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THE MINERAL DEPOSITS OF TASMANIA

Tasmania contains numerous mineral deposits, particularly in the western, north-western and north-eastern districts. The primary deposits of metallic minerals include those of gold, copper, tin, silver-lead, zinc-lead-silver, iron, osmiridium, tungsten, nickel etc, while those of non-metallic minerals include barite, asbestos, talc, etc. The sedimentary rocks contain deposits of coal, oil shale, limestone, dolomite, sandstones, clay etc. The secondary metallic mineral deposits include those of gold, tin, osmiridium, ilmenite, etc. The variety of deposits is illustrated by the following table of production since 1880 until 31st December, 1934.

Mineral or Metal	Value (£)	To 1934
Asbestos	7,105	7,105
Barytes	6,933	6,948
Bismuth	25,083	25,788
Cadmium	20,914	20,914
Carbide	730,180	959,757
Cement	1,294,888	1,578,983
Coal	2,386,298	2,553,408
Copper (Blister) to 1918 (now shown under silver and copper)	13,778,527	13,778,527
Copper Matte	133,736	133,736
Copper ore to 1918 (now under copper)	577,873	577,873
Copper (from 1919)	6,657,634	7,320,262
Gold	7,733,419	7,814,132
Iron ore	25,701	25,701
Iron Pyrites	94,319	107,847
Lead (from 1919)	1,535,274	1,582,984
Limestone	1,022,669	1,100,594
Nickel	33,298	35,246
Ochre	375	375
Osmiridium	598,251	607,716
Scheelite	112,468	112,468
Shale (oil)	20,780	23,893
Silver-lead to 1918 (now shown as Silver and Lead)	6,429,291	6,429,291
Silver (since 1919)	1,245,628	1,312,566
Talc	269	307
Tin	16,332,184	16,741,471
Wolfram	254,745	289,921
Zinc	973,201	973,201
Unenumerated	31,988	31,988
	62,063,031	64,153,758

Metallic Minerals

The metallic mineral deposits are present in the north-eastern, north-western, and western districts. The north-eastern district contains deposits of gold, tin and tungsten. The north-western district contains those of tin, silver-lead, tungsten, copper, iron, gold, and osmiridium. The western district contains those of copper, silver-lead, zinc-lead-silver, iron, nickel and osmiridium. Osmiridium occurs in the south central, and small deposits of tin in the south-western district. The geographical distribution of each metal or mineral will be described separately under its own heading.

Distribution throughout the Rock Systems etc.

Primary Deposits

The primary metallic (and certain non-metallic) mineral deposits are distributed throughout the various rock systems as follows:

Proterozoic. The Proterozoic rocks contain no important mineral deposits, but only a few small and not very important ones. This is due probably to non-development of large intrusions of granite or porphyry in these rocks. Near Cox Bight, and Ray River small veins of tin ore are present, while near Port Davey small veins of stibnite occur. Near Mt. Remus, pyritic and other veins carry molybdenite, and cobalt (in the pyrite), while in the Pelion district lodes containing ores of tin, tungsten and copper occur. Basic igneous rocks at Quamby Bluff contain copper ores.

Cambro-Ordovician. The Pre-Dundas or Rosebery series is not extensively developed on the West Coast but possibly the Farrell slates belong to this series and contain the North Mount Farrell silver-lead ore-body. The Balfour series may also be the equivalent and this series contains the copper lodes and some of the tin lodes of the Balfour district.

The Dundas series contains some of the silver-lead lodes at Zeehan and Dundas, tin and silver-lead lodes of North Dundas, tin lodes at Renison Bell and Mt. Lindsay, copper lodes at Colebrook Hill, some of the unimportant silver-lead lodes of the Waratah district, and the unimportant copper and silver-lead lodes of the Leven River district.

The Mathinna series of the north-eastern districts contains the auriferous quartz reefs, the tin-tungsten lodes of the Storey's Creek district and the copper, tin, and tungsten lodes of the Scamander district.

Silurian. The rocks of this system contain some of the silver-lead lodes of Zeehan, barite lode on Howard's Plain, possibly a small part of the Mt. Lyell Copper deposits, some of the tin lodes of Mt. Bischoff, unimportant galena lodes of the Waratah district, the silver-lead, the tin and tungsten lodes of the Moina district, and the iron deposits of the Dial Range and Blythe River districts.

Devonian Igneous Rocks. The granite of the north-eastern and western districts in almost every case contains numerous tin deposits.

The porphyries at Mt. Bischoff contain some of the tin deposits, while the sheared porphyries of the West Coast mineral belt contain the copper deposits of Mt. Lyell and Jukes Darwin and the zinc-lead-silver deposits of Mt. Read, Rosebery etc.

The basic and ultrabasic rocks contain the osmiridium lodes of Bald Hill, Mt. Stewart and Adamsfield, the copper-nickel lodes of the Five-Mile (Zeehan), the nickel deposits of Trial Harbour etc., the iron deposits of Zeehan, Long Plains and Anderson's Creek, and the silver-lead deposits of Magnet etc. in the Waratah district.

Permo-Carboniferous. The only deposits in these rocks are the unimportant gold ones in the Cygnet district.

Detrital Deposits.

The detrital deposits are restricted to the younger rocks especially the Tertiary and Recent ones.

Permo-Carboniferous. In a few places in the North-Eastern districts e.g. Roy's Hill, the basal conglomerates contain detrital tin ore derived from lode formations in the underlying granite.

Tertiary. The Tertiary fresh water sediments in mineral districts often contain minerals such as gold, tin ore, and osmiridium. In many cases they are overlain by Pliocene basalt and form sub-basaltic systems of deep leads. The most important system is that of the Ringarooma Valley which contains the important tin deposits worked in the Arba, Briseis, Echo, Pioneer and other mines. The leads of the George, and Mussel Roe Rivers and the St. Dizier lead are also tinbearing. The deep leads at Lefroy and Back Creek contain gold, while those at Bald Hill contain osmiridium.

Recent. The numerous alluvial deposits along the present streams of tin contain valuable metals and minerals. Those of the north-eastern districts, and of Heemskirk, Stanley River, Waratah River, Cox Bight etc., have been worked for their tin ore. At Lisle, Mangana, Mathinna, Alberton, Lefroy, Corinna, and Queenstown districts they have been worked for gold. Practically the whole of the osmiridium won has been obtained from the Recent deposits at Bald Hill, Nineteen-Mile Creek, Savage River, Wilson River, and Adamsfield districts.

Metallogenetic Periods

It will be realised from the above descriptions that the primary metallic (and certain non-metallic) mineral deposits are almost entirely restricted to Lower Palaeozoic sedimentary rocks and Devonian igneous rocks. This means, in other words, that the Devonian intrusions of igneous rocks represent the most important metallogenetic periods. Other periods occur and will be referred to below but are relatively unimportant.

Proterozoic. The only ores definitely referrable to this period are some copper ones in the Quamby Brook district which A.M. Reid found to be associated with a certain band of basic igneous rocks of Proterozoic age.

Cambro-Ordovician (Porphyroid). Certain ore-bodies such as the iron ores of Jukes-Darwin, some of the copper ores of the same region, the iron ores of Long Plains, the barite deposits and other unimportant ones were formerly referred to this period, but are now regarded as belonging to the Deveonian period as the igneous rocks with which they were associated are referrable to the Devonian intrusions.

Devonian. This is the most important metallogenetic period in the State and resulted in the formation of the important primary mineral deposits. Several phases are recognised.

Basic. The serpentinised periodites of the Bald Hill, Mt. Stewart, Wilson River, and Adamsfield districts have been the source of the osmiridium which rendered the detrital deposits of such importance. Similar rocks contain the nickel deposits at Trial Harbour, Heazlewood etc., and the more important ones at Five-Mile District, Zeehan. The magnetite of Long Plains and possibly that of Zeehan are also associated with the basic rocks.

Acidic. The whole of the tin deposits are associated with the granitic rocks and the porphyries connected herewith. The auriferous quartz reefs of the north-eastern regions are also associated with the granitic rocks and occur in the adjacent intruded sedimentary rocks.

The copper, silver-lead, zinc-lead-silver, barite, and gold deposits of the western and north-western regions appear to be associated with the porphyry off-shoots from the granitic intrusions.

Tertiary. This is an unimportant period and has given rise to only one set of deposits, viz. the gold deposits of the Cygnet district. Gold occurs at and near the contact of alkali porphyry with Permo-Carboniferous mudstones etc.

GOLD

Gold was the first metallic mineral found in Tasmania in payable quantities, the first discovery being at the Nook near Fingal in 1852, and the first quartz mine started in the same district. Since then a number of fields have been discovered chiefly in the north-eastern districts.

