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WESTERN AUSTRALIA.

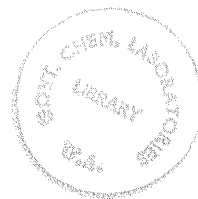
REPORT

OF THE

GEOLOGICAL SURVEY

FOR THE

YEAR 1940



PERTH:

BY AUTHORITY: FRED. WM. SIMPSON, GOVERNMENT PRINTER.

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1941.

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Annual Progress Report of the Geological Survey of Western Australia for the Year ended 31st December, 1940.

The Under Secretary for Mines.

I have the honour to submit, for the information of the Honourable the Minister for Mines, my report on the operations of the Geological Survey for the year 1940.

STAFF.

There was one staff change during the year. In August the Survey lost the services of Mr. H. A. Ellis, who, at the request of Military Headquarters, Western Command, was released for military duties with the Defence Forces. From August onward the staff consisted of the Government Geologist, three field geologists, a senior typist, a junior clerk and a messenger.

The progress of systematic field work in the Mount Margaret and Yilgarn Goldfields was interrupted during the year to enable the concentration of the field staff on special investigations of industrial minerals, and of those minerals brought into special demand for war requirements.

The principal activities of the professional officers are set out below.

F. G. Forman, Government Geologist:

During January, I inspected the vermiculite deposits at the Young River, east of Ravensthorpe and the barite deposits at Cranbrook.

In February, I visited Collie to inspect the conditions resulting from a "creep" in the Proprietary Colliery, and at the same time took the opportunity to inspect bucket dredging operations at Greenbushes.

During March and April I was engaged principally in activities arising from my membership of two Royal Commissions, one inquiring into a creep at the Collie coalfield, the other inquiring into coal supplies and development in the Collie coalfield. At the end of April I made a second visit to the Greenbushes tinfield on the occasion of an inspection by the Hon. the Minister for Mines.

In May I accompanied the State Mining Engineer to Ravensthorpe to assist in obtaining samples of sulphide ores for experimental purposes connected with a request to the Department for the establishment of a central plant to treat the gold-copper ores from this district. During the later part of May and most of June I was at Koolan Island, Yampi Sound, engaged on work connected with the investigation of iron deposits.

In July I inspected the progress of departmental field work in the northern portion of the Yilgarn Goldfield. A proposed inspection of similar work in progress in the Mount Margaret Goldfield was necessarily abandoned owing to a major breakdown of the only available means of transport.

August and September were occupied mainly by investigation of the bauxitic laterites of the Darling Ranges near Perth, and the phosphate deposits of the Dandaragan district. Early in August I accompanied the other members of the Commission to Collie to discuss, with Amalgamated Collieries, Ltd., matters arising out of the report of the Royal Commission on creep.

During October I visited the Northampton Mining district in order to inquire into the future possibilities for the production of lead and copper in this district. In the same month I inspected the Yinnie-tharra mica and bismuth areas.

During December I inspected the drilling operations of the Freney Kimberley Oil Company at Nerrima Bore site, West Kimberley.

The remainder of my time during the year was fully occupied by a number of short inspection trips in the vicinity of Perth and with administrative duties in Head Office.

H. A. Ellis, Geologist:

Mr. Ellis was on leave from the beginning of the year until the 23rd January.

In February he made several visits to Greenbushes in connection with bucket dredging operations, in addition to compiling data relative to the tale, magnesite and vermiculite deposits of the State.

Early in March Mr. Ellis commenced field work on the systematic examination of the known tale, magnesite and vermiculite deposits of the south-west part of the State, including magnesite deposits east of Ravensthorpe and vermiculite deposits on the Young River.

In April Mr. Ellis made an examination of the "Famous Blue" gold mining lease and surrounding country at Duketon for departmental purposes.

In July Mr. Ellis examined the bismuth and mica deposits at and near Morrissey Hill on Yinnie-tharra Station in the Gascoyne River district. Towards the end of the month he was called up for military duties and left the Geological Survey on August 14th.

R. A. Hobson, Geologist:

From January to the middle of April, Mr. Hobson was at Head Office preparing material for the Annual Report; making preparations for continuing field work in the Mount Margaret Goldfield; and attending to other office duties. During this period he took his annual recreation leave.

From April to July he was at Murrin continuing the geological survey of portion of the Mount Margaret Goldfield. This work was stopped at the end of July due to war conditions and Mr. Hobson returned to Perth. The work in the Mount Margaret Goldfield is incomplete.

During August, September and October, Mr. Hobson was engaged on office work associated with the Mount Margaret Goldfield; the object being to leave this work in such a condition that it can be readily continued at some future time. Also during this period he was engaged on computations connected with the iron ore reserves of Koolan Island and made preparations for a trip to the Murchison and Yalgoo Goldfields.

During most of November, he was inspecting copper occurrences in the Murchison and Yalgoo Goldfields.

For the remainder of the year he was at Head Office preparing notes on the copper occurrences inspected during November, and attending to other office duties.

R. S. Matheson, Geologist:

From January to March, Mr. Matheson was engaged in compiling reports on some mines in the Yilgarn Goldfield examined during 1939 field season, proof reading and indexing Bulletin No. 98, and carrying out miscellaneous office work.

Mr. Matheson left Perth to resume the examination of the mines in the northern portion of the Yilgarn Goldfield at the beginning of April, and was continuously engaged on this work until the middle of August. Before returning to Perth, he visited the "Scorpio" and "Green Bird" leases at Marvel Loch to advise the lessees on future prospecting.

From September to the end of October, Mr. Matheson was engaged in writing reports on mines examined during the 1940 field season, and carrying out miscellaneous office work.

In November, Mr. Matheson inspected the copper deposits in the Peak Hill Goldfield and on his return to Perth was employed writing a report on these deposits. He commenced his annual leave on 23rd December.

K. R. Miles, Geologist:

Mr. Miles was engaged for the greater part of the year on various duties necessitating his remaining at Headquarters. From January to late in March he was employed on the completion of reports for the Annual Progress Report; redrafting of plans in connection with his recent field work in the Laverton district, and on other routine office duties.

From the latter end of March to the beginning of May he made a fairly complete overhaul of a large part of the Survey rock and mineral collection. During this time some 14,000 rock and mineral speci-

mens were resorted and repacked into drawers in the museum; while many unwanted specimens were discarded and missing rocks recorded. By this means an enormous amount of space has now been made available for the storage of new specimens such as are continually being brought in from the field.

During the greater part of the remainder of the year Mr. Miles was engaged in petrological work. This work included a fairly detailed petrological report on the rocks of the Mount Margaret Goldfield collected during the 1937-40 field seasons, and numbering some 650 in all, and also a brief petrological examination and identification of the rocks obtained during the re-survey of the northern portion of the Yilgarn Goldfield.

On 1st August he left Perth for Mount Palmer where he was engaged until 21st August on detailed geological mapping of the vicinity of some bore sites on temporary reserves at Heaney's Find and Meier's Find held by Yellowdine Gold Development, Limited.

On his return to Perth, Mr. Miles continued with his petrological work on Mount Margaret and Yilgarn rocks, and other office duties. Towards the close of November he began preparation for the petrological portion of an investigation of the metasomatism of the Corinthian ore body.

Apart from the petrological work mentioned above Mr. Miles has throughout the year carried out numerous petrological determinations and has prepared many brief reports both for departmental purposes and for the general public.

He commenced his annual leave on 30th December.

FIELD TRANSPORT.

I would again draw attention to my remarks in last year's annual report to the difficulties existing in regard to motor transport in the field. These difficulties still exist and in addition during 1940 two serious and expensive delays were caused to field work by the breaking of the chassis on the two older utility trucks. Both these breakages were unavoidable and due to metal fatigue. They involved dislocation of the programme of field work at a critical time, and heavy repair bills.

PUBLICATIONS.

During the year the following publications were issued by this branch:—

Annual Progress Report of the Geological Survey for the year 1939.

Geological Survey Bulletin 98:—The Mining Groups of the Yilgarn Goldfield South of the Great Eastern Railway, Part 1, from Southern Cross Southwards to Marvel Loch, by R. S. Matheson, B.Sc., and R. A. Hobson, B.Sc. (Hons.).

The results of the principal field operations, except where investigations were carried out purely for departmental purposes, are covered by the reports which follow this section.

As a measure of economy a number of this year's reports of investigations have been replaced by brief summaries showing the nature, scope and principal results of the work. The full reports and the plans

which accompany them are available for inspection by the public at the Geological Survey Office, Perth.

I wish to record my appreciation of the excellent manner in which all members of the field and office staff carried out their duties during the year.

F. G. FORMAN,
Government Geologist.

THE TALC, MAGNESITE AND VERMICULITE DEPOSITS OF THE SOUTH-WEST DIVISION.

SUMMARY.

Early in March Mr. Ellis commenced a field investigation of industrial minerals. Preliminary analysis of recorded data suggested that the South-West Division of the State was the most suitable place in which to commence work, and, because the localities of known occurrences of talc, magnesite and vermiculite appeared to be suitably grouped for the most economical work, it was decided in the first place to investigate deposits of these three minerals.

The area covered by the present survey comprises the south-west corner of the State bounded on the north by the Eastern Goldfields railway and on the east by the No. 1 Rabbit Proof Fence which passes through Burracoppin on the Eastern Goldfields railway and meets the south coast about 25 miles east of Hopetoun. Although they lie outside the area described above, the vermiculite deposits of the Young River were included in the programme because of their proximity to other mineral deposits in the Phillips River Goldfield.

Field work was completed at the end of June but owing to unavoidable delays in the laboratory investigation of various samples and Mr. Ellis's transfer to defence duties in August, his reports are at present not completed.

The deposits showing most promise of economic importance are indicated in the following summary.

Talc.—No workable deposits of micaceous talc suitable for the manufacture of the higher grade products such as toilet powders, and no massive steatite of "lava" forms were discovered. There is, however, a good prospect of being able to produce slab soapstone and powdered soapstone for use in industry from a deposit at Glen Lynn, six miles south of Bridgetown. The deposit is entirely undeveloped, but is extensive and of a quality likely to be of commercial importance.

