1927.

—

WESTERN AUSTRALIA

ANNUAL PROGRESS REPORT

OF THE

GEOLOGICAL SURVEY

FOR THE

YEAR 1926.

With Seven Plates.

PERTH :

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

—

1927.

t9882/27

TABLE OF CONTENTS.

LIST OF PLATES.

Annual Progress Report of the Geological Survey for the Year 1926.

Compared with previous years the greater proportion of the time of the somewhat limited personnel has, during the calendar year 1926, been devoted to writing reports, though such field work as was found possible to carry out has been on similar lines to those adopted in the past.

THE STAFF.

There were six classified officers engaged upon the manifold work of the geological survey during the year 1926, and there have been some changes in the staff.

I was retired from the Service on the 1st November, under Section 66 of the Public Service Act, after having continuously served as Government Geologist since the 1st November, 1896.

Mr. A. G. D. Esson, temporary Field Geologist, severed his connection with the Department on the 11th December, after having served in that capacity for nearly five years.

FIELD WORK.

The table hereunder shows in brief the distribution of the field work carried out during the year, together with the names of the officers engaged, and the districts in which they were employed.

Table showing the distribution of Field Work during the year 1926.

Goldfield or Land Division.	F. R. Feldtmann.		A. G. D. Esson.	
	No. of days in the field.	Percentage of working days.	No. of days in the field.	Percentage of working days.
South-West Division	...	...	52	14·2
East Coolgardie Goldfield	22	6	...	...
Total ...	22	6	52	14·2

F. R. Feldtmann, Field Geologist.

Mr. Feldtmann took his annual leave for the year 1925 in the early part of January. The period intervening between his return to duty on the 6th January and the 14th May was devoted to the preparation of the report and maps on the Gypsum deposits of the South-West Division, which appeared in the progress report of 1925; the report, maps, and sections on the work carried out in connection with the underground geological survey of Kalgoorlie; the revision of proofs of bulletins (with plates and maps) in the hands of the Government Printer; together with various duties incidental to the work of the office.

Mr. Feldtmann commenced his long service leave on the 19th June, and was in consequence absent from duty until the end of the year. It was, in consequence, only possible for him to devote 22 days to active field work.

A. G. D. Esson, Field Geologist.

Mr. Esson's field work during the year 1926 comprised a series of visits of short duration to certain localities in the South-West Division. These included: three weeks of the month of April devoted to an examination of the peat deposits of Bayswater, of which the results have appeared in the progress report for the year 1925, q.v.; a short visit to Muja on the Collie Coalfield in June; an investigation into a clay deposit at Clackline, under the provisions of the Mining Act; a visit of a similar nature to a silver-lead deposit at Mundijong; and an examination of the alunite deposit of Lake Brown between the 7th and the 25th of November. Fifty-two days were devoted to field work, which was solely confined to the South-Western Division. Mr. Esson's term of service expired on the 11th December, when he severed his connection with the Survey.

PRINCIPAL RESULTS OF THE YEAR'S FIELD OPERATIONS.

1.—PROGRESS REPORT ON THE KALGOORLIE SURVEY.

(F. R. Feldtmann, Field Geologist.)

During 1926, field operations were mainly confined to the examination and survey of underground workings, in particular of those of Messrs. Black and Levy on the northwest slope and near the northern end of the Brown Hill Consols ridge, and in the northwest portion of G.M.L. 5247E. The country rock of this area is much sheared fine-grained greenstone, mostly oxidised in the workings examined, and with a capping of dense laterite on the top of the Brown Hill Consols ridge. A long dyke of albite porphyrite occurs immediately northwest of the workings described, but should pass a few feet west of the ladderway of the southwest workings and none of this rock was seen in the workings examined.

The most extensive of these workings are from a shaft about 200 feet southeast of the westernmost corner of G.M.L. 5247E. Two lodes have been cut in the workings from this shaft, which has a vertical depth of 66 feet. The more westerly lode should outcrop from 4 to 8 feet east of the shaft. The average strike of this lode is approximately N. 19° W.

From the shaft, levels have been driven at vertical depths of 42 feet and 66 feet. The rock at both levels is completely oxidised. The shaft is practically vertical as far as the 42 feet level, but thence has a slight westerly dip.

The western lode, which is in the shaft at the 42 feet level, has been driven on at this level, north for about 26 feet and south for 35 feet. From the south drive a crosscut has been driven east for 15 feet. An incline crosscut, which meets the south drive about eight feet south of the shaft, connects these workings with a small shaft, 130 feet west of the first (hauling) shaft at a depth of 14 feet. This second shaft is used as a ladderway.

Payable ore only extended a few feet north and south of the hauling shaft at this level, the ore body being stoped underfoot to about 15 feet south of the shaft, but the lode is fairly well defined and ferruginous. The walls of the lode, particularly south of the shaft, are marked at this level by narrow zones of intense shearing accompanied by brecciation.

At the 66 feet level the lode has been driven on south for 58 feet. The north drive had been mullocked, but was said to be about 40 feet in length. The lode, which was not so well defined at this level, averages a little more than two feet in width in the south drive. It was only payable for a short distance north and south of the shaft.

From the end of the south drive at this level a crosscut extends east for 123 feet. From 43 to 52 feet east of the drive an ill-defined shear zone, in which a fair amount of manganese oxide is present and carrying a trace of gold, was cut by this crosscut. Traces of gold were also obtained at the end of the crosscut from a steep narrow shear zone of somewhat mullocky appearance. This shear zone was driven on north for 16 feet and south for about 80 feet. No gold, however, was found in the drives and the shear zone is barely traceable near the end of the south drive.

Another crosscut was being driven east from the shaft at this level, at the time of my survey. From about 43 feet east of the shaft to the then face—60 feet east of the shaft—of the crosscut, the rock is much sheared and near the face some ferruginous matter is evident, but little or no gold appears to be present. The sheared rock in the last six or seven feet of this crosscut without doubt represents the shear zone or lode cut in the crosscut to the south, from 43 feet to 52 feet east of the south drive.

About 265 feet north of the hauling shaft and immediately north of the northwest boundary of G.M.L. 5247E is a shaft, 47 feet in vertical depth and on a westerly underlay of about 70°, on a lode which from its position and strike is obviously the northerly continuation of that cut at 43 feet to 52 feet in the east crosscut off the south drive from the hauling shaft.

From this northern shaft levels have been driven at vertical depths of 29 feet and 47 feet. Owing to the difference in the surface levels at the two shafts, the 47 feet level from the northern shaft is practically equivalent to the 66 feet level from the hauling shaft.

At the northern shaft the lode has been driven on for 88 feet at the 29 feet level and for 72 feet at the 47 feet level. The lode in these workings strikes, on the average, about N. 10° W., and averages a trifle more than two feet in width. It is cut by a series of narrow, nearly vertical shear zones, striking about N. 40° W., along which it appears to be faulted a few inches to the east, going north.

A few small cross joints and cross veins of quartz were noted. These appear to cut the lode, but to be cut by the later shears.

The lode is not very well defined and, owing to the shearing of the country rock both prior to and later than the period of lode formation, is difficult to follow, particularly at the 47 feet level. It is, however, as a rule more ferruginous than the enclosing rock.

Only one small shoot of payable ore was obtained in these workings, between about 37 feet and 57 feet north of the shaft at the 29 feet level and about 48 feet and 54 feet north at the 47 feet level. This shoot has been stoped between the two levels and for eight or nine feet above the floor of the 29 feet level.

It was stated in the Annual Report of the Survey for 1925 (page 10) that two parallel zones of intense shearing, observed a few feet southeast of the southeastern boundary of the Lucelle G.M.L. 5375E and east of an old shaft with a high dump, were possibly the southerly extensions of the lodes worked by Sassella Bros. in the former Williamstown G.M.L. 4499E, later covered in part by G.M.L. 5375E. The strike of these shear zones is about N. 42° W.—approximately parallel to that of the later shears cutting the lode in Black and Levy's north shaft—and they should meet the southerly continuation of Sassella's lodes a short distance north of the Williamstown-Brownhill road. The two lodes cut in Black and Levy's working, however, strike about N. 10°-20° W. and should meet Sassella's lodes, which in the southernmost workings examined during the survey of the North end averaged about N. 32° W. in strike, a little south of the road. It should be stated that in the workings mentioned Sassella's lodes appeared to be bending in a more southerly direction.

I am now of the opinion that Black and Levy's lodes are the southerly continuations of Sassella's lodes and that Sassella's south shaft, immediately north of the Brownhill Road, is too far east to cut the lodes, except by crosscutting. The old shaft south of the road is probably between the two lodes at the surface.

2.—THE SILVER-LEAD DEPOSITS AT MUNDIJONG, COCKBURN SOUND DISTRICT, SOUTH-WEST DIVISION.

(A. G. D. Esson, M.A., Field Geologist.)

I.—Introduction.

In accordance with instructions an examination of the country comprised in and around Prospecting Areas Nos. 474H, 475H, Mundijong, has been made by the writer. This followed upon instructions issued to the Government Geologist in accordance with Section 197 of the Mining Act to enter, inspect and report on this land to ascertain whether there is reasonable probability of the land containing minerals lead and zinc in payable quantities.

When visited, the areas were deserted, and would appear to have been so for some considerable time. Workings were inaccessible, and the deep main windlass shaft upon Prospecting Area No. 474H was filled with water to within seven or eight feet of the surface. Notwithstanding, the writer was able to make a brief examination of the surface indications of mineralisation and of the geology of some of the sur-

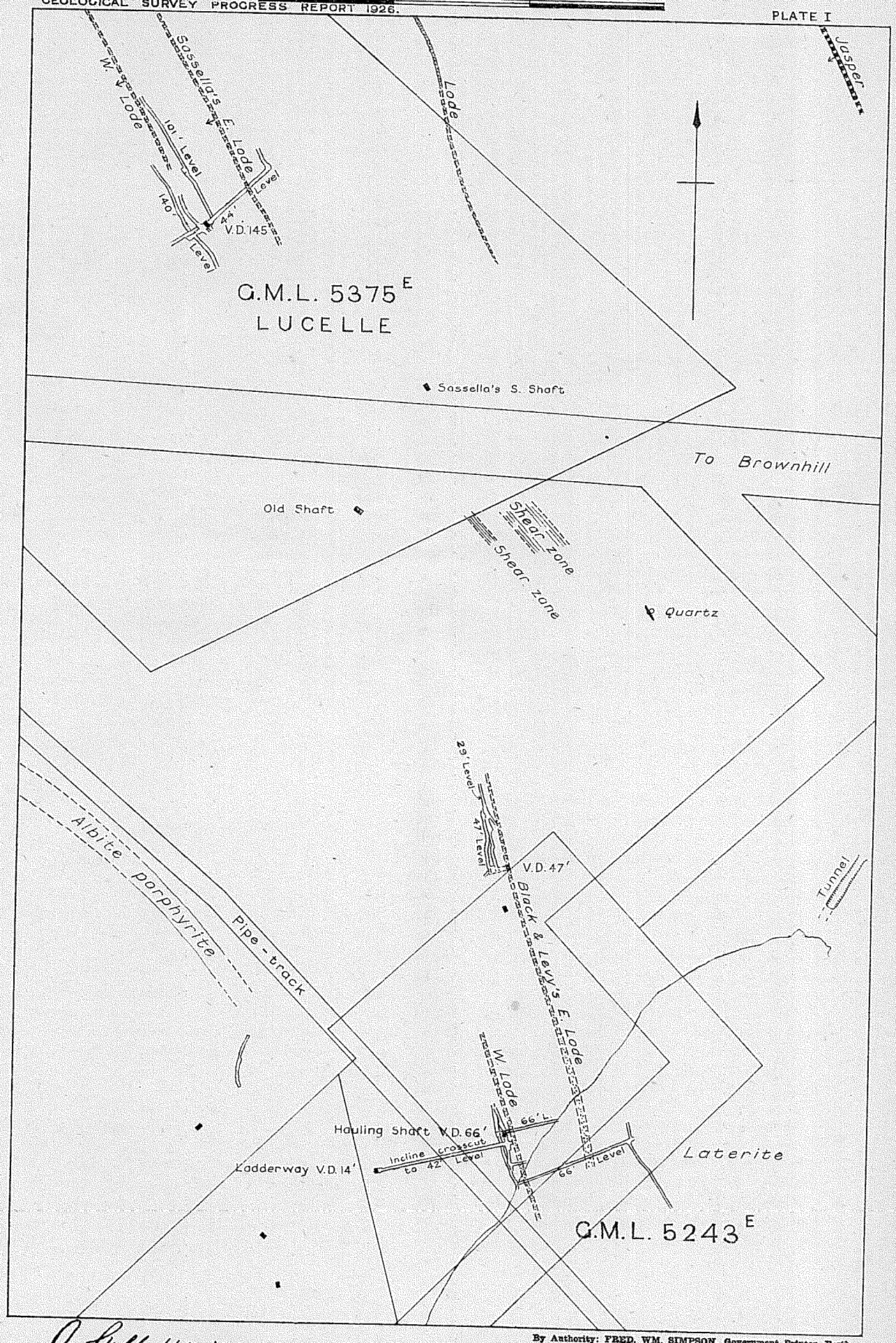
The Hon. M. F. Troy, M.L.C.
Minister for Mines.

PLAN SHOWING RELATIVE POSITIONS OF BLACK AND LEVY'S AND SASSELLA'S LODES
KALGOORLIE, EAST COOLGARDIE G.F.

Chains 0 2 4 6

GEOLOGICAL SURVEY PROGRESS REPORT 1926.

PLATE I



A. Gibb Maitland
Government Geologist

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

rounding country. A map has been prepared by the writer and accompanies this report. Boundaries between rocks were found to be much obscured—in some places by laterite, and in others by deep alluvium. Hence the writer does not claim that the examination, made in so short a time as was available, is definitely conclusive, and minor alterations in geological boundaries may be found necessary with more detailed field work. Traverses made by the writer will, nevertheless, give a reasonable degree of accuracy to the map.

The occurrence of silver-lead in this locality has been known for many years. As far back as 1907, Mr. Montgomery, State Mining Engineer, reporting on this ground as Leases Nos. 6H and 7H, says that first discoveries of silver and lead here were reported to have been made many years before 1907. A shaft was sunk to 40 feet, and later deepened to 86 feet.

Various syndicates and owners have held the land comprised in these leases and prospecting areas, which have had a chequered career and indifferent success up to the present.

The present applicants were not in evidence at the time of examination so that nothing could be found out from them regarding the exact places on the prospecting areas at which silver, lead and zinc were found. Only on Prospecting Area No. 474H has any serious attempt been made to prove the existence of metalliferous bodies or lodes, and the writer relied solely on his own observations in making this report.

II.—Locality.

Prospecting Areas Nos. 474H and 475H are situate about two miles east of Mundijong Railway Station. Prospecting Area No. 474H lies partly within Locations 23, 407, and 410, the latter of which is the Jarrahdale-Rockingham Timber Company's Railway Reserve. Prospecting Area No. 475H, as applied for, would lie in Location 653, and a small portion possibly in Location 269, although adjustment of the prospecting area boundaries could be made to get over this difficulty.

Location 23 is held by the Crown for asylum purposes, and the other locations mentioned are held by private parties.

III.—Geology.

(a)—*General Geology of the District.*

The underlying formations are largely obscured by the ordinary concretionary laterite, found so commonly throughout the Darling Ranges, and from near Mundijong townsite there is a gradual transition and rise to the lower slopes and foothills of the southern extension of the Darling "Range" Fault Scarp.

Near to Mundijong the surface is covered by low level laterite which may obscure extensions of some of the sedimentary beds underlying the metropolitan area. On Location 500, immediately south of Mundijong, the writer found some fragments of shale similar to the Cardup-Byford-Armadale shales in close proximity to a windmill-well upon the block. He was assured by Mr. Walsh, the holder of the block, that these came from the shaft of the well when it was being excavated. If this is so, and if there is any solid bed of shale, then there is here a probable extension of the Armadale shales and possibly a correlation in age between these shales and those of the metropolitan area. No shale outcrops were observable at this point, and small sections upon an adjacent creek showed clay loam to sandy loam overlying lateritic formation and detritus.

Further east the laterite gives way in places to white sand upon the surface, and nearing the intersection of the Bunbury Road and the Rockingham-Jarrahdale Timber Company's line, the surface becomes more lateritic, and there is a gradual transition to red clay.

At the intersection of the Bunbury Road and Mundijong Road there are small quarries upon the same Cardup-Armadale shales, and these latter are overlain by laterite.

Going still further east into the Darling Ranges proper, there are occasional outcrops of the underlying rocks, but except upon the higher points of the ridges and hills laterite and alluvium obscure most of the rocks.

In the vicinity of Location 23, the fundamental rocks are seen to be foliated hornblendic granite gneiss with a distinctly north-west foliation strike, intruded by later epidiorite dykes so characteristic of the whole Darling Range escarpment.

Enfolded in the gneiss are beds of shales similar to the so-called Kelmscott clay deposits. These shales are highly argillaceous, and in cross section are beautifully banded with alternating blue or black and white laminae. In the vicinity of the prospecting areas there would appear to be at least three separate belts of shales, all with a very high dip.

In one place at a shallow shaft in the north Prospecting Area No. 474H, porphyrite with large bleached felspar crystals was noticed. No absolute strike of this rock was seen, but it seems likely that it would occur in dyke formation with a main strike direction closely approximating to the general north-west foliation strike of the igneous fundamentals. It is possible that this foliation strike would develop closely parallel zones of weakness suitable for intrusion of the porphyritic magma.

