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PROGRESS REPORT ON ACTIVITIES  
IN E.L. 8/65 (MOINA AREA) TO  
JUNE 1967  
by  
K.O. REID

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I. INTRODUCTION

The Moina area of 110 square miles, under exploration lease by the Mt. Lyell Mining and Railway Co. Ltd., occurs within the Sheffield and Middlesex districts of northern Tasmania. The lease boundary is outlined in Fig. 1. Access to the area is by third class gravel road from Sheffield or by sealed road through Gowrie Park - Cethana H.E.C. dam site - Cradle Mt. road; the latter road is not yet open to the public. Within the area access by road is usually quite good as a result of active logging in recent years and local development by the Hydro-Electric - Commission around Cethana.

The investigations in this area have been aimed at assessing the nature, extent and economic potential of the varied and widely occurring mineralisation.

During the period January - March 1966 a party of two, consisting of a geologist and field assistant conducted preliminary investigations in the area. These involved familiarisation with the geology and existing mines and geological mapping. Dr. J. Walker of Barringer Research Ltd., spent three days appraising the area with regard to the application of geochemical prospecting in assessing its mineral potential. Following on the recommendations made in his report of October 1966, a field party of three, consisting of one geologist (occasionally two) and two field assistants proceeded with a stream sediment sampling program and subsequent soil sampling in local areas of interest. This program was carried out between December 1966 and April 1967.

In March and April of 1966, Australasian Mining and Engineering Geophysics Pty. Ltd. (AMEG) conducted an airborne magnetometer survey and in the same period Australian Aerial Mapping Pty. Ltd. aerially photographed the lease area. Numerous reports on the regional geology and geology of the various mines in the area are available. Many of them will be referred to in the text of this report. A list of literature concerning the area is presented at the end of the report.

#### ACKNOWLEDGEMENTS

The writer wishes to acknowledge the assistance of the H.E.C. in permitting access through their development area on the Cethana dam site and inspection of diamond drill core from the Cethana and Wilmot dam sites. Considerable assistance and hospitality has been given both to the Company and the writer by Mr. J. Smith of the Erriba Post Office, particularly with regard to the storage of the Company's caravans for the duration of the winter both in 1966 and 1967.

#### GEOGRAPHY

Topographically the area is very rugged, particularly in the southern portion drained by the Forth and Dove Rivers, elevations ranging from 1,400 to 3,000 feet. The latter two rivers have deeply dissected the basalt plateau at 2,500 feet and now flow in steep sided, rugged gorges, the sides of which are extensively cliffed or thickly vegetated. To a lesser degree the Iris, Lea,

## GEOGRAPHY (Cont.)

Wilmot and Campbell Rivers are similar to the above. The drainage density averages four linear miles per square mile, this being excellent for a reconnaissance stream sediment survey.

The vegetation is variable, showing climatic and altitude control. In the more protected, wetter valley bottoms thick myrtle - sassafras rain forest gives way to zones of horizontal scrub along the stream courses, particularly in the western and southern parts of the area. Elsewhere thick eucalypt forest with a dense undergrowth characterized by ti-tree and Bauera dominates the lower slopes and extends onto the upper slopes. The higher flatter areas are vegetated by open eucalypt forests with generally relatively open undergrowth, apart from occasional stands of dense ti-tree. Around Moina, Lorinna and Daisy Dell open grazing lands are still in use, but with little active farming. The average annual rainfall for the area is about 72 inches.

Throughout the area outcrop is poor, being essentially restricted to stream beds and ridges with additional exposures along road cuttings. Exposures around the old mines which were available to earlier workers have now been covered by thick secondary regrowth, slump and collapse material.

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 II. GEOLOGY

STRATIGRAPHY

Both the Middlesex and Sheffield districts have been systematically mapped by the Tasmanian Department of Mines, this information, including a concise summary of surveys on individual mines being presented by Jennings (1963) and Gee (1966). As these reports are readily available the writer does not intend to unnecessarily duplicate them but to present a brief outline of the relevant geology including any modifications or additional information resulting from the recent field work (Fig. 1).

Precambrian Rocks

Precambrian quartz-sericite schists and quartzites of the Dove Group outcrop across the southern part of the area in the Dove and Forth River valleys. The northern boundary of the Group has been intruded by granite or overlapped by Lower Palaeozoic rocks and Tertiary basalt. Pyrite, galena, chalcopyrite and pyrrhotite veins occur at numerous localities; these will receive further attention in a later section. Structurally the Dove Group is quite complex, having at least three generations of folding and two sets of cleavage (Jennings, 1963). In the south-eastern corner adjacent to the Mersey Granite, Ordovician sandstones and siltstones unconformably overlie Precambrian green-grey and purple, finely laminated muscovite-quartz schists contorted by kink bands, minor drag folds and numerous small faults. These schists are locally quite haematitic with some bands showing varying degrees of alteration to serpentine.

Cambrian System

Along the northern slopes of the Dove River Valley, Cambrian rocks unconformably overlie those of the Precambrian Dove Group, but also occur extensively throughout the area as a whole. Due to the lack of continuous sections and fossils in the Cambrian System, considerable uncertainty exists regarding the succession. It consists of a thick and variable sequence of sediments (mostly greywackes with minor chert bands) interbedded with acid volcanic rocks.

The units of the system, as defined at present, include the Lorinna Greywacke, Bull Creek Volcanics and Minnow Keratophyre. Considerable discrepancies still remain concerning the respective interpretations and correlations of the various members (Twelve trees 1913, Reid 1919, Elliston 1954, Jennings 1958, 1963, Gee 1966).

Lorinna Greywacke

The Lorinna Greywacke as defined by Jennings (1963) includes "an assemblage of greywacke, chert, quartzite and volcanic rocks which underlies the Moira Sandstone on the Five Mile Rise and also outcrops in the Forth River about half a mile north of Lorinna Bridge". In addition to the above localities, these rocks outcrop in the south-west corner of the area around Quaile Falls. Near the H.E.C. Cethana dam site purple to green, fine - medium grained serpentinised greywackes which are very closely fractured and cut by serpentine-quartz

### Lorinna Greywacke (Cont.)

veins have been mapped as Lorinna Greywacke by Jennings. Rocks mapped as Lorinna Greywacke in the north-western corner of the area, are considered by the writer to belong to the Minnow Keratophyre suite.

In the Forth River, south of Lorinna and on the south-eastern slopes of the Five Mile Rise the unit includes granitised greywacke and porphyroid type rocks. In the latter area intercalations of greywackes and granitised greywackes of varying degrees occur, rarely containing veinlets and local sparse disseminations of pyrite and chalcopyrite; specularite is also present in narrow veins. Because of the granitisation of the Lorinna Greywacke its boundary with the Dove Granite is indistinct and apparently gradational. Further west on the Five Mile Rise outcrops of grey, massive, porphyritic rocks containing phenocrysts of quartz and narrow veins of specularite are unconformably overlain by basal Ordovician conglomerates. Superficially the rock resembles a porphyry but according to Jennings (1963, p.40) microscopically it resembles a greywacke.

Adjacent to Quail Falls in Olivia Creek light grey, massive cherts and quartzites outcrop, these varying to a medium grey rock consisting of angular fragments of quartz (1mm diameter) set in an aphanatic ground-mass and also a quartzose porphyritic rock containing angular "xenoliths" of chert. About half a mile to the east a light grey massive chert is exposed in a small quarry and contains intercalations of greywacke-conglomerate which has been partially granitised.

Pyrite is widely distributed in these rocks as minor disseminations and coatings on joint planes, while pyrrhotite is sparsely disseminated locally.

In the Dove Valley the Lorinna Greywacke is considered to exceed 1,000 feet in thickness, while in the Forth Valley Paterson (1960) reported the thickness as "some 600 feet".

### Bull Creek Volcanics

The Bull Creek Volcanics occur extensively across the central part of the area and consist of a complex assemblage of sheared porphyritic acid lavas, greywackes, siltstones and cherts outcropping in the Forth River near Geales Bridge and exposed in road cuttings north of Lorinna. These rocks outcrop as sheared apparently structureless bodies which lack the characteristic features of lavas and are not obviously intrusive.

Burns(1960) subdivided the Bull Creek Volcanics into the Upper Porphyry Member (at least 700 feet thick), the Geales Bridge Member (about 500 feet of greywacke, sandstone, conglomerate and siltstone, interbedded in places with porphyry) and the Lower Porphyry Member (at least 300 feet thick, but possibly much more). Mapping by the writer in the Forth River supports these subdivisions in the vicinity.

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## Bull Creek Volcanics (Cont.)

In the hand specimen the porphyritic acid lavas are dark grey rocks, consisting of quartz phenocrysts in a fine grained groundmass. Some rocks can be recognised as quartz keratophyres and dacites that have been only slightly altered, while others are so altered, both hydrothermally and by shearing, that only the quartz phenocrysts remain unaltered. A feature of these rocks is the relatively strong development of green, fibrous hornblende and or epidote in the groundmass replacing ferromagnesian (Gee 1966) and as veins or segregations. Throughout the area, but particularly at Geales Bridge, the ellipsoidal segregations (3 to 4 inches long) consist of fibrous, dark green hornblende and granular, olive-green epidote, commonly surrounded by white haloes of cryptocrystalline siliceous material. Elsewhere they also occur as lenses and stringers. Gee (1966) reports that the segregations and veins occasionally contain a small core of chalcopyrite. The porphyritic rocks are widespread in occurrence across the central part of the area and are generally unweathered, except in the area surrounding the Lawkewlaw and Pig and Whistle Mines where they have been extensively weathered to soft light grey and red rocks.

The Bull Creek Volcanics unconformably underlie the Ordovician conglomerate and sandstones and probably overlie the Lorinna Greywacke, however the latter may be equivalent to the Geales Bridge Member of the Bull Creek Volcanics.

## Minnow Keratophyre

Along the northern boundary of the area, several thousand feet of acid lavas, soda rhyolites and keratophyres with some greywackes and siltstone, outcrop. Around Bell Mount outcrops and exposures reveal strongly cleaved brown, cream and purple siltstones and slates with acid lavas, including quartz keratophyres and rhyolites. These are commonly crossed by horizontal kink bands, paralleled by quartz tension gashes and cut by milky quartz veins, sometimes bearing micaceous haematite. Similar rocks outcrop in the north western corner of the area, these including sheared rhyolites, siltstones and coarse greywackes and were mapped by Jennings (1963) as the Lorinna Greywacke.

Lying unconformably beneath the Roland Conglomerate on the Lorinna Road near Cethana, the Minnow Keratophyre is represented by a series of cleaved siltstones and pale green quartz keratophyres. Similar rocks are exposed in the vicinity of the H.E.C. Cethana dam site.

Ordovician System

Within the lease area the Ordovician System is represented by more than 4,500 feet of conglomerate, sandstone, shale and limestone. These have been assigned to three formations, notably the Roland Conglomerate, Moina Sandstone and Gordon Limestone.

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### Roland Conglomerate

The Roland Conglomerate is a formation of quartz conglomerates lying unconformably on the Cambrian System and overlain conformably by the Moina Sandstone. It has a maximum thickness of 800 feet on Mt. Roland but thins rapidly south from Round Hill to Tin Spur and Olivers Hill where it is only 20 feet thick (Jennings 1963). In the Lorinna area and on the northern slopes of the Dove River the conglomerate is generally absent, but on the Five Mile Rise a road cutting exposes a maximum of 10 feet of coarse white siliceous conglomerate consisting of subangular - subrounded quartz pebbles set in siliceous matrix unconformably overlying Cambrian Greywackes. The conglomerates are overlain by 10 - 15 feet of white and dark grey, siltstones containing Lingula valves and then into the typical grey, massive quartzites of the Moina Sandstone. The conglomerate also appears to lense out to the west between the Iris and Lea Rivers.

The massive conglomerate is usually pink or white in colour and consists of subrounded fragments of quartzite, quartz and quartz schist in a fine-medium grained siliceous or occasionally argillaceous matrix. In the vicinity of the Dolcoath Granite the conglomerate has undergone recrystallisation to a dense white "Ghost Conglomerate" (Nixon 1954). The Roland Conglomerate is rarely the host rock to mineralisation.

### Moina Sandstone

Jennings(1963) defines the Moina Sandstone as a sequence of marine sandstone, quartzite, shale and conglomerate of about 800 feet maximum thickness, occurring stratigraphically below the Gordon Limestone and above the Roland Conglomerate. The Roland Conglomerate - Moina Sandstone boundary is transitional, the transition zone consisting of interbedded quartzites, conglomerates and grits and is considered to be up to 50 feet thick by Jennings(1963), but at least twice this by the writer. The upper boundary with the Gordon Limestone is also transitional through about 100 feet of interbedded sandstones, quartzites, calcareous sandstones and mudstones and shaley limestones.

The formation consists of white, grey and brown, fine to medium grained, hard quartzites and sandstones with minor beds of siltstone, shale, grit and conglomerate. Fossiliferous horizons are limited although worm tubes are quite common and brachiopods occur locally. The beds are usually one to two feet thick and are cut by a well developed joint system. Folding is of the concentric type with bedding plane slip relieving much of the tension and small break thrusts in the cores of anticlines and synclines.

The intrusion of the Dolcoath Granite into the formation has caused strong induration of the sandstone and introduced numerous mineralised veins. Road outtings along Narrawa Creek have exposed grey, fine grained, hard quartzites containing irregular green segregations very similar in appearance to those in the Bull Creek Volcanics. The segregations consist of diopside hornblende and quartz and frequently contain disseminated pyrrhotite (about 1%). These cuttings also reveal numerous

### Moina Sandstone (Cont.)

quartz - muscovite veins up to 3 inches wide, containing wolframite, pyrite, molybdenite, beryl and fluorite. Pyrite is widely disseminated throughout the formation and is also widely present on joint and fracture surfaces.

In addition to the above types of mineralisation minor disseminations of chalcopyrite, galena and arsenopyrite occur at scattered localities (Fig. 2, p. 14). The Moina Sandstone is an important host rock for the dominantly structurally controlled ore deposits of the region.

### Gordon Limestone

The Gordon Limestone conformably overlies the Moina Sandstone but nowhere within the lease area is the top of the formation exposed. It is preserved only in synclinal positions and is unconformably overlain by Tertiary sediments. Outcrops are present at Moina, in the vicinity of Fletchers and Stormont Mines, on the southern side of Bell Mount, at Lorinna and in the vicinity of Round Hill where two small deposits occur in the bed of Claude Creek, with at least 300 feet exposed in the end of No. 3 Adit of the Round Hill Mine (Jennings 1958 p.52).

In the Moina Valley the transition beds between the Moina Sandstone and Gordon Limestone include an alternation of dark grey siltstones, dense white chert bands, sandstones and black dolomitic limestone, the proportion of limestone increasing up the section. Green epidote crystals are not uncommon on joint and bedding planes of the sandstones and scattered patches of disseminated pyrite are also present. Macro-fossils are not common in the limestone and are poorly preserved (Twelve-trees 1913, Reid 1919, Gee 1966).

The intrusion of the Dolcoath Granite has metasomatised the limestone in the Shepherd and Murphy, Fletcher's Adit and Stormont Mine areas to a garnet-pyroxene-magnetite-epidote rock (skarn, taektite). Further local occurrences of this rock are south of Tin Spur Creek and in Claude Creek near Round Hill. Outcrops in the Iris River at Moina reveal calc-silicate and skarn phases of the basal limestone beds; these beds contain widely disseminated pyrite.

Only the basal and transition beds of the Gordon Limestone appear to have been noticeably altered and reconstituted by the metasomatism. It is suggested that the metasomatising fluids moved with relative ease up through the Moina Sandstone until meeting the basal limestone beds, which being essentially impervious, but more highly reactive, confined the fluids to this horizon. This basal zone is quite an important host for mineralisation in the Moina, Fletcher's Adit and Stormont Mine areas.

