AIG Field Trip

Cygnet Area: There's More to Cygnet than Syenite

Saturday 30 April 2022 (with additions)

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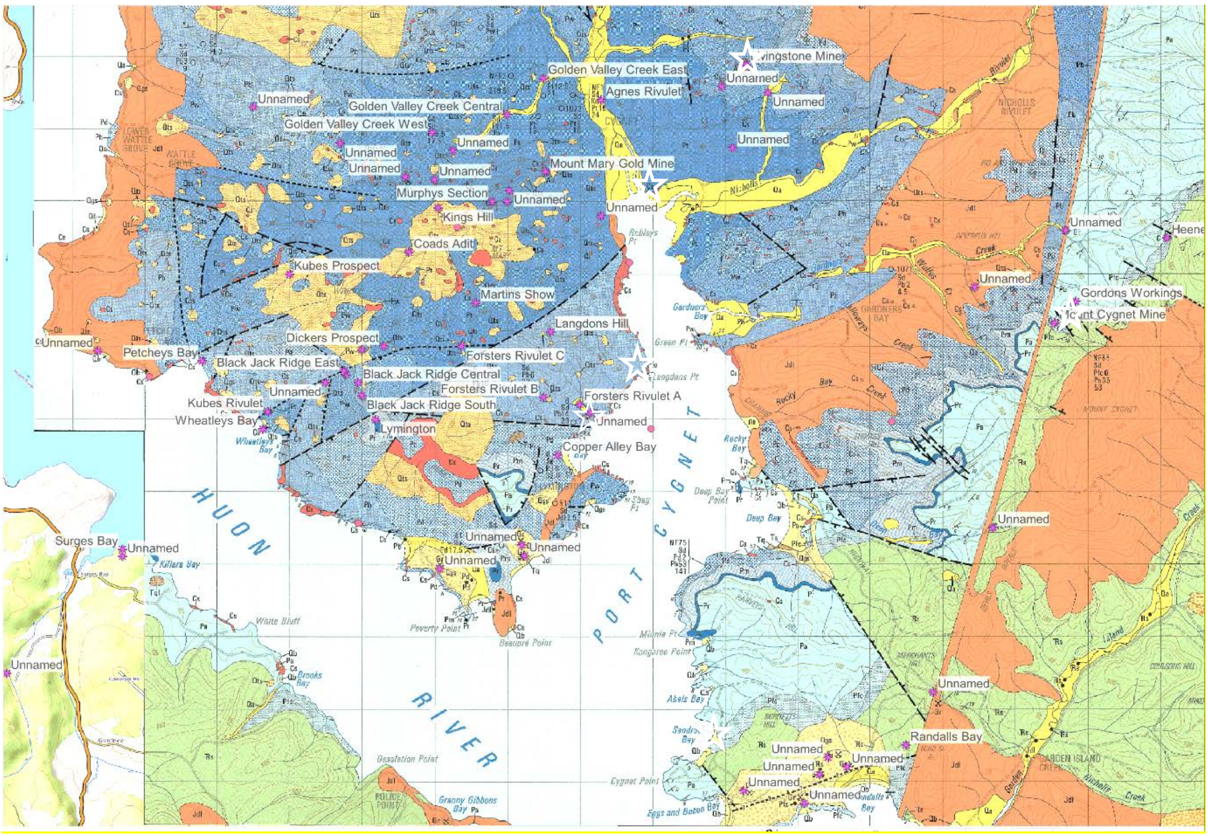

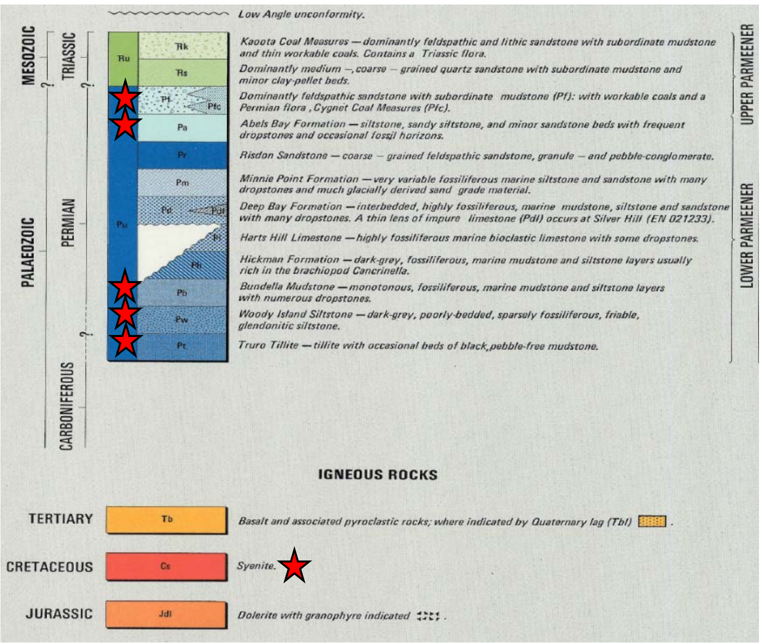

Figure 1. *Extract from Kingborough 1:50,000 Geological Map (Farmer, 1981) showing the Port Cygnet area. The locations visited are shown on the map above (white stars) and their positions within the regional stratigraphy are shown on the stratigraphic column below (red stars). Unfortunately, we do not have the time on this trip to visit representative exposures of the entire stratigraphic sequence. See Figure 19 (a and b) and 20 for aeromagnetic and gravity geophysics.*

Introduction

This field trip was organised by John Bishop and Tony Webster as an introduction to the geology of this fascinating and scenically beautiful region. John has lived near Cygnet for 20 years and wanted to learn more about his own ‘backyard’. Tony offered to help with the organisation and was interested in the gold mineralisation, coal measures and the mining history.

Neither John nor Tony is an expert on the geology of Cygnet. But hopefully, this field trip might show that it does not take an expert on the geology of a region to organise and lead a field trip if there are good published and online resources, and with any luck, some experts who are willing to come along on the day and explain the finer details. Perhaps this field trip might encourage others to organise similar excursions to other parts of Tasmania.

One of the original objectives was to examine key parts of the Permo-Triassic sedimentary sequence, and particularly some of the spectacular fossil exposures. Unfortunately, the shortening days of the Tasmanian Autumn, and the dissected geography of the area made this difficult to achieve in a single day. And the diversity of the geological features of the Cygnet region further hinders such an aim. John and Tony have therefore been rather reluctantly forced to present what is only a ‘taster’ of the very interesting geology in this wonderful part of Tasmania.

Field Trip Leaders.

John is the founder and a Director of Mitre Geophysics, a provider of high-level geophysical consultancy services to the global mining, engineering and energy sectors. John has lived in the Cygnet region for just over 20 years. https://au.linkedin.com/in/john-bishop-b5440618

Tony is a Hobart-based consulting geologist working with GeoDiscovery Group Pty Ltd. He specialises in the applications of structural geology to mining and exploration, and the structural controls on mineral deposits. Tony lives near the mouth of another nearby estuary. https://au.linkedin.com/in/tony-webster-17582221

Acknowledgements

The field trip would not have been possible without the knowledge of Ralph Bottrill, John Everard and Clive Calver (written and in-person). UTAS student field trip notes created or modified by Garry Davidson, Karin Orth and Izzy Von Lichtan were also very helpful. Mark Duffett supplied the geophysical images and interpretations.

We were greatly impressed by the interest and enthusiasm shown by the landowners on whose properties many of the important stops occur (the mines). Many thanks to Claire Byers, Sam and Ben Haugland, Jane Grosvenor, Jim McEwan and Josh Dean.

And thank you to the local knowledge of Chris Dayton ('TinTin') and the very helpful volunteers of the Cygnet Living History Museum.

Regional Geology

The geology of the Cygnet region is dominated by the marine sedimentary sequences of the Permian Lower Parmeener Supergroup. These sediments range from tillite at the base, through dropstone-rich mudstones, siltstones, glacially derived sandstone and limestone before transitioning into freshwater sandstones and subordinate siltstones and mudstones containing significant coal measures in the upper part of the section (known as the Upper Parmeener Supergroup). There are many spectacularly preserved *in situ* Permian fossils exposed in their original seafloor settings on coastal platforms (which we sadly lack the time to visit this trip).

The Permian sedimentary units reach a thickness of c 850 m. The basal Permian unit is the Truro Tillite which has a thickness > 300 m. It is overlain para-unconformably by a sequence of fossiliferous (bryzoa and brachiopods) marine mudstones and siltstones (including the Woody Island Siltstone, Bundella Mudstone and Deep Bay Formation) which pass upwards into Upper Permian Risdon Sandstone and sandy siltstones of the Abels Bay Formation. At the top of the Permian, the freshwater sediments become coal bearing, and host the Cygnet Coal Measures (Figure 1).

Overlying the Permian sequence, but still within the Upper Parmeener, is a c 450 m thick sequence of massive to cross bedded coarse quartz Triassic sandstone that forms much of the elevated topography of the surrounding region (Farmer, 1981; Jones, 1986).

Like so much of Tasmania, the sedimentary sequence has been extensively intruded by Jurassic dolerite sills and dykes, which crown most of the highest peaks, particularly to the north and east of Port Cygnet. Figures 19 and 20 present images of the regional aeromagnetics and gravity (compare with Figure 1).

Occurrences of Rare Igneous Rocks.

