

1906.

WESTERN AUSTRALIA.



ANNUAL PROGRESS REPORT

OF THE

GEOLOGICAL SURVEY

FOR THE

YEAR 1905.

(WITH TWO FIGURES.)

PERTH:

BY AUTHORITY: A. CURTIS, ACTING GOVERNMENT PRINTER.

1906.

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Annual Progress Report of the Geological Survey for the Year 1905.

The Hon. H. Gregory, M.L.A., Minister for Mines, Perth.

Geological Survey Office,
Beaufort Street, Perth,
26th January, 1906.

SIR,

I have the honour to submit, for your information, the Progress Report of the Geological Survey for the calendar year 1905. Field work has been carried out in different portions of the State, on the lines adopted in former years.

As has been the case in the past, numerous reports in connection with the alienation of mineral lands (a matter in which important geological considerations are involved) have occupied the attention of the staff. Reports of this nature have numbered 88, in addition to 11 special reports in connection with subsidies under the Mining Development Act.

THE STAFF.

The work of the Department has been carried out during the year with the same numerical staff as heretofore. The position rendered vacant by Mr. C. F. V. Jackson, to which allusion was made in last year's report, has been filled by the appointment of Mr. H. P. Woodward, whose intimate knowledge of the State renders him well fitted for the post. Mr. Woodward's appointment dated from the 1st of April.

FIELD WORK.

The work of the field staff has been distributed as usual over the length and breadth of the State, in so far as the requirements of the public seemed to demand.

A. GIBB MAITLAND.—In addition to duties connected with the preparation of my own reports, the editing of the various official publications, and the general routine of the Department, a considerable portion of my own time has been devoted to work in the field. The period between the 10th of February and the 2nd of March found me in the Irwin River District in connection with the boring for coal along the Murchison Railway; whilst that between the 25th of June and the 28th of November was devoted to the completion of the examination of the mining districts in the North-West Division of the State. During the year I was employed 186 days in the field. In my capacity as a member, I attended the meetings of the Colliery Managers Examining and the School of Mines Advisory Boards, in addition to giving scientific evidence before the Royal Commissions on (a) the Collie Coalfield and (b) Immigration.

H. P. WOODWARD.—The 8th to the 14th of April found this officer engaged upon an examination of the Wagin neighbourhood, in connection with some supposed phosphatic deposits and the prospects of the existence of coal in the vicinity. On the 4th of May, this officer left Perth for the purpose of commencing a geological survey of Menzies district, which was continued with more or less interruption and the fieldwork finally completed on the 20th October. Owing to the necessity for Mr. Woodward remaining in touch with the office during my absence and paying short visits to different portions of the State for specially urgent purposes, the Menzies survey could not be carried out continuously. A few days in the early part of May were devoted to an examination of Windanya; the 21st to the 23rd of June was occupied on the Collie Coalfield in connection with several applications for the alienation of land; a short visit was paid to Kanowna in July, for the purpose of reporting upon an application for a subsidy under the terms of the Mining Development Act; the 24th to the 30th of August was devoted to field work in connection with a report upon the possible auriferous character of the Northam District; the 20th to the 25th November was spent in visiting the site of the Government bore at Mullewa. During the year this officer was employed 125 days in the field.

W. D. CAMPBELL.—The major portion of this officer's time was devoted to the office work connected with the geological survey of Norseman, alluded to in last year's report. From the 6th of February to the 26th of March was devoted to mine surveys and inspections at Norseman; between the 14th and the 22nd of November visits were paid to Northampton and Arrino in connection with inquiries regarding the alienation of mining lands; and a short visit was paid to Greenbushes, in December, to report upon recent mining developments. During the year Mr. Campbell was employed 56 days in the field.

C. G. GIBSON.—Up to the end of January this officer acted as *locum tenens* for the Mineralogist and Assayer, as alluded to in last year's Annual Report. Returning from leave on the 13th of April, Mr. Gibson resumed his duties as Assistant Geologist, and on the 15th May took the field and was continuously employed in the Mount Margaret Goldfield until the 26th of November. During the year this officer was employed 196 days in the field.

H. W. B. TALBOT.—This officer was engaged in the Pilbara and West Pilbara Goldfields, assisting me in the survey then in progress. Mr. Talbot was absent from Perth from the 12th of April to the 19th of December, and during the year under review was engaged 251 days in the field.

LABORATORY WORK.

The Laboratory has, as usual, with the exception of the month of January, been in charge of Mr. E. S. Simpson, the Mineralogist and Assayer, throughout the whole period covered by this report.

From the table prepared by the officer in charge, showing in detail the routine work in the laboratory during 1905, it appears that the total number of samples dealt with has amounted to 1,234, being the heaviest yet experienced.

The following table gives a detailed statement of the work performed during the year:—

Table showing details of Assays, etc., made in the Geological Survey Laboratory during 1905.

Classification.	Public.		Official.		Totals.
	Pay.	Free.	Geological Survey.	Other Departments.	
Total Samples dealt with	202	411	214	153	980
Mineral and Rock Determinations ...	4	148	102	44	298
Assays for					
Gold	142	185	77	66	470
Silver	23	58	2	8	91
Platinum ... ..	...	1	...	...	1
Copper	1	35	4	1	41
Lead ... ..	...	11	1	1	13
Zinc ... ..	...	...	...	1	1
Tin	9	40	3	3	55
Iron	2	7	2	...	11
Nickel ... ..	...	1	...	...	1
Cobalt	1	...	1	...	2
Tantalum	13	14	3	2	32
Niobium	13	14	3	2	32
Cadmium ... ..	...	...	1	...	1
Tellurium ... ..	...	1	1	...	2
Lime ... ..	...	3	...	...	3
Analyses—					
Complete	5	8	21	17	51
Partial	1	6	2	...	9
Proximate	19	16	...	5	40
Miscellaneous	8	28	36	8	80
Totals	241	576	259	158	1,234

Reporting upon the work of the year, Mr. Simpson observes:—

“Owing to the inadequate strength of the staff, two very important special investigations which had been begun have had to be temporarily abandoned. These were (1) an examination of the mineral constituents of the soils along the Goldfields Water Supply pipe-track, with a view to discovering the causes of corrosion of the pipes on the outside, and checking this action; (2) an examination of the more or less heavily mineralised boiler waters used at the State Batteries, in order to prolong the life of the boilers and prevent the recurrence of such disasters to them as have occurred during the past year at Leonora and Black Range. Both these investigations are of great importance to the State, and the results of them would save in maintenance and renewals far more than the cost of the extra assistance needed to carry them out. An addition to the staff is also highly desirable in order to ensure the promptness in the issue of assay reports, which is impossible in the present congested state of the work.”

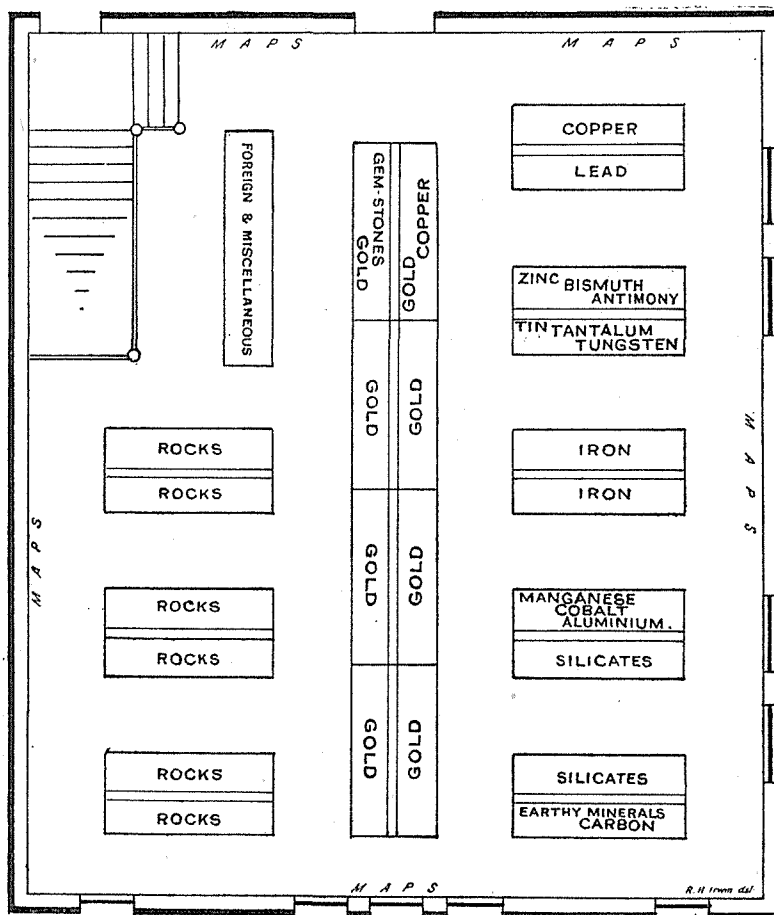
GEOLOGICAL AND MINERAL COLLECTION.

The additions to the survey collection during the year 1905 amounted to 714, bringing the total number registered up to 6,571.

The additions comprised 305 minerals, 337 rocks, and 72 fossils; with a few exceptions the minerals and rocks are in triplicate. Of microscope slides 102 were prepared during the year, and added to the collection, bringing the total number in the books up to 618.

The new show cases urgently required for the Departmental Museum having been placed in the building, a considerable portion of the time of the Mineralogist and Assayer was devoted to overhauling the collection and re-arranging those already on exhibition. The geological museum, which has been

arranged in the manner shown in the plan which forms Fig. I., now presents a fine illustration of the various mineral resources of the State, as well as of the matrices of the ores in those districts which have been examined in detail by the officers of the Department. One of the most interesting exhibits is a fine collection of local ores of tantalum, to which reference is made in a later page.



PLAN OF GEOLOGICAL MUSEUM

FIG. I.

Kalgoorlie being the typical home of telluride minerals it seems strange that the official collection is so poor in respect of them, especially when one remembers the magnificent specimens sent by the Government to the Exhibitions at Paris and Glasgow, all of which were either sold or given away, none being retained for the museums of the State itself.

Mineral collections were prepared for two exhibitions, viz., at Adelaide and Melbourne. It would appear advisable to keep a floating collection solely for exhibition in this way from time to time as opportunity offers.

