in chromite quality was probably due mainly to the removal by acid dissolution of chrome-bearing aluminous geothite nodules and coatings, some magnetite and high-iron chromite, and probably some high-alumina chromite. Reserves of the chromite sand (the premium quality chromite) are obviously very small. Any expansion of reserves by incorporating underlying clay-matrix chrome-bearing fine sediments and/or laterite and/or saprolite would seriously depress both in-situ chromite grade and the quality (Cr_2O_3 content) of the final average chromite products, and introduce serious treatment and waste disposal problems related to the clay content. The investigations were curtailed when the economic effects of these adverse factors were appreciated.

The main implications from the metallurgical testing can be demonstrated by comparing the composition of "average" chromite recovered from tabling then magnetically separating the -100+300 mesh "Sweco" fractions derived from samples 62515 (in situ chromite sand), 62517 (modified, layered laterite) and 62516 (primary saprolite, minor laterite) which, in the above order progress down the weathering profile. The relevant data are presented below:-

Sample No.	Type (Facies)	Magnetic Fraction & % of table Conc.	Cr_2O_3 (total)	FeO (total)	Al_2O_3	MgO	CaO	SiO_2	Hot HCl Sol. Cr_2O_3
62515	In situ chromite sand	M/S M/A 4 90.8%	63.2	17.6	7.1	9.4	<0.2	0.49	N.D
62517	Modified (layered) laterite	M/S M/A 3 81.5%	42.8	17.3	23.9	12.2	<0.4	1.9	0.94
62516	Primary saprolite (with minor unmodified laterite)	M/S M/A 4 85.2%	57.3	16.8	10.4	9.5	<0.4	1.3	0.2

The compositional difference in the chromite of the above three samples can be interpreted in the following general terms:-

1. On weathering of serpentinite to saprolite accessory chromite did not change significantly either in concentration or in composition.

2. As lateritisation proceeded, iron and alumina were enriched in the upper zone at the expense of magnesia and silica which were either flushed out of the system in solution or redeposited in the lower, saprolite, zone.

3. During deposition of the Tertiary gravels, lateritisation was suppressed because the weathering profile lay below the water table.

4. As the gravel and its peaty interbeds were eroded, the ultramafic weathering profile was again subjected to the hydraulic and chemical effects of a fluctuating water table. The groundwater was charged with humic acid extracted from peat beds and vegetal matter dispersed through the siliceous gravel sequence.

5. On contact with the laterite, the acid groundwater dissolved limonite and, to a lesser extent, aluminous geothite forming solution channels just below the gravel/laterite interface.

6. As the erosion surface lowered and exposed the gravel/laterite contact, springs and seepages emerged around the flanks of gravel-capped mesas (e.g. Barnes Hill), from solution channels etched into the iron-rich part of the old laterite profile. Insoluble residues from the laterite, mainly chromite and secondary silica, together with siliceous silt and clay flushed from the overlying gravels, accumulated in the solution channels and around the spring outlets. Repeated flushing of these insoluble mineral accumulations by acidic groundwater dissolved geothite coatings from chromite grains. The absence of magnetite and the low content of magnetic chromite in these accumulations suggest that magnetite and to some extent high-iron (magnetic) chromite was susceptible to leaching by acid groundwater. Similarly, the low alumina content of the chromite in these concentrations implies selective dissolution of high-alumina chromite. No attempt has been made to substantiate these assumptions by controlled acid extractions on these minerals.

7. That part of the iron-rich laterite below the zone of groundwater channelling (represented by sample 62517) was subjected to insidious leaching of amorphous, skeletal, hydrous iron oxides but the high Al_2O_3 content of its chromite suggests that aluminous geothite coatings on chromite were partly or wholly preserved. This high Al_2O_3 content may also be due in part to accretion of aluminous geothite containing chromium (hot HCl extractable Cr) derived from the more severely leached chromite sand concentrated in overlying subterranean channel deposits.

8. Dissolution of hydrous iron oxides from this modified laterite zone resulted in severe shrinkage and local collapse

which residually concentrated and sub-horizontally layered all insoluble minerals. The sub-horizontal layering of secondary silica flakes and chips is most conspicuous but, the finer resistate minerals, including chromite and clays, also conform. In the upper part of the profile this layering by compaction looks like sedimentary bedding but in the lower part the layering merges downwards into massive saprolite in which secondary silica fracture fillings have no preferred orientation. Although this layered "deflated" laterite contains a high chromite content (10 to 15%) over 2 to 3 metres it could not be regarded as a supportive reserve for the high grade chromite sand because of the poor quality of the chromite (high Al_2O_3 low Cr_2O_3 versus FeO) and treatment and disposal problems consequent on the high clay content.

9. As the gravel cappings eroded, the underground channel and sink-hole chromite sand concentrations were exposed, eroded and dispersed. Much very fine chromite, and presumable some Cr in solution, has been redeposited in the alluvium of adjacent valleys. This is demonstrated by the high Cr content of black organic clays (samples 03, 04, and 05) collected for the environmental study (see appended report by J. Miedecke). The chromite in these deposits is extremely fine grained and would be difficult to recover from the clay matrix. These deposits are not a viable chromite resource.

10. After erosional stripping of the Tertiary gravel capping, a new cycle of weathering (lateritisation) has been superimposed on the partly eroded, extensively leached and chromite-enriched, older laterite. The residual enrichment of chromite caused by the leaching by acid groundwater derived through overlying gravel and peat beds provided a high background chromite level for the youngest ferricreted laterite now cropping out on Scot Hill and Tattersalls Hill. This probably accounts for the unusually high Cr content (up to 5.6% Cr) in this ferricrete.

The chromite in these ferricretes is heavily encrusted with geothite which contains some Cr. It could not be considered a viable source of chromite.

11. GENERAL CONCLUSION

Field and metallurgical investigations have indicated that size potential and chromite quality are not sufficiently encouraging to proceed with more detailed investigations which would have involved a major drilling and costeaning programme.

12. ACKNOWLEDGEMENTS

Messrs. H.K. Wellington and L. Rhodes of the Mines Department Laboratory in Launceston were particularly helpful with historical background, metallurgical advice and the provision of metallurgical services.

Mr. R. Vivian, formerly resident geologist for Austamax Resources Ltd. in Launceston, who was instrumental in the application for the Exploration Licence, maintained contact with the project and provided much useful information and discussion.

The competent services of Mr. J. Miedecke, engineering and environmental consultant, are gratefully acknowledged.

Mr. G. Tattersall, the owner of the property containing the former mining area at Barnes Hill is thanked for the granting of permission to enter his property for surface investigations and sampling.

Field assistant, David Ellis, provided reliable logistic support throughout the project.

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PHOTOS 1 TO 13 INCLUSIVE

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PHOTO 1

Scar left after previous mining at Barnes Hill (upper left). Cleared patches at lower left are abandoned quartz gravel workings in the rifle range area. Two cleared areas at upper right are Tailings Dams used by Northern Chromite Limited.

PHOTO 2

Barnes Hill, remnants of Amalgamet survey grid at upper left is on quartz gravel (white) and patches of chromite sand. Orange ground is laterite some of which has been redistributed in an attempt to resoil mined area.

PHOTO 3

Randomly disseminated chromite in partially weathered harzburgite from outcrop at Barnes Hill.

PHOTO 4

Sub-parallel chromite segregations in serpentinite "float" from Barnes Hill. Not seen in outcrop.

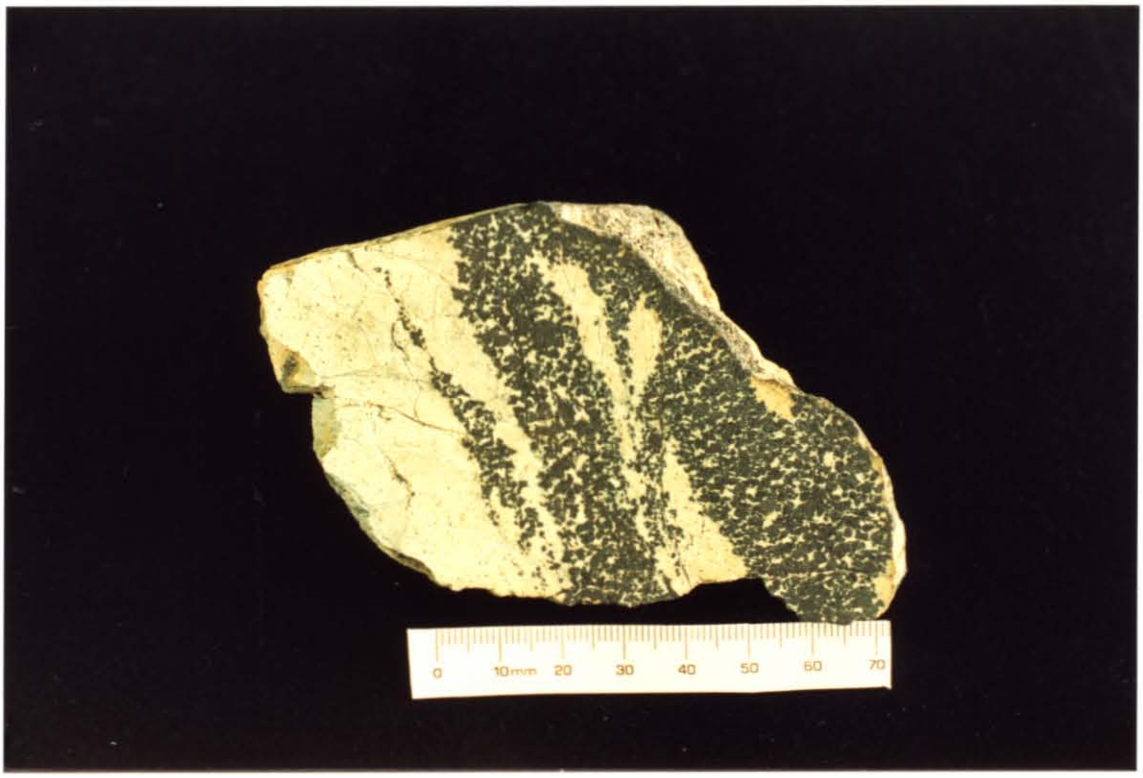

PHOTO 5

Secondary silica fracture fillings in serpentinite low in weathering profile at Barnes Hill. In photo 6 note incipient layering of silica flakes in saprolite between residual serpentinte boulders due to compaction and removal of soluble weathering products by groundwater flushing.