While the Permo-Triassic and Jurassic elements of the geology are like much of the rest of southern Tasmania, the Cygnet area also hosts some of the most unusual and rare igneous rocks on the island. The sedimentary rocks are intruded by the Cretaceous Cygnet Alkaline Complex, which is centred beneath the township of Cygnet. The felsic alkaline rocks intrude, and locally metamorphose and metasomatise the Parmeener sediments and dolerite and there are many small sills, dykes and possible stocks that poke through to the surface over a 110 km2 area (Everard and Bottrill 2021). These alkaline igneous rocks have garnered much scientific interest since they were first described by R. M. Johnson in 1888, and have drawn scientific visitors since the early 20th century (e.g. Twelvetrees, 1903).

According to Everard and Bottrill (2021), most authors *subdivide the rocks of the Cygnet Alkaline Complex into two main categories, together with transitional types and several volumetrically minor variants. These are:*

(1) syenite porphyry, "oligoclase porphyry" or "banatite."
This, the most common and petrographically uniform type, is silica-oversaturated. It forms all the larger intrusions and many of the narrower dykes in the main Cygnet area. It is the only variant in the smaller Kettering area.

(2) sanidine porphyry.
This type occurs as dykes in the Cygnet area, sometimes cross-cutting intrusions of syenite porphyry. It is petrographically and mineralogically very variable, and ranges from strongly

silica- undersaturated to slightly oversaturated.

A third group, sometimes included in the Complex, are the so-called "hybrid rocks." These comprise a net vein complex of intensely metamorphosed and metasomatised Jurassic dolerite, intruded by dykes and veins of syenite porphyry, and are restricted to the foreshore near Robleys Point, just south of Cygnet.

Economic Geology

The small area traversed during this fieldtrip also encompasses a gazetted goldfield, from which considerable alluvial and hard rock gold was produced (including from small underground workings, such as the Mt Mary Mine). And it has a gazetted coalfield that once supplied the zinc smelters at Risdon.

Gold

Alluvial gold has been found in most of the incised creek lines and gullies draining the high ground to the west of Port Cygnet (Mt Windsor, Kings Hill, Coad's Hill, and Mt Mary) from at least 1878, and specimens of gold bearing reefs had been displayed in Hobart. By 1887, R M Johnson was reporting that "*at Lymington, [], gold in an alluvial form has been worked with more or less success in the valleys associated with this porphyritic rock, and it is a question of much interest to ascertain by careful experiment whether the pyrites of the metamorphic rocks associated with the porphyry may not also be auriferous."*

A company was formed in the early 1890's to work the alluvials at Lymington, on land owned by Mr Coad but after a couple of "cleanings", was let on tribute to the manager. This operation ceased when he moved on to manage a mine elsewhere. It was only in the late 1890's that a serious attempt was made to locate the primary source of the alluvial gold (Mercury, Monday 10 October 1898). It seems that one of the earliest prospectors was Father O'Flynn, who discovered the Mount Mary deposit, one of the earliest to be developed as a hard rock mine. The Livingstone Mine, east of Port Cygnet was discovered soon after (see below).

Gold mining saw a resurgence in the early 1920's and the reinvigorated Mount Mary Mine was equipped with a headframe and winder, and was even visited by the Premier and Mrs Lyons. There was considerable optimism about the gold mining potential but, once again, the field did not come to much.

Jones (1986) summarised the production of the goldfield as follows. *Several small lode and alluvial gold deposits have been worked in the district since 1898. Most of the gold production, estimated at 3000 ounces, has come from alluvial deposits. The largest of these were at Lymington (Forsters Rivulet) and Wheatleys Bay (Riseleys Creek). Small lodes were prospected by adits and shafts at the Mount Mary and Livingstone mines near Cygnet and prospecting pits were sunk at other localities where pyrite and other sulphides had developed in alkali to felsic intrusives and adjacent sediments (Black Jack Ridge and King's Hill workings).*

Coal

At Cygnet, on the slopes of Mt Cygnet and Mt Heeney, small-scale mining began in 1881, and continued in a haphazard and intermittent fashion until the 1940's (or possibly into the post-war era). The Cygnet coal is of Late Pennian age and can be correlated with the coal at Adventure Bay (Bruny Island) (Bacon and Banks (1989).

Geomorphology

Port Cygnet and surrounds lie within one of the most scenically beautiful, and agriculturally fertile parts of Tassie. Let's allow W. H. Twelvetrees (1903) to describe the Cygnet landscape.

Cygnet lies *"at the head of the arm of the Huon, known as Port Cygnet, about a mile [1.6 km] south of the township of Lovett [the original name of Cygnet township], the scene was owned to be highly picturesque. Wooded heights ascend from the water's edge on each side, and large fruit orchards diversify the aspect of the slopes. The view eastwards is shut in by* *the high range in the background, a ridge of Mesozoic diabase (dolerite), the holocrystalline plagioclase-augite rock, which H. M. Johnston shows, is prolonged southwards from Mt. Wellington and apparently forms the axis of the peninsula which divides the waters of Port Cygnet from the Channel." "At the extreme head of the arm the water is shallow, and old residents say that it has receded considerably in recent years."*

The Field Trip

Stop # 1 Sandrock Bay (Abels Bay), Upper Permian Sequence and the Cygnet Coal Measures.

Location: Approximately 14 km south of Cygnet via the Abels Bay Road.

There are good exposures of the upper units of the Tasmanian Permian section exposed in coastal cliffs and on shore platforms along the shoreline of Sandrock Bay, an inlet of Abels Bay. We examine the boundary between the Abels Bay Formation and the Cygnet Coal Measures and the transition upwards towards the contact with the Triassic sandstone (outcropping in the adjacent cove around the southern headland).

The oldest part of this part of the Permian sequence outcrops, near the northern end. The Middle portion of the section is just below the cliffs at the small beach (Davidson student notes).

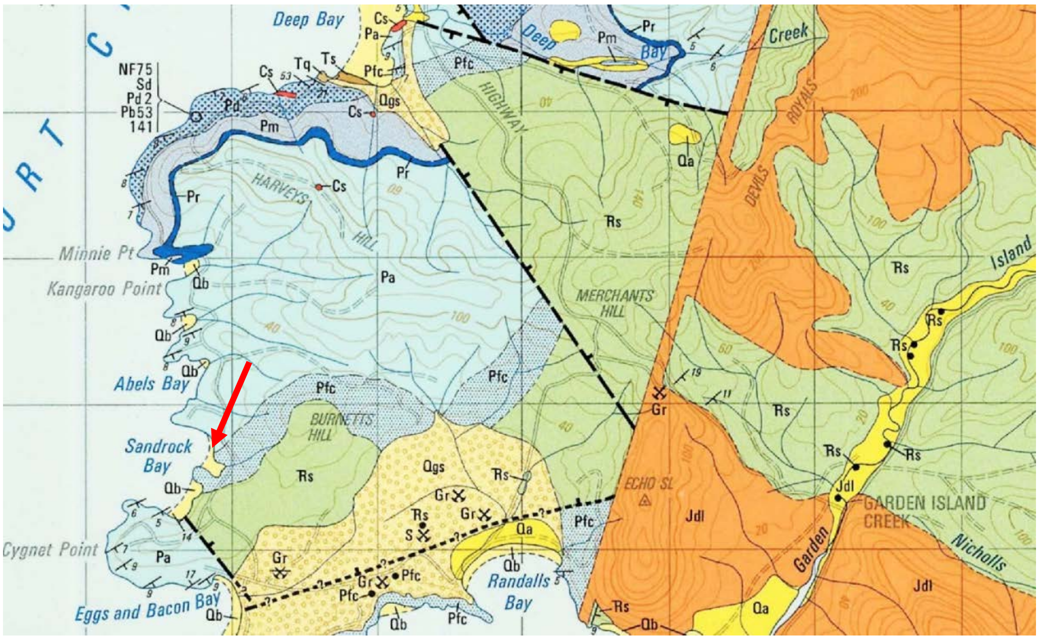

***Figure 2**. Extract from the Kingborough 1:50,000 Geological Map (Farmer, 1981) showing the Abels Bay area. The boundary between the Abels Bay Formation (Pa) and the Cygnet Coal Measures (Pc) that will be examined is arrowed. Rs = Triassic Sandstone.*

Of particular interest for this field trip is the boundary between the Abels bay Formation and the Cygnet Coal Measures and the transition upwards towards the contact with the Triassic sandstone. While not coal bearing at this locality, the stratigraphy is the same as we will see at the second stop – at the historic workings of the former Mt Cygnet Coal Mine.

Walk down the path to the beach and turn north to walk along the shoreline to the *Pa/Pfc* contact. Note: this is the contact between the marine Lower Parmeener Abels Bay Fm and the freshwater Upper Parmeener Cygnet Coal Measures. Also note, there is no coal here; only carbonaceous shales. The boundary is above the carbonaceous shales which are at the top of the Pa (Figure 3). This boundary is defined by the loss of the foraminifera – which confirms the strata as marine and Pa (Clive Calver pers. comm April 2022).

The transition from the marine Lower Parmeener and the freshwater Upper Parmeener is marked by the base of the Cygnet Coal Measures and the loss of the foraminifera in the underlying Abels Bay Formation (Clive Calver pers. comm April 2022) (Figure 3).

