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DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS:

1963/77

THE GEOLOGY AND MINERAL DEPOSITS OF THE MOUNT GARNET AREA, NORTH QUEENSLAND.

by

D.O.Zimmerman, K.R. Yates, and B.J. Amos.

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THE GEOLOGY AND MINERAL DEPOSITS OF THE MOUNT GARNET AREA, NORTH QUEENSLAND

SUMMARY

The Mount Garnet area is situated on the south-western edge of the Atherton Tableland of North Queensland, and forms part of the Herberton Mineral Field.

The rocks in the Mount Garnet area range in age from Precambrian to Recent. They comprise Precambrian schist, quartzite, and granite, which crop out as a small inlier near Mount Garnet; Silurian to Devonian greywacke, siltstone, and limestone of the Mount Garnet Formation; probable Lower Carboniferous arenaceous sediments of the Ringrose Formation and the Montalbion Sandstone; Middle to Upper Carboniferous acid volcanics; two Upper Carboniferous granites - the Herbert River and Elizabeth Creek Granites; and Cainozoic alluvial sediments, consisting of partly consolidated or unconsolidated silt, clay, sand, grit, and gravel, with interbedded basalt. The Herbert River Granite (granodiorite and adamellite) and the Silurian to Carboniferous sediments and volcanics are intruded by the highly acid Elizabeth Creek Granite, which crops out over almost half of the map area, and is the source of nearly all of the mineralization in the area. The Cainozoic sediments occupy a basin (the Mount Garnet Basin) south of Mount Garnet township, as well as valleys in the hilly country to the north of the Palmerston and Northern Inland Highways. Alluvial cassiterite has been worked on a small scale in many of the valleys, but the only deposits suitable for large-scale mining occur along Smith's, Return, Battle, and Nettle Creeks.

The main economic metals, in order of decreasing importance, are tin, copper, zinc, silver-lead, tungsten, molybdenum, bismuth, and gold; tin has always been by far the most important of these.

Two bucket dredges working alluvial cassiterite deposits near Mount Garnet currently account for about 40 percent of Australia's annual tin production. From published reserves it appears that dredging may cease about 1971. However, both operating companies have been actively engaged in prospecting areas outside of their leases, and, although the results of this testing have not been disclosed, it seems possible that dredging will continue after 1971.

Testing of the Wurruma and ATR alluvial tin prospects by Tableland Tin Dredging N.L. and the Bureau of Mineral Resources during 1962 proved unsuccessful.

Drilling carried out by Tableland Tin Dredging N.L. in Smith's and Return Creeks, by Ravenshoe Tin Dredging Ltd in Battle and Nettle Creeks, and by the Broken Hill Pty Co. Ltd in Nettle Creek had indicated that the downstream limits of dredging ground coincide fairly closely with the limits of the hilly country through which those streams flow before entering the Mount Garnet Basin. Refraction seismic and gravity surveys, geological mapping, and scout boring carried out by the Bureau of Mineral Resources during 1962 in lower Return Creek and lower Smith's Creek confirmed the earlier results, and it now seems certain that prospects of discovering economic deposits of alluvial cassiterite in the Mount Garnet Basin are negligible.

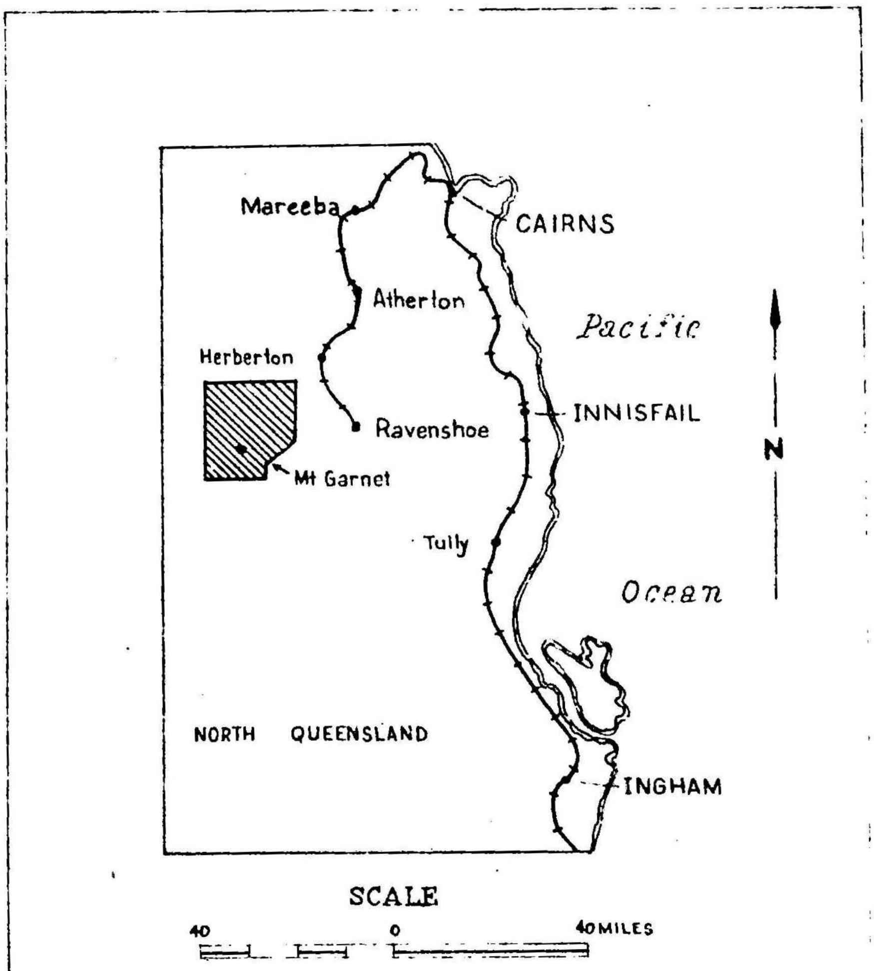
The principal lode-tin deposits in the area are in chlorite-cassiterite lodes and quartz veins in sediments, and in greisen veins in the Elizabeth Creek Granite. Areas of massive greisen, e.g., at Geebung Hill, are worth prospecting as large-tonnage, low-grade tin deposits, and mapping and testing indicated that many of the chlorite-cassiterite lodes in the Brownville-Coolgarra area should be more fully examined.

The actual and potential tin reserves in that part of the Mount Garnet area which was mapped during 1962 are:

1. Dredging ground in the valleys of Smith's, Nettle, and Battle Creeks. Dredging in Return Creek ceased in 1952, and operations in Battle Creek will probably cease about August, 1964. Extensive drilling has been carried out by Tableland Tin Dredging N.L. along Return Creek for about 3 miles downstream from Strathvale Homestead, but the results of this testing are not yet available.

Fig. 1.

LOCALITY MAP



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2. Alluvial and eluvial deposits in the upper parts of the drainage systems of Smith's and Return Creeks. Some testing has been carried out by B.H.P. and Tableland Tin in these areas. Large yardages are available, but the results were apparently not sufficiently encouraging to warrant working the deposits in the foreseeable future. The Companies have given up their Authorities to Prospect.

3. Shallow, near source, alluvial and eluvial deposits in tributaries of Smith's, Return, Battle, and Nettle Creeks. What remains of these could be worked only on a small scale, mostly during the wet season.

4. Alluvial deposits in the Wild River system. Some test drilling has been carried out by Tableland Tin in selected areas along the Wild; results are not known, but it seems unlikely that this area will add greatly to the reserves. Mining along the Wild itself is certain to be hampered by basalt in some places.

5. Chlorite-cassiterite lodes, massive greisen, and greisen lodes in the hilly country north of Mount Garnet. Further inspection and preliminary sampling of massive greisens and the larger greisen lodes should be carried out. Detailed mapping and sampling of chlorite-cassiterite lodes in the Brownville-Coolgarra area should be undertaken, and should be followed by diamond drilling, if warranted. Whether or not some of the mines could be re-opened, or new lodes developed, depends not only on the grade of ore, but also on the availability of efficient treatment facilities.

Geochemical drainage sampling outlined several areas containing anomalous amounts of copper, tin, molybdenum, lead, and beryllium, and closer sampling is recommended in the anomalous areas.

Geological mapping of the area is continuing during 1963, and some additional scout boring is being carried out in the lower Return Creek area.

INTRODUCTION

Location and Access:

The Mount Garnet area is situated about 70 miles south-west of Cairns, North Queensland, and has an average elevation of about 2600 feet above sea level (Fig.1). Mount Garnet is linked with Cairns, a major town with air, sea, road, and rail transport facilities, by about 125 miles of sealed road. Mount Garnet was connected to Cairns by rail until 1961, when the line was closed and partly dismantled. The nearest railhead is now at Ravenshoe, about 30 miles east of Mount Garnet, and a road transport service operates between Mount Garnet, Ravenshoe, and Innisfail on the coast. An earth airstrip, suitable for light aircraft, is maintained at Mount Garnet but there is no regular air service.

Access within the Mount Garnet area is generally good. There is a network of formed roads and numerous tracks suitable for four-wheel drive vehicles.

Climate, Vegetation, and Local Industries:

The Mount Garnet area is situated in a climatic belt defined as tropical highland, and is characterized by tropical woodland and savannah woodland types of vegetation (see Atlas of Australian Resources, 1952-60).

Data on annual rainfall (average 23-30 inches per annum) and temperature are summarised in Fig.2, which also illustrates the distinct wet and dry seasons and the location in a rain shadow area. Mount Garnet commonly experiences a few frosts each winter.

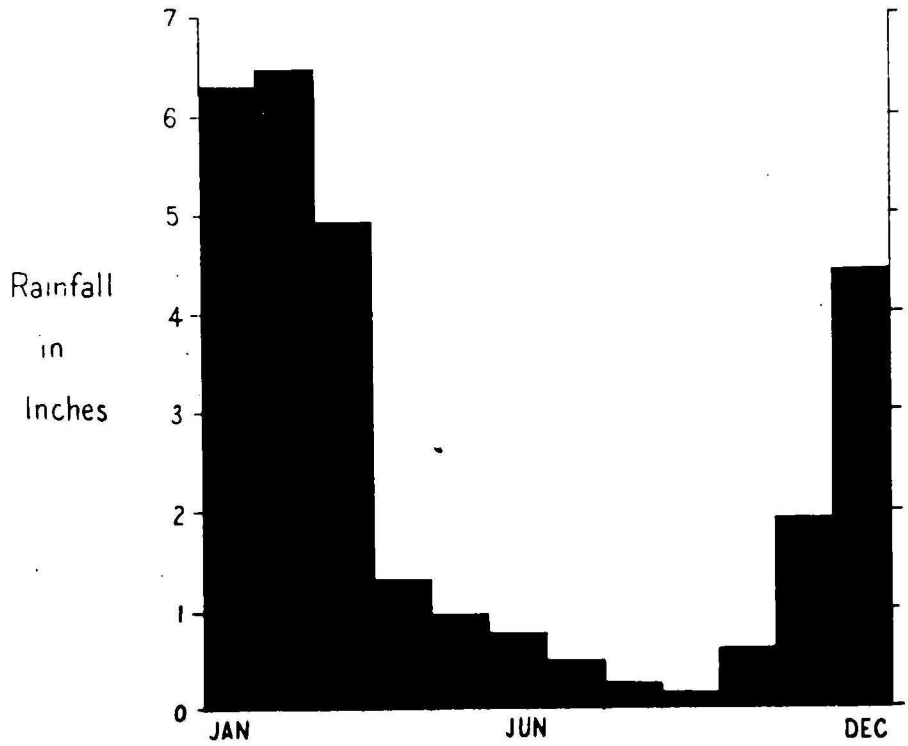


Fig.2a. Average monthly rainfall recorded at Mount Garnet during the period 1911-1940 (From Meteorological Branch, Commonwealth of Australia. Book of Standards, No.1 Rainfall).

	Maximum	Minimum
Jan.	95°F	70°F
July.	75°F	50°F

Fig.2b. Mean temperature figures Mount Garnet area. (From Atlas of Australian Resources 1953-59).

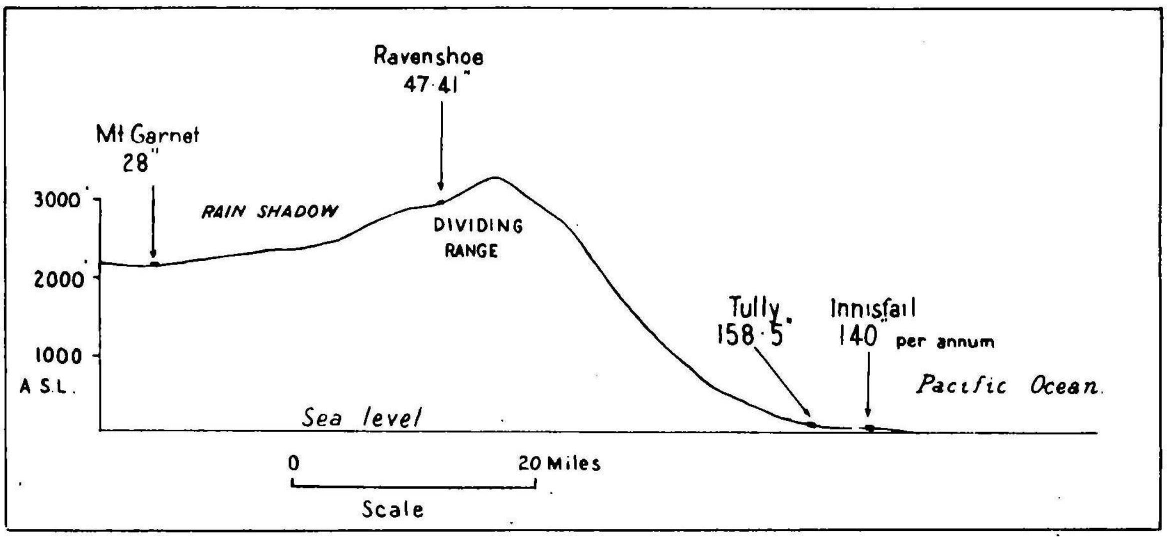


Fig.2c. Diagram showing topography and average rainfall, from the coast inland to Mount Garnet.

Fig.2. Climatic data - Mount Garnet area.

The area has an open forest type of vegetation. Trees are mainly eucalypts, yellow box, iron bark, and bloodwood being the most abundant varieties. Gums and sheoaks are common along watercourses and adjacent alluvial flats, and stunted ti-tree (paper bark) grows profusely on local swampy areas. The main grasses are spear grass and kangaroo grass, and some stunted spinifex grows on granite eluvium in the northern part of the district. Shrubs are not common, although "Heart Leaf Poison", Gastrolobium grandiflorum, grows on lateritic soils west and south of Mount Garnet.

Apart from mining, the only other local industry of importance is cattle grazing, which is virtually restricted to the alluvial areas. Efforts are currently being made to establish a tobacco-growing industry on alluvial flats adjacent to the Herbert and Wild Rivers.

Water Resources and Power:

The Herbert River, the Millstream, and Blunder Creek, in the south-east corner of the area, are the only permanent streams. Subsurface flow, linking a few permanent water holes, occurs in the Wild River and in lower Nettle Creek, which is fed by the Innot Hot Springs. There is no permanent surface water in the hilly country north of Mount Garnet, so that small-scale alluvial mining in that area is restricted to the summer wet season.

The largest water storage in the district is a rock-fill and log-crib dam on Return Creek. This has a capacity of about 5,000,000 acre feet, and is used by Tableland Tin Dredging Ltd for their operations on Smith's Creek, and in their concentrating plant near Mount Garnet. Leakage from the Return Creek dam generally maintains surface flow downstream as far as Mount Garnet, and the township utilises this flow for its domestic supply by piping water under gravity from a point two miles upstream. A booster pump supplements this supply during the dry season.

Ravenshoe Tin Dredging N.L. pump water directly from the Herbert River for their operations on Battle Creek.

The water table is commonly within 50 feet of the surface in the alluvium-filled valleys of the larger creeks in the area, and in the flat area south of Mount Garnet; even during abnormally dry seasons drill holes commonly strike water within 100 feet of the surface.

The Queensland Department of Irrigation and Water Supply is currently planning small dams for the headwaters of the Herbert River - one situated near Ravenshoe, and another near the junction of the Wild River and the Millstream. These dams will be designed primarily to provide water for tobacco farms downstream. A large dam is also contemplated on the Herbert River, about thirty miles south of Mount Garnet, as part of a new hydro-electric scheme. A good site for a small, Return Creek-type dam exists on Smith's Creek, about one mile south of Nymbool.

Hydroelectric power has been generated at Tully Falls, about 40 miles east of Mount Garnet, since 1957, and it is brought to Mount Garnet via Ravenshoe by an overland high-tension power-line.

The Herbert River provides the water supply for the coastal township of Ingham.

Previous Investigations:

The discovery of alluvial cassiterite near Herberton by J.V. Mulligan in 1874 attracted numerous prospectors to what is now known as the Herberton Mineral Field. A brief history of mining activity in the Mount Garnet area is given later in this report, but the principal geological studies of the area are noted below.

The first formal publication relating to the Mount Garnet district was by A.G. Maitland in 1891. He described some of the mines around Coolgarra, and recorded the unconformity between "acidic lavas and ashes" overlying "altered sedimentary rocks" about six miles south-west of Coolgarra. A number of short reports on particular mines and areas subsequently appeared in the publications of the Geological Survey of Queensland, the Queensland Government Mining Journal, and the Annual Reports of the Queensland Department of Mines, and these are noted in the list of references accompanying this report. W.E. Cameron, B. Dunstan, E.C. Saint-Smith, J.H. Reid, L.C. Ball, and C.C.Morton were the principal authors.

In 1930 Whitehouse recorded Silurian corals from the Mount Garnet area. This appears to be the first mention of marine fossils from the district.

In 1938 the Aerial, Geological and Geophysical Survey of North Australia examined about 1000 square miles of the Herberton district using aerial photos and maps compiled from these photos by the R.A.A.F. This survey provided a regional map of the area, and it also accurately reported on many of the mines (Jensen, 1939).

Enterprise Exploration Company Pty Ltd took out an Authority to Prospect over 580 square miles of the Mount Garnet district in 1948. The company drilled the Mount Garnet Copper Mine and a zinc prospect at Bald Hill, east of Nymbool, as well as examining several small mines in the district (Knight, 1949; Bacon, 1949).

In 1956 the Mount Garnet Copper Mine was again under examination, this time by Metals Exploration (Hare, 1956), but only one hole was drilled.

In 1957 New Consolidated Gold Fields (A'asia) pty Ltd, took out Authorities to Prospect over large areas of North Queensland, including the Mount Garnet district. This company did some regional work, and examined several old mines in the Herberton Mineral Field during 1958-59; the results are described by Dimmick and Cordwell (1959), and include a further appraisal of the Mount Garnet Copper Mine, although this company did not carry out any drilling there.

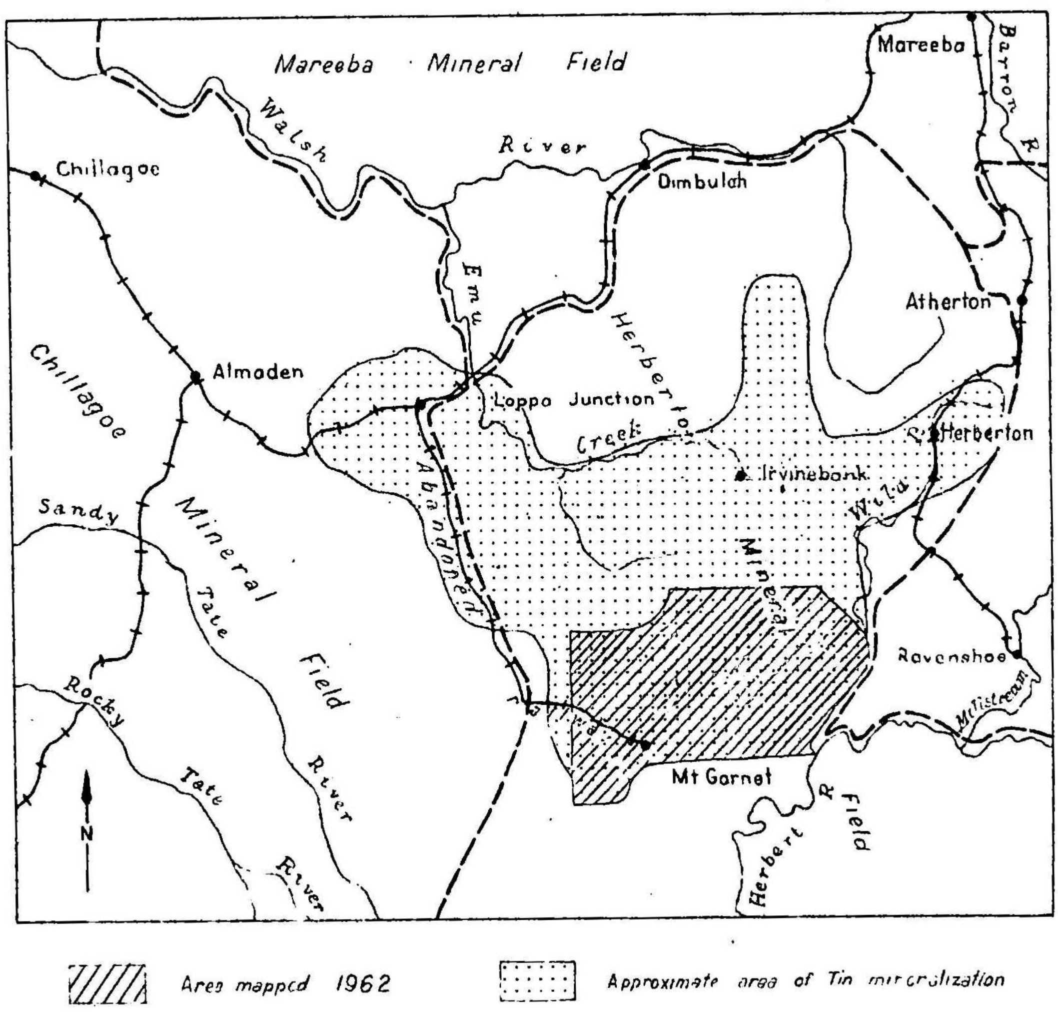
Levingston (1960) recorded abundant crinoid stems, fragments of brachiopod shells, and the fossils Favosites, Alveolites?, Heliolites, and Cystiphyllum from an outcrop of limestone 1500 feet north of the Mount Garnet post office. The fossils were not sufficiently well preserved to allow determination of species, but they indicate a Silurian-Devonian age.

The Bureau of Mineral Resources and the Geological Survey of Queensland began regional mapping in the Cairns-Townsville hinterland in 1956, and this work is still in progress. The Mount Garnet district was examined during 1959 (Best, 1962b), and White (1961) has summarised some of the results up to 1960 in a paper on the geological history of the hinterland. During the regional mapping, samples of granite and acid volcanics were collected for age determination. The results of the dating programme are as yet unpublished.

Branch (1961, 1962) studied the Upper Palaeozoic igneous rocks in detail. Best (1960) dealt with some aspects of the Cainozoic volcanic activity of the region, and Morgan (1961) described selected specimens of basalt from the Einasleigh and Atherton 1:250,000 Sheet areas.

Best later (1962a) suggested that the easterly draining Herbert (Wild) River may have originally flowed west into the Tate River system. The area of postulated 'abandoned drainage' south-west of Mount Garnet thus held promise as an unexplored alluvial tin prospect, and another alluvial prospect was suggested in the Wurruma Swamp area. One of the aims of the 1962 field season was to test these prospects.

MINERAL FIELDS NEAR HERBERTON Fig. 3.
North Queensland



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Scope of 1962 Investigation:

From the preceding section it is apparent that the general geology of the Mount Garnet area was fairly well known, but there were no comprehensive maps showing the positions of the lode and alluvial workings and their relationships to the local geology.

The 1962 programme had three main objects:

(i) to investigate certain alluvial prospects in the Mount Garnet area by detailed mapping, geophysical work, and scout boring;

(ii) to begin detailed mapping of the stanniferous part of the Herberton Field at a scale of about 1:24,000;

(iii) and to obtain comprehensive information on the economic mineral potential of the area, particularly alluvial and lode tin.

Percussion drilling was carried out by a contractor (Tableland Tin N.L.), and the Geophysical Branch of the Bureau of Mineral Resources carried out detailed seismic and gravity work in an effort to delineate fossil channels in lower Smith's Creek, lower Return Creek, the Wurruma Swamp area, and the ATR area (Ancestral Tate River of Best, 1962a) (Fig.4). The geophysical and geological parties collaborated closely, and all relevant, available geophysical results were considered before selecting drilling targets.

Mapping of several small areas in the Mount Garnet district, notably around the Mount Garnet Copper Mine, east of Coolgarra, and the area between Battle and Nettle Creeks and east to Pool's Creek, will be completed during the 1963 field season, and the mapping will then be extended north towards Herberton and Irvinebank.

The topographic base maps used in the compilation of the geological field sheets are enlargements of topographic bases at a scale of 1:50,000, which were prepared by the Division of National Mapping from air photographs taken by the R.A.A.F. in 1951. Adastra air photographs at a scale of 1:24,000 were used for the mapping. The air photos covering the Tirrabella One Mile Sheet area were taken in 1957, and controlled topographic maps at a scale of 1:31,680 are being prepared from these photos by the Queensland Surveyor General's Department. The photographs covering the Mount Garnet One Mile Sheet area were flown in 1959, but no topographic map has as yet been prepared from them. A military one mile map of the Mount Garnet area was prepared by the Army in 1944, but it was not used for compilation because the National Mapping bases were more up to date and closer to the required scale.

Acknowledgements:

We wish to thank Mr. G. Naumoff, Inspector of Mines at Herberton, and the companies (Tableland Tin Dredging Ltd , Ravenshoe Tin Dredging N.L., Mineral Deposits Pty Ltd, and the Broken Hill Pty Co. Ltd) operating and prospecting in the area for their co-operation and for readily making available information. Numerous private individuals also helped in locating and naming old workings, and we should like to thank all of these people for their generous efforts, particularly Messrs. A.R. Dunmall, A. Edwards, C. Smith, J. Ludlow, H. Fletcher, J. Young, P. King, and C. McAuley. Dr. M.J. Bik, formerly of the C.S.I.R.O., contributed to the understanding of the Cainozoic sediments of the Mount Garnet Basin.

PHYSIOGRAPHY

The Mount Garnet district comprises two distinct physiographic units - moderately rugged uplands to the north, and flat alluvial plains in the south (Fig.18). The alluvial areas extend into the uplands along the major stream valleys; these valleys, which drain tin-bearing country, are the loci of tin-dredging operations. The physiographic units are distinctly related to rock types; the uplands are composed mainly of slightly metamorphosed, Middle Palaeozoic sediments, and Late Palaeozoic granite (Elizabeth Creek Granite) and acid volcanics, whereas the lowlands probably consist of Precambrian metamorphics and a much more readily weathered Late Palaeozoic granite (Herbert River Granite). Outcrops are rare in the lowlands, which are largely covered by Cainozoic sediments with some interbedded basalt flows.

Dr. M.J. Bik, formerly of the C.S.I.R.O. Division of Land Research and Regional Survey, studied the geomorphology of the district, and named the broad flat area of Cainozoic sedimentation south of Mount Garnet 'the Mount Garnet Basin' (Bik. pers.comm.). It forms part of the Gunnawarra Plain of Best (1962b).

The area mapped in 1962 lies almost entirely on the eastern side of the Great Divide, and the most common stream-direction is south to south-east. A less important drainage-direction is towards the south-west. The Wild River and the Millstream join in the south-eastern corner of the area, and form the Herbert River which flows roughly south-west for eight miles, before turning sharply south, and maintaining a dominantly south-south-easterly direction for 40 miles. The sharp change in direction of the river eight miles south-east of Mount Garnet was interpreted by Best (1962a) as possibly resulting from river capture. He proposed that the Herbert River originally may have flowed west into the Tate River system, and thence into the Gulf of Carpentaria. This theory held important implications for alluvial tin prospecting in the area, but field evidence gathered in 1962 did not substantiate the theory. Moreover, Bik (pers.comm.) concluded that the Herbert River has always drained east to the Pacific Ocean. There is a possibility that the River may have drained the Mount Garnet Basin via the Gunnawarra Gap rather than by the present exit (Fig.4).

Cainozoic basalt flows entered the area from the Atherton Tableland, via the valleys of the Wild River, the Millstream, and Blunder Creek. Basalt extends west and south along the valley of the Herbert River, and it backed up into many of its tributaries. The basalt flows undoubtedly caused some displacement of the streams from their original courses but the overall drainage direction appears to have been maintained. Recent sedimentation has buried much of the basalt, but in some places - e.g., in lower Return Creek - streams degrading through Quaternary cover are cutting down into it.

The Cainozoic sediments and the interbedded basalts are discussed in detail in the chapter on stratigraphy.

STRATIGRAPHY

Rocks ranging in age from Precambrian to Cainozoic occur in the Mount Garnet district, but there are gaps in the succession in the Lower Palaeozoic, and from the Permian to Early Tertiary. During the Middle and Upper Palaeozoic the area formed a part of the western border-zone of the Tasman Geosyncline (White, 1961).

PRECAMBRIAN

Precambrian rocks in the Mount Garnet district consist of muscovite-quartz schist and interbedded cream to brown quartzite. Exposures are generally poor. The largest outcrop area straddles the town of Mount Garnet, and small, isolated outcrops are found near the aerodrome, in lower Return Creek, and in a creek one mile south of Seven Mile Hill. Weathered Precambrian rocks have been identified in several percussion drill holes in the Wurruma Swamp area and in lower Return Creek. Precambrian rocks crop out outside the map area on the south-western and southern margins of the Mount Garnet Basin, north of Expedition Creek, and near Gunnawarra homestead. Silicified serpentine has been recorded from the latter locality (Best, 1962b).

Gold appears to be the only economic mineral related in time to the Precambrian rocks. It occurs with pyrite and arsenopyrite in small quartz lenses half a mile east, and north-east of Mount Garnet. Some azurite has also been observed in this area. The Mount Garnet Copper Mine occurs adjacent to Precambrian rocks, but the mineralization is apparently related to Upper Carboniferous granites.

The Precambrian exposure at Mount Garnet represents the most north-easterly exposure of the Georgetown Inlier, as defined by White (1961).

SILURIAN - DEVONIAN

Mount Garnet Formation

The name Mount Garnet Formation was proposed by Best (1962b) for a rock unit consisting dominantly of greywacke which crops out in an arcuate belt extending from Almaden to the southern end of the Wild River. He regarded these rocks as Upper Silurian to Lower Devonian by direct correlation with the Chillagoe Formation. Previously their age was interpreted by Jack and Etheridge (1892) as Permo-Carboniferous, by Whitehouse (1930) as possibly Silurian, by Jensen (1939) as Silurian-Devonian, and by Levingston (1960) as Silurian or Devonian.

Fossiliferous limestone crops out about 1500 feet north of Mount Garnet Post Office, and poorly preserved Favosites, Heliolites, Cystiphyllum, Alveolites?, fragments of brachiopod shells, and crinoid ossicles have been identified from this locality (Levingston, 1960). At the Mount Garnet Copper Mine brachiopods and crinoid ossicles have been completely replaced by pyroxene and garnet. These fossils indicate a Silurian or Devonian age, and we prefer to date this formation as Silurian to Devonian, rather than to restrict its age limits to the Upper Silurian to Lower Devonian, as done by Best (1962b)

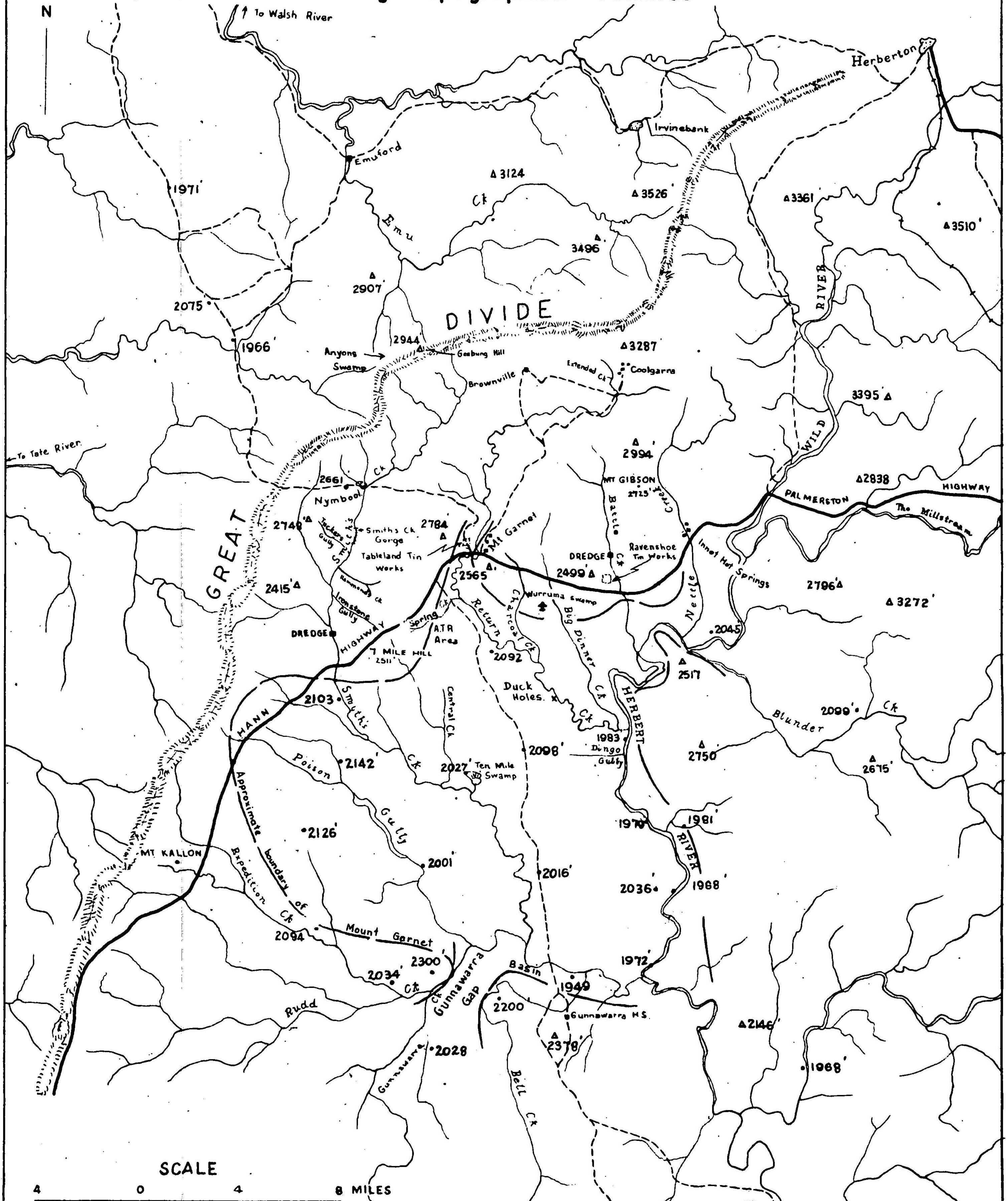
The formation consists of interbedded greywacke and siltstone, with lesser amounts of limestone, calcareous conglomerate, sandstone, basalt, and chert. The greywacke-siltstone lithology is well exposed between Brownville and Coolgarra, where calcareous lenses and basic lavas are absent from the succession. Greywacke is also the dominant rock type at Mount Gibson and Top Nettle Camp, and in the northerly elongated belt of sediments west of the Wild River. It is commonly massive, but shows some fine graded bedding, which may be associated locally with load casts, convolute bedding, and small-scale current bedding. Colour ranges from light to dark grey, and average grainsize ranges from 0.2 to 0.5 mm. A characteristic constituent is white mica which occurs as randomly arranged, ragged flakes up to 2 mm. long. Angular to subangular quartz (60%-80%) occurs as deformed or undeformed individual or composite grains, and lineated, granulated, fine-grained, composite grains of metamorphic quartz are common. Feldspar (10%-20%) is microcline, perthite, orthoclase, or sodic plagioclase. Rock fragments are not common, but those noted include siltstone, shale, and mica schist; the grainsize of the fragments ranges up to 3.5 mm.. The framework/matrix ratio is high, and the matrix commonly constitutes less than 10 percent of the total rock.