PUBLICATIONS.

During the past year, the following publications were issued to the public:—

Annual Progress Report for the year 1904.

Geological Features and Auriferous Deposits of Mount Morgans, Mount Margaret Goldfield; and Notes on the Geology and Ore Deposits of Mulgabbie, North Coolgardie Goldfield, by C. F. V. Jackson.

Minerals of Economic Value, by E. S. Simpson.

Further Report upon the Geological Features and Mineral Resources of the Pilbara Goldfield, by A. Gibb Maitland.

The Bulletin on Minerals of Economic Value, by Mr. Simpson, contains a very considerable amount of valuable information with regard to the character, mode of occurrence, impurities, etc., in minerals of commercial importance. As explained in the introduction:—

“For many years gold was almost the only mineral which attracted the attention of the lay and expert public in Western Australia, but recently more frequent inquiries have been made with regard to other sources of mineral wealth. In order to meet these, and if possible interest a larger number of prospectors and others in our latent possibilities in other directions, the original (private) notes have been considerably enlarged and cast into a suitable form for publication.”

The publications of the Geological Survey have a fairly wide circulation, but in order to increase their usefulness arrangements have been made whereby they may be distributed in such a way as to be more easily available to prospectors and others than has been the case in the past.

In addition to the publications previously alluded to, there have been lithographed the following mining and geological plans, which are designed to accompany the report upon the Norseman District, which has now been completed :—

- Plan and Section of the Princess Royal Gold Mine. Scale, 100 feet per inch.
- Plan and Section of the Norseman Gold Mine. Scale, 100 feet per inch.
- Plan and Section of the Cumberland Gold Mine. Scale, 100 feet per inch.
- Plan and Section of the Lady Mary and Valkyrie Gold Mines. Scale, 100 feet per inch.
- Geological and Topographical Map of Norseman. Scale, 20 chains per inch.
- Section from Lake Cowan to Dundas. Scale, 20 chains per inch.

PRINCIPAL RESULTS OF THE YEAR'S FIELD OPERATIONS.

MINERAL RESOURCES.

Pilbara Goldfields.—A more or less detailed examination of the mining centres of Glenroebourne and Weerianna was made by Mr. Talbot, the field assistant, and a full report upon the districts is in course of preparation. The mining centres of Station Peak, Tambourah, Western Shaw, Just-in-Time, and the newly opened tinfield of Wodgina were also investigated, and in addition a traverse from Croydon Station southward to the Hamersley Range afforded an invaluable opportunity for ascertaining something of the structural relationships of the different formations and the natural resources of a portion of the State of which little is known geologically. Full details as to the districts visited will be found in the report which is in course of preparation.

Wodgina Tinfield.—In accordance with telegraphic instructions conveyed to me at Whim Creek, I proceeded to Wodgina and in due course submitted the following interim report on my observations on the field, the examination of which occupied my close attention for about a month :—

The Wodgina Tinfield is situated on the headwaters of the western branch of the Turner River, and within the limits of the Pilbara Goldfield, about 74 miles from Port Hedland.

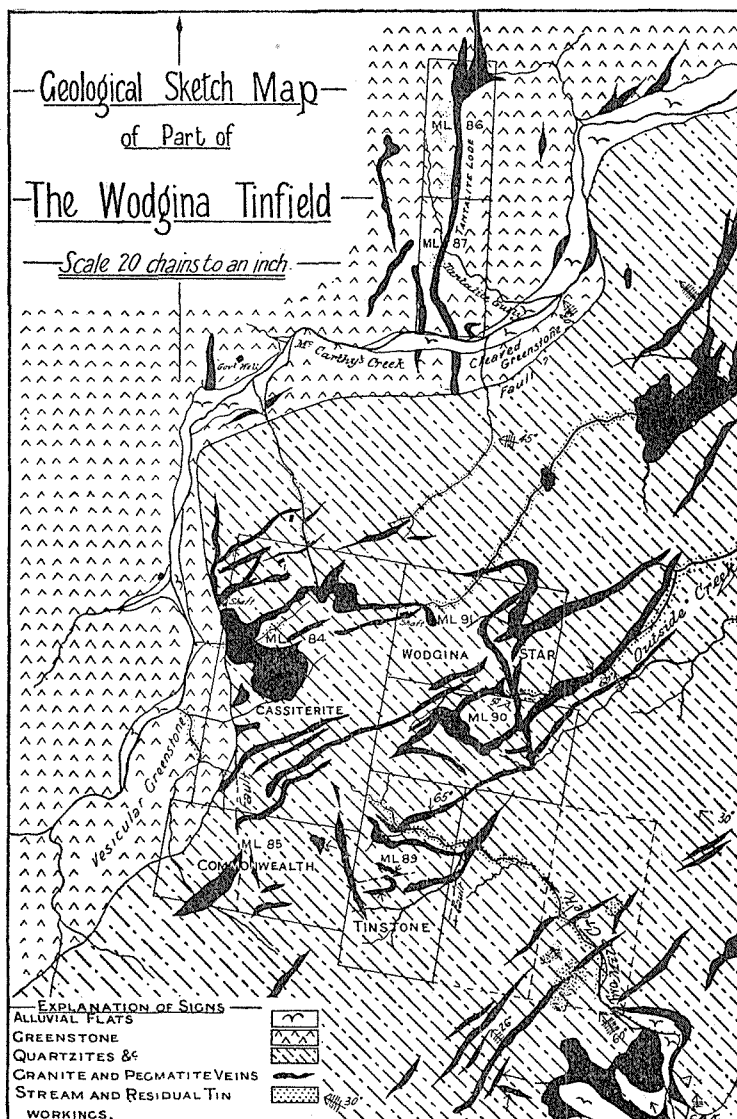


FIG. II.

Geologically, the field consists of a series of sedimentary and bedded igneous rocks, skirting an extensive granite mass which occupies a very large area of country. These sedimentary beds are very much faulted and have a prevailing dip to the west; they occupy a very rugged range, which rises to considerable altitudes above the level of the surrounding plains.

The sedimentary rocks are pierced by granite and pegmatite veins (in reality offshoots from the mass previously described), which invariably form the matrices of the tin and tantalite ores.

Wherever the pegmatite veins have been opened up it is invariably found that the tin occurs on either wall of the vein, in a band (of more or less width) consisting of mica and tourmaline in varying proportions, though in one case the occurrence of tin ore in the vein itself was noticed. The bed of the ravines and the slopes on the hill sides carry detrital and residual tin and tantalite everywhere over the whole area occupied by the granite and pegmatite veins. These latter have been mapped in some detail, and should afford a valuable guide to those engaged in mining operations on the field. Attached to this report is a copy of the material portion of the geological and mining plan of Wodgina. A careful inspection of the surface and plan (Fig. 2) attached shows that the tin lodes are numerous, and occupy a considerable area of country; it, however, yet remains to be proved whether they can be profitably mined, for operations have yet hardly gone beyond the most rudimentary prospecting stages, and no material progress can be made without capital to provide the necessary equipment for properly opening up and mining the lodes.

From a careful examination I am of opinion that the district bids fair to rise to importance, and that it will continue to be a tin and tantalite producer.

A very important feature of the Wodgina field is the tantalite lode, the position of which is accurately shown on the plan which forms Fig. 2. The "lode" traverses the whole length of two of the leases applied for, viz., 86 and 87. Upon the most southerly of the two not much work has been done, operations having been confined to dryblowing the surface along the outcrop and in the vicinity of the pegmatite vein. The principal activity is centred upon the ground embraced within the limits of M.L. 86. The pegmatite vein (the lode) has been opened up for a length of 45 feet, but only to a depth of three or four feet, and exposes coarse fragments and crystals of tantalite; one fragment weighed a little over four hundredweight. To the west of the open cut its width is 41 feet, whilst 264 feet farther its width is 34 feet. It is not possible from the amount of work done to ascertain the thickness of the vein, nor the actual amount of its underlie. A commencement has been made with the sinking of a shaft in the open cut, and as operations proceed definite information upon these material points should soon be available. It may be mentioned that the lode is in "greenstone country" and not in sedimentary rocks as is the case with the tin lodes yet opened up. A considerable amount of dryblowing is being carried out upon the slope of the hill adjoining and to the west of the lode. Several tons of tantalite (some of it being very coarse) have been obtained in this manner, and it is estimated that about 18 tons of the mineral have been taken from the surface of the lease. This detrital tantalite results from the disintegration of the rich chute in the vein adjoining.

Owing to the kindness of Messrs. McGuinness and Naysmith, the representatives of the lessees and the dryblowers respectively, the departmental collection has been enriched by about 1cwt. of tantalite specimens now in the Survey Museum.

About 300 feet to the west of the main tantalite lode is a smaller pegmatite vein, containing tantalite. Dryblowers have been at work near the southern end and have obtained about 1cwt. of the fine-grained mineral.

What may be called the tantalite group of lodes has been followed with more or less interruption for about a mile to the north of the Tantalite Lease 86; it eventually merges into the granite underlying the plains. A fair quantity of detrital tantalite has been obtained from this locality, and I have every reason to believe that the area over which the mineral occurs will be extended. I did not deem it necessary to devote any further time to the mapping of the extension of these veins, seeing that other portions of the district required attention, and the field season was rapidly passing away.

Having due regard to the uses to which recent scientific research has proved the metal can be put, provided the tantalum-bearing minerals can be obtained in sufficient quantities, the find at Wodgina is of considerable importance and should be the means of encouraging prospecting in other districts in which identical geological conditions prevail. An analysis of the tantalite from Wodgina appears on page 21 of the Annual Report for the year 1904.* It is unnecessary for me to add that tantalite has been known in Greenbushes for a number of years, and full particulars of which have been available to the public in several of the Bulletins of the Survey.

According to the letter of the Warden accompanying Ministerial instructions of the 20th of June, and his letter to me of the 29th of the same month, it appears that some objection has been raised to the granting of leases on the grounds that "it is alluvial country." My attention was naturally directed to this question, and for the purpose of your guidance a copy of a portion of the Geological and Mining Map of Wodgina, which it was essential should be prepared, is attached (Fig. 2). Upon this map there have been indicated:—

- (a.) The water-courses, and the portions which have been worked;
- (b.) The tin and tantalite lodes (i.e., the pegmatite and granite veins);
- (c.) The only lease granted, M.L. 84;
- (d.) The leases surveyed but not approved, e.g., 91, 90, 89, 85, 86, and 87;
- (e.) Certain leases applied for but not yet surveyed or approved; and
- (f.) That portion of the field, as yet unapplied for, which I should advise being withheld from lease, until such time as some competent officer certifies that the alluvial ground thereon has been worked out.