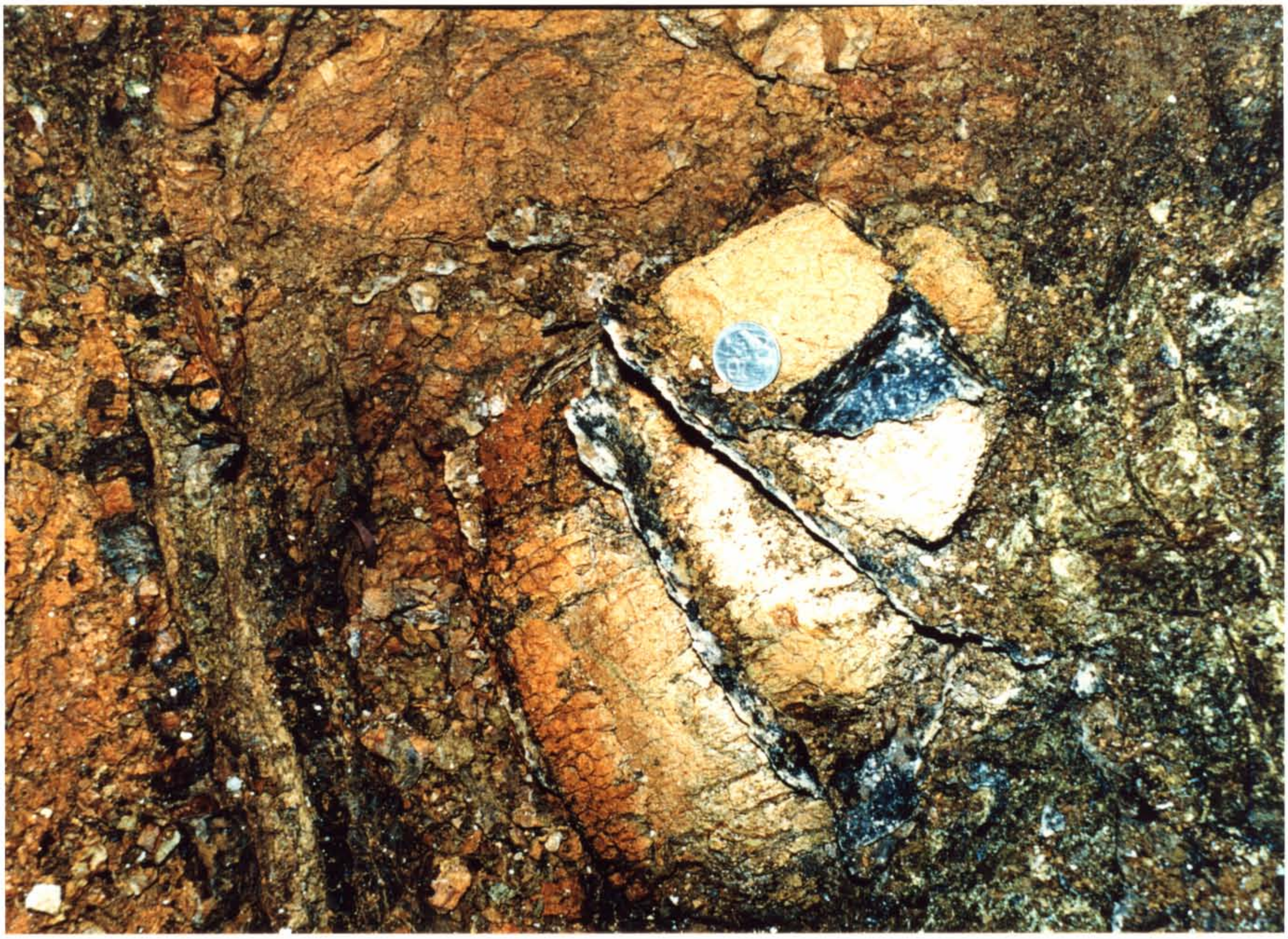

PHOTO 6

Secondary silica fracture fillings in serpentinite low in weathering profile at Barnes Hill. In photo 6 note incipient layering of silica flakes in saprolite between residual serpentinite boulders due to compaction and removal of soluble weathering products by groundwater flushing.

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PHOTO 7

Loosely cemented boulder containing silica platelets in fine chromite sand (not visible at scale of photo), contains about 40% chromite "float" from Barnes Hill.

PHOTO 8

Silica platelets in chromite sand on flank of narrow gutter in ultramafic saprolite below Tertiary quartz gravels at Barnes Hill.

PHOTO 9

Peat beds interbedded with putty coloured clay containing very fine chromite at base of Tertiary quartz gravel (upper left) and overlying ultramafic laterite. Barnes Hill.

PHOTO 10

Small alluvial fan (grey) of chromite (and silica platelet) sand on N.W. flank of Barnes Hill. Possibly old spring outlet from solution channel in laterite below Tertiary gravel.

PHOTO 11

Two chromite sand-filled solution channels cut deeply into ultra-mafic laterite and saprolite exposed in recent erosion gutter on N.W. flank of Barnes Hill. This gutter also exposes serpentinite bedrock - see lower central part of photo.

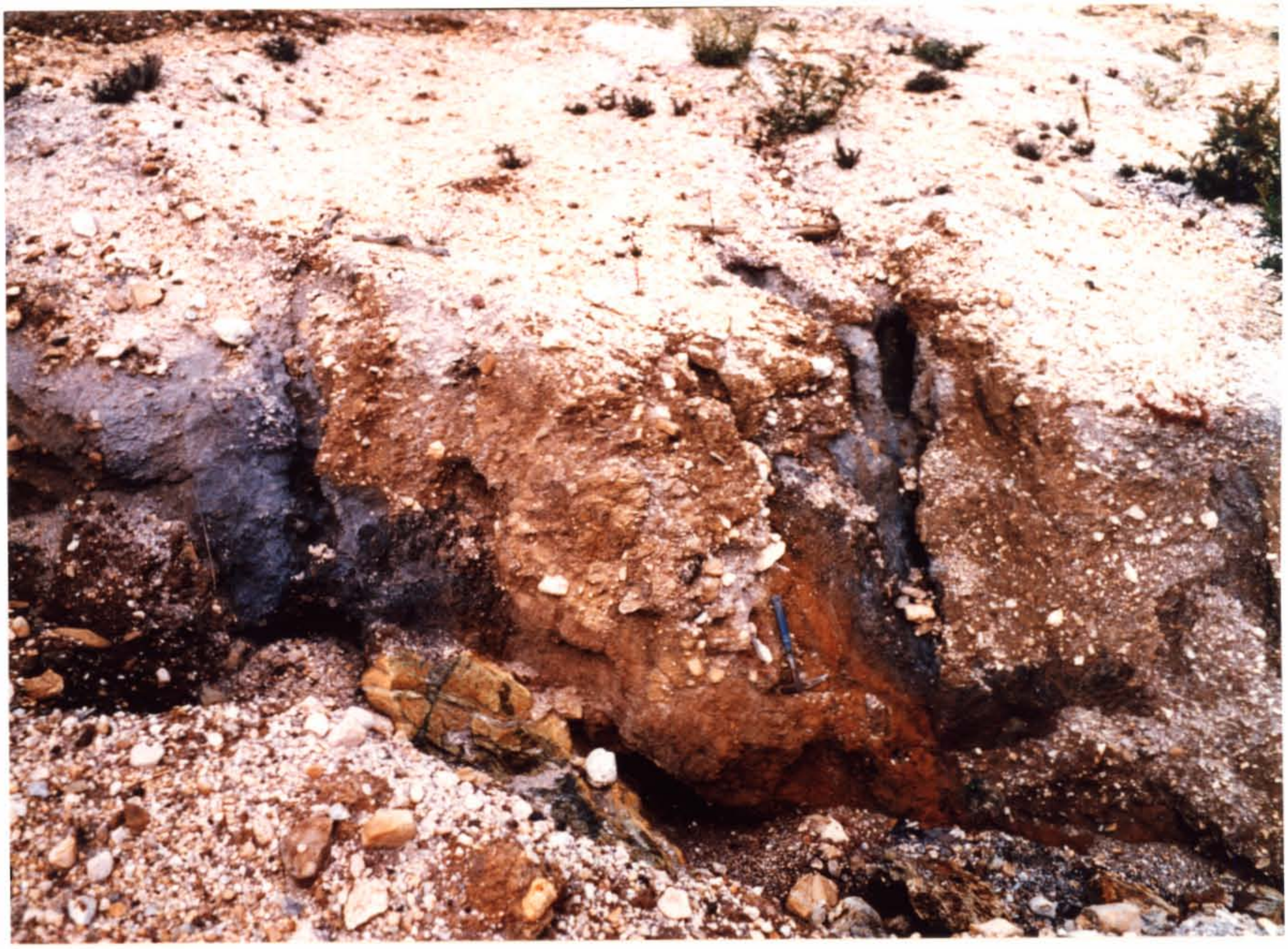

PHOTO 12

Detail of chromite sand filled channel shown in right of photo 11, on previous page. Note layering of silica "platelets" and ferricrete fragments roughly confoimable with channel wall which is ultramafic saprolite. Quartz "float" (white) at surface is exotic having been spread after mining to retard erosion.

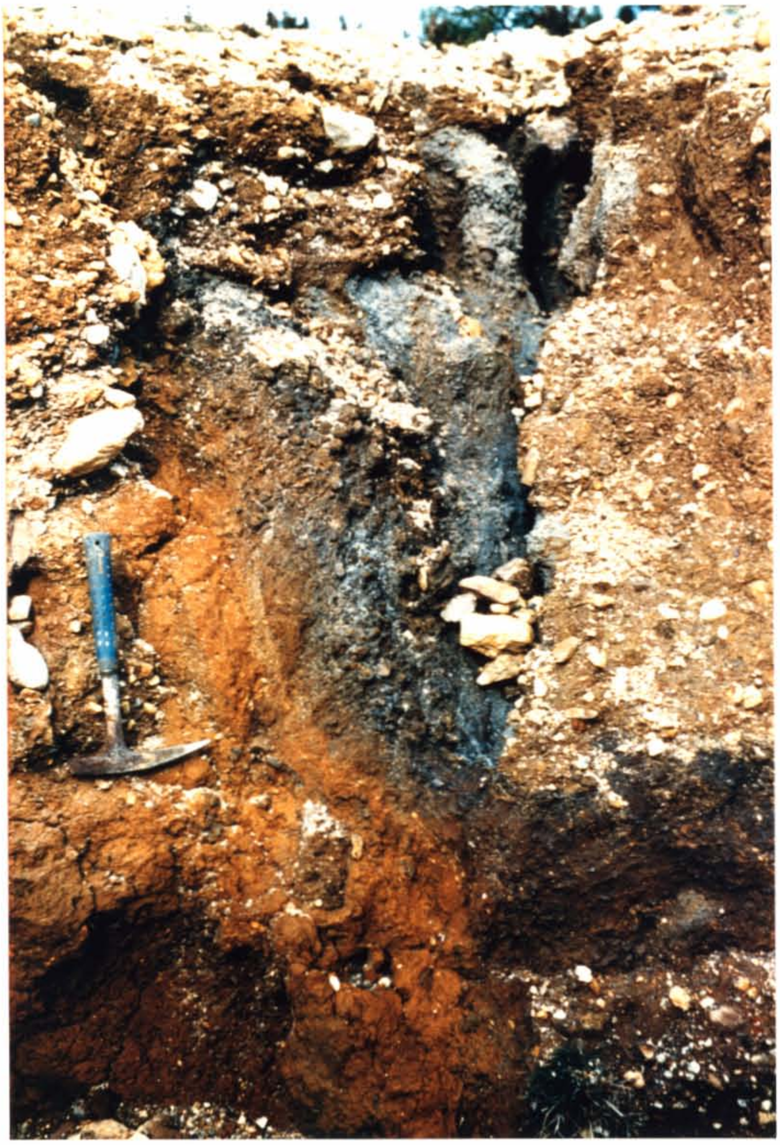

PHOTO 13

Stockpile (or dump) of fine, processed, chromite sand from which sample number 62514 was taken. Contained chromite has the following approximate composition:-