Magnesite.—At Bandalup Creek, 16 miles east of Ravensthorpe on the Esperance road, the weathering of basic dykes, intrusive into quartzites and mica schists, has produced magnesite. In a radius of about three-quarters of a mile from the road crossing over Bandalup Creek, numerous patches of magnesite occur as boulders of varying size, in some places forming almost continuous masses. In places the magnesite was seen to be three to four feet in thickness but the extent of mineral of this thickness cannot be determined in the absence of prospecting pits. The boulders vary from hard nodular to soft cellular and a bulk sample was obtained by picking over an area of about two acres on the south side of the road and west of the creek bed. This sample

(G.S./M42) gave the following result on analysis in the Government Chemical Laboratory:—

Silica, SiO ₂	.. .. .	2.17 per cent.
Iron and Alumina, Fe ₂ O ₃ , Al ₂ O ₃	.. .. .	1.26 per cent.
Magnesia, MgO	.. .. .	39.42 per cent.
Lime, CaO	.. .. .	7.26 per cent.
Carbon dioxide, CO ₂	.. .. .	47.35 per cent.

Vermiculite.—The most promising vermiculite deposit examined was that on Halbert's leases on the Young River situated 64 miles by road east of Ravensthorpe. Numerous samples from these leases have been tested in the Government Chemical Laboratory with promising results. An exhibit prepared by the Government Mineralogist and Analyst, showing the various grades of raw material and the expanded products obtained from them, has been placed on view in the entrance hall of the Mines Department.

The Young River leases are at present held under option by the proprietors of the Perth Modelling Works and are being actively developed. The company has up to the present processed and sold about 10 tons of expanded vermiculite products.

MICA MINING ON MINERAL CLAIM 159H, MORRISSEY HILL, YINNIETHARRA STATION, GASCOYNE RIVER.

(H. A. Ellis, B.Sc., A.O.S.M.)

During a recent trip (July, 1940) to this locality to inspect occurrences of bismuth carbonate on other leases in the district, the writer had the opportunity of inspecting some mica-mining operations on Mineral Claim 159H—a mineral claim of 24 acres recently pegged to include the old open cut on former M.C. 39H, known as the "Mica King" lease, which was reported on by Mr. R. C. Wilson in the Annual Report of the Department of Mines for 1926.

The old open cut is situated less than half a mile south of Morrissey Hill on the northern bank of Morrissey Creek.

GEOLOGY.

The mica occurs as a well defined vein up to three feet thick situated at or near the hanging wall of a coarse-grained pegmatite dyke intrusive into straight banded gneisses and biotite-muscovite-tourmaline schists which strike a little north of west and dip at 40° to 50° southwards.

The dyke can be seen to be at least 20 feet thick in some places, and contains irregular-shaped concentrations of mica irregularly distributed in it, apart from the well defined mica concentration on or near the hanging wall.

The economic possibilities of the deposit are governed by the uni-mineral concentration of mica in a defined part of the dyke, and the quality of the mica confined thereto.

The books of mica average about 9 inches by 6 inches by 4 to 5 inches thick and are enclosed in a felspar matrix which constituted less than 40 per cent. of the vein structure in the existing faces (July, 1940).

MINING OPERATIONS.

The syndicate at present operating the claim is carrying out its work under the direction of a Mr. Spargo in whose name the claim is pegged.

The old open cut appeared to have reached a maximum depth of some 30 feet on the underlay, over about 60 or 70 feet of the length of the outcrop of the mica vein on the hanging wall of the pegmatite dyke.

The new workings consist of a vertical shaft commenced at the junction of the mica vein with the hanging wall at the western end of the old open cut, and sunk for a vertical depth of 40 feet through the pegmatite dyke into the footwall country for a few feet only.

A crosscut through the dyke for 20 feet to the south met the mica vein near the hanging wall, and drives of 26 feet east and 20 feet west had been driven on the mica at the time of inspection (July, 1940). Both faces were in mica, and the deposit was being mined exactly as if it were a gold-bearing quartz reef. A round of eight holes was being bored in each working face, the holes being kept in the mica deposit, and full charges of explosives fired in each round.

This is a most unusual method of mining for mica and obviously is a very wasteful one, particularly when the schistose nature of the walls permits of the use of better methods. The mica is heavily iron stained, the books being quite opaque as the result of a series of iron oxide inclusions arranged on a linear pattern intersecting at 60° and 120°.

Some of the books are penetrated by acicular tourmaline or quartz crystals, and many of them have flat, thin accumulations of what appears to be secondary silica between the laminae.

The prospects of the mica becoming cleaner in depth can be summarised as follows:—

- (a) Iron oxide films which produce the variegated patches of colour in the mica at present being mined will become less frequent.
- (b) The thin crusts of secondary silica between the laminae will disappear.
- (c) The linear inclusions arranged on the crystallographic pattern will persist, these being, in all probability, developed at the same time as the mica crystallised from the parent magma.

The mine is equipped with a 15 h.p. Rushton Hornsby crude oil engine, small C.P. compressor and receiver, geared friction winch and rock drills fitted with Riley bits. The mica is trimmed only on the mine, a hand guillotine being used for this purpose.

The owners claim that they have a profitable market for their comparatively low grade product, and prospects of obtaining considerable quantities of stained mica of otherwise good quality are good, as the mica vein outcrops through the soil for some 200 feet westwards from the shaft, and the present workings are at 40 feet vertical depth only and confined to the western 20 feet of this length.

Good grade stained mica still persists in the vein on the hanging wall at the bottom of the old open cut, and if the relative proportion of mica to matrix as is exposed in the faces being worked at present persists in future development work, the quantity of mica won per ton of formation mined will be relatively high for mica mining operations.

REPORT ON BISMUTH CARBONATE DEPOSITS IN PEGMATITE DYKES ON M.C. 195H, AND P.A. 744H, NEAR MORRISSEY HILL, YINNIETHARRA STATION, GASCOYNE RIVER.

(Lands Dept., Litho. 78/300 S.W. Quadrant.)

H. A. Ellis, B.Sc., A.O.S.M.

Mineral Claim 195H.

LOCALITY.

This claim is registered in the name of Messrs. Hassell and Roe, has an area of 30 acres, and is situated on the south side of Morrissey Creek about three quarters of a mile south 30° east of Morrissey Hill. Morrissey Hill is a low but prominent quartz capped hill situated on gently undulating country, some eight miles due north of Yinnietharra Station Homestead, the latter being built on the north bank of the Gascoyne river. The Morrissey Hill locality is reached in 12 miles by station road, first in a general direction of N.20° E. for eight miles and then westerly for four miles.

GENERAL GEOLOGY.

A prominent series of straight banded gneisses and biotite-muscovite-tourmaline schists with a regional strike approaching to east and west and dipping at moderate to steep angles to the south outcrops frequently in the locality.

Intrusive into this series are numerous very coarse grained pegmatite dykes, quartz reefs, greisen dykes and massive granite. The pegmatites are both concordantly and transgressively intrusive into the schists and gneiss and are noteworthy for the particularly large crystalline development of the component minerals, mica and feldspar. Some large crystals of tourmaline and beryl occur in the dykes, being frequently associated with the quartz segregations. There is also a tendency for the formation of almost mono-mineralic concentrations, e.g., masses of mica, feldspar or quartz, and occasionally tourmaline.

THE BISMUTH CARBONATE OCCURRENCE.

Towards the north-western corner of the lease, a roughly oval shaped pegmatite mass some 200 feet long in an east and west direction and some 100 feet thick in a north and south direction is intrusive into biotite-muscovite-tourmaline schist, and forms a quartz-capped hill some 60 to 70 feet high immediately on the south bank of Morrissey Creek.

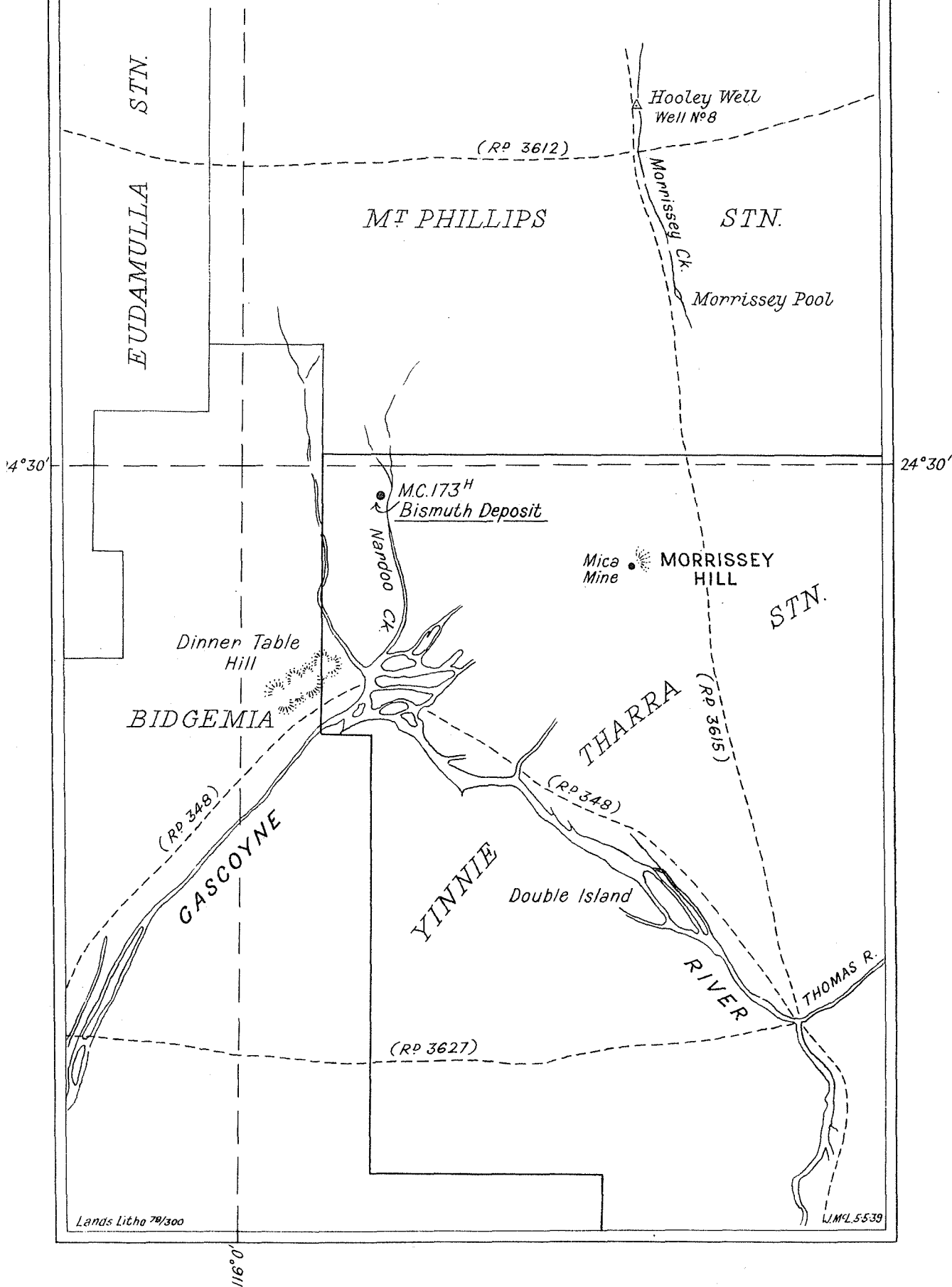
Quartz concentrations occur mainly on the southern edge of the mass and the rest of it is a typical very coarse grained pegmatite.

