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THE SPRAY SHEAR ZONE

Z E E H A N

T A S M A N I A

A SILVER-LEAD-ANTIMONY PROJECT

by

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MICROFILMED

THE SPRAY SHEAR ZONE OF ZEEHAN

A Silver-Lead-Antimony Project

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PREFACE

Both Mount Lyell and Zeehan are undeniably localities of intense mineralisation, but Zeehan has never had the integration of finance, courage and project perception which has been and still is the characteristic of Mount Lyell. Changing phases of mineral constitution of progressively available ore bodies at Lyell have coincided with newly attainable mining, metallurgical and mechanical methods, while at Zeehan far more pronounced mineralogic changes when first exposed faced a metallurgical impasse. Rendered idle by untreatability, important ore complexes at Zeehan have been lost sight of. It is now opportune to resurrect them.

The Onah-Western tin-silver project is in process of testing. This compilation presents the spray shear zone silver-lead-antimony project embracing mineral assemblages exposed and abandoned 60 years ago.

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THE SPRAY SHEAR ZONE OF ZEEHAN

A Silver-Lead-Antimony Project

CONSPECTUS

The Spray Shear Zone is the outstanding structural unit of the Zeehan Field. It stretches from the south-western corner of the Argent Flat through the old spray mine for a distance of 9600 feet. It is essentially a belt 900 to 1000 feet wide with a known development of five well defined shears. These shears have a noticeable parallelism which at magnetic bearing of 332° is parallel to the shear zone as a whole.

The shear zone begins at the north on its north-western limit in Nubeena Quartzites of the Nike, extends through narrow belts of Keratophytic Tuffs and Spilite Tuffs where it has had limited penetration - may be unimportant towards the spray in which it has its most prolific exploration and exploitation. Thence it continues south-eastwards through scattered workings known consecutively as Foam, Wave, Nubeena and South Nubeena with Perry's as a possible offset south-easterly extension.

Although the subject of a little surface work at the Nubeena in 1892, the important and productive Nos. (1) and (3) Lodes were not discovered until 1898 by two prospectors Page and McDermot. From then until 1908 the Spray Zone produced 49,000 tons of lead and 4,500,000 ozs. of silver.

The lodes as worked up to 1908 had shown galena plus subordinate tetrahedrite and jamesonite in the upper levels but a drastic change at A.M.L. 1800 (i.e. No. 4 level of Spray Mine) to tetrahedrite plus jamesonite with no galena or an insignificant amount of it.

The inability of the Spray gravity mill to treat this mixture and the imposition by ore-buyers of heavy penalties for antimony resulted in the closing down of the Spray Mine in 1908. There has been no production since.

Valiant attempts to open up the south-eastern extensions of Lodes (1) and (3) within the Shear Zone by successive small syndicates in the Foam, Wave, Nubeena and South Nubeena where the topography compelled penetration to be confined to higher levels circa A.M.L. 2100 which was the upper limit of the rich shoots in

the spray, failed to disclose the solid galena bands essential to those with limited capital. However, such work, although economically unprofitable, did disclose the persistence and strength of the Nos. (1) and (3) Shears with indications of the continuance of the others. As a result it is now possible to delineate the spray shear zone as an important producer when attacked at the appropriate level. This is illustrated by the map and sections accompanying this compilation. It must incidentally be emphasised that the structural unit, designated Spray Shear Zone being between the N.W. - S.E. Montana Tear Fault and the North Austral N.E. - S.W. Tear Fault converging to the east with sub-horizontal movement, created the stress on the susceptible Nubeena Quartzites, fits concordantly into the major tear-fault system which dominates the metallogenic problem of Zeehan.

The future of the Spray Shear Zone rests not on galena, which in the Nubeena Quartzite formation is merely a shallow level phase, but in the tetrahedrite-jamesonite-boulangerite complex attainable by depth development. This ore has high silver values, the Ag : Pb ratio in the crude ore being ^{1.7:1} ~~1:1~~.

The last 60 feet of driving on No. (1) Lode at the Spray in 1908 at No. 6 level (A.M.L. 1600) on the Centre Shoot, was face-sampled over a width of 6 feet and gave a bulk assay as reported by Vincent:

Pb	14.3 %
Ag	23 ozs. per ton.

The ore was a mixture of tetrahedrite and jamesonite but practically no galena. No complete assay of the metal components was ever published but surreptitiously divulged, the results from the Zeehan Smelters confirmed by one of my students at the Launceston Technical School, who privately secured part of the bulk sample, disclosed the following:-

Pb	14 %
Sb	11 %
Cu	2 %
Ag	23 ozs. per ton.

This 11% Sb made any economic sale out of the question and the management, throwing their hands up in despair, shut down the mine. The ore has not been touched since.

It was the antimony which was the 'bete noir' of the Spray Shear Zone although the Company's published assays never reported it. So much was it a bugbear that even Twelvetrees and Ward in Geol. Surv. Bull. No. 8 brush aside any 'antimonial lead ore' as unimportant. The following pages demonstrate in detail how important it is and how it can be pursued and developed.

THE SPRAY SHEAR ZONE OF ZEEHANI - LOCATION, EXTENT AND ACCESS

The Spray Shear Zone is situated in the south-central portion of the Zeehan Field. It extends from the Nike mine at the southern end of Queen Hill across the old Grubbs (Comstock) Tram, through the Spray Mine, thence along the Nubeena Hills to the North Austral Tear Fault which, offsetting it to the east, presents a possible south-easterly extension known as Perry's.

Its width is 900-1000 feet. The actual number of individual shears has not been determined but there are five within a width of 600 feet in the Spray workings. So far, Shears Nos. (1) and (3) have proved to be the most important.

The total length of the Zone is 9600 feet as measured to the North Austral Tear Fault, but if Perry's proves to be an offset continuation the figure approaches the 10,000 feet mark.

Although in an area of youthful topography, the contours ranging from A.M.L. 2000 to A.M.L. 2600,⁽¹⁾ access to any part of it presents no difficulties. In the general map accompanying this compilation the state of existing lines of communication are differentiated by appropriate symbols into:-

Roads usable by heavy motor trucks.

Roads suitable only for cars and jeeps.

Tracks available only as footpaths.

Attention is drawn to the road along the old Spray Tram which passes through a tunnel under the Grubbs Tram. This tunnel was meant to take ordinary mine trucks on rails and therefore will not take a wide or high truck load although quite adequate for ordinary cars.

(1) These heights are in feet above an arbitrary datum of 1275 feet below sea level. This is to facilitate correlation of mine workings and to prevent future mine levels of minus figures. Thus the collar of the Western Shaft at 725 ft. above sea level becomes A.M.L. 2000.

It is realised that venturesome youth would, with some improvisation, take a jeep or Land rover over any of the tracks shown on the map.

The access data of the Groups from North to South are:-

NIKE

Good lorry road of 90 chains from Main Street. Shaft collar is 100 chains in a straight line from H.E.C. Transformer Station near the Post Office.

SPRAY

No. 1 Shaft collar is accessible on good motor transport road either from Main Street along Fowler Street via north-east side of Manganese Hill and thence along the old Comstock Tram route or alternatively along the latter starting from near Zeehan Railway Station. The distance along either route is 90 chains. The H.E.C. Transformer Station is 104 chains distant in a straight line.

FOAM

These old workings are accessible via the Comstock and Grubbs tramway formations, a branch of the latter 9 chains in length leading to the western side of the Spray Hill, the total distance along this route being $3\frac{1}{2}$ miles from Main Street.

WAVE

An extension of the abovementioned branch from Grubbs tramway leads in 12 chains to the Wave workings which in a straight line are 170 chains distant from the H.E.C. Transformer Station in Main Street.

NUBEENA

The workings here are on both the western and eastern slopes of the Nubeena Hill. Access to the former is by a 15 chains branch from Gubbs tramway. The eastern side known as Llewellyn's is accessible along an old tram formation which starts from Smelters Road at the northern end of the Austral Flux Quarry. It is 86 chains from the road to the workings; the distance of the turn-off from Main Street is 84 chains, thus making the workings 170 chains from Main Street. The nearest H.E.C. Transformer Station is at the old Smelter site, the distance being 120 chains.

SOUTH NUBEENA

Alternatively known as Butler's or Beaumont's these workings are reached via a 14 chains branch from Llewellyn's tramway. It is the same distance from the Smelters Road as the Nubeena.

PERRY'S

This possible offset southerly extension of the Spray Shear Zone is reached by a foot track branching from Llewellan's tramway at a point 10 chains from Smelters Road. It is thus 30 chains from the road and 104 chains from Main Street.

II RELATION TO REGIONAL GEOLOGICAL STRUCTURE

1. The Master Faults

A pronounced anticline with a corresponding syncline to the east developed at Zeehan during the early phase of the late Devonian (Tabberaberan) Orogeny. The dynamic factor was pressure from the west. This pressure broke the anticline between Kemp's on the north and the Oceana in the south. The result was the Waller Fault which brought the Cambrian formations in juxtaposition to those of Silurian Age. The movement was upward at a steep angle and was the order of magnitude of some thousands of feet. Mount Zeehan stands as a relatively unbroken relic of this major structure.

At a later stage of the Tabberaberan Orogeny, the pressure from the west became more horizontal and the movement took the form of sub-horizontal Tear Faults. The movement (from west to east) on these Tear Faults varies, but is of a major order of magnitude. Thus the movement on the south side of the Balstrup Tear Fault is upwards of 3000 feet horizontally and that on the north side of the Oceana Tear Fault is 2500 feet. The mechanical magnitude of the movement along these Tear Faults is further emphasised by the Montana-Oonah Tear Fault which, although showing a lateral translation of only 1600 feet, discloses a breccia zone 150 feet wide. The Tear Faults extend for many miles in length, the Montana Main Tear Fault penetrating and translating the Heemskirk granite 10 miles to the west.

These Tear Faults are the great ore-feeders of the West Coast sometimes as at North Lyell and the Oonah stannite lode being the actual repository of ore, but more often being the feeders to minor structures where ore-bodies have developed.

