302001

A STATISTICAL & GEOLOGICAL REVIEW

OF THE ZEEHAN SILVER-LEAD MINES

WEST TASMANIA

by

D King

28 September 1961

61_335

AMG REFERENCE POINTS ADDED

ACCOMPANYING PLANS

ACCOMPANYING TABLES

CONCLUSIONS

1. The bulk of the silver-lead ores produced from the Zeehan district was from mines located in the pre-Cambrian to Early Cambrian quartzitic sequences, especially where accompanied by Early Cambrian spilitic extrusives. The total recorded lead ore produced prior to 1919 amounted to 263,000 tons and can be appropriated in respect to geological environment as follows:

	per cent
Pre-Cambrian to Early Cambrian rocks, spilite present	84.6
" " " " " " , no spilite observed	1.7
Middle to Upper Cambrian rocks (Dundas Group)	3.2
Ordovician rocks (Gordon Limestone)	0.7
Silurian to Devonian rocks	9.8
	100.0

2. The life of the individual mines was greatly influenced by the silver values of their respective ores, as the return for the lead present hardly defrayed smelting and freight costs. Silver values were invariably highest in the lodes associated with the spilite volcanics, and this probably contributed to their more extensive development.

3. Mineralisation of the fractures has mainly occurred in proximity to major faults, sporadic both laterally and in depth. As a whole, the ore shoots of the district were small and irregular, and became depleted or poorer in values within a few hundred feet of the surface - and likewise along strike.

4. Intensive exploration has been carried out in the district during and subsequent to the early mining activity, but results since 1900 have been generally poor. The area can in fact be considered as thoroughly tested in respect of near-surface lode deposits, and while not at present even supporting small syndicates the type of mineralisation present (para. 3) is unattractive by present-day Company standards.

It is the considered opinion of the writer that deeper exploration can only be expected to reveal similar types of deposits (in different planimetric positions) to those which were responsible for the short-lived prosperity of Zeehan as a mining town; costly programmes of sub-surface exploration are therefore believed to be unwarranted.

INTRODUCTION

This report was compiled from data gathered as a part-time project while residing in Zeehan from 1956 to 1960 in the employ of Rio Tinto Southern Pty. Ltd. The investigations on which it is based involved regional geological mapping of the whole district, surface examination of all old mines and dumps, and a review of literature relating to production statistics and underground geology of the various mining properties.

The work was carried out with the objective of determining the geological and structural setting of the principal ore producers of the field, as distinct from scores of other workings which were essentially unproductive, and to apply these observations in delineating areas which may warrant additional sub-surface exploration.

The report is not intended to be a comprehensive review of the geology and ore deposits of the Zeehan district, but has been compiled as a supplement to the previously published reports, highlighting new observations and interpretations which may assist in the conduct of any future exploration work in the district.

The writer acknowledges having freely incorporated observations or suggestions of other officers of the Rio Tinto and Electrolytic Zinc Companies which he considered appropriate to the analysis.

This report happens to be negative as regards encouragement for further work; however, the writer would have been especially pleased if it had proved otherwise, as he greatly appreciated the assistance rendered by the Zeehan community during the conduct of the exploration work and admired their continued efforts to re-establish the prosperity of the town.

HISTORY OF EXPLORATION

Almost all of the productive mines of the Zeehan field were found and commenced operations prior to 1890, within three years of the original discovery of silver-lead in the district; subsequent intensive prospecting during the period of active mining operations, from about 1890 to 1912 failed to disclose many other worthwhile showings. The Spray is one exception where an additional lode was discovered in 1898 and led to the development of another important mine, but in later years a great deal of money has been spent on various kinds of exploration with incommensurate results.

Government Aid: Following the closure of most of the mines by 1914, the Tasmanian Government carried out more than 4,000 feet of trenching in the Brittania, T.L.E., north Zeehan, north Comstock, Queen and Oonah mine areas, reopened the No. 5 Argent workings (renamed the State Mine), and liberally assisted in the financing of driving and sinking by many tributing parties. No new discoveries of ore nor any substantial increase in silver-lead production resulted from this expenditure.

Diamond Drilling: The earliest diamond drilling was carried out by the Tasmanian Government at the Crown mine, where two horizontal test-holes were completed in 1894. No other drilling is reported until 1931-2, when the Government sank a 930 ft. deep drillhole at the Spray Mine (Rept. Sec. for Mines, 1932) with poor results.

During the period 1946-7, Zeehan Explorations put down five drillholes in the Oceana mine locality, four in the Despatch mine area, three at the Austral flux quarry, ten bores along the King - Bell line of lode, two at the Nike mine and others at the Spray mine. The lode intersections were poor in all but the Oceana mine area.

In 1948, the Electrolytic Zinc Company drilled a number of short holes in the Comstock mine and temporarily carried out some small-scale mining operations. The same Company completed three holes totalling 1300 ft. at the Big Ben lode in 1950 but failed to intersect any ore which warranted assaying.

The Mariposa Mine, which lies on the eastern limb of the Zeehan Basin opposite the Oceana mine, was tested by 8 drillholes by Zeehan Explorations during 1950, and proved to be sub-marginal in terms of dimensions and grade.

Diamond drilling has also been undertaken during the last decade at the site of B.M.R. geophysical anomalies north of Zeehan (see Fig. 1), and by the Government at the South Tasmanian. Details of these drillholes are not available to the writer, but it is understood that D.D.H. Nos. 3 and 4 showed that the largest geophysical anomaly was due to graphitic slate, and that no important findings resulted from the other holes.

Mining Since 1912: In addition to small-scale tributing operations in the upper levels of the abandoned mines, production since 1912 has largely been from reopened workings at the No. 5 Argent (State Mine), Nike, Swansea and Oceana mines. The only newly discovered lodes of value were at the New Montana - Western, situated 2 miles north of Zeehan, which operated from 1940-41 and 1948-58.

Geophysical Surveys: Ground geophysical surveys employing electromagnetic, magnetic and self-potential methods have been undertaken by the Bureau of Mineral Resources in parts of the Zeehan district on behalf of various mining Companies. Localised areas were covered prior to 1950 at the Oceana and Mariposa mines as a basis for drilling operations, and later regional surveys were carried out in three localities north of Zeehan, as shown in the accompanying Plan No. 3.

PRODUCTION RECORDS

Production figures prior to 1919 were recorded in annual and quarterly reports of the Mines Department in terms of tons of silver-lead ore despatched from the mine, with no specific information on grade; it is assumed to have largely comprised reasonably clean galena or concentrates.

A summary of all available production figures prior to 1919 is given in Table 1. These records are believed to be realistic in the case of the larger operating Companies but are probably incomplete in respect of the smaller individual operations. It is known however, that production attributed to some of the main mines also includes parcels from other small mines taken over by the Companies. The Spray figures include some ore from the Argent group of mines, and the Montana figures include some ore from the Crown, Despatch and other small workings.

