

1913.  
—  
WESTERN AUSTRALIA.



---

ANNUAL  
PROGRESS REPORT

OF THE

GEOLOGICAL SURVEY,

FOR

THE YEAR 1912.

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WITH ONE MAP.

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PERTH :

BY AUTHORITY : A. CURTIS, ACTING GOVERNMENT PRINTER.

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## MAP.

Map of Western Australia showing four miles to one inch series of Geological Sketch Maps .. .. . at end

## Annual Progress Report of the Geological Survey for the Year 1912.

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Geological Survey Office,  
1st March, 1913.

The work of the Geological Survey during the calendar year 1912 was continued on much the same lines as heretofore, and may be broadly subdivided into geology in its relation to (a) Mining (b) Water Supply, and (c) Agriculture.

### THE STAFF.

The work of the Department has been carried out during the period under review by 20 officers.

As a result of the recent reclassification proposals, which have been adopted by the Government, the present organisation of the Survey comprises one Assistant Government Geologist, one Petrologist, one Assistant Geologist, three Senior and two Junior Field Geologists, one Chemist, two Assistant Chemists,

two Draftsmen, one Clerk, and one Museum Assistant; of these six are trained Engineers.

During 1912 the Survey lost through resignation the services of Mr. E. C. Saint-Smith, who accepted an appointment on the Geological Survey of Queensland.

Mr. Torrington Blatchford, who formerly acted as Assistant Government Geologist between May 1897 and June 1900, was appointed to the newly created position of Assistant Geologist on the 1st of September.

### FIELD WORK.

The field work of the year 1912 has been carried out in different portions of the State in the districts set out in the table attached.

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Table showing the Distribution of Field Work for the year 1912.

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.
North-West Division .. .. .	..	..	119	32.5	..	..	..	..	..	..	..	..	..	..
Peak Hill .. .. .	..	..	..	..	..	..	..	..	7	1.9	..	..	..	..
East Murchison .. .. .	1	0.3	..	..	..	..	..	..	200	54.6	..	..	..	..
Murchison .. .. .	136	48.1	..	..	..	..	..	..	2	0.5	..	..	..	..
Mount Margaret .. .. .	..	..	..	..	..	..	..	..	16	4.4	..	..	..	..
Broad Arrow .. .. .	..	..	..	..	..	..	125	34.1	..	..	..	..	..	..
North-East Coolgardie .. .. .	..	..	..	..	..	..	76	20.8	..	..	..	..	..	..
East Coolgardie .. .. .	..	..	5	1.4	..	..	7	1.9	..	..	283	77.3	170	46.4
Coolgardie .. .. .	..	..	..	..	31	8.4	..	..	..	..	..	..	94	25.7
Yilgarn .. .. .	..	..	71	19.4	131	35.8	..	..	..	..	..	..	..	..
Eastern Division .. .. .	..	..	..	..	..	..	..	..	28	7.7	..	..	..	..
South-Western Division .. .. .	10	3.5	6	1.6	19	5.2	9	2.5	6	1.6	..	..	19	5.2
Totals .. .. .	*147	51.9	201	54.9	181	49.4	217	59.3	259	70.7	283	77.3	283	77.3

\* Only 283 days were devoted to Geological Survey Work ; during the rest of the year Mr. Woodward acted as State Mining Engineer.

A. GIBB MITTLAND.—Administrative work has naturally taken up a large part of my own time and attention during the year.

A considerable portion thereof was of necessity occupied with the reading and revision of manuscripts, maps, proof reading and other editorial duties, in addition to the current work of the office. Some idea of the labour involved in this very essential editorial work may be gauged by the tabulated return hereunder:—

Table showing Editorial Work, 1912.

Report.	Pages.		Figs.	Maps.
	MS.	Type.		
Bulletin XLII. ..	232	198	50	2
Do. XLIII. ..	130	100	16	0
Do. XLIV. ..	118	80	18	3
Do. XLV. ..	92	61	11	2
Do. XLVI. ..	35	23	0	2
Do. XLVII. ..	135	106	34	3
Do. XLVIII. ..	220	186	53	11
Do. XLIX. ..	206	..	54	10
Do. L. ..	102	68	7	1
Annual Report, 1911	65	14	0	0
Total ..	1,335	836	243	34

Despite these duties opportunity was found for a few short visits to the field officers, for the purpose of going over some of the work which was being carried out. . . . .

I also attended, as the representative of Western Australia, the Interstate Conference on Artesian Water Supplies, which sat in Sydney, New South Wales, between the 30th of April and the 18th of May. . . . .

H. P. WOODWARD.—During January the Assistant Government Geologist visited Eradu with the object of examining in detail the area over which coal-bearing operations had been carried on.

Owing to the illness of the State Mining Engineer, Mr. Woodward temporarily discharged his duties, during the months of February, March, and the greater part of April, having for this purpose been gazetted Acting State Mining Engineer. Having fulfilled these duties, Mr. Woodward resumed his work on the Survey, spending about four months in the field in the Murchison District.

While engaged upon this field a more or less detailed survey of the two newly discovered tin mining centres of Poonah and Coodardy was made, this being followed by a flying survey of the South-Western portion of the Murchison Goldfield, including the centres of Cue, Day Dawn, Cuddingwarra, Mindoolah, Weld Range, Moyagee, The Island and Mainland, Lake Austin, Webb's Patch, Reedy's Find, Eilya, Tuckanarra, and Stake Well. A short visit was also paid to the Wilgie Mia, or Native Ochre Mine. Mr. Woodward was also instrumental in the discovery of Emeralds at Poonah. On the completion of his field work on the Murchison, Mr. Woodward, acting under Departmental instructions, visited Sandstone with the object of enquiring into the exact nature of a request for the services of a member of the staff to carry out geological work at that centre.

A brief visit was paid to Rottneest in connection with matters arising out of the boring for artesian water being carried on at that centre.

During the year 1912 the Assistant Government Geologist was in the field upon work for the Geological Survey, 147 days, exclusive of the 82 days during which he acted for the State Mining Engineer; he occupied the position of Acting Government Geologist for a period of 42 days; was on leave of absence for 31 days, while the remaining 63 days (including public holidays) were occupied in the preparation of reports and making arrangements for field work.

TORRINGTON BLATCHFORD.—A few days during the month of January were spent in the vicinity of Moora, in connection with proposals to bore for artesian water in that locality. The last week in March, the whole of the months of April, May, June, and the first half of July were spent in the Pilbara, West Pilbara, and Ashburton Districts, enquiring into the present condition of Mining, and the methods by which such could be legitimately assisted. The months of August and September were occupied in writing the report thereon, and completing one on the Coolgardie Goldfield. In October, Mr. Blatchford was instructed to proceed to Marvel Loch, Yilgarn Goldfield, and take over the field work from Mr. Saint-Smith, who was transferred to the South-West District in connection with geological investigations in regard to the lime deposits, in the interests of the Agricultural industry. While on the Yilgarn Goldfield Mr. Blatchford continued the work to the south of Marvel Loch, and completed the mapping of the geological boundaries, from the southern limits, Cheritons, as far north as the Victoria Leases. . . . .

During the year Mr. Blatchford spent 201 days in the field. . . . .

E. C. SAINT-SMITH.—This officer spent 131 days in the Yilgarn Goldfield, and, during the period engaged on the detailed mapping at Marvel Loch, he visited Weston's, Golden Valley, and Southern Cross, in connection with application for State Aid for boring, under the terms of the Mining Development Act. From the 26th of March to the 9th of April Mr. Saint-Smith was engaged in examinations of Mineral Areas at Southern Cross, Ennuin, and Marvel Loch, which it was proposed should be alienated. Four weeks during the months of May and June Mr. Saint-Smith, in conjunction with Mr. J. T. Jutson, was engaged in sampling the mines at Ora Banda, in connection with an application for a State Battery at that centre.

From the 2nd of July to the 16th of October his attention was occupied in the geological survey of the southern portion of the Yilgarn Goldfield when the work was taken over by Mr. Blatchford.

The month of November and a portion of December were devoted to the lime deposits of the South-West Division.

During the year Mr. Saint-Smith spent 181 days in the field.