* Further particulars regarding tantalite will be found on page 20 of this report.

(For the purpose of considering the objections raised to the granting of mineral leases, it is necessary to bear in mind that "alluvial ground" is that which is defined in the Mining Act.) There is only a very limited area of detrital deposits in the gullies and ravines and such are only narrow, and in no case of any depth. On the low slopes of the main range, to the east of the Cassiterite lease, there are numerous veins, which have shed a fair quantity of tin (and a little tantalite), which now lies not far from its parent source, and should, I think, be withheld from lease until such time as some competent officer certifies that the ground (which is but shallow) has been worked out.

Despite the fact that the surface of the country is traversed by lodes and contains more or less tin set free by their disintegration, the field cannot be said to constitute an alluvial field, differing in this respect (and geologically) from that of Moolyella previously reported on.

Mt. Margaret Goldfield.—During his work on the Mt. Margaret Goldfield, Mr. Assistant Geologist Gibson examined and reported upon the following centres:—Laverton (including Lancefield and Ida H.), Burtville, Erlistoun, Duketon, and Mulga Queen, in addition to which a brief examination was made of the country between these centres. Geological sketch maps have been prepared, on a scale of 20 chains to an inch, of Laverton, Lancefield, Ida H., and Burtville, and black and white maps on a similar scale, showing the position of the principal lines of reef at the centres of Erlistoun, Duketon, and Mulga Queen. In addition to this work an examination was made of the country at the Cosmo Newberry Ranges and thence to Mounts Shenton, Venn, and Warren, and on to the Ulrich Range at the south end of Lake Wells. Mr. Gibson has prepared the following brief description of the salient geological features of the principal centres examined:—

"**LAVERTON** (including Lancefield and Ida H.).—This centre is the present terminus of the Eastern Railway. The salient geological features are practically identically similar to those of Mt. Morgans, which has already been dealt with in detail by Mr. Jackson in Bulletin No. 18. The staple formation consists of a series of basic and acidic rocks, of which the basic occupy by far the larger area. The basic rocks, the greenstones, are essentially hornblendic and occur both massive and schistose, being similar to those usually found forming the auriferous series of the Eastern Goldfields. It is within these greenstones that the auriferous reefs and lodes are found to occur. The acidic rocks vary through felsites, felspar-porphyrries and granites, and occur chiefly as dykes and intrusive masses, being most largely developed at the north end of the district in the vicinity of Lancefield. A few small deposits of laterite (ironstone conglomerate) occur, forming the cappings of low greenstone hills and ridges, but is mostly of an inferior grade. The greater part of the area under examination is covered by a varying depth of recent detrital deposits, which render detailed mapping extremely difficult, and on this account many of the geological boundaries may be looked upon as purely arbitrary. The ore deposits, like those of Morgans, can be divided into two classes:—

"(a.) Lodes which are genetically similar to the banded and hematite-bearing quartz lodes which form so conspicuous a feature of the Murchison and Mt. Margaret Goldfields.

"(b.) Gold-bearing quartz reefs of the normal type.

"Most of the principal mines are working on deposits of the first class. The district as a whole is well watered, but timber is not too abundant and is rapidly becoming exhausted.

"**BURTVILLE.**—This centre differs from the majority of West Australian mining districts as yet opened up, in that the majority of the auriferous quartz reefs are found in an area of granitic rocks. This area occupies a roughly circular extent of between one and two miles in diameter, and is situated entirely within the greenstones, into which it appears to be intrusive; it has also apparently been subjected to the same strains as the greenstones, and the reefs in it almost without exception run parallel to those found in the adjoining greenstones. The greenstones, which occupy the larger portion of the field, are of the usual type and consist both of massive and foliated varieties. Both they and the granites are very much decomposed and weathered, such weathering continuing well below the deepest mine workings (about 200 feet). The greater part of the district is covered with recent detrital deposits, often to a depth of 20 or 30 feet, and this renders accurate detail mapping almost impossible; very few of the reefs outcrop; floaters are picked up on the surface and the reefs are found by deep costeaning, or sinking and crosscutting, the soft nature of the country rendering this a fairly easy undertaking. The reefs are of white quartz and are numerous, but small (4 to 10 inches), and almost invariably rich—five and 10 ounce crushings being of common occurrence. This fact, taken together with the soft nature of the country, renders it an ideal district for prospectors but not of much use to companies, there not being sufficient stone procurable to keep any sized crushing plant continuously at work. Fresh water is abundant on the field, but timber is scarce.

"**NORTH ERLISTOUN.**—This district embraces the centres of Erlistoun, Duketon, and Mulga Queen. Mining is very slack, with the exception of the last centre. The salient geological features are much the same as those of most of the other mining centres of the Eastern fields. At Erlistoun are found the banded and hematite-bearing quartz lodes traversing the greenstones in a general north and south direction. Here, although auriferous, they have not proved sufficiently so to pay for working. The reefs being worked throughout the three centres are white quartz reefs of the normal type; they are usually of fair size and often of considerable length. They occur without exception in the greenstones, and at Duketon appear to be along the junction of the greenstone schists with a granitic rock, though the country is so decomposed and rotten that it is almost impossible to discriminate between the two classes of rock. There is an abundant supply of fresh water throughout the district, and timber of good quality is fairly abundant.

"**COSMO NEWBERRY RANGES and MOUNTS SHENTON, VENN, and WARREN.**—A detailed examination was made of the country at these centres, as well as of the country at the Ulrich Range on the south end of Lake Wells.

"At the Cosmo Newberry there is an area of country some ten miles long and three to five miles wide, consisting for the most part merely of a series of small lenticular gashes in the greenstones, and from their appearance are not likely to live continuously to any great depth; their gold contents, too, are mostly low. A good deal of surface prospecting has been done here, but no work of any importance; several potholes have been put down, and one shaft has been sunk to a depth of about 30 feet.

"There is a Government well at the Ranges, but the supply of water is small, due to the well not being deep enough.

"Mount Shenton is the highest point on a north and south range of hills formed by a large belt of hematite-bearing quartz reefs; this belt is in greenstones, and the whole extent of the probable auriferous country is only some 10 miles by 2 (including Mt. Venn, which is the southerly extension of the range). This hematite-bearing quartz belt is some three miles long, but as far as tested is practically non-auriferous. Near Mt. Venn the belt dies out, but there is a larger extent of greenstone country. These greenstones are mostly massive, and are intruded by masses of porphyry; a few quartz reefs occur, but they are mostly small and irregular and low in gold contents.

"At Mt. Warren are a series of rough greenstone ranges extending over an area of some six or eight square miles; these greenstones appear to be similar to those usually comprising the auriferous series of our goldfields, but as far as could be seen in a cursory examination (owing to scarcity of water) quartz reefs are conspicuous by their rarity.

"A full detailed account of these districts will be given in the report now in course of preparation."

New Find 60 miles E.N.E. of Duketon.—Mr. Gibson prepared the following preliminary report upon this district:—

"I have visited the new find, situated on the south-east side of Lake Wells, in the vicinity of the Ulrich Range, and about 60 miles east-north-east of Duketon, and have made an examination of it as to its extent and probable resources.

"The workings are situated on the north-eastern side of a low rough ridge of greenstone hills, trending in a general north-west and south-easterly direction for five or six miles, and having a maximum width of a little over a mile, tapering to nothing at either end; these hills are entirely surrounded by sand plains and spinifex. The rocks which comprise this ridge consist of fine to coarse-grained massive and foliated greenstones (amphibolite), similar to those usually found forming the auriferous series of the Eastern fields, and are traversed by a large number of acidic dykes, varying from a coarse-grained granite to a fine, compact, quartz porphyry, the latter type being by far the more prevalent. These dykes vary greatly in size, and run in all directions, though the majority of them have a general north and south trend; they also appear to be newer than the quartz reefs which they frequently cut through; the greenstones are usually considerably crushed and foliated in close proximity to them. The north-eastern fall of the hills is into a long narrow arm of salt lake—probably part of Lake Wells—lying from about two miles away.

"This lake runs past the north-western end of the hills, and then turns and runs southerly, being crossed by the road about six miles west of the 'find.'

"The present workings are situated on a small gully running down the eastern fall: this has been worked at irregular intervals for a length of about 20 chains, and a good deal of work has been done. Most of the gold has been got in the wash right in the bed of the creek at a depth of from two to four feet from the surface, and usually at points where the gully is crossed by the granitic dykes which form natural riffles on the bed of the gully. No, or very little, gold has been got on the fall of the hills into the creek; and this fact, viz.:—that all the gold has been shed and carried into the bed of the creek, militates against the chance of any rich leaders being found. So far most of the gold found is pretty fine, the largest piece obtained being less than 10dwts. No specimens have been obtained, but one or two pieces of gold were found with small pieces of ironstone attached, which would show that the gold has been shed from a small ironstone leader, or leaders, in the greenstones, which has been completely denuded away. There are several other gullies in the hills, and these have all been tried for alluvial, and so far with negative results; the sides of the hills and the flats at the foot of them have also been tried in numerous places with similar results. At the time of my visit there were seven men at the 'find,' one of whom was employed in carting water from the soak 20 miles distant by road, the remaining six were engaged in alluvial working, and had obtained amongst the lot of them between 15 and 18dwts. of gold as the results of a week's work. These men professed themselves as very dissatisfied with the district, and gave it as their intention to leave the place within the next few days. On my way into Duketon I passed another party of five on their way out to the 'find'; this will make quite a sufficient number of men to thoroughly test the locality, if that has not been done already.

"While at the 'find' I saw several runs put through the shakers, and all of them with very disappointing results, mostly only a couple of small 'colours.' A party of four who were at the 'find' some weeks before the present party obtained 8ozs. 7dwts. of gold as the result of six weeks' work; while, in addition to this, one man got from 28 to 30dwts., but I was unable to ascertain how long it took him to get this amount.