A minor occurrence of metasomatised greywacke-conglomerate was mapped immediately west of the Dalcouth Mine. This rock has the same mineral composition as the associated greywacke, but contains fragments of metamorphic and vein quartz measuring up to 10 mm., and fragments of siltstone and claystone measuring up to 6 mm., set in a matrix of detrital quartz and feldspar grains with an average size of 0.2 mm.

LOCALITY MAP MT GARNET AREA

Fig. 4.

Showing Topographical Features



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The interbedded siltstone is generally dark grey and poorly bedded, and has an average grainsize of about 0.05 mm.. It contains up to 90 percent of angular to subangular quartz in a very fine-grained sericitic matrix. All gradations from siltstone to coarse-grained greywacke have been observed.

Calcareous rocks are next in order of abundance within the Mount Garnet Formation. These have almost invariably been contact-metamorphosed to calf-silicate hornfelses or marble (see section on Contact Metamorphism), so that much of their original texture has been destroyed. Relatively unmetamorphosed limestone crops out in Limestone Creek, 1500 feet north of Mount Garnet post office; on the Coolgarra road 3½ miles north of Mount Garnet; and in Deadman's Gully, a tributary of the Wild River. Pebbles and boulders of limestone occur in a conglomerate at the Bald Hill Zinc prospect, east of Nymbool. All known localities of limestone and calc-silicate rocks are delineated on the 1:24,000 maps (Plates 2-5, incl.).

Calc-silicate rocks are most abundant west and south-west of Mount Garnet, and there is a large roof pendant of similar composition at the head of Ironstone and Ned's Gullies, which are tributaries of Battle Creek. In the former area, the sediments prior to metamorphism consisted predominantly of calcareous conglomerate, sandstone, and siltstone, in order of decreasing abundance; pure carbonate rocks are apparently rare in the area, and the only exposure found is a small body of marble 300 feet west of the Northern Inland Highway about 7 miles by road south-west of Mount Garnet. The calcareous conglomerates are generally massive, and have a green (diopside-rich) matrix. Thin sections of the matrix show, in addition to diopside, subangular to subrounded fragments of metamorphic quartz, vein quartz, chert, and siltstone, up to 15 mm. in diameter, enclosed in finer-grained, calcareous, arenitic quartz-feldspar base. In the area of sediments parallel to, and immediately south of, Hammond's Creek the conglomerate is grey on the weathered surface, and contains fewer impurities. It consists of subrounded, elongate cobbles of limestone, up to 12 inches long, set in a fine-grained calcareous matrix, and it crops out as jagged karst-type knolls. The contact metamorphism of calcareous rocks by the Elizabeth Creek Granite has produced small contact hematite deposits south-west of Mount Garnet, and, by analogy, small hematite bodies within the granite 3 miles north of the Ravenshoe Tin mining camp may represent the last erosional remnants of calcareous roof pendants.

Basic volcanic rocks occur south of the Northern Inland Highway between the racecourse and Smith's Creek, and in isolated outcrops aligned north-south half a mile west of Tableland Tin's works. There is a minor exposure of metasomatised basalt within the roof pendant west of Battle Creek. The basalt is fine-grained and dark grey, and contains aggregates of yellow-green epidote, notably along joints. South-west of the racecourse most of the basalt has been thermally metamorphosed to a fine-grained, dark greenish grey hornblende hornfels containing veins and segregations of colourless plagioclase and epidote (see section on Contact Metamorphism).

Chert is a minor constituent of the formation. It is a dense black or brown rock, slumped in places. The distribution of these siliceous rocks suggests that they are related to the lime-rich sediments.

White (1961) considered the Mount Garnet area to be a shelf with an irregular sea floor and steep shoreline during Silurian-Devonian time. The following criteria are considered to be important in any discussion of the depositional environment of the Mount Garnet Formation:

1. The scarcity of reef limestone compared to calcareous cemented detritus.
2. The unsorted nature of arenites within the sequence.
3. The presence of turbidity current structures within the greywackes.
4. The overall dominance of arenite/lutite sedimentation over carbonate deposition.

The general composition of the greywackes indicates a metamorphic-granitic source area compatible with the Precambrian Georgetown Inlier to the south and west.

Most of the Silurian-Devonian lithologies are consistent with deposition in the unstable zone between the edge of a stable shelf and a subsiding basin.

?LOWER CARBONIFEROUS

Ringrose Formation:

The name Ringrose Formation was first used by Best (1962b) because Skertchly (1899) had named the "Ringrose Conglomerate" after R.C. Ringrose, who first described conglomerate and sandstone of this formation in the vicinity of Herberton in 1897.

Beds of grey siltstone and fine-grained sandstone which occur north and east of Coolgarra have been included within this (?)Lower Carboniferous formation because they show a marked lithological contrast to the adjacent, dominantly arenitic Mount Garnet Formation. The formation is intruded by the Elizabeth Creek Granite, and its distribution suggests that it is unconformable with the underlying Mount Garnet Formation succession, but the unconformity has not been observed in outcrop, and no fossils have been found.

The Ringrose Formation crops out as steep sided, rugged hills with sharp ridges and crests in contrast to the more rounded topography developed on the Mount Garnet Formation. A marked change in slope almost invariably occurs at the junction of the two units, and the Ringrose Formation commonly has a more dense tree cover - which is apparent on air photos.

Within the map area, the unit is a sequence of blocky, poorly bedded to massive, pale grey siltstone, and fine-grained sandstone which commonly shows widespread pink to orange iron-staining along cleavage-planes and fractures. This iron-staining commonly completely disguises the true colour of the rock. The conglomerate and coarser-grained sandstone included within the formation at Herberton are absent in the Mount Garnet area.

The sediments of the Ringrose Formation are considered by White (1961) to indicate an overlap of Upper Devonian/Carboniferous sedimentation from the Hodgkinson Trough in the north-east onto the Mount Garnet Shelf in the south-west.

Montalbion Sandstone:

Skertchly (1899) first described the Montalbion Beds, consisting of sandstone and shale , at Montalbion Trig., about 19 miles north of Mount Garnet, and considered them to be of Devonian age. Well-bedded quartzites were mapped at Montalbion by Jensen (op.cit.), and Best (1962b) renamed the unit the Montalbion Sandstone. He found it to be unconformable on the Mount Garnet Formation, and therefore considered it to be Carboniferous and the near-shore equivalent of the Ringrose Formation.

Within the area mapped the Montalbion Sandstone apparently lies in a small fault block, and also forms a small inlier of greywacke, sandstone, and conglomerate within Carboniferous acid volcanics in the north-eastern corner of the map area, near the Dry River. This interpretation follows the work of Best (1962b). However, extension of the mapping northwards may yield evidence as to the exact relationship of these rocks to other stratigraphic units within the area.

MIDDLE AND UPPER CARBONIFEROUS

Undifferentiated Acid Volcanics:

These rocks were not mapped in detail during the present survey because no significant mineralization has been recorded in them. On the accompanying map they are therefore undifferentiated, although Branch (1962) and Best (1962b) have divided them into two major units, the Nanyeta Volcanics, of Middle Carboniferous age, and the Glen Gordon Volcanics, of Upper Carboniferous age. The former unit crops out in a large mass straddling Return Creek, and the latter occurs as a small body within this mass, and also in the area along, and to the east of, the Wild River.

In the earlier volcanism the principal rock-types extruded or deposited were cream, grey or pink rhyodacite, rhyodacitic welded tuff, agglomerate, breccia, and tuff, trachyandesite, and minor shale, siltstone, and greywacke. Rhyodacite, dacite, and rhyolite flows and welded tuffs predominated in the later volcanic episode.

There is a marked unconformity at the base of the volcanics where they overlie the Mount Garnet Formation (Maitland, 1892). The unconformity immediately south of the Miracle Mine is marked by a basal agglomerate containing angular pebbles, cobbles, and boulders of greywacke up to 4 feet in diameter.

UPPER CARBONIFEROUS

Herbert River Granite:

This granite was first named during the period 1956 to 1958, when the Einasleigh Sheet area was mapped as part of a combined survey by the Bureau of Mineral Resources and the Geological Survey of Queensland. The name is derived from the Herbert River Falls area, 42 miles south-southeast of Mount Garnet. White (1961) shows the "Herbert River Batholith" as covering an area of 5000 square miles.

The Herbert River Granite occurs in two main areas within the Mount Garnet district. The largest body is situated 3 miles west of Mount Garnet, and has an area of 12.5 square miles (Fig.5). At Nymbool scattered boulders and outcrops in creek beds amid extensive sand cover indicate a body occupying an area of at least 5 square miles. A few small, isolated outcrops were also found in and near Return Creek, and west of the Gunnawarra road.

Each of the two major granitic rock-types in the area gives rise to a distinctive topography. The Herbert River Granite is poorly exposed, and forms areas of gently undulating hills, in contrast with the prominent rocky hills which are characteristic of the Elizabeth Creek Granite.

The Herbert River Granite within the map area is essentially a greyish, medium-grained, quartz-poor, biotite granodiorite. Table 1 indicates some of the petrological variations. Excepting specimen R12193, which was collected at Nymbool, the rocks listed in the table weretaken from the small boss west of Mount Garnet, where part of the intrusion has come into contact with calcareous rocks (Fig.5). Branch (1962) describes the Herbert River Granite as a biotite adamellite to granodiorite, and considers that the presence of hornblende in places indicates limestone assimilation. In the Ruddygore-Zillmanton copper mine area, near Chillagoe, assimilation of limestone by the Herbert River Granite has also resulted in the development of a granodiorite magma (Dallwitz, pers.comm.). Assimilation of calcareous rocks would enrich the magma in lime, and result in the crystallization of a more calcic plagioclase and hornblende at the expense of free silica and biotite. This process explains the occurrence of hornblende-bearing rocks ranging in composition from granodiorite to diorite, and commonly containing mafic-rich xenoliths, adjacent to the contacts with calcareous rocks of the Mount Garnet Formation. As is evident in the table, this contamination has produced a wide range in modal percentage of quartz, a progressive decrease in grainsize as the rock types become more basic, and a tendency towards very even grainsize with decrease in acidity. Excluding specimen R12193, all rocks mentioned in Table 1 are aphyric.

Table 1

Petrological variations within the Herbert River Granite

Rock Name	Rock Number	Average ground-mass grain-size.	Modal per-centage of quartz	Maximum grainsize and frequency of phenocrysts	Extinction angles of plagioclase on albite twins
Porphyritic biotite adamellite	R12193	1.5 mm.	41	100 mm., common	15° - 17° (An_{33}-An_{35})
Biotite-hornblende granodiorite	R12208	1-1.5 mm.	16	3-4 mm., sporadic	20° - 24° (An_{38}-An_{44})
Biotite-hornblende granodiorite	R12194	1 mm.	16	5 mm., uncommon	15° - 17° (An_{33}-An_{35})
Hornblende-granodiorite	R12196	0.5 mm.	13	4 mm., uncommon	16° - 20° (An_{34}-An_{38})
Hornblende-biotite tonalite	R12195	0.5 mm.	8	2.5 mm., rare	Very variable 10° - 30° (An_{28}-An_{54})

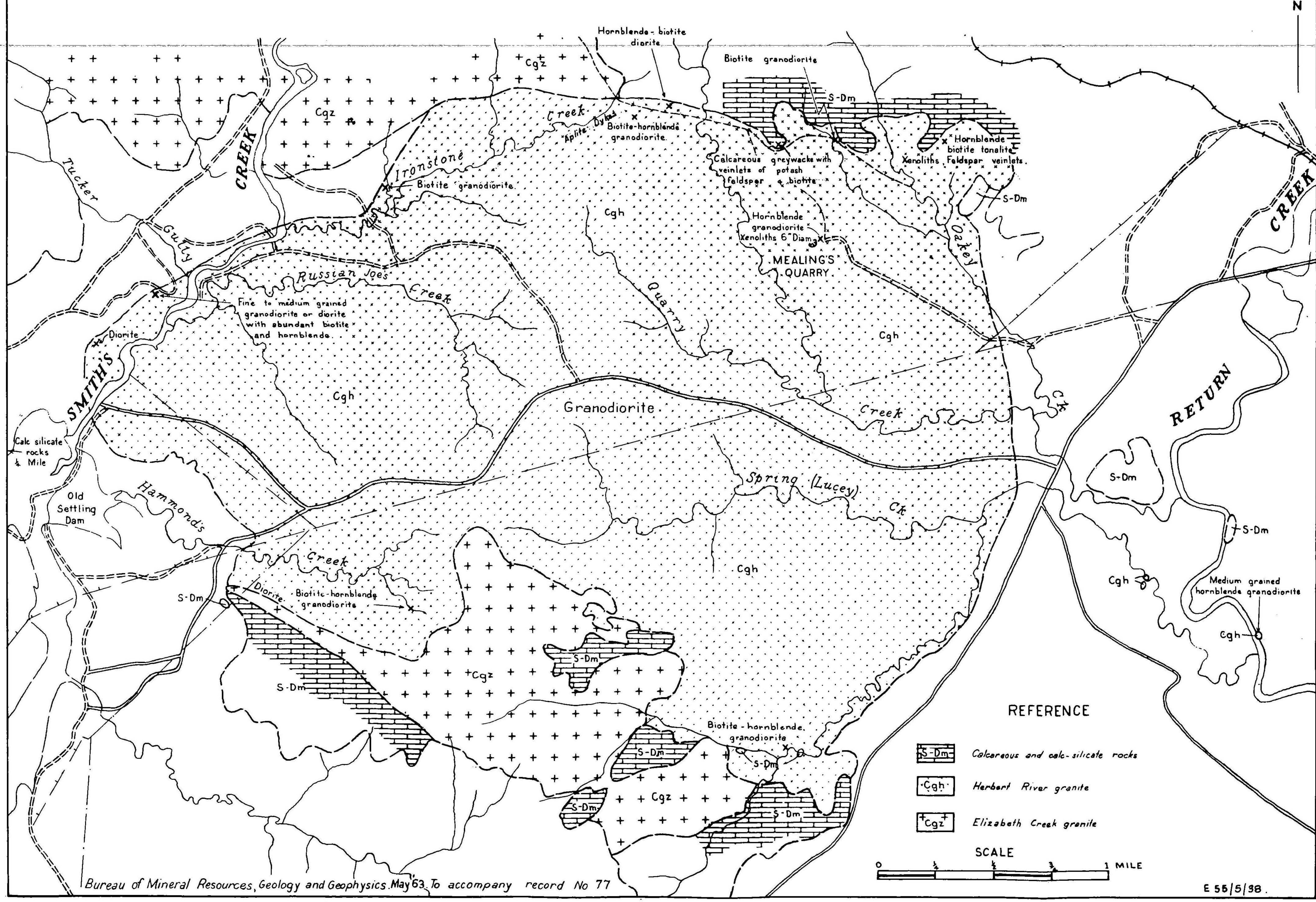
The quartz in the Herbert River Granite is commonly anhedral, and is the mineral with the smallest grainsize, but in specimen R12193 phenocrysts of individual and composite grains are up to 100 mm. in diameter. Some of the quartz shows a closely spaced system of fractures. Alkali feldspar is either orthoclase or string perthite. Perthite occurs in the biotite adamellite from Nymbool as large, poikilitic plates enclosing quartz and biotite, and as scattered subhedra in specimen R12196, which also contains abundant micrographic intergrowths of potash-feldspar and quartz. Zoned plagioclase is fairly common. The feldspars are partly altered to kaolin and sericite.

The plagioclase is commonly andesine, except in strongly contaminated contact varieties in which the plagioclase shows a wide range of composition. It is commonly porphyritic, and is zoned and altered to kaolin, sericite, or calcite. The alteration has generally affected inner zones more than the peripheral ones. Locally the perthite contains small, discrete grains of albite (specimen R12193).

Biotite is the most abundant ferromagnesian mineral in the more acid varieties, but is subordinate to hornblende in the more strongly contaminated rock types, e.g., specimens R12195 and R12196. In the latter, biotite is a very minor constituent. It is pleochroic from red-brown to straw yellow, and shows negligible alteration in the very acid types, whereas in the more basic types alteration to chlorite and epidote is widespread. The common habit is separate ragged flakes, but tight radiating aggregates of smaller flakes occur locally.

Fig 5

GENERALIZED MAP SHOWING RELATIONSHIPS BETWEEN HERBERT RIVER GRANITE AND CALCAREOUS CONTACT ROCKS



Hornblende is found in discrete anhedral to subhedral grains or in radiating clusters. It is pleochroic from bright apple green to greenish yellow, and shows alteration to chlorite, epidote, or calcite. The accessory minerals are magnetite, zircon, and apatite.

Within the area mapped there is no known mineralization genetically related to the Herbert River Granite. The mineralization at the Mount Garnet Copper Mine may be related to the Herbert River Granite, but insufficient evidence is available to establish such a relationship beyond doubt.

No analyses of Herbert River Granite from the map area are available. Macroscopically, however, the granite resembles the Almaden Granodiorite, which is a variety of the Herbert River Granite that has assimilated a considerable amount of limestone during emplacement. Analyses of both these rock types are listed in Table 2 (after Branch, 1962). Characteristic features are a lower-than-average silica content, and a high CaO and MgO content due to the presence of hornblende and andesine.

The Herbert River Granite intrudes the Mount Garnet Formation, and is itself intruded by the Elizabeth Creek Granite, as evidenced by numerous rhyolite and aplite dykes west of Mount Garnet, and by tin mineralization at the Smith's Creek and Adelaide mines near Nymbool.

The granite has been dated by the K/Ar method at 285-292 m.y. (Upper Carboniferous) - (Dr. J.R. Richards, pers.comm.).

Elizabeth Creek Granite:

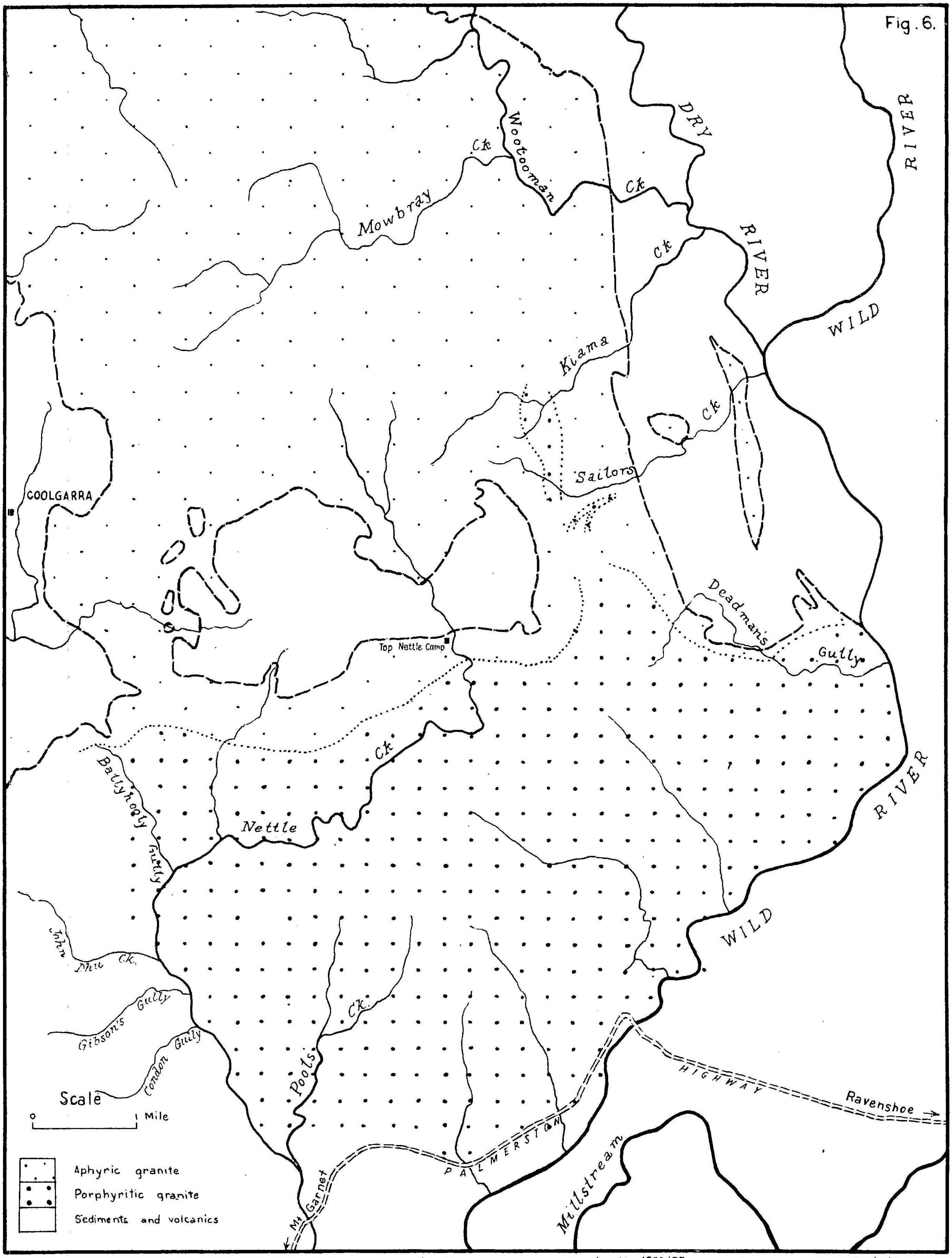
The type area for this granite is in Elizabeth Creek near Cumbana homestead, on the Einasleigh 1:250,000 Sheet. Branch (1962, p.82-3) describes the rock type as "an orange to salmon-pink, massive leucocratic granite with little to no mafic minerals", and he notes that its outcrop areas "are scattered and aggregate 2000 square miles". In the Mount Garnet area the granite is generally similar to that of the type area, except that it is more weathered and consequently paler on the surface.

The Elizabeth Creek Granite crops out over much of the map area, and it generally forms rugged hills with rough, boulder-strewn surfaces. The exposures in the Mount Garnet area probably represent a roof-zone because there are several pendants in the granite, as well as extensive areas of greisen. Much of the district may be underlain by Elizabeth Creek Granite, particularly the Brownville-Coolgarra area, where numerous tin lodes, with associated hydrothermal alteration, crop out in sediments of the Mount Garnet Formation. The granite contacts commonly dip at less than 15°; this is particularly evident in the northern half of the area, where the granite margins are subparallel to the stream directions in a number of places.

In the map area the granite has two main forms: a medium-grained, aphyric variety, and a medium to coarse-grained porphyritic variety. The latter type is well exposed between Innot Hot Springs and the Wild River (Fig.6), and contains numerous phenocrysts of quartz and feldspar, up to two inches long, set in a medium to coarse-grained groundmass. Both varieties contain more biotite than the type granite (which has from 1 to 5 percent), but the total biotite content rarely exceeds 10 percent. Fine-grained, porphyritic varieties occur near Geebung Hill and Mulligan's Gully, but they appear to be of small extent.

Branch (1962) classified the Elizabeth Creek Granite as a mafic-poor adamellite. In the map area it consists of quartz (30 - 40 percent), perthite (30 - 50 percent), oligoclase-andesine (10 - 30 percent), and biotite (less than 10 percent). Branch notes that hornblende may also be present as the result of assimilation of sediments or basic rocks, but this feature was not observed in the Mount Garnet area. He also records the following accessory minerals: zircon, apatite, sphene, fluorite, epidote, piedmontite, calcite, tourmaline, and allanite.

OUTCROP OF ELIZABETH CREEK GRANITE BETWEEN THE WILD RIVER AND COOLGARRA



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The Elizabeth Creek Granite is unusually rich in silica and poor in lime and magnesia. Six analyses of Elizabeth Creek Granite from North Queensland are listed in Table 2 (after Branch, 1962), and, although all the analysed samples are from other areas, the samples are macroscopically similar to the Elizabeth Creek Granite near Mount Garnet. Rattigan (1960, p.1279) discussed the characteristics of granite with associated tin mineralization, and concluded that "the higher the ratio of K+Na to Ca+Mg in acid differentiates the greater is the frequency that cassiterite occurs as a free accessory constituent". Tin has a tendency to become fixed in the lattice of ferro-magnesian minerals, especially biotite, during crystallization; thus, if magmatic differentiation produces an acid magma poor in ferro-magnesian minerals, - i.e., one with a high ratio of K+Na to Ca+Mg - then more tin than usual will be free to crystallise as cassiterite.

Rattigan (op.cit.) also notes that high silica content alone is not indicative of a tin-bearing granite. This is illustrated in Fig. 7a where silica is plotted against CaO+MgO for eight samples of Elizabeth Creek Granite and eleven samples of Herbert River Granite. Four of the samples of the latter granite contain more than 75 percent silica, which is well within the range for the tin-bearing Elizabeth Creek Granite. However, there is no record of tin mineralization genetically related to the Herbert River Granite.

Fig. 7b shows a plot of CaO+MgO against K_2O+Na_2O for the same 19 samples of granite as in Fig. 7a. This shows a clear distinction between the two granite types, and the contrast is strongest between the tin-bearing granite and the biotite-hornblende granodiorites. The latter types have assimilated some limestone - e.g., the Almaden Granodiorite. It is also interesting to note that samples of Elizabeth Creek Granite from areas of known mineralization have a CaO+MgO content of less than one percent.

Elizabeth Creek Granite has been found intruding all of the Palaeozoic rocks in the map area. In the headwaters of Big Dinner Creek, the granite appears to grade upwards into an acid volcanic sequence; this is interpreted as evidence of a genetic relationship between the granitic and the volcanic rocks, and agrees with the findings of Branch (1962, p.192) that the Upper Palaeozoic acid volcanics in North Queensland are co-magmatic with the Elizabeth Creek Granite. In the map area, the intrusive character of the pink granite is commonly indicated indirectly by aplite dykes, by hydrothermal alteration, and by tin mineralization along fractures in the sediments. The dykes, the alteration, and the tin are genetically related to the granite.

No evidence of chilled margins has been found on any of the granite contacts. The grainsize is commonly unchanged right up to the contact.

The relationship between the porphyritic and aphyric varieties of the granite is not clear. Their distribution in the eastern part of the area is shown on Fig. 6, but the boundary between them is only approximate, except where it was mapped in creeks. The western boundary of the coarse porphyritic granite is not known. This type crops out near the junction of Condon Gully and Nettle Creek, and may also be represented by the outcrops near the Palmerston Highway, west of Little Dinner Creek (Plate 1). Field relations suggest that the boundary may be related to the roof of the batholith because the boundary lies immediately south of, and parallel to, the granite contact at Deadman's Gully, and it parallels the contact northwards to Sailor's Creek and Kiama Creek as a long tongue before turning west-south-west and paralleling the southern margin of the large roof pendant at Top Nettle Camp (Fig.6).

The age relationships of the two varieties of granite are not clear. Flat-lying sheets of coarse, aphyric granite, from 6 to 15 feet thick, occur within the porphyritic granite in Nettle Creek and also in the lower reaches of Deadman's Gully. However, near Sailor's Creek the reverse occurs, and a large, sheet-like body of porphyritic granite 50 - 60 feet thick, lies within the aphyric variety. None of these bodies have chilled margins.

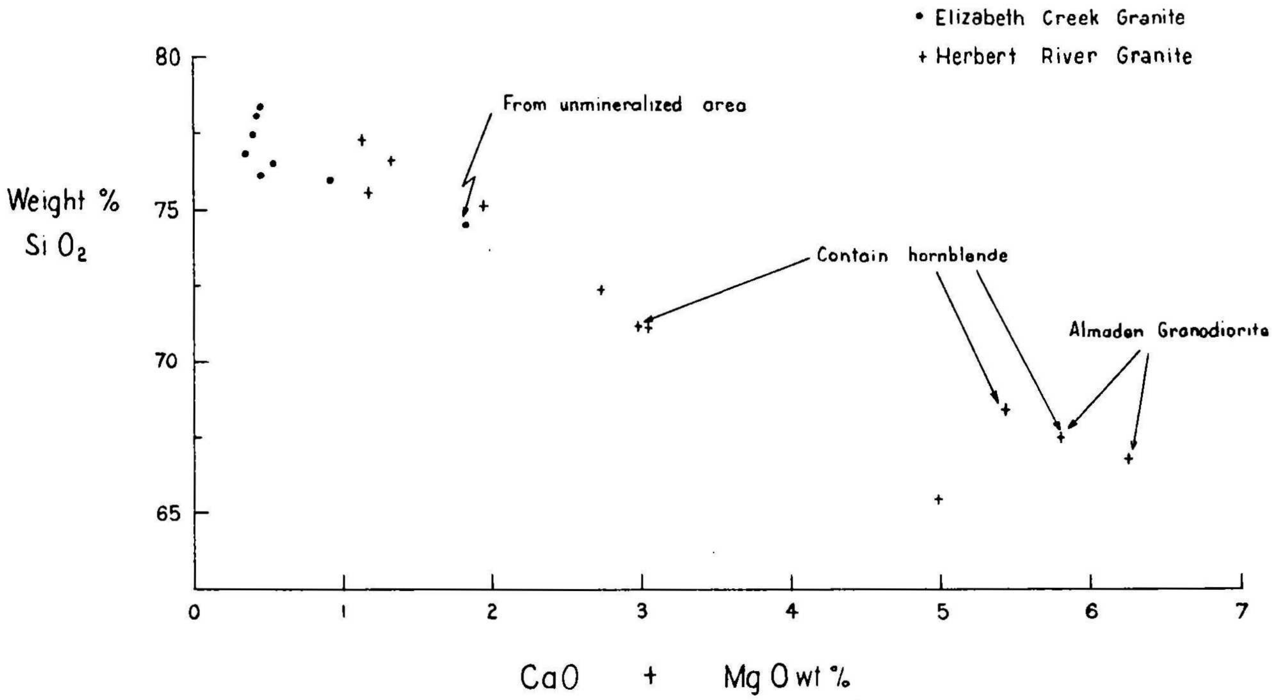

Fig 7a *Plot of silica against lime + magnesia for North Queensland granites*

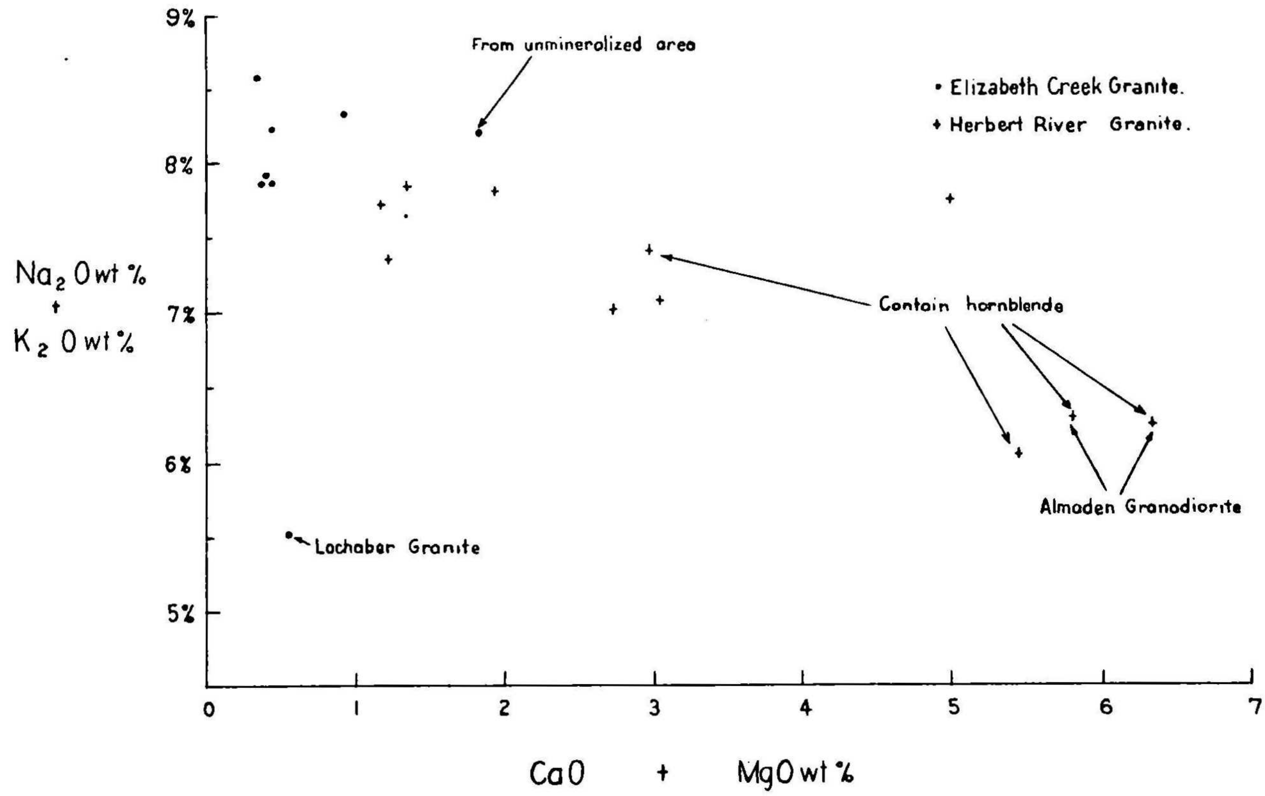

Fig. 7b. *Plot of alkalis against lime + magnesia for North Queensland granites*

Data from Branch (*1962, Tables 8 and 12*)

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TABLE 2

CHEMICAL ANALYSIS OF NORTH QUEENSLAND GRANITES*

Rock Unit	HERBERT RIVER GRANITE	=	ALMADEN GRANODIORITE		Unmineralized area	ELIZABETH CREEK GRANITE				
Sample No.	E55/5/8	E55/9/12	E55/1/16	E55/5/6	E55/5/25	E55/5/1	E55/9/3	E55/9/11	E55/9/13	E55/9/17
SiO_2	71.2	71.09	67.5	66.76	74.5	78.36	77.47	78.18	76.19	76.0
Al_2O_3	14.1	15.06	15.3	15.32	13.1	12.18	12.38	12.74	13.28	12.7
Fe_2O_3	0.86	0.86	1.50	1.36	0.36	0.60	0.92	0.51	1.11	0.50
FeO	1.79	2.07	2.40	2.92	1.33	0.37	0.67	0.27	0.50	0.99
MgO	0.73	0.64	1.75	2.02	0.23	0.00	0.03	0.03	0.05	0.20
CaO	2.25	2.40	4.05	4.23	1.59	0.44	0.36	0.38	0.40	0.71
Na_2O	3.35	4.02	3.10	3.11	3.40	2.95	3.25	3.52	3.39	4.10
K_2O	4.05	3.05	3.20	3.22	4.80	4.92	4.61	4.40	4.85	4.25
H_2O-	0.56	0.11	0.87	0.11	0.14	0.13	0.09	0.07	0.13	0.13
H_2O+	0.24	0.32	0.14	0.80	0.29	0.62	0.52	0.52	0.58	0.24
CO_2	0.16	n.d.	0.03	n.d.	0.12	n.d.	n.d.	n.d.	n.d.	0.13
TiO_2	0.29	0.22	0.05	0.29	0.19	0.02	0.03	0.04	0.02	0.07
P_2O_5	0.07	0.19	0.09	0.17	0.05	0.06	0.03	0.05	0.03	0.03
MnO	0.06	0.07	0.04	0.10	0.02	0.07	0.02	0.02	0.03	0.03
Totals	99.7	100.1	100.02	100.41	100.22	100.72	100.38	100.73	100.56	100.07

E55/5/8 Biotite-hornblende adamellite (limestone-assimilation area), 10 miles S.W. of Chillagoe.
Analysts, C.R. Edmunds and H.W. Sears, A.M.D.L.