CR_2O_3	FeO	Al_2O_3	MgO	CaO	SiO_2
57%	18%	10%	8.5%	<0.2%	0.7%

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ANDERSONS CREEK CHROMITE PROJECT,
GEOCHEMICAL - ENVIRONMENTAL INVESTIGATIONS
BY J. MIEDECKE

936057

JOHN MIEDECKE AND PARTNERS PTY LIMITED

engineering, environmental and planning consultants

ANDERSONS CREEK CHROMITE PROJECT

GEOCHEMICAL-ENVIRONMENTAL INVESTIGATIONS

Prepared for : Australian Consolidated Minerals Limited

July 1986

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Table of Contents

1.0 INTRODUCTION

Austamax, now Australian Consolidated Minerals, hold an exploration licence over the Andersons Creek area near Beaconsfield in Northern Tasmania. Chromite was previously mined in the area, the small surface mine and plant closing in 1982 due to the depletion of reserves.

After a review of available information, ACM suspected an inbalance between assayable Chromium (Cr) and recoverable chromite with an apparent Cr loss from the system. Because of the reserve implications it was necessary to trace the "missing" Cr, and for environmental reasons it was considered prudent to check whether any Cr or other toxic elements were being released into surface waters, clays or silts.

John Miedecke and Partners Pty. Ltd. was engaged to carry out the sampling, and report on any environmental implications. Dr. Stuart Miller, a specialist in environmental chemistry, was engaged in a subconsultant's role.

2.0 OBJECTIVES

The purpose of this study was to investigate the distribution of potentially toxic elements- readily soluble and less readily soluble, in a variety of natural materials on and in the vicinity of the Andersons Creek ultramafic outcrop, with particular attention to the element Cr.

More specifically, the objectives were:

- To carry out sampling of water, sediments and biota in the Andersons Creek catchment at locations specified by ACM.
- To conduct analyses of samples collected.
- To interpret results with respect to the environmental significance and geochemical processes.
- To recommend any further investigation required.

3.0 GEOLOGICAL ENVIRONMENT AND CHROMIUM CHEMISTRY

3.1 Geological Environment (extracted from ACM report by J.E.Thompson).

The chromite deposits at Barnes Hill and Rifle Range are residual and alluvial concentrations derived from peridotite components of a fault bounded wedge of mafic and ultramafic rocks to which a Cambrian age of emplacement has tentatively been assigned (Gee and Legge, 1974)

This mafic-ultramafic Complex is exposed over an elongate area of low to moderate relief, approximately 5km long and 1.5km wide, aligned north-north-westerly. The middle reach of Andersons Creek flows roughly along the axis of the complex and the south-eastern flank is drained by western tributaries of Middle Arm Creek. Both of these drainages flow into the Tamar Estuary.

The Complex comprises about 70% peridotite (harzburgite, dunite and pyroxenite) about 20% basic feldspathic rocks (gabbro, anorthorite, albitite) and 10% rodingite and dynamically metamorphosed sediments. These latter rocks are probably metamorphic products associated with the dynamics of thrusting . Crude mineral and rock type layering suggests regional zoning from gabbroic facies along the western margin, through harzburgite, to dunite along the eastern flank which implies a westerly dipping sequence comprising gabbro over harzburgite over dunite.

To the north and south, unconformable Permian and Tertiary sediments limit the outcrop of the mafic-ultramafic complex, whereas on the east, faulted contact with steeply dipping Ordovician fine sandstone and shale (Cabbage Tree Formation) can be inferred from a few outcrops and drill information at Rifle Range.

The western boundary of the Complex is a major fault along which the mafic-ultramafic block has been thrust against, and probably over, a thick sequence of fine clastic sediments which forms the Dazzler and Asbestos Ranges. These sediments have turbidite affinities and have been tightly folded but only feebly metamorphosed. they were presumed by Gee and Legge (1974) to be Precambrian. However, they may well be Palaeozoic trough sediments which have responded incompetently to thrusting from the east to produce a complexly folded and faulted imbricate "package" which, because of its structural complexity, was assigned to the preCambrian.

The source of detrital chromite in the Barnes Hill and Rifle Range deposits is the ultramafic rocks within the mafic-ultramafic complex. In order of importance these are harzburgite, dunite and pyroxenite. The chromite is randomly distributed through all three facies comprising 0.5 to 1.5 percent approximately. Locally chromite occurs in durite as high concentration clusters and gravitationally differentiated layers to 3cm thick containing up to 50% chromite as closely packed modified euhedra up to 2mm in diameter..

The chromite has been released and concentrated through successive processes of serpentinisation, lateritic weathering and erosion during the pre-Tertiary. The early Tertiary land surface on which chromite bearing laterites and minor surficial alluvial chromite deposits had formed was blanketed by sequence of mid and late Tertiary quartzose gravels up to 40 metres thick. This gravel sequence has subsequently been partly eroded and remnants of the pre-tertiary land surface have been exhumed. It is on these surfaces that the economically interesting chromite deposits occur.

3.2 Chromium Chemistry

Chromite is highly resistant to weathering and only a very small amount is released under normal weathering conditions. Any Chromium (Cr) released is strongly adsorbed by organic matter and hydrous oxides of Aluminium (Al), Iron (Fe) and Manganese (Mn) and precipitated as an oxide. This results in only minor amounts in solution.

Streams draining from an ore body would therefore be expected to concentrate Cr in the stream sediments as both hydromorphic (adsorbed) where Cr has been dissolved, and as detrital chromite, as products of erosion.

Cr is amphoteric, the three common oxidation states are 2+, 3+ and 6+. The trivalent and hexavalent forms are of primary environmental concern. However, the trivalent form is not present at pH above 5 (i.e more alkaline).

Fresh water concentrations of Cr are very low, usually less than 0.001 mg/l. Seawater contains only 0.00005 mg/l. Some general water quality guidelines have been recommended for Cr and are as follows:

Drinking water <0.05 mg/l
Irrigation Water <0.1 mg/l
Fresh water organisms < 0.05 mg/l
Marine Organisms (particularly oysters) <0.01 mg/l

There is little information on Cr levels in fish or shellfish. Fisheries authorities apparently use a limit of 1 to 2 mg/kg for oysters.

The normal level of Cr in non-mineralised soils is approximately 100 mg/kg. Soils with greater than 200 mg/kg are slightly contaminated and more than 2,000 mg/kg is considered highly contaminated.

These guidelines provide a basis for assessing the baseline for this study.

4.0 STUDY METHODS

4.1 Sampling

Sampling was carried out in the two months period between February and April. Locations of the samples were determined by ACM. Conditions were typical of a Tasmanian summer - being warm and dry. One water sample was taken after the first late Summer-Autumn rains (24 April), when runoff occurred from the area draining the old tailings dams.

4.1.1 Water

Sample locations are shown in Figure 1. Four samples were taken from standing waters, three on the eastern side of the EL (Sample numbers BC3-5) and one near Andersons Creek downslope of the Barnes Hill mine area (BC1). The latter was from an enclosed dam. Later observations showed that this dam was independent from the surrounding drainage and was therefore not representative of the waters of the area. One other sample was taken from running water in a buttongrass swamp draining into the Beaconsfield Reservoir (BC2). As mentioned above, a sample was taken of waters draining the old tailings dams after the first period of rain (BA).

All water samples were immediately taken to the Department of Mines Laboratories in Launceston where they were analysed for pH and conductivity. The samples were then filtered, acidified with HNO_3 and forwarded to the WA laboratory for analyses.

4.1.2 Sediments

These comprised stream sediments, black organic silts from swamps, and residual and bedded clays from Barnes Hill.

Sample locations are shown in Figure 1. Ten -80 mesh stream sediments were taken from the stream floor from sites where heavy minerals (e.g chromite) were not expected to have concentrated.

Organic silts from contemporary swamps were obtained by a power auger. Prefix 'a' denotes a sample taken approximately in the middle of the profile. Prefix 'b' denotes a sample taken from the base of the profile, just below the black clay in the boulder zone or in a significant colour change which could denote an acid leaching.

Pre-tertiary layered clays and saprolite residual clays derived from chromite bearing serpentinite were sampled at Barnes Hill - samples C1-4. C5 was taken by ACM from the Rifle Range area. C1 was from an old costean approximately 30m to the east of the Barnes Hill surface workings, and just below the rich chromite bearing sands and silts. Samples C2-4 were taken from an erosion gully within the mined area and were taken down the profile, again below the chromite layer.

4.1.3 Biota

Biological samples were taken from both estuarine and fresh waters. Locations are shown in Figure 1.

Estuarine species consisted of oysters and flathead. Oysters are well known as accumulators of heavy metals and flathead are the most widespread table fish. Freshwater species consisted of trout which are regularly caught as a sporting fish by the locals, and eels which are a long living bottom feeding fish.

Oysters were collected from the rocks at low tide - approximately 15 at the two locations - one near the entrance of Andersons Creek and another approximately 1km down the estuary. These were shucked and combined. Flathead (2-3) were caught by line fishing at one location. The freshwater species were procured by the Inland Fisheries Commission. An electric shocking unit was used in Andersons Creek and a gill net in the Beaconsfield Reservoir.

All fish were filleted and frozen before forwarding to the laboratory.

4.2 Analytical Testing

Three different accredited laboratories were used to analyse the samples.

4.2.1 Water

Water samples were analysed by Analytical Services (WA) Pty. Ltd. in Perth WA. Full details of the methods are included in Appendix A . Most of the analyses were by Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

4.2.2 Sediments

All samples were split and submitted by the Department Of Mines Launceston Laboratories for water, hot and cold acid (HCL), and hot and cold NaOH extraction.

4.2.3 Biota

Fish and shellfish samples were analysed at the Hobart based Allison Laboratories. A full list of techniques is include in Appendix B.

5.0 RESULTS AND DISCUSSION

This section presents and discusses the results of the field and laboratory investigations.