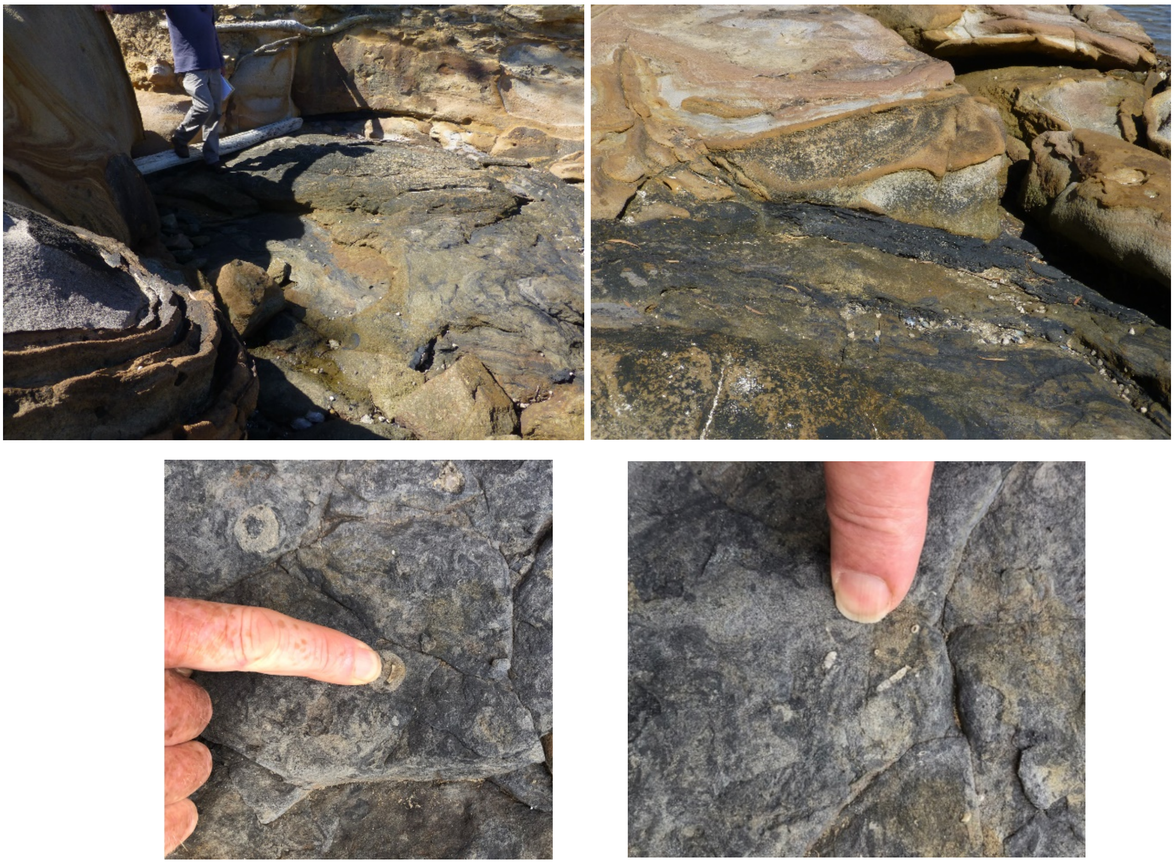

Figure 3. *Geological features at the boundary of the Abels Bay Formation and the Cygnet Coal Measures in Sandrock Bay. Top (left and right), The change from carbonaceous mudstone and siltstone to sandstone near the boundary. Bottom. Foraminera in Pa, Sandrock Bay; nr the contact with the overlying Pfc. Note: the marine Abels Bay Fm is the top of the Lower Parmeener, and the freshwater Cygnet Coal Measures define the base of the Upper Parmeener*

There is Triassic sandstone on the south side of Sandrock Bay (south of the peninsula in the middle of the bay) and which is characterised by the presence of “slump folds which are a characteristic of the Lower Triassic” (Clive Calver, pers. Comm., April 2022) (Figure 4).

***Figure 4**. Slump folding, South side of Sandrock Bay ‘Peninsula’. A characteristic of Lower Triassic sandstone.*

<u>Stop # 2</u>. Mt Cygnet Coal Mines, No 1 and No 2 Pits – Traverse

Location: Off Coal mines road, approximately 17 km by road to the NE of Stop 1 (20 mins) (Figure 5).

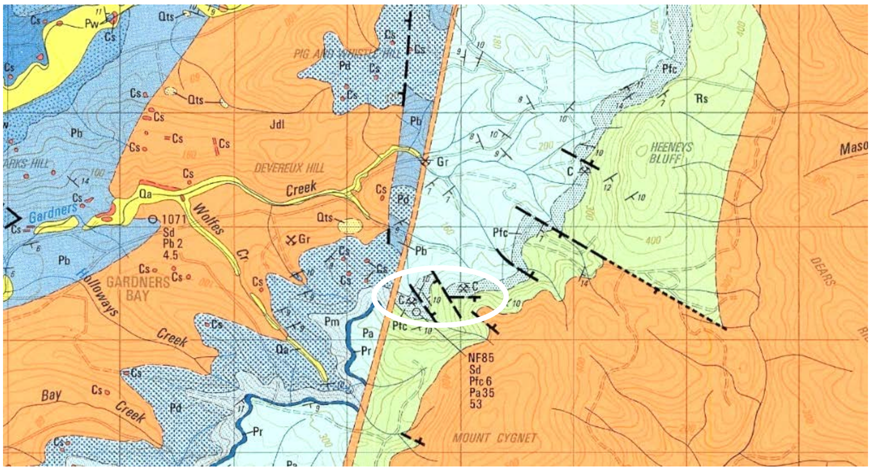

***Figure 5**. Extract from the Kingborough 1:50,000 Geological Map (Farmer, 1981) showing the Gardners Bay area. The coal mines (No 1 and No 2 pit) are circled. The extent of the Cygnet Coal Measures is shown as Pfc. Pa = Abels Bay Formation. Rs = Triassic.*

__The Mt Cygnet Coal Mine__

The Mt Cygnet Coal Mine, developed within the Cygent Coal Measures, was opened in 1881 (Farmer, 1985) but by the time the first report on the mine was presented by Thureau (1881), little activity had taken place (Figure 6).

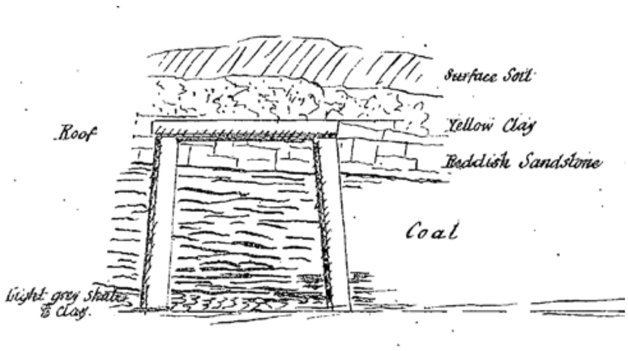

Figure 6. *The No 1 Pit incline drive portal in the bed of the creek at stop # 2. Right. A geological sketch of the strata at the entrance to the portal (possibly the No 1 Pit, from Thureau (1881)*

In 1887, R M Johnson described the Mt Cygnet Coal Mine (No 1 Pit). The seam was being worked *"by an inclined adit or drive on the northern slope, near the bed of one of the tributaries of Gardner's Creek* (Figure 6 and 7)*, and the coal [was being] carried about two miles westward by a [horse-drawn] wooden tramway to the jetty at the township of Welsh [now Green Point], near Port Cygnet. The main drive from the creek level follow[ed] the seam of coal, which average[d] about 2 feet 8 inches thick, at an angle of about 1 in 6, dipping S.S.E. into the mount. The extreme length reached by this main drive [was in 1887] about 6 chains, and in this distance two step faults running east and west have been met with successively, throwing down the seam 2 feet 3 inches and 2 feet respectively without materially affecting the angle of dip. The coal measures have been pierced near this spot by several bores, and the evidence collected shows that they are frequently faulted and dislocated to a very considerable extent. The slopes along the valley have been subjected to much denudation, and hence it is difficult to predict, with anything approaching certainty, the exact position where the coal seam may be struck, even in the immediate vicinity of the present workings. It is also impossible to say, at present, whether there is more than the one seam, as no bore has yet pierced beyond the first one met with, and in each case the seam so* *reached appears to be identical with the one now being worked; for although the levels at which the coal seam was struck are extremely variable, the differences in absolute level are no more than might be occasioned by the angle of dip, and especially by the numerous faults and dislocations.*

The seam at Mount Cygnet is invariably overlain by a greyish flaggy sandstone, which, according to the extent of denudation, may be found from a few feet to 100 or 200 feet in thickness. Thus, although the seam at the workings crop out in the creek, a shaft cut to it about two chains from this point on the slope of the hill shows the following section in a downward direction:

- *Grey flaggy sandstones, with occasional carbonaceous streaks 60'*
- *Shaly parting 1"*
- *Coal, slaty and anthracitic 2' 8"*
- *Coal glance, brilliant lustre 8" to 10'*
- *Greyish-black arenaceous and carbonaceous clod, very trace 4" to 18"*
- *Dark brownish clod and shales, full of impressions of Vertebraria australis, Gangamopteris spathula – unknown thickness*

The mine was only worked occasionally until 1897, when Robert Harvey took over the operations, producing 3000 tonnes of coal in 1901. By 1922 several operators had developed the area and many trenches, adits and shafts had been excavated at points spaced along the outcrop for about 5 km (Farmer, 1985). The mine was taken over by the Risdon Zinc Co in 1920, and redeveloped, with great plans for its future.

Two coal seams were worked, the main seam (1 m thick) and a lower seam (0·3 m thick) that was 8·3 m below the main seam. Two accesses were in use by 1923, the dip tunnel or No 2 Pit (Gordon's Workings) and the No 1 Pit incline. Pillars had been extracted from No 1 Pit by 1922, with most coal being produced from No 2 Pit. Roof rolls were reported to be common (Farmer 1985).

The coal is sub-anthracitic, probably because of the proximity of Jurassic dolerite. Sulphur content is low (0.41 – 0.57%) but ash content is high (17.6-23·2 %) (Farmer 1985). It was a fair steaming coal, and in the 1920's was considered a good domestic heating fuel in Hobart. However, its main value in the 1920's was as a metallurgical coal for the Risdon smelters (Mercury, 12 March 1926).