However, they have played a special role in giving rise to the Spray Shear Zone. This has resulted from the relative orientations of two groups of tear faults - a northern and a southern. The North Group run N.W. - S.E. while the South Group strike N.E. - S.W. The lateral movement is eastwards on the south side of the North Group and also eastwards on the north side of the South Group. There is thus a block of sedimentary formations squeezed between the Montana-Oonah and the Oceana Tear Faults converging eastwards from a distance apart of 21,000 feet

at the meridian of the Western Shaft down to 12,000 feet at the meridian of the Zeehan Smelters.

Any attempt to decipher the structural character of Zeehan must also take cognisance of a Central Group of Tear Faults with orientations approximately West-East. Two are on a minor scale, viz: the Manganese and Central Tear Faults through Manganese Hill. But one is on a major scale namely the Balstrup Tear Fault which in combination with the Nubeena Tear Fault shows an easterly translation of the south block of 3,000 feet. This structural block embraces the major portion of the Spray Shear Zone namely the Spray, Foam, Wave, Nubeena and South Nubeena being terminated at the North Austral Tear Fault and thus having a length of 8000 feet.

The measurement of the above-stated lateral translations is based on the relative positions of the Waller Fault which preceded the tear faults and was later cut by them. The nature of the Tear Faults has been recorded by Waller in no uncertain manner. This is part of what he said of the Northern Group in 1904 when they were open to his detailed examination. (2)

"A curious feature of the Montana and surrounding mines is the presence of what I believe is a series of parallel cross-lodes, striking about 50° to 60° west of north and dipping to the north-east at an angle of 40° to 50° . These cross-lodes, or as they are termed locally, 'slides' are more permanent than most of the productive lodes. The latter appear to occur in the country between two such cross-lodes, and the same productive lode has never with certainty been known to cross them. The cross-lodes are large fissure formations, with slickensided walls, the slickensides being usually horizontal, showing that the movement has been horizontal and not vertical."

The effect of such compression has varied in different parts of the field and in different rock formations. This report is confining itself to a belt about 1000 feet wide in which the stress produced well-defined shears oriented on a general magnetic bearing of 332° . The central portion of this belt between Tear Faults Balstrup and North Austral is an arresting 6000 feet in length. It contains five shears within a width of 600 feet. Waller saw

(2) G.A. Waller: The Zeehan Mining Field - P.37,38.

them and studied their characteristics while they were being opened up. This is what he wrote in 1904:⁽³⁾

"The lodes of the Spray Mine present a remarkable contrast to those on the adjoining sections to the north. In the latter the lodes are very numerous, but they are for the most part, small irregular, ill-defined and patchy. The good lodes on the Spray section are on the other hand, fine, well-defined fissure formations, running parallel with one another, and maintaining a true course throughout. The strike of the lodes is about 28° west of north and the dip almost vertical. The latter changes somewhat in different parts, being sometimes slightly to the east and sometimes to the west. The two principal ones are No. 1, or the main Spray lode, and No. 3 (Gurnie's lode) 584 feet to the south-west of the main lode. Between these there are three other formations, which so far have not been developed. These lodes belong to the pyrito-siderite formation, the gangue being partly pyrites and partly carbonate of iron..... As I have already stated the lodes are large fissure formations, with usually a main seam of 'dig' or flucan on one of the walls..... The walls are usually grooved or striated in a nearly horizontal direction but inclined slightly to the north."

In the general map accompanying this report the Spray Shear Zone is shown continuing another 1600 feet north-westwards from the Balstrup Tear Fault. It is thus shown as passing through a width of 400 feet of the late Proterozoic Spillite tuffs and slates between Tear Faults Balstrup and Central. Then through 1600 feet of Cambrian Keratophytic Tuffs and slates, and finally 600 feet into the southern portion of the Nubeena quartzites and slates of the Queen Hill. It is the character of the lode types in this latter locality (the Nike) which attracts this north-westerly extension. Although not definite shears, there occur in these Nubeena Quartzites a stockwork of lead-antimony-silver

(3) G.A. Waller: "The Zeehan Mining Field" 1904. P. 79.

mineralisation of the Spray type within a shatter-zone.

In the intervening spilitic and keratophyric belts, only one lode (Moyle's on the line of No. 3 Spray Lode) has so far been located on the surface although underground workings followed the Spray No. 1 Lode well into the spilites.

In the south-eastern portion of the Spray Shear Zone there exists a problem as to what happens beyond the North Austral Tear Fault. No continuation of either Nos. 1 and 3 shears on the 332° strike have been found, but about 600 feet east Perry's lode is suggestive of Spray No. 3 Lode. The Spray Shear Zone appears, therefore, to be offset about 2200 feet eastwards. This requires further exploration.

2. The Nature of the Shears

Nos. 1, 2, 2A and 4 Lodes follow the shears. Their general orientation is therefore 332° . The only marked variation from this orientation is at 120 feet north of No. 2 Shaft where No. 1 lode deviates 12° - 15° from the general bearing for a distance of about 250 feet, beyond which it resumes its normal course.

In addition there is the rather obscure reference to "the split" in Twelvetrees "Field Notes". Waller does not mention it and McDermott has never heard of it. Walford states that at anything from 30 to 100 feet north of the Internal Shaft they met a break or split in the No. 1 lode at all levels, the lode being offset 8 to 10 feet. This may or may not be "the split" referred to by Twelvetrees. This is what Twelvetrees says (quoting information from Mr. T. Vincent, Manager, Spray Mine).⁽⁴⁾

"First came on the Split in No. 1 and in the adit.
Split dipping to S. Split in N.W. direction. Have
picked the split up in all the levels. A very rich
bunch at the junction 11ft. wide. Three years ago
got a rich bunch of ore at the split of the lodes.
Stoped out the ore between two winzes."

If Twelvetrees "split" corresponds to Walford's "break" there is some confirmation of it in the mine plan at Nos. 1, 3, 5 and 6 levels where offsets or bulges in the drives show a south-dipping effect. This

(4) W.H. Twelvetrees "Field Notes" 1909. P.2.

south dip actually brings the effect south of the Internal Shaft at 5 and 6 Levels.

Another local and limited departure from the regular orientation is mentioned by Twelvetrees. He states:-

"Crosscourses in No. 5 and 6. These carried a very little galena. The branch was never seen above No. 4. Strike about W. 5° N. Nothing payable found in it. The lode has a tendency to branch again further on in the same level and in same direction." (5)

"In Nos. 4 and 5 levels north the lode turns W. This is rather a poor branch. They then picked up the east wall of the lode with ore giving 60 oz. and 7%. No sign of it (the ore. GA) in No. 4. The main channel continued towards the No. 1 Spray Shaft". (6)

"Never saw galena in No. 5 drive. The W. branch of No. 5 carried lead ore 3 or 4 stopes up. The E. branch never carried lead ore. It is 4 ft. wide antimonial ore and siderite - the first place where there was any distinction between antimonial ore and lead ore". (7)

It would thus appear that Twelvetree's reference to "Crosscourses in Nos. 5 and 6" should be read "Crosscourses in Nos. 4 and 5". It seems scarcely likely that they are "crosscourses" similar to those in the Montana etc. On the evidence it would at present be preferable to regard them as "counters" associated with the shear at Kalgoorlie for example.

In regard to No. 3 Lode the only recorded deviation from the regular direction is the split at the extreme southern end at Adit level. This is shown in mine plans.

(5) Twelvetrees "Field Notes 1909" P. 4
 (6) " " " " P. 5
 (7) " " " " P.6..

III THE ROCK FORMATIONS INVOLVED

It must be emphasised that, as so far observed, the outstanding shearing is in the Nubeena Quartzites and Slates. This rock formation shows up prominently in the Nubeena Hills as near-white outcrops. Actually both quartzites and slates are dark-grey to blackish when opened up underground. The whitish surface appearance is the combined effect of weathering and of numerous gash-veins of white quartz. The latter are particularly noticeable in the eastern portion of the Nubeena area.

As the Spray Shear Zone is followed north-westwards through the narrow belts of spilitic and keratophyric tuffs, no obvious shearing is in evidence, the lode known as Moyle's although right on the line of spray No. 3 Lode does not display the characteristics of a straight shear but these may be masked by the factual intersecting of it by the Central Tear Fault.

Where the Zone re-encounters the Nubeena quartzites at the Nike the effect is shatter, no definite shear having so far been exposed in the workings.

It is especially noteworthy that the mineralisation in both shear and shatter zones within the Nubeena Quartzites is characterised by the presence of antimony which may be in the form of tetrahedrite, jamesonite or boulangerite. The relationship between the galena and this antimonial ore is dealt with in the next chapter but it is opportune to condemn the practice common to most of the literature of Zeehan of disparaging by brushing aside such ores as 'antimonial lead'.

IV THE FACTOR OF MINERAL VARIATION
HORIZONTALLY AND VERTICALLY

Twelvetreets and Ward imposed on Zeehan the Spurr - Emmons - Lindgren dogma of mineral control as a simple factor of distance from a hypothetical granitic hearth. Subsequent studies of metallogenesis and disclosures by actual mining operations compels a realisation that on the West Coastal Region of Tasmania no such simple zonal control has operated. It must be admitted, of course, that localities such as Butte Montana and Cornwall England show a close approach to zonal precipitation of text book type. But the great mining fields of the world such as Broken Hill, Mt. Isa and the Rand show no signs of it. So the West Coast and particularly Zeehan are in good company.

Nevertheless, mineral changes within the ore lode do occur as positive and persistent developments of great economic importance. Thus the Silver Lode of the Western mine changed at A.M.L. 1500 from siderite-galena to siderite-tetrahedrite-chalcopyrite. The zinc-lead sulphide of the Black P.A. at Rosebery changed in a vertical distance to a tin lode carrying 4% Sn. The stannite lode of the Oonah carrying some galena near the surface shows none at the No. 6 Level (A.M.L. 1600).

This change does not follow along the lode at a constant level. Thus the Silver Lode of the Western shows its change of mineralisation occurred at A.M.L. 1800 ^{in the junction} and in the Oonah at A.M.L. 2000.

Recently N.L. Markham⁽⁸⁾ has drawn attention to the change from south to north at Lyell of decreasing pyrite with a concomitant increase in chalcopyrite, bornite, chalcocite and digenite with pyritic lead-zinc ores with tetrahedrite occupying the marginal fringe. This is not a zonal concept but is an indication of a variation in phase equilibria from south to north horizontally.

