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WESTERN AUSTRALIA.

ANNUAL PROGRESS REPORT

OF THE

GEOLOGICAL SURVEY

FOR THE

YEAR 1924.

With Two Plates.

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Annual Progress Report of the Geological Survey for the Year 1924.

The range of activities of the Geological Survey during the year 1924, as has been the case in the past, has been of a varied nature and carried out along the usual lines. Good progress, considering the limited personnel, has been made in the field work, and those related investigations to which such gives rise. Full details of the field work and the deductions drawn therefrom are given in different sections of the report.

In addition to what may be called the regular work of the department, endeavours have been made to collect information bearing upon the geological side of mining, and also to obtain records of and examine the specimens from borings for water and other minerals as occasion arises.

Several advisory reports, in which geological considerations are involved, were made in connection with (a) the alienation of mineral-bearing lands, (b) matters raised under Section 40b of the Mining Act, and (c) subsidies under the Mining Development Act.

ADMINISTRATIVE AND OTHER DUTIES OF THE GOVERNMENT GEOLOGIST.

Administrative, routine, and other duties left little time for work in the field; nevertheless, it was found possible to devote 98 days to outside work in different parts of the State.

The period between the 12th of May and the 26th of July was devoted to a reconnaissance of the country in the vicinity of Israelite Bay.

Having been appointed Chairman of the Interstate Conference on Artesian Water Supplies of Australia, the period intervening between the 1st and the 16th of October was devoted to the main work of the conference. This, *inter alia,* entailed a short journey with the visiting members between the 6th and 14th October to the Gascoyne River at Bidjemia, starting from Meekatharra and returning *via* Mullewa.

Portions of the months of November and December were spent at Kalgoorlie in connection with the underground geological survey of that field.

A traverse of the country from Bullabulling to Red Hill, near Lake Lefroy, was made between the 18th of November and the 15th of December.

THE STAFF.

The manifold work of the Geological Survey during the year 1924 has been carried out by six classified officers, and there has been no change in the personnel.

FIELD WORK.

The record of the field work for 1924 has been, on the whole, one of progress; it has been carried out over a wide extent of country, of which little detailed geological data was available, but on a less extensive scale than hitherto. Goldfields surveys and investigations of mineral resources occupied by far the greater portion of the time of the available staff. The underground geological survey of Kalgoorlie was continued; the work is necessarily very intricate, and if it is to be effective, requires the most careful compilation and correlation of details, which entails relatively slow progress if scientific and official accuracy is to be attained. Several important advances in our knowledge of the field have already been made, and will be found set out on pages 10-15.

A more or less detailed survey was made of Paynesville and the surrounding district on the Murchison Goldfield, and a good deal of information obtained regarding the gold occurrences of a portion of the State about which very little or nothing was known.

Details regarding the surveys are shown in the table hereunder, which indicates the distribution of the work of the field geologists, together with the names of those engaged thereon:—

Table showing the distribution of field work during the year 1924.

Goldfield or Land Division.	F. R. Feldtmann.		A. G. D. Esson.	
	No. of days in field.	Percentage of working days.	No. of days in field.	Percentage of working days.
Murchison Goldfield ...	...	...	226	61·92
East Coolgardie Goldfield	64	17·53	...	...
South-West Division ...	4	1·10	...	...
Total ...	68	18·63	226	61·92

F. R. Feldtmann.

The early portion of the year up to the 13th of April was devoted to various duties at headquarters, amongst which were the work on the report, maps, and diagrams of the Youanmi district, and bringing up to date of the black and white geological map of the State, included in Bulletin 89.

The gypsum deposits of Lake Cowcowing were examined during the 14th to the 18th April, and the preparation of the report occupied Mr. Feldtmann up to the 7th May.

Mr. Feldtmann took charge of the office during my absence in the field, and on the 20th October he proceeded to Kalgoorlie, for the purpose of carrying out geological investigations at the North End, particular attention being devoted to the more important mining work carried out in that area, since the detailed survey has been made.

An examination of G.M.L. 5372, P.A. 1991E, and a report made in connection with an application for State assistance under the terms of the Mines Development Act.

Mr. Feldtmann spent in all 68 days in the field during the year, 64 of which were in the East Coolgardie Goldfield.

Alexander G. D. Esson.

During the early part of 1924, Mr. Esson was occupied with a portion of his annual recreation leave for 1923, and thereafter in the preparation of "An Interim Report upon the Paynesville Centre and District," for the Annual Report for 1923, in addition to various details in connection with field plans necessary for further field work at Paynesville, and also in consultation with Dr. Larcombe, Acting Petrologist, regarding specimens of rocks submitted for examination, as well as in other multifarious duties necessitated by the nature of the geological work upon which he was engaged.

On Monday, February 11th, 1924, this officer left Perth for the resumption of his field work at the Paynesville centre and surrounding district, and he arrived back at the Head Office in Perth on Tuesday, September 23rd, 1924. The work covered in that time included an examination of about 300 square miles of country, some of which was carried out in very careful detail, but the main portion, as would be expected, was executed in a broad way. The final reports and maps of the Paynesville centre and district are now in course of active preparation, and ought to be available shortly.

Notes upon the results of various broad driving traverses have been prepared, and are to be found in that portion of this report dealing with the principal results of the year's field operations.

From the date of return to Head Office, Mr. Esson was occupied in the preparation of maps and final report upon Paynesville, in consultation and collaboration with the Acting Petrologist regarding specimens submitted for examination and correlation in various duties, and in annual leave for 1924.

In all 226 days were spent in the field, giving a percentage of total working days of 61.8 per cent. in field work. All the field work by Mr. Esson having been on the Murchison Goldfield.

PRINCIPAL RESULTS OF THE YEAR'S FIELD OPERATIONS.

1.—INTERSTATE ARTESIAN WATER CONFERENCE.

(A. Gibb Maitland.)

The Fourth Interstate Conference on the Artesian Water Supplies of Australia was held in Western Australia during the month of October. The Conference, which was attended by representatives from New South Wales, Victoria, South Australia, and the Commonwealth Government (unfortunately Queensland did not officially participate), sat in Perth between the 1st and 6th of October and again from the 14th to the 16th of October, the period intervening being occupied in travelling to the Gascoyne River for the purpose of enabling some of the members to obtain a personal acquaintance with the basal beds of the strata forming part of what is known as the North-West Basin.

The members attending the Conference were:—

Commonwealth—
- Thos. Hill, M.V.I.E., Chief Engineer, Works and Railways, Melbourne.

New South Wales—
- E. C. Andrews, B.A., Government Geologist.
- H. H. Dare, M.E., M.Inst.C.E., Commissioner for Water Conservation and Irrigation.

Victoria—
- W. Baragwanath, Director of the Geological Survey.
- A. S. Kenyon, State Rivers and Water Supply Commission.

South Australia—
- L. Keith Ward, B.A., B.E., Government Geologist and Director of Mines.
- J. G. Stewart, M.Inst.C.E., Engineer-in-Chief.

Western Australia—
- A. Gibb Maitland, Government Geologist, Chairman.
- P. V. O'Brien, M.Inst.C.E., Chief Engineer for Water Supply, Irrigation, and Drainage.
- F. W. Lawson, Engineer for Metropolitan Water Supply, and

The Permanent Secretary to the Conference—
- Mr. J. E. Slade, of the Water Conservation and Irrigation Commission, New South Wales.

One of the chief objects of these periodical Interstate Conferences is to ascertain the extent, the effective yield, and the amount of stability of Australian artesian supplies with a view to an equitable policy of conservation in order to make them serve as large an area and as large a population as long as possible. It may be of interest to direct attention to the fact, as pointed out on page 11 of the Annual Progress Report of the Geological Survey for the year 1912, that the Interstate Conference "virtually forms a part of that great modern scientific movement of the Conservation of the Natural Resources which is slowly but surely making itself felt throughout the whole civilised world."

Amongst the important matters dealt with during the course of the deliberations of the Western Australian Conference were: temperatures of artesian water at considerable depths; sources of supply of artesian water; chemical composition of the water; leakage of artesian water; palaeontology of the different water-carrying formations; diminution of bore flows, and the means to prevent exhaustion of the supply.

It has been found that in most areas there is an appreciable diminution in the yield from the artesian wells. In the case of Queensland, which draws its supplies from the Great Australian Basin, the following figures, as made available by the Government Geologist, relating to the diminution of the flow in the basin, are significant. Between the years 1914 and 1923 the yield from the artesian wells fell from 500,000,000 gallons to 300,000,000 gallons per day, although 300 additional bore holes were put down. This represents a diminution in the supply of water equal to about 4.6 per cent. per annum, or 6 per cent. if the yields are averaged with the number of bores; at this rate of diminution it has been estimated that in 50 years the basin will only be yielding 20,000,000 gallons of artesian water per diem, an amount about equal to that from 50 of the bores at the present time.

A lessening or even cessation of flow does not of necessity indicate a permanent exhaustion of a basin for there are always fluctuations in the level of underground water. Diminished yields due to (a) lateral leakage of the water; (b) choking of the bores as a result of "creep"; (c) accumulation of sand, fine mud, or some mineral product; and (d) wearing out of or defects in the casing are capable of remedy by methods known to engineers. A permanent decrease in the supply as a result of the

exhaustion of the head by an uncontrolled draft is, however, irremediable; hence in the absence of a healthy public opinion on the matter, legislative enactment is the sole preventative.

2.—GRAPHITE ON THE LOWER PALLINUP RIVER.

(A. Gibb Maitland.)

A brief account of the graphite deposit of the Lower Pallinup River appeared as Article 2 in the Annual Progress Report of the Geological Survey for the year 1923. Since that article was written the following report on a sample (1/3865) collected by myself, and submitted to the Government Chemical Laboratory has been received:—

Proximate Analysis (L. 898/24).

Volatile matter	6.54
Carbon	54.72
Ash	38.74
	100.00

"The gangue is mainly kaolin. This sample is of no value as a source of flake graphite owing to the graphite being present in minute scales. It contains too much mineral matter to be of use for foundry work or pencil making, but might be used for stove polish."

3.—NOTES ON THE COUNTRY IN THE VICINITY AND TO THE NORTHWARD OF ISRAELITE BAY, EUCLA DIVISION.

(A. Gibb Maitland.)

The period between the 12th May and the 26th July was devoted to a reconnaissance of the geologically little known country between Esperance, Israelite Bay, and Fraser's Range. The country was reached by an overland journey from Ongerup *via* Ravensthorpe.

An examination of the country between Norseman and Esperance had been made prior to the present journey by travelling from Norseman via Moir's Rock and the Fitzgerald Peaks, thence down the Salt (or Lort) River to the coast. From the mouth of the Lort River the road to Esperance was followed as far as Gage Lake, into which the Dalyup River discharges its waters, thence up the river to the Norseman road as far as the Government tank at the Salmon Gums. A return to Esperance *via* the Grass Paddocks and Bostock Swamp was made. The eastern margin of the country was examined from the Old Fraser's Range Road, *via* Mount Ridley, Clear Streak Well, and Boojebeenyer. The route followed, involving about 800 miles on horseback, enabled a general idea of the geology of the whole of the Esperance hinterland to be obtained, the salient features of which have been included in these notes.

The country in the neighbourhood of Esperance Bay and the hinterland is a tableland made up mainly of granitic rocks of which that [11847] from Mount Ridley is typical. Mount Ridley (N. 24) is a very conspicuous granite ridge trending generally east and west, with a fairly bold escarpment on the northern face. The ridge is about a mile in length, and the highest point rises to a height of about 340 feet above the level of the well.

At Cowalyina (Reserve 2790), several miles to the north of Mount Ridley, the granite has given place to granitic gneiss [11848], the foliation planes of which are vertical and have a dominant strike of northwest and southeast.

The surface of the tableland is of extreme irregularity, and is occupied by a series of salt pans and lakes. These dry or salt lake basins are exceptionally numerous; they are very variable in their outline, are in some cases many miles wide, and the area of some of them is very great. These salt lakes are often very isolated, though at other times loosely strung together, being separated by narrow divisions. Their resemblance to and connection with river channels may be noted in their elongated shape, of which Lake Raeside, over 100 miles in length, may be cited as a typical example. Lake Raeside constitutes the main channel of the central group of lakes forming an ancient water course flowing into the upper reaches of the Ponton River, which is the only defined water channel of any length. The Ponton River in parts of its course is a deep channel with well-defined banks and empties into a large clay pan at a point about 40 miles from where it crosses the Trans-Continental Railway line between Zanthus and Kitchener. Its course from the clay-pan is represented by a broad ill-defined channel trending southward for about two miles, when it loses itself in a large salt-bush flat broken by low banks of powdery gypsum. The flat represents the uplifted estuary into which the Ponton flowed north of Balladonia. The estuary of the Ponton is 120 miles due north of the coast line along the Great Australian Bight.

The series of which Lakes Dundas and Cowan form part are not lakes in the ordinary sense of the word, with a well-defined basin, but are merely parts of another independent river system which had its mouth in the Miocene Sea near Norseman, and the Archipelago of the Recherche near the Lort River. In traversing the Lort (or Salt) River in August, 1911, it was then a strong deep running river of salt water, almost a brine, owing to the fairly heavy rains which had fallen in the hinterland, and was carrying off the overflow from the lakes. A similar condition of affairs was noticed in 1919 by my colleague, Mr. Talbot, when traversing the Ponton; at that time, after a rainfall of two and a half inches, the upper reaches of the river were running very strongly with salt water derived from the salt lakes which form the upper portion of its course.