### Tertiary Deposits

At least in the Moina - Bell Mount area, a sub-basaltic siliceous conglomerate with interbedded sandstones extensively outcrops. Superficially the rock is rather similar to the Roland Conglomerate being a light grey, pink or

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Tertiary Deposits (Cont.)

white, poorly sorted rock composed of well rounded - angular pebbles of Moina Sandstone and Roland Conglomerate in a fine to medium grained sand matrix and cemented by chalcedonic quartz (Gee 1966). This grey-billy is thought to have been a lake sediment, later silicified by the overlying basalt.

At the Bell Mount gold workings, clays and sands occur below the basalt and overlying the Gordon Limestone and Moina Sandstone. Similar sediments overlie the limestone in the vicinity of the Iris Bridge at Moina and have also been recorded between the basalt and limestone in diamond drill holes along the H.E.C. Wilmot - Cethana tunnel line (Paterson pers. comm. 1967).

Gee(1966) reports sparse outcrops of ferromanganese gossan "on a small hill across the Iris River from Moina" between the basalt and grey-billy at an altitude of about 1,750 feet. Burns (1957) describes similar gossanous outcrops in the area around the Bell Mount gold diggings and interprets them as being iron cemented sub-basaltic deposits of Tertiary age, being remnants of a capping that originally extended across the area at a general elevation of 1,775 feet. An additional occurrence of massive ferromanganese gossan occurs on the western side of the Forth River above the Cethana dam site at an altitude of 1,200 feet. This was associated with Cambrian rocks and may not be related to the above type.

Quaternary Deposits

These consist of relatively thin deposits of gravels, sands and silts overlying the Gordon Limestone at Moina and Lorinna, much of this material being reworked fluvioglacial sediments (Gee 1966). "Varves occur at several points in the Forth Valley between the Dove saw mill and Lorinna" (Spry, 1958). The thickest exposure is at the Addison Creek road crossing south of Lorinna, where they are about 100 feet thick. Extensive blankets of basalt talus and landslip debris occur on the slopes of the Forth and Dove Valleys near Lorinna, and to a lesser degree throughout most of the area.

IGNEOUS ROCKS

Dove Granite (Cambrian)

The Dove Granite is exposed in the Dove River near the Devon Mine, and at the Dove-Forth confluence and in the Mersey Valley on the south-eastern boundary of the lease. These intrusions are located along or near the Precambrian-Cambrian unconformity.

The granite is predominantly a red or light grey, coarse grained rock consisting of quartz, plagioclase, potash feldspar, hornblende and biotite with tourmaline, zircon, apatite and sulphides as accessories. Where exposed in the road cuttings south of Lorinna the granite is deeply weathered, the only fresh granite available being from the Powerful Mine where it is the light grey variety in contrast to the more common red granite occurring elsewhere. The northern boundary of the granite in the Forth and Dove Rivers is difficult to define as it has intruded the Lorinna Grey-

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Dove Granite (Cambrian) (Cont.)

wacke granitising it to varying degrees.

In the vicinity of the Devon Mine on the Dove River porphyritic granites and a variety of porphyritic rocks are closely associated with the granite. The grey porphyritic granites are composed of rounded crystals of quartz feldspar and biotite in a fine grained quartzose - feldspathic ground-mass. There are occasional composite fragments of quartz and feldspar and fragments composed of interlocking biotite crystals indicating that at least some of the coarser grained minerals belong to an earlier generation (Jennings 1963). Disseminated chalcopyrite (less than 1%) and pyrrhotite (approx. 2%) were observed at two localities in the porphyritic rocks associated with the granite upstream from the Devon Mine (Fig. 2). At the confluence of Olivia Creek and the Dove River a closely fractured pale green-grey, pyroxene-quartz porphyry is exposed.

Above the Powerful Mine and in the south-eastern corner of the area, the granite is overlain by unaltered Moina Sandstone, suggesting a Cambrian age for the intrusion. Potassium-argon dating on biotite and hornblende by McDougall and Leggo (1965) led them to the conclusion that the granite was intruded during the late Cambrian.

Serpentine (Cambrian)

Just outside the north-eastern boundary of the lease, serpentine is exposed in a small trench along side the Cethana-Gowrie Park road. Apart from narrow, irregular veinlets of asbestos there is no apparent mineralisation associated with the serpentine which intrudes Cambrian greywackes. Mention has already been made of minor serpentine in association with Cambrian greywackes on the western slopes of the Forth River above the Cethana dam site and also serpentinised Precambrian rocks near the Mersey Granite. The serpentine is apparently of Cambrian age as no trace of it has been found in the Ordovician rocks of the area.

The aeromagnetic survey by AMEG Pty. Ltd. of the lease area revealed a "plateau-like high ..... caused by rocks other than those exposed at the surface and which possess an appreciably higher susceptibility value than the neighbouring rocks". This "high" zone is situated in the central-southern part of the lease, its source possibly being "tabular body with a gentle northerly dip" about  $10^{\circ}$  (Zarsavatjian 1966 p.12). The positive magnetic trends in the north western corner of the area "almost certainly refer to vertical or steeply dipping dyke-like bodies" of similar lithology to that producing the "plateau high" (Zarsavatjian, op. cit.). Depth estimates to the tabular body are 200 - 500 feet in the central area to near surface on the southern edge above the Powerful Mine (Zarsavatjian op. cit.).

The various occurrences of serpentine reported from the area may be surface expressions of the basic tabular body.

### Dolcoath Granite (Devonian)

The Dolcoath Granite outcrops towards the centre of the area as a small stock like body about one mile in diameter. It is extensively weathered to depths of about 60 feet, although near its southern boundary in the Forth River, patches of relatively fresh light grey granite are exposed. The coarse grained granite typically consists of potash feldspar, quartz, plagioclase and biotite respectively, with accessory Zircon, fluorite, apatite, cassiterite, topaz, beryl, wolframite, molybdenite, chalcopyrite and pyrite.

Late stage dyke and vein intrusions are common in the northern parts of the granite but are either absent or rare in the southern region. Throughout the northern section, mineralised pegmatite and greisen dykes and veins are frequently sites of old mines eg. Sayer's, Hidden Treasure, Premier, Dolcoath, Povey and Johnson and Squib Mines as well as numerous other unnamed workings. Gee(1966) records pegmatite dykes up to 3 feet wide, outcropping beside the Lorinna road a quarter of a mile south of Tin Spur. Aplite dykes up to 2 feet wide are exposed in the Forth River south of Narrawa Creek and along the Lorinna road.

Despite the stock like appearance of the granite Gee(1966) noted several lines of evidence suggesting that the granite is essentially a northerly dipping body, plunging gradually westward beneath Moina. The granite intrudes both the Bull Creek Volcanics and Moina Sandstone and has been dated by McDougall and Leggo(1965) at 345 million years.

### Basalt (Tertiary)

The higher plateau areas are extensively covered by olivine basalt flows, probably as much as 1,000 feet thick. Associated with the basalts are basaltic agglomerates in the Moina-Lea River area. The distribution of the basalt was determined by the pre-basalt drainage system as described by Spry(1958) and Rundle(1958). The total thickness of the basalt was sufficient to overflow the pre-existing divides and to introduce lava flows into the Mole Creek Valley.

## STRUCTURAL GEOLOGY

### Precambrian Rocks

The Precambrian rocks which outcrop in the southern part of the area and include the Dove Schist and Fisher Group were considerably deformed during the Precambrian (Spry 1958, 1962, 1963). The dominant schistosity and main compositional banding has a regional east-west trend. First order structures formed during the Precambrian are intersected by later north westerly trending Tabberabberan structures. Within these major folds several sets of smaller scale folds are present; the first order folds are two to three miles across and appear to plunge to the west, the second order folds are a few hundred feet across and generally plunge to the east, while the third order folds (about one foot across) plunge both east and west (Jennings 1963).

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Cambrian Rocks

The lack of outcrop and massive nature of the Cambrian rocks make it difficult to determine accurate fold patterns in these rocks. According to Jennings(1963) they show similar type folds with strong axial plane cleavage, particularly in the axial regions of the first order folds. The thick keratophyre bands tend to be concentrically folded with accommodation by bedding plane slip at the expense of the less competent greywacke and "pyroclastic" formations which are isoclinally folded with an associated axial plane cleavage.

Minor folds plunging to the north-west and south-east are similar to smaller folds in the Ordovician rocks. These folds often diverge in trend from the regional schistosity and are apparently late Tabberabberan structures.

The Bull Creek Volcanics outcropping in the Forth River south of the Dolcoath Granite have been regionally folded into the Dolcoath Anticline and show a strong schistosity which has its maximum development on the southern side of the anticline. Gee(1966) and Burns(1961) have been able to show that the schistosity is of Devonian age. Burns(1961) also reports drag folds, of wavelength about 30 feet, with their axial planes parallel to the schistosity.

In the Lorinna Gorge, the Lorinna Greywacke shows a strongly developed schistosity (80-85/275°N). At the abandoned H.E.C. dam site the Moina Sandstone is apparently conformably overlying green, cleaved siltstones of the Lorinna Greywacke, but this situation has been attributed to a low angle thrust fault (Gee 1966). The shearing in the acid lavas is probably related to the thrusting as there are several additional small thrusts in the Gorge and at its southern end a powerful fault thrusts the greywackes over the Gordon Limestone. All thrusts in the area strike approximately east-west and dip steeply north.

Jennings(1963), Burns (1961) and Gee(1966) produce several lines of evidence indicating that the Cambrian rocks had suffered deformation prior to the deposition of the Ordovician sediments. Jukesian faulting in this area would be difficult to confirm as most of the faults would have undergone subsequent movement during the Tabberabberan Orogeny.

Ordovician Rocks

The Ordovician rocks were strongly folded and faulted during the Tabberabberan forming open concentric folds accommodated by bedding plane slip and break-thrusts in the cores of anticlines and synclines. At least two fold trends are present (Fig. 1). This fold pattern indicates compression parallel to the basin with upward relief, hence the prevalence of thrust faults in the area. The already deformed Cambrian rocks, being under some cover, yielded by shear folds with conjugate wrench faults, resulting in relief across the basin (Jennings 1963). One such fault is the Bismuth Creek fault, trending north west - south east across the central part of the lease area, relative movement across the fault being north block up. In the vicinity of the Shepherd and Murphy Mine at Moina, movement on the near vertical reverse fault was at least a "heave of 1,200 feet" (Blake 1956), possibly with as much as 400 yards dextral transcurrent movement. Blake also considered the fault to be

Ordovician Rocks (Cont.)

post-mineralisation.

## MINERALISATION

This section includes a general discussion on the nature and controlling factors of the mineralisation in the area. Consequently although some specific mines will be mentioned and discussed, no detailed description of the old workings will be attempted, as these have been adequately documented by earlier workers and most have been included in summaries by Jennings(1963) and Gee(1966). In all instances the earlier workers had better access and exposures than exist around the old workings today. A table summarising the basic features of mineral deposits in the area is presented in the appendix (p. 30 ).

The pattern of mineralisation in the area clearly demonstrates the close relationship between the tin-tungsten-molybdenum-bismuth mineralisation with the Dolcoath Granite (Fig. 2). As Elliston (1953) pointed out, there is a reasonable zonation of mineralisation around the Dolcoath Granite with the relatively high temperature deposits of tin-tungsten-molybdenum-bismuth (Williams 1958) being distributed in and around the northern margin of the granite and extending west to the Moyna area. Successive "haloes" of gold silver-lead and copper deposits occur further out.

With at least two phases of granite intrusions, one during the late Cambrian and the other in the Devonian, there is the possibility of two phases of mineralisation. While there is a strong association of mineralisation with the Devonian Dolcoath Granite there is little evidence strongly indicative of a Cambrian phase of mineralisation. According to Jennings (1963, p.112) "haematite lodes ..... seem to be restricted to the vicinity of the Dove Granite and related to it .....", this being indicative of a relationship of mineralisation (including gold and silver-lead) to the Dove Granite. Lead, Zinc and copper mineralisation occur in and around the Dove Granite but then may be satisfactorily attributed to the later mineralisation. Haematite lodes are also common in the Minnow Keratophyre of the Bell Mount area and also occur in the Moyna Sandstone on the Five Mile Rise. This combined with the concentration of magnetite around the Shepherd and Murphy, Stormont and Fletchers Mines indicates a close association with the Dolcoath Granite, but does not rule out the possibility of a Cambrian mineralisation with subsequent remobilisation during the Devonian.

Small alluvial deposits have been worked in the lease area, these being essentially confined to the northern part of the area, although some detrital gold was won from creek beds on the Five Mile Rise and along the Forth River. Other areas of alluvial gold include the Bell Mount goldfield, Olivers Hill in the vicinity of the Devonian Mine and in the Lea River near Fletchers Adit. Colluvial tin and wolfram have been worked on the steep slopes around the Dolcoath Granite and in particular at the Iris and All Nation Mines just to the west of the granite.

The reader is referred to Fig. 2 for mine and mineralisation localities mentioned in the text below.

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Controls of Mineralisation

## Precambrian Rocks

Mineralisation in the Precambrian rocks is limited but includes both vein and disseminated types. Reid (1919 b) reported a 3 inch pyromorphite vein at the Silver Dove Prospect on the Dove River, on which a tunnel 150 feet long was subsequently driven without encountering any worth while mineralisation. In the extreme south-western corner of the area a small quarry exposes muscovite-amphibolite - quartz schists cut by thin flat lying veins of chalcopyrite (approx. 2%) and pyrite (approx. 50%) and a 5 inch wide vein of pyrrhotite containing euhedral crystals of quartz and scattered blebs of chalcopyrite. An assay of the vein material revealed only a trace of tin (0.05% Sn.).

At the Dove Road crossing of Olivia Creek, little deformed thinly bedded micaceous quartzites were found to contain minor traces of disseminated chalcopyrite which appeared to be confined to a purple-grey, dark spotted quartzite. Half a mile to the south-east a massive quartzite bed in a succession of micaceous quartz schists contained minor disseminations of galena, chalcopyrite, sphalerite and pyrite within 20 yards of a strongly pyritic fault zone about 5 feet wide.

## Cambrian Rocks

The Cambrian rocks apparently exert little stratigraphic control on mineralisation. Local very minor disseminations of chalcopyrite were found in the Lorinna Greywacke on the south eastern slopes of the Five Mile Rise and associated with the hornblende-epidote segregations in the Bull Creek Volcanics. Sparsely disseminated pyrrhotite was also found in cherts to the east of Quaille Falls, while in the Dove River about one mile downstream from Olivia Creek similar rocks contain flecks of chalcopyrite, sphalerite and galena. Porphyritic rocks associated with the Dove Granite, upstream from the Devon Mine, contain small amounts of chalcopyrite and pyrrhotite.

Elsewhere mineralisation is of the vein or lode type and is influenced by pre-existing structures including joint systems, faults and shear zones e.g. in the Devon, Powerful, Campbells Reward, Union, Lawkemplaw and Pig and Whistle Mines. Approximately a quarter of a mile downstream from the confluence of Stormont Creek with the Iris River, the Bull Creek Volcanics are cut by a 3 inch quartz vein carrying magnetite (about 30%) and minor pyrite. The host rock also contains ultra-basic segregations similar to those at Geales Bridge (p. 5). As was described earlier the Bull Creek Volcanics on either side of the Bismuth Creek Fault contain moderate-strong disseminated pyrite mineralisation.

Analyses of two grab samples from the end of the adit at the Powerful Mine for nickel and cobalt were negative.