Small pieces of angular eluvial bismuth carbonate were found on the northern, western and southern slopes of the small hill, and a well defined run of eluvial was located on the northern slope, which when followed upwards lead to the location of a patch of bismuth carbonate with intergrown clear glassy quartz of about 400 lbs. weight *in situ* in the pegmatite dyke. The pegmatite surrounding the concentration consists mainly of feldspar with a small proportion of fine, sealy green mica, and the feldspar near the bismuth carbonate mass appears to be partially kaolinised.

The excavation from which the bismuth ore was dug was about six feet long by three feet wide by three feet deep when inspected on the 21st July,

PLAN SHOWING
LOCALITY OF BISMUTH DEPOSIT
YINNIE THARRA STATION

Scale 300 chains to an inch
300 0 300 600



1940, and a small oval shaped patch of partially kaolinised felspar some nine inches across was visible in the bottom of the hole. No bismuth ore was noticed, and beyond this slight kaolinisation of the felspar there was no mineralogical or structural guide as to possible location of any other concentration of bismuth ore.

Another very much smaller concentration of a few pounds weight only was reported to have been located near the quartz concentration on the southern side of the mass near the crest of the hill. The shallow excavation did not reveal the true nature of that part of the dyke in which this ore was found.

Still another very small concentration of bismuth carbonate was located on the northern fall near the top of the hill, this time in massive white and glassy quartz. The shallow excavation did not reveal any evidence leading to the possible occurrence of further ore.

PROSPECTS OF DEVELOPMENT.

The position at the time of inspection (21st July, 1940), was that the concentrations of bismuth carbonate located by surface prospecting methods (visual examinations and panning) had been recovered from shallow excavations, and that in no instance was there a sure structural or mineralogical guide as to the possible location of more ore.

A plant consisting of an oil engine, compressor and rock drill was on the way to the claim, and preparations were being made to install the plant.

The cumulative evidence gathered from the manner of occurrence of this elusive mineral in this claim and P.A. 744H, situated near Morrissey Hill, and Mineral Claims 173H and 191H situated some eight miles further westwards, is that the bismuth ore is a pegmatitic mineral deposited primarily as a sulphide (bismuthinite) forming an accessory mineral to the mica, felspar and quartz of the pegmatite.

Its manner of occurrence can be best likened, perhaps, to the sporadic distribution of, say, the currants in a currant bun, to use a simple comparison, and the geological probability of the occurrence of other patches of unpredictable dimensions near those already found is such as to make almost certain, in the absence of extreme good fortune, the mining of large quantities of barren dyke without encountering more ore.

This peculiarity of occurrence also makes it almost immaterial, in the absence of structural or mineralogical guides, in what direction in the dyke exploratory work is undertaken.

There is, perhaps, one slightly encouraging feature about the pegmatite dykes of the Morrissey Hill locality which has a bearing on the occurrence of possible concentrations of bismuth ore, and that is the tendency in the dykes for the formation of almost uni-mineral masses such as the mica veins of the mica leases, the irregular shaped masses of almost pure felspar, of mica, or tourmaline or quartz, or the large beryl crystals occasionally two feet across, sometimes seen.

The 400 lb. patch of bismuth carbonate and quartz already found may be regarded as one of these uni-

mineral masses, but the metallic mineral contents of pegmatite dykes are notoriously erratic in distribution in whatever part of the world they are found, although in some cases there is a tendency for these minerals to be situated in certain portions of the dykes such as marginally, or at dyke intersections.

The future development of this deposit depends on the location of new concentrations of bismuth ore by a prospecting campaign which cannot be guided by the usual mineralogical and structural indications associated with deposits of many other minerals, and which is also a campaign in which more than the usual amount of prospectors' good fortune will be needed on account of the irregular manner of occurrence of the bismuth ore.

It was suggested to the owners that the sinking of shallow shafts on the spots where the patches of bismuth ore were found *in situ*, and lateral prospecting in any direction for short distances from the shafts, was perhaps as intelligent a way as any other of searching for more ore. A sharp watch should be kept for mineralogical or structural indicators in these operations, and from the results of three or four of these excavations, evidence about the manner of occurrence of the mineral sufficiently conclusive to decide whether or not a continued search is warranted would be obtained.

P.A. 744H.

This prospecting area of 48 acres is situated about 1½ miles N.N.W. of Morrissey Hill in similar country geologically to that in the vicinity of Mineral Claim 195H.

Near the western end of a particularly coarse-grained pegmatite dyke forming a low ridge on this prospecting area, there is a considerable development of greisen dykes as well as many concentrations of quartz as large irregular lenses.

A small occurrence of bismuth carbonate was located in partially kaolinised felspar in a small mixed patch of greisen and pegmatite. A small shallow excavation some three feet deep still shows traces of bismuth carbonate and yellow bismuth oxide in one wall, which is mainly kaolinised felspar with some fine scales of a greenish coloured mica. The greisen and pegmatite are more decomposed in the vicinity of this excavation than is usually the case in this district, and further burrowing in a lateral direction and vertically is warranted here.

The same conditions as apply to the manner of occurrence of the bismuth carbonate and the means of prospecting the dyke on Mineral Claim 195H are applicable here.

There are some particularly large beryl crystals lying about on the surface of this prospecting area, and a thin quartz lens with associated copper carbonate stains in a biotite-muscovite-tourmaline schist occurs in one place. This copper occurrence is of mineralogical interest only, and has no commercial prospects.

Crystals of green tourmaline were found on the surface of the ground close to the pegmatite dykes, but those seen were too fractured to be of value as gem stones.

PROGRESS OF WORK ON MINERAL CLAIM
173H, YINNIETHARRA STATION.

(H. A. Ellis, B.Sc., A.O.S.M.)

This was the first mineral claim pegged for bismuth in the Morrissey Hill locality and was visited and inspected by H. A. Ellis in April, 1939. The report is published in the Annual Progress Report of the Geological Survey for 1939.

At the time of the inspection the claim was under option to a Perth syndicate of business men and was being worked by the owners, Messrs. Thompson and Hodges, as employees of the syndicate.

The recommendation was made to the principals of the syndicate that the best procedure was to work out all the possible eluvial and alluvial ground, and not to attempt the mining of the pegmatite dyke. Apparently the option was surrendered before this was done, as the original holders are still in possession of the claim.

During the option period, up to the time of inspection—April, 1939, some 800 lbs. of eluvial bismuth carbonate was reported to the syndicate, and since then, some three tons of bismuth carbonate mostly eluvial, has been obtained from the claim.

A considerable number of shallow excavations best described mainly as horizontal burrowings in the dyke hill, and costeans, trenches and shallow shafts, but in the main representing a considerable expenditure of labour and explosives, have been dug chiefly on the southern fall of the ridge near the crest and particularly at the eastern end. These were made in the pegmatite in search of bismuth ore, and according to the owners resulted in the finding of very little ore. They were mainly started at or near places where a small area of a square yard or so of the surface contained sharply angular bismuth carbonate.

The net result of all of these openings was to prove the original contention of the writer, that mining the dyke was unpayable, as there was no structural or mineralogical guide to the position of the next patch of bismuth ore.

A careful inspection of the claim leads one to believe that the bulk of the bismuth carbonate so far obtained from this claim has been won from the repeated sieving of the eluvium covering less than a square chain in area on the southern fall at the eastern end of the hill.

Natives have been freely used in these sieving operations, and no doubt their peculiar adaptability to surface prospecting has been in no small measure responsible for the quantity so far won.

Unless further patches of eluvial or alluvial bismuth carbonate are located on the lease, the production from this area will cease when the present small eluvial patch is worked out.

NOTES ON BISMUTH DEPOSITS ON MINERAL
CLAIM 191H, NARDOO CREEK, YINNIE-
THARRA STATION.

(H. A. Ellis, B.Sc., A.O.S.M.)

Mineral Claim 191H of 100 acres is apparently Mineral Claim 175H of 179 acres re-pegged to a smaller area confined to the eastern portion of M.C. 175H as originally pegged.

The claim adjoins M.C. 173H (Thompson & Co.) to the west, and takes in part of the western end of

the ridge of pegmatite which comprises the main asset on M.C. 173H. Faulty pegging of M.C. 173H in the first instance left this portion of the bismuth carbonate bearing pegmatite dyke included in M.C. 173H out of that claim, and after some trouble Stuart & Co. were able to include it in M.C. 191H.

Close to the eastern boundary of the claim immediately west of the cairn, and at the foot of the ridge on the western end of which the cairn is built, the owners found a small patch of eluvial bismuth carbonate on the surface of the weathered coarse-grained pegmatite dyke.