J. T. JUTSON.—Up to the 6th of February this Officer was engaged upon the writing of reports, preparation of plans for field work, etc. During the period between the 6th and the 15th of February Mr. Jutson was engaged reporting on the occurrence of rutile at Yulgering. On the 19th of April he left Perth for Kanowna, and until the 23rd was engaged in making arrangements for the season's work. The three following days were spent in obtaining a general idea of the surrounding district. Up to the 6th of July Mr. Jutson's time was devoted to a detailed survey of Ora Banda and sampling certain of the mines. Between the 8th

of July and the 5th of August was devoted to investigations at Kanowna, arising out of proposals to carry out some deep boring at that centre. The recent gold discoveries at Kurnalpi occupied Mr. Jutson's time between the 6th and the 15th of August, whilst between the 28th of August and the 3rd of September this officer accompanied me in a rapid traverse through the Kanowna, Gindalbie, Mulgarrie, and Gordon Districts. The Ora Banda survey was continued with more or less interruption, up to the 5th of December, upon which date it was finally completed.

During the year Mr. Jutson was engaged in the field 217 working days.

H. W. B. TALBOT.—With the exception of six days upon which Mr. Talbot was engaged on field work in the Darling Range in connection with the geological map of the Metropolitan Area, the whole of the time up to the 7th of March was devoted to the writing of the report and the preparation of the plans of the previous season's field work.

On March 7th Mr. Talbot left Perth and until August 28th was engaged upon a flying geological survey of a portion of the East Murchison Goldfield, with but a slight interruption in April, when an examination of the Mount Keith neighbourhood was undertaken, with the object of affording information regarding the advisability of erecting a State Battery at that centre.

From the 27th of August to the 13th of September Mr. Talbot was at headquarters, on the 14th inst he left again for Wiluna and on arrival at the latter place continued the flying survey of the East Murchison Goldfield until the 1st of December.

During the year Mr. Talbot spent 259 days in the field.

F. R. FELDTMANN.—The whole of Mr. Feldtmann's time available for field work during the year was spent at Kalgoorlie. The period between the 1st of January and the 30th of April was devoted to completing the first section of the detailed geological survey of the North End of Kalgoorlie.

From the 1st of May to the 12th of June Mr. Feldtmann spent at headquarters writing his report in connection therewith; the 16 days from the 13th to the 28th of June were spent in Kalgoorlie clearing up some points which had arisen in connection with the report, which was completed on the 7th of August. The remaining portion of the year was spent in the field carrying on the second portion of the detailed survey of Kalgoorlie.

In all 283 days were spent in the field during the year.

C. S. HONMAN.—This officer's first field work during the year was between January 22nd and February 3rd, when on examination of the clay deposits between Mundijong and Swan View was undertaken.

A week towards the end of February was devoted to surveying the high-level laterites in the Darling Range. A more or less detailed survey of the Binduli area at Kalgoorlie occupied Mr. Honman's attention from the 9th of April to the 31st of July.

From the 1st of August to the 3rd of December detailed geological field work in the country between Kalgoorlie and Coolgardie, and 20 miles south of the railway line was undertaken, and a few days in November were spent in an examination of the gold discoveries on the Woodline Rush, six miles north of Bulong. Mr. Honman spent 283 days in the field during the year under review.

#### LABORATORY WORK.

The Chemical and Physical Examinations required for the investigations of the Survey, and the public assaying, the work for the State Battery Branch, etc., have as usual been carried on by Mr. E. S. Simpson and the officers working under his direction. The work for the State Battery Branch is, as has been the case in the past, carried out by an officer, whose salary becomes a charge upon the State Battery Vote, hence his position does not appear in the classified list of officers of the Geological Survey.

During the year 1912 the total number of samples dealt with in the Chemical Laboratory amount to 1911, as against 1,999 in the previous year, and as may be seen by the attached table, the bulk of the work done for "other departments" has been for the State Batteries Branch.

It is very much to be regretted that the position of Cadet set out in the reclassification proposals of the Public Service Commissioners, adopted by the Government, and the salary for which has been provided by Parliament has not even yet been filled.

The laboratory being in a separate building is a serious drawback, and a great inconvenience in addition to preventing adequate supervision of the work being carried on. It is to be hoped that steps will soon be taken to properly house the whole of the staff and collections of the Geological Survey in one building.

The attached table shows the routine work performed during the year 1912:—

	Public.		Geological Survey.	Other Departments.	Totals.
	Pay.	Free.			
Samples .. .. .	76	435	199	1,201	1,911
Assays for Gold .. .. .	68	245	77	1,163	1,553
" Silver .. .. .	3	74	4	181	262
" Copper .. .. .	2	44	9	41	96
" Tin .. .. .	..	39	7	1	47
" Lead .. .. .	1	16	..	..	17
" Arsenic .. .. .	..	1	..	5	6
" Iron .. .. .	..	4	..	5	9
" Manganese .. .. .	..	3	..	3	6
" Nickel .. .. .	..	2	..	7	9
" Sulphur .. .. .	..	1	1	17	19
" Other metals and non-metals .. .. .	5	13	6	1	25
Analyses complete .. .. .	2	2	46	2	52
" Partial .. .. .	..	4	27	26	57
" Proximate .. .. .	..	6	..	..	6
Mineral Determinations .. .. .	2	149	65	65	281
Clay tests .. .. .	..	11	..	..	11
Miscellaneous .. .. .	..	11	13	3	27
Totals .. .. .	159	1,060	454	2,721	4,394

Mr. Simpson in reporting to me on the year's operations remarks *inter alia* :—

Owing to the staff being insufficient to cope with the routine work, all research had to be abandoned early in the year. It is generally recognised that one of the most important functions of any Government Laboratory is the carrying out of researches with a view to initiating or stimulating the utilisation of the natural products of the country. It is disappointing therefore that no opportunity was found for carrying out researches previously planned with a view to aiding directly in the exploitation of the mineral wealth of the State. One such, as far as it went, resulted in the discovery of a suitable mixture of local clays for the production of vitrified pipes and other similar ware of better quality than that which was previously made here, and which was largely composed of clay imported from Victoria at considerable expense. The immediate results of this have been :—

- (1.) The establishment of a new factory in Perth for the production of such ware.
- (2.) The certain material reduction in the near future of the cost of drain-pipes and therefore of sewerage connections and reticulations, accompanied by an improvement in the quality of the pipes used.
- (3.) The exploitation of a hitherto unutilised mineral of local occurrence.

Very little time was found for working up accumulated information for publication. Except for minor reports, the only ones so prepared during the year were :—

"Radium-Uranium Ores from Wodgina." Now in the press in Bulletin 48.

"Notes on the Carbonate Minerals occurring in certain Kanowna Rocks." Published in Bulletin 47.

In addition to the above, two papers were, with the Government Geologist's permission, published outside the Department, viz. :—

"Notes on Laterite in Western Australia." (*Geological Magazine*, September, 1912.)

"The Rare Metals and their Distribution in Western Australia." (Natural History and Science Society of W.A.)

The following previously unrecorded mineral occurrences were noted during the year and are of more than passing interest :—

*Common Beryl* and *Emerald* (precious green beryl) at Poonah, Murchison District.

*Scheelite* (tungstate of calcium) at Wodgina, N.-W. Div.

*Xenotime* (phosphate of yttrium) at Nannup, S.W. Div.

*Manganocolumbite* (niobate of manganese) at Coodardie, Murchison Div.

*Aragonite* (carbonate of calcium) filling the beds of Lake Clifton, S.W. Div.

*Barytes* (sulphate of barium) constituting a lode at Tenterden, S.W. Div.

*Pyrrhotite* (sulphide of iron) forming the major component of a lode 60 feet wide at Parker's Range, Central Div.

*Siderite* (carbonate of iron) forming a second lode at Parker's Range, Cen. Div.

#### PETROLOGICAL WORK.

During the year Mr. Farquharson was fully employed in carrying on the work required by the field officers, and in addition making such other miscellaneous examinations as were required for the public.

The rocks collected by Mr. Saint-Smith in his survey of the South-West Division were fully described, and appear in Bulletin 44.

The specimens collected by Mr. Talbot during his reconnaissance of parts of the North Coolgardie and East Murchison Goldfields were thoroughly examined and a petrographical description thereof was embodied in Bulletin 45.