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## Ordovician Rocks

Mineralisation in the Roland Conglomerate is very limited. Where the Lorinna Road cuts Tin Spur the conglomerate contains several thin milky quartz and pegmatite veins containing isolated specks of cassiterite and wolframite. One such vein contains arsenopyrite, pyrite, wolframite, cassiterite and chalcopyrite. Quartz veins carrying wolfram were seen in the conglomerate north of the Lawkenlaw Mine and Pig and Whistle Mine. Nixon(1954) cites several instances in which quartz-wolframite lodes in the Bull Creek Volcanics do not penetrate the overlying conglomerate but tend to form horizontal ore-bodies at the junction of the two rock types. It would appear that the conglomerate acts as a shield, due to a lack of fracturing locally preventing the upward extension of lodes.

Between Moina and Olivers Hill mineralisation in the Moina Sandstone is dominantly associated with quartz veins or lodes in which there is a marked parallelism to the Dolcoath Anticlinal axis. The build up of stresses in the rocks during the development of the Anticline was relieved by the formation of tension gashes, paralld to the anticlinal axis and at right angles to the direction of greatest tension. These tension gashes were subsequently filled by mineralised quartz veins, during the intrusion of the granite. In this area the mineralised quartz lodes typically include wolframite and cassiterite while bismuthinite, sphalerite, chalcopyrite, molybdenite, sphalerite, galena and pyrite may also be present. Mines and workings on this type of lode include the Shepherd and Murphy, All Nations, Lawkenlaw, Pig and Whistle, Nichols and Smiths Tribute, Pochins Adit, Poveys Adit and others. Several unworked lodes 4 to 5 inches wide occur on the northern slopes of Narrawa Creek and exposed by the H.E.C. development roads.

Mineralisation in the Round Hill, Round Hill Extended and Wilmot Mines tends to replace the incompetent shaley beds between the massive quartzite beds of the Moina Sandstone, particularly in the crests of anticlines, forming saddle reef type lodes and occurring locally along bedding planes. Thrust faults intersecting the anticlinal crests appear to have acted as feeder channels to the mineralisation. The ore-bodies consist of coarse and fine grained galena, pyrite and chalcopyrite with lesser amounts of sphalerite, arsenopyrite and bismuthinite.

The Five Mile Rise gold field includes all the small mines located on the west bank of the Forth River opposite Lorinna. It is notable that all the lodes so far discovered are along small faults striking at or close to 140 degrees, this direction being one of a conjugate set of fractures, striking at approximately 140° and 230°. "The lodes outcropped as gold-rich rubbly gossans which, ..... became impoverished underground and passed into mixed sulphide ores, generally silver-lead and pyrite with minor amounts of arsenopyrite, chalcopyrite, gold, sphalerite and sometimes bismuthinite. In the lower adit of the Union Mine small haematite lodes were encountered which may have been the downward extension of the sulphide veins ..... Where the lodes were traced across the contact (Moina Sandstone-Cambrian greywacke) they passed into the Cambrian rocks without alteration." (Jennings 1963).

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## Ordovician Rocks (Cont.)

Minor amounts of gold were mined in the Devonport Mine in the north-western corner of the lease area. In addition to gold the mineralisation includes minor quantities of pyrite, micaceous haematite and chalcopyrite in several small quartz and gossanous lodes which have formed in a shear zone parallel to a fault (65/154W).

Local, sparsely disseminated chalcopyrite, galena and pyrite mineralisation was observed in hard, massive, fine grained quartzite beds of the Moina Sandstone at several localities between the Lea Bridge and the confluence of the Lea and Iris Rivers, about  $3/4$  mile upstream from the Stormont Mine and in Machinery Creek above the Round Hill Mine. Minor flecks of pyrrhotite were observed in a hard green-grey, fine grained quartzite, about half a mile south of the Stormont Mine and along Narrawa Creek.

Limited occurrences of galena, pyrrhotite and pyrite (both disseminated and associated with quartz veining) were observed in core drilled by the H.E.C. along the Wilmot-Cethana tunnel line.

As was mentioned earlier, it is generally only in areas where skarn has developed that mineralisation has been found in the Gordon Limestone. However examination of core from the vicinity of the Bell Mount gold field revealed scattered bbbs of pyrrhotite and pyrite. At the Shepherd and Murphy Mine the skarn has apparently had little influence on the mineralisation, (with the notable exceptions of pyrite banding and magnetite) the east-west trending lodes traversing the quartzite-skarn boundary unaltered.

Bismuth mineralisation in the Stormont Mine is apparently confined to the garnetiferous skarn, Cordwell(1961) also noting that the mineralisation is most impoverished in the amphibolitic sections of the skarn, and absent from the magnetitic skarn horizons. The Mineralisation consists of bismuthinite with minor bismutite and bismite in both lode and disseminated bodies (Cordwell 1961). Richer segregations of bismuth occur in the more garnetiferous rocks, the bismuthinite being present in fractures in the garnets and apparently closely post dates the garnet formation. It also occurs along joints and shears, on which thin films of gold have been reported (Cordwell 1961), paralld to a fault striking at 330 degrees which has dropped the skarn against the apparently unmineralised Moina sandstone.

Similar calc-silicate rocks occupy a synclinal position in the Fletchers Adit area and have also been dropped into juxtaposition with the underlying Moina Sandstone by a north-west trending fault. (Fig. 7 ). Narrow galena-chalcopyrite-sphalerite veins, occasionally carrying wolframite, bismuthinite and pyrrhotite also occur in this area.

Mineralisation in the granite is in the form of pegmatite dykes, greisen and quartz veins and disseminations. The minerals of economic significance occurring in the granite include wolframite, cassiterite, molybdenite and chalcopyrite, the latter being found only locally disseminated in the Premier Mine. The concentration of mineralised

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Ordovician Rocks (Cont.)

dykes and veins around the northern edge of the granite was mentioned earlier, this localisation also apparently holds for disseminated mineralisation, although several flakes of molybdenite were found near the southern boundary on the Forth River. A total of eleven samples obtained from Blacks, Squib, All Nations and Shepherd and Murphy Mines were analysed for yttrium content; in all instances the concentration of yttrium was less than 30 ppm. - an uninteresting level of concentration.

Summary of Controlling Factors of Mineralisation

1. Structural Controls
    - (a) Faults, joints, shear zones
    - (b) Bedding planes
    - (c) Tension cracks
    - (d) Anticlinal crests
  2. Stratigraphic Controls
    - (a) Incompetent (shale) beds between competent (quartzite) beds } *Monna s.s.*
    - (b) Skarn and calc-silicate rocks
    - (c) Fine grained, massive quartzite beds
    - (d) Massive cover of Roland Conglomerate
  3. Source Control
    - (a) Granite - source rock for mineralisation
- eg. Hornblende is like aluminous spt. shales?*

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III STREAM SEDIMENT AND SOIL SAMPLING

INTRODUCTION

In an attempt to quickly and inexpensively assess the mineral potential of the lease area, a program of systematic sediment sampling (on 1/4 mile sample intervals) of both large and small streams was conducted. Following the recommendations of Walker (1966) the -80 mesh fraction of each sample was analysed for hot 0.5N hydrochloric acid extractable zinc and copper, and the (-35 +80) mesh fraction analysed for total tin by colorimetric analysis. Where additional discrimination of the mineralisation was required, analyses of the anomalous samples was undertaken for hot 0.5N hydrochloric acid extractable lead and molybdenum using the fusion - zinc dithiol method.

Follow-up examination of the anomalous geochemical areas delimited from the stream sediment results involved soil sampling of the "B" soil horizon. This was achieved by pitting to depths of up to four feet. To date only two areas have been subjected to soil sampling surveys, notably the eastern slopes of the Wilmot River and the Fletcher's Adit area. Samples from these localities were subjected to molybdenum, tin and tungsten colorimetric analysis and atomic absorption spectrophotometric analysis for bismuth, respectively. The analyses were carried out by Geochemical and Mineralogical Laboratories of New South Wales.

In order to assess the nature of the tin, copper and zinc results in terms of background and anomalous values, each set of results was subjected to straight forward statistical treatment, as outlined in Hawkes and Webb (1962, p.30). Erratic high values were omitted from the estimation of threshold values. The threshold values obtained by this method for possible and probable anomalous values correspond closely to those arrived at subjectively from an inspection of the results.

The calculated threshold values for possible and probable anomalous values for the three elements are listed below :-

	<u>Threshold Values</u>	
	Possibly Anomalous	Probably Anomalous
Tin	16.9	23.5
Copper	17.4	25.6
Zinc	112.9	145.4

On the basis of the calculations for possibly anomalous values only 1 in 40 background samples is likely to exceed the threshold content, whereas only 1 in 667 background samples is likely to exceed the cut off for probably anomalous values.

Stream SedimentsDiscussion of Results

A graphical presentation of the results (Fig. 3) permits the direct comparison of the values obtained for the respective elements (tin,

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## Discussion of Results (Cont.)

copper and zinc) in the stream sediments. There is usually a close correlation between the zinc and copper values indicating that this association is widespread within the area. The Zinc has a much higher background value than the copper due to a combination of the higher mobility of zinc under the near neutral pH conditions and relative concentrations of the elements in the source areas. With the exception of the Shepherd and Murphy Mine area there is little or no direct correlation between tin and copper-zinc mineralisation.

In assessing the intensity of a drainage anomaly it must be borne in mind that the anomaly is a function only of the total amount of metal that has been leached from the catchment area, minus what has already been precipitated before the water enters the surface drainage.

## Dispersion of Zinc and Copper

Bismuth Creek below the Shepherd and Murphy Mine at Moira provides the primary example of anomalous zinc and copper in the area (Figs. 4 and 5). However, from information available in existing reports concerning the mine and from observations in the field, zinc and copper are present only as accessory minerals to the tungsten-tin mineralisation. To the west, in the Iris River and its western tributary, zinc and copper are again locally anomalous and although not as extensive the intensity of this anomalous area is comparable with the former area, particularly when mining development at the Shepherd and Murphy Mine is considered. Further to the west along a line through these two anomalous areas is the bismuth mineralisation in the Stormont Mine and Fletcher's Adit area on the Lea River. Despite the occurrence of several narrow veins containing sphalerite and minor chalcopyrite exposed in the bed of the river near Fletcher's Adit, the stream sampling results reflect no indications of mineralisation in the vicinity; undoubtedly due to dilution.

Other copper-zinc anomalous areas of immediate interest are situated in the south-western corner of the area in the Lea River and Olivia Creek. The Lea River area also contains scattered areas of anomalous tin. All of the areas mentioned above warrant additional investigation to assess the exact nature of the mineralisation and its potential as a significant source of ore grade minerals.

Numerous other copper-zinc anomalous areas occur scattered throughout the area; these largely consist of single samples from minor tributaries along the Forth River and particularly the Dove, Campbell and Swift Rivers. It is difficult to evaluate the significance of these results since the samples frequently and unavoidably contain a higher proportion of organic materials than do samples from the main streams. Samples with high organic content tend to give anomalous high results for mobile elements, such as copper and zinc, due to the formation of organic complexes. Stream anomalies of this type which are of potential interest include those tributaries of the Forth River just to the east of Bell Mount, the tributary about a mile north-west of Oliver Hill,

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## Dispersion of Zinc and Copper (Cont.)

two neighbouring tributaries on the western slopes of the Campbell River and in the Dove River due south from Daisy Dell.

Isolated anomalies for either copper or zinc are of scattered occurrence and of doubtful interest. For example the zinc anomaly near the serpentine exposure on Claude Road, Bell Creek and in the Lea River above Stormont Creek, and the copper anomalies in Dolcoath and Tin Spur Creeks as well as several tributaries in the Dove Valley. The presence of the copper anomalies adjacent to the Dolcoath Granite may be indicative of copper mineralisation associated with pegmatite veins as at the Premier Mine.

A feature of the results is the failure of the copper values to reflect any sign of mineralisation in Claude Creek, particularly in view of the galena-sphalerite-chalcopyrite mineralisation in the Round Mount Mine. The zinc values are also disappointing in this regard, sample S163 being possibly anomalous and S152 in the vicinity of the Round Mount Extended workings being probably anomalous. This is also somewhat puzzling when the copper and zinc anomalies are compared with those below the Shepherd and Murphy Mine since the zinc and copper mineralisation appears to be considerably stronger in the Round Mount Mine. Claude Creek should be resampled in the vicinity of the Round Mount Mine and Extended workings and analysed for copper, zinc and lead in order to confirm or discredit the existing results. Should check results confirm those presented here it will place renewed interest on the widely scattered isolated anomalous copper and zinc values.

## Dispersion of Tin

The main feature of the tin dispersion (Fig. 6) in the stream sediments is the strong anomaly in the Wilmot River extending downstream from the H.E.C. Wilmot Dam site to the northern boundary of the lease. From this anomalous zone, samples S70, 74, 76 and 78 were resampled and analysed with vastly different results to those initially obtained (Fig. 3). This discrepancy warrants additional investigation by resampling, in duplicate, the Wilmot River from the northern lease boundary to the Lea-Iris River confluence. Incidental observations in the course of stream sampling revealed relatively abundant pebbles of quartz containing wolframite, cassiterite and molybdenite in the stream bed. In the light of the existing evidence it was considered that this material had been shed from a quartz lode on the eastern slopes of the Wilmot River and a series of three short traverses were sampled in the C soil horizon at 200 foot intervals (Fig. 6). These samples were analysed for tin, tungsten and molybdenum, but the results were not encouraging (Fig. 3). The samples listed above were also analysed for lead and molybdenum and while the results for molybdenum were not encouraging, lead was shown to be anomalous (Fig. 3). The lead is presumably being derived from the vicinity of the Wilmot (Washington) Mine on the eastern slopes of the Wilmot River. Similar analyses for lead and molybdenum in Bell Creek were unrewarding.

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### Dispersion of Tin (Cont.)

Bismuth Creek below the Shepherd and Murphy Mine is strongly anomalous for tin, however the strong tin anomaly in Brampton Creek is of some interest, suggesting either a westward extension of the lodes in the Shepherd and Murphy Mine or the presence of a paralld lode system.

Dolcoath and Narrawa Creeks are locally anomalous for tin, this material presumably being shed from the numerous small mines in the area. Several local but strong tin anomalies occur in the Forth River at S330 and in small tributaries north of Oliver Hill at S218 and S212, the latter example also being strongly anomalous for copper and zinc. The numerous less intense stream anomalies particularly in the northern half of the lease area do not appear to warrant additional investigation at this stage.

### Soil Sampling

Dispersion of Bismuth in the "B" soil Horizon - Fletchers Adit Area.

Despite the lack of any indication of mineralisation from the stream sediment survey, the visible bismuth mineralisation in the skarn above Fletcher's Adit was sufficient incentive to proceed with a "B" horizon soil sampling program. Tentative threshold values (calculated on the basis of 45 samples) for possibly and probably anomalous values are 42 ppm. and 50 ppm. respectively.

A surprising feature of the results is the absence of any indication of bismuth mineralisation in the vicinity of Fletcher's Adit, since observations in the field revealed quite strong mineralisation in the trenches above the adit (Fig. 7). It is suggested that this zone adjacent to the fault be resampled at 100 foot intervals.

In the western part of the area soil sampled there is a strongly anomalous north-west to south-east trending zone which transgresses the skarn - Moira Sandstone boundary. The southern part of this anomaly was not intersected by the initial survey which will have to be extended to adequately cover the zone. AT this stage it would appear that this anomalous zone is situated over a fault, as it is aligned paralld to other faults nearby.