E55/9/12 "Granodiorite" 10 miles E. of Minnamoolka H.S..
Analysts, A. McClure and S. Baker, B.M.R.

E55/1/16 Hornblende-biotite granodiorite, 10 miles N.N.W. of Rookwood H.S. (limestone-assimilation area).
Analyst, H.W. Sears, A.M.D.L.

E55/5/6 One mile W. of Almaden (limestone-assimilation area).
Analysts, A. McClure and S. Baker, B.M.R.

E55/5/25 Biotite adamellite, 16 miles S.W. of Mt. Garnet, unmineralized area - possibly more deeply eroded than elsewhere.
Analyst, H.W. Sears, A.M.D.L.

E55/5/1 Bamford Hill, 2 miles N. of Petford (Mo, W mineralization nearby).
Analyst, A. McClure, B.M.R.

E55/9/3 Biotite granite, Elizabeth Creek, near Cumbana H.S. (Sn mineralization nearby).
Analyst, A. McClure, B.M.R.

E55/9/11 8 miles E. of Glen Anne H.S. (W mineralization nearby).
Analyst, A. McClure, B.M.R.

E55/9/13 18 miles E.S.E. of Mt. Surprise (some Sn mineralization nearby).
Analyst, A. McClure, B.M.R.

E55/9/17 Biotite adamellite, 3 miles E. of Whitechalk H.S. (W, Sn mineralization nearby).
Analyst, H.W. Sears, A.M.D.L.

* Analyses taken from Branch (1962), Tables 8 & 12; notes on mineralization and limestone assimilation added by present authors.

Age determinations made at the Australian National University indicate an age of about 275 million years - i.e., Upper Carboniferous - for the Elizabeth Creek Granite (Dr. J.R. Richards, pers.comm.).

Alteration - Greisenization: Quartz-greisen is present in many places in the Elizabeth Creek Granite in the Mount Garnet district, but it is most abundant in the area extending north from Broken Gully, near Innot Hot Springs. It is also plentiful near the granite contact north and west of Brownville, and numerous small greisen veins occur in the Seven Mile Hill area, west of Battle Creek, and north of Coolgarra.

The greisens crop out as veins (or lodes) from less than one inch up to several feet wide, and as irregular areas of apparently massive greisen which may cover many acres - e.g., at Geebung Hill. A siliceous (quartz) core is commonly present in the larger greisen veins - e.g., at the Harbour Light Mine. The slopes of greisen ridges are thickly covered with greisen rubble, which may obscure outcrops of unaltered granite, and give a false impression of the extent of the greisen. The veins range in length from a few feet to over a mile - e.g., at the Harbour Light Mine. Where they are found in an incipient state they invariably lie along joints. Large areas of seemingly massive greisen occur at Geebung Hill, along a ridge south of Mount Gibson, and north of Coolgarra. Branch (1962, p.84) mentions large areas of greisen "with no well defined boundaries" in the Emuford-Wild River area, and some of these extend into the northern part of the map area. Table 4 shows that steeply dipping, north-west striking joints are those which are most commonly greisenised. Steeply dipping greisen veins are commonly evident in areas of massive greisen, and they are separated by massive greisen tending to be more micaceous than the vein-type material (Fig.8).

The greisens of the Mount Garnet district, and in the Elisabeth Creek Granite generally, are commonly greenish grey, and consist essentially of anhedral quartz set in a groundmass of fine mica. Some of the mica is pleochroic from pale grey to very pale yellow, and partial chemical analyses of the greisens (Table 3) by S. Baker revealed minor quantities of lithium. From the rather meagre microscopic and chemical information available the micas appear to be muscovite and varieties of lepidolite containing a small to moderate percentage of the protolithionite molecule. According to Winchell and Winchell (1951, p.371) "nearly all analyses of lepidolite show a deficiency in Li_2O"; A.N. Winchell "considers that this is due to the presence of some interlayered (but not isomorphously combined) muscovite".

Table 3

Results of partial analyses of greisens, Mount Garnet area.

Sample No.	Locality	% K_2O	% Na_2O	% Li_2O	% SrO
R 13717	Geebung Hill	3.66	0.10	0.04-*	0.01
R 13718	" "	3.54	0.05-	0.04-	0.01
R 14242	S. of Mt. Gibson	10.32	1.20	0.19	0.02
R 14243	" "	8.65	0.20	0.15	0.03
R 14244	Gibson's Gully	8.08	0.10	0.11	0.02
R 14245	Clarrie Smith's Lode	7.07	0.05-	0.06	0.02
J 60C	Wild River area	3.38	0.05-	0.04-	0.01-
J 118A	Dingo Mine	5.66	2.12	0.09	0.02
J 187	1.5 m. W.S.W. of Top Nettle Camp	7.90	0.05-	0.25	0.02
J 189	Devon Mine	8.88	0.05-	0.19	0.03
R 14247	Tucker's Gully	4.12	0.05-	0.04	0.01

* 0.04- = less than 0.04 percent.

Analyst: S. Baker,
Bureau of Mineral Resources.

The greisens are commonly porphyritic with sub-equant quartz grains and mica clusters up to 15 mm. across enclosed in a micaceous groundmass with an average grainsize of about 1 mm. or less; or medium-grained, and massive with local coarse-grained mica segregations made up of flakes up to about half an inch wide. Flow banding has been observed in greisens on a ridge half a mile south-east of Mount Gibson, but it may be an inherited texture. Cores of massive quartz are common in greisens north and south of Mount Gibson and south of Seven Mile Hill, and these are shown on the map as quartz greisens (q.gr). Small quantities of topaz, cassiterite, wolfram, and earthy iron oxide weathering products, are commonly present in the quartz cores. Topaz, fluorite, cassiterite, wolframite, monazite, and iron oxides (possibly derived from pyrite and arsenopyrite) are accessory minerals in some of the greisens. Molybdenite, chalcedony, copper minerals, zircon, and tourmaline are less common. Beryl is to be expected with this mineral assemblage, but to date it has been positively identified only from a mine dump 1.2 miles west-south-west of Top Nettle Camp.

Most of the greisens have probably been formed by pneumatolytic alteration of granite in place; joints have provided the initial openings for entry of the reactive agents. Beus (1962) considers that the process of greisenisation starts with high-temperature acid leaching of the granite by fluorine-rich solutions; subsequently, as the acid becomes neutralized, precipitation of new minerals takes place. The principal change appears to be the replacement of feldspar by mica; free silica is released or added during the greisenisation process, and it forms quartz cores and quartz-rich segregations. Some of the greisens may also be formed by the alteration of sedimentary rocks. These would be difficult to recognise macroscopically, but in a thin section of one specimen from Tucker's Gully the quartz exhibits secondary growth and slight strain shadows, and the general texture resembles that of a partly replaced quartzite or greywacke.

The massive greisens were formed by coalescence of steeply dipping greisen lodes or veins, and/or by greisenization along flat joints located near the roof of the parent granite (Fig.8). In places quartz cores are found in greisenised horizontal joints - e.g., at The Glen mines - but they are most common in the steeply dipping joints.

<u>Zoning of greisens</u>: The presence of quartz cores in micaceous greisen is regarded as a form of zoning. Comparing this form with Beus's (op.cit.) Fig.2, which shows the development of vertical zoning in greisen formed along joints in microcline granites, it appears that the two-zone form found in the Mount Gibson-Harbour Light Mine area represents the upper part of a zoned greisen which widens at depth. Beus's more subtle zones, such as mica greisen and quartz-mica greisen, could probably be recognised if the greisens were examined more closely. During the mapping, mica-rich and quartz-rich varieties of greisen were recognised, as well as more slightly altered, greisenised granite. For convenience in mapping, all of these forms have been grouped under the general heading of greisen.

Economically the Elizabeth Creek Granite and its greisens are important as a source of tin. Much of the lode tin and tungsten produced in the area has come from greisen at Gurrumba and from The Glen mines, respectively. Jensen (op.cit.) thought that much of the alluvial cassiterite in the Greater Herberton district was derived from greisens, and the present mapping supports this theory.

<u>Alteration - Siliceous Cappings</u>:* (See end of Section) Cappings of fine-grained, massive quartz are found mainly in the area west of Mount Garnet, and they also make up the low hills in the area of Lucey's Knob, south of Mount Garnet. The cappings are intensely fractured and brecciated in some places, and they are interpreted as roof-zone alterations of the Elizabeth Creek Granite, or overlying sediments. In the area west of the Smith's Creek gorge, the cappings form moderately high hills (400 feet above the gorge), and overlie Elizabeth

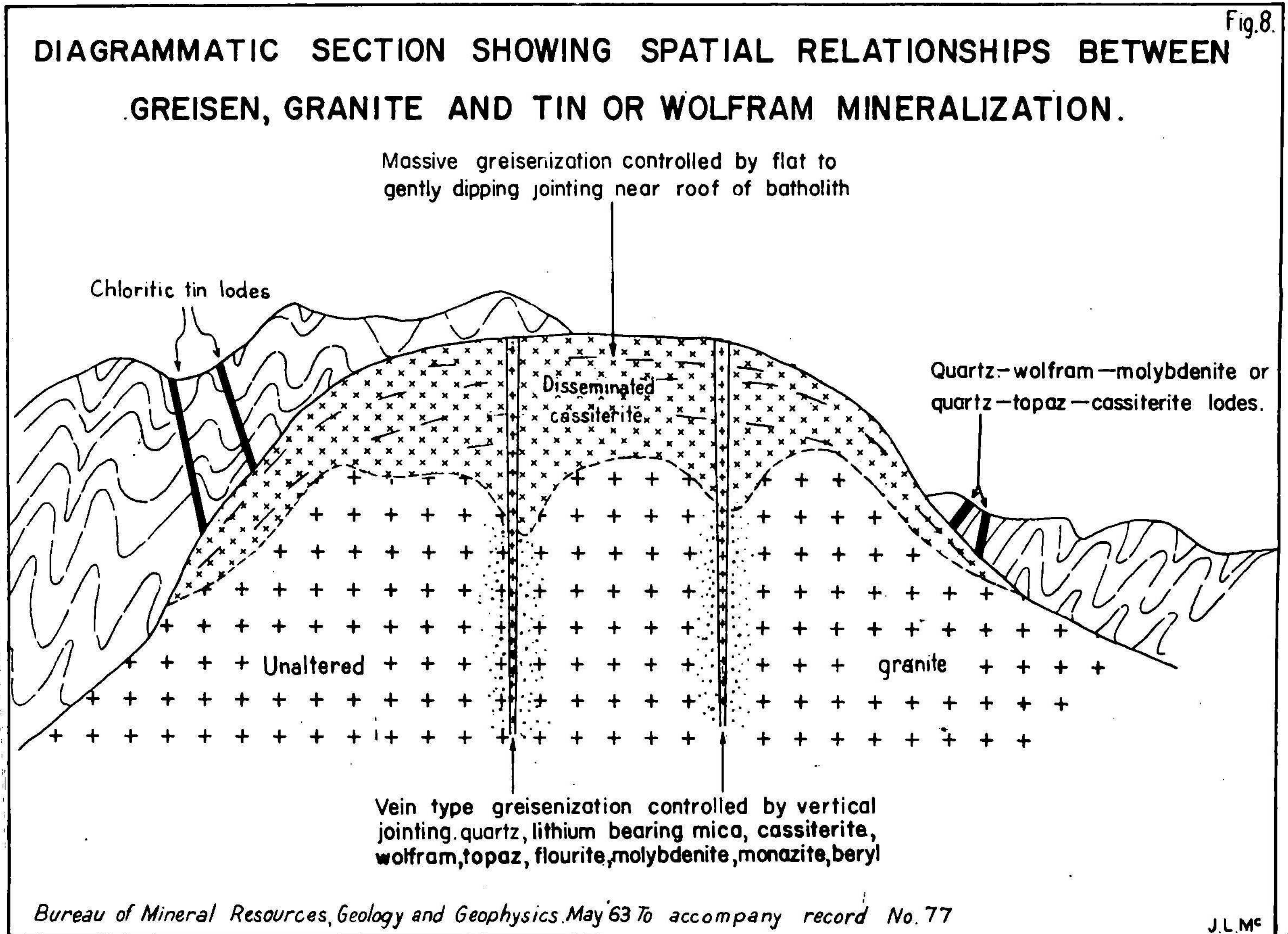
Fig.8.
DIAGRAMMATIC SECTION SHOWING SPATIAL RELATIONSHIPS BETWEEN GREISEN, GRANITE AND TIN OR WOLFRAM MINERALIZATION.
Massive greisenization controlled by flat to gently dipping jointing near roof of batholith
Chloritic tin lodes
Disseminated cassiterite
Quartz-wolfram-molybdenite or quartz-topaz-cassiterite lodes.
Unaltered
granite
Vein type greisenization controlled by vertical jointing. quartz, lithium bearing mica, cassiterite, wolfram, topaz, flourite, molybdenite, monazite, beryl
Bureau of Mineral Resources, Geology and Geophysics. May '63 To accompany record No. 77
J.L.Mc

E55/5/41

Creek Granite in which some greisen has been formed. No sedimentary rocks were found. At Lucey's Knob, a minus 80-mesh sample of the soil from between siliceous outcrops contained 60 p.p.m. tin, and O.D. Paterson (pers.comm.), of Mineral Deposits Ltd, obtained cassiterite by crushing a sample of the siliceous cap rock. The outcrops of siliceous rocks in Spring or Lucey's Creek, two miles west-south-west of Mount Garnet, are therefore regarded as caps to bosses and stocks of Elizabeth Creek Granite intruding the Herbert River Granite in that area.

The siliceous cappings at Lucey's Knob may cover stanniferous greisen and granite. If this postulated stanniferous zone was exposed before or during the Cainozoic sedimentation of the Mount Garnet Basin, erosion would have released cassiterite grains which may have been concentrated into placer deposits in the sediments of the Basin, and could account for part of the tin known to occur in the lower reaches of Return Creek.

*(Early in the 1963 field season the areas described in this section were re-examined by W.B. Dallwitz and K.R. Yates; as a result some changes in interpretation have been suggested, but the maps accompanying the report have not been altered to conform with these changes. The "cappings" west of Smith's Creek gorge are highly siliceous greisens, commonly containing little or no mica, within Elizabeth Creek Granite. The "cappings" near Spring Creek are weathered, pyritised, and probably silicified parts of a rather leucocratic, fine-grained variety of Herbert River Granite. The rock at Lucey's Knob is unlike any other in the area, and has not yet been examined in thin section; in most places it has the appearance of a very fine-grained, siliceous, and somewhat porous greisen, and in others it resembles a very fine-grained granite aplite. Lucey's Knob may belong to the Precambrian, parts of which crop out about 2 miles to the east, near Return Creek; several samples of the rock were ground to minus 80- mesh B.S.S., and carefully panned, but no cassiterite was detected.)

Dyke Rocks:

Rhyolite is the most common dyke rock in the Mount Garnet district, but coarse quartz-feldspar porphyry, aplite, and dolerite dykes have also been found. On the whole dykes are rather rare, and they are generally poorly exposed.

Rhyolite: Several small, steeply dipping rhyolite dykes have been mapped where they intrude Herbert River Granite, four to five miles west of Mount Garnet. These rhyolites are pink and grey, and are best exposed in creeks. In some places they are intensely fractured.

The largest dyke occurs half a mile west of Brownville. It has an arcuate form, and appears to be an offshoot, or feeder dyke, of a large area of undifferentiated Upper Palaeozoic acid volcanics exposed farther to the south-west. The dyke is continuous with the volcanics, and it consists of pink and cream rhyolite. Small rhyolite dykes are common adjacent to the boundaries of the large mass of undifferentiated acid volcanics. The rhyolite dykes are considered to be genetically related to the Elizabeth Creek Granite.

Quartz-Feldspar-Porphyry: Several dykes of coarse-grained quartz-feldspar porphyry were found in the area immediately south-west of Mount Gibson. Two dykes of similar composition also occur one to two miles west of Innot Hot Springs. The dyke-rocks are grey, and have a porphyritic texture. Feldspar phenocrysts are up to 30 mm. long, and intensely kaolinised. Phenocrysts of quartz are smaller, and range up to 5 mm. The groundmass consists mainly of quartz and a few flakes of biotite.

These dykes intrude greywackes of the Mount Garnet Formation, and their composition indicates a genetic relationship to the Elizabeth Creek Granite. The coarse grainsize of the phenocrysts may be due to derivation from the coarse-grained, porphyritic phase of the Elizabeth Creek Granite which crops out east of the dykes.

A small dyke or lens of medium-grained, greenish grey quartz-feldspar-porphyry occurs in the Elizabeth Creek Granite about one mile west of Ironstone Hill. Its origin is uncertain. A lens of similar rock about 100 feet long also occurs half a mile south-east of Mount Gibson.

Aplite: A few small, pink and grey, steeply dipping and generally intensely fractured aplite dykes intrude the Herbert River Granite in Russian Joe's Creek and Ironstone Creek, west of Mount Garnet. Aplite dykes also occur in the roof pendant of Mount Garnet Formation half a mile west of Top Nettle Camp, and here they contain small quartz and quartz-muscovite veins carrying cassiterite. The aplite was derived from the Elizabeth Creek Granite.

Basic Dykes: Two small dolerite dykes intrude Elizabeth Creek Granite near Top Nettle Camp, and one at a place one and a half miles north-west of Innot Hot Springs. They are fine-grained, dark grey rocks consisting of about 80 percent labradorite and 20 percent titanaugite. Their composition suggests that they are not related to the Cainozoic olivine basalt extrusions. All three dykes strike north-west, and were probably intruded along tension joints.

Pegmatite: No pegmatite dykes have been found in the Mount Garnet district. However, pegmatitic segregations of quartz and feldspar occur at the Elizabeth Creek Granite - Mount Garnet Formation contact two thirds of a mile west of Mount Gibson.

Products of Contact Metamorphism:

Sediments of the Mount Garnet Formation have been thermally metamorphosed by both the Elizabeth Creek and the Herbert River Granites. Poor exposure limits study of the rocks in contact with the Herbert River Granite, but those in contact with the Elizabeth Creek Granite crop out extensively throughout the area. The mineral assemblages developed in the metamorphic rocks in contact with the Elizabeth Creek Granite probably resulted from thermal effects and contact metasomatism, and in many places the latter may have been the more important process. This metasomatism affected the sediments, notably the more calcareous types, at the granite contacts, and it caused intense local alteration of sediments and Herbert River Granite adjacent to tin-bearing lodes (see Economic Geology section).

Calc-silicate hornfels: This rock-type is best developed in the roof pendant 1.5 miles west of Battle Creek, and in roof pendants west of the Mount Garnet racecourse. In the former area, pure marble occurs locally. The most common rock-type is composed of grossularite, vesuvianite, diopside, epidote, calcite, and prehnite, in order of decreasing abundance. This assemblage of minerals occurs as metasomatic pockets and veins in hornfelsed basalt and in marble. Commonly ovoid areas up to 30 mm. in diameter containing a peripheral zone of grossularite and a core of vesuvianite (whith in places forms columnar crystals approaching 20 mm. in length) are found.

Grossularite occurs in broad areas consisting of tight aggregates of crystals, averaging 0.4 mm. in diameter, which are xenoblastic in contact with one another and idioblastic in contact with other minerals. Diopside and/or prehnite occur in the interstices between grossularite crystals. The columnar aggregates of subidioblastic vesuvianite poikiloblastically enclose numerous small inclusions of diopside or grossularite about 0.04 mm. in diameter. Diopside (average grainsize 0.1 mm.) occurs in tight, granular, almost monomineralic aggregates, and as inclusions in vesuvianite, or interstitial to grossularite.

Near the junction of Smith's and Black's Creeks calcareous siltstone has been metamorphosed to a green, fine-grained hornfels containing quartz, hedenbergite, sphene, chlorite, epidote, calcite, and pyrite. In an impure, fine-grained, calcareous conglomerate from Eastine Creek the fine-grained calcareous matrix has been reconstituted to form grossularite and epidote.

The calc-silicate rocks west of the racecourse are similar in composition to those near Battle Creek.

Hornblende hornfels: Basalt in the Mount Garnet Formation south-west of the racecourse has been metamorphosed to a rock containing 70 percent hornblende, 25 percent plagioclase, and minor biotite, epidote, and sphene. The plagioclase (calcic oligoclase) occurs as unaltered, in places twinned, laths, averaging 0.4 mm. in length, and scattered throughout decussate or radiating aggregates of bright olive-green, strongly pleochroic hornblende. Veinlets and segregations of plagioclase and epidote are common.

Metagreywacke: Low-grade thermally metamorphosed greywacke occurs locally throughout the area, but is most abundant in the vicinity of Mount Gibson. Within these rocks quartz occurs in two forms: the original detrital quartz grains, the outlines of which are still apparent, have been recrystallized to form composite grains; and fine-grained, granoblastic quartz, averaging 0.05 mm. in diameter, which crystallized from the original clay-silt matrix. Biotite occurs as scattered flakes or decussate aggregates within the fine-grained quartzose matrix. Its grainsize is similar to that of the associated quartz. The original detrital feldspar remains unaltered.

Greywacke-conglomerate near the Dalcouth Mine contains dark green hornblende in decussate glomeroporphyroblastic aggregates ranging from 5 to 20 mm. across. These aggregates are scattered unevenly throughout the rock. A small amount of epidote is also present. This alteration has probably resulted from a metasomatic process similar to that which formed the chloritic gangue of tin lodes within the Mount Garnet Formation.

Iron Deposits: Small hematite deposits are common where calcareous rocks are in contact with Elizabeth Creek Granite. The localities are listed in the section on Economic Geology.

Tourmaline Vein: A vein of massive, black tourmaline three feet wide and about 300 feet long occurs about ten chains north-west of Brownville Battery. The occurrence is interesting, as tourmaline is rare in the map area.

CAINOZOIC

The Cainozoic succession in the Mount Garnet area consists of sediments, in different degrees of consolidation, with interbedded basalt flows. This succession is found in the Mount Garnet Basin and in the valleys of the Wild and Herbert Rivers and their tributaries. High-level Cainozoic gravels are found near the Excelsior Mine, about one mile north-west of Brownville, but this is the only known occurrence of this type. Dr. M.J. Bik, formerly of the C.S.I.R.O. Division of Land Research and Regional Survey, made a brief study of the geomorphology of the district, and many of the following data on the Cainozoic sediments are taken from his notes. The sediments are important economically because they contain tin placer deposits at several localities.

Sediments:

Bik (pers.comm.) regards the Mount Garnet Basin as an erosional feature (in soft Precambrian metasediments and Herbert River Granite) which was filled with sediments in Cainozoic times. He recognized five phases of sedimentation ranging in age from probable early Tertiary to Recent, and believes that erosion and deposition occurred in the Basin as alternating processes related to climatic cycles. The effect of earth movements during the Cainozoic cannot be estimated, and Bik believes it is possible to explain the Cainozoic history of the area solely in terms of climatic changes.

The oldest sediments in the Mount Garnet Basin, according to Bik's interpretation, are characterised by a dark brown to grey lateritic duricrust which is strongly cemented and mottled by iron oxide in the lower horizons. They are best exposed in Dingo Gully, a tributary of the Herbert River (Fig.4), and large blocks of brown duricrust have been brought to the surface by dredging in Return Creek, near the pumping station. Only one such phase of duricrust formation has been found in the Mount Garnet district, although pseudo-duricrusts were formed, especially in the next younger phase of sedimentation, by the erosion and redeposition of the original duricrust components.

Bik believes that a duricrust forms by the irreversible drying out of a zone of lateritised sediments during a dry phase of a climatic cycle. Dissection of this zone facilitates the process of dehydration and cementation.

The second phase of sedimentation is now represented by deeply weathered sediments containing bands with iron and manganese nodules. They are characteristically red, but yellow, brown, leached grey, and white types are also present. Bik believes that this phase accounts for the greater part of the sediments dredged in Smith's and Return Creeks. It is also exposed on the surface near Central Creek (Fig.4). The sediments of the second phase are exposed in erosional (cut and fill) valleys in the duricrust zone, and also overlie this zone. Gravel layers in the post-duricrust sequence commonly form slightly higher ground owing to the effects of differential compaction of coarse and adjacent fine sediments.

The second phase was followed by at least another two phases of sedimentation, probably during the Pleistocene. These consist mainly of alluvium, and are characterised by yellow or yellow-brown soil profiles. They form cut and fill deposits in the earlier sediments, and are attributed by Bik to the Pleistocene because of the lack of weathering effects.

The youngest sediments in Bik's classification are sandy channel- and heavy-textured backswamp-deposits found adjacent to all the larger stream channels in the district. As yet no soil profile has developed on these sediments, and they are thought to be Recent.

Since the above was written a ^{14}C age determination on carbonized wood taken from a depth of 60 to 70 feet in a drill hole about half a mile south of the dredged area in Smith's Creek has shown that the dredged sediments are much younger than postulated above. The age obtained on this sample by the Institute of Nuclear Sciences, D.S.I.R., Lower Hutt, New Zealand, was 36,600 $\pm$ 1,900 to 2,400 years.

The maximum thickness of the Cainozoic succession is unknown. A borehole in the ATR area penetrated 204 feet without reaching bedrock; the Bureau's hole MRW 14 was unbottomed at 184 feet in lower Smith's Creek, and hole MRW 12 was unbottomed at 143 feet in lower Return Creek.

The Cainozoic sediments comprise clay, silt, sand, and gravel of colluvial and alluvial origin derived from the uplands in the northern half of the map area. The Mount Garnet Basin may represent a basalt-dammed lake, which was subsequently filled with sediments, but most of the observed sediments are not consistent with such a mode of origin. Local ponding probably occurred within the basin - e.g., some 25 feet of blue clay overlies the basalt intersected in hole MRW 12, and this probably represents a local lake deposit in front of a basalt flow.

Basalt:

The Cainozoic basalt in the Mount Garnet district is a vesicular olivine basalt, and is best exposed in the valleys of the Wild and Herbert Rivers. It originated from vents on the Atherton Tableland, and entered the Mount Garnet area along the valleys of the Wild River, the Millstream, and Blunder Creek. Basalt apparently 'backed up' tributaries of the Herbert River because it is found in boreholes at Nettle and Battle Creeks, about 40 and 60 feet, respectively, below the level of the Palmerston Highway. Basalt is exposed on the Palmerston Highway east of Blairs' Gully, at Russian Gully, and in a small gully one mile south-west of Innot Hot Springs. Basalt also occurs in most of the alluvial flats along the Wild River, commonly buried under a few feet of sand.

In lower Return Creek weathered basalt is exposed in places for two miles upstream from the junction with the Herbert River. In drill hole MRW 12 this basalt was intersected 28 feet below the surface as a layer 9 feet thick. MRW 12 also intersected 58 feet of basalt flows with interbedded thin clay horizons from 69 to 127 feet below surface. The thickness of this latter intersection suggests that the basalt occupies a major valley, and it may represent a former channel of the Herbert River. However, it could also represent basalt backed up along a former channel of Return Creek, although such a process would imply an even greater thickness and a much greater volume of basalt in the main Herbert River channel.

Drill hole MRW 14, in lower Smith's Creek, intersected about 5 feet of basalt cobbles 130 feet below the surface. Because little sand was found with the cobbles, they are interpreted as a partly decomposed basalt flow. This occurrence of basalt is anomalous, as it is 7½ miles in a direct line from the nearest known basalt on the surface (in lower Return Creek), and MRW 14 is 9 miles from fresh basalt exposed in Gunnawarra Gap (Fig.4). Gradients in direct lines from these exposures to the occurrence in MRW 14 are 6.6 feet per mile from Return Creek and 7.7 feet per mile from Gunnawarra Gap. These gradients seem too gentle to enable such thin flows to extend so far from their parent vents. There is no evidence to suggest that either of the exposed basalts and the one in MRW 14 are the same flow, and the depth of burial in MRW 14 makes such a correlation unlikely. Gentle warping may have affected the area since the extrusion of the basalt, and this would have modified the gradients.

Age of Basalt: No isotopic dating of the basalts in the Mount Garnet district has been carried out. However, pebbles of Cainozoic basalt occur in gravels underlying the lateritic duricrust in Return Creek, half a mile north-east of Duck Holes. This indicates that basalt extrusion began early in the Tertiary. Evidence of the age of the younger phase is given by a diatomite deposit, occurring with basalt near Innot Hot Springs. Crespin (1947) said the age of the diatoms was Recent to Sub-Recent. This deposit was not located during the present mapping, and its exact relation to the basalt is, therefore, unknown. Other exposures showing evidence of the age of the most recent basalt flows are found in lower Return Creek, a few hundred yards from its junction with the Herbert River. Here cobbles and pebbles of weathered basalt are plentiful in a rhyolite cobble conglomerate, and a small, residual outcrop of fresh basalt occurs some 50 feet above this conglomerate. The conglomerate is similar to sediments attributed to the Pleistocene by Bik, and the overlying basalt may be late Pleistocene or even early Recent. Most of the fresh basalt flows now exposed at the surface are probably Pleistocene or early Recent.

Basalt-filled drainage-channels: Basalt entering the area has partly filled the original valleys of the Wild River, the Millstream, Blunder Creek, and the Herbert River, and the present stream channels are probably very different from the original ones. Moreover, the general scarcity of washed basalt detritus in the district suggests that there has been little erosion of the Cainozoic basalt. Field evidence suggests that basalt flows were buried by alluvial and colluvial sediments soon after extrusion. Subsequent erosion of basalt seems to have had local effects only, and is, apparently, restricted to degrading stream channels. The present levels of basalt may, therefore, be used for approximate calculations of original direction of flow, bearing in mind that the surfaces of basalt flows may have been modified slightly by collapse after cooling, and possibly by warping and local tilting.

Levels on the surface of basalt along the Palmerston Highway from the Wild River (2130') to Battle Creek (2020'), and farther south at the mouth of Nettle Creek (2010'), suggest that the Herbert (Wild) River originally flowed along a higher, more northerly course than at present (Fig.9). This interpretation is based on the contrast between levels on basalt near the Palmerston Highway and those near the mouth of Nettle Creek and along Blunder Creek. The levels near the highway show a regular fall of 17 feet per mile from near Blair's Gully west to Battle Creek.* Levels on basalt cropping out along a

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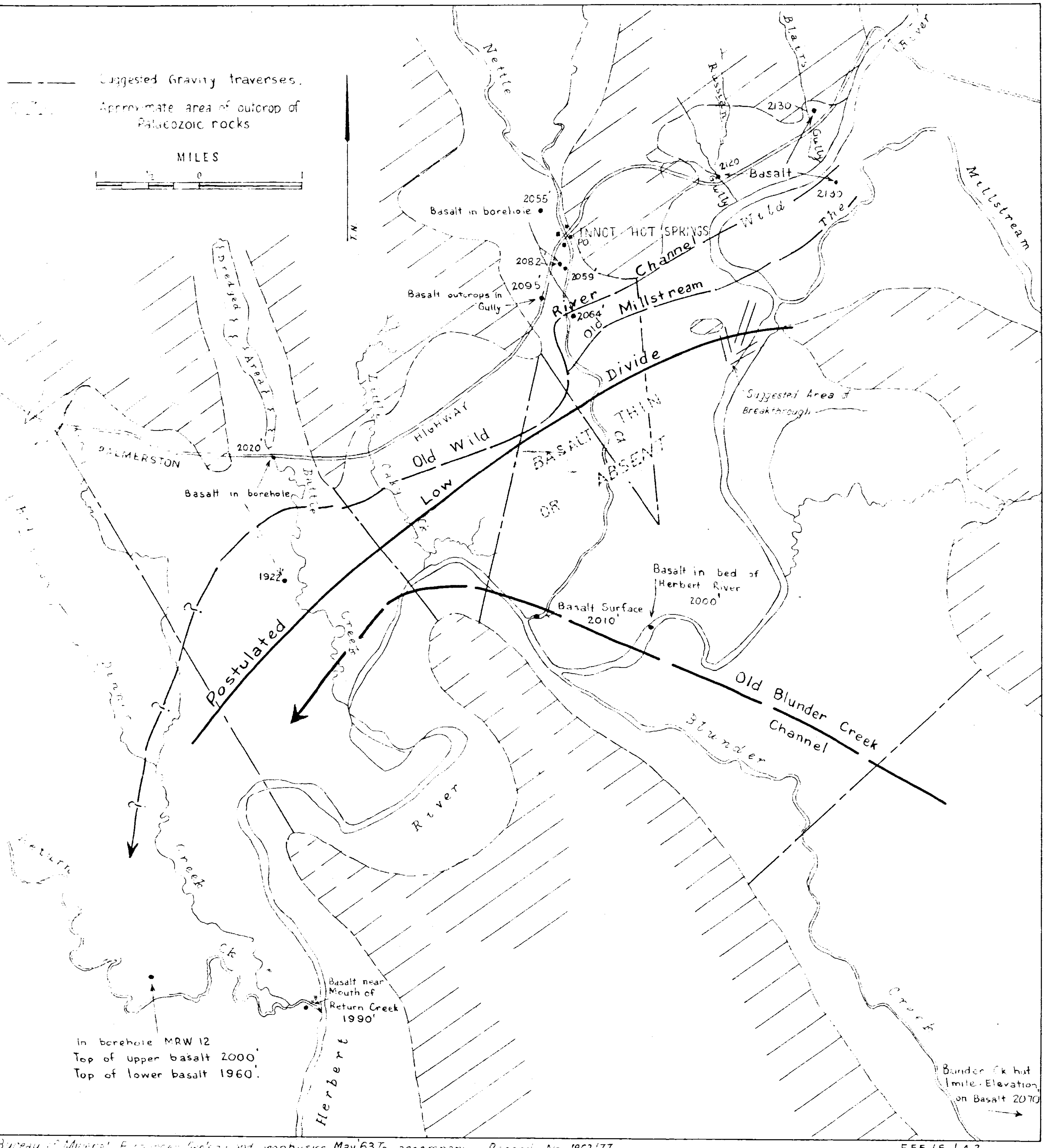
* The level (2060') of basalt in a borehole near the Nettle Creek bridge is anomalous, and it may represent a flow older than those exposed at the surface. This lower flow may have backed up Nettle Creek, or it may have been laid bare by erosion before it was buried under its present cover.

DIAGRAMMATIC MAP OF HERBERT RIVER VALLEY SHOWING

Postulated Former Drainage Pattern



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north-south line through the mouth of Nettle Creek show an elevation difference of 85 feet between the outcrop one mile south-west of Innot Hot Springs (2095') and the exposure at the mouth of Nettle Creek (2010'). Moreover, the latter exposure is 10 feet lower than the basalt in a drill hole at the Battle Creek bridge, which is three miles downstream relative to Nettle Creek. Thus it appears that the basalt near the Highway and that at the mouth of Nettle Creek flowed along different drainage channels separated by a low divide - unless erosion of 100 feet or more of basalt and interbedded sediments from above the Nettle Creek - Herbert River exposure is acceptable. (This thickness would be necessary to back up basalt from the present Herbert River channel to the exposure on the Highway south-west of Innot Hot Springs.) Furthermore, the levels on basalt at the mouth of Nettle Creek (2010'), and nearby in the Herbert River (2000'), when compared with levels on basalt upstream along Blunder Creek, near the Blunder Creek hut (2070'), show a regular fall of 9 to 10 feet per mile, and this fall is in a direction opposite to that from the Highway to Nettle Creek. Any theory advocating erosion of 100 feet of basalt and sediments from above the mouth of Nettle Creek must, therefore, contend with erosion of a comparable amount of basalt and sediment from the valley of Blunder Creek, and no evidence of such extensive erosion of basalt has been found. It is unlikely that earth movements could have lowered the area around the mouth of Nettle Creek relative to the Palmerston Highway without also lowering the area of Blunder Creek.

