Exploration Potential of Exploration Licence 27/2011, Mount Paris, NE Tasmania

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SUMMARY

Cassiterite-bearing greisens in the roof zone of the Mount Paris granite pluton were the primary source of alluvial tin deposits in the Ringarooma River valley, which accounted for nearly two thirds of north-eastern Tasmania's total recorded tin production (~70,000 t). There was minor historical production from eluvial deposits on weathered greisen zones, but only negligible production from mining of the numerous 'hardrock' greisen lodes that exist in an apparently structurally controlled west-north-west corridor extending across the exposed pluton.

Results of prospecting ventures in the first half of the 20th century, and relatively superficial exploration and drilling programs in the fifteen years preceding the collapse of the tin price in 1985, indicate that the mineralized greisen zones are small, restricted to a few tens of metres vertical thickness, and generally low grade, averaging less than 0.2% tin.

Modern exploration of the Mount Paris tinfield has not been exhaustive, and there has been no effective exploration of it during the past quarter century. Moderate potential remains for tin bearing greisens, particularly in the south-western quarter of the granite pluton, which is still partly covered by metasedimentary rocks. Such deposits have a low to moderate discoverability factor because of their lack of response to electrical and magnetic geophysical survey techniques. Gravity surveying may assist in delineating favourable cupolas in the covered granite roof zone, and a combination of systematic multi-element geochemical and short wavelength infrared spectral analysis could map extremely fractionated and/or altered intrusive phases of the granite.

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INTRODUCTION

Frontier Resources Limited recently applied for an exploration licence, EL 27/2011, covering an area of 100 km^2 over the Mount Paris area, located between the towns of Branxholm, Ringarooma and Weldborough, in northeast Tasmania. Frontier is targeting Devonian granitoid-related tin, tungsten, tantalum, Rare Earth Elements, and gold deposits, in a range of greisen, disseminated, and vein deposit styles hosted in granites and/or Mathinna Beds. Alluvial deposits are not a major focus.

Frontier Resources' Tasmanian Exploration Manager, Grant MacDonald, commissioned me to undertake a general prospectivity review of the Mount Paris EL, with specific emphasis on:

- Assessing Sn, W, Ta, REE and Au mineral potential – by taking an optimistic view of 'what might be' rather than a pragmatic 'what is'.
- Compilation and summary of all previous documentary exploration data.
- Listing of all relevant geologic, geochemical, geophysical and drilling data and maps for subsequent capture into digital form by Frontier Resources.

This work has been undertaken as a short-term geological consultancy; based entirely on a review of existing geologic and exploration reports available from Mineral Resources Tasmania's TIGER and TASXPLOR databases; it has not involved any fieldwork nor generated new data.

Data

- The DVD disc, on which this review is presented, also contains digital PDF copies of most of the cited documents, in a folder entitled 'Mt Paris Refs'. The majority of them were downloaded from MRT's document search website.
- The accompanying Excel™ spreadsheet 'Mt Paris References.xls' contains lists of the MRT Document Details, as copied from MRT's website, and sorted by dates, in columns and rows, in separate worksheets.
- The third worksheet in that file, 'Refs for DataCapture', lists documents that contain potentially useful maps and geologic or geochemical data that could be compiled into a GIS system for spatial analysis.

Physiography and Land Tenure

The area of EL application 27/2011 entirely surrounds a 1 km^2 mineral exploration licence at Bells Hill, EL28/2007, held by N & S Brown and Low Impact Diamond Drilling P/L, and a 5 ha lease for construction materials held by Gunns Ltd., about half a kilometre south of the former. It includes about fifty-five minor tin deposits and old workings, mainly distributed along the northwest trending ridge from Rattler Hill to Mount Paris, none of which have produced significant ore in recent times (Figure 1).

The country is mountainous, with a local relief of about 700 metres between the Ringarooma River valley along the western and northern boundaries of the EL and the crest of Rattler Hill rising to 900 metres above sea level near the southeast corner. Most of it is forested, apart from a number of clear-felled coupes in the south-western half, and an area of sub-alpine vegetation above about 750 m elevation at Rattler Hill. Accordingly, the greater part of the EL area is multiple-use State Forest, with some private farm and forest properties along the south-western boundary. The Mount Paris Road, connecting Branxholm and Weldborough, bisects the area and there is a fairly close network of forest roads and tracks for vehicular access, particularly in the south-western half where most of the known mineral deposits are located.

GEOLOGIC SETTING

The Palaeozoic basement of NE Tasmania is dominated by an Ordovician to Early Devonian quartz-wacke turbidite sequence, known as the Mathinna Beds, which was deformed during the Tabberabberan Orogeny and subsequently intruded by large Upper Devonian granitoid complexes. The granitoids were emplaced at high crustal levels, mainly by upward displacement or crustal rifting, and they produced only narrow contact metamorphic aureoles, up to a few hundred metres wide (Clarke, 1978; McClenaghan, 2006).

EL 27/2011 is centred on and covers most of the exposed portion of the roughly circular, ~10 km diameter, Mount Paris pluton, located at the western edge of the Blue Tier Batholith. The Blue Tier Batholith is the largest (40 x 70 km) of four major batholiths in Northeast Tasmania. It is dominated by I-type hornblende+biotite granodiorite and biotite adamellite-granite, with smaller plutons and sheet-like bodies of stanniferous S-type alkali-feldspar granite at Mount Paris, Lottah, Little Mt Horror and Mt Cameron.

The alkali-feldspar granites associated with tin mineralization are the youngest granitoid intrusive phases, dated at ~375-380 Ma by U-Pb isotopic ratios in zircon (McClenaghan, 2006). They are highly crystal-fractionated S-type granites existing in the upper levels of the Blue Tier Batholith, and occupy about 10% of its area (Purvis, 1988). They are typically pale pink to cream coloured, equigranular to K-feldspar-porphyritic textured granites, composed of quartz, K-feldspar, albite and Fe-rich biotite, with accessory apatite, zircon and monazite, secondary muscovite, and rare topaz, fluorite, cassiterite and tourmaline.

According to the Geological Survey of Tasmania's 1:25,000 scale maps, the Mount Paris pluton is composed of a fairly intricate complex of variably textured biotite+muscovite alkali feldspar granites/syenogranites (Figure 2). Mapping in the north-western quarter of the Mount Paris pluton delineated separate fine to coarse grained equigranular (Dgafe) and fine to medium grained feldspar+quartz porphyritic (Dgafq) varieties, but the greater part of the pluton is 'undifferentiated' (Dgafu). Its north-eastern side abuts monzogranite and granodiorite of the Poimena and Pyengana plutons, respectively.

The wall rocks around its northern western and southern perimeter are contact metamorphosed sandstone-dominant turbidites of the Mathinna Beds. The metamorphic aureole generally appears to be less than about one kilometre wide at surface. However, about a quarter of the pluton, particularly over the south-western half, is covered by metamorphosed Mathinna Beds in extensive roof pendants. This indicates that although the tin-bearing granitoids have been exposed to erosion since late Palaeozoic time and have shed considerable cassiterite into alluvial deposits in north-eastern Tasmania (Askins, 2007), the present level of erosion has not entirely unroofed the Mount Paris alkali granite pluton. Gerald Purvis (1988, quoting Young (1981) noted that the present topography at Rattler Hill at the south-eastern corner of the pluton largely reflects the original form of the granite suggesting relatively recent exhumation of a high level apophysis. Likewise Nye (1933a) considered the remnants of metasedimentary cover rocks at Mt. Paris to be 'of great economic importance' because it meant that 'practically the whole of the [tin] deposits in the cupola are intact and a small proportion only have been removed by denudation'.

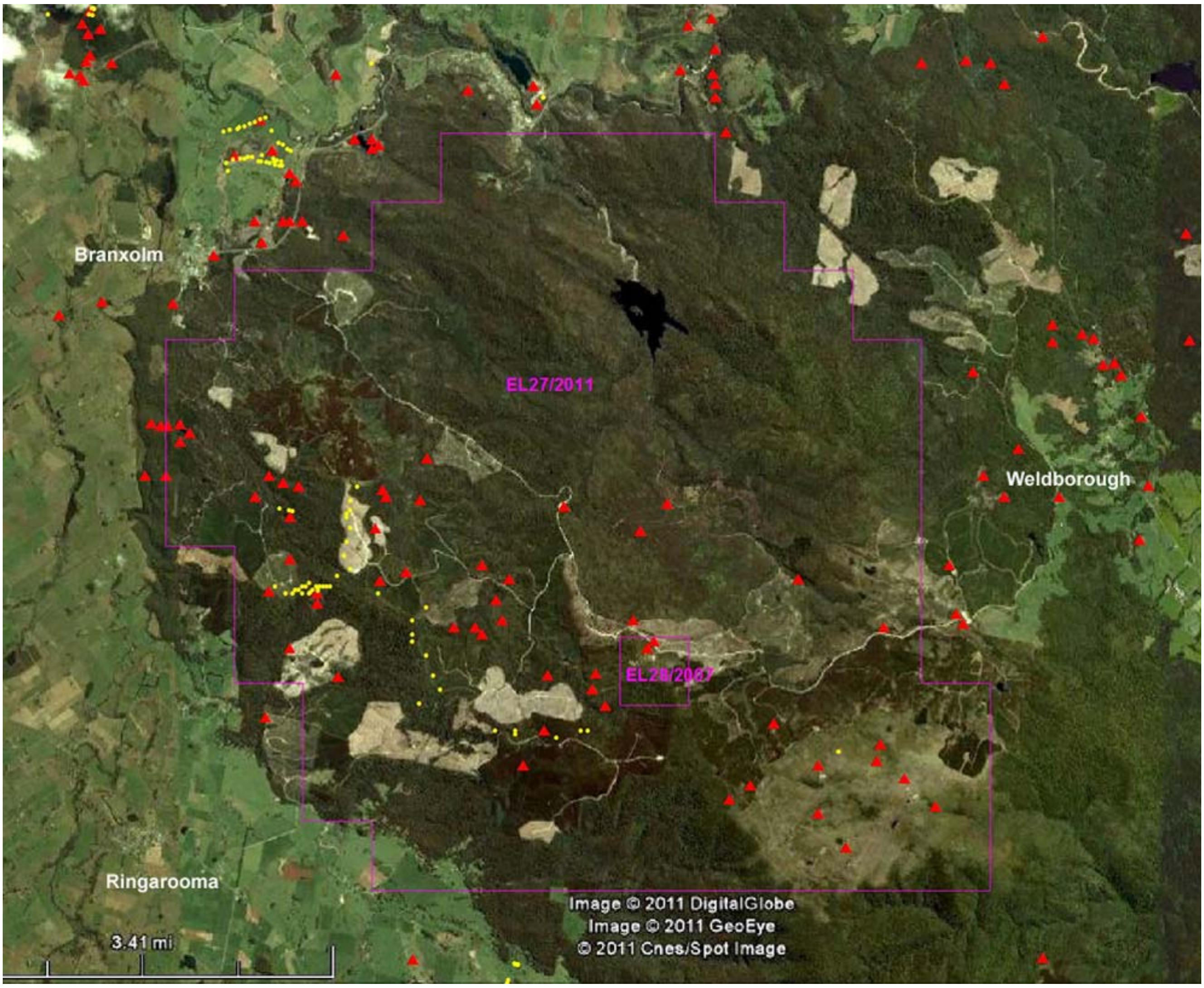

Figure 1 Location diagram showing exploration licence boundaries, historic tin prospects (red triangles), and drill hole locations (yellow dots) projected onto GoogleEarth's satellite image. Approximately 1:100,000 scale.