Figure 7. *Screen shots of the Leapfrog Geo model and Google Earth imagery showing the relationship between the old No 1 Pit underground coal workings (lower left in the upper figure) and the modern surface features. It is surprising how far these workings followed the shallow dip of the coal seam into the hill. However, the mine is at least >60m below the house at the lower edge of the image (red rectangle). The lower image is a screen shot of a sliced and isometric view of No 1 Pit workings from the same 3D model.*

The large sandstone boulders lying on the flat below that No 2 Pit workings are probably from the Cygnet Coal Measures (Clive Calver pers com, April 2022). The heap of boulders on the bend possesses slump folds and were therefore likely to also be Pfc (probably from the excavations at the house site further south along the road).

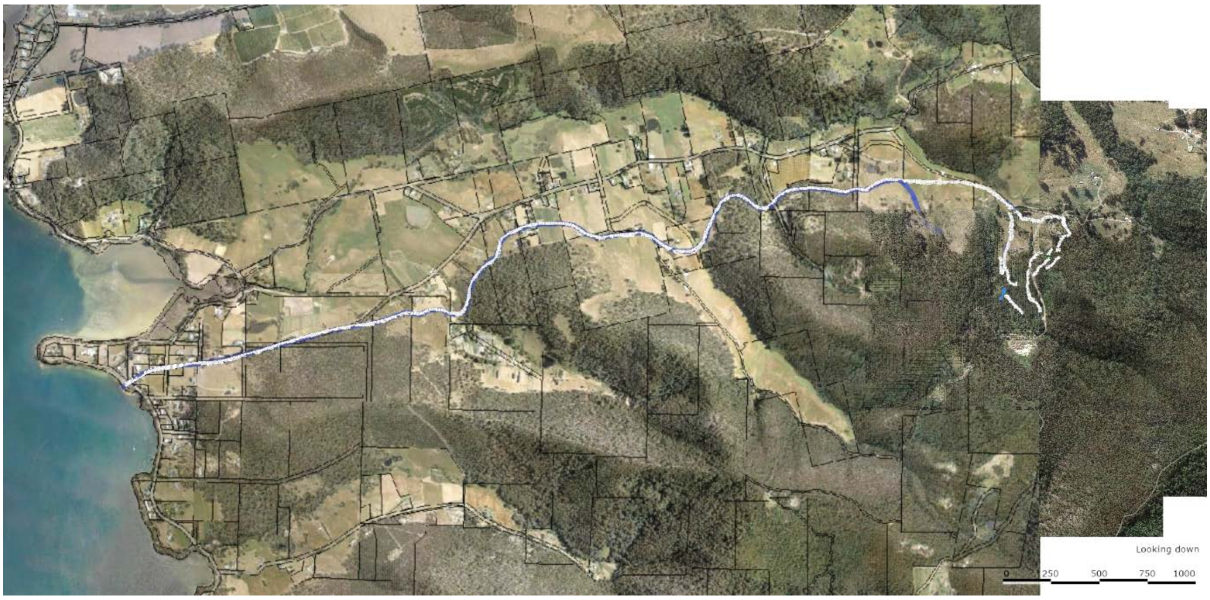

Figure 8. *The route of the coal tramway from the mines to the coal jetty near Green Point (white line). The tramway alignment only occasionally follows the alignment of Woodbridge Hill Rd and Gospel Hall Rd and lies mostly to the south.*

Mine Settlement

There was a small settlement in the valley near the mine, where the mine manager's residence was located. There were also some other miner's cottages. The sites of these buildings can still be seen near the driveway to Claire's house (which follows the tramway alignment) (Figure 9). The mine managers house was apparently removed to Cygnet by horse drawn tram (via the coal jetty at Green Point, Figure 8), and then shipped to Cygnet by barge. It was re-erected on the north side of Charlton St in Cygnet, near the current roundabout at the intersection of Channel Highway (Claire Byers, pers comm, March 2022). The house is still there (Figure 9).

Figure 9. *Top Left. The site of the mine managers house (and mine office?) is located on the flattened site in the middle distance (where the timber is piled up). Bottom. The former coal mine managers residence, now located on Charlton Rd Cygnet (photo by Homelands Property). Top right. John Bishop standing on the formation of the old tramway leading from the No 1 Pit (which is in the forest further up the valley) to the coal jetty near Green Point (see Figure 8). The original tramway had wooden rails but we understand that steel rails were still in place near Gospel Hall Rd until recently. A Mercury article of 22 May 1920 stated that The Risdon Zinc Co had recently taken ever the Mount Cygnet Coal Mine and were extending their operations very rapidly, increasing output and carrying out surveys to find an alternative route for a redeveloped tramway (probably from the No 2 Pit, which lies to the east of this site – see below). They were expecting to be employing some 200 or 300 hands.*

<u>Stop # 3</u> Livingstone Gold Mine and Quarry (Tobys Hill)

Location: Private property off Toby's Hill Rd. 12 km by road from Cygnet Stop 2 (Coal Mine Rd, Woodbridge Hill Rd, Channel Highway and Tobys Hill Rd) (16min).

Gold mineralisation in the Cygnet area is spatially and temporally associated with the intrusion of the Cretaceous alkaline porphyries into lower Permian sedimentary sequences. The porphyries occur as numerous dykes and sills, and probably also as laccoliths. Mineralisation is associated with both quartz-saturated and unsaturated intrusive rocks (small, variably feldspathoidal and / or garnet bearing), but the saturated intrusive rocks (monzonites) usually predominate (Taheri and Bottrill 1999).

The gold occurrences all lie along a NE-SW trend that is associated with the domed roof of the underlying Cygnet Syenite Complex. Gold mineralisation along this linear trend occurs as far to the southwest as Wattle Grove (and alluvial gold has been produced nearby at Wheatleys Bay) and as far to the northeast as Kettering. The Mt Mary Mine, the most historic and significant hard rock prospect lies on the far (western) side of Port Cygnet, to the south of Kings Hill Rd on Mt Mary (Figure 10).

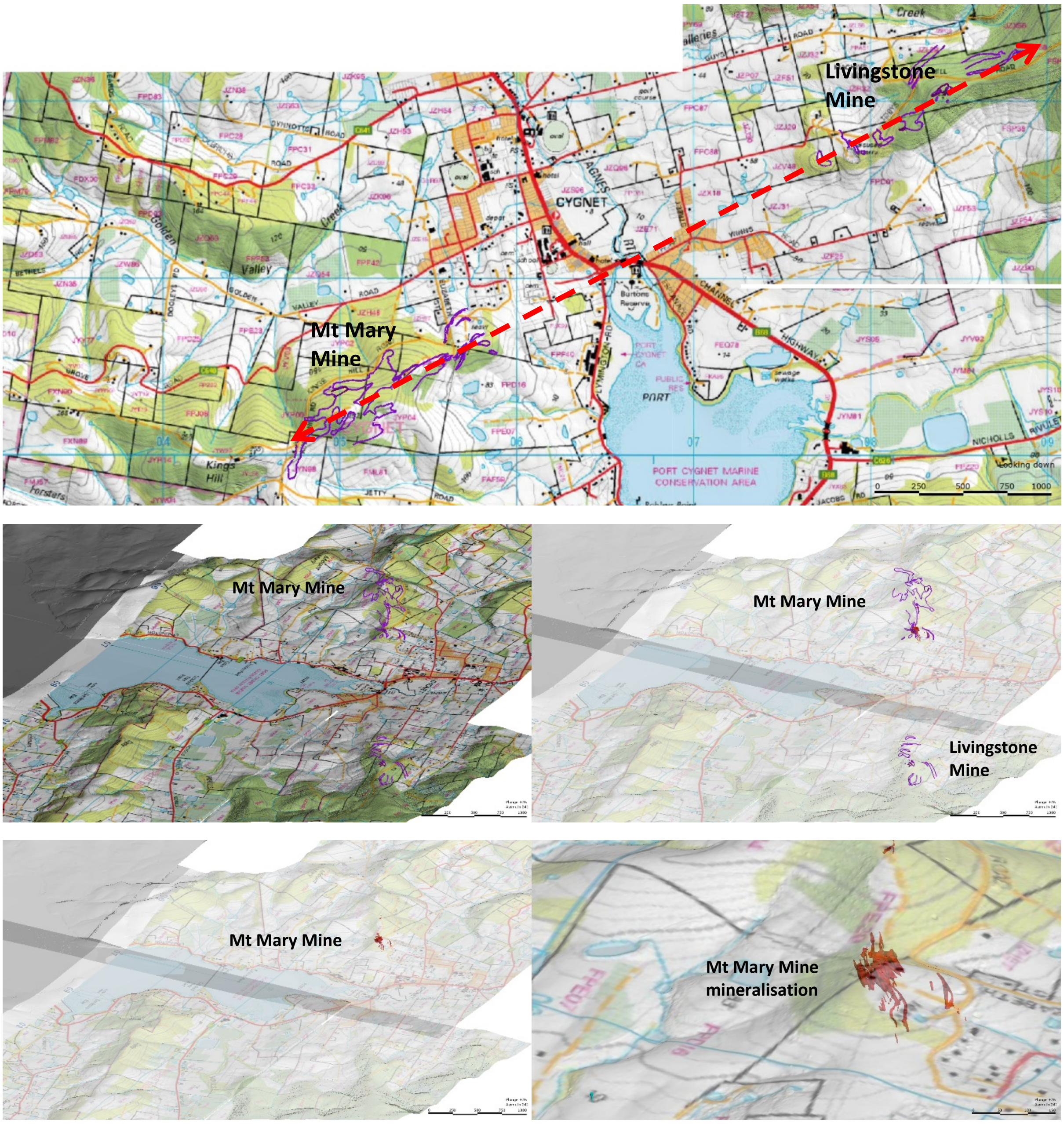

Figure 10. *Screen shots of the Leapfrog Geo 3D model of the terrain at the head of Port Cygnet. The DTM is overlain by the 1:25,000 topographic map. Top. Plan view (looking down) of the Cygnet area showing the trend of the Au mineralisation (double headed red arrow). The Livingstone Mine (NE Corner) and the Mt Mary Mine (SW corner) lie on the same linear trend, which is also a steep linear ridge the traverses the head of Port Cygnet. The mineralisation is closely associated with linear Cretaceous dykes. The mapped boundaries of the syenite dykes are shown as purple lines. Centre Left. Perspective view of the DTM looking approximately west (241^{o} across the Livingstone Mine (foreground) to the Mt Mary Mine (far ground). The mapped boundaries of the syenite dykes are shown as purple lines. Centre right. The same view as previous with the DTM made transparent to show the mineralised zone at the Mt Mary Mine (red). Lower Left. Same view as previous with the syenite dykes removed. Lower right. Close up view of the broad, linear Au mineralised zone at the Mt Mary Mine (low grade halo).*

History and Geology of the Livingstone Mine.