Thus it is not surprising to find that as the Spray No. 1 Lode is followed southwards, it shows tetrahedrite - jamesonite ore at A.M.L. 2100. This is at the bottom of the Foam Adit workings which have not been touched for over 60 years. Fragments of the jamesonite-tetrahedrite ore can still be found on the old knapping floor. This old exposure is 900 feet south of the most southerly of the Spray drives.

(8) N.L. Markham: "An Interpretation of the Mt. Lyell Copper Ore Paragenesis" Proc. A.I.M.M. No. 206. 1963. P.123.

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All the workings southwards of this are at a higher level but almost invariably the lode material shows signs of the antimony effect. Thus at Llewellan's it is sufficient to lift the Pb : Ag ratio to 1 : 1.3.

Northwards at the Nike jamesonite is prominent right from the surface.

Although, therefore, there is some evidence of a rise of the top of the antimony supremacy southwards, it seems more probable that this horizon fluctuates between A.M.L. 1800 and A.M.L. 2100.

It is abundantly apparent that the Nubeena Quartzites and Slates are 'par excellence' the repositories of the Pb-Sb-Ag phase, the Tear Fault feeders being the Balstrup, Nubeena, Manganese and North Austral.

Thus the rock-type appears to be an influence but not a determining factor. We must look for a more dominating control. There are two outstanding determinants - the Tear Faults and Magma Hot-Spots.

In the Western United States, Billingsly and Locke have shown that tear faults are the feeders of the mineral fields; Thomas and Macalister depict similar faults as ore-feeders at St. Andreasberg; in Tasmania, Mount Lyell, Mount Bischoff, Renison Bell, Read-Rosebery and Zeehan the same thing applies.

However, in studying the details within the western portion of the Zeehan mineral field, it has become disclosed that each Tear Fault produces its own particular vein-type. It is further apparent that such vein-types vary with the distance from certain magmatic hot-spots through which the Tear Fault passes.

Thus the Montana Main Tear Fault produced the tetrahedrite-chalcopryrite Silver Lode, being fed from the Sligo hot-spot; the Oonah Tear Fault produced the Stannite Lode and Clarke's Lode being fed from the same heat source; the Queen Tear Fault produced Bradshaw's and Pastkuchen's Lodes as well as the zinciferous No. 4 Queen Lode more distant from the heat source; the Balstrup Tear Fault fed the Spray Lode with its tetrahedrite-jamesonite character as contrasted with its Montagu No. 1 siderite-galena product further to the east from the Comstock hot-spot.

V THE MINING AND PROSPECTING PENETRATIONS

1. Shafts

(a) Spray

No. 1 or Main Shaft is from the surface at A.M.L. 2085. It was started in 1905 to replace the internal shaft. It is 18' x 7' in the clear and is down 410 feet, the bottom being at A.M.L. 1695. It is in good condition. It is connected with 'E' Adit drive at A.M.L. 2057, with No. 3 Level at A.M.L. 1857; but at No. 5 Level A.M.L. 1701 a drive of 45 feet southwards is still 66 feet north of the north drive from No. 2 shaft.

The Internal or No. 2 Shaft was originally a winze on the No. 1 Lode from the 'A' Adit Level. It was later enlarged to a working shaft, winding engine etc, being installed in a chamber excavated at Adit Level. A ventilation rise was put up to 'C' Level. It is 475 feet deep to bottom of sump at A.M.L. 1600. As a working shaft it proved cumbersome and uneconomic. Waller had this to say in 1904.

"The sinking of a main shaft in this part of the property should, I think, be taken into consideration by the management. The present system of mining is far from economical, and the splendid returns which have been obtained from these lodes surely warrant the expenditure necessary for their thorough and systematic development".⁽⁹⁾

The No. 2 Shaft was re-equipped in 1947 by Zeehan Mines Ltd. and unwatered down to No. 4 Level. At that stage the sudden abandonment of operations by Zeehan Mines Ltd. was reminiscent of the blundering despair of the Vincent regime early in 1909.

The maximum water pumped from both shafts during the winter of 1908 was 24,000 gals. per hour⁽¹⁰⁾. This is very much less than many other mines such as the Florence or the Oceana.

(9) G.A. Waller: Report on the Zeehan Silver-Lead Mining Field 1904. P.82.

(10) Z & D Herald: 25th March, 1918.

(b) FoamColonel North Shaft:

Location: On W. side of Nubeena Ridge at A.M.L. 2250
 Date: 1896
 Depth: 200 feet at A.M.L. 2050
 Condition: Collapsed.

Adit Shaft:

Location: From Foam Adit at A.M.L. 2150
 Date: 1902
 Depth: 100 feet at A.M.L. 2050
 Condition: Unknown.

Surface Shaft:

Location: 100 ft. S. Foam Adit Portal at A.M.L. 2250
 Date: 1908
 Depth: 310 feet at A.M.L. 1940
 Condition: Collapsed.

(c) WaveSurface Shaft:

Location: At portal Upper Wave Adit at A.M.L. 2350
 Date: 1902
 Depth: 70 feet at A.M.L. 2230
 Condition: Open.

(d) NikeMain Shaft:

Location: Alongside portal of Upper Adit on Main Lode Group at A.M.L. 2180
 Date: 1915-1926
 Depth: 240 feet at A.M.L. 1940
 Condition: Incline Shaft blocked by fall in approach.

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2. Adits

(a) Spray

Tunnels B,C, D, and F are at the upper levels and have no special significance at the present juncture.

'A' Tunnel at A.M.L. 2067 runs straight from portal to No. 3 Lode - a distance of 1071 feet. The entrance is open but needs draining. It was re-opened and reconditioned by Zeehan Mines Ltd. in 1947. The chamber at the collar of No. 2 Shaft was enlarged and the shaft put into operation.

'E' Tunnel at A.M.L. 2086, which is about 10 feet higher than 'A' runs straight to the end at 360 feet having cut No. 1 Lode at 330 feet. The entrance is blocked by an accumulation of ferric hydroxide but can be easily drained. It should be in good condition.

'H' Tunnel at A.M.L. 2105, is about 20 feet above the collar of No. 1 shaft. It has been driven a distance of 50 feet to cut the northern continuation of the No. 1 Lode. It is open.

'G' Tunnel at A.M.L. 2076 cut No. 1 Lode at 45 feet.

(b) South Spray

The area being one of high relief adits prevail. The following are the principal adits. The exact length of some of them is at present unknown. The need is obvious for re-opening and examination.

Foam Adit

Elevation: A.M.L. 2150
Direction: 40°
Length: 600 feet

Upper Wave Adit

Elevation: A.M.L. 2350
Direction: 170°
Length: 250 feet.

Lower Wave Adit

Elevation: A.M.L. 2250
Direction: 100°
Length: 500 feet.

Barnett's Adit

Elevation: A.M.L. 2230
 Direction: 90°
 Length: 250 feet.

Llewellyn's Upper Adit

Elevation: A.M.L. 2380
 Direction: 330°
 Length: 90 feet.

Llewellyn's Lower Adit

Elevation: A.M.L. 2300
 Direction: 330°
 Length: 250 feet.

Upper South Nubeena Adit

Elevation: A.M.L. 2180
 Direction: 150°
 Length: 100 feet.

Lower South Nubeena Adit

Elevation: A.M.L. 2150
 Direction: 220°
 Length: 160 feet.

Beaumont's Adit

Elevation: A.M.L. 2020
 Direction: 220°
 Length: 700 feet.

Perry's Adit

Elevation: A.M.L. 2030
 Direction: 240°
 Length: 650 feet.

(c) North SprayTop Adits

Elevation: At A.M.L. 2180
 Direction: 360° and 330° respectively
 Length: Unknown.

Quigley's Adit

Elevation: At A.M.L. 2100
 Direction: 60°
 Length: 460 feet.

Old Adit

Elevation: At A.M.L. 2000
 Direction: 360°
 Length: 275 feet.

 3. Drives

Any approach to extensive driving is confined to two lodes and one old mining entity. These are respectively Spray Lodes Nos. 1 and 3 and the Spray Mine itself. Elsewhere along the Spray Shear Zone excepting for a relatively closely spaced conglomerations of workings in the Nike mine, the drives within it are short and spaced with long untested intervals. The general plan accompanying this report presents the overall picture but the following are the schematic details presented now with the individual lodes treated from the viewpoint of continuity in length and development in depth.

(a) No. 1 LODE

"D" Adit at A.M.L. 2210	100 feet
"B" Adit at A.M.L. 2207	210 feet
"C" Adit at A.M.L. 2139	450 feet
"A" Adit at A.M.L. 2067	660 feet
"E" Adit at A.M.L. 2057	860 feet
"H" Adit at A.M.L. 2105	60 feet
"G" Adit at A.M.L. 2076	420 feet
No. 1 Level Spray at A.M.L. 2016	660 feet
No. 2 Level Spray at A.M.L. 1935	1140 feet
No. 3 Level Spray at A.M.L. 1857	1320 feet
No. 4 Level Spray at A.M.L. 1803	1260 feet
No. 5 Level Spray at A.M.L. 1701	1210 feet
No. 6 Level Spray at A.M.L. 1606	690 feet

From Foam Adit at A.M.L. 2150	80 feet
From Foam Adit Shaft at A.M.L. 2100	57 feet
From Cross-cut from Foam No. 2 Shaft at A.M.L. 1975	150 feet
Along Wave Upper Adit at A.M.L. 2350	250 feet
From Lower Wave Adit at A.M.L. 2270	200 feet
Along Llewellyn's Upper Adit at A.M.L. 2380	90 feet
Along Llewellyn's Lower Adit at A.M.L. 2300	250 feet
Along South Nubeena Upper Adit at A.M.L. 2180	200 feet
From South Nubeena Lower Adit at A.M.L. 2150	200 feet

At the Nike a complex criss-cross of drives and crosscuts at a wide range of orientations is indicative of a stockwork measuring about 800 feet in a north-south direction and 400 feet in width.

