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Received / Answered	5 AUG 1983			E & IL
DEPT. OF MINES REF. No. 7012/83				

[illegible]AL REPORT
EL5/[illegible]RIAL HARBOUR
EL16/13 OCEAN BEACH

AMG REFERENCE POINTS ADDED

July 1983

S.R.M. Harvey
Abbotsford Pty Ltd
19 Paterson Street
Launceston 7250

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SUMMARY

The report outlines exploration conducted by Abbotsford and affiliates over parts of Tasmania's west coast.

Details of the study were sent to the Department of Mines during course of the survey in a series of reports running to some 130 pages.

The venture was aimed chiefly at discovery of secondary tin deposits in Recent coastal sediment. Such sediment is judged prospective because mineralised regions lying short distances inland contain substantial concentrations of tin and other valuable material.

Sediment examined, coarse fo fine-grained quartzose sand, does appear mainly terrestrial and local in origin, containing concentrations of chromium, plus small quantities of zinc, tin, and other elements unlikely to have been introduced from more southerly and northerly sectors of the coast.

Concentrations are associated with a heavy mineral fraction comprising an average 4 to 5% of the sands. Zircon, ilmenite and modest amounts of rutile and leucoxene also occur in the heavy mineral suite. In addition, it is enriched in cerium, lanthanum and yttrium.

No significant part of the sediment body can be mined profitably at current commodity prices.

There is evidence that valuable minerals, on the whole much smaller in particle size than grains of host sediment, are being selectively removed from the sands. This useful fraction should be accumulating offshore, a possiblity that is considered to merit attention.

C O N T E N T S

1.0 BACKGROUND

1.1 Investigators

This project has been carried out by Abbotsford Pty Ltd and Aberdare Incorporated.

Abbotsford, set up in 1975, is a Tasmanian company headquartered in Launceston.

Aberdare is a US company based in Princeton, New Jersey. It represents the interests of the HOLB Group formed in 1973. Aberdare owns an Australian subsidiary, Elisna Pty Ltd Elisna's registered office is in Canberra.

Abbotsford and Aberdare were established to find and promote development of mineral prospects. The companies identify likely areas, secure rights, carry out preliminary exploration and evaluation, then turn over leases to organisations with the resources needed to conduct more detailed work and to exploit deposits so defined.

Geophysics and drilling recently undertaken by Amoco, Fluor and partners on the west Tasmanian continental shelf were parts of such an enterprise initiated by Abbotsford.

1.2 Target

The project described here centred on search for large economic bodies of secondary tin similar to the one found by the author off NE Tasmania in 1965.

Though the latter deposit containing a proven 30,000,000 yd^3 sediment running 105 ppm Sn would not at present support profitable marine dredging, a properly executed sampling programme stands a high chance of raising the reserve to a mineable level.

Extensive secondary deposits exposed in Recent unconsolidated materials on seafloor or along coasts remain unusually attractive targets.

Unlike most big orebodies found underground in rock, they require no stripping or shaft-sinking for access; no drilling, blasting, crushing and pulverising of ore is required; neither de-watering nor mine ventilation are called for. Instead, mineral-bearing sediment is pumped direct to separatory plant on board dredges. Valuable fractions are removed and host material is returned overboard to backfill areas mined.

Larger volumes of ground can be handled in this manner at lower cost with smaller work forces than is possible using standard terrestrial mining methods.

Environmental disturbance is minimised and at dredge sites offshore generally constitutes no more than a small percentage of that occasional by current, swell and wave action.

The majority of useful components available for recovery from such operations, for example gold and tin, zircon, rutile and ilmenite, can be separated and concentrated by simple physical means without involving the more expensive and commonly hazardous chemical procedures employed at hard rock mines.

Savings outlined above allow dredging to exploit low grade concentrations. Sizes of deposits and the frequency with which they occur rise as grade demands fall, in turn reducing exploration costs and permitting economies of scale to be realised in extraction and processing.

Tin is a prime target because of its high price. Concentrations no more than a few tens of times crustal abundance of the element can be worked profitably by dredges. By contrast, most other mineral commodities, particularly where extracted from rock, require concentrations several hundred times crustal abundances to be profitable.

Tin deposits are rare and of the few countries producing tin several are unstable politically. From time to time supply is thus disrupted and prices rise, another factor favouring choice of the element as a target.

To safeguard reserves found and capital invested in them, tin properties should be sought in countries where political risks are lower, hence our interest in Australian prospects.