Topographically, the country in the neighbourhood of the prospecting areas consists of deep gullies and steep ridges forming the lower foothills of the Darling Range escarpment. Through Prospecting Area No. 474 H runs a deep gully north-westwards down which flows Mundijong Brook. To the northeast is Manjedal Brook also running north-west towards the sea along a somewhat more mature gully. In both gullies there is a good depth of alluvial matter largely derived—in the Mundijong Brook gully—from disintegration of slates and epidorite.

(b)—*The Rocks.*

(1)—*Gneiss.*

Granitic rocks occupy a great portion of the Western Australian Plateau, and in the Darling Ranges they are very prominent in association with intrusive dykes of later epidiorite greenstone. These granitic rocks along with various metamorphic schists, greenstones, and epidorite dykes are considered to be pre-

Cambrian in age, and it would appear that these pre-Cambrians form the ultimate fundamental rocks of the whole Western Australian Plateau.

The granitic rocks vary a great deal in composition from biotite-microcline granites to hornblende granites throughout the ranges, but they would seem to be products of the same magma varying only by segregation. There are later granitic rocks, but it is not necessary to consider them meantime. In the vicinity of Mundijong the predominant type would appear to be the hornblendic type. Most of the outcrops of this type observed by the writer were seen to be distinctly gneissic in structure. Possibly there has been metamorphism or segregation or both processes perhaps, to produce a more basic form which would be known as hornblende schist.

Hornblende gneiss has been observed by the writer at Armadale and Cardup, and also at Clackline many miles further north, but still, in common with the other places mentioned, upon the Darling Ranges. The continuance of gneissic structure in much the same direction throughout the ranges would point to a possibility of it being due to strain developed at time of faulting of the Darling Scarp, but this assumption is not meantime accepted conclusively by the writer.

The strike of foliation planes of the gneiss near the prospecting areas varies from place to place, and the general direction throughout the district appears to conform largely to that of the reefs, viz., roughly northwest to north-north-west. At times upon first examination, the gneiss in close proximity to the main reef at the deep windlass shaft seemed to be almost basic in character, but closer examination revealed the fact that it is merely a phase of the gneissic fundamental. In this it closely resembles the occurrences at the reported gold discoveries of Mundijong some 1½ miles south-east of the silver-lead shows. This would lend some credence to Campbell's supposition (Geological Survey Annual Report) that these reefs in the gneiss are also particular phases of the gneiss due to the separation of quartz from hornblendic and other material.

This, however, was not definitely clear to the writer at the main shaft of Prospecting Area No. 474H, and further work would be necessary before agreeing with Campbell's supposition in its entirety. If Campbell is correct, then there will be little likelihood of finding any great ore body in association with the reef. In places the reefs have a somewhat foliated apearance, and in others they are decidedly bucky.

At the south-west corner of Location 23, a very much weathered and rather fragmentary outcrop was found. A specimen collected here is seen to consist largely of quartz, and ferruginous minerals have been altered to limonite and other iron oxides, thus giving the rock in section a banded appearance with white and red or yellow stripes. The banded appearance is due to an original gneissic structure, and evidently the iron minerals are derived from the alteration of hornblende. There is little doubt in the mind of the writer that this is merely a surface alteration product of the hornblende gneiss, although upon first examination it would appear to be a sandstone when coarse in grain or even a quartzite when more compact. It is possible that an occurrence such as this might give rise to the idea that sandstones are associated and interbedded with the shales.

In places small stringers of quartz are found filling what evidently has been faults across the folia of the gneiss. The writer is not quite clear as to the derivation of that quartz, but in a specimen from the main windlass shaft in Prospecting Area 474H it would appear to be secondary in origin, and it is there associated with crystalline pyrites.

(2)—*Porphyrite.*

It has already been pointed out that this intermediate to basic rock, usually occurring in other parts of Western Australia as later dykes intrusive into older rocks, was observed in the north Prospecting Area No. 474H, and that in the limited time available it was impossible to find out exactly its connection with adjacent rocks. It would appear, however, to be a dyke striking roughly northwest alongside an intrusive epidorite dyke. In the map it has been suggested that the porphyrite dyke is of comparatively short extent southwards, but this is not absolutely conclusively proved, although boundaries were delineated from observations made on a few traverses.

The age of such rocks in other areas has not yet been determined, although it has been suggested by Dr. Larcombe that these are most probably post-gold in age as they are not, in general, found to be mineralised in any way.

In fresh specimen the rock is of a greenish colour, and shows plentiful flat crystals of plagioclase felspar which are much bleached and altered. It weathers to a reddish-brown rock with dirty yellowish-white phenocrysts of felspar.

It is understood that this same rock is found to occur at a number of places along the Darling Range escarpment. The writer is informed of its occurrence at Serpentine, Cardup, and Byford. He has not verified these occurrences, but it seems likely that at a late period of activity these dykes of porphyrite would be intruded along lines of weakness from a sub-acid (?) or intermediate magma.

(3)—*Greenstones.*

Among the rocks of the district, greenstone also finds a place. This greenstone consists of fine-grained to medium-grained epidiorite intrusive in the form of dykes. At various points through the ranges, this greenstone has been found in close proximity to and indeed often intruding the shale beds.

Clarke and Williams in their "Geology and Physiography of Parts of the Darling Range near Perth" (*Journal Royal Society, W.A.*, Vol. XII.), mention the fact that at certain places in the Darling Ranges there would seem to be evidence of more than one age of epidiorite dykes, but certain occurrences lead them meantime to accept the idea of all epidiorite dykes being of the same age.

In the writer's Mundijong examination, time was too limited to permit of very detailed examination of epidiorite dykes in the vicinity, so that it is impossible to say meantime if there is here definite evidence of more than one age in these dykes. It is suspected, however, that there may be evidence of this

kind here and also at Armadale and Cardup. The writer, in the Annual Report, Geological Survey, W.A., 1922, has drawn attention to the strange parallelism of such dykes at Wongong Brook Weir site (which is also in the Darling Range), with two main directions of strike, and he suspected there also different ages of such dykes.

In the map accompanying this report the writer has shown dykes of epidiorite running in two main directions, northwest to north-northwest and north-northeast. These dykes seem to occupy lines of weakness closely conforming to their strike. It is somewhat remarkable that the quartz reefs observed had a main northwest to north-northwest strike conforming to one of the main shear directions observable right throughout the Western Australian Plateau. It seems likely that this is one of the oldest—if not the oldest—of the shear directions of Western Australia, and from point of view of age would point to the possibility of mineralisation having ample time for being at work.

If this is accepted, it may be presumed—although perhaps not proved—that epidiorite dykes conforming to this strike are of greater age than those conforming to the north-northeast strike.

(4)—*Shales.*

The writer has been able to find evidence of four *possible* belts of shales in the Mundijong district. Two are in the immediate vicinity of Prospecting Area No. 474H, and these have a main northerly strike which varies at times to almost north-northeast. Definite outcrops were hard to find except in small cuttings on the Jarrahdale railway line and in a costean northwest of the northwest cornerpost of Prospecting Area No. 474H. In general one had to be satisfied with fragmentary deposits derived by weathering of upended deeply dipping shales underlying or presumably closely adjacent to the detritus. For this reason it was somewhat hard to fix boundaries with any degree of exactitude. The shales rest upon their edges, and have a steep dip which in places closely approximates to vertical.

Essentially the shales are altered mudstones and are highly argillaceous. Bedding planes are observable in narrow bands of alternating blues, black and white. In places there is evidence of alteration by pressure and also probably by intruded heated dykes such as the epidiorites.

In the vicinity of Prospecting Area No. 474H it would appear that one of the epidiorite dykes intrudes the shales, and this might be taken as definite evidence of the comparative age of the shales. It has generally been assumed that similar intrusive epidiorites are pre-Cambrian in age—although not admittedly so in this case—and this would point to the shales being of great age. It is to be noted that the Government Geologist has suggested that these "Armadale Shale Beds" are possible extensions of the Yandanooka Beds (*Mining Handbook,* G.S., Mem. No. 1, Chap. 2, Economic Geology, Chap. II., Lead Deposits of W.A., page 6). The writer could not find any evidence of mineralisation of shale beds further than that of the occasional development of pyrites—evidently by pressure. E. de C. Clarke has suggested that these beds of much jointed shales are representatives of the Yilgarn Series (Handbook, Aust. Assoc. Adv. Science, 18th Meeting, Perth, 1926 page 26).

At Mundijong the writer could find no evidence that the shales are in any way concerned with lead deposition, and they are not in themselves mineralised.

Occasionally a very finely-banded, close-grained, highly metamorphosed phase of the shales was found. This, upon first examination, was thought to be, from its appearance, a "jaspilite" similar to those so common on the various goldfields, but closer examination soon revealed its true nature.

Sometimes the shales were found to break across the bedding planes and to approach a blue slate, but normally they are to be considered merely as highly metamorphosed shales.

No fossils of any kind are to be found in these shales, and this may perhaps give some idea of their age and of the amount of metamorphism that they have undergone. Normally these shales would be expected to yield plentiful fossils but, so far, negative results have been obtained.

Iron material in the weathered shales produce red hydrated oxide of iron, and ultimately by degredation a very heavy black loam. With a somewhat youthful, but full maturity, the lower valley of the Mundijong Brook in the vicinity of the prospecting areas is largely cloaked by such black material to a fair depth.

Economically these shales are of value for brick-making, and for some years the Armadale deposits have been utilised for this purpose by private enterprise. There seems to be no reason why the Mundijong shales should not be developed in the same way.

(5)—*Laterite.*

Laterite covers much of the surrounding country, and obscures the underlying rock relations. In general, the laterite is of the normal red, ferruginous concretionary type, but occasionally it is somewhat more ferruginous, especially when ultimately derived from greenstone.

(6)—*Reefs.*

In general, the reefs were found to have a main northwest to north-northwest strike in conformity with the strike of shearing already mentioned above. Although at times they exhibit a sheeted to laminated appearance, consideration of the fact that they are found in shear zones in the greenstone as well as in the gneiss would lead to the supposition that those reefs came probably after the intrusion of epidiorite dykes of largely the same strike. It is possible that the intrusion of these dykes was along prevailing lines of weakness which again were opened up at a later time, perhaps, by the intrusion of the greenstones or, perhaps, by the intrusion of the later deep-seated acid granite magma.

Throughout Western Australia it is now recognised that the intrusion of deep-seated acid magmas has been responsible for the circulation of hot solutions, which in turn deposited quartz and contained minerals in convenient fissures and places where conditions were favourable for doing so.

(c)—*Particular Geology of Prospecting Area No.* 474H.

A brief resumé of the salient points of the geology of this prospecting area is given herewith. The prospecting area is situate along a deep valley through

which runs the brook designated Mundijong Brook. This valley seems somewhat mature, but it is doubtful if it is more than youthful. Its bottom and sides are largely cloaked with a deep deposit of alluvial material derived from the weathering of laterites and of the underlying rocks.

The fundamental rock is gneissic hornblende granite. In this upon edge lies a belt of shales with a main north-northeast to north strike. These shales appear to be thinning out towards the southern portion of the prospecting area.

These have been intruded by greenstone (epidiorite) dykes and by porphyrite, the exact boundaries of which rock are by no means certain. It is possible that in the area, marked porphyrite on the map, there are more than one separate dyke.

A long line of reef on the southwest side of the prospecting area has been followed and mapped by the writer. This has a main northwest strike and lies in the gneiss with a strike almost parallel to the epidiorite. Upon this line are the main workings. There are other workings off this line in the north of the prospecting area but none of these is of any great importance.

Upon the main line of workings is Main Windlass Shaft. In 1907 Mr. Montgomery made an examination of this shaft and of the adjacent workings. In this report use will be made of details supplied by him, as owing to the height of water in the shaft it was impossible for the writer to make any examination of these underground workings. The shaft is 86 feet deep (or more) with levels at 30 feet, 52 feet, and 70 feet. Very little work was done at any level but the 70 feet level, where a crosscut was made for 23 feet northeast through the reef and a winze sunk 30 feet. The reef seems to widen considerably with depth and with a dip northeast of 85° or more it passes out of the shaft between 50 feet and 70 feet levels. In the crosscut it was seen to be about 16 feet wide, and the lode matter consisted of strings and bunchy patches of blende and galena in quartz. Very little pure galena was exposed, and hand-picking would have to be resorted to so that material of commercial value should be obtained. An examination and assay of samples was made for Mr. Montgomery by the Government Mineralogist and Analyst and the following results were obtained:—

Lead	...	...	...	8·30% (wet assay).
Zinc	...	...	...	5·31%
Copper	...	...	...	Slight Trace
Silver	...	...	...	14dwts. 8grs. per ton.
Gold	...	...	...	Trace.
Silica	...	...	...	77·71%

The assay results are not promising and, apart from lead and zinc, minerals are of no consequence. There seems to have been small justification for calling this a "silver-lead show." There seems to be no reason, however, why, with shoot and ore body increasing with depth, a good ore body should not be obtained at depth.

The work done in this shaft seems to have been more or less of an exploratory nature, rather than developmental.

Specimens of ore obtained by the writer from the dump at the Main Windlass Shaft head consisted of pure white semi-transparent glassy quartz, much fractured and occasionally re-silicified, with bunchy deposits of galena and zinc blende. Unfortunately, the amount of zinc is too great in these specimens to permit of the ore being treated in the ordinary way and a special treatment will be necessary. Careful sampling at depth from various points upon the ore body would reveal the possible utility and value of the ore.

Southeast of the Main Windlass Shaft is a small tunnel into the reef. This probably was cut in for the purpose of testing the extent of the reef. Further southeast along the same line of the reef are two costeans across the reef. In these there is no great mineralisation and the quartz is somewhat bucky.

Northwest of Main Windlass Shaft is a long costean along the reef, and east of this there is a shallow shaft. It is not known what the function of this shallow shaft was, as it also was found to be full of water, but from its dump materials it appears to have been put down on a narrow stringer quartz reef contacting with the main reef near the Main Windless Shaft, and lying wholly in hornblende gneiss.

Other reefs are marked upon the map accompanying this report, but none seem to have had any mineralisation worth noting.

IV.—Conclusions and future possibilities.

There are two aspects worthy of consideration in determining whether the land in this area should be alienated for mining purposes.

1st.—Minerals of economic value are to be found, and, in the writer's opinion, they occur only upon the reef in which are the main workings. Upon the evidence of the writer and of Mr. Montgomery, lead (galena) and zinc (blende) are found in a shoot in the Main Windlass Shaft. Hence there is justification for permitting the mining of these minerals.

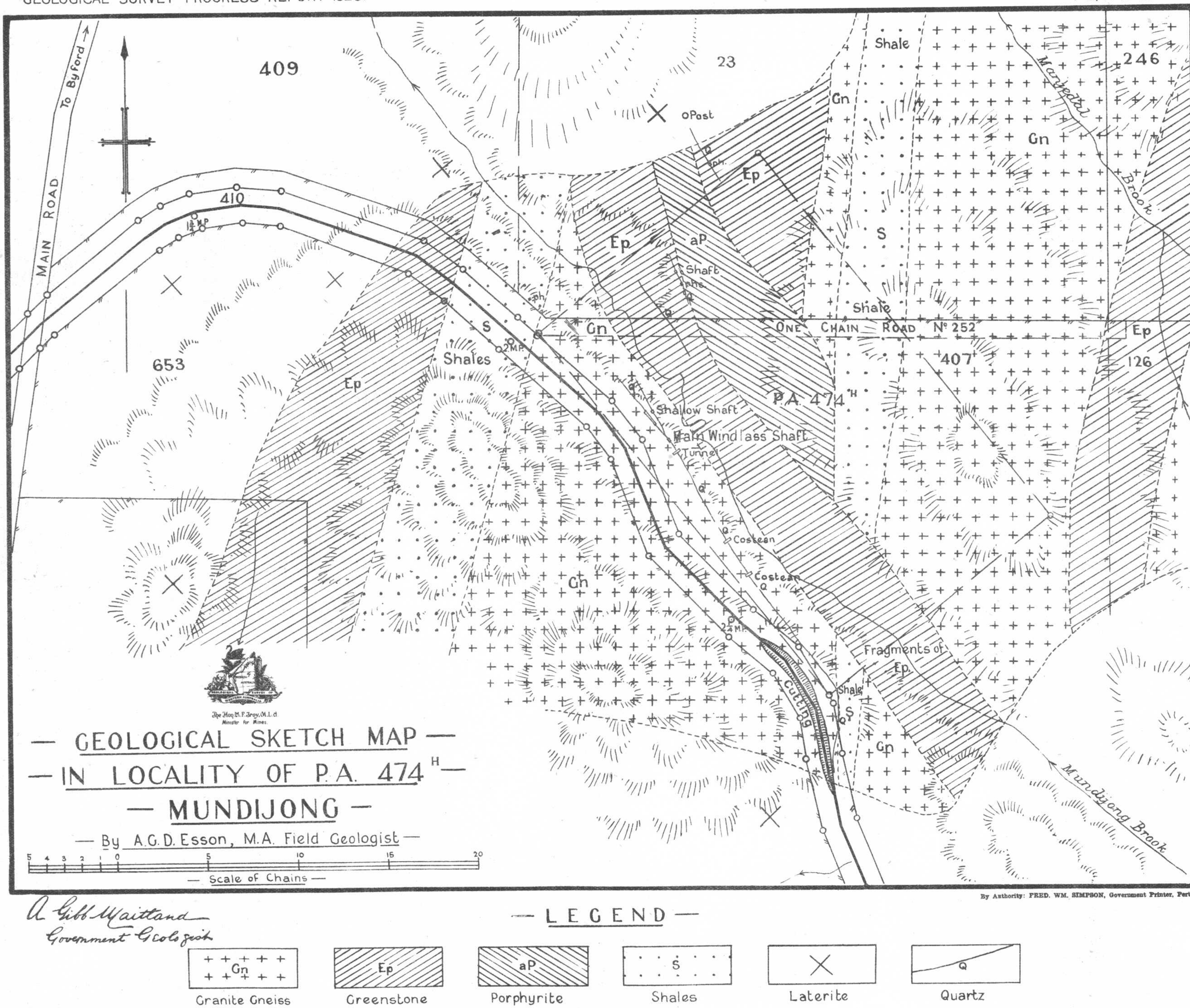
2nd.—There are two large beds of shales, similar to those which have been found to be of value for brick-making at Cardup, Byford and Armadale.

