



Tasmanian Geological Survey Record 2001/08

A mineralogical field guide for a Western Tasmania minerals and museums tour

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This guide was originally produced for a seven day excursion held as part of the International Minerals and Museums Conference Number 4 in December 2000. The excursion was centred on the remote and scenically spectacular mineral-rich region of northwestern Tasmania, and left from Devonport. The tour began with a trip to the Cradle Mountain National Park, then took in visits to various mines and mineral localities (including the Dundas, Mt Bischoff, Kara and Lord Brassey mines), the West Coast Pioneers Memorial Museum at Zeehan and a cruise on the Gordon River. A surface tour of the copper deposit at Mt Lyell followed before the tour moved towards Hobart. The last day was spent looking at mineral sites in and around Hobart.

Although some of the sites are not accessible to the general public, this report should provide a guide for anyone wishing to include mineral sites in a tour of Tasmania.

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Tasmania – General Information

The island of Tasmania is the smallest and most southerly of Australia's six States. It has a population of 473,000 and lies about 200 km south of the State of Victoria, being separated from mainland Australia by Bass Strait. The heart-shaped island is about 315 km across and 286 km long, making it about the same size as Ireland and a little larger than West Virginia. Much of Tasmania is still wilderness and more than 20 per cent of the area has been listed with UNESCO as a World Heritage Area, in recognition of one of the world's great natural treasures.

Tasmania was originally named Van Diemens Land by the Dutch explorer Abel Tasman in 1642, but it was not colonised until the British started a penal colony in 1803. At that time it is believed there were about 5000 Aboriginal people living on the island with a presence extending back for more than 50,000 years, although most had died from various diseases within 30 years. Convict transportation ceased in 1853. Until then the convicts had provided the main source of building labour in the colony and this heritage is still evident throughout much of Tasmania today. The capital city is Hobart with a population of 193,000. Statistically, Hobart has half the rain of Sydney, more sun than Melbourne and is warmer than Madrid.

Tasmania, like its minerals, is incredibly diverse and beautiful, and we hope you will enjoy your visit.

Natural history and climate

Tasmania is geographically quite different to most of Australia, being comparatively rugged, cool and wet. The State comprises one major island and numerous smaller islands, with an area of about 64 000 km², lying in a belt of moisture-laden westerly winds. Western Tasmania is largely mountainous and lies in the path of these winds, giving it year-round rain (over 2000 mm in places). Eastern Tasmania is mostly drier, being in a rain shadow.

The highest Tasmanian mountain is Mt Ossa at 1617 m, and there are over 60 peaks above 915 metres above sea level. These peaks and plateaus are frequently snow covered in winter, and some summer snowfalls occur, but there is no permanent snowline. Vegetation is complex, ranging from montane (alpine heathlands) to temperate rainforest (myrtle forest), dry sclerophyll forest (eucalypt forest, including some of the world's tallest flowering trees), sedgeland (buttongrass plains) and coastal heath. The vegetation has two main components: an Antarctic or Gondwanaland flora (also represented in New Zealand and South America) and an Australian flora, dominating most of Australia. Tasmanian fauna is generally similar to mainland Australia.

Tasmania has a mild maritime to cool temperate climate. In summer (December to February) the average daily temperature range varies from about

5–16°C in Waratah (western Tasmania) to 11–21°C in Hobart (eastern Tasmania). In winter (June to August) the average daily temperature range varies from about 1–8°C in Waratah to 5–12°C in Hobart. Rainfall varies from about 2200 mm/annum in Waratah to 620 mm/annum in Hobart, with rain falling throughout the year but peaking in winter. Snow is common over much of the higher parts of Tasmania in winter but is rare in summer.

Personal requirements

Whenever working in the sun wear a broad-rimmed hat and use a sun-block preparation (particularly November to March). The ozone layer is thin and the Tasmanian sun may feel cool, but can burn rapidly. In central and western Tasmania be prepared for snow and rain at any time of year, and very sudden changes in weather. **Always** take appropriate clothing – a warm pullover and raincoat and wear sturdy footwear. An insect repellent may be useful at times. Leeches, ants and snakes can be a nuisance in places and suitable (long and tight fitting) clothing and footwear is recommended for the squeamish.

Safety equipment, including hard hats, safety glasses and sturdy boots (preferably steel-capped) should be carried.

General geology

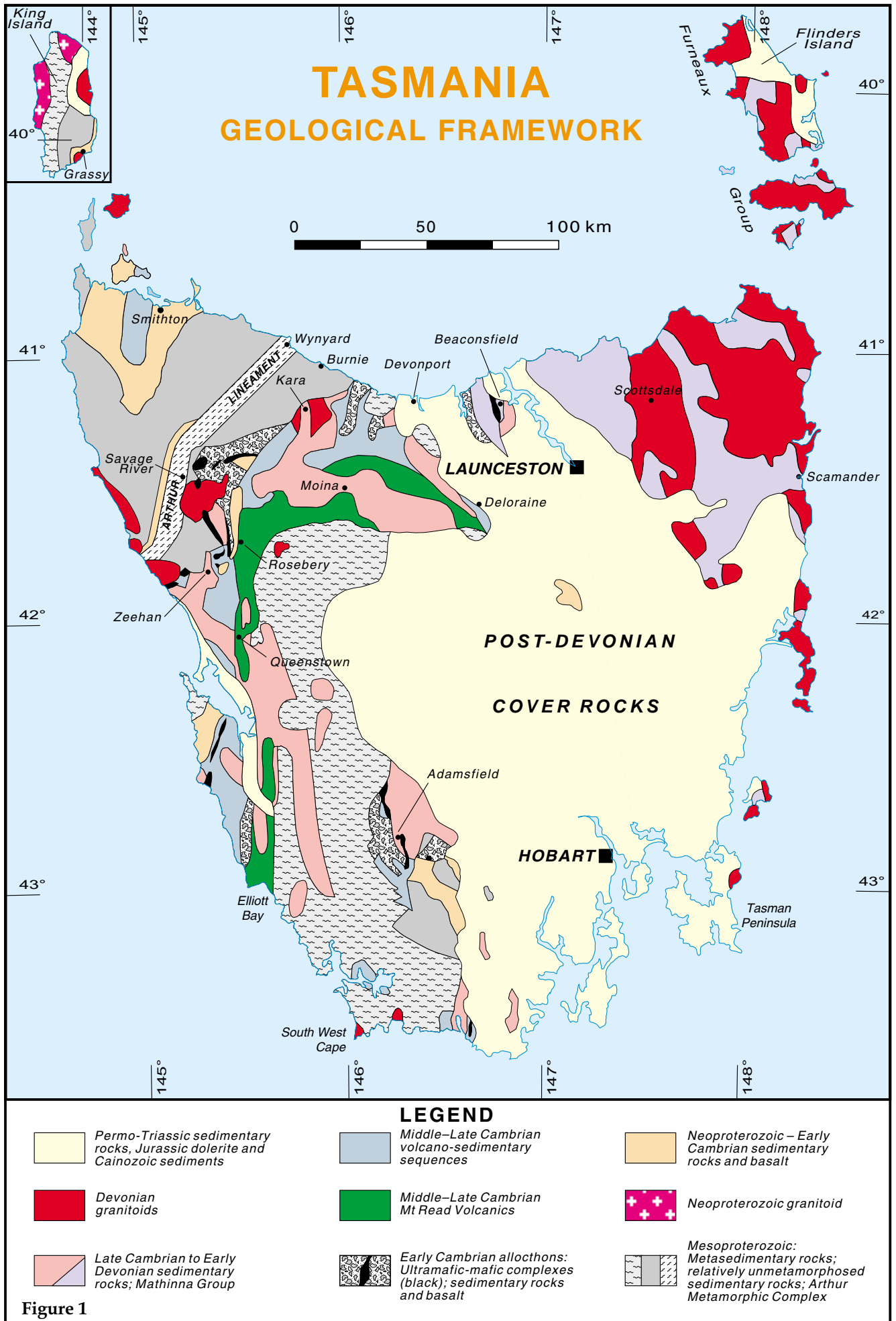
The geology of Tasmania is complex, with rocks of most major ages, from mid-Proterozoic to Cainozoic, being represented (fig. 1). There is considerable metamorphism, mineralisation and hydrothermal alteration in many areas (Burrett and Martin, 1989).