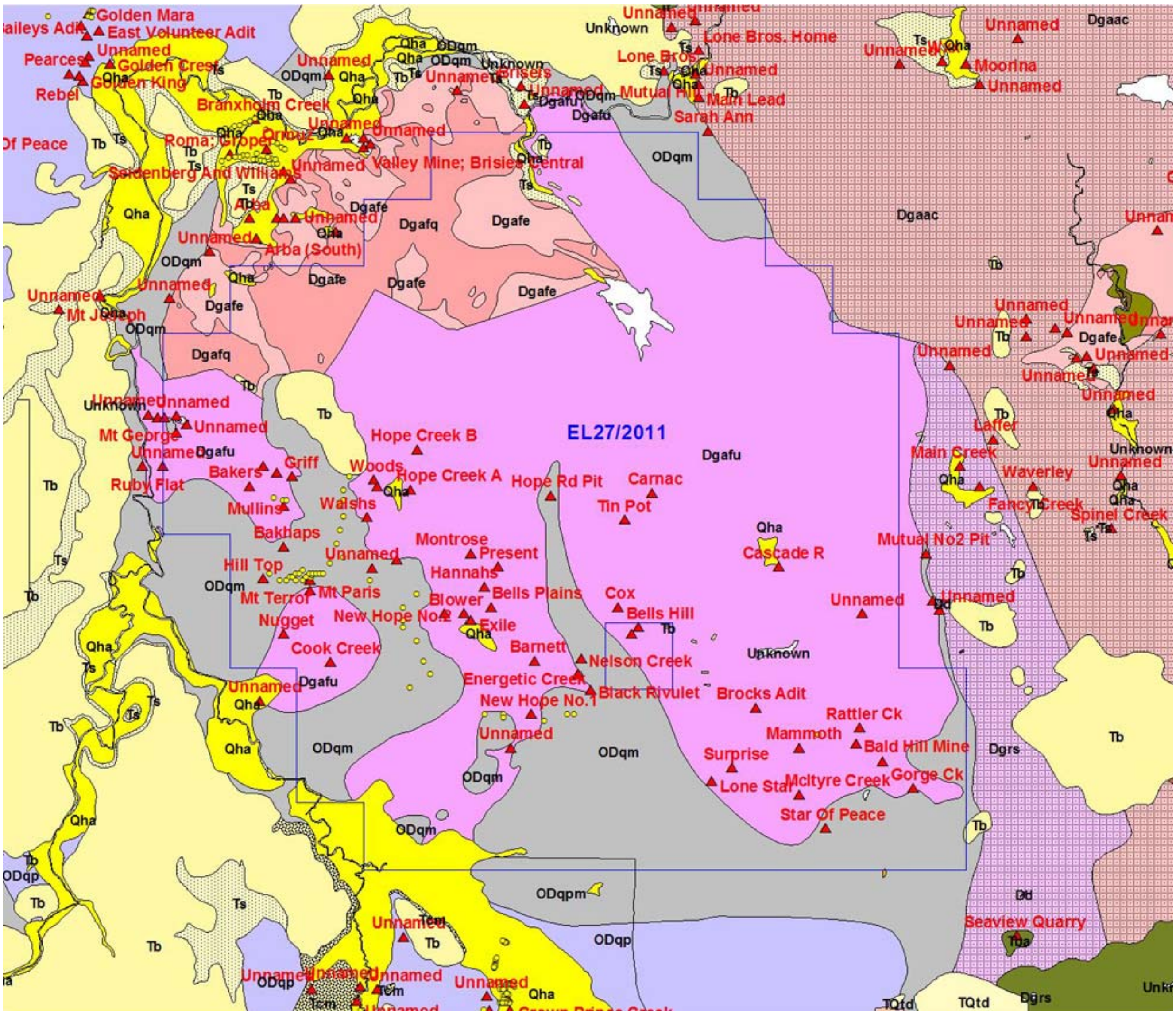

Figure 2 Geological map of Mount Paris pluton, showing EL 27/2011 boundary, known mineral deposits (red triangles), and existing exploration drill holes (yellow dots). *(Adapted from MRT's 1:25,000 digital geological data).*

MINERAL DEPOSITS

MRT's mineral deposit database lists fifty-five minor tin deposits and old workings distributed along the northwest trending ridge from Rattler Hill to Mount Paris and down to the Ringarooma River a little south of Branxholm. About twenty of them are small alluvial placer deposits.

Purvis (1988) classified the Mount Paris hard rock deposits into three types:

1. Quartz-greisen veins containing coarse cassiterite with minor chalcopyrite, sphalerite, pyrite, arsenopyrite, and traces of silver, tungsten and uranium.
2. Steeply-dipping stanniferous greisen lodes surrounded by zones of kaolinite-altered granite. The argillic-altered facies containing up to 0.1% Sn were extensively sluiced by early miners. The generally less than 2-m-wide semi-vertical greisen lodes contain erratic higher grades but did not produce much tin because they required crushing.
3. Flat lying greisen sheets apparently restricted to the vicinities of the Rattler Hill and Mount Paris prospects.

These deposit types are all are associated with the undulating granite roof zone, located at or close to the contact with overlying Mathinna Beds, with occasional thin veins extending into the contact metamorphosed sedimentary rocks. The mineralized and greisenized zones exist in the granite within a few tens of metres of the upper contact and diminish with depth.

References to prospecting of the 'endogranitic' deposits in the Mount Paris area date back to the 1880s (e.g. Thureau, 1884; Nye, 1924; Cundy, 1925; Reid, 1925; Nye, 1933a). Jennings & Williams (1967) noted that 'mining of primary tin ore in NE Tasmania began about 1895 as veins were exposed following the sluicing of alluvial deposits'. However, there are few details of significant tin production from the primary 'hard rock' deposits in the Mount Paris tin field. Nye's (1933a) description of the Mount Paris Mine workings noted that while underground exploration of 'hard quartz greisen lodes' was underway from 1882 the treatment was unsuccessful, but that 'a large portion of the surface had been sluiced to shallow depths by Chinese [miners] for detrital tin ore'. Cundy's (1925) report on the Bells Hill Mine described 20 acres of mineralized 'granite bottom' that had been exposed by sluicing of eluvial tin and commented that it was 'many years since it was worked as a lode tin proposition'.

Likewise, Keid's (1944) account of several prospects in the central to south-eastern part of the field stated that: 'The early operators on the field concentrated on the recovery of alluvial tin from the surface wash. Large areas have already been worked out. They have been responsible for extensive prospecting by shaft sinking and the driving of adits. Several treatment plants were erected to test the grade of ore but all were unprofitable'.

Jack's (1966) version of some of the same workings in the headwaters of the Cascade River (Star of Peace, Mammoth and Rattler Hill) observed that 'production from this area has been largely from alluvial workings and previous attempts to work the greisen veins have failed as these veins are too small to support a mining operation'. And again, in a description of workings in the Mount George area at the western end of the Mount Paris field Jack (1962b) reported: 'The area surrounding the greisen veins has been sluiced to a maximum depth of approximately 20 feet. Areas of hard greisen remain and no attempt has been made to work this material'.

Gerald Purvis (1988) listed the total production from the Mount Paris tin field of 500 tonnes of tin metal as coming from 'hardrock' deposits (Table 1). However, the inferences in the historic reports are that most of it was actually produced from shallow eluvial or small alluvial deposits on or near the greisen zones, and very little of it from hard rock mining of primary endogranitic greisen lodes or quartz veins.

Nevertheless, as Purvis (1988) pointed out, the approximately 44,500 t of tin produced from alluvial deposits along the Ringarooma River valley[1] largely originated by partial erosion of the Mount Paris pluton, which therefore alone accounted for nearly two-thirds of the total north-eastern Tasmanian tin production (Table 1).

[1] Askins (2007) estimated total north-eastern Tasmanian alluvial tin production at about 36 300 tonnes of tin metal; 22% less than Purvis' estimate.

At today's tin price[2] of about A$23,750/t, the 500 tonnes of production from Mount Paris equates to only about $12 million. The derived Ringarooma valley alluvial production would be worth somewhere between $0.8 billion and $1.1 billion, according to Askins' and Purvis' tonnage estimates, respectively.

The data in Table 2 place these estimates in economic perspective relative to other Tasmanian tin deposits. The present day value of Ringarooma alluvial cassiterite production is roughly equivalent to that of the Queen Hill deposit, which remains undeveloped but may progress to mining feasibility studies this year (Gooday, 2011). The only 'significant' greisen resource in the list is the low-grade Anchor tin deposit, also undeveloped.

Table 1 Northeast Tasmanian tin production in tonnes of tin metal *(adapted from Purvis, 1988).*

District	Hard Rock	Alluvial	Total
Blue Tier Tin field	3,100	160	3,260
Royal George Deposit.	1,000		1,000
Great Pyramid Deposit	340		340
Rossarden Area	18,670		18,670
Mt. Paris Tin field	500		500
Ringarooma River system		44,500	44,500
St. Helens area		2,000	2,000
Totals	**23,610**	**46,660**	**70,270**

Table 2 Tonnages, grades, and present-day in situ tin values of Tasmanian tin deposits[3].