Production after 1918 was recorded as lead (tons) and silver (ounces) returned from the ore. The Oceana (13,500 tons lead) and the New Montana - Western (2,100 tons lead) were the only operations yielding significant production since 1915 (Fig. 2) and both are now closed.

The output of the various mines are considered in relation to their geological environment in the following section of this report.

LODE DEPOSITS IN THE PRE-CAMBRIAN TO EARLY CAMBRIAN ROCKS

The pre-Cambrian to early Cambrian rocks are represented by a thick and highly disturbed succession of predominantly quartzites and slates exposed over an extensive area extending northerly and westerly from the outskirts of Zeehan township. The greater part of this area features an abnormally sparse and stunted button-grass vegetation and a monotonous sequence of stressed quartzites and pallid shales which can be logically equated with the pre-Cambrian Davey Group. At the perimeter of the Zeehan Palaeozoic Basin, where one might expect to be higher in the pre-Cambrian succession, quartzites and black and grey slates of Montana Hill, Oonah Hill, Queen Hill and the northern face of Spray Hill are interstratified with dolomites and fragmental volcanics, constituting an assemblage which is characteristic of the Carbine Group of Upper Proterozoic to early Cambrian age. However, no precise boundary could be defined between the respective groups despite detailed investigations.

A major proportion of the silver-lead ore produced from the district was from fissure lode deposits occurring within these older sedimentary sequences. Sixty per cent of the total output of the field prior to 1919 was from the Western, Montana, Queen and Oonah groups of mines. The Spray (which yielded 24% of the total output), Grubbs (Colonel North), the Comstock, new Montana - Western, Nike and Brittania were the best among other deposits found in the same rocks.

Less productive deposits in the same quartzitic sequences were worked at the Big Ben, Barnett's, Western Extended, McDermott's Great Western, Junction, Prairie, Silver Beauty, Crown, Doric, Nubeena, Foam, Wave and Victoria Zeehan mines.

While these quartzitic rocks are highly deformed and faulted throughout their extensive areas of outcrop, known mineralisation of the fractures is most intense near the periphery of the Zeehan Basin and decreases progressively to insignificant amounts within a few miles lateral distance of the Basin. Thus most of the payable lodes occur high in the pre-Cambrian sequence in the quartzite - slate - dolomite - spilite assemblage which has tentatively been assigned to the Carbine Group.

Dolomitic Limestones: Although the carbonate rocks are only rarely seen in outcrop, dolomitic limestones were encountered in some of the principal mines of the Western, Montana and Queen group. Thin beds of grey dolomite occur interbedded with sandstones and slates in a cutting on the Corinna road near the main dump of the Western mine, and similar material can be found on the dump. Massive black dolomitic limestone is plentiful on the waste dumps of the Montana No. 1 and No. 4 Queen mines, and grey dolomite was recorded in Government drillholes and occurs on the dump at the Crown mine, on the eastern margin of Montana Hill (Sec. of Mines Rept., 1894-5). Bands of grey dolomite have been observed on the dump of an adit immediately south of the Oonah main shaft. Grey and blue dolomitic limestones are also present in the country rocks of the Comstock mines, west of Zeehan.

Partial chemical analyses of some typical specimens are given hereunder:-

Sample No.	CaO %	MgO %	CO_2 %
C1	29.45	20.35	45.0
C2	26.11	16.45	36.0
C8	20.45	11.75	28.9

C1. Comstock mine, dump south of main shaft. Pale grey sandy dolomite.

C2. Montana No. 1 mine on dump from main shaft; black dolomite.

C8. Western mine, dump from main shaft. Blue-grey siliceous dolomite.

Likewise the associated quartzites are commonly rich in disseminated talc grains which would reflect an original dolomitic composition of the matrix. Good examples of these talcose quartzites were noted in the road cuttings west of the Silver Beauty mine, and at the Spray and Nike mines.

<u>Spilites and Related Pyroclastics</u>: Numerous bodies of glassy amygdaloidal lava and pyroclastics, the so-called melaphyre (Thomae, 1895-6) or spilite (Twelvetrees and Ward,

1910) of previous writers, are intimately associated with the quartzite - dolomite sequence of the Western, Montana, Oonah and Queen groups of mines, all known exposures being shown on the geological plan (Fig. 3). Other occurrences in areas where they do not outcrop are reported from Nos. 2 to 5 levels in the north end of the Spray workings (N.B.H. report, 1947) and at the north end of the bottom level in Grubbs mine (Twelvetrees, 1900).

The pyroclastic members of the volcanic suite range from coarse agglomerates to tuffs, and are mainly composed of spilite fragments. Where observed at the Nos. 2 and 3 Queen workings, and underground in the southern tunnel on the Oonah lode, and in the Western mine (Montgomery, 1893, 1895-6), they are conformable with the enclosing bedded sequence. Thus Twelvetrees (1900) concluded that the volcanics (his tuffs) are undoubtedly the same age as the accompanying rocks because they can be seen, "especially in the Oonah and Montana mines, interbedded with the sedimentary strata in contemporaneous sheets".

Surface exposures of the lavas, however, commonly show discordant relations with the bedded rocks, as can be readily seen on the accompanying geological plan. This could be explained in part by faulting at the contacts, but some bodies of melaphyre are obviously intrusive into the ordinary sediments and presumably mark volcanic vents of a somewhat later cycle than the pyroclastics. Indeed, the agglomerates of No. 3 Queen Shaft appear to have been baked at the contact of such an intrusive body, and evidences of volcanism involving fragments of spilitic rock (e.g. Rock Spec. No. 6) have been found to extend into the Middle to Upper Cambrian sequence (Dundas Group) of the Argent and Austral flats.

Petrographic descriptions of the spilitic lavas have been recorded by Twelvetrees and Ward (1910); other varieties and associated pyroclastics are described below:-

Rock No. Z1. Western mine dump, amygdaloidal spilite enclosing large fragments of slate. It consists of a vesicular glass which appears to represent material near the top of a lava flow. The material is scoriaceous with the cavities drawn out into oval and lenticular shapes. The majority of the cavities are lined with calcite. Some are filled with chlorite, while others are filled with cryptocrystalline silica. The glass is transparent in parts and opaque in parts. In some areas the glass exhibits a texture resembling that of a perlitic obsidian.

The contact of the glass and the enclosed slate is irregular and the slate is apparently a fragment which has been caught up in the lava. The contact is obscured by the presence of calcite veins which are parallel to the contact. However, the glass surrounds the fragment of slate and has intruded it along fractures.

Rock No. Z7. Western mine dump, glassy fragmental pyroclastic. It consists of vesicular glass, and is identical with the glass in Z.1. The cavities are again filled with calcite, chlorite and cryptocrystalline silica. The glass, as in Z.1., exhibits a texture resembling a perlitic obsidian.