5.1 Water

Six water samples were collected for analysis as described in section 3.2.1. The results of field measurements and ICPMS analysis are given in Appendix A. The results show that the surface waters are acid , pH 4.3 to 4.9 (except for sample BC1 which is from a dam with limited catchment and has a pH of 7.2 - this site is considered non representative of the catchment). The water has a very low salinity with the electrical conductivity ranging from 69 to 125 µS/cm. The levels of heavy metals and specific ions are low except for Hg which exceeds drinking water criteria. This finding was referred to the Department of Mines, and subsequently the Department of the Environment repeated sampling at selected sites and analysed for Cd, Cu, Pb, Zn, Hg and NFR (non-filtrable residue). The results of these analyses are given in Appendix B and show that Hg levels were below the detection limit of 4 µg/l. However, this sampling was undertaken after heavy rain when the catchment had been flushed and it may not be a proper indication of the Hg content in low flow periods .

Even though surface waters are acid with a very low buffering capacity, the concentration of Cr in all samples was very low, less than 50 µg/l. This result indicates the Cr in the mineralised zone is relatively immobile with negligible impact on the environment.

A sample of seepage water from the old tailings dam was also collected and analysed. The results show that the seepage has a neutral pH and a low salinity (EC 250 µS/cm). The concentration of heavy metals and specific ions are also low. The levels of Cr and Hg are below the detection limit confirming the limited solubility and mobility of metals in this environment.

5.2 Sediments

Samples of stream sediment, organic peat and bedded residual clays beneath the ore zone were sampled and analysed for extractable and total Cr. Water, cold HCl, hot HCl and hot and cold NaOH extractable Cr was determined. The results are presented as mg of Cr per kg of sample and are given on Table 1. No Cr was removed by water and therefore this catagory is not listed in Table 1.

The results show that the content of Cr in all sediment, peat and clay samples are high relative to normal levels in non mineralised rocks and soils. However, the levels in samples associated with the ore body are significantly higher than other samples and range up to 4.8% Cr. There is definite hierarchy with samples closest - and downstream-of Barnes Hill, having the highest concentrations. These are sediment samples 4 and 5, and organics O3 and O5 (refer Figure 1 for locations).

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Table 1 **Sediments- Cr Extractions**

DATABASE NO	Sample No#.	Cold HCL all results mg/kg (ppm)	Hot HCL	Cold NaOH	Hot NaOH	Total Cr	
1831	S1	10	40			7000	
1832	S2	40	130			2600	
1833	S3	0	20			200	
	S4	110	360			15400	NOT ON MAP
1834	S5	440	1830			47700	
1835	S6	40	280			1400	
1836	S7	20	80			*	
1837	S8	180	730			*	
18356	S9	170	480			2900	
	S10	10	30			1000	NOT ON MAP
	O1a	110	170			800	
	O1b	140	180			1000	
organic peats in swamps	O2a	20	70			1400	
	O2b	40	70			2700	
	O3a	430	1180			27500	
	O3b	750	2100			48800	
	O4a	110	450			4800	
	O4b	530	1230			14600	
	O5a	1250	1750	2	4	49000	
	O5b	450	730			14200	
	C1	1090	3040			12900	
	C2	4640	7200	3	2	28600	
Clays	C3	2220	2770			19000	
	C4	1610	2590			17000	
	C5	4700	3130			34300	

Refer to Figure 1 for sample locations. * Insufficient sample for analyses

Sediments and peat-showed an excellent correlation between extractable and total Cr (see Figures 2and 3), clays much less so (Figure 4).

In peat and sediments, hot HCl was more effective at extracting Cr than Cold HCl (2 times and 4 times respectively) . However, in the clay samples the results were variable with cold more efficient than hot in some samples and hot more efficient than cold in others.

Figures 2, 3 and 4 show that for a given level of total Cr the amount extracted by hot HCl is similar in peat and sediments but significantly higher in the clay samples. This suggests that Cr in the clay is more readily extractable than in the sediments and peat materials.

Even though there is less Cr in clays than either sediments or peat, the amount extractable is significantly greater.

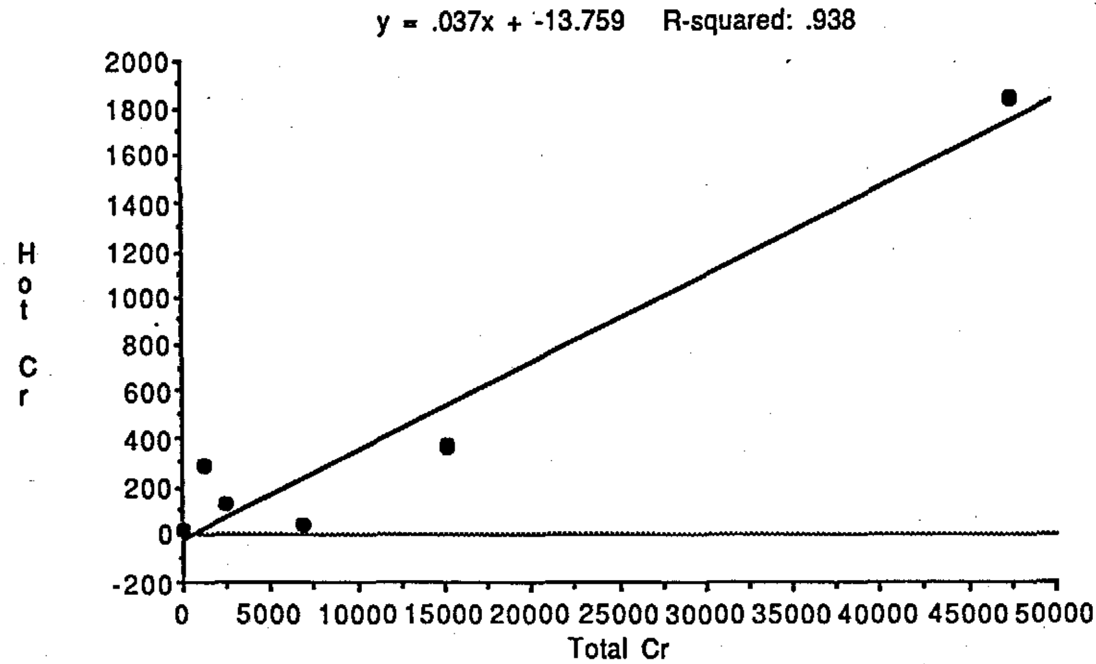

FIGURE 2 SEDIMENTS HOT ACID EXTRACTABLE VS TOTAL CR (all no's as mg/kg)

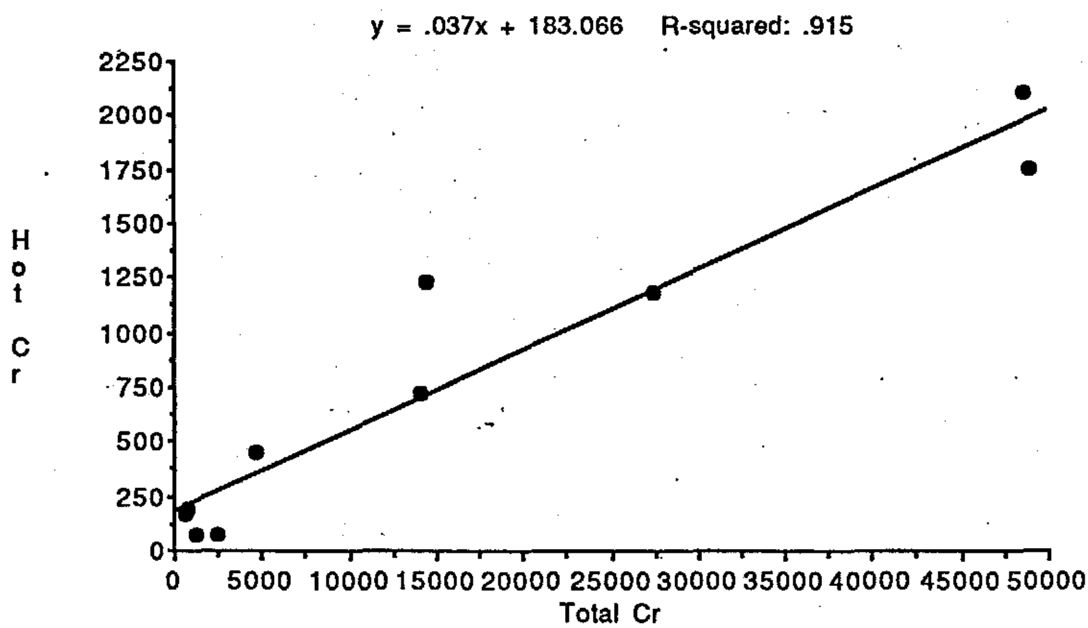

FIGURE 3 ORGANICS HOT ACID EXTRACTABLE VS TOTAL CR (all no's as mg/kg)

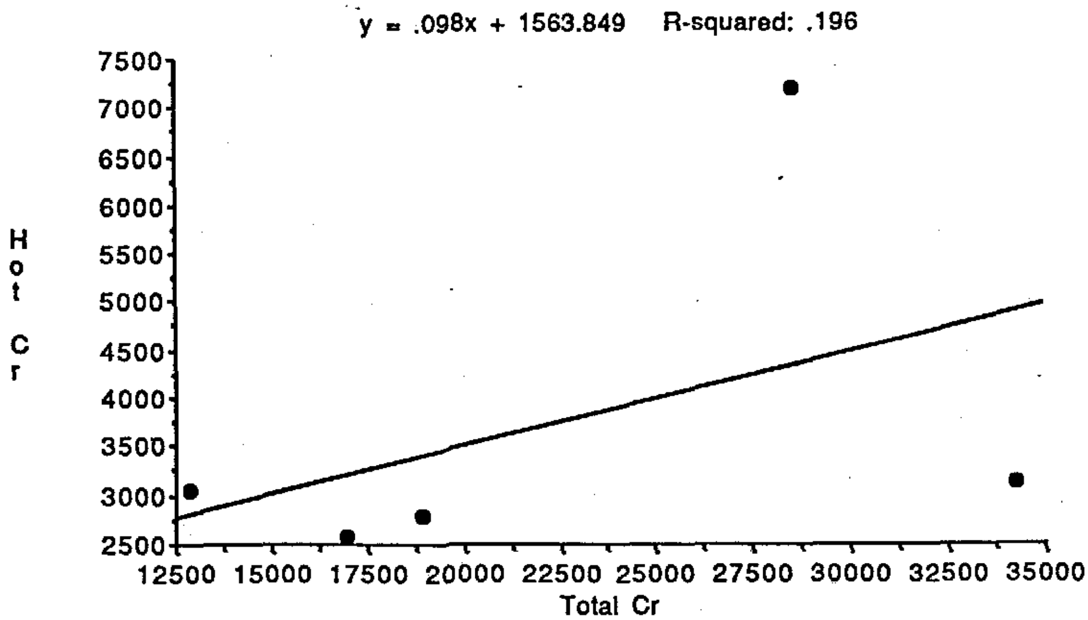

FIGURE 4 CLAYS HOT ACID EXTRACTABLE VS TOTAL CR (all no's as mg/kg)

5.3 Biological

The sampling results area are shown in Table 2, together with the applicable public health limits. The results show that there is an elevation of Cr levels in the biota in waters which were expected to have Cr in the sediments. That is, Andersons Creek and the estuary. However, although these exceed the PHS by a small amount, they are not of concern. Mercury levels in trout in the Beaconsfield Reservoir were determined because of the high Hg levels recorded in the water. Levels in the trout are below PHS in both cases.