The material acquired by Messrs. Blatchford and Jutson during an investigation into the mining geology of the Kanowna Main Reef Line of Lode was also undertaken, and the results appear *in extenso* in Bulletin 47.

As opportunity offered during the routine work inseparable from an office of the nature of the Geological Survey, Mr. Farquharson was enabled to spend a little time in the field examining the ore-bodies and adjacent rocks at Meekatharra, Southern Cross, and other portions of the Goldfields. A short time was spent by Mr. Farquharson at Kalgoorlie, for the purpose of obtaining sufficient knowledge of the field relations of the quartz-keratophyre and doleritic and gabbroid rock types to collaborate with Mr. Feldtmann in the preparation of a report upon the North End of Kalgoorlie.

A suite of rocks from Ora Banda collected by Mr. Jutson during the course of his survey was examined, as were also those from Coolgardie and Mount Monger acquired by Mr. Blatchford from that neighbourhood.

The specimens from Binduli obtained by Mr. Honman were examined in more or less detail and the results will be embodied in a report upon that work now in preparation.

The taking and printing of the numerous microphotographs accompanying the petrographical reports appearing in the Bulletins published during the year occupied a good deal of Mr. Farquharson's time; pending proper arrangements being made for this work being done in the Geological Survey Office, the Director of Technical Education was pleased to allow the petrologist free access to the photographic equipment, etc., in the Perth Technical School. The new camera and accessories arrived from England towards the close of the year, and a micro-photographic room is now being fitted up to enable this very necessary work to be done on the premises.

During the course of the year's work 265 rock sections were cut and deposited in the Survey Collection.

Mr. Farquharson commenced his annual leave on the 16th December.

#### LIBRARY.

During the year, 768 publications have been received from cognate departments throughout the world.

111 volumes were added by purchase and 59 volumes bound.

A new system of rearrangement and classification of the library is about to be commenced as soon as other work connected with the publication of several bulletins has been finally disposed of.

The distribution of the survey publications is naturally carried out departmentally, and the total number of Bulletins, Reports, and Maps sent out during 1912 amounted to 2,216, being a considerable increase on the figures for 1911.

#### GEOLOGICAL MUSEUM.

The additions to the Survey Collection during the year 1912 amounted to 770, bringing the total registered up to 12,866. The accessions comprised 651 rocks, 115 minerals, and four fossils. 265 microsections were cut during the period under review, bringing the total up to 1,939.

The arrangement of the Survey Collection, housed in the National Museum, remains in the same state as it was last year, and no new specimens have been placed in the show collection as arranged in the gallery.



It is to be hoped that proper steps will shortly be taken as to the housing of the Survey Collection, for the present arrangement precludes the possibility of the department properly fulfilling its functions, besides being in other respects unsatisfactory.

#### PUBLICATIONS.

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

Annual Progress Report for the Year 1911.

Bulletin 43.—Petrological Contributions to the Geology of Western Australia. I.: by R. A. Farquharson.

Bulletin 45.—Geological Investigations in part of the North Coolgardie and East Murchison Goldfields: by H. W. B. Talbot.

Bulletin 46.—Part of the Yilgarn and North Coolgardie Goldfields: by H. P. Woodward.

Bulletin 47.—The Kanowna Main Reef Line of Lode: by T. Blatchford and J. T. Jutson.

Bulletin 50.—The Geology and Mineral Industry of Western Australia: by A. Gibb Maitland and A. Montgomery.

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

Bulletin 42.—Contributions to the study of the Geology and ore deposits of Kalgoorlie, Part I.: by E. S. Simpson and C. G. Gibson.

Bulletin 44.—The South-West Division of Western Australia: by E. C. Saint-Smith.

Bulletin 48.—Miscellaneous Reports, Nos. 9 to 32.

Bulletin 51.—Contributions to the study of the Geology and Ore Deposits of Kalgoorlie, Pt. II.: by R. A. Farquharson and F. R. Feldtmann.

Bulletin 52.—The Mineral Resources of the North-West: by T. Blatchford.

The following will it is hoped be shortly in the hands of the printer:—

General Index to Reports, 1870–1910.

The Geology of Ora Banda.

The Country to the South and West of Kalgoorlie:

whilst a memoir on—

The Geology and Mineral Resources of Western Australia, accompanied by a four-sheet Geological Sketch Map, on the scale of  $1/1,584,000$  is in course of active preparation.

#### GENERAL.

In addition to the ordinary work of the Department there were made during the year 39 special reports in connection with the alienation of mining lands, and 34 connected with proposals to grant subsidies under the Mining Development Act.

Several requests have been made during the year, for reports upon individual mining properties, by private persons. None of these requests have been complied with, for the reason that it is hardly within the province of the Geological staff to examine and report on individual or private mining properties except when they form part of a larger investigation embracing the district in which the mine may be situated; exceptions are of course made in those cases in which application for State Aid is made under the terms of the Mining Development Act.

Good progress has been made, in pursuance of the policy for which the staff was increased in 1911, with the mapping of the country in the mining districts, with the ultimate aim of meeting the demand

for geological information of outside and lesser known areas and thus tending to direct prospecting into legitimate channels. The attached map shows the work which has been so far accomplished. The geological sketch maps are issued on the scale of four miles to the inch, and each is numbered in accordance with the 300-chain series issued by the Department of Lands and Surveys.

#### *Principal Results of the Year's Operations.*

##### WATER SUPPLY.

##### *Interstate Conference on Artesian Water Supplies.*

1. In accordance with instructions I attended, as the representative of Western Australia, the Interstate Conference on Artesian Water Supplies, which sat in Sydney between the 30th April and the 18th of May inclusive, with a short interruption between the 3rd and 8th, when opportunity was taken to visit an important portion of the New South Wales Artesian Water Area, near the Queensland border.

2. The members attending the Conference were as follows:—

E. F. Pittman, Government Geologist and Under Secretary for Mines, New South Wales—Chairman.

J. B. Henderson, Government Hydraulic Engineer, Queensland.

L. Keith Ward, Government Geologist, South Australia.

A. Gibb Maitland, Government Geologist, Western Australia.

A. S. Kenyon, Engineer in Charge of Water Boring, Victoria.

H. H. Dare, Engineer in Charge, Water Conservation and Drainage, New South Wales; and

R. F. Jenkins, Officer in Charge, Artesian Water Bores, New South Wales.

3. On the 18th May a preliminary report upon the results of the deliberations of the Conference was signed by all the members, subsequently printed and issued to the public.

4. Amongst the more important facts elicited during the course of the deliberations of the Conference were:—

(a.) The very large portion of Australia occupied by Artesian Water Areas, and the extent to which the interest of several States are involved in regard to more than one of the known artesian basins;

(b.) The amount of work which has been officially done in this connection in Australia, and the very variable degree of precision of the investigations carried out in the different States of the Commonwealth;

(c.) The very marked and serious diminution both in the flow and pressure of those artesian wells of which periodical measurements have been made under direct Government supervision; and

(d.) The very serious corrosion of bore casings which up to the present time, however, seems confined to certain restricted, though extensive, areas of Australia.

5. The members of the Conference, after discussing fully the source, utilisation and conservation of the Artesian Water Supplies of the Commonwealth, unanimously recommend, *inter alia*, for the serious

consideration of the respective Governments of Australia :—

- (a.) A uniform system of delimiting the different Artesian Water basins of Australia ;
- (b.) A hydrographic survey, with the view of arriving, so far as is possible, at an estimate of the water annually absorbed by the respective basins ;
- (c.) Legislation to prevent an unnecessary multiplication of bores, with the object of effectively conserving for all time the underground water resources of all Australian artesian basins ;
- (d.) Uniform legislation to ensure the effective control by the States of all existing and future bores within all artesian basins ;
- (e.) No new irrigation enterprises, which depend for their supplies of water upon artesian wells, being inaugurated until certain investigations recommended by the Conference have been carried out ;
- (f.) A uniform system of casing all artesian wells ;
- (g.) Investigations into the composition and structure of the metals of which bore casings are made, and into the efficiency of coatings or linings in such casings in so far as their powers of resisting corrosion are concerned ;
- (h.) The formation of a permanent Interstate Board for the discussion, correlation and recording data in regard to the artesian basins of the Commonwealth ; and
- (i.) The cost of any special investigations recommended by the present Conference to be borne in equitable proportions by the respective States.