A fall of 9 to 10 feet per mile for 7 miles along the Blunder Creek valley may seem rather low. However, the width of basalt exposed in the Blunder Creek valley immediately south-east of the Herbert River ranges from one to two miles, and this implies that the basalt is quite thick (up to 50 feet or more) in parts of the valley. The low gradient (9 to 10 f.p.m.) is acceptable for a large volume of basalt moving slowly along a broad valley.

Once the postulated original channel of the Herbert (Wild) River became filled with basalt, water and additional basalt would have overflowed into the topographically lower, southerly channel of Blunder Creek at the first available low point. This may have occurred south east of Innot Hot Springs near the present junction of the Millstream and the Wild River, and erosion and sedimentation associated with the overflow could have produced the present course of the Herbert River. Filling and subsequent drainage diversion along the northern channel would have dammed northerly tributaries of the Herbert (Wild) River, such as Nettle Creek. These tributaries then would have had more erosive power than usual because of the lower level of the Blunder Creek (now Herbert River) valley; they could have cut through the basalt and interbedded sediments filling the northern channel, and then through the low divide between the northern and southern channels along fairly direct courses from the point of damming to the southerly channel. The abandoned, basalt-filled, northerly channel has presumably been buried by sheetwash and stream sediments from the uplands to the north.

If the above interpretation is correct, there should be an area between the old channels of the Herbert (Wild) River and Blunder Creek which is devoid of basalt, or which is covered by only very thin, sheet-like flows that welled over the low divide between the two channels. This postulated basalt distribution could be checked by gravity work.

Further consideration of the significance of the 58-foot intersection of basalt flows in drill hole MRW 12 may help to establish the drainage history of the area. Because of its thickness this basalt is regarded as "fill" in a major stream channel, and it should be possible to map this buried, basalt-filled 'channel' by geophysical techniques. This 'channel' is regarded as a possible southerly extension of the former northerly Herbert (Wild) River channel.

Some of the anomalies in basalt distribution in the Mount Garnet Basin could be explained if a vent existed in the area. No evidence for the presence of a vent has been found, although a small eruptive centre could have been completely buried by more recent sediments.

Economic Aspects:

The Cainozoic sediments in the valleys of the Wild River, Nettle Creek, Battle Creek, Return Creek, and Smith's Creek all contain tin placers. These have been dredged in the latter three creeks, and sluiced in Nettle Creek. The basalt flows have probably covered some tin placers, and the most promising area for a deep lead deposit would be along the postulated northerly Herbert River channel near the Palmerston Highway (Fig.9). This would have received alluvial tin from tributaries of the Wild River, Blair's Gully, Nettle Creek, and Battle Creek, as well as some fine tin from the Herberton area. However, any placer deposits underlying basalt would probably be water-saturated and difficult to prospect and work, and the grade of the tin-bearing wash in the Mount Garnet area in general is not high enough to encourage a deep lead prospecting programme.

STRUCTURE

FOLDING

The Mount Garnet Formation is isoclinally folded about northerly-striking axes. The only large-scale fold delineated during the mapping is two miles to the north-west of Mount Garnet. This is a south-plunging anticline whose axis strikes at about 025°. The beds are commonly slightly (up to 10°) overturned, and small-scale folding of various amplitudes may be seen in places.

Folding within the Carboniferous acid volcanics is less intense. Fold axes strike north-west, and dips range up to 60°.

FAULTING

Extensive faulting occurs along the Dry and Wild Rivers, and to a lesser degree in the Brownville - Coolgarra area. The strike of the faults ranges from 320° to 040°, but most strike between 350° and 010°. Fault-planes dip at angles ranging from 60° to vertical. Within the Mount Garnet Formation many of the faults have acted as loci for tin mineralization.

JOINTING

Only the joints within the Elizabeth Creek Granite have been studied in detail, and measurements were confined to master joints which crossed the complete width of the outcrop at which readings were taken. This restriction was designed to prevent cluttering the diagrams with measurements of minor joints which might have only very local significance. Joints were divided into four categories: ordinary joints, "greisenised" joints, quartz-filled joints, and mineralised joints. In addition, some measurements were made on granites foliated by numerous, thin, closely-spaced (ten to an inch) quartz-filled fractures.

The "greisenised" joints referred to in this report are joints along which the granite has been altered to a dark-grey, hard, siliceous rock which contrasts markedly with the normal pink or grey granite.

Mineralised joints are those which contain ore minerals, and which have been worked for their mineral content. In nearly all places the ore occurs in greisen similar to that found along the unmineralised, greisenised joints already mentioned.

In Figure 10 the poles to all the unmineralised joints have been plotted on a stereographic net, and the densities contoured.

The plot reveals a definite pattern with double maxima in the north-east and south-west quadrants corresponding to steeply dipping joints with a north-westerly strike, and a lesser maximum in the north-west and south-east quadrants corresponding to similar joints with a north-easterly strike. One of the maxima in the south-west quadrant is stronger than the other, and this alters the otherwise almost perfect orthorhombic symmetry to monoclinic.

To analyse the distribution of the various types of joints, the numbers of each variety occurring within the 2 percent contour was calculated separately from the north-west/south-east and north-east/south-west maxima, and the results expressed as percentages (Table 4). This demonstrates that greisenised joints with a north-west strike are much more common than those with a north-east strike.

Table 4

Orientation of each joint type within 2% contour expressed as a percentage ot total joints within each maximum.

	North-west south-east quadrant	North-east south-west quadrant
Ordinary joints	70%	50%
Greisenised joints	13%	37%
Quartz-filled joints	14%	17%
Foliation in granite	4%	1%

In Fig. 11 the poles to the mineralised joints have been superimposed on the contours of Fig. 10. This diagram shows that the mineralised joints are most commonly members of the north-west striking set of joints, and rarely are they members of the north-east striking set. There is, however a tendency for some of the mineralised joints to have a north-south orientation, which does not correspond to any maxima in the unmineralised joints.

A set of low-angle joints is commonly visible in mine workings, and these joints are represented on the stereographic diagram as a partial girdle about a north-west axis. They have been observed "cutting off" lodes either upwards or downwards in mine workings, but they are in some places mineralised themselves. Several small lodes have been observed with a sub-horizontal orientation. The "cut-off" lodes are commonly picked up again by following "slime tin" along the low angle joints. In the Herberton district lodes are in places displaced as much as 35 feet along these low-angle joints, and this suggests that appreciable movement has occurred on all of the major joint-systems.

The pattern of the joints is the same throughout the area, in both the aphyric and porphyritic forms of the Elizabeth Creek Granite.

ECONOMIC GEOLOGY

BRIEF HISTORY OF THE FIELD *

The main mineral product of the Mount Garnet district is alluvial cassiterite, and this has been the major product throughout the life of the field, except during the period 1900-1910 when large quantities of copper and silver were mined at Mount Garnet, and 1514 tons of cassiterite concentrates were produced from lodes at Smith's Creek Mine, north-west of Nymbool.

Dunstan (1913, p.298) states that tin was first found in Nettle Creek on 19th February, 1881. The first reference to the district in the Annual Reports of the Queensland Department of Mines was in 1883, and it indicates that work began on lode tin mines in the Coolgarra area (Return Creek) in 1881, and that small shafts had been sunk on copper and silver ore at Mount Garnet by 1883. Small-scale alluvial-cassiterite mining has continued intermittently since the opening of the field, but this type of work can be done only during the annual wet season because of the lack of permanent water in the area. Unfortunately, production figures for alluvial cassiterite are very incomplete (see Fig.12), especially in the period pre-1930 .

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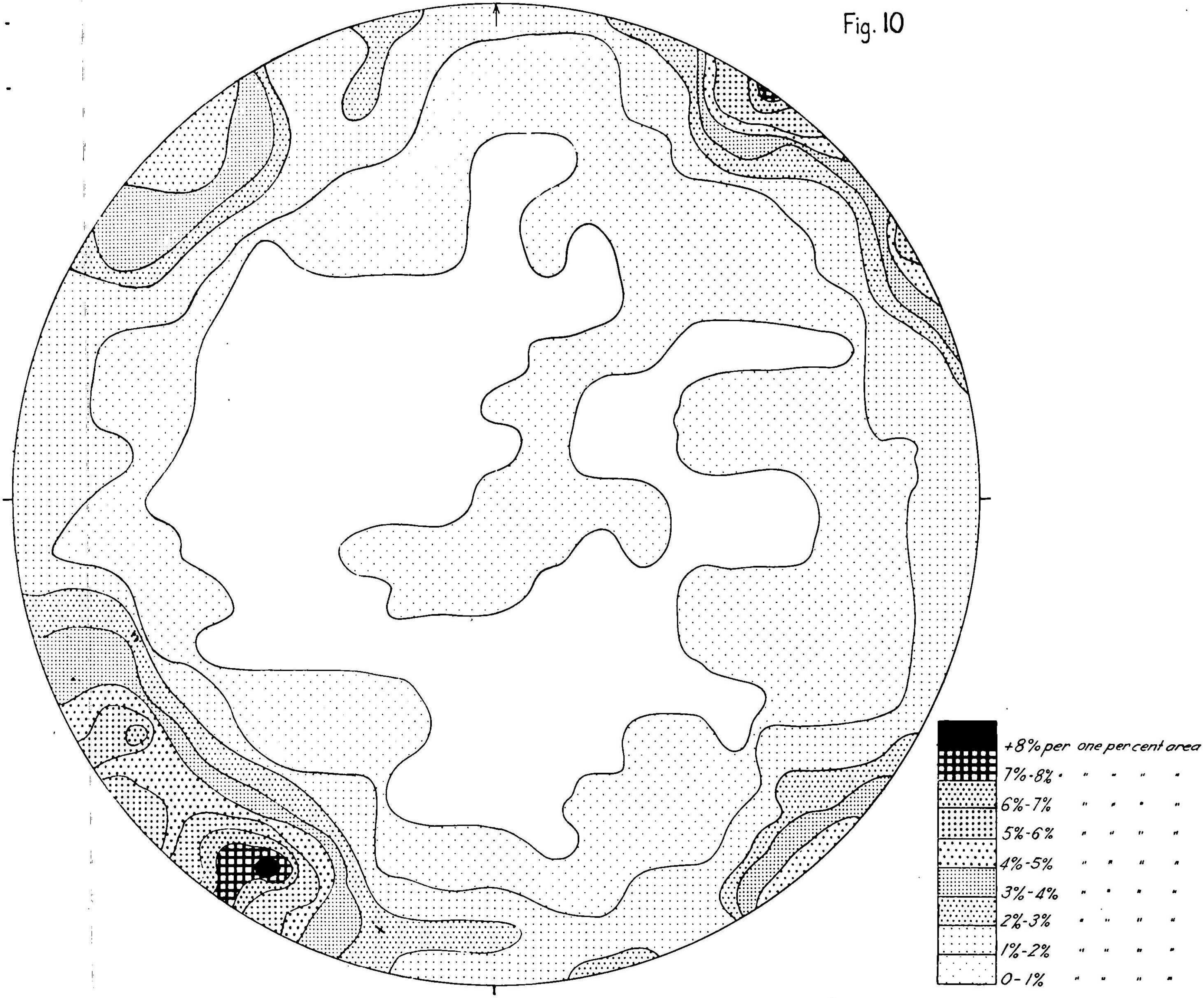
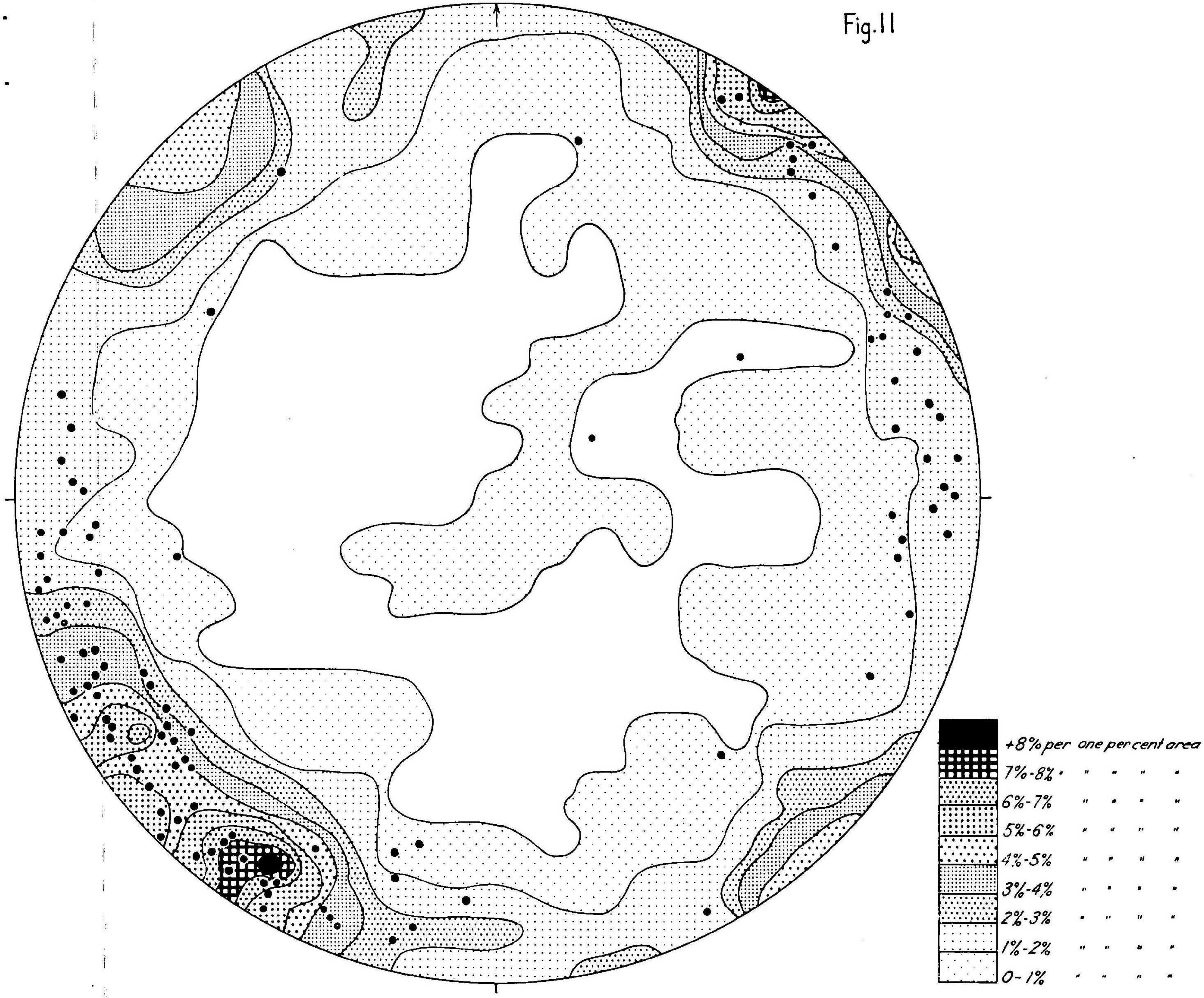
* This history is compiled mainly from the Annual Reports of the Queensland Department of Mines.

Fig. 10



Contoured plot of poles to unmineralized joints 486 pts. including greisenized joints
Maximum 8%. Contoured at one per cent per cent interval

Fig. 11



Plot of poles to mineralized joints (•)

104 Pts. superposed on contoured plot of poles to unmineralized joints

Bureau of Mineral Resources Geology and Geophysics April 1963 To accompany record No 77 E55/5/21

Lode-tin mining has been spasmodic (Fig.12), and production has depended mainly on the price of tin and the availability of treatment facilities. After the initial discoveries around Coolgarra and Glenlinedale early in the 1880's, development was delayed until batteries were built, and then further delays occurred while initial treatment plant difficulties were being corrected. Batteries began crushing at Coolgarra in 1884, and at Glenlinedale in 1887, but by 1891 both batteries were idle. Lode-tin production virtually ceased because of the high cost of transporting ore to other batteries, and, in addition, the grade of ore at Glenlinedale fell below economic limits.

The greatest boom in the history of the field began in 1898 when the Mount Garnet Freehold Copper and Silver Mining Company began opening up the Mount Garnet Copper Mines, and started construction of a smelter at Mount Garnet. Construction of a railway line to connect Mount Garnet with the Chillagoe line at Lappa Junction was approved in 1900, and the line was completed in 1902. These developments brought many people to the field, and in 1901 Mount Garnet had a population of about 2000. Unfortunately the mine and smelter were forced to close down during 1903, after only three years of operation, because of financial difficulties. However, the field had been opened up, and new discoveries, among which was the Smith's Creek lode at Nymbool, were made. The Smith's Creek Mine operated from 1903 to 1909, and was by far the most productive lode-tin mine in the area (see Table 5). The mines in the Coolgarra - Brownville area were also active during this period. The first recorded production of wolfram was in 1904, and wolfram and bismuth were mined at The Glen mines from 1910 till 1920. Production of wolfram for the whole field was small, and amounts to about 242 tons of concentrates. An attempt was made to work alluvial cassiterite in Glutton Gully in 1906 by hydraulicking, but it proved unsuccessful, and work ceased in 1908.

There was little activity in the Mount Garnet area between 1910 and 1930. Efforts were made to re-open the Mount Garnet Copper Mine in 1915-16 and in 1926, but were unsuccessful. Towards the end of this period three important developments took place: a dredge was constructed to work the alluvial deposits in Return Creek; Oakey Creek Tin Mines N.L. was formed in 1929 to work a group of small mines in the Brownville-Coolgarra area; and the Nettle Creek Company was formed to sluice alluvial cassiterite deposits in Nettle Creek. Shortage of water restricted the alluvial projects, and the dredge proved unsatisfactory. The Nettle Creek Company continued operations until 1941, when it was taken over by the Broken Hill Proprietary Company Ltd. The Oakey Creek Company built a battery and dam at Brownville in 1931, and operated successfully until 1937, when the company went into liquidation. However, the Brownville Battery remained, and it is still in use today.

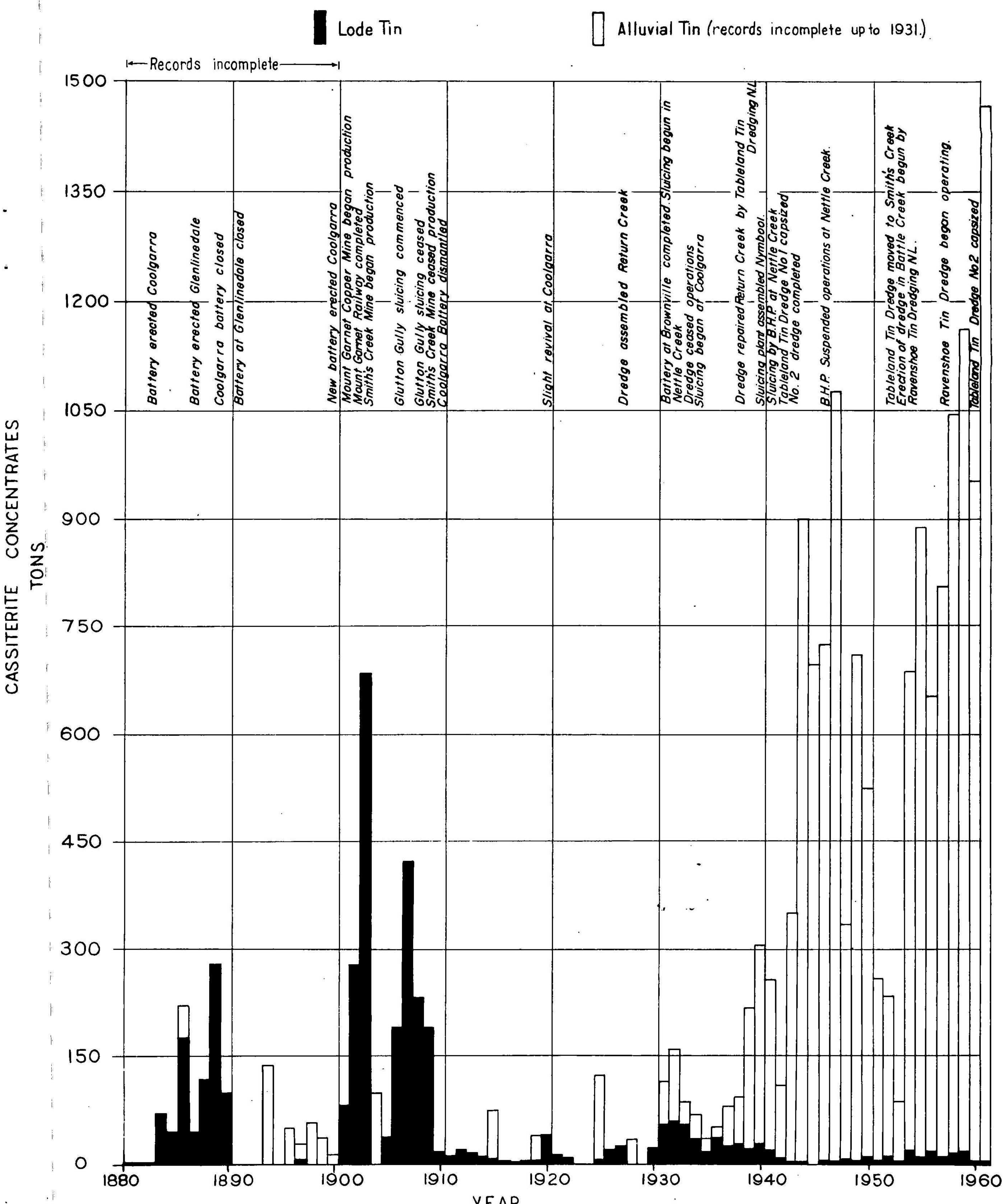
In addition to the events listed above, the period 1930-40 saw the start of large-scale alluvial mining in the area. After some test drilling had been carried out in Return Creek, Tableland Tin Dredging N.L. was formed in 1937. This company rehabilitated the old Return Creek dredge, and resumed operations in the same locality in 1939. The company also constructed a 1500 kilowatt powerhouse at Mount Garnet, and increased the capacity of the dam on Return Creek. The Coolgarra Sluicing Company was formed in 1933, and it operated intermittently until 1940. The B.H.P. Company carried out test drilling in Nettle and Battle Creeks from 1935 onwards, and this led to alluvial mining in these areas, and the ultimate takeover of the Nettle Creek Company in 1941. Hydraulic sluicing was also begun in Surprise Gully, near Nymbool, in 1940, and this continued intermittently until 1962. Some gold was mined near Mount Garnet during 1933-34, but total production was small.

The period 1940-1950, including World War II, saw a substantial increase in alluvial productivity owing to dredging, and a general decline in lode-mining activity. Tableland Tin completed construction of a new dredge in 1943; this replaced the old Return Creek dredge which capsized in a flood early in 1942. The new dredge greatly increased production, and it operated successfully in Return Creek until 1952, when a dispute

Fig 12.

HISTOGRAM SHOWING TIN PRODUCTION

MOUNT GARNET (Excluding Gurrumba Mines)



Bureau of Mineral Resources, Geology and Geophysics May 63 To accompany record No. 77

E55/5/43 J.L.Mc

over land near Mount Garnet caused the dredge to be dismantled and re-erected on Smith's (Black's) Creek where it is still operating. The production of the dredge completely overshadowed the shut-down of the B.H.P. Company's sluicing plant on Nettle Creek in 1946. World War II and the Korean War created a demand for wolfram which led to some activity at the few wolfram localities in the area. The Enterprise Exploration Company Pty. Ltd. investigated and drilled the Mount Garnet Copper Mine in 1947, and they also examined a zinc prospect at Bald Hill, east of Nymbool, from 1947-1949. However, both prospects were subsequently abandoned.

The period 1953-1962 has been the heyday of dredging at Mount Garnet. Ravenshoe Tin Dredging Ltd was founded in 1953 to work deposits in Battle Creek and Nettle Creek, and it commenced operations in the former area in 1957, soon after hydro-electric power from the Tully Falls project became available at Mount Garnet. The last recorded production of wolfram was in 1955, but lode-tin mining continued on a small scale. Metals Exploration Ltd. and New Consolidated Gold Fields (A/asia) Pty. Ltd. prospected in the area in 1956 and 1957-59, respectively, and the former company drilled one hole at the Mount Garnet Copper Mine. No developmental work resulted from this prospecting. Tableland Tin Dredging received a setback in 1960, when its dredge partly capsized, and was idle for eight months. Further, during the very dry winter of 1962 this company had difficulty in maintaining an adequate supply of fresh water to the dredge pond, so that the specific gravity of the pond water rose, and thereby lowered recovery of cassiterite.

The economic minerals and the more important mines of the area are discussed below.

PRIMARY DEPOSITS

Tin:

Tin is widely distributed in the Mount Garnet area. It occurs as the oxide, cassiterite, disseminated sporadically in elongate, steeply dipping lodes and in areas of massive greisen. The tin is genetically related to the Elizabeth Creek Granite, and the lodes are confined to zones of pneumatolytic alteration along, and adjacent to, joints or faults situated either in the roof zone of this tin-bearing granite, or in intruded rocks close to the granite contact. Most of the latter occurrences are in the Mount Garnet Formation, especially in the Coolgarra - Brownville area, although isolated lodes are known in the Ringrose Formation, e.g., Alhambra and Never-Can-Tell Mines; in Herbert River Granite, e.g., Smith's Creek Mine; and in the Montalbion Sandstone, e.g., Captain Mine. A definite structural control is evident because nearly all of the elongate lodes trend between north-west and north. No lithological control has been identified.

The lack of comprehensive descriptions of the deeper, now inaccessible workings of the area limits knowledge of the form of the tin orebodies. However, the mine workings apparently are located in near-surface lenses or pipe-like bodies within the lodes or within areas of massive greisen. Some of the mines - e.g., the Alhambra - have reached sulphide at depth. The presence of chalcopyrite and pyrite suggests that stannite may also be present in sulphide zone, even though the grade of tin is reputed to have decreased with depth.

The various types of tin deposits in the area are classified and briefly described below.

Chlorite lodes. This type occurs only in rocks intruded by Elizabeth Creek Granite, and it accounts for most of the lode production from the area. Three good examples of this type of lode are the Smith's Creek, Alhambra, and Extended Mines.

Chlorite lodes in the Brownville - Coolgarra area crop out as dark, iron-rich and/or siliceous, massive veins, and they are commonly identificable on airphotos because of a slightly more dense line of trees along the lodes. In old workings the characteristic lode colour is dark red, due to iron oxide. Vein quartz is rare but it does occur as thin stringers and knots, most of which contain some cassiterite crystals. Kaolin is a common associate of chlorite in the oxidised zone, e.g. at the Summer Hill Mine. Microscopic examination of fresh ore samples of chlorite lodes from the Smith's Creek Mine showed an approximate composition of 70 percent chlorite, 25 percent calcite, and 5 percent quartz. The grainsize of the cassiterite ranges from 0.2 to 1 mm., and averages 0.25 mm. Two sections of weathered chlorite lodes from near Coolgarra contain up to 80 percent chlorite and about 20 percent quartz. Cassiterite grains in these rocks range from 0.05 to 0.2 mm. and the average is less than 0.1 mm. The fine grainsize of the cassiterite in the chlorite lodes causes problems in the treatment of the ore.

Greisen lodes. Most of the greisen lodes occur within the Elizabeth Creek Granite, and have been described earlier in this report. Some of the narrow, steeply dipping greisen lodes are continuous for a mile or more along the strike. The greisen consists essentially of quartz and lithium-bearing mica, and the larger greisen lodes commonly have a quartz core. Cassiterite occurs disseminated or in clusters within the greisens or in the central quartz cores; the largest cassiterite grains (up to a quarter inch (7 mm.) in diameter) are found in these cores. Coarse cassiterite is also found on joint planes in the greisen. The most common accessory minerals are wolframite, topaz, and fluorite. The Harbour Light Mine is a good example of a greisen lode having a prominent quartz core, and the Croesus and Main Divide Mines are examples of greisen lodes without quartz cores. In general, mines in greisen are small, but only the rich shoots have been mined, and there is a possibility that some of the greisen lodes are suited to low-grade large-tonnage mining.

Massive greisens. These are restricted to roof-zones of the granite (Fig. 8) - e.g., at Geebung Hill and the ridge south of Mount Gibson. Several small shafts and pits have been dug in the greisen at both these localities, but the total production of tin has been small. These deposits may have potential as large-tonnage low-grade producers, but will require extensive testing owing to the sporadic distribution of the cassiterite. Thin sections of greisen from Geebung Hill showed cassiterite grains ranging in size from 0.05 to 0.5 mm.; their average size was 0.1 mm. Other areas of massive greisen occur north of Coolgarra, but they have not yet been mapped in detail.

Quartz - cassiterite lodes in sediments. This lode type does not include quartz veins or lenses in greisen, such as occur near Mount Gibson.

Some of the quartz lodes are large continuous veins consisting of coarse-grained, vuggy quartz containing coarse, euhedral cassiterite crystals - e.g., the Captain and Never-Can-Tell Mines. The Snake Mine is a small irregular vein which contained abundant coarse cassiterite. On the whole production from quartz-cassiterite lodes has been small, and the Captain Mine is by far the largest producer.

The General Gordon Mine at Glenlinedale, which was not examined during this survey, is described by Dimmick and Cordwell (1959) as a quartz-tourmaline lode in sediments with cassiterite most abundant in the tourmaline-rich sections of the lode.

Lodes associated with aplitic granite. Cassiterite occurs in joints in aplitic granite at the Surprise Mine, and associated with aplite dykes and greisen at the Dingo Mine. This type of lode is commonly small, and is relatively common in the north-eastern part of the area; greisen is present in most cases. The Dingo Mine is probably the largest producer of this type.

Pebbles and boulders of cassiterite have been found on the slopes of Mount Garnet, although no tin lodes have been worked in this area. This mineralization may be in acid volcanics.

Tin lodes which have a total recorded production of more than 60 tons of SnO_2 concentrates are briefly described below.

TABLE 5

Production of Major Tin Mines - Mount Garnet Area

Mine	Ore (tons)	Cassiterite Concentrates (tons)	Recovery Grade % SnO_2.
Smith's Creek	61,779	1,514	2.4
Alhambra Nos. 1 & 2	22,827	453	2.0
Extended	?	At least 180	6-8
Excelsior	11,309	171	1.5
Victoria	450	140	31.1
Captain	512	63	12.3
John Bull	450	52	11.6
Dalcouth	2,748	51	1.9
Excellent	2,261	34	1.5
White Elephant	2,225	31	1.4
Miracle	840	27	3.2
Jimbilly	529	22	4.2
Summer Hill	1,969	22	1.1

Note: Production figures for some of the mines - e.g., Victoria John Bull, Magdala - are incomplete.

Principal Tin Mines:

Smith's Creek Mine: This mine was discovered in 1901, and was opened in 1902 by the Smith's Creek Proprietary Company. Peak production was in 1903, when 18,674 tons of ore were mined for a yield of 585 tons of cassiterite concentrates. Mining operations ceased in 1909 when the main shaft had reached a depth of 500 feet, and the orebody had been mined at five levels. Prospecting by diamond drilling was successful in 1904, but no ore of mineable grade was found when further drilling was carried out in 1909. Although records are inconsistent, it seems that the lode had a strike of 120°, a width of 30 to 40 feet, and a probable maximum length of 240 feet at the 300 foot level. Faulting apparently determined the ore limits at the 200 and 300 foot levels.

The ore consists predominantly of massive dark green chlorite and calcite containing cassiterite and minor quartz, muscovite, and sulphide minerals. The chlorite is strongly pleochroic from bright olive-green to pale yellow, and has an average grainsize of 0.2 mm. Calcite is almost entirely segregated from chlorite in areas up to 8mm. in diameter, and most of the cassiterite occurs within these areas. The grainsize of the cassiterite ranges from 0.2 mm. to 1 mm., and averages 0.25 mm. in the thin sections examined. Curved twin planes within the calcite provide evidence of post-ore deformation.

The country rock is a poorly outcropping biotite adamellite which forms part of the Herbert River Granite; the lode also crops out poorly. A large amount of both eluvial and alluvial tin has been shed by the ore-body, and this provided most of the tin in the rich alluvial deposits in Surprise Creek. In 1904, the area of eluvial material surrounding the mine was sluiced, and yielded almost 105 tons of cassiterite concentrates.

Alhambra Mine: First recorded work at this mine was in 1886 when a tunnel was driven 300 feet to intersect the lode, but the mine did not become an important producer until 1901, when a battery was erected at Coolgarra by the Coolgarra Tin Company. The mine was closed down in 1908. Small parcels of ore were produced in 1915, 1927, and 1933.

Workings consist of an open cut and two shafts, one of which is connected to an adit at the 110 foot level. Most of the ore was extracted from the open cut which extends from this level to the surface. The mine reached a total depth of 395 feet, and dump material suggests that it bottomed on sulphide-bearing ore within Elizabeth Creek Granite. The lode strikes 335°, and dips steeply to the east. It consists predominantly of red, massive, weathered chlorite and quartz containing shoots of cassiterite. From the 200 foot level to the 355 foot level the ore was rich in native bismuthinite, and contained variable amounts of pyrite, wolframite, and lead and copper minerals. The grade of tin was low in the sulphide section of the orebody.

The country rock is massive, fine-grained sandstone and siltstone of the Ringrose Formation. The ore has been localized along shears and at shear intersections in these sediments.

The workings at the Magdala Mine, to the north of the Alhambra Mine, consist of an adit, and a shaft which is vertical for 50 feet before underlying to the north. The ore occurrence is similar to that at the Alhambra Mine, and Maitland (1891) records a production of 130 tons of cassiterite.

The Bolivia, John Bull, and Victoria Mines are situated east of the Magdala Mine, and they apparently were important producers in the early days of the field. The lodes consist of quartz cores in greisen at the contact of the Elizabeth Creek Granite. Mining seems to have been selective. The following production figures are quoted by Maitland (1891).

John Bull Mine:	52 tons of cassiterite concentrates from 450 tons of ore (i.e., about 11.6% SnO_2).
Victoria Mine:	140 tons of cassiterite concentrates from 450 tons of ore (i.e., about 31.1% SnO_2).

Extended Mine: The first recorded production from the Extended Mine was in 1885. In 1886 most of the ore crushed by the Coolgarra battery came from the Extended, and 172.4 tons of cassiterite concentrates were obtained from 2,211.5 tons of ore - an average recovery grade of 7.8% SnO_2. No other record of activity at this mine was found. It is being worked at present by A. R. Dunmall, of Brownville. The lode is vertical, strikes at 105°, and has been mined from two shafts to a depth of 160 feet over a width of 10 feet. The ore is bright red, dense, weathered chlorite which contains leaders of quartz and cassiterite, and seams of creamy white kaolin, some of which are very rich in cassiterite. Small amounts of fluorite occur within the lode, and pyrite is present within the surrounding interbedded greywacke and siltstone.

Excelsior: This mine began production in 1906 after being purchased by the Irvinebank Company. Work ceased in 1908, and it was not until 1929, when the lease was taken up by Oakey Creek Tin Mines N.L., that the mine became a significant producer. Mining continued intermittently until 1960.

Workings consist of an open cut about 80 feet long and 40 feet wide; a main shaft, 130 feet deep, north-east of the open cut; levels at 77 feet, 86 feet, and 130 feet; and a cross-cut at 77 feet, connected with the open cut. There are also two small shafts east of the open cut. The levels and the cross-cut were excavated mainly to prospect beneath the open cut, which bottomed on a fissure dipping 15 degrees across the cut at a depth of 60 feet. Tin values are reported to have been negligible below this fissure.