Deposit & Type	Mt	Sn %	W %	In situ Tin value A$
Sulfide skarns				
Renison Bell	24.54	1.41		8,218,000,000
Mount Bischoff	10.54	1.1		2,754,000,000
Cleveland	12.4	0.61		1,796,000,000
Razorback	0.34	0.9		73,000,000
Queen Hill	3.6	1.2		1,026,000,000
Silicate skarns				
St Dizier	2.6	0.5	0.05	309,000,000
Veins				
Aberfoyle	2.1	0.91	0.28	454,000,000
Pieman E Renison	0.43	1.0		102,000,000
Greisens				
Anchor	2.39	0.28		159,000,000
Mount Paris				12,000,000
Alluvial				
Ringarooma River				1,057,000,000

[2] On 22/6/2011 the LME tin price was US$25,100/t and US$1 = A$0.946

[3] Tonnage and grade data from Tasmanian Geological Survey Bulletin 72 (Seymour et al., 2007); in situ value of Mount Paris and Ringarooma based on Purvis' (1988) production estimates.

EXPLORATION HISTORY

Pre 1968

Prospectors discovered most of the major north-eastern Tasmanian alluvial tin deposits during the early to mid 1870s and by the early 1880s they were exploring the endogranitic primary deposits of the Mount Paris area (Nye, 1933a). Numerous reports by Department of Mines' geologists and engineers between the mid-1920s and mid-1960s describe some of the many small mines and prospects on the Mount Paris tin field. The deposits had mainly been worked by sluicing of shallow eluvial material on weathered or argillic-altered mineralized greisen. The primary bedrock cassiterite-bearing greisen zones and vein/lodes were generally too hard, too erratic, or too low grade to be profitable, and the small syndicates and companies on the field explored them sporadically and haphazardly by shaft sinking and adit driving.

In 1962, R.H. Jack reported on one of the Tasmanian Department of Mines' more pragmatic efforts on the Mount Paris mining field. He mapped and described old sluice workings on greisen veins on mineral leases at Mullins-Guiding Star:

> 'The general strike of the veins is 105° to 110° and they dip from vertical to 80° to the east [north!]. These greisen veins were formed by the alteration of the granite along nearly parallel joint planes and they vary in composition from highly siliceous to almost wholly micaceous. They also vary rapidly in width from one inch to over five feet along the strike. There is more tin in the micaceous and quartz-mica greisen than in the quartz greisen, though large crystals of cassiterite are sometimes found coating fractures in the hard quartz greisen. Locally, small amounts of pyrite, arsenopyrite and wolfram were seen in the veins.'
>
> 'The area surrounding the greisen veins has been sluiced to a maximum depth of approximately 20 feet. Areas of hard greisen remain and no attempt has been made to work this material' (Jack, 1962b).

His assays of the greisen lodes peaked at 0.9% Sn over 9 feet, but altered granite zones that had been sluiced around the resistant greisens contained <0.1% Sn in, which suggested the sluiced areas had somehow been enriched by weathering processes to bring them up to payable grades. Because the 'discontinuous nature and lenticular shape of the greisen veins' made it difficult to estimate the tin grade, and would necessitate bulk mining of the whole mineralized zone, he proposed a two-hole diamond drilling program to give a preliminary indication of the overall grade.
The Tasmania Department Mines consequently drilled three shallow, inclined diamond drill holes[4] on lease 9M/60 to test the greisens over a strike length of 170 metres. All the holes intersected porphyritic granite with narrow zones up to 3 metres wide of greisenized granite containing between 0.1 and 0.8 % Sn (Table 3).

The wide greisen veins observed at surface apparently, 'lensed out in depth as they do along the strike at surface', and their diminished tin grade at depth was also unfavourable. Jack (1962a) concluded that the prospect was unattractive for lode mining and had no potential for low grade bulk mining. He recommended no further drilling of *any* of the similar prospects in the district.

Table 3 Intercepts in Mines Department drill holes at 9M/60

Hole	From (m)	To (m)	Length (m)	Sn %
RFB1	3.7	4.3	0.6	0.60
RFB1	9.1	9.6	0.5	0.47
RFB1	32.9	35.8	2.9	0.35
RFB2	13.4	14.6	1.2	0.14
RFB2	17.2	18.0	0.8	0.80
RFB2	24.4	26.7	2.3	0.21
RFB2	29.0	31.1	2.1	0.19
RFB3	25.6	27.1	1.5	0.12
RFB3	28.2	29.9	1.7	0.17

Modern systematic exploration for north-eastern Tasmanian tin deposits commenced in the late 1950s but, in recognition of the proportions of historic production, was again initially entirely focussed on alluvial tin potential. During the 1960s Riotinto and the Utah Development Company carried out regional-scale prospectivity reviews, outlined areas for testing and followed up with some mapping and drilling campaigns in the Ringarooma River valley and coastal areas (Rattigan, 1958a, b; Warin and Appleby, 1964, 1966) but none of them produced results directly relevant to Frontier's current EL 27/2011. Likewise, there seems to have been fairly continued interest and sporadic drilling campaigns to test Ringarooma valley alluvial prospects during the 1970s to mid 1980s by various groups including Texins, Anglo American, Amdex, Kibuka, Triako, Hellyer Mining and etcetera, and briefly again during the late 1980s (Threader, 1989). There has been a resurgent interest in the placer tin deposits since about 2005 (e.g. Askins, 2007).
However, those alluvial explorations were almost entirely outside the area of Frontier's EL 27/2011 and I have not examined the data from them in detail. The following sections summarize the last four decades of endogranitic tin exploration on the Mount Paris pluton.

1968-1974: Texins-Geophoto, EL6/68

Texins Development PL held Exploration Licence 6/68 covering most of the Blue Tier area (~650 mi^2) extending from Gladstone to Mathinna, with its western boundary slightly overlapping Frontier's current EL27/2011 at Rattler Hill just west of Weldborough. Texins' consulting arm, Geophoto Resources, carried out a district scale review mainly focussed on tin potential (Herd, 1969), an airborne radiometric survey intended to map granite types and explore for uranium (Rattigan, 1969a), and a stream geochemical survey for base metal deposits (Rattigan, 1969b).

[4] TASEXPLOR database lists them as 'Ruby Flat 1, 2, & 3, Branxholm' of 51, 70, & 39 metres depth, respectively. The cores are apparently stored at MRT's Mornington Rockstore.

The stream geochemical survey identified a ~2-km-diameter Cu+Zn+Bi+Mo anomaly centred on the Bald Hill prospect at Rattler Hill, which they followed up by detailed soil sampling surveys (25 x 50 feet in some cases) on six small grids, although likely contamination from several old workings had been recognized (Mortimore and Rattigan, 1970b). The soil geochemical data on four of the sampled grids indicated semi-coincident Cu ± Sn anomalies (up to about 250 ppm Cu), which Mortimore & Rattigan (1970a) recommended for testing by diamond drilling.

In 1971 Texins geologically mapped the prospect and drilled four diamond core holes[5] inclined at 45° to the northeast to test the soil geochemical anomaly and cassiterite bearing greisens exposed in old workings over a strike length of about 250 metres (Mortimore, 1971, 1974). The holes intersected granite and greisenized granite with short intervals of quartz + mica greisen carrying unspectacular tin grades rarely exceeding 0.1% Sn, but including a few short intervals of few feet carrying 0.2-0.4% Sn, and locally up to 0.1% Cu and Zn. Mortimore (op. cit) concluded that tin grades in the greisen zones diminish markedly with depth, and that the best mineralized zone was ‘long since removed by weathering’, thus downgrading the potential for ‘hardrock’ tin resources.

Temporarily reverting to the example set by historic mining, Texins then switched their emphasis to the alluvial and eluvial tin potential (Mortimore, 1973). At their Bald Hill prospect they dug 421 pits, 307 by backhoe and 114 by hand, to depths up to 2.3 m (average 0.5 m) in residual soil and the underlying decomposed granite, on a ~100 m grid pattern (locally 30 x 100 m) over about 1.5 km, extending between the Star of Peace and Rattler Hill workings (Mortimore, 1972). One or two samples (~30 litres) from each pit were ‘assayed’ by panning down to a heavy concentrate followed by geochemical analysis, and conversion to a $ per cubic yard equivalent based on a tin price of $1.25/lb. This outlined seven ‘pockets’ of ground containing an estimated total of 131,000 cubic yards at an average tin value of $2.15/c.y.[6] Mortimore concluded that it did ‘not rate as a company venture’ but there was scope for a small mining syndicate to make it a profitable operation.

Texins and Geophoto considered that their diverse programme had ‘adequately covered every avenue from which a viable mining venture…could eventuate’, and a complete review of exploration results over the whole of EL 6/68 in February 1974 ‘failed to produce any sound basis for continued exploration’ (Mortimore, 1974).

[5] Labelled DDHs 1 -4 by Texins but recorded as BLDs 1, 2, 3 & 4 in MRT’s database. 122, 77, 104, & 122 metres deep, respectively; i.e. up to about 85 m below surface. Core recovery was negligible in the top 30 m of DDH3. No assays or description of DDH 4 apart from borehole cross section in Appendix III of Mortimore’s report (TCR 78_0817).

[6] $2.15/cubic yard in 1971 is equivalent to about $69/m^3 at today’s tin price of $52.35/lb; i.e. an in situ resource value of about $7 million. At those price parameters, and assuming an S.G. of ~1.8, $2.15/cubic yard in 1971 implies a grade of about 0.16% Sn.

1970-72: Ringarooma Company, EL15/68

During the early 1970s the area of the Mount Paris mining field to the west of Rattler Hill was held under EL 15/68, and a number of small mining leases, by the Ringarooma Prospecting Company and Mr H.T. Reardon who engaged Michael Solomon and David Groves to undertake a review, and reconnaissance mapping and sampling programs, of some of the historical prospects (Solomon, 1970, 1971; Groves, 1972).

The reconnaissance work (Solomon, 1971) produced brief geologic descriptions of five tin prospect areas (Ruby Flat-Mullins, Walsh’s, Bells Plain, and Mammoth-Star Of Peace) scattered across the entire width of Mt Paris tin field. It highlighted the potential for paper-making and ceramic quality kaolinite at Ruby Flat, and 'unusually rich' potentially economic cassiterite greisens at Star of Peace.