The oldest rocks are Precambrian (mid to late Proterozoic) metasediments, mostly quartzite, dolomite and slate, with some magnesite, schist, amphibolite, blueschist and eclogite. Some of these rocks host major tin deposits (e.g. Renison and Mt Bischoff), smaller silver-lead-zinc, gold and copper vein deposits, and some magnesian ± borate skarns.

Thrust over these rocks in many parts of Tasmania are Cambrian mafic-ultramafic ophiolitic complexes. These are now mostly serpentinised and host a wide range of ore deposits (platinoids, chromite, nickel, silver-lead-zinc, copper and gold).

Overlying the older rocks are Late Cambrian sedimentary, volcanic and intrusive rocks, particularly the Mount Read Volcanics. These are also highly mineralised, with the Mt Lyell, Rosebery, Hellyer and Hercules mines all being world-class base and precious metal deposits. Significant gold deposits also occur.

These rocks are largely conformably overlain by Ordovician to Early Devonian sedimentary sequences. These host some very important gold deposits and



tin-tungsten-bismuth, wollastonite, fluorite and Pb-Zn skarns.

All of the preceding sequences are affected to varying degrees by the intrusion of many large and widespread Devonian granitoids, forming hornfels and skarns and causing the introduction or remobilisation of much of the above-mentioned mineralisation.

Following the granitoid intrusions and orogenies in the Devonian, extensive fluvioglacial sediments were deposited in the Late Carboniferous to Triassic. These rocks were intruded by numerous large Jurassic dolerite dykes and sills, equivalent to those in Antarctica and South Africa. Although mostly unmineralised, some of these rocks contain zeolites and related secondary minerals. Partial erosion of columnar dolerite has produced many spectacular landforms and mountains.

Widespread uplift during the Cretaceous resulted in only limited sedimentation, although there were some local high level alkaline intrusions (feldspathoidal syenite to quartz monzonite, some gold-bearing), and phonolite and andesite flows. Further uplift and erosion in the Tertiary formed some minor sedimentary basins (Late Cretaceous to Recent), intercalated with numerous basalt flows (some highly zeolitised).

Mining history

On a world scale, mining is a relatively recent phenomenon in Tasmania, excluding some minor working of flints, ochre and other minerals by Aboriginal people. A little coal and iron ore were worked by convicts in the early 1800s, but the discovery of gold in northeastern Tasmania in 1852, inspired by the Victorian gold rush, was the first real impetus for mineral exploration (Dickens, 1995).

The climate and terrain of the Western Tasmanian mineral belt impeded exploration, but prospectors trickled westwards and made some major mineral discoveries in the 1870s and 1880s (particularly the deposits of tin at Mt Bischoff and copper and gold at Mt Lyell). These discoveries resulted in extensive prospecting and mining operations, most of which had ceased by the turn of the century, and nearly all by World War I. Some major producers have remained in continuous operation for about 100 years or more, for example the Renison tin mine, the Mt Lyell copper mine and the Rosebery lead-zinc mine. Mineral exploration continues and new discoveries are still being made (for example the Henty gold mine, opened in 1996).

Fossicking Areas — general information

There are many localities within Tasmania where interesting lapidary and mineralogical material occur, including the Lord Brassey and Colebrook Hill mines, which are described below.

In recognition of the recreational activity of fossicking, several of the best of these areas have been declared official Fossicking Areas under the *Mineral Resources Development Act 1995*. These areas are specially set aside for the use of fossickers (gem and mineral collectors), and will not be included in any exploration licence or mining lease application. The areas and fossicking restrictions are described in a booklet (*Fossicking Areas in Tasmania*, compiled by C.A. Bacon and R. S. Bottrill, 1997) available from Mineral Resources Tasmania.

Conditions apply to the use of Fossicking Areas. Fossickers should avoid causing undue damage to the land, and should take only a 'fair share' of material.



Figure 2

Mineral Locations

Moina quarry

Crystals of topaz (to 40 mm), cassiterite, quartz, monazite and wolframite occur in veins and joints and argillised pockets in Ordovician sandstone, altered by Devonian granites. Tin and tungsten have been mined extensively in the district, as well as gold, bismuth, silver, zinc, lead and other commodities.

Middlesex Plains

Crystals of chabazite (to 15 mm) occur in vesicles in Tertiary basalt, with some analcime, phillipsite, calcite, pyrite and natrolite crystals.

Lord Brassey mine

The Lord Brassey mine is a small but world famous deposit situated near the former mining town of Heazlewood (fig. 3). This former nickel mine is the source of many rare minerals and is the type locality for heazlewoodite and hellyerite (Andersen *et al.*, in press).

The discovery of the nickel mineralisation around Brassey Hill (Nickel Hill) was made in the 1890s when prospectors were searching for 'osmiridium' (platinum-group minerals), of which the nearby Bald Hill locality was an important source. In 1896, an adit was driven into the hill by the Lord Brassey Nickel Company and a few tons of nickel sulphide ore was extracted.

The nickel ore of the Lord Brassey mine, and the iridium-osmium ore of Bald Hill, occur within a large body of serpentine, part of a large Cambrian ultramafic complex consisting originally of pyroxenite and peridotite, altered mostly to green-black lizardite. During the latest stage of Devonian metamorphism, fault-controlled bodies of fibrous and waxy green serpentine (chrysotile and antigorite) were formed due to metasomatism (Peck and Keays, 1990). The nickel mineralisation at Lord Brassey appears to be localised within such an antigorite-bearing serpentinite body and can probably be ascribed to this stage (Peck and Keays, 1990). Other links to late granite-related, skarn-like metasomatism include vein-style diopside, magnetite, chlorite, andradite, talc, molybdenite and magnesite (Mann, 1988; Andersen *et al.*, in press).

The nickel mineralisation is seen as small veins and pods of primary sulphides, principally heazlewoodite, which is intergrown with awaruite, magnetite, andradite, chlorite and other minor nickel, iron and copper sulphide minerals. Groundwater percolating up through shear planes within the serpentine has reacted with the primary sulphide minerals to form the secondary nickel mineralisation (Henry and Birch, 1992).

The area was also worked extensively for alluvial 'osmiridium', containing various platinum group alloys, mostly osmium and iridium with minor

rutheniridosmine, ruthenium, rhodium, gold, tetraferroplatinum and ferronickelplatinum (Ford, 1981). Some associated sulphide and arsenide minerals include cherepanovite, erlichmanite, hollingworthite, iridarsenite, kashinite and laurite (Peck and Keays, 1990).

Important minerals

Andradite: $\text{Ca}_3(\text{Fe,Cr})_2(\text{SiO}_4)_3$; fine grained veinlets, bright green to white; hydrous.

Awaruite: (Ni,Fe); metallic white, rusty.

Dypingite: $\text{Mg}_5(\text{CO}_3)_4(\text{OH})_2 \cdot 5\text{H}_2\text{O}$; pale blue to white, botryoidal crusts.

Heazlewoodite: Ni_3S_2 ; bronzy yellow patches in serpentine.

