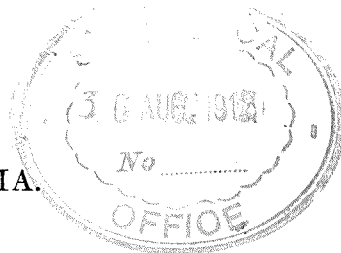


GEOLOGICAL SURVEY
OF WESTERN AUSTRALIA

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ANNUAL PROGRESS REPORT

OF THE

GEOLOGICAL SURVEY

FOR THE YEAR 1911.

PERTH:

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

1912.

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ANNUAL PROGRESS REPORT OF THE GEOLOGICAL SURVEY FOR THE YEAR 1911.

The Secretary for Mines.

The Annual Report of the Geological Survey for the calendar year 1911, which is submitted herewith for the information of the Hon. the Minister for Mines, follows the general plan and arrangement of its immediate predecessors.

THE STAFF.

The work of the Department has been carried out during the period under review by 19 officers.

The additions to the numerical strength of the staff, referred to in the previous annual report, were made during the year, and comprised three field geologists, one assistant field geologist and a petrologist, together with an assistant mineralogist and assayer for work in the laboratory. These additions will enable a great deal of field and other incidental work to be carried out over a large area with greater rapidity than has been the case in the past.

FIELD WORK.

The field work of the year 1911 has been carried out in different portions of the State as the exigencies of the situation seemed to require.

A. GIBB MAITLAND.—A very large portion of my own time has been, as is usual in an office of this nature, devoted to administrative routine. I was absent from duty, through illness, from the 21st of February to the 8th of April, and took my accumulated recreation leave immediately thereafter, returning to office work on the 13th of May. Despite this lengthy absence, opportunity presented itself for devoting a little time to work in the field.

In the month of January I accompanied, as Government representative, the Scottish Agricultural Commission on their visit of inspection to Kalgoorlie and Boulder.

February found me in Meekatharra, in connection with the question of mining on the water reserve at Garden Gully.

In accordance with the special instructions of the Government, a more or less detailed investigation of the underground water resources of the belt of wheat-growing country lying to the south of Norseman, the existence of which had been previously reported by the members of the Railway Advisory Board, was made by myself during the months of August and September.

The period between the 29th of October and the 10th of November was spent in Kalgoorlie upon an inspection of the field work carried out by Messrs. Blatchford, Jutson, and Feldtmann.

The interval between the 3rd and the 21st of December found me at Kanowna and Kalgoorlie in connection with the work at the former centre being carried out by Messrs. Blatchford and Jutson.

Short visits were also paid to the Darling Range, where, when opportunities presented themselves, the mapping of the high level laterites was in progress.

Geological Survey Office,

Perth, 15th January, 1912.

This latter work forms part of that which has been carried out more or less intermittently during a number of years past, in connection with a detailed geological survey of the metropolitan area. Altogether I was absent from Perth on field duty 108 days during the year.

H. P. WOODWARD.—On the 19th of January this officer left Perth to rejoin his party with the camels at Mount Magnet, at which place they had been left on the termination of the field work of the months of November and December, referred to in the annual report of last year. The work carried out by Mr. Woodward on the flying survey was brought to a conclusion at Burracoppin on the 4th of March. The middle of March found this officer at Meekatharra investigating the questions of mining on the water reserve at Garden Gully. In May short visits were paid to Southern Cross in connection with the work being carried out at that centre by the recently appointed members of the field staff: to Rottneest Island in connection with its underground water supply; and to Eradu, on the Greenough River, regarding boring for coal.

In June visits were paid to Cue, in connection with the selection of sites for suggested boring for quartz reefs on Volunteer Flat: to Pinjarrah regarding the purchase of land containing limestone deposits.

July found Mr. Woodward in Albany with the object of inspecting the site of some coal-boring operations on the Fitzgerald River.

In August visits were paid to Donnybrook to report upon some supposed coal finds: to Armadale, in company with the Federal naval officers, regarding a quarry site.

Between the 1st and 11th of September Mr. Woodward was engaged on a trip of inspection to Mount Jackson, on the Yilgarn Goldfield.

A large portion of the month of October was spent on the Murchison and Peak Hill Goldfields, visiting Meekatharra, Namine, Stake Well, Tuckanarra, and Cue.

The month of November was mostly taken up with work for the Lands Resumption Office with regard to some brick pits at Bellevue.