The existence of such river systems points to the fact that this portion of Western Australia had a heavier rainfall and was much better watered than it is at present, and implies a comparatively recent desiccation of the country which resulted from a regional uplift of about 1,000 feet. Such an uplift tends to cause the rainfall to become heavier on the coastal areas and lighter in the interior. The increase of rainfall in the coastal areas tends to hasten the lowering of their level by denudation and the cutting back of their channels, with ultimately the restoration of a more even distribution of the rain.

Many of the salt lakes contain gypsum deposits. The large lake to the east of Stennet's Rock (Reserve 3045)* has along its edge a deposit about 12 inches in thickness of small crystals of gypsum, whilst near the centre of the lake they are of larger size, often over an inch in length. The crystals in the centre of the lake are not perfectly formed, whilst those along the banks have as a rule all their edges rounded as a result of wind erosion.

Along the shores of some of the lakes horizontal beds of gritty ferruginous sandstone are met with.

*Lands and Surveys Department, Lithograph 11/300.

These sandstones are nowhere very thick. In other localities outliers of quasivitreous quartzites occur and testify to the former wide extension of sedimentary rocks in this portion of the State.

With the exception of a *Pecten* (?) [1/3916] obtained by Mr. C. Hancock from the Oil Prospecting Area 154H, no fossils have yet been met with in the more immediate vicinity of Esperance.

These thin sediments are in all probability only the remnants left in the Plantagenet (Miocene) Beds which are met with at intervals along the maritime districts of the southern portion of the State. Remnants of an extensive limestone deposit of Miocene age occur at Norseman at an altitude of 900 feet above sea level and about 100 miles distant from the coast, and which forms part of the same series.

There is in addition a soft white siliceous rock made up almost entirely of the spicular remains of siliceous sponges. Representatives of these sponge beds have also been met with on the northern shores of Lake Cowan. The deposit consists of a fine-grained marine silt exposed in a series of low white cliffs near the head of Lake Cowan, about 35 miles above Norseman, thus furnishing an indication of the wide area over which these Miocene beds at one time extended.

Cape Paisley Mica Deposit.—A very coarse grained pegmatite [1/3696] dyke, measuring 15 feet in width and of considerable horizontal extent, occurs on the seaward slope of hill No. 61* at Cape Paisley, which rises to a height of 545 feet† above sea level. The dyke occurs along the vertical foliation planes of a highly micaceous gneissic granite, which constitutes the staple formation in the vicinity of the cape, and which has a general northeast and southwest strike. The pegmatite, so far as can be seen, contains potash mica in the form of small books, from which fair quantities of scrap mica are obtainable, although from the material lying on the surface there were sheets capable of being cut into sizes averaging about 2 by 3 inches. In addition to the mica the dyke contains some large fragments of the potash felspar, microcline [1/3705], which in this locality forms an important constituent of the pegmatite and might under suitable conditions prove capable of being exploited as a source of commercial potash, for the deposit appears capable of yielding a considerable tonnage of felspar.

Other mica deposits occur in the vicinity of Cape Paisley. One is situated about three miles north of Bellinger Sand Patch. The mica occurs in pegmatite dykes as "books," from some of which sheets three by four inches could be cut. The quality proved to be excellent, and when submitted to electrical tests proved to be of very high grade.

What is shown on the maps issued by the Department of Lands and Surveys and the Admiralty charts as Mica Hill, some miles to the north of Cape Paisley, takes its name from the mineral occurring in that locality. Some of the mica from Mica Hill (?) contains inclusions of magnetite (magnetic oxide of iron).

The mica-carrying belt of this portion of the State is of considerable extent, having been noted at Simon's Hill, in the Fraser's Range, at which locality several coarse-grained pegmatite veins occur. One of these dykes, about 6 to 10 feet wide, in which "books" of mica two or three inches square occur, has been opened out to a depth of from 6 to 8 feet. Large crystals of black tourmaline occur in the dyke in addition to the mica crystals.

Mount Ragged Range.—Opportunity was taken to make a brief examination of that group of hills of which Mounts Ragged, Dean, and Russel Range constitute the most conspicuous and outstanding features. Mount Ragged (Rugged) was described by Matthew Flinders in January, 1802, as "lying N. 8° W., 9 or 10 leagues from Cape Paisley." The natives of the interior gave the name of Barninggunyah to the mountain, whilst those of the coastal tribes called it Carta-currup. It was referred to as a "jagged peak" by Mr. E. J. Eyre on the 16th May, 1841, in the journal describing his overland journey from Adelaide to King George's Sound.‡

The Russel Range, "lofty and abrupt mountain masses," which lies to the north of Mount Ragged, was named by Eyre on the 26th May, 1841, in honour of Lord John Russel, who at that time occupied the position of Secretary for State for the Colonies.

Mount Ragged, situated about twenty-five miles west-north-west of Israelite Bay, forms one of the landmarks on the dividing line between the Eastern and the Eucla land divisions. The mount forms the highest summit of a very narrow razor-backed ridge with very deep sides, alpine in its grandeur, which extends for some three miles in a direction about north 20 to 30 degrees east.

Mount Ragged is separated from Mount Russel by a well-defined valley trending generally northwest and southeast, and suggesting the possibility of its marking the trend of a fault which extends to the southeast and truncates the southwestern continuation of that range, the principal and most conspicuous summit being formed by Mount Dean. The Mount Dean Range lies to the eastward of Mount Russel and is separated from it by a longitudinal valley from three to four miles wide, and which trends generally northeast and southwest with a gradual fall to the south. No opportunity presented itself of visiting either Mounts Dean or Russel, but from what could be seen from Mount Ragged, they seem to be similar in geological constitution and structure.

The Mount Ragged Range is made up of granitic gneisses and allied schistose rocks, the foliation planes of which dip to the southeast at angles varying from 50 to 60 degrees, and have a general strike of north 20 to 30 degrees east. The mineral constituents of the schists are mainly quartz, with silvery white mica giving them a characteristic lustre, oxide of iron, and a few small zircons. The schists seem to be genetically related to plutonic igneous rocks and probably owe their origin to the transmutation of a granite as a result of the stresses and strains to which it has been subjected since consolidation.

There is a highly plicated thin micaceous band near the southern end of the range, which appears to mark a shear zone along a highly inclined thrust plane. There are numerous contorted quartz veins which conform to the folding which the laminae have undergone. The band contains some fairly large crystals of andalusite [1/3718]. The mineral was

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* Lands and Surveys Department Lithograph 3/300. † Admiralty Chart 1059 gives the height as being 345 feet.
‡ Natural Features of Israelite Bay. J. P. Brooke. Aust. Assn. Adv. Sci., Brisbane, 1895, p.p. 561–569.

examined by Dr. E. S. Simpson, who reported that "This has density of 3.22 with a mean refractive index 1.63. It is andalusite, crowded with minute inclusions chiefly carbon, but also rutile, quartz, gas, etc. Similar specimens were received from this locality in 1910, and recorded in the census published by the W.A. Museum in 1912."*

Two schistose rocks [1/3698] and [1/3699] from different portions of the Mount Ragged Range have been examined by the Acting Petrologist, Dr. Larcombe, and chemical analyses made in the Government Laboratory under the direction of Dr. Simpson.

[1/3698, S. 4515.] South end of Mount Ragged. Macroscopic features: A very fine grained granular and somewhat foliated rock with a saccharoidal appearance. It consists of grains of sand with specks of white mica, which are abundant enough to give a powerful sheen to fractures in the direction of the planes of schistosity. Microscopic features: In section the rock is made up of a more or less even granular aggregate of quartz grains averaging about 1/5 m.m. or 1/130 of an inch in diameter. The quartz grains are irregular in shape and do not show much rounding. Between the quartz grains are small rods of white mica arranged with their lengths in more or less parallel direction. The average length of the rods of mica is about 1/125 of an inch. The only other constituents in the rock are a few black specks of oxide of iron and an occasional minute prism of zircon. The rock is a quartz sericite schist the cataclastic microstructure of which suggests strongly a sedimentary origin.

[1/3699, S. 4517.] Spring, East of Tower Peak, Mount Ragged Range. Macroscopic features: A pinkish, medium-grained somewhat saccharoidal-looking quartzitic rock, the foliation planes of which are coated with scaly white mica. Microscopic features: In section the rock is similar to [1/3698] in that it is a quartz sericite schist, but it differs from [1/3698] in fabric. The quartz grains are much larger, their average diameter being about 1/40 of an inch. These large quartz individuals are wrapped round and separated by a very fine grained quartz sericite mosaic. The mica rods are, in places, squeezed and drawn out between the large quartz grains. The section shows strong schistosity and the microstructure indicates a sedimentary origin.

A representative suite of the rocks from the Mount Ragged Range has been analysed in the Government Chemical Laboratory, under the direction of Dr. E. S. Simpson:—

TABLE I.

Chemical Analyses of Rocks from Mount Ragged Range.

Registered No., Name, and Locality.	1/3698. Quartz Sericite Schist, South end of Mt. Ragged.	1/3699. Quartz Sericite Schist, Spring East of Tower Peak, Ragged Range.
SiO_2	92·46	90·46
Al_2O_3	4·11	4·88
Fe_2O_3	1·34	1·47
FeO	·08	·10
MnO	·09	·15
MgO	·42	·42
CaO	*Nil*	·09
Na_2O	·04	·02
K_2O	1·26	1·49
LiO_2	...	*Nil*
H_2O-	·08	·04
H_2O	·53	·67
TiO_2	·11	·11
P_2O_5	*Nil*	·05
ZrO_2	trace	...
CO_2	*Nil*	·07
FeS_2	*Nil*	·11
	100·52	99·85
Sp. Gr. ...	2·69	2·69
Analyst ...	H. P. Rowledge	H. Bowley

The open bay, with a base trending generally northwest and southeast, lying to the westward of the bold headland of Cape Arid and the cape to the south of Tragon Harbour, near the mouth of the Thomas River, in all probability has been determined by the fractures which are responsible for the formation of the bold Mount Ragged Range and that to the east, of which Mount Dean forms the most prominent feature and upon which the Trig. Station has been built.

The shape and general northeasterly arrangement of the coastline from Cape Paisley through Israelite Bay to the neighbourhood of Wattle Camp, suggests that it has been in the main determined by that of the trend of the foliation of the gneisses, which is also parallel to that of the ranges referred to.

Point Dempster, a bold headland which shelves gradually into the ocean, is made up of a coarse granitic gneiss, upon which rest sand dunes. The headland is probably continued to the southeast and forms the bold islands of the "Eastern Group," which lies about two miles from the coast. About four miles northeast of the Israelite Bay Telegraph Office, and on the western side of the telegraph line, are a series of low rises made up of granitic gneiss of the type which characterises Point Dempster; the gneiss is first seen near the northern end of the Yellow Lake, which crosses the northern boundary of Reserve 3805. Near the sea coast the gneisses are covered by blown sand. Similar gneisses are visible along the north-western shores of that long salt lagoon, which extends from Point Malcolm to Point Dempster. The road from Israelite Bay to Mount Ragged skirts the northwestern shores of the lake and surmounts the tableland of the interior at an altitude of about 500 feet by aneroid above sea level. The summit of the tableland, about 12 miles from the Post Office, is made up of granitic rocks, upon which there is a thin covering of horizontal white limestone, forming a low escarpment representing in all probability the southerly extension of the Eucla Limestone.

Leaving the Mount Ragged Range, the main road to Balladonia was followed, and at Junana Rocks gneissic rocks of the prevailing type are exposed. A characteristic specimen has been described by the Acting Petrologist as:—

[1/3697, S. 4513.] Junana Rocks, North-West of Mount Ragged, Neridup District. Macroscopic features: A white granulose rock with gneissose structure and well-marked foliation planes coated with black lustrous biotite. When viewed along the cross fracture the biotite takes the form of disconnected black streaks averaging about 1/5th of an inch in length, though in places the streaks are half an inch long. The granulated material consists of glassy quartz and felspar, many plates of the latter showing cleavage faces. Microscopic features: The minerals observed were quartz, microcline, plagioclase and biotite. In plain light the section is made up of a holocrystalline aggregate of slightly clouded and cleaved felspar, clear quartz and flakes of brown biotite. The bulk of the felspar has a refractive index less than Canada balsam and shows typical cross-hatched twinning. It is therefore microcline, possibly with a little orthoclase. There is a small amount of acid and finely striped plagioclase. The quartz is clear, allotriomorphic and intergrown with microcline in granitic fashion. The biotite occurs in flakes, strongly pleochroic, in dark brown to almost black colours. The rock is a granulated biotite gneiss of igneous origin.

* Census of the Minerals of Western Australia: E. S. Simpson. Guide Book to the Western Australian Museum, Part VI., Minerals. Perth. By Authority, 1912.

The road from Junana trends generally due north to what is known as Pine Hill, where there is an excavated tank. The rocks in the neighbourhood are fine-grained granitic gneiss traversed by pegmatite dykes. A typical specimen of the gneiss has been examined and described by Dr. Larcombe:—

[1/3702, S. 4520.] Pine Hill, Dempster District. Macroscopic features: An even grained pink to flesh-coloured rock of aplitic texture and somewhat granulose appearance. The constituents are glassy quartz and cleavage facets of felspar. Small flakes of black biotite, with a tendency toward parallel arrangement, are uniformly scattered throughout the rock. Microscopic features: The minerals observed were quartz, microcline, orthoclase, and biotite. In section the rock is an even grained admixture of quartz and microcline in about equal proportions, with, if anything, more microcline than quartz. The quartz is colourless, shapeless, and intimately intergrown with microcline in granitic fashion. The microcline is for the most part hypidiomorphic with well developed "gridiron" texture. A few plates of plagioclase, with very finely striated lamellae and extinction angles of less than five degrees are evidently oligoclase. Dark brown lath-shaped flakes of biotite, with a parallel arrangement of their direction of elongation, are uniformly distributed throughout the rock. The rock is a fine-grained aplitic biotite microcline gneiss. It bears a strong resemblance to [1/3697] and evidently belongs to the same family. It differs textually from [1/3697] in being finer in grain and typically aplitic as well as not being so gneissic. On the other hand, it has the same mineralogical constitution as [1/3697]. The biotite is identical in pleochroism and the plagioclase is quite similar.