The mineralization appears to have been controlled by a system of closely spaced, vertical, north-westerly trending fractures which localized chlorite-tourmaline lode material containing some cassiterite. Ore and altered siltstone and greywacke were apparently extracted over the full width of the open cut.

Captain: This mine was worked continuously from 1908 to 1919, and intermittently in 1930, 1936, and 1942. The main shaft reached a depth of about 200 feet, and it is said to be connected underground to another vertical shaft located 130 feet farther west. Ore is confined to two narrow quartz veins striking at 90° and 115°, respectively, and located along fractures in Montalbion Sandstone. Dimmick & Cordwell (1959) note that the "main production has been won from a pipe of chloritic lode near the projected intersection of the quartz veins".

The mines at Glenlinedale, in the headwaters of Glen Creek, were not visited during the 1962 season, and are therefore not shown on the accompanying map. In the period 1888 to 1890 the General Gordon Mine in this area produced 479 tons of cassiterite concentrates from 7,902 tons of ore - an average grade of 6.1 percent SnO_2.

Tungsten (Wolframite).

Minor tungsten mineralization is widespread throughout the Mount Garnet area. It occurs mainly as wolframite, although scheelite is known at some localities, e.g., near Top Nettle Camp. Production records are incomplete; they show a total of 242 tons of wolframite concentrates for the period 1900-1955, but production before or after this period has not been recorded. Nearly all deposits are small and of low overall grade. Most of the mining has been selective.

Wolframite-bearing lodes occur either eithin the Elizabeth Creek Granite or close to its contacts. Some of the tin and copper mines also carry small amounts of wolframite, e.g., Dawn Mine (Sn), Mount Fairy Mine (Cu).

The types of wolframite-bearing lodes are as follows:-

(1) Narrow topaz veins with quartz, wolframite, bismuthinite, arsenopyrite, fluorite, and chalcopyrite occurring along horizontal joints in Elizabeth Creek Granite and its greisenized equivalent. The veins at The Glen mines are the only examples. This type of ore is of more uniform grade than any of the other varieties.

(2) Zoned greisen lodes in granite, consisting of a narrow outer zone of quartz-mica greisen, an intermediate zone of coarse, dark brown, lithium-bearing mica, and a central zone of quartz and fluorite. Coarse wolframite, and, in some lodes, molybdenite, is distributed sporadically in the central zone. Minor amounts of these two minerals may occur also in the innermost part of the intermediate zone. Associated accessory minerals include tourmaline, monazite, hematite, beryl, uranium minerals and primary sulphides; e.g., Devon Mine, Treasure Mine, Midnight Mine.

(3) Quartz veins in greinsenized granite. Wolframite occurs within the quartz with or without fluorite, topaz, pyrite, and arsenopyrite; e.g., ¼ mile north of Devon Mine.

(4) Quartz-wolframite-molybdenite veins or pipes localized in small shear-zones transecting sediments close to granite contacts; e.g., east of Fingertown Mine, Butler Gully, Dreadnought Gully.

(5) Some quartz-muscovite veins carry wolframite. There is little or no wall-rock alteration associated with this type.

(6) Large low-grade quartz-fluorite-wolframite lodes in sediments. The Fingertown Mine is the only known example of this type.

The more important of the tungsten mines are discussed below.

The Glen mines: Wolframite-bismuth ore was discovered on Glen Creek in 1910. Records of the Herberton Mineral Field show continuous production of tungsten-bismuth concentrates from 1910 until 1920, and smaller amounts in 1948, 1952, and 1953. Assuming that The Glen mines were the sole producer of this type of ore in the period 1910-1920, total production is 102 tons of mixed wolframite-bismuthinite concentrates.

The ore contains wolframite, bismuthinite, arsenopyrite, and chalcopyrite occurring as small crystals distributed in a gangue of fine-grained topaz, quartz, and fluorite. The veins, which are up to three feet thick, are localized along horizontal joints in biotite granite and its greisenized equivalent. These veins occur in at least two zones within the hill. Ore was mined mainly by gouging laterally from adits.

Fingertown Mine: This mine was first mentioned in reports in 1914. However, no records of production were published until 1942. Between 1942 and 1955 22 tons of wolframite concentrates were produced, mainly from dump material.

Wolframite occurs as scattered crystals up to one inch across, evenly but sparsely distributed throughout a gangue of quartz and green or mauve fluorite. The lode strikes 285° and dips steeply southwards, and has been mined over a width of up to 20 feet in open cuts 10 to 15 feet deep over a length of about 250 feet. There is a small shaft at the eastern end of the open cut. Production records and observations within the open cut indicate that the ore was low-grade. The country rock is silicified, grey, fine-grained greywacke which is exposed about 600 feet south of its contact with the Elizabeth Creek Granite.

Griffin Mine: In 1908, Wm. Griffin marketed a parcel of wolframite presumably extracted from this mine. First use of the above name was in 1911. Last recorded work was in 1953. Reports of production are incomplete, but 14 tons of wolframite concentrate are reported to have been produced from 1908 to 1953.

The workings consist of two shafts and a small open cut. The main shaft is reported to have been 180 feet deep, and at the bottom of the shaft the lode was 9 feet wide, and carried some wolframite. The lode strikes 170° and dips east at 72°. Wolframite occurred in rich pods with quartz and fluorite, and in the deeper parts of the mine it was associated with scheelite, molybdenite, bismuth, malachite, azurite, and massive and banded pyrite. Some coarse muscovite is associated with the quartz and fluorite, and coarse cassiterite was found with some of this mica.

Devon Mine: This is probably the oldest wolframite mine in the area. Production records are very incomplete, and the only recorded production was in 1908 when 4½ tons of wolframite concentrate were extracted. In 1915 and 1916 an attempt was made to rehabilitate the mine.

Numerous small workings are situated on a lode striking 155°. The main workings comprise a shaft 140 feet deep and an open cut 15 feet long and 12 to 15 feet deep. The width of the lode ranged from 3 to 4 feet at the surface, but it widened rapidly in depth. The country rock is slightly porphyritic, coarse-grained biotite granite which is altered to a zone of greisen one to two feet thick on either side of the lode. The greinsen grades into a rock consisting almost entirely of dark brown to black lithium-bearing mica (specimens J187, J189, Table 3) in flakes ranging from $\frac{1}{8}$ to $\frac{1}{4}$ inch across. Towards the centre of the vein this mica becomes coarser, and flakes have a maximum diameter of two to three inches. The central zone consists of massive quartz and fluorite containing wolframite, molybdenite, and monazite. Tourmaline and pyrite occur locally. The wolframite is coarse-grained, and is confined to the central quartzose zone and the inner micaceous zone.

A mine on a lode mineralogically similar to the Devon occurs on a hill 1.2 mines west-south-west of Top Nettle Camp. This may be the Granite Knob Mine referred to in records from 1917 to 1919 as producing 45 tons of wolfram. Tourmaline and a small rosette of beryl crystals were noted at this mine during the 1962 mapping.

Copper:

This metal is widely distributed throughout the Mount Garnet area, but the only deposit of importance is at the Mount Garnet copper mine. Copper is found within the Elizabeth Creek Granite and in all formations which it intruded. Traces of copper mineralization also occur in the small Precambrian inlier at Mount Garnet.

The following types of deposits have been recognised:

(1) The largest deposits are found where faults or granite intersect calc-silicate rocks of the Mount Garnet Formation, e.g., Mount Garnet Copper Mine; 1.7 miles south of the Wild-Dry River junction; and near Ironstone Hill, south-east of Mount Garnet. This mineralization is localised by calcareous rocks.

(2) Narrow, discontinuous lodes confined to small shear-zones within the greywacke-siltstone belt in the Brownville-Coolgarra area, e.g., Mount Fairy, Mount Cadiff. Lead and zinc minerals may be present as minor or major constituents of this ore type - e.g., Brilliant Mine and Tucker's Mine.

(3) Small veins confined to joints or shear-zones in the Elizabeth Creek Granite, e.g., Copper Gully, north of Fingertown Mine; 2 miles north-north-east of Nymbool; and north of Mulligan's Gully. Arsenopyrite is a common associate of this type. Wolframite may be a minor or a dominant constituent of such veins, e.g., at Geebung Hill, The Glen mines.

(4) Chalcopyrite in association with other base metal sulphides in the deeper parts of large chloritic tin lodes, e.g., Alhambra Mine. Type 2 may represent a deeply eroded equivalent of chloritic tin lodes.

(5) Small amounts of copper in wolframite-bearing quartz veins in sediments adjacent to the granite contacts, e.g., Griffin Mine, Butler Gully Mine, and a mine about 1.5 miles south-west of Top Nettle Camp.

In recent years there has been a tendency to regard the Herbert River Granite as the parent of much of the copper mineralization in North Queensland, e.g., in the Chillagoe area, but most, if not all, of the occurrences listed above are genetically related to the Elizabeth Creek Granite. The genetic relationships of the copper at the Mount Garnet Copper Mine are uncertain.

Mount Garnet Copper Mine: Copper was discovered at Mount Garnet in 1883, but it was not until 1898, when the area was taken up by the Mount Garnet Freehold Copper and Silver Mining Company that any large-scale mining commenced. A smelter was completed in 1900, and from February, 1901, to 1903, 89,896 tons of secondary ore were smelted to a matte containing 4,415 tons of copper and 948,651 oz. of silver. This corresponds to a recovery grade of 4.9 percent copper and 10.7 oz. of silver per ton. The mine was leased to the New Chillagoe Company from 1903 to 1904, and in 1904 9,124 tons of ore were sent to Chillagoe for treatment. At this stage the bottom levels of the mine had revealed an orebody rich in zinc, and the property ceased to be of economic interest.

An effort was made to rehabilitate the mine from 1915 to 1916 using funds from the sale of the Mount Garnet railway to the State Government, and "some hundred tons" of zinc-rich ore were extracted; however, there is no record of this ore having been sold.

In 1926, at least six parties of tributers worked the Mount Garnet Copper Mine, and a total of 966.65 tons of silver-lead ore containing some copper was sent to the Chillagoe smelters.

Diamond drilling of the deposits was carried out in 1948 by Enterprise Exploration Company Pty. Ltd., and again in 1956 by Metals Exploration N.L.

The orebodies consist of copper, lead, and zinc minerals concentrated within a prominent vertical fault zone striking at 005°. This zone can be traced on the surface for at least 250 feet, and the width of the iron-rich outcrop at the surface ranged from 20 to 200 feet. Carbonate ore has been mined from open cuts, the largest of which is 60 feet deep and 200 feet long. A winze is recorded as reaching a total vertical depth of 220 feet. The ore occurs in lenses or pipe-like bodies within garnet-rich calc-silicate hornfelses of the Mount Garnet Formation, and the primary mineralization within these rocks consists predominantly of chalcopyrite, sphalerite, pyrrhotite, and pyrite extending over widths exceeding 100 feet. No record of the presence of galena in the Mount Garnet Copper Mine was found in the reports consulted, but galena is presumed to be present because of the record of silver-lead ore produced in 1926, and the naming of the Northern "Lead" Lens.

At least three distinct lenses of ore are recognisable along the line of lode. Two of these lenses have been mined, namely the Northern "Lead" Lens (Dimmick and Cordwell, 1959) and the Central Lens, which received most attention.

The only other copper mine with any recorded production, Mount Fairy, produced 94 tons of ore in 1893. Smelting of this ore produced 19 tons of copper metal. At this mine two shafts have been sunk on a lode trending 325° and dipping west at 80°. The ore consists of malachite and azurite associated with coarse-grained wolframite in a narrow, brecciated quartz vein. Scheelite is reported in the ore at the bottom of the main shaft.

<u>Silver-Lead:</u>

Within the area mapped, silver-lead mineralization has been recorded at the following localities:

1. Along the east and west banks of Rankin Creek near the Brownville road, from the Miracle mine south to the Return Creek crossing - e.g., Kohinoor, Tank, Brilliant, and Tucker's Mines.

2. The Chinaman Mine, adjacent to the Palmerston Highway 3.3 miles by road east of Mount Garnet.

3. A north-westerly trending line of lode extending from the bank of Return Creek, 1.2 miles east-north-east of the Return Creek crossing on the Brownville road, to north of the Federal Mine.

4. Near the crossing over Five Mile Creek immediately north of the Coolgarra road, and about 250 yards east of the creek.

5. In the headwaters of a tributary of Return Creek, 2.3 miles east of the Return Creek crossing on the Brownville road.

6. In the headwaters of Battle Creek, 0.8 miles south-south-east of (5).

7. Immediately east of the Coolgarra road, 5 miles by road north-east of Mount Garnet.

8. In minor amounts at the Bald Hill Prospect, 4 miles north-west of Mount Garnet.

9. In the sulphide zones in the lower levels of some of the larger tin mines, e.g., Excellent, Dreadnought, and Bolivia Mines.

(10. In the Mount Garnet Copper Mine (see above).)

None of these occurrences are of economic importance. Production figures for silver-lead ore are sparse, except for the Mount Garnet Copper Mine. The only other known records of production are for the Kohinoor Mine (see below) and the Tank Mine. Figures for the Tank record the sale of 50.5 tons of ore between 1917 and 1920; a parcel of ore despatched in 1920 averaged 64 percent lead and 111 oz. of silver per ton.

The mineralization at all these occurrences has been localized in small shear-zones within sediments of the Mount Garnet Formation. At the Mount Garnet Copper Mine there has been a lithological control in conjunction with a structural control. At this mine and at the Bald Hill prospect, the mineralization is confined to limestone and calc-silicate rocks which were more susceptible to replacement than the associated greywacke and siltstone.

Most of the ore mined has come from the oxidized zone, the minerals present being cerussite, anglesite, pyromorphite, malachite, azurite, and a greenish-yellow earthy mineral identified as beudantite or corkite (hydrated iron-lead arsenate or phosphate with sulphate) by X-Ray analysis (W. M. B. Roberts, pers. comm.). Small amounts of galena are exposed at the Kohinoor Mine, and a narrow, gently dipping vein at the Brilliant Mine shows galena, sphalerite, chalcopyrite, and pyrite cropping out at the surface.

Most occurrences of silver, lead, and zinc in the map area are situated close to, and outside the margins of, areas of Middle and Upper Carboniferous acid volcanics.

Kohinoor Mine: This mine is situated 1¼ miles south-west of Brownville, and was opened in 1883. It is recorded as producing ore in 1888 and 1889. No production figures are available, but Maitland (1891) states that 11 tons of ore yielded 40 percent lead and 94 oz. of silver per ton, and that some of the galena assayed 500 oz. of silver per ton.

The mineralization occurs in greywacke along a 600-foot section of a fault which strikes 105°, and is recognisable over a distance of at least half a mile. Cerussite, pyromorphite, anglesite, galena, and quartz occur within the fault-zone. The lode is almost vertical, and the workings consist of seven shafts and pits and one adit. The deepest shaft is 60 feet, and the width of the mineralized zone ranges from 3 to 8 feet.

Zinc:

Zinc mineralization is sparse in the Mount Garnet area, and it is known only at:

1. Mount Garnet Copper mine;

2. Bald Hill Prospect, 4 miles north-west of Mount Garnet;

3. Brilliant Mine, as small amounts of sphalerite in associated with other sulphides, and

4. in the deeper tin mines, where minor quantities of sphalerite occur in the sulphide zone, e.g., Excellent Mine, Dreadnought Mine.

Bald Hill Prospect: This prospect was tested by Enterprise Exploration Co. Pty. Ltd. during 1948-1949, and reported on by Bacon (1949). The deposit had been tested earlier by a 90 foot shaft. Light to dark-brown, coarse-grained sphalerite, galena, and minor chalcopyrite and pyrite have selectively replaced coarse calcareous conglomerate and marble of the Mount Garnet Formation close to its contact with an outlier of Carboniferous acid volcanics. No visible structural control of mineralization is apparent.

Mount Garnet Copper Mine: The geology of this mine has been discussed in the section on copper.

Molybdenum:

Small amounts of molybdenite are present in almost all wolframite mines. The mineral occurs in the quartz cores of zoned wolframite lodes within the Elizabeth Creek Granite, e.g., at the Treasure Mine and the Devon Mine, and in the smaller quartz-wolframite lodes within sediments adjacent to granite contacts, e.g., east of the Fingertown Mine.

There is no recorded production of molybdenite from the area.

Bismuth:

Bismuth concentrates have been won from The Glen mines and Alhambra Mine. In 1908 about 6 cwt. of bismuth concentrates were produced at the Alhambra Mine, and wolframite-bismuth concentrates were extracted from mines at The Glen from 1910 to 1920, and in 1948, 1952, and 1953.

Gold:

Gold has been mined at only one locality within the map area. The Golden Prospect Mine, ½ mile north-east of Mount Garnet, produced 185.37 oz. of gold and 217.47 oz. of silver from 247.25 tons of ore between 1932 and 1934. The average recovery grade of the ore was, therefore, 15 dwt. of gold and 17.6 dwt. of silver per ton.

The gold is confined to a zone whose width ranges up to 4 feet. This zone contained numerous narrow quartz veinlets intersecting contorted Precambrian cream quartzite and mica schist. Some of these veinlets contain pyrite and arsenopyrite. The ore-bearing zone is conformable with the enclosing rocks which strike north. The main shaft was sunk to a depth of 150 feet; small levels were put in at 34 feet and 65 feet, but no production is recorded below 90 feet. Several small shafts and costeans have been excavated along the line of lode.

Antimony:

At the headwaters of a tributary of Sailor's Creek, 2½ miles south-west of the Wild-Dry River junction, stibnite occurs as aggregates of long, bladed crystals within a quartz-cemented brecciated zone, which trends 175° in strongly foliated granite. A shaft has been sunk on this zone. This may be the Zig-Zag Mine, which in 1951 produced 3.9 tons of 51.7 percent ore and 4.9 tons of 54.4 percent ore.

Iron:

There is no recorded production of iron ore from the area. However, small contact deposits of hematite crop out 1½ and 5½ miles south-west of Mount Garnet, at Mount Ruby near the Wild River, in the tributary of Battle Creek south of Bowden's Gully, and in the tributary of the Wild River south of German Gully. All are localized at the contact of Elizabeth Creek Granite and calcareous rocks of the Mount Garnet Formation.

Fluorite:

Small veins composed almost entirely of fluorite, or quartz and fluorite, occur immediately west of the Northern Inland Highway 3.8 and 6.3 miles south-west of Mount Garnet, and one mile north-west of Brownville.

Fluorite is a common accessory mineral in the cassiterite-bearing greisen lodes in the Wild River area, and it may be quite abundant in some wolframite lodes within the Elizabeth Creek Granite.

Other Minerals:

Small quantities of radioactive minerals occur in the coarse, dark brown mica-wolframite-quartz lodes within the Elizabeth Creek Granite. At the Devon Mine monazite is associated with the wolframite, and at the Treasure Mine a small specimen of zeunerite was collected from the dump, and identified by X-ray analysis (G. J. G. Greaves, pers. comm.). Monazite also occurs in alluvial deposits in the area, especially in Smith's Creek.

Silicified sediments were mined half a mile south-west of Strathvale H.S. as a flux for the smelters at Mount Garnet.

Fractured yellow crystals of beryl are associated with biotite, wolframite, tourmaline, etc., at a mine 1.2 miles south-west of Top Nettle Camp.

Large crystals of colourless or milky yellow topaz occur in the central quartz cores of greisen bodies near Mount Gibson and near the Harbour Light Mine. At Petersen's Tin Lode, west of Mount Gibson, the fractured columnar topaz crystals are up to 2.5 feet, or more, long. Topaz is a common accessory mineral in the greisen-cassiterite lodes in granite west of the Wild River, and it also occurs in most of the large alluvial tin deposits in the area. Most of the topaz crystals found are fractured and colourless, and few are of good gem quality. Small zircon crystals are also found in the large alluvial deposits, and Dunstan (1913) reported corundum from Nettle Creek.

Grossularite or andradite garnet is a constituent of most calc-silicate rocks throughout the area.

Road and Building Materials:

Two miles north-west of Mount Garnet, two small quarries have been opened up in pink medium-grained Elizabeth Creek Granite, and a small quantity of hornblende granodiorite (Herbert River Granite) has been blasted at Mealing's quarry 3 miles west of Mount Garnet. It is not known for what purpose the granite was mined, but both types would probably be suitable as building stone and for facing buildings.

Small road metal quarries in lateritic soil and gravel are situated beside the Palmerston Highway $\frac{3}{4}$ mile south-east of Mount Garnet and near Ravenshoe Tin settlement.

Limestone:

The positions of outcrops of limestone and marble are noted within the Stratigraphy section of this report.

Diatomaceous Earth:

Crespin (1947) has recorded a deposit of diatomite occurring with basalt near Innot Hot Springs outside the area mapped in 1962. Her examination showed that the diatomite 'is of fairly good grade for filtration purposes'.

ALLUVIAL DEPOSITS

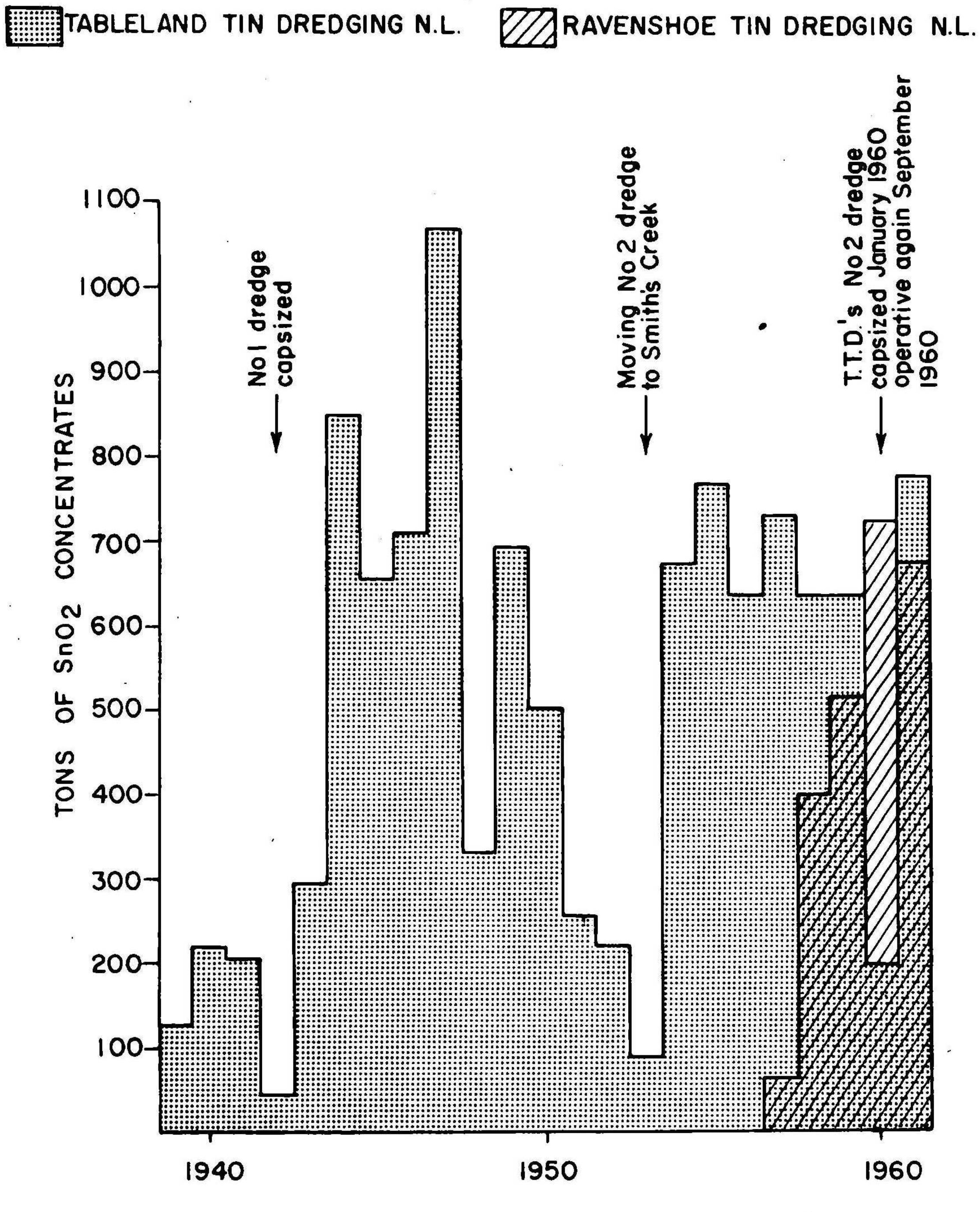
Cassiterite is the only mineral of economic importance in alluvial deposits in the Mount Garnet area. Small placers of wolframite occur in some areas, but they are not being worked. Ilmenite, zircon, and monazite are found in the tin placers; although they are separated during final cleaning up of cassiterite concentrates obtained by dredging, these minerals are not marketed. The alluvial cassiterite deposits range in size from major placers, mined by dredging or hydraulicking, to minor deposits worked by individual miners during the wet season.

Alluvial Cassiterite Deposits.

Major Deposits: The principal deposits occur in Smith's Creek, Return Creek, Battle Creek, Nettle Creek, and the Wild River area. Bucket dredging in Smith's Creek, Return Creek, and Battle Creek from 1939 - 1962 produced a total of 14,706 tons of cassiterite concentrates (Figure 13). Since Ravenshoe Tin Dredging N.L. began operations in 1957, the annual production from dredging has risen to about 1000 tons, and a peak of 1451 tons was reached in 1961. This is slightly less than half of Australia's annual production. The records of alluvial production other than by dredging are incomplete.

The sediments in the larger alluvial deposits have been described in the section on Cainozoic stratigraphy. Within these deposits the bulk of the cassiterite occurs in lenses of sand and fine to coarse conglomerate (gravel). The gradient of these payable zones ranges from about 15 to 40 feet per mile. The cassiterite-bearing lenses are scattered haphazardly

PRODUCTION OF TIN CONCENTRATES BY BUCKET DREDGING AT MOUNT GARNET SINCE 1939



through the alluvial sequence, and rich zones resting on bedrock are not common; in fact, "false bottoms", or cemented layers overlain by cassiterite-bearing gravels, are a feature of the alluvial sequence. An extreme example of such a "false bottom" is the lateritic duricrust in Return Creek, blocks of which have been brought to the surface by dredging. The distribution of tin lenses and the general alluvial sequence are similar to those at the Billiton deposits in Indonesia, as figured by Van Overeem (1960, his figure 8).

The heavy mineral assemblage differs slightly in each of the main deposits. It commonly includes, in addition to cassiterite, topaz, monazite, zircon, and ilmenite and other iron oxides; isolated occurrences of spinel, garnet, corundum, and beryl are also known. The cassiterite is variable in colour; black, amber, ruby, and honey-coloured varieties are all present. Baker and Edwards (1956) found that some of the cassiterite from Smith's Creek, particularly the black variety, is magnetic. The grain-size of the alluvial cassiterite has not been studied in detail, although during the 1962 field season a size analysis was carried out each week on 4000 to 5000 grams of concentrate taken directly from the dredge at Smith's Creek. The results were consistent while the density of the dredge pond remained stable, and they showed that about 75 to 80 percent of the cassiterite recovered is within the range minus 36 to plus 100 B.S.S. mesh size, and the remainder was distributed between plus 36 mesh (about 15 percent) and plus 200 mesh (3 to 7 percent). However, it is not known whether or not this represents the actual mode of grainsize in the deposits. It is suspected that much of the cassiterite of minus 100 B.S.S. mesh size passes through the dredge, and is lost.

Each of the major deposits is discussed below:

<u>Smith's Creek</u>: Tableland Tin Dredging N.L. began dredging in Black's Creek, near its confluence with Smith's Creek in 1953, and, up to the end of 1962, about 27,500,000 cubic yards had been treated for a yield of 5511 tons of cassiterite concentrate. The dredge concentrates contain zircon, monazite, and magnetite-ilmenite which are removed by electrostatic and electromagnetic separators at the treatment plant near Mount Garnet. Some cassiterite is also removed by the magnetic separator (Baker and Edwards, op. cit.), so the stockpile of separated magnetic minerals is treated from time to time to recover more of the cassiterite.

The average gradient in the dredged area of Smith's Creek is about 15 to 20 feet per mile. The dredge worked downstream from Black's Creek until October 1962, when it had reached the southern limit of dredging ground, about 0.6 miles north-north-west of the causeway over Smith's Creek on the Northern Inland Highway. The dredge is at present working its way upstream through scattered pockets of tin-bearing ground which are marginal to, but could not be included in, the original dredge course. Ultimately the dredge will work in "Finches Area", immediately downstream from Smith's Creek Gorge. This area is "estimated to contain 9,000,000 cubic yards with a recoverable value of 12 oz. per cubic yard, or a total of 3134 tons of tin oxide". * Besides Finches Area the dredge will work an area at Hammond's Gully which contains "6,250,000 cubic yards with a recoverable value of 8.4 oz. per cubic yard and a depth of as much as 130 feet". * The dredge operated by Tableland Tin can dig to 63 feet below pond level, carrying a 30 foot face; i.e., it can dig to 93 below surface. During 1961-62 deeper deposits were worked after the top 25 feet of barren over-burden had been dry-stripped by earth-moving equipment. Presumably this technique will also be used to some extent at Hammond's Gully.

The dredge operated by Tableland Tin has an average annual through-put of about 3,500,000 cubic yards, and the reserves quoted above indicate that dredging will be continued in Smith's Creek for about five years. Allowing for movement time and dredging of other small areas, a figure of six to seven years from January, 1963, is probably more realistic. Detailed testing has been carried out in lower Smith's Creek near the high-way, but results have been disappointing.

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* Mining and Chemical Engineering Review, January 15th, 1963, p.13.

Large areas of alluvium occur along Smith's Creek upstream from the gorge. The area between Nymbool and the gorge is estimated to contain 12,000,000 cubic yards, assuming an average depth of 18 feet, which is probably conservative. Tableland Tin drilled 28 holes in this area in the vicinity of Ambrose Creek; depth to bedrock ranged from 20 to 35 feet, but the grade was not good enough to encourage further testing. The alluvial area of Smith's Creek upstream from Nymbool contains more than 15,000,000 cubic yards of cassiterite-bearing alluvium, assuming an average thickness of 18 feet. Some of the alluvial banks in this part of Smith's Creek are 25 feet high, and there is no sign of bedrock at the base; samples from one of these banks averaged about 7 oz. cassiterite per cubic yard over the whole 25 feet. The B.P.H. Company Ltd has recently tested the area upstream from Nymbool by bulldozer trenching; results are not available, but the Company has relinquished its Authority to Prospect.

Smaller areas of alluvium occur along Black's Creek, and these will be mapped in 1963.

The primary source of the cassiterite in Smith's Creek is uncertain. A considerable amount undoubtedly came from the Black's Creek area and the area of Elizabeth Creek Granite between Black's Creek and the Smith's Creek Gorge, e.g., Tucker's Gully. Some tin mines also occur near the head of Black's Creek, and it is possible that cassiterite was shed from these and from the area of the Smith's Creek Mine into the Black's Creek drainage at an early stage in the erosion cycle. At present this latter shed goes into Surprise Creek and thence into Smith's Creek. The origin of the tin occurring in Smith's Creek upstream from Nymbool is uncertain because the headwaters of this creek are now in non-stanniferous Middle Carboniferous acid volcanics. It is possible that the creek formerly drained some of the stanniferous area near Brownville.

The area of Anyon's Swamp, in the headwaters of the west branch of Smith's Creek, was examined as a potential alluvial area, but alluvium there is thin (less than 10 feet) and apparently non-stanniferous.

<u>Surprise Creek</u>: This tributary of Smith's Creek near Nymbool was worked by hydraulic sluicing from 1940 until 1962. About 321,000 cubic yards were treated during this period for a recorded yield of 286 tons of cassiterite concentrates. In addition, the eluvial deposits adjacent to the Smith's Creek Mine at the head of Surprise Creek were worked in 1904 by the Smith's Creek Proprietary Company for a yield of about 125 tons of concentrates. The eluvium near the mine is mostly cemented, and it requires special treatment. The Surprise Creek area has therefore produced at least 391 tons of cassiterite concentrates, and some ground is still available for treatment. The deposits appear to be shallow (about 10 feet), and consist mainly of coarse gravel.

<u>Return Creek</u>: For purposes of this report Return Creek is best considered as divided into an upper section (above the dam), a middle section between the dam and Strathvale Homestead, and a lower section downstream from this homestead.

(1) Middle Return Creek. This area has been dredged from near the confluence with Glutton Gully to just south of the highway at Mount Garnet. Payable ground exists around Strathvale Homestead, but dredging ceased because the Company and the landholder could not agree on compensation.

Bucket dredging began in Return Creek near Glutton Gully in 1928, but the dredge was apparently unsuitable, and operations ceased in 1932. Records for 1928 and 1931-2 show a production of 150 tons of concentrates from about 500,000 cubic yards. Tableland Tin Dredging N.L. rehabilitated the old dredge, and resumed operations in 1939. This old dredge was swamped by floods in 1942, and was replaced by No. 2 dredge in 1943. Dredging ceased in 1952, and, in the period 1939 to 1952, about 33,937,000 cubic yards were treated for a yield of 6114 tons of concentrates. Sluicing was also carried out in the Glutton Gully area in 1906 to 1908, but no production records are available.

The alluvial deposits of middle and lower Return Creek are characterized by the presence of brown rhyolite pebbles derived from the Carboniferous volcanics in the area of the dam. Gravels appear to be abundant in the deposits, and fragments of a hard, subsurface, lateritic duricrust two to three feet thick have been brought up by dredging. Most of the middle section of the creek appears to have been worked out. The only remaining possibilities are small areas on the edges of the dredged area - e.g., half a mile due north of Mount Garnet Post Office, the area around Strathvale Homestead - and some ground which may have been left by the No.1 dredge, which could not dredge as deeply as the No.2 dredge. It would probably not be economic to bring a dredge in to work these deposits. Stanniferous alluvium also occurs in Glutton Gully, but has not yet been mapped. The alluvial cassiterite in Return Creek is probably derived from chlorite lodes in the Mount Garnet Formation in the Brownville-Coolgarra area.

(2) Upper Return Creek System. This area, which includes the whole drainage system of the stanniferous Brownville-Coolgarra area, was test-pitted and bulk-sampled by the B.H.P. Company Limited in 1962. The results of their work are not yet available, but the ground was relinquished during 1963. Individual alluvial deposits are small, and consist mainly of coarse gravel. Several pounds of cassiterite per cubic yard can be expected in some areas, and the main problem for a company is to discover a method of working the various small deposits economically without polluting the water in the Return Creek Dam, which provides the water supply for Tableland Tin and Mount Garnet township. Records show a production of 203 tons of alluvial concentrates from the Coolgarra area, but the actual production is probably very much greater.

(3) Lower Return Creek. There has been no production from this area. Extensive testing by Tableland Tin has shown that alluvial cassiterite is present, but the volume and grade of the deposits are not known. The area is discussed in more detail later in this report.

Battle Creek: Ravenshoe Tin Dredging Ltd has been working the deposits at Battle Creek since 1957, and to the end of 1962 the Company had treated about 13,000,000 cubic yards for a yield of 2931 tons of cassiterite concentrates. This represents a recovery of about 75 percent of the tin indicated by boring. Some sluicing was also carried out in Battle Creek during World War II, but recorded production shows only 5 tons of concentrates.

The dredge used by Ravenshoe Tin is smaller than that at Smith's Creek. It can dig to 40 feet and carry a face of about 20 feet, but it has the advantage of being able to raise its bucket line to an almost horizontal position and remove overburden by dry stripping. This overburden by-passes the treatment plant of the dredge, and thus pollution of the dredge pond water is minimized. The Ravenshoe Tin dredge has an average annual throughput of about 2,500,000 cubic yards.