A shaft was commenced on the spot with the intention of "sinking to the bismuth lode." At the time of inspection, 19th July, 1940, the shaft was down 35 feet in fresh, coarse-grained pegmatite, and in all some 50 lbs. of carbonate ore, including the 30 lbs. of eluvial first found at the shaft site, had been located in three small concentrations some 10 feet or so apart in the shaft.

The dyke here dips to the south at about 60°, and strikes a little north of east. The footwall country and part of the dyke had been exposed in a N.-S. costean some six feet deep and 60 feet long excavated prior to the sinking of the shaft. No ore was found in this costean.

The country rock on the footwall is a partially decomposed biotite-muscovite-tourmaline schist, and the hanging wall country is not exposed, being covered by alluvium.

No mineralogical or structural indications exist which point to the likely position of more bismuth ore, and the dyke, which is itself the bismuth lode, consists mainly of large felspar and stained mica crystals with some quartz.

The nature of the mineral occurrence was explained to the prospectors who were working under the syndicate's instructions, and if it was desired to continue the search for large bismuth ore concentrations, they were advised to crosscut to the south and drive to the east since they were instructed to crosscut and drive. These directions would keep the working definitely in the dyke at least, though with no predictable chance of success.

Some 15 chains N.W. of the shaft, a quartz concentration in a pegmatite mass on a ridge was being opened up on no definite indication except the finding in the vicinity of a few small pieces of eluvial bismuth carbonate.

THE GEOLOGY AND MINING GROUPS OF
PORTION OF THE MT. MARGARET GOLD-
FIELD.

(R. A. Hobson, B.Sc. (Hons.))

SUMMARY.

In October, 1937, a commencement was made at Beria to re-examine a portion of the Mt. Margaret Goldfield. This survey was continued by the writer and his colleagues until August, 1940, when work was suspended due to war conditions, before the completion of the mapping over the area it had been proposed to examine. Progress reports have already appeared in the Annual Report for the years 1937, 1938, and 1939. During the 1940 field season Mr. Miles was absent from the field due to the lack of transport, and the writer's attention was confined to

the examination of mining groups. Mining groups at Pike's Hollow, Pennyweight Point, Yundamindera, Redcastle and Murrin were examined and reports on these centres have been compiled. Mr. Miles has petrologically examined some 600 specimens collected since the commencement of the survey.

Since 1937 broad geological mapping, on a scale of 80 chains to an inch, has been carried out over an area which covers approximately the eastern halves of Lands Department Lithos 43/300 and 52/300 and also a small portion of 44/300. The area mapped includes the towns of Murrin, Morgans

and Laverton and extends north to include the old townsites at Erlistoun and Duketon, east to include Burtville, and south to include Wilga, Trig. Station and the old Yundamindera Townsite. The 80-chain mapping has been supplemented by mapping on a scale of 20 or 40 chains to an inch over quite appreciable areas. In addition to this 25 mining groups have been mapped since 1937 on a scale of five chains to an inch. Underground workings have been examined and where necessary mapped.

The following rock classification table summarises the general geological information now available:—

CLASSIFICATION OF ROCKS FROM PORTION OF THE MT. MARGARET GOLDFIELD.

Age.	Description.	Notes.
Recent to Sub-recent	Soil, alluvium, siliceous and ferruginous laterite, grits and conglomerates	
Age unknown	Glacial erratics	
Pre-Cambrian ...	<div>Intrusives—<div>Lamprophyres ... ..</div><div>Dolerites ... ..</div><div>Granite, gneiss, porphyries, porphyrites, pegmatites, aplites, barren and auriferous quartz reefs</div><div>Medium and coarse-grained amphibolites and epidiorites</div><div>Ultra basic rocks ... ..</div><div>Flow rocks and sediments—<div>Intermediate and basic lavas and pyroclastics, erosion sediments, including conglomerates and jaspilites</div></div></div>	<div>These are believed to be post folding in age, but granitic rocks intruded in part before the end of the period of folding.</div> <div>Relative ages not known; also age relative to folding not known, but may be pre-folding sills.</div> <div>The auriferous series. Pebbles occurring in conglomerates include granitic rocks and amphibolite (one specimen). No other evidence of two ages of granite.</div>

Although outcrops are too poor to enable a precise figure to be given it appears likely that the proportion of sediments to flow rocks in the auriferous series is as high as 50% and may even be higher. Outcrops are too poor to enable these two rock types to be mapped over any extent of country. The only bed which can be traced for any distance is the jaspilite—all outcrops of which have been carefully mapped. More information about the general geology is to be found in the writer's complete progress report, and in Mr. Miles's petrological notes. Problems remaining to be solved and localities where more mapping may solve these problems are also indicated. Reference is also made in the writer's report to previous reports, which outline the broad structure of the area or give information about mining groups. It is believed that the broad geological structure has been satisfactorily worked out, and it is shown that the mining centres of Laverton, Morgans and Murrin are not associated with a major crossfold. No minor crossfold or other minor structural feature is apparent in the vicinity of Laverton and Morgans, but it would seem to be desirable to review the mapping at these centres before finally leaving the area. The mapping in the vicinity of Murrin is not yet complete.

COPPER IN THE MURCHISON AND YALGOO GOLDFIELDS.

(R. A. Hobson, B.Sc. (Hons.))

SUMMARY.

During November, the writer inspected all the known occurrences of copper in the Murchison and

Yalgoo Goldfields. No copper is being mined at the present time and all the old workings are inaccessible. Information about the size and nature of the ore bodies is therefore very incomplete. Descriptions of some of the old workings are to be found in Mines Department publications. At some places information can be obtained from prospectors, who have been resident in the district for a long time, while at other places the only information available is such as can be obtained from an inspection of the ore paddocks or the dumps, and from the general distribution of the shafts.

The total production from the Murchison Goldfield is 1,024 tons from which 139.69 tons of copper have been produced. In the Yalgoo Goldfield 69.9 tons of ore have yielded 7.48 tons of copper.

The following types of ore body are recognised:—

- A. Quartz reefs and lodes worked primarily for gold, but containing some copper.
Production: Murchison Goldfield, 75.34 tons copper; Yalgoo Goldfield, —.
- B. Quartz reefs worked primarily for copper, but may contain some gold.
Production: Murchison Goldfield, 7.78 tons copper; Yalgoo Goldfield, 2.08 tons copper.
- C. Ore bodies which consist in the oxidized zone of limonite and copper carbonates.
Production: Murchison Goldfield, 45.5 tons copper; Yalgoo Goldfield, —.
- D. Narrow seams and irregular bunches of malachite in weathered country rock,

which may be either schistose or massive. Narrow quartz veins may be present and the malachite may be associated with these.

Production: Murchison Goldfield, 1.41 tons; Yalgoo Goldfield, —.

- E. Sulphide ore bodies (chalcocite) in the oxidized zone.

Production: Murchison Goldfield, not known; Yalgoo Goldfield, —.

Auriferous quartz reefs containing less than 1% copper are of very frequent occurrence and many small gold mines have closed down because the sands contained too much copper for cyanidation. In some auriferous reefs the copper minerals are concentrated into scattered rich patches, which have been mined for copper. These constitute ore bodies of type A above. More than half the total production of the Murchison Goldfield has come from ore bodies of this type occurring in the immediate vicinity of Gabanintha townsite. The largest production from any one mine is 45.5 tons of copper from "Lady Alma," M.L. 4N at Gabanintha, where ore bodies of type C have been worked. In all 139.69 tons of copper have been produced at Gabanintha. Ore bodies of type B have produced small quantities of copper at Holden's Find, Day Dawn, Twin Peaks and Mt. Gibson. The only production from ore bodies of type D is 1.41 tons of copper from Yaloginda. Sulphide ore bodies (type E) were worked during 1898 or 1899 at Day Dawn, but no record is available of the copper produced.

The ore bodies have all been small and there are no indications at the surface, suggesting the existence of larger ore bodies. While further prospecting may reveal new ore bodies it is unlikely that any of these will be large enough to warrant the erection of a treatment plant. This being so, ore must be shipped away outside the State for treatment and costs will be high. For Gabanintha it is estimated that 17% of copper is required to cover transport and treatment costs and that for Day Dawn 15% copper is required to cover the same charges. These percentages are based on an assumed price for copper of £A75 per ton and are for parcels of not less than 10 tons. The ore has been assumed to contain no impurities, which would render it liable to penalty charges.

Prospecting in the vicinity of Gabanintha and Day Dawn and possibly also in the vicinity of M.L. 66 (30 miles N.N.W. of Cue) might reveal some new ore bodies, which are likely to be small and scattered.

THE COPPER DEPOSITS OF THE PEAK HILL GOLDFIELD.

(R. S. Matheson, B.Sc.)

SUMMARY.

During November, 1940, the writer inspected the principal copper deposits in the Peak Hill Goldfield, which are situated at Ilgarari, Kumarina, Bulloo Downs and Truman's Find. A complete examination of the deposits was not attempted, as the object of the investigations was to find out in the shortest

possible time, the nature of the deposits and whether or not large quantities of copper ore could be expected from them.

At the time of inspection the only activity in the area was at Truman's Find, where two copper lodes were being prospected, and, with the exception of a few shallow pot holes, these were the only accessible workings. The information in this report is therefore mainly based on observations made at the surface, but some details concerning the underground workings have been obtained from previous reports published by the Geological Survey.

The official records show that to the 31st July, 1940, the Peak Hill Goldfield produced 355.40 long tons of metallic copper, valued at £A32,364, by the treatment of 1,030.10 long tons of ore. Approximately 88% of the copper came from mines at Ilgarari and Kumarina.

