

2. An investigation into the basic dykes, Wongong Brook Weir Site.
3. Field work at Melville (Noongal), Yalgoo, and Mugga Mugga, Yalgoo Goldfields.

On 20th July Mr. Esson proceeded to Yalgoo to await my arrival, during which time an examination in a broad and general way of the country in the vicinity of Yalgoo was made.

Acting upon instructions Mr. Esson proceeded to Noongal (Melville), 14 miles north of Yalgoo, for the purpose of completing the work and filling in the blanks on the maps begun by Mr. E. de C. Clarke, late Field Geologist in the Geological Survey of Western Australia, and referred to in the Annual Report for the year 1919. On 27th October, in accordance with instructions, Mr. Esson left Melville for Youanmi, where he collaborated with Mr. Feldmann in his work at that centre. During his stay at Youanmi a preliminary reconnaissance was made of the country south of Youanmi to Curran's, which lies about 14 miles distant. In the main, the country is greenstone intruded by granite and obscured by alluvium. In some of the shafts at Curran's shearing has taken place and, broadly, the geology is very similar to that at Youanmi. Probably they both form part of the same belt of disturbance. On 1st December Mr. Esson left Youanmi in the company of the Government Geologist upon a trip by horse from Youanmi to Merredin, going first to the 206-mile post on Rabbit-proof Fence No. 1, thence along the fence southwards to the 49-mile post, and thence to Merredin by Muckinbuddin and Nungarin. Altogether during the year 1922 191 days were spent in the field out of a possible 305 days, *i.e.*, 62.6 per cent. In the interim, whilst at the head office, Mr. Esson was engaged preparing maps and plans and collecting information connected with the various reports, as well as compiling the several reports themselves. In addition he carried out various duties deputed to him.

PRINCIPAL RESULTS OF THE YEAR'S FIELD OPERATIONS.

1.—THE YOUANMI GOLD-MINING CENTRE, EAST MURCHISON GOLDFIELD.

(F. R. FELDMANN.)

GEOGRAPHY.

Location.—The Youanmi gold-mining centre is situated in the Black Range District of the East Murchison Goldfield, approximately 52 miles SSW. of Sandstone, the centre of the district, and about 19 miles E. of No. 1 Rabbit-proof Fence, which forms the western boundary of the goldfield. It is 71 miles (79 miles by road) SE. of Mount Magnet on the Geraldton-Meekatharra Railway. A mail motor-car runs twice a week between Mount Magnet and Youanmi.

The main mining area is situated from three-quarters of a mile E. to a mile N. of the township. Two other small groups of leases, the Commonwealth and Golden Crown, are situated respectively 1½ miles NNW. and about three-quarters of a mile S. of the township.

Topography.—The country north and west of Youanmi is undulating, but the area is one of comparatively low relief, there being no hills of any size near the town. The most conspicuous hill in the district is Trig. or Bald Hill, a conical shaped hill about 5½ miles E. of Youanmi.

West of the town, a succession of small laterite hills and breakaways mark the level of the former plateau. Of these, the nearest and one of the most prominent is an abrupt little hill on the Rifle Range Reserve. North of the town are a number of low ridges, the backbones of which are formed by jaspers.

The chief drainage channel of the centre is a broad ill-defined creek, which runs in a southeasterly direction between the town and the mining area, passing to the south of the Youanmi Mine, whence it runs slightly south of east.

GEOLOGY.

The rocks of this area are much obscured both by weathering and by superficial deposits. In common with most mining centres of the goldfields the auriferous area lies in a belt of greenstones enclosed by granite, the greenstones near the margin being cut by numerous tongues of granite which run in from the main mass.

The full extent of the greenstone belt has not yet been determined, but it is probably more than 20 miles in length, extending for some miles north of Youanmi and beyond Curran's Find, 14 miles south.

The greenstones are separable into three main types including: (a) a very fine-grained schistose rock, representing a fine-grained doleritic epidiorite, now largely chloritised and in places carbonated, which forms the main country rock of the lodes; (b) a medium to coarse-grained epidiorite from a gabbro or coarse dolerite; and (c) a very fine-grained massive amphibolite or epidiorite, with scattered hornblende phenocrysts and occasional small areas of a pegmatitic facies with hornblende crystals up to three inches in length.

But little information is available as to the relative age and relationships of these three types. What appears to be a dyke of the coarser-grained type occurs, however, in the fine-grained schistose rocks in G.M.L. 731B, near the northern end of the main group of leases, both rocks being cut by granite dykes, and it is probable that the fine-grained schistose rocks correspond to the Older Greenstones of Kalgoorlie, the coarser gabbroid rocks to the Younger Greenstones.