Hellyerite: $\text{NiCO}_3 \cdot 6\text{H}_2\text{O}$; pale blue coatings and very attractive crystals, < 2mm.

Molybdenite: MoS_2 ; small patches of massive dark grey to occasionally purple grey.

Reevesite: $\text{Ni}_6\text{Fe}_2^{3+}(\text{CO}_3)(\text{OH})_{16} \cdot 4\text{H}_2\text{O}$; a lemon yellow crust on serpentine.

Retgersite: $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$; pale to mid blue crusts.

Theophrastite: $\text{Ni}(\text{OH})_2$; a green crystalline crust on slickensided serpentine.

Unnamed: Ni-Fe sulphate; yellow-green, powdery.

'Zaratite': $\text{Ni}_3(\text{CO}_3)(\text{OH})_4 \cdot 4\text{H}_2\text{O}$; the most obvious nickel 'mineral'; emerald green coatings and mammillary, stalactitic or amorphous encrustations along the shear planes and joint surfaces of the serpentine.

Other minerals

Native Elements: Unnamed Bi-Ni-Fe-Pt alloy, auricupride.

Sulphides: covellite, digenite, millerite, pyrite, pentlandite, polydymite, pyrrhotite, violarite.

Silicates: antigorite, chrysotile, clinochlore, diopside, enstatite, grossular, lizardite, opal, palygorskite, stevensite, talc.

Carbonates: gaspeite, magnesite, otwayite, pyroaurite.

Others: annabergite?, atacamite?, brucite, magnetite.

Mt Bischoff

The Mt Bischoff mine was discovered by part-time prospector James 'Philosopher' Smith in 1871, and for many years was one of the world's richest tin mines (Groves *et al.*, 1972). After 70 years of continuous production, the Mt Bischoff mine closed in 1947. Since then, mining ventures have only been spasmodic.

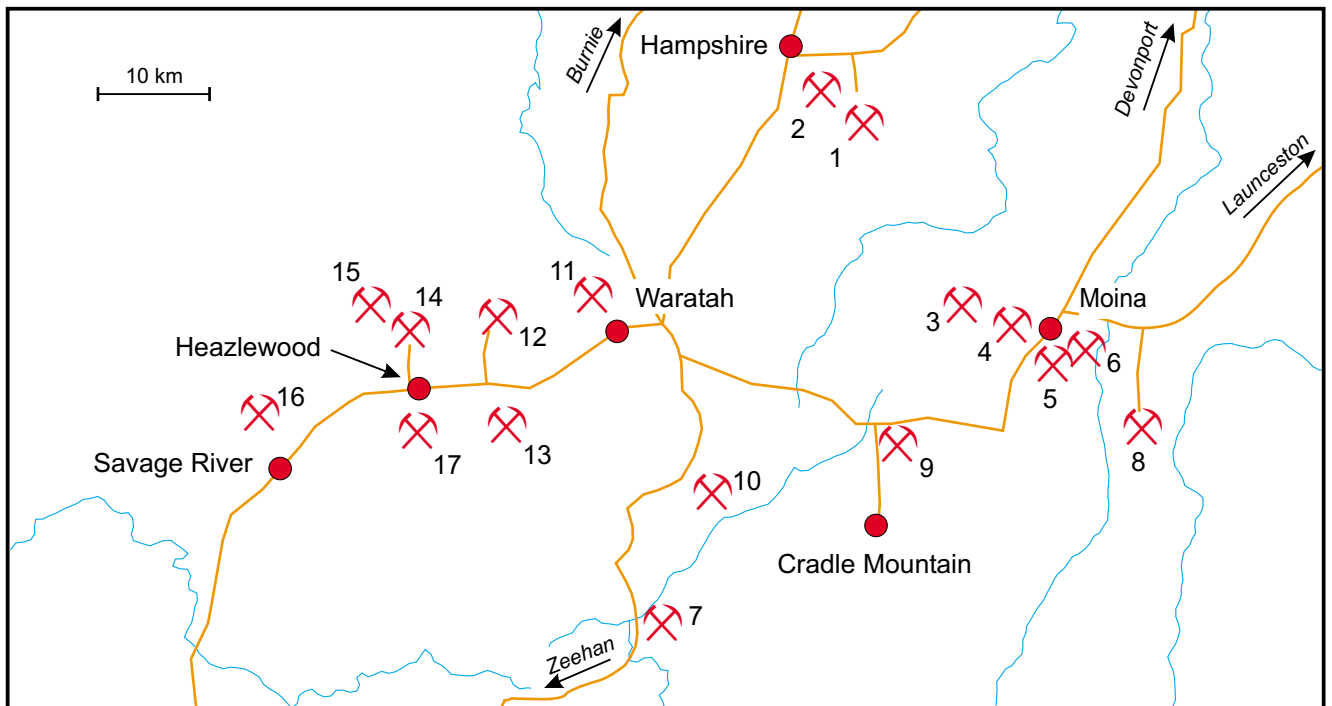


Figure 3

The Waratah district – sketch map and principal mineral deposits: 1. Kara W-Fe mine; 2. Hampshire Ag mine; 3. Stormont Bi-Au mine; 4. Shepherd and Murphy Sn-W-Bi-Au mine; 5. Moina quarry and All Nations Sn-W mine; 6. Sayers and Princess Sn-W-Be mines; 7. Mt Farrell Pb-Ag mine; 8. Gads Hill (zeolites); 9. Middlesex Plains (zeolites); 10. Que River and Hellyer Pb-Zn-Ag-Au mines; 11. Mt Bischoff Sn mine; 12. Magnet Ag-Pb-Zn mine; 13. Cleveland Sn mine; 14. Lord Brassey Ni mine; 15. Bald Hill Os-Ir mines; 16. Savage River Fe mines; 17. Heazlewood Ag-Pb mine.

Mt Bischoff was the first major mineral resource developed in Tasmania, with a total production of around 62 000 tonnes of metallic tin. The discovery provided the impetus for exploration of other areas of the west coast and the subsequent discovery of other mining areas such as Mt Lyell and Renison.

Geology

Precambrian quartzite, shale and dolomite at Mt Bischoff have been intruded by a radial group of Devonian quartz-feldspar porphyry dykes and breccia dykes, related to the nearby Meredith granite. Tin-base metal sulphide mineralisation accompanies these dykes, and occurs as a replacement of dolomite, as greisenised dykes, and as veins and fracture linings (Groves *et al.*, 1972; Wright and Kwak, 1988; Halley and Walshe, 1995; Sorrell, 1997; fig. 4). Tin mineralisation occurs within a radius of about one kilometre from the summit of Mt Bischoff, and several silver-lead-antimony deposits surround the mine. Supergene zones were minor.

Dolomite-replacement mineralisation

Dolomite-replacement mineralogy is dominated by sulphides (mostly pyrrhotite), Fe-Mg-Mn carbonates, fluorides (fluorite, sellaite), tourmalines and magnesium silicates (chondrodite, norbergite, clinohumite, phlogopite, talc and serpentine), in part as magnesian skarns and 'wrigglite' (banded skarn),

largely retrogressed. The highest tin grades were found within a quartz-pyrrhotite-topaz-fluorite assemblage (the most strongly altered dolomite replacement rocks) adjacent to the dykes (now largely worked out). Dolomite-replacement mineralisation is found at the Greisen Face, where talc-pyrrhotite alteration occurs, and at the Slaughteryard Face, where quartz-pyrrhotite alteration and fluorite 'nodules' occur.

Dyke mineralisation

Greisenised dyke rocks are characterised by a white, fine-grained groundmass of quartz and topaz, with orthoclase phenocrysts variably pseudomorphed by siderite, pyrrhotite, quartz, topaz, pyrite, fluorite and cassiterite. One of the most prominent features of Mt Bischoff is the Western Dyke, a greisenised porphyry with cassiterite both disseminated and coating joint surfaces.