Except at Kumarina, where the host rocks of some of the lodes are considered to belong to the Warrawoona Series, all the copper deposits occur in rocks of Nullagine age. All the lodes are situated in steeply dipping fissures, and consist of a mixture of cellular quartz, kaolin and a little limonite, which is impregnated with copper minerals. Small ore shoots occur erratically in the lode channels, and they have been mined to water level (25 to 50 feet vertical depth) in several places. The main ore minerals are *chalcocite* and *malachite*, which are present in the form of small lenses, bunches and seams, but associated with them are minor quantities of *chrysocolla*, *azurite*, *cuprite*, and *tenorite*. *Chalcopyrite* was also observed in one of the shaft dumps at Kumarina. Strong neutralising agents, although not abundant, are associated with the lodes, and *calcite* has been detected in specimens of ore from Ilgarari, Kumarina and Truman's Find.

The chalcocite appears to be of secondary origin, and its occurrence in the lodes between the surface and ground water level suggests that an acceleration in the rate of erosion has occurred in the district. The chalcocite is expected to gradually disappear at depth, and chalcopyrite become the principal copper mineral in the lodes. It is unlikely that lode material from the primary sulphide zone would be payable under existing conditions.

With the price of metallic copper at its present figure of approximately £A75 per long ton, it has been estimated that ore forwarded for treatment must have a metallic copper content of about 30% to cover mining, transport and smelting charges and yield a small margin of profit. Transport charges are a big item in these overhead costs, as parcels of ore have to be forwarded to Port Kembla (New South Wales), for treatment. Selective mining of the lodes underground and hand picking of the ore at the surface is necessary to retain a metallic copper content of not less than 30%.

In conclusion, the only production which can reasonably be expected from the district in the immediate future, is that from small and infrequent parcels of ore, but the production would be augmented if prospecting along the following lines was successful.

(1) As mining of the main ore bodies has almost everywhere been discontinued in the vicinity of ground water level before the primary sulphides were

encountered, deeper prospecting for a possible extension of the secondary sulphide zone is warranted.

(2) As the lodes at Truman's Find are similar in character to those already mined in the district, a continuance of prospecting at this centre is recommended.

(3) All the lodes mined in the district have strong indications of copper at the surface, and none of the limonite gossans without copper stains or the cellular quartz reefs without copper stains or indigenous limonite, which frequently occur on the strike of the cupriferous lodes, have yet been investigated. These gossans may represent the leached outcrops of copper lodes, and at least one of each of these two types of gossan should be prospected.

MINING GROUPS IN THE YILGARN GOLDFIELD.

(North of the Great Eastern Railway.)

(R. S. Matheson, B.Sc.)

SUMMARY.

The detailed investigations of the mining groups in this area were continued during 1940, and brought to conclusion in August. Reports accompanied by maps and plans have been compiled to cover the following groups, which are all situated in the Jackson Belt.

Evanston Group	Athlone Group
Broadbent's Find	Jackson Group
Rainy Rocks Group	Millar's Find
Diemel's Find	Allen's Find
Yarbu Group	Riedel's Find
Clampton Group	Boondine Group
Bullseye Group	Burgoose Group
Die Hardy (Olby Rocks) Group	
Atkinson's Find (Butcher Bird Group)	

As a result of these investigations it was found that the following areas in the Jackson Belt offer the best scope for future prospecting.

(a) The belt of greenstone country, which runs in a north-easterly direction from Diemel's Find, is lithologically and structurally favourable for ore deposition. It is about 10 miles wide and about 30 miles long, and contains numerous horizons of jaspilite. Ore bodies are most likely to be found within or in proximity to the bands of jaspilite, which have a platy structure, particularly where they show local deviations in strike from the general strike of the country. In recent years, discoveries have been made in this belt of greenstone at Evanston, Broadbent's Find and Rainy Rocks.

(b) Prospecting is warranted along the greenstone-granite contact, which runs north from Jackson through Clampton, particularly due west of existing mining groups.

(c) The Manning and Bungalbin Ranges were not visited by the writer, but from what information is available it appears that prospecting may be done to advantage in these areas.

Although no work on the general geology of the Jackson Belt has been carried out, the detailed mapping around Marda suggests that the sediments, which have been correlated with the Kurrawang

Series by Honman*, are really two series, one of which belongs to the Yilgarn System and the other of recent age.

Since the completion of the fieldwork for the re-survey of the mining groups in the northern portion of the Yilgarn Goldfield, Mr. K. R. Miles has made a petrological examination of the rocks collected in the area, and has compiled a report† on the more interesting types.

EVANSTON GROUP.

YILGARN GOLDFIELD.

(R. S. Matheson, B.Sc.)

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GENERAL INFORMATION.

The Evanston leases are situated on a prominent ridge approximately 17 miles north-east of Pigeon Rocks.

The main road to the group is from Bullfinch, and it passes through Glasse's Well, Marda, and the Die Hardy Ranges, but the centre can also be reached by a track which branches off the Pigeon Rocks-Menzies road about 20 miles from Pigeon Rocks. The Menzies road is used when mining material or ore is being transported between Kalgoorlie and Evanston, as it is the shortest route between the two centres.

Acting on the advice of a sandalwooder named Evans, the first prospecting area at the group was pegged by Walters on the 22nd February, 1937, and the discovery was followed by a mild rush. Shortly afterwards the Western Mining Corporation acquired an option over the main holdings, but as this option was subsequently surrendered, it is assumed that the results of their prospecting campaign were not encouraging. Development work since that time however, has proved Evanston to be one of the most important discoveries in recent years.

At the time of inspection (April-May, 1940) the main activity was on the Ridge Bros. Property, and this syndicate held the following leases:—"Evanston" G.M.L. 3868; "Ridges" G.M.L. 3891; "Blue Peter" G.M.L. 3895; "Mac Bean" G.M.L. 3887; "Ryans" G.M.L. 3894; "Evanston East" G.M.L. 3870; "Goldies" G.M.L. 3888; "Harbour Lights" G.M.L. 3912; "McCourt" G.M.L. 3886; "Evanston South East" G.M.L. 3879; "Evanston South West Central"

*Honman, C. S., G. S. W. A. Bull, No. 71, pp. 161-165.

†See p. 18.

G.M.L. 3878; "Evanston North West Central" G.M.L. 3877 and P.A. 5048.

The only other leases in existence were the "Evanston North" G.M.L. 3869 and the "Everett" G.M.L. 3890. The latter lease has since been acquired by the Ridge Bros. and renamed the "Four B's" G.M.L. 3963.

Water for mining purposes is obtained from a bore situated about 1½ miles south of the main mine. The bore is equipped with a pump, engine and overhead tank, so that the water can be conveniently obtained. It is reported that the bore is 132 feet deep, and that ground water level is at 122 feet. This bore is said to be capable of supplying 10,000 gallons of stock water per day.

Water for domestic purposes is carted from Pigeon Rocks a distance of 22 miles by road. The supply is a soakage well equipped with a windmill and tank. The quality and the supply are good, but the equipment is badly in need of replacement. It is understood that the Water Supply Department are

considering the provision of a domestic water supply closer to Evanston than Pigeon Rocks.

The vegetation in the vicinity of Evanston consists of a mixture of mallee and mulga, which, apart from a few patches of tall mulga, is quite unsuitable for mining purposes. The Ridge Bros. obtain their supplies of mining timber (salmon and gimlet) from south of Marda, about 40 miles distant.

On the Ridge Bros. mine a 5-head battery, with grinding pans*, a cyanidation plant and filter presses, is in operation, but it is not available for public crushings.

The nearest public battery is the Butcher Bird Battery at Marda, where a 5-head mill and a cyanidation plant are available. This battery is about 34 miles from Evanston.

The official records show that to the 31st July, 1940, the Evanston Group of mines has treated 18,412·54 long tons of ore for the recovery of 11,020·93 fine ozs. of gold. The production data for the individual leases are given in the following table.

PRODUCTION OF GOLD FROM EVANSTON GROUP TO 31st JULY, 1940.

Number of Lease.	Name of Lease.	Dollied and Specimens.	Ore Treated.	Gold Therefrom.	Grade.
		fine ozs.	long tons.	fine ozs.	fine ozs. per ton.
3895	Blue Peter ... ..	...	1,288·00	285·84	0·22
3868	Evanston ... ..	...	14,378·30	9,375·09	0·65
3870	Evanston East ... ..	...	34·00	13·59	0·39
3869	Evanston North ... ..	...	1,439·99	997·48	0·69
3888	Goldies ... ..	...	200·00	43·15	0·21
3912	Harbour Lights ... ..	...	337·00	80·38	0·23
3890	Everett ... ..	...	300·00	142·49	0·47
3963	Four B's ... ..	...	12·00	7·83	0·65
	Sundry Claims ... ..	...	423·25	75·08	0·17
	Total ... ..	...	18,412·54	11,020·93	0·59

GENERAL GEOLOGY.

The leases are situated on a prominent ridge, occurring in a previously unmapped belt of greenstone country. The belt is 1¼ miles wide, and is composed of metamorphosed, interbedded, greenstones and jaspilites, which have been contorted, and intruded by garnetiferous pegmatite dykes and barren quartz reefs. To the north-west and south-east the rocks grade into biotite gneiss, which is believed to be of replacement origin. The general strike of the country is N. 50° E. and the dip varies from 20-60° N.W. Due to folding however, some local south-westerly dips are met with in the area mapped (Plate II.). The rocks are presumed to be of Pre-Cambrian age.

Greenstones.—The greenstones are represented by fine to coarse grained amphibolite schists. The schistosity is strongly developed and because of its parallelism in strike and dip to the jaspilite horizons, it is believed to be more or less coincident with the bedding. A vertical north-west jointing is also present in the rocks, and this is attributed to the forces producing the set of folds, which have northwest-southeast axes. The writer is of the opinion that the greenstones are metamorphosed, basic sediments, but it has been suggested to him by the Government Geologist that they may have originally been basic lavas. Until the mode of origin of these rocks is definitely established, they will be referred to as

basic schists. The greenstones are fairly fresh throughout the area, except in proximity to the barren quartz reefs, where they are bleached and silicified. They also show a biotitic alteration near the lode channels.

Jaspilites.—Two main zones of jaspilite, each made up of several bands, occur in the area. All the jaspilites are the brown ferruginous variety, but two distinct types are present. The jaspilites of the northern zone are a platy type, which are only gently folded, while those of the southern zone are a massive type, and they are highly contorted. All the ore bodies so far discovered at Evanston, occur in proximity to the northern zone of jaspilite, which is believed to have been more favourable to gold deposition than the southern zone, because of its distinctive characteristics.