An analysis of this rock is given in the table appended. Gneissic rocks occupy the country as far north as Pownia, to the west of Curnading Rock.* At Pownia the gneisses are vertical, and have a general strike of north 20 degrees east. The gneisses of Pownia give place at Balladonia Station to coarse grained massive granite, made up of quartz, microcline and biotite, with a little magnetite, rising to a height of about 50 or 60 feet above the general level of the limestone [1/3703], by which it is everywhere surrounded, and covering an area of about 200 acres. The granite is traversed by pegmatite dykes. The limestone, which is very hard, is only about five or six feet thick, and rests upon a thin bed of reddish sandstone which directly overlies the granite. A suite of fossils was collected from the Balladonia limestones, but this yet awaits determination and description. The limestones of Balladonia form the western portion of the Miocene beds, which constitute the Nullabor Plains. The limestone occupies a portion of the country along the road to Newman's Rocks* for about 20 miles with two relatively small outcrops of granitic rocks at Booma Rocks and Woolganyia (Wahgoninya or the 15-Mile Rocks); at the latter locality the granite is lithologically identical with that at Balladonia, being very coarse in grain.

Newman's Rocks (264/97) are made up of coarse garnetiferous gneiss, which rises to a height of about 60 feet above the general level of the surrounding country. These gneissic rocks occupy the country as far as Fraser's Range; they are, however, intersected by basic dykes, one of which has a north-westerly strike, being met with on the main road at about six miles from Newman's Rocks.

The whole of the country, therefore, inland between Esperance and Israelite Bays is made up of gneissic rocks of igneous origin, which have had impressed upon them a dominant northeast and southwest foliation. They are traversed by numerous pegmatite dykes, and so far as observations have been carried these appear to have escaped sensible mechanical deformation; hence they are of a younger generation than the gneisses, which occupy a stratigraphically inferior position.

Fraser's Range.—Passing through Fraser's Range, "Orrallinna," *en route* from Balladonia to Norseman, exigencies of travel necessitated a day or two's delay at the Fraser's Range head station, latitude 32° 2′ 15″ S., during which opportunity was taken to make a very brief examination of the country in the vicinity, and to collect samples of the different rocks for investigation.

Numerous references to the geology of the Fraser's Range have been made in several publications issued since 1891, but no systematic description and investigation of the country within the limits of the Fraser's Range has yet been attempted nor been found possible.

In the year 1890 a well organised party equipped by Sir Thomas Elder with the object of exploring the country to the westward of Warrina, on the Great Northern Railway line, 633 miles from Adelaide, lying between the parallels of 27° and 29° South latitude, spent some time in the vicinity of Fraser's Range. The brief account of the geology was written by Mr. Victor Streich, the geologist attached to the party, and published as part of the Scientific Reports of the Expedition by the Royal Society of South Australia.†

The highest summit of the range, The Peak, was determined by hypsometric measurements as being 2,010 feet above sea level, and 761 feet above the station hut. The loftiest portion of the range was stated to be about 15 miles in length with a width of from six to eight miles, though it really has a very much greater extension and gradually merges into the surrounding country.

The main mass of the Fraser Range, according to Streich, consists of indistinctly striated hornblendic schists, traversed by more or less parallel granitic dykes, the outcrops of some of which stand up above the surrounding country like walls of masonry.

The distinctly banded rock, forming the main mass of the range, collected and described by Streich as hornblende schist, was submitted with the others in the collection to Professor A. W. Stelzner, of Freiberg, who referred to it as "an undecomposed diabase."‡

In 1911 Mr. J. Allan Thomson¶ re-examined the duplicate collection and described the rock as "a norite with feeble protoclastic structure, and well marked fluxion banding"; the rock was made up chiefly of schillerised hypersthene, with a little mica and very little hornblende.

Mr. H. P. Woodward, in 1894, gave the geological constitution of the Fraser's Range as being that of

* Lands and Surveys Department Lithograph 17/300. † Trans. Roy. Soc., S.A., Vol. XVI., Pt. II., 1893, p.p. 74–115. ‡ Loc. cit.
¶ Thomson, J. Allan: On Rock Specimens from Central and Western Australia, collected by the Elder Scientific Exploring Expedition of 1891–2.—Proc. Roy. Soc., N.S.W., Vol. XLV., 1911, p.p. 292–317.

massive hornblendic rocks, intersected by basic dykes together with "quartz blows and veins of magnetite and manganese."*

During the course of his investigations into the geology of the country traversed by the Trans-Australian Railway, Mr. C. G. Gibson† referred to the Fraser's Range as being made up of rocks varying from garnetiferous quartz-schist to garnetiferous biotite-gneiss, intersected by coarse-grained pegmatite dykes containing books of mica about two inches square, large crystals of tourmaline, and some allanite.

The two trig. stations, Mount Pleasant‡ to the north, and Wyralinu to the south, of the homestead at Fraser's Range, are made up of garnetiferous pyroxene-gneiss [1/3700] and [1/3707], which may be merely granular varieties of the hornblende granite [1/3704] and [1/3706] frequently met with in the country between the range and Norseman.

The hill known as Mount Pleasant is made up of garnetiferous-gneiss [1/3700] and gneissic hypersthene-gabbro [1/3719] with a marked northeast and southwest vertical banding. The individual bands are not very wide, reaching in the vicinity of the trig. station on Mount Pleasant a thickness of about three of four feet.

A basic rock [1/3707] with a very marked mineral banding forms Wyralinu. The strike of the banding is northeast and southwest, and the rock is virtually a garnetiferous gneiss; it contains in places very large crystals of felspar, too much decomposed, however, to enable specimens to be obtained.

At the Fraser's Range station is a biotite hypersthene-gabbro or norite [1/3708], exhibiting a distinct mineral banding identical in its character with that which constitutes the gneissic gabbro [1/3719] of Mount Pleasant. A similar garnetiferous pyroxene gneiss has recently been obtained by Mr. Inspector of Mines Phoenix from Simon's Hill, about 20 miles to the northeast and near the northern extremity of Fraser's Range. The rock has been examined by Dr. C. O. G. Larcombe, the Acting Petrologist. The gneisses of the Simon's Hill neighbourhood vary somewhat in their lithological character, passing in places from garnetiferous quartz-schist to garnetiferous biotite-gneiss. These gneisses extend over a considerable area of country, and form part of that belt occurring at Bunnginia, about 40 miles to the northeastward, where the trend of the foliation is also northeast and southwest.

According to the observations of Streich, as indicated in the section forming Fig. 12 of Plate V., accompanying the scientific results of the Elder Exploring Expedition, the Fraser's Range is made up of hornblendic, felspathic, and siliceous schists.

The southeastern extremity of the Fraser's Range, about 22 miles from the head station, is stated to be made up of "hornblende schist."

The configuration of the range appears to have an intimate connection with the trend of the banding of the rocks, which is on the whole northeast and southwest.

Four analyses of the rocks in the vicinity of Fraser's Range have been made in the Government Chemical Laboratory, under the direction of Dr. E. S. Simpson:—

TABLE II.

Chemical Analyses of Rocks from Fraser's Range.

Registered No., Name, and Locality.	1/37 0. Garnetiferous gneiss, Mount Pleasant.	1/3707. Garnetiferous gneiss, Wyralinu.	1/3708. Norite, Fraser's Range Station.	1/3719. Norite, Fraser's Range.
SiO_2	60·86	77·10	49·11	52·21
Al_2O_3 ...	14·79	11·89	16·98	17·37
Fe_2O_3 ...	1·12	·36	1·94	·78
FeO	7·05	·80	8·87	8·55
MnO	·28	·15	·37	·47
MgO	2·17	·44	8·44	6·43
CaO ...	4·91	1·31	9·69	8·67
Na_2O ...	2·02	1·68	2·29	2·60
K_2O ...	4·48	5·90	·81	1·38
H_2O	·08	·08	·06	·09
H_2O	·22	·03	·52	·03
TiO_2	1·60	·29	·95	·60
CO_2	·04	·06	*Nil*	·89
P_2O_5	·46	·15	·24	·18
FeS_2	...	*Nil*	·04	·09
Cr_2O_3 ...	...	...	·06	·02
	100·08	100·24	100·37	100·36
Sp. Gr. ...	3·02	2·64	3·05	2·98
Mode ...	Felspars Quartz Garnet Augite Ilmenite Apatite Magnetite Zircon	Felspars Quartz Garnet Augite Hornblende Magnetite Ilmenite Apatite Limonite Zircon	Andesine Hypersthene Hornblende Biotite Ilmenite Apatite Limonite	Andesine Hypersthene Hornblende Biotite Calcite Quartz Ilmenite Apatite Pyrite Zoisite Zircon
Class ...	...	...	III.—5, 4, 4 Auvergnose	
Analyst ...	J. N. A. Grace.	J. N. A. Grace.	H. P. Rowledge.	H. E. Hill.

The principal point of interest and importance brought out by the reconnaissance of the country in the vicinity of Fraser's Range is the igneous nature of the rocks examined. Some of these are characterised by the presence of hypersthene, garnets and a marked persistent mineral banding. These rocks appear to bear some resemblance to that group of hypersthene-bearing rocks of India (the Charnockite series) and elsewhere.

Hypersthene bearing rocks, however, have already been described from Norseman, on the Dundas Goldfield, 60 miles east from the Fraser's Range. The hypersthene rock (norite) of Norseman occurs as an east and west dyke, varying from half a mile to a mile in width, which has been proved to extend in an uninterrupted line about 12 miles eastward as far as Mount Norcott, and for a considerable distance to the westward of Norseman itself. This rock, which bears some resemblance to that at Fraser's Range, if not actually part of the same rock mass, exhibits noticeable variations "ranging from hypersthene, through olivine norite to quartz norite with enstatite augite and pyroxene-perthite in many of the specimens." Detailed chemical analyses of the Norseman norite are given in Table "C" on pages 30 and 31 of Bulletin 67, "Analyses of Western Australian Rocks, Meteorites, and Natural Waters," by Edward S. Simpson, 1916.

Norites have also been described from Ora Banda, Broad Arrow Goldfield [12466]; from Cue, Murchison Goldfield [3832]; and from the Cavenagh Range, Eastern Division [1/1099], [1/1098], and [1/1107]; whilst at Cohn Hill, in the same division, a garnetiferous hypersthene-gneiss [1/1095] occurs, which resembles the gneisses of Fraser's Range, where it is associated with other rocks similar in character to those constituting the Charnockite Series of India.

* Woodward, H. P.: On the Country between Broome Hill and the Dundass Hills and the Mines in that neighbourhood. Ad. interim Report of the Department of Mines for the year ending 30th June, 1894. Perth: By Authority, 1894, p.p. 17–18.

† Gibson, C. G.: The Geological Features of the country lying along the route of the proposed Transcontinental Railway in Western Australia.—Geol. Survey Bull., 37. Perth: By Authority, 1909, p.p. 4–21.

‡ Lands and Surveys Department Lithograph 17/300.

Following the main road from Fraser's Range Station to Norseman, the basic rocks continued for about seven miles, when they gave place to granitic gneiss at what is known as the Ten Mile Rock.* The gneiss at the Ten Mile Rock is vertical, and has an average strike of north 10 to 15 degrees east. At a rock hole 38 miles from the station a hornblende microcline granite (soda granite) [1/3704] occupies the country and continues as far westward as Buldania Rocks (A.8) to the north of Mount Northcott [1/3706]. The granite continues as far as Norseman, where its apophyses, the quartz-porphyries and the soda-porphyries (ceratophyres), penetrate all the rock series developed on the field other than the metamorphic sedimentary beds and the newer norite dyke.

Chemical analyses of the two soda-granites and two gneisses were made in the Government Chemical Laboratory, under the direction of Dr. E. S. Simpson; these are given in Table III. hereunder.

TABLE III.

Chemical Analyses of some Rocks from the Country between Mount Ragged Range and Norseman.

Registered No., Name, and Locality.	1/3702. Biotite gneiss, Pine Hill.	1/3697. Microcline biotite gneiss, Junana Rocks, North West of Mt. Ragged.	1/3704. Soda granite, Rock Hole, 38 miles East of Fraser's Range Station.	1/3706. Soda granite Buldania Rocks (A. 8).
SiO_2	75·00	73·23	71·32	69·88
Al_2O_3 ...	12·57	12·78	15·14	15·18
Fe_2O_3 ...	·85	1·06	·67	1·21
FeO	1·00	1·98	·54	1·19
MnO	·15	·15	·08	·12
MgO	·17	·50	·43	1·13
CaO	·87	1·27	1·47	2·86
Na_2O ...	2·90	3·66	5·25	4·78
K_2O	5·82	4·92	3·14	2·15
H_2O — ...	·04	·03	·16	·06
H_2O + ...	·23	·46	·40	·60
TiO_2	·24	·48	·11	·31
P_2O_5	·07	·17	·57	·15
CO_2	*Nil*	·02	·20	·04
FeS_2	*Nil*	*Nil*	*Nil*	trace
S	...	...	·13	...
			99·61	
Less F ...	...	...	0·06	...
	99·91	100·71	99·55	99·66
Sp. Gr. ...	2·63	2·66	2·65	2·68
Mode ...	Microcline Quartz Oligoclase Biotite Magnetite Limonite Sphene Apatite Riebeckite (?) Garnet (?)	Microcline Oligoclase Quartz Orthoclase Biotite Hornblende Sphene Magnetite Calcite Apatite Riebeckite	Oligoclase Quartz Microcline Hornblende Epidote Biotite Apatite Magnetite Calcite Sphene Fluorite Limonite Kaolin	Oligoclase Quartz Microcline Biotite Hornblende Epidote Muscovite Zoisite Sphene Magnetite Ilmenet Apatite Limonite Zircon
Class ...	I.—4 (3), 1 (2), 3 Liparose, near Alaskose and Toscanose	I.—4, 1(2), 3 Liparose, near Toscanose	I.—4, 1, 4 Kallerudose	I.—4, 2, 4 Lassenose
Analyst ...	D. G. Murray.	D. G. Murray.	H. P. Rowledge.	J. N. A. Grace.