(b) No. 3 Lode

Along Spray Top Adit at A.M.L. 2460	240 feet
From Spray Middle Adit at A.M.L. 2400	180 feet
From Spray Lower Adit at A.M.L. 2200	720 feet
From Spray 'A' adit at A.M.L. 2067	720 feet
From Spray No. 3 Level Cross-cut at A.M.L. 1857	720 feet
From Crosscut at Col. North Shaft at A.M.L. 2050	50 feet
From Barnetts Adit at Nubeena at A.M.L. 2230	130 feet
Trenches on Moyle's Lode at A.M.L. 2250	100 feet
From Perry's Adit at A.M.L. 2030	250 feet

(c) No. 2 Lode

From Spray 'A' adit at A.M.L. 2067	200 feet
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(d) No. 4 Lode

From Spray 'A' Adit at A.M.L. 2067	100 feet
From Barnetts Adit of Nubeena at A.M.L. 2230	250 feet

4. Crosscuts

No. 1 Lode

Comparatively little crosscutting has been done. The crosscut at No. 3 Level from No. 1 to No. 3 Lode is 600 feet in length.

The mine plan shows small crosscuts as follows:-

- At Adit Level : 7 crosscuts from 10 to 20 feet.
- At No. 1 Level : None.
- At No. 2 Level : 1 crosscut of 30 feet.
- At No. 3 Level : None.
- At No. 4 Level : 3 crosscuts from 10 to 30 feet.
- At No. 5 Level : 3 crosscuts from 10 to 20 feet.
- At No. 6 Level : 3 crosscuts from 10 to 15 feet.

No. 3 Lode

- At Adit Level : 2 crosscuts of 10 feet.
- At No. 3 Level : 3 crosscuts from 10 to 25 feet.

5. Review of Past Limited Exploration

The facts so far presented in this compilation are a mixture of short-term active production and long drawn-out spasmodic and sporadic attempts, and it is characteristic of both of these phases that they invariably had a sudden cessation.

Thus the Spray between 1898 and 1908 produced 230,000 tons of crude ore which yielded 45,000 tons of lead and 4,000,000 ounces of silver, yet suddenly closed down in January 1909 leaving an uncompleted Main Shaft and much valuable ore exposed but unmined.

The Nike between 1915 and 1926 under the inspiration of T.C. Goodall produced 4,000 tons of crude ore yielding 3,000 tons of lead and 310,000 ounces of silver, but shut down immediately after Goodall's accidental death.

In regard to the portion of the Spray Shear Zone south of the

Spray, it is opportune to point out that although Grubbs Tramway was constructed in 1890, the discoveries along this belt which have a present-day significance were not made until 1901 following on the spectacular development in the Spray discovered by tributors Page and McDermott. Nevertheless, some work was done on the Old Nubeena Lode in 1892, including a branch tramway from Grubb's which was later (1901) extended to the Silver Wave. Also in 1896 the Colonel North Coy. sank a shaft to 200 feet on the ironstone outcrop of what is now the Sunshine but later transferred its activities to the old Grubb's mine.

The discoveries which now assume importance were made by tributors. The Silver Foam and Silver Wave Tributing Companies were formed in 1901 to develop two such discoveries within the Colonel North Company's lease. They both put branch tramways to their workings from Grubb's Tramway. Llewellan's Lode was discovered in 1903 on the Nubeena lease but was never connected by tram or road to Grubb's Tramway. The South Nubeena lode was discovered shortly afterwards.

The whole of the work on this belt has been halting, indefinite, long drawn-out and unappreciated. The successive attempts have been by various companies, syndicates and tributors at different times at the same locality under different names. The reading of published reports is hopelessly confusing unless the following history at each locality is realised:-

Foam Locality:- Originally known as Colonel North.

The eastern portion later became the Silver Foam. Still later (1909) it became the Victoria-Zeehan. The western portion ceased to be the Colonel North (this title being transferred to Grubb's) then became in turn Silver Beach, Victoria Zeehan and finally the Sunshine (1923).

Wave Locality:- Originally known as the Nubeena. Then

became the Silver Wave and later the Victoria-Zeehan.

Llewellan's Locality:- Originally the Nubeena. Then became

the Old Nubeena, later Llewelin's and ended up as the Venezia.

South Nubeena Locality:- Originally known as South Nubeena

and ended up as Butler's.

It is important to realise three aspects of the limited exploration of this southern belt. Firstly, there is the fact that the objective was solid galena - milling ore or 'antimonial lead' was of not interest to the individuals or small syndicates whose courage was greater than their finances. Secondly, no major company with the necessary financial and technical equipment paid any attention to it in spite of the restrained but significant statement by Twelvetrees in 1910:-

"Several silver-lead lode systems intersect the Victoria-Zeehan property in a general south-easterly direction. These are continuations of known lodes on the Spray section to the North, and some of them evidently pass through the entire property and across the Nubeena and South Nubeena sections further south. The Spray lode system is perhaps the longest on the whole Zeehan field, being traceable for about $1\frac{1}{2}$ miles at intervals through these sections". (11)

Revised?
Lento?
1949?
Tas. Geol.
1932?

In the third place is the limited depth penetration. At the Spray A.M.L. 1638 was reached and in the Nike and Foam A.M.L. 1940, but in all the other workings A.M.L. 2050 and upwards are the horizon figures attained. The metallogenically important A.M.L. 1800 is thus still well below all exploration except Spray No. 1 Lode.

It is also opportune to draw attention to the paucity of crosscuts. With the exception of the 'A' Adit and No. 3 level crosscuts, the whole width of the Shear Zone has not been explored. In the Spray there have not been enough crosscuts from drives along the lodes to adequately establish their true width.

The pronounced counter lodes from Spray No. 1 Lode at Nos. 4 and 5 levels are probably only two of an unexposed series of them.

(11) Geol. Surv. Tas. Bull. 8. P.114.

VI THE LODES

1. Mineralogic Constitution

It is a striking fact that the mineralogy of the lodes of the Spray Shear Zone has never been fully studied. Waller mentions some of the constituent minerals but is quite indefinite as to total composition.⁽¹²⁾ In addition, Waller never saw below No. 3 Level.

Twelvetrees and Ward never saw the lodes as they were all under water at the time of their investigation of 1909 and they omit spray mineralogy entirely in Geol. Surv. Bull. No. 8. But in their field notes there is evidence that they were trying to obtain from T. Vincent the Manager of Mount Zeehan (Tas.) Silver-Lead Mines Ltd. details of the composition of the Spray ore. The following is an extract from their field notebooks:-

"Vincent states that they never had any tin in their ore. Had copper pyrites. One piece = 12% Cu. Never got copper in the clean ore only in the siderite. Once a little copper was got in the galena. It rarely occurs in the lead ore. It went 12% Cu and 80 ozs. Ag"⁽¹³⁾

It would seem that Twelvetrees and Ward were questioning Vincent regarding the actual composition of the ore at Nos. 5 and 6 levels which he abandoned. As will be pointed out later in this report, ore assays throughout all Vincents reports omit any recording of copper or antimony although tetrahedrite and jamesonite are widespread. Vincent's irrelevant replies to their questions are in concordance with his all round ineptitude which is exposed in Chapter VII of this report.

No mineragraphic study of the ore variants has been carried out but the general trend of mineralisation may now be indicated.

Galena, tetrahedrite, jamesonite and boulangerite are the important metallic minerals of the primary ore with pyrite and sphalerite as accessories and

(12) Report on Zeehan Silver-Lead Mining Field 1904. P.79

(13) W.H. Twelvetrees "Field Notes" 1909. P.2

argentite as a much rarer accessory. Quartz is the principal gangue mineral with siderite as a variable accessory. Chalcopyrite occurs occasionally, being mostly 'in siderite'.

The relative ratios of galena on the one hand and tetrahedrite-jamesonite on the other vary within wide limits, but even where galena dominates as in the upper levels, the tetrahedrite-jamesonite complex is never absent. At present it is not possible to say definitely whether galena is entirely absent from the tetrahedrite-jamesonite complex below No. 4 level of the Spray.

2. Mode of Origin

The lode material is fundamentally siliceous, the constituent minerals being distributed within this groundmass.

The ore is a replacement of the country rock by solutions spreading from the controlling shear into which the Tear Faults fed their solutions at various horizons. All the Tear Faults involved namely Manganese, Central, Balstrup, Nubeena, North Austral and South Austral have acted as ore feeders eastwards of the Spray Shear Zone but their contribution of the Actrahedrite-jamesonite-boulangerite complex is confined to the latter belt.

The replacement origin as far as No. 1 Lode is concerned is indicated by the following extract from Twelvetrees field notes:-

"The lode only makes one wall. No wall on other side. The west wall is the only one and on the opposite side there is no clear division between lode and country."⁽¹⁴⁾

3. No. 1 Lode

(a) Spray

(i) Length and Width

Length:-

At Adit Level : 1440 feet

At No. 1 Level : 510 feet

(14) W.H. Twelvetrees "Field Notes" 1909. P.7.

At No. 2 level : 1140 feet

At No. 3 level : 1320 feet

At No. 4 level : 1200 feet

At No. 5 level : 1215 feet

At No. 6 level : 690 feet (both N. and S. faces showing strong lode).

Width:-

"The lode in the lower levels maintains an average width of about 10 feet. The full width is not taken in driving but it does not vary much wherever they have proved it."⁽¹⁵⁾

It is here that we encounter the secrecy and obscurity associated with the management of the Spray Mine. This is presented with special emphasis in Chapter VII, Section 1. It hinges on what was the minimum pay-ore acceptable to Vincent. It will be established that this was nothing less than 17% Pb. The following personal communications from Walford and McDermott - old Spray miners and tributors - may be accepted as reliable opinions of sound men:-

It is a fact that the richer galena shoots above No. 4 level have been stoped out. At the same time it must be remembered that this refers to Vincent's pay-ore only. We do not know the values outside the shoots which have been defined by actual stoping but there was ore in them.

(ii) Jamesonite-Boulangerite-Tetrahedrite.

These concentrations start at or just below the No. 4 level in the case of the North and South concentrations and just above the No. 6 level in the case of the centre one. As far as is at present known, they are confined to No. 1 Lode.