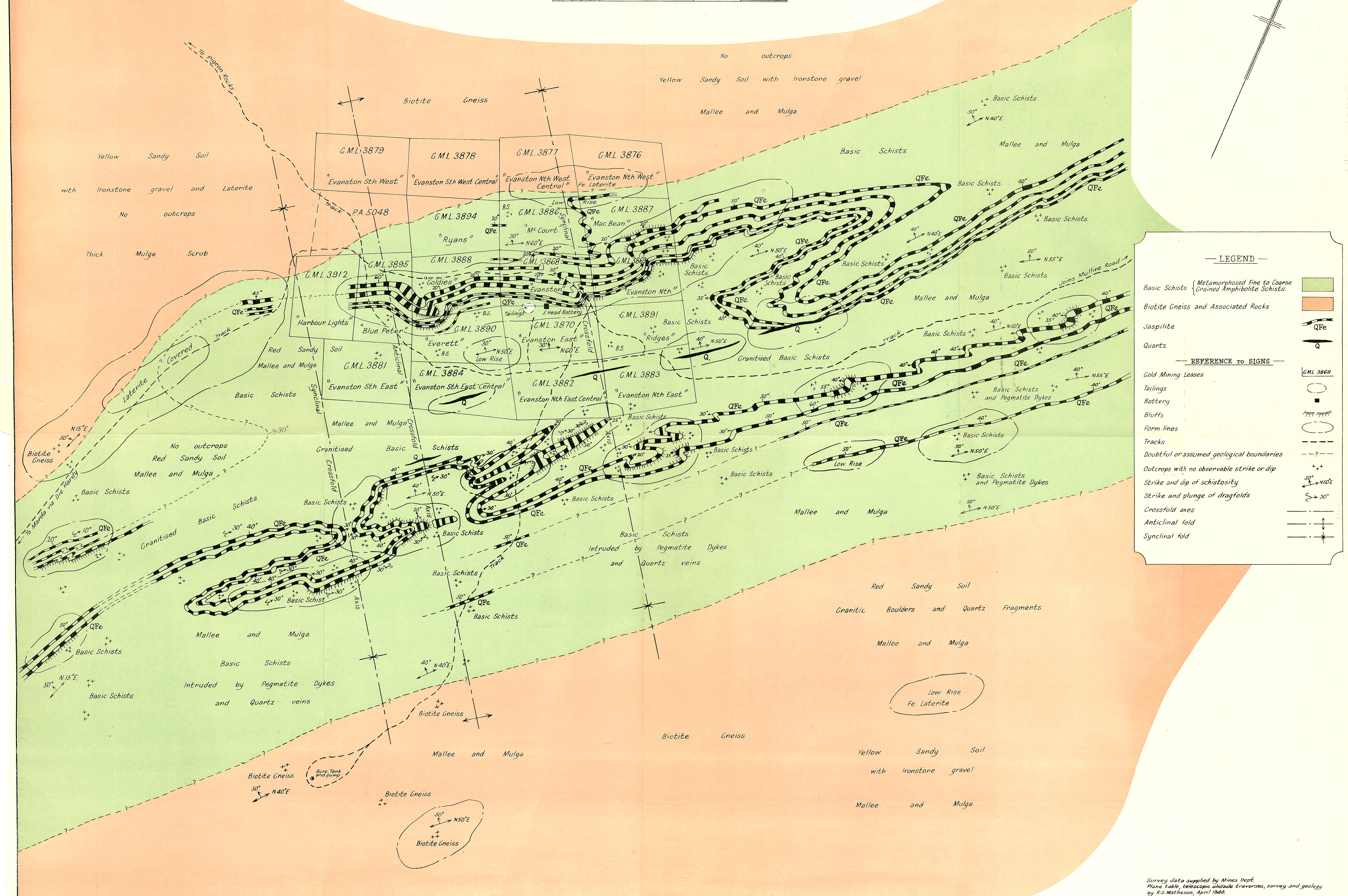
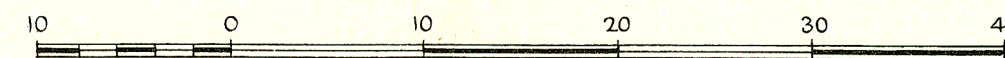
To the writer's knowledge, all the main ore bodies in the Yilgarn Goldfield, occurring within or in proximity to jaspilites, are associated with the platy type. When the massive type is auriferous, it is associated with small, rich shoots, which live only to shallow depths. It is not known whether the two types of jaspilite† owe their origin to differences in original composition, or to differences in the intensity of metamorphism, but they certainly have an economic significance.

*Since the inspection was made a ball mill has been installed.

†Refer to Appendix by K. R. Miles, p. 17.

YILGARN GOLDFIELD

Scale 10 chains to an inch



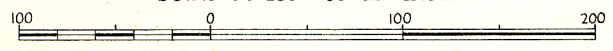
Survey data supplied by Mines Dept
Plane table, telescopic alidade traverses, survey and geology
by R.S. Matheson, April 1940.

before Page 15.

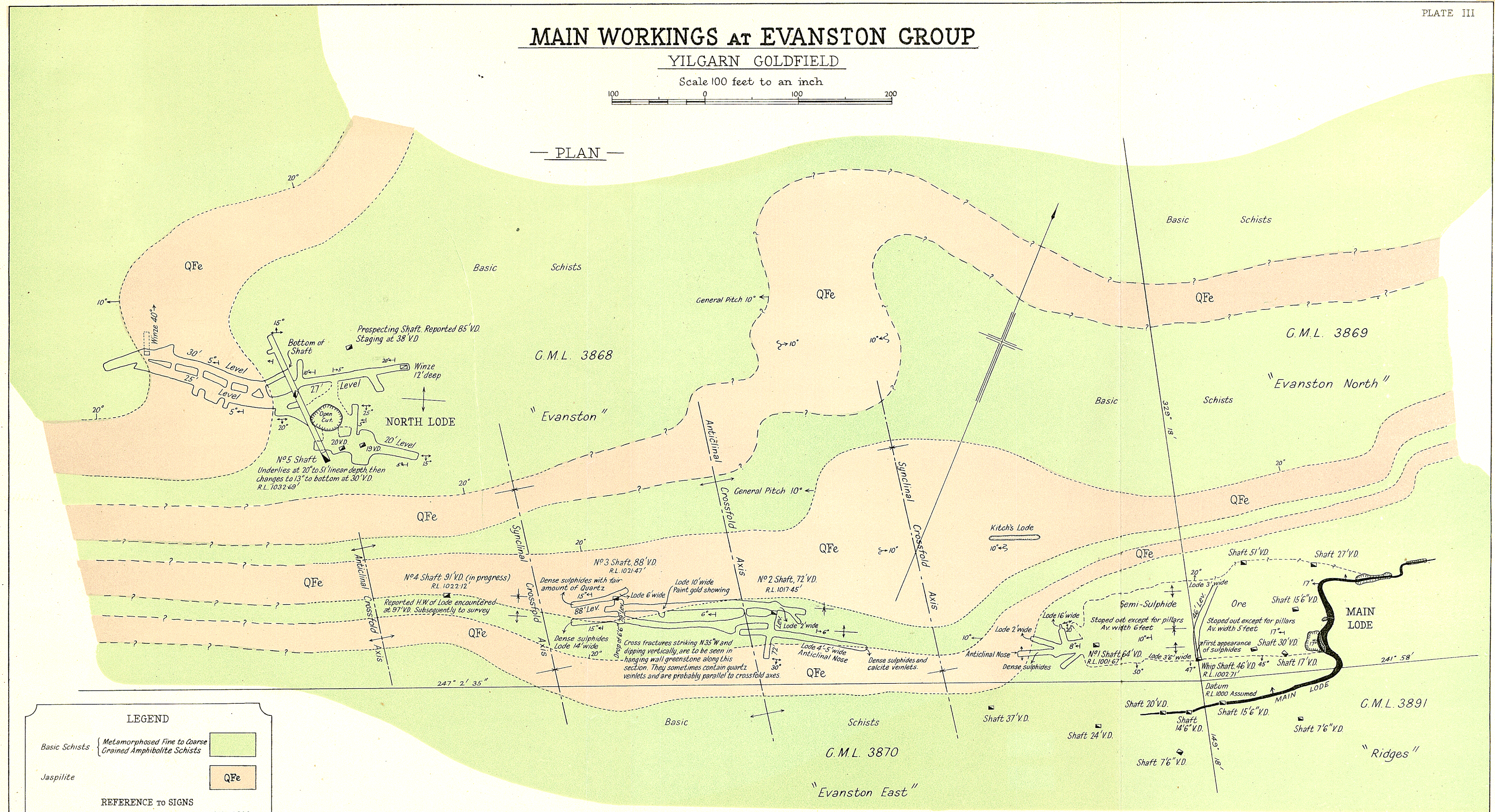
MAIN WORKINGS AT EVANSTON GROUP

YILGARN GOLDFIELD

Scale 100 feet to an inch



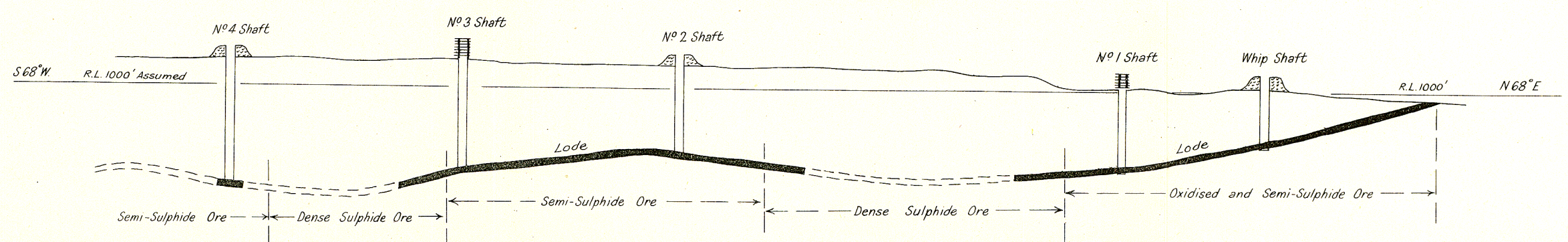
— PLAN —



LEGEND

- Basic Schists { Metamorphosed Fine to Coarse Grained Amphibolite Schists
- Jaspilite
- QFe
- REFERENCE TO SIGNS
- Gold Mining Leases
- Open Cuts
- Shafts
- Winzes
- Anticlinal Folds
- Synclinal Folds
- Crossfold Axes
- Strike and Plunge of Dragfolds
- Dip
- Pitch
- Observed Geological Boundaries
- Doubtful or Assumed Geological Boundaries

DIAGRAMMATIC CROSS SECTION DOWN PITCH OF MAIN LODGE



In the plan, geology is at the surface. All depths and levels taken from ground level. Survey and geology by R.S. Matheson 1914, 1920.