Groves’ (1972) follow-up mapping and rock chip and costean sampling campaign came up with the following conclusions:

- A number of greisen bodies exposed at Star of Peace lease, and for about 2 km to the northwest, were too small and low grade to warrant further exploration.
- Bells Plain was a prime target for alluvial-eluvial tin exploration by bulldozer trenching, backhoe pitting and seismic surveying – even though there was little existing information on grades.
- Potential for a kaolinite resource at Ruby Flat outweighed the tin potential. Mapping indicated potential for 2 million cubic yards of <20μ, 24%, kaolinite.
- Bells Hill appeared to be the greatest concentration of greisen lodes in the area but the results of preliminary sampling were ‘not encouraging’ for bulk mine-able low-grade tin deposits because of erratic tin grades in the greisen lodes and barren granite between the lodes. The most promising result from sampling of costeans was 140 feet at 0.25% Sn (which included the Main Lode) but an adjacent costean had 109 feet at only 0.12% Sn.
- The Main (greisen) Lode at Bells Hill averages 0.57% Sn over the 600 feet of strike length that was sampled. Its surface extent of about 1500 x 10 feet and known depth of at least 180 feet (in underground workings) suggested a potential for around 200,000 tons or greater, but there were doubts about grades persisting at depth.

1976: Stannon Engineering, EL7/76

In 1976 the Stannon Engineering Company Pty. Ltd. held a large 450 km^2 exploration licence covering the Alberton to Warrentinna goldfields, and overlapping the western two-thirds of the Mount Paris pluton. Their exploration seems to have been limited to a superficial two-day reconnaissance and structural analysis of the known gold deposits, which led to a conclusion that ‘gold is either structurally or stratigraphically controlled’ and ‘that all the fields under examination are structurally linked’(Dart, 1976)!

1977-78: Mineral Holdings, Newmont, EL 11/77

In 1977 the southern half of the Mount Paris pluton was taken up by Mineral Holdings as EL 11/77, of 66 km^2, which covered all of the known prospects from Ruby Flat to Rattler Hill. Mineral Holdings set up a joint venture with Newmont PL as the operating partner. Newmont's exploration (entirely tin-greisen-centric) rationale was based on observations that the numerous known, but typically less than 2-metres-wide, endogranitic greisen lodes frequently strike NW, sub parallel to the overall trend of the mineral field and the southern margin of the pluton. This suggested that faults influencing intrusion of the granite may have remained active during its crystallisation, forming a system of fractures that acted as channel ways for late-stage pneumatolytic fluids. Furthermore, the absence of mineralized veins in the apparently impervious overlying Mathinna Beds inferred that there had been accumulation of fluids in domes and cupolas near the granite roof, and thus potential for laterally extensive cassiterite-mineralized greisen zones in favourable flat or domed structural settings (Clarke, 1978).
The prime targets were considered to be the Rattler Hill area, which is the topographically highest point on the pluton, and the Mount Paris prospect, located on a small altered granite cupola surrounded by metasediments.

Newmont carried out semi-systematic rock chip geochemical sampling of outcrops and old workings, aimed at sampling the top two metres of the granite near the metasedimentary rock contact and over areas of exposed greisens. The results were disappointingly low at Walsh's workings (1.3 km north of Mount Paris). At Bells Hill, which had previously been sampled by Groves (1972), they found values generally below 0.06% Sn. And an 800 metre sampling traverse of kaolinite-altered granite at Ruby Flat found grades generally below 0.01% Sn. However, the sampling highlighted anomalous zones at Star of Peace, where about 500 metres of the contact zone averaged 0.1% Sn (and <20 ppm W), and at also at Mount Paris where samples from the top of the cupola also averaged 0.1% Sn (Clarke, 1978).

The rock chip sampling indicated that disseminated cassiterite zones would be 'restricted' to the top two metres of the granite. Newmont tested the known Sn-anomalous zones, and other potentially favourable zones of poor exposure or with shallow metasedimentary cover, with an Air-Trac[7] shallow percussion drilling program of 99 holes totalling 1,980 metres in four areas (Clarke, 1978):

- Grid-pattern drilling (nominally on 100 x 200 m, locally 50 x 200 m spacing) along 1400 metres of the contact zone at Star of Peace showed that the contact dips more steeply (at 8 to 20°) to the southeast) than expected, which reduced the potential tonnage of an open-cut mine-able resource. Most granite intercepts were 'apparently unaltered' and tin assays of 2-metre samples from the top-of-granite zone were all <0.1% Sn, with a maximum of 0.065% over 4 metres in one hole.
- A traverse of eight 20- to 30-metre-deep holes about 200 m northwest of the exposed tin-anomalous granite cupola at Mount Paris all bottomed in Mathinna Beds. On a second traverse within about 50 metres of the granite contact, only three holes out of seven intersected greisenized or kaolinite-altered granite at depths of 32-38 m. However, these all contained low <0.05% tin.
- A series of 20- to 34-m-deep holes spaced at ~200 m apart along the track north of Mount Paris, on what was thought to be an area of shallow metasedimentary cover, failed to intersect granite.
- Only two of six holes between 9 and 30 metres deep at New Hope No.1 prospect (3 km southeast of Mt Paris) intersected granite containing low tin levels.
- Eight 20m-deep holes drilled at 200-m intervals on metasedimentary cover at Dead Horse Hill (between Mount Paris and New Hope No.1) did not penetrate to granite.

Newmont were discouraged by their drilling results that had indicated steeper than anticipated dips on the granite contacts, extensive zones of greater than 20-m-thick metasedimentary cover, and very low tin grades in the underlying granite. And so, they terminated the joint venture.

1980-82: Union Corporation, EL 11/77,

There are no MRT records of exploration during the two years after Newmont withdrew, but Mineral Holdings managed to organize another joint venture, commencing in July 1980, with Union Corporation Australia PL as the operator.

Union Corporation collectively (Winnall, 1980; Edwards, 1981) considered three types of cassiterite deposit might make the economic grade:

- Fracture controlled quartz and quartz + muscovite greisen veins.
- 'Cupola' greisens in sub-horizontal roof zones of the pluton; e.g. Mount Paris and Star of Peace prospects, possibly under areas covered by Mathinna Beds.
- Greisen veins and kaolinite-altered granite host rock that would 'bulk together' in a low grade large tonnage deposit amenable to open pit mining.

Winnall (op.cit.) carried out some reconnaissance mapping and sampling over several of the known prospects, and sparse stream sediment sampling, but didn't add significantly to the previous knowledge. Edwards (1981) followed up with some more detailed mapping and rock chip sampling centred on the high ground around the Mount Paris, Mount Terror, Hilltop and Bakhaps prospects. Low weighted average tin values in his rock chip samples (0.14 % at Mount Terror and 0.025% at Mount Paris) indicated the greisens, in the 150-m-wide 'cupola' forming a steep topographic knob and adjacent lodes, were too low-grade and too small. Nevertheless, Edwards (op.cit.) proposed a percussion drilling program to test for extensions to the cupola at Mount Terror -Mount Paris Mine, and possible other

[7] Air-Trac is a type of small track mounted percussion rig that was commonly used for blast hole drilling in quarries & etc.

metasedimentary-covered cusps at nearby Hilltop and Mount Paris topographic knolls. He also suggested 'consideration' of a gravity survey to assist in drill targeting – but without offering any justification in density contrast.

Union Corp. drilled four diamond core holes to test the Mount Terror greisen, and one percussion hole at each of Mount Paris and Hilltop. The percussion drill holes were aimed at testing the granite roof zone under Mathinna Beds cover, apparently in the belief that these topographic eminences might reflect underlying granite morphology (Winnall, 1981).

The two percussion holes (Mount Paris MP1, 99 m, vertical; Hilltop HP1, 128 m, incl. -80°) intersected Mathinna Beds with erratically variable tin contents between 5 and 115 ppm but did not penetrate to the granite contact.

The results of four inclined diamond drill holes (MT1 of 74 m; MTs 2, 3, & 4 of 100 m each) indicated the greisen knob at Mount Terror was a layered complex of quartz + muscovite greisen and semi-greisenized granite about 30 m thick, underlain by a 50-m-thick layer of coarse intrusion breccia consisting of angular fragments and blocks up to boulder size of Mathinna Beds metasedimentary 'xenoliths' (50-70 % by volume) in a matrix of locally pegmatitic muscovite aplite, which is in turn underlain by massive porphyritic adamellite-granite (Figure 3). The tin contents, although locally variable, decrease inversely with depth: averaging 0.05% Sn in the upper greisen (maximum 1.2 m @ 0.18%), 0.017% in the intrusive breccia, and 0.005% Sn in the massive porphyritic adamellite-granite below. Winnall (op.cit.) estimated the combined tonnage of the layered greisen and intrusion breccia zone at 1.4 million tonnes. His cross-sectional interpretation of the set up (Plan 3 in: Winnall, 1981) indicates the greisen zone, restricted to the apex of the peak, would represent less than a fifth of that total.

Winnall (1981) cagily omitted to comment or draw conclusions on the drilling results, and (puzzlingly) pointed towards future work focussing on follow up of stream sediment geochemical anomalies. In the following year he briefly reported on follow-up geologic and sampling reconnaissance of some stream sediment geochemical anomalies between the Guiding Star and New Hope prospects (Winnall, 1982). He came to the reasonable and obvious conclusion that the anomalies were attributable to contamination from old sluice workings and the known small greisen vein deposits, which had 'little potential as economic, large scale deposits', and recommended cessation of exploration.