The fine-grained massive amphibolites of type (c) may represent a still later doleritic intrusion. They are, however, cut by acid dykes and therefore do not belong to the youngest series of basic dykes found on the goldfields.

The older schistose rocks occupy the eastern portion of the belt. Outcrops of these rocks are, with but few exceptions, completely weathered, and much of the area occupied by them is covered by detrital deposits. The gabbroid rocks appear to occupy a large part of the western portion of the belt; a few outcrops are found to the west of the Cemetery.

The only occurrence observed of the fine-grained massive amphibolites was at a point about a quarter of a mile west of the Anketell telegraph line, and about four miles north of Youanmi, where they form a small, low knoll.

The granite mass east of the mining area is composed of rock differing from the normal biotite granite of the goldfields. Biotite is almost absent, the rock consisting of quartz, felspar—probably a soda-bearing variety—and muscovite. In grain the rock ranges from coarse to fine.

The margin of the granite forming the eastern boundary of the greenstones runs in a general north-northwesterly direction, through the main group of

leases, a little to the east of the lode channels, but is very irregular, and, as stated, numerous tongues run from it into the greenstones. North of the mining area, the boundary, so far as examined—a distance of about four miles—is approximately parallel to, and a short distance east of, the telegraph line to Anketell Siding.

The dykes running from the main granite mass into the greenstones are composed, for the most part, of rock very similar to that of the main mass. In a few, however, biotite is present in fair amounts. The smaller dykes are usually fine in grain, and in some a gneissic structure, probably original, is present.

The strike ranges from northwest to northnorthwest and the dip, as a rule, is southwest at angles ranging from 65 deg. to 75 deg. From their marked parallelism and the very acute angle they make with the margin, the dykes evidently occupy lines of shearing in the greenstones, formed prior to or during the intrusion of those rocks by the granite. The dykes are older than the lodes, but cause a certain amount of deflection and impoverishment in them.

A series of dykes somewhat different from those mentioned occurs in the main workings of the Yuanmi Mine at the Nos. 5 and 7 levels. These are usually of a pinkish or reddish colour and range in texture from fine-grained, almost felsitic, to coarse pegmatitic, with large pink or pale-red orthoclase crystals. Fluorite, in small quantities, and small veins of red and white carbonates are associated with these dykes.

Jaspers are not so well represented in this as in most other centres of the Murchison and East Murchison Goldfields. A number of bars, mostly of no great length, occur along a general line which runs in a northnorthwesterly direction through the Golden Crown and Commonwealth groups of leases, respectively south and northnorthwest of the town, and extends for some miles to the north. In the main group of leases, only a few short bars, mostly striking east-northeast, occur. A few of these penetrate the granite for a short distance, but most stop short at the margin. Owing to subsequent intense shearing, including that immediately preceding ore deposition, several of these bars are now represented only by a few disconnected short lenses.

In the Commonwealth group, the ore bodies, which appear to be very short, are closely associated with the jaspers, which have evidently influenced the deposition of the gold.

The principal lodes of this centre occur in the greenstone schists as a series of elongated lenses in a comparatively narrow zone of highly sheared rock along the margin of the granite. They strike approximately parallel to, or, if anything, slightly more northerly than the general strike of the margin, but as that is very irregular, run into the granite in places to die out a short distance from the margin. So far, auriferous bodies have been found to occur in the contact zone over a length of about $1\frac{1}{4}$ miles, but a number have not proved to be payable for any length. The average strike of the lodes is a few degrees west of north; the dip ranges from about 55 deg. W. to vertical.

Auriferous reefs of any size are not common in this area, but numerous small quartz veins of a granitic type and carrying little or no gold are common in the sheared zone, along the granite margin. There are a fair number of buck reefs, mostly in the granite. Most of these strike approximately east, the dip, so far as could be determined, being to the south at a steep angle.

In addition to the older lines of shearing occupied by the granite dykes, jaspers, and lodes, there is evidence of intense shearing at several periods subsequent to gold deposition. Shear zones and planes belonging to several series younger than the lodes occur in the contact zone. These have shattered or faulted the lodes in places, seriously affecting the continuity of the ore shoots.