A xenolith, which is roughly cubic in shape and measures approximately 1.5 cm, is present in the glass. This consists of chert and has been intruded by the glass. Calcite and chlorite are also present within the chert, and occupy veins and irregularly shaped areas.

Rock No. Z4. No. 2 Queen shaft dump, pyroclastic composed largely of spilite fragments.

This is a pyroclastic rock consisting of rock fragments and grains of quartz in a matrix of extremely fine quartzo-felspathic material. Some of the rock fragments consist of the vesicular glass described above (Z.1.) Other rock fragments are themselves fragmental, suggesting that they were also of pyroclastic origin. Calcite is abundant and fills interstitial areas in the rock. Calcite also occurs in the fragments of the vesicular glass. Quartz occurs as grains which vary greatly in angularity and grain size. The largest of the quartz grains are approximately 0.25 mm. Pyroxene and zeolites are also present, but in very minor amount.

This rock can be related to sample No. Z.1 since fragments of the glass are common in this rock.

LODE DEPOSITS IN THE MIDDLE TO UPPER CAMBRIAN ROCKS

A distinctive sequence of argillites, grits and tuffs underlie areas of subdued topography in the Argent, Austral, Sylvester and Swansea flats, and locally higher ground on Manganese Hill. These mainly comprise fault-bounded blocks wedged between the older quartzitic sequences and the succeeding Eldon and Junee Group rocks and are equated on lithological grounds, apparent stratigraphic level and some fossil evidence, with the Dundas Group of Middle to Upper Cambrian age. Where unaffected by faulting, they appear to be transgressive upon the older quartzitic sequences, which they dip off along the Spray - Brittania line of contact; the same is true where the actual contact can be observed in Warren's Tunnel, west of the Zeehan golf course in Argent Flat. The argillite - tuff beds of the Dundas Group are much more intensely folded and faulted than the overlying Middle Palaeozoic sequences, and away from the influence of faulting, the latter are believed to unconformably succeed the Dundas Group.

The lodes opened up within these rocks were individually and collectively of minor importance. They include all but No. 2 of the Argent group, Montana No. 2 and New Mt. Zeehan, of Argent flat; Balstrup's mines on Manganese Hill; the Austral, Maxim and Watt and McAuliffe mines of Austral flat; and the Sylvester, T.L.E., Tasmanian, Stonehenge and Swansea mines in the western part of the Zeehan field.

Tuff beds: The argillite - tuff sequence is characteristically deeply weathered, being represented at the surface by yellow and reddish-brown clays. Conspicuous among the fresh rocks found in the waste dumps of the mine workings, however, are greenish grey tuffs such as described hereunder:

Rock No. Z5: Maxim mine dump. This sample is a crystal tuff. The main constituents are fine anhedral crystals and fragments of crystals of quartz and plagioclase. The majority of the felspar is highly altered, but some crystals can be classified. These felspar crystals are in the oligoclase-andesine range in composition. Minor constituents are devitrified glass, pyroxenes, muscovite and opaque minerals. Calcite occupies interstitial areas and also occurs in narrow veinlets.

Rock No. Z6: Long Tunnel dump, north side of Manganese Hill. Similar to Z5 except that this tuff contains fragments which appear to be vesicular glass described above (Rock Z1, spilite group). However, the main constituents are crystals and fragments of quartz and felspar (highly altered). A trace of pyrite is present and is associated with calcite veins.

Dolomitic Beds: In addition to the tuffs, which are slightly calcareous, dolomites and dolomitic siltstones are also commonly present in the country rock seen on the dumps. Partial chemical analyses of some of the carbonate rocks are given below:

Sample No.	CaO %	MgO %	CO_2 %
C4.	24.96	11.2	35.6
C5.	18.25	9.05	31.3
C6.	2.3	5.06	6.0

C4. Dump of State mine shaft, dense grey calcareous siltstone.
C5. Dump of No. 2 Spray shaft, banded grey dolomitic siltstone.
C6. Long Tunnel dump, Manganese Hill (tuff specimen Z6).

LODE DEPOSITS IN THE ORDOVICIAN ROCKS

No metalliferous deposits have been found within the Lower Ordovician conglomerates and sandstones (Owen Conglomerate), but several occurrences of silver-lead ores have been located and worked in the overlying Gordon Limestones. Outstanding among these was the Oceana mine, which was originally worked during 1890-1893, and reopened from 1954 to 1960 by the South Broken Hill Company who produced ore yielding more than 13,000 tons of lead. Other insignificant or fruitless mining operations were carried out in the limestones at South Oceana, Pyramid, in the Austral Valley south of the flux quarry, near the post office in Zeehan township, and at the Despatch property. Mineralisation of the limestones extends well beyond the limits of the Zeehan mining district (and the mapped area).

Ore emplacement in the limestones has been essentially confined to faulted zones, with some replacement of the wall-rocks. At the Oceana mine, for example, Jack (1960) reports that "This shearing, which is pre-ore, has provided favourable access for mineralisation which occurs principally along the two most prominent shears .... The mineralisation has also selectively replaced the crushed rock in some of the tension fractures which formed in the shear zone between the two major shears".

Consistently low silver values, and costly mining arising from caving and excessive underground water, have seriously affected the success of the few mines established on deposits in these limestones.

LODE DEPOSITS IN THE SILURIAN - DEVONIAN ROCKS

In the Silurian - Devonian fossiliferous marine sediments of the Zeehan Basin, profitable silver-lead mining resulted from operations at the Florence mine, and at Fahey's Tribute at the South King. Extensive but less successful mining was carried out in lodes cutting these sediments at the King, Bell, part of the No. 6 Argent workings, and on a smaller scale at the Sunrise and Monte Christo properties.

SILVER VALUES

The ruling prices for lead and zinc during the period of active mining at Zeehän were as follow:-

	lead	silver
1890	£14 per ton	3/10d. per ounce
1900	£12.5.0 per ton	2/ 3d. per ounce

Thus first-class ore averaging say 60% lead and 100 ounces of silver to the ton was valued at the mine at about £20 in 1890 and had fallen to £14 by 1900. Costs of freight and smelting in 1900 amounted to about £5.10.0 per ton, which was little more than defrayed by the value of the lead produced, so that the margin of profit and prosperity of individual mines was very largely determined by the silver content of the respective ores - which it will be shown below varied greatly.

The average silver values of galena ore from the various mines in the district, calculated from published production records, are listed in Table 3 in separate groups according to the age of the enclosing country rocks. These figures illustrate very clearly that the lodes which intersect the older quartzitic sequences are characterised by argentiferous galena with the silver fraction exceeding 1 ounce to the unit of lead. In particular, an abnormally high silver content was invariably found to be present in those lodes bordering or traversing the spilitic volcanic members of the older series.