The North concentration is 200 feet long at No. 4 level but the length at No. 5 level is undetermined. The width is 10 feet.⁽¹⁶⁾

The South concentration is 520 feet long at No. 5 level and 420 feet at No. 6 level although in neither case has the southern limit been definitely established. The width according to Twelvetrees (quoting T. Vincent) averages 6 feet.⁽¹⁷⁾

(15) W.H. Twelvetrees "Field Notes" 1909. P.4

(16) " " " " " P.4

(17) " " " " " P.3

029

"The average width of the lode in No. 6 level for a length of 200 feet is 6 feet and with Pb 5% and Ag 30 oz. This is the lowest level in the mine and the ore is there yet. They had a trial treatment of the ore by the Elmore process at Broken Hill."

The Centre concentration was seen only at the north end of No. 6 Level. It was driven in for 60 feet with the north face still in ore. Twelvetrees quotes the following assays of daily face samples from here.⁽¹⁸⁾

<u>Pb</u> <u>%</u>	<u>Ag</u> <u>ozs.</u>	<u>Pb</u> <u>%</u>	<u>Ag</u> <u>ozs.</u>	<u>Pb</u> <u>%</u>	<u>Ag</u> <u>ozs.</u>
3.0	42	3.2	24	2.5	11
1.0	12	4.5	255	1.2	30
28.0	65	0.5	32	14.3	23
31.0	11	5.5	43	0.5	19
Bulk Assay		<u>Pb</u> <u>%</u>	<u>Ag</u> <u>ozs.</u>		
		14.3	23		

The mine closed down a few days later. This therefore is the very last work done at the Spray Mine below the Adit Level.

Incidentally it is by no means certain that the lode in No. 5 level between the northern and southern concentrations contains no ore and it seems probable that there is jamesonite-tetrahedrite ore in No. 6 level between the southern and central concentrations.

There is another ore occurrence which, although not justifying the status of a concentration, might have future possibilities. This is at the extreme northern end of No. 3 level north of No. 1 shaft.

Walford is definite that galena occurs throughout the whole of No. 3 as driven on. But what are the values?

McDermott states that the No. 1 lode as driven on by him at 'E' level never was barren of galena. His milling ore had to give in the mill a

(18) W.H. Twelvetrees "Field Notes" P.8

minimum recovery of 12.5% Pb or the Company would not take it. Since the mill tailings average 4.5% Pb, McDermott's milling ore would have to assay 17% Pb. When the Smelters agreed to take "two twenties ore" i.e. 20% Pb, 20 ozs. Ag, McDermott preferred to select the ore by knapping and picking, only sending the rejects to the mill. McDermott insists that the whole of the unstoped portion at all levels carried metal - there was no really barren lode.

The evidence therefore points to the possibility that present-day pay-ore exists between the stoped out pay-shoots and beyond them. The only way to find out is by sampling the unstoped sections.

"The 'A' Adit cut the top of one of the richest shoots of ore which has been mined in the Zeehan Field. The ore for most of the distance hardly lined up to the roof of the drive. It was sunk on and widened out very rapidly to from 4 to 8 feet of solid metal. This shoot of ore is now known to be nearly 400 feet in length of which about 200 feet is exceptionally rich. At its best the lode carried 16 feet of ore, about two-thirds of which was galena, while for long distances from 3 to 5 feet of solid ore was present in the lode."

Waller's reference to the "ore" osculating the Adit level must be interpreted as meaning "high grade ore" as the lode undoubtedly carried values above the level near the Internal Shaft, thus making the shoot really continuous with the rich ore mined by McDermott and Page at and above the 'E' Adit.

The galena was in due course followed downwards from the lowest level (No. 4 level) seen by Waller. He reports the face at about 60 feet north of the Internal Shaft as assaying in bulk sample Pb 13.1%, Ag 35.6 ozs. However, subsequent work showed that the galena continued for only a small depth below No. 4 level. There the galena entirely disappeared, its place being taken by jamesonite and tetrahedrite.

iii Pay-ore Shoots

It is essential to realise that all stoped ground shown in old longitudinal sections indicate the extraction of Vincent's pay-ore standard, viz. Pb 20% and Ag 34 ozs.

It is pertinent also to indicate that stoped areas shown in Geol. Surv. Bull. 8 do not agree with the official longitudinal section at the Mines Department, Hobart which is dated 13th October, 1908.

In fact, neither show the stoping above 'A' Adit in the vicinity of No. 2 Shaft which was done by tributors after the mine closed down in January 1909. The addition of this to the other sections indicates continuity of ore from the northernmost workings of Page and McDermott to the southern limit of Waller's rich galena shoot. In the longitudinal section accompanying this report, this is given reality.

The depicting of 'shoots' therefore is merely the recording of those portions of the lode which were higher grade than the general run. Wherever I personally have seen the shear there has invariably been well developed mineralisation and it is well to bear in mind McDermott's statement:

"In 'E' Adit No. 1 lode wherever driven on by him was never barren of galena."

Waller's dimensions of 'ore shoots' are in-complete as much development took place between 1903 and 1908 after Waller's departure.

Vincent's dimensions are restricted because of his insistence of Pb 20% and Ag 34 ozs. standard and of his succumbing to the antimony bugbear. This and other very significant aspects of Vincent's part in the drama will be given in Chapter VII but the following throws some light on it:-

Between Nos. 4 and 6 levels there are two more or less defined sections almost wholly unstoped with a third just projecting above No. 6 level. This ore containing jamesonite and tetrahedrite could not be effectively treated by the gravity-concentration mill. It could not be sold to the Smelters because of the penalties for antimony. If high-grade enough, it showed a profit. Twelvetrees illustrates this:⁽¹⁹⁾

"They broke out a parcel just to show that they had clean ore. It assayed 425 ozs. silver and 16.3% lead. This was last year and fetched £44: 0: 8 per ton."

(19) W.H. Twelvetrees "Field Notes" 1909. P.1

No assays for antimony are given in any records but the above parcel must be assumed as assaying at least 12% antimony. Twelvetrees emphasises the crippling effect of the antimony: (20)

"The mine depends upon the Smelters. The ore would not pay cartage to Strahan on account of its antimonial contents."

In the longitudinal sections accompanying this report, an attempt has been made to eliminate this stultifying and inhibiting factor.

(b) Foam

(i) Length and Width

At A.M.L. 2100 80 feet driven on 3 feet wide with splashes of galena and jamesonite. Bulk sample: Pb 20%
Ag 19 ozs. Sb ?

At A.M.L. 1975 150 feet driven on 6 feet wide with a little galena.

(ii) Pay-ore Shoot

None disclosed. Mineralisation sporadic.

(c) Wave

(i) Length and Width

At A.M.L. 2350 250 feet driven on 6 feet width of 'good seconds'

At A.M.L. 2270 200 feet driven on wide lode with spurs joining the two walls.

(ii) Pay-ore Shoots

Original work done about 1892 (i.e. before discovery of Spray lodes). More work was done about 1903 and again about 1930. An output of about 50 tons of hand-picked ore was achieved. This ore was bedevilled by associated jamesonite as is still observable on the old knapping floor and near the lower Adit there is a dump which would assay 8 -12% Pb again associated with jamesonite.

(d) Nubeena

(i) Length and Width

"Llewelin's lode is a very large loose fissure formation striking about 28° west of north, and dipping almost vertically, or perhaps a little to the east. I take it to be a continuation of the main Spray Lode. It is the same character of lode and the walls are grooved in a nearly horizontal direction,

(20) W.H. Twelvetrees "Field Notes" 1909. P.2

pitching slightly north, just as in the case of the Spray lode,"⁽²¹⁾

At A.M.L. 2380. Driven 90 feet on lode.

At A.M.L. 2300. Driven 250 feet on lode.

(ii) Pay-ore Shoots

The whole of the 200 feet driven on must be classed as ore-shoot.

Waller reports:-

"The values were higher in the northern portion. Solid galena 18 inches wide in the upper level widened to 4 feet downwards but decreased to 8 inches at the lower level. A cross-cut at the lower level showed 15 feet of 'splendid jiggling ore'."

To qualify for the term 'jiggling ore' Zeehan standard was from 20 to 40% Pb.

Llewellyn knapped and hand-picked and there is left a dump of rejects which by visual examination would assay 10 - 15% Pb.

(e) South Nubeena

(i) Length and Width

At A.M.L. 2180. Driven on 200 feet of lode.

At A.M.L. 2150. Driven on 200 feet of lode.

At A.M.L. 2020. Driven on 50 feet of lode.

The only information available is from Waller:-⁽²²⁾

"When I saw the lode it had been driven on for about 20 feet..... On the wall there was a seam of metal 1 to 2 inches in thickness. To the west of this was a seam of dig and rubble, 12 inches wide, and then sheared and broken country of undetermined width. This lode has now been driven on for about 120 feet. The formation is a very large one and it is difficult to know what to follow. There is metal right through the formation, but up to the present no payable ore has been cut."

(21) G.A. Waller "Report on Zeehan Silver-Lead Field" 1904 P.91

(22) " " " " " " " " " P.92

(ii) Pay-ore Shoots

Dr. G.E. Butler persisted for some years in his endeavour to open up a Southern Spray. He drove two adits and did some stoping on the lode and produced a few tons of hand-picked ore.

After he gave up the two brothers Beaumont drove a lower adit to cut the lode 130 feet deeper. After driving 700 feet they hit the lode which was a wide and impressive formation showing the characteristic shearing but only disseminated ore. They drove for about 50 feet on it and then gave up.

(f) Nike

(i) Length and Width

In various parts of Zeehan, irregular and anastomosing lodes occur whose spacing is not wide. But the outstanding occurrence with close spacing is in the vicinity of the Nike workings. Here there is something approaching a stockwork. Waller refers to it as "a regular network of lodes".

There appear to be two groups - one embracing Featherstone's lode and the other around No. 3 Lode - but it is by no means certain that the intervening space of only about 300 feet does not also contain the network. Waller says of the Featherstone group:-

"The other lodes are all small branches, often containing nice bunches of metal, but too small and irregular to yield large profits."

Of the No. 3 lode group he says:-

"There are a number of other lodes on this section west of No. 1 Lode".

The Nike workings are in the Featherstone group.

As far as observed up to the present, however, the pronounced shear planes of the Spray and South Spray do not occur. Instead there seems to be a notable development of shatter.