### Eastern Slopes of Wilmot River

As was mentioned earlier, three short soil sampling traverses were used in an attempt to locate the source of the tin anomaly in the sediments of the Wilmot River (Fig. 6). On the basis of the evidence available it was assumed that the anomalous material was being shed from a north-easterly trending quartz-wolframite-cassiterite-molybdenite lode or series of lodes. However, the results obtained from the "C" horizon soil samples were not encouraging. The apparent failure of the results is puzzling since on traverse III (Fig. 6) some positive indications were expected. An adequate explanation of this is not available at present because while the immobile tin and wolfram might be expected to yield inconsistent results from such a survey, the highly mobile molybdenum should be more widely dispersed.

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IV SUMMARY OF AEROMAGNETIC SURVEY AND DISCUSSION

The following summary concerning the aeromagnetic survey is largely derived from a report submitted by Zarzavatjian (1966). The reader is referred to the latter report for additional information.

In general the numerous complex anomalies in the central-south western and south-eastern parts of the area correlate well with known basalt occurrences (Fig. 8). However some basalt occurrences do not appear to affect the magnetic pattern eg. trends 6 and 7, and the basalt in the south-eastern section is less complex magnetically than elsewhere. This latter feature and other complications in the magnetic expression of the basalt may be due to weathering (whereby the ferromagnetic minerals have lost their magnetic properties either partly or completely), variations in the height of the helicopter above the ground and/or variable thickness of the basalt.

Adjacent to the southern part of the area anomalies of 300 to 400 gammas have been correlated with thick basalts, while in general the basalts exhibit anomalies ranging from a few gammas up to 250 gammas. Hence it is difficult to assign the 500 gamma anomaly 12 to a small, thin basalt outlier on the hill above the Powerful Mine. Depth estimates on this anomaly indicate a surface or near surface source. The basalt outlier has been sampled in order that susceptibility tests may be conducted, to gain more evidence with regard to the nature of the anomaly. The results of the susceptibility tests, which were also carried out on the Dove and Dolcoath Granites and serpentine, are not yet available. A small stream draining from the vicinity of anomaly 12 was found to be possibly anomalous for copper.

Most of the sedimentary and metamorphic rocks of the area have no distinctive magnetic characteristics and little of the remaining magnetic pattern can be correlated with the local and regional geology (excluding the basalt). A notable exception to this is the close correlation between the negative anomaly 28 and the Dolcoath Granite. Anomaly 29 of low amplitude transgresses the contact between the Roland Conglomerate and unassigned Cambrian rocks without any visible effects and consequently appears to have a source other than the exposed sediments. The small stream running parallel to Claude Road was found to be anomalous for zinc right on the lease boundary. This stream anomaly is adjacent to both anomaly 29 and 30 but further field investigations are required before conclusions regarding the possible source of the sediment anomaly or relationship to the magnetic anomalies are made. According to Zarzavatjian(1966) the low amplitude of anomaly 30 would tend to preclude the small serpentine outcrop as being the source of the magnetic anomaly.

Anomalies 31 and 32 occur in an area mapped as Moira Sandstone but there is some doubt that their sources are within this formation (Zarzavatjian, 1966 p.11). The depth estimates for the source of anomaly 31 as being between 50 and 100 feet should place it within the Moira Sandstone; source depth estimates are not available for anomaly 32. The Round Hill Mine is situated on the eastern periphery of anomaly 31 which is bounded by anomalous tin in Claude and Tin Spur Creeks with possibly anomalous zinc below the Round Hill Mine and anomalous copper in Tin Spur Creek on the southern flank of the magnetic anomaly. This area should be high in priority for additional investigation.

## SUMMARY OF AEROMAGNETIC SURVEY AND DISCUSSION (Cont.)

Removal of the magnetic effects of the basalt reveals a plateau-like high in the central and south-eastern part of the area which with the strong trends such as trend 7 in the north-western corner, appear to possess an appreciably higher susceptibility value than the neighbouring rocks. The positive trends in the latter area almost certainly refer to vertical or steeply dipping dyke-like bodies which appear to be of similar lithology to that of the plateau-like high (Zarzavatjian 1966 p. 13). The plateau-like high is a reflection of a tabular, basic sheet, gently dipping north (dip tentatively estimated at  $10^{\circ}$ ). Supporting field evidence for the existence of such a body is the small serpentine outcrop near anomaly 30 and serpentinised Precambrian rocks a mile south of anomalies 10 and 11 which are reputedly "near-surface" expressions of the basic sheet. The average depth estimates of anomalies 10, 11 and T-73E is 210 feet and of anomalies 21 and 22, 450 feet.

The strongest magnetic anomaly in the area is the centrally situated north west - south east trending anomaly 24 characterised by a high susceptibility corresponding to 5 or 6 percent magnetite by volume and 10% by weight (Zarzavatjian 1966, p.15). The parameters of this anomaly are a depth estimate of 200 to 500 feet, dip  $86^{\circ}$  S, width 500 to 1,200 feet and intensity of approximately 1400 gammas. The centre of anomaly 24 is located in an area mapped as Moine Sandstone transgressing the unconformity into the Cambrian, Bull Creek Volcanics. However depth estimates of the source of the anomaly probably place it entirely in the latter formation. To the north-west this anomaly appears to merge with trend 4 of amplitude 200 gammas described as an infinite dyke comparable to that of trend 7, the depth estimate being 200 to 250 feet, width 550 - 600 feet and having a northerly dip of  $54^{\circ}$  -  $64^{\circ}$ . It extends only a short distance to join trend 5 of amplitude greater than 200 gammas. Obliquely traversing this general magnetic anomalous trend is the south-eastern extension of Bismuth Creek fault along which moderate-strongly pyritic sericite schists (Fig.2) have been extensively found.

The small stream flowing into the Forth River at the western end of anomaly 24 was found to be anomalous for zinc and possibly anomalous for copper. Although no definite conclusions can be drawn from this information at present, the zone, particularly anomaly 24 itself is of sufficient interest to be the subject of further investigations.

At the western end of trend 5 where it is cut by the Iris River and lesser streams the stream sediments were found to be locally anomalous for tin, copper and zinc. The elongated anomaly 34 of 80 to 100 gammas is located just west of trend 5 and appears to be a lower intensity extension of the latter. There is no stream sediment anomaly in the neighbourhood of anomaly 34. The association of stream sediment and magnetic anomalies such as that mentioned above may be coincidental as many of the stream anomalies do not appear to be associated with magnetic anomalies. However associations such as exist in the vicinity of the Shepherd and Murphy Mine lend some plausibility to these conclusions.

## SUMMARY OF AEROMAGNETIC SURVEY AND DISCUSSION (Cont.)

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The small east-west elongated anomaly 33 is a high amplitude anomaly of over 600 gammas situated over the Shepherd and Murphy Mine. This is a locality of well known mineralisation worthy of investigation by diamond drilling to test for additional lodes, particularly in the light of the strong stream sediment tin anomaly immediately to the west in Brampton Creek.

The predominantly east-west striking trend 7 is well defined having an intensity of over 300 gammas and includes the 600 gamma anomaly 35. In the Lea River which passes over anomaly 35 several samples were respectively anomalous for zinc, copper and tin. A minor much less pronounced extension of trend 7 is the west-north west striking 100 gamma anomaly 36 over the Washington Mine, previously worked for galena. Several isolated stream samples from the Wilmot River below the mine were analysed for lead (Fig. 3) and found to be anomalous. The possible relationship of the tin anomaly in the Wilmot River with the magnetic anomaly 36 appears to be rather dubious particularly when the soil sampling across the latter anomaly failed to reveal a source for the tin.

The depth estimates for anomalies 20 and 22 of 350 feet, anomaly 21 of 550 feet and anomaly 30 of 300 feet, agree well with that of 200 to 500 feet obtained for anomaly 24. "It appears that these anomalies represent the shallower parts of the basic tabular mass at its central portion" (Zarzavatjian, 1966 p.17). Anomalies 21 and 22 are located immediately west of Lorinna in an area mapped as Gordon Limestone, however the depth estimates may place the source of the anomaly within the underlying Moina Sandstone. Similarly anomaly 20 is centred over an area of basalt talus presumably overlying Gordon Limestone but extending over the Cambrian, Lorinna Greywacke formation.

In the south-west corner anomalous copper and probably anomalous zinc appear to be associated with the near surface magnetic anomaly 14 of 200 gammas. Nearby a stream draining from the partly recorded anomaly 1 of intensity 180 gammas is anomalous for copper.

It is difficult to make similar tentative correlations between magnetic and stream sediment anomalies in addition to those above. A puzzling feature of the magnetic map is the lack of expression over the Dove Granite exposures. This southern part of the area is essentially featureless with respect to magnetic response, but this can be largely attributed to the Precambrian quartzites and schists. The stream sediment anomalies across the Bull Creek Volcanics in the Iris River adjacent to Weaning Paddock Creek is in an area characterised by complex negative magnetic anomalies.

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v.RECOMMENDATIONS

## STREAM SEDIMENT ANOMALIES

Numerous stream sediment anomalies in the lease area require initial follow-up investigation to confirm their existence and intensity and/or to more accurately locate their position and source. This involves resampling of the anomalous areas preferably on a closer sample interval (about 200 yards) prior to setting up a soil sampling or geophysical program. In this regard it is strongly suggested that a wider spectrum of elements should be analysed in an attempt to elucidate the nature of the mineralisation. Additional to re-analysis of the anomalous samples for tin, copper and zinc, analyses for lead, bismuth, molybdenum and tungsten may also prove to be of interest.

The stream sediment anomalies of particular interest requiring re-sampling are listed below.

1. Copper, zinc and tin anomalous areas in the Iris River and tributaries, immediately above the Iris Bridge at Moina.
2. Zinc anomaly in the Iris River above Stormont Creek.
3. Zinc, copper and tin anomalous areas in the Iris River in the vicinity of Weaning Paddock Creek.
4. Copper and zinc anomalies in Olivia Creek.
5. Copper and zinc anomalies in the Dove River and tributary below magnetic anomaly 14.
6. Possibly anomalous copper in stream draining from magnetic anomaly 12 above the Powerful Mine.
7. Copper, zinc and tin anomalies in small eastern tributary of the Forth River approximately a mile north of Oliver Hill.
8. Claude Creek, particularly in the vicinity of the Round Hill Mine and Tin Spur Creek between the Lorinna Road and the Forth River.
9. Copper, zinc and tin anomalies in several small streams draining from the eastern slopes of Bell Mount into the Forth River.
10. Zinc anomaly adjacent to magnetic anomaly 30.
11. Zinc, copper and tin anomalies in the Lea River adjacent to magnetic anomaly 35.
12. Tin anomaly in Brampton Creek at Moina.

Investigations concerning the tin anomaly in the Wilmot River should also be preceded by re-sampling in order to confirm its extent and intensity, as the results available at present are somewhat confusing (Fig. 3). Concomitant with the re-sampling of the stream sediments, "C" horizon soil samples should be obtained from either bank at each stream sample point, thus further delimiting the area for future investigations.

## FLETCHER'S ADIT SOIL ANOMALY

The immediate work required in the Fletcher's Adit area is the extension of the existing "B" horizon soil sampling program to cover the southern end of the strong bismuth anomaly. This would involve about six additional samples. Subsequently it would be expedient to subject the area to an electromagnetic survey; the area is readily accessible. Several check samples from above Fletcher's Adit should be collected to confirm the

## FLETCHER'S ADIT SOIL ANOMALY (Cont.)

absence of the bismuth anomaly - from field observations of bismuth mineralisation in the skarn from several trenches a bismuth soil anomaly would be expected adjacent to the fault.

## AEROMAGNETIC ANOMALIES

Several magnetic anomalies in the area are of particular interest including anomaly 24 and the smaller but strong anomaly 12 adjacent to the Powerful Mine. The writer considers that electromagnetic surveys would be the most effective method of determining the nature of the anomalies sources, possibly with supporting ground gravity in the above instances. It may be necessary to use at least reconnaissance ground magnetometer surveys to more accurately locate the aeromagnetic anomalies prior to the implementation of other techniques.

Other instances in which electromagnetic surveys may prove to be an effective tool are anomalies 20, 21, 22 and 31 and trend 5 (Fig. 8). Additional geochemical results from stream sediment resampling may support anomalies 31 and trend 5 in this regard.

Final decisions concerning the application of various geophysical techniques are awaiting professional advice.

## SHEPHERD AND MURPHY MINE AREA

Mineralisation in the mine area occurs in a series of six main east-west trending lodes and several lesser north-west trending lodes, averaging from 8 to 20 inches wide which traverse the Moina Sandstone and Gordon Limestone (skarn) Fig. 9. The steeply dipping Bismuth Creek fault has displaced the skarn into juxtaposition with the Moina Sandstone. The fault strikes on a general bearing of  $315^{\circ}$  and the displacement of the strata indicates "a heave of at least 1,200 feet" (Blake 1955) with transect movement of about 1,300 feet. Blake also reports that wolfram bearing veins are dislocated by the fault however the lateral extensions of the lodes in the mine have not been reached, thus it is not known if they are similarly displaced.

The lodes are quartz-wolfram cassiterite veins with molybdenite and bismuthinite and accompanying sulphides. The ore occurs sporadically in the lodes as bunches of crystals with larger patches occurring less frequently; some mineralisation of the wall rocks for a few feet on either side of the lodes is quite common. From the surface down to a depth of 340 feet the lodes have been worked by way of 4 adits. Below No. 3 Adit, which is the lowest, they have been developed to a further depth of 150 feet in 2 levels from a main shaft (Blake, 1957). Robinson (1957) has estimated "probable" and "possible" ore reserves of 42,400 tons and 34,600 tons respectively at a grade of 0.21% Sn and 0.37%  $WO_4$  for the existing mine workings. These estimated tonnages do not include No. 5 Lode (Fig. ) which according to Robinson has good potential but due to lack of intersection does not enter into the above ore reserve calculations. The possibility of recovering other ore minerals was not considered.

## SHEPHERD AND MURPHY MINE AREA (Cont.)

The possible tonnage quoted by Robinson is too meagre to warrant mining unless additional reserves are forthcoming. Consequently it is proposed that the extent and grade of the existing lodes be tested to the west and at depth, with concomitant prospecting for other zones of paralled ore shoots, by means of a long cross outting diamond drill hole. Such a hole would also serve to appraise any disseminated mineralisation. This could be achieved by a hole (D.D.H.1, Fig. 10) collared at about 200 feet north-west of the old mine office (Fig. 9), having a bearing of  $185^{\circ}$ ,  $-20^{\circ}$  inclination and a proposed length of 1,500 feet. The cross section (Fig.10) is based on Blake's (1955) geological map of the mine area, but is essentially only diagrammatic. If this hole proves to be unsuccessful it is proposed that the program be dropped, however should it be successful D.D.H.2 would follow (Fig. 10).

Provided that the presence of the tin anomaly in Brampton Creek is confirmed by resampling, it would indicate either the western extension of the Shepherd and Murphy lodes or the existence of a paralled zone of similar lodes. The zone west from the latter mine to the Fletchers Adit area appears to be one of extensive mineralisation.

Assuming that the main lodes of the mine area have been displaced by the Bismuth Creek fault at least one ground magnetometer traverse from the vicinity of the mine to the Cradle Mountain road, on the eastern side of the fault is recommended. This would either confirm or negate the presence of any displaced lodes.

In the event of future investigations in the vicinity of the Shepherd and Murphy Mine being successful the possibility of working other wolfram-tin deposits in the area, in conjunction with the latter, must be borne in mind. The neighbouring area which includes the All Nations, Lawkewlaw and Pig and Whistle Mines and the northern margin of the Dolcoath Granite, has some potential in this regard. The known lodes in this area which have formed the basis of the above mines are of the order of 6 to 10 inches wide, although Reid (1919) reports widths of up to 2 feet in the All Nations Mine where the lodes also carry bismuthinite, molybdenite and gold. A ground magnetometer survey consisting of at least four traverses of 2,000 feet in length, south from the road on the northern side of the All Nations Mine, with readings at 10 to 20 foot intervals, should be adequate to detect the presence of additional lodes (Fig. 11).