Galena deposits worked in the Gordon Limestone were consistently poor in silver.

REGIONAL STRUCTURES

The pre-Ordovician sedimentary sequences are characterised by effects of intense diastrophism, featuring complex folding along predominantly east-west axial lines, and intense faulting and brecciation with no established regularity. A lack of satisfactory stratigraphic markers and a paucity of outcrop evidences have prevented any satisfactory elucidation of these structures in all but a few localised areas.

The Middle Palaeozoic (Ordovician - Devonian) sequences of the Zeehan Basin are confined to an infolded synclinal remnant with a N.N.W. - E.S.E. axial trend conforming with the generally simple pattern of folding of the Devonian Orogeny. Within the Basin, the Gordon Limestone and succeeding sediments are transgressive upon the Owen Conglomerate of Mt. Zeehan, where its locally thick development can only be interpreted as due to the infilling of a fault basin or graben in Lower Ordovician times.

The synclinal structure of the Zeehan Basin is dislocated by a system of normal and reverse faults effecting very large displacements. The faults can be readily and accurately defined within the Middle Palaeozoic sequences, and can be traced with reasonable accuracy into the neighbouring older rocks. Three predominant directions of faulting are represented, including an earlier set of N.E. - S.W. low-angle planes of movement such as the Waller Fault - dismembered sections of which are indicated on the geological plan - and a minority of N.N.W. - S.S.E. low-angle faults including the Main Slide of the Western and Montana mine area. Most of the major faults, including the Montana, Argent and T.L.E. Faults, have a common W.N.W. - E.S.E. orientation and are steeply disposed.

Some faults of the W.N.W. - E.S.E. group (e.g. T.L.E. and Argent Faults) have displaced the granitic rocks of Mt.

Heemskirk, yet other faults are intruded in places by porphyritic rhyolite dykes which can be reasonably assumed to be derivatives of the granite. Most of the faults shown on the map are therefore believed to have occurred in Devonian times during an interval following emplacement of the granite but preceding the intrusion of later rhyolitic and aplitic apophyses of the granite. This conclusion accords with observations of Waterhouse (1915), who showed that the principal directions and frequency of conspicuous tourmalinised fractures occurring throughout the granite are N.E. - S.W. (9), N. - S. (19) and E. - W. (22), or similar in orientation to the major faulting described above.

In addition to the extensive faulting associated with the pre-Ordovician and Devonian diastrophisms, there are evidences of post-Permian faults which probably reflect a rejuvenation of movements along pre-existing lines of weakness. Thus overthrust faulting involving the Permian Tillite has been observed at the New Montana - Western and Big Ben mines (Campana and King, 1958), northerly of Zeehan, while folded and faulted Tertiary sediments are exposed in the workings of the St. Dizier alluvial tin mine, North Heemskirk (beyond the limits of the mapped area).

Likewise, in the Zeehan Township area, the present physiography is suggestive of youthful faulting, with such areas as Argent flat being almost perfectly peneplained, yet lacking any alluvial cover, and bordered by abrupt escarpments rising to the higher-level planated surfaces of Queen Hill and Montana Hill. Twelvetrees (1900) referred to these "peculiar flat valley bottoms round Zeehan margined by abruptly rising hills" and believes they "are no doubt the products of marine erosion .... well sluiced by the sea in Tertiary times, as we see the bedrock everywhere". The complete absence of any Tertiary marine deposits in the district must surely discount this explanation.

MINERALISED FISSURE LODES

The distribution and orientation of all the known fissure lodes of the field are shown in relation to host rocks and major structures on the geological plan (Fig. 3), and in relation to the boundaries of the various mining properties on the mine locality plan (Fig. 4). It will be observed that the pattern of the lode fractures is a complex one featuring widely divergent trends, changes of course along strike, and convergences at various angles, but with a predominating tendency towards a meridional strike in keeping with the axial direction of the Middle Palaeozoic Zeehan Basin.

The lode fissures constitute but few of the countless planes of fracture that are developed throughout the various rocks of the district, and which are particularly abundant and widespread in the pre-Ordovician formations. Those that have been proved to be mineralised, however, are almost invariably found branching from one side or the other of the major cross-faults shown on the geological plan. More specifically, some of the largest ore shoots can be shown to have occupied minor satellite fractures on the southern or footwall side of the major fault planes, an environment which applies in the case of the Western and Montana mines, new Montana - Western, Oonah, T.L.E., Tasmanian and Swansea lodes. The Spray, Brittania and Comstock lodes are similarly situated in respect to an unconformity or major fault.

Underground observations showing that the same structural controls are in evidence on a detailed scale are recorded in a paper by the former Manager of the Montana mine (Craze, 1905) who states that the Montana lodes "could not be identified on the north or hanging-wall side of the faults, but in some cases where a lode was identified on the north side of the fault it was small and unbroken and rarely contained galena". Nevertheless Craze and Twelvetrees and Ward (1910) considered that the main faults (or slides) of the Montana - Western area predated mineralisation and "enrichments near the slides had in some way been an effective controller of ore deposition". Likewise, speaking of the Spray lode, Waller (190 reports that the contact of the slates and sandstones with the melaphyre tuffs is approximately east west - "The lodes so far only proved to be productive southerly of the tuff belt".

The Florence and Oceana mines, both of which were highly productive, are situated on the south-eastern margin of major faults of the N.E. - S.W. system.

The Nike mine was opened up in a mineralised shatter zone rather than a defined fissure and is one of the few productive workings established on the northern or hanging-wall side of the major cross-faults. Another was Simson's Lode at the Western.

While the majority of the lode fissures are undoubtedly feather fractures related to the main faults, others may have been older and were truncated by the major faulting prior to mineralisation. Thus Curries Lode in the Florence mine area bends from north to west as it approaches the Waller Fault and some lodes in the Western and Montana mines behave in a similar manner near their convergence with the main slide (Montana Fault).

The King - Bell line of lode, along which a valuable ore shoot was encountered by tributors at Fahey's workings, is a singularly persistent line of strike faulting where mineralisation appears to occur independently of cross-faulting.

The published mine records provide only scanty figures on the size of the lodes and ore shoots, but it is apparent that the majority were less than one foot in width and of limited length and depth. According to the Manager of the Montana No. 1 mine (Craze, 1905), the lodes of the district "generally form a complex series, branching in various directions, and often forming a network of small veins, sometimes composed of pure ore; while at other times the veins of lode matter may be folkwed for long distances without producing anything of value. The size of the lodes also varies, ranging in width from one inch up to three feet. Some lodes are even up to 13 feet in width of nearly solid galena ore, but these are very rare. The average width of the lodes may be taken at from 6 to 8 inches, their value varying in the same manner as their width. The ore sometimes forms in shoots of lens shape while others have no particular shape but form patches or bunches in the lode gangue, thus necessitating continuous exploratory work on the part of the mines. Long drives are often driven without any signs of payable ore, while the lodes, when stoped as a whole, give very fair results".