"This district was originally prospected by H. Swincer, who is said to have obtained a little alluvial gold here about four years ago; a couple of years later, Kirkpatrick and party, as the result of several weeks' work, obtained a few ounces of alluvial gold; I was unable to ascertain the exact amount, but it was said to be somewhere about 10ozs.

"As regards the reefing possibilities of the district, I don't think anything of importance is likely to be found in this line. Quartz reefs are certainly fairly numerous, but they are small and very irregular, being for the most part merely short lenses or gashes running with the foliation of the greenstones, and are, I think, not likely to live to any great depth; they are also much broken and distorted, owing to the

intrusions of granitic dykes; the quartz is white and glassy, and, as far as tested, very low in its gold contents; a large number of samples were 'dollied' by myself, and the best result obtained was only slightly better than a trace, most of them being blanks. There is, however, one fairly well-defined line of reef—or, rather, line of lenses—traceable on the surface in a north and south direction for a distance of about 10 chains, the largest continuous length of quartz being about 60 feet, and having a maximum width of about three feet; it is, however, broken in several places by granitic intrusions, and the lenses of stone are likely to behave just as irregularly vertically as they do longitudinally.

"The stone in this line is the typical white glassy quartz, and near the north end has a considerable quantity of carbonate of copper associated with it, as well as occasional small pockets of galena. This line was carefully sampled by myself, and a large number of samples dollied, the best prospect obtained being equal to about 1 to 2 dwts. per ton. A few of the samples gave traces of gold, but the majority of them were blanks.

"Almost every one of these reefs show signs of having been sampled several years back, and the area of possible auriferous country is so restricted that two or three men could thoroughly prospect it, from a reefing point of view, in a couple of weeks, and I am of opinion that this has already been done. The country rock is extremely hard right on the surface, and under existing conditions, *i.e.*, with the nearest battery 60 miles away, and over heavy sand at that, reefs would have to be exceptionally rich to be of any use to the prospectors, and I do not think there are any reefs of this description in the locality; and in my opinion, even if the reefs were of fair grade, there is nothing of sufficient size or regularity to warrant even the thought of erecting a battery on the spot.

"With regard to other possible finds in the vicinity, from personal observations, there is no auriferous country to the south until the Cosmo Newberry Ranges are reached: none south-easterly till Mt. Warren—and this is an exceedingly poor belt; and none westerly or south-easterly till the Duketon-Erlistoun belt. To the north and north-east, beyond Lake Wells, low granite ranges and sand plains extend as far as can be seen, and these are said to extend in this direction for practically an unlimited distance.

"As to the water supply of the locality, a well has been sunk on the eastern fall of the hills, about a mile and a-half from the lake, in which water was struck at about 30 feet. This water is, however, too salt to be of use even as stock water. If a well was put down on the other fall, I think the chances are that this would probably be salt too, as the lake runs round this side of the hills as well, though at a somewhat greater distance—about six miles. I do not think a permanent fresh water well is likely to be found in the locality. The present water supply is from a soak in a small creek eighteen direct miles from the 'find' along the Duketon road; water has to be carted from here to the 'find' over heavy sand, and the supply is only very limited and unless replenished by rain is not likely to last many more weeks. Between this and Duketon there is no water except at a rock hole six miles from the soak; this, however, is most probably dry by now as there were only a few gallons of water in it early in November.

"I don't think the 'find' is of sufficient promise to warrant the Government going to the expense of putting down wells along the road, but if these are put down, almost the only places where they could be put would be (1) on the cork tree flat, 16 miles from Duketon, and (2) on the creek, a little below the present soak, and I am not in great hopes of a supply being obtainable at either place, especially at (1)—that is in shallow wells.

"If these wells are put down—and this applies to all shallow wells in the out back country—I would very strongly advise that they should be put down in the summer season, for if a supply is met with then it can fairly safely be relied upon as permanent, whereas if they are put down in the winter—usually the wet season—a fairly heavy supply of soakage water is often met with which goes dry, or nearly so, before the dry season is over, and this is often a very serious matter in that part of the State. The Cosmo Newberry Government No. 2 Well is a case in point; this well is now only making a few gallons of water per day, and that only after it has been sunk another five or six feet by private parties."

Windanya Group of Leases, Broad Arrow Goldfield.—In the month of June Mr. Woodward prepared the following report upon the Windanya Leases, near Broad Arrow:—

SITUATION.—Windanya* is situated about four miles in a south-westerly direction from Bardoc, a town upon the eastern railway line 418 miles from Fremantle and 31 from Kalgoorlie.

GEOLOGY.—*Superficial Deposits.*—The area in which this group of leases is situated may be described as a valley running in a north-westerly and south-easterly direction of about four and a-half miles in length by half a mile in width, the surface of which is covered by a deposit of rich red loamy soil broken by two small patches of diorite boulders towards the southern extremity, the only indication of the presence of quartz reefs being lines of strewn fragments of quartz.

Laterite.—This valley is enclosed upon its eastern and western sides by lines of low ironstone-capped hills (laterite).

Schists.—The basic series are here represented by hornblende schists met with in sinking beneath the red loam of the flats, and are found to be much weathered above the water level (about 200 feet), and even below it in the immediate vicinity of the lodes.

Granite and Porphyry.—The acid series are represented by a granite intrusion, which outcrops in one of the patches of diorite towards the south end of the valley and by numerous small porphyritic dykes met with in the lodes.

Quartz Reefs.—The quartz reefs in the oxidised zone are much iron-stained and often contain vughs filled with gossan, which are generally rich in gold. Below the water level the quartz assumes a more banded appearance, and often contains pyrites in considerable quantities which in the vughs sometimes

* Vide Lithograph L 17, issued by the Department of Mines.

assumes a botryoidal form. The casing of these veins often consists of talcose rocks with veins of serpentine and fibrous talc. At the northern end of this area there are two main lines of lode fissure, the one upon which the Half Mile Reef mine is situated strikes north-west and south-east; whilst the other, upon which are the Struck Oil and Half Mile North, strikes north-north-west and south-south-east; both of these underlie to the eastward, and should junction if they continue a little south of the Half Mile workings. From this point to the southward, the country is considerably broken, the reefs being, although often rich, of short length, and have, for the most part, an easterly and westerly course, with a dip in a southerly direction.

THE MINES.—There are at the present time only two mines at work in this district, one, the Half Mile Reef, which is in the hands of a party of tributers, who are raising the small patches of stone which were unprofitable for the Company to handle; the other, the Half Mile North, which is a prospecting show worked by the owners.

THE AUSTRALASIA HALF MILE REEF, LTD.—Mr. T. Blatchford, B.A., formerly Assistant Government Geologist, in his report on this district, accompanied by a geological map, published in the Annual Progress Report of the Geological Survey for the year 1899, page 27, says of this mine:—"The reefs which are being worked on this lease do not appear at the surface in a defined outcrop, though they have been followed for a considerable distance in the underground workings. In the southern end of the lease, however, loose masses of quartz may be still seen at the surface, and these, no doubt, led to the discovery of the reefs lying but a few feet beneath the surface." Upon this property a considerable amount of work has been done, a main working shaft has been sunk to a depth of 565 feet, from which are the following levels:—120 feet level, 343 feet in length; 170 feet level, 580 feet in length; 250 feet level, 540 feet in length; 285 feet level, 120 feet in length; the 365 feet level being 440 feet; the 465 feet level being 310 feet; the 565 feet level, 250 feet; whilst from this level a winze has been sunk on the ore body for a further depth of about 40 feet. The ore body varied very considerably in size, but averaged about two feet in thickness in the portion removed, which was carried in an ore chute that dipped to the southward of about 150 feet in width. North and south of this chute the country was tested for a considerable distance, as will be seen from the length of the levels, but as the veins become too small and poor to be worth following or pinched out, work was abandoned; whilst in the bottom level the stone has become so small and of such low value that the work of sinking has been discontinued. The little water this mine makes comes from the upper levels, the lower being comparatively dry. This mine has now been regularly worked for a number of years, during which time it has yielded 22,962·00 tons of stone, from which 14,432·52ozs. of gold have been obtained, the average value of the ore crushed being 63oz. of gold to the ton. The question of the future of this mine is not one in which science can lend any assistance, since the ore body is still intact in the lower levels, but simply one of whether the stone from greater depths will pay to raise and crush or not.

THE STRUCK OIL.—This property is situated a little to the north-east of the Half-Mile Reef, but belongs to the same Company, who use it as a water shaft for the supply of the battery. The shaft is about 300 feet deep, with a small crosscut from the bottom, in which a small vein of highly-mineralised stone heavily charged with water was cut. This latter was said to make at the rate of 45,000 gallons per diem, and thus stopped further prospecting at the time. There are several small shafts upon a small quartz reef, from which some years ago 139 tons of stone were raised and crushed, which yielded 105·05ozs. of gold, or an average per ton of 75oz.

WINDANYA HALF MILE NORTH.—This lease is apparently upon the same line as the Struck Oil, and about 400 yards to the north of it; there was no outcrop of reef through the alluvium, but it was discovered by fragments of quartz upon the surface. It has now been opened up by three shafts, one at the northern extremity of the lease, one near the south, and the other a little north of the latter. No. 1 shaft is situated near the southern boundary, and has been sunk to a depth of 60 feet, at which point it struck the reef. There is also a crosscut at 40 feet from the surface to the reef from which a quantity of stone was raised. The reef is here from five feet to six feet in width, but considerably broken. No. 2 or middle shaft is about two chains north of the first mentioned, and has also been sunk to a depth of 60 feet, passing through the reef near the surface where it was small. At the bottom of this shaft a crosscut has been driven 30 feet east to the reef, from which point it has been followed for a distance of 85 feet north and 35 feet south, the ore body being eight feet to nine feet in width. No. 3 or the northern shaft was sunk close to the northern boundary to a depth of 103 feet, passing through the lode at 40 feet from the surface. At this level it was followed both north and south for a distance of about 20 feet. At the bottom of the shaft, a crosscut was driven east 30 feet to the reef, which is here about 12 feet in width. The reef was followed south from this point for a distance of 40 feet, and a winze sunk 30 feet upon it. All the stone raised from these workings has been crushed, yielding 779·79ozs. of gold from 927·25 tons of ore, averaging 84oz. per ton. The country rock in the immediate vicinity of the lode is hornblende schist, the casing of the vein itself being often talcose. The lode consists of sections of quartz which are generally ferruginous, divided one from the other by intrusions of copper-stained porphyritic rock which lie between the lode walls intersecting the quartz, but in no instance so far penetrating the country.