## CONCLUSIONS

The areas of immediate interest which are recommended for prompt additional investigation occur predominantly in the northern half of the lease and are listed below in approximate order of priority.

1. Bismuth soil anomaly near Fletcher's Adit - electromagnetic survey.
2. Shepherd and Murphy Mine - at least one diamond drill hole complemented by a ground magnetometer survey.
3. Geophysical investigation of magnetic anomalies 24,12,31,20,21,22 and possibly trend 5 - electromagnetic surveys.
4. Resampling of the stream sediment anomalies outlined earlier (p.24). This can be largely conducted while supervising the above aspects of the program and may lead to further soil sampling or geophysical investigation.

031  
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PROGRESS REPORT ON ACTIVITIES  
IN E.L. 8/65 (MOINA AREA)  
TO JUNE 1967  
by  
K.O. REID  
APPENDIX, MAPS AND DIAGRAMS

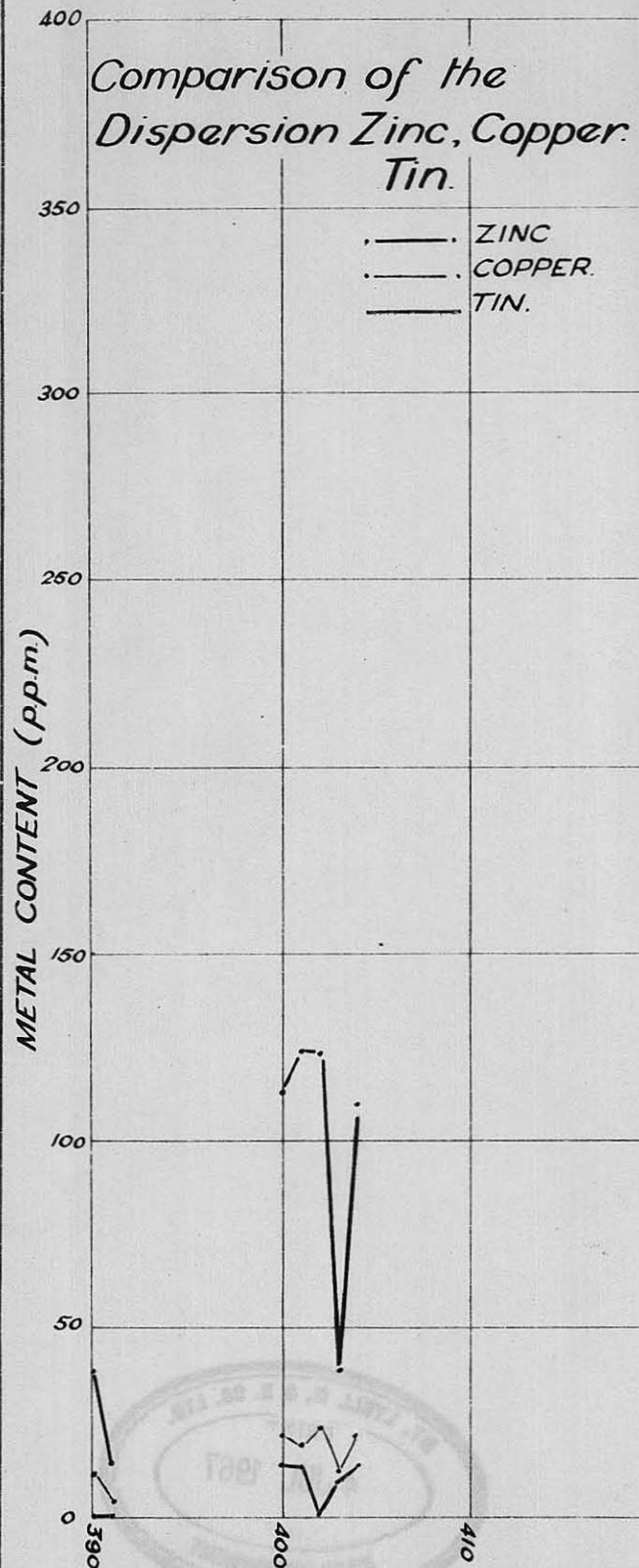




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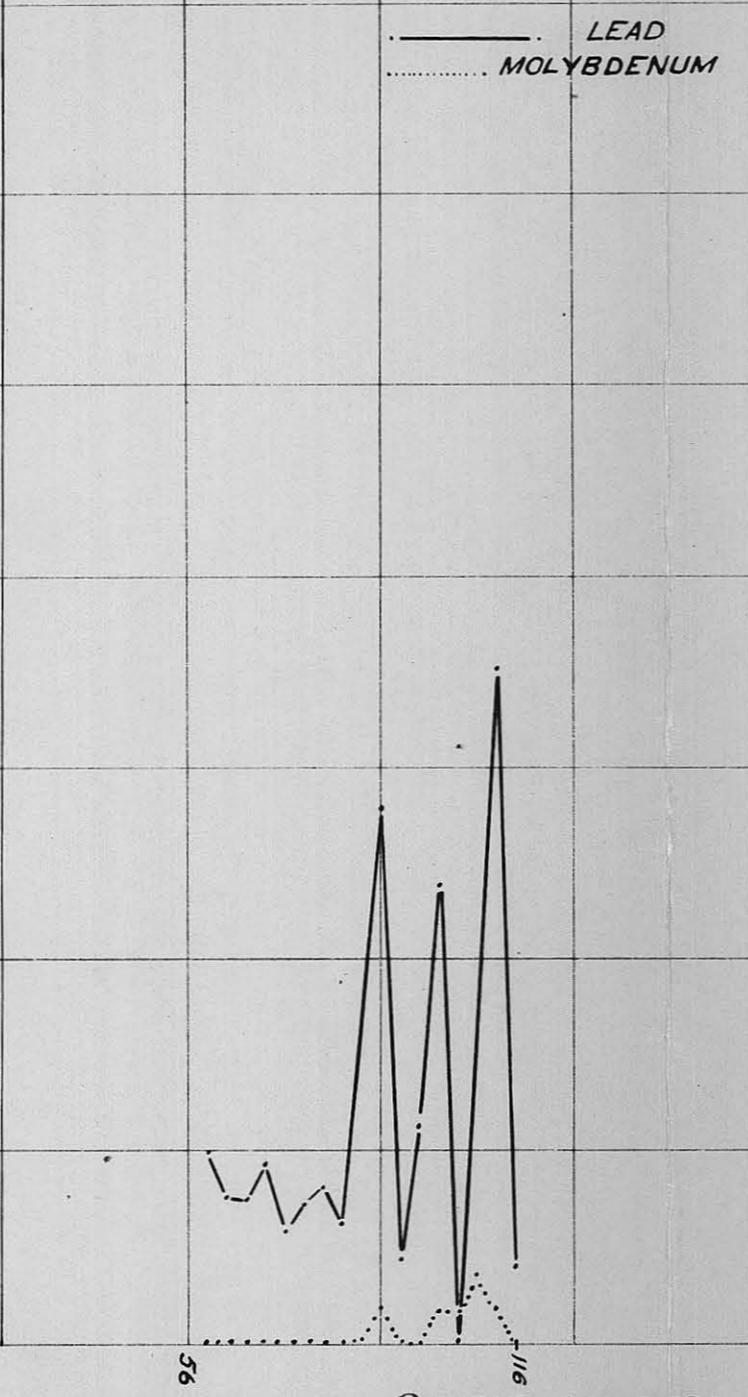
Comparison of the Dispersion Zinc, Copper, Tin.

— ZINC  
— COPPER  
— TIN.



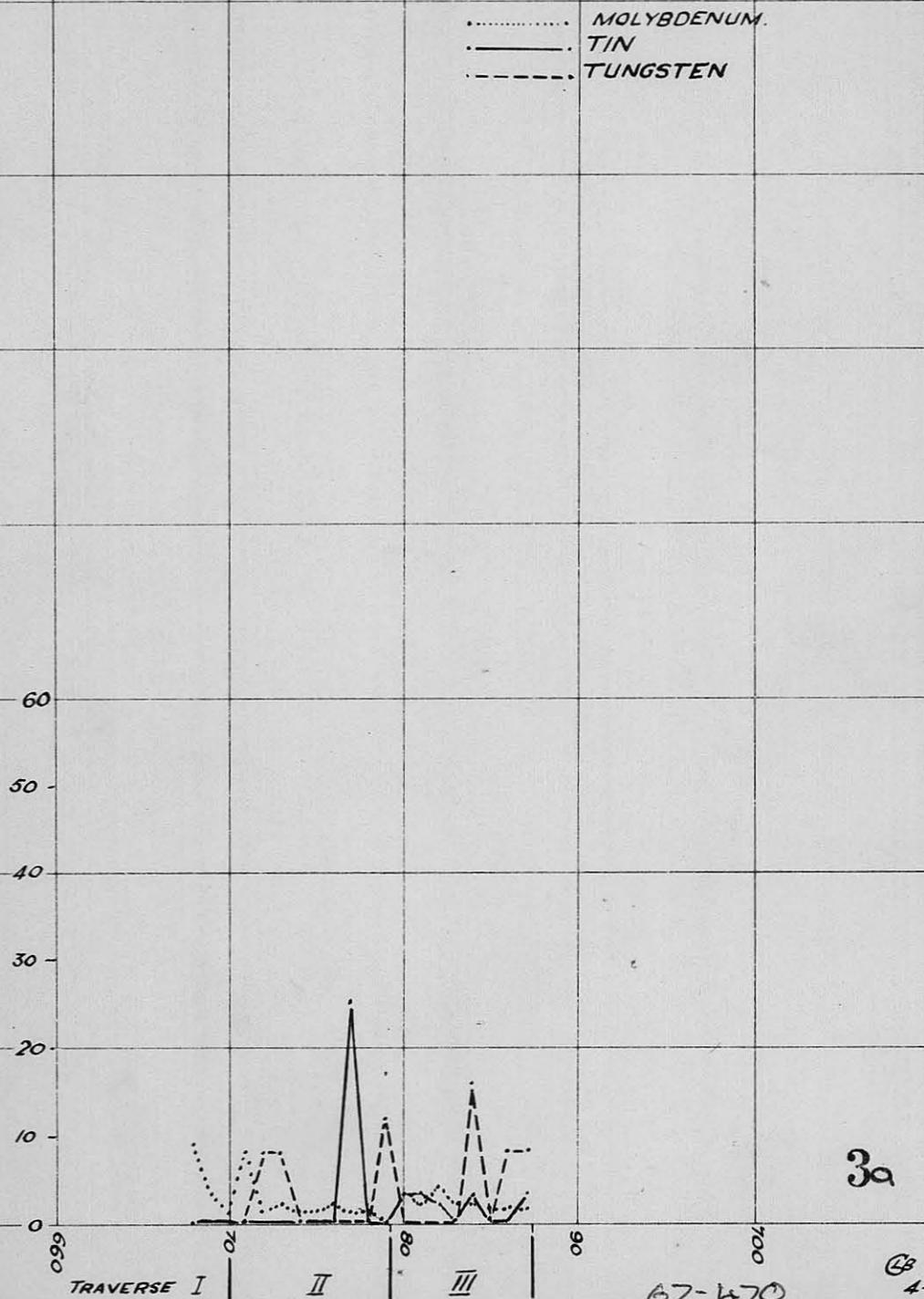
Comparison of the Dispersion of Lead and Molybdenum in the Wilmot River.

— LEAD  
..... MOLYBDENUM



Comparison of the Dispersion of Tin, Tungsten and Molybdenum in "C" Horizon Soil Samples - Northern Slopes of Wilmot River.

..... MOLYBDENUM  
— TIN  
- - - TUNGSTEN

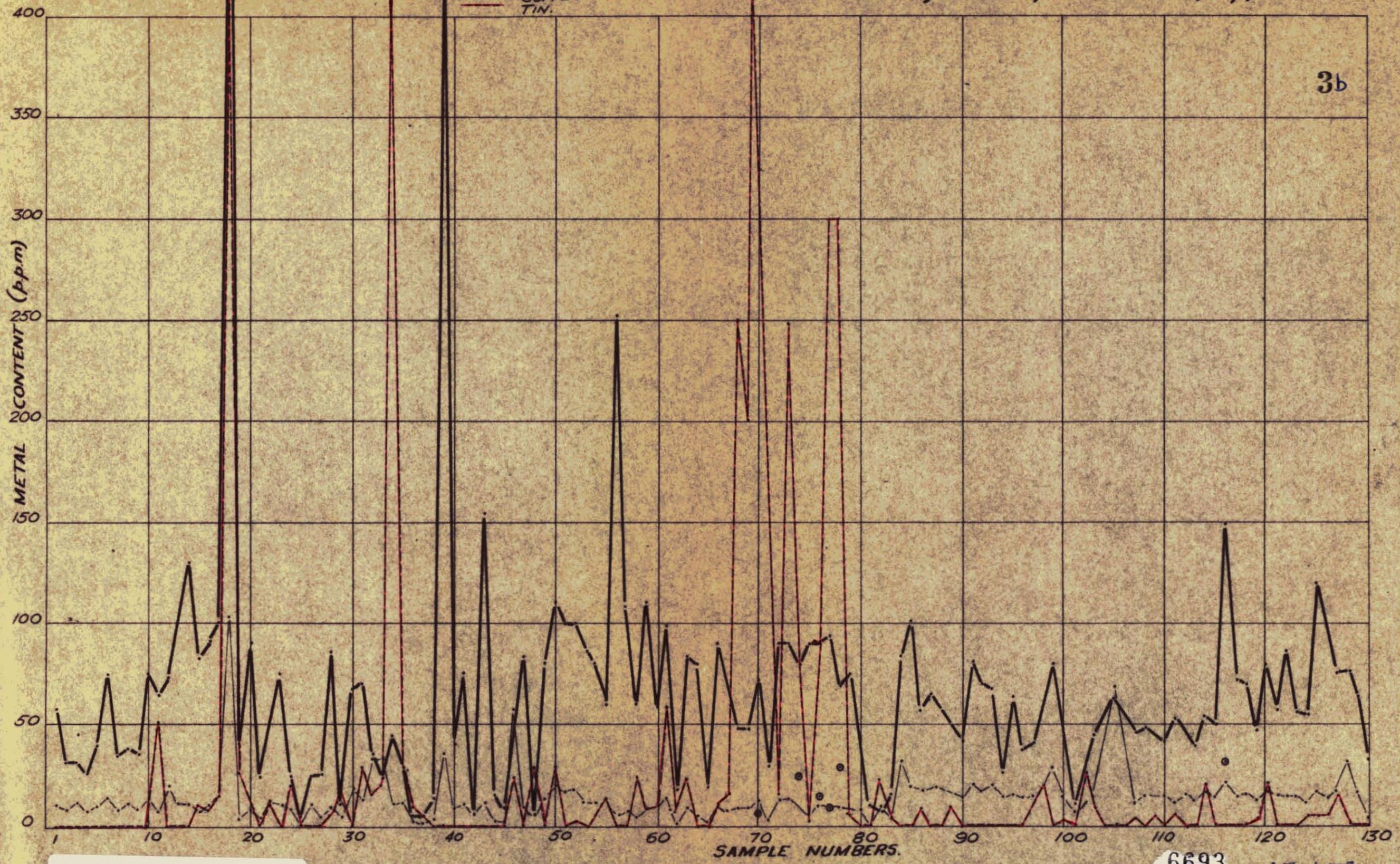


3a

67-470  
169038  
4-7-67  
6692

# Comparison of the Dispersion Zinc, Copper and Tin.

— ZINC  
— COPPER  
— TIN.  
⊙ Repeat values TIN.