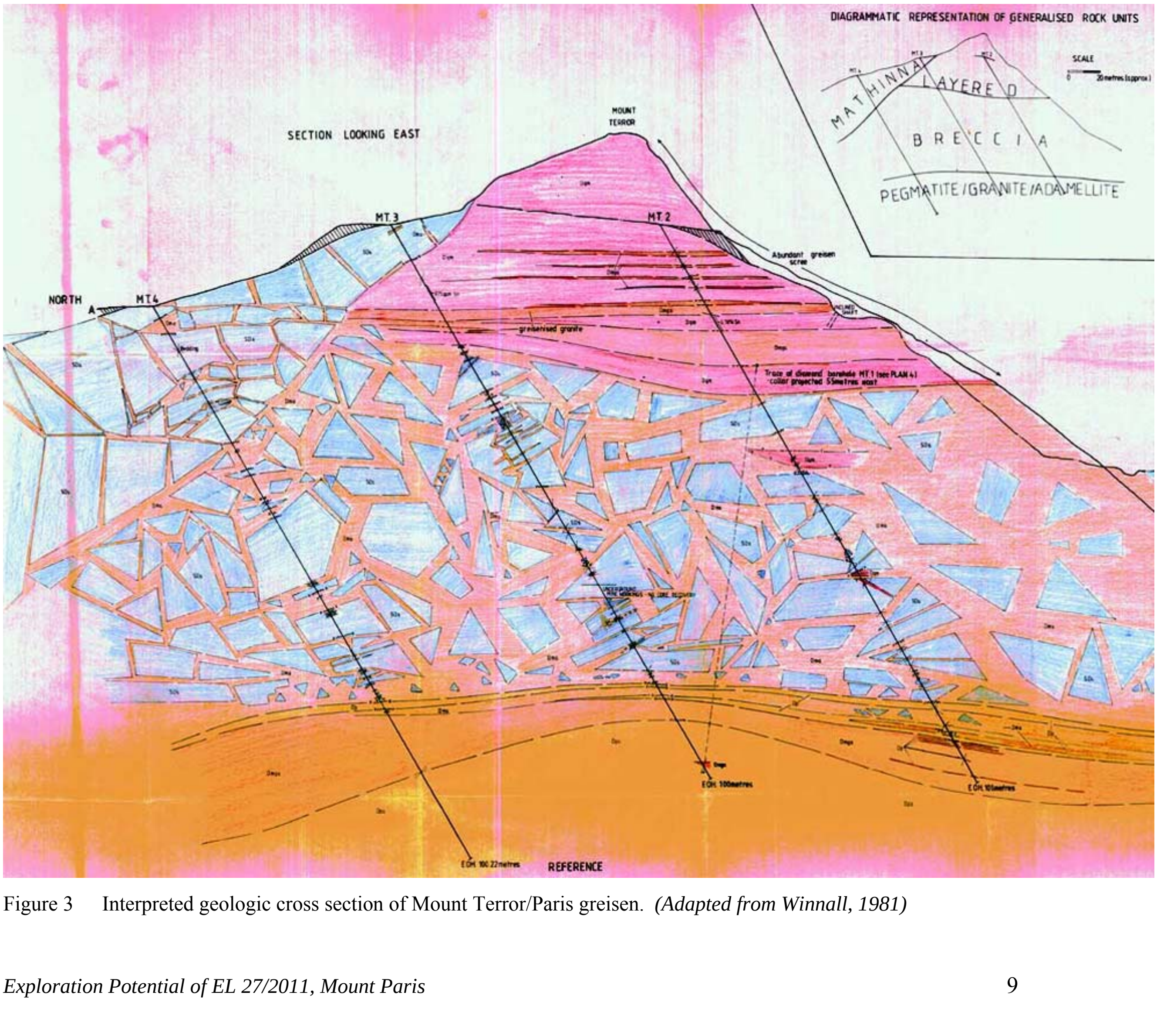

Figure 3 Interpreted geologic cross section of Mount Terror/Paris greisen. *(Adapted from Winnall, 1981)*

1982-84: Amax Australia Ltd. EL 11/77 & ML 77M/77

In July 1982, few months after Union Corporation's departure, Amax Australia entered an option agreement with Mr. H.P. Reicher[8] to explore his Mining Lease M77/77 at Rattler Hill, which was enclosed by Mineral Holdings' EL 11/77 (Yeates, 1982).

Amax put in a 200 x 300 metre grid and produced a 1:500 scale geologic map showing about four WNW trending quartz + phlogopite[9] greisen lenses occupying a zone of about 110 metres wide and about 250 metres strike (extending beyond the eastern boundary of the lease) enclosed in 'porphyritic biotite granite'. About 75-80% of that zone was 'suggested to be strongly mineralised greisen' (Yeates, op.cit.). A detailed 25 x 10 m rock chip geochemical sampling program (for Sn, W, F) indicated greater than 0.2% Sn over a 100 x 100 metre area, of which a part averaged greater than 0.4%, and several values exceeded 0.6% Sn. Tungsten contents are generally 10-20 ppm (rarely up to 25 ppm), and fluorine typically in the range 0.1 - 0.3%.

Petrographic examination of four samples showed that:

- Greisenation of the porphyritic biotite granite occurred prior to structural preparation and introduction of tin and fluorine.
- About 60% of the cassiterite exists in quartz veins.
- Fluorine is (probably) in the phlogopite lattice and does not exist as fluorite or topaz.

A year later, in August 1983, Amax cut two bulldozer costeans[10] across the mineralized zone (Vivian, 1983). Costean RHC1 was excavated outside the eastern boundary of ML 77M/77, in EL 11/77, after obtaining permission from Mineral Holdings. Both costeans, about 150 metres apart along strike, exposed five or six WNW-trending semi-vertical to steeply north-dipping greisen lenses, in zones about 33 to 53 metres wide. Vivian (op.cit.) mapped the costeans and took continuous 2-m chip samples, which were assayed for Sn, W, and F.

Cassiterite was observed as disseminated grains up to 5 mm size, in drusy quartz greisen veins in the greisen lenses and in the inter-greisen granite, with local traces of pyrite, arsenopyrite and malachite. In the eastern costean (RHC1) a 54 m wide zone containing six greisen lenses averaged 0.15% Sn, with a best interval of 5 metres at 0.43% Sn, which included one metre at 0.9% Sn. Background values in the (weathered) granite host rock are less than a few hundred ppm Sn, with sparse mineralized quartz greisen veins peaking at 0.23% Sn. The 33-metre-wide zone containing five greisen lenses exposed in the western costean RHC2 (excavated above Texins' drill hole DDH1) averaged 0.17% Sn, including a best interval of 8 metres at 0.24% Sn.

[8] Reicher received a first payment of $7,500 for the deal.

[9] Phlogopite is Mg-rich biotite. In this case tentatively identified by micropetrographic examinations of fine grained felted greenish mica. Previous descriptions of the quartz + mica greisens only mentioned muscovite.

[10] Costeans: RHC1 of 157 m, RHC2 of 152 m length.

On the assumptions that the greisen rich zones are continuous over about 150 metres between the costeans, and not greater than 30 metres deep as suggested by previous drill holes, Vivien (op.cit.) guessed the potential tonnage to be 'less than 400, 000 t… with a grade much less than 0.2% Sn'.
The low grade and tonnage results downgraded the economic potential and Vivian (op.cit.) recommended against further exploration of ML 77M/77 *and* the enclosing EL 11/77.

Mineral Holdings subsequently endeavoured to entice CRA Exploration, Goldfields Exploration, and evidently also Noranda into joint venture arrangements[11] (Thomas and Weber, 1985). But these efforts met without success and EL 11/77 ultimately expired in November, 1984.

1985-2006: Tin in doldrums

In late 1985, following the collapse of the International Tin Council, tin prices caved in and remained below $10,000 per tonne for a couple of decades. Interest in exploration for Tasmanian tin deposits virtually evaporated, for both hard rock and alluvial deposit types. Although there were possibly a few true-believer prospectors who held onto their favourite leases for a while, I have found no MRT database references to tin exploration in the Mount Paris area during these two decades.

Goldfields Exploration's EL 17/86 covered the goldfields from Mathinna to Forester, and overlapped the western half of the Mount Paris pluton, but their short-lived 1987 exploration program was exclusively for gold and did not venture onto the tinfields (Roberts, 1987).

Mineral Holdings reappeared on the north-eastern Tasmanian scene in 1999 to 2002 with an interest in SEL 22/99, which covered the exposed part of the Mount Paris pluton and large parts of the neighbouring Pyengana and Poimena plutons, extending east to Weldborough Pass and north to near Pioneer. Their exploration target was gemstone quality sapphires in placer deposits, and the evaluation of potential was largely based on purchasing small parcels of sapphire from fossickers. One of these was a 'parcel of 40 grams sourced from small creeks in the vicinity of the Star of Peace tin workings [Mount Paris tinfield]. Principally [of] low grade sapphire and corundum, three pieces of reasonable bluish sapphire were too fractured to be cut' (Duncan, 2002). There was only limited new alluvial sampling and although gold and tin were considered as possible credits the focus was firmly on gemstones.

[11] Graeme Weber commented that: 'The trenches have been well trampled - I think he [Neil Thomas] has really passed this area around' (Thomas and Weber, 1985).

2007-10: Green River Resources Ltd., EL 41/2007

The sustained improvement in tin value from about 2006 initiated a revival of interest in Tasmanian tin exploration. Late in 2007, Green River Resources Limited was granted EL 41/2007, which occupied exactly the same area as Frontier Resources' current EL 27/2011 application, to explore the 'multi-element potential' of the Mount Paris area (Dahl, 2009). Their ($78,000) exploration program during 2008 and 2009 involved a 'literature study' and two short prospecting trips by an exorbitantly remunerated[12] consultant, who generated practically no data and produced reports that would barely pass in a 2nd year undergraduate economic geology course (Dahl, 2009, 2010b). Twenty days of prospecting 'along roads and tracks accessible by 4WD vehicle' involved testing (an undisclosed number of) rock and stream sediment samples by hand lens, crushing, panning, and an ultraviolet lamp, which failed to recognize any gold, cassiterite, molybdenite or wolframite in any of the samples[13]!

Despite his unspectacular prospecting results, Dahl (2010a) concluded the Mount Paris area 'has a good potential of hosting a significant resource of Sn in the form of Sn-carrying greisens', and foretold further sampling and mapping to lead up to RC percussion drilling in 2010. Green River Resources agreed that the area 'has a very good potential for hosting a significant resource of tin' but conceded that their program had found 'little evidence' of significant mineralisation (Murphy, 2010). Blaming the Australian Government's proposed mining super tax, and the low tin price[14], Green River Resources decided it would not proceed with exploration in Australia, but would instead surrender the tenement - and wind up the company.[15]

[12] $2,000 per day!

[13] Yet many of the previous reports referred to coarse – even specimen grade – visible cassiterite to 5 mm grainsize in the greisens and quartz veins (Jack, 1962b; Groves, 1972; Vivian, 1983).

[14] In May, 2010, at the date of Green River's final report, the tin price was around US$18,000/t, increased from US$14,500 the previous July, but lower than its previous peak value of around US$25,000 in May 2008.

[15] At face value, the Green River Resources episode at Mount Paris is a sad reflection of the downturn in the *quality* of exploration that seems, these days, to attend the upturns in exploration *expenditure*, which is clearly not the same thing as exploration *activity*.

MOUNT PARIS DEPOSIT MODELS

Apart from the Ringarooma Prospecting Company's early interest in the potential for economic kaolinite deposits at Ruby Flat (Groves, 1972), the long history of Mount Paris exploration revolves around cassiterite – in endogranitic greisen, vein, eluvial and alluvial type deposits.