OTHER LEASES.—To the southward of the Half Mile Reef there are a series of abandoned claims upon which shallow shafts have been sunk to win rich stone from cross reefs; but to judge from the amount of work done, they must have been small and of limited extent.

THE SURBITON.—At the south end of this valley is an abandoned mine called the Surbiton, upon which a considerable quantity of work has been done and plant erected, which latter has since been removed. This property was inspected by Mr. Blatchford, who in the Annual Progress Report for the year 1899, page 27, states that the reef strikes east and west dipping to the southward, and has been

opened by three shafts to a depth of 240 feet with a level at 80 feet from the surface, 206 feet in length, in which the lode is 132 feet in length and averages 10 inches wide, also a level at 160 feet driven east and west for a distance of 350 feet, the vein extending 255 feet, being about 15 inches wide upon the average. He further states that 10 tons of stone had been crushed, yielding 18ozs. of gold.

Wagin District.—Mr. Woodward visited the Wagin district for the purpose of reporting upon the possibilities of coal occurring and the reputed phosphatic deposits. From this report, which is given *in extenso* below, it appears that the occurrence of coal deposits is somewhat problematical, and that the reputed phosphatic deposits, which apparently cover a large area, do not contain sufficient quantities of phosphoric acid for fertiliser purposes:—

“Wagin* is situated upon the Great Southern Railway line, 193 miles from Perth and 147 miles from Albany, at an elevation of 840 feet above the sea level. It lies in one of the main valleys which drain the great tableland of the interior, the fall of which is so slight that in place of a well-defined water course a series of lakes have been formed which only during periods of great floods overflow one into another, by which means the water eventually finds its way into the Beaufort River.

“To the westward the ground rises rapidly for a distance of about four miles, attaining the greatest elevation in the district of Badgarnung Hill, which is a small ridge of granitic rocks about 300 feet above the level of the town.

“Should at any future time a water supply of greater magnitude than that at present in existence be required, there are several sites upon the eastern slope of this hill which would lend themselves admirably for reservoir construction from which 100 to 150 feet head of pressure could be obtained by a gravitation scheme, and a good water supply assured.

“A striking feature of this range is that it is clothed by a distinct vegetation from the surrounding country, the flora being identical with that met with in the coastal regions, whilst all around it nothing but the tableland vegetation is encountered.

“The main valley in which the town is situated runs in a north-east and south-west direction, from which the country rises gently to the north, whilst to the south and east it rises more abruptly on to sand plains, along the edge of which polished granite knobs outcrop here and there similar in every respect to those around the lake basins of the goldfields.

“Although this is one of the main drainage valleys from the salt interior, the holding capacity of the lakes is so great that without very exceptionally wet seasons occur inland little or no salt finds its way westward of the railway line, therefore the chain of lakes below it being filled locally are comparatively fresh, whilst those to the eastward, in some instances, contain salt in such large quantities as to render its removal after a long dry summer like the past a highly profitable undertaking.

“Upon the eastern side of this valley, running in a north-eastern direction from Lime Lake for a distance of about three miles, are some limestone deposits which in places consist largely of small shells, whilst the surface of the adjoining lake bed is covered by a deposit of earthy gypsum.

“**BONNAR'S LEASES** are situated upon the eastern side of Lime Lake, covering a portion of this lake bed, the low bank between it and the gypsum lake, part of which latter is also included.

“**LIME LAKE.**—This lake covers an area of about 200 acres with limestone outcrops upon its eastern and southern sides, whilst to the westward and northward, if these deposits do exist, they are covered with accumulations of blown sand. The bed of this lake is covered upon the south-eastern side by a deposit of black earth full of small shells, beneath which are shelly limestones, which give place further into the basin to an earthy limestone perforated by root holes that have mostly been filled with earth. Beneath these superficial deposits cream-coloured chalky limestones are exposed in an old excavation which was opened some years ago in order to obtain limestone which was burned and used for building purposes in the town and which, to judge by the mortar, yielded a most excellent lime. This hole has now fallen in, and, as no reliable information can be obtained as to its depth and whether or no the total thickness of the beds was tested, it is impossible to state anything definite under this head until more work has been done. The lower portion of this lake bed upon which water lies after heavy rains, and the adjoining belt upon which salt-loving plants grow, is covered with earthy gypsum, which deposit is being used in conjunction with the burnt limestone in the manufacture of a fertiliser.

“Upon the low ridge between this lake and the Gypsum Lake, which lies to the eastward, are some old kilns which are at present being used by the lessee in which he burns the root-pierced limestone from the lake bed, and some creamy limestones which outcrop upon this ridge.

“In a small hole sunk in the Gypsum Lake a white chalk gypsum deposit is exposed, but this so far has not apparently been much worked.

“**WILSON'S LEASES** are situated about two miles north of the Lime Lake deposits, upon a low ridge between lake branches. Little work has been done here as yet, but to judge from the appearance of the surface stone, and that exposed in the excavation for the kilns, it is apparently of very good quality and admirably suited for the purpose to which it is proposed to put it, viz., the manufacture of a fertiliser by the addition of phosphatic and other substances to the calcined limestone.

“The whole of this deposit, so far as examined in this district, is decidedly of lacustrine origin apparently resulting directly from the weathering of shelly deposits similar to those met with at the surface, the occurrence of the latter proving conclusively that, in comparatively recent geological times, this area must have been covered by a huge lake which, to judge from the type of the shells, was in all probability salt.

* The localities mentioned throughout will be found on Lithographs 408 and 409, issued by the Lands Department.

"A number of samples were taken and tested for phosphates, but as will be seen from the attached analyses they contain too small a percentage of phosphoric acid to be classed as anything but limestones.

"This goes far to indicate the absence of fish in large quantities, for had they been present one would naturally expect to find a higher percentage of phosphoric acid, whilst to go one step further, this absence of fish might almost be expected in a salt lake, the water of which would be liable to vary so greatly in density owing to the intermittent character of the inflow of fresh water in a country destitute of flowing streams.

"Although containing too small a percentage of phosphoric acid, to be of any appreciable value as a phosphatic manure, these deposits should be of considerable value since they are situated in the very heart of what is rapidly becoming a most extensive agricultural district, the soil of which, resulting for the most part from the disintegration of granitic rocks, is almost destitute of lime, a most essential substance in the production of first-class milling wheat. Gypsum is also a most valuable fertiliser, for in that form not only lime but also sulphur, a most important element in plant life, is conveyed to the soil.

"The supposed coal deposits of this district are entirely of a problematic character. A considerable tract of country which was once a large lake bed exists, but whether coal measures exist beneath the modern superficial deposits or not can only be proved by boring or sinking. Since no outcrops have so far been discovered, before any such work were undertaken it would be necessary to have a geological survey made in order to prove the extent of the area over which coal measures might extend.

"Gold is reported to have been discovered in some hills upon the northern side of the lake area, about 17 miles to the eastward of Wagin. The country in this locality changes decidedly in character, the red soil indicating the presence of hornblendic rocks, whilst the hill itself is composed of feldspathic rocks which at the surface is too much weathered to exhibit any structure. These rocks are intersected by numerous small quartz and ironstone veins, some of which have been opened up by pits and small shafts; but the parcels of stone tested did not prove of a sufficiently encouraging nature to warrant further expenditure upon them.

"The stone in places is of a very promising character, and is well worth prospecting in an inexpensive manner by simply dollying surface stones until gold is discovered, then by trenching in an east and west direction across the strike of the rocks to locate the lodes, which will probably be found to consist of a network of small leaders in a belt of dyke stone, the quartz being probably highly mineralised below the water level."

Appendix A.—The following are the results of analyses of specimens from Wagin, made by Mr. Simpson in the Survey Laboratory:—

Lab. No.	Description.	Phosphoric anhydride P_2O_5 .	Calcium sulphate $CaSO_4$.	Calcium carbonate. $CaCO_3$.
871	Siliceous limestone, ridge lake side, surface ...	·008	...	...
872	Siliceous limestone, ridge lake side, under surface ...	·014	...	...
873	Siliceous limestone, under shell deposit, lake bed ...	·010	...	...
874	Siliceous limestone, old lime pit, lake bed ...	·026	...	...
875	Calcareous clay, gypsum lake ...	trace	·96	41·58
876	Calcareous earth, gypsum lake bed ...	trace	1·07	52·26
877	Siliceous limestone, Wilson's low ridge excavation ...	·008	...	...

Calcium carbonate is the only constituent present in sufficient quantities to be of value for fertilising purposes.

Appendix B.—Phosphatic Deposits in General.—"As an introduction to this subject it may be as well to mention that the bones of all vertebrates are composed of phosphates of lime, and that all skin, feathers, hair, nails, hoofs, and scales are rich in phosphoric acid, whilst even the fleshy portions of the body, more especially the brains and nervous system of all birds, beasts (including man), and fishes, particularly the latter, contain phosphoric acid.

"It will be recognised from the above that it is absolutely necessary that man be supplied with phosphates of lime; and as he does not now eat the bones of his prey, he must look for his supply of this substance from some other source, the most convenient being found in bread, since all cereals contain phosphate of lime, particularly in the outer skin of the grain, which is now generally discarded as bran and pollard.

"Since cereals contain phosphate of lime, it naturally follows that the soil upon which they grow must be furnished with it; otherwise after a few crops have been taken off a piece of land its productivity will be exhausted. Other substances, such as nitrates and potash, are just as essential to plant life, but here only phosphates are being considered.

"Now, since phosphate of lime does not occur in large quantities in the average soil, if crops requiring it are grown year after year it naturally follows that this must be supplied, which of course can be done in the form of crushed bones or guano; but since the supply is limited and the demand great, other sources of supply must be considered.

"It has now been discovered that certain rocks rich in phosphoric acid, but which in their natural state are practically valueless as a fertiliser, become of greater value after treatment by a chemical process, which renders the insoluble phosphate of lime soluble and thus available as a plant food, when it is called a super-phosphate.