Veins and fracture linings

Fissure lodes are a late phase of mineralisation, cross-cutting dykes and country rocks. They contain variable proportions of quartz, siderite, tourmaline, topaz, fluorite, cassiterite, wolframite and sulphide minerals (pyrite, pyrrhotite, galena, sphalerite, chalcopyrite, bismuthinite, As-Sb-Bi sulphosalts and stannite).

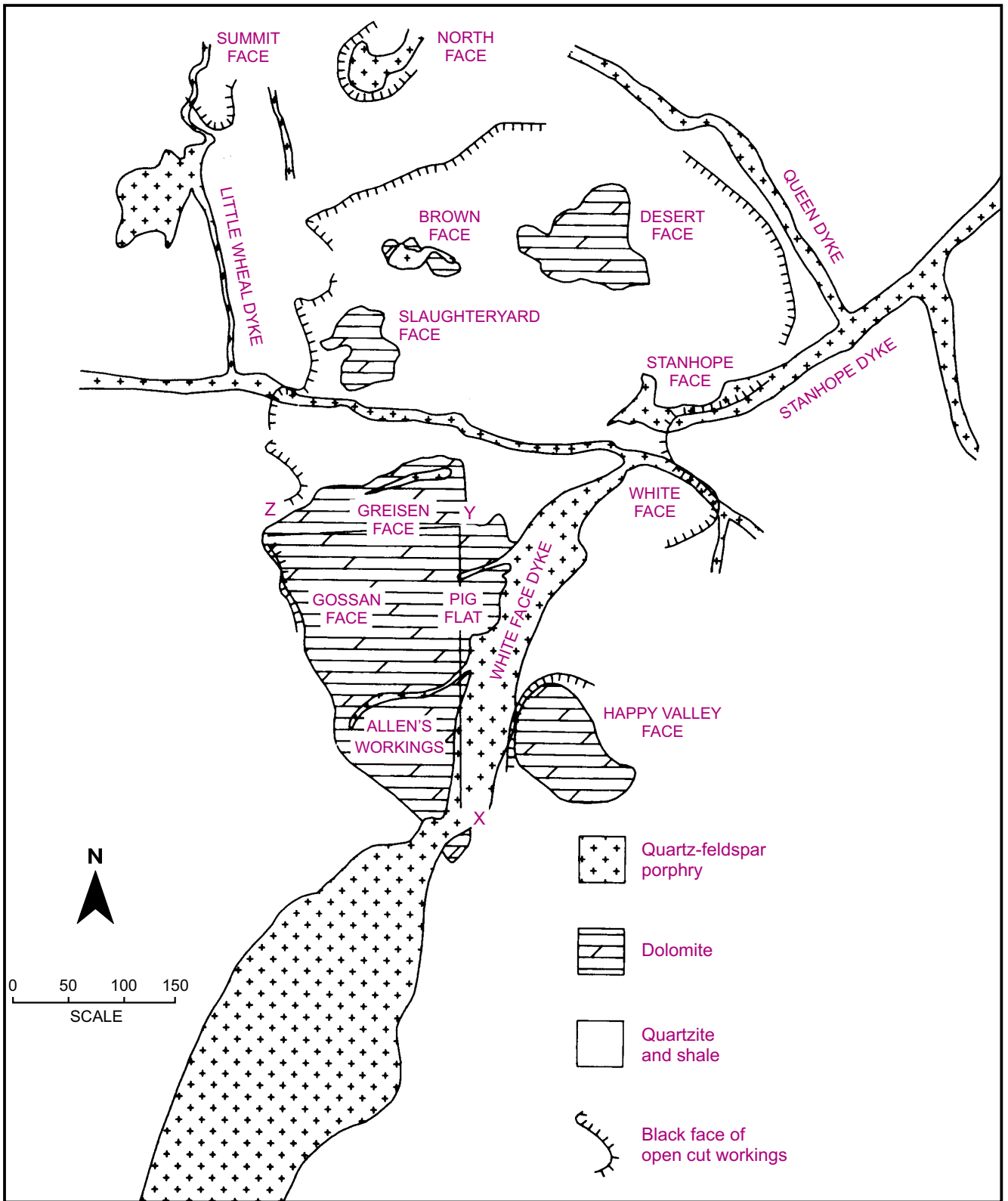


Figure 4

The Mt Bischoff mine (from Halley and Walshe, 1995)

Mineralogy

More than 100 mineral species have been recorded from Mt Bischoff. The extensive alteration and large amounts of magnesium and fluorine in the system produced uncommon minerals such as sellaite, chondrodite, norbergite, wagnerite and fluoborite (Wright and Kwak, 1988; Halley and Walshe, 1995; Sorrell, 1997).

Beryl

Pale to mid-blue, opaque crystals of beryl up to 50 mm in length occur at Mt Bischoff, especially near the Slaughteryard Face, associated with an emerald green tourmaline. Some of these crystals exhibit colour zoning which can be seen on the flat terminations of the hexagonal prisms. Other beryllium minerals recorded from Mt Bischoff include bavenite, hambergite and phenakite.

Carbonate minerals

The major carbonate present is commonly referred to as siderite, but most appears to be an Fe-magnesite, except in more quartz-rich rocks. Generally the lighter the colour of the specimen, the less iron content. Rhodochrosite is rare here. Most siderite/magnesite is found as tabular hexagonal crystals to 50 mm across and is common in the dolomite replacement bodies, often associated with fluorite.

Cassiterite

Cassiterite was the most important tin mineral mined at Mt Bischoff. It occurs in a number of environments and was particularly abundant in the dolomite replacement bodies (especially the White and Brown faces). Much of the cassiterite mined was eluvial or alluvial, released through weathering processes. In 1880, a five hundredweight (250 kg) solid nugget was recovered from the Slaughteryard Face. It is still possible to pick up masses of cassiterite up to 60 mm with bright euhedral crystals in cavities. Bright red-brown, yellowish or black crystals to 3 mm can be found lining joints in the dyke rocks and sedimentary rocks adjacent to the dykes. Crystalline cassiterite generally occurs as short, equant prisms, often twinned, or rarely acicular crystals to about one millimetre. Stannite and teallite are the other tin minerals recorded here.

Fluorite

This is abundant in many parts of the mine, particularly the dolomite replacement bodies and veins, especially in the Slaughteryard Face. It is found mostly as cubes to 30 mm, modified by octahedral (111) and to a lesser extent, dodecahedral (110) faces on a matrix of either magnesite or siderite. Most specimens are transparent lustrous crystals, either colourless or pale blue, but massive purple fluorite also occurs. Some brown octahedral fluorite occurs in cellular quartz-topaz-sellaite. Part of the Happy Valley Face was worked in the late 1980s for specimen material;

transparent colourless crystals of fluorite, almost always as cubes, sometimes elongated or flattened, occurring on Fe-magnesite. Associated minerals included quartz, pyrite and sphalerite. Green fluorite, sometimes with purple cores, has been found near the White Face dyke in recent years. Near the gossan face dark purple fluorite occurs as complex cubo-octahedral crystals with tourmaline, siderite, pyrite, marcasite and smoky quartz.

Other fluoride minerals identified include sellaite, prosopite, ralstonite and weberite.

Quartz

Abundant small, white to colourless quartz crystals occur in the porphyry dykes and in other areas such as the Happy Valley Face, occasionally as wheatsheaf aggregates. Smoky quartz specimens to 40 mm are much less common but very aesthetic, occurring with purple fluorite and siderite crystals.