Kaolinite

Groves (1972) was uncertain about its mode of formation (hydrothermal or weathering ?) and hence the potential depth extent, but he 'felt' that there could be about 2 million cubic yards of kaolinite-altered granite in the Ruby Flat-Mt George area, averaging perhaps 24% filler-grade (<20μ) kaolinite and 0.5 lb/cubic yard cassiterite. At those estimated grades, and prices current at that time, the kaolinite value outweighed the tin value by a factor of twenty. Accordingly, Groves recommended that exploration there should focus on determining the kaolinite resource, provided that some test samples proved to be of satisfactory quality. Subsequent exploration companies, focussed on tin, seem to have overlooked this potential.

I am unable to comment further on the kaolinite prospectivity of Mount Paris, except to note that forty years ago it was considered to have some potential. Results of a brief internet search suggest there is sustained demand for kaolinite (Anonymous, 2010a), and high quality product for paper coating is worth a few hundred dollars per tonne (Sykes, 2000; Border, 2001). Tasmanian production of kaolinite from the Tonganah Mine near Scottsdale was a little less than 8,000 tonnes in 2009-10 (Anonymous, 2010b); which is a significant decline from 22,000 tonnes per annum in the mid 1990s (Bottrill, 1995) possibly related to a reduction in local paper manufacturing.

Tin deposits

The fifty-five or so small prospects, and the significant production from downstream alluvial deposits, leave no doubts about the tin fertility of the Mount Paris Pluton. It is the 'right' kind of highly crystal-fractionated, reduced, ilmenite-bearing (non-magnetic) S-type tin granite, of characteristic per-aluminous, low Sr, Ba, and high Rb geochemical composition (Groves, 1977; Young, 1979; McClenaghan, 2006).

Accordingly, preceding exploration programs have quite sensibly been directed to finding the most fractionated and pneumatolytically altered and mineralized parts of the pluton, likely to contain the highest concentrations of incompatible elements such as tin, and situated in favourable structural settings in the roof zone of the pluton. These could include vein swarms in the overlying metasedimentary host rocks, or greisens in the upper levels of the pluton. Greisens have been the prime targets at Mount Paris, in recognition of the level of erosion, which has stripped the metasedimentary cover rocks from about three-quarters of the pluton area. They are most likely to have formed in apical cupolas (e.g. the Mount Terror-Mount Paris prospect explored by Newmont and

Union Corp., Figure 3) and in gently sloping roof zones (e.g. the conceptual target explored by Newmont at Star of Peace prospect), as variously depicted in Figure 4. They may also exist in intra-granitoid settings (e.g. diagram (a) in Figure 4) similar to the 'Anchor-type' greisen sheets investigated by Aberfoyle (Young, 1979) and Amoco (Jones, 1984) at Cream Creek.

Assuming (hypothetically) that the Ringarooma valley alluvial production of ~44,500 tonnes Sn represents only half of the tin already eroded from greisen deposits in the Mount Paris pluton, then its primary greisen source (not necessarily in one deposit) could have been about 4.5 million tonnes at an average grade of (say) 0.2% Sn. A tin deposit of that size would have a present day in situ value of about A$214 million.
Assuming (now rather far out on the hypothetical limb) that the area of the pluton was originally evenly mineralized, then the remaining quarter still under metasedimentary cover might contain about 1.5 million tons at ~0.2% Sn (A$71 million). However, the distribution of prospects shows that the greisen zone has not been entirely eroded from the south-western half of the pluton; this allows the possibility of a greater remaining tonnage, maybe 3 million tonnes. If that hypothetical resource was (but not necessarily is) in a single semi-horizontal greisen deposit, with a thickness of 30 metres and density of 2.6 g/cm^3, it would have a an area of about 200 x 200 metres.

The point is: that hypothetical deposit is not a large target. But it is consistent with the typically smallish size of tin greisens. Menzie & Reed (1986) graphically depicted the sizes and grades[16] of ten tin greisen deposits ranging between 0.8 and 65 million tonnes and 0.17 to 0.47% Sn. Their median deposit size was 7.2 Mt @ 0.28% Sn; the Anchor deposit at Lottah was the second smallest on their list. Nor is it an economically outstanding target. The comparable Anchor deposit, 2.4 Mt @ 0.28% Sn, is recognized as the largest Tasmanian tin greisen, but the most recent evaluation found that it would be uneconomic (Minemakers, 2008).

There may be potential for exogranitic 'porphyry-tin' deposits in vein swarms in the Mathinna Beds cover, analogous to the large but low grade Taronga deposit[17] in north-eastern New South Wales (Anonymous, 2009), or larger veins like the Aberfoyle and Storey's Creek vein deposits in north-eastern Tasmania (Jennings and Williams, 1967). However, and notwithstanding Groves' (1977, p.88-89) mention of small deposits of this type in the roof zone of the Mount Paris pluton, the overwhelmingly granite-hosted distribution of the known tin deposits at Mount Paris, which were undoubtedly discovered by thorough surface prospecting in the early years, and the results of several EL 11/77 drilling programs, suggest that insignificant exogranitic mineralization occurred in the south-western quarter that is still under metasedimentary cover.

Moreover, the overall west-north-west trend of the Mount Paris tinfield, and the typical northwest strikes of individual greisen lodes (e.g. Solomon, 1971, Fig.1) which were also observed at Cream Creek (Young, 1979), suggests some kind of intra-plutonic structural control on late-stage greisen and vein mineralization. If Mount Paris mineralization was concentrated in that single north-west trending 'corridor' and the remainder of the pluton was relatively non-mineralized, the current level of erosion may have already exposed, and maybe largely removed, the best-mineralized zone.

Other elements

Various companies have analysed for other elements, mainly as pathfinders for tin exploration or as potentially extractable co-products.

- Texins/Geophoto's diverse and extensive north-eastern Tasmanian exploration objectives included base metal deposits; consequently they analysed their Bald Hill-Rattler Hill prospect samples for a broad range of elements typically including Cu, Pb, Zn, Ag, As, Sn, Mo, Bi, W, Ni, Co, and F. Mo, Bi, and W proportions were mainly below (not stated) detection limits, and peaked at 30, 335 ppm and 0.05%, respectively. Fluorine levels in DDH1 samples were typically 0.5-1.0% and peaked at 4.2% but not clearly correlated with Sn (Mortimore, 1971).
- Groves' (1972) samples of Star of Peace and Bells Hill greisen lodes were assayed for Sn and W, but W maxima were only 0.02%.
- Union Corp. claimed to have analysed for W, Au and Hg, but reported only a few tungsten analyses (e.g. 1.17% W in a quartz + wolframite sample from Cox's prospect near Bells Hill) and sparse mercury data up to 6 ppb Hg in the Hilltop Prospect percussion drill hole HT1.
- Amax's Rattler Hill grid-pattern rock chip samples, and follow-up costean samples, were assayed for W and F, with maxima around 25 and 4,200 ppm, respectively (Yeates, 1982; Vivian, 1983).

Highly fractionated granites and associated pneumatolytic-hydrothermal deposits may contain anomalous concentrations of lithium, rubidium, tantalum, yttrium, niobium, beryllium, uranium, thorium, zirconium, and the Rare Earth Elements (REE). However, I have found no reference to exploration for, or analysis of, these elements amongst the reviewed previous exploration reports. Bottrill (2001) noted numerous Tasmanian occurrences but only minor production of rare earth minerals from beach sands or tin-bearing placer deposits, and that there has been little significant exploration for Ta, Nb or Sc deposits.

Of the twelve Australian REE-bearing deposits currently in production, according to Hoatson et al. (2011), ten are heavy mineral sand deposits, one (Olympic Dam, SA) is an iron-oxide breccia deposit, and one (Mount Weld, WA) is in lateritic regolith developed on carbonatite. Mount Weld is the only Australian deposit from which REE are (or will be) recovered. There are very few pegmatite-hosted REE deposits (the most likely REE-mineralization

[16] The grades are (naturally) inversely related to tonnage.
[17] Taronga resource estimate: 31 Mt @ 0.165% Sn, ~51,000 tonnes tin.

type applicable to the Mount Paris geologic setting) in the extensive list of Australian deposits (Hoatson et al., op.cit.). Furthermore, primary granitoid-associated deposits seem to be relatively unimportant in terms of global REE production.