The Battle Creek deposits are somewhat different from those described above in that the alluviated part of the valley is relatively narrow, fairly straight, and steeper than usual. The average gradient is between 30 and 40 feet per mile, and in some parts dredging has continued laterally up to, and against, outcrops. Also the bottom of the dredged area is very irregular because of transverse rock bars. The cassiterite concentrates obtained from the dredge are relatively clean, probably because they are derived mainly from tin lodes in the Elizabeth Creek Granite; final concentration is carried out in the tin shed using only a Willoughby classifier and a Wilfley table. Rare beryl and barytes are reported to have been identified in the concentrates (F. Chapman, pers. comm.).

Initial drilling of the Battle Creek deposits showed a depth of about 80 feet at their southern end near the Palmerston Highway, but they are shallower in the upper reaches. However, many of the holes did not reach bedrock. Basalt, which was found about 50 feet below surface near the Palmerston Highway, possibly marks the southern limit of the dredging ground. The Company's prospectus quoted the volume of dredgeable ground in Battle Creek as 16,000,000 cubic yards and, in the annual report for the year ended June 30th, 1962, it was reported that dredging was expected to tontinue in Battle Creek for at least another year. Recent drilling in the upper reaches of Battle Creek has increased the reserves slightly, and it is now estimated that dredging will be completed in July or August, 1964. The dredge will then be moved to Nettle Creek.

Nettle Creek: The tin in Nettle Creek was one of the first discoveries made in the district (1881), and alluvial mining appears to have been going on, whenever water was available, at least since 1886. The main production recorded was in the period 1931-46 when hydraulic sluicing was carried on, first by the Nettle Creek Company, and later (1941-46) by the B.H.P. Co. Ltd. The recorded production for this period is 410 tons of tin concentrates, obtained from about 1,000,000 cubic yards. Ravenshoe Tin Dredging Ltd currently have the area under lease, and will probably begin dredging it in 1965. Testing has outlined two payable sections - one with 12,500,000 cubic yards averaging 8.53 oz. (i.e., 2975 tons of tin oxide) and a second area with 2,500,000 cubic yards averaging 17 oz. per cubic yard (i.e., 1186 tons of tin oxide). The southern limit of dredging ground in Nettle Creek is possibly also delineated by basalt, which was found 40 to 50 feet below the surface in boreholes about half a mile upstream from the Palmerston Highway. The average gradient of the Nettle Creek deposits is about 31 feet per mile, and the concentrates should be relatively clean because most of the cassiterite seems to have been derived from within the granite. The reserves of 15,000,000 cubic yards should keep the Ravenshoe Tin dredge working for about six years, i.e., until about 1971. There is also a possibility that additional dredging ground is present in the lower reaches of Pool's Gully.

Numerous small eluvial and alluvial cassiterite deposits occur in gullies draining into Nettle Creek over almost the whole of its length, and many of these should be suitable for small-scale operations, especially in the vicinity of Condon's Gully and Gibson's Gully. About 34,000 square yards of alluvium occur near Top Nettle Camp, but old workings there are small and localised along the creek, and tests failed to find any significant tin values.

Wild River System: No large-scale alluvial tin mining has been carried out in the Wild River system in the Mount Garnet area. The individual deposits are small and too scattered to be worked by a company. Prospects within the Wild River itself are poor, because most of the larger areas of alluvium are underlain at shallow depth by basalt. The only important recorded production is 126 tons of cassiterite concentrates won from deposits along Woolooman Creek between 1894 and 1900, although it can be seen on Plate 1 that most of the westerly tributaries of the Wild and Dry Rivers have been worked for alluvial tin.

Two areas of perched alluvium occur near the junction of Woolooman Creek and the Wild River. The alluvium is only a few feet thick, but it is perched about 50 feet above the present stream level. Most of this alluvium has been worked out, but some may remain beneath a small remnant of Cainozoic basalt in that area. The perched position of the alluvium and the remnant of basalt testify to a considerable amount of Cainozoic (possibly Recent) erosion, and this process probably removed and redistributed moderate-sized alluvial deposits from the Dry River area. About 200,000 cubic yards of alluvium (average thickness about 4 feet) occurs at the junction of Mowbray and Woolooman Creeks, and was being tested by prospectors at the time of mapping.

A maximum of about 200,000 cubic yards of alluvium occurs in Deadman's Gully near the Herberton road crossing. Two gullies carrying tin lie directly above this alluvial area, and tests revealed appreciable quantities of cassiterite in various parts of the deposit.

Coarse cassiterite is present in coarse, bouldery, alluvium along Sandy Creek, but the volume available is small. In the lower reaches of the creek, values of up to 5 lb. per cubic yard were found in an 8 inch layer of alluvium resting on basalt, and overlain by 9 to 10 feet of barren sand.

An area of alluvium occurs along the lower reaches of Shady Creek; this deposit has been test-drilled by Tableland Tin, but the results are not available.

The possibility of deep lead tin deposits in the lower reaches and a possible former channel of the Wild River has been previously discussed (see page 23).

Minor deposits: There are a number of minor alluvial deposits in the Wild River - Dry River area and upper Return Creek (see Plate 3). Plate 1 shows that alluvial workings also occur in most of the creeks draining Elizabeth Creek Granite, particularly where greisen is abundant in the granite. Many of these creek deposits are worked by local residents each wet season. They are mostly small and shallow, and commonly contain coarse, bouldery "wash".

Alluvial Wolframite Deposits:

Alluvial wolframite deposits in the Mount Garnet area are small and unimportant. The only known localities are near the Warieka Mine along a tributary of Copper Gully, and in a tributary of Boot Creek, 2½ miles north-west of Brownville. Some wolframite has also been won from eluvium near a lode wolframite occurrence, west of Ironstone Hill, 5½ miles south-west of Mount Garnet.

DISCUSSION OF RESULTS OF 1962 INVESTIGATIONS

The 1962 programme at Mount Garnet was directed towards locating new reserves of lode and alluvial tin. Areas of interest are discussed below, and anomalous areas which were outlined by geochemical sampling are described in the next chapter.

LODE-TIN PROSPECTS

All lode-tin mining so far carried out in the Mount Garnet area has been on a small scale. The Smith's Creek Mine, worked to a depth of 500 feet, is the largest mine. However, the discovery of the Phoenix Extended lode near Coolgarra during 1961-2 showed that the area has not been exhaustively prospected, and sampling of exposed chlorite lodes west of Coolgarra also revealed appreciable quantities of cassiterite, although there are only a few small pits on some of these lodes.

It appears that a number of chlorite-cassiterite lodes in the Coolgarra-Brownville area could be worked on a small scale if efficient treatment facilities were available. A battery is operated at Brownville by A.R. Dunmall, but it is virtually the same as when it was built in 1931, and recovery is poor (estimated at 50 percent or less), and throughput small. Several of the larger mines in the Coolgarra area stopped work in a sulphide zone, and the possibility that cassiterite gives way to stannite in these zones should be investigated.

Numerous stanniferous greisen lodes occur in the Mount Garnet area, but individually we consider them less promising than the chlorite lodes because of lower grades and patchy distribution of the cassiterite. The massive greisens in the area warrant investigation as large-tonnage, low-grade tin prospects. During 1962 only three such areas were outlined - Geebung Hill, the ridge south of Mount Gibson (and other greisen ridges in this area), and the greisen areas around the Harbour Light Mine, north of Mount Gibson. Additional areas of massive greisen possibly occur north and north-east of Coolgarra. Massive greisens are also known in the Reid's Creek area, east of Gurrumba. Testing of the massive greisens should involve first taking sufficient samples to obtain a rough estimate of the grade; if results are encouraging, detailed mapping and surface sampling should be undertaken, and drilling should follow if justified. In evaluating the greisens the possibility of producing by-products such as fluorite and possibly beryllium should also be considered.

ALLUVIAL TIN PROSPECTS.

Evaluation of alluvial prospects in the Mount Garnet area was carried out by detailed geological mapping, geomorphological studies, refraction seismic and gravity surveys, and scout boring. It was the first time that geophysical surveys of this kind had been carried out in the Mount Garnet area, and the results are presented in reports by Sedmik (1963) and Hussin and Horvath (1963), of the Geophysical Branch of the Bureau of Mineral Resources. The geophysical profiles were used as a guide in selecting sites for drill-holes in prospective areas, but the drilling results showed that, although the profiles were useful in a general way, they did not provide a reliable guide to depth of alluvium or depth of the weathering profile in bedrock (Figs. 15, 16, 17). The difficulties were probably due partly to variations in rock-type and differences in relief and depth of weathering within the basement. Velocities in alluvium could not be distinguished from those in weathered bedrock, and lenticular velocity-layers which were interpreted as representing bodies of alluvium which might carry more gravel and sand than neighbouring bodies were not unequivocally confirmed as such when tested by drilling, though it must be emphasized that the amount of testing done was small, and that it was all carried out in areas now considered to be generally unfavourable for the accumulation of gravel, and sand, and associated economic deposits of cassiterite. Furthermore, there was no positive indication of the presence of basalt flows later found by drilling to be tens of feet thick (this applies especially to hole MRW 12).

Fifteen holes, totalling 1586 feet, were drilled in the Mount Garnet Basin by Tableland Tin Dredging N.L. under contract to the Bureau of Mineral Resources. The positions of these holes and of the geophysical traverses are shown in Fig. 14. In addition Tableland Tin drilled, at its own expense, another fifteen holes, totalling 1580 feet, along traverse ATR 3, and hole MRW 10 (45 feet) on traverse ATR 1.

The Compagnie Generale de Geophysique carried out some refraction seismic investigations on an Authority to Prospect held by Mineral Deposits Pty Ltd in the central part of the Mount Garnet Basin. Drill holes MRW 12 and MRW 14 were sited on two of the seismic traverses. Mineral Deposits Pty Ltd also ran some magnetometer traverses with the main aim of tracing basalt beneath alluvium in their area, but without success, probably because the basalt was weathered.

The Compagnie Generale de Geophysique also carried out a refraction seismic survey in the dredging area of Battle Creek for Ravenshoe Tin Dredging Ltd. The method was completely successful here in defining the old stream channel because bedrock was much less weathered than in the Mount Garnet Basin.

Initially the Bureau parties were to investigate the Wurruma and A.T.R. prospects, which had been outlined by Best (1962a), and the southern extension of the alluvium being dredged by Tableland Tin in the valley of Smith's Creek. A considerable amount of work was also done in lower Return Creek, and one hole was drilled on a C.G.G. seismic traverse on lower Smith's Creek. These investigations are discussed below.

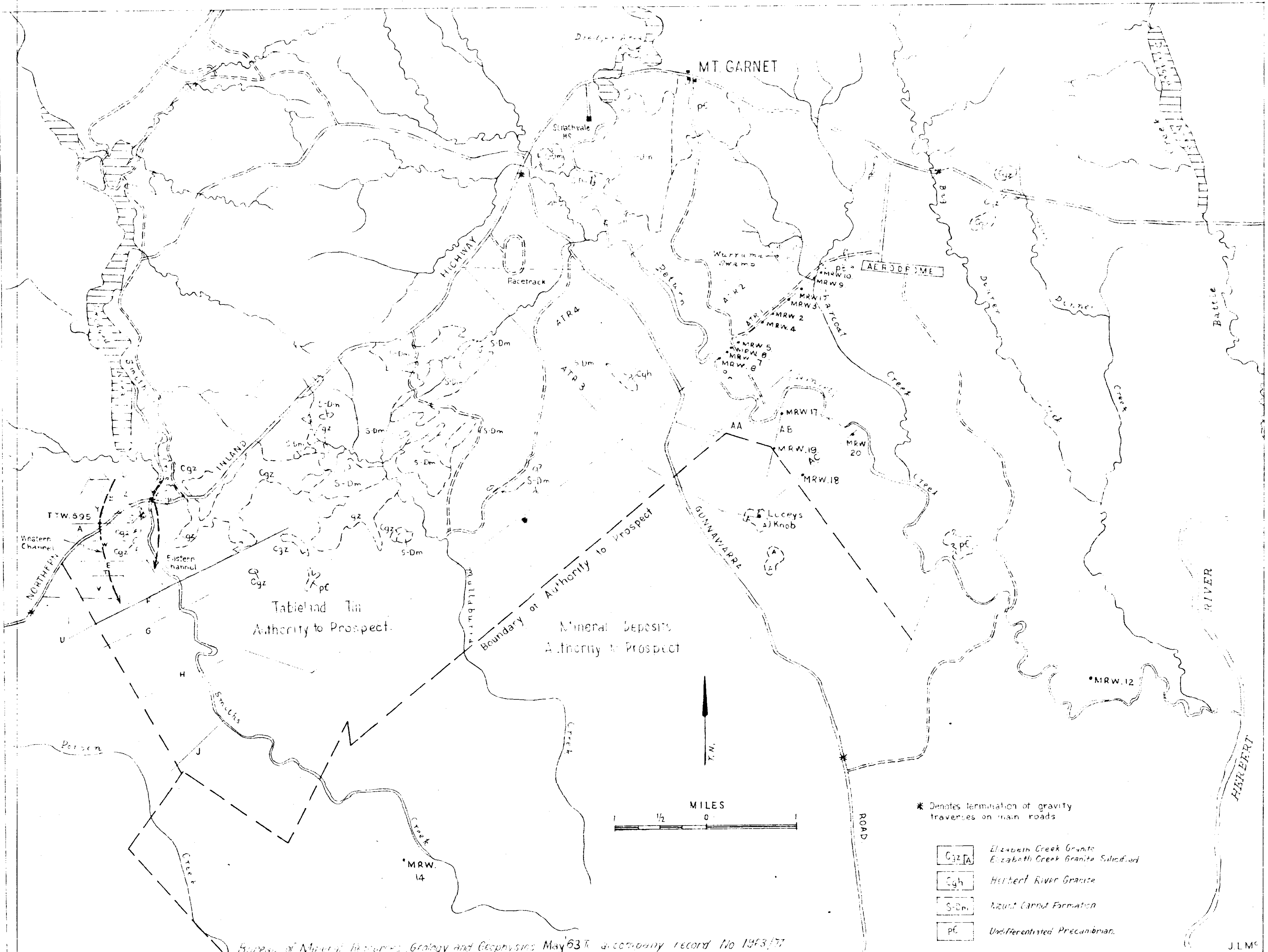
<u>Wurruma Prospect</u>: Best (1962a) suggested that Return Creek may originally have flowed through the area now occupied by Wurruma Swamp, south-east of Mount Garnet. Reconnaissance gravity and seismic traverses along the ATR 1 line (Fig. 14) preceded drilling, and the geophysical results were used in siting the drill holes. In all, ten holes, totalling 907 feet, were drilled on this line by the Bureau (MRW 1 - 9) and Tableland Tin (MRW 10). The results are summarised in Fig. 15. None of the holes near Wurruma Swamp encountered significant tin values or the characteristic gravels of Return Creek - i.e., gravels containing brown rhyolite pebbles - and it was concluded that Return Creek had never flowed through this area. All bedrock encountered in the drillholes appeared to be deeply weathered Precambrian metamorphics. The poor correlation between the bedrock as found in drill holes and as indicated by the seismic traverses is probably due to a deep but irregular weathering profile in the Precambrian rocks.

MOUNT GARNET — QUEENSLAND

Positions of Percussion Drill Holes and Geophysical Traverses

B.M.R. Survey 1962.

Fig 14.



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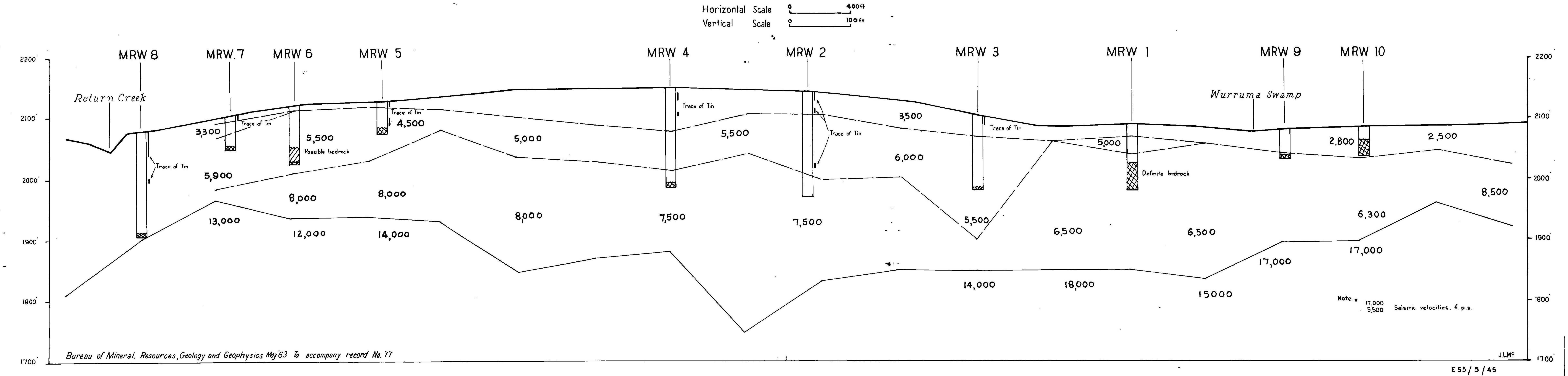
TRAVERSE ATR. I.

GRAPHIC SECTION SHOWING BORE HOLES and SEISMIC PROFILE

Fig.15.

WURRUMA PROSPECT MT GARNET



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Smith's Creek: During 1961, when the Tableland Tin dredge was about 1½ miles north of the Northern Inland Highway, the Company requested the Bureau of Mineral Resources to carry out a geophysical survey along the valley of Smith's Creek, immediately below the dredge, in order to provide information on the positions and probable depths of any buried stream channels. The Bureau was not able to undertake this work until the 1962 field season, and, in the meantime, the Company carried out a considerable amount of drilling in the area. The results were disappointing, though a small area of some promise was found about one mile south of Smith's Creek causeway. The drilling had also indicated a narrow, gorge-like channel east of and parallel to the present course of Smith's Creek (Fig. 14), but tin values, although high in some holes, were not sufficiently continuous for economic dredging. In addition, the channel found by drilling was too narrow for the passage of a dredge, and this conclusion was supported by outcrop mapping in the vicinity.

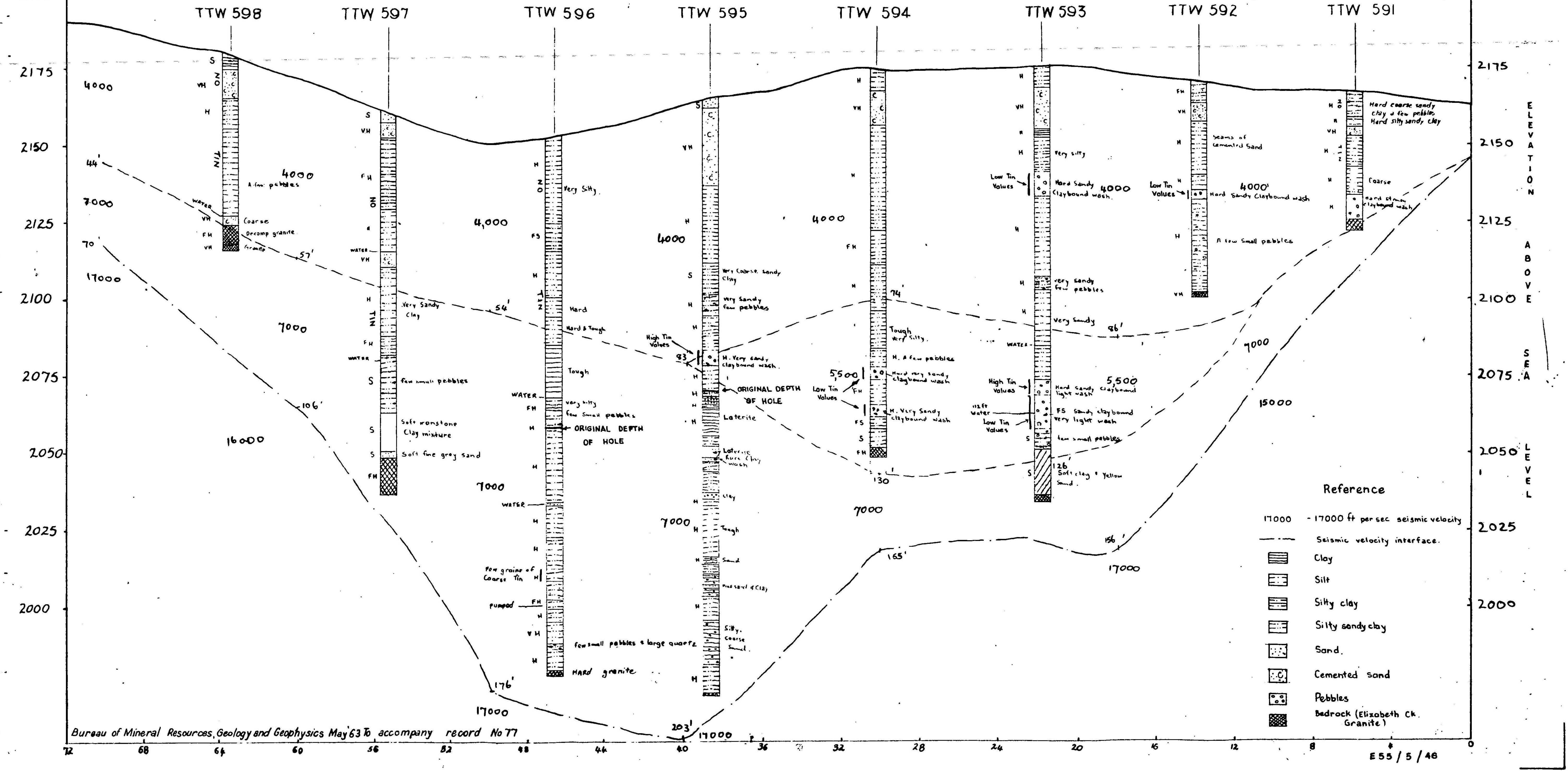
The only possibility of a dredgeable channel then lay in the alluviated area west of the granite which crops out above the right bank of Smith's Creek, just south of the Northern Inland Highway. Accordingly, the Company drilled two lines of holes in this area, but tin values were sub-economic throughout. However, insufficient drilling had been done to determine beyond doubt the direction of any major channel which might exist in the area. In order to eliminate the possibility of missing a payable channel the Bureau carried out refraction seismic surveys along a number of traverses west of Smith's Creek. Two of these (traverses A and T) were along the lines of the holes already drilled. The seismic work outlined a deep channel (Figs. 14 and 16) west of and parallel to the present course of the creek, and it also became apparent that holes TTW 595 and 596 on traverse A had probably not reached bedrock. These holes were subsequently deepened, as shown in Fig. 16, but no significant occurrences of cassiterite or gravel were found. It was also shown that the western channel is considerably deeper than the eastern one, which either may have been the original channel, or may have been cut in weathered granite on the eastern bank of the stream after the western channel had been partly filled.

As a result of the test-drilling and geophysical work the Company decided not to continue dredging downstream; the dredge is now working upstream towards high-grade deposits immediately below Smith's Creek Gorge. Now that the dredge has been turned around any attempt to work deposits in Smith's Creek south of the highway is out of the question. In any case, there is no doubt that the decision to discontinue dredging downstream was correct. Even if a payable deposit had been found south of traverse T before the dredge was turned, it would have been necessary to take the dredge through at least 1½ miles of very low grade ground to reach it, and the cost of this operation would have been a heavy debit against any future returns. This means that the grade of any deposits south of traverse T would have had to be above average to offset this cost, and there was no reason for expecting that this would be so. On the contrary, the evidence available indicates that the alluvium south of the dredged area becomes progressively poorer in grade, and deeper, and less gravelly, so there was no encouragement whatever to continue testing in that direction.

Lower Smith's Creek: Drill hole MRW 14 was sited on a seismic traverse recorded by the Compagnie Generale de Geophysique, and the hole intersected fine sand and clay carrying traces of cassiterite, monazite, and zircon from the surface to a depth of 104 feet. No gravels were intersected. Below 104 feet the hole passed through 25 feet of bluish, puggy clay overlying 11 feet of basalt rubble. The blue clay may represent a lake deposit formed by damming of drainage against a basalt flow. The hole continued to a depth of 184 feet - i.e., 44 feet below the basalt - but no cassiterite was found in this lower section, and the sediments were mainly tough clay containing fragments of basalt. The hole was unbottomed at 184 feet. The absence of gravel, the preponderance of fine alluvium, and the fact that the area in which hole MRW 14 was drilled is even farther downstream than the unfavourable tract near the Northern Inland Highway, indicate that no further prospecting should be carried out there.

Fig. 16.

GRAPHIC SECTION BORE HOLE and SEISMIC DATA
"A" TRAVERSE SMITH'S CK MT GARNET.
SCALES : Horizontal 200ft = 1inch Vertical 25ft = 1inch.



The A.T.R. Prospect: Best (1962a) suggested that a major stream, which he called the Ancestral Tate River (A.T.R.), may formerly have flowed westwards or south-westwards through the area of the Mount Garnet Basin, and joined the present Tate River system. Differential earth movements during the late Cainozoic were considered to have diverted the westerly-flowing waters towards the south-eastern part of the Basin, whence they now flow to the coast as the Herbert River. The implication of this hypothesis was that the abandoned river channel would contain stanniferous alluvium carried in by Smith's, Return, Battle, and Nettle Creeks, and by the Wild River from the Herberton area. The Wild River was, in fact, postulated as being the major headwaters stream of the Tate River system.

Following Best's suggestion, Tableland Tin Dredging N.L., early in 1962, drilled fifteen holes, totalling 1580 feet, at 200-foot centres along a line normal to the postulated course of the abandoned channel in the area about 1 mile south of the Mount Garnet racecourse (Fig.14). Seismic traverse ATR 3 was subsequently run along this line of holes; it extended north-west and south-east beyond the extremities of the line of drill-holes, and traverse ATR 4 was run at right angles to it. The alluvium penetrated by the drill-holes was mainly clay and silt, but medium-sized gravel with traces of cassiterite was found in some holes. Most of the holes were unbottomed, but some in the north-western part of the line reached bedrock. The deepest hole, near the intersection of traverses ATR 3 and 4, was unbottomed at 204 feet.

The results of this drilling cast doubts on the validity of the A.T.R. hypothesis, and the geophysical work and further geological mapping confirmed them. The seismic profiles along traverses ATR 1, 2, and 4 indicated valleys trending south, not west, and the Mount Garnet Basin was found to be land-locked in the west, as indicated in Fig.4: there was no evidence for any alluvial channel leading towards the headwaters of the Tate River, nor any sign of a significant break in the Great Dividing Range in that vicinity.

Lower Return Creek: Tableland Tin Dredging N.L. has tested along Return Creek for about 3½ miles downstream from Strathvale Homestead, but the results are not available. When the A.T.R. hypothesis was abandoned it was decided to carry out some refraction seismic surveys and drilling with a view to tracing the fossil channel of Return Creek within the Mount Garnet Basin downstream from the last line of company drill-holes. Accordingly, a geophysical traverse (AA) was laid out along this line, and two additional traverses, AB and AC, were run to complete a Z-shaped pattern, as shown in Fig.14. Another traverse was run about 2 miles south-east of traverse AC.

Information obtained from drill-holes and outcrops in the vicinity of traverse AA suggests that bedrock here consists of Precambrian metamorphic and granitic rocks. A graphic section (Fig.17) along traverse AA comparing refraction seismic data and drilling data made available by Tableland Tin shows little correlation between the two sets of information. The figure shows that the high velocity (greater than 13,000 f.p.s.), unweathered bedrock zone is deep throughout the profile, that most of the drill-holes were not deep enough to establish the boundary between alluvium and weathered bedrock, and that it is impossible, in this area, to distinguish between alluvium and deeply weathered bedrock by the seismic method.

The results of drilling and seismic work along traverse AA suggest that some holes drilled by Tableland Tin to the north-west of this traverse prior to 1962 may have been unbottomed. However this does not mean that any economic deposits in the area tested were overlooked. Figure 17 shows that it is fairly safe to assume that holes have been drilled to weathered bedrock, or to a depth beyond the limit of dredging, or to a depth such that any tin-bearing gravels below the bottom of the hole would have to be rich beyond reasonable expectation to compensate for the low values at higher levels.

Drill holes MRW 17, 18, 19, and 20 were sited on geophysical traverses AB and AC to test the interpretation of the seismic data, and to prospect for stanniferous alluvium. The first three of these holes intersected tin-bearing

GRAPHIC SECTION BORE HOLE and SEISMIC DATA.

TRAVERSE "AA" LOWER RETURN CK MT. GARNET.

SCALES Horizontal 200' = 1" VERTICAL 25' = 1"

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gravels, but the overall grade was very low in holes 17 and 19; hole 18 contained 4.96 oz. of tin oxide per cubic yard over a depth of 89 feet. The driller's and panner's logs of these three holes are reproduced in Appendix 1. Some additional scout drilling will be carried out in this area during 1963, and also in the area north-west of Lucey's Knob, where geophysical data suggest there may be a channel.

Drill hole MRW 12 (Fig. 14) was sited on a refraction seismic traverse recorded by the Compagnie Generale de Geophysique near Return Creek about 8 miles south-south-east of Mount Garnet. The hole intersected basalt from 28 to 37 feet and from 69 to 127 feet, and there were traces of cassiterite at intervals throughout the alluvium; the hole had to be abandoned at 143 feet because of running sand. The thickness (58 feet) of the lower basalt flow suggests that the lava has filled a major stream channel which may be a former channel of the Herbert or Wild River (see discussion on Cainozoic basalt under "Stratigraphy"); if this is so, stanniferous alluvium from Battle Creek, Nettle Creek, Blair's Gully, and the Herberton area may underlie the basalt. However, as stated earlier in this report, the prospect of finding economic deposits below basalt in this area is not promising.

Other Areas: The results of the examination of small alluvial deposits in the Mount Garnet area are referred to in the section on alluvial deposits.

General review of alluvial tin prospects in the Mount Garnet Basin: From information obtained by geophysical methods, drilling, and field observations during 1962, and from data made available by dredging and prospecting companies who are, or have been, active in the area, it is now possible to make a general assessment of the alluvial tin prospects of the Mount Garnet Basin. This Basin, which has an area of about 150 square miles, was of particular interest during the Bureau's investigation, as within it lay the only possibility of increasing substantially the reserves of alluvial tin already blocked out by the dredging companies.

No new concept which might enhance the prospects of the Mount Garnet Basin has emerged to take the place of the A.T.R. hypothesis (now known to be incorrect), and it now seems clear that the drainage throughout the history of the Basin has been towards the south-east.

The Mount Garnet Basin is a deeply alluviated area whose surface slopes gently towards the south-east. From the few outcrops of solid rock which may be seen in the Basin, and from drilling information, it appears that the alluvium, which contains interbedded basalt at various levels, rests on a basement consisting mainly of Precambrian metamorphic and granitic rocks. However, on either side of the Gunnawarra Road, within about 3 miles of the Northern Inland Highway, the basement probably consists largely of Herbert River Granite and rocks of the Mount Garnet Formation. Circumstantial evidence in favour of a predominantly Precambrian basement is provided by the fact that almost all the metamorphic rocks of the Georgetown Inlier, of which the Precambrian rocks of the Mount Garnet area are part, occupy areas of low relief, whereas the Elizabeth Creek Granite, the Carboniferous volcanics, and rocks of the Mount Garnet Formation, which surround the Basin, form hilly country.

The margins of the Basin are, in general, marked by the limits of the hilly country, and the places where the four main stanniferous creeks emerge from the hills correspond fairly closely with the known limits of economic deposits of alluvial cassiterite within their valleys.

Before deposition of alluvium began within the Basin its topography appears to have been undulating. In those places where outcrops of quartzite and other siliceous rocks now occur the relative relief must have been at least 250 feet.

A number of different inferences concerning the sedimentational history of the Mount Garnet Basin may be drawn from the apparent coincidence of the limits of dredgeable stanniferous alluvium in the four main creeks with the margin of the Basin. Unfortunately there is insufficient information available to enable one to visualize the condition of the Basin when erosion of the tin lodes began. Either it was empty, or it was already partly filled with alluvium, and, of course, the gradient of the streams flowing across it is unknown. Thus there is ample scope for speculation about the distance that any alluvial cassiterite which entered it would travel, and about its depth below the present surface. A critical factor in this connection is the kind of profile which would develop where a stream flows from relatively resistant Palaeozoic rocks on to the generally less resistant and probably more deeply weathered Precambrian metamorphic rocks. A waterfall or rapids would almost certainly have formed in the harder rocks immediately upstream from the boundary of the Precambrian, and no alluvium could have been deposited there during this phase of the stream's history. Any cassiterite that travelled farther downstream would have been deposited at a depth well beyond the limit of dredging. The presence of outcrops of Herbert River Granite and Mount Garnet Formation along Return Creek south-east of the Northern Inland Highway indicates that bedrock is probably relatively shallow there, and thus helps to explain why there was encouragement to continue test-drilling farther down Return Creek than down Smith's Creek.

The conditions envisaged above could, in principle, account for the apparent absence of mineable concentrations of cassiterite within the Mount Garnet Basin. There is room for some speculation concerning the pattern of deposition of cassiterite as the streams aggraded and the Basin became filled with alluvium, but there can be no doubt that the general picture is one of progressively finer grainsize and lower grade in the higher layers of alluvium. This would be so especially within the Basin, most of which, at any rate in the middle and later stages of its depositional history, would have behaved as a flood-plain over which any cassiterite carried beyond the relatively confined stream channels in the hilly country would have been dispersed.

(Most of the cassiterite that has been released from lodes since the main stream channels were aggraded has accumulated as relatively small but rich eluvial and alluvial placers in or near tributaries of the more important streams. An appreciable quantity of tin has been recovered from such deposits, and some of them are still worked on a small scale during the wet season.)

The fact that there is some relief in the floor of the Mount Garnet Basin suggests that local concentrations of cassiterite could have been derived from any tin lodes within its limits. A local source may account for the anomalously high grade (4.96 oz. per cubic yard) of the alluvium in hole MRW 18. However, any primary sources of cassiterite which may exist under the alluvium must be insignificant compared with those between Nymbool and the Wild River: if any substantial area of mineralization were present within the Basin, outcrops of Elizabeth Creek Granite and greisen, which are much more resistant to weathering than are most of the Precambrian rocks, would almost certainly have been found there.

There is a great deal still to be learnt about the areal and vertical distribution of basalt within the Basin. However, the evidence that is available tends to diminish rather than enhance the prospects of finding economic deposits of alluvial cassiterite, both above and below basalt. Lava flows in a stream valley have a marked influence on the nature and distribution of sediment subsequently deposited by the stream. If basalt flows upstream, as, for example, in Battle and Nettle Creeks, the situation is fairly simple: a lake would be formed ahead of the flow, so it would not be possible for stanniferous alluvium of payable grade to be deposited on or alongside the basalt until the lake was breached, and a stream channel of suitable gradient re-established. If basalt flows downstream the picture is much more complicated, as the gradients of the tops of flows may locally be either greater than or less than those of the stream, depending on the viscosity of the basalt and the gradient of the stream. The general tendency would be for the surface gradient to become steeper downstream from the point of entry of basalt, and reversed above. However, if the basalt is very fluid, and the gradient of the stream fairly steep, the gradient of the top of a flow may be less than that of the stream bed for some distance below the place of entry; at the toe of such a flow the gradient would be steep, owing to the increased viscosity of the basalt. Multiple flows would further complicate the picture. Basalt in the valleys of Nettle, Battle, and Return Creeks has almost certainly flowed upstream from the channel of the Wild (Herbert) River, so in parts of the Mount Garnet Basin we are concerned either with lake deposits above basalt or with alluvium in possible stream channels cut in or alongside basalt. If subsequent channels exist it may be possible to locate them by geophysical methods, but in view of the increasing fineness and decreasing tin content of the higher layers of alluvium in the Basin generally and in the four main stream channels which enter it, the prospect of finding economic deposits above basalt is not promising. (In the valley of the Wild and Herbert Rivers the situation is probably quite complex owing to the interplay of several different factors in different places along the valley, viz., original gradients along stream beds, gradients of streams locally cut alongside or through basalt, flows entering the valley via the Millstream and Blunder Creek, and, of course, the supply of cassiterite.)