At least three series of these later shear zones have been recognised in the Yuanmi Mine, namely:—(a) One striking a few degrees east of north and dipping west at angles ranging from about 45 deg. to 55 deg.; (b) One striking approximately parallel to the lodes, but, as a rule, straighter and also steeper, the dip ranging from 64 deg. W. to vertical, and averaging between 70 deg. and 80 deg.—the shear zones of this series are said to be highly carbonated in places and to contain barren sulphides, and in the oxidised zone may easily be mistaken for true lodes; and (c) a third striking approximately N. 60 deg. W. and dipping SW. at about 70 deg.

A large proportion of the shear zones belonging to these series are said to occur in portions of the main workings of the Yuanmi Mine, which were inaccessible during my survey, and the information as to their occurrence was supplied by Mr. L. B. Williams, until recently manager of the Yuanmi Gold Mines Ltd. With the exception of those of group (c), which appear to be confined to a small area at the southern end of G.M.L. 863B, where the workings were inaccessible, my observations in those portions of the mine which were accessible, and along the belt north of the Yuanmi Mine, confirm those of Mr. Williams.

Of the three series (a) appears to be the oldest—it is best represented at the northern end of the Yuanmi Mine. The relative age of (c) is uncertain; Mr. Williams is inclined to regard it as younger than (a), but its relationship to (b) is obscure.

In addition to the above, a number of fault planes, striking approximately N. 30°—40° W. and dipping southwest at a shallow angle, affecting the granite dykes and quartz veins, were observed in the east crosscut off the south drive from Prospect Shaft.

There is not much evidence of transverse faulting in this area, the only place where it appears to have taken place being along a large buck reef, striking a few degrees north of east, at the southern end of G.M.L. 770B, Hill End. Along this reef the granite boundary, which here strikes about northnorthwest, shows an apparent horizontal displacement of 160 feet—the displacement being to the west, going north. About 140 feet farther NNW. along the granite boundary is what appears to be a subsidiary parallel fault, a small jasper being displaced for a horizontal distance of about 12 feet. In this case, however, the faulting may be due to a northward-striking shear zone.

THE LODES.

As stated, the main ore bodies of this centre occur in a zone of highly sheared rock along the margin of the granite forming the eastern boundary of the greenstones. Although auriferous deposits occur over a length of about one and a quarter miles in this zone, only those in the southern portion have proved payable for any length, the continuity of the ore bodies being much affected by granite dykes and by later shear zones.

Mineral composition.—Owing to the inaccessibility of the deeper workings of the Yuanmi Mine it is

impossible to give a detailed description of the lodes in the sulphide zone. Representing zones of intense shearing in the greenstones, they are highly schistose, but in places the schistosity is partly obscured by silicification. The ore contains much finely granular pyrite, but some of the densest pyrite seems to be associated with the steeper series of later shear zones and is therefore barren. The presence of stibnite and arsenopyrite in large quantities in the Yuanmi main lode has greatly increased the difficulty and cost of treatment. In the P Shaft Lode stibnite is present but arsenopyrite is said to be practically absent. According to Mr. Williams there is some evidence for regarding the stibnite as associated with the steeper shear zones. As a general rule carbonates appear to be absent from the lode or present only in small quantities, their occurrence being associated with the steeper shear zones and the pink granite. The Yuanmi mine is also characterised by the presence of very finely granular magnetite in large quantities, usually outside the lode channel; it appears to have been formed prior to ore deposition and is possibly connected with the jaspers.

Occurrence.—The most important lodes in this area are those of the Yuanmi Mine, which includes G.M.Ls. 863B, 864B, 865B, and 866B—the outcrops of the lodes so far discovered being confined to the first two leases—and those of G.M.L. 886M, United, and G.M.L. 770B, Hill End.

The lodes of the Yuanmi Mine include the Main Lode, West Lode, East Lode, Prospect Shaft Lode, and P (Pollard) Shaft Lode. Of these the most important is the Main Lode which has been proved for nearly a length of 1,000 feet—extending from a point a little north of No. 1 Shaft, about 420 feet from the northern boundary of G.M.L. 863B, to the southern end of a large open cut, about 150 feet north of the south boundary of the same lease. The lode has been proved to a depth of 778 feet (No. 7 level) below the collar of the main shaft. The ore shoots, however, were not by any means continuous over this distance, being broken by the later shears, and by poor zones where the lode shear cut through granite dykes, into a series of lenses of varying length. The greatest length of ore in the sulphide zone occurred at the 558 feet and 657 feet levels. At the 778 feet level the ore body was much broken owing to the presence both of shear zones of series (a) and (b) and of granite dykes. The average dip of the lode is stated by Mr. Williams to be 58°. The average width was about 4½ feet.