It may perhaps be of interest to note that this Conference virtually forms a part of that great modern scientific movement of the Conservation of Natural Resources which is slowly but surely making itself felt throughout the whole civilised world.

#### *Rottnest Island Bore.*

A deep bore in search for artesian water was put down to a depth of over 2,500 feet.

Owing to difficulties in connection with the boring plant operations were stopped, without the (Jurassic) water-bearing sandstones, which are believed to be beneath Perth, having been reached.

The strata pierced in this bore hole were of considerable geological interest and the bore cores were submitted to Mr. Etheridge, of the Australian Museum, Sydney, who reported :—

“The core pieces can be at once divided into two series, Nos. 20ft.-209ft. and 1285ft.-2185ft.

Nos. 20ft.-209ft. are clearly of very recent geological date, probably upraised Post Tertiary marine beds, a chalk-like calcareous deposit. Numbers 1285ft.-2185ft. can only be one of two things, viz., Tertiary or Late Mesozoic. Many of the core portions, comprised within these numbers (except 2021ft.-31ft.) shown on the fractured surfaces broken up shells quite impossible of determination or of significance. On numbers 1480ft.-1541ft. charred vegetable tissue is visible. The small objects on numbers 1575ft.-95ft. and numbers 1595ft.-2021ft. puzzle me very much. If they be not fragments of a Crustacean integument, I do not know what they are. Numbers 1595ft.-2021ft. are certainly portions of one of the higher Crustacea. Numbers 1595ft.-2031ft. I believe to be one of the valves of an Entomostracan. Numbers 1595ft.-2021ft. is, I think, a very elegant and small example of a *Pinna*. Of the several little objects under No. 1595ft.-2021ft. I know not what to make, unless they are small bivalve shells,

and yet they seem too delicate and thin for this to be the case. I at first took them to be an *Estheria*, but have failed to detect the characteristic sculpture of that genus.

The objects, so far as they go, are all new to me. The character of the matrix is similar to that of some of our Lower Cretaceous beds, but of course, matrix alone is not of much value. I think it will be quite safe to assume the age of the deposit to be not older than that mentioned.”

#### AGRICULTURE.

##### *Limestone Deposits of the South-West.*

An examination of the principal limestone deposits in portion of the South-West District was made in the interests of Agriculture by Mr. E. C. Saint-Smith.

This officer submitted the following preliminary report. The localities visited were—Pinjarra, Capel, Busselton, and Waroona.

At *Pinjarra* there is an apparently extensive deposit of limestone on the property of Mr. Paterson. This deposit has already been reported upon and sampled to a limited extent by Messrs. Mann, Government Analyst, and H. P. Woodward, Assistant Government Geologist. There is nothing to add to their reports other than that before any action in the direction of purchase be taken the deposit should be systematically bored and analysed. By far the greater portion of the deposit is soil-covered, and the exact delimitation of the area over which the limestone extends can only be determined by boring operations. The deposit is situated right on the railway line, about  $1\frac{1}{2}$  miles north of Pinjarra railway station.

A fairly extensive deposit of limestone also occurs in the district between “Ravenswood” and Mandurah ; the material here is also for the most part sand and soil covered.

*Capel.*—On what is known locally as the Tuart Reserve, about three miles West of Capel, there is a very extensive deposit of Coastal Limestone which outcrops to a few inches above the surface in odd places. This deposit is largely composed of shells. Where any considerable outcrop was visible the loose blocks were collected and burnt for lime with, it is stated, good results. As this deposit could be worked without the initial cost of purchase, being on a Government Reserve, and also appears to be of fairly pure composition in parts, it should, in my opinion, be bored and accurately mapped.

*Busselton.*—Around Busselton are several deposits of coastal limestone which find their greatest development in the Yallingup district and Southwards thereof, but in view of the more conveniently situated deposits at Capel, Pinjarra, etc., I am not of opinion that much attention need be paid to these Southerly situated occurrences for the present, seeing that similar material more centrally situated is to be found all along the coastline between Busselton and Perth.

*Lake Clifton, Waroona.*—Lake Clifton is situated about 14 miles West of Waroona, and about three miles from the ocean. It is approximately 10 miles in length and half a mile in average width.

At the time of my examination in December, the water was only slightly brackish, but I am informed that by the end of summer it is noticeably more saline though not nearly so salt as the ocean water. In winter the water is practically fresh.

The lime occurs in the form of a very loose white material forming the bed and shores of the lake. Trials of the depth of the deposit were made by me with a pole across the centre of the lake at frequent intervals, from which it is certain that a minimum average depth of 13ft. 6in. of the material

is present. The lime is for the most part quite impalpable and has been produced by an accumulation of tiny gasteroped shells, exfoliated shells, shell fragments, and chemically precipitated lime, the last mentioned substance forming apparently the bulk of the deposit. Associated with this material are numerous diatoms.

Partly surrounding the lake, more especially along its Western side are ridges of Coastal Limestone, the material from which finds its way into the lake during the heavy winter rains; as the summer approaches the lake shrinks considerably in volume, with the result that the water becomes supersaturated with lime and chemical deposition takes place.

Judging from a cursory examination of the shores of the lake, I have little doubt but that an extension of the deposit will be found to occur to the West of the lake on the Government reserve.

Where resistance to the further passage of the pole through the lime was met, an examination of the bottom surface of the pole indicated the existence of a thin deposit of guano beneath the loose lime.

Mr. Claude Newnham of the Boulder Farm, Waroona, has a lease (No. 411/41A) of about 700 acres of the central portion of the lake bed, but the deposit certainly extends far beyond his lease boundaries. The existence of the lime here had apparently not been detected previously to Mr. Newnham's discovery, and some credit is due to that gentleman for the persistence with which he sought for suitable lime deposits in his district for agricultural purposes; the actual fact that the water-covered bed of the lake was one immense deposit of lime might easily have escaped the notice of a geologist.

A strong smell somewhat resembling that of phosphoretted hydrogen is given off when the lime is disturbed below the surface.

Especially along the Eastern shore small circular patches of fairly compact lime are forming as the result of the growth of colonies of small organisms, but the deposit appears to be entirely superficial.

Owing to the receding of the water of the lake in the summer months, the lime forming edges of the lake becomes dried and is inclined to form small soft lumps, but this feature disappears with the return of the winter months.

A carefully averaged sample of the centre of the lake was secured by me from a depth of one foot below the surface of the deposit; this sample has been reported upon by Mr. Simpson, Chemist and Assayer, in the following terms:—

The material submitted was a fresh marl composed mainly of carbonate of lime precipitated partly by organic and partly by inorganic chemical agencies in a very finely divided state. An analysis on a sample dried at 100°C showed the presence of:—

	Per cent.
Lime, CaO .. ..	48.88
Carbon dioxide, CO <sub>2</sub> .. ..	37.07
Organic matter (including Nitrogen, 8.93 0.32 per cent.)	
Silica, SiO <sub>2</sub> .. ..	1.61
Magnesia, MgO .. ..	1.01
Iron oxide and Alumina .. ..	.24
Sulphur trioxide, SO <sub>3</sub> .. ..	.39
Phosphoric oxide, P <sub>2</sub> O <sub>5</sub> .. ..	.09
Salt, NaCl .. ..	2.02
	<hr/> 100.24

Approximately 47 per cent of the lime is present as carbonate (84 % CaCO<sub>3</sub>), the small remainder being present in combination as sulphate and as a salt of one or more organic acids.

The variety of carbonate of lime in the sample is not calcite, which is that found in almost all limestones, but aragonite. This is of importance in connection with the utilisation of this material as a fertiliser since aragonite is known to be more susceptible to the attack of rain water and ground water than calcite. The minute size of the particles of aragonite will ensure a maximum activity in the soil.

A considerable percentage of nitrogenous organic matter is present, the value of which as a fertilising agent must not be overlooked.

The silica shown by analysis exists almost entirely in the form of siliceous skeletons of diatoms and fresh water sponges.