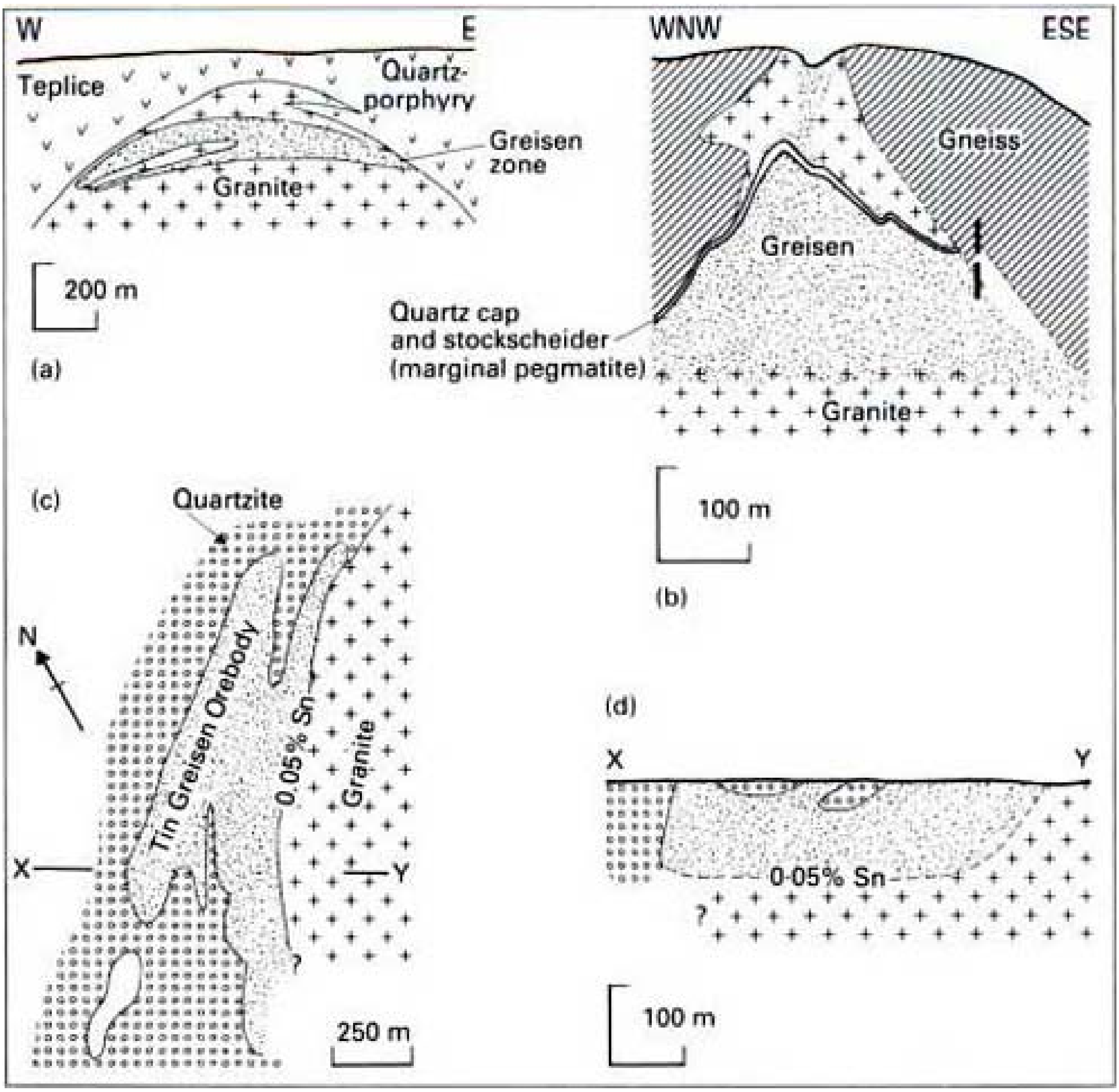

Figure 4 Geologic settings of some tin greisen deposits; (a) Cinovec, Czechoslovakia, (b) Sadisdorf, Germany, (c) & (d) East Kemptville, Nova Scotia. *(Adapted from: Evans, 1993).*

EXPLORATION APPROACHES

The results of previous prospecting and 1970s to 1980s-era exploration of the Mount Paris tinfield suggest that none of the fifty-odd known tin prospects are likely to contain economic tin resources – either singly or collectively. Table 4 lists some of the tentative resource estimates made by previous explorers.

Table 4 Resource estimates of some Mount Paris prospects.

Prospect	Tonnes	Sn %	Reference
Ruby Flat	750,000	<0.5	Groves, 1972
Greisen lodes west of Mammoth	1,000,000	0.1 - 0.4	Groves, 1972
Bells Hill	400,000	0.5	Groves, 1972
Rattler Hill eluvial	~180,000	~0.16	Mortimore, 1972
Rattler Hill greisen	<400,000	<0.2	Vivian, 1983
Mount Paris	1,400,000	~0.02	Winnall, 1981

Nevertheless, the exploration efforts have been fairly superficial, largely based on surface sampling, pitting, costeaning or, at best, shallow drilling of exposed greisen lodes at the known historical prospects. The Mines Department's three holes at Guiding Star reached barely 50 m below surface (Jack, 1962a), and Texins' four holes at Bald Hill (Mortimore, 1971), and Union's four holes at Mount Terror (Winnall, 1981), likewise to only about 85 m below surface. However, none of those drilling programs provided encouragement to go deeper, and there are many reported observations that the greisen zones are limited to vertical thicknesses of about thirty or forty metres.

Newmont and Union Corporation (consecutively) took subsurface exploration one step further by drilling for greisen cupolas hidden below the metasedimentary Mathinna Beds cover; their targets guided by not much more than distance away from the granite contact at surface, and topography. But again, their exploratory percussion drill programs, constrained by the quest for open-cut-minable resources, were shallow: Newmont's to only 44 metres and Union's at Hilltop prospect to a maximum of about 125 metres.

Not only superficial, those exploration programs were individually brief. Perhaps, I suspect, because of the joint venture arrangements that they operated under. Exploration of the Mount Paris tinfield may have been more sustained, scientifically based, and effective if the investigation in the decade preceding the 1985 collapse had been conducted by one of the committed Tasmanian tin producers, e.g. Aberfoyle or Renison, instead of a series of short-term joint ventures under Mineral Holdings.

Despite the lack of success to date, the most empirically probable undiscovered tin resource at Mount Paris is likely to exist in greisen: either in an apical granite cupola covered by metasedimentary rocks, or in 'Anchor-type' greisen sheets within the granite. Unfortunately, as Phil Jones (1984, p.19) astutely remarked, exploration for non-exposed tin greisen deposits is difficult, because they are not likely to be detectable by conventional surface geochemical and geophysical methods.

Some of the techniques that might be worth a try are:

- Gravity survey. Mike Roach (1992) claims to have effectively modelled sub-Mathinna Beds granite bodies using (rather wide-spaced) gravity measurements, even though the density ranges of Mathinna Beds and Blue Tier Batholith overlap (2.55 – 2.80 g/cm^3 and 2.59 – 2.63 g/cm^3, respectively). I think it would be worth obtaining an expert geophysical opinion on whether this gravity survey approach might be effective in outlining potential greisen cupolas under the covered, south-western quarter of the Mount Paris pluton.

- Short wavelength infrared (SWIR) spectral mapping. SWIR analysis could be an effective means of mapping the distribution of alteration minerals in the granite, and possibly reveal meaningful zonation related to the greisen and quartz vein deposits. Although there was uncertainty about the origin of kaolinite (hydrothermal or weathering, or both?) several of the known prospects, particularly at the western end of the field, are associated with significant zones of kaolinite-altered granite, e.g. Ruby Flat, Star of Peace (Groves, 1972) and Royal Gordon (Nye, 1933b). Amax's petrographic analysis indicated coarse cassiterite was associated with fine felted phlogopite altered zones at Rattler Hill; this should also be mappable by SWIR. Topaz might exist in the most highly fractionated phases of the granite, which could be most favourable sites for concentration of tin and other incompatible elements. None of the previous reports have mentioned topaz, which would be visually difficult to distinguish from quartz if it exists in the greisens but it is very distinctive, even at low proportions, in SWIR spectra. MRT's trial interpretation of ASTER remote sensing spectral data over northeast Tasmania does not seem to have identified significant altered zones at Mount Paris (Maloney et al., 2007). However, ASTER data have poor SWIR spectral resolution, and poor (30 m) spatial resolution, and the mineral responses would be masked by vegetation cover.

- Multi-element geochemistry to map out granite compositional variations, which probably relate to degrees of magmatic crystal fractionation, and indirectly to mineralization processes. Systematic sampling and analysis for fractionation-susceptible major and trace elements may assist in mapping granitoid intrusive phases and developing conceptual targets. This would be most effectively combined with SWIR spectral analysis and (unfashionable) geologic mapping; all limited by degree of outcrop.

- The previous explorers have analysed extensively for tin, in rock chips and residual soils, and (not surprisingly) found it to be in highly variable proportions at small scales. However, a GIS compilation of all the existing data may reveal a semi-coherent pattern for exploration targeting. Data quality could severely limit this approach; some of the early analyses reported in percentage terms had rather high detection limits, e.g. Groves' (1972) detection limit of 0.01% Sn. The distribution of existing assay data of elements other than tin is probably insufficient and too patchy to contribute much to district scale exploration.

REFERENCES

Anonymous, 2009, The Taronga Tin Project Technical Review, Taronga Mines Ltd., 7 p., http://www.tarongamines.com/reports.php

Anonymous, 2010a, Kaolin: Web Page, Sydney Construction Materials, 1 p., http://www.sydneyconstructionmaterials.com.au/kaolin.html

Anonymous, 2010b, Mineral Resources Tasmania Annual Review 2009/2010, Department of Infrastructure, Energy and Resources, 53 p., http://www.mrt.tas.gov.au/portal/page?_pageid=35,830861&_dad=portal&_schema=PORTAL

Askins, P. W., 2007, Report on Prospectivity of EL 65/2004 - Derby Deep Leads Tin Project: Company exploration report, 43 p., TCR 08_5610A, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/08_5610A

Border, S., 2001, Kaolin - not just for indigestion, SMEDG, 41 p., www.smedg.org.au/skardonkaolin.ppt

Bottrill, R. S., 1995, The clay resources of Tasmania: Tasmanian Geological Survey
Record 1995/02, 9 p., UR1995_02, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR1995_02

Bottrill, R. S., 2001, Rare earth, tantalum and niobium minerals reported in Tasmania, Mineral Resources Tasmania, 9 p., Tasmanian Geological Survey Record 2001/07, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR2001_07

Clarke, N. G., 1978, Final Report, Exploration Report for E.L. 11/77 Mt Paris, for the Period 1.1.78-19.6.78, Newmont PL, 41 p., TCR 78_1281, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/78_1281

Cundy, W. H., 1925, Bells Hill Tin MIne: Unpublished record, Tasmania Department of Mines, 6 p., URMISCB_035_40, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/URMISCB_035_40

Dahl, N., 2009, EL41/2007 Mt Paris Annual Report for the period ending 18/12/2008, Green River Resources Limited, 14 p., TCR 09_5842, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/09_5842

Dahl, N., 2010a, EL41/2007 Mt Paris Annual report for the period ending 18/12/2009., Green River Resources Ltd., 14 p., TCR 10_6014, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/10_6014

Dahl, N., 2010b, Sn in Tasmania - a brief overview, Consultant's report for Green River Resources Ltd., 14 p., Appendix 1 in: TCR 10_6014, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/10_6014

Dart, G. W., 1976, Reports 1 and 2 (Combined) E.L.`s 6/76, 7/76, 8/76,, Stannon Engineering Company Pty Ltd,, 2 p., TCR 76_1191, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/76_1191

Duncan, D. M., 2002, Annual Report on Exploration - October 2001 to September 2002 - SEL 22/1999, Mineral Holdings Australia Pty. Ltd.,, 35 p., TCR 02_4794, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/02_4794

Edwards, P. W., 1981, Report on Mapping, Mount Paris Tin Prospect - E.L. 11/77 North-East Tasmania., Union Corporation Australia PL, 27 p., TCR 81_1532, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/81_1532

Evans, A. M., 1993, Ore geology and industrial minerals: an introduction, 3rd edition, Blackwell Science, 379 p., http://books.google.com.au/books?id=VbTyfOjMpRgC&pg=PA154&lpg=PA154&dq=tin+greisens&source=bl&ots=gm5SQhGQ_Z&sig=u0CaKY2npJJ3H7iQbF5UxWyl1jU&hl=en&ei=D3USTt_rBafnmAW7yNXJDg&sa=X&oi=book_result&ct=result&resnum=8&ved=0CFIQ6AEwBw#v=onepage&q=tin%20greisens&f=false