December was occupied with short visits to Marvel Loch in the Yilgarn Goldfield, to Rottneest Island in regard to its water supply, and to Kelmscott in connection with the site of the proposed State brickworks.

During the twelve months under review, Mr. Woodward spent 145 days in the field, in addition to which he also carried out the other multifarious duties incidental to the administration of the office during my absences therefrom.

TORRINGTON BLATCHFORD.—This officer, who had previously occupied the position of Assistant Government Geologist, was appointed Field Geologist for a period of two years. Mr. Blatchford reported himself on the 30th of March, and after a few days pre-

paratory work in the office left for Coolgardie to make an examination of the country in and around Coolgardie, with the object of fixing suitable sites for locating auriferous ore channels by means of boring operations. The necessary field work occupied him until the 20th of May.

In June instructions were issued to Mr. Blatchford to proceed to Coolgardie to extend to the southward, beyond the old Londonderry gold mine, the detailed survey which he carried out at that centre in 1897-98, when an officer of the Survey. Between the dates June 17th and 26th, Mr. Blatchford accompanied the petrologist, Mr. Farquharson, to the mining centres of Coolgardie, Gibraltar, Burbanks, Kalgoorlie, Kanowna, and Boorara (Golden Ridge) in order that he might become acquainted with the occurrence of the more important types of rocks in the field. The time between the 28th June and the 4th July was spent at the Majestic and Mount Monger in connection with proposals to throw open the timber reserves to a private wood and timber company. For a few days at the later end of July Mr. Blatchford accompanied myself in an inspection of the leading features of the country in and about Burbanks and Gibraltar, with the view to deciding the exact lines upon which his field work should be carried out.

On August the 16th Mr. Blatchford had completed in more or less detail some 60 square miles in and around Burbanks, when he proceeded to Gibraltar, from which centre he started a survey of the country extending from Bullabulling on the north to Victoria Rocks on the south, and eastwards as far as the old Norseman-Coolgardie coach road. This work, which occupied Mr. Blatchford up to the end of September, has been laid down on a map on the scale of one inch to the mile, and roughly embraces an area of 900 square miles.

After a brief visit to Perth, Mr. Blatchford completed some underground work in the mines at Burbanks in the month of October, and thereafter accompanied Mr. Feldtmann to Kalgoorlie.

Early in November I joined the party and laid out the lines upon which the work was to be extended as far as Kanowna, and the surrounding district.

From the 8th to the 17th of November Mr. Blatchford was at headquarters preparing the necessary field plans for this work, which occupied him, in conjunction with Mr. Jutson, Field Geologist, until the 21st of December.

During his nine months' service Mr. Blatchford spent 233 days in the field.

E. C. SAINT-SMITH.—This officer, who had been appointed from the staff of the New South Wales Survey to one of the newly created positions of Field Geologists, reported himself on the 3rd of April. On the 24th of the month he proceeded to Southern Cross, where until the 9th of August he was mainly engaged, with the assistance of three of his colleagues, in a more or less detailed geological survey of the district and the preparation of a geological plan, on the scale of 100 feet to the inch, of the area traversed by the main ore channel in the more immediate vicinity of Southern Cross itself. During the period in question Mr. Saint-Smith examined several areas at Marvel Loch, Lake Koorkoordyne, Mount Rankin, Southern Cross, etc., in connection with the alienation of mineral lands. On the 13th of May an inspection was made of a supposed asbestos discovery at Golden Valley.

Three days at the end of June were spent in accompanying Mr. Farquharson over the Southern Cross and Bullfinch districts to enable that officer to become personally acquainted with the rocks in the fields, which he had under examination. The 18th of August was devoted to assisting Mr. Woodward in sampling the Maori Lass lease, near the New Zealand Gully dam, in connection with an application for a subsidy.

From the 13th of September to the 19th of December, Mr. Saint-Smith was engaged on an examination of the Donnybrook Coal Series, between that locality and the South Coast. Preparatory to this a short time was spent in acquiring a general knowledge of the geology of the country between Perth and Bunbury; and two days were spent by him on the Collie Coalfield.

During his term of service Mr. Saint-Smith was engaged 216 days in the field.