Sulphide minerals

Pyrite and pyrrhotite are ubiquitous. Pyrite can occur as attractive crystals, often as cubes or less commonly pyritohedrons and other forms, although some does decompose. Other sulphides found in crystalline form include arsenopyrite, marcasite and sphalerite.

Topaz

The porphyries contain a compact fine-grained form of topaz known as pycnite, found as pseudomorphs after feldspar, and as radiating groups of transparent acanthine crystals to 2 mm. Coarser crystals are rare.

Tourmalines

Tourmaline is common at Mt Bischoff, generally as blue to green masses or thin tufted acicular crystals and rarely as very fine-grained botryoidal masses. Compositions range between dravite, schörl, olenite and foitite. Elbaite has also been reported but not confirmed.

Minerals Reported

Native elements: arsenic, bismuth, copper, gold, graphite, sulphur.

Sulphides: arsenopyrite, berthierite, bismuthinite, boulangierite, chalcocite, chalcopyrite, galena, jamesonite, marcasite, molybdenite, proustite, pyrargyrite, pyrite, pyrostitpnite, pyrrhotite, sphalerite, stannite, stibnite, teallite, tetrahedrite.

Oxides: brucite, cassiterite, chromite, corundum, cuprite, diaspore, gahnite, goethite, hematite, magnetite, pyrolusite, rutile, thorianite, tungstite.

Halides: bodalyrite?, fluorite, halite, prosopite, ralstonite, sellaite, weberite, sylvite.

Carbonates: ankerite, aragonite, azurite, calcite, dolomite, magnesite, malachite, rhodochrosite, siderite, smithsonite.

Sulphates: barite, chalcantinite, copiapite, goslarite, gypsum, halotrichite, jarosite, melanterite.

Silicates: actinolite, albite, allanite, andradite, annite, augite, bavenite, beryl, biotite, chondrodite, chrysotile, clinocllore, clinohumite, dravite, elbaite, enstatite, epidote, foyite, forsterite, hemimorphite?, hisingerite, hornblende, hydrogrossular, illite, kaolinite, lepidolite, lizardite, microcline, muscovite, natrolite, norbergite, olenite, opal, orthoclase, palygorskite, phlogopite, pyrophyllite, quartz, schorl, sillimanite, talc, titanite, topaz, tourmaline, tremolite, vesuvianite, wollastonite, zircon.

Phosphates and other: arsenobismite, fluorapatite, hambergite, isokite, monazite, scorodite, scheelite, vivianite, wagnerite, wavellite, wolframite (ferberite), xenotime.

Kara mine

This is a relatively recent mine, having operated since 1977, initially as a scheelite mine but now producing mostly magnetite. There is potential for some other products, including wollastonite, garnet and gold.

There are a number of skarns in the Kara district, variously dominated by magnetite, garnet, vesuvianite, wollastonite, pyroxenes, amphiboles and other minerals (Kwak, 1987; Whitehead and Turner, 1990). These occur in Ordovician limestone near the contact with Devonian granite. The Kara magnetite-scheelite bearing skarns occupy a trough-like pendant within a Late Devonian red granite known as the Housetop Granite. Ore-grade scheelite and magnetite mineralisation at the Kara No. 1 deposit are hosted by andradite-pyroxene-vesuvianite skarn which forms an irregularly-shaped blanket draped 15–25 m above the granite. Between the skarn and the granite is a tungsten-poor, quartz-epidote reaction zone (Whitehead and Turner, 1990). The skarns are variably retrogressed to amphiboles ± epidote and fluorite and are mostly overlain by Tertiary basalt.

Major minerals

Andradite: $\text{Ca}_3\text{Fe}_2(\text{SiO}_4)_3$; large, lustrous, brown dodecahedral crystals.

Bavenite: $\text{Ca}_4(\text{Al,Be})_4\text{Si}_9\text{O}_{26}(\text{OH})_2$; colourless radiating/bladed crystals.

Calcite: CaCO_3 ; white rhombic to bladed crystals.

Danalite: $\text{Fe}_4\text{Be}_3(\text{SiO}_4)_3\text{S}$; coarse red tetrahedral crystals.

Epidote: $\text{Ca}_2\text{FeAl}_2(\text{SiO}_4)(\text{Si}_2\text{O}_7)(\text{O,OH})_2$; small green prismatic crystals.

Fluorite: CaF_2 ; purple octahedral crystals.

Magnetite: Fe_3O_4 ; good, large dodecahedral crystals.

Malachite: $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$; green, botryoidal.

Molybdenite: MoS_2 ; hexagonal flakes.

Scheelite: CaWO_4 ; disseminated or rare white bipyramidal crystals.

Stolzite: PbWO_4 ; rare, orange blocky to bladed crystals.

Amphiboles: (tremolite-actinolite, hastingsite, ferroedenite, etc); fibrous green-white crystals.

Pyroxenes: (diopside-hedenbergite), green-black crystals.

Rarer and/or less obvious minerals

Skarn minerals: anorthite, clinozoisite; vesuvianite; wollastonite.

Weathering zone: anthoinite and mpororoite (hydrous Al-Fe tungstates, alteration products of scheelite), hematite, montmorillonite.

Granite minerals: allanite, biotite, chlorite, fluorapatite, orthoclase, plagioclase, quartz, sphene.

Sulphides: aikinite, arsenopyrite, bismuthinite, chalcopyrite, galena, pyrite, sphalerite.

Colebrook Hill, Dundas

This location has produced Australia's best ferroaxinite specimens, some of which are world class. The deposit is hosted by an unusual skarn, sometimes described as a limurite or axinite-hornfels, probably derived from calcareous or dolomitic rocks associated with mafic-ultramafic intrusive rocks (Blissett, 1962). The skarn has formed where boron and sulphur-rich solutions from an underlying Devonian granite reacted with the reactive calcium-rich rock types. The mine was originally worked for copper, but various silver, gold, tin, lead, zinc, tungsten and other minerals are also present. The deposit is very complex and of great mineralogical interest. Specimen minerals are usually dissolved from the enclosing calcite with acids. The area is in a designated fossicking reserve, but is difficult to access.

Minerals that can be collected and identified in hand specimens

Calcite: CaCO_3 ; very common as white to colourless massive material, and less commonly as well-formed rhombohedral crystals.

Chalcopyrite: CuFeS_2 ; common as massive or granular material with a bright brassy yellow colour and rough fracture, sometimes tarnished purplish.

Datolite: $\text{CaBSiO}_4(\text{OH})$; uncommon, as glassy white or very pale blue-green, short prismatic monoclinic crystals to about 20 millimetres.

Ferroaxinite: $\text{Ca}_2(\text{Fe,Mn})\text{Al}_2\text{BSi}_4\text{O}_{15}\text{OH}$; this is a dominant mineral in the lodes and occurs as massive or crystalline material of a deep violet colour. Well-formed wedge-shaped triclinic crystals up to

20 mm in length occur, and may be very lustrous and attractive.

Arsenopyrite: FeAsS; this is rather abundant as massive material or as excellent orthorhombic crystals to about 10 mm, with a bright silver-grey colour.

Quartz: SiO₂; this is quite common as massive material and as hexagonal crystals, milky white in colour, to about 20 mm in length. Japan-law twins occur.

Tremolite-actinolite: Ca₂(Mg,Fe)₅Si₈O₂₂(OH,F)₂; this occurs as a massive, coarse-grained fibrous material, and as radiating aggregates and ragged to fibrous monoclinic crystals, up to 20 mm or so in size. The colour is usually a pale grey-green.

Scheelite: CaWO₄; this mineral has been reported rarely as small groups of white tetragonal crystals.

Other minerals reported from this locality

Sulphides: loellingite?, pyrite, pyrrhotite, bornite, galena, sphalerite, marcasite, tetrahedrite, millerite.