Gooday, P., 2011, Stellar Resources advancing high-grade tin project on Tasmania's west coast, Mine Life Daily Resources Bulletin, 3 p., www.stellarresources.com.au/media

Groves, D. I., 1972, Geological Survey and Sampling Programme of Parts of Exploration Licence 15/68 near Branxholm, North Eastern Tasmania, Ringarooma Mining PL, 43 p., http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/72_0855

Groves, D. I., 1977, The geology, geochemistry and mineralisation of the Blue Tier Batholith, Geological Survey Bulletin 55, Tasmania Department of Mines, 110 p., GSB55, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/GSB55

Herd, B. R., 1969, Prospects and Investigation in the Blue Tier Tin Field of North Eastern Tasmania, Geophoto Resources Consultants for Texins Development PL, 19 p., TCR 69_0559, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/69_0559

Hoatson, D. M., Jaireth, S., and Miezitis, Y., 2011, The major rare-earth-element deposits of Australia: geological setting, exploration, and resources, Geoscience Australia, 204 p., https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=71820

Jack, R. H., 1962a, Drilling Results, Branxholm Tin Deposits, Tasmania Department of Mines, 3 p., TR7_23_25, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/TR7_23_25

Jack, R. H., 1962b, Tin Deposits, Branxholm: Technical Report, Tasmania Department of Mines, 9 p., TR6_23_31, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/TR6_23_31

Jack, R. H., 1966, Star of Peace Area; Weldborough: Technical Report, Tasmania Department of Mines, 7 p., TR10_42_48, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/TR10_42_48

Jennings, I. B., and Williams, E., 1967, Geology and Mineral Resources of Tasmania, Geological Survey Bulletin No. 50, Tasmania Department of Mines, 90 p.

Jones, P. A., 1984, Progress Report January to June 1984, Exploration Licence 32/82, Weldborough, Tasmania, Amoco Minerals Australia Company,, 38 p., TCR 84_2178, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/84_2178

Keid, H. G. W., 1944, The Weldborough Tin Field: Unpublished record, Tasmania Department of Mines, 9 p., UR1944_017_25, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR1944_017_25

Maloney, M., Nunn, D., and Nano, S., 2007, ASTER Processing and Interpretation of Northeast Tasmania: Consultants report to MRT, Global Ore Discovery, 18 p., GPCR2007_01, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/GPCR2007_01

McClenaghan, M. P., 2006, The geochemistry of Tasmanian Devonian-Carboniferous granites and implications for the composition of their source rocks: Tasmanian Geological Survey Record 2006/06, Mineral Resources Tasmania, 31 p., http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR2006_06

Menzie, W. D., and Reed, B. L., 1986, Grade and tonnage model of Sn greisen, *in* Cox, D. P., and Singer, D. A., eds., Characteristics of mineral deposit occurrences: U.S. Geological Survey Bulletin 1693, p. 70-72.

Minemakers, 2008, Other North-east Tasmanian Tin Projects - Anchor, Minemakers Ltd., 1 p., http://www.minemakers.com.au/projects-tas-other.php#Anchor

Mortimore, I. R., 1971, Diamond Drilling on the Rattler Hill Prospect, Bald Hill, E.L. 6/68, N.E. Tasmania, Geophoto Resources Consultants for Texins Development PL, 51 p., TCR 71_0817, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/71_0817

Mortimore, I. R., 1972, Bald Hill Eluvial Tin Prospect E.L. 6/68 N.E. Tasmania, Geophoto Resources Consultants for Texins Development PL, 10 p., TCR 72_0906, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/72_0906

Mortimore, I. R., 1973, Status of the Alluvial Tin Programme, E.L. 6/68, N.E. Tasmania, November, 1973, Geophoto Resources Consultants for Texins Development PL, 41 p., TCR 73_0979, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/73_0979

Mortimore, I. R., 1974, Final Report on Exploration Activities Within E.L. 6/68, N.E. Tasmania, Geophoto Resources Consultants for Texins Development PL, 77 p., TCR 74_0999, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/74_0999

Mortimore, I. R., and Rattigan, J. H., 1970a, Analyses from Grids, A, B, C, D, E and F, Bald Hill Project, E.L. 6/68, N.E. Tas., Geophoto Resources Consultants for Texins Development PL, 51 p., TCR 70_0694, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/70_0694

Mortimore, I. R., and Rattigan, J. H., 1970b, Memorandum Report on the Bald Hills Project, Upper Cascade River, E.L. 6/68, Geophoto Resources Consultants for Texins Development PL, 9 p., TCR 70_0623, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/70_0623

Murphy, C., 2010, EL41/2007 Mt Paris. Final surrender report for the period 19 December 2007 to 20 May 2010, Green River Resources Ltd., 14 p., TCR 10_6080, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/10_6080

Nye, P. B., 1924, Report on M R Brocks Tin Mine near Weldborough: Unpublished Record, Tasmania Department of Mines, 2 p., UR1924_256_257, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR1924_256_257

Nye, P. B., 1933a, Report on Mt Paris Mine: Unpublished record, Tasmania Department of Mines, 5 p., UR1933_127_131, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR1933_127_131

Nye, P. B., 1933b, Report on the Royal Gordon Workings, vicinity of Mt George - Branxholm., Tasmania Department of Mines, 4 p., http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR1933_171_174

Purvis, J. G., 1988, Tasmanian Tin Prospects, Part 2, NE Tasmanian Tin Province: Consultant's Report, J.G. Purvis & Associates for: Aberfoyle Resouces Ltd., 60 p., TCR 06_5259, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/06_5259/

Rattigan, J. H., 1958a, The Prospects for Alluvial and Other Secondary Tin Deposits Within S.P.L. 323, North Eastern Tasmania., Riotinto Australia Exploration PL, 25 p., TCR 58_0226, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/58_0226

Rattigan, J. H., 1958b, Review of Prospects Ringarooma Permits N.E. Tasmania, Riotinto Australia Exploration PL, 9 p., TCR 58_0247, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/58_0247

Rattigan, J. H., 1969a, Gamma Ray Spectrometer Survey, North East Tasmania, Geophoto Resources Consultants for Texins Development PL, 24+ p., TCR 69_0584, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/69_0584

Rattigan, J. H., 1969b, Stream Sediment Geochemistry of EL 6/68, Northeast Tasmania to July 31st, 1969, Geophoto Resources Consultants for Texins Development PL, 62 p., TCR 69_0566, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/69_0566

Reid, A. M., 1925, Report on the Work Performed by C. Brock at the Mammoth Mine, Weldborough: Unpublished record, Tasmania Department of Mines, 1 p., UR1925_026, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/UR1925_026

Roach, M. J., 1992, Regional geophysics of the Alberton-Mangana goldfield, northeast Tasmania: Tasmania: an island of potential, Hobart, 16/9/1992, Tasmania Department of Mines, Geological Survey Bulletin 70, p. 199-207, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/GSB70_199_207

Roberts, P. A., 1987, E.L. 17/86, Branxholm Area, Relinquishment Report for 157 sq. km Area, Goldfields Exploration PL, 31 p., TCR 87_2733, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/87_2733

Seymour, D. B., Green, G. R., and Calver, C. R., 2007, The Geology and Mineral Deposits of Tasmania: a Summary, Mineral Resources Tasmania, 32 p., Geological Survey Bulletin 72, 2nd edition, www.mrt.tas.gov.au/mrtdoc/dominfo/download/GSB72_2/

Solomon, M., 1970, Report on Exploration Licence 15/68, near Derby, North East Tasmania, Ringarooma Mining Company PL, 10 p., TCR 70_0693, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/70_0693

Solomon, M., 1971, Reconnaisance Geological Survey of Exploration Licence 15/68 near Branxholm, North East Tasmania, Ringarooma Prospecting Company, 16 p., TCR 71_0733, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/71_0733

Sykes, T., 2000, Aust Kaolin hits the Bermuda Triangle Financial Review - Pierpoint, 1 p., http://www.pierpont.com.au/article.php?Aust-Kaolin-hits-the-Bermuda-Triangle-54

Thomas, N. M., and Weber, G. B., 1985, Final Report - Exploration Licence 11/77, Mineral Holdings Aust. PL & CRA Exploration PL, 13 p., TCR 85_2434, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/85_2434

Threader, V. M., 1989, Annual Report (1988-89), EL 4/88, Pera Flats,, Vic Threader and Associates Pty Ltd,, 11 p., TCR 89_2991, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/89_2991

Thureau, G., 1884, An interim report on some of the more Stanniferous Deposits in the vicinity of the River Ringarooma, County of Dorset, Tasmania: Interim Report, Tasmania Department of Mines, 4 p., OS_052, http://www.mrt.tas.gov.au/mrtdoc/dominfo/download/OS_052

Vivian, R. M., 1983, Supplementary Report on Costeaning Activities Within ML 77M/77 and EL 11/77 Rattler Hill. August, 1983, Austamax Operations PL, 27 p., TCR 85_2497, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/85_2497

Warin, O. N., and Appleby, W. R., 1964, Tin Resources of North Eastern Tasmania and Proposed Drilling Programme, Utah Development Company, 135 p., TCR 64_0381, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/64_0381

Warin, O. N., and Appleby, W. R., 1966, Progress Report on the Exploration for Alluvial Tin Deposits in N.E. Tasmania and the Furneaux Group, Utah Development Company, 45+ p., TCR 66_0430, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/66_0430

Winnall, N. J., 1980, Preliminary Report-E.L. 11/77, Union Corporation Australia PL, 11 p., TCR 81_1526, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/81_1526

Winnall, N. J., 1981, E.L. 11/77 Six Monthly Report, Union Corporation Australia PL, 140 p., TCR 81-1631, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/81_1631

Winnall, N. J., 1982, E.L. 11/77 Final Report, Union Corporation Australia PL, 5 p., TCR 82_1711, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/82_1711

Yeates, R. J., 1982, Progress Report on the Rattler Hill Tin Prospect, Amax Australia Limited, 32 p., TCR 06_5357, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/06_5357

Young, C. H., 1979, Progress Report, Exploration Licence 19/78, Weldborough, August 20th, 1979., Aberfoyle Exploration Pty Ltd,, 22 p., TCR 79_1387, http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/79_1387

Young, C. H., 1981, Rattler Hill ML 77M/77: Unpublished property examination report, Aberfoyle Exploration Ltd., ? p.,