The total production of gold to date has been 1,925,647 ozs. with a value of £7,733,419. This has been obtained from quartz reefs, copper ores, alluvial deposits, etc.

The primary deposits, are with one exception, all of the same age and occur in Lower Palaeozoic, rocks intruded by Devonian granites and porphyries. In the north-eastern districts, the quartz reefs occur in Cambro-Ordovician slates and quartzites intruded by granite. The main belt is that through Mangana, Mathinna, Mt. Victoria, Alberton, Warrantinna, Forester and Waterhouse. This belt occupies a trough between two cupolas of the granite batholith. The fields of Lisle, Lefroy and Beaconsfield occur outside this belt, but may occupy analogous positions with regard to the western side of the batholith.

In the north-western and western districts quartz reefs are not numerous, but those that do exist and also small alluvial districts, occur near Devonian porphyries which are intrusive into Lower Palaeozoic rocks and particularly those belonging to the Silurian system.

The deposits of the north-eastern districts are the normal quartz-reefs. In addition to the gold they carry small quantities of sulphides, such as arsonopyrite, pyrite, galena, sphalerite, stibnite etc. In the Alberton and other fields in the far north-east, arsenopyrite is the predominant sulphide and in conjunction with the proximity to granite, indicates a higher temperature of formation. At Mathinna pyrite was the predominant sulphide while galena was more closely associated with the gold than the other sulphides. At Lefroy pyrite and stibnite were the most plentiful sulphides.

The Mathinna field is occupied by slates and quartzites with strikes of 20° to 30° west of north. In general the reefs show no relationships to the rock structures, but the most important reefs occur in a narrow zone of close folding. The Golden Gate was the most important mine and produced 246,000 ounces of gold from 290,000 tons of ore. This mine was remarkable in that only one reef (Western) really outcropped. Loane and Main reefs were discovered at shallow depths and worked to a depth of 800 feet. Two other reefs (East and West) were worked from 800 to 1800 feet. A "slide" bearing 30° W. of N. exists in the south end of the mine and the reefs appear to terminate at it, but it is probable that the slide is prior in age to the reefs and that it acted as a channel for the solutions which formed the reefs.

The Alberton or North Mount Victoria field contains more than 100 reefs (not all of commercial importance in a belt 4¾ miles long and 1½ miles wide and trending in a N.N.W. direction. The reef-bearing belt comprises a closely folded (and faulted) zone in slates and quartzites which otherwise represent a westerly-dipping series. The reefs have strikes which divide them into two groups striking at 30° and 330°, the former representing fault fissures and the latter fissures coincident with the bedding in strike but not always in dip. The Strike of 30° (and a dip to the south-east) is the most common and is the prevailing one in the northern half of the field. In the southern half three zones are recognisable - the eastern with strikes of 330° and north easterly dip, a central one with strikes of 30° and south-easterly dips and an unimportant western one with strikes of 330°. About £100,000 has been the value of the production, the most important mines being the Ringarooma and Mount Victoria.

The Lefroy gold-field is occupied by Cambro-Ordovician slates and sandstones, which show signs of alteration chiefly by the development of mica in the latter. These rocks have a strike between 320° and 340° and dip to the west at angles from 30° to 50°; folding being absent. The rocks at Back Creek, six miles to the north-east of Lefroy dip to the east, showing that folding exists in adjacent regions. Faulting is the dominant structural feature of the district, and the auriferous reefs have been injected along a parallel series of faults which have bearings of approximately 80°. Subsequent movements along some of the fault planes have broken the reefs into a rubbly mass of quartz and mullock, and finally into a soft pug. All the reefs in this field owe their value to surface enrichment, and below the 400 ft. level all the mines have become unpayable. The New Pinafore Company sank their shaft to 1200 ft. and did very extensive cross-cutting and driving at this and other levels, but they were on unpayable ore practically all the time below the 400 ft. level.

The Beaconsfield field is occupied by slates, sandstones, grits, conglomerates, limestones etc. forming a conformable series with a strike of 335° and dip of 45° to the north-east. Several small folds occur at the north-western end of Cabbage Tree Hill. Faulting is common but is earlier than the mineralisation. The principal reef worked was the Tasmania reef from which 854,600 ounces of gold were obtained from 1,022,692 tons of quartz. The Tasmania reef has a general strike from N.E. to S.W. but has a distinct curve at its western end, the strike finally approaching a north-westerly one. The reef dips to the south-east and had a maximum length of 1500 feet. At the Eastern end, the reef has a natural ending and breaks up into a series of veins in a clay bed adjacent to limestone. At the west end, two faults occur and there has been differences of opinion as to whether these were pre-reef in age or post-reef (and displaced the reef). The reef was however picked up west of the main fault and possibly west of the other one. The reef was worked to a depth of 1500 feet, but the shoot became shorter and of lower value in depth.

The Mount Lyell mine was originally worked as a gold mine, the hematite adjacent to the pyritic body carrying good gold values. Since copper smelting started, the mine has been a consistent producer of gold and a total of 406,545 ounces (fine) has been obtained.

Detrital deposits are restricted to Tertiary to Recent river gravels &c. Sub-basaltic deep leads exist at Lefroy and Back Creek, but have not been proved payable. Small quantities of alluvial gold were won in all the goldfields of north-eastern and western districts, but the most important alluvial field was that of Lisle from which at least 250,000 ounces were obtained.

SILVER.

Deposits composed chiefly of silver minerals do not occur, but small quantities are contained in the copper, silver-lead, and zinc-lead-silver ores, but the treatment of which has yielded considerable quantities of silver. The total production is estimated at 55,500,000 ounces. The Mt. Lyell Co. has produced 14,470,902 ounces (fine) from its copper ores, and the remainder (41,000,000 ounces) has been derived from the lead and zinc-lead deposits of Zeehan, Dundas, Magnet, North Mt. Farrell, Rosebery, Mt. Read &c. These ore-bodies will be described under their respective headings.

Copper

Copper deposits are restricted almost entirely to the western and north-western districts. The most important, field is that at Mt. Lyell, while others occur at Jukes Darwin, Heazlewood, Balfour and Scamander. The copper-nickel deposits at the Five-Mile district, Zeehan are discussed under "Nickel".

The Mount Lyell district is occupied by three important rock systems and formations, viz:

Silurian sedimentary rocks
Queen River Syenites or Porphyries
Mt. Lyell schists.

The Silurian rocks include the West Coast Range Conglomerate series and the Queen River series. The former series is at least 2000 feet thick and consists of conglomerates, quartzites and shales. Conglomerate predominate in the lower portion and quartzite (with shales) in the upper portion. The Queen River series consists of limestones, sandstones and shales, the sandstones being fossiliferous and often of a friable nature. The Conglomerate series is the basal one and is overlain by the Queen River series.

The Queen River porphyries occur in a belt along the east side of the Queen River, the belt having a width of 1 to 2 miles and a general north and south trend. The rocks include numerous types of intermediate and acid porphyries such as quartz porphyry etc. Gregory regarded these rocks as older than the Silurian, but it is not clear as to whether he regarded them as intrusive or extrusive. Loftus Hills regarded them as pre-Silurian lava flows. In recent years the Geological Survey have examined these rocks at many localities along the West and North-west coastal districts and have found them to be intrusive into all rocks up to and including the Silurian. They are therefore now regarded as intrusive porphyritic rocks of Devonian age.

The Mount Lyell schists represent a belt of schistose rocks occurring in the vicinity of the ore-bodies, and occupying a position between the Queen River porphyries on the west and the Silurian rocks on the east. They were regarded by Gregory as altered porphyrites and tuffs of Pre-Silurian age. Loftus Hills considered them to be metamorphosed tuffs of Pre-Silurian age. The Geological Survey are not regarding them (in conformity with similar schists at Rosebery etc.) as sheared porphyries of Devonian age, i.e. sheared representatives of the Queen River porphyries.

The structure of the district is rather complicated. Gregory considered the boundary of the schists on the west and the conglomerates on the east to be a faulted junction with a general north-south trend. He also mapped numerous east-west faults branching off the main one and extending into the conglomerates on the east side. Hills' conceptions of the structure were similar to the above, but he showed more cross faults and emphasised the folding, overthrusting and faulting. If the more recently-adopted views with regard to the porphyries are correct, the main schist-conglomerate contact will be partly if not wholly an intrusive one.