Anderson and Thorpe discovered a quartz reef near the top of the western fall of the narrow, N.E. and S.W trending ridge (now the site of Sam's new house), which runs through the original sections (630 feet above sea-level). The reef could not be traced on the surface, because of the covering of angular debris. An underlay shaft was sunk to a depth of about 60 feet (18 m) (Figure 11). The reef varied in thickness from about 2 ft. 6 in. (0.7 m) to 4 feet (1.23 m), and had an indeterminate strike of about N. 70° E. Near the surface it was almost vertical, but at the bottom of the shaft has a considerable underlay to the S.S.E. The quartz was fairly solid in places, but generally occurred in small parallel bands separated by thin seams of decomposed porphyry, which give it a somewhat laminated appearance (Smith, 1899).

Anderson, and Thorp were granted reward claims and did most of the hard preliminary work of opening up and developing the lode – working for months "for a mere existence" to open up their discovery. The mine was originally developed on the two 20-acre sections adjoining Lot 19M of 500 acres purchased by John Thorp Jn in 1898 (Smith (1899).

On the evening of Wednesday 24 August 1898, a large and enthusiastic meeting of Cygnet residents and other interested parties was held at Harvey's Hall, where it was decided to form the Livingstone Gold Mining Company No Liability, with a capital of £7,500 in 30,000 shares of 5*s* each. The following company officers were appointed: Mr W. Omant (legal manager; note' he was also manager of the Mount Mary mine); and Messrs. R. Harvey, John Lawler, D Tolland, H. Livingstone, and A. Livingstone as directors. More than half of the shares were allotted at the meeting. It seems probable that the mine and the company were named for the two Livingstone's who were probably major shareholders (*Mercury, Saturday 27 August 1898, page 4)*.

The company planned to begin operations on Monday 29 August. As mentioned above, the property had previously been held by Anderson and Thorpe and a considerable amount of work had already been done, including a 48' shaft following a reef that was 3' 6" wide. An adit had also been driven 350'. There was an intent to test the reef at a lower level (*Mercury, Saturday 27 August 1898, page 4).*

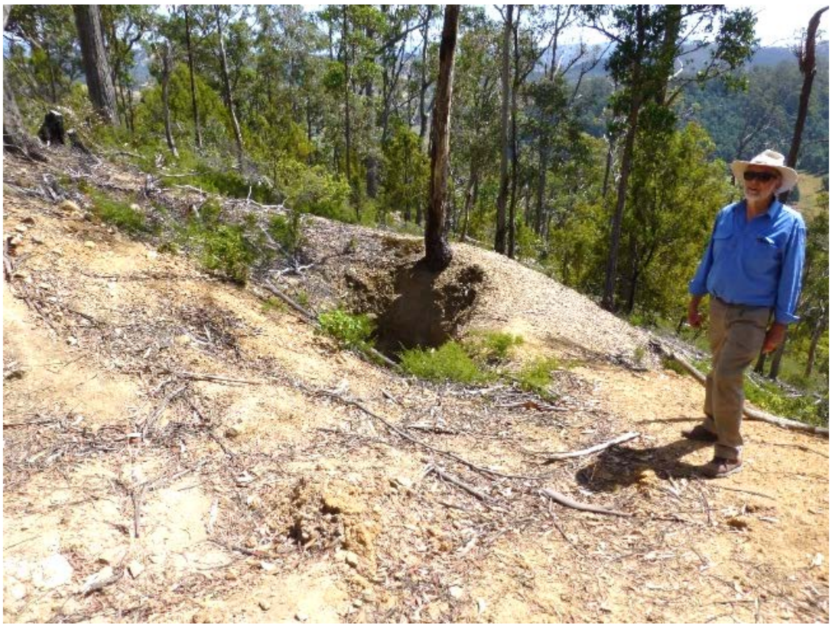

Figure 11. *The Livingstone Mine Shaft. This inclined shaft followed the gold bearing veins down-dip to a depth of around 18m.*

A progress meeting was held in Cygnet on the 7th October 1898 and it was reported that a true fissure lode was present in the shaft and that free gold was showing in the walls and in the rubble at the bottom. There was considerable optimism that a reef mining district might develop from which all would benefit (*Mercury, Monday 10 October 1898, page 3)* but little came of the field. The initial impetus may have died away after the three deaths that occurred at the Mount Mary mine in 1898.

The following description of the mine is taken largely verbatim from Smith (1899).

The country rock on either wall was a brownish, somewhat-decomposed porphyry. Several picked samples of quartz were sent to Melbourne for assay, with two returning grades of 3oz. 23 grs (c 120 g) and I oz. 12 dwts. 6 grs. (c 46 g) Au/ton respectively. A sample of 48 Ibs of ore treated yielded 10 dwts. 13 grs (c 16 g) of free gold per ton. A bulk sample of about one ton yielded 5.5 dwts (8.5 g) free gold per ton.

Pyrite and chalcopyrite were irregularly distributed through the quartz, and gold is said to have been seen in the stone in the last few feet of sinking. However, a 5-6 lbs sample taken by Smith (1899) across the reef near the shaft bottom contained no gold.

On the [southern] side of the ridge, about 150 feet [45 m] vertically below the mouth of the shaft, a tunnel was driven about 350 feet [106 m] (Figure 12). This started in a north-westerly direction, but was turned considerably towards the west, and the end was running a little west of north. The country passed through consisted chiefly of compact mudstone and sandstone (note: fossils of Spirifers and Fenestella were found near the mine) with several bands of porphyry, the last one passed through near the end of the tunnel being about 10 feet thick, and was almost vertical, with an approximately north-south strike. Had the tunnel been kept on its original course, Smith (1899) suggested that with the distance driven, it would have probably intersected the line of the reef, and something definite would have been known as to whether the reef lived or not.

Figure 12. *The Livingstone Mine adit portal on the south side of the ridge. This adit extends 106 m northwest into the ridge but may never have intersected the mineralised reef that it was targeting. Right. John Bishop inside the adit, which passed through compact mudstone and sandstone with several bands of porphyry.*

From the information obtained from Sam, the current property owner, and from a brief visit with Sam in March 2022, it seems that the adit and shaft were never developed any further and the mine was abandoned soon after Smith's visit.

More recent exploration of the Livingstone Mine was carried out in the early 1980s comprised of a significant amount of geological mapping, rock chip and geochemical sampling and a programme of costeaning (Jones 1986). The following description of the modern exploration is taken largely from Jones' report on this work.

The Livingstone Mine (Tobys Hill) was developed on a quartz stockwork vein approximately 1 m wide located in an altered monzonite near the contact with massive siltstones and mudstones. The mine was developed as a shaft, many pits, trenches, and adits associated with weakly altered massive siltstones and altered monzonites/syenites (Livingstone Mine area - gold values to 0.78 g/t). Minor contact metamorphism with associated mineralization (4 m at 0.93 ppm gold) was found in one of the five costeans excavated in the early 1980s. The other contact zones were barren (Jones 1986). Recent work by Ralph Bottrill (pers comm. 2022) suggests that the Livingstone Mine Shaft is located at the intersection of two Cretaceous dykes with differing trends. The trend of one of these dykes can be followed westwards and the other is visible down the slope and on the edge of a lower road.

An example of the costean testing is Trench 1. It was designed to test a composite rock chip sample assaying 0.21 g/t gold from a small costean near the Livingstone Mine. The trench exposed variably altered monzonitic intrusives cutting a sequence of massive weakly altered siltstones. A 2 m zone assaying 0.41 g/t gold located adjacent to the porphyry contact was found on reanalysis by fire assaying to be <0.005 g/t gold. This may be due to a nugget effect or an initial incorrect assay (Jones 1986).

No recognisable trend for mineralization was observed during surface mapping after the costeaning program. Gold values to 0.2 ppm gold in trench 10175E were associated with highly altered fossiliferous mudstones adjacent to a small intrusive dyke/stock complex similar to those at Mount Mary. There appears to be little strike extent to the mineralised zone. The numerous other pits around the Livingstone shaft were geochemically barren (Jones 1986).

The 1980's work was apparently discouraging because no follow-up drilling was done, unlike the better results obtained at the Mt Mary Mine, which saw significant drill testing at that time.