"When the term phosphatic deposits is used, it is generally understood to refer to a combination of phosphoric acid and lime sometimes called rock phosphates. But although the term is generally applied to the above, phosphoric acid also occurs in combination with other elements commonly such as lead and iron, in the latter of which forms it has played an important part as one of the best known phosphatic fertilisers of the world, viz., Thomas's Phosphate or basic slag, being a pulverised slag resulting from the conversion of phosphates of iron into steel by Thomas's process.

"Phosphatic deposits as they occur in Nature may be divided into two classes, those derived from mineral and those from organic sources. The former of these comprise deposits resulting for the most part from the disintegration of certain volcanic rocks rich in the mineral Apatite (phosphate of lime), the second which embraces by far the most numerous and most important may be classed under two heads, the first being fossil phosphatic deposits, and the second altered recent deposits.

"The fossil phosphates are mostly met with amongst the Mesozoic Rocks, where beds resulting from deposits formed by large fish-eating reptiles occur, called coprolites, whilst the more modern are limestones which have absorbed a considerable quantity of phosphoric acid from overlying guano beds, and as these latter are by far the most likely to be met with in this State it will be necessary to consider them more carefully.

"Deposits of phosphate of lime of this class are very similar in every respect to ordinary limestones, and since they contain the phosphoric material in an insoluble form they are of no particular value as a fertiliser until manufactured, and in consequence exhibit no evidence of their existence by increased vegetation. Therefore, if deposits of limestone are met with along the coast, or even at a considerable distance inland under the following conditions, they are well worth testing.

"Since these limestone deposits, which contain a large percentage of phosphoric acid, evidently in some bygone time have formed the camping and nesting ground of sea birds, they must at such periods have been near the sea, either on the top of cliffs, ridges of rock, or islands, whilst now as the coast line is rising rapidly, and has been for a considerable period, if they exist at all will be found inland upon the hill tops or sides at a considerable elevation above the sea level, or as isolated hills upon the coastal plains. If patches of limestone are found in the hollows or areas of depression, there is small chance of their proving to be rich in phosphoric acid, as they are in all probability lake deposits; and the same remark may apply to the coastal coralline limestone hills, which are recent wind-formed deposits.

"When the fact is borne in mind that similar phosphatic deposits are being formed at the present time from Geraldton northward along our west and north-west coasts, it is highly probable that similar deposits to those met with on Yorke's Peninsula in South Australia will be discovered in this State."

The Sunbeam Lease, No. 1121x, Kanowna.*—In the month of July Mr. Woodward prepared the following report in connection with a proposal to grant State aid towards the development of the mine:—

"This lease, which contains an area of 20 acres, is situated about half a mile to the northward of the north-west corner of the township boundary of Kanowna, and immediately adjoins the Ballarat lease upon the west, whilst the North Lead passes upon its western side.

"The property has been worked for a considerable number of years, during which period 4,870·25 tons of stone have been raised, yielding 7,744·56ozs. of gold, worth £28,800, the average value of the stone per ton being 1·59ozs.

"Upon this property there are two main lines of reef, called respectively the eastern and western reefs, whilst between them several rich flat leaders have been worked.

"The eastern reef has a north-easterly course and lies upon the eastern side of the property, having an underlay of about 30 degrees to the eastward or into the adjoining mine. That portion of this reef which lies within the boundaries of this property has been entirely worked out above the 130-foot level from the whip shaft upon the lease and below that from the Ballarat Company's shaft. At the 130-foot level the reef has been followed for a distance of 180 feet within the property, for which length it is well defined, but at the southern end it is broken and small. From the northern end of this level a crosscut has been driven 60 feet to the whip shaft, and then on for another 130 feet to the western reef, which has been followed from this point south for a distance of 265 feet. This reef averages about 10 inches in width, and dips generally at about 62 degrees east. Above this level most of the stone has been stoped to the surface, where the reef can be traced for a distance of about 450 feet.

"From this level three winzes have been sunk: the first near the crosscut to a depth of 46 feet; the second, 130 feet further south, to a depth of 41 feet; and the third, near the end of the level, to a depth of 56 feet; whilst the two latter are connected at the 170-foot level.

"This reef has a well defined hanging wall, which is sometimes striated. The foot wall is not well marked, the country upon that side being much broken, highly mineralised, containing stringers and leaders of quartz, but which as a rule are poor in gold. The north and south ends of the 130 feet level have been mullocked up; therefore the reef cannot be inspected, but it is said to be small.

"At the bottom of the southern winze, water has been struck; this would be at a vertical depth of about 160 feet and corresponds with the water level in the adjoining mine where water is said to make at the rate of from 50,000 to 60,000 gallons per diem.

"Above the water level the country is comparatively soft but stands well in the workings with but little timber. In the northern winze, however, the rock is extremely hard, consisting of a porphyritic rock impregnated with marcasite (white iron pyrites). This rock upon the footwall side of the lode is so heavily charged with mineral close to the reef that it presents the appearance of a pyritic vein.

* Vide Lithograph L 13, issued by the Department of Mines.

"The reef consists mostly of quartz of a laminated character, stained in places with oxide of iron and containing pyrites near the water level. Judging from the character of the western reef, it is a true fissure vein and therefore has every prospect of maintaining in depth. Its longitudinal extent has not yet been proved, but to judge from the surface indications it will probably split up and be lost to the southward. The lode is small but of good quality, as has been proved by the very constant returns of about $1\frac{1}{2}$ ounces of gold to the ton. It is by no means a company proposition, but there is every reason to believe that a party of working miners like the present owners should be able to make a fair return from it.

"The proposed work for which the loan is asked is to sink a main working shaft nine feet by four feet in the clear, divided into three compartments, and timbered throughout to a depth of 250 feet at a point which will cut the western lode at that depth. Besides this it is proposed to purchase a winding engine, boiler, headgear, cages, rope, and tanks for bailing water, also pumps and piping if required. If this work is undertaken it will be with every reasonable prospect of success provided the sum available is sufficient to carry through the undertaking."

Northam District.—In the month of September, Mr. H. P. Woodward visited Northam for the purpose of examining and reporting upon certain gold discoveries. It appears that discoveries of gold have been reported from the vicinity of Northam, from the period of its earliest settlement, and that prospecting work has been carried out at various periods, both by the Government and the residents, whilst the establishment of an ore crushing plant at Seabrook has given a considerable impetus to the search for gold in recent years.

Mr. Woodward's work in the district was exclusively confined to the examination and sampling of those localities where gold is reported to have been discovered. The high state of cultivation in the district resulted in most of the potholes and trenches in which lodes are reported to have been opened up being filled up, and any sampling possible consisted solely of collecting scattered fragments from the surface.

Mr. Woodward's report is as follows:—

"Northam* is situated upon the Avon River at its junction with the Mortlock; the surface is hilly and broken but the hills for the most part are soil-clad to the summits. Rocky ridges are rarely met with, the rock outcrops being mostly confined to the low-lying tracts and the stream beds.

"The rocks of the district are mostly granitic with belts of schistose country which strike roughly north and south with an easterly dip, and it is in these belts or along the junction of these with the granite that the mineral veins occur.

"Traversing one of these belts which lies immediately to the eastward of Northam are some large ferruginous banded quartz dykes very similar to those met with upon the Murchison goldfield. These form bold, rough, broken ridges of hills which can be traced for many miles. Associated with these dykes are numerous ferruginous quartz and hematite veins, also outcrops of limonite with opal veins and garnet rock.

"The tops of a few of the highest hills are capped by superficial ferruginous deposits (laterite), the under beds being ochre clays which are often weathered away, leaving caves beneath the harder upper beds.

"The first point examined was upon the Grass Valley road about $1\frac{1}{2}$ miles from Northam, upon Block P. 1 (Cunine); here the road passes through a break in a large banded ferruginous quartzite dyke mass striking north and south and dipping to the eastward. A sample of this was taken and numbered No. 1, but the sample yielded no gold.

"There was also a white quartz outcrop running at an angle to it, the strike of which was more to the north-west, but owing to the extremely barren and flinty character of the stone it was not sampled.

"At Mallabine, Block 1080, about two miles to the north-eastward of the last mentioned, a considerable amount of prospecting has been done by the owner, Mr. J. Beard, and his father before him. Good prospects are said to have been obtained from small ferruginous leaders which were opened upon by means of pits and trenches which are now pretty well filled in, but a considerable quantity of stone is lying about the surface from which a sample was taken, No. 2, which yielded no gold upon assay.

"In this locality a shaft has been sunk to a depth of 72 feet 6 inches in mica schist with the object of cutting the leader at a depth, but this shaft is not deep enough to attain its object.

"Copper is said to have also been discovered in this vicinity, but since all the old holes have now been filled in and the surface ploughed over there is no trace of it to be seen at the present time.

"About half a mile north, upon the northern half of Block 1080, Mr. Beard has also done some further prospecting upon what is said to have been a ferruginous leader rich with gold, but since all the stone has been removed and the shaft is not accessible a sample could not be taken. The rocks here are similar to that at the last mentioned, with the additions of bands of garnet rock.

"At the south-east corner of P. 3, near a conical hill with a laterite capping, gold is said to have been discovered in small potholes, now filled in, upon the west side of the hill. This land is now under crop, but some fragments of common opal are strewn about upon the surface.

"Upon the east side of the hill a shaft has been sunk to a vertical depth of over 100 feet in crystalline schists with veins of hypersthene, hematite, quartz, garnets and tourmaline, the joints of the rocks being often coated by thin facing of opal.

"About three miles north of this, upon the eastern edge of P. 4, there is a large and well-defined quartz outcrop of a very barren character, striking north-west and south-east, near which, in a creek bed, gold is said to have been discovered. In this stream bed a number of holes have been sunk but apparently without result, and these have now been filled in.

* Vide Lithograph 27, issued by the Department of Lands.

"Mt. Dick, which is about five miles north of Northam, is upon the line of ferruginous quartzites, but close to it are some outcrops of limonite with veins of semi-opal which have been opened up. The opal is much weathered, but is apparently of the fire variety and should be worth a further trial.

"There are also some veins of ligniform asbestos, but this mineral is too brittle in the fibre to be of any value.