In addition, railway facilities are comparatively close to both occurrences.

Against these it must be considered that the areas lie in private land as well as in Crown reserves for lunacy purposes. The writer could see no justification for considering that the area south of Jarrahdale Railway Reserve Location 410 was mineralised, especially as the reef in Main Windlass Shaft dips northeast away from the railway. A rough examination of this country south of the railway was made and the writer could find no signs of any attempt at prospecting it and certainly no signs of mineralisation. It is not claimed that mineralisation does not occur there, but no trace of it was observed.

Another point at issue is the fact that it will be necessary to alienate "private" lands. It is likely that this will be a question for decision by the Warden, as it is understood that the prospectors were unable to come to any agreement with the owners of the lands.

It seems highly probable that the ore in the Main Windlass Shaft will be bunchy, but there is no reason why it should not make into a profitable body at depth. It was noted that occasionally there is a development of pyrites in specimens from the dump



By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

A Gibb Maitland
Government Geologist

but it is not known from what depth such samples came. Probably the lode will make into copper deposits at depth. Before making any development of the show, some attempt should be made to prove the extent and value of the shoot.

It might be noted in conclusion that somewhat sporadic deposits of gold, copper, zinc, lead and silver have been noted at various places along the Darling Range escarpment going northwards from this area, but in most cases they have proved unprofitable. In this connection is mentioned the barytes deposits at Cardup, where a barytic-quartz body has been worked and is now abandoned.

3.—ALUNITE SALT LAKE DEPOSITS, CAMPION, AVON DISTRICT.

(A. G. D. Esson, M.A. (Aberd.), Field Geologist.)

1.—Introduction.

During 1925 Mr. J. Chandler, of Campion, a comparatively new agricultural district recently opened up for wheat growing, submitted for examination samples of the muddy beds of salt lakes situate in Campion. These samples were examined by the Government Mineralogist, and were found to contain alunite. Subsequently the Government Mineralogist (Dr. Simpson) and the Government Geologist (Mr. Maitland) made a short examination of these lakes. At the time of their visit little more could be done than to verify the deposits and to take samples, owing to the fact that the lakes were under water to a depth of two or three inches.

Owing to the importance of the alunite for agricultural and other purposes, the writer was instructed to proceed to the district and to map out the deposits in detail, so that information could be obtained regarding the quantity of alunite available. Leaving Perth on 1st November, 1926, the writer occupied three weeks in the examination, and this report is the result of his investigations. A geological sketch map acompanies this report and embodies the main work done by him on the field.

2.—Location.

The alunite deposits are found on two lakes designated Reward Lake and Chandler's Lake, both of which lie about 22 miles slightly west of north of Burracoppin and 24 miles by road in a main northerly direction from Burracoppin. Roads to the deposits are, in the main, fairly good, although there is some distance of lake country to be passed through.

3.—Topography.

The salt lake system, loosely designated Lake Brown, consists of a series of salt lakes and playas, which appear to have been at an early stage in Western Australian history—although possibly late geologically—an old river system running westwards to the sea. Cartographers seem to have suggested that this river system at one time joined up with the River Avon. Whether that be so or not, the writer cannot say definitely at present, but he found the lakes in the Campion area to have a general fall southwards. In addition it seems likely that in the south the drainage turns west and northwest towards the main Lake Brown, as the general fall of the country is in that direction.

There are natural barriers to perfect drainage in the form of kopai ridges, and it is likely that only in flood periods is water able to move towards the main Lake Brown, as in every case, where there was opportunity of testing, the writer found water in the lakes to be extremely salt. Hence, evaporation must account for a considerable amount of the water collecting on these lakes. So salt were the lakes found to be that it was sufficient when collecting salt from them to dig trenches and to allow seepage waters to collect. Dissolved salts crystallise out as a thick crust upon the waters, and can be easily collected. The most common salt observed was common salt or sodium chloride.

The salt lakes in this western extension of Lake Brown lie in depressions in a gently sloping surface through which occasionally bare granitic rocks appear. These playas or salt lakes are divided from each other by ridges of kopai, and occasionally of impure to pure white seed gypsum. These ridges, which presumably are blown up by prevailing winds, rise to a height of 20 or 25 feet above the level of the lake beds.

To the writer it seems likely that igneous rock outcrops—perhaps lateritic—form the cores of many of these kopai dunes. Probably these cores would form convenient places against which to deposit gypseous matter blown off the dry lakes in summer weather. This blowing-up of the powdery gypseous matter was actually seen by the writer during his examination.

Occasionally flat granitic outcrops are met, and in one of these on Block 14340 a small gnamma hole of characteristic form was found. The capacity of this hole is about 50 gallons, and it is the only fresh surface water observed in the district. For agricultural purposes water is conserved by means of dams. The district is decidedly dry, and is largely dependent for water upon the nearest standpipe of the Goldfields Water Supply Scheme.

4.—General Geology.

Rock outcrops are not numerous except in one or two places in the area under discussion. In most cases, rock outcrops were found to consist of some form, altered or fairly fresh, of gneissic granitic rock. In addition, in one or two places small fragments of jaspilite and of epidiorite greenstone were found. The greenstone fragments were by no means common, and they may have been derived from occasional narrow intrusive dykes.

Various forms of laterite largely obscure outcrops and, although in the main these lateritic forms appeared to be granitic, in one or two cases they had an appearance such as might indicate derivation from greenstone.

Except for a few narrow dykes of greenstone, the rocks observed on the road while travelling from the alunite deposits to Burracoppin *via* Goomarin were found to be upon examination granite, generally of a gneissic form. The same is true of the country rock observed while travelling from Merredin to the alun-

ite deposits. The rocks observed for about six miles north, four miles east, and two miles west were mainly granitic.

In the vicinity of the alunite deposits, the granitic rocks were found to outcrop more strongly on the western side of Chandler Lake. They form low rounded ridges of characteristic granite-weathering form, and occasionally the bare granitic rock—fairly fresh—outcrops at the surface. In most cases these granites were seen to be distinctly gneissic, although occasionally a pegmatitic or an aplitic phase was observed. Possibly these latter forms would be later intrusive granites, but there is no reason why they should not be particular phases of the main country rock.

This gneissic country rock was observed at many places between Burracoppin and Campion, and between Merredin and Campion.

Specimen 27 L.B., collected by the writer from the near vicinity of the gnamma hole in Block 14340 ↑ 11210 northwest of Chandler Lake, may be taken as being characteristic of the main country rock of the district. It was found to be gneissic biotite granite of a speckled greyish colour and a banded appearance. This specimen was examined by Dr. Larcombe, the Acting Petrologist, and the following is his report:—

> "A medium grained, banded and somewhat granulated biotite-gneiss. The more acidic bands contain only quartz and felspar. This gneiss may be regarded as of igneous origin, representing a partially transformed and differentiated granite."

It is to be noted that Dr. Larcombe does not consider this gneiss to be of sedimentary origin, and that gneissic granite of this nature has been observed by the writer at a number of places throughout Western Australia. Macroscopically there seems to be little difference essentially between occurrences. In short, in the writer's opinion this granite is the characteristic gneissic granite found forming a large portion of the Western Australian plateau.

Close to the edge of the northwest corner of Chandler Lake, granite again outcrops, forming a low rugged steep bank for some ten chains. This granitic rock is highly altered and decomposed, and its most outstanding feature is the pronounced banding—evidently relict structure of an original gneissic form. Felspars are almost completely kaolinised, and from field examination the writer is of the opinion that this is merely an altered phase of the gneissic biotite granite already discussed.

Borings in the Chandler Lake revealed the fact that this rock is found continuing below the lake clay and other deposits, and forms probably the ultimate fundamental bed of the lake. If borings had been deepened sufficiently all over the lakes, it is likely that they would bottom on this igneous country rock. The lakes appear to lie in a depression in this gneissic granite, and undoubtedly the latter will be found to grade from highly altered rotten rock to the fresh and less altered gneiss.

Specimen 28 L.B., collected by the writer from the bank on the northwest corner of Chandler Lake, was examined by the Acting Petrologist, and the following is Dr. Larcombe's report:—

> "A highly decomposed rotten granite rock, consisting essentially of white clay with protruding quartz grains due to their resistance to weathering. On fractured surfaces, a distinct banding was noticed and the fresh, unaltered rock is probably gneissic."

The writer put down a number of bore holes of shallow depth—up to 12½ feet—throughout the lakes and kopai ridges. In some cases ferruginous material that might be referable to lateritic origin, was brought up in the borings, and it seems possible that the floor of the depression, in which the lakes are, was at one time covered by lateritic material.

5.—The Alunite Deposits.

Alunite is a hydrous sulphate of aluminium and potassium, whose chemical formula is generally represented as $K_2O.3Al_2O_3.4SO_3$, $6H_2O$. From an agricultural point of view, the valuable ingredient is the potash (K_2O), which is extractable by calcining the alunite and by subsequent treatment with water to leach out soluble potash compounds either in the form of alum (potassium aluminium sulphate) or in the form of potassium sulphate. The residue after full treatment should be alumina of high grade suited for porcelain manufacture.

Generally alunite is found as a white or pink, compact or granular substance in nodular masses or in veins in other rocks, and the theories regarding its origin are that it is produced from felspathic rocks (containing potash felspars) either (1) by the action of sulphurous vapours such as emanate from fumaroles or from volcanoes; or (2) by the action of percolating waters containing sulphuric acid derived from sulphides such as pyrites by oxidation.

It is reported that alunite has been found in various localities in Western Australia, and an extensive deposit found at Kanowna in commercial quantities has been described by Mr. T. Blatchford in Geological Survey Bulletin 77.

The Campion deposits of alunite are, however, somewhat different in occurrence and nature to other deposits previously examined. They occur as sedimentary deposits, forming the beds of salt lakes designated Chandler Lake and Reward Lake, and they consist of very fine powdery material with which is mixed kaolin and fine quartzose sand.

To a depth of up to nine inches, the alunite consists of a bluish material, and with depth this grades through greys and browns to pure white with occasional layers of brilliant-red material, below which gritty clay and sand are found.

Occasionally there is a fair amount of gypsum mixed with the surface material, and near the outer edges of the lakes alunite material becomes more admixed with and is gradually replaced by either seed gypsum or kopai.

It is understood that Mr. H. Bowley has observed on the west side of Chandler Lake a quartz reef from which crystals of pyrites have been weathered.

(*Vide* p. 18, Annual Report of Government Mineralogist and Analyst, 1925.) Further, Mr. Chandler, the holder of M.C. 37H and of M.L. 38H, informed me that Mr. Bowley found distinct evidence of the presence of sulphuric acid in certain portions of Chandler Lake.

The writer observed that the gneissic biotite granite in the vicinity of the lake edge and for some distance below the lake had undergone considerable alteration. Felspathic material was almost completely changed to kaolin, and material of the same nature as the alunite in the top surface of the lake bed was found to be gradually leaching out from these granites. On the east side of Chandler Lake, granitic material of the same nature was found very close to the surface.

Hence the writer has little hesitation in ascribing the formation of alunite in this area to the action of sulphuric acid—produced from weathering of the sulphides of the nature of pyrites—upon the potash-bearing felspars of the gneissic biotite granite forming the country rock of the district. In this connection an examination and analysis of Specimens 27 L.B. and 28 L.B. by the Government Mineralogist and Analyst would be of great value.

In one case hard white material of the appearance of ordinary compact white alunite was encountered at a depth of 4 feet 4 inches in borehole P. 9 in the north of Chandler Lake at a point about twelve chains due south of the most northerly corner post of M.L. 38H. Unfortunately no drill was included in the boring outfit, and it was found impossible to collect a decent sample of this harder material. In view of this the writer can, meantime, give no opinion regarding the possibility of compact alunite vein or nodular deposits being found in the country rock underlying the lakes. If such veins do occur, there is a possibility that the whole of the lake deposits are derived from the weathering and disintegration of these veins.

A number of samples of material from various depths were taken by the writer when he was boring, and, until these have been examined by the Government Analyst, it will be impossible to form a correct estimation of the amount of alunite available in the two lakes.

In Chandler Lake the area of the surface over which alunite extends is 18,340,200 square feet approximately, or 421 acres approximately. In Reward Lake the area of alunite deposit is 1,429,400 square feet approximately, or 32.8 acres approximately. Altogether the area of alunite deposits in these lakes amounts to 453.8 acres, and if a conservative average depth of nine inches be taken meantime, pending the examination of borings, the amount of alunite available is in the region of 733,000 tons.

6.—The Economic Aspect of Utilisation of the Alunite Deposits.

In utilising these alunite deposits one or two points, for and against, need consideration.

Sources of potash have been and will be of prime importance in the extension and development of a country such as Australia. For many years the chief supplies of potash throughout the world have been drawn from Germany. During the Great War such supplies were not available and the cost became prohibitive. This induced various States in Australia to make a stocktaking of their own potash reserves, and from this necessity arose the idea of utilising such substances as alunite for potash content. If the potash necessary in agriculture for local requirements can be commercially produced at a cost that will enable it to compete with the imported article, then there is every reason for utilising such deposits as those that form the subject of this report.

In this connection it might be well to note that the available alunite will be easily excavated as it is a surface deposit, and it seems likely that material of commercial value will be able to be recognised by its colour—a fact that is of some importance when dealing with unskilled labour. Further examination chemically has revealed the fact that about seven per cent. on an average is a fair estimate of available potash in this alunite.

Preliminary treatment by calcination and lixivation of the material can be well done upon the field so as to reduce the cost of transport. Wood for this purpose is available in plenty upon the field.

Roads to and from the deposits are fairly good, and transport to railhead should be easily and cheaply obtainable. Labour in excavating the material would seem to be available, and costs will be kept down if the work is let at contract.

It will be necessary to expend some capital in special machinery and in buildings.

Against these must be considered the following:—

Owing to the want of a decent water supply lixivation may be somewhat expensive, as before water can be obtained it may have to be carted for some distance. Preliminary washing of the alunite also will form an item to be considered.

There is no railhead nearer than about 12 miles.

All things considered, however, there seems reason for believing that the opening up and utilisation of these lake deposits may be far reaching in its effects, and that they will form a new industry of immense value and importance to Western Australia.

7.—Gypsum in the same Locality.

It has been already noted by Dr. Simpson (Annual Report, 1925, Gov. Min. and Anal.) that gypsum occurs in large quantities as ridges in this area. He appends analyses of both seed and kopai gypsum samples which he collected north of Reward Lake, and it is unnecessary for me to repeat these here. It is to be noted, however, that he found the kopai to yield a dirty green plaster which would not set hard. The seed gypsum yielded a pinkish plaster which set hard in two hours.

Mention has already been made by the writer of the extent of seed gypsum occurring on the ridges dividing lakes and partly surrounding them in some cases; particularly to the west, southwest and south of the lake that is designated on the geological sketch map accompanying this report as Red Lake. In this

locality there is a very great extent of seed gypsum in addition to the ordinary kopai that forms the bulk of the dunes. In the south and west of Chandler Lake there is also a large deposit of seed gypsum, but not of so good a quality as that nearer Red Lake.

The exploitation of these deposits must, however, remain in abeyance until better and cheaper railway facilities are available in this district and until deposits nearer to the metropolis are depleted.

Sample 25 L.B. is of fine seed gypsum from the large deposit at the southeast corner of Red Lake, and sample 26 L.B. is of large crystals of gypsum from the middle west bank of Red Lake.

List of Specimens and Samples collected at Campion by A. G. D. Esson.

1. L.B. Salt from S. 28 intermediate chaining post on southeast boundary of M.L 38.
2. L.B. White pug from S. 29.
3. L.B. White pug from S. 30.
4. L.B. White pug from S. 31.
5. L.B. Red pug from S. 32.
6. L.B. Samples of borings from various depths of bore at S. 38.
7. L.B. Samples of borings from various depths of bore at Q. 86.
8. L.B. Brilliant red ochreous pug from S. 40.
9. L.B. Blue and grey pug from S. 41.
10. L.B. White pug from S. 41.
11. L.B. Brilliant red ochreous pug from S. 41.
12. L.B. Lowest white pug from S. 41.
13. L.B. Borings from O—15½in. at S. 43.
14. L.B. Borings from O—15½in. to 45½in. at S. 43.
15. L.B. Borings from O—45½in. to 49½in. at S. 43.
16. L.B. Borings from O—49½in. to 117½in. at S. 43.
17. L.B. Borings from O—117½in. to 129in. at S. 43.
18. L.B. Seed gypsum from Q. 120 B.
19. L.B. Blue pug mixed with large gypsums from Q. 120 D.
20. L.B. White pug 23in. to 73in. in bore at Q. 119.
21. L.B. Miscellaneous samples of borings at Q. 75.
22. L.B. Miscellaneous samples of borings from Q73.
23. L.B. Miscellaneous samples of borings from P. 9.
24. L.B. Miscellaneous samples of borings from I. 21 .
25. L.B. Samples of fine to coarse seed gypsum from the seed and kopai dunes at southeast corner of Salt Lake.
26. L.B. Large crystals of gypsum from middle west edge of Salt Lake.
27. L.B. Gneissic biotite granite from vicinity of gnamma hole in Loc. 14340 ↑ 11210.
28. L.B. Rotten gneissic granite from bank on northwest corner of Chandler Lake.
29. L.B. Sample of blue top material at K. 9 Reward Lake.
30. L.B. Sample of blue top material at C. 14 Reward Lake.