The ore-bodies are associated with the eastern side of the schists and occur at or near the schist-conglomerate contact. Hills considered the location of individual ore-bodies to be due to the presence of the cross faults or thrust planes, the North Lyell and Blow thrust planes having been responsible for the North Lyell and Mt. Lyell ore bodies respectively. There are two main types of deposits, viz:

(a) Lenticular bodies of pyrite.

(b) Mineralised bands of schists etc.

The pyritic bodies include the Mount Lyell and South Lyell deposits. The Mt. Lyell body was elliptical being 800 feet long and 200 feet wide at the outcrop, and tapered gradually downward to a rounded base, and probable depth being 730 feet. The South Lyell body probably represents the parallel body to theMt. Lyell body. The pyritic bodies are very pure, consisting essentially of pyrite with some chalcopyrite galena and less sphalerite, while the gangue (chiefly quartz and barite) is present in only small amounts. At first ore containing 2.35% copper was mined, but the grade decreased and the average content became 0.5% copper with 1.5 ozs. silver and 0.04 ozs. of gold per ton.

The outcrop of the Mt. Lyell body was represented by hematite, rich in gold and the mine was originally operated as a gold mine until the hematite was depleted.

The mineralised bands of schist etc. include the ore-bodies of the North Lyell (and adjacent Crown Lyell Blocks, Royal Tharsis) mine and the Lyell Comstock mine. They form large ore-bodies of considerable length and vertical extent but irregular in shape and with a considerable range in width. The North Lyell body has been mined to a depth of 1,300 feet from the surface, while the Tharsis has been proved to a depth of 1,000 feet. The ore consists of schists, or quartzite etc. with bornite, chalcopyrite, pyrite etc.

All the above ore-bodies are owned by the Mt. Lyell Mining and Railway Company and the following figures for the reserves were supplied by the General Manager (Mr. R.M. Murray) :

	Tons	Copper Content
North Mt. Lyell Mine	700,000	4.75%
Lyell Comstock Mine	700,000	3.00%
Crown Lyell Mine	500,000	2.00%
Royal Tharsis Mine	2,500,000	2.25%
Prince Lyell Mine	5,000,000	1.00%

Since its inception until the 31st December, 1932, the Mt. Lyell Company has produced from 9,493,399 tons of ore, 258,079 tons of copper, 14,470,902 ounces (fine) of silver and 406,545 ounces (fine) of gold and paid £5,251,569 in dividends.

The present scale of operations is illustrated by the figures for 1932 during which year 380,800 tons were mined. Of this 13,622 tons of North Lyell ore were sent direct to the smelter, and the remainder was concentrated to yield 45,535 tons of concentrates. Including a small amount of purchased ore, 59,168 tons of copper-bearing material were smelted for a production of 11,101 tons of blister copper containing 10,995 tons of copper, 161,633 ozs. of silver and 4,865 ozs. of gold with an approximate value of £441,222.

The Jukes Darwin Field is situated to the south of Mt. Lyell field and possesses the same geological features. The ore-bodies are similar and occur under similar geological conditions and structural relations. The field has not been exploited owing to transport difficulties and absence of high grade deposits.

The Mt. Balfour field is occupied by Cambro-Ordovician sedimentary rocks intruded by Devonian (?) granite and amphibolites. The copper lodes are enclosed in the sedimentary rocks and the amphibolites. The metallic minerals are chalcopyrite and pyrite in a gangue of quartz, chlorite, sericite and dolomite.

Very little production has taken place.

The Heazlewood field is occupied by intermediate basic and ultrabasic igneous rocks intruded in Cambro-Ordovician and Silurian sedimentary rocks. The copper deposits consist of bornite and chalcopyrite in the ultrabasic rocks probably as segregations. The deposits are small and the production has been very limited.

The Scamander field is occupied by Cambro-Ordovician slates and quartzites intruded by granite. The rocks strike N.W.-S.E. and the lodes agree them in strike. The primary ore consists of quartz, chalcopyritic and arsenopyrite. The lodes appear to be low-grade and have only been worked where secondary enrichment occurs at and near water-level.

The statistics of the Mines Department show the total production from Tasmania as follows (up till December, 1931) :-

Copper and Silver in blister copper to 1918	£13,778,527
Copper ore to 1918	577,873
Copper matte	133,736
Copper (from 1919)	6,257,872
	£20,748,008

Silver-lead and Zinc

Silver-lead and zinc-lead-silver deposits are restricted to western and north-western districts, the most important fields being those of Zeehan, Dundas, Read-Rosebery, Tullah, Magnet and Moina.

The ores are of two types, viz. the silver-lead ores of Zeehan, Tullah and Magnet, and the zinc-lead-silver of Read-Rosebery. The silver lead ores consist generally of coarse-grained galena and sphalerite (usually high in iron and of the marmatite variety), the most common and characteristic gangue being manganiferous siderite. The Round Hill ore was somewhat different in that sphalerite was not present to any great extent, but chalcopyrite was plentiful.

The zinc-lead-silver ores of Read-Rosebery are fine-grained mixtures of sphalerite, galena and pyrite and are important on account of their zinc content whereas the others were worked for their galena content, the sphalerite being discarded.

The Zeehan Field is occupied by rocks of two sedimentary systems (pre-Silurian and Silurian) and numerous types of igneous rocks. The pre-Silurian system consists of slates, quartzites, breccias with spilite lavas and tuffs and keratophyre tuffs and though not identical with the rocks of the Dundas series, they are sufficiently similar to be correlated with that series. The Silurian system comprises conglomerates, quartzites, slates, sandstones and limestones with Silurian fossils, and includes the West Coast Range Conglomerate series and the Queen River (or Zeehan) slate and sandstone series.

The igneous rocks include dykes of granite porphyry, aplite and mica gabbro, while to the west serpentine, gabbro-amphibolite and granite occur. These rocks all belong to the Devonian intrusions. The two sedimentary systems occupy their present positions by virtue of faulting.

In the northern part of the field, there appears to be one main fault with a trend from N.N.W. to S.S.E. which separates the Dundas series on the west from the Silurian to the east, the latter being on the down-thrown side.

The greater number of the reefs have strikes parallel to the main fault and the earth-movements apparently caused the formation of the fractures or fissures along which the lodes formed. There is an earlier set of fractures and fault zones which cross the lode fissures.

The vein types are numerous and include pyrite-cassiterite, magnetite, magnetite-pyrite-chalcopyrite-sphalerite-galena, the pyrite-blende-galena, pyrite-galena, siderite-galena, pyrite-stannite-chalcopyrite, and pyrite-stannite-galena. The siderite-galena type has been the most important type from the economic aspect. The siderite is manganiferous, and the galena argentiferous, while tetrahedrite and bournonite also contribute to the silver value of the ore. The proportion of silver was usually one ounce per unit or less.

Numerous mines were worked in the past, the most important being the Western, Montanna, Spray, Queen etc. The total production of the field was approximately £5,000,000. Most of the lodes were worked to shallow depths only, but the important ones were payable to 600 feet and though tested to 1000 feet were found unprofitable.

The Magnet ore-body occurs near the footwall of a composite dyke of basic and ultrabasic rocks. The dyke was intruded along the northern side of a block of Silurian slates and sandstones faulted down into Dundas slates and breccias. The bounding faults intersect at Magnet and form the western end of the faulted block which extends easterly as far as Waratah. At the intersection of the faults the dyke extends to the west along the line of the southern bounding fault. The dyke was later than the faulting and is Devonian in age. The dyke is 5 miles in length with a width of 5 to 10 chains and generally appears to be a medium to coarse dolerite (much weathered and altered). In the vicinity of the Magnet mine the dyke is 20 chains wide and dips to the north-west. The south-eastern or footwall side consists of 360 feet of ultrabasic rock described by Rosenbusch as Websterite porphyrite. The central part is occupied by 300 to 400 feet of basic rock described by Rosenbusch as diabase porphyrite with which is associated some variolite. The western part is composed of spheroidal websterite or bronzitite.

The ore-body occurs in the hanging wall part of the websterite porphyrite adjacent to the diabase porphyrite. The junction between these rocks is represented by the dolomite hanging wall of the ore-body, this wall having a strike of 25° and dip of 55° to the north-west. The wall is polished and slickensided indicating movement along it. The dimensions and form of the ore-body have altered as depth was attained. At the surface and down some distance the ore-body had a strike of 20° to 30° and occurred under the dolomite hanging wall. At depth a branch made off to the south on the eastern side of, and approximately midway along, the ore-body. The southern part of the main portion diminished in length and importance as did also the northern part but at a less rate, while the branch (with a strike of N. & S.) became more important, while a large body of ore came in between the branch and the southern portion. The latter body in the apex became the most important at depth. Another change was also found at depth when a narrow lode was revealed some 10 feet west of the dolomite hanginining wall. The country between the new lode and the main one was composed of dolomite and dolomitised diabase porphyrite, but at No. 16 level the country between the two lodes was occupied by ore over a considerable distance.