This shatter zone seems to be confined to the Queen Hill rock series and apparently has not been developed in the keratophyric tuffs and breccia series. It is quite striking how the shattering begins immediately the shear zone passes over into the sandstones and slates.

035

One of the most significant pieces of evidence as to the stockwork character of this network is the belt of shattered slate carrying veins and veinlets of galena encountered in the east crosscut in the Nike workings. This is reported to be upwards of 50 feet in width. Evidence of it is seen in the mullock dumps wherein slates with seams and veins of ore are prominent.

The length of the 'shatter zone' is 800 feet. The width is 400 feet.

(ii) Pay-ore Shoots

The lodes of the Nike Network are essentially siliceous. Vein quartz is not prevalent, the silica being in the form of silicified rock carrying disseminated minerals. Solid core up to 2 feet wide is frequent. The veins in the Shatter Zone consist wholly of ore in criss-crossing veins in the slate.

Galena is dominant. Jamesonite is subordinate but characteristic. Sphalerite is accessory.

It is really inappropriate to talk of ore-shoots in such restricted workings. It must suffice to mention the runs of solid galena mined by Featherstone in 1899 and by the Nike Company in 1915-1926. Apparently most of the constituent lodes of the Nike Network carry continuous values with solid galena shoots. That is as far as present knowledge goes.

Milling ore has not been mined. Ore sold was obtained by selective mining plus knapping and hand-picking. Indications of the value of the milling ore are obtained from the mullock dumps which contain the milling ore which was unavoidably mined in taking out the solid galena. The large boulders of quartzose material carrying about 25% Pb came mainly from the 170 ft. level.

Information as to the value of the shatter zone in the slate will only be available when the workings are opened and sampling is possible.

The Pb : Ag ratio is high, being of the order of magnitude of 1 : 1.

4. No. 3 Lode.

(a) Spray(i) Length and Width

At A.M.L. 2450 Driven on for 240 feet.

At A.M.L. 2400 Driven on for 180 feet.

At A.M.L. 2200 Driven on for 700 feet.

At A.M.L. 2067 Driven on for 720 feet.

At A.M.L. 1857 Driven on for 720 feet.

Twelvetrees gives the width as 28 feet,⁽²³⁾ while W. Walford who worked in the mine gives it as 30 feet wide.

(ii) Pay-ore Shoots

There is some uncertainty as to what was actually stoped from this lode and also as to its mineral content at No. 3 level.

The interpretation of the ore shoot or shoots in No. 3 Lode is not at all clear. At the upper levels a length of 700 feet was mined. At the Adit level it was mined over a length of 500 feet. The position at No. 3 level (lowest level on No. 3 Lode) is obscure. Waller never saw this level. Neither did Twelvetrees see it (it was under water) in 1909 but he quotes Mr. T. Vincent as follows:⁽²⁴⁾

"The lode in the north end (Adit level C and A) is soft, between slate and hard quartzite. The quartzite is traversed by irregular gashes of quartz,.....It goes down for some depth and then in the bottom level there is nothing."

This is another of the disparaging and misleading nature of Vincent's attitude. It is indicative of the standard of pay-ore which encompassed the Spray to quote Waller on ore in No. 3 Lode:

"The grade of the galena in this lode is not quite so good as in No. 1 Lode, a bulk sample of the ore yielding 82 ozs. of silver per ton with 68% of lead. Still it is good metal."

Vincent's self-interest pay-ore standard which wiped No. 3 Level on No. 3 Lode must be contrasted with the following personal communication from

(23) Twelvetrees Field Notes 1909. P.6

(24) " " " " P.7

W. Walford:-

"The pay-ore shoot at No. 3 level started at the cross-cut and running south for 150 feet. This was 8 to 10 feet wide with a foot or more of solid galena on each wall with "good seconds" in between. Northwards from the crosscut, the lode was 3 to 4 feet wide bulging in places to 10 to 12 feet and also narrowing to 6 inches. The lode along the whole 400 feet of the north drive carried values but was only stoped at the bulges."

It is pertinent to remark that No. 3 level is at A.M.L. 1857 which is getting close to the A.M.L. 1800 change to the tetrahedrite-jamesonite-boulangierite complex. Was this Vincent's "nothing"?

(b) Foam

(i) Length and Width

At A.M.L. 2050 Driven on for about 50 feet; full width undisclosed.

(ii) Pay-ore Shoot

This occurrence was recorded in 1892 by the Colonel North Coy. before the Spray discoveries were made and it had no special significance at the time but "antimonial ore" is mentioned.

(c) Nubeena

(i) Length and Width

At A.M.L. 2230 Driven on for 130 feet with width 4 to 5 feet.

(ii) Pay-ore Shoot

Stoped for about 20 feet up for galena which was disseminated with one 6 inch band of solid mineral.

(d) Perry's

(i) Length and Width

At A.M.L. 2030 the lode driven on for about 100 feet is pyrite-galena. It is a wide formation and resembles the No. 3 Spray formation.

(e) Moyle's

(i) Length and Width

At A.M.L. 2250 about 100 feet of deep trenching has disclosed

lead mineralisation with a dolomite gangue. It is crossed by the Central Tear Fault and thus has as its rock repositories both the Spilite and Keratophytic tuff formations. Some basic components of either could account for the dolomite and crocoite. Waller describes it as "a big formation", but its real significance is that it probably indicates a continuance of No. 3 Lode on its 332° strike for about 800 feet beyond its most northerly exposure within the Spray workings.

5. No. 2 Lode.

(a) Spray

(i) Length and Width

At A.M.L. 2067 this lode was cut in the Spray 'A' Adit, 200 feet west of No. 1 Lode and driven on for about 200 feet and a shallow winze sunk at the northern end.

(ii) Pay-ore Shoot

As the shear showed only disseminated galena and jamesonite no stoping was done.

6. No. 2A Lode.

(a) Spray

Described by Waller as well defined and carrying jamesonite but was not driven on.

7. No. 4 Lode.

(a) Spray

(i) Length and Width

Cut by 'A' Adit at A.M.L. 2067 this shear shows the development of "mullocky lode-matter with strings of iron carbonate and antimonial galena"⁽²⁵⁾. It was driven on showing a width of 5 feet for a length of 100 feet. It is 180 feet east of No. 3 Lode.

(ii) Pay-ore Shoot

No stoping was attempted.

(25) G.A. Waller "Report on the Zeehan Silver-Lead Mining Field" 1904. P.81

(b) Nubeena(i) Length and Width

At A.M.L. 2230 what has been known as Barnett's Lode is 200 feet east of No. 3 Lode (Jaeger's) and is oriented similarly to No. 4 Lode at the Spray. It has been driven on for 170 feet with a width of 4 to 5 feet. The ore is pyrite-galena with accessory jamesonite.

(ii) Pay-ore Shoots

Stoped over a length of 170 feet to height of 100 feet. An output of about 50 tons assayed Pb 60%, Ag 40 ozs. after knapping and hand-sorting.

VII PAST MANAGEMENT, EXPLORATION AND ECONOMICS.

1. The Vincent-Spray Perplexity.

My intimate contact with Zeehan and its history, combined with my personal contacts with the Vincents, both father and son, justify at this juncture the expression of my opinion that Vincent selfishly despoiled and unwarrantedly disparaged the Spray Mine.

Perplexity enters the picture when the London Board of Directors are exposed as 'get rich quick' operators bulldozed by Vincent's pessimism and sadly lacking in mining enterprise and courage. This perplexity is intensified when Twelvetrees' field-notes are contrasted with the inexplicable absence of any significant details of the ore at Nos. 5 & 6 Levels in Geol. Surv. Bull. No.8. This may account for the otherwise surprising ignorance of the West Coast mining world of the character and extent of the ore left in the lower levels of the Spray Mine.

The word 'astounding' must be called upon to refer to the terms of Vincent's position of Manager: namely, no salary, only a percentage of profits. Although this was common knowledge at Zeetan it is interesting to have it confirmed in the following letter from T. Vincent to the Commissioner of Taxes, Hobart. (32)

"In reply to yours of 21st inst. My Assistant is my son T.H. Vincent who during the year ending 31st Dec.1908 filled the position of Underground Manager on the above Company's mines, and during my absence at any time, was in sole charge. The salary I pay him is earned, and has no bearing on the relation between us; but, unfortunately, owing to the depressed values of metals and other causes, my own emoluments from Commission on Profits was practically nothing. As this state of things still continues, it is my intention to make other arrangements for the year 1909." (26)

The general opinion at Zeehan was that Vincent only took the richer ore out in order to ensure his income being adequate. At one period (in 1906) the Zeehan and Dundas Herald took the question up and considerable enmity developed. This is referred to by T.H. Vincent in 1911. (27)

26. T. Vincent "Letter-book" 1909-1912. p.93.

27. T. Vincent "Letter Book" 1909-1912 p.245.

"Had I thought the report in the "Rag" would have been noticed I would have written requesting them to correct it; but at the time the matter appeared to me to be too trivial to bother, and is just in keeping with their usual treatment of my father and self. Their antagonism dates from about five (5) years ago, when their Mining Reporter - Sligo - was not allowed to go through the Company's Mines".

What was it that they did not want Sligo to see?

The reference to T.H. Vincent (T. Vincent's son) as participating in the management in 1907-1908 may partly explain the 1909 debacle since his glaring incapacity was exposed in World War 1. We Tunnellers associated with him were never able to decide which was worse - his drunken incapacity or his erratic excitability when sober. It was so bad that he was sent back to Australia as S.N.L.R.

But T. Vincent himself displayed sufficient ineptitude to cause the death of the Spray, as is illustrated by the following extract of a letter written by him to his Directors in London dated 20th December, 1908 dealing with suggestions and trials to deal with the intractable retrahedrite-jamesonite-boulangierite complex at Nos. 5 & 6 Levels: (28)

"In reference to the Minerals Separation Concentration Process and enclosure with your letter of 23 September, and the question of other experiments being conducted with the Elmore process as suggested by Mr. White, I would like to say that, at present there is not an Experimental Plant in Australia, the ore at Broken Hill having been taken over by the Zinc Corporation Ltd. Besides, the freight costs of sending other large parcels for experimental treatment puts this quite out of the question, and as, on Appeal, the Courts have decided that "Minerals Separation" is an infringement of the Elmore process, and have granted an injunction against further infringement, there is hardly need to further discuss their relative merits."