N.B.—Samples from 1 to 24 L.B. are from Chandler Lake.

The following are partial analyses of nine samples of Alunite from Lake Chandler (M.C. 30H), Campion:—

No.	25/27	26	27	28	328	329	330	331	332
Mark ...	6LB	7LB	22LB	23LB	13LB	14LB	15LB	16LB	17LB
On Washed Sample—	%	%	%	%	%	%	%	%	%
Potash, K_2O	6·74	6·79	7·00	6·88	6·96	7·35	7·62	6·59	...
Soda. Na_2O	·68	·91	·85	·82	·99	·95	1·45	·57	...
Sulphur trioxide, SO_3 (Soda soluble)	23·70	23·44	25·46	24·58	25·29	26·68	26·79	22·74	8·49
Water soluble Salts ...	6·99	7·79	5·90	5·44	8·02	5·32	5·80	5·36	5·60

4.—THE FIRECLAY DEPOSIT ON MINERAL CLAIM 50H, CLACKLINE.

(A. G. D. Esson, M.A., Field Geologist.)

1.—Introductory Remarks.

In accordance with instructions a brief examination of the proposed Mineral Claim (50H) for fireclay, situate at Clackline, was made by the writer with, at the same time, a short and rough examination of as much of the surrounding country as was found feasible to be examined in the limited time available and under the prevailing stormy weather conditions. Owing to floods and consequent washaways upon the railway line, the examination was deferred for a short time.

Clackline station is situate at a distance of some 51 miles by rail from Perth, upon the Eastern Railway line, close to the intersection of that line with the Toodyay (formerly Newcastle) branch line, and it lies in the South-West Division of the State.

Two local residents of Clackline, Messrs Coates and Ellsom, have made application for a Mineral Claim, No. 50H, with the object of working a clay pit for fireclay, upon Location 19454, which is already held by Mr. H. B. Ellsom, one of the abovenamed applicants for M.C. 50H. Both applicants have had experience of fireclay deposits in the Clackline district. Location 19454 is leased to a depth of 200 feet, but in view of the fact that the lessee is one of the applicants for this mineral claim, any adjustment in regard to compensation would be a matter of mutual arrangement between applicants.

2.—Topography.

Clackline district is upon a slight fall eastwards of the Darling Ranges, and the height of the railway station above sea level is given as 756 feet. It is a very hilly locality, and the numerous ridges are intersected and divided by steep gullies carrying water in the wet season. The most notable creek in the vicinity lies north of the railway line and roughly parallel to it for some distance in Clackline Gully, and it is fed by numerous small tributary creeks which follow side gullies leading into Clackline Gully.

At the time of visit (winter) Clackline Gully was running a "banker," and much damage had been done by the swiftly flowing waters. Beautiful examples of the work of the stream in erosion and deposition could be noted.

— GEOLOGICAL SKETCH MAP —

— SHOWING —

— ALUNITE DEPOSITS —

— CHANDLER LAKE & REWARD LAKE —

— CAMPION —

— By A.G.D.Esson, M.A. Field Geologist —

10 0 10 20 30

— Scale of Chains —

Laterite Ironstone

Muddy Kopai with Granitic Sand

Granite Clay

15986

Kopai Mud

14341

Opaline

Granitic Clay

Laterite Ironstone Breccia

Muddy Kopai

26 Large Crystals Gypsum

Gate

Travertine Laterite

Samphire Flats

Gneissic Biotite Granite

Clayey Granite Detritus

Clayey Kopai

Low Kopai Ridges

Quartzose Sand

14340

Red Kopai

Quartzose Clay

Banded Jasper

Sandy Granitic Clay

SALT LAKE

Traces of Alunite mixed with muddy Kopai

Sandy Kopai

1210

Gneissic Biotite Granite Ridge

Sandy Clay

Biotite Granite

Sandy Clay

Coarse Seed Gypsum

15986

15987

Kopai Ridges

27 Gnamma Hole in gneissic granite outcrop. Capacity about 50 gallons

Traces of Alunite below muddy surface

25 Fine Seed Gypsum

V5

Clayey Kopai

Dirty Brown Seed Gypsum

Decomposed Granite Gneiss

28 Sandy Clay with Alunite

Kopai Ridge

Decomposed Granite Gneiss

Ridges of Kopai

Gneissic Biotite Granite

Granitic Sand

Laterite Ironstone Gravel

15985

22

CHANDLER LAKE

Kopai Ridges

M.C. 37E

Kopai

Kopai

21

23

Alunite

Coating of Cubical Salt Crystals

REWARD LAKE

30 Alunite

Sandy Kopai

Sandy Clay with dirty Seed Gypsum

M.C. 38H

Kopai Ridge

29

Kopai

24

Ridges of Kopai

Alunite

Kopai

V4

7 8-11 9-12 8

Gneissic Granite

Salt Crystal Encrustation 1

2 Kopai Ridges

6 5 4 3

Granitey Sand

Claypan with muddy Kopai

20 Seed Gypsum

18 19

Dead Man's Corner

Samphire Flats

Salt Encrustation

Kopai and Seed Gypsum

Sandy Kopai

Kopai Ridges and Seed Gypsum

A Gibb Maitland
Government Geologist

The Hon M.F. Troy, M.L.C.
Minister for Mines.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

Occasionally, in gullies, it was possible to see sections showing the underlying rocks, and had the time been available a fairly accurate geological map of the immediate district could have been prepared probably in a few weeks.

In general the hills are very rough and rugged owing to the lateritic cap of ironstone found upon them.

A geological map based partly upon personal field work and partly upon the work of members of the Geological Survey accompanies this report.

3.—Vegetation.

The ridges are fairly heavily timbered with, in the main, white and red gums as well as with occasional banksia and blackboy. Sometimes shrubs of the variety of *Hakea Illicifolis* were noted, and York poison and box are fairly common.

4.—Geology.

1.—General Geology of the Clackline District.

The general geology of the Clackline district is largely that of the Darling Range among the heights and gullies of which it lies. Fundamentally the rocks are the slightly altered Pre-Cambrian igneous rocks forming the mass and basis of the Western Australian Plateau.

It is generally agreed that the face of the Darling Ranges westwards towards the sea marks a fault line along which a further coastal strip broke off and slipped down to below sea-level. Eastwards from the Darling Ranges this old plateau still persists, somewhat eroded in places and in other places hidden by young or old sediments.

Evidently a fault plane would be a suitable place for the intrusion of later igneous rocks, but whether these later intrusives came after faulting along induced lines of weakness or whether the intrusion of these later igneous rocks caused weakness which ultimately assisted in or developed into faulting is not quite clear meantime. In any case there has been more than one age of faulting, as has been pointed out by Jutson in his "Physiographical Geology of Western Australia," Bulletin 61, G.S. W.A.

The fundamental rocks of the Clackline district are granites which occasionally are gneissic. The acid granites are, in turn, intruded by later epidiorite dykes, some of which are of considerable extent. These dykes vary much in texture and in ultimate composition, but they all seem to be derived from the same basic magma. They form throughout the extent of the Darling Ranges an outstanding feature on account of their hardness and their resistance to weathering—a fact that may be taken as proof of their comparative youth in contradistinction to the rocks they intrude. There is a possibility that some basic dykes may be of later age than the main member. These igneous rocks, acid and basic, are, in general, all capped by lateritic formations which are so characteristic of the rock formations of Western Australia. Laterite, of course, may not be confined to igneous rocks alone, but in the Clackline district there seems to be little doubt that it is derived directly from the igneous rocks underlying it.

A few additional remarks regarding the rocks enumerated above may not be out of place.

(a) Granite.—It has already been pointed out that granite forms the fundamental rock of the district. This granite was found to vary considerably in comparative mineral composition from biotite granite to hornblende granite. Occasionally it is coarse and even pegmatitic or porphyritic. Both varieties would seem to result from magmatic segregation in one main mass—an occurrence that is quite common in most large bodies of igneous rocks.

At different points there appears to have been much shearing of the granites and a resultant change in them to granite gneiss. This gneiss occasionally takes the form of biotite mica schist in which by extreme shearing the quartz and felspars are ground down and dissolved and biotite mica collected in fairly thick bands along the shear planes. This biotite mica can be dug out fairly easily as it is quite soft. Sometimes an intermediate form is found when on first examination one would say that it is a laminated jasper similar to those found on most of the eastern goldfields. In the writer's opinion this form might be more correctly named a highly sheared augen gneiss.

Both of the two latter forms, biotite mica schist and augen gneiss, were found on Location 860 a few chains south of the railway line and about 1½ miles westsouthwest of the Clackline siding. Biotite mica schist was observed also in a gully south of the railway line and about 10 chains east of the Clackline station. A question regarding the possibility of using the decomposed biotite mica schist on Location 860 as a paint was addressed to me by Mr. W. Coates. A sample was submitted to the Government Mineralogist and Analyst, who, however, reported on it as being of no use as a paint making material.

(b) Epidiorite.—Little can be added to what has already been said regarding the basic epidiorite dykes. Mr. Feldtmann has noted that most of these dykes conform to one or two main directions. Most of them strike east or slightly north of east, and the others about northnorthwest. They vary very much in texture from very fine to coarse. During the limited time at the writer's disposal no detailed examination to determine different relative ages, if any, could be made. Kaolin produced from the epidiorite rocks is, in general, of excellent quality and, when of a purely white colour, is highly suited for use as china clay.

It is to be noted that, in common with the granite into which the epidiorite dykes are intruded, they are lateritised, and that the resultant laterite from epidiorite is generally more highly ferruginous than that formed from granite.

(c) Laterite.—It has generally been accepted that laterisation is a process of efflorescence due to normal processes of weathering accompanied by abnormal conditions of rainfall and denudation. The abnormal conditions of rainfall would be complete saturation of weathered products by rainfall followed by complete desiccation of them again, and abnormal conditions of denudation would consist in slow denudation of the products of weathering.

Rainwater attacks rocks consisting largely of metallic silicates and dissolves certain mineral constituents. These solutions soak into the ground and ultimately kaolin and quartz may be left as residuals of the original rock. With very dry summers the rocks are highly desiccated, and by capillarity solutions bearing certain minerals such as iron compounds are brought to the surface and evaporated, thus causing redeposition of the minerals as laterite.

Thus there will be unchanged rock below, and from it are derived ultimately succeeding formations which may be considered to be merely grades of alteration of the original. In this way proceeding upwards there will be found the weathered form of the original rock, followed by white kaolin or clay and quartz. This again is followed by white kaolin, then by ironstained clay, and on the top will be ferruginous laterite.

The kaolin obtained in this way will be found to contain generally a proportion of quartz which will render it suitable for utilisation in the making of fire-bricks.

II.—Detailed Geology of the Proposed Mineral Claim 50H.

Application has been made by Messrs. W. Coates and H. Ellsom for Mineral Claim 50H for the purpose of working fireclay deposits to be found upon it. The area for which application is made amounts to 7 acres and, as pegged meantime, it would comprise about 8 acres. The datum peg is situated about 1½ miles in a direct line almost southsouthwest from Clackline Station and about 23 chains southeast of the westerly peg of Location 19454 in which the claim lies.

As in other places in the Clackline district the fundamental rocks in Location 19454 are various phases of granite with intrusive bars of fine-grained epidiorite. These rocks outcrop in rough ridges with steep sides and deep intermediate gullies. The ridges are everywhere capped by ferruginous laterite beneath which kaolin has been formed from the underlying less altered igneous rocks.

The claim lies on the western side of one such ridge which would appear to be wholly granitic. On the crest (and upper slopes generally) pisolitic laterite still remains in a somewhat table-top fashion and immediately below this hard topping kaolin of varying quality is found forming lower slopes of the hill—often at the surface, and sometimes covered by ferruginous secondary laterite for a depth of a few inches.

At one or two points on the crest of the hill the highly ferruginous nature of the laterite would seem to indicate the possibility of the occurrence there of a small dyke of epidiorite, but there is no definite evidence of this intrusion. On the other hand, the quartzose nature of the kaolin found upon the claim would point to its derivation from an acid rock of the nature of granite. In fact, granite somewhat altered but still recognisable as such, is found upon the north lowermost slopes of the main ridge. West of the datum peg and outside of the lease there is on the side of a small gully an outcrop of a dyke of epidiorite which appears to run almost north and south and which appears to have a width of about 20 feet.

From the examination made the writer was able to see that there is here a very extensive deposit of good quartzose kaolin highly suited for fireclay purposes. In fact, the whole of the ridge beneath the laterite cap would seem to be composed of kaolin of this nature.

5.—The Kaolin upon Mineral Claim 50H.

At present there are six potholes of a shallow depth averaging about 5 feet throughout the claim. These can in no way be considered as workings as they have been put down merely to test the deposits and to prove the extent of good quality material.

In the main, samples taken by the writer prove to be very fine, workable, pure white kaolin in which are set phenocrysts of white transparent quartz of varying size. Sometimes the phenocrysts can be barely seen and they vary from that up to about ⅛in. in diameter. Evidently the deposit will require careful crushing before mixing, but apart from that the available material will require very little work before burning.

The points noted in the various potholes are summarised as follows:

Pothole 1.—This pothole is down for a depth of about 5 feet in a somewhat ferruginous clay which contains much quartz. The ferruginous matter runs in red streaks throughout the clay and it may be due to staining derived from the decomposition of very ferruginous laterite upon higher slopes. This laterite may possibly denote the presence of a narrow dyke of epidiorite as has been mentioned *supra*. The pothole lies in the south end of the claim.

Pothole 2.—This lies in almost pure white kaolin with many phenocrysts of quartz. Evidently the kaolin here is derived from underlying kaolinised medium to coarse-grained granite *in situ*. It may mark a somewhat pegmatitic phase of the granite.

Potholes 3 *and* 5 are similar to No. 2.

Pothole 4.—Here the material is somewhat more gritty and less coherent and it is probable that this marks a less altered phase of the granite. No large phenocrysts of quartz are to be seen in this material.

Pothole 6.—This lies in the north end of the claim and here the kaolin is of finer quality and of a purer white colour. There are in it phenocrysts of quartz of a very small size and evidently the best quality material in the claim is at this point.

Throughout the claim all the material appears to be of excellent quality and to be highly suited for making into fireclay bricks and locomotive lumps, and with washing it is possible that excellent kaolin will be produced suitable for porcelain making. The deposit of kaolin available appears to be extensive and it would seem to have a thickness of about 20 feet. Practical work only can give an estimate of the exact amount available, but judging from the occurrence in other places the estimate of depth may be found to be a conservative one.

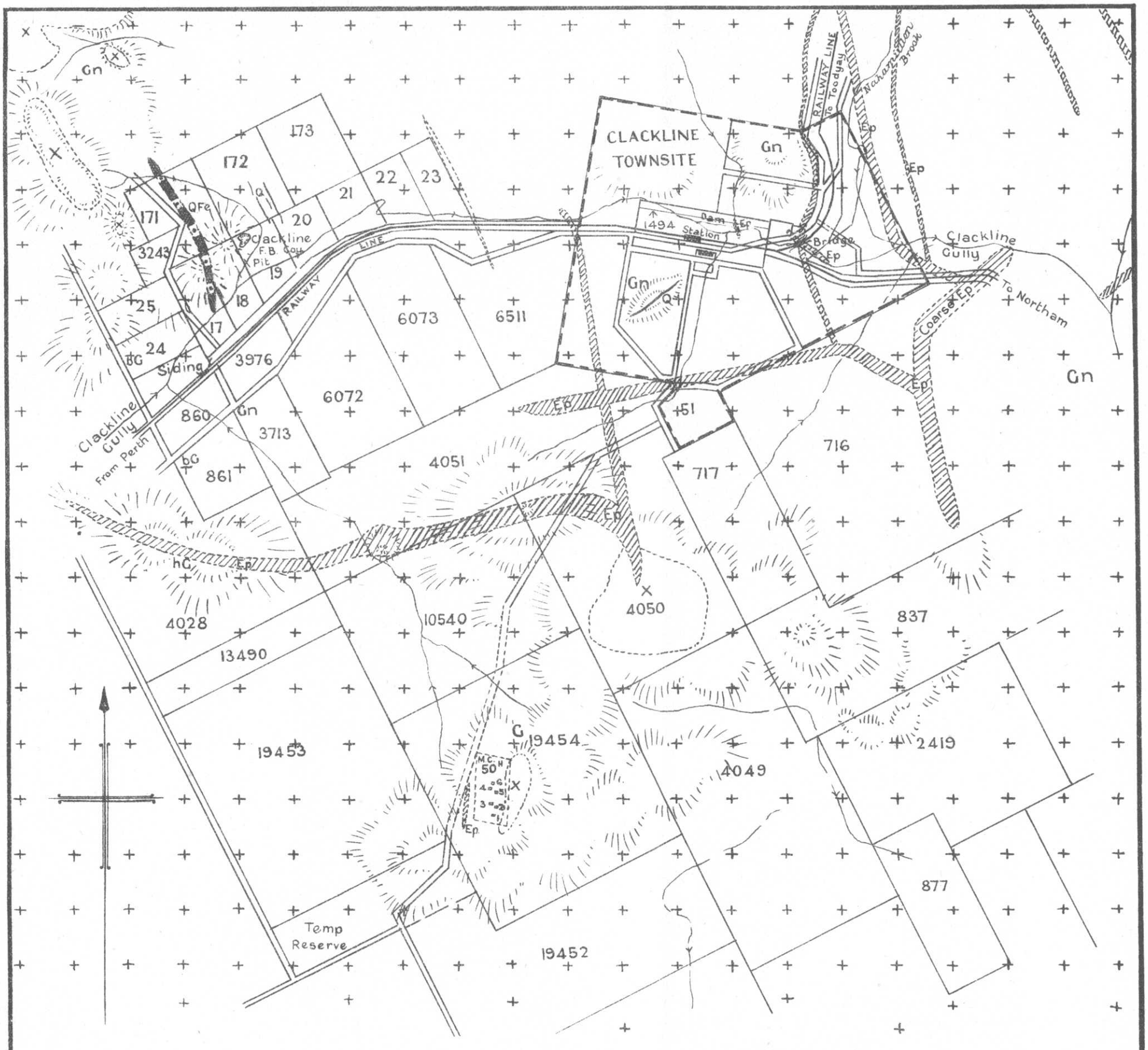
6.—General Remarks.