As Tasmanian tin reserves plus the total produced amount to some 500,000 mt and comprise over 50% of the total for the Commonwealth, Aberdare and Abbotsford focused interest here rather than in other states.

In this project we directed attention toward NW Tasmania, previous workers having largely overlooked its secondary tin potential. Reserve + production estimates for this region make up three-quarters of the tonnage cited for the State as a whole.

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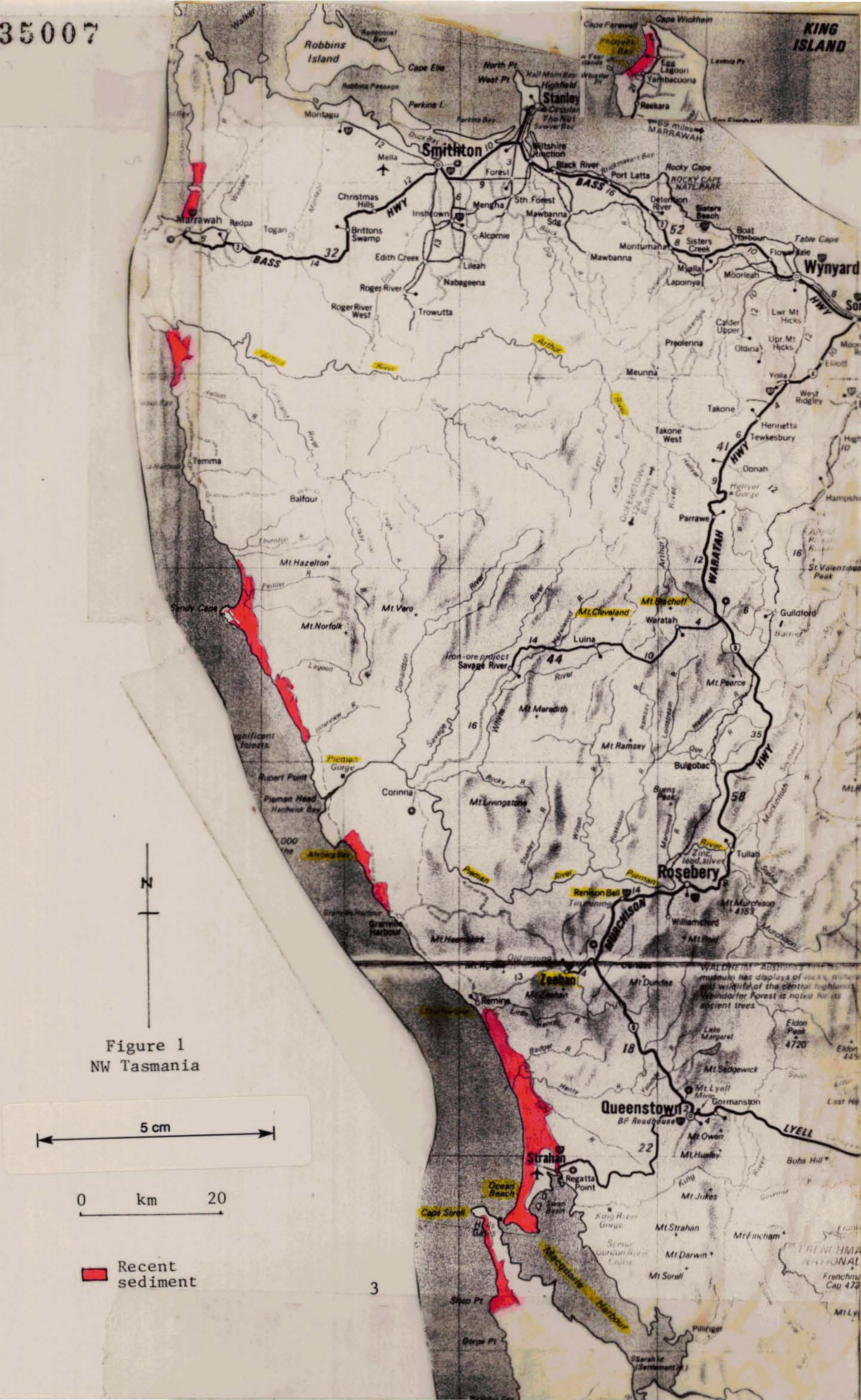

Figure 1
NW Tasmania

The region contains several major deposits of primary tin, notably those of Mt Bishoff, Renison Bell and Mt Cleveland, as well as that defined over the last few years by Aberfoyle at Zeehan. Locations of these deposits are shown at Figure 1.