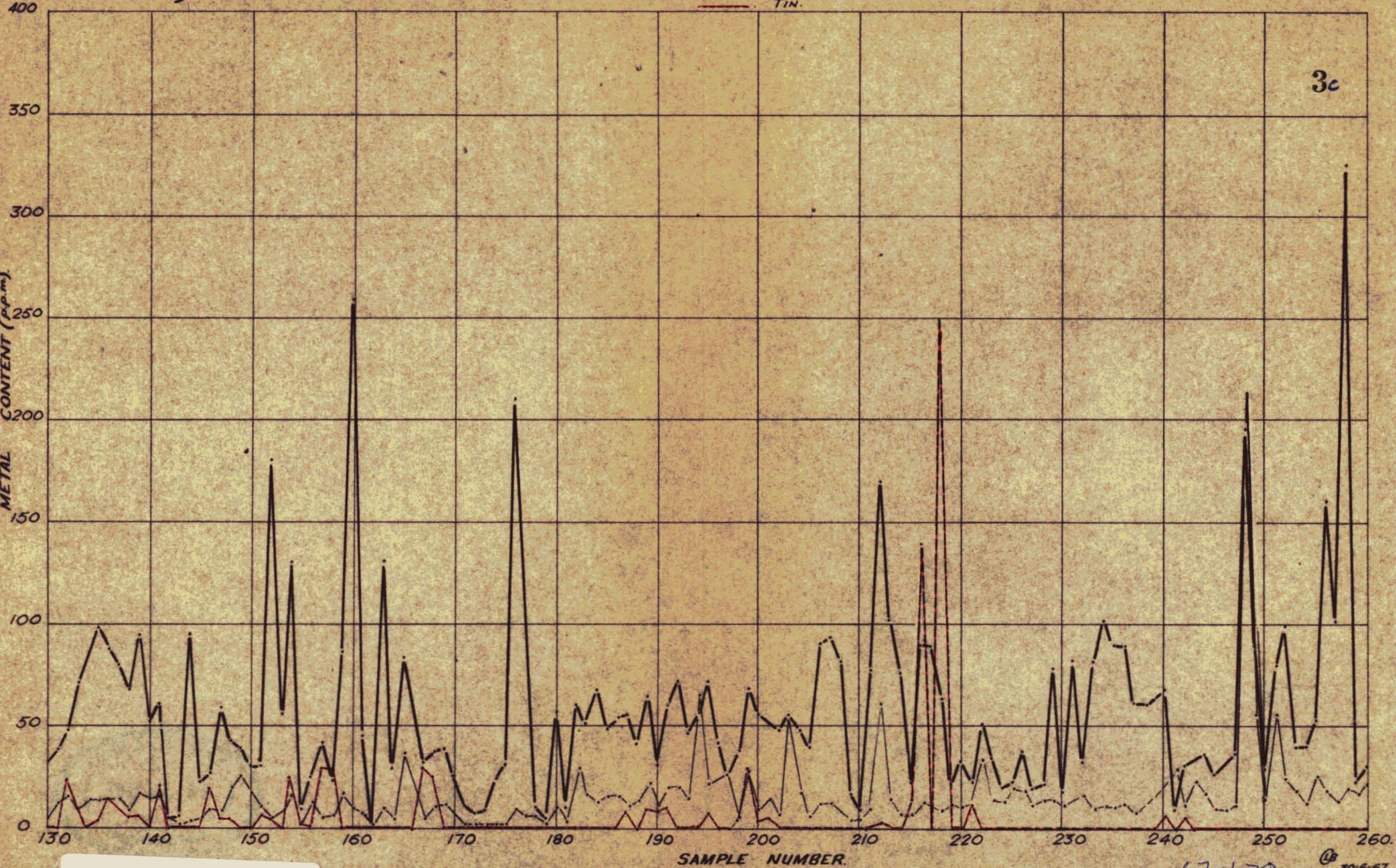


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5 cm

6693 67-470  
169039

Comparison of the Dispersion Zinc, Copper and Tin.



3c

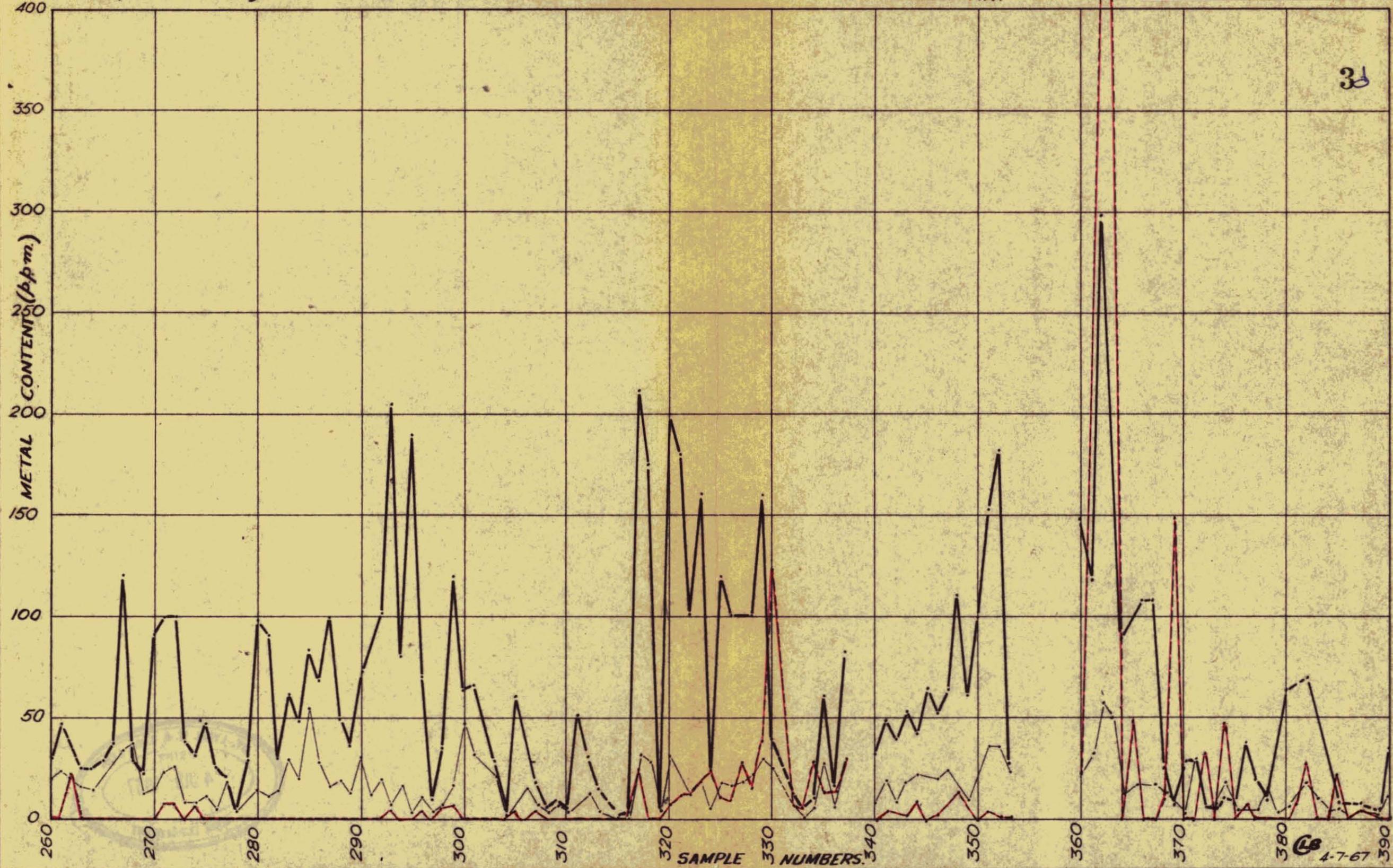
5 cm

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30-6-67  
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# Comparison of the Dispersion Zinc, Copper and Tin.

— ZINC  
- - - COPPER  
- - - TIN

5 cm

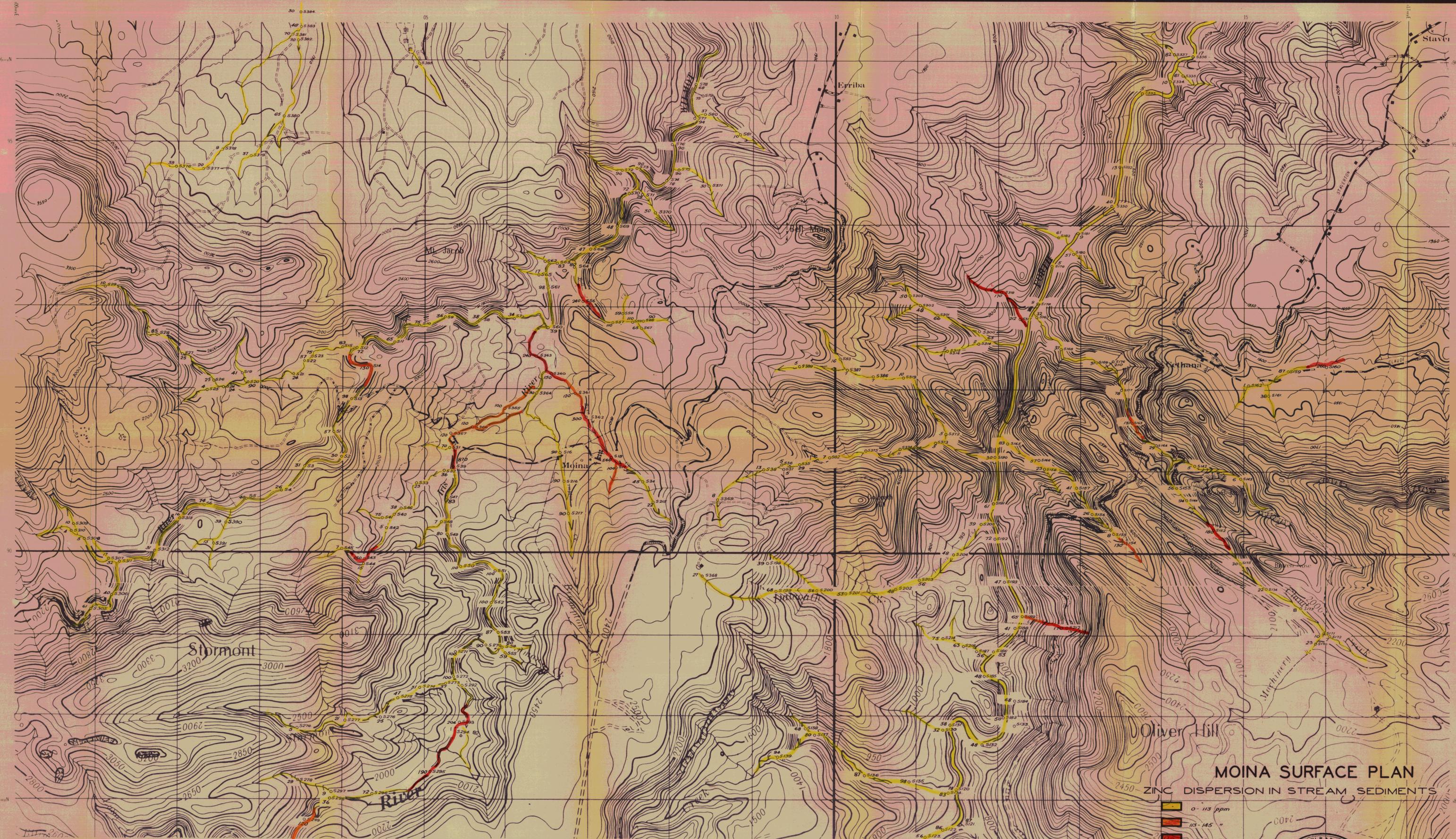


31

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163011 67-42

6695



**MOINA SURFACE PLAN**

ZINC DISPERSION IN STREAM SEDIMENTS

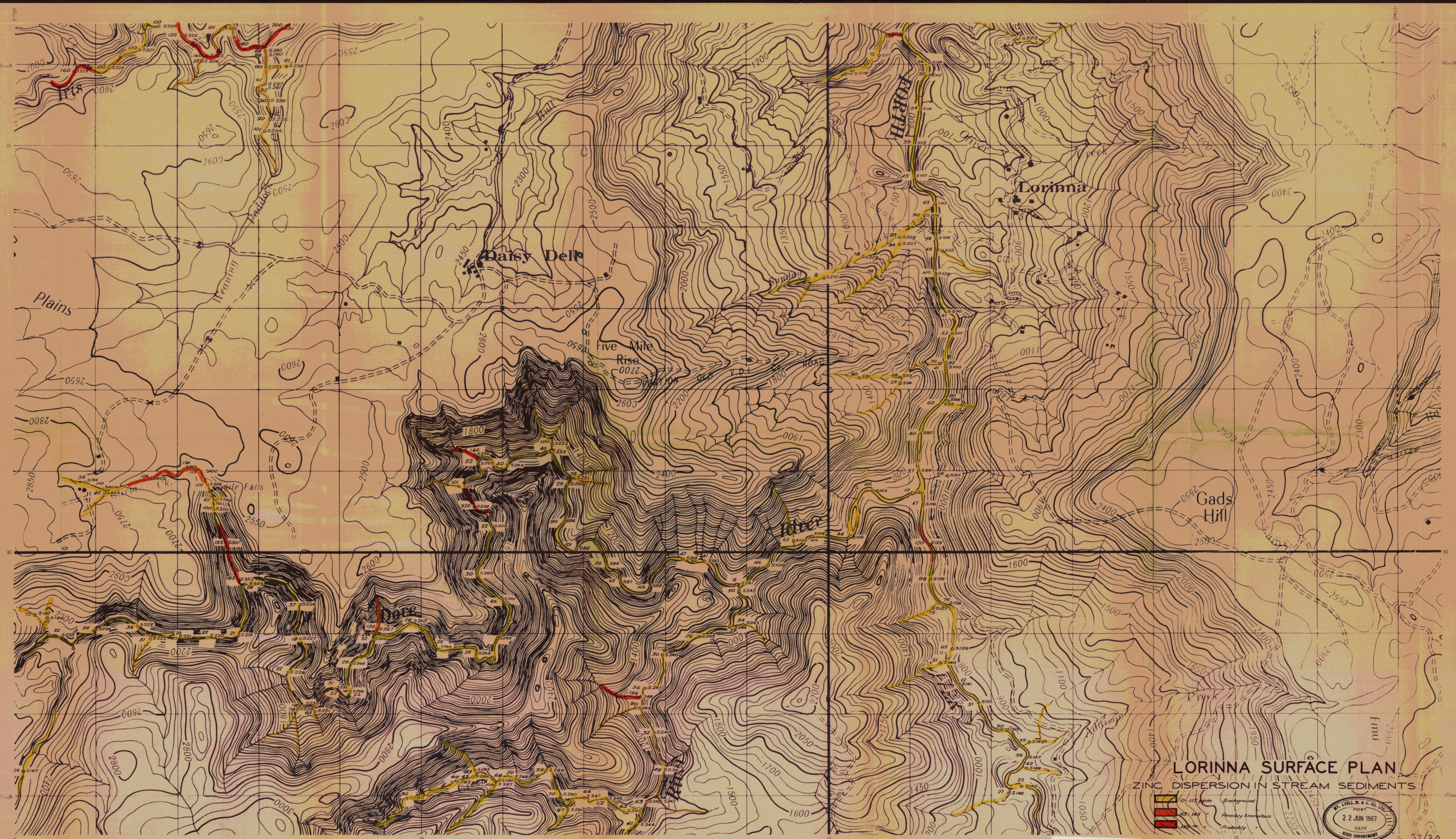
- 0-113 ppm
- 113-145 "
- 145 "