The proportion of salt in the marl will naturally vary with the season, being dependent entirely on the quantity and degree of concentration of the water associated with the deposit. It will be least during the rainy season, and highest at the end of summer.

A considerable deposit of somewhat similar material occurs in Martin Tank, Salt Lake, and a group of small salt lakes near by, but owing to the heavy amount of saline matter present I do not consider that much attention need be directed to these occurrences in view of the more accessible deposit in Lake Clifton itself. In view of the possible deterioration of the lime by the deposition of salt at the end of the summer, I would suggest that the material be raised during the early part of the season in order that the extra supply of water may be present in the lake; at this portion of the year the salt present would be in solution and would therefore be practically absent from the lime itself.

At the present time this deposit is, of course, too far removed from a railway for cheap transport, but in the event of the construction of the suggested Pinjarrah to Brunswick Junction loop line it would only be about 1½ miles from the latter, to which it could be easily connected by a spur line.

The working of the deposit presents no difficulties whatever as the material could be cheaply taken out either by a dredge or by means of a sand pump or other similar appliance; staging would need to be erected on which the material could be dried before being removed.

Taking into consideration the fact that there are many millions of tons of lime cheaply available and in an excellent physical condition for direct application, there is no doubt but that in Lake Clifton the State has a remarkably fine asset which will very materially assist in the utilisation of the extensive swamp and other lands in the South-West and elsewhere. In my opinion the material forming the lake bed is all of a very similar composition to that of the sample referred to previously, but careful systematic sampling of the deposit is recommended before any serious attempt is made to exploit the deposit.

#### MINING, ETC.

##### *The Country North of Lake Way.*

The principal results of Mr. Talbot's field work in the country to the North of Lake Way are set out in the preliminary report which he has prepared and which is given *in extenso*:—

The following is a short description of the country examined during the past season.

In addition to the Wiluna greenstone area,\* the boundaries of which were mapped to its southern limits and northwards as far as the Gascoyne River, three greenstone areas have been placed upon the maps with some degree of accuracy. The most westerly of these † lies about 20 miles to the S.-W. of Wiluna. Its southern point reaches the Wiluna-Nannine road at the Bore well, at its northern end it disappears under the sedimentary series which extends westwards from the Finlayson Range and, in all probability, it is only a branch

\* Lands Department Lithos. 53/300, 60/300 and 71/300.

† Lands Department Litho. 60/300.



from the main Wiluna belt, which lies a few miles to the eastwards. The point at which it bifurcates cannot, however, be seen owing to the covering of sedimentary rocks.

The Wiluna greenstone area\* commences a few miles to the S.E. of Mt. Keith. It runs N.N. Westerly in a narrow zone through Kingston to near the "Quartz Blow" on the Lawlers-Wiluna Road. There the Western boundary swings round to the W.N.W. to Diorite Well on the Wiluna-Nannine Road. It then turns northwards again and is seen at intervals underlying the sedimentary series, as far as Thadunganna Pool on the Gascoyne River. This is not the northern limit of the belt as greenstone hills were visible to the North of the pool. There is a marked change in the type of rock in this belt to the Northwards of Wiluna. At Wiluna and to the Southwards of that place large areas are occupied by indurated schists traversed by acid and basic dykes and there are numerous quartz reefs and also a large number of bands of ironstone which coincide with the general strike of the country, and I am of opinion that many of these ironstone outcrops are the capping of lodes some of which may prove to be auriferous. To the Northwards of Wiluna the rock is all of the massive type and there are but few quartz reefs and those seen appeared to be of a particularly hungry character.

What may be called the Barlows belt† lies about thirty miles to the East of Wiluna. At Barlows it is only about five miles in width but from here the Western boundary turns to the West North-West to the May Queen Leases from which point it turns to the North-West and the belt finally pinches out about fifty miles to the North West of Barlows. This belt runs in a narrow zone South Eastwards from Barlow's to a point about five miles South of Maitland Peak (or Mt. Joe as it is known locally). Here it widens out considerably to the Westward but turns back on its original course again at Beats Well on the Sir Samuel-Barlow's Road. Southwards from this point the belt is about 12 miles in width and it extends Southwards beyond the limits of my travels in that direction.

Mining has been carried on in three localities on this area.

1. In the vicinity of Collavilla.
2. Around Barlow's, and
3. At Bronzewing.

All the leases have, however, been abandoned.‡ None of the old workings were accessible, but from what I could gather from a surface examination I formed the opinion that few of the reefs worked were of any width, and a want of linear continuity appeared to be characteristic of all of them.

Throughout this belt there are a large number of bands of ferruginous quartz-schists and these all conform to the general strike of the country, viz., a little to the West of North.

The Northern point of the most Easterly belt§ lies a little to the West of Long. 121deg. 30min. in Lat. 26deg 24min. S. This area runs in a general Southerly direction past the Stirling Peaks and Mt. Carnegie to beyond the Eristoun Creek. Its Southern limit was not reached by me. A little prospecting work has been done in the vicinity of Mt. Eureka, but none of the country seen gave much promise of becoming important from a mining point of view.

The country between these greenstone belts is occupied by granite of which there are several types. These will be fully described in the detailed report to be written later.

The most interesting geological feature seen during the season's field work was the large area of sedimentary rocks occurring in the vicinity of Charles Wells Creek and Lake Carnegie|| these consist of sandstones, shales and limestones. This sedimentary formation, on its Western and Southern edges rests upon granite and outliers of this latter rock are seen in places in the Princess Range. At the Northern boundary of the sedimentary area the beds are seen resting unconformably upon the upturned edges of the belt of metamorphic slates which were fully described in Bulletin 39§. The basal beds consist of soft fine-grained sandstones overlain by grey and blue shales as the belt is followed Eastward thin bands of limestone, about an inch in thickness, are seen interbedded between the shales. A series of excellent sections of these shales and limestones were seen in a traverse made down Charles Wells Creek. As the Creek is followed eastward the limestone beds become thicker and more numerous and near the crossing of the Wongawall track a bed of limestone about five feet thick was seen. The shales and limestones are overlain by coarse flaggy sandstones and

quartzites. These latter form isolated hills and rough broken ranges and the quartzites are invariably found on the tops of these. These are of no great thickness and represent sandstones indurated by the deposition of secondary silica drawn to the surface by capillarity. This surface induration is quite common throughout the interior of the State, in fact it is only rocks seen in cliff sections that are not more or less indurated. The amount and direction of the dip in the beds forming the sedimentary series described above varies in different localities. In some places they are almost horizontal and the greatest angle at which the beds are inclined is about twenty degrees. This latter dip, however, is seen only in the vicinity of faults or local folds of which a few were seen. The mean dip of the beds is about 5deg. and the prevailing direction is to the North-East.

These sedimentary rocks extend far beyond the limits of my travels to the Eastward, and it would be of interest to have their extension in that direction mapped as there may be a possibility of artesian water being found near the centre of the area. This, however, would not be of much value as the area described is watered by numerous large water holes and springs, and water of good quality can be obtained at a shallow depth by sinking.

The area mapped during the season's field work embraces portions of the Lands Department Lithos. Nos. 52/300, 53/300, 60/300, 61/300, and 71/300.

A series of the limestones were submitted to Mr. Etheridge, of the Australian Museum, and in one of them [12505] from a locality seven miles South of Wongawall, on the East Murchison Goldfield, this gentleman recognised "in the less dense portion there is certainly a queer half obliterated polygonal structure which to my eye, may be the remains of a coral, such as a minute *Favosites*, but it is altogether too problematical to speak definitely."

#### *The Northern Portion of the Kalgoorlie Goldfield.*

Mr. Feldtmann mapped in detail an area at the extreme Northern end of the productive portion of Kalgoorlie, so far as at present understood.

In the course of this work some important data have been brought to light, as set out in the digest, which Mr. Feldtmann has prepared:—

From the beginning of the year until the 30th April I was engaged in completing the field work for the first section of this work, which included roughly that portion of the field which lies to the North of the Kanowna railway line and East of the Menzies line, embracing about one square mile, taking in the Golden Zone, Mystery, and Kapai lines of lode.