As already stated, there is no encouragement to prospect for alluvial tin deposits below the basalt in the Mount Garnet area.

Though some additional scout boring will be carried out in the lower Return Creek area during 1963, there is, even now, every indication that the Mount Garnet Basin can be dismissed as a prospective area for alluvial tin. This is shown clearly by recent drilling and geophysical results in Smith's and Return Creeks. In Battle and Nettle Creeks the presence of basalt may preclude the possibility of dredging south of the Palmerston Highway, and, for reasons already given, dredgeable deposits probably would not have extended far downstream from the hilly country even if no basalts had been present. Isolated holes (e.g., MRW 18) within the Basin may penetrate payable ground, but the available information suggests that the possibility of finding deposits sufficiently shallow and extensive for large-scale mining is remote.

GEOCHEMICAL DRAINAGE SAMPLING

Some geochemical sediment sampling was carried out in conjunction with the mapping. The sampling and analytical techniques have been described previously (Zimmerman and Howard, 1962); briefly, these techniques involve sieving stream sediment on the spot, and retaining the minus 80 mesh fraction, which is then analysed spectrographically for nickel, cobalt, copper, vanadium, tin, molybdenum, lead, beryllium, and phosphorus. The results for each element are discussed below, and the analytical results are listed in Appendix 2. Sample localities and anomalous elements are noted on Plate 6.

Nickel and Cobalt:

These elements were not detected in most samples, and no significant anomalies were found. A value of 20 ppm. cobalt recorded in a tributary of Eastine Creek is probably related to basalt within the Mount Garnet Formation in that area.

Copper:

Samples containing 30 ppm., or more, of copper are regarded as anomalous. Most of the samples having anomalous copper values are from creeks draining areas of Palaeozoic sediments or Herbert River Granite. Two main copper provinces are indicated; they are the area of sediments east and north-east of Brownville, and the area of Herbert River Granite south-west of Mount Garnet. Isolated copper occurrences are known in the former area, and they may be associated with tin mineralization. The copper content of 25 samples from this area ranged between 20 and 100 ppm., and averaged 50 ppm.; further prospecting is warranted to establish whether or not the copper has been derived from the nearby small, narrow, chloritic tin lodes. If this is the case copper may be used as an indicator in prospecting for tin in this area.

The area of Herbert River Granite south-west of Mount Garnet is especially interesting because anomalous molybdenum and vanadium accompany the hich copper values. The possibility of extensive, low-grade copper mineralization in this area should not be overlooked, and further sampling is recommended.

Several isolated samples are also of interest. Most notable is sample 120 from near Black's Creek; it contains 200 ppm. Cu and 1000 ppm. Pb. This area has yet to be mapped in detail, and the high values will probably be traced to a mine. Sample 121 with 30 ppm. Cu and 500 ppm. Pb in the same area is also of interest. Sample locality 113, from a tributary of Ambrose Creek, is worth further checking because of its isolated anomalous nature and its value of 150 ppm. Cu.

Other areas having high copper values are the roof pendants of Mount Garnet Formation near Top Nettle Camp and near the Wild and Dry Rivers, and an area near the junction of Harvey's Gully and Wyndham Creek, north of Coolgarra.

Vanadium:

The area as a whole appears to be poor in vanadium, and anomalous values (30 ppm. or more V) are rare. Almost all the high vanadium values are associated with high copper values in sediments of the Mount Garnet Formation. The highest value obtained was 70 ppm. V from sample 572, near Top Nettle Camp.

Tin:

High tin values are common throughout the area, especially in streams draining areas of Elizabeth Creek Granite. High tin values are frequently associated with higher-than-normal values for molybdenum, lead, and to a lesser extent, beryllium. Sample 520 from a tributary of Kiama Creek is anomalous in that it contains 2000 ppm. Sn, 30 ppm. Cu, 5 ppm. Mo, 200 ppm. Pb, and 7 ppm. Be, yet no lode or alluvial workings are known near the stream. This is an outstanding anomaly within the area of Elizabeth Creek Granite, because all other anomalies can be related to workings. Several samples (Nos. 210, 211, 809, 843, and 852) from streams draining Palaeozoic sediments and acid volcanics contain anomalous tin, and the localities where they were collected warrant further examination.

Molybdenum:

Samples containing anomalous amounts of molybdenum are common throughout the areas of Elizabeth Creek Granite, although the highest value is only 20 ppm. in sample 229, which comes from a wolframite-molybdenite area north-west of Brownville. High molybdenum and lead seem to be indicators of tin mineralization in the granite, and molybdenum may also be present in the stanniferous greisens in some inconspicuous form. By analogy, the anomalous molybdenum and lead values in samples 114 - 116, along the eastern side of Black's Creek, may indicate tin mineralization in that area. It is interesting to note that anomalous molybdenum values are not found in the stanniferous Brownville-Coolgarra area, where tin occurs almost exclusively in chlorite-lodes in sediments. Anomalous molybdenum occurs in the mineralized roof pendant west of Top Nettle Camp, but the type of mineralization in this area is different from that west of Coolgarra.

Anomalous molybdenum values of up to 15 ppm. occurring with high copper values in the area of Herbert River Granite south-west of Mount Garnet are suggestive of porphyry-copper-type mineralization, and much more sampling is required in this area.

Lead:

As mentioned above, high lead values appear to be associated closely with high tin and molybdenum values. Lead values are relatively high throughout the area of Elizabeth Creek Granite, and lead may also be concentrated in an inconspicuous form within greisens. However, it is more likely that lead is contained in the lattice of feldspars in the granite, and that it is released by weathering. A lead province appears to exist around Black's Creek, culminating in samples 120 and 121 which contain 1000 and 500 ppm. Pb, respectively. Sample 501 in the Dry River is also of interest because of its content of 50 ppm. Cu, 500 ppm. Sn, and 400 ppm. Pb. Geological mapping is incomplete in this area, so this result cannot be appraised at this stage.

Beryllium:

Beryllium is absent from most samples, although it is common locally in greisenised areas of the Elisabeth Creek Granite. These areas occur near Mount Gibson, and in Ambrose Creek, Little Woolooman Creek, Kiama Creek, Mowbray Creek (and in gullies near its junction with Woolooman Creek), Derwent Creek, in the upper reaches of Wyndham Creek, and south-west of Top Nettle Camp. Beryl has been identified from the latter area only, and the relative abundance of beryllium in the sediment samples suggests that it may be present in greisens in the area.

Fig. 18. View south-west from Mount Gibson, showing the Ravenshoe Tin dredge in Battle Creek, and the broad flat area of the Mount Garnet Basin in the distance.

Fig. 19. Geebung Hill, north-west of Brownville.

Fig. 20. Tableland Tin dredge, Smith's Creek. Note that the overburden here has been removed by dry stripping.

Fig. 21. View north along the dredged area of Smith's Creek; hills of altered Elizabeth Creek Granite and siliceous cappings on the skyline.

Phosphorus:

This element was sought in all samples, but not detected.

CONCLUSIONS AND RECOMMENDATIONS

The geological map of the Mount Garnet area resulting from detailed mapping in 1962 is essentially similar, in its major features, to the map of the same area produced by Best (1962b) during the regional mapping of the Atherton 1:250,000 Sheet area. The detailed mapping led to minor changes in the positions of some geological boundaries, and to the addition of some small outcrop areas of various rock types which were understandably overlooked during the regional survey. The greatest contribution of the detailed mapping appears to be the recording of the positions of all workings in the area, both lode and alluvial, and their relation to the local geology.

At present two bucket dredges, working in Smith's Creek and Battle Creek, produce about 40 percent of Australia's annual output of cassiterite concentrates, but according to published reserves dredging may cease about 1971. However, both operating companies are actively prospecting in the area, and it is likely that additional payable ground will be proved, especially if tin prices remain high.

Information made available by Tableland Tin and Ravenshoe Tin, and geophysical investigations, geological mapping, and scout boring carried out by the Bureau of Mineral Resources during 1962, combined with geomorphological considerations, indicate that there is no possibility of adding to reserves by further prospecting within the Mount Garnet Basin.

All sulphide ores associated with cassiterite deposits - e.g., in the Coolgarra area - should be checked for the presence of stannite. This mineral could easily have been overlooked and lost during treatment in the stamp batteries which have been used in the area up to the present. If sufficient stannite is present, some of these sulphide ores may be economic.

The geochemical drainage sampling carried out in 1962 has indicated several areas containing anomalous amounts of one or more of the following elements, viz., copper, tin, molybdenum, lead, and beryllium. It is recommended that follow-up work should be carried out on the stronger and more extensive of these anomalies, and that an attempt should be made to collect geochemical drainage samples fairly evenly throughout the area.

No reversals of drainage have been identified in the Mount Garnet area, but there is some evidence that fairly recent earth movements have affected the topography. For example, at the junction of Woolooman Creek and the Dry River remnants of Cainozoic alluvium and basalt are perched some 50 feet above the present stream bed. Furthermore, it seems difficult to explain low gradients between exposures of basalt in the Mount Garnet Basin without invoking some gentle warping, though additional geological mapping and collation of borehole data obtained by Ravenshoe Tin and the Broken Hill Pty Co. Ltd may resolve some of the apparent difficulties.

The actual and potential tin reserves of the Mount Garnet area fall into five categories:

1. The dredging ground in the valleys of Smith's, Return, Battle and Nettle Creeks.
2. Alluvial and eluvial deposits in the upper parts of the drainage systems of Smith's and Return Creeks.
3. Shallow, near-source, alluvial and eluvial deposits in the headwaters of Battle and Nettle Creeks, and in tributaries of Smith's, Return, Battle, and Nettle Creeks.
4. Alluvial deposits in the Wild River system.
5. Chlorite-cassiterite lodes, massive greisen, and greisen lodes in the hilly country north of the latitude of Mount Garnet.

The known reserves of dredging ground in Smith's Creek will probably be exhausted by about 1971. Dredging in Return Creek ceased in 1952; however, some ground remains as selvedges to the dredged area. This ground was of marginal grade at the time of dredging, but it would be worth mining if the price of tin remains high enough to warrant re-treatment of the tailings in Return Creek. It may also be possible to dredge some of the ground downstream from Strathvale Homestead, but no information on the volume and grade of alluvium in this area has been disclosed. Dredging in Battle Creek will probably cease in July or August, 1964, and the dredge will then be moved to Nettle Creek, where known reserves will permit operations to continue to about 1971; some additional dredging ground may be found in the lower reaches of Pool's Creek.

The B.H.P. Company Ltd has recently tested the alluvium in Smith's Creek upstream from Nymbool, as well as the alluvial and eluvial deposits in the upper parts of the Return Creek drainage system, and Tableland Tin has tested some of the alluvium between Smith's Creek gorge and Nymbool. The results of the testing were, apparently, not encouraging, for although the alluvial areas are quite extensive they have all been relinquished by the testing companies. It seems unlikely that any of these deposits will be worked in the foreseeable future.

Shallow, near-source, alluvial and eluvial deposits of category 3, though generally rich compared with dredging ground, could not add substantially to the available reserves of tin. On the whole, those that remain are suitable only for small-scale mining during the wet season. Most of the larger ones have been worked out, but some ground is still available - for example, in the Surprise Creek area, which has produced over 500 tons of cassiterite concentrates.

The Wild River and its tributaries can probably not add greatly to known reserves. Some of the alluvium either contains layers of basalt or is overlain by basalt. Tableland Tin has carried out some testing in the lower reaches of Shady Creek and of the Wild, but information on volume and grade is not available.

It is possible that large-tonnage, low-grade deposits could be developed in areas of massive greisen exposed in roof-zones of the Elizabeth Creek Granite; these and the larger vein-type greisen lodes are being investigated during 1963, and preliminary sampling is being carried out.

Some of the chlorite-cassiterite lodes of the Brownville-Coolgarra area have been fairly systematically mined, others have been worked on a small scale, and many have not been developed at all. These lodes should be mapped and sampled, and the more promising of them tested by diamond drilling. Whether or not they can be mined in the future depends partly on availability of efficient treatment facilities.

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APPENDIX 1

DRILLING LOGS

Introductory Remarks.

The following drill logs for holes MRW 17, 18, and 19 are based on the logs prepared by the driller and the panner at the time of drilling. The terminology used is generally consistent with that used in scout boring for alluvial tin in the Mount Garnet area.

COMBINED DRILLERS AND PANNERS' LOG

Drillers. J. Watson & J. Forrest
Panner. H. Edwards
Supervisor. J.G. Best.

BORE NO. MRW 17. AREA. RETURN CREEK. DATE 5/11/62 POSITION SEISMIC TRAVERSE AB Peg 30.

Depth in feet Section	Total	Nature of Material	Colour	Weight oz.	Value Oz./C.yd	Interval x Value
1	1	Fine silty sandy loam fine trace of tin and iron	mottled			
1	2	Hard silty sandy clay and laterite pebbles	red			
1	3	Hard silty sandy clay and worn stone	and			
1	4	Hard silty sandy clay and pebbles	yellow.			
4	8	Hard silty sandy clay some cement with small chert and rhyolite pebbles	mottled			
1	9	Hard cemented material	red-			
5	14	Very hard silty sandy claybound wash trace of tin	brown.	trace		
2	16	Hard silty sandy cemented clay	fawn.			
1	17	Hard silty sandy claybound wash	red,	0.1023	12.78	12.78
2	19	Hard silty sandy clay	brown			
6	25	Hard silty sandy clay and very hard cement	and white			
8	33	Hard cement and silty sandy clay fine traces of iron	mottled.			
20	35	Hard silty sandy clay, little cement, little gravel	mottled			
6	41	Hard silty sandy clay, little cement	fawn-white.			
11	52	Deeply weathered mica schist	grey.			

Tin bottom at 17 feet in claybound wash. Hole drilled to 52 feet in mica schist.

Value to 17 feet = 0.74 oz. per cub. yd.

COMBINED DRILLERS AND PANNERS' LOG

Drillers. J. Watson & J. Forrest.
Panner. H. Edwards.
Supervisor. J.G. Best.

BORE NO. MRW 18. **AREA** RETURN CREEK. **DATE.** 7/11/62 **POSITION.** SEISMIC TRAVERSE AC Peg 30.

Depth in feet Section	Total	Nature of Material	Colour	Weight oz.	Value Oz./C.yd	Interval x Value
1	1	Silty sandy soil.				
8	9	Hard silty clay, laterite pebbles	mottled yellow and red.			
3	12	Very hard silty cemented sand	grey-brown.			
2	14	Very hard sandy clay some cement, few pebbles	red-brown.			
5	19	Very hard cemented silt	mottled red - white - brown.			
11	30	Hard silty clay				
5	35	Hard silty clay some cemented				
4	39	Hard sandy clay brown and white				
1	40	Very hard and stony claybound wash no values				
2	42	Hard sandy clay with some pebbles				
3	45	Hard rubbly claybound wash, no values.				
13	58	Hard silty clay yellow and white				
7	65	Hard silty clay and cemented sand with pebbles of quartz and chert, trace of iron.				
2	67	Hard fine silty sandy clay, trace of iron	fawn and white.			
6	73	Hard fine silty sandy clay, few pebbles	red-brown and white.			
9	82	Hard fine silty very clay rich sand, trace of iron	red brown and mustard and white mottled.			
7	89	Hard sandy claybound wash		2.01955	63.11	441.77
17	106	Hard decomposed granite bottom, water at 102'	khaki.			

Tin bottom at 89 feet in claybound wash. Hole drilled to 106 feet in decomposed granite.

Value to 89 feet = 4.96 oz. per cub. yd.

Driller. J.H. Watson.
Panner. H. Edwards.
Supervisor. J.G. Best.

COMBINED DRILLERS AND PANNERS' LOG

BORE NO. MRW 19 **AREA** RETURN CREEK **DATE** 14/11/62 **POSITION** SEISMIC TRAVERSE AB Peg 50.

Depth in feet Section	Total	Nature of Material	Colour	Weight oz.	Value Oz./C.yd	Interval x Value
0	1	Hard very fine silty clay soil, fine trace of iron				
7	8	Hard silty sandy clay and laterite nodules, trace of iron	fawn.			
3	11	Hard medium fine silty sandy clay, rare pebble	mottled red-brown, white.			
3	14	Hard silty sandy clay and cement, rare pebble	mottled dull ochre red, white.			
2	16	Very hard cemented clay)	mottled red-brown, white.			
12	28	Hard silty sandy clay, some cemented)				
1	29	Very hard silty sandy cemented clay)	fawn - white.			
8	37	Hard fairly silty sand, little sand, fine trace of iron)				
4	41	Hard silty sandy claybound wash, poor values.		0.2780	8.62	34.72
8	49	Hard silty sandy clay, very fine trace of iron.	mottled red-brown-white.			
2	51	Hard very silty sandy clay, fine trace of iron)	mottled fawn-white.			
5	56	Hard silty clay, fine trace of iron)				
7	63	Very hard silty sandy, one large stone)				
2	65	Hard sandy clay trace of iron)				
3	68	Hard silty sandy very clayey light wash)	mottled white-red.	0.1926	8.02	24.06
4	72	Hard silty clay, little sand)				
6	78	Very hard silty sandy clay)				
6	84	Hard fine silty clay, some cemented, trace of iron	mottled red-white (possibly decomposed granite)			

Depth in feet Section	Total	Nature of Material	Colour	Weight oz.	Value Oz./C.yd	Interval x Value
4	88	Hard fairly silty clay little sand, traces of tin and iron	Mottled white-red (possibly bottom)			
6	94	Hard fairly silty clay little sand, fine trace of iron				
8	102	Hard fairly silty clay little cement, fine trace of tin	mottled ochreous red-white.			
13	115	Hard fairly silty clay little sand, fine trace of iron	yellow-red-white (sandy clay resembling decomposed granite on freshly broken surface)			
5	120	Hard fairly silty clay, particles of quartz sand				
11	131	Hard fairly silty clay, particles of quartz sand				
16	147	Soft fairly silty sandy clay, particles of quartz sand and chert	mottled mauve red, yellow white.			
5	152	Soft fairly silty clay, particles quartz sand				
1	153	Fairly soft fine silty clay, quartz sand and mica				
16	169	Fairly soft fine silty clay, quartz sand and gravel				
5	174	Fairly hard rotten decomposed granite	mottled red, yellow-white.			

Tin bottom at 68 feet in silty sandy clayey wash. Hole drilled to 174 feet in decomposed granite.

Value to 68 feet = 0.86 oz. per cub.yd.

APPENDIX 2

ANALYSES OF GEOCHEMICAL SAMPLES

Introductory Remarks.

The following analyses were carried out spectrographically in the Canberra laboratory of the Bureau of Mineral Resources by E.J. Howard. The 'lower limits of anomalous values' shown in the heading apply particularly to samples collected from drainage on the Elizabeth Creek Granite, as the majority of samples belong to this category. Some samples contain lower values than these 'lower limits', but they are regarded as anomalous because they do not occur in drainage on or from Elizabeth Creek Granite. Sample No. 843 is a good example; it contains 100 ppm. tin, and it was collected from a stream which nowhere flows over Elizabeth Creek Granite or over an area containing known tin mineralization. Ideally the 'lower limits of anomalous values' should be calculated for each rock type, in order that anomalous samples may be selected more accurately.

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
Lower limits of accurate analysis			5	5	10	10	10	2	10	2	
Lower limits of anomalous values			10	10	30	30	100+*	2+	100+	2	
48	bank	Gibson's Gully	5-x	5-	20	20	70	2	10	-	
	bed		"	"	"	10	100	2-	"	-	
49	bank	" "	"	"	"	"	70	2	"	10	Sn, Be
	bed		"	"	10	10-	200	"	20	7	
50	bank	" "	"	"	"	10	500	"	10	10	Sn, Be
	bed		"	"	"	"	100	"	20	7	
51	bank	" "	"	"	"	20	150	"	10	-	Sn, Be
	bed		"	"	"	10	500	"	20	5	
52	bank	" "	"	"	"	"	300	"	"	-	Sn, Be
	bed		"	"	20	"	150	"	"	5	
53	bank	John Dhu Creek	"	"	10	10-	500	"	50	-	Sn
	bed		"	"	"	"	200	"	"	-	
54	bank	"	"	-	"	10	"	-	"	-	Sn
	bed		"	-	10-	10-	300	-	"	-	
55	bank	"	-	-	"	"	1000	-	70	-	Sn
	bed		-	-	"	"	300	-	"	-	
56	bank	"	5-	-	"	"	200	-	100	-	Sn, Pb
	bed		-	-	"	"	"	-	70	-	
57	bank	"	5-	5-	20	20	200	2	20	-	Sn
	bed		"	"	10	10	20	-	10	-	
58	bank	"	"	"	50	20	"	-	"	-	Cu
	bed		"	"	"	10	50	2	"	-	
59	bank	Wilcox Gully	"	"	"	20	80	"	200	-	Cu,Sn,Pb
	bed		"	"	30	10-	150	-	20	-	
60	bank	"	"	"	70	10	"	2	30	5	Cu,Sn,Be
	bed		"	"	10	10-	500	"	50	-	
61	bank	S. of Wilcox Cully	"	"	30	10	400	"	150	5	Cu,Sn,Pb,Be
	bed		"	-	10-	10-	70	2-	20	15	
62	bank	"	"	5-	"	"	"	"	10-	10	Be
	bed		"	"	"	"	30	"	"	5	
63	bank	"	"	"	20	10	50	"	20	"	Be
	bed		"	"	10	10-	100	"	10-	10	
64	bank	"	"	"	"	10	"	"	20	7	Sn, Be
	bed		"	"	"	10-	150	"	10	"	
65	bank	Condon Gully	"	-	10-	"	200	3	30	5	Sn,Mo,Be
	bed		"	-	"	"	700	2	"	"	

* 100+ = more than 100 p.p.m.

x 5- = less than 5 p.p.m.

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
66	bank	Condon Gully	5-	-	10-	10-	300	2	50	5-	Sn, Be
	bed		"	-	"	"	100	"	30	5	
67	bank	"	"	-	"	"	300	"	"	-	
	bed		"	5-	20	"	200	3	100	-	Sn, Mo
68	bank	Bulldog Gully	"	"	10-	"	300	-	30	5-	Sn, Be
69	"	John Dhu Creek	"	-	10	"	70	-	50	-	
70	"	Bulldog Gully	"	5-	"	10	"	2	20	-	
71	"	"	"	-	10-	10-	150	5	70	-	Sn, Mo
72	"	"	"	-	"	"	50	2-	50	-	
73	"	W. of Broken Gully	"	-	"	"	70	2	150	-	Pb
74	"	Broken Gully	"	-	"	"	100	2	100	-	
75	"	"	"	-	"	"	"	7	"	-	Mo
76	"	"	"	-	"	"	70	"	50	-	Mo
81	"	Tribty. of Eastine Creek	"	20	10	20	30	-	100	-	Co
82	"	"	"	5-	20	10	10	-	70	-	
83	"	"	-	5	10	"	200	2	200	-	Sn, Pb
84	"	"	5-	5-	"	20	50	5	200	-	Mo, Pb
85	"	"	"	5	"	"	10	-	"	-	Pb
86	"	Nr. Eastine Creek	"	5-	"	"	70	-	300	-	Pb
87	"	"	-	-	10-	10-	-	-	20	-	
88	"	"	5-	5-	10	10	-	-	200	-	Pb
89	"	"	"	5	10-	50	-	-	30	-	V
90	"	S.E. of Nymbool	"	5-	10	20	10	2	150	-	Pb
91	"	"	"	5	"	"	"	-	100	-	Pb
92	"	"	"	5-	"	"	"	-	20	-	
93	"	"	"	"	"	"	50	-	100	-	Pb
94	"	"	-	5-	10-	10-	-	-	"	-	
95	"	Smith's Creek Gorge	-	-	20	20	300	-	"	-	Sn
96	"	"	-	-	10-	10-	150	-	"	-	Sn
97	"	"	5-	5	10	"	30	2	300	-	Pb
98	"	"	-	"	20	"	100	"	"	-	Pb
99	"	Ambrose Creek	5-	5-	"	20	200	"	100	-	Sn
100	"	"	"	"	10	10	-	5	"	-	Mo
101	"	"	-	-	"	"	500	10	"	-	Sn, Mo
102	"	"	-	-	10-	"	50	7	"	-	Mo
103	"	"	5-	5-	10	"	10	"	50	-	Mo
104	"	"	"	"	20	"	"	5	70	-	Mo
105	"	"	"	"	"	30	30	2	50	5	V, Be
106	"	"	"	"	10	10	200	"	20	15	Sn, Be
107	"	"	"	"	"	"	20	"	10	5	Be
108	"	"	"	"	10-	"	"	"	"	-	
109	"	"	"	"	10	"	"	"	20	-	
110	"	"	"	"	20	20	"	"	"	-	

Sample No.	Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
111 bank	Ambrose Creek	5-	5-	20	20	20	5	20	5	Mo, Be
112 "	"	"	"	"	10	10	2	30	-	
113 "	"	"	"	150	10	10	2	50	-	Cu
114 "	Black's Creek	-	-	10	10-	20	5	200	-	Mo, Pb
115 "	"	-	-	10-	"	100	"	300	-	Mo, Pb
116 "	"	-	-	"	"	"	7	"	-	Mo, Pb
117 "	"	-	-	"	"	30	2	"	-	Pb
118 "	"	-	-	"	"	150	-	200	-	Sn, Pb
119 "	"	-	-	"	"	30	2	300	-	Pb
120 "	"	5	5-	200	10	20	"	1000	-	Cu, Pb
121 "	"	5-	"	30	"	150	-	500	-	Cu,Sn,Pb
122 "	"	-	"	10-	10-	30	-	200	-	Pb
123 "	"	5-	"	20	20	20	2	100	-	
124 "	"	"	5-	10-	10-	30	-	200	-	Pb
125 "	"	-	-	"	"	100	-	150	-	Pb
126 "	"	-	-	"	"	-	-	150	-	Pb
127 "	"	-	-	"	"	30	-	50	-	
146 "	Erin Creek	5-	5-	20	10	500	-	150	-	Sn, Pb
147 "	"	"	"	10	20	-	-	100	-	
148 "	E. of Nymbool	"	"	10-	"	10	-	50	-	
200 "	Ironstone Creek	"	-	"	10-	70	-	150	-	Pb
bed		-	-	"	"	10	-	200	-	
201 bank	"	-	-	"	"	-	-	20	-	
bed		5-	5-	"	10	-	-	70	-	
202 bank	"	"	"	10	"	-	-	100	-	
bed		"	"	10-	"	-	-	50	-	
203 bank	Geebung Creek	"	10	50	"	30	2	20	-	Co, Cu
204 "	Anyon's Swamp	-	-	10-	10-	-	-	"	-	
205 "	"	-	-	"	10	-	-	"	-	
206a "	Lead Creek	-	5-	"	20	-	-	50	-	
206b "	Anyon's Swamp	-	"	"	10	-	-	30	-	
207 "	Lead Creek	-	-	10	"	30	2	200	-	Pb
208 "	"	-	5-	10-	"	-	-	50	-	
209 "	"	-	-	"	10-	20	-	70	-	
210 "	"	-	-	"	"	100	-	100	-	Sn, Pb
211 "	"	5-	5-	10	10	"	2	50	-	Sn
212a "	"	-	"	10-	20	-	"	30	-	
212b "	Geebung Creek	5-	"	50	10	50	2	20	-	Cu
213a "	"	"	"	10	10-	200	"	100	-	Sn
213b "	W. of Miracle Mine	"	-	"	10	70	5	150	-	Mo, Pb
214 "	"	"	5-	"	"	10	-	30	-	
215 "	"	"	-	20	20	50	-	200	-	Pb
216 "	"	"	5-	10	10	200	2	200	-	Sn, Pb

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
217	bank	Nr. Miracle Mine	5-	5-	10	10-	20	2-	30	-	
218	"	Surprise Creek	-	-	70	"	300	-	"	-	Cu, Sn
219	"	The Lagoons	-	-	10-	"	10	-	"	-	
220	"	"	-	5-	10	10	20	-	70	-	
221	"	Corella Creek	5-	5-	"	"	10	-	20	-	
222	"	E. of Nymbool	"	"	20	20	"	-	30	-	
223	"	"	"	"	10	"	"	-	20	-	
224	"	Nr. Miracle Mine	"	"	"	"	300	2	30	-	Sn
225	"	"	"	"	20	30	200	-	100	-	V, Sn
226	"	"	-	"	10-	10-	10	-	50	-	
227	"	"	5-	"	"	"	"	2-	"	-	
228	"	"	"	"	10	10	200	"	100	-	Sn
229	"	"	"	"	20	"	150	20	300	-	Sn,Mo,Pb
230	"	Wyndham Creek	"	"	30	"	50	2	50	-	Cu
231	"	"	"	"	100	"	"	-	30	-	Cu
232	"	E. of Brownville	"	"	50	20	70	-	10	-	Cu
233	"	"	"	"	70	"	50	-	20	-	Cu
234	"	"	"	10	50	"	70	-	30	-	Co, Cu
235	"	"	5-	5	50	20	50	-	20	-	Cu
236	"	N. of Extended Mine	"	5-	20	"	100	-	30	-	
237	"	"	"	5	30	50	150	-	20	-	Cu,V,Sn
238	"	"	"	5-	"	30	"	-	30	-	Cu,V,Sn
239	"	"	"	5	70	"	50	-	30	-	Cu,V
240	"	"	"	"	50	"	"	-	20	-	Cu,V
241	"	"	"	5-	30	50	150	-	100	-	Cu,V,Sn,Pb
242	"	"	"	5	"	"	50	-	70	-	Cu, V
243	"	Wyndham Creek	"	"	100	"	200	2	"	-	Cu,V,Sn
244	"	"	"	"	50	30	70	-	20	-	Cu,V
245	"	"	"	"	100	20	50	-	30	-	Cu
246	"	"	"	"	"	30	"	-	50	-	Cu,V
247	"	"	"	5-	70	50	30	-	30	-	Cu,V
248	"	Nr. Extended Mine	"	"	30	30	70	-	50	-	Cu,V
249	"	"	"	10	"	"	150	-	"	-	Co,Cu,V,Sn
250	"	W. of Coolgarra	"	5-	20	10	700	-	"	-	Sn
251	"	"	"	5	30	20	300	-	"	-	Cu,Sn
252	"	"	"	5-	"	30	"	-	30	-	Cu,V,Sn
253	"	S. of Extended Mine	"	10	50	20	50	-	"	-	Co,Cu
254	"	"	"	5	70	"	200	-	70	-	Cu,Sn
255	"	Head of Battle Creek	"	5-	20	10	70	-	"	-	
256	"	"	"	"	"	"	50	-	50	-	
257	"	"	"	"	30	20	50	-	70	-	Cu
258	"	"	"	"	20	"	70	-	50	-	
259	"	Dreadnought Gully	"	"	"	30	100	-	100	-	Cu,V
260	"	"	"	"	"	10	150	-	"	-	Sn

Sample No.	Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
261 bank	Nr. Dreadnought Gully	5-	5-	30	10	100	-	150	-	Cu, Pb
262 "	"	"	"	20	10-	70	-	30	-	
263 "	Head of Limestone Creek	"	"	10-	10	300	-	30	-	Sn
264 "	"	"	"	"	10-	50	-	30	-	
500 "	Dry River area	5-	5-	10-	10-	300	2	50	-	Sn
501 "	"	"	"	50	10	500	2-	400	-	Cu, Sn, Pb
502 "	"	"	"	10	10-	"	2	50	-	Sn
503 "	"	"	"	10-	10	"	2-	20	-	Sn
504 "	"	"	"	30	"	"	2	30	-	Cu, Sn
505 "	"	"	"	20	"	"	"	50	-	Sn
506 "	Wild River area	"	"	50	"	300	"	100	-	Cu, Sn
507 "	"	"	"	50	20	"	2-	150	-	Cu, Sn, Pb
508 "	"	5	5	10	"	70	"	50	-	
509 "	"	5-	5-	"	10	150	2	100	-	Sn
510 "	"	"	"	20	20	"	2-	100	-	Sn
511 "	"	10	5	10	"	30	"	30	-	Ni
512 "	"	5	"	20	"	100	"	70	-	
513 "	"	"	"	"	"	50	"	50	-	
514 "	"	"	5-	10-	"	70	2	100	-	
515 "	"	"	5	20	10	200	"	150	-	Sn, Pb
516 "	"	"	5-	10-	"	50	5	200	-	Mo, Pb
517 "	"	10	10	20	50	100	-	10	-	Ni, Co, V (basalt?)
518 "	"	5-	5-	10-	10-	300	-	150	-	Sn, Pb
519 "	"	"	"	"	10	70	-	70	-	
520 "	Kiama Creek	"	"	30	10-	2000	5	200	7	Cu, Sn, Mo, Pb, Be
521 "	"	"	"	10-	"	1500	2	70	-	Sn
522 "	"	"	"	"	"	2000	"	"	5	Sn, Be
523 "	Deadman's Gully	"	"	10	"	100	"	150	-	Pb
524 "	"	"	"	"	"	"	"	"	-	Sn, Pb
bed	"	"	"	10-	"	200	"	100	-	
525 bank	Sailor's Creek	"	"	30	"	100	"	150	-	Cu, Pb
526 "	Deadman's Gully	"	"	10	"	200	2-	70	-	Sn
527 "	"	"	"	"	"	70	"	100	-	
528 "	Top Nettle Camp	"	"	10-	"	200	2	50	-	Sn
529 "	"	"	"	20	10	400	2-	"	-	Sn
530 "	Woolcoman Creek	"	"	10-	10-	1000	2	70	-	Sn
531 "	Wild River	5-	5-	10	10-	150	2	100	-	Sn
bed	"	-	-	"	"	300	-	"	-	
532 bank	Dry River	-	-	10-	"	100	2	"	-	Sn, Mo
bed	"	-	-	"	"	500	3	70	-	
533 bank	Woolooman Creek	5-	-	"	"	200	2	50	-	Sn