Clays from Clackline have been used for a number of years for the manufacture of fireclay bricks and "loco. lumps" (locomotive linings, etc.). For some years the Clackline Firebrick Company has been working a deposit situate about 1 mile west of Clackline Station on the north side of the railway line. The Government Mineralogist and Analyst has examined clays from this pit and very satisfactory reports upon them have been given by that officer.

The Hon. M. F. Troy, M.L.C.
Minister for Mines.

GEOLOGICAL SURVEY PROGRESS REPORT 1926.

PLATE IV



— GEOLOGICAL SKETCH MAP —

CLACKLINE

— By A.G.D. Esson M.A. Field Geologist —

— Incorporating information by W.D. Campbell & F.R. Feldtmann —

20 0 20 40 60

— Scale of Chains —

— LEGEND —

Granitic Rocks	Biotite Granite	Horneblende Granite	Gneiss	Epidiorite dykes	Jasper	Quartz Reefs	Laterite
G	bG	hG	Gn	Ep	QFe	Q	×

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

A. Gibb Maitland
Government Geologist

In Mr. Campbell's report upon the Clackline Firebrick Company's pit (Annual Report, Geological Survey, 1906), Dr. Simpson's analysis is given. He reports the clay to be of excellent quality and, when burned, to compare favourably with firebricks from Garteraig in Scotland.

From the examination made by the writer the conclusion is arrived at that the kaolin on Coates and Ellsom's Mineral Claim 50H would appear to be of a similar quality and of similar origin to that in the Clackline Firebrick Company's pit.

Mr. Coates has informed me that he has prepared firebricks from his deposit and has had them burned in a Maylands kiln and that he has received a report to the effect that the resulting firebricks were of good quality.

Without doubt the successful exploitation of Mineral Claim 50H and of its clay deposit will provide very necessary material for an extension of the fireclay industry in the Clackline district and in Western Australia generally.

The results of the analysis and testing of samples are as follow:—

Locality	M. C. 50H South of Clackline station.		
Reg. No.	2506/26	2507/26	2508/26
Mark	E.C.1	E.C.3.	E.C.5
Washing Test—	%	%	%
Clay substance ...	49·24	52·99	52·53
Grit under 90 mesh	5·80	7·45	5·86
„ „ 60 „ ...	2·37	3·30	3·75
„ „ 30 „ ...	8·62	9·45	11·27
„ „ 10 „ ...	30·57	21·76	24·33
Grit over 10 „ ...	3·40	5·05	2·26
	100·00	100·00	100·00

Burning Tests.—Briquettes were made of the clays and burnt at 1,350° centigrade in an assay muffle furnace, the duration of heat being about nine hours each, giving the following figures:—

Linear shrinkage from wet plastic to air dry state, per cent.	7·6	5·3	4·2
1350° C.—			
Linear shrinkage from air dry, per cent.	2·6	3·7	2·8
Porosity (water absorbed), per cent.	23·8	19·3	19·2
Colour	White	Creamy White	Creamy White
Surface	Moderately rough	Rough	Rough
Hardness	Scratched by steel	Scratched by steel	Scratched by steel
Strength	Friable	Brittle	Brittle
Body	Cracked	Finely Cracked	Finely Cracked

Conclusions.—These are granitic fireclays, carrying much coarse quartz grit, showing moderate shrinkage and no signs of softening at 1,350° C., and evidently capable of withstanding a much higher temperature. The body in each case is deficient in strength and in order to make a satisfactory clay they would require an admixture of a stronger clay.

5.—REPORT ON BLOCK WEST OF 2191 AND NORTH OF 1856 (LITHO. SHEET 410D40) COLLIE COALFIELD.

(Alex. G. D. Esson, M.A., Field Geologist.)

Introduction.

Approximately two days were spent in the examination of this proposed block and of the surrounding country. Because of periodical floodings by the Collie River the whole of the eastern end of the Collie Coalfield coal measure basin consists largely of sandy swamp with occasional low hills of laterite. For this reason the exact boundaries are very much obscured and it is impossible to do more than fix a possible boundary between the coal measures and the granite, as the laterites overlying both show little or no difference.

In the short time at the disposal of the writer it was impossible to extend investigation to any great extent so as to correlate similar areas in different parts of Collie Coalfield but the investigations made by the writer would seem to prove that the extreme eastern boundary defined by Woodward is probably as nearly correct as can be ascertained without actual boring.

Geology (General).

It is now more or less agreed that the Collie coal measures are of Permo-Carboniferous age and that they occupy a depression in the Pre-Cambrian crystalline rocks. Faulting would appear to be responsible for the preservation of the coal measures which by this means were let down into troughs in the Pre-Cambian rocks. The exact amount of faulting has not as yet been ascertained.

The coal measures consist of sandstones, grits, micaceous shales, and coal seams, all lying with a slight dip southwards. These beds are covered and obscured by extensive estuarine or lake deposits consisting largely of clays, semi-indurated gravels and sands. Upon these later deposits laterite formed and this laterite is more or less similar to the laterite found upon igneous rocks in the vicinity. This laterite has been eroded and denuded, producing secondary laterite, and residual patches of hard laterite are left here and there throughout the basin with sandy levels and valleys between.

The above brief resumé would show that nowhere will the coal measures be expected to outcrop except possibly in the north if overlying sediments are denuded, and in fact the actual discovery of coal in the Collie coalfield was only found by examination of the Collie River bed in an extremely dry season.

Close to Muja the writer found stratified clays, sandstones, and a specimen (from a shaft) which would appear to consist of the tailing off of a low grade coal seam. Hence it is assumed that the coal measures do extend as far as Muja.

Geology of the Block.

With regard to the particular proposed block in question, very little can be said regarding the geology. A low laterite hill runs the length of the block and fine sands occupy the lower portions on either side of the laterite. No points of special distinction were observed in the laterite. South of the block and about 30 chains south of the northern

boundary of block 1856, a prominent bar of later basic epidiorite greenstone was followed in an east and west direction for about 20 chains. There is no evidence of igneous intrusion among the known Collie coal measures and hence it is presumed that this bar lies within the area of the igneous rocks. Probably it lies close to the junction of igneous rocks and sediments. Block 2191 consists largely of laterite and granite can be found south of the block.

Conclusions.

For reasons enumerated above, the writer cannot at present see fit to suggest alteration in Woodward's boundary in this particular portion of the coalfield. There is a possible doubt which could be dispelled only by putting down a series of shallow bores in certain positions—a procedure that would be advisable before considering any further alienation of land in this portion of the Collie coalfield. The Government Geologist is familiar with the legal aspect of alienation and also with the Collie coalfield generally and he will be able to draw his own conclusions and to make suitable recommendation, but the writer is not satisfied that the geological knowledge of this portion of the coalfield is such as to admit of alienation at present.

PETROLOGICAL WORK.

(C. O. G. Larcombe, D.Sc.)

During the early part of the year an investigation was made of material from two Government subsidised bores at the Lady Shenton Mine, Menzies. A large part of the year was devoted to making a detailed examination and study of the core from bores put down in various parts of the State under the new scheme of State boring set out by the Hon. the Minister in November, 1925.

As a result of petrological investigations extending over many years, it was possible to give a good deal of important information to the Technical Committee appointed by the Federal Government. The mining representative of the Committee was taken through the Oroya Shoot and one day was spent in making an all round surface field examination of the Kalgoorlie area.

Much time was devoted to matters connected with the visit of members of the Australasian Association for the Advancement of Science, and special rock sections were prepared for petrographic projection at the lecture given in September.

The ordinary discussions took place with the Government Geologist, field and other officers, and information, the result of petrographic investigation, was supplied to the public when required.

The microscopic examination this year was extensive, on account of the large amount of State boring being carried out, and the necessity for the greatest care in examining the core so as to detect any possibility of the presence of "values," and, in the event of such discovery, to make a proper presentation of the economic aspects of the rock formations in relation to the ore occurrences and their future development. A total number of 261 slides was microscopically examined.

The boring at the North End, Kalgoorlie, where three bores were put down, certainly proved the downward extension of the Hidden Secret channel, but unfortunately at those points where the bores cut the various lodes the "values" were quite unpayable.

On the other hand the No. 2 bore proved the existence of contact lodes between keratophyre and quartz dolerite greenstone, and quartz dolerite greenstone and calc schist. As pointed out further on in this report these contacts are prone to develop lode formations, and there is really no reason why at the surface these lodes may not contain rich patches, depending of course on the sum total of gold in the lodes, the amount of superficial rock removed by weathering, and the agencies controlling the concentration of gold into patches.

Four bores were put down at Yalgoo. Three of these proved nothing at all, but in the No. 3 bore on the Old Emerald Lease 12 feet of quartz was passed through at a depth of 150-162 feet. Most of this quartz contained gold, and one assay yielded 8 dwts. 4 grs. per ton. It cannot be said that these values would not increase along the strike of this reef.

Suitable and representative samples of core from these bores have been registered and put away in the Departmental collection.

The drill has now been removed to Sandstone, where boring is being carried on. Boring has also commenced at Coolgardie, with a view to testing at depth the acid dykes.

The following may be regarded as a summary of the more important work carried out during the year:—

I.—Boring at Kalgoorlie.

II.—Boring at Yalgoo.

III.—Report on subsidised boring at Lady Shenton Gold Mine, Menzies.

IV.—Preparation of material and lecture to members of the Australasian Association for the Advancement of Science.

V.—Report on curious rocks from four miles east of Argyle Station, Ord River, King District, Kimberley Division.

VI.—Petrographic determinations for the Department and for the general public.

Details of Government Boring Operations.

The Government has initiated a scheme of State boring on a considerable scale in furtherance of its determined policy to assist the mining industry. The object of the boring is to aid the discovery of new ore bodies, help in the search for the continuation of lodes and reefs that have been worked, and prospect and otherwise test unknown ground.

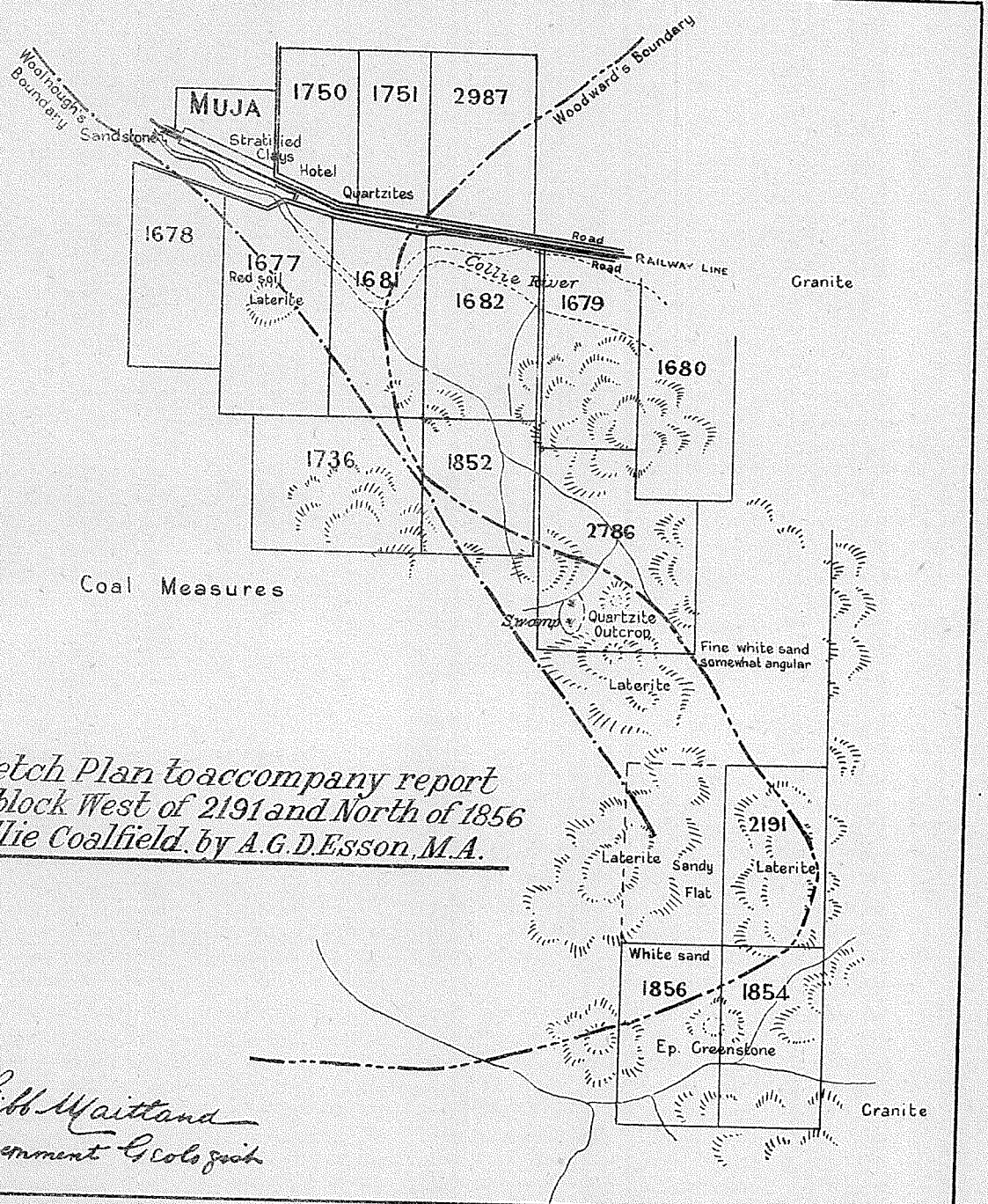
In November, 1925, the Hon. the Minister decided to carry out a system of boring throughout certain goldfields in Western Australia. Consequently, in March, 1926, a programme was set out for boring in the mining centres of Kalgoorlie, Yalgoo, Sandstone, Mt. Magnet and Cue. To this list Coolgardie was added recently, and boring was commenced at that centre in December.

At the close of the year 1926 three bores had been completed at Kalgoorlie, four at Yalgoo, the first of a number (six) started at Sandstone, and one started at Coolgardie. A total of 3,422 feet 4 inches of boring was done at Yalgoo and Kalgoorlie.

The Hon. M. F. Troy, M.L.C.
Minister for Mines.

GEOLOGICAL SURVEY PROGRESS REPORT 1926.

PLATE V



Sketch Plan to accompany report on block West of 2191 and North of 1856 Collie Coalfield. by A.G.D. Esson, M.A.

A. Gibb Maitland
Government Geologist

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

In view of the great importance attached to these boring operations with a view to (a) new metalliferous discoveries, (b) determining the economic aspects of rock formation in relation to contained ore bodies, and (c) adding to the geological knowledge of the State and the advancement of science generally, special care has been taken in making a thorough physical, mineralogical, and petrological examination of the core. Every foot of core that showed any signs whatever of silicification, pyritification, shearing or other indications of the possible presence of "values" was sent for assay to the Government Mineralogist and Analyst. In connection with the boring at Kalgoorlie and Yalgoo, 269 samples (including sludges) were assayed. The details will be given when describing the individual bores.

The results of the petrological investigations are set out under the following headings:—

A.—Boring at Kalgoorlie:
- The Williamstown No. 1 Bore.
- The Williamstown No. 2 Bore.
- The Williamstown No. 3 Bore

B.—Boring at Yalgoo:
- Old Emerald Mine—
  - No. 1 Bore.
  - No. 2 Bore.
  - No. 3 Bore.
- Old Ivanhoe Mine—
  - No 4 Bore.

I.—Boring at Kalgoorlie.

It has long been the wish of mine owners and others at the North End of the Kalgoorlie goldfield that the ore bodies of that area should be tested at depth by means of boring. The Government acceded to this request and the first diamond drill bore was commenced at Williamstown on 14th April.

The boring was designed to test the long and persistent line of lodes which pass through Leases 4035E, 4001E and 4036E, constituting the Hidden Secret Area; and also to prospect the untested ground to the west. The gold won from the Hidden Secret lodes, which occur in a powerfully altered channel, was 15,384.83 ozs. from 10,643.95 tons of ore.

Plate VI. has been drawn to show the sites of the three bores, and Plate VII. contains geological cross sections designed to indicate the positions of the lodes and the nature of the rock formations passed through in each bore.