All four primary deposits were exposed in part. Unknown but probably large fractions are likely to have been removed by erosion. Numerous smaller deposits also occur within the region and likewise may be taken to have contributed material for deposition as secondary tin.

The main accumulations of dredgable material likely to contain detrital tin derived from primary deposits inland are the bodies of Recent unconsolidated material formed along the west coast of Tasmania. Study of these bodies consequently appeared worth undertaking.

1.3 History

Australian Titan Products and Strahan Sands Ltd examined sediments of Ocean Beach on the northwest coast in 1957. CSIR undertook detailed study of two samples resulting from the survey.

In the late 'sixties Pickands Mather Inc. explored sands of Ann Bay and drilled one or two short holes near the entrance of Macquarie Harbour.

In 1970 and 1971 a Sydney consultant carried out scout drilling at Ocean Beach and Ann Bay for the Electrolytic Zinc Company.

None of these surveys resulted in further work and licences held were dropped.

2.0 OPERATIONS

2.1 Preliminaries

Our interest in the region began in 1973.

We assembled results of previous surveys,together with airphotos, marine charts, topographic and geological maps.

Collected data were reviewed.

Likely targets were defined. In NW Tasmania there are two classes of Recent sediment in which large volumes of mineral-bearing detritus derived from the interior might be expected to accumulate, notably those at the coast comprising beaches and dunes, and those found offshore.

It was decided to concentrate initially on deposits of the coastal class. Although theoretically less promising than those of the seafloor category, coastal deposits can be examined at lower cost.

Next, a field reconnaissance was made. Initial indications were considered favourable enough to justify application for an exploration licence.

2.2 Licences

Situation of the two exploration licences discussed is shown in Figure 2.

EL 16/73 embracing Ocean Beach was applied for in March 1973 and granted on 28th June.

Eastern parts of the licence cover a prospect unlike that of Ocean Beach. El 16/73 was transferred to Cities Service International and later to Union Oil Development Corporation, US companies Aberdare interested in this eastern prospect. The companies held EL 16/73 for a total of five years. Results of all investigations undertaken in connection with the prospect were reported to the Department of Mines by Cities and by Union.

During Aberdare's tenure of the licence,four separate relinquishments were made,reducing the original area by 90%.

EL 5/76 at Trial Harbour was obtained on 11 May 1976, in my name, on behalf of Abbotsford. Fieldwork had by then pointed attention toward the northern end of Ocean Beach.

An area of 16 km^2 was sought but was extended to 20 km^2 by the Department of Mines so that it would abut an existing licence area situated north of it.