Biotite Gneiss.—Most of this country is covered by sandy soil or ferruginous laterite, but the gneissosity of the few outcrops that were seen, showed a parallelism to the general strike and dip of the greenstone country. The gneiss is believed to have been formed by the granitisation of pre-existing basic schists.

Pegmatites.—No pegmatite dykes are met with in the workings, their occurrence being confined to the margins of the greenstone belt. The barren quartz reefs probably belong to this period of intrusion, which is presumed to be of post-gold age.

GEOLOGICAL STRUCTURE.

As regional geological mapping did not fall within the scope of the writer's investigations, it is impossible to give more than a suggestion concerning the position of Evanston with relation to the major structure. All that can be said, is that the Evanston belt appears to be a north-easterly extension of portion of the Die Hardy Ranges, and the attitude of the rocks is suggestive of it being on the nose of a north-westerly pitching anticline.

More information is available concerning the minor geological structure at Evanston however, and by reference to the geological map (Plate II.), it will be seen to be very interesting. Two sets of folds are present in the rocks, one of which has west-southwest axes, and the other north-west axes. The northern zone of jaspilite is folded into the form of a broad syncline of the northwest-southeast set and the leases are situated on the axis of this fold. This fold is not simple however, but contains several smaller folds, the presence of which is indicated by the folding in the southern zone of jaspilite. Folds of this type cause reversals in pitch of folds belonging to the west-southwest set, and because of this they can be conveniently referred to as crossfolds. It is believed that the presence of two sets of folds which intersect one another, is one of the factors essential for ore deposition, and it localises deposition in the favourable host rocks. The importance of folding in two directions during ore deposition, is suspected to be due to the opposing forces forming channels suitable for the entry of gold-bearing solutions, and also closed structures where the ascending solutions are trapped. The successful application of these forces is probably limited to certain rock types, and at Evanston, the northern zone of jaspilite and the country in its immediate vicinity have been the favourable host rocks.

Further information concerning geological structure and its relation to ore deposition is given in a later section of this report.

THE MINES.

RIDGE BROS. SYNDICATE.

As has been pointed out previously, this Syndicate held twelve leases and one prospecting area at the time of inspection (April-May, 1940), but mining operations were confined to the "Evanston" G.M.L. 3868.

To 31st July, 1940, 9375.09 fine ozs. of gold were produced from this lease by the treatment of 14,378.30 long tons of ore. The production recorded from the other leases* took place prior to their acquisition by

the Syndicate, which hopes to resume operations on them at some later date.

The Ore Bodies.—Two different types of ore body are being mined on the main lease, namely a jaspilite lode, and a siliceous, carbonated lode, and these can be conveniently referred to as the North and Main Lodes respectively. Only jaspilite lodes have so far been disclosed on the remainder of the Syndicate's holdings.

Main Lode.—The Main Lode consists of a highly carbonated mixture of quartz and bleached basic schists, which has a high gold content. Zones, which are heavily mineralised with sulphides, occur at intervals in the lode at depth, and as this ore is not amenable to battery treatment, selective mining of oxidised and semi-sulphide ore is at present being carried out. The lode outcrops on G.M.L. 3869, which is not held by the Syndicate, but it passes into their ground at a shallow depth.

As will be seen from the Plan of Workings (Plate III.), the lode occurs in greenstone country in a dragfold which pitches very flatly west-southwest. Ore deposition has been greatest around the anticlinal nose of this dragfold, and mining operations have been more or less confined to this shoot. The shoot has been opened up at intervals to about 960 feet down the dip, and due to the remarkably flat dip the shoot is only about 100 feet from the surface in the deepest workings.

From the outcrop to 265 feet down the dip, the shoot has been stoped out, except for pillars, over an average length of 80 feet, and an average width of six feet. Between this section and the deepest workings, the lode thickens and the average width is 8-10 feet, but so far the shoot has only been proved over an average length of 50 feet. No systematic stoping has yet been done in these deeper workings, as development work is providing sufficient ore for immediate requirements.

Apart from the main shoot, some mining has been done to a shallow depth, between the line of shafts on the southern limb of the Main Lode, and the production from these workings is that recorded for G.M.L. 3870.

North Lode.—This ore body consists of a mixture of jaspilite lode material and quartz stringers, which occurs at the nose of a broad anticline, pitching flatly west-southwest. The limits of this shoot are not yet clearly defined, but the extent of the work done on it can be seen on Plate III. The Lode has not been worked from the outcrop, but work commenced on it at 12 feet V.D. from the surface, where it was encountered in prospecting shafts. The outcrop of this lode is believed to be folded jaspilite, east-northeast of the workings. The lode is oxidised, and no signs of carbonation or sulphide mineralisation have been met with in the workings. The management report that this ore body has produced £10,000 worth of gold.

Mineral Associations.—At depth the Main Lode is heavily mineralised with sulphides, and specimens of the ore have been collected by the writer, and submitted to the Government Mineralogist and Analyst for mineral determination. The results are not yet

*Refer to Production Table, p. 14.

to hand, but some information concerning the mineral content is available from investigations which have been carried out on this ore by Dr. F. L. Stillwell.

The main constituents are *arsenopyrite* and *pyrite*, but small amounts of *marcasite*, *pyrrhotite*, *chalcopyrite*, *enargite*, *covellite*, *chalcocite*, and *sphalerite* are also present. The sulphides occur in very dense seams and are also disseminated through the ore body. At present, the dense sulphides are confined to the sections of the lode in synclinal crossfolds, but at depth, where the processes of oxidation are ineffective, the lode may also be heavily mineralised with sulphides on the anticlinal crossfolds.

There is a close association between gold and arsenopyrite, and roasting will be necessary in the treatment of this ore. The recovery of *arsenic* should be considered when treating this ore, as arsenopyrite is very abundant.

Minerals, such as *iron oxides* and *scorodite*, which are decomposition products of the sulphides, occur in the oxidised and semi-sulphide zones.

Of the non-metallic minerals associated with the lode, *calcite* is by far the most abundant, but *fluorite* and *apatite* have also been recorded.

Structural Control of Ore Deposition.—The accompanying plans show that two sets of folds occur in the area, one of which has west-southwest axes and the other north-west axes. Ore deposition has been confined to folds of the first set, and the other set (crossfolds) has caused variations in the width of the lodes.

The Main and North Lodes occur in parallel dragfolds belonging to the west-southwest set, and the bulk of the evidence points to their axial planes having a vertical or steep south-southeast dip, but there is some suggestion that the dip of the axial planes may be at a low angle to the south-southeast. The crossfolding has taken place on a vertical plane, however, and this fact is borne out by the occurrence of vertical joints in the country rocks, which have a northwesterly strike.

The folds containing the ore bodies are by no means simple folds, but have numerous minor flexures on them and these cause variations in the thickness of the lode. The lode is thicker on the anticlinal flexures than on the synclinal flexures, and thinnest on the limbs, but other variations in thickness are caused by the crossfolding. On the axes of anticlinal crossfolds a thickening of the lode may be expected to occur on the minor anticlines, and a thinning in the minor synclines, while the reverse would be the case on the axes of synclinal crossfolds. Where a thinning of the lode occurs, the shoot may lengthen. Mining operations have shown that this control of width by folding has actually occurred.

Mode of Ore Deposition.—The Main Lode is believed to have been formed by metasomatic replacement, at the nose of a dragfold, in a structurally weak zone, which has offered free circulation to gold bearing solutions, presumably from a granitic magma. Subsequent to primary mineralisation secondary enrichment of the ore body took place, which is indicated by the frequent occurrence of paint gold in secondary jasper seams in the oxidised ore. The North Lode occurs in a similar structure, but the ore body has been formed, rather by the mechanical in-

jection of auriferous quartz veins into fractures in the jaspilite, than by replacement. The jaspilite lode material associated with the quartz veins is believed to be mainly of secondary origin.

Diamond Drilling.—During their prospecting campaign, the Western Mining Corporation put down seventeen bores to determine the limits of the Main Lode. The results of the diamond drilling have kindly been made available, but the writer has not yet had time to examine this information. Details of this diamond drilling will be published at a later date.

Conclusions and Recommendations.

1. There is no obvious reason why the Main Lode should not live to some considerable depth, but values and width are expected to show a slight decrease below ground water level, due to the cessation of the processes of secondary enrichment. Sulphides are expected to be uniformly distributed through the lode at depth. Owing to the flat attitude of the ore body however, it may be several hundred feet down the dip before ground water level is encountered, and patches of oxidised ore disappear entirely.

The prospects of the North Lode are not so promising, and the persistence of the ore body below ground water level will depend on the abundance of quartz veins. Mining will be confined to their immediate vicinity, as they contain the primary gold and the jaspilite lode material is mainly of secondary origin. In this case also, because of the flat pitch of the ore body, secondary enrichment may extend for several hundred feet down the dip from the present workings. All the jaspilite lodes at Evanston have similar prospects.

2. Prospecting for parallel ore bodies is warranted in the dragfolded portions of the other jaspilite horizons on the main lease. A small amount of ore has already been mined from one of these horizons in what are known as Kitch's workings, and this horizon in particular should be prospected.