J. T. JUTSON.—It was not until the 22nd of August that this officer reported himself at headquarters, so that very little opportunity was afforded for carrying on any extended field work. On the 30th of August Mr. Jutson proceeded to Kalgoorlie, where he was engaged for some time in acquiring a knowledge of its structural geology, with a view to the mapping of the auriferous series to the northward in the direction of Broad Arrow, Kanowna, etc. This work occupied Mr. Jutson until the 13th of November, when he returned to Perth, where plans in connection with the survey of certain mines at Kanowna were prepared. On the 20th of November Mr. Jutson proceeded to Kanowna, where, in conjunction with Mr. Blatchford, he was engaged until the 21st of December on work in connection with the mining geology of the Kanowna Main Reef line. Since the date of his appointment Mr. Jutson spent 92 days in the field.

H. W. B. TALBOT.—On the 8th of February Mr. Talbot was promoted to the position of Assistant Field Geologist. From February 8th to March 10th this officer was engaged in the Darling Range, in the vicinity of Kalamunda, on work connected with the geological map of the Metropolitan area. Between March 27th and April 12th Mr. Talbot was at Southern Cross taking part in the detailed mapping which was being carried out at that centre. Mr. Talbot spent the whole of the time between the 23rd of May and the 7th of November in a flying geological survey of the tract of country which lies between the Murchison and East Murchison Goldfields, in the vicinity of Lake Barlee. A few days in December were spent at Kelmscott in connection with investigations regarding the proposals to establish State Brickworks.

The total number of days Mr. Talbot spent in the field was 230.

F. R. FELDTMANN.—This officer joined the staff in the capacity of Assistant Field Geologist on the 1st of March. Four days were spent with Mr. Talbot at Kalamunda in the Darling Range, whilst from the 27th of March to the 9th of August Mr. Feldtmann was at Southern Cross assisting Mr. Saint-Smith. The time between the 24th of October and the end of December was spent in field work at Kalgoorlie, attention being concentrated at the North End working out the structural features in considerable detail.

C. S. HONMAN.—This officer, who was appointed Topographical Surveyor, formally commenced his duties on the 10th of April.

Up to the end of May Mr. Honman was engaged on the survey of the Southern Cross Field, whilst between the 22nd of May and the 7th of November he assisted

Mr. Talbot in his examination of the country around Lake Barlee. On his return to Perth Mr. Honman proceeded to Cookernup in connection with matters arising out of the boring for artesian water, and after completing this he was engaged in continuing the survey of the high level laterites which cap the Darling Range in the neighbourhood of Kalamunda.

R. A. FARQUHARSON.—This officer, who was appointed to the newly-created post of Petrologist, reported himself on the 20th of April. Mr. Farquharson's first duty was naturally to make himself as fully conversant as possible with the character of the rocks and minerals of the State, such as could be ascertained by carefully going over the numerous rock specimens and micro slides already in the Survey collection. As opportunity offered during the routine inseparable from an office of this nature a careful revision was made of the collection with the view to bringing the classification of the material into line with the modern system of nomenclature, and the formation of a reference collection for the use of the field staff and the general public.

In addition to this very necessary work, a large number of petrographical determinations have been made of the rocks collected by the field geologists in the course of the year's work.

Between the dates of June 16th and June 30th Mr. Farquharson devoted his time to acquiring a personal acquaintance with the rocks, in the field, at Kalgoorlie, Coolgardie, Southern Cross, and Bullfinch.

July was devoted to an examination of the rocks from Warrawoona, in the Pilbara Goldfield; bore cores from Whim Creek; and cores from the Cookernup artesian water bore. Investigations were also commenced into the origin of the so-called banded hematite schists which make such a marked stratigraphical feature in most of the Western Australian Goldfields.

August was chiefly devoted to determinations of specimens sent in by Mr. Blatchford from Coolgardie; a report on several rocks from Mons Cupri mine, on the West Pilbara Goldfield; whilst a report was prepared on the material collected by Mr. Saint-Smith in the course of his work at Southern Cross, the results of which will be incorporated in the Bulletin of that field, which is in the course of preparation.

The naming and description of various rocks from Kalgoorlie occupied the greater part of September; the balance of the time being spent in the petrographical description of the rocks associated with the ore body in the Ingliston Extended mine at Meekatharra; of some specimens from Three Springs and bore cores from Kellerberrin. A short time was spent in work in the field at the end of the month.

October was largely devoted to routine work in the office, and in preparing material for a forthcoming Bulletin, containing a further instalment of Miscellaneous Reports. The latter half of October was spent on the Murchison Goldfield, examining the ore bodies and adjacent rocks in several of the mines. The results of these observations will be shortly issued in Bulletin form.