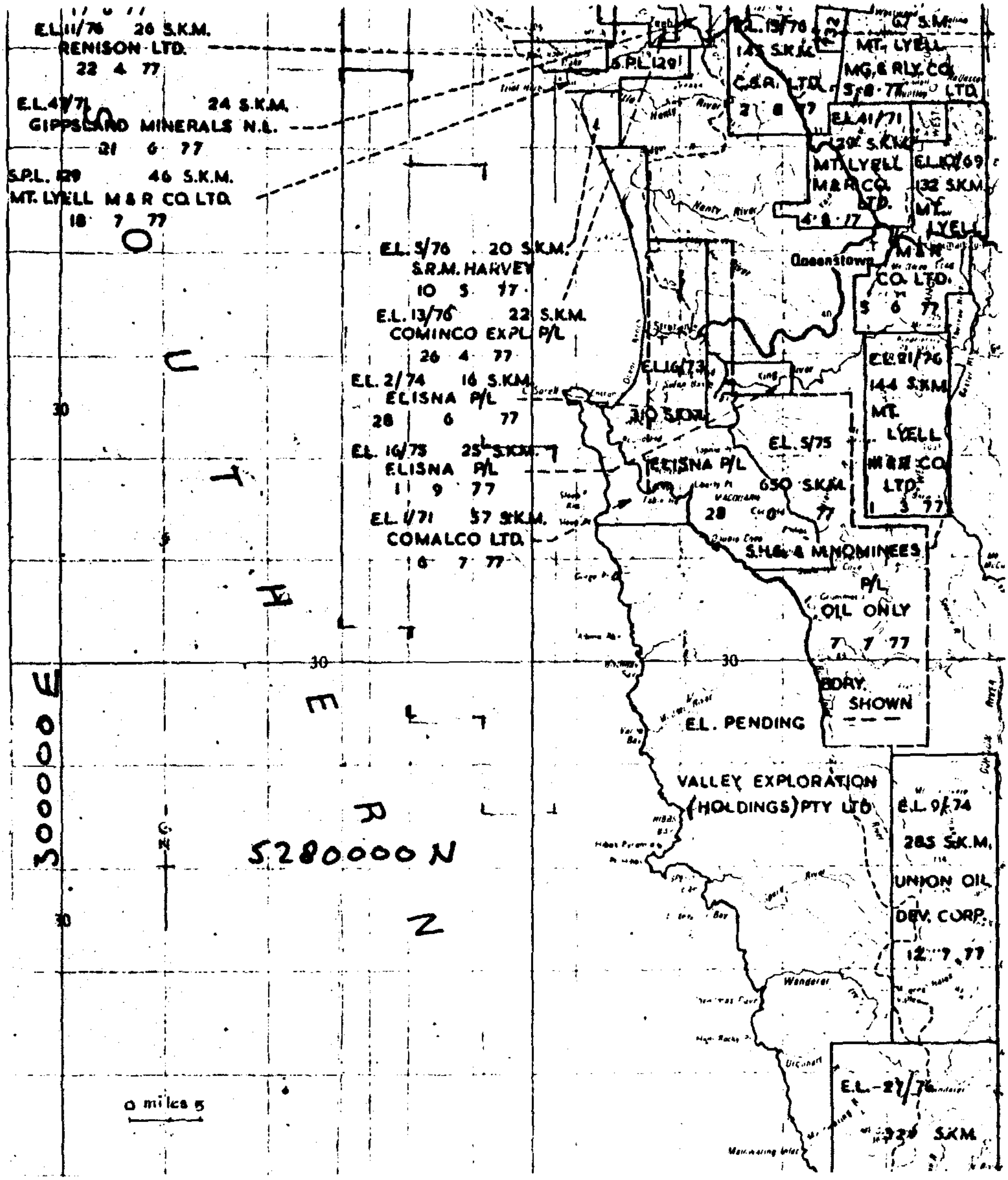

Figure 2. Exploration licences, March 1977
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5 cm

AMG REFERENCE POINTS ADDED

In November 1980 a northern section of the licence area was turned over to Trial Harbour Mining Company which holds leases there.

In 1981 the eastern part of EL 5/76 was relinquished, reducing the area held to 15 km^2.

2.3 Activity

Test pits were sunk at half-kilometre intervals along the length of Ocean Beach from its southern end, bordering the entrance channel of Macquarie Harbour, to the Henty River.

Series of holes were run across the width of the beach at selected points,and channel samples were collected from dune faces backing the beach.

A similar sampling programme was conducted on EL 5/76,with special emphasis being placed on sands of the Little Henty spit.

Sands at Ann Bay were inspected briefly and records of work conducted on Three Hummock Island by earlier investigators were examined.

Plans to sample beaches situated between Trial Harbour and Arthur River were cancelled after CRA obtained a licence over all vacant sections of NW Tasmania in 1977 and refused to exclude coastal parts covered by Recent sediments.

Oceanographic, meteorological and bathymetric data bearing on prospects offshore were closely analysed.

Lab work on beach samples was carried out by Abbotsford/Aberdare in New Jersey and by Amdel in South Australia.

In 1981 short magnetometer traverses were run over parts of EL 16/73 and EL 5/76, using a proton precession instrument of one-gamma sensitivity, but failed to detect anomalies.

During the course of our survey a proposal was prepared and was later discussed with potential participants, specifically with Stevin in Holland, and with US Steel and Pacific Tin in the United States. In Australia we were approached by Abminco and Newmont.

Pacific Tin commissioned a ground study by an independent consultant but declined to accept his recommendation that the company join the venture.

Stevin and Abminco each proposed to examine the licences but in neither case could terms judged satisfactory be secured.

By 31 July 1983 expenditure on operations associated with EL 5/76 will have amounted to about US $98,420. Man-hours devoted to this fraction of the work will have totalled some 3,550. Time and cost expended on related activities covering EL 16/73 are estimated to have amounted to US $22,900 and 740 man-hours, additionally. In local currency the project has therefore cost approximately $139,500.