TABLE 2 CR and Heavy Metal Concentrations - Biota

Sample	Hg	As	Zn	Cu	Pb	Cd	Cr	Location
	all results mg/kg.							
Oyst. A							1.7	Estuary
Oyst. B	0.08	0.01	880	210	0.9	1.4	1.0	AndersonCr.& Est.
Flat.	0.15	0.04	7.3	0.4	<0.4	0.1	0.1	Estuary
Trout A	0.50	<0.01	7.9	0.6	<0.4	0.1	0.6	Anderson Creek
Trout B	0.48						<0.1	Beac. Reservoir
Trout C							<0.1	Beac. Reservoir
Eels							1.2	Anderson Creek
Public Health Standard	1.0	1.0	1500	70	2.5	2.5	1.0	

6.0 CONCLUSIONS

The results of the water and biological sampling all confirm that there are no significant environmental hazards associated with the chromite resources at Barnes Hill or Rifle Range. This is despite extensive disturbance from mining operations and contamination from collapsed tailings dams. High concentrations of Cr were observed in the peats, sediments and clays associated with ore bodies. However, at the pH and leaching environmental conditions existing in the Andersons Creek catchment, this Cr is not soluble and will remain tightly fixed in these materials.

The high Hg levels are still of concern, and while these are not related to mining activities, it is recommended that additional sampling by an appropriate authority should be carried out in the next dry period.

It has been suggested that the remobilisation and accumulation of Cr in the various soil layers was a function of past groundwater movement and organic acids. It is also possible that Cr accumulation in the soil layers was related to past variable redox conditions.

This has obvious resource economic implications, and if further investigations are proposed, an investigation into the solubility of Cr using various organic solvents, oxidising and reducing agents is recommended.

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7.0 APPENDICES

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DEPARTMENT OF MINES—TASMANIA

TELEPHONES:
Metallurgical Research .. .. } 44 2431-2 (2 lines)
Laboratory .. .. ..
Mines Inspection .. .. ..
Explosives & Inflammable Liquids

LAUNCESTON OFFICES
287 WELLINGTON STREET
SOUTH LAUNCESTON 7249

April 7, 1986

Mr J Miedecke
Austamax Resources Ltd
20 Invermay Road
INVERMAY TAS 7248

Reg Nos. 860348-357

Dear Sir

Please find below results of samples submitted to this laboratory on March 21, 1986.

The 10 Cr bearing sediments were leached for 5 hours with cold water, hot water, cold conc. HCl and hot conc. HCl.

Chromium was not extracted with either the cold or hot water.

The results of the HCl leachings are listed below as a percentage of sample extracted as Cr (not Cr_2O_3).

Reg Nos	Description	Cold HCl	Hot HCl
860348	Sed 1	0.001	0.004
860349	Sed 3	nil	0.002
860350	01 A	0.011	0.017
860351	01 B	0.014	0.018
860352	05 A	0.125	0.175
865353	05 B	0.045	0.073
860354	C1	0.109	0.304
860355	C2	0.464	0.720
860356	C3	0.222	0.277
860357	C4	0.161	0.259

Analyses by ....L. M. Fley.

Fee $200.00

Yours faithfully

(L J Rhodes)
Acting Chief Chemist & Metallurgist

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DEPARTMENT OF MINES—TASMANIA

TELEPHONES:
Metallurgical Research .. ..
Laboratory .. .. ..
Mines Inspection .. .. ..
Explosives & Inflammable Liquids
} 44 2431-2 (2 lines)

LAUNCESTON OFFICES
287 WELLINGTON STREET
SOUTH LAUNCESTON 7250

24th April 1986

Austamax Resources Ltd,
C/- Mr. J. Miedecke,
20 Rees Street,
LAUNCESTON

Reg. Nos 860352 - 55

Dear Sir,

Please find below results of samples submitted to this laboratory on 21st Mar'86. Further analyses requested by Mr. J. Thompson.

Reg. No	Description	Cold NaOH Leach % Cr Extracted	Hot NaOH Leach % Cr Extracte
860352	05 A	0.02	0.04
860355	C2	0.03	0.02

Note: The results of the leachings are listed above as percentage of sample extracted as Cr (not Cr_2O_3)
(Not as % of Cr extracted).
The Chromium bearing sediments were leached for 5 hours wit cold 0.2M NaOH, hot 0.2M NaOH.

Analyses by.. [signature]

(L.J. Rhodes)
Acting Chief Chemist & Metallurgist

Fee $20.00

071 AM 1588

936072

DEPARTMENT OF MINES—TASMANIA

TELEPHONES:
Metallurgical Research .. .. }
Laboratory .. .. .. } 44 2431-2
Mines Inspection .. .. .. } (2 lines)
Explosives & Inflammable Liquids }

LAUNCESTON OFFICES
287 WELLINGTON STREET
SOUTH LAUNCESTON 7250

2nd May 1986

Austamax Resources Ltd,
C/- Mr. J. Miedecke
20 Rees Street,
LAUNCRSTON

Reg. Nos 860557-71

Dear Sir,

Please find below results of samples submitted to this laboratory on the 23rd April 1986.

The results of the HCl leachings are listed below as a percentage of sample extracted as Cr (not Cr_2O_3).

Reg. No	Description	Cold HCl % Sample extracted as Cr.	Hot HCl % Sample extracted as
860557	S 2	0.004	0.013
860558	S 4	0.011	0.036
860559	S 5	0.044	0.183
860560	S 6	0.004	0.028
860561	S 7	0.003	0.008
860562	S 8	0.018	0.073
860563	S 9	0.017	0.048
860564	S 10	0.001	0.003
860565	O 2 A	0.002	0.007
860566	O 2 B	0.004	0.007
860567	O 3 A	0.043	0.118
860568	O 3 B	0.075	0.210
860569	O 4 A	0.011	0.045
860570	O 4 B	0.053	0.123
860571	C 5	0.047	0.313

Analyses by...L.M.Floy.

Yours faithfully,

(L.J. Rhodes)
Acting Chief Chemist & Metallurgist

Fee $150.00

072

936073

COPY

18th June 1986

Austamax
5 West Street
BEACONSFIELD Tas.

Reg. Nos 860557-71

Dear Sir,

Please find below further results on samples submitted to this laboratory on the 23rd April 1986 and stated to be from the Beaconsfield area.

Reg. No	Description		% Cr_2O_3
860557	S 2		0.39
558	S 4		2.26
559	S 5		7.02
560	S 6		0.20
561	S 7	No Sample	
562	S 8	No Sample	
563	S 9		0.42
564	S 10		0.15
565	O 2A		0.21
566	C 2B		0.39
567	O 3A		4.05
568	O 3B		7.17
569	O 4A		0.72
570	O 4B		2.15
571	C 5		5.05

Yours faithfully,

(L.J. Rhodes)
Acting Chief Chemist & Metallurgist

Analyses by.........

865

073

REFERENCE NUMBER 28729

1 MAY , 1986

ORDER NUMBER 8604242

John Miedecke and Partners Pty Limited
****

20 Rees Street

LAUNCESTON TAS 7248

Analysis of Solutions
****

ANALYSED BY :
ANALYTICAL SERVICES (WA) PTY LTD
19 AUGUSTA ST
WILLETTON WA 6155
TELEPHONE 457 1496 457 2569
TELEX AA 94767

AUTHORISED BY : C.L. ELDRIDGE

936074

074

****

Sample Det Limit

Li	< 5 ppb	Be	< 1 ppb	B	< 20 ppb	Na	ppb	Mg	<0.5 ppm	Al	<0.5 ppm
Si	<0.2 ppm	P	<0.1 ppm	S	<0.5 ppm	K	ppb	Ca	<0.2 ppm	Sc	< 50 ppb
Ti	< 5 ppb	V	< 5 ppb	Cr	< 2 ppb	Mn	< 20 ppb	Fe	<0.5 ppm	Ni	< 5 ppb
Co	< 2 ppb	Cu	< 10 ppb	Zn	<0.2 ppb	Ga	< 2 ppb	Ge	< 50 ppb	As	< 10 ppb
Se	<200 ppb	Rb	< 1 ppb	Sr	< 2 ppb	Y	< 1 ppb	Zr	< 5 ppb	Nb	< 20 ppb
Mo	< 10 ppb	Ru	< 2 ppb	Rh	<0.5 ppb	Pd	< 5 ppb	Ag	< 5 ppb	Cd	< 5 ppb
In	<0.5 ppb	Sn	< 20 ppb	Sb	< 10 ppb	I	< 50 ppb	Te	< 50 ppb	Cs	< 1 ppb
Ba	< 5 ppb	La	< 1 ppb	Ce	< 2 ppb	Pr	<0.5 ppb	Nd	< 2 ppb	Sm	< 2 ppb
Eu	< 1 ppb	Gd	< 5 ppb	Tb	<0.5 ppb	Dy	< 2 ppb	Ho	<0.5 ppb	Er	< 2 ppb
Tm	< 2 ppb	Yb	< 2 ppb	Lu	< 1 ppb	Hf	< 20 ppb	Ta	< 5 ppb	W	< 50 ppb
Re	< 2 ppb	Os	< 10 ppb	Ir	< 2 ppb	Pt	< 5 ppb	Au	< 5 ppb	Hg	< 20 ppb
Tl	< 2 ppb	Pb	<200 ppb	Bi	< 5 ppb	Th	< 2 ppb	U	< 2 ppb		