And on 24th January, 1909, he wrote :- (29)

"As yet I have nothing encouraging to report in Spray No.1 Shaft. The lode has been cut (at No.5 Level C.L.H.) and driven on for 50 feet but, so far is valueless. A vein of ore stuff in the South face, when sampled gave on assay the very poor result of 7.5% Lead and 0.5 ounces Silver per ton. The North face has a promising appearance, and if the bunch of ore we had in No.3 Level North lives down, I hope to have better news to report in this mine".

The mine closed down a few days later.

2. The Tributing System.

Companies holding appreciable areas at Zeehan sub-let limited portions to parties of working miners on a royalty basis. They thus complied with the labour covenants at no expense to themselves. Thus in the greater part of Zeehan exploration was carried out by parties with quite inadequate resources to do justice to the numerous surface exposures. Nevertheless hardy prospectors made some valuable discoveries e.g. the Oonah Galena Lode and the No.1 Spray (Page & McDermott) and No.3 Spray (Gurnie) which they proceeded to open up and exploit with such satisfactory results that the Company then took over. But where rich values did not persist to the surface such as Foam, Wave, Nubeena and South Nubeena the original optimism, enthusiasm, hard work and money petered out and the lodes they laboured on were abandoned and went into oblivion.

Even when a good payable lode was ready for stopping e.g. at No.6 Argent No.3 Lode at the 170 ft. level the tributors did not have and could not obtain the money to buy firewood to supply power to pump 20,000 gals. per hour. This was in December, 1923.

3. The Power Factor.

One of the many off-hand condemnations of Zeehan has been that it was excessive water which made the mines unworkable. Actually, however, the quantity of water pumped in operating the Montana, Oonah, Western, Spray and similar mines ranged between 9,000 to 25,000 gals. per hour.

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Nevertheless the cost of pumping even this not abnormal water proved very costly by the steam-cornish pump outfits. Gerald Ahearn (mine manager) testifying before a Parliamentary Public Works Committee in 1915 quoted steam power at £35 per horse-power and spoke longingly of the proposed Hydro-electric power at £7 per horse-power.

And now the water and power problem stands adequately dealt with the availability of unlimited hydro-electric power.

4. Grade of Ore Mined.

The only accurate figures available as to the grade of ore actually mined are contained in a letter written by T. Vincent to H. Simpson, Hobart, the Legal Manager in Tasmania for the Mount Zeehan Silver-Lead Mines Ltd.

He states : (30)

"I beg to append the following figures for the Financial Year ending 30th June, 1908 -

Ore Raised	12,885 tons
Ore Produced	5,007 tons

Containing -

Lead	2,106 tons
Silver	315,944 ounces".

The concentrate as actually sold thus assayed:-

Pb	Ag
%	ozs
42	63

Calculating back to the ore as raised from the mine this means that the recovered values were:-

Pb	Ag
%	ozs
16.3	24

The tailings average:- (31)

Pb	Ag
%	ozs
4.5	10

(30) T. Vincent "Letter Book" 1909-12. p.152.

(31) Do do p.115 and confirmed by systematic sampling of tailings dump in 1947 by Zeehan Mines Ltd.

Therefore the crude ore as extracted from the mine must have assayed in round figures:-

Pb	Ag
%	ozs
20	34

It thus seems clear that the standard for pay-ore was high. It must inevitably be asked - what did they leave behind? McDermott is definite that the lower grade ore was left unstoped or used as filling. It is quite certain that no filling was ever sent down from the surface.

VIII METHOD OF ATTACK.

The details presented in the preceding pages are the salient facts which point to the existence of a major mining entity which has so many attractive features that an important mining project emerges as a very promising enterprise. There are three degrees of activity with which such an enterprise may be handled. These are :-

1. DIRECT ACTION.

Erect power line from Zeehan Transformer Station to Spray No.1 Shaft - 100 chains. Equip No.1 shaft with headframe etc. adequate to deepen the shaft and use it as main pumping station. It will be necessary to provide appropriate equipment to deal with the nitrogen gas which will temporarily seep from its imprisoned crevices as dewatering proceeds. Drive the 65 feet at No.5 level to connect with the north drive from No.2 shaft. Deepen No. 1 Shaft 75 feet to No.6 level, crosscut to lode and drive the 400 feet to connect with the north drive from No. 2 Shaft.

This method avoids the complication of mullock in the No.2 Shaft from 5 level downwards. Its justification rests on the ore left standing between Nos. 4 & 6 levels and calculatable as having a gross value of at least £750,000. This figure is based on the longitudinal section dated 13/10/08 submitted to the Mines Department by the Company. It also allows for no higher assay than that brushed aside by Vincent as valueless exposed by the last work northwards at No.6 level viz:-

Pb 14% Ag 23 ozs.

If it is assumed that all the Pb is jamesonite and that all the silver is in the tetrahedrite this ore would assay :-

Pb	14%
Sb	11%
Cu	2%
Ag	23 ozs.

At the present price of metals this gives a gross value of £60 per ton.

2. Partial Approach.

With hydro-electric power laid on unwater No. 1 Shaft to No.3 level and the diamond-drill hole in the No.3 Crosscut which was abandoned when about

half way to its objective which had been designed to be the No. 1 lode at A.M.L. 1400. From this same set-up both Nos. 1 & 3 lodes could be explored both in depth and length and incidentally test lodes 2, 2A & 4 on their way.

3. Probing Attack.

The lode orientation - contour relationship presents difficulties in drilling from the surface. This is illustrated by the accompanying map of the Spray area and a cross-section thereon. It was experienced by the State Mines Dept. when they attempted to test No. 1 Lode at 250 ft. below No. 6 level in 1931. They chose the northern slope of the Spray Hill rather than the southern. They aimed at the South Shoot. They assumed a slight westerly dip of the lode and calculated to hit it at 969 feet with a base depressed at 42°. They drilled for 10 months, reached 930 feet and stopped. At 911 - 917 they passed through 5 feet of lode formation containing iron pyritis and siderite with traces of antimonial ore. ⁽⁴⁰⁾ Was this the No.1 Lode? Although short of the calculated objective the exploration could lie in upward deflection of the bore.

The problem of drilling from the western slope is difficult as the lengths involved are unduly high. An example could be a drill-hole at the A.M.L. 2400 aimed to hit No.3 Lode at 100 feet below No.3 level and No. 1 Lode at 200 feet below No.6 Level. Such a drill-hole would be 1700 feet long depressed 40°.

The conditions are much better for testing the northern end of No.1 lode below No.3 level. i.e. north of No.1 Shaft. Holes at high angles westward could be designed from about A.M.L. 2000-2100.

Character of Objectives.

It must be realised that the objectives of diamond-drilling at the Spray are lodes in which values are irregularly distributed. One drill-hole could penetrate either a rich or poor section. Reliability of results will be directly proportional to the number of holes. Multiplicity of holes is possible from underground but impracticable from the surface.

Southwards from the Spray, unless the 'Direct Action' method is adopted and south drives along the shears at A.M.L. 1600 is the ultimate

(40) Annual Report Secretary for Mines, Tasmania. 1932 and "Drilltog" Spray Mine.

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attack after the deepening of No.1 Shaft exploration will have to be by diamond-drilling. Access and the shear-contour relationship present no difficulties and it would be accepted that the high relief must present opportunities to penetrate the Shear Zone at appreciable depths below its surface or near-surface manifestation. Diamond-drill sites down to the 700 ft. contour could be selected within drillable distance of the Shear Zone.

Good strategic points based on the contour factor are :

South-west of Foam Shaft at A.M.L. 2150.

West of Wave at A.M.L. 2200.

West of Barnett's-Llewelin's at A.M.L. 2200.

East of South Nubeena at A.M.L. 2100.

Character of Objectives.

The objectives of any diamond-drilling campaign would be twofold.

In the first place traverses across the Shear Zone are required to determine the distribution within it of ore occurrences. Horizontal or slightly depressed holes could be used for this purpose.

In the second place steeper holes would be required to search for ore-shoots below known ore occurrences or lode formations known at shallow levels with emphasis on reaching A.M.L. 1800.

Probing the shatter zone at the Nike could best be effected by a series of diamond-drill holes starting at A.M.L. 2100 east of the Shaft and sufficiently distant from the eastern boundary of the Shear Zone so that a slightly depressed bore hits the latter at A.M.L. 1900 or 1800.

C. Loftus-Hills

(C. LOFTUS-HILLS)

11th November, 1963.

legend

STRUCTURAL GEOLOGY

- Tear Faults
- Waller Fault
- Shears Driven On
- Shears Hypothetical
- Shear Zone

STRATIGRAPHY

- Juneau-Eldon Series
- Keratophyrio Tuffe & Slates
- Nubeena Quartzites & Slates
- Spillite Tuffe, Sandstones & Slates