Surface features including shafts were surveyed by means of the tacheometer, which appears to be an ideal instrument for work of this nature, and were mapped on a scale of 100 feet to the inch. A careful examination was made of such underground workings as were accessible and where no mine plans were available these were drawn on a scale of 50 feet to the inch.

Outcrops within the area mapped being chiefly conspicuous by their absence, accurate mapping of geological boundaries was a matter of some difficulty and for this I had to rely mainly on the underground work.

*General Geology.*—The results of the detailed examination showed the area to consist for the most part of rocks of gabbroid or doleritic origin, now largely represented by amphibolite, which forms the country rock of the Golden Zone line of lode. On the Western side the amphibolite is generally of fairly coarse grain, carrying a large proportion of felspar. There is also a considerable extent of rock forming the country of the Mystery and Kapai lines of lode composed chiefly of talc and chlorite, possibly representing a more highly altered portion of the amphibolite.

Of later origin than the amphibolitic rock is a pale grey or pinkish rock consisting largely of albite felspar which occurs for the most part in dyke-like masses. This rock has been classified as a quartz-keratophyre; it intrudes the previously mentioned rocks and would appear to be closely connected with some of the ore bodies, particularly along the Mystery line of lode.

Lateritic deposits are common within this area, several being of considerable thickness and containing a high percentage of iron.

The lower lying country is for the most part covered by soil of no great depth.

*Ore deposits.*—The line of lode which runs through the New Reefers, Golden Zone, and Napoleon Leases, is of different character to the formation of the central and eastern portions of the map. It is composed chiefly of silica, which has metasomatically replaced the country rock along a line of shearing. It averages from two to four feet in width.

\* Lands Department Lithos., 52/300, 61/300 and 71/300.

† Lands Department Lithos., 52/300 and 61/300.

‡ The existing leases at Collavilla are on the granite area to the West of the main greenstone belt.

|| Lands Department Lithos., 61/300.

§ Geological Survey Bulletin No. 39, Perth: By Authority, 1910.



The main formation which runs through the Mystery and adjoining leases consists chiefly, in the oxidised zone, of kaolinic material, and is of considerable width; it contains numerous veins and stringers of quartz, striking across the lode, which generally carry values. There is also a series of flat tourmaline-bearing quartz veins which as a whole, are non-auriferous. Stringers and lenses of ironstone are common in the oxidised zone. It is possible that much of the gold in the upper levels is of secondary origin.

The Kapaï or eastern line of lode is closely associated with one of those haematite-quartz rocks generally known as "jasper bars" which are so common on these goldfields.

But little gold is found in the haematite-quartz rock itself, the best values being obtained from cross leaders of quartz running roughly at right angles to the "jasper," and also in kaolinic material on the walls of the latter generally on the Western side.

As in the case with the Mystery line of lode, the Kapaï line appears to owe much of its gold contents in the oxidised zone to secondary concentration, and neither appear to present the same possibilities at depth as the Western line.

The fieldwork in connection with the second section of the work was commenced on the 8th August. This section will complete the detailed examination of the North End of the field. Since the above date, my attention has been mainly devoted to the mapping of surface features generally.

This portion of the work was completed early in December, and the examination of the underground workings was then commenced.

#### *The Country between Kalgoorlie and Coolgardie.*

With the object of linking up mining centres, Mr. Honman mapped, in a more or less broad way, an area between these two centres, and brought several important facts to light. This officer summarises his work in the preliminary report which is as follows:—

A—Binduli mapped in detail, comprises an area of 16 square miles, extending two miles north of Binduli Railway Station, and three miles south of the same, and in an easterly and westerly direction from the Kurrawang conglomerate ridge, to within four miles of Kalgoorlie. Mr. C. G. Gibson, a former officer of the Survey, has already mapped the area in a broad way, and his classification of the rock areas is entirely confirmed by the detail work done last year. Mr. Gibson divided the rocks into two groups, viz.:—Porphyries and Sedimentaries. The Sedimentary Rocks occupy a considerable area of the country under review, about eight square miles. The topographical features compose a conglomerate ridge bearing 340° and running across the Coolgardie road at 16 miles 30 chains from Coolgardie, also a ridge of massive porphyry and schists bearing 325° to 330° crossing the railway line near the Binduli Railway Station. The general slope of the country is to the South where it terminates in breakaways and salt lakes. Two miles north of the Railway Station the country attains its highest elevation, and is very sandy; it falls very gradually northwards for many miles, and culminates in salt lake country; it consists of sand covered with mallee and spinifex.

The office work is not as yet far enough advanced for the formation of any final conclusions as regards the geological structure and history of the area, but the following features are brought out by the field work:—

The strike of the bedding planes does not necessarily coincide with the strike of the schistosity or cleavage.

The presence of conglomerate schists and slates in the porphyry area. The slates are apparently interbedded with the schistose porphyry.

The sedimentaries outside and west of the porphyritic area have a consistent dip to the west at a high angle, which becomes more pronounced in a westerly direction.

The conglomerate formation is persistent right across the area and the conglomerate series is at least half a mile thick.

There are two systems of fissuring in which quartz veins have formed:—

- (a.) Vertical coinciding with shear and cleavage planes caused by pressure at right angles to the strike of the cleavage.
- (b.) Flat, though with a slight southerly; the fissures are small and discontinuous.

The quartz veins occur both in the schists and the massive porphyry. In both they have been found to carry gold which from report averages about 10dwts. to the ton, but the veins are small and the porphyry is too hard to enable them to be worked profitably.

B.—*An area between Coolgardie and Kalgoorlie.*—This comprises 350 square miles and has been mapped broadly with the object of bringing out the structural relations of the different rocks.

The topographical features are controlled by the geological formations. The greenstone areas which occupy about 100 square miles are characterised by hilly country composed of long rugged hills with their longer axes coinciding with the dominant strike of the rocks which varies from 300 deg. to 340 deg. The granite and porphyry areas compose prominent rises characterised by flat-topped bosses of granite and porphyry. The sedimentary rocks with the exception of the conglomerate and quartzite occupy the depressions and flanks of the ridges. The conglomerates north of the lake which stretches from near Boulder towards Coolgardie form two well defined parallel ridges which are two miles apart and represent the eastern and western legs of the huge syncline. These encroach on the lake country which extends for about 14 miles in a south-westerly direction from M.H.L. 47E to within 7 miles of Coolgardie. This lake is separated from Hannans Lake by a prominent greenstone ridge and it is three miles wide in places. The northern margin of the lake is bounded by breakaways which in places exhibit excellent geological sections, while the southern edge is composed of sandhills and a white powdery deposit locally known as "Copi." The area comprises four main groups of rocks:—Sedimentary, Greenstone, Porphyry, and Granite.

No opportunity has yet occurred of definitely working out the relative ages of the respective rock groups, but when the necessary office work is more advanced the facts observed in the field can be properly studied and correlated. At the present stage the following statements can be provisionally made:—

An important syncline exists between Coolgardie and Kalgoorlie about 8 miles wide, the axis of which is very close to the Kurrawang Railway Station. The syncline has a strike of 340 deg. and if anything pitches very slightly to the North. The presence of this syncline suggests that the country is composed of big folds whose bedding planes have been destroyed by great lateral pressures producing schistosity and cleavage.

The Binduli porphyries persist with an almost uniform width for 24 miles passing through Wongi and are associated with sedimentary beds.

The conglomerates can be followed for over 15 miles along their strike.

Where the porphyries abut the greenstone rocks to the east they contain large phenocrysts of orthoclase which weather out in perfect crystals up to 1½ inches long.

Greenstone bands occur in the sedimentary rocks close to Mungari Railway Station, which make into a larger greenstone formation to the South striking 340 deg. and becoming wider while connecting with the greenstone area of which Mt. Herbert and Mt. Marion form prominent hills in the Hampton Lands and Railway Syndicate's Location 53.

Granite is intrusive into the sedimentary series and has transmuted those in close proximity into micaceous and chistolite schists. This has given the Coolgardie rocks a strike bearing more to the west of north than the main sedimentary area. It is probably to this intrusion that the highly metamorphosed state of the sedimentary rocks and the great abundance of tourmaline in the whole area is primarily due.

A greenstone area occurs at the western end of Location 53 and is probably continuous with that at Coolgardie.