Sample BC 1 — Dam near Anderson's Creek (mostly direct rainfall) PH 7.2 Cond 190

Li	< 5 ppb	Be	< 1 ppb	B	20 ppb	Na	17 ppm	Mg	15 ppm	Al	<0.5 ppm
Si	0.2 ppm	P	<0.1 ppm	S	2.0 ppm	K	780 ppb	Ca	1.8 ppm	Sc	< 50 ppb
Ti	< 5 ppb	V	10 ppb	Cr	4 ppb	Mn	120 ppb	Fe	<0.5 ppm	Ni	10 ppb
Co	8 ppb	Cu	< 10 ppb	Zn	37 ppb	Ga	< 2 ppb	Ge	100 ppb	As	< 10 ppb
Se	<200 ppb	Rb	6 ppb	Sr	46 ppb	Y	1 ppb	Zr	45 ppb	Nb	< 20 ppb
Mo	< 10 ppb	Ru	< 2 ppb	Rh	<0.5 ppb	Pd	< 5 ppb	Ag	35 ppb	Cd	20 ppb
In	<0.5 ppb	Sn	< 20 ppb	Sb	490 ppb	I	100 ppb	Te	< 50 ppb	Cs	5 ppb
Ba	50 ppb	La	8 ppb	Ce	12 ppb	Pr	1.0 ppb	Nd	4 ppb	Sm	< 2 ppb
Eu	1 ppb	Gd	< 5 ppb	Tb	<0.5 ppb	Dy	< 2 ppb	Ho	<0.5 ppb	Er	< 2 ppb
Tm	< 2 ppb	Yb	< 2 ppb	Lu	< 1 ppb	Hf	< 20 ppb	Ta	< 5 ppb	W	< 50 ppb
Re	< 2 ppb	Os	< 10 ppb	Ir	< 2 ppb	Pt	< 5 ppb	Au	< 5 ppb	Hg	< 20 ppb
Tl	2 ppb	Pb	9.4 ppm	Bi	< 5 ppb	Th	< 2 ppb	U	< 2 ppb		

Sample BC 2 — Sedge swamp draining u/s Th'fold Water Supply PH 4.3 Cond 69

Li	< 5 ppb	Be	< 1 ppb	B	< 20 ppb	Na	7.8 ppm	Mg	1.0 ppm	Al	<0.5 ppm
Si	2.6 ppm	P	<0.1 ppm	S	<0.5 ppm	K	510 ppb	Ca	0.8 ppm	Sc	< 50 ppb
Ti	10 ppb	V	< 5 ppb	Cr	< 2 ppb	Mn	80 ppb	Fe	<0.5 ppm	Ni	5 ppb
Co	2 ppb	Cu	< 10 ppb	Zn	84 ppb	Ga	< 2 ppb	Ge	100 ppb	As	< 10 ppb
Se	<200 ppb	Rb	3 ppb	Sr	12 ppb	Y	< 1 ppb	Zr	< 5 ppb	Nb	< 20 ppb
Mo	< 10 ppb	Ru	< 2 ppb	Rh	0.5 ppb	Pd	5 ppb	Ag	10 ppb	Cd	< 5 ppb
In	<0.5 ppb	Sn	40 ppb	Sb	< 10 ppb	I	100 ppb	Te	< 50 ppb	Cs	9 ppb
Ba	25 ppb	La	17 ppb	Ce	< 2 ppb	Pr	<0.5 ppb	Nd	< 2 ppb	Sm	< 2 ppb
Eu	< 1 ppb	Gd	< 5 ppb	Tb	<0.5 ppb	Dy	< 2 ppb	Ho	<0.5 ppb	Er	2 ppb
Tm	< 2 ppb	Yb	< 2 ppb	Lu	< 1 ppb	Hf	< 20 ppb	Ta	10 ppb	W	< 50 ppb
Re	< 2 ppb	Os	< 10 ppb	Ir	< 2 ppb	Pt	< 5 ppb	Au	< 5 ppb	Hg	40 ppb
Tl	< 2	Pb	<200	Bi	< 5	Th	< 2	U	[illegible]		

936075

Sample BC 3 — Beaconsfield Reservoir — PH 4.9 Cond 125

Li	< 5 ppb	Be	< 1 ppb	B	< 20 ppb	Na	1[illegible]	Mg	2.5 ppm	Al	<0.5 ppm
Si	1.2 ppm	P	<0.1 ppm	S	3.5 ppm	K	1.8 ppm	Ca	2.2 ppm	Sc	< 50 ppb
Ti	< 5 ppb	V	5 ppb	Cr	< 2 ppb	Mn	60 ppb	Fe	<0.5 ppm	Ni	< 5 ppb
Co	2 ppb	Cu	< 10 ppb	Zn	78 ppb	Ga	< 2 ppb	Ge	150 ppb	As	< 10 ppb
Se	<200 ppb	Rb	2 ppb	Sr	18 ppb	Y	< 1 ppb	Zr	< 5 ppb	Nb	< 20 ppb
Mo	< 10 ppb	Ru	< 2 ppb	Rh	0.5 ppb	Pd	< 5 ppb	Ag	< 5 ppb	Cd	< 5 ppb
In	1.0 ppb	Sn	< 20 ppb	Sb	< 10 ppb	I	400 ppb	Te	< 50 ppb	Cs	< 1 ppb
Ba	15 ppb	La	< 1 ppb	Ce	< 2 ppb	Pr	0.5 ppb	Nd	4 ppb	Sm	< 2 ppb
Eu	< 1 ppb	Gd	< 5 ppb	Tb	<0.5 ppb	Dy	< 2 ppb	Ho	<0.5 ppb	Er	< 2 ppb
Tm	< 2 ppb	Yb	< 2 ppb	Lu	< 1 ppb	Hf	< 20 ppb	Ta	< 5 ppb	W	< 50 ppb
Re	< 2 ppb	Os	70 ppb	Ir	< 2 ppb	Pt	< 5 ppb	Au	10 ppb	Hg	120 ppb
Tl	6 ppb	Pb	<200 ppb	Bi	< 5 ppb	Th	4 ppb	U	< 2 ppb		

Sample BC 4 — Bruins Pond — PH 4.5 Cond 105

Li	< 5 ppb	Be	< 1 ppb	B	< 20 ppb	Na	15 ppm	Mg	2.0 ppm	Al	<0.5 ppm
Si	1.4 ppm	P	<0.1 ppm	S	1.5 ppm	K	430 ppb	Ca	0.8 ppm	Sc	< 50 ppb
Ti	< 5 ppb	V	< 5 ppb	Cr	2 ppb	Mn	20 ppb	Fe	<0.5 ppm	Ni	< 5 ppb
Co	< 2 ppb	Cu	< 10 ppb	Zn	56 ppb	Ga	< 2 ppb	Ge	100 ppb	As	< 10 ppb
Se	<200 ppb	Rb	< 1 ppb	Sr	8 ppb	Y	< 1 ppb	Zr	< 5 ppb	Nb	< 20 ppb
Mo	< 10 ppb	Ru	< 2 ppb	Rh	<0.5 ppb	Pd	< 5 ppb	Ag	< 5 ppb	Cd	< 5 ppb
In	0.5 ppb	Sn	< 20 ppb	Sb	< 10 ppb	I	200 ppb	Te	< 50 ppb	Cs	< 1 ppb
Ba	10 ppb	La	< 1 ppb	Ce	< 2 ppb	Pr	<0.5 ppb	Nd	< 2 ppb	Sm	< 2 ppb
Eu	< 1 ppb	Gd	< 5 ppb	Tb	<0.5 ppb	Dy	< 2 ppb	Ho	<0.5 ppb	Er	< 2 ppb
Tm	< 2 ppb	Yb	2 ppb	Lu	< 1 ppb	Hf	< 20 ppb	Ta	< 5 ppb	W	< 50 ppb
Re	< 2 ppb	Os	30 ppb	Ir	< 2 ppb	Pt	< 5 ppb	Au	< 5 ppb	Hg	80 ppb
Tl	4 ppb	Pb	<200 ppb	Bi	< 5 ppb	Th	2 ppb	U	< 2 ppb		

Sample BC 5 — Brandy Pond — PH 4.7 Cond 105

Li	< 5 ppb	Be	< 1 ppb	B	< 20 ppb	Na	15 ppm	Mg	2.5 ppm	Al	<0.5 ppm
Si	0.8 ppm	P	<0.1 ppm	S	1.5 ppm	K	430 ppb	Ca	1.0 ppm	Sc	< 50 ppb
Ti	< 5 ppb	V	< 5 ppb	Cr	< 2 ppb	Mn	40 ppb	Fe	<0.5 ppm	Ni	< 5 ppb
Co	< 2 ppb	Cu	< 10 ppb	Zn	54 ppb	Ga	< 2 ppb	Ge	150 ppb	As	10 ppb
Se	<200 ppb	Rb	1 ppb	Sr	16 ppb	Y	< 1 ppb	Zr	< 5 ppb	Nb	< 20 ppb
Mo	< 10 ppb	Ru	< 2 ppb	Rh	1.0 ppb	Pd	< 5 ppb	Ag	< 5 ppb	Cd	< 5 ppb
In	<0.5 ppb	Sn	< 20 ppb	Sb	< 10 ppb	I	150 ppb	Te	< 50 ppb	Cs	< 1 ppb
Ba	15 ppb	La	< 1 ppb	Ce	< 2 ppb	Pr	<0.5 ppb	Nd	< 2 ppb	Sm	< 2 ppb
Eu	< 1 ppb	Gd	< 5 ppb	Tb	<0.5 ppb	Dy	< 2 ppb	Ho	<0.5 ppb	Er	< 2 ppb
Tm	< 2 ppb	Yb	< 2 ppb	Lu	< 1 ppb	Hf	< 20 ppb	Ta	< 5 ppb	W	< 50 ppb
Re	< 2 ppb	Os	20 ppb	Ir	< 2 ppb	Pt	< 5 ppb	Au	< 5 ppb	Hg	80 ppb
Tl	4 ppb	Pb	<200 ppb	Bi	< 5 ppb	Th	< 2 ppb	U	< 2 ppb		

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076

Sample Det Limit

Li	= <0.5 ppb	Be	= <0.2 ppb	B	= <0.5 ppm	Na	= ppm	Mg	= <500 ppb	Al	= < 1 ppm
Si	= < 1 ppm	P	= <5000 ppb	S	= < 5 ppm	K	= ppm	Ca	= < 1 ppm	Sc	= < 50 ppb
Ti	= < 50 ppb	V	= <100 ppb	Cr	= < 50 ppb	Mn	= < 20 ppb	Fe	= < 2 ppm	Ni	= < 50 ppb
Co	= < 1 ppb	Cu	= <100 ppb	Zn	= 10 ppb	Ga	= <0.2 ppb	Ge	= < 50 ppb	As	= <200 ppb
Se	= < 50 ppb	Rb	= <0.2 ppb	Sr	= < 1 ppb	Y	= <0.5 ppb	Zr	= < 1 ppb	Nb	= < 5 ppb
Mo	= < 5 ppb	Ru	= <0.5 ppb	Rh	= <0.2 ppb	Pd	= < 1 ppb	Ag	= < 1 ppb	Cd	= < 2 ppb
In	= <0.2 ppb	Sn	= < 5 ppb	Sb	= < 2 ppb	I	= < 5 ppb	Te	= < 5 ppb	Cs	= <0.1 ppb
Ba	= < 1 ppb	La	= <0.5 ppb	Ce	= <0.5 ppb	Pr	= <0.2 ppb	Nd	= < 1 ppb	Sm	= <0.5 ppb
Eu	= <0.5 ppb	Gd	= <0.5 ppb	Tb	= <0.1 ppb	Dy	= <0.5 ppb	Ho	= <0.2 ppb	Er	= <0.5 ppb
Tm	= <0.1 ppb	Yb	= <0.5 ppb	Lu	= <0.5 ppb	Hf	= < 2 ppb	Ta	= <0.5 ppb	W	= < 10 ppb
Re	= < 1 ppb	Os	= < 5 ppb	Ir	= <0.5 ppb	Pt	= < 1 ppb	Au	= < 1 ppb	Hg	= < 5 ppb
Tl	= <0.5 ppb	Pb	= < 50 ppb	Bi	= < 1 ppb	Th	= <0.5 ppb	U	= <0.5 ppb		