Scale 4" = 1 mile  
169042 67-470

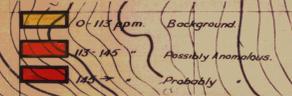
5 cm



37/20  
08 20-6-67



**LORINNA SURFACE PLAN**  
**ZINC DISPERSION IN STREAM SEDIMENTS**

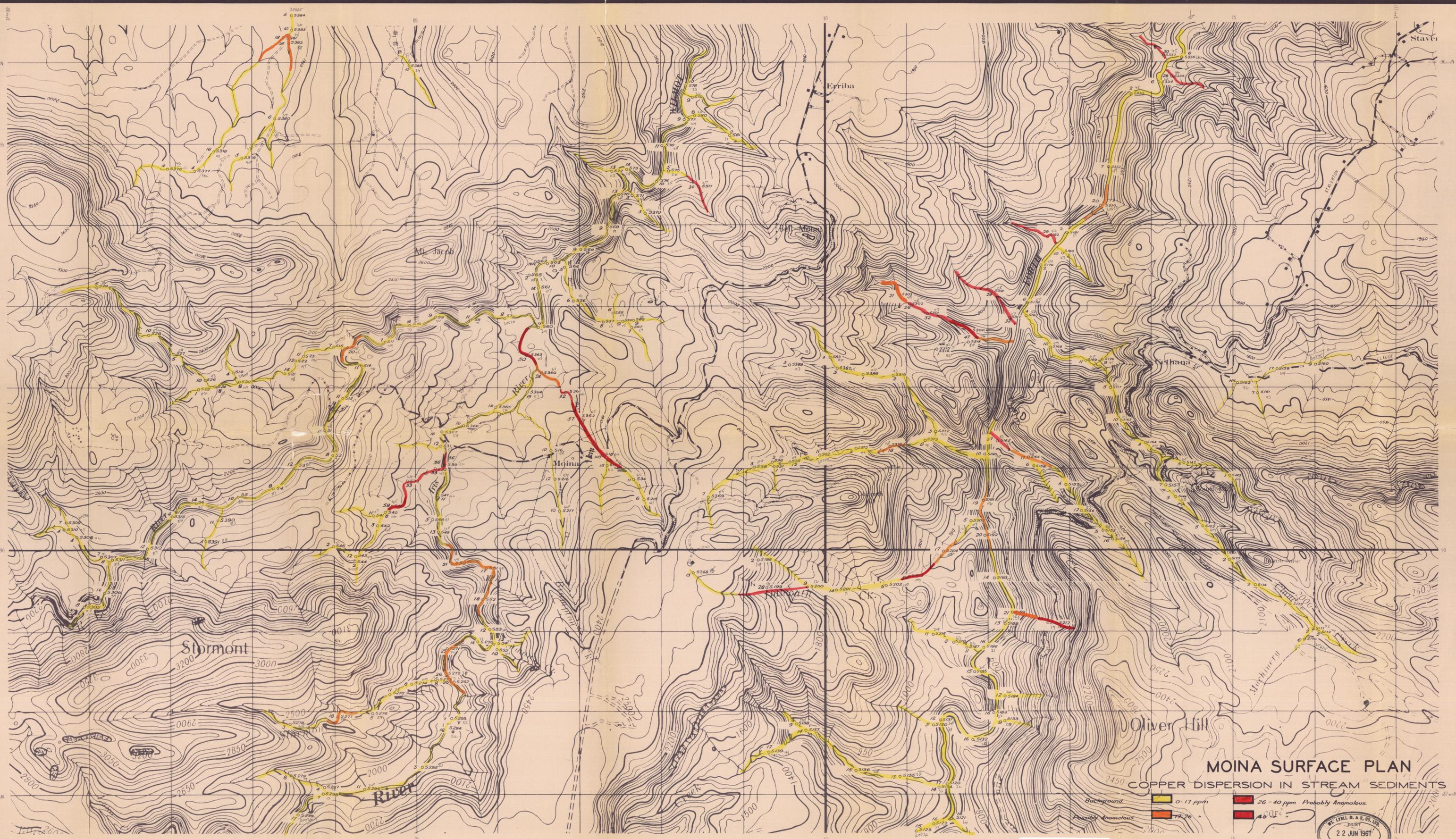


Scale 4" = 1 mile

4b  
 67-40 6897

169C13

37/20  
 20-6-67



**MOINA SURFACE PLAN**  
 COPPER DISPERSION IN STREAM SEDIMENTS

Background 0-17 ppm  
 Possibly Anomalous 17-26 "  
 26-40 ppm Probably Anomalous  
 40-200 "

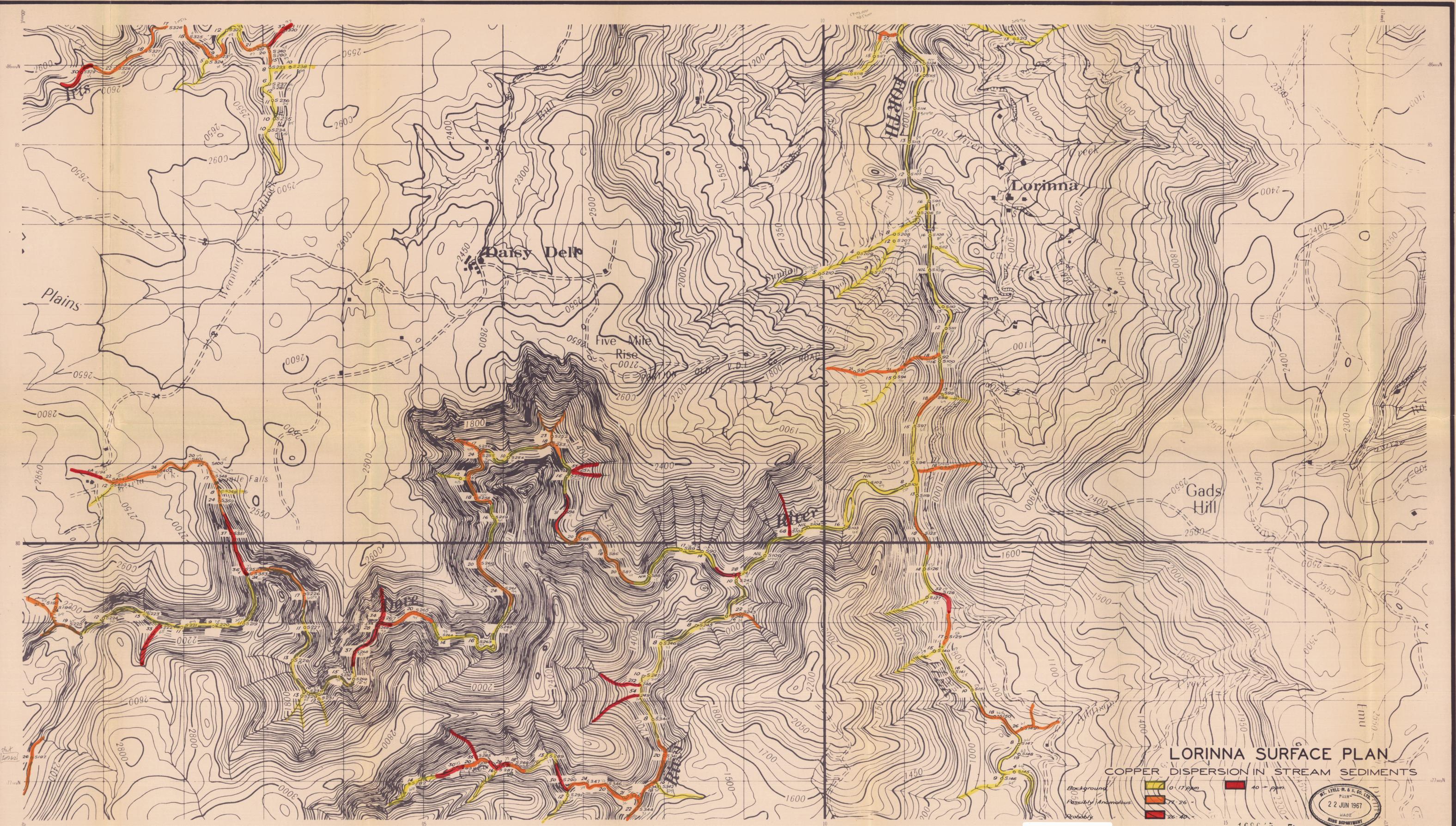
W. L. L. & B. CO. LTD.  
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 MINING DEPARTMENT

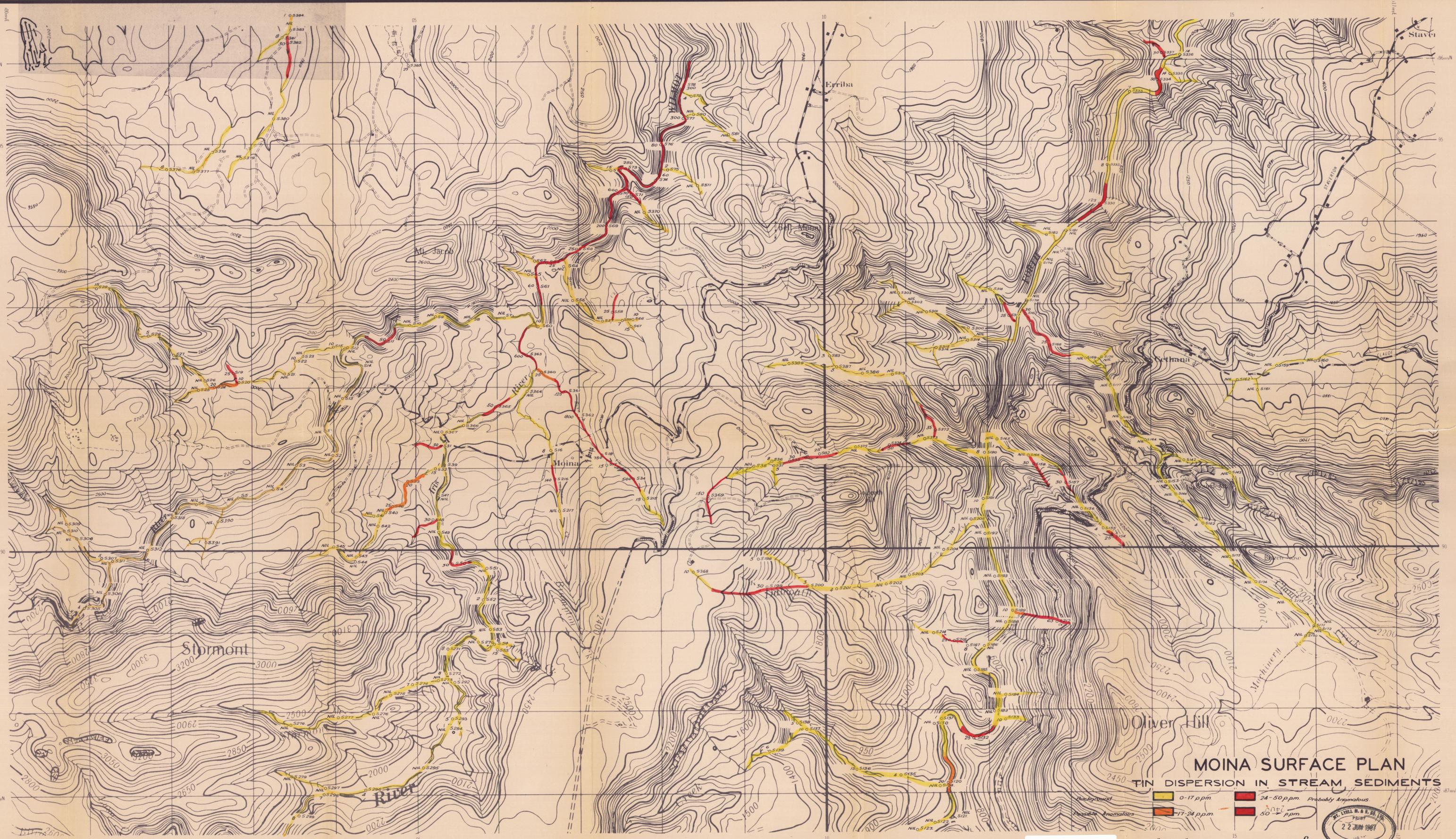
Scale 4" = 1 mile

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169044 6698

67-470





**MOINA SURFACE PLAN**  
**TIN DISPERSION IN STREAM SEDIMENTS**

- |  |           |  |                                |
|--|-----------|--|--------------------------------|
|  | 0-17 ppm  |  | 24-50 ppm. Probably Anomalous. |
|  | 17-24 ppm |  | 50+ ppm                        |

5 cm

Scale: 4" = 1 mile

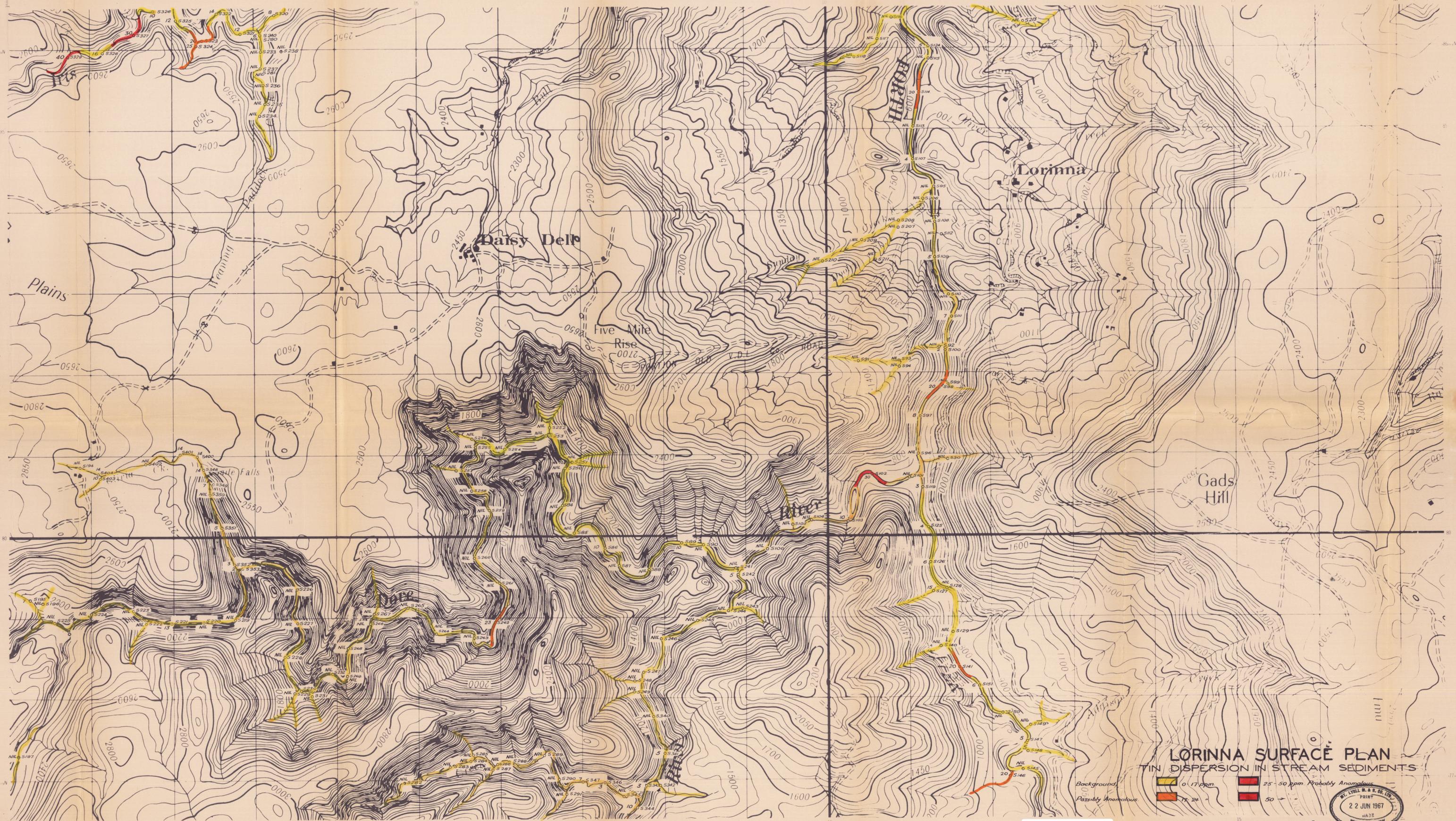
DR. L. L. B. & S. B. B. B.  
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 GEOLOGICAL DEPARTMENT