DEPTH PERSISTENCE OF THE ORE SHOOTS

Published records of which extracts are given below clearly demonstrate that the basic reason for abandoning many of the larger mines was a decline in the dimensions of ore shoots rather than depressed ore values, water problems, or increased costs of progressively deeper mining.

Western: Winze sunk to 80 ft. below 800 ft. level; the lode in the bottom is small and poor.

Montana No. 1: Poor below 500 ft. level, shoots shorter, lodes principally siderite.

Spray: Shoot missing below No. 4 level.

Grubbs: Shoot of ore said to be very good above No. 3 level, lower down much poorer grade.

Junction: Lode went poor in No. 3 level.

Faheys (South King): Rich ore had pinched out at 200 ft.

Argent No. 4: Good shoot 75 ft. long to No. 2 level but did not live down to No. 3 level.

Considering the aerial extent of the Zeehan mineralised belt, which embraces about 20 square miles, it seems remarkable at first glance that each of the numerous lodes developed throughout the district proved to pinch out or become poorer at depths of only a few hundred feet - in some cases less than the range of altitudes at which deposits crop out at the present natural surface. However, the strike lengths of individual or shoots (and the lode fissures themselves) are likewise rarely more than a few hundred feet long, and the overall limited dimensions are considered to reflect the highly irregular and disrupted nature of the fracture system, giving rise to a different geometrical distribution of the lodes and ore shoots at various depths in any one locality.

MINERALISATION ALONG THE MAJOR FAULTS

The localisation of important lode deposits in proximity to the planes of major faulting, as described above, demonstrates that the latter have played an important role in providing access for mineralising solutions originating from a deep-seated (and probably granitic) source, but no important primary ore-bodies have been discovered along the recognised major faults. However, occurring at intervals along the major faults are large outcrops of manganiferous limonite resembling gossanous lode cappings, as at Balstrup's Manganese Hill, Central Balstrup, the Austral Valley flux quarry and Marsh's Iron Blow. Similar prominent ferruginous outcrops lie along unconformities, or possibly faults, at the Susannite and Boss mines. Tunnelling and shafts below each of these outcrops revealed that oxidation persisted to the tested depth limits of several hundred feet, but sporadic high silver values were invariably encountered, and although insufficient to justify deeper testing of these zones, are indicative of former primary mineralisation. Such deep weathering effects are unusual in the district and probably resulted from excessive ground water circulation that would be expected along these major structural breaks.

D. King

D.King
Brisbane
28.9.61.

REFERENCES

Campana & King, 1958. The age of the Zeehan Tillite (west Tasmania). Aust. Journal of Science. Vol. 20, No. 8.

Craze, 1905. The West Coast of Tasmania Mining Field. Zeehan School of Mines, Annual Report.

Jack, 1960. Report on the Oceana Mine, Zeehan. Tas. Dept. Mines, Technical Reports No. 5.

Montgomery, 1893. Interim Report on the State of the Mining Industry on the West Coast. Tas. Mines Dept., Sec. of Mines Report.

Montgomery, 1895-6. Report on the Progress of the Mineral Fields in the neighbourhood of Zeehan. Tas. Mines Dept., Sec. of Mines Report.

Thomae, 1895-6. The Zeehan and Dundas Silver Field, Tasmania. Trans. Inst. Min. Met., London.

Twelvetrees & Ward, 1910. The Ore-Bodies of the Zeehan Field. Tas. Mines Dept., Bull. No. 8.

Twelvetrees, 1900. Report on the Mineral Districts of Zeehan and Neighbourhood. Tas. Mines Dept., Sec. of Mines Report 1900-01.

Waller, 1904. Report on the Zeehan Silver-Lead Mining Field. Tas. Mines Dept.

Waterhouse, 1915. The South Heemskirk Tinfield. Bulletin 21, Tasmanian Mines Dept.

302023

TABLE I

PRODUCTION RECORDS OF SILVER-LEAD ORE FROM THE ZEEHAN DISTRICT

PRODUCTION PERIOD 1890-1918 OF SILVER-LEAD ORE IN TONS.

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	TOTALS
Montana No. 1				183	1366	1688	2218	2816	3353	3334	3301	3793	4030	3630	3932	3605	4531	4361	3572	7423	2909	2232	1433	1222	530	106	291	224	126	66209
Western	100	×400	×1000	×3000	×4000	×5000	×5000	×5000	3970	4062	2714	1605	12	58	390	881	2414	1806	613	600	690	352	383	183	27	29	72	38		44399
Spray									903	1687	3271	4158	5905	6763	6752	7206	8898	6685	4422	1485	443	1076	349	290	458	368	808	437	777	63141
Queen	×500	×1200	×2000	×2000	×2500	3700	3000	2000	1445	1704	1182	1202	1233	92	150	1647	1115	324	234	200	17	35	162	117	281	178	247	318	502	29285
Queen Extd								60	60	40			72	71	25	57	200	260	514	36	42		238	229	200					2104
Oonah			92	×400	×1100	×1400	×1500	×1500	1611	1805	445	227	255	114	52	107	407	2407	703	49	53			25			251	36	49	14388
King (mainly Faheys Tribute)										1571	2913	3463	1019	33	51	583	8	69	93	25										9828
Florence (Smiths)							×1000	×1500	1258	1500	2000			38	644	981	656	1965	2808	262	453			12						15077
Sylvester				38					40	135					36	516	302	80	50											1197
New Mt. Zeehan		300	350										65		131	423	306	301	589	139	40									2644
Balstrups																		151	124	67	23	10	11	13						399
State Mine (No. 5 Argent)																										458	812	618		1888
T.L.E.																		80	30	10	11	13								144
Sunrise			35									11									35									81
Maxim																	98				19									117
Nike																										157	592	211	327	1287
Swansea																													210	210
Nubèena			8												173	60	11	29	73	13										367
Comstock	×50	×100	×150									6	16				61	89	16											488
South Comstock												100	8	11	46	484	305	21	22		80	42	159	272						1550
Oceana	×200	×300	×500						517								130			22										1669
Watt & Mc Auliffe												50	73		25	181	99	166	61											655
Colonel North (Grubbs)		×287	×300	×400	×500	×400					450	200	105						320	250										3212
Victoria Zeehan																	14		28											42
Bell	×50	×100	×100							18	73	62	136	27				180	94											840
Crown			12						200	90																				302
Despatch			5																											5
Tasmanian	200	300	450																											950
Junction			25																											25
Brittania																														240
Western Consolidated												30	10												240					40
TOTALS	1100	2987	5027	6021	9466	12188	12718	12876	13357	15946	16349	14907	12939	10837	12407	16731	19555	18974	14366	10581	4815	3760	2735	2363	1736	1296	3073	1882	1991	262883