It has been generally assumed on the mine that the main lode has been faulted transversely at a point about 100 feet north of the southern boundary of G.M.L. 863B and that Prospect Shaft Lode was the faulted portion.

Other than a small eastward-striking quartz vein, of which a trace is visible at the surface, no sign of any transverse line of weakness was seen, and, moreover, so far as can be judged, the granite boundary to the east has not been faulted, at any rate to any appreciable extent. I am, therefore, inclined to regard the trace of lode matter cut at the junction of the northeast crosscut from V shaft with the southwest crosscut from Prospect Shaft as the southerly continuation of the Main Lode.

The West Lode outcrops a few feet east of the Main Shaft but has not been worked at the surface for any distance. It has been driven on at the 66 feet, 162 feet, and 300 feet levels, the greatest length

of driving being at the 162 feet level where the lode was followed for about 400 feet. The drives, however, disclosed but little payable ore. From the direction of the southern end of the drive at the 162 feet level and the low assay values, it is possible that the lode was disturbed by a shear zone of series (a). The formation followed for a short distance from V shaft is possibly the southerly continuation of this lode.

The East Lode outcrops about 160 feet east of the northern portion of the Main Lode and is only a few feet from the granite boundary, horses of granite being enclosed in the lode in places. It has only been followed for short distances at the 40 feet and 100 feet levels from two small shafts. At a shallow shaft a little to the south of those mentioned, the lode is affected by a shallow-dipping shear zone.

The East Lode is on the same line as Prospect Shaft Lode and the two may prove to be continuous, but owing to the proximity of the granite, any intervening ore shoots are likely to be of no great length.

The Prospect Shaft Lode has only been followed for 130 feet north of that shaft by a drive at a vertical depth of 50 feet—the face of the drive was said to be in granite. South of the shaft it is disturbed by two large and several small granite dykes and apparently also by one of the shallow-dipping shear zones. The probable southerly continuation of this lode was cut in the east crosscut off the south drive from Prospect Shaft, but at this point it cuts a small granite dyke.

The most important lode in the southern portion of the mine is the P Shaft Lode. This lode has been worked for a total length of about 900 feet and to a vertical depth of about 300 feet. The ore shoots are somewhat broken owing to the presence of granite dykes, including one very large dyke in which the north drive at the 300 feet level ends, and to faulting by nearly vertical shear zones. At the upper levels the lode appears to split on reaching the large dyke and to continue northwards as two bodies, of which the more westerly, which has not been followed for any distance, appears to be on the line of Prospect Shaft Lode, of which it may be the southerly continuation. At the surface P Shaft Lode appears as a series of detached lenses, of which the southernmost has a marked easterly dip, and as a whole this lode dips more steeply than the Main Lode. The best shoot in this lode extended from about co-ordinate 1,050 feet south (the main shaft being taken as the datum) to about 1,250 feet south, but was somewhat patchy.

Two lodes have been worked in the United and Hill End leases, which are north of the Yuanmi Mine, but separated from it by G.M.L. 873B. The more easterly lode of the two outcrops in the Hill End lease approximately parallel to, and about 50 feet east of, the western boundary, the strike being nearly due north. The lode has been worked in an open cut close to the southern end of the lease and from shafts in the United lease, into which it dips, and G.M.L. 873B to the south. It has not been worked to any extent below water-level, the flow of water being too great for the prospectors to handle, but a considerable tonnage of oxidised ore has been extracted. At its southern end the lode is much disturbed and has apparently been faulted along the westerly continuation of the large buck reef previously mentioned as occurring at the southern end of the Hill End. At its northern

end the lode runs into the main granite mass and dies out close to the margin.

The second lode is situated in the northern portion of the United lease. It strikes approximately north-northwest. At the surface it is separated into two portions by a long wedge of granite which has been dragged back along the lode channel. The western branch consists mainly of greenstone schist, the eastern in part of granitic material.

The lode has been worked for a length of about 280 feet, chiefly from a large but shallow open cut and from a shaft about 140 feet deep, 350 feet southwest of the northeast corner of the lease. At the southern end of the open cut the lode appears to be narrowing. The lode probably dies out to the north, in granite, near the northern boundary of the lease. As with the previously mentioned lode a fair amount of oxidised ore has been extracted, but little work has been done below water-level, which is said to be at about 100 feet in the shaft.

SUMMARY AND CONCLUSIONS.