November was devoted to routine work, in preparing several reports for publication, and in drawing up a brochure on rocks and rock-making minerals for the use of prospectors and others.

A portion of December was taken up with work connected with a petrographical description of rocks from the deep mines at Kalgoorlie for the Royal Commission on Miners' Lung Diseases, and in miscellaneous determinations for the officers of the field staff.

The attached table shows the disposition of the field staff during the year and the time each officer spent in the various districts:—

Table showing the Distribution of Field Work during the Year 1911.

| Goldfield or Land Division. | H. P. Woodward. | | T. Blatchford.* | | E. C. Saint-Smith. † | | J. T. Jutson. ‡ | | H. W. B. Talbot. | | F. R. Feldtmann. | | C. S. Honman.§ | |
|-------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|---------------------------|------------------------------|
| | No. of days in the field. | Percent-age of working days. | No. of days in the field. | Percent-age of working days. | No. of days in the field. | Percent-age of working days. | No. of days in the field. | Percent-age of working days. | No. of days in the field. | Percent-age of working days. | No. of days in the field. | Percent-age of working days. | No. of days in the field. | Percent-age of working days. |
| East Murchison | 3 | 1·0 | .. | .. | .. | .. | .. | .. | 75 | 24·0 | .. | .. | 75 | 24·0 |
| Murchison | 28 | 8·9 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Yalgoo | 16 | 5·1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| North Coolgardie | 8 | 2·6 | .. | .. | .. | .. | .. | .. | 73 | 23·3 | .. | .. | 73 | 23·3 |
| Broad Arrow | .. | .. | .. | .. | .. | .. | 2 | ·6 | .. | .. | .. | .. | .. | .. |
| North-East Coolgardie | .. | .. | 34 | 10·9 | .. | .. | 40 | 12·8 | .. | .. | .. | .. | .. | .. |
| East Coolgardie | 2 | ·6 | 28 | 8·9 | .. | .. | 62 | 19·8 | .. | .. | 69 | 22·0 | .. | .. |
| Coolgardie | .. | .. | 171 | 54·6 | .. | .. | 2 | ·6 | 6 | 1·9 | .. | .. | 6 | 1·9 |
| Yilgarn | 63 | 20·1 | .. | .. | 118 | 37·7 | .. | .. | 50 | 16·0 | 131 | 41·9 | 50 | 16·0 |
| South-West | 25 | 8·0 | .. | .. | 98 | 31·3 | .. | .. | 26 | 8·3 | .. | .. | 34 | 10·8 |
| Totals | 145 | 46·3 | 233 | 74·4 | 216 | 69·0 | 106 | 33·8 | 230 | 73·5 | 200 | 63·9 | 238 | 76·0 |

*Appointed, 30th March, 1911. † Appointed, 3rd April, 1911. ‡ Appointed, 22nd August, 1911. || Appointed, 28th February, 1911. § Appointed, 5th April, 1911.

LABORATORY WORK.

Mr. E. S. Simpson has, as usual, continued in direct charge of the Survey Laboratory. During the year 1911 the total number of samples dealt with amounted to 1,999 as against 1,733 in the previous year. The assay work required by the State Battery Branch has been, as heretofore, carried out in the

Survey Laboratory by an officer, Mr. Murray, whose salary becomes a charge upon the State Battery vote. The total number of assays performed in this connection is included in and forms the bulk of the work done for "Other Departments," set out at length in the attached table, showing the routine work performed during the year 1911.

Table showing Routine Work of the Geological Survey Laboratory during 1911.

| Description. | Public. | | Official. | | Totals. |
|--|---------|-------|---------------------|---------------------|---------|
| | Pay. | Free. | Geo-logical Survey. | Other Depart-ments. | |
| Samples Registered. | 126 | 687 | 121 | 1,065 | 1,999 |
| Assays for Gold | 104 | 459 | 23 | 1,045 | 1,631 |
| " Silver | 2 | 108 | 12 | 32 | 154 |
| " Copper | 10 | 63 | .. | 17 | 90 |
| " Tin | 1 | 22 | 1 | 1 | 25 |
| " Lead | .. | 9 | .. | .. | 9 |
| " Tungsten | .. | 2 | 5 | .. | 7 |
| " Nickel | .. | 5 | .. | .. | 5 |
| " Other Metals | 4 | 16 | .. | 1 | 21 |
| Analyses complete | 3 | 3 | 53 | 5 | 64 |
| " partial and proximate | 5 | 4 | 33 | 1 | 43 |
| Determinations and reports on minerals | 4 | 226 | 28 | 13 | 271 |
| Miscellaneous Examinations | 6 | 15 | 41 | 5 | 67 |
| Totals | 139 | 932 | 196 | 1,120 | 2,387 |