The downward and westward extension of the Hidden Secret lode channel has been positively proved, although at the points intersected by the bores the lodes were not payable.

It has been proved, as a result of the petrological examination, that the favourable quartz dolerite greenstone rock (which forms the country on the eastern slope of Mount Gledden) may be extended under the soil-covered ground as far east as Plumer Street. This enlargement of the quartz dolerite greenstone zone makes it still more remarkable that no payable lodes were discovered. The fine-grained greenstone, which is shown (on sheet 19, Plate XIII., Bull. 69, G.S.W.A.) to end in a V-shaped patch in Baden Street, was also found to continue as far north as Mafeking Street. I have discussed the revision of these boundaries with Mr. Feldtmann, who quite agrees with the alterations.

Details of Boring.—The following are details of the three bores put down:—

——	Inclined depth.	Vertical depth.	Direction.	Inclination.
	ft. in.	feet		
Williamstown No. 1	1,000 4	866	N. 53° E.	60°
Williamstown No. 2	610 0	431	N. 53° E.	45°
Williamstown No. 3	612 0	530	N. 46° E.	60°

The Williamstown No. 1 Bore.

The Williamstown No. 1 Bore was commenced on the 14th April and finished on 3rd August. This bore was put down near the southwestern end of the first block on the southeastern side of Mafeking Street where it junctions with Plumer Street. The direction of the bore was N.53°E. toward the southern side of "C" shaft on Lease 4036E (see Plate VI.).

The depth of the bore was 1,000 feet 4 inches, and the angle of depression 60 degrees (i.e., a horizontal distance of 500 feet and a vertical depth of 866 feet).

This bore was not successful in locating any ore even approaching a payable grade, but the fact of penetrating five distinct bands (two 25 feet through) of pyritic, carbonated, and highly altered rock such as is typical of lode channels, shows that the main southern Hidden Secret channel was cut. If there are shoots at this depth, such as those that carried the rich ore in the Hidden Secret mine, they were not met with in this bore. The five channels referred to contained 74 feet of barren lode material. It is unfortunate that at these points the gold contents, due evidently to some form of selective action, were virtually nil.

Geology.—The rock formations met with were as follows:—

(a) Oxidised material.
(b) Fine-grained greenstone.
(c) Fine-grained amphibolite.
(d) Dolerite greenstone—
  (1) Mottled form.
  (2) Bleached form.
(e) Mottled carbonate rock.
(f) Fuchsite-quartz-carbonate rock.
(g) Lodestuff.

(a) *Oxidised Material.*—This extended from the surface to 122 feet and consisted of the usual brownish-yellow—to purplish in places—soft, and highly decomposed (rotten) greenstone.

(b) *Fine-grained greenstone* extended from 122 to 285 feet. A dense compact dark green soft greenstone, with patches of darker chlorite in places. In section it varied from a mass of pale green scaly chlorite showing shear tracks with some carbonate and a little pyrites to areas of dusky dense carbon-

ated material with patches of scaly chlorite. (Sections 4700, 4701, 4702, and 4703.)

(c) *Fine-grained amphibolite* extends from 285 to 516 feet. It is a dense dark grey to greenish rock showing, with a lens, a distinctly acicular texture. In section it consists of a dense dusky feathery aggregate of brightly polarising colourless to pale green fibrous actinolite or hornblende, throughout which are patches of pale green chlorite, lumps of calcite, and amphibolites grading into actinolite schists.

(d) *Dolerite Greenstone,* together with its bleached and carbonated forms, is the most important rock.

(1) The dark green mottled form extends from 516 to 600 feet. It is distinctly mottled, dark green and white, and more or less evenly granular in grain. In section it is essentially a crystalline aggregate of pale green chlorite (containing colourless grains of epidote) and calcite. Small flakes of biotite are scattered through some sections. A feature of this rock is the small brown rutile needles. Some sections are made up of well-defined plates of calcite set in a mass of pale green chlorite containing rutile prisms.

(2.) The bleached dolerite greenstone is much paler than the dolerite greenstone, and it is still mottled through segregations of chlorite, and with a lens, minute bright green specks of fuchsite are visible. The bleaching is due to increased carbonation, mainly, but there is a litle silicification, some fuchsite and white mica occurs, and pyrites is not uncommon. Rutile is present. In section the rock is mostly a mass of calcite with quite a lot of small flakes of fuchsite. Chlorite occupies the interstices. This rock certainly encloses No 1 lode.

(e) *The mottled carbonate rock* is quite similar in appearance to the bleached dolerite greenstone, but is distinguished by the presence of a curious fine lining. In section it is a dusky carbonate rock with a fair amount of microscopic white to pale greenish mica. Patches of chlorite are common, and there is a little quartz mosaic. The colourless lines may be filled with wisps of sericite, calcite and chlorite; they cross one another without displacement.

(f) *The fuchsite-quartz-carbonate rock.*—This name is only given to that portion which shows distinct green macroscopic patches of fuchsite. The main zone lies between 830 and 880 feet and encloses Lode 3. In hand specimens it is a dense pyritic pale grey carbonate rock studded with bright green specks of fuchsite. In section it is a dusky brown carbonate rock with large spaces filled with ground-down chlorite full of microscopic sericitic wisps, and numerous patches of crystalline calcite. The linings are distinct (Section 4754) in the dusky portion. More altered forms are just patches of calcite, cryptocrystalline silica, patches of scaly fuchsite, with wisps of fuchsite throughout the quartz mosaics and intimately associated with the calcite. Small siliceous veins were noted.

(g) *The lodestuff* is a metasomatic product of the bleached dolerite greenstone, the fuchsite-quartz carbonate rock and the mottled carbonate rock. For the most part it is similar physically, viz., a mottled, silicified, carbonate rock with traces of fuchsite and impregnated with pyrites. In some sections there is strong shearing and segregation of pyrites along the shear lines. Quartz sericite mosaics occur, and pale chlorite with much rutile (Section 4757). Heavy pyritification is at times a feature. Large patches of carbonates are common.

The following may be regarded as the general distribution of rock changes as indicated in Plate VII.

Depth.				Nature of rock.
Ft.	in.	Ft.	in.	
0	0	122	0	Zone of oxidation.
122	0	285	0	Fine-grained greenstone.
285	0	516	0	Fine-grained amphibolite.
516	0	600	0	Dolerite greenstone (mottled).
600	0	728	3	Bleached dolerite greenstone (containing white mica and fuchsite).
728	3	753	3	Lode I. Metasomatic product of bleached dolerite greenstone.
753	3	790	0	Bleached dolerite greenstone.
790	0	822	6	Mottled carbonate rock (micaceous) with curious linings
822	6	830	0	Lode 2.
830	0	880	0	Fuchsite quartz carbonate rock enclosing Lode 3 between 851ft. 6in. and 866ft.
880	0	901	0	Mottled carbonate rock, with strong microscopic fuchsite.
901	0	926	0	Lode 4. Heavily pyritic.
926	0	963	0	Mottled carbonate rock.
963	0	965	0	Lode 5.
965	0	1,000	4	Mottled carbonate rock with strong linings and with microscopic mica.

Lode channels and the occurrence of values:

Five zones were met with in which the carbonation, pyritification and general alteration and shearing were such as to entitle the rock to be termed "lodestuff."

The following table indicates the inclined and vertical depths of these lodes, together with the number of assays and their results.

Material.				
Lode.	Depth in feet,		No. of Assays.	Result.
	Inclined.	Vertical.		
	ft. in. ft. in.			
No. 1	728 3—753 3	630	25	Seventeen: *Nil.* Eight: 3 grains per ton.
No. 2	822 6—830 0	712	2	One: 3 grains per ton. One: *Nil.*
No. 3	851 6—866 0	737	6	Five: *Nil.* One: 3 grains per ton.
No. 4	901 0—926 0	780	11	No gold at all.
No. 5	963 0—965 0	834	1	Gold, 14 grains per ton.
Core from other places:				
Between: 107 and 153 feet ...		...	7	Six: *Nil.* One: 5 grains per ton.
202 and 406 feet ...		...	16	Fourteen: *Nil.* Two: 3 grains per ton.
422 and 583 ft. 7in.		...	11	Ten: *Nil.* One: 3 grains per ton.
889 and 890 feet ...		...	1	Gold, 13 grains per ton.
Assays of sludges:				
Between: 20 and 450 feet ...		...	31	Twenty-one: *Nil.* Eight: Traces. One: 3 grains per ton. One: 5 grains per ton.
Total ...		...	111	

The five channels referred to contained 74 feet of lode material, and, as the above table indicates, 111 assays were made. Eighty of these were from core; the other 31 were from sludge material that came up the barrel.

The Williamstown No. 2 Bore:

The Williamstown No. 2 bore was started because of some work on an old lode to the west of the Hidden Secret lode, under Plumer Street. The bore was successful in that at an inclined depth of 588 feet, and a vertical depth of 416 feet, seven feet of siliceous jasperoid pyritic lodestuff was met with. This lode contained gold throughout, but the highest assay return was 21 grains of gold per ton. It is evidently the downward extension of the lode under Plumer Street. Another lode was met with between 439 and 450 feet, at a vertical depth of 310 feet. This lode was in shattered quartz dolerite greenstone where it contacts with the eastern wall of a large keratophyre dyke; the highest assay was only 10 grains of gold per ton. Nevertheless this contact zone may be worth prospecting at the surface.

The No. 2 bore started from a point 480 feet southwesterly from and in the same direction (viz., N. 53° E.) as the No. 1 bore. The depth was 610 feet at an angle of depression of 45 degress.

Geology.—The geological information gained from this bore is not only interesting scientifically, but possibly also economically. Petrological investigation has proved the following facts:—

(1.) It is now possible to add a much larger area of favourable quartz dolerite greenstone to the eastern edge of that rock found at Mount Gledden. The new eastern boundary is shown in Plate VI.

(2.) There is a large dyke of keratophyre almost continuous from 257 to 439 feet, *i.e.*, a width of 128 feet. A lode has formed along the eastern wall of this dyke, in the quartz dolerite greenstone, which proves that the contact between keratophyre and quartz dolerite greenstone is favourable to lode formation.

(3.) The calc schist country continues northerly from Baden Street, and it likewise makes lodestuff where it contacts with the strip of quartz dolerite greenstone to the east of the keratophyre dyke.

The contact zones referred to in (2) and (3) may possibly contain rich patches of gold at the surface, depending of course on the sum-total of gold in the lodes, the amount of superficial rock removed by weathering, and the agencies controlling the concentration of gold into patches.

The rock formations met with are as follows:—

(a) Oxidised material.
(b) Quartz dolerite greenstone.
(c) Keratophyre.
(d) Black carbonaceous rock.
(e) Calc schist.
(f) Lodestuff.

(a.) *Oxidised material.*—This extended from the surface to 148 feet. It consisted of yellowish to brown rotten rock.

(b.) *Quartz dolerite greenstone.*—This rock forms the hanging and footwalls of the large keratophyre dyke and occurs between the following depths: 148-257 feet, 270-284 feet, 450-588 feet. It is a dark green, soft, slightly pyritic mottled greenstone showing numerous small pieces of leucoxene scattered throughout the rock. The chlorite renders the quartz almost invisible. In section it is made up of prominent "archipelagoes" of clear quartz and lumps of ragged leucoxene set in a heterogenous mass of chlorite and calcite (Section 4780). Relict felspar textures may be seen, and micropegmatite is present. As the quartz dolerite greenstone approaches the keratophyre the quartzes become almost completely absorbed and disappear.

(c.) *Keratophyre.*—This forms a large dyke 128 feet wide between the depths of 257 and 439 feet. It is a dense pale brownish felsitic rock with, if anything, a sub-resinous lustre—as compared with the dull lustre of the calc schist. The fresher form—and the only form showing distinct felspars—is at 269 feet, where the microscope shows it to be made up of minute, clean, microlitic felspars set in a mass of carbonate granules, wisps of sericite, and small flakes of chlorite, with some needles of brown rutile. The bulk of the rock is extremely fine in grain, cryptocrystalline and carbonated, considerable areas consisting of dusky-coloured material of low birefringence.

(d.) *Black carbonaceous rock* enclosed within the keratophyre dyke, and evidently derived from it.

(e) *The calc schist* is a dense, soft, dull-lustred, felsitic, ash-coloured rock, full of dark spots, and traversed by minute veinlets of chlorite and calcite. In section it is a dusky cryptocrystalline dense carbonated rock, traversed by straight lines of a dirty grey substance. Scattered throughout this mass are colourless patches—sometimes with straight edges—of calcite and chlorite.

(f) *Lodestuff.*—This occurs in (1) quartz dolerite greenstone from 439 to 450 feet, and (2) in calc schist from 588 to 595 feet. The quartz dolerite greenstone lode is shattered and traversed by carbonate veins; pyrites is present and there is evidence of shearing. In section it is a strongly fractured mass of carbonates and chlorite, with a little pyrites. The calc schist lode is strongly silicified and jasperoid, heavily pyritic, and in part carbonaceous.

The general order of succession of the rock formations described above is as follows. (See Plate VII.)

Depth in feet.	Nature of rock.
0—148	Rotten rock from zone of weathering.
148—257	Quartz dolerite greenstone with ferruginous patches
257—270	Keratophyre.
270—284	Quartz dolerite greenstone.
284—311	Keratophyre.
311—337	Keratophyre with veinlets.
337—395	Carbonaceous zone.
395—439	Keratophyre.
439—450	Lode in quartz dolerite greenstone.
450—588	Quartz dolerite greenstone.
588—595	Pyritic flinty jasperoid lode in calc schist.
595—610	Gray calc schist.

Assay results and distribution of values.—The Government Mineralogist and Analyst made a total number of 50 assays; 33 from core submitted and 17 from sludge.

The highest assay value was, however, only 21 grains of gold per ton from core taken between 591 and 592 feet. The next highest assay was 10 grains per ton; all the rest were lower in value.

In view of the importance of the boring at Kalgoorlie, and in order thoroughly to test the ground passed through, every precaution was taken to detect the presence of values, as the following details will show:—

Source of Material.	No. of Assays.	Result of Assay.
1. Oxidised material from 20 to 108 feet	1	3grs. gold per ton.
2. Quartz dolerite greenstone between 157ft. 9in. and 207ft. 9in.	3	1 : 5grs. gold per ton. 2 : *Nil.*
3. Keratophyre between 264ft. 6in. and 327ft.	14	1 : 5grs. gold per ton. 1 : 3grs. „ „ 12 : *Nil.*
4. Carbonaceous rock between 384 and 385 feet.	1	Gold, *Nil.*
5. Lode 1. In quartz dolerite greenstone from 439 to 450 feet	7	3 : 10grs gold per ton. 1 : 3grs „ „ 3 : *Nil.*
6. Lode 2. In calc schist from 589 to 595 feet	7	1 : 21grs. gold per ton. 1 : 10grs. „ „ 1 : 7grs. „ „ 2 : 5grs. „ „ 2 : 3grs. „ „
7. Sludges between 120 and 610 feet	17	5 : 3grs. gold per ton. 12 : *Nil.*
Total ...	50	

The Williamstown No. 3 Bore.

This bore was put down in order further to test at depth the southern end of the Hidden Secret line of lodes. It started from a point 66 feet north of Baden Street and 112 feet west of Barton Street, its direction being N. 46° E., straight for "A" shaft near the southeastern corner of Lease 4036E (see Plate VII.). The total depth reached was 612 feet and the angle of depression was 60 degrees from the horizontal.

The bore was successful in cutting at depth the southern extension of the Hidden Secret lode channel. Three distinct lodes were met with, but the highest assay was only 6 dwt. 11 grs. of gold per ton at a depth of 513 to 514 feet.

Geology.—The rock formations met with were as follows:—

(a) Oxidised material.
(b) Fine-grained greenstone.
(c) Dolerite greenstone.
(d) Talc-chlorite-carbonate rock.
(e) Fuchsite-carbonate rock.
(f) Lodestuff.