In addition to the magnetite and manganese referred to in the report by Mr. Woodward, previously quoted, ilmenite (titanite of iron) occurs in some portion of Fraser's Range, for a sample of this was handed to me while at the head station. No opportunity, however, presented itself of making an examination of the locality from which the mineral was obtained.

4.—THE GYPSUM DEPOSITS AT DUKIN, AVON DISTRICT, SOUTH-WEST DIVISION.

(F. R. Feldtmann.)

Geography.

Location.—Dukin Siding is situated in the Avon District on the Wyalcatchem-Mount Marshall branch railway about 115 miles NE. of Perth, as the crow flies, and approximately 159 miles by rail. It is close to the southeastern edge of Cowcowing Lake, a large and, in this area, comparatively well-defined salt lake, extending in a southwesterly direction.

Mineral Claim 29H—the only area being worked during my visit—is situated on the southeastern edge of the lake from half a mile to a mile north of the siding. It is within Location 16454,† formerly held by the Plaster of Paris and Gypsum Company, Ltd., and adjoins part of the western boundary of Lot 124.

Topography and Vegetation.—The surrounding country is gently undulating, there being no hills of any size. There is, for the most part, a gentle slope towards the lake, but in places the lake is fringed by fairly steep, but comparatively low, banks.

The chief timber is salmon gum, which is fairly thick on those areas left uncleared. Some small areas of ti-tree occur along the edge of the lake.

Geology.—The country is largely covered by detrital material, the surface soil being of a fairly light sandy character. A few fragments of travertine were seen in places.

The underlying rock is, without doubt, granite, but only one small outcrop, on the northwest shore of the lake at a point 3¼ miles NW. of the siding and immediately north of the re-entrant angle of Location 18932, was seen. This outcrop was in the form of a low breakaway, and consisted of much decomposed granite, showing incipient laterisation at the surface.

The Gypsum Deposits.—Cowcowing Lake consists, in the vicinity of Dukin, of a number of small clay pans, either more or less oval in shape, or forming narrow winding channels, of which one follows the southeastern edge of the lake. These clay pans are separated by low irregular banks composed chiefly of fine clay and sand, with some gypsum in the form of crystals or the earthy variety kopai, and in places small gasteropod shells and fragments thereof.

The bed of the clay pans consists of a dense, fine, puggy grey clay, extending in potholes in Mineral Claim 29H to a depth of about five feet. A pothole a few feet from the edge of the lake shows the material underlying the grey clay to consist of clay of paler and more reddish colour, containing a large proportion of quartz grains. This deposit was exposed to a depth of about four feet, but no information was available as to its total depth.

The gypsum deposits appear to be chiefly confined to the southeastern side of the lake. In the dry season the floor of the clay pans on this side of the lake, with the exception of the lowest-lying portions, is covered by a layer of gypsum, mainly of the seed type. This layer ranges in thickness from a mere film to nearly a foot. The main deposit on Mineral Claim 29H is usually from four to six inches in

* Lands and Surveys Department Lithograph 18/300. † *Vide* Lands and Surveys Department Lithograph 56/80.

thickness. The surface portion of the deposit is fairly white and pure, but the lower portion contains a proportion of fine clay, increasing with the depth. As a rule, only the top two inches is taken off, and this is roughly washed before bagging for transit.

The lowest portions of the clay pans are usually covered by a thin film of salt.

The water level in the dry season is approximately one to two feet below the surface. The water is extremely salt, and in places contains gypsum in solution, as may be seen by the growth of gypsum on grass tufts blown into the potholes.

The extent of the gypsum deposits is said to vary from year to year. One portion of the southeastern channel which was said to be covered by a salt film the previous year was, at the time of my visit, covered by a layer of coarse seed gypsum.

A few shallow potholes near the northwest corner of the claim, in a low bank forming the western edge of the southeastern channel, disclosed a layer, at a depth of about 1½ to 2 feet, containing, in some of the potholes, fairly well developed, usually single, crystals of clear gypsum up to 2½ inches in length and 1½ inches in diameter. Some of the crystals are markedly elongated, one, two inches in length, having a diameter of not less than one-fifth of an inch. In other potholes the gypsum is of a rounded flake-like form.

In places, on the southeastern edge of the lake, are irregular narrow banks of seed gypsum, evidently wind-blown. These banks are probably several feet thick in places. The gypsum composing them is cleaner than that on the floor of the clay pans, but the presence of numerous small bushes, the roots of which penetrate the gypsum, would interfere with the working of this deposit to some extent.

In a few places, for example near the northwest and southwest corners of Lot 124, there are fairly high dunes on or near the edge of the lake. Unlike the dune fringing the southeastern portions of the gypsum lakes at Hine's Hill, where the composing material consists largely of seed gypsum, these dunes are composed mainly of kopai, that composing the dune near the southwest corner of Lot 124 being almost pure. A shallow pothole near the bottom of the western slope of this dune shows the kopai, at this point, to be underlain by discoloured seed gypsum, apparently to a depth of several feet.

As at Hine's Hill, the position of the dunes and of the low banks of seed gypsum indicates that the prevailing wind is from the northwest.

About 1½ miles SW. of Mineral Claim 29H and 24 chains WNW. of the southwest corner of Lot 125, a deposit characterised by unusually large gypsum crystals has been cut in a shallow trench at the foot of a low bank on the lake. The gypsum is distributed as large crystals of arrowhead or of elongated spearhead form, or as irregular aggregates of these forms, mostly arranged with their longer axes nearly vertical, in a band of very puggy grey clay. This band is from 1½ to 2 feet thick and is covered by an overburden, from a few inches to about 2 feet thick, of fine, dusty clay. The base of the gypsum deposit is at about water-level in the dry season. The deposit is underlain by dense, puggy clay. The largest mass of gypsum seen in this deposit was about 2½ feet in length, and was composed of two imperfect crystals, joined irregularly. The crystals are mostly imperfect, but one nearly perfect arrowhead measuring about 11½ inches in length by 5¼ inches in maximum width was obtained, and also a crystal of the spearhead type measuring 16¾ inches by a little more than one inch. The crystals are fairly clear, but some are stained slightly brownish, probably by organic matter, and contain small inclusions of clay, arranged parallel to the re-entrant angle of the crystals.

Owing to the difficuly of working this last deposit, and particularly of separating the crystals from the dense, puggy clay, it is unlikely that it will prove payable.

5.—RECENT DISCOVERIES AND DEVELOPMENTS AT THE NORTH END, KAL GOORLIE.

Including the Surprise North Cross Lode and the Paymaster Lode.

(F. R. Feldtmann.)

During the recommencement of the Kalgoorlie survey, it was considered advisable to examine some of the work done at the North End since the survey by myself of that area, the results of which were given in Bulletins 51 and 69 of the Geological Survey, and since my brief visit in 1917. It was hoped that an examination of the recent work, in particular that in the vicinity of the largest albite porphyrite dyke (*vide* Bulletin 69, page 39), which runs through the middle of the Younger Greenstone belt, would supply information that was not available at the time of my original survey. The area occupied by, and that for some distance east of, this dyke, particularly to the north of the Transcontinental Railway, is almost completely obscured by superficial deposits, and at the time of the original survey but few shafts in that area were of sufficient depth to give any indication as to the nature and relative positions of the rocks. From the appearance of the material on some of the dumps north of the Kanowna railway, the presence of a second albite porphyrite dyke, east of the main dyke, was suspected, but no data were available as to its strike and extent. The mining work done since my survey affords a considerable amount of information, still unfortunately incomplete, as to the occurrence of this dyke, as well as of the main dyke and associated lodes.

The leases examined in most detail were the Surprise North G.M.L. 5193E and the Paymaster and Paymaster Proprietary G.M.Ls. 5333E and 5167E, adjoining the Surprise North on the northeast and southeast respectively. The northwestern boundary of the Kanowna Railway Reserve forms the southeastern boundary of G.M.L. 5193E, and that of the Transcontinental Railway Reserve, the southeastern boundary of G.M.L. 5333E. The southeastern boundary of G.M.L. 5167E runs a few feet northwest of the Transcontinental Railway Reserve.

The Surprise North G.M.L. 5193E.

(Plate I.)

General Geology.—This lease, which is held by Mr. M. Hartigan, covers part of the southern portion of former G.M.L. 4461E (4419E), Lone Hand No. 2 (Bulletin 51, pages 42 and 43; Bulletin 69, Plate XIII, sheet 10), and part of the western portion of former G.M.L. 4146E (1121E), Devon Con-

PLAN AND SECTIONS OF THE WORKINGS ON THE SURPRISE NORTH CROSS LODE.

PLATE I

KALGOORLIE, EAST COOLGARDIE G.F.

Feet 0 20 40 60 80 100

Note : on account of their overlap the 125 Feet and 164 Feet levels are shown separately in plan.

PLAN

125 Ft. Level

General trend of longitudinal section

164 Ft. Level

CROSS SECTION

Laterite

LONGITUDINAL SECTION

Lode largely stoped out hereabouts

Top of ladder-way 36'

92'9"

125'3"

164'3"

Talc rock

Carbonaceous sericitic rock

Albite porphyrite

Pass

NW. Drive

S. Drive

Flat

Stope

Shear Winze

Shear zone

Fuchsite rock

Shear with fuchsite

Lode ?

SE. Drive

Rise

Talc rock

Albite porphyrite face

Lode

Shear zone

Note : in this section the boundaries of the porphyrite dykes, the lodes and shear zones, are shown at their junctions with the footwall of the Cross Lode.

F.R.F.

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

sols Consolidated. The main albite porphyrite dyke runs through the middle of the lease. That portion of the lease west of the dyke is partly in talc-chlorite-carbonate rock—derived by incipient vein alteration from hornblendite—partly in quartz dolerite greenstone. The boundary between these two rocks, which both represent portions of the great dyke of Younger Greenstone, is indefinite. That portion of the lease east of the main porphyrite dyke is in talc rock, but an undetermined area of albite porphyrite which may represent a cross band joining the main dyke with the dyke to the east, or be a faulted portion of the eastern dyke, occurs near the northeastern boundary of the lease, a short distance northwest of the Kanowna Railway Reserve.

At the surface, the higher ground in the northern portion of the lease is covered by a deposit of dense laterite. In the lower-lying ground, the rocks near the surface, in addition to ordinary weathering, are largely obscured by detrital material.

The Lodes.—The southerly continuation of the Mystery-Lone Hand line of lode, at or near the northeastern boundary of the main porphyrite dyke, runs through the lease. This lode, which is usually at the junction, but in places is entirely in the porphyrite, is on the whole ill-defined and variable in width and gold content. The workings on this lode in the northern portion of the lease were described in Bulletin 51 (page 43 and figure 23).

A lode of unusual type, discovered since the previous survey, is the Cross Lode, worked from a hauling shaft, approximately 200 feet WNW. of the east corner of the lease. This shaft follows the lode on the underlay—the general dip being approximately 78°—to a vertical depth of 164 feet from the surface, levels being driven at depths of 93 feet, 125 feet, and 164 feet.

A total length of 107 feet of driving—the last 9 feet trending NNW.—has been done west of the shaft at the 164 feet level, and 15 feet east of the shaft. At the 125 feet level, drives have been put in west for 175 feet and east for 163 feet. At the 93 feet level the east drive has a length of 17 feet. The west drive at this level was examined, but, as the stoping between it and the 125 feet level rendered it difficult to survey this drive single-handed, was not surveyed; it is, however, probably fully 140 feet in length. In addition, an intermediate level between the 93 feet and 125 feet levels has been driven east for a considerable distance.

A very considerable amount of stoping has been done between the 125 feet level and the surface west of the shaft, and between the 125 feet level and the intermediate level east of the shaft.

The Surprise North Cross Lode differs from the other lodes yet found at the North End in its strike, direction of dip, and enclosing rock. Although lines of weakness striking nearly east and west are common at the North end, these, with the exception of this lode, are seldom more than one or two inches in width, are filled by typical vein quartz of the fissure type, and, with few exceptions, dip north, and occur mainly in the greenstones. The strike of the cross lode is, on the average, a few degrees north of west. The dip south at angles ranging, so far as determined, from 70° to nearly vertical, the western portion of the lode appearing on the whole to be somewhat steeper than the eastern. The average dip is probably about 78°. The lode extends from the western edge of the main albite porphyrite dyke—cutting completely through that dyke—to the western edge of the more easterly dyke, the total length being approximately 400 feet. The lode has been formed by intense shearing followed by vein alteration, now consisting of a shear zone of more or less schistose rock with veins and lenses of metasomatic quartz, of a brownish grey colour in the oxidised zone, the middle of the lode being, as a rule, occupied by a main quartz vein.

The lode, where examined, ranges approximately from 1 foot 3 inches to 4 feet 6 inches in width, averaging probably between 2 feet 6 inches and 3 feet, but in places near the surface the lode has been stoped over a greater width, this being probably due to secondary impregnation in the zone of oxidation. The main quartz vein ranges from a thread to 1 foot 3 inches, the greatest width seen being in the shaft about 10 feet above the 125 feet level.