The ore consist of coarse-grained galena, sphalerite (marmatite) and pyrite with the gangue minerals - mangano-siderite or manganiferous siderite and ankerite, and partly replaced country rock. The ankerite is sometimes stained green apparently by a chromiferous mineral. The first four minerals belong to one period of mineralisation but the ankerite is distinctly later and replaces all other minerals. The ore on the footwall is banded but the remainder has no banding and the deposit appears to have been formed by replacement.

The ore-body has been worked to a depth of approximately 1200 feet below the outcrop by the Magnet Company. The mine has yielded ore containing approximately 35,000 tons of lead and 7,000,000 ozs. of silver.

<u>The Tullah or Mt. Farrell field</u> is occupied by Silurian sedimentary rocks and Devonian igneous rocks. The Silurian rocks include most of the members of the system from the West Coast Range conglomerates of Mt. Farrell to the slates, sandstones and limestones of the Queen River and Zeehan series. The slates etc. of the mineralised belts have been referred to as the Farrell slates and possibly of Cambro-Ordovician age but it is by no means impossible that they are members of the Silurian system and will be regarded as such. The igneous rocks are those typical of the West Coast mineral fields from Mt. Lyell through Mt. Read and Rosebery to Tullah. They have been described as being chiefly volcanic rocks with small bodies of intrusive rocks, but are now regarded as being wholly intrusive. They include quartz porphyry and felspar porphyry, syenite, granite porphyry etc. while granite occurs at Granite Tor to the east. In places the igneous are schistose and have probably been rendered so by shearing.

The ore-bodies occur in a zone with a general north and south strike. They are not confined to any one rock but exist in the porphyries and also the slates near porphyry contacts. They are generally of the fissure lode type, but unimportant disseminated deposits also occur. The economically important lodes are those of silver-lead and both carbonate-lead and pyritic-lead types are present.

The North Mount Farrell has been the most successful mine. The lode has a strike of 9° and dips westerly at 60° to 70°. It is contained in slates, a short distance east of their contact with porphyry. The ore consists essentially of galena, sphalerite and siderite, with smaller amounts of chalcopyrite, pyrite and carbonate minerals other than siderite. The mine was worked to a depth of 900 feet from the surface, but work at that depth ceased during 1932. The North Mount Farrell Company produced ore containing over 40,000 tons of lead and 4,000,000 ounces of silver.

The Round Hill Field is occupied by Silurian conglomerates, quartzites, sandstones, limestones etc. and Palaeozoic igneous rocks. The latter have been described as Cambro-Ordovician felsites, Keratophyres etc., but are now regarded as porphyries and sheared porphyries of Devonian age. Several parallel lodes occur in a belt of folded tubicolar quartzite 800 feet wide, and are associated with the crests of anticlinal folds, the strike being W.N.W. The ore consists of galena with abundant chalcopyrite, and some pyrite, sphalerite and siderite, while bismuthinite, pinite and quartz are also present.

The Read-Rosebery Field is occupied by Lower Palaeozoic sedimentary rocks and Devonian intrusive igneous rocks. The former include those of a Pre-Dundas or Rosebery series, the Dundas series and the Silurian system. The Rosebery series occupies the central portion of the field and has a general north and south trend, the rocks being dark slates and quartzite. The Dundas series forms a parallel belt of westerly dipping rocks overlying the Rosebery series, the rocks being the typical grey, green and red slates and breccias. The Silurian rocks (conglomerates) occupy the mountains to the east of the field.

The igneous rocks include ultrabasic (serpentine) basic (gabbro) and acid types. The latter are the most extensive and important rocks and occupy the eastern half of the field. They include quartz porphyries and felspar porphyries, and certain zones of which have been rendered schistose by shearing and referred to as the Read-Rosebery schists. These rocks were formerly regarded as acid lava flows (keratophyres etc.) interbedded with Lower Palaeozoic sedimentary rocks, but on evidence in this field and numerous other localities in Tasmania, they are now regarded as intrusive porphyries of Devonian age.

The zone of sheared porphyries occurs along the western margin of the main porphyry intrusions and the most important lodes occur in this zone. The planes of schistosity strike 340°. Isolated blocks of sedimentary rocks (possibly roof pendants) occur in the porphyries and the shearing forces apparently reached their maximum in the vicinity of such blocks. The lodes occur at intervals over a length of 6 miles, the most important being the Rosebery lode at the north end and the Hercules and Mt. Read groups at the South end. The Rosebery lode is a tabular one 4,000 feet in length containing 5 more or less distinct lenses of payable ore. It occurs at the eastern boundary of the schistose porphyry and adjacent to an included block of slates etc. the latter determining in a general way the length of the lode. The lode, schistosity and slates all dip to the east. The Hercules group include up to 8 lodes, some of which are irregular outline. Schistose porphyries and slates are also in evidence here but the structure has not been worked out in detail.

The ore is a fine grained one of massive sulphides composed chiefly of sphalerite, pyrite and galena, with a small amount of carbonates and quartz as gangue

The Rosebery ore contains 35% of sphalerite, 31% of pyrite and 7.3% of galena with 24% of gangue, the assay being Zn 21.3%, Pb 6.4%, Cu 0.5%, Ag 8.5 oz. per ton and Au 2.12 dwts. per ton. The Rosebery lode may have been formed by replacement of the sheared porphyries or as simple fissure veins while the Hercules ores appear to be replacement deposits.

The Electrolytic Zinc Company of Australasia lease all the important deposits. The mines are opened up, a modern treatment plant has been erected at Rosebery, but the deposits are not being worked at present on account of the low prices for metals.

Tin.

Tin ore is one of the most important mineral products of the State, the present annual production being 800 tons (metallic) with a value of £110,000 while the total recorded production has been 139,381 tons (oxide and metallic) with a value of £16,332,184. It occurs in the north-eastern, north-western, western and south-western districts. In the north-eastern districts both primary and detrital deposits occur, the greater production being from the detrital deposits. In the north-western and western districts, both types occur, but the production has been chiefly from the primary deposits. Cassiterite is the common tin mineral produced, but from the Oonah mine, Zeehan, small quantities of stannite were won in the past.

Primary. - The North-Eastern district includes many fields and an extraordinary number of types of deposits. One of the principal groups of fields is that extending from Branxholm on the west to Blue Tier on the east. This group occupies the summit of a range with a general trend from W.N.W to E.S.E and has supplied the greater part of the tin ore to the Ringarooma deep leads and to deposits in other streams. The deposits occur in Devonian granite which has intruded Cambro-Ordovician slates and quartzites. In the western portion, in particular, numerous remnants of the slates etc. which formed the roof of this part of the granite, batholith, occur. The tin deposits extend right up to the slates and as a general rule, do not penetrate the latter, although in a few cases veins of nearly pure cassiterite of dark colour extend upwards into the slates. The above conditions viz. the top of the granitic intrusion, are the most favourable to occurrence of tin deposits especially if the granite rises as a cupola above the top of the batholith. Other favourable conditions are around the sides of the cupolas. The deposits include veins of quartz greisen, quartz-mica greisen, and mica greisen, and irregular deposits of altered porphyritic granite (apparently ramified with extremely narrow veins of cassiterite), altered aplitic rocks and "tin granites". The greisen veins were formed by pneumatolyic or hydrothermal actions along fissures in the granite. The altered granites clearly received their context of tin ore and were subjected to the alteration (kaolinisation of the felspars, etc.) by pneumatolyic action on the already crystalised granite. The origin of the altered aplites and the "tin granites" has been considered to be due to either alteration of the granite, or to separate intrusions following the normal granite. The latter is probably the correct explanation, the intrusions however being accompanied by pneumatolyic action along their sides and summits. The "tin granites" differ little, if any, from the altered aplites and consist essentially of fine to medium grained, non-porphyritic granitic rocks composed essentially of quartz, white felspar (more or less altered) and mica (either muscovite or what appears to be a bleached biotite). Pinite (used in Dana's sense of a massive mineral with the composition of muscovite) almost invariably accompanies the aplites and tin granites and is particularly abundant where the rocks are richer in cassiterite. The tin granites and the ore shoots in them contain other minerals in small quantities such as fluorspar, tourmaline, topaz, molybdenite etc. The tin granites are the most plentiful in the Blue Tier district in the vicinity of Lotta and Poimena. Numerous mines were worked in them, the Anchor mine at Lottah having been the largest.