Secondary minerals: azurite, malachite, copper, cuprite, olivenite? (var. leucochalcite), erythrite?, connellite?, aurichalcite, rosasite, brochantite, chalcantite, chrysocolla, langite, posnjakite, spangolite.

Other: boracite?, danburite, schorl.

Serpentine Hill – Nevada Creek – Stichtite Hill, Dundas

This area is one of the principal sources of stichtite specimens in the world. It is hosted by sheared Cambrian serpentinite bodies.

The stichtite replaces small disseminated chromite/magnesiochromite grains, and is also remobilised into coarser patches. It may be intermixed with its polymorph barbertonite, and may occur with aragonite, chlorite and magnetite, hosted in serpentinite.

Crocoite mines, Dundas

These old Ag-Pb mines in western Tasmania include the Adelaide, Red Lead, Dundas Extended, West Comet, Platt, Kozminsky and Kapi mines (fig. 5), and are the prime sources for crocoite in the world. Some of these mines are still being worked for specimen material. The primary ore occurs as Pb-Zn-Ag sulphides in veins in siderite-ankerite-rich fault zones cutting Cambrian serpentinite and ultrabasic-derived greywacke, and Precambrian slate. The ore and host rocks in upper levels are largely altered to clays and gossan, but the crocoite may grow freely in vughs and joints.

Minerals of Dundas

Anglesite: PbSO₄; occurs uncommonly as white to grey or green orthorhombic crystals to a few millimetres with cerussite, usually coating galena.

Bindheimite: Pb₂Sb₂O₆(O,OH); earthy, yellow, with crocoite; sometimes labelled massicot.

Cerussite: PbCO₃; this area is famous for its 'chrome cerussite', which is locally abundant as very attractive crystalline aggregates of complex yellow crystals, possibly coloured by small traces of chromium. More normal white to colourless cerussite is also common at some mines.

Chalcofanite: (Zn,Mn,Fe)Mn₂O₅.2H₂O; this mineral occurs as finely drusy masses of lustrous purplish black hexagonal crystals on Mn oxides.

Chlorargyrite: AgCl; this mineral forms waxy masses and crusts varying from yellow to green when fresh, darkening to violet brown with exposure to light. It was an important silver ore in the gossans.

Coronadite: PbMn₈O₁₆; this mineral is present in the gossans as massive or stalactitic, hard grey material.

Crocoite: PbCrO₄; this mineral is very common here as attractive, fine, monoclinic prismatic to bipyramidal crystals to 50 mm, usually hollow, with a bright orange to red colour. The crystals occur as entangled masses, as single crystals on gossan or gibbsite, or more rarely intergrown with dundasite or yellow 'chrome cerussite'. Large terminated crystals occur but are relatively uncommon.

Dundasite: PbAl₂(CO₃)₂(OH)₄.H₂O; botryoidal-fibrous aggregates of white to pale green crystals with crocoite.

Gibbsite: AlO(OH); botryoidal to massive, white to yellow and black where impure; overgrows crocoite.

Goethite: FeO(OH); an important constituent of the gossans. Usually massive, powdery yellow to brown and black when massive; pseudomorphs siderite.

Grimaldiite: CrO(OH); a soft, grey to dark green powdery mineral replacing chromite and coating crocoite.

Linarite: CuPb(SO₄)(OH)₂; deep blue, prismatic crystals with cerussite and anglesite.

Mimetite: Pb₅(AsO₄)₃Cl; relatively rare in the gossans as small, colourless to yellow, orange, red and brownish-green hexagonal prismatic crystals. Sometimes described as vanadinite.

Muscovite: ('fuchsite') Massive, bright green clays are mostly this chromian mica.

Petterdite (new species): PbCr₂(CO₃)₂(OH)₄.H₂O; pink to lilac, very fine grained coatings on galena with anglesite and cerussite.

Philipsbornite: PbAl₃(AsO₄)(AsO₃OH)(OH)₆; grey, green, yellow to off-white; much was previously described as weilerite, gorgeixite or hidalgite.

Phosgenite: Pb₂(CO₃)Cl₂; recorded in the gossans as adamantine, brown to colourless crystals on galena. Rarely reported, but probably mistaken for anglesite or cerussite.

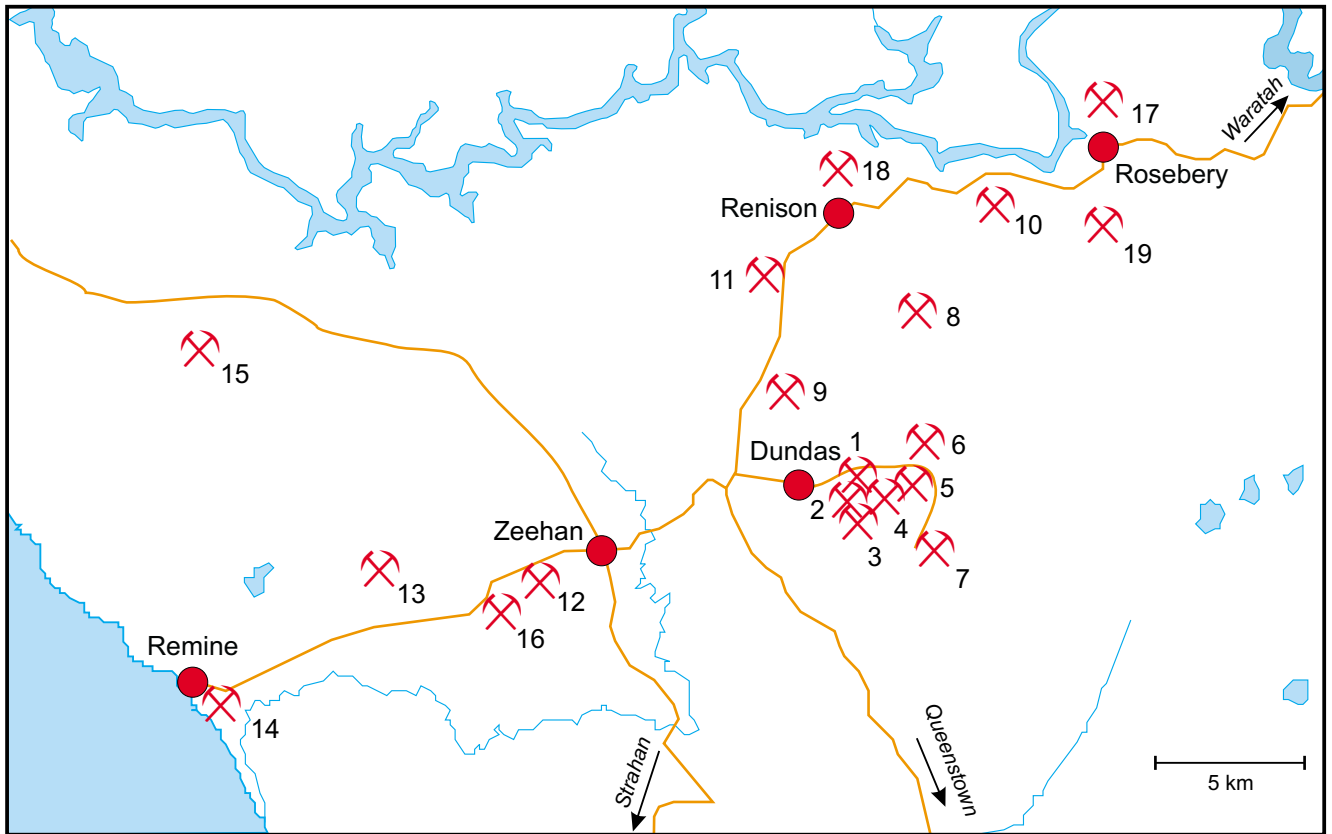


Figure 5

Sketch map and principal mineral deposits, Zeehan district.