× Annual production figures estimated by proportionating total production to 1897

7376

7376 FROM [illegible]

302024

TABLE 2

PAST PRODUCTION OF ZEEHAN MINES CONSIDERED IN RELATION TO AGE OF HOST ROCKS

(Production of Silver-Lead Ore in Tons Prior to 1919)

Pre-Cambrian to Early Cambrian				Middle to Upper Cambrian		Ordovician Gordon Limestone		Silurian to Devonian	
Spilite Present		No Spilite Observed							
Grubbs	3212	Nike	1287	Sylvester	1197	Oceana	1669	King	9828
Montana No. 1	66209	Nubeena	367	New Mt.Zeehan	2644	Despatch	5	Florence	15077
Oonah	14388	Comstock	488	Balstrups	399	Crown		Sunrise	81
Queen	29285	S. Comstock	1550	State	1888			Bell	840
Queen Extd.	2104	Victoria Zeehan	42	T.L.E.	144				
Spray	63141	Crown	302	Maxim	117				
Western	44399	Junction	25	Swansea	210				
		Brittania	240	Watt & McAuliffe	655				
		Western Con.	40	Tasmanian	950				
TOTALS (tons)	222,738		4,341		8,204		1,674		25,826
PER CENT.	84.6		1.7		3.2		0.7		9.8

609

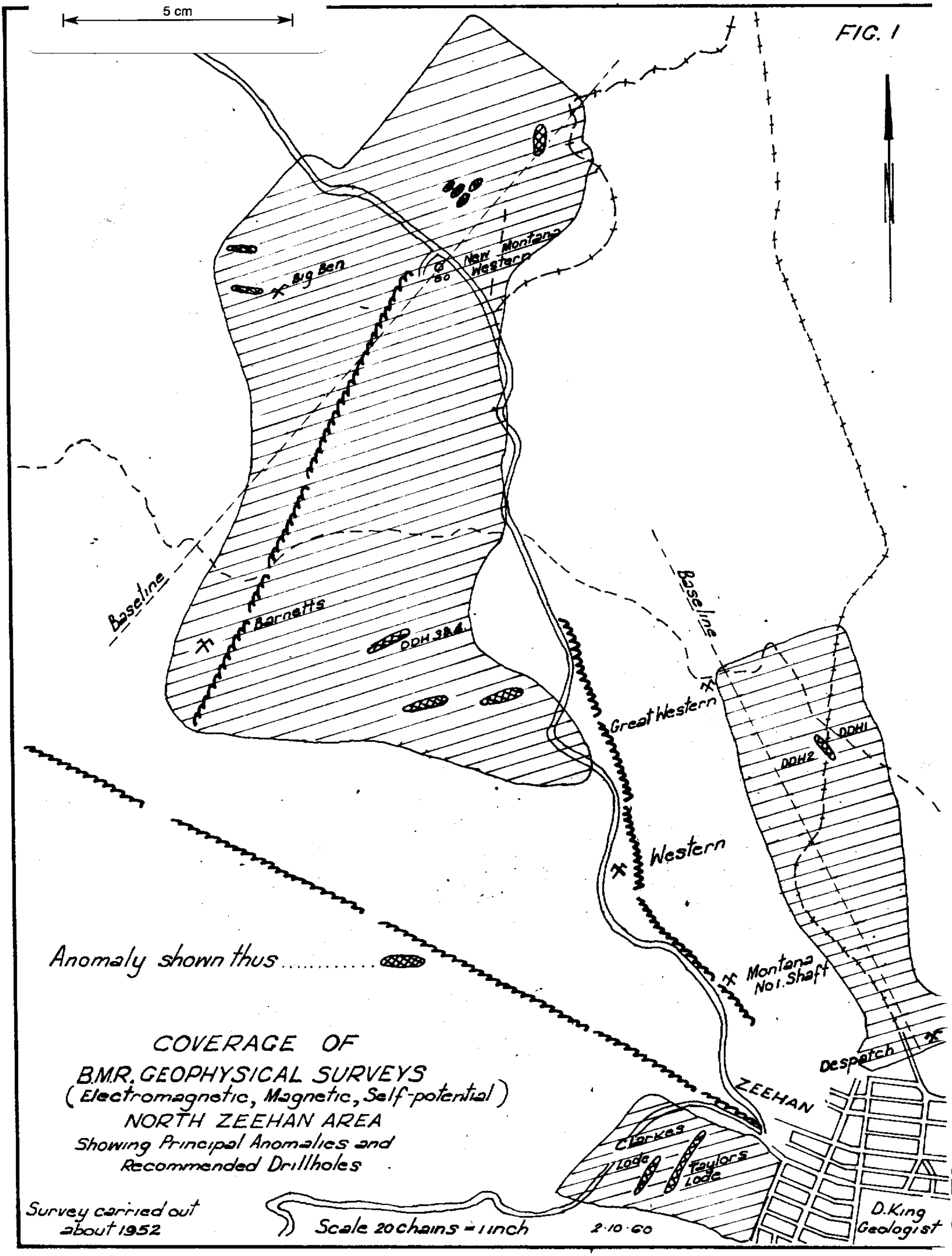
TABLE 3

WEIGHTED AVERAGE SILVER VALUES OF GALENA ORE FROM ZEEHAN MINES CONSIDERED IN RELATION TO AGE OF HOST ROCKS.

(silver values in ounces/unit of lead)