The Ben Lomond district is occupied by Cambro-Ordovician slates and quartzites intruded by Devonian granite. Permo-Carboniferous sedimentary rocks overlie the above and have been intruded by Mesozoic dolerite. The tin ore deposits occur in the Cambro-Ordovician rocks and the granite and were formed as a result of the granitic intrusions. The deposits consist chiefly of quartz veins and greisen veins, the "tin granite" type being absent but the tin-bearing graphic granites, pegmatites and porphyries are present. The quartz veins consist of ordinary reef quartz and occur in the granite (but to a less extent) as well as in the slates and quartz mica varieties, while quartz-tourmaline veins and pipe-like bodies also occur.

The Gipps Creek field includes quartz veins and quartz-mica greisen veins in granite, the general strike being 340 to 350 and dips easterly. Both cassiterite and wolfram occur, cassiterite predominating in the northern, and wolfram in the southern part of the field.

The Story Creek field consists of slates and sandstones, the chief mineral deposits being quartz veins containing cassiterite and wolfram. The Story Creek mine has opened up two veins, striking 350 and 335 respectively and dipping westerly at 20 and 37 respectively. The veins were over 130 feet apart at the surface, but met at a depth of 480 feet on the dip. At this depth they diverged along their strike, but it appears that they are continuing in depth as one vein. The mineral present are cassiterite, wolfram, pyrite and martite in coarse and separate aggregates usually near the walls. The ore contains 0.75 to 1.75% tin oxide, and 0.75 to 2.0% wolfram and slightly over £300,000 worth of these minerals has been produced.

The Aberfoyle mine has opened up a series of narrow quartz veins striking 10 in slates and quartzites striking 315 and dipping south-westerly. A fault striking at 350 crosses the vein system at an acute angle. The downthrow is to the west) and the throw is at least 50 feet and may be considerably greater. This fault has lowered the Permo-Carboniferous basal beds which unformably overlie the Cambro-Ordovician rocks, and the fault at the surface is marked by the contact of the two rock systems. Up to 50 feet of the Permo-Carboniferous rocks overlie part of the vein system, thus concealing the outcrop of many of the veins. The veins range in width up to three feet and have lengths of several hundred feet. The veins consist of white reef quartz and contain veinlets and blebs of cassiterite, wolfram, pyrite, sphalerite etc. with pinite (finely crystalline to massive muscovite) and some fluorspar. The cassiterite is generally associated with the pinite and both occur along the walls of the veins.

The Gipps Creek field includes veins of greisen (with cassiterite and wolfram) in the granite and what is unusual in this part of the State, veins of reef quartz in the same rock. The Rex Hill ore body is associated with graphic granite and a portion of it consists of a mixture of cassiterite, chalcopyrite, spalerite, galera, quartz etc.

The St.Paul River field contains veins and bodies of quartz greisen, quartz-mica greisen and quartz tourmaline in the granite. The Royal George mine was the most successful and opened up a quartz-greisen ore body and produced at least 900 tons of tin ore.

The tin fields in north-western districts include those of Moina, Housetop and Waratah, the Housetop field being relatively unimportant. The Moina field is occupied by rocks of the Silurian system (including nearly all series) overlying the so-called Porphyroid series of pyroclastics, extrusive and esdrusive igneous rocks, and intruded by Devonian granites, porphyries, etc. The ore-bodies are of two types - firstly, pegmatite and greisen veins in the granite, and secondly, quartz veins in the metamorphosed sedimentary rocks and to a less extent in the granite. The most important mine was the S. & M. at Moina.

The country rocks are quartzites and garnet rocks, representing metamorphosed sandstones and limestones. The garnet rock consists of garnet (andradite and grossularite) with epidote, pyroxene magnetite, vesuvianite, fluorite etc. The rocks strike north and south and dip westerly at 30° to 45°. Seven parallel lodes exist with general east-west strikes, and consist of quartz fillings of fissures traversing at right angles the beds of quartzite and garnet rock. The lodes are remarkably straight and have lengths up to 1200 feet. They are more uniform and contain the best values in the garnet rock. The mineral components of economic value are cassiterite, wolfram, bismutite and bismuthinite in the proportion of cassiterite, 20; wolfram, 12; and bismuthinite, 3; concentrates of the three being obtained and marketed.

The Mount Bischoff or Waratah field is occupied by Silurian sandstones and slates faulted down into Dundas slates and breccias, both systems being intruded by Devonian granite and porphyries. The ore-bodies of Mt.Bischoff are restricted to portion of the downfaulted Silurian Block which is ramified by porphyry dykes. The ore-bodies are of four types viz.

(1) Fillings of joints in, and impregnation of, slates and quartzites.

(2) Mineralized porphyry.

(3) Quartz fissure veins traversing the slates and sandstones, and the porphyries.

(4) Replacement deposits at intersections of fault and lode fissures.

The first three types need no description, but the fourth includes the largest and most interesting type. These replacement ore-bodies occur at the intersection of the fault and lode fissures and consist according to A.M. Reid, of pyrite and pyrrhotite replacements of dolomite, the latter being a hydrothermal alteration of peridotites and pyroxenites. They include the Gossan Face, Happy Valley, White Face, Slaughter-Yard, and Brown Face ore-bodies. The Mount Bischoff Tin Mining Company worked nearly all the ore-bodies on the mountain and has produced until the end of 1933, some 79,310 tons ofcassiterite. The adjacent West Bischoff mine mined the Wheal or Giblin Lode, one of the quartz reef types.

A number of fields exist to the south-west of Mt. Bischoff and are connected with the granite of the Mt. Ramsay, Meredith Range, Parson's Hood, Stanley River districts. At Luina, the Cleveland mine workings have exposed a number of replacement-fissure lodes of two types viz. pyrrhotite-chalcopyrite and pyrite-quartz with cassiterite as the economically important mineral. In the Mt. Ramsay district, the primary deposits are mainly quartz-tourmaline bodies. In the Stanley River district the deposits are of the quartz-tourmaline and the contact metamorphic types. The latter has been opened up in the Mt. Lindsay mine and consists essentially of magnetite, pyrrhotite and other sulphides, and typical contact metamorphic minerals such as garnet, vesuvianite, epidote, hornblende, etc.

The Renison Bell field is occupied by Dundas slates etc. in which are intruded quartz-porphyries, gabbros, and serpentines probably of Devonian age. The ore-bodies include the following types with gradations between them - quartz, quartz-tourmaline, pyritic (including pyrrhotitic), and dolomitic. The pyritic deposits with pyrite marcasite, and pyrrhotite are the most important, the tin being present as cassiterite.

In the Heemskirk field, the tin deposits are largely restricted to the granite, few occurring in the intruded slates etc. The deposits comprise a number of types including quartz greisen, quartz-mica greisen, quartz-tourmaline, pyritic, and pinitoid veins.

Mention must be made of the stannite deposits of Zeehan in the Oonah and Silver Queen mines. The Oonah lode is the most important, and besides stannite contains cassiterite and pyrite, chalcopyrite and other sulphide minerals.

Secondary. - Alluvial deposits of recent age and containing cassiterite occur along most of the streams in the tin fields described above and have yielded considerable quantities of tin ore.

In addition to the above, there are deeper and older deposits ranging back into the Tertiary era. Some of these have been covered by basalt flows and represent typical sub-basaltic deep leads.

The most important system of leads is that of the Ringarooma River and its tributaries. The tributaries are mainly north-flowing ones and derived their tin ore content from the numerous greiser lodes etc. on the high country between Branxholm and the Blue Tier. All mine workings have been carried out on the tributary leads which include those of Branxholm Creek (Arba mine), Valley Creek, Cascade River (Briseis mine), Weld River, and Wybiford River (Pioneer mine).

As the Briseis mine, 200 feet of basalt (in three flows) overlies 310 feet of gravels, clays, grits etc., and the workings yielded over 13,000 tons of tin ore. At the Pioneer mine, the basalt had been removed by denudation and only 110 feet of "drifts" remain and the workings have yielded approximately 9000 tons of tin ore.

At Gladstone the alluvial deposits are probably younger, Werrikooian or Pleistocene sands, clays etc. having been deposited in an estuary and covered by later river gravels which in places contain tin ore.

Near St. Helens, the conditions are similar, the deep lead containing little or no tin ore, while the surface layers possibly of later origin, contain in places profitable amounts.

In the North Heemskirk field, basalt covered deep leads also exist.

Tungsten

Both wolfram and scheelite have been mined, the production to the end of 1932 being 2264.5 tons of wolfram and 589 tons of scheelite.