1: West Comet and Dundas Extended mines; 2: Adelaide mine; 3 Red Lead mine; 4: Stichtite Hill; 5: Platt and Kosminsky mines; 6: Comet-Maestries mines; 7: South Comet mine; 8: Kapi mine; 9: Nevada Creek; 10: Colebrook Hill; 11: Serpentine Hill (Tunnel Hill); 12: Sylvester/Queen mines; 13: Tenth Legion; 14: Trial Harbour Ni mines; 15: St Dizier Sn mine; 16: Comstock mine; 17: Rosebery mine; 18: Renison Sn mine; 19: Hercules mine.

Pyrolusite: MnO_2 ; this powdery brown-black to silvery grey mineral occurs in the gossan.

Pyromorphite: $Pb_5(PO_4)_3Cl$; occurs in some mines as crusts of bright green prismatic crystals forming attractive combinations with crocoite.

Unknown: Mn-Cr-Pb-O; black, platy, resembles chalcophanite.

Other minerals reported in the Dundas district

Native elements: gold, graphite, lead, silver, sulphur.

Sulphides: argentite arsenopyrite, bismuthinite, boulangerite, chalcopyrite, cosalite, dufrenoyite, enargite, freibergite, glaucodot, galena, gudmundite, jamesonite, loellingite, marcasite, pyrite, pyrargyrite, proustite, sphalerite, stannite, stephanite, tetrahedrite and zinkenite.

Oxides: arsenolite, bismite, bismutostibiconite, cassiterite, cervantite, chromite-magnesiochromite, cuprite, ferrotantalite, hematite, hollandite, ilmenite, lepidocrocite, litharge, lithiophorite, magnetite, minium, senarmontite, stibiconite, todorokite-ranceite, valentinite.

Carbonates: ankerite, aragonite, azurite, calcite, dolomite, hydrocerussite, malachite, rhodochrosite, siderite, stichtite.

Silicates: actinolite, epidote, halloysite, hornblende, kaolinite, quartz, romanechite, serpentine, talc, wollastonite.

Others: atacamite, barite, beudantite, corkite, evansite, hinsdalite, langite, phoenicochroite, vauquelinite.

Trial Harbour nickel mine

The nickel ores of this area are similar to those of the Lord Brassey mine at Heazlewood. The mineralisation is hosted by a body of serpentinised Cambrian ultramafic rocks which have been metasomatised by the nearby Devonian Heemskirk Granite.

This deposit contains disseminated heazlewoodite, chromite, magnetite and awaruite in serpentine with minor millerite, bravoite, violarite, sphalerite, galena and shandite ($Ni_3Pb_2S_2$) for which this is the type location. Other minerals include zaraitite, reevesite, aragonite, talc, hydromagnesite and tremolite. Nickel mineralisation at the related Avebury deposits, a few kilometres to the east, is presently being evaluated for mining. The deposits comprise a number of small but Ni-rich bodies (more S-rich than Lord Brassey and Trial Harbour), containing pentlandite, pyrrhotite, chalcopyrite, magnetite, niccolite, pyrite and valleriite.

The Mt Lyell mines

This group of mines near Queenstown was at one stage collectively one of the world's largest copper producers, and production has been almost continuous for nearly 120 years. They are some of the oldest significant mines in Australia, and have produced about 1.4 Mt of copper, 43 t of gold and 733 t of silver from some 119 Mt of ore (to 1999). The field was found in 1883, at the Iron Blow (which was first worked as a gold mine), and has been responsible for a large proportion of Tasmania's gold production, as well as most of its copper.

The Mt Lyell mines are mineralogically most important as the co-type locality for the rare copper-iron-tin sulphide mawsonite, named after Sir Douglas Mawson, the Antarctic explorer and geologist (Markham and Lawrence, 1965). Many other rare minerals are also recorded from these mines, including betechtinite, florenceite, svanbergite-woodhousite, stannoidite, hessite, jalpaite, magnesiofoitite, zunyite and stromeyerite. At least 85 species have been reported from the mines, many in attractive specimens.

The mineralisation is mostly hosted by schistose, highly altered rhyolitic to andesitic lavas and tuffs of the Cambrian Mount Read Volcanics, with minor occurrences in Ordovician conglomerate and limestone, and appears to be controlled by the intersection of two major faults. Devonian lamprophyre bodies cut the ores, but appear unrelated to mineralisation (Baillie and Sutherland, 1992). The mineralised zone covers some 10 km² (fig. 6) and is up to about 800 m thick (Solomon *et al.*, 1987). There are five major styles of mineralisation:

- Massive pyrite-rich bodies, with colloform textures and high-grade copper, gold, arsenic and silver-rich shoots. These are postulated to have formed at or near the Cambrian seafloor, as volcanogenic massive lead-zinc deposits (Solomon *et al.*, 1987). High-grade ore shoots in the massive pyrite bodies were the original ores mined (after working of the gossan cap for gold), particularly in the Mt Lyell (Blow) and South Lyell mines. These shoots contained pyrite, chalcopyrite, tetrahedrite, tennantite, stromeyerite, arsenopyrite, molybdenite, enargite and 2–3 g/t gold (Markham, 1963). Gangue minerals include quartz, barite, hematite, muscovite and pyrophyllite.
- Banded, thin pyrite lenses with chalcopyrite, galena and sphalerite (volumetrically very minor). These are also postulated to be Cambrian volcanogenic massive sulphide deposits (Solomon *et al.*, 1987). The banded pyrite ores contain grades of up to 28% lead and 20% zinc.
- Disseminated, low to moderate-grade chalcopyrite and pyrite. This is also considered to be Cambrian in age, probably formed during early sub-seafloor alteration of the volcanic rocks and is highly deformed. It is the principal ore mined in recent

decades, particularly from the Prince Lyell mine, and contains pyrite, chalcopyrite, and minor tennantite, molybdenite, galena, sphalerite, bornite with traces of other sulphide minerals. Gangue minerals, in approximate order of abundance, include quartz, muscovite, chlorite, siderite, magnetite, hematite, rutile, pyrophyllite, apatite, barite, fluorite, calcite, ankerite, zircon and monazite.

- Higher grade bornite-rich ores along the Great Lyell Fault. These appear to have been remobilised during Devonian syn-deformational, fault-related hydrothermal events, and are common in western Tasmania, often associated with Devonian granites (Solomon *et al.*, 1987). The bornite-rich mineralisation is characteristic of the North Lyell area but is somewhat variable in nature. Ore minerals include bornite, chalcopyrite, pyrite, chalcocite, tennantite, galena, betekhtinite, mawsonite, digenite, sphalerite, molybdenite, linnaeite, stromeyerite and others. Gangue minerals are as above, but cherty quartz, barite, fluorite and hematite are typically more abundant.
- 'Copper-clay' deposits containing native copper, cuprite, chalcocite, digenite, bornite, covellite, chalcopyrite, galena, sphalerite and goethite in illite-kaolinite clays derived from deeply weathered argillaceous Ordovician limestone. The origin of these is unclear; they are possibly related to Devonian hydrothermal activity, or Ordovician to Recent weathering (Solomon *et al.*, 1987).

Summary of Mt Lyell mineralogy (from Bottrill, Olubas and Adams, in prep.)

Native Metals: copper, gold, silver (Au, Hg-).

Halides: fluorite.

Oxides: anatase, cuprite, delafossite, goethite, hematite, magnetite, rutile, tenorite.