Reporting, at my request, upon the work carried out under his more immediate supervision, Mr. Simpson states:—

At the beginning of the year there were two vacancies in the professional staff as shown by the Public Service List, viz., those of Senior and 3rd Assistant (Nos. 629 and 631). The former position was filled by the appointment of Mr. A. J. Robertson, B.Sc., who entered upon his duties on the 5th May. The other position (631) has not yet been filled. As the doubling of the field staff of the Survey during the year has greatly increased the work of the Laboratory, the logical outcome is that this work is getting far into arrears, with no immediate prospect of overtaking it. Extra assistance is urgently needed.

Details of such routine work as is capable of tabulation are shown in the accompanying table. In addition much time is spent in giving prospectors and others verbal information as to the value and uses of minerals, methods of preparing for market, etc.

Fees are charged for all umpire and check assays and for some few other classes of work done for the public. No fees are collected for the work done for other Government Departments nor for those numerous investigations made for prospectors under the "Free Assay Section" of the Regulations. Were the Laboratory credited with the value of this work as it should be, its finances would bear a very different aspect as the following figures show:—

| | £ | s. | d. |
|--|--------|----|----|
| Revenue actually received for Pay | | | |
| Assays | 106 | 11 | 6 |
| Value at schedule rates of work done free for other Government Departments | 833 | 0 | 0 |
| Value at schedule rates of work done free for the General Public | 733 | 0 | 0 |
| Total expenditure of Laboratory on salaries and supplies | £1,265 | 0 | 0 |

In February the manuscript of a monograph on the Minerals of Kalgoorlie was handed to the Government Geologist. Later in the year several short articles were written for insertion in a Miscellaneous Bulletin.

At the request of the Museum authorities a revised Census of Minerals of the State was prepared for publication in a new issue of the Natural Science Section of the official Year Book.

By permission of the Government Geologist, a paper was read before the Natural History and Science Society describing some unusual petrifications from Dandarragan. It described the conversion of coniferous wood of Mesozoic age into fluor-apatite (fluorophosphate of calcium), and dufrénite (hydrated phosphate of iron).

Several collections of local minerals were prepared for distribution abroad.

Opportunity was found during the year to initiate an investigation into the clays of the State. Practically no official information is available with regard to these, though they are destined to form the basis of many permanent industries as time goes on.

Further information was obtained as to the actual quality of the gold in some locally-made jewellery. It was found, as on previous occasions, that the metal in some examples was well below the fineness stamped upon them.

During previous years some samples of Fergusonite (tantalate of yttrium) from Cooglegong were distributed with a view to opening up a market for the mineral. One of these samples was subjected to examination by Prof. E. Wedekind of Strassburg University. In conjunction with W. Maas, Prof. Wedekind published an article in the *Zeitschrift für angewandte Chemie (Journal of Applied Chemistry)*, which concluded thus:—

As the result of our experience up till now, we feel justified in recommending the Australian fergusonite as a starting point for the preparation of tantalum salts, all the more because the preparations at present on the market are just as expensive as they are impure.

Since the new radio-active mineral, PILBARITE, was discovered at Wodgina, a keen lookout has been kept for other radio-active minerals. At a greater depth in the same lode, two further minerals have been found containing uranium, radium, and thorium. These minerals resemble, and may be identical with, two minerals, mackintoshite and thorogummite, previously

recorded from Texas, U.S.A. The chief constituents of the three Wodgina minerals are:—

| | Mackintoshite? | Thoro-gummite? | Pilbar-ite. |
|--|----------------|----------------|-------------|
| Thoria, ThO_2 | 24.72% | 24.46% | 31.34% |
| Uranium dioxide, UO_2 | 35.60% | none | none |
| Uranium trioxide, UO_3 | trace | 37.33% | 27.69% |
| Radium by calculation, centigrams per ton | 11 | 10 | 7 |

All three minerals are of high commercial value, and representative samples have been requisitioned from England, France, and Germany for experimentation on industrial lines. A detailed description of their occurrence, composition, and properties is now in course of preparation.