The order of succession in which these formations were met with is shown in Plate VII. The following is a detailed description of the rocks from point to point:—

Depth in feet.				Nature of Rock.
ft.	in.	ft.	in.	
0	0	127	0	Rotten brownish and yellow decomposed rock. The bottom of the zone of the weathering was reached at 127 feet.
127	0	325	0	Fine-grained greenstone; in some places mottled and consisting of about equal proportions of dark green chlorite and dirty grey material. The latter is bleached, feathery and fibrous hornblende. Some of the rock is a uniform microscopic and dense aggregate of carbonates and chlorite.
325	0	420	0	Dolerite greenstone: a mottled soft greenstone made up of patches of chlorite and carbonates. Microscopically it is a mass of pale green scales of chlorite with patches of calcite which in places form perfect rhombohedra. A feature of the rock is minute crystals of pale brown rutile.
420	0	428	0	Dolerite greenstone, much disturbed, somewhat sheared—evidently an aftermath of lode-making forces—partly pyritic and slightly carbonaceous.
428	0	430	0	Carbonaceous pyritic black rock with quartz veinlets.
430	0	434	9	Dark pyritic chlorite rock.
434	9	458	0	Lode 1. 23 feet 3 inches of lode stuff. The first 4ft. 3in. was finely pyritic and flinty grey to white quartz, with bunches of massive pyrites. The rest of the ore was dense, dark, fine-grained and pyritic, with strong evidence of shearing and even schisting in places. The mineral contents are carbonates, chlorite, pyrites, quartz, and a little rutile. This lode is a highly altered and metasomatic form of dolerite greenstone.
458	0	471	0	Footwall of Lode 1. A dense grey felsitic rock crowded with curious lines and radial markings filled with chlorite. It contains a lot of carbonate distributed through cryptocrystalline material that may be bleached actinolite zoisite rock
471	0	494	0	Lode 2. Dark grey dense and somewhat sheared pyritic siliceous ore made up of cryptocrystalline silica with carbonate grains scattered throughout it. The carbonates become strongly segregated in places, and there are patches of chlorite. In parts there is a general impregnation of grains of sulphide of iron.
494	0	508	0	Footwall of Lode 2 and hanging wall of Lode 3. Similar to rock between 45 and 471 feet. Fine-grained dense felsitic-looking rock with a feathery texture. It may be calc schist, though there is a resemblance to the actinolite zoisite amphibolites.
508	0	518	0	Lode 3. A compact dark green chloritic siliceous ore, strongly impregnated with minute grains of iron pyrites. In section it is mainly an aggregate of chlorite, carbonates and cryptocrystalline silica studded with small crystals and grains of iron pyrites.
518	0	575	0	Dark green soft chloritic and somewhat mottled rock, showing evidence of schisting and a somewhat sheeny surface on which lumps of carbonates stand up in relief. At 533 feet the rock contains quite a lot of talc, the plates of which are arranged in parallel direction. Rhombohedra of carbonate appear as pseudo-phenocrysts. Chlorite is intimately mixed with the talc. In one place there is a large plate of biotite and muscovite combined. The rock is a talc-chlorite-carbonate species.
575	0	587	0	A connecting link between the talc chlorite-carbonate and fuchsite-carbonate rock. It contains large plates of carbonate and plates of secondarily developed plagioclase.
587	0	612	0	Fuchsite-carbonate rock, bright green at 593 feet, but becoming less fuchsitic and a mass of carbonate containing white quartz veins at 612 feet.

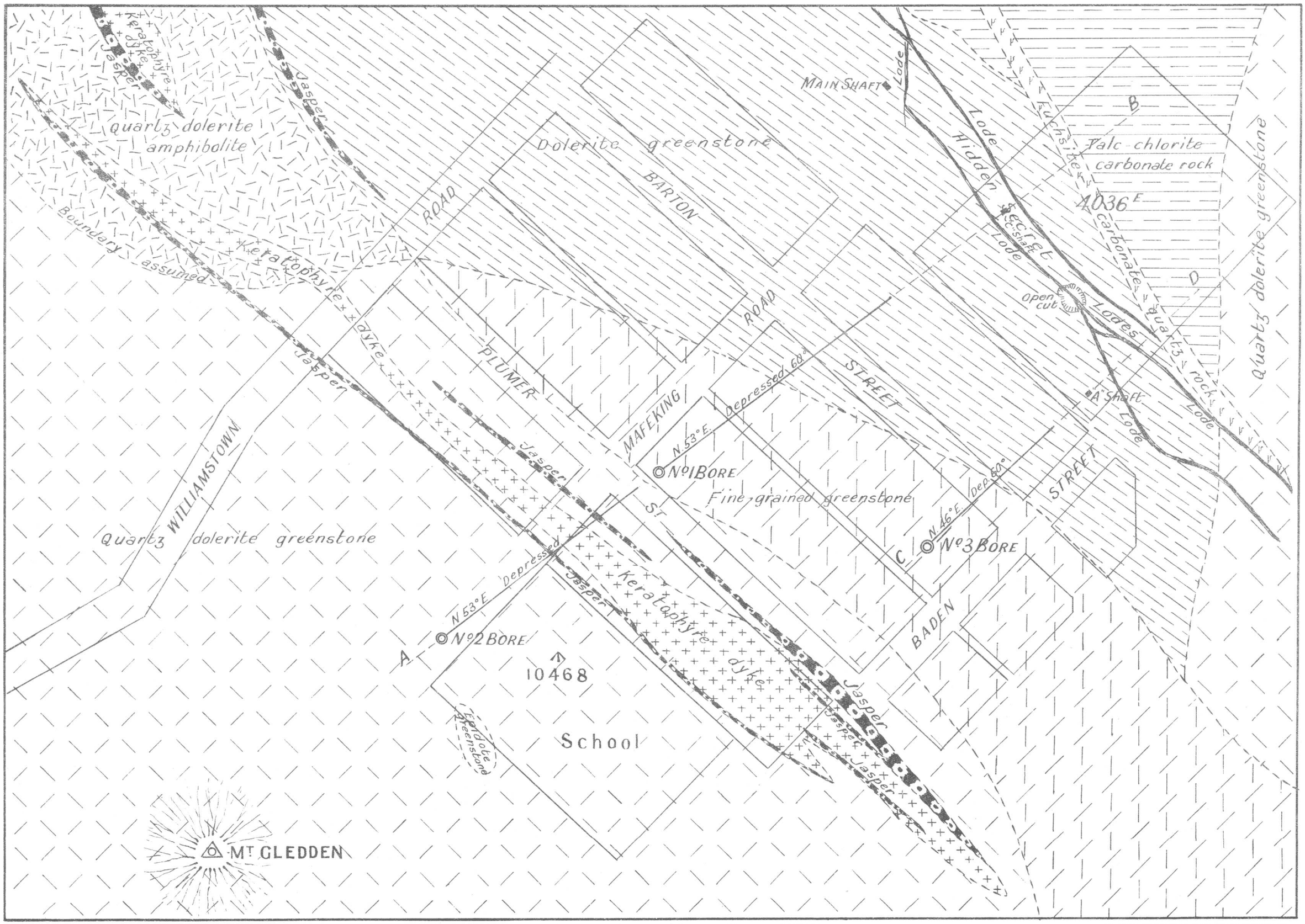
The Hon. M. F. Troy, M.L.C.
Minister for Mines.

GEOLOGICAL MAP SHOWING SITES OF BORES Nos 1, 2 & 3

NORTH END (HIDDEN SECRET AREA) KALGOORLIE

By

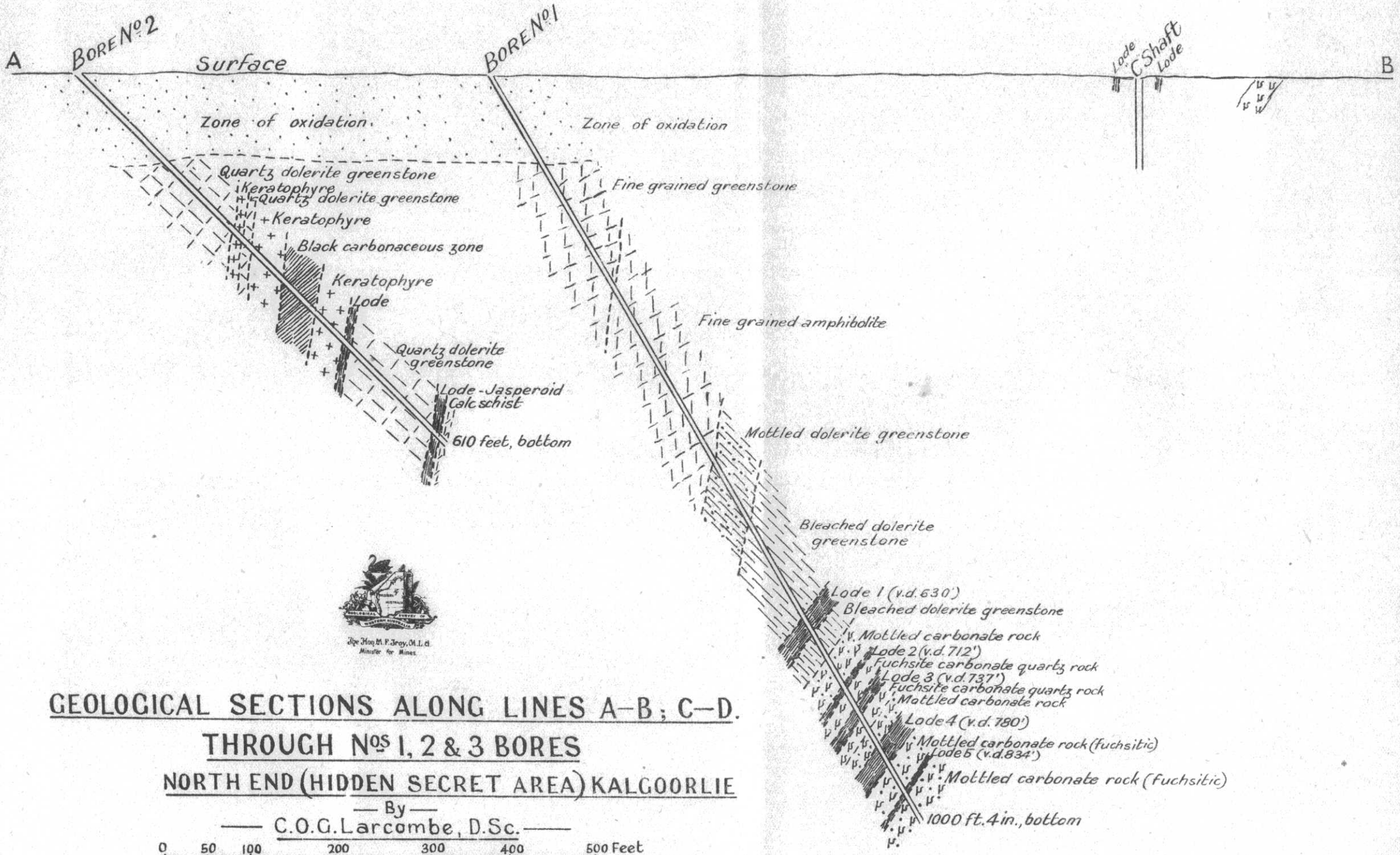
C.O.G. Larcombe D.Sc.



0 50 100 200 300 400 500 Feet
0 1 2 4 6 8 Chains
—Scale—

A. Gibb Maitland
Government Geologist

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.



The Hon. M. F. Troy, M.L.C.
Minister for Mines

GEOLOGICAL SECTIONS ALONG LINES A–B; C–D.
THROUGH Nos 1, 2 & 3 BORES
NORTH END (HIDDEN SECRET AREA) KALGOORLIE

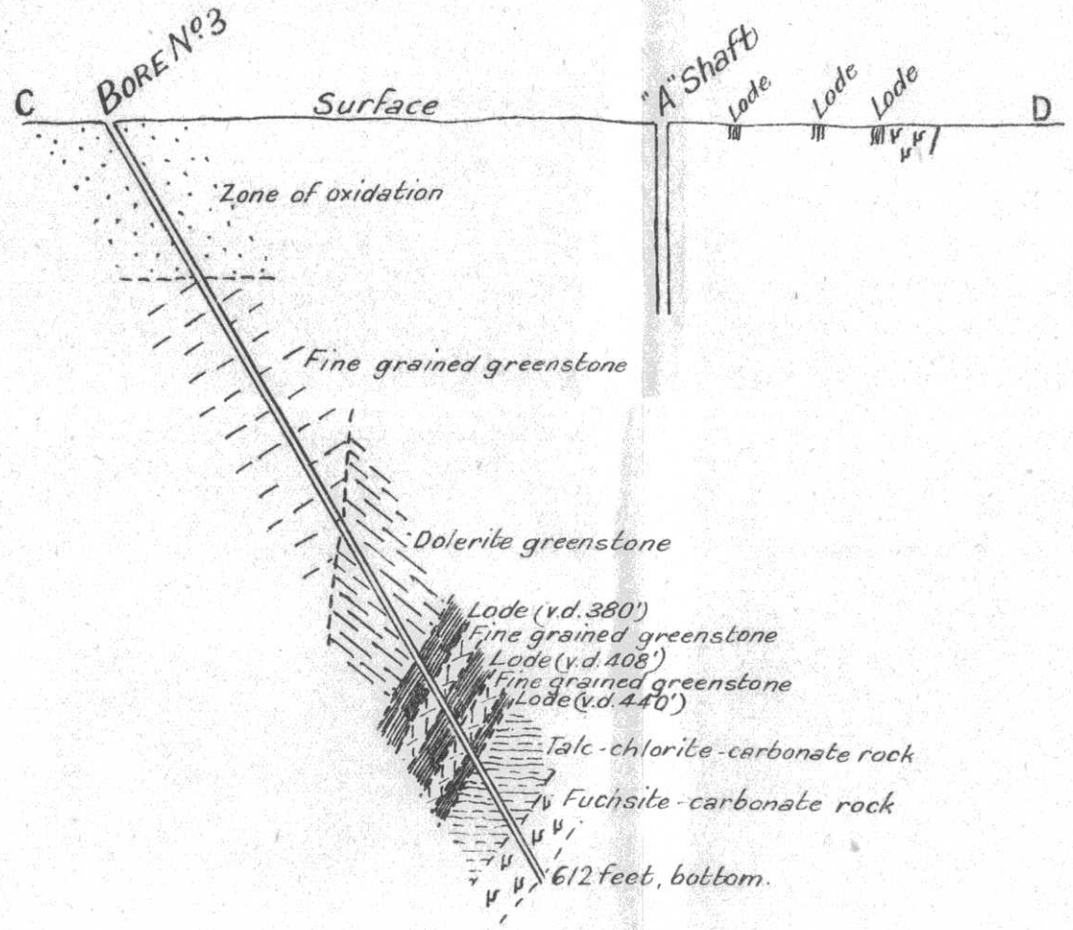
— By —

C. O. G. Larcombe, D.Sc.

0 50 100 200 300 400 500 Feet

0 1 2 4 6 8 Chains

— Scale —



A Gibb Maitland
Government Geologist

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

Lode channels and distribution of values.

Every sample of stone showing the slightest signs of silification, mineralisation, the development of pyrites, or other features indicative of lodestuff, was sent for assay. Out of a total of 54 assays the highest value was 6dwts. 11grs. of gold per ton; the remaining 53 assays were unpayable.

The three lodes met with had all the appearance of good ore, consisting of dense, fine-grained, somewhat dark-looking pyritic, siliceous and strongly carbonated rock, with frequent evidence of shearing and in places marked siliceous zones.

The following table indicates the inclined and vertical depths of these lodes together with the number of assays and their results:—

Lode.	Depth. Inclined.	Depth. Vertical.	No. of Assays.	Result of Assay.
	ft. in.	ft.		
No. 1	434 9—458	376	22	2: 14grs. gold per ton. 1: 13grs. „ „ 1: 10grs. „ „ 2: 5grs. „ „ 2: 3grs. „ „. 14: *Nil.*
No. 2	471 0—494	408	22	1: 1dwt. 5grs. gold per ton. 1: 10grs. gold per ton. 6: 5grs. „ „ 6: 3grs. „ „ 8: *Nil.*
No. 3	508 0—518	440	10	1: 6dwt. 11grs. gold per ton. 1: 2dwt. 17grs „ „ 1: 1dwt. 12grs. „ „ 1: 1dwt. 5grs. „ „ 1: 3grs gold per ton. 5: *Nil.*

The assays, 54 in number, were made mostly in 1ft. lengths; 22 from Lode 1; 22 from Lode 2; 10 from Lode 3.

With the exception of one assay of 6dwt. 11grs. from 513 to 514 feet; one of 2dwts. 17grs. from 511-512 feet; one of 1dwt. 12 grs. from 508-509 feet; and two assays of 1dwt. 5grs. each from 492-494 feet and 512-513 feet, respectively, there was nothing of more than half a dwt. to the ton. Twenty-seven assays yielded no gold at all.

II.—Boring at Yalgoo.

In furtherance of the policy of the Government, boring was commenced at the Old Emerald Mine on 22nd June.

The bores put down at Yalgoo are as follows:—

No. of Bore.	Location.	Inclined depth.	Vertical depth.	Inclination.
		feet.	feet.	degs.
No. 1 ...	Old Emerald Mine	300	260	60
No. 2 ...	do. do.	300	260	60
No. 3 ...	do. do.	300	260	60
No. 4 ...	Old Ivanhoe Mine	300	212	45

Old Emerald Mine.

The Acting Government Geologist states that—

"In the vicinity of Yalgoo two mines were worked in the early days, the Lake View and Emerald (late Royal Mint) Of these the Emerald produced 8,700 ozs. of fine gold from 3,061 tons of ore treated . . . . . There are quartz leaders showing in some of the old shafts, and there is no evidence of a defined lode. In any case the ore was rich and would possibly warrant development below the shallow water-level if a bore revealed good values . . . . .To prove the proposition three bores of 300 feet would be sufficient. The country rock has a slight dip if any to the east, and a bore set at an angle of 60 degrees, two chains to the west, would cut through the ore channel at approximately 200 feet from the surface. I would suggest that the hole be started two chains east from the eastern corner of the concrete foundation of the old 5-head mill which has since been removed."

The general result of the boring at the old Emerald Mine showed that (1) the three bores were all in the same country rock, viz., a medium grained greenstone consisting largely of hornblende; (2) there was no definite lode met with in the No. 1 Bore, but the country rock contained many glassy quartz veins mostly about a foot wide, though one measured 2 feet 6 inches; (3) there was no true lodestuff in the No. 2 Bore—in other respects it was similar to No. 1 Bore; and (4) in the No. 3 Bore a definite quartz reef was met with at 150 feet; it extended to 162 feet, *i.e.*, 12 feet, and assayed up to 8 dwts. 4 grs. of gold per ton between 153 feet and 154 feet 6 inches.

The following are further details of the three bores put down at the old Emerald Mine, Yalgoo.

No. 1 *Bore.*—This bore reached a total depth of 300 feet at a depressed angle of 60 degrees. There was no zone of oxidation. The country rock was the same throughout the whole length of the bore, viz., a medium-grained greenstone consisting almost entirely of hornblende of metamorphic origin, with in places a fair amount of biotite. More crushing would make this rock a typical hornblende schist.