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**LORINNA SURFACE PLAN**  
**TIN DISPERSION IN STREAM SEDIMENTS**

Background	0-17 ppm	25-50 ppm. Probably Anomalous
Possibly Anomalous	18-24 "	50 "

22 JUN 1967  
 PRINTED BY THE GEOLOGICAL SURVEY OF AUSTRALIA

5 cm

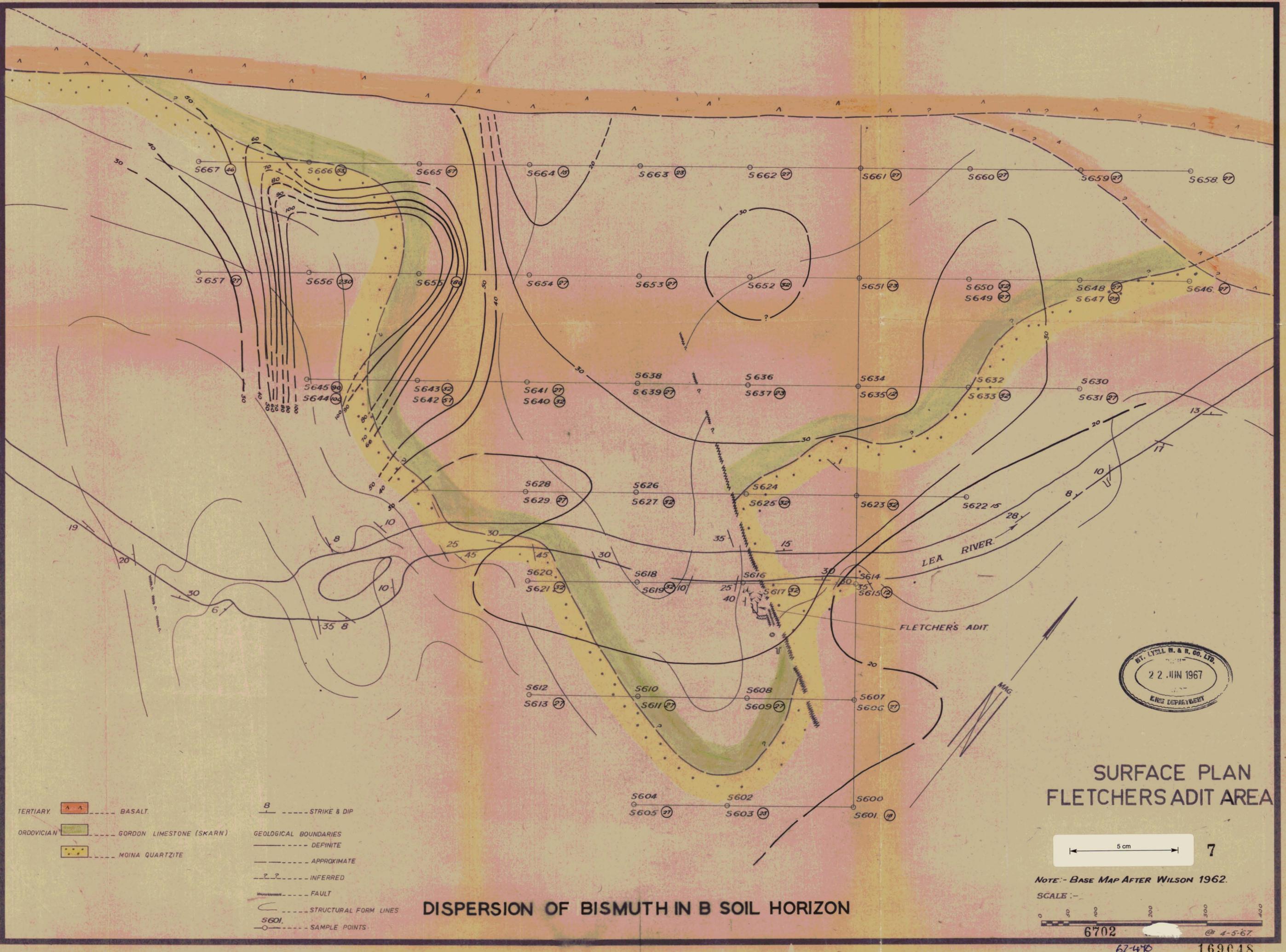
Scale 4" = 1 mile

67-470

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169047 6701

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**DISPERSION OF BISMUTH IN B SOIL HORIZON**

**SURFACE PLAN  
FLETCHERS ADIT AREA**



- TERTIARY BASALT.
- ORDOVICIAN GORDON LIMESTONE (SKARN)
- MOIRA QUARTZITE
- STRIKE & DIP
- GEOLOGICAL BOUNDARIES
  - DEFINITE
  - APPROXIMATE
  - INFERRED
  - FAULT
  - STRUCTURAL FORM LINES
  - SAMPLE POINTS

5 cm

7

NOTE: - BASE MAP AFTER WILSON 1962.

SCALE: -

0 50 100 200 300 400

6702

67-470 169048



**STREAM SEDIMENT ANOMALIES**

<span style="color: blue;">█</span>	POSSIBLY ANOMALOUS - COPPER
<span style="color: purple;">█</span>	PROBABLY " "
<span style="color: green;">█</span>	POSSIBLY " ZINC
<span style="color: orange;">█</span>	PROBABLY " "
<span style="color: red;">█</span>	PROBABLY " TIN



**LEGEND**

<span style="border: 1px solid black; border-radius: 50%; padding: 2px;">15</span>	ANOMALY NUMBER		SURFACE STRUCTURAL FEATURES
<span style="border: 1px solid black; padding: 2px;">TR.2</span>	ANOMALOUS TREND		FAULTS
<span style="border: 1px solid black; padding: 2px;">ZONE B</span>	ANOMALOUS ZONE BOUNDARIES		FOLDS
<span style="border: 1px solid black; padding: 2px;">ZONE A</span>			MINES AND MINERALS WORKINGS
	BASALT OUTCROP		
	GRANITE OUTCROP		

INTERPRETATION BY PARKEN & ZARZAVATJIAN

**LEGEND**

	MAGNETIC CONTOURS
	MAGNETIC LOW
	MINIMUM CONTOUR INTERVAL - 20 GAMMA
	TRAVERSE INTERVAL - 1/4 MILE
	FLIGHT ALTITUDE - 500 FEET MTC
	MAGNETIC DATUM - 80,000 GAMMA

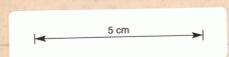
COMPILED BY AMEG & BKLENON & ASSOC PTY LTD

INTERPRETATION  
**STAVERTON AREA - TASMANIA**  
 TOTAL MAGNETIC INTENSITY  
 MEASURED BY AIRBORNE PROTON MAGNETOMETER

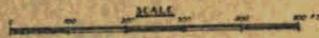
FOR  
**MT LYELL RAILWAY & MINING CO**

SCALE 31,680  
 0 1 2 MILES

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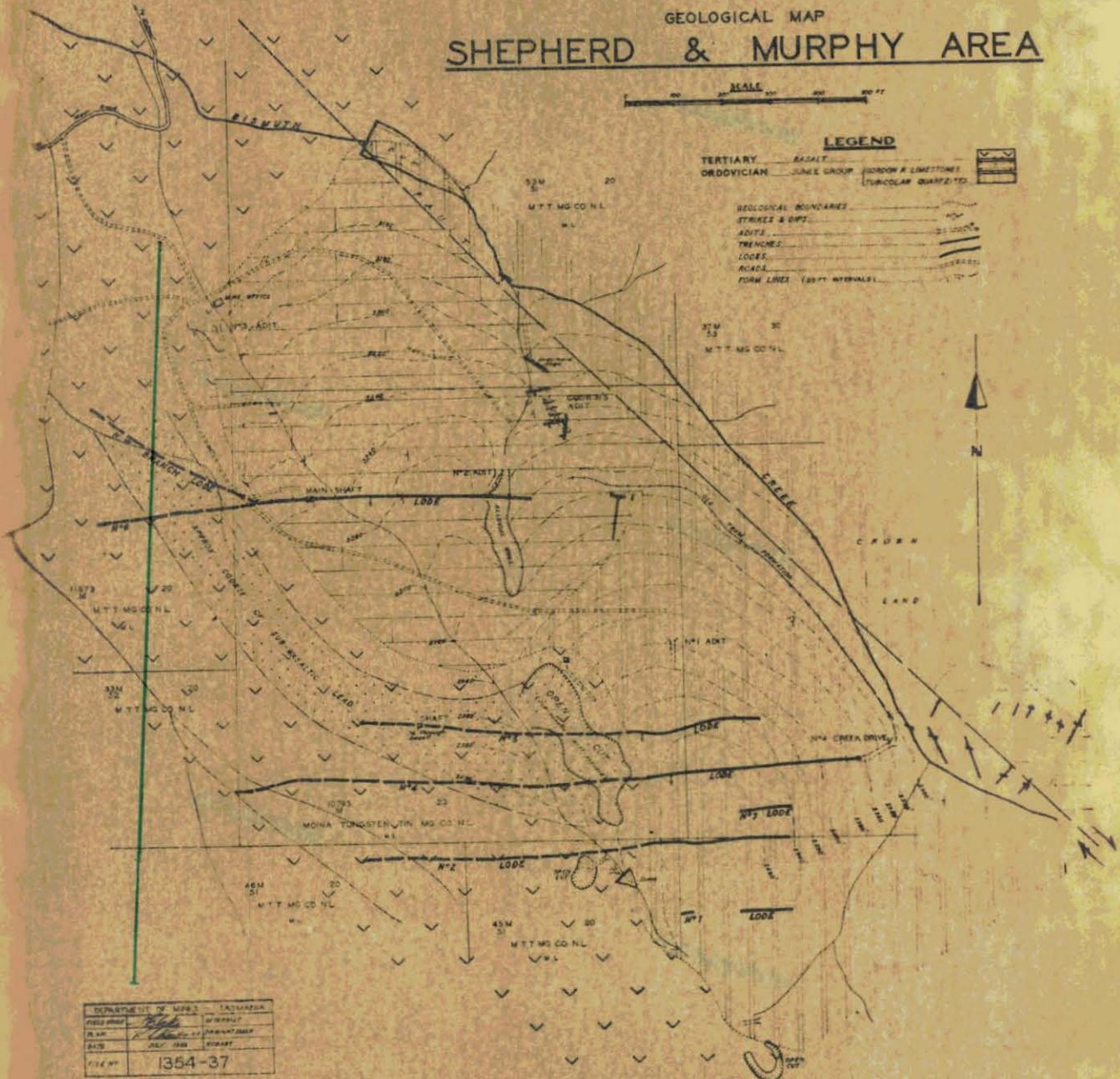
# GEOLOGICAL MAP SHEPHERD & MURPHY AREA



**LEGEND**

TERTIARY BASALT  
 ORDOVICIAN JUNEE GROUP (GORDON & LIMESTONE)  
 (TRICOLOR QUARTZITE)

GEOLOGICAL BOUNDARIES  
 STRIKES & DIPS  
 ADITS  
 TRENCHES  
 LODES  
 ROADS  
 FORM LINES (20 FT INTERVALS)



DEPARTMENT OF MINES	TASMANIA
FILE NO.	1354-37
DATE	JULY 1968
BY	ROBERT

169050



37/20  
 6704 9  
 67-470

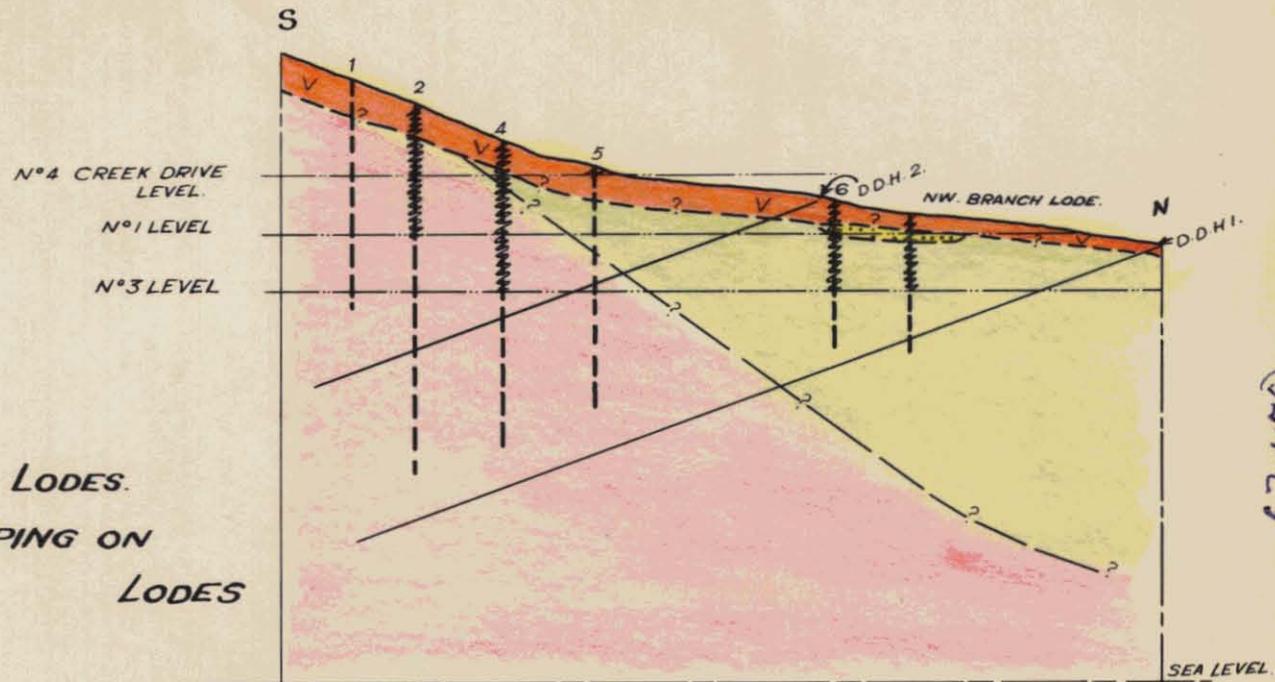
# SHEPHERD AND MURPHY MINE

## DIAGRAMMATIC SECTION

### SHOWING PROPOSED D.D.H. 1 & 2

- TERTIARY BASALT.
- SUB-BASALTIC LEAD.
- SKARN
- MOINA SANDSTONE.

- PROJECTED POSITION OF LODES.
- MAXIMUM DEPTH OF STOPING ON LODES



5 cm

10

Horizontal Scale: FEET.  
Vertical Scale: - 500' to 1"

6705  
29-6-67