The wolfram is associated with the tin deposits and has been produced chiefly from the Storys Creek, Aberfoyle and S. & M. mines which have been described above. In the Story Creek mine, the lodes contain approximately equal percentages (1.0 to 1.4) of cassiterite and wolfram but in the more recent mining, the wolfram content has been slightly the greater. In the Aberfoyle mine, the amount of wolfram is small compared with the cassiterite produced. In the Gipps Creek district wolfram is present in some of the quartz veins in granite to the exclusion of cassiterite. In the quartz veins of the S. & M. mine, Moina, wolfram was sub-ordinate to the cassiterite. Wolfram is the predominent mineral in other mines in the Moina district and in one (All Nations) cassiterite is entirely absent.

Scheelite occurs in small quantities in the S. & M. mine, but the only deposit of commercial importance is that at Grassy, King Island. The King Island mine was worked between 1917 and 1920 for a production of 589 tons of scheelite. The ore-bodies occur in a series of slates and quartzites which at the mine strike east and west and dip south at 20 to 40. These are intruded by narrow veins of aplite, while granite outcrops to the south. The ore-bodies are probably five in number and conform in strike and dip with the enclosing rocks. They consist of garnet (andradite) with subsidiary amounts of quartz, and about 1% scheelite. Associated garnet pyroxene rocks, and the aplite, are also reported to contain scheelite. The garnet rock represents altered and replaced beds in the slates. The ore-bearing zone has a general westerly trend and is probably bounded on the northern side by a fault.

Molybdenum

Molybdenite occurs at a number of localities within the State and more particularly on the tinfields, but not in sufficient quantity to warrant mining. In the north-eastern districts it occurs in small amounts in some of the tin deposits. At Mt. Stronach it occurs in apparently unaltered granite but veins of pegmatite and possibly oxidised sulphides suggest mineralisation.

Molybdenite is present in small quantities in the King Island scheelite mine and some of those in the Moina district. At Mt. Remus, molybdenite occurs in puritic bodies containing also cobalt and varadium, the former being contained in some of the pyrite and the latter in chlorite present in the ore.

Bismuth

Bismuth ores have been mined to a small extent the total production to date being 77.7 tons. The Moina district has supplied almost the whole of the output, the S. & M. mine being the largest producer. The ores do not as a general rule occur in bismuth lodes but as accessary minerals in the tin and wolfram lodes already described above. Native bismuth in the S & M and All Nations mines; bismuthinite and bismutite in the S.&.M., Princess, Squib, and Premier mines.

At the Stormont mine, to the south-west of Moina, a bismuth ore-body free from other metallic minerals was discovered in recent years. Bismuthinite is the principal mineral with small amounts of bismutite and bismite also present. The ore-body is composed of garnet (almandine) rock formed by contact metamorphism from shales etc. of Silurian age interbedded with tubicolar sandstones and intruded by quartz porphyry. Areas of less altered rocks containing tremolite occur, as do also bodies of garnet-magnetite rock. The garnet rock occurs in bodies of two types, one being more or less horizontal and the other vertical. The former represent replacements of flat dipping beds and the latter appears to be related to faulting. The best values are close to the fractures which allowed the ascent of the mineralizing solutions. The concentrates contain high gold values, the gold being present in the free state. Sulphide minerals occur in quartz veins in the vicinity.

Iron

Iron ores occur at a number of localities on the north, north-west and west coasts, both hematite and magnetite deposits being present.

At Anderson's Creek (Beaconsfield district), superficial deposits of limonite with some hematite and magnetite exist. The deposits have formed from the iron content of underlying Devonian serpentine, the magnetite being, however, derived from veins in the serpentine. The principal deposits are at Mt. Scott, Mt. Vulcan and Barnes Hill.

The ore is a low grade ore and contains small amounts of chromium and nickel, the following table showing the average composition as determined by bore samples;-

	SiO_2	Fe_2O_3	FeO	Cr_2O_3	Al_2O_3	H_2O
Mt. Vulcan	12.28	59.10	2.20	5.18	10.11	9.07
Mt. Scott	17.72	51.50	2.93	5.63	13.39	7.89
Barnes Hill	14.17	51.74	2.31	7.80	11.39	9.75

Attempts were made to smelt the ore (chiefly from Mt. Vulcan) in 1872 and 1876, but were not successful, due largely to the difficulty in working the cast iron.

The Blythe River field contains one or more parallel lodes of hematite with strikes of 30 and high dips to the south-east. The country rocks are Silurian conglomerates, quartzites, sandstones and slates, while Devonian granite outcrops some distance to the south. Tertiary basalt overlies the Silurian rocks and covers parts of the iron lodes. The lodes agree in strikes and dip with the enclosing rocks. The ore occurs as a number of lenses, along the general line of the lodes, over a length of 70 chains. The width ranges from 30 to 100 feet, and estimates of amount of ore range from 9 to 30 million tons. The lenses have been opened up by a number of adits and the quality of the ore tested. Some parts are siliceous and it has been stated that the ore as a whole was too siliceous. Average results indicate an iron content of 63% and a silica content of 7% though these are probably from the better grade ore.

Similar deposits occur on the Dial Range and along Penguin Creek. The former have a north and south trend and consist of red hematite replacing Silurian conglomerates over a maximum width of 200 feet. The Penguin Creek deposits consist of red hematite in association with Silurian conglomerates, sandstones and slates. They occur along a length of 1¼ miles and have a strike of 30. The iron Cliffs lode has a north-south trend and consists of limonite derived apparently from the oxidation of iron sulphides.

The Long Plains deposits consist of disconnected bodies of magnetite along a tract of country 25 miles long and half a mile wide. This tract has a general north and south trend and is occupied by altered basic igneous rocks. The ore is contained in a gabbro-amphibolite with which is associated in places almost unaltered gabbro. The gabbro-amphibolite is contained in, and apparently merges into talc, hornblende and serpentinours schists. Metamorphosed sandstones and slates are also present. The trend of the planes of schistoscity is northerly, while the schist zone strikes north-westerly. The schists have been referred to as Proterozoic, but may represent younger metamorphosed rocks. The deposits consist of numerous large and disconnected lenticular bodies of magnetite and are regarded as magmatic segregations. Some hematite is associated with the magnetite and at places small amounts of pyrite, pyrrhotite and chalcopyrite are also present. The latter also occur as separate parallel bands and have possibly contributed much of the alluvial gold to the streams. The largest lens is 2000 feet long and 100 feet wide and it has been estimated that the field contains 20,000,000 tons of ore. The ore is high grade and samples indiaate an iron content of 63 to 69%.

The Zeehan ironfield is situated five miles to the west of the Zeehan township, and at the foot of Mt. Agnew. The Heemskirk Range to the west and north of the district consists of Devonian granite, while basic and ultra-basic igneous rocks (gabbros, serpentines etc. in the forms of dykes fringe its southern and eastern sides. The granite, gabbro or intrude Cambro-Ordovician slates, sandstones, breccias etc. the basic and ultra-basic rocks being also of Devonian age, but intruded prior to the granite. The gabbros have been altered by saussuritisation of the felspars and alteration of the pyroxenes to amphiboles. Other changes have taken place particularly near the margin of the dykes and in the vicinity of the ore-bodies, the mineralisation having been apparently the main factor in the metamorphism. Bodies of massive diopside and of crystalline dolomite occur, while tremolite, actinolite, epidote, chlarite, serpentine, quartz, calcite etc. are also present. The iron ore exists, as discontinuous, lenticular bodies of magnetite along the margins of the basic dykes. A number of these bodies (up to 8 in number) have been discovered, but have not been opened up by development work to any extent. The general strike is from north of west to south of east. The largest body is the Tenth Legion with a length of 1400 feet at the outcrop, and a width of 50 feet. The ore is of high grade with an iron content between 60% and 70%. The reserves have been estimated at 2,900,000 tons.

Manganese

No deposits of commercial importance exist, but two unimportant ones are known in the Dial Range and Penguin districts. The ores range from low grade manganese ore to manganiferous iron ore. The Dial Range deposit is the more important and occurs under conditions similar to those of the iron deposits of the district viz replacements of Silurian sedimentary rocks, the ore consisting of a mixture of various oxides of manganese (manganite etc.) and manganiferous iron ore.

The Penguin deposit consists of boulders on the beach possibly representing the partial replacement of a siliceous rock. Some of the ore contains psilomelane.

Chromium

No important deposits of chromium ores are known to exist. Chromite occurs in some of the serpentine rocks of western regions, but not in large bodies. The alluvial deposits in the vicinity of the serpentines contain abundant chromite, but have not been worked for that mineral.