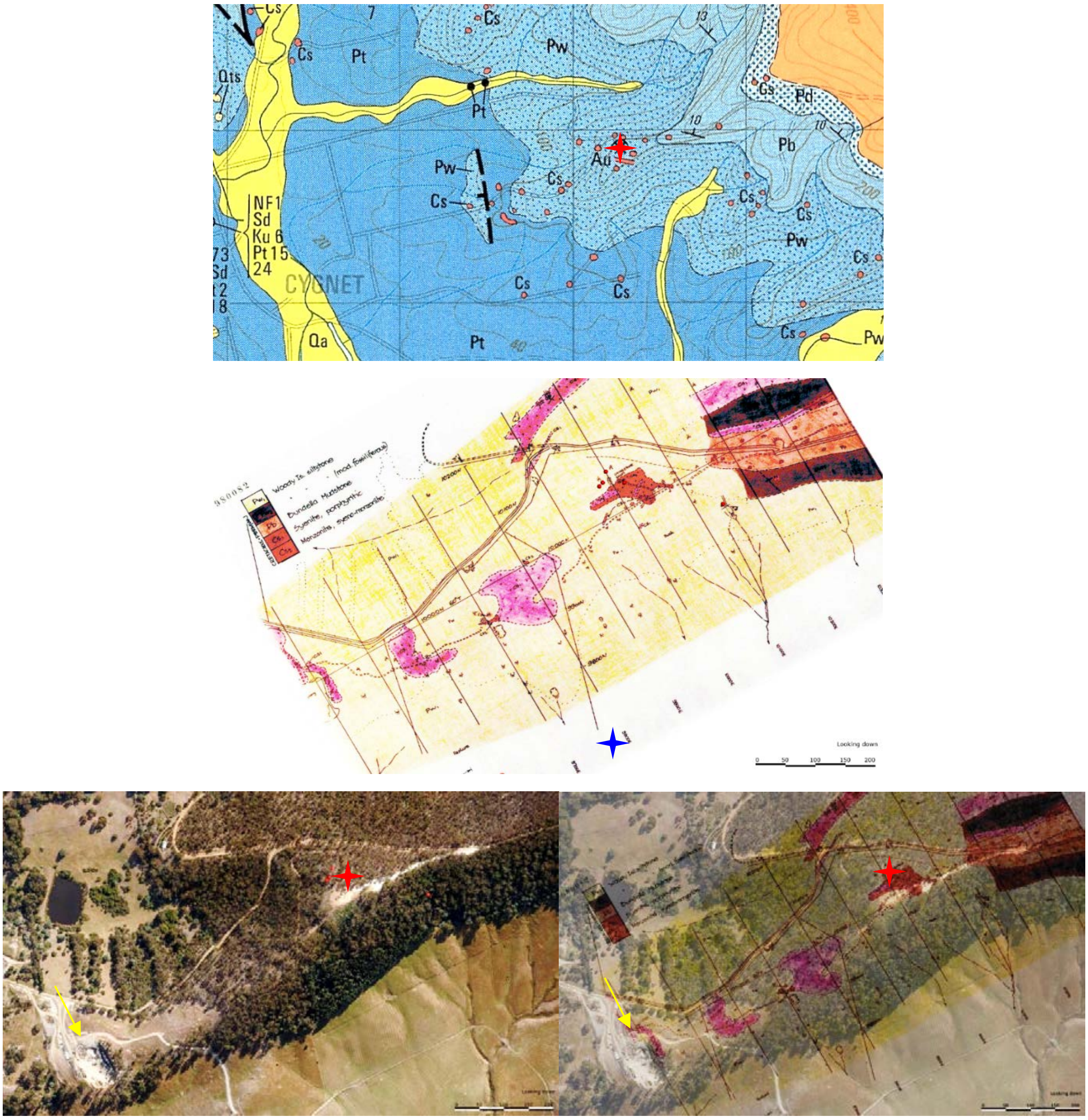

Figure 13. *Geology of the Livingstone Mine area. The location of the Livingstone Mine incline shaft is shown with a red (or blue) star. Top. Extract from the Kingborough 1:50,000 map sheet (Farmer, 1981). The Woody Island Siltstone (Pw) is the main host of the mineralisation. Centre. Geology of the Livingstone Mine (Tobys Hill) based on surface mapping, sampling and costeaning, from Jones (1986); Bottom left. State aerial imagery of the mine area showing the new house site and driveway. Bottom right. State aerial imagery overlain on Jones' (1984) map of the mine area and showing the new house site and driveway. The location and trend of a sanidine dyke at stop #3b is indicated with a yellow arrow.*

Stop # 3b. Ben's Quarry (former council quarry)

The quarry is mainly developed in Woody Island Siltstone but there was formerly a sanidine dyke exposed in the face of this quarry, which has since been mined away. The dyke originally cut across the quarry area from NW to SE (see Figure 13 above).

However, loose pieces of the dyke containing large and well-formed platy sanidine crystals can be found in the broken material that has been pushed up against the quarry entrance wall. With Ben’s permission (the landowner and quarry operator), this is (hopefully) a chance to collect some sanidine crystal specimens (Figure 14).

Note that this is a working quarry, so please do not wander away from the main group.

Figure 14. *The broken and excavated material from the quarry face near the entrance to the quarry floor where sanidine crystal specimens might be found.*

<u>Stop # 4.</u> **Martins Point, Truro Tillite (Lunch)**

Location: The Esplanade, Martin’s Point. 3.7 km by road from Cygnet Stop # 3 (via Tobys Hill Rd, Thorp St and The Esplanade).

Martin's Point is a very pleasant scenic spot, with boulders of Truro Tillite (labelled *Pt* in Figure 15, below), the oldest Permian rocks on the Kingborough map sheet. The tillite is the host to the Au mineralisation at Mt Mary Mine west of Cygnet.

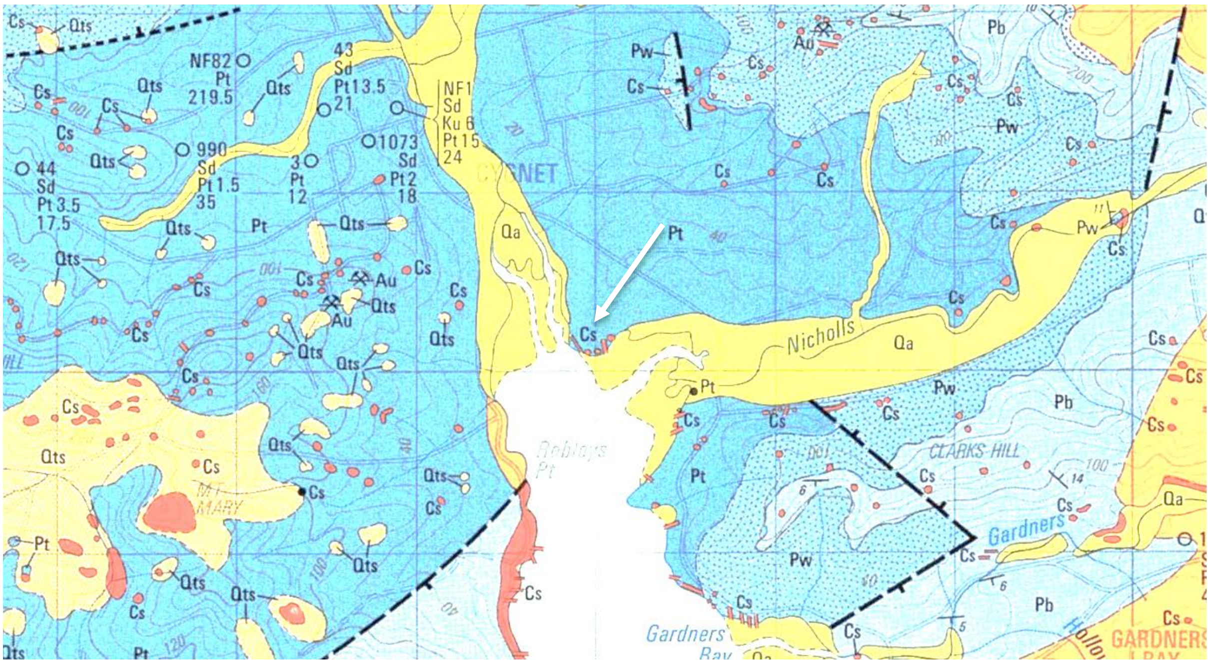

Figure 15. *Extract from the Kingborough 1:50,000 geological map (Farmer 1981). Truro tillite (Pt) can be found at Martins Point as boulders and part of the coastal platform which has been dissected by several syenite dykes.*

The formation consists almost entirely of dark grey, massive, unstratified, poorly-sorted, matrix supported (disrupted framework) diamictite of glaciogenic origin. Pebble-free or pebble-poor banded mudstone and laminate (?rhythmite) sequences, up to several metres in thickness, form a minor, but characteristic, element within the formation. Where clasts are found within the laminite sequences they are usually restricted to granule size particles (Farmer, 1985).

Cygnet Stop #5. Langdons Point Dykes and the Swirling Sanidines.

Location: Langdons Point, 4.7 km from Cygnet Stop # 4, off Lymington Rd.