Although the lode occupies a zone of intense shearing, faulting of the porphyrite dyke along it is not noticeable. Striae on the footwall of the lode, in the talc rock immediately east of the main dyke, pitch east at about 50°, and apparently the hanging-wall portion has moved in this direction relatively to the footwall.

The lode itself is completely oxidised even at the 164 feet level, but from 17 to 18½ feet, and also from 20½ to 28 feet, from the face of the west drive at this level, hard compact fuchsite-carbonate rock, associated with a shear zone striking NNW. is noticeable on the south side of the drive, and from 19 to 27 feet on the north side. At the 125 feet level, the wall rock, to about 110 feet west of the shaft is too completely decomposed for determination, but west of this point the rock is distinctly fine-grained albite porphyrite, the porphyrite continuing to a point about 156 feet west of the shaft. West of the point where the porphyrite is first determinable, the lode shear gradually dies out, and near the western edge of the dyke is represented only by the hanging-wall and footwall planes, about 2 feet apart, a vein of oily white quartz up to 3 inches in width occupying the hanging-wall plane. West of the porphyrite is a band —about 10 feet wide in the drive—of weathered carbonated sericitic rock, evidently derived from the talc rock, which, in a partly oxidised form, adjoins it on the west. At the 164 feet level the lode does not appear to extend so far west, and is very narrow for the last 30 feet of the drive, being represented near the face only by a single plane, which at the face is practically vertical. In the east drive at the 164 feet level, the lode is in the porphyrite, which, however, is indeterminable for the most part, for about 97 feet, at which point it enters the talc rock. In the talc rock it consists of a somewhat ill-defined shear zone without quartz. The drive starts to bend north about 24 feet east of the junction of the two rocks and leaves the lode at 30 feet east. At about 46 feet east of the edge of the main dyke the drive again enters porphyrite in which it continues to the face—a distance of about 20 feet. This porphyrite, which is hard and compact and comparatively unweathered, may either represent a faulted portion of the Paymaster dyke or be a tongue joining that dyke with the main one. The boundary strikes northwest and dips southeast at 87°.

The lode cuts and is cut by numerous shear zones or lodes striking in the normal northwesterly direction. Two of these have been driven on—one, consisting of a narrow shear zone with stringers of milky quartz, about 40 feet west of the shaft, has been driven on north for a fair distance at the 93 feet level. The shear zone is apparently younger than the cross lode as its planes cut those of the latter, and if auriferous at all is evidently of low grade. The other shear zone, which is at the shaft at the 125 feet level and about 20 feet west at the 164 feet level, is from 1½ to 2 feet in width, and strikes between NW. and NNW. The dip is steep, ranging from about 70° SW. to nearly vertical. At both levels this lode or shear zone has been driven on southeast for a few feet. The shearing is more marked than in the first shear zone and the lode is apparently cut by, and is older than, the cross lode, but the gold content, if any, is low.

A few feet west of the eastern margin of the main dyke at the 125 feet level is a lode or shear zone, about 5 feet wide, striking northwest and dipping southwest at a steep angle. This lode contains stringers of quartz similar to those of the cross lode and apparently formed at the same time. Some of the planes of the cross lode cut through those of this lode. This lode is very probably the southerly continuation of the Mystery-Lone Hand lode, but appears to carry little or no gold at this point.

Mention should be made of a flat fault or shear zone, striking almost due north or slightly east of north and dipping east at about 45°, from about 103 feet to 110 feet west of the shaft at the 125 feet level and from 59 feet to 62 feet west at the 164 feet level, at which level it is better defined. It cuts through and faults the cross lode slightly. It probably belongs to the same period as the flat fault in the Paymaster hauling shaft at the roof of the 80 feet level.

Official returns for the lease to the end of March, 1925, give a total of 937.93 tons of ore treated for a return of 1,359.36 fine ounces of gold, but the amount of stoping done indicates that a somewhat greater tonnage has been taken out, returns for portion of which may be included in those for earlier leases. The rate per ton—1.45 fine ounces—is unusually high for a lode at this end of the field, particularly considering the nature of the enclosing rock. The gold content is probably patchy, but in the absence of work below the oxidised zone it is impossible to determine what influenced its distribution. The well-defined character of the lode and the high gold content shown by the returns give promise of payability at depth, despite the usually unfavourable nature of the enclosing porphyrite.

The Paymaster G.M.L. 5333E and Paymaster Proprietary G.M.L. 5167E.

(Plate II.)

The rocks within these two leases are almost entirely obscured at the surface by superficial deposits, and below these are weathered to a considerable depth—about 170 feet in the Paymaster main workings. In addition to normal weathering, incipient laterisation appears to have taken place to a considerable depth in places.

The second albite porphyrite dyke, the western boundary of which is in the vicinity of the main working, situated from about 100 to 140 feet NE. of the main dyke, runs through the western portion of the Paymaster lease. The general strike of this dyke appears to be about N. 30° W., and the dip probably about 85° WSW. The maximum width is probably about 180 feet. The remainder of the lease is in the talc rock.

The only places where the western boundary of this porphyrite dyke can be determined with any certainty are the Paymaster main workings and those from a shaft—known as the "Green Shaft" from the pale emerald-green colour of the dump—situated 120 feet SE. of the Kanowna railway line and about 190 feet SE. of the Paymaster hauling shaft. In the Transcontinental railway cutting the rocks along the line of the dyke are too completely weathered for determination. From an old shaft on the Paymaster southwestern boundary, 220 feet from the west corner of the lease, a crosscut, now inaccessible, was driven east for 50 feet. This crosscut, which is in completely weathered rock, does not appear to have cut the porphyrite, but from the material on the dump it is probable that the face is very near the western boundary of the dyke.

The position of the eastern boundary is even more uncertain. In a shallow shaft 200 feet ENE. of the Paymaster hauling shaft the rocks are too decomposed for determination, but it is possible that a shear zone, striking about N. 25° E., on which the shaft has been sunk, marks the eastern boundary of the dyke. The only point where this boundary is definitely determinable is in a crosscut driven SW. for 77 feet from an old shaft 300 feet N. of the west corner of the Paymaster lease. This shaft was recently reopened by Messrs. Baudinette and Cousins, and continued to a depth of 58 feet. The crosscut was driven from the bottom of the shaft in the hopes of cutting the northerly continuation of the Paymaster lode. The eastern boundary of the dyke was cut 68 feet west of the shaft, and the crosscut continued in the albite porphyrite for a further 9 feet. About 250 WNW. and 340 feet NW. of this last shaft, and about 50 feet and 40 feet, respectively, east of the Broadarrow Road are two old shafts, both in the talc rock. The dyke should, on its strike from Baudinette and Cousin's shaft, pass between these two shafts, if it continues so far north, but must be narrower than to the south.

G.M.L. 5167E is almost entirely occupied by the main porphyrite dyke, except for a strip of talc rock along its northeastern boundary.

The Ore Body and Workings.—The Paymaster hauling shaft, which has a vertical depth of 160 feet, is situated just within the Kanowna Railway Reserve immediately east of the junction of its northwestern boundary with the southwestern boundary of G.M.L. 5333E. An air shaft and travelling way, 74 feet in depth, is situated 125 feet south of the hauling shaft, with the 80 feet level from which it is connected, and within G.M.L. 5167E and the southeastern portion of the Railway Reserve. The Green Shaft, already mentioned, is 100 feet ESE. of the Air Shaft; it has a vertical depth of 77 feet. In addition, there are a number of shallow shafts in the eastern portion of the Paymaster lease, mostly sunk in the early days of the field and now inaccessible.

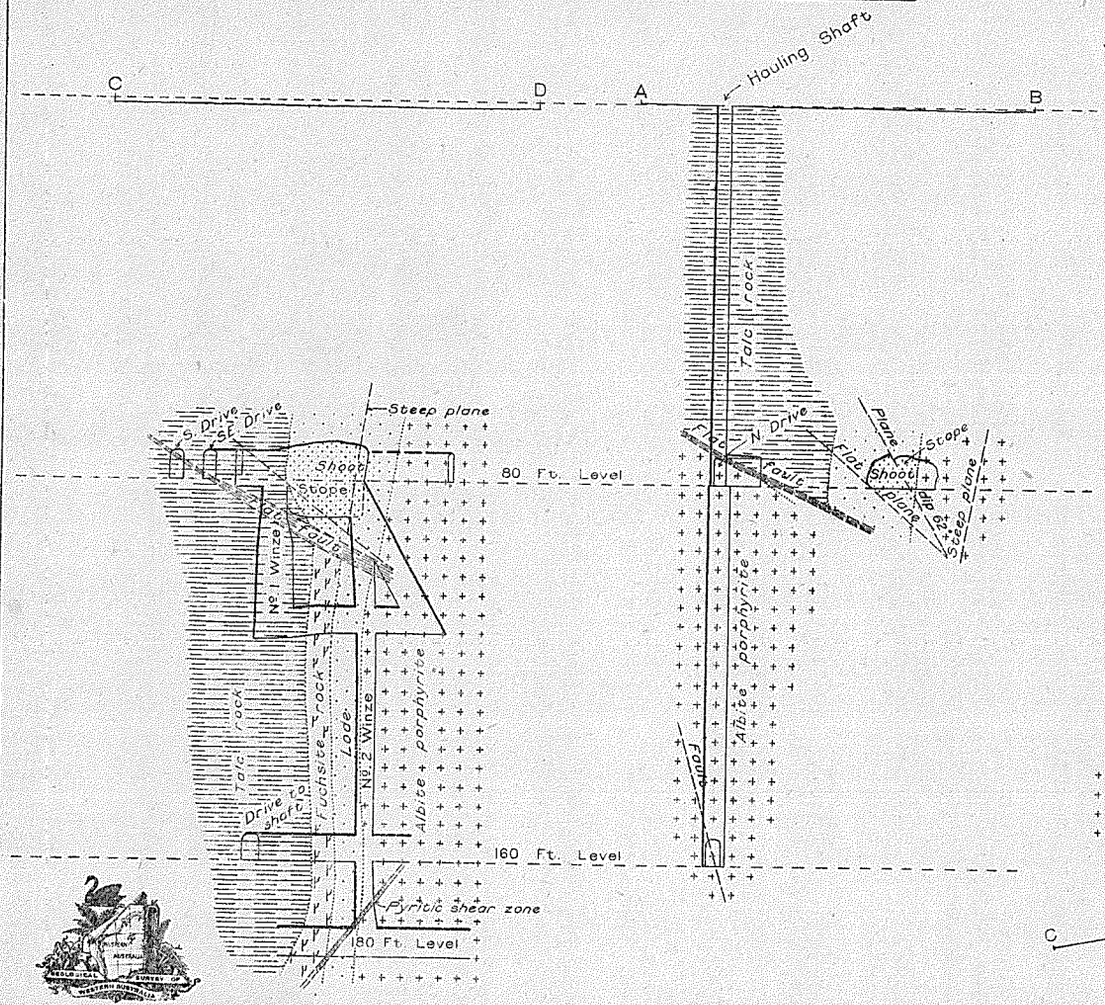
The Old Thunderbolt main shaft, now covered by the Transcontinental railway embankment, is situated about 90 feet south of the south corner of the Paymaster. From this shaft crosscuts extend west

KALGOORLIE, EAST COOLGARDIE G. F.

PLATE II

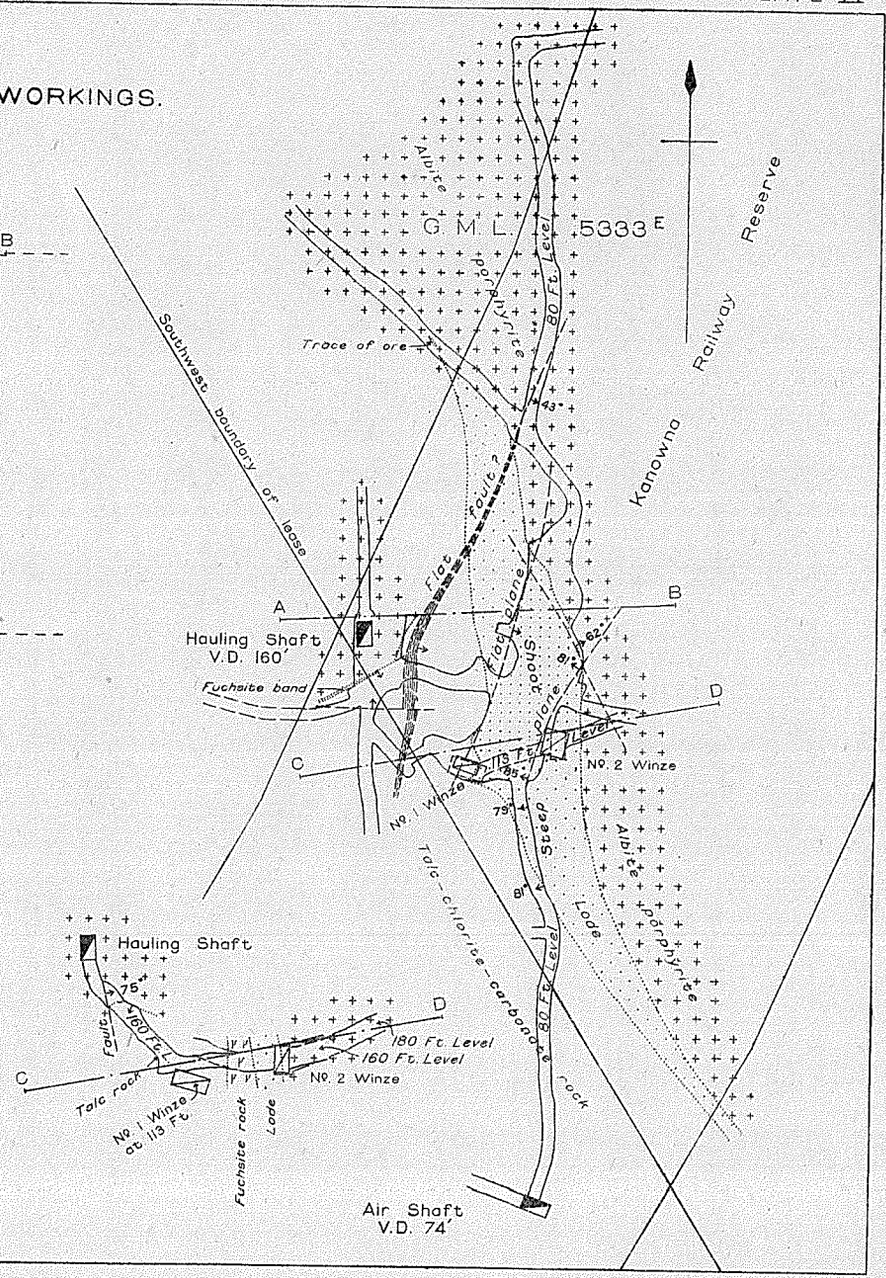
PLAN AND SECTIONS OF THE PAYMASTER MAIN WORKINGS.