The chromiferous iron ores of the Anderson's Creek district have been described under that heading.

Nickel

Nickel minerals occur at several localities in the western districts, but only ore deposit (Five Mile district) is of commercial importance. The deposits are intimately associated with the Devonian basic and ultrabasic igneous rocks.

At Heazlewood narrow veins of pentlandite and its oxidation product - zaratite - occur in the serpentine. Near Trial Harbour pentlandite and magnetite occur as grains throughout the serpentine which is veined with deweylite and secondary minerals.

<u>Five-Mile District</u>. This field is situated five miles north of Zeehan and adjacent to the Emu Bay Railway. Purple and grey slates and breccias of the Dundas series occupy the greater part of the field. They are intruded by two narrow basic dykes with a general north and south trend and easterly dip. The basic rock is dolerite or fine gabbro, the augite of which is largely altered to chlorite.

The ore-bodies are associated mainly with the eastern dyke and occur in it or at its footwall and conform to it in strike and dip. This dyke is 1½ miles in length and the ore-bodies extend over 1¾miles, apparently continuing further south than the dyke. The ore-bodies are not continuous, but occur at intervals along the dyke, the total number being eight.

The ore is a massive sulphide and consists essentially of pyrrhotite, pentlandite and chalcopyrite with smaller amounts of pyrite, marcasite etc. It is fine in grain, and while pyrrhotite and chalcopyrite sometimes occur as blebs, the pentlandite does not do so and is difficult to distinguish from the pyrrhotite. The ore is therefore a nickel-copper ore, the pentlandite supplying the nickel content and the chalcopyrite the copper content. The average metal contents are nickel 9 to 12% and copper 5 to 6%. In the case of the Devereaux ore-body, the relative proportions are reversed, while an analysis also revealed silver (1.1 to 1.4 ozs. per ton), gold (0.02 to 0.03 oz per ton), and platinum (0.10 to 0.16 ozs per ton).

The available information about the ore-bodies is summarised in the following table:-

	Length Feet	Width Feet	Depth Feet	Remarks
Devereaux	not known	1.0-1.5		Exposed in shallow shafts and trenches
Nickel Reward	30	2.0-8.0		Proved by shallow shafts.
Vaudeau.	79 at 70 ft. Level; 30 at 122 ft. level	Up to 10; 3 at 122 ft.lev.	122	Worked down to 122' level with 1500 tons above this level.
Blowfly	60	?	small	Worked out.
Dundas Cuni South(Eastern)	90	?	75	Worked down to 75' Level.
Dundas Cuni. South(Western)	Possible maximum 150'	2¼	not from	Indicated by Geophysical survey. Outcrop proved by two trenches. Metal contents not known.
Dundas Cuni North or Copper-Nickel South.	80 at 70' Level; Possible Maximum 200-300	2	70	Zone 300' long indicated by Geophysical Survey with concentration over 200'. Partly worked out above 70!
Copper-Nickel North	Possible maximum 350	3	110	Indicated by Geophysical survey. Several trenches and two bore holes have interested it.

Ore has been produced mainly from the Vaudeau (2849 tons). Dundas Cuni South (1189 tons) and Copper Nickel South ore-bodies (2000 tons approximately.

The ore as mined was marketed overseas before the Great War, but no market has been available since.

Chromium.

Chromite occurs in association with the serpentine of western and north-western districts, but no important primary deposit exists. It however occurs plentifully in some of the alluvial deposits adjacent to the serpentine. The alluvial deposits of the Adamsfield osmiridian field contain chromite with an almost complete absence of any other heavy mineral. Chromite is also plentiful in the alluvial deposits north and west of Renison Bell.

The chromiferous iron ore of the Anderson's Creek district has been discussed under "Iron".

Osmiridium.

Tasmania is one of the largest producers of osmiridium in the world, the production being derived almost entirely from alluvial deposits. Primary deposits have been discovered in three of the fields. In the alluvial fields the source of the osmiridium can be traced to bodies of serpentine. The original rock is in all cases completely serpentinised and it is difficult to determine its type. Both Twelvetrees and Reid have considered the rock to have been a peridotite containing bronzite. Reid also considered that serpentines derived from pyroxenites and gabbros did not contain osmiridium and that the presence of bronzite rich in alumina in the peridotites was an essential feature for the occurrence of osmiridium in the serpentinised peridotites.

As a general rule, the osmiridium-bearing serpentines contain irregular veins and patches of coarsely crystalline enstatite or bronzite, and these are apparently just as characteristic as the probable peridotite containing an orthorhombic pyroxens. The metallic oxide minerals which occur in the serpentine and accompany the osmiridium are not the same for all fields. At Bald Hill they comprise magnetite, picotite, ilmenite etc., while at Adamsfield chromite is present to the exclusion of the others.

The first primary deposit discovered was the Caudry prospect on the north-western slopes of Bald Hill. Osmiridium was found along a line with a S.S.E. - N.N.W. trend and excavations revealed a foliated zone with vertical walls four to six feet apart. The excavation was 200 feet long, but osmiridium-bearing rock occurred at three places only. At depths of 15 to 25 feet the bounding walls were not so definite and the foliation becomes less prominent and more irregular. It was also found that the osmiridium was not confined to the rock between the walls but was present in dark bluish unfoliated rock to the east of the eastern wall. The production from this deposit was approximately 250 ozs.

Near Mt. Stewart, three structural places were located and osmiridium found as "schlieren" in the places but not in the serpentine adjacent to the places.

The most important primary deposit is that at Adamsfield. The serpentine occurs as a dyke over three miles long with a width of 20 chains at the southern end and increasing to 40 chains to the north and ending in a knob or bulge 80 chains wide at its north end. The primary deposit or lode occurs within a few chains of the eastern boundary of this bulge. It has a general north and south trend, but conforms to the boundary of the dyke and is curved to the west at its northern and southern ends. Towards the southern end, the lode consists of serpentine between two well-defined vertical walls eight feet apart, the osmiridium bearing portion consisting however of 1,2, or 3 narrow veins of somewhat foliated serpentine.

Immediately west of the lode is a 10 foot band of massive talc dirty white in colour and representing altered serpentine. Short narrow and irregular veins accompany the talc in some places and also occur in the lode but to only a small extent. The lode has been traced for 15 chains, but becomes narrower and not so well defined at both ends but particularly to the north. In this direction, also, the lode, owing to the narrowing of the dyke, intersects and to the north occupies the content between serpentine and Lilurian shales. Nuggests of chromite up to 4" diameter occur in the lode, while the serpentine and the talc contain innumerable small octahedral crystals of the same mineral. Towards the south end a narrow branch of the lode trends to the west and traverses the talc for a short distance.

The lode has been mixed to a depth of approximately 50 feet at several places, and is still osmiridium-bearing at that depth. The osmiridium is dark-coloured due to adhering serpentine etc. It is obtainable in nuggets ranging up to an ounce and over in weight. The production has probably been between 200 and 400 ounces.

While the above deposits are the best known, it is probable that other similar, though smaller ones exist. This must be the case in order to account for the osmiridium in the alluvial deposits on the various fields. These will probably be similar to those described above, but the possibility of the osmiridium being in some cases disseminated through the serpentine cannot be disregarded.

<u>Alluvial</u>. The production of osmiridium has been derived almost entirely from the alluvial deposits. The principal fields are five in number and include Bald Hill, Savage River, Mt. Stewart, Wilson River and Adamsfield.

The Bald Hill field is situated some 15 miles west of Waratah. It includes all the alluvial workings around Bald Hill and in the valleys of Nineteen Mile Creek and Heazlewood River. The osmiridium has been shed from a small body of serpentinised peridotite on Bald Hill including Caudry Prospect already described above. The deposits consist of recent gravels along the streams, detrital material on the slopes of Bald Hill and Tertiary gravels.

The Savage River field is really an extension of the Bald Hill field and derived its osmiridium from Bald Hill by way of Nineteen Mile Creek. The stream gravels and terraces have been worked over a length of 15 miles.

The Mt. Stewart field is 13 miles south-west of Waratah. The deposits include the stream gravels of Loughnan Creek and Castra River. The osmiridium is derived chiefly from the serpentinised peridotite in Loughnan Creek and which contains the Cordry prospect.

The Wilson River field lies to the north of Renison Bell. The deposits include the recent stream gravels and also detritus on the serpentine. The osmiridium has been derived from serpentised bronzitite and peridotite and a few short "schlieren" have been found.