"About six miles north of Northam, upon Mr. Morgan's property, T. 1, gold is said to have been discovered many years ago, and to test this the Government sunk a shaft over 100 feet deep upon the top of a hill at some little distance from the point where the discovery is said to have been made.

"A number of small holes have been sunk with the object of discovering the reef, but so far although a considerable quantity of quartz was met with, no definite body was encountered.

"The quartz from these holes varies considerably in character, but an average sample was taken of the whole, No. 3, the assay of which yielded a trace of gold. If a selection of the most promising stone had been treated alone there is no doubt but that a much better result would have been obtained.

"In the bend of the river immediately north of Northam, two pits have been sunk on two small parallel reefs by Mr. Cohen. This land is now under cultivation, but samples were taken from the stone raised, Nos. 4 and 5, neither of which yielded any gold.

"Taking the district as a whole it does not present any promising mineral character, but it is highly probable that gold may be discovered in small quantities, but it is extremely questionable whether these will prove to be payable. Small low-grade lodes are of absolutely no value, therefore without large auriferous formations are discovered there is no hope of a gold mine being worked at a profit in this district.

"The following is a return of assays made in the Survey Laboratory, under the supervision of Mr. E. S. Simpson:—

1293—No. 1	...	...	...	Gold— <i>nil</i> .
1294—No. 2	...	...	...	Gold— <i>nil</i> .
1295—No. 3	...	...	...	Gold—trace.
1296—No. 4	...	...	...	Gold— <i>nil</i> .
1297—No. 5	...	...	...	Gold— <i>nil</i> ."

Recent Mining Developments at Greenbushes.—A visit of the Assistant Geologist, Mr. Campbell, in the month of December to Mullalyup in connection with a question affecting the alienation of mining lands, afforded an opportunity for acquiring some information regarding the recent developments at Greenbushes. On his return, this officer submitted the following notes on the observations made:—

"I have the honour to report that, in accordance with instructions, I visited Greenbushes on the 13th December and obtained from Warden Geary some particulars of the localities where tantalite had been obtained.

"The principal one is M.L. 369, the Enterprise, held by Messrs. Jones, Grey, and Marsh, and is on the main road about three-quarters of a mile south of the post office. An open-cut about 12 feet deep has been made on the west side of the road; the upper seven feet shows a wash of tin and tantalite (*see* Mineral Specimens [6507, 6508, 6509]); below this is kaolinised gneiss containing a micaceous lode formation, 18 inches wide (*see* Mineral Specimen [6506]), slightly greenish in tint, but in places slightly ferruginous, carrying particles of tantalite and tourmaline from coarse dust to chunks; one inch in diameter. A drive has been put on the lode 30 feet. The lode is seen for 18 feet when it tapers out, but the micaceous formation continues and appears to be making again at the end of the drive. The strike of the lode is 323 degrees and the underlay 22 degrees to the south-west. A shaft, about seven feet deep, has been commenced a few yards further south to reach this lode further on the underlay. A pothole one and a-half chains north-west of the last spot shows a somewhat similar wash; *see* Mineral Specimen [6508]. Sample [6509] is the washed ore, ready for the market.

"A little tantalite is said to have been found in wash with tin on the next lease to the north, No. 370, The Wills, held by Alfred Seabrook, and a claim, No. 755, the Dill-McKay, held by Messrs. Hille and O'Farrell, adjoining the east side of M.L. 369, and also in M.L. 379, the Galtimore, held by Messrs. Marsh and Galt; this is one mile south-westerly from the Greenbushes Well Reserve 13811; it adjoins part of the south side of M.L. 313, The Battler's Hope; the workings of the latter were not accessible at the time of my visit. Several shafts have been put down in a line bearing 235 degrees at a depth of 40 feet in kaolinised granite; a micaceous lode containing tantalite is stated to have been found. (*See* Mineral Specimen [6375] given by Mr. Galt.)

"The remainder of the day I devoted to the examination of several leases where it appeared that tin-bearing lodes were being worked. Most work has been done in the Cornwall, M.L. 356, formerly No. 40, when it was held by the Greenbushes Tin Development Co., a Kalgoorlie syndicate I understood. The old workings comprised several shafts from 60 feet to 120 feet depth on the various lines of lode, of which there appear to be four in number (*see* Mineral Specimens 6510, 6511, 6512), striking about 161 degrees with a westerly underlay of 84 degrees. The two western lodes at least are in decomposed granite, and either one or two of the eastern lodes are probably in the dark mica schist [6514] showing in the dump of the 120-feet shaft. Very little stoping appears to have been done by this company, their chief endeavour being to go deeper. The mine was reported on by Mr. Maitland, the Government Geologist, on the 26th of October, 1901, in connection with an application of several mines for Government subsidies, shortly before the mine was abandoned. The present owners, Messrs. Woodgate and Meagher, have been stoping and driving from the old workings at 60 feet to the surface of the decomposed rock, which is overlaid by about 7 feet of tin wash and gravel. They state that they found rich patches of ore. They have also sunk several minor shafts with drives and stopings, and have been very well satisfied with the mine.

"The Statist's returns for the year 1904 give the output as 2·33 tons value £163. This is the total value for that date. I inspected part of the workings down to 50 feet depth; the next level at 65 feet was partly flooded, so that I could not see that part. The lodes are somewhat sinuous, and vary from 18 inches to 5 feet in width, and are approximately parallel, though probably not all continuous through the lease. The formation in which the tin accompanied with tourmaline occurs is more or less decomposed granite slightly ferruginous in places and represent probably impregnations of the granite adjacent to a line of weakness caused by either fracture or pressure as is frequently the case in the Cornish mines in England.

"At M.L. 300, the South Cornwall, adjoining a portion of the west boundary of the previously described lease, another parallel lode is being worked. The main shaft is 80 feet deep, and the lode adjacent is stoped from 63 feet to the surface, for a width of eight feet from the western side where the schist is more decomposed there is a crosscut east for 78 feet which the owners state is tin-bearing all the way. This shaft is to be deepened 50 feet more, the country rock is mica schist.

"About 100 feet further north the lode has been opened up by a 50-foot shaft and is stoped from 50 feet to surface for about 250 feet in length.

"The Statist's return for the year 1904 gives for South Cornwall leases, M.L. 300 (315), 4·50 tons value £330; total to date, 13·10 tons value £931.

"Another lease, No. 374, the Lost and Found, which comprises portion of the extinct M.L. 56, Amanda, is now held by Messrs. Andrew, Winter, and McGowan, and is situated $1\frac{1}{2}$ miles south of the Post Office, at the Bunbury end; here a shaft 54 feet deep in kaolinised granite has been sunk on a lode composed of four veins or bands of about five inches each, in a total width of four feet, having an underlay of about 25 degrees to the east and a strike of 40 degrees. The formation is gneissic and slightly ferruginous in places; no lode mining has previously been done here. See Mineral Specimen [6516]. This formation carries crystals of tin and tourmaline, and resembles the lode in the Cornwall lease. I was informed by Mr. Andrew that, in the lead of tin-wash near here, a solitary specimen of gold was found, weighing $1\frac{1}{2}$ grains, at 24 feet depth.

"In Dumping Gully, three-quarters of a mile north of the post office, another lode said to be five feet wide has been opened up in M.L. 375, the Glasgow, to about 30 feet depth. I did not visit the locality but obtained samples from 30 feet depth and near the surface from Warden Geary. The name of White Lode has been given to it, as it is not ferruginous; see Mineral Specimens [6517, 6518].

"I also visited M.L. 313, the Battler's Hope, held by W. and J. Johnston, already referred to, where two shafts of 113 feet and 110 feet have been put down in a mica and tourmaline schist [6515]. The wash level at the 113-foot shaft, the easternmost shaft, is at 93 feet; here, a drive, I was informed, goes 100 feet west. The wash contained numerous water-worn boulders of quartz up to six inches diameter. The 110-foot shaft is 91 feet to the wash; a drive goes 970 feet to the west. I understand that a Government subsidy of £115 7s. 6d. was paid for sinking and driving. Unfortunately no payable wash was found. Generally in regard to the floor on which the wash occurs in this district, I was informed that it is frequently on the smooth surface of the undecomposed rock. Great activity prevails on the various leases owing to the high price of tin, which was 27s. 6d. per unit at the time of my visit.

"Since my return, I find on inquiry that the monthly returns of tin won discriminate between lode and stream tin, but the Statist's published returns give only black tin. I would suggest that the two kinds of mining be distinguished in the same way that alluvial gold is shown distinct from reef gold, and enable the change in the character of mining in this district, that is coming about, to be appreciated."

Boring for Coal near Mullewa.—Reference was made in the Annual Progress Report of the Geological Survey for the year 1903 to the Carboniferous Rocks of the Irwin River Series, and it was suggested that as the discovery of commercial coals along any portion of the Murchison Railway would be of the utmost public importance, some experimental boring should be carried out in that district.

In the month of November, 1903, arrangements were made with the Goldfields Diamond Drilling Company to bore at the $47\frac{1}{4}$ mile peg on the Geraldton to Cue Railway Line; the position of the spot may be found by reference to Lithograph C 55 issued by the Department of Lands and Surveys.

Operations were duly commenced, and despite the many causes which stood in the way of boring, a total depth of 1,418 feet was reached.

The following is a description of the strata pierced, so far as can be ascertained from the data and cores in this office:—

Strata.	Thickness of Cores.
	Feet.
Sandstone and grit...	405
Light grey mudstones and bands of fine sandstone ...	195
Pebble grits, ferruginous sandstones, grey shales, fine sandstone, grits, shales, and pyrites, and fine sandstones	150
Light grey mudstone with carbon and dark shales with pyrites, light grey micaceous sandy shale	80
Grey mudstone with bands of pyrites and quartzites ...	120
Light grey mud stones, dark grey shales with pyrites and coaly particles ...	85
Yellow grit, carbonaceous shales, black grit, dark grey micaceous shale coal ...	285
Dark carbonaceous shale with pyrites and bands of hard, dark dolomitic limestone	40
(No record) ...	58
Total depth ...	1,418

The bore was carried down to a depth of 1,418 feet, when operations were suspended. The strata pierced belong to the Permo-Carboniferous series, hence the object for which the bore was put down cannot be said to have been accomplished until the base of the formation has been unequivocally reached. It is proposed to carry out further boring in the district after a more detailed geological examination has been made to determine whether the whole series could not be penetrated by a series of shallow bores in the valley of the Greenough River or some of its branches.