Feet 0 20 40 60 80 100



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

F. R. Feldtmann.



for about 130 feet and east for 200 feet, at a vertical depth of 200 feet. These crosscuts, which must cut both porphyrite dykes and would have thrown much light on the geology of this area, were unfortunately inaccessible at the time of the original survey.

The main workings are those at the 80ft. level of the hauling shaft. From this shaft drives extend north and south for about 30 feet and 45 feet respectively, both being now partly mullocked up. The north drive is in porphyrite, which extends for 9 feet south of the shaft, but the porhpyrite ends on a flat shear or fault zone at the roof of the plat, above it being talc rock. The south drive is in talc rock. From a point in the south drive about 15 feet south of the shaft, a crosscut, now mullocked up, has been driven westward for about 35 feet, partly on what is probably the easterly extension of the Surprise North Cross Lode, here represented by a thin band of fuchsite-quartz rock, carrying pyrite, at the junction of the porphyrite and talc rock. The crosscut was started in the talc rock, but was said to pass into the porphyrite.

From a point 6 feet south of the shaft a crosscut extends east for 58 feet. In the western portion of this crosscut, in talc rock, was an irregular thin seam, with quartz in places, carrying gold. This may be the continuation of the Cross Lode. The main ore body was cut in the crosscut from 25 to 56 feet east of the south drive. It consists at this level of fuchsite-bearing kaolinic material with, in places, ferruginous patches. East of the ore body the crosscut is in kaolinised porphyrite. From the crosscut drives were extended north and south on the ore body, which has been largely stoped out at this level, the stope extending for about 18 feet south and 40 feet north of the crosscut and for a maximum depth of 8 feet below the floor of the level, but only a short distance above the roof in places.

The south drive off the east crosscut connects with the air shaft. This drive leaves the ore body about 41 feet south of the crosscut, or 23 feet south of the stage, and continues in talc rock—the lode lying to the east of the drive.

The stope passed out of ore at about 30 feet, and 20 feet north of the crosscut on the west and east sides, respectively, and north of these points was in highly ferruginous matter. From a point 41 feet north of the crosscut the drive was continued northwest for 85 feet. This portion of the drive is entirely in weathered porphyrite, the only traces of ore occurring on the west side from 44 to 47 feet from the face, and in the roof of the drive at 40 feet from the face. As no payable body of ore was found in this drive, another drive was put in due north, from a point 18 feet northwest of the stope, for a distance of 85 feet and a crosscut driven east for 18 feet from the end of the drive. Both are entirely in weathered porphyrite.

Two winzes have been sunk in the southern portion of the stope. The No. 1 winze at the southwest corner of the stope has a vertical depth of 32 feet. It is entirely in talc rock. At the bottom a crosscut connects with the No. 2 winze. This crosscut is partly in decomposed fuchsite-carbonate rock, partly in decomposed porphyrite, the lode being at the junction of the two rocks. The crosscut extends east of the No. 2 winze for 15 feet, in porphyrite.

The No. 2 winze is on the east wall of the stope, from 6 to 12 feet south of the main east crosscut. This winze was started with an easterly underlay, but passed out of the ore body and was restarted vertically and sunk to a depth of 180 feet from the surface, or 92 feet below the floor of the stope. It is partly in the porphyrite and partly in the lode which is very ill-defined. From this winze crosscuts have been driven at depths of 160 feet and 180 feet from the surface. At 160 feet the crosscut was driven west for 26 feet with the intention of connecting with the hauling shaft, but as a result of my survey was turned northwest from this point, and the shaft reached after driving a further 30 feet. Porphyrite was entered about 11 feet from the shaft, the margin striking approximately WNW. at this point. At the 180 feet level from the winze crosscuts extend west for 19 feet and east for 22 feet. The east crosscut is entirely in dense, hard, practically unweathered albite porphyrite, the west crosscut mainly in fuchsite-carbonate rock, carrying some porphyrite. The lode is particularly ill defined at this level, and the gold content low.

The geological structure in the vicinity of the hauling shaft at the 80 feet level is complicated. As stated, the north drive from the shaft is entirely in porphyrite, which extends to about nine feet south of the shaft, its junction with the talc rock striking approximately ENE. The west crosscut is also stated to be mainly in porphyrite. From about 5 feet and 8 feet above the floor of the level, however, the shaft passes into talc rock, the junction, which is marked by a shear zone about a foot wide, striking about NNE. and dipping ESE. at a very shallow angle, the dip ranging from about 30° to 40°. What is probably the same shear zone occurs at the junction of the northwest and north drives from the stope, the dip here being 43°. This remarkably flat junction marked by shearing is highly suggestive of a fault, particularly as what appears to be the southwest boundary of the same mass of porphyrite is cut in the east crosscut at the 125 feet level from the Surprise North hauling shaft. The position of the porphyrite in the crosscuts from No. 2 winze, below the possible fault, indicates, however, that the movement along this fault cannot have been more than two or three feet at most, unless block faulting has taken place, with another nearly vertical fault, along the southern boundary of the porphyrite south of the hauling shaft. Against this is the occurrence of traces of ore in the northwest drive from the stope, unless the lode is younger than the faulting, or the ore is of secondary origin. An alternative solution is that this body of porphyrite is an original tongue connecting the Paymaster porphyrite dyke with the main dyke. Against this last suggestion is the flat dip of the upper boundary which is most unusual for the Kalgoorlie field. Further evidence is necessary to solve this problem satisfactorily.

Conclusions and Recommendations.—There is little doubt that the lode or shear zone worked at the 38 feet and 77 feet levels from the Green Shaft is the southerly continuation of the Paymaster lode. At the 38 feet level it consists of a shear zone, about 3 feet in width, stained pale-green by fuchsite. It is nearly vertical, with a slight dip southwest. It appears to have contained little or no gold in these workings.

In the Transcontinental Railway cutting, immediately east of the projection of the line of the Paymaster southwest boundary, is a shear zone, about

12 feet in width, striking in the direction of the Green Shaft. This may be the southerly continuation of the same lode, in which case it does not follow the southwestern boundary of the porphyrite for any great distance, as is also suggested by the trace of ore in the northwest drive in the Paymaster main workings.

The comparatively short length of the ore body in the main workings, and the fact that the lode is unpayable in those of the Green Shaft suggest two alternatives. Either the supposed lode is a barren shear zone of later origin than the true lodes, and is of the same type as the barren shear zones of the Hannans Reward and other mines (*vide* Bulletin 69, pages 76 to 81 and pages 98 and 101), and the gold in the shoot at the Paymaster 80 feet level has been leached by surface solutions from the eastern portion of the Surprise North cross lode or parallel auriferous quartz leaders; or it is a true lode and the gold has been deposited from deep-seated solutions with concentration at the junction with the cross lode, the extent of the shoot being possibly later modified by surface solutions.

In the first case the shoot is not likely to extend below the zone of oxidation. In the second case the gold will extend to greater depths, but the shoot will most probably be restricted more closely to the junction of the two lodes. As the cross lode has a distinct southerly dip, the pitch of the shoot will be to the south at a steep angle. Short drives north and south might be put in at the 160 feet immediately west of No. 2 winze, to test whether a shoot occurs at this level.

As the shoot at the 80 feet level extends diagonally across the northern portion of the stope, and traces of ore occur in the northwest drive, a crosscut might be put in west from the northwest corner of the stope for a distance of 12 or 14 feet. to see whether payable ore extends in this direction.

As already stated, the south drive between the stope and the air shaft leaves the lode about 23 feet south of the stope. A drive put in in a southeasterly direction from a point about 20 feet south of the stope would test the lode south of this point. A crosscut or borehole might also be put in east for 10 or 12 feet from this point, to test the width of the lode and its gold content. The lode should lie from about 40 to 45 feet northeast of the air shaft, but it is doubtful whether it will be payable so far south. Should the lode prove payable in this direction a drive continued south would, if deepened 4 or 5 feet, connect with the workings from the green shaft.

Official returns for the Paymaster G.M.L. 5333E to the end of March, 1925, give a total of 393.80 tons of ore treated for a return of 161.01 fine ounces of gold—a rate of 0.41 fine ounces of gold per ton.

Other recent work at the North End.

Surprise South G.M.L. 5244E.—During my visit work was being done at a shallow depth on a narrow steeply-dipping lode southwest of the Kanowna railway and near the southwest corner of G.M.L. 5244E, which adjoins G.M.L. 5167E on the southwest and covers part of the old Milanese G.M.L. 4293E (Golden Dream G.M. Company, No-Liability). This lode was being worked close to its junction with a jasper which could be seen at the surface during my first examination of this area, but was later covered by the tailings from the Golden Dream treatment plant. The lode, which is fairly well defined, appears to be the southerly continuation of the Golden Dream middle lode, worked from the old hauling shaft, north of the Kanowna railway, to a depth of 184 feet. At the time of my first survey the lode had been driven on at the 82 feet level from this shaft for a distance of about 80 feet, and at the 112 feet level for 120 feet. The Golden Dream lodes were all of low grade, but the oxidised ore was easily treated.

Fair Play G.M.L. 4069E (Bulletin 69, Plate XIII., Sheet 17, and Fig. 16).—Descriptions of the ore bodies and workings on this lease, formerly G.M.Ls. 4052E Fair Play, and 4063E Fair Play Extended, were given on pages 67 to 70 and 135 to 136 of Bulletin 69, and on page 14 of the Annual Report for 1917. Since the examination of this mine in 1917, some work has been done on a small cross shear zone, parallel to the "Green Shear Zone" and that to the south, at its junction with the main lode. The new cross shear zone is south of those previously worked, and a few feet north of the hauling shaft at the 107 feet level. It has been worked from a short crosscut north of the shaft, and followed in a winze for 10 or 12 feet below its junction with the lode. A small patch of good ore was obtained at the junction. The lower portion of the winze appears to be east of the main lode which is ill-defined south of the junction.

In addition to this work, about 40 feet of driving has been done south of the hauling shaft at the 197 feet level without, however, discovering payable ore. This drive appears to be on one of the barren shear zones of later origin than the lodes, and not on the true lode. This shear zone, which is highly carbonated, but contains practically no pyrite, is identical with the supposed northwest branch of the lode which cuts the true lode about 20 feet north of the shaft at this level. The true lode strikes approximately NNE. and, unless faulted, should lie a few feet west of the shaft. A short crosscut should therefore be driven west from the shaft. The Green Shear Zone, which forms the southern wall of most of the ore shoots and dips south at about 60° to 65°, passes through the shaft just above the 197 feet level, but is not well-marked at this level. Should the suggested crosscut locate the lode, a winze sunk on the lode with a southerly pitch of about 65° might locate another shoot.

Lucell G.M.L. 5375E.—This lease is situated southeast of Williamstown, and is entirely in the older fine-grained greenstones. It covers the greater portion of former G.M.L. 4499E, Williamstown (Bulletin 69, page 127), and the southern portion of G.M.L. 4550E, Marian Catherine, formerly G.M.L. 4450E, Great Secret (Bulletin 69, page 125). At the time of my visit work was being done near the northern end of the lease on the same lode as, but a short distance south of, that formerly worked by Barrass and Hamilton, with whose drive at a depth of 40 feet the work had been connected. The drives are on a lode which here strikes nearly northwest and dips southwest at about 65° As is usual in the fine-grained greenstones the lode is of low grade.

It was stated on page 125 of Bulletin 69 that this lode should meet the main north and south line, which farther north closely follows the boundary between the Older and Younger Greenstones, at a point approximately 210 feet NNW. of the south corner of the old A.W.A. lease—approximately 34 feet due west of the east corner of G.M.L. 5338E,

Central South, and about 320 feet northwest of the more northerly of Barrass and Hamilton shafts. The ore shoots on the former Creswick and Isabel leases farther north have mainly occurred at the junction of the lodes striking northwest or northnorthwest with the main north and south line and the junction in the Central South is the most likely place along this line for the occurrence of another payable shoot. The surface round this point has been largely obscured by the tailings from the old A.W.A. United plant, and, so far as I know, has never been prospected.

6.—FIELD NOTES UPON THE RESULT OF VARIOUS RECONNAISSANCES AND OTHER EXAMINATIONS.

ALEXANDER G. D. ESSON, M.A. (Aberd.),
Field Geologist.

(a) *The country east, northeast and southeast of Mr. G. A. Moses' "Windsor" Station Homestead, Paynesville, Murchison Goldfield.*

"Windsor" Station, owned by Mr. G. A. Moses, adjoins on its western boundary Paynesville Commonage, and extends eastwards to Rabbit-proof Fence No. 1. Four and a half miles eastwards along the railway line from Paynesville Siding is situate the homestead close to the old abandoned "Windsor" Group of gold mining leases.