Adamsfield is situated 50 miles W.N.W. of Hobart. A long dyke of serpentine intrudes folded and faulted Silurian rocks. The serpentine has shed osmiridium mainly from the eastern margin and particularly from the vicinity of the lode at the head of Main Creek. The deposits are of many types and osmiridum has been obtained from stream gravels, surface soil, sub-soil, clay, detritus from serpentine etc.

The recorded production of osmiridium since 1910 is 26,676 ozs. with a value of £598,251 and of this Adamsfield since 1925 had produced 11,211 ozs. with a value of £238,476.

Titanium.

Both rutile and ilmenite exist in the State, the known deposits being alluvial ones.

The most important deposits of rutile are situated in the Lewis River district between Macquarie Harbour and Port Davey. The rutile occurs in the deposits along the present streams and in the gravels on a dissected plain. It is associated with cyanite (clear blades with brown centres) and small amounts of garnet. The source has not been discovered.

Rutile also occurs in the Ulverstone district in deposits along the present streams and also in sandstones probably of Tertiary age.

Ilmenite occurs in small quantities throughout the State, being derived from the Tertiary basalt, Mesozoic dolerite, and some of the Devonian ultrabasic rocks. The only important deposit is a raised beach along the coast near Narracoopa, King Island. A small amount of cassiterite is associated with the deposit which was formerly worked for that mineral but without success. The deposit also contains garnet, zircon and possibly rutile. The ilmenite is the most plentiful mineral and the deposit was recently exploited for the extraction of that mineral which was used to manufacture titanium dioxide for white paint.

NON-METALLIC MINERALS

Barite.

Barite deposits are restricted to western and north-western districts. It has been mined at a number of places, but only on a small scale, the total production being 1800 tons.

The barite occurs in Lower Palaeozoic sedimentary rocks and schistose porphyries of either the same or Devonian age, but particularly in the sedimentary rocks near the porphyries. Barite also occurs as a gangue mineral in the copper deposits of Mt. Lyell, the zinc-lead deposits of Mt. Read and Rosebery, etc. These deposits are now considered to be genetically associated with the Devonian intrusives (porphyries etc.) and it is probable that the barite ore-bodies are similarly associated.

On the Intercolonial Spur, at Mount Jukes, on east-west vein of barite has a length of 26 chains and a width ranging from 1 to 8 feet. Both samples have assayed up to 86% of Ba S04. At Madam Howard Plains, near Queenstown, a main lode with a strike of 250° traverses Silurian sandstones, while to the north a zone containing veins and small lodes, has a general north-easterly strike.

A number of ore-bodies occur at Murchison River, Lynch Creek, Pinnacles and Mt.Block between Tullah and Mt. Block. Porphyries and schistose porphyries are common in these districts, but the deposits have not been opened up.

At Beulah, a number of lodes and veins conform in strike with the enclosing slates with which are associated schistose basic porphyries.

The Riana deposit is a small lode striking north and enclosed in slates and breccias probably of the Cambro-Ordovician system.

The Alma deposit occurs in dark slates and quartzites, probably belonging to the Cambro-Ordovician system. On the Paradise range, north-north-westerly trending veins traverse sandstones with which are associated schistose porphyries.

The Harford lode traverses quartzites and slates of the Cambro-Ordovician system. No outcrops of Palaeozoic igneous rocks are known in this district.

Asbestos.

Asbestos occurs at two localities viz Anderson's Creek in the Beaconsfield district, and at Asbestos Point, on the south side of Macquarie Harbour. The former is the more important deposit and was worked during 1917, 1918 and 1919 for the production of 440 tons of asbestos fibre. The asbestos is of the chrysotile type and generally of the cross-grain variety. It occurs as narrow veins in serpentine or serpentinised ultrabasic rocks.

At Anderson's Creek, the country rocks include Cambro-Ordovician conglomerates, quartzites and sandstones, intrusive into which are Devonian peridotites and pyroxerites. The latter have been intruded by small dykes of granite aplite etc., and have been almost completely converted into serpentine though small portions escaped serpentinisation.

The serpentinisation of the ultrabasic rocks and particularly the formation of the asbestos veins were associated with the intrusion of the granite and aplite dykes. The asbestos occurs in veins up to 4 inches wide, but the usual width is below half an inch, though a number of these narrow veins may be parallel and closely spaced over a wider zone. The fibres are generally arranged across the vein (cross-fibre), but the slip-fibre variety is also present. In addition to chrysolite asbestos, picrolite and amphibole-asbestos are also present in the serpentine in the form of veins. Magnetite also occurs as veins of cross-fibre type.

At Asbestos Point, the country rocks include schistose basic igneous rocks, possibly of Proterozoic or Lower Palaeozoic age. Along narrow dyke of pyroxenite intrudes the above and has been partly serpentinised. Narrow veins of chrysotile asbestos are present at several places along the dyke and are of the cross-fibre type. Only a small amount of development work has been carried out, and so production has taken place.

In both the above districts, the cross-fibre asbestos is pale-green in colour and often with a bronze sheen, but yields, when teased, a white fibre with a soft and silky feel.

Talc.

The talc deposits are not of any great extent or commercial importance, the total production being 88 tons.

At Gawler, near Ulverstone, a narrow vein up to two feet in width occurs in Proterozoic mica schists and appears to conform to the planes of schistosity. It is fine in grain and nearly pure white in colour. This is the only deposit that has been worked, 88 tons having been produced.

At Mt. Stewart, west of Waratah, a two-foot vein of coarse-grained talc traverses the altered pyroxenites of the district.

At the Razorback mine, Dundas, a large body of talc occurs adjacent to the pyritic tin ore-body. It is fine-grained and a dirty white colour and was formed by alteration, during mineralisation, of a serpentine.

Limestone.

Limestone exists in the Lower Palaeozoic, Permo-Carboniferous and Tertiary rock systems. The Lower Palaeozoic limestones are dark grey types of high grade, and occur in beds many hundreds of feet thick, generally dipping at high angles. They are found in western and north-western and southern districts and are used for various purposes. The Ida Bay deposits are used in the manufacture of carbide at Electrona; for making lime-sulphur sprays; and in the metallurgical process of the Electrolytic Zinc Co. at Risdon. The Melrose stone is shipped to Newcastle for fluxing purposes in the iron smelting industry. The Beaconsfield, Railton and Mole Creek deposits are burnt for lime for agricultural and building purposes. The Railton deposit is also used in the manufacture of cement by the Goliath Portland Cement Co. The Queenstown deposits are used as flux in the copper smelting operations of the Mt. Lyell Mining & Railway Company, and the Zeehan deposits were formerly used as flux in the lead-smelting industry.

The Permo-Carboniferous limestones are light grey in colour and generally of low grade with a silica content ranging up to 20%. They occur as horizontal or slightly inclined beds ranging in thickness up to 100 feet. They are burnt for lime at Bridgewater and were formerly used for cement manufacture at Maria Island.

The Tertiary limestones are of no great extent and are little utilised. Marine limestones occur at Marrawah and King Island and fresh water ones at Flinders Island and Risdon.

Dolomite.

The most important and extensive deposits of dolomite are the sedimentary beds in the Smithton district. Similar beds, but probably of less extent, occur in adjacent districts such as Montagu, Black River etc., but have not been geologically surveyed. These rocks are interbedded with the Dundas series of slates and breccias and are probably near the base of the series.

Another type of deposit results from the alteration of the Devonian ultrabasic and basic rocks by mineralising solutions. One such deposit on the Arthur River consists of a mixture of dolomite and magnesite. In the Magnet silver-lead mine, the basic and ultrabasic rocks on the hanging wall of and in the lode channel were altered to ferriferous dolomite, or ankerite.

The Smithton deposits are in the form of a large syncline, but are largely covered by Pleistocene and recent marls, peats, sands etc. The eastern limb is the better known andthe beds outcrop along Duck River and dip west at 45°. The dolomite is generally of a very fine grained type with a dirty white to cream colour. Near Smithton, a coarser-grained crystalline type occurs over considerable areas. It is generally white in colour and very high in grade, containing only a very small percentage of impurities. The dolomite was formed by the dolomiterisation of limestone and the conversion was complete as the calcium and magnesium carbonates are present in the theoretical proportions for dolomite. Calcite appears to be absent except in a few spots where it is present as small veins or coarse crystals. An interesting feature is that a bed of limestone 300 feet stratigraphically below the dolomite, has not been dolomitised to any extent.

The purity of the deposit is such that a company undertaking tests with a view to manufacturing magnesium compounds and metallic magnesium.

Diatomaceous Earth.

Only one deposit is known and is situated several miles east of Andover in the Midlands.

The material occupies one or two basin-like depressions in the dolerite bedrock. It is not of high grade as it contains a proportion of clay, but is suitable for some purposes.