RUTILE (oxide of titanium) has been known for some years to occur at Yulgering Spring in the Avon district. Recently a typical sample has been shown to contain:—

| | |
|--|--------------------|
| Titanium dioxide, TiO_2 | 94.97% |
| Iron sesquioxide, Fe_2O_3 | 2.81 |
| Chromium sesquioxide, Cr_2O_3 | .33 |
| Silica, etc. | 2.36 |
| | <hr/> 100.47 <hr/> |

Its comparative purity having thus been established, efforts are now being made to open up the deposit and export the mineral. Its chief application is in the manufacture of titanium-steel rails.

AMBLYGONITE, a commercially valuable fluo-phosphate of lithium and aluminium, has been detected in specimens from a pegmatite vein at Ravensthorpe. It has previously been recorded from Ubini.

BARYTES (sulphate of barium) was discovered at Cardup Brook near Beenup, but samples submitted were not sufficiently pure to be of commercial value. A bulk sample yielded:—

| | |
|--|---------|
| Barium Sulphate, Ba SO_4 | 55.33 % |
| Silica, Si O_2 | 36.98 % |

Three new metallic METEORITES have been examined during the year, two being from Premier Downs in the Eucla Division, the third from Mt. Dooling in the Ullaring district. Descriptions of two of these have been prepared for inclusion in a Bulletin.

PETROLOGICAL WORK.

Mr. Farquharson, who had been specially appointed at Petrologist to assist in undertaking the whole of such work required in connection with the field operations carried out by the Department, reports upon his year's work in the following terms:—

My first care, after entering upon the duties of my office on the 20th April, 1911, was naturally to become as fully conversant as possible with the state of knowledge of the geology, and in particular of the petrology, of the colony in so far as it could be gathered from the specimens and publications of the Survey. Accordingly, with the exception of determining various specimens for the Mines Department, I spent the month of May in going over both the mineral and rock collections of the Survey in the Museum and the large collection of rock slides in the office. It was soon apparent that many of the identifications of rocks were not quite up to modern nomenclature. From May onwards, therefore, as opportunity has permitted, I have devoted considerable attention to naming the collections, with the object of ultimately forming an arrangement of the rocks of the State that will serve as a reference for the officers of the field staff and as a guide for the general public.

Apart from this work, from June to the end of December I have been busily engaged along a variety of lines. To begin with, there have been many determinations to be made of both minerals and rocks for prospectors and mining men, and even for settlers. One group of specimens identified is specially worthy of mention, viz., that sent down at intervals from a locality about 40 miles west of Mount Magnet and a mile or two north of Yoweragabbie. These included massive fibrous tourmaline—schorl rock—and corundum. When it is remembered that these minerals are very frequently associations of cassiterite, it will

be obvious that a careful prospecting of the locality for tinstone is highly desirable.

There has further been a considerable amount of material reported on in connection with bores put down for water. In particular, the cores of the Cookernup bore down to a depth of 2,215 feet have all been carefully examined and described, and it has been shown that, while the supply got has, up to the present, been limited, bedrock has not yet been reached. Various specimens from other bores have been reported on, and in several cases information and advice have been given direct to those who have come for it. During the former half of the month of June I was occupied chiefly in determinations of numerous specimens from Southern Cross for Mr. St. Smith's report. Some of the results have already appeared in the Preliminary Report on that field. The striking feature of these rocks was the very large number of hornblende varieties. From a consideration of them, it is certain that many are altered forms of gabbros and dolerites in which the original augite has been changed by dynamic action to hornblende or uraltite, while the feldspars have been bent, broken, or faulted. It would, therefore, appear that many of these rocks are very old plutonic intrusions, and that, subsequent to their consolidation, they have been acted on by great earth movements, evidences of which exist all over the State. As the result of these movements, large anticlinal and synclinal faults and fault-planes, as well as fissures, have probably been produced, and these planes of weakness thus produced have allowed of the penetration of ore-bearing solutions, which have doubtless accompanied late acid and basic intrusions. Sufficient evidence is not yet available to enable a theory, properly worked out and based on the results of modern petrological work, to be put forward, but there can be little doubt that the outcome of the more or less regional survey of the Kalgoorlie field at present being undertaken, together with the deductions of the all-important petrological work, will go far towards clearing up the structure of the interior of the State and towards a true explanation of the genesis of the ore-deposits, and thus tend to materially assist the mining industry. Determinations of a number of Kimberley rocks also occupied part of my time in June. The detailed results of the examination of these will appear in the Kimberley Bulletin. Suffice it to say here that conspicuous among the specimens are various fresh and amygdaloidal dolerites, some ferruginous sandstones, and three specimens of highly epidotic rocks, one an epidosite, the other two probably epidotised diorites or related rocks. One of these two has a mineral which, pending a chemical analysis, is to be referred to glaucophane.