Near to this point and slightly east of it, a line running roughly north and south would divide the station into two portions, the eastern portion being mainly granite and the western portion greenstone. A number of prospecting areas and gold mining leases are to be found in the greenstone portion, and these will be fully dealt with in the final report upon Paynesville. It is sufficient to say, meantime, that this greenstone has been examined by the Acting Petrologist, Dr. Larcombe, who has determined it as epidiorite, and believes it to be *contemporaneous with the Kalgoorlie auriferous greenstone.* It is sheared in a north and south direction, a circumstance that is probably attributable to the granite. Reefs follow this main shear direction.

Whilst the writer was engaged in the examination of this portion of the Paynesville greenstone belt, opportunity was taken to examine some more or less new country in the northeast of the granite portion of Windsor Station. In the main this was found to consist of granite with, in places, small inclusions of very much sheared and altered greenstone which could be referred to the Paynesville belt of greenstones. The granite, upon examination by the Acting Petrologist, was found to consist of a large amount of orthoclase felspar, with muscovite, biotite and quartz, and with small quantities of plagioclase felspar. In short, it is a normal granite. There are numerous local variations of composition and form, giving muscovite granitè and muscovite gneiss, biotite granite, pegmatite granite, graphic granite, etc.

Near the juncton of the greenstone, the granite becomes more pegmatitic and contains numerous veins with large plates of white clear muscovite mica. This is particularly the case also south of and close to the Government Well, "Woodley's Soak," where there is a small sheared greenstone inclusion in the main granite mass. It is possible that, if the mica be found sufficiently large in size, a marketable deposit may be found. Some specimens found by the writer were very promising and prospectors might be on the outlook for such a deposit. Considering the cost of transport, etc., small mica lodes are not meantime worth prospecing but, from the indications, it is concluded that some very large mica may be found.

Further to the north and to the east of Woodley's Soak, the granite outcrops as large breakaways whose rugged outlines form a prominent feature in the landscape. They form suitable holding ground for the retention and storage of rain water in the form of large gnamma-holes, and evidently these have been used for that purpose by the aborigines as is evidenced by the signs of native occupation around them. One such gnamma hole was about 30 feet or more deep, and even in very dry seasons was reputed by the aborigines to hold water.

The country between lines of breakaways consists of sandy flats derived from the denudation and weathering of the granite. In suitable basins or catchments it will be found that sand soaks can be obtained in this sandy detrital country. In places the aboriginal has utilised some of these as native wells.

It is not to be expected that gold will be found in this area, but minerals other than gold may be looked for, *e.g.,* tin (cassiterite), molybdenite, hematite, mica, etc.

In one place a small bar of hematite was encountered. The hematite was fairly pure but, from a cursory examination, did not seem to be extensive. Other deposits of the same kind may, however, be found.

Further to the south, particularly below the railway line, the granite becomes more solid and outcrops in the characteristic "tor" and poised boulder form. In places shearing has taken place. There are also many coarse muscovite mica veins, which, also, may be worth prospecting. Only good veins of large mica will be worth while, and they ought to be in fairly soft sheared ground, as overhead expenses will cut down values greatly.

The scrub in the northeast portion of the granite area, near to Rabbit-proof Fence No. 1, consists of mulga, needlebush, occasional belts of sandalwood and solitary kurrajongs. It is particularly thick, and on account of its impenetrability, has been designated "The Dismal Scrub"—a very appropriate name in places where light has difficulty in filtering through. Few people, if any, until recently have been able to penetrate it for any distance. In one place near the Dismal Scrub, a small man-built stone mound was observed, but no identification marks could be found in or near it.

(b) *Two mining areas at Mount Magnet, Murchison Goldfield.*

(1) Richardson and Vidilini's P.A. 970M.

(2) J. A. Combe's "Royal Consols" G.M.L. 1029M.

While the writer was passing through Mount Magnet on 13th February, 1924, he was met by various miners and prospectors, and was asked for advice as well as to make a rough examination of the abovenamed shows. Only a very cursory examination could be made on account of the fact that the writer was proceeding to Paynesville in order to resume his field work there.

(1) Messrs. Richardson and Vidilini were working P.A. 970M, half a mile northwest of Mount Magnet town, and on the site of the old "Speedwell." The area taken up is 18 acres and, if values persist, a lease called "Rich Rock" is to be taken out.

The country rock is sheared epidiorite, similar to that found at Paynesville. The new workings were still in the surface cement and altered surface rock. There are a number of small quartz-hematite bars, much fractured, upon which the workings are situate, and fracturing seems to have been responsible for the gold deposition.

The gold found was extremely rich and coarse, consisting in places of solid plates and of semi-crystalline gold in fractures in the quartz-hematite. It is likely that the gold is secondary, but, nevertheless, it is very rich. It is possible that, from the nature of the occurrence, values will be patchy near the surface but, when found, they will be well worth while.

(2) Mr. J. A. Combe was working "Royal Consols" Gold Mining Lease, No. 1209M, some two and a half miles southwest of Mount Magnet town.

This lease has been successively worked by various parties. It is the original 1055M "Worker" G.M.L., and was held after 1912 as P.A. 807M in 1919, P.A. 826M in 1920, G.M.L. 1190M "Patagonia" in 1920, and 1209M "Royal Consols" from 1923 to present date.

It was not found possible in the limited time to examine all the workings which are somewhat irregular and fairly extensive, but Mr. J. A. Combe, at time of examination, was engaged in developing further a large irregular stoped excavation east of the lode in a crushed contorted black quartz-hematite (or jaspilite?) bar. This bar forms a prominent ridge, and it is banded with alternating vari-coloured bands of quartz, hematite, and possibly limonite.

It is quite evident that there has been a great amount of crushing, and Gibson and Jutson have noted (*vide* Geological Survey Bulletin 59, Misc. Rep. 39), that there is distinct evidence of a fault in the quartz-hematite bar to the east of the workings. Samples of the lode, collected by Mr. Mines Inspector Deeble, upon assay gave returns from 5 dwts. to 18 dwts. per ton.

The faulting and crushing of the quartz-hematite bars seem to be characteristic of the Mount Magnet Centre, and it seems probable that this is intimately associated with the gold deposition.

It is, however, to be noted in the case of the Royal Consols that the gold, which is fine, is found in the crushed zone of the quartz-hematite bar, and it is possible that values may live at depth. This latter is a point that, although possible, can be cleared up only by further exploratory work and a more detailed examination than it was possible for me to give at the time. The full width of the bar and the exact walls of the lode had not been reached. As a *low grade* proposition it may prove worth while exploiting.

To the south of "Royal Consols" Mr. Prospector Bell had found small specimens of gold associated with specks of iron and quartz. This also may be referred to the same bar, or at least to the east fault in the bar and probably, if the fault be followed carefully, small quartz leaders upon it may be found to be the place of origin of the specimens.

Generally in regard to the Mount Magnet Centre, it is to be noted that the auriferous area is of the following character.

(i.) The area consists of a comparatively narrow belt of greenstones of some form of epidiorite, with quartz-hematite bars probably derived from the greenstones.

(ii) The east and west boundaries of the belt are of granite.

(iii.) The gold is associated with faultings and crushings of the quartz-hematite bars, and in all probability will in many cases be found to be very rich and patchy, and in other cases finely disseminated through the crush-lodes.

(c) *Mr. N. Trude's Prospecting Area upon the Magnet-Youanme Road.*

About 29 miles 32 chains from Magnet, upon the Magnet-Youanme Road, Mr. Prospector N. Trude was found at work some 100 feet south of the road upon a quartz-hematite bar running about south-southeast.

The country rock is coarse gabbroid epidiorite much obscured by ironstone gravel, and it is probable that it forms part of the Paynesville belt of greenstones. It has, where seen, a northwest and southeast strike.

The quartz-hematite bar has been fractured and portions of it have been assimilated, breccia-fashion, by a large quartz reef with a southeast strike.

On the north of these Mr. Trude found small specimens consisting of coarse gold with iron-coated and iron-stained quartz. These he traced up to the break where the quartz reef assimilates the quartz-hematite bar, but at the time of examination (February 15th, 1924) no definite ore body had been found.

It is probable that there is here a small patch of values, and that the cause of the gold deposition is the fracturing of the quartz-hematite bar. It is quite possible that other patches may be found, but, judging from what was seen at time of inspection, no extensive deposit may be expected.

(d) *A specimen handed to the writer by Mr. A. Sharpe, Paynesville, and collected at Eelya Hill, near Cue.*

Mr. Prospector A. Sharpe handed the writer for an immediate opinion some specimens of auriferous, cellular, iron-stained and coated gneissic quartz mica schist, which Mr. Sharpe collected in the vicinity of Eelya Hill, about 17 miles eastnortheast from Cue.

By panning, the specimens give about 15 dwts. of gold per ton. Apparently the specimens were found in granite country, and upon examination this fact is verified by the Acting Petrologist, Dr. Larcombe, who reports as follows:—

"The specimens consist of very coarse schistose rock made up of bands of quartz schist, ferruginous quartz, and ferruginous muscovite schist."

The material, then, has come from a shear zone in granite, and this shear zone has formed a suitable channel for the passage of gold-bearing solutions.

In the Annual Report of the Mines Department for 1906, Mr. A. Montgomery, State Mining Engineer, reports:—

"All the way to Errol's the road from Cue passes over granite country, which does not seem at all promising for new discoveries of gold. Almost on the

direct line to Barrambie, however, there has been some little mining at Eelya, about 20 miles from Cue, and some fairly rich crushings are recorded. The veins as yet tried are currently reported to be small and not likely to prove of permanent importance. From the information given to me in Cue about them, I did not think it advisable to go out of my way to see them."

Mr. Mines Inspector Landor also reports much to the same effect but, having visited Eelya, is more hopeful of gold permanence, and says the area is in granite country.

There seems to be very little doubt that the veins from which the specimen came, are in granite country probably highly sheared. That auriferous veins should occur in granites is not unknown, but it is not, nevertheless, common, and the occurrence is remarkable in that respect, as fairly good values have been obtained from similar veins in that district.

Although it is not likely that permanent auriferous reefs or lodes may be found in granite country, without personal examination, it is impossible to give a definite opinion, but it may be noted that the veins, where found, are occasionally fairly rich in gold values.

(e) *Lewis P.A. at Mooletar, 9 miles from Mount Magnet.*

Near to Mooletar Pool and on the south side of the Magnet-Youanmi road, Mr. Prospector H. Lewis has been working a small Prospecting Area, which is somewhat noteworthy in view of the fact that rich gold is here found associated with nontronite, an apple-green, unctuous-feeling, hydrated iron silicate, and a variety of chloropal.

The nontronite has no special economic value, but it is somewhat rare in occurrence, and particularly so in association with gold.

Its occurrence is in the form of narrow veins of no great length and, apparently, of no great depth in sheared epidiorite among the greenstone ridge outcrops, which are a feature of the landscape in this locality.

The gold is found very finely disseminated through the chloropal and also in small coarse fragments. It is found that the value cut out at depth, but the gold gained was extremely rich, and it is possible that more deposits of a similar nature, as well as associated with quartz, may be expected in this locality. There is a line of greenstone hills north of the road where prospecting might be carried on with this idea in view.

PETROLOGICAL WORK.

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

The early part of the year 1924 was occupied in making a detailed examination of the bore cores from the South End of Kalgoorlie. On arrival at Kalgoorlie a complete survey and classification of all the bore holes—18 altogether—was made and a plan prepared, followed by the preparation of a summary of the results of the petrological investigations of the cores. This summary, together with the plan, was completed in June, and was published in the Annual Report for 1923.

Two visits to headquarters in Perth were made. On the first occasion, at the end of May, a conference took place with the Government Geologist as to the preparation of the Annual Report for the year 1923, and also with the field officers regarding the petrological aspects of the work upon which they had been engaged. Preparations were also made for the possible return of Mr. Farquharson, the Petrologist. On the second occasion, during the month of July, I was present at a conference with the State Mining Engineer and Mr. John McDermott, the Superintendent of the Ivanhoe Gold Mine, at the opening of the boxes containing the core from the boring being carried out on the Wiluna Development Syndicate's Lease 6J, at Wiluna, under the supervision of Mr. McDermott. A microscopic examination of the core from the No. 2 Bore from the surface to 539 feet 4 inches was made. The zone of oxidation in this locality is very deep, altered and decomposed rock continuing to a depth of 383 feet. Only one rock section was made from the core at 391 feet; it proved that the country rock was originally a quartz dolerite, quite analogous to the country rock on the "Golden Mile," at Kalgoorlie. It will probably be proved on further microscopic investigation that the lodestuff is a metasomatic product of the quartz dolerite. No further details can be given until the company approves of the carrying out of the assaying and detailed petrological investigation, the results of which should throw much light on the origin and genesis of the ore, the primary origin of the ore in relation to any secondary enrichment, and finally the possible life and continuation of the ore body in the zone of fracture—a factor of great importance where it is proposed to heavily capitalise a mine.

Other work carried out during the year may be briefly summarised as follows:—

1. Reports and determination for the Government Geologist and officers of the Geological Survey.
2. Reports and determination for other Departments as well as for the general public.
3. The supervision and preparation of models for the British Empire Exhibition.

The following are synoptical notes on some of the more important investigations made in connection with items 1 and 2.

The Petrology of Paynesville.—Mr. Feldtmann spent part of his field season at Paynesville in 1923.

The rocks were classified as follows:—

1. Acid igneous rocks.
   - A.—Quartz porphyries and their sheared representatives.
   - B.—Felsite.
2. Basic igneous rocks.
   - A.—Epidiorite (gabbro amphibolite).
   - B.—Micropegmatitic quartz epidorite (micropegmatitic quartz dolerite amphibolite).
3. Zoisite rock.