3.0 RESULTS

3.1 Records

The Department of Mines has been furnished regularly with comprehensive statements on the course of the coastal project since its start: these presented results as they accumulated.

From April 1976 data bearing on EL 16/73 which relate to the project have been given in monthly and more recently in quarterly reports provided for EL 5/76.

Besides statements regarding progress, two summaries and this closing report have been written. Altogether, reports on the project run to some 40,000 words.

With periodic accounting details, renewal applications quarterly and annual returns, maintaining the licences has required over 300 submissions to Government by Aberdare and Abbotsford.

Cities Service and later Union Oil, the companies responsible for investigation of inshore parts of EL 16/73, made an estimated 140 additional submissions, including progress and final reports.

3.2 Sediments

Much of the west coast of Tasmania is too steep to permit anything but small pocket beaches to be established. However, relief is subdued enough along seven sections of the coast for substantial bodies of sediment to have developed. They are outlined at Figure 1.

Lengths of the seven larger sediment accumulations are as follows:

Phoque Bay, King Island	10 km
Ann Bay	10 km
Arthur River mouth	10 km
Kenneth and Johnson Bays	30 km
Ahrberg Bay	14 km
Ocean Beach	37 km
Cape Sorrell	14 km

Westerly winds have moved much of the shoreline sediment inland so that, generally, beaches are backed by dunes.

The coastal deposits are approximately one kilometre wide on average. Beach parts constitute a small fraction only: they vary in width from a few metres to a maximum of 200 metres, depending upon tides, short term weather conditions, season and location.

Average thickness is difficult to gauge but probably is about 15 metres. Dunes do not rise higher than 50 metres a.s.l. and typically attain less than half this elevation. Mid-sized rivers of the region formally were graded to a level approximately 40 metres below present sea level, which sets a downward limit on thickness of beach sediment.

Sediment appears to have been derived from adjoining land as alluvium carried to the sea by rivers and streams, as eluvial material descending from elevated ground bordering sediment deposits and sea, and thirdly from products of coastal erosion.

Some sediment comes from the surf zone,but mostly this is thought to be material from one or other of the three categories listed which,after temporary deposition at the coast,has been reworked by waves.

Pumice, organic matter, tar, and other water-borne materials are introduced from the west but this fraction is unimportant quantitatively. Furthermore, its larger fragments are ground up rapidly by surf action or are dissolved; then they are removed offshore.

Winds and rain, coming predominantly from the west over great expanses of water, are unlikely to carry much dust. Probably they bring in considerable quantities of salt, but this is likely to be flushed from coastal sediment, as most dust is expected to be.

Under the existing climatic régime alluvium and reworked alluvial material is likely to make up the bulk of the coastal sediments.

Sediment transport on the west coast is effected by by currents, by rips, swell, waves, backwash, chop, run-off and wind.

According to Admiralty Sailing Directions a current setting NNW runs up the shelf offshore. However, spit headings,bay scalloping and other considerations indicate that the northnorthwestward movement is balanced,at least in part, by a counter current inshore, streaming SSE.

Swell generally impinges on the coast slightly north of normal so that,in combination,resultant waves, reflected waves and run-off tend to move beach sediment northward.

Study of meteorological data gives no clear answer but analysis of dune trends shows conclusively that over the last century or two at least, prevailing winds headed an average 125° true. Movements resulting from chop plus run-off and from wind itself thus have a southerly component. Intermittent offshore winds generally head WSW.

The effect of processes above is to carry sediment particles to and fro between surf and dune belts and, in doing so, to move material small distances northward or southward along the coast as well. As movements in the latter direction predominate the net result is longshore drift SSE.

Contouring charts of the region reveals existence of pronounced submarine valleys off the Arthur and Pieman Rivers. A similar feature associated with the Gordon River and Macquarie Harbour occurs west of Cape Sorrell.

These valleys and the riverine discharges associated with them are believed to act as barriers, preventing most sediment from any one of the four sectors of coast defined by the valleys from reaching neighbouring sectors. Sediment entering the valleys under the influence of the southsoutheastward drift inshore or the northnorthwestward drift offshore should be being carried down the channels, across and off the continental shelf.

In sum, the bulk of sediment found between the Arthur and Pieman Rivers for example, appears to have derived mainly from the Arthur catchment and from terrain lying between it and the Pieman catchment.

As no major mines exist north of the Pieman catchment or as far south as the catchment of the Gordon River, sediment bodies of principal interest are the two lying between the Pieman and Cape Sorrell, notably that of Ahrberg Bay and that of Ocean Beach.