There is also a possibility that parallel ore bodies may exist in the greenstone country on the footwall side of the Main Lode.

3. The prospects of locating further ore bodies along the strike are very favourable.

Some mining has already been done on ore shoots occurring in the folded portions of the jaspilites on G.M.L.'s 3888, 3895, and 3890, but there was no activity at the time of inspection. Now that the structural control of ore deposition is better understood however, further prospecting of these shoots is warranted.

There is a strong likelihood of an ore body similar to the Main Lode occurring in this fold, on the footwall side of the main jaspilite horizons. The ore body should be similarly situated with relation to the jaspilites, as the Main Lode is to the jaspilites on G.M.L. 3868.

4. By reference to the Plan of the Workings (Plate III.), it will be seen that the synclinal portion of the Main Lode has not been investigated. Prospecting of this section should not be neglected, because while indications may point to only a short length for the shoot, values on the other hand may

be high. The best place to prospect the synclinal trough would be on one of the synclinal crossfold axes, where the shoot should attain its maximum width.

5. Some small, rich shoots may be disclosed in the crossfolds on the southern jaspilite zone, but it is unlikely that any large ore bodies will be encountered.

6. With regard to general recommendations for prospecting in the vicinity of Evanston, the greenstone complex a few miles to the north is worthy of attention. Further details are given in the report on Broadbent's Find.

"EVANSTON NORTH" G.M.L. 3869.

As will be seen from the accompanying plans, the ore body consists of the upper 140 feet of the Main Lode, which passes, at that depth, into the property of the Ridge Bros. Syndicate. Mining has been mainly confined to the anticlinal portion of the ore body, but some ore has also been won from the northern limb of the fold. On the limb however, the lode formation dwindles away to an unpayable width at a short distance from the main shoot. The ore body consisted entirely of oxidised and semi-sulphide ore, and it was almost stoped out at the time of inspection. The oxidised ore was treated at the Three Boys Battery, Southern Cross, and the semi-sulphide ore was forwarded to Kalgoorlie for treatment. Full information concerning the nature, mode of origin, and attitude of the ore body is contained in the section of this report describing the Ridge Bros. Syndicate.

The official records show that, to 31st July, 1940, this lease has produced 997.48 fine ozs. of gold by the treatment of 1,440 long tons of ore.

Recommendations.

1. There is a possibility of obtaining a short shoot of rich ore in the trough of the synclinal portion of the Main Lode, which so far has not been investigated.

2. The best place for prospecting on this lease however, is the sharp fold in the country, occurring near the north corner of the lease. Both jaspilite lodes, and a lode similar to the Main Lode, may occur in this fold, and they are expected to show a parallelism in attitude to the known ore bodies. The two most southerly horizons of jaspilite, in particular, warrant prospecting, and the Main Lode type of ore body should be looked for in the greenstone country stratigraphically below them.

"EVERETT" G.M.L. 3890.

The ore body on this lease consists of jaspilite lode material and quartz stringers, occurring in a fold which pitches flatly west-southwest, but the shoot passes into G.M.L. 3888 at a shallow depth.

Shortly after the inspection the lease was acquired by the Ridge Bros., and renamed the "Four B's" G.M.L. 3963.

To 31st July, 1940, the total production from this ground was 150.32 fine ozs. of gold from the treatment of 312 long tons of ore.

Prospecting in the greenstone country on this lease is recommended, as an ore body similar to the Main Lode very likely exists.

APPENDIX.

NOTES ON "PLATY" AND "MASSIVE" TYPES OF JASPILITES FROM EVANSTON.

(K. R. Miles, B.Sc. (Hons.))

Mr. Matheson has distinguished two types of jaspilite in the Evanston District—the first a "*platy*" type which is usually only gently folded and the second a "*massive*" variety which is frequently highly contorted. He attributes considerable economic significance to the distinction between the two varieties as he believes that all the main ore bodies occurring within jaspilites in the Yilgarn Goldfield are associated with the former rather than the latter type. He considers that auriferous bodies in jaspilites of the massive type are characterised by small rich shoots which live only to shallow depths.

The following are petrographical notes on specimens of the two types from Evanston collected by Mr. Matheson himself.

(a) Massive Type.—Specimen 2/2244.

Dense fine-grained, evenly banded rock consisting of alternate layers of black, fine-grained metallic iron ore and dense fine yellow-brown siliceous material, ranging from about .01 inch to .1 inch in width. The iron ore is but feebly magnetic or completely non-magnetic and grinds to a dark red-brown powder—hence it is probably made up predominantly of *hematite*.

In thin section the iron-ore bands consist of fairly closely packed, fine-grained aggregates of subhedral to euhedral *hematite* surrounded by and interlocked with grains of clear *quartz*. Different bands vary slightly in granularity. The alternating siliceous bands consist essentially of an interlocking mosaic of fine *quartz* scattered with separate crystals of iron ore, and containing oriented stringers of reddish opaque fibres (limonite or goethite) associated with frequent patches of brownish isotropic colloform *silica* (opaline). These fibres evidently represent decomposed relicts of an iron silicate mineral—probably *gruneritic amphibole*. Here and there are recognisable crystal laths now completely replaced by opal. In these quartzite bands are also occasional narrow zones of very fine microcrystalline *chert*, and stringers of opaline silica can also be seen occasionally cutting transversely across the siliceous bands and entering into some of the coarser iron ore bands.

Evidently this rock has suffered only slight thermal metamorphism—sufficient for only partial recrystallisation and the formation of minor amounts of *gruneritic amphibole* from reaction between the siliceous and ferruginous layers. Probably entirely as a result of surface weathering this amphibole has later been decomposed into hydrated iron oxide (limonite) and silica, now seen as secondary opal.

(b) Platy Type.—Specimen 2/2246.

This specimen is rather weathered. It consists essentially of bands of fine fibrous to acicular *amphibole* weathered to yellowish brown colour and associated with some fine grained *quartz*, alternating

with narrow layers of very fine granulated black iron ore. This iron ore when powdered is black and fairly strongly magnetic and is predominantly *magnetite*. In hand specimen the banding is fairly even and fine but is rather masked by the presence of several cross-fractures filled by dense brown *cherty limonite* containing tiny veinlets of *opaline silica*.

Thin section shows the *amphibole* in masses of crystals in broad bands usually enclosing layers of granular iron ore, and separated by bands of fine iron stained *quartzite*. The *amphibole* is more or less completely altered into amorphous masses of red *limonite* and light straw-coloured *opaline* pseudomorphs. Here and there less altered crystal plates show the form birefringence, twinning, extinction, and other optical properties, of the iron-rich *grunerite*. It has obviously been formed by reaction between the original black iron ore bands with the adjacent silica. In some portions of the slice the iron ore layers have been almost entirely replaced by *amphibole*.

This "platy" rock appears to have had essentially the same original composition and form as the "massive" type. The chief difference between the two types appears to be in the far greater development of the *grunerite* in the former. This indicates that the "platy" rock has reached a higher grade of metamorphism, i.e., has suffered far more complete recrystallisation at higher and more sustained temperatures than the "massive" type. The general structure and random orientation of the *amphibole* in the former rock indicates predominant contact or "thermal" metamorphism.

Differences in physical condition particularly of surface specimens of these two types are probably due mainly to this mineral difference. The presence of layers of softer and more easily decomposable *amphibole* probably tends to make the whole rock less resistant to weathering and to give it a more noticeable "platy" structure. Assuming that the rocks were thermally metamorphosed prior to folding it is possible that the *amphibole*-rich types would shear and become slip faulted, rather than minutely contorted as in the case of the more homogeneous "massive" banded quartz-iron ore rock. Whether or not these physical differences would have any effect upon the capacity of the rock to act as a host for auriferous ore-bodies is a matter for considerably more investigation than has been carried out at present.

SUMMARY OF PETROLOGICAL NOTES ON SOME ROCKS FROM THE YILGARN GOLDFIELD.

(North of the Great Eastern Railway.)

(K. R. Miles, B.Sc. (Hons.))

During a petrological examination of rocks collected by Messrs. Matheson and Ellis in the course of the North Yilgarn re-survey a number of interesting and unusual rock types were noticed and detailed petrographic descriptions of these have been made. They include:—(a) a suite of Basic Gneisses from Wither's Find, (b) some Ultrabasic Rocks, (c) an interesting Olivine Dolerite from Newfield and (d) some Metamorphosed Sediments.

(a) The Basic Gneisses range from re-crystallised amphibolites or basic granulite gneisses to fairly acid gneisses in which original *amphibole* is metasomatically replaced by *biotite* and the whole rock has suffered an addition of pegmatitic quartz and feldspar. These represent so-called "granitised" greenstones.

(b) The Ultrabasic rocks. Apart from the anthophyllite rock of the South Yilgarn* and an occurrence of carbonated ultrabasics in the Mt. Jackson District† there has been no previous recognition of ultrabasic rocks as a unit of the greenstone series in the North Yilgarn. Specimens described recently include Serpentine derived from olivine-rich peridotites, carbonated serpentines from the Bullfinch District, and an Olivine-Tremolite-Serpentine Rock from Westonia.

(c) The Olivine Dolerite from Newfield is interesting in that it represents the first record of an under-saturated younger basic intrusive in the Yilgarn Goldfield. The more common type is an augite dolerite or quartz-augite dolerite typical of the saturated or over saturated younger dolerite magma of the Darling Range.

(d) The Metamorphosed Sediments described in this report include a Chiastolite Slate from north of Pigeon Rocks—a new locality—and an Andalusite-Kyanite-Quartz-Schist from the sedimentary series near Eenuin. This rock is of interest in that it is identical in structure and mineral composition with specimens from Mt. Leonora in the Mt. Margaret Goldfield. Finally a special type of metamorphosed sediment is a Magnetite-Grunerite Schist from south of Koolyanobbing Trig. This rock is formed by recrystallisation under high temperatures of an original banded ferruginous quartzite or jaspilite bed.

* G. S. W. A. Bull. No. 97, p. 78, etc.

† G. S. W. A. Bull. No. 71, pp. 153-4.

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