Sample BA Anderson - Draining tailing dumps PH 7.2 Cond 250

Li	= <0.5 ppb	Be	= <0.2 ppb	B	= <0.5 ppm	Na	= 22 ppm	Mg	= 23 ppm	Al	= < 1 ppm
Si	= 7.7 ppm	P	= <5000 ppb	S	= 10 ppm	K	= 1.2 ppm	Ca	= 1.2 ppm	Sc	= < 50 ppb
Ti	= < 50 ppb	V	= <100 ppb	Cr	= < 50 ppb	Mn	= 60 ppb	Fe	= < 2 ppm	Ni	= 50 ppb
Co	= 5 ppb	Cu	= <100 ppb	Zn	= 10 ppb	Ga	= <0.2 ppb	Ge	= < 50 ppb	As	= <200 ppb
Se	= < 50 ppb	Rb	= 1.4 ppb	Sr	= 20 ppb	Y	= 45 ppb	Zr	= < 1 ppb	Nb	= < 5 ppb
Mo	= < 5 ppb	Ru	= <0.5 ppb	Rh	= <0.2 ppb	Pd	= < 1 ppb	Ag	= < 1 ppb	Cd	= < 2 ppb
In	= <0.2 ppb	Sn	= < 5 ppb	Sb	= < 2 ppb	I	= 220 ppb	Te	= < 5 ppb	Cs	= 0.2 ppb
Ba	= 13 ppb	La	= 470 ppb	Ce	= 1.1 ppm	Pr	= 110 ppb	Nd	= 350 ppb	Sm	= 62 ppb
Eu	= <0.5 ppb	Gd	= 60 ppb	Tb	= 0.6 ppb	Dy	= 4.0 ppb	Ho	= <0.2 ppb	Er	= <0.5 ppb
Tm	= 0.1 ppb	Yb	= 0.5 ppb	Lu	= <0.5 ppb	Hf	= < 2 ppb	Ta	= <0.5 ppb	W	= < 10 ppb
Re	= < 1 ppb	Os	= < 5 ppb	Ir	= <0.5 ppb	Pt	= < 1 ppb	Au	= < 1 ppb	Hg	= 20 ppb
Tl	= <0.5 ppb	Pb	= < 50 ppb	Bi	= < 1 ppb	Th	= 0.5 ppb	U	= <0.5 ppb		

936077

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077

NOTES ON ANALYSIS OF THESE SAMPLES

These elements have been determined directly on the sample supplied.
The elements Na and K have been determined by Atomic Absorption.
The elements .. Mg, Cr, V, Ni, As, Fe, Ti, Ca, Al, Zn, Cu, P and S
have been determined by Optical Emmission Plasma Spectrometry.
All other elements have been determined by Inductively Coupled Plasma - Mass Spectrometry.
Since short integration times have been used in assessing element concentrations,
these results should be considered SEMI-QUANTITATIVE.
The element detection limits for this analytical run have been reported,
and consideration should be given to them in relation to low level
positive results on samples.

936078

936079

078

TASMANIA

Department of the Environment

5th FLOOR, KIRKSWAY HOUSE
2 KIRKSWAY PLACE, HOBART

Enquiries: Mr. J. Isaac
Telephone: 30 8033 ext.6574
Postal Address:
G.P.O. Box 1396, Hobart 7001

Our Ref.: JAI/TAS 3/1
Your Ref.:

Mr. J.G. Miedecke
Principal
John Miedecke and Partners Pty. Ltd.
20 Rees Street
INVERMAY Tas. 7248.

-4 JUN 1986

Dear Sir,

MERCURY IN DAMS IN BEACONSFIELD AREA

I refer to your letter of the 7 May 1986.

On the 13 May 1986 this Department carried out water sampling in the same area referred to in your letter and the results are attached.

A copy of this letter has been forwarded to the Director of Mines.

Yours faithfully,

T.E. Brown
DIRECTOR OF ENVIRONMENTAL CONTROL

Enclosure

079

DEPARTMENT OF THE ENVIRONMENT

936080

Laboratory Report

NO. 1902

Reported to: Director

CEO

~~WPO~~ To Water

~~Laboratory~~

Departmental File No. 3/1

Lab. No. 86/1030-1043

Submitted by D. Bartle

Submission date 13/5/86

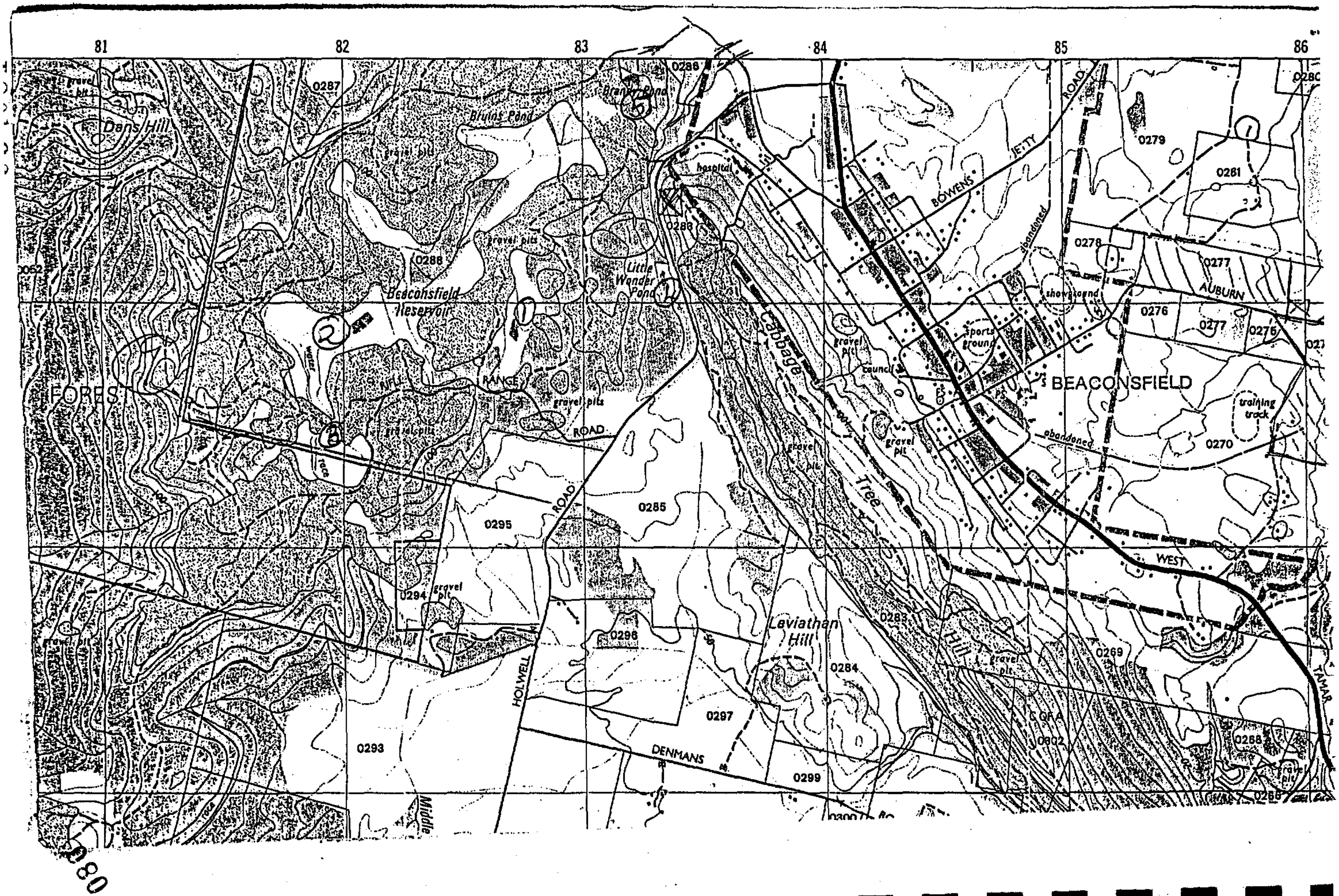
Reported date 21/5/86

WATER - BEACONSFIELD
SAMPLED 13/5/86

Site	Cd(ug/L)	Cu(ug/L)	Pb(ug/L)	Zn(ug/L)	Hg(ug/L)	NFR(mg/L)
1	0.7	5	9	23	<4	08
2	<0.5	2	5	77	<4	4.0
3	1.0	5	<5	144	<4	3.5
4	0.5	<2	<5	3.1	<4	1.9
5	0.7	5	6	40	<4	3.9

16378

Senior Chemist ....



81
82
83
84
85
86
Dans Hill
gravel pit
Bruins Pond
Brandy Pond
gravel pits
hospital
BOWENS
JETTY
ROAD
abandoned
AUBURN
showground
sports ground
council
BEACONSFIELD
training track
abandoned
Beaconsfield Reservoir
Little Wonder Pond
RANGE
ROAD
FORES
Cabbage Tree Hill
HOLWELL ROAD
Leviathan Hill
DENMANS
WEST
TAMAR
CORA
Middle
0287
0286
0288
0279
0281
0278
0277
0276
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0283
0284
0269
0302
0300
0280

936082

081

ALLISON LABORATORIES

4 WARWICK STREET, HOBART TASMANIA 7
TELEPHONE: (002) 34 7

- APPLIED RESEARCH AND DEVELOPMENT
- INDUSTRIAL AND AGRICULTURAL ANALYSIS
- TANK AND CARGO SURVEYS
- EFFLUENT ANALYSIS

JOHN MIEDECKE AND PARTNERS
20 Rees St
Invermay
LAUNCESTON 7250

For Attention Mr John Miedecke

RESULTS OF ANALYSIS

Samples labelled as shown hereunder were received 1 May 1986.