A study of the conglomerates in the field shows conclusively that the bedding of the rocks is independent of the schistosity or cleavage, the elongation of the pebbles corresponding with the latter.

The whole area is intensely metamorphosed resulting from lateral pressure exerted in an easterly and westerly direction, and accentuated, if not actually caused, by the granite intrusions at the 8-Mile on the Coolgardie Road and at the Water Reserve 2956 in Location 53.

#### *Petrological Work.*

A brief synopsis of the results of the Petrologist's work during the year is given in his own words below:—

Most of the results of the year's work in detail either are now in the press or have already been issued in Bulletin form. Little more, therefore, is called for in these pages than a brief statement of the broad facts elicited in the examination of the rocks from the various districts. The more important localities from which specimens have been collected during the year are as follows:—

- The North Coolgardie and East Murchison Goldfields.
- The Kanowna Main Reef Line.
- The North End Kalgoorlie Field.

Ora Banda.  
Coolgardie, Mount Monger, and Gibraltar.  
Marble Bar.  
The Binduli and Kalgoorlie Area of Mr. Honman.  
Southern Cross.  
The Oroya Black Range Gold Mine.

*North Coolgardie and East Murchison Fields.*—The majority of the rocks from this district, as described in Bulletin 45, are epidiorites or amphibolites of which, while some bear no trace of original structure, others indicate clearly from the presence of ophitic structure, an igneous origin from doleritic or gabbroid rocks. Since the absence of definite structure in some hornblende rocks is common in areas that have undergone strong dynamic metamorphism, it is probable that all described are of igneous origin.

For economic reasons, these outcrops deserve careful prospecting, for consideration of many other fields in the State has shown that auriferous formations occur both as quartz reefs in amphibolite or more altered rock and as lodes in the altered zones near the contact of the greenstones with, commonly, the granite.

There occur also a somewhat sugary quartzite, a ferruginous quartzite without banding and a mica schist. To these, though the elastic structures have not been certainly identified and the field evidence of the relationships of the rocks is necessarily small, it is probable that a sedimentary origin is to be assigned. A serpentine with silvery biotite has also been described from the district (see Bull. 45).

*Kanowna Main Reef Line.*—As will be seen by reference to Bulletin 47 already published, the rocks of this area are of several kinds:—(a.) Greenstones that have all been more or less completely altered chemically and probable dynamically with the production of talc, chlorite, sericite, magnetite, quartz, and ferrous and other carbonates. In most cases the alteration has proceeded to such a degree that all traces of original structures have been obliterated. The secondary minerals, however, which usually include talc, chlorite, ferrous carbonate, some iron ores and brown-yellow rutile suggest an origin from basic igneous rocks.

The green fuchsite-magnetite-quartz rock that I have already described from Meekatharra is well developed in the area, but, as before, there is not sufficient evidence to enable any definite pronouncement to be made as to its origin. It is noteworthy, however, that recently at Meekatharra in the Ingliston Extended Mine a white quartz reef is being worked at a profit in this rock.

(b.) The dyke rocks.—These include quartz-porphyrates of slightly differing varieties and an albite-porphyrate. Of the former some are fresh, others to a greater or less extent carbonated, and in some cases so altered as to possess but few original structural characters. Evidence of earth-movements over the area subsequent to the consolidation of the rocks is afforded by striated and slickensided surfaces on the specimens, by undulose extinction and cracks in individual crystals. Especially worthy of mention are two specimens with xenolithic enclosures; both are more or less normal quartz-porphyrates, one with an enclosure of a green chromiferous schist-illustrated in Bulletin 47, page 40—the other with small patches of greenish chloritic material which proves to be closely similar in structure and composition to the albite porphyrite that occurs in the field. There is another specimen with soft greenish spots, the origin of which is fully discussed in the text of the Bulletin.

The albite-porphyrate has been described from this field for the first time.

(c.) There are a number of rocks not classified on account of the impossibility of obtaining even relict structures. Further information with regard to these will be found in Bulletin 47.

*North-East Kalgoorlie.*—The importance of the survey of this area, lies in the fact that there is being gained in a less altered portion of the Kalgoorlie field information that must be of great value when the more chemically and mineralogically altered portions come to be considered. As shown in Bulletin 51, the main points which have emerged from an investigation of this area are these:—

The earliest rocks, and those that form the greater portion of the area, are greenstones, which comprise masses of doleritic or gabbroid type, others of amphibolite without doubt derived by extreme dynamic metamorphic action either from the former or from similar rocks, and talc-chlorite rocks which probably represent the extreme phase of chemical and dynamic alteration both of the dolerite and of the amphibolite. The movements which contributed to the production of the hornblende of the amphibolite from the augite of the dolerites or gabbros not only produced a shearing in the rocks themselves, but developed actual fissures in the rock masses in two series at right angles. Along several lines, moreover, the shearing and crushing stresses were probably greater than along others, with the result that distinct lines of weakness were produced in the rocks.

At a later date, along these lines and various fissures in the mass, there were intrusions of a highly acid dyke rock rich in soda and with frequent hornblende phenocrysts—on albite-porphyrate or quartz-keratophyre. A peculiar feature of the latter is that it possesses in places distinct xenolithic enclosures of chloritic schists, between which and the enclosing rock there does not appear to have been any sensible assimilative action.

Accompanying the acid intrusive were boracic vapours which not only caused the production of tourmaline in the keratophyre and in the quartz leaders, but which in association with other gasses exerted a pneumatolytic action on the surrounding rocks.

There is evidence of distinct secondary enrichment in the lodes, a feature which, however, Mr. Feldtmann has enlarged upon in the Bulletin on the area.

*Ora Banda.*—From such an examination has as already been made of the rocks from this locality, the main types prove to be:—Serpentine, a fresh hypersthene-gabbro or norite, hornblende, amphibolised dolerite, zoisitised dolerite or gabbro and the so-called "native cat" rock. This latter has a green, rather fine-grained base with irregular yellowish white patches composed of granular epidote, zoisite, and some clear albite. The rock has a porphyritic appearance and has been put down as a saussuritised gabbro. That there is a true porphyritic facies, however, I discovered recently when examining a dump on the mine. There I obtained specimens, the counterparts of which had not been forwarded by the Field Geologist. These showed large dark-coloured fairly fresh idiomorphic feldspars in a ground-mass of epidote, calcite, chlorite, etc. In most cases the feldspars were in process of decomposition to epidote and other minerals. The rock may, therefore, be put down as a saussuritised gabbro-porphyrate. The amphibolised dolerite is identical with that from the North End Kalgoorlie.

Some secondary silicification appears to have taken place in the area, for specimens have been obtained of brown quartz and chalcedonic silica enclosing greenish chromiferous chlorite.

*Marble Bar.*—These specimens consisted chiefly of serpentine and opal serpentine.

*Coolgardie, Mount Monger, and Gibraltar.*—A large number of rocks were collected from these localities. The specimens include amphibolite, garnet, and biotite-amphibolite, hornblende-schist, hornblende, epidiorite gabbro, norite, hornblende gneisses, granite, aplite and pegmatite, quartz-porphyrates and porphyrites, mica gneiss, graphitic schist, sericite schist and banded ferruginous schist.

The amphibolitic varieties are essentially similar to those that have been described in the Bulletin on Southern Cross. The granites vary from the normal yellowish-grey type, through hornblende granite to gneissose hornblende-granite, and in the normal type veins of aplite and pegmatitic modifications appear to be not uncommon. The gabbroid or doleritic rocks include a saussuritised amphibole micropegmatitic quartz dolerite, a saussuritised quartz gabbro and an ophitic quartz dolerite, some specimens being identical again with the amphibolised quartz dolerite from the North End Kalgoorlie and other places.

A fresh norite occurs in dykes, exactly similar to that described from Cue, from Ora Banda, and from other localities in the State. The porphyritic rocks comprise quartz-porphyrates of several varieties, and some specimens of more basic composition with silica slightly under and slightly over 60 per cent., which have been put down as quartz-porphyrates.

One porphyry specimen is closely akin to Spurr's alaskite, described from the Yukon district in Alaska, and, as in many places, this alaskite is gold-bearing, being one of the final stages in the development of gold-quartz veins from granitic rocks, it may repay the attention of prospectors.