TOPOGRAPHY

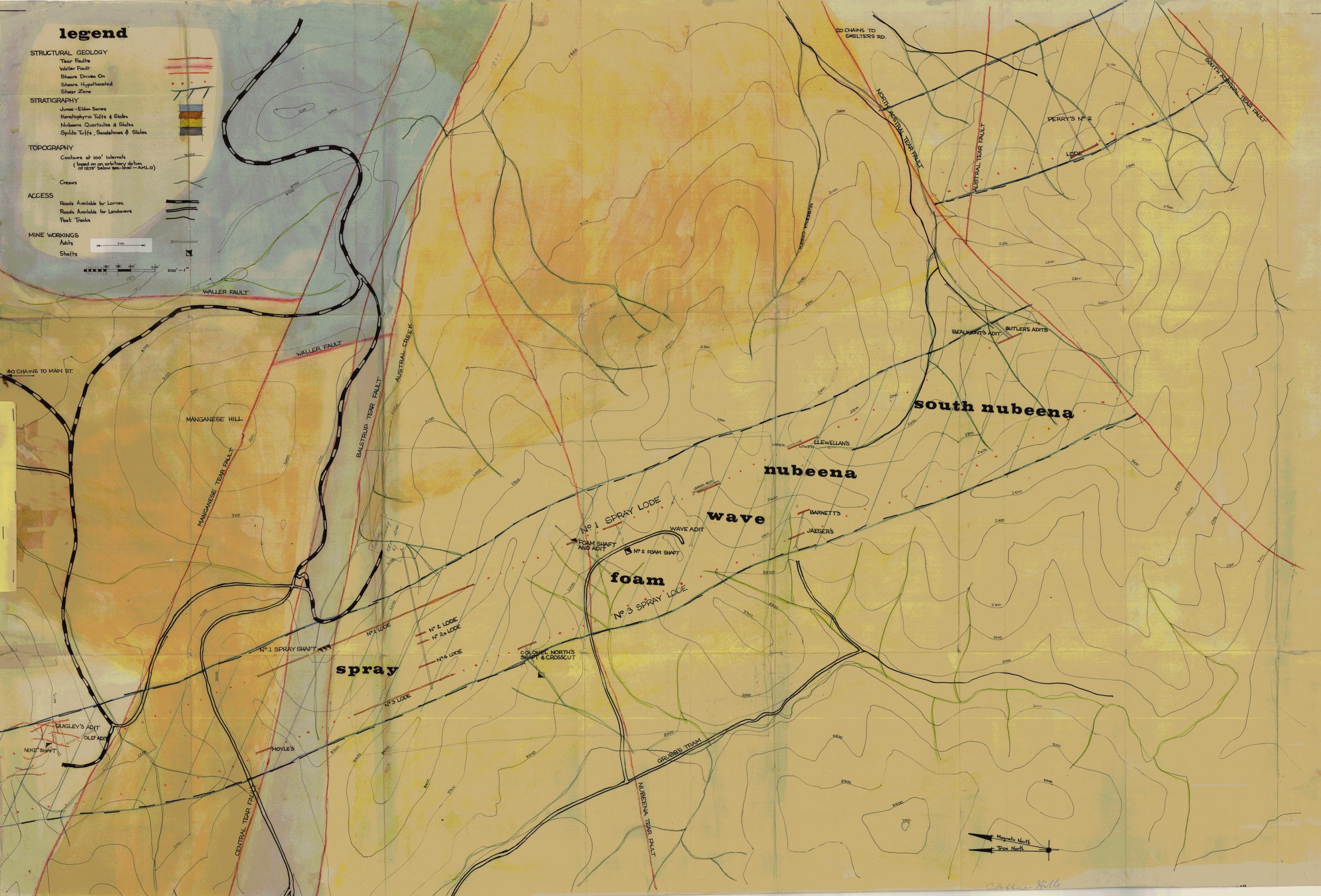
- Contours at 100' intervals
(based on an arbitrary datum
of 1275' below sea-level - A.M.L.O.)

ACCESS

- Roads Available for Lorries
- Roads Available for Landrovers
- Foot Tracks

MINE WORKINGS

- Adits
- Shafts



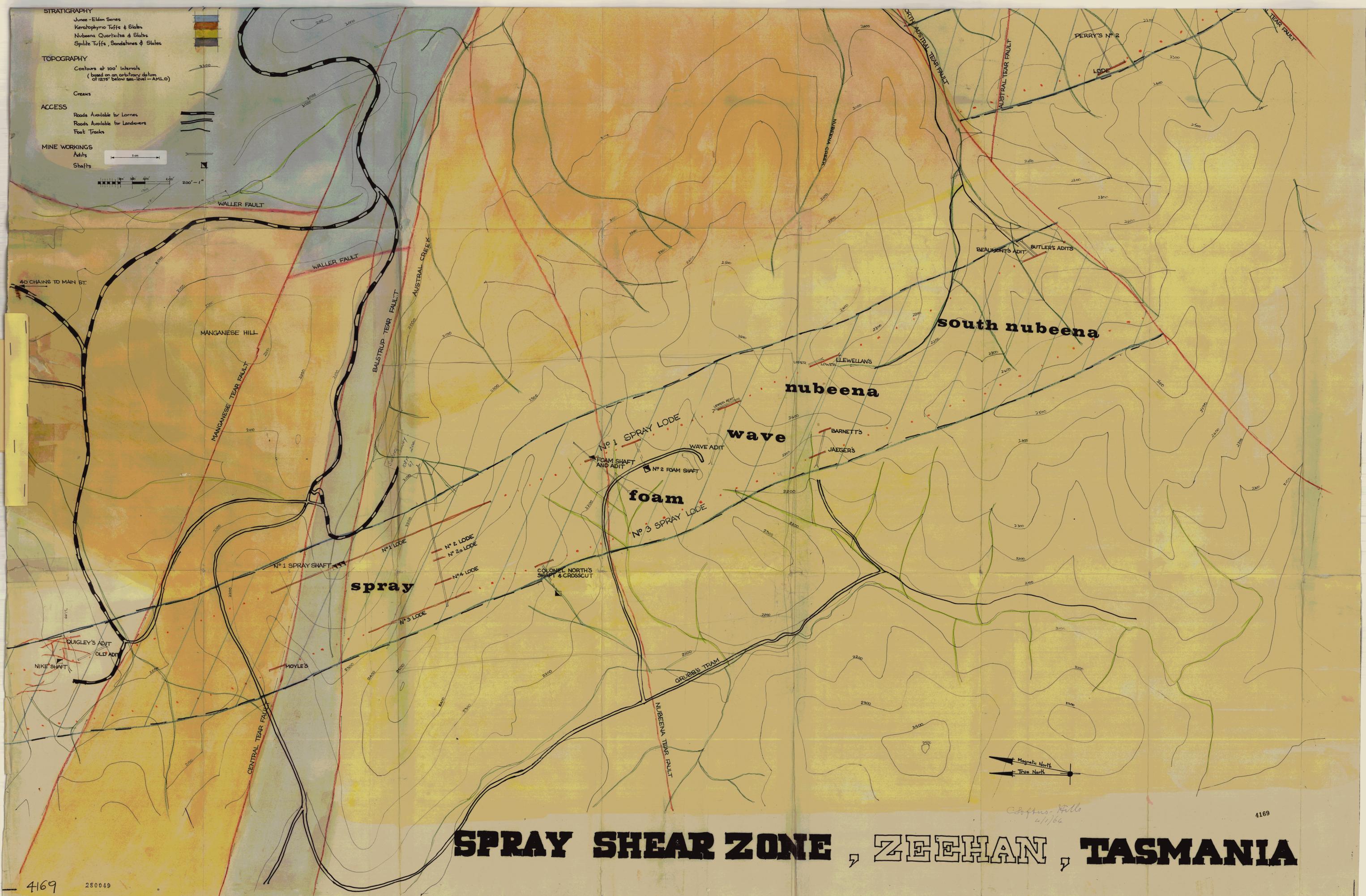
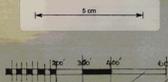
Chas. Hill

STRATIGRAPHY
 Juneae-Eldon Series
 Keratophyric Tuffs & Slates
 Nubeena Quartzites & Slates
 Spillite Tuffs, Sandstones & Slates

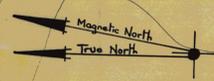
TOPOGRAPHY
 Contours at 100' intervals
 (based on an arbitrary datum
 of 1278' below sea-level - A.M.L.O.)

ACCESS
 Creeks
 Roads Available for Lorries
 Roads Available for Landrovers
 Foot Tracks

MINE WORKINGS
 Adits
 Shafts



SPRAY SHEAR ZONE, ZEEHAN, TASMANIA



*Chaffins Falls
4/1/64*

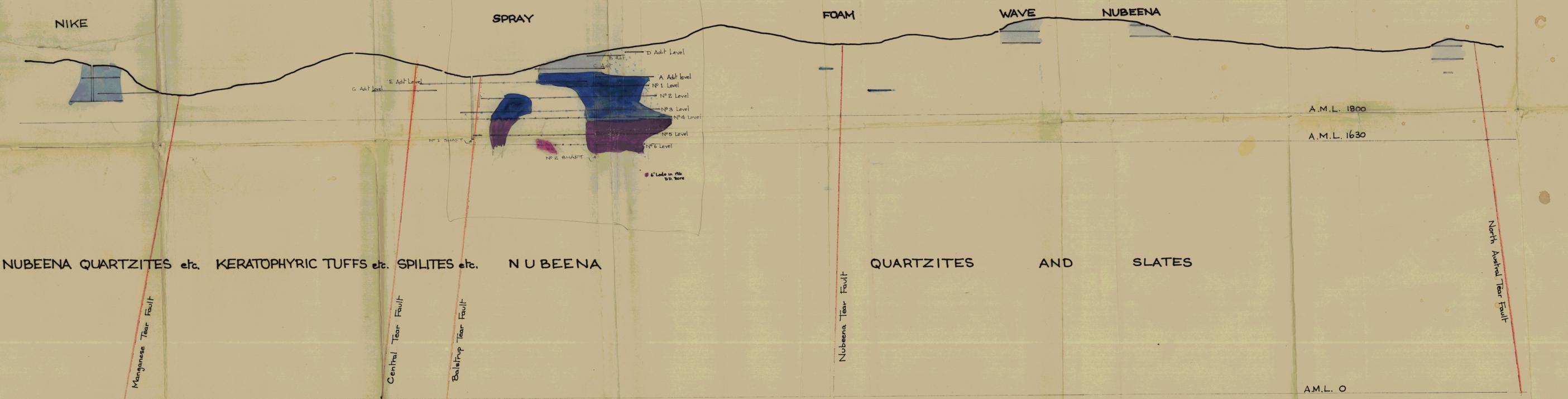


LONGITUDINAL SECTION SPRAY NO 3 SHEAR

0 100 200 400 600 800 feet

legend

- Gossan
- Galena with accessory Jamesonite
- Jamesonite with accessory Galena



LONGITUDINAL SECTION SPRAY NO 1 SHEAR

0 100 200 400 600 800 feet

legend

- Galena with accessory Tetrahedrite
- Galena with Jamesonite & Tetrahedrite
- Jamesonite, Boulangerite & Tetrahedrite
- Mineralised but to degree unknown

*C. Sigfus-Hills
4/1/64*

5 cm