These samples were analysed generally in accord with the relevent methods as set out in :-

Mercury: method similar to that of Hatch and Ott. as recommended by Tasmanian Fisheries Development Authority

Zinc, Copper, Lead, Cadmium, Chromium: Food analysis by atomic absorption (Varian techtron)

Arsenic: VGA-76 Operation Manual & notes (1986) (Varian techtron)

(All digestions were done in a Buchi 445 all silica rotary digestor)

(All results mg/kg)

LAB NO	SAMPLE	Hg	As	Zn	Cu	Pb	Cd	Cr
50933	Oyster A W. Arm	-	-	-	-	-	-	1.7
50934	Oyster B Anderson Creek	0.08	0.01	880	210	0.9	1.4	1.0
~~50935~~	~~Oyster C~~	~~0.13~~	~~1.4~~	~~830~~	~~660~~	~~1.2~~	~~1.9~~	~~0.7~~
50936	Flathead A Anderson Creek	0.15	0.04	7.3	0.4	<0.4	0.1	0.1
~~50937~~	~~Flathead B~~	~~0.56~~	~~0.06~~	~~7.8~~	~~0.5~~	~~<0.4~~	~~0.1~~	~~0.3~~
50938	Trout A Anderson Creek	0.50	<0.01	7.9	0.6	<0.4	0.1	0.6
50939	Trout B Beac Reserv.	0.48	-	-	-	-	-	<0.1
50940	Trout C Beac Res	-	-	-	-	-	-	<0.1
50941	Eels Anderson Creek	-	-	-	-	-	-	1.2

G.F. ALLSION
CHARTERED CHEMIST (AUSTRALIA)

REPORT NO: 10396
ISSUED: 19 May 1986

NATA

LOCALITY MAP

083

figure 1

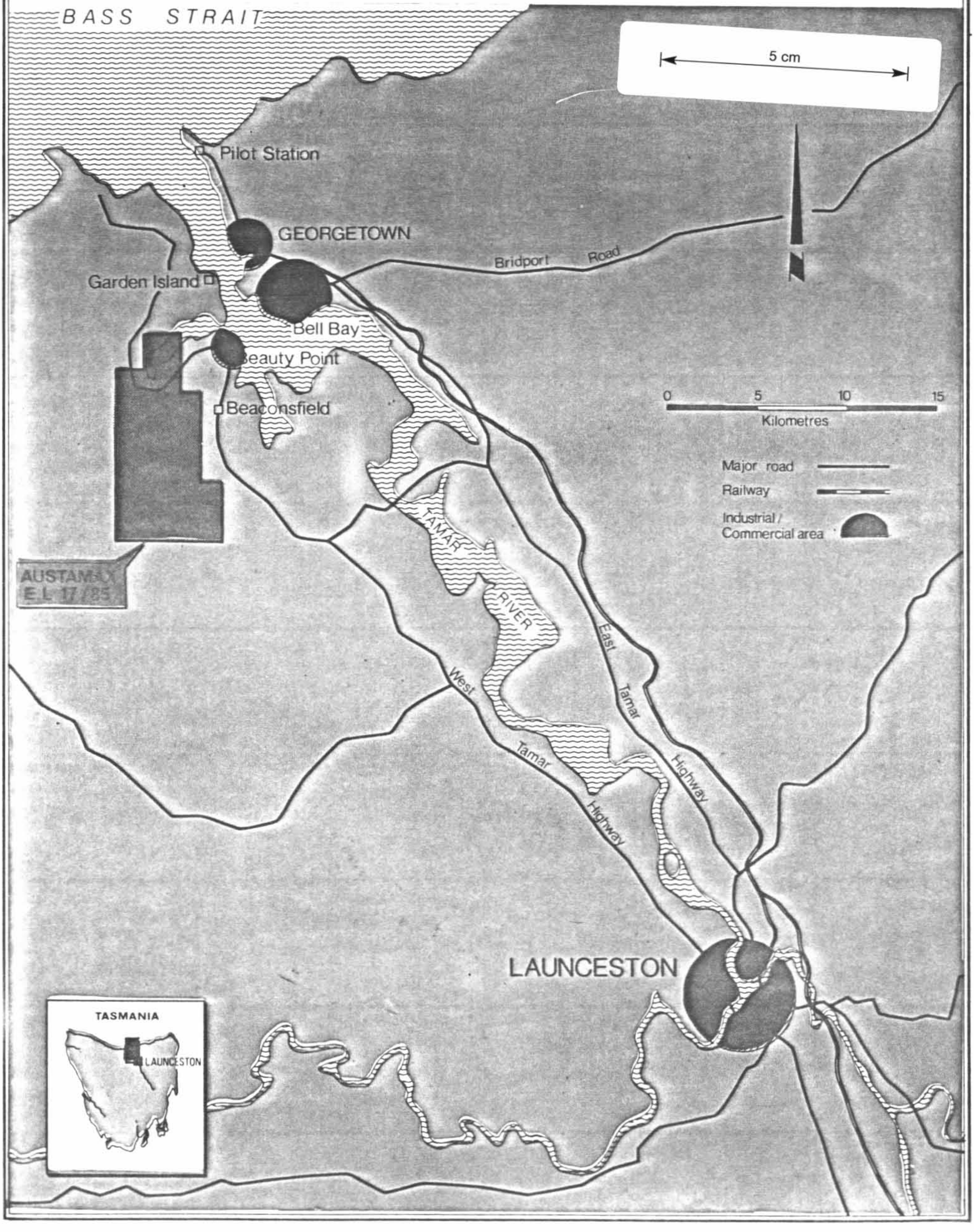
AUSTAMAX RESOURCES LIMITED

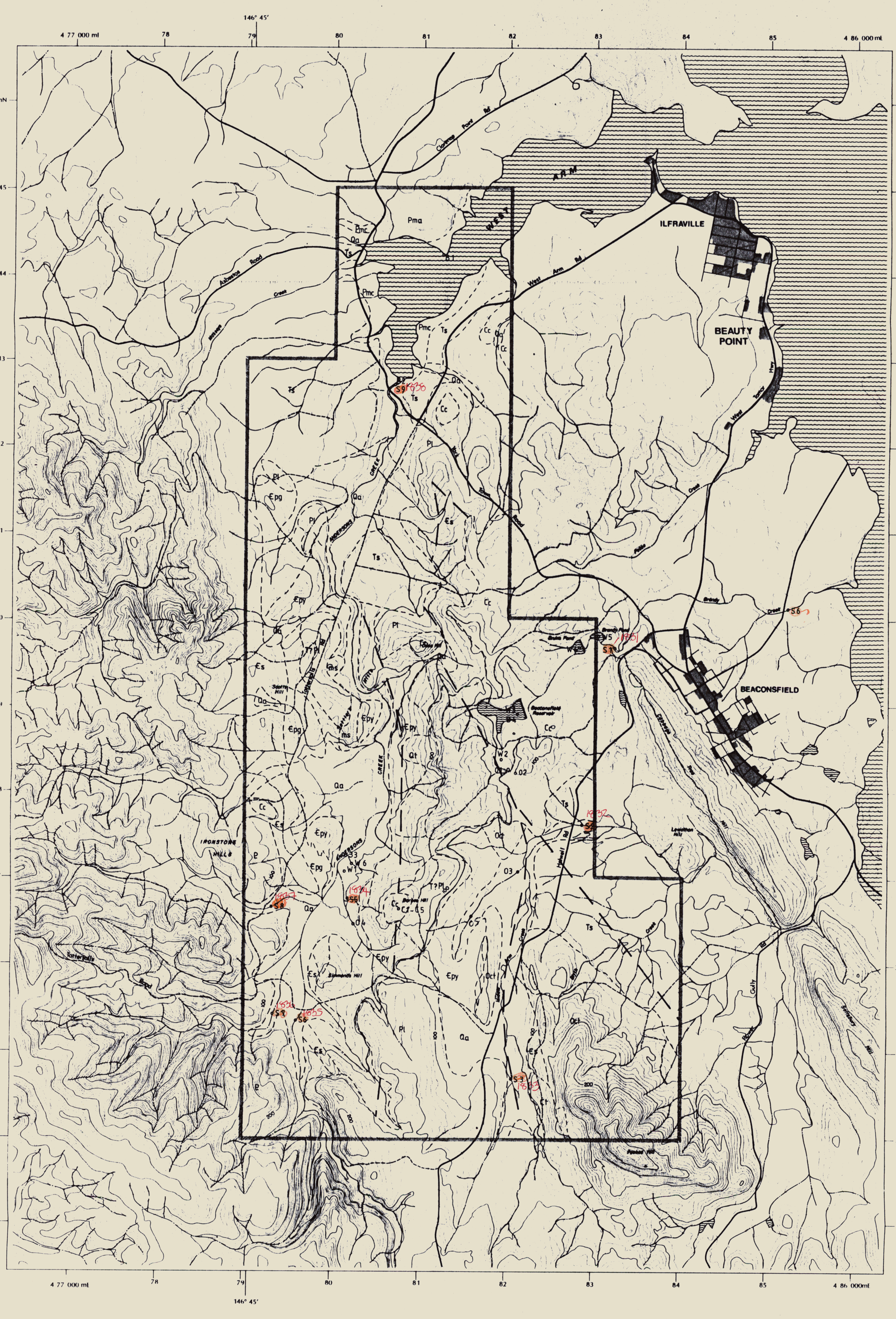
936084

TASMANIA

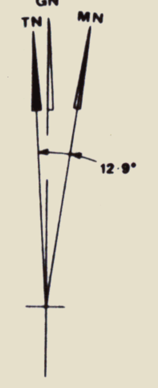
ANDERSONS CREEK CHROMITE PROJECT

LOCATION MAP





87-2650



SAMPLE LOCATIONS

C Clay
B Biological
O Organic Peat
S Sediment

Boundary of AUSTAMAX E.L. 17/85

Major Road

Secondary Road, track

Creek, Stream

Built up area

BASE MAP PREPARED FROM 1:25 000 SCALE

LEGEND

Qa	River alluvium & marsh deposits
Qt	Talus Qtb - basalt, Qtd - dolerite, Qtg - gravel.
Cc	Partially consolidated conglomerate
Ts	Sand clay & gravel
T?Pl	Pisolitic ironstone, pre-Ts in age
Pmc	Masseys Creek Group - mudstone, pebbly siltstone & sandstone
Oct	Cabbage Tree Formation
Ꞓs	Slate with impersistent units of greywacke
P	Badger Head Group - sandstone, slate & phyllite
Ꞓpg	Layered pyroxenite & gabbro
Ꞓpy	Pyroxenite (serpentinised pyroxenite
ms	Included septum of metamorphic rocks

DEPT OF MINES STREAM SEDIMENT DATA-BASE NUMBERS IN RED (1831 ~ 1838)

CONTOUR INTERVAL : 10 metres

AUSTAMAX Resources Limited

936085

TASMANIA

ANDERSONS CREEK PROJECT

BEACONSFIELD

5 cm

SCALE 1:25 000

0 500 1000 2000 3000

METRES

180