The latter half of June, in accordance with instructions, I spent in a brief examination of the rocks of some of the mines on the Eastern Goldfields.

During July attention was paid to some rocks from Warrawoona, two of which are described in detail for a forthcoming Bulletin. The interest of these rocks is that the existence of metamorphosed sediments in this district has been definitely established and the views previously held by the Government Geologist as to the origin of the formations at least partly confirmed.

An investigation was also begun into the origin of the so-called Banded Ironstones, which form such a peculiar feature of the landscape and geology of the State. So far as the results of this research, extending at long intervals from August to December, have shown, some at any rate would appear to be weathered and altered forms of heavily pyritised hornblende rocks. Very similar formations, called Amphibole-Magnetite rock, have been described in particular, from the Cuyuna Iron Range, Minnesota, in association with cherty iron carbonates, ferruginous cherts, etc. On a recent visit I paid to the Nemesis Mine at Tuckanarra in the Murchison Goldfield, specimens were obtained which appeared to show the passage from the ferruginous schists on the surface to a rock almost identical with the amphibole-magnetite rock of the Cuyuna. The actual mineralogical determination of the amphibole has not yet been made out but it is probably, in part at least, the species grüncrite. According to F. S. Adams, "this amphibole-magnetite rock was produced by partial anamorphism of the original iron formation due to heat and pressure developed by con-

tact with intrusive⁵ and by acute folding." It is important to note that in several instances these banded rocks are auriferous, especially where they are intersected or interrupted by quartz reefs. Unfortunately, owing to the large amount of work to be done for the field staff, a continuation of the investigation has had to be deferred.

In August, besides a considerable number of determinations for Mr. Blatchford and a report on other Southern Cross rocks, an examination was made of several specimens from the Whim Well Copper Mine, West Pilbara Goldfield. These were all highly altered rocks, now consisting some almost wholly of chlorite and secondary quartz, others of kaolinised feldspars and quartz.

Following on a determination in September of an obscure rock for Mr. Turner of the Ingliston Extended Mine, Meekatharra, a batch of the country rocks of the lode formations in this field was sent down, and since, hitherto, descriptions of these rocks had been couched in the vaguest terms, a thorough petrological examination of them has been made and an attempt to arrive at some conclusions as to the original rock and the original of the lode material. The results will be published in a forthcoming Bulletin. From the 13th to the 14th I visited Kelmseott to report on a supposed building stone in the vicinity. In spite of a diligent search, none of any quality was discovered. From the 19th to the 22nd, inclusive, I was at Collie with a view to the examination of the district.

From the beginning of October to the middle of November, my time was largely spent in reporting on rocks from Coolgardie and Burbanks for Mr. Blatchford, on specimens from the Yilgarn and Yalgoo Goldfields for the Government Geologist, on some Meekatharra specimens, and on rocks from Recovery G.M.L.L. The results will very shortly be published.

About the middle of November, seeing that for months previously it had been pretty evident that there was considerable confusion with regard to rock terminology and the principles on which it is based, I undertook to write a paper which should contain not only descriptions of the more important rock-forming minerals from the point of view of those characters which would enable an identification of them to be made with the naked eye or a lens and a pocket-knife, but also a rock classification with the names and a brief account of the chief rocks of general occurrence. This paper will be published in the forthcoming Bulletin containing the various miscellaneous Reports. During December the paper was finished, numerous determinations were made for Mr. Woodward's Report on the Peak Hill District, for Mr. Talbot's Report on his flying Survey of the North Coolgardie Country, and a report was made on a collection of specimens from the deep mines of Kalgoorlie for the Royal Commission on Miners' Lung Diseases. These latter rocks, though very much altered, can be roughly classified under two or three heads, and a close comparison of them with others in the collection will throw a considerable amount of light on the original rock facies of that field.

PALAEONTOLOGICAL WORK.