The Petrology of Youanmi.—The rocks from this district were classified as follows:—

1. Acid igneous rocks.
   - A.—Granite.
   - B.—Aplitic rocks (Alsbachite).
   - C.—Quartz sericite schists.
2. Basic igneous rocks.
   - A.—Coarse-grained greenstones.
     - (a) Epidiorite (dolerite amphibolite).
     - (b) Amphibolite (reconstructed from epidiorite).

B.—Greenstone schists.
(a) Actinolite schist.
(b) Quartz-chlorite schist.
C.—Fine-grained greenstones.
D.—Gabbro (diallagic).
3. Epidosites.
4. Lodestuff.
5. Banded magnetite-quartz rocks.
6. Weathered products:
A.—Massive silicified clay.
B.—Schisted silicified clay.

The Youanmi and Paynesville areas are thus seen to be made up of a complex of acidic to basic rocks and their crushed and metamorphosed representatives.

The gold areas lie in contact zones of more or less sheared greenstone near granite or some grade of acid porphyry, a feature that, as time goes on, should be more clearly recognised by the prospector.

The complete conversion of the greenstones into lodestuff was no doubt brought about by solutions either concomitant with or as an aftermath of the acidic—either granitic or porphyritic—intrusions.

Rocks from Fraser Range and Israelite Bay.—The Government Geologist, during his field trip through the southeastern portion of the State, collected a more than ordinary interesting suite of rocks.

These consisted of garnetiferous pyroxene gneiss, garnetiferous gneiss, biotite norite, gneissic hypersthene gabbro, hornblende microcline granite, and biotite hornblende granite.

The hypersthene, the garnets, and the granulitic and other features of the rocks from Fraser Range make it clear that they form a most interesting series, which in some respects resembles the Charnockites of India and Ceylon, and perhaps the Hyperites of Sweden. This is not the first reference that has been made to these rocks. Dr. Thomson referred to a norite from Fraser Range, and Mr. Farquharson described a garniferous hypersthene gneiss or granulite from Cohn Hill, with an undoubted resemblance to some of the acid varieties in the Charnockite Series from South India.

The whole of the rocks from Fraser Range which have so far been examined, are of igneous origin. It is quite possible that this Charnockite Series may form a valuable addition to our knowledge of the petrography of the Western Australian Pre-Cambrian Areas.

Russell Range.—The specimens from the Russell Range consisted of granulated biotite microcline gneiss, fine-grained aplitic biotite microcline gneiss, and quartz sericite schist. The schists appear to be of sedimentary origin. The degree of metamorphism in these rocks indicates that they probably represent one of the oldest portions of the Western Australian Pre-Cambrian Areas.

North-West Artesian Water—No. 3 Bore, Minilya Station.—In November an examination was made of a set of drillings from No. 3 Bore on the Minilya Station, between the depths of 1,720 and 2,020 feet. The bore contained a large amount of limestone with some mudstone, shale, and fine-grained sandstone. The rock from the bottom was a very fine-grained arkose containing microcline. A descriptive report was prepared and summarised in the following words:—

"There are no geological reasons, judging from the micro-structure of the rock at the bottom of the bore, for stopping the drilling. If large beds of rock like this are encountered, there may be others less clayey, which, provided the intake and rainfall were suitable, as well as the hydrostatic pressure, may contain artesian water."

North-West Artesian Water Basin—No. 2 Bore, Byro Plains.—In the month of December an examination was made of drillings from between 2201 and 2218 feet (bottom) in No. 2 Bore on Byro Plains Station. All the samples contained water-worn grains of sand, which when compacted into rock might easily form a porous sandstone that would hold water. There is no lithological reason for stopping a bore that produced such material as indicated by the samples from this bore.

Emu Mine, Cue.—A set of highly weathered and decomposed samples from the Emu Mine was examined. So far as the extreme alteration of the material would admit of interpretation, the rocks from the centre of the lode, from the footwall, and from the western crosscut indicated originally argillaceous sandstones or graywackes, which, as a result of extreme metamorphism had been converted into micaceous (biotite) quartzitic sandstones.

1/3650: (a "bar" in the footwall) proved to be quartz felspar porphyry—an acid intrusive. It is important to ascertain the relation of this rock to the ore deposits, because, if it were intruded prior to the period of ore deposition the lodestuff will pass through it, perhaps with a change in values. If it is of newer or later origin than the lodes its influence so far as the displacement of the lode is concerned should be determined.

Experience has shown that porphyries of this nature in other mining fields do not occur in very large masses, and as a rule they do not displace the lodes to any material extent.

Surprise Mine, Northampton.—A sample from the Government Mineralogist and Analyst, Dr. Simpson, and a suite of specimens received from the Government Geologist, were examined.

As a result of detailed petrographic investigations, the following classification was put forward:—

1. Acid igneous rocks.
A.—Fine-grained garnetiferous biotite-microcline granite of aplitic texture. [1/3710] (2).
B.—Garnetiferous biotite granite. [1/3715] (7).
C.—Myrmekitic gneissose granite. [1/3711] (3).
2. Basic igneous rocks.
A.—Ophitic gabbro. [1/3716] (8).
B.—Massive chlorite rock (fine-grained greenstone). [1/3714] (6).
3. Ultrabasic igneous rocks.
A.—Talcose serpentine. [1/3709] (1).
B.—Biotitic serpentine. [1/3713] (5).
4. Metamorphic product.
A.—Siliceous epidosite. [1/3717] (9).
B.—Quartz-zoisite rock of aplitic texture.
5. Vein material.
A.—Quartz felspar rock. [1/3712] (4).

The interesting features in these rocks are the garnets with kelyphitic borders in [1/3711] and the myrmekitic intergrowths in the same rock; as well as the curious vein material [1/3712].

Dr. Simpson's quartz-zoisite rock of aplitic texture, with subordinate amounts of muscovite and chlorite, with possibly a little graphite, is of more than ordinary interest. It is desirable that the field relations of this rock be determined at a favourable opportunity. The rock may be of metamorphic origin, but it is open to argument whether, on the other hand, in view of modern research into the production of zoisite, it may be a product of igneous origin.

Rock specimens from Ord River and Oakover River respectively:

Mr. Blatchford, of the State Mining Engineer's Office, submitted two specimens collected by him, one from the Ord and another from the Oakover River, with a view to comparing one with the other. Although these two localities are more than 600 miles apart, it was not possible lithologically to distinguish specimen A (Ord River) from specimen B (Oakover River). Both rocks are creamy-white, dense, and compact, with a hardness of about 3 and a white streak. They each contain curious reddish-brown patches, somewhat elliptical-shaped in cross section, and of similar consistency and hardness to the white material, but with a brownish red streak.

Under the microscope the white portion of the rocks (A and B) is seen to consist essentially of a mass of impure clay, so fine in texture that it can scarcely be resolved with the highest powers of the microscope.

The brownish-red patches are simply ferruginous areas in the clay rock that have been coloured by oxide of iron deposited from iron-bearing solutions that have segregated along these specific areas. The ferruginous patches pass by insensible gradations into the surrounding clay rock. Minute grains of quartz are scattered throughout the oxide of iron, which presents the appearance of a pigment.

In both rocks the original material must have been of the consistency of silt, or finer, and such rocks would be expected to form in quiet water far from the land.

"A" and "B" are alike in the following respects: (1) They are lithologically the same; (2) they were originally of a silty, or finer, nature; and (3) the ferruginous patches in each are quite analogous and of the same origin.

"A" differs from "B" in the following respects: (1) The fact that it contains very minute grains of quartz, which are absent from "B"; (2) the absence of sericite which is abundant in "B"; and (3) the slightly greater hardness and density of "B," which may be due to its intense fineness in texture.

There is no reason why these rocks could not have formed in the same geological period, and under similar conditions.

I have gone into some detail in describing these rocks because there is an important geological problem involved, viz., whether it is possible for the older rocks of the Ord River to be continuous beneath the great Permo-Carboniferous area that extends from the Napier-Oscar Ranges southwesterly to the Paterson Range, a little north of the Oakover River.

Big Bell Mine:

Two samples were submitted from the 50ft. level and one from the south end of the open cut of the Big Bell Mine near Cue, Murchison Goldfield. They all proved to be quartz-muscovite schists.

Griffith's Gold Mine, Coolgardie:

Two of the specimens from the Griffiths Gold Mine, at Coolgardie, consisted of biotitic syenite aplite. The other was a massive actinolite rock. The aplitic and more acid rocks form the ore-bodies of this region. They intrude the greenstones. The acidic dyke rocks present much interest, for they are analogous to similar rocks that produced a lot of gold at Treadwell, Alaska. Some day these dykes at Coolgardie may be tested at depth. There is little doubt that they are of deep-seated origin.

La Fortuna Mine, Balgarrie:

The rocks from La Fortuna Mine, Balgarrie, proved to be of unusual interest in so far as three of them represented the extreme acid and auriferous phase of a granitic magma. They were classified as follows:—

1. Aplitic alaskite.
2. Biotite alaskite.
3. Actinolite alaskite.
4. Massive chlorite rock.

The first three rocks are undoubtedly forms of alaskite, and bear strong petrographical resemblances to those described from Alaska and Silver Peak, Nevada.

Alaskite is a general term, without regard to texture, applied to siliceous end products consisting essentially of quartz and alkali felspar from granitic magmas. It is known that alaskite may pass into quartz through all conceivable gradations, and these occurrences at Balgarrie form no exception to that rule, probably forming the end products of rock segregation in that region. A feature in these rocks (1, 2, and 3) is that in many places the magma became filled with large and contiguous felspar crystals or segregated patches of quartz or of quartz and felspar.

The presence of gold in these alaskites reminds one of the remarkable occurrence at Edna May, where the ore-body was undoubtedly a siliceous end product from some granitic magma.

The massive chlorite rock was lithologically similar to the chlorite rock at Mount Monger. It may have been formed by the breaking down and recrystallisation of the enclosing greenstone under the influence of the alaskite intrusion.

Sponge Spicules in a rock from the Plantagenet Beds, Lower Pallinup River, Plantagenet District, South-West Division:

The Government Geologist submitted a sample (1/3664) collected by him from the lower reaches of the Pallinup River in the Plantagenet District. It consisted of very light, porous, creamy-white sediment of the consistency of silt. It contained very minute irregular-shaped grains of quartz sand. The rock is non-calcareous and gave a poor reaction for alumina. The micro-organisms are present in the form of sponge spicules of the Demospongiae class and tetractinellida order. Other orders may also be present. In one or two places three rays were visible; in others only one ray; but each form contained the typical axial canal. The spicules were distinctly isotropic and consisted apparently of colloid silica.

Rock from a large virgin lode near "The Chimney" at Ajana, near Northampton, South-West Division:

A compact greenish-grey felsitic rock crowded with shapeless areas of a glassy amethystine mineral and very minute metallic-looking black specks. The rock is a garnetiferous felspar porphyry impregnated by exceedingly small flakes of graphite. Microscopic investigations indicated that it is an acid eruptive of igneous origin. It was evidently at one time a felspar porphyry with a few quartz phenocrysts. The base is finely crystalline, extremely altered, and mostly felspathic. It is crowded with shapeless areas of garnet that are much cracked and altered into dirty green chlorite; in fact, in some places the garnets have been almost completely changed into chlorite. Minute flakes of crystalline graphite are distributed throughout the slide.

The supervision and preparation of models for the British Empire Exhibition:

Right up until the first week in February was devoted to the supervision, construction, and preparation of two models made from actual rock taken from the mines on the "Golden Mile." These two models were designed to illustrate the geological structure of the lode formation and their relation to the surrounding rocks of the field, as well as the Oroya shoot, by means of cross sections down to 3,000 feet. A descriptive article was prepared and illustrated by a drawing made by Mr. Higgins of the Mines Office drafting staff. These models attracted considerable attention at the British Empire Exhibition, and it is hoped that when opportunity is favourable, the plan and descriptive account of the models will be printed in pamphlet form. Copies could then be sent to London where they should be instructive to those interested in the great goldfield of Kalgoorlie, apart altogether from their educational and scientific value as a brief resumé of the gold contents and production of some of the greatest lodes in the world, as well as a short description of the geology, history, and origin of the ore bodies.

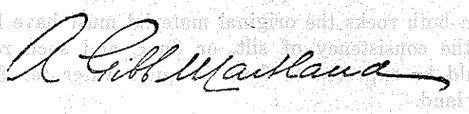
GEOLOGICAL SURVEY MUSEUM AND COLLECTIONS.

The Geological Survey collections remain in somewhat the same condition as in the year 1923. The accessions to the collection during the year 1924 amounted to 81, thus bringing the total number registered up to 17,725. The number of microsections cut and registered was 30, thus making a total of 4,522 slides in the possession of the Survey.

LIBRARY.

The accessions to the library from cognate departments in all parts of the world numbered 585, whilst 19 were added to the collection by purchase. The publications during the period under review comprised the Annual Progress Report for the year 1923 of the usual series issued by the department, and Bulletin 89, a revised edition of Bulletin 50, "The Geology and Mineral Industry of Western Australia." Several of the Geological Survey publications are now out of print, and for some of them there has been a considerable demand; it is, however, obviously undesirable to issue new editions without such revision as is necessary to bring the information up to date. This, however, is at present an impossibility.

Bulletins 84, 85, 86, 87, 88, 90, 91, and 92 have been completed, and are now in the hands of the printer; they should be available for distribution at an early date. Had they been printed earlier the cost of issue would probably have been unduly high, hence the publication of the bulletins has been deferred.



Government Geologist.

Geological Survey Office,
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