There are some examples of schistose or foliated rocks—discussed in the Bulletin on the district—which may possibly be of sedimentary origin derived by consolidation and foliation from arkoses, siliceous sediments, and basic detrital material.

*Binduli, etc.*—The collection so far examined from Binduli and the vicinity, consists mostly of the following groups of rocks:—(a) acid porphyries generally pinkish in colour, and varying from felsites with feldspar phenocrysts to rocks which agree in character with granite porphyries; (b) basic rocks of doleritic type; (c) a peculiar group of highly schistose green rocks, mostly altered to a considerable extent. In certain cases—of the more highly schistose and altered varieties—these latter specimens are practically indistinguishable from altered sheared porphyrites, but in one specimen, the characters are entirely consistent with the origin from a quartzose-feldspathic-chloritic sediment that has been very considerably sheared. The feldspar shapes are mostly angular, the quartz crystals are partly angular and partly rounded, frequently cracked. When account is taken of the fact that Mr. Honman has proved the presence in the

area of large developments of conglomeratic beds, of contact altered sediments now represented by chialtolite schists, mica schists, etc., there is no room for doubt that this specimen is a much sheared arkose or fine-grained chloritic conglomerate. It is highly probable, also, that the other very similar green schists are but more severely altered phases of the same rock.

One important feature of the felsitic pink porphyry of group (a) is the fact that there occurs a sheared sericitised modification of it, in many respects almost identical with the so-called "fish rock" of the Golden Mile. It will be remembered that Card, in a careful study of some of the Kalgoorlie specimens, came to the conclusion that one of the original rocks of the field was an acid intrusive, and I am at present strongly of the opinion that this pinkish porphyry with few quartz phenocrysts is the rock which, passing through the sheared sericitised phase in which original structure is fairly plain, appears as the sericite-quartz-carbonate rock of the Golden Mile.

*Southern Cross.*—The oldest series of rocks in this field appear to be hornblende schists, etc., and the sedimentary rocks near Hope's Hill. Whether the latter are younger or older than the former, there is at present no means of discovering, but there is a presumption in favour of the younger age.

Before the movements took place, which affected the greenstones, there was an acid intrusion into the latter represented now by small foliated quartz porphyry dykes. Then came a large batholithic intrusion of granite which probably caused the contact metamorphism of some sediments with the production of garnetiferous phyllite and mica schist. Great movement then seems to have taken place in the

greenstone area and the effect of it extended some distance into the granite mass. Apophyses of the granite penetrated the greenstones with the production of pegmatite dykes, and granitic quartz reefs. The granite is the normal yellowish-gray biotite microcline granite, seemingly similar to the old Granite of South Africa. There is indubitable evidence that most, if not all the greenstones are but modifications by pressure and heat of rocks of doleritic and gabbroid origin, and though St. Smith makes two series of greenstones, the the Older and the Newer, the latter may be merely a zone of the older series that has been less strongly affected by dynamic action. An origin of one or two of the specimens of the older series from volcanic ashes is at least possible.

The auriferous reefs are found mostly in the schistose or older greenstones, the pegmatitic and quartzose apophyses of the granite being non-auriferous. The area is dealt with fully in Bulletin 49.

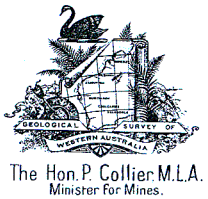
*Oroya Black Range.*—The examination from specimens from this district has been worthy of note owing to the proof obtained of the existence of a doleritic basalt with andesitic and glassy phases at Sandstone, identical with that in the Great Fingall Mine at Day Down. The rock occurs in each case as a dyke, and is probably the youngest rock in the field, being younger even than the lode formation.

I have, etc.,



Government Geologist.





The Hon. P. Collier M.L.A.  
Minister for Mines

# MAP OF WESTERN AUSTRALIA

Showing  
4 Mile to 1 Inch Series of Geological Sketch Maps.

Annual Report 1912.

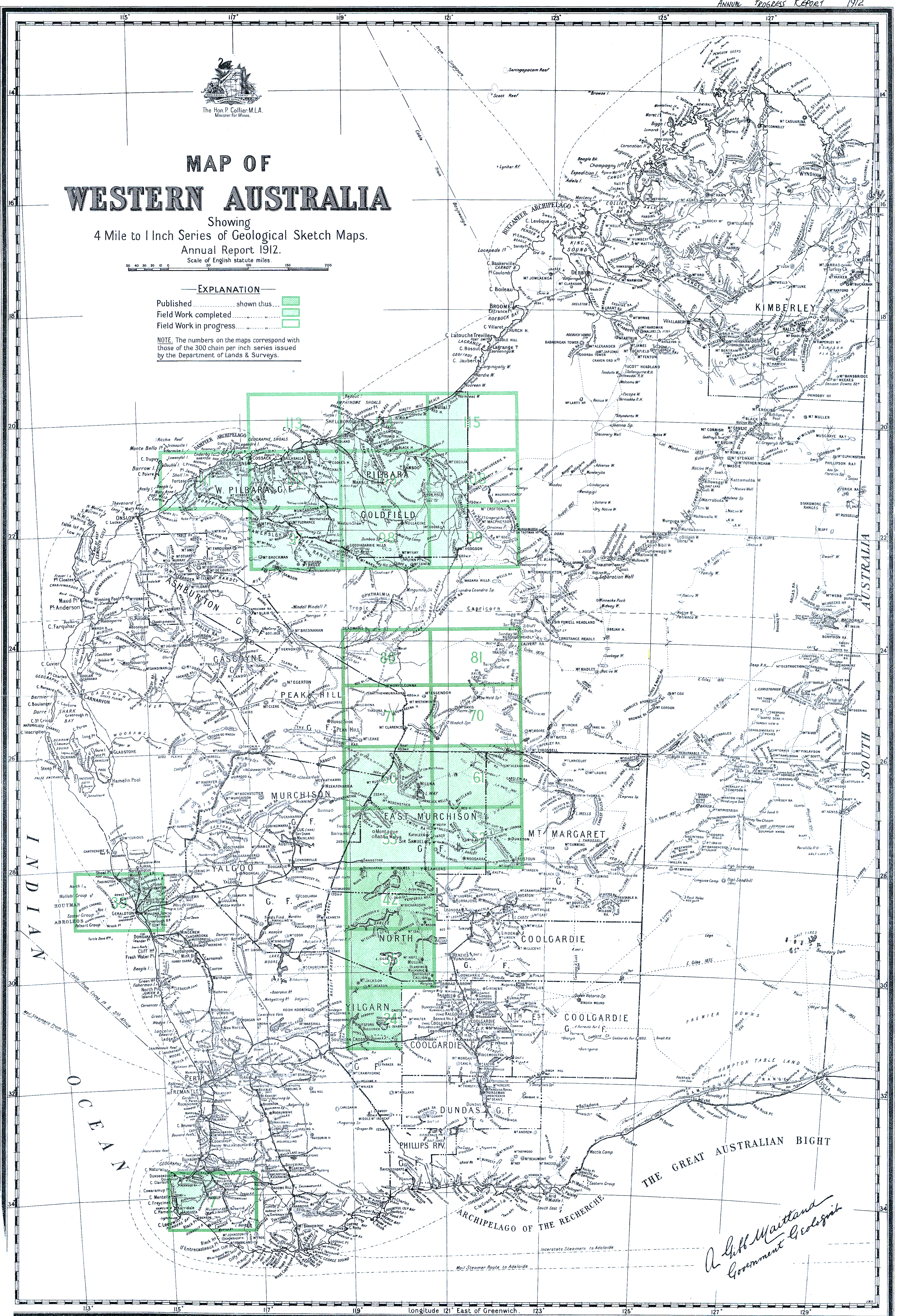
Scale of English statute miles.

50 40 30 20 10 0 50 100 150 200

## EXPLANATION

Published ..... shown thus .....  
Field Work completed .....  
Field Work in progress .....

NOTE. The numbers on the maps correspond with those of the 300 chain per inch series issued by the Department of Lands & Surveys.



*A. Giff Maitland*  
Government Geologist



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