Sulphides and sulphosalts: aikinite, arsenopyrite, berzelianite, betekhtinite, bornite, bournonite, calaverite, chalcocite, chalcopyrite, clausthalite, covellite, cubanite, digenite, djurleite, enargite, galena, geffroyite?, hessite, jalpaite, linnaeite, mawsonite, molybdenite, pentlandite, petzite, pyrite, pyrrotite, renierite, sphalerite, stannoidite, stromeyerite, tellurobismuthite, tennantite, tetrahedrite, wittichenite.

Phosphates: florenceite-(Ce), fluorapatite, gorceixite, monazite, svanbergite, vivianite, woodhousite.

Silicates: albite, chamosite, clinocllore, clinzoisite-epidote, illite, kaolinite, magnesiofoitite (an alkali-deficient tourmaline), muscovite, pyrophyllite, quartz, topaz, zircon, zunyite.

Sulphates: anhydrite, barite, boothite, chalcantite.

Carbonates: ankerite, calcite, dolomite, malachite, siderite.

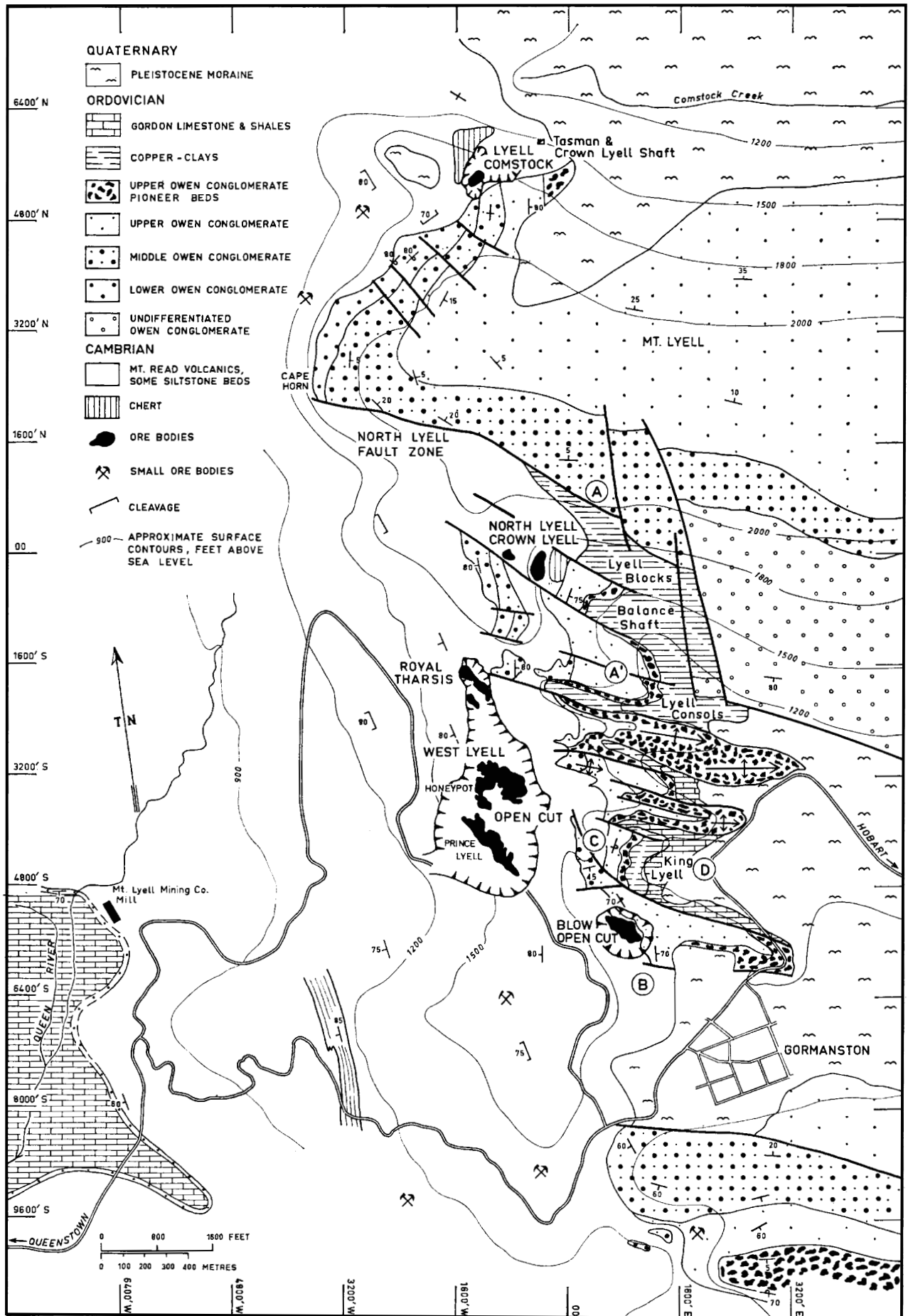


Figure 6

Mt Lyell mines (from Solomon, 1969).

The minerals of the Cygnet district

This section has been adapted from Sorrell and Bottrill (1998).

The Cygnet district has the distinction of being the site of some of the earliest mineralogical, geological and petrological investigations in Australia. Peron (1807) reported on some rocks thrown at him by natives (they probably just wanted a mineral identification!) during the sojourn with Nicolas Baudin in 1801, described by von Buch. The mineralogist A. W. Humphrey arrived in 1804 with some early settlers and scientists and also collected and described rocks from the area (Ford, 1983). Twelvetrees and Petterd (1899) conducted some of the earliest petrographic investigations in Australia on some rocks from Cygnet.

The geology at Cygnet is dominated by glaciogene Permo-Carboniferous mudstone and siltstone, intruded by Jurassic dolerite and numerous Cretaceous alkaline igneous intrusive rocks. The latter rocks, a variable group of quartz-poor porphyritic rocks usually described as sanidine, monzonite or syenite porphyries, comprise the Cygnet alkaline intrusive complex, and were formed in response to the rifting of Tasmania from Antarctica about 100 million years ago. They are the most interesting rocks in the area mineralogically, containing most of the ~80-90 species recorded from the area. They are dominated by sanidine and plagioclase, with minor pyroxenes, amphiboles, garnets and many other minerals. They are also associated with gold mineralisation at several areas, particularly the Mt Mary gold mine, the

Livingstone mine, the King Hill and Black Jack prospects (Taheri and Bottrill, 1999).

The following minerals have been reported (Sorrell and Bottrill, 1998).

Primary minerals of the porphyries: aegirine, aenigmatite?, albite, allanite, amphiboles (including pargasite, ferropargasite, edenite, hastingsite, reibeckite and magnesiohornblende), analcime, andesine, andradite, anorthoclase, augite, biotite, bytownite, cancrinite, corundum, diopside, fluorapatite, eudyalite, haüyne, hedenbergite, ilmenite, labradorite, magnetite, nepheline, nosean? oligoclase, orthoclase, pyrochlore?, quartz, sanidine, sodalite, spessartine, sphene, wöhlerite?

Secondary minerals of the porphyries: aragonite, barite, calcite, epidote, marialite, mordenite, natrolite, pectolite, scolecite, stellerite.

Minerals mostly of the contact rocks and xenoliths: andalusite, chlorites, graphite, muscovite, phlogopite, pigeonite, prehnite, pyrrhotite, rutile, tremolite-actinolite-ferroactinolite, wollastonite, zircon.

Minerals mostly of the mineralised zones: arsenopyrite, cerussite, chalcopyrite, cinnabar, covellite, galena, goethite, gold, gypsum, hematite, jarosite, marcasite, zincian montmorillonite-nontronite, opal, plumbogummite, pyrite, pyromorphite?, siderite, silver minerals (chlorargyrite?), sphalerite, sulphur.

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[15 September 2001]