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
534	bank	Wooloomian Creek	-	-	10-	10-	200	2	70	-	Sn
	bed		-	-	"	"	300	"	"	-	
535	bank	"	5-	5-	"	"	700	5	150	-	Sn,Mo,Pb
	bed		"	"	"	"	5000	"	50	-	
536	bank	Little Wooloomian Creek	"	"	"	"	700	7	"	5	Sn,Mo,Be
	bed		"	"	"	"	200	5	"	"	
537	bank	"	"	"	"	"	"	"	70	10	Sn,Mo,Be
	bed		"	"	"	"	300	"	"	"	
538	bank	"	"	"	"	"	1500	"	100	-	Sn, Mo
	bed		"	"	"	"	150	7	"	-	
539	bank	"	"	"	"	"	400	"	"	-	Sn, Mo
	bed		"	"	"	"	2000	5	50	-	
540	bank	Mowbray Creek	"	"	"	"	150	"	200	-	Sn,Mo,Pb
	bed		"	"	"	"	700	2	100	-	
541	bank	"	"	"	"	"	400	10	"	-	Sn,Mo
542	"	Dry River	"	"	10	10	100	2	150	-	Sn,Pb
	bed		"	"	10-	10-	150	"	100	-	
543	bank	"	5	5	20	20	-	2-	100	-	
	bed		-	5-	10	30	-	-	30	-	
544	bank	"	5-	"	"	20	50	2-	70	-	
	bed		"	"	"	"	"	"	50	-	
545	bank	"	"	5	"	"	10	"	100	-	Pb
	bed		"	5-	"	10	"	"	150	-	
546	bank	"	"	"	"	20	10-	"	50	-	
	bed		"	"	"	10	50	"	70	-	
547	bank	"	"	"	"	"	10-	"	50	-	
	bed		"	"	"	20	10-	"	70	-	
548	bank	"	"	"	"	"	"	"	50	-	
	bed		"	"	10-	"	20	2	"	-	
549	bank	Little Wooloomian Creek	"	"	"	10-	700	"	30	5	Sn,Be
	bed		"	"	"	"	1500	2-	50	-	
550	bank	"	"	"	10	10	100	"	30	-	Sn,Be
	bed		"	"	10-	10-	300	"	20	3	
552	bank	Wooloomian Creek	"	"	"	"	200	2-	50	-	Sn
	bed		"	"	"	"	5000	2	30	-	
553	bank	"	"	"	"	"	1000	"	150	-	Sn,Pb
	bed		"	"	"	"	5000	"	100	-	
554	bank	"	"	"	"	"	3000	"	70	5	Sn,Be
555	"	"	"	"	"	"	700	5	100	-	Sn,Mo,Be
	bed		"	"	"	"	500	"	70	3	
556	bank	"	"	"	"	"	1500	"	"	"	Sn,Mo,Be
	bed		"	"	"	"	300	2	50	-	
557	bank	"	"	"	"	"	"	2-	"	-	Sn,Be
	bed		"	"	"	"	100	"	"	7	

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
558	bank	Russian Gully	–	–	10–	10–	700	2	100	–	Sn,Mo
	bed		–	–	"	"	300	10	"	–	
559	bank	"	–	–	10	"	200	–	"	–	Sn
	bed		–	–	10–	"	150	–	10	–	
560	bank	"	–	–	"	"	300	–	50	–	Sn
	bed		–	–	"	"	200	–	"	–	
561	bank	"	–	–	"	"	50	–	100	–	Sn
	bed		–	–	"	"	150	–	"	–	
562	bank	Shady Creek	–	–	"	"	"	2	"	–	Sn
	bed		–	–	20	"	200	"	70	–	
563	bank	"	–	–	10–	"	70	–	100	–	
	bed		–	–	"	"	50	2	50	–	
564	bank	"	–	–	"	"	500	"	70	–	Sn
	bed		–	–	"	"	150	–	"	–	
565	bank	"	–	–	10	"	700	–	100	–	Sn
	bed		–	–	"	"	200	2	50	–	
566	bank	Sandy Creek	–	–	10–	"	"	"	100	–	Sn
	bed		–	–	"	"	150	–	"	–	
567	bank	"	–	–	"	"	300	–	"	–	Sn
	bed		–	–	"	"	"	2	70	–	
568	bank	Deadman's Gully	–	5–	20	10	70	–	100	–	
	bed		5–	5–	10–	"	"	–	20	–	
569	bank	"	"	"	10	20	"	–	"	–	
	bed		"	"	"	"	50	–	10	–	
570	bank	German Gully	"	5	30	30	500	–	70	–	Cu,V,Sn
	bed		"	"	20	20	150	2	50	–	
571	bank	W. of Top Nettle Camp	"	"	"	"	"	"	10	5	Cu,Sn,Be
	bed		"	"	50	10	30	–	"	2	
572	bank	"	"	5	20	70	50	5	"	5	V,Sn,Mo,Be
	bed		–	5–	"	10	500	2	"	20	
573	bank	"	–	"	70	20	300	"	30	5	Cu,Sn,Mo,Be
	bed		–	"	150	10	"	5	20	"	
574	bank	"	5–	5	30	30	30	–	10	–	Cu,V
	bed		–	"	"	20	100	–	"	–	
575	bank	"	–	"	50	30	200	–	50	–	Cu,V,Sn
	bed		–	"	30	20	500	–	30	–	
576	bank	"	–	–	20	10–	100	5	100	–	Sn,Mo
	bed		–	5–	"	"	700	–	10	–	
577	bank	"	–	5	"	20	200	2	"	5	Cu,Sn,Be
	bed		–	5–	30	"	150	–	"	–	
578	bank	Micky Oaks Gully	–	–	10	10–	10	2	30	–	Cu
	bed		–	5–	30	10	100	2	30	–	
579	bank	Nettle Creek	–	–	10	10–	300	–	"	5	Sn,Be
	bed		–	–	"	"	2000	–	"	"	

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
580	bank	Ballyhooly Gully	-	-	10	10-	70	2	30	-	Sn
	bed		-	-	"	"	150	2	50	-	
581	bank	Little Woolooman Creek	5-	5-	10-	"	2000	5	150	-	Sn,Mo,Pb,Be
	bed		"	"	"	"	1500	"	30	7	
582	bank	"	"	"	"	"	500	2	50	-	Sn,Be
	bed		"	"	"	"	"	"	30	7	
583	bank	"	"	"	"	"	200	5	50	10	Sn,Mo,Be
	bed		"	"	"	"	300	2	30	-	
584	bank	"	"	"	"	"	700	-	50	5	Sn,Be
	bed		"	"	"	"	1000	2	"	10	
585	bank	"	"	"	"	"	700	2	70	5	Sn,Be
	bed		"	"	"	"	"	"	30	-	
586	bank	"	"	"	"	"	500	"	50	5	Sn,Mo,Be
	bed		"	"	"	"	1000	5	30	7	
587	bank	"	"	"	"	"	100	-	"	10	Sn,Be
	bed		"	"	"	"	1000	2	"	-	
588	bank	"	"	"	"	"	300	-	50	10	Sn,Be
	bed		"	"	"	"	500	-	"	"	
589	bank	Mowbray Creek	5-	5-	10-	10-	100	-	150	5	Sn,Pb,Be
	bed		"	"	"	"	1500	2	200	-	
590	bank	"	"	"	"	"	150	-	50	5	Sn,Pb,Be
	bed		"	"	"	"	200	-	300	-	
591	bank	"	"	"	"	"	100	2	100	-	
	bed		"	"	"	"	70	-	30	-	
592	bank	"	"	"	"	"	100	-	100	7	Sn,Be
	bed		"	"	"	"	150	-	"	"	
593	bank	"	"	"	"	"	300	-	200	-	Sn,Pb
	bed		"	"	"	"	"	-	"	-	
594	bank	"	"	"	"	"	700	-	70	-	Sn
	bed		"	"	"	"	1000	-	"	-	
595	bank	"	"	"	"	"	700	2	150	5	Sn,Mo,Pb,Be
	bed		"	"	"	"	500	3	70	"	
596	bank	"	"	"	"	"	200	5	50	"	Sn,Mo,Be
	bed		"	"	"	"	500	"	50	-	
597	bank	"	"	"	"	"	2000	"	70	7	Sn,Mo,Be
	bed		"	"	"	"	5000+	"	50	5	
598	bank	"	"	"	"	"	70	2	100	-	
	bed		"	"	"	"	100	-	"	-	
599	bank	"	"	"	"	"	500	2	70	-	Sn
	bed		"	"	"	"	2000	"	100	-	
600	bank	Headwaters of Wyndham Creek	"	"	"	"	500	"	70	-	Sn,Be
	bed		"	"	10	"	100	-	100	10	
601	bank	"	"	"	"	"	200	2	70	"	Sn,Be
	bed		"	"	"	"	"	-	"	"	

Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
602	bank	Headwaters of Wyndham Creek	5-	5-	50	10	300	-	50	10	Cu,Sn,Be
	bed		"	"	30	10-	200	-	70	"	
603	bank	"	"	"	50	"	"	2	"	7	Cu,Sn,Be
	bed		"	"	"	"	"	"	50	10	
604	bank	Harvey's Gully	"	"	"	10	150	5	20	"	Cu,Sn,Mo,Be
	bed		"	"	"	"	50	2	"	5	
605	bank	Wyndham Creek	"	"	"	"	500	"	30	-	Cu,Sn
	bed		"	5	"	"	300	"	70	-	
606	bank	"	"	"	10	10-	100	"	100	15	Sn,Pb,Be
	bed		"	"	"	"	150	"	150	15	
607	bank	"	"	5-	20	"	500	"	200	5	Sn,Pb,Be
	bed		"	"	"	"	100	"	150	15	
608	bank	Derwent Creek	5-	5-	20	10-	200	2	200	10	Sn,Pb,Be
	bed		"	"	10	"	150	-	"	5	
609	bank	"	"	"	"	"	"	2	100	"	Sn,Pb,Be
	bed		"	"	"	"	500	-	200	10	
610	bank	S.W. of Top Nettle Camp	"	"	10-	"	200	-	50	-	Sn
	bed		"	"	"	"	300	-	30	-	
611	bank	"	"	"	"	"	200	-	50	-	Sn,Be
	bed		"	"	"	"	"	-	70	15	
612	bank	"	"	"	"	"	100	-	"	-	Sn,Be
	bed		"	"	"	"	700	-	50	10	
613	bank	"	"	"	50	10	1000	-	20	-	Cu,Sn
	bed		"	"	10	"	500	-	"	-	
800	bank	Mulligan's Gully	"	-	10-	"	70	2	50	-	
801	"	"	-	-	"	10-	150	-	100	-	Sn
802	"	"	5-	-	30	10	500	7	100	-	Cu,Sn,Mo
803	"	"	-	-	10	"	200	2-	70	-	Sn
804	"	"	5-	-	50	10-	100	2	200	-	Cu,Sn,Pb
805	"	"	-	-	10	"	700	-	100	-	Sn
806	"	S. of Mulligan's Gully	-	-	"	"	100	2	"	-	
807	"	"	-	-	10-	"	30	2	70	-	
808	"	Mullaburra Creek	5-	5-	20	20	10	2	20	-	Cu,V
	bed		5	"	30	30	50	2	30	-	
809	bank	E. of Mullaburra Creek	"	"	10	10	200	-	50	-	Sn
810	"	"	5-	10	"	"	70	-	20	-	Co
811	"	"	"	5-	"	"	30	-	30	-	
812	"	Nr. Causeway, Smith's Creek	-	-	"	10-	20	-	300	-	Pb
813	"	"	-	-	"	"	100	-	70	-	
814	"	Munro Creek	-	-	"	"	10	-	100	-	
815	"	"	-	-	10-	"	"	-	"	-	
816	"	Mullaburra Creek	5-	5-	10	10	30	-	50	-	

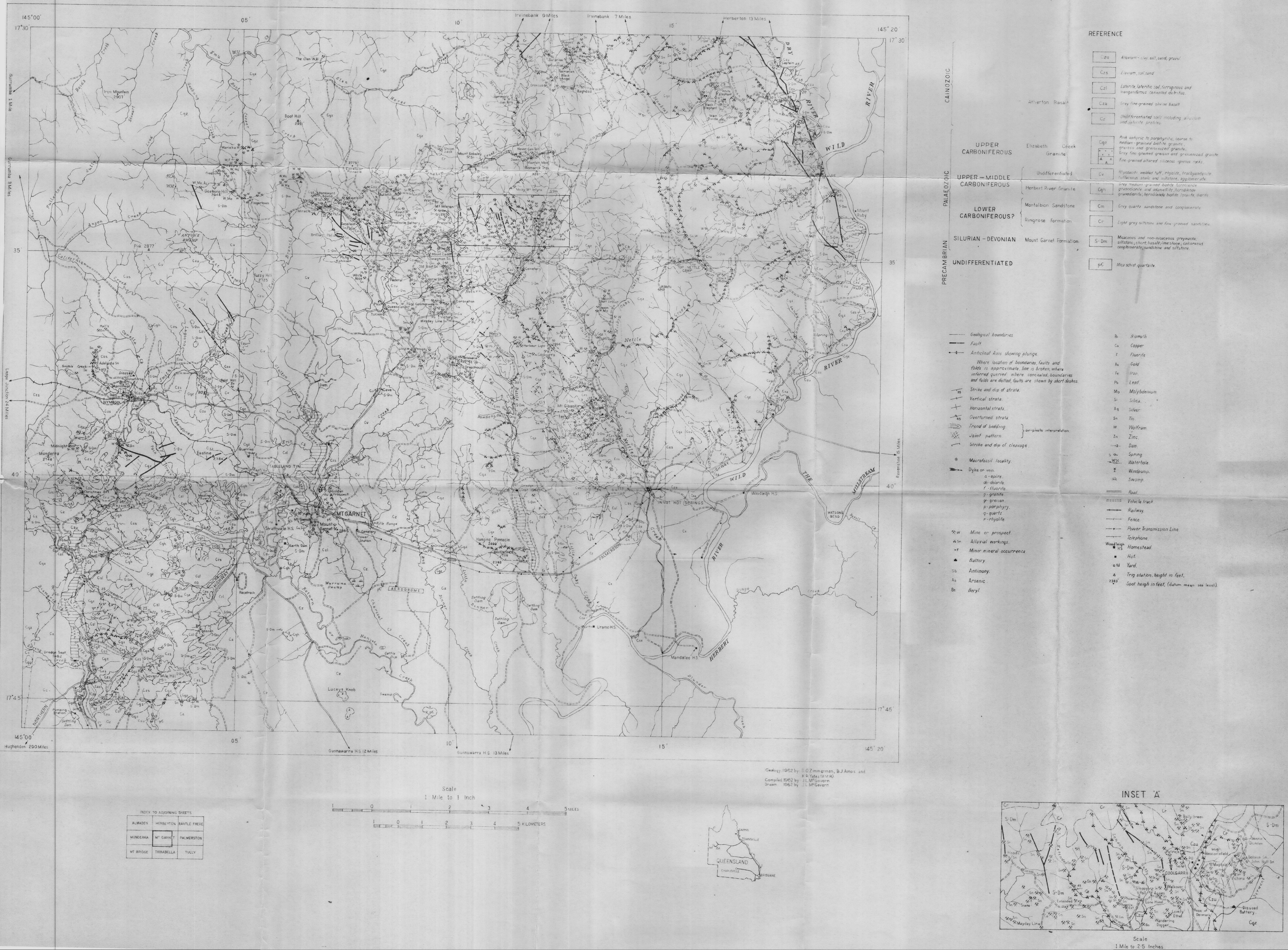
Sample No.		Locality	Ni	Co	Cu	V	Sn	Mo	Pb	Be	Anomalous elements
817	bank	Spring Creek	-	5-	50	10	-	15	50	-	Cu,Mo
818	"	"	-	"	10-	"	-	7	"	-	Mo
819	"	Quarry Creek	-	"	"	"	-	2	20	-	
820	"	"	5-	"	10	30	-	-	30	-	V
821	"	"	"	"	"	20	30	-	70	-	
822	"	Nr. Tucker's Gully	-	-	10-	10-	30	5	100	-	Mo
823	"	"	-	-	20	"	20	2	150	-	Pb
824	"	"	-	-	10	"	500	10	"	-	Sn,Mo,Pb
825	"	"	5-	5-	20	10	30	-	100	-	
826	"	Hammond's Creek	"	-	10	"	20	-	200	-	Pb
827	"	Ironstone Gully	-	-	10-	10-	50	2	20	-	
828	"	"	5-	-	20	10	20	"	100	-	
829	"	"	"	5-	"	"	50	"	200	-	Pb
830	"	Hammond's Creek	-	-	10-	20	-	-	70	-	
831	"	N. of Hammond's Creek	5-	5-	20	"	-	2	30	-	
832	"	Hammond's Creek	"	"	50	10	-	7	20	-	Cu,Mo
833	"	"	"	"	20	50	-	5	150	-	V,Mo,Pb
834	"	Lower Return Creek	5	5	"	"	70	2	200	-	V,Pb
835	"	Spring Creek	5-	5-	30	70	-	"	150	-	Cu,V,Pb
836	"	"	"	"	10	"	-	"	100	-	V
837	"	"	"	"	20	10	100	"	"	-	
838	"	"	"	"	100	70	10	10	50	-	Cu,V,Mo
839	"	"	"	"	10	10	30	-	30	-	
840	"	"	"	"	"	20	10	-	20	-	
841	"	Mullaburra Creek	"	"	"	"	50	-	"	-	
842	bed	"	"	5	"	"	30	-	30	-	
843	bank	S. of Racecourse	5	"	30	30	100	-	70	-	Cu,V,Sn
844	"	Little Oaky Creek	5-	5-	10-	10-	150	-	10	-	Sn
845	"	"	"	"	"	"	10	-	"	-	
846	"	"	"	"	"	"	"	-	30	-	
847	"	"	"	5	10	10	10	-	"	-	
848	"	"	"	5-	"	20	50	-	50	-	
849	"	W. of Innot Hot Springs	"	"	"	10	10	-	10	-	
850	"	"	"	5	"	"	30	-	"	-	
851	"	"	"	5-	10-	10-	10	-	20	-	
852	"	"	"	"	"	"	200	-	"	-	Sn
853	"	Broken Gully	"	"	"	"	1500	-	"	-	Sn
854	"	"	"	"	"	"	2000	10	100	-	Sn,Mo

PRELIMINARY EDITION 1962
SUBJECT TO AMENDMENT

Plate. 1

MT GARNET AREA

QUEENSLAND



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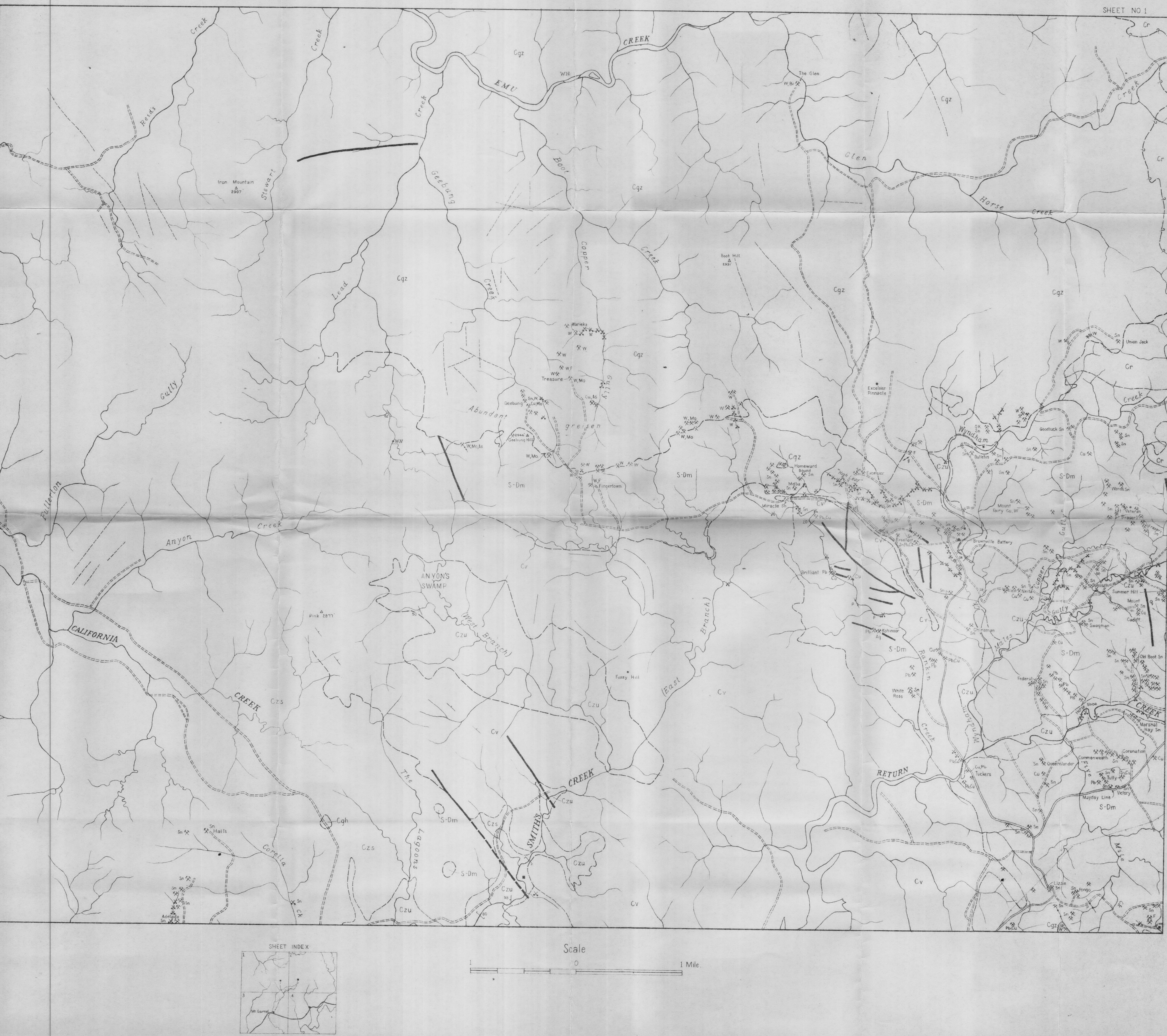
Compiled 1962 by: J L McGovern
Drawn 1962 by J L McGovern

MT GARNET AREA

NORTH QUEENSLAND

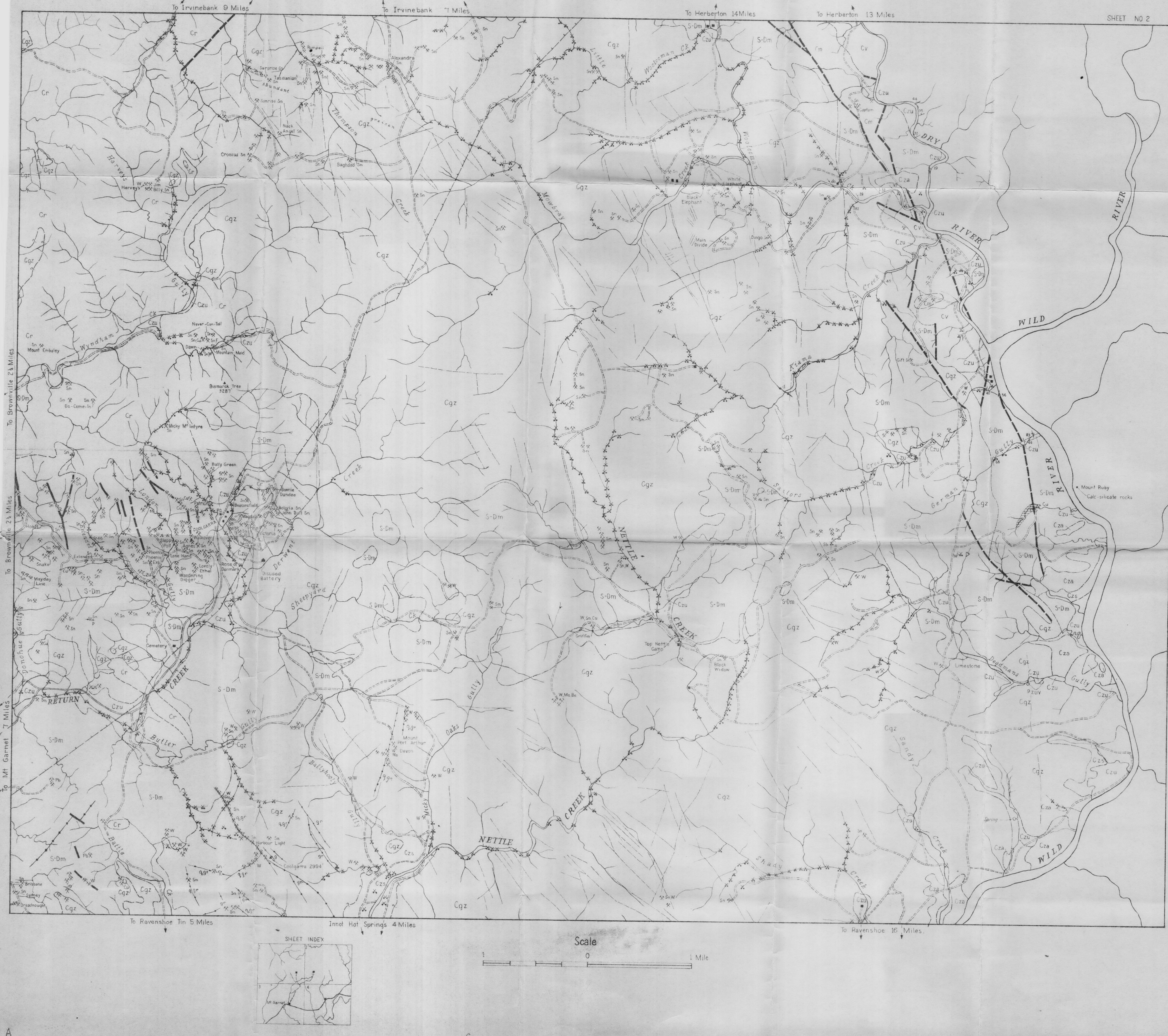
Plate. 2.



MT GARNET AREA

NORTH QUEENSLAND

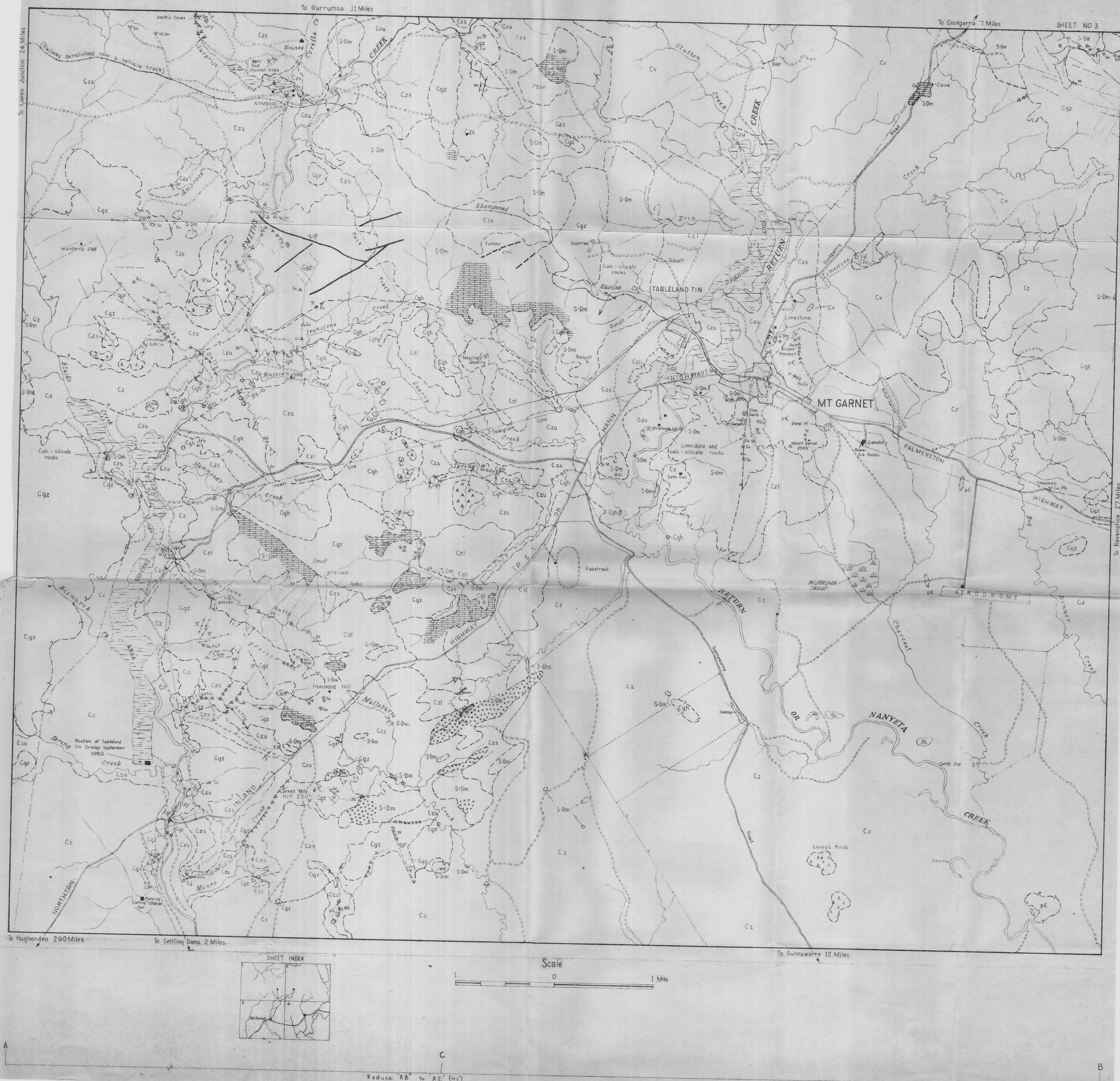
Plate 3.



MT GARNET AREA

NORTH QUEENSLAND

Plate 4



MT GARNET AREA

NORTH QUEENSLAND

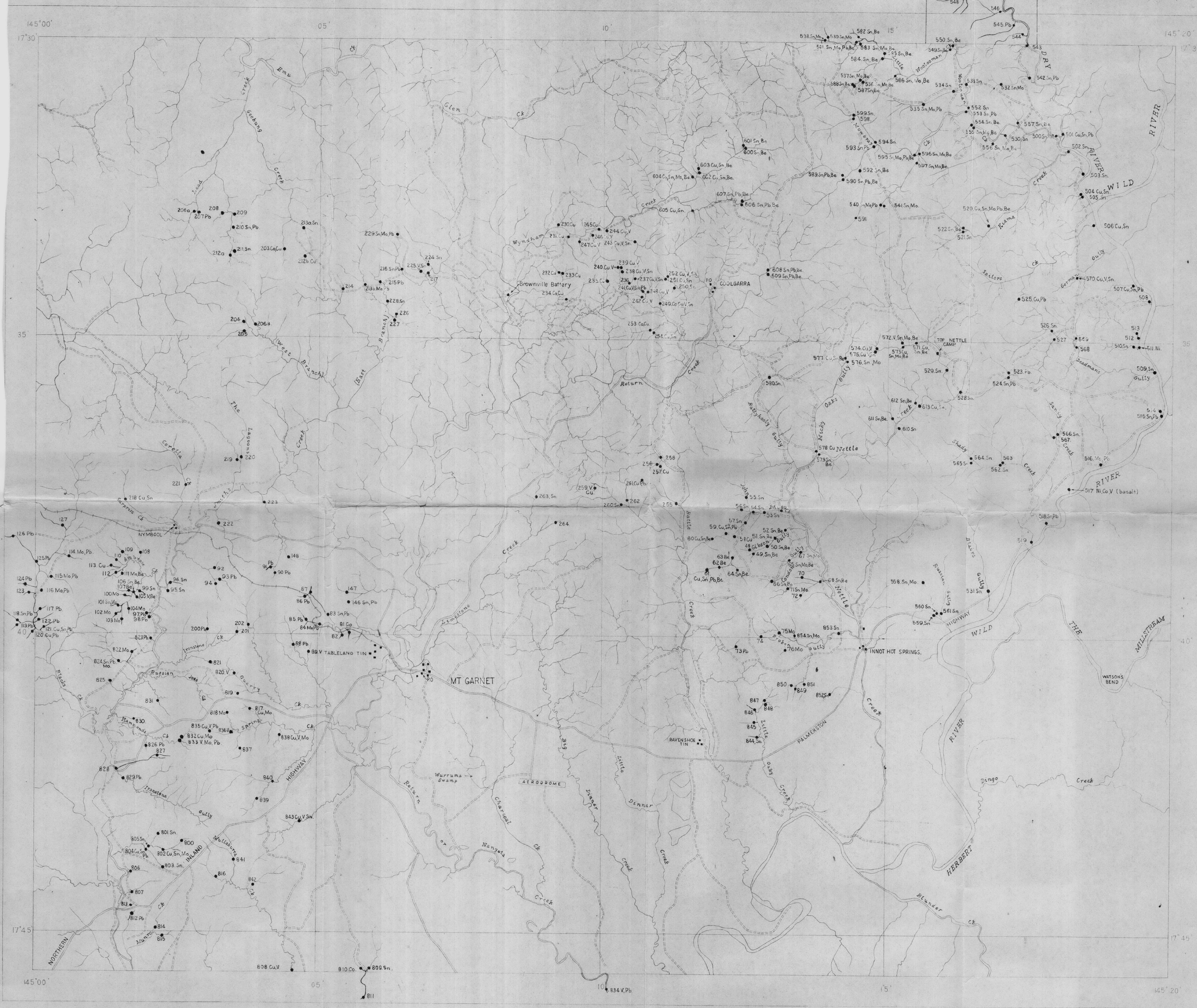
Plate. 5.

MT. GARNET AREA

Plate.6.

SHOWING

Geochemical Sampling Localites and Anomalous Elements



Drawn 1962 by J.L.McGovern.

Scale
1 Mile to 1 Inch

1 0 1 2 3 4 5 MILES

1 0 1 2 3 4 5 KILOMETERS

NOTE.

812 Pb. Geochemical sample locality showing anomalous elements for:

Be · Berylium
Co · Cobalt
Cu · Copper
Pb · Lead
Mo · Molybdenium
Ni · Nickel
Sn · Tin
V · Vanadium

CAINOZOIC			Czu	Alluvium – clay, silt, sand, gravel
			Czs	Eluvium, soil, sand.
			Czl	Laterite, lateritic soil, ferruginous and manganiferous cemented detritus
		Atherton Basalt	Cza	Grey fine-grained olivine basalt.
			Cz	Undifferentiated soils including alluvium and laterite profiles.
PALAEOZOIC	UPPER CARBONIFEROUS	Elizabeth Creek Granite	Cgz	Grey fine-grained greisen and greisenized granite Fine-grained altered siliceous igneous rocks.
	UPPER — MIDDLE CARBONIFEROUS	Undifferentiated	Cv	Rhyodacite welded tuff, rhyolite, trachyandesite, tuffaceous shale and siltstone, agglomerate
		Herbert River Granite	Cgh	Grey medium-grained, biotite hornblende granodiorite and adamellite, hornblende granodiorite, hornblende biotite tonalite.
	LOWER CARBONIFEROUS?	Montalbion Sandstone	Cm	Grey quartz sandstone and conglomerate.
		Ringrose Formation	Cr	Light grey siltstone and fine-grained sandstone.
	SILURIAN-DEVONIAN	Mount Garnet Formation	S-Dm	Micaceous and non-micaceous, medium grained, greywacke, siltstone Limestone, calcareous conglomerate sandstone, and siltstone; chert Altered basalt
PRECAMBRIAN	UNDIFFERENTIATED		p€	Mica schist, quartzite.

Geological boundaries.

Fault.

Anticlinal Axis showing plunge.

Where location of boundaries, faults and folds is approximate, line is broken, where inferred queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

35 Strike and dip of strata

Vertical strata

Horizontal Strata

45 Overturned strata

Trend of bedding } air-photo interpretation.

Joint pattern } air-photo interpretation.

Strike and dip of cleavage

Dyke a-aplite do-dolerite f-fluorite g-granite gr-greisen p-porphyry q-quartz r-rhyolite

Macrofossil locality

F Minor mineral occurrence

W Mine or prospect

Sn Alluvial workings

Ag - Silver	Cu - Copper
Fe - Iron	F - Fluorite
Mo - Molybdenum	Pb - Lead
Si - Silica	Sn - Tin
W - Wolfram	Zn - Zinc
Sb - Antimony	Be - Beryl
As - Arsenic	Bi - Bismuth

Battery

Road

Vehicle track

Railway.

Fence

Power Transmission line.

Telephone.

Built up Area.

Woodleigh HS. Homestead.

Hut.

Yd Yard.

Dam small.

WH Waterhole.

S Spring.

Swamp.

Windpump.

Trig station height in feet.

2383' Spot height in feet. (datum: mean sea level)