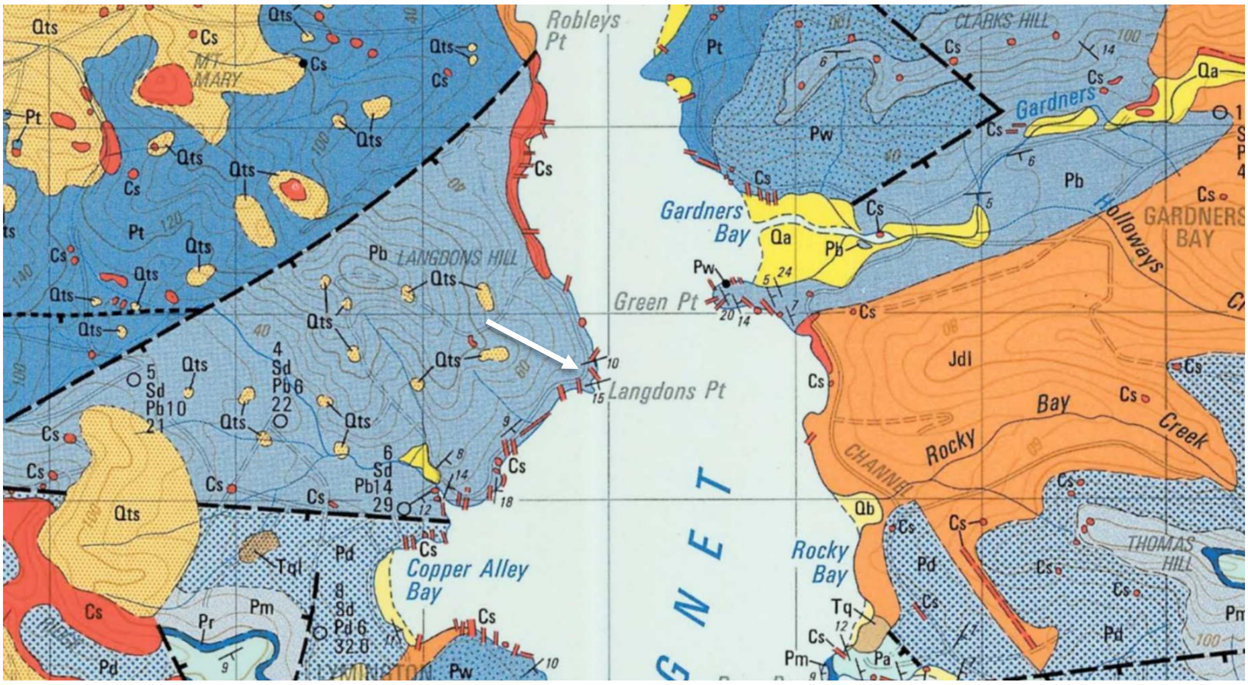

Figure 16. *Extract from the Kingborough 1:50,000 geological map (Farmer 1981) showing Langdons Point. The host sediments of the dykes are Bundella Mudstons (Pb).*

There are excellent exposures of two types of rare igneous dykes on the shoreline at Langdons Point (Lymington), a Sanidine porphyry ("tinguaite") dyke with green groundmass and a "Garnet trachyte" dyke with epidote (Figure 16). They have been described by Everard and Bottrill (2021) as follows.

About 100m north of the former jetty site, there is a prominently outcropping dyke about 0.8 m wide that displays very abundant aligned sanidine phenocrysts (typically 20 x 2 mm) with swirl structures. The green colour of the groundmass is due to abundant clinopyroxene (Figure 17)*.*

Hauyne, cancrinite, nepheline and rare pink grains of eudialyte $Na_4(Ca, Fe^{II})_2 ZrSi_6O_{17}(OH,Cl)^2$ have been identified in this rock. Although it assayed at only 50 ppb Au, Ford (1983) obtained an SEM image of a 50µm gold fragment from this dyke.

About 30 m south of the former jetty site, there is a 1 m wide sanidine porphyry dyke ("tinguaite"), trending at 160°, which intrudes gently tilted and baked Permian beds (Bundella Mudstone). The dyke contains large (≤ 15mm) narrow aligned sanidine phenocrysts in a grey groundmass with garnet microphenocrysts (Figure 17).

The unique *"Garnet trachyte" (Garnet-epidote porphyry "garnet trachyte") rock forms a dyke, 0.4 - 0.8 m wide, intruding Bundella Mudstone, near high water mark ~200 m N of Langdons Point.*

Phenocrysts (≤ 15 mm) of pinkish-brown garnet (spessartine) and subordinate green epidote, rimmed by a white halo of sanidine, are erratically distributed in a grey groundmass. Phenocrysts of sanidine are rare. In thin section, epidote is seen to overgrow and possibly partly pseudomorph garnet. One garnet phenocryst is successively overgrown by possible labradorite (now altered to zeolite, possibly chabazite), followed by epidote and sanidine. Pyrite also accompanies garnet, but does not occur as inclusions within it. The groundmass consists of aligned sanidine laths with intergranular epidote and green to reddish-brown chlorite.

Figure 17. *Langdons Point dykes. Left. The dyke located to the south of the old jetty site. Centre and right. Photos of some of the sanidine dykes exposed to the north of the old jetty.*

The rock is also highly potassic, although near-saturated with high Sr and Ba and anomalous MnO, Zn and Pb. Ford (1983) suggested that it had formed by assimilation, by sanidine porphyry magma, of mineralised Early Palaeozoic carbonate in basement rocks. Some *further support was provided by the weakly positive (+2.9 δ34S) isotopic composition of pyrite associated with garnet, suggesting a hydrothermal component to the sulphur.*

There are also some excellent examples of fossils here, including large *Eurydesma,* a bivalve and some excellent molluscs. There are known to be fossils replaced by sulphides and other minerals in this area (Ralph Bottrill (pers. comm, April 2022).

Cygnet Stop #6 * (Possible) Lymington Cutting (Forsters Rivulet Delta) and Alluvial Au

The deeply incised valley of the Forsters Rivulet was one of the major alluvial gold producers of the Cygnet area (Figure 18).

During regional exploration activities in the 1980s, rock chip sampling near this cutting returned anomalous gold values, with one sample returning 943 ppb Au (i.e., nearly 1 g/t) (Figure 18). Visible gold has been found in this cutting face by Ralph Bottrill (pers. comm, April 2022).

Smith (1899) provided the following summary of alluvial gold mining.

A little alluvial gold has been found in several of the gullies near Port Cygnet, and at Lymington some rich patches were obtained, but they were of small extent. A company was formed some years ago to work on private property belonging to Mr Coad; a small dam was made and long tail-race fluming built, but the latter is not low enough, and the water supply seems to have been very poor. I have been unable to obtain particulars of the amount of gold won, but I was informed that the company nearly paid expenses for about two years, when work was abandoned, And all the old prospecting holes have since been filled in. I was shown a sample of about 10 oz of coarse shotty gold obtained from a small paddock on Mr. Coad's farm, and several dishes of the surface stuff washed in my presence all showed a few fine colours of gold. Probably systematic prospecting along Forster's Rivulet would reveal richer patches, but all the land is freehold property, and there does not seem to me to be *sufficient inducement to warrant the destruction of the apple orchards and beds of raspberry canes which this would necessitate.*

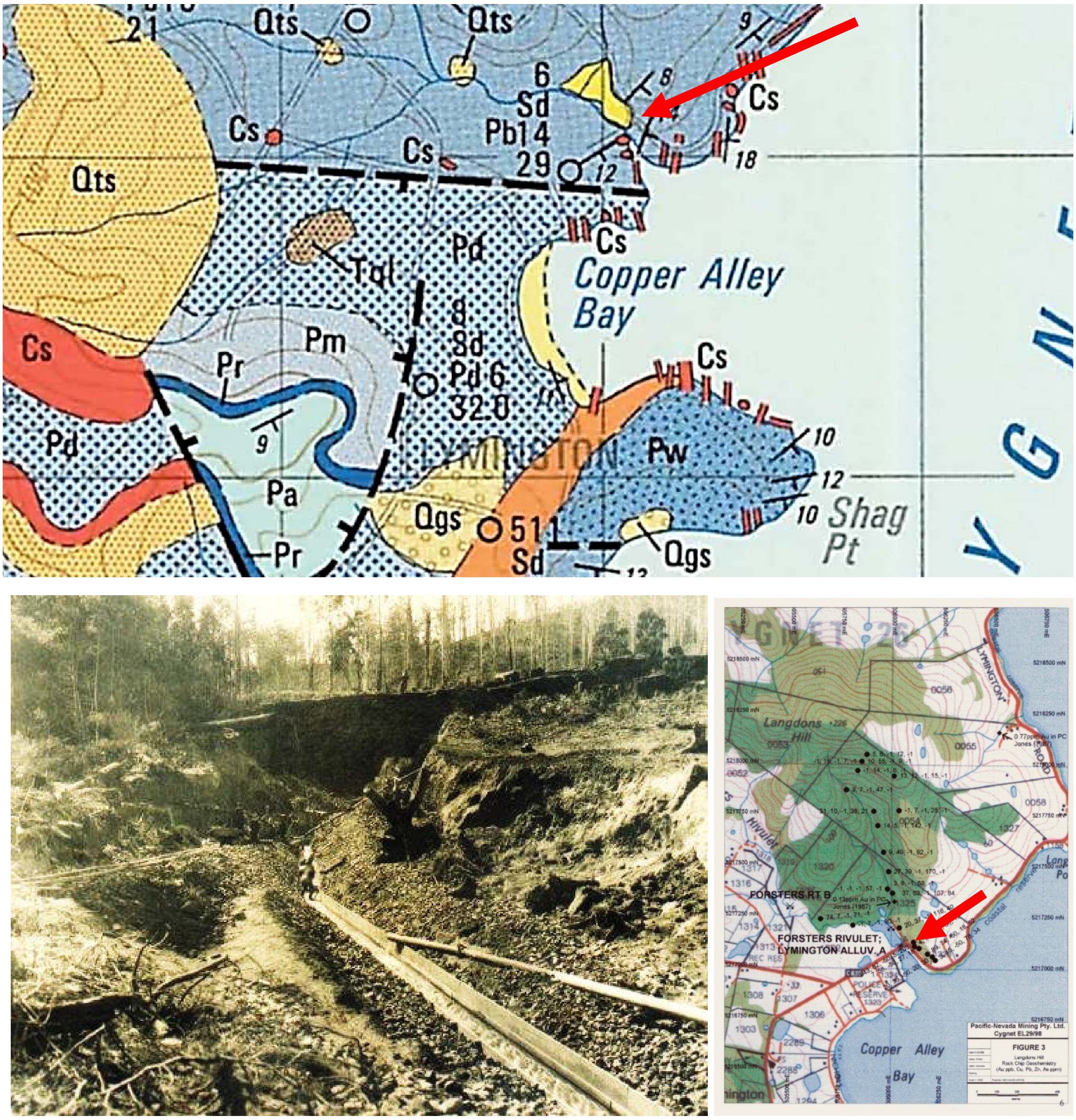

Figure 18. *Top. Extract from the Kingborough 1:50,000 geological map (Farmer 1981) showing the Forsters Rivulet (Lymington) area. The bridge and cutting is arrowed. Lower left. The historic alluvial gold working face (sluice face?) and tail race on Forsters Rivulet, Lymington in the late 1800s. The alluvial workings were upstream of the bridge. Source Lorraine Cowen collection on Pinterest. Lower right. Extract from Pacific Nevada exploration report showing the locations of rock chip sampling and the 943 ppb sample (with others).*