Attention was focused on the Ocean Beach body, because it is the larger and was covered in its entirety by EL5/76 and EL16/73.

3.3 Composition

Sediment of Ocean Beach is chiefly quartzose, with feldspathic and lithic elements increasing toward the north, and a minor clay fraction rising in content southwards. Lignitic fragments and calcareous material are present but nowhere constitute more than 3% of the sediment mass.

Calcareous root tubules occur in the dunes; so do plant remains and ash.

Apart from measuring sizes of grains comprising them, these lower density constituents of the sediment body were ignored.

Grain sizes range between 0.2mm to 1.5mm in the north and 0.1mm to 0.5mm in the south. Lower ends of these size ranges are well represented in dune material found east of the beach. Averages for these lower density components of the sediment body are 0.6mm in the north and 0.3mm in the south. Grains with sizes at or near upper ends of stated ranges predominate on the beach during winter, those with average diameters preponderate in summer.

The percentage of material with SG $\geq$ 2.85 present in Ocean Beach sediment varies between 0 and 30%. Percentages are high close to Trial Harbour, fall sharply a short distance south of it and rise gradually with continued passage southward to reach a maximum about 5 kilometres NNE of Macquarie Harbour entrance. From the high point to the entrance channel the percentage drops considerably. For sediment of Ocean Beach as a whole the content of heavy mineral is 4 to 5%.

Dense fractions of the sediment consist principally of chromite, chloritoid, augite, and other ferromagnesians, and of ilmenite, magnetite and zircon. There are minor quantities of haematite apatite, rutile, leucoxene, garnet, tourmaline, topaz, and andalusite present. Small amounts of cassiterite, sulphides ? and several other species are inferred to occur, but grains of these are rare and seldom visible except in concentrates.

Particle sizes of heavy mineral components range between 0.02 mm to 0.6 mm in the north and 0.05 mm to 0.25 mm in the south. Averages are 0.3 mm for heavy minerals found in relatively coarse-grained sediment and 0.15 mm for those in finer-grained material occurring near Cape Sorrell.

Commercially valuable members of the heavy mineral suite, mainly those of higher densities, have grain sizes lying between minimum and average figures given for the suite as a whole: thus the valuable particles are considerably smaller than the majority of particles making up host sediment.

Partitioning of 12 elements between various fractions of mineral-bearing sediment from the west coast is illustrated in Table 1.

Data in the table were prepared from several sets of analyses carried out for Abbotsford by Amdel, of Adelaide, South Australia.

Trial Harbour material represented in the table comes from the north end of the Little Henty spit, the Ocean Beach material from an area 6km southwest of Strahan.

Table 1. Metal contents, west Tasmanian beach sediment.

Element	Detec. limit	SG - 2.96 TH	SG - 2.96 OB	SG - 4.2 TH	SG - 4.2 OB	SG † 4.2 TH	SG † 4.2 OB	Crustal avg.
Ag	0.1	0.1	0.2	0.1	-	0.1	0.2	0.1
Be	1	-	-	5	2	-	-	2
Ce	300	-	-	-	-	600	-	46
Cr	20	200	150	10^4	6000	10^4	10^4	200
Fe	100	10^4	10^4	10^4	10^4	10^4	10^4	50000
La	50	-	-	-	50	200	100	18
Nb	20	-	-	20	150	20	50	24
P	100	100	100	-	-	-	-	1180
Sn	1	-	-	300	25	1500	60	3
Ti	100	400	600	4000	10^4	4000	10^4	4400
Y	10	10	10	60	250	100	500	40
Zr	10	80	80	300	1000	700	9000	160
Ta	100	-	-	-	-	-	-	2
Th	100	-	-	-	-	-	-	10
W	50	-	-	-	-	-	-	1
Avg weight %		96	96	0.67	2.95	3.33	1.05	

TH sediment from EL5/76

OB sediment from EL16/73

\- undetectable

4.0 PROSPECTS

4.1 EL 5/76

Reference to Table 1 shows the densest fraction of Trial Harbour material to be enriched in tin, chromium, cerium and lanthanum. The elevated contents of these elements are presumed to stem from concentrations in the sediment of cassiterite, chromite and an unidentified rare-earth mineral, probably a silicate or fluoride. Phosphorus is too low for the host of the rare earths to be monazite.