The Yuanmi mining centre is situated near the eastern margin of an extensive greenstone belt, enclosed by granite, and comprising rocks of three types and of two, possibly three, ages.

The eastern portion of the belt consists of fine-grained schistose epidiorites, largely chloritised, probably corresponding in age to the older fine-grained greenstones of Kalgoorlie; the western of coarse-grained gabbroid or doleritic epidiorites similar in appearance to certain of the younger Kalgoorlie greenstones. The third type, which is possibly younger than either, is a massive fine-grained amphibolite occurring about four miles north of Youanmi.

The eastern portion of the belt is cut by numerous granite dykes.

The principal ore bodies are situated in a comparatively narrow zone of intense shearing in the older fine-grained greenstones along the granite margin. They include the lodes of the Yuanmi Mine, of which the most important are the Main Lode in G.M.L. S63B and P Shaft Lode in G.M.L. S64B, and those of the United and Hill End leases.

The continuity of the ore shoots is much affected by the presence of numerous granite dykes, causing impoverishment at the point of intersection, and by a number of later shear zones of several series, which have shattered and dissipated the ore bodies in places. Of these the most serious are the steeply-dipping shear zones owing to their strike being practically identical with that of the lodes and to their great width in places.

The Yuanmi Main Lode has been worked to a depth of 778 feet, the P Shaft Lode to a depth of about 300 feet. That payable ore bodies occur below these depths there is little doubt, but to predict the positions of such ore bodies at any given depth, accurate projections of the dykes and shear zones encountered at the levels above would be necessary. At a level put in from the main shaft at a depth of 880 feet the Main Lode would probably be free from the steeper shear zones that affected it at the 778 feet level, but would be affected at intervals by those of the flatter series—a less serious matter—and to some extent by granite dykes.

2.—ALLUVIAL AND LATERITE DEPOSITS OF THE HELENA RIVER, BETWEEN DARLINGTON, BOYA, ZIG-ZAG, EAST GUILDFORD, SOUTH-WEST DIVISION.

(ALEX. G. D. ESSON, M.A.)

Upon March 9th, 10th, 20th and 23rd, 1922, a reconnaissance was made of the valley of the Helena River for the purpose of plotting the Helena alluvial deposits from a point on the river bearing about 207 deg. from Darlington Station, down to East Guildford, where Morrison's bridge crosses the river. I also made an examination of the laterite deposits at Boya and near to the Zig-Zag, on the Canning Jarrah Timber Company's railway line.

1. *Helena Valley Alluvium:*

It is to be noted that the term alluvium has two applications. It may be applied to river deposits, which, in the case of the Helena, would be largely flood deposits or flood plains. On account of the economic importance of these, I have taken this application of the term in making this report.

Alluvium is deposited on the old worn-out valley of the Helena, a valley cut out when the river was much younger and probably flowed faster. In places a difference of eight or ten feet in the height of the two banks was noticed. This could probably be explained as being due to the fact that the river when younger deposited an alluvial plain consisting largely of sand and clay. The river then cut into this plain, forming a fairly wide, new bed, upon one side of which it again deposited alluvium at a much lower level than the older plain. In some places a difference in the deposits on either bank can be seen, although both are distinctly alluvial.

In no case does the alluvium extend to more than ten or twelve chains from the river, and in places lateritic ironstone and granitic rocks border the present bed of the river.

Economically, these alluvial flats are of great importance, on account of their depth and productivity, especially in connection with intensive agriculture or market gardening. I am informed by a resident of one of the flats that the depth of alluvium varies from twenty-seven or thirty feet in the middle of the valley to nothing on the extreme edge. The alluvium is largely good loam, very finely divided. In places, however, it seems to be composed mostly of clay.

In some places it is possible that the deposit is covered by æolian deposits of dune sand and in such a case, in the short time available, it was impossible to estimate exact boundaries.

(2.)—*Laterite Deposits:*

It was impossible to make more than a superficial examination of these. I examined them:

(a) *On Greenmount Hill, from Boya Siding.*—Here the deposits seem to begin at a height of forty feet or less from the summit and extend all over the hill top. They are highly ferruginous.

A distinct difference in the character of the vegetation on and off the laterite deposits was noticed.

Lower down the hillside, the rock was more or less weathered granite, while, lower down still, everything was covered with the detritus from this weathering.

(b) *Boya Quarries.*—Granite and diorite are quarried here from the sides of small spurs of Greenmount Hill. The diorite seems to be intrusive into the