Geophysics

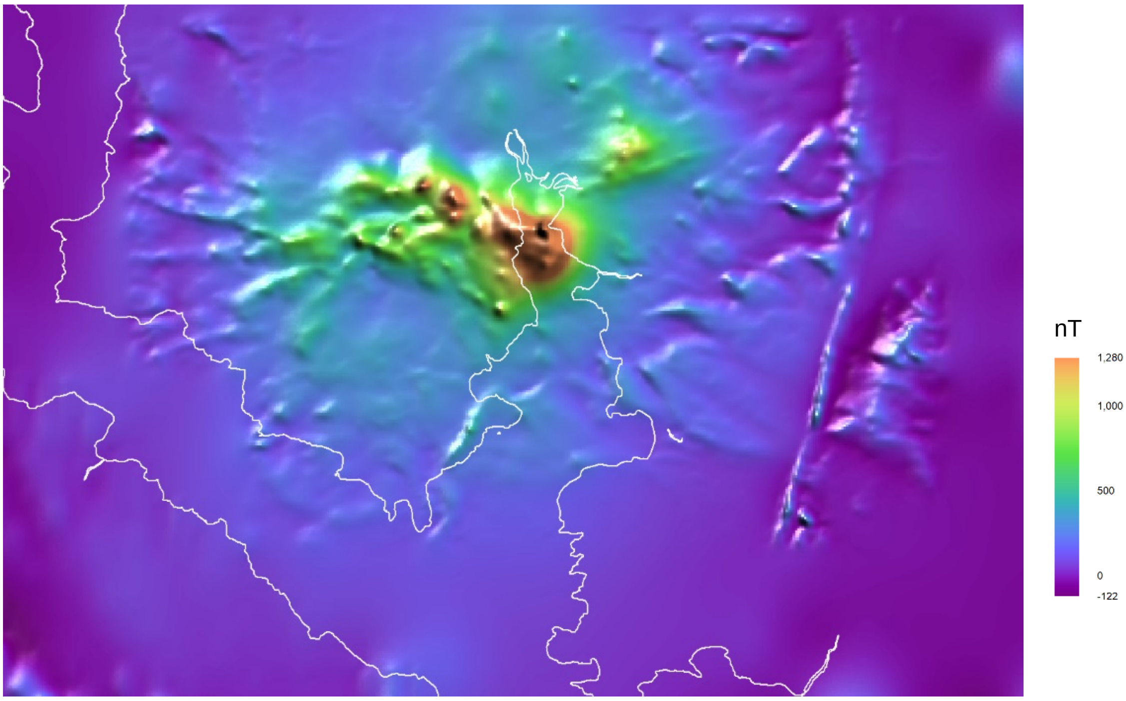

Figure 19a. *Image of reduced-to-the-pole (RTP) aeromagnetic data courtesy of Mineral Resources Tasmania, showing a strong positive response centred off Crooked Tree Point, south of Cygnet township. Most of the Cretaceous syenite dykes in the area show a low magnetic susceptibility and this response might be caused by a different, relatively deep, phase of the intrusion. Parts of the image reflect the mapped extents of the Jurassic dolerite intrusions very well: e.g., portions of the NNE trending dyke running from Randall's Bay, northwards past the Mt Cygnet Coal Mine to Nicholls Rivulet. Other dolerite occurrences, e.g., along the eastern shore of the Huon River around Brabazon Point, show no response. These differences may be due to differing volumes of dolerite and/or to different phases of dolerite with differing magnetic susceptibilities.*

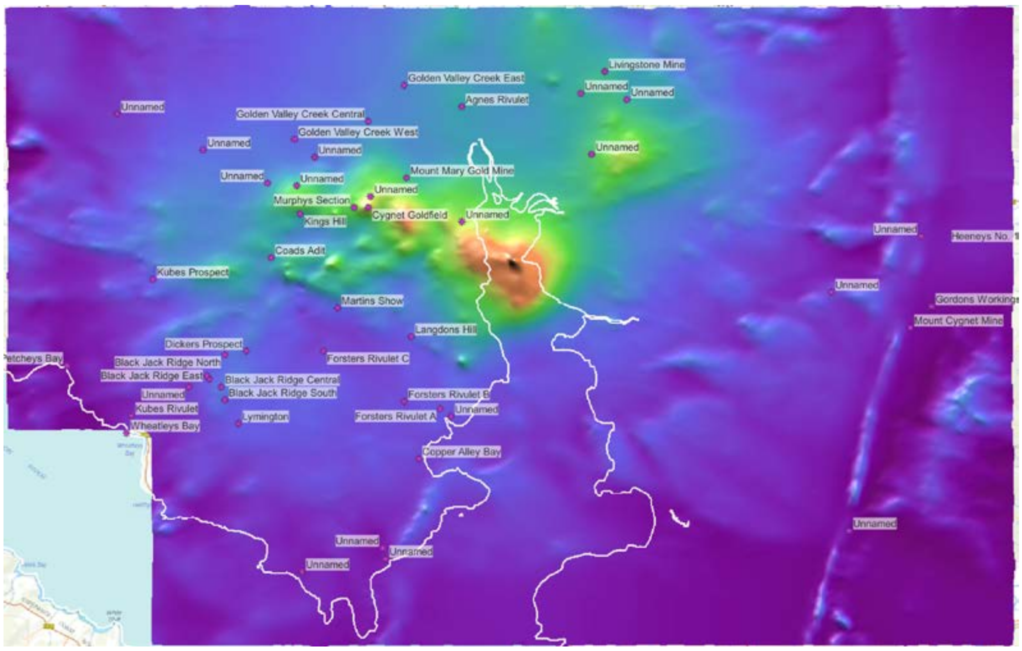

Figure 19b. *Mineral occurrences superimposed on zoomed RTP aeromagnetics*

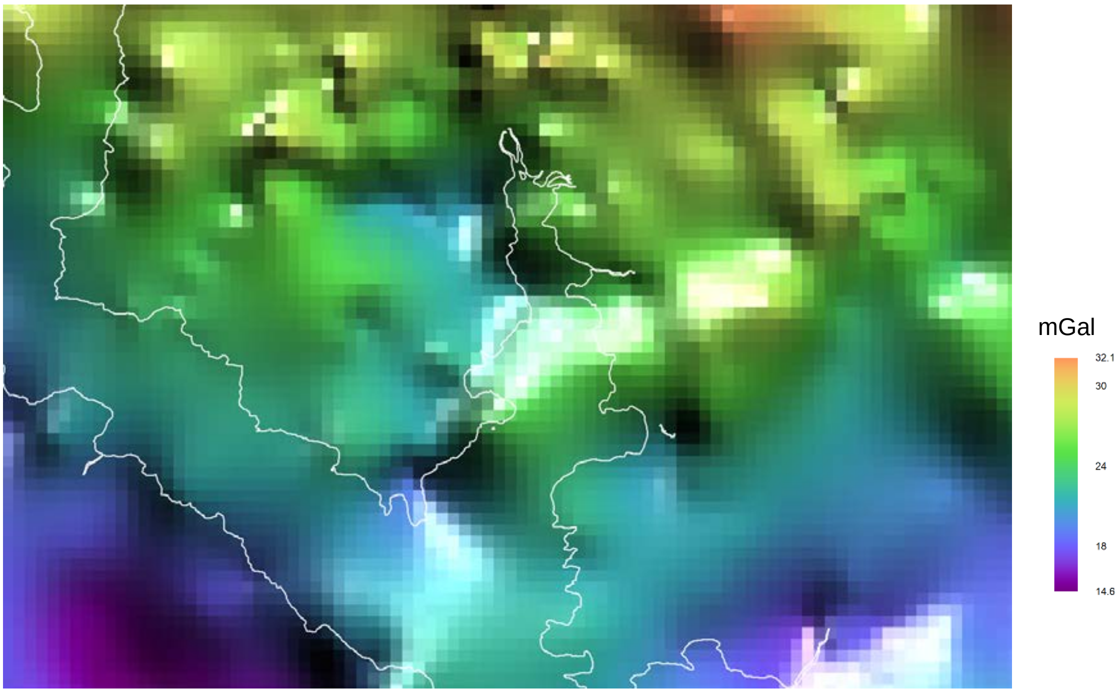

Figure 20. *Image of residual Bouguer gravity for the Cygnet Region courtesy of Mineral Resources Tasmania. The gravity data does not provide a simple correlation with the magnetic response. The low to the west of Port Cygnet (west of Robleys Point) may be reflecting the non-magnetic phase of the syenite (e.g., see Leaman and Naqvi, 1967, fig. 20), with some (all?) of the highs due to greater thicknesses of dolerite.*

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