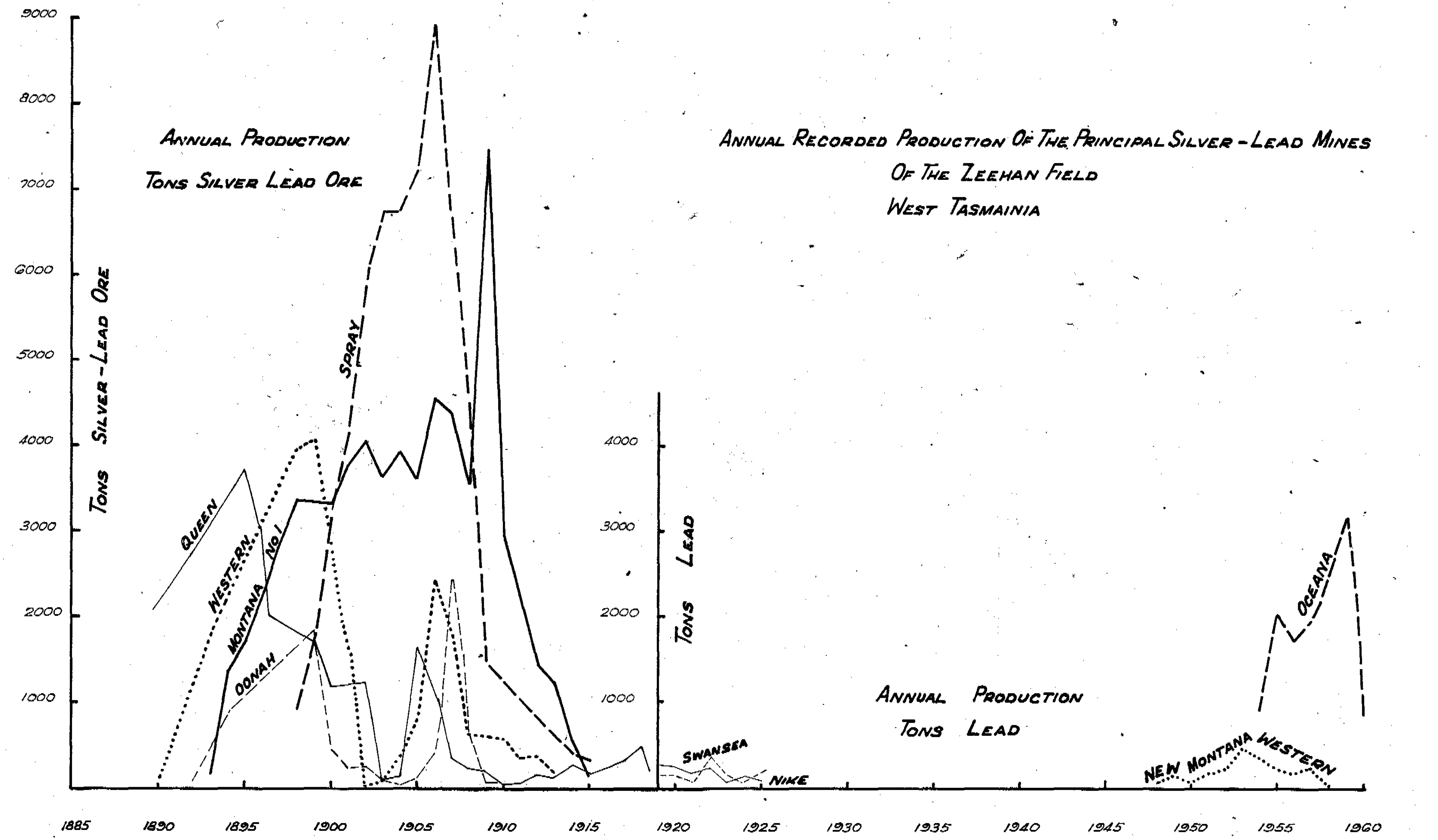
Pre-Cambrian to Early Cambrian				Middle to Upper Cambrian		Ordovician Gordon Limestone		Siluvian to Devonian	
Spilite Present		No Spilite Observed		(Dundas Group)		(Eldon Group)		(Junee Group)	
Grubbs	0.9	No.2 Argent	1.4	No.2 Montana	0.6	Despatch	0.1	Bell	0.8
No.1 Montana	1.4	Big Ben	1.2	New Mt.Zeehan	0.6	Kemp's	0.3	Florence	1.3
Oonah	1.3	Brittania	1.0	Stonehenge	1.0	Oceana	0.4	King	0.4
Queen	1.2	Comstock	0.8	Swansea	0.5	Pyramid	0.1	King, South	0.8
Queen Extd.	1.0	Comstock South	1.3	Sylvester	0.4				
Spray	1.2	Crown	1.0	Tasmanian	0.5				
Western	1.8	New Mont.West	1.2	Tasmanian, North	0.9				
		Nike	1.0	T.L.E.	1.3				
		Nubeena	0.9						
		Sunshine	0.8						
		Susannite	1.2						

302026



FROM D KINGS ORIGINAL

302027 FIG 2.



Compiled from Mines Dept. Annual & Quarterley Reports. D. King 24·8·61

From D King originals

302028

LEGEND

STRATIGRAPHY

PERMIAN
Montana Tillite
SILURIAN TO DEVONIAN
Eldon Group (undifferentiated)
ORDOVICIAN
Gordon Limestone
Owen Conglomerate
MIDDLE TO UPPER CAMBRIAN
Dundas Group
PRE-CAMBRIAN TO EARLY CAMBRIAN
Davey and Carbine Groups

IGNEOUS ROCKS

TERTIARY BASALT
JURASSIC DOLERITE
DEVONIAN GRANITE AND PORPHYRITIC RHYOLITE — Dg
CAMBRIAN GABBROS (and Serpentine)
CAMBRIAN SPILITES AND PYROCLASTICS