Miscellaneous Mineral Notes.—Mr. Simpson has prepared the following notes upon some of the more important minerals, which have passed through the laboratory during the whole period under report:—

"Tantalum ores.—One of the most interesting features of the year has been the sudden demand for the hitherto useless metal tantalum and its ores. As much as 18s. per lb. for 80% ore was paid early in the year in London. Prices rapidly fell, however, owing to the large production and limited demand to about one-sixth of that amount. In this connection the ultimate value of the research work carried out in the laboratory was well illustrated. Immediately news was received in Perth of the demand for tantalum ores, abundant information with regard to those ores and their occurrence in the State was available for the information of those interested in the matter.

"Tantalum was first detected in this State in Greenbushes stibiotantalite (tantalate of antimony) by Mr. Goyder, of Adelaide, in 1896. Subsequently in 1900 tantalite (tantalate of iron) was detected in this laboratory in alluvial material from Greenbushes; manganotantalite (tantalate of manganese) in 1904 in material from Wodgina (Pilbara G.F.); manganocolumbite (niobate and tantalate of manganese) and calciotantalite (tantalate of lime and iron) in 1905 from Wodgina and Green's Well (Pilbara G.F.).

"At Greenbushes tantalite has been found *in situ* as a constituent of a highly micaceous greisen, but is most frequent in water-worn pieces from the size of fine shot up to 13lbs. in weight, associated with stream tin ore. An analysis of a detrital specimen yielded the following results:—

G.S.M. 2025.

Ta ₂ O ₅	...	...	...	...	...	...	...	...	80.61
Nb ₂ O ₅	...	...	...	...	...	...	...	...	2.50
SnO ₂	...	...	...	...	...	...	...	...	1.51
WO ₃	...	...	...	...	...	...	...	...	.13
H ₂ O combined	...	...	...	...	...	...	...	...	.14
FeO	...	...	...	...	...	...	...	...	10.94
MnO	...	...	...	...	...	...	...	...	3.78
NiO	...	...	...	...	...	...	...	...	.02
MgO	...	...	...	...	...	...	...	...	.19
(Ce.Y) ₂ O ₃	...	...	...	...	...	...	...	...	Nil
									99.82
Sp. Gr.	...	...	...	...	...	...	...	...	7.74

"This specimen, like all other obtained from Greenbushes, showed no crystal faces.

"Associated with the tantalite, but in much smaller and less frequent pieces, is the unique mineral stibiotantalite. It is found forming thin veins in tantalite, of which it is almost certainly an alteration product due to the passage of antimonial solutions through cracks in the parent mineral, and also occurs in water-worn fragments from the size of a pin's head up to about two inches in diameter. Most of these consist of pure yellow stibiotantalite, but some consist of an ill-defined black core of tantalite surrounded by yellow stibiotantalite. It is always more or less well crystallised and exhibits one very distinct cleavage. Assays of various samples of it have given the following results:—

Ta ₂ O ₅	...	51.13	...	51.95	...	50.57 per cent.
Nb ₂ O ₅	...	7.56	...	4.49	...	12.58 "

"At Wodgina and Green's Well manganotantalite and manganocolumbite occur in detrital fragments from small grains up to 37 lbs. in weight associated with more or less tin ore, as well as *in situ* in veins of albite-granite. Specimens are frequently well crystallised, and the following faces were recognised on a parcel of crystalline ore from Green's Well:—a,100; b,010; c,001; u,133; k,103; m,110; e,021; g,130; y,210; z,530. These are arranged in their relative order of frequency.

"Natural Nitrates.—The naturally occurring nitrates of soda and potash have for many years been very profitably worked for use as fertilisers, etc., in the desert regions of Chili, India, and other countries. Owing to the somewhat similar conditions prevailing in the interior of this State, a keen lookout has been kept for some years for indications of their existence. The following are the most interesting results so far obtained:—

L.756B., Soil,	Kurrawang	...	...	Sodium nitrate	0.1614 %.
889B., Water, Cue	...	...	...	"	0.0217 "
1125B., "	Pingin	...	...	"	0.0063 "
1254B., "	Leonora	...	...	"	0.0181 "
1271B., "	Mt. Ida	...	...	"	0.0029 "
1274B., "	Meekatharra	...	...	"	0.0231 "
1278B., "	Yundamindera	...	...	"	0.0085 "
1279B., "	Niagara	...	...	"	0.0156 "
1280B., "	Boogardie	...	...	"	0.0079 "
1281B., "	Lennonville	...	...	"	0.0055 "
1409B., "	Black Range	...	...	"	0.0222 "
1513B., "	Pingin	...	...	"	0.0157 "

"Waters from the Norseman and Phillips River Goldfields show only the faintest traces of nitrates. In view of the close association of nitrogen-fixing bacteria with leguminous plants, it is interesting to note

that all the nitrate-bearing waters come from the "mulga country," that is from that large area of the State in which mulga (a variety of the leguminous genus *Acacia*) forms by far the greatest part of the vegetation.

"*Bat Guang*.—A sample (L.929B) of this material said to represent 100 tons raised from a cave at Yanchep, 30 miles north of Perth, has been analysed with the following results:—

Moisture	13.89
Organic matter	21.99
Mineral matter, insoluble	22.91
" " soluble	41.21
	<hr/>
	100.00
Total Phosphoric anhydride, P_2O_5	13.19
" Lime, CaO	19.56
" Nitrogen, N	3.36
Viz., Nitrogen as nitrates	1.61
Organic nitrogen	1.75

"In this connection it is interesting to quote an analysis recently made of a sample (L.948B) of pseudo-bitumen from the Wilgi Mia (War-paint Cave), Weld Ranges:—

Moisture over H_2SO_4 and at $80^\circ C$	2.17 per cent.
Loss at 100° (Ammonia, etc.)	1.03 "
Organic lost at red heat	43.88 "
Ash SiO_2	6.17
Fe_2O_3	23.62
Al_2O_3	2.15
MnO ... ..	.18
CaO	2.27
MgO ... ..	.90
K_2O	9.88
Na_2O ... ..	.66
P_2O_5 ... ..	.85
SO_3	2.20
Cl	5.69
	<hr/>
	54.57
Less $O=Cl$ 1.65	52.92
	<hr/>
	100.00
Total Nitrogen	3.58 per cent.
Action of Solvents—	
Gold water	Extract 53.23 "
" alcohol	6.39 "
Boiling ether ... ..	.96 "
" chloroform ... ..	.43 "
" carbon bisulphide	1.06 "

"The water extract included all the organic matter except a little short hair.

"The material analysed was typical of a number of samples that have been received from time to time from different parts of the State. They have been collected under the impression that they were true bitumens and possibly indicative of the existence of petroleum. It is evident from the composition and behaviour with solvents that though they resemble bitumen in outward appearance and smell they are really the result of the drying up of water which has passed through beds of bat or marsupial guano, and extracted therefrom organic matter and salts of potash, etc. The iron and silica in the sample are present in the form of dust derived from the walls of the cave, which is hollowed out of a lode of siliceous iron ore.

"*Crocidolite*.—The occurrence in the State of the yellow variety of this gem (tiger's eye) was recorded in the annual report for 1903.* During 1905 analyses were made of some of the gem itself from Yarra Yarra Creek and of the yellow opaline matrix enclosing it. The results are as follows:—

	Crocidolite.	Matrix.
SiO_2	91.24	84.42
H_2O above $100^\circ C$	3.60	4.08
K_2O ... ..	.05	.12
Na_2O ... ..	.32	.24
MgO ... ..	.13	.52
CaO	Trace	.08
Fe_2O_3	2.87	7.17
Al_2O_3 ... ..	.77	1.43
H_2O at $100^\circ C$	1.20	1.96
	<hr/>	<hr/>
	100.18	100.02
	<hr/>	<hr/>
Sp. Gr.	2.13	2.36

"*Graphite*.—During the past year considerable interest has been taken locally in deposits of graphite, and those on the Donnelly River have been worked to a slight extent. The surface material at this locality consists of a very greasy clay impregnated with fine amorphous graphite, the mixture being incapable of concentration. Very few samples have been obtained from below the water line, and these appear to consist of a chlorite slate with fine scaly graphite both in bunches and also more or less evenly distributed through the mass.

* Annual Progress Report for 1903, p. 27.

The following are typical analyses :—

No.	...	...	...	...	L.840B	...	1188B	...	1189B
Graphite (Fixed Carbon)	...	...	...	...	32.48	...	38.74	...	41.86
Moisture	...	...	...	...	7.16	...	.94	...	.90
Volatile at red heat	...	...	...	...	5.77	...	4.18	...	4.42
Ash	...	...	...	...	54.59	...	56.14	...	52.82
					100.00	...	100.00	...	100.00

“Crystalline flakey graphite occurs in the Northampton district in a matrix of oxide of iron and clay, from which it is readily separated by washing. The following are typical analyses :—

No.	...	...	...	...	765	766	766A
Description.					Crude Ore.	Crude Ore.	Concentrates from 766.
Graphite (Fixed Carbon) ..					68.92	12.41	61.04
Moisture	...	...	...	...	.39	1.08	.21
Volatile at red heat	...	...	...	...	4.82	7.10	4.01
Ash	...	...	...	...	25.87	79.41	34.74
					100.00	100.00	100.00

“*Chromiferous Laterite*.—A sample of laterite iron ore was received from Comet Vale (North Coolgardie) for iron assay, and proved very interesting on account of the presence in it of a notable amount of chromium, mostly in the form of a hydrate readily soluble in hydrochloric acid, the balance being present in the form of chromite. The ore was of the usual cellular and concretionary type, black and brown in colour. The following results were obtained on analyses :—

Fe ₂ O ₃	...	...	...	...	...	...	79.01 per cent.
Cr ₂ O ₃	...	...	...	...	...	...	5.30 ”
SiO ₂	...	...	...	...	...	...	3.14 ”
S	...	...	...	...	...	...	.124 ”
P	...	...	...	...	...	...	.078 ”
H ₂ O by difference	12.35 ”
							100.002 ” ”

I have, etc.,
A. GIBB MAITLAND,
Government Geologist.

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