During a short visit to the Collie Coalfield in the month of September, Mr. Farquharson collected several fossil leaf impressions at West Collie, of which a more or less preliminary examination has been made. The results of this investigation have once more raised doubts as to the Permo-Carboniferous Age of the Coal Measures. No impressions demonstrably of "*Glossopteris browniana*" were obtained by Mr. Farquharson; on the other hand there were one or two extremely like those of certain Upper Mesozoic and Early Tertiary plants from New South Wales. It is contemplated making a fuller collection before any definite conclusions on the question are published.

LIBRARY.

As has been the case in the past, the Library has received a considerable number of additions during the year under review, having been increased by 741 presentations and 95 purchases.

GEOLOGICAL SURVEY COLLECTION.

The additions to the Survey Collection during the year 1911 amounted to 761, bringing the total number registered up to 12,097. The accessions comprised 174 minerals, 535 rocks, 39 fossils, and 13 bore-cores. Of microscope slides 228 were prepared during the year, and added to the collection under the care of the Petrologist, bringing the total number now on the books up to 1,675.

The officers of the Survey have, in the ordinary course of their duties in the field and the office, taken 87 photographs of geological and mining subjects, bringing the total number of negatives now registered up to 789.

In the Annual Report for 1908 reference was made to the transfer of the National Geological Collection to the Survey. In consequence of the passing of the Public Library, Museum, and Art Gallery of Western Australia Act, whereby all property, other than that which was on loan, became vested in trustees, the collection transferred was handed back to the trustees and the Survey specimens rearranged in our own cases, which are at present housed in the mineral gallery of the Western Australian Museum. Three show cases containing the Survey collection of fossils have been lent to the trustees, pending other arrangements being made regarding the housing of the Geological staff and its belongings.

A duplicate collection of about 1,200 minerals and rocks has been presented to the Museum trustees, and arrangements made whereby further duplicates will be donated as opportunity offers.

PUBLICATIONS.

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

Annual Progress Report for the Year 1910.

Topographical Map of Meekatharra.

Bulletin No. 41—The Geology and Ore Deposits of the West Pilbara Goldfield: by H. P. Woodward.

In addition to the above, there are now in the hands of the Government Printer:—

Bulletin No. 42.—Contributions to the Study of the Geology and Ore Deposits of Kalgoorlie. Part I.: by E. S. Simpson and C. G. Gibson.

whilst the following Bulletins, which represent the results of last season's field work, will very shortly be in the hands of the Printer:—

Bulletin No. 43.—Petrological Contributions to the Geology of Western Australia. I.: by R. A. Farquharson.

Bulletin No. 44.—A Geological Reconnaissance of a portion of the South-West Division of Western Australia: by E. C. Saint-Smith.

Bulletin No. 45.—Geological Investigations in the country lying between Latitude 28° and 29° 45' South and Longitude 118° 15' and 120° 40' East, embracing part of the North Coolgardie and East Murchison Goldfields: by H. W. B. Talbot.

Bulletin No. 46.—A General Description of the Northern Portion of the Yilgarn Goldfield and the Southern Portion of the North Coolgardie Goldfield: by H. P. Woodward.

Bulletin No. 47.—The Mining Geology of the Kanowna Main Reef Line, Kanowna, North-East Coolgardie Goldfield: by T. Blatchford and J. T. Jutson.

Bulletin No. 48.—Miscellaneous Reports, 9-32: by various members of the Staff.

And the following are rapidly approaching completion:—

The Geology and Ore Deposits of Coolgardie: by T. Blatchford.

The Southern Cross Auriferous Belt: by E. C. Saint-Smith.

Good progress has been made with the preparation of the general index to the whole of the geological and mining reports published by the Government, and it is hoped that this much felt want will be finally completed before the close of the present financial year.

In order that the index might be speedily completed, the services of Mr. J. J. East, whose literary and technical attainments render him well qualified for special work of this nature, were enlisted, and his temporary appointment dated from the 15th of August.

GENERAL.

In addition to what may be called the ordinary work of the Department there were made during the year 30 reports connected with the alienation of mineral lands: some of these entailed special visits to the districts in which the land was situated; others it was possible to deal with by the information already acquired in the ordinary course of the work of the office.

There were also eight reports connected with proposals to grant subsidies under the Mining Development Act.

In bringing this report of the year's operations to a close, it affords me much pleasure to record the fact that the various members of the staff have, without exception, continued to discharge their respective duties not only with assiduity and efficiency but also with enthusiasm, and have never hesitated to extend their labours far beyond official hours whenever the exigencies of the work demanded.

I have, etc.,

A. GIBB MAITLAND,
Government Geologist.

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