STRUCTURAL

Strike and dip of Bedding — 20
Form lines
Synclinal Axis
Anticlinal Axis
Fault

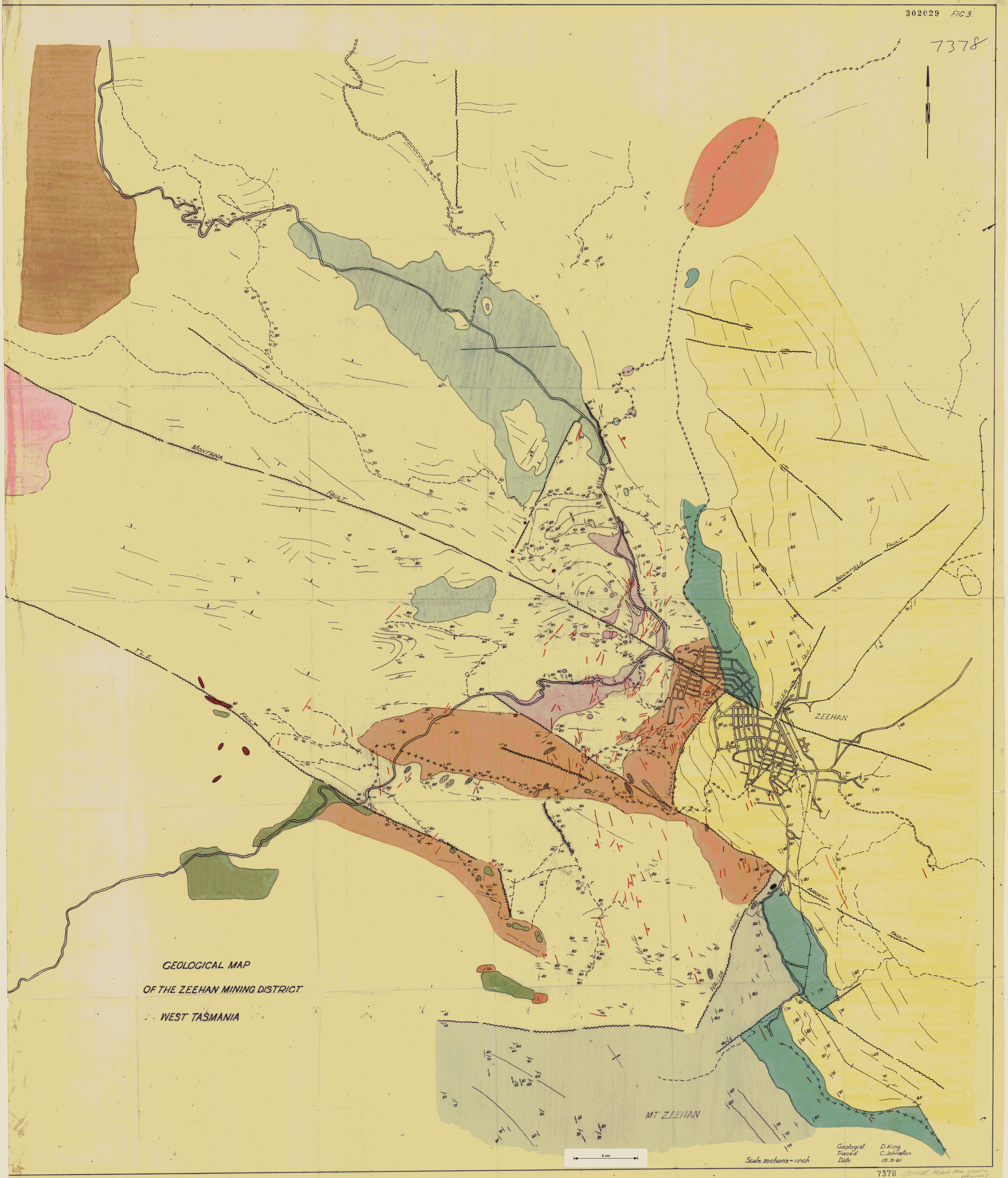
MINERALISATION

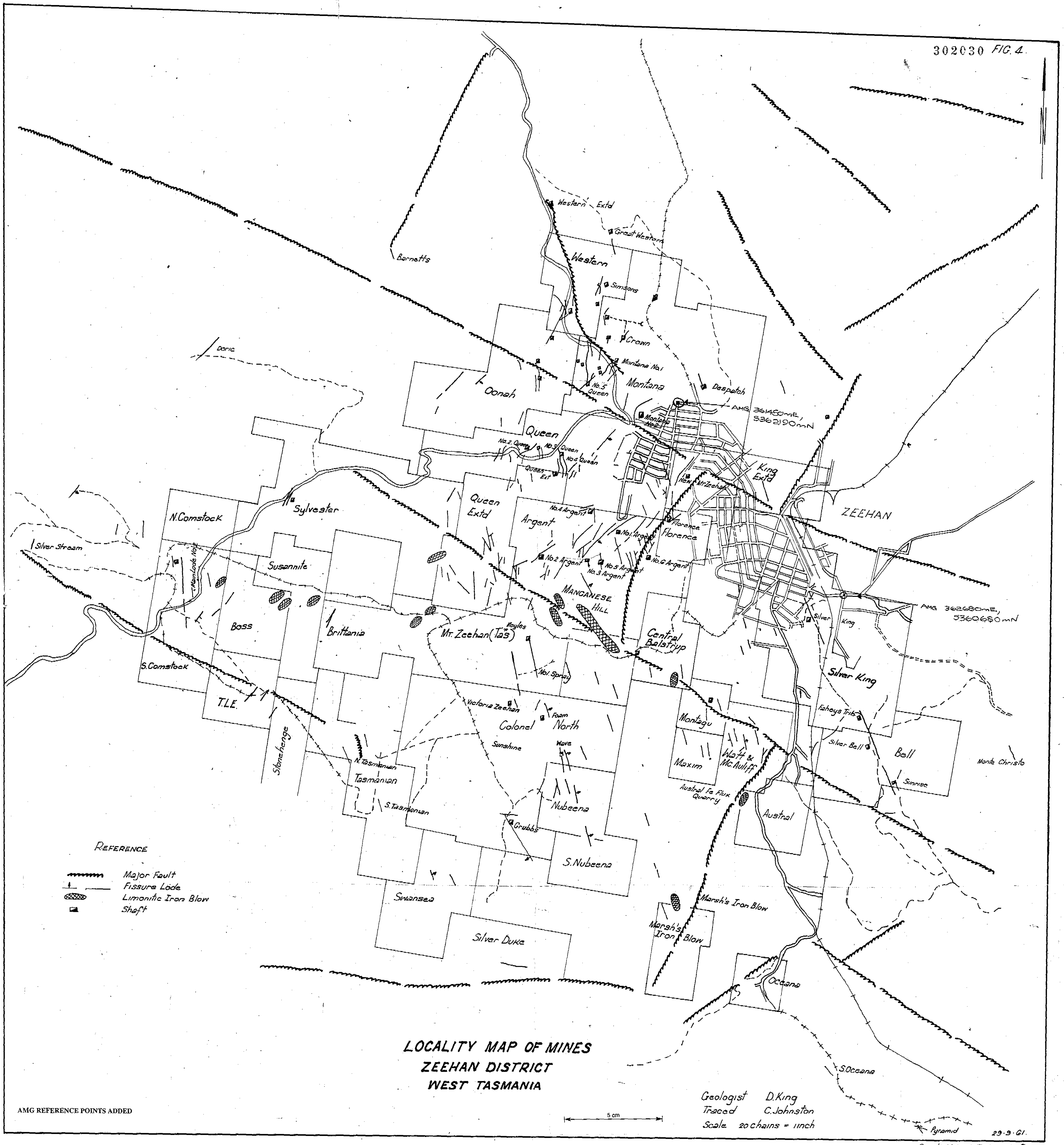
Productive Fissure Lode
Limonitic Iron Blow
Magnetite Segregation

TOPOGRAPHIC

Main Road
Track
Railway
Tramway

Topographic Base From Lands & Survey Dept 20 chain plans Zeehan Sheet


302029 FIG 3.
7378
N
MONTANA FAULT
TLE FAULT
BOCKFIELD FAULT
WALLER FAULT
ZEEHAN
ARGENT FAULT
MT ZEEHAN
GEOLOGICAL MAP
OF THE ZEEHAN MINING DISTRICT
WEST TASMANIA
Scale 20chains = 1inch
Geologist D.King
Traced C.Johnston
Date 15·9·61
7378
OUTSIDE PLAN FROM DKINGS ORIGINALS



LOCALITY MAP OF MINES
ZEEHAN DISTRICT
WEST TASMANIA

Geologist D. King
Traced C. Johnston
Scale 20 chains = 1 inch

29.9.61.

AMG REFERENCE POINTS ADDED

From D. Kings original

7379