No definite lode was met with, but in places there was evidence of crushing and incipient schisting. The only part of this rock likely to carry values were the small veins of pure glassy quartz. A number of these was met with, the largest being two and a half feet wide.

A total of nineteen assays was made, but the results were negative. Seventeen assays gave no gold at all, and two assays yielded 3 grains of gold per ton.

No. 2 *Bore.*—This bore reached a total depth of 300 feet at a depressed angle of 60 degrees. There was no zone of oxidation. The country rock was similar to that passed through in No. 1 Bore, but more actinolitic. In places the rock is schisted.

No true lode was met with. The only parts likely to carry gold were the glassy quartz veins and actinolitic rock with quartz veinlets.

Ten assays were made. Six of these yielded nothing; three yielded 3 grains of gold per ton; and one from between 222 and 224 feet—at a point where there was some evidence of iron sulphide—yielded 1 dwt. 2 grains per ton. This bore cannot be regarded as having passed through anything worth sinking for.

No. 3 *Bore.*—This bore reached a total depth of 300 feet at a depressed angle of 60 degrees. The country rock was the same throughout the full length of the bore, viz., a dense, dark green, actinolitic hornblende rock similar to that met with in Nos. 1 and 2 bores. This rock is made up entirely of plates of fibrous actinolitic hornblende, with feathery aggregates of the same mineral. It is a reconstructed amphibolite. A small zone of oxidation extended to 32 feet.

At a depth of 150 feet (vertical 130) the bore cut a reef made up of glassy white quartz. This reef continued to 162 feet—a total of 12 feet.

Samples of this reef were sent for assay to the Government Mineralogist and Analyst. The following are the results:—

Depth.				Assay results.
ft.	in.	ft.	in.	
150	0	153	0	Gold, *Nil.*
153	0	154	6	Gold; 8dwts. 4grs. per ton.
154	6	156	0	Gold; 21 grs. per ton.
156	0	158	0	Gold; 1dwt. per ton.
158	0	160	0	Gold; 21grs. per ton.
160	0	161	0	Gold; 10grs. per ton.
161	0	162	0	Gold; 14grs. per ton.

Not knowing anything about the dip of the ore body, the question is whether this reef is in the ore channel of the Emerald Lease. The reef has a considerable width and contains consistent values over 9 feet out of the 12 feet where it was penetrated by the bore. It cannot be said that these values would not increase along the strike of this reef.

In view of a statement that fine gold could be got between 62 feet 2 inches and 64 feet 6 inches, further assays of core were made with the following results:—

Depth.				Assay result.
ft.	in.	ft.	in.	
61	4	62	4	Gold; *Nil.*
62	4	64	1	Gold; 3grs. per ton.
64	1	70	7	Gold; 5grs. per ton.
72	0	76	8	Gold; *Nil.*

No. 4 Bore, Old Ivanhoe Mine, Yalgoo.

This bore was finished at a depth of 300 feet. There was no zone of oxidation, the whole bore being in greenstone.

The country rock (Section 4785), of which a sample from a depth of 213 feet may be regarded as typical, consists of a mediumly dense dark greenstone with an uneven fracture, and showing in places minute facets of cleavable hornblende. Very small grains of iron pyrites are scattered throughout the rock. It is a reconstructed amphibolite, and under the microscope is seen to be made up of large plates of pale green hornblende which, in places, has been broken up into minute plates. Strain shadows and numerous fractures filled with water-clear material bear evidence of the stresses to which this rock has been subjected. A little shapeless quartz occurs in places.

Nothing in the way of a continuous lode, reef, or ore body was met with in this bore, but the country from the surface to 53 feet was more or less schisted, and ten assays were made from this material. One assay yielded five grains of gold per ton; four yielded each three grains of gold per ton; and five yielded no gold at all.

Between 112 feet 6 inches and 113 feet 6 inches there was a pure white quartz vein containing pale massive pyrites, a little copper pyrites and a trace of galena. This sample assayed 1 dwt. 15 grains of gold per ton.

The details of the assays made are as follow:—

Depth.				Assay results.
ft.	in.	ft.	in.	
7	0	9	0	Gold; 5grs. per ton.
14	0	14	6	Gold; 3grs. per ton.
15	0	16	0	Gold; *Nil.*
24	0	25	0	Gold; 3grs. per ton.
28	0	30	0	Gold; 3grs. per ton.
30	0	31	0	Gold; *Nil.*
31	5	32	9	Gold; *Nil.*
33	0	34	0	Gold; 3grs. per ton.
43	0	45	0	Gold; *Nil.*
47	5	51	6	Gold; *Nil.*
112	6	113	6	Gold; 1dwt. 15grs. per ton.

The No. 4 Bore began on 24th August and finished on 24th September. It was the last bore put down on the Yalgoo Goldfield. The drill was then removed to Sandstone.

III.—Subsidised Boring at Lady Shenton Gold Mine, Menzies.

1. In connection with a subsidy from the Government two bores were put down in the Lady Shenton gold mine at Menzies on G.M.L. 5423Z.

2. The No. 1 Bore was put down to a depth of 157 feet at an angle of 40 degrees east of the bottom level. The No. 2 Bore reached a depth of 69 feet, and was put down at an angle of 55 degrees 107 feet south from the centre of the shaft.

3. The No. 1 Bore was confined to a dense medium-grained reconstructed amphibolite which, in places, has been crushed down to a hornblende schist. Four assays were made from core between 61 feet 7 inches and 80 feet 7 inches; three of these assays went traces and the remaining one assayed 13 dwts. 19 grains of gold per ton. Four assays were made of core from between 104 feet 4 inches and 125 feet, but none of these went more than 5 grains of gold per ton.

4. It will thus be seen that out of a total of 8 assays, only one assayed more than 5 grains per ton.

5. The assays were made by bulking two compartments at a time (the core in one compartment measured 2 feet 2 inches).

6. The No. 2 Bore contained core somewhat more amenable to examination. The greater part of the rock passed through in this bore was hornblende schist, derived from the breaking down of a reconstructed amphibolite similar to that met with in the No. 1 Bore.

7. A slightly auriferous zone occurred between 48 feet 4 inches and 60 feet 9 inches, between which depths five assays were made, the highest result being 21 grains of gold per ton between 52 feet 6 inches and 54 feet 6 inches. This is to be regretted because between 50 feet and 58 feet the rock showed signs of great alteration, and mineralogical and other physical conditions favourable to the occurrence of gold, *e.g.*, at 52 feet 6 inches, there is a powerful silicification accompanied by the introduction of biotite; at 53 feet and again at 54 feet 6 inches there is silicification with a fair proportion of iron sulphide.

8. In conclusion it might be added that the petrographic investigation indicates that the country passed through in these two bores is favourable to the occurrence of gold. Sheared auriferous lines are likely to be met with in hornblende schist, and it is hoped that shoots other than those that have been already worked may yet be discovered.

IV.—Lecture to Members of the Australasian Association for the Advancement of Science.

Some members of the Association (Section C, Geology and Mineralogy) visited Kalgoorlie under the leadership of Professor Sir Douglas Mawson, D.Sc., F.R.S., President of the Section. Opportunity was taken prior to the visit for a visit to special localities with the view to the preparation of rock sections for projection purposes in order that the more important facts regarding the geology and petrology of the Kalgoorlie goldfield might be made available to the visiting members.

The visitors were taken (a) for a geological excursion covering a large area around Kalgoorlie as far as Kurrawang; (b) for a trip to Kanowna; and (c) for an underground excursion through the Oroya Shoot.

In the evening a lantern lecture illustrated by numerous rock sections, was given by myself on the Geology and the Petrology of the Pre-Cambrian complex of Western Australia.

At the conclusion of the lecture an address was given on (1) the economic and utilitarian aspect of geology applied to mining and (2) the future of the mining industry.

V.—Some Rocks from Four Miles East of Argyle Station, Ord River, King District, Kimberley Division.

Macroscopic Features.—A dense, compact, beautifully banded rock made up of alternate bands of dark reddish brown material half an inch in width, and white bands of similar consistency about one-fifth of an inch wide. The reddish-brown and white bands have a hardness of about 3, the former yielding a pale pinkish-brown streak, the latter a white streak.

The white material is of a clayey nature, is practically infusible, and gives a reaction for alumina. Carbonates, if present, are negligible.

Minute white specks—pale brownish in the dark portion—are scattered throughout the rock. On exposed surfaces these white specks are represented by holes.

Microscopic features.—Under the microscope this rock is so dense that it takes high powers of the microscope to resolve it at all. The white parts are essentially fine clay with numerous wisps of sericite. Minute clear and angular quartz grains are scattered through the clay. The largest quartz grain seldom exceeds 1/500 of an inch. The grain of the rock is so fine as to suggest original material of the consistency of silt.

The dark reddish brown bands are simply ferruginous zones intercalated with the clay; they contain similar quartz grains to the white bands, into which they pass by insensible gradations. There is no absolute line of demarcation between the white bands and the ferruginous reddish-brown bands; they pass gradually one into the other.

Classification.—The rock may be regarded as a somewhat siliceous banded ferruginous claystone of sedimentary origin. (See rock 1/3962; Sections 4673, 4676, 4677.) In December, 1924, two rocks were described for Mr. Blatchford, one from near Ivanhoe Station on Ord River, and one from a creek on Barramine Station on the Oakover River. Mr. Blatchford's rocks may be regarded as similar to the specimens from four miles east of Argyle Station.

Origin.—It is reasonable to suggest that this rock was formed in quiet waters and at considerable depth. The alteration in the colour and composition of the layers is so frequent and so constant that no hypothesis will account for their originally massive character. Sedimentation seems to be the only answer. The microscope shows most perfect gradations between the white and reddish-brown bands. If orogenic or earth movements had been responsible for this banding, surely incipient shear or other planes would have separated the layers?

The general microscopic appearance indicates origin by means of very slow deposition either in quiet or deep waters, accompanied by the addition at repeated and frequent intervals of deposits of hydrated oxide of iron, followed again by siliceous clayey deposits.

This interlamination of siliceous and ferruginous material is quite common in the older rocks of America, *e.g.*, the Penokee District. It is moreover well known that iron ores have formed by chemical reactions in bodies of water, and these yield a notable proportion of the iron production of the world. The iron has been supplied from the land areas in the form of solutions. The oxide comes apparently from dissolved iron salts and not from detrital minerals of iron, so far as genesis is concerned. The surface waters extracted iron from the ferromagnesian silicates, as well as oxide or other minerals such as would be abundant in the older Pre-Cambrian land surfaces of that portion of Western Australia. The dissolved iron was carried into the sea.

Sea water contains dissolved air to the extent of 14 to 28cc. per litre, and this gas is present at great depths as well as at the surface. Hence, reactions in sea water would favour the forming of ferric compounds, unless reducing agents like organic matter were present, which is improbable. In fact, the red mud that is so abundant in the deep sea basins of the ocean is comparatively rich in ferric oxide.

The possibility of the reddish-brown ferruginous bands resulting from the oxidation of ferrous carbonate is small, because thick beds of siderite are not likely to be deposited in the open sea, since the oxygen in the water would tend to oxidise the ferrous compound. Limonite is an actual sedimentary deposit.

In specimen 1/3962 the bands are quite perfect and parallel, but in Mr. Blatchford's specimen the bands were not continuous and some forms presented curious elliptical cross sections. It is really a question of the segregation of the iron oxide from point to point: lenticular layers taking the place of irregular rounded nodules—certainly a distinction of no great importance.

It does not seem reasonable to suggest that the iron was introduced into this rock by atmospheric waters along the line of outcrop or downward through the overlying strata.

It might be remarked that it took 26 years to accumulate several inches of limonite in a Swedish deposit in shallow water along the shores. (Geikie, A., *Text Book of Geology,* 4th Edition, page 187.) The process in the Ord River area must have been infinitely slow in this deep sea deposit, particularly as suggested by the number of contacts of the white and reddish-brown bands examined microscopically. A feature of importance revealed by the petrographic investigation of this rock is the light it throws on the time question involved in some sedimentation, and the enormous periods of time represented by the pre-Cambrian and early Palaeozoic periods.

VI.—Petrographical Determinations for the Department and General Public.

The most interesting of these determinations are as follows:—

G.S. 13/25.—The occurrence of cyanite in gneiss from a little to the east of Lake Needoonga in the Upper Chittering Valley near Gingin. Since the collection of this cyanite gneiss some beautiful blue cyanites have been discovered in quartz veins in the Chittering Valley.

The gneiss is powerfully foliated, and consists of numerous bands of black and white mica with somewhat granulated looking quartz. In section the cyanite is pale pinkish, of high refractive index, strongly cleaved, and with high extinction angles (30°) measured from the trace of the cleavage. Microscopic features indicate a possible sedimentary origin for this cyanite-gneiss.

G.S. 220/21.—Three rocks were examined from Logan's Find, Gnalbain, Coolgardie Goldfield. All three were typical of auriferous country. No 1/3997, S. 4690, was a coarse-grained epidiorite made up of about equal proportions of uralite and plagioclase. No. 1/3998, S. 4688, was a very dense fine-grained amphibolite consisting of minute prisms, shreds, and plates of hornblende. The felspar was negligible. No. 1/3999, S. 4689, was a granulated and crushed felspar-porphyry.

G.S. 2/25.—Rocks submitted from Marie's Find, Bullfinch, Yilgarn Goldfield, by the Inspector of Mines, were made up of hornblende-schist and acid intrusives in the form of aplite.

G.S. 281/10.—A massive greenish rock (1/4010, Busselton) with the appearance of a mudstone or decomposed fine-grained greenstone. It proved to be of sedimentary origin. Under the microscope it was made up of dirty green and yellowish-brown ferruginous material in about equal proportions. Throughout this material irregular-shaped quartz grains are scattered, together with occasional pieces of felspar, one piece being certainly microcline.

G.S. 45/02.—Rock from half a mile east of Burrambie Station, Braeside, Pilbara Goldfield. This was a very dense greenish-grey felsitic, almost flinty-looking rock, throughout which numerous small dark patches and areas of chlorite were distributed. In section it consisted of a dense dirty grey lithoidal groundmass throughout which may be seen excessively minute microlites that appear to represent incipient stages of felspathic crystallisation. It is probable that this rock is an amygdaloidal lava of great age. In some aspects it is not unlike the lavas from the Nullagine series.

G.S. 86/12.—Rock from Goomalling, South-West Division. A medium-grained granite that has been intruded by a dense black basalt dyke, fragments of which may be seen adhering to the granite. Microscopic investigation showed the black rock to consist of a very dense irresolvable groundmass studded with black specks of oxide of iron. Exceedingly minute microlites of felspar are set in the groundmass in all azimuths. Perfectly colourless idiomorphic phenocrysts of plagioclase are distributed throughout the base.

G.S. 253/11.—A curious rock from Mingenew, South-West Division. This rock is of a decided metamorphic origin. It consists of black lustrous biotite and a soft dark-grey massive and somewhat resinous lustred substance. In section it is made up of large plates of biotite, associated with a mass of scaly and vividly polarising material that is evidently a form of pinite, most probably after cordierite. This rock was apparently a cordierite-biotite-schist, in which the cordierite has changed into pinitic growths.

G.S. 34/26.—Sample from Balfour Downs Station, about two miles west of the new gold find on the Curana Goldfield. This is an epidote-bearing coarse-grained basic epidiorite, a rock not uncommon on the goldfields.

G.S. 50/26.—From 15 miles north of Glenburgh Station, via Mullewa. This is a rather fine specimen of epidote and zoisite, with some pale green chlorite and interstitial quartz with water-clear felspar. The rock may be called epidosite.

GEOLOGICAL SURVEY MUSEUM AND COLLECTIONS.

Progress in connection with the sadly needed rearrangement, etc., of the Geological Survey Collections has not been found possible during the year 1926.

The collection which has been acquired by the survey officers in the ordinary course of departmental duties, or acquired by purchase or donation, forms the basis of the Geological Museum and now amounts to 18,101 registered specimens, most of which are in triplicate. During the calendar year 1926, 154 rocks were received and registered, in addition to eight minerals. Rock sections cut and registered amounted to 216, bringing the total number of microslides in the possession of the survey to 4,814. Two new meteorites (1/4077, Ticraco Creek, North Murchison; 1/4078, Mount Stirling, Avon District, South-West Division) were added to the collection, and 5,942 feet of bores were received.

The collection of geological photographs now amounts to 2,169, there having been 31 added to the list during the year. As has been previously pointed

out, the photographs cover a wide range of geological subjects, representative of the different portions of the State in which departmental activities have extended.

The set of prints from the survey negatives is contained in 44 special albums and in the library; such a collection is of considerable scientific and historic value, which increases as years go by.

LIBRARY.

The additions to the Geological Survey Library amounted to 613 publications from all the Geological Survey and cognate institutions throughout the world, in addition to 24 purchases, bringing the total number of publications, including maps, up to 20,992 registered.

The distribution of the official publications issued during 1926 amounted to over 2,000; these were transmitted to the addresses on the regular exchange list and to others in response to requests for specially named reports, bulletins or maps.

GENERAL.

The present is the thirtieth and last in the series of Annual Progress Reports issued under the auspices of the writer. The regret with which I close the official relations with the staff of the department is mitigated by the kindly feeling which prompted the expressions at the meeting of the 9th December.

A Gibb Maitland

Government Geologist.

INDEX.

By Authority: Fred. Wm. Simpson, Government Printer, Perth.