Assuming the sediment to have a density of 1.6mt/m^3, that 70% of the tin, chromium and rare earths are recovered, that the value of tin is A$4.50/lb Sn, that the chromite runs 40% Cr and is valued at 5 cents/lb, and that the rare earth mineral runs 50% Ce + La and is valued at 10 cents/lb, the sediment is worth approximately $1.60/m^3. Tin accounts for 68% of this total and chromite for 30%.

Sediment worth $1.60/m^3 is regarded as subeconomic. At a working cost of $2/m^3, a 50% tax on profits and a post tax profit objective of 20%, sediment would need to be worth $2.80/m^3 or more to warrant mining. This would require grade to be 75% better than that of material analysed.

A modest operation mining sediment worth $2.80/m^3 and yielding $1,000,000 per year after tax would need a sediment reserve of about 4,000,000 m^3 to sustain 16 years' work.

With average thickness of 10 metres the reserve would measure about 650 metres per side, if square, or say 2 km by 0.2 km if rectangular.

High concentrations of heavy mineral extending over areas of such magnitude were not encountered on EL 5/76. Sediment with heavy mineral contents of 2 to 6% is widespread but the grade of the material is unlikely to average more from a quarter of that sought.

4.2 EL 16/73

Using assumptions of the preceding section and a zircon price of 10 cents/lb, total value of Ocean Beach sediment represented by data in Table 1 is approximatley 40 cents/m^3 and thus substantially below economic level. The chromite value comprises 60% of the total, that of zircon 30%, and that of tin 10%.

The total could be augmented by taking into account small quantities of rutile present and by adopting a higher tin grade, in part justified by determinations on dense fractions of isolated samples in which tin contents up to 4x that of Column 8, Table 1, were detected. However, these higher tin values are not thought representative of any large volume of Ocean Beach sediment. Elevated contents of Nb and Ta also are encountered, betokening possible presence of columbo-tantalite but, again, cannot reasonably be applied to the mineral-bearing sediment as a whole. In any event, including gains from these sources in the total would not raise it more than 50%.

Dense fractions are significantly enriched in yttrium but, as in the case of rare earths at Trial Harbour, phosphorus is too low for yttrium to occur as xenotime. Probably it is present in zircon, together with minor concentrations of cerium and lanthanum detected in some samples from the area. Forty ppm uranium also, found in one sample, is likely to have been resident in the zircon fraction. Zircon from other parts of the world is known to carry concentrations of, variously, the rare earths, yttrium and uranium.

As the value of Ocean Beach sediment is too low to be of interest, reserve calculations are unnecessary.

4.3 Offshore

Because most dense mineral particles found in beaches of the licence areas are appreciably smaller than grains of host sediment, heavy minerals are being selectively removed from the coast and deposited offshore.

Profiles constructed for sea floor bordering the west coast show it to consist of three belts. The inner or surf belt, about 700 metres wide on open coast, covers bottom sloping at 1:80 from sea level to a depth of 9 metres. Adjoining bottom under the middle belt, that of building waves, slopes from approximately 9 metres b.s.l. to 40 metres b.s.l. at a gradient of 1:70. This belt averages 2.2km in width. The third or outer belt extends to the western edge of the continental shelf. Seafloor of the third belt has a slope of 1:170.

Bottom gradients and energy levels of the inner and middle belts are too high to allow heavy mineral particles of size ranges specified permanent residence. Though many of these fine-grained particles reaching the two belts from the coast are returned temporarily to beaches, it is believed that backwash, rips and current combine to move some of the particles out to the third belt where disturbances probably are small and deposition is likely to occur with little interruption.

Sediment deposited at the 40-metre slope break along the eastern edge of the outer belt is considered a potential target. Heavy minerals accumulating there are likely to be diluted by addition of clays, fine-grained quartz particles and considerable quantities of organic matter, but much of the latter should be being recycled, and the offshore current probably is strong enough to move some of the clays northward out of the area.

Sediment volume should be large.

Bottom at 40 metres is beyond the range of all but the largest of ladder dredges but extraction of mineral-bearing sediment which might be found there could be handled by airlift equipment at an estimated cost of $\$3/m^3$.

Surface sediment from this zone seems worth sampling. The most promising section should prove to be that lying between the Pieman and Cape Sorrell submarine channels. Sampling should begin at the more accessible southern end and proceed northward, as results warrant.

No such survey can be justified however until legislation providing for resumption